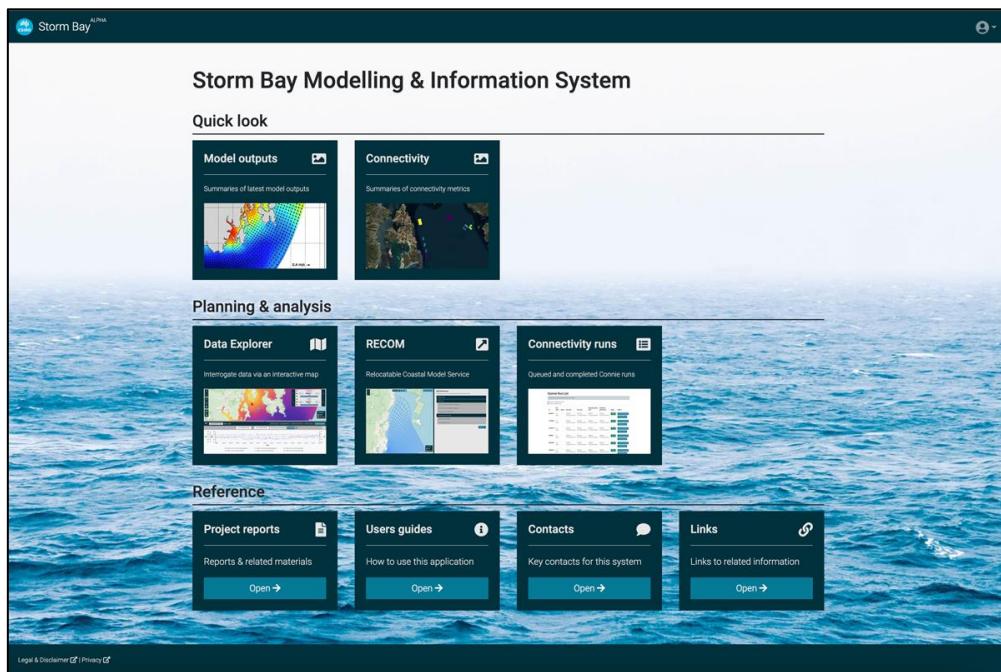


APPENDICES PART 1

Storm Bay Biogeochemical Modelling and Information System

Supporting sustainable aquaculture in Tasmania.



Karen Wild-Allen, John Andrewartha, Mark Baird, Jack Beardsley, Elizabeth Brewer, Lev Bodrossy, Ruth Eriksen, Rob Gregor, David Griffin, Mike Herzfeld, David Hughes, Pete Jansen, Clothilde Langlais, Nugzar Margvelashvili, Andrew Martini, Merinda McMahon, Andrew Revill, Farhan Rizwi, Jenny Skerratt, Cassie Schwanger, Kendall Sherrin, Sascha Fryzman, Dan Wild.

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10 Appendices

- A.4 Storm Bay biogeochemical model parameters
- A.5 Biogeochemical model vs glider data including statistics
- A.6 Biogeochemical model vs monitoring data including statistics

A.4 Storm Bay biogeochemical model parameters

Model parameter values for the biogeochemical model run TASSE73K. This simulation used hydrodynamic transport model forcing from the hydrodynamic model v1.2 and the calibrated sediment model.

Parameter description	Symbol	Value	Units
Phytoplankton			
Chl-specific scattering coefficient. for microalgae	bphy	0.2	m^{-1} ($\text{mg Chl a m}^{-3}\right)^{-1}$
Natural (linear) mortality rate, large phytoplankton in water column	PhyL_mL	0.14	d^{-1}
Natural (linear) mortality rate in sediment, large phytoplankton	PhyL_mL_sed	1	d^{-1}
Natural (linear) mortality rate, small phytoplankton in water column	PhyS_mL	0.14	d^{-1}
Natural (linear) mortality rate in sediment, small phytoplankton	PhyS_mL_sed	1	d^{-1}
Natural (linear) mortality rate, dinoflagellates in water column & sediment	PD_mL	0.14	d^{-1}
Respiration as a fraction of maximum growth rate (μ_{max})	Plank_resp	0.025	none
Radius of the large phytoplankton cells	PLrad	10.0×10^{-6}	m
Maximum growth rate of large phytoplankton at Tref	PL μ_{max}	1.5	d^{-1}
Ratio of xanthophyll to Chl α of PL	PLxan2chl	0.81	mg mg^{-1}
Radius of the small phytoplankton cells	PSrad	2.5×10^{-6}	m
Maximum growth rate of small phytoplankton at Tref	PS μ_{max}	1.6	d^{-1}
Ratio of xanthophyll to Chl α of PS	PSxan2chl	0.51	mg mg^{-1}
Maximum growth rate of dinoflagellates at Tref	DF μ_{max}	0.5	d^{-1}
Ratio of xanthophyll to Chl α of dinoflagellates	DFxan2chl	0.81	mg mg^{-1}
Radius of dinoflagellate cells	DFrad	10.0×10^{-6}	m

Parameter description	Symbol	Value	Units
Zooplankton (ZL)			
Growth efficiency, large zooplankton	ZL_E	0.426	none
Fraction of growth inefficiency lost to detritus, large zooplankton	ZL_FDG	1.0	none
Fraction of mortality lost to detritus, large zooplankton	ZL_FDM	1.0	none
Natural (quadratic) mortality rate, large zooplankton	ZL_mQ	0.02	$d^{-1} (\text{mg N m}^{-3})^{-1}$
Diel vertical migration rate of large zooplankton	ZLdvmrate	0	m d^{-1}
Grazing technique of large zooplankton	ZLmeth	rect	none
Zooplankton light dependency	ZLpar	1.0×10^{-12}	$\text{mol photons m}^{-2} \text{s}^{-1}$
Radius of large zooplankton cells	ZLrad	5×10^{-4}	m
Swimming velocity for large zooplankton	ZLswim	1.5×10^{-3}	m s^{-1}
Maximum growth rate of large zooplankton at Tref	ZLμmax	1.33	d^{-1}
Growth efficiency, small zooplankton	ZS_E	0.462	none
Fraction of growth inefficiency lost to detritus, small zooplankton	ZS_FDG	1.0	none
Fraction of mortality lost to detritus, small zooplankton	ZS_FDM	1.0	none
Natural (quadratic) mortality rate, small zooplankton	ZS_mQ	0.07	$d^{-1} (\text{mg N m}^{-3})^{-1}$
Grazing technique of small zooplankton	ZSmeth	rect	none
Radius of the small zooplankton cells	ZSrad	12.5×10^{-6}	m
Swimming velocity for small zooplankton	ZSSwim	0.0002	m s^{-1}
Maximum growth rate of small zooplankton at Tref	ZSμmax	2.0	d^{-1}
Filter Feeders FF (excludes farmed shellfish)			
Nitrogen-specific area of filter feeder density	FFden	0.002	$\text{m}^2 \text{ mg N}^{-1}$
Max. growth rate of filter feeder at Tref	FFumax	0.2	d^{-1}
Mortality of filter feeder at Tref	FFmort	8.0×10^{-10}	$d^{-1} (\text{mg N m}^{-2})^{-1}$
Grid scale to filter feeder reef scale ratio	FFarea	0.1	m m^{-1}

Parameter description	Symbol	Value	Units
Seagrass (SG)			
Half-saturation of SG N uptake in sediment	SG_KN	420	mg N m ⁻³
Half-saturation of SG P uptake in sediment	SG_KP	96	mg P m ⁻³
Natural (linear) mortality rate of SG	SG_mL	0.03	d ⁻¹
Critical shear stress for SG loss	SG_tau_critical	2	N m ⁻²
Time-scale for critical shear stress for SG loss	SG_tau_efold	43200	s
Fraction (target) of SG biomass below-ground	SGfrac	0.75	-
Nitrogen-specific area of SG leaf	SGleafden	1.5	m ² g N ⁻¹
Compensation irradiance for SG	SGmlr	1.5	mol m ⁻²
Natural (linear) mortality rate, SG root	SGROOT_mL	0.004	d ⁻¹
Maximum depth for SG roots	SGrootdepth	-0.15	m
Seagrass seed biomass as fraction of 63 % cover	SGseedfrac	0.01	-
Time scale for seagrass translocation	SGtransrate	0.0333	d ⁻¹
Orientation of seagrass	SGorient	0.5	-
Maximum growth rate of SG at Tref	SGμmax	0.2	d ⁻¹
Macroalgae (MA)			
Natural (linear) mortality rate, macroalgae	MA_mL	0.01	d ⁻¹
Nitrogen-specific area of macroalgae leaf	MAleafden	1	m ² g N ⁻¹
Maximum growth rate of MA at Tref	MAμmax	1.0	d ⁻¹
Critical shear stress for MA loss	MA_tau_critical	2	N m ⁻²
Time-scale for critical shear stress for MA loss	MA_tau_efold	86400	s
Nitrogen-specific area of kelp leaf	MAGleafden	0.01	m ² g N ⁻¹
Maximum growth rate of kelp at Tref	MAGμmax	1.0	d ⁻¹
Critical shear stress for kelp loss	MAG_tau_critical	5	N m ⁻²
Time-scale for critical shear stress for kelp loss	MAG_tau_efold	86400	s
Microphytobenthos (MPB)			
Radius of the MPB cells	MBrad	10.0 E ⁻⁶	m
Maximum growth rate of MPB at Tref	MBμmax	1.05	d ⁻¹
Ratio of xanthophyll to Chl a of MPB	MBxan2chl	0.81	mg
MPB natural (quadratic) mortality rate, applied in sediment	MPB_mQ	0.0001	d ⁻¹ (mg N m ⁻³) ⁻¹

Parameter description	Symbol	Value	Units
Biogeochemistry			
Reference temperature (Tref)	Tref	15	Deg C
Temperature coefficient for rate parameters	Q10	2	none
Breakdown rate of dissolved organic matter	r_DOM	0.00176	d ⁻¹
Respiration as a fraction of max growth rate μ_{max}	Benth_resp	0.025	none
Breakdown rate of labile detritus at 106:16:1	r_DetPL	0.1	d ⁻¹
Breakdown rate of labile detritus at 550:30:1	r_DetBL	0.1	d ⁻¹
Breakdown rate of refractory detritus	r_RD	0.0036	d ⁻¹
Concentration of dissolved N2	N2	2000	mg N m ⁻³
DOC-specific absorption of CDOM at 443 nm	acdom443star	0.00013	m ² mg C ⁻¹
Fraction of labile detritus converted to dissolved organic matter	F_LD_DOM	0.01	none
Fraction of labile detritus converted to refractory detritus	F_LD_RD	0.19	none
Fraction of refractory detritus that breaks down to DOM	F_RD_DOM	0.05	none
Maximum anammox rate in sediment	r_ana_sed	40.0	d ⁻¹
Maximum anammox rate in water column	r_ana_wc	0.1	d ⁻¹
Maximum denitrification rate in sediment	r_den_sed	60.0	d ⁻¹
Maximum denitrification rate in water column	r_den_wc	0.01	d ⁻¹
Maximum nitrification rate in water column	r_nit_wc	0.1	d ⁻¹
Maximum nitrification rate in water sediment	r_nit_sed	5.0	d ⁻¹
Minimum carbon to chlorophyll ratio	C2Chlmin	60	wt/wt
Nominal N:Chl a ratio in phytoplankton by weight	NtoCHL	7	g N (g Chl a) ⁻¹
Oxygen half inhibition coeff. For dentification in water column	KO_den_wc	1000	mg O m ⁻³
Oxygen half-inhibition of denitrification rate in sediment	KO_den_sed	10000	mg O m ⁻³
Oxygen half-saturation coeff. for Anammox in water column	KO_ana_wc	1000	mg O m ⁻³
Oxygen half-saturation coeff. for Anammox in sediment	KO_ana_sed	5000	mg O m ⁻³
Oxygen half-saturation for aerobic respiration	KO_aer	256	mg O m ⁻³
Oxygen half-saturation for nitrification in sediment	KO_nit_sed	2000	mg O m ⁻³
Oxygen half-saturation for nitrification in water column	KO_nit_wc	5000	mg O m ⁻³
Oxygen half-saturation for P adsorption	Pads_KO	2000	mg O m ⁻³
Rate at which P reaches adsorbed/desorbed equilibrium	Pads_r	0.04	d ⁻¹
Exponent for Freundlich Isotherm	Pads_exp	1	none
Freundlich Isothermic Const P adsorption to TSS in water column	Pads_Kwc	30	mg P kg TSS ⁻¹
Freundlich Isothermic Const P adsorption to TSS in sediment	Pads_Ksed	74	mg P kg TSS ⁻¹
Rate of conversion of PIP to immobilised PIP	r_immob_PIP	0.0012	d ⁻¹
Sediment-water diffusion coefficient	EpiDiffCoeff	3.0 E-08	m ² s ⁻¹
Thickness of diffusive layer	EpiDiffDz	0.0065	m
Absorption of amber river water at 440nm	a440cdom_amber	1	m ⁻¹
Absorption of dark river water at 440nm	a440cdom_dark	8	m ⁻¹
Absorption of pale river water at 440nm	a440cdom_pale	0.1	m ⁻¹
Spectral slope of CDOM absorption for amber river water (for Derwent, Snug, Esperance, Coal, Carlton NWBay, Jordan Rivers)	Scdom_amber	0.0125	nm ⁻¹
Spectral slope of CDOM absorption for dark river water (for Huon River)	Scdom_dark	0.015	nm ⁻¹
Spectral slope of CDOM absorption for pale river water	Scdom_pale	0.01	nm ⁻¹
Wavelengths of light	Light_lambda	Various	Nm
Rate of COD decay	r_COD_decay	0	d ⁻¹
Rate of consumption of oxygen by COD	tau_COD	12	d ⁻¹
COD concentration wheb detrital remin tends to 0	COD_max	32000	mg O m ⁻³
Atmospheric NH4 flux	flux	0.274	mg N m ⁻² d ⁻¹

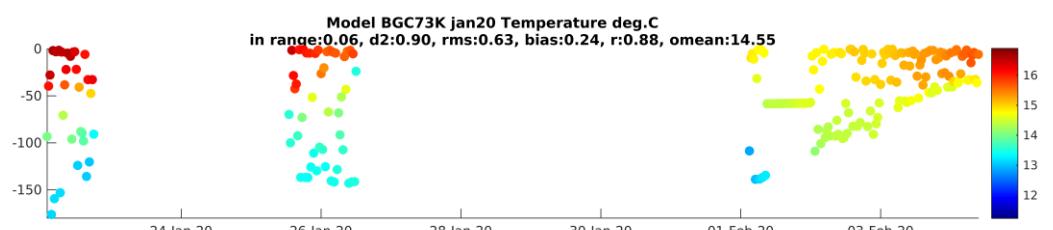
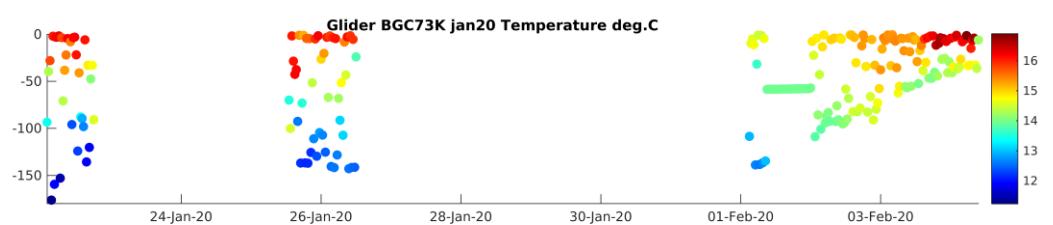
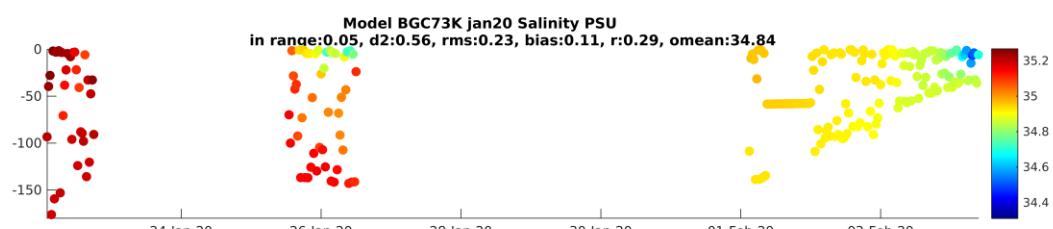
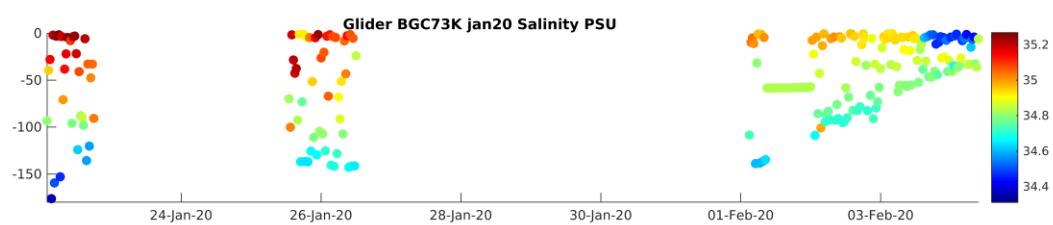
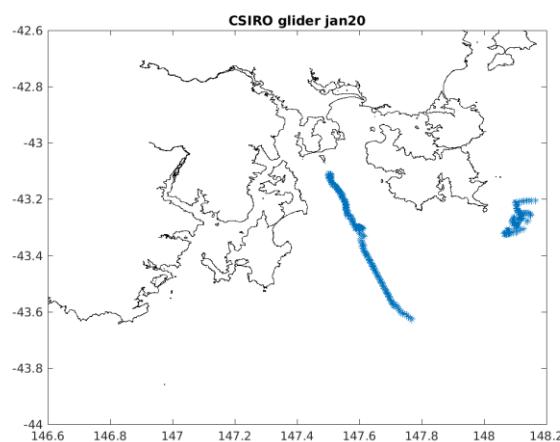
Initial conditions for the 1 year pilot model run to generate a spatially resolved and self-consistent biogeochemical model initial condition [dissolved organic and inorganic nutrients, plankton detritus, oxygen, epibenthic macroalgae, and seagrass across the model domain].

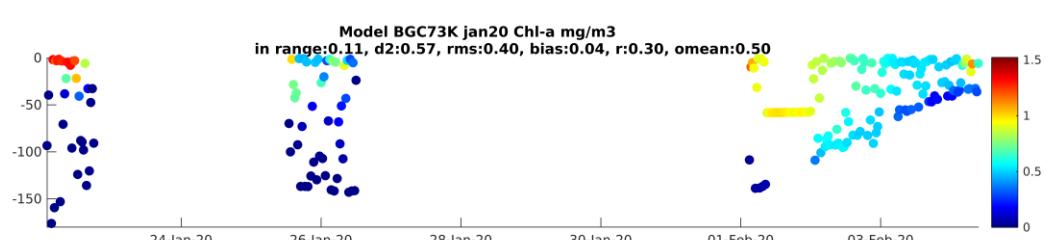
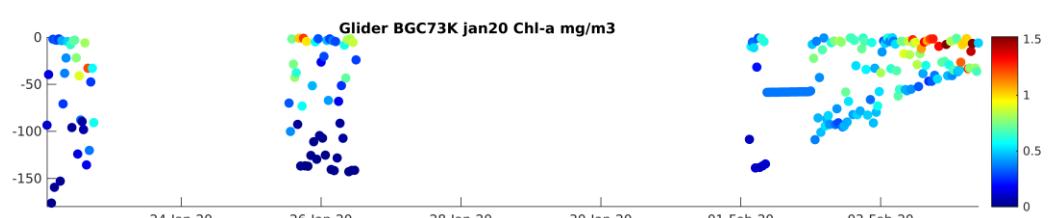
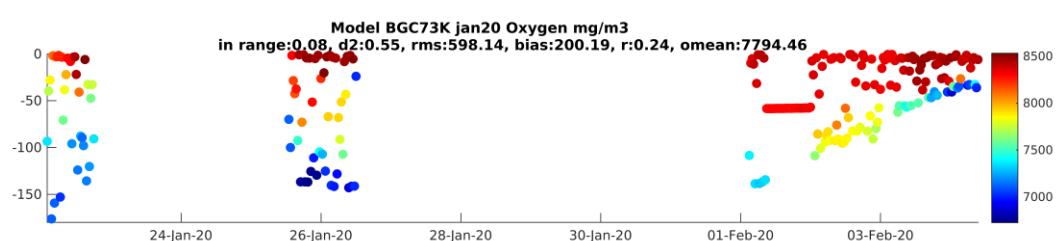
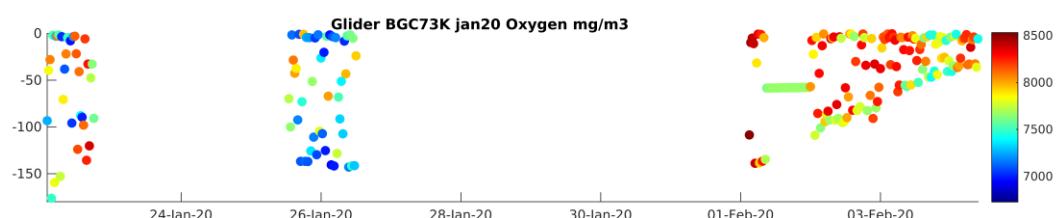
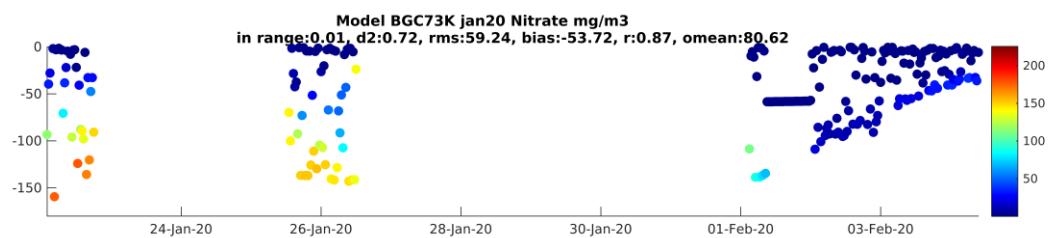
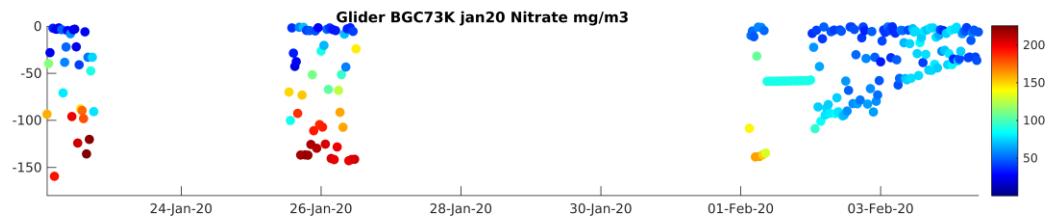
Variable	Code name	Water Column	Sediment	Unit
Labile Detrital Nitrogen Benthic	DetBL_N	0	500	mg N m ⁻³
Labile Detrital Nitrogen Plank	DetPL_N	0.01	500	mg N m ⁻³
Refractory Detrital Carbon	DetR_C	0.01	8000	mg C m ⁻³
Refractory Detrital Nitrogen	DetR_N	0.01	500	mg N m ⁻³
Refractory Detrital Phosphorus	DetR_P	0.01	138	mg P m ⁻³
Dissolved Inorganic Carbon	DIC	24758	24758	mg C m ⁻³
Dissolved Inorganic Phosphorus	DIP	10	100	mg P m ⁻³
Dissolved Organic Carbon	DOR_C	1000	1000	mg C m ⁻³
Dissolved Organic Nitrogen	DOR_N	300	300	mg N m ⁻³
Dissolved Organic Phosphorus	DOR_P	5	5	mg P m ⁻³
Ammonia	NH4	14	200	mg N m ⁻³
Nitrate	NO3	100	500	mg N m ⁻³
Dissolved Oxygen	Oxygen	6505	65.05	mg O m ⁻³
Chemical Oxygen Demand	COD	0	0	mg O m ⁻³
Dinoflagellate chlorophyll	PhyD_Chl	1	0	mg Chl m ⁻³
Dinoflagellate I reserve	PhyD_I	7	0	mmol photon m ⁻³
Dinoflagellate Nitrogen	PhyD_N	5	0	mg N m ⁻³
Dinoflagellate N reserve	PhyD_NR	2	0	mg N m ⁻³
Dinoflagellate P reserve	PhyD_PR	0.5	0	mg P m ⁻³
Large Phytoplankton chlorophyll	Phyl_Chl	2	0	mg Chl m ⁻³
Large Phytoplankton I reserve	Phyl_I	14	0	mmol photon m ⁻³
Large Phytoplankton N	Phyl_N	10	0	mg N m ⁻³
Large Phytoplankton N reserve	Phyl_NR	4	0	mg N m ⁻³
Large Phytoplankton P reserve	Phyl_PR	0.5	0	mg P m ⁻³
Small Phytoplankton chlorophyll	PhyS_Chl	2	0	mg Chl m ⁻³
Small Phytoplankton I reserve	PhyS_I	14	0	mmol photon m ⁻³
Small Phytoplankton N	PhyS_N	10	0	mg N m ⁻³
Small Phytoplankton N reserve	PhyS_NR	4	0	mg N m ⁻³
Small Phytoplankton P reserve	PhyS_PR	0.5	0	mg P m ⁻³
Particulate Inorganic Phosphorus	PIP	0.1	1000	mg P m ⁻³
Particulate Inorganic Phosphorus on dust	PIP_dust	0.01	10	mg P m ⁻³
Immobilised Particulate Inorganic Phosphorus	PIPI	0	0.01	mg P m ⁻³
Large Zooplankton N	Zool_N	15	0	mg N m ⁻³
Small Zooplankton N	ZooS_N	10	0	mg N m ⁻³
Macroalgae N	MA_N	0.01	-	g N m ⁻²
Microphytobenthos chlorophyll	MPB_Chl	0	48.2	mg Chl m ⁻³
Microphytobenthos light reserve	MPB_I	0	797.22	mmol photon m ⁻³
Microphytobenthos N	MPB_N	0	337.4	mg N m ⁻³
Microphytobenthos N reserve	MPB_NR	0	169.65	mg N m ⁻³
Microphytobenthos P reserve	MPB_PR	0	23.32	mg P m ⁻³
Seagrass N	SG_N	0.05	-	g N m ⁻²
Seagrass root N	SGROOT_N	-	0.01	g N m ⁻³
Filter feeder N	FF_N	600	-	mg N m ⁻²

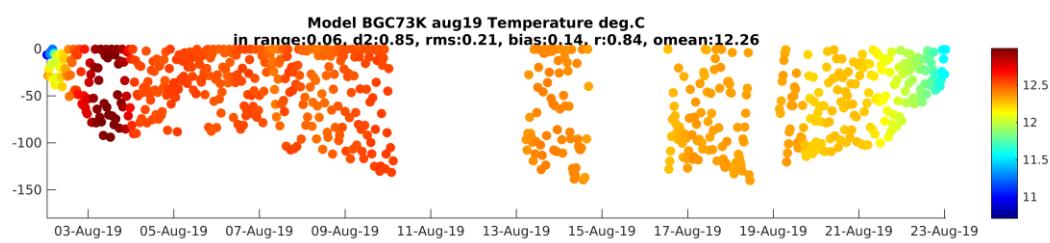
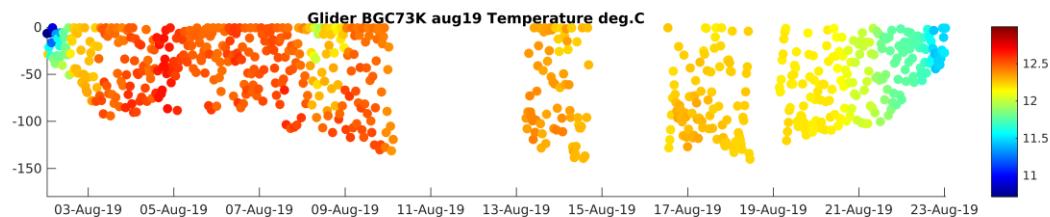
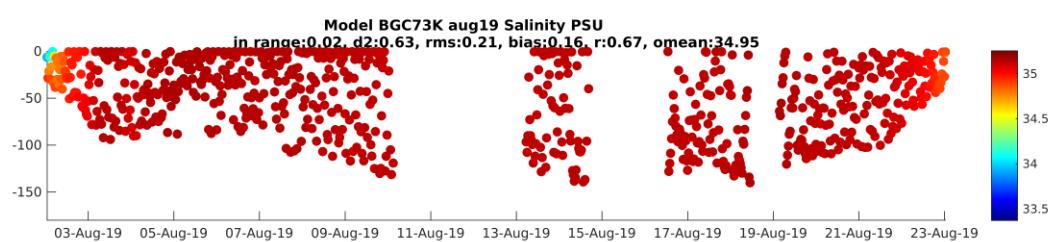
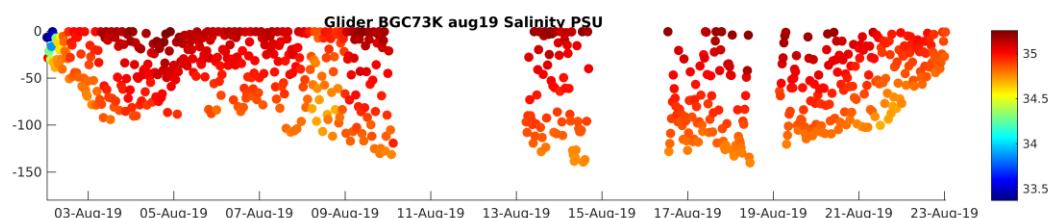
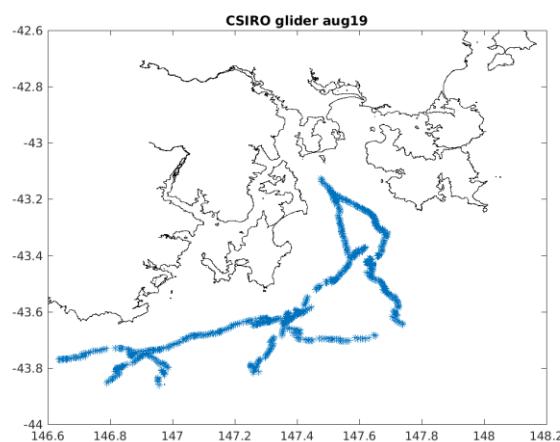
A.5 Biogeochemical model vs glider data including statistics

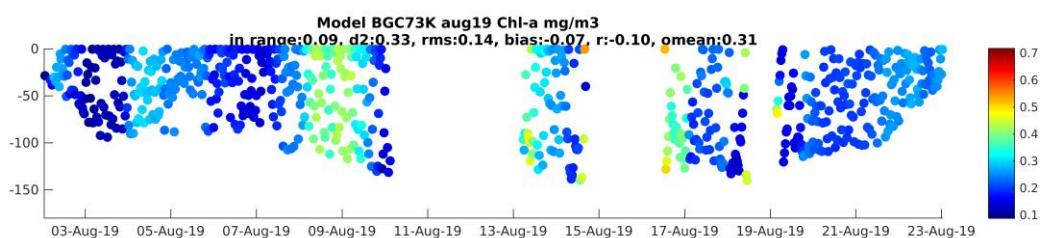
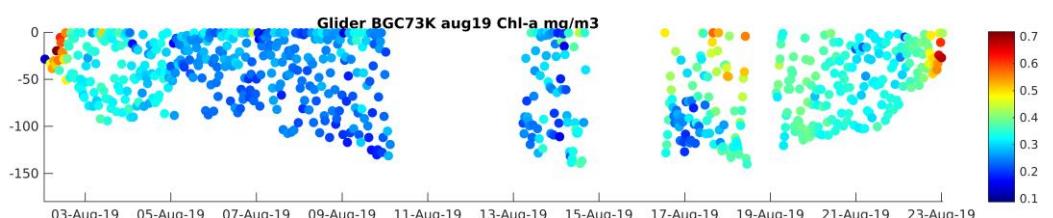
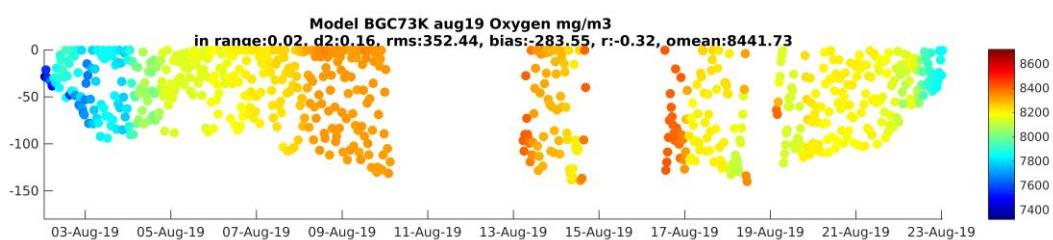
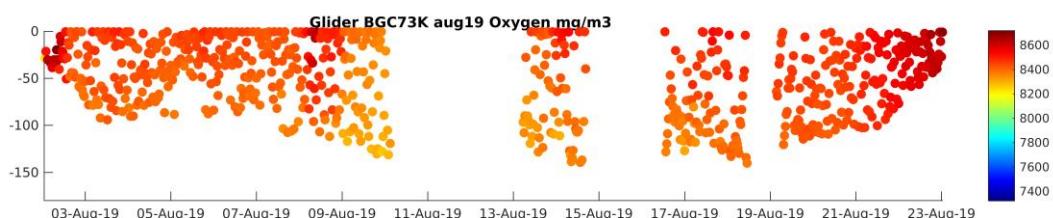
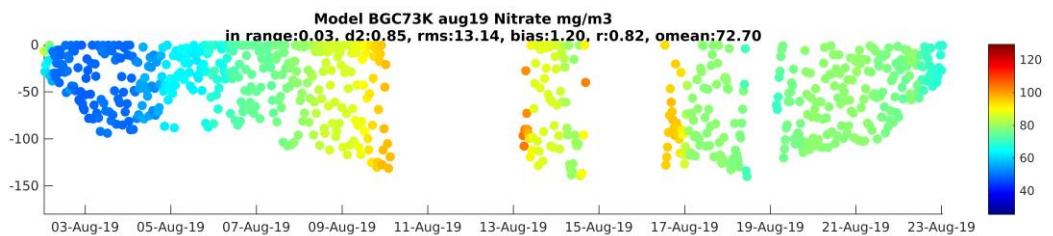
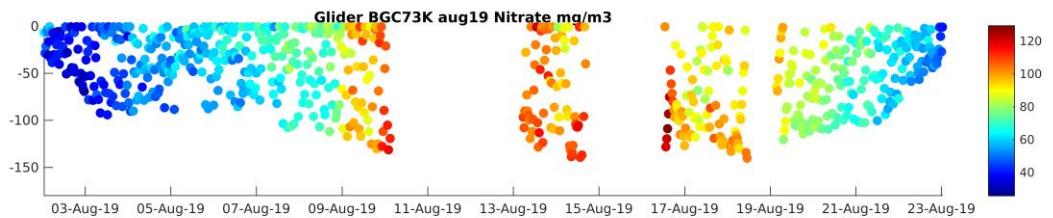
Summary of model vs glider observations statistical skill assessment [properties [yellow/green Willmott score > 0.4 (good), dark green Willmott score > 0.6 (very good), red Willmott score < 0.3 (poor); blue model bias low, red model bias high].

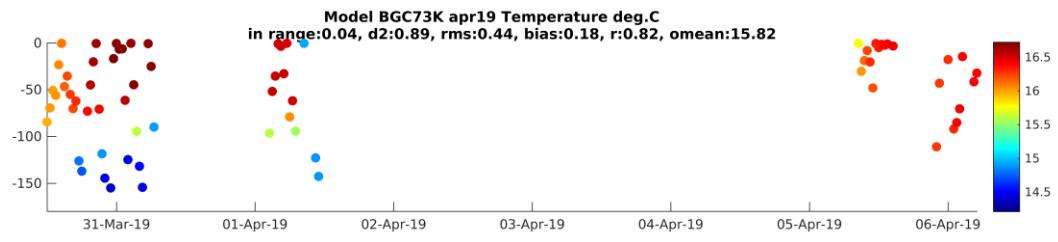
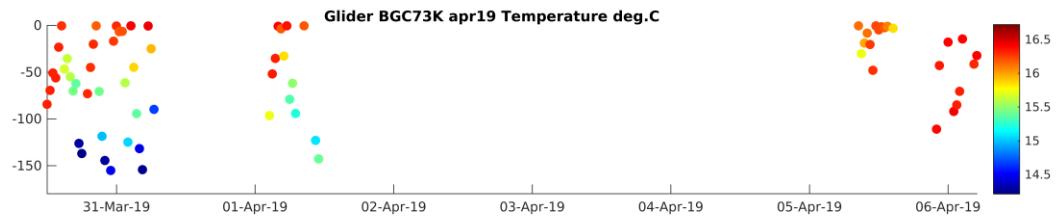
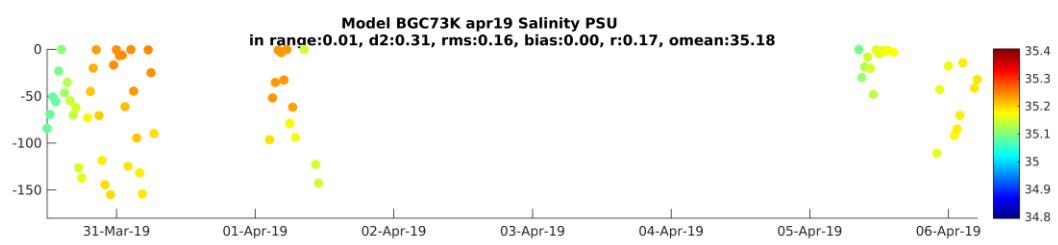
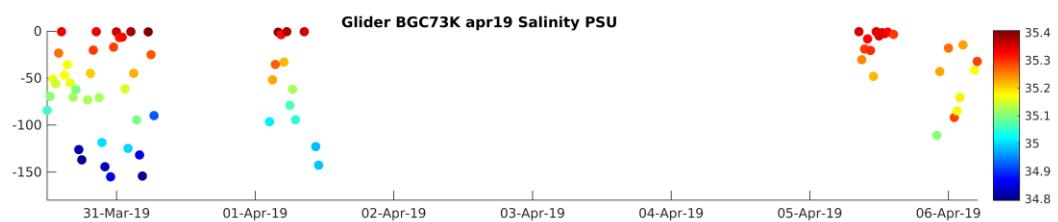
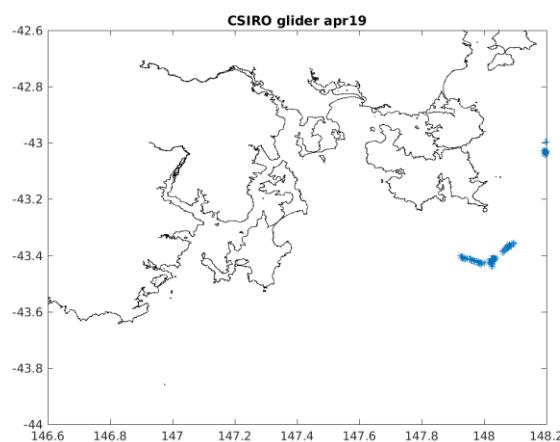
Willmott Skill	Chl-a mg/m3	Oxygen mg/m3	Ed 440 W/m2/nm	Ed 490 W/m2/nm	Ed 550 W/m2/nm	Ed 670 W/m2/nm	Nitrate mg/m3	Temp deg.C	Salinity PSU
Feb-15	0.60	0.73	0.85	0.86	0.89	0.88		0.81	0.69
Apr-15	0.60	0.34	0.87	0.86	0.88	0.86		0.57	0.47
Jun-15	0.50	0.17	0.84	0.85	0.89	0.90		0.95	0.93
Aug-15	0.55	0.33	0.92	0.90	0.93	0.91		0.70	0.88
Oct-15	0.46	0.45	0.85	0.85	0.89	0.92		0.80	0.75
Apr-16	0.62	0.40	0.81	0.79	0.80	0.87		0.57	0.55
Sep-16	0.77	0.41	0.92	0.93	0.91	0.80		0.63	0.96
Feb-17	0.66	0.86	0.91	0.91	0.92	0.93		0.68	0.71
Mar-17	0.70	0.57	0.88	0.90	0.91	0.87		0.84	0.64
May-17	0.71	0.33					0.74	0.53	0.58
Sep-18	0.48	0.13					0.10	0.83	0.50
Apr-19	0.55	0.78					0.63	0.89	0.31
Aug-19	0.33	0.16					0.85	0.85	0.63
Jan-20	0.57	0.55					0.72	0.90	0.56
<hr/>									
Normalised Bias									
Feb-15	-0.35	0.03	-0.47	-0.43	-0.32	-0.35		-0.06	-0.01
Apr-15	-0.44	0.01	-0.35	-0.33	-0.23	-0.44		-0.02	0.00
Jun-15	-0.58	-0.08	-0.40	-0.34	-0.18	-0.46		0.01	0.00
Aug-15	-0.47	-0.05	-0.25	-0.26	-0.13	-0.39		-0.02	0.00
Oct-15	0.56	0.01	-0.32	-0.34	-0.22	-0.31		-0.02	0.00
Apr-16	-0.42	0.00	-0.36	-0.32	-0.26	-0.22		-0.03	-0.01
Sep-16	-0.06	0.09	-0.28	-0.26	-0.31	-0.55		0.00	0.00
Feb-17	-0.44	-0.02	-0.12	-0.18	-0.13	-0.25		-0.06	0.00
Mar-17	-0.29	0.15	-0.39	-0.35	-0.30	-0.40		-0.03	0.00
May-17	-0.51	-0.07					0.12	0.04	0.00
Sep-18	-0.20	0.04					5.11	0.00	0.01
Apr-19	-0.69	0.01					0.57	0.01	0.00
Aug-19	-0.23	-0.03					0.02	0.01	0.00
Jan-20	0.08	0.03					-0.67	0.02	0.00
<hr/>									
Mean									
Willmott	0.58	0.44	0.87	0.87	0.89	0.88	0.61	0.75	0.65
Correlation	0.44	0.19	0.79	0.79	0.82	0.85	0.66	0.71	0.61
Normalised Bias	-0.38	0.01	-0.35	-0.33	-0.23	-0.39	0.12	-0.01	0.00

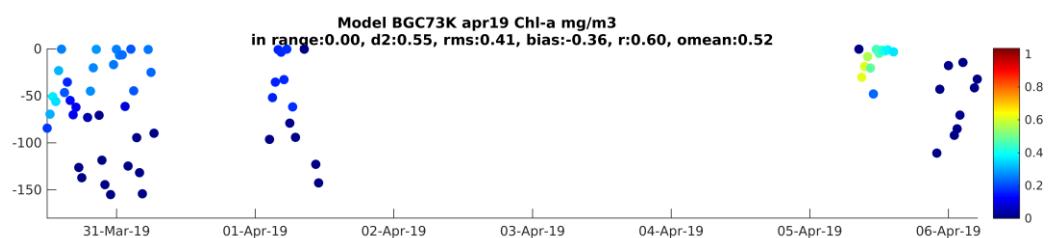
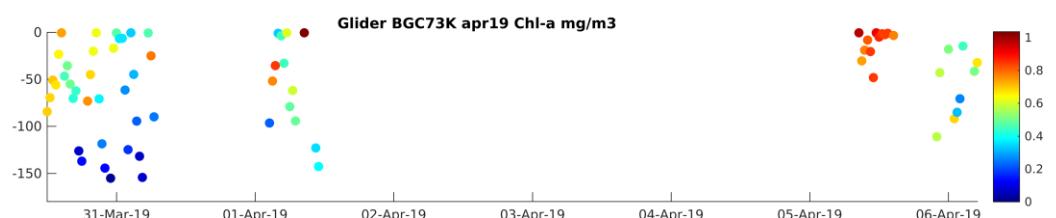
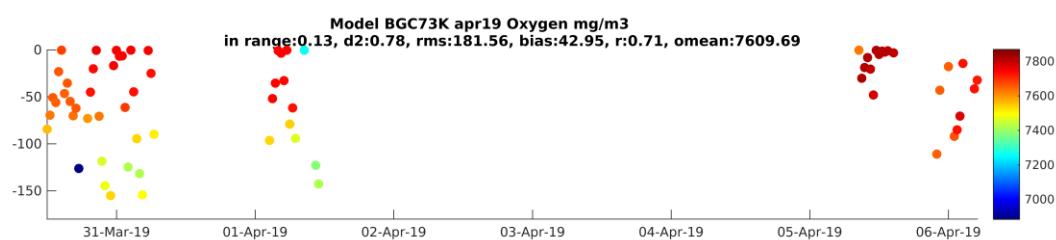
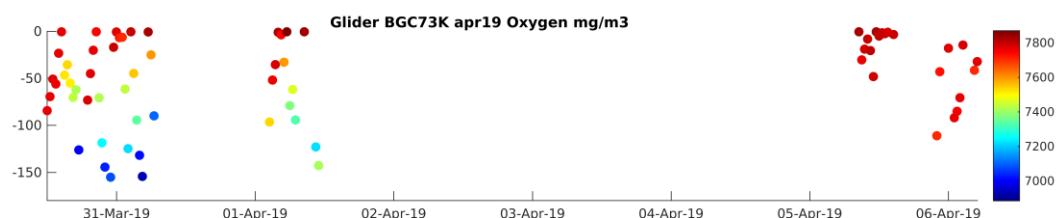
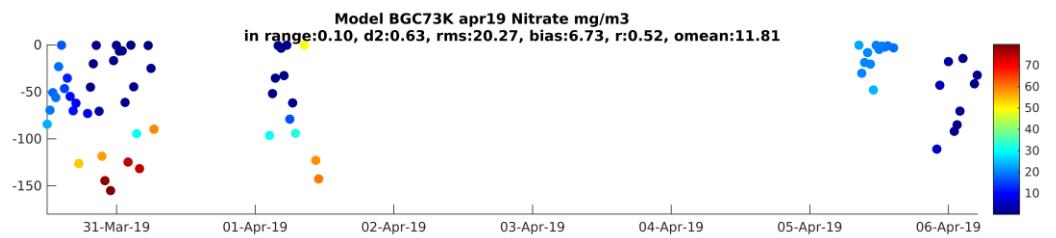
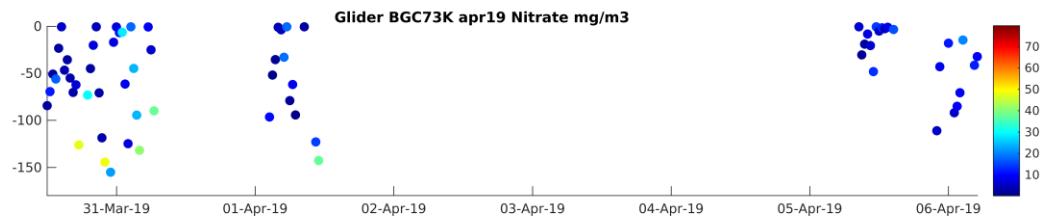


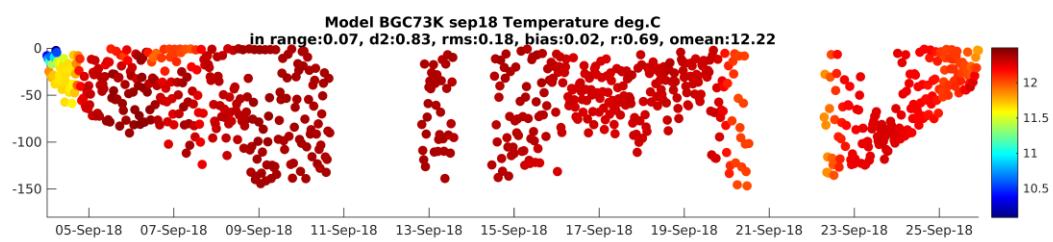
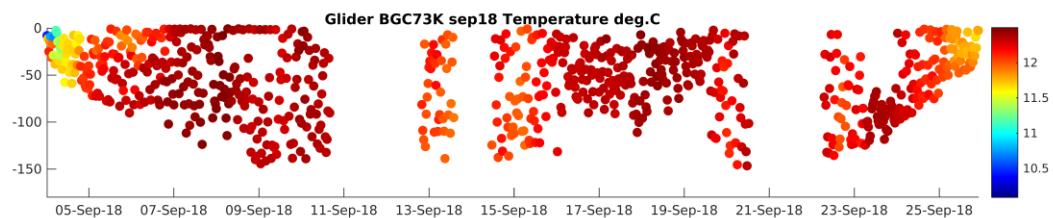
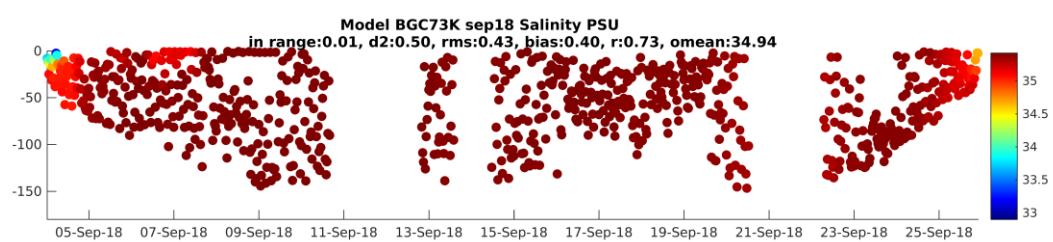
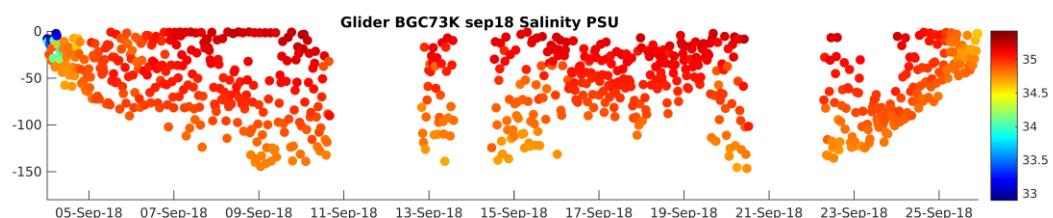
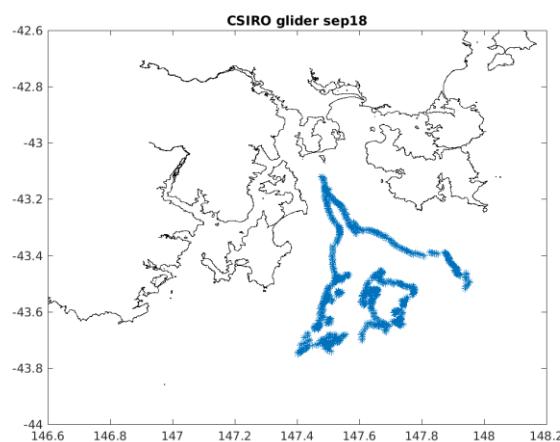


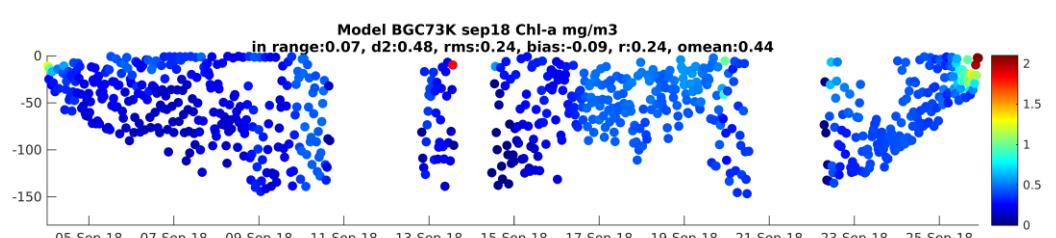
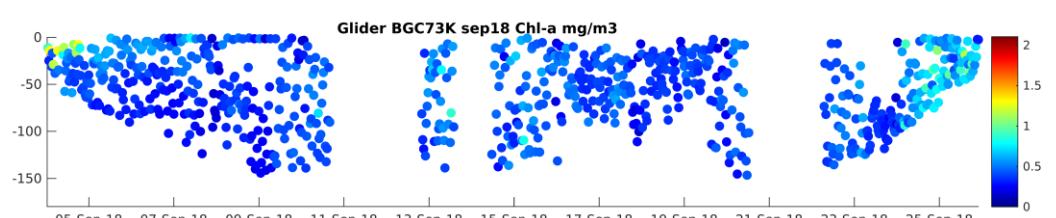
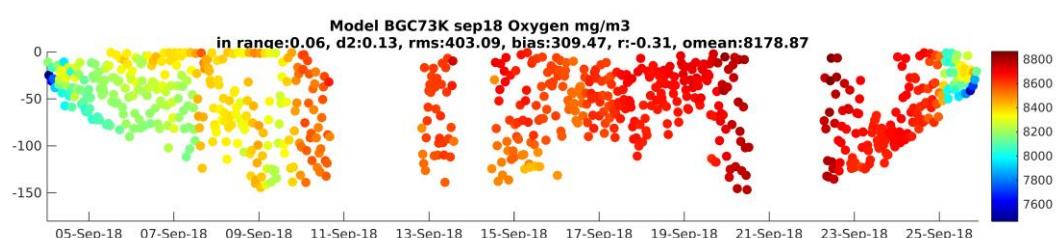
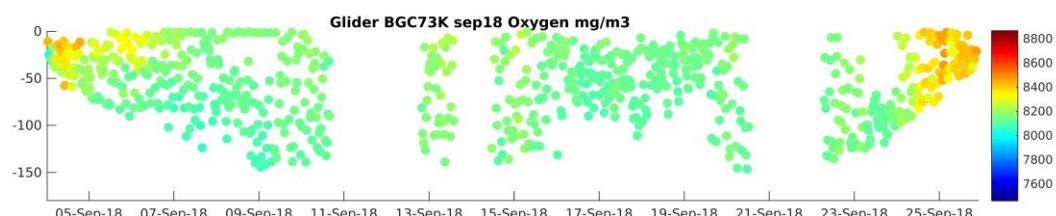
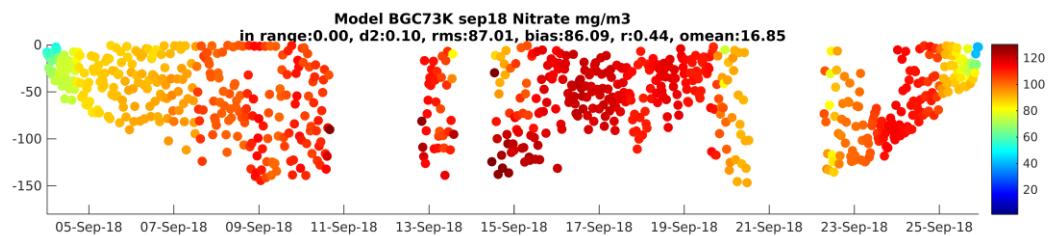
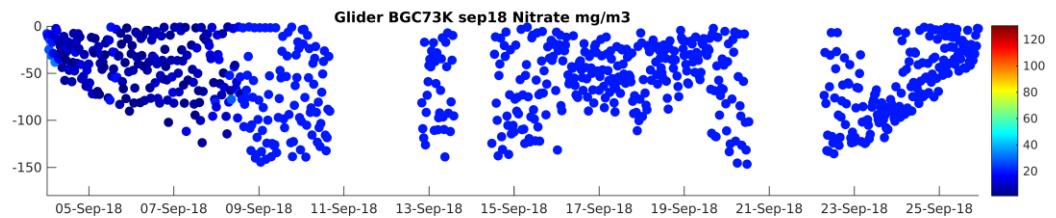


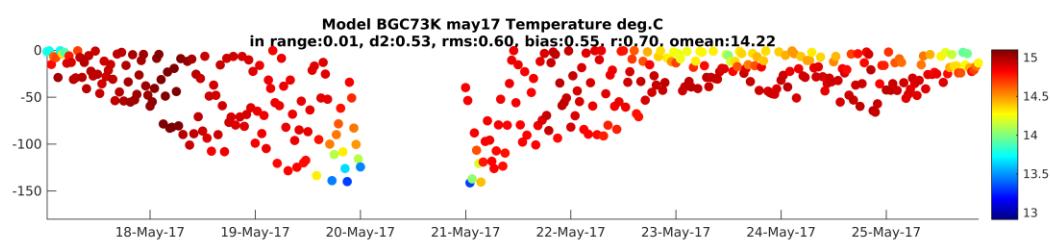
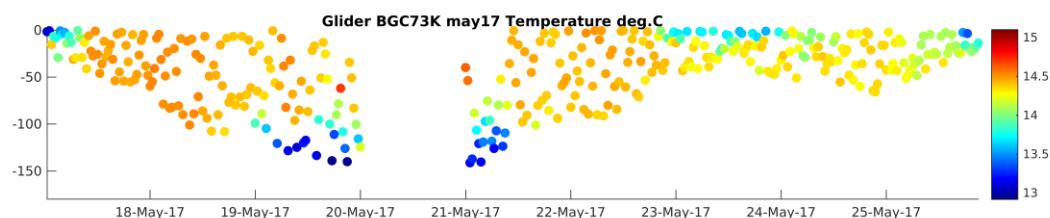
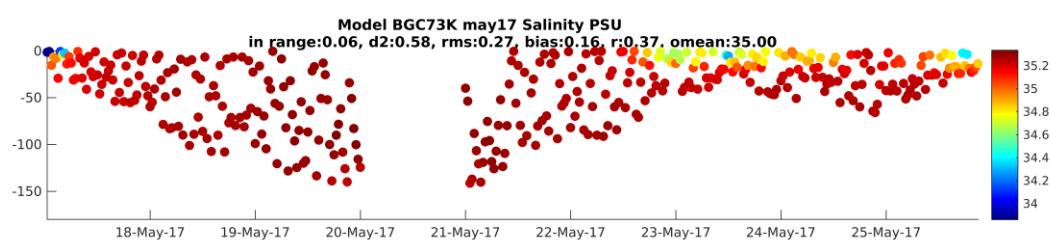
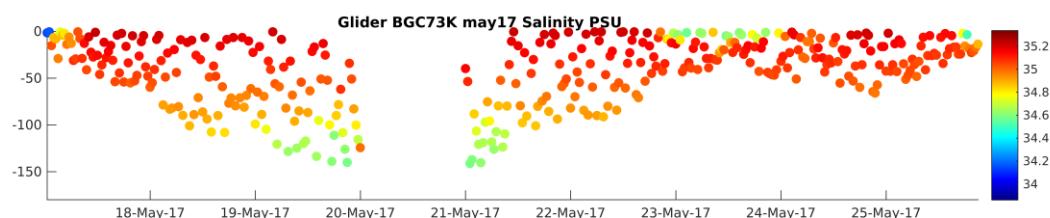
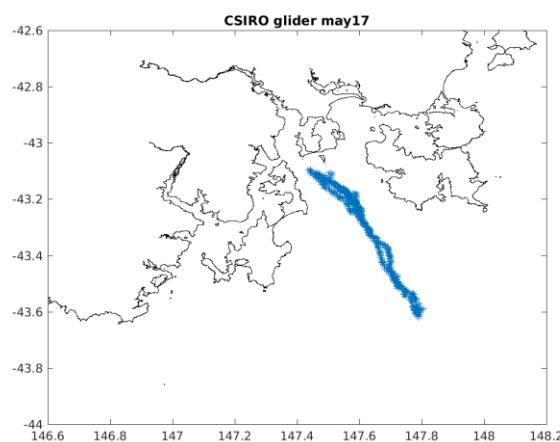


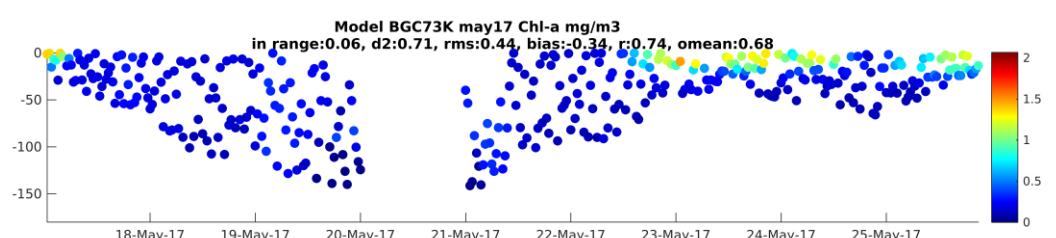
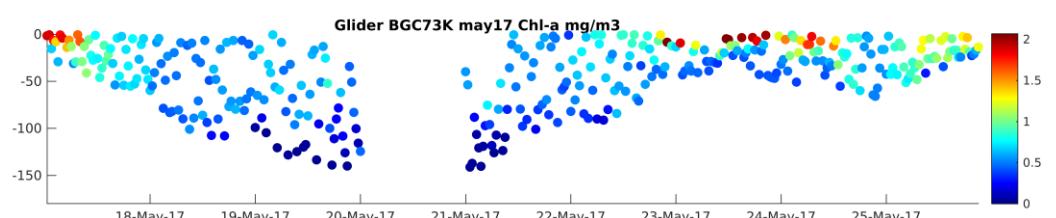
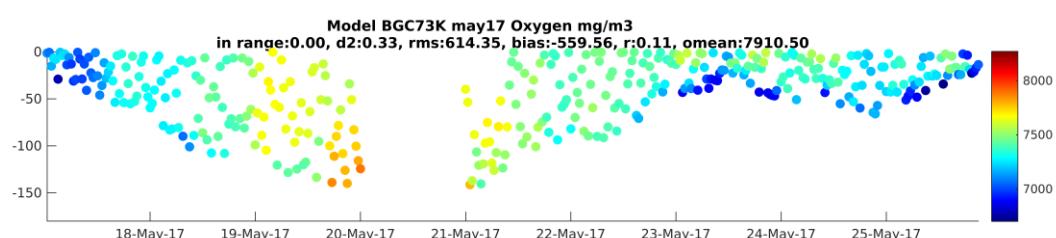
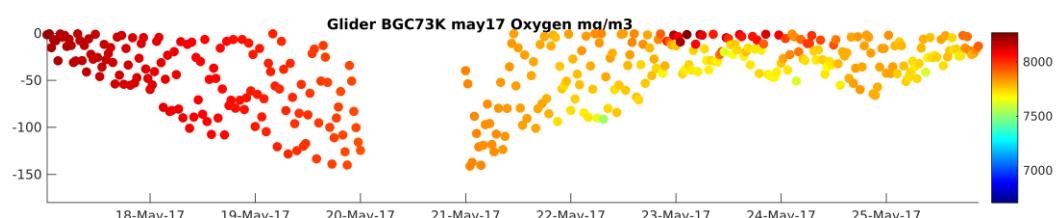
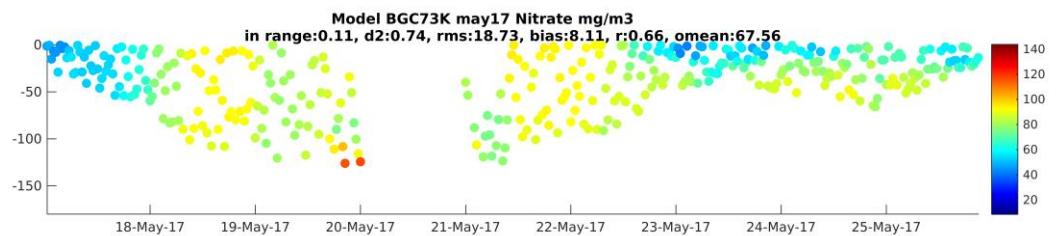
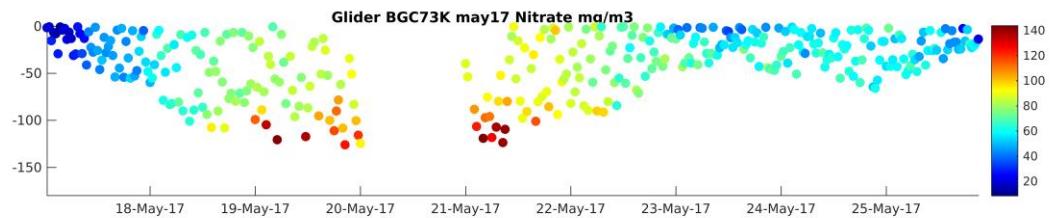


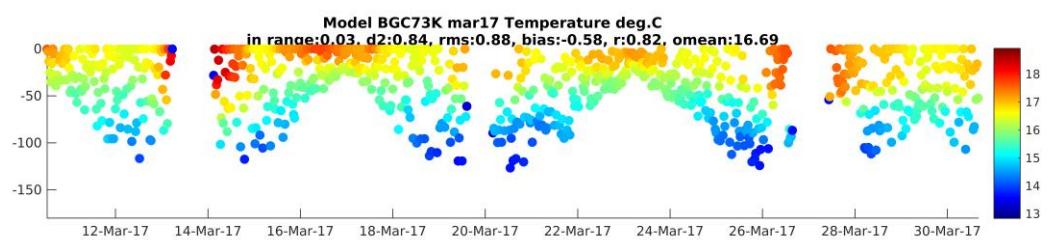
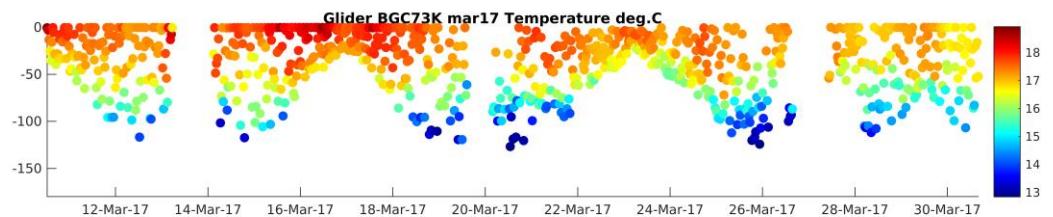
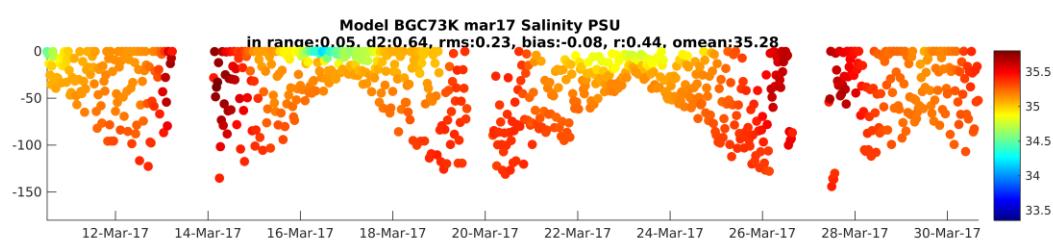
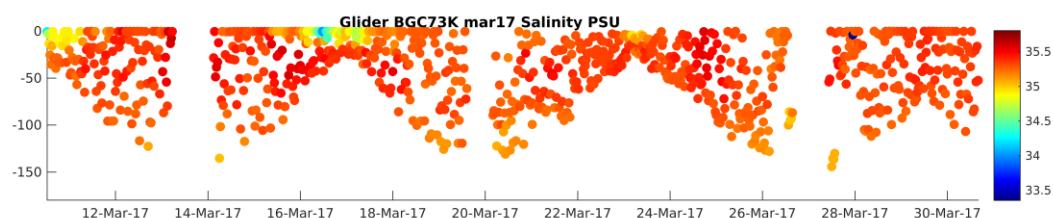
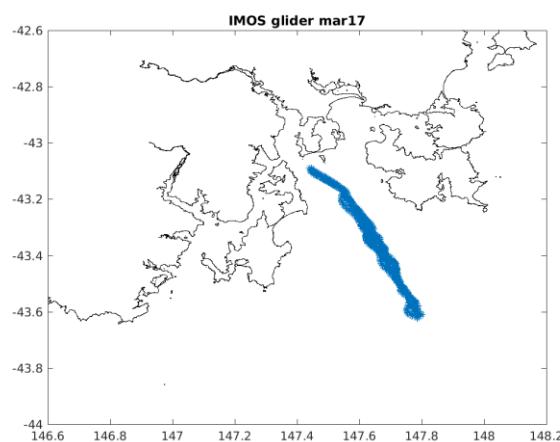


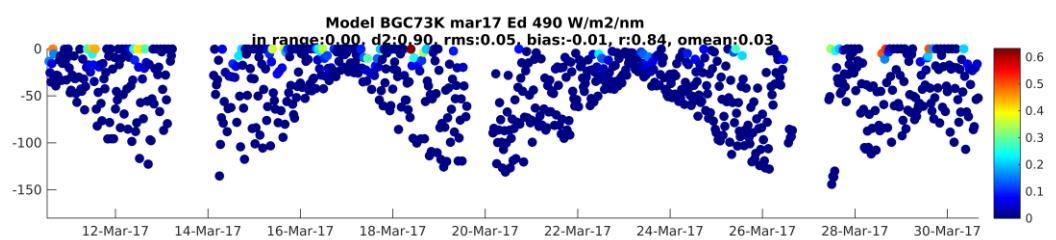
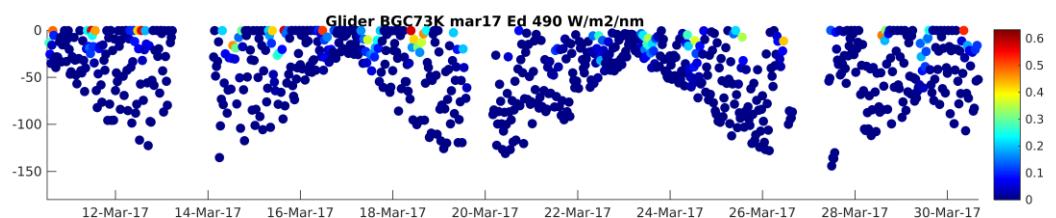
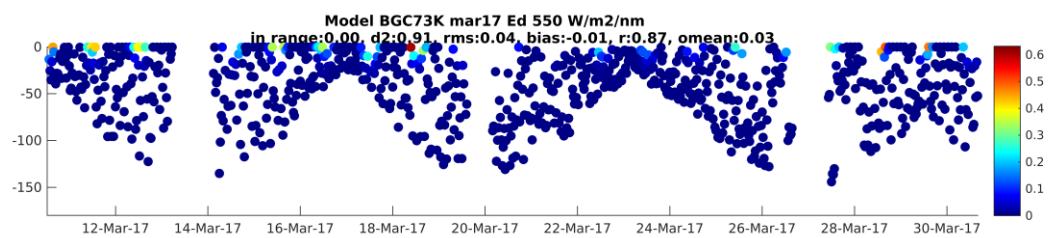
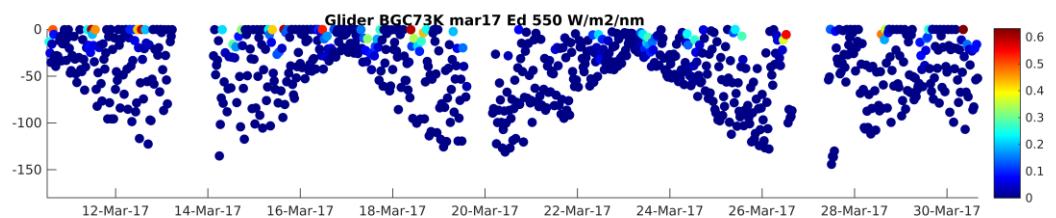
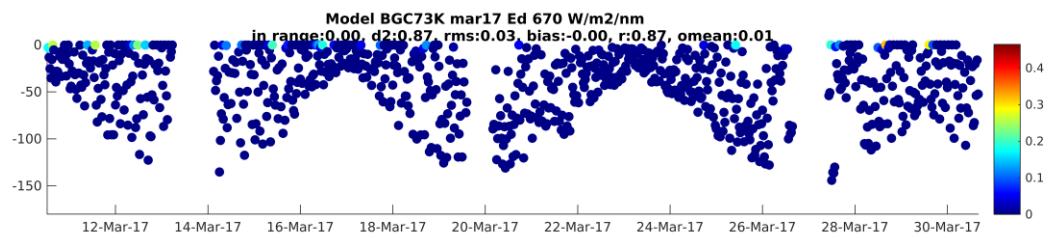
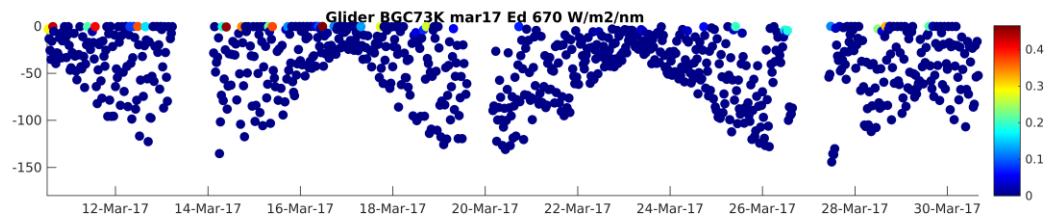


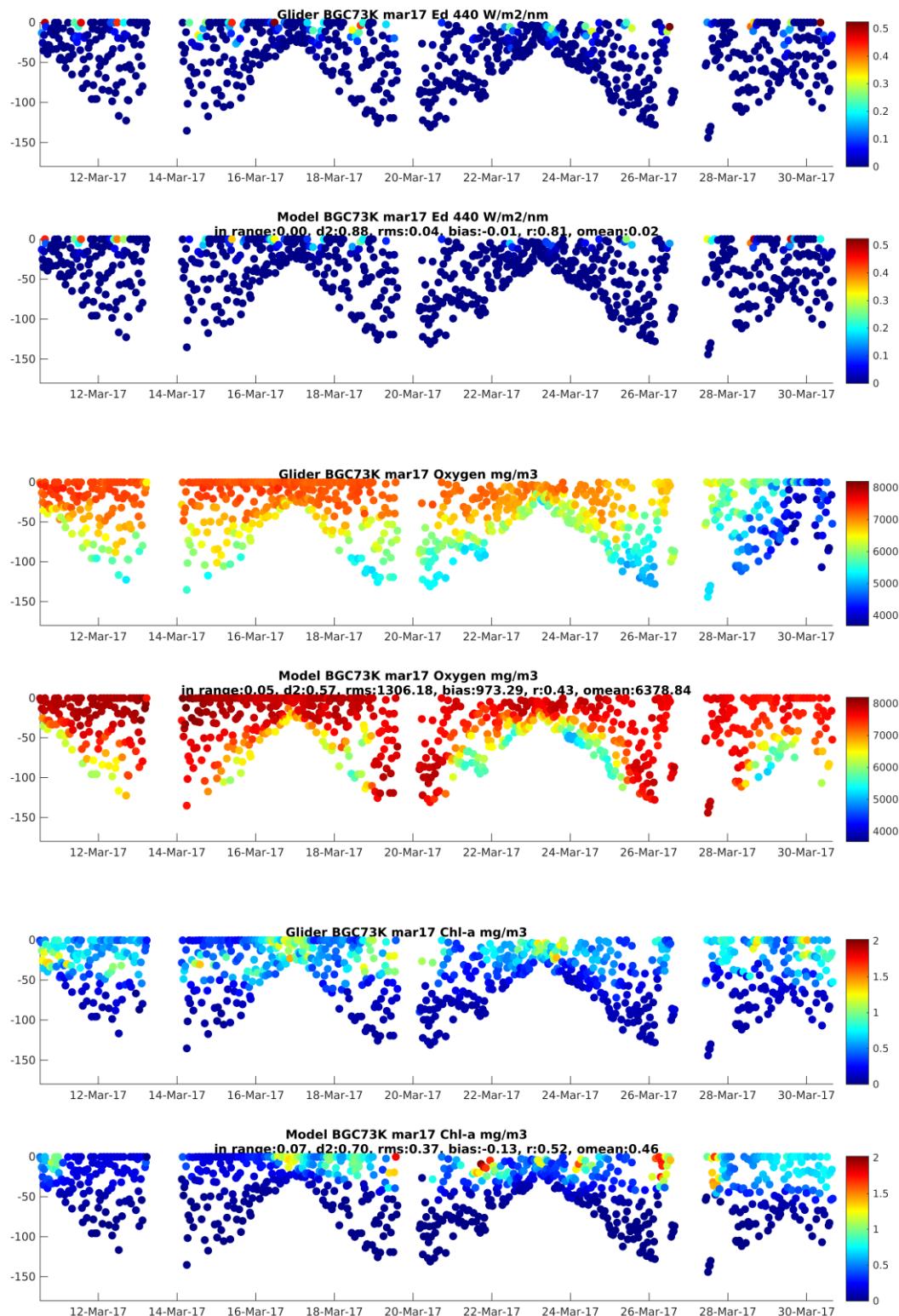


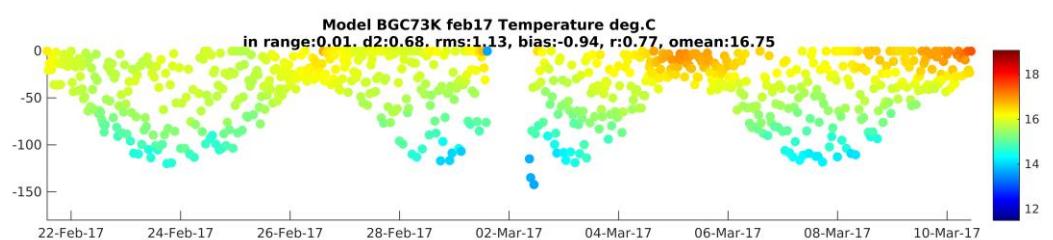
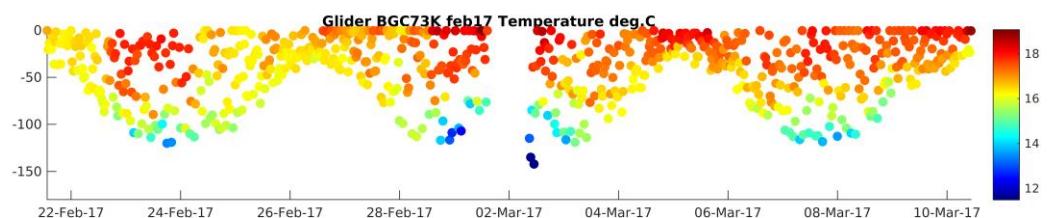
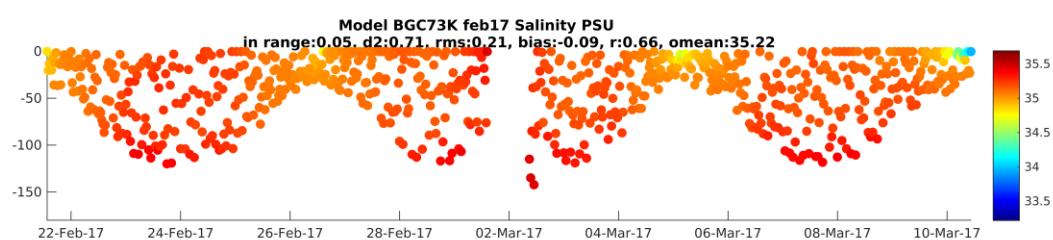
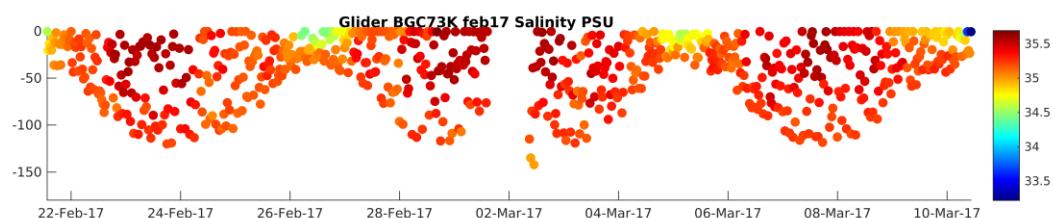
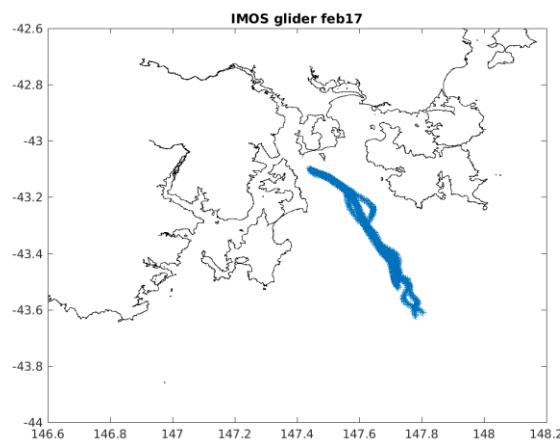


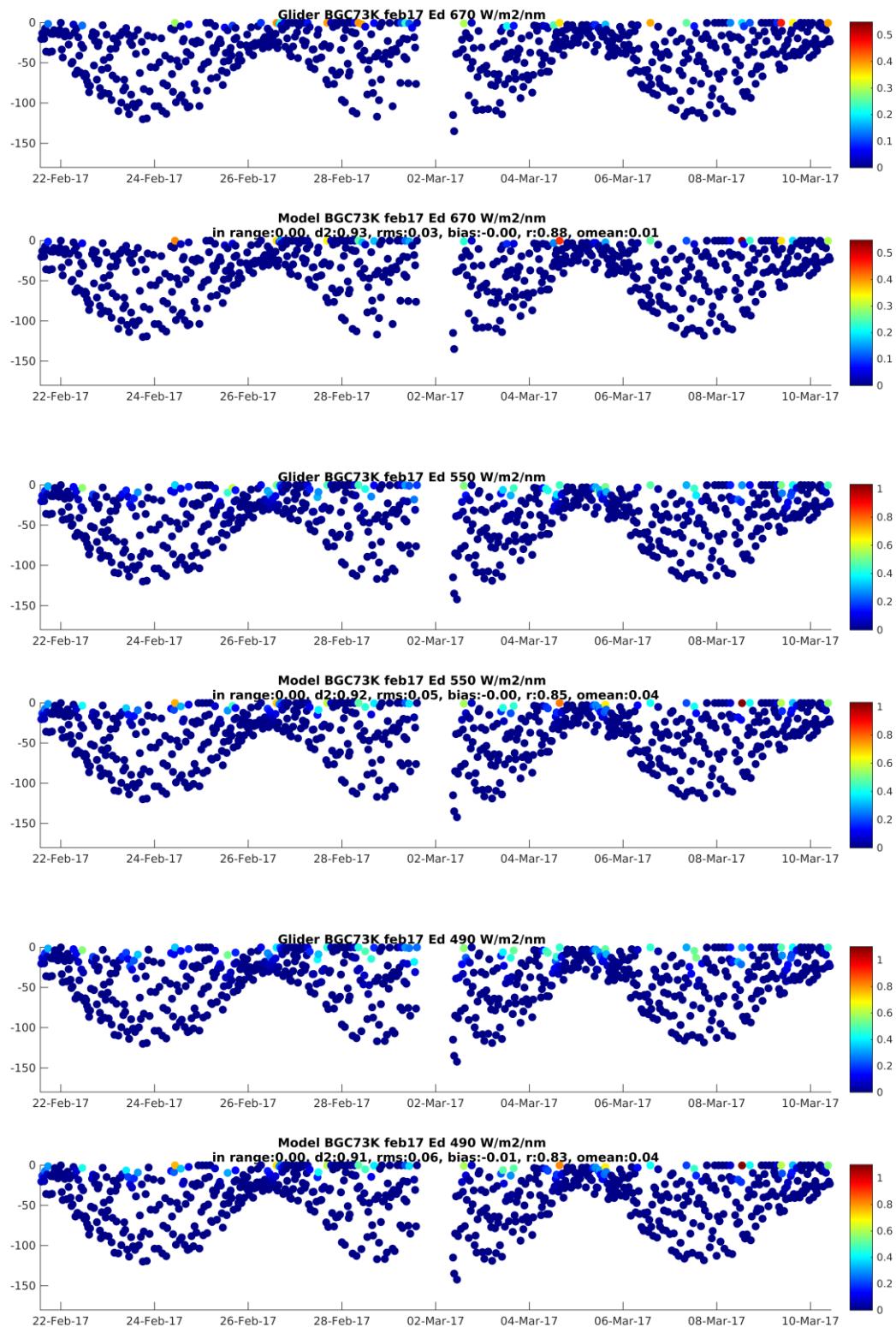


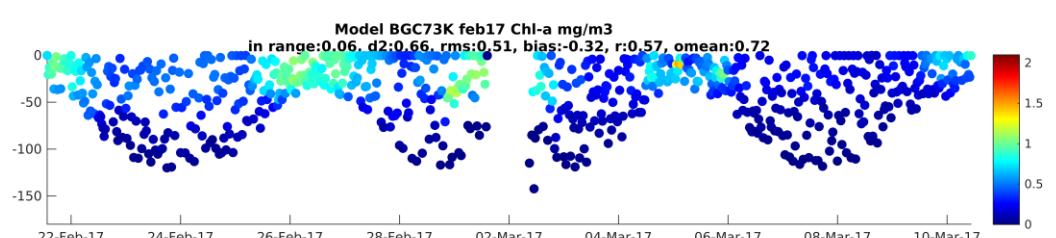
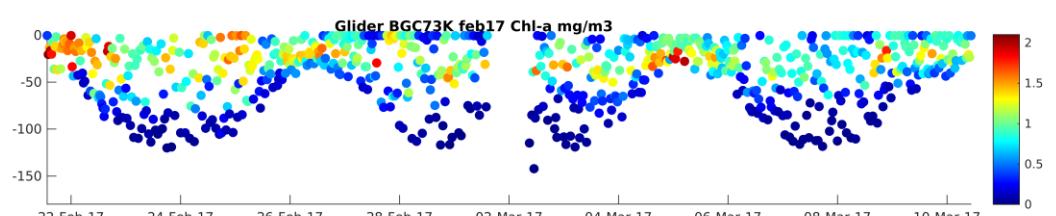
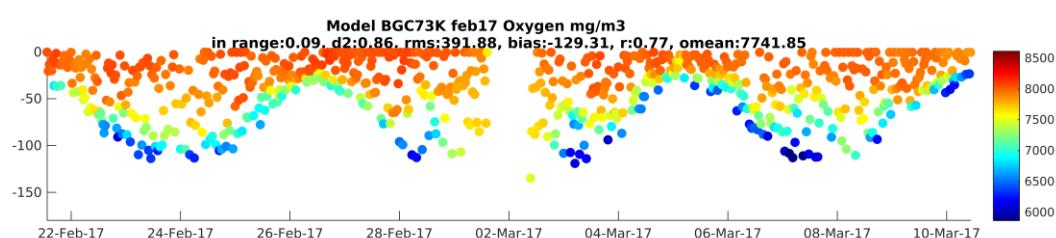
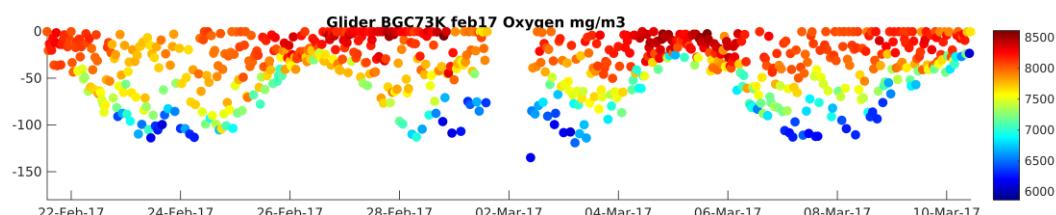
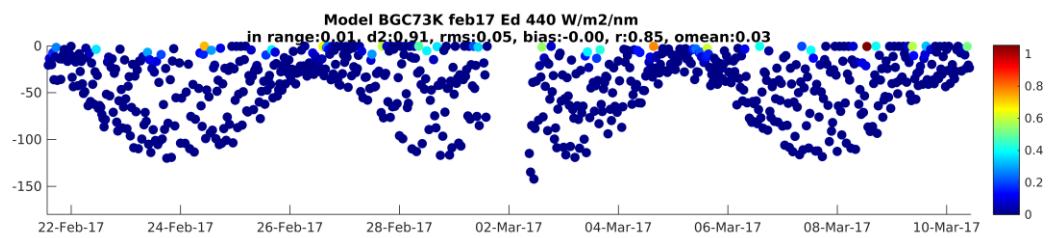
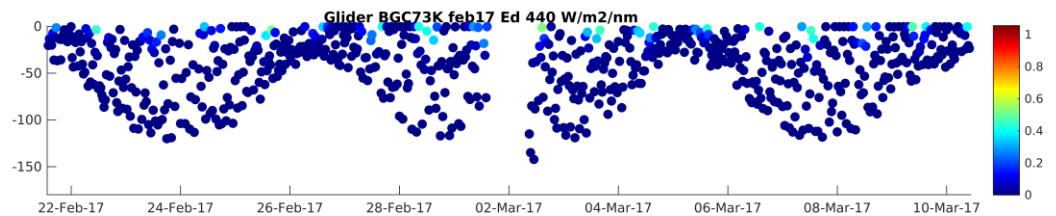


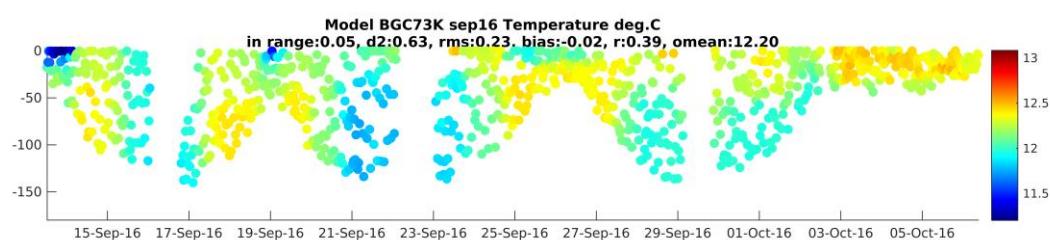
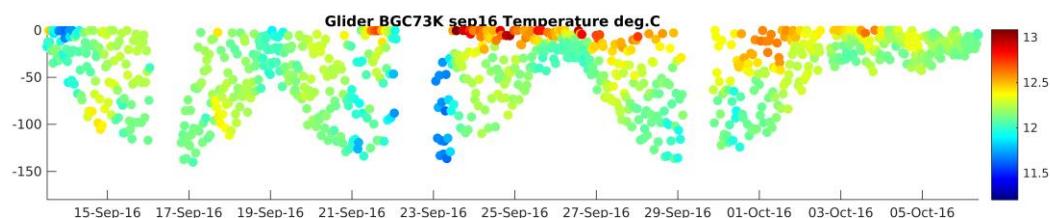
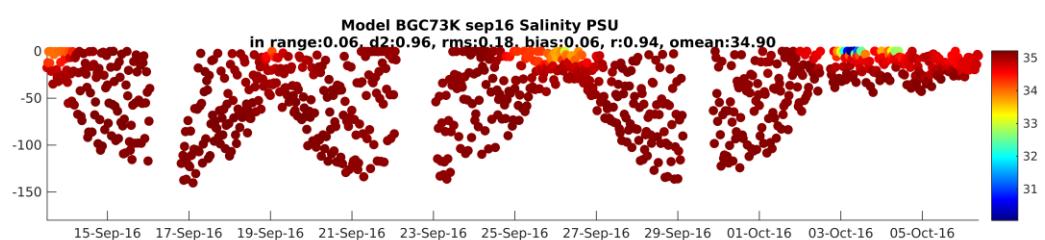
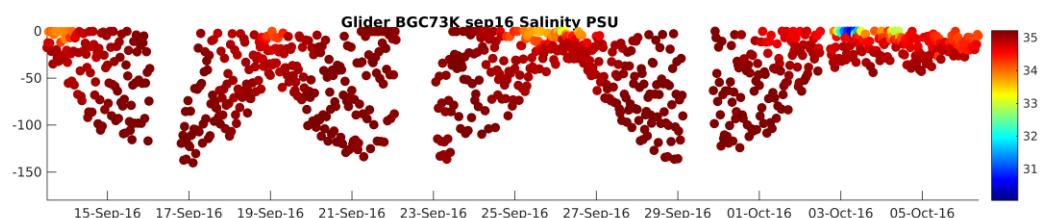
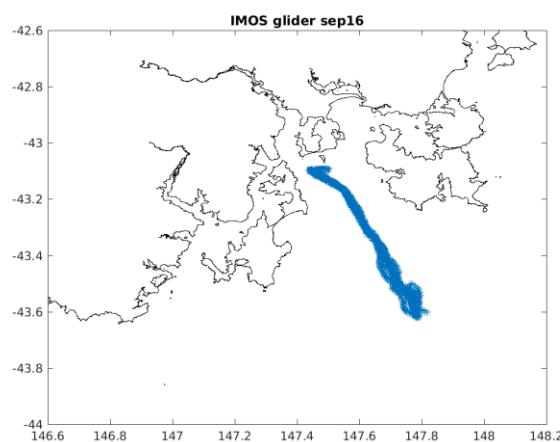


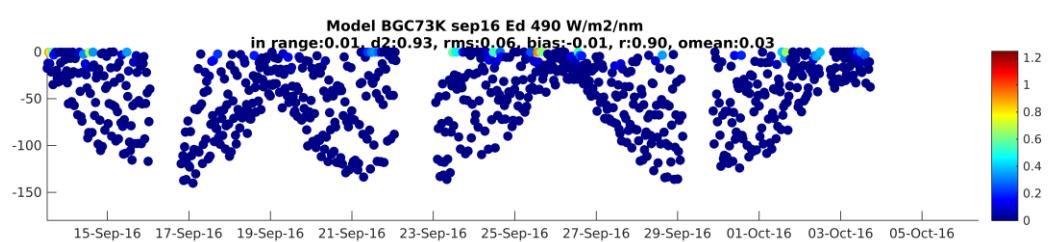
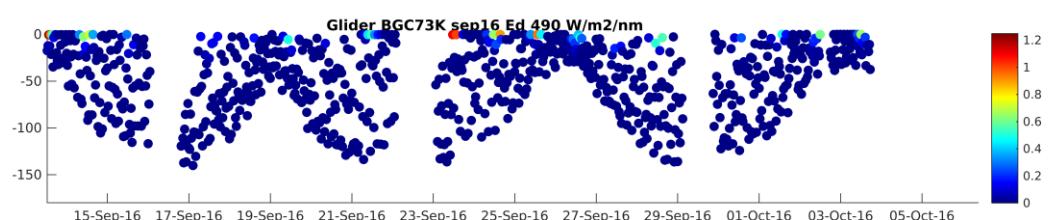
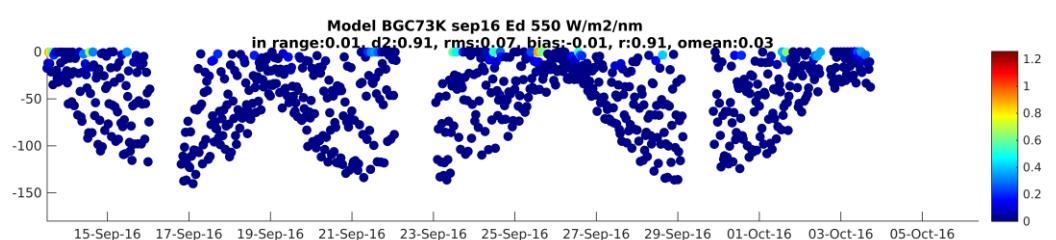
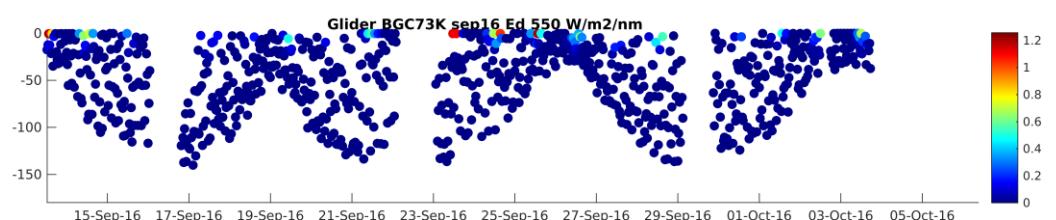
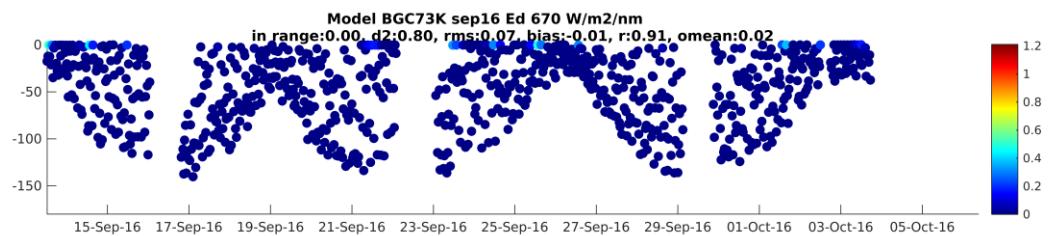
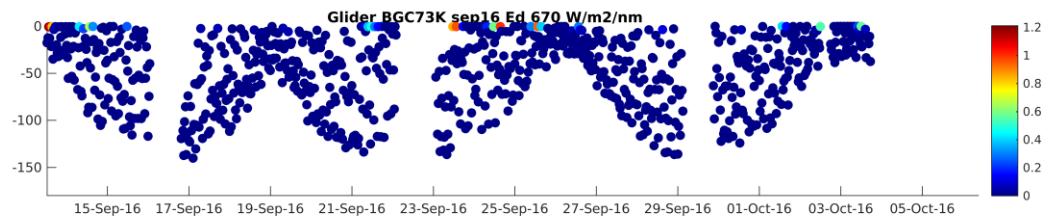


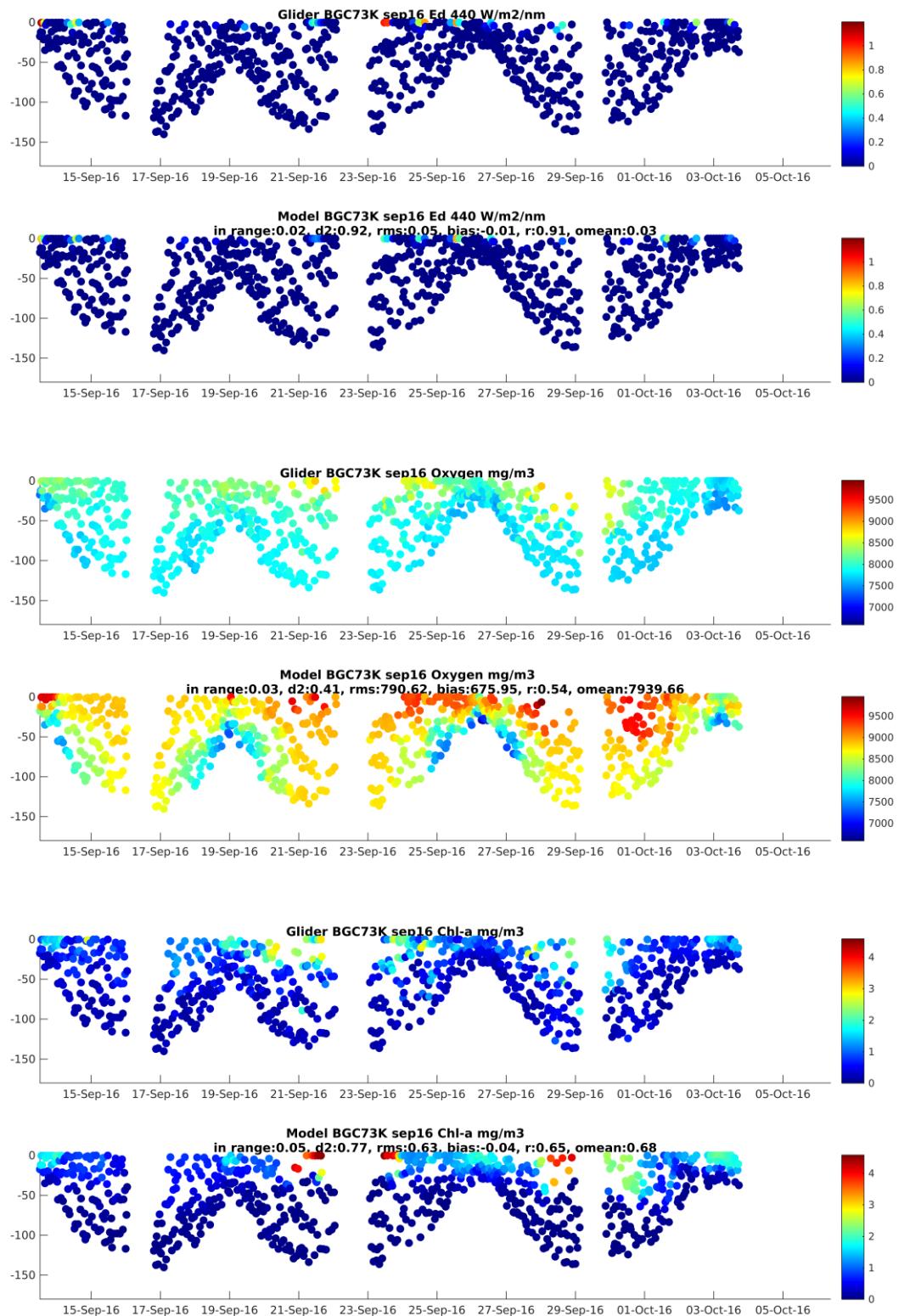


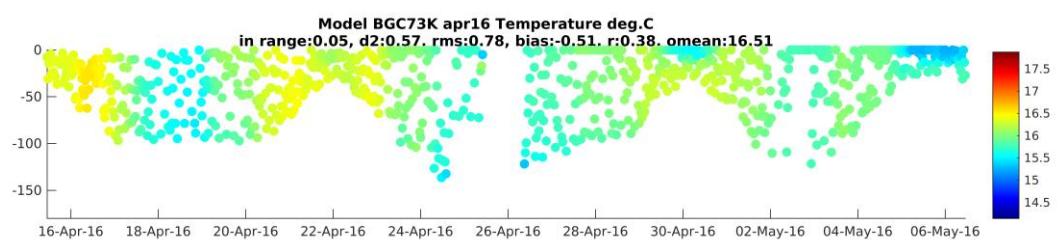
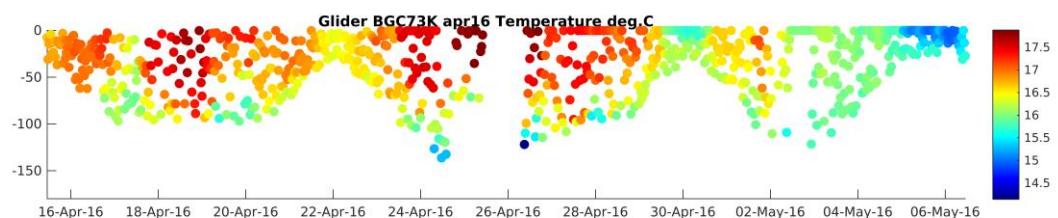
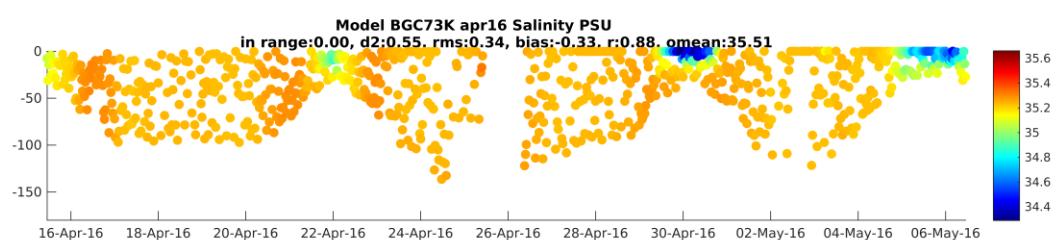
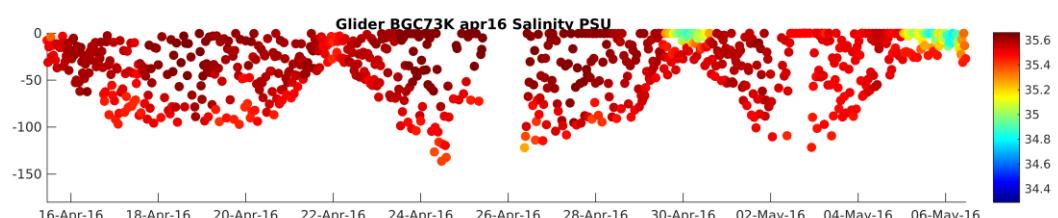
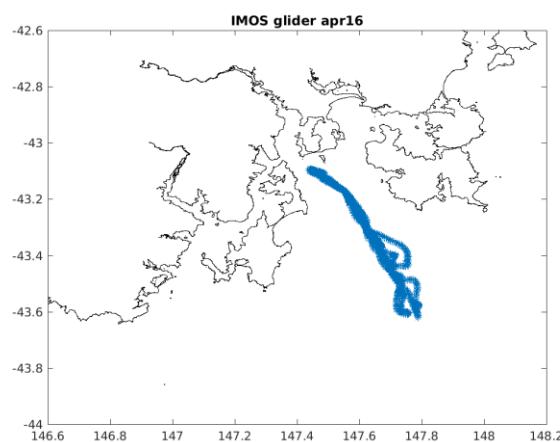


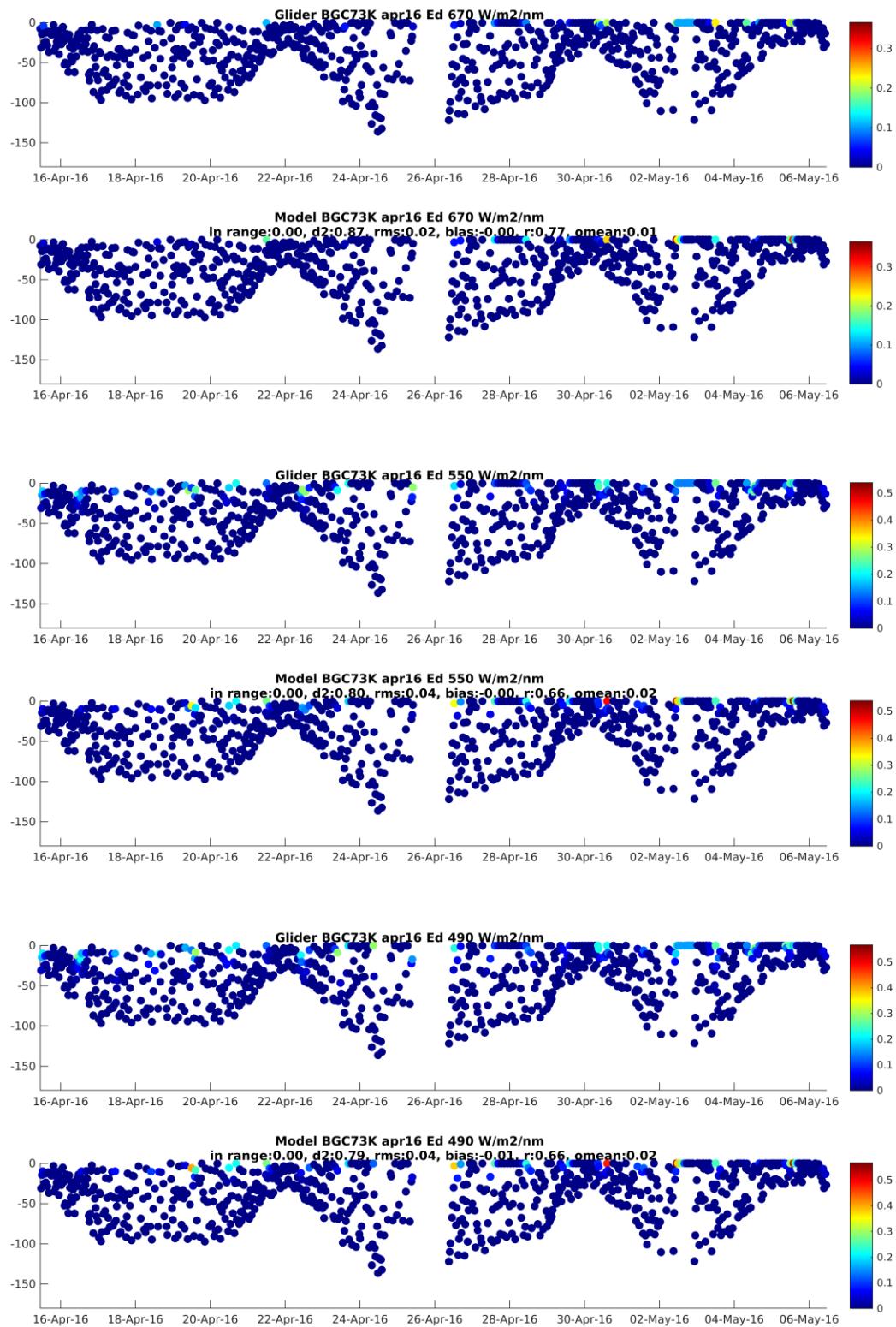


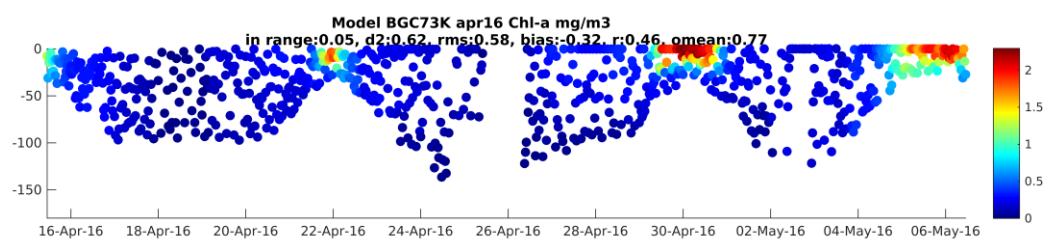
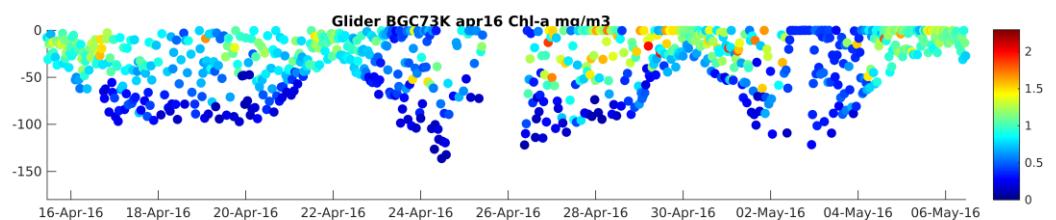
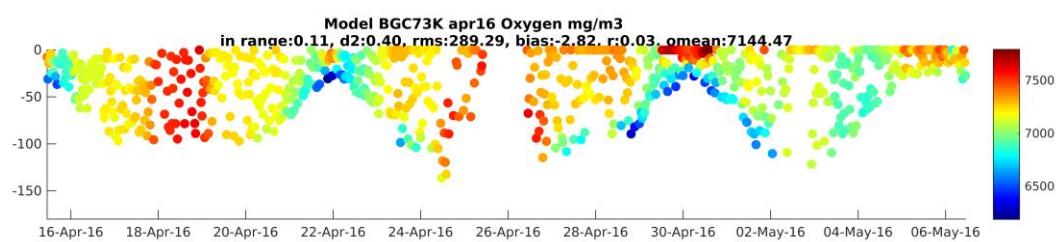
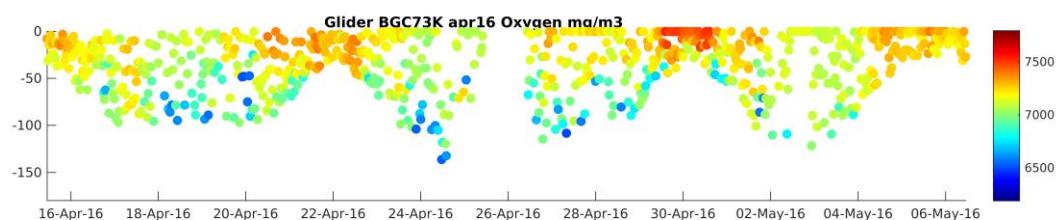
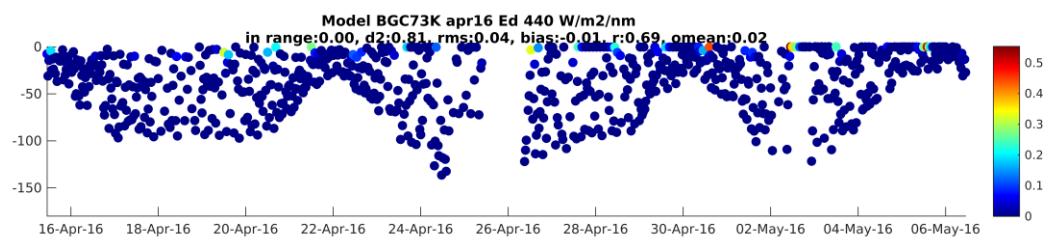
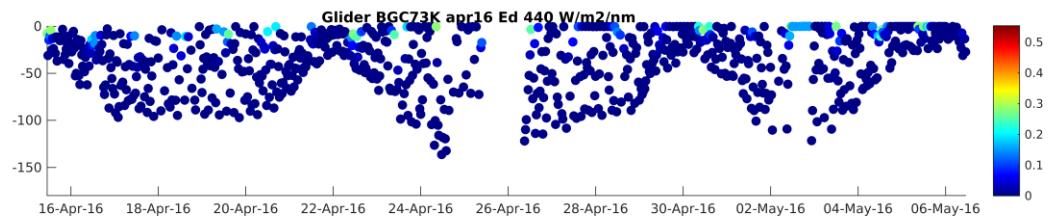


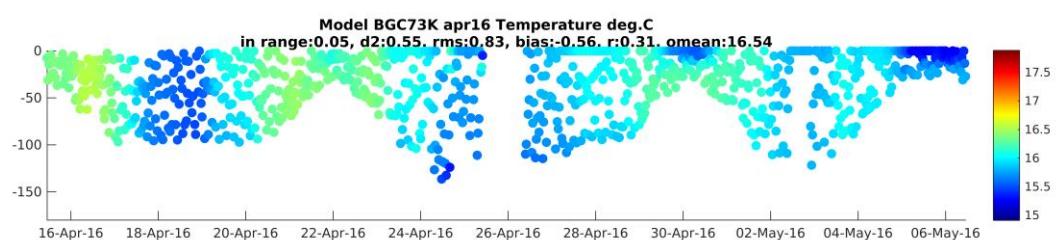
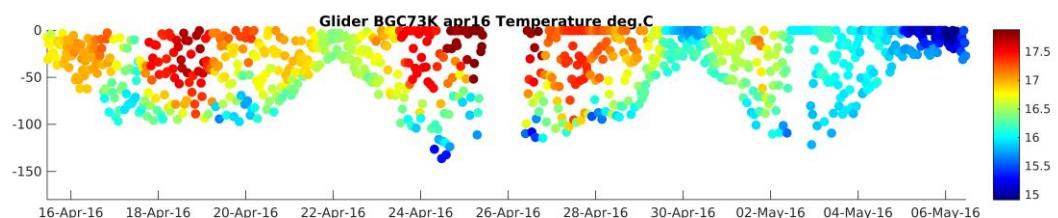
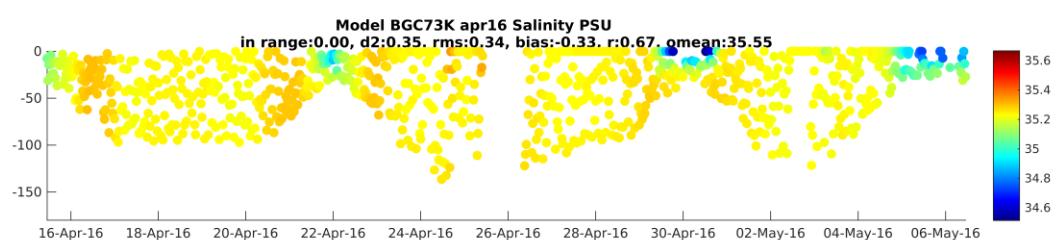
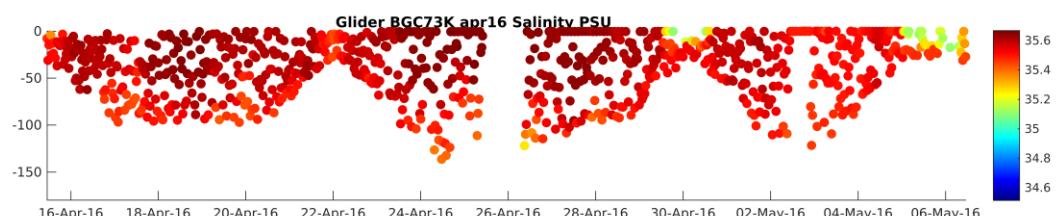
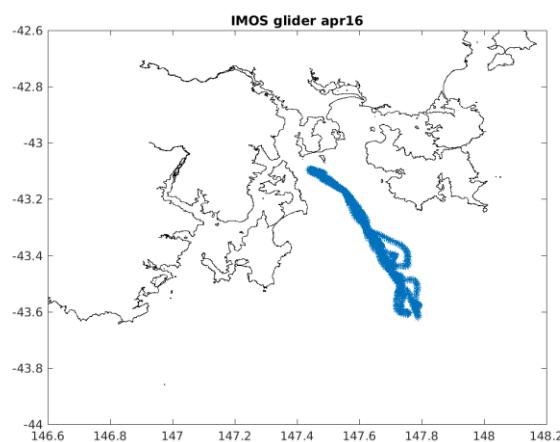


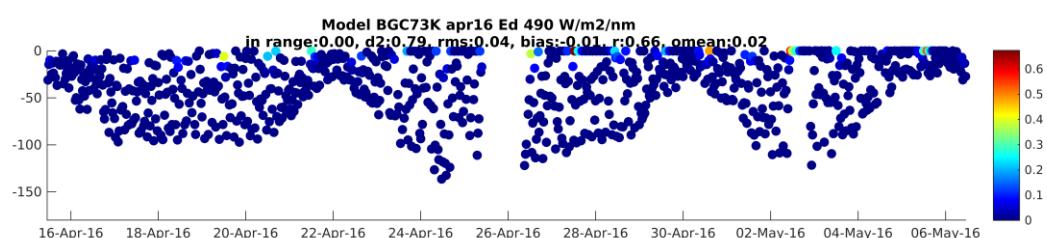
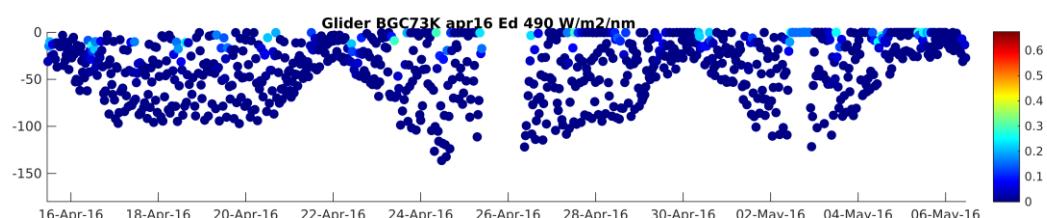
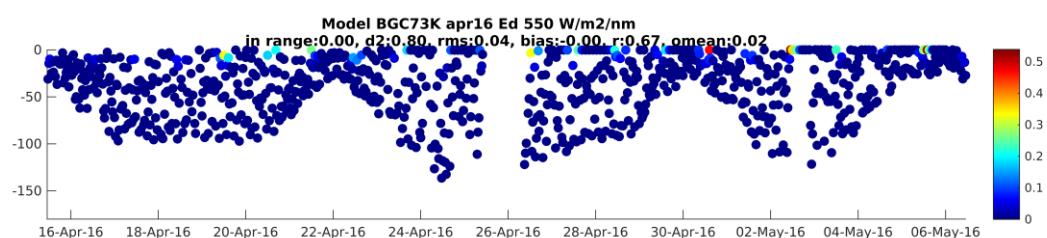
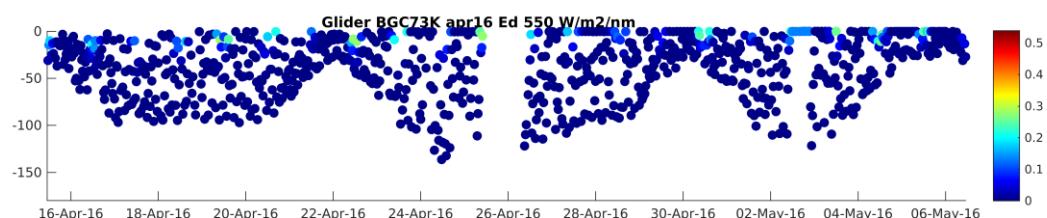
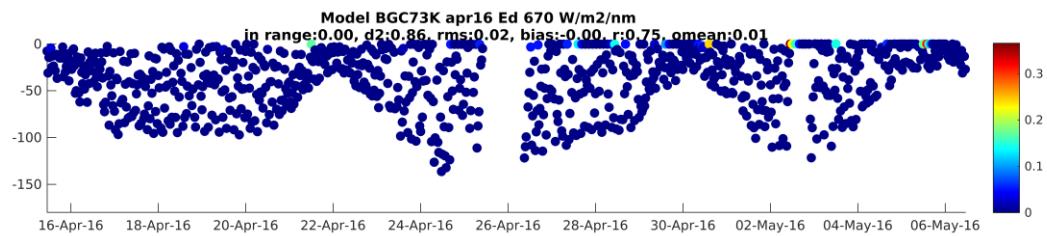
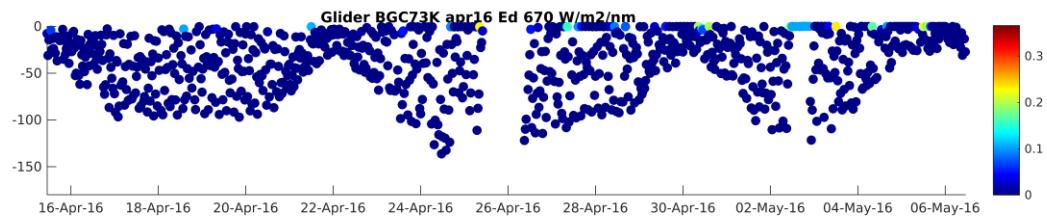


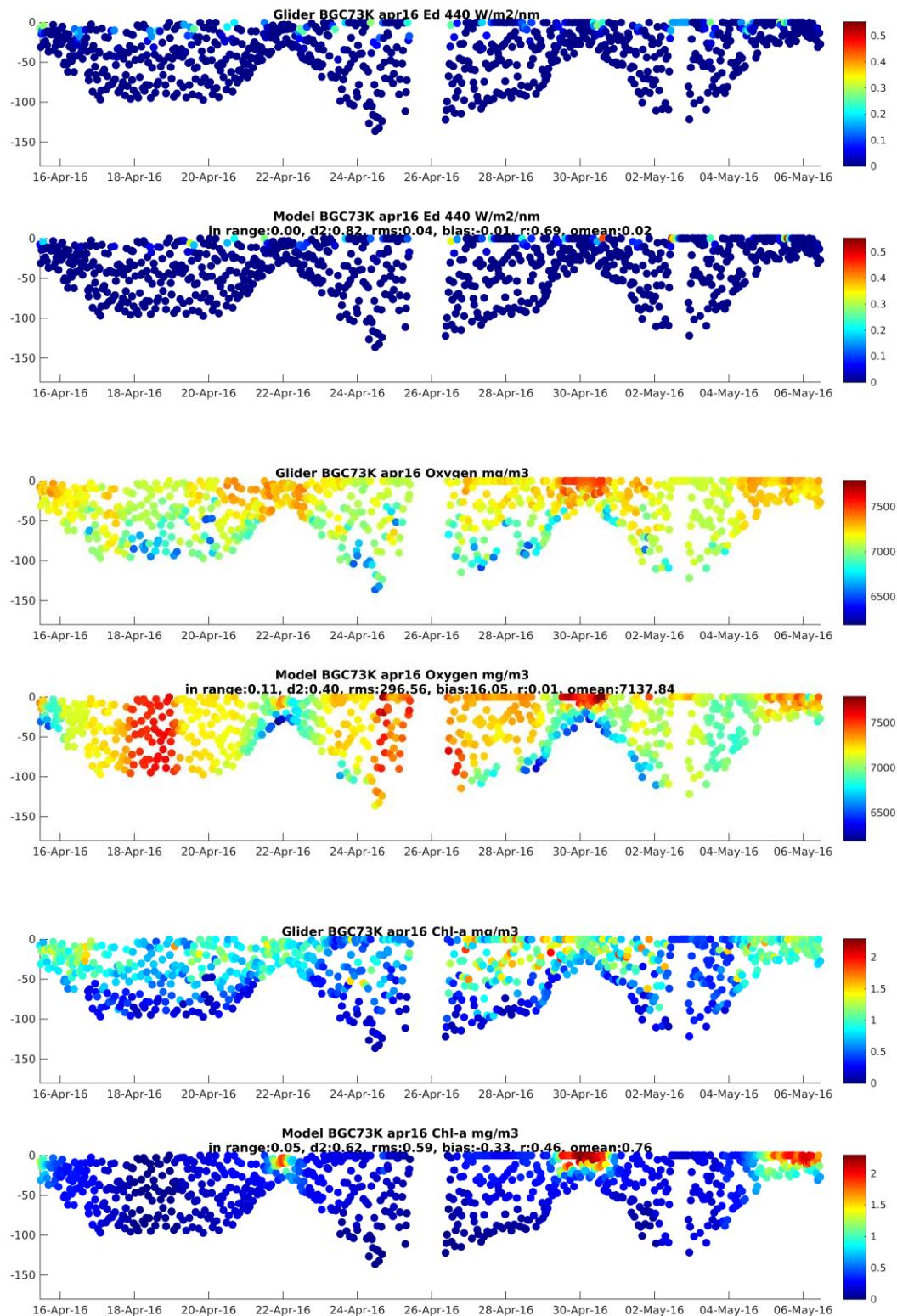


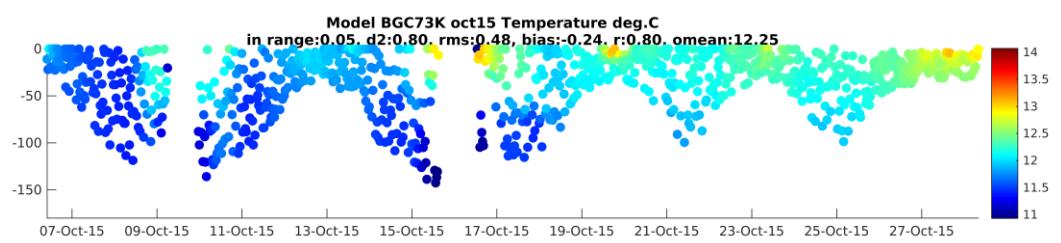
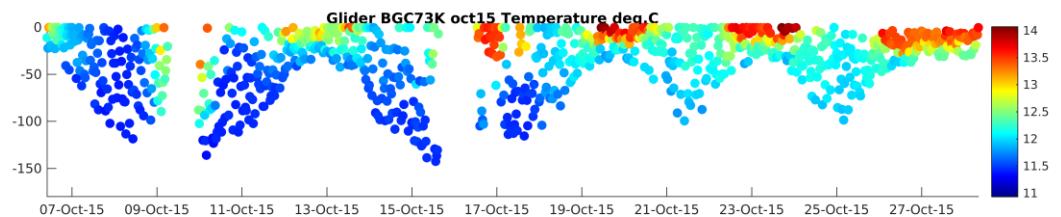
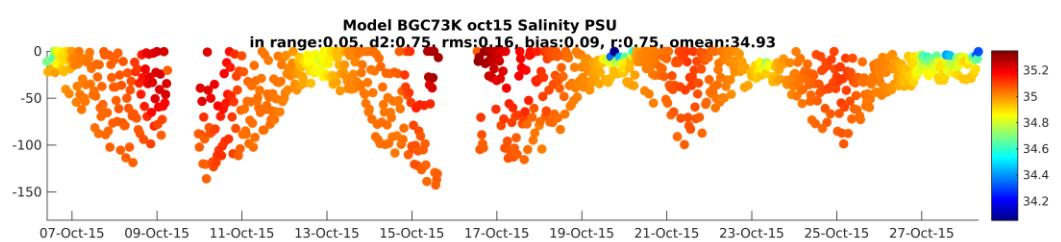
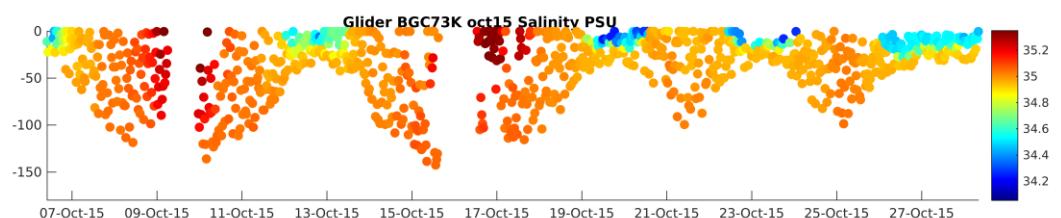
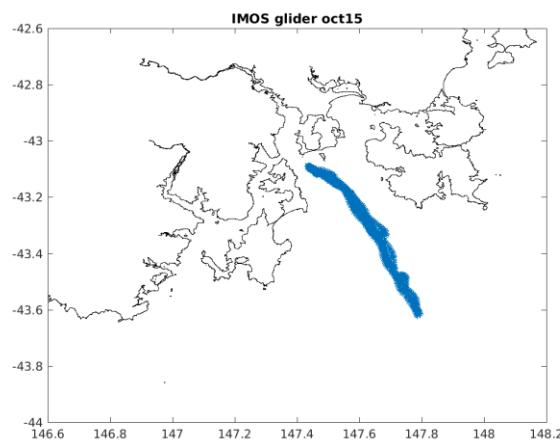


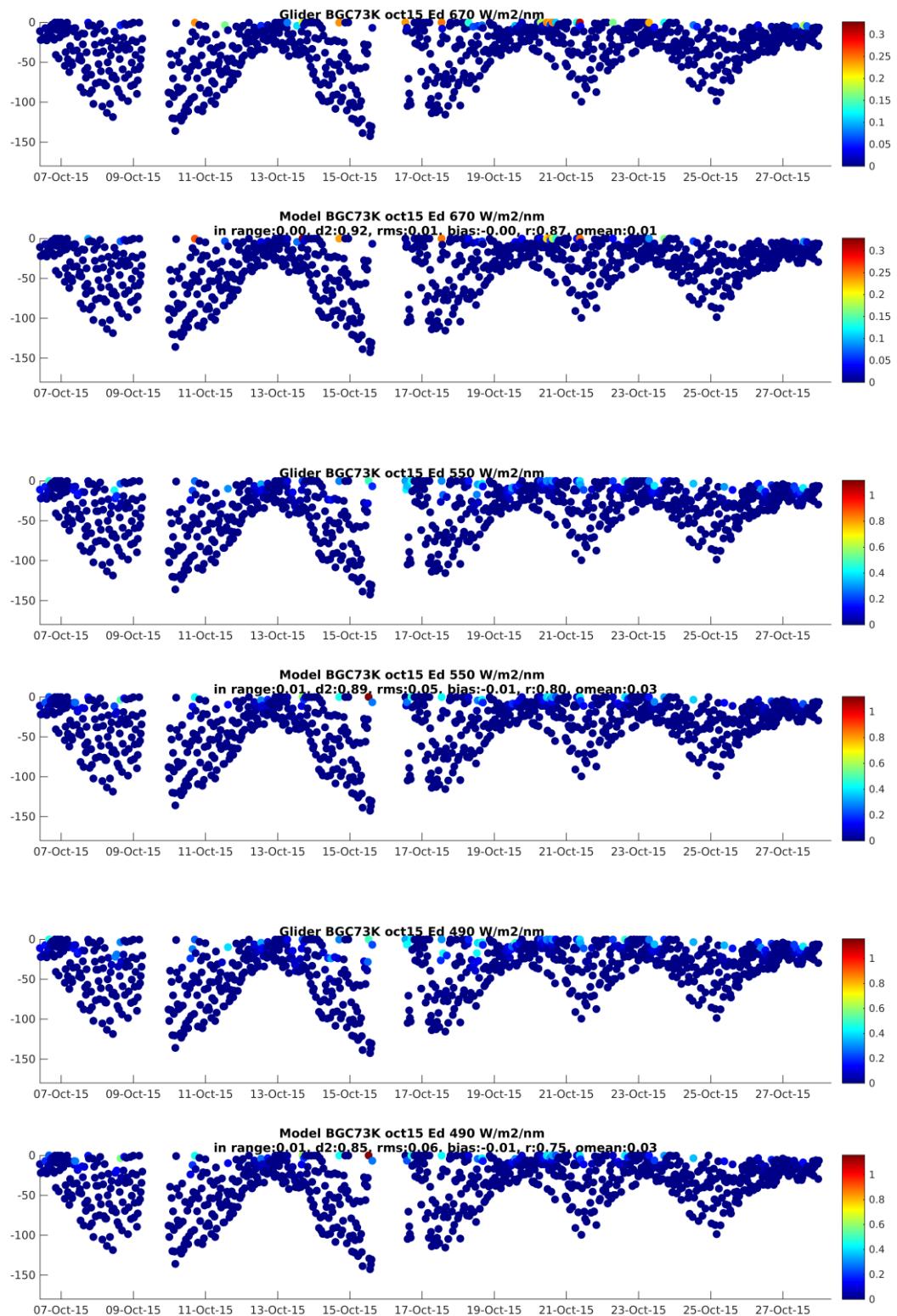


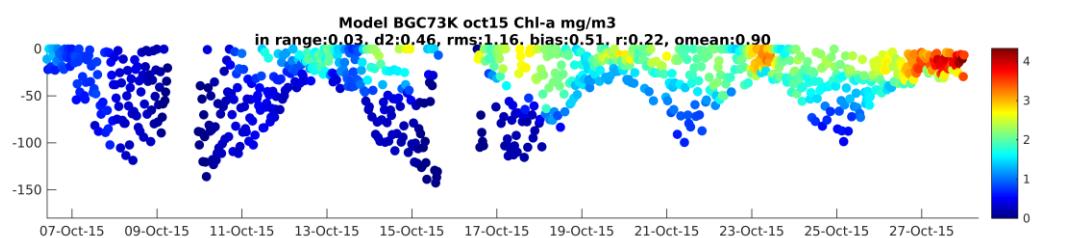
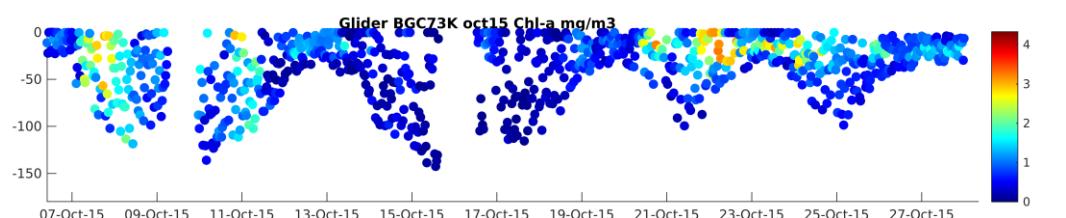
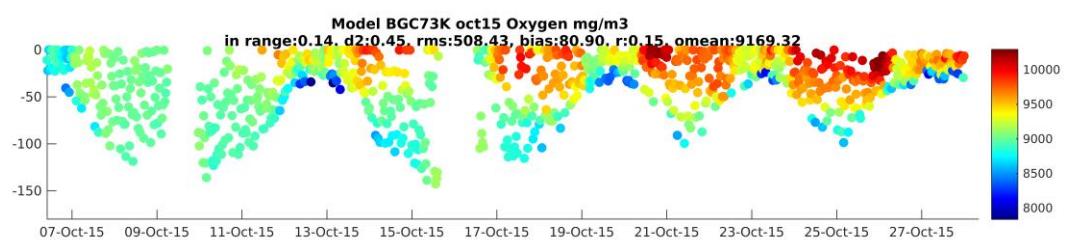
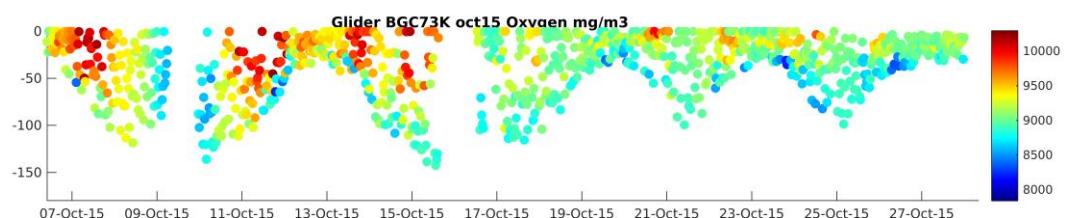
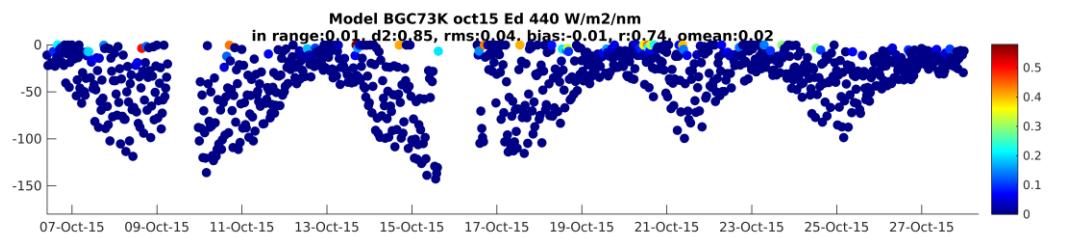
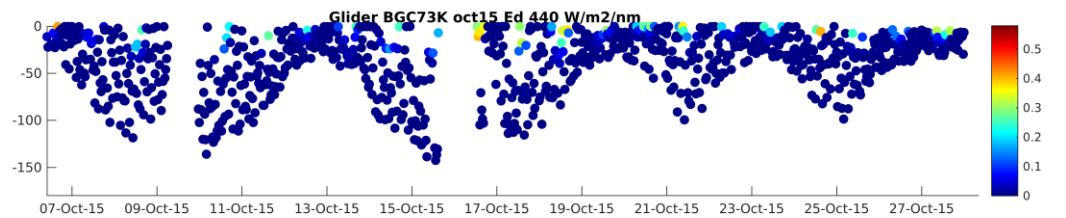


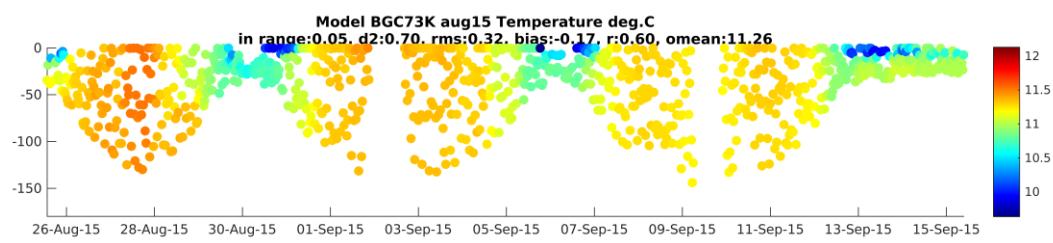
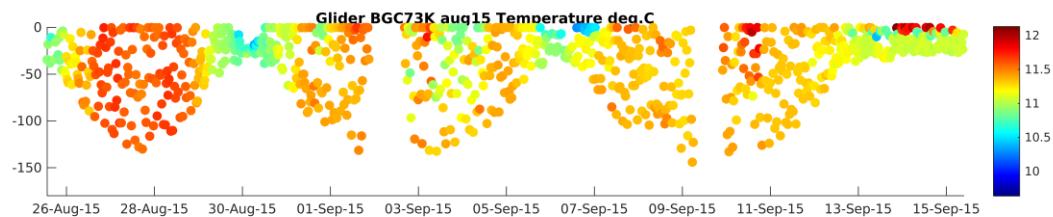
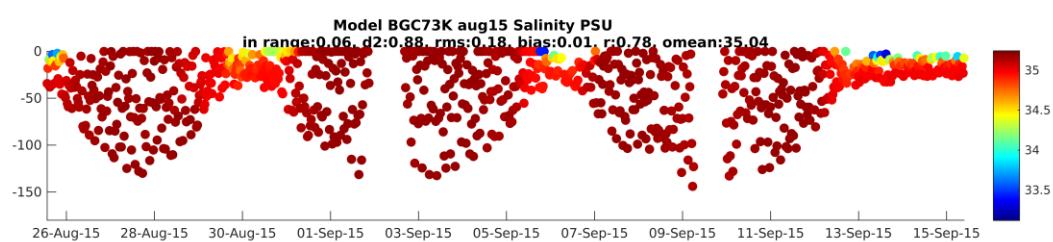
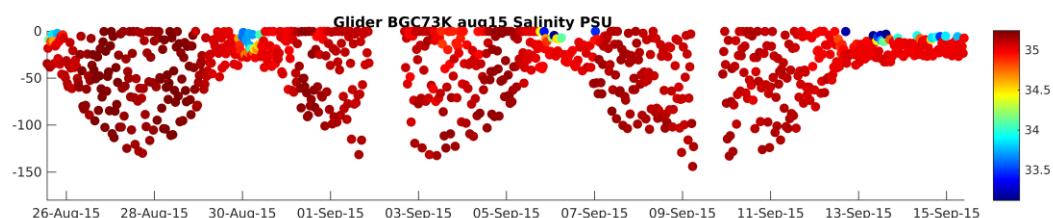
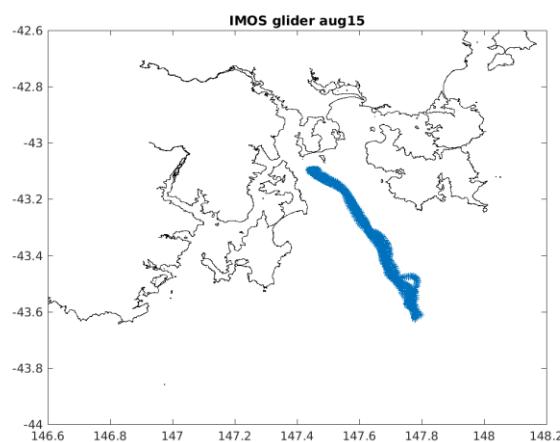


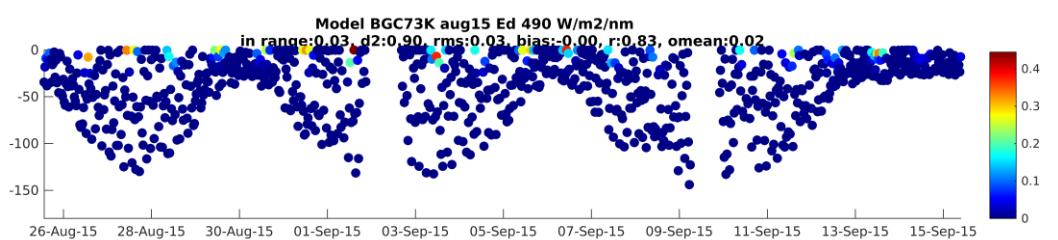
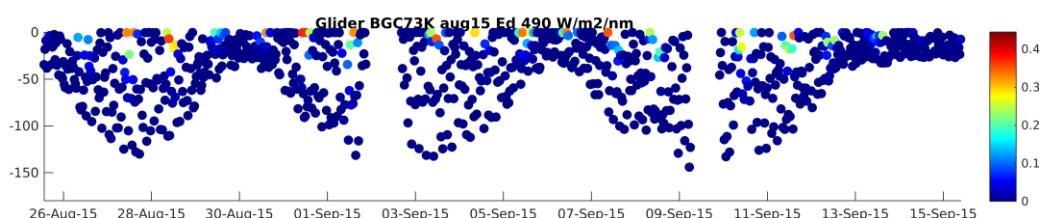
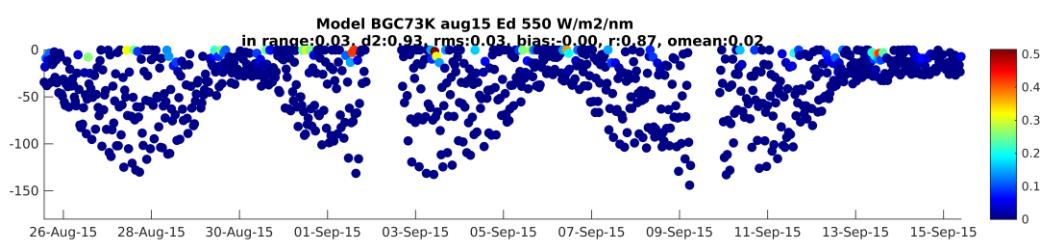
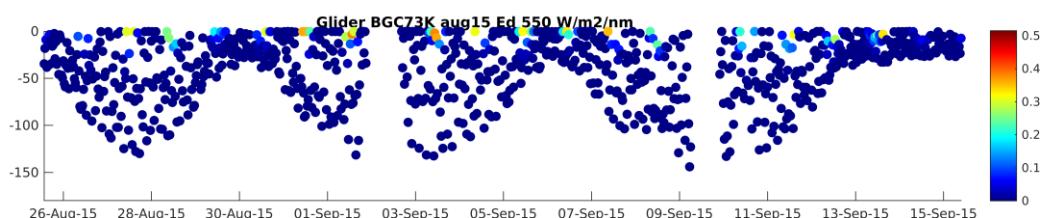
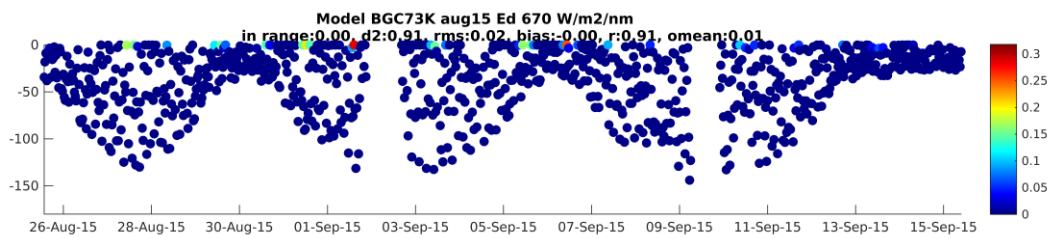
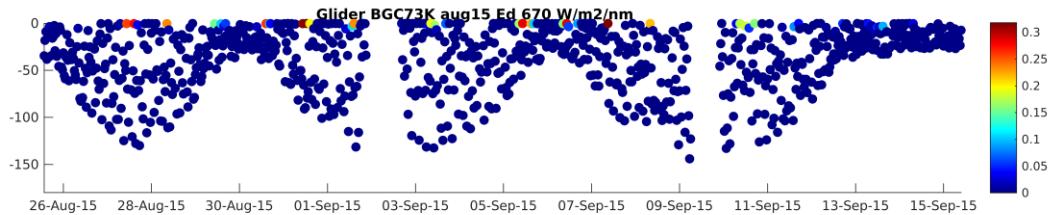


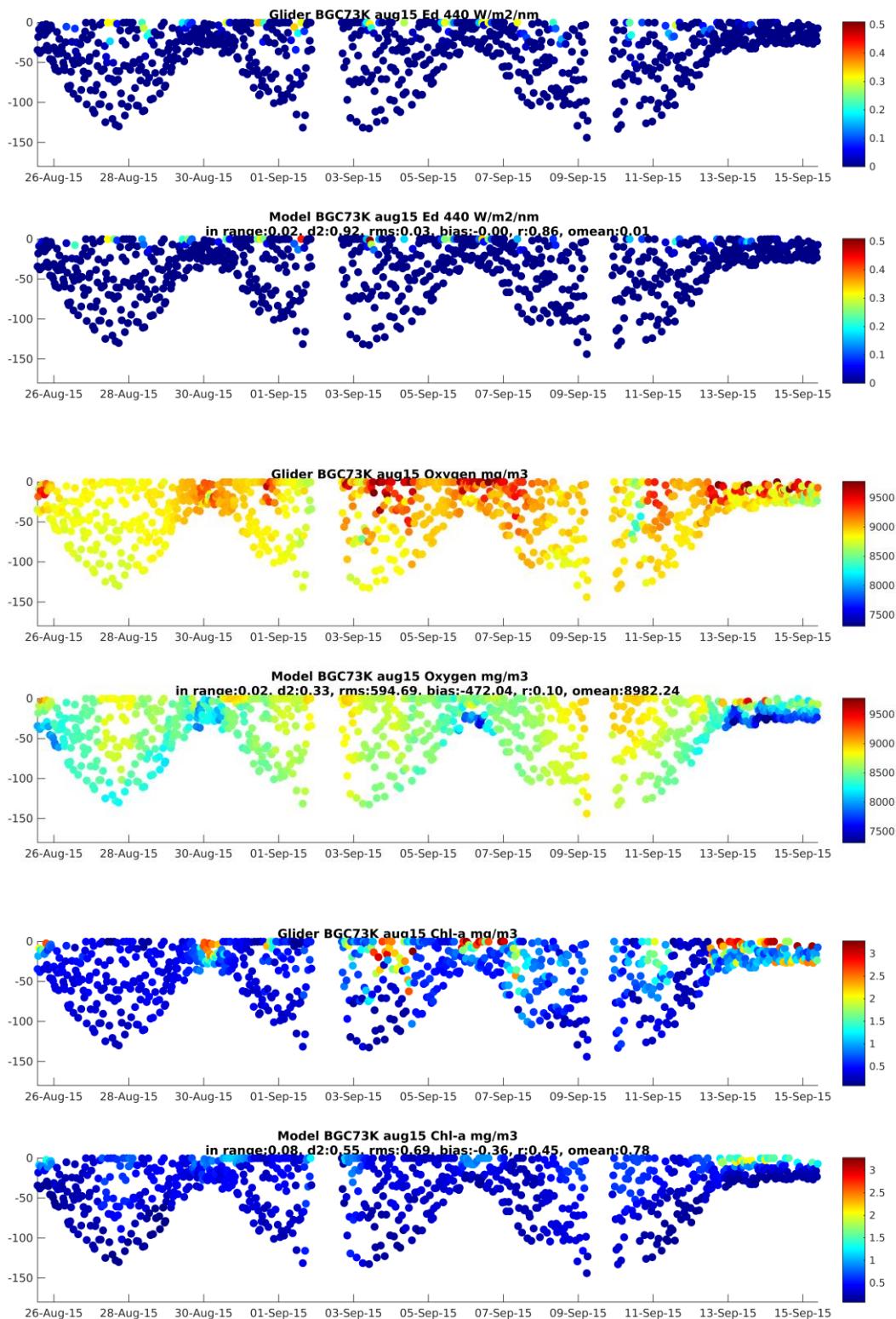


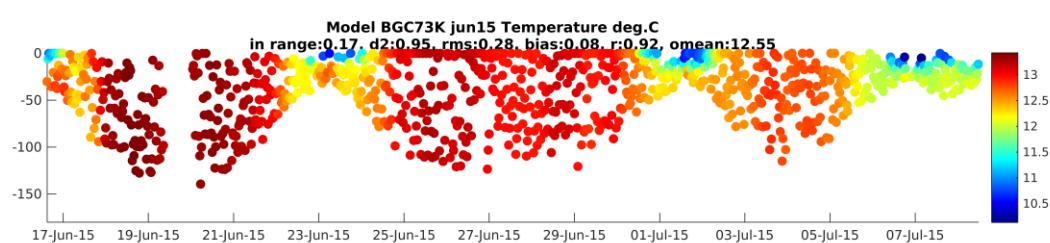
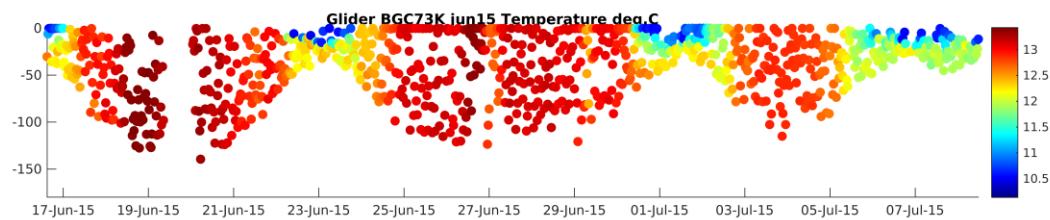
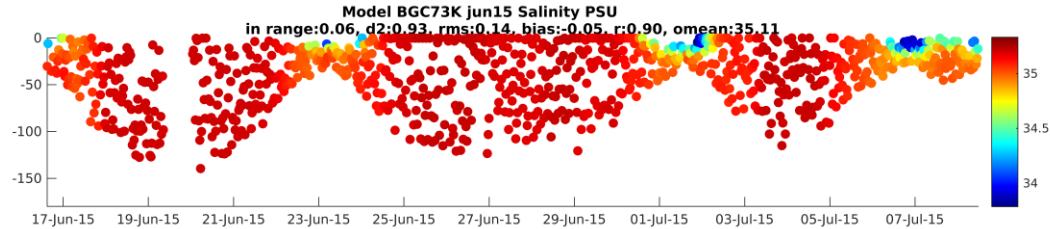
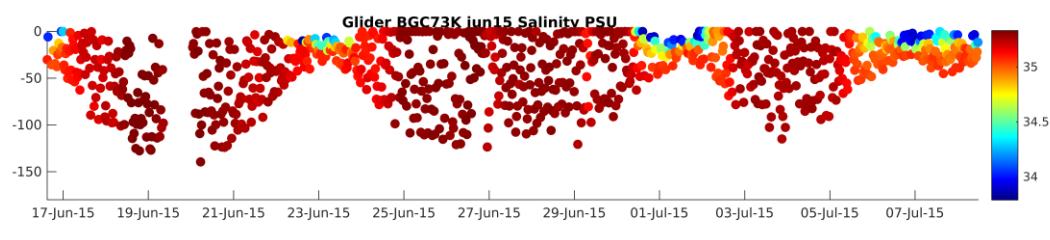
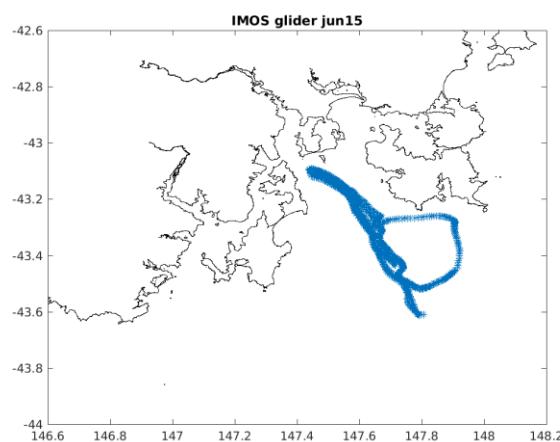


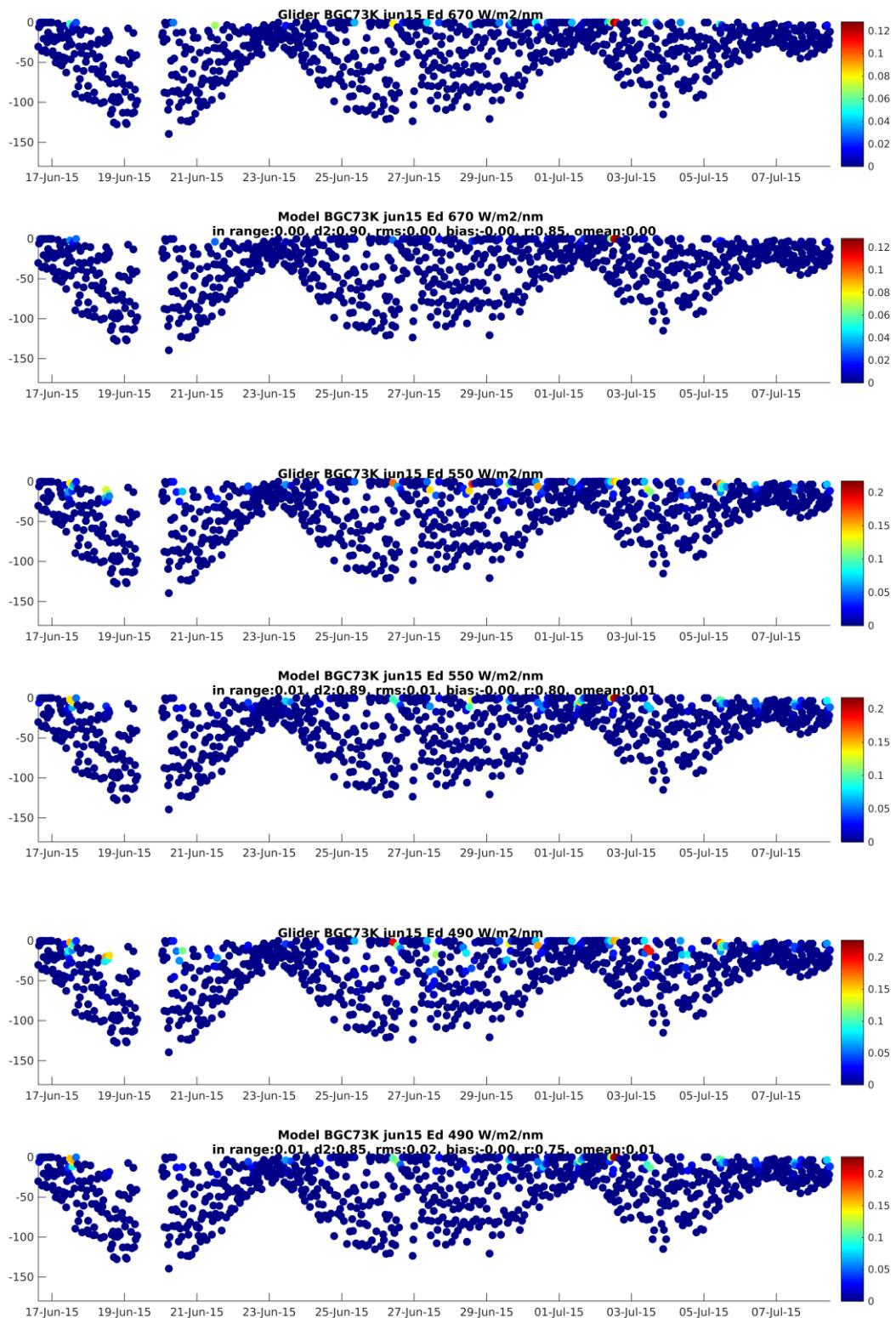


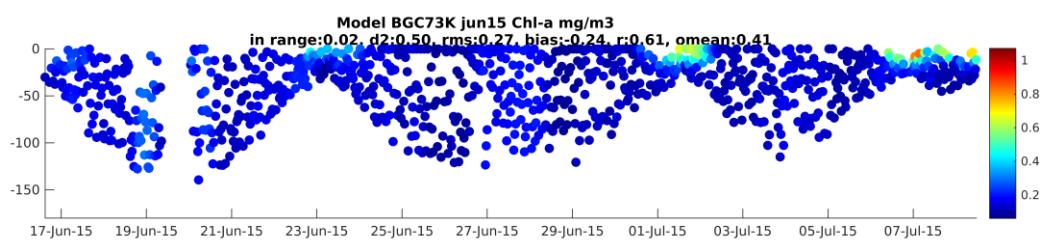
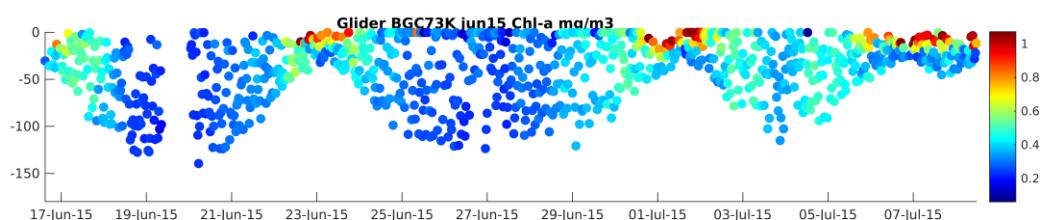
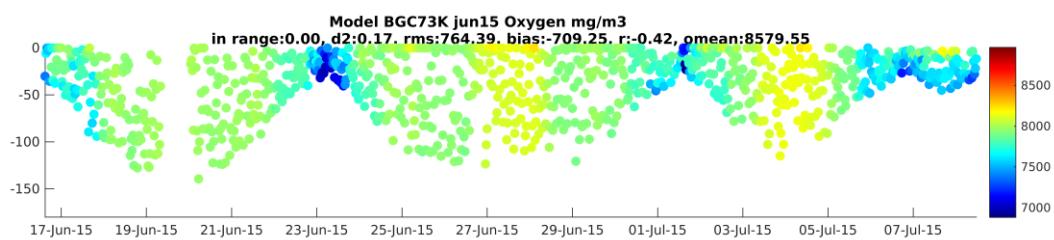
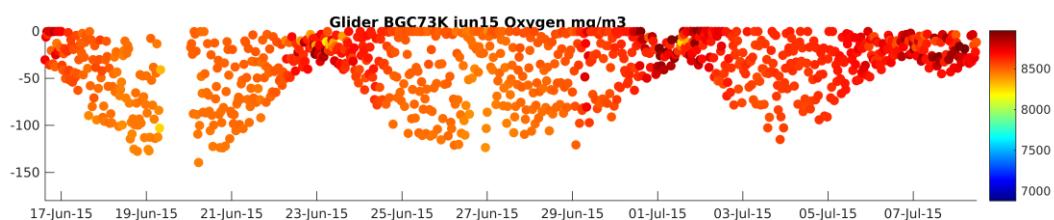
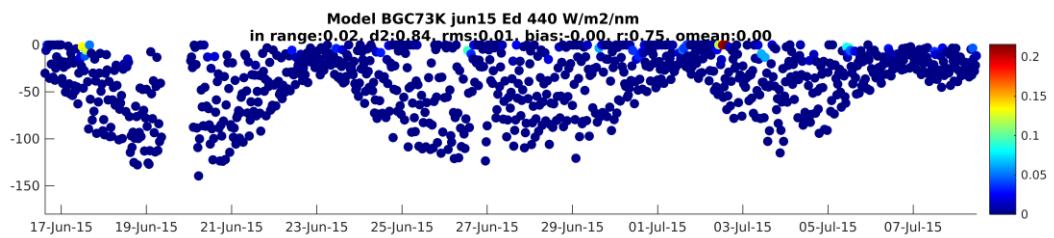
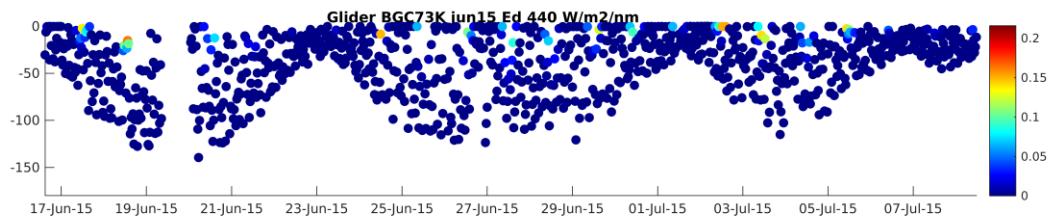


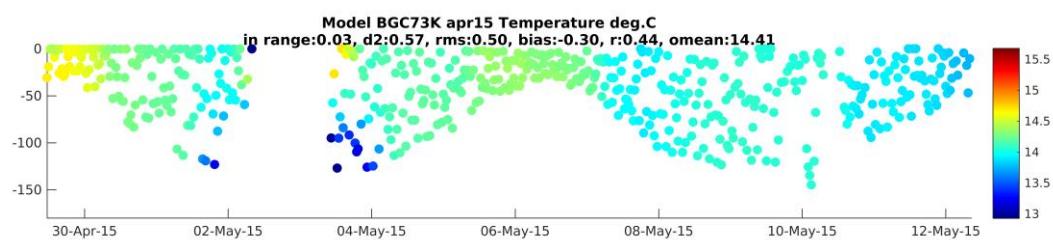
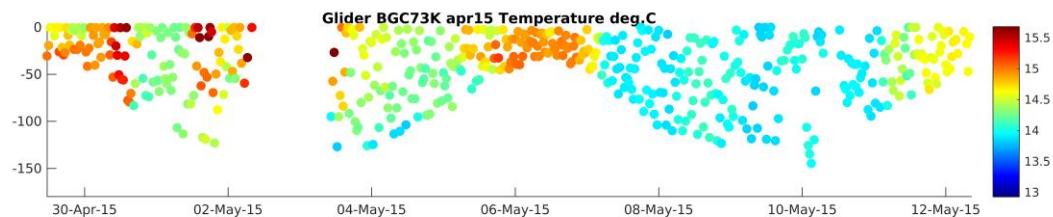
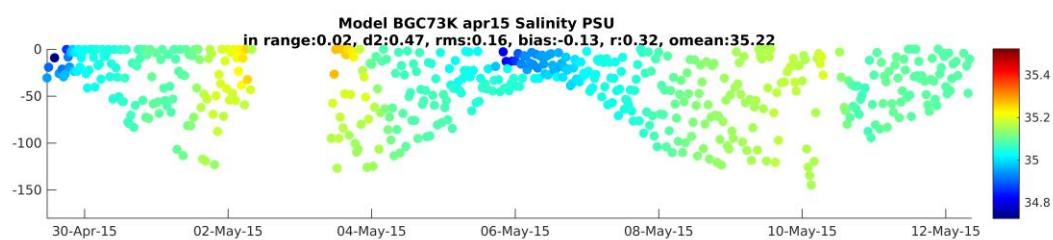
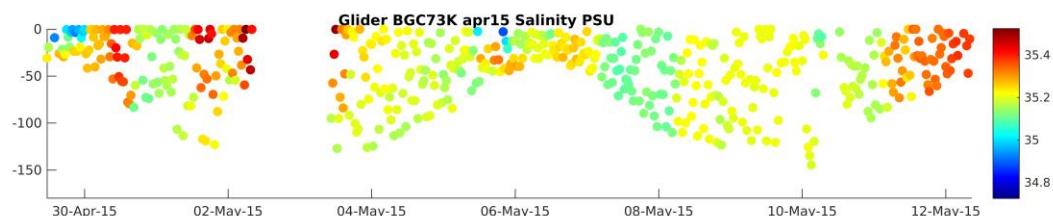
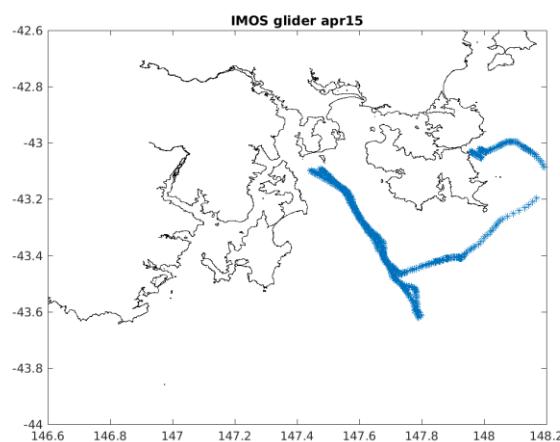


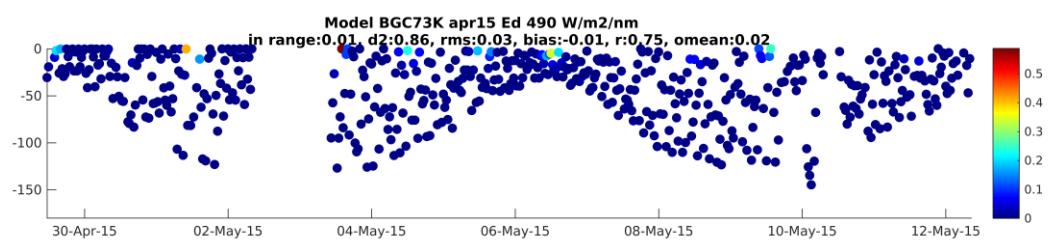
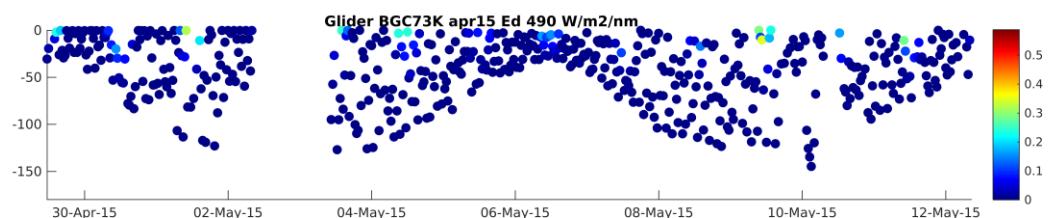
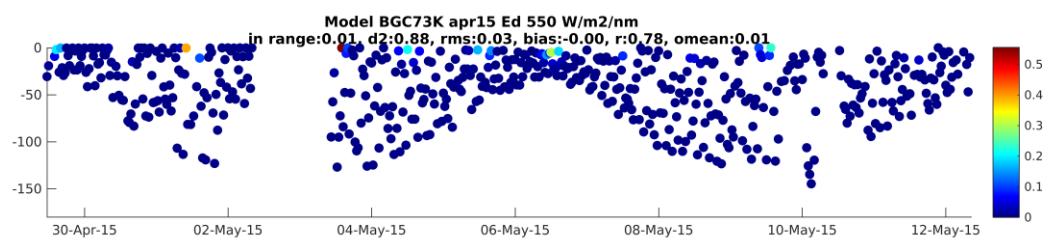
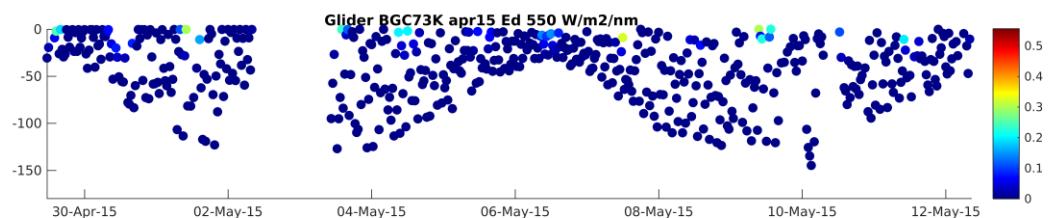
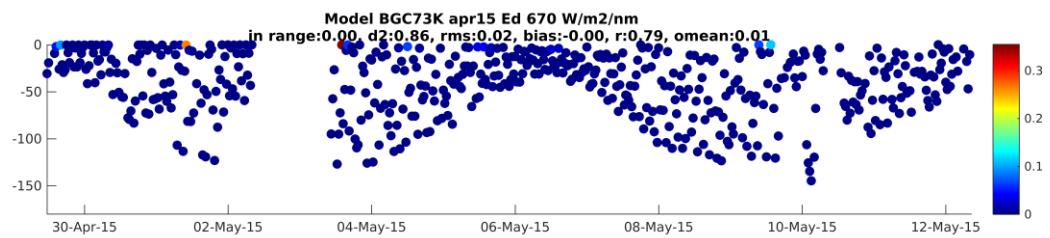
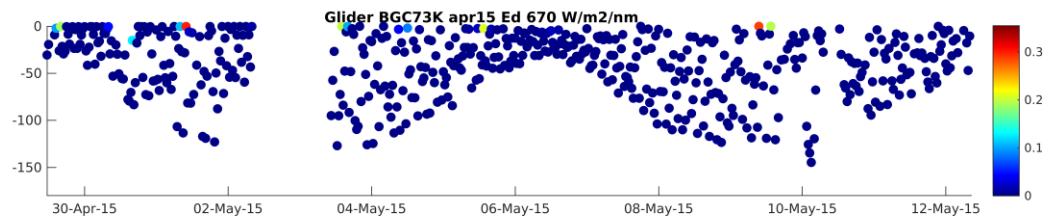


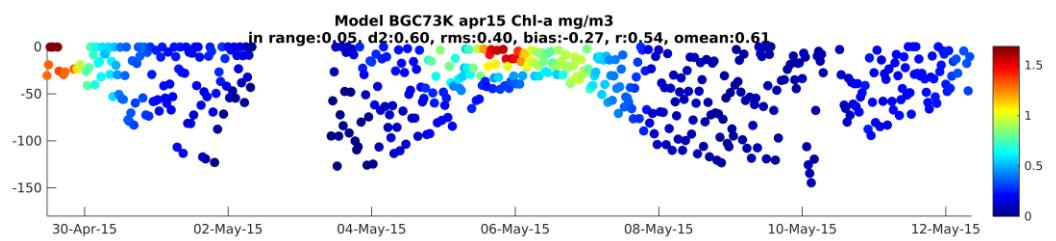
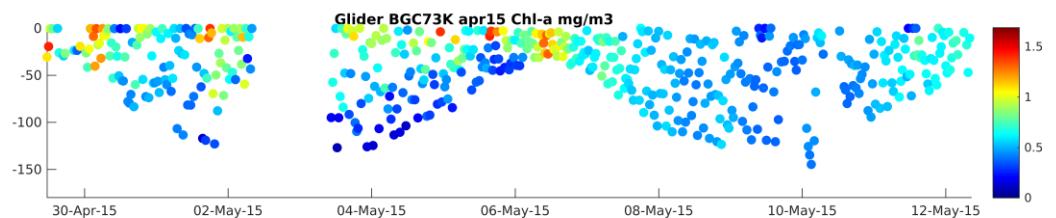
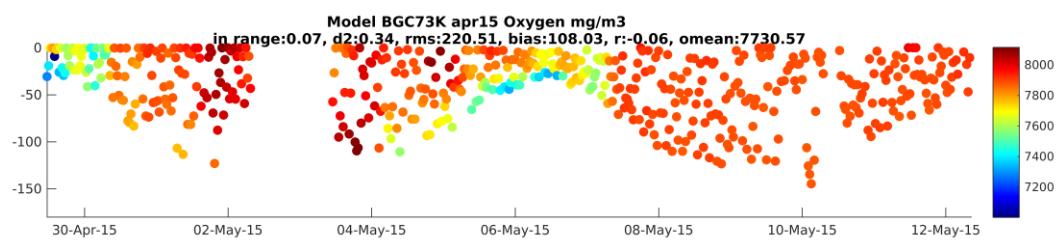
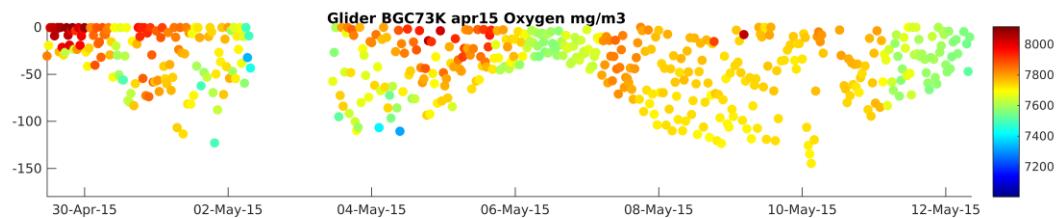
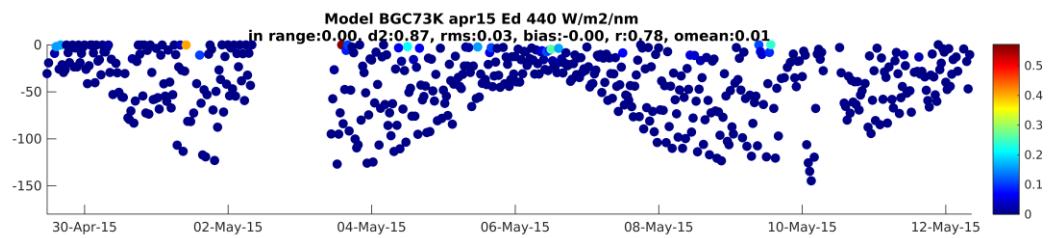
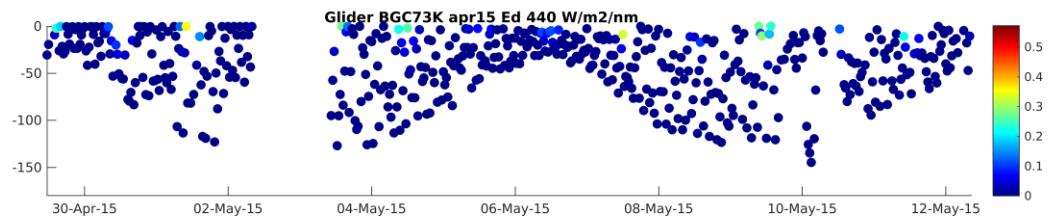


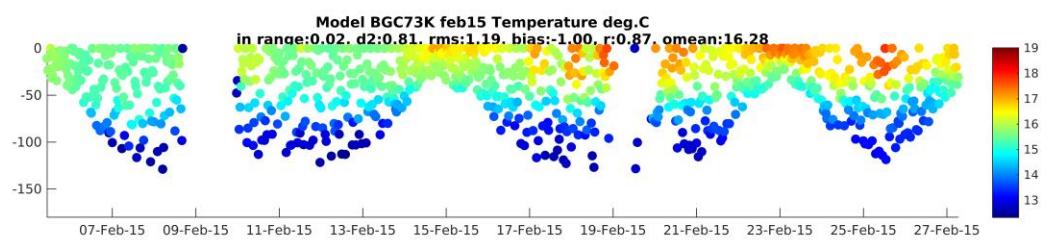
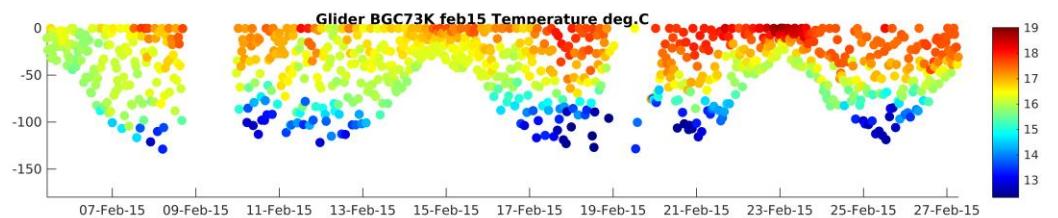
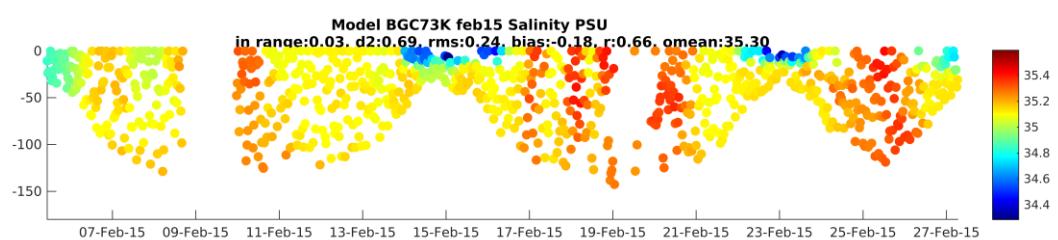
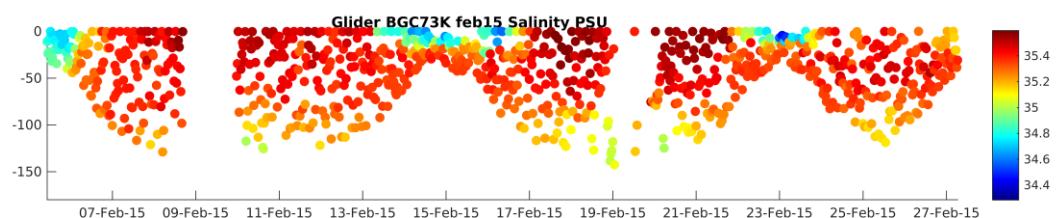
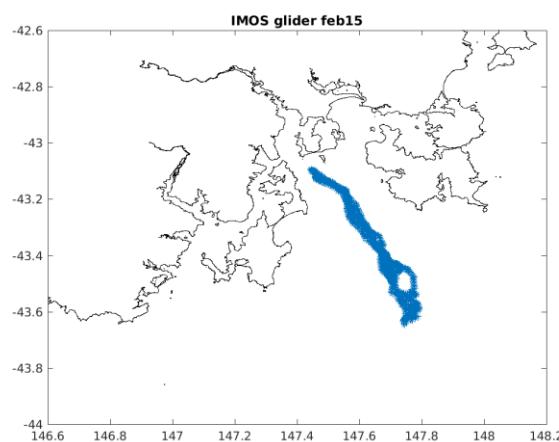


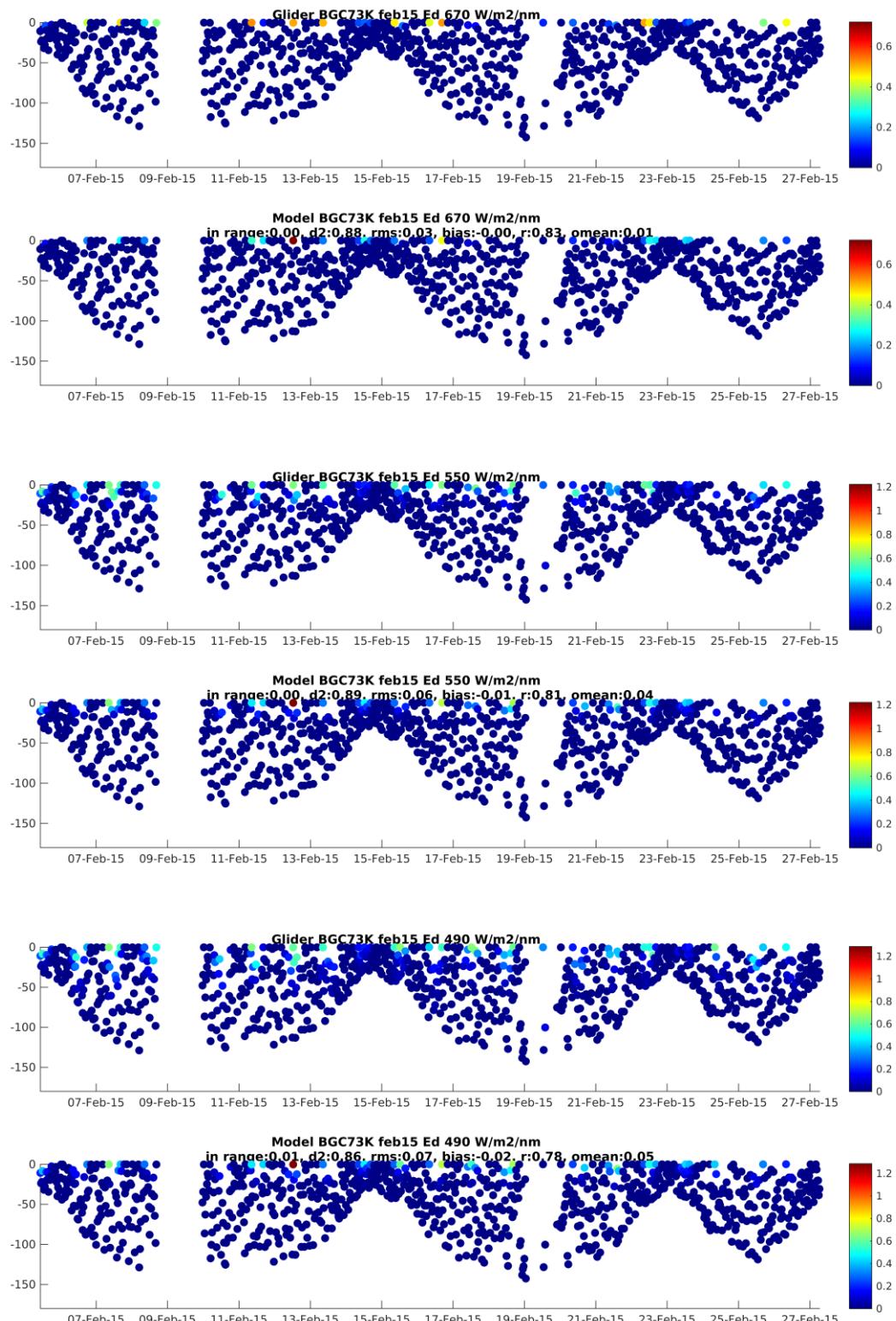


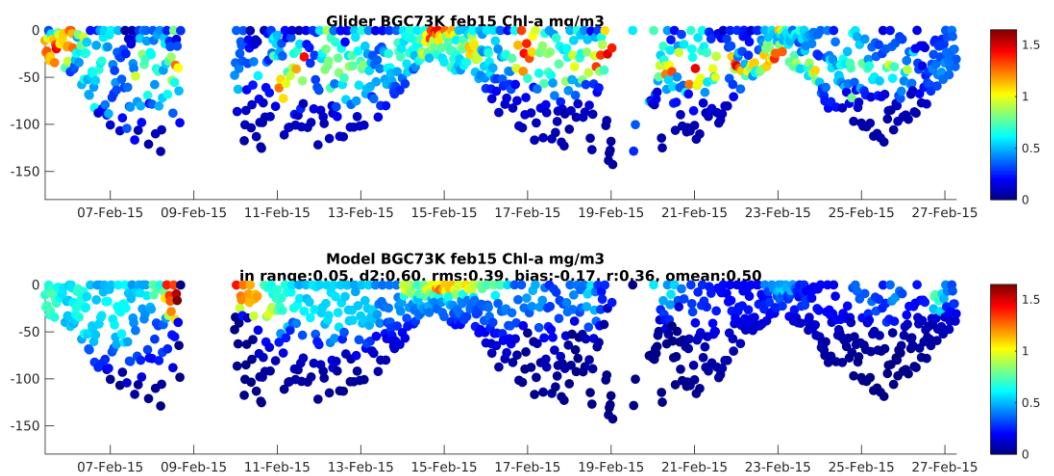
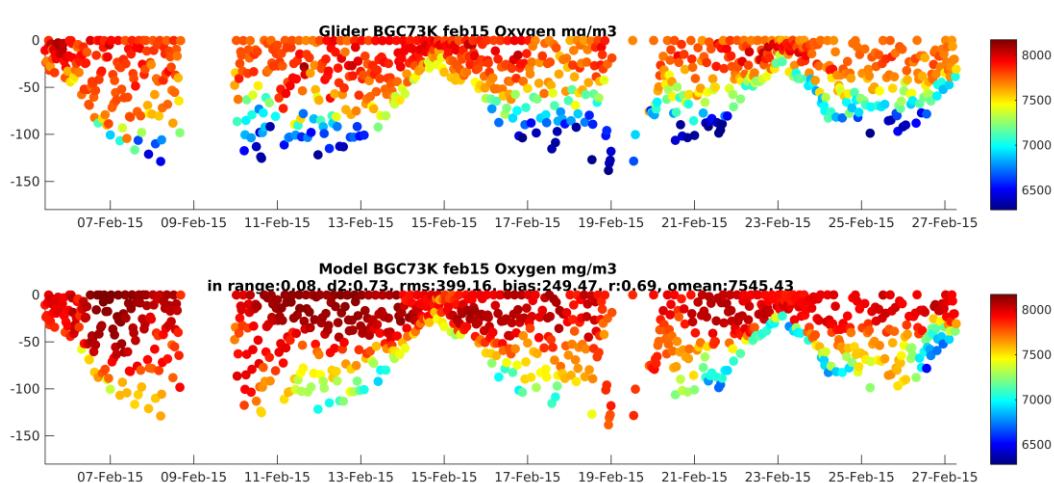
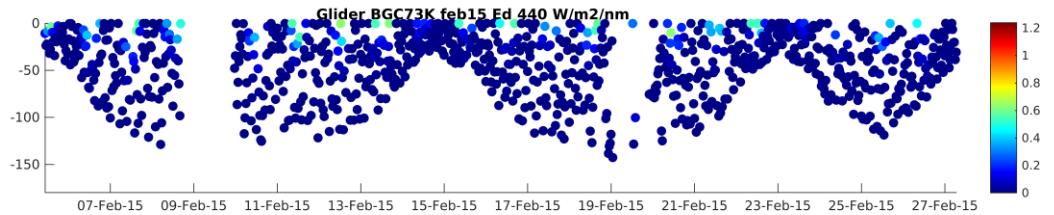












A.6 Biogeochemical model vs monitoring data including statistics

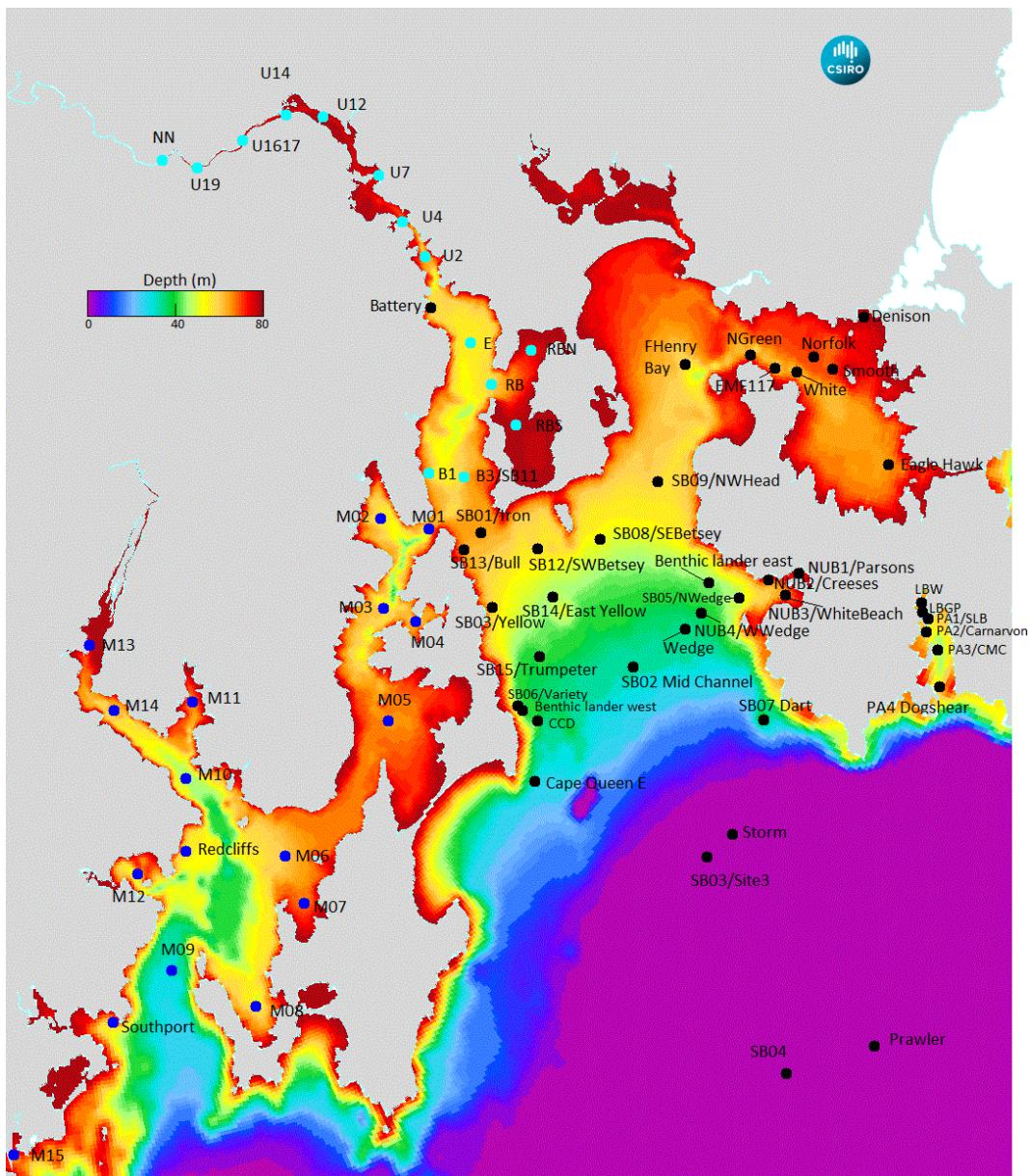


Figure A6.1 Site locations for field observations: ● EPA/IMAS/BEMP Aquenal ● DEP sites; ● Additional EPA/IMAS sites including eastern bays

Table A6.1 Summary statistics for timeseries comparison of observed and simulated water quality at stations throughout the region from 2015 to (May) 2020 [Willmott & Correlation > 0.4 are coloured green, < 0.3 are red, model bias low is blue, model bias high is orange].

BGC73K		Mean Willmott	Mean Correlation	Median Normalised Bias	N. Obs	N.Days	N.Substances
Storm Bay	SB01_Iron	0.57	0.52	0.20	1259	42	11
	SB03_Yellow	0.55	0.43	0.09	377	16	10
	SB08_SEBetsy	0.56	0.51	0.00	395	16	10
	SB09_NWHead	0.51	0.45	0.11	413	16	11
	SB05_NWedge	0.54	0.46	0.20	1550	58	11
	NUB4_SWedge	0.61	0.49	0.00	1552	63	9
	SB02_Mid	0.60	0.49	0.01	453	15	11
	SB06_Variety	0.54	0.39	0.04	464	16	11
	SB04_CQE	0.53	0.27	-0.02	473	16	10
	SB03_site3	0.59	0.92	0.02	54	2	4
	SB07_Dart	0.53	0.33	-0.02	523	14	10
	SB11_Evariety	0.54	0.51	0.50	167	10	7
	SB12	0.48	0.52	0.45	167	10	7
	SB13	0.45	0.43	0.45	167	10	7
	SB14	0.45	0.42	-0.03	167	10	7
	SB15	0.48	0.32	0.03	167	10	7
Fredrick Henry & Norfolk Bay	FHenryB	0.53	0.51	0.21	210	6	10
	Ngreen	0.46	0.35	0.23	192	6	10
	EMF117	0.51	0.37	0.24	492	6	10
	NB2_EMF117N	0.46	0.41	0.24	438	6	10
	White	0.55	0.43	0.27	210	6	10
	Norfolk	0.52	0.50	0.34	126	6	10
	Smooth	0.49	0.43	0.48	192	6	10
	Denison	0.48	0.40	0.32	84	6	10
	Eaglehawk	0.45	0.40	0.20	174	6	10
Nubeen	NUB2_Creeses	0.52	0.50	0.10	1406	64	9
	NUB3_WhiteB	0.60	0.53	-0.01	1396	64	9
	NUB1	0.53	0.48	0.12	1386	64	9
Port Arthur	PA4_Dog	0.60	0.50	-0.03	1629	65	10
	PA3_CMC	0.64	0.51	-0.02	1663	65	10
	PA2_Carnarvon	0.64	0.51	-0.01	1611	65	10
	PA1_SLB	0.61	0.57	0.00	1490	65	10
	LBGP	0.44	0.29	0.06	273	13	10
	PA6	0.45	0.06	-0.07	179	9	10
Derwent	SB11_B3	0.61	0.58	0.13	1275	26	10
	B3	0.60	0.55	0.05	2833	64	9
	B1	0.59	0.51	0.02	2974	64	9
	RB	0.80	0.75	0.00	2120	54	3
	RBS	0.77	0.77	-0.06	677	54	3
	RBN	0.48	0.39	0.25	1925	64	9
	E	0.59	0.51	0.14	2919	63	9
	NN	0.78	0.83	-0.03	1892	60	9
D'Entrecasteaux	M15	0.55	0.41	0.06	1613	83	9
	M09	0.63	0.56	-0.01	1613	83	9
	M08	0.63	0.58	0.04	1613	83	9
	M07	0.59	0.52	0.04	1612	83	9
	M06	0.61	0.56	0.07	1613	83	9
	M12	0.68	0.65	0.00	1613	83	9
	M10	0.61	0.59	0.14	1613	83	9
	M11	0.53	0.51	0.24	1613	83	9
	M14	0.57	0.55	0.15	1613	83	9
	M13	0.53	0.42	0.12	1613	83	9
	M05	0.56	0.53	0.42	1613	83	9
	M03	0.60	0.55	0.26	1613	83	9
	M04	0.58	0.57	0.30	1613	83	9
	M02	0.62	0.61	0.14	1613	83	9
	M01	0.61	0.58	0.15	2503	109	10

Table A6.2 Summary statistics for each observed substance from timeseries comparison of observed and simulated water quality at stations throughout the region from 2015 to (May) 2020 [Willmott & Correlation > 0.4 are coloured green, < 0.3 are red, model bias low is blue, model bias high is orange].

	Mean Willmott	Mean Correlation	Median Normalised Bias	N. Obs	N.days	N.Sites
Temp deg.C	0.96	0.96	-0.02	12423	2421	55
Salinity psu	0.68	0.63	0.00	12330	2412	55
Oxygen mg/m3	0.69	0.62	-0.05	10695	2325	55
All Chl-a mg/m3	0.44	0.20	-0.13	2578	2419	63
NO3 mg/m3	0.56	0.66	1.79	5419	2462	57
NH4 mg/m3	0.27	0.21	0.96	5419	2458	57
TN mg/m3	0.59	0.40	0.03	5419	2462	57
DIP mg/m3	0.58	0.58	0.43	5419	2462	57
TP mg/m3	0.47	0.34	0.36	5419	2462	57
DOC mg/m3	0.21	0.17	1.56	928	313	34

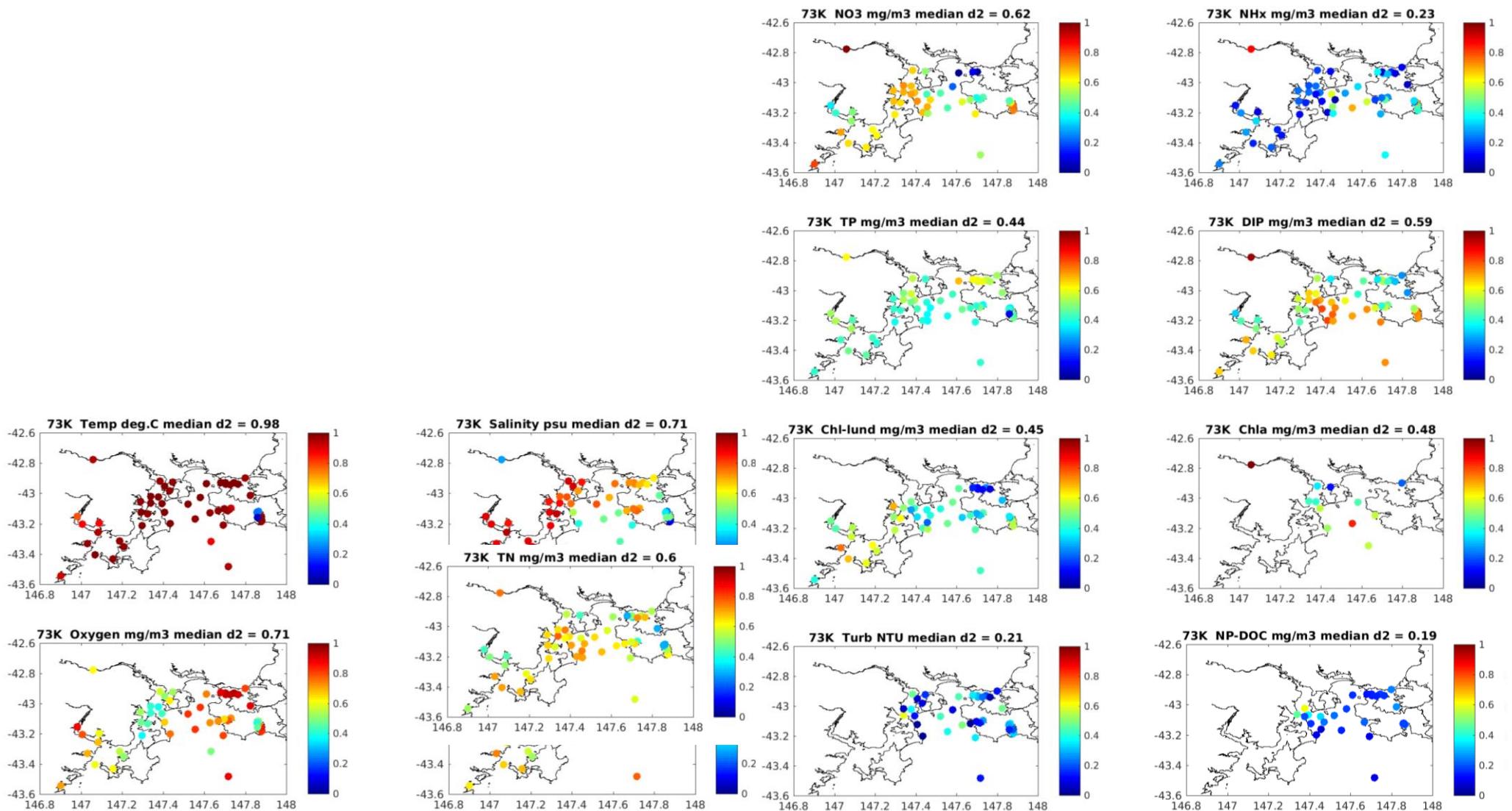


Figure A6.2 Spatial distribution of Willmott skill for model vs observations at stations throughout the region from 2015 to (May) 2020.

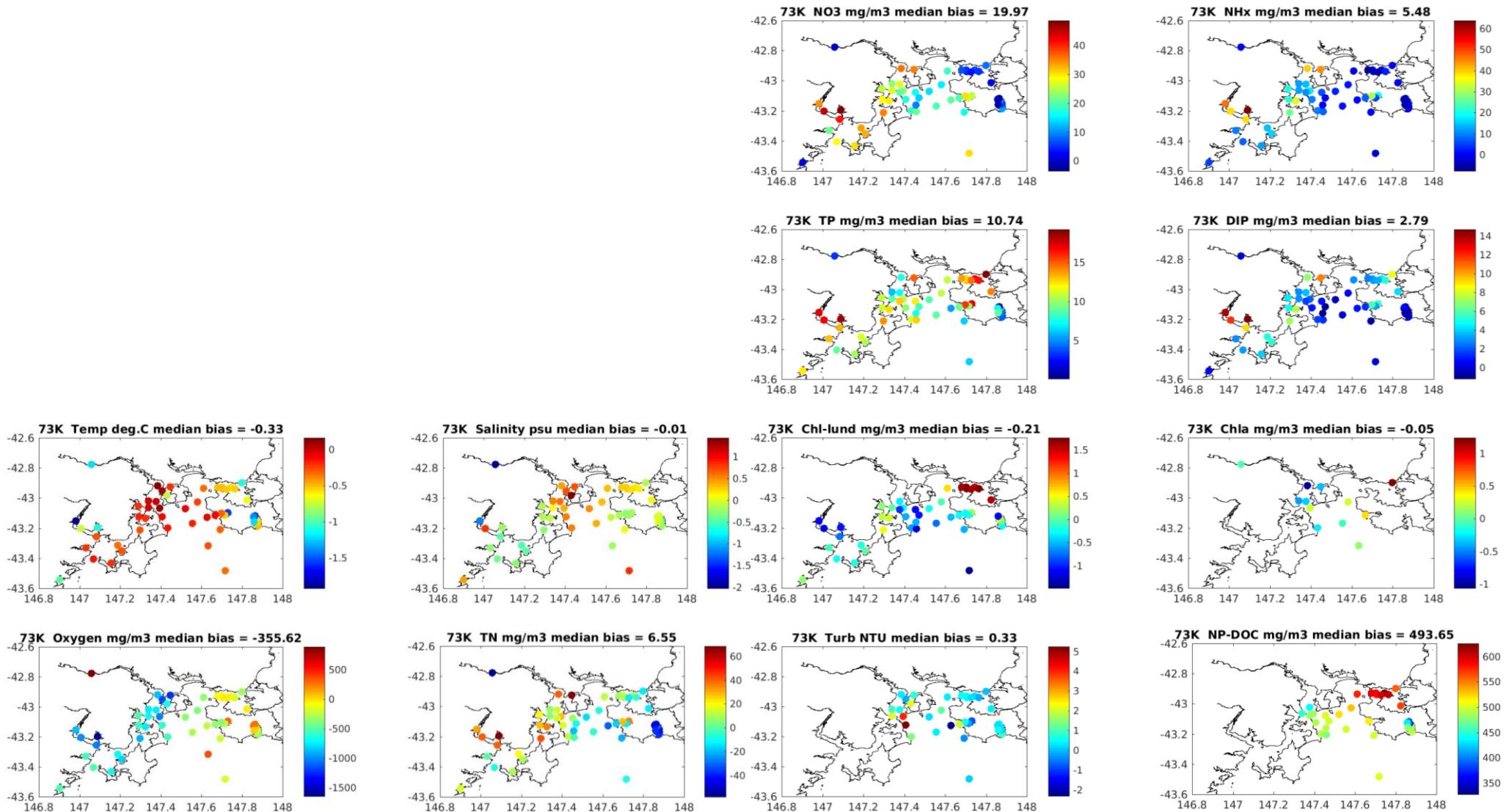
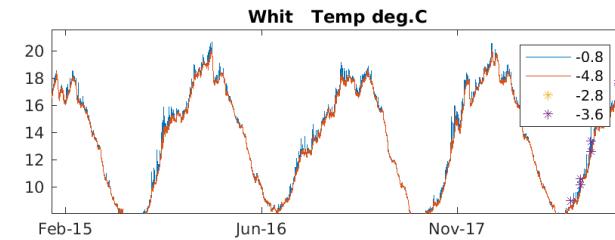
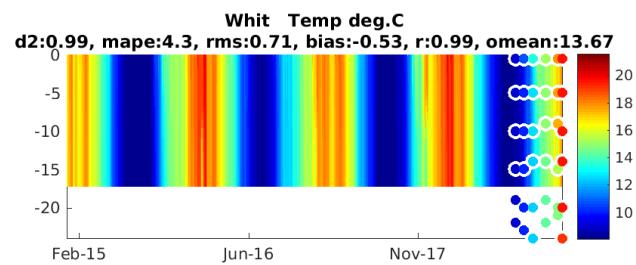
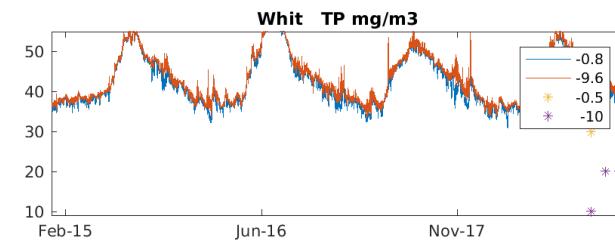
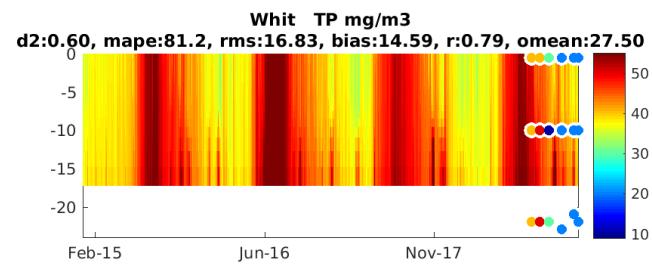
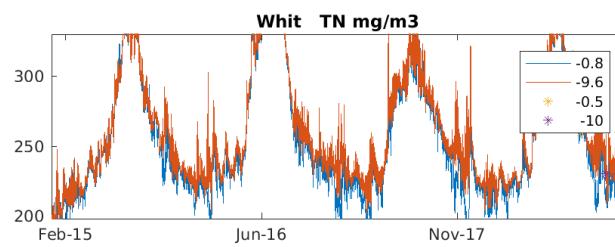
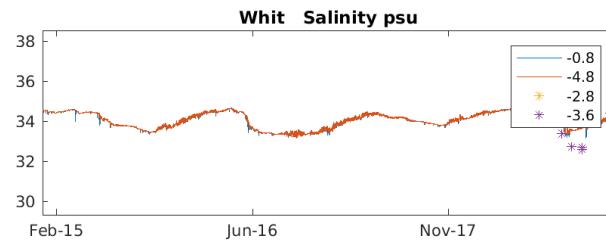
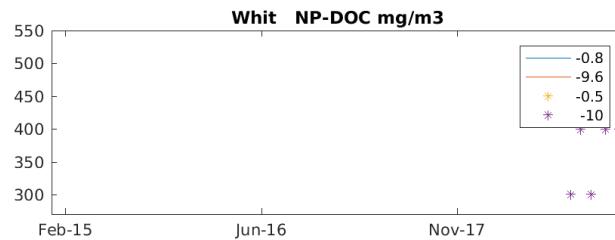
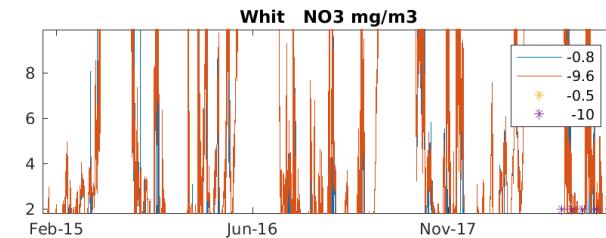
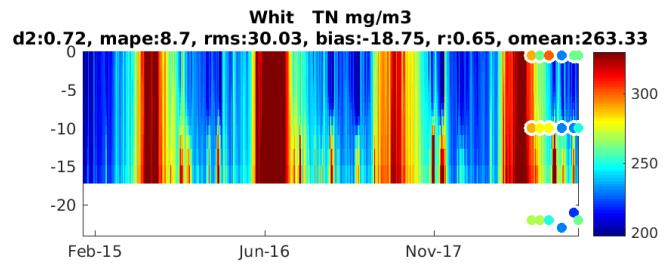
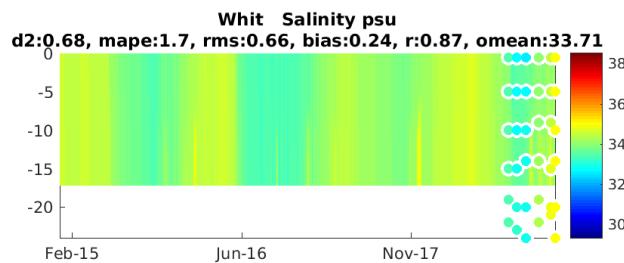
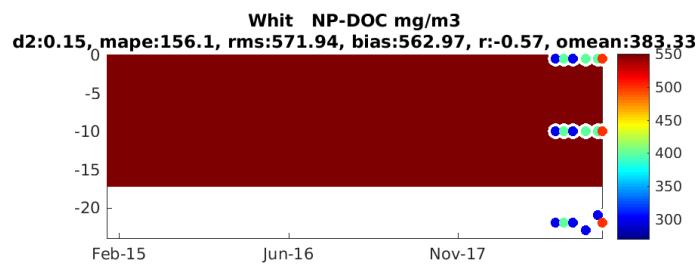
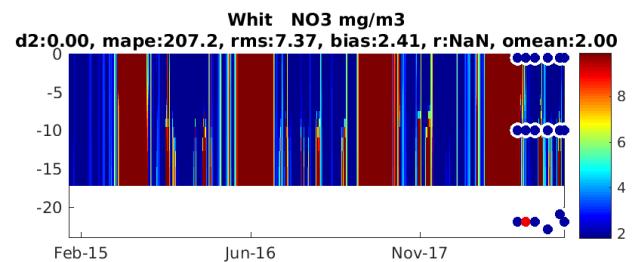
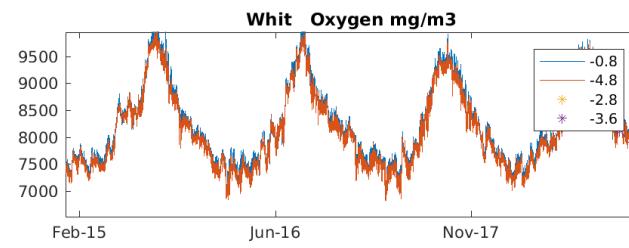
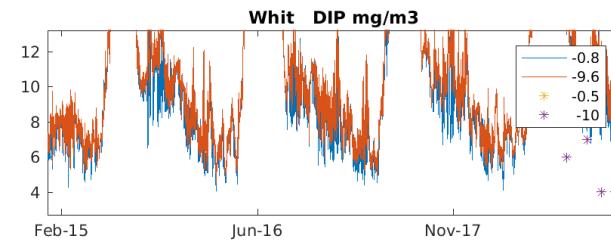
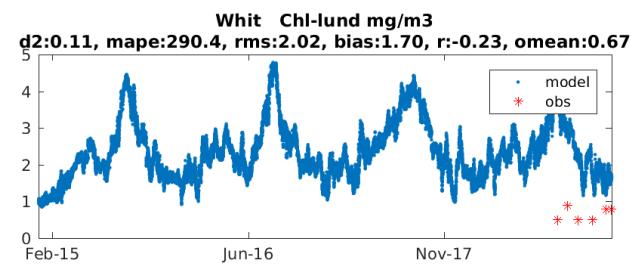
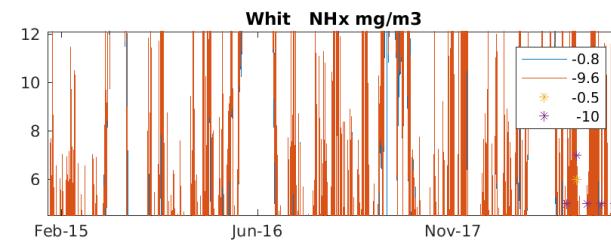
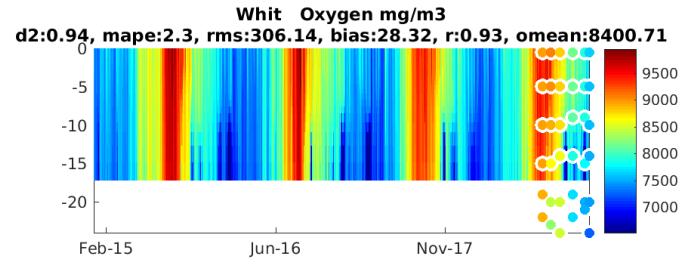
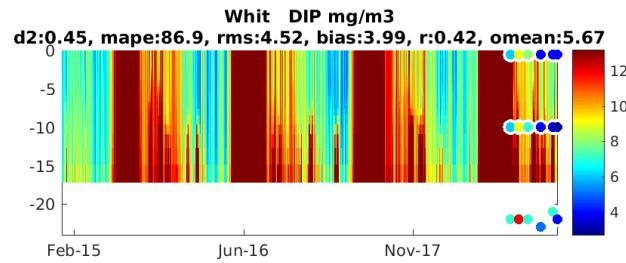
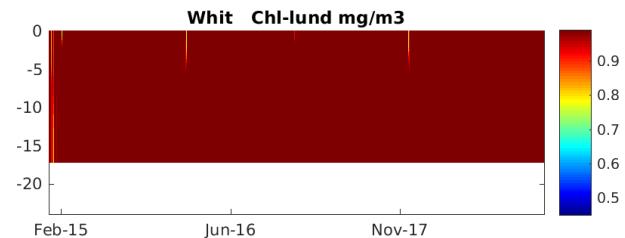
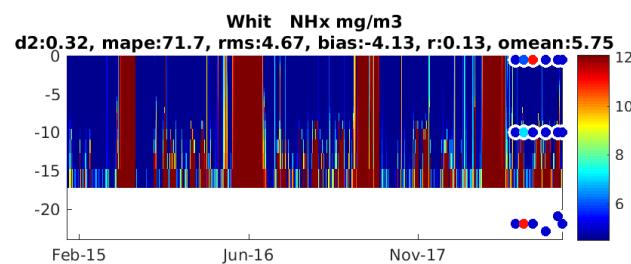
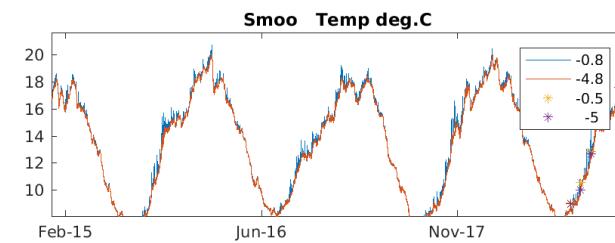
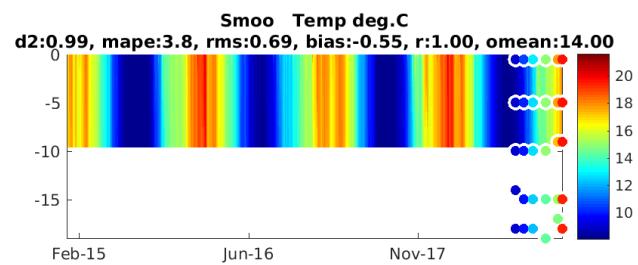
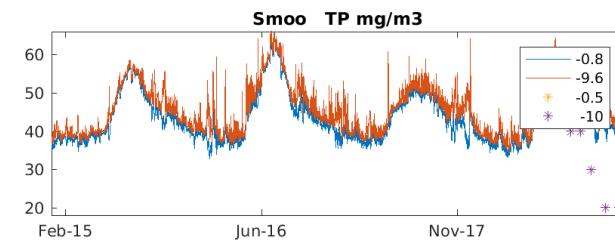
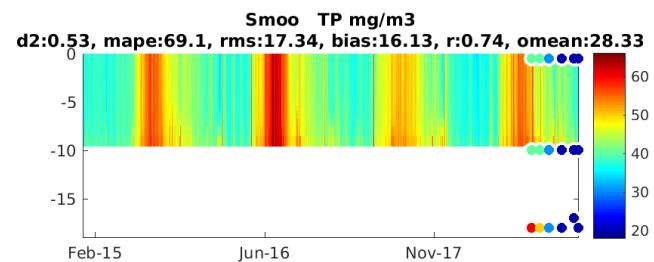


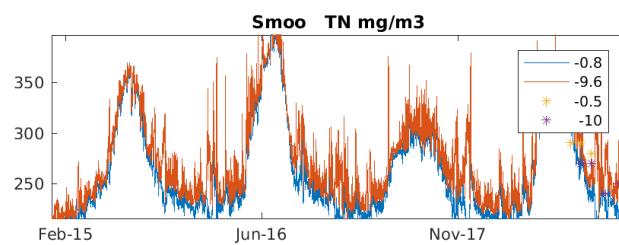
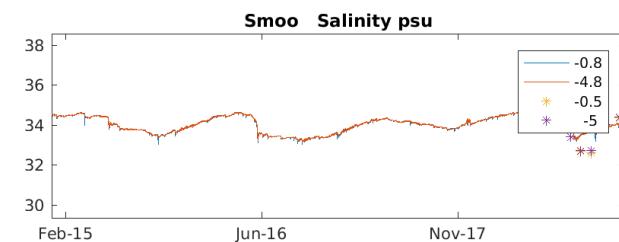
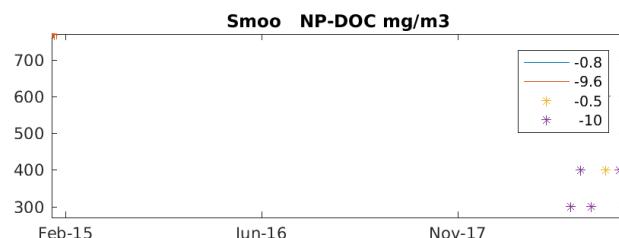
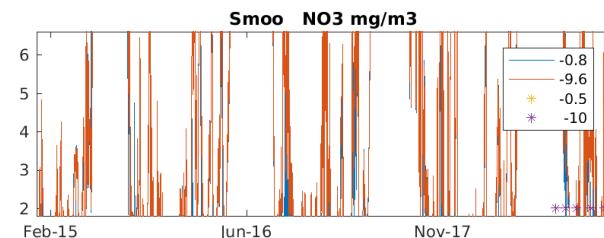
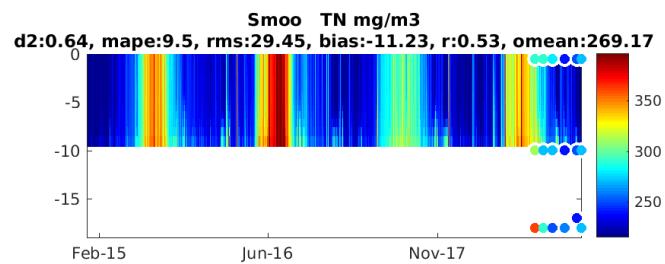
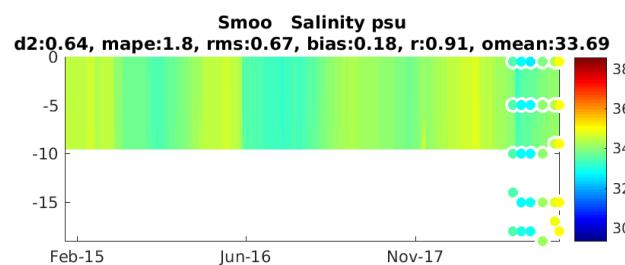
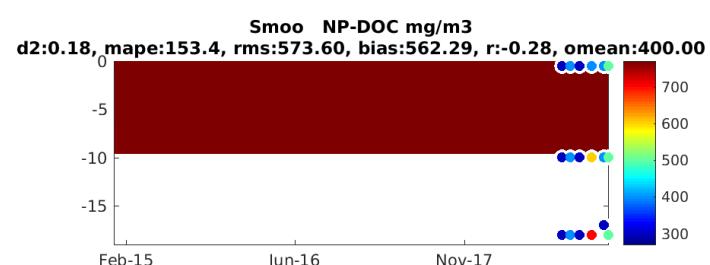
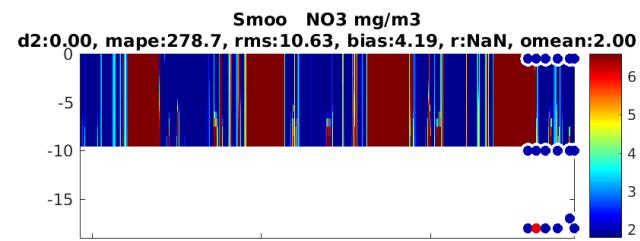
Figure A6.3 Spatial distribution of model bias c.f. observations at stations throughout the region from 2015 to (May) 2020.

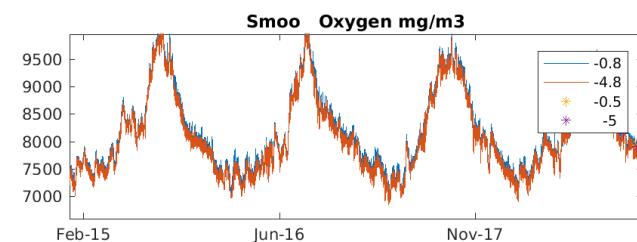
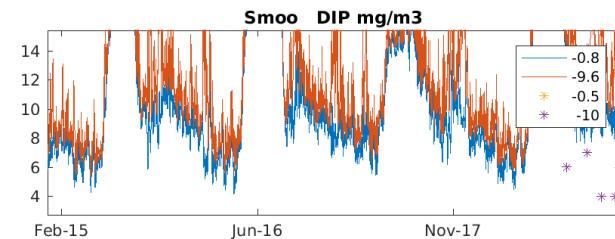
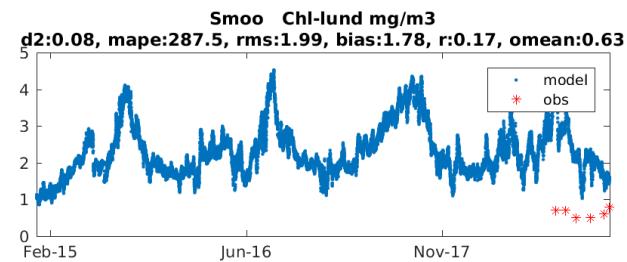
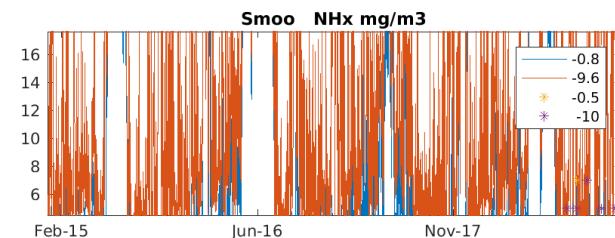
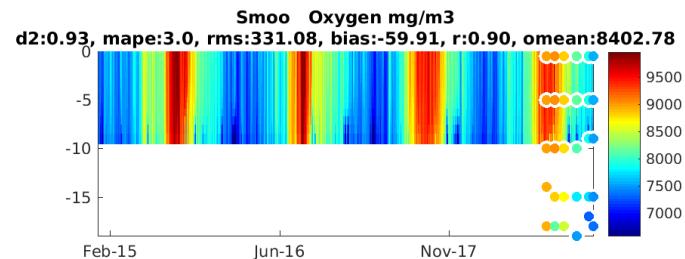
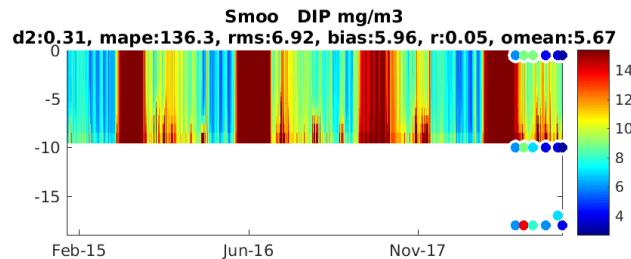
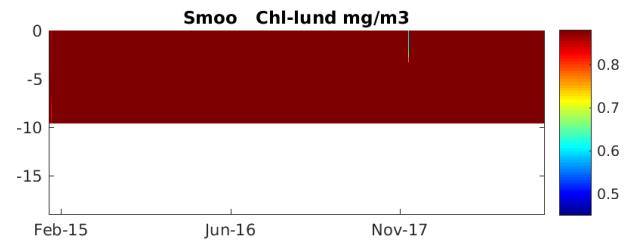
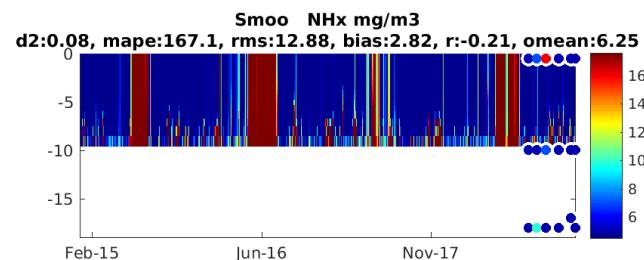


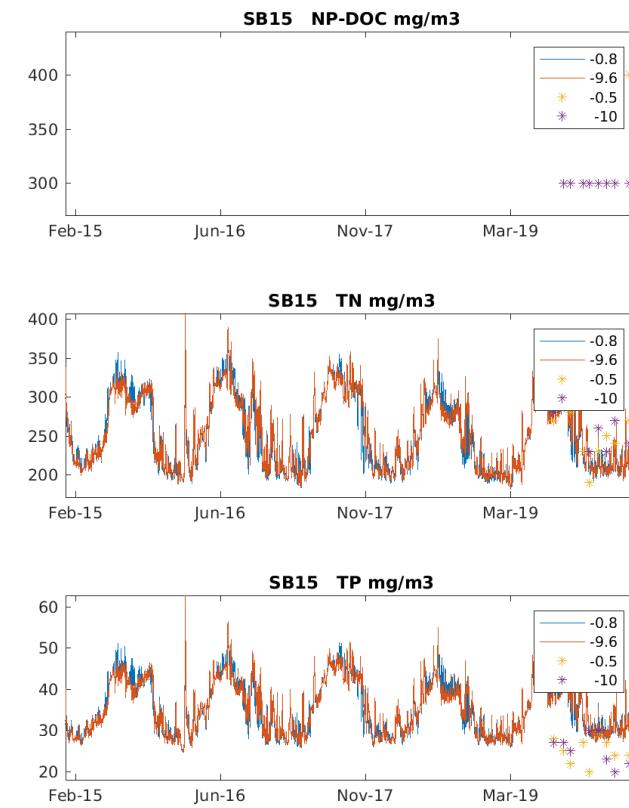
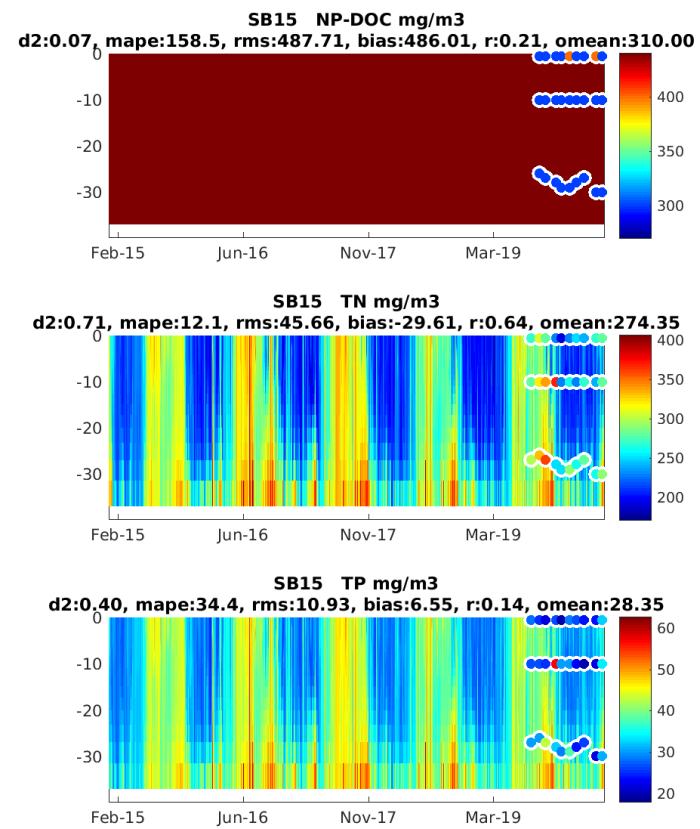


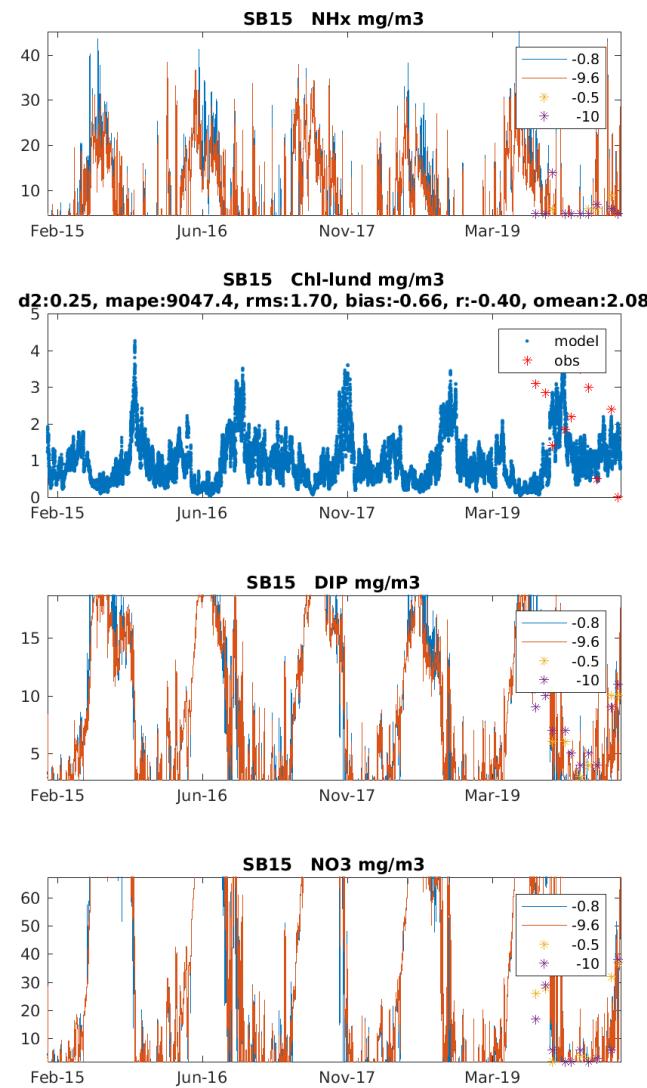
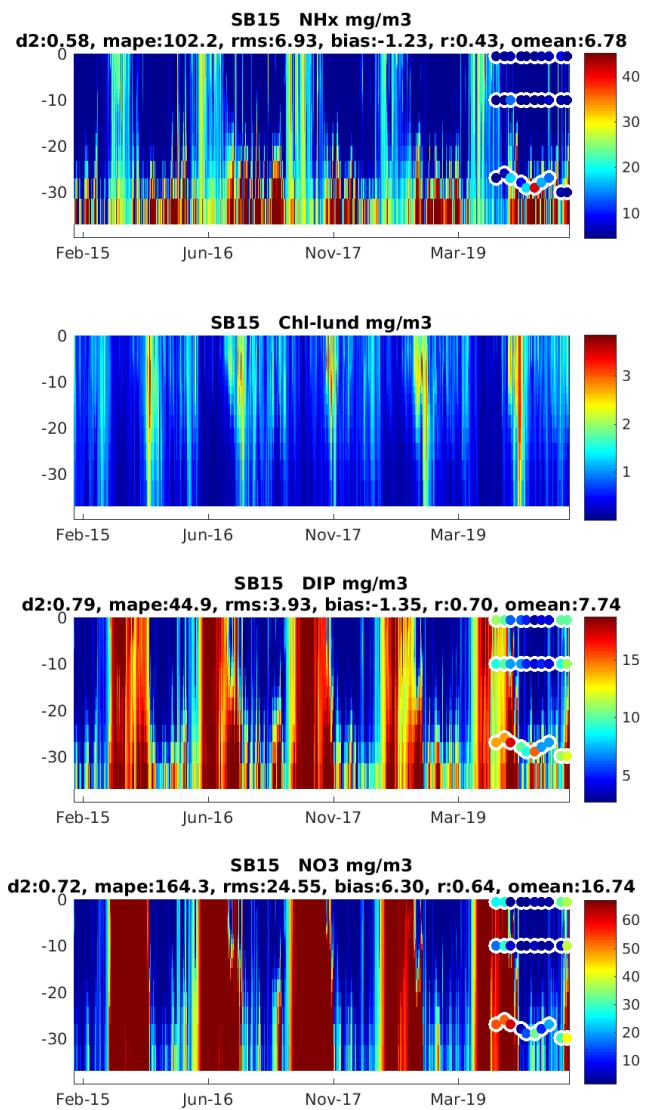


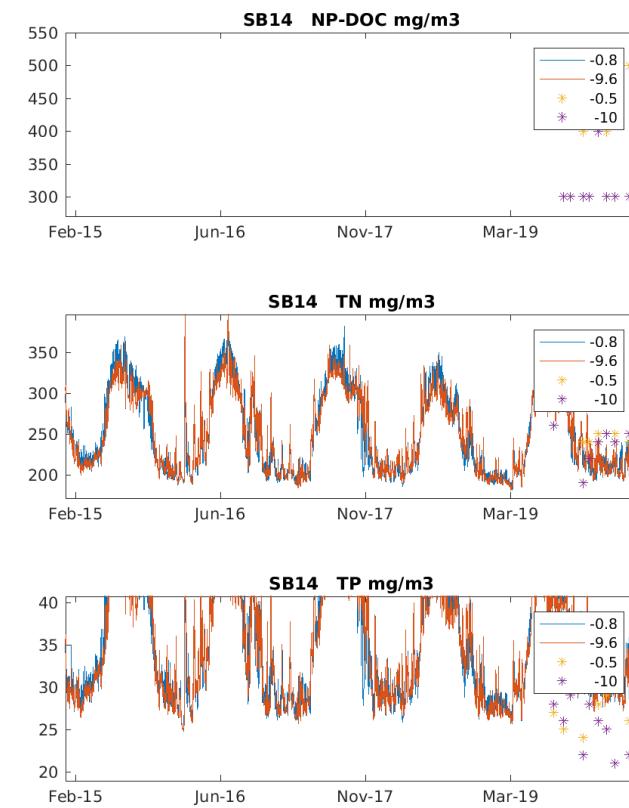
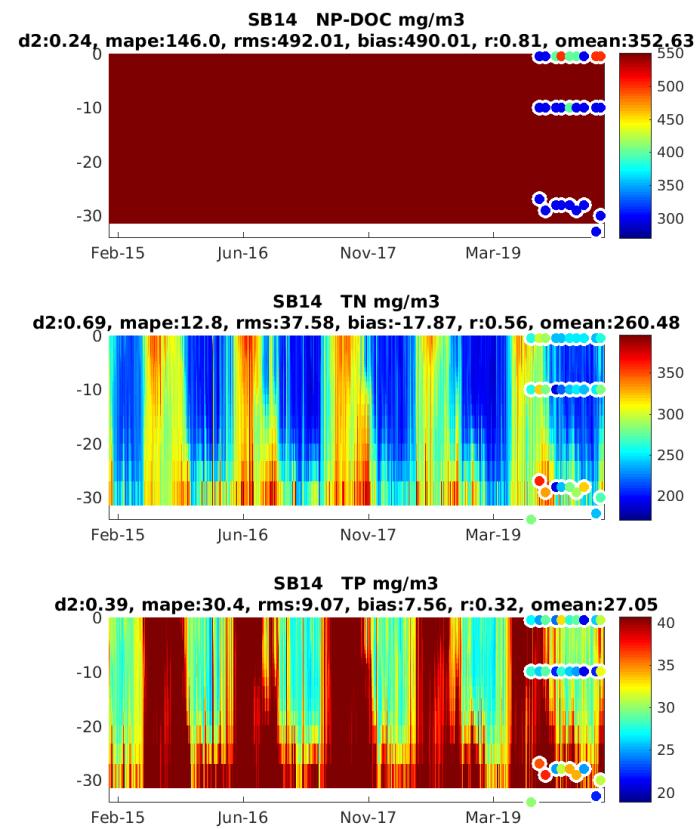


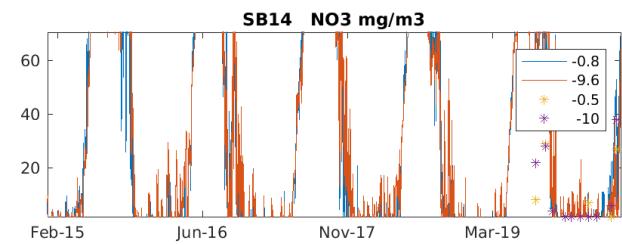
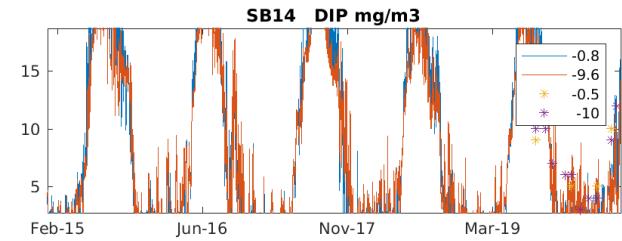
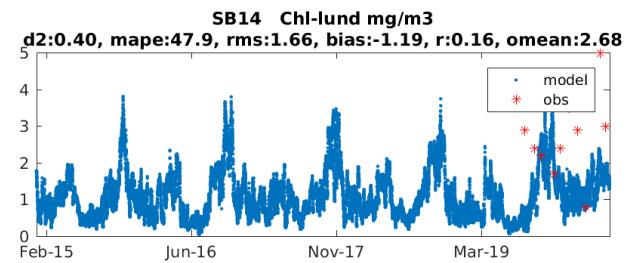
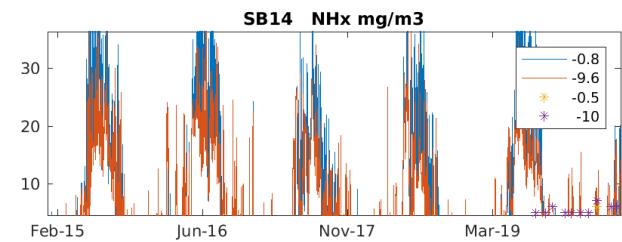
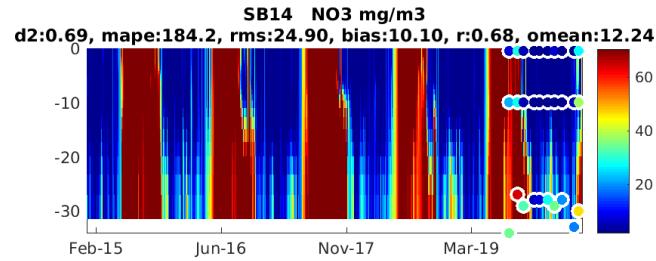
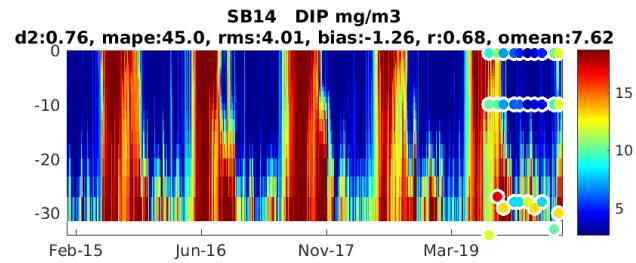
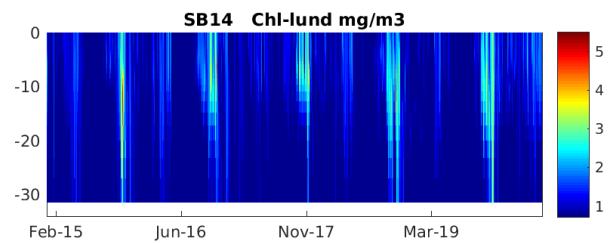
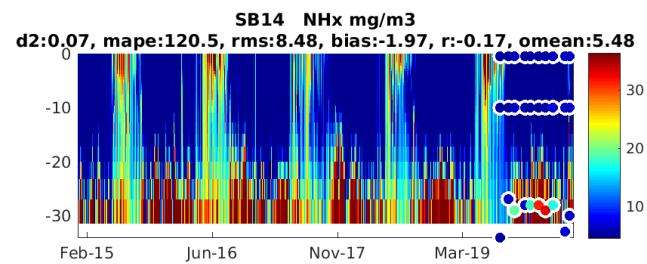


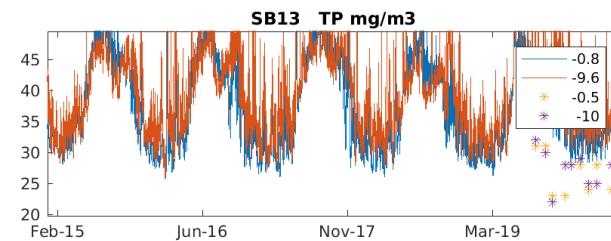
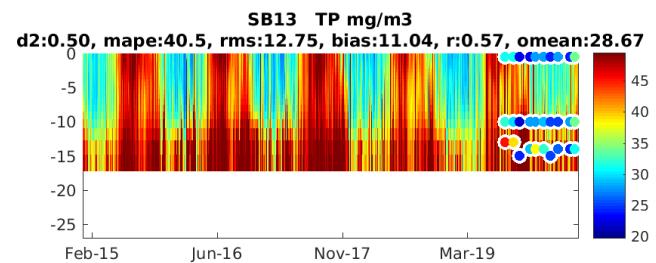
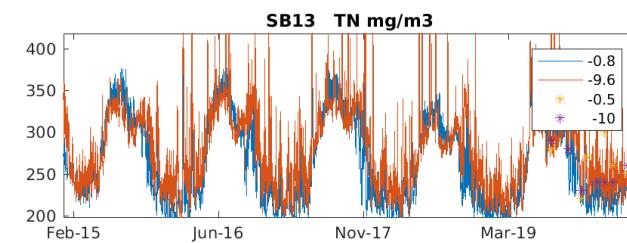
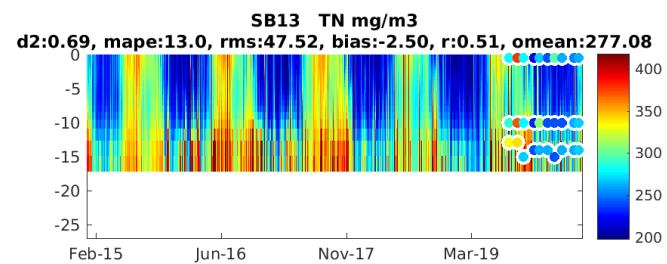
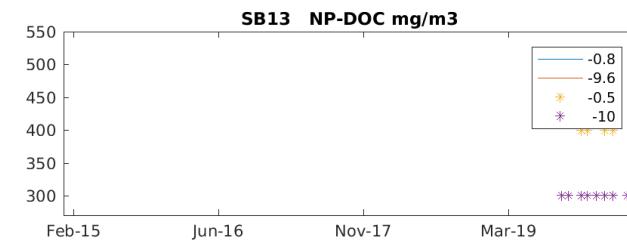
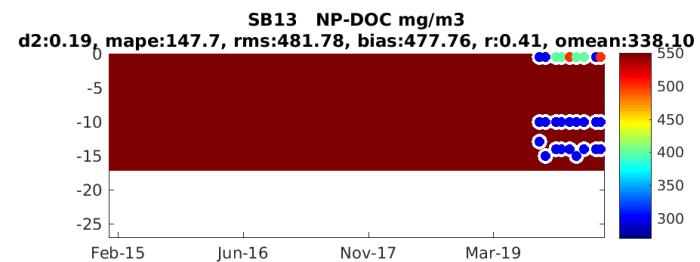


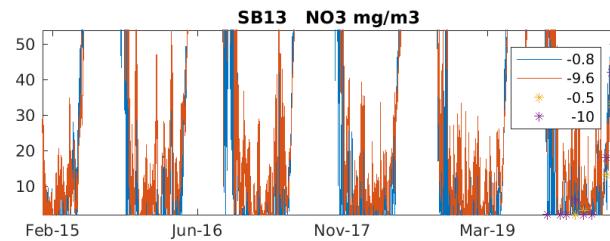
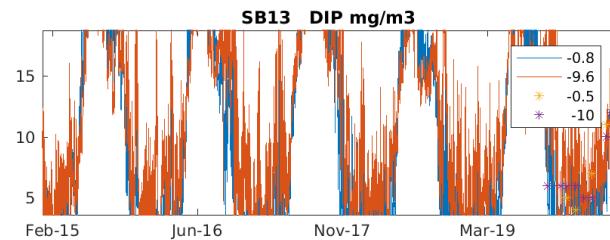
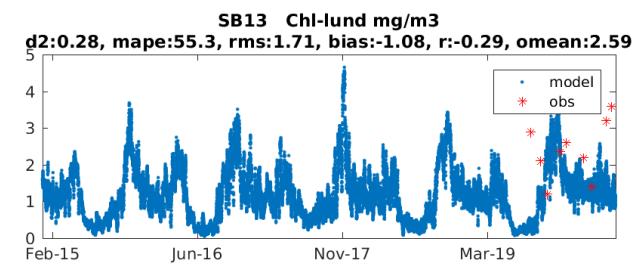
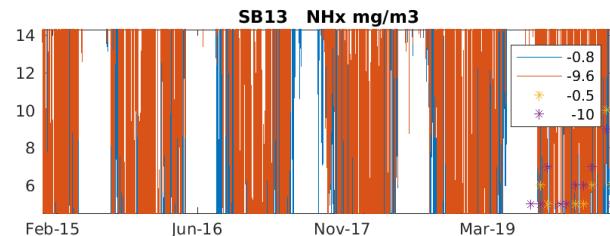
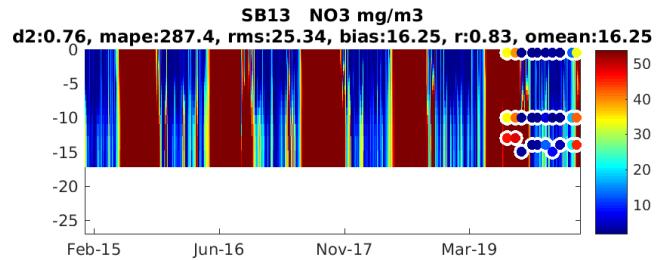
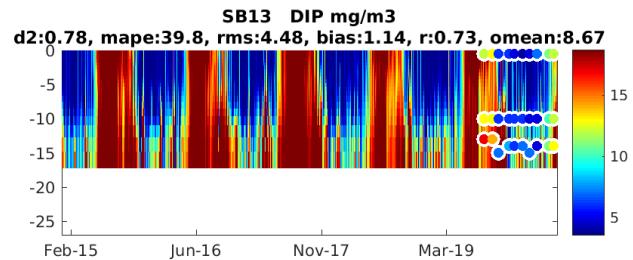
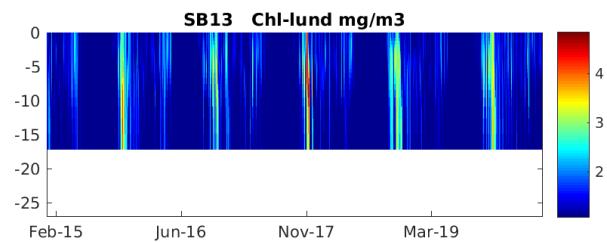
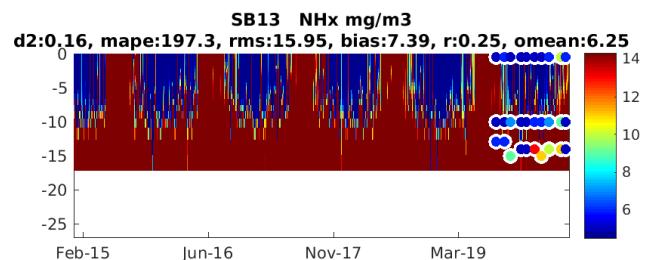


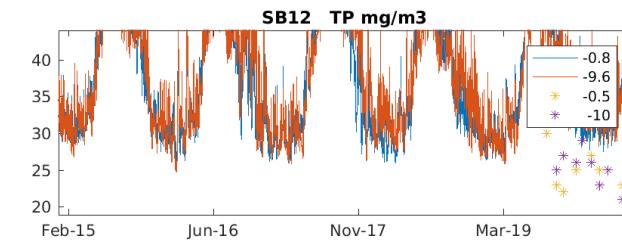
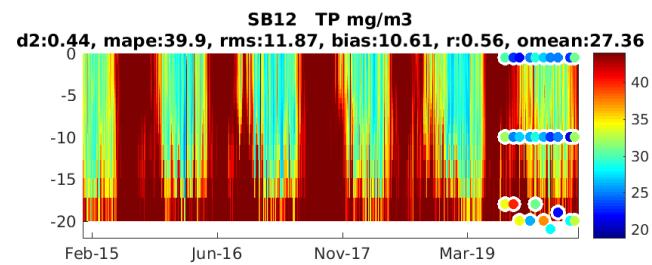
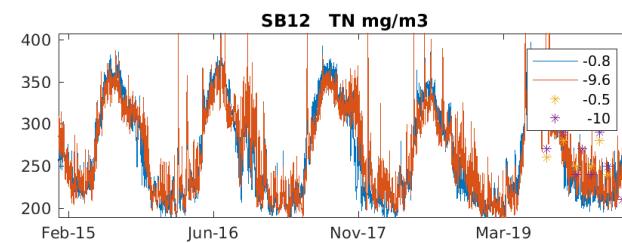
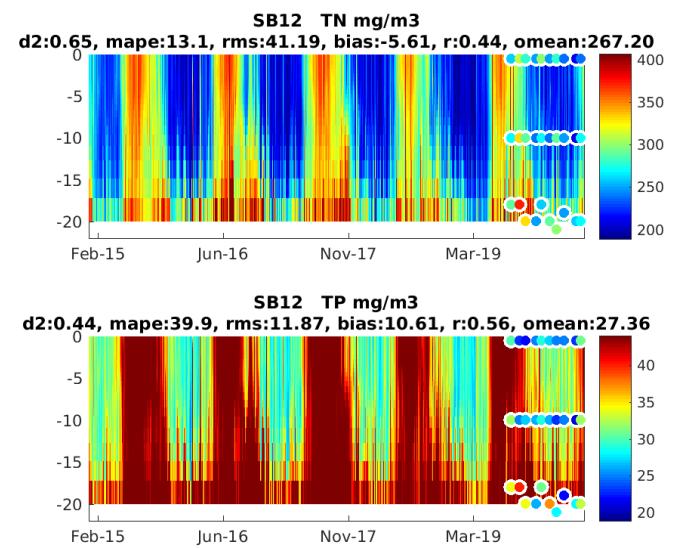
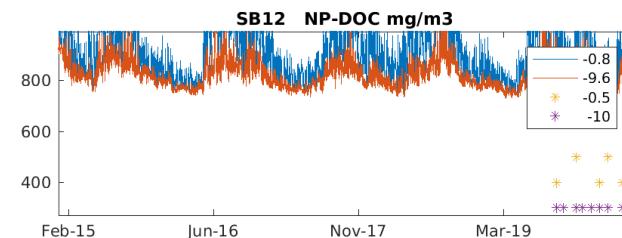
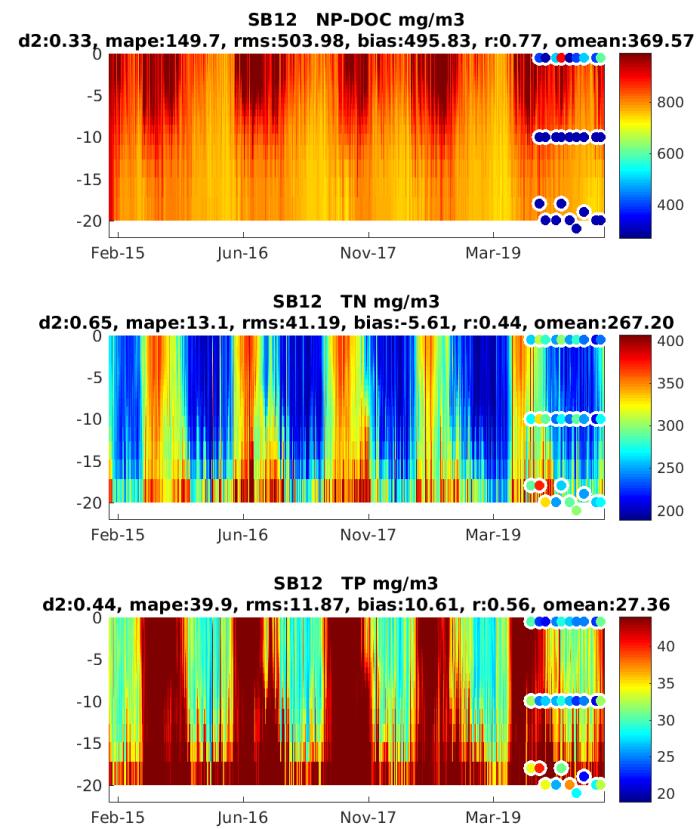


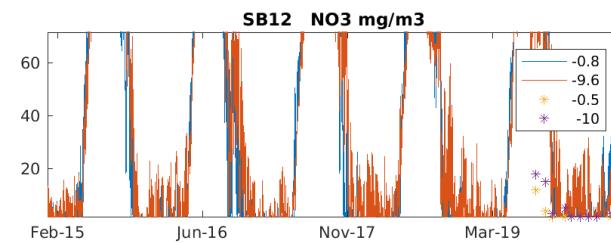
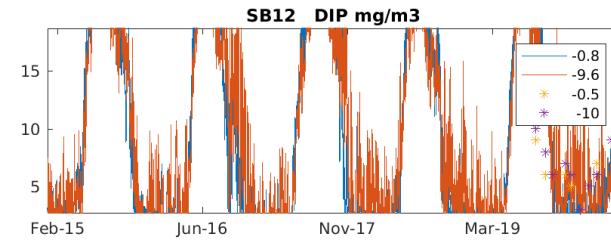
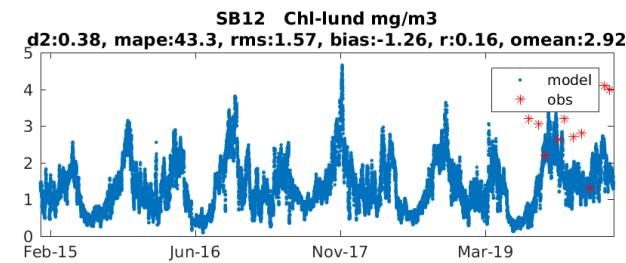
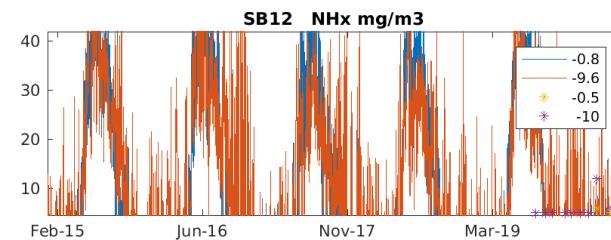
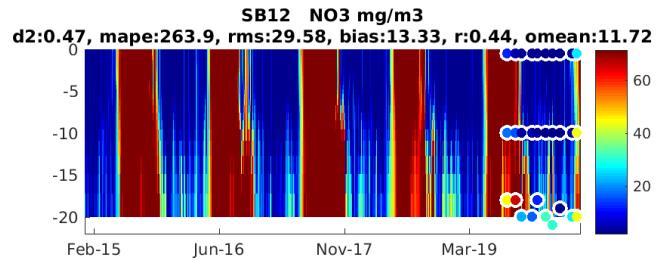
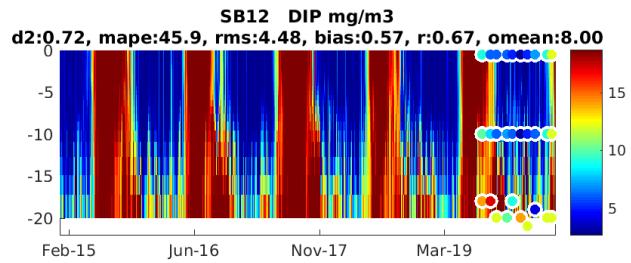
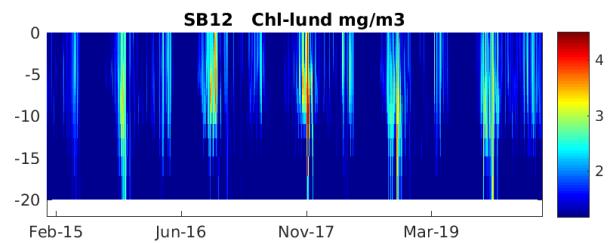
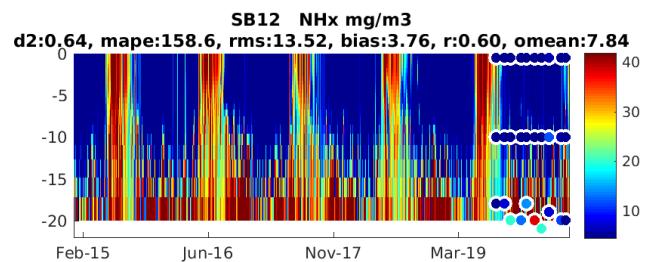


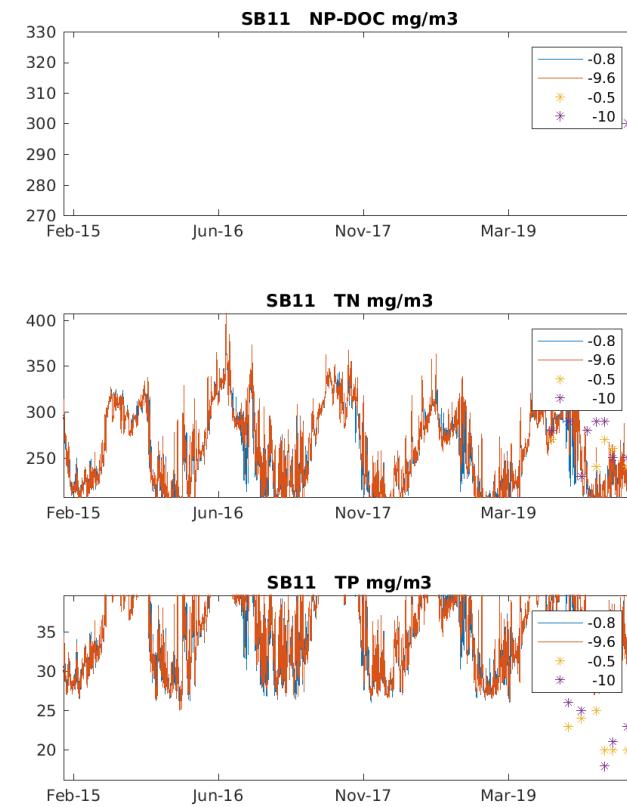
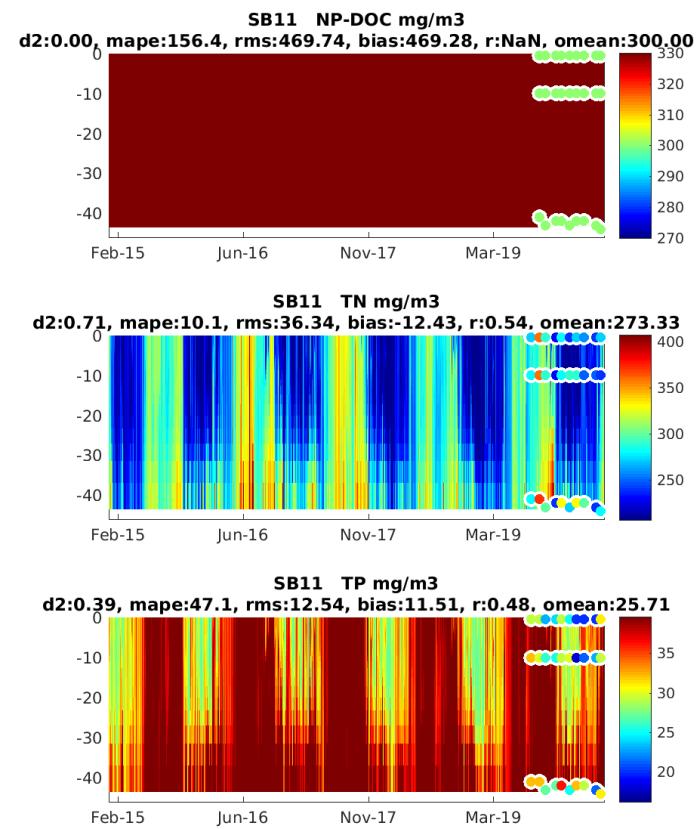


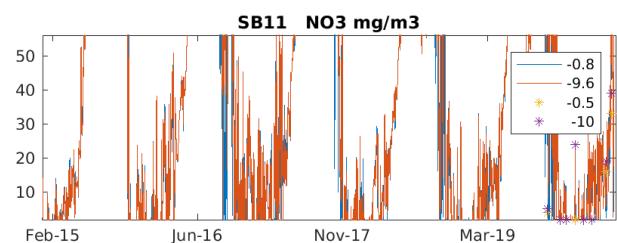
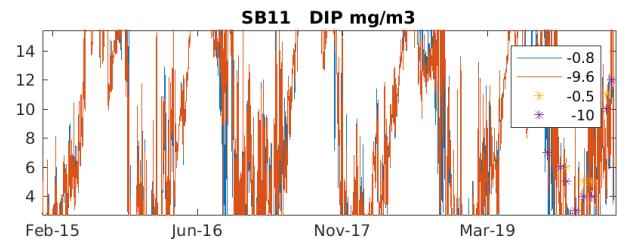
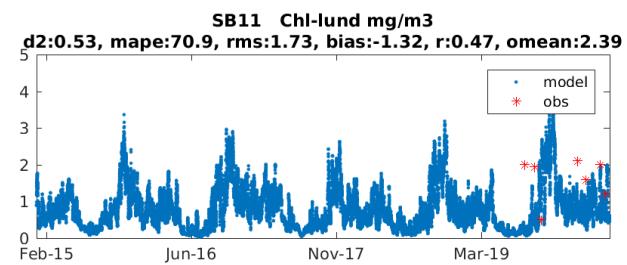
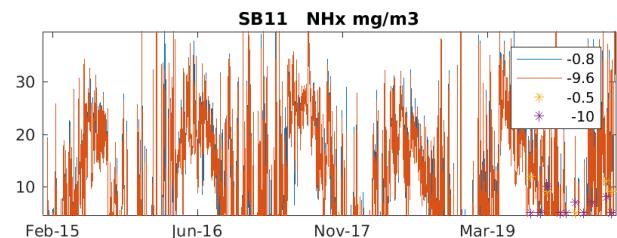
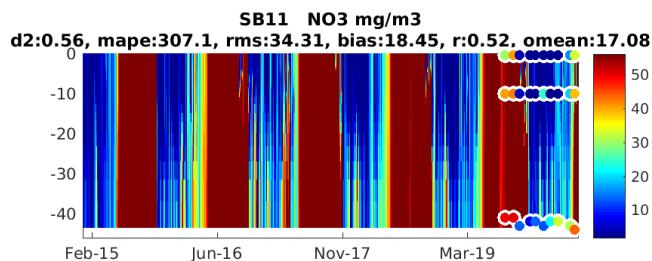
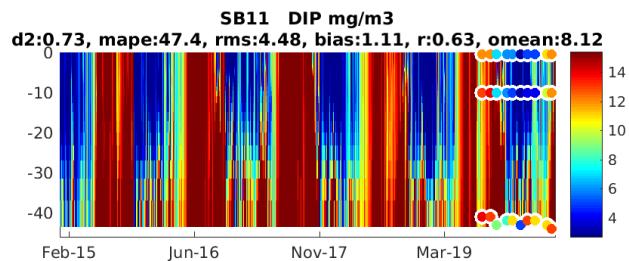
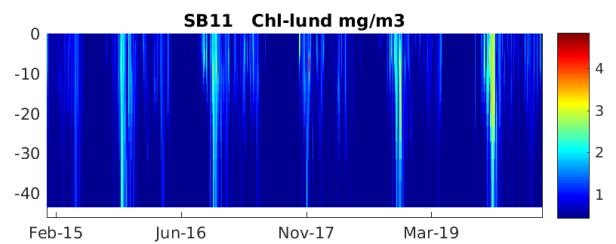
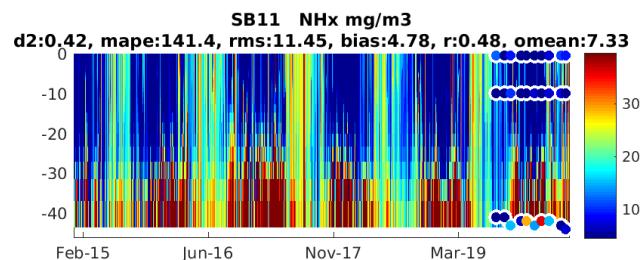


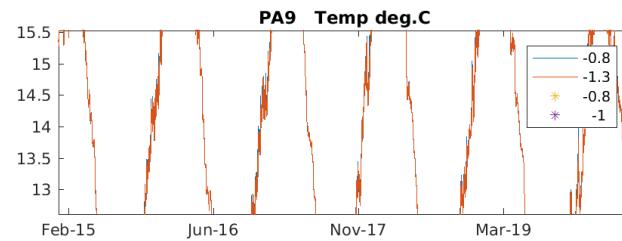
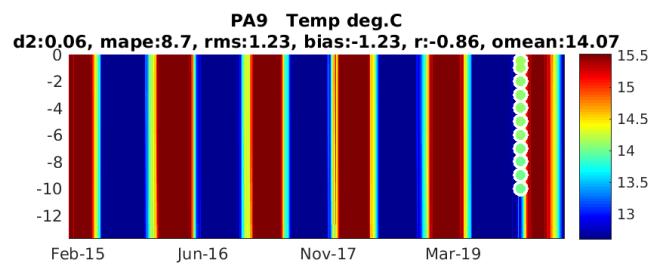
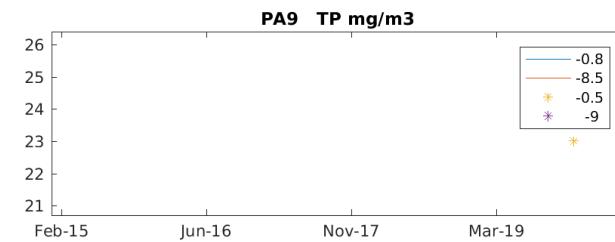
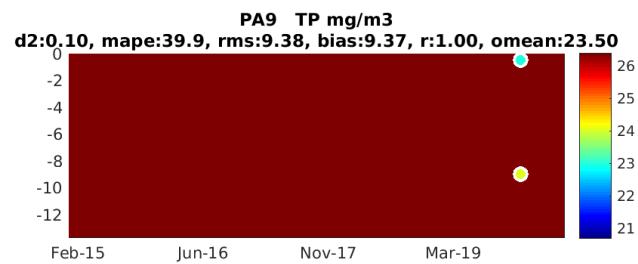


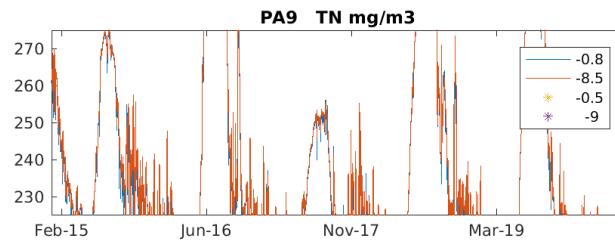
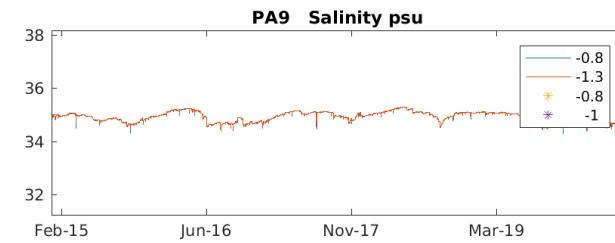
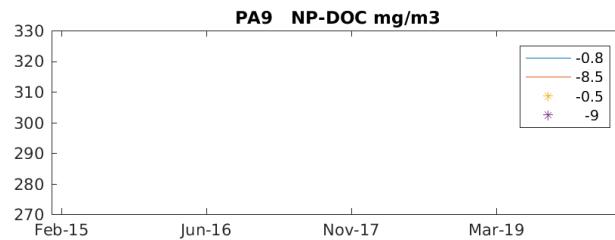
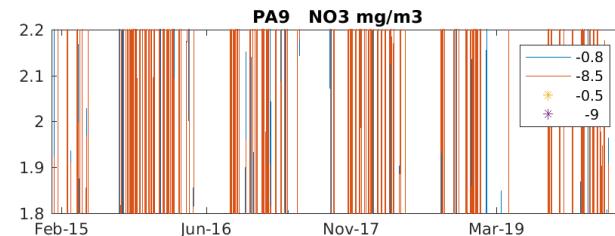
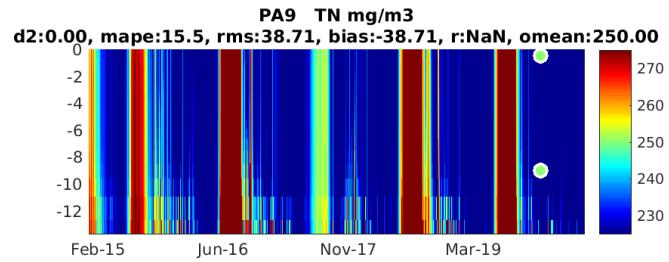
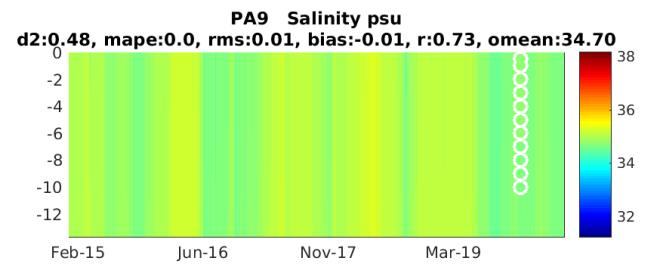
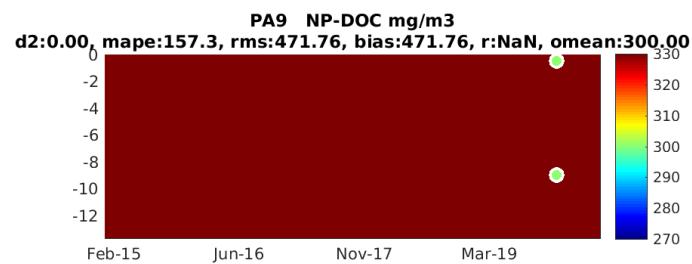
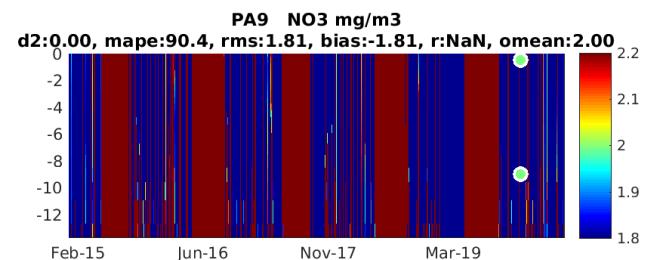


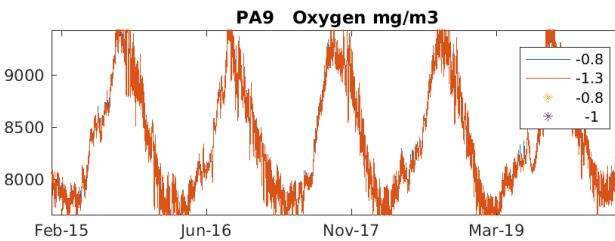
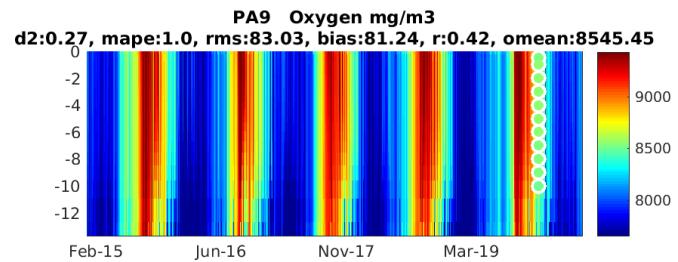
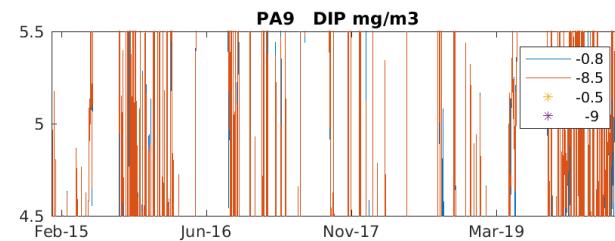
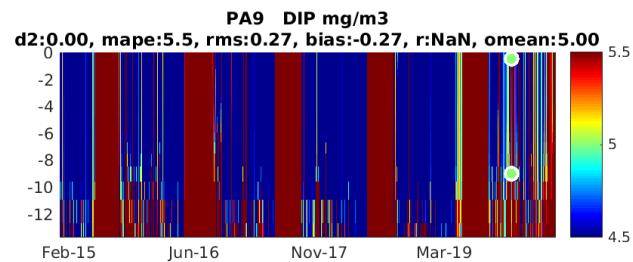
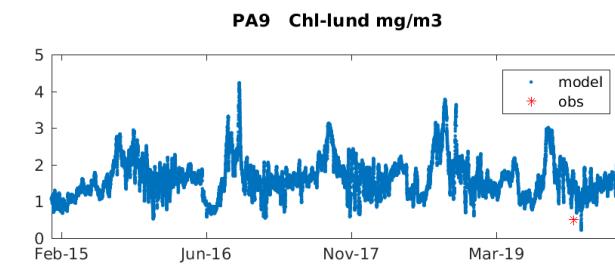
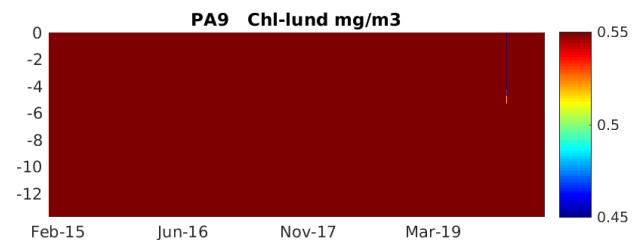
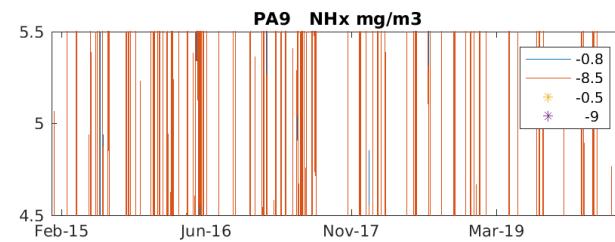
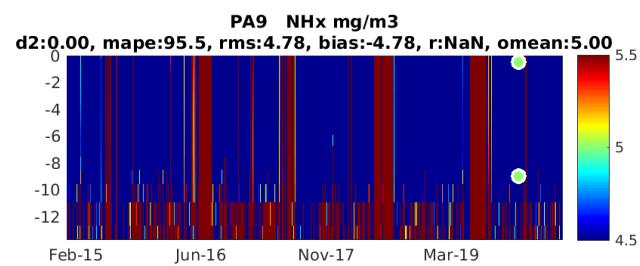


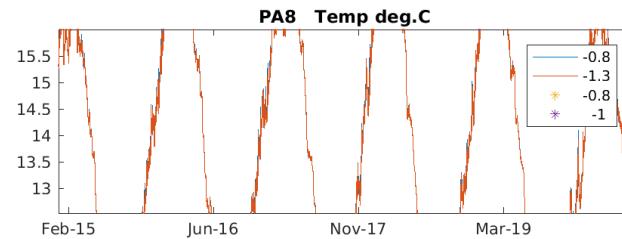
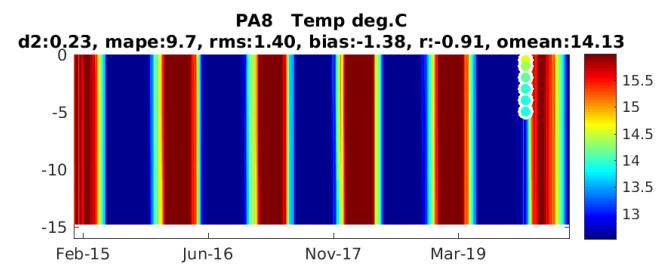
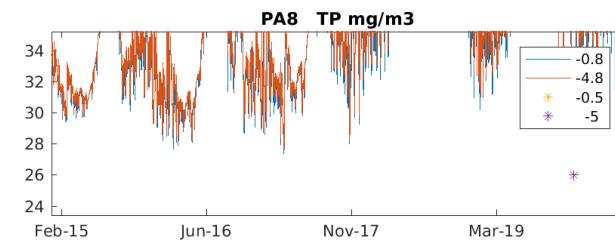
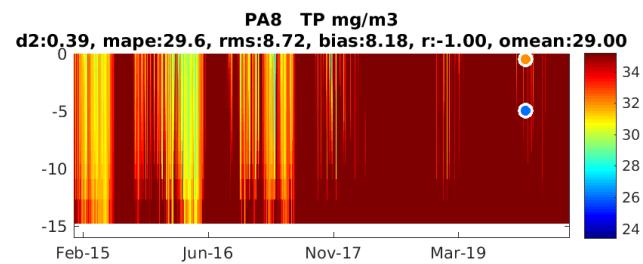


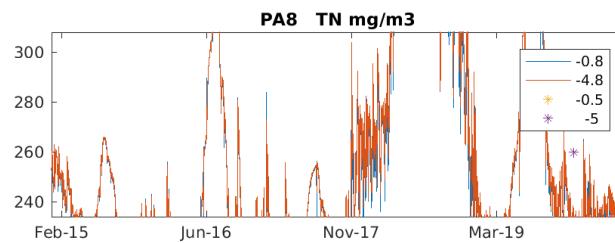
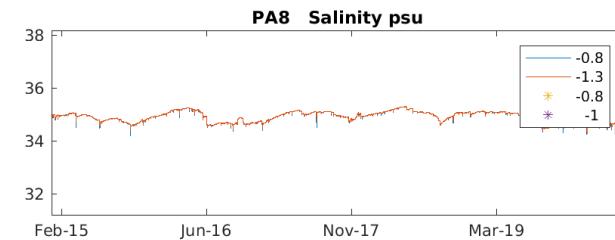
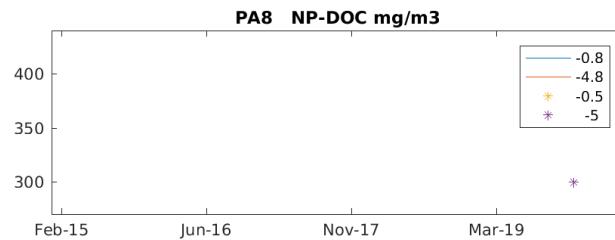
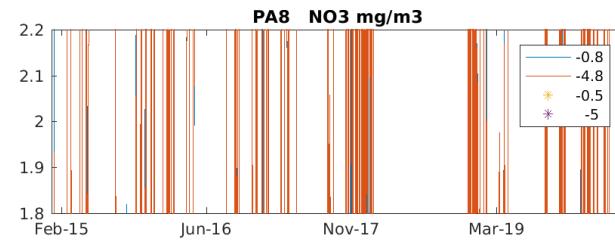
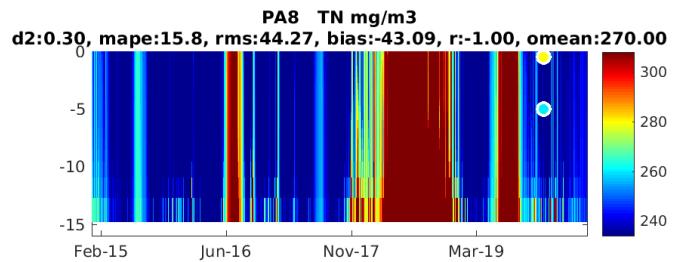
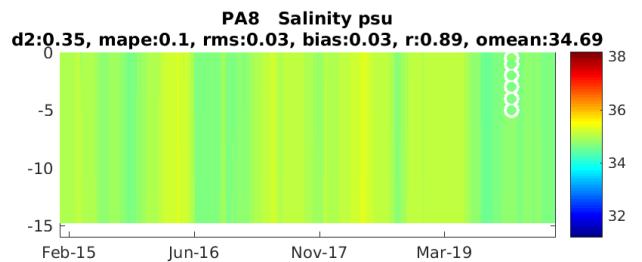
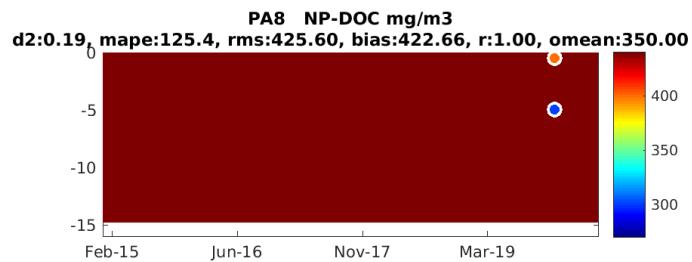
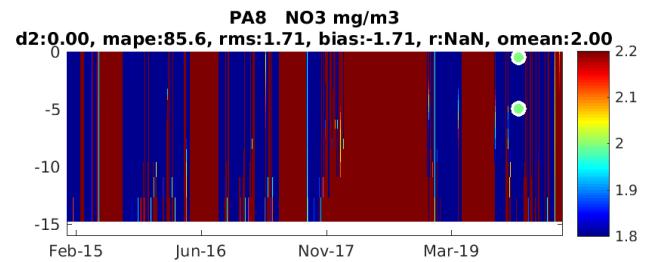


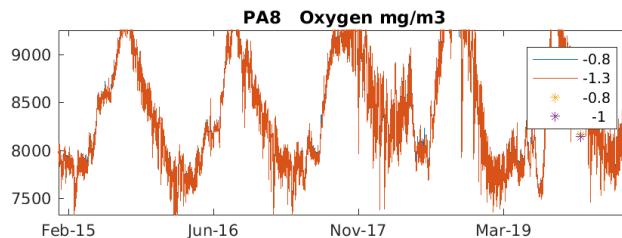
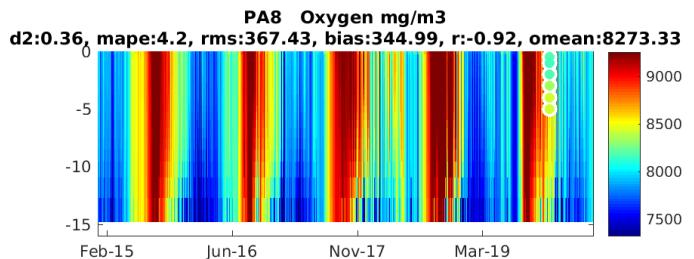
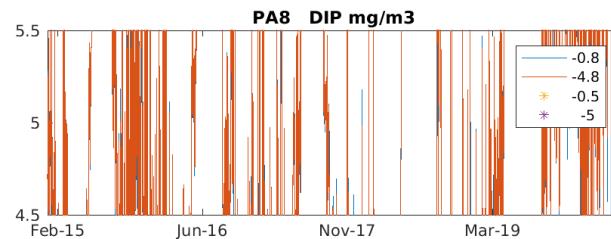
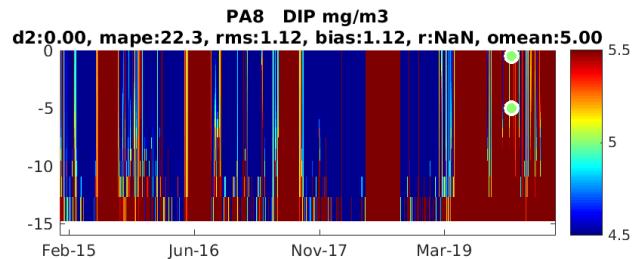
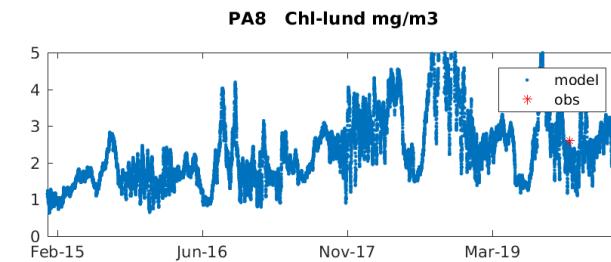
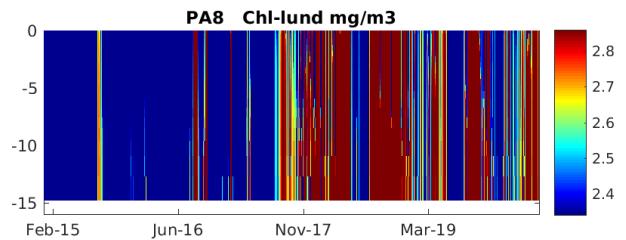
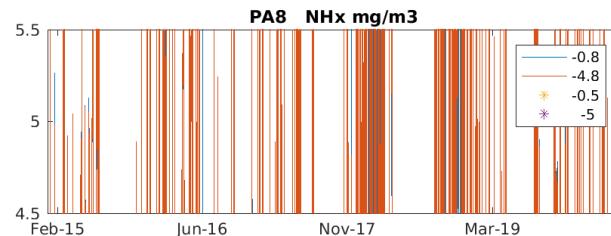
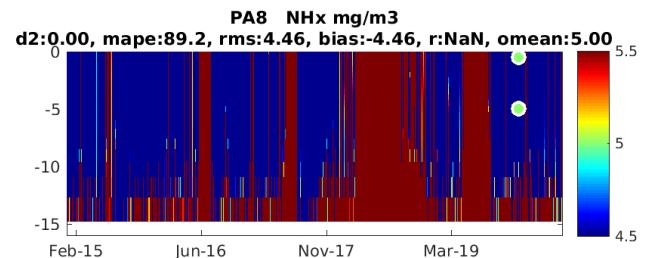


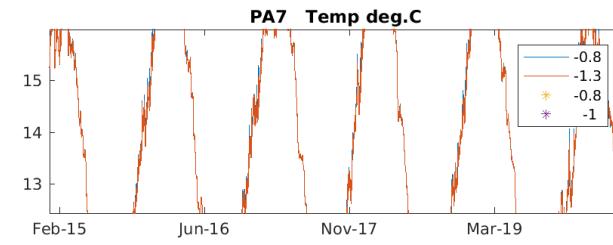
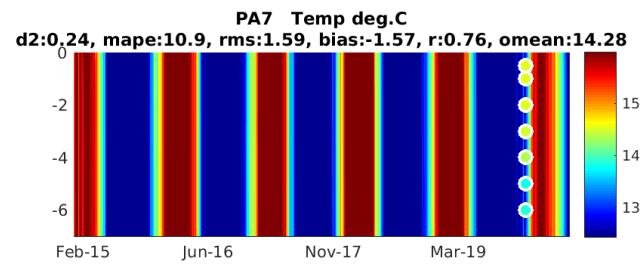
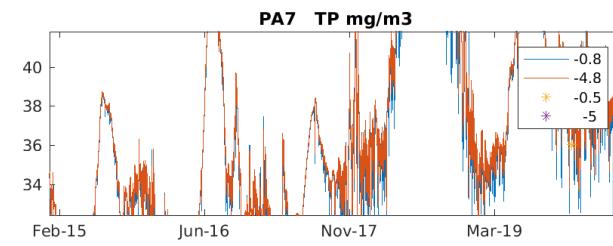
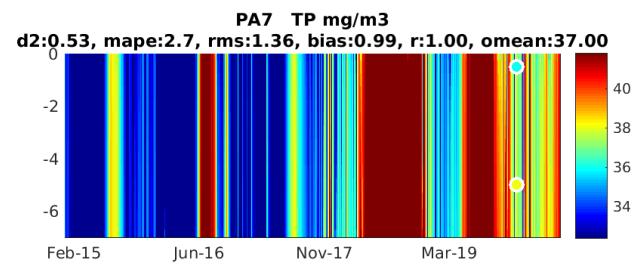


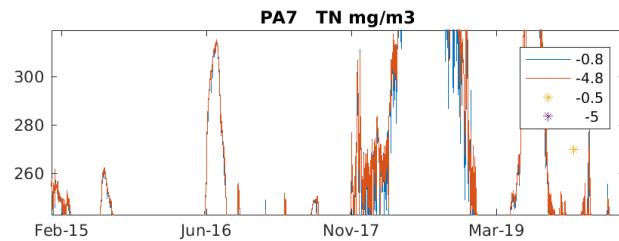
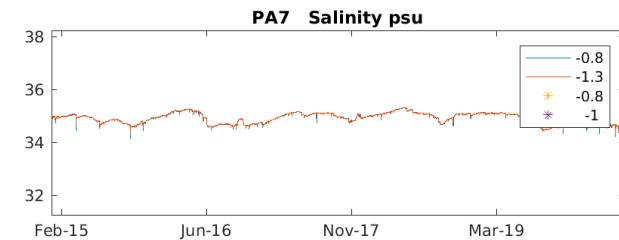
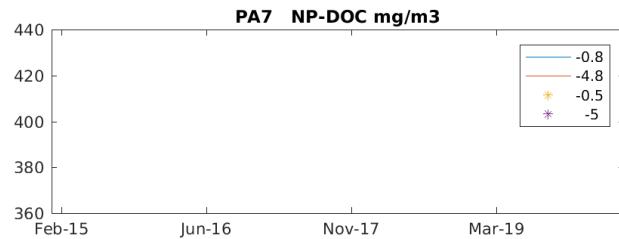
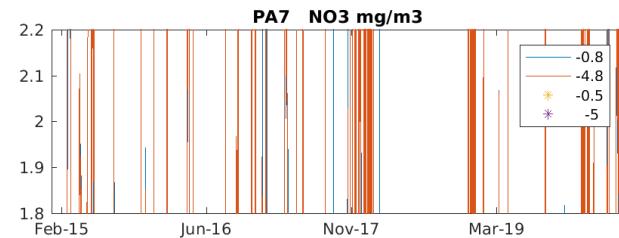
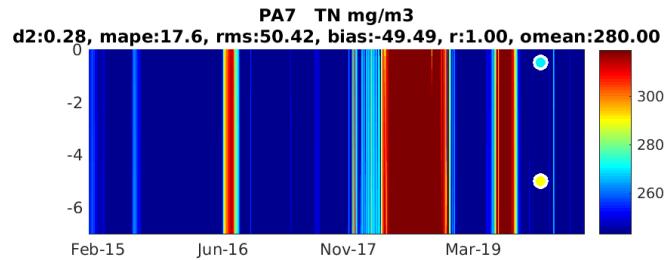
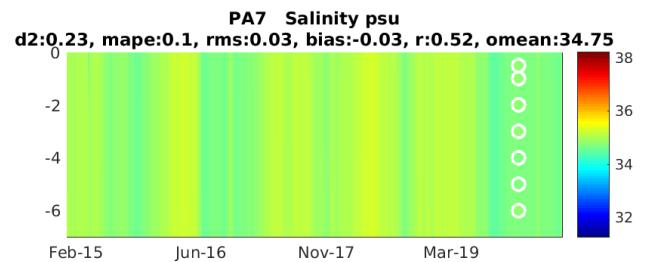
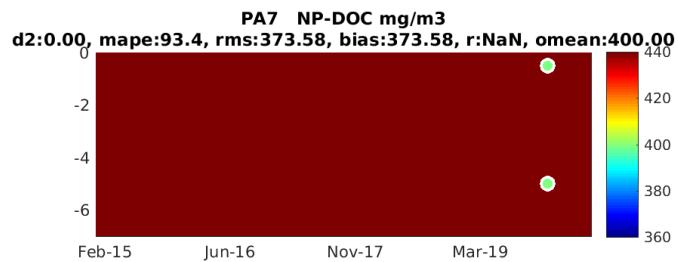
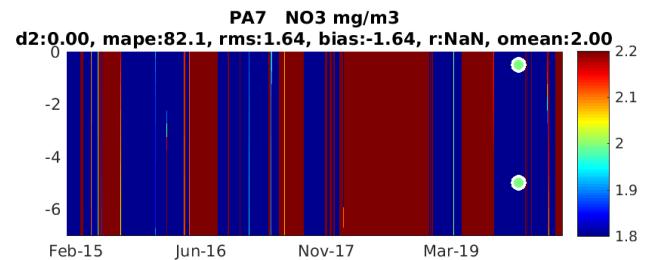


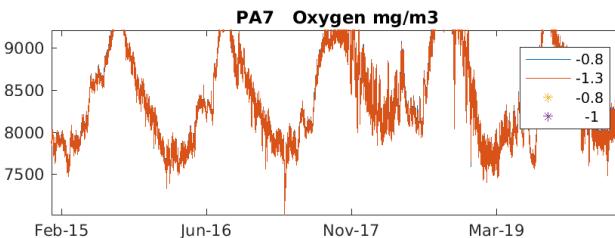
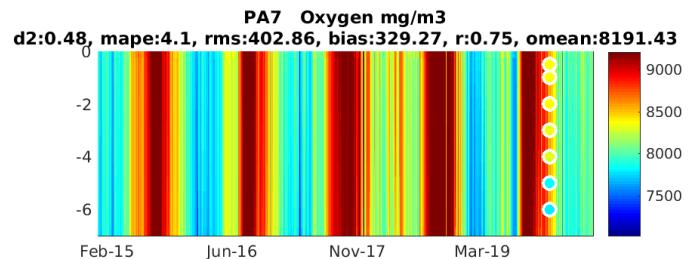
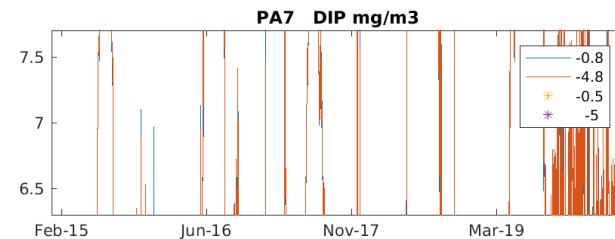
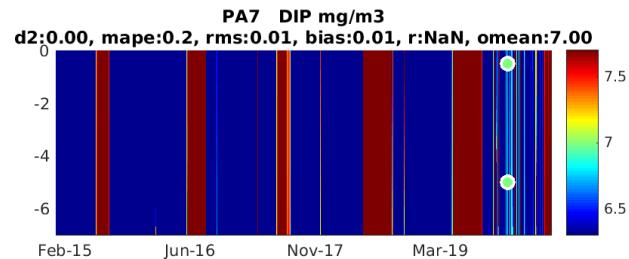
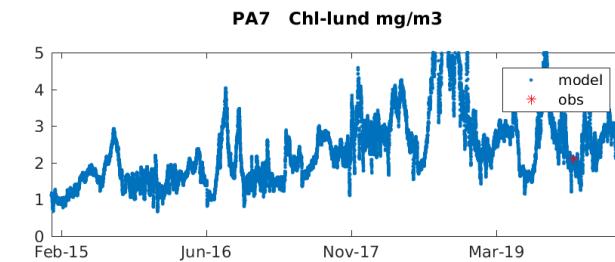
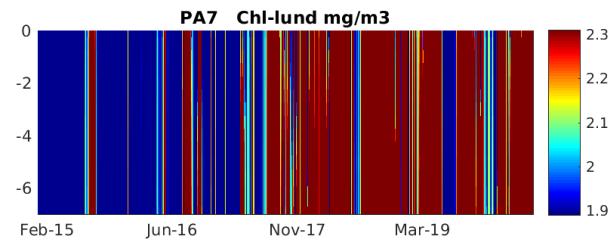
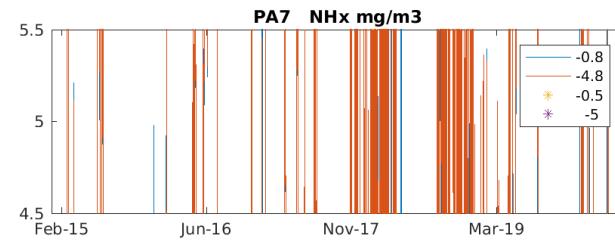
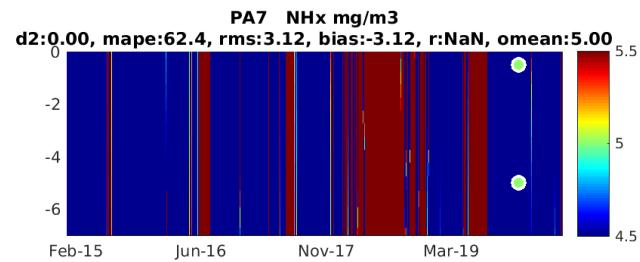


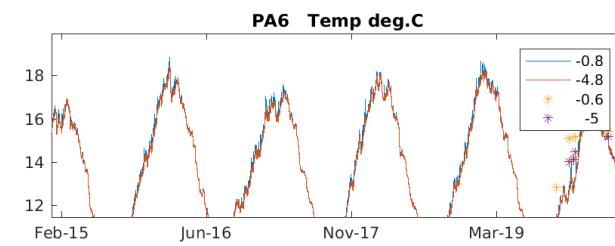
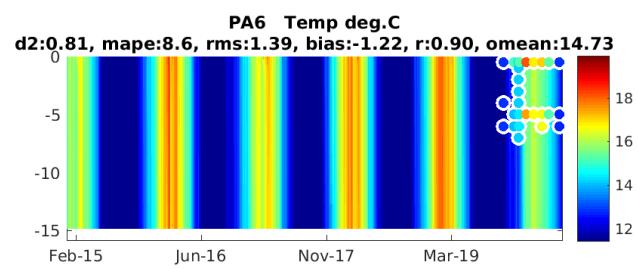
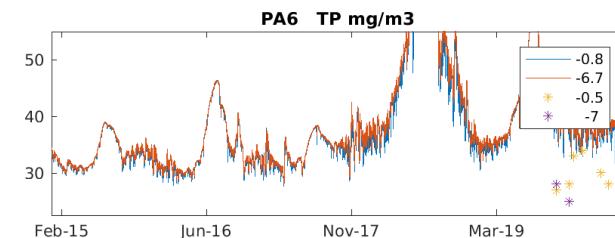
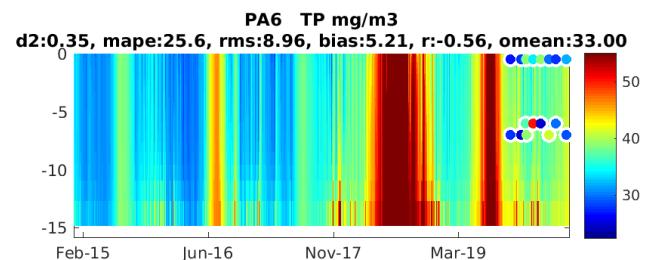


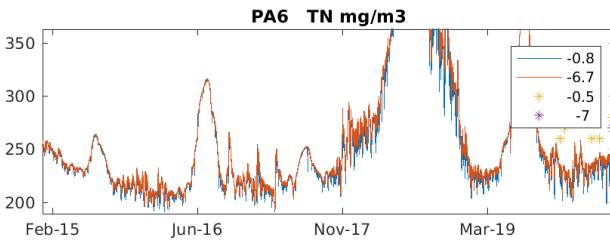
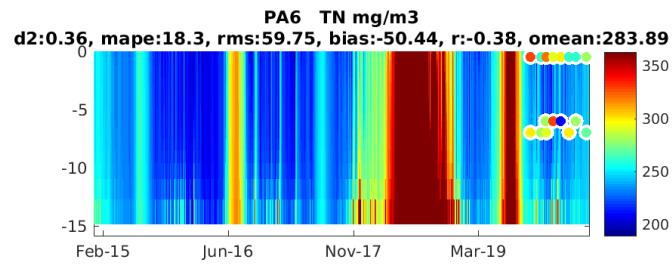
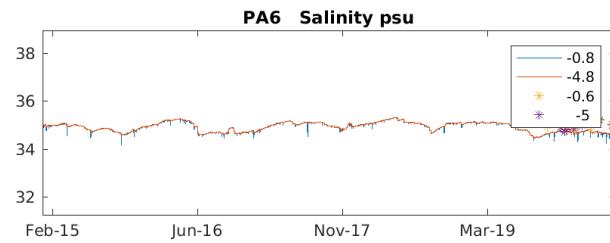
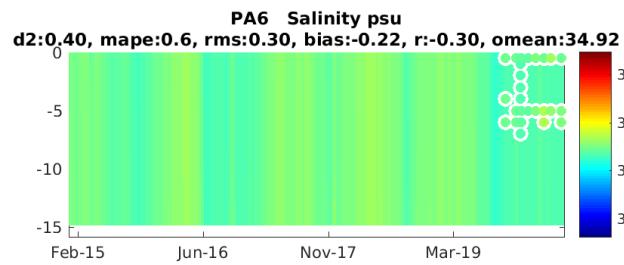
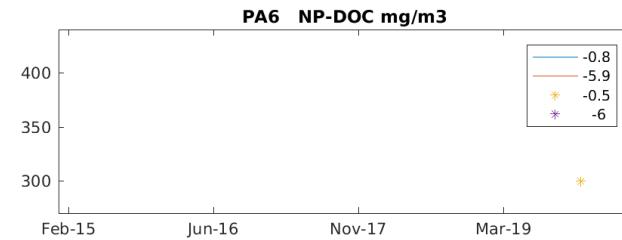
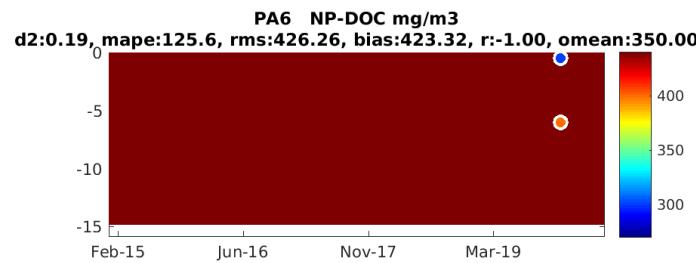
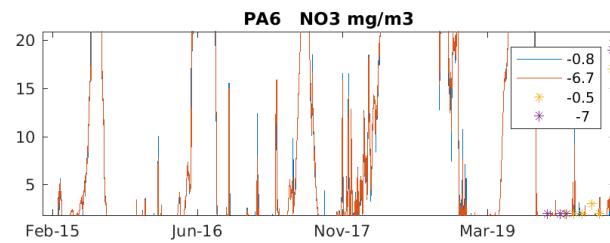
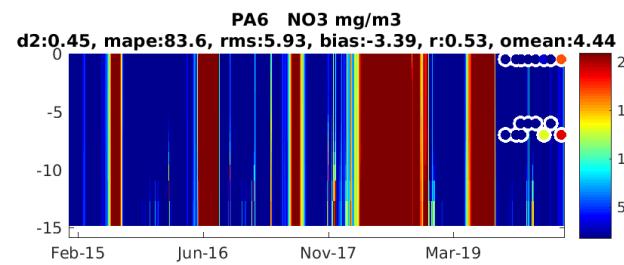


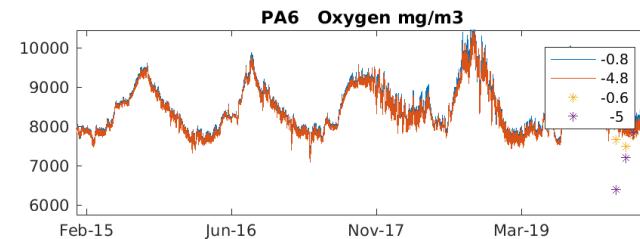
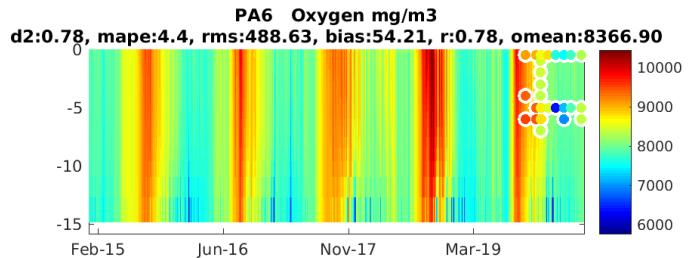
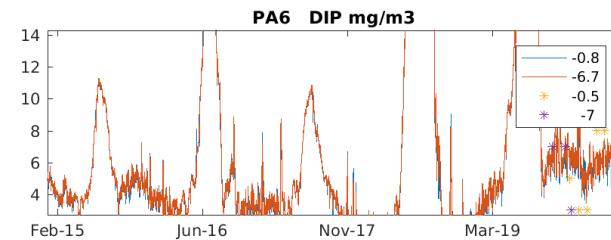
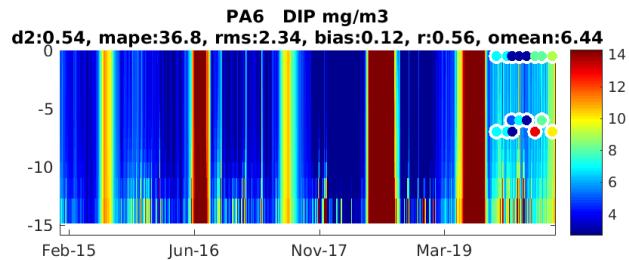
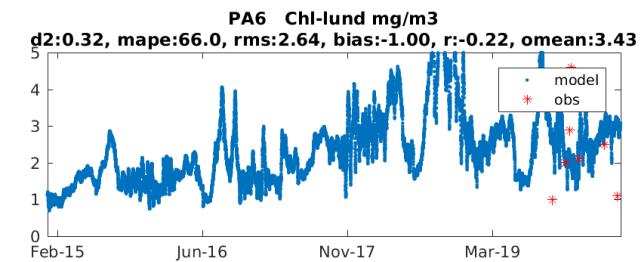
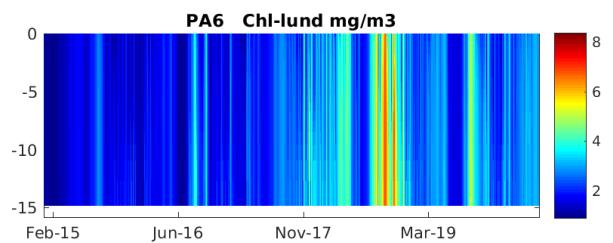
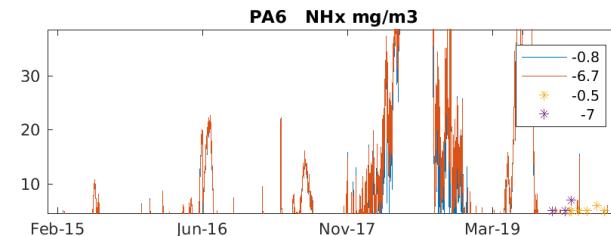
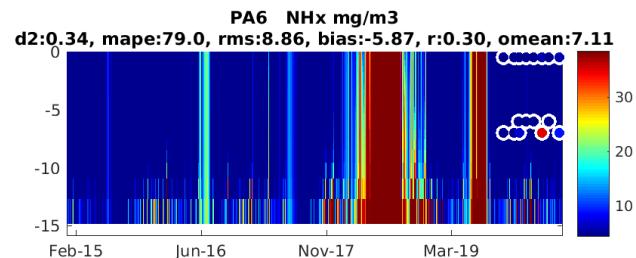


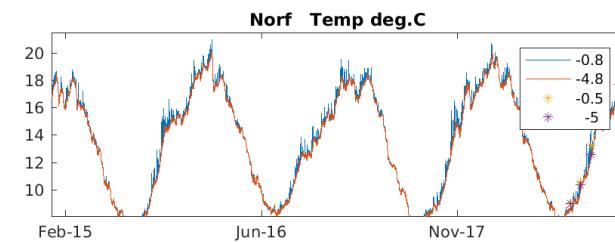
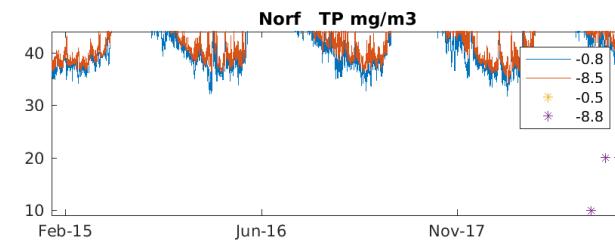
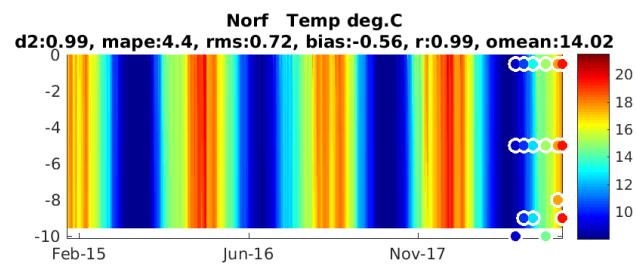
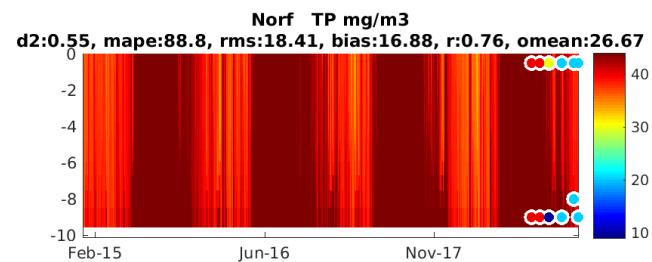


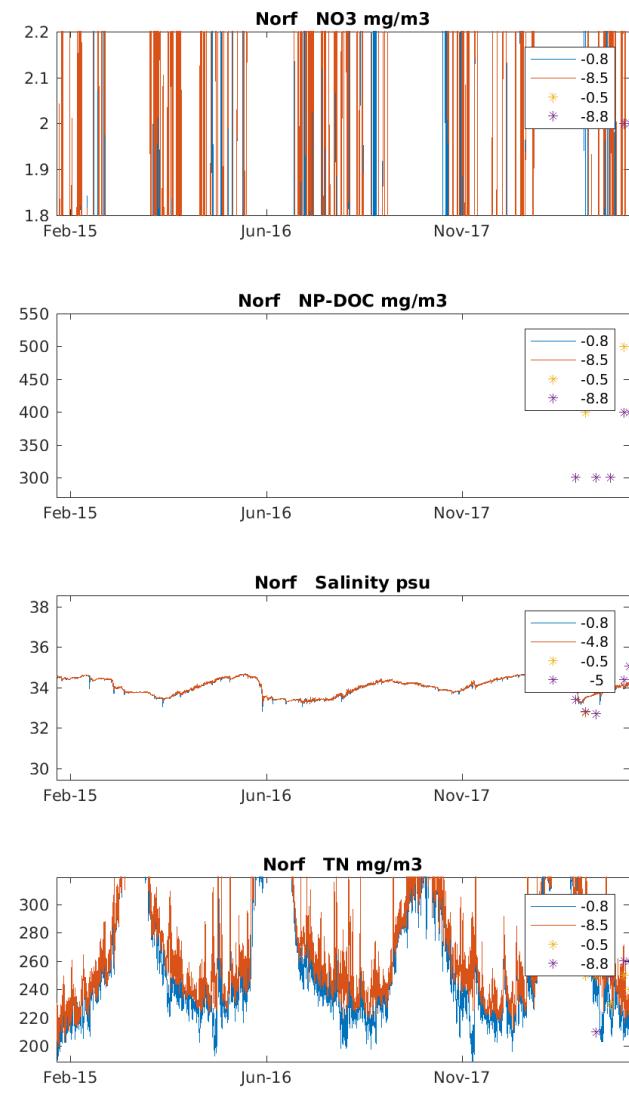
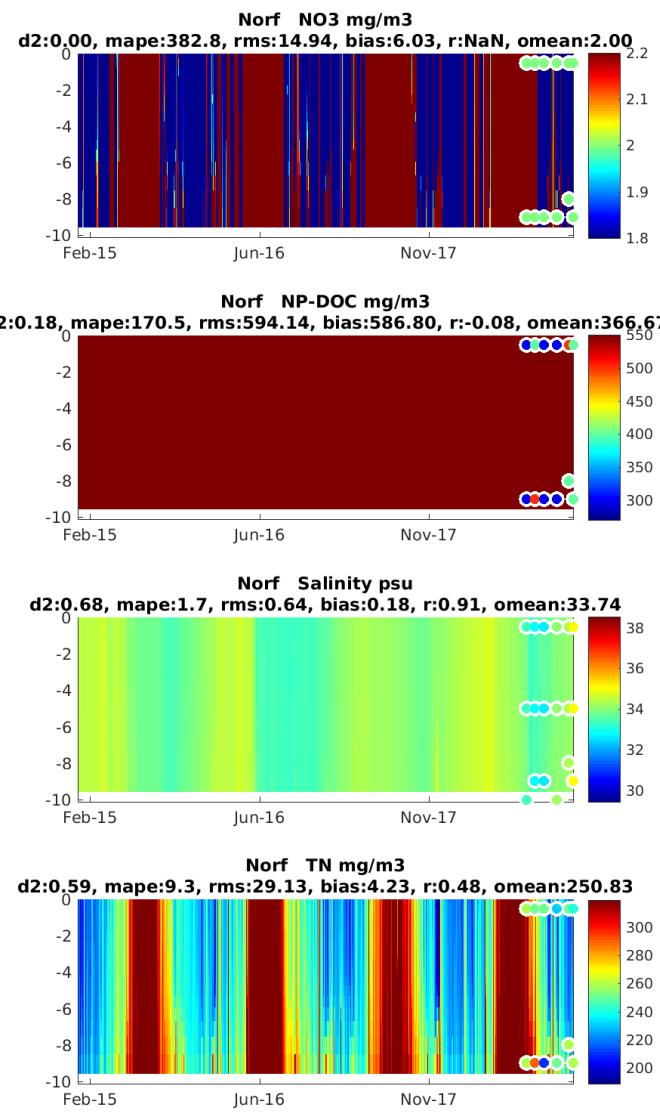


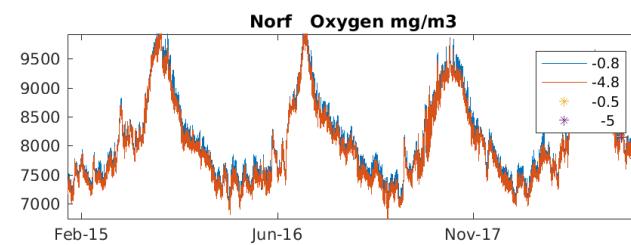
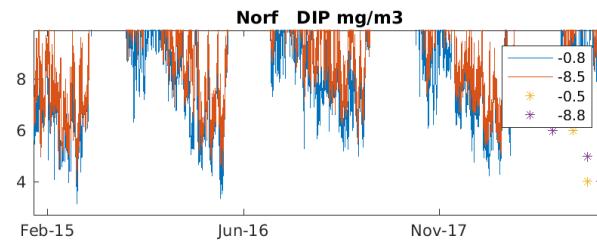
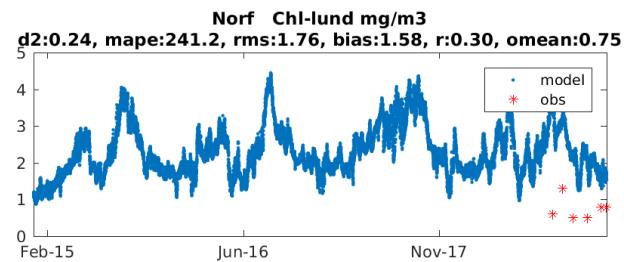
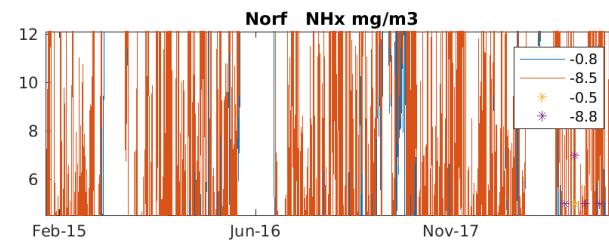
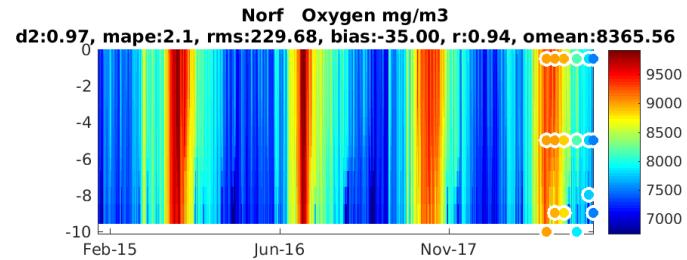
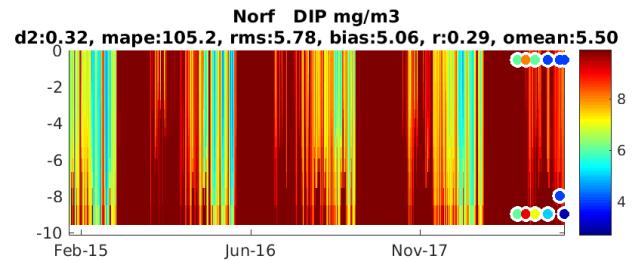
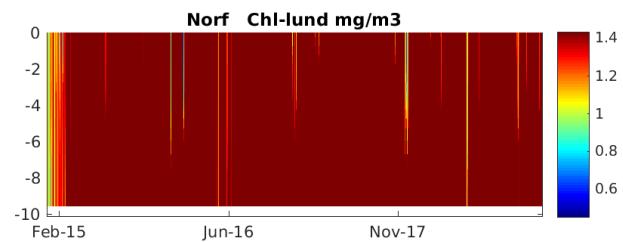
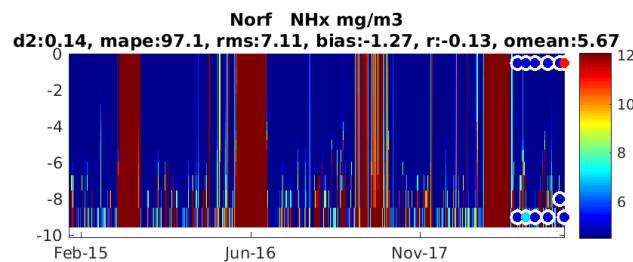


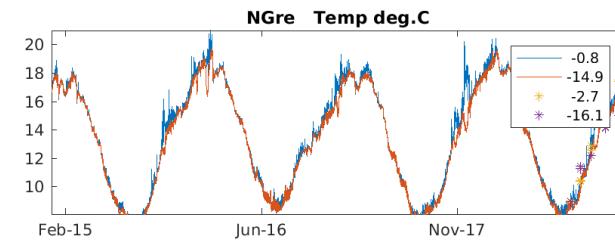
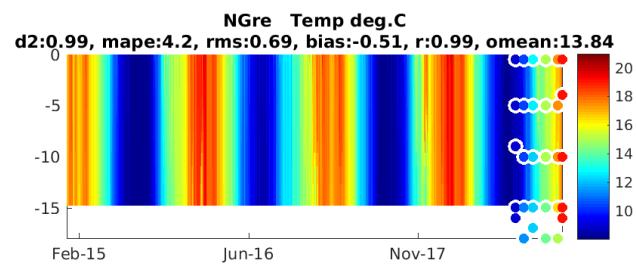
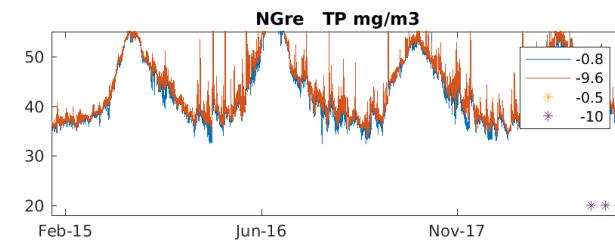
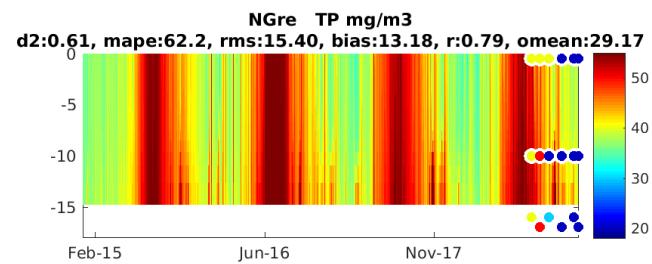


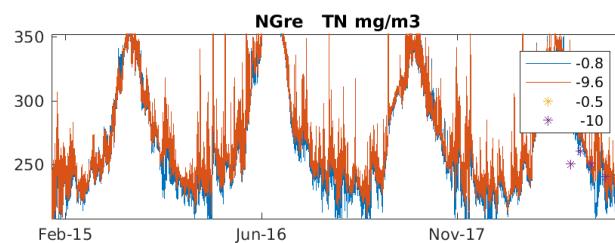
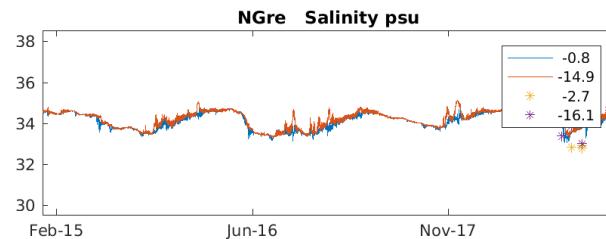
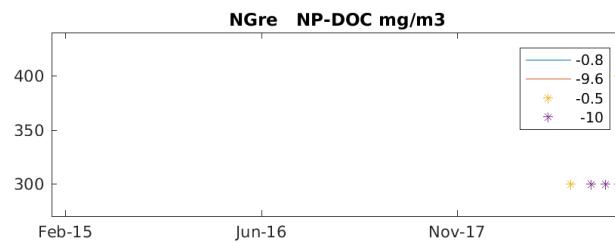
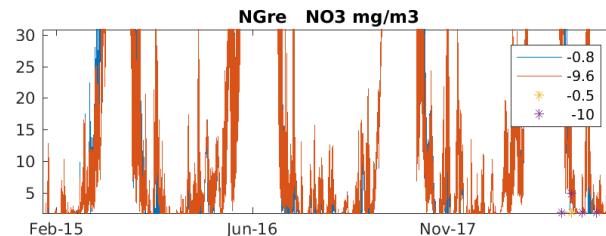
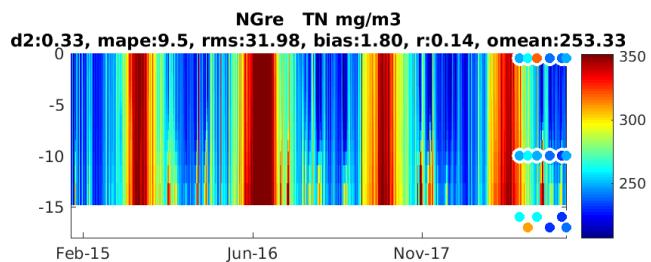
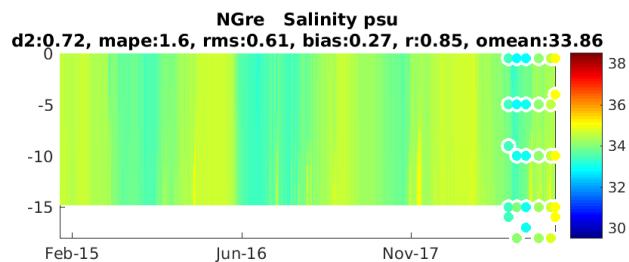
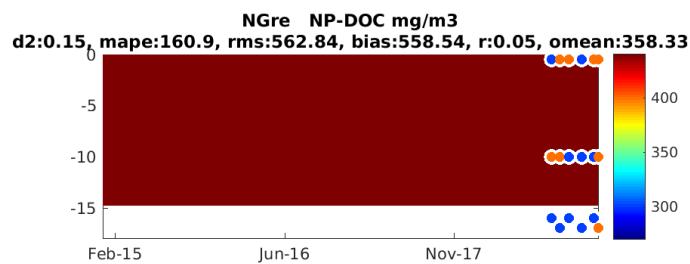
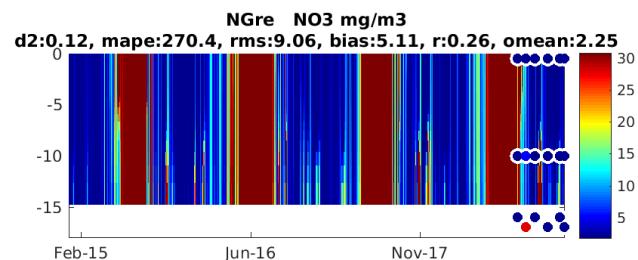


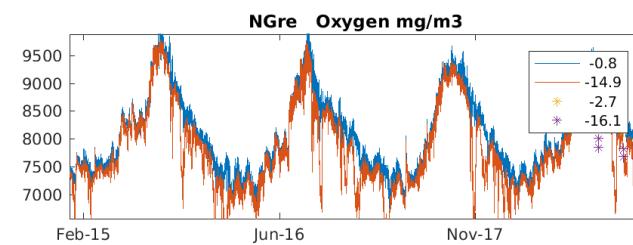
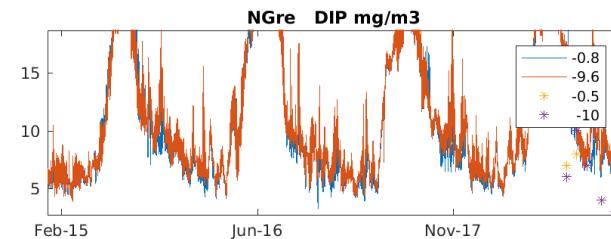
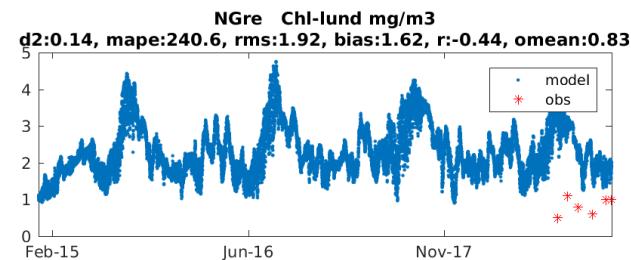
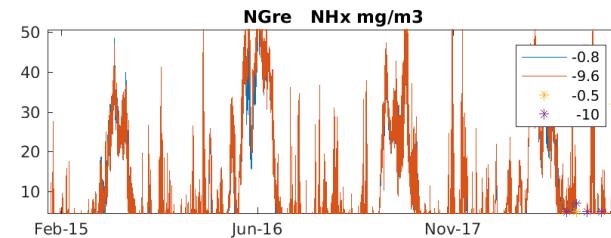
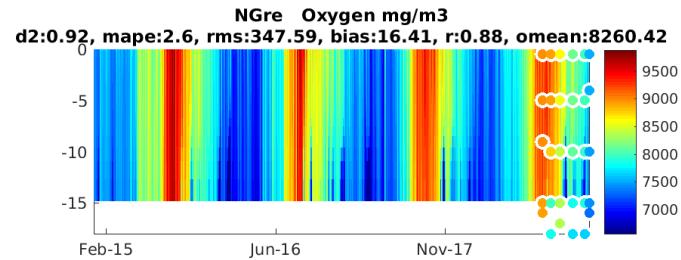
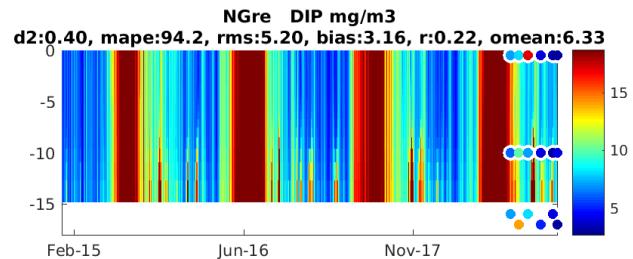
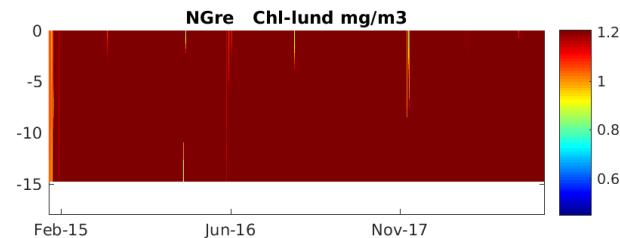
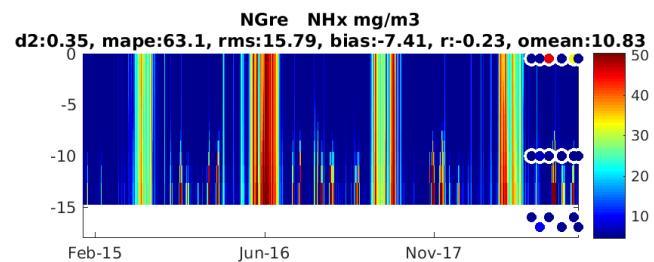


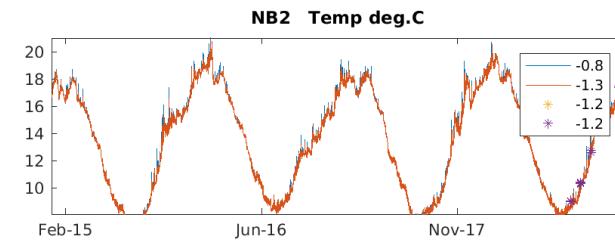
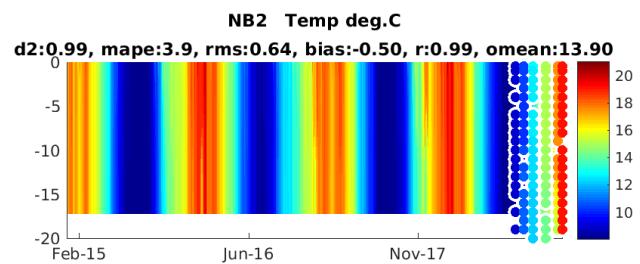
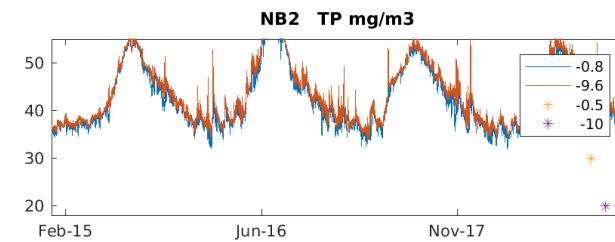
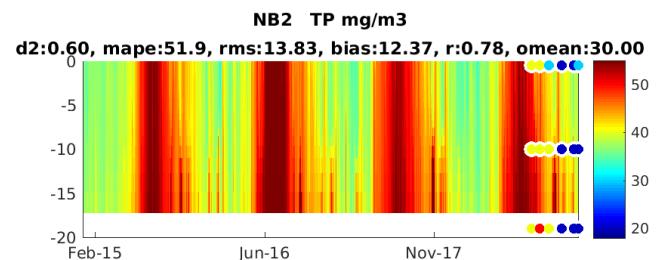


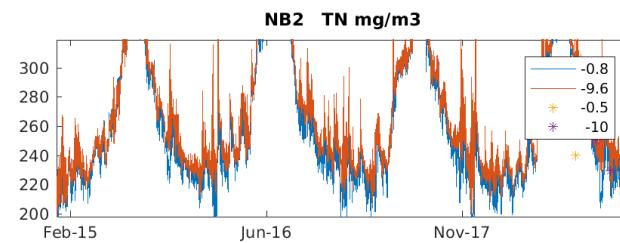
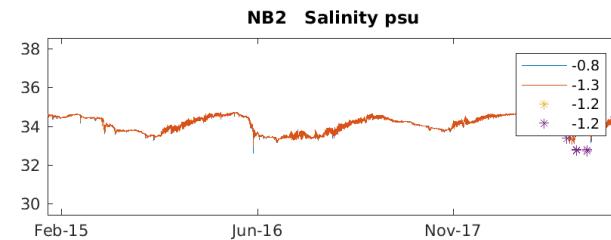
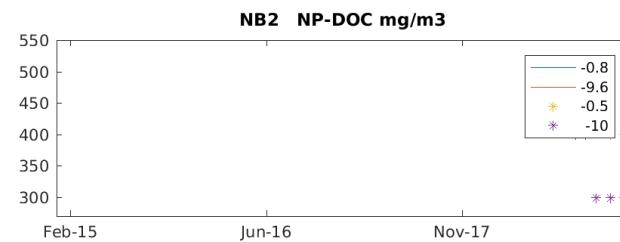
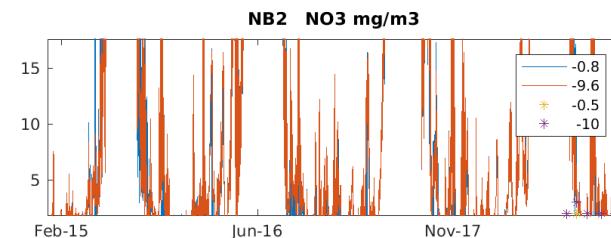
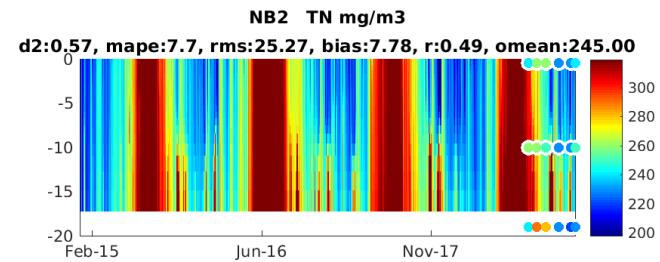
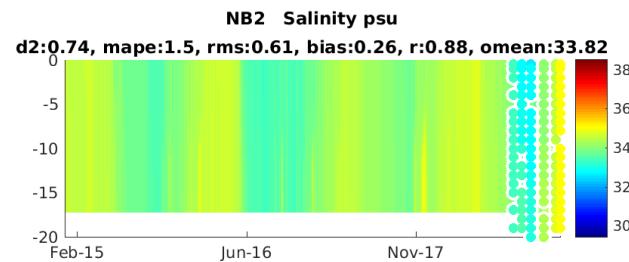
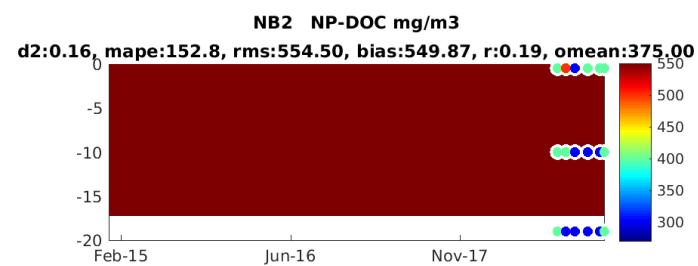
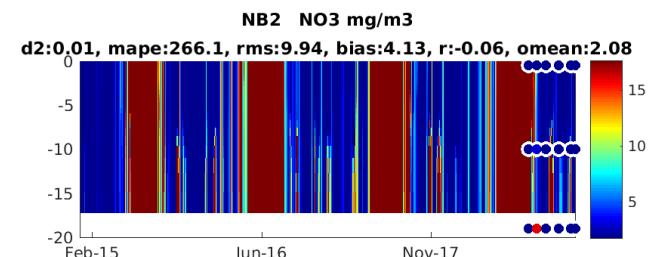


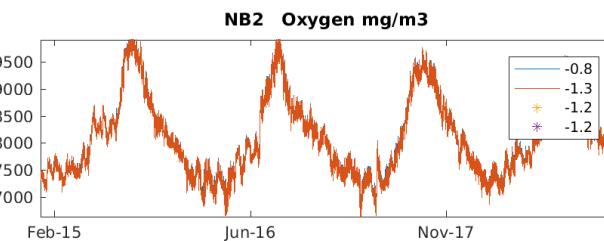
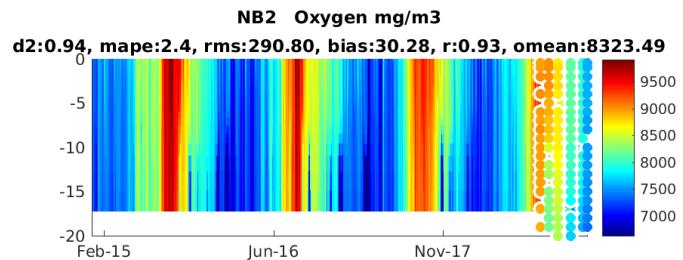
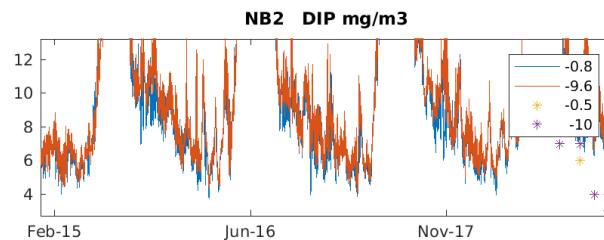
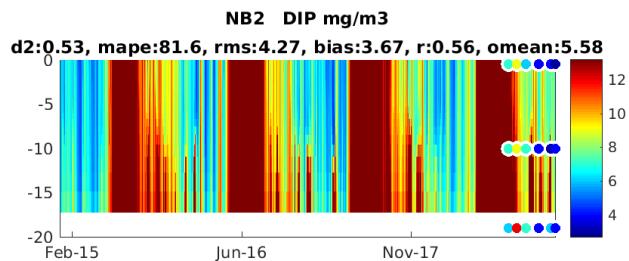
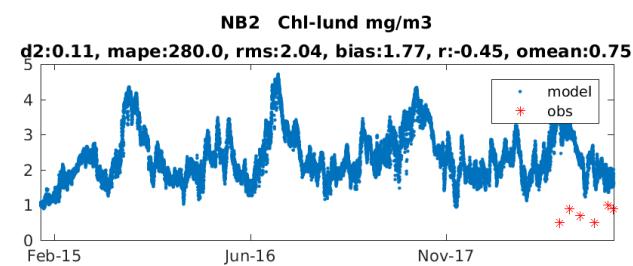
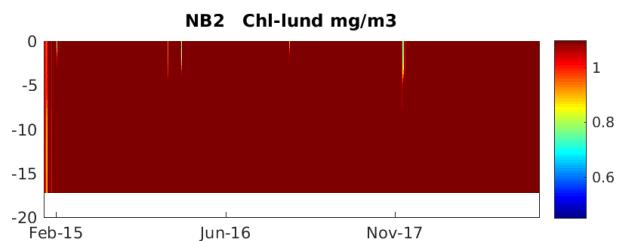
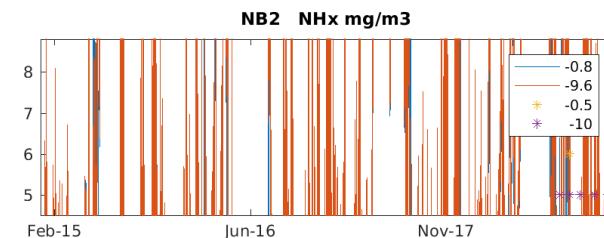
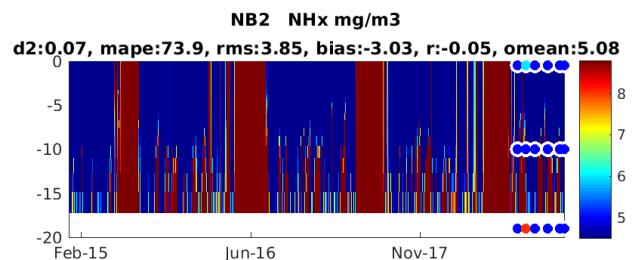


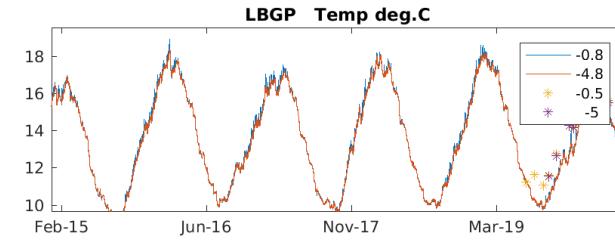
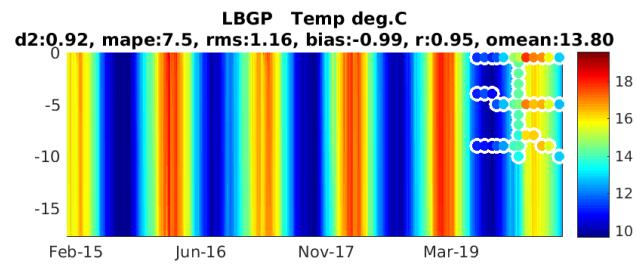
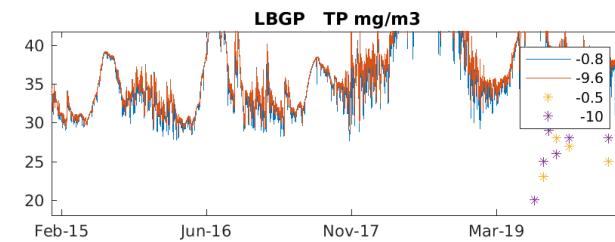
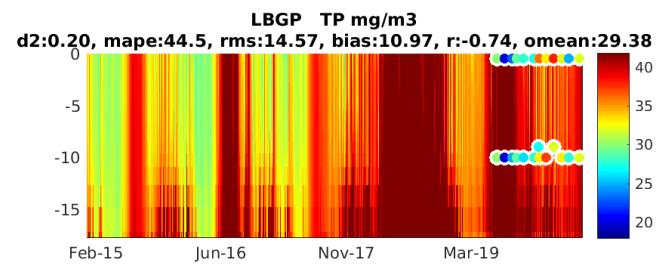


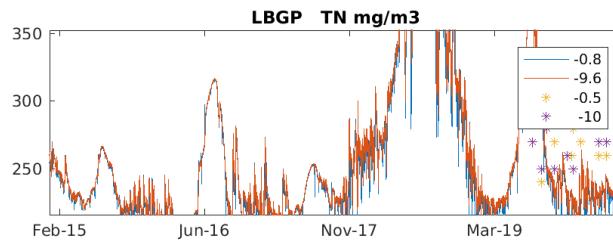
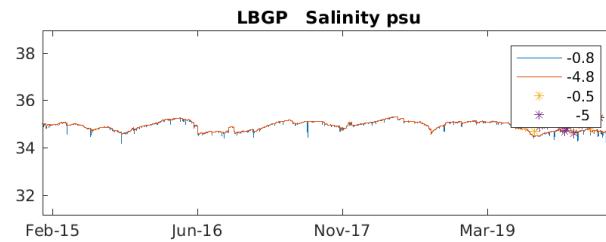
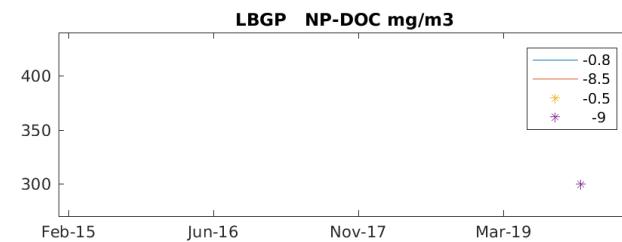
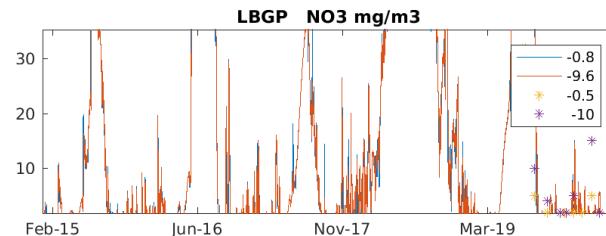
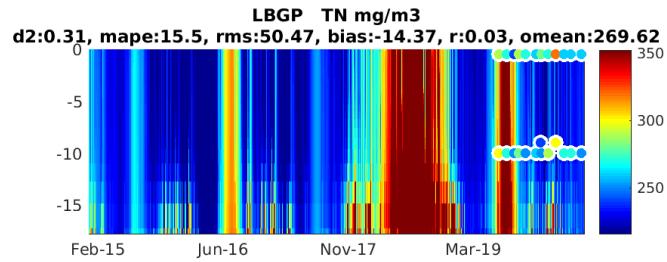
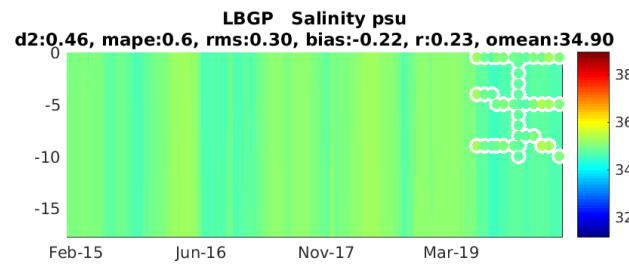
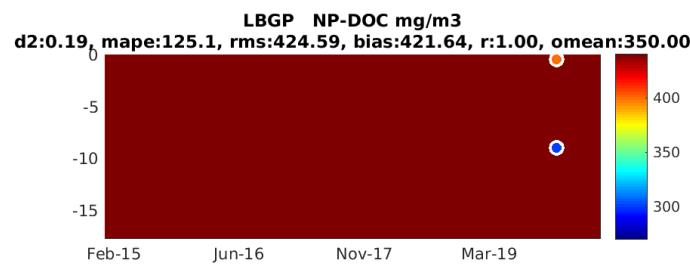
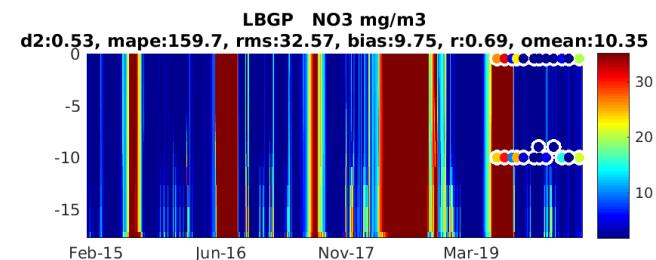


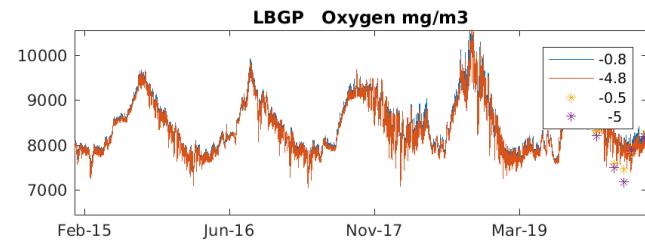
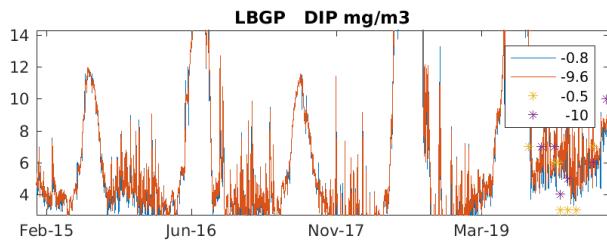
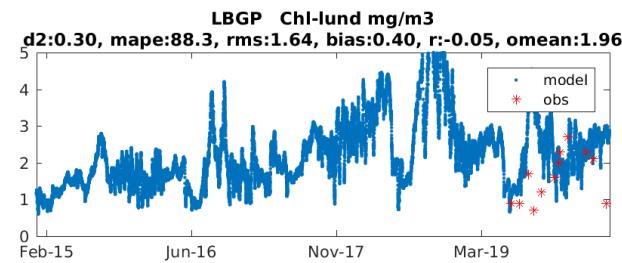
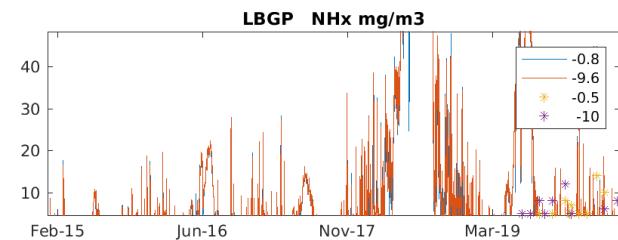
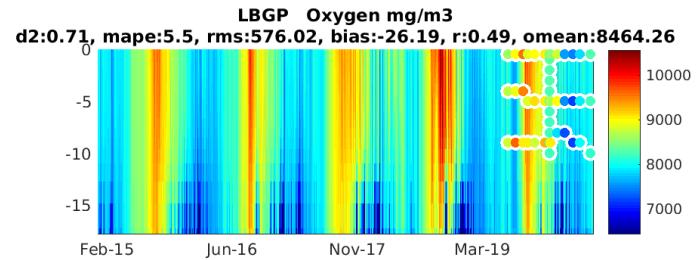
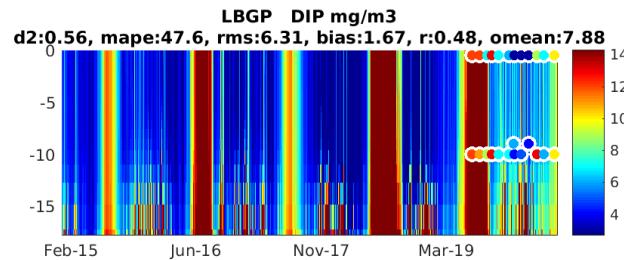
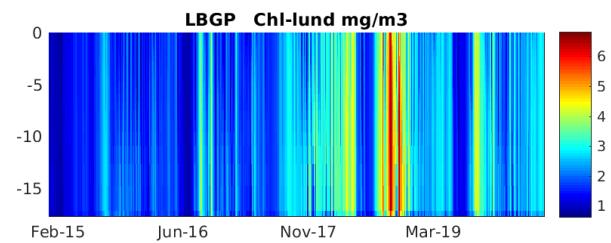
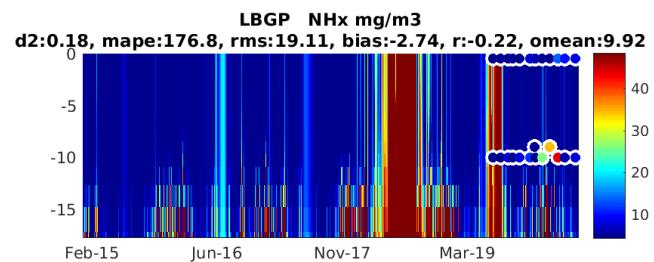


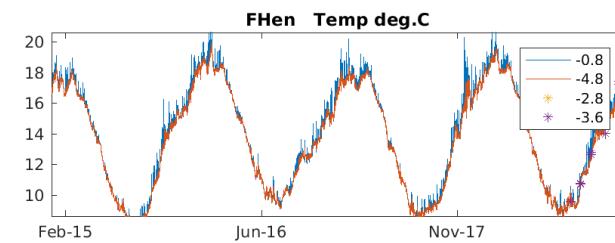
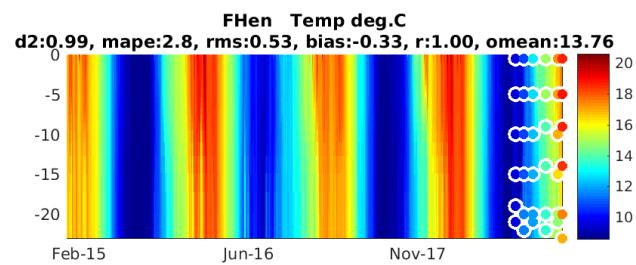
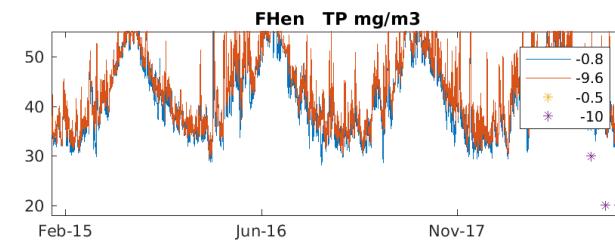
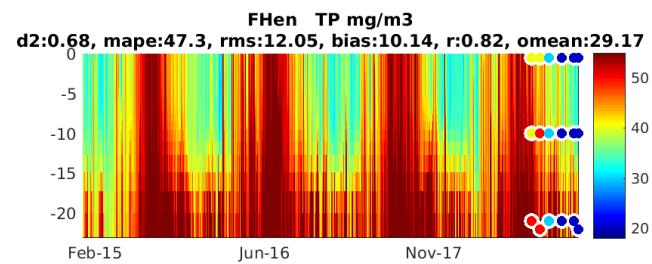


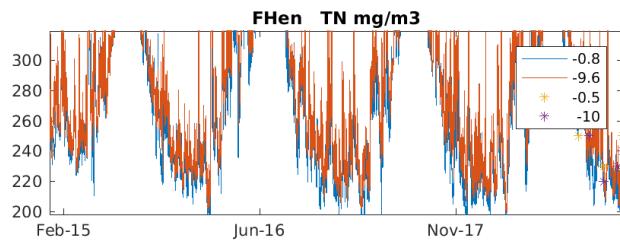
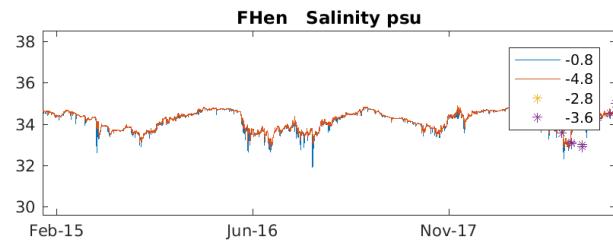
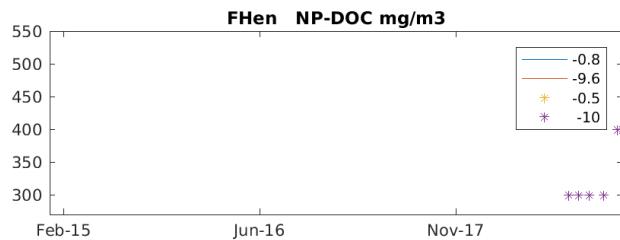
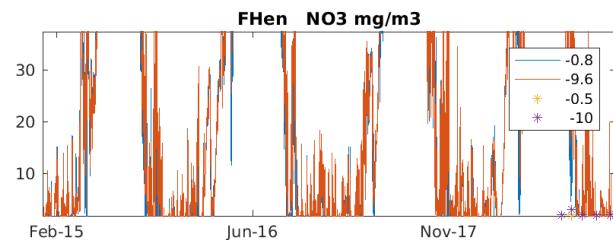
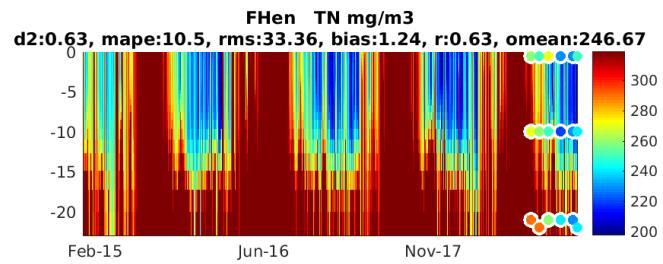
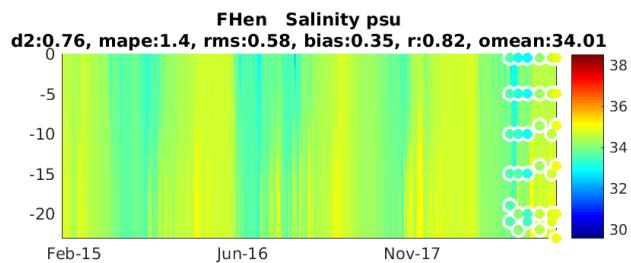
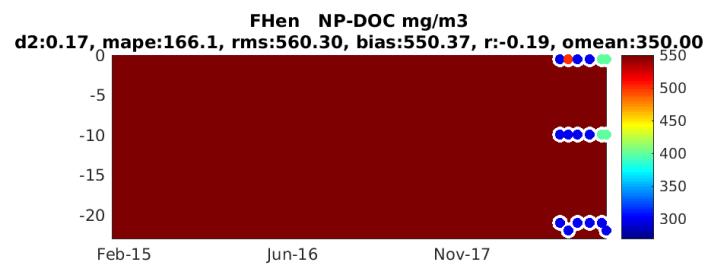
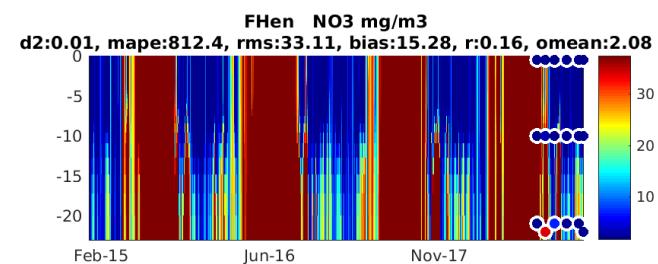


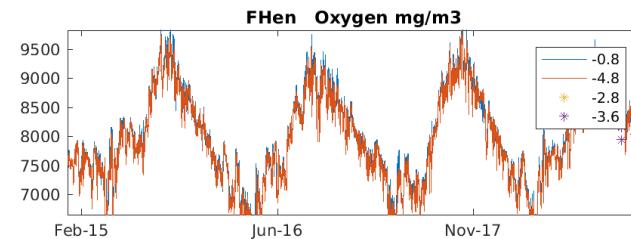
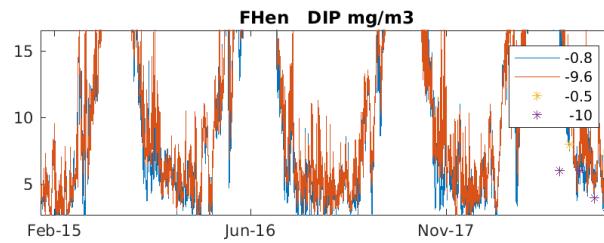
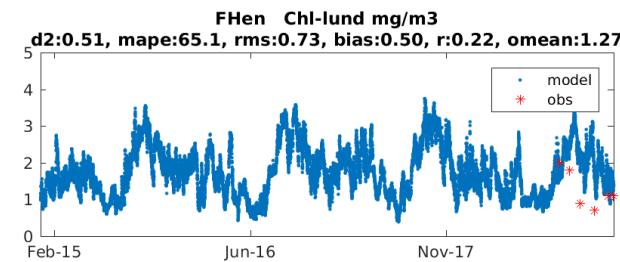
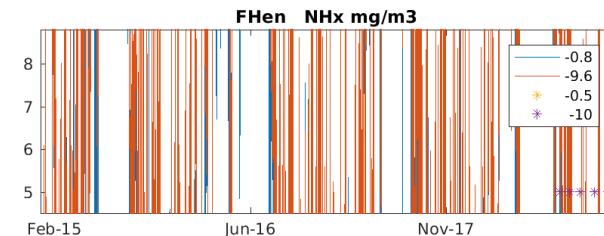
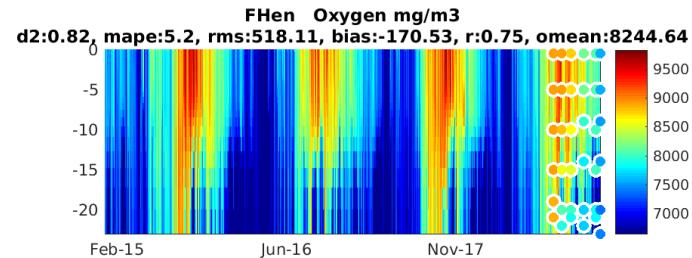
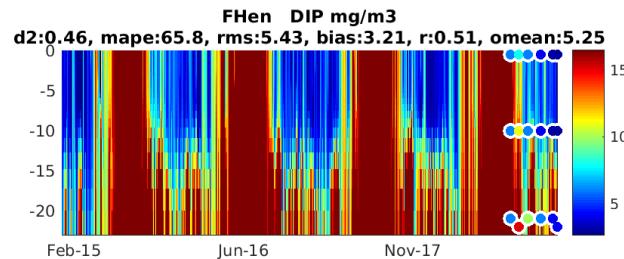
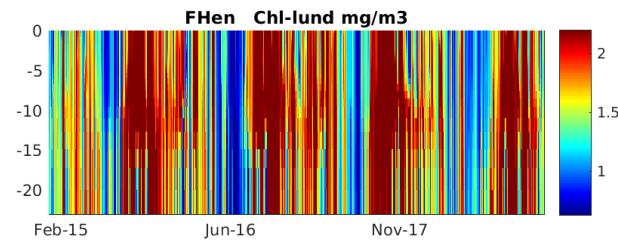
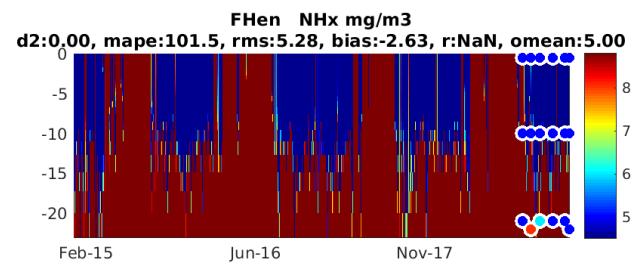


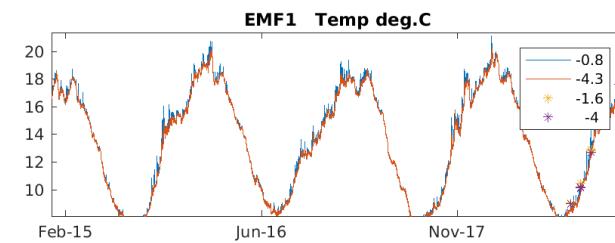
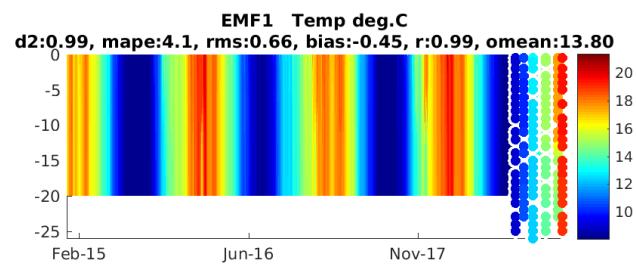
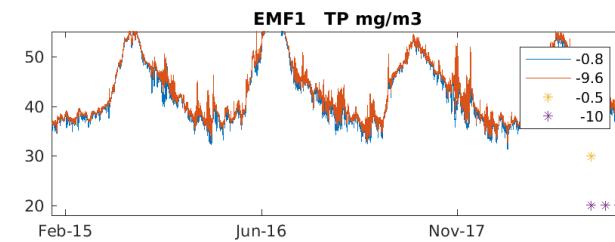
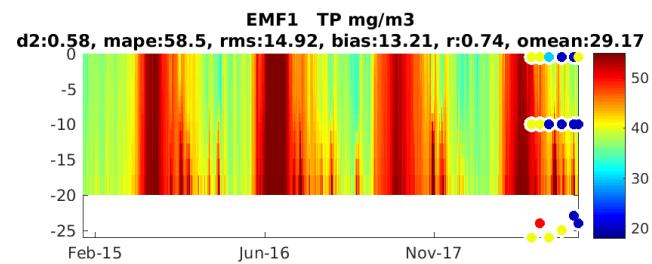


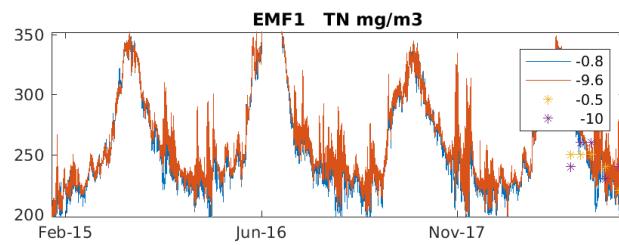
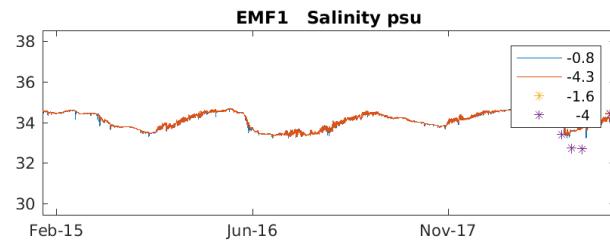
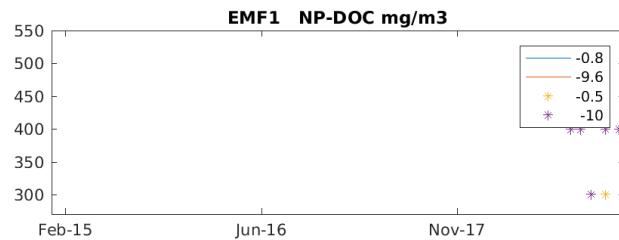
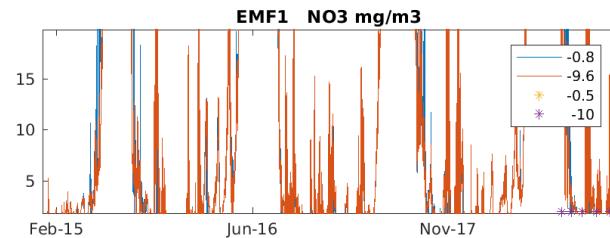
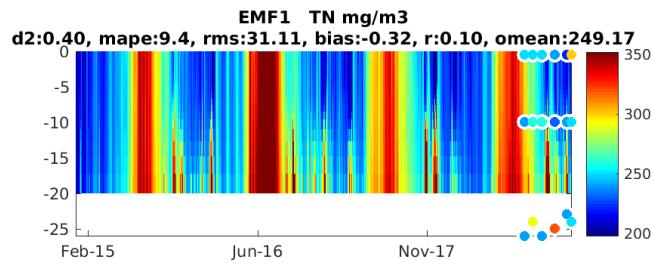
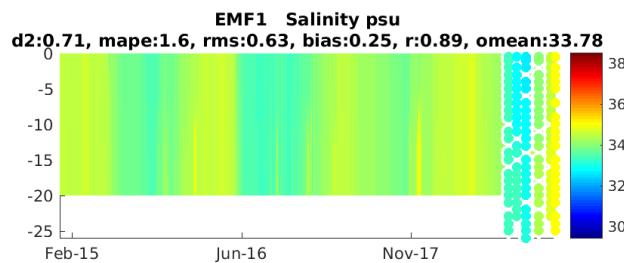
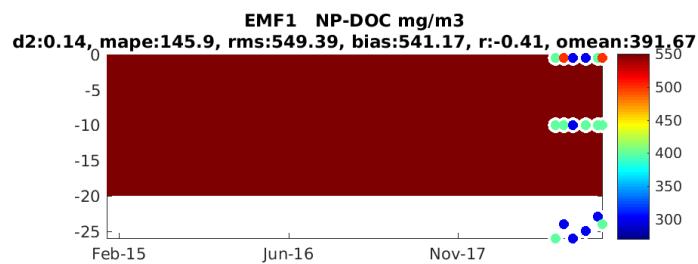
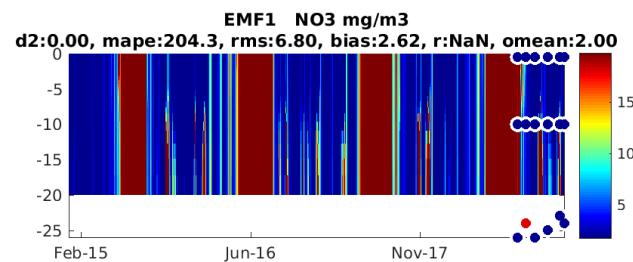


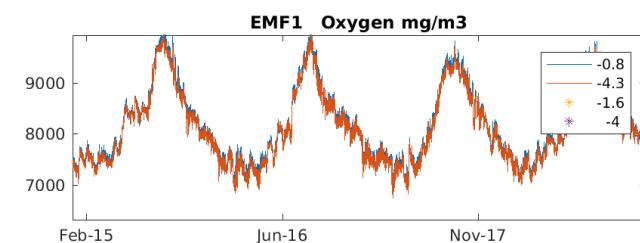
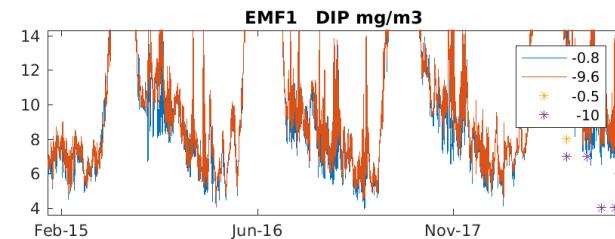
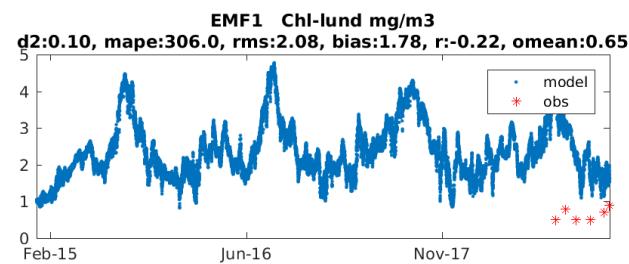
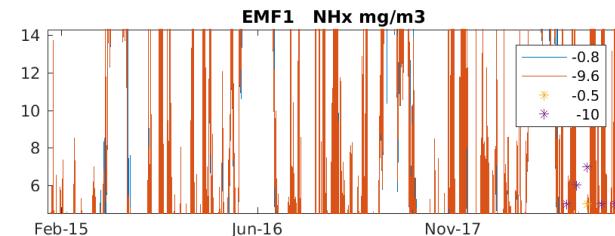
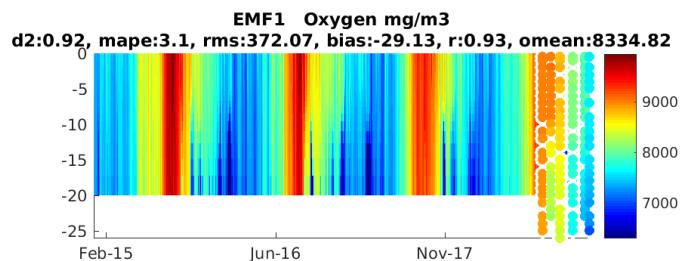
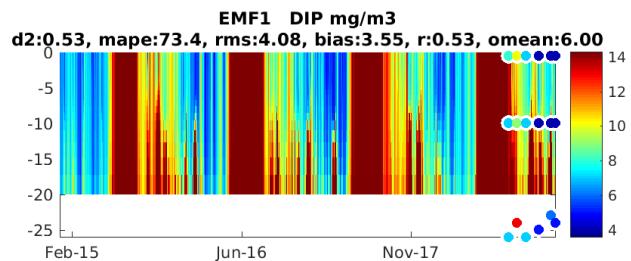
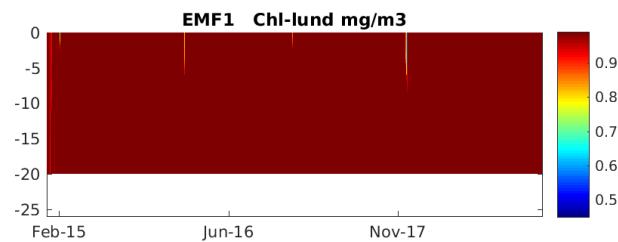
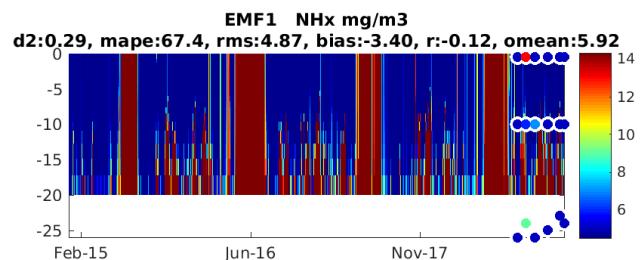


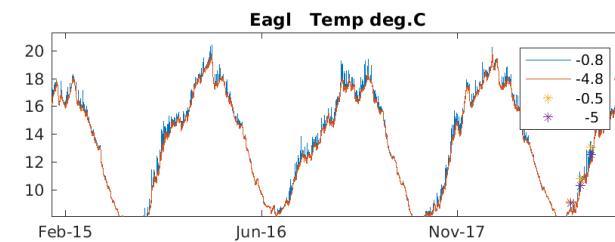
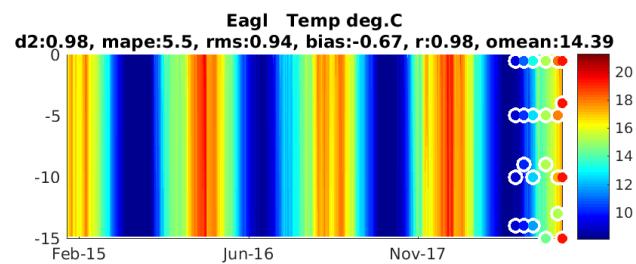
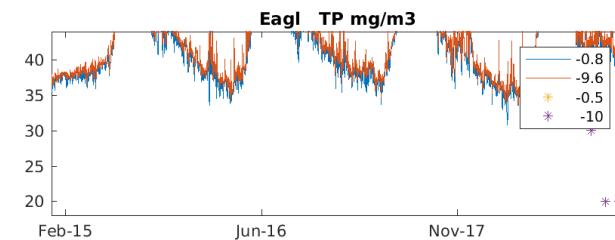
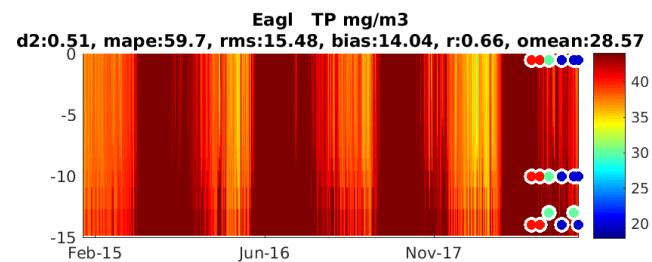


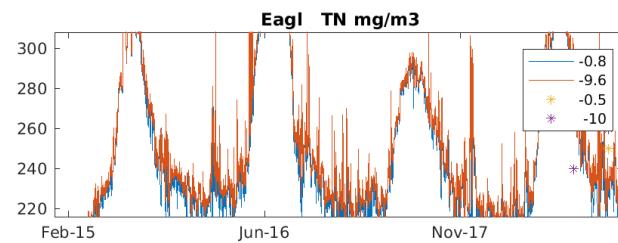
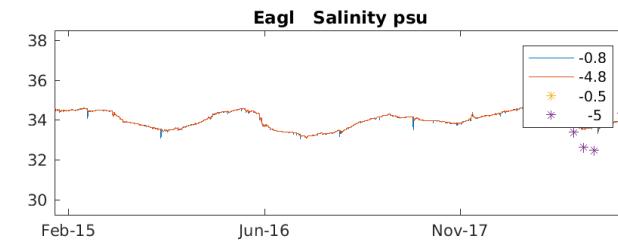
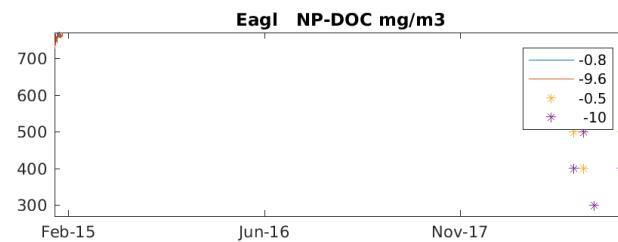
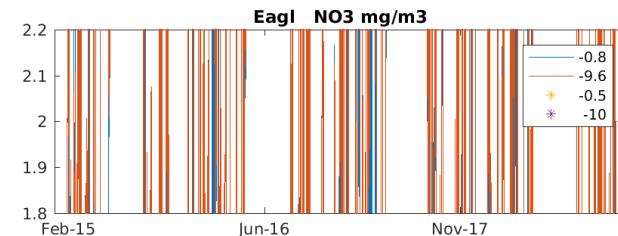
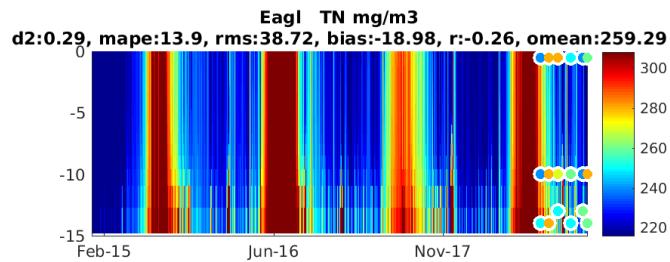
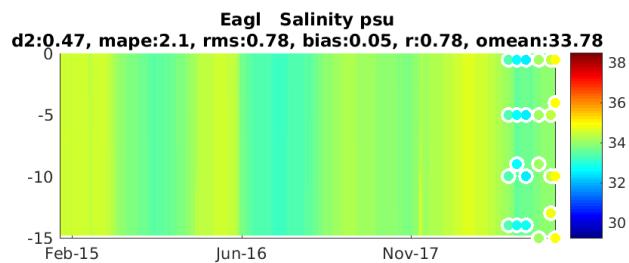
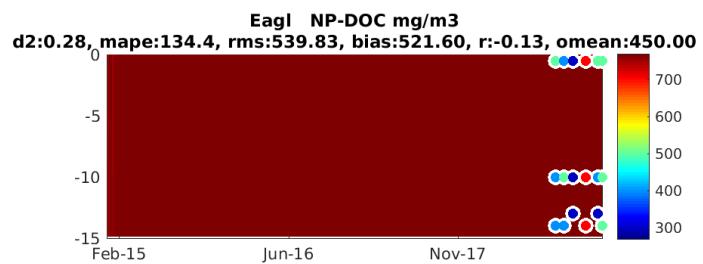
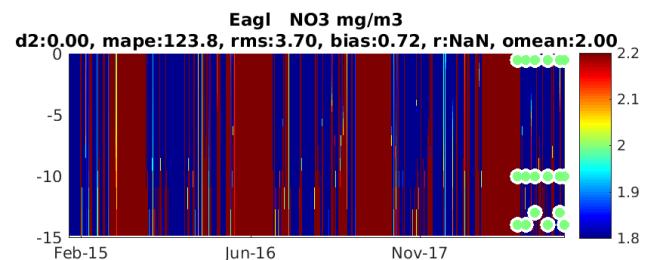


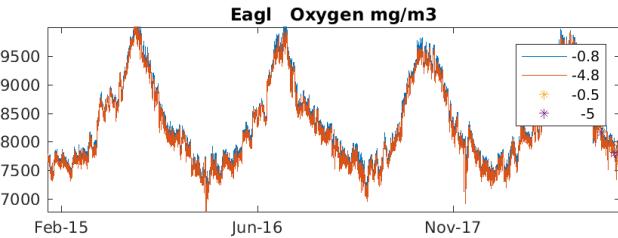
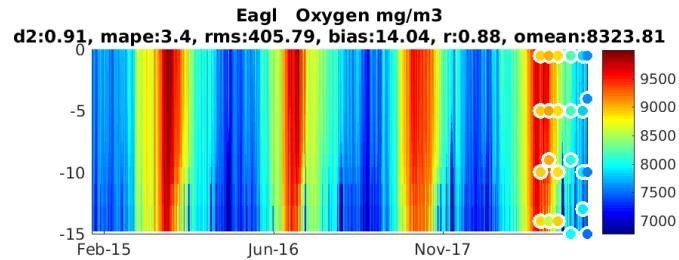
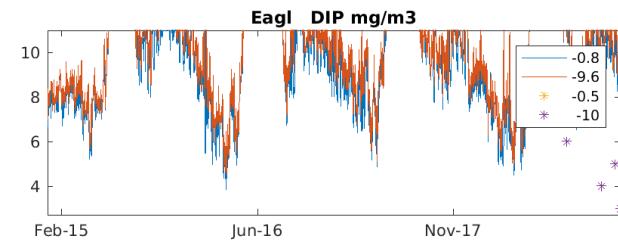
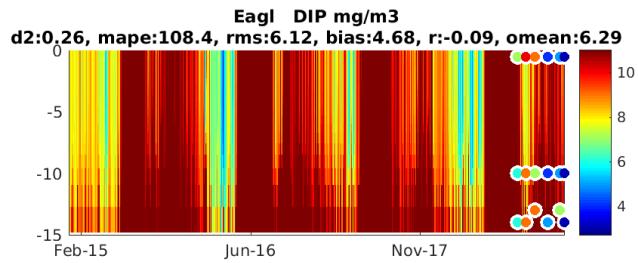
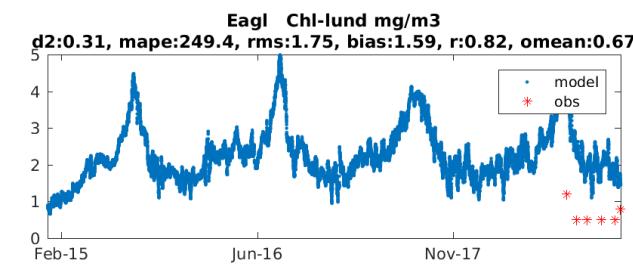
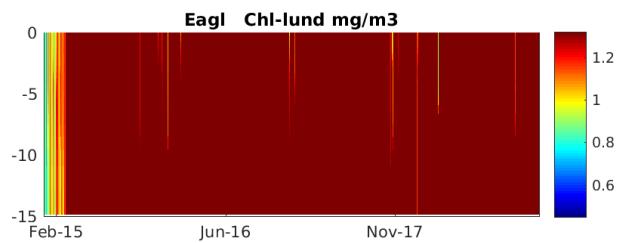
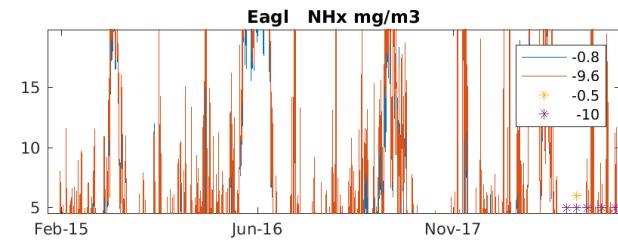
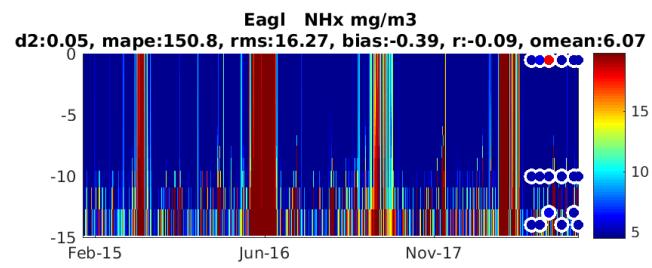


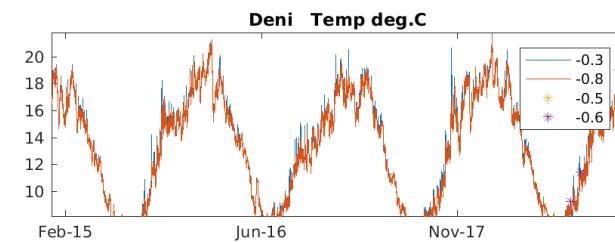
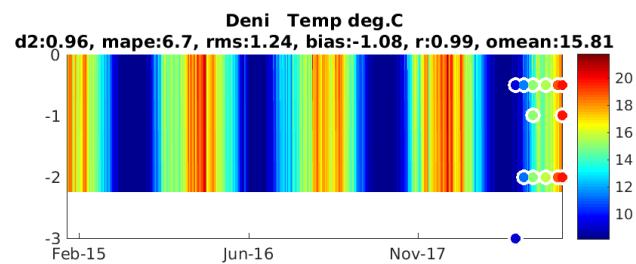
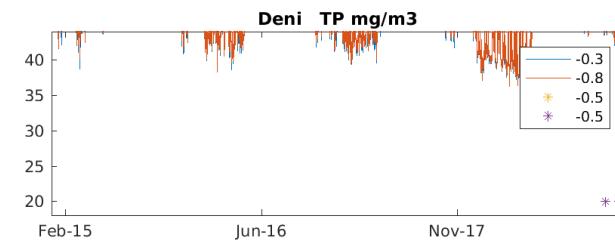
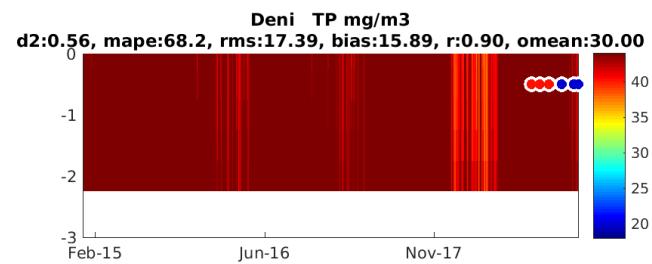


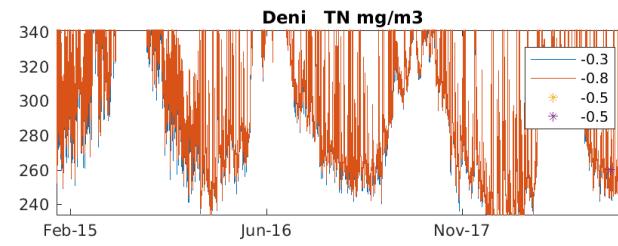
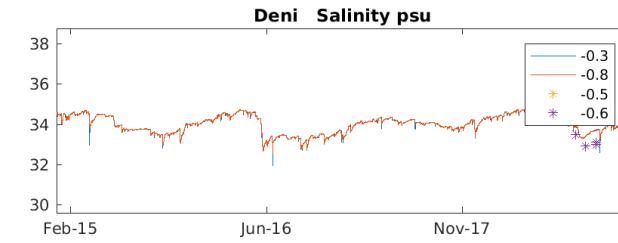
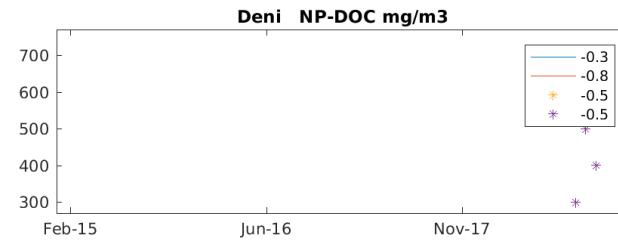
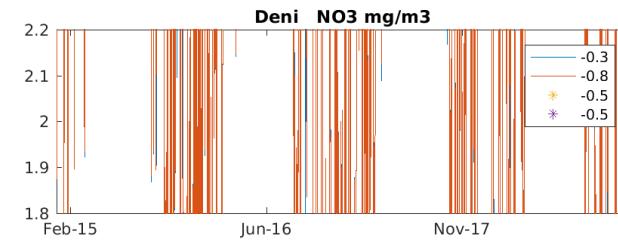
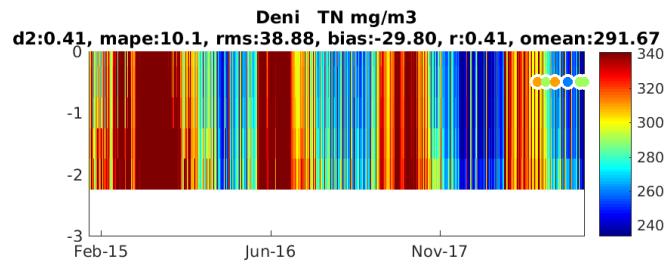
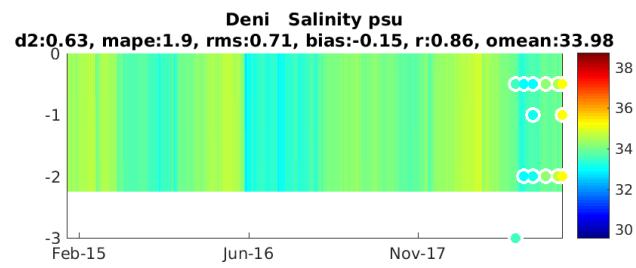
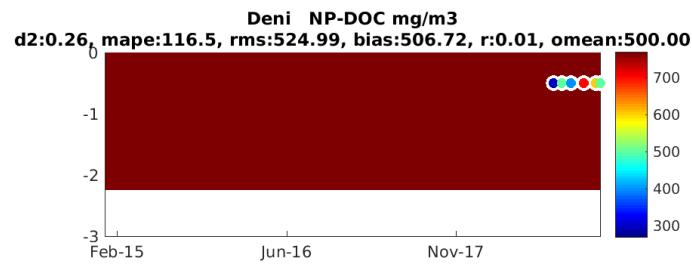
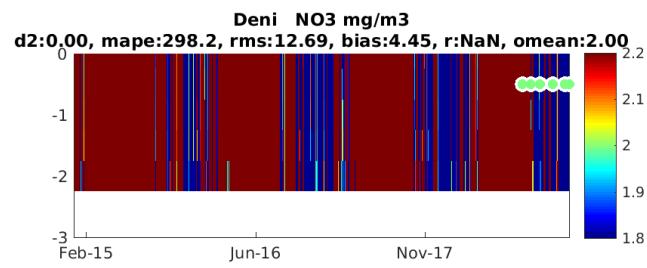


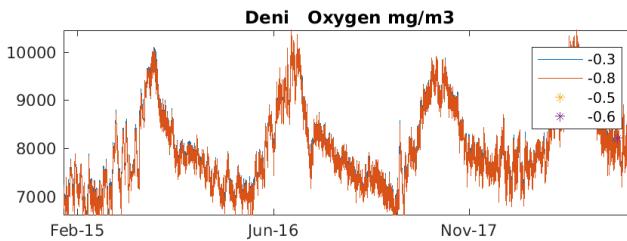
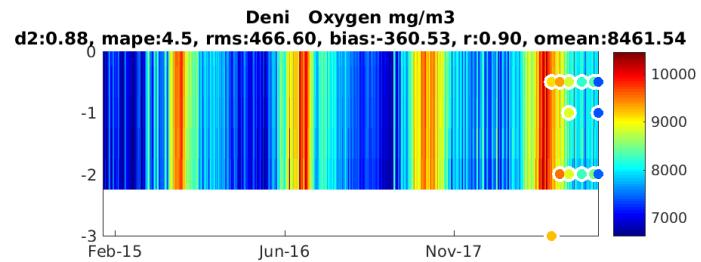
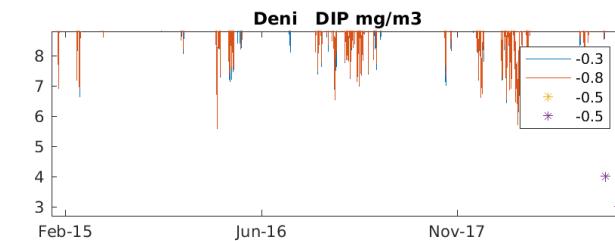
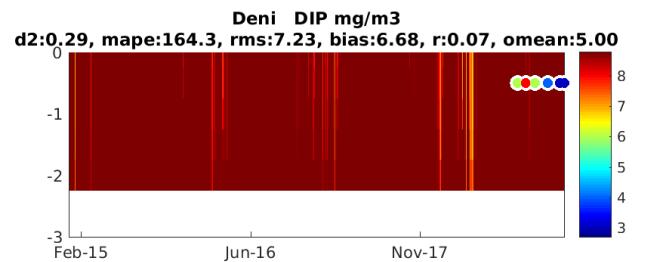
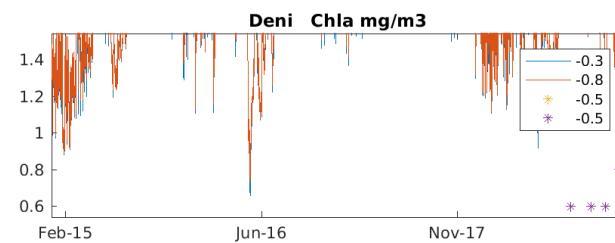
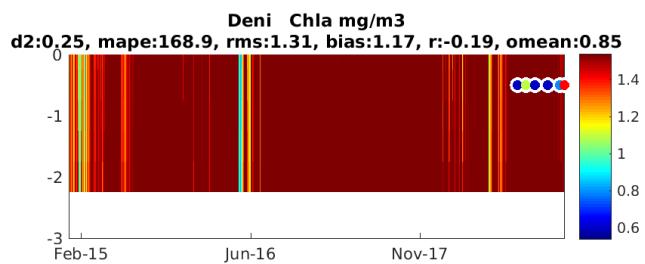
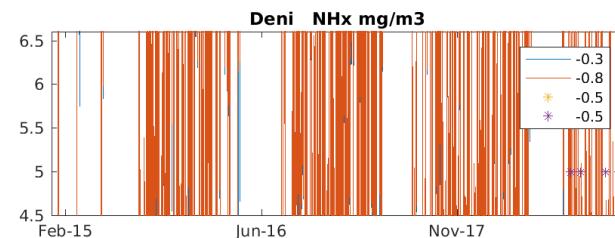
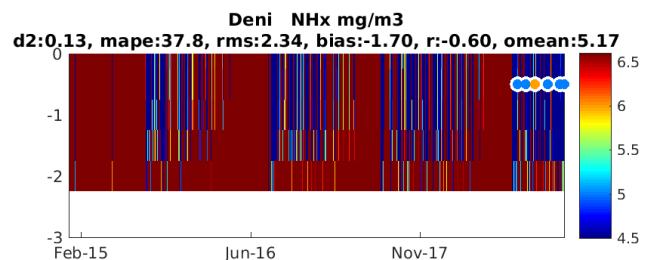


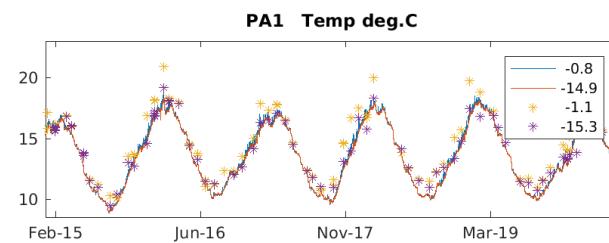
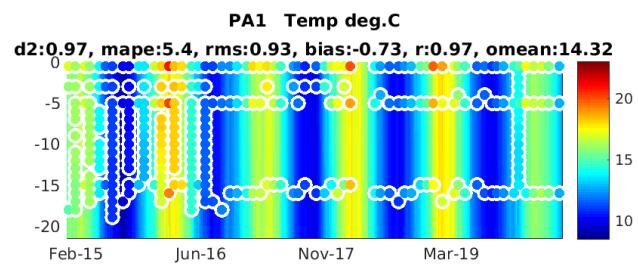
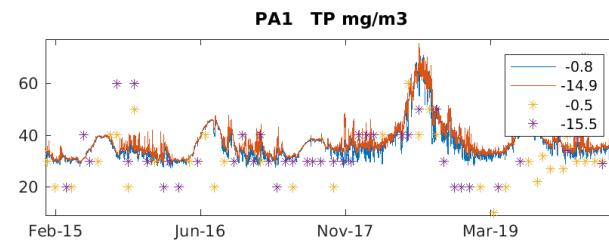
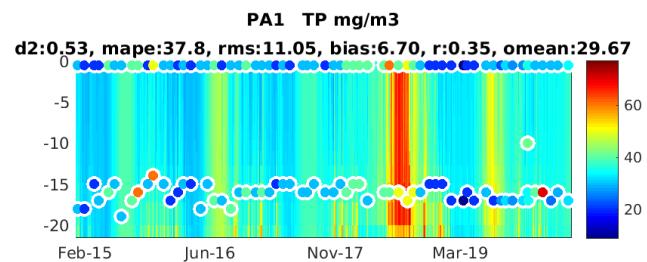


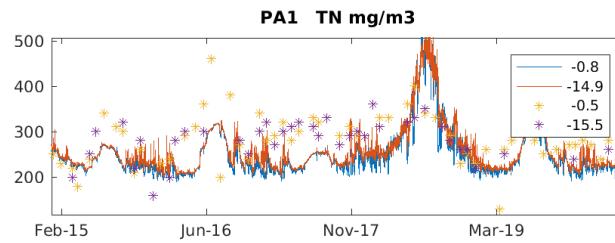
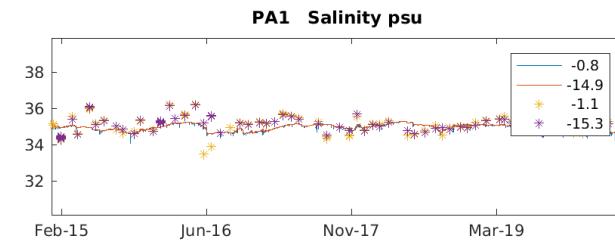
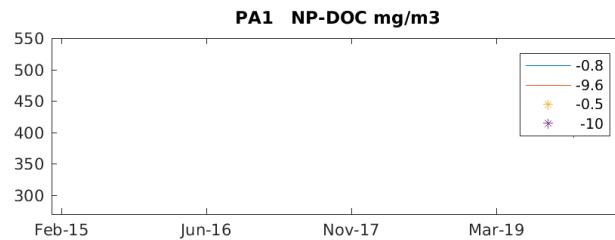
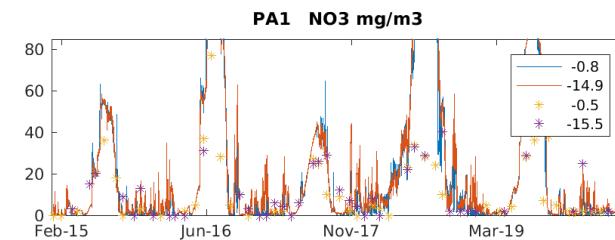
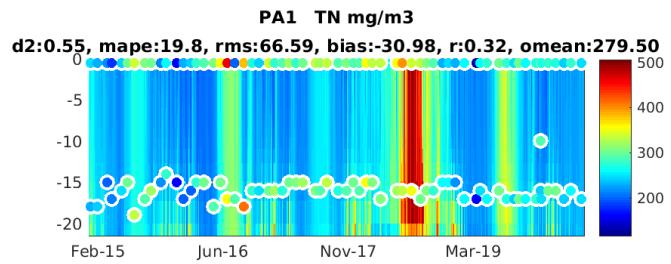
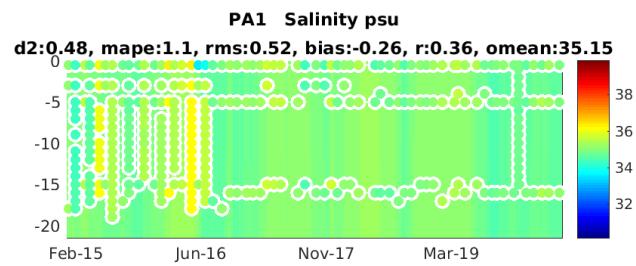
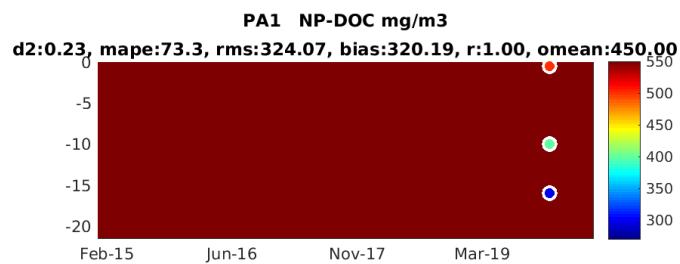
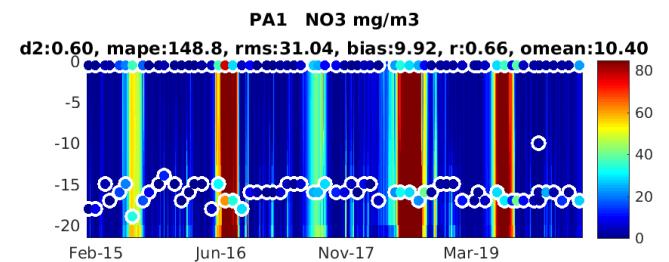


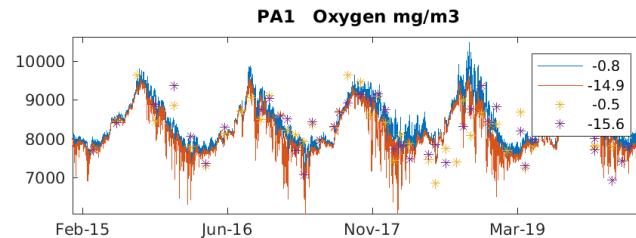
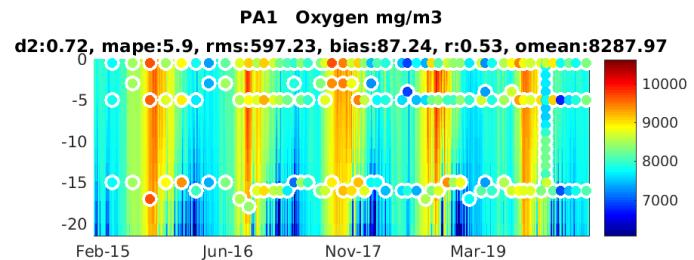
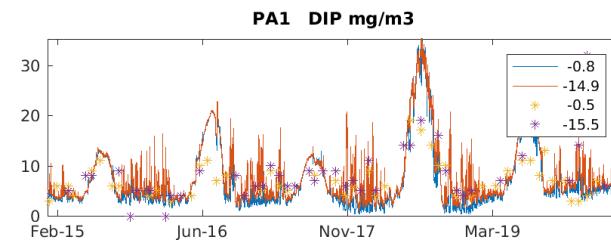
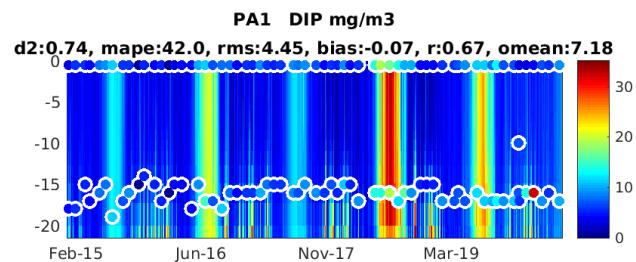
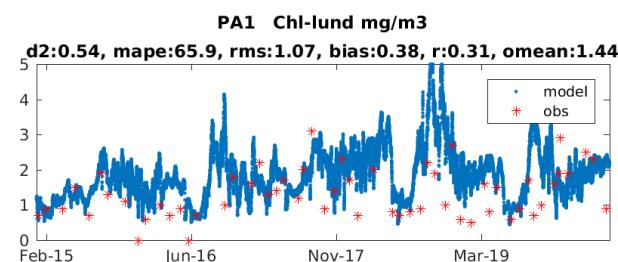
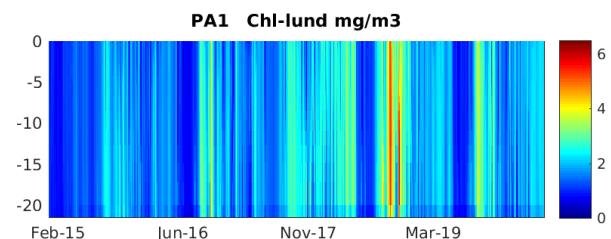
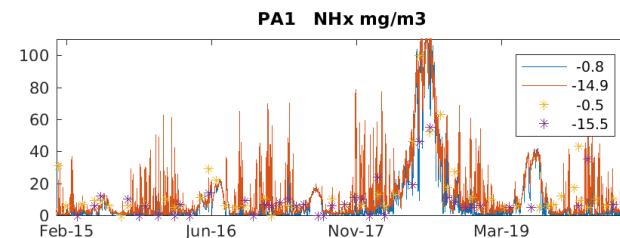
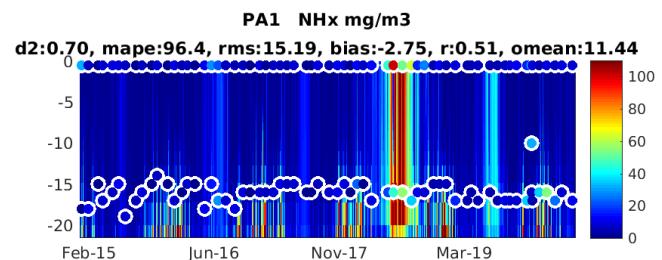


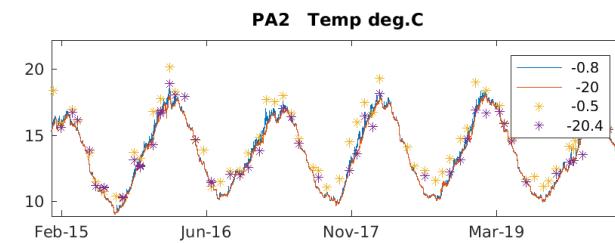
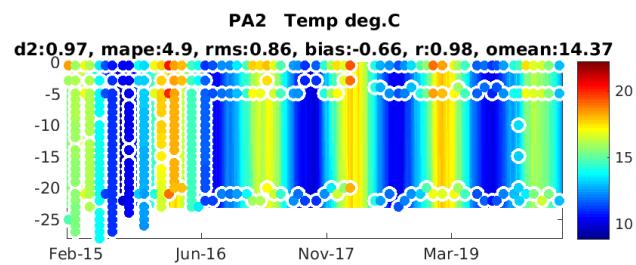
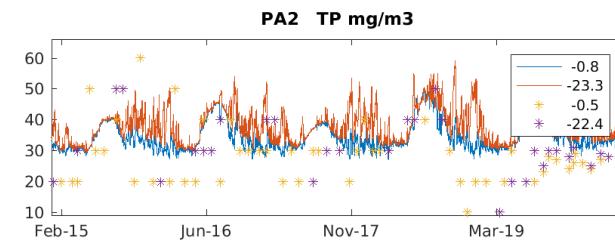
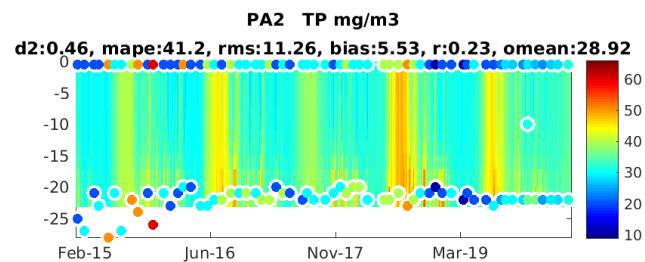


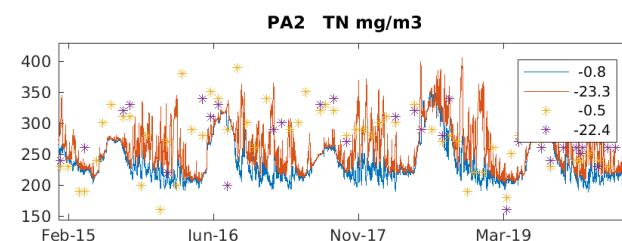
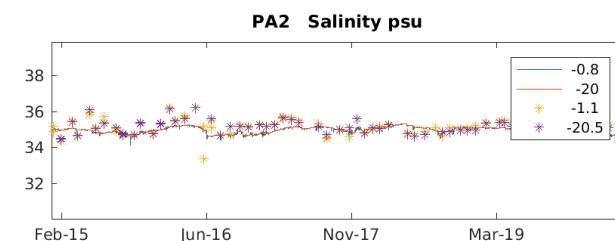
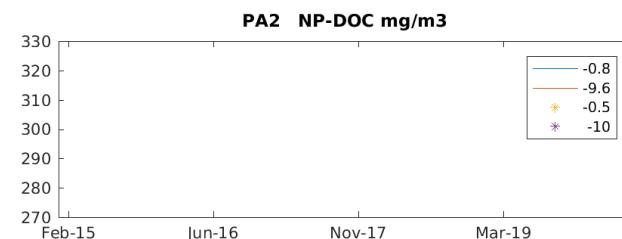
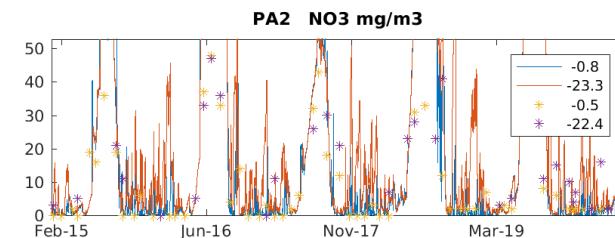
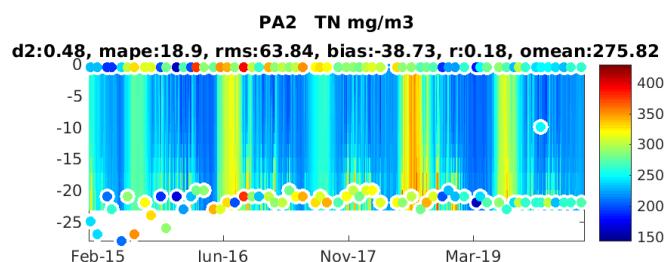
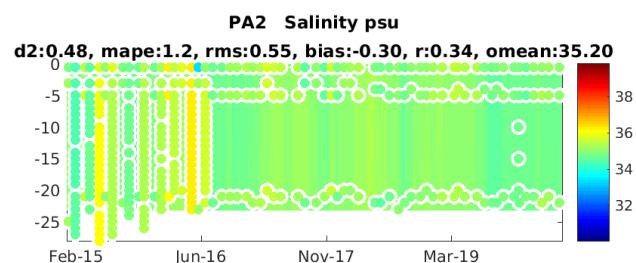
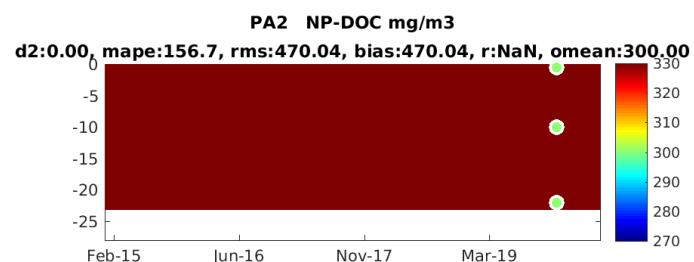
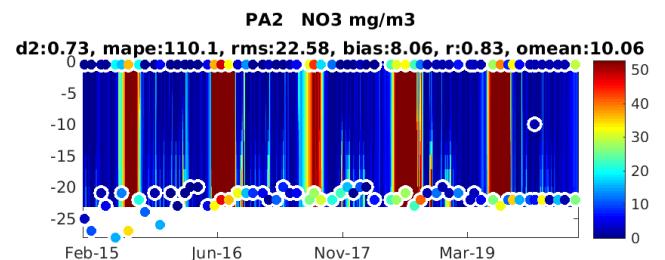


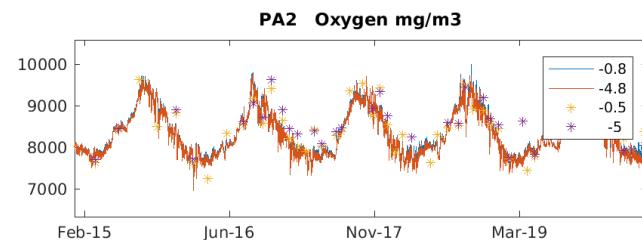
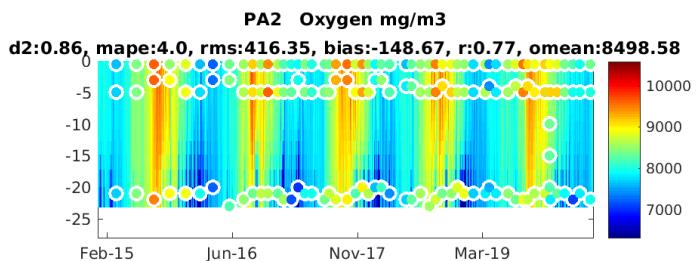
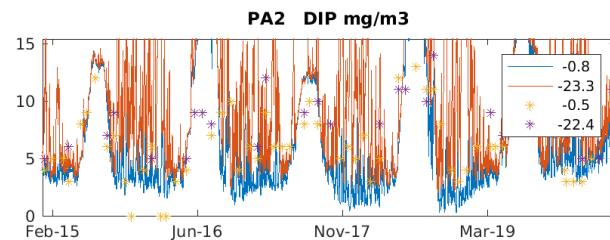
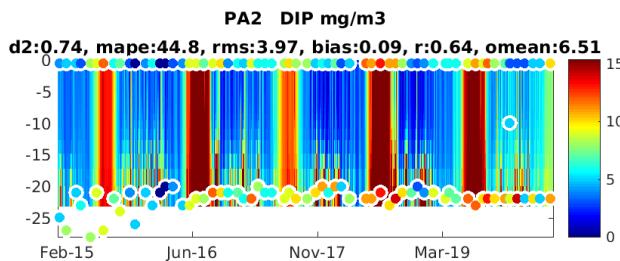
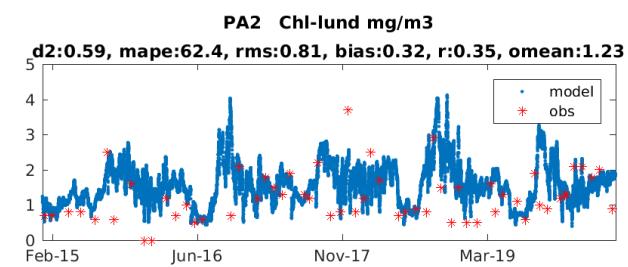
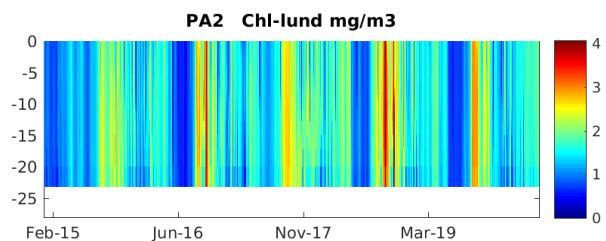
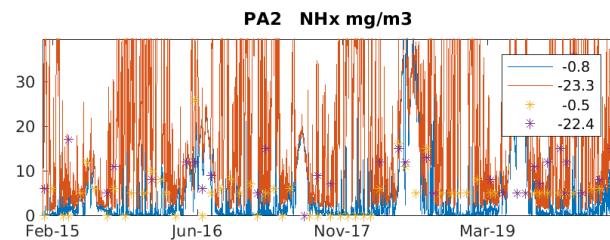
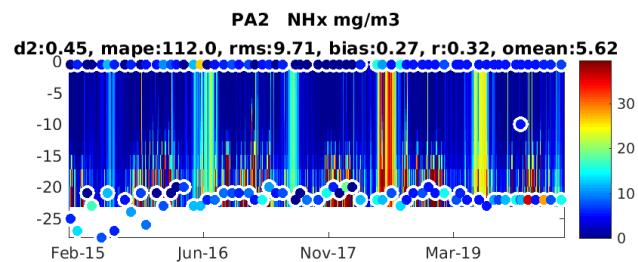


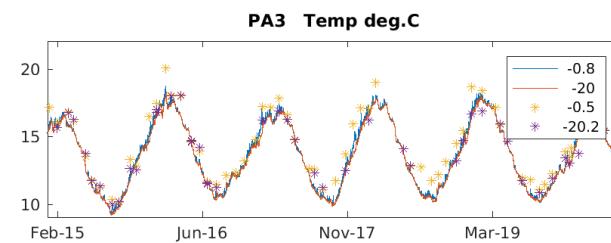
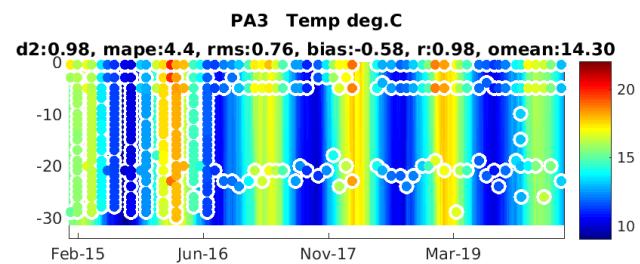
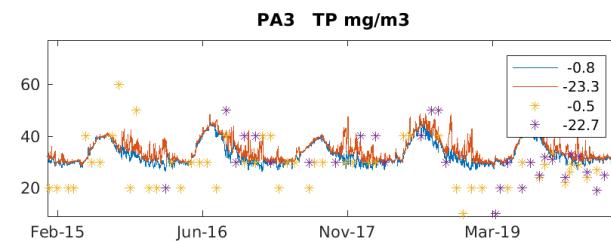
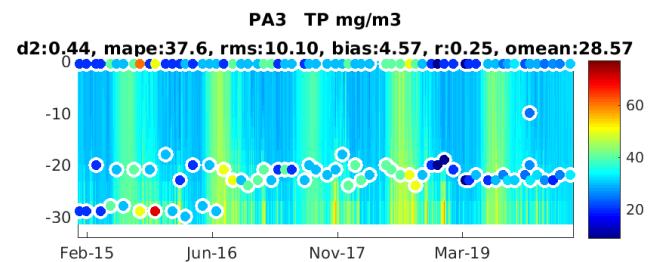


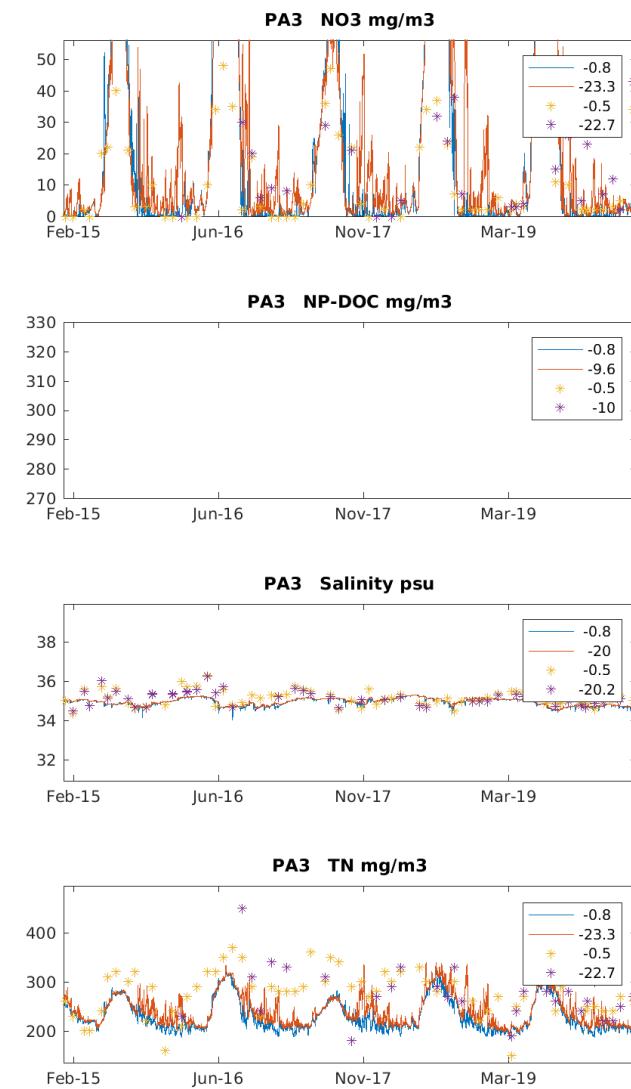
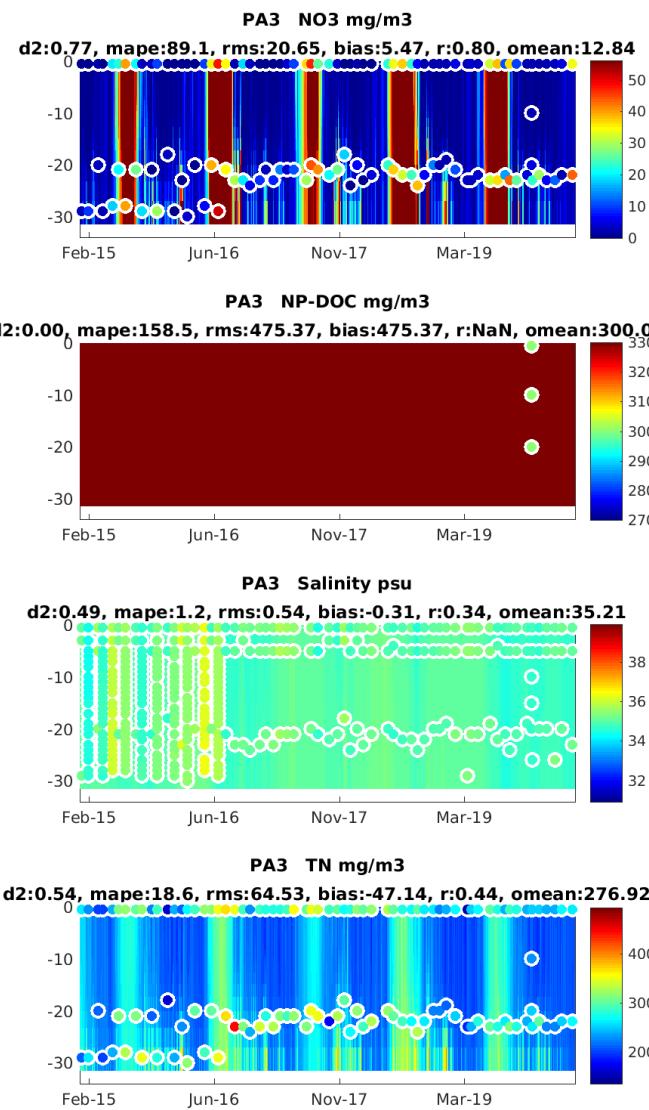


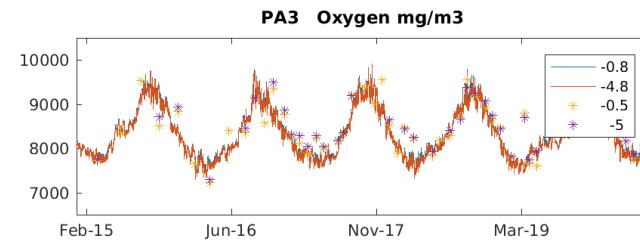
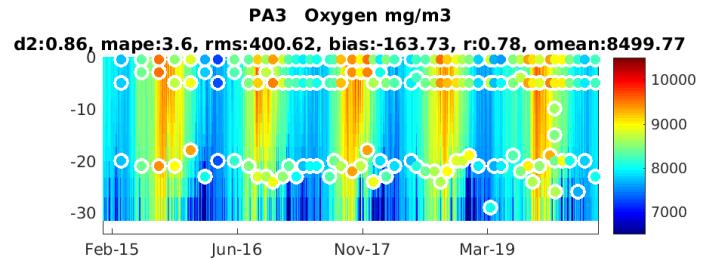
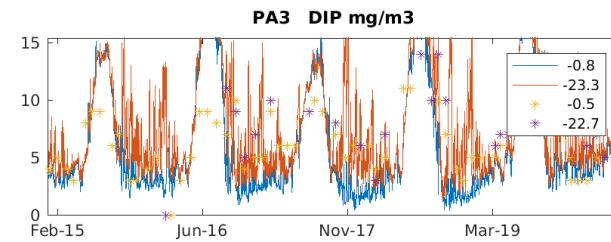
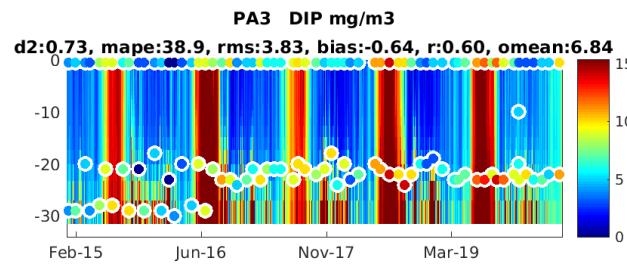
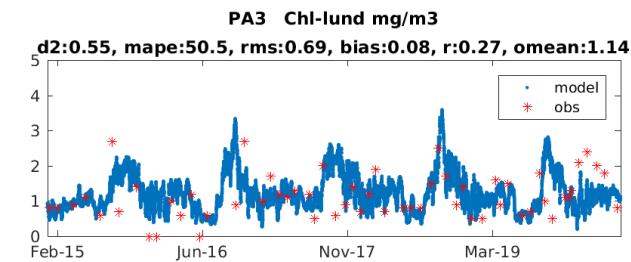
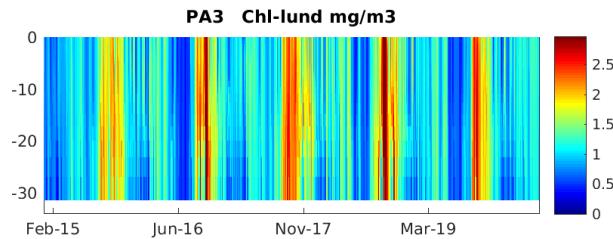
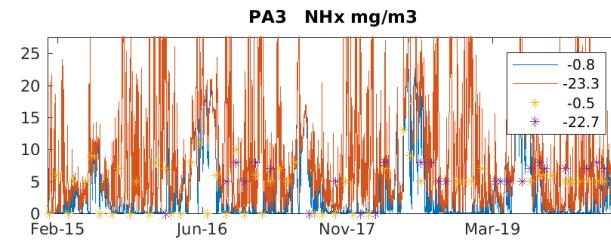
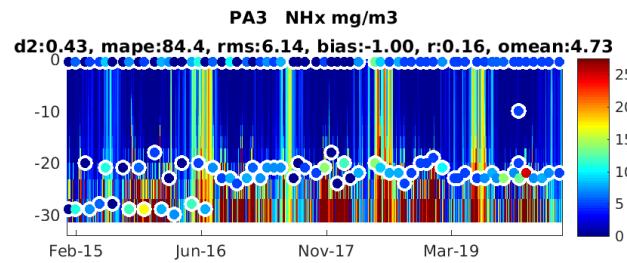


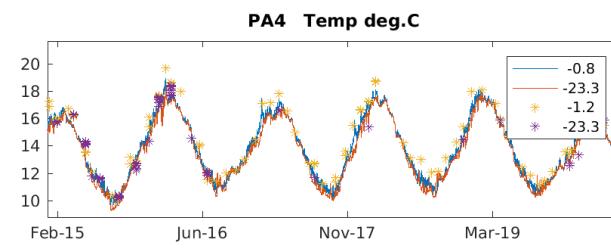
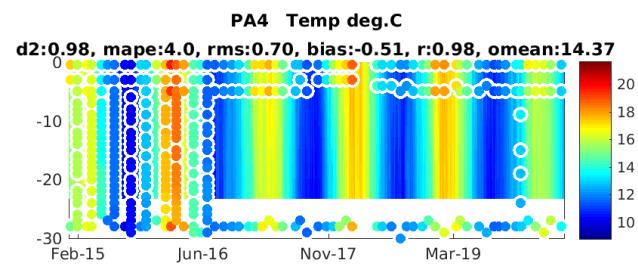
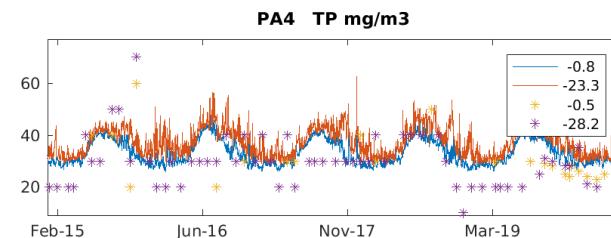
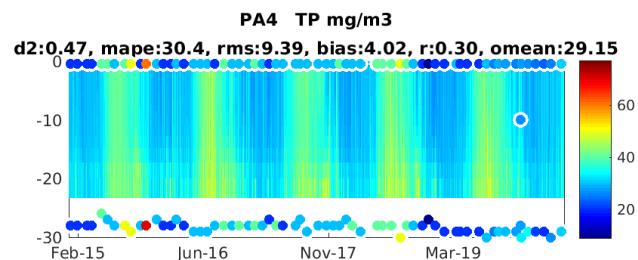


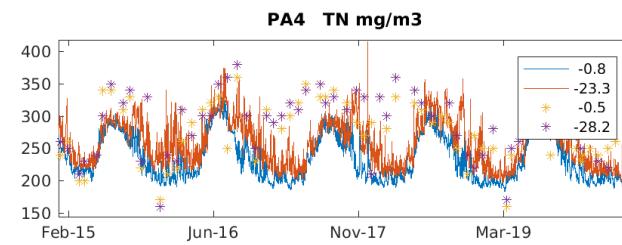
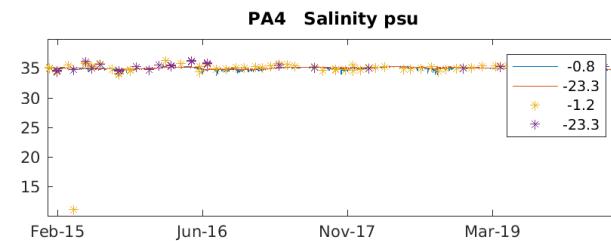
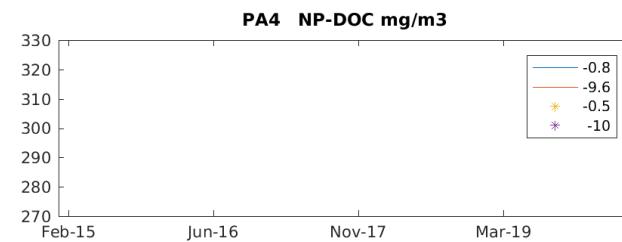
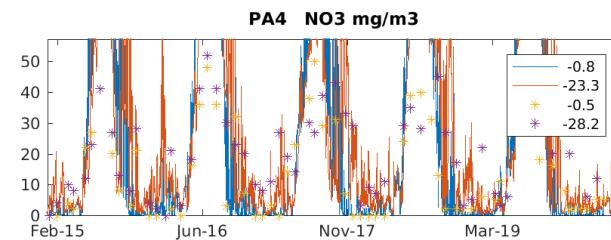
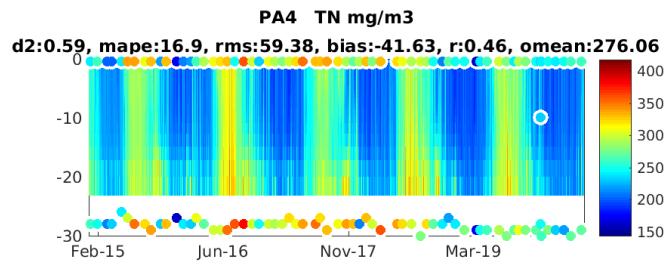
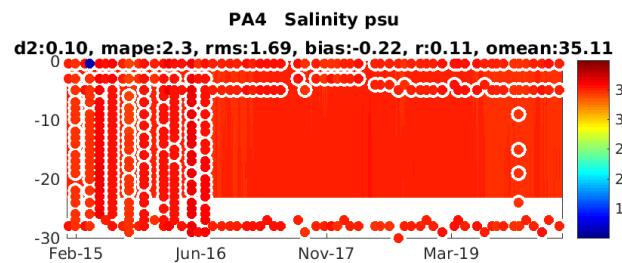
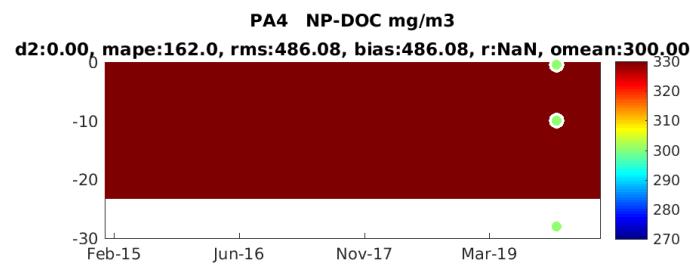
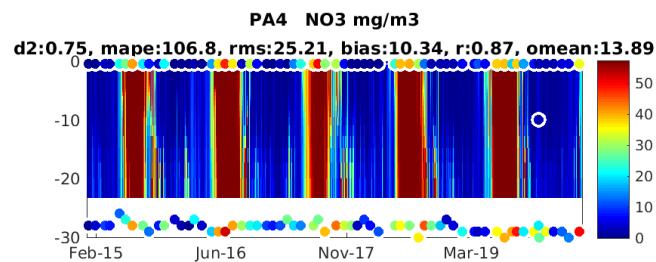


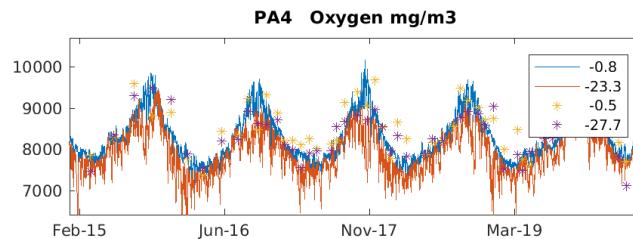
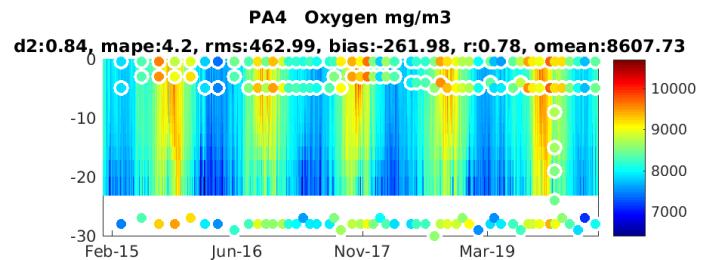
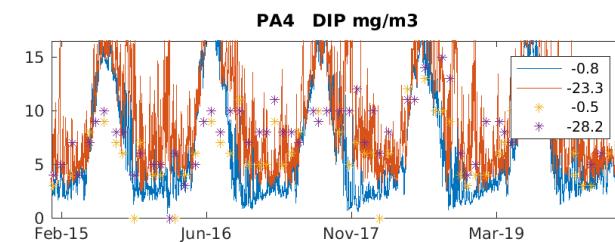
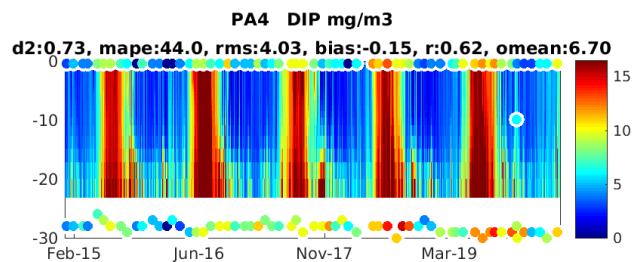
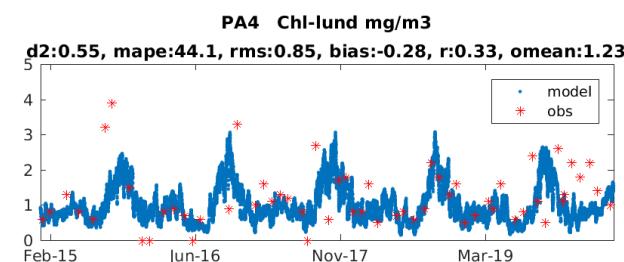
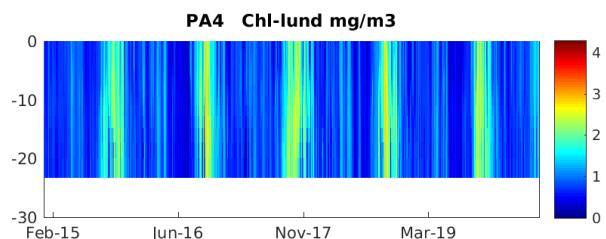
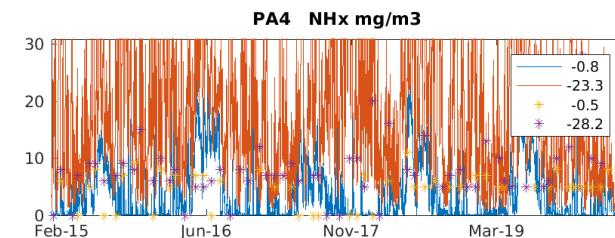
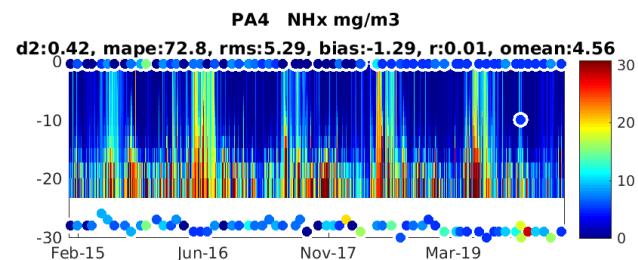


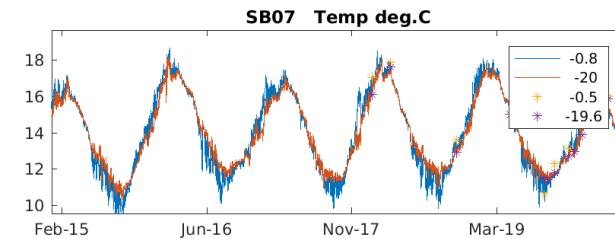
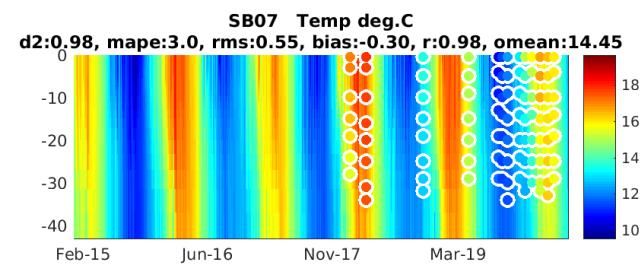
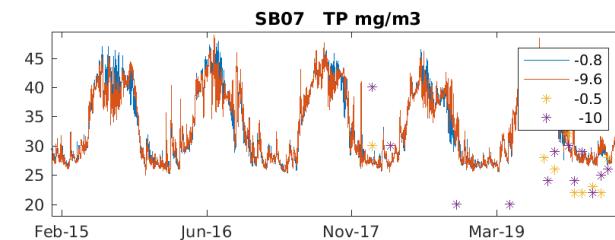
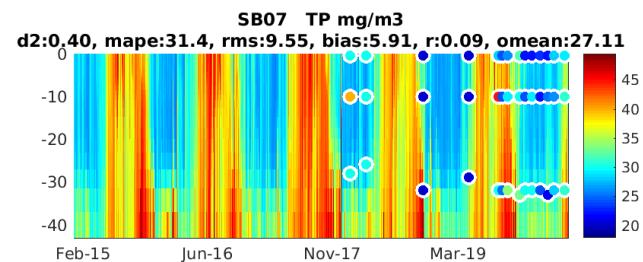


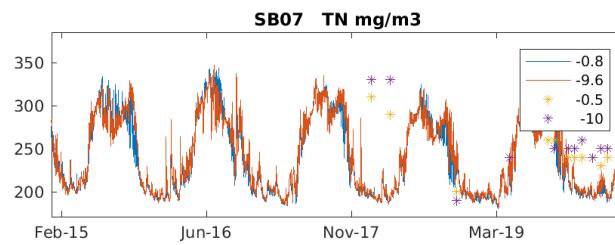
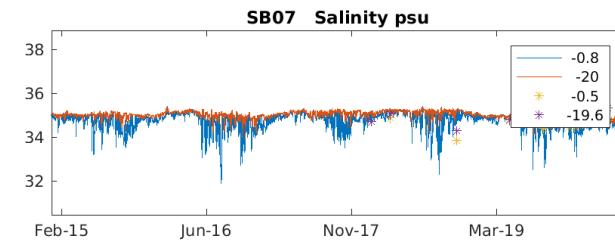
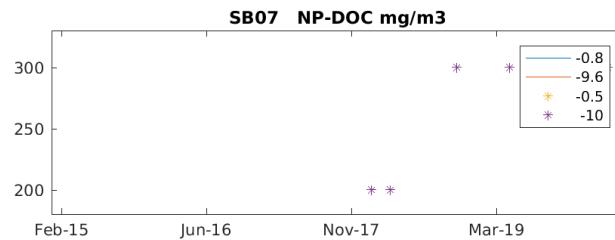
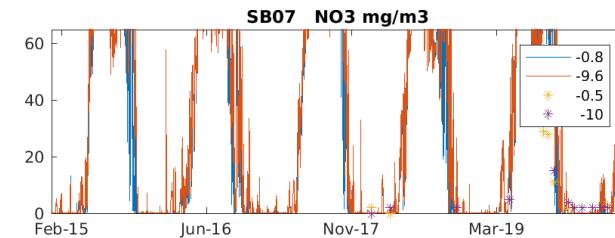
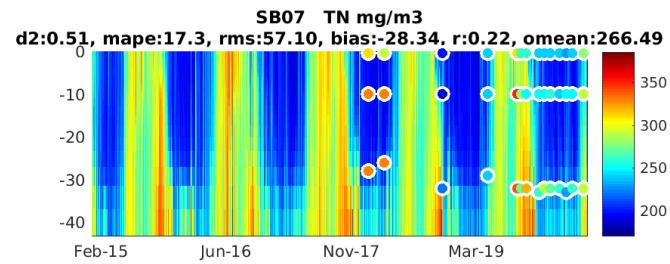
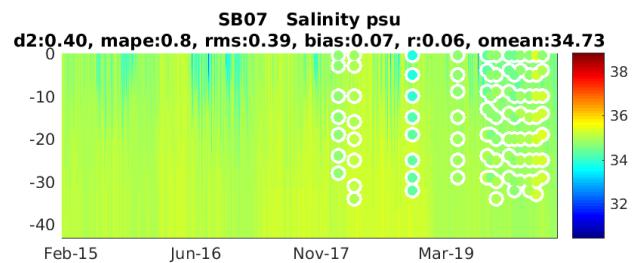
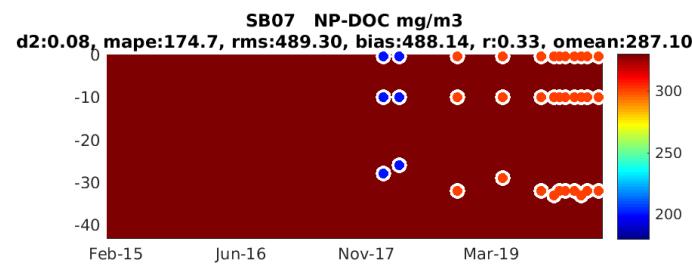
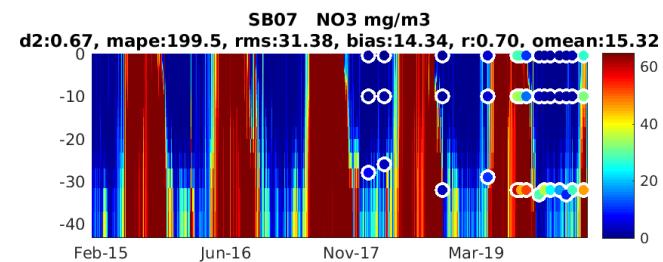


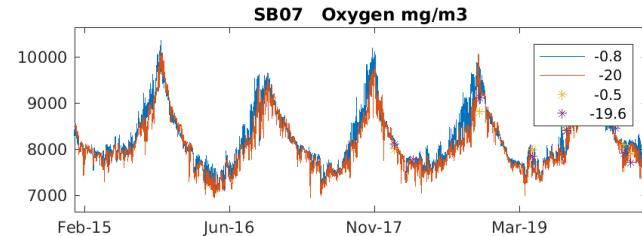
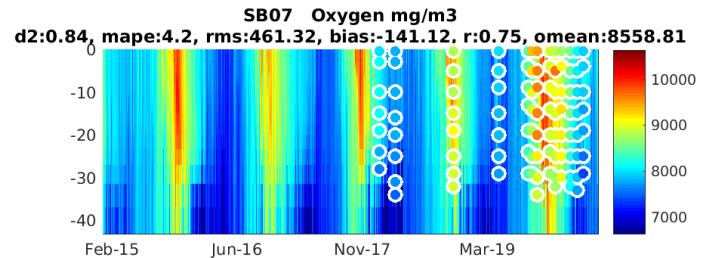
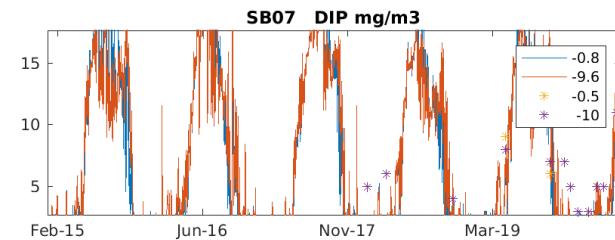
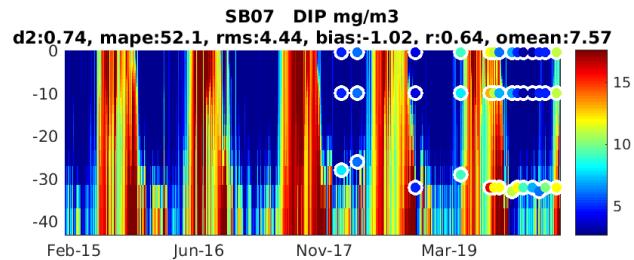
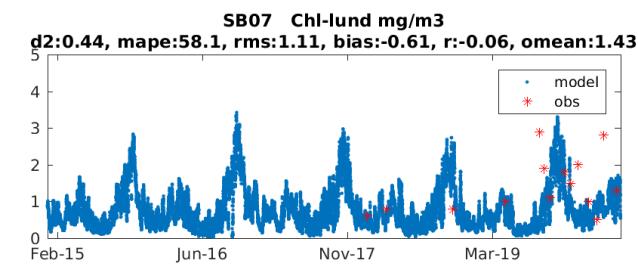
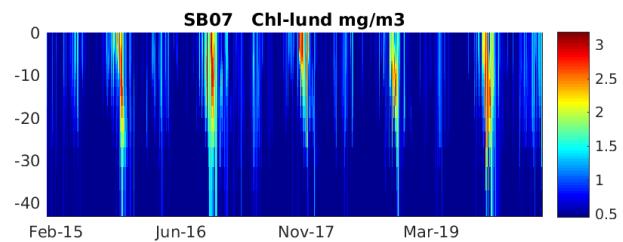
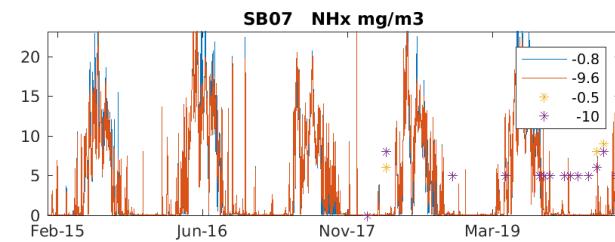
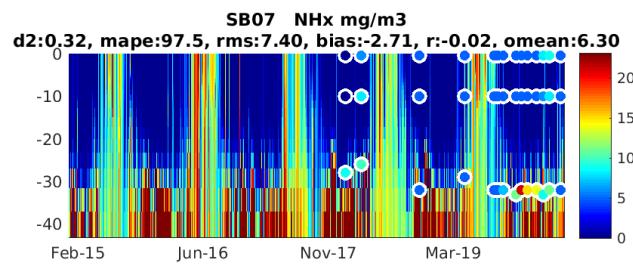


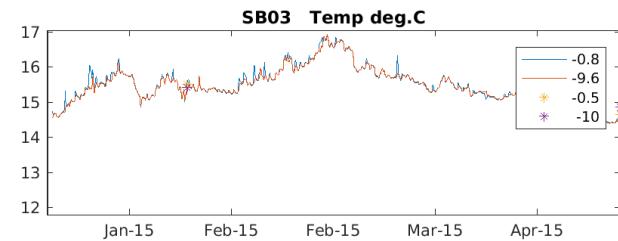
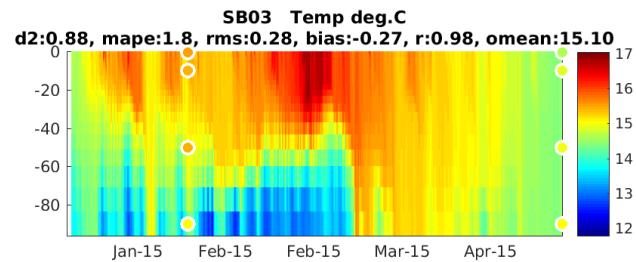
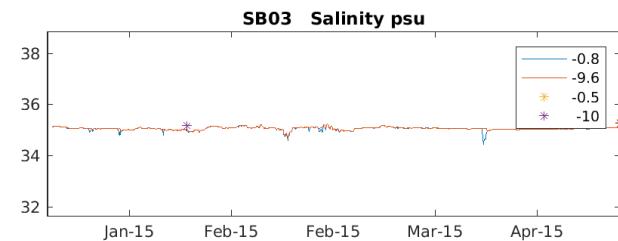
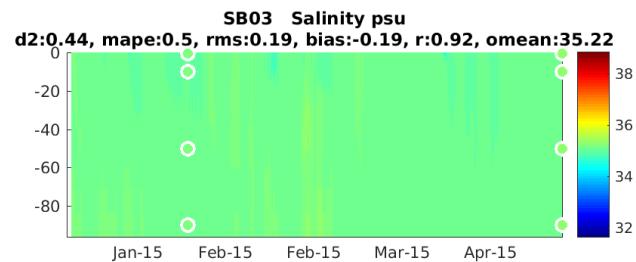
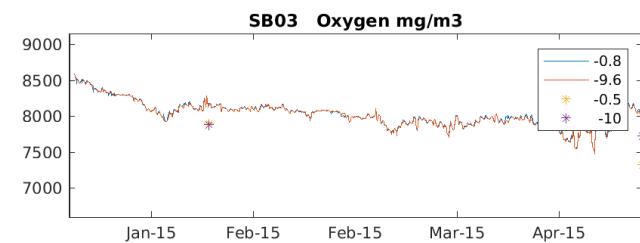
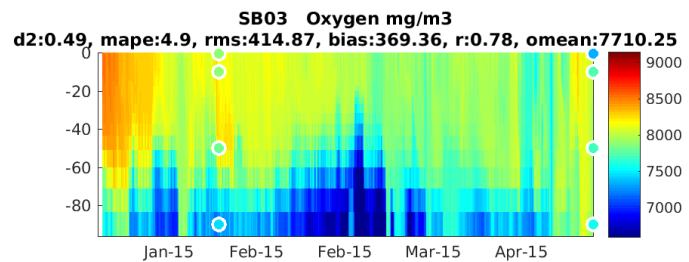
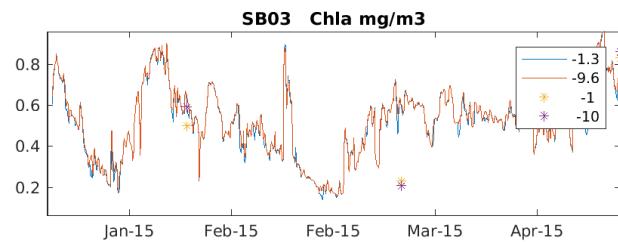
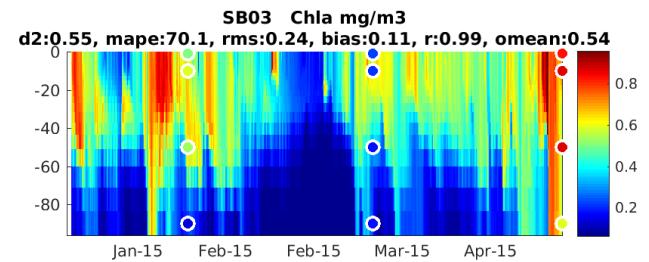


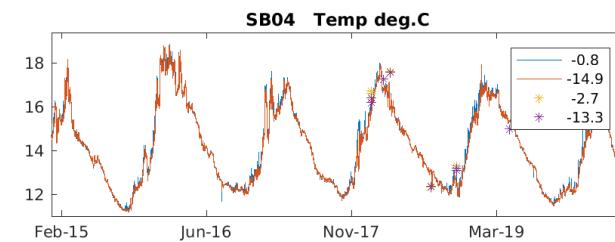
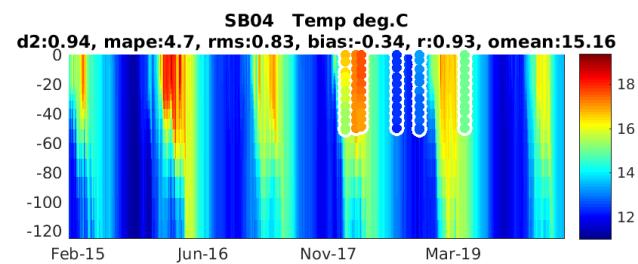
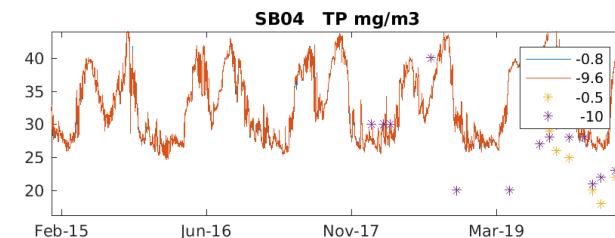
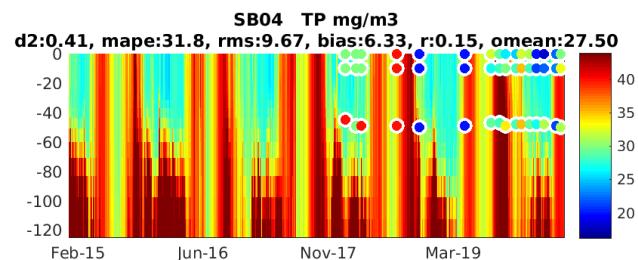


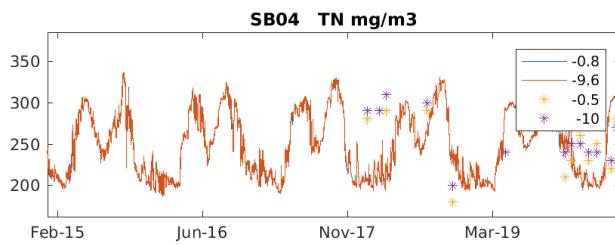
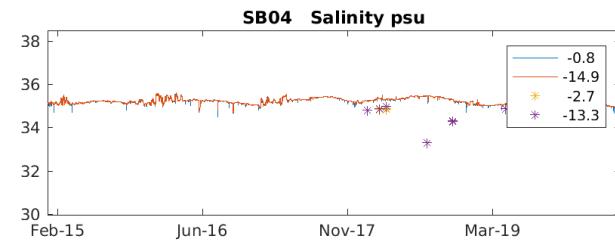
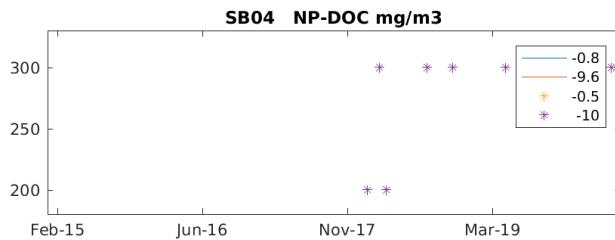
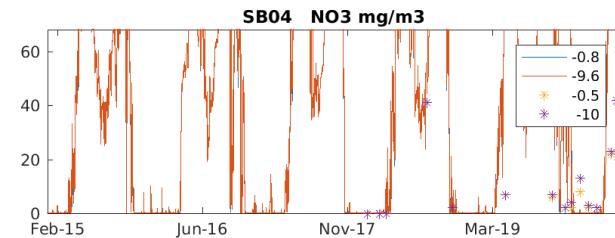
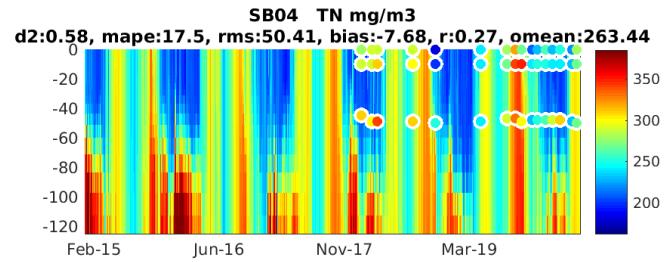
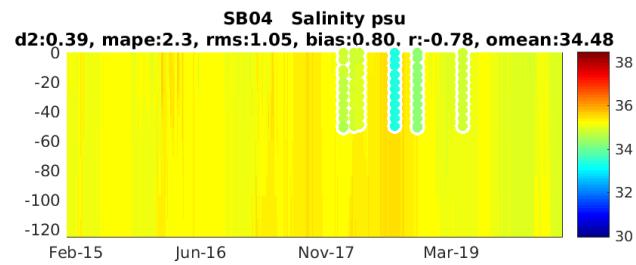
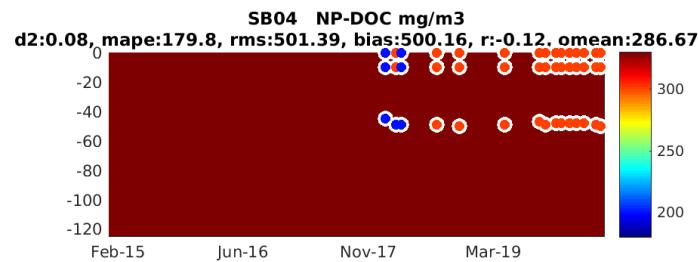
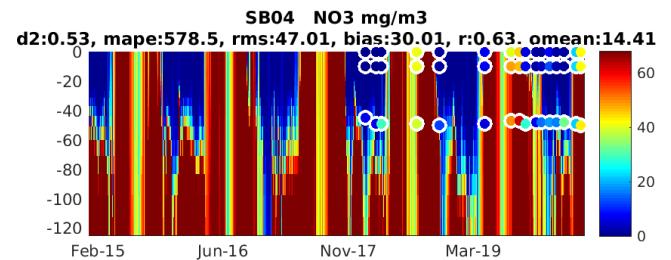


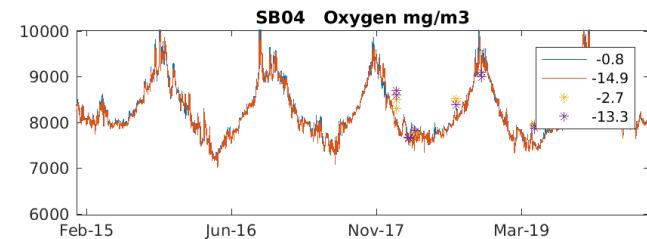
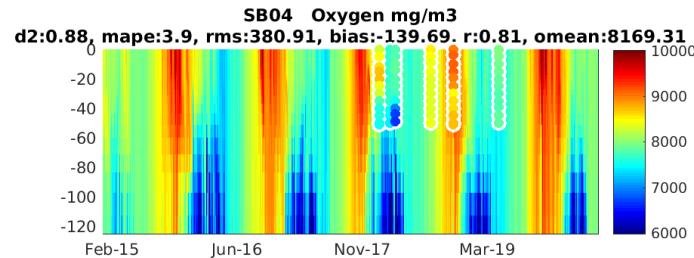
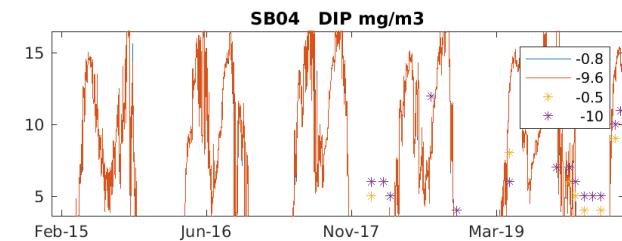
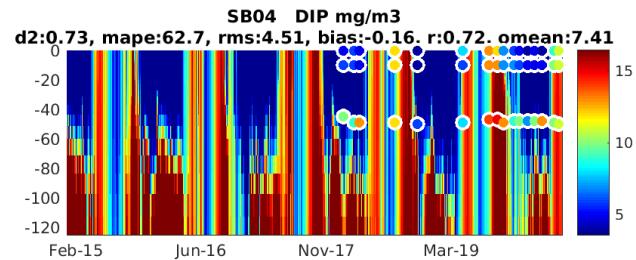
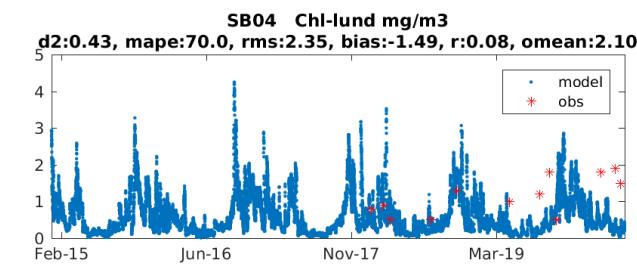
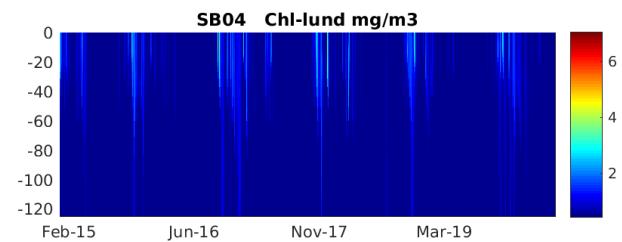
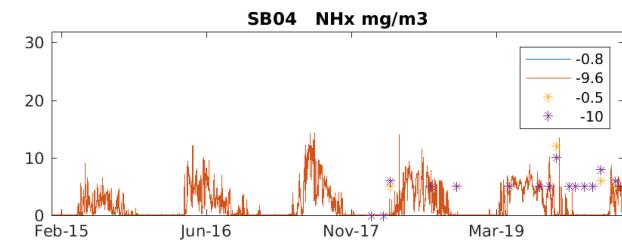
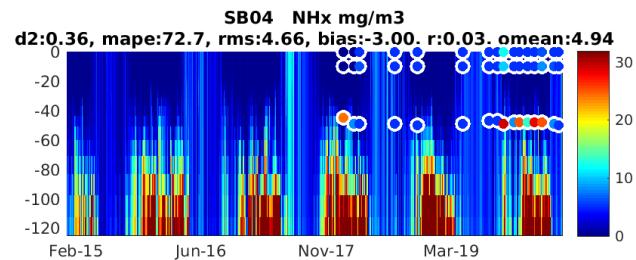


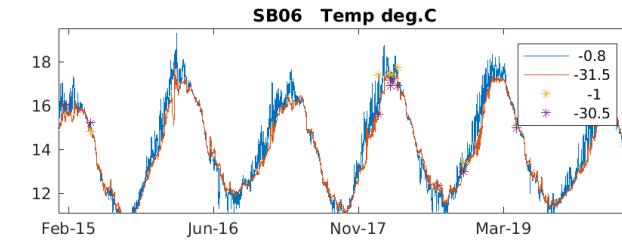
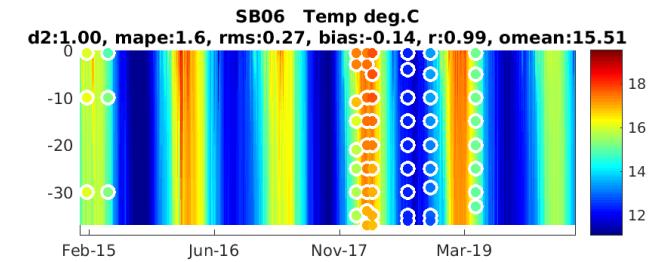
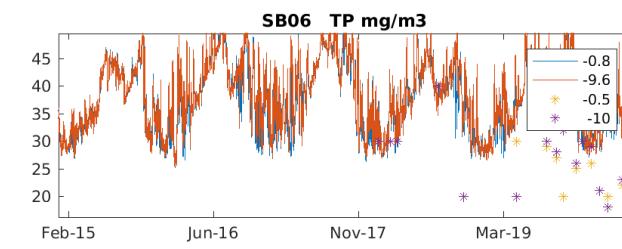
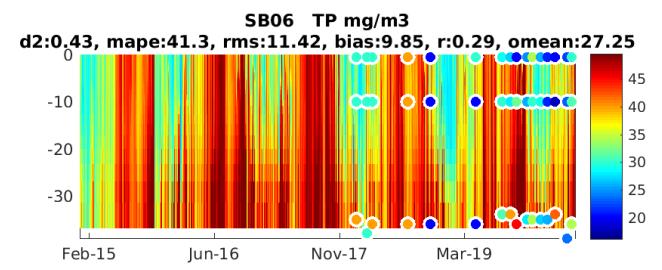
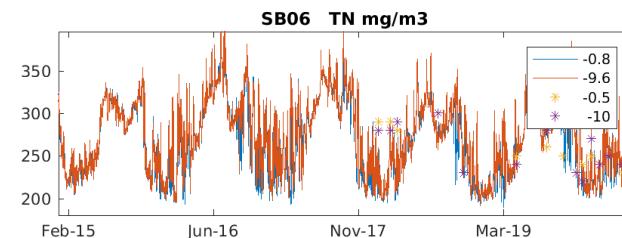
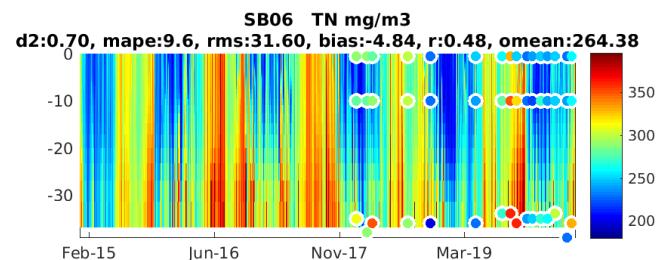


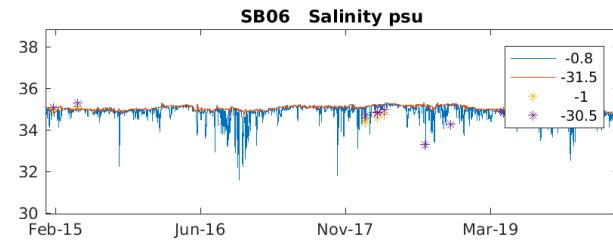
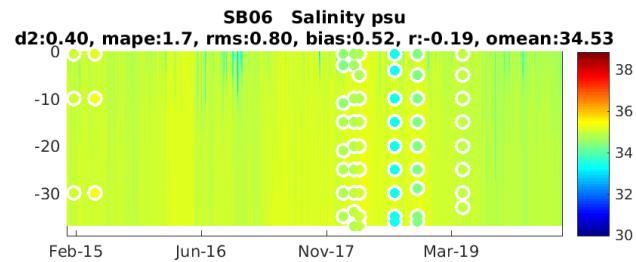
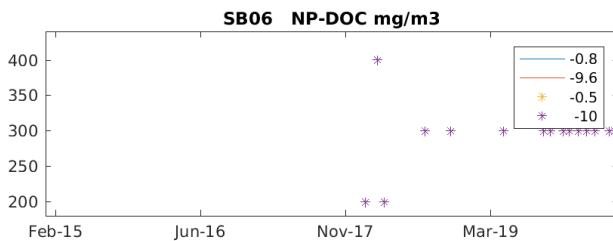
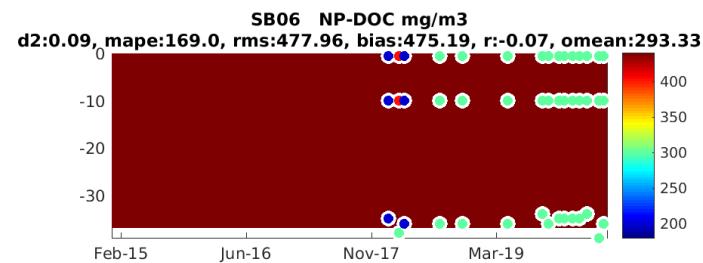
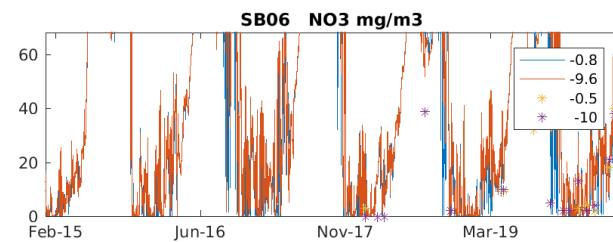
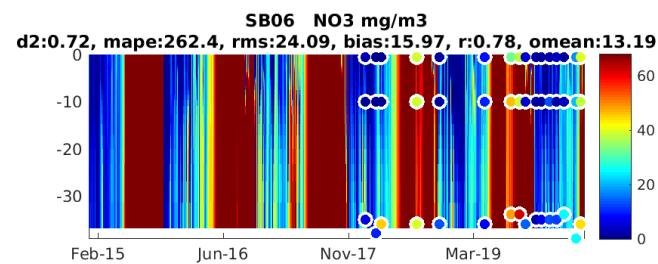
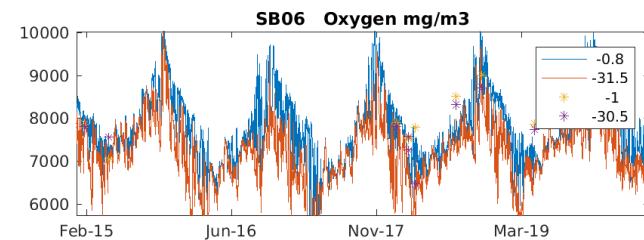
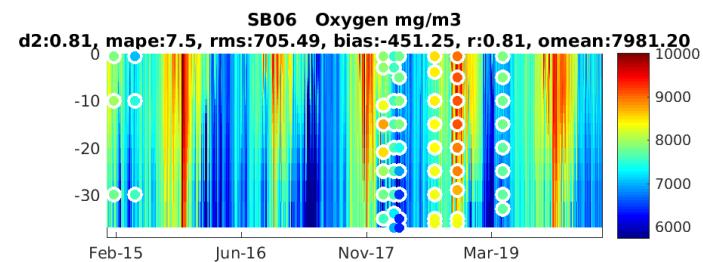


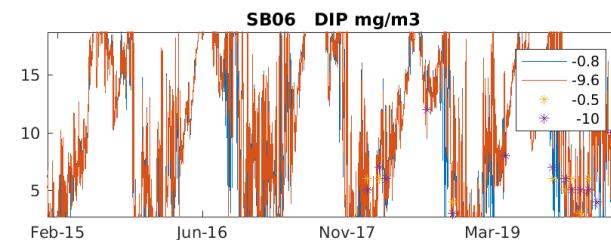
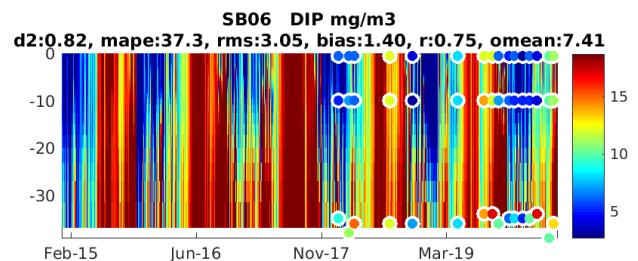
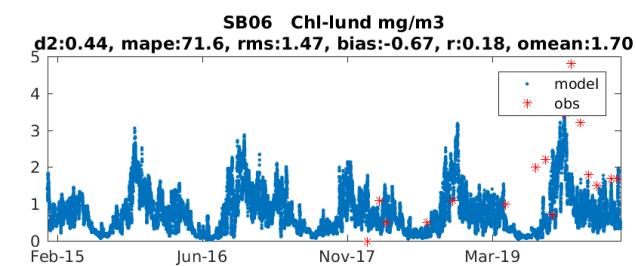
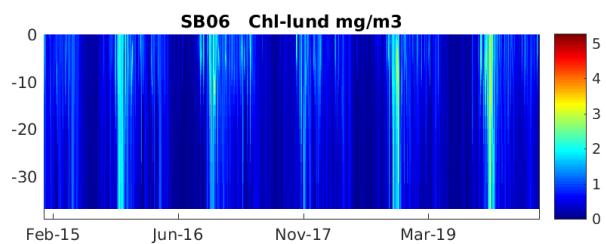
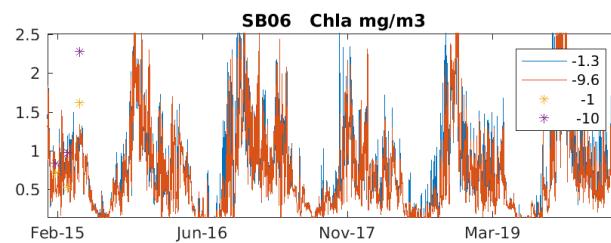
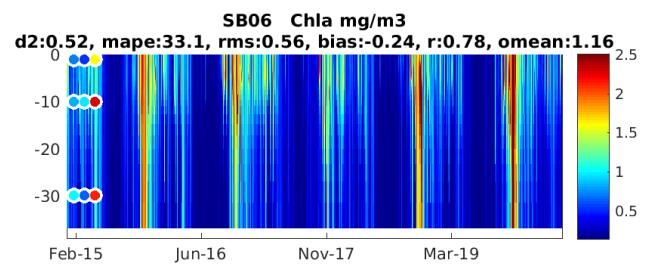
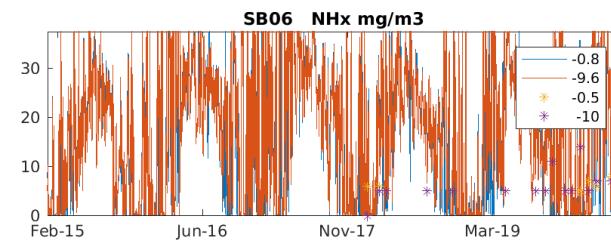
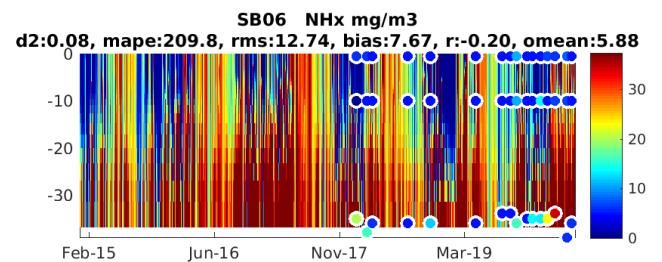


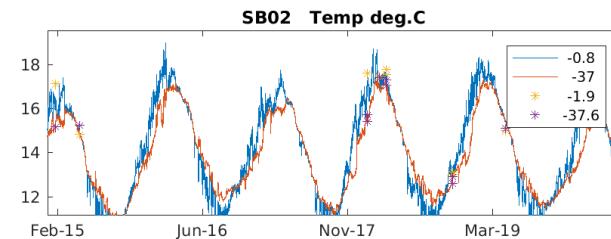
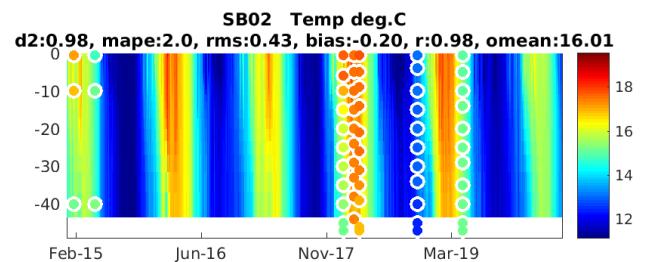
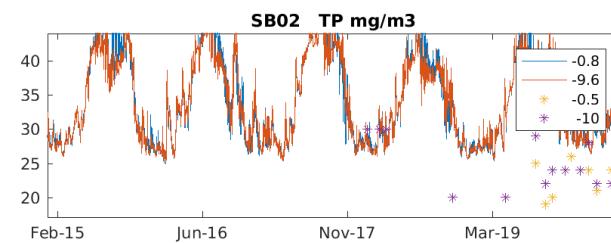
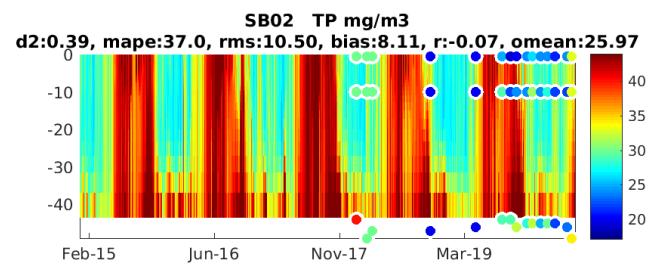
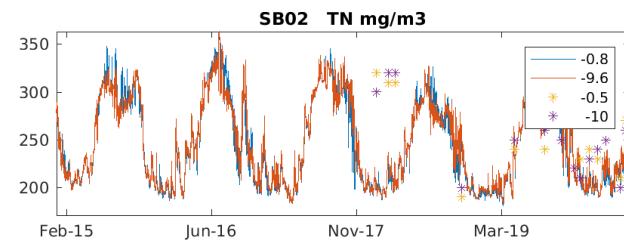
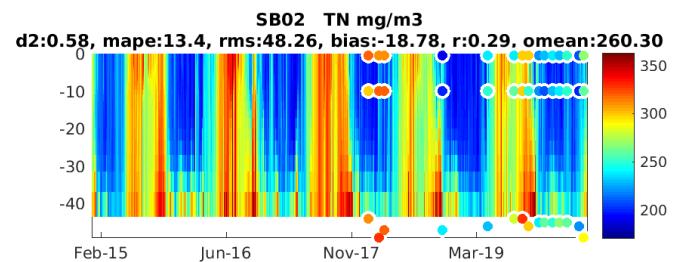


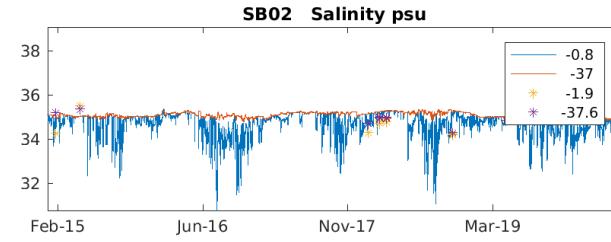
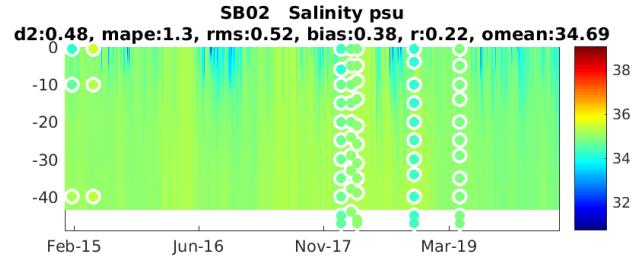
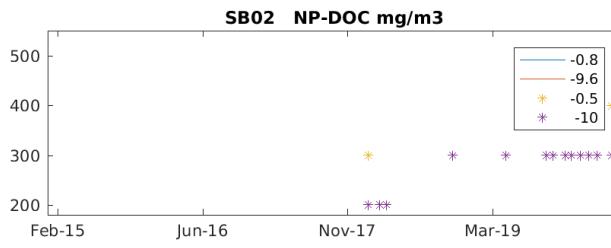
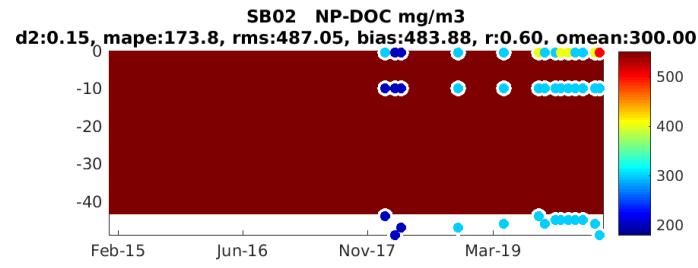
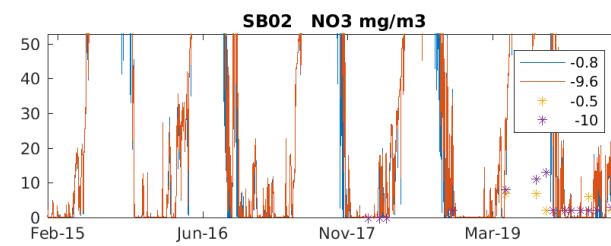
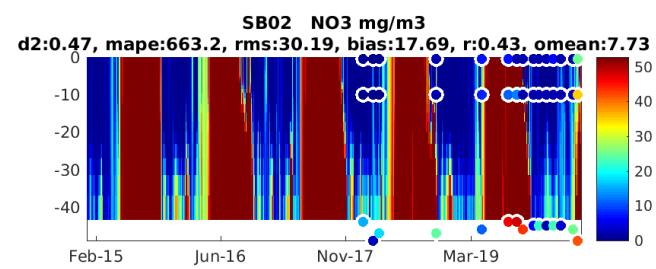
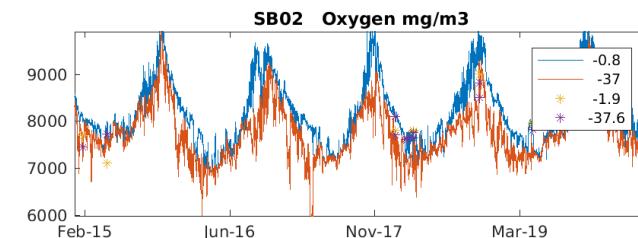
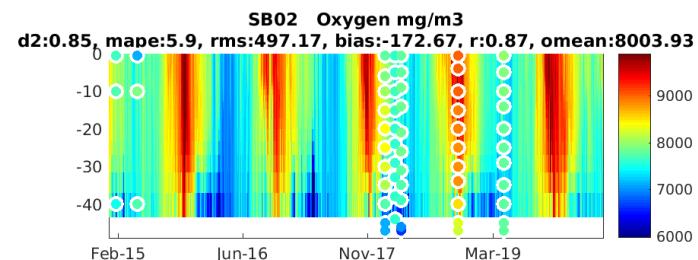


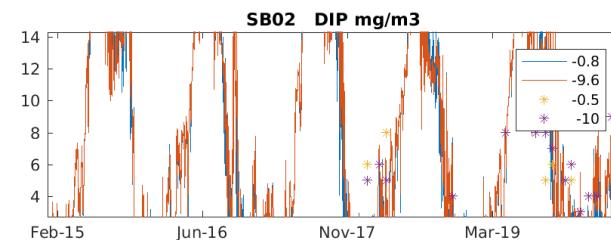
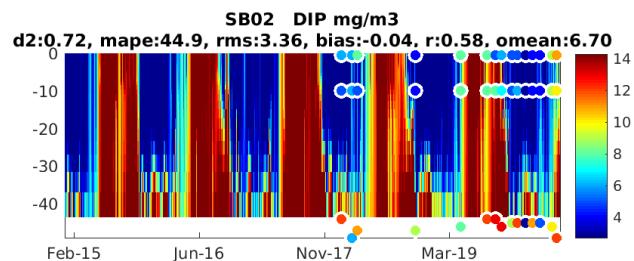
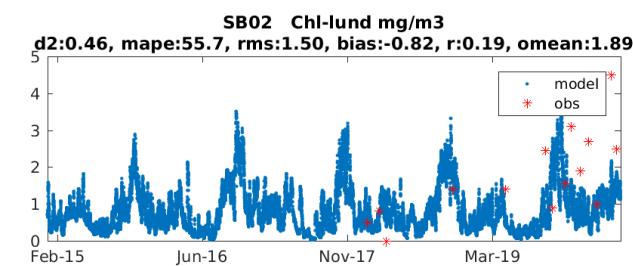
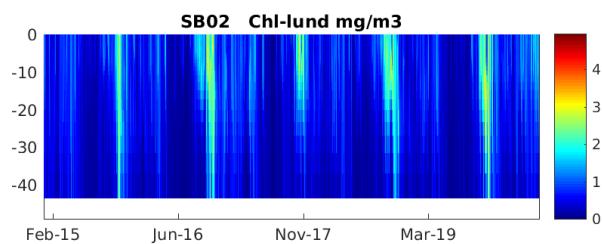
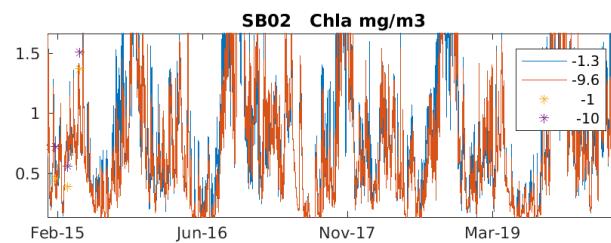
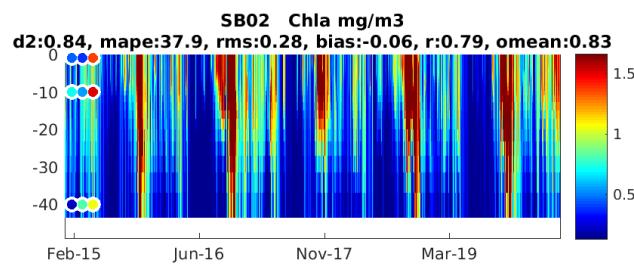
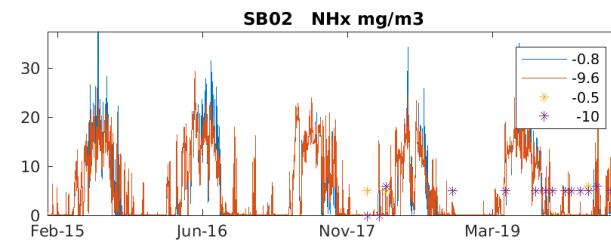
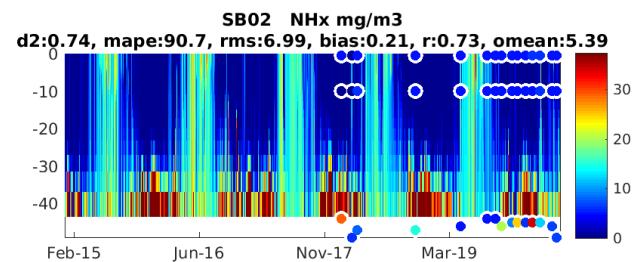


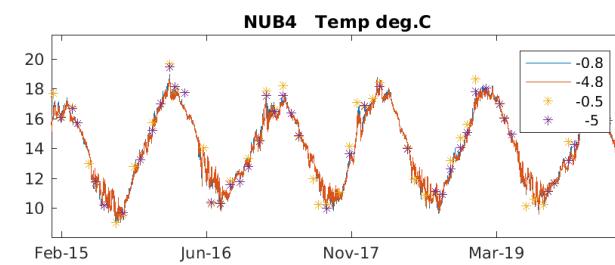
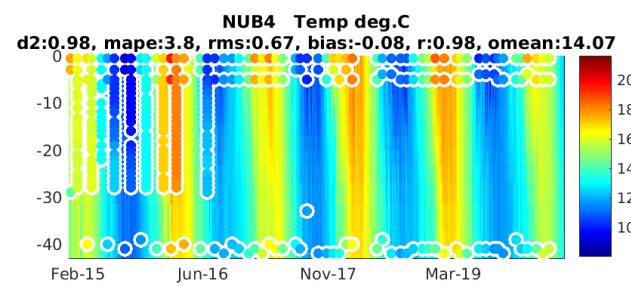


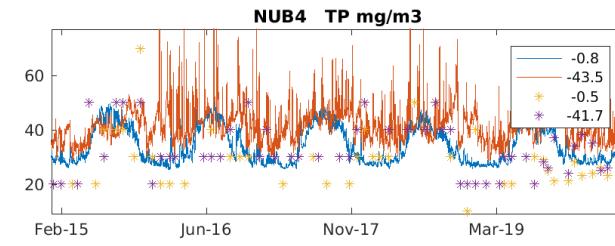
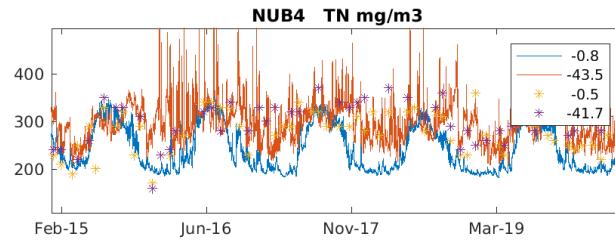
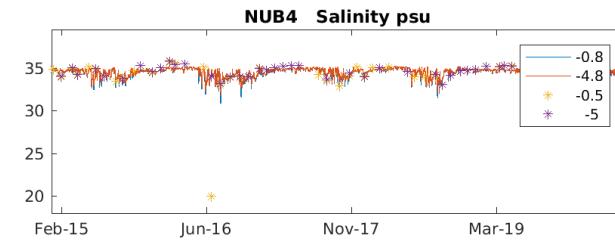
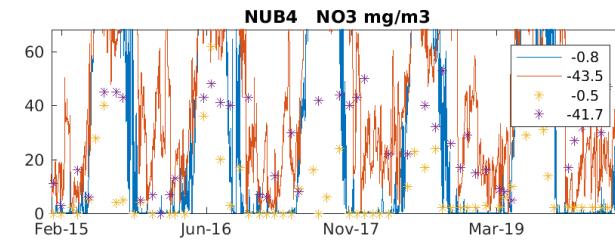
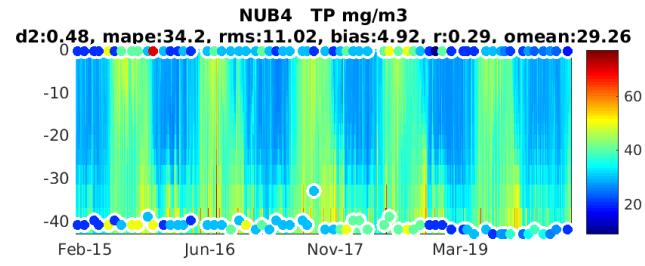
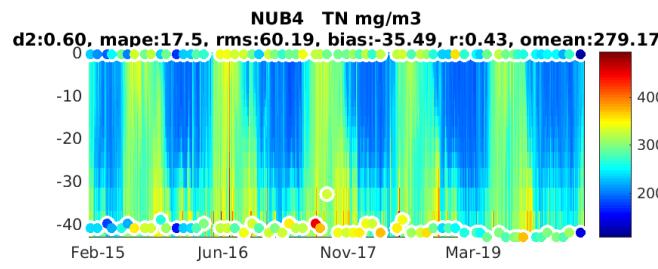
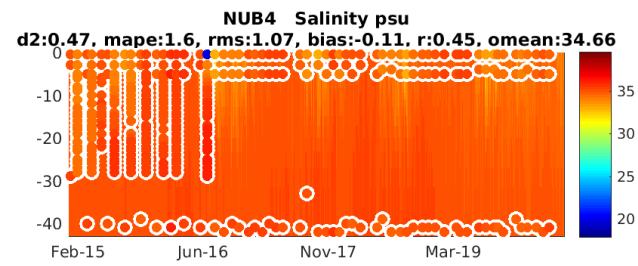
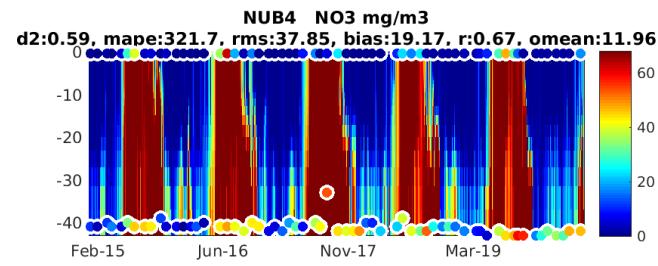


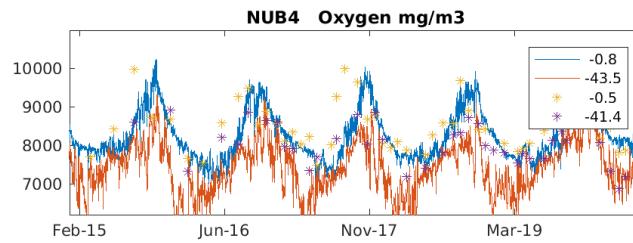
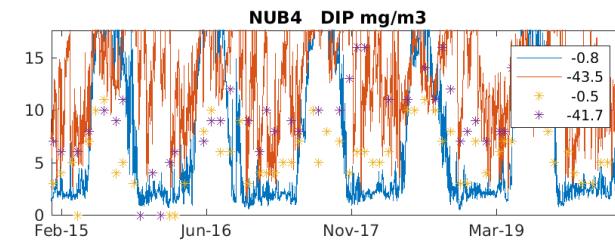
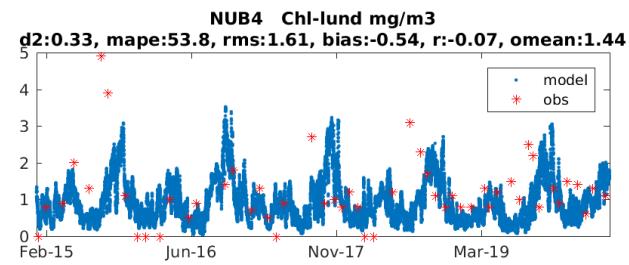
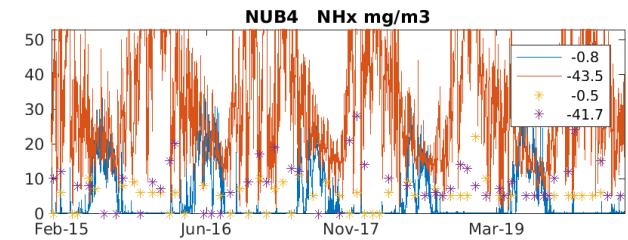
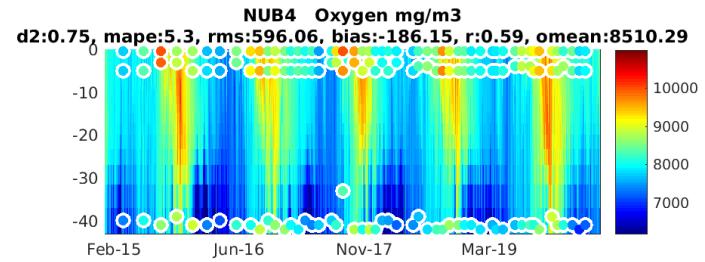
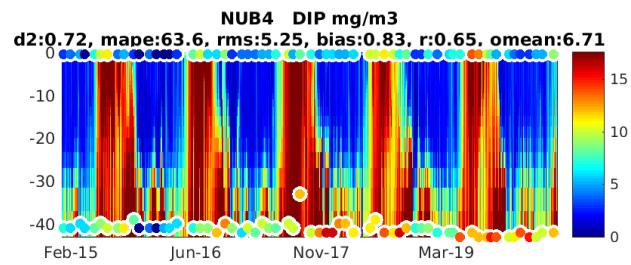
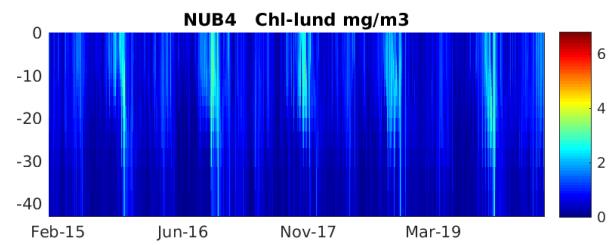
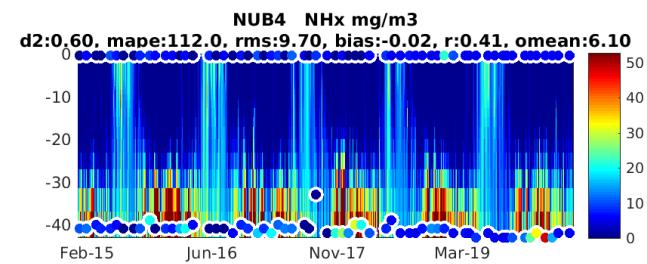


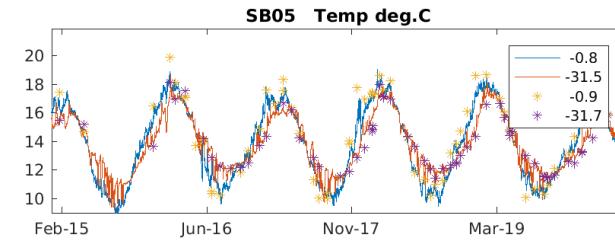
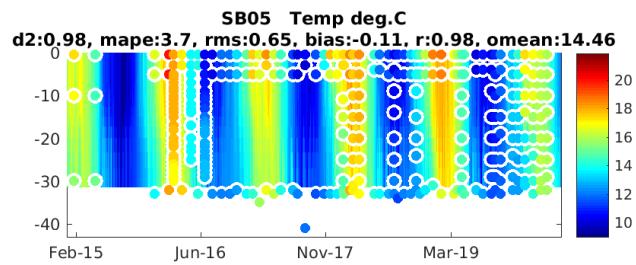
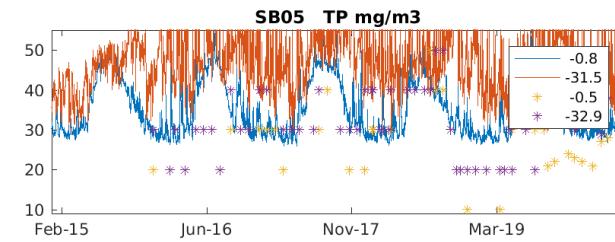
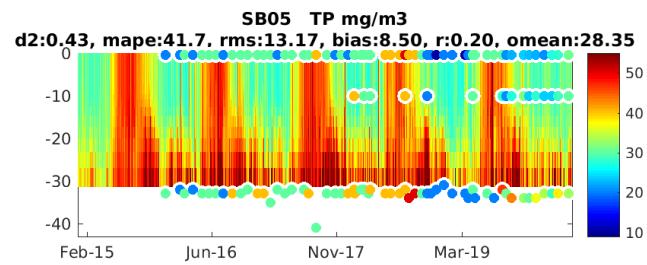
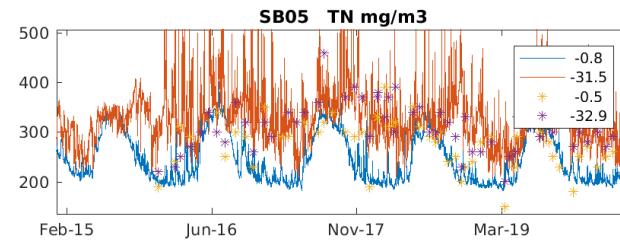
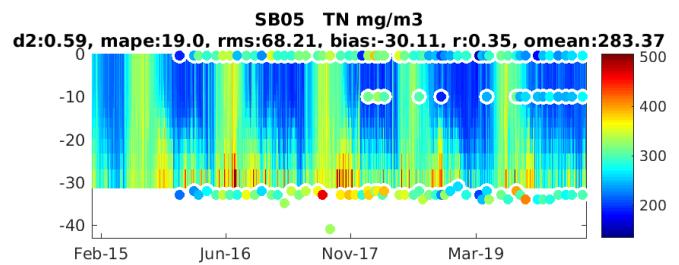


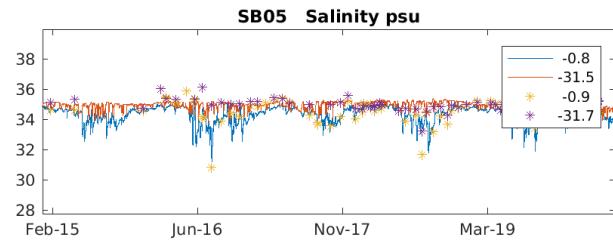
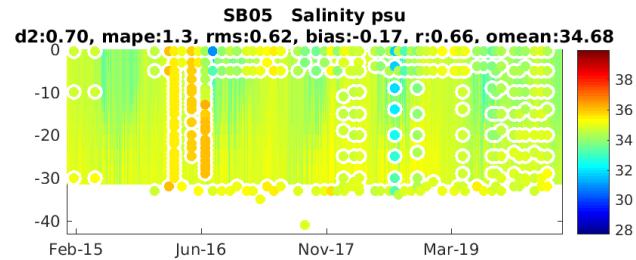
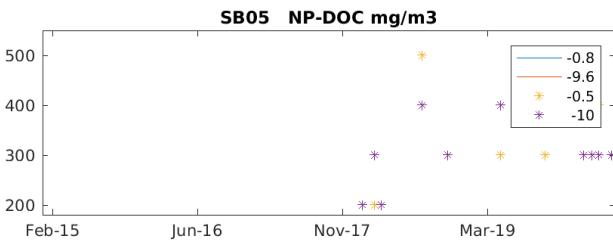
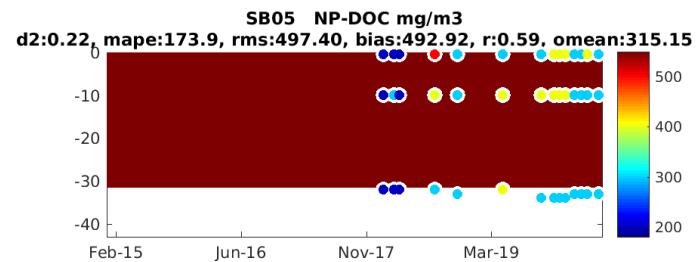
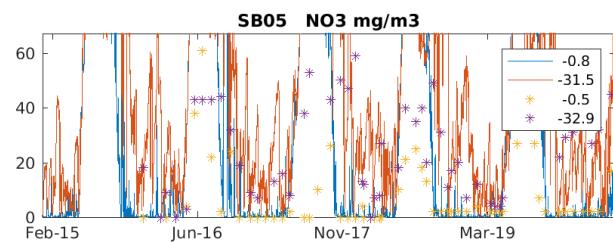
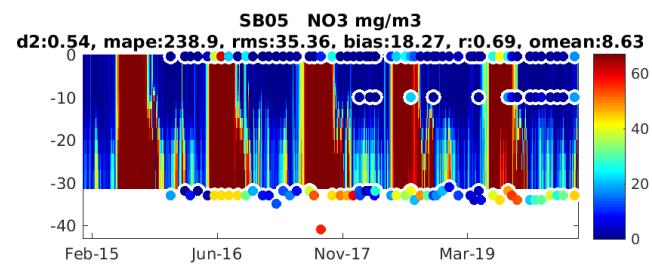
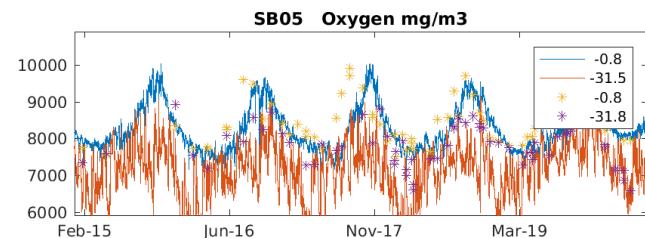
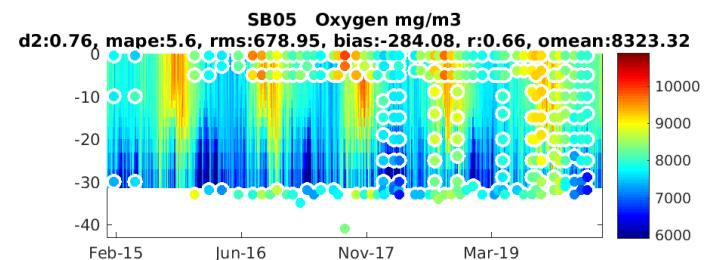


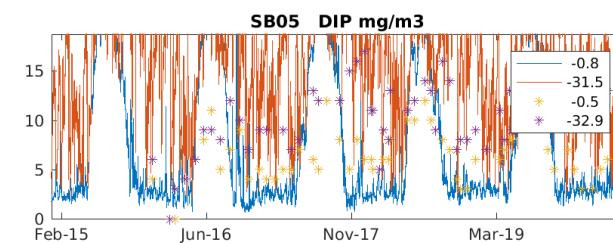
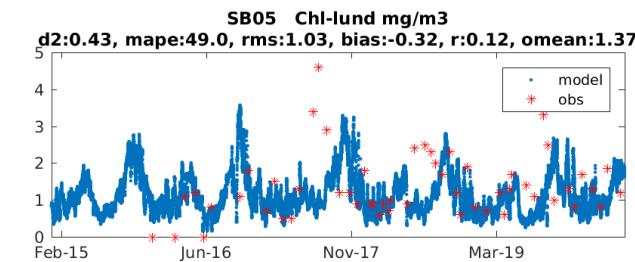
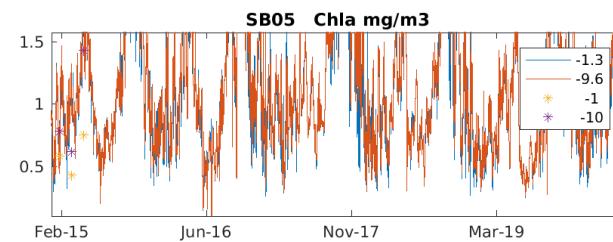
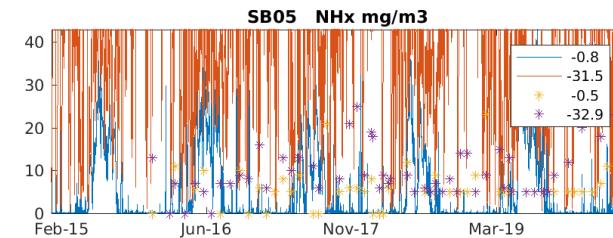
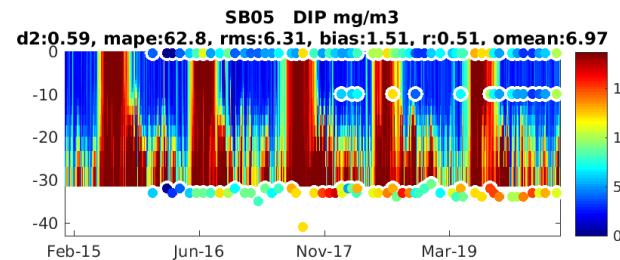
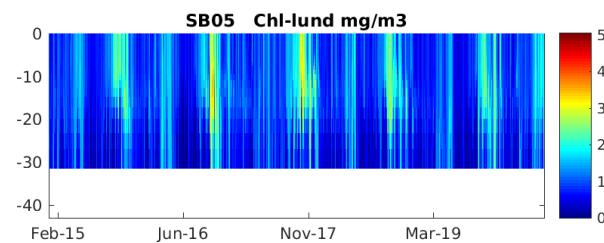
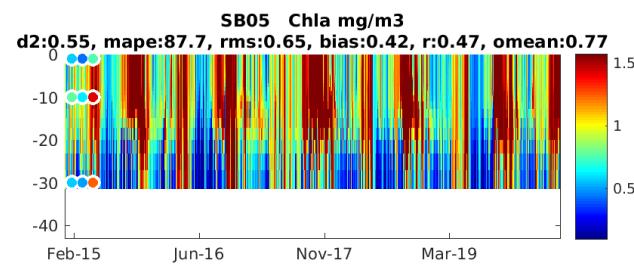
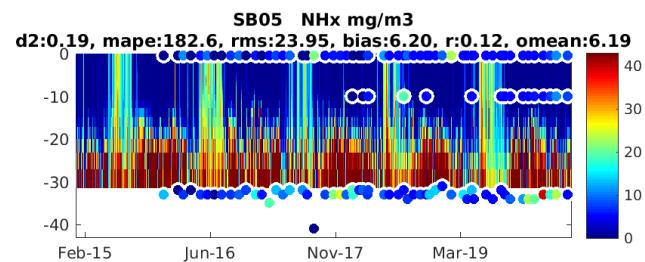


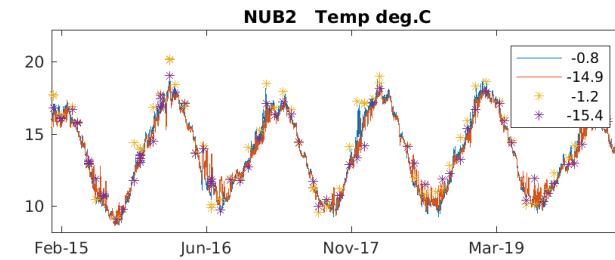
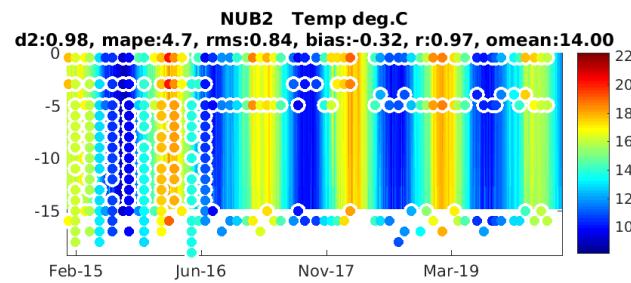


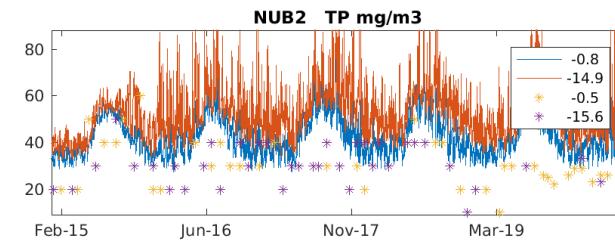
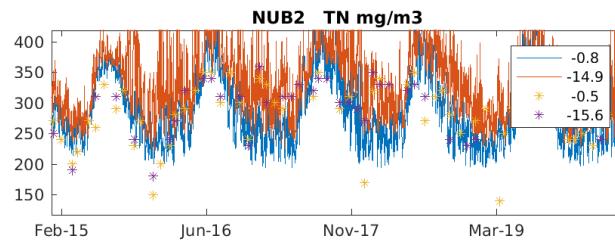
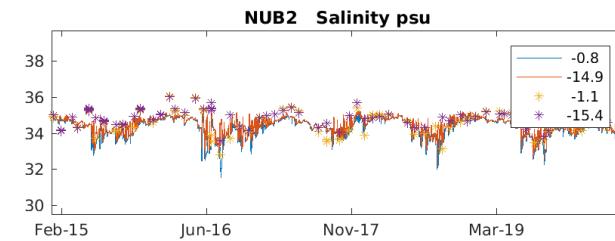
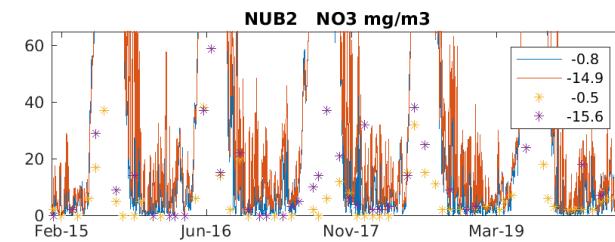
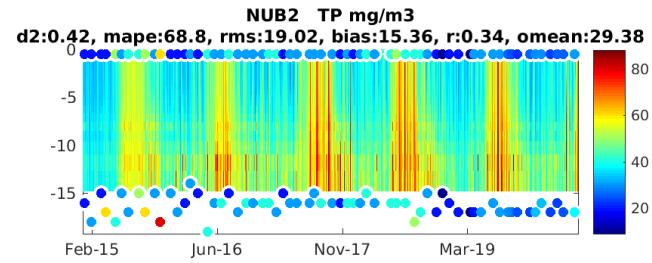
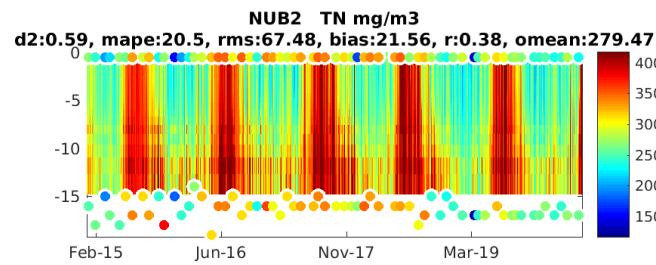
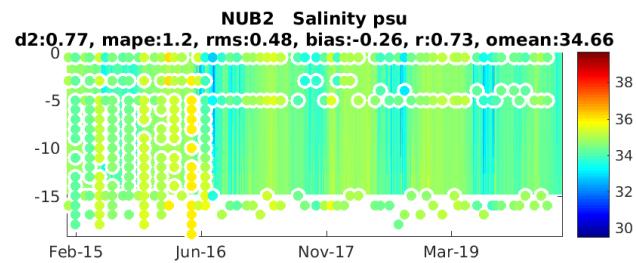
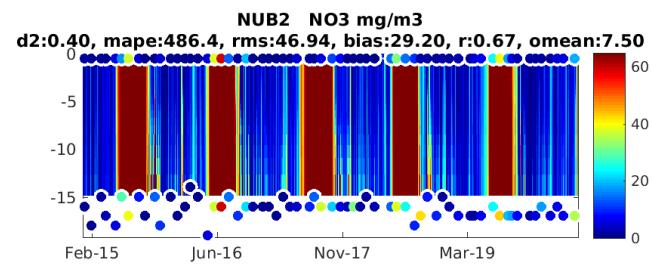


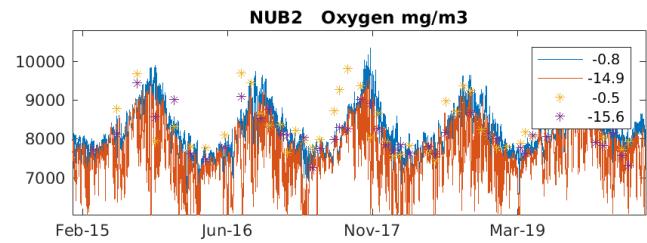
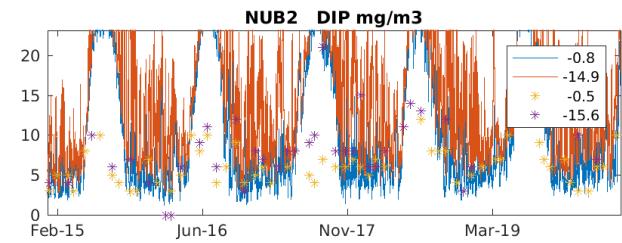
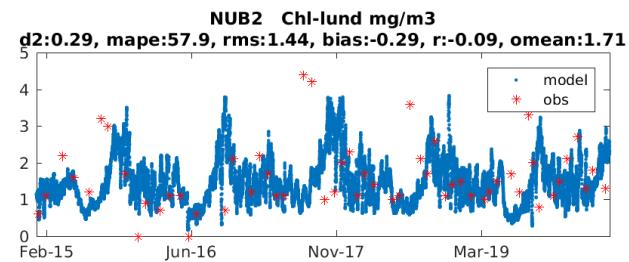
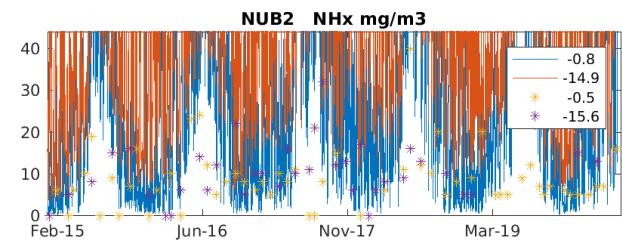
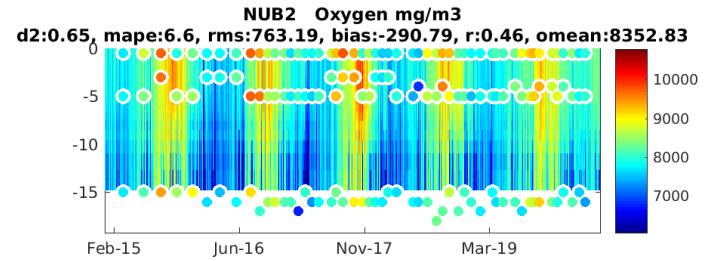
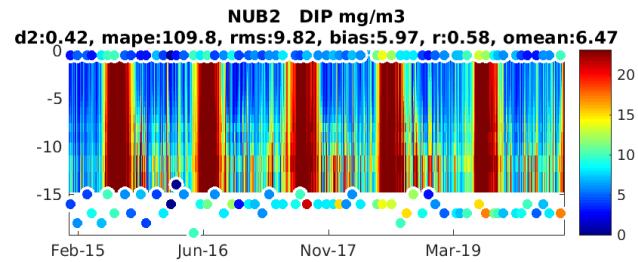
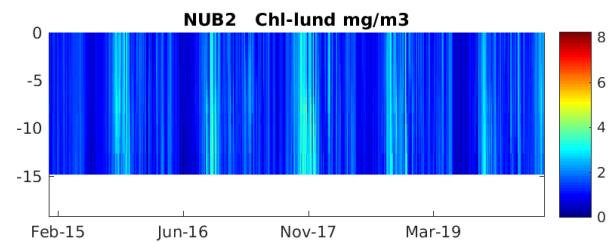
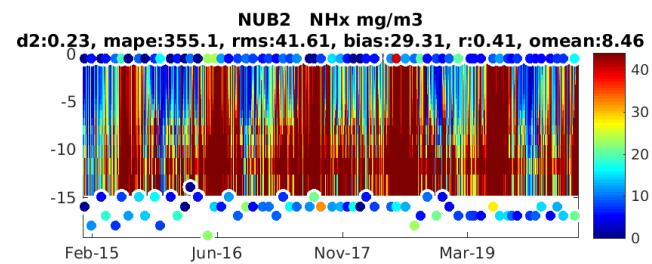


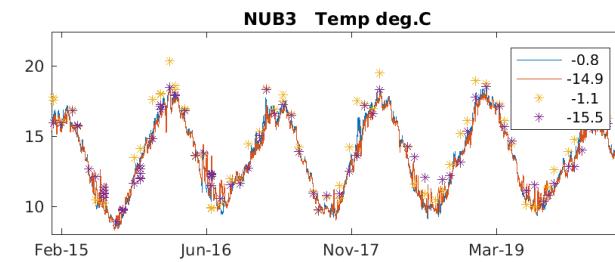
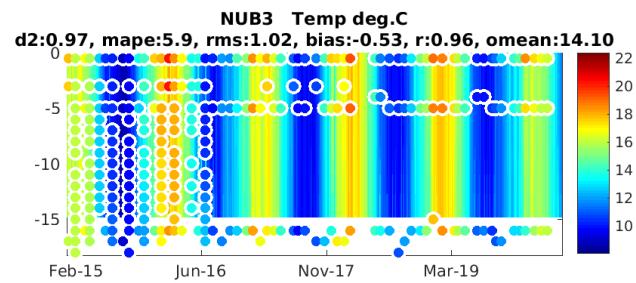


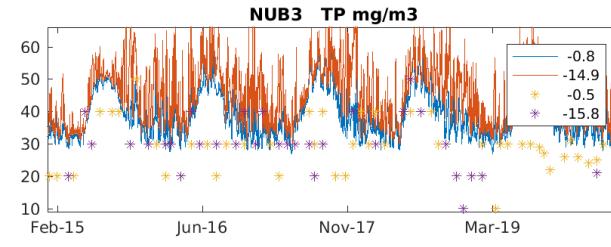
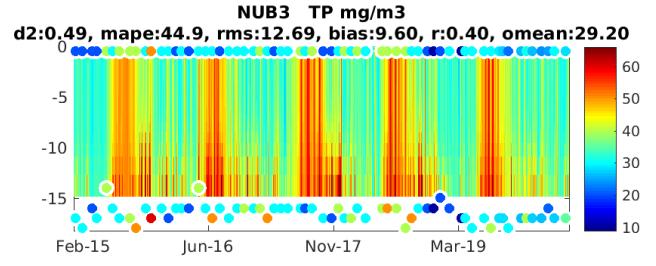
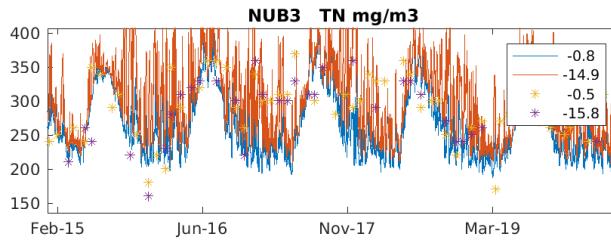
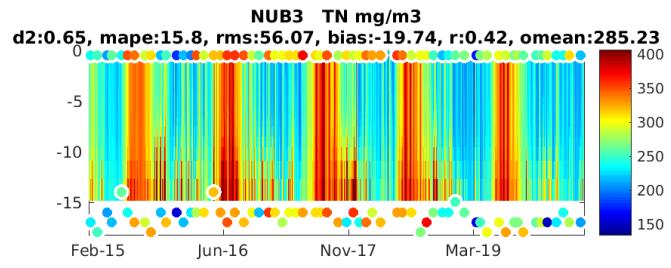
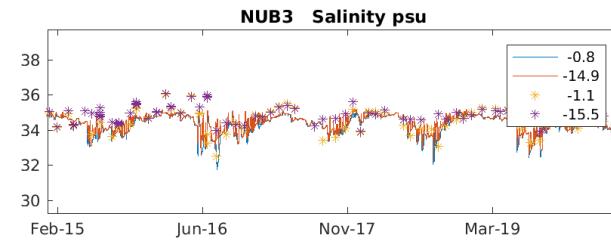
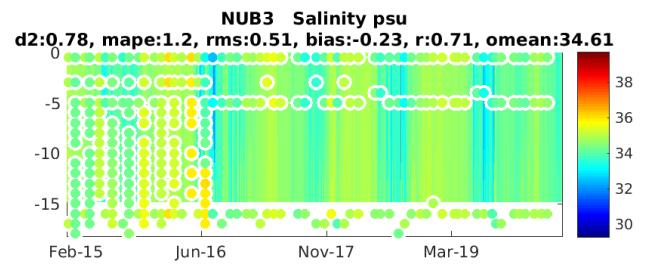
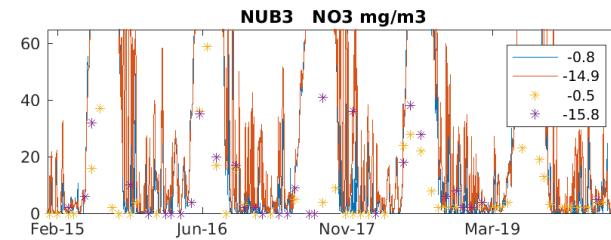
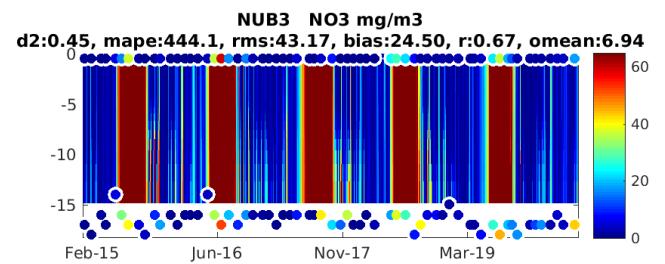


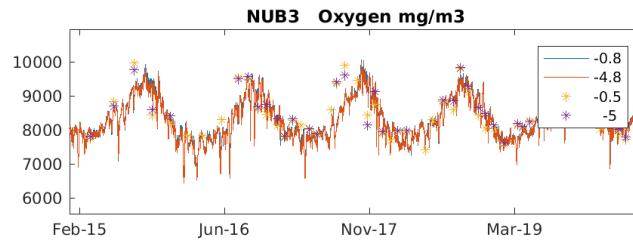
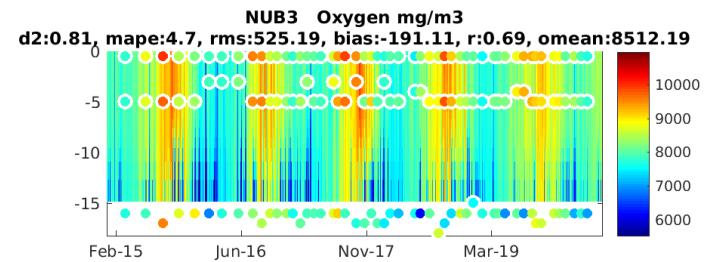
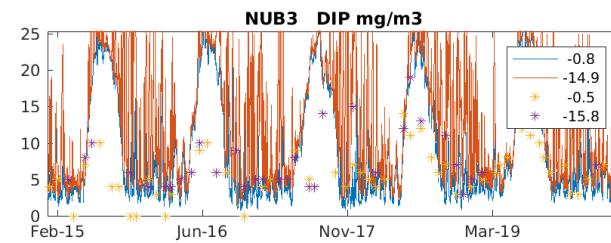
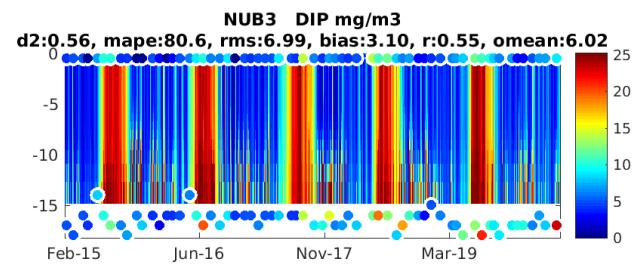
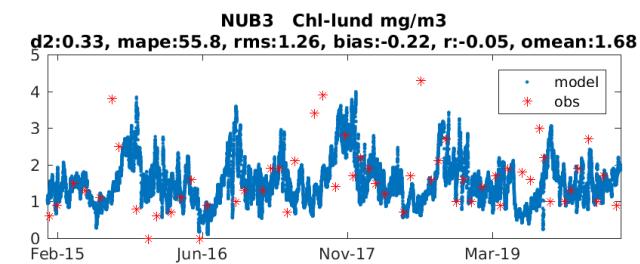
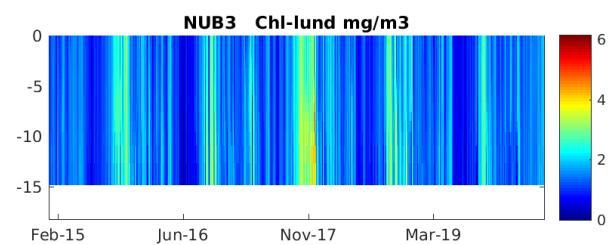
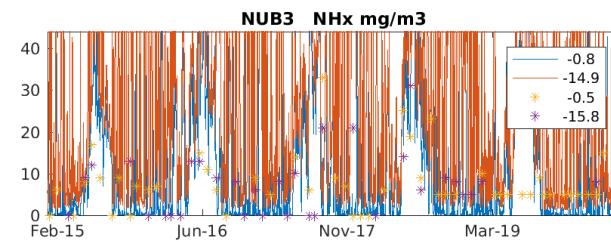
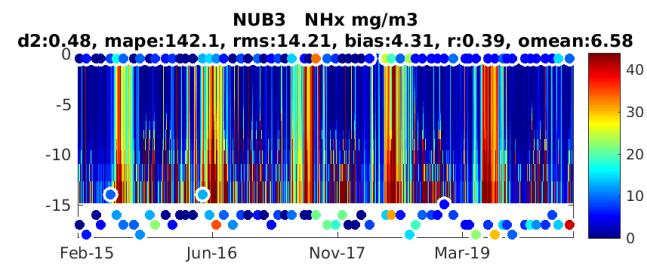


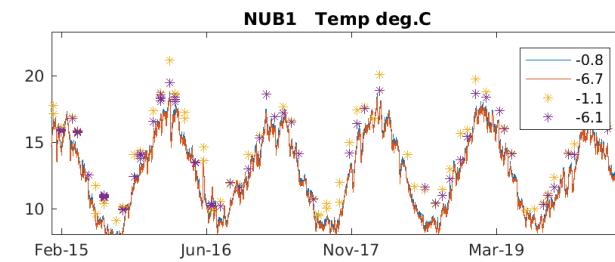
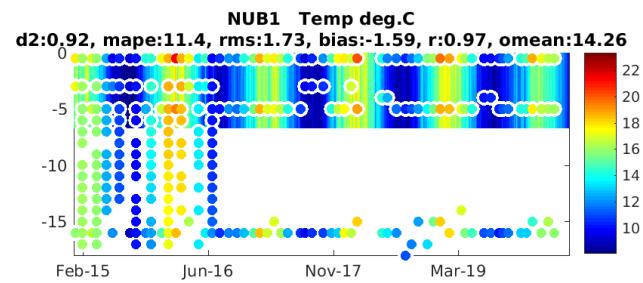


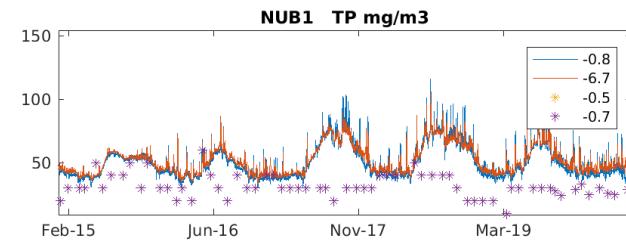
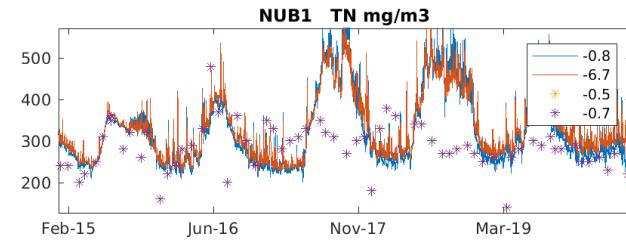
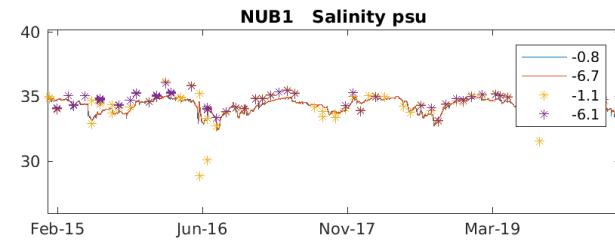
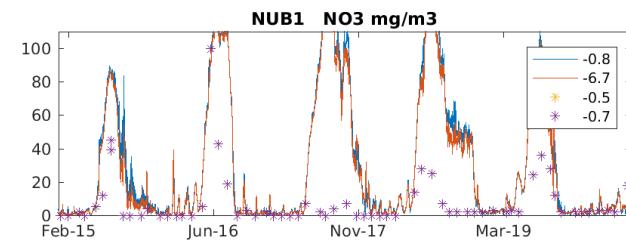
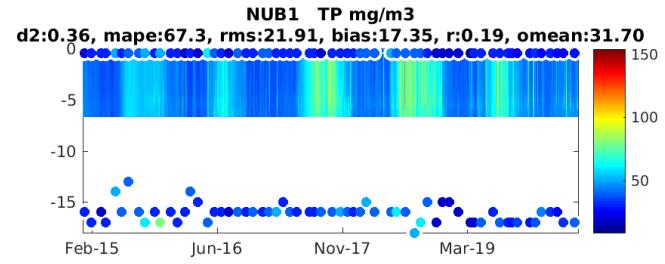
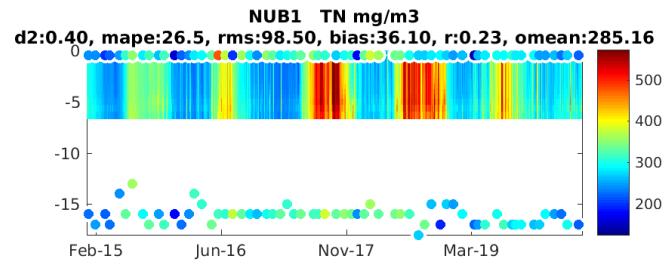
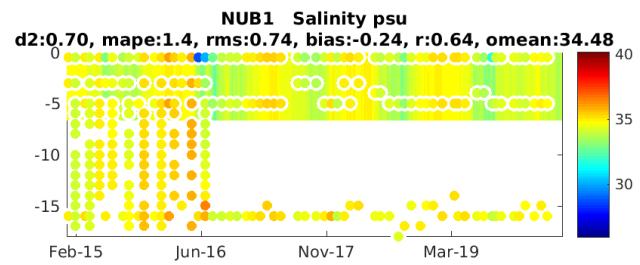
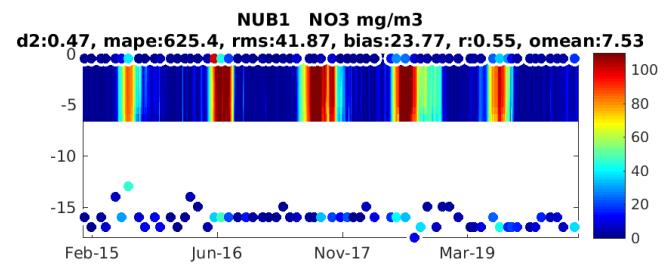


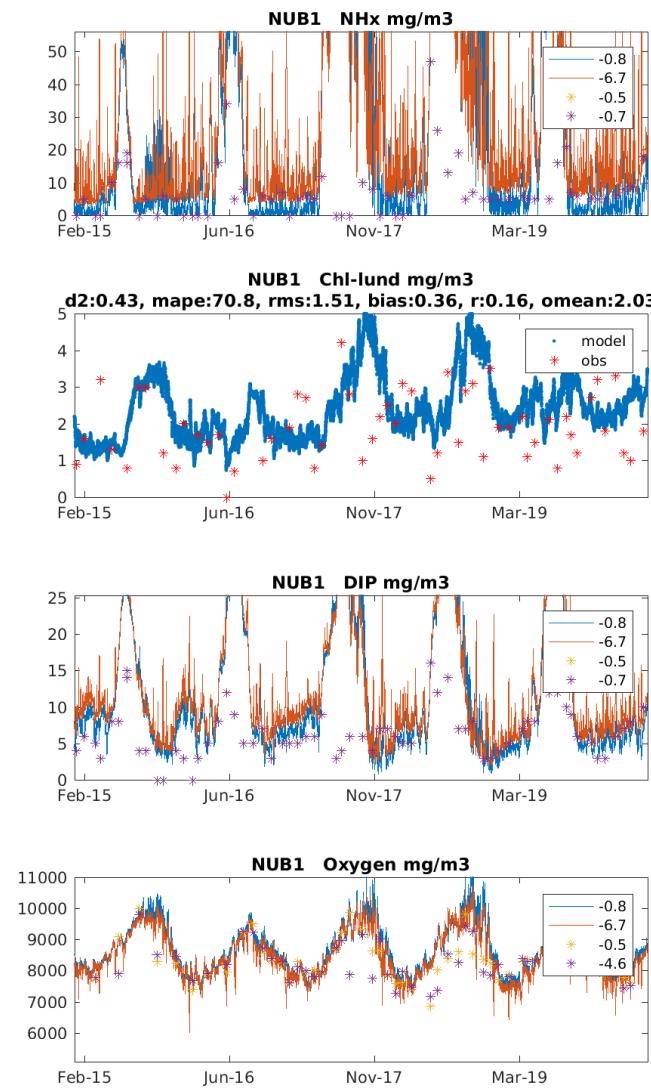
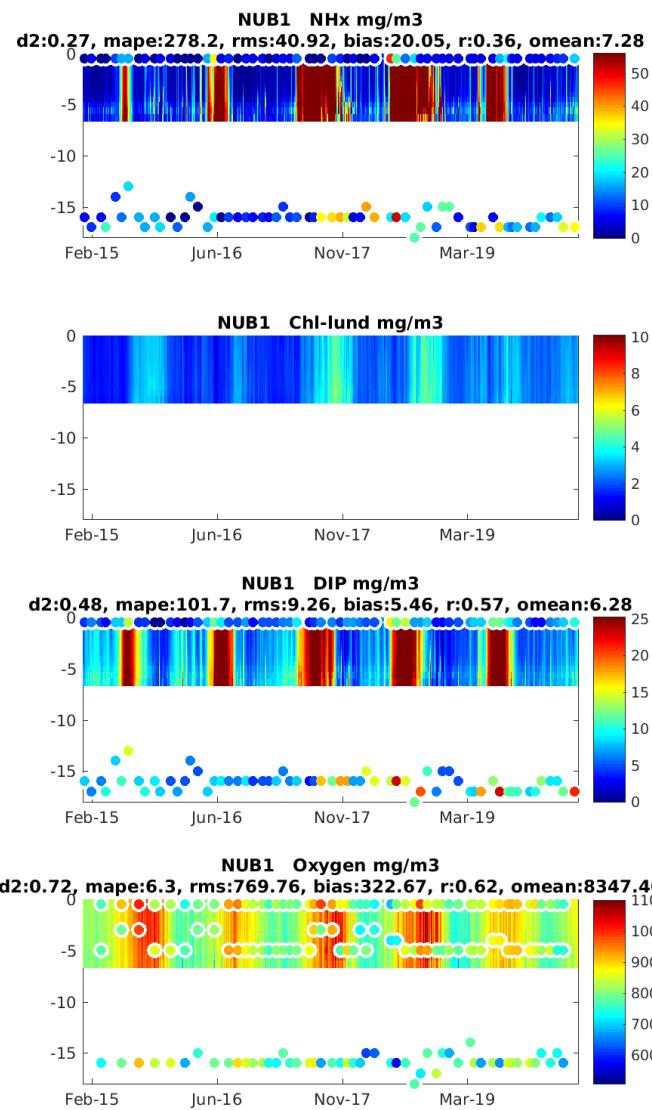


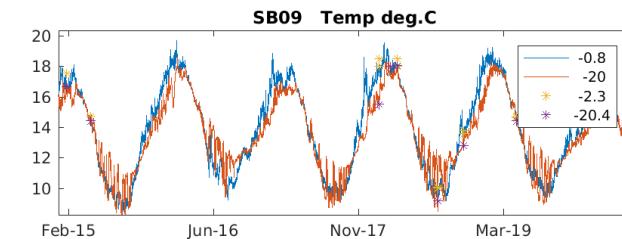
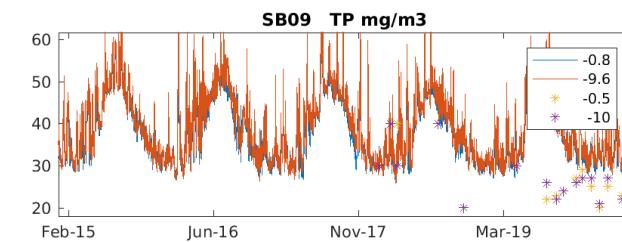
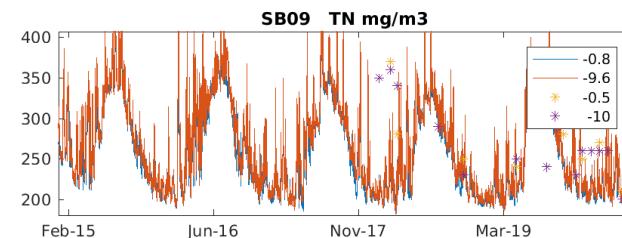
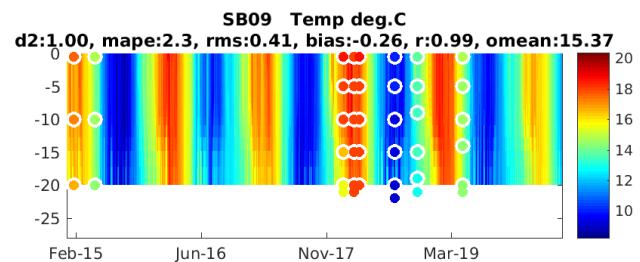
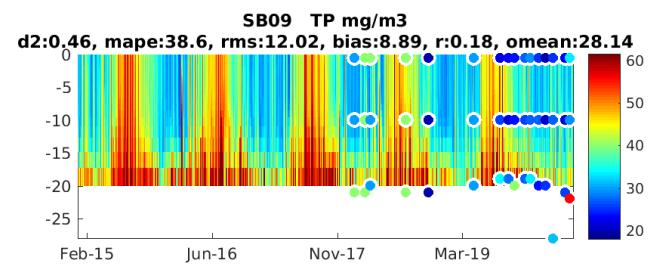
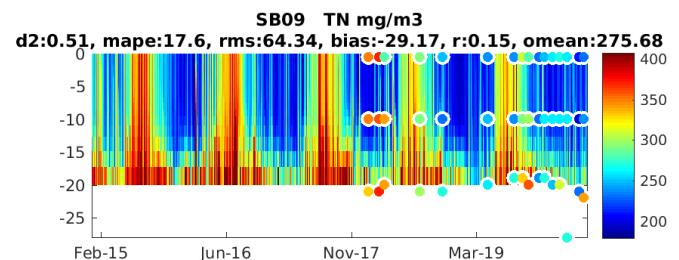


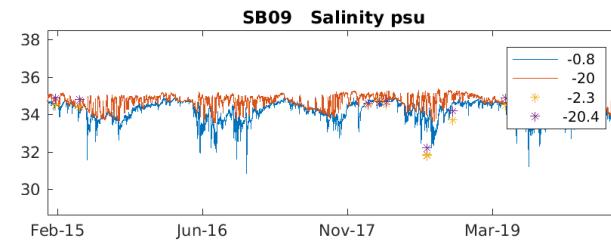
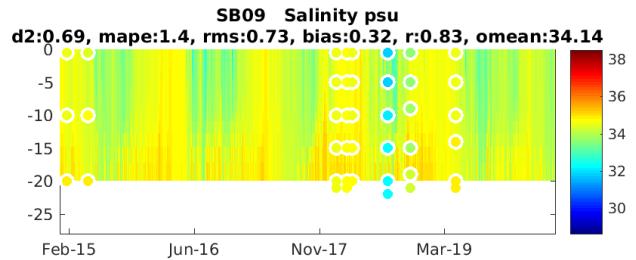
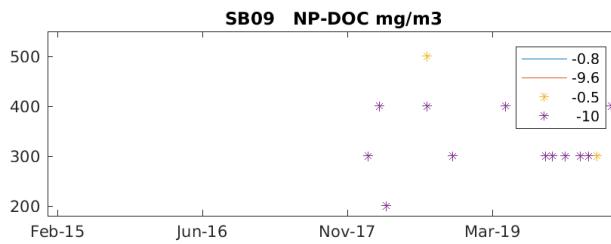
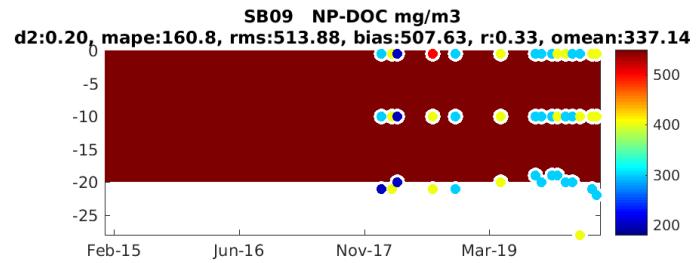
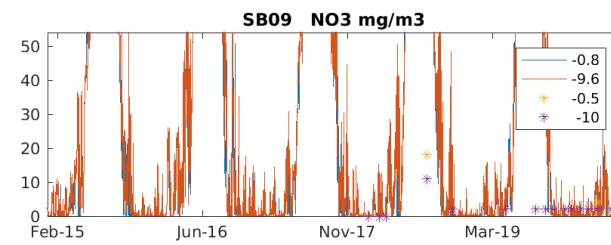
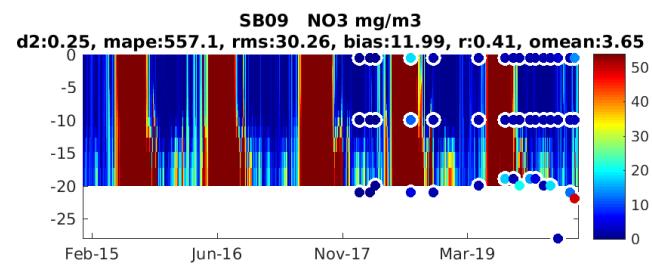
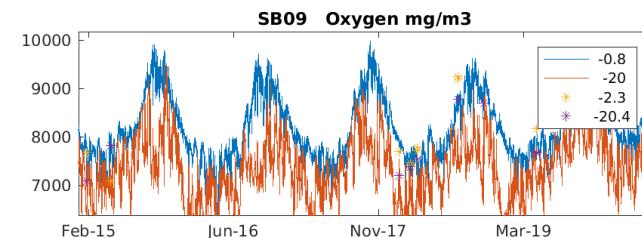
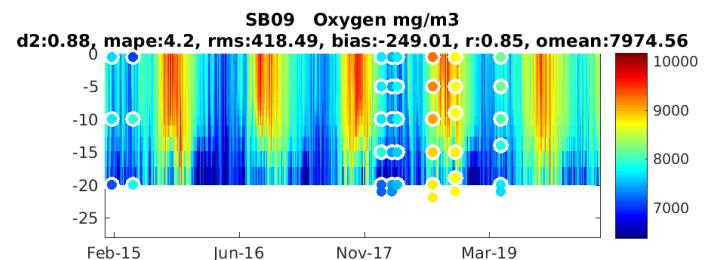


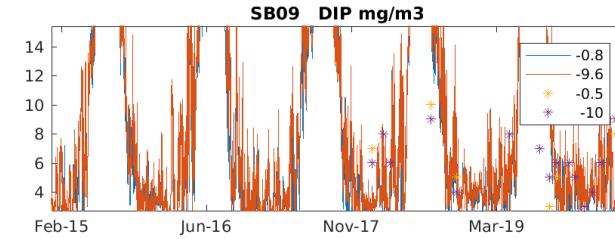
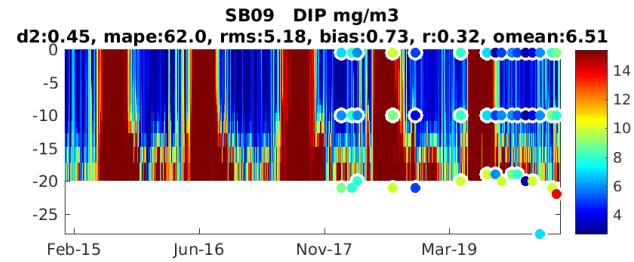
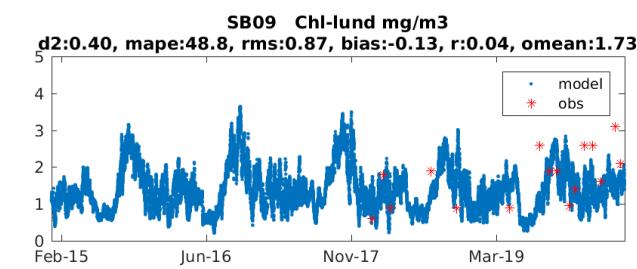
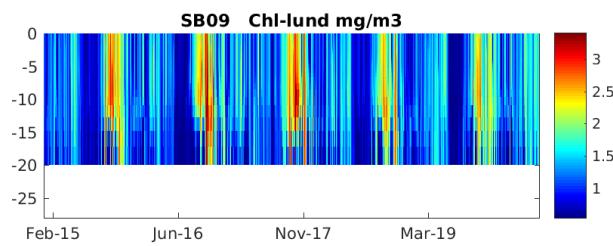
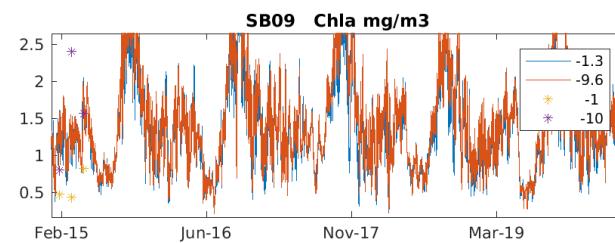
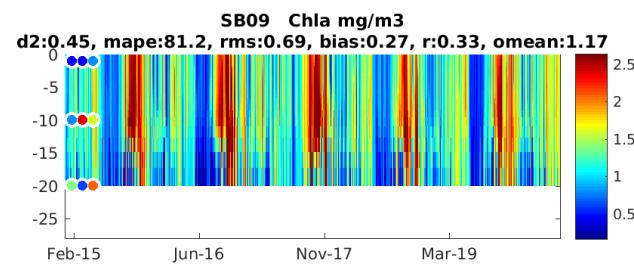
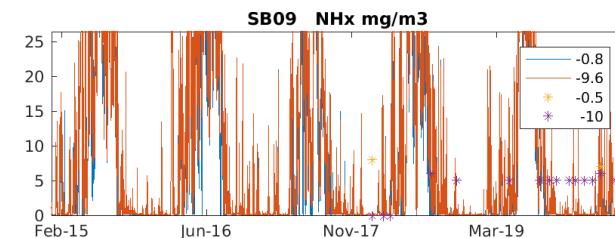
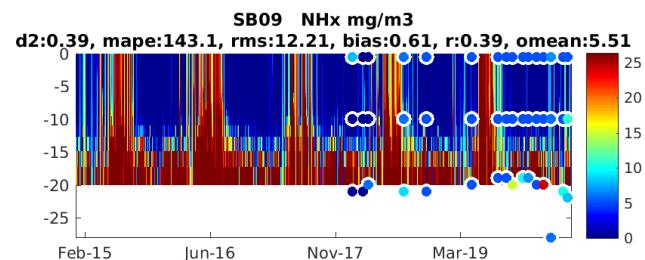


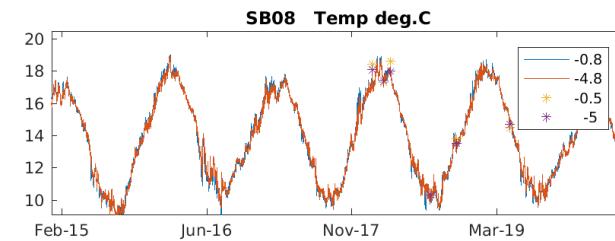
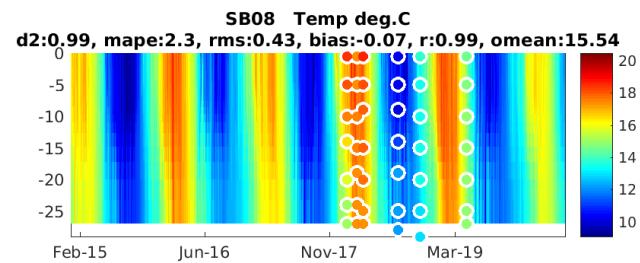
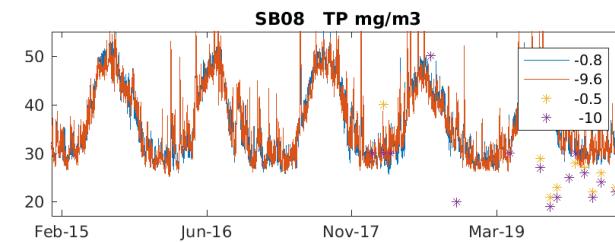
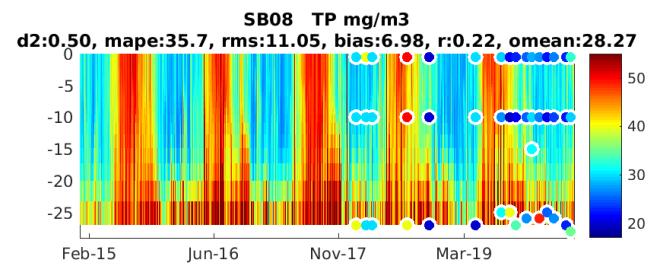


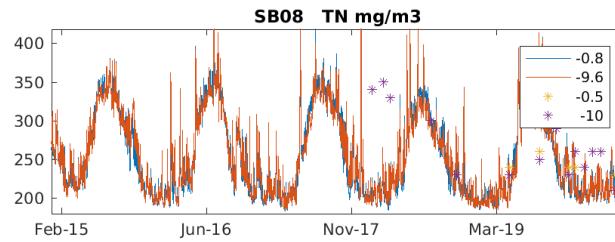
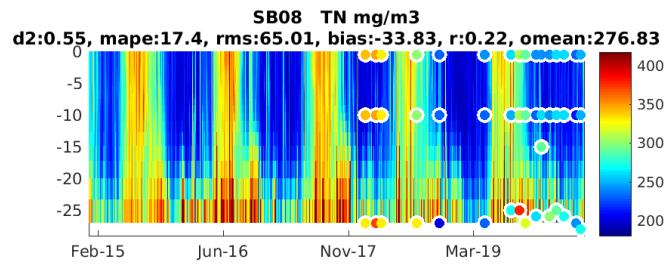
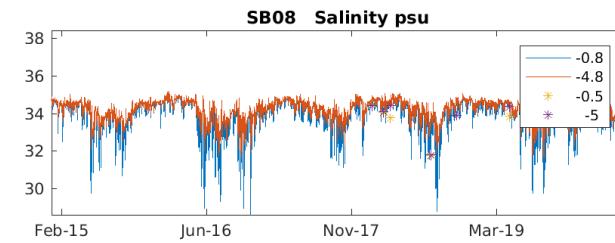
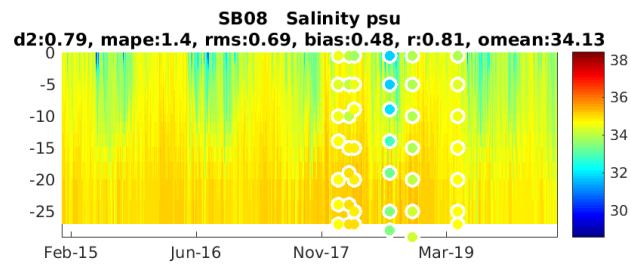
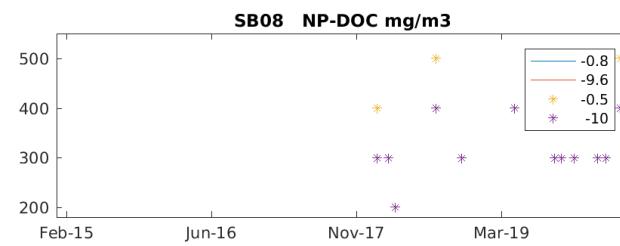
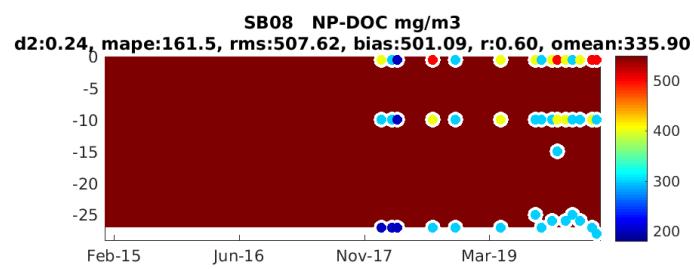
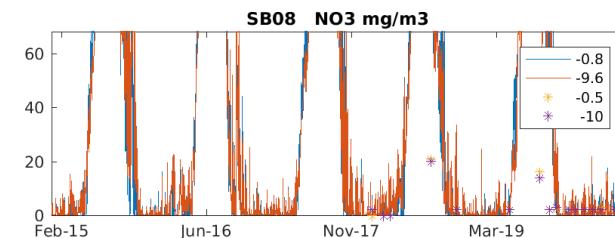
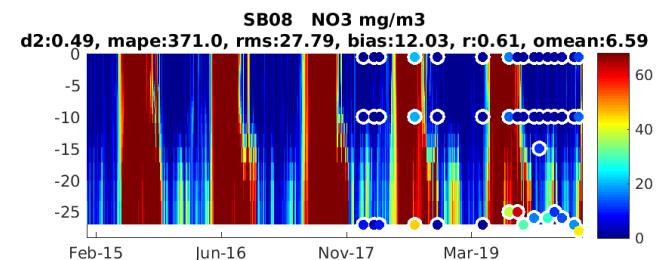


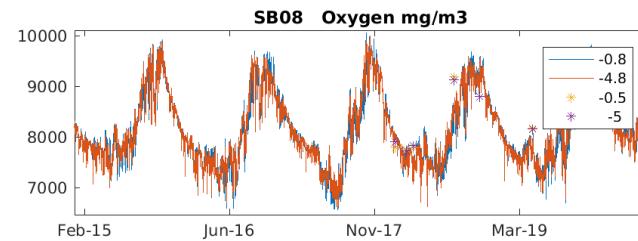
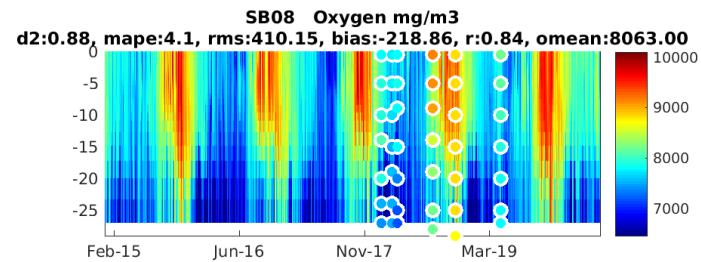
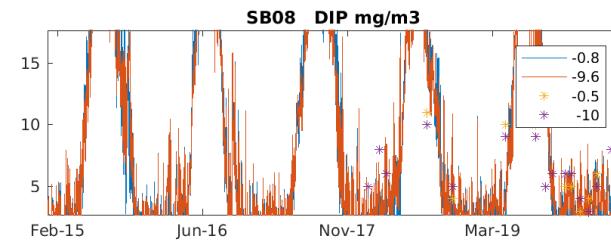
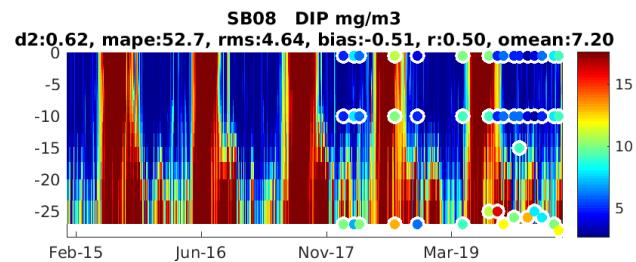
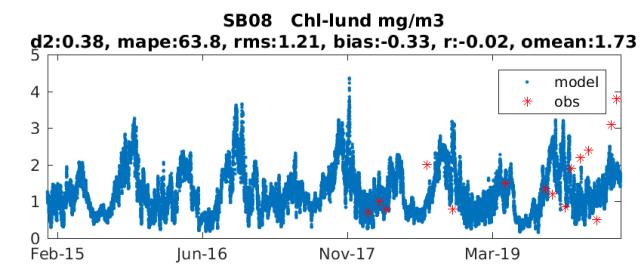
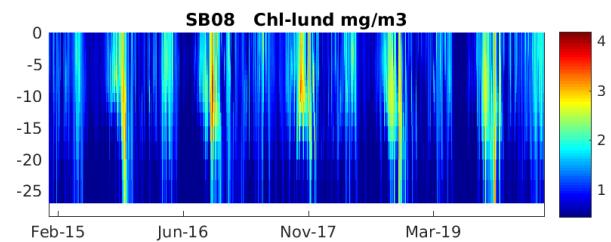
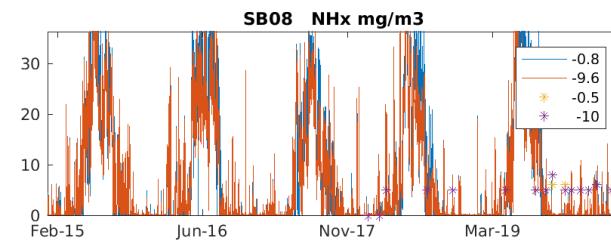
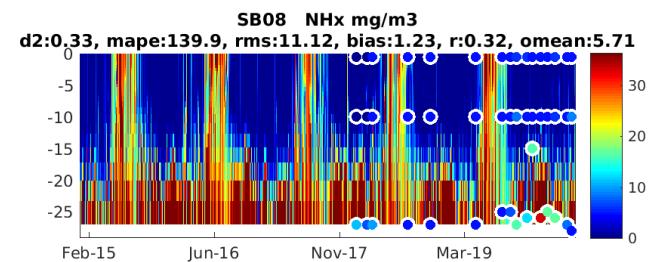


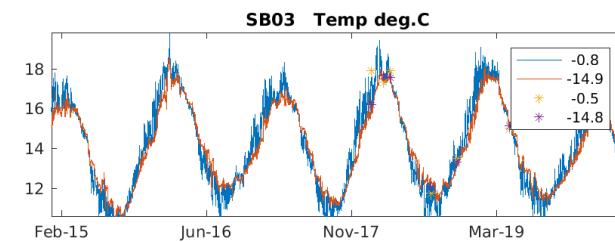
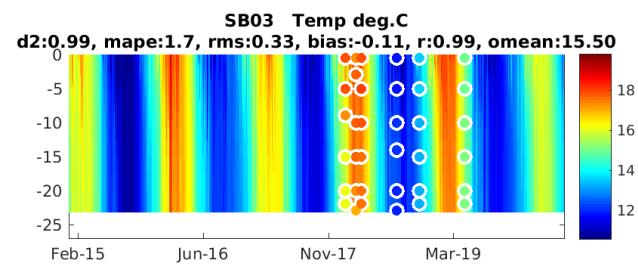
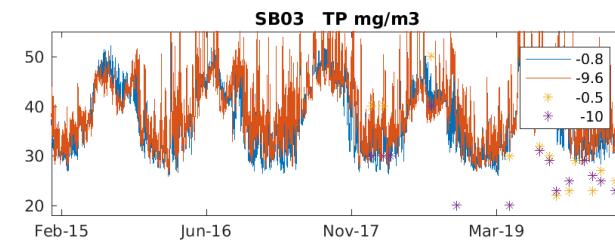
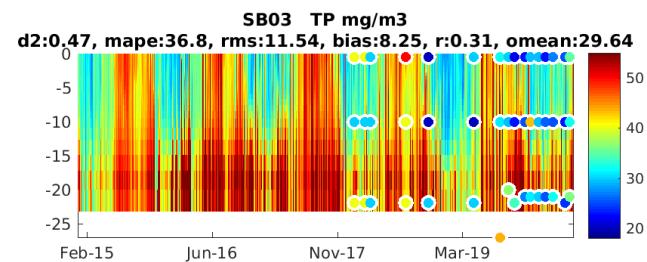


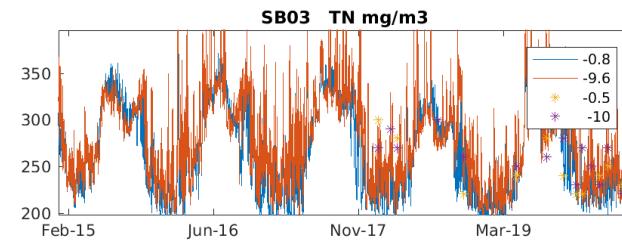
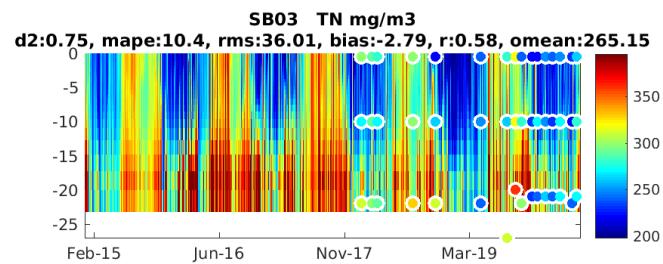
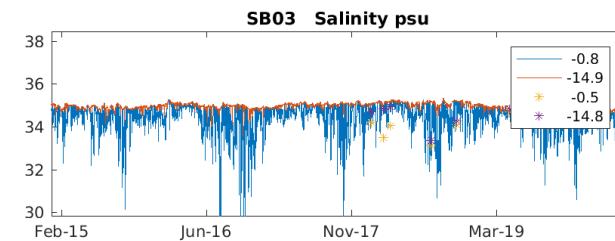
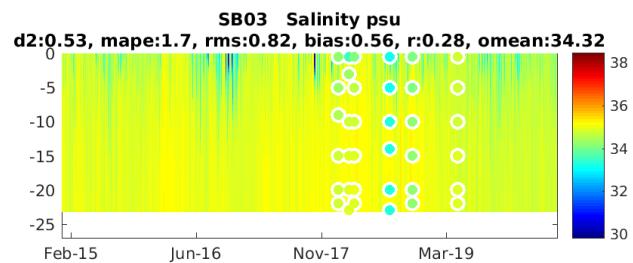
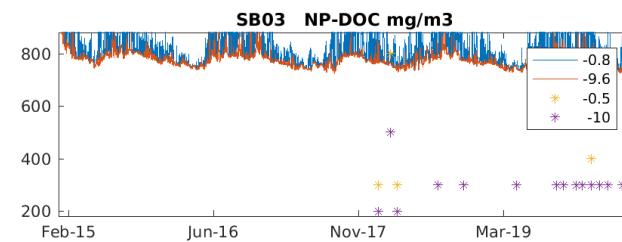
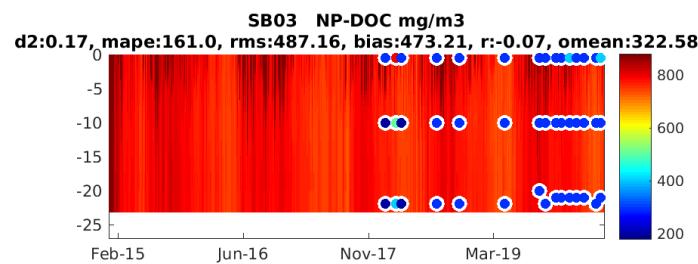
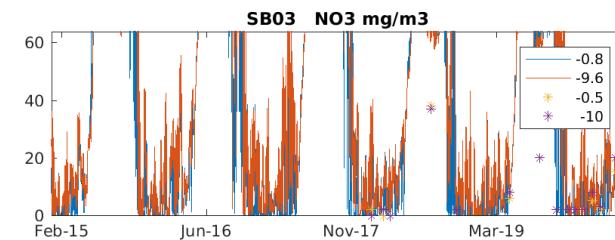
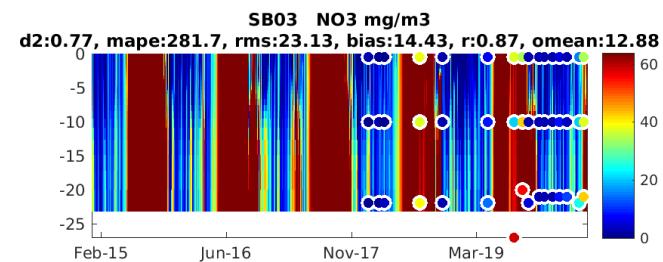


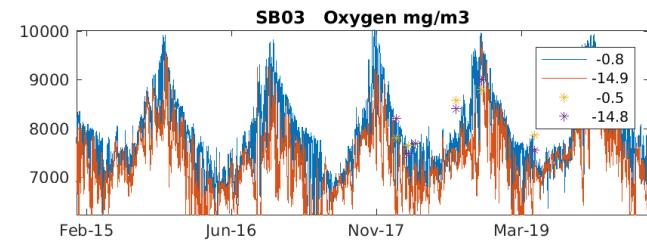
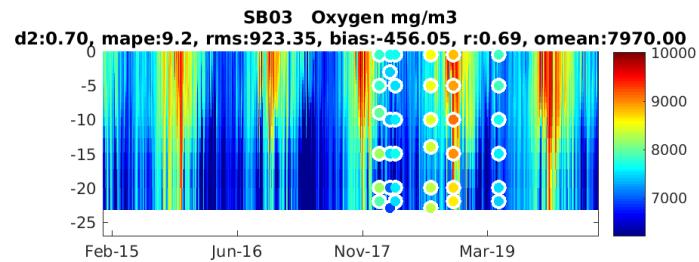
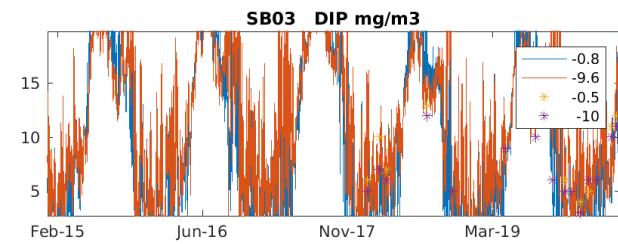
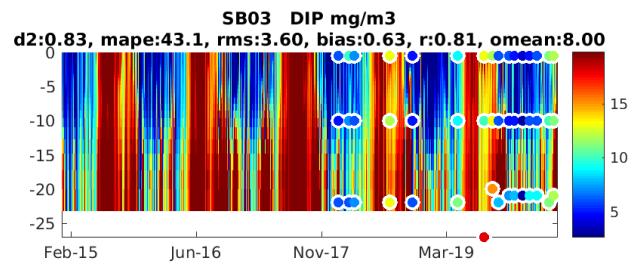
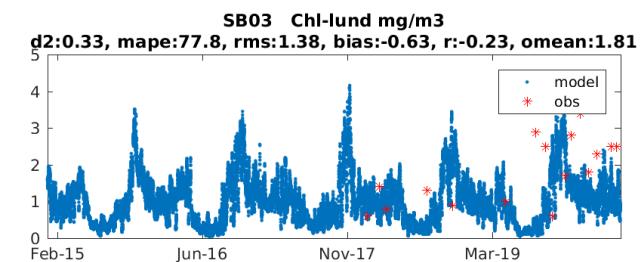
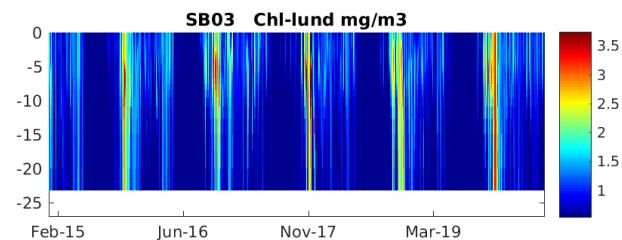
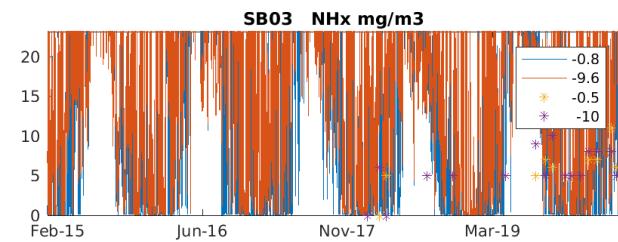
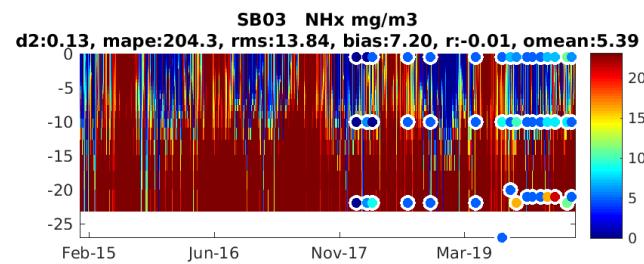


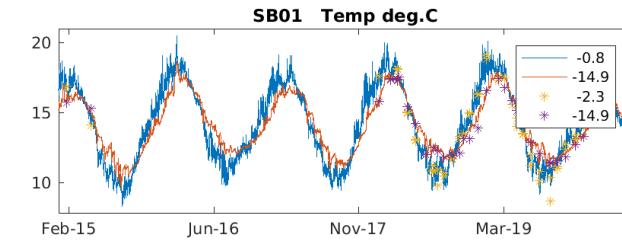
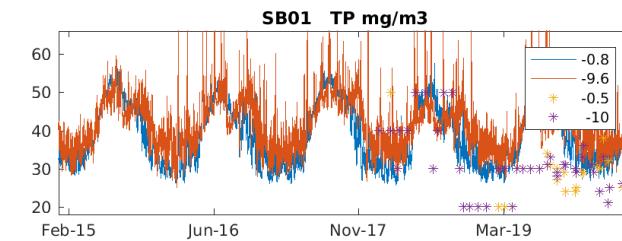
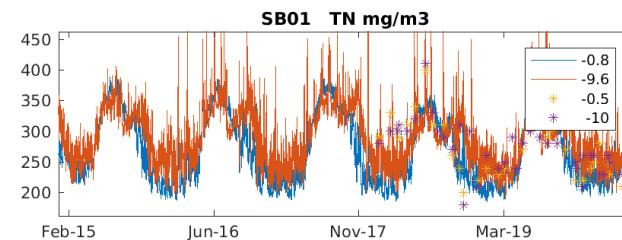
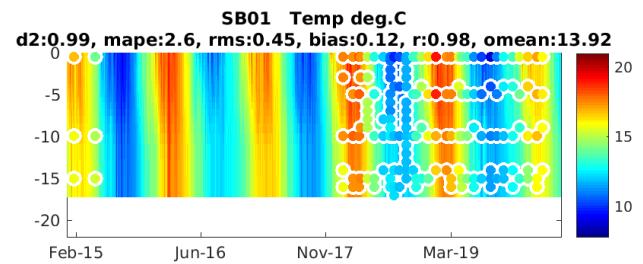
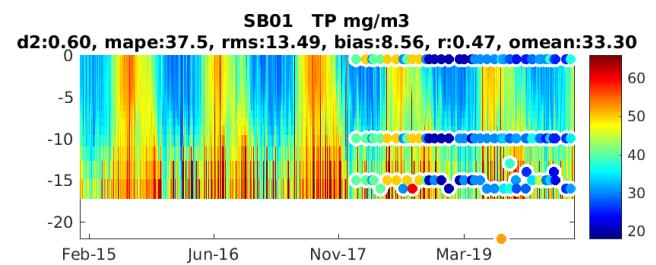
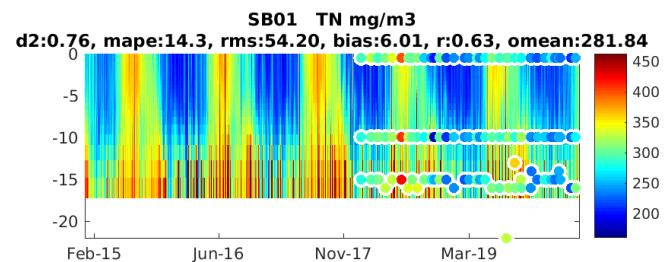


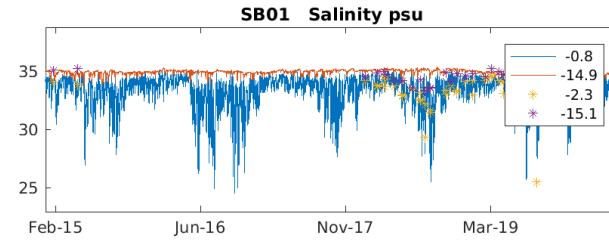
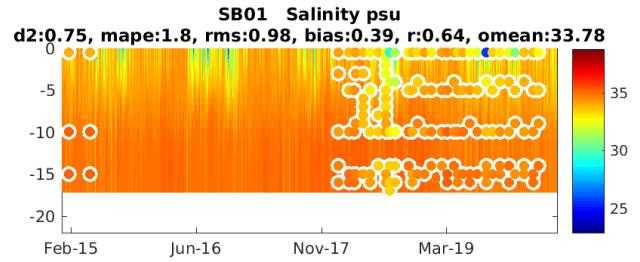
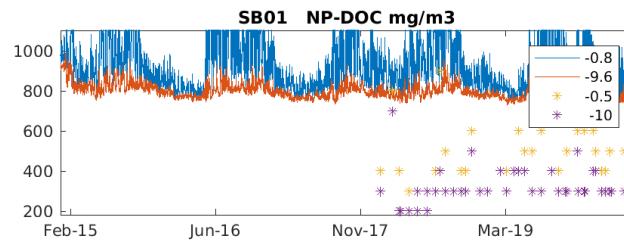
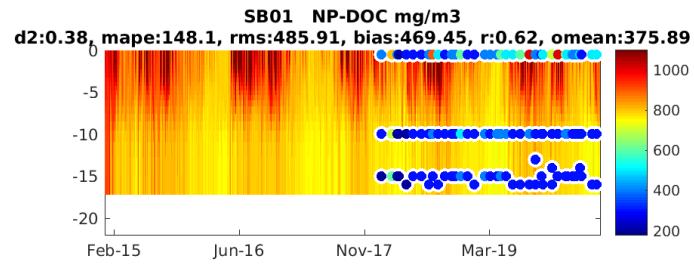
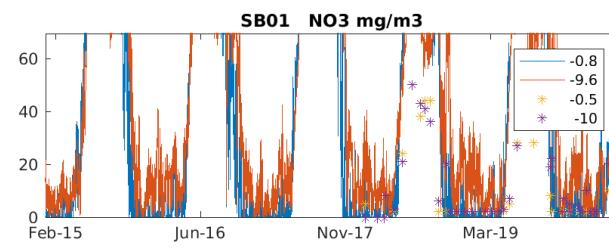
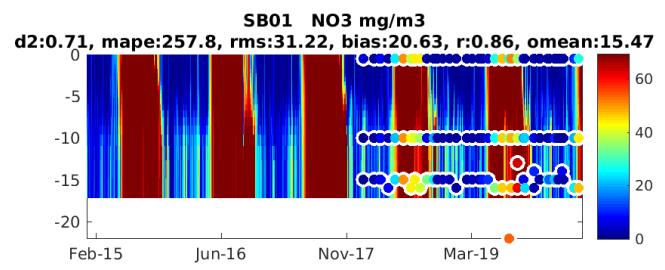
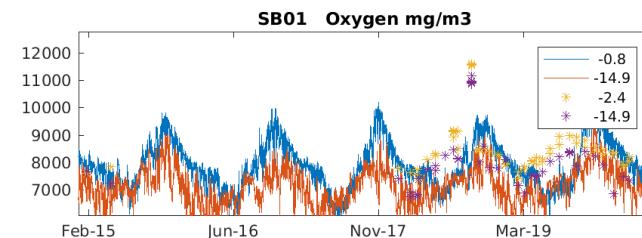
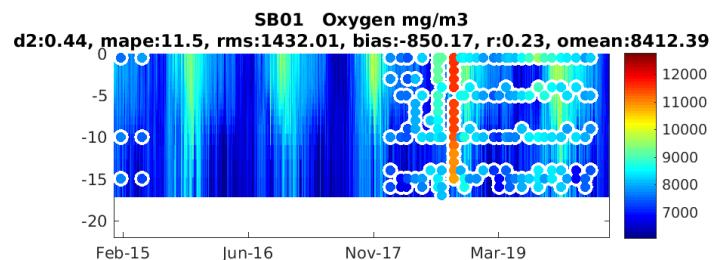


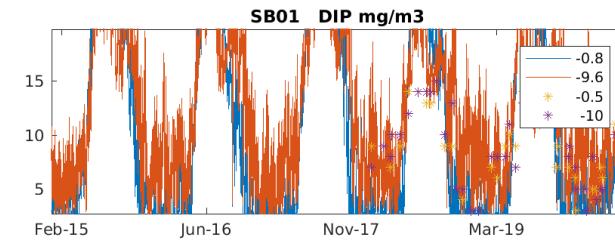
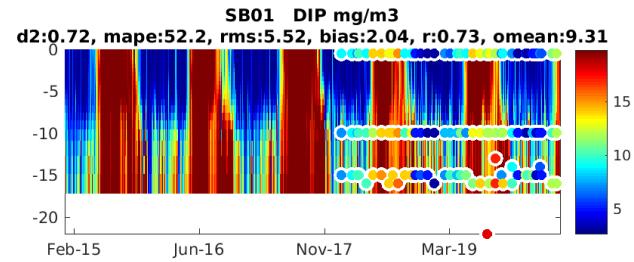
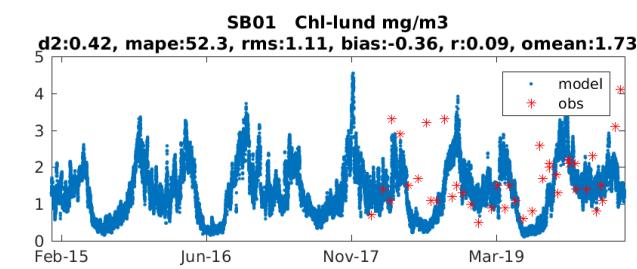
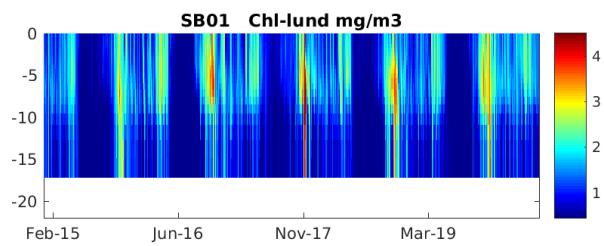
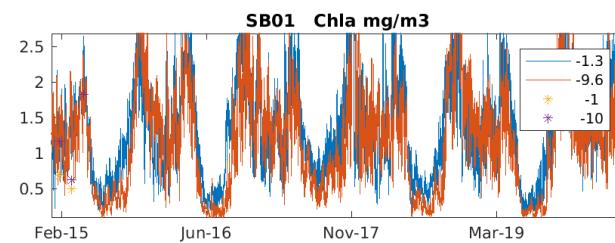
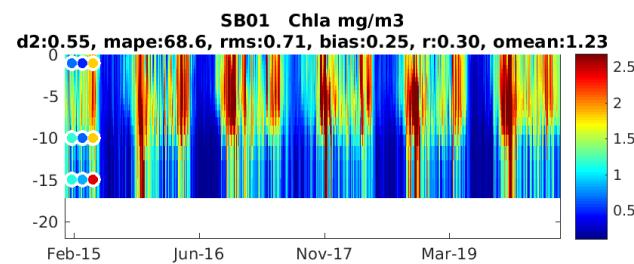
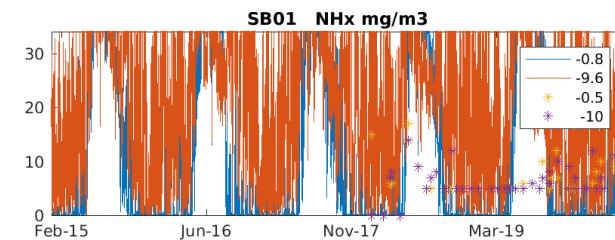
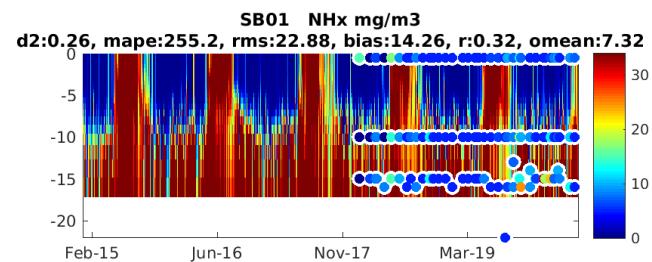


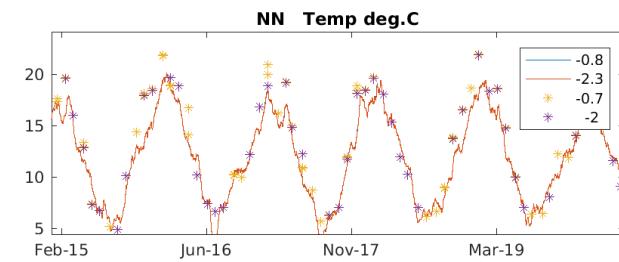
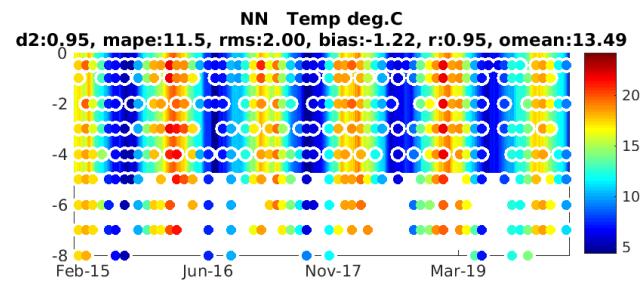


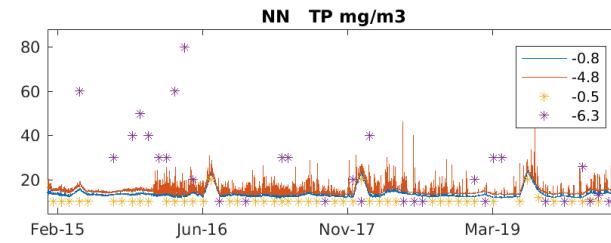
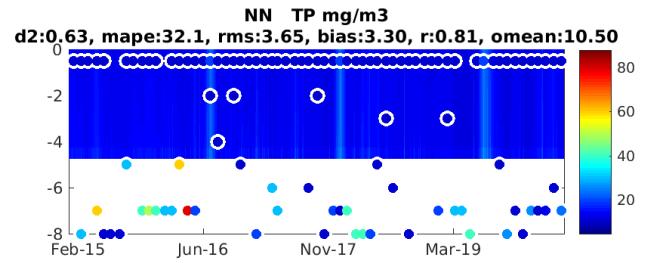
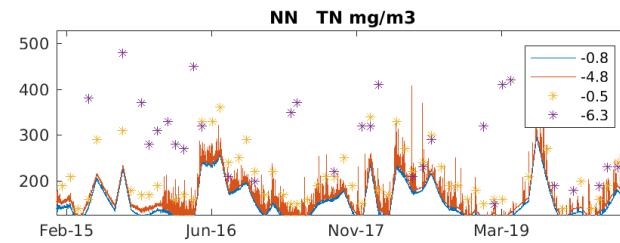
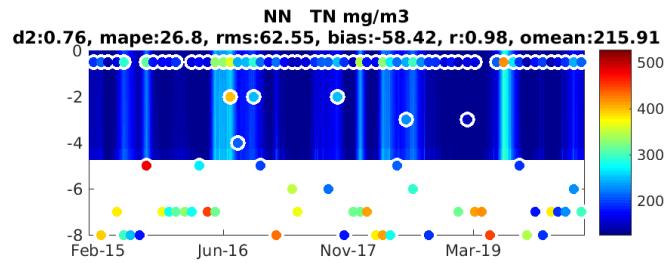
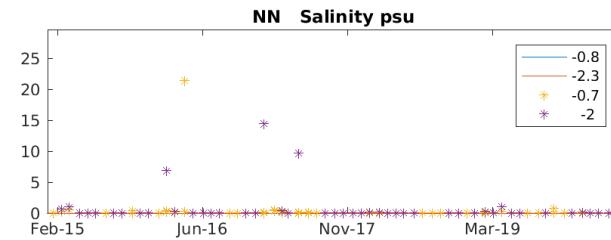
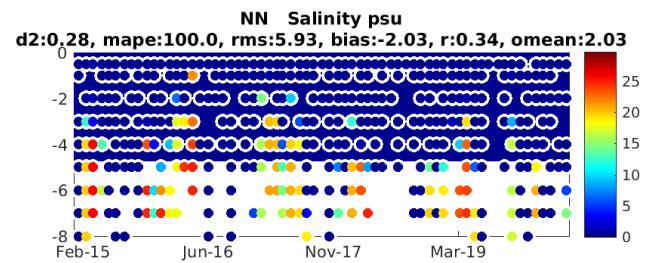
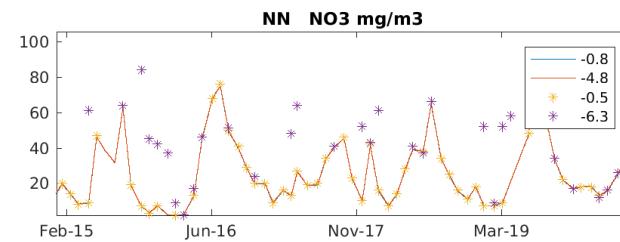
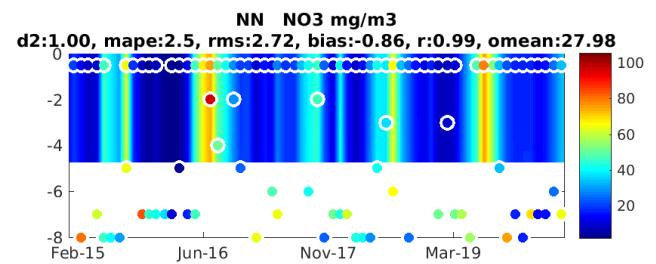


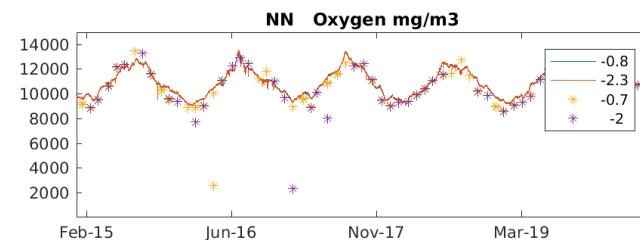
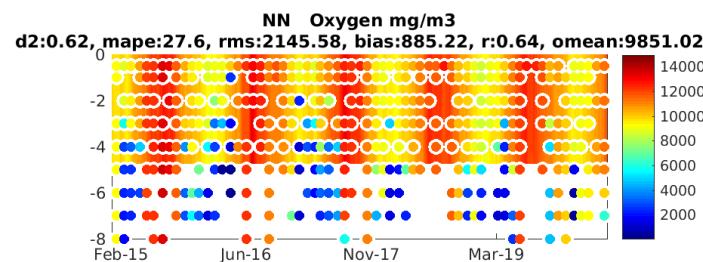
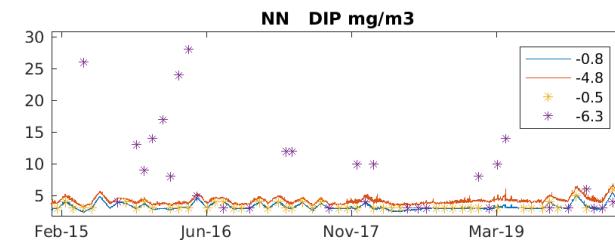
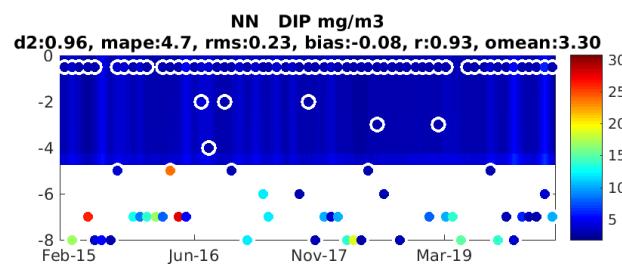
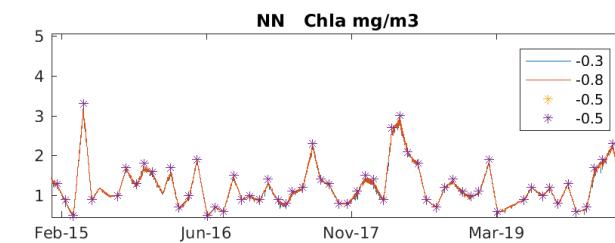
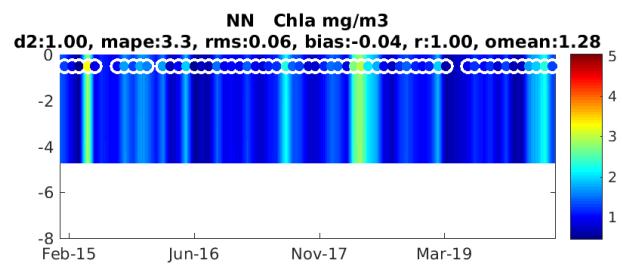
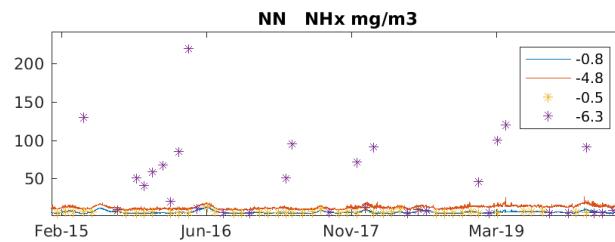
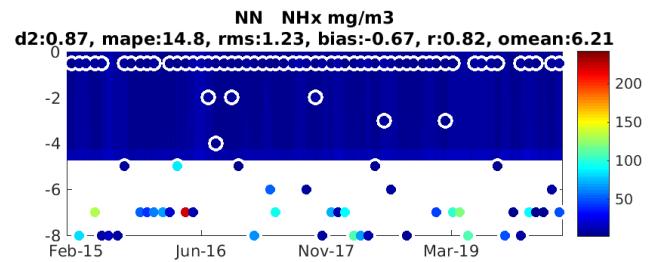


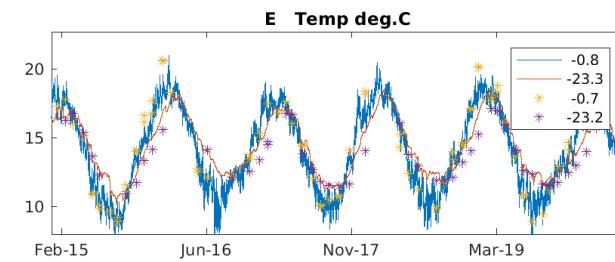
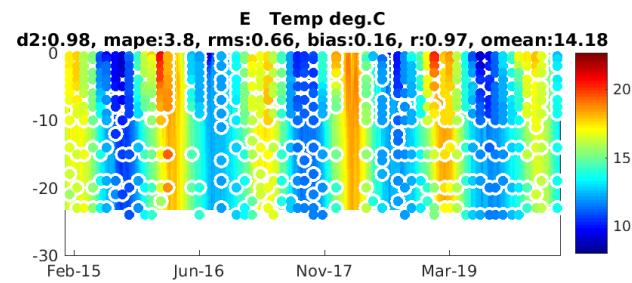


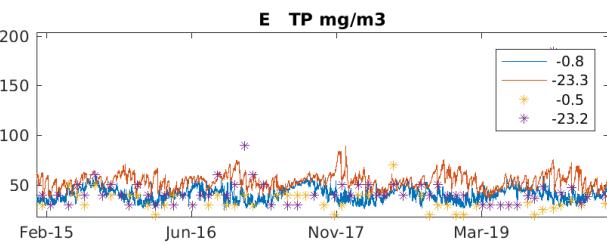
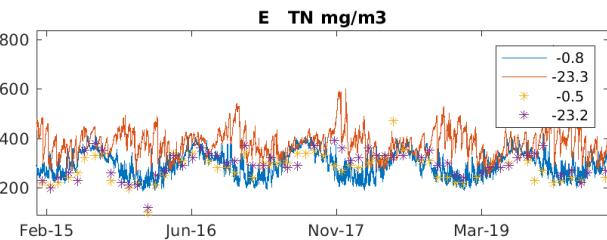
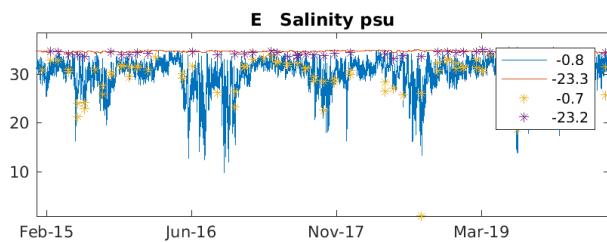
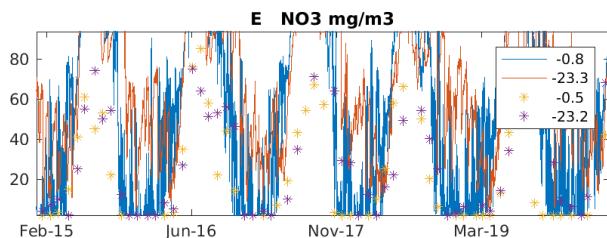
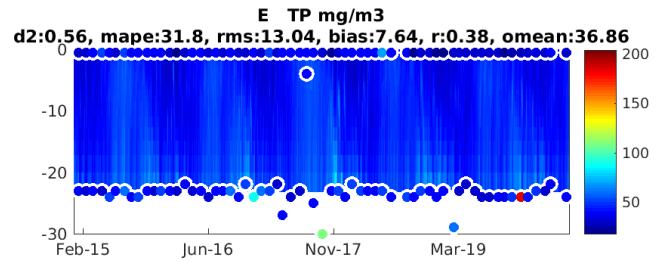
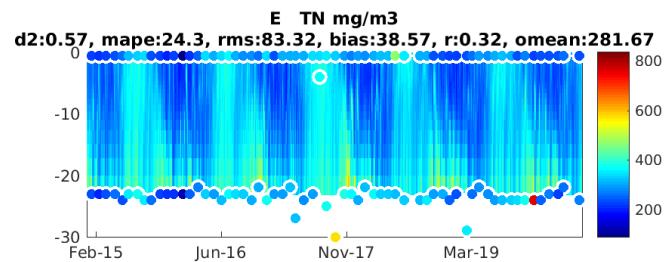
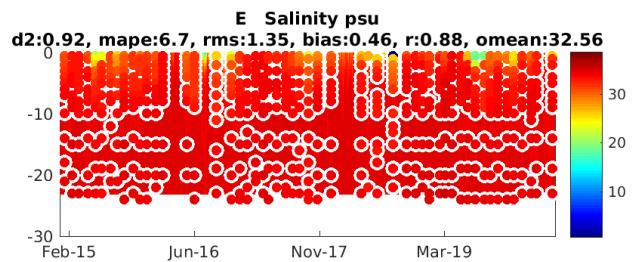
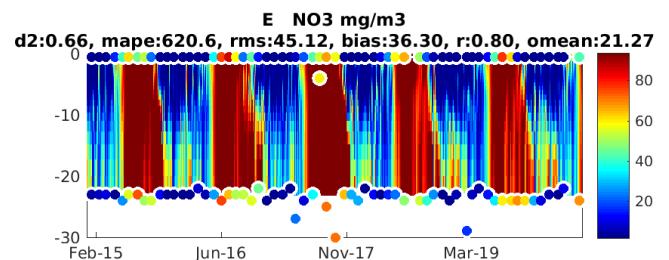


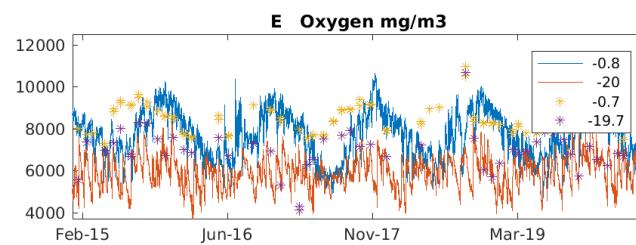
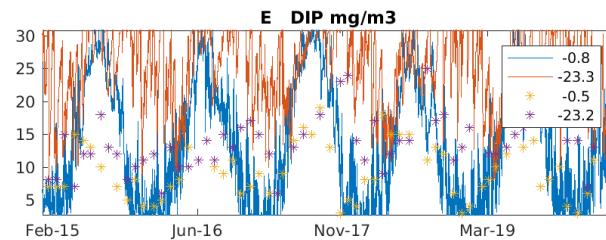
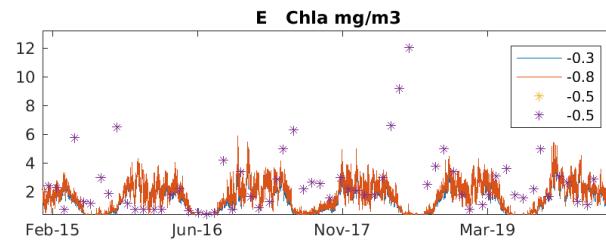
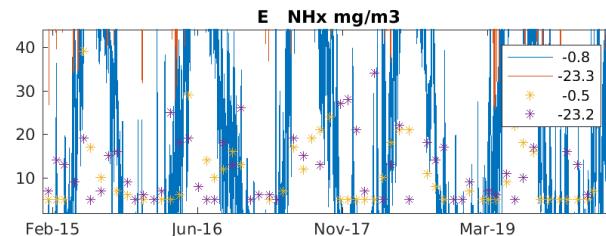
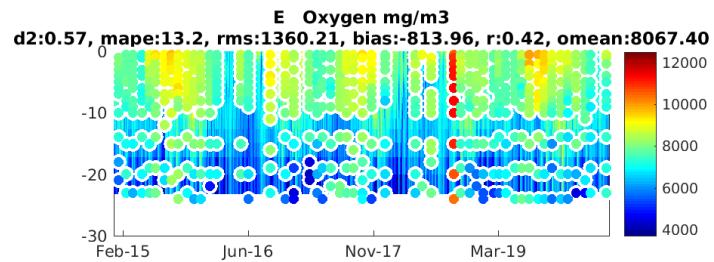
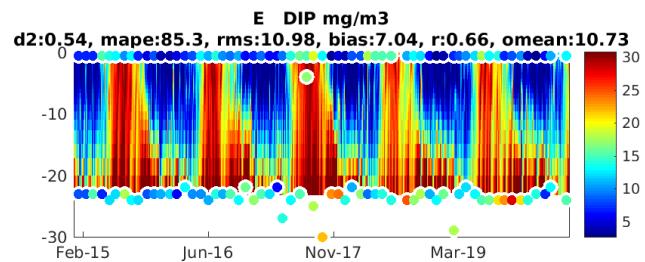
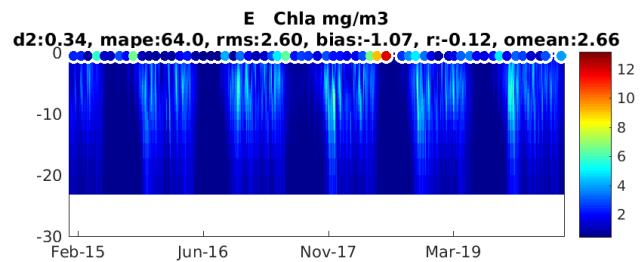
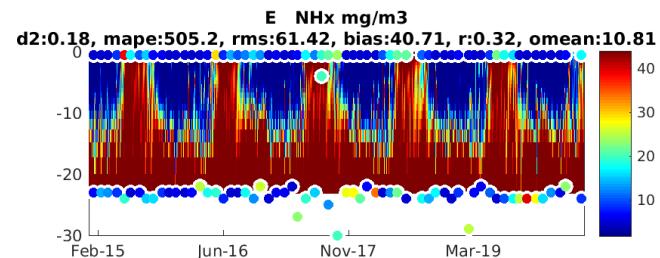


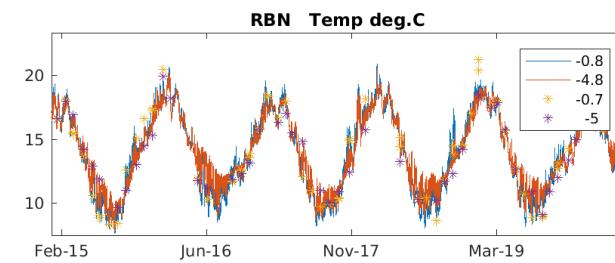
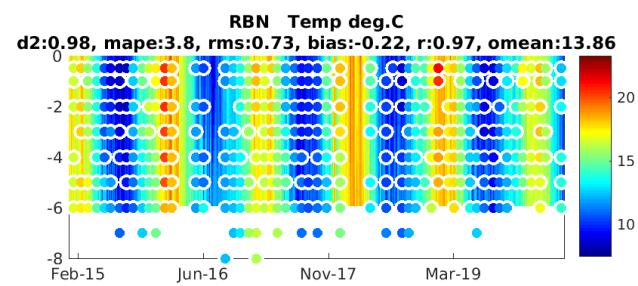


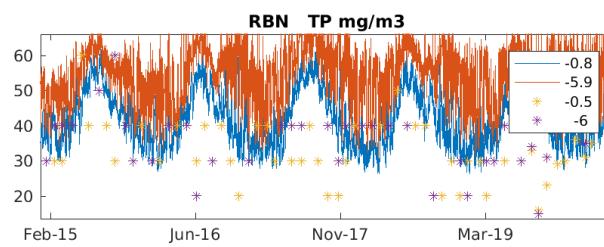
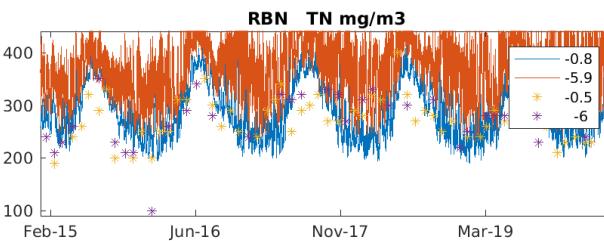
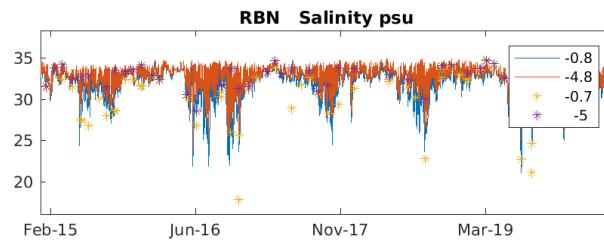
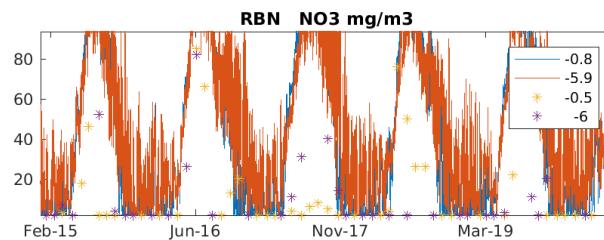
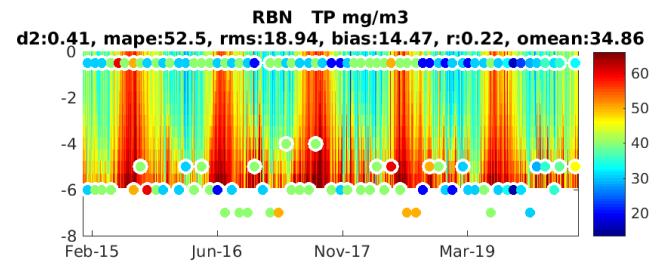
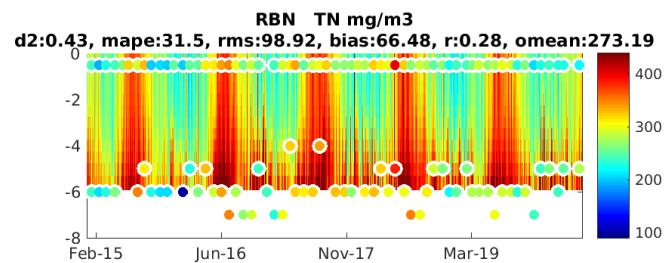
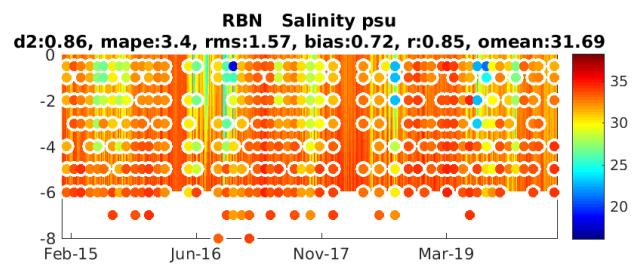
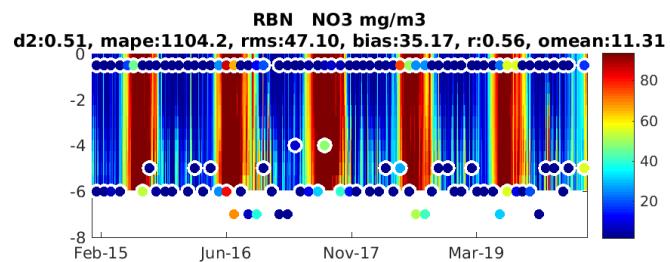


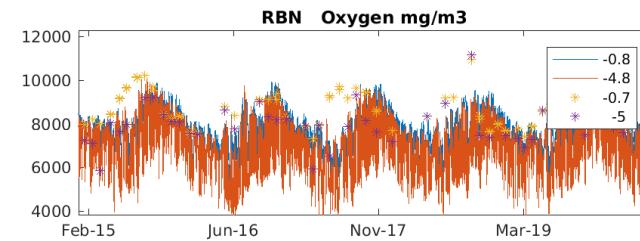
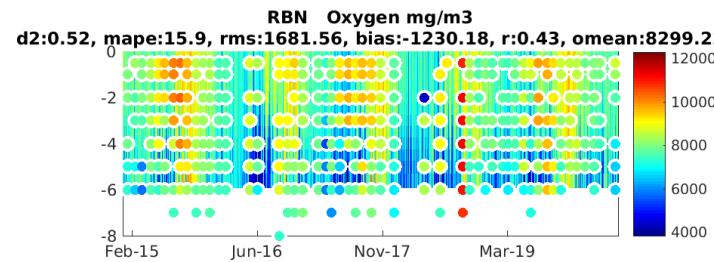
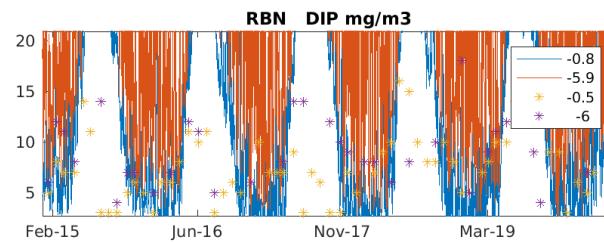
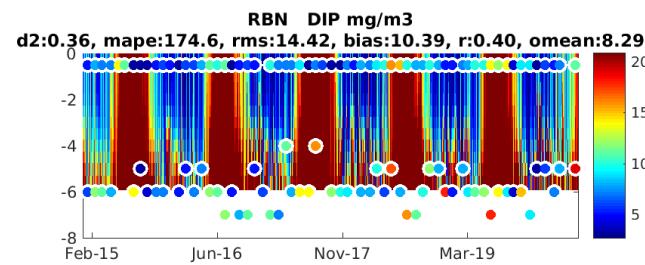
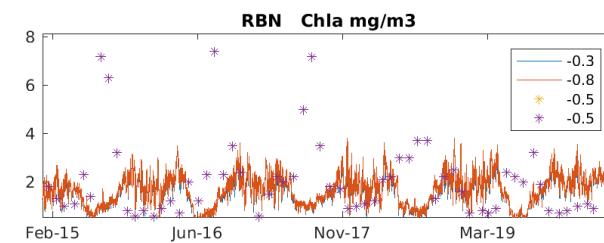
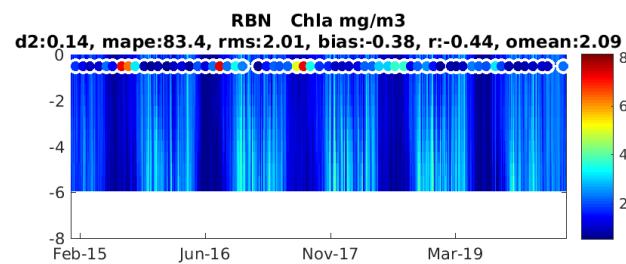
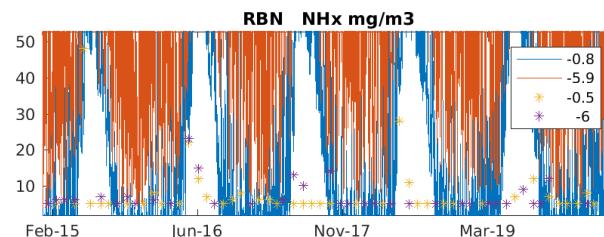
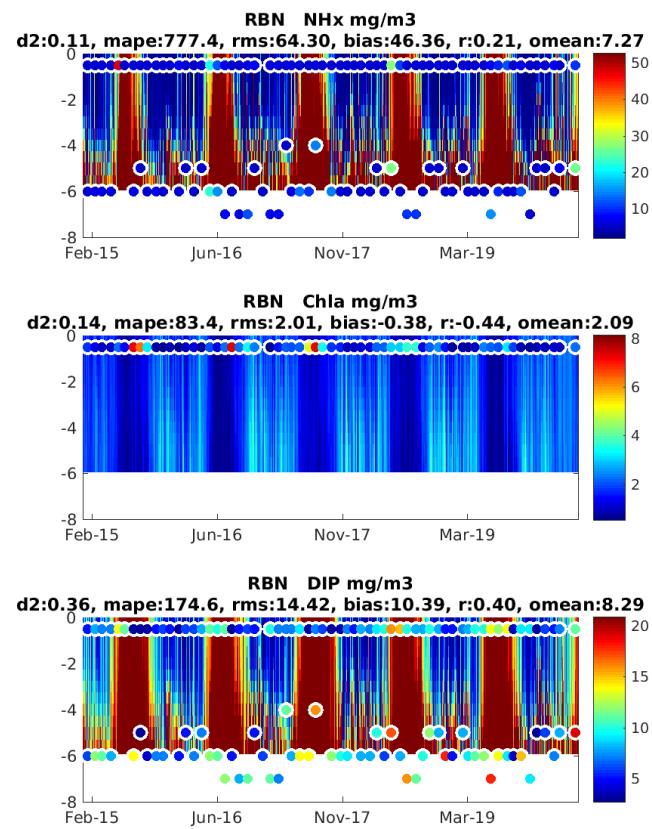


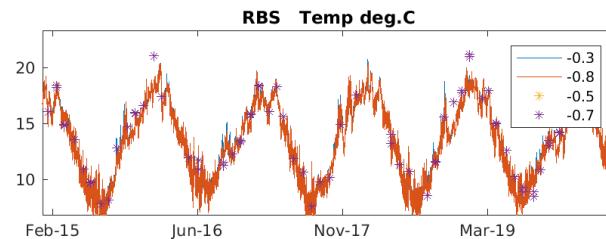
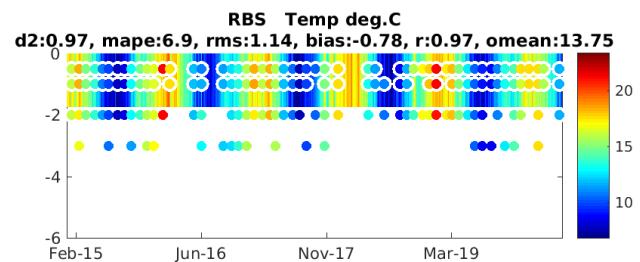
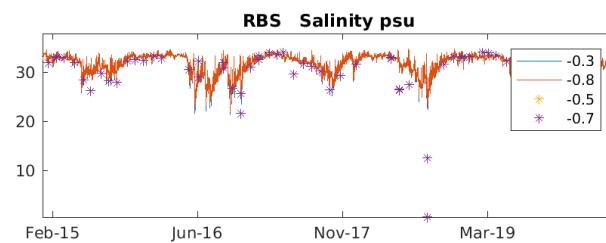
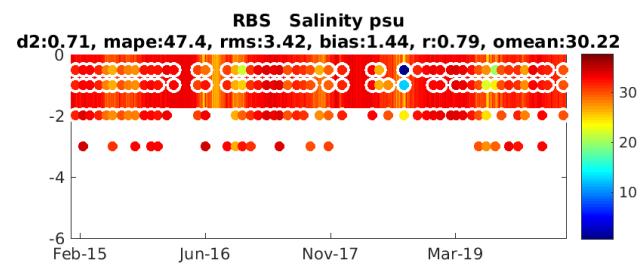
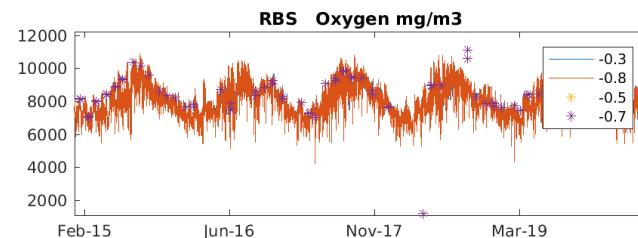
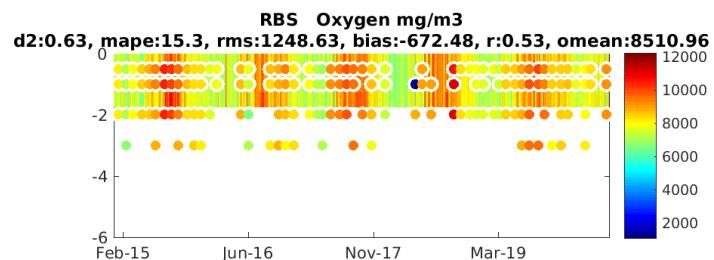


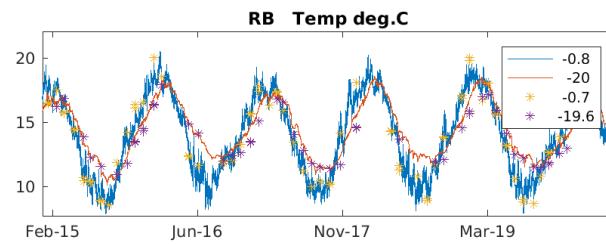
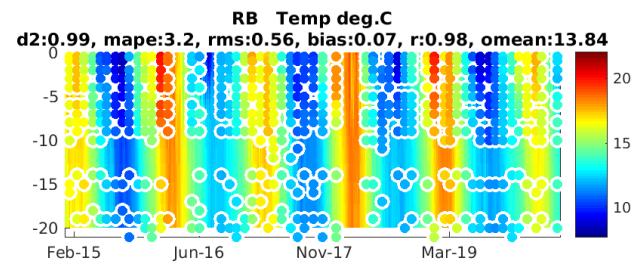
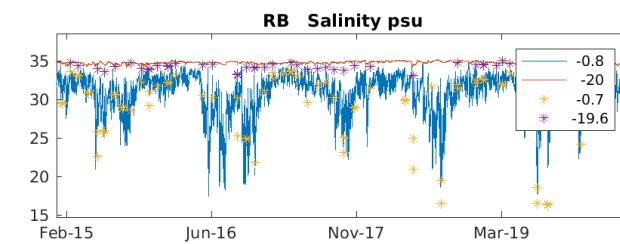
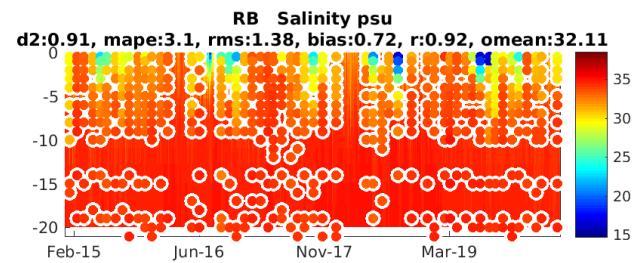
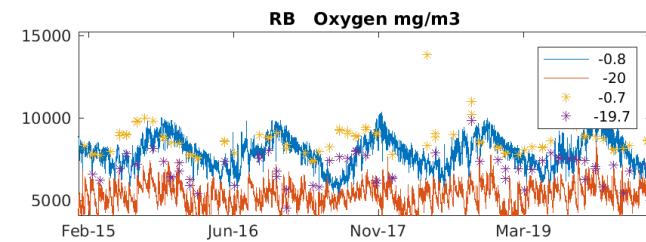
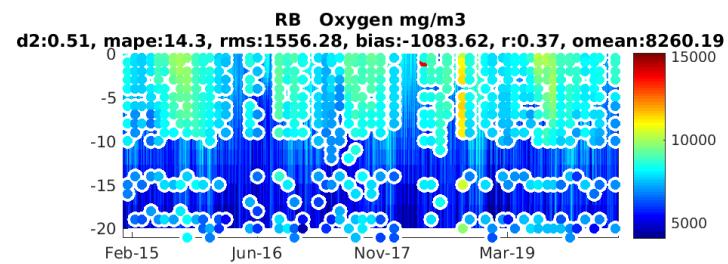


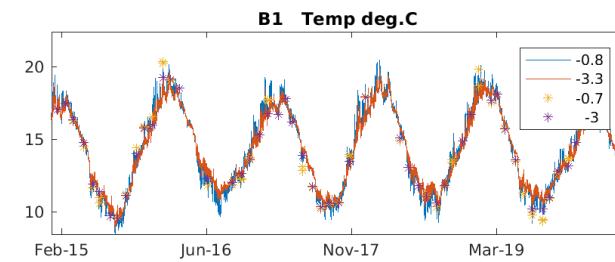
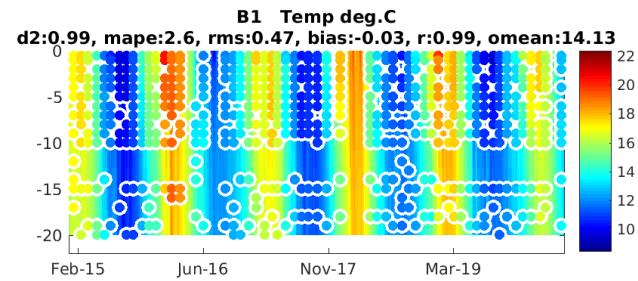


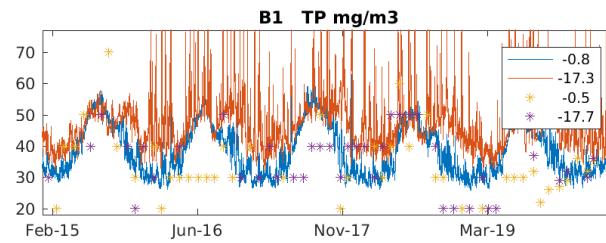
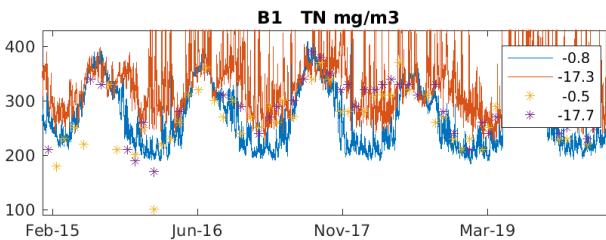
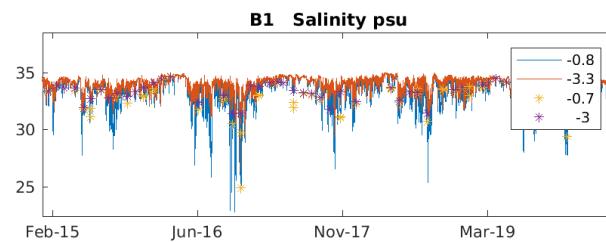
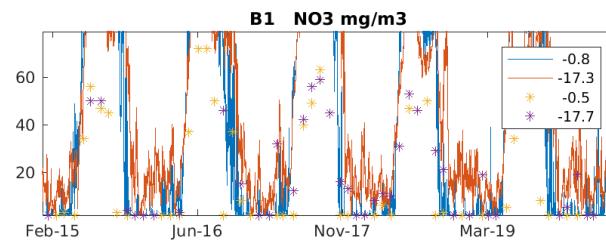
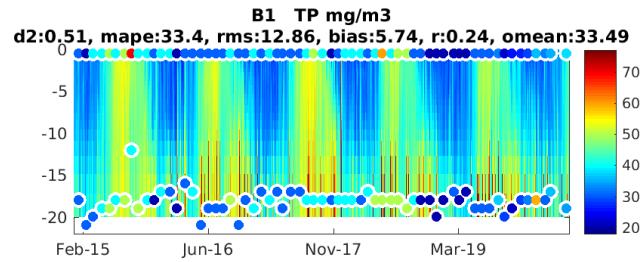
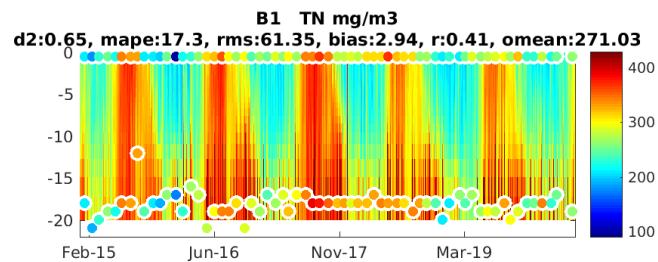
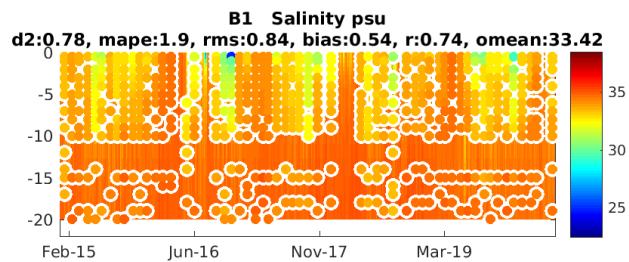
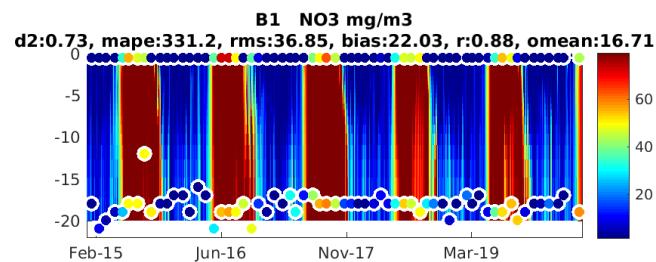


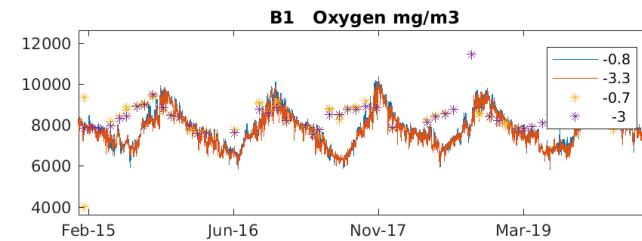
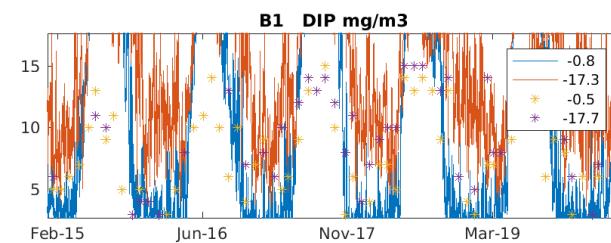
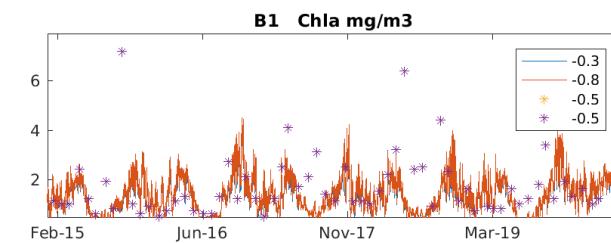
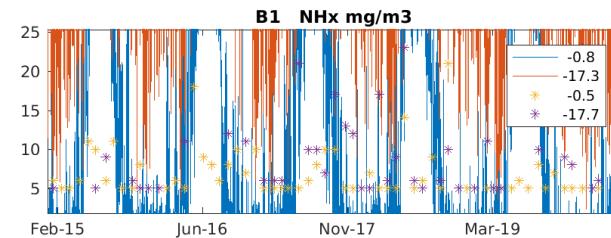
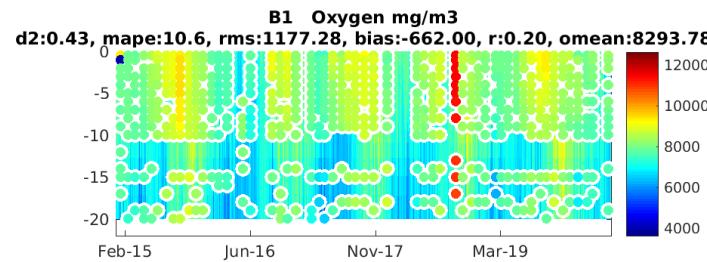
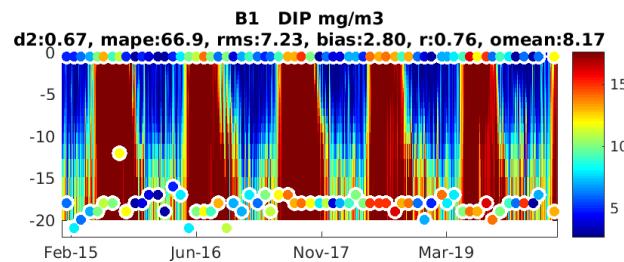
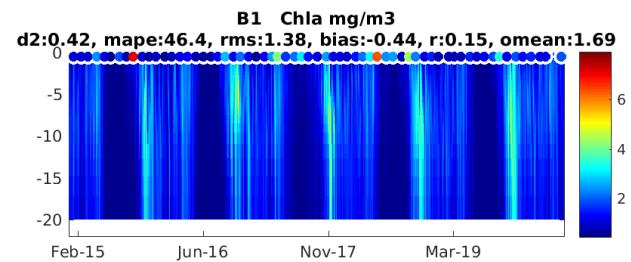
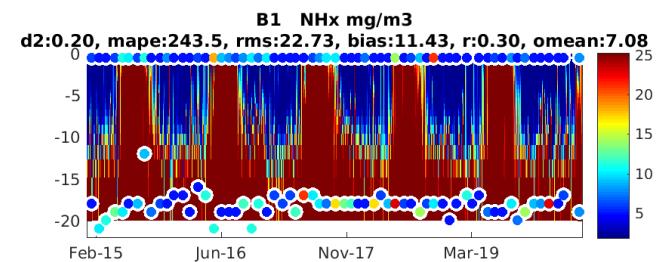


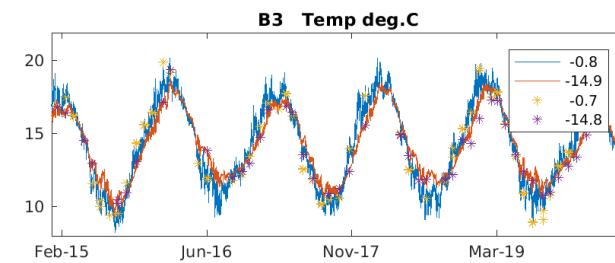
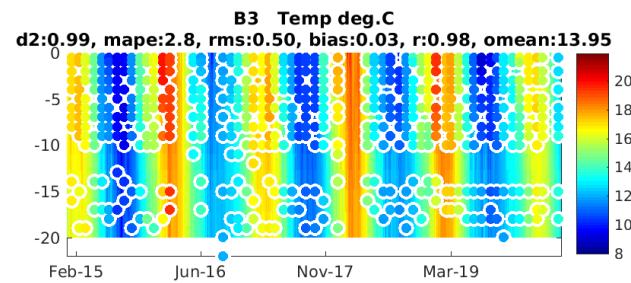


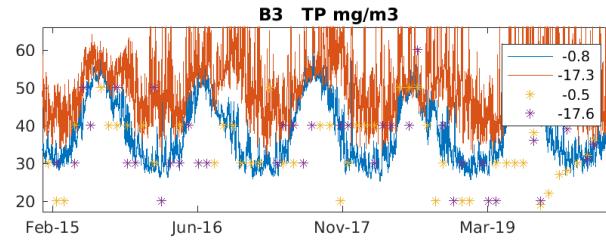
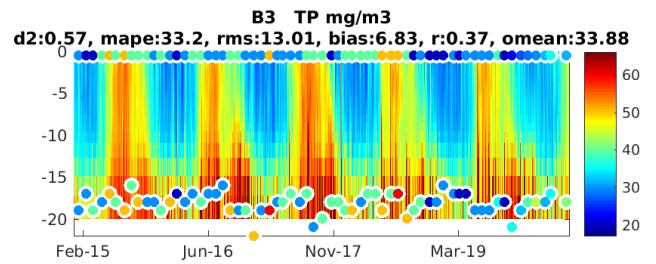
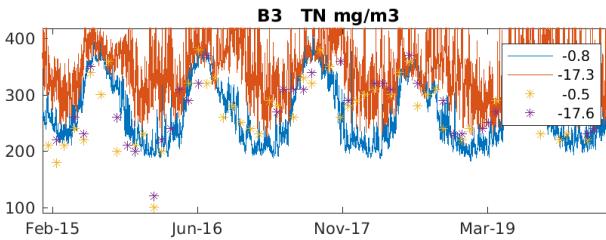
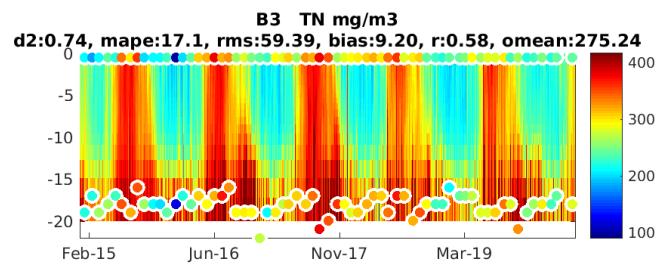
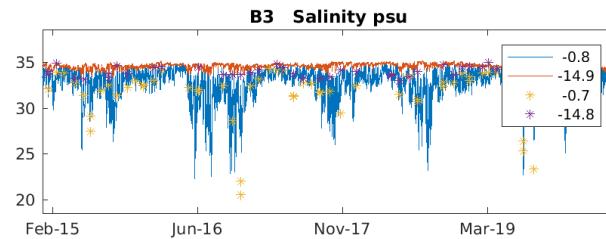
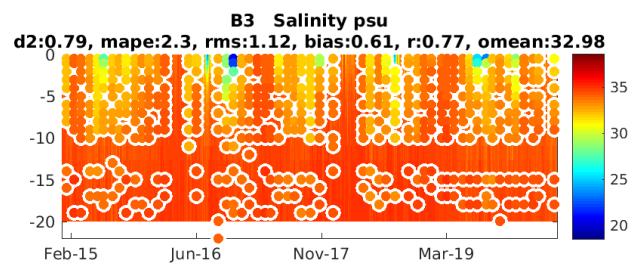
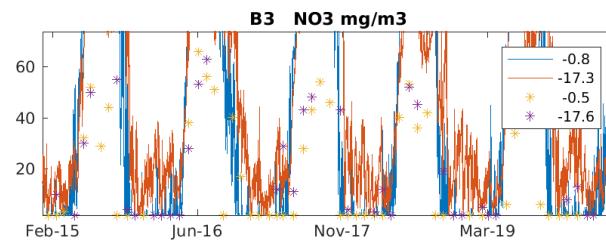
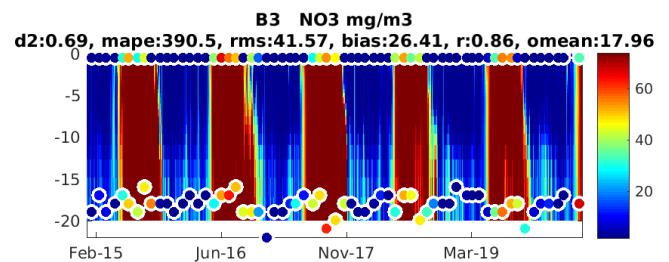


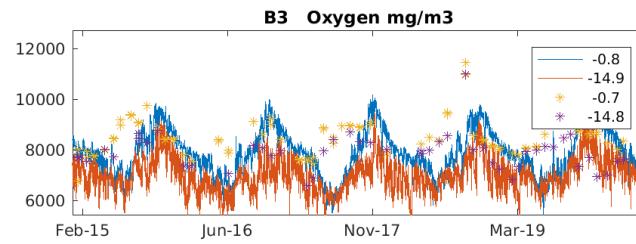
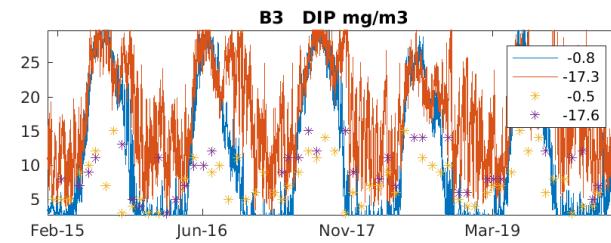
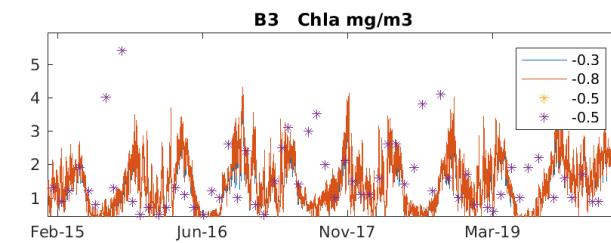
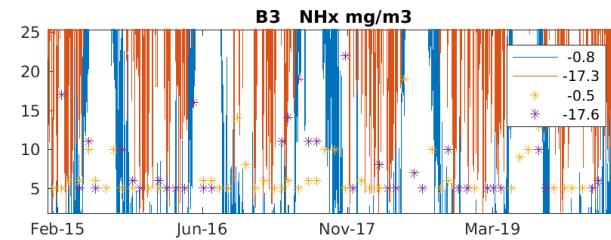
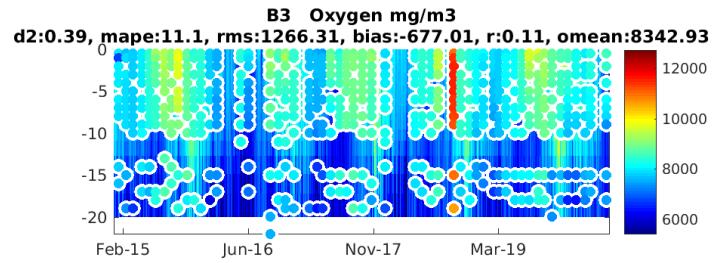
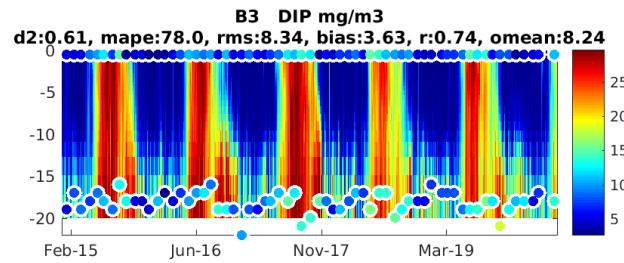
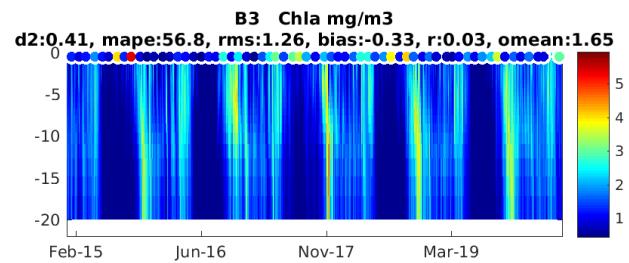
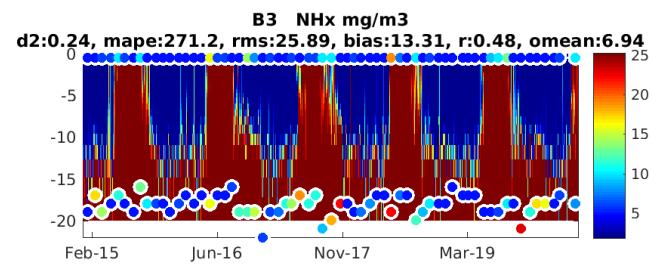


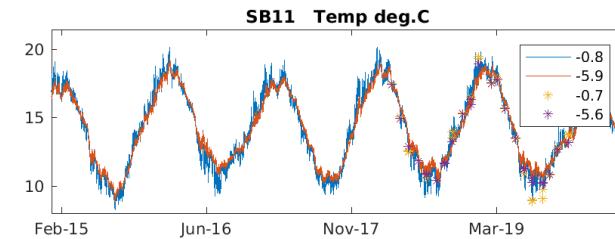
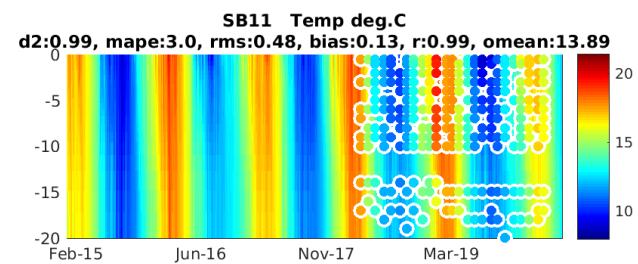
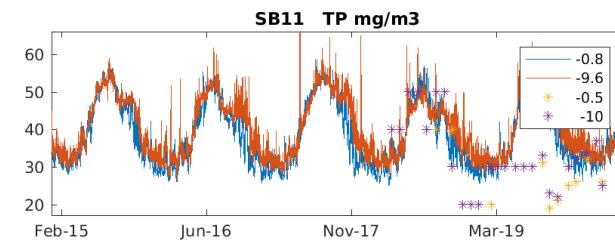
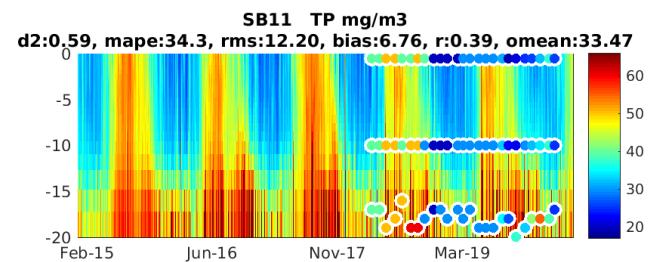


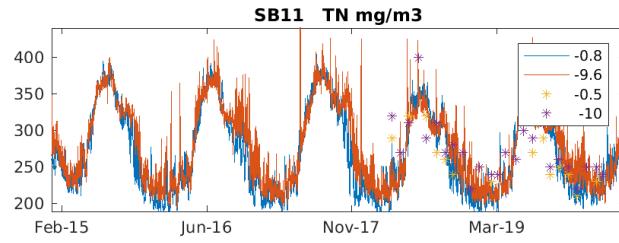
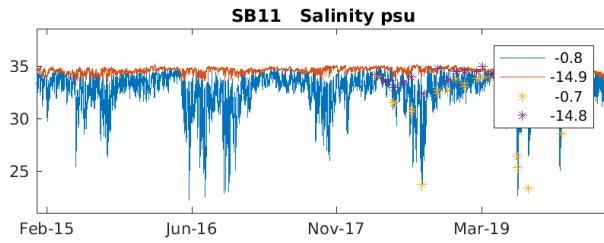
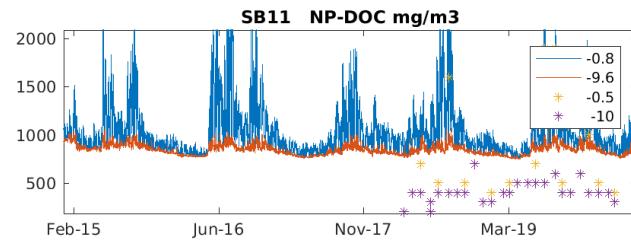
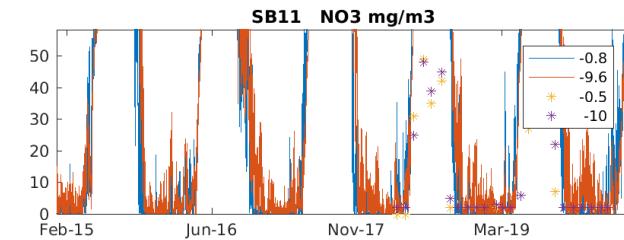
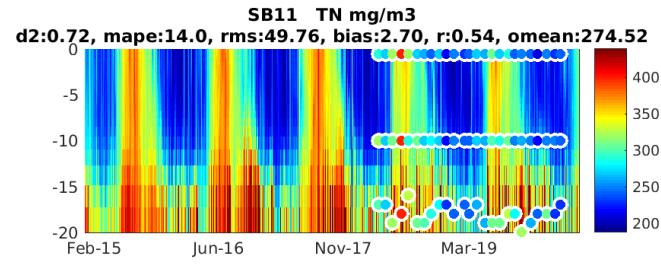
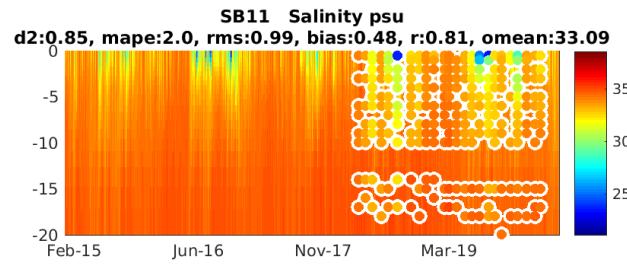
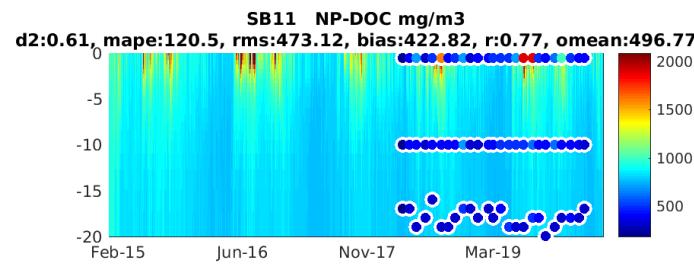
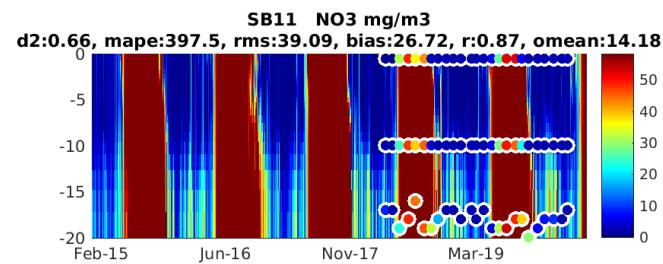


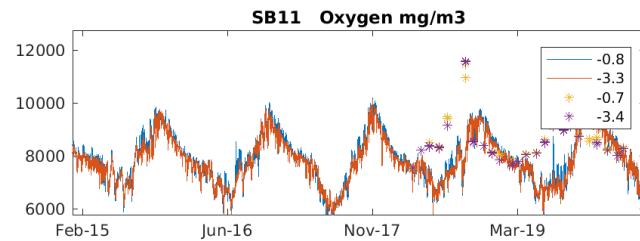
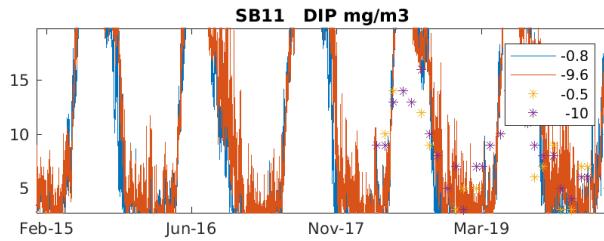
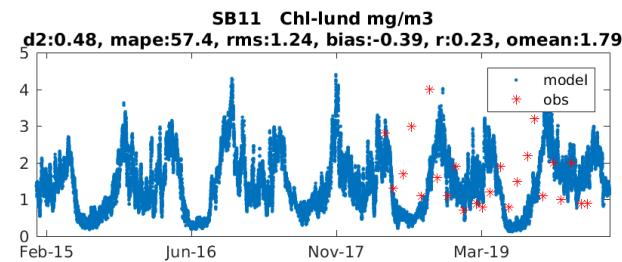
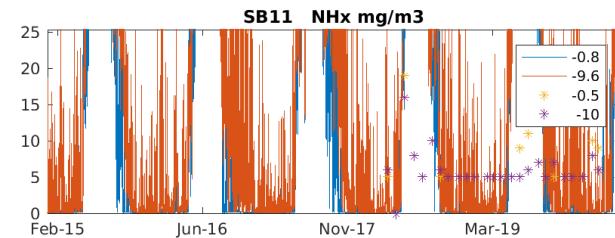
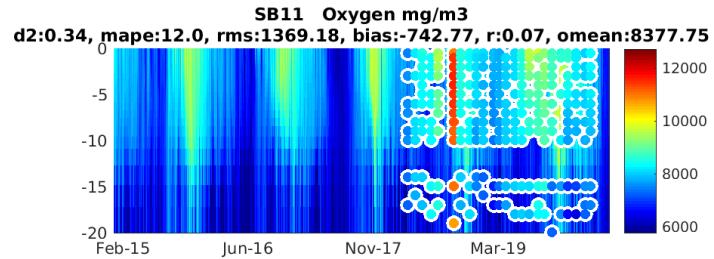
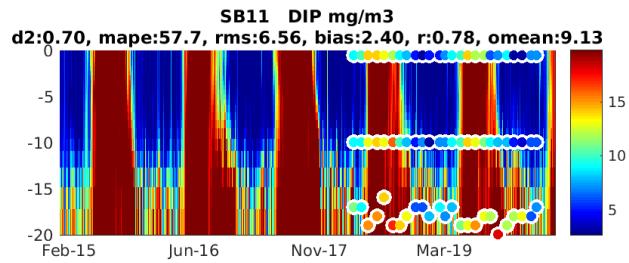
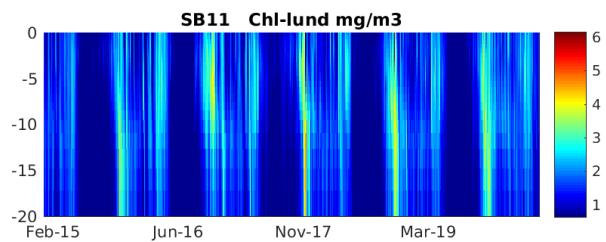
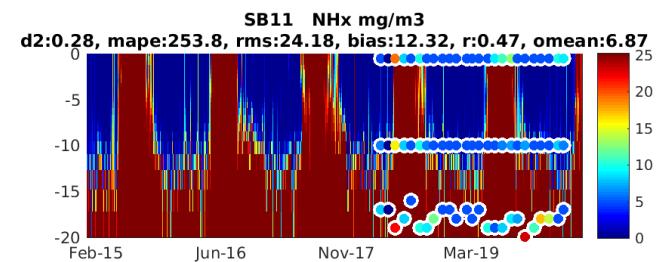


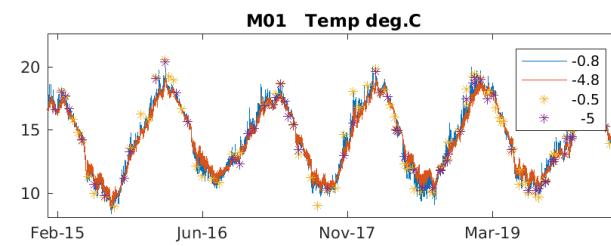
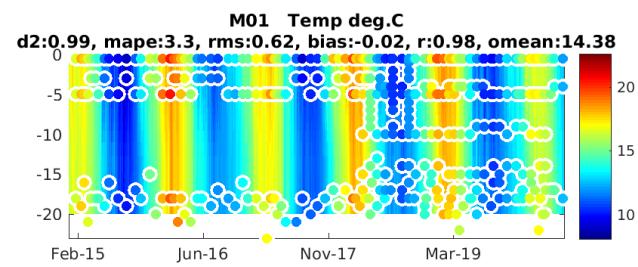
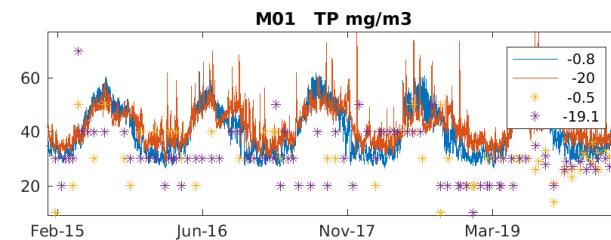
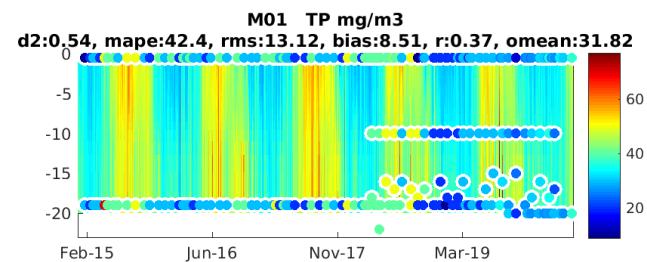


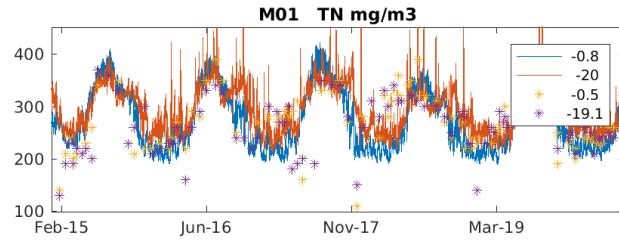
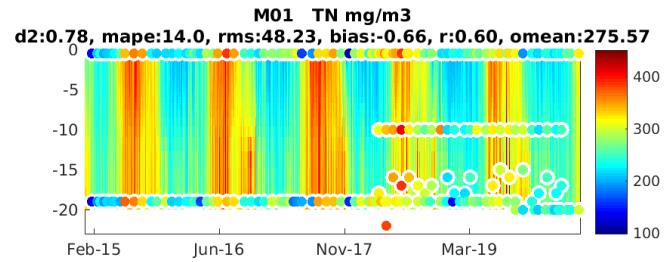
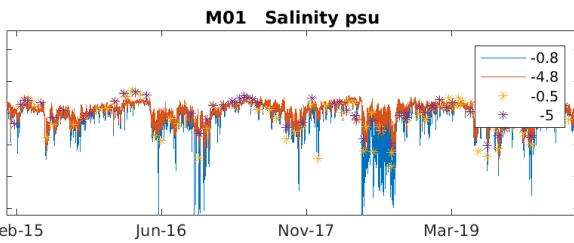
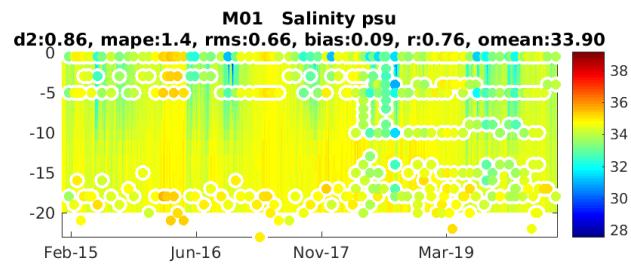
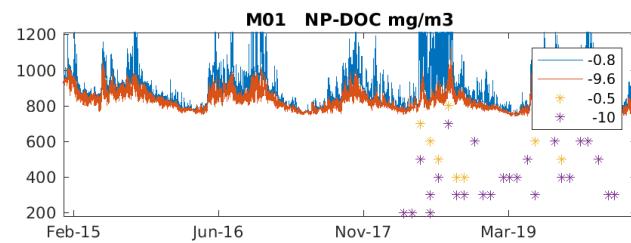
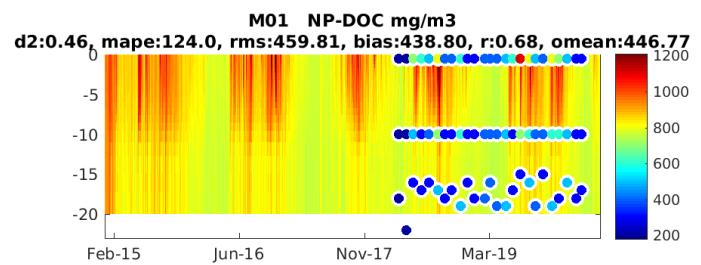
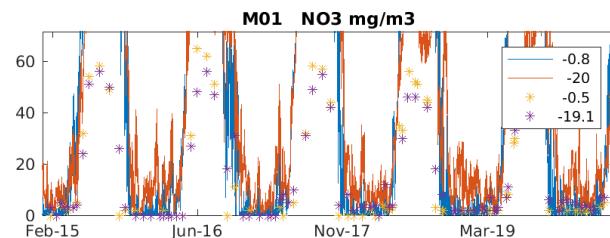
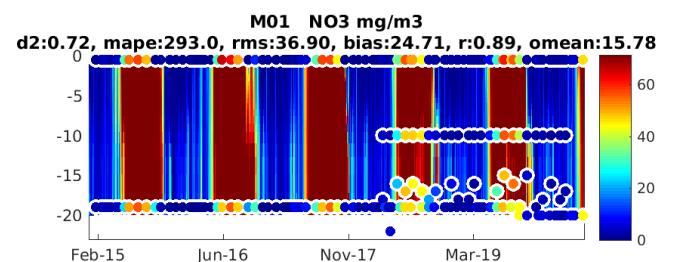


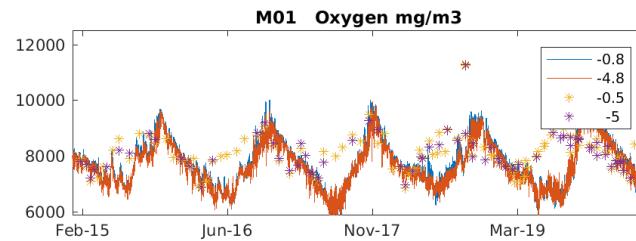
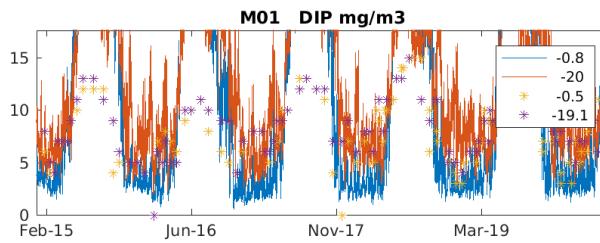
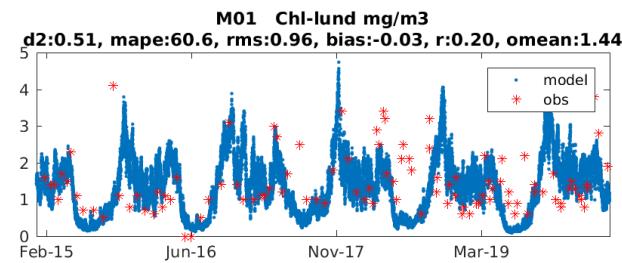
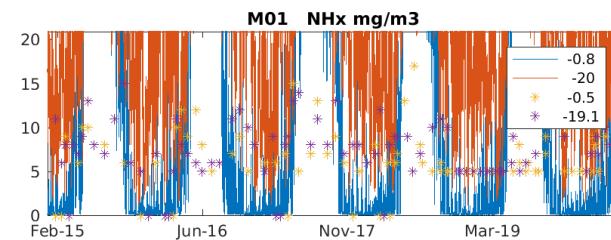
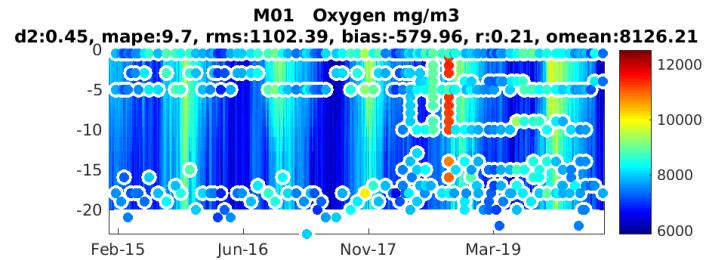
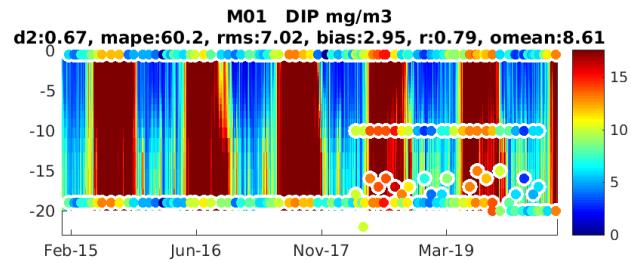
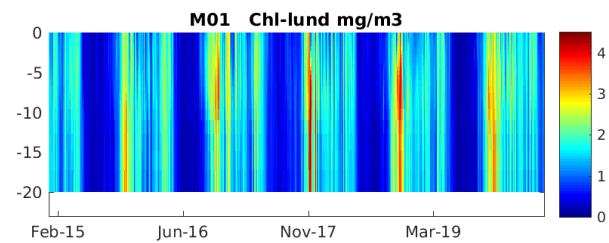
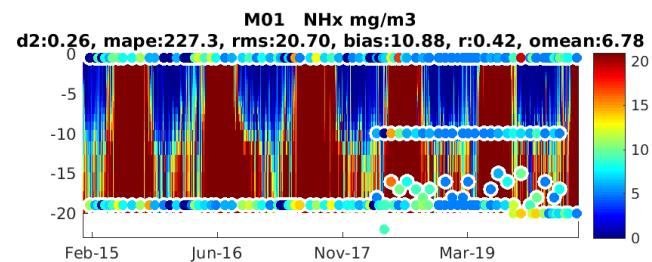


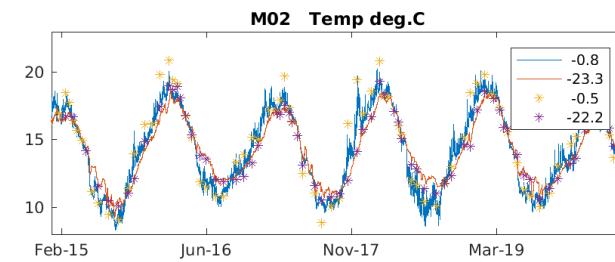
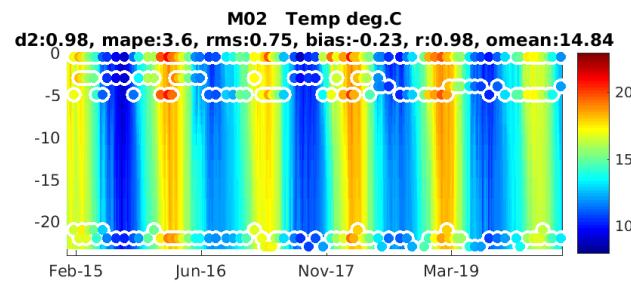


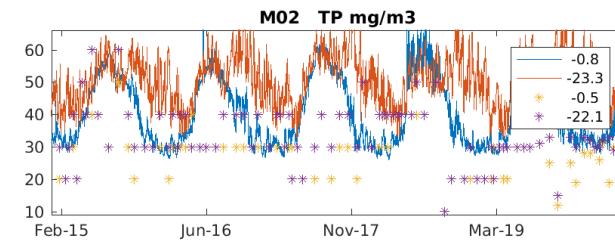
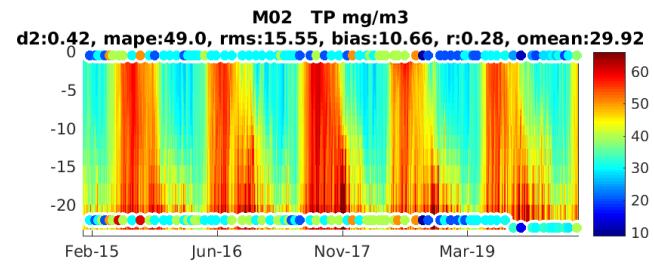
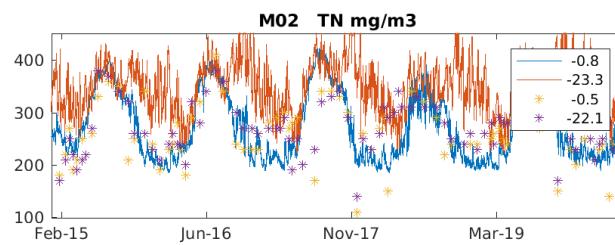
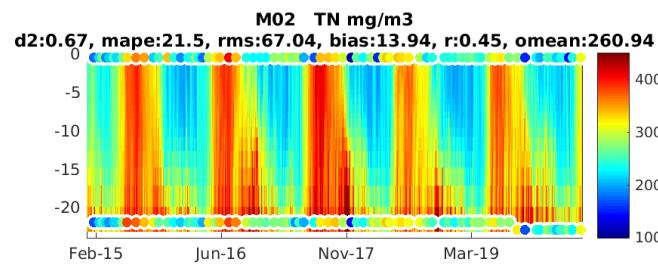
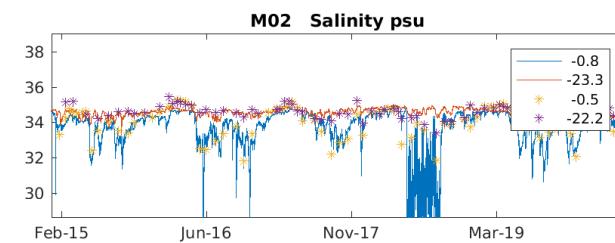
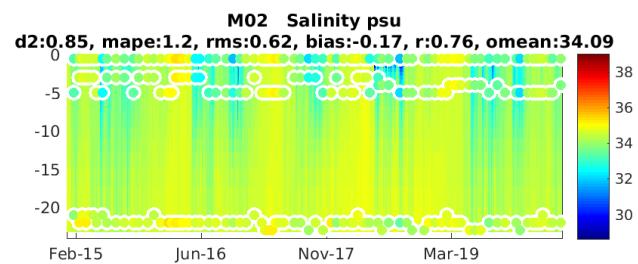
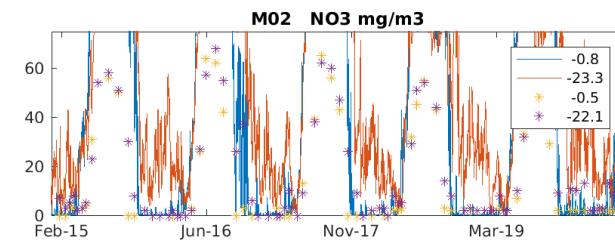
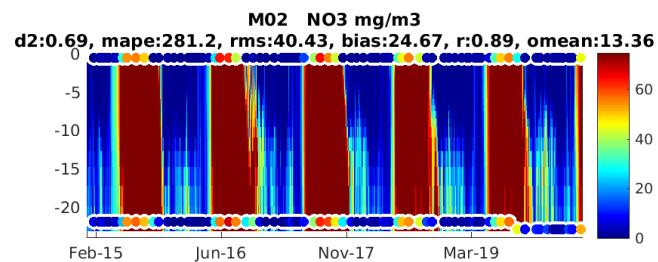


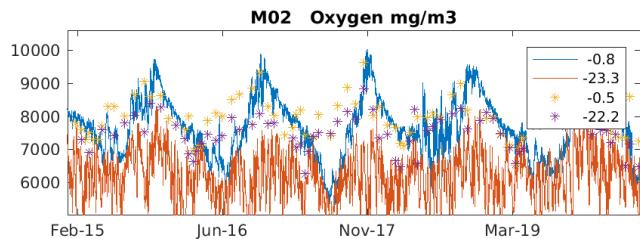
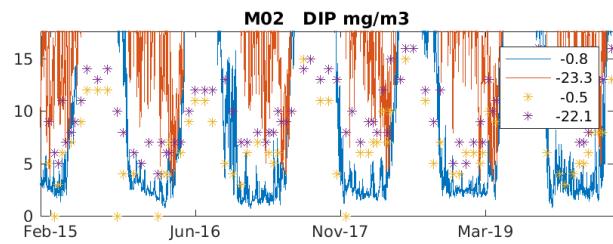
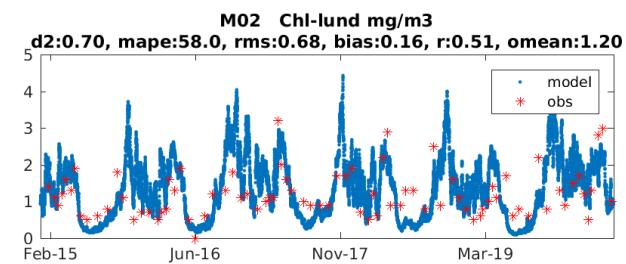
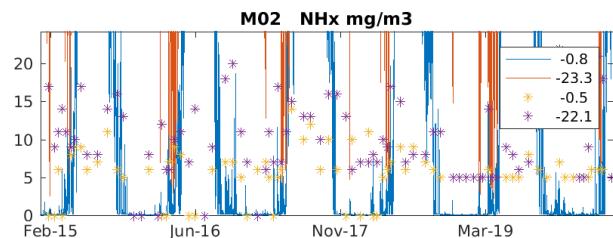
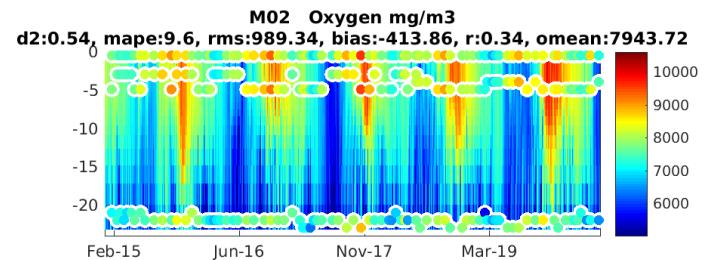
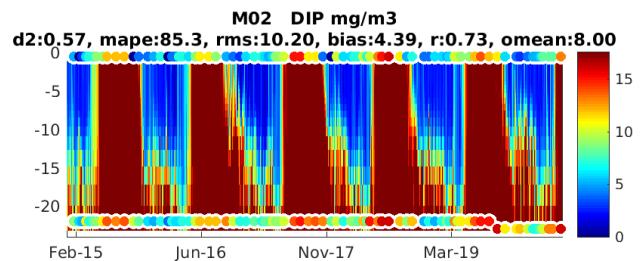
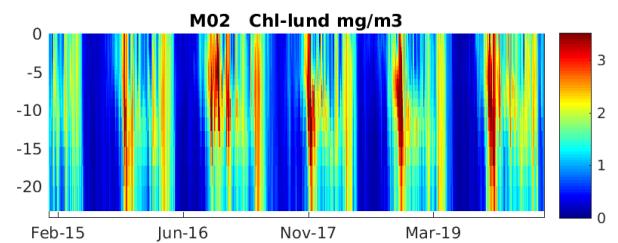
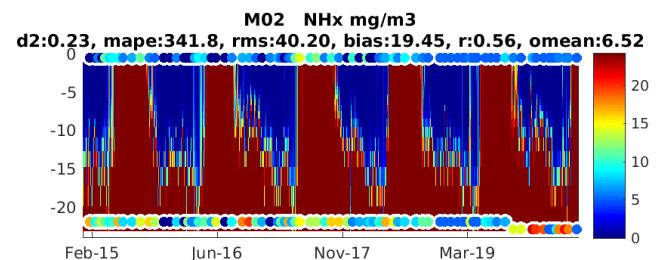


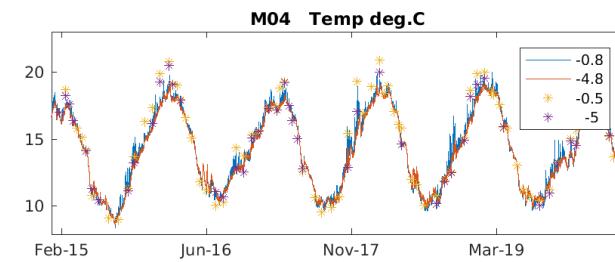
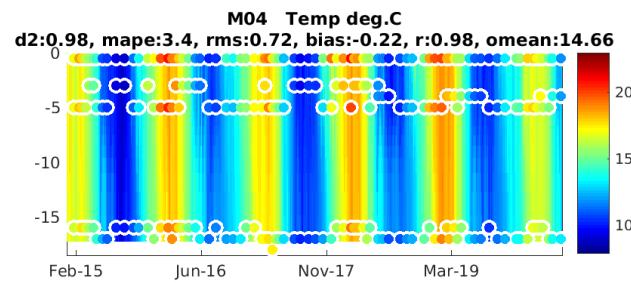


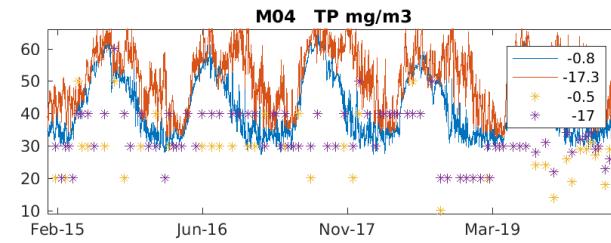
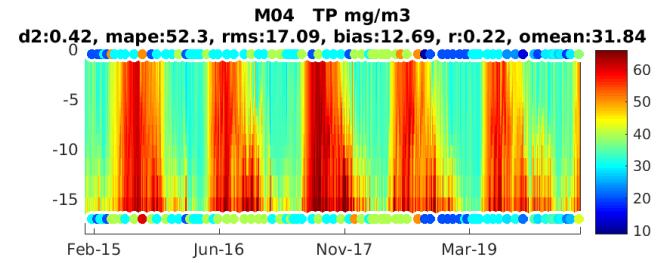
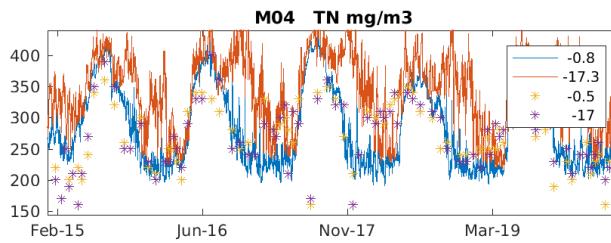
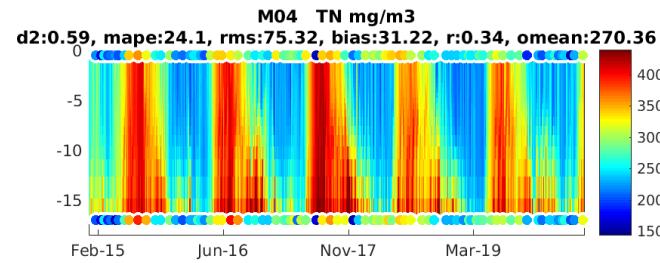
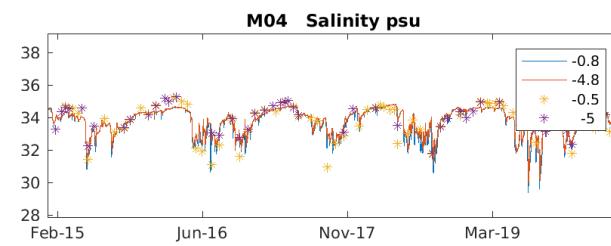
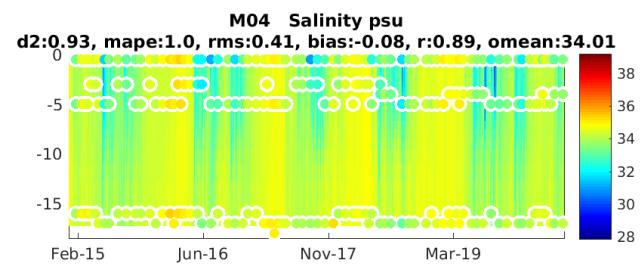
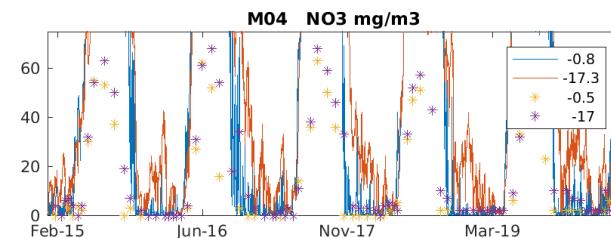
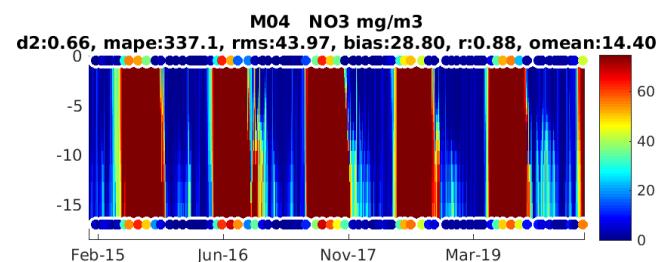


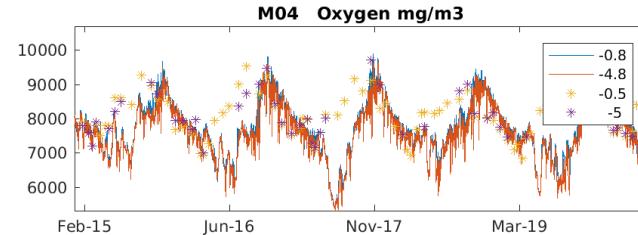
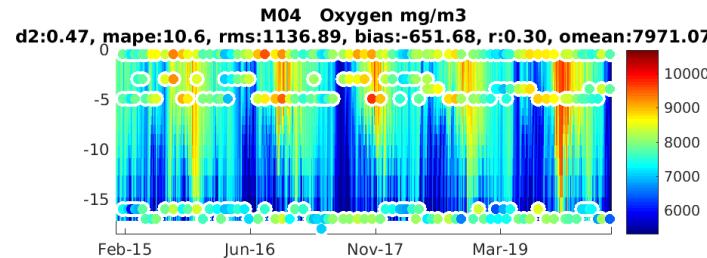
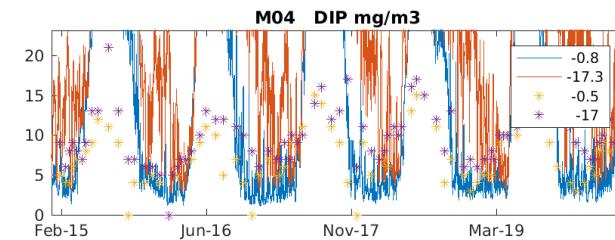
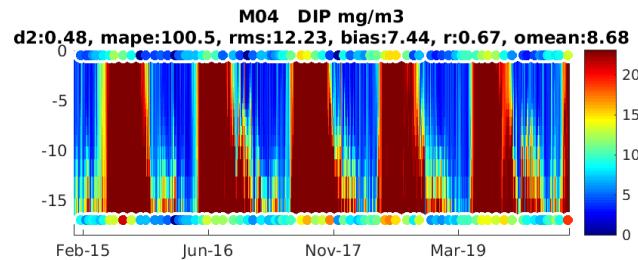
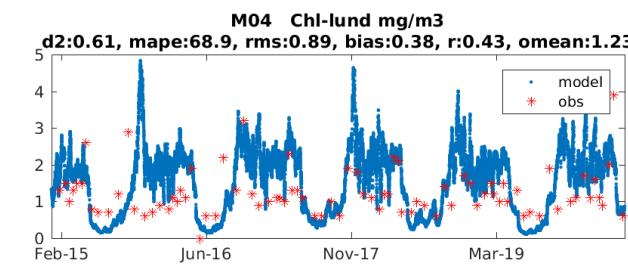
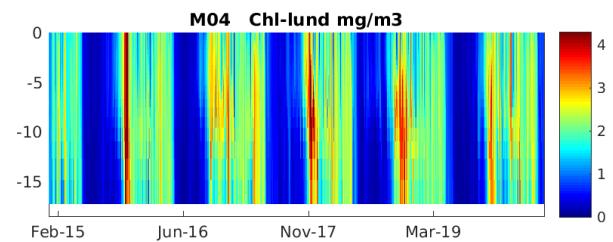
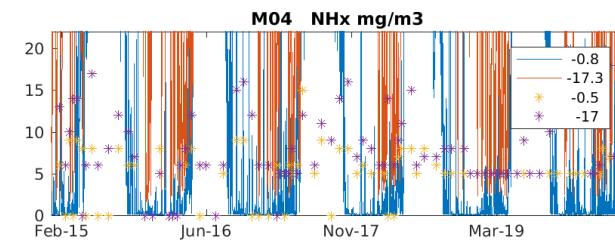
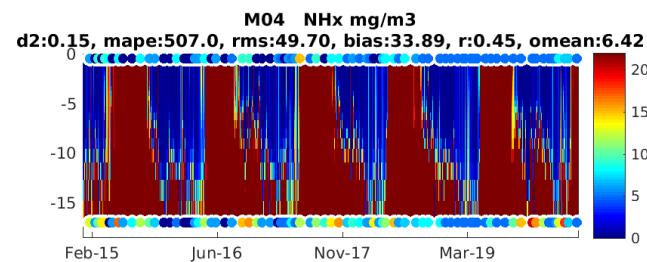


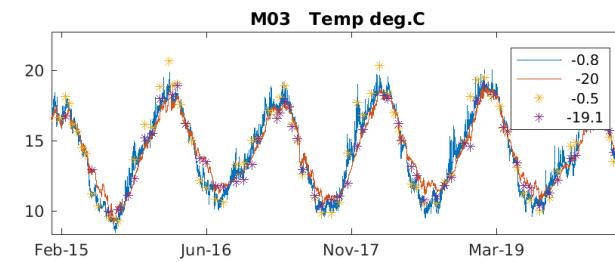
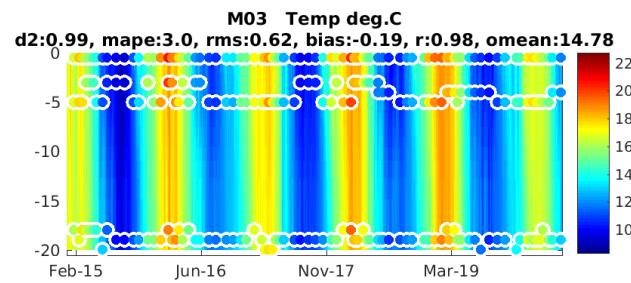


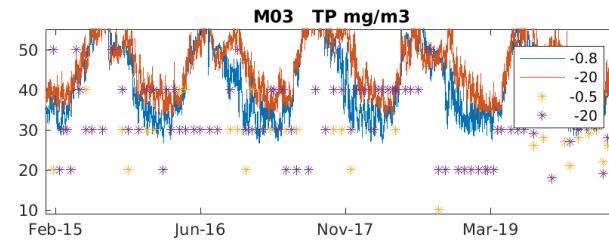
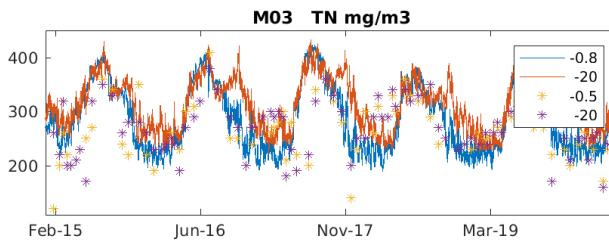
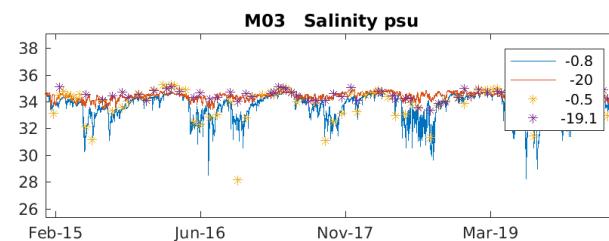
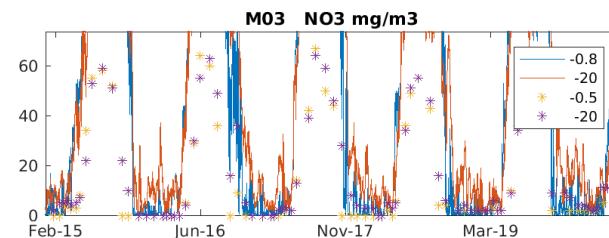
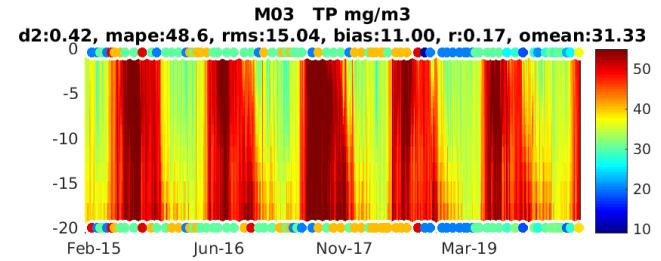
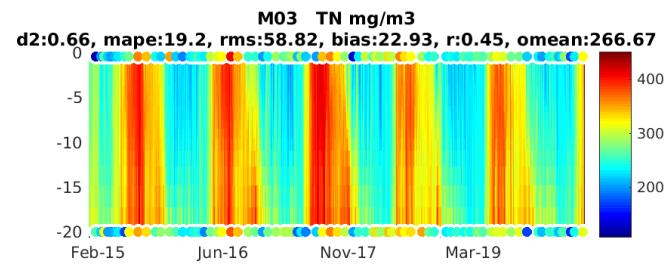
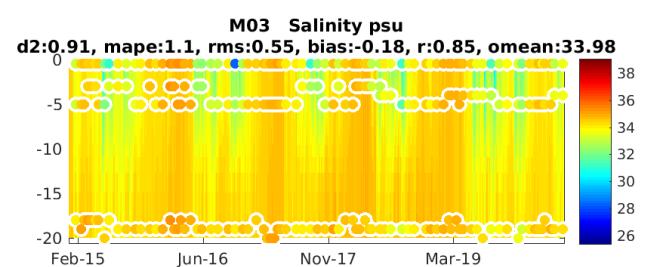
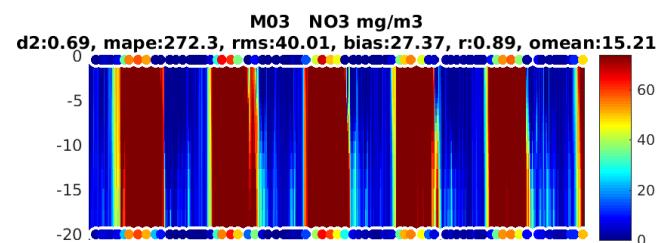


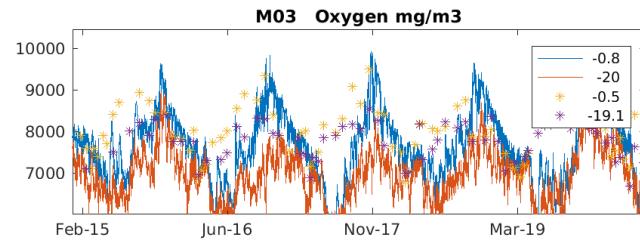
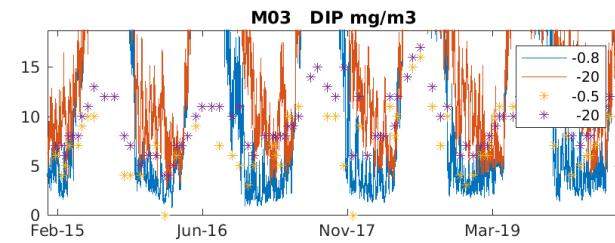
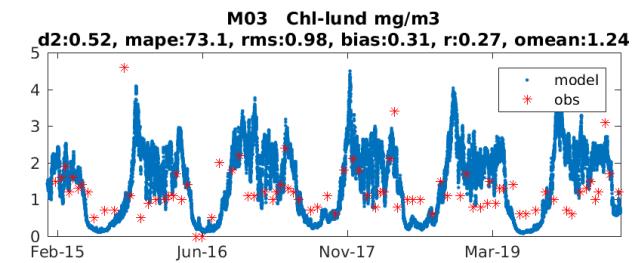
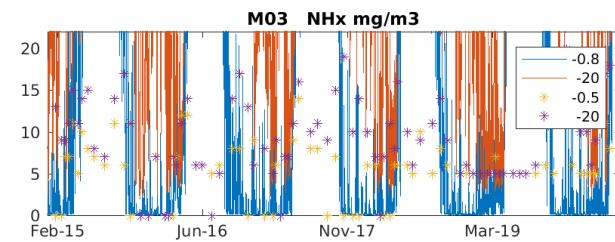
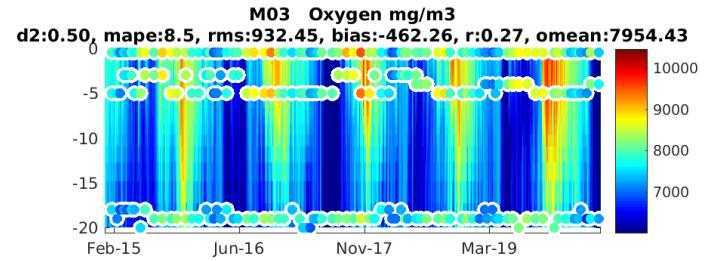
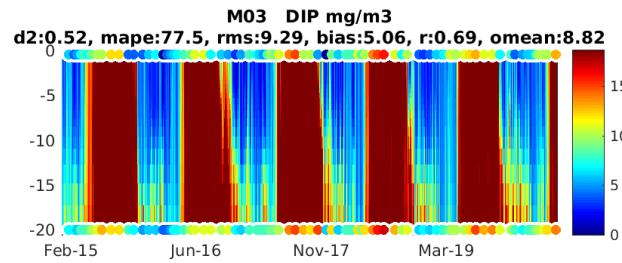
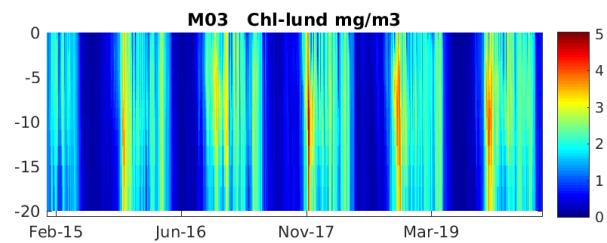
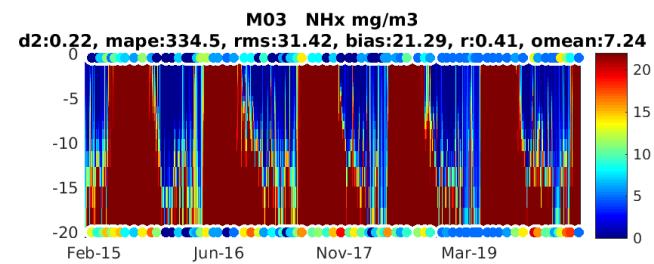


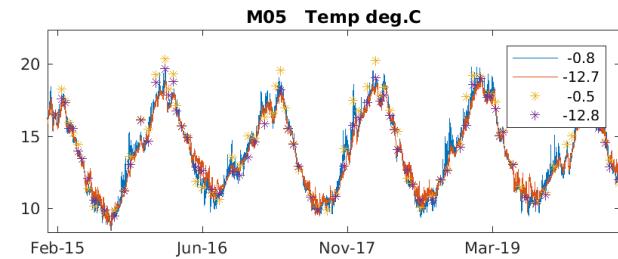
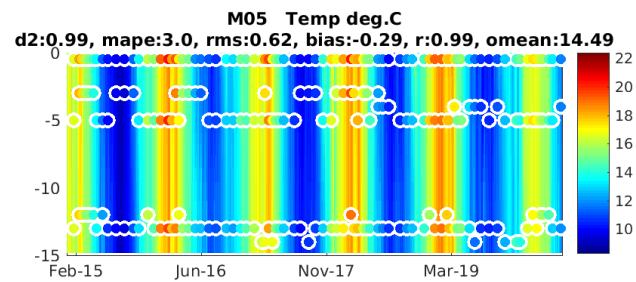


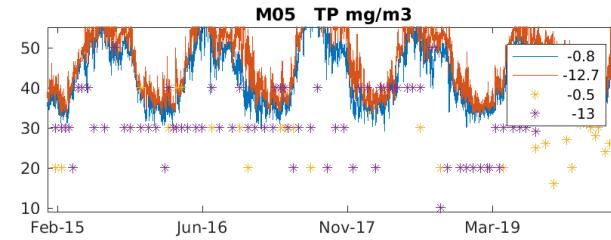
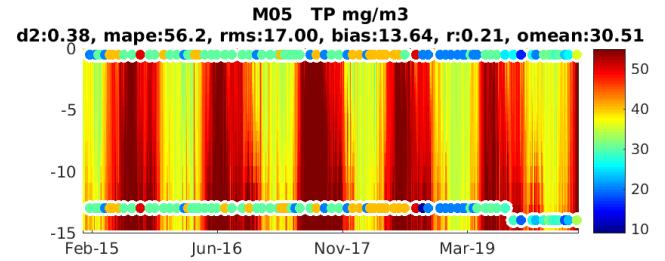
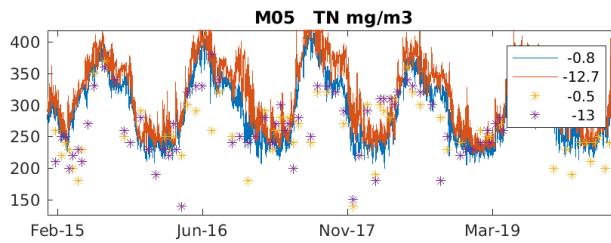
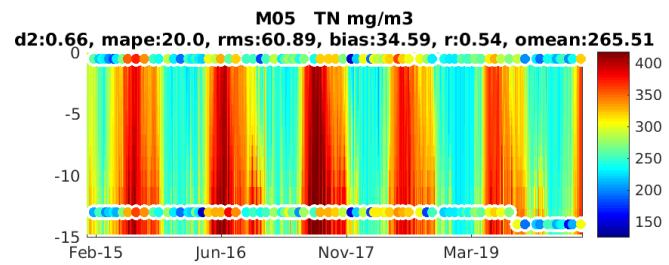
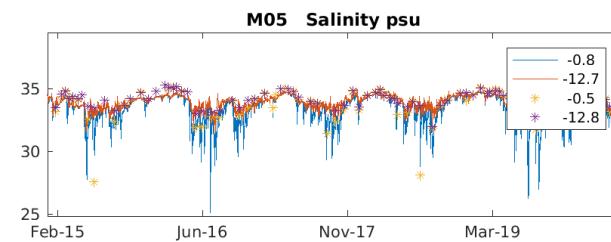
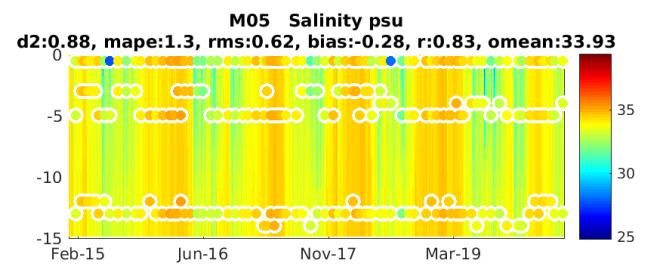
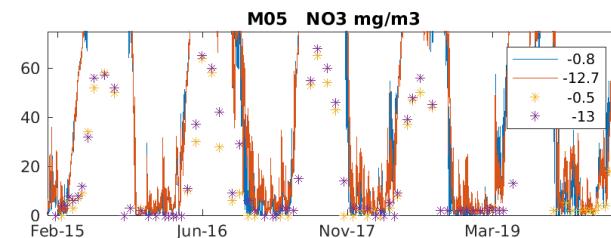
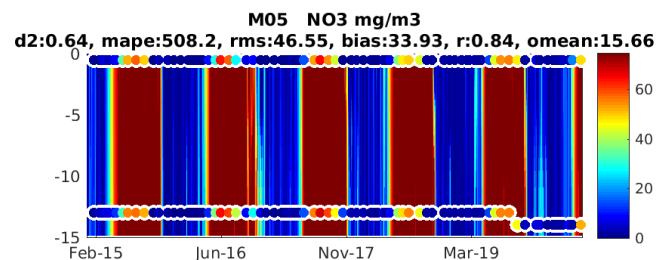


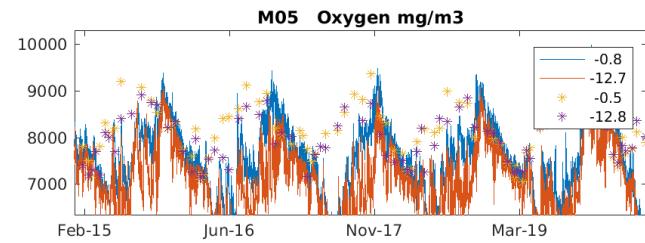
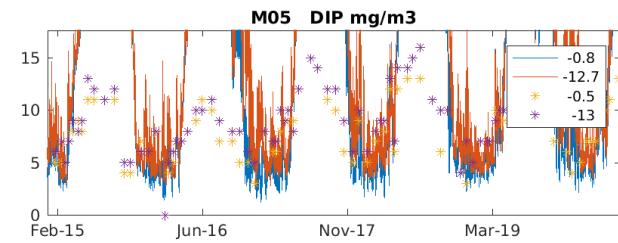
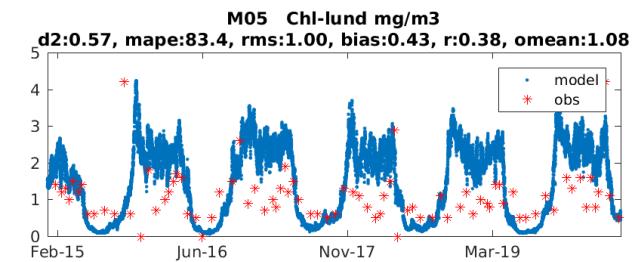
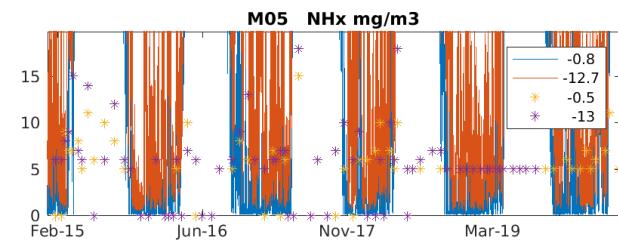
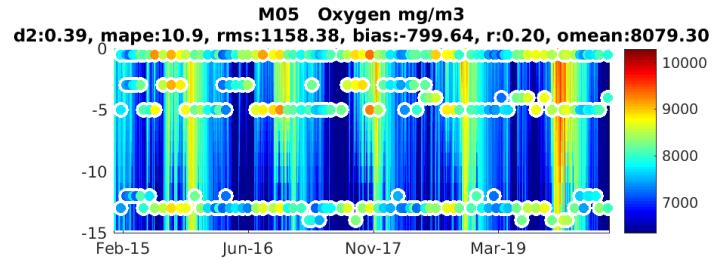
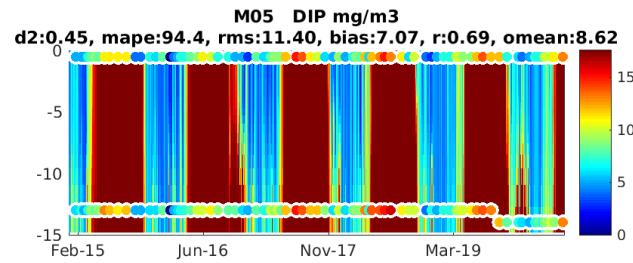
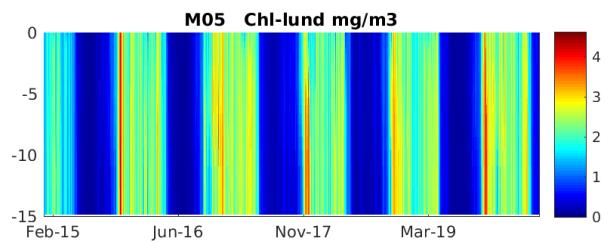
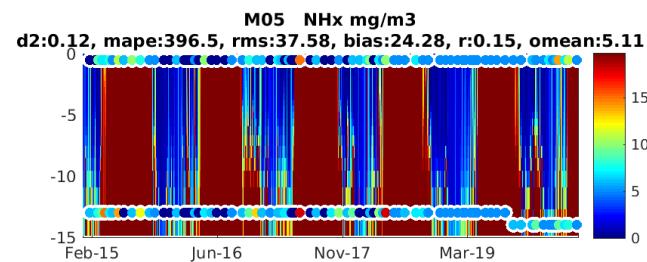


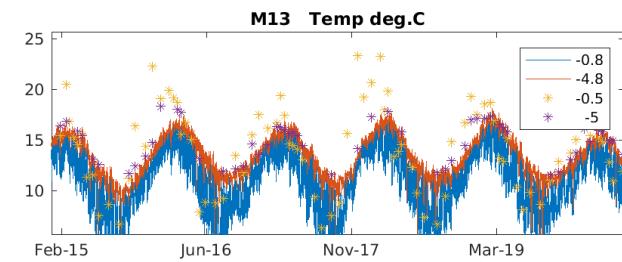
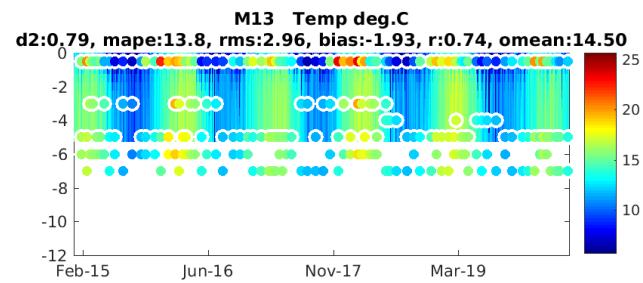


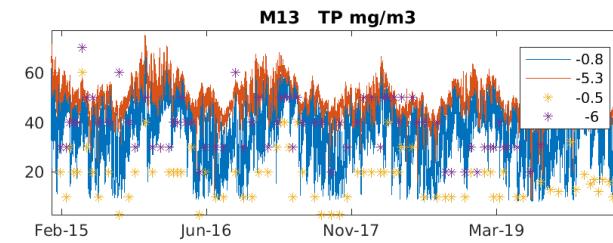
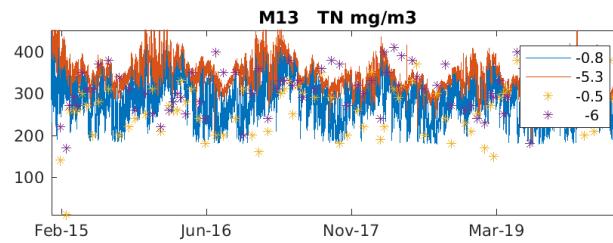
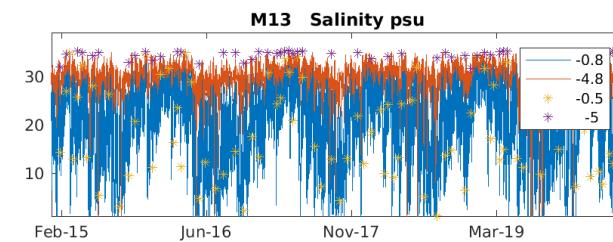
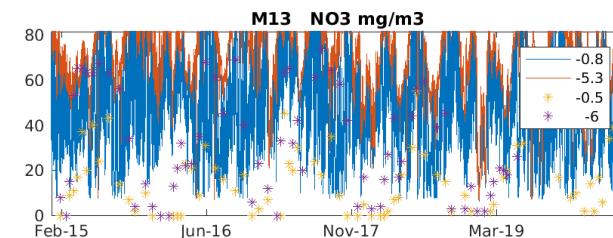
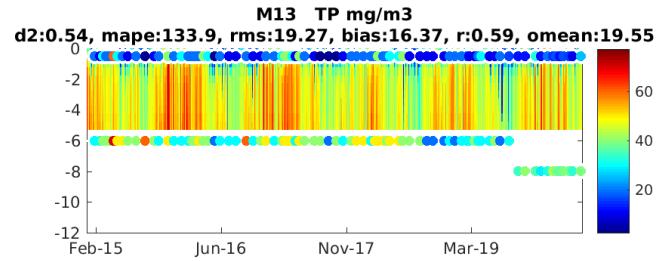
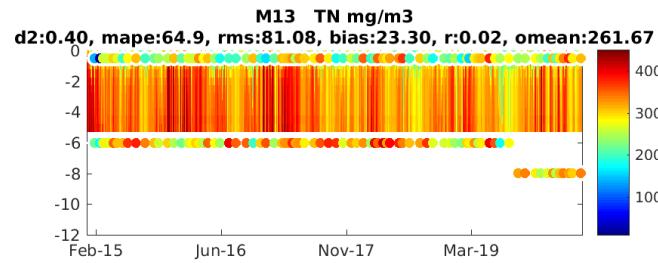
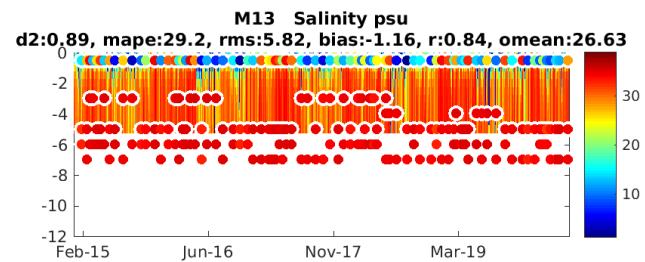
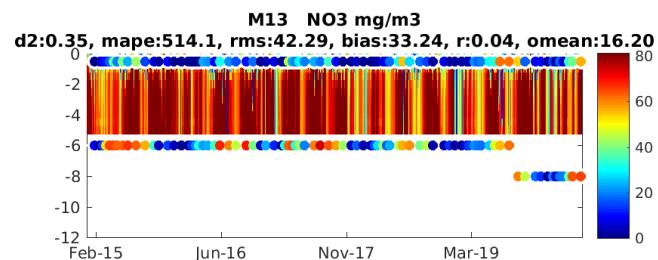


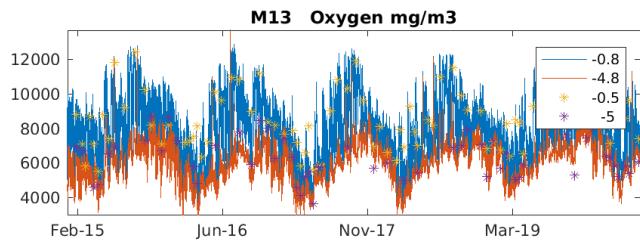
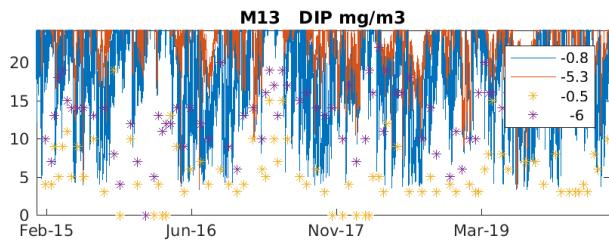
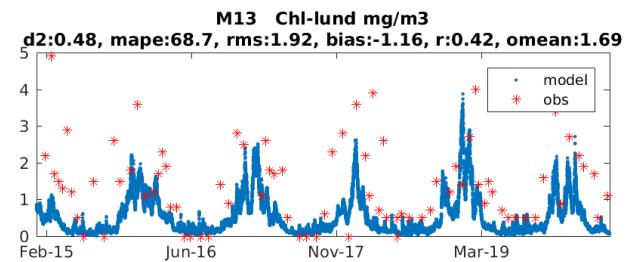
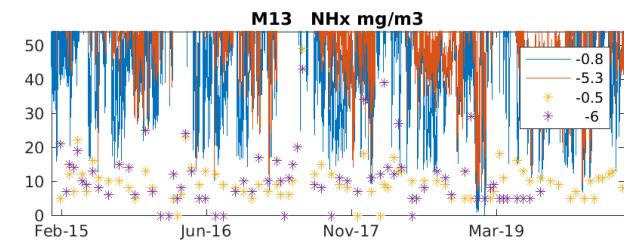
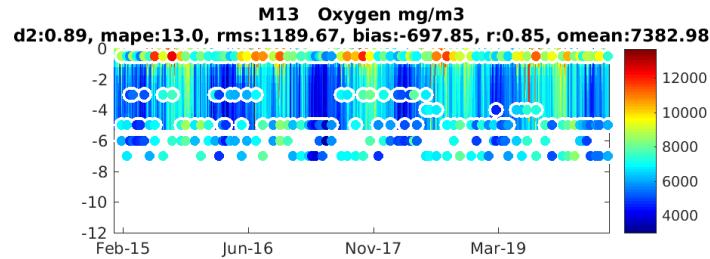
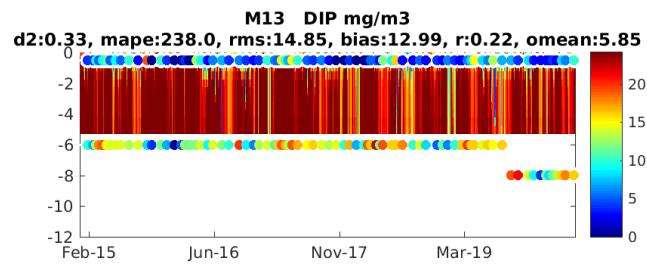
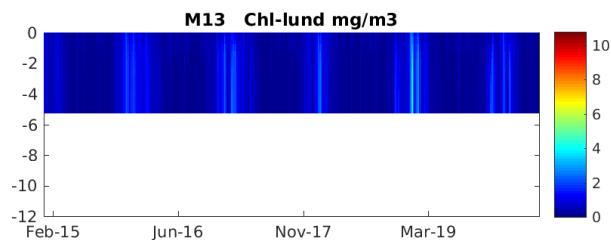
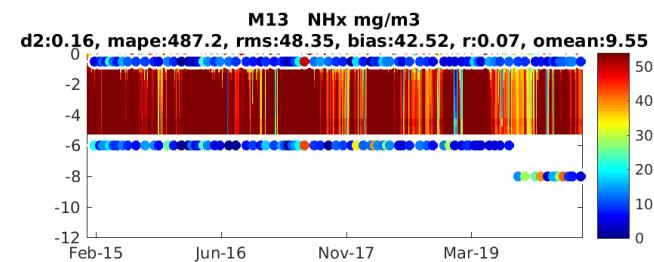


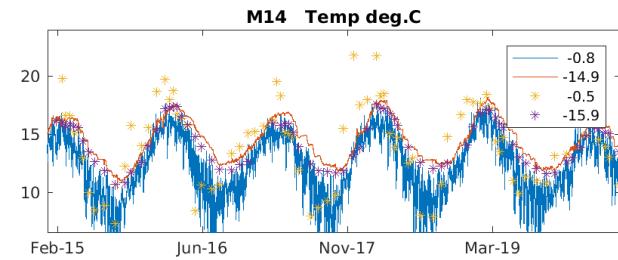
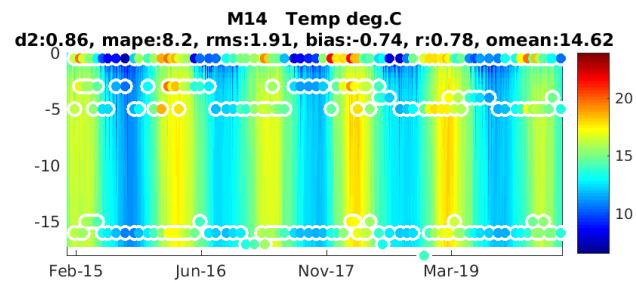


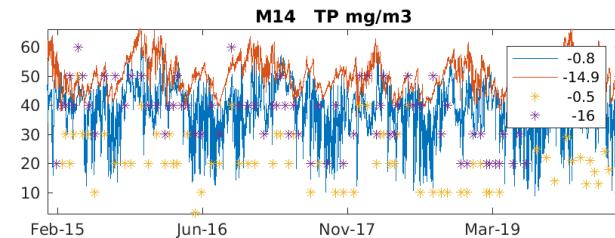
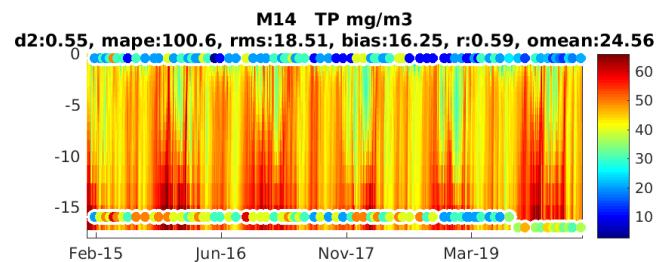
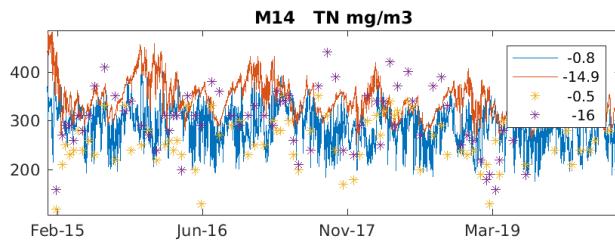
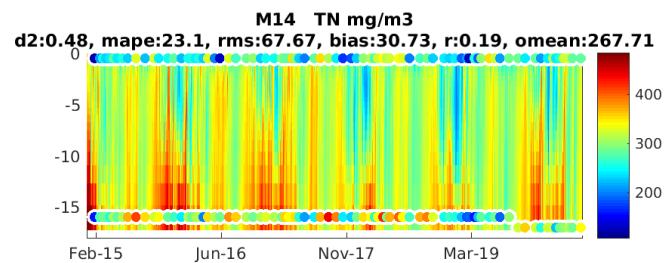
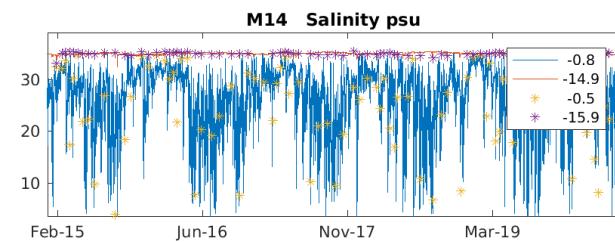
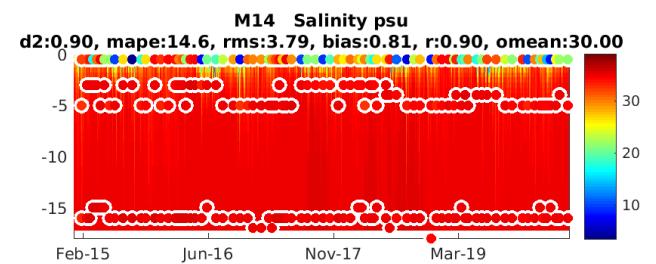
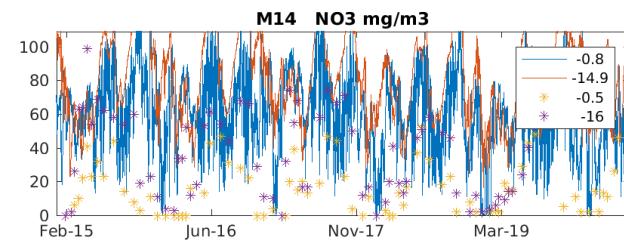
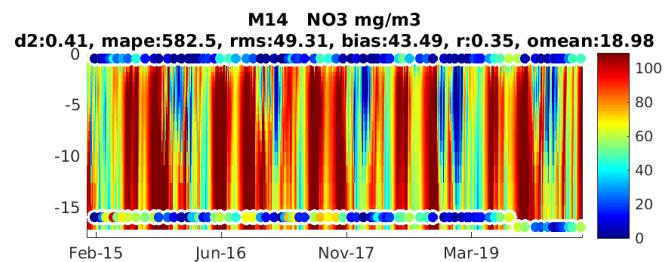


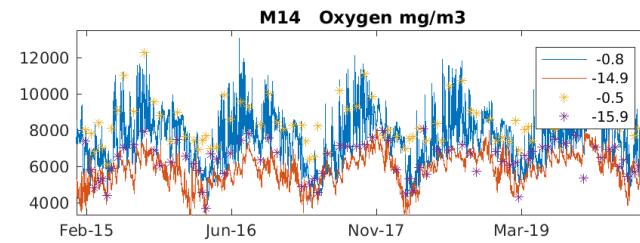
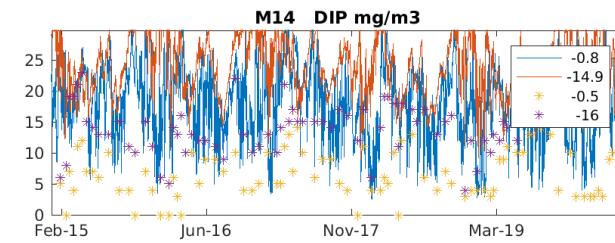
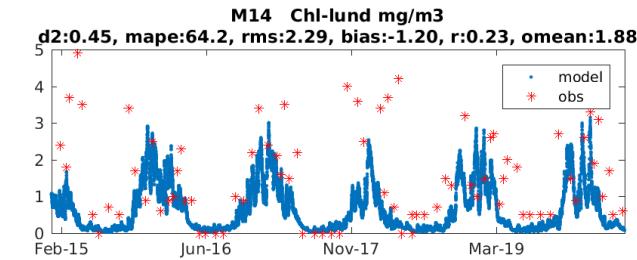
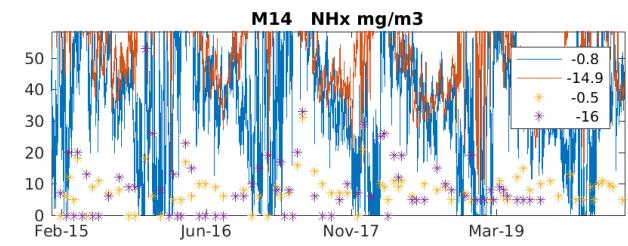
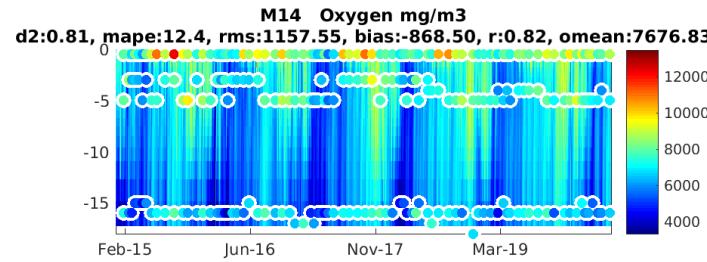
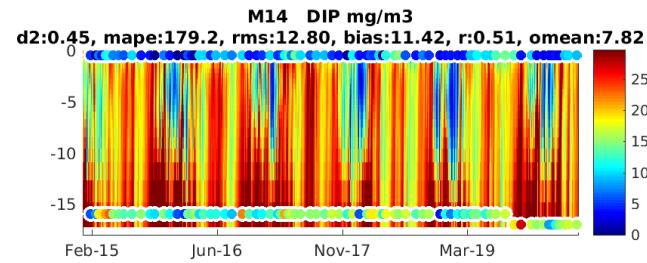
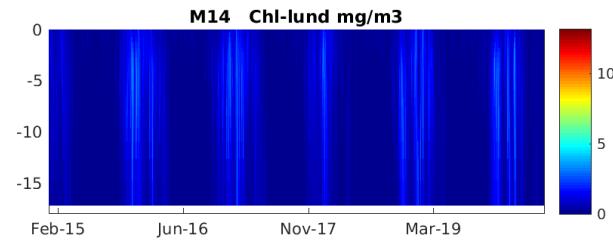
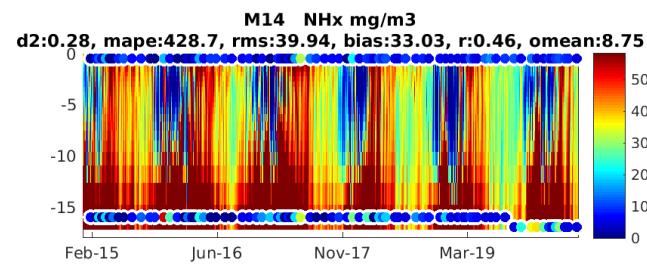


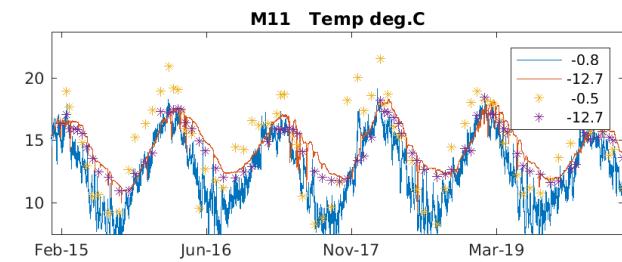
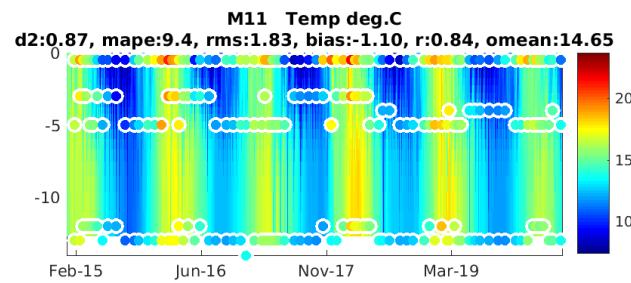


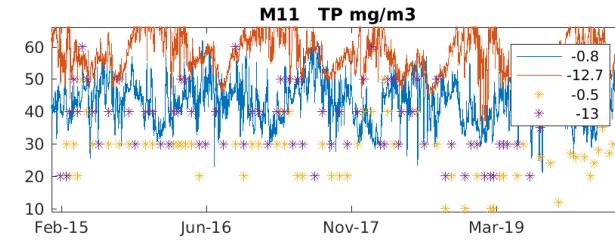
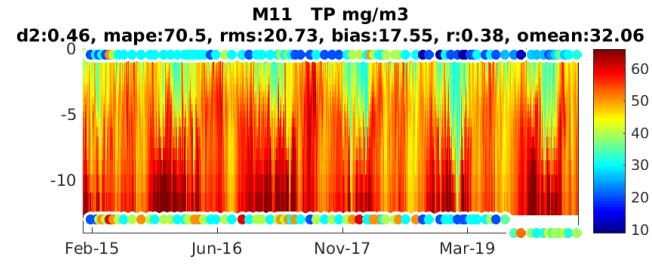
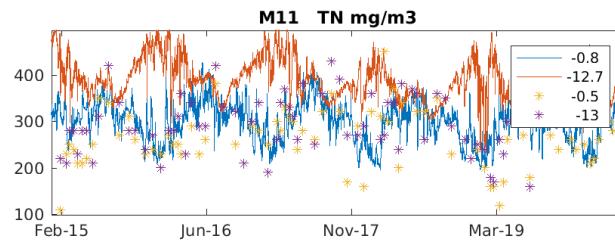
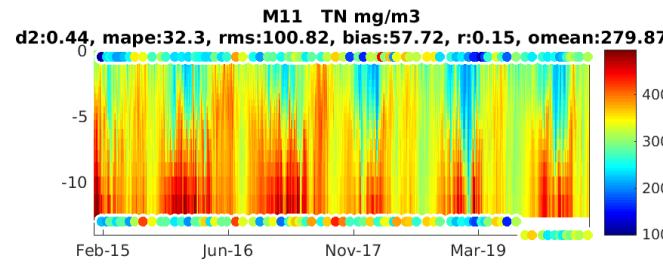
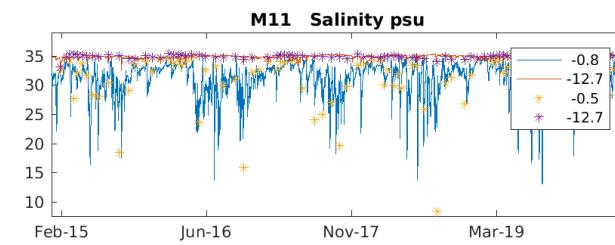
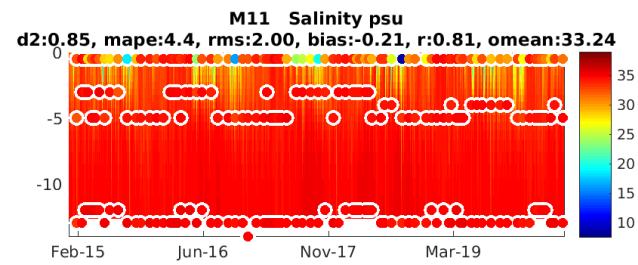
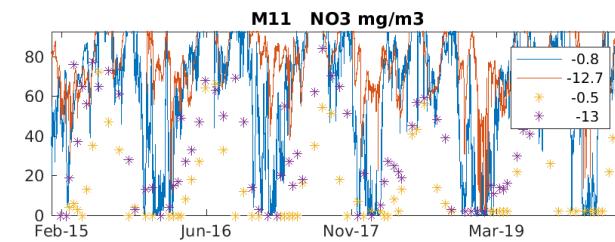
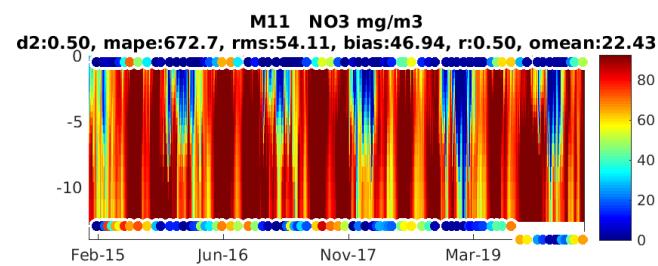


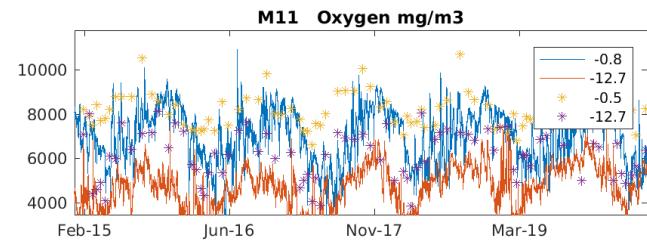
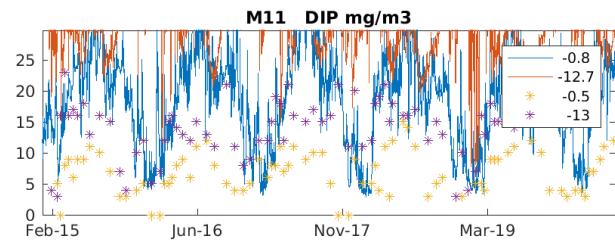
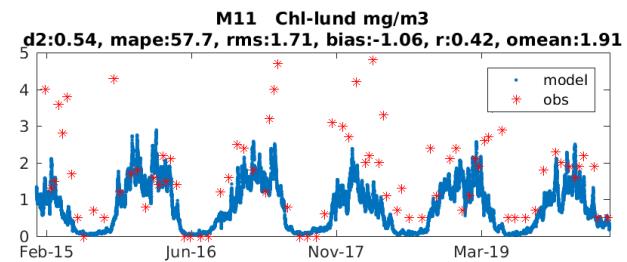
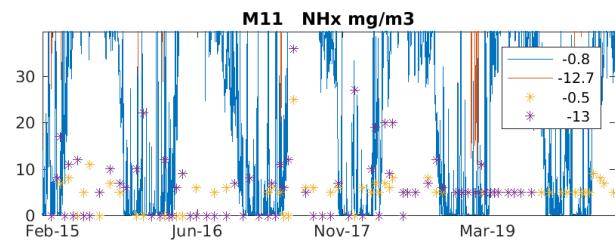
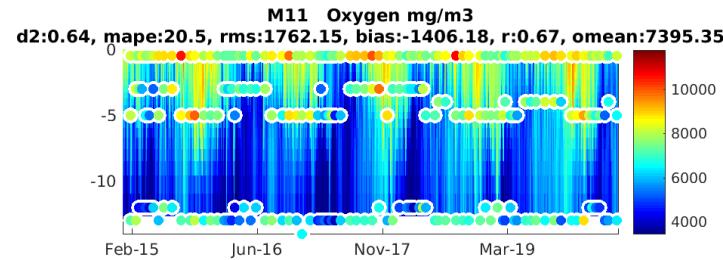
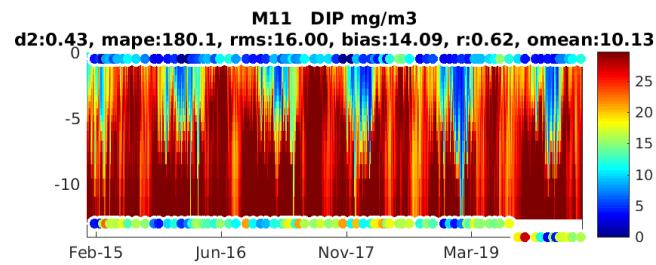
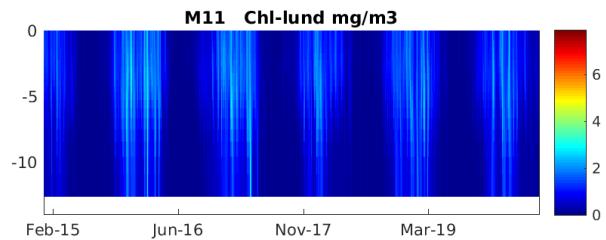
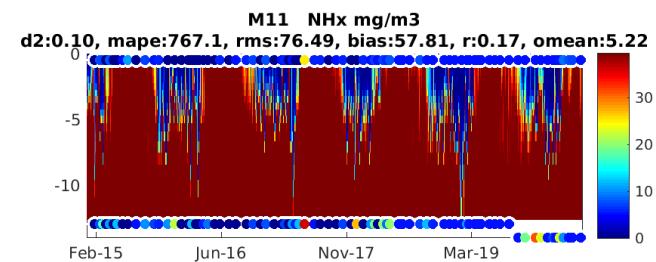


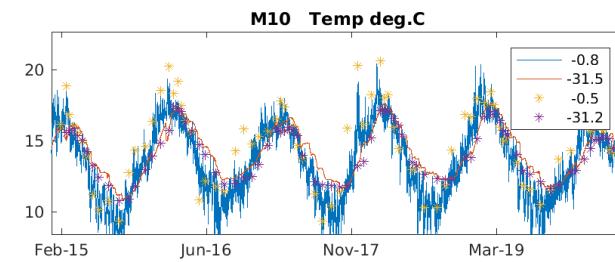
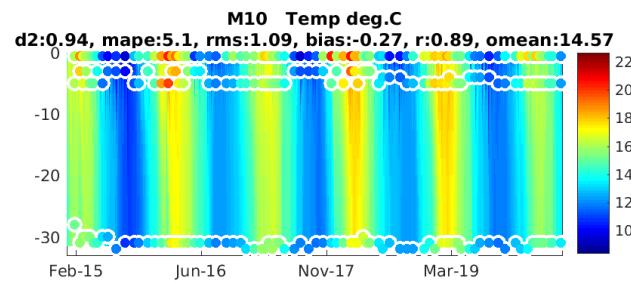


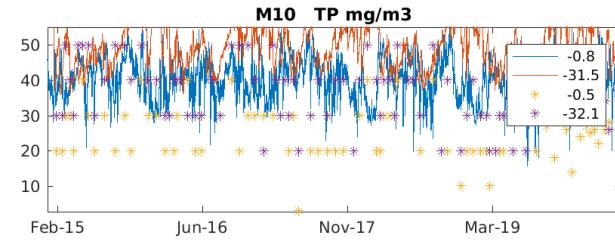
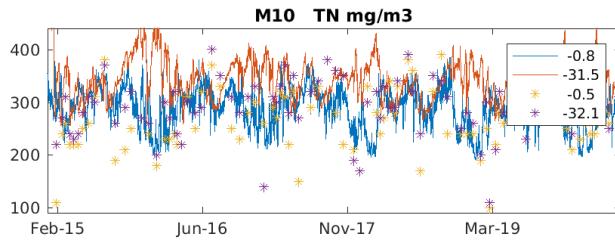
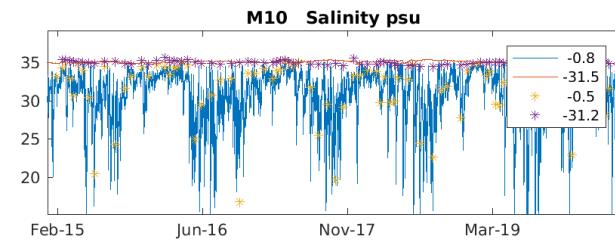
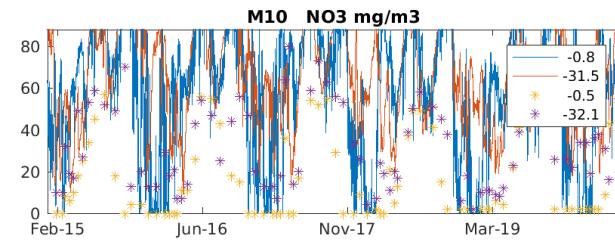
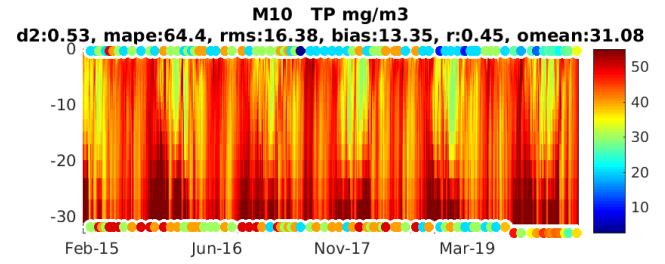
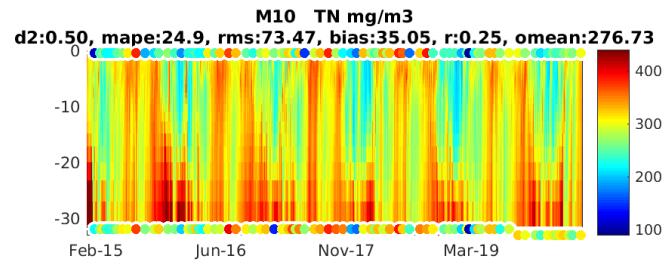
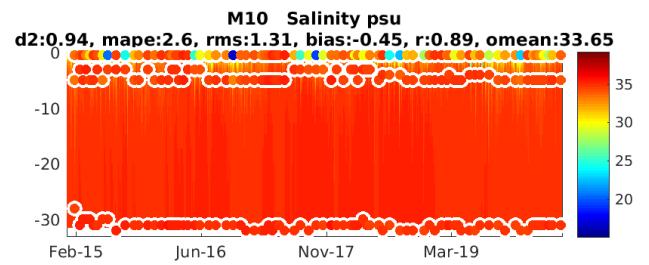
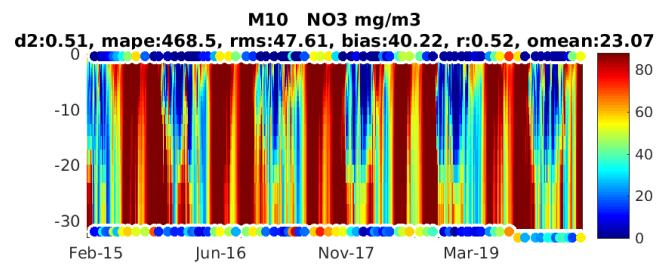


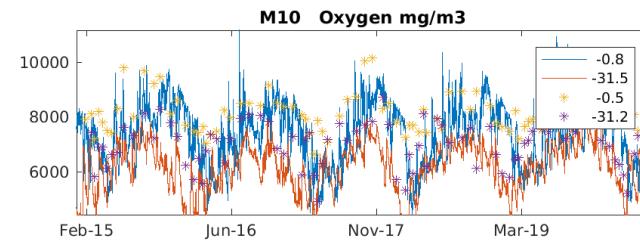
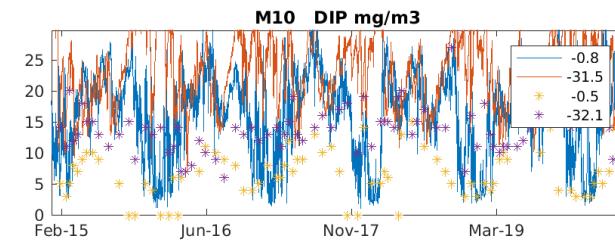
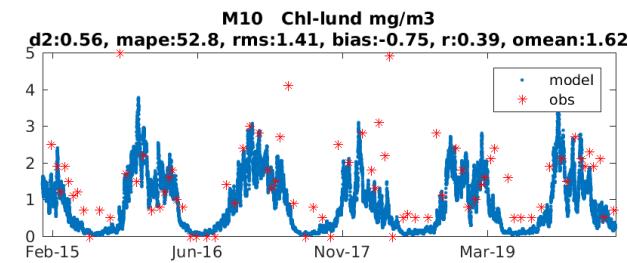
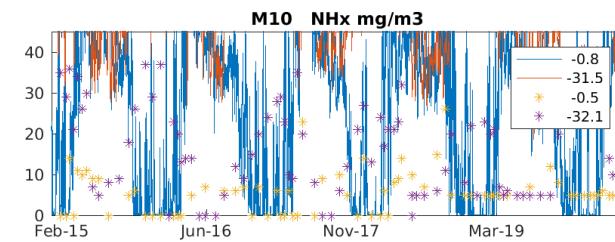
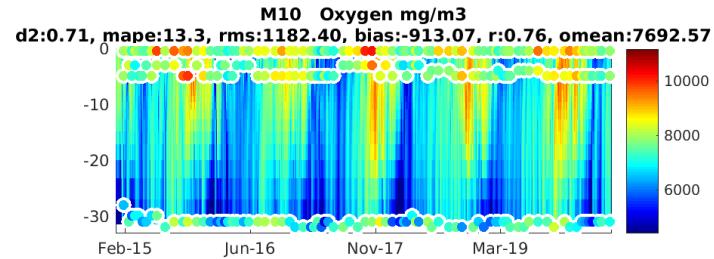
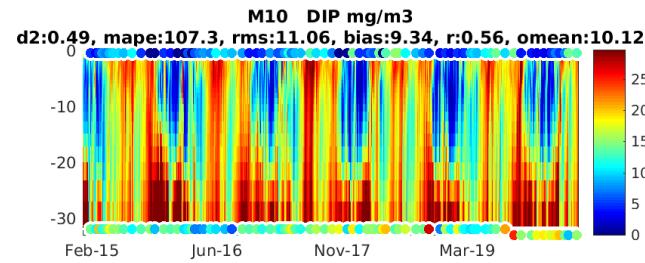
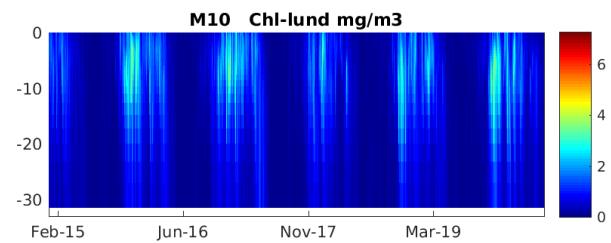
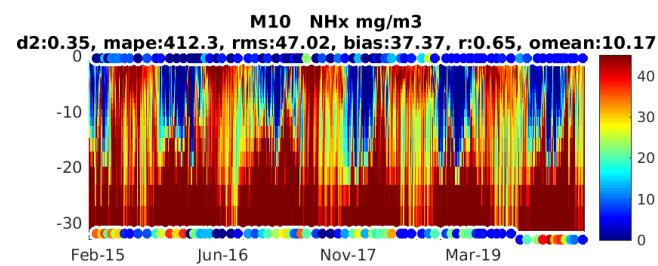


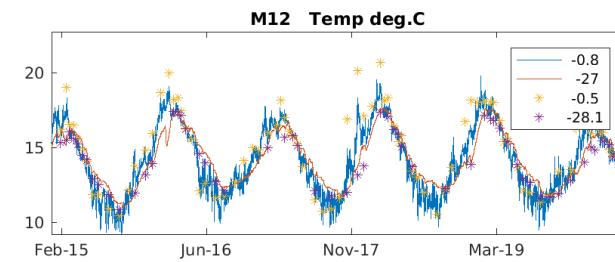
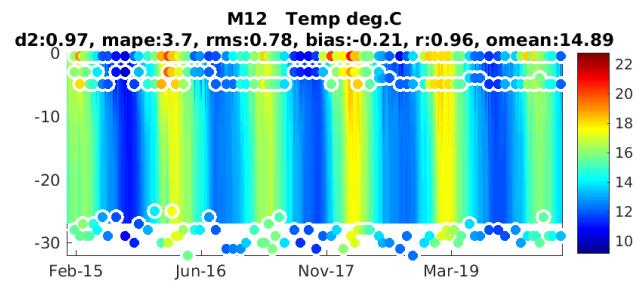


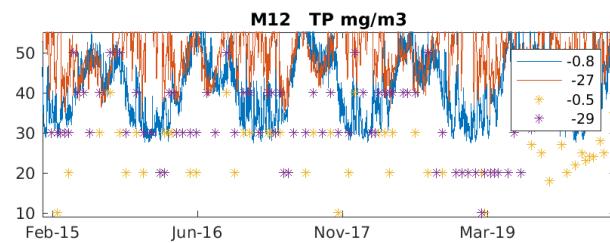
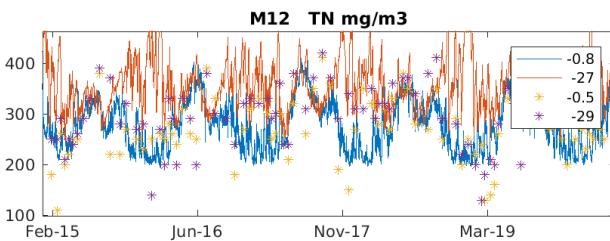
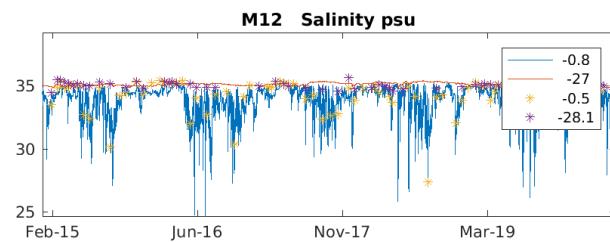
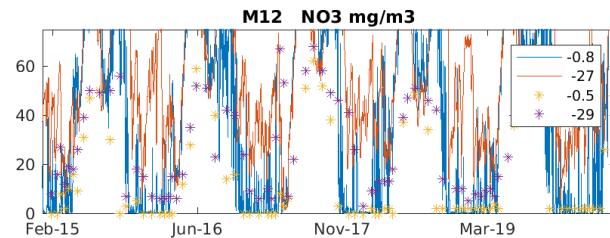
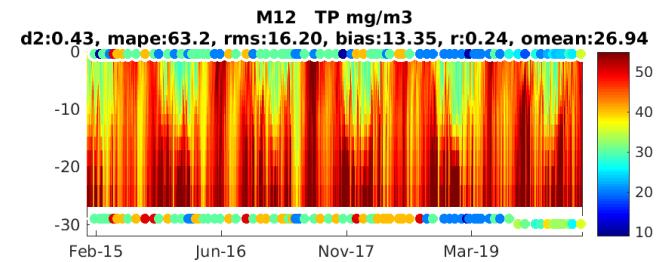
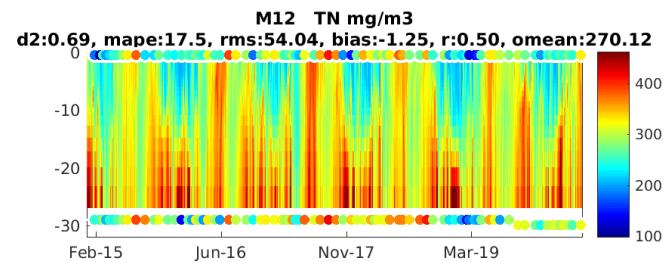
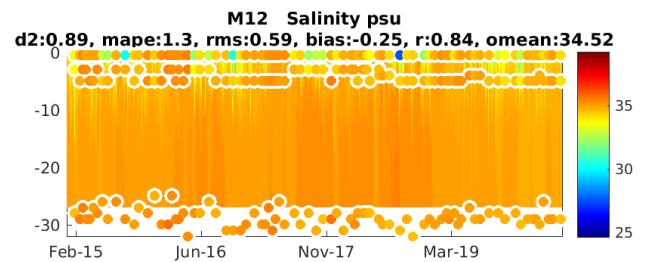
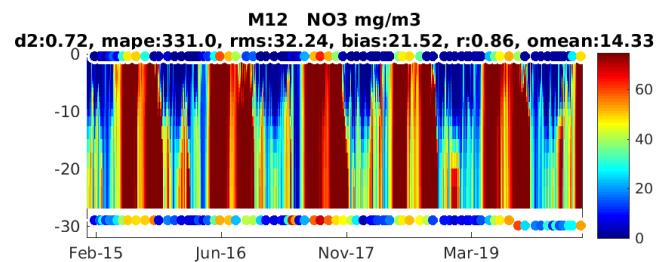


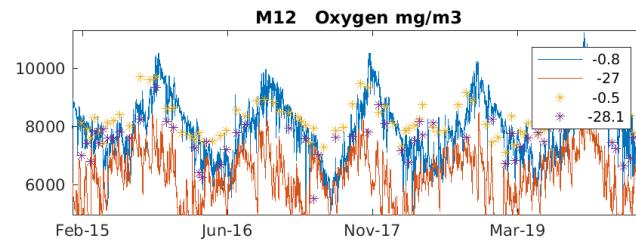
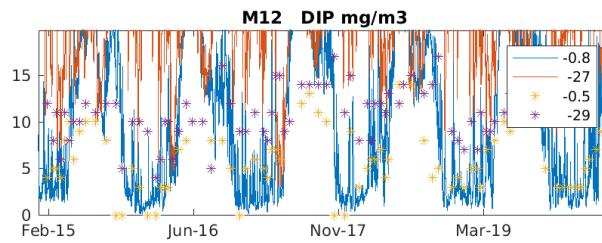
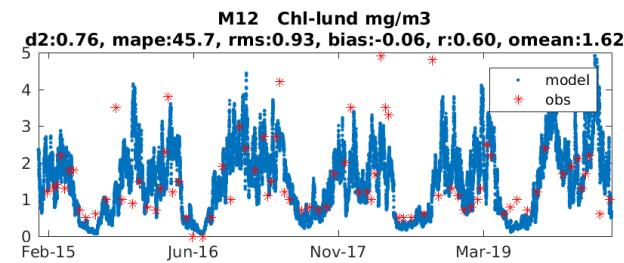
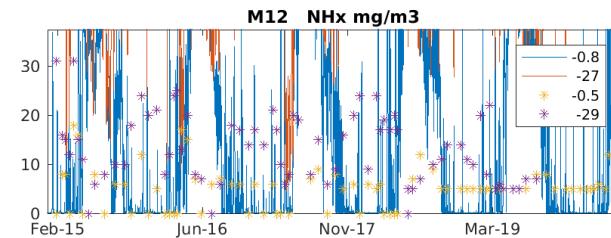
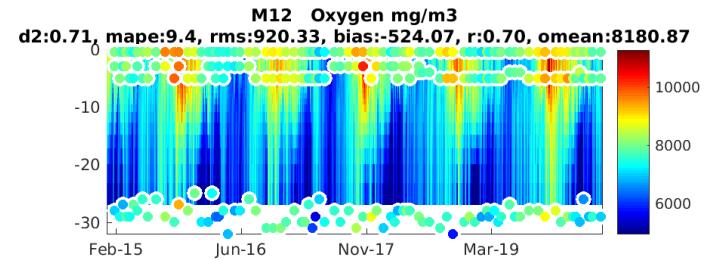
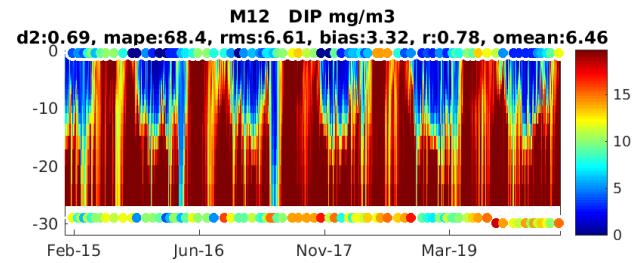
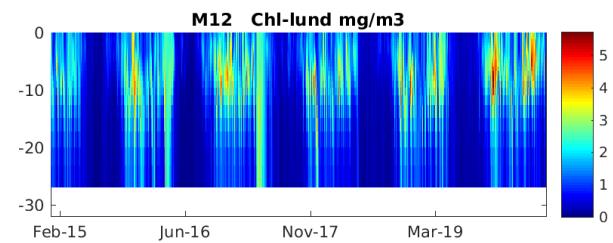
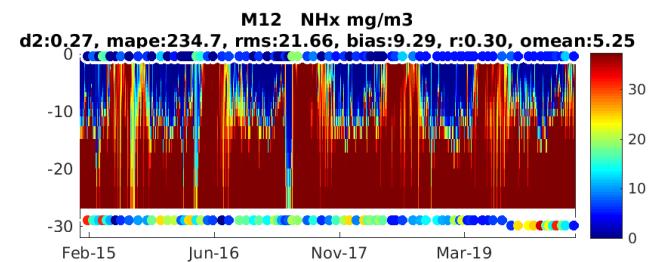


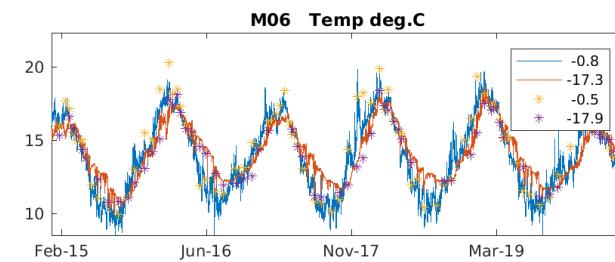
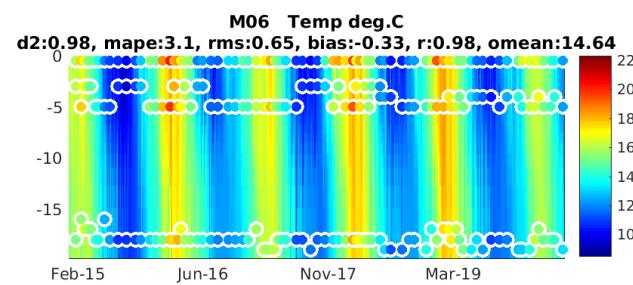


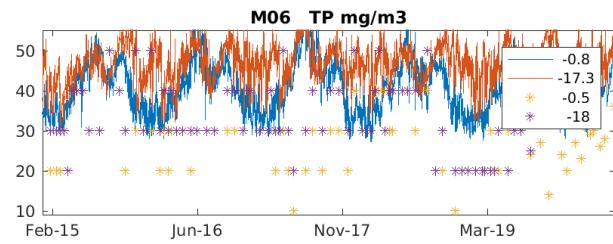
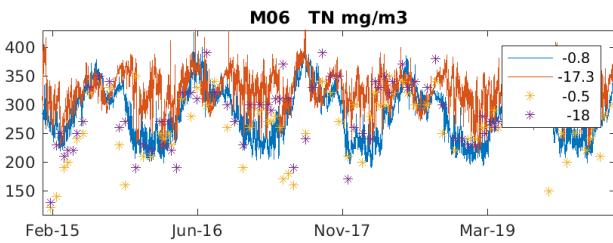
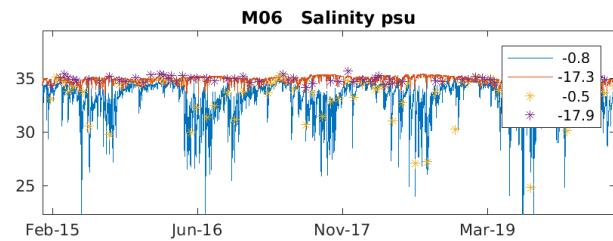
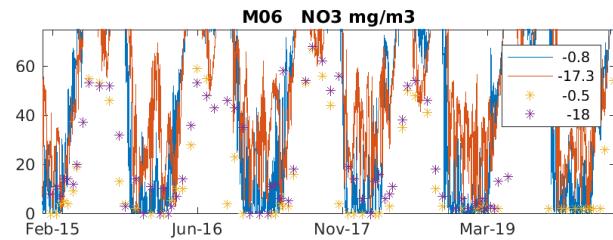
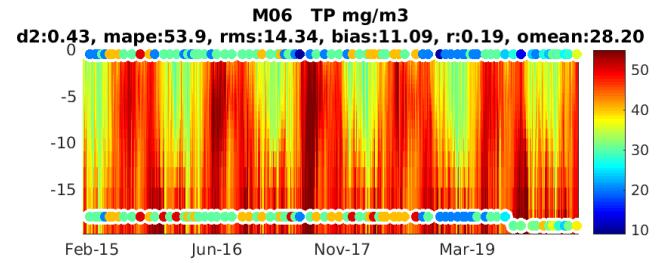
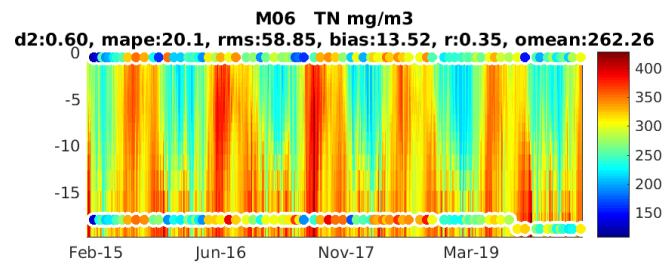
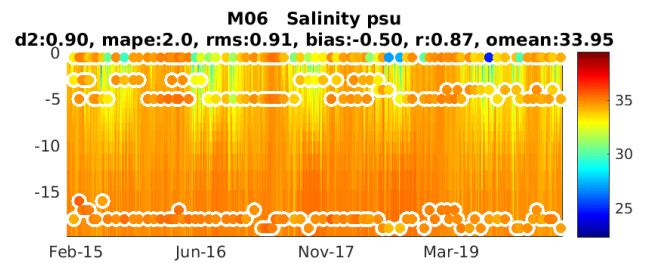
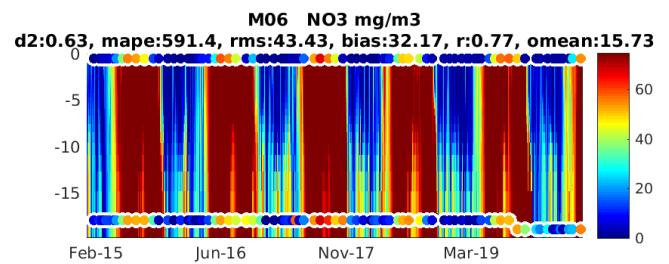


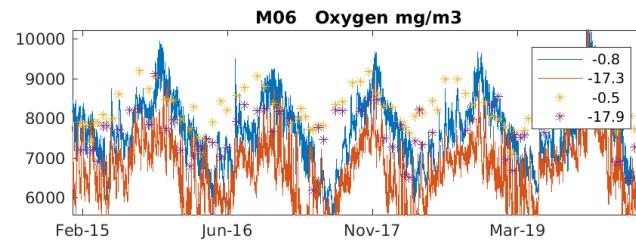
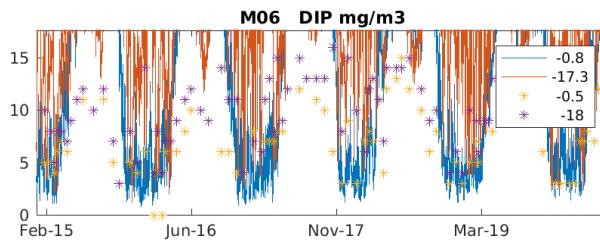
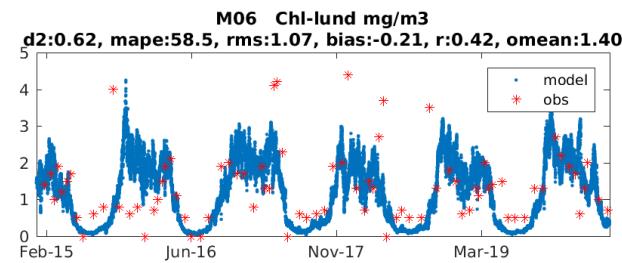
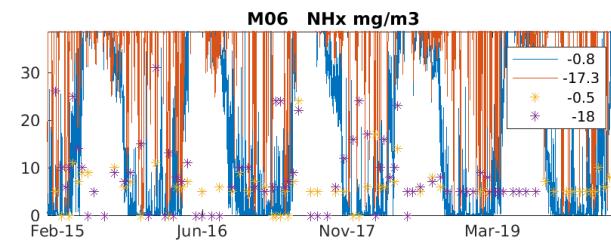
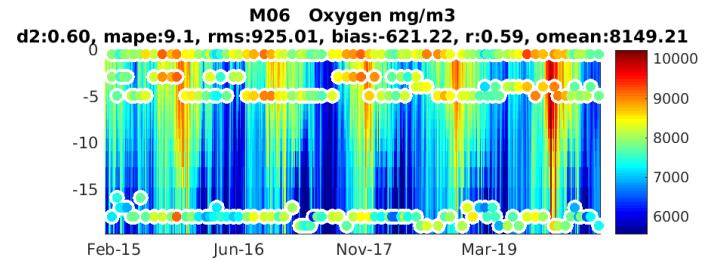
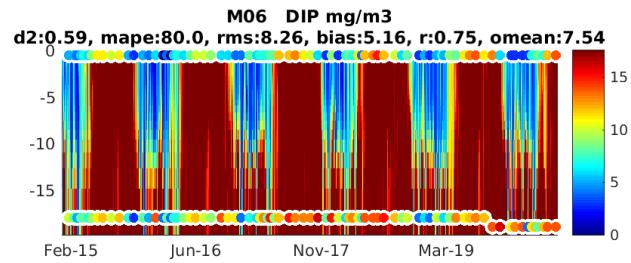
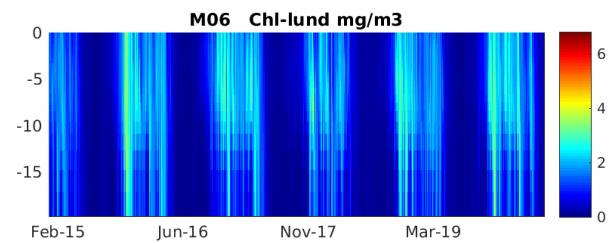
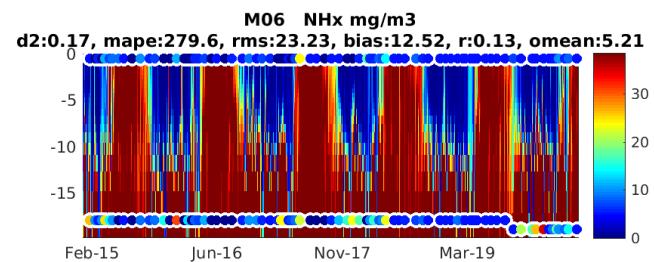


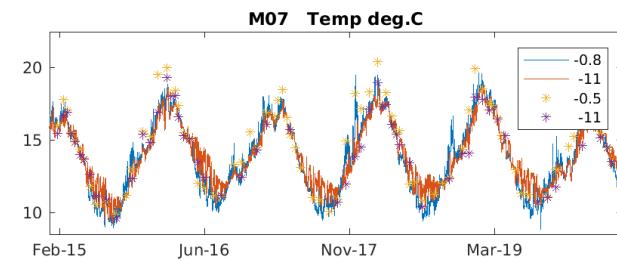
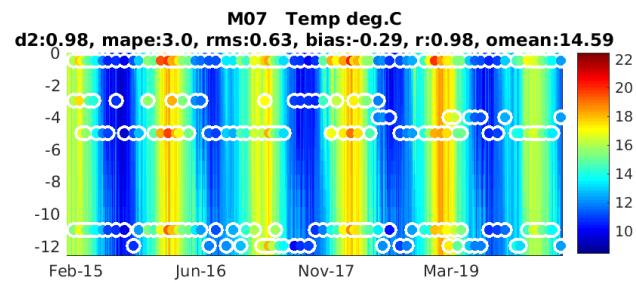


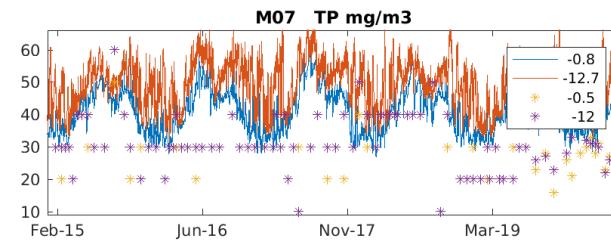
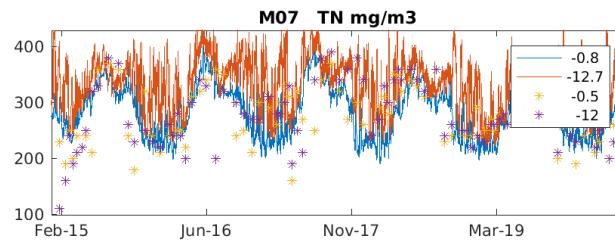
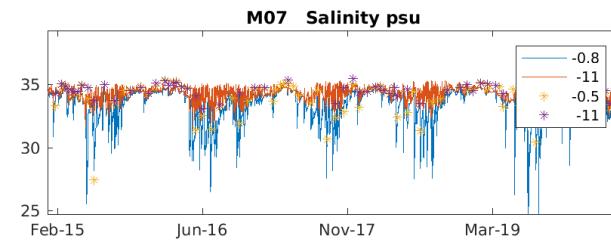
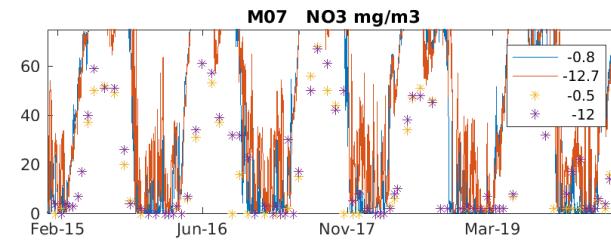
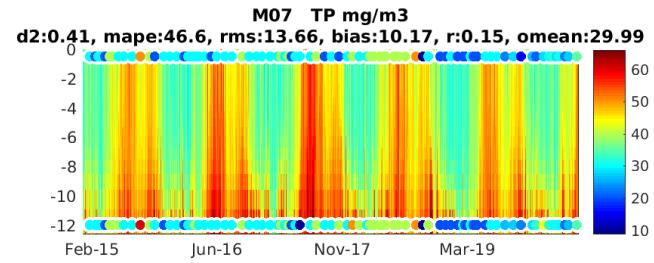
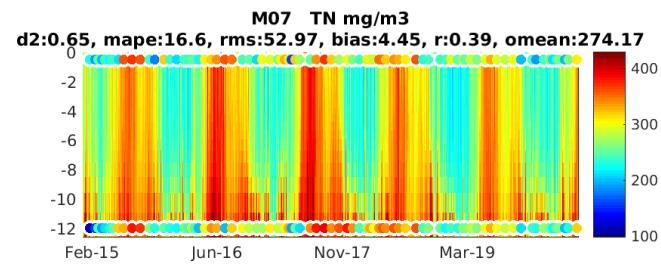
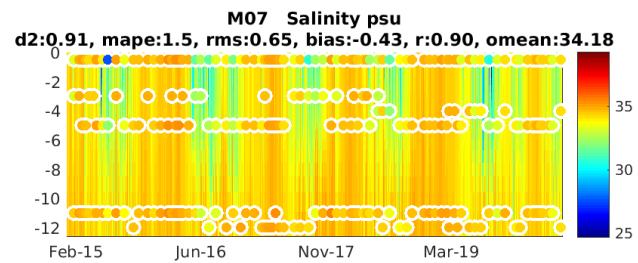
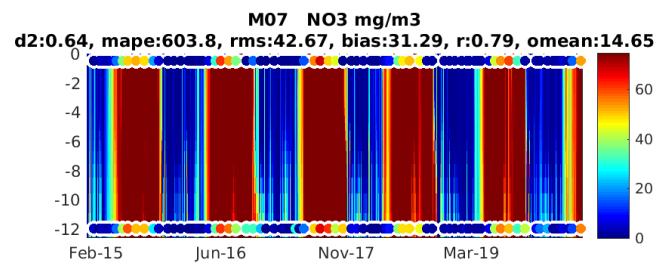


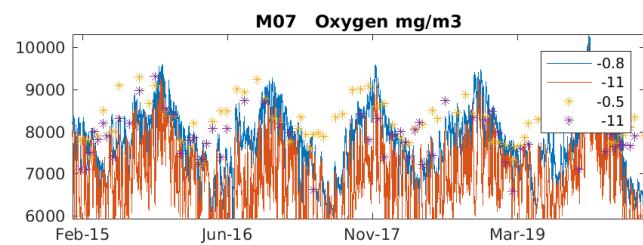
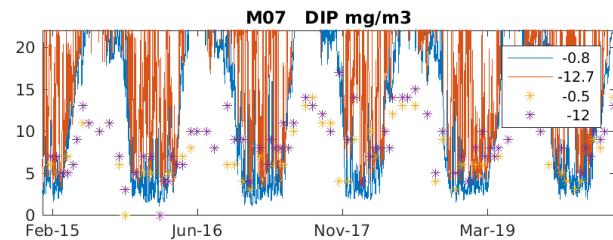
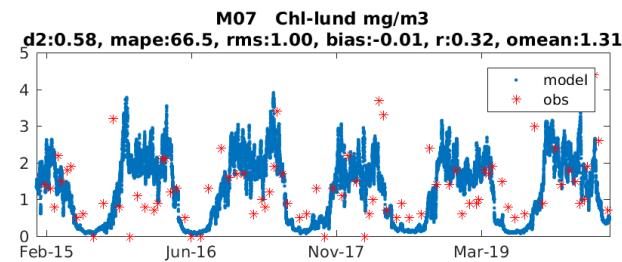
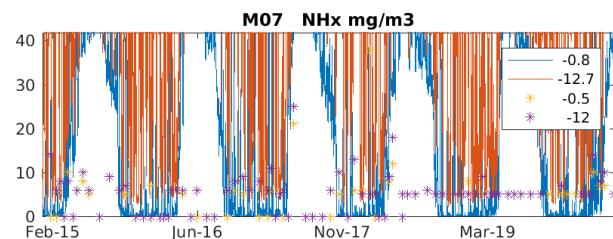
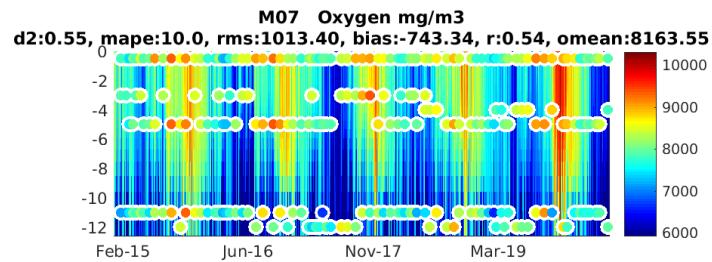
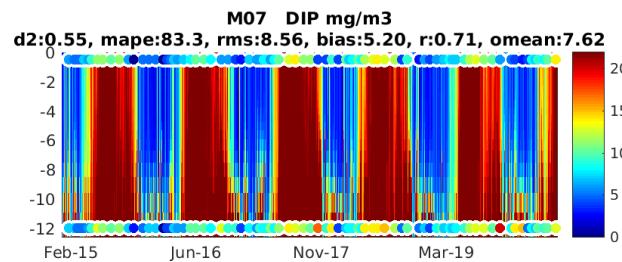
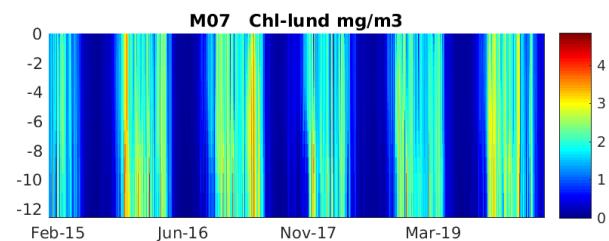
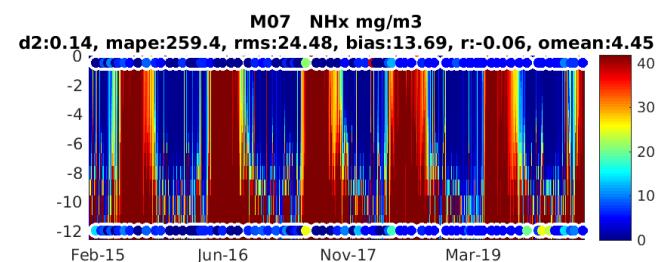


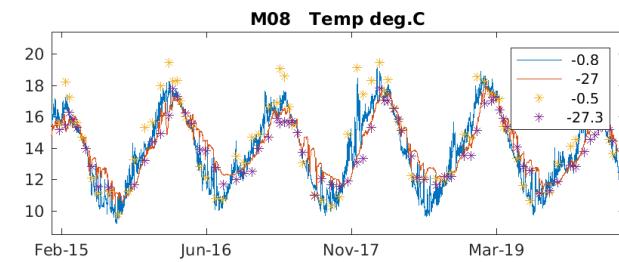
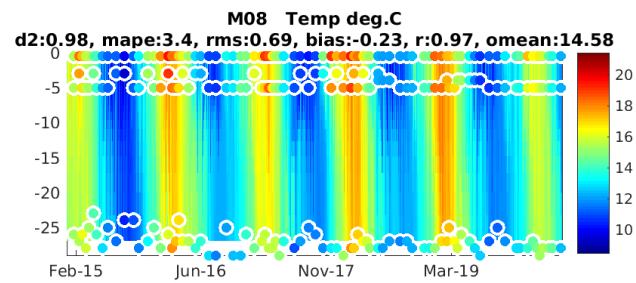


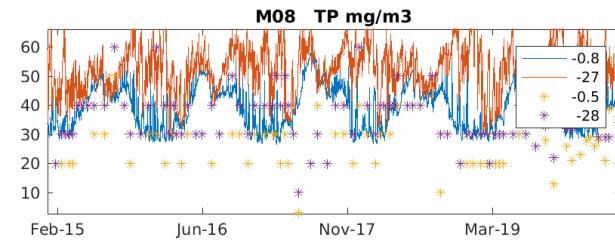
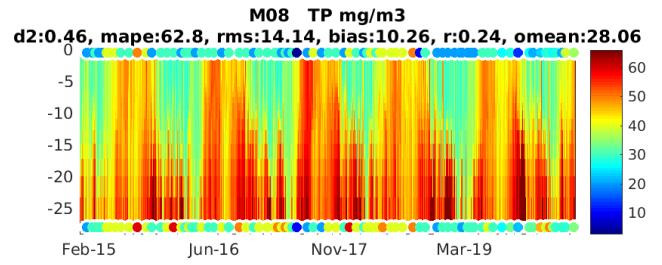
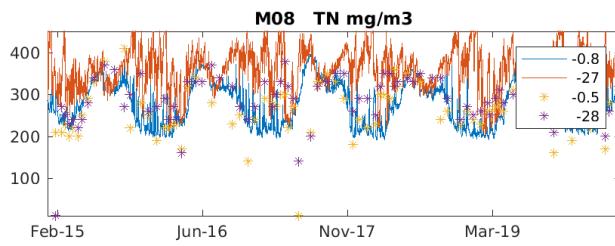
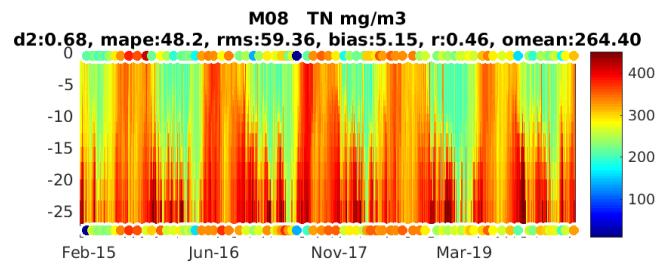
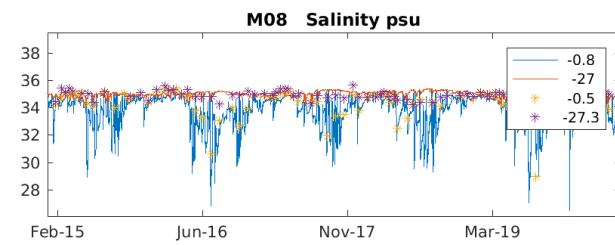
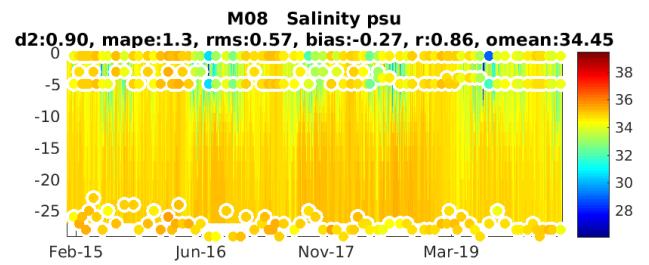
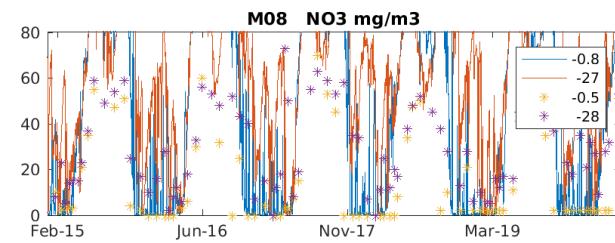
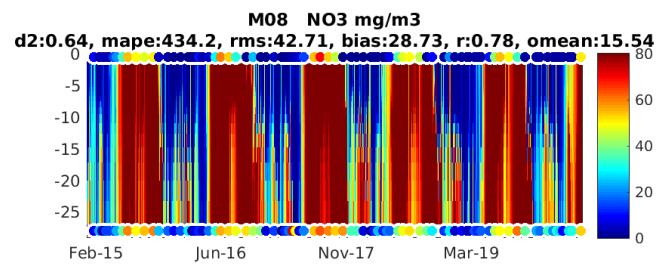


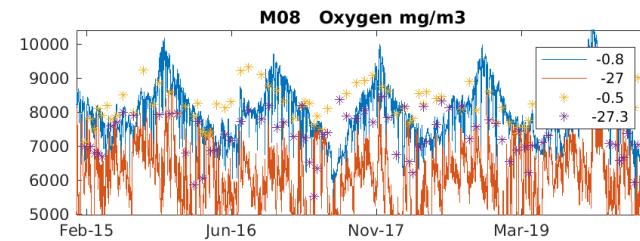
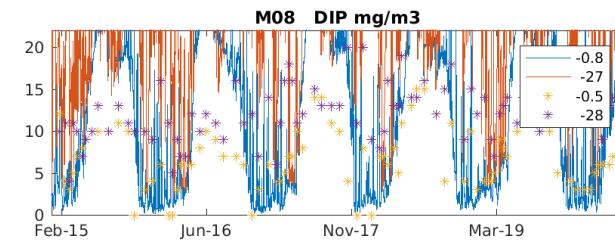
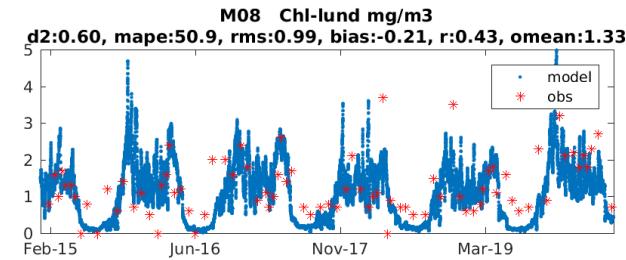
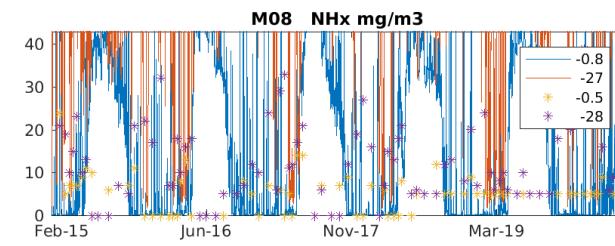
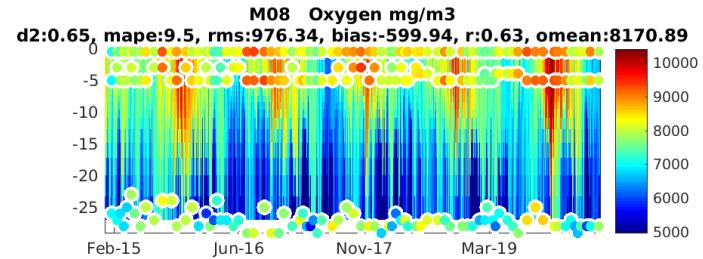
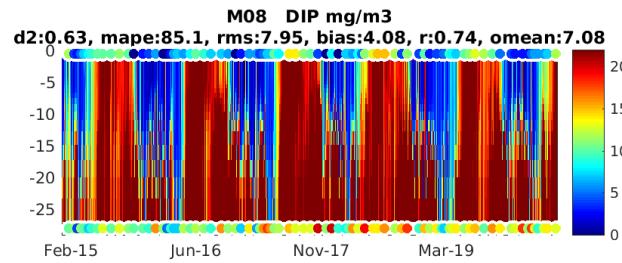
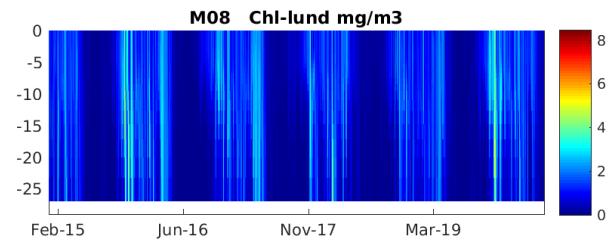
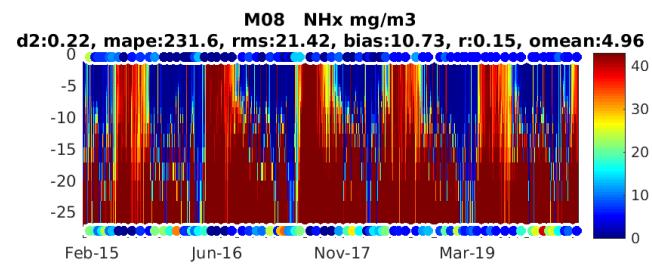


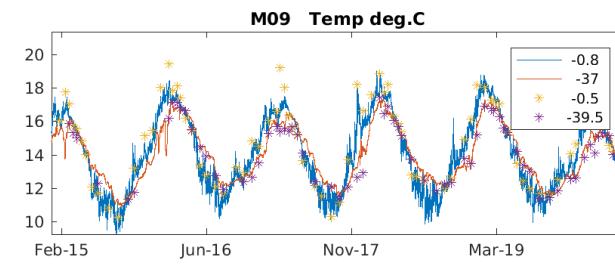
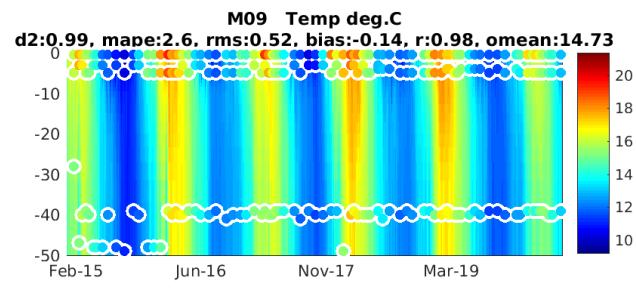


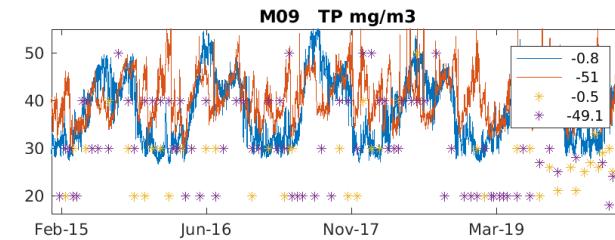
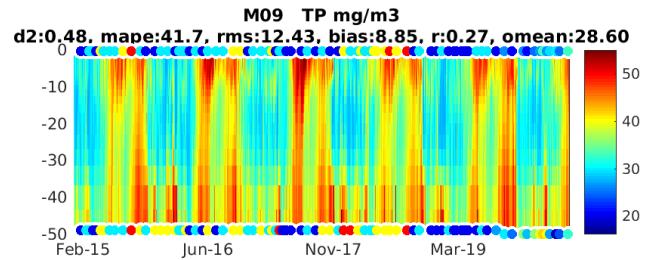
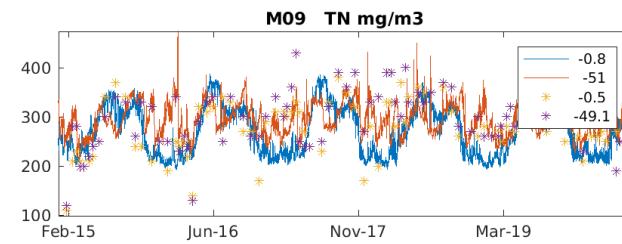
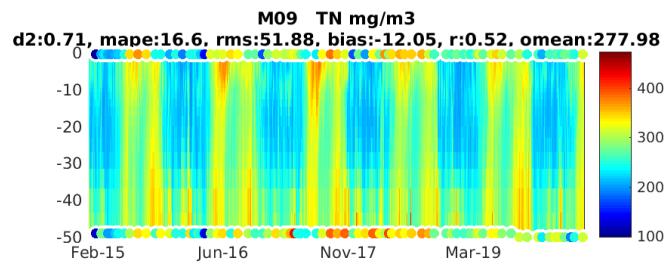
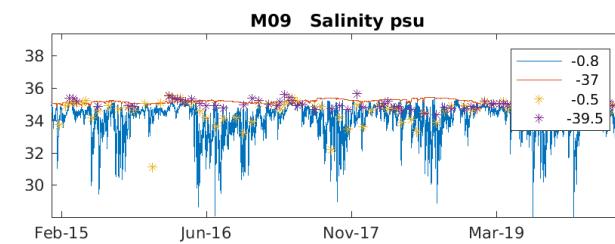
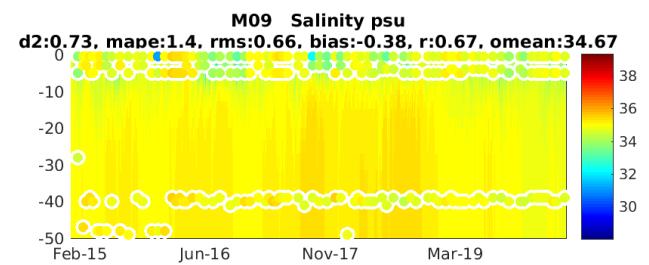
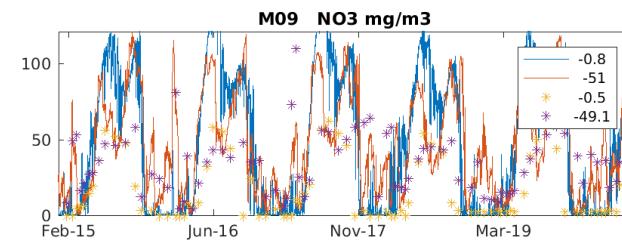
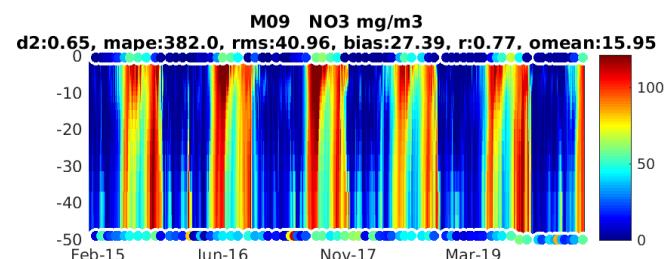


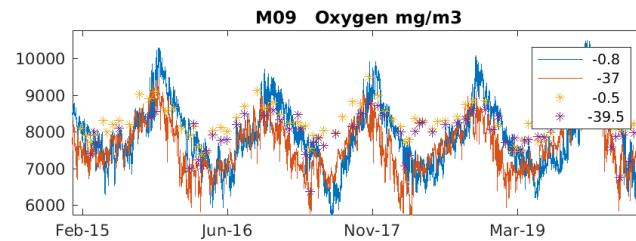
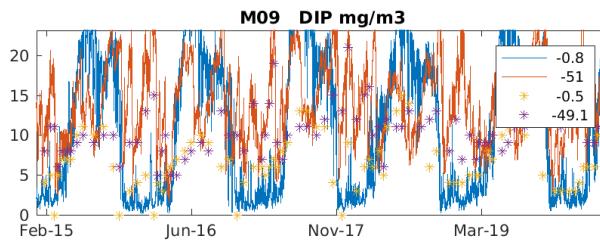
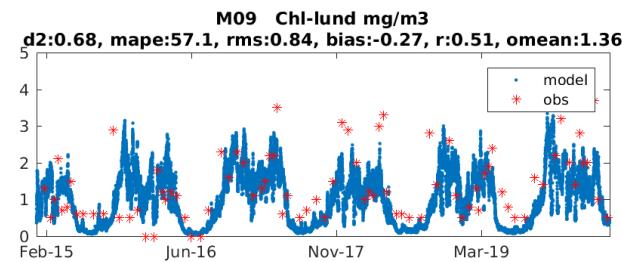
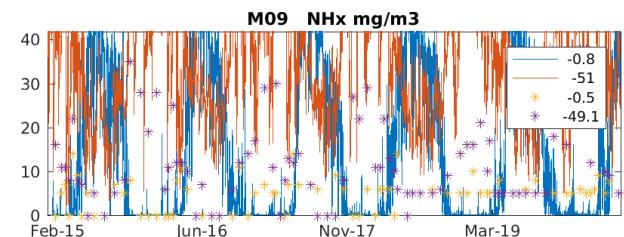
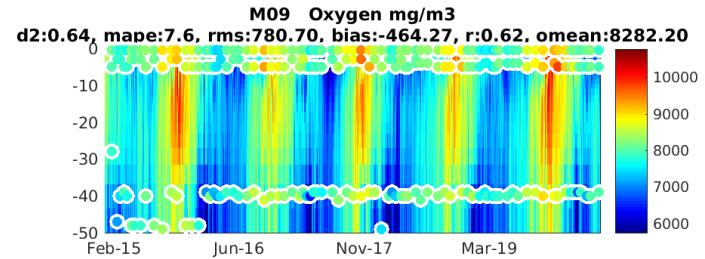
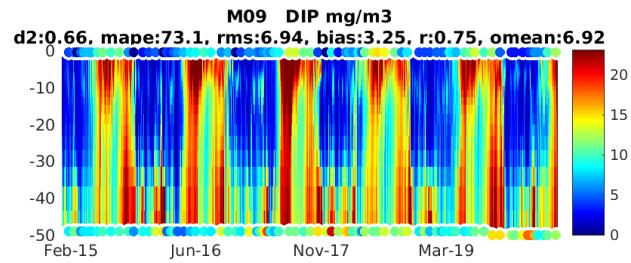
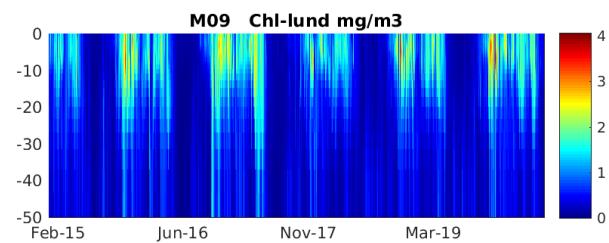
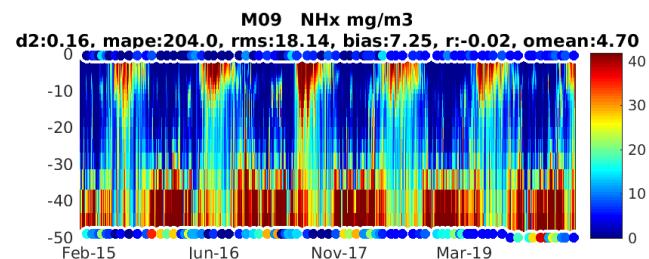


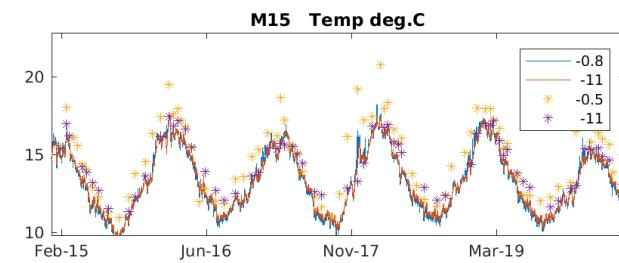
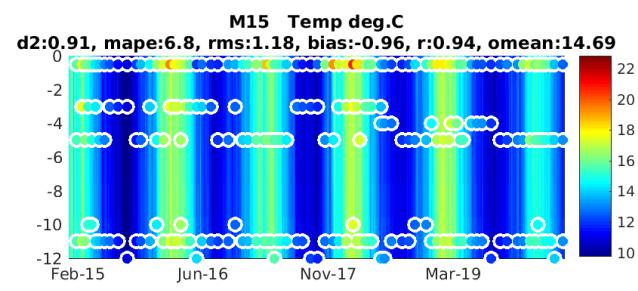


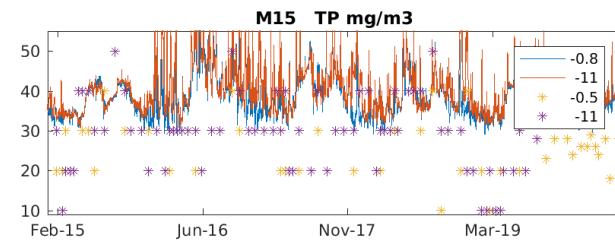
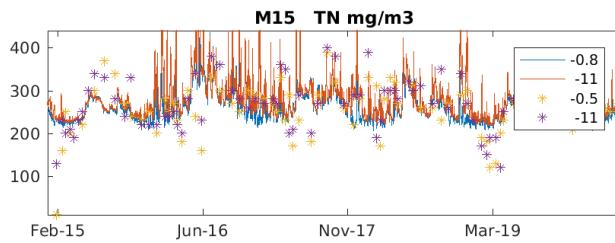
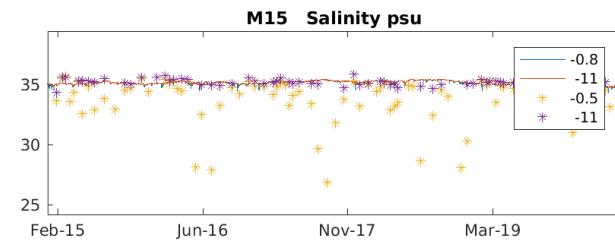
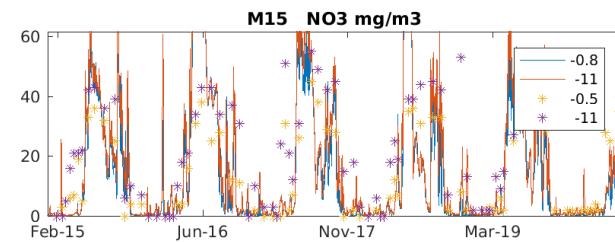
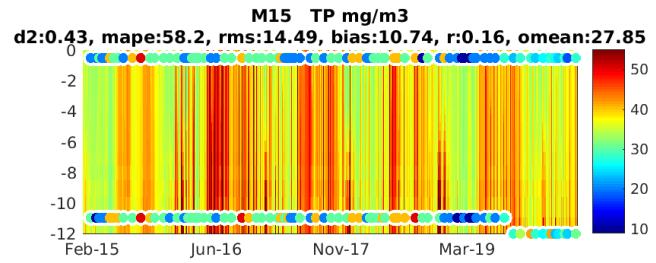
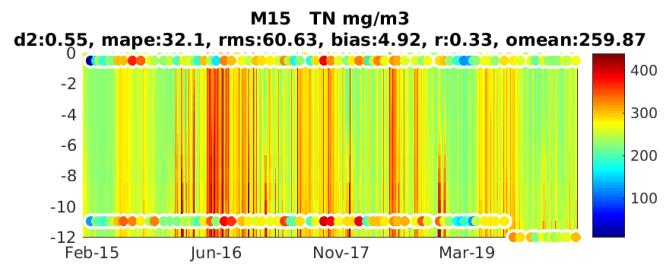
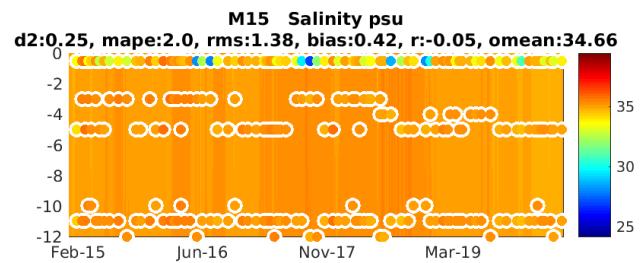
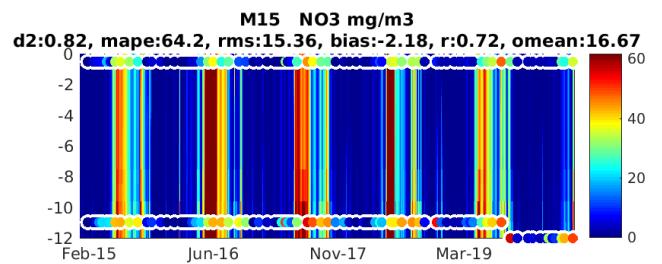


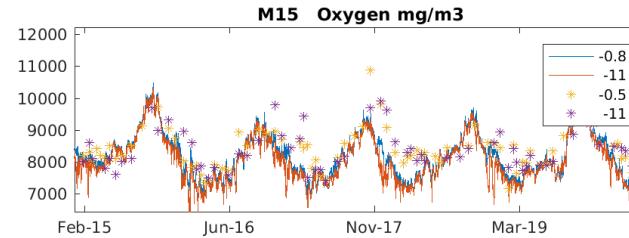
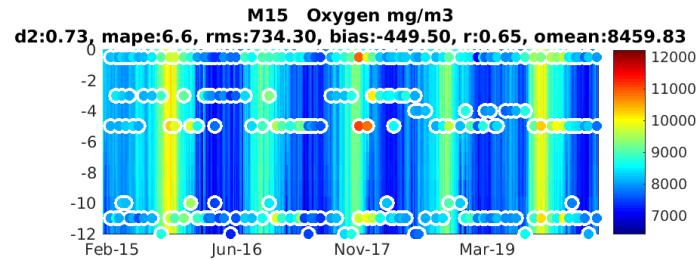
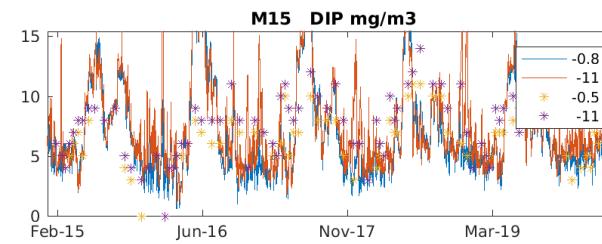
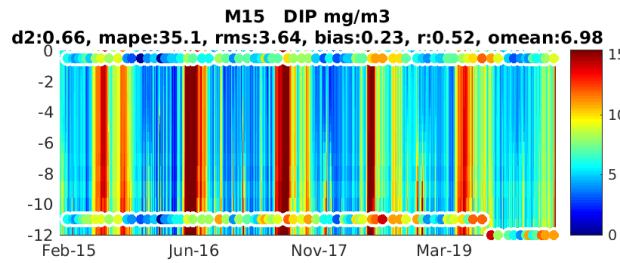
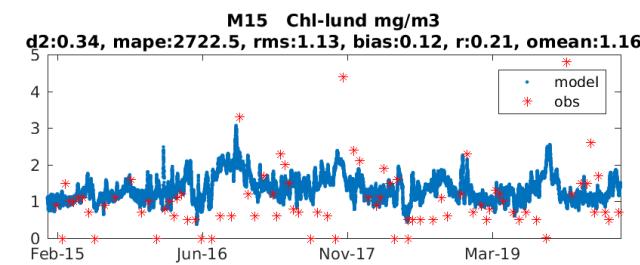
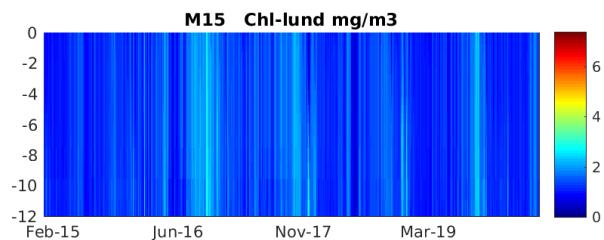
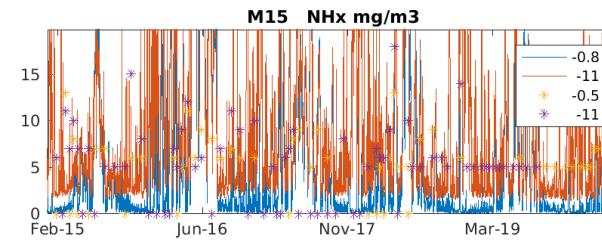
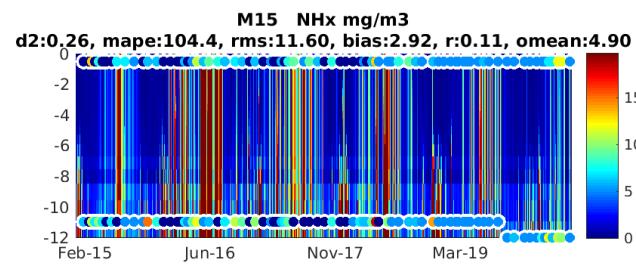












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