Argo in Marginal Seas: examples of data and hydrographic properties.

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Marginal Seas Argo DMQC workshop, Sopot, Poland
18.04.2023-19.04.2023

German Argo floats in the Baltic

Institut für Chemie und Biologie des Meeres

German activities since 2021

- Cooperation between BSH, ICBM and IOW
- Focus on Gotland Basin
- A total of 8 floats deployed/recovered
- All BGC floats, mix of APEX and PROVOR
- At present one active float (3902488)

WMO Number	Deployment date	Parameters	Number of cycles	Recovered y/n
6904117	01.02.2021	CTD (TSP), Oxygen, 4 Channel Radiometer, CHLA, Backscatter, CDOM, Dual Nitrate Sensors	201	Y
7900587	25.03.2021	CTD (TSP) Oxygen, hyperspectral radiometer, CHLA, Backscatter, CDOM,	170	Y
7900579	25.03.2021	CTD (TSP), Oxygen, 4 Channel Radiometer, CHLA, Backscatter, CDOM, pH	165	Y
6904116	25.03.2021	CTD (TSP), Oxygen, 4 Channel Radiometer, CHLA, Backscatter, CDOM, Dual Nitrate sensors	204	Y
7900586	25.03.2021	CTD (TSP), Oxygen, hyperspectral radiometer, CHLA, Backscatter, CDOM,	168	y
7900580	25.03.2021	CTD (TSP), Oxygen, 4 Channel radiometer, CHLA, Backscatter, CDOM, pH	171	N (empty battery)
6904226	31.03.2022	CTD (TSP), Oxygen, 4 Channel Radiometer , CHLA, Backscatter, CDOM, Nitrate, PCO2	60	Y
3902488	13.02.2023	CTD (TSP), Oxygen, 4 Channel radiometer, CHLA, Backscatter, CDOM, Nitrate, PCO2	11 up to now	

Float models and sensors

- 2 dual nitrate BGC Argo floats (IOW/BSH), Provor
- 4 optic/radiometric BGC Argo floats (ICBM), Apex
- 1 Float with novel pC02 Sensor (IOW/BSH), Provor

(c) J. Kuss/IOW

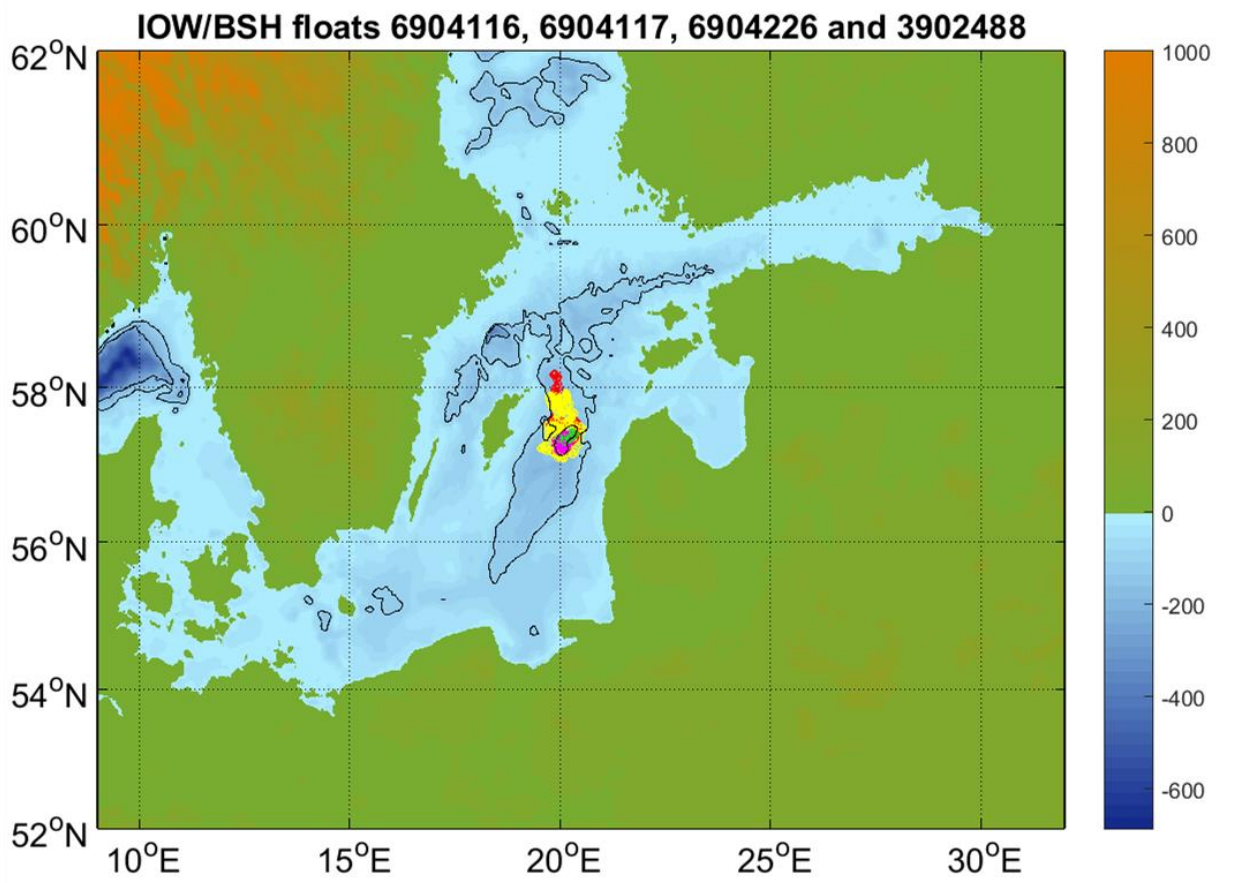

-4H-Jena Contros HydroC pCO_2

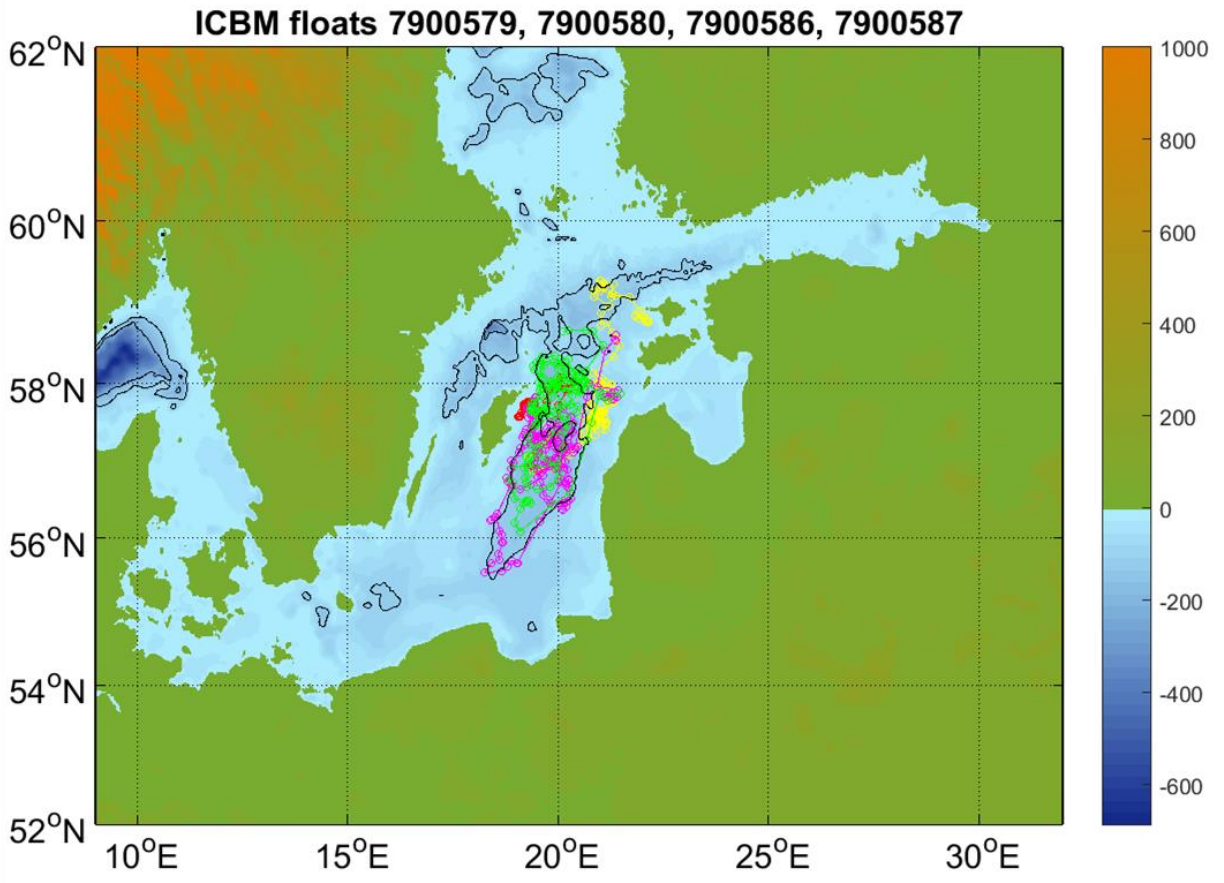
(c) H. Bittig/IOW


(c) A. Mazur, Voice of the Ocean Foundation


(c) M. Naumann/IOW

Trajectories



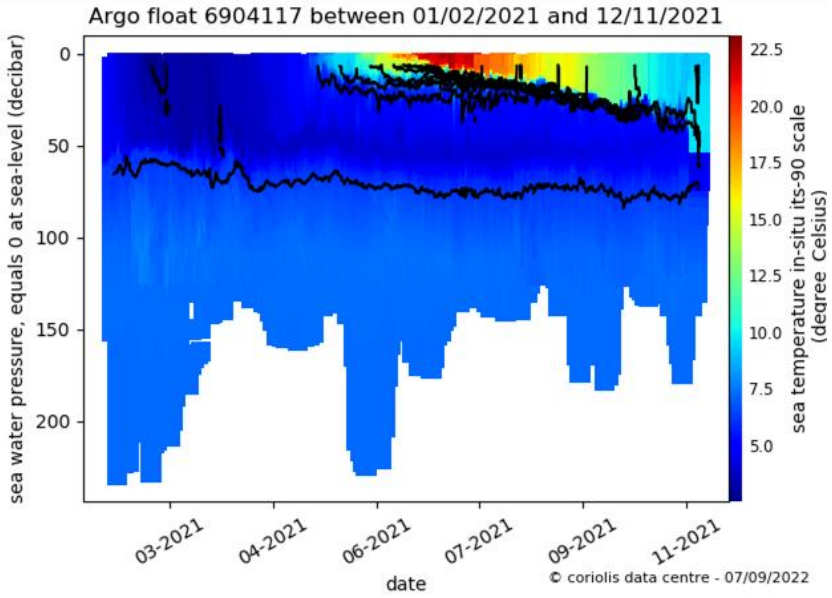


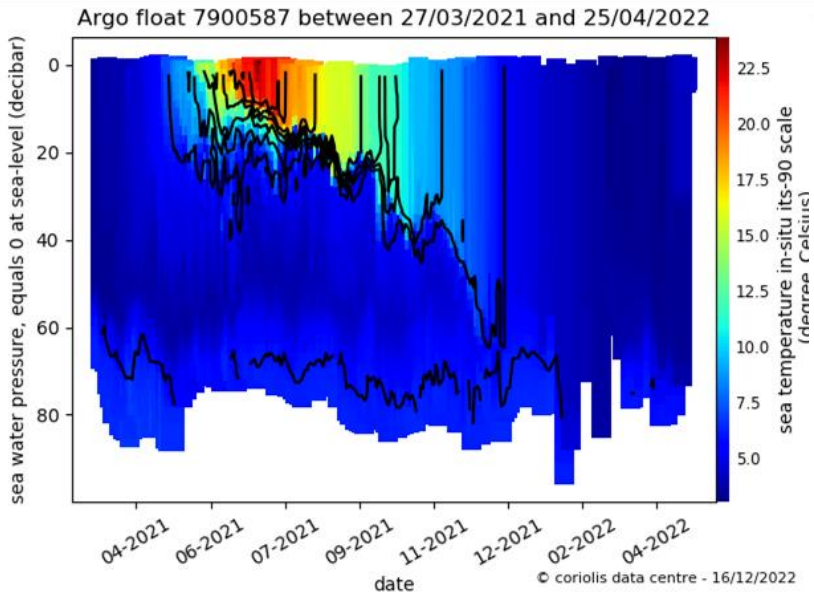
6904116, 6904117, 6904226, 3902488

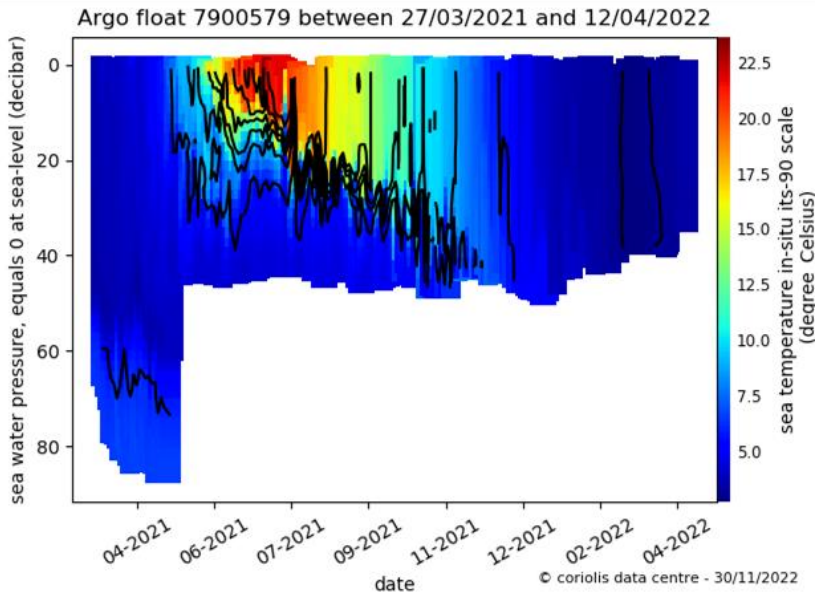
7900579, 7900580, 7900586, 7900587

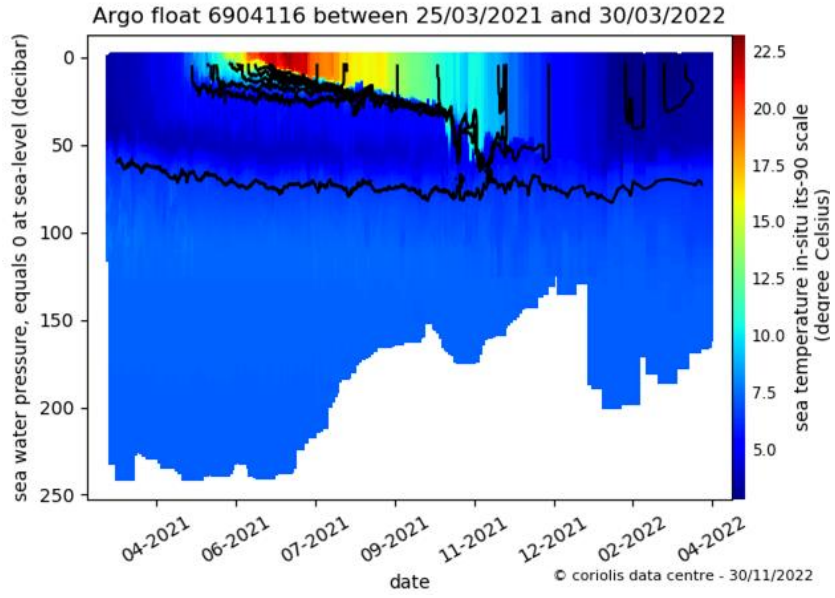
Floats are mostly confined in the deep Gotland Basin and have circular trajectories, following topography. IOW floats park close to bottom, IOW below halocline

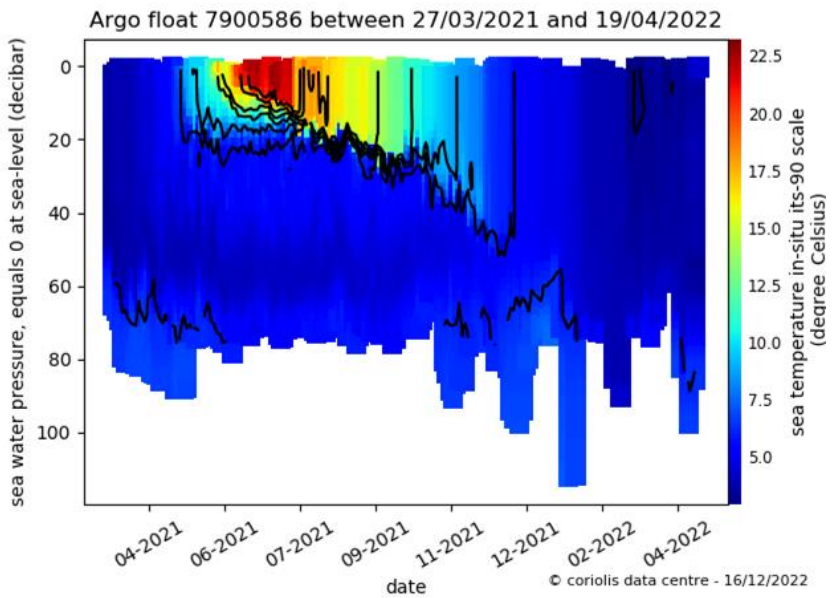
Temperature sections in 2021

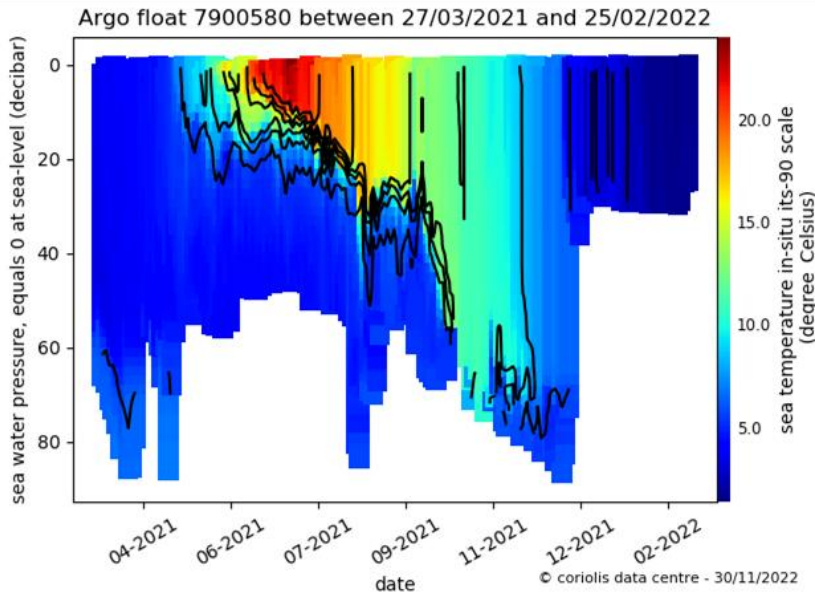




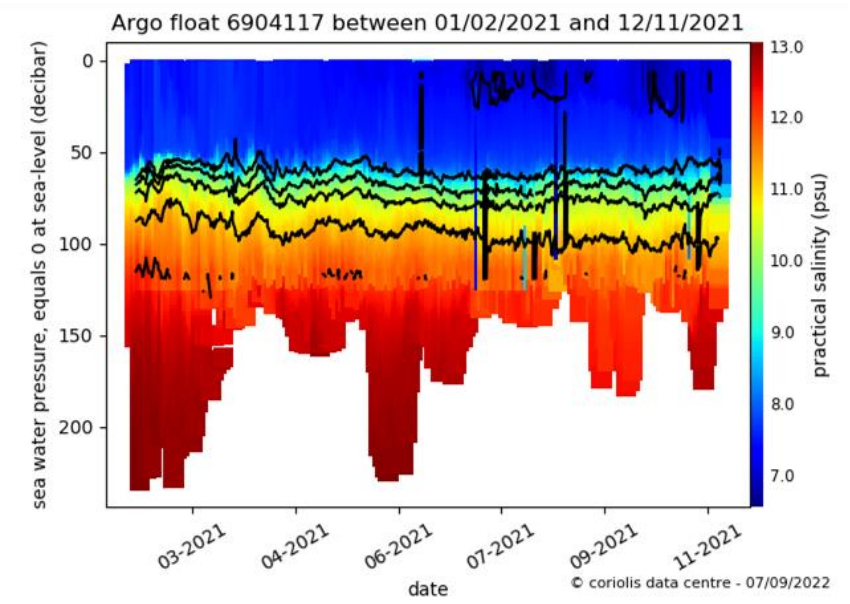


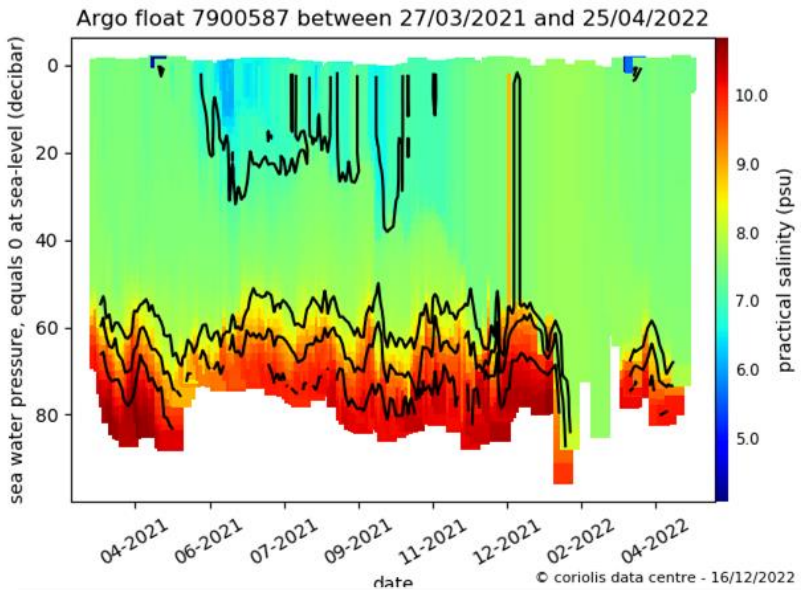


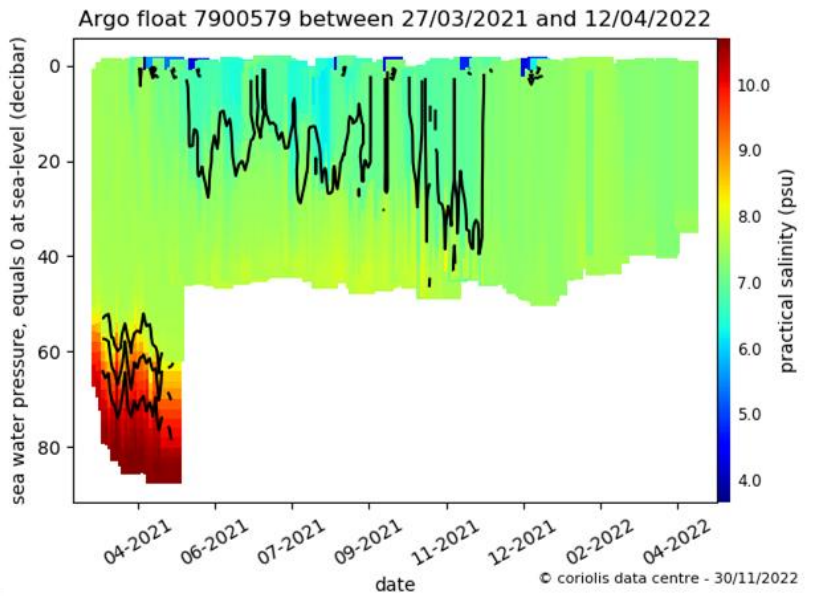


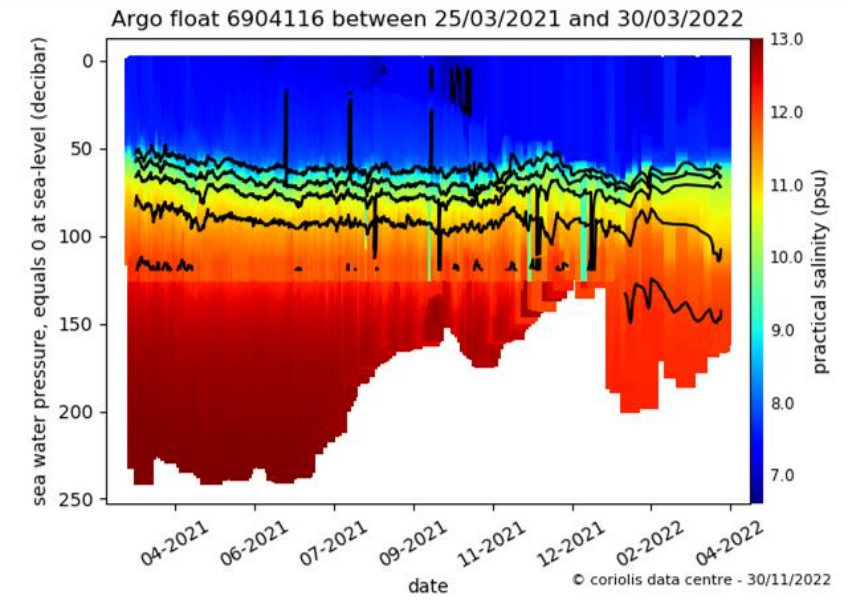


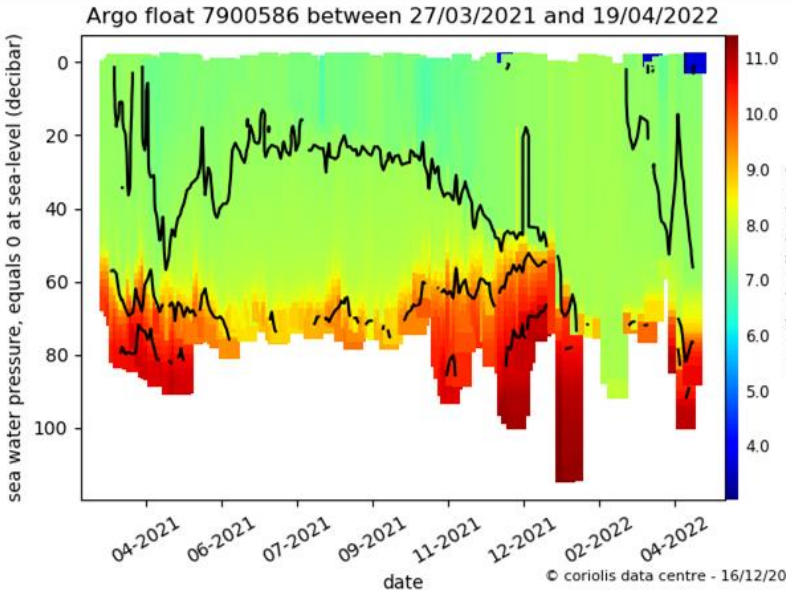
Salinity sections in 2021

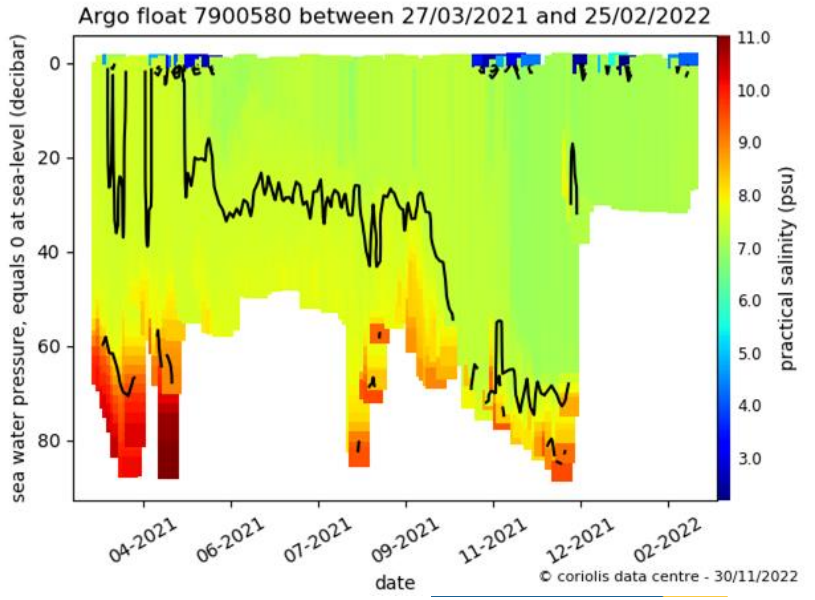




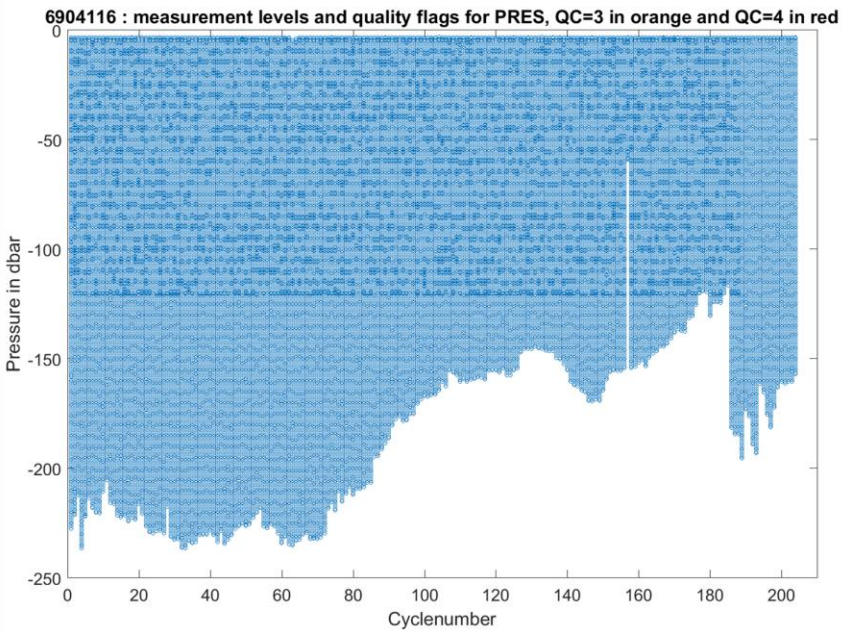


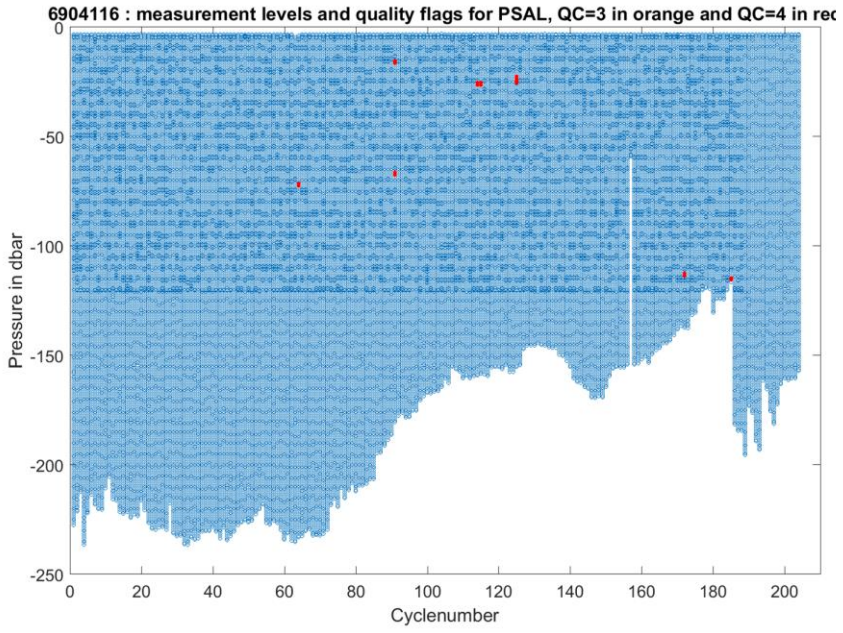


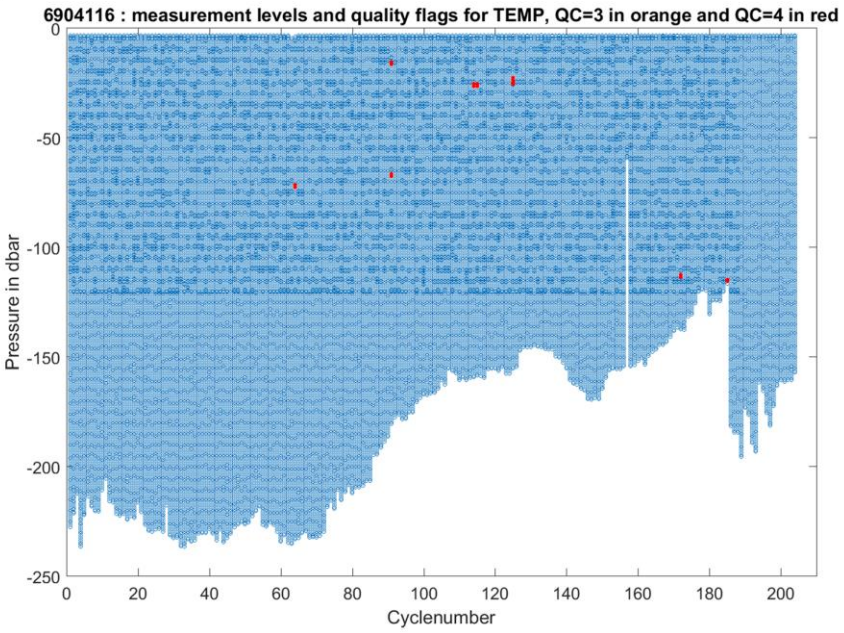


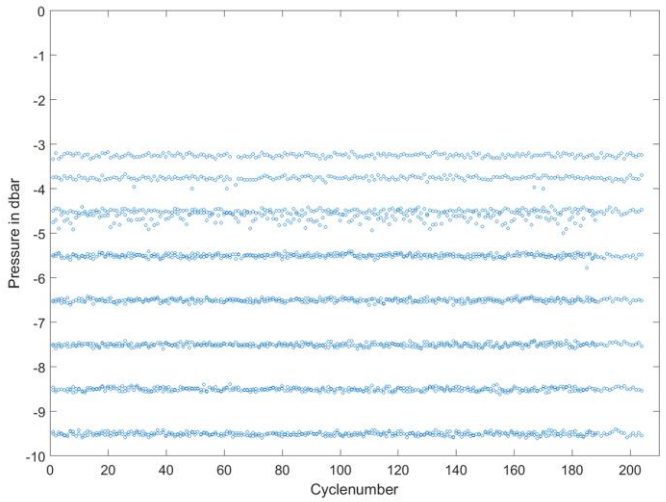


Vertical resolution and data quality: 6904116



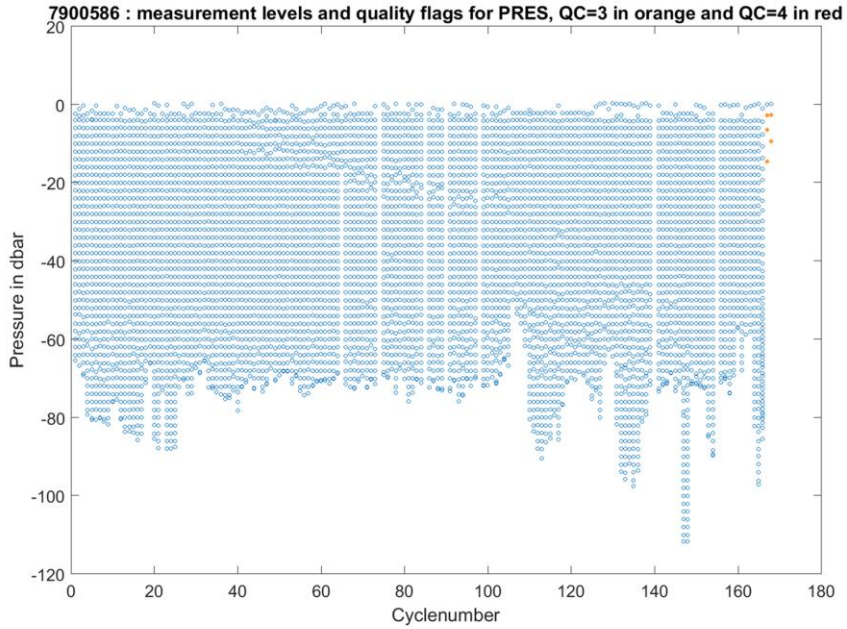


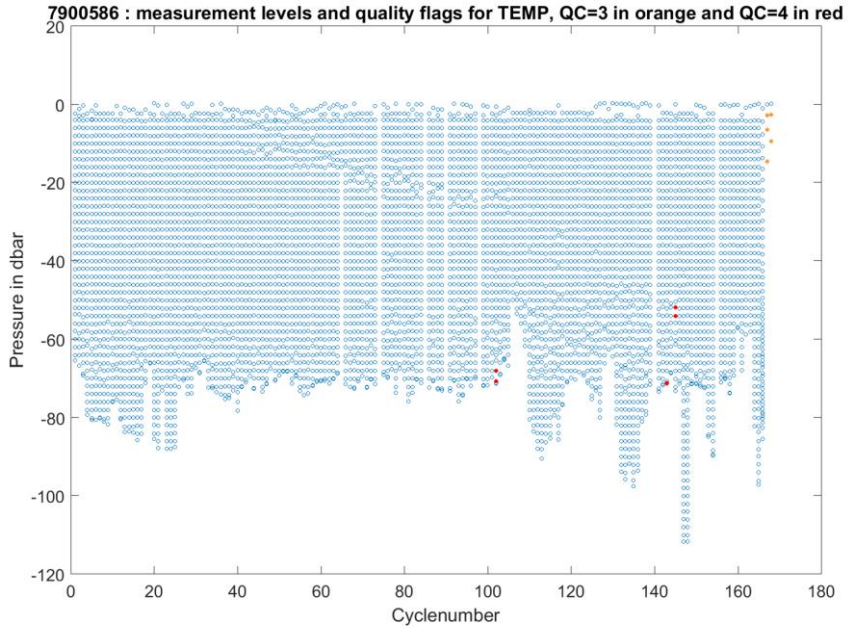


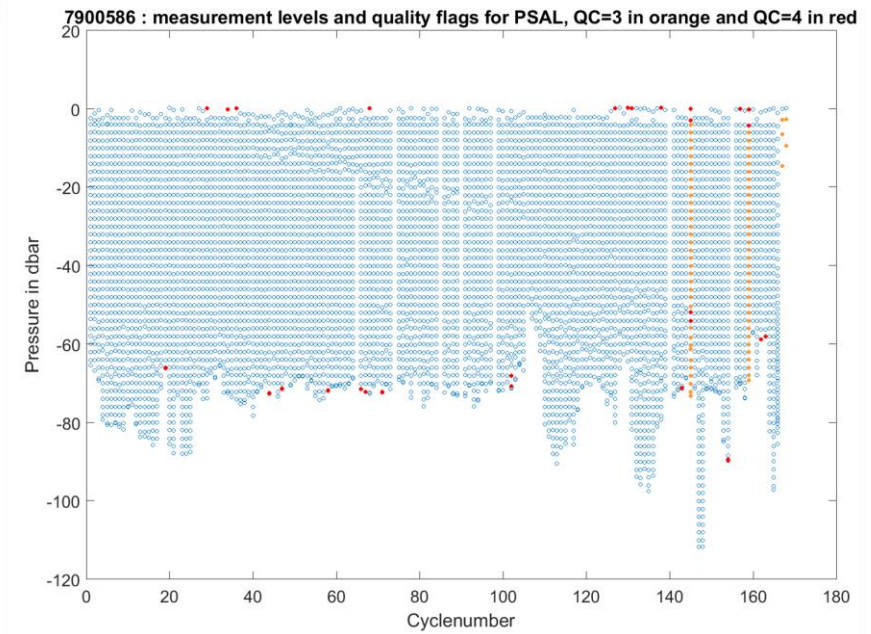


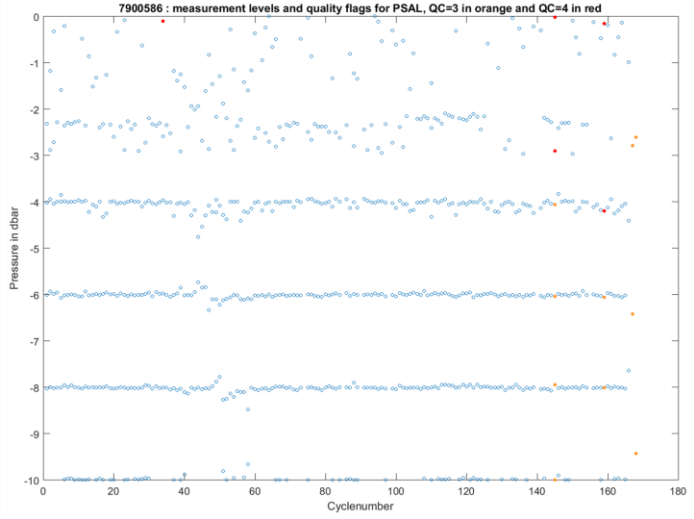
- Dense sampling throughout the water column for this Provor float
- Few data are flagged as bad in TEMP and PSAL by RTQC tests
- CTD was programmed to stop at 3 dbar to avoid contamination
- Regular sampling of the near surface layer achieved by buoyancy engine
- Ascend and descend sampling (same cycle number) are at same levels A+D sampling was selected to determine hysteresis in the oxygen sensor and validate oxygen corrections.

Vertical resolution and data quality: 7900586



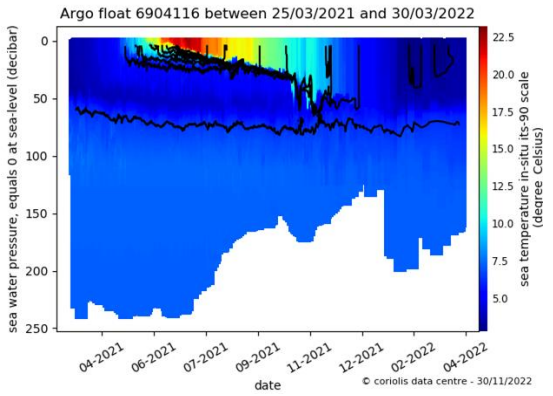


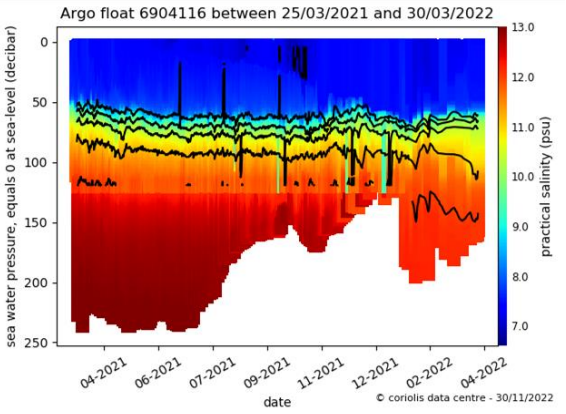




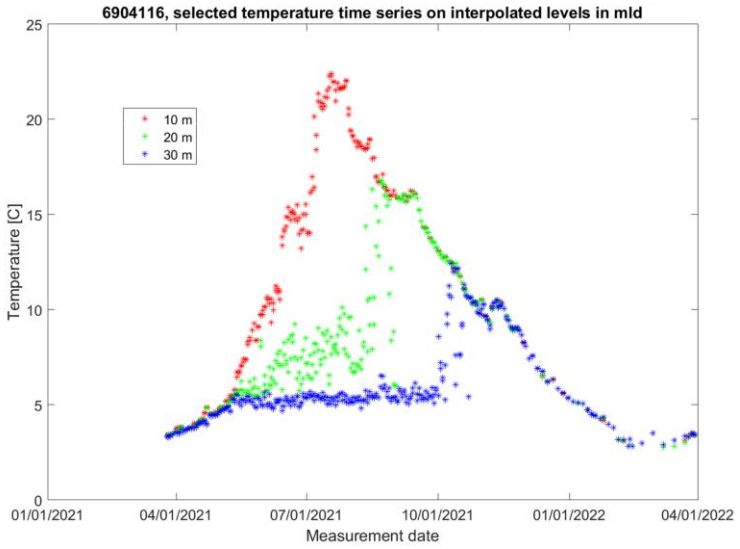
- Dense sampling throughout the water column for this Apex float
- More data are flagged as bad in TEMP and PSAL and PRES
- The CTD was programmed to stop at 4 dbar to avoid contamination,
- But due to the less efficient buoyancy engine (compared to Provor) irregular sampling resulted in the near surface layer.
- Sampling limited to upper 80 m to protect the pH sensor from the anoxic layer below halocline
- Ascend sampling only

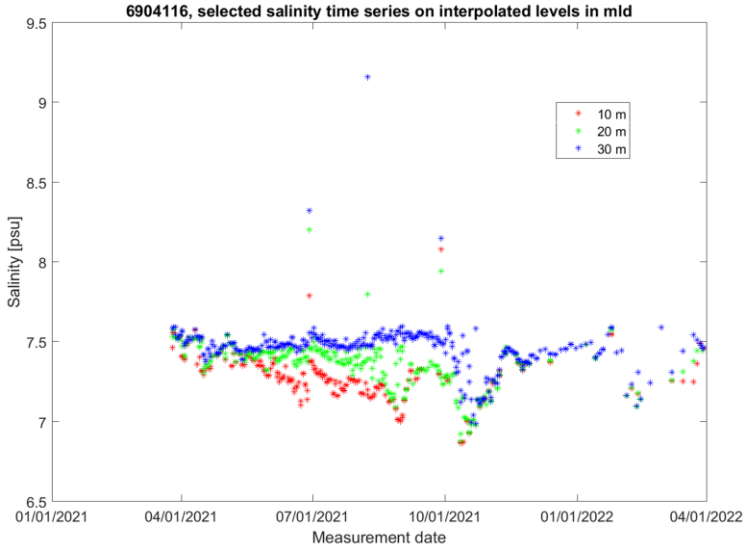
Seasonal signals in the water column





- Sections show halocline at 50-80 dbar
- Above an below homogeneous salinity layers
- But seasonal signal in temperature down to 40 m



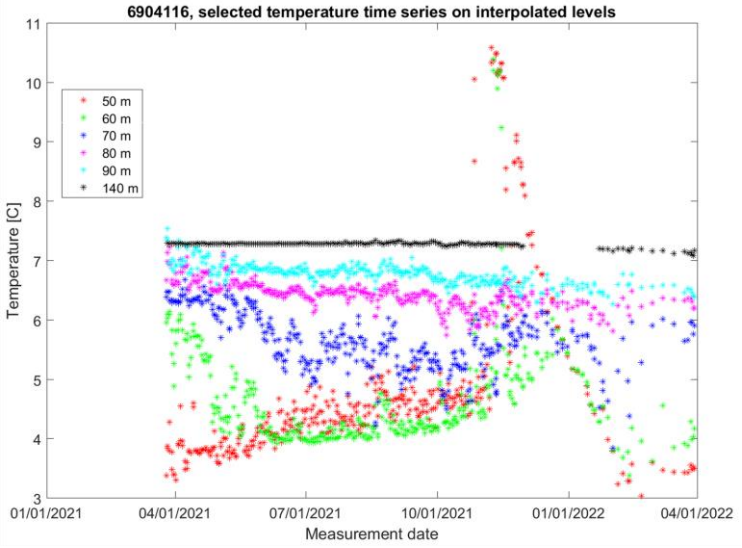


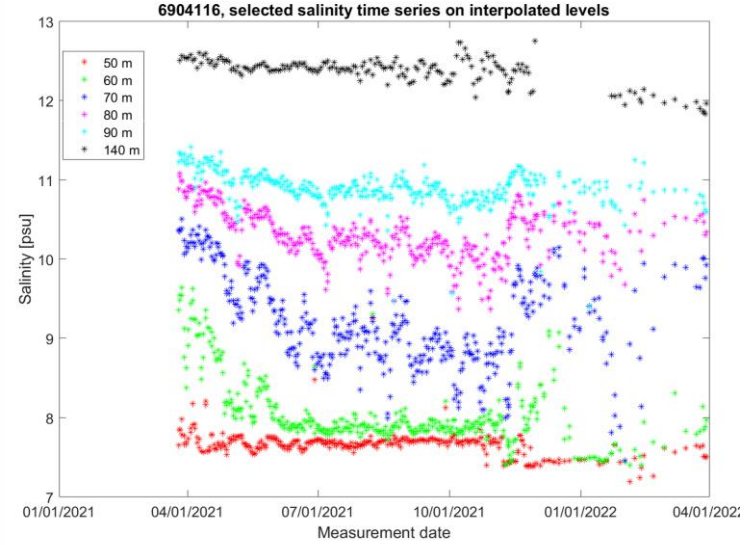
Issues for the DMQC:

Are corrections of seasonal cycle necessary?

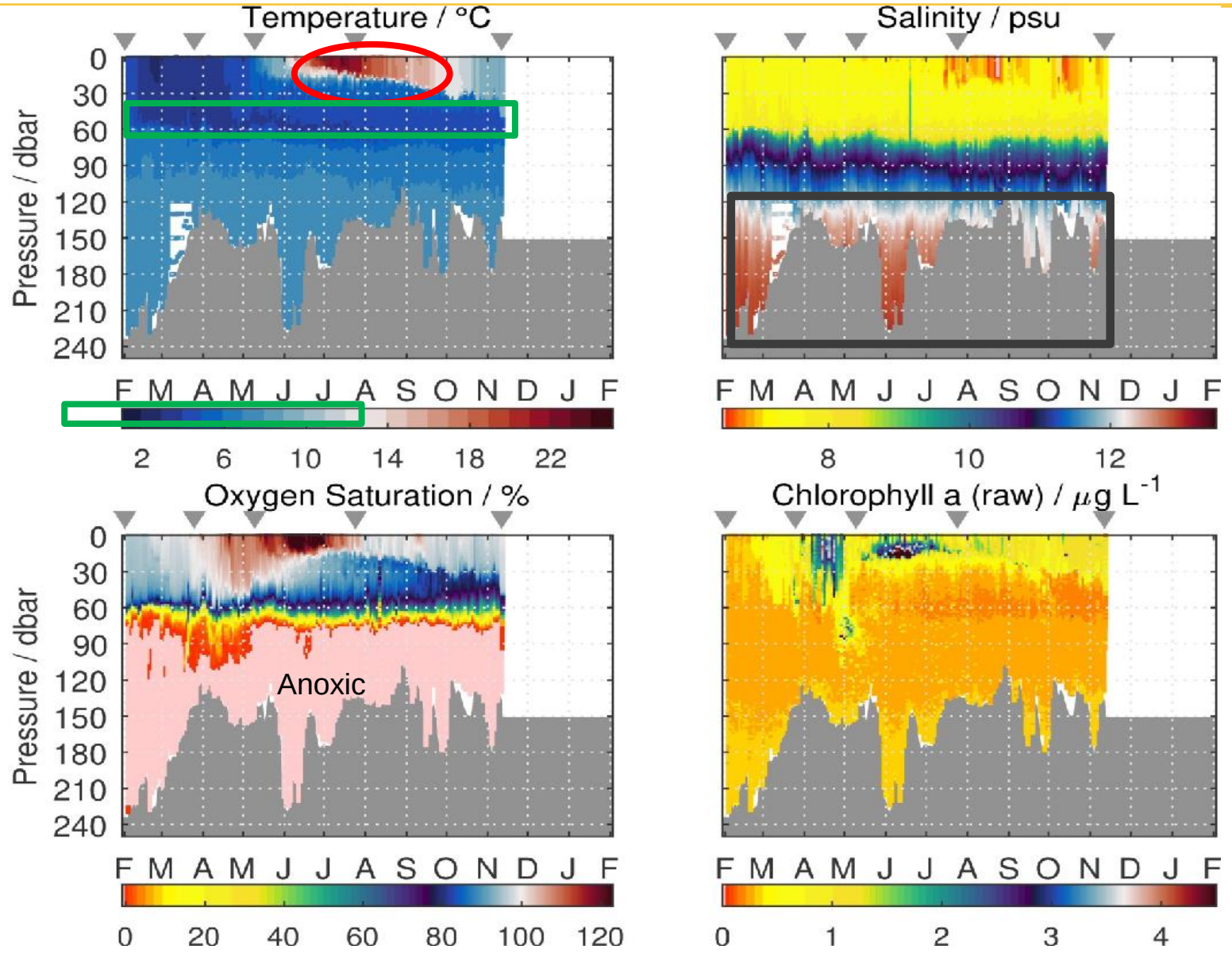
Or will a search criterion of 30 days reduce effects enough?

Does the seasonal signal in temperature has to be considered for salinity?





BGC time series for 6904117



Warm surface water

Cold winter water

Deep water

Hydrographic setting:

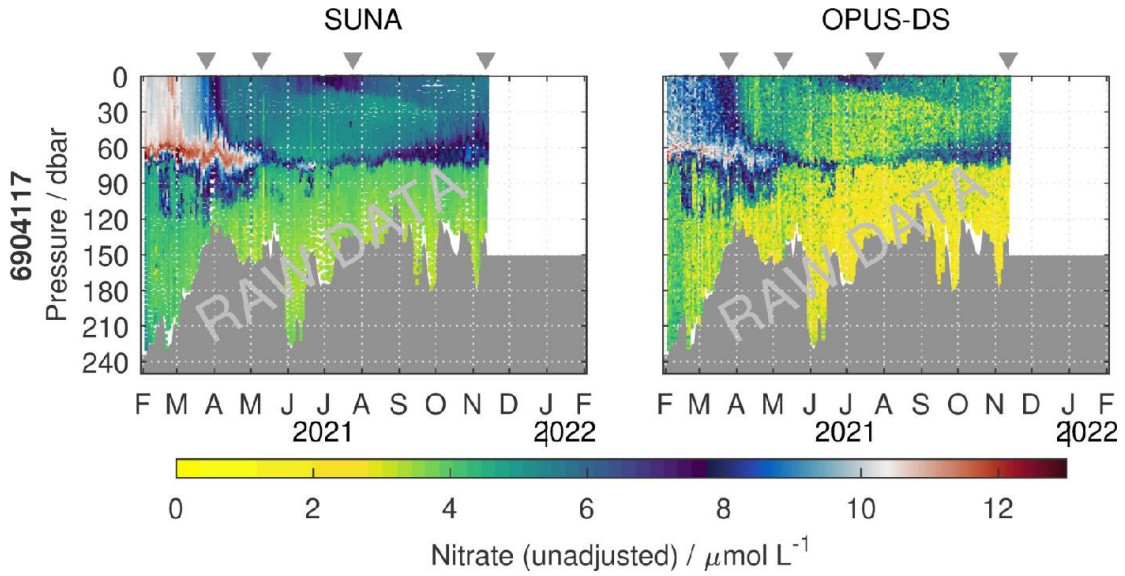
- Strong, permanent stratification with Deep Water
- Seasonal surface stratification: Cold winter water + warm summer surface water

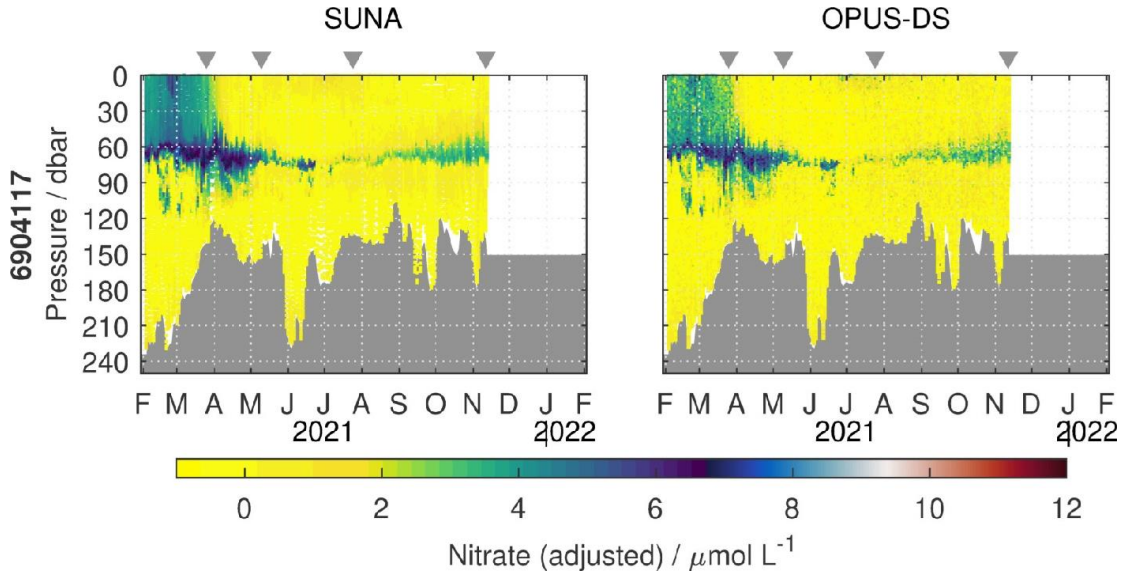
Biogeochemical setting:

4x – 5x ship reference profiles during deployment (every ▼)

- Deep water: Mostly anoxic, presence of sulphide -> no nitrate, high amounts of old CDOM
- Winter water slightly under-saturated in O2
- Intense spring bloom in ~April (consumes all nitrate, see next slide)
- Intense Cyanobacteria summer bloom (N2 fixation), fresh CDOM

Nitrate time series from both sensors

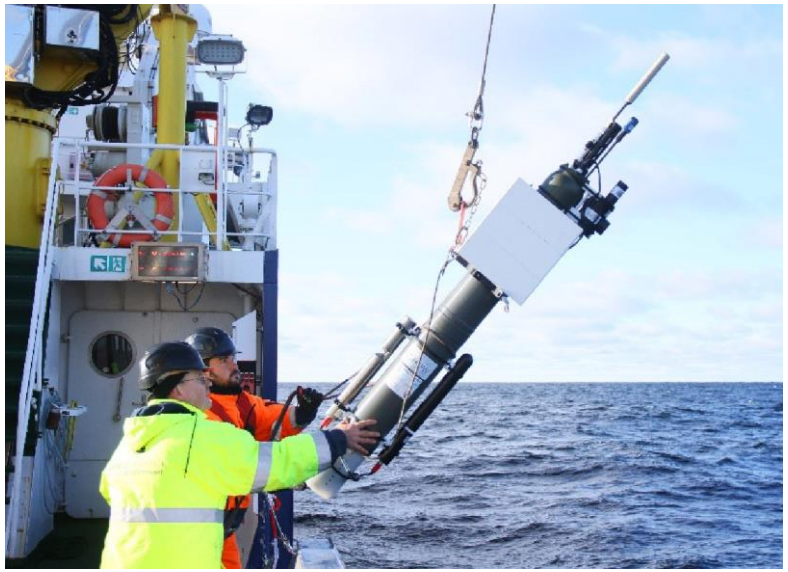




IOW has tested calibration procedures for the nitrate sensor in the Baltic

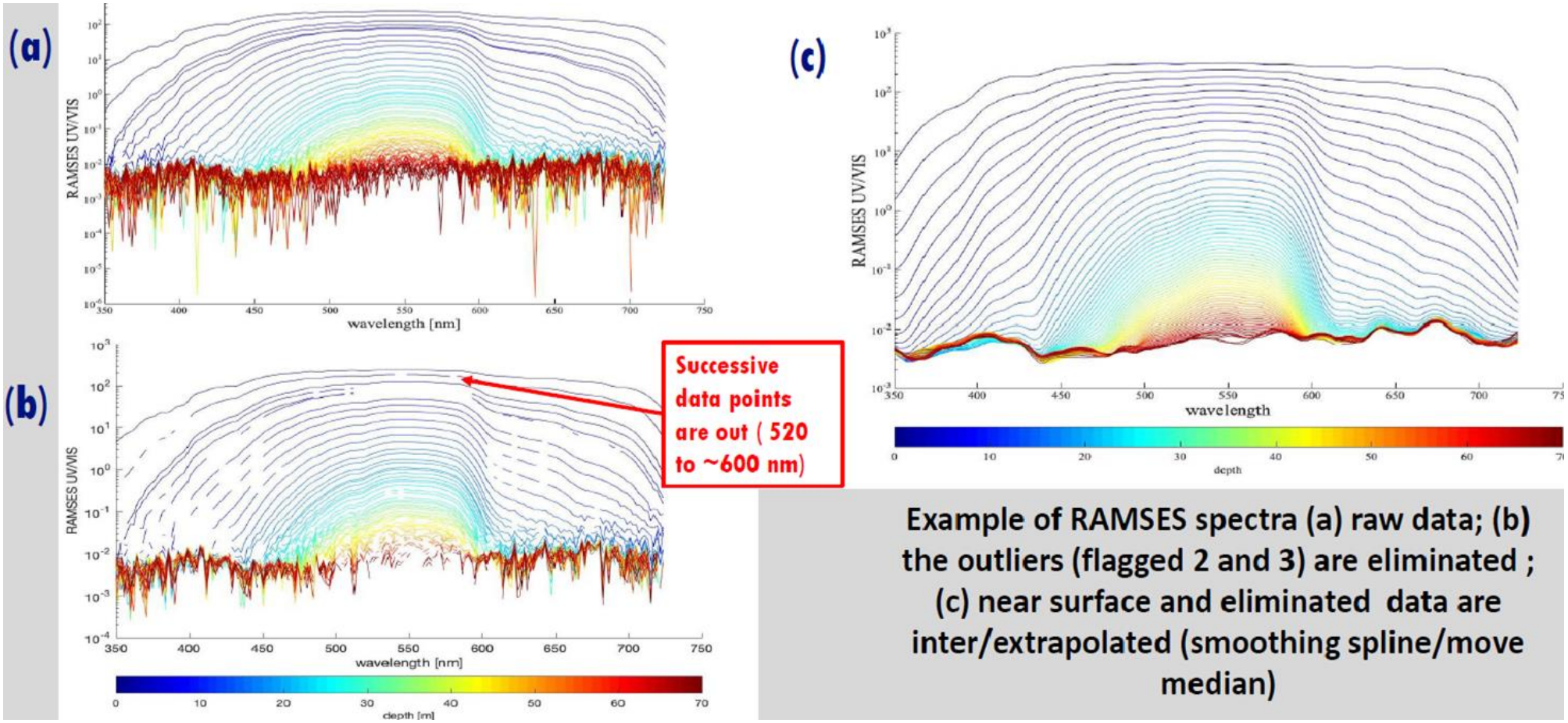
Nitrate (raw) data: Good OPUS / SUNA agreement
OPUS and SUNA give equivalent and accurate data after calibration
Nitrate adjustment for Baltic Sea requires adapted DMQC methods:
Since no stable, deep reference available is available, but a permanent / seasonal zero-nitrate occurrence is a given
Use FDOM signal for zero-nitrate correction

Surface nitrate consumed with spring bloom
Deep water & summer surface & winter water with low/zero values



BGC time series for optical sensors

Methods for data flagging and quality control for the radiometers are developed by ICBM



Example of RAMSES spectra (a) raw data; (b) the outliers (flagged 2 and 3) are eliminated ; (c) near surface and eliminated data are inter/extrapolated (smoothing spline/move median)

OCR-504 (SeaBird)

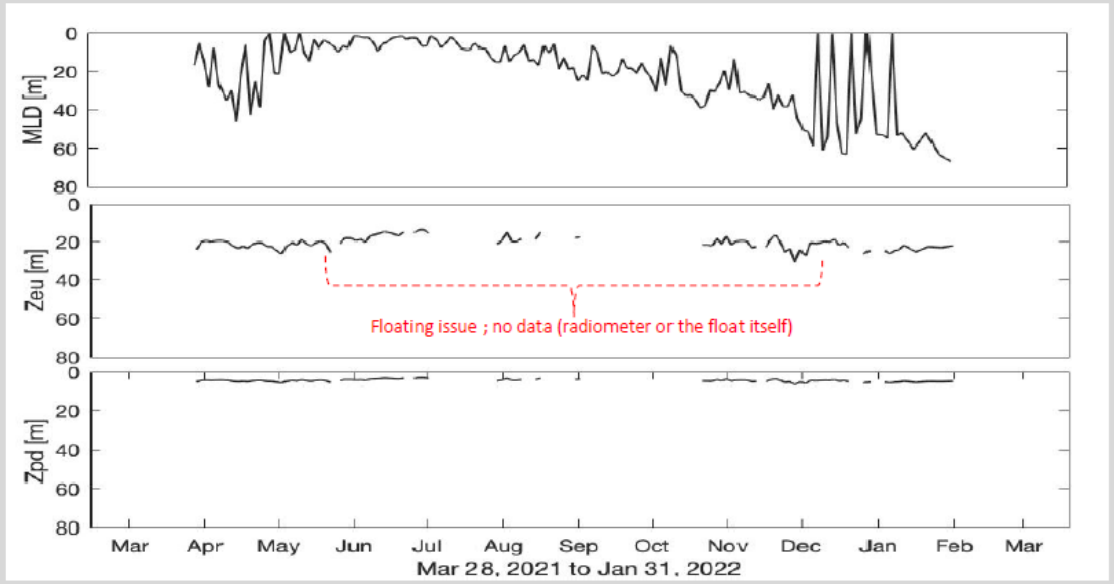
Ramses (Trios)

BGC time series for optical sensors

Aim is to use the optical data to determine time series of key variables for optical/biological process such as light penetration depth and depth of euphotic zone.

- Mixed layer depth (CTD: PRES, TEMP, PSAL)
  - ➢ **Construct time series of mixed layer properties in the Baltic Sea** ☺

- Photic zone and first optical depth (Radiometer: RAMSES)
  - ➢ **interruption/ discontinuance of optical parameters**
    # same issue for the Fluorometer ☹



The light first penetration depth Z_{pd} , photic zone (Zeu)in units of meters (right) and mixed layer depth from Mars 28, 2021 to January 31, 20022 (80m pressure profile)

MLD refers to the uniform surface layer (**de Boyer Montégut et al., 2004**)

Zeu: above zone at depth which PAR ; (400 to 700nm) has reached the 1% of the surface value

$\boldsymbol{Z_{pd}} = Z_{eu}$ /4.6
(Morel, 1988)

➢ **Platform (or sensor?) related factors restricted the completion of the mission in the Baltic Sea**
(pycnocline? Technical details faced the radiometer/fluorometer or the float itself?).

thanks for your attention

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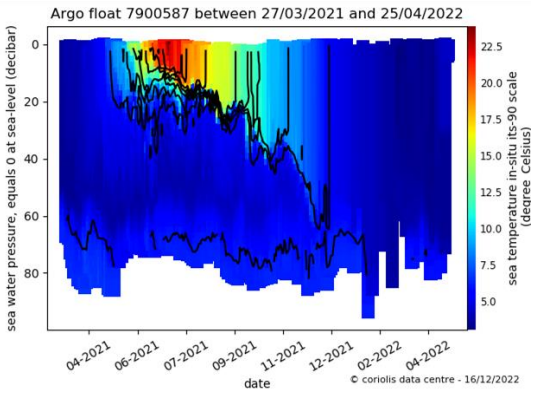
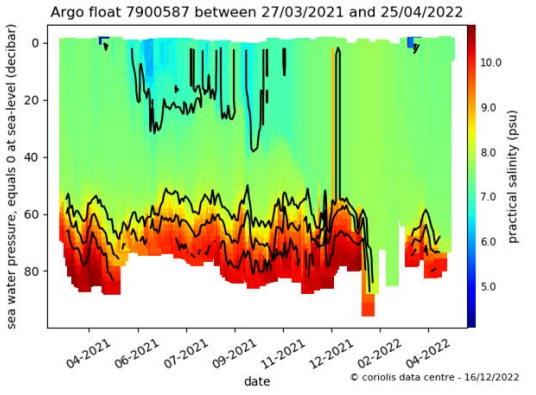
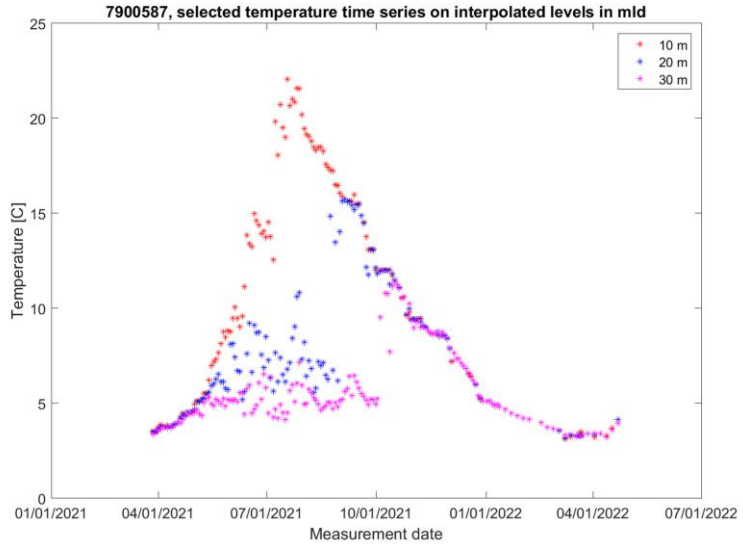
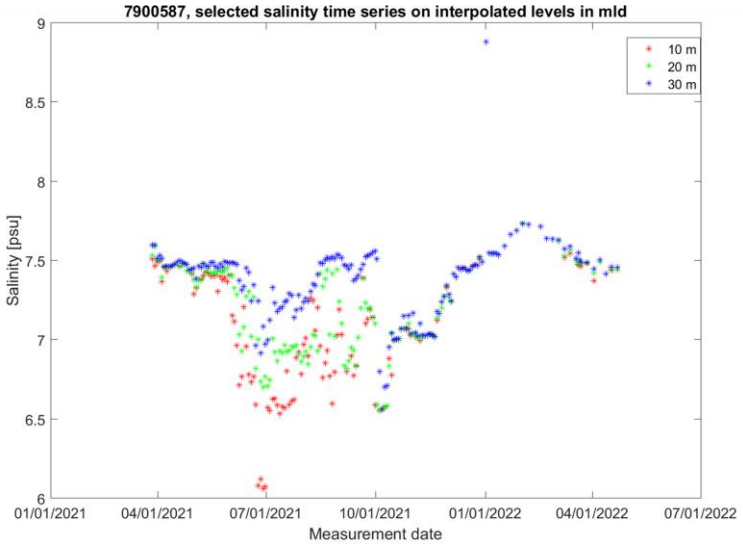
Timeseries at fixed levels to be used for comparison with climatology

D2.7 suggested to use 10-30 m range in the southern Baltic to avoid the variable signal from the North Sea water signal at the bottom.
What to select for the Gotland Deep?









- Float only measured to 80 dbar
- Sections show halocline at 50-80 dbar
- Above homogeneous salinity layer
  But seasonal signal in temperature down to 40 m

Select surface or deeper layer?

Corrections of seasonal cycle necessary? Or will a search criterion of 30 days reduce effects enough?

Does seasonal signal in temperarure has to taken into account for salinity?