CONWEST-DYCO - Role of fine scale coastal ocean dynamics in North Sea and Baltic Sea

L. Fenoglio[1], V. Mohrholz[2], H. Uyanik[1], J. Chen[1], J. Kusche[1]

1) Inst. of Geodesy and Geoinformation, University of Bonn 2) Leibnitz Institute for Baltic Research Warnemuende (IOW), Germany

Motivation

CONWEST-DYCO investigates fine scale variability and hydrodynamic processes in coastal and estuarine regions with space observations. The two research questions are: can we

- observe sub-mesoscale structures and hydrodynamic processes at the coast?
- track the water exchange between inland waters and coastal zone?

ROIs are the Eastern Gotland Basin (EGB) and Danish Straits (DS), both in SWOT Adopt-A-Crossover (ADAC) Consortium initiative. Oceanic processes in EGB connect deep-water and surface layer, with a basin scale cyclonic gyre (radius 25-35 km) with mean current velocity of 5 to 10 cm/s. In DB the transport is driven by water level differences and by barotropic pressure gradient. Fine scale processes (upwelling, frontal structure and filaments) are superposed to the estuarine circulation.

Methodology of validation and data

Water level from nadir- and swath-satellite altimetry are compared to mooring pressure data and to in-situ gauges. Further we will study: ocean currents, absolute geostrophic currents (uag, vag) and geostrophic current anomalies (uga, vga) to be derived from maps of absolute dynamic topography (ADT) and Dynamic Topography (DT) anomalies assuming geostrophy. Products to be used are L2 LR SSH KaRIn products, upper-ocean currents to be compared to currents from CMEMS/DUACS L4 and Globcurrent for validation. Also, steric height computed from Temperature and salinity measurements at depth will be compared to the altimetric heights. Below is a list of the data available:

- Sub-surface moorings: $Gotland_{NE}$, $Gotland_{C}$, $Gotland_{SW}$ (CBa, 1d), Boknis Eck + Fehmarn Belt (WBa, 1d), Marnet stat (WBa, 21d): T,S,vel
- Ships CTD 10km CBa 5x/y (Ja-Ma-Ma-Ju-No): T,S,vel, air-sea flux, bio
- two VOTO gliders: M11 (11-04-2023 to 16.05.2023) and M12 (16.05.2023-20.06.2023)
- Argo T S, surface SST
- Alti along-track (RADS,stand,ded-coast ESA/U-Bonn), gridded (AVISO)
- Ocean models: SCHISM(HZG DA,10-400m Elbe) and BSH (90 meters)

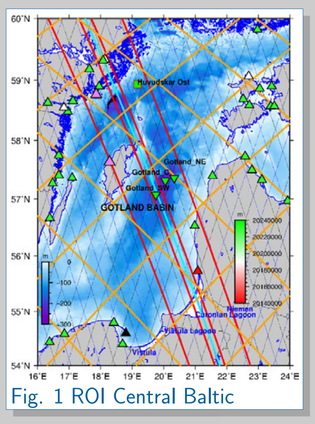

Fig. 1 ROI Central Baltic

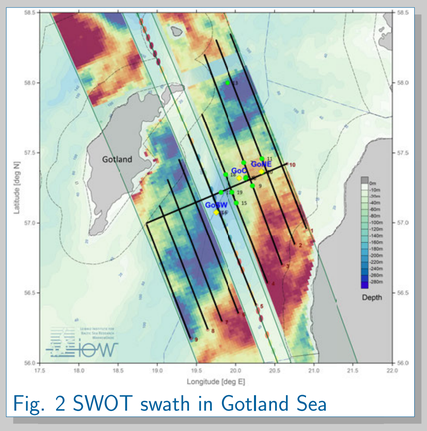

Fig. 2 SWOT swath in Gotland Sea

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SWOT AdAC campaign

The IOW cruise CIREG-SWOT EMB316 measured high-resolution 3D snapshot of hydrographic conditions in 18-28 April 2023.
Scientific objectives are:

- Assess suitability of SWOT SSH data for EGB circulation meso and sub-mesoscale patterns studies. Goal is EGB circulation and closing of the Baltic overturn circulation.
- Temporal variability. Today long-term moorings in the EGB equipped with bottom pressure sensors for SWOT 1-day.
- Spatial variability: 3D hydrographic snapshot
- All gathered data are integrated in the IOW Baltic Long-Term Observation program.

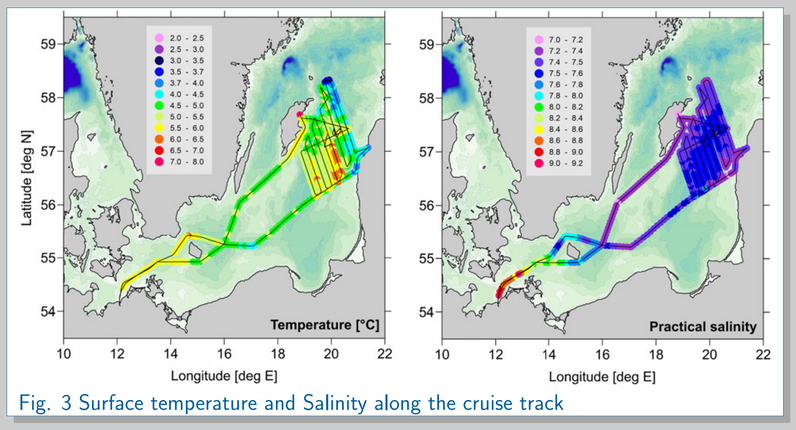

Fig. 3 Surface temperature and Salinity along the cruise track

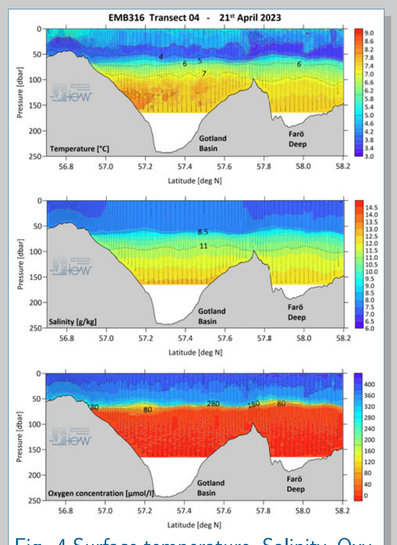

Fig. 4 Surface temperature, Salinity, Oxygen concentration of ScanFish transect 4

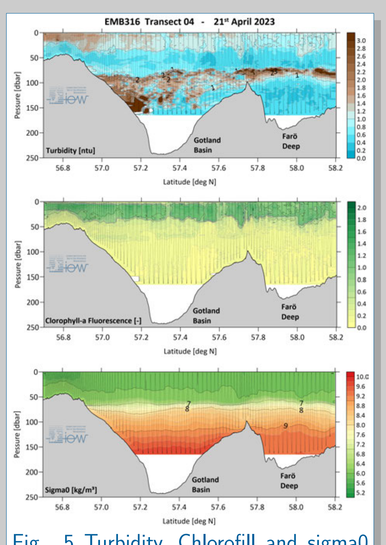

Fig. 5 Turbidity, Chlorofill and sigma0 along transect 4

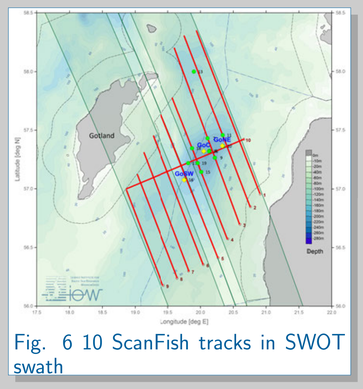

Fig. 6 10 ScanFish tracks in SWOT swath

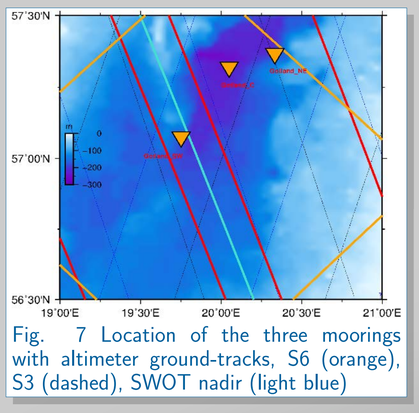

Fig. 7 Location of the three moorings with altimeter ground-tracks, S6 (orange), S3 (dashed), SWOT nadir (light blue)

Measurement done in Campain:

- long-term mooring, pressure compared to sea level in Fig. 8.
- 10 ScanFish tracks in SWOT swath (Fig. 6). Adjacent transects distance 6 to 7 n.m. Along track resolution 0.5 to 1.0 n.m. Length of transects 50 to 90 n.m., depth until 140 m.
- Ocean current measurements with ADCP mounted in the moon pool of the ship.
- CTD casts at mooring and at stations in EGB deep-water layer below 140m, to collect data for Scanfish data calibration and extend time series of moorings data.
- Underway measurements along Scanfish grid with the ships thermosalinograph, to obtain high resolution SST/SSS data.
- gliders (VOCE, Sweden)

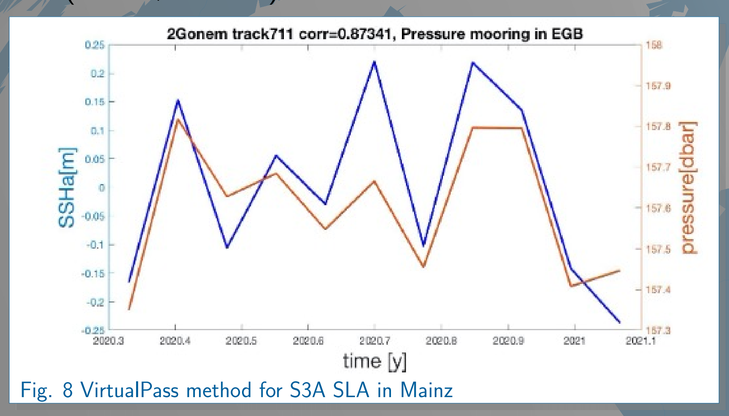

Fig. 8 VirtualPass method for S3A SLA in Mainz

SWOT First Results

We use SWOT L2 NALT IGDR, SWOT L2 LR SSH 1.1 Expert Product and L3 LR SSH. Sea level heights are validated against pressure of mooring $Gotland_C$ (GOCE) in Central Baltic, collected between Dec. 2022 and May 2023. Sea level was not corrected for ocean tide and atmospheric effects (DAC). The correlation between pressure and sea level from Sentinel-6 is 0.7 (Fig. 9).

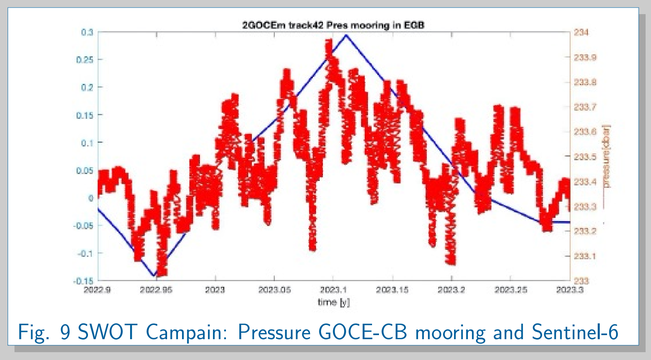

Fig. 9 SWOT Campain: Pressure GOCE-CB mooring and Sentinel-6

The correlation between pressure and sea level from SWOT nadir and SWOT-karin is 0.49 and 0.43 (Fig.10). STDD between SWOT-nadir and SWOT-karin is 5 cm.

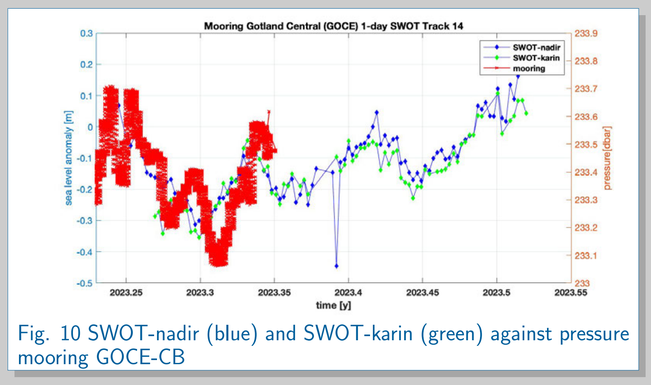

Fig. 10 SWOT-nadir (blue) and SWOT-karin (green) against pressure mooring GOCE-CB

The accuracy of sea level from SWOT L2 NALT nadir against the Visby tide gauge record is 6 cm (STDD), correlation is 0.8 (Figs. 11,12). Altimetric time-series are built with the overpass method (Fenoglio et al., 2020).

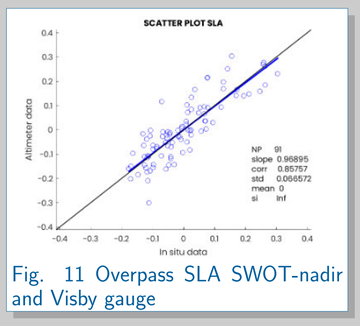

Fig. 11 Overpass SLA SWOT-nadir and Visby gauge

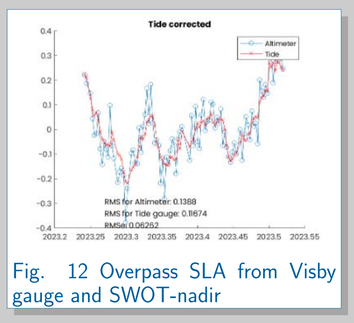

Fig. 12 Overpass SLA from Visby gauge and SWOT-nadir

The correction $SWOT.heightcorxover$ applied to ssh_{karin} in L2 LR impacts largely the water level time-series (Fig. 13, Fig. 14). See difference with and without this correction in Figs. 10 and 14 (green curves).

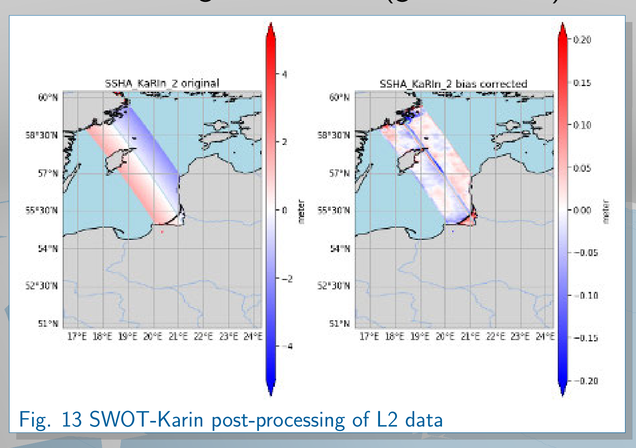

Fig. 13 SWOT-Karin post-processing of L2 data

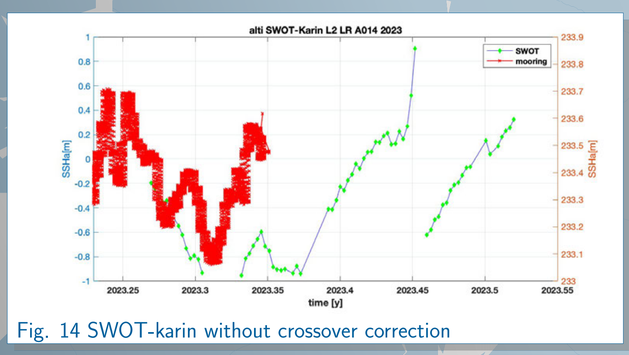

Fig. 14 SWOT-karin without crossover correction

Conclusions

- ADAC CONWEST-DYCO CIREG-SWOT in Baltic
- Corr 0.8 moorings GOCE NE AND CE against S-3, S-6
- Corr 0.4 mooring GOCE CE against SWOT-nadir, -karin
- Corr 0.8 SWOT-karin against SWOT-nadir
- Large effect of xover correction on water level

Contact
Luciana Fenoglio,
fenoglio@uni-bonn.de,
www.igg.uni-bonn.de/apmg