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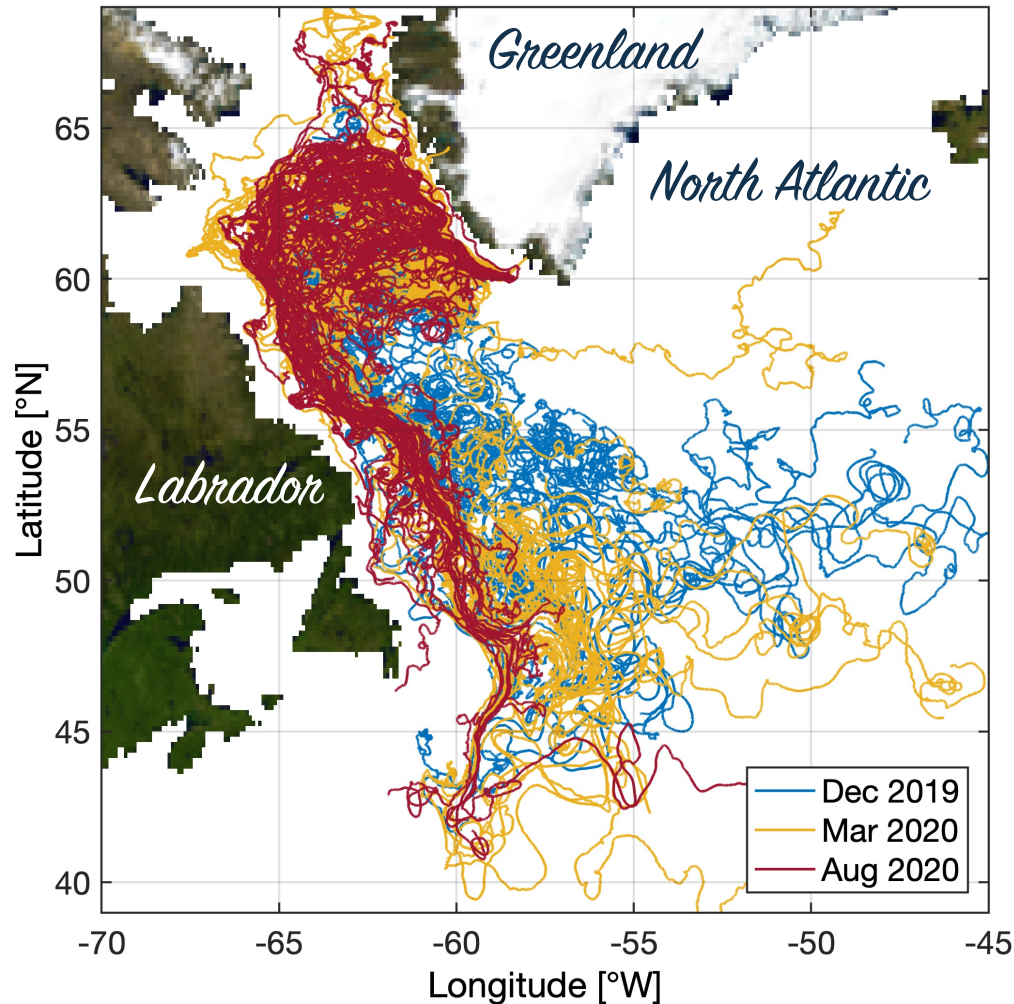
Wind driven Ekman transport vs eddies – ultimate fight or peaceful cooperation in the Labrador Sea?



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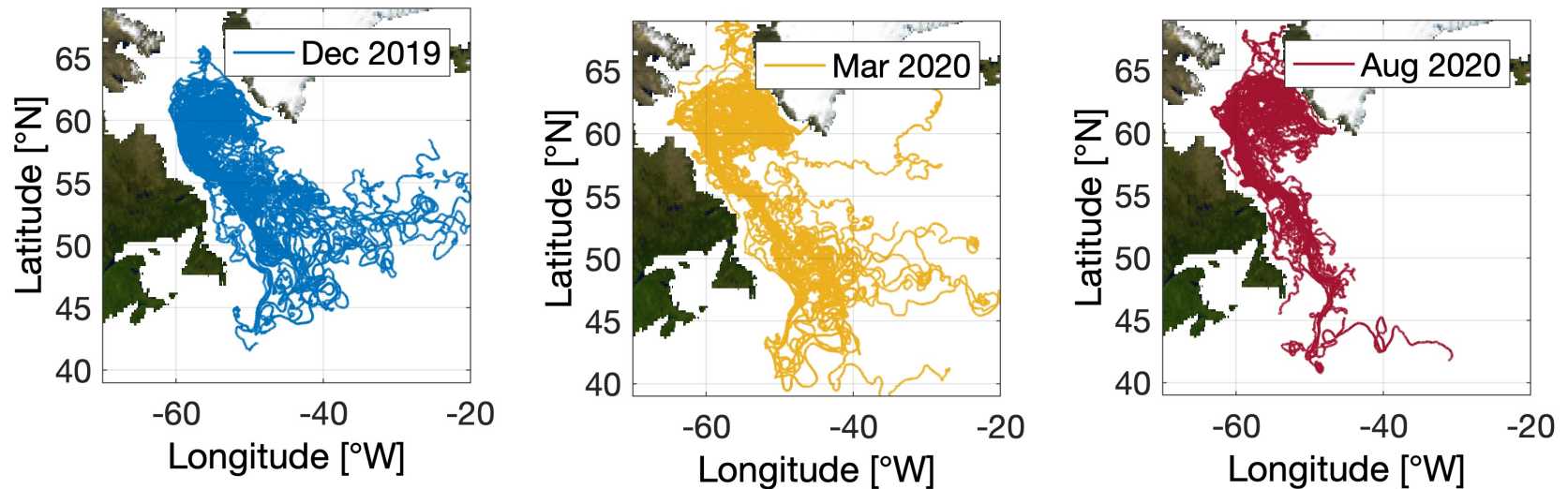


150 surface drifters deployed west of Greenland



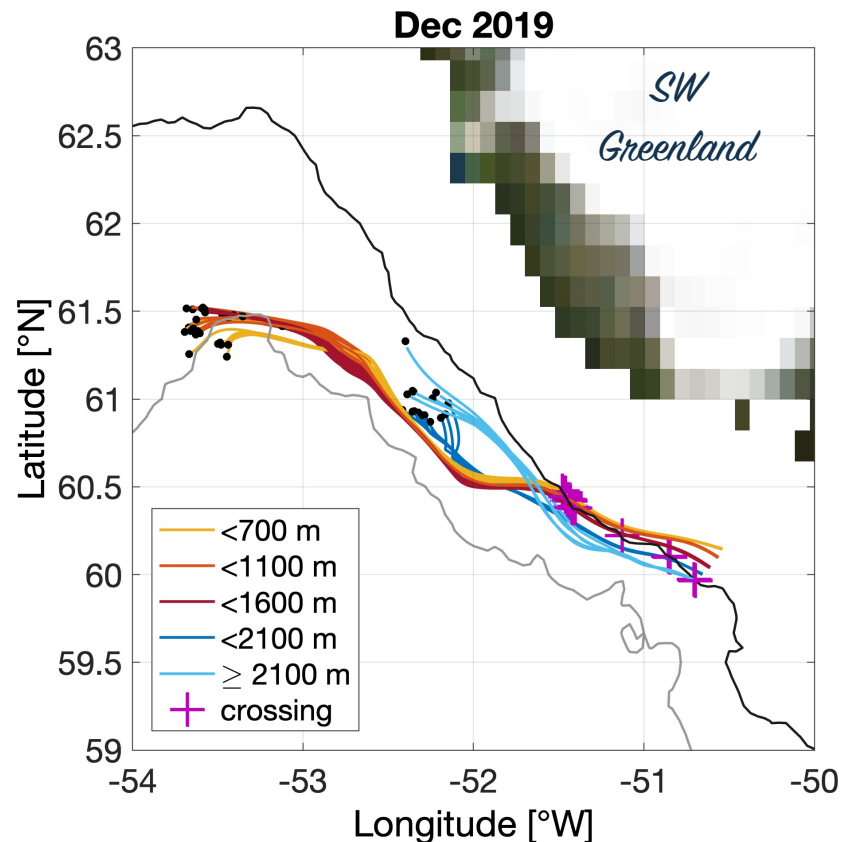
The instruments used in this study are the Scripps Institution of Oceanography's surface drifters with T sensor and drogue centered at 15 m.

Drifter trajectories (as for late April 2021)



- The maps show three deployments:
 - December 2019 (Adolf Jensen, Qaqortoq)
 - March 2020 (Adolf Jensen, Qaqortoq)
 - August 2020 (Maria Sibylla Merian, GEOMAR MSM96 cruise)
- The extension of drifter pathways to the north varies depending on SPG contraction/expansion phase
- Fastest pathway – along the boundary
- Slowest pathway – across the central Labrador Sea

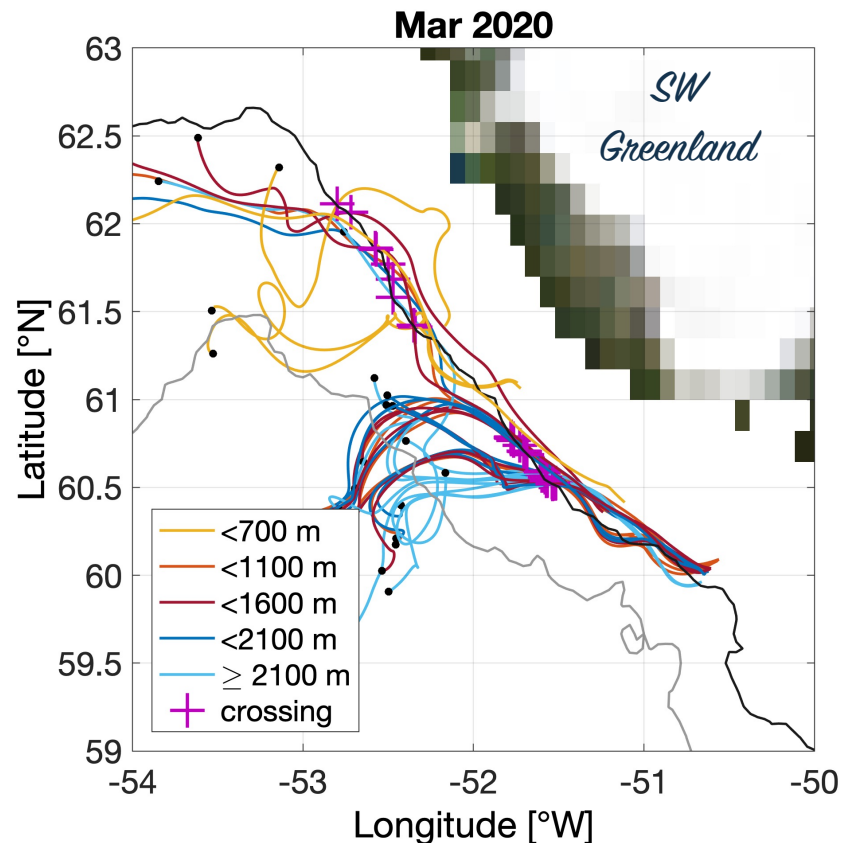
Results – December 2019 deployment



- Drifters deployed inshore detached after passing Cape Desolation
- Drifters deployed offshore crossed 2500 m isobath earlier but then part of them (the most offshore) turned inshore
- The inshore deployed drifters have the higher speed
- The wind started to get stronger and from direction favourable for offshore transport later in that winter.

The 2500 m isobath is represented by spatially reduced contour derived from smoothed ETOPO bathymetry). Fragments of trajectories cover 145 h time window (from 72 h before/start to 72 h after the crossing). Hourly data were filtered with 14 h Butterworth filter to remove the inertial oscillations. Line colors mean depth of deployment.

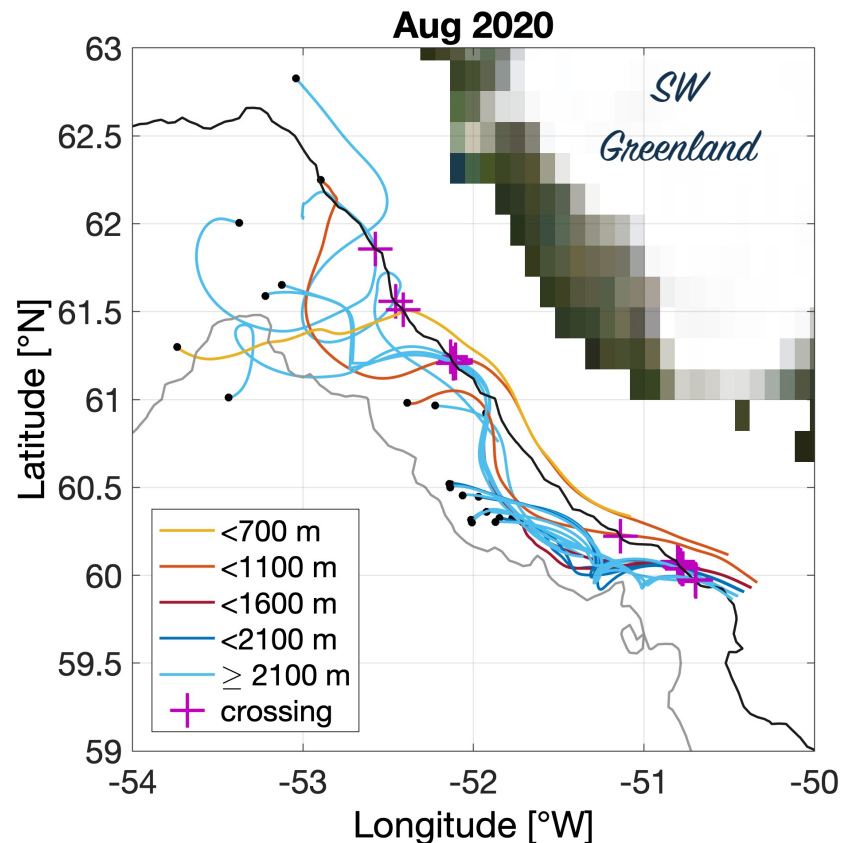
Results – March 2020 deployment



- Strong NW wind caused a substantial offshore Ekman transport
- There was smaller number of initial crossings than in December, though
- One drifter deployed onshore came back to 2500 m isobath and crossed it later
- More drifter followed the internal path and did not cross the 2500 m isobath west of Greenland (13/50 drifters)

The 2500 m isobath is represented by spatially reduced contour derived from smoothed ETOPO bathymetry). Fragments of trajectories cover 145 h time window (from 72 h before/start to 72 h after the crossing). Hourly data were filtered with 14 h Butterworth filter to remove the inertial oscillations. Line colors mean depth of deployment.

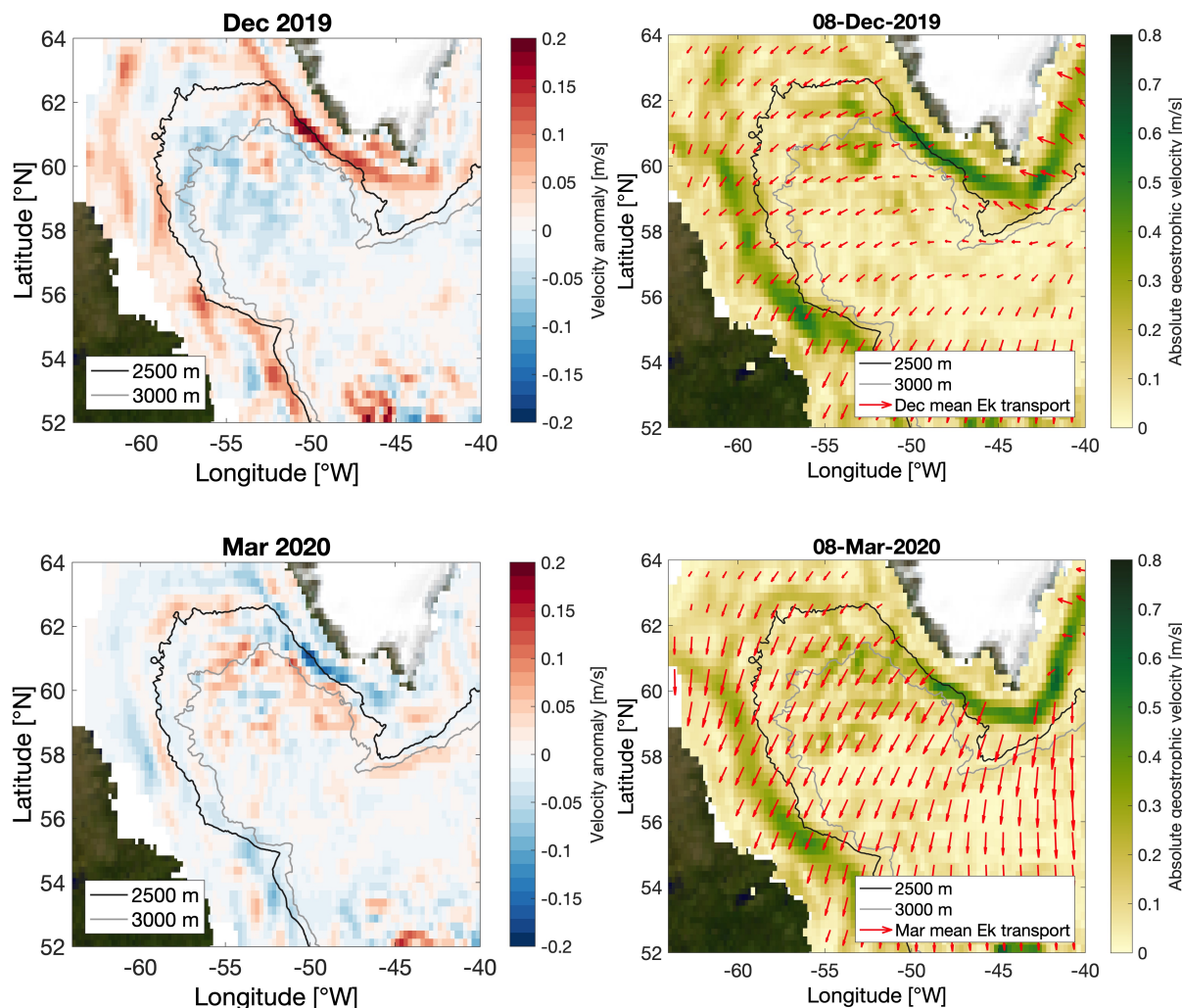
Results – August 2020 deployment



- The wind was much weaker than in winter
- 17 drifters deployed offshore crossed the 2500 m isobath
- Only one drifter deployed inshore (<700 m) crossed the 2500 m
- 22/50 instruments did not cross the 2500 m isobath west of Greenland and kept the most internal, coastal path
- Some of the instruments crossed the boundary current later, though

The 2500 m isobath is represented by spatially reduced contour derived from smoothed ETOPO bathymetry). Fragments of trajectories cover 145 h time window (from 72 h before/start to 72 h after the crossing). Hourly data were filtered with 14 h Butterworth filter to remove the inertial oscillations. Line colors mean depth of deployment.

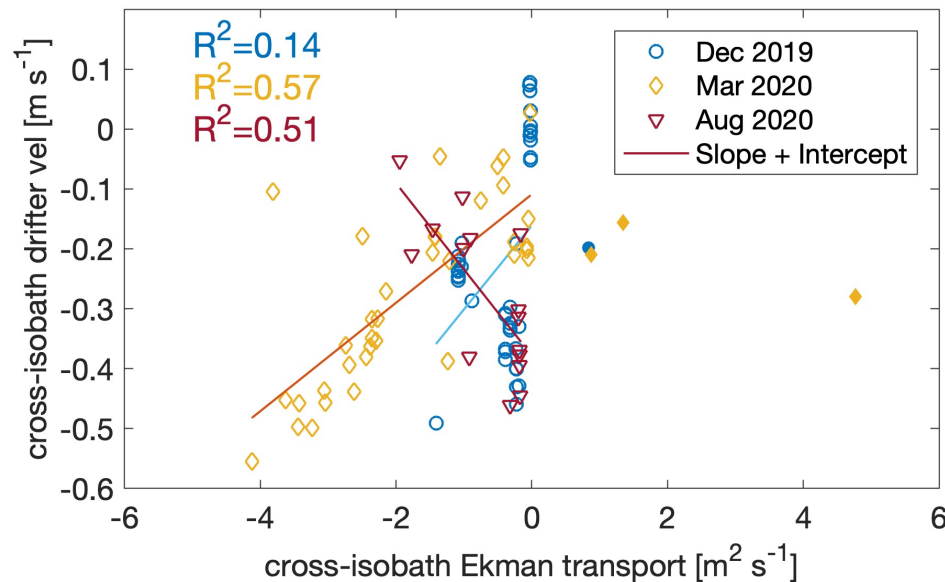
Absolute geostrophic velocity vs Ekman transport



- Anomalies of monthly mean absolute geostrophic velocity (ref period: Dec 2019-Jun 2020) indicate strongest West Greenland Current in December 2019 and weaker boundary current in March 2020
- Mean Ekman transport shows stronger offshore transport in March 2020 compare to December 2019

Geostrophic velocity was derived from Copernicus gridded SSALTO/DUACS Delayed-Time Level-4 0.25 x 0.25 deg product. The Climate Data Toolbox was used to calculate the Ekman transport based on ECMWF ERA5 reanalysis.

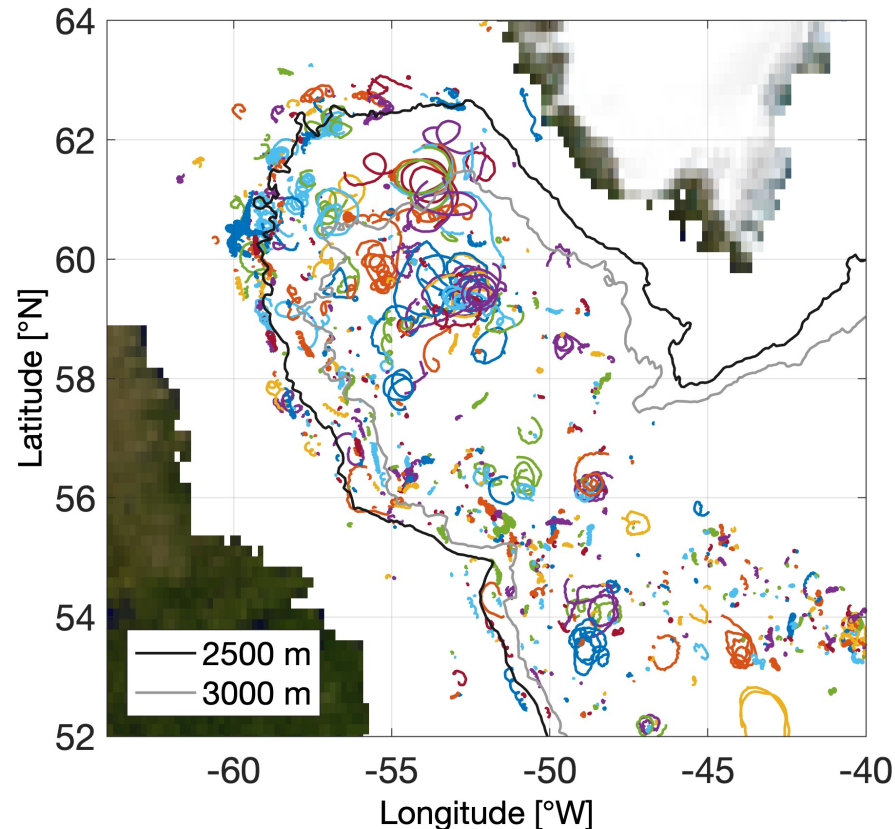
Drifter velocity variance explained by the wind



- In March, wind induced Ekman transport explains 57% of the drifter velocity at the crossings distributed in time and space along the WGC
- In December, most drifters left the WGC short after deployment and only 14% of the velocity variance can be explained by the wind forcing
- In August, only 17 drifters crossed the WGC while the rest was carried by the coastal current. Relation to the wind is negative yet the linear fit explains 51% of the velocity variance

The drifter and wind vectors were projected on the spatially reduced 2500 m isobath. Negative value of the obtained cross-isobath component means offshore direction. The results were filtered with 14 h filter to remove the inertial oscillations. Mean values of drifter crossing the 2500 m isobath were calculated in 18 h (or shorter) time window (from 12 h before/start to 6 h after the crossing).

Eddies in the Labrador Sea: different sizes and origin

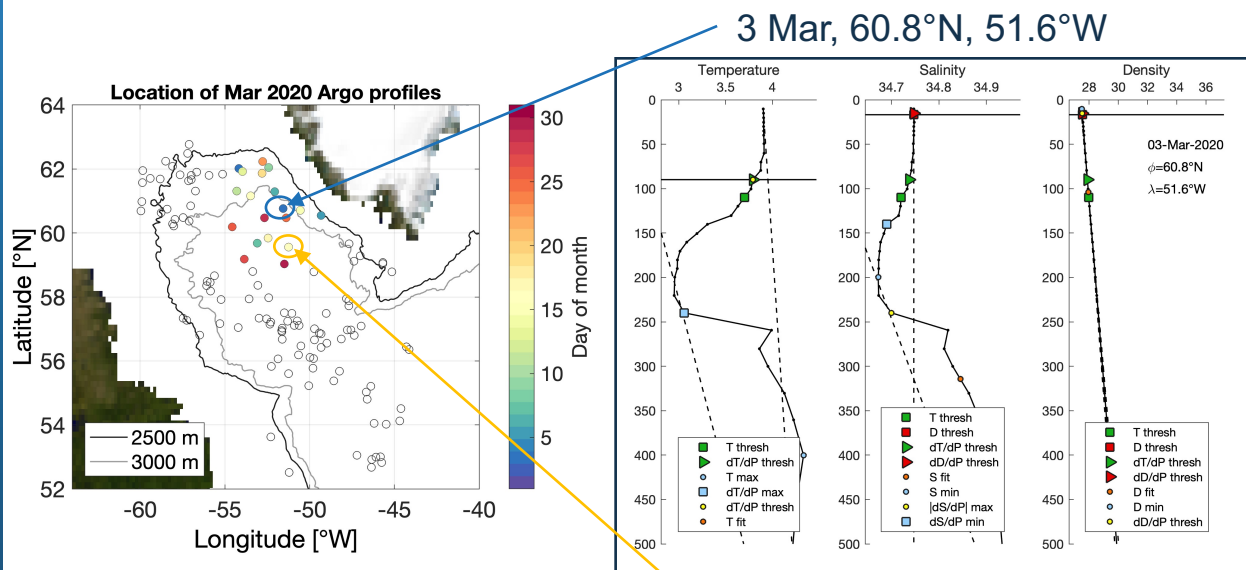


- Ellipses derived from drifter trajectories
- Notice the lack of eddies in the areas of low EKE (according to AVISO altimetry)
- Separating ridges – input:
 - FMAX - Maximum ratio of frequency to Coriolis frequency
 - FMIN - Minimum ratio of frequency to Coriolis frequency
 - P - Wavelet duration, $P \geq 1$
 - M - Ridge length cutoff in units of wavelet length $2P/\pi$
 - RHO - Ridge trimming factor, removing $RHO \cdot P/\pi$ from each end

(FMAX = 2, FMIN = 1/64, P=1.8, M=1, RHO=1/2)

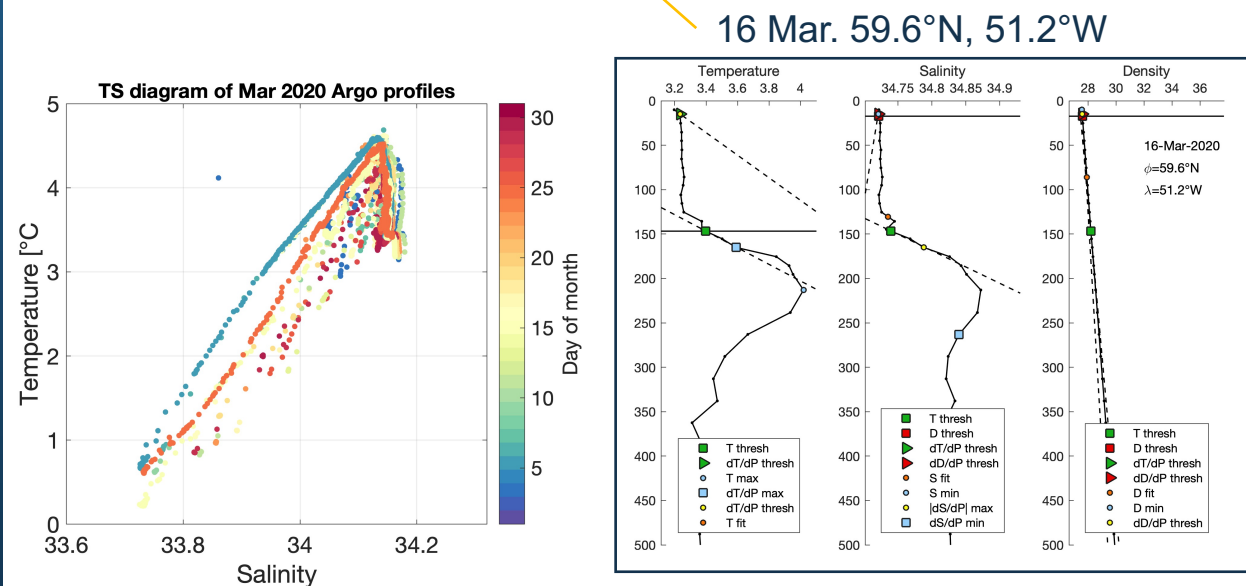
The ridges were separated with JLab 1.7.0 functions

Stratification of the upper water column, Argo, Mar 2020



- In general, in March, the evolution/deepening (80 ->150 m) of the upper water column happens due to intense heat loss to the atmosphere

- In the first selected profile (upper panel) the T, S subsurface minima indicate subduction of the fresh and cold coastal water



- In the second profile (lower panel) the subsurface T, S maxima are related to the Irminger/Atlantic origin water that found its path into the center of the Labrador Sea

The Argo profiles were downloaded from Coriolis DAC. The MLD was calculated with Holte & Talley method, various criteria as shown in legend

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<https://projects.noc.ac.uk/terific/>

Acknowledgements

We would like to thank the crew of ‘Adolf Jensen’ and NOC colleagues for their great help during two drifter deployments off Greenland, as well as the crew and science party of ‘Maria S. Merian’ for deploying the drifters during their summer cruise under the fieldwork-disturbing COVID-19 conditions.