EGO 2011 Meeting, Las Palmas, 16-18 March 2011

Fram Strait Observatory - recent glider activities and future plans

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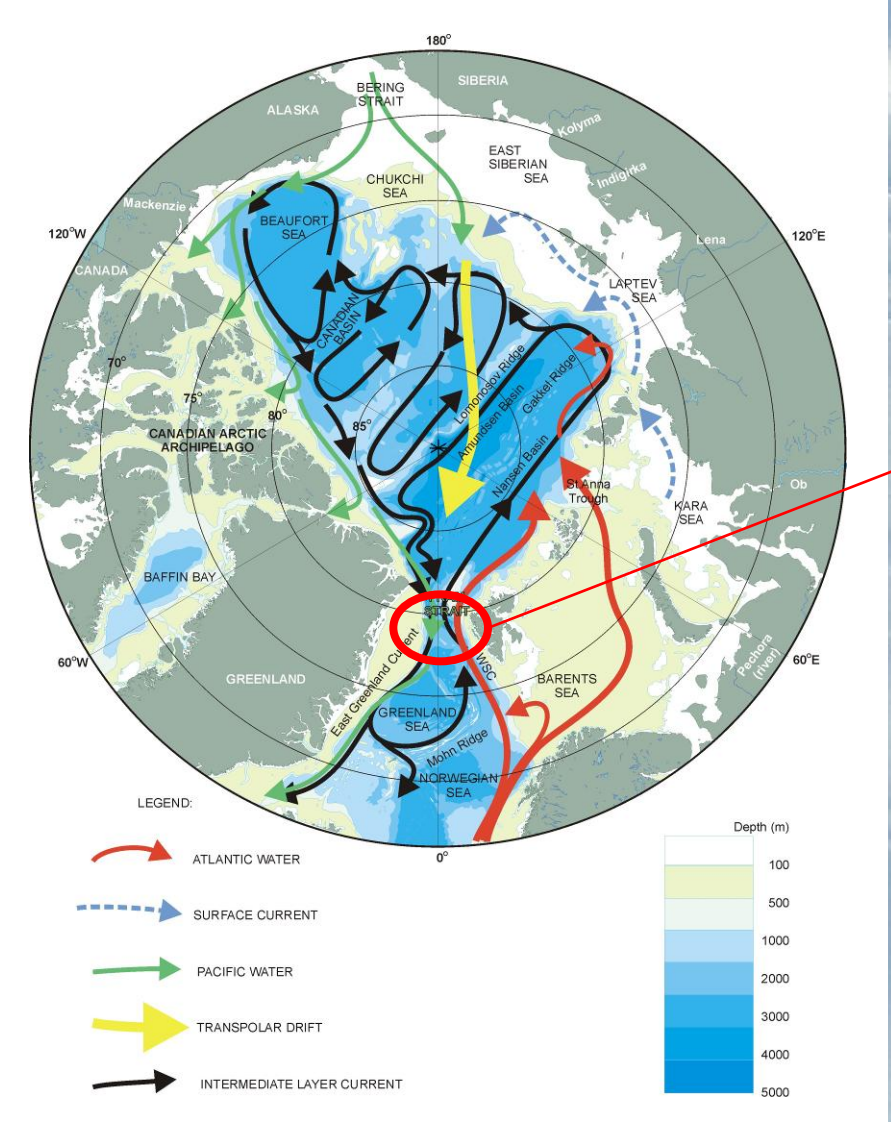
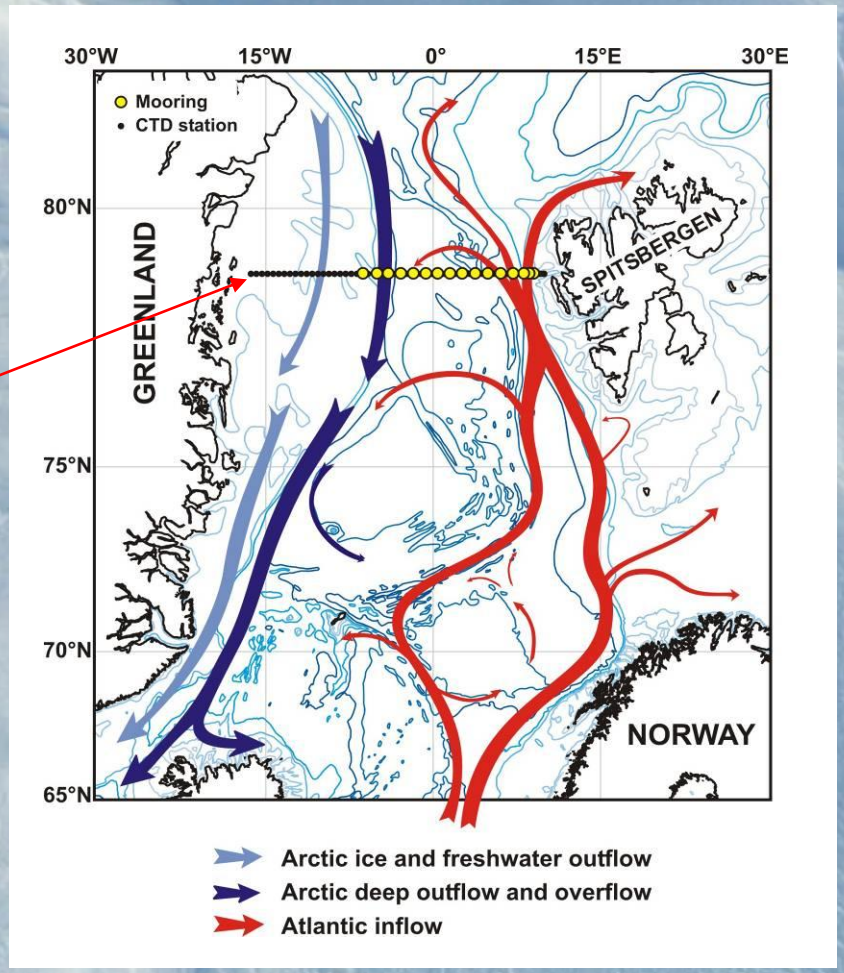
[4)]NERSC, Bergen

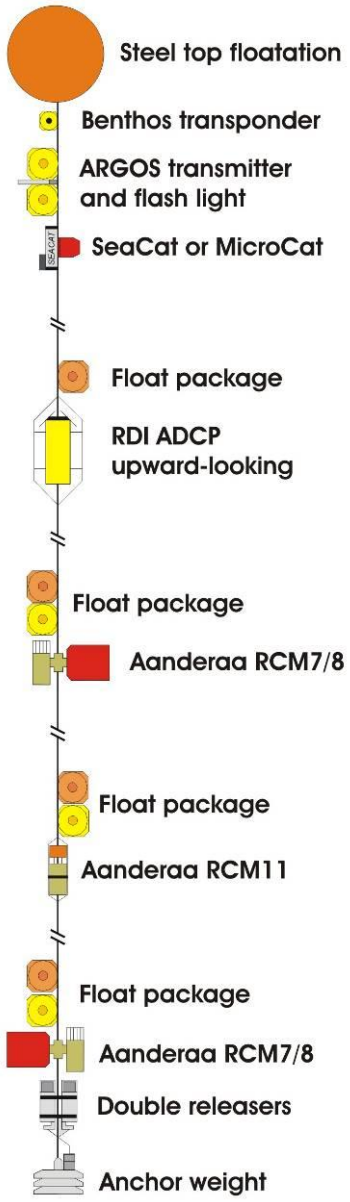
Fram Strait – a gateway to the Arctic Ocean

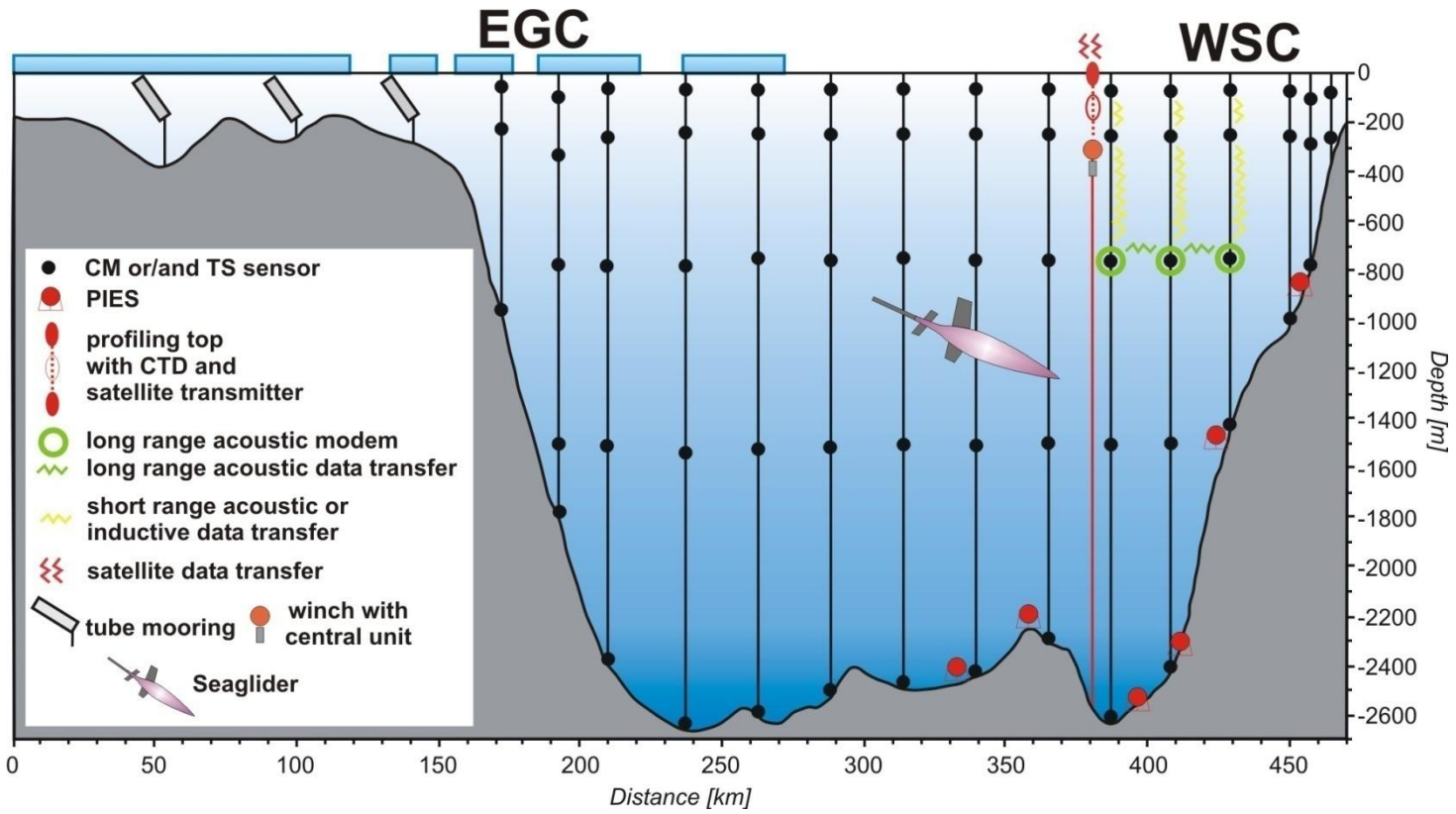




Østerhus after Rudels

Fram Strait moored observatory – oceanographic moorings



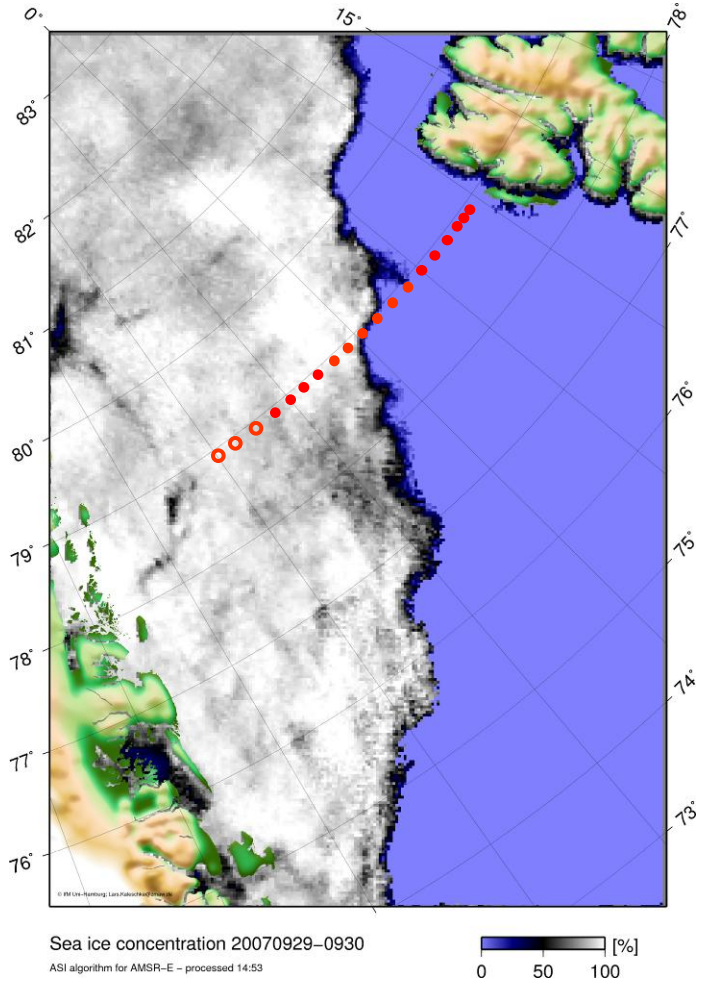


16-18 oceanographic moorings
has been maintained by AWI and NPI since 1997
in the northern Fram Strait at the latitude of 78°50‘N

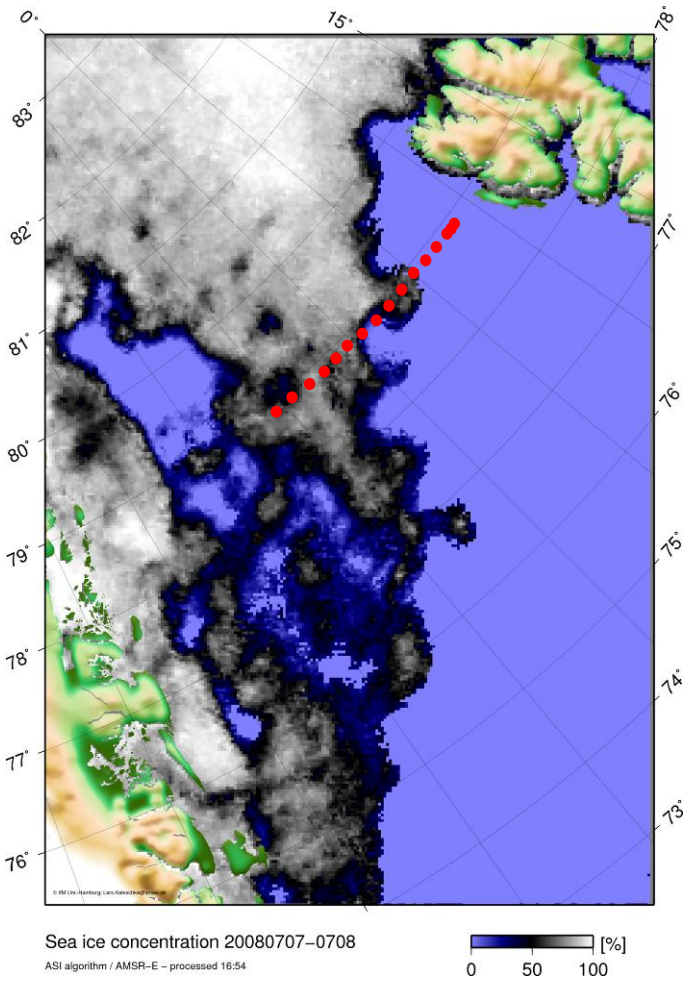
Gliders in use since 2008

Summer sea ice conditions in Fram Strait

September 2007

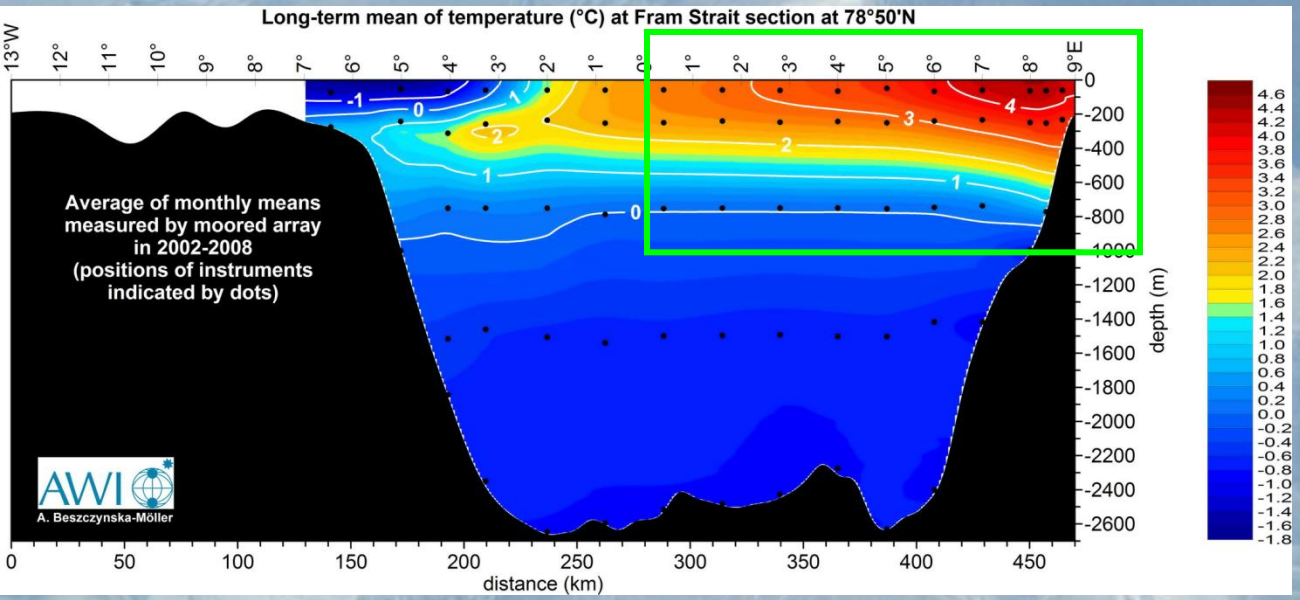


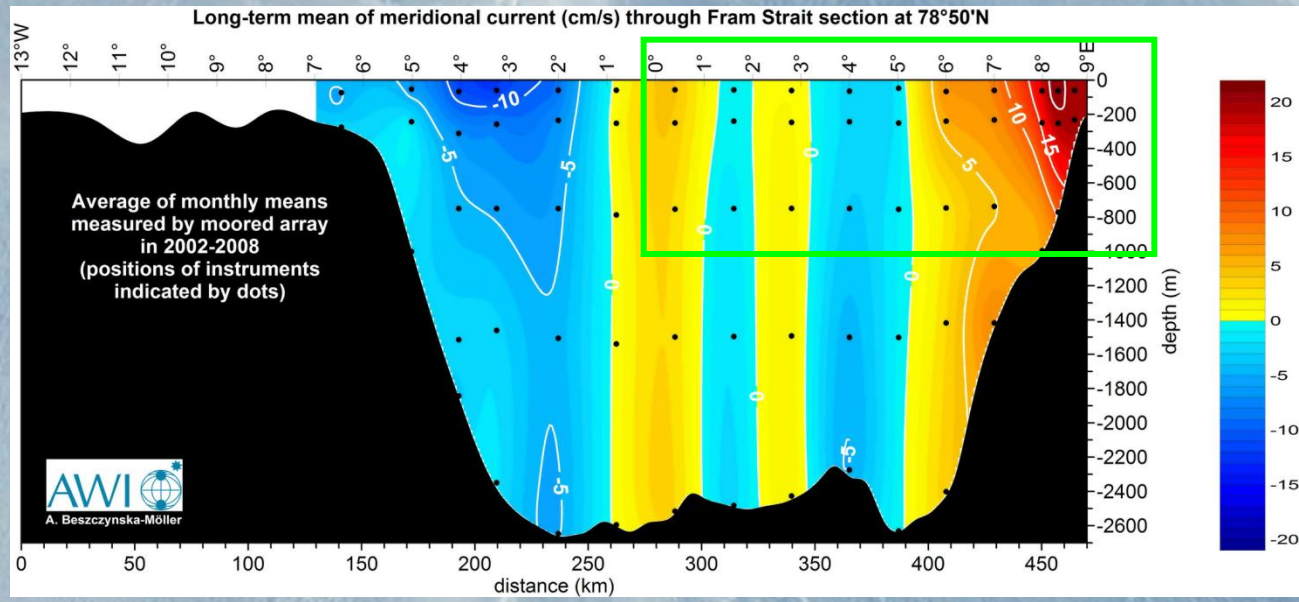
July 2008



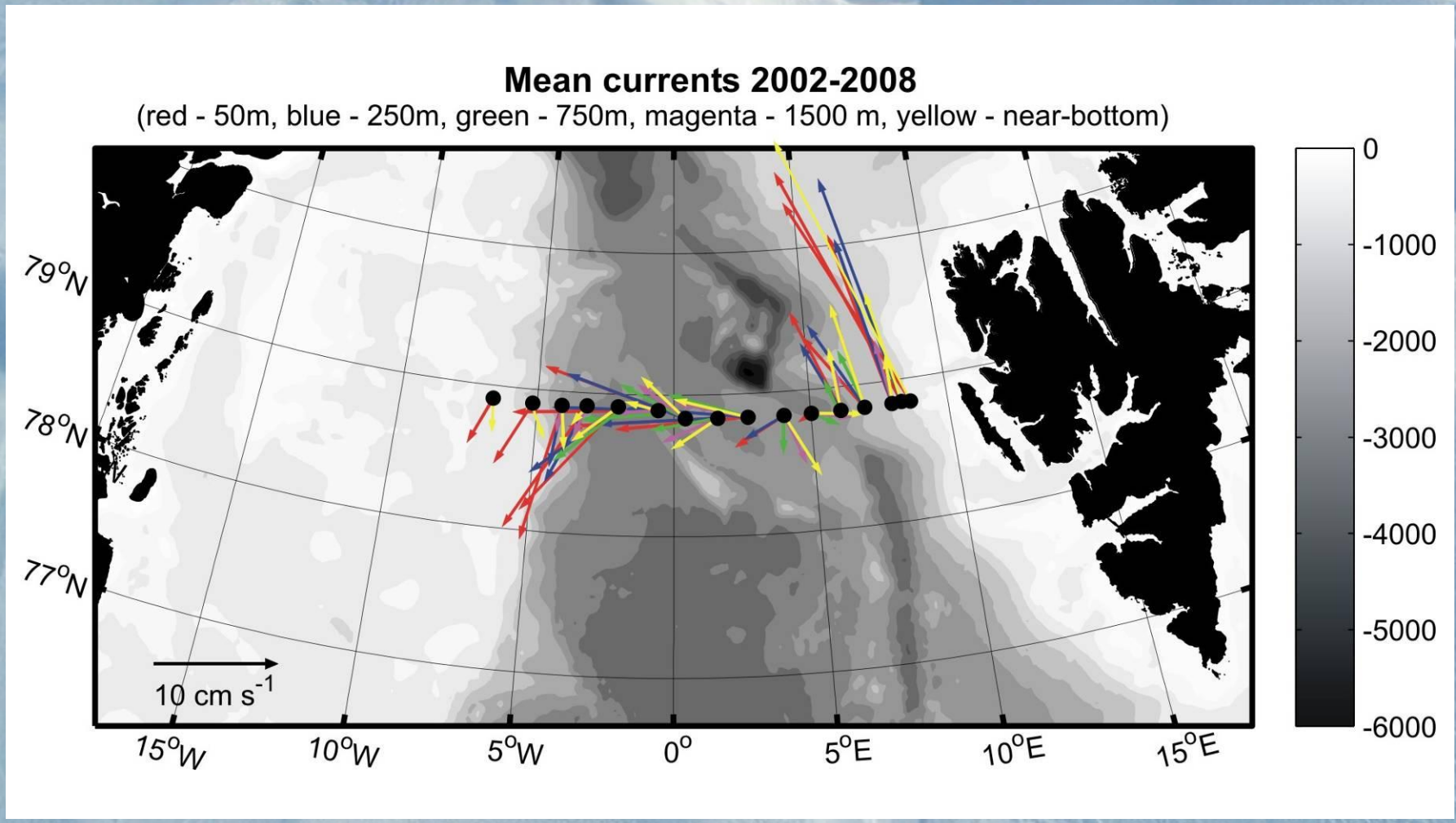
Sea ice map from the website of UIP, University of Bremen

Temperature and cross-section currents (2002-2008) measured at Fram Strait section

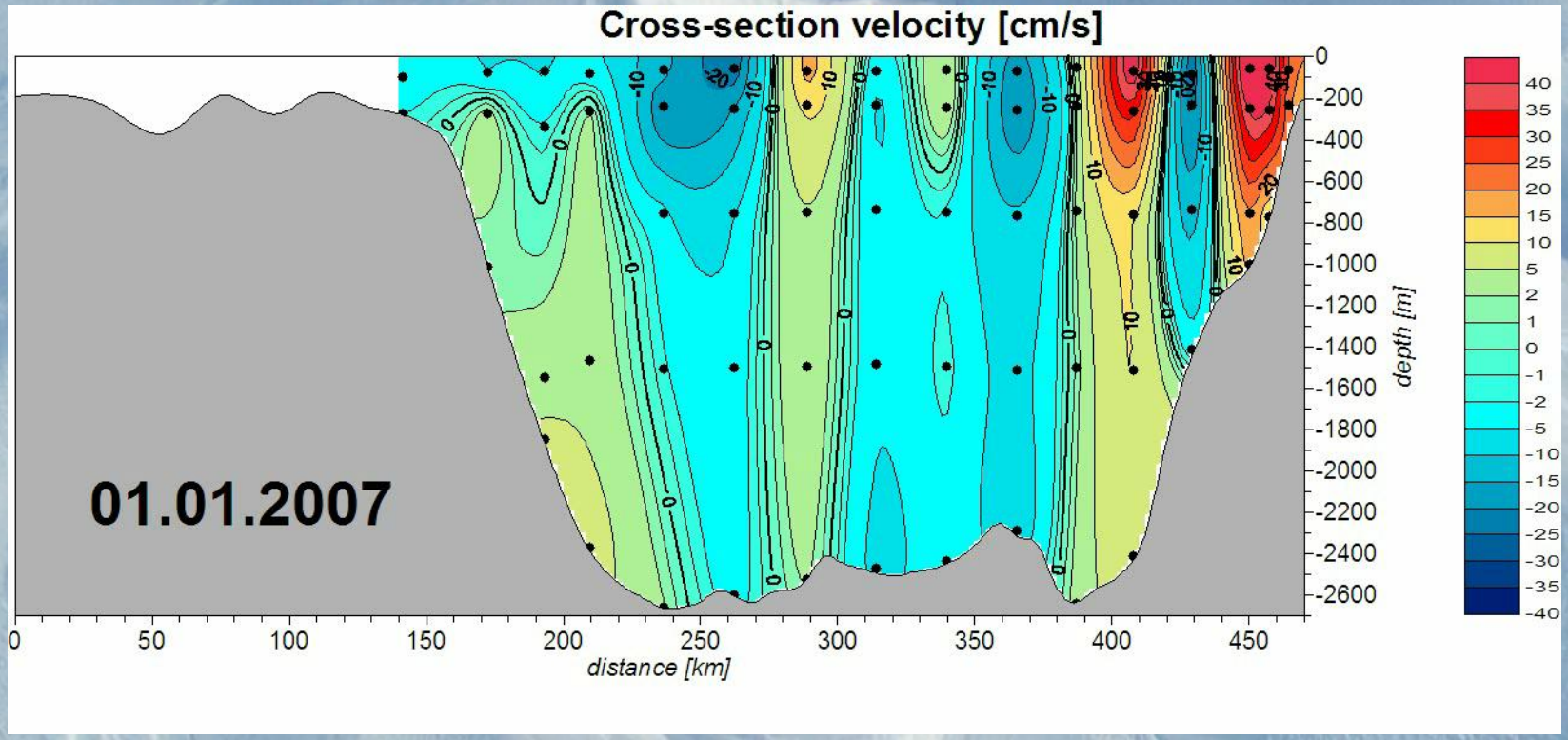




Mean current vectors at Fram Strait section ASOF/DAMOCLES period (2002-2008)

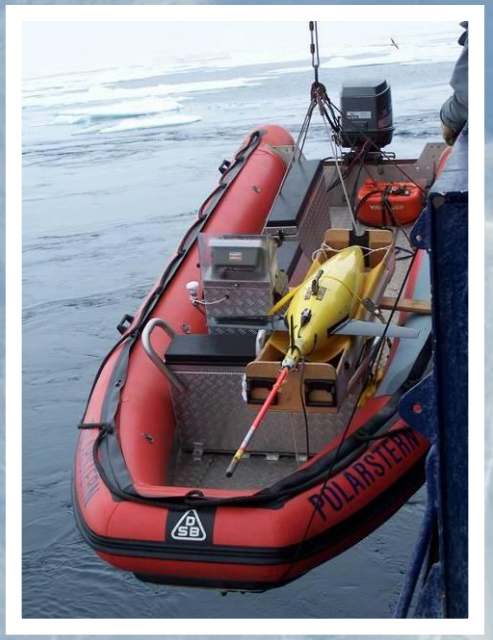


Daily means of meridional current in Fram Strait



- strong variability on daily scales (tides already removed)
- bands of currents related to bottom topography
- generation and propagation of eddies at the egde of the WSC

Glider measurements in Fram Strait in 2008-2010



In Fram Strait AWI employs Seagliders, developed in a collaboration between the Applied Physics Laboratory and the School of Oceanography of UW in Seattle. A standard Seaglider is currently commercially available the from iRobot Corporation.

Fram Strait gliders are operated from the base station at the Glider Operation Center, established by OPTIMARE, Bremerhaven. RUDICS service is successfully used for communication, the Iridium modem serves as a backup.

In collaboration with APL-UW, the under-ice, acoustically navigated glider equipped with RAFOS capabilities, successfully used by APL in the Davis Strait, is under implementation for measurements in the ice covered part of Fram Strait.

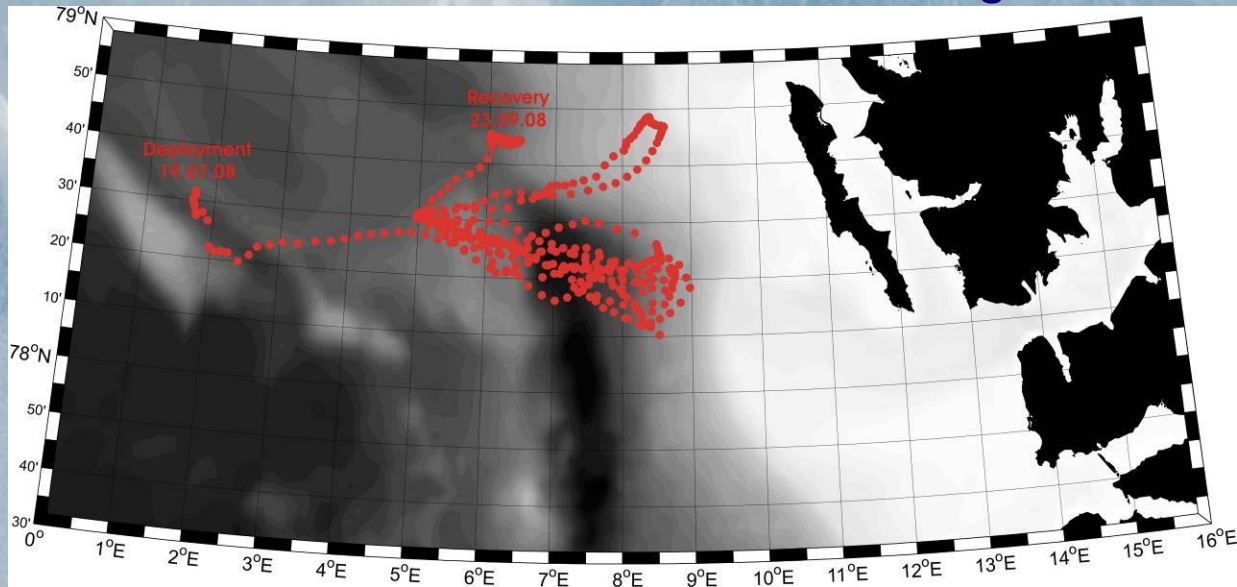
Seaglider SG127 mission in Fram Strait in summer 2008

Recovery from KV Svalbard

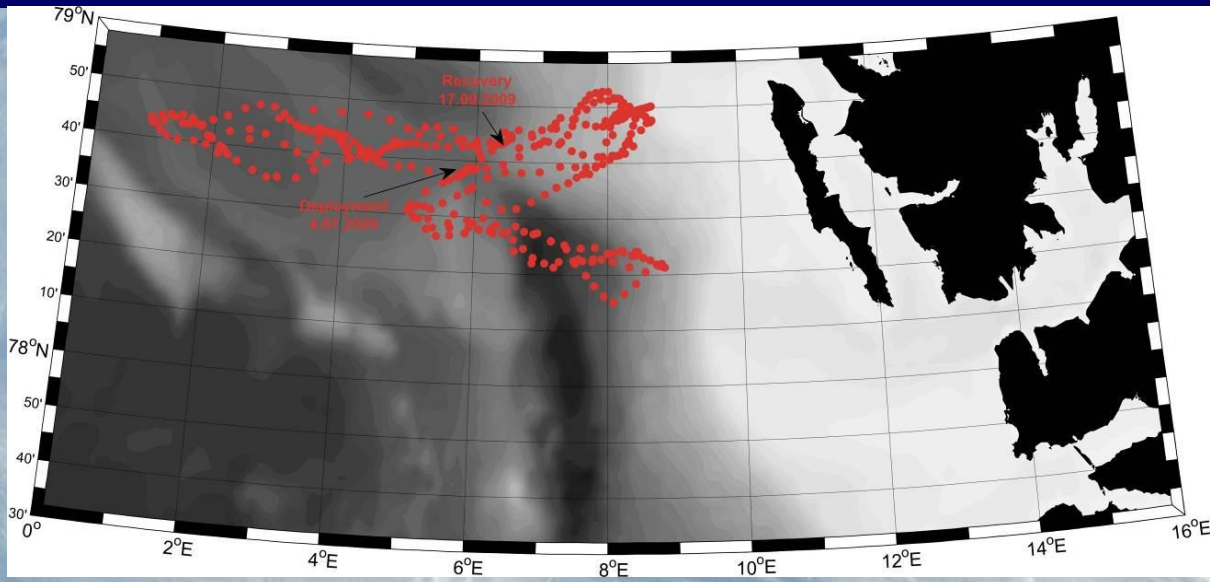
Seaglider SG 127 summer 2008 mission:

- 67 days
- 721 Nm
- 394 dives
- 74% energy used
- max. depth 1000 m
- one RAFOS sound source deployed, no RAFOS signal received by glider, the most likely due to sound source failure (recovered flooded)

Seaglider track



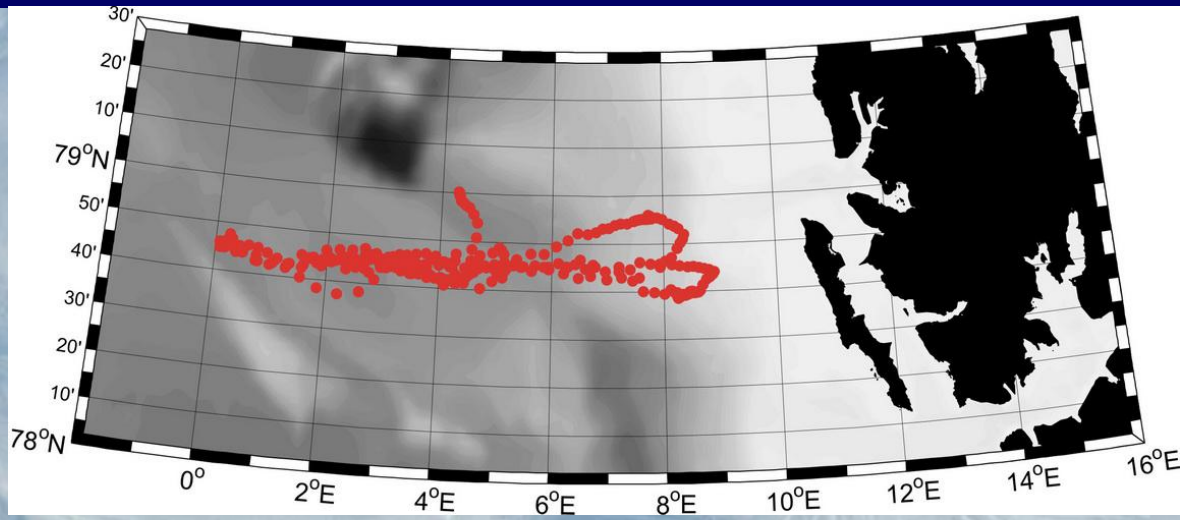
Seaglider SG127 mission in Fram Strait in summer 2009



Seaglider SG 127 summer 2009 mission:

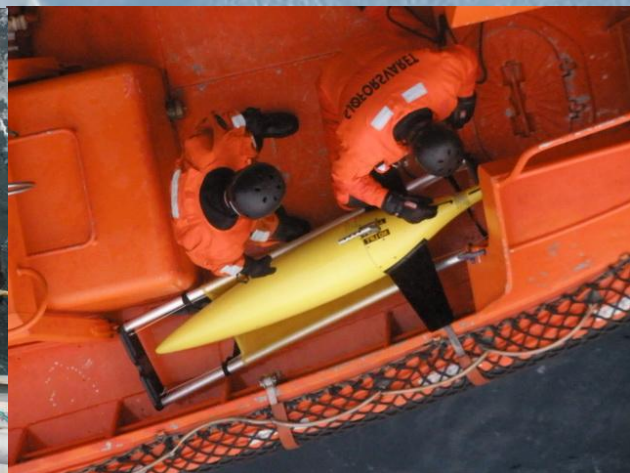
- 76 days
- 793 Nm
- 400 dives
- 73% energy used
- max. depth 1000 m
- deployed from RV Polarstern, recovered with KV Svalbard
- no RAFOS sound sources available during this mission

Seaglider SG127 mission in Fram Strait in summer 2010

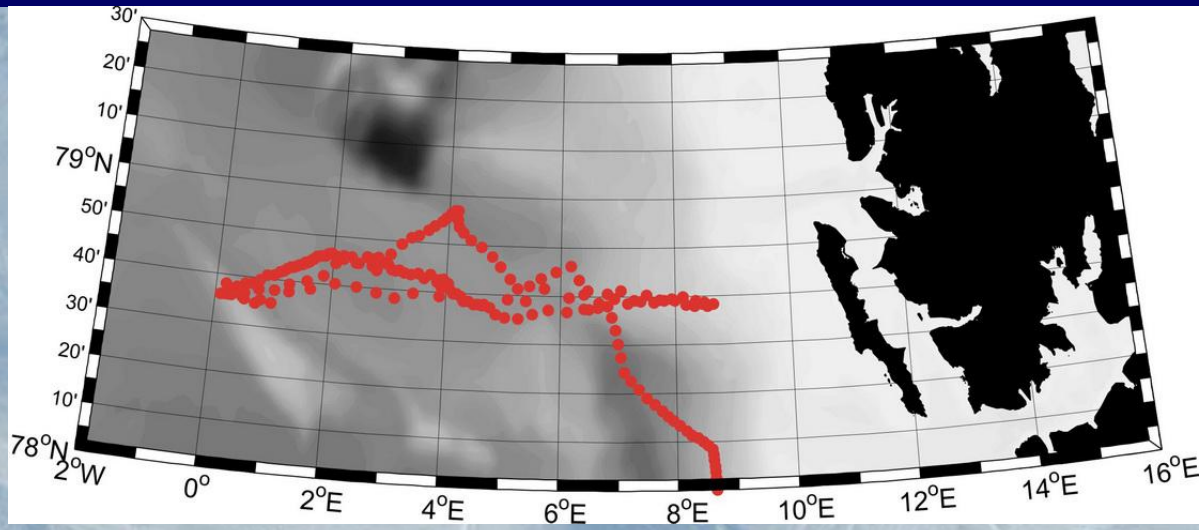


Seaglider SG 127 summer 2010 mission:

- 71 days
- 539 Nm
- 294 dives
- 65% energy used
- max. depth 1000 m
- deployed from RV Polarstern, recovered with KV Svalbard
- 3 RAFOS sound sources available during this mission, and at the end also tomo source A

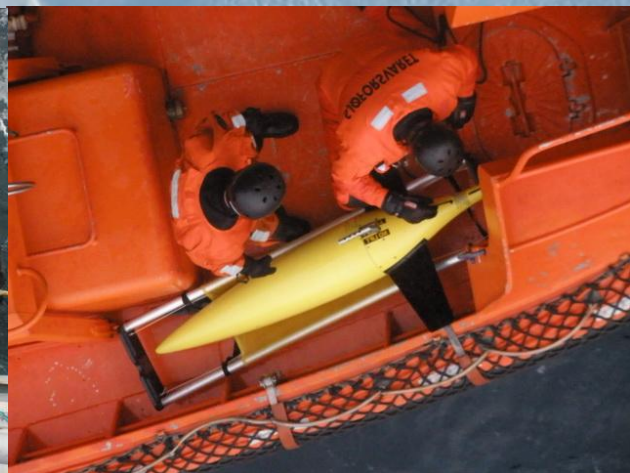


Seaglider MK501 mission in Fram Strait in autumn/winter 2010

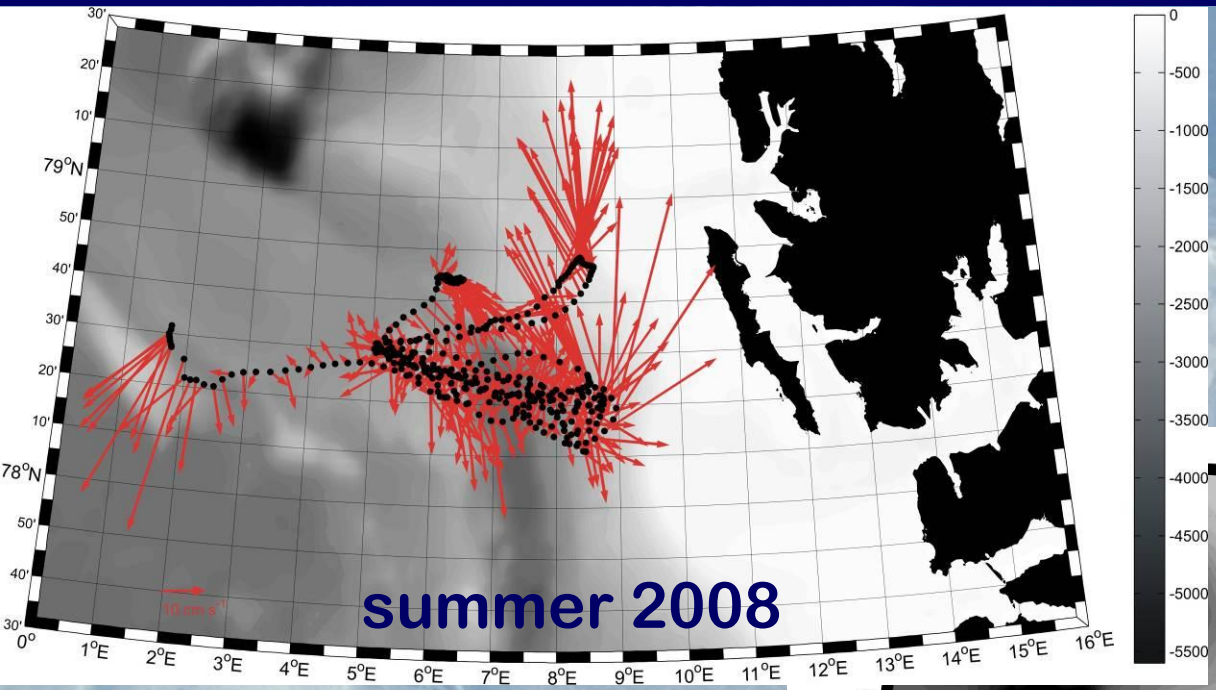


Seaglider MK501 autumn/winter 2010 mission:

- 72 days
- 837 Nm
- 284 dives
- 50% energy used
- max. depth 1000 m
- deployed from KV Svalbard
- recovery planned for the end of February/beginning of March
- 2 RAFOS sound sources and 3 tomo sources (A, B, C) providing RAFOS available during this mission
- lost at the beginning of December 2010



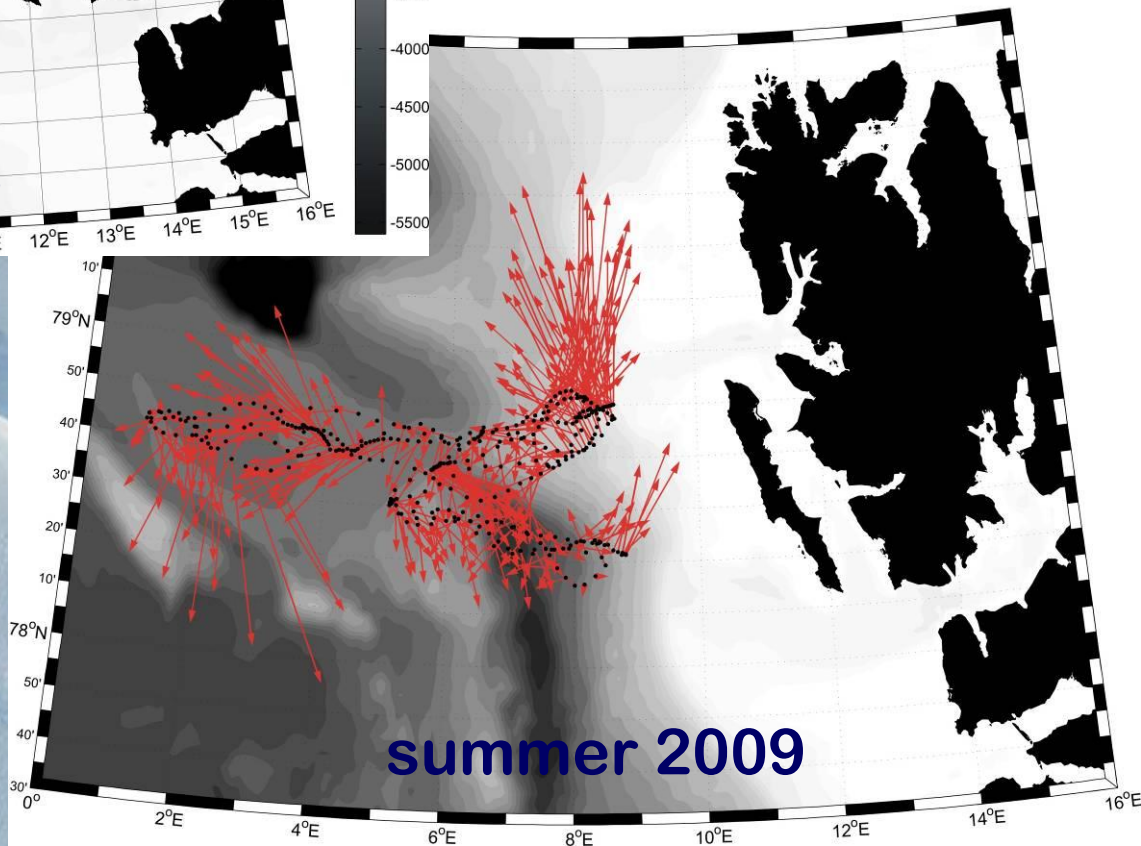
Vertically averaged currents during SG127 missions in 2008 and 2009



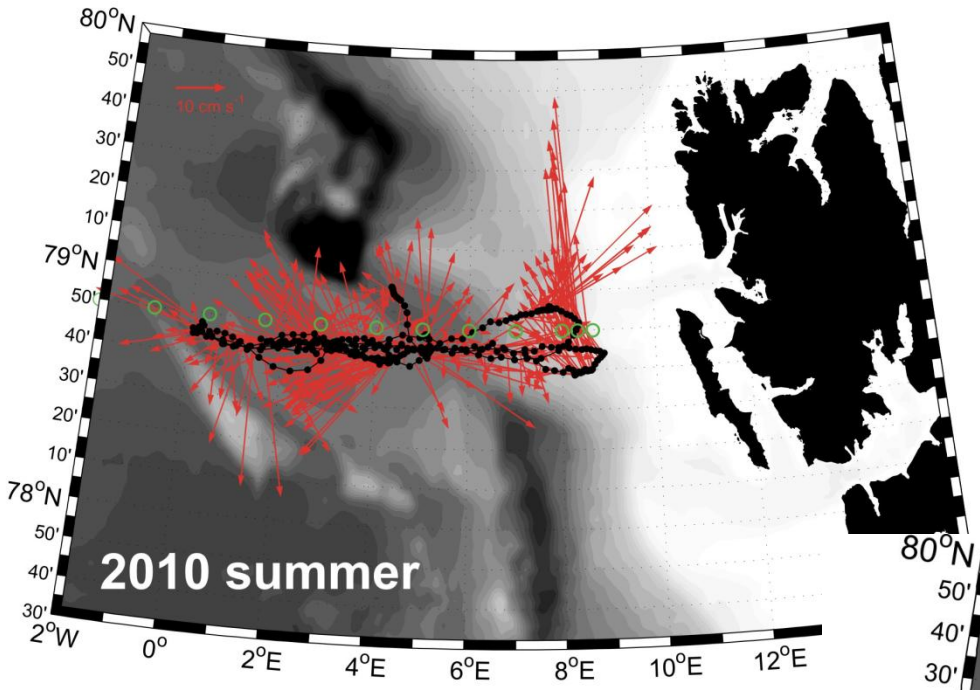
A big challenge – the West Spitsbergen Current:

- strong boundary current
- events up to 80 cm/s
- most of energy used there

- significant deviations from planned trajectory
- difficulties with turning the glider within the WSC



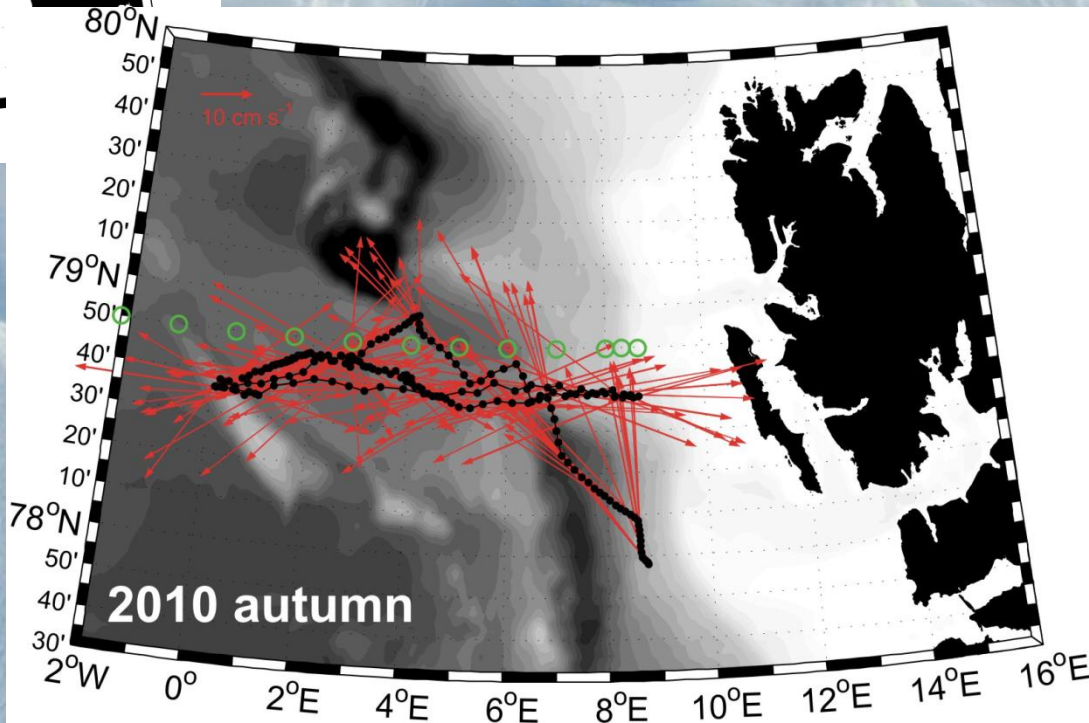
Vertically averaged currents during SG127 and MK501 missions in summer and autumn/winter 2010



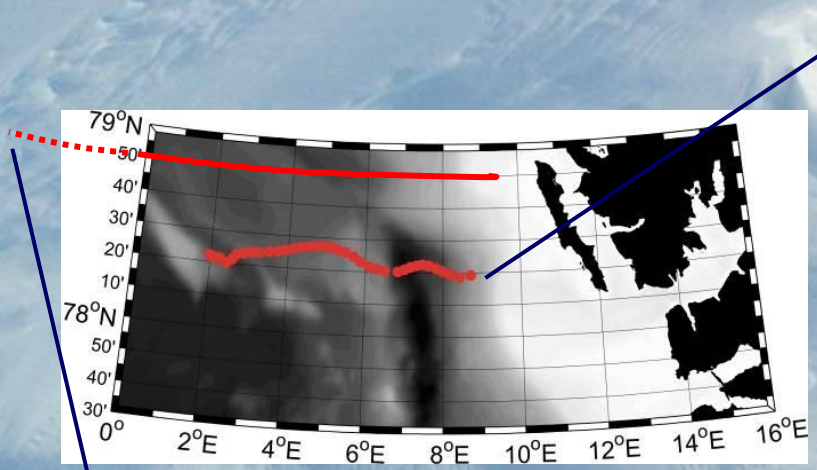
A big challenge – the West Spitsbergen Current:

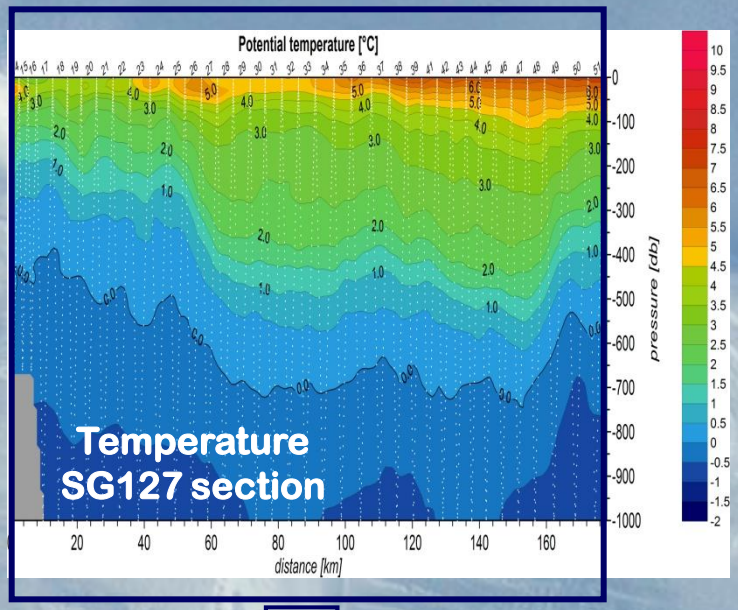
- strong boundary current
- events up to 80 cm/s
- most of energy used there

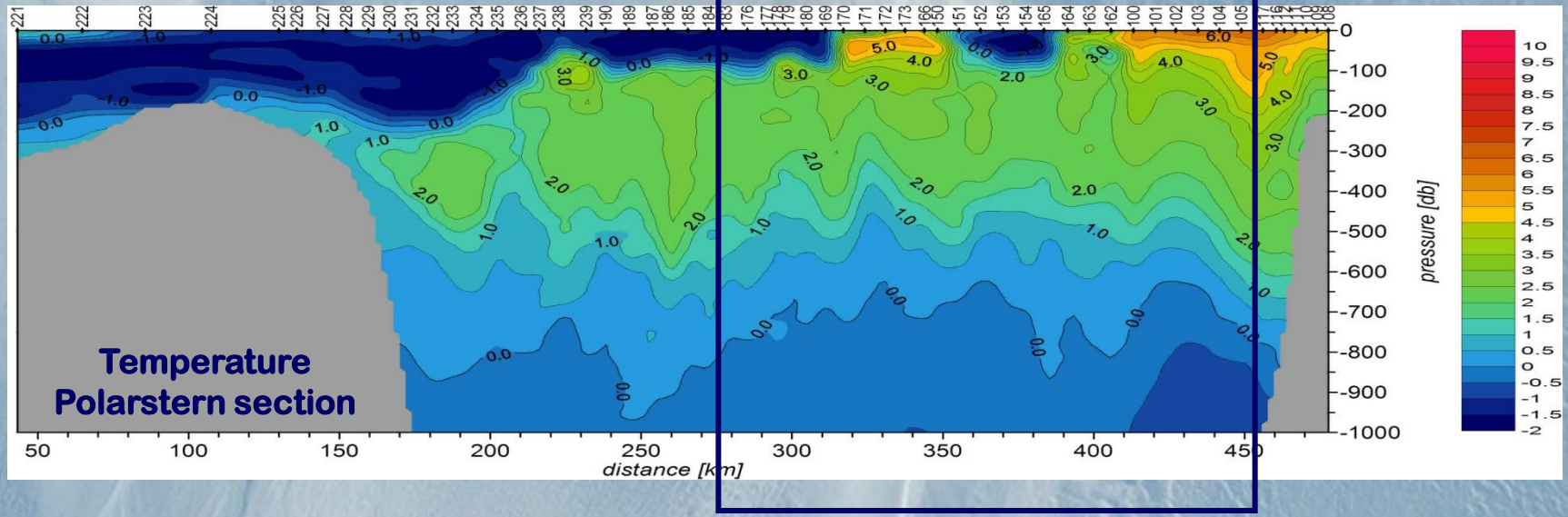
- in 2010 more experience in steering the glider, using different navigation modes, staying shorter in the WSC, less deviations form the planned tracks
- however, technical problems with MK501 glider



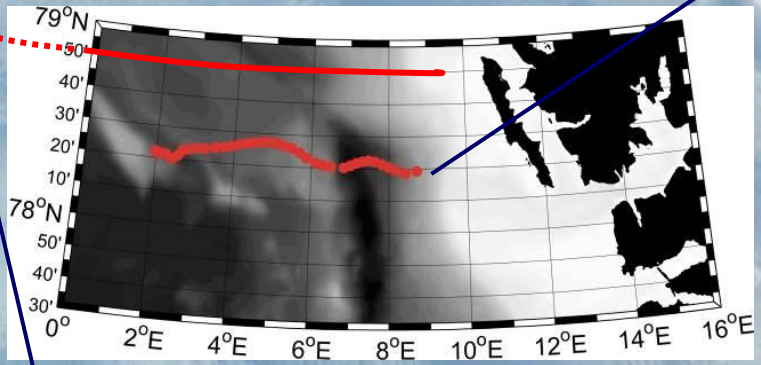
Temperature at section 78°50‘N measured from RV Polarstern and at section 1 measured by Seaglider in 2008

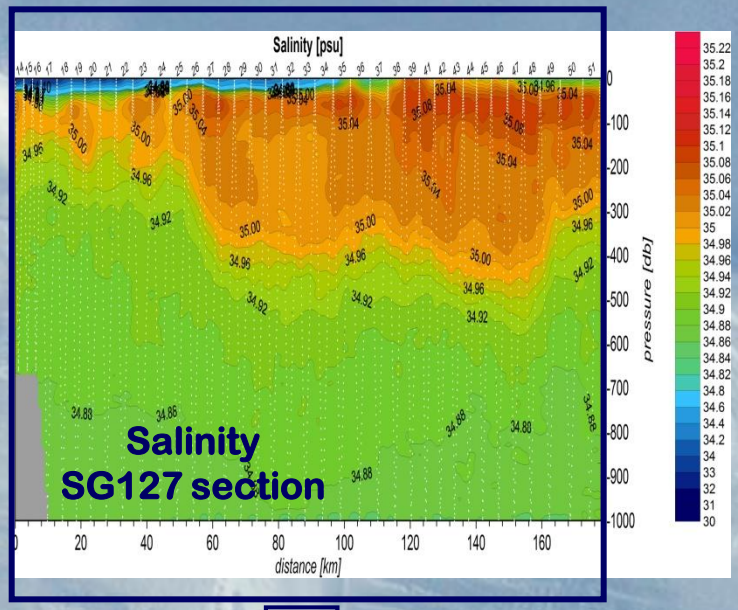


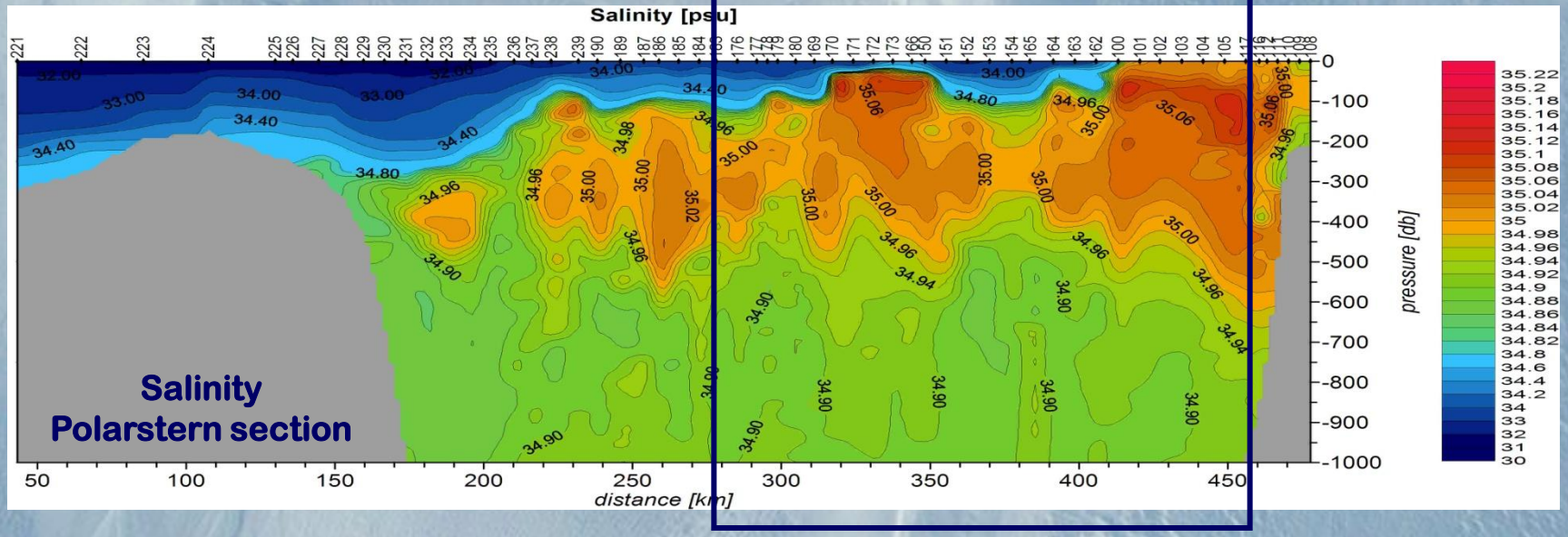




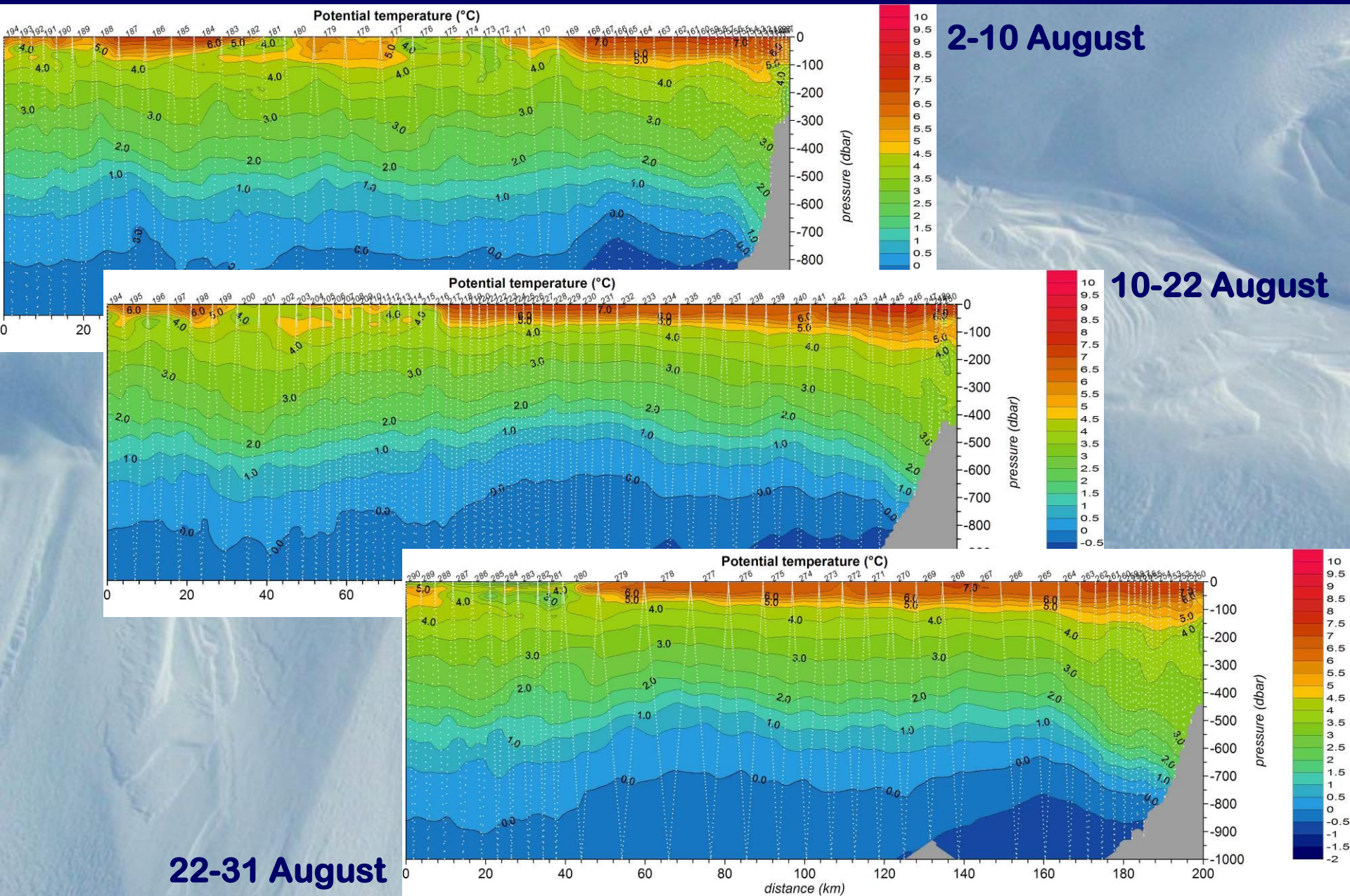
Salinity at section 78°50‘N measured from RV Polarstern and at section 1 measured by Seaglider in 2008



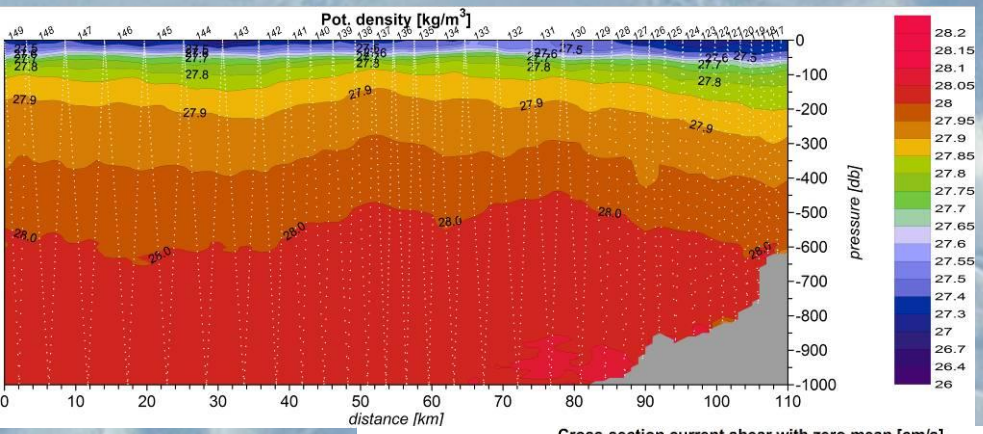




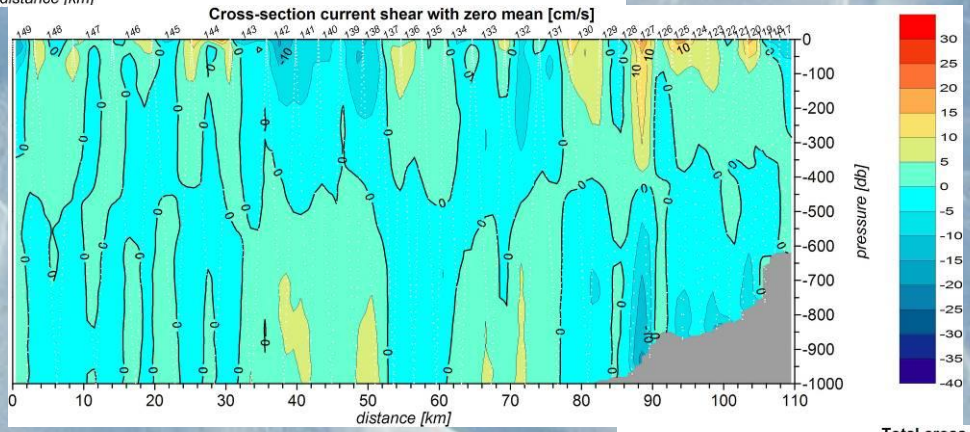
Temperature at Fram Strait section (repeated 3 times) measured by Seaglider SG127 in 2009



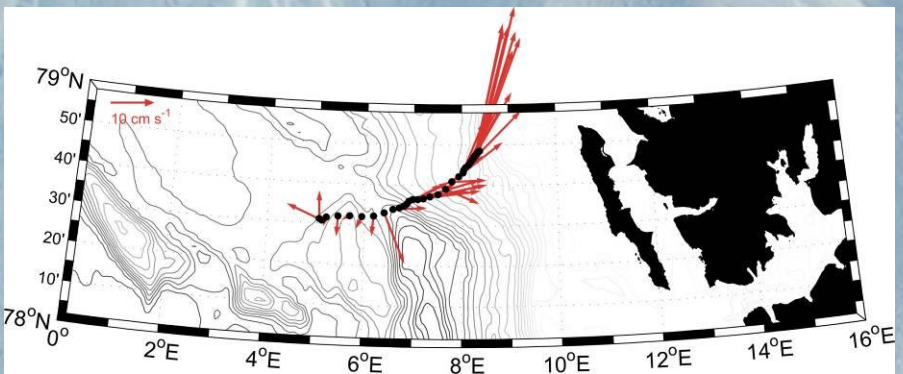
Absolute current calculated for Section 7 in 2008



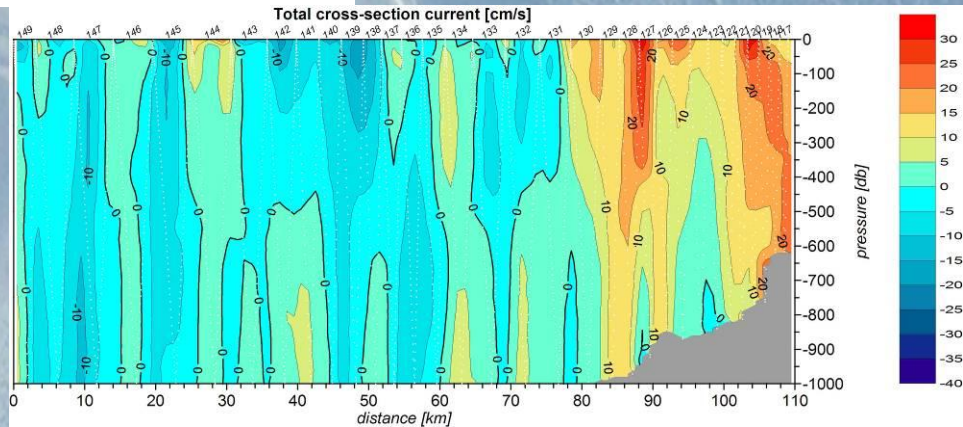
Density field



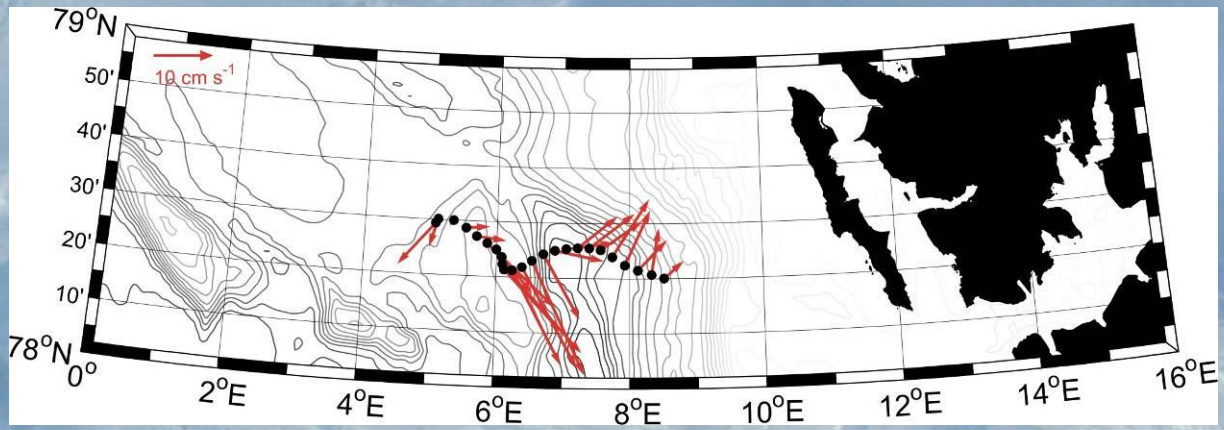
Current shear

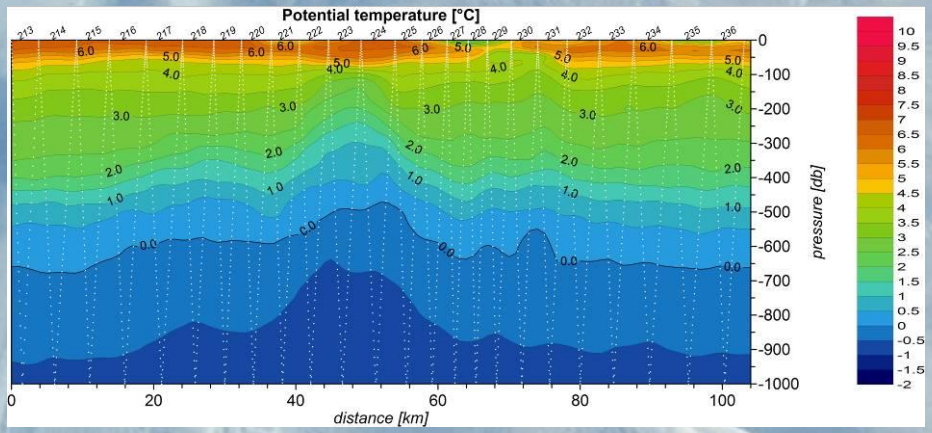


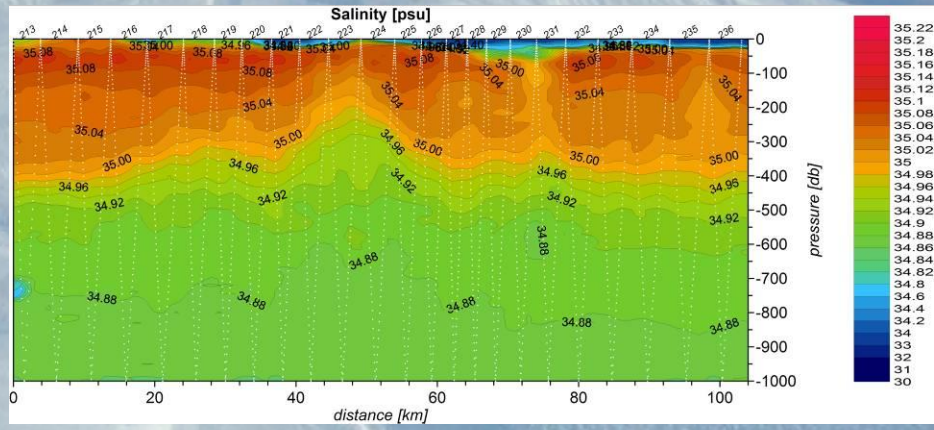
Total current

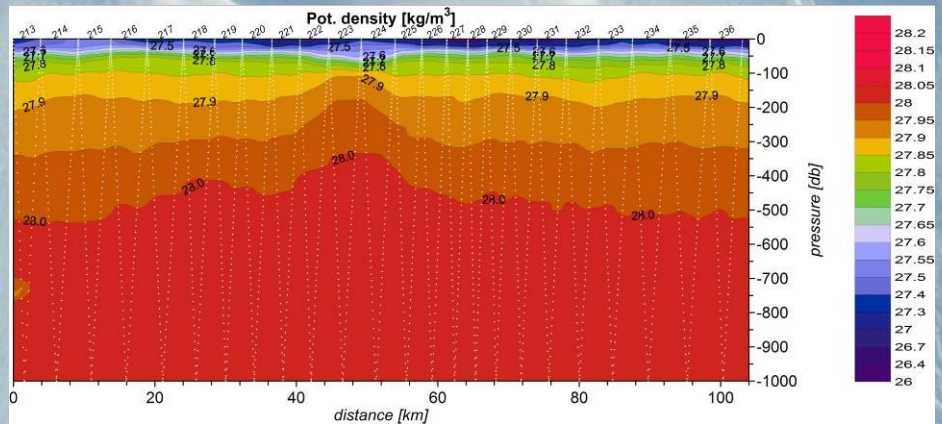


Eddy crossed by SG127 at Section 11 in 2008

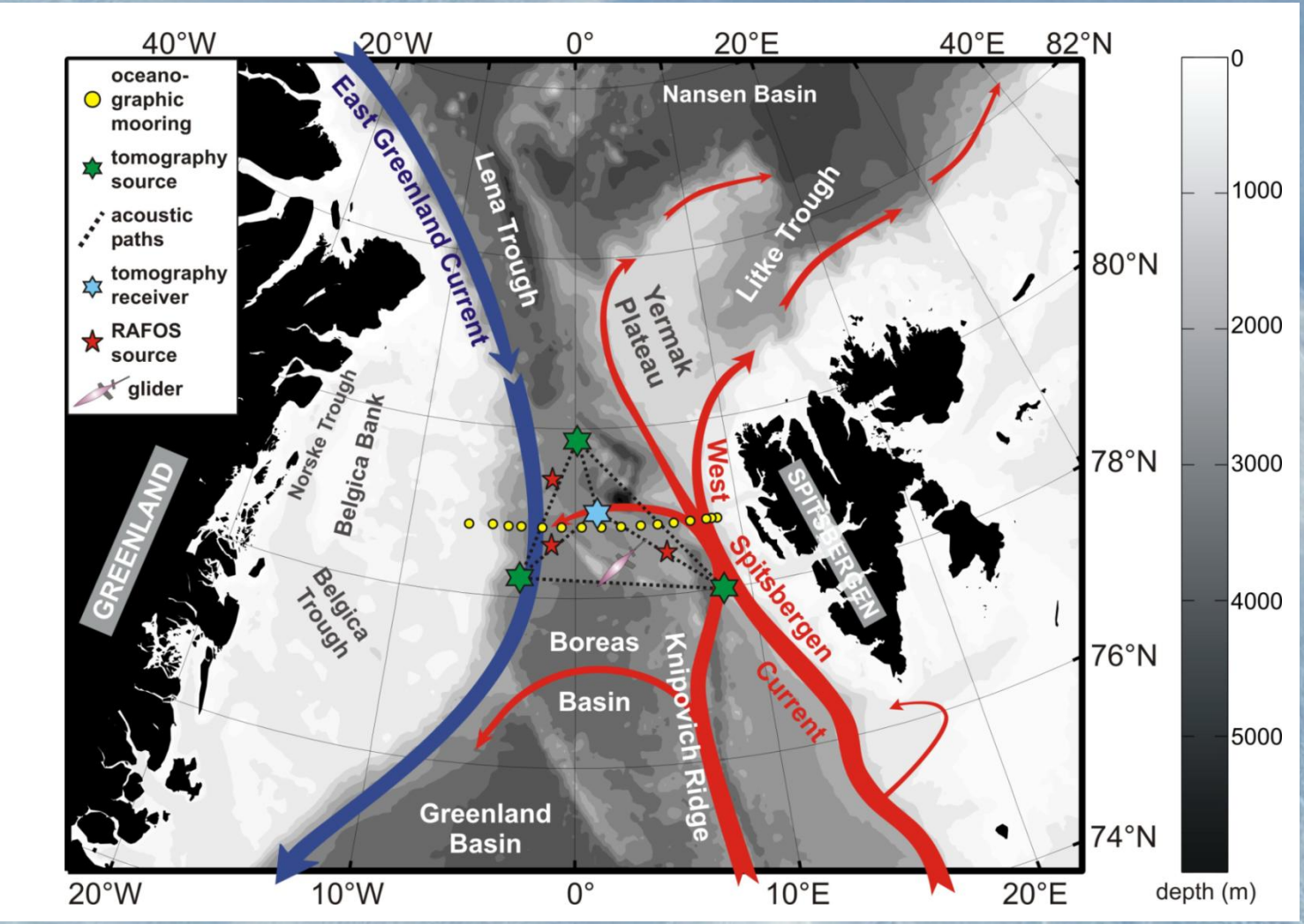






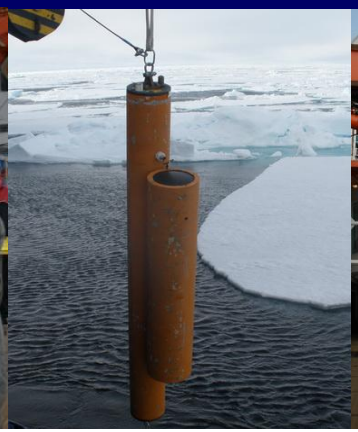
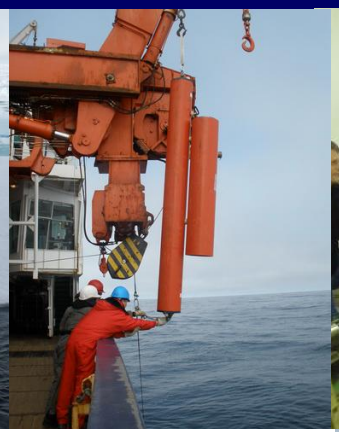


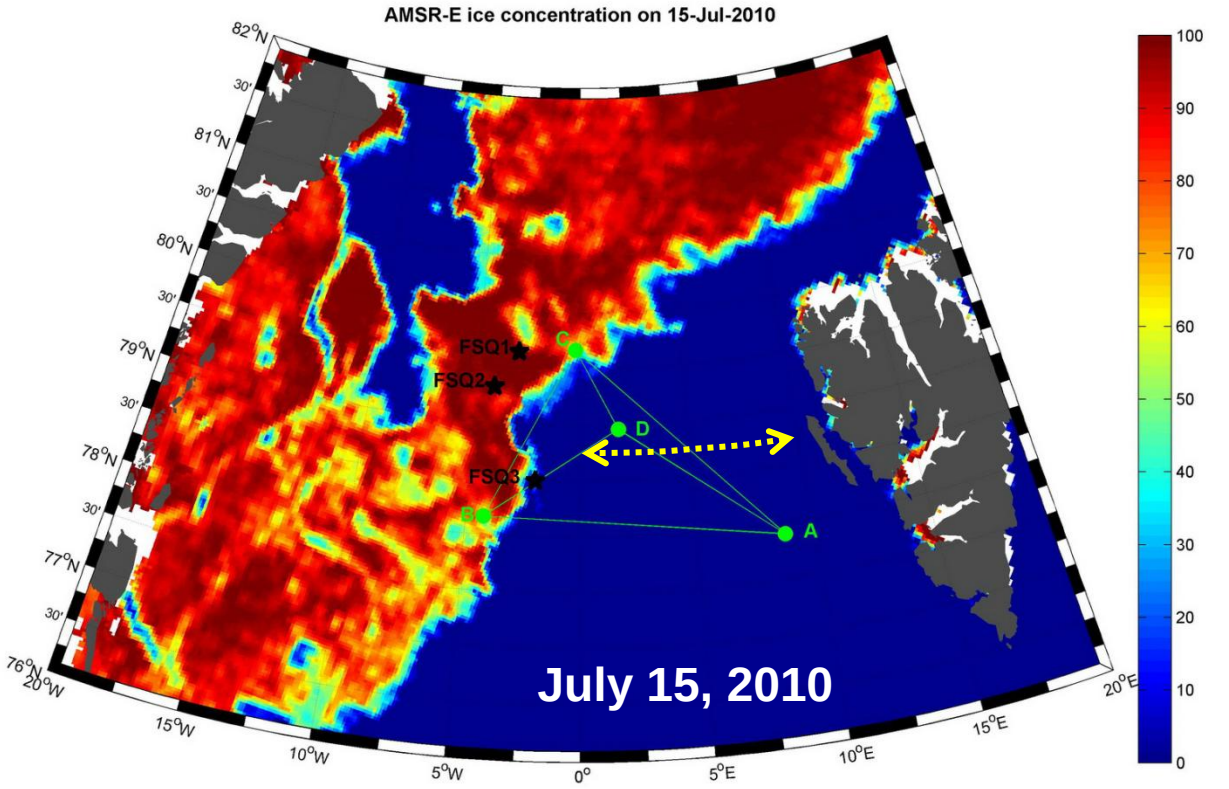
Fram Strait Observatory in 2010-2011



- oceanographic moorings, gliders, RAFOS sources: AWI and NPI
- technical solutions and support for under-ice glider navigation: APL-UW
- tomographic sources providing additionally RAFOS signals: NERSC

RAFOS sound sources recovery and deployment in ice from Polarstern in July 2010

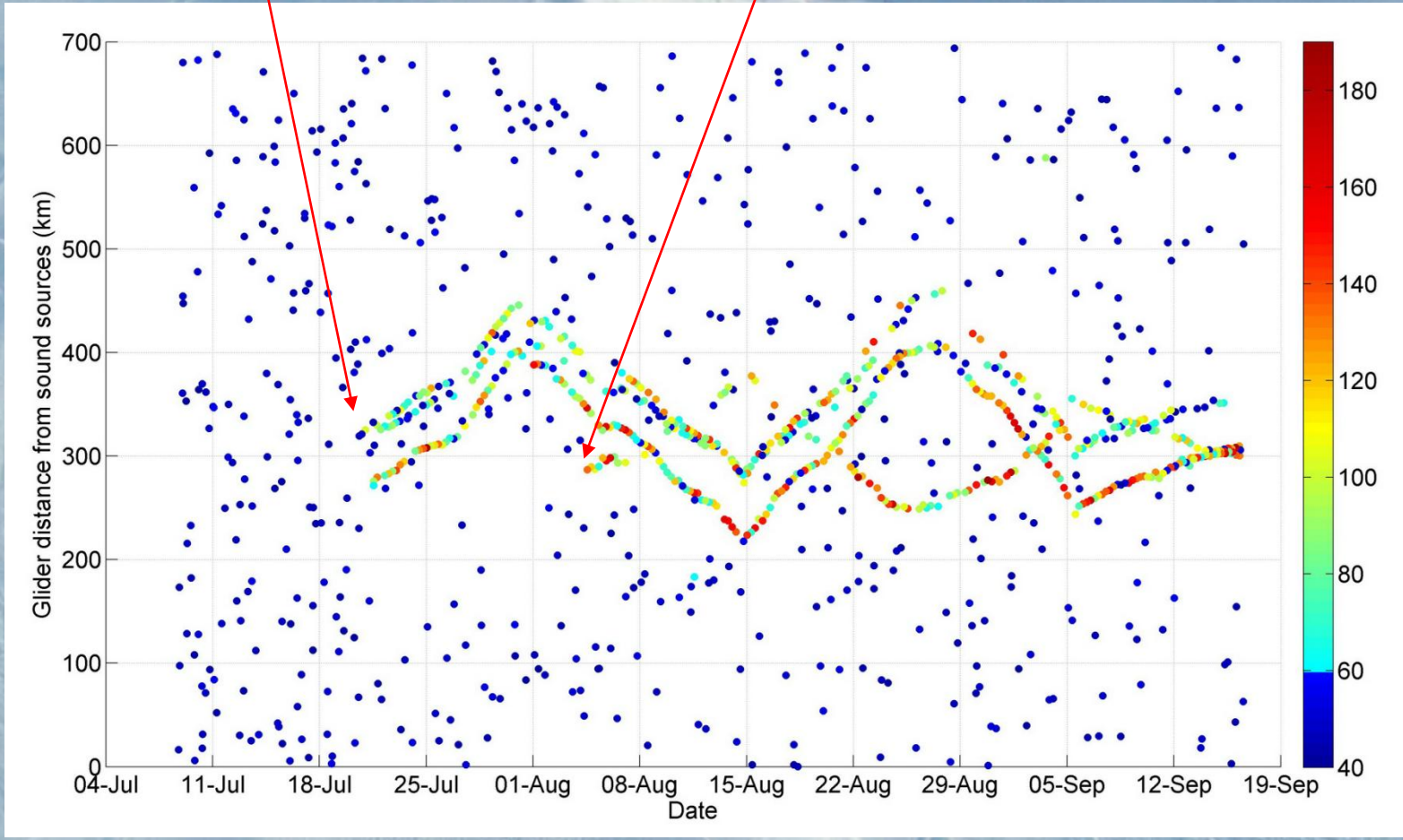



RAFOS sound sources
260 Hz moored
at the depth of 800 m:
FSQ1-2,FSQ2-2,FSQ3-1
old Webb sources,
technical problems
with clocks

RAFOS transmissions received by Seaglider SG127 during deployment in summer 2010

deployment of 3 RAFOS sources in the western Fram Strait

deployment of tomographic source A in the easten Fram Strait

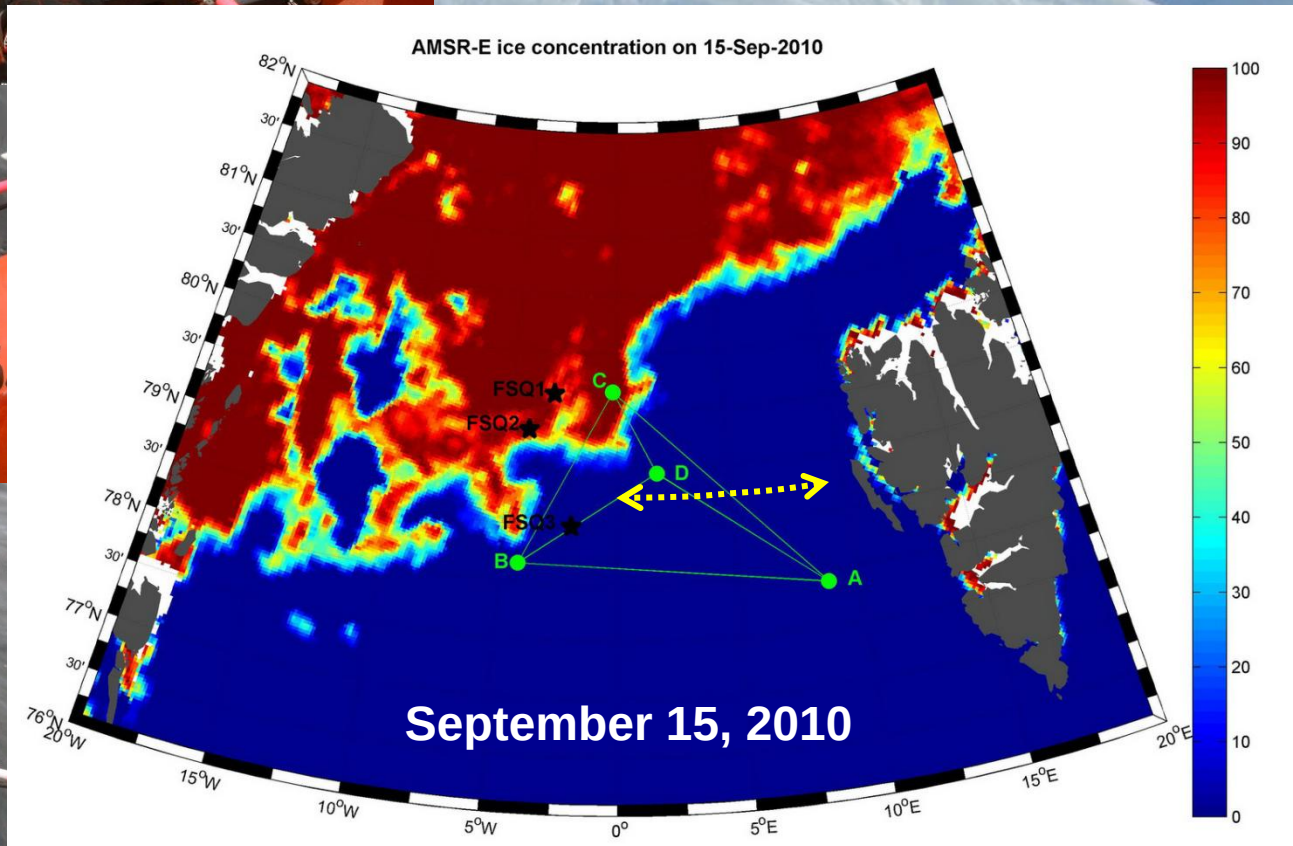


Distances between different RAFOS sound sources and glider from all received broadcasts (color coded – peak correlation)

Deployment of Seaglider MK501 in 2010 for autumn/winter mission

Seaglider MK501

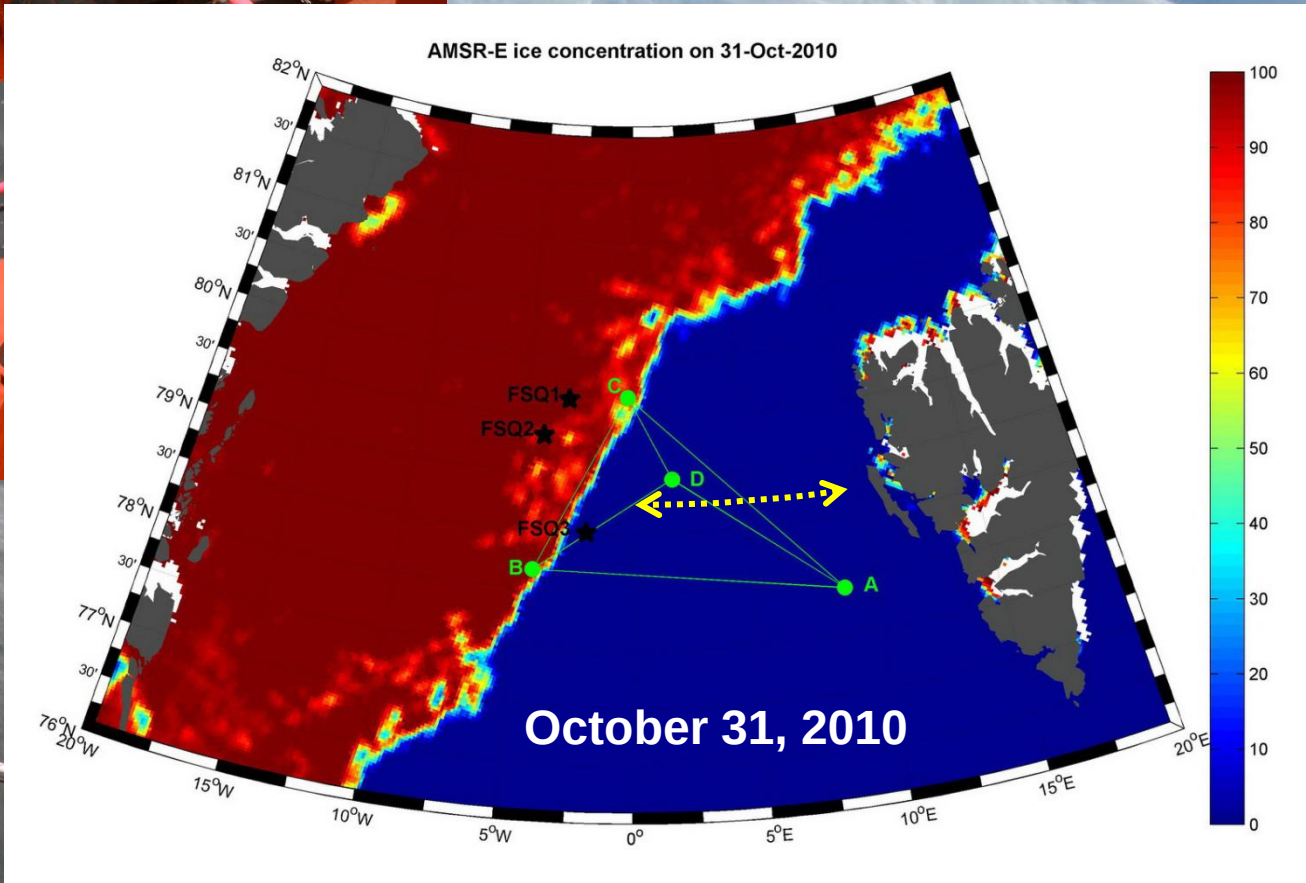
Planned for winter mission in the eastern Fram Strait deployed on 15 September 2010 from KV Svalbard



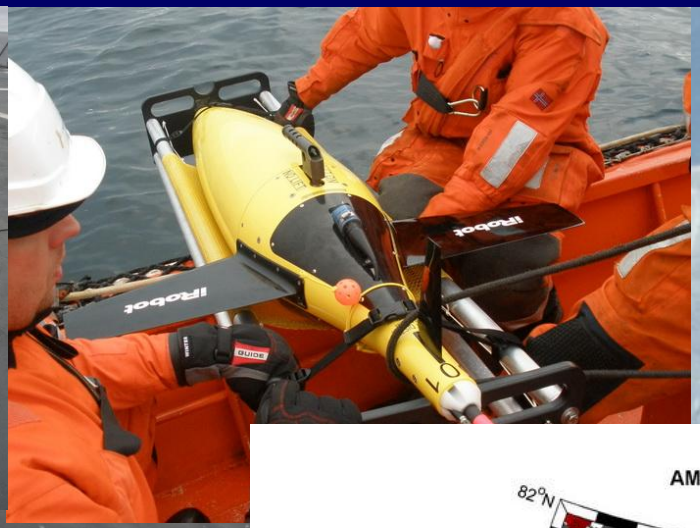
Deployment of Seaglider MK501 in 2010 for autumn/winter mission

Seaglider MK501

Planned for winter mission in the eastern Fram Strait to be recovered end of February/beginning of March

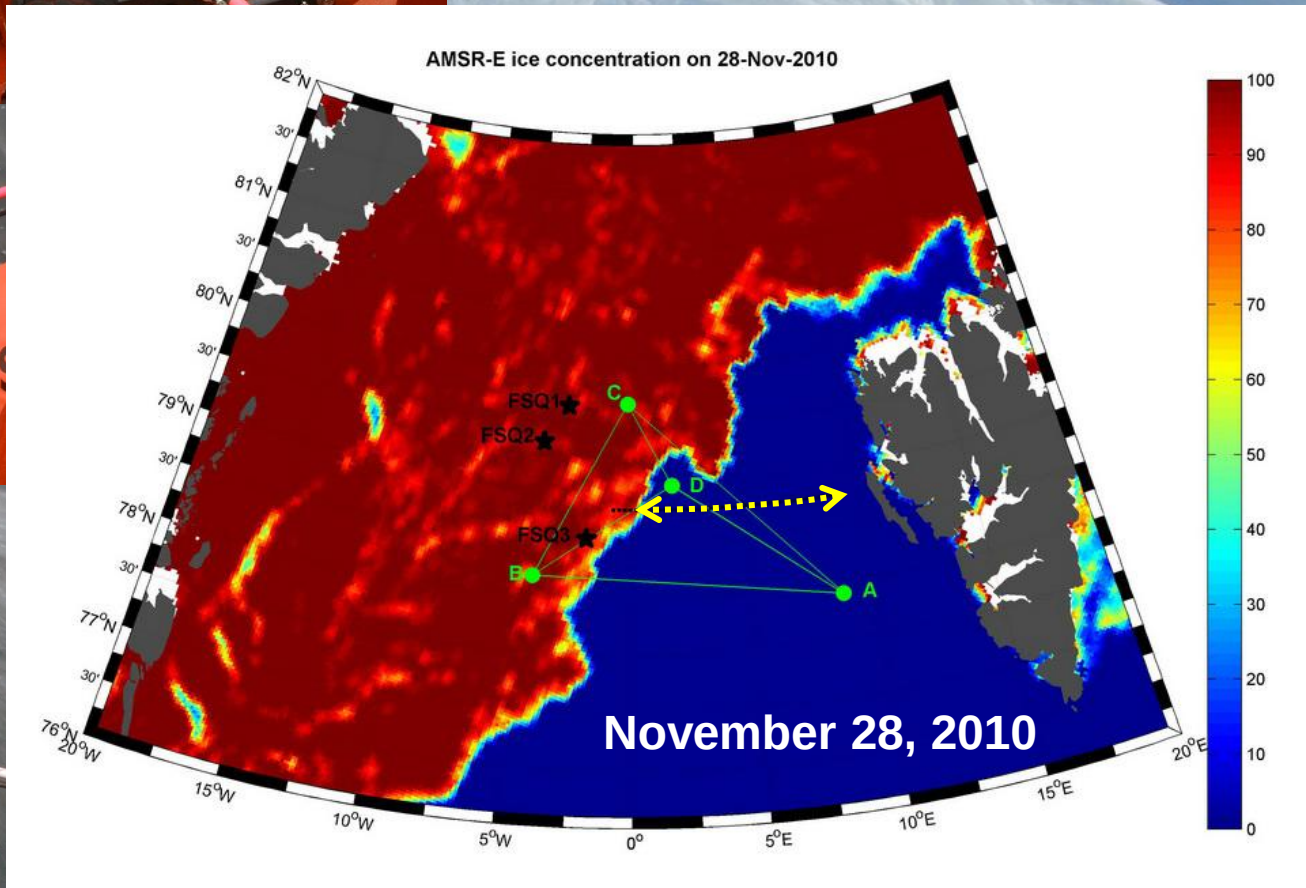


Deployment of Seaglider MK501 in 2010 for autumn/winter mission

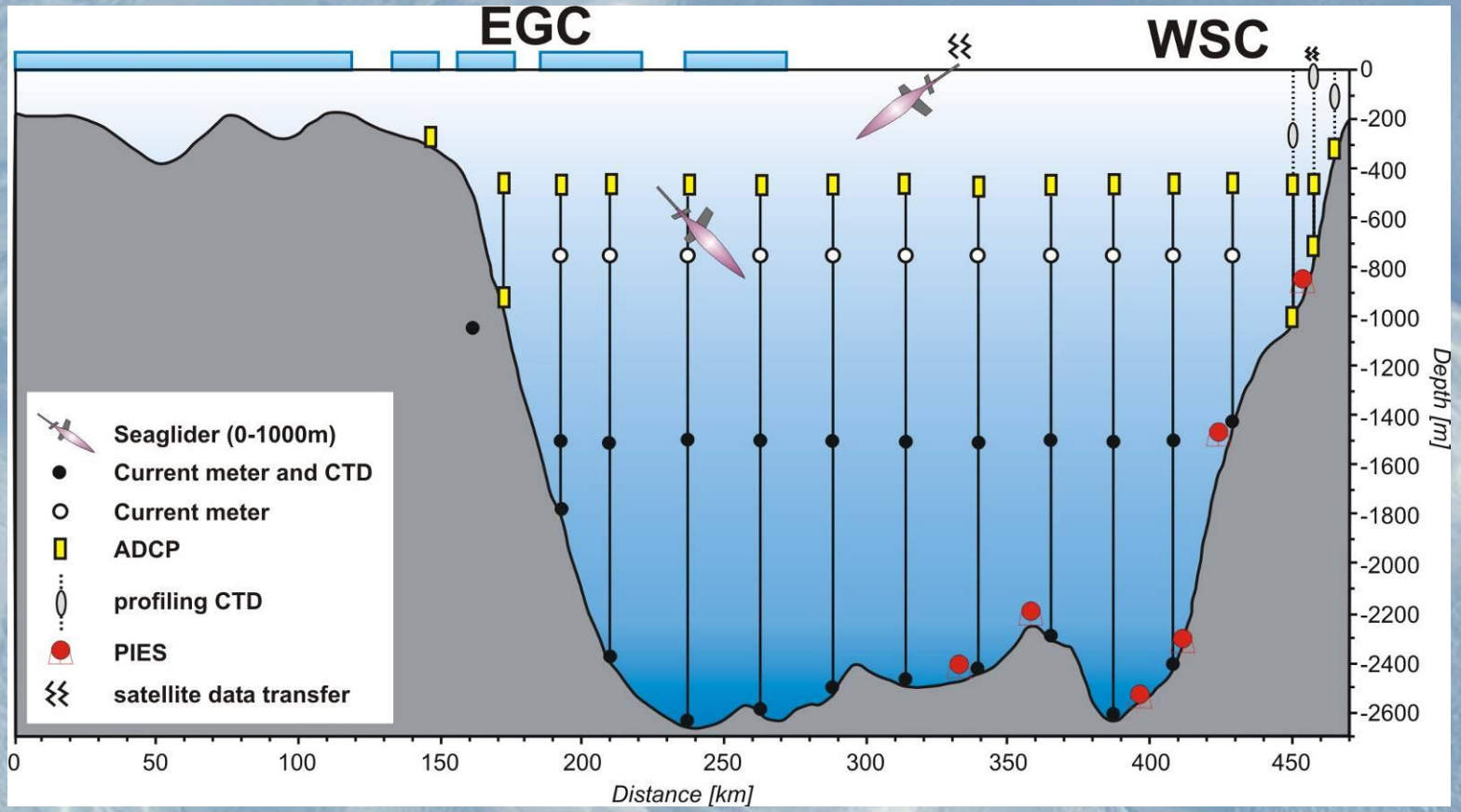


Seaglider MK501

Planned for winter mission in the eastern Fram Strait to be recovered end of February/beginning of March

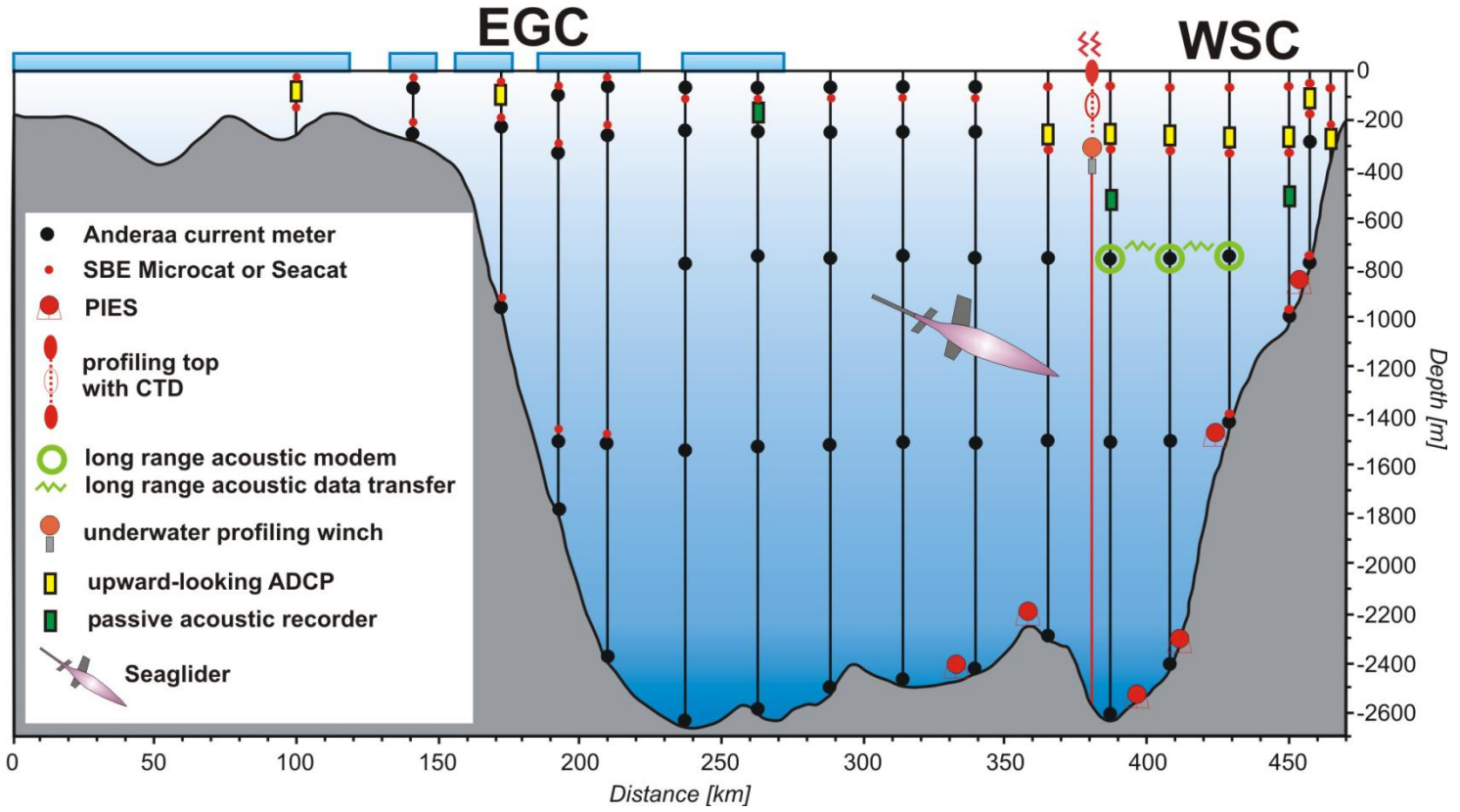


Hybrid Arctic/Antarctic Float Observing System (HAFOS) – future perspective for Fram Strait moored array



- Moorings will extend from the seafloor to about 500m depth and will be equipped with current meters and CTD loggers
- Moorings will be topped by upward looking ADCPs to monitor the upper layer flow
- Hydrographic properties of the upper 1000 m layer will be collected by a pair of patrolling Seagliders
- At the east, profiling CTDs will provide high resolution data of the West Spitsbergen Current

Fram Strait Observatory in 2010 and plans for 2011

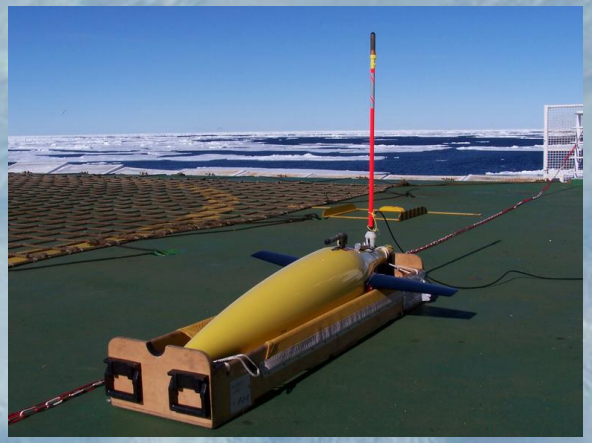


Fram Strait moored array deployed in 2010 with 7 ADCPs covering the upper layer

In June 2011 during Polarstern cruise:

- redeployment of the array,
- deployment of one glider
- deployment of 4 RAFOS sources

Long-term perspective – FSO gliders serving HAUSGARTEN



BOX 1: MEASUREMENTS AND SAMPLING AT HAUSGARTEN

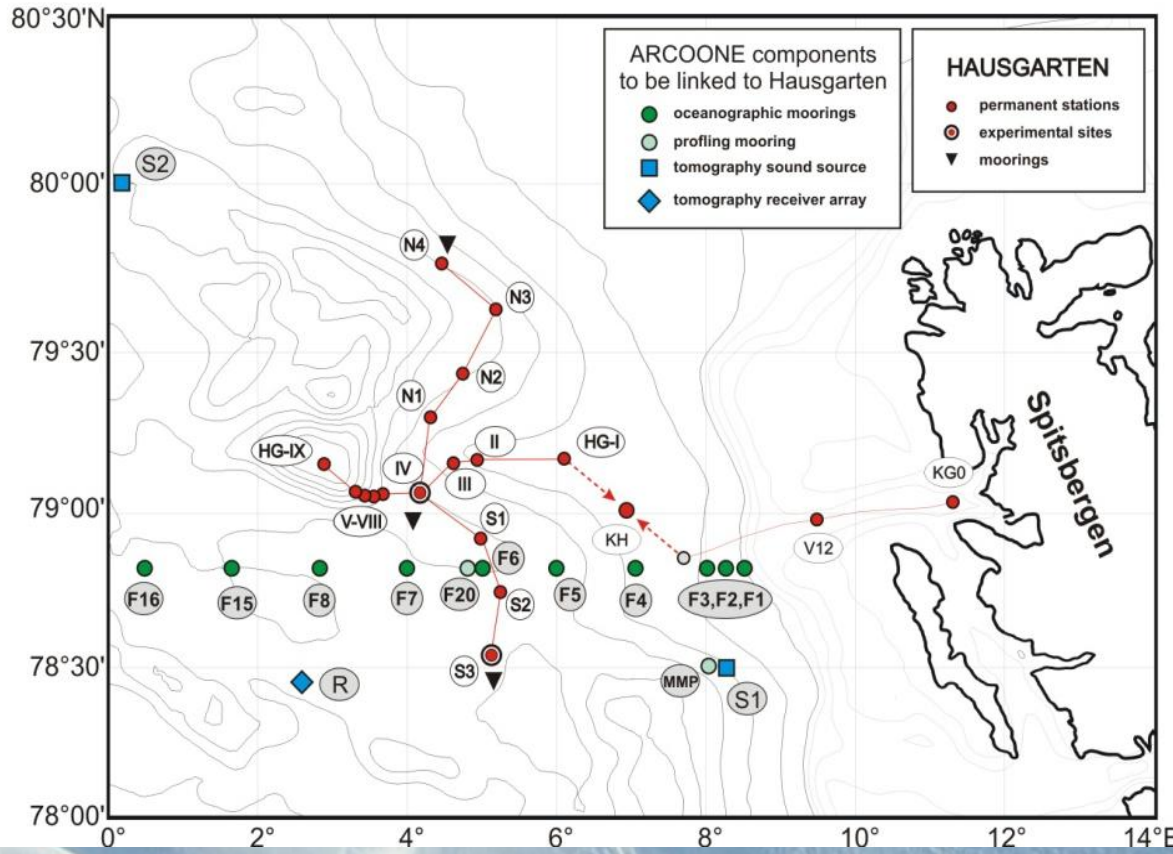
PELAGIC ZONE
- temperature
- salinity
- currents (speed, direction)
- particle flux (biogenic, lithogenic)

BENTHIC BOUNDARY LAYER
- oxygen concentrations
- nutrients
- bacterial densities
- near-bottom currents in high-resolution

SEDIMENT-WATER INTERFACE
- carbon remineralization (oxygen microelectrodes, sediment community oxygen consumption)

SEDIMENTS
- granulometry
- porosity
- organic carbon
- carbonates
- opal
- C/N ratios
- biomarker (e.g., alkenone, n-alkanes)
- organic matter input (phytodetrital pigments)

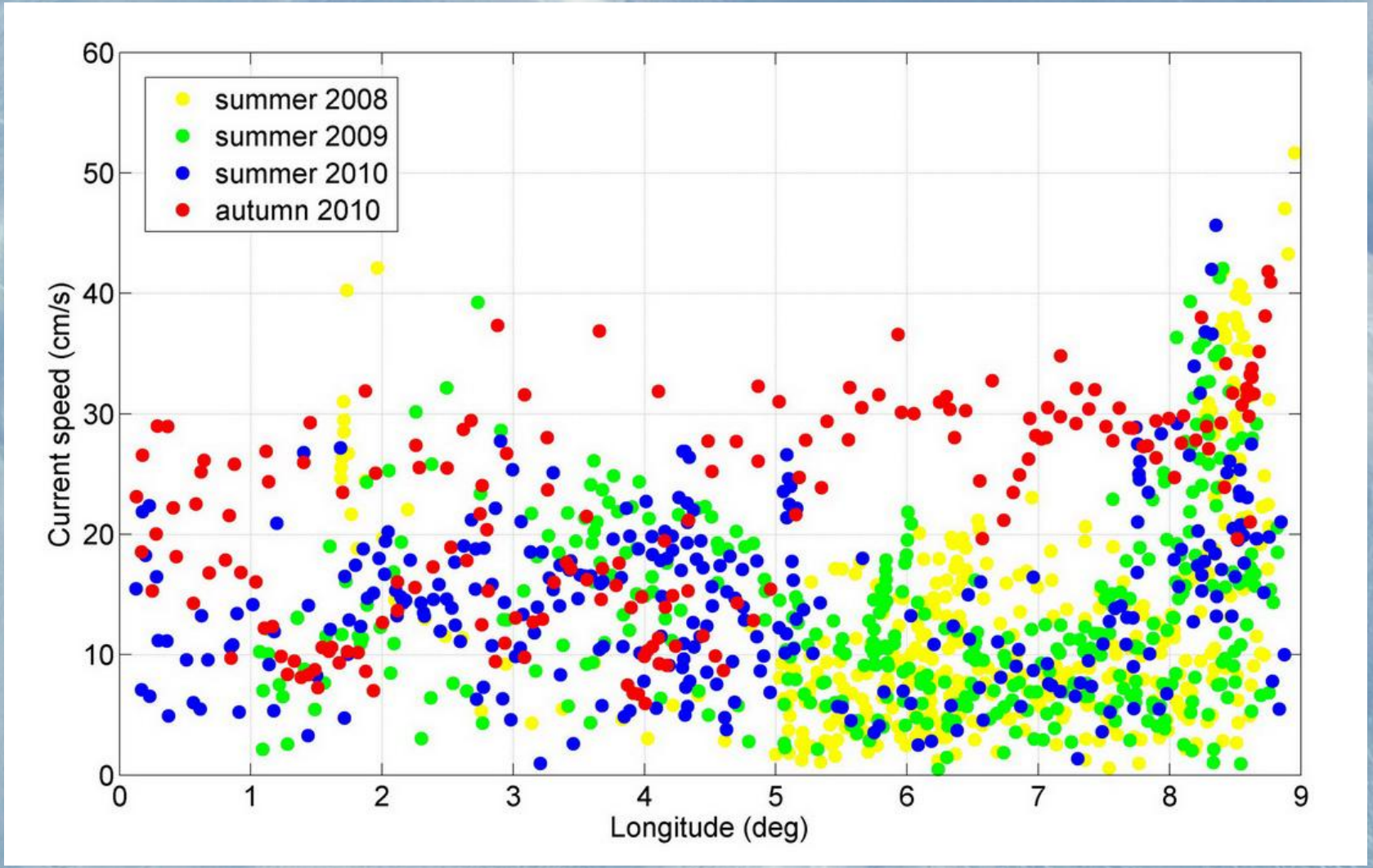
BENTHIC ORGANISMS
- bacteria (activities, densities, biomasses)
- meiofauna
- macrofauna
- megafauna, including demersal fish (densities, biomass, dispersion, biodiversity)



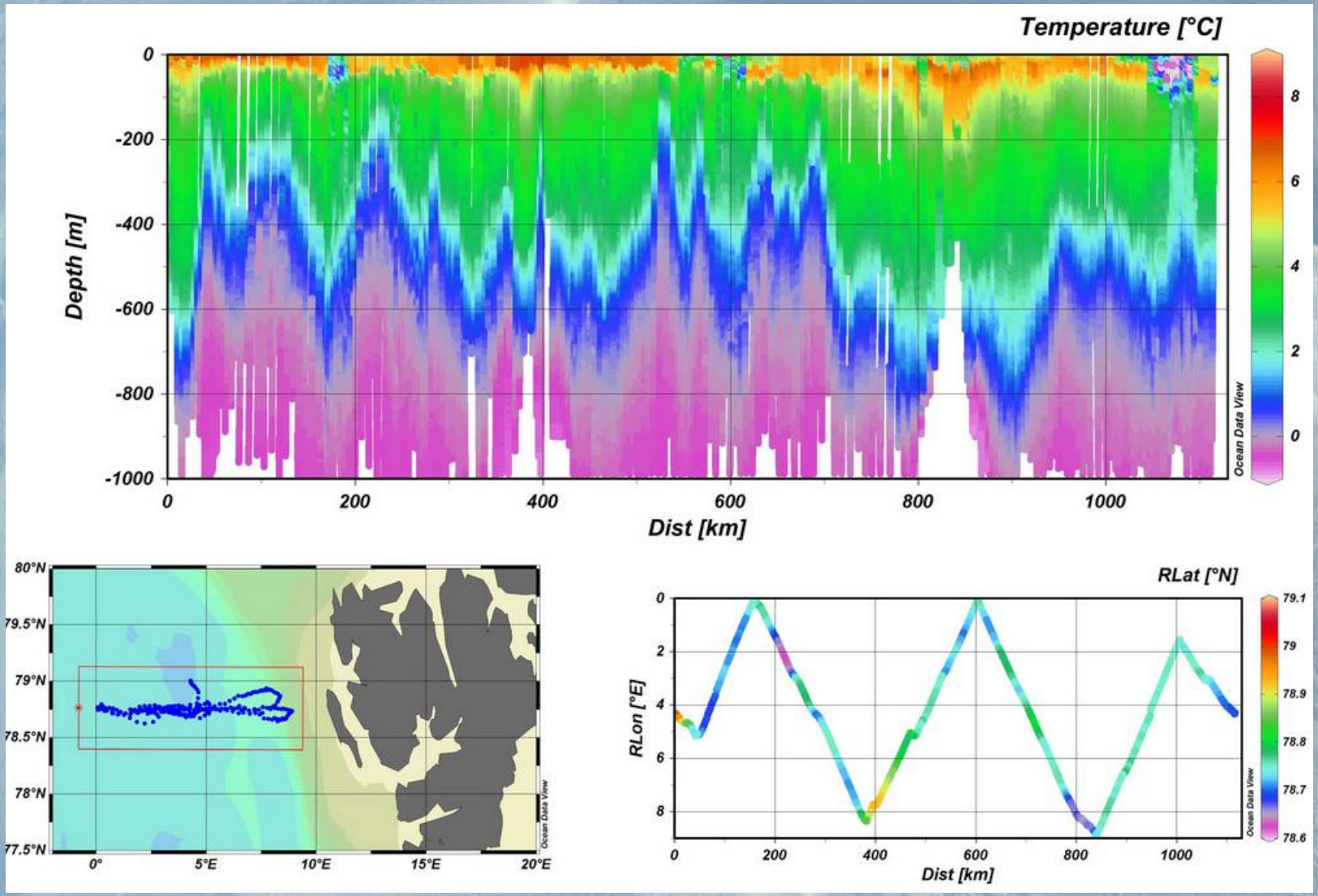
- **HAUSGARTEN provides GMES (Global Monitoring of the Environment and Safety) capabilities for ESONET**
- **Proposed as STAND-ALONE observatory within EMSO (European Multidisciplinary Seafloor Observatory)**
- **Listed in the Annex of SIOS (Svalbard Integrated Arctic Earth Observing System)**

Thank you for attention...

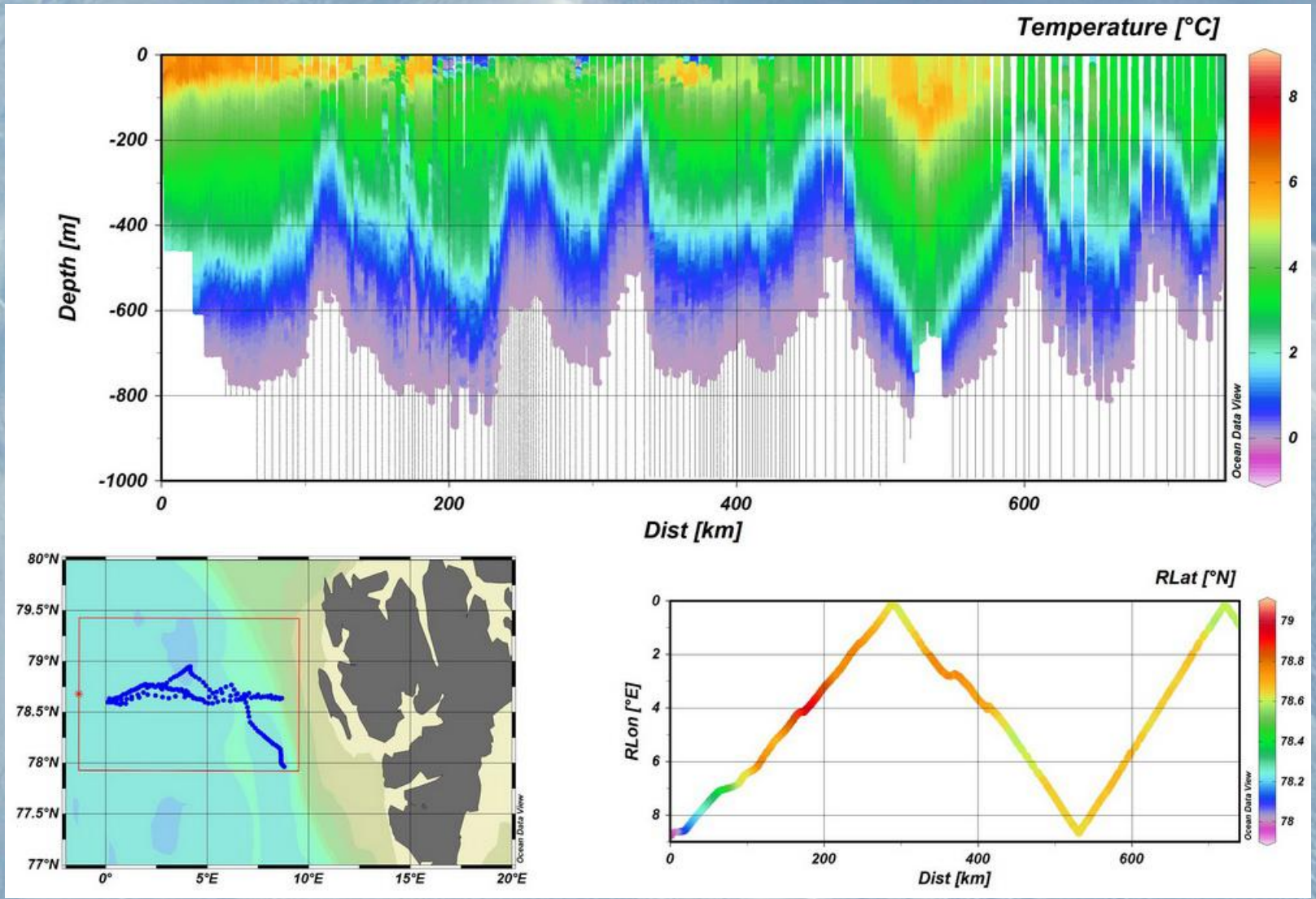
Depth-averaged current speed measured by gliders in 2008-2010



Temperature measured by SG127 in summer 2010 along the whole track

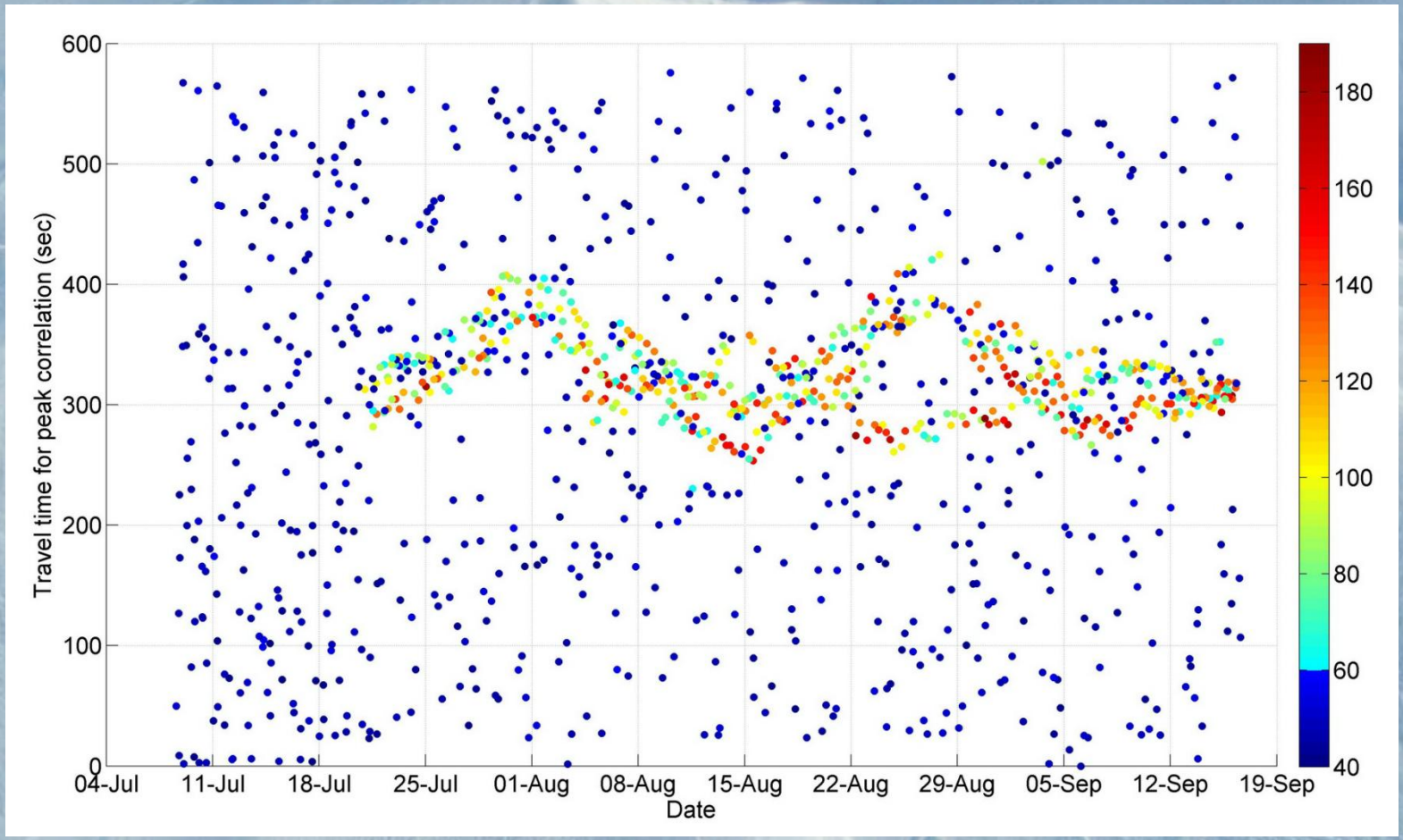


Temperature measured by MK501 in autumn 2010 along the whole track (until October 31)



RAFOS transmissions received by Seaglider SG127 during deployment in summer 2010

Travel time between different sound sources and glider from all received broadcasts (color coded – peak correlation)



RAFOS transmissions received by Seaglider MK501 during deployment in autumn 2010

Travel time between different sound sources and glider from all received broadcasts (color coded – peak correlation)