Moving towards assimilation of acoustic tomography data

Using a regional ocean model with ECCO boundary conditions to model acoustic tomography arrivals in Fram Strait

Florian Geyer[a], Hanne Sagen[a], Bruce Cornuelle[b]

[a]Nansen Environmental and Remote Sensing Center, Bergen, Norway
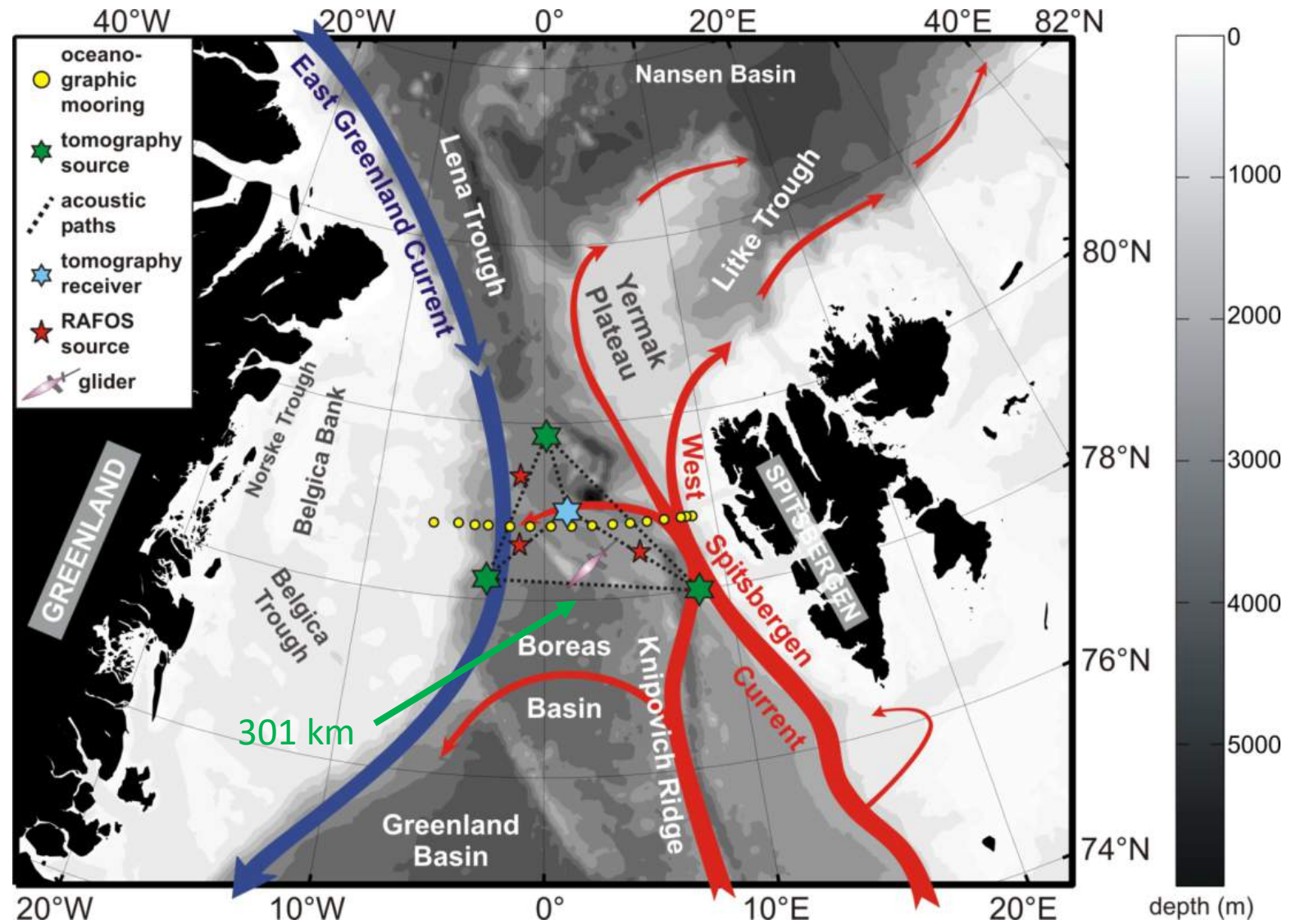[b]Scripps Institution of Oceanography, UCSD, USA

Acknowledgements

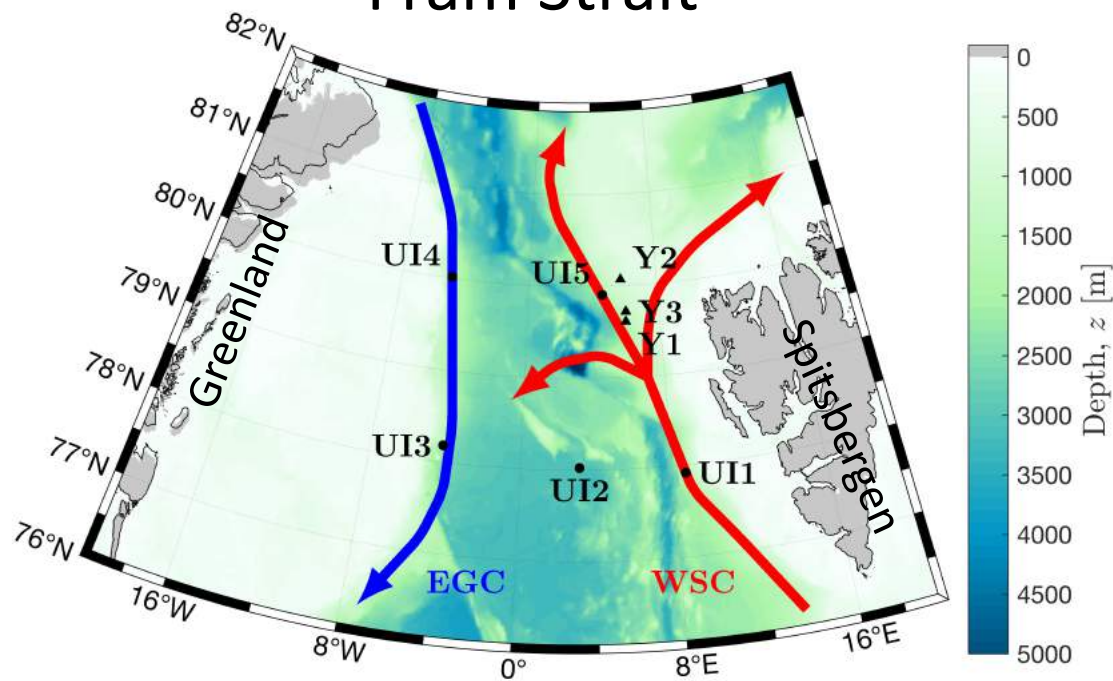# Background – The ACOBAR experiment

ACOBAR:
- Time: 2010-2012
- 3 acoustic source moorings (200-300 Hz sweep)
- 1 receiver mooring
- Published in JASA: Sagen et al. , 2017
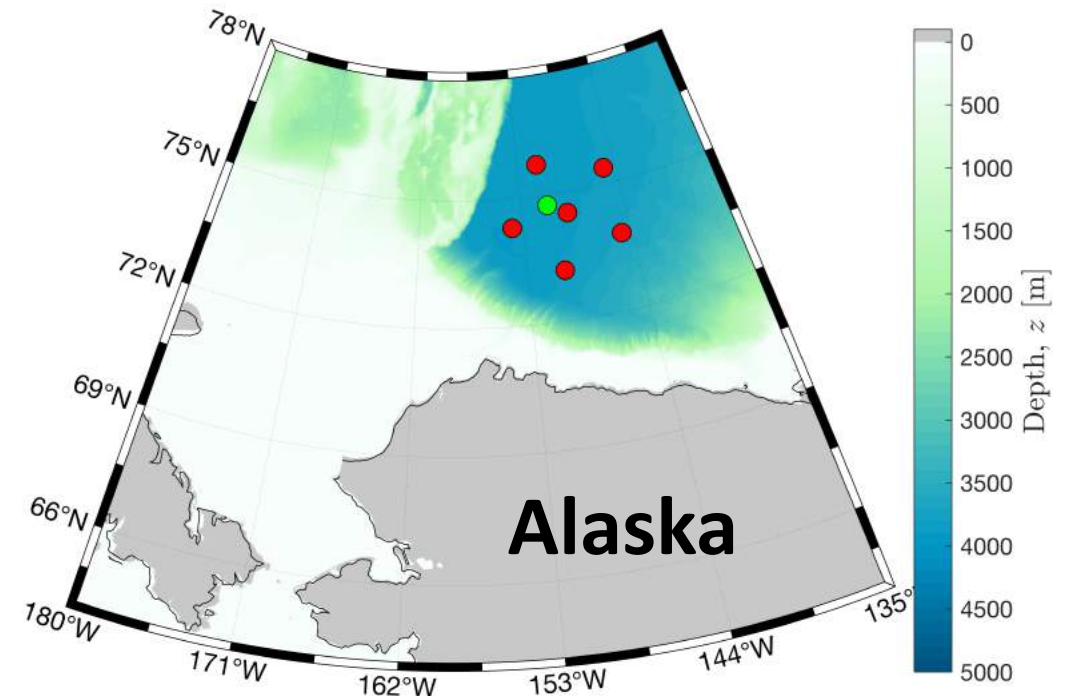
AWI/NPI: mooring section
operating since 1997

Next aim: the UNDER-ICE and CANAPE experiments

UNDER-ICE
Fram Strait

CANAPE
Beaufort Sea

Nansen Center: inversions nearly finished

Scripps: first results

Testing the ASTE state estimate and other models for Fram Strait

Example: section A-D

State-of-the-art operational ocean models and ocean state estimates struggle to reproduce observed sound profiles
(same for climate models)

Bias correction with respect to climatology necessary

Decision: using bias corrected ASTE fields for boundary conditions (Uni. Texas, Austin: A. Nguyen, P. Heimbach, V. Ocana)
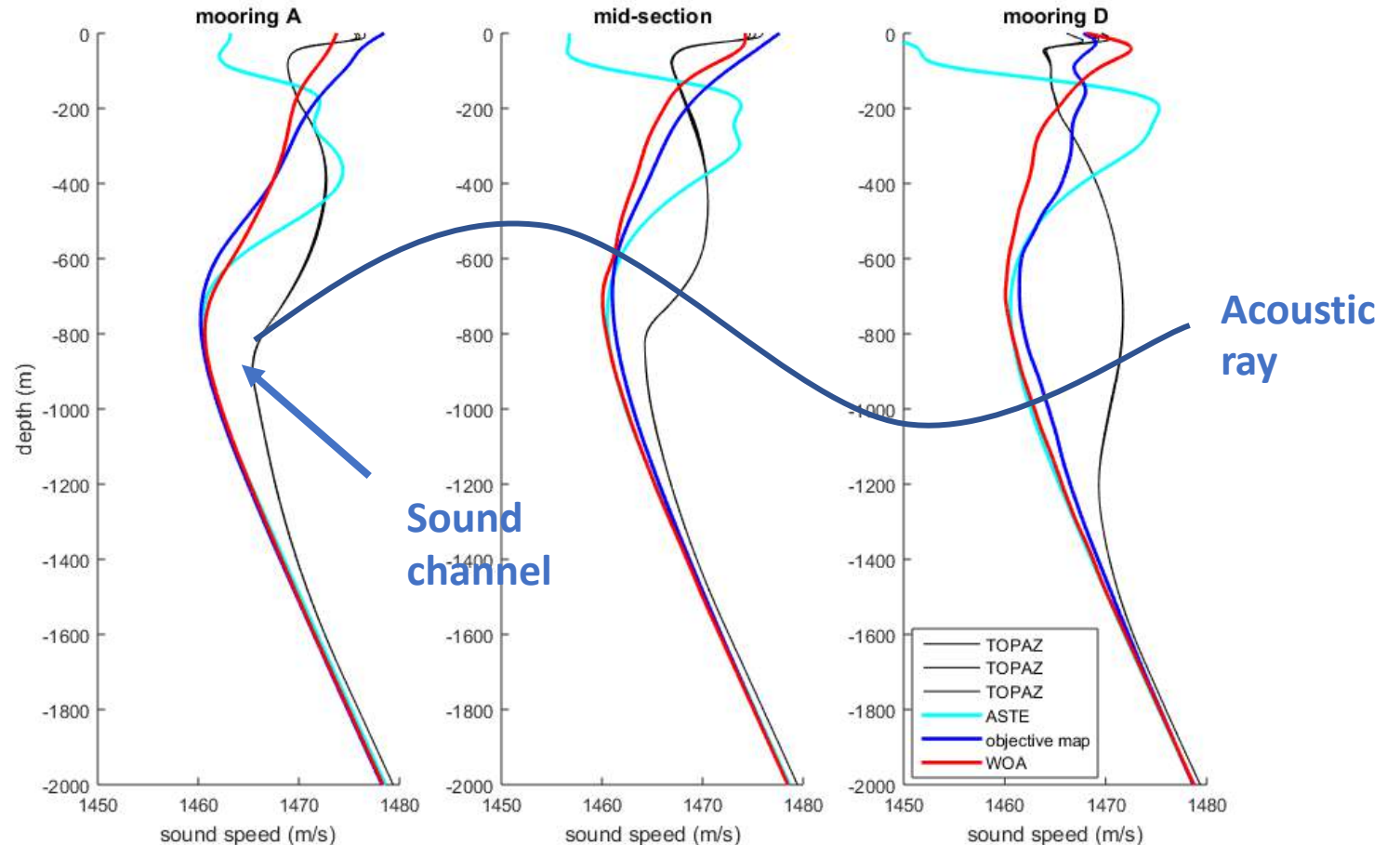

Figure: Section A-D: Comparison of section objective map data based on hydrographic profiles (15.9.-17.9.2011) to daily TOPAZ reanalysis, monthly ASTE (ECCO) model output (September 2011) and World Ocean Atlas climatology (September)
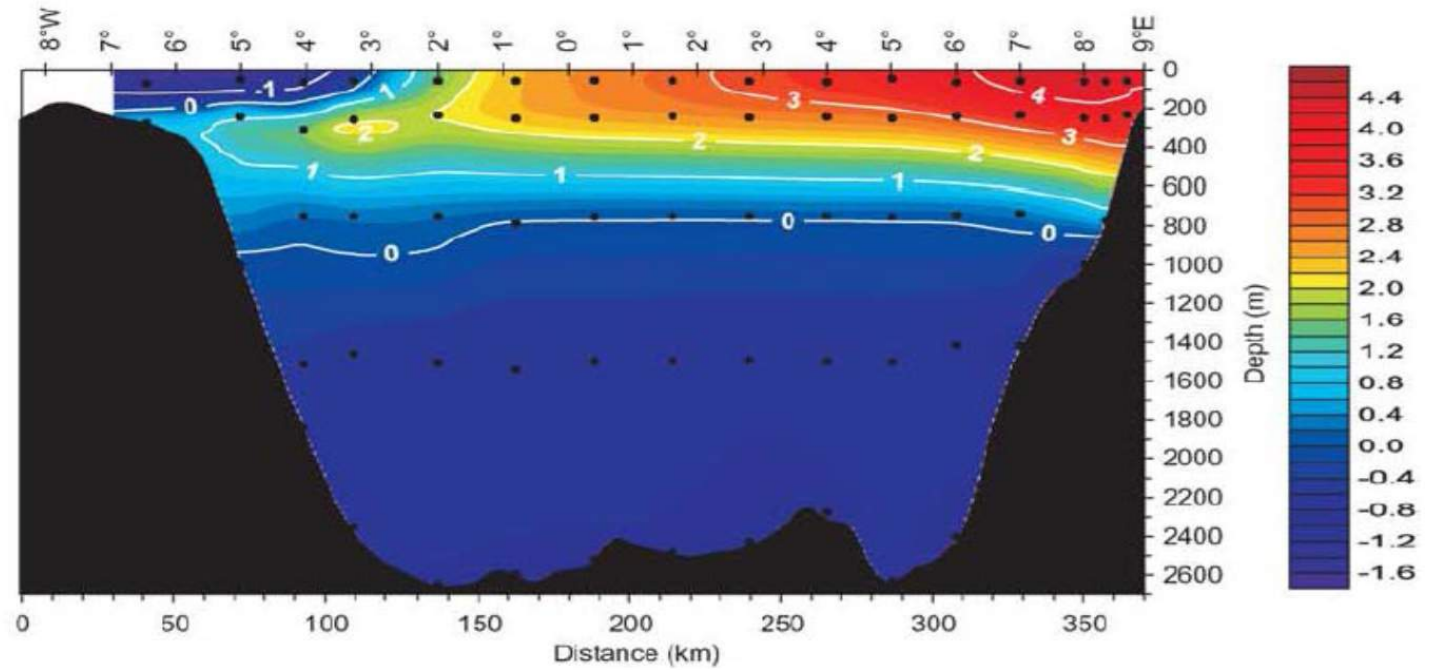
The regional Fram Strait model

- MITgcm (z-coordinate model)
- 52 vertical layers
- Horizontal resolution about 4.5 km
- Initial and Boundary conditions: bias-corrected ASTE
- 3 year run 2010-2012
- 4DVAR assimilation of acoustic tomography results (just technical tests so far)
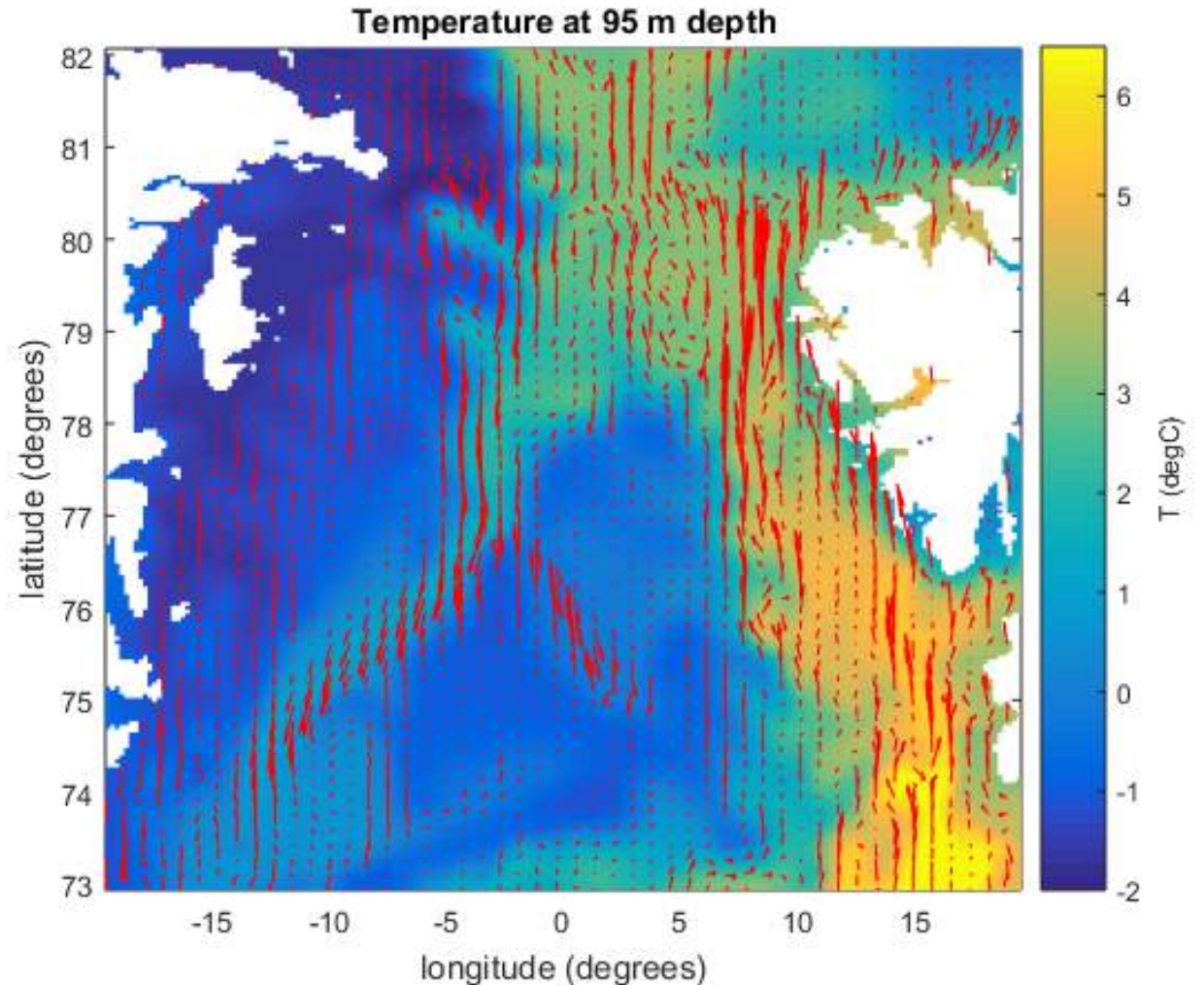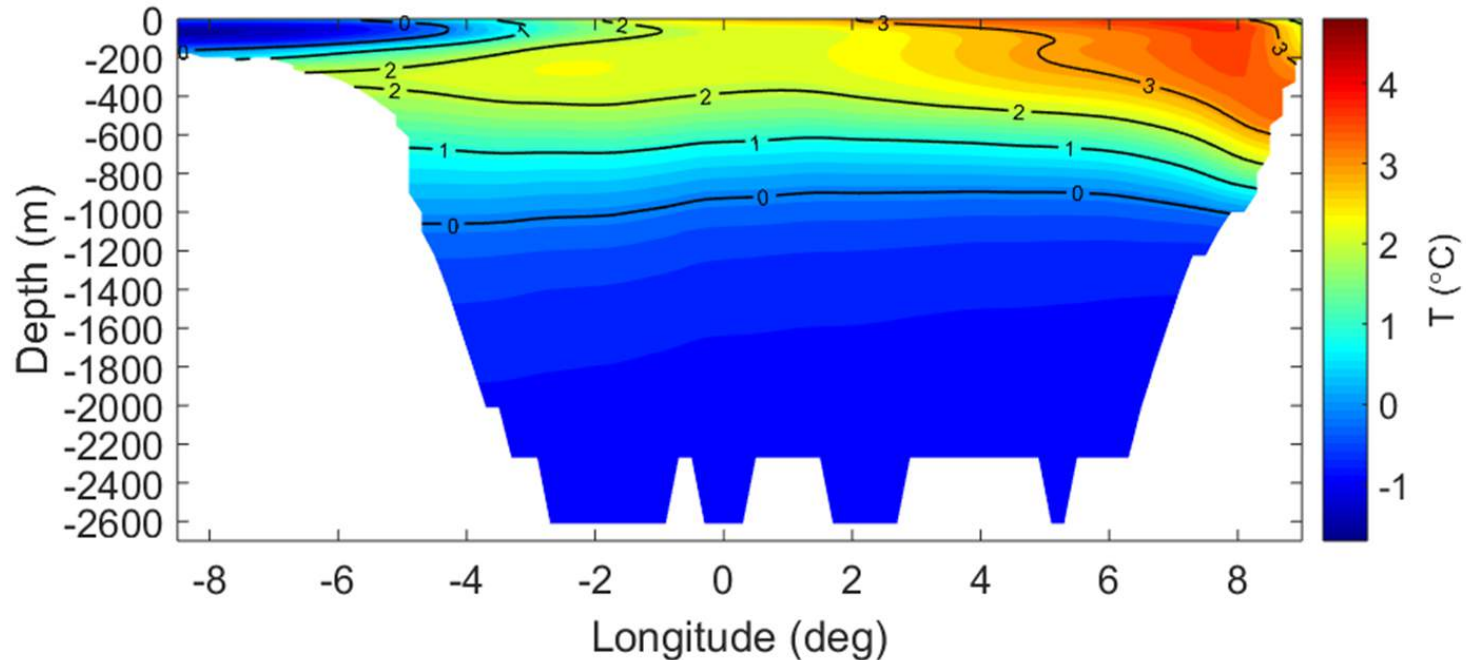

Model snapshot on 12.09.2010

Comparison of model and measurements

Measured long-term mean temperatures for mooring section along 78N50 (from Besczcynska-Möller et al., 2012)

Fram Strait model temperatures for section along 78N50 (2010-2012 mean) using the bias-corrected ASTE initial and boundary conditions
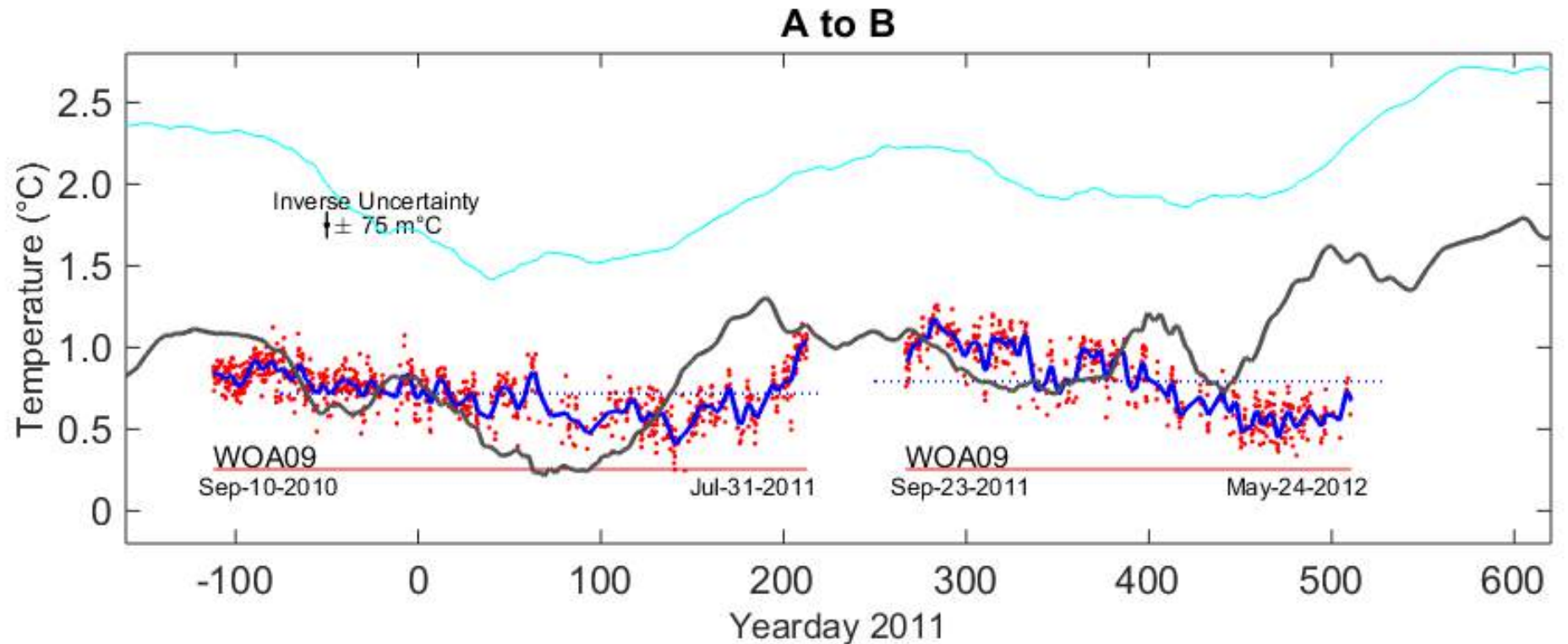
Comparison of temperature time series:
ASTE, Fram Strait model, WOA, inversion results from acoustic tomography experiment
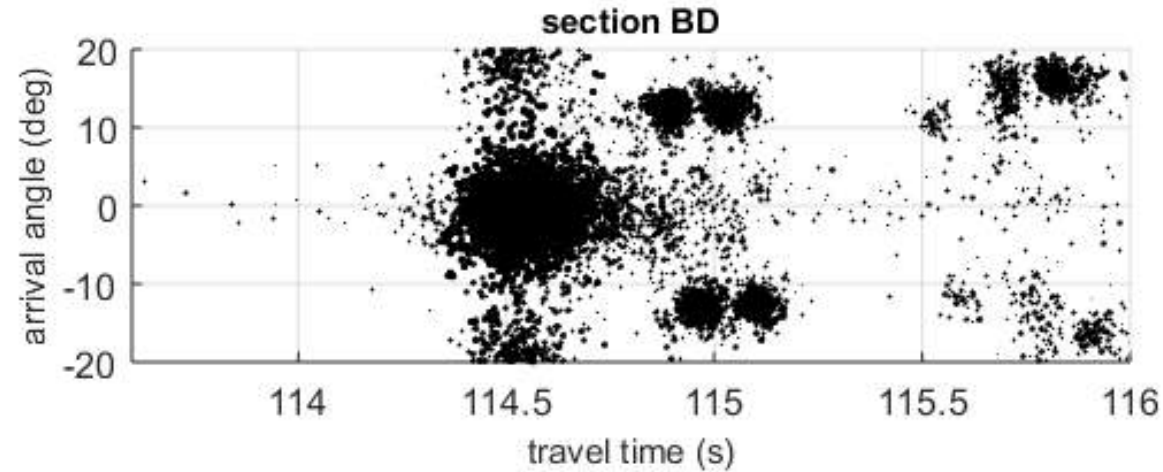
Cyan: ASTE

Gray: Fram Strait model

Red: WOA

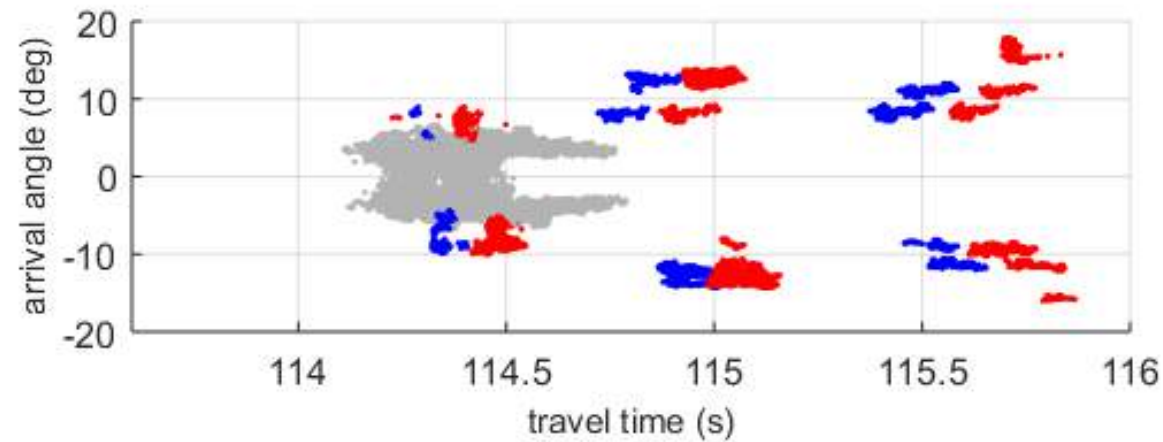Blue + red dots: inversion result from acoustic tomography

Prediction of observed acoustic arrival structure

Observation

Model

Grey: refracted rays
Red/blue: SRBR ray

Conclusions and questions

- Models have difficulties to reproduce the observed stratification in Fram Strait
- High-resolution model with bias-corrected ASTE as initial/boundary conditions is successfully used for acoustic modelling
- The same model will be used for assimilation data of range/depth-average temperatures

- Would it be promising to assimilate range/depth-average temperatures in ASTE/ECCO?
- What would the reaction of the state estimate be considering the vertical stratification bias?
- What challanges or benefits would assimilation of range/depth-averaged properties have?