Variability in Circulation and Hydrography in the Denmark Strait

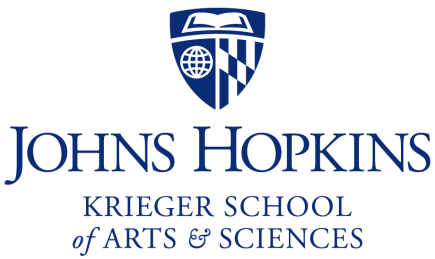
Mattia Almansi

Department of Earth and Planetary Sciences

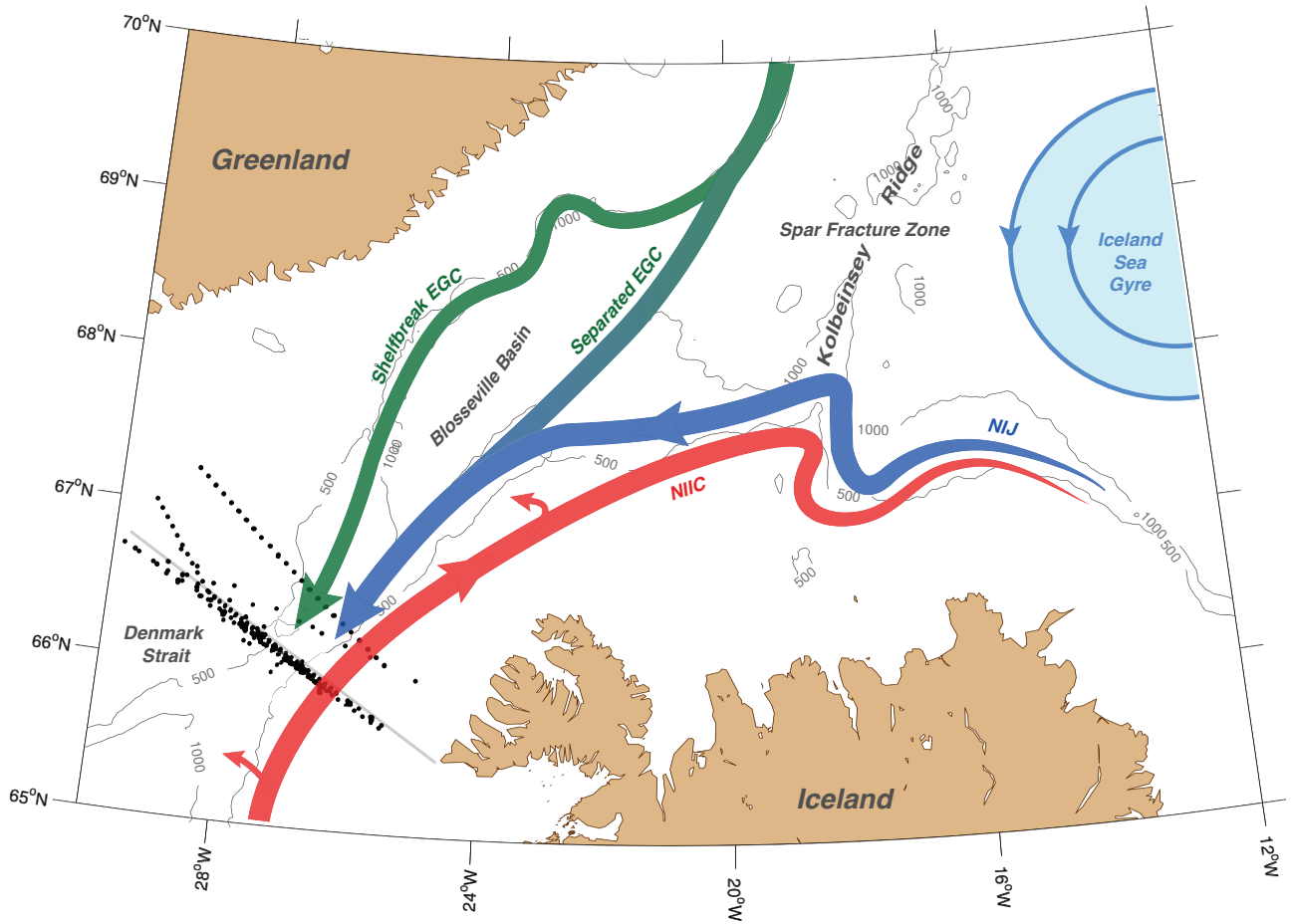
The Johns Hopkins University

ASOF Meeting

Mar. 21, 2017

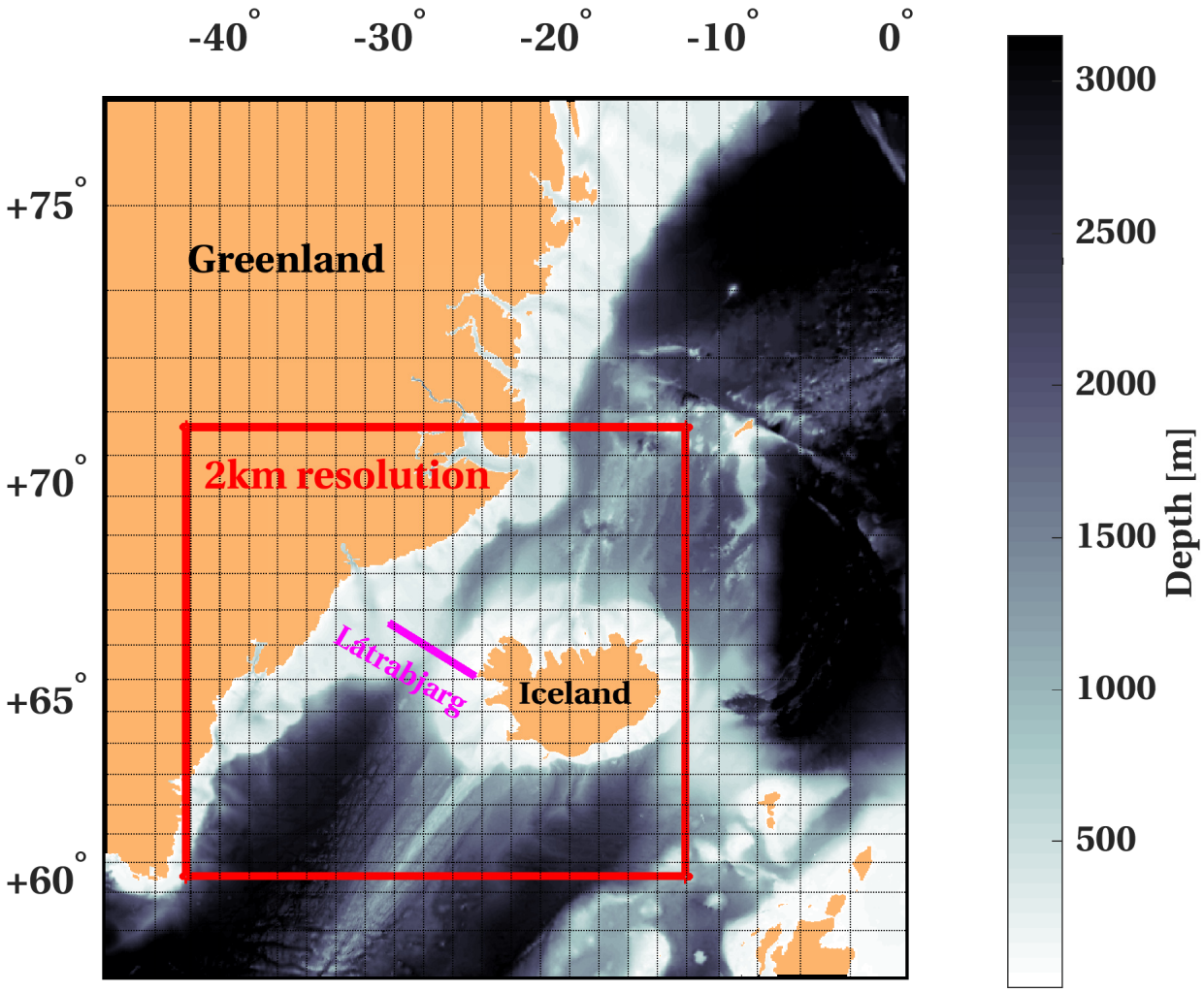


1. Why the Denmark Strait?
2. Model configuration
3. Comparison with observations
4. Boluses and Pulses
5. Conclusions

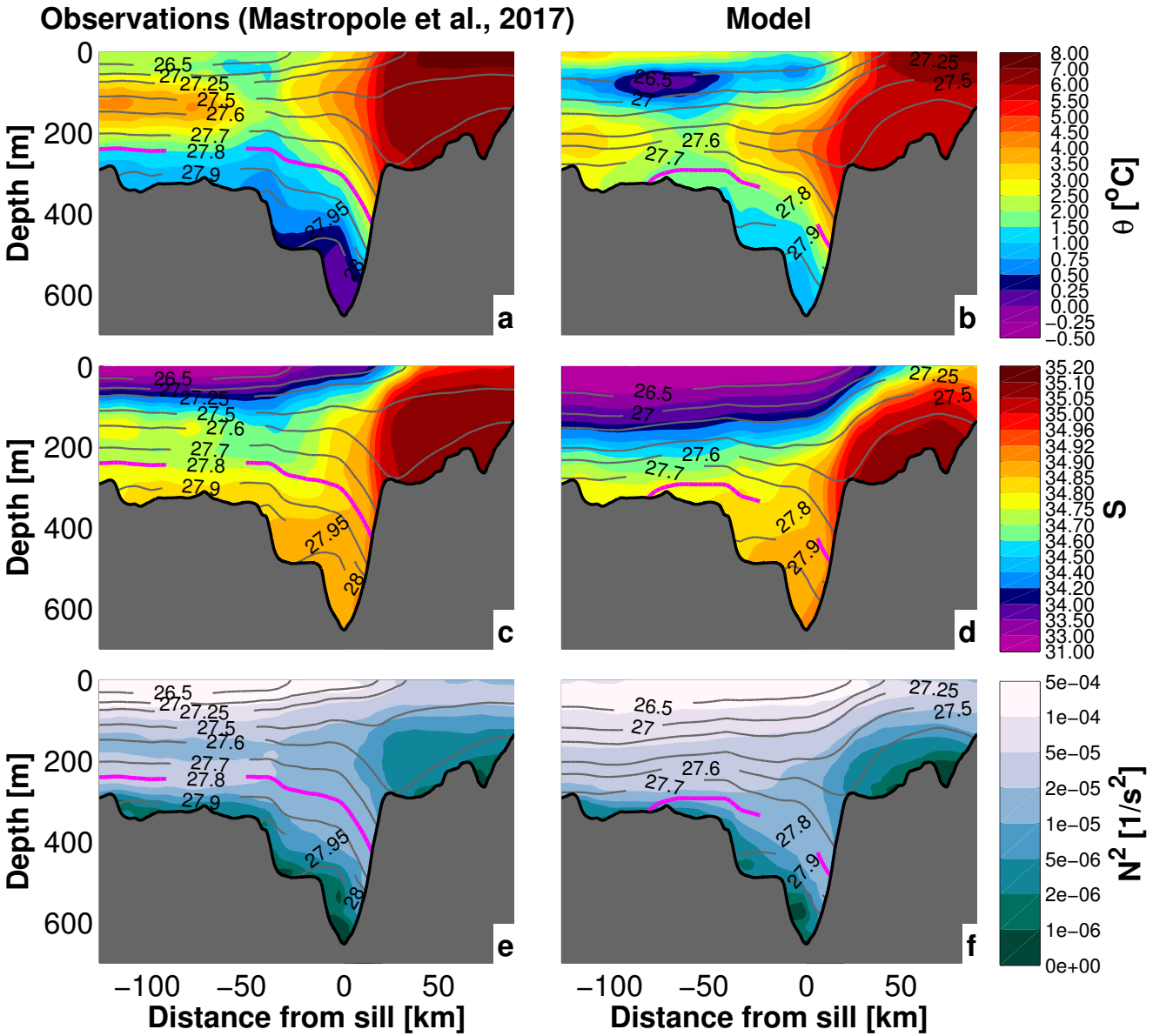


(Mastropole et al., 2017)

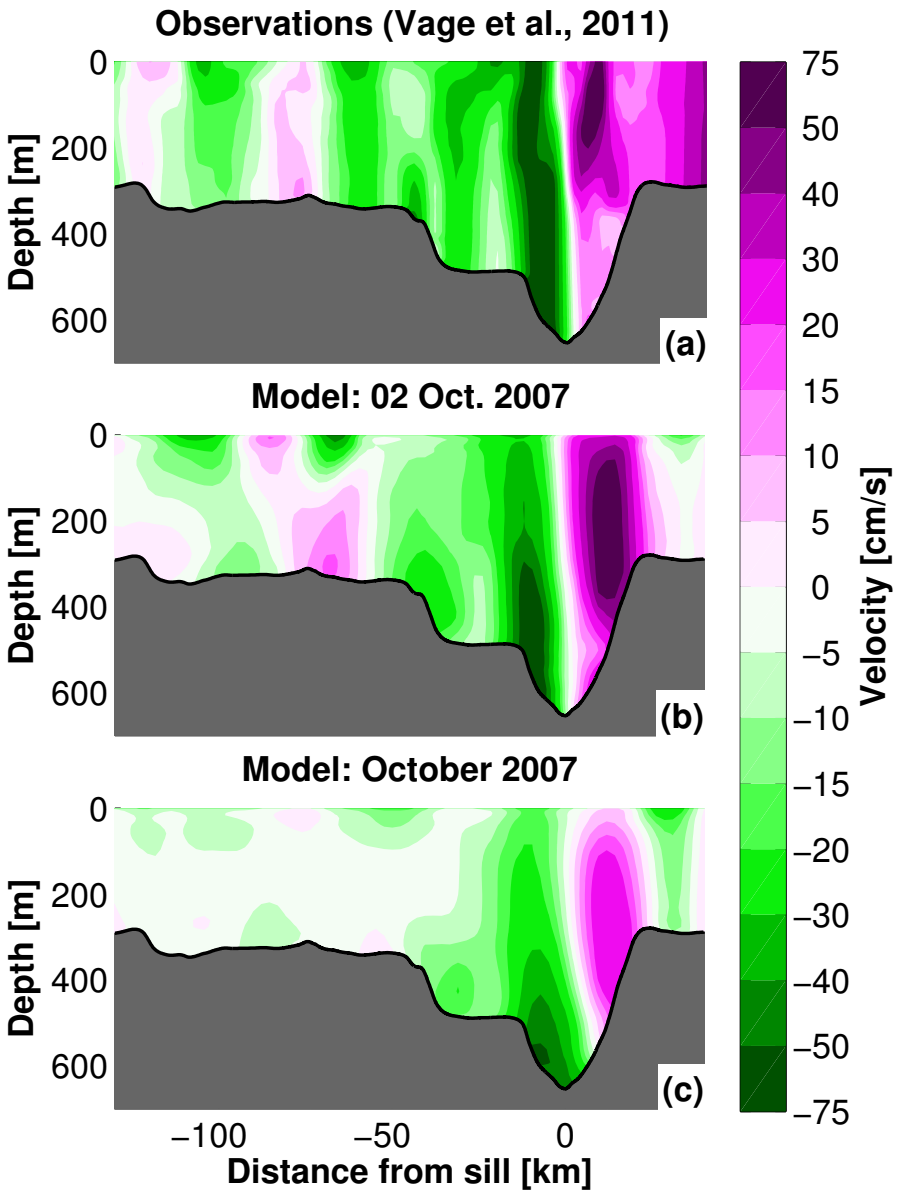
High resolution realistic model



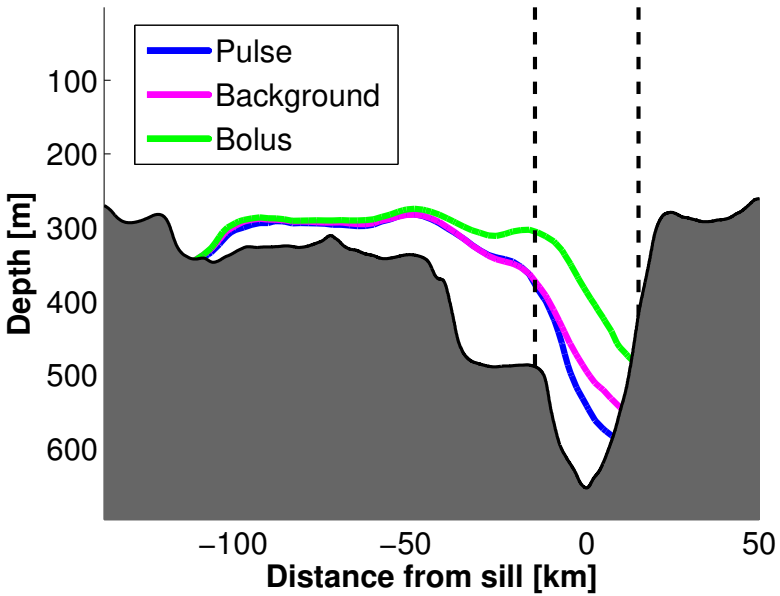
Hydrograpy


Observations (Mastropole et al., 2017)
Model
Depth [m]
0
200
400
600
a
b
c
d
e
f
θ [°C]
S
N² [1/s²]
Distance from sill [km]
−100
−50
0
50

Normal velocity (+ poleward)

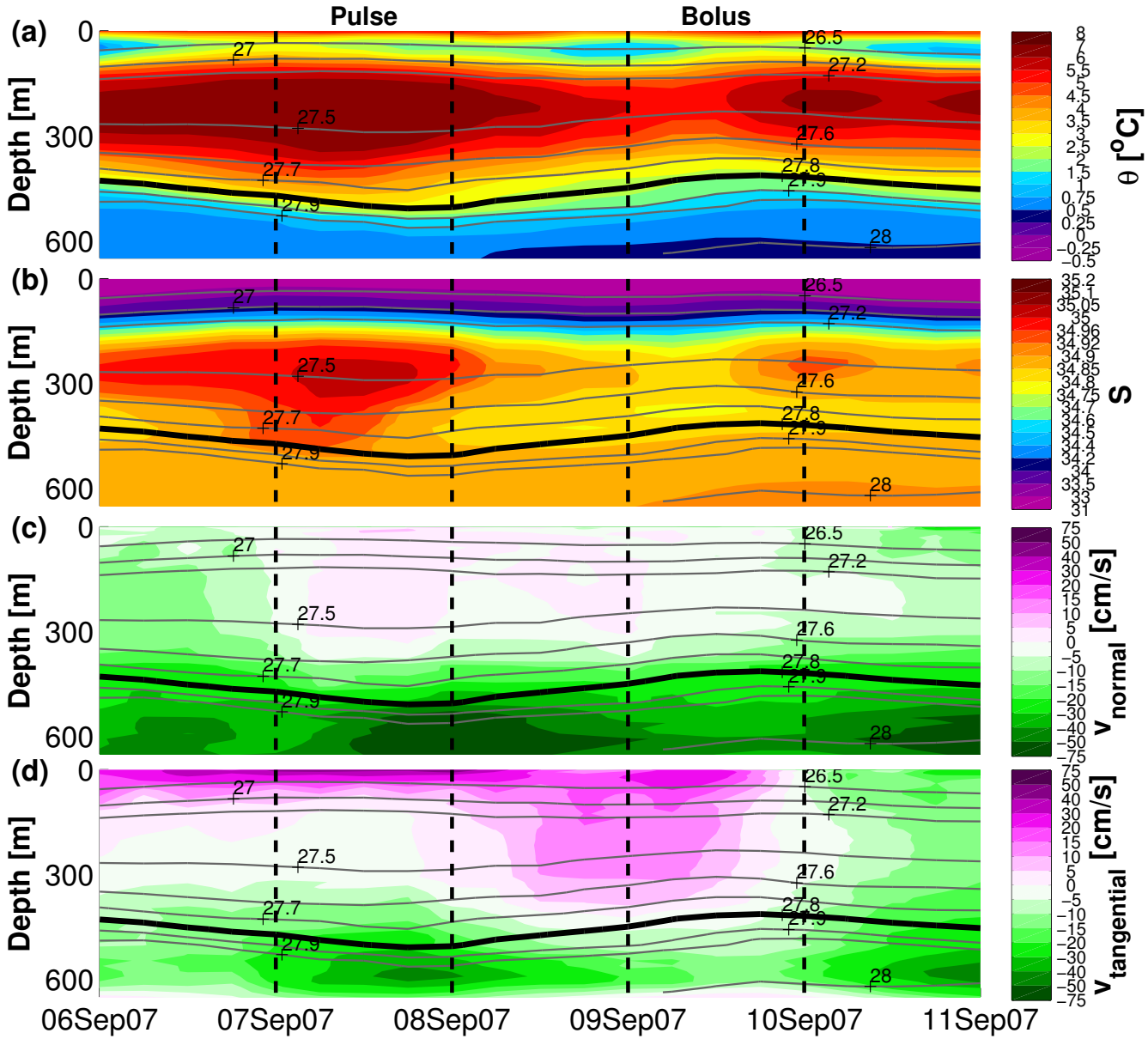


Boluses and Pulses

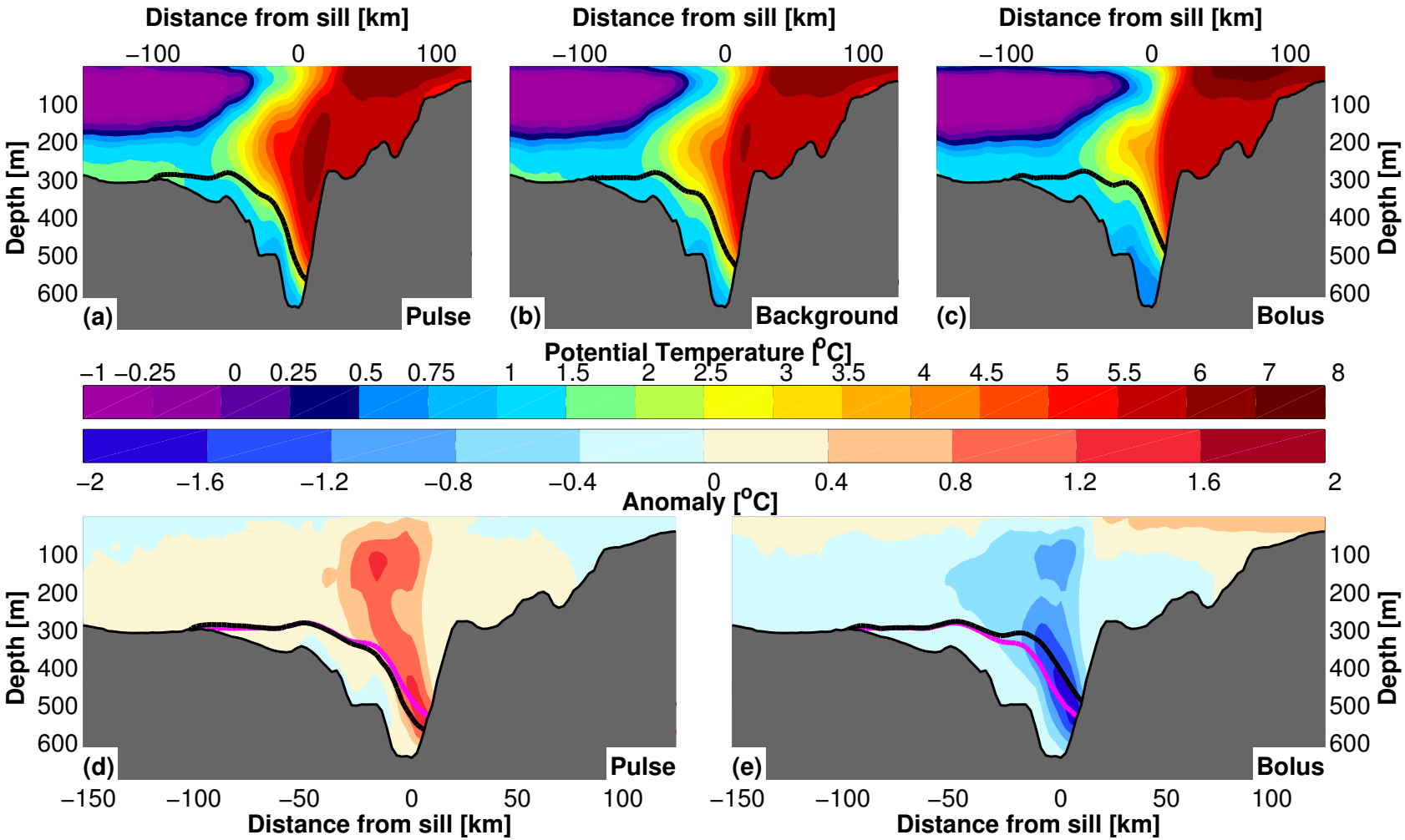


- Boluses and Pulses increase the DSOW transport by 30%
- Boluses are more frequent:
  - Pulses: ∼20%
  - Boluses: ∼30%
  - Background: ∼50%
- Boluses have longer duration:
  - Pulses: 28 hours
  - Boluses: 57 hours
- Boluses mean transport is almost twice that of Pulses
- Boluses have a stronger impact on transport

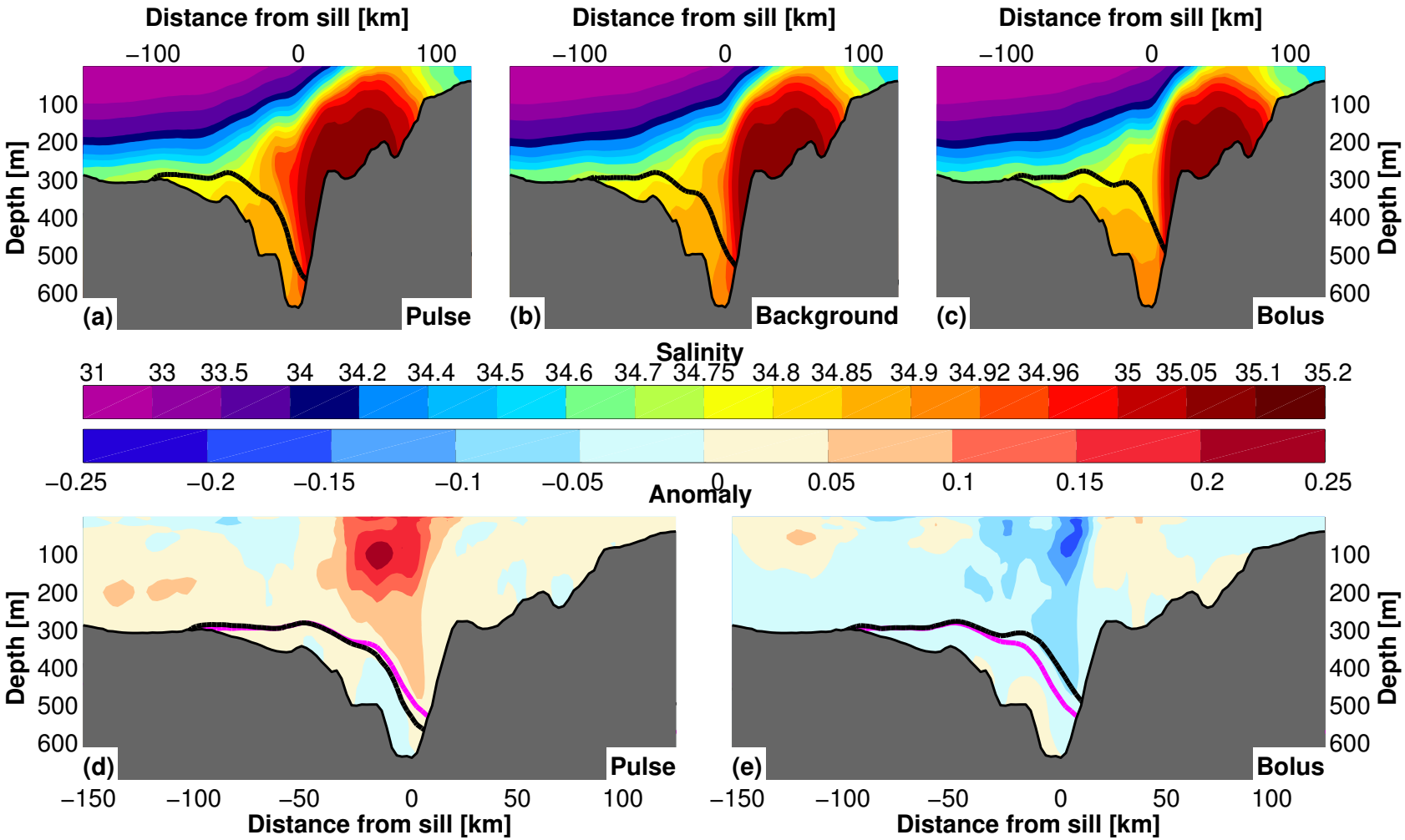
Time evolution



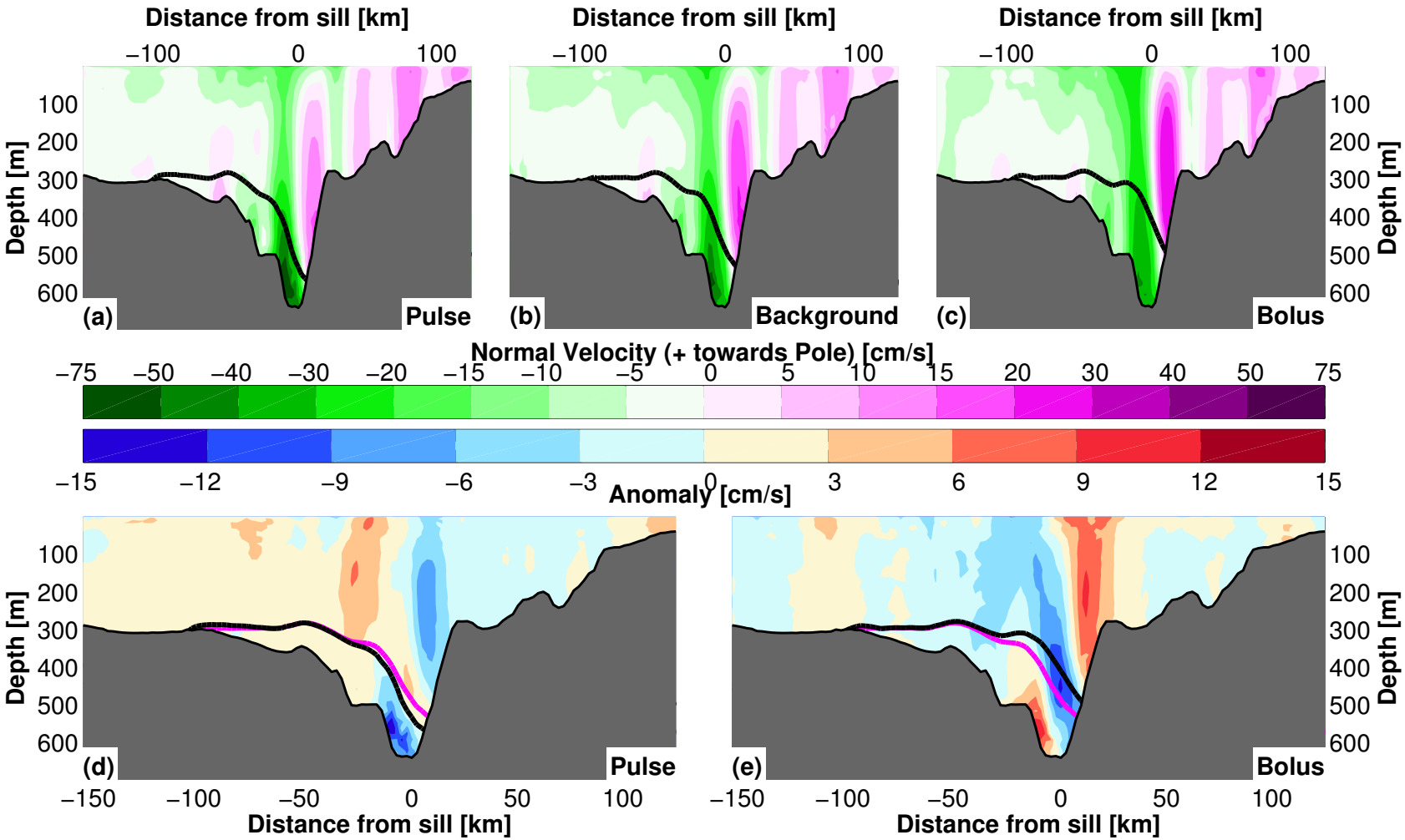
Spatial distribution: Temperature



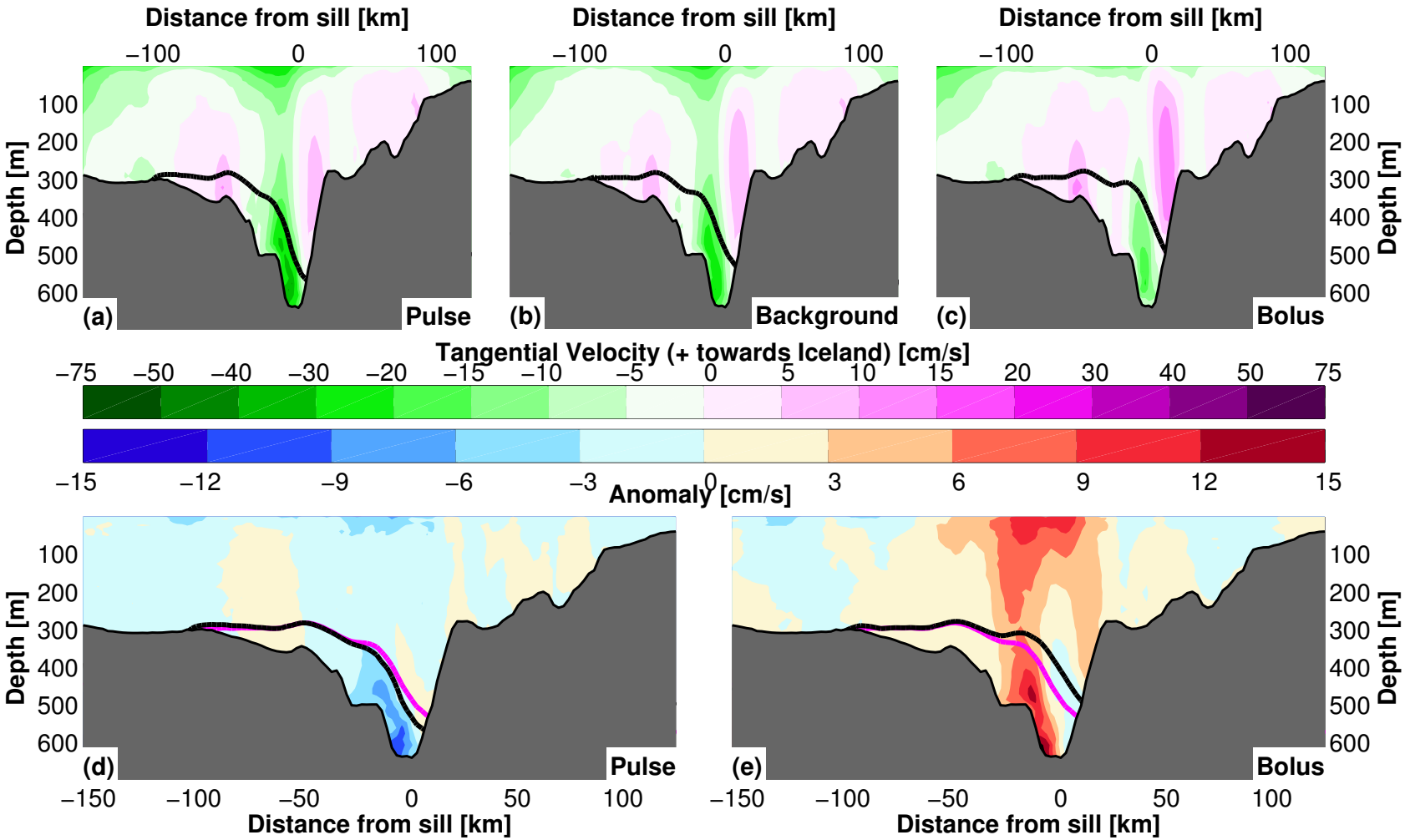
Spatial distribution: Salinity



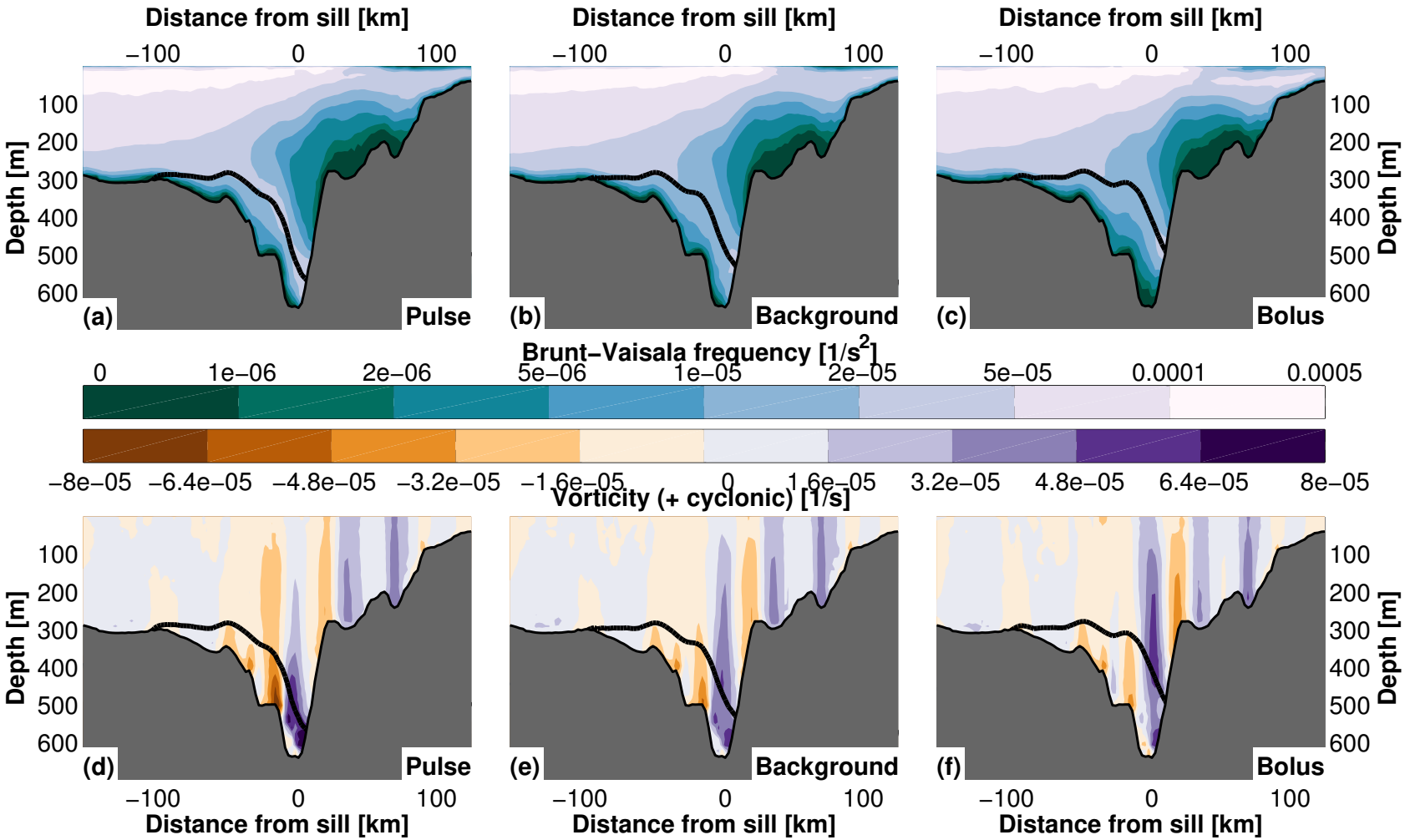
Spatial distribution: Normal Velocity



Spatial distribution: Tangential Velocity



Spatial distribution: Stratification and Vorticity



Conclusions

- Model hydrography and velocity structures in the Denmark Strait are consistent with observations.
- Our method to identify boluses and pulses is based on transport and sectional area thresholds.
- Both boluses and pulses increase the DSOW transport (boluses have larger impact), but their temperature, salinity, density, and velocity structures are different.
- Boluses may be brought to the Denmark Strait by the NIJ, while it is unclear where pulses form and how they get to the Denmark Strait.
  Next step: Lagrangian particle backward-tracking.
- Stratification (N^2) can be used to detect boluses. Vorticity anomalies are not spatially homogeneous during boluses/pulses events.

Mastropole, D., Pickart, R. S., Valdimarsson, H., Våge, K., Jochumsen, K., & Girton, J. (2017, jan). On the hydrography of Denmark Strait. *Journal of Geophysical Research: Oceans*. Retrieved from http://doi.wiley.com/10.1002/2016JC012007 doi: 10.1002/2016JC012007

Våge, K., Pickart, R. S., Spall, M. A., Valdimarsson, H., Jónsson, S., Torres, D. J., ... Eldevik, T. (2011). Significant role of the North Icelandic Jet in the formation of Denmark Strait overflow water. *Nature Geoscience*, *4*(10), 723–727. Retrieved from https://domicile.ifremer.fr/ngeo/journal/v4/n10/full/,DanaInfo=www.nature.com+ngeo1234.html{%}5Cnhttps://domicile.ifremer.fr/ngeo/journal/v4/n10/pdf/,DanaInfo=www.nature.com+ngeo1234.pdf doi: 10.1038/ngeo1234

Von Appen, W.-j., Mastropole, D., Pickart, R. S., & Girton, J. B. (2017). On the Nature of the Mesoscale Variability in Denmark Strait. , 567–582. doi: 10.1175/JPO-D-16-0127.1