

Temporal and Spatial Hydrodynamic Variability in the Mallorca Channel (Western Mediterranean Sea) From 8 Years of Underwater Glider Data

**Bàrbara Barceló-Llull^{1,2}, Ananda Pascual², Simón Ruiz²,
Romain Escudier³, Marc Torner⁴, and Joaquín Tintoré^{2,4}**

¹ APL-University of Washington, USA

² IMEDEA (UIB-CSIC), Spain

³ CMCC, Italy

⁴ SOCIB, Spain



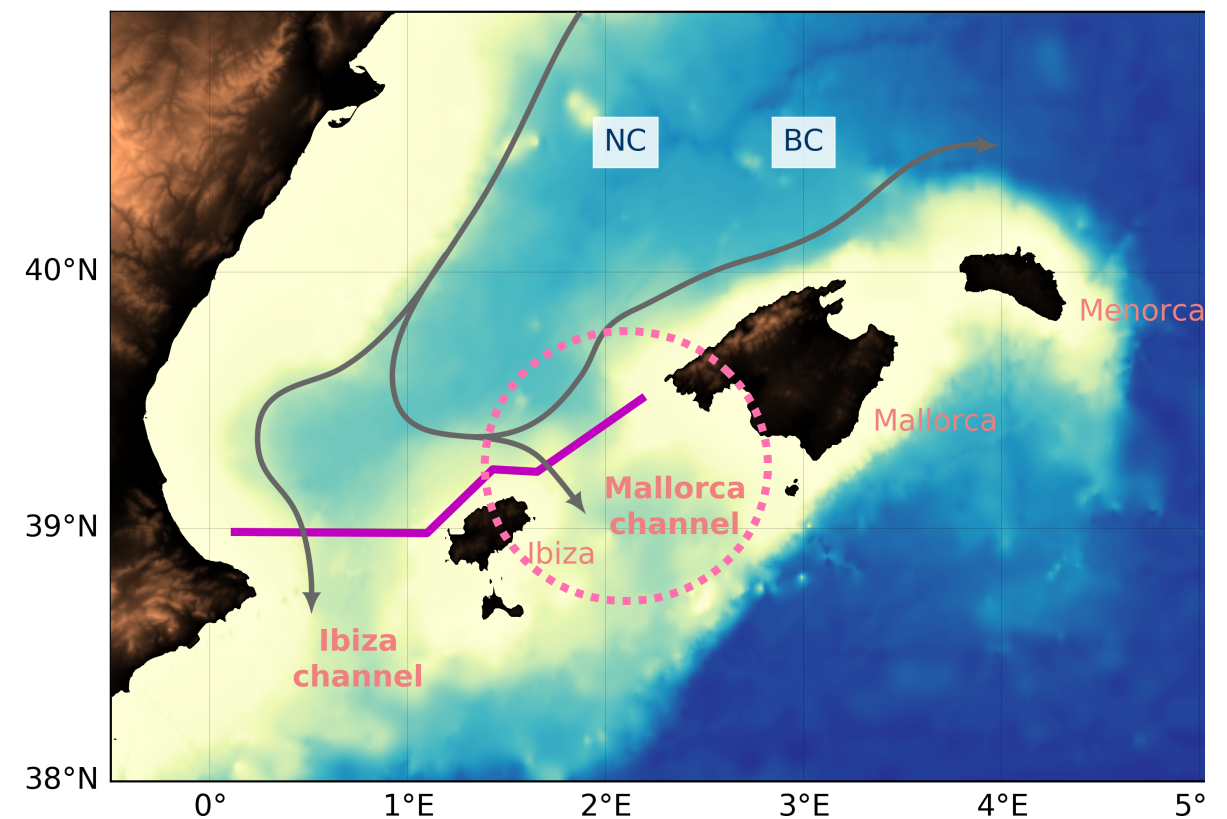
Barceló-Llull, B., Pascual, A., Ruiz, S., Escudier, R., Torner, M., & Tintoré, J. (2019). Temporal and spatial hydrodynamic variability in the Mallorca channel (western Mediterranean Sea) from 8 years of underwater glider data. *Journal of Geophysical Research: Oceans*, 124. <https://doi.org/10.1029/2018JC014636>

Objective

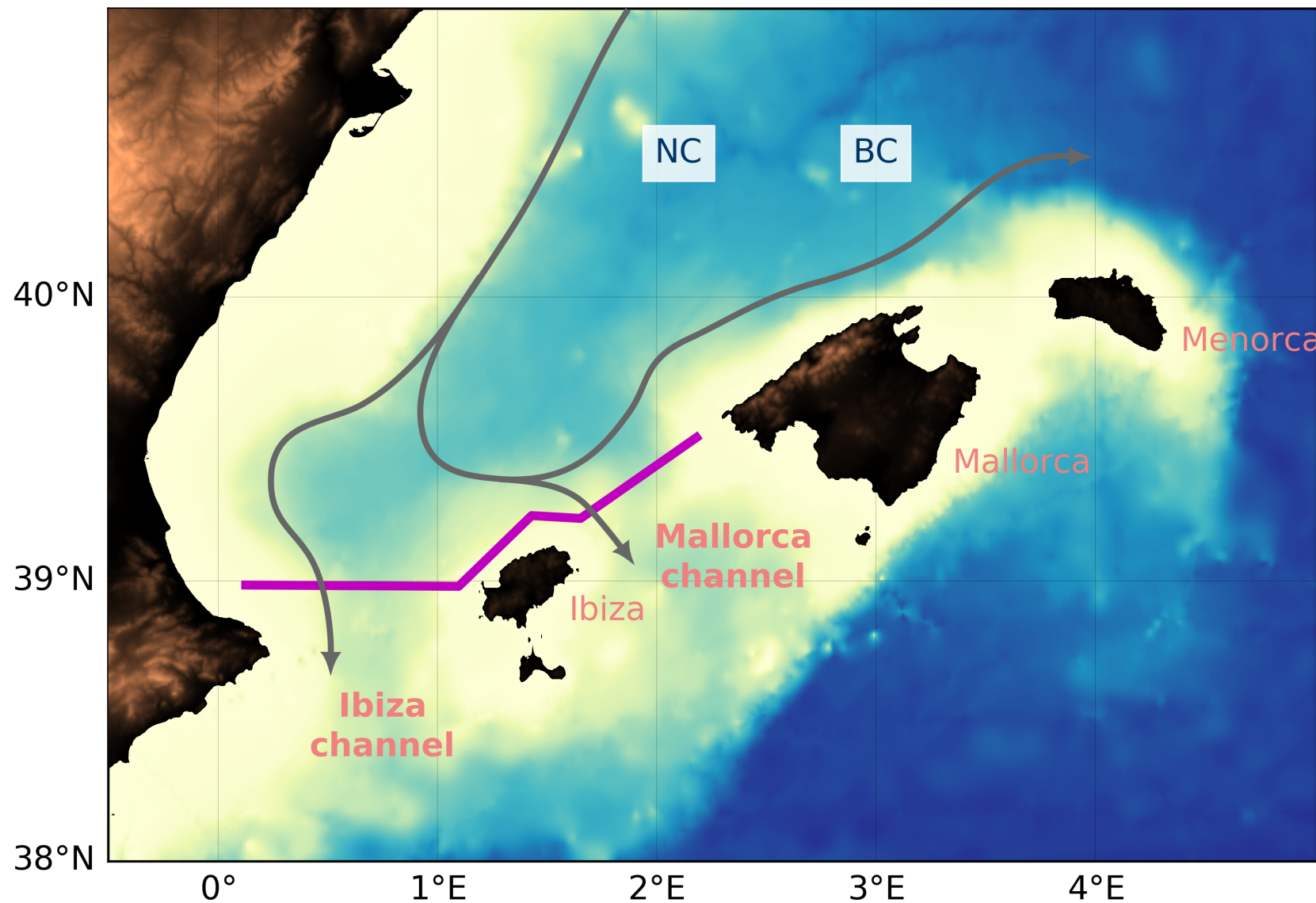
Characterize a region in the Western Mediterranean Sea that will be sampled at high spatial and temporal resolution by the SWOT satellite mission during the fast phase after launch in 2021.



Mallorca channel



Canales project

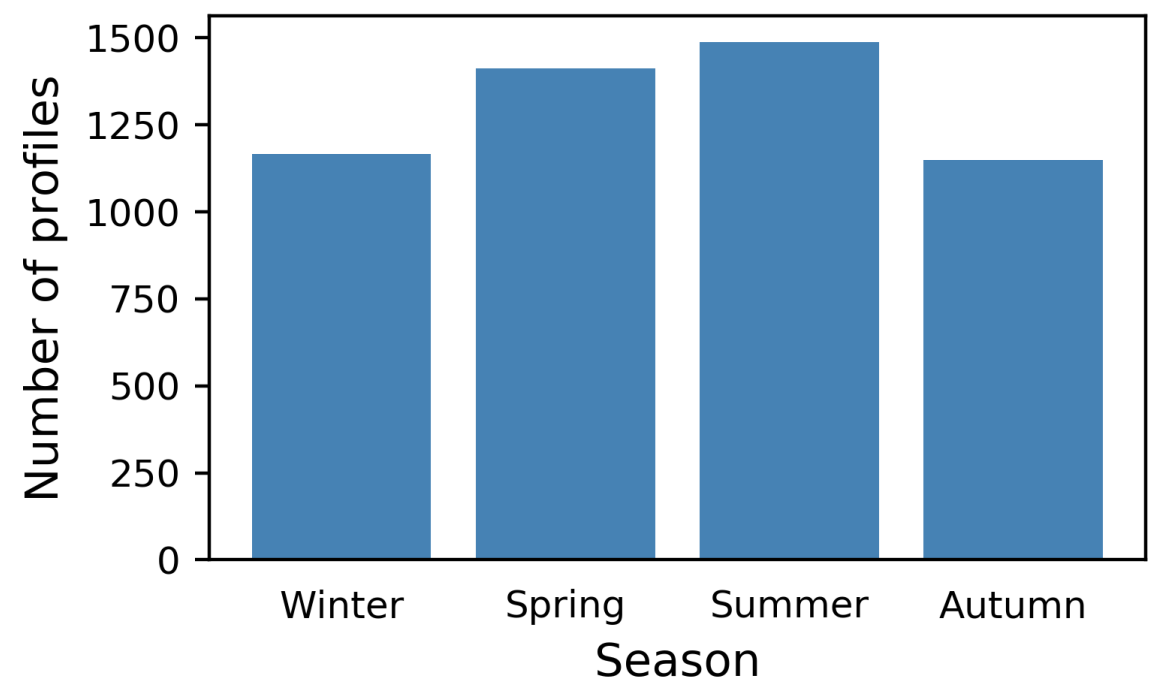


- Measured variables include **pressure, temperature, and salinity**
- Processed with the **SOCIB Glider Toolbox**, which includes thermal lag correction and quality control (Troupin et al., 2015)

8 years of glider data along the Mallorca channel



- 55 transects
- ~5000 profiles reaching a maximum depth of ~950 m
- Horizontal resolution ~2 km in the deepest part of the 65-km wide channel
- 2.8 days to complete a transect



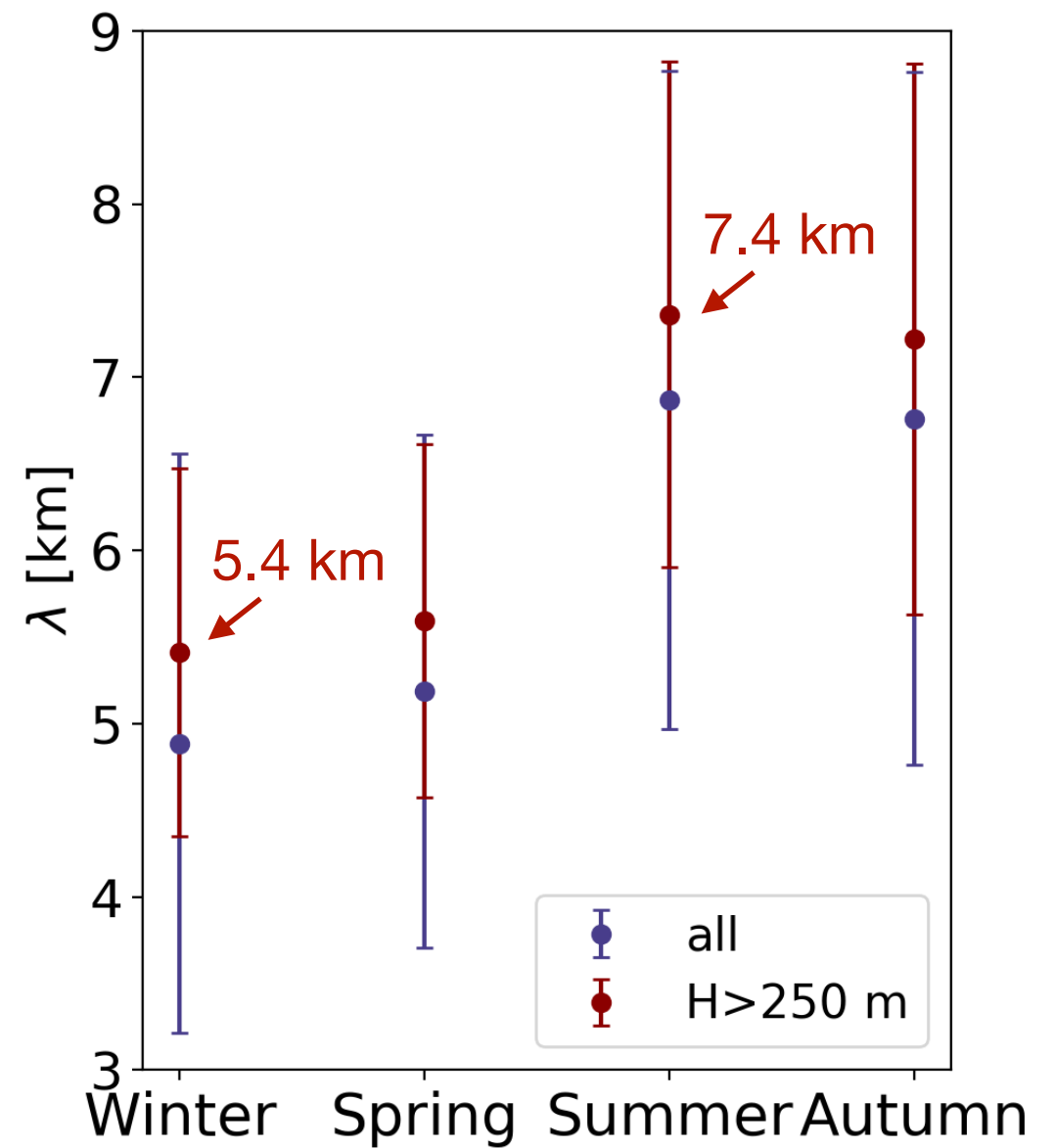
First Baroclinic Rossby radius of deformation

$$\lambda_1 \approx \frac{1}{f\pi} \int_{-H}^{-30} N(z) dz$$

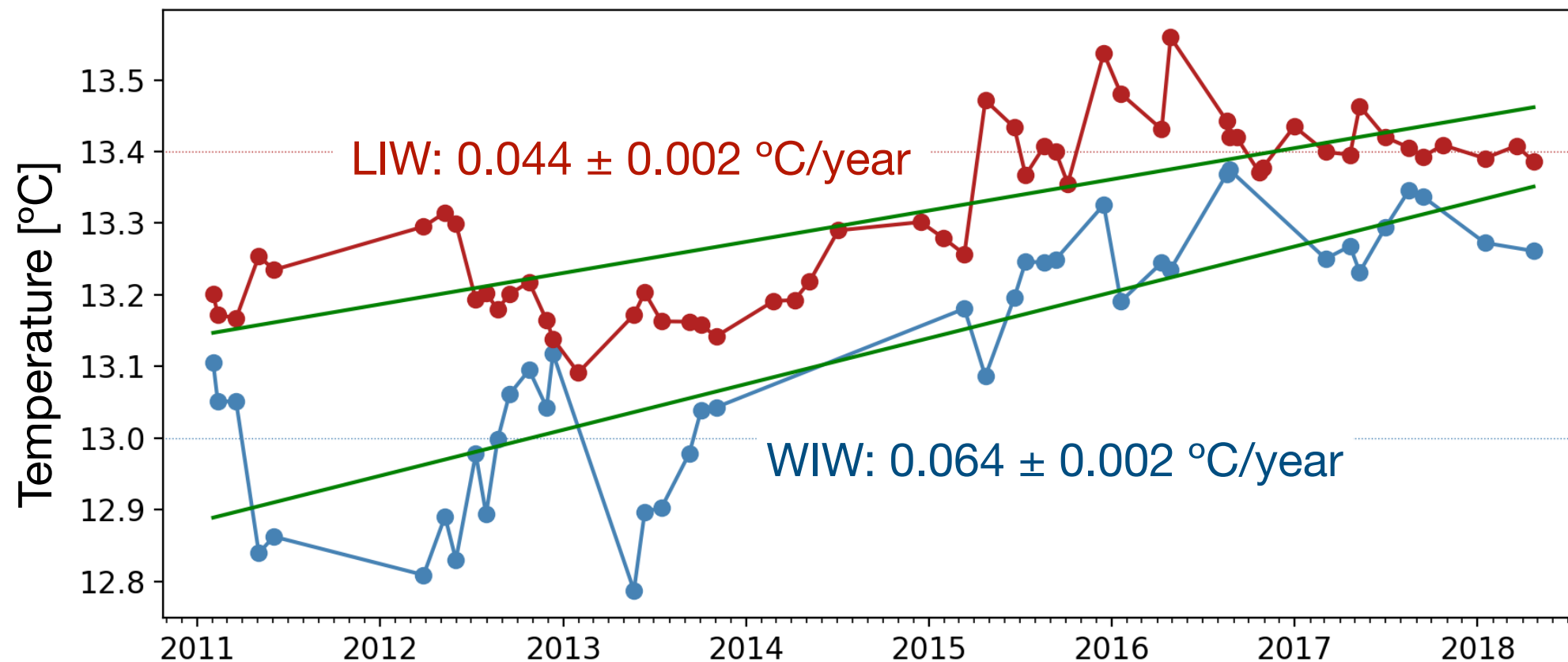
Chelton et al. (1998)

Mean $\lambda_1 = 6.0 \pm 2.0$ km

- In this region SWOT will resolve the mesoscale



Warming of intermediate waters



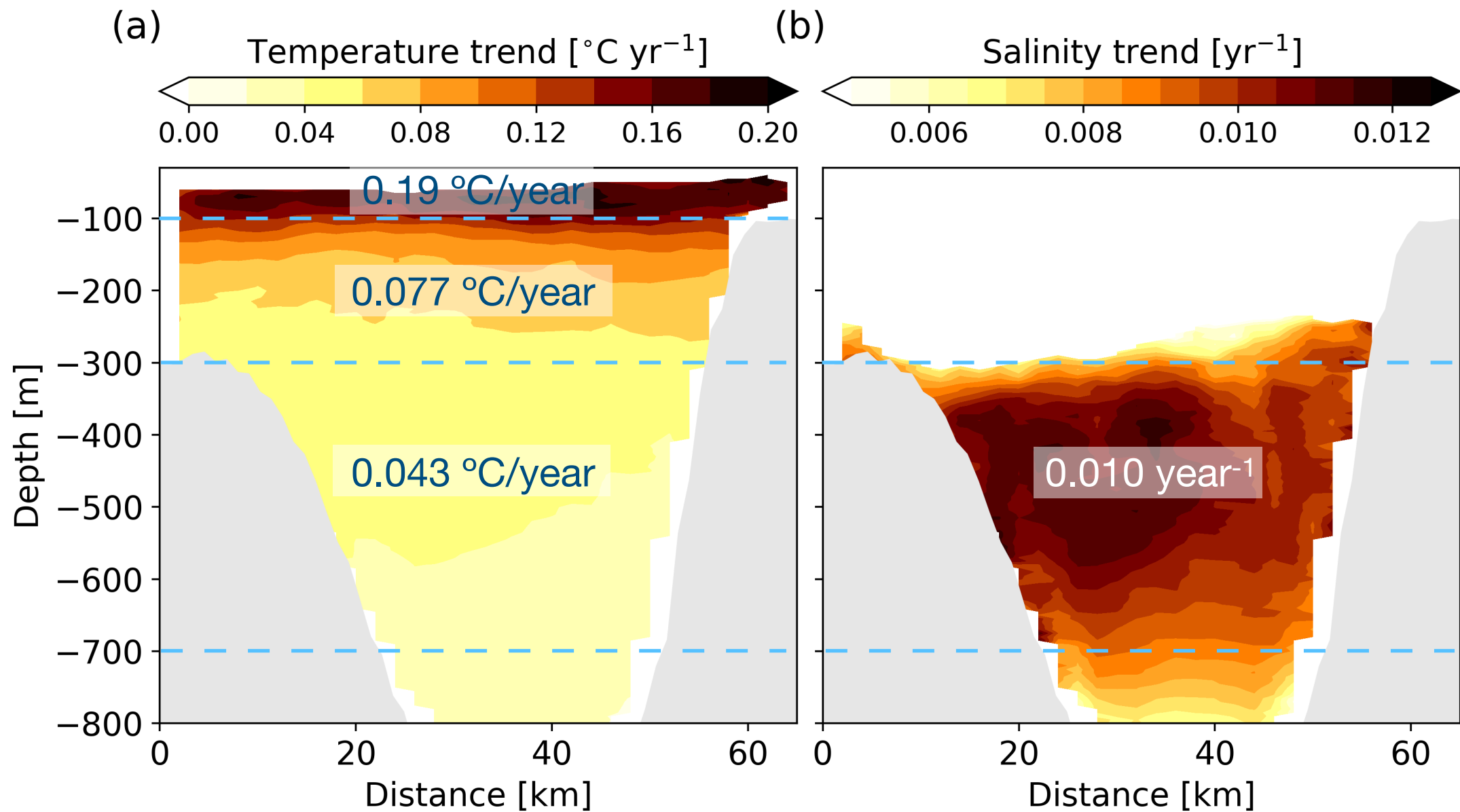
*WIW: Western Med. Interm. water (100-300 m)

*LIW: Levantine Interm. water (300-700 m)

Temperature of intermediate waters increases significantly over time

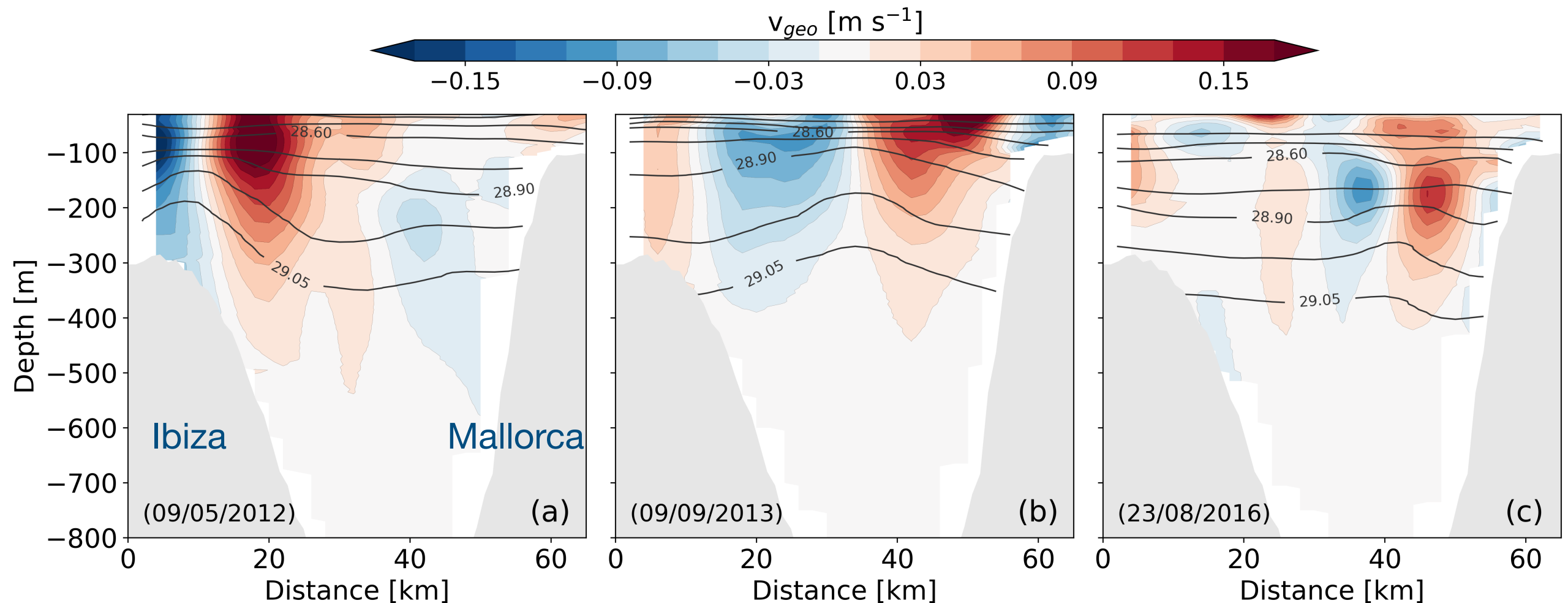
- Tendencies an order of magnitude higher than those reported for the global ocean intermediate layer
- Similar rates in regions of the central and western Mediterranean Sea (Schroeder et al., 2017)

Temperature and salinity trends



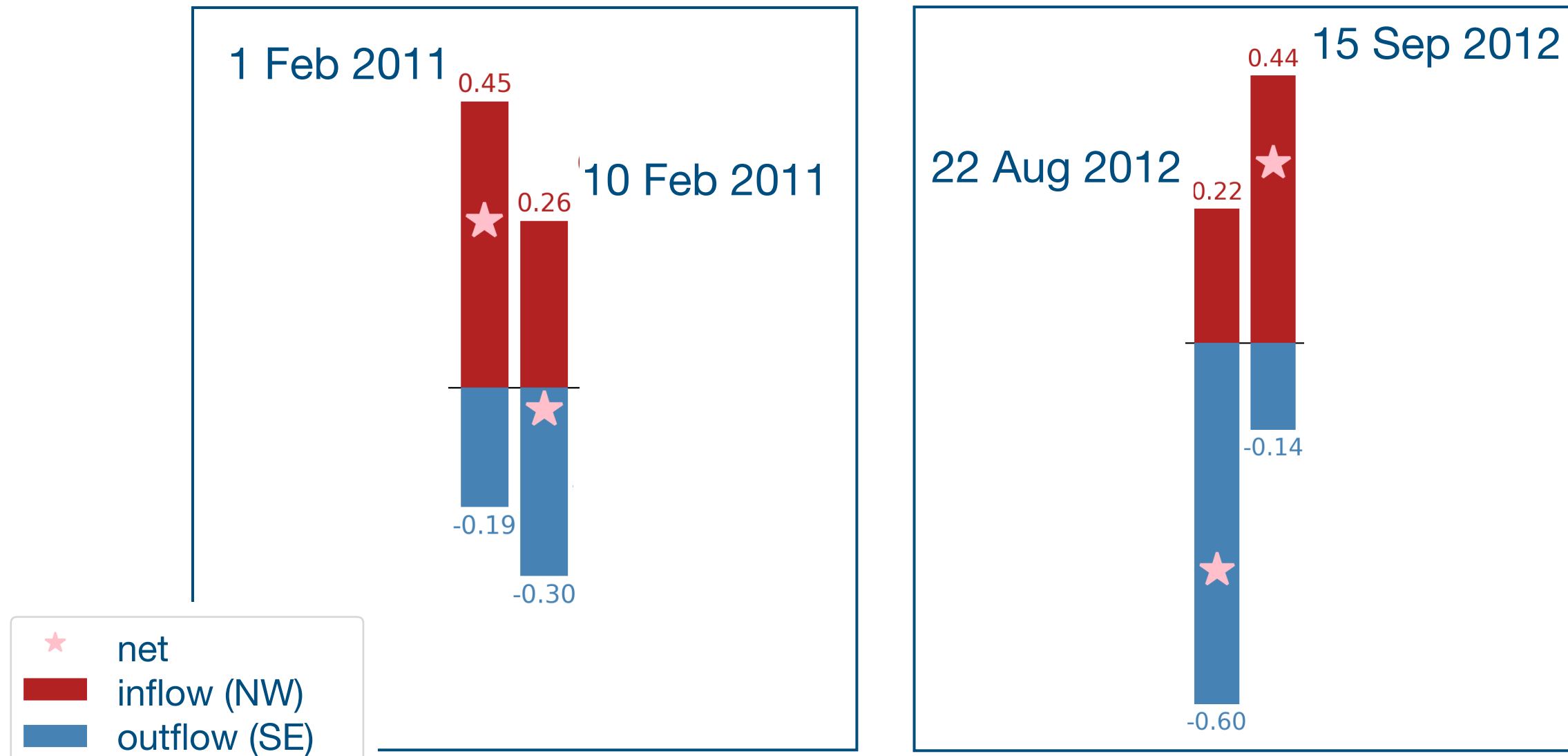
Mean salinity trend between 300 and 700 m (LIW): 0.010 year^{-1}

Eddies within the Mallorca channel



The signature of eddies with radius ranging from 5 to 18 km is apparent in 16% of the transects analyzed and mainly in spring and summer, with a dominance of subsurface cyclonic eddies

Transport of water (Sv)



Variations of water transport over timescales of weeks to months can be similar to those identifiable as seasonal changes

Conclusions

With 8 years of glider data we have been able to analyze the interannual evolution of the water masses, and the high-frequency variability that dominates the circulation across the channel.

- Temperature and salinity of intermediate waters increase over time.
- Eddies from 5 to 18 km in radius are apparent in 16% of the transects, and are mainly observed in spring and summer.
- Variations of water transport over timescales of weeks to months can be similar to those related to seasonal changes.

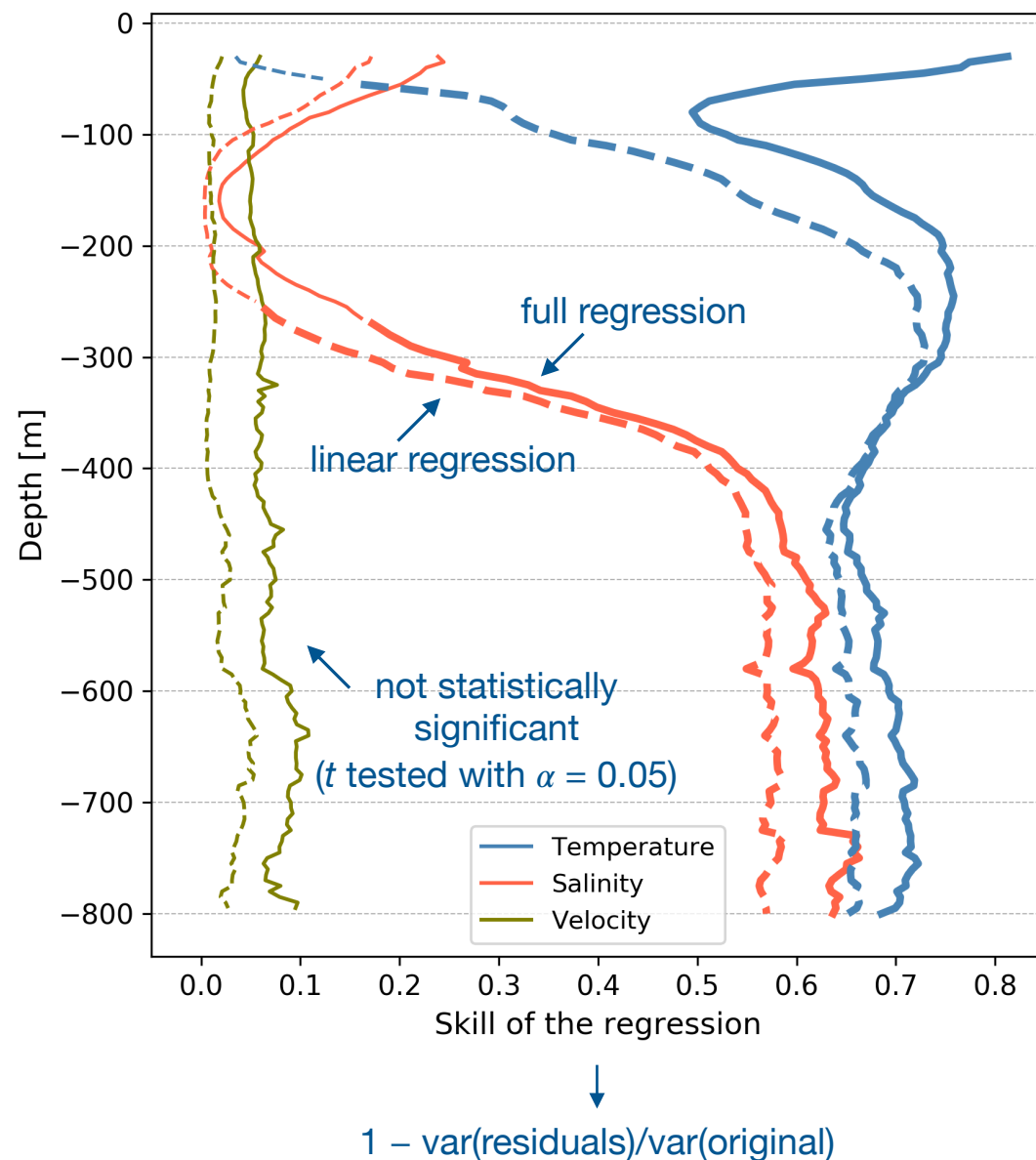
Next challenges...

- **Reach temporal scales from hours to weeks.**
- **Reconstruct a 3D view of the local dynamics:** new technologies and integrated approaches (including satellite data, in situ observations, and numerical modeling).
- **Continuous improvement of glider data processing and quality control.**

Hydrodynamic temporal variability

- Harmonic function with a linear term fitted to the temporal series of temperature, salinity and geostrophic velocity.

$$\underbrace{A_0}_{\text{Mean}} + \underbrace{A_t t}_{\text{Tendency}} + \underbrace{A_c \cos(2\pi t/T) + A_s \sin(2\pi t/T)}_{\text{Annual cycle}}$$



- Temperature and salinity: the skill of the linear regression represents ~90% of the skill of the full regression
- Lower values of the temperature linear regression skill are found in the upper layers: important contribution of the seasonal cycle
- Skills of the geostrophic velocity regressions are not statistically significant, suggesting the key role that high-frequency variabilities may have in this region