Variability of turbulent mixing and diapycnal solute fluxes in the Peruvian upwelling region: First results from Meteor Cruise M92

Marcus Dengler, Gerd Krahmann und Tim Fischer

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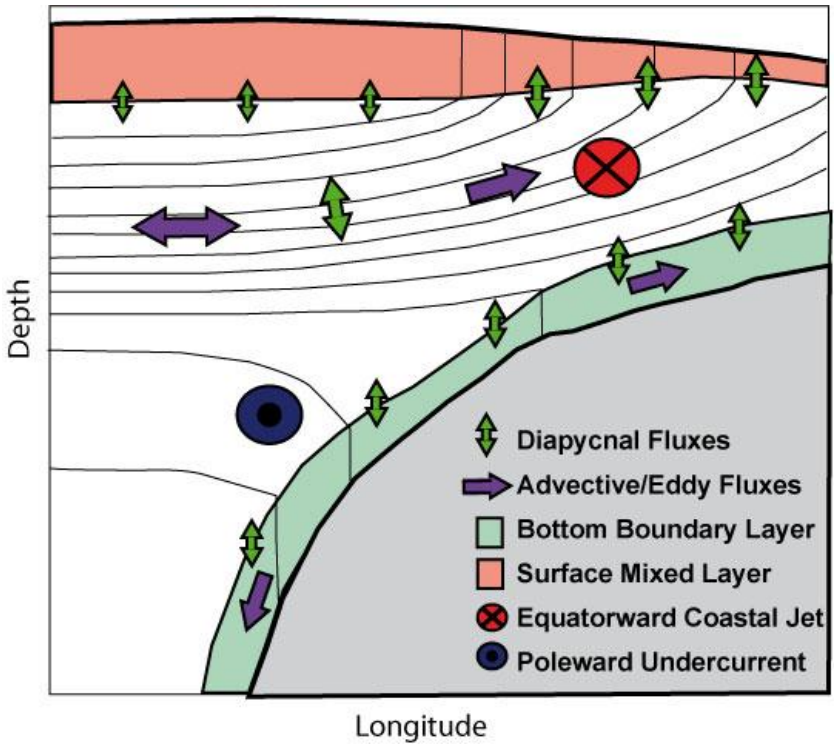
Motivation

A8 - Transport and Fluxes across the Bottom Boundary Layer

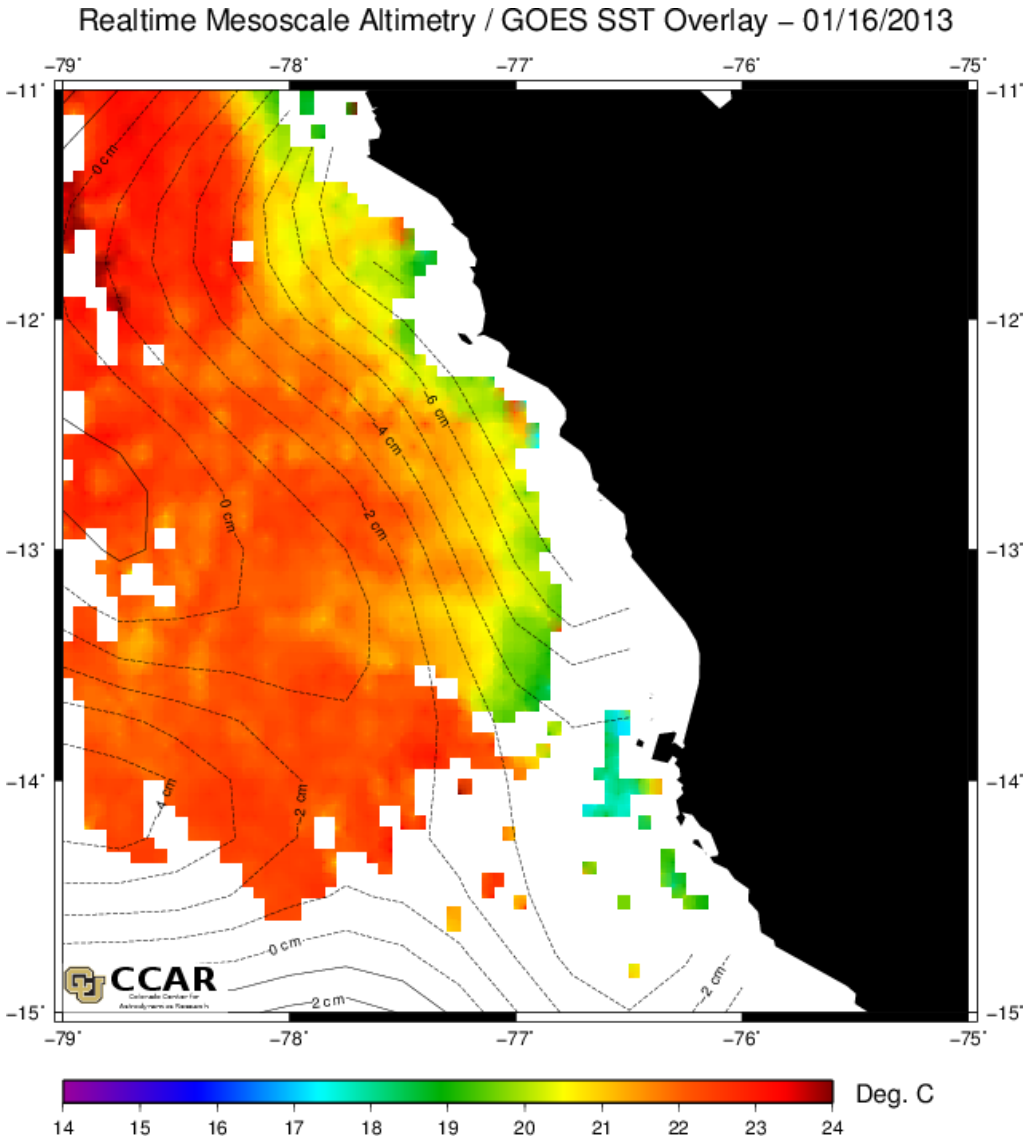
- Sediments in the oxygen minimum zones (OMZs) release or take up significant amounts of nutrients (e.g. ammonium, nitrate, nitrite, phosphorus, iron, silicate)
- Sediments represent a sink for dissolved oxygen, nitrate and nitrite



Open Question: Fluxes of solutes of sedimentary origin into the water column, their iso- and diapycnal diffusion and their relative contribution to the total solute budget

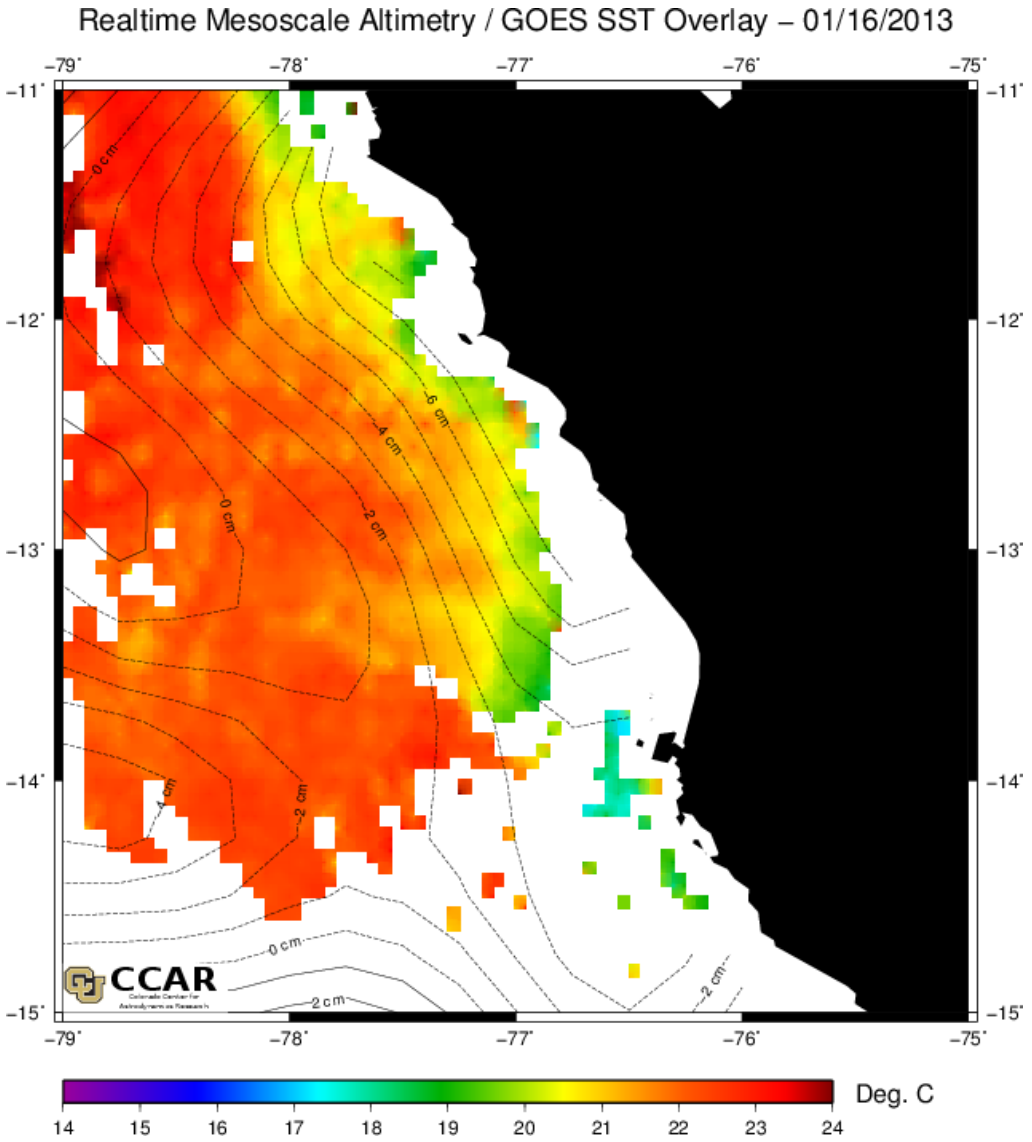
The Peruvian Upwelling Region

- **Upwelling is driven by northward winds. The resulting offshore Ekman transport causes an equatorward flow on the shelf**



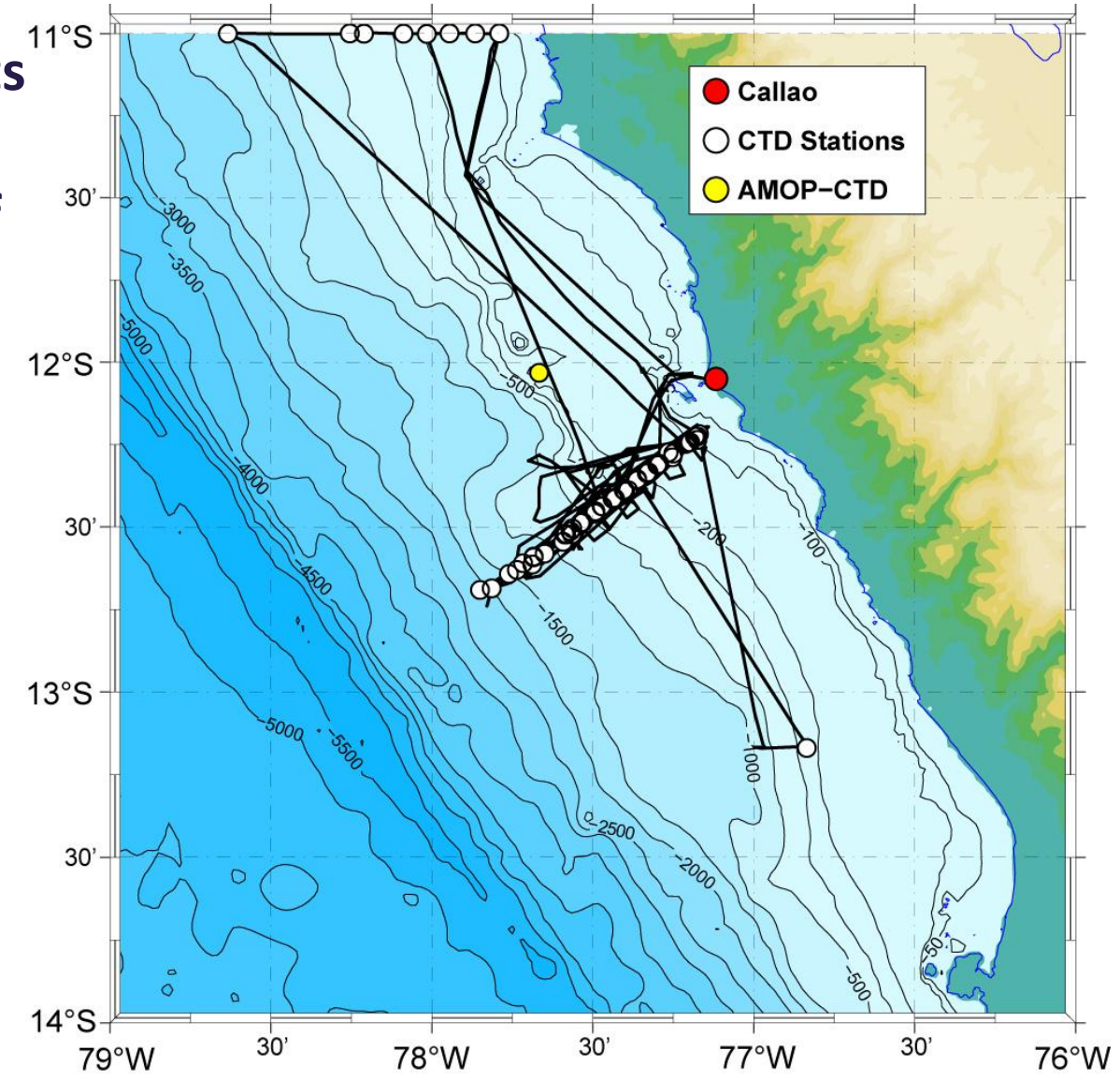
The Peruvian Upwelling Region?

- Upwelling is driven by northward winds. The resulting offshore Ekman transport causes an equatorward flow on the shelf
- Observation during the cruise: Light to no winds (mostly below 10kn)



CTD Station during M92

- **CTD measurements include water column analysis of nutrients, N-isotopes, oxygen, salt, DIC, N2, Argon, CO2, N2O, radium, thorium**



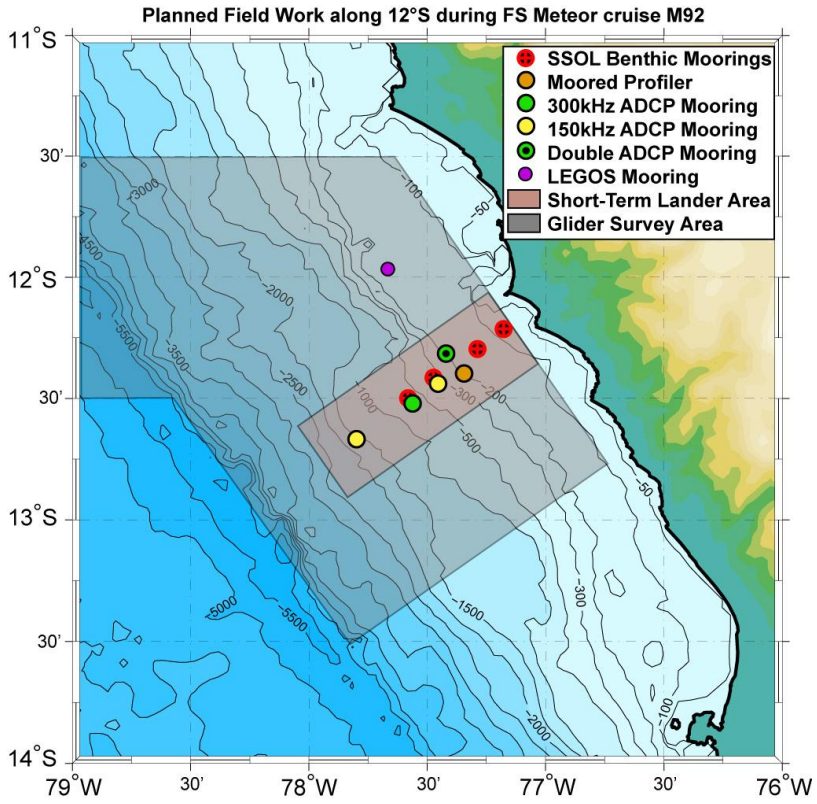
Mooring work during M92

A8 - Transport and Fluxes across the Bottom Boundary Layer

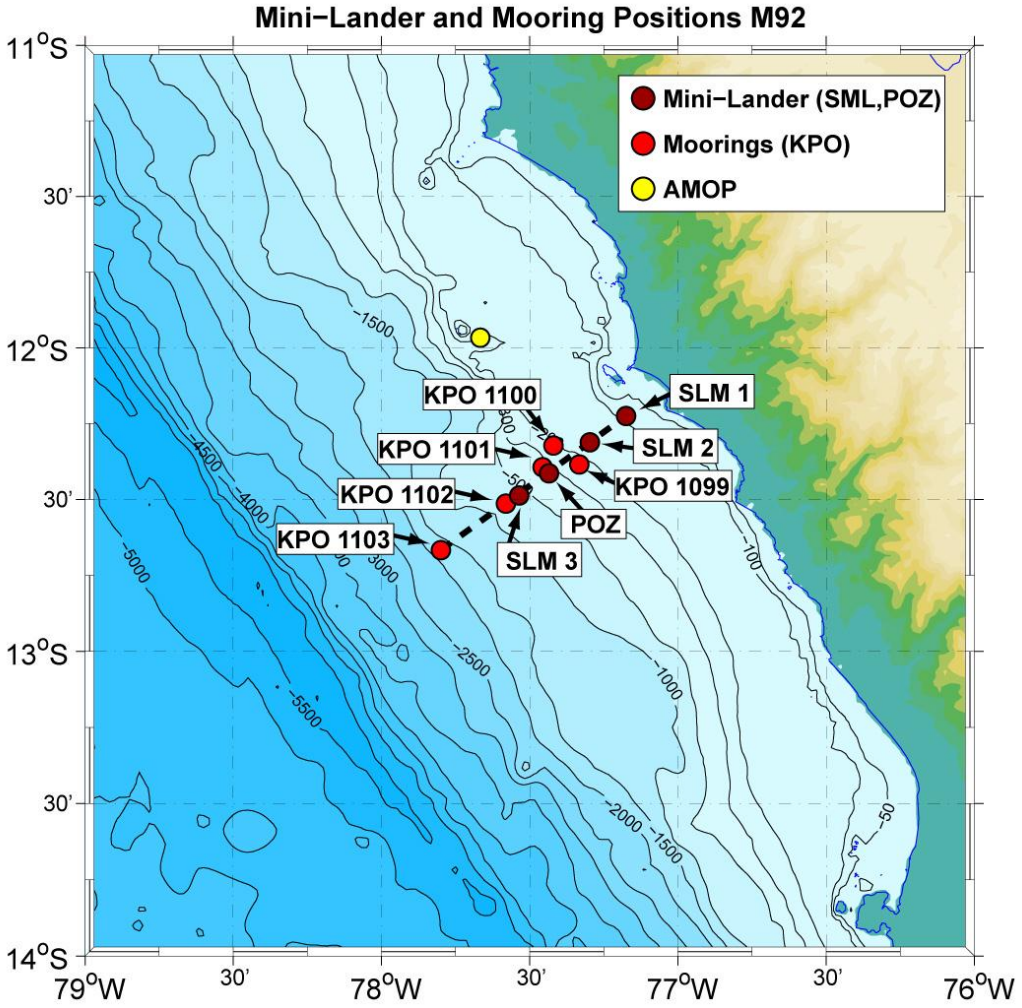
- In cooperation with B6 and B9

(8 deployed, 1 more to go)

Planned



Deployed

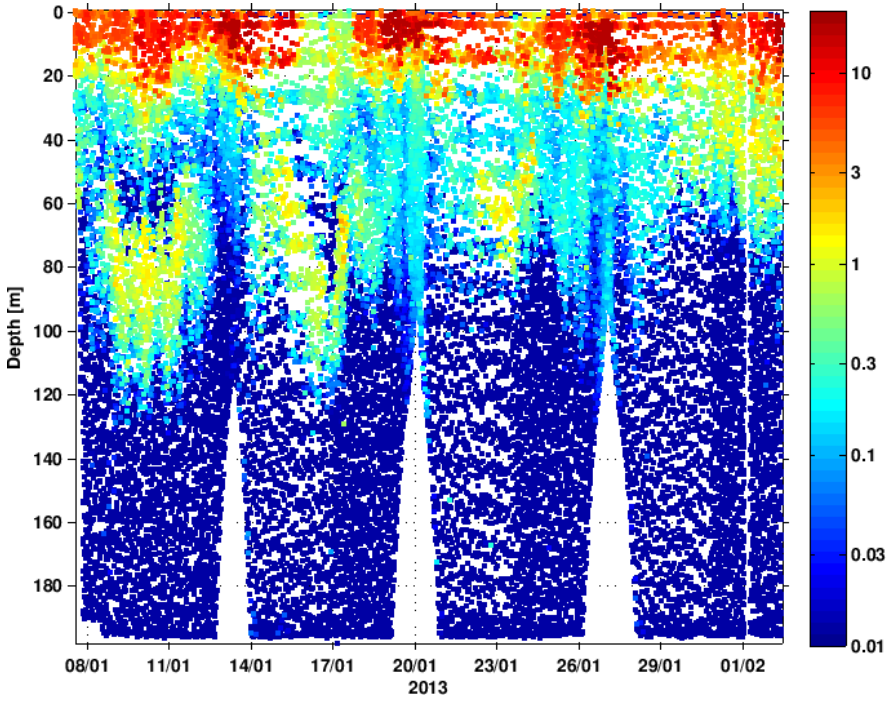


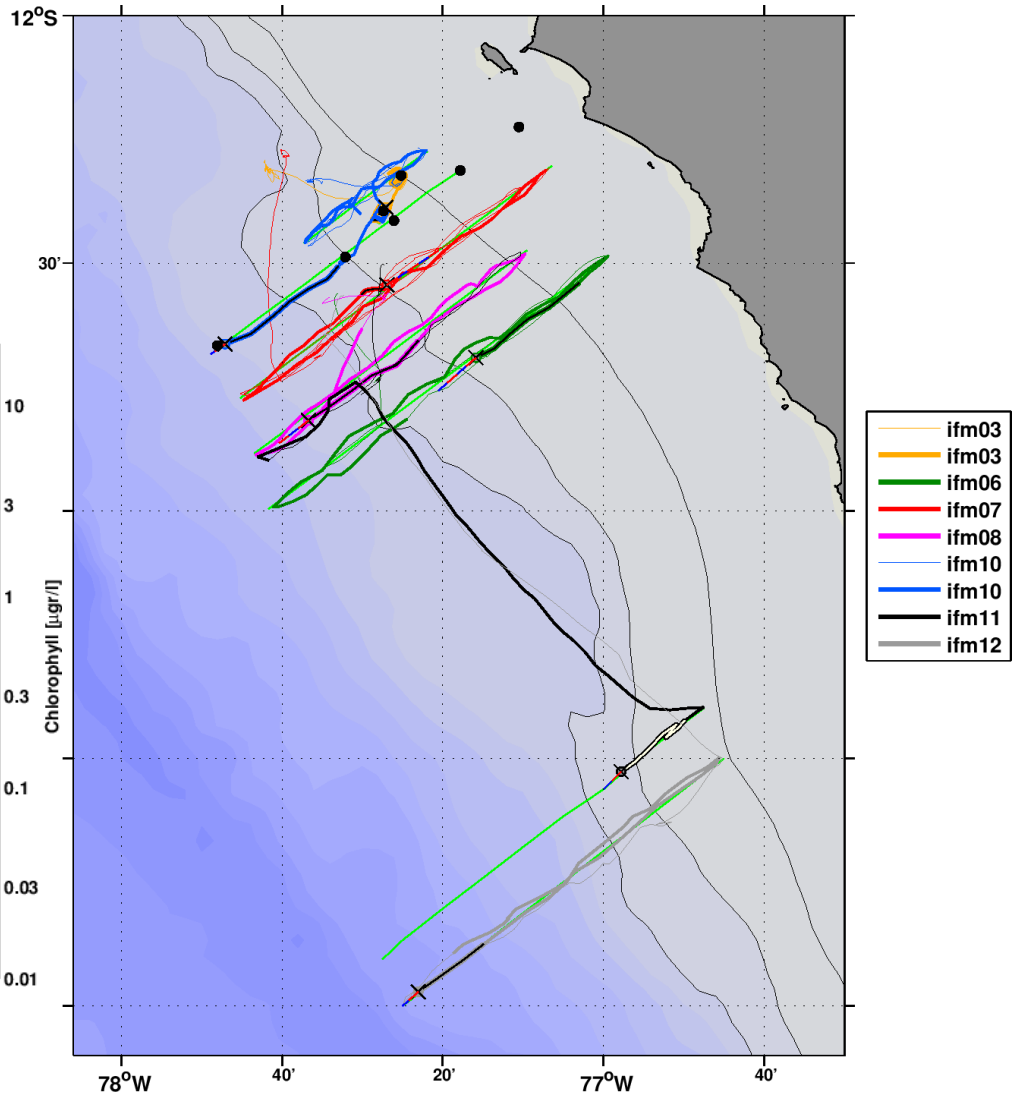
Glider Deployments + Observations

- In cooperation with B9

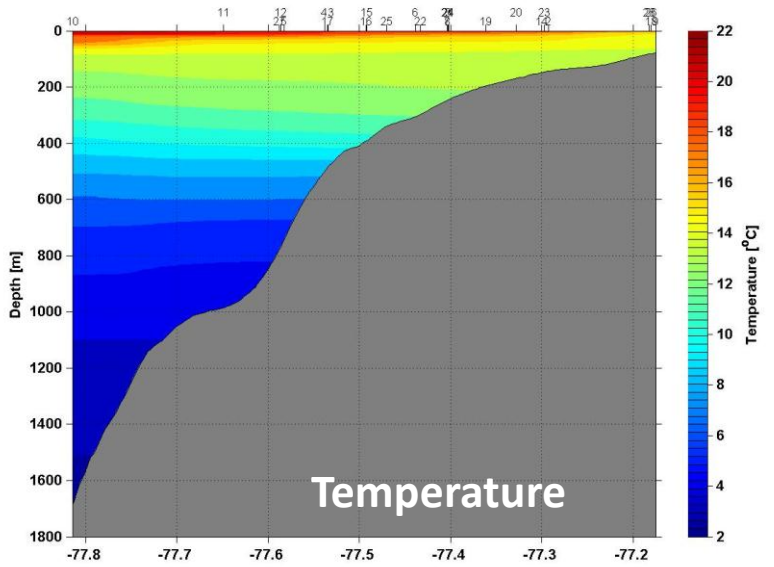
(7 released)

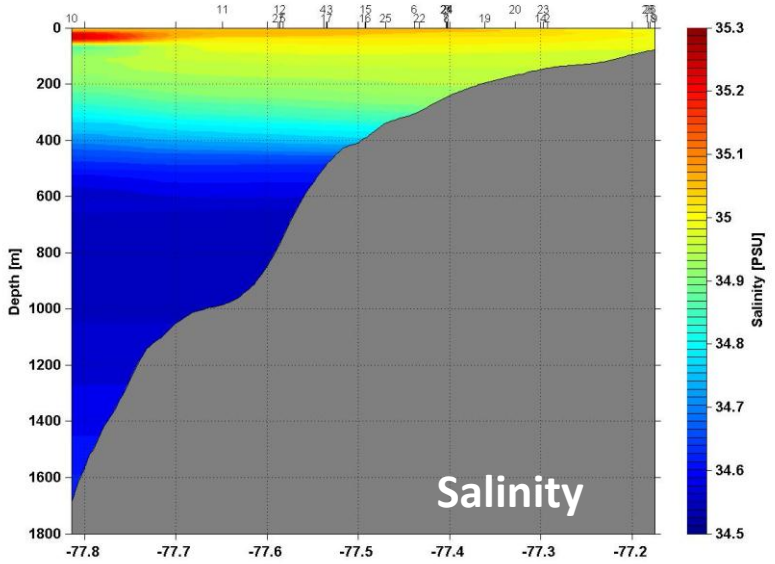
Chlorophyll

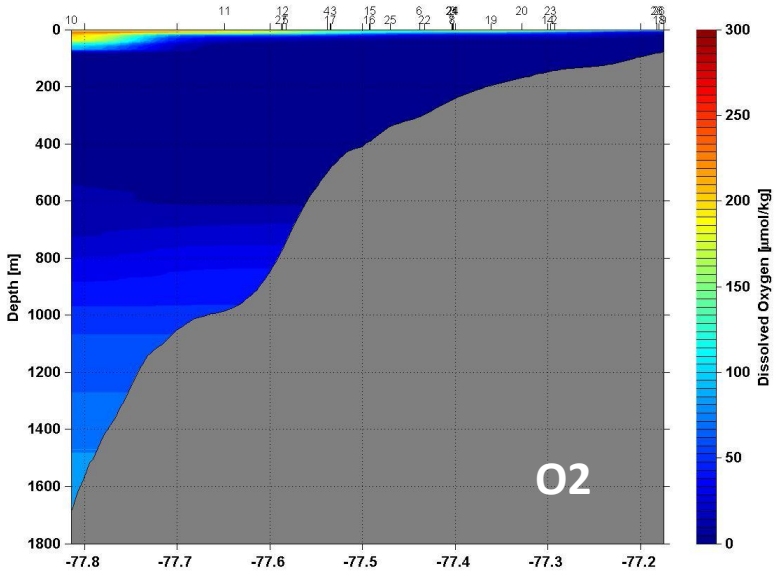


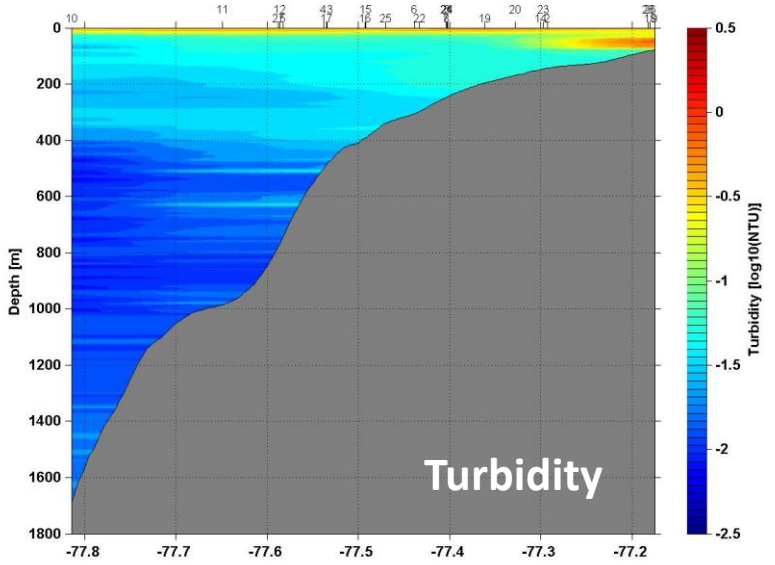


Results from M92: Hydrography



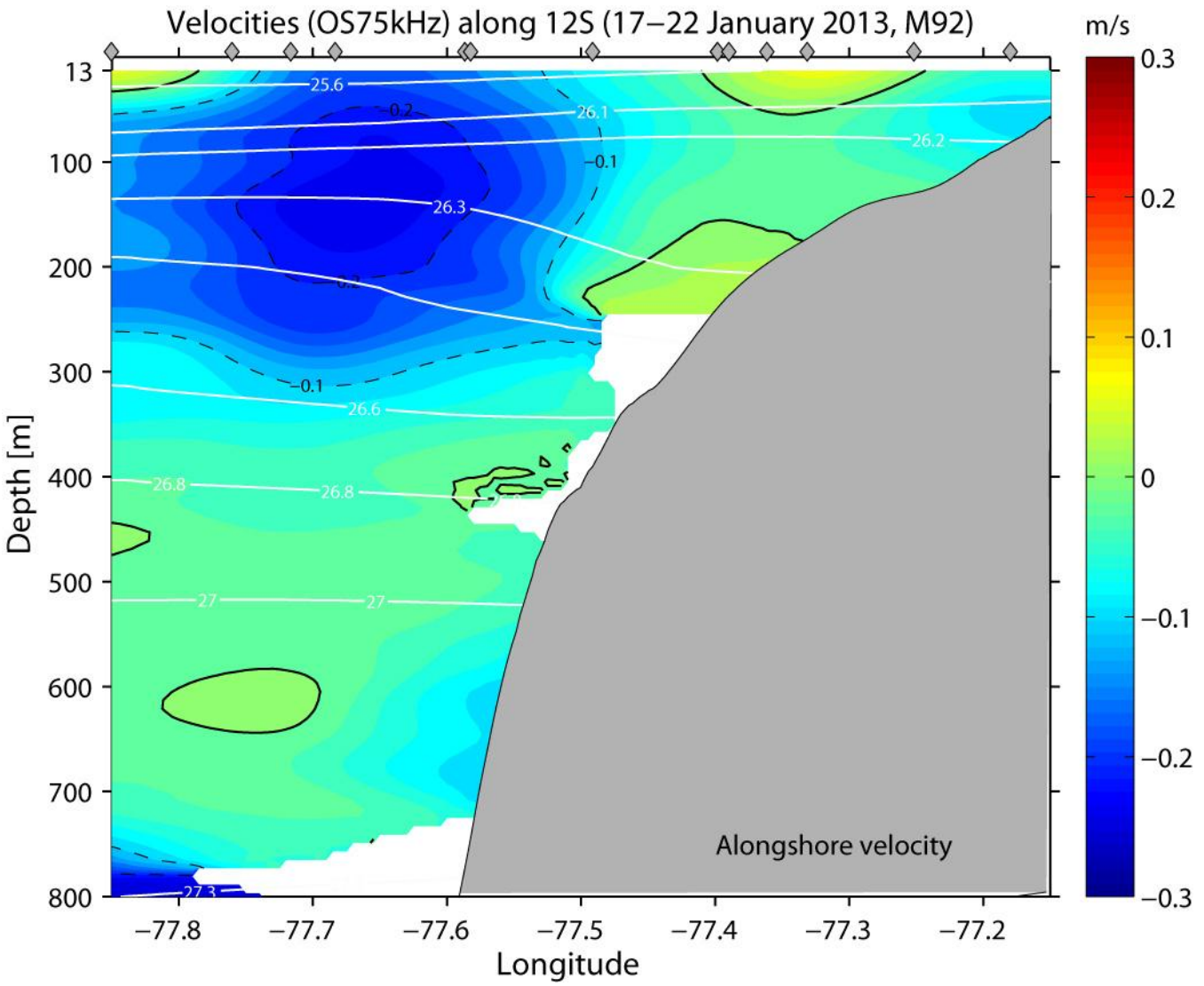




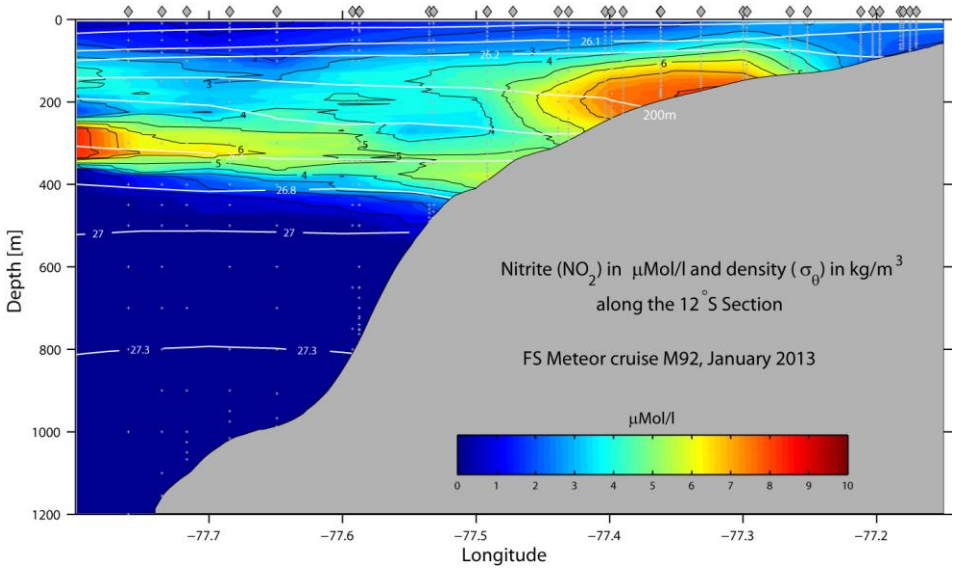


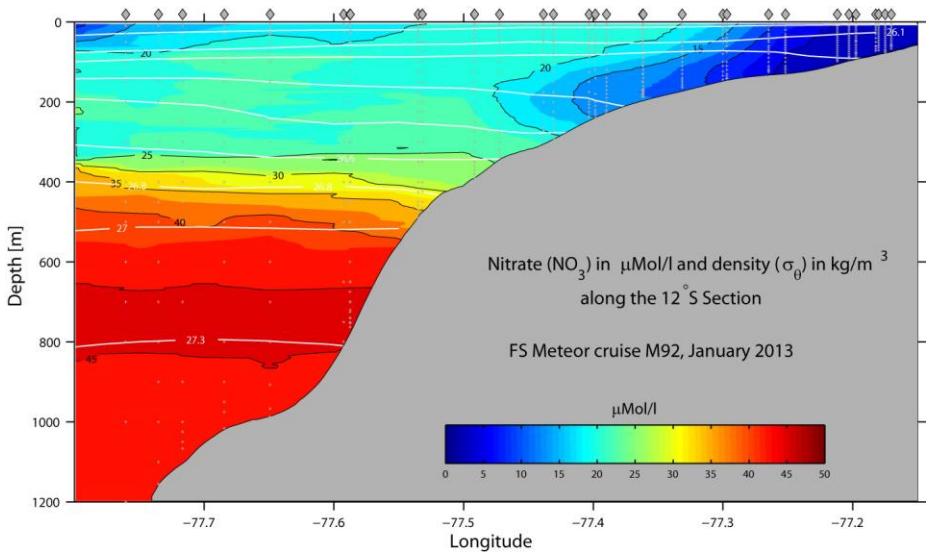
Results: Along-slope currents at 12°S

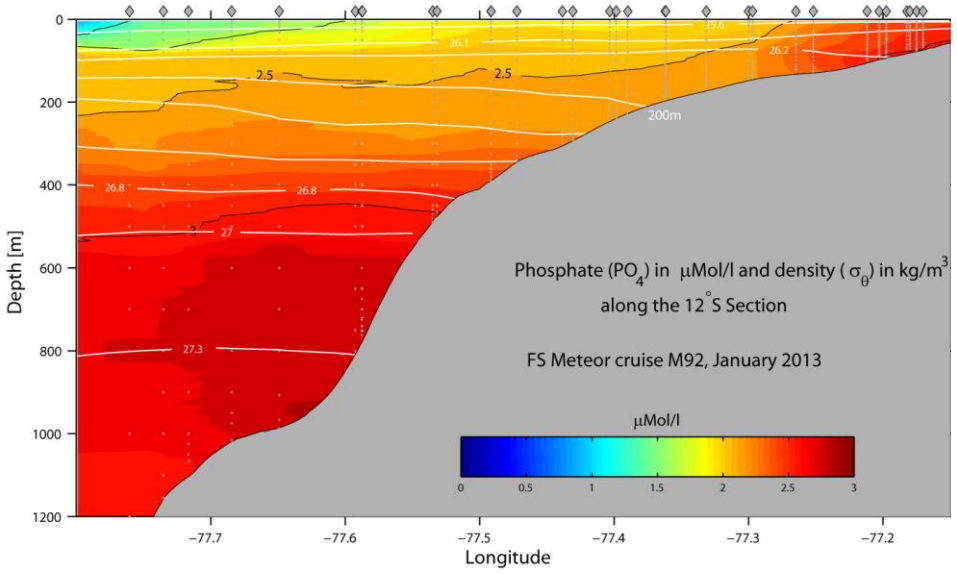
- **Currents show southward transport all along the continental slope (which is thought to be driven by wind-stress curl**
- **No northward current on the shelf**

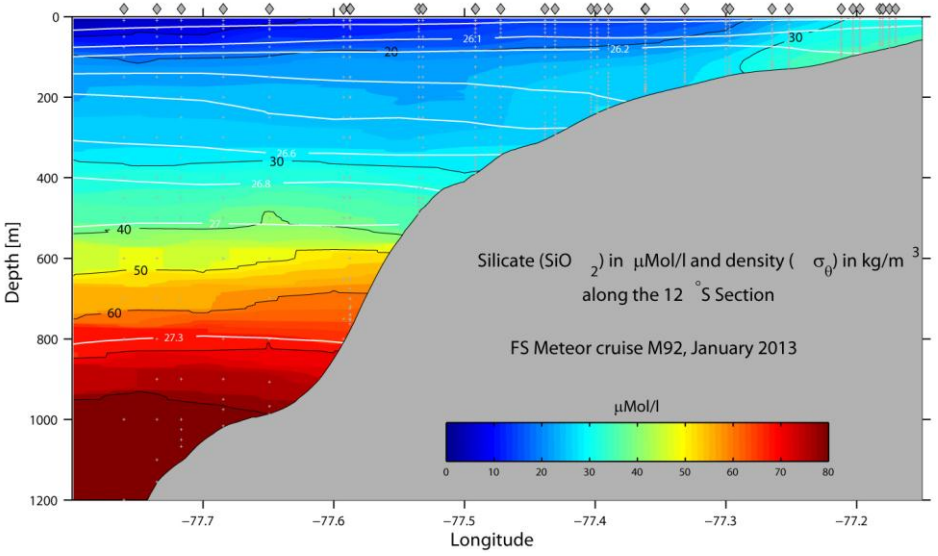


Nutrients distribution along 12°S

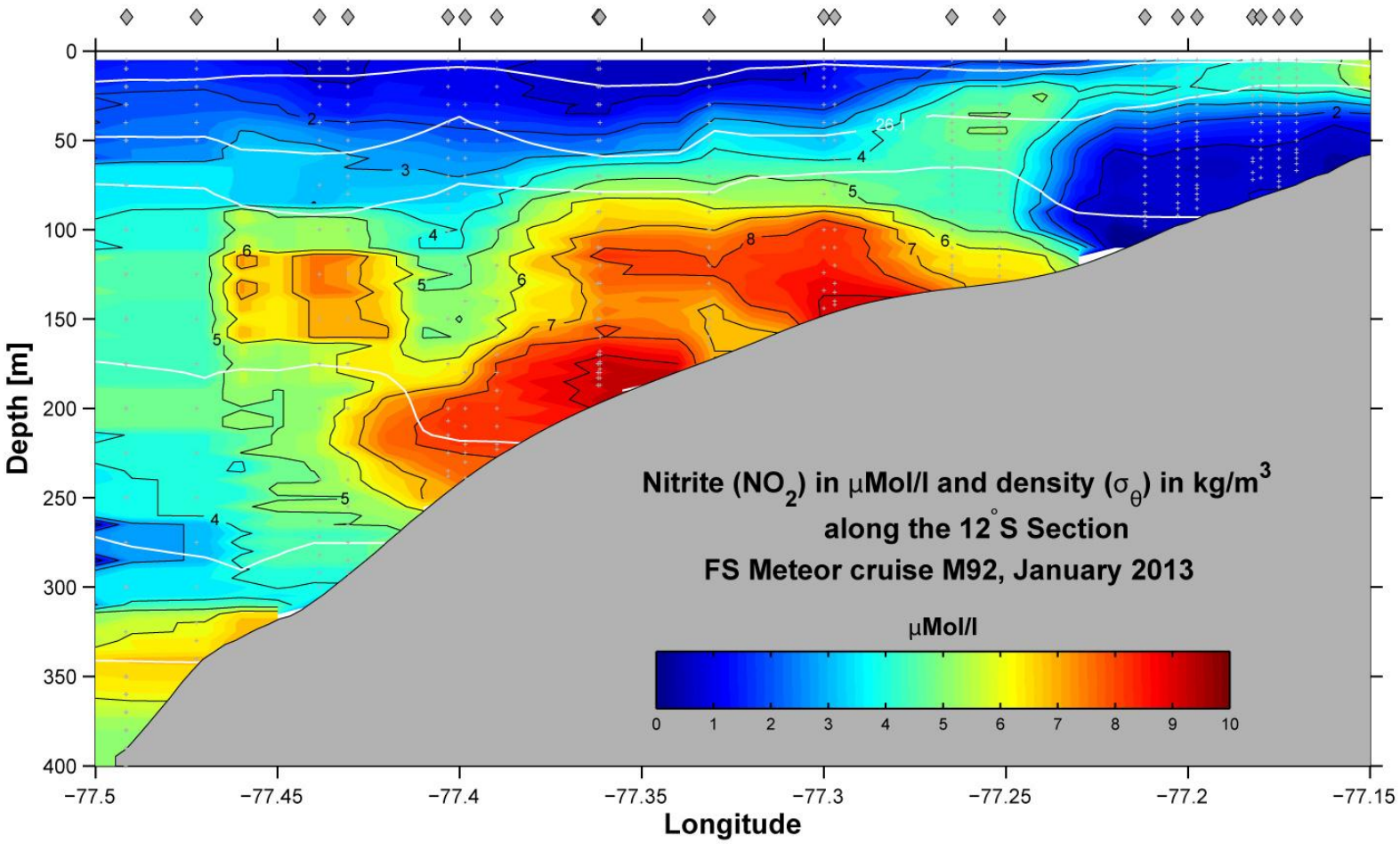




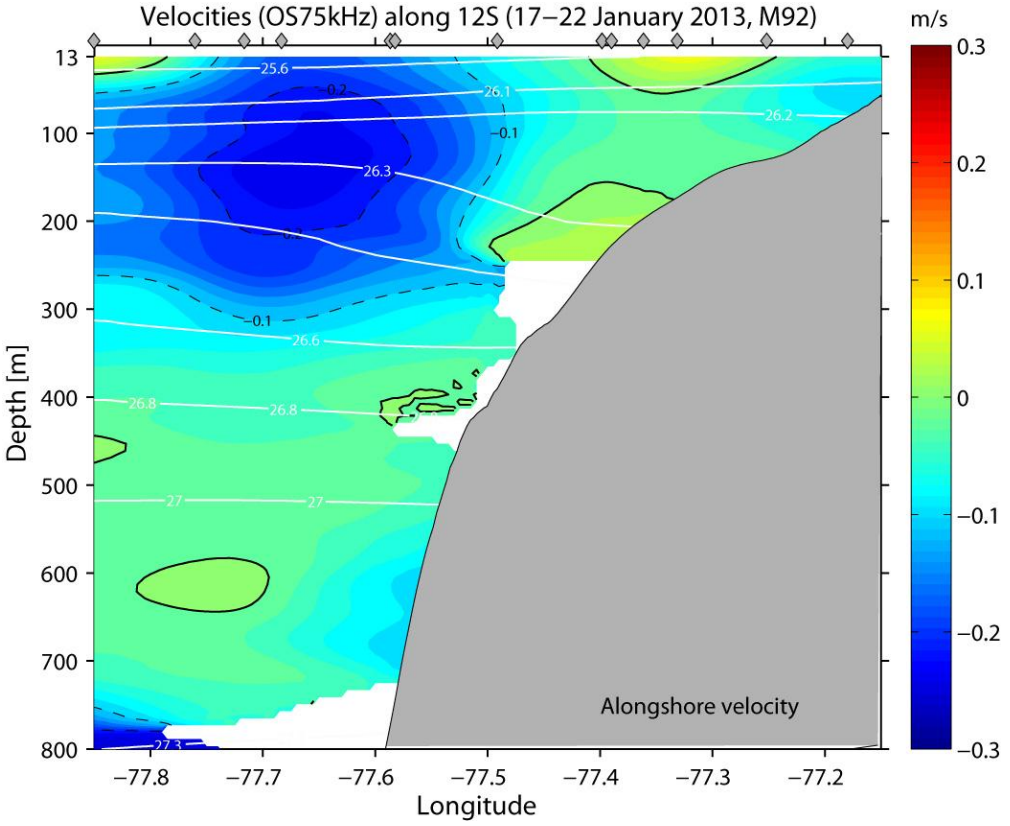


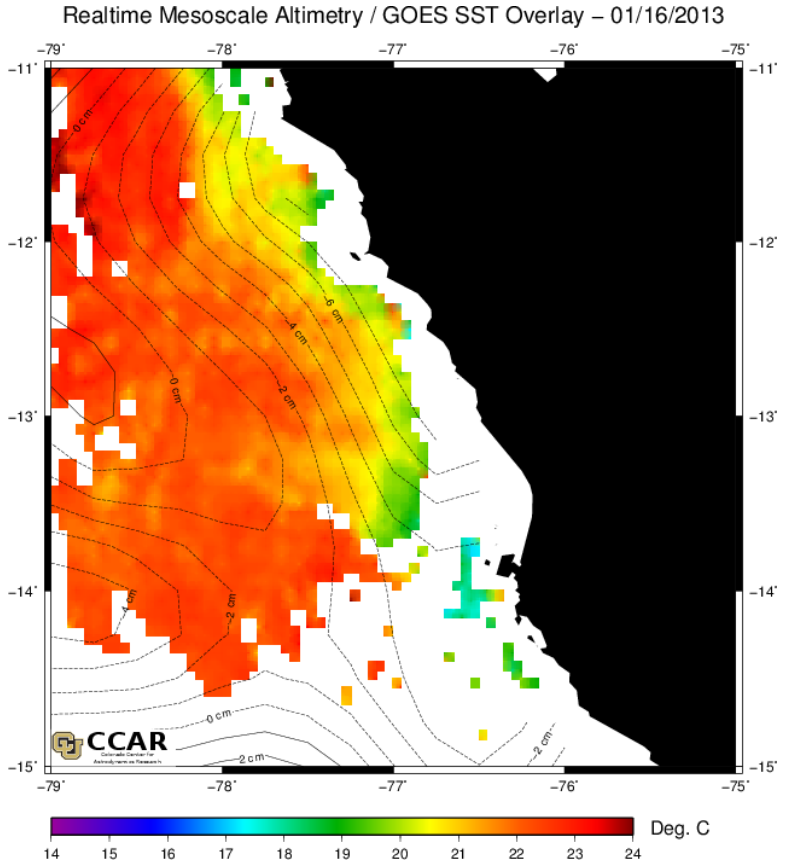


Nitrite distribution along 12°S

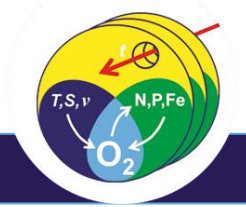


The Peruvian Upwelling Region?





Internal wave observations

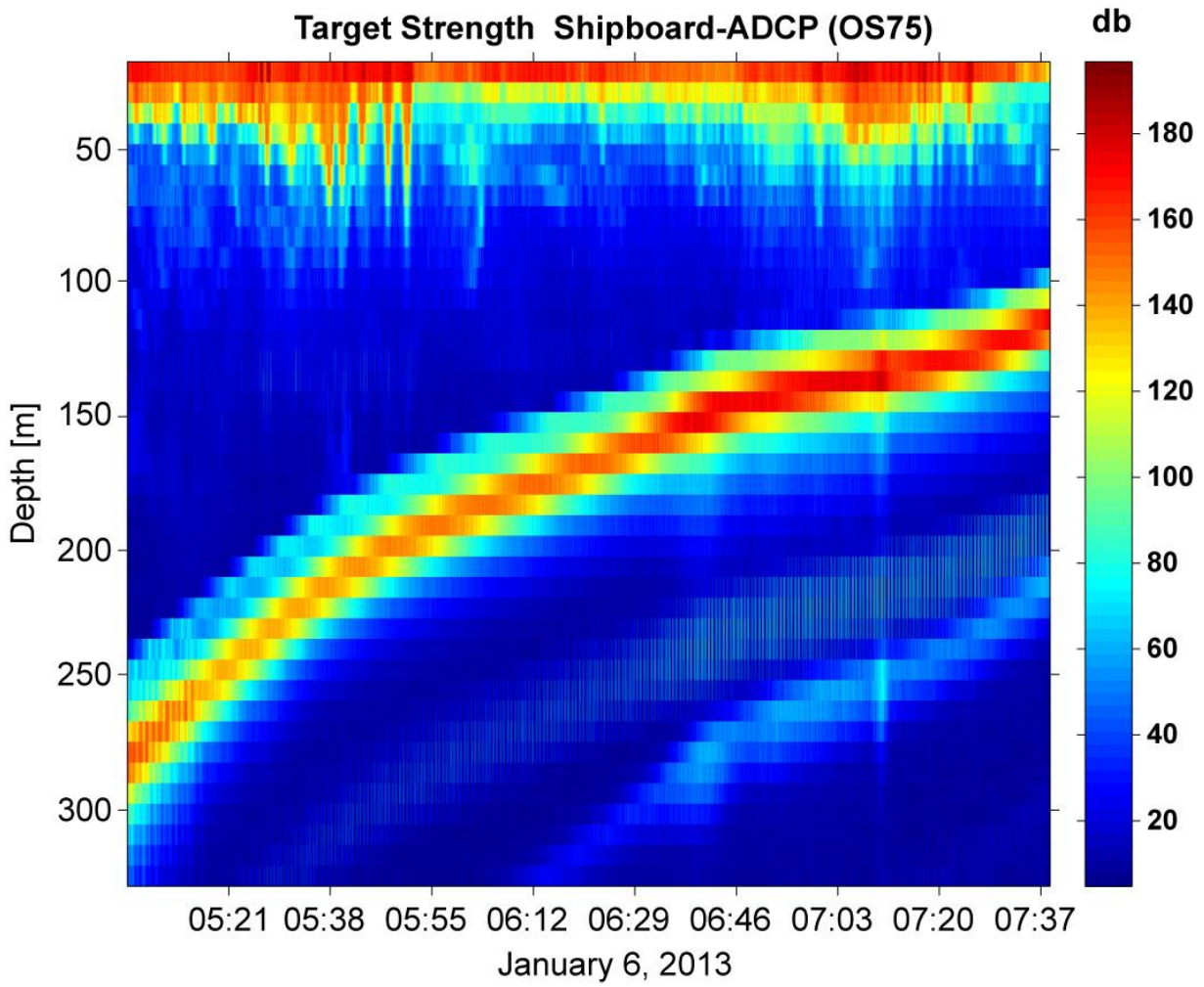


However, take a look at what tides can do when the impinge on a continental shelf

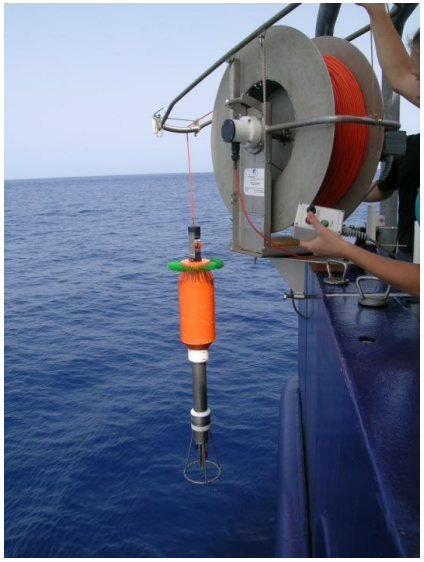
(Animation kindly provided by Sonja Legg, GFDL, Princeton University, USA)

Near surface internal wave trains

Results from ADCP measurements



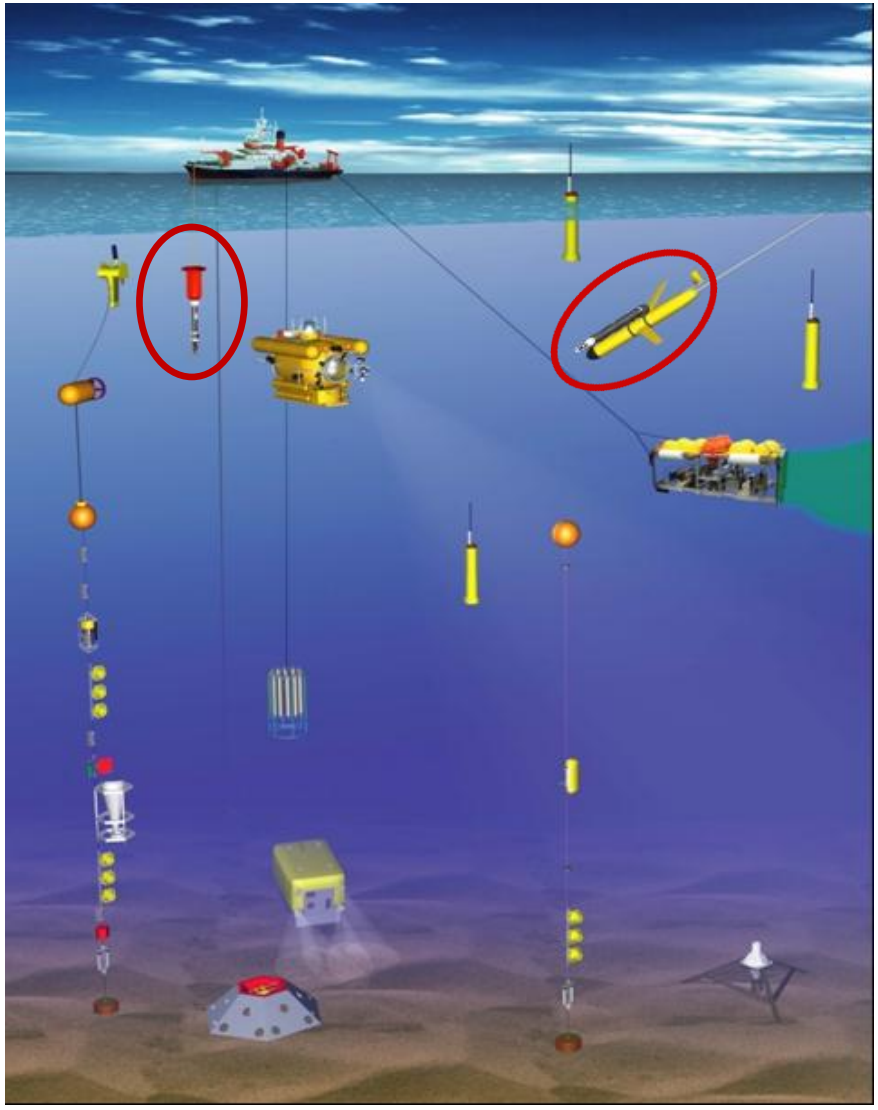
Measuring the smallest movements in the ocean



Microstructure System (MSS):

- Profiler (loosely-tethered)
- Winch (1100m)
- Deckunit

During M92, 272 MSS profiles were acquired



MicroRider (MR):

- piggybags on a Glider
- measures autonomously

Measuring the smallest movements in the ocean

Loosely-tethered Profiler:

Profiler MSS90D (2000m)

- 16 channels that are recorded at a rate of 1000Hz
- 2 or 4 shear sensors (250 Hz, Airfoil)
- fast thermistor (125 Hz, NTC)
- tilt sensors
- acceleration sensor
- standard CTD Sensors (24 Hz) (pressure, conductivity, temperature

Manufacturer: Sea & Sun Technology and ISW – Wassermesstechnik

What are the oceans‘ smallest movements?

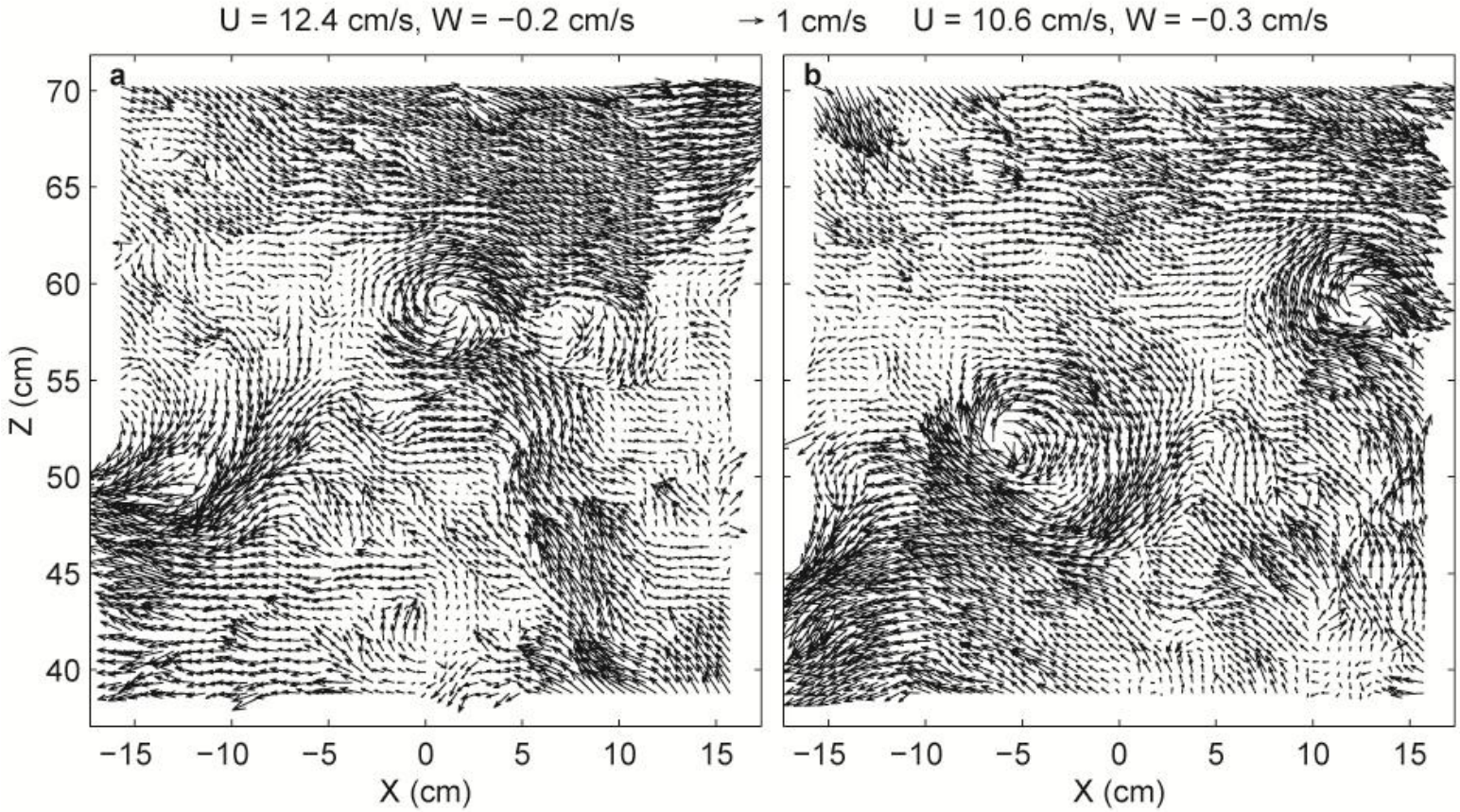
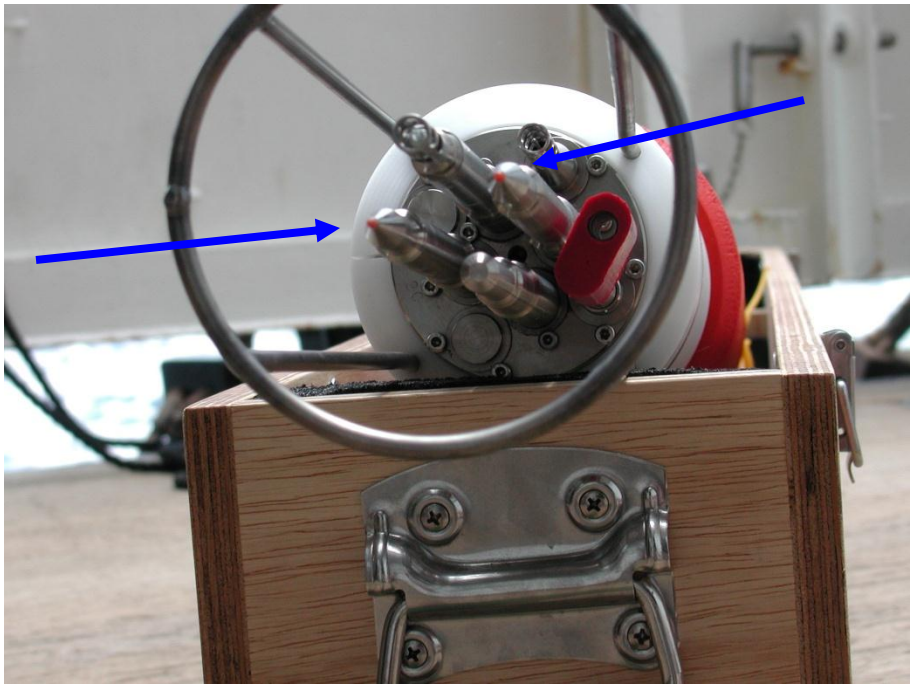
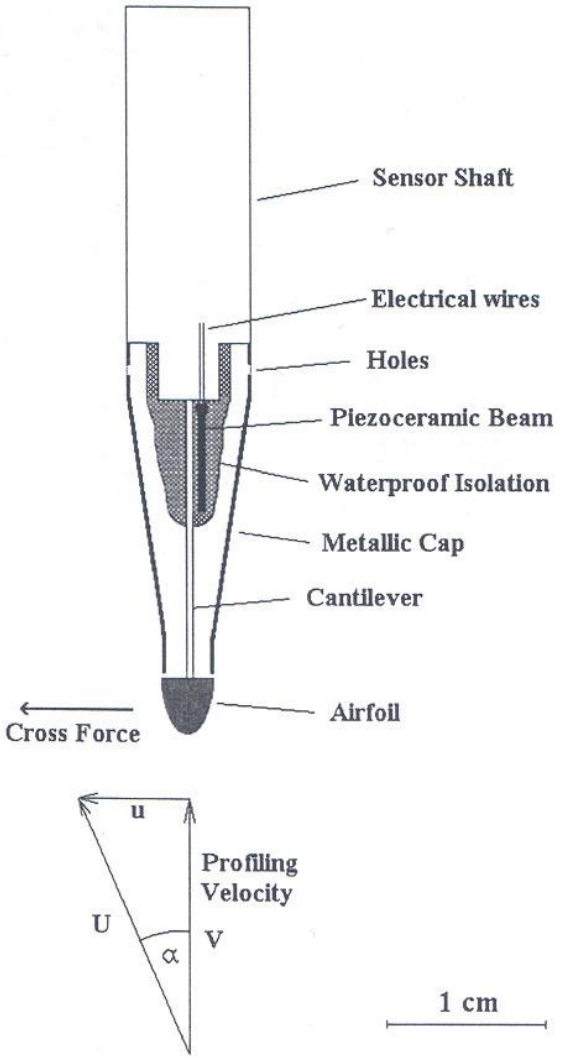


Figure 1.7: Two velocity vector maps of the same area, sampled 1 s apart. The instantaneous mean velocity of the sample area (shown at the top of each map) is subtracted from each vector to highlight the turbulence structure. The vertical coordinates represent the actual distance from the bottom. These frames were observed by means of Particle Image Velocimetry (PIV) near the LEO-15 site off the coast of New Jersey in 15 to 21 m depth of water. Figure by Alex Nimmo Smith (Plymouth, England), see also Nimmo Smith et al. [2002].

Measuring the smallest movements in the ocean
Part I: The Microstructure System (MSS)

Shear sensors (airfoil probe):

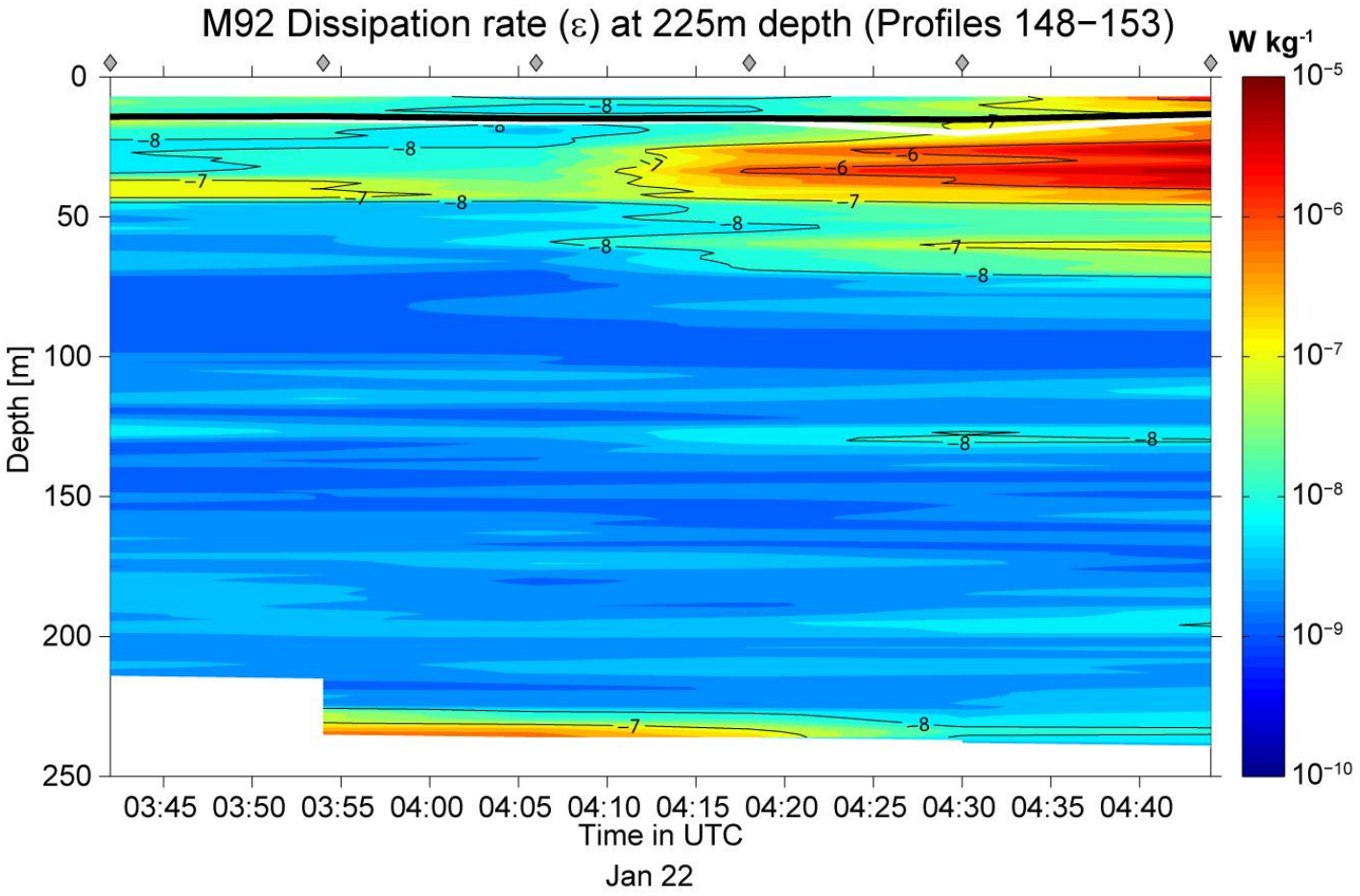




1000 Hz sampling rate
- resolution 10^{-11} W/kg
- Zeitkonstante 3ms

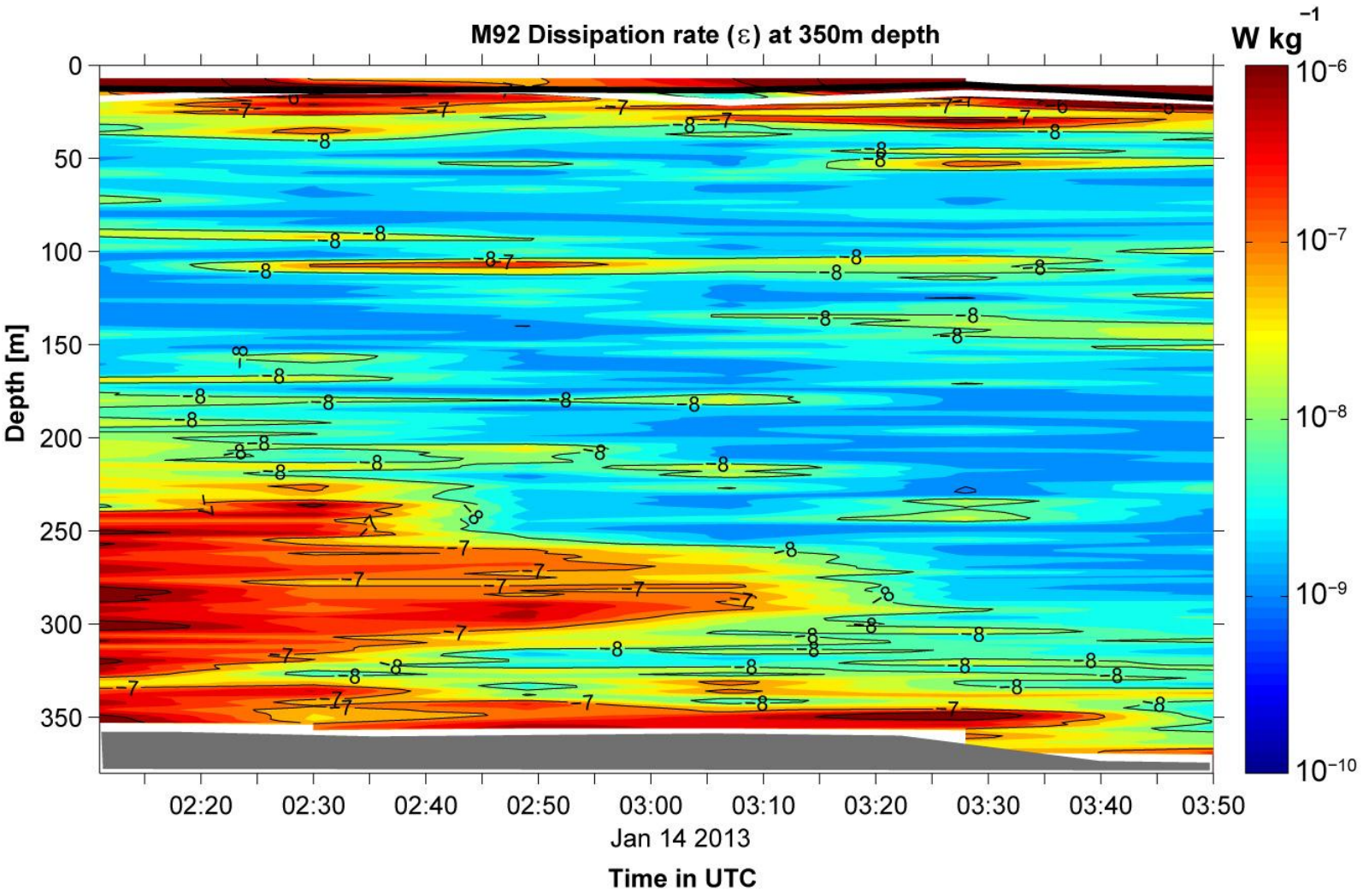
Upper ocean turbulence maximum

Results from MSS measurements



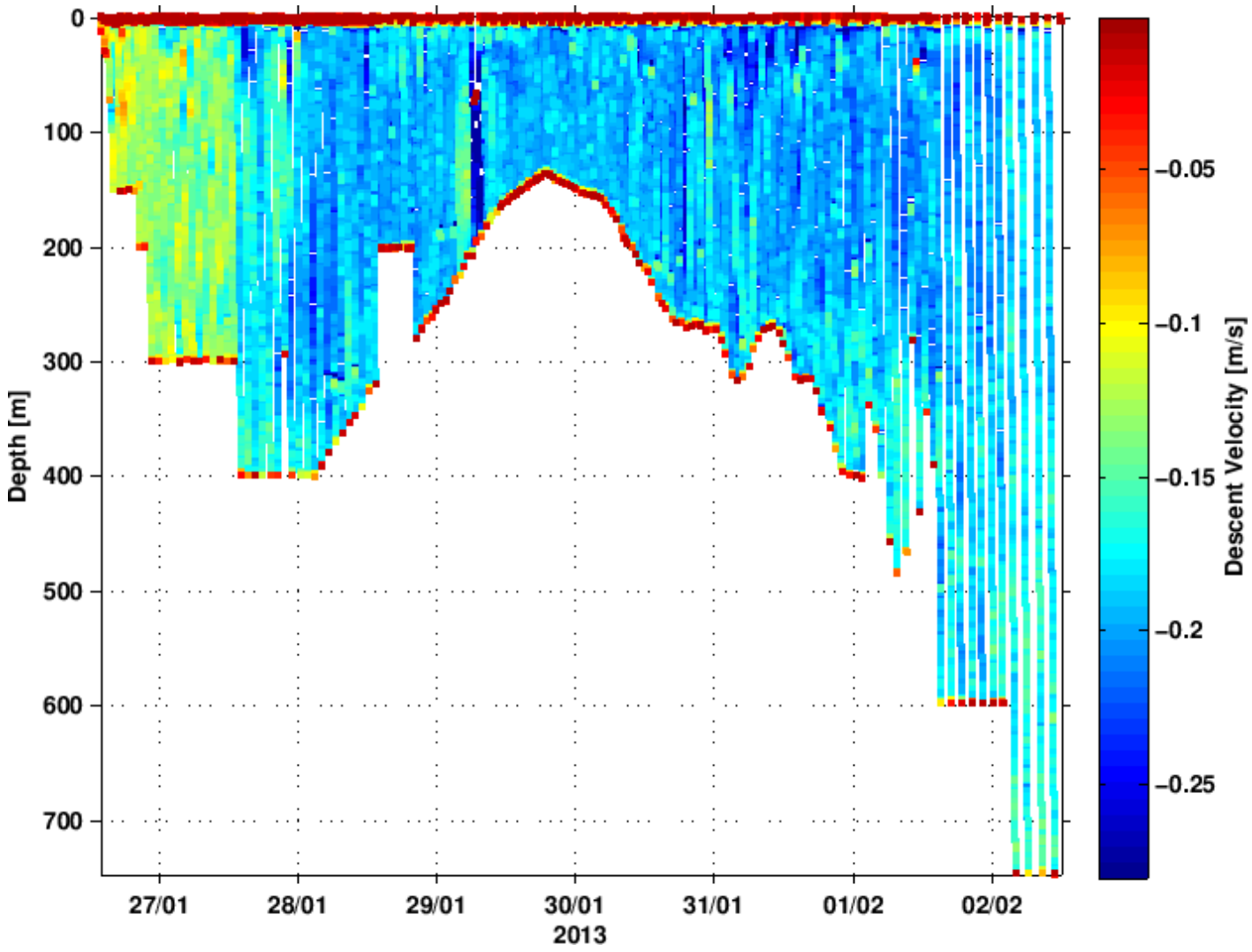
Near bottom turbulence maximum

Results from MSS measurements

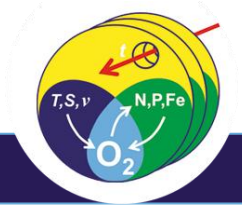


Glider Observations

Glider vertical velocity (downward)



Summary



- First results from M92 indicate extensive mixing occurring on the continental slope of Peru.
- Despite the strong mixing, nutrient gradients are pronounced on the shelf.
- Mixing due to internal wave is likely to strongly contribute sustaining the cold water on the shelf.