Coordinated surveys using Slocum gliders and free-floating drifters for tracking frontal features

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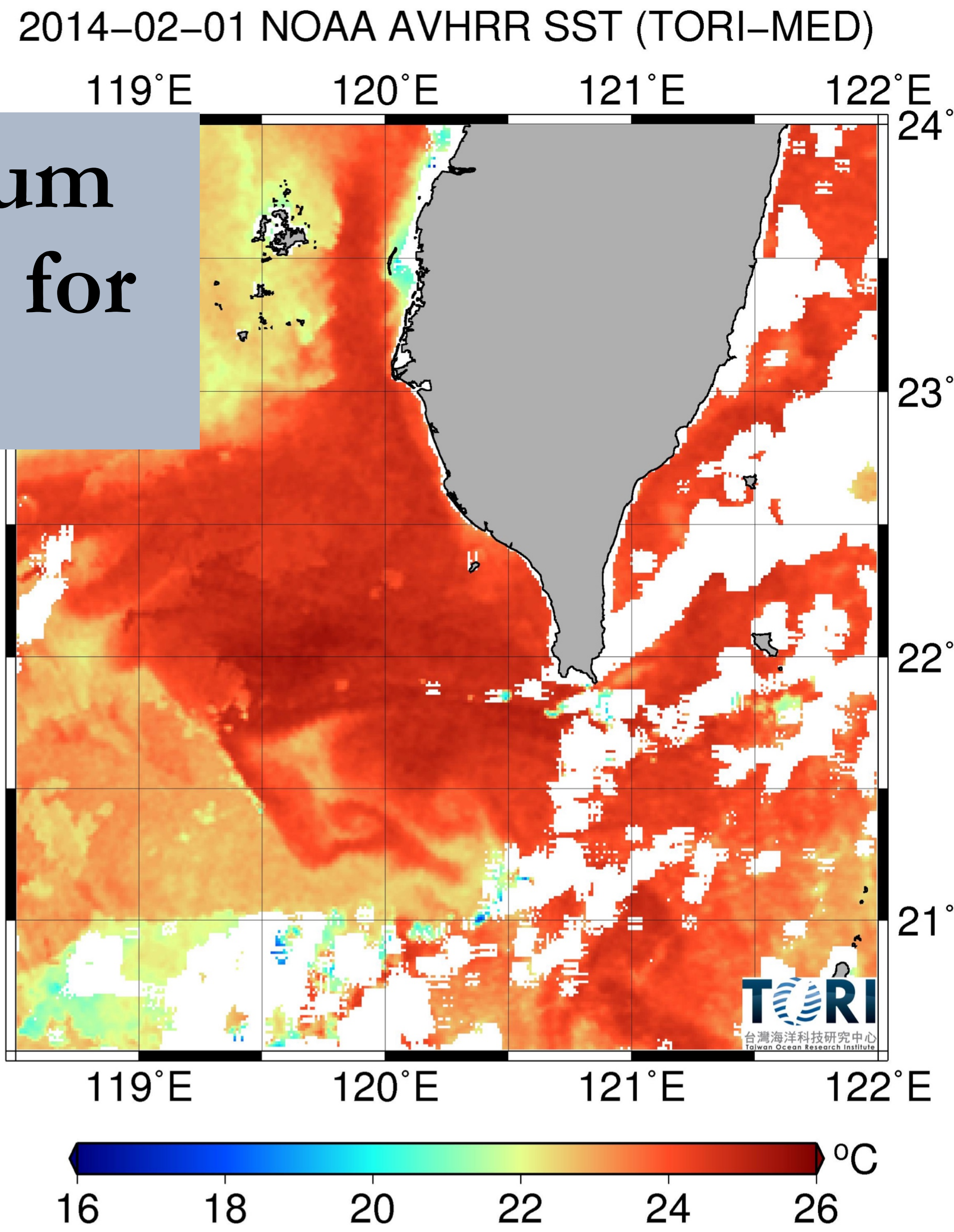
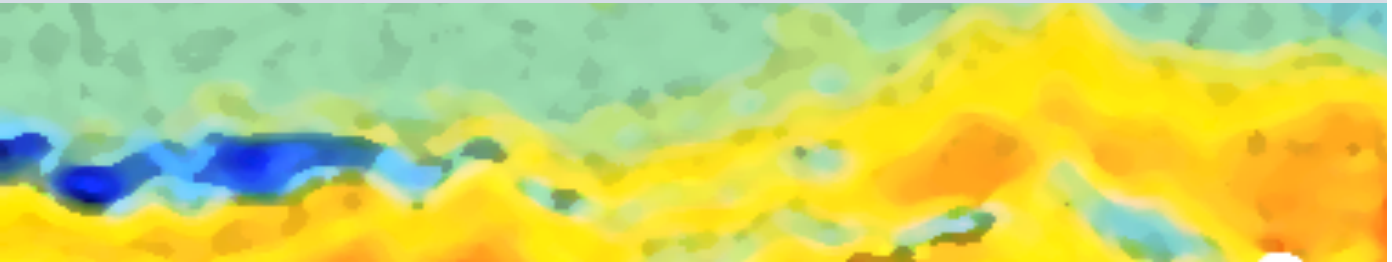
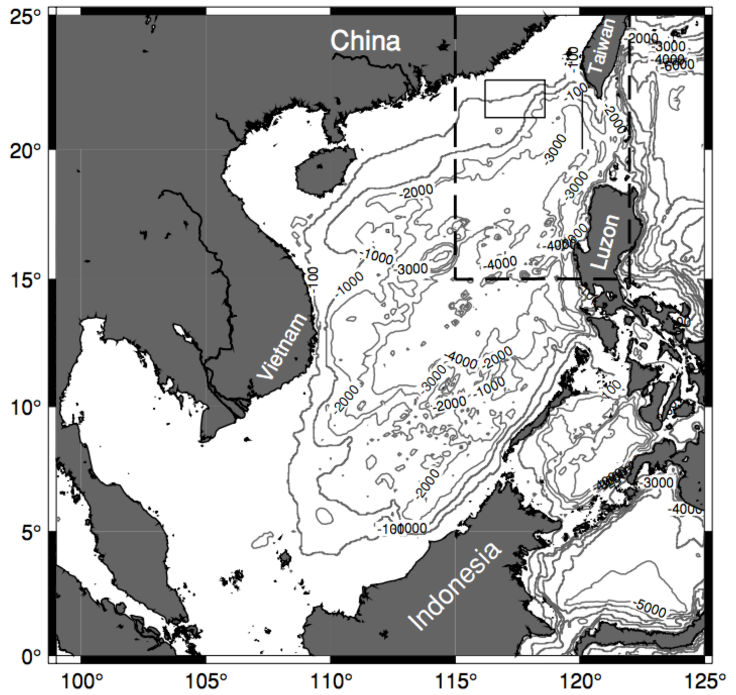


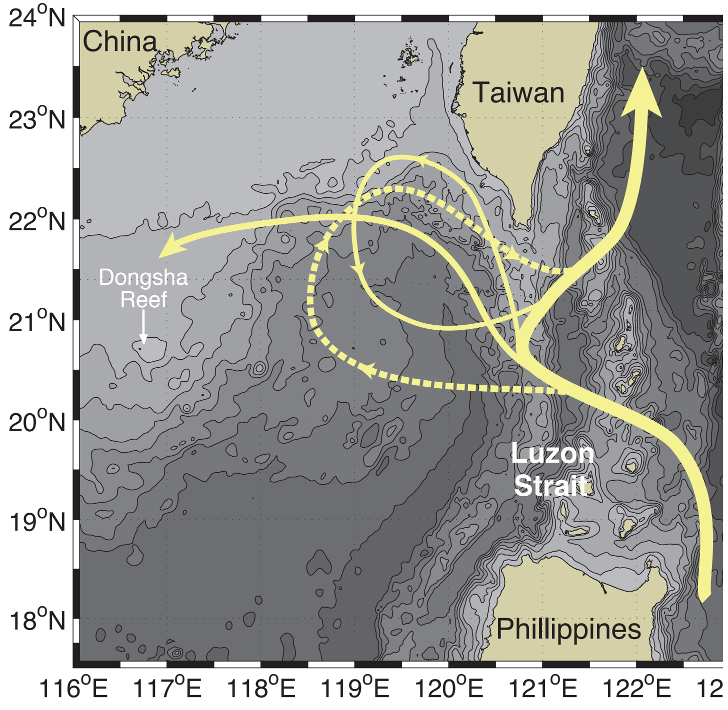


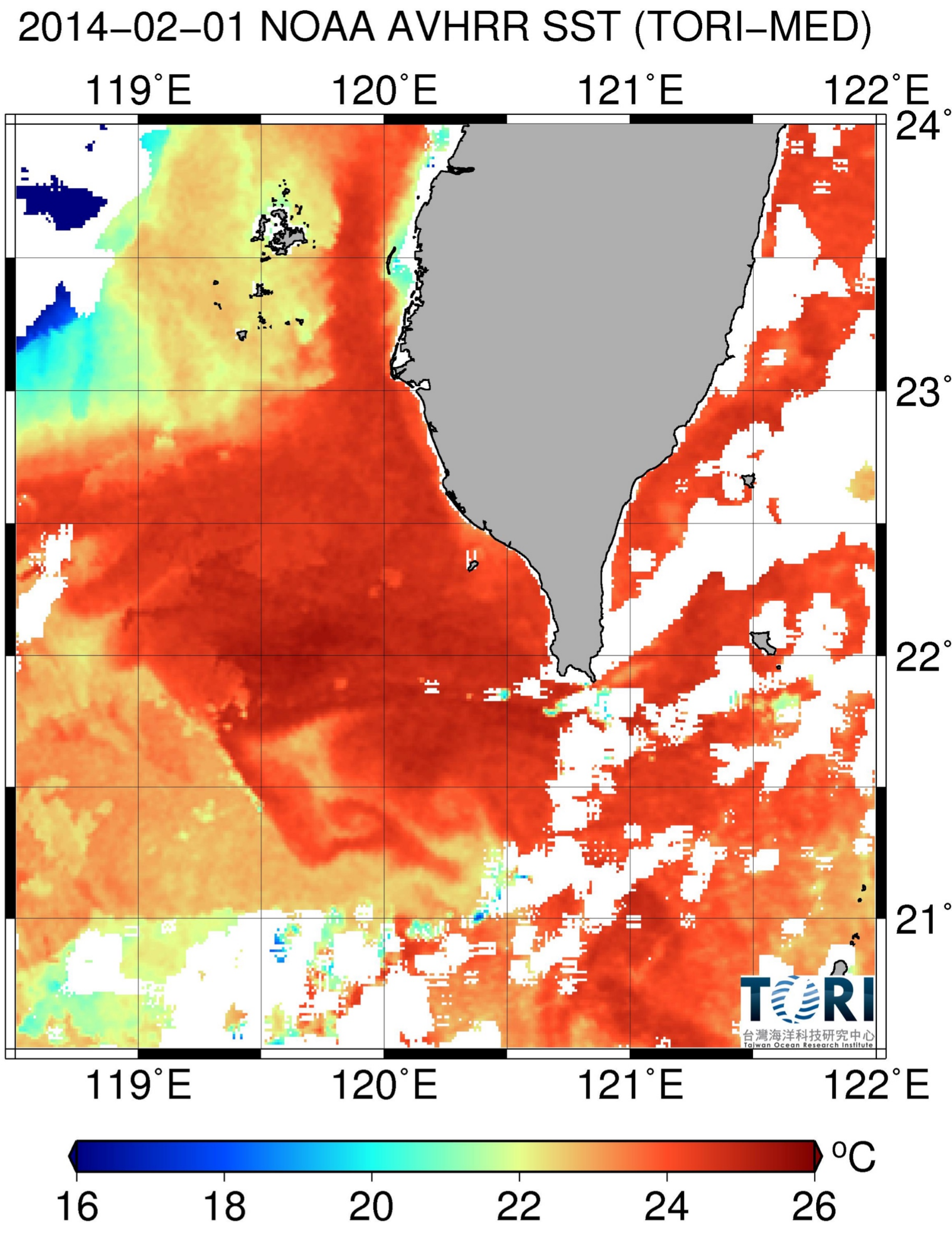
Kuroshio Intrusion

- Front created when the Kuroshio Current intrudes into the South China Sea bringing heat, salt, nutrients and organism.
- National and international collaboration using a large range of long- and short- term measurements.

M. J. Caruso *et al.* 2006



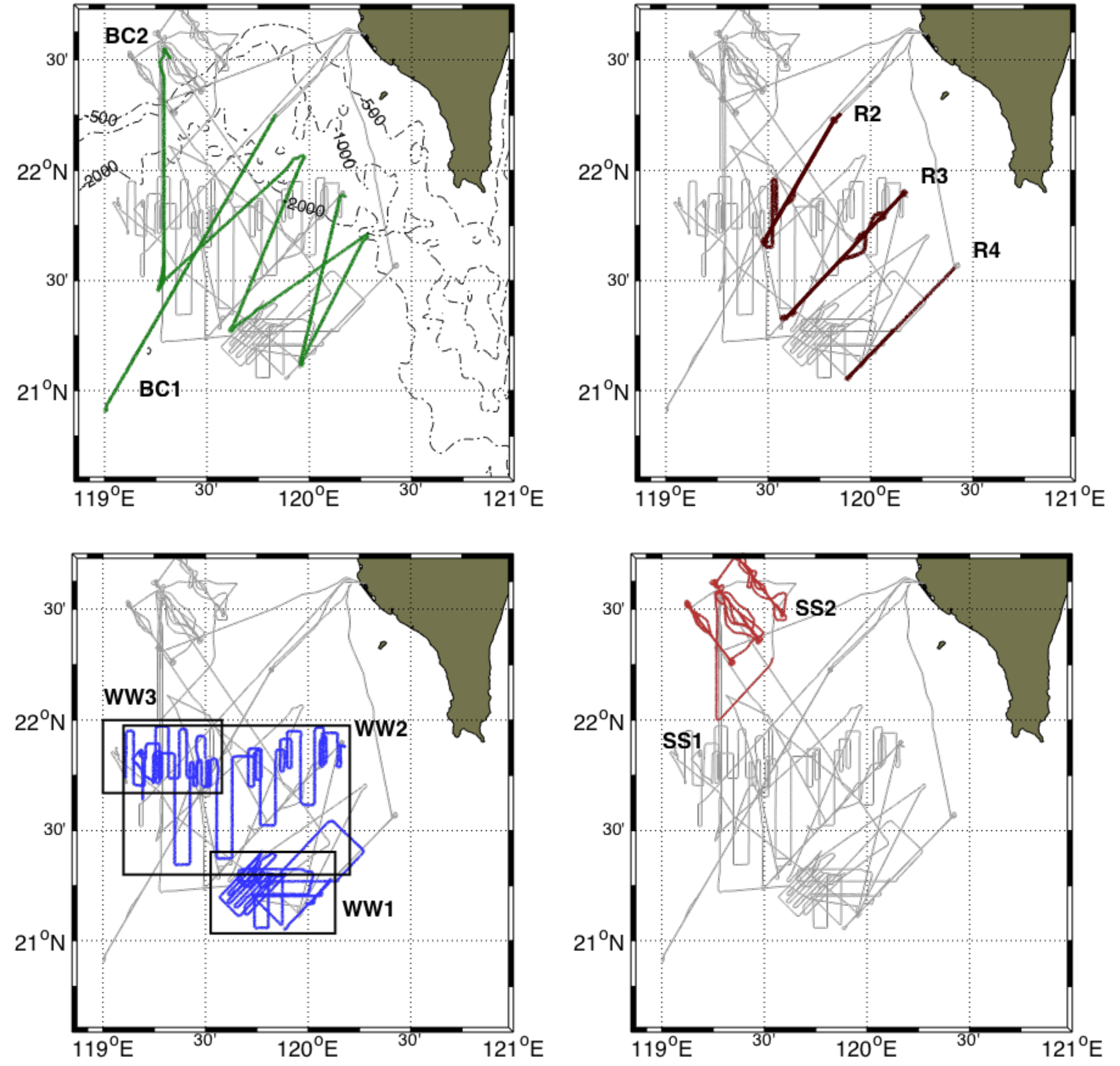




South China Sea Winter 2014

Motivation: Characterize the processes that lead to lateral mixing between the Kuroshio current water and the South China Sea water during a KC intrusion,

- In a 1 month long cruise we carried out 4 modes of operation.
- Project done in collaboration with Taiwanese universities
- Drifts mode : WireWalker (WW)



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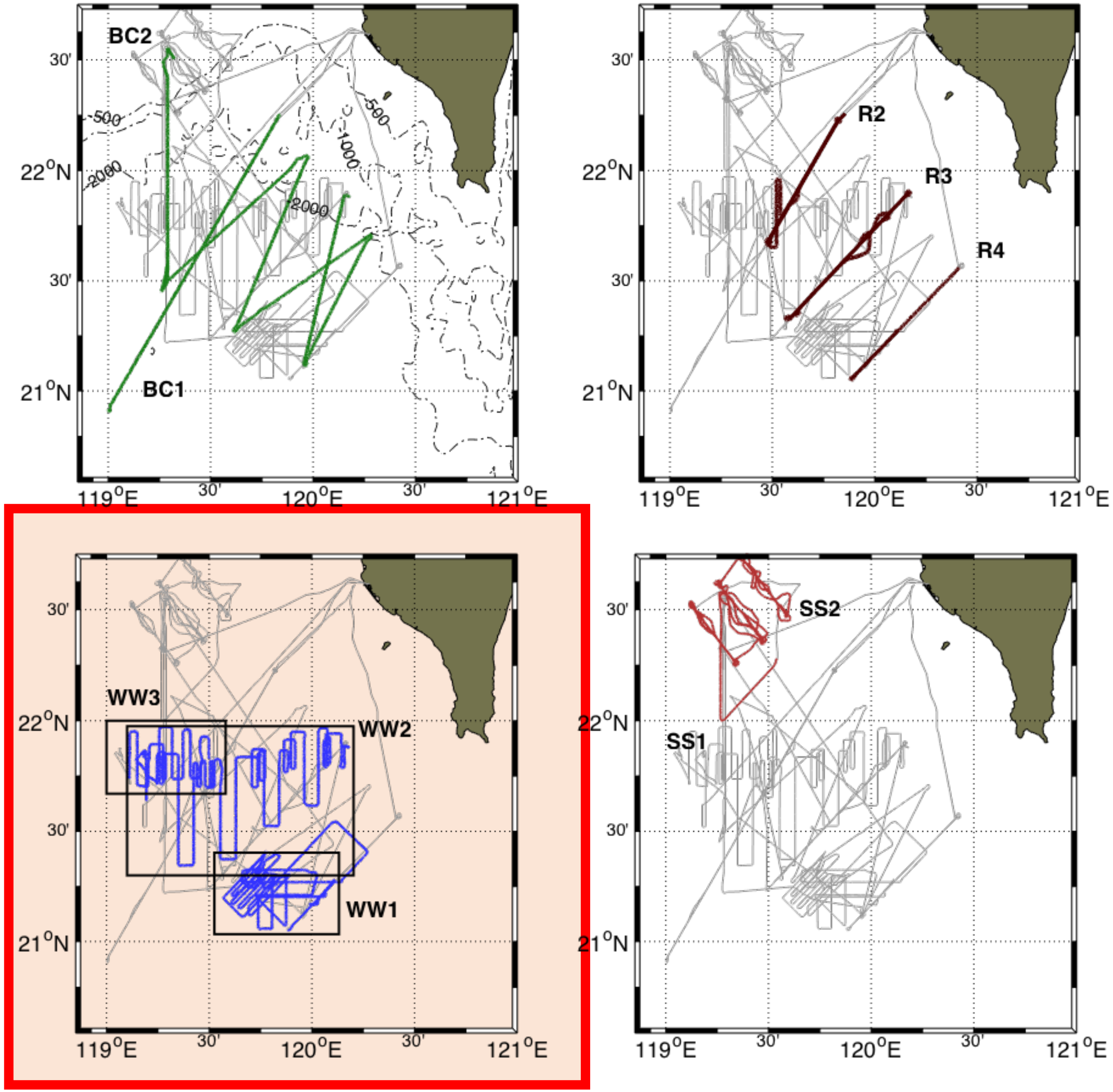
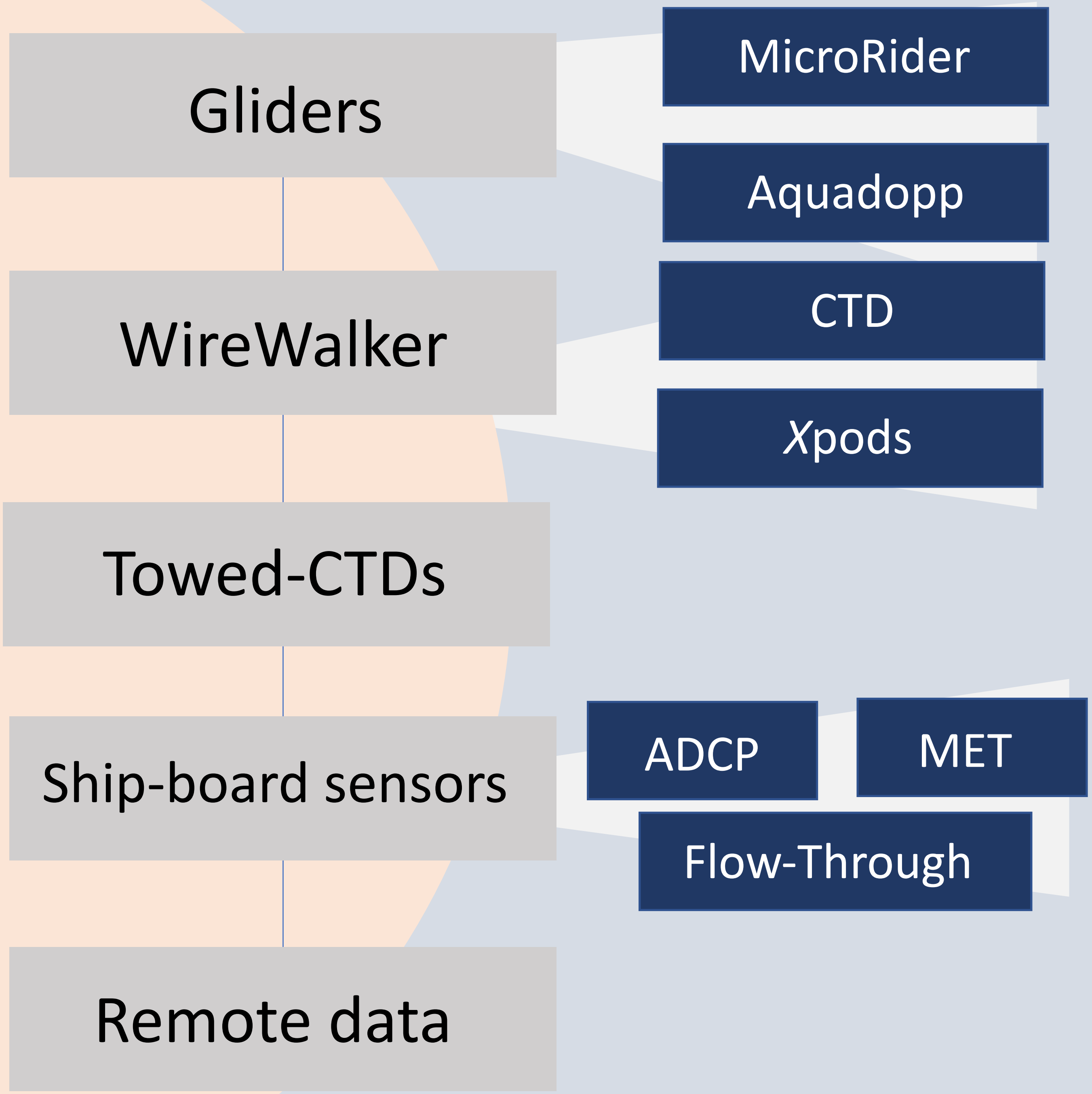


Chasing fronts with

a combination of short and long term *in-situ* measurements and satellite data to detect fronts in real-time

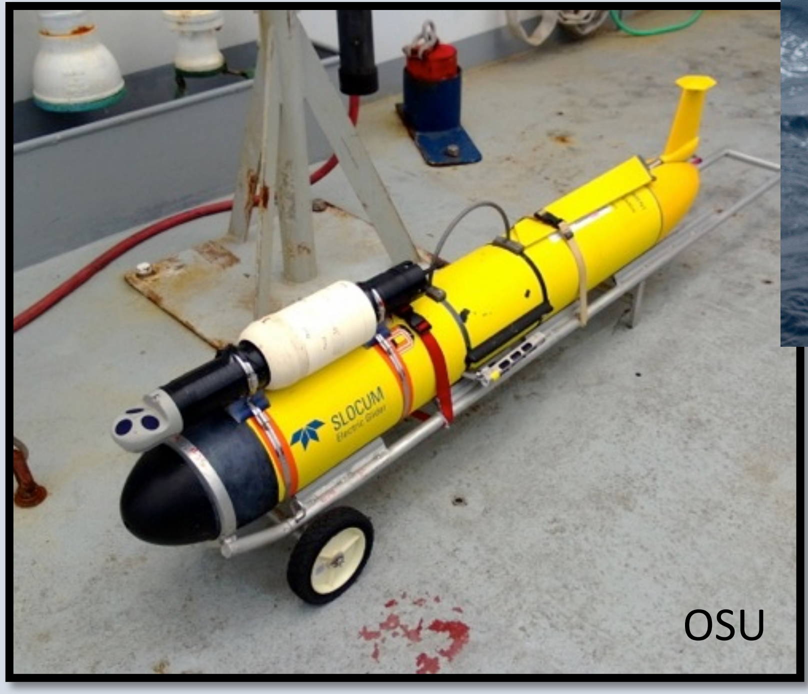


Instruments during 2014

Wirewalker: profiles down to 200 m

TRIAXUS:

Towed CTD, profiles to 250m depth



Slocum Glider

CTD,

Aquadopp (shear)

MicroRider(dissipation)

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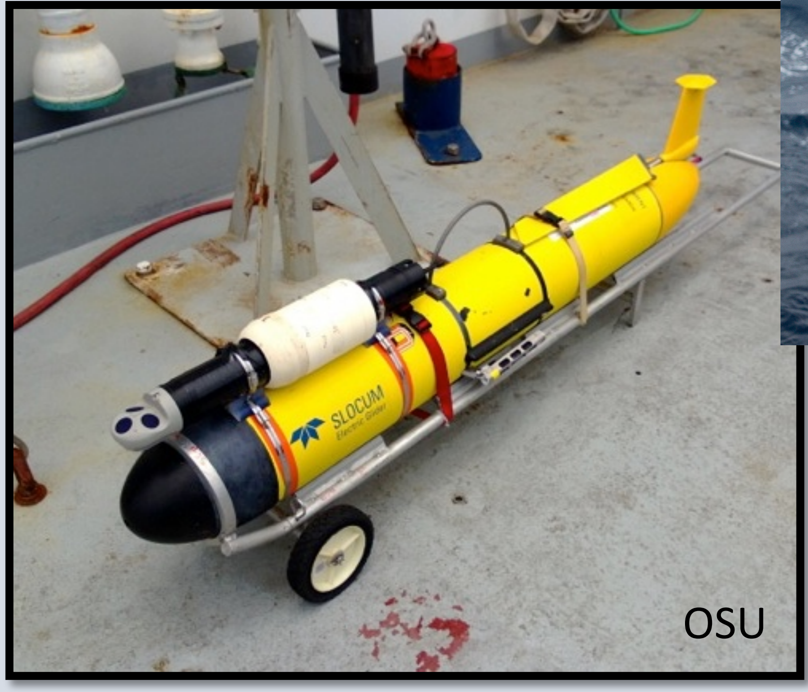
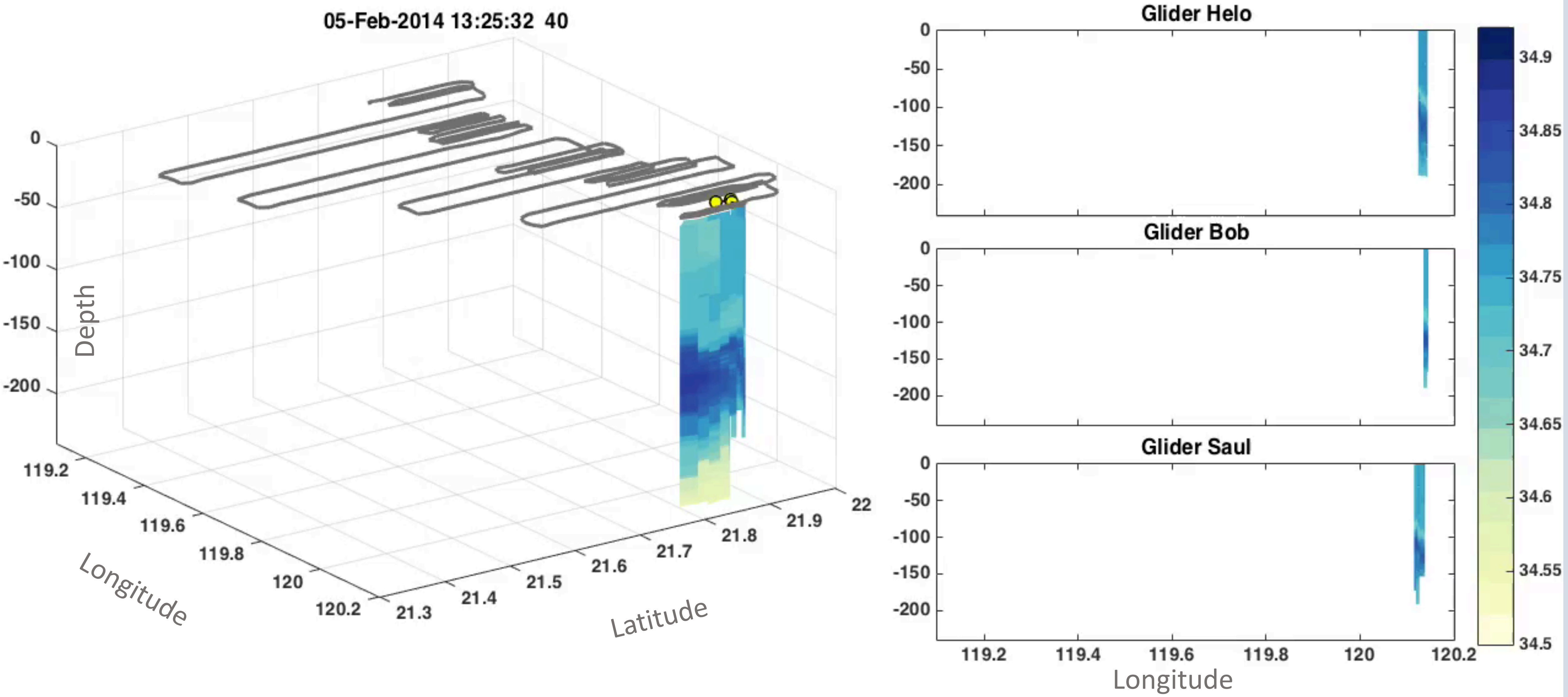


Me

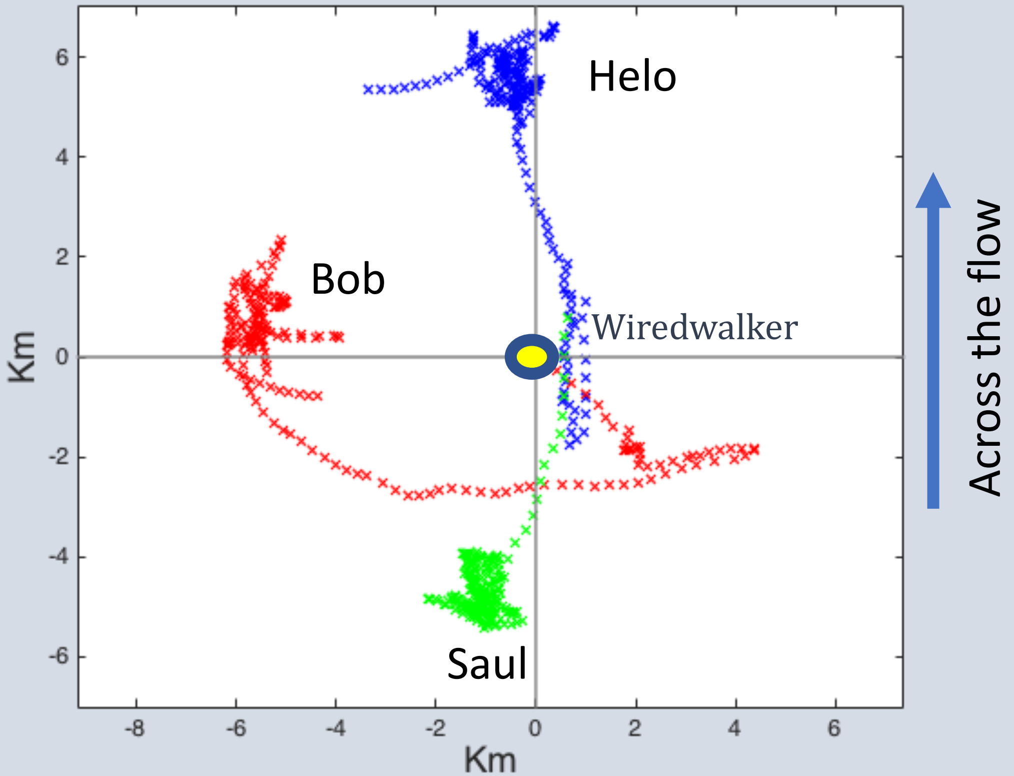
Slocum Glider
CTD,
Aquadopp (shear)
MicroRider(dissipation)

Example of a coordinated survey

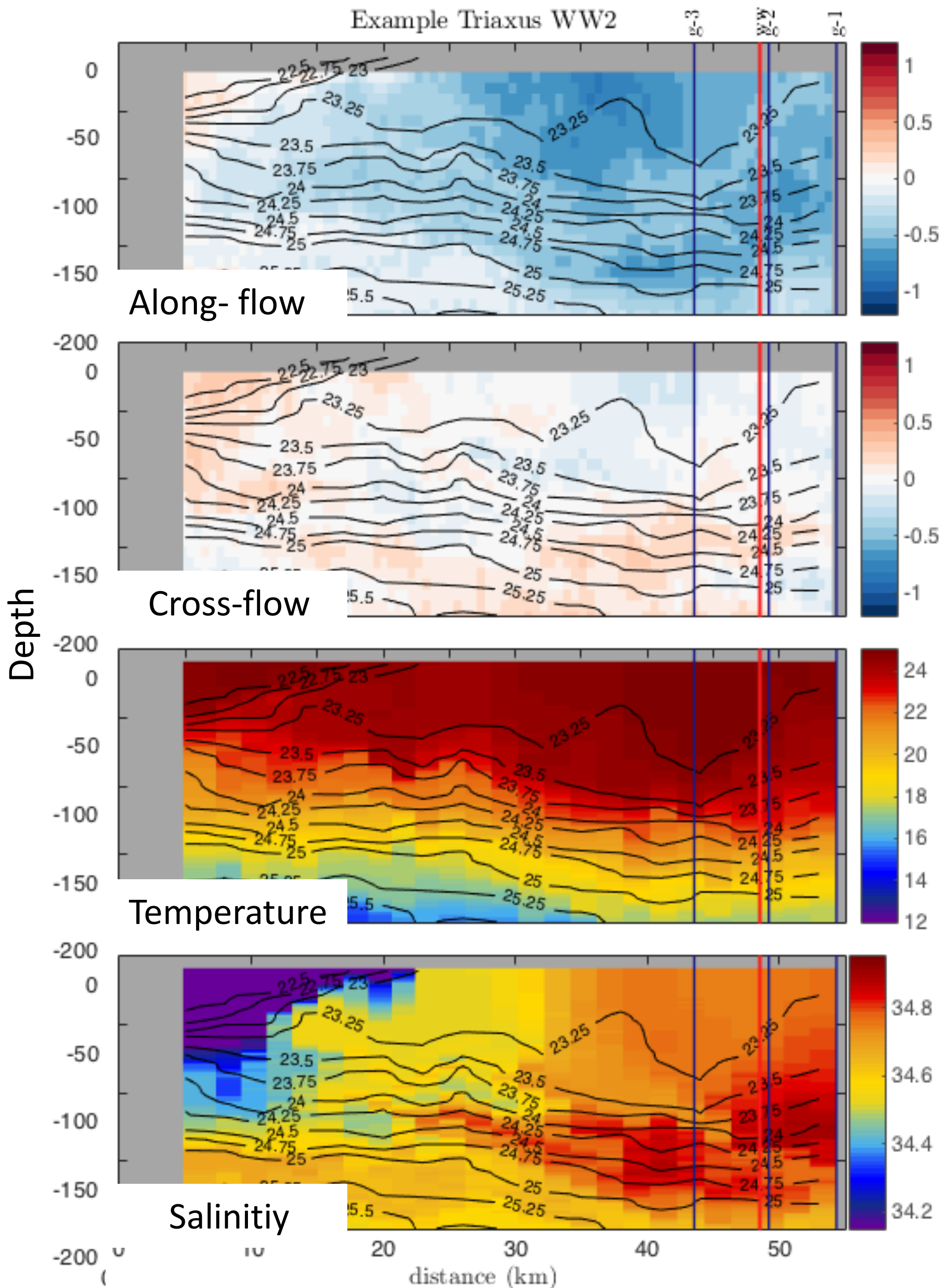


Structure of the front

- Besides a high resolution section along the float trajectory, we also obtain sections across the flow.



Relative location of the gliders with respect to the wirewalker



Density Ratio and Shear

Turner Angle

$$R_\rho = \alpha\Theta_z / \beta S_z$$

$$R_\rho = -tan(Tu + 45^o))$$

$$Tu = tan^{-1}[(\alpha\Theta_z + \beta S_z)/(\alpha\Theta_z - \beta S_z)]$$

Richardson Number

$$Ri = N^2/S^2$$

$$S = \frac{\partial u}{\partial z} + \frac{\partial v}{\partial z}$$

We investigate when the profiles were potentially unstable to:

Double diffusion & Shear

Salt finger

($Tu > 75^o$)

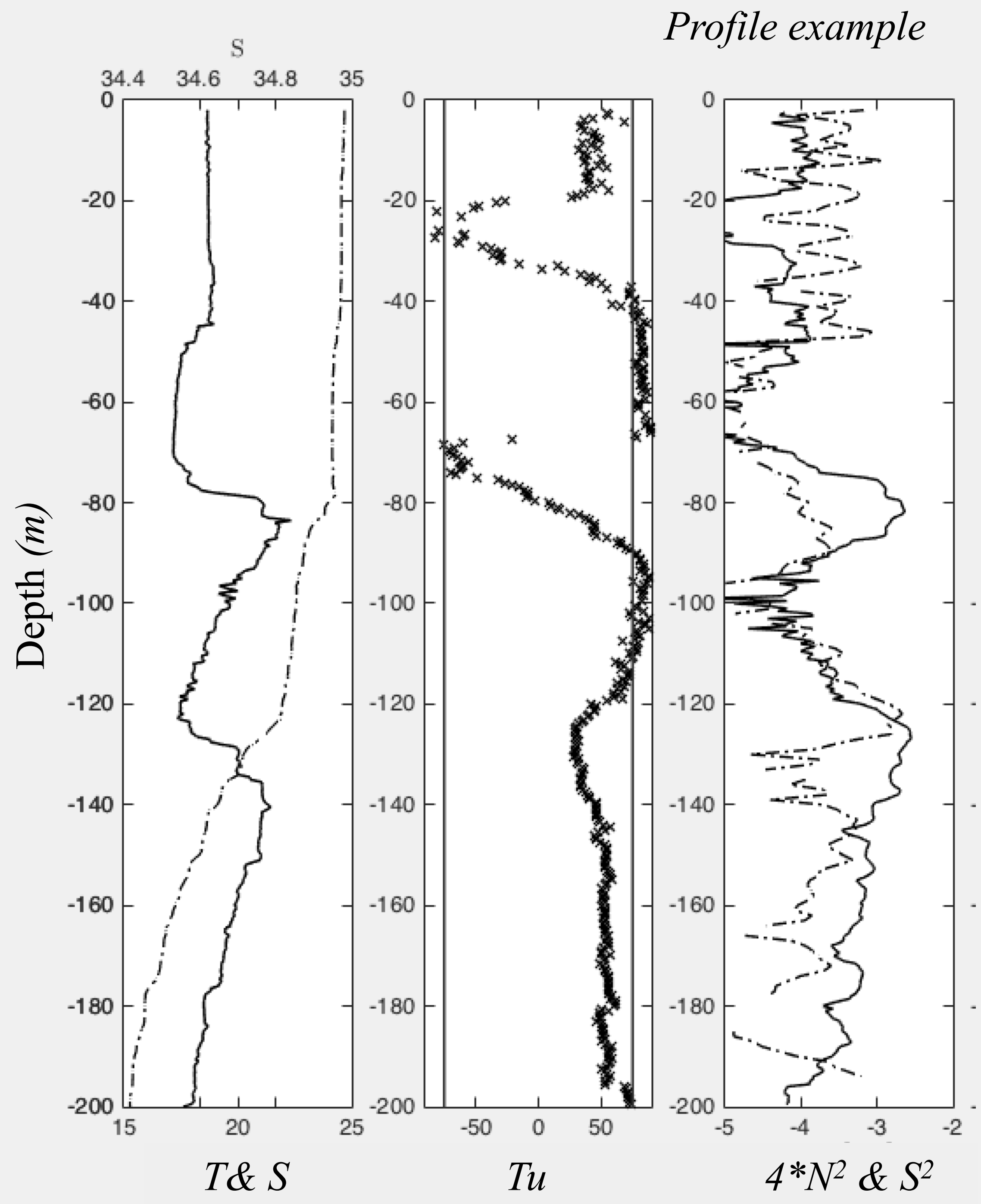
Diffusive convection

($Tu <$ -75^o)

$$S^2 - 4N^2 > 0$$

(Ruddick 1983)

(Sun et.al., 1983)



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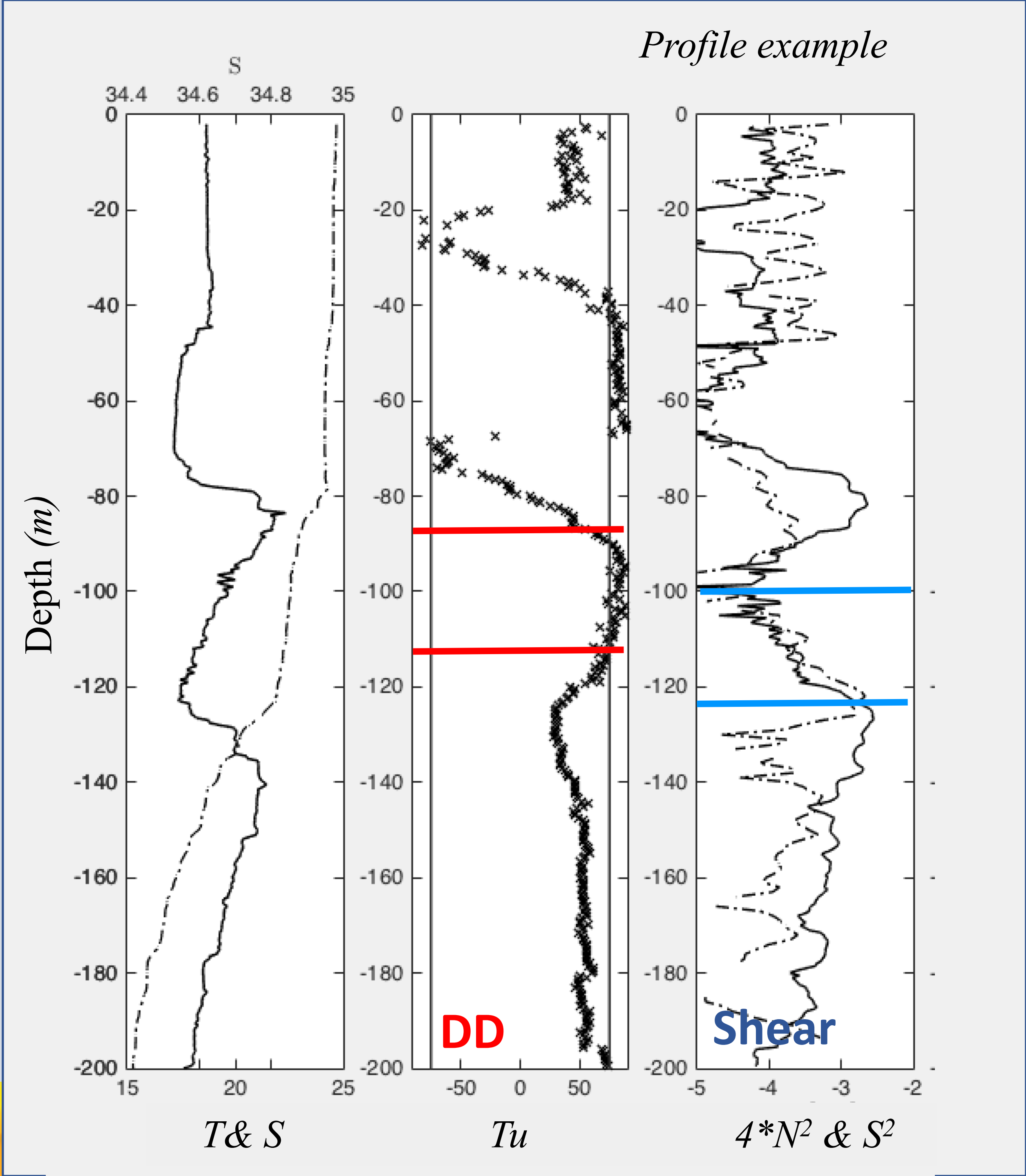
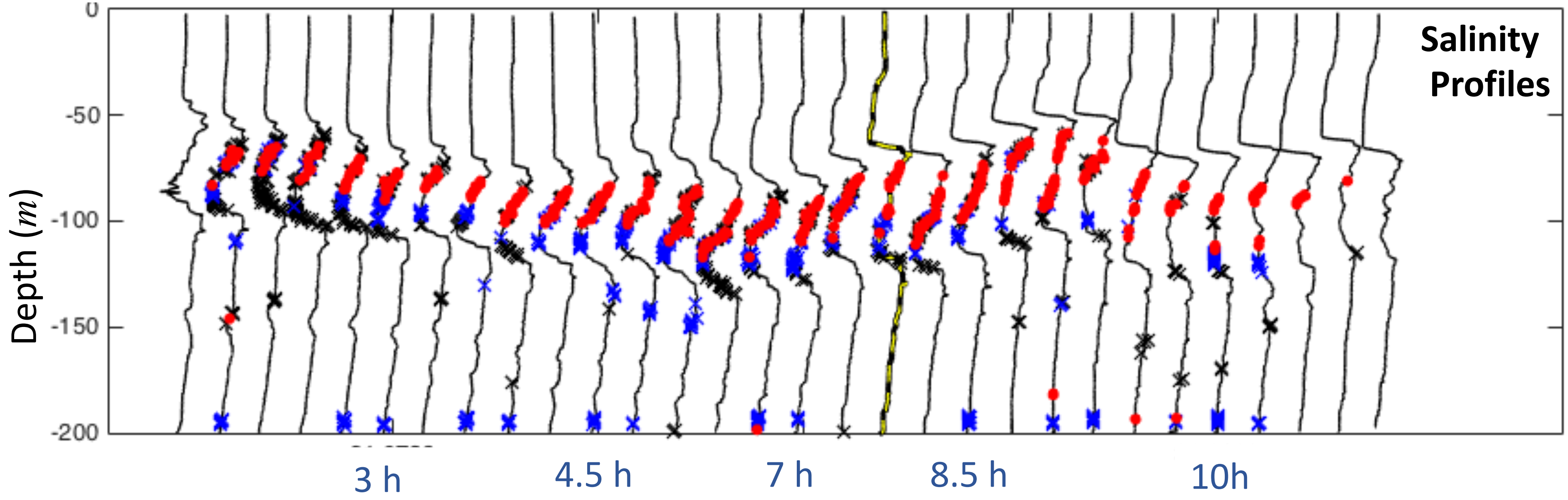




Red dot = Tu > 75°

Blue cross = $S^2 - 4N^2 > 0$

Micro-structure data

Black cross = Dissipation of thermal variance

$\chi > 10^{-6}$ K²/m

Fine- & Microstructure

Using available Micro-Structure data:

ϵ = Dissipation of Turbulent Kinetic energy

χ = Dissipation of Thermal variance

We compared the location of:

- High dissipation
- Low values of Ri
- Potential location of salt fingers ($Tu > 90$)

Which are associated with the location of the fresh interleaving

Dissipation of thermal variance

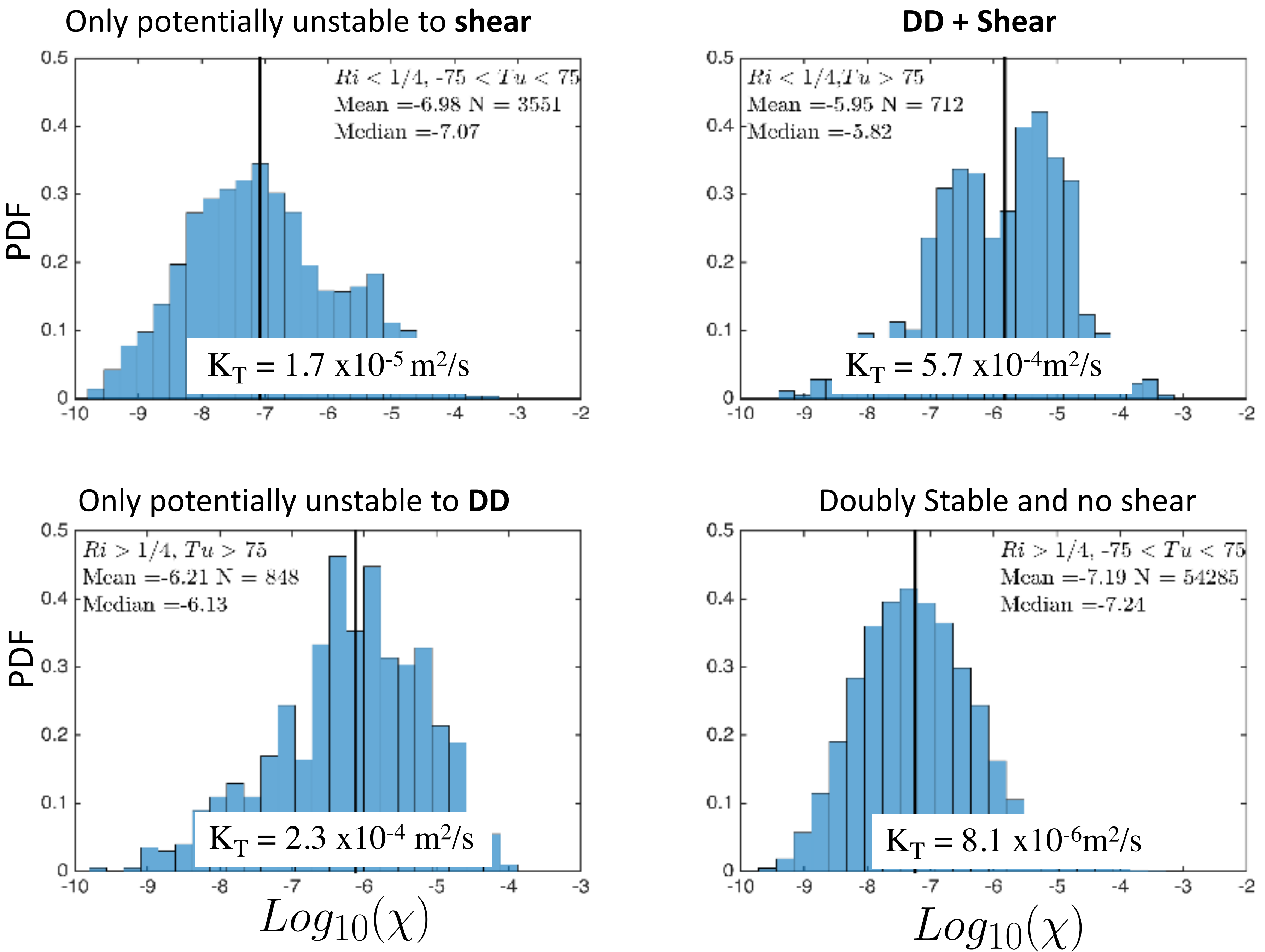
Creating subsets of data to analyze thermal variance associated with:

- Double diffusion
- Shear
- DD + Shear

- Estimate of vertical thermal diffusivity Parametrization

$$K_T = \frac{\chi}{2\overline{T_z}}$$

(Osborn & Cox 1972)



Estimated heat flux

An estimated mean vertical heat flux associated with the interleaving

$$Q_t = \rho_o c_p \bar{K}_t < \frac{\partial T}{\partial z} >$$

Double Stable < 5 W/m^2	Shear < 15 W/m^2
Salt fingers 40-80 W/m^2	Combo 80-100 W/m^2

Advantages and limitations of coordinated surveys

1. Permit simultaneous measurements of thermal and momentum dissipation and employ real-time decision making logistics, which can be challenging during field-work

2. Most of the coordinated surveys last less than 4 days, which limits the statistics that can be used in the analysis.

3. The combination of instruments allows us to discern between processes dominating mixing within the interleaving. Although careful consideration has to be taken to decide how to overlap the measurements. Large implication in how we parameterized mixing

Funding by

Thank you