

SeaSoar surveys of frontal dynamics, internal tide generation, and mixing

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AESOP observations

PI	Measurements	Goals
Klymak Pinkel	<ul style="list-style-type: none"> - FLIP - 100-s profiles of T, S - u, v to 800 m 	<ul style="list-style-type: none"> - energy transfer from internal tide to internal waves - pathways to mixing: wave-wave interactions, overturns
Girton Kunze	<ul style="list-style-type: none"> - XCP survey near FLIP - microstructure 	<ul style="list-style-type: none"> - internal tide energy fluxes - turbulent dissipation rates
Gregg Miller	<ul style="list-style-type: none"> - microstructure survey around the shelf in MB 	<ul style="list-style-type: none"> - turbulent dissipation rates
Johnston Rudnick	<ul style="list-style-type: none"> - SeaSoar survey of front and internal tides - mixing from TMS 	<ul style="list-style-type: none"> - vertical velocities, mixing at front - internal tide energy flux, mixing
Lee D'Asaro	<ul style="list-style-type: none"> - neutrally buoyant float - Triaxus survey 	<ul style="list-style-type: none"> - lateral variability of boundary layer turbulence - horizontal and vertical mixing

AESOP Model-Data Metrics

1. Horizontal diffusivity in boundary layer

D'Asaro, Capet, Harcourt, Jachec, Lee

2. Vertical wavenumber spectra of shear and stratification, PDFs of $S^2 - 4N^2$

Girton, Pinkel, Jachec, Kunze, Huei-Ping, Wang, Klymak

3. Dissipation in boundary layer, shear layers

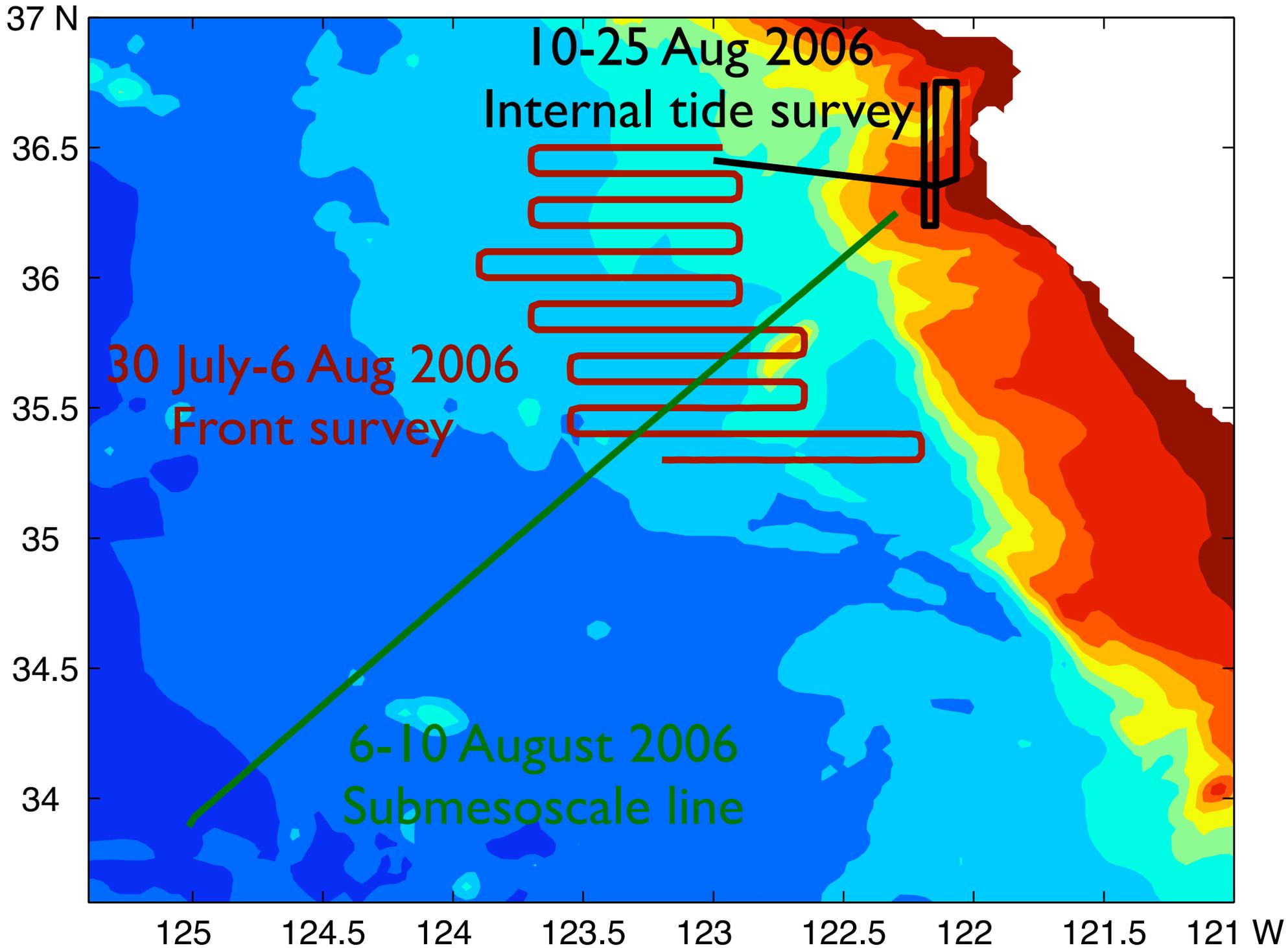
Johnston, Rudnick, Girton, Kunze, Pinkel, Sarkar, Harcourt

4. Strain, vorticity, horizontal gradients of T, S in boundary layer

Capet, Huei-Ping, Rudnick, Johnston, Lee

5. Internal tide energy flux

Klymak, Jachec, Pinkel, Girton, Kunze, Wang, Johnston, Rudnick



AESOP- SeaSoar surveys

Frontal dynamics

- How does submesoscale horizontal variability affect the surface mixed layer and the transition layer below it?
- Where are vertical velocities large?
- Where does vertical mixing take place at a front?
- Collaborators: D'Asaro and Lee (APL/UW)

Submesoscale decay away from the coast

- What is the observed statistical description (e.g., temperature gradient horizontal wavenumber spectra, vorticity probability distribution functions)?
- How does it compare to a high-resolution regional model?
- Collaborators: Capet and McWilliams (UCLA)

Internal tide generation and dissipation

- Where is the internal tide generated in the Monterey Bay area?
- How and where is it dissipated?
- How well do parameterizations describe internal tide-driven mixing?
- Collaborators: Klymak (UVic) and Pinkel (SIO), Girton (APL/UW) and Kunze (UVic), Jachec and Fringer (Stanford), Wang and Chao (JPL)

SeaSoar surveys

- covered ~9000 km
- towed at 4 m/s
- sawtooth profiles
- $\Delta x \sim 3$ km, $\Delta z = 8$ m

Hydrography

- T, S, fluor, beam c, O₂

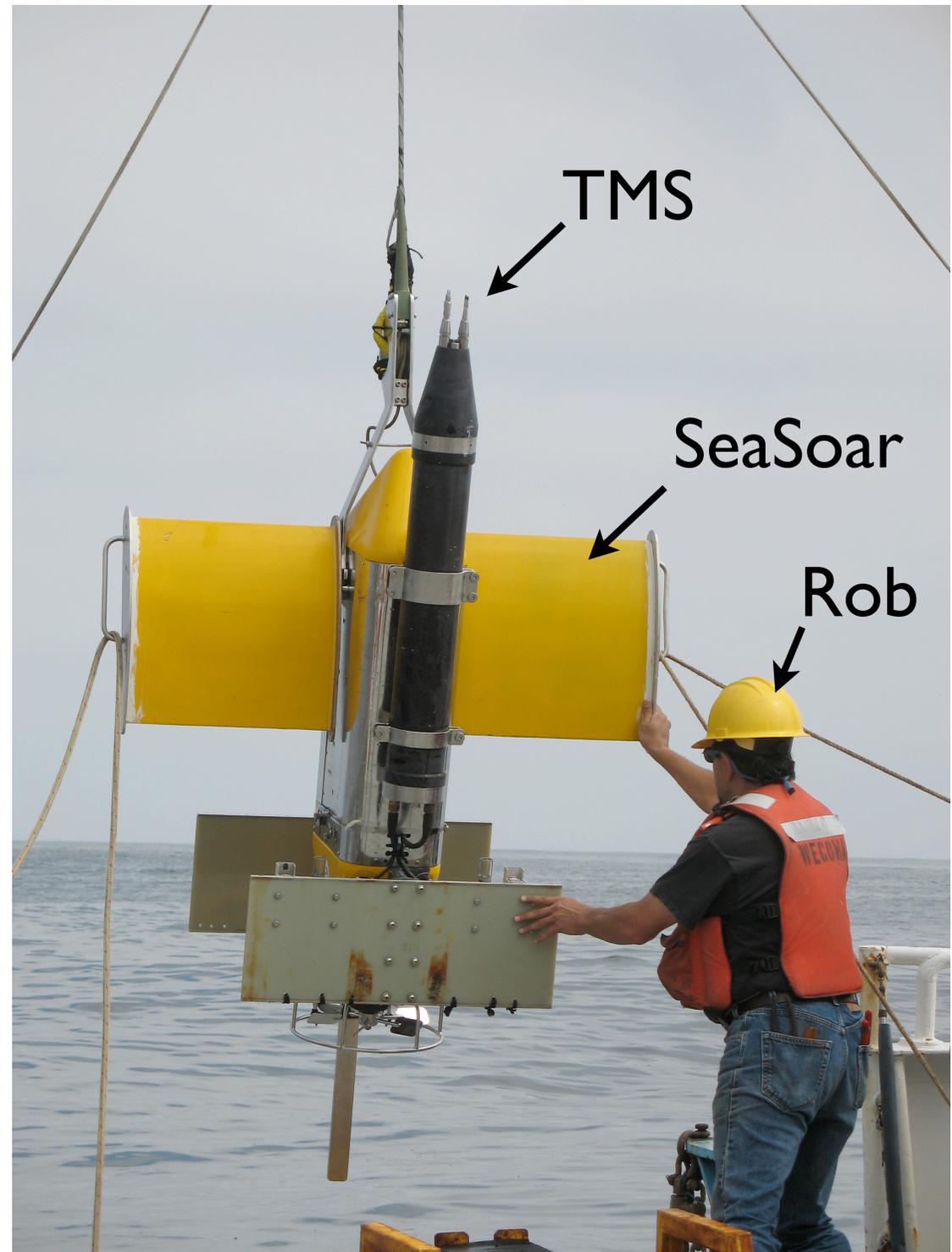
Currents

- 75 kHz BB: 8-m bins to 400 m
- 75 kHz NB: 16-m bins to 600 m
- 300 KHz: 4-m bins to 100 m

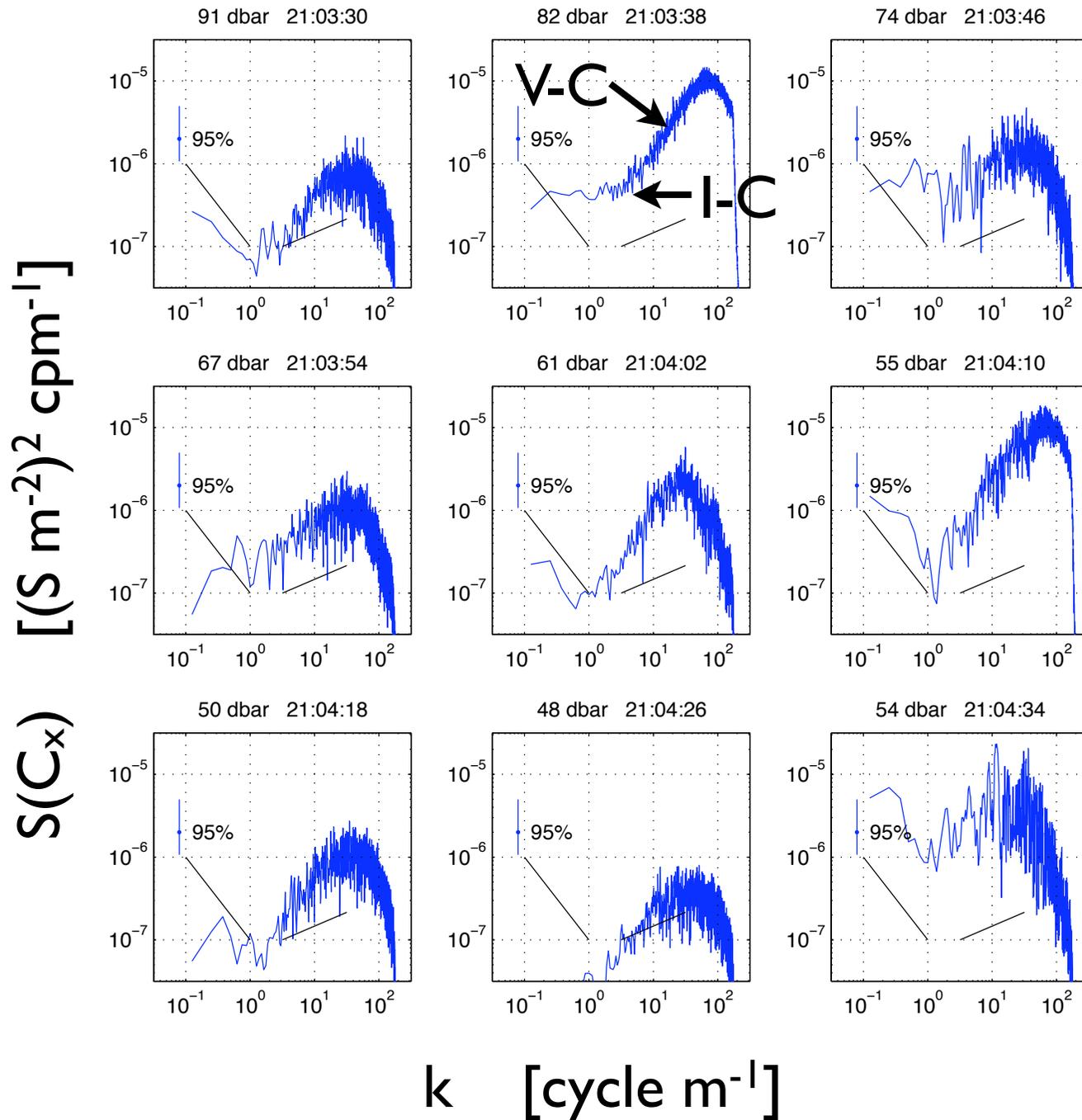
Microstructure

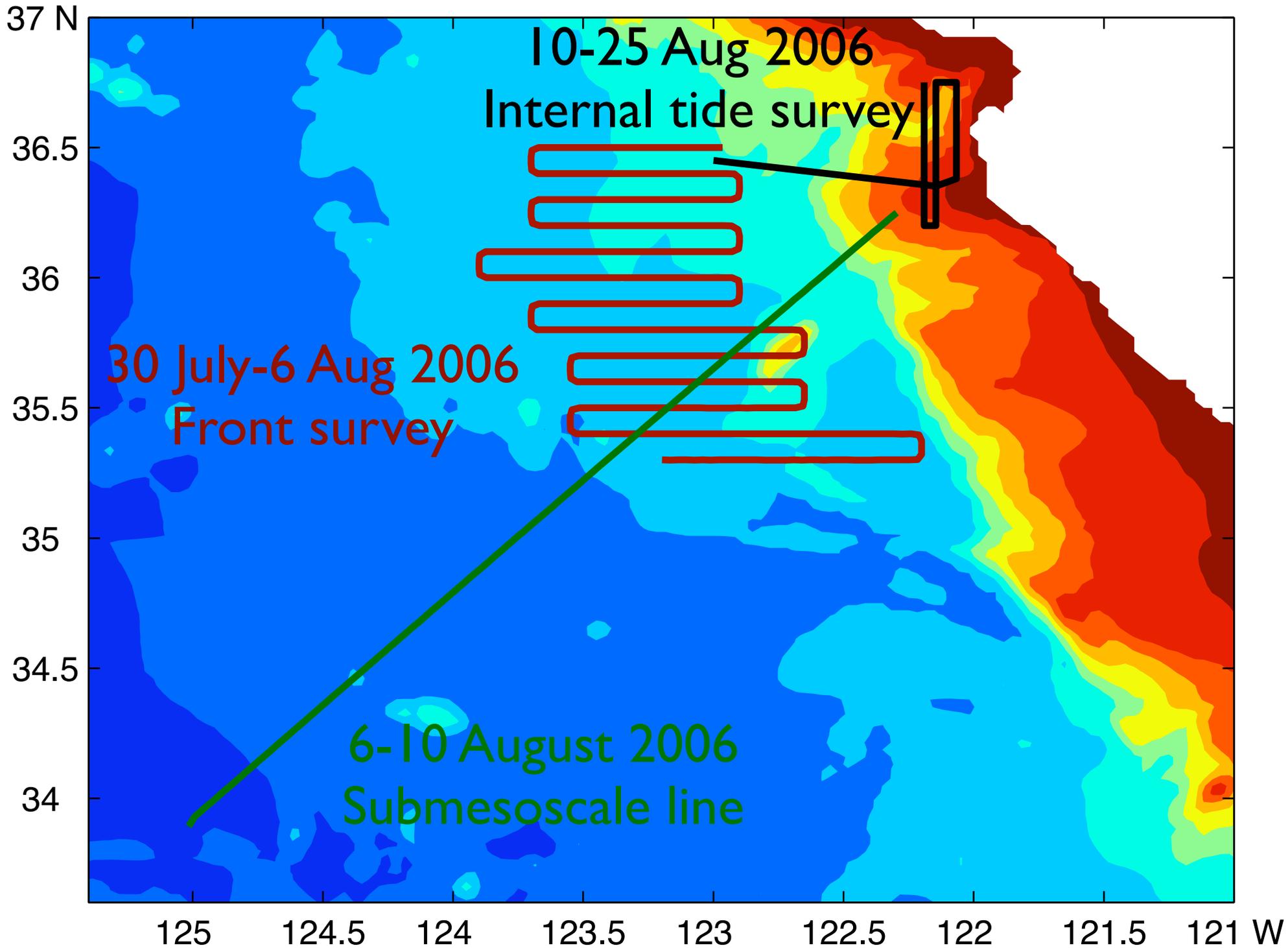
- 2048 Hz microconductivity

$$C_{ox} = \frac{\langle (\partial_z T)^2 \rangle}{\langle \partial_z T \rangle^2}$$

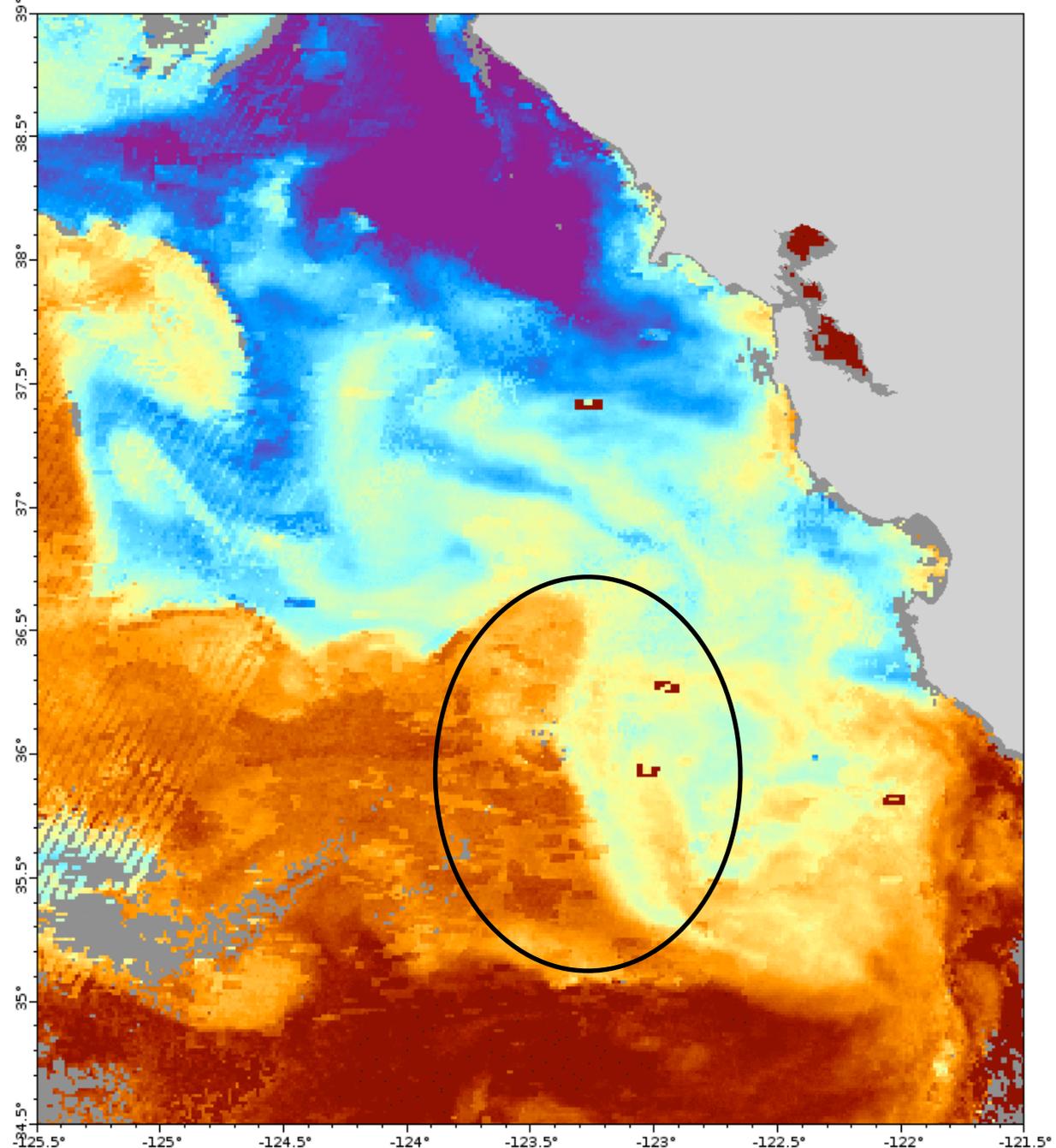


Conductivity gradient spectra

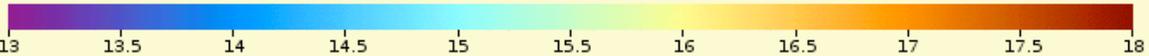




Sea surface temperature

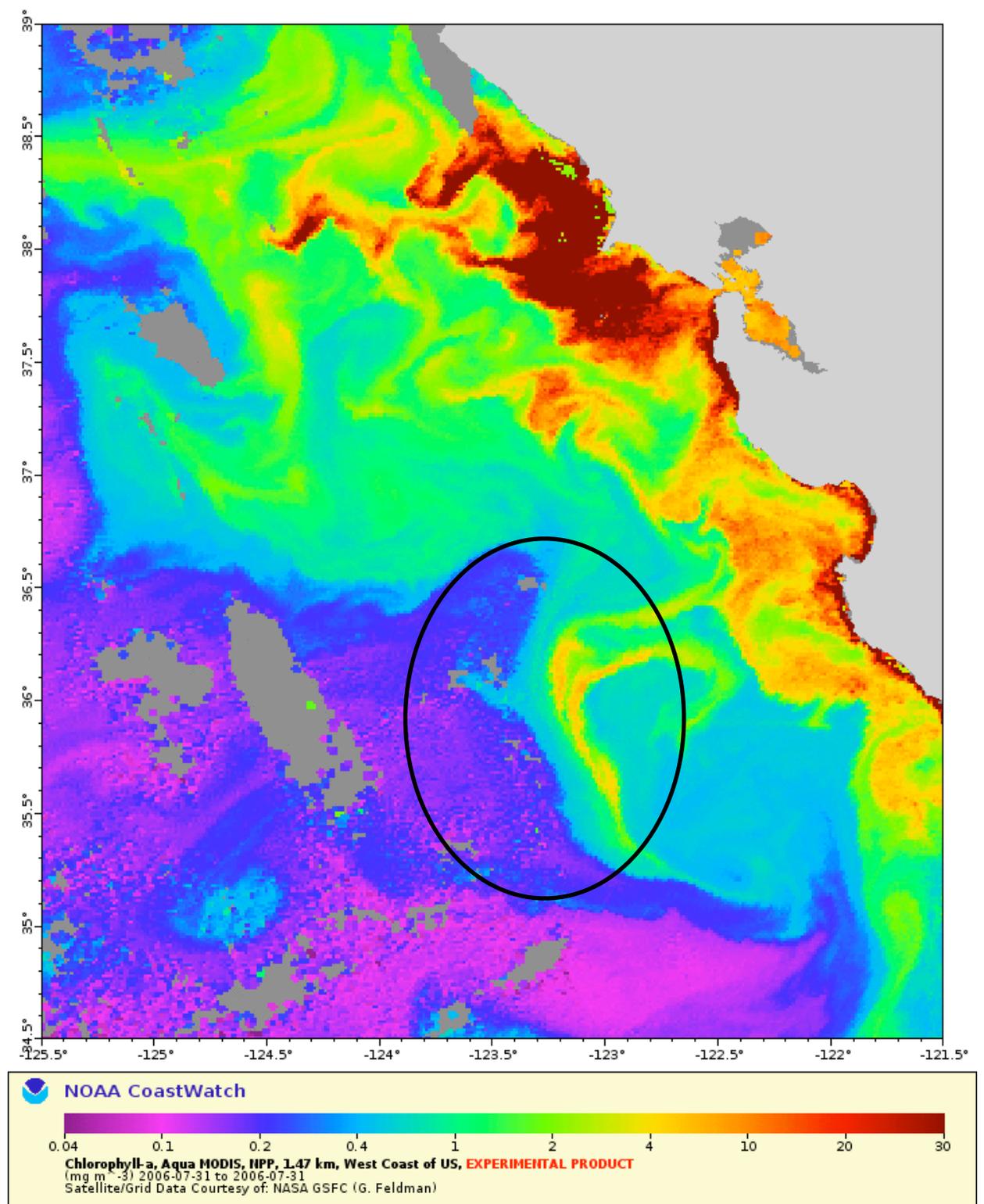


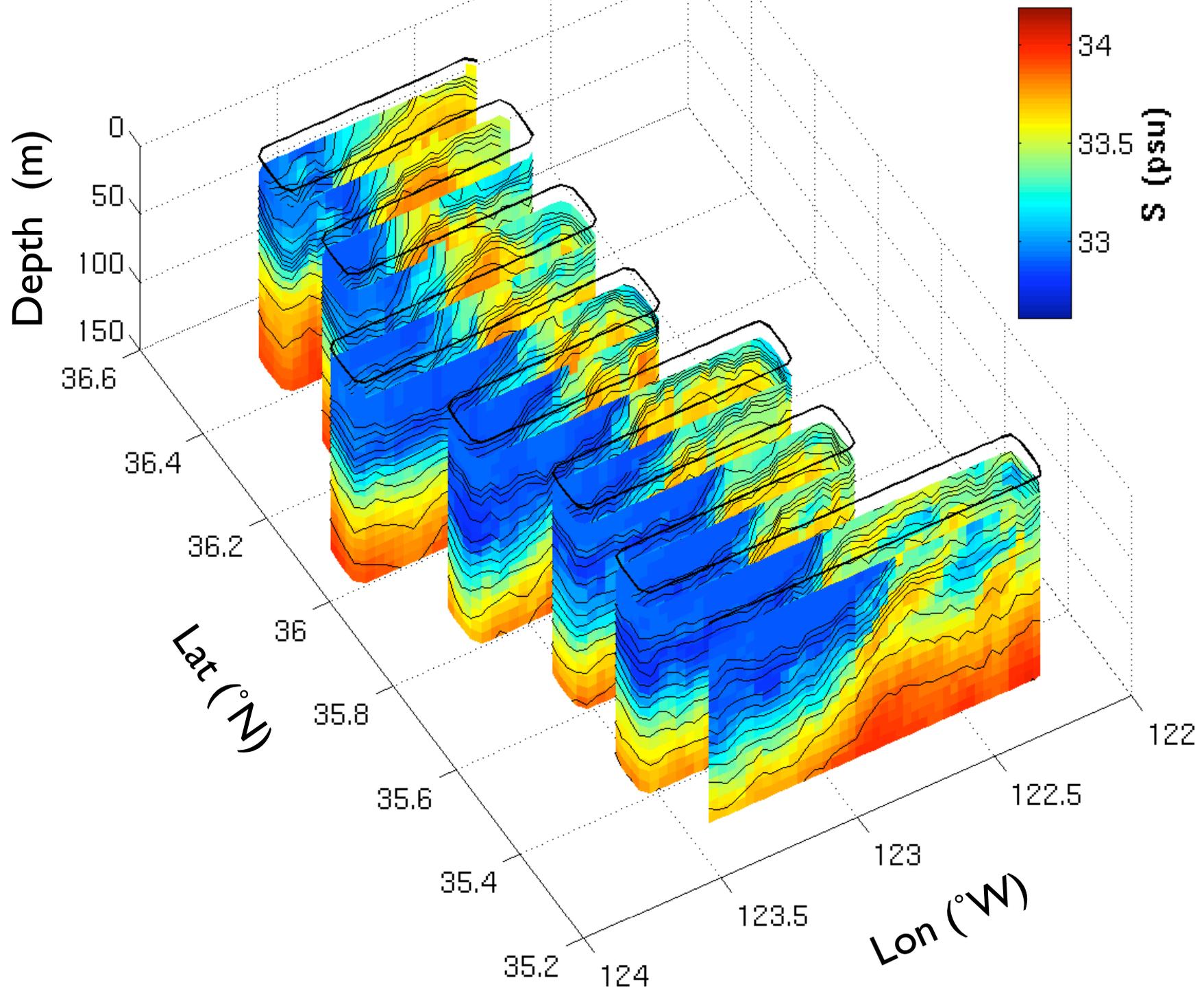
 **NOAA CoastWatch**

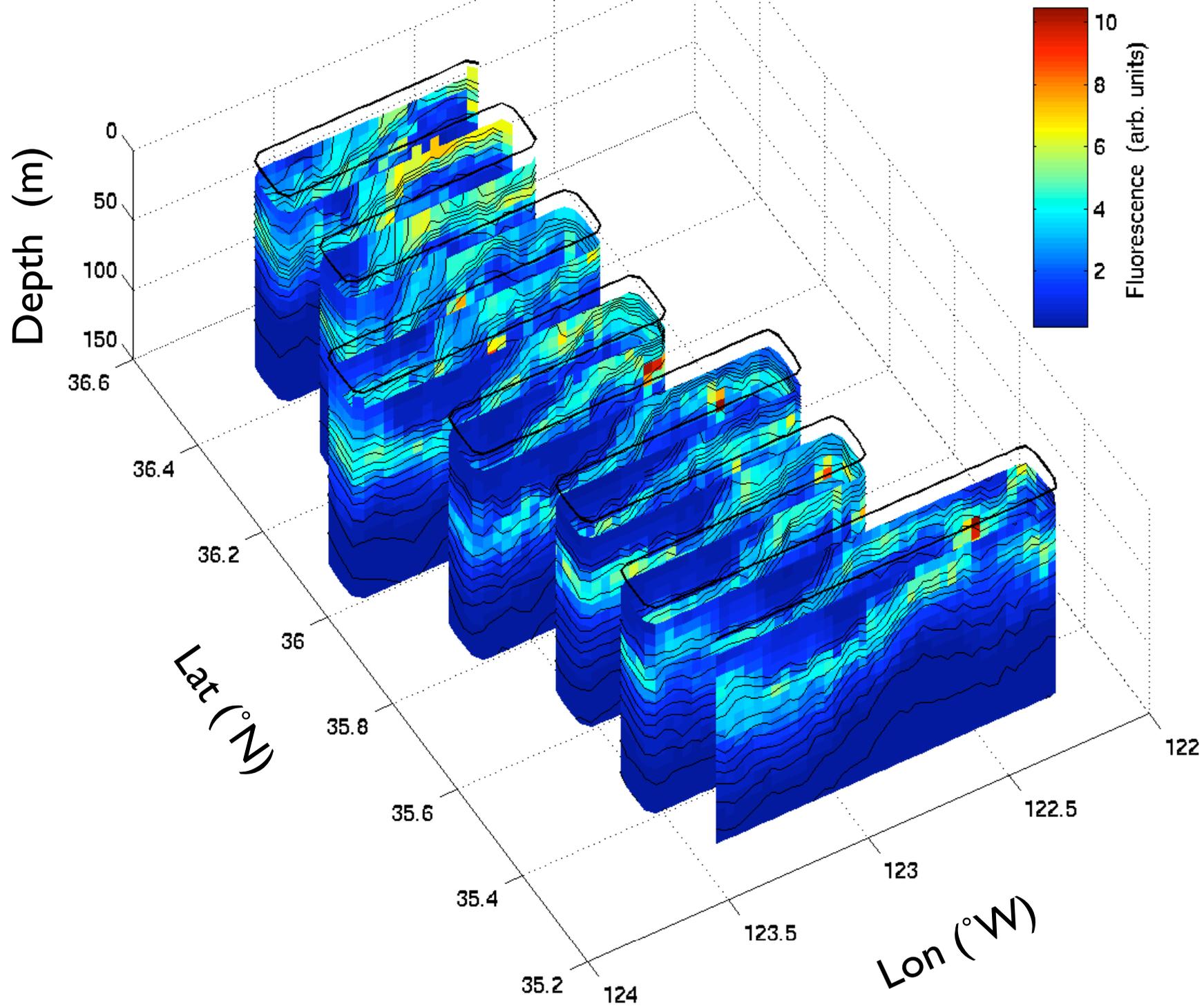


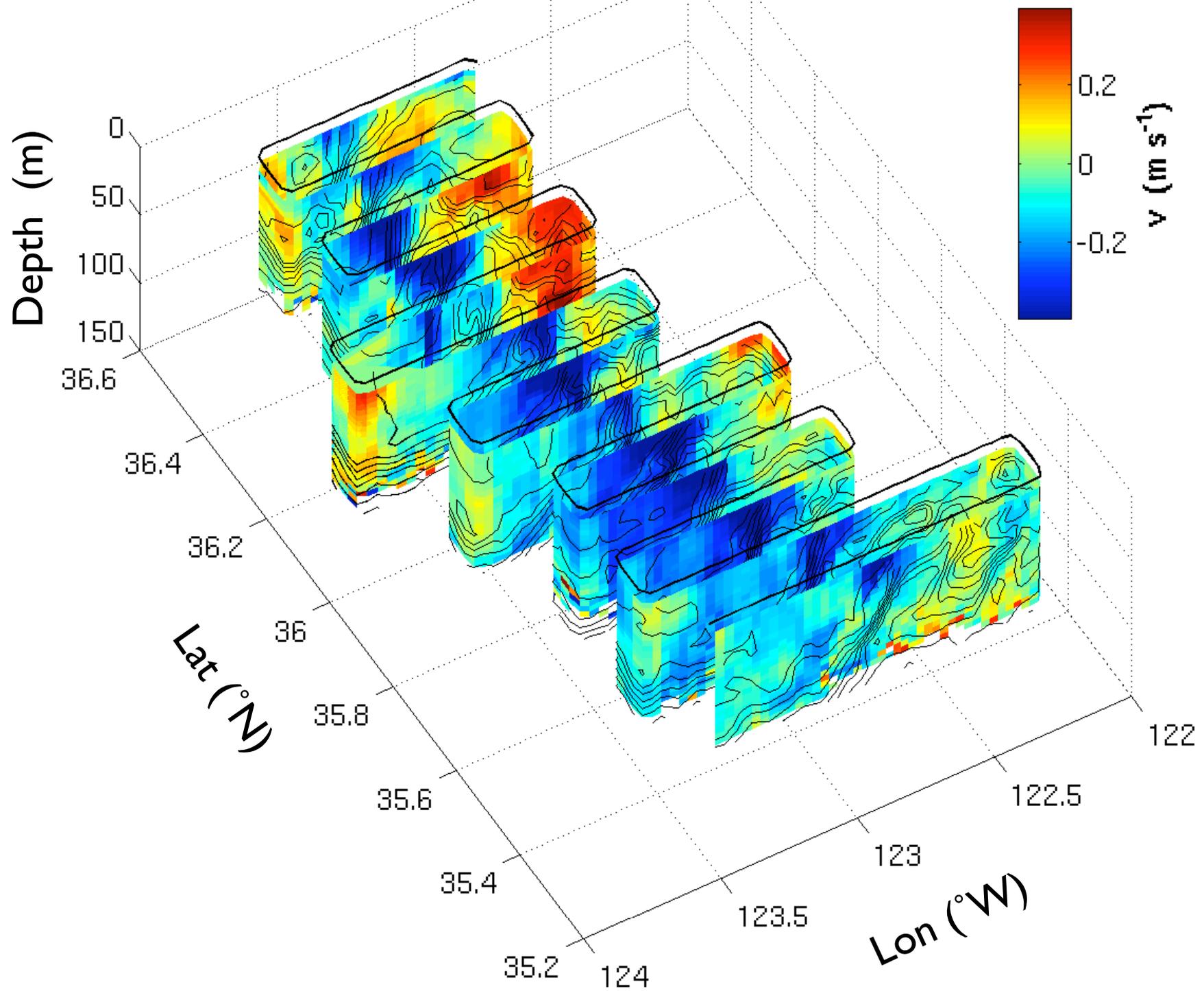
SST, NOAA POES AVHRR, LAC, 1.25 km, West Coast of US, Day and Night
(degree C) 2006-07-31 to 2006-07-31
Satellite/Grid Data Courtesy of: NOAA NWS Monterey and NOAA CoastWatch

Sea surface chlorophyll-a

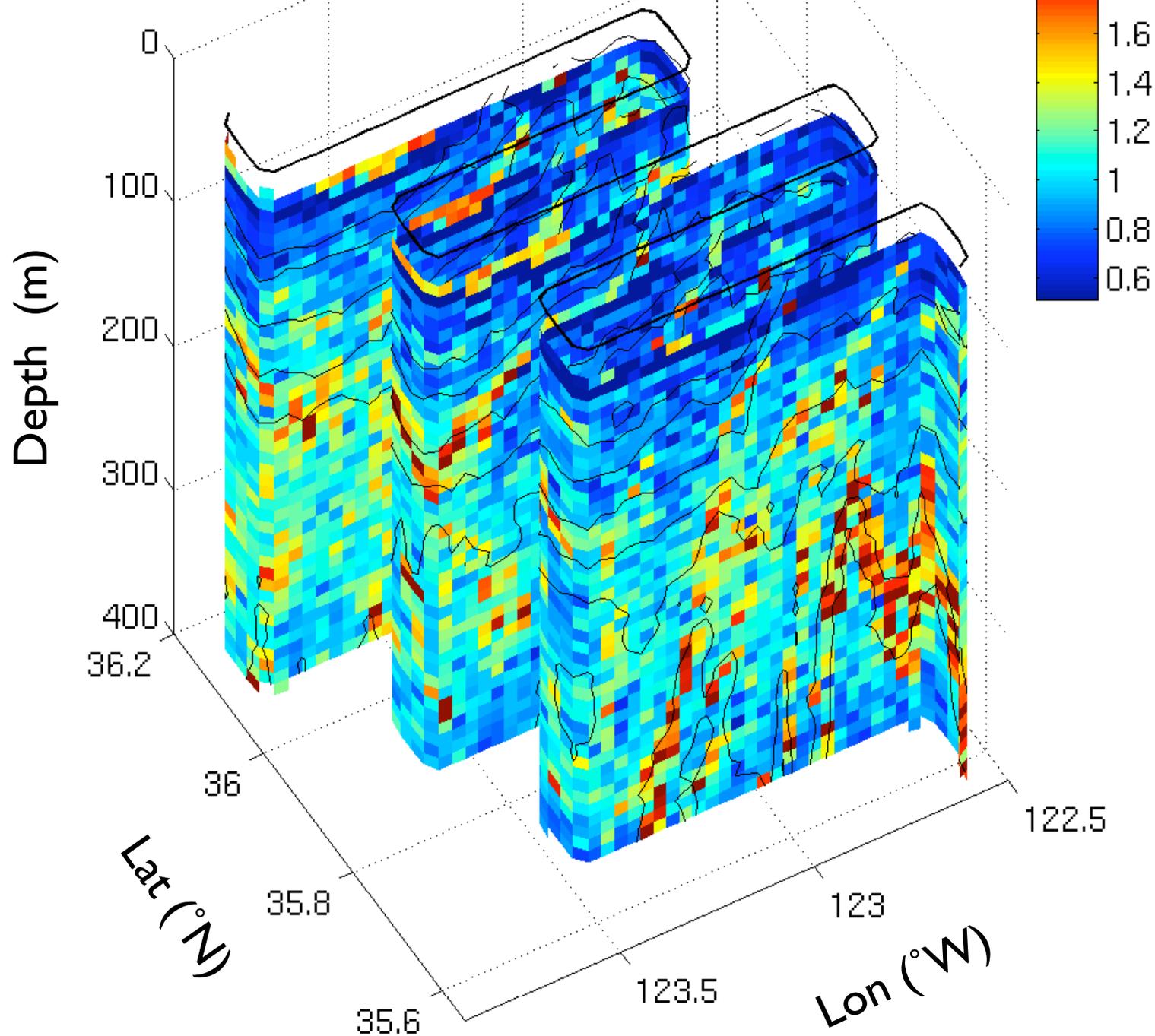




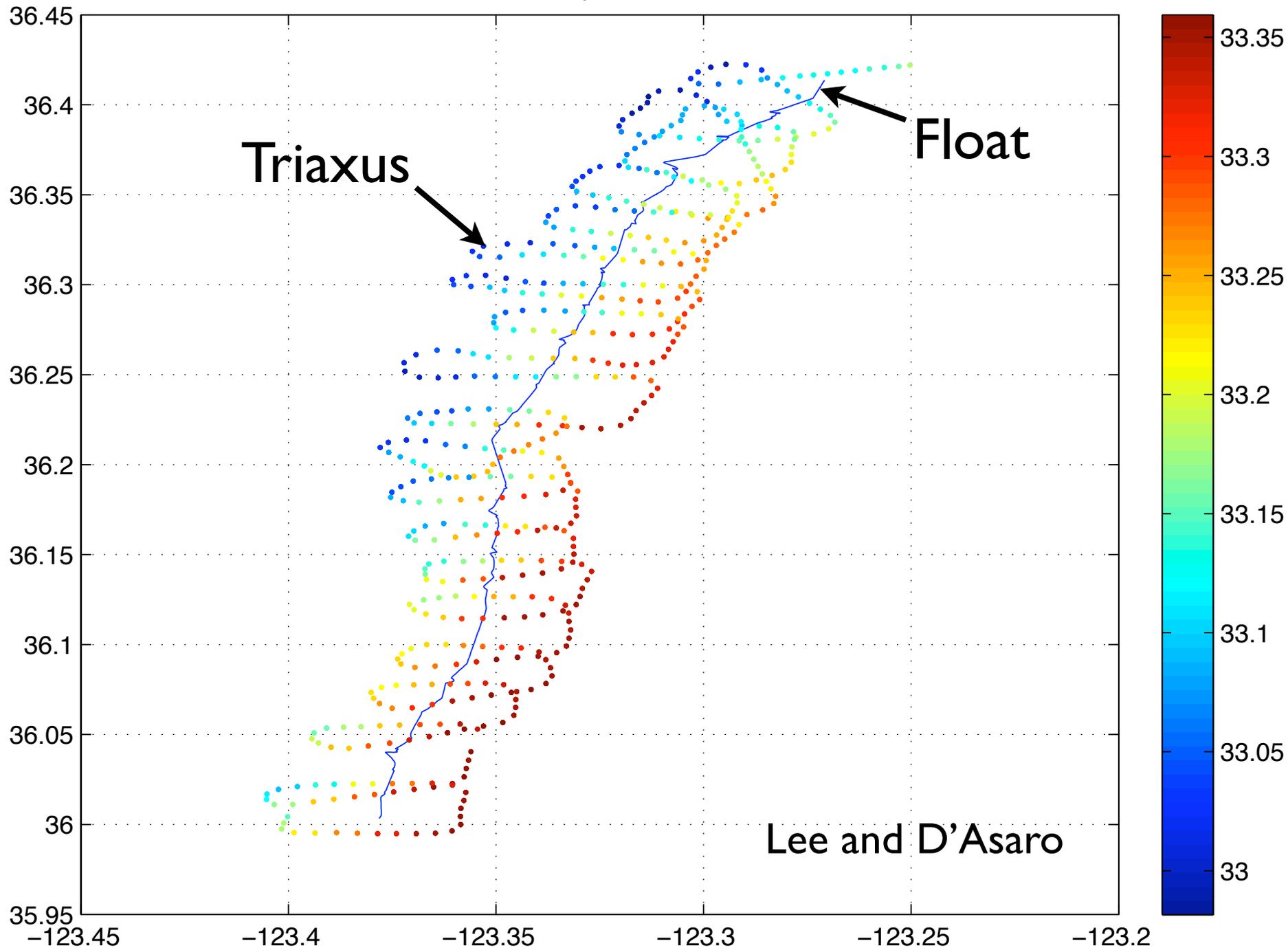


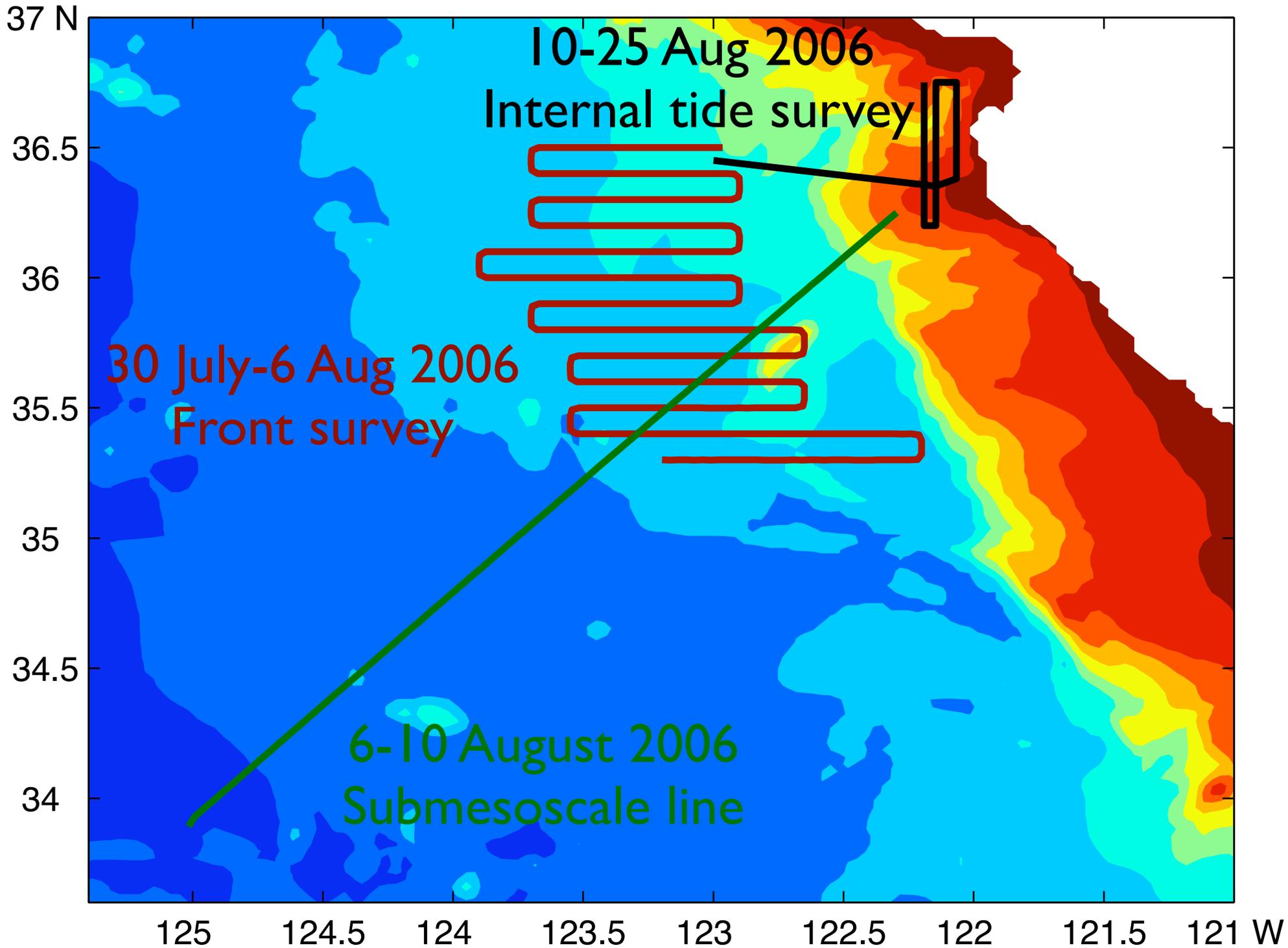


$$C_{\text{ox}} = \frac{\langle (\partial_z T)^2 \rangle}{\langle \partial_z T \rangle^2} \sim \frac{\text{var}(\mu\text{cond voltage})}{(\Delta T)^2}$$

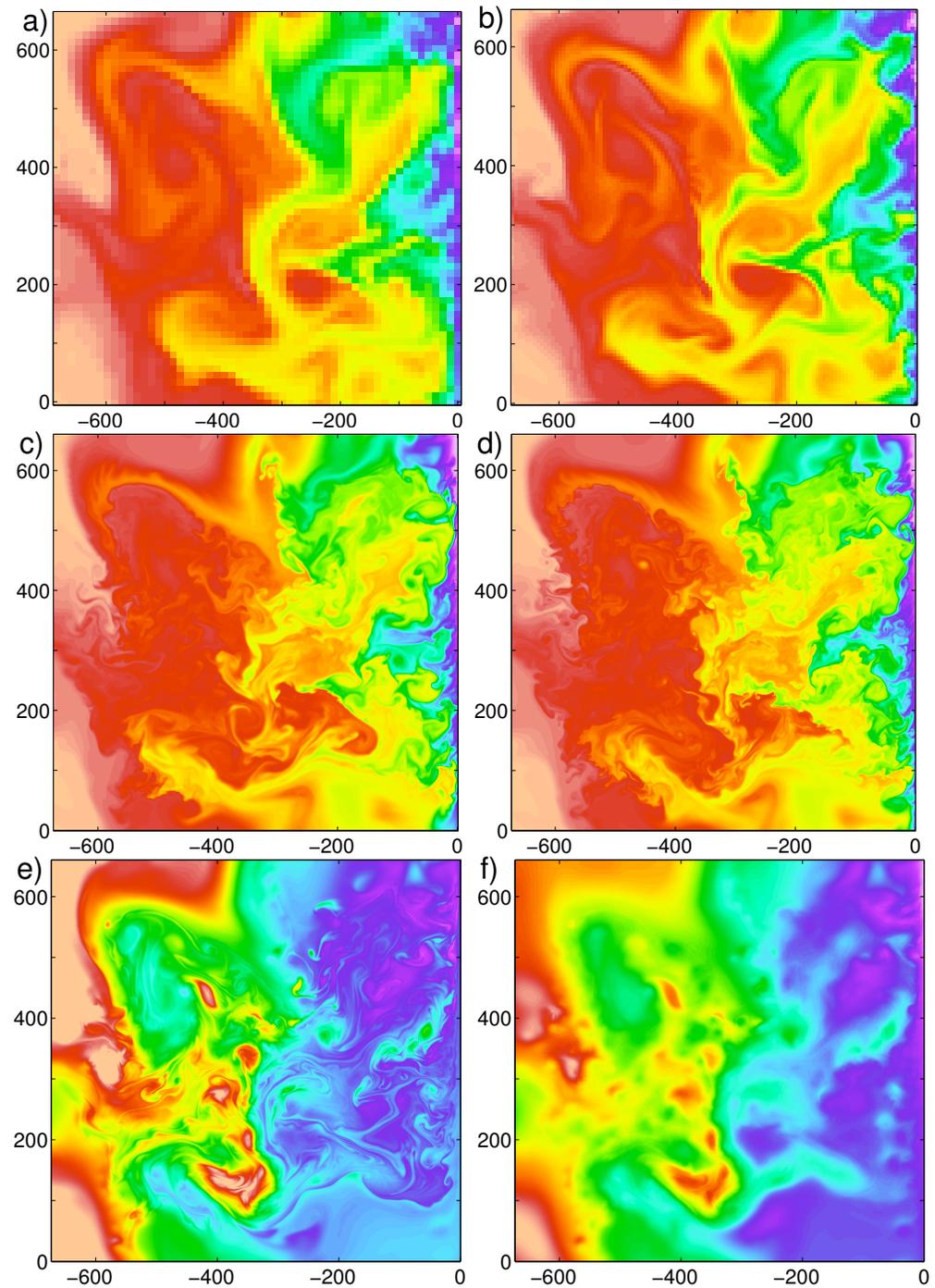


Salinity at 10 m





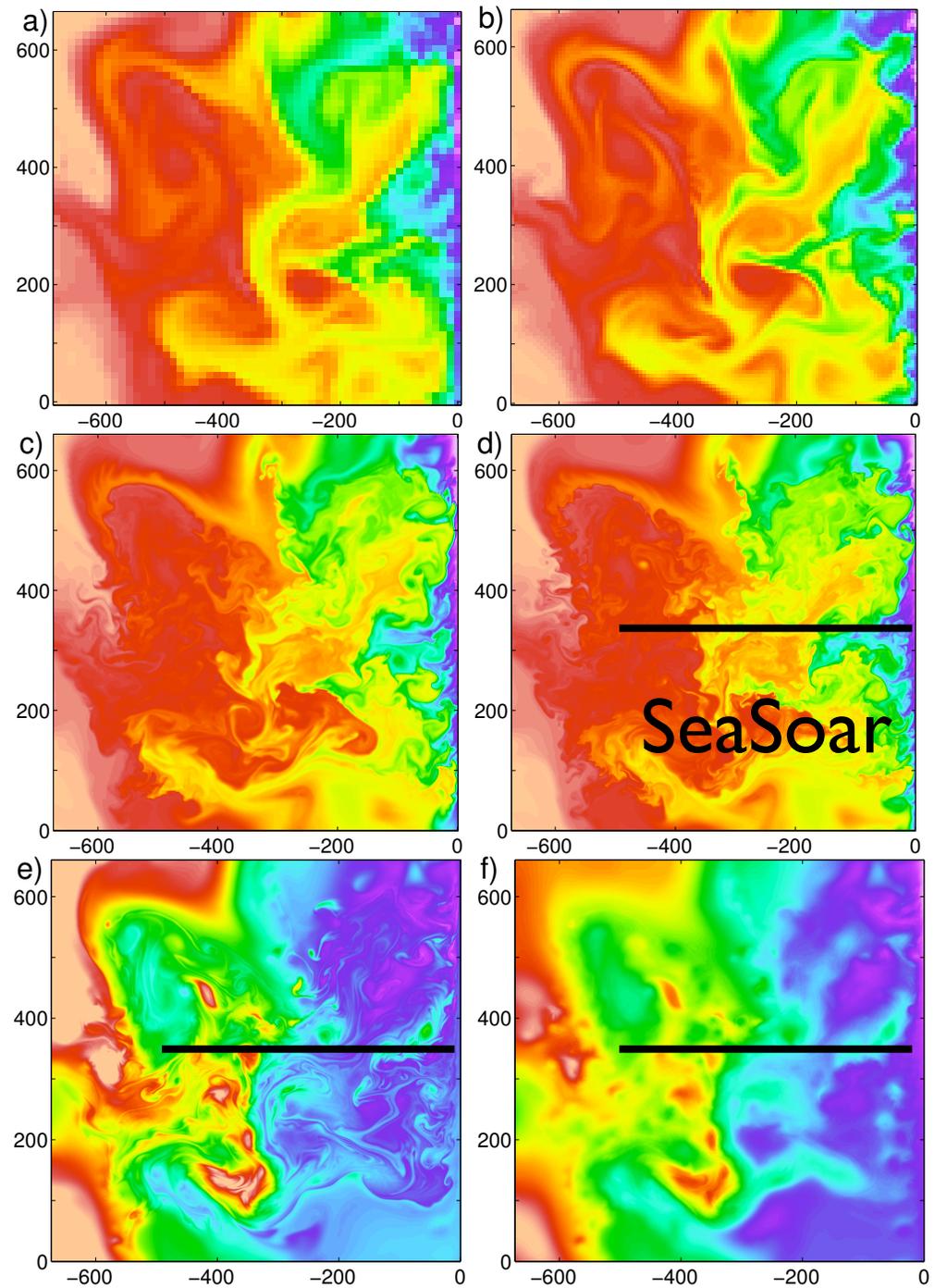
Submesoscale decay away from coast



Capet et al., 2006

Figure 3: Instantaneous $T(x, y)$ and $\rho(x, y)$ fields 30 d after ICC initialization: (a) T at 10 m depth in ICC12; (b) T at 10 m in ICC6; (c) T at 10 m in ICC1; (d) T at 10 m in ICC0; (e) T at 70 m in ICC0; (f) ρ at 70 m in ICC0. T ranges are 10 - 20° C at 10 m and 7.5 - 16.5° C at 70 m, and the ρ range is 1024 - 1026.2 kg m⁻³.

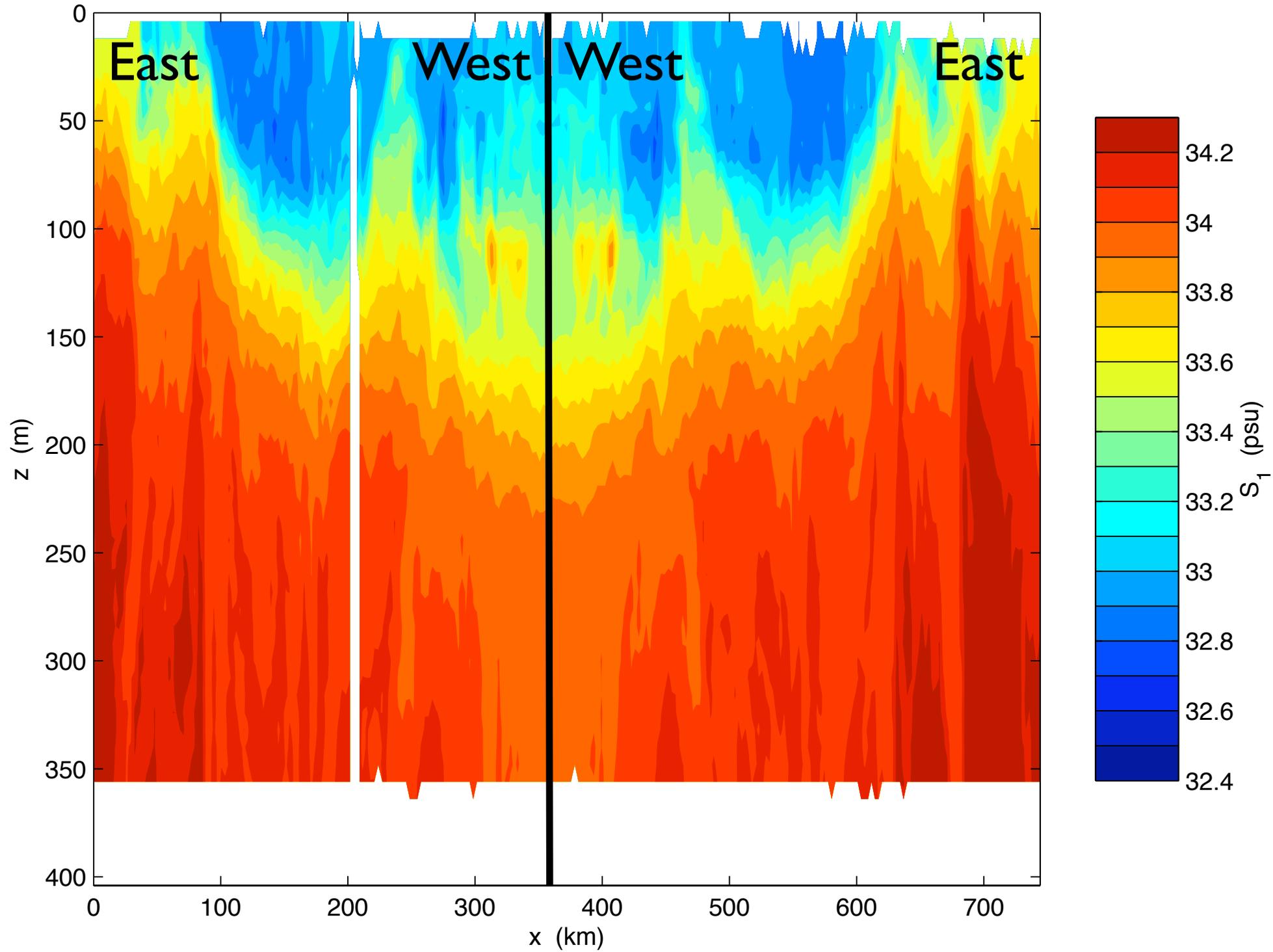
Submesoscale decay away from coast

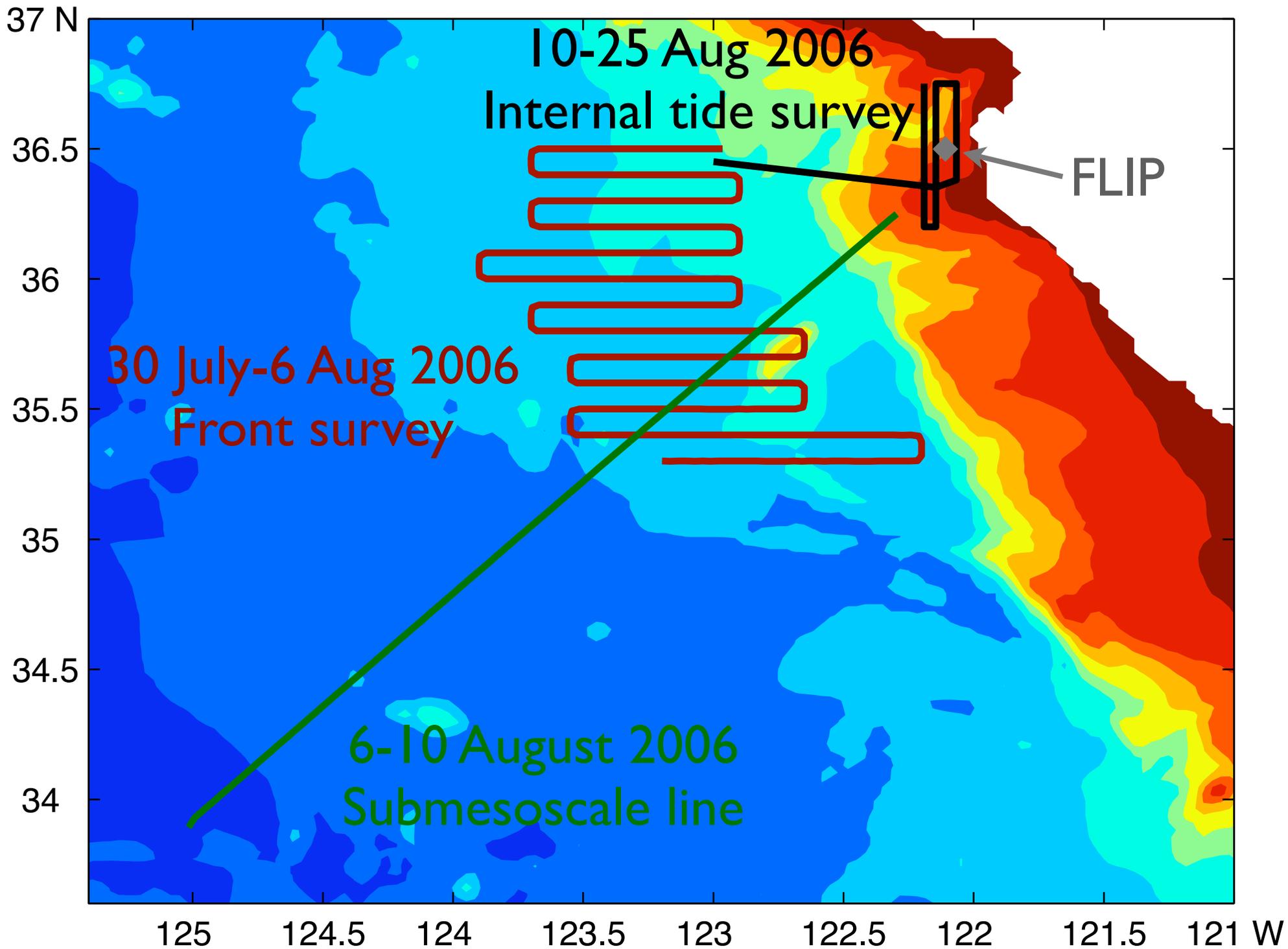


Capet et al., 2006

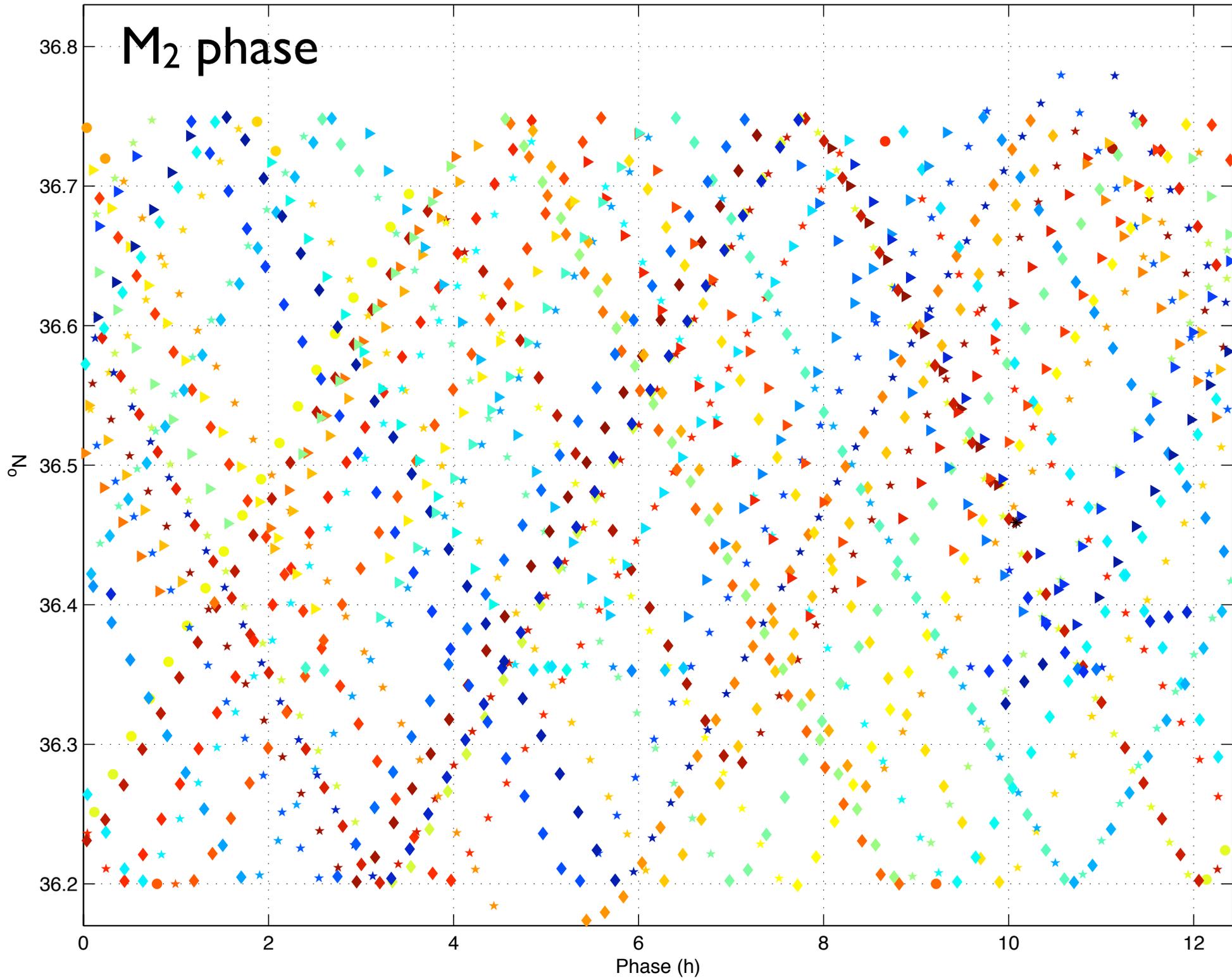
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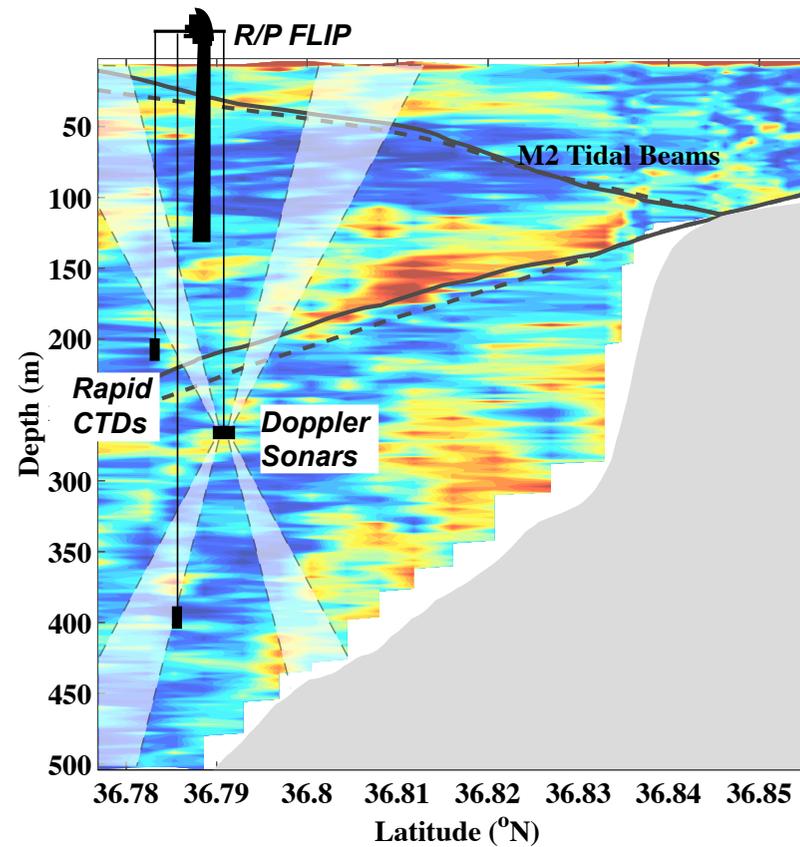
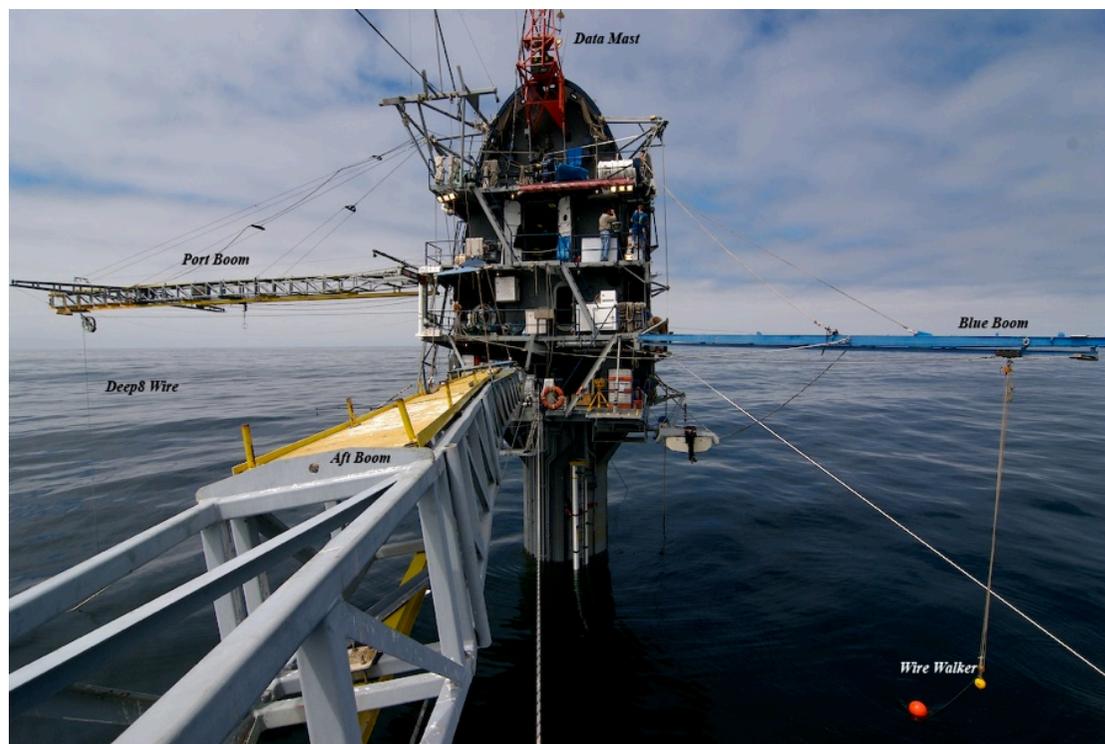
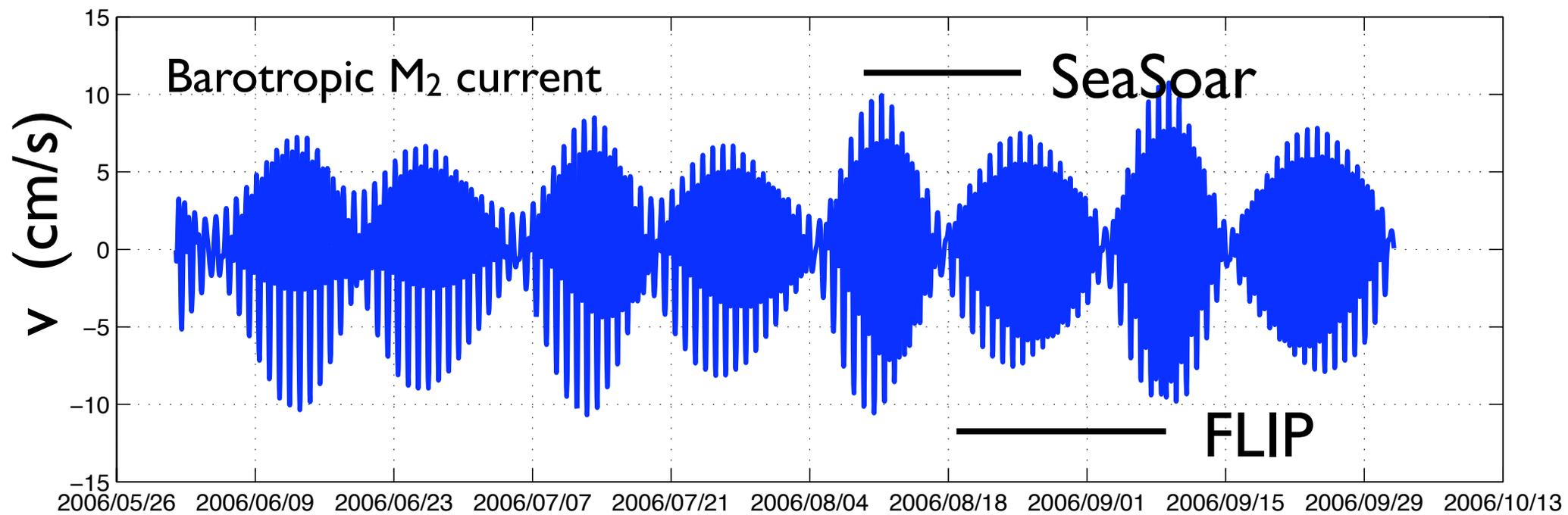
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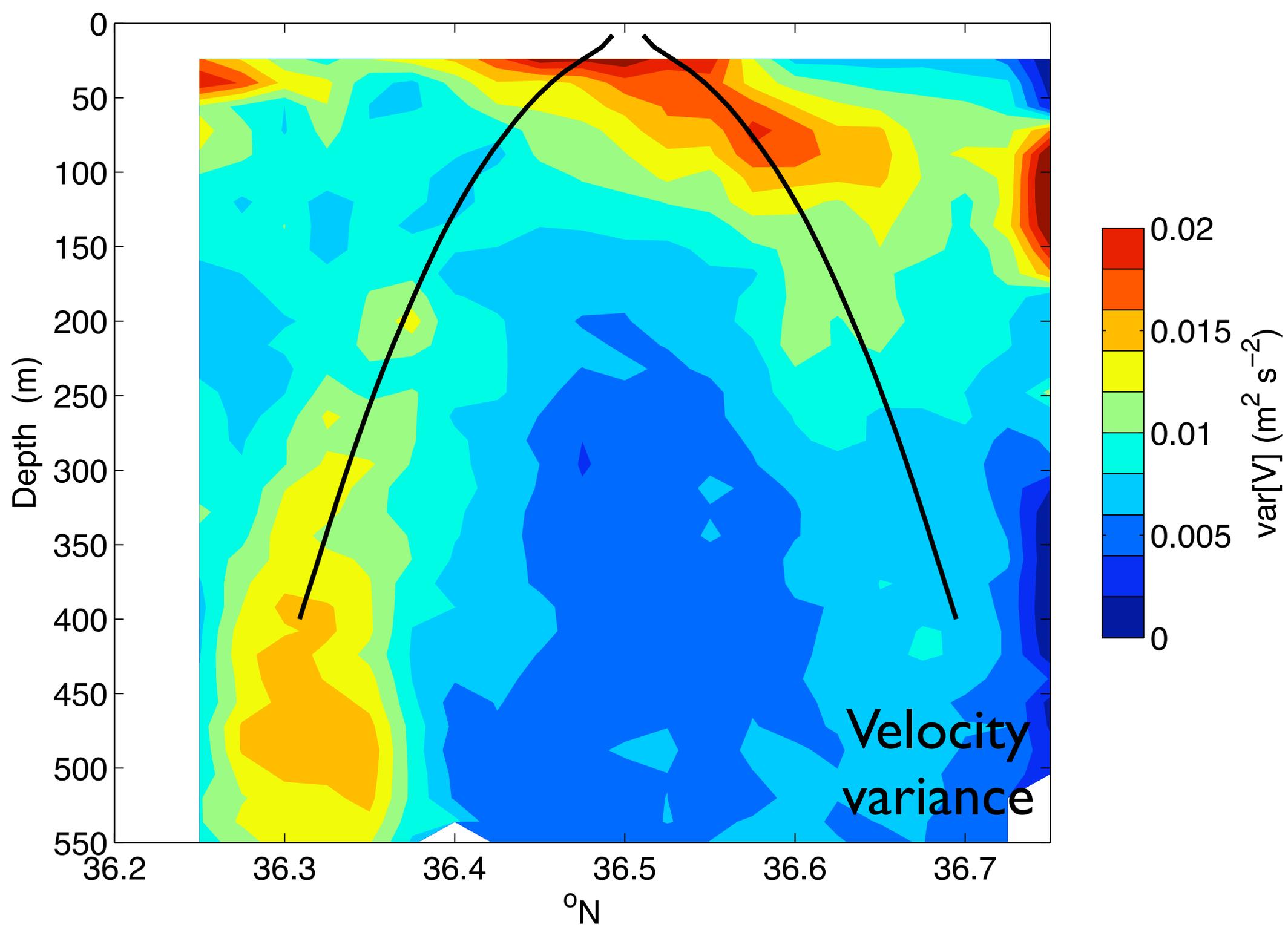


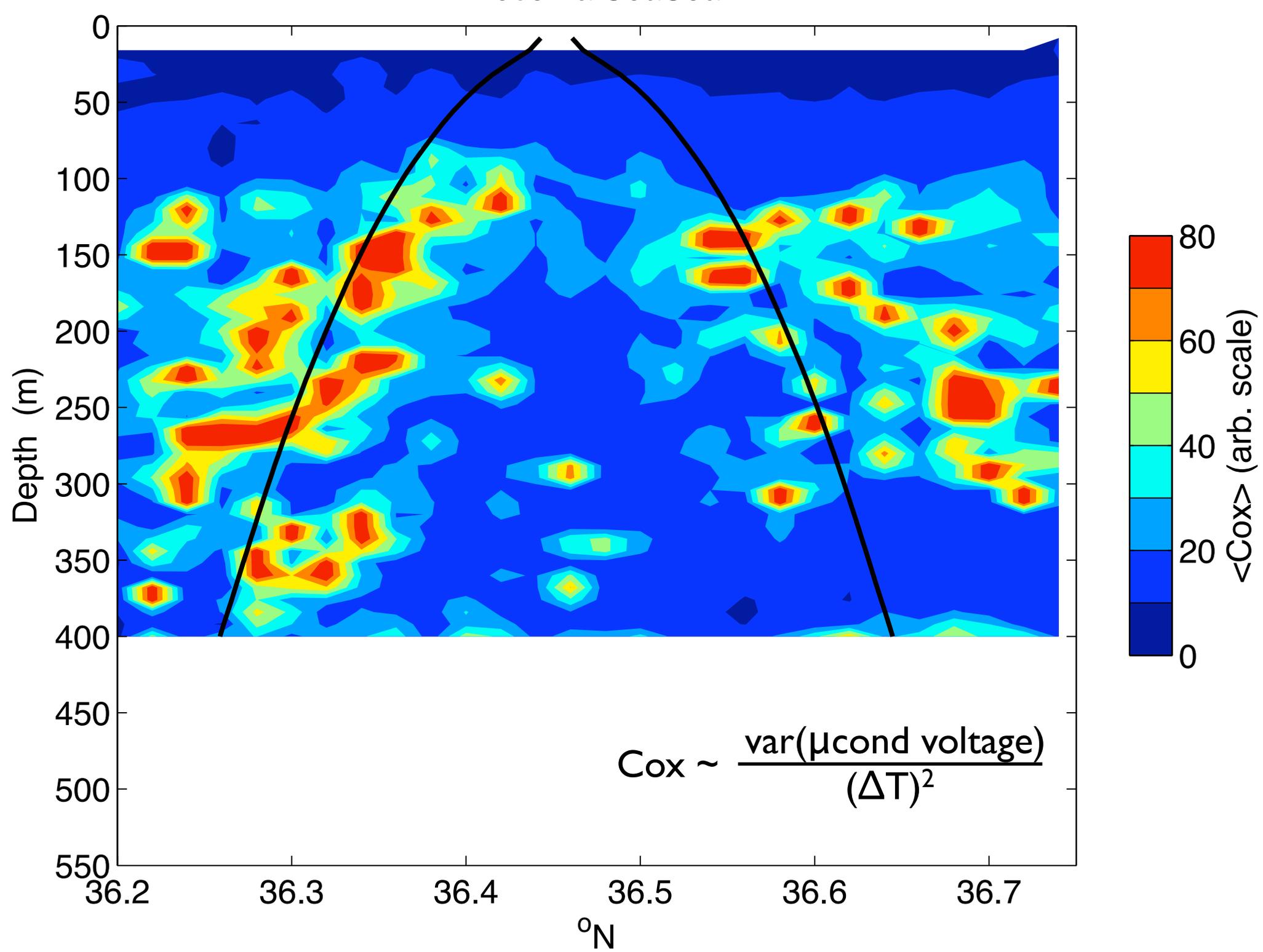


M₂ phase

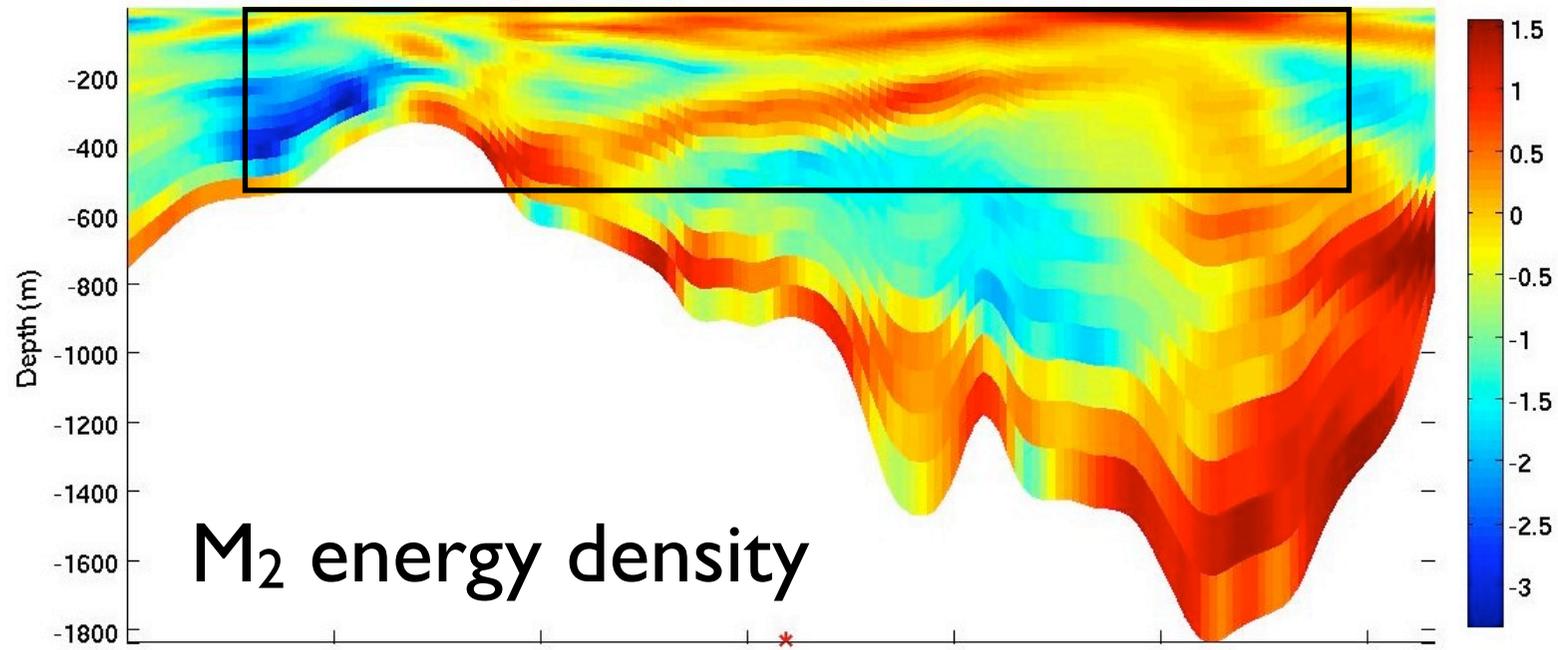




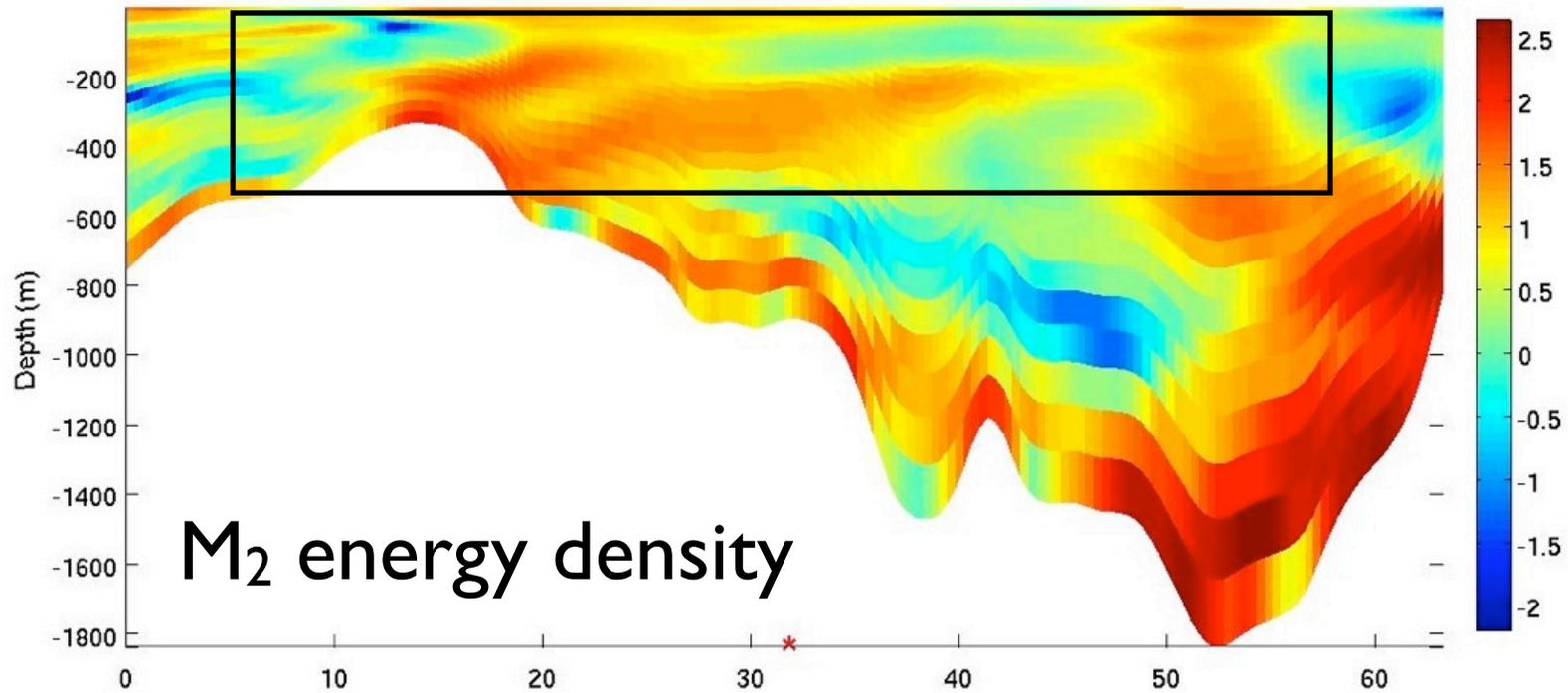




Energy density (log) for M2 (J/m**3) (600m) 2006080503

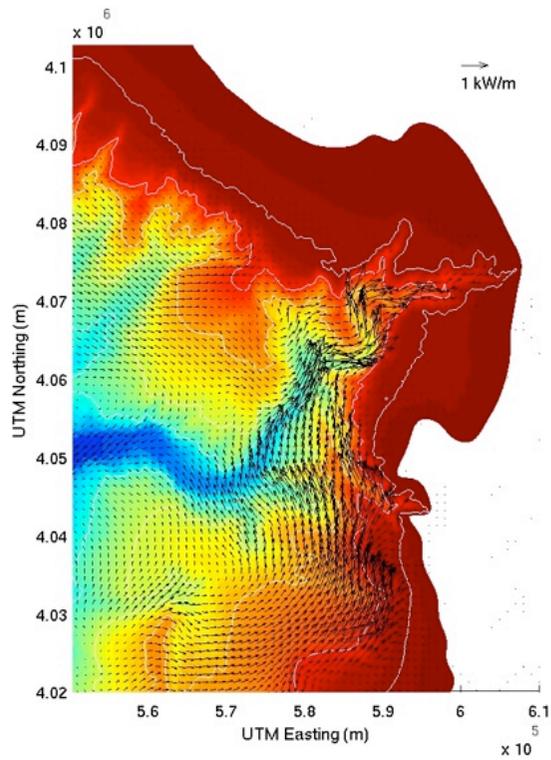


Energy density (log) for M2 (J/m**3) (600m) 2006080803



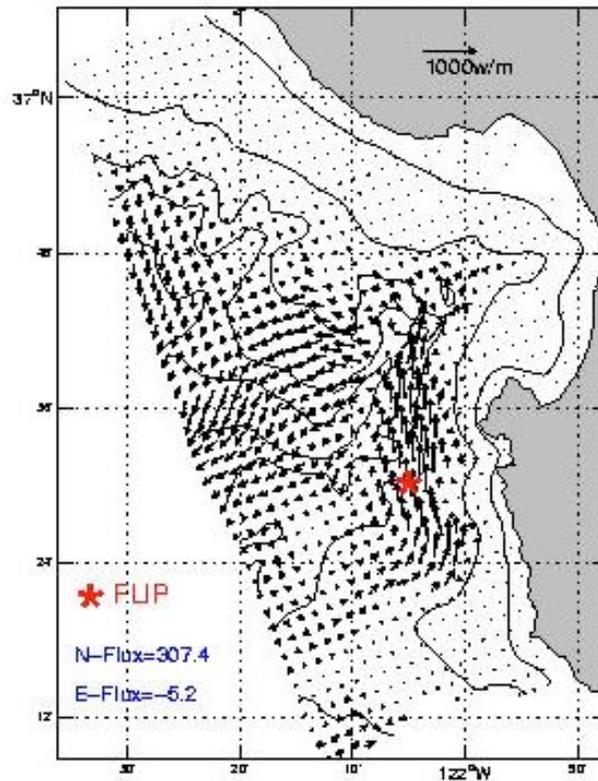
km from (36.2N -122.1W) Northward

M₂ baroclinic energy flux



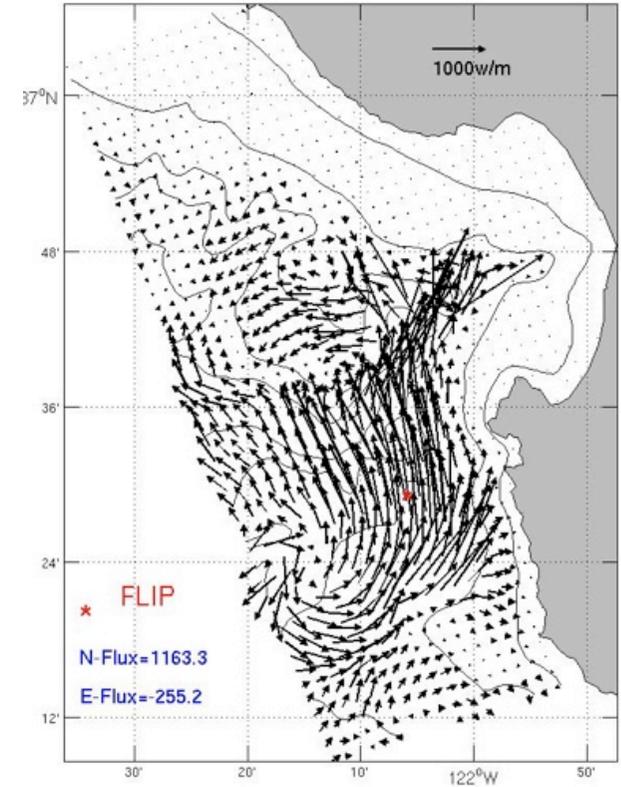
Jachec and Fringer

Depth Integrated Baroclinic Tide Energy Flux (2006080503) M2



Wang and Chao

Depth Integrated Baroclinic Tide Energy Flux (2006080803) M2



Preliminary results

- Enhanced mixing at front in shear zones between water masses along subducting isopycnal
- Tidal beams in velocity variance and Cox number

To do:

- Process data
- Determine w at front from quasigeostrophic omega equation
- Calculate Cox #
- Compare with turbulence parameterizations
- Calculate M_2 energy flux and density
- Collaborations with ASAP