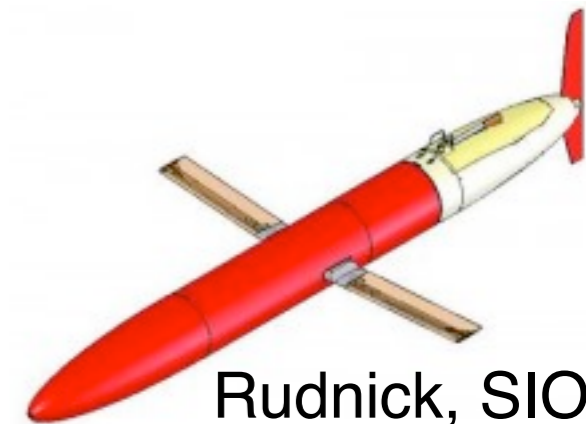
A red and white underwater glider is shown floating on the surface of the ocean. The glider has a long, slender body with a white central section and red sections at the ends. It has a red fin at the rear and a white sensor pod at the front. The number '142' is visible on the white section. The background is a deep blue ocean with gentle ripples.

Spray underwater glider operations off California and in the Gulf of Mexico

Dan Rudnick
Scripps Institution of Oceanography

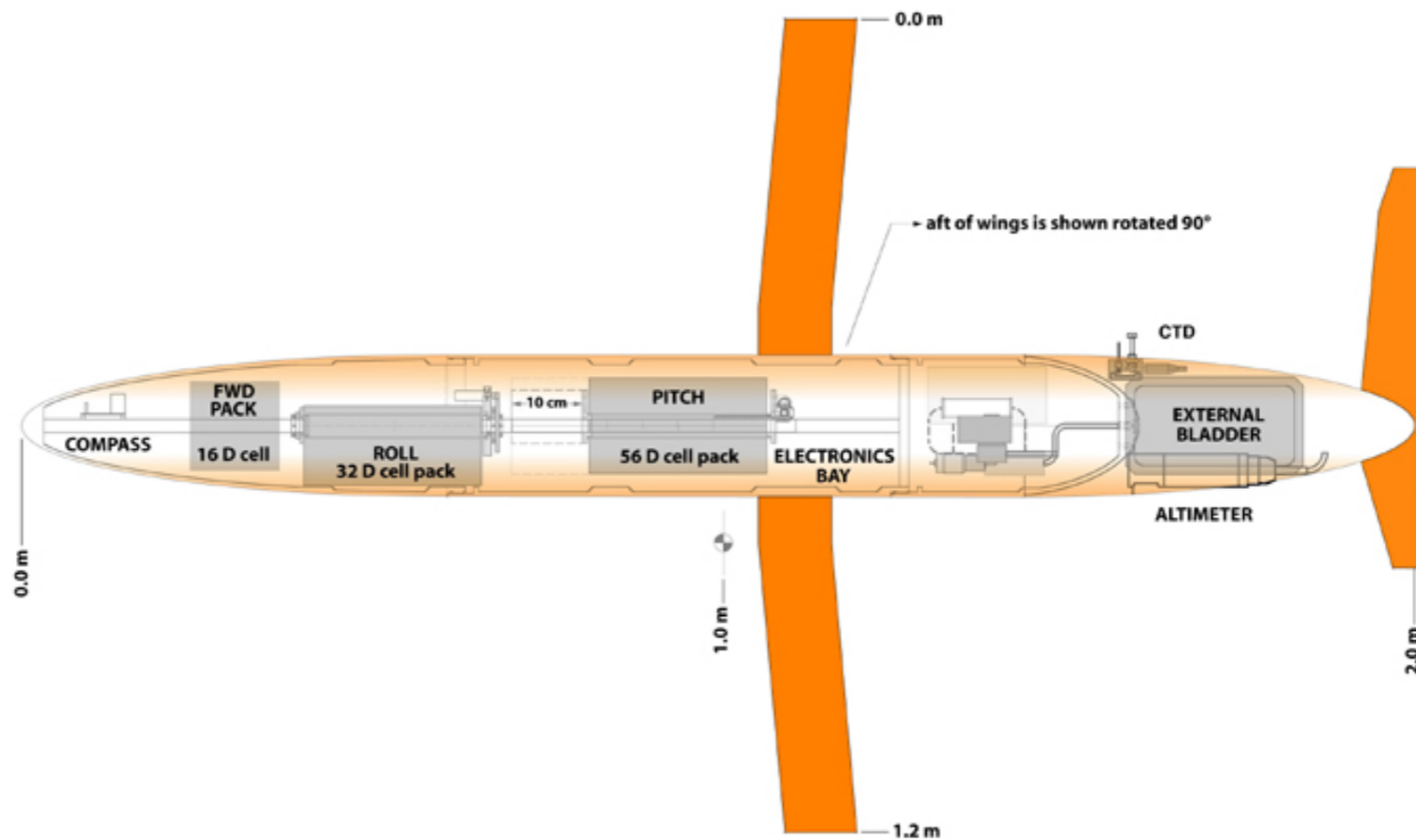
Introduction

- Spray underwater glider
- Worldwide operations
- Results from California
- Results from the Gulf of Mexico

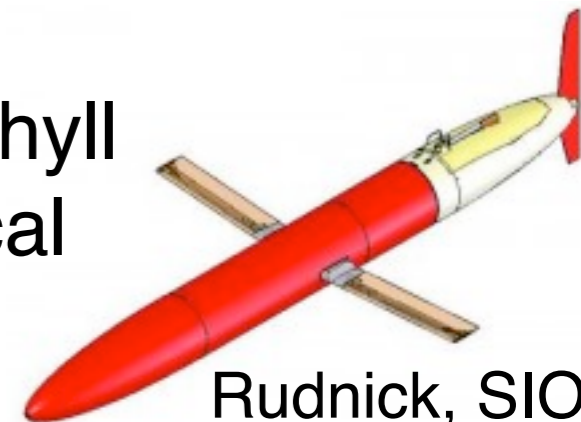


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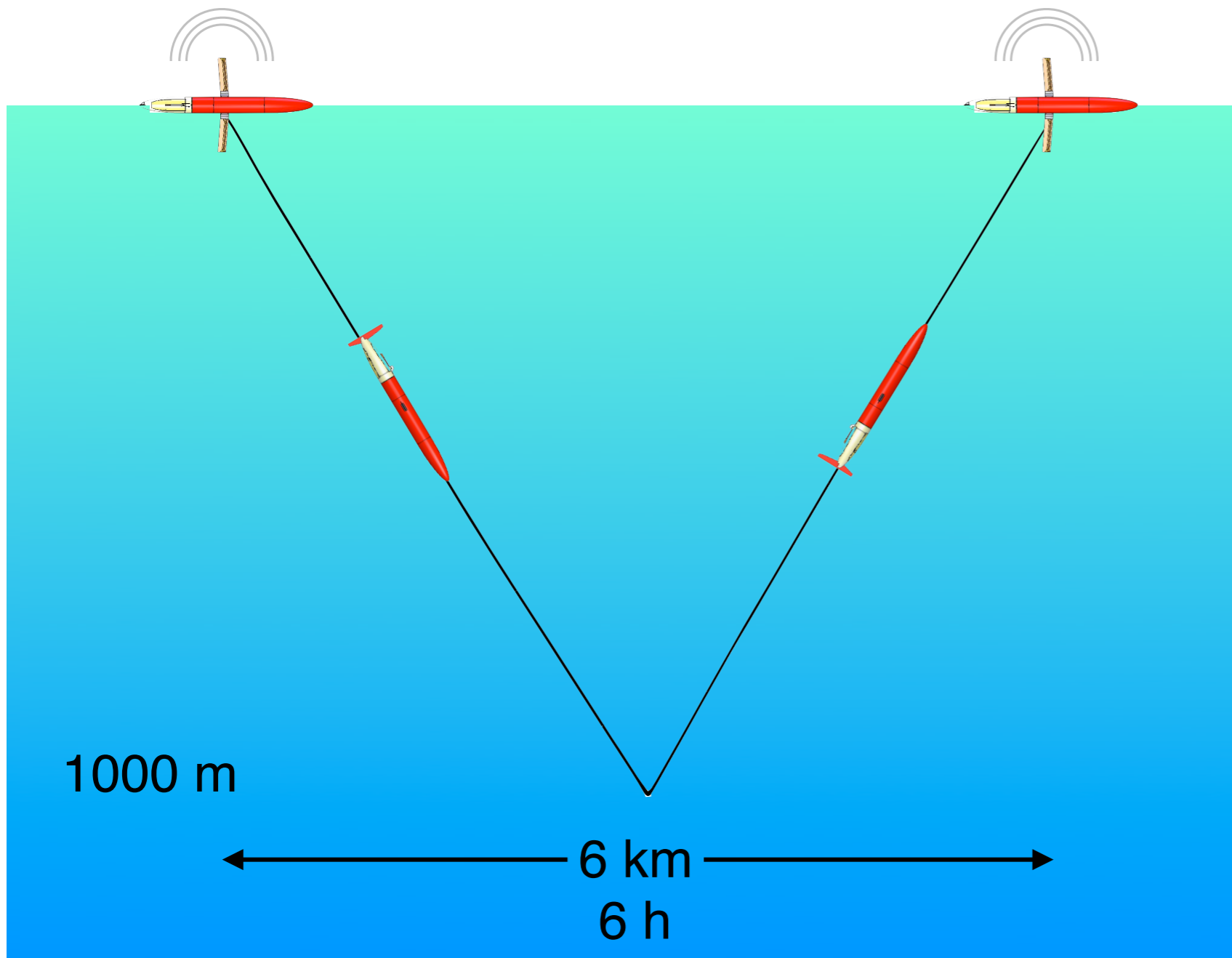
Spray underwater glider



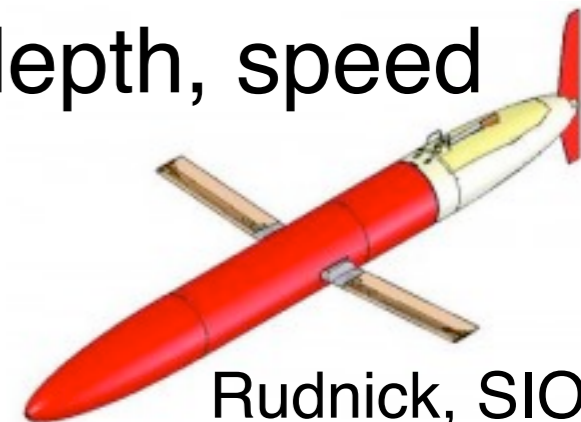
- Weight: 50 kg, Length: 2 m, wingspan: 1 m
- Profiles by changing buoyancy
- Steers by changing center of mass
- 2-way Iridium communication
- GPS navigation
- Pressure, temperature, salinity, velocity, chlorophyll fluorescence, acoustic backscatter, nitrate, optical backscatter, dissolved oxygen, ...



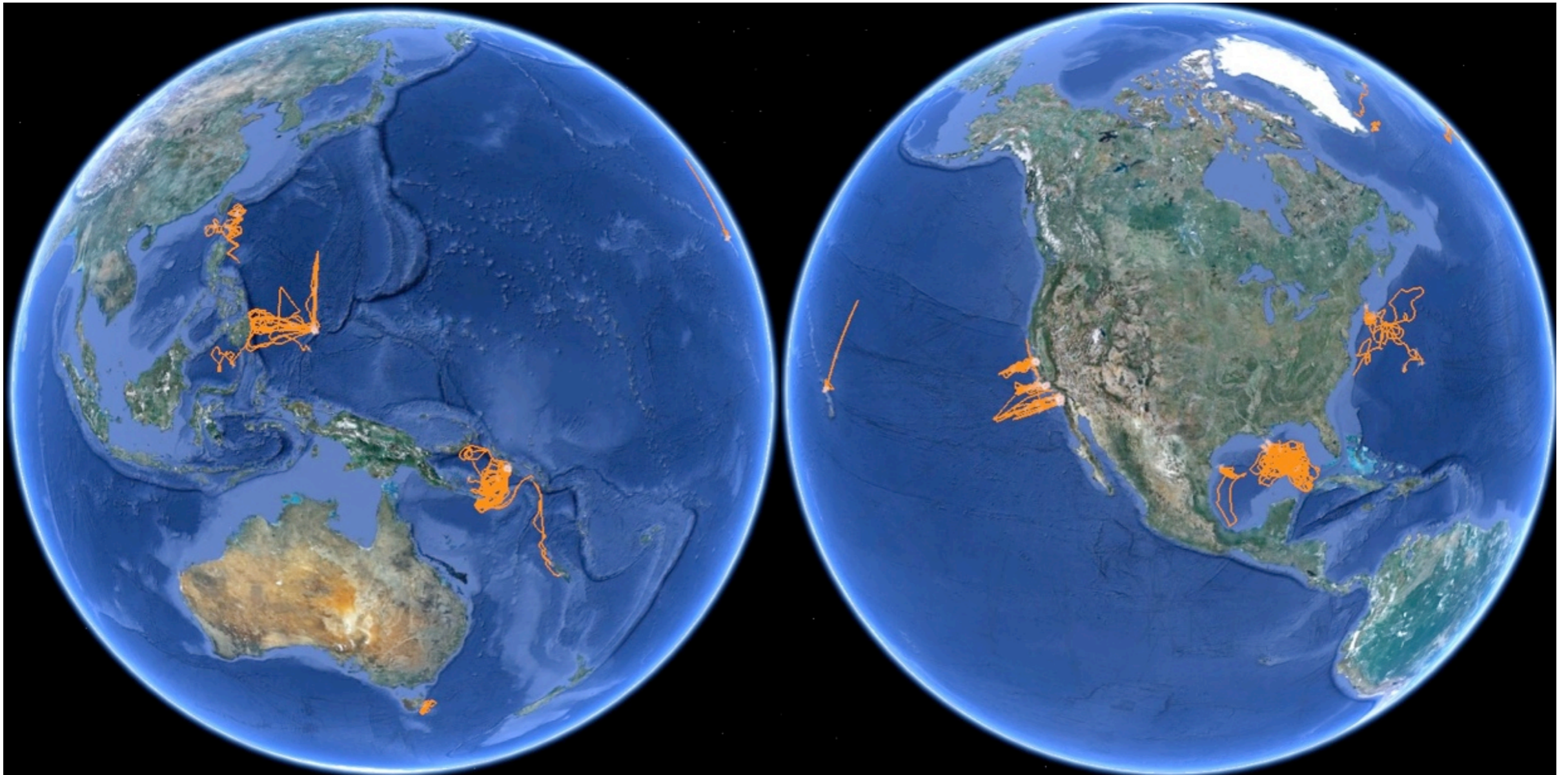
Glider operations



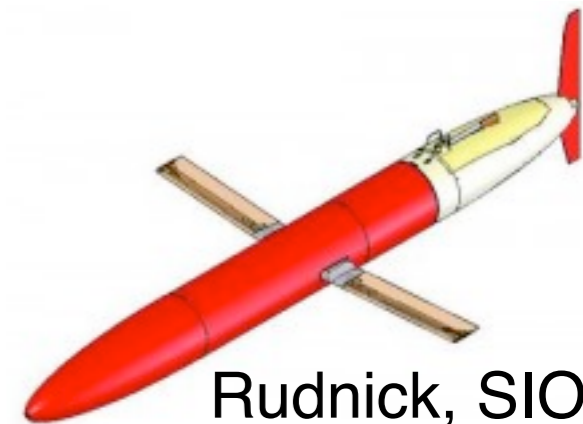
- Cycle 0-1000 m, 6 km, 6 h
- Horizontal velocity: 0.25 m/s
- Vertical velocity: 0.1 m/s
- Typical duration: 3-5 months
- Endurance depends on sensor suite, stratification, dive depth, speed



Worldwide operations



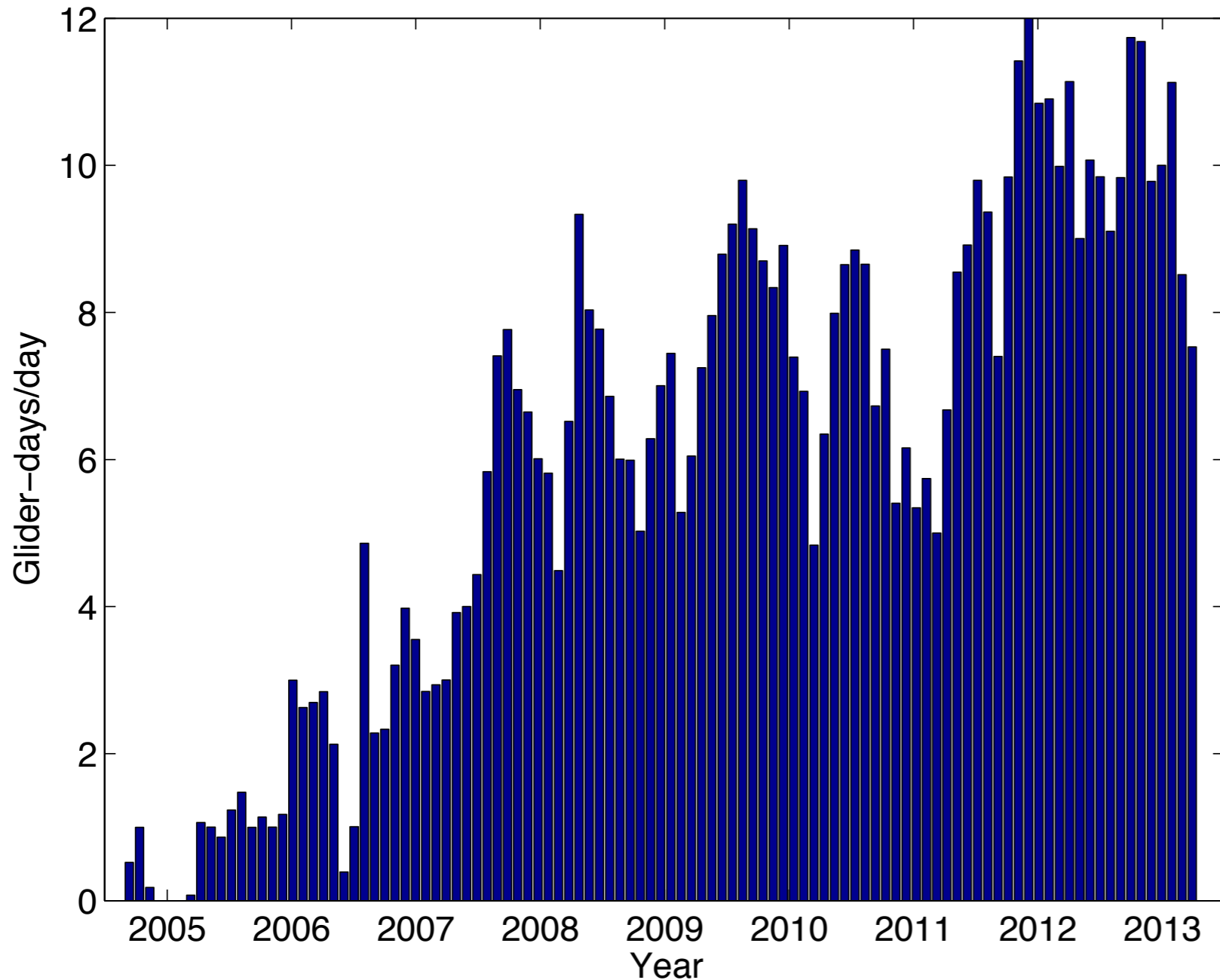
- Over 50 glider years
- Nearly 400,000 km covered



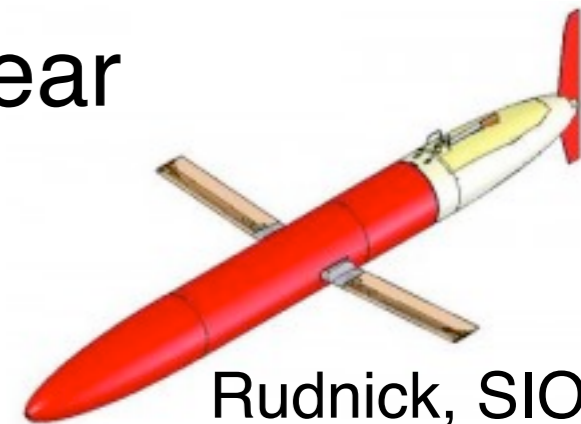
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A growing enterprise

Spray operations



- Glider-days/day in 30-day averages
- Improving ability to sustain glider observations
- Averaging 10 gliders in the water over the last year



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California Glider Network



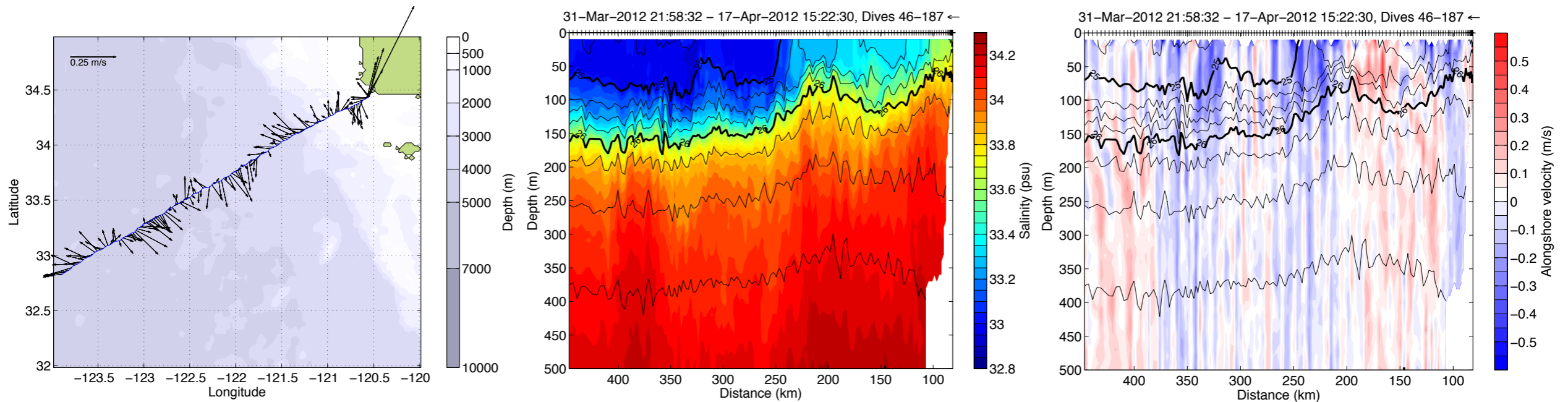
Southern California Coastal Ocean Observing System (SCCOOS)
Central and Northern California Ocean Observing System (CeNCOOS)

- Spray underwater gliders are part of a system to observe regional effects of climate variability
- Sustained since 2006
- Sections repeated every 3 weeks
- 6788 days
- 139,862 km over ground
- 152,516 km through water
- 62,645 dives

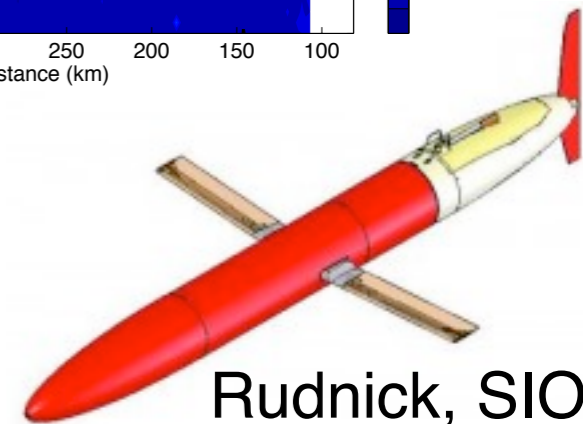
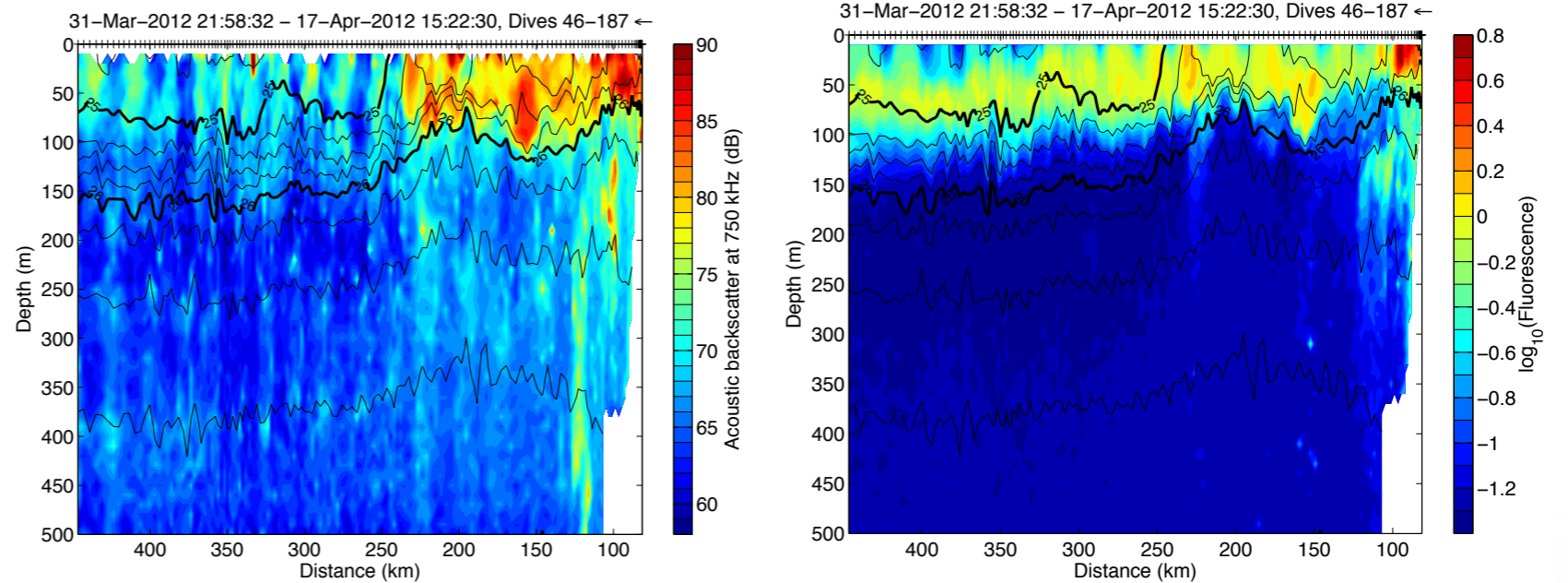


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Sections on CalCOFI line 80

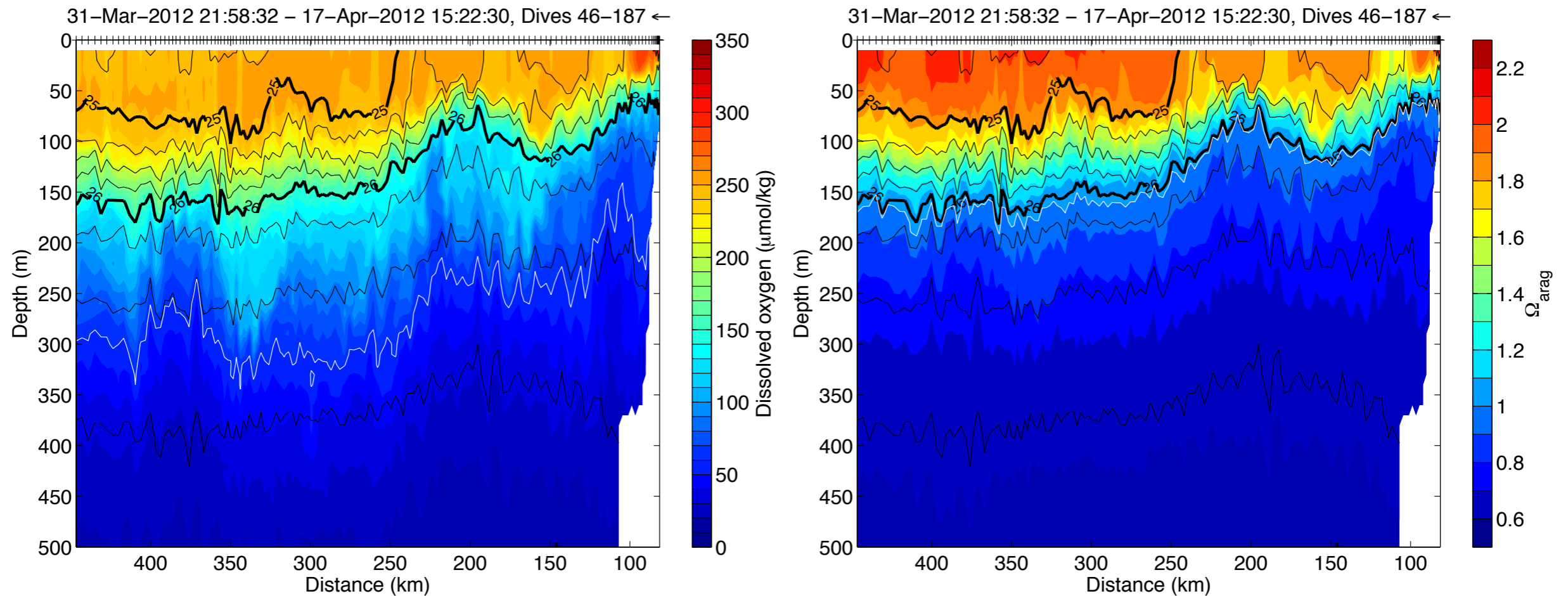


- 31 Mar - 17 Apr, 2012
- Depth-average velocity
- Salinity
- Along-shore velocity
- Acoustic backscatter
- Chlorophyll fluorescence

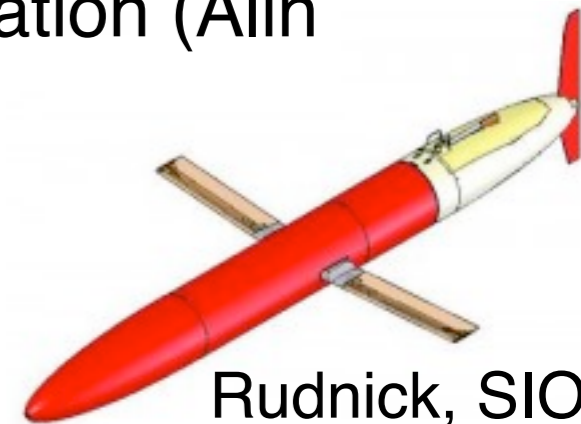


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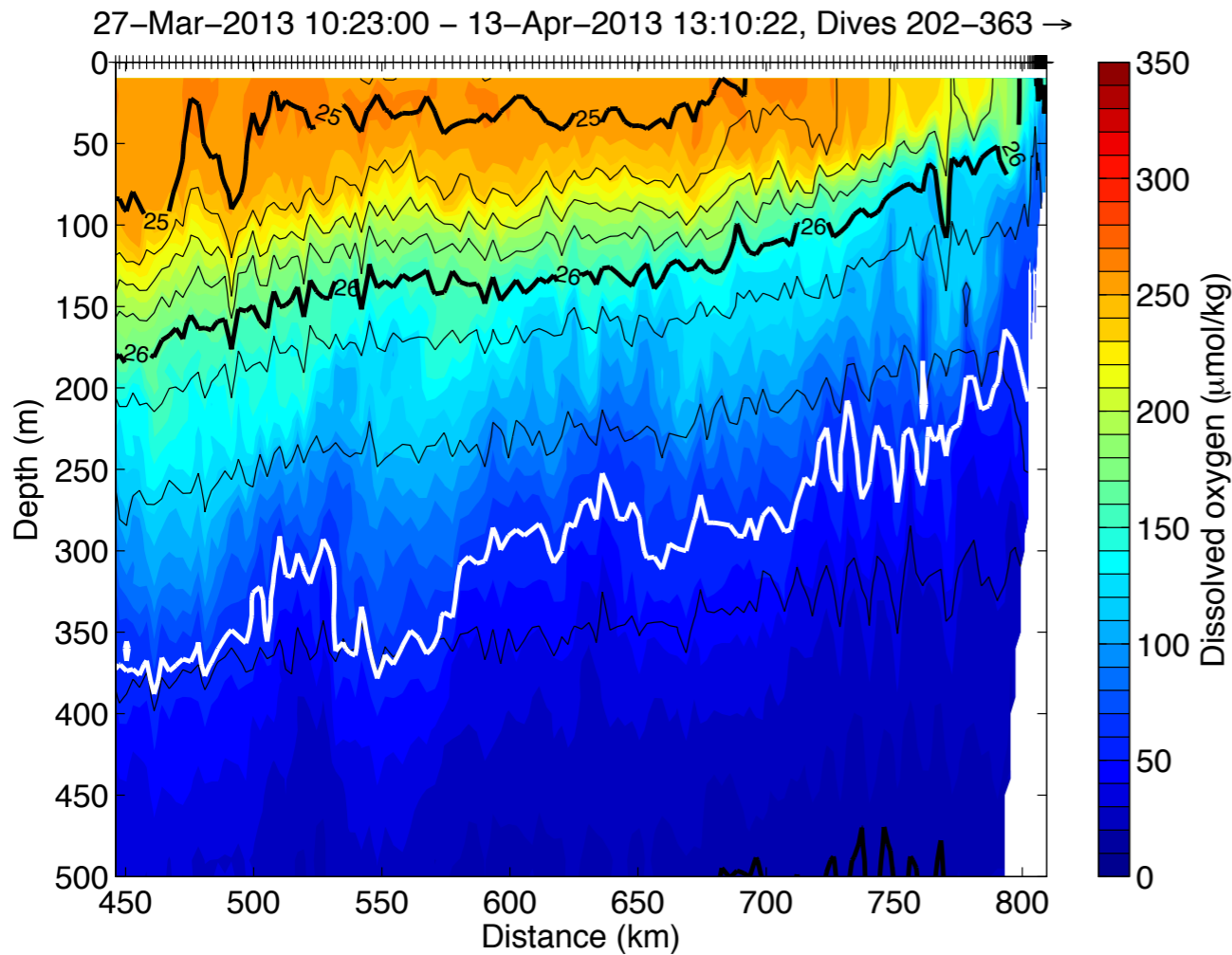
Dissolved oxygen and ocean acidification



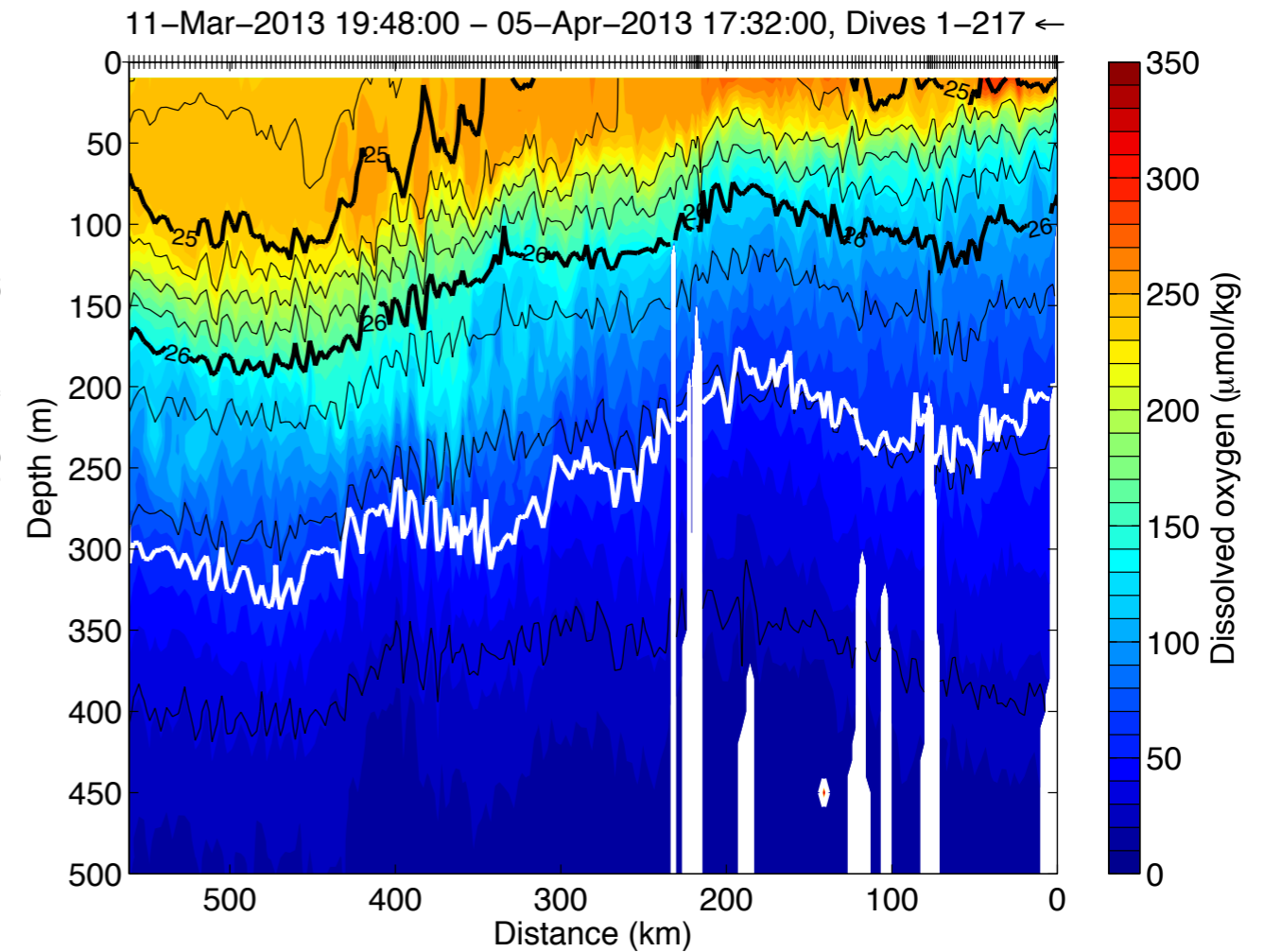
- Upwelling causes hypoxic, corrosive water to shoal near the coast
- Using a proxy relationship to derive aragonite saturation (Alin et al. 2012)
- pH sensors will soon be available



Ongoing observations of dissolved oxygen

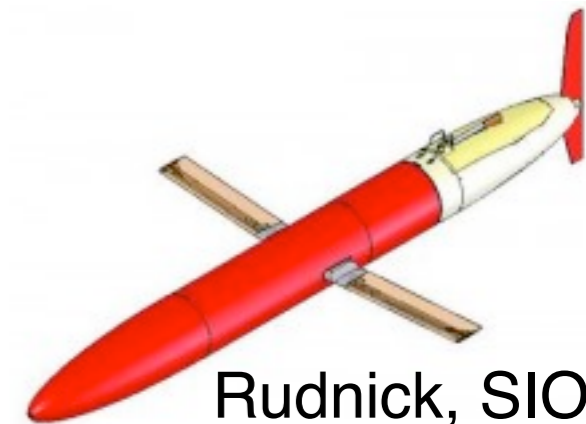


Line 80, SBE 63

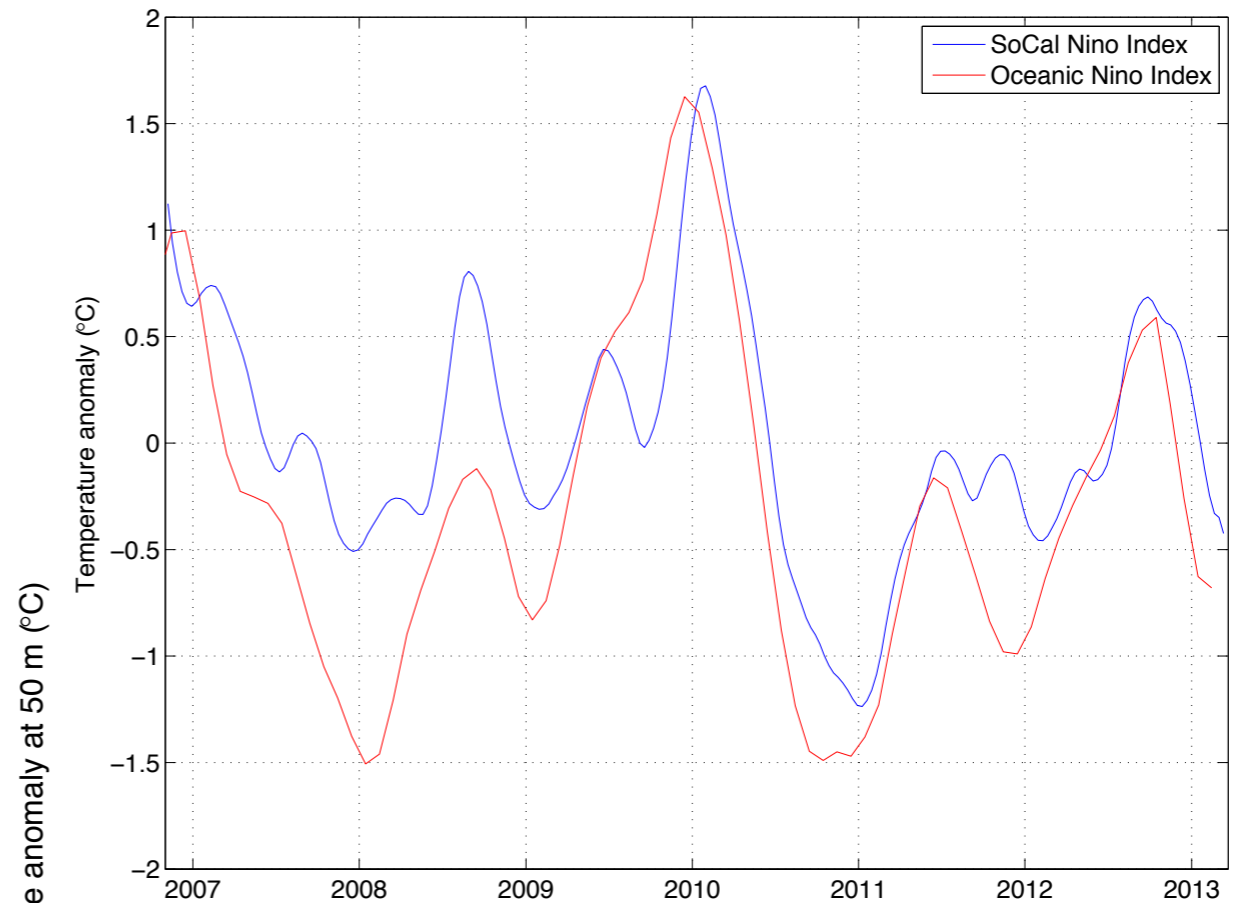
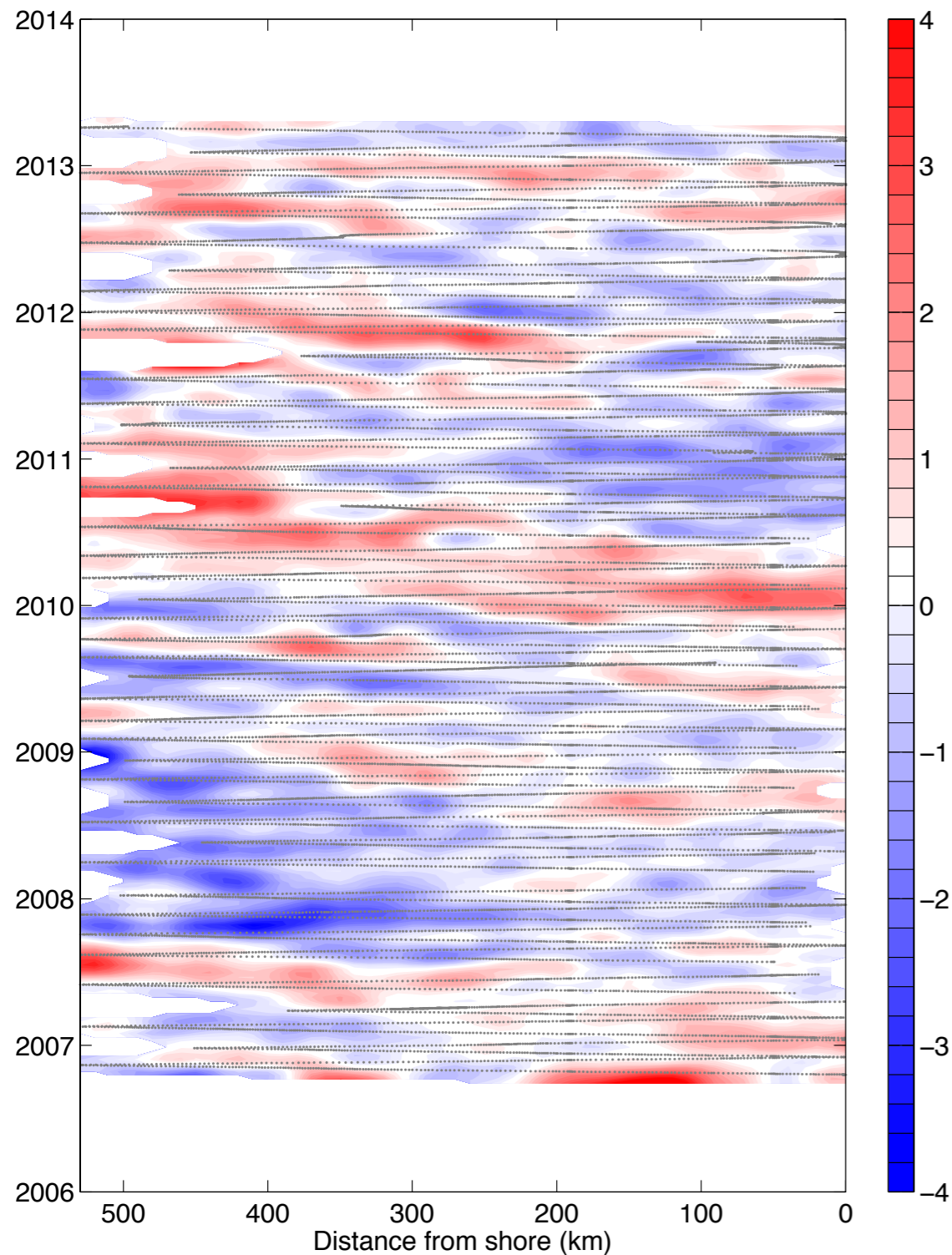


Line 90, SBE 43

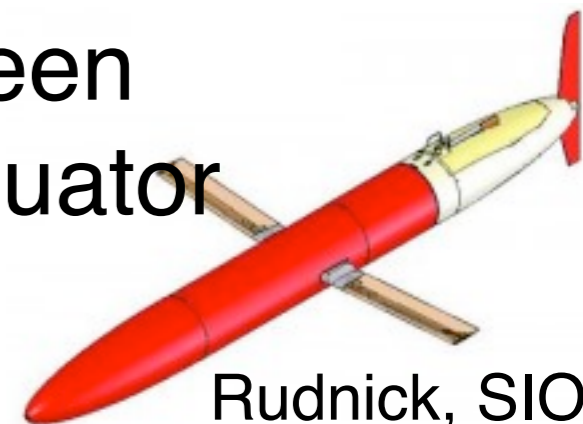
- Evaluating two Sea-Bird sensors
- Calibrate by profiling next to CalCOFI stations
- Posted in real time to SCCOOS.org



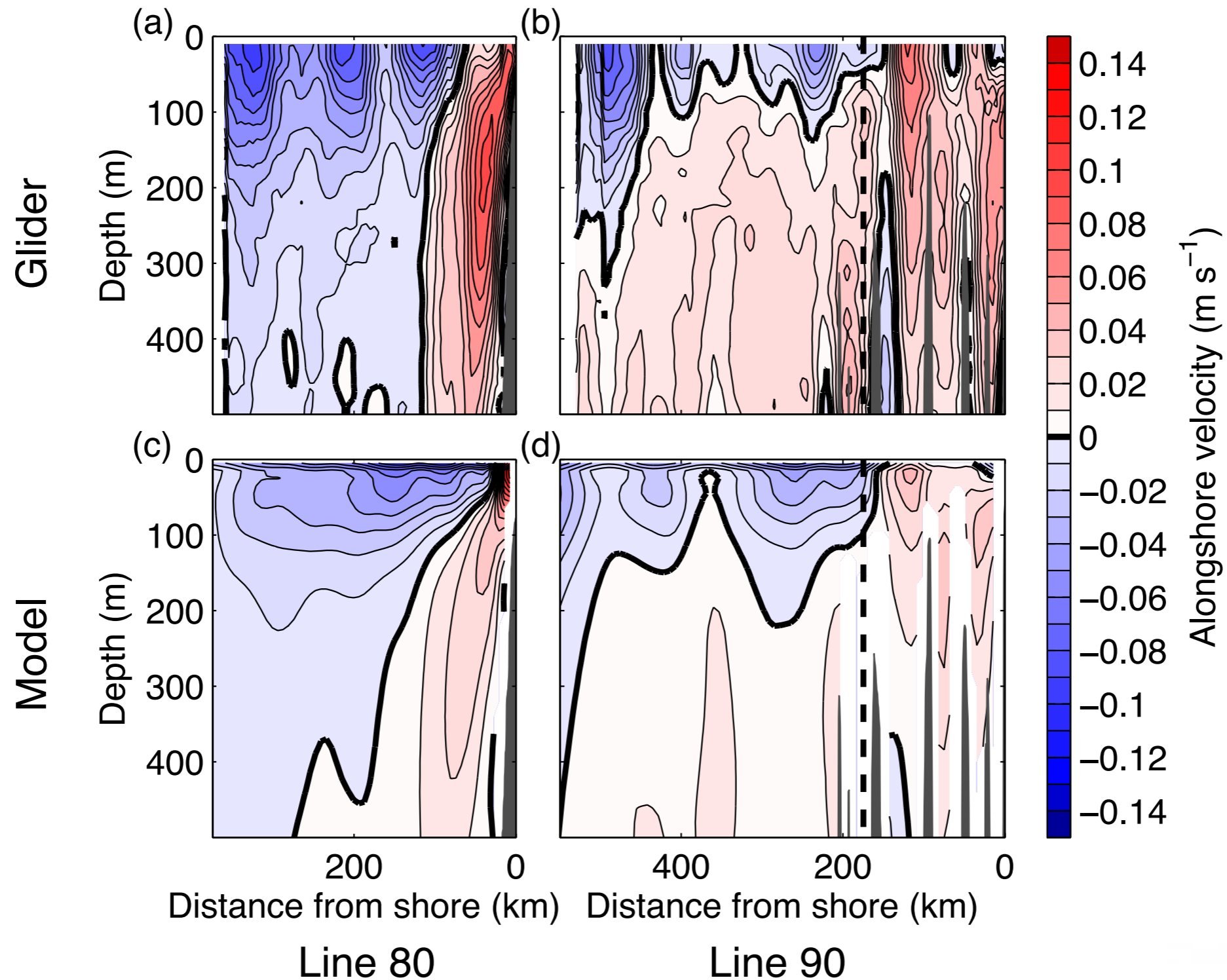
The SoCal Niño Index



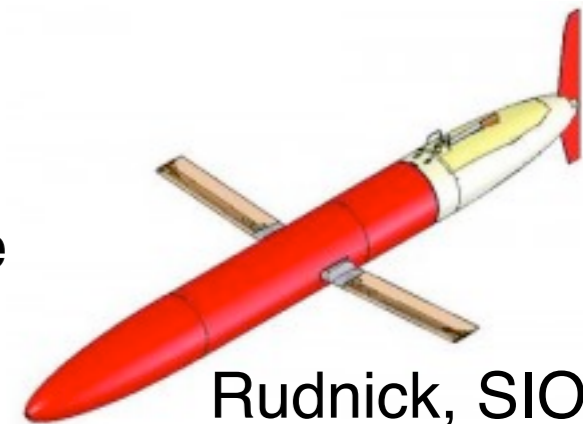
- Temperature anomaly at 50 m
- Correlation between California and equator



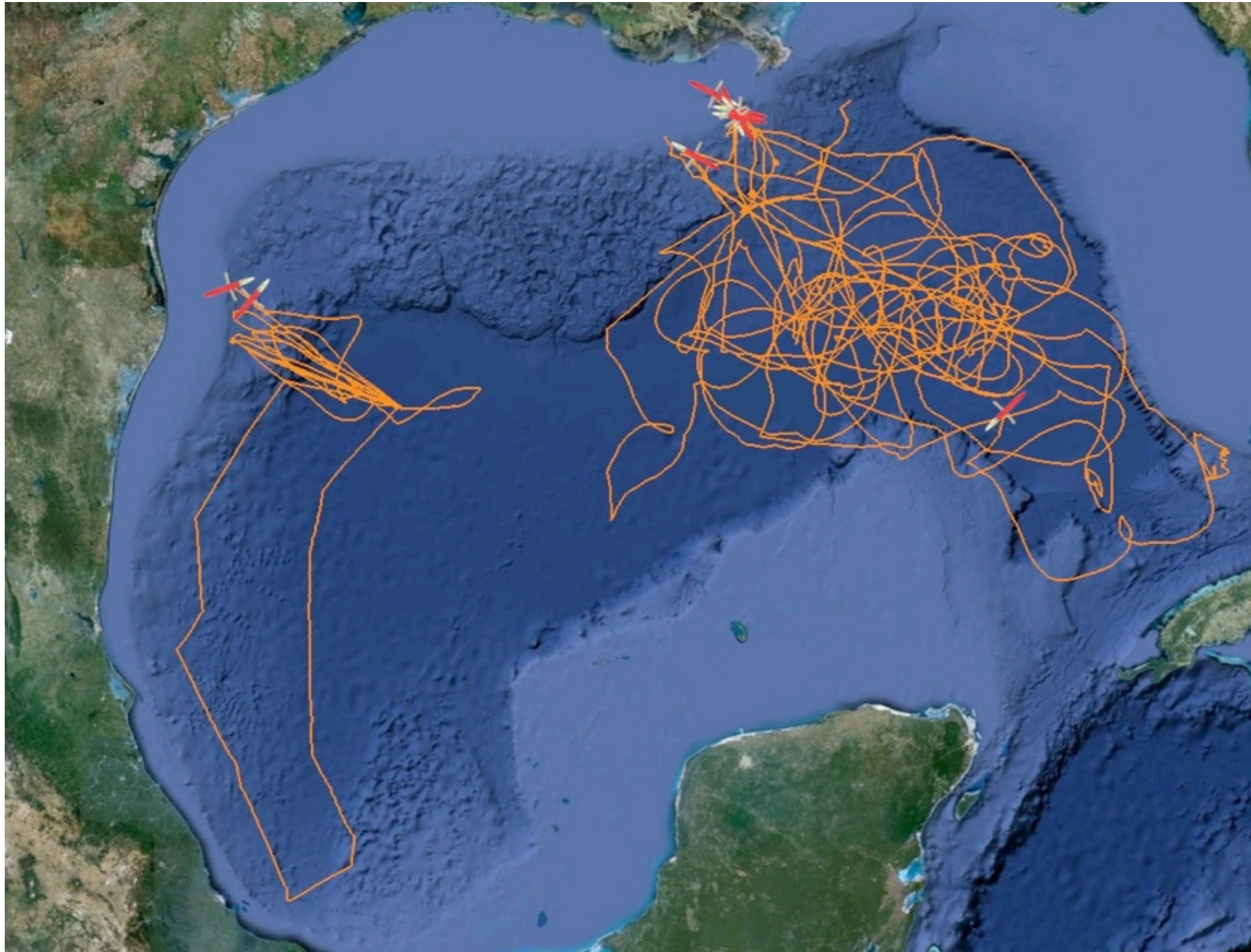
Mean alongshore velocity from glider and model



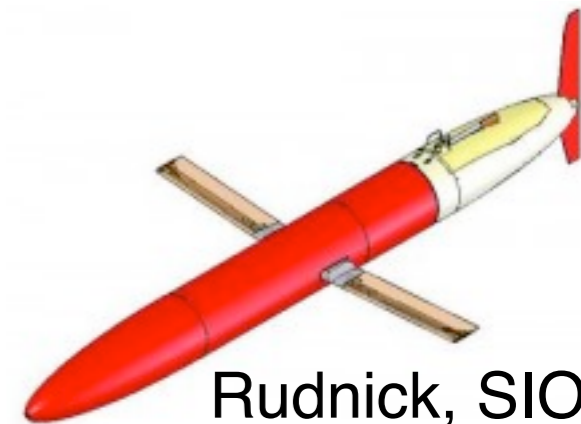
- Undercurrent apparent in cores of poleward flow
- California current is broad equatorward flow offshore near surface
- Remarkable agreement between data and model



GoM missions 2010-2013

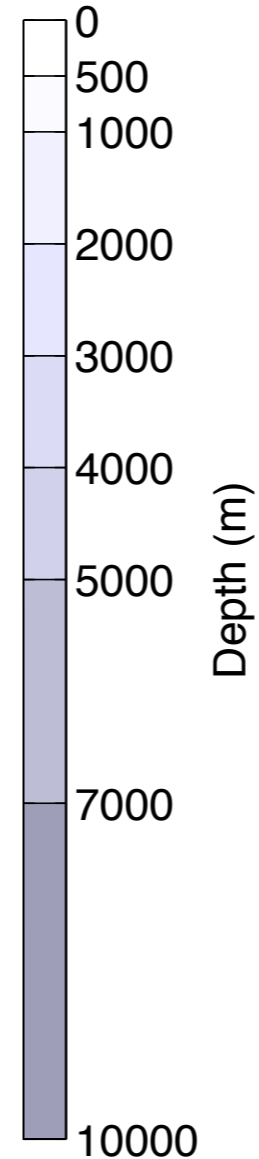
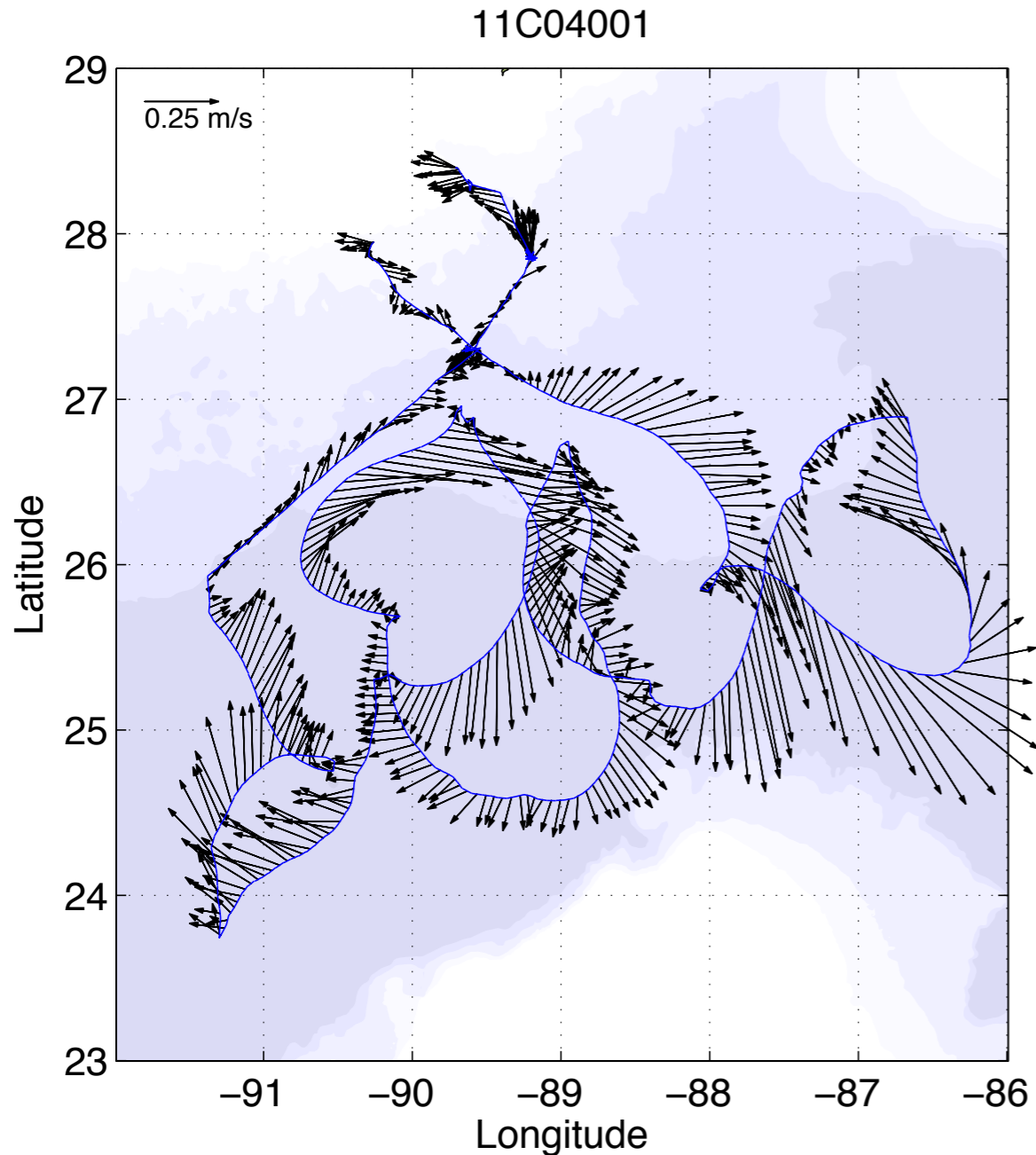


- 1128 days
- 28995 km over ground
- 25744 km through water
- 5480 dives

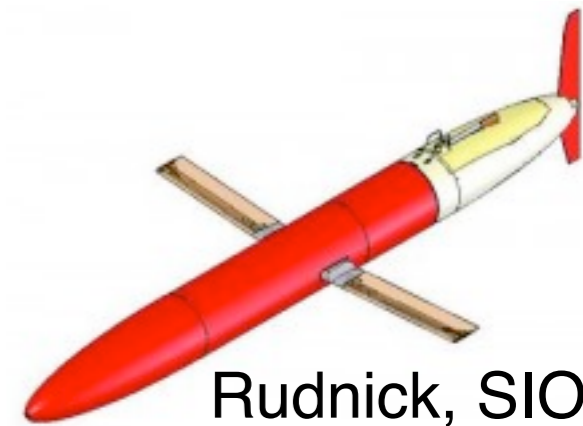


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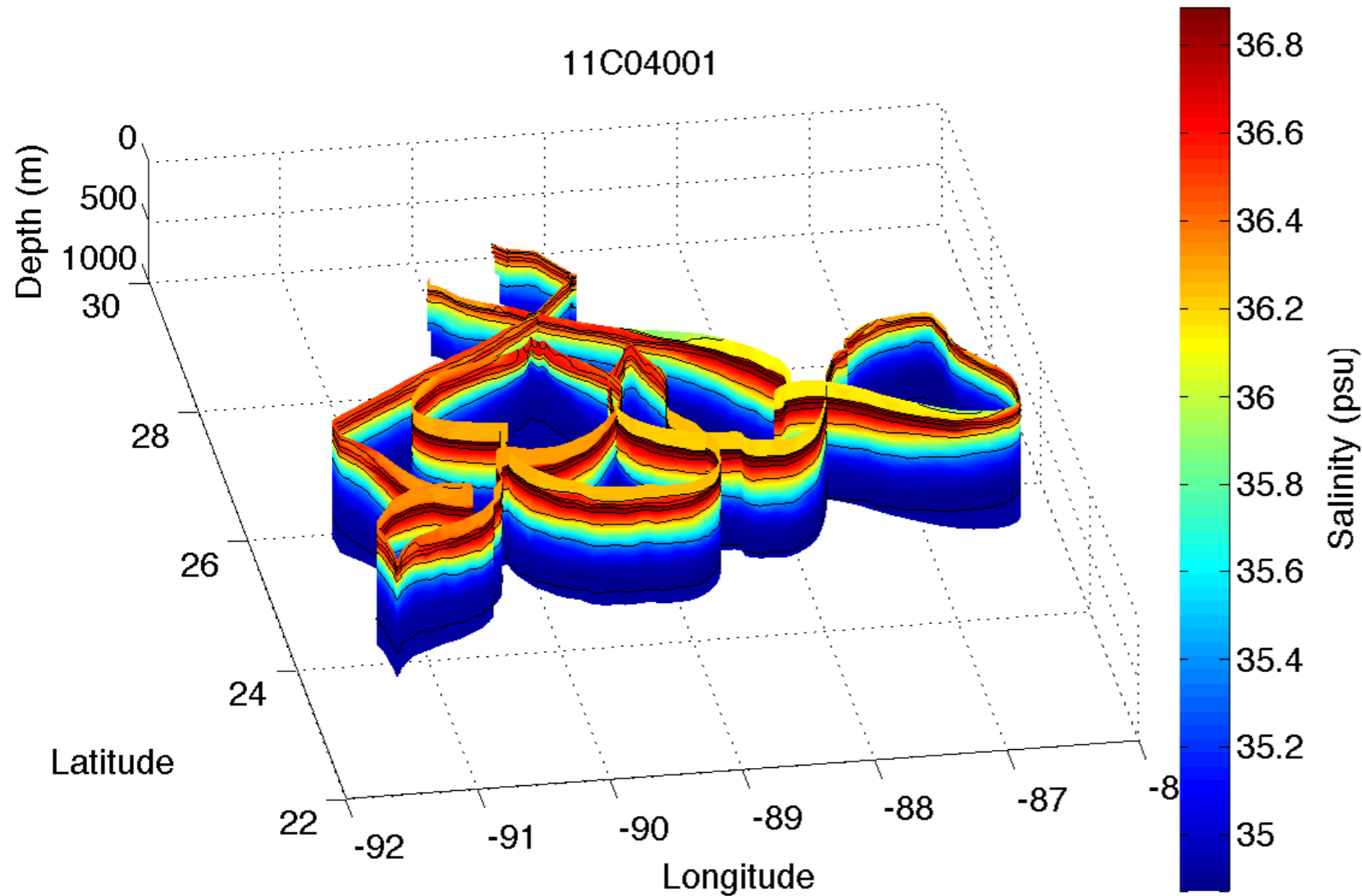
Depth-average current



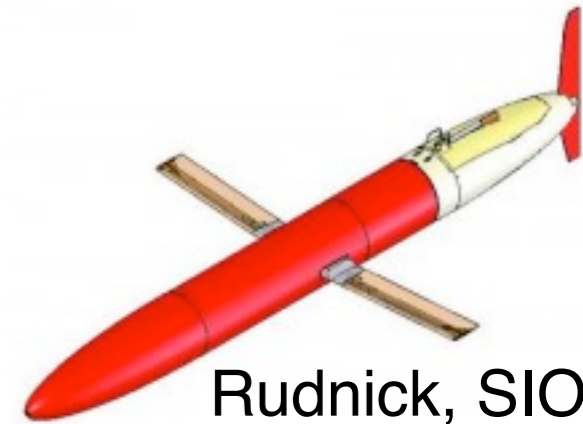
- Anticyclonic Loop Current Eddy
- Cyclonic eddy



Salinity

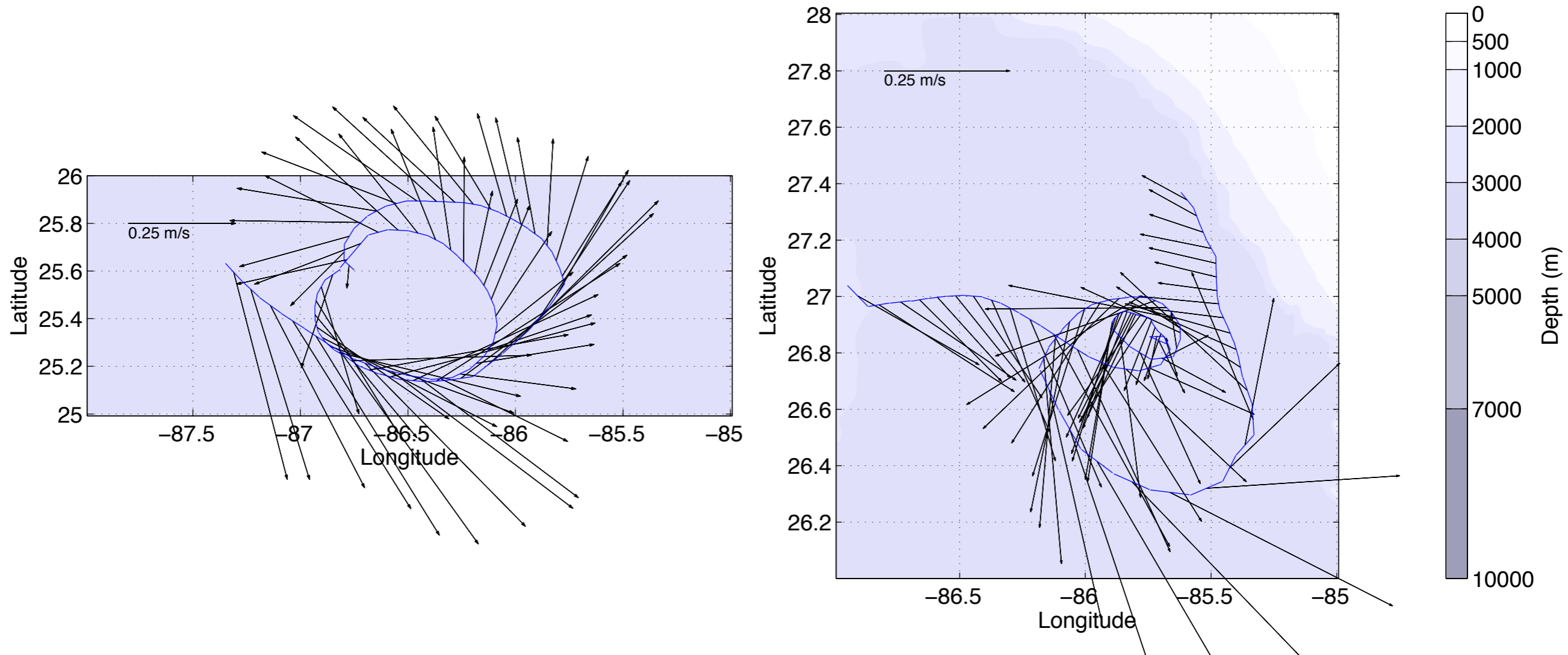


- Sequence of profiles shown as a curtain
- Loop current eddy marked by subsurface high in salinity

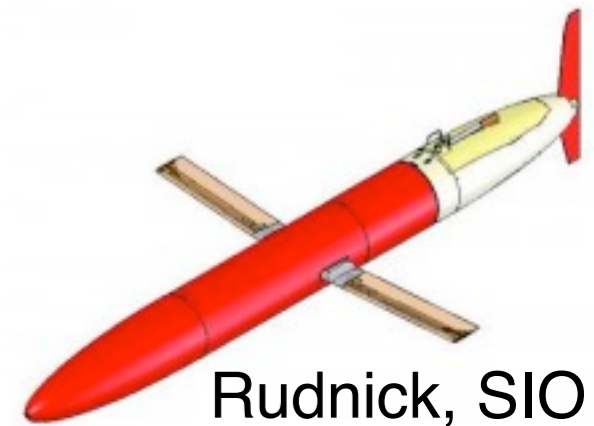


Rudnick, SIO

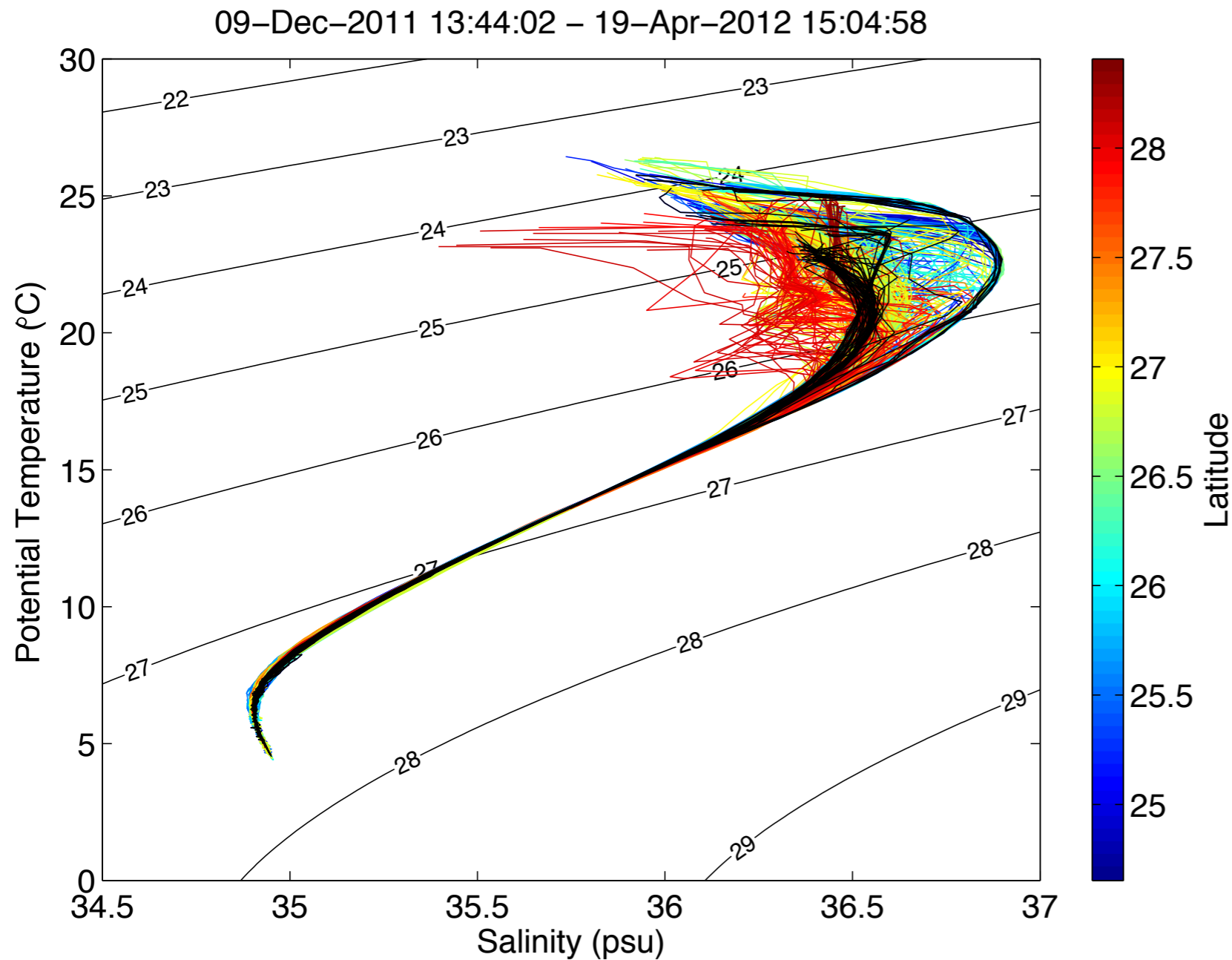
Cyclonic eddies



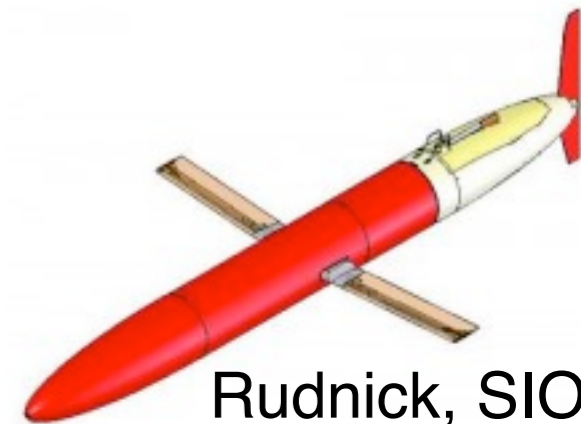
- Like tornados, but much slower
- Rossby number 0.2



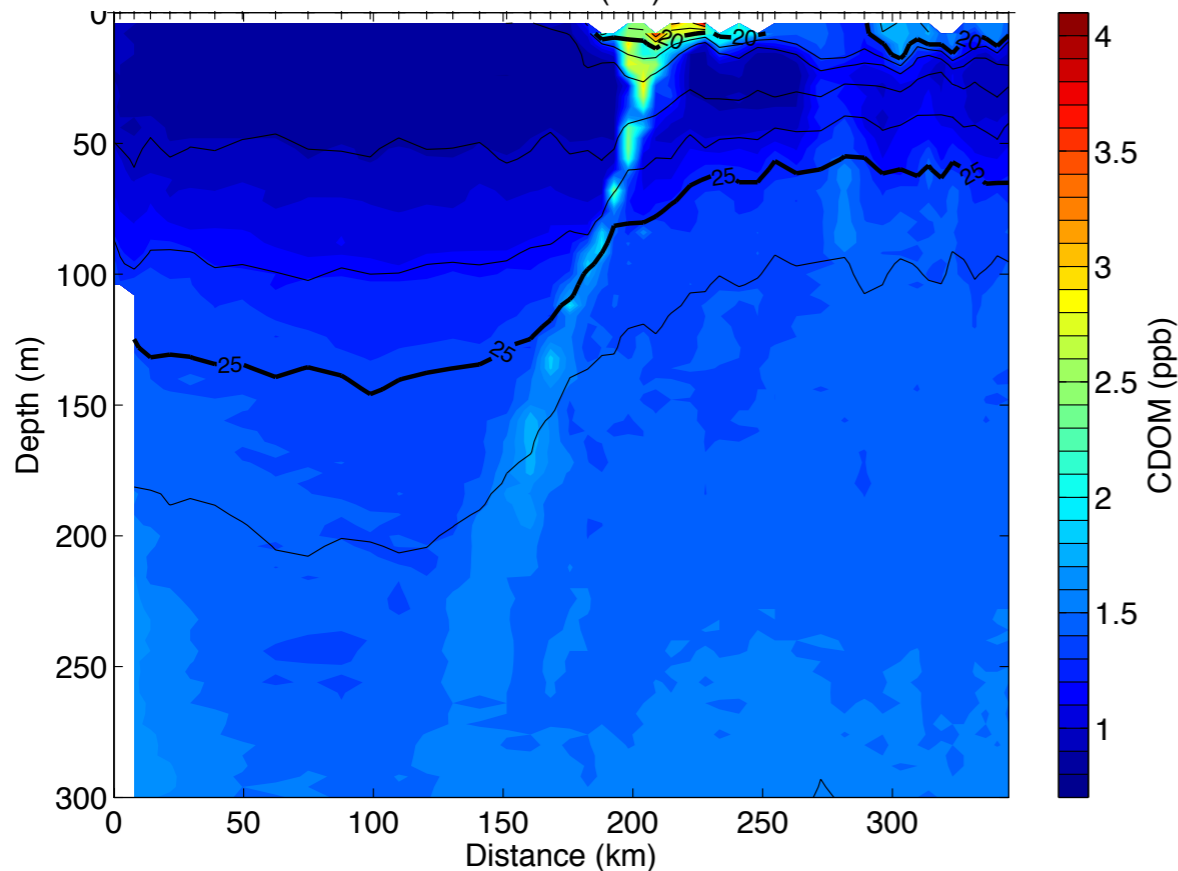
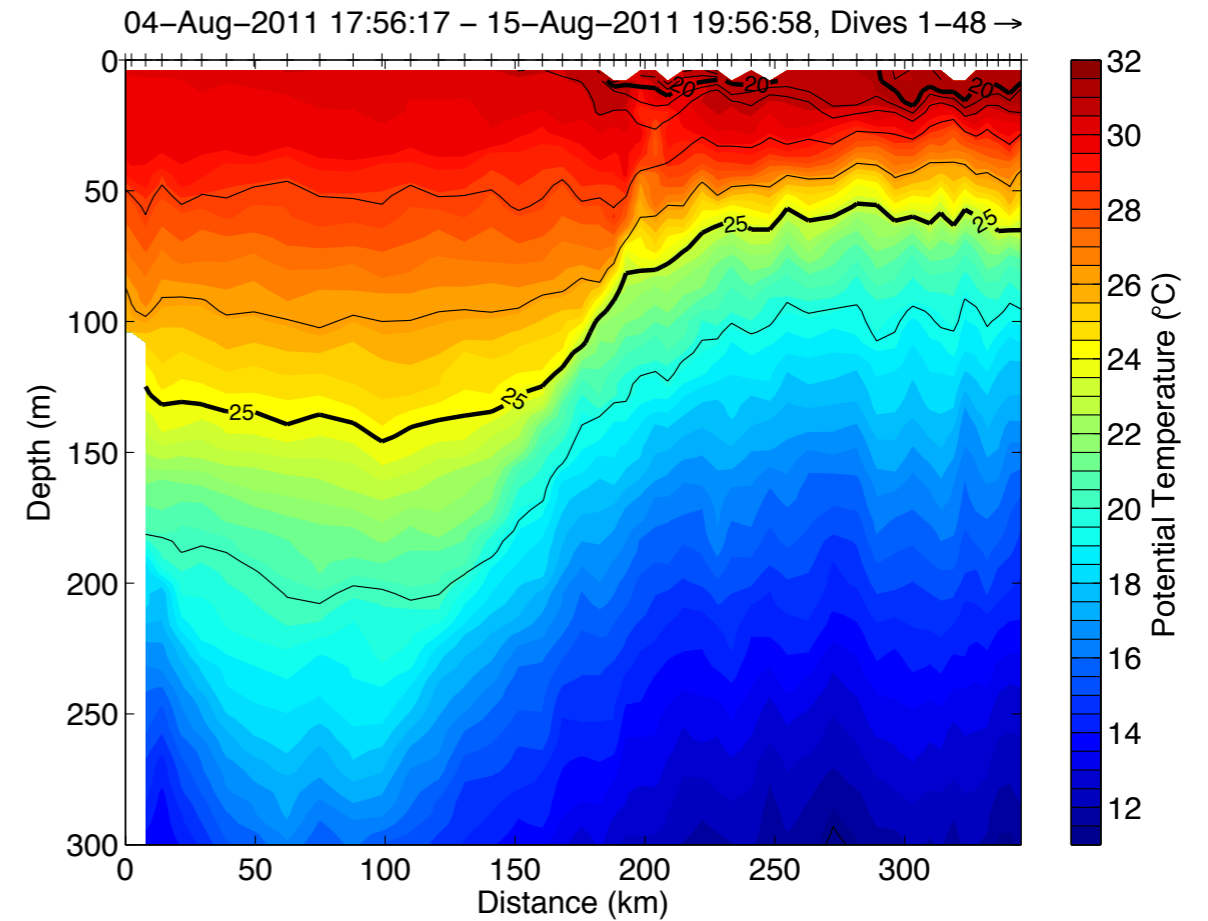
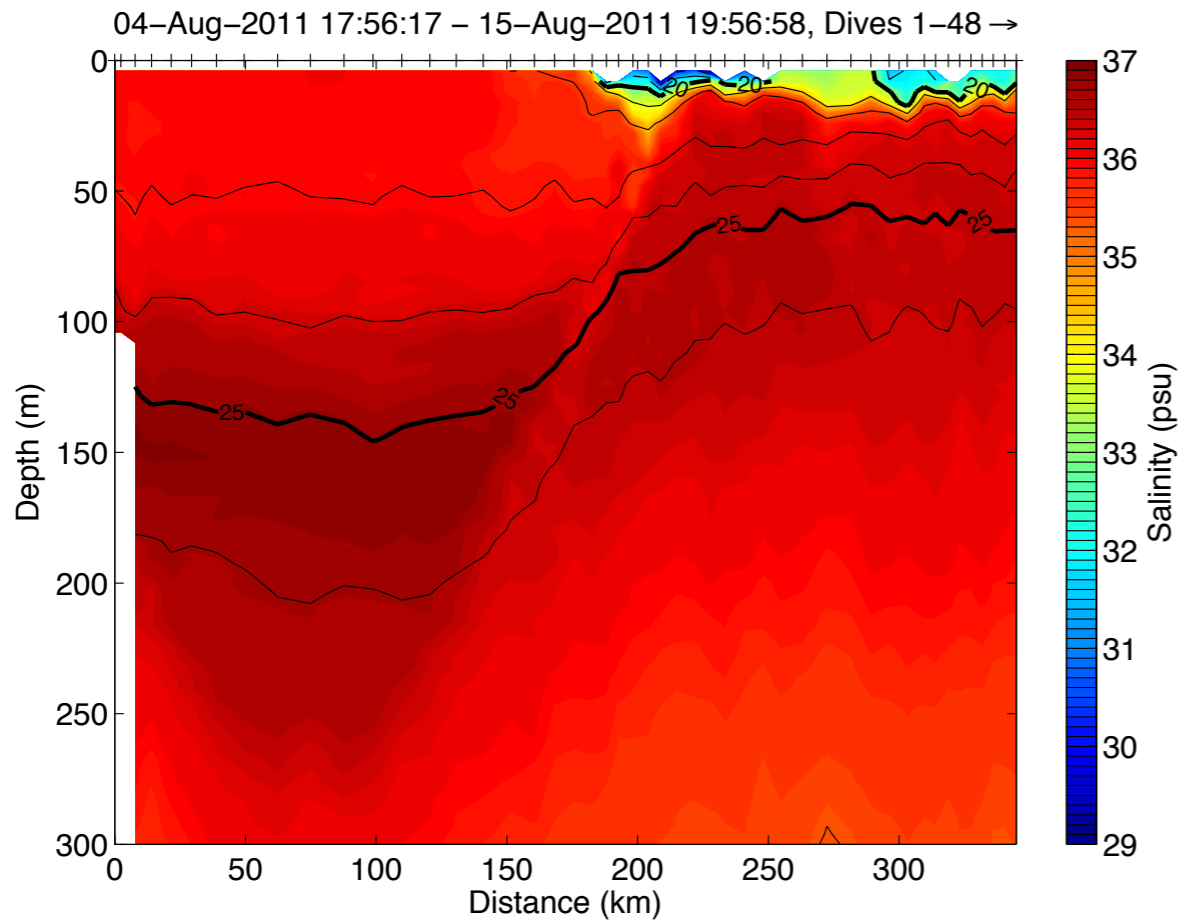
Hydrographic properties



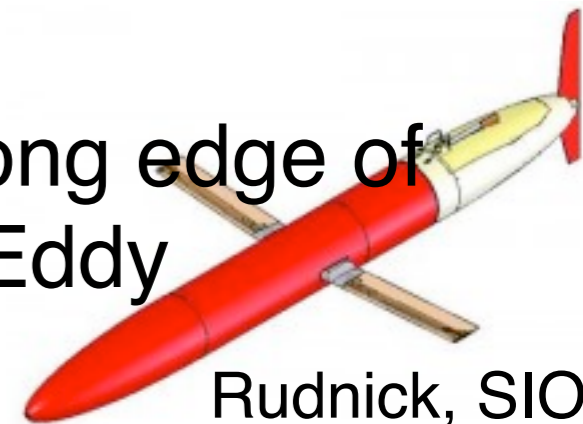
- Saltiest water is in LCE, from Atlantic
- Cyclonic eddies on boundary of LCE, include water of gulf origin



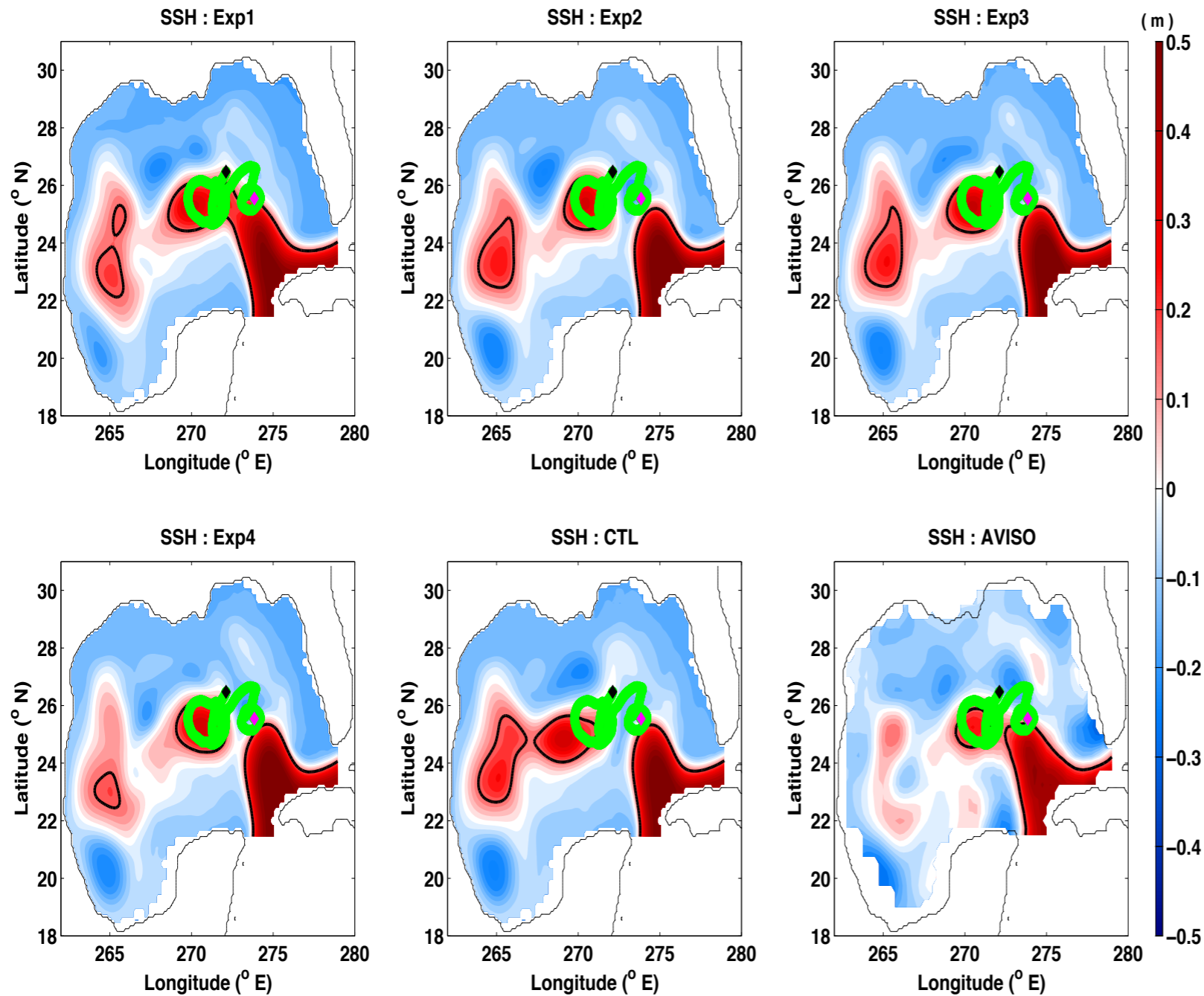
Mississippi River water in the Gulf of Mexico



- Thin layer of fresh water, 29 psu, 32°C, 1017 kg/m³
- CDOM tracer of river water
- Subduction along edge of Loop Current Eddy



Glider data for model initialization

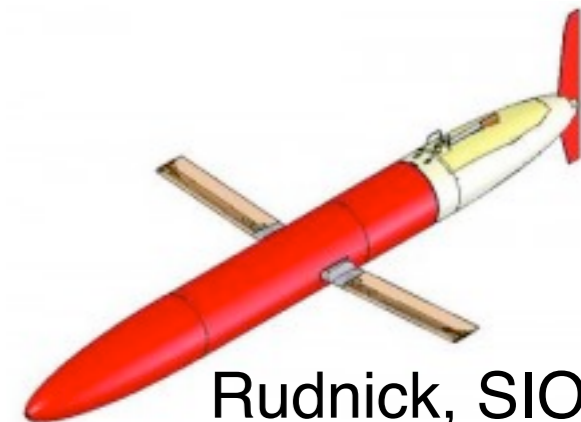


- Data being used to initialize MITgcm
- Shown to improve predictions
- At first glance, glider in cyclonic eddies helps most



Conclusion

- Spray underwater glider
- Worldwide operations
 - Focus on boundary currents
- Results from California
 - Record approaching 7 years
 - Climate and ecosystem variability
- Results from the Gulf of Mexico
 - Loop Current and Eddy
 - Prediction



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