The California Underwater Glider Network

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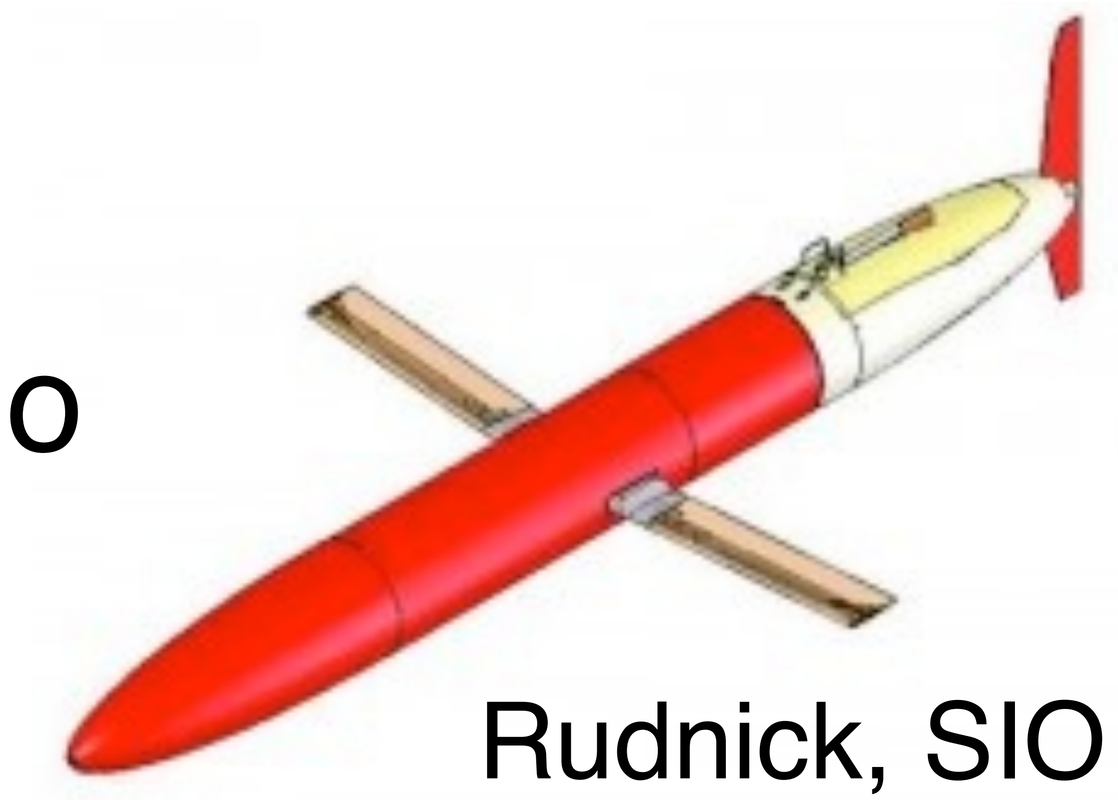
Outline

- The Spray underwater glider operations
- The California Underwater Glider Network
- Glider sampling
- A climatology of the California Current System
  - Mean
  - Annual cycle
  - The anomalies of 2014-2015 and the 2015-2016 El Niño



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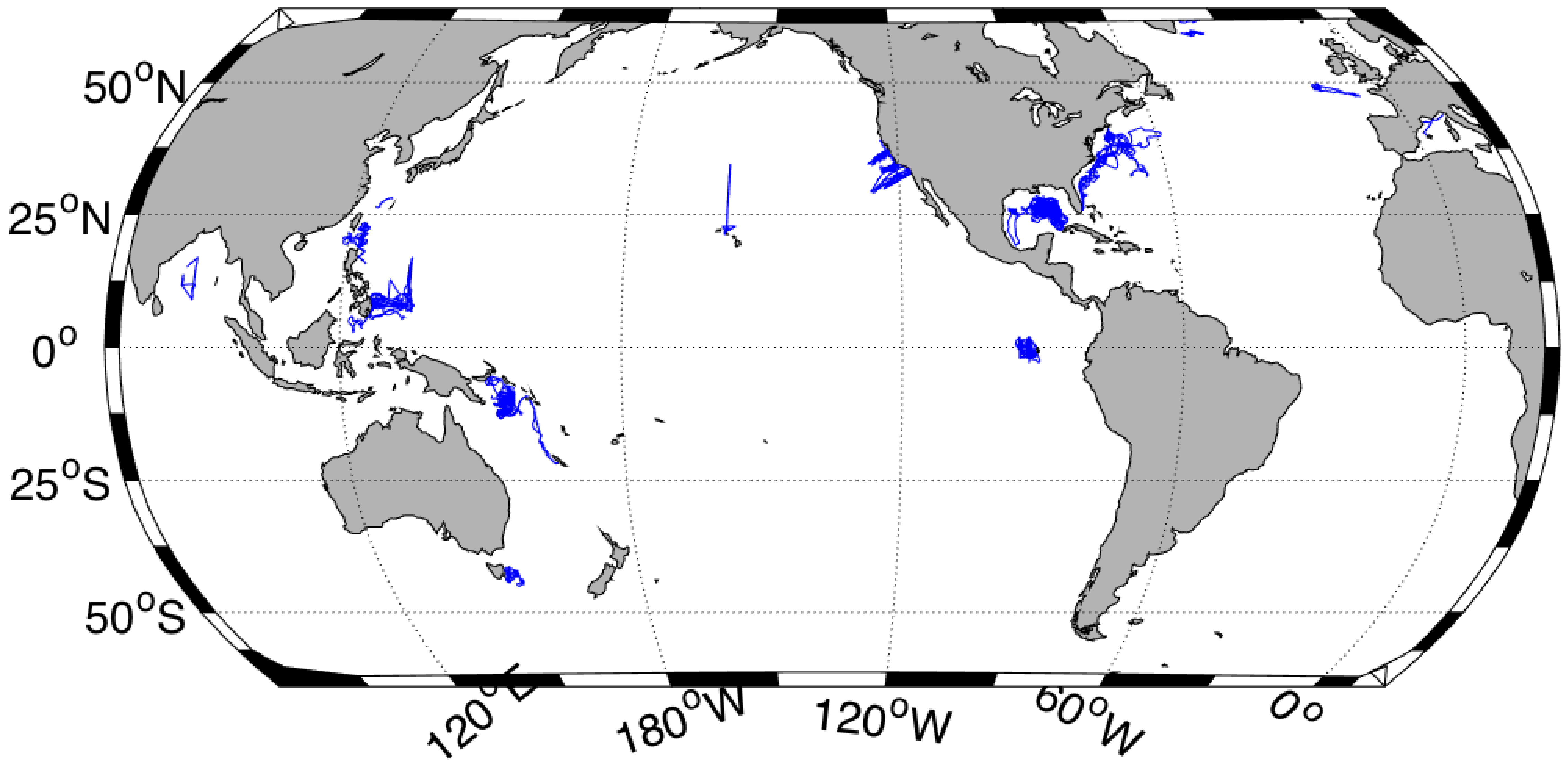
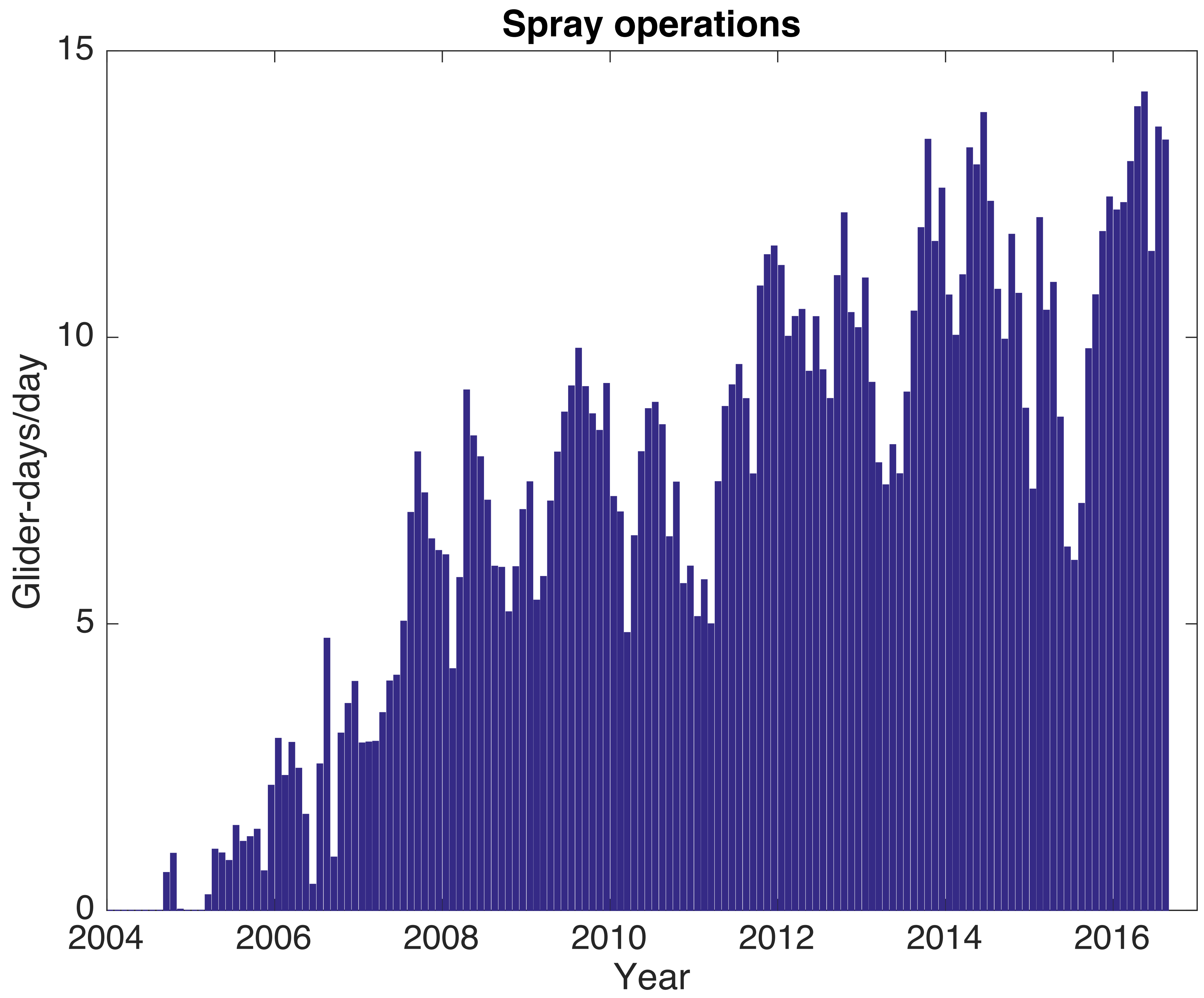
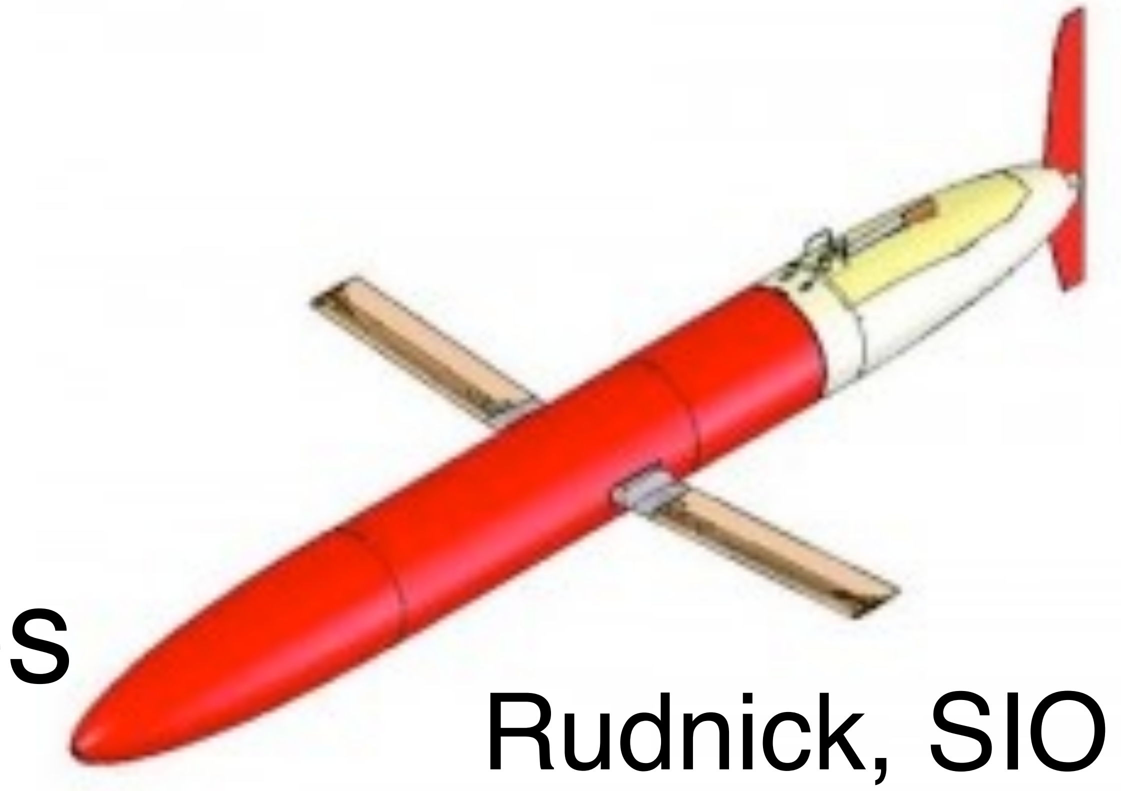
Spray operations





- Many collaborators
- WHOI
- MBARI

- 89 years
- 650,000 km
- 220,000 dives



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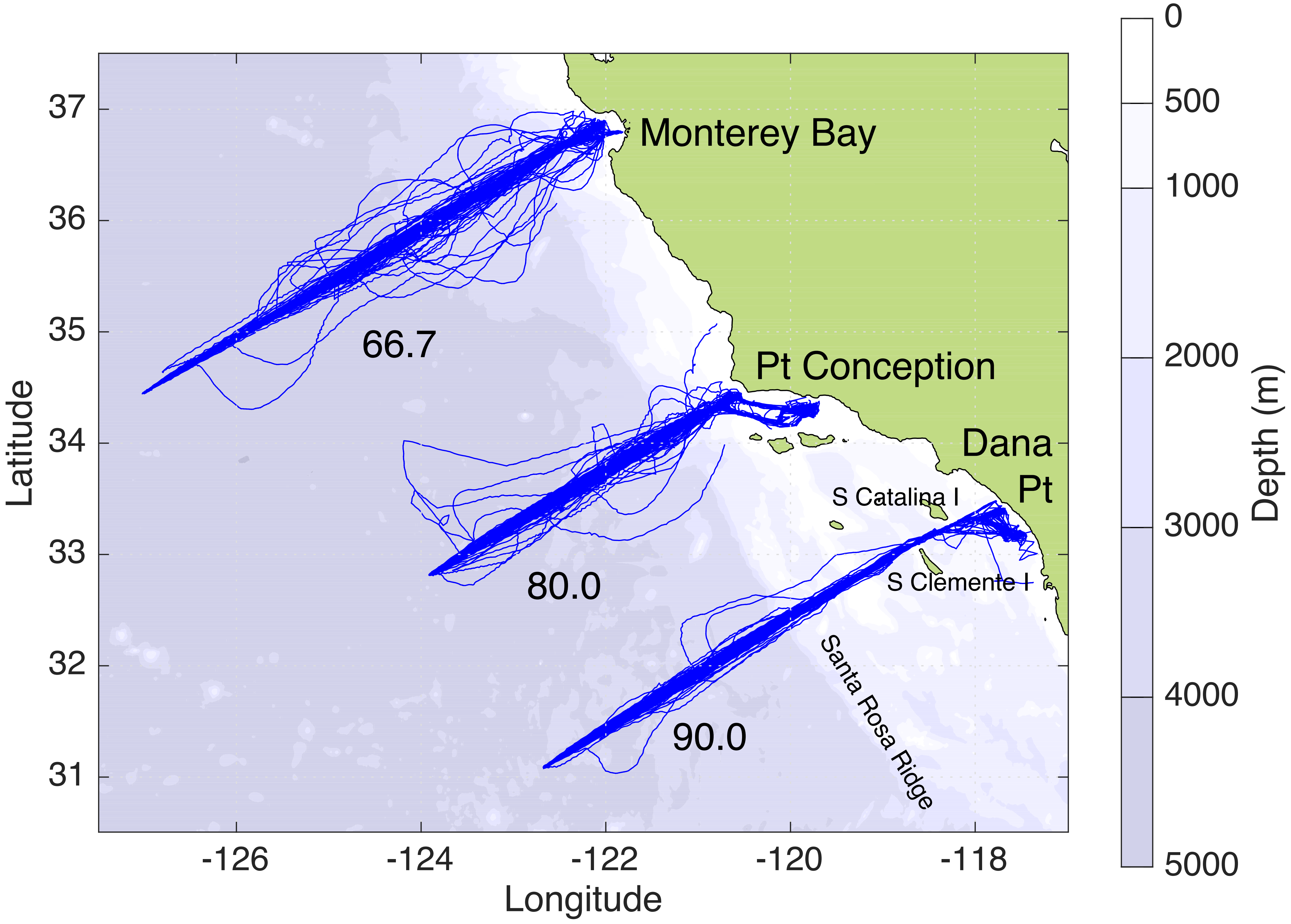
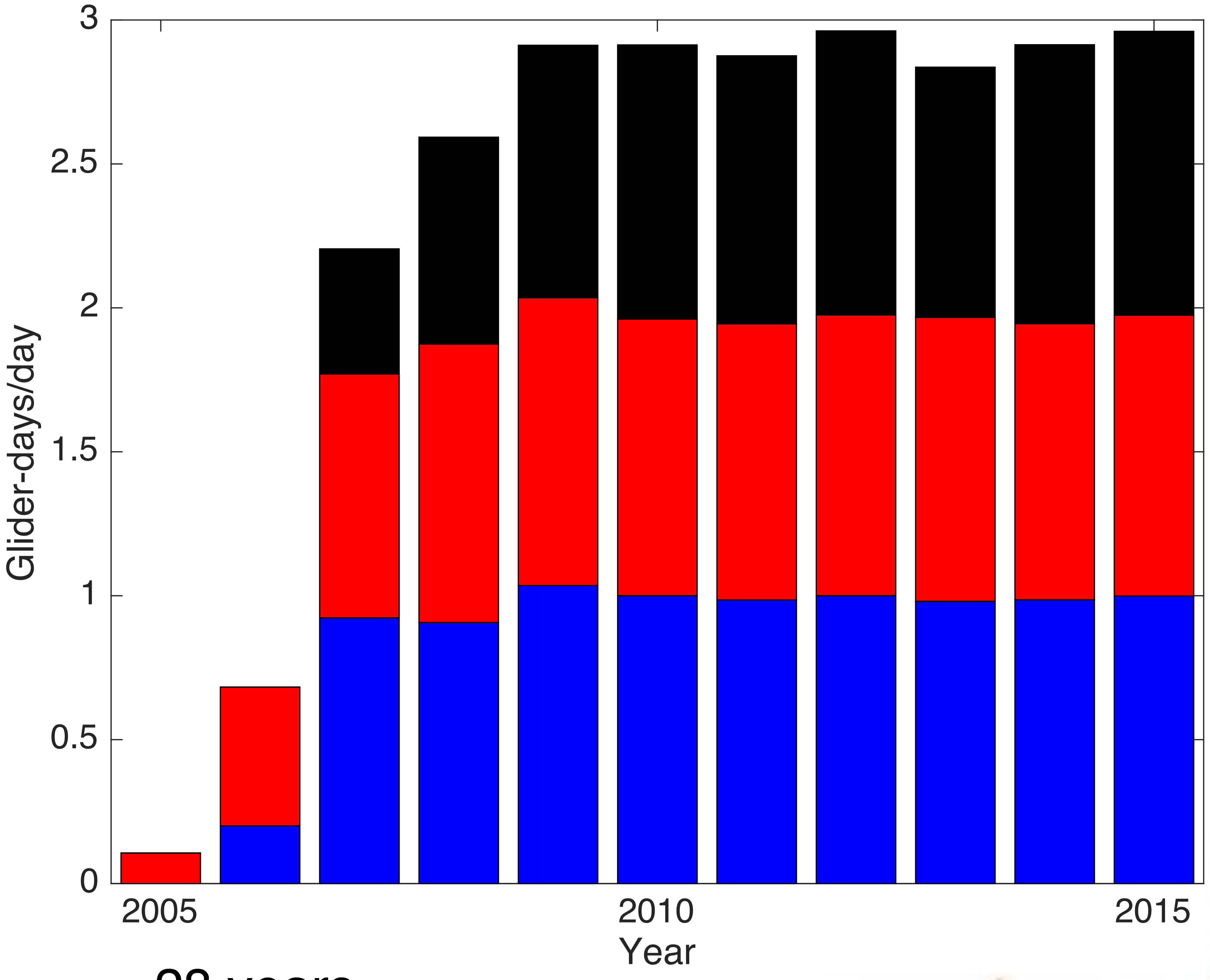
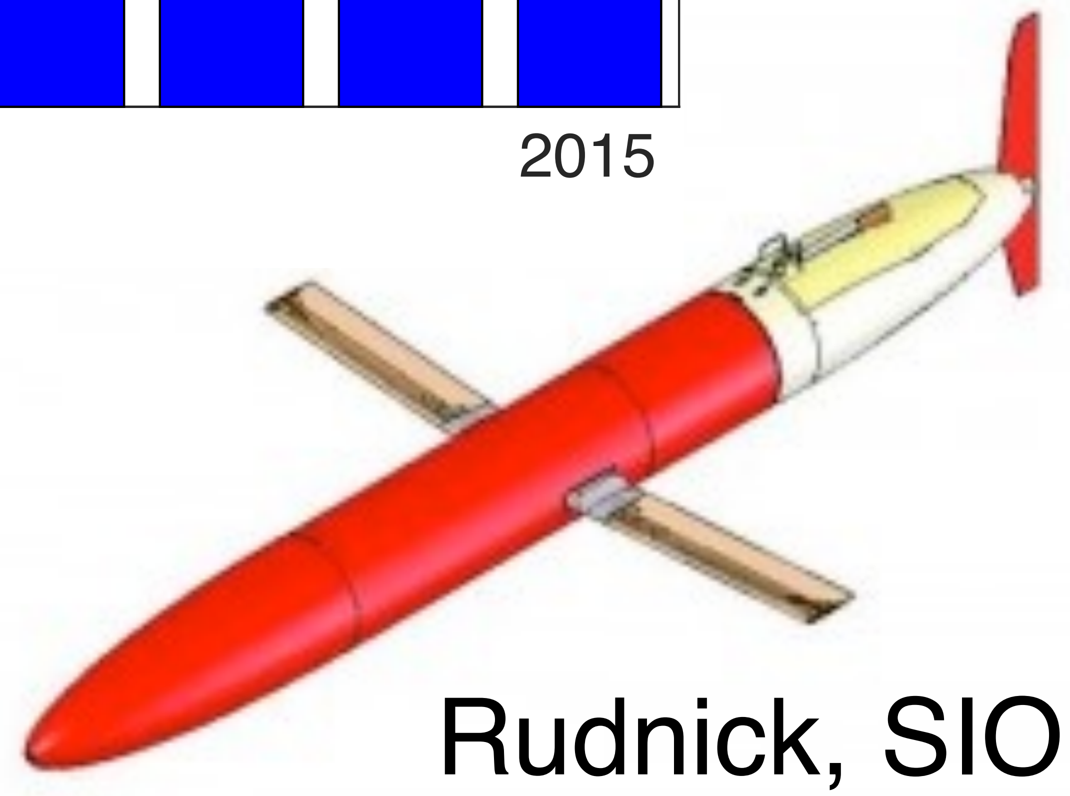


- Regional effects of climate variability
- On traditional CalCOFI lines
- Data distributed in real time, assimilated in models



- 28 years
- 219,000 km
- 96,000 dives



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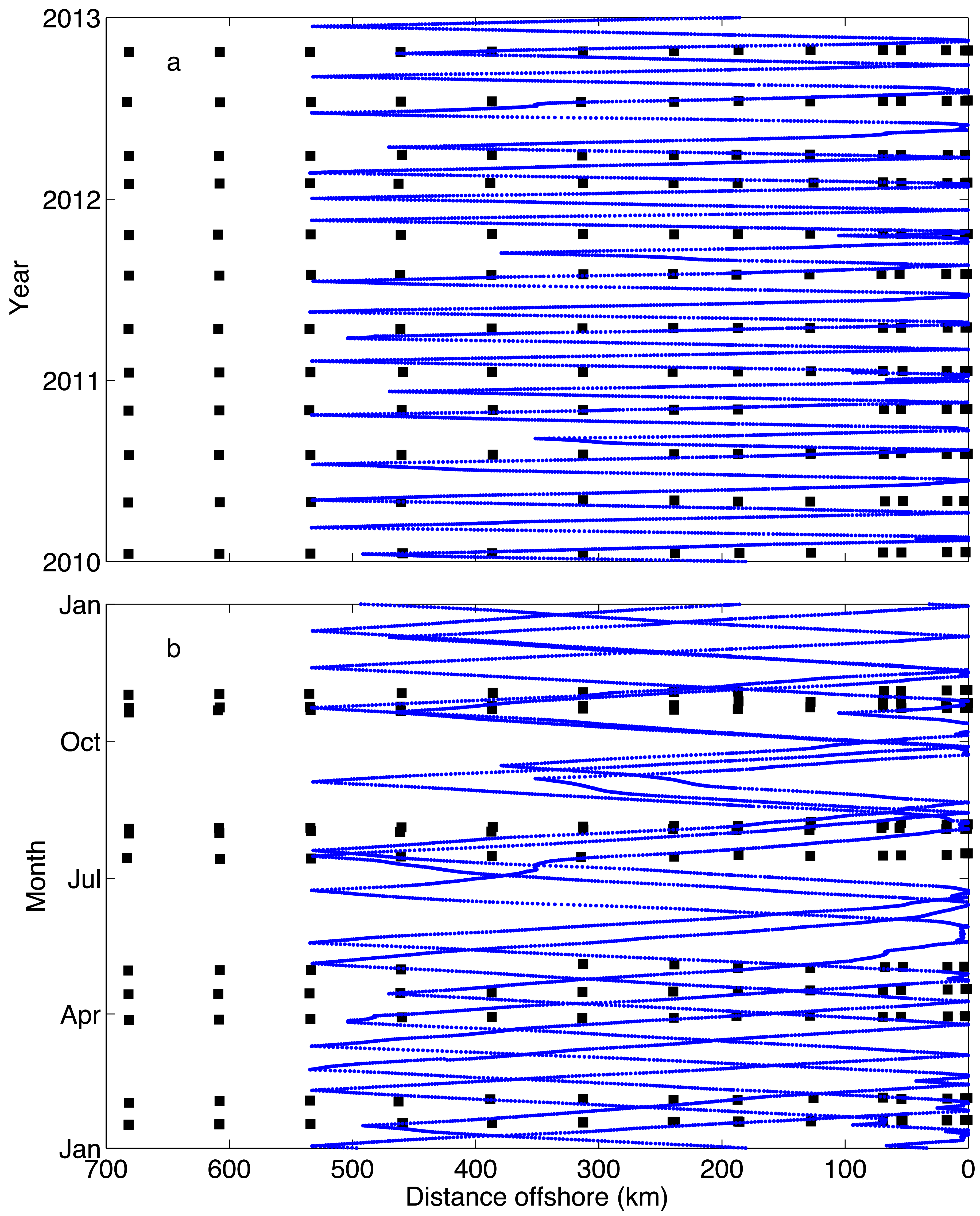
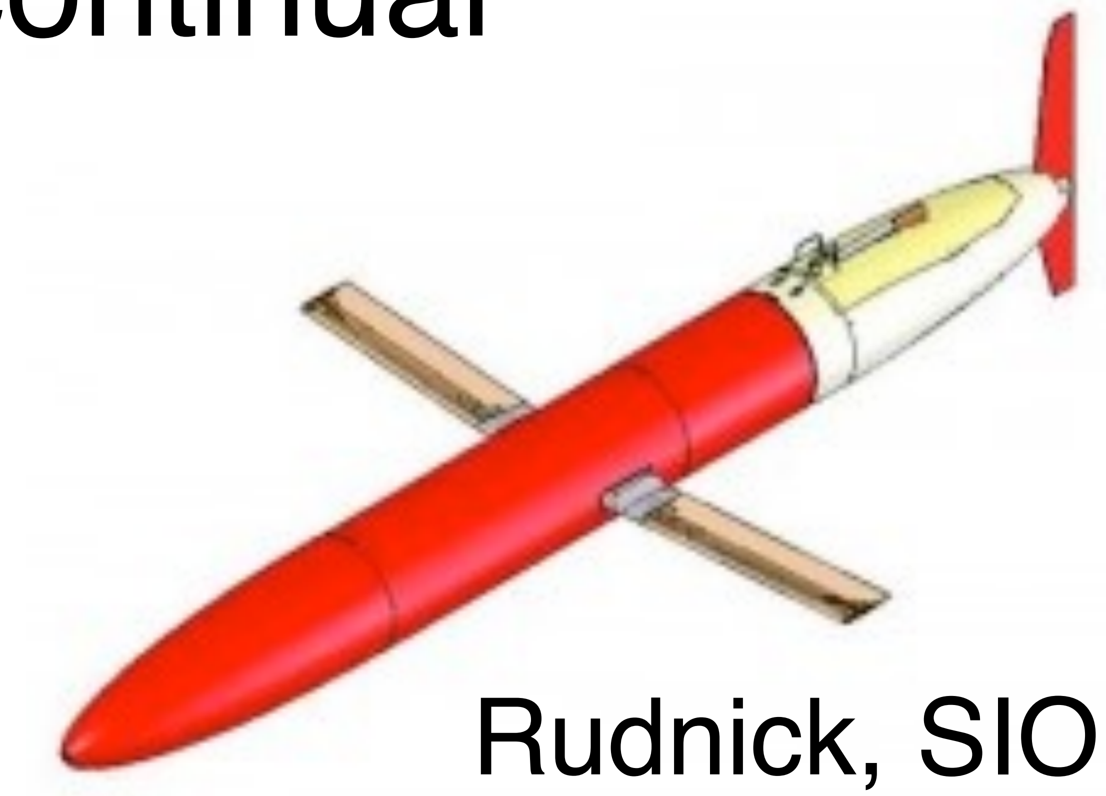
Sampling: glider vs. ship



- Line 90
- 9429 glider profiles
- 165 ship profiles
- 57 times as many glider profiles as CalCOFI stations
- A virtue of gliders is continual presence.
- Annual cycle



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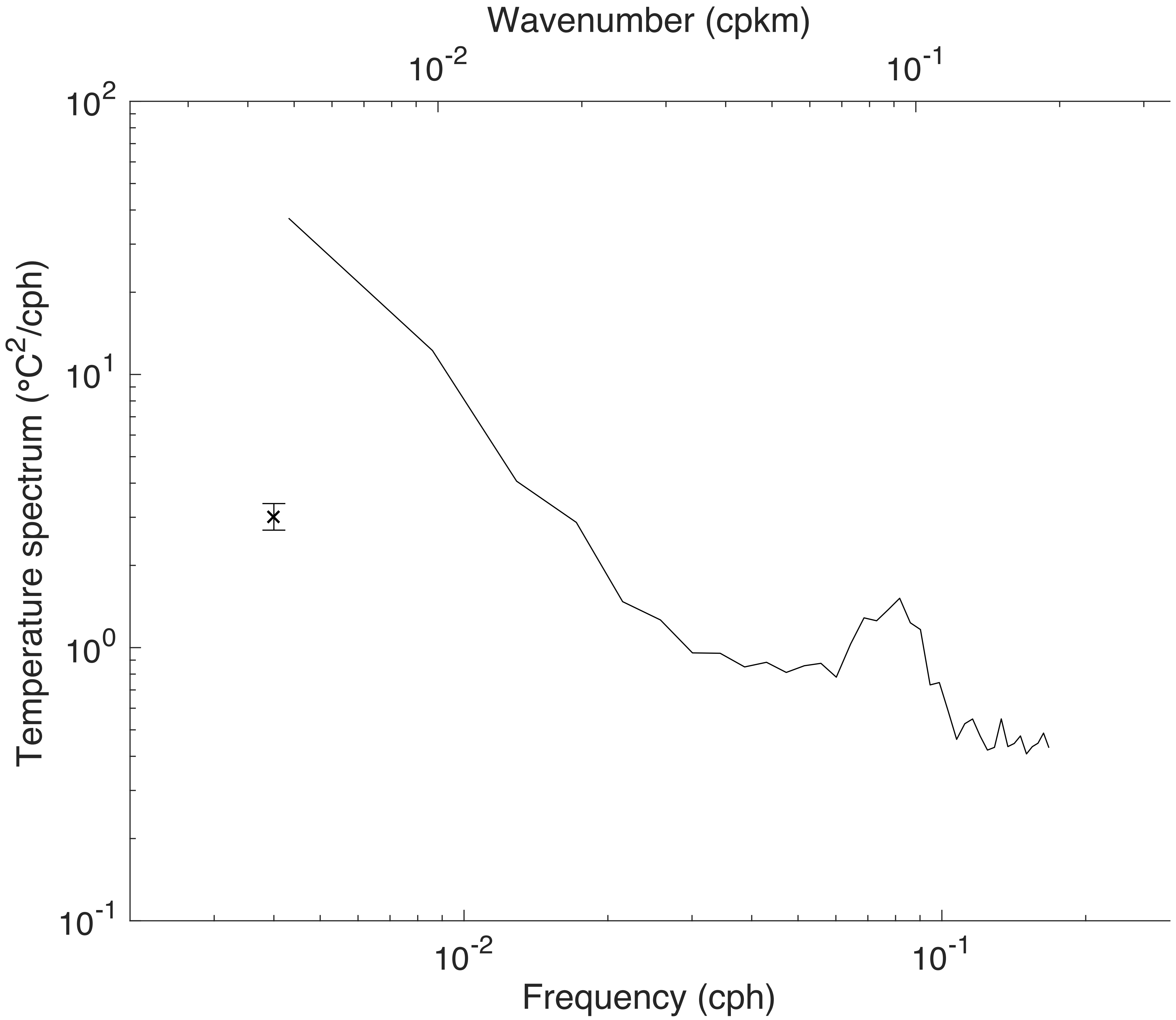
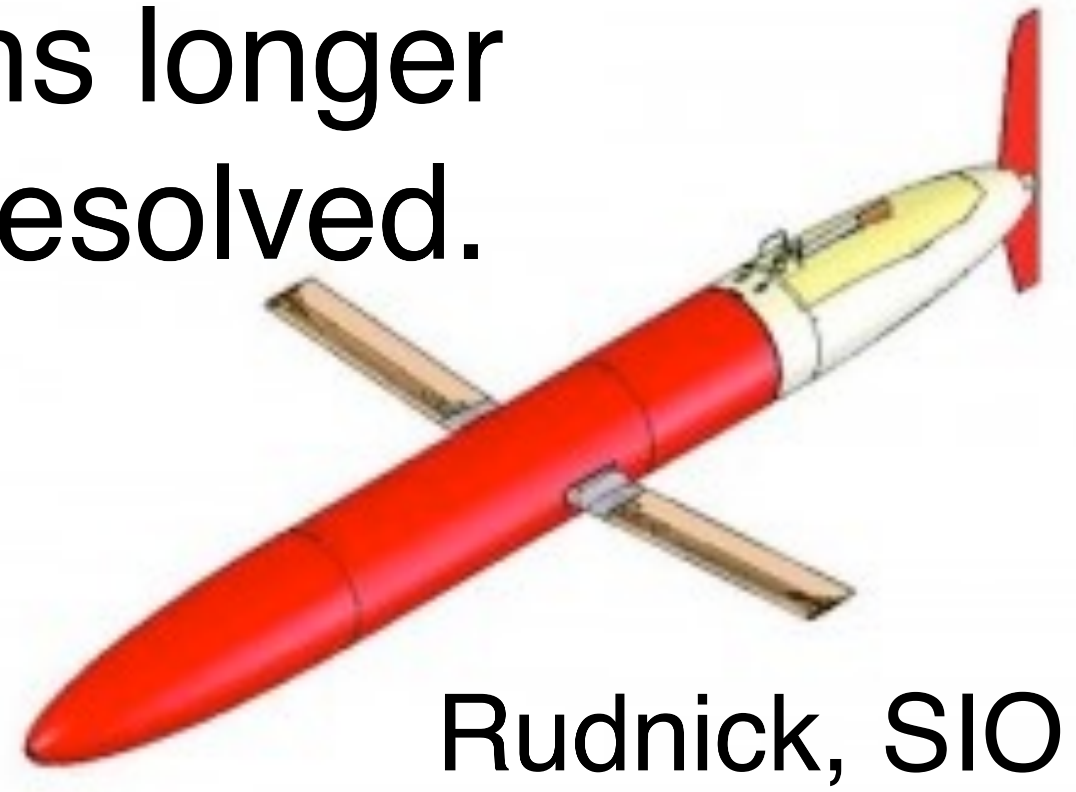
Sampling: projection of internal waves



- Like all other methods of surveying the ocean, gliders take a finite time to complete a profile or a survey
- High frequency variability, as by internal waves, are projected into glider observations of horizontal structure
- For CUGN, wavelengths longer than about 30 km are resolved.



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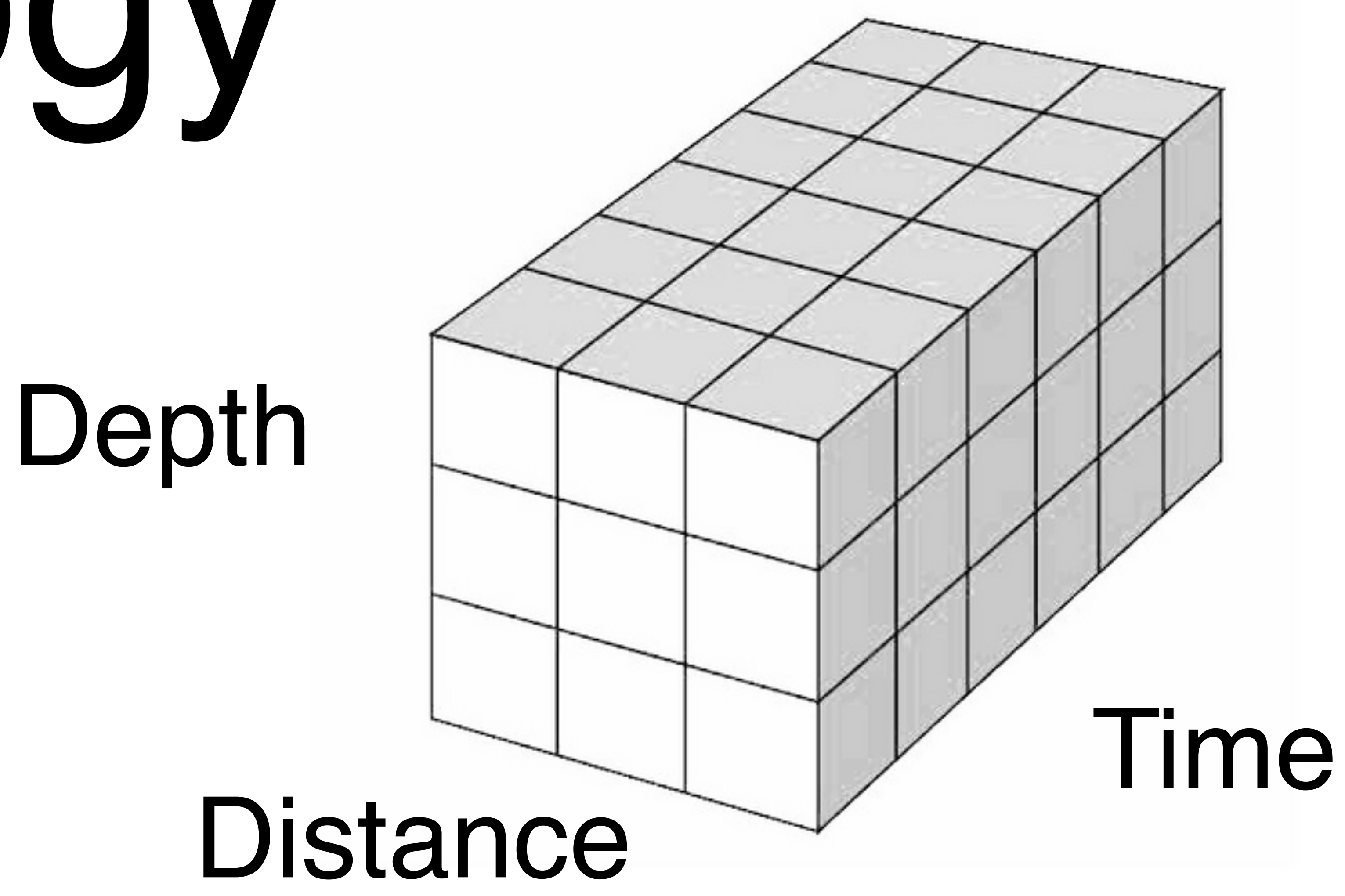
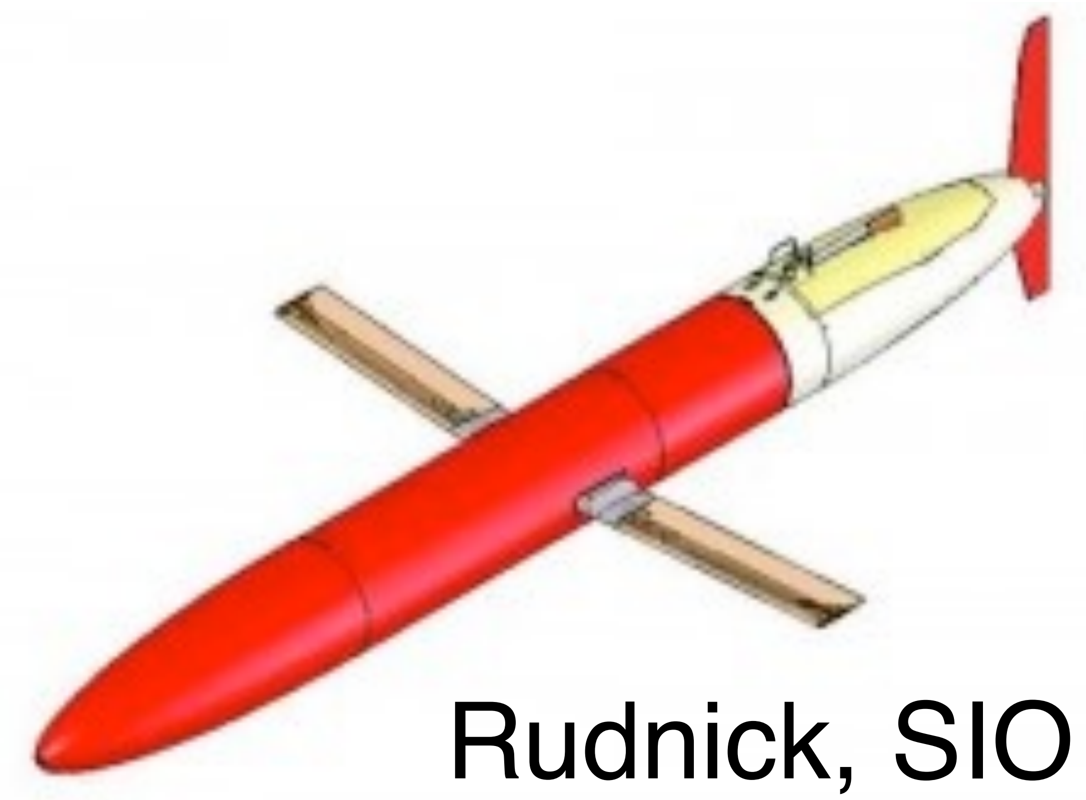
CUGN climatology

- Regular grid
  - 10 m in depth
  - 5 km in distance
  - 10 day in time
- Mean and annual cycle by least-squares fit weighted with a 15 km Gaussian window
- Anomaly by objective map, 2-d Gaussian, 60 days × 30 km
- Mean fields
- Annual cycle
- Interannual variability
- Temperature, salinity, depth-average velocity
- Density, geostrophic velocity





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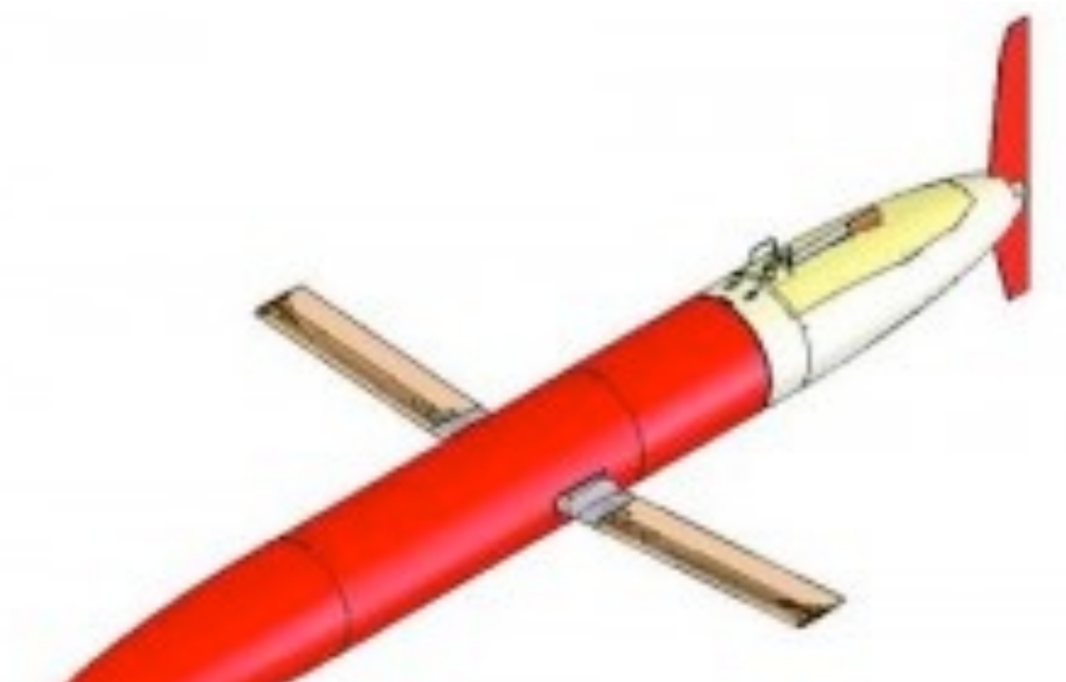
Mean on line 90

- Cores of poleward California Undercurrent
- Equatorward California Current
- Change near edge of bight



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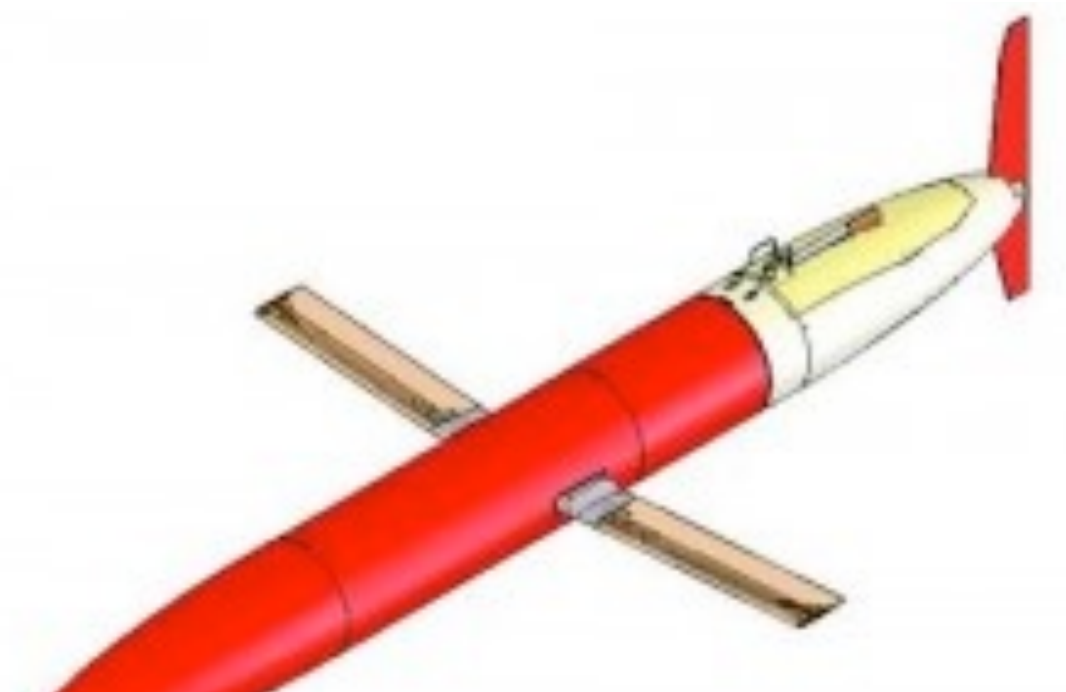
Mean on line 80

- Cores of poleward California Undercurrent
- Equatorward California Current
- Undercurrent maximum near 100 m



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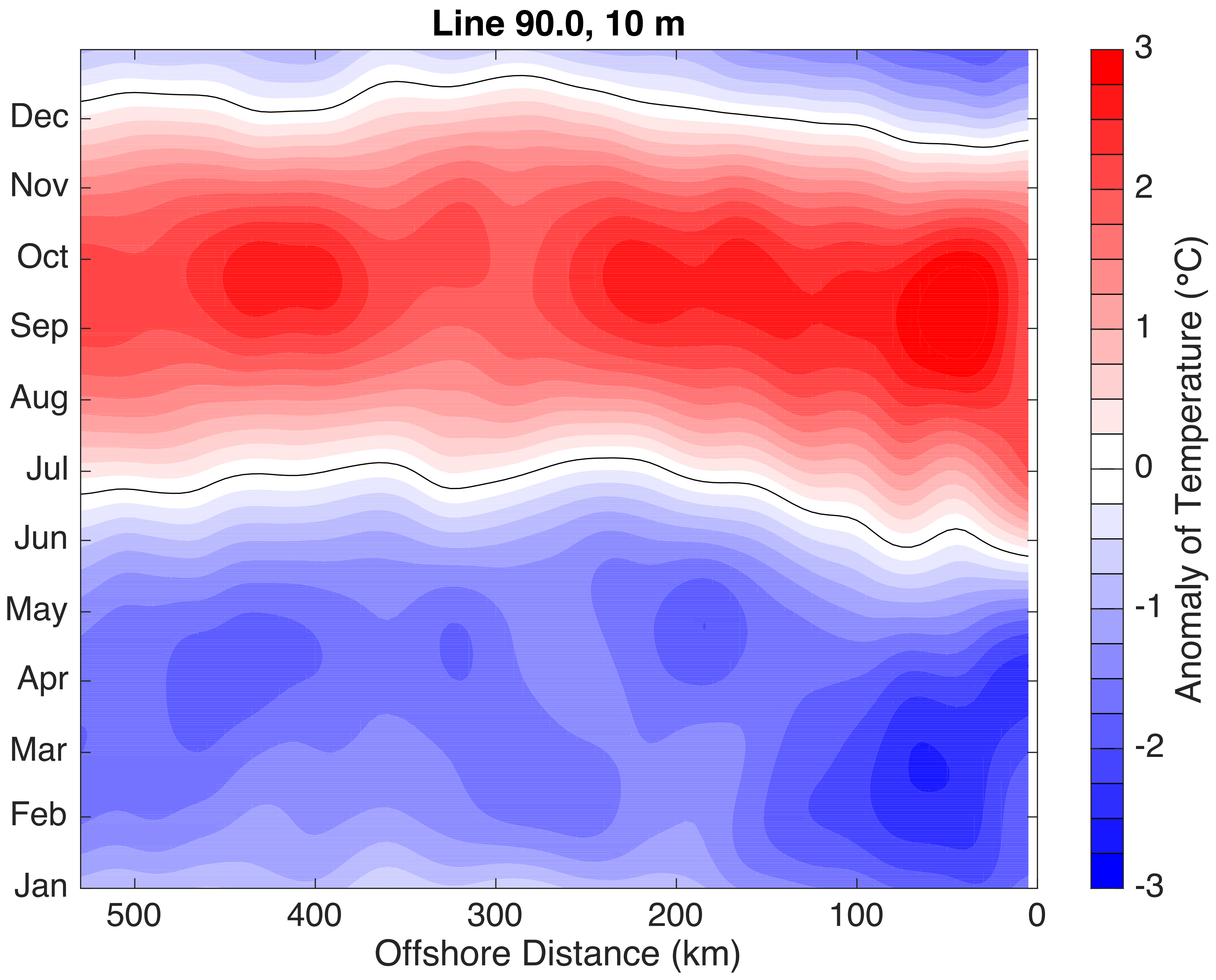
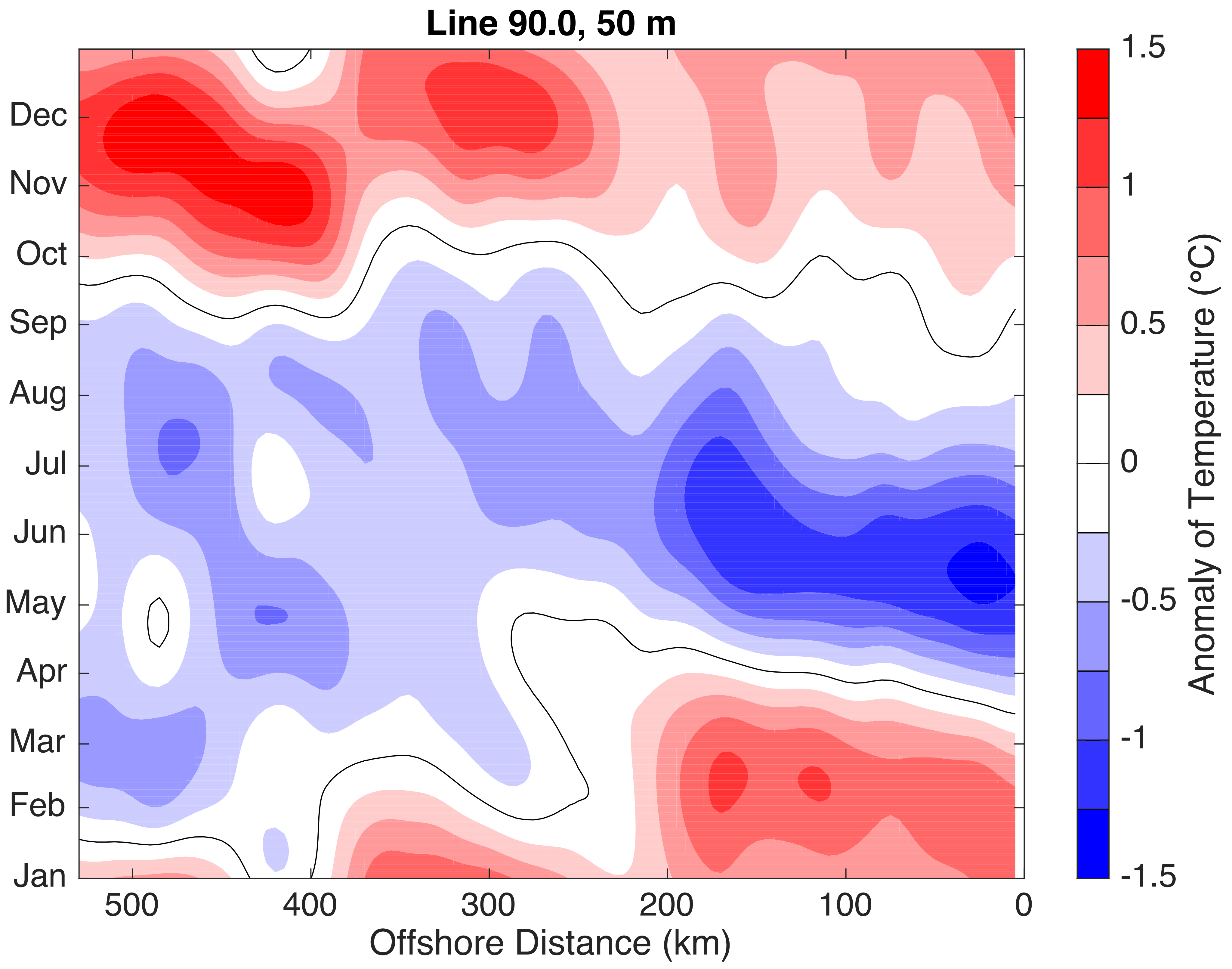
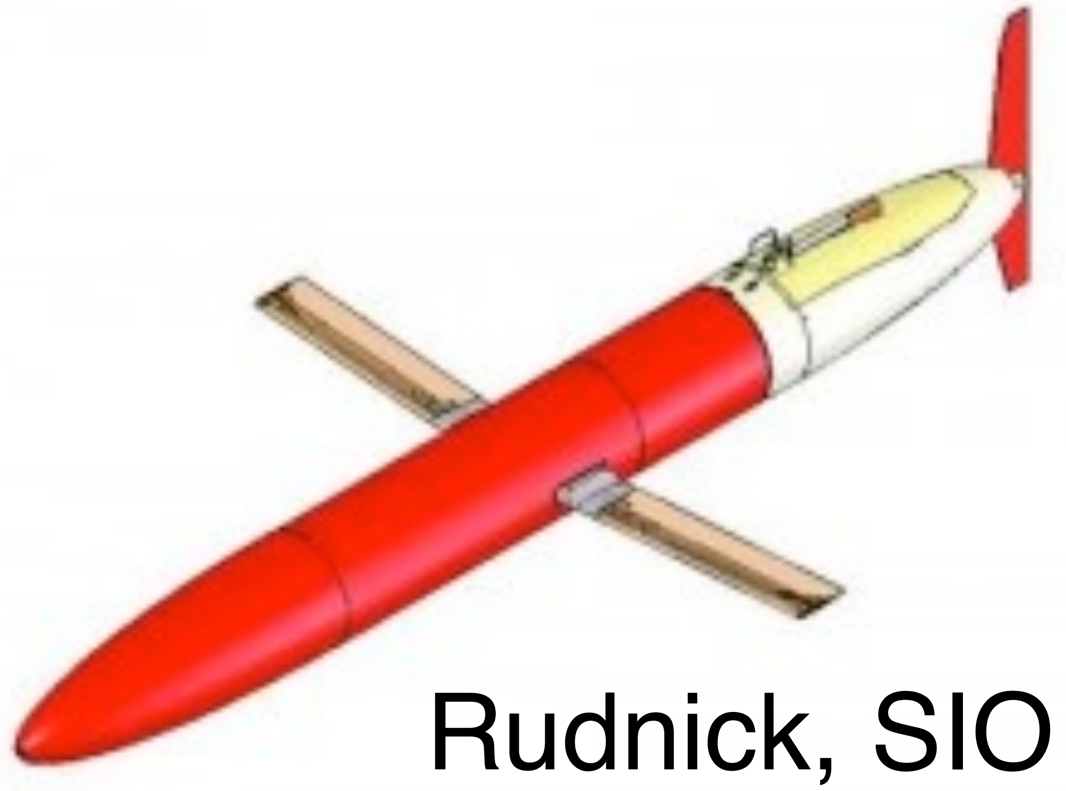
Annual cycle of temperature on line 90





- Surface driven by heat flux from atmosphere
- Thermocline driven by wind stress (curl)



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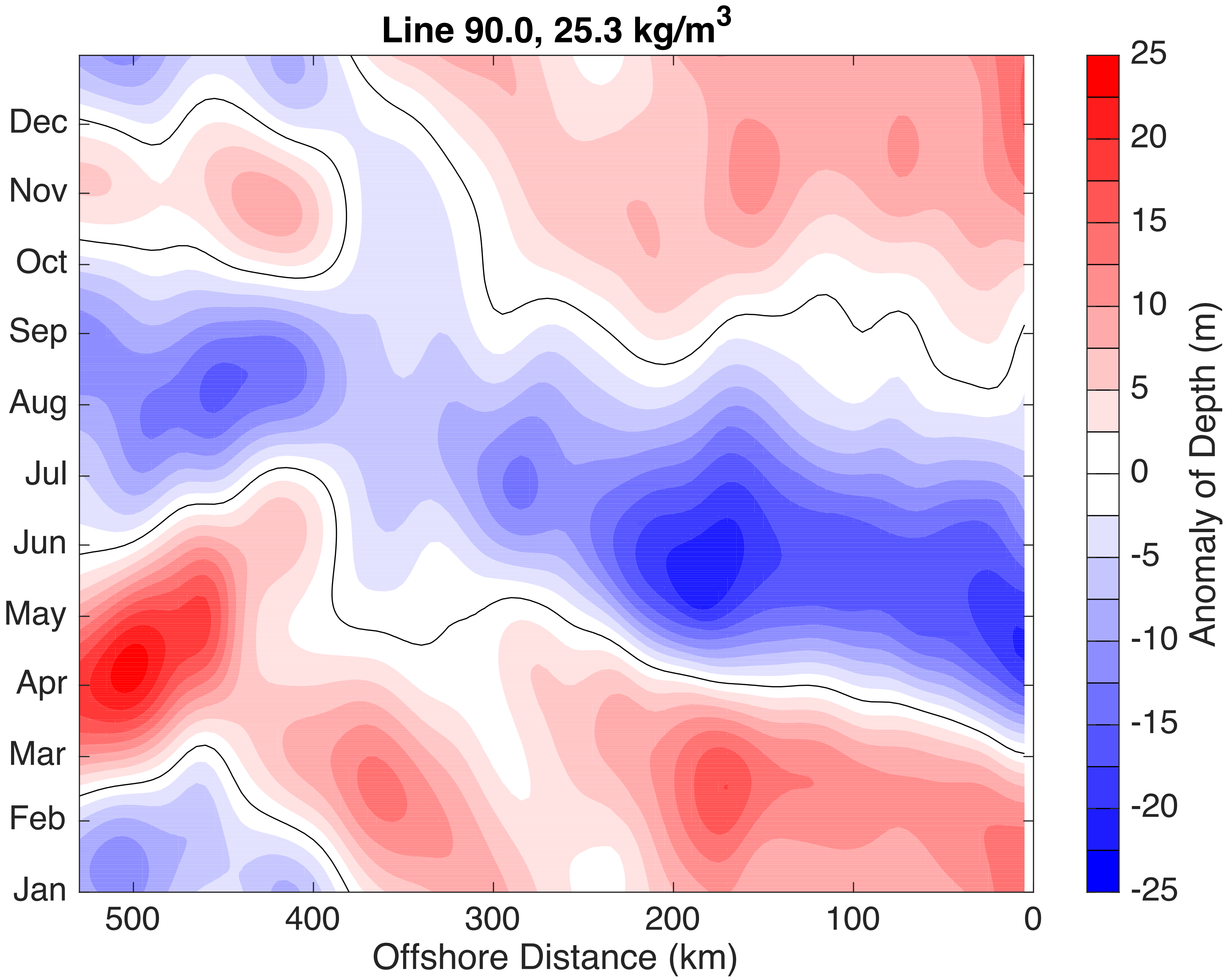
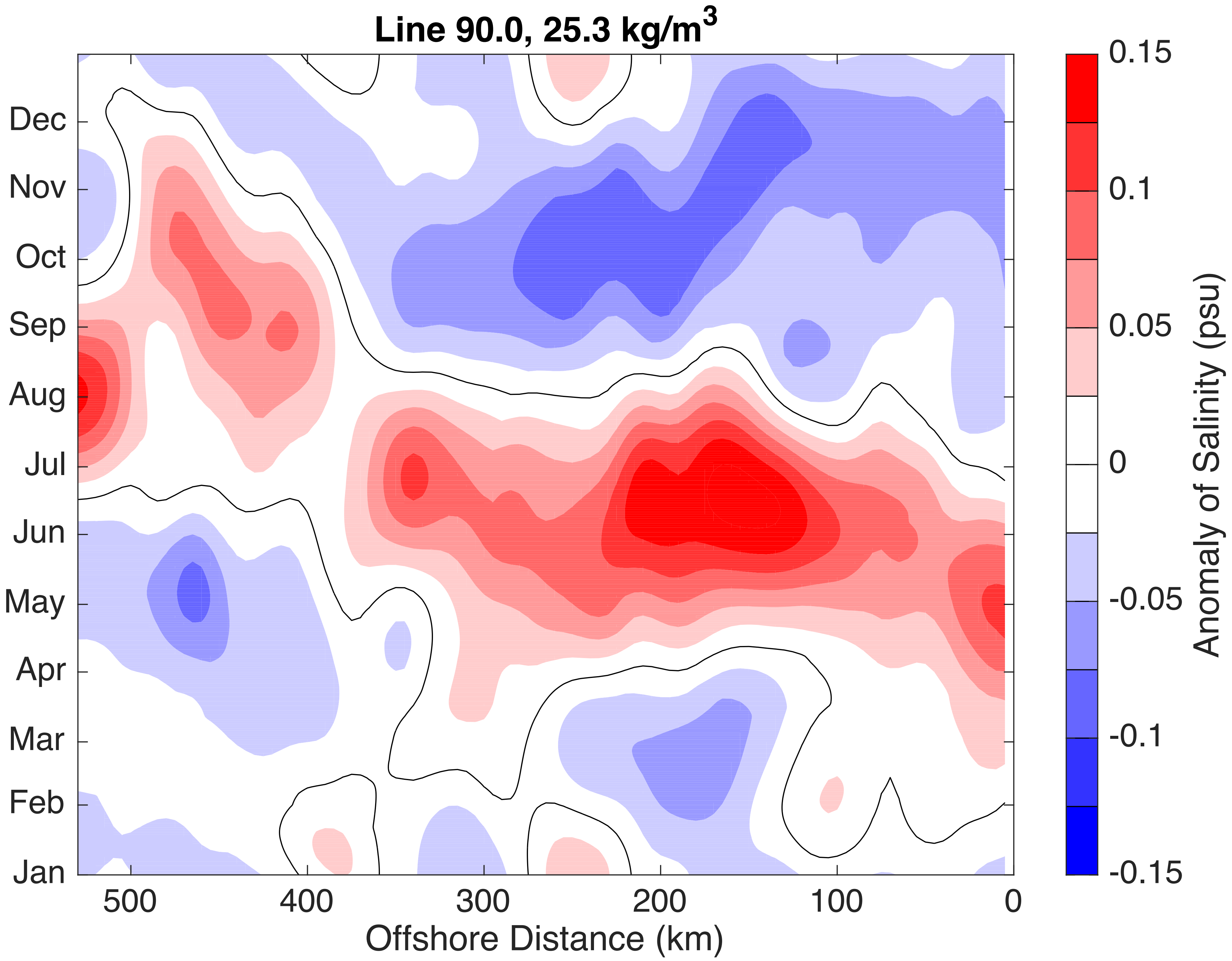
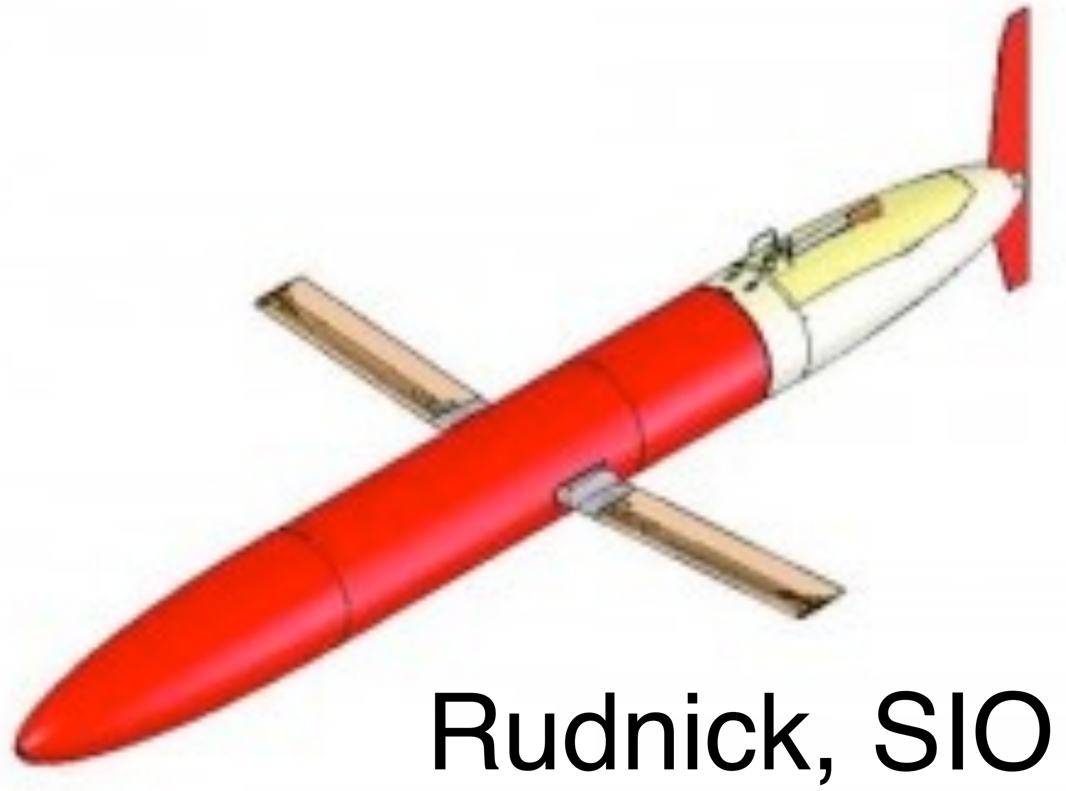
Annual cycle on an isopycnal





- Annual upwelling
- Annual cycle in salinity caused by mixing



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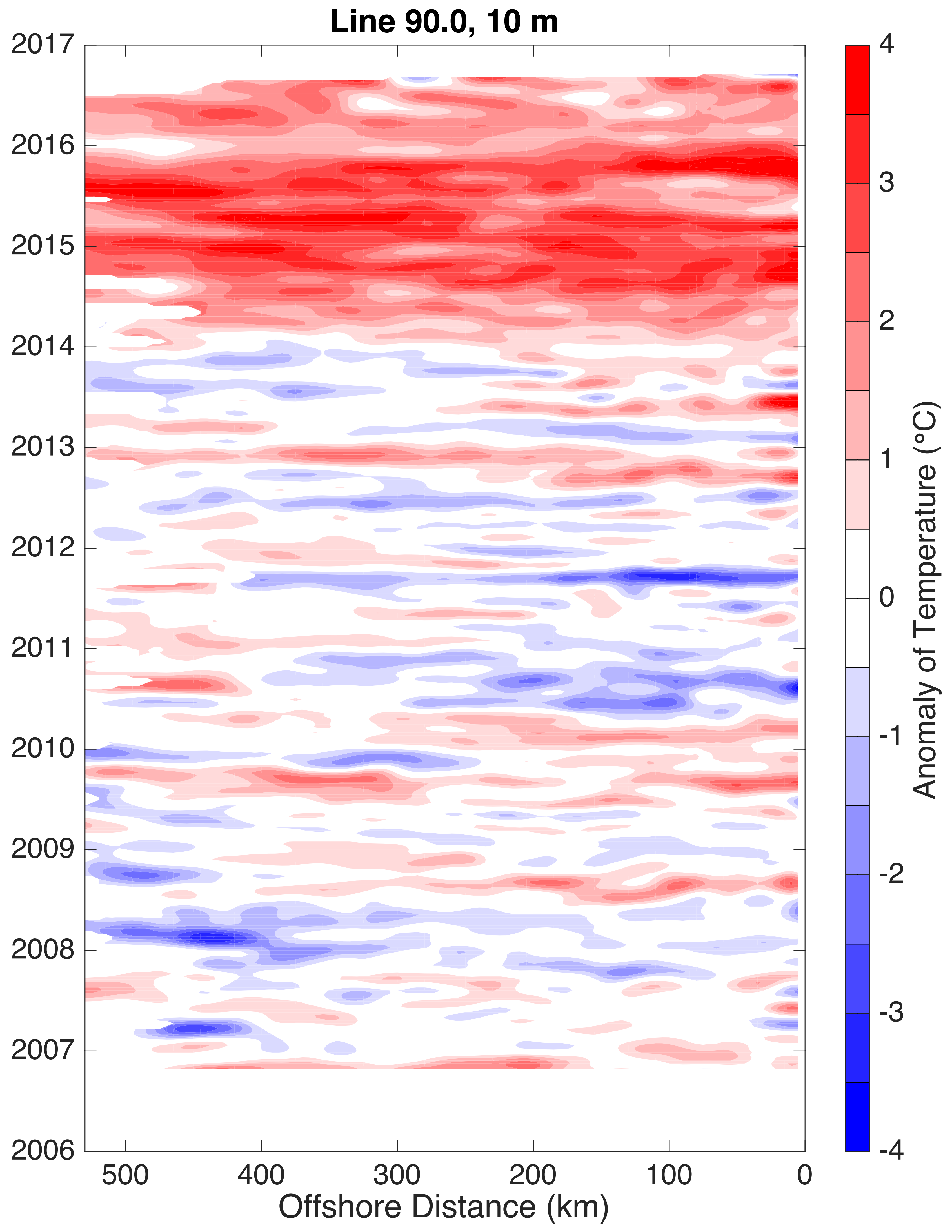
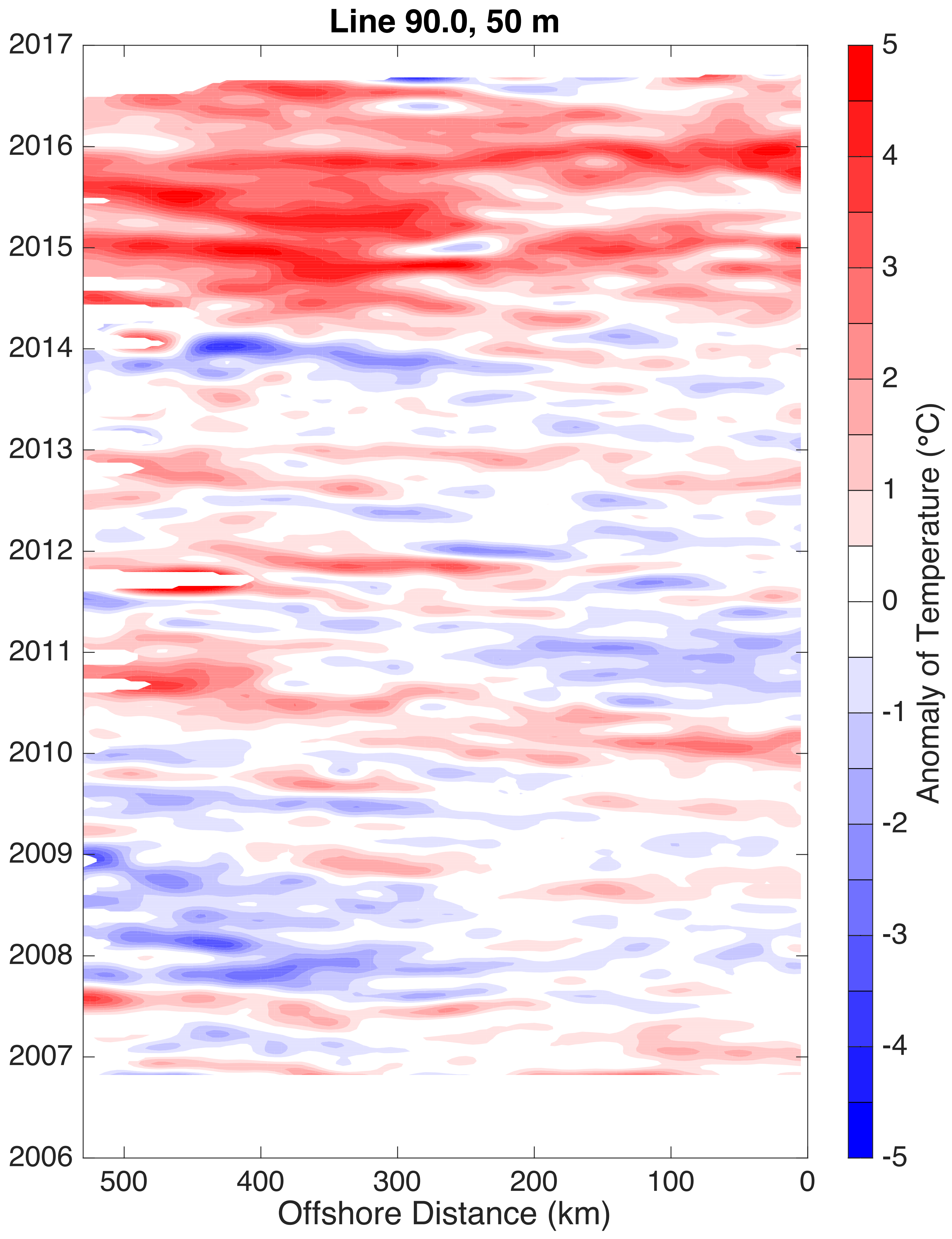
Interannual anomaly of temperature





- Anomalous warming of 2014-2015
- 2015-2016 El Niño
- 2009-2010 El Niño

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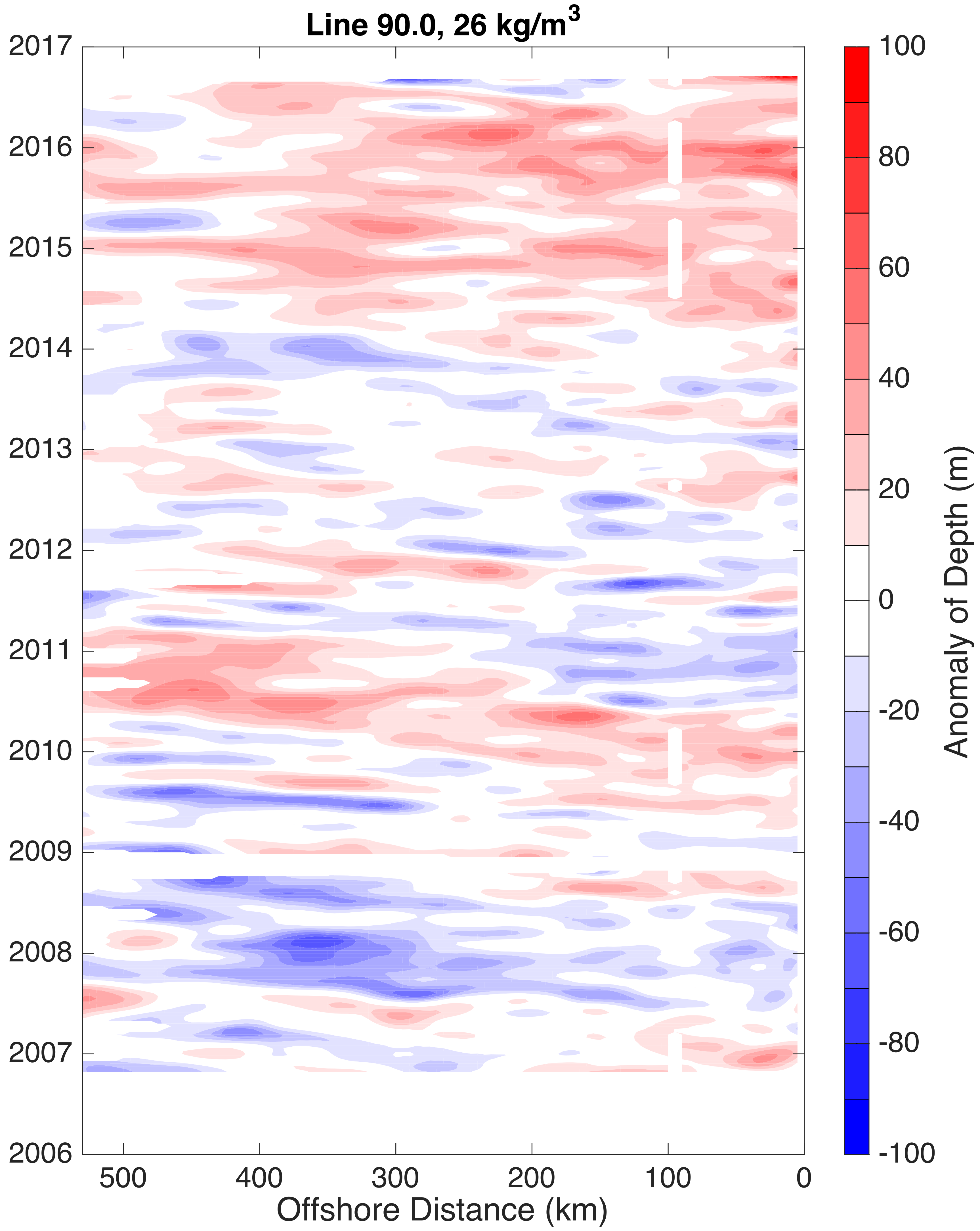
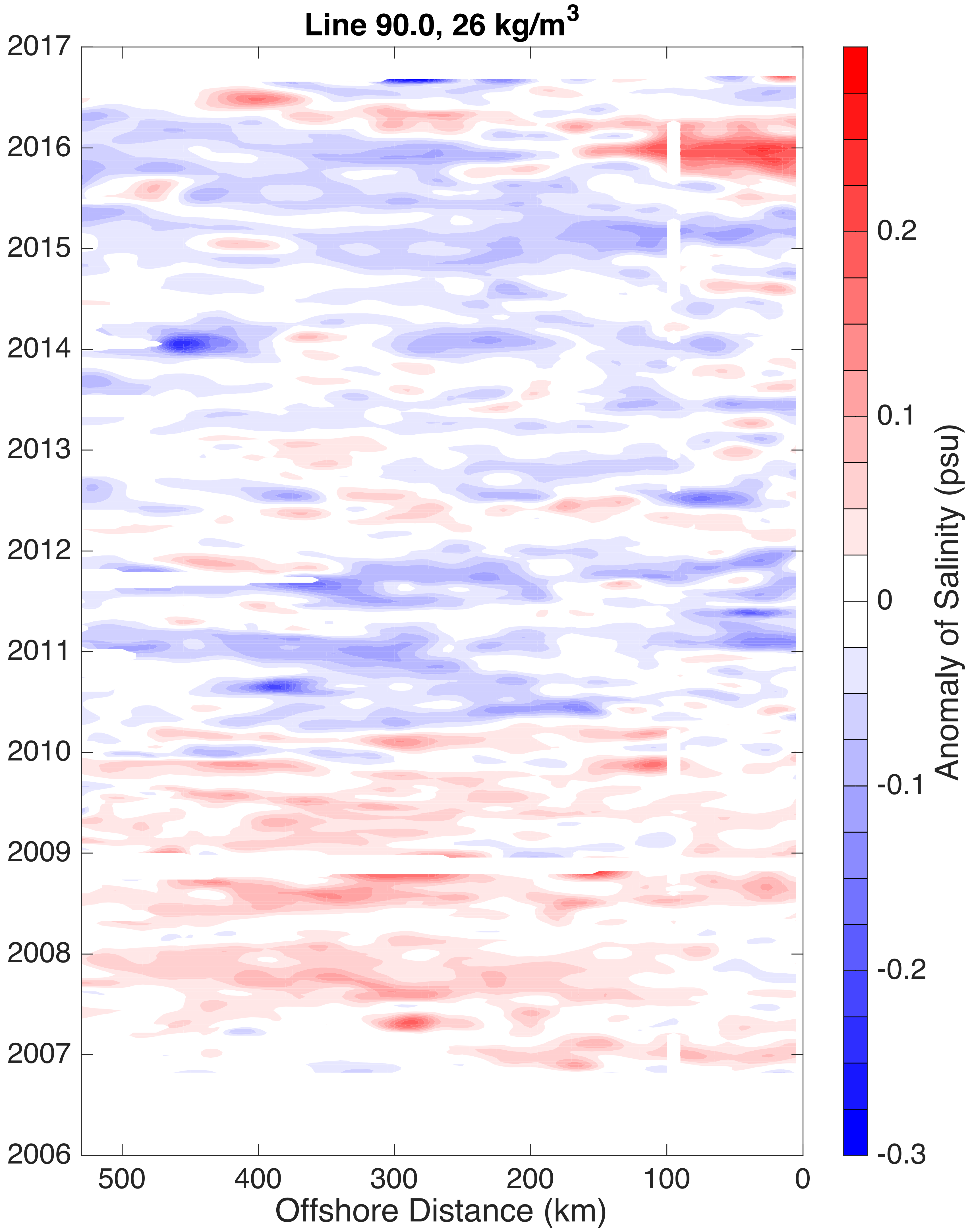
Interannual anomalies on an isopycnal





- Anomalous deepening in 2014-2015
- Greater deepening during 2015-2016 El Niño
- Salinity anomaly during 2015-2016 El Niño

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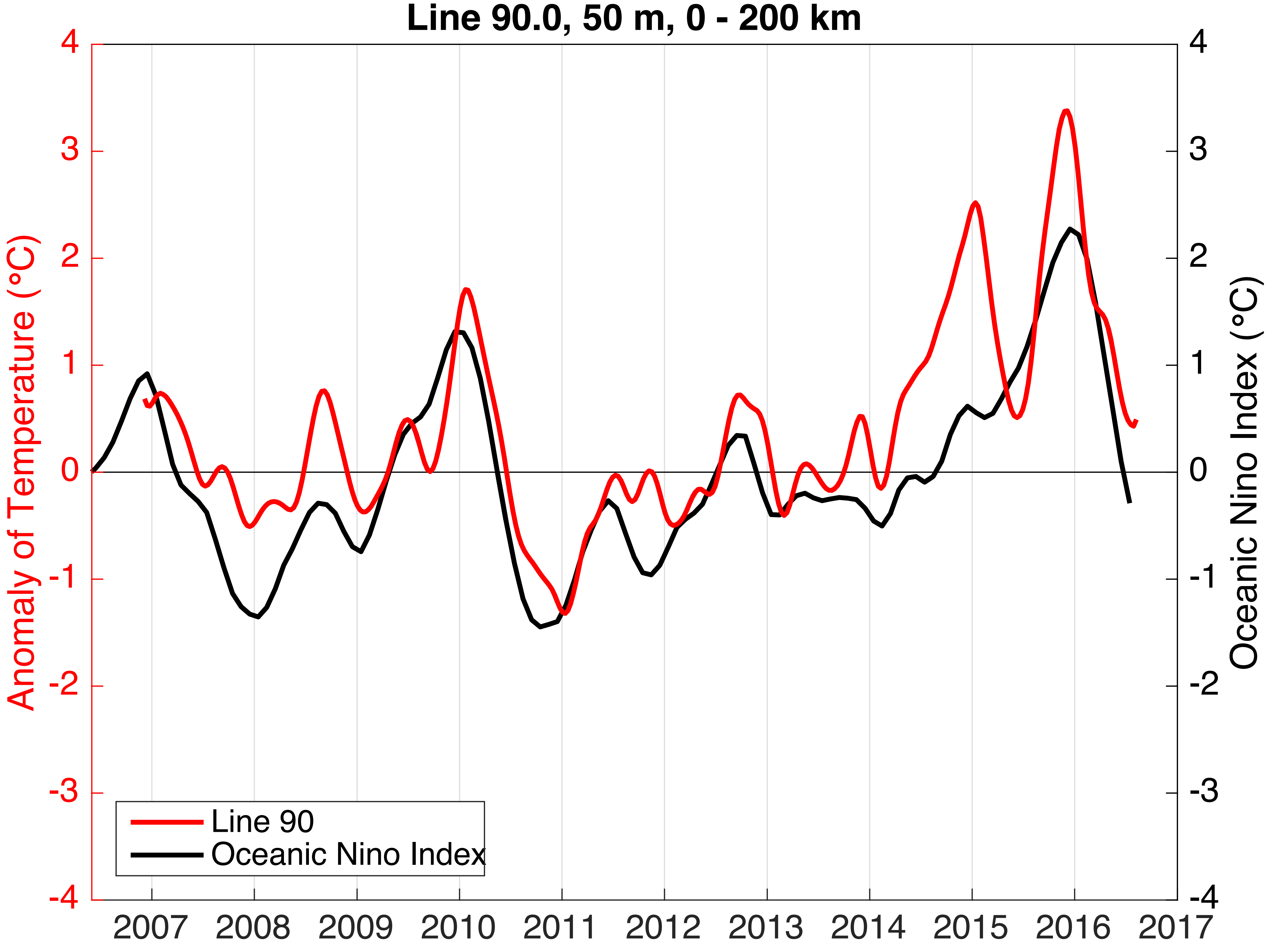
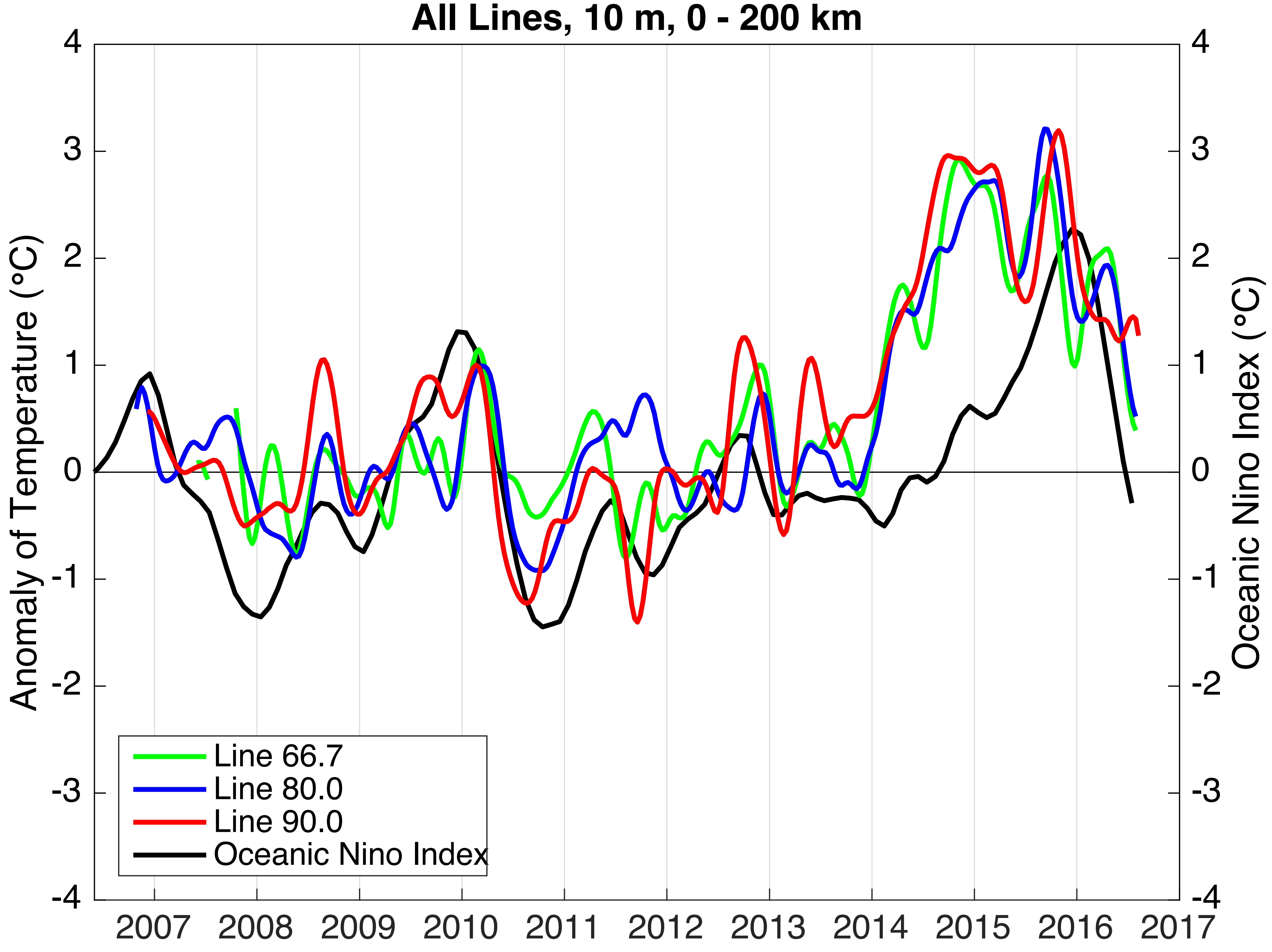
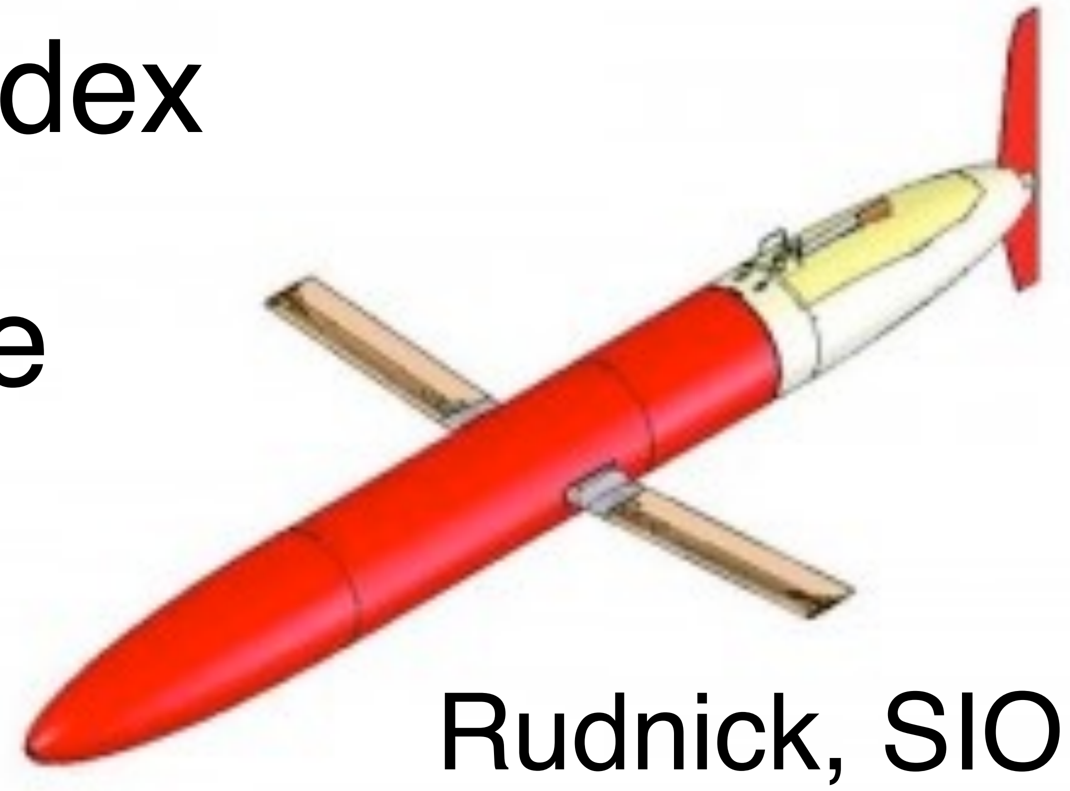
Indices of climate variability in CCS





- 50-m temperature, line 90: Southern California Temperature Index
- 10-m temperature: warming of 2014 happened on a large scale
- http://www.sccoos.org/data/el-nino/



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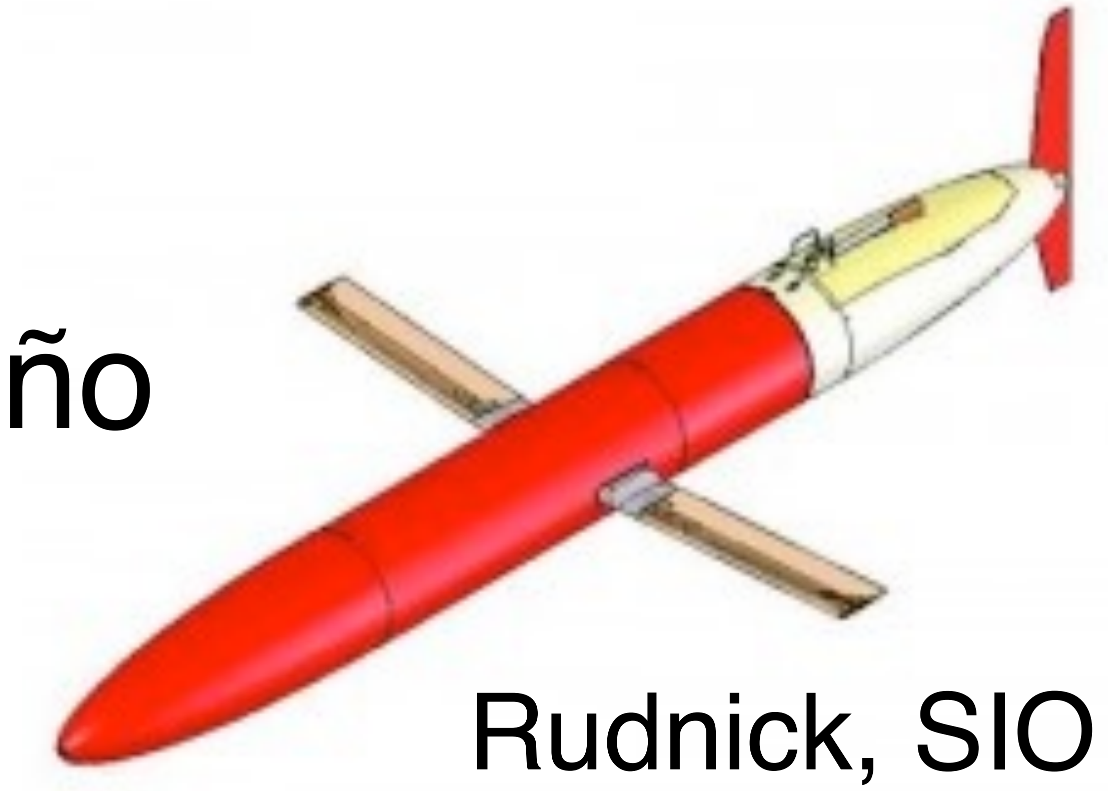
Conclusion

- California Underwater Glider Network (CUGN)
- Nearly 10 years continuous occupation of 3 lines
- A climatology on each line as a function of depth, distance, time
- Highly resolved mean
- New view of annual cycle
- Climate anomalies: 2014-2015 warming, 2015-2016 El Niño



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