Estimating TS Climatologies from Argo Data

Dealing with noise due to mesoscale variability

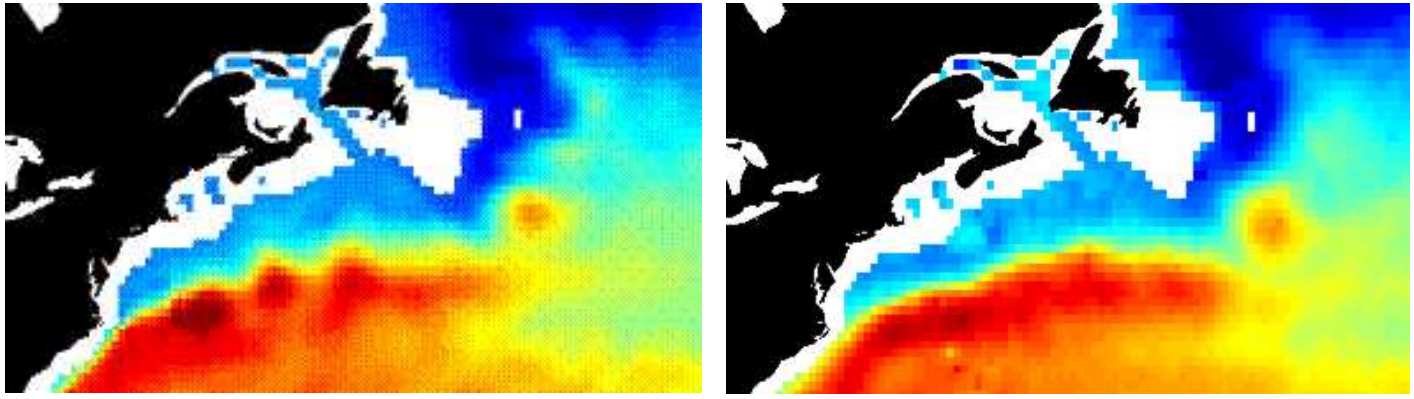
Simon Higginson, Keith Thompson & Yimin Liu

GEOIDE

DALHOUSIE UNIVERSITY
Inspiring Minds

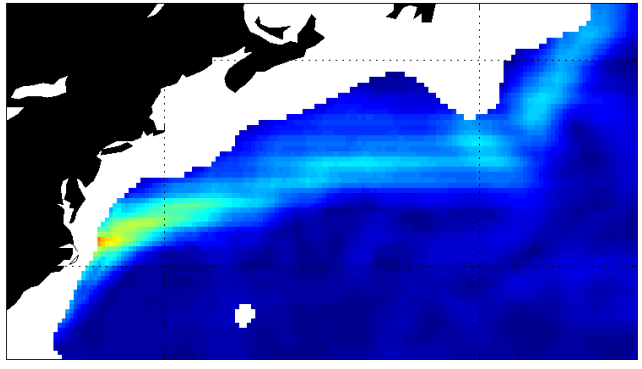
GOAPP
Global Ocean-Atmosphere Prediction and Predictability

Motivation

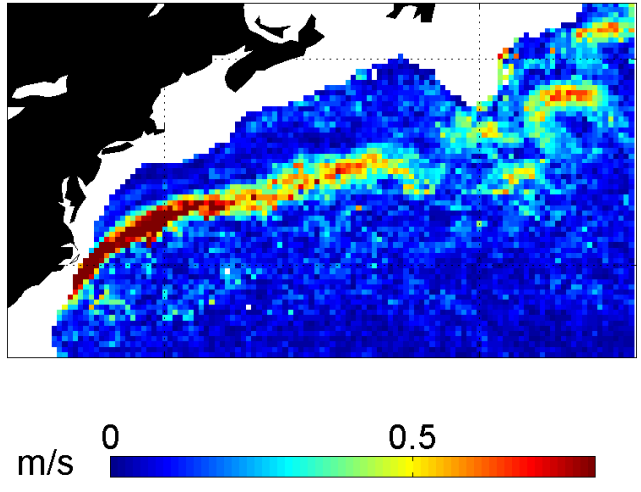


- Mean sea surface topography from a model (left) and observations (right).
- Model is nudged to climatological T,S values.
- "Waves" in the Gulf Stream do not appear in observations.
- What is the cause?

Motivation



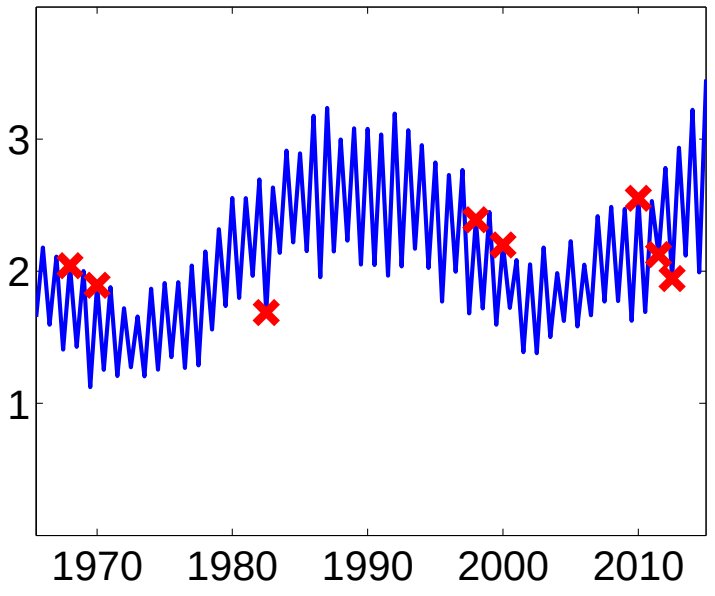
- Levitus 0.25° climatology.
- Geostrophic current from steric height.
- Gulf Stream is too weak and broad.



- Speed from surface drifters.
- Ekman contribution removed.
- Gulf Stream is much stronger and narrower.

Low-frequency variability

- Idealized variability.
- Traditional observations are too sparse to resolve the variability.
- Argo is producing far more observations than were previously available.
- A seasonal climatology can now be defined for a single decade.
- But mesoscale variability remains problematic.



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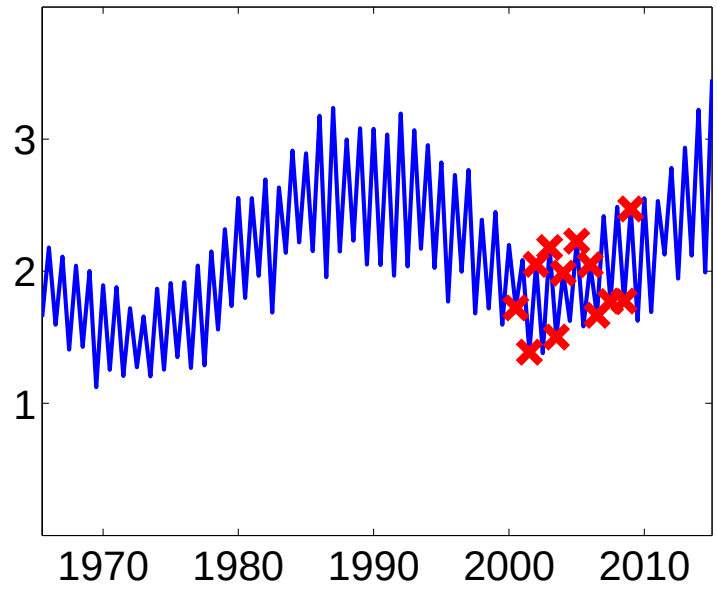

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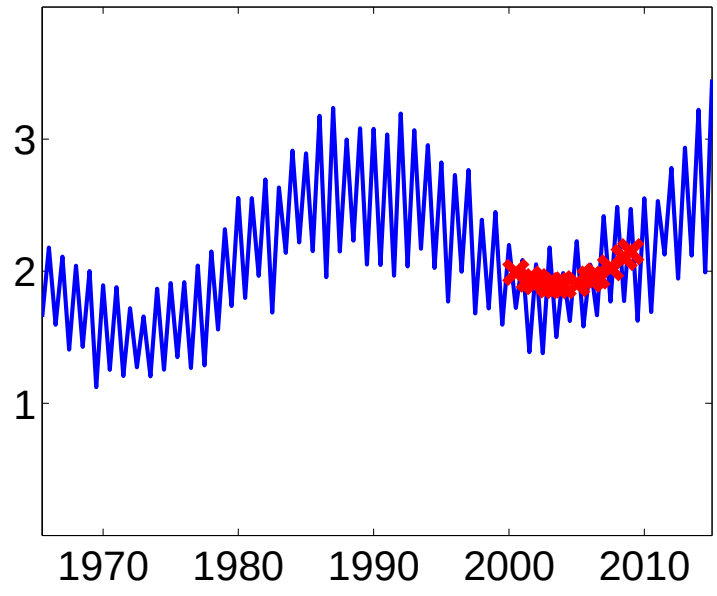
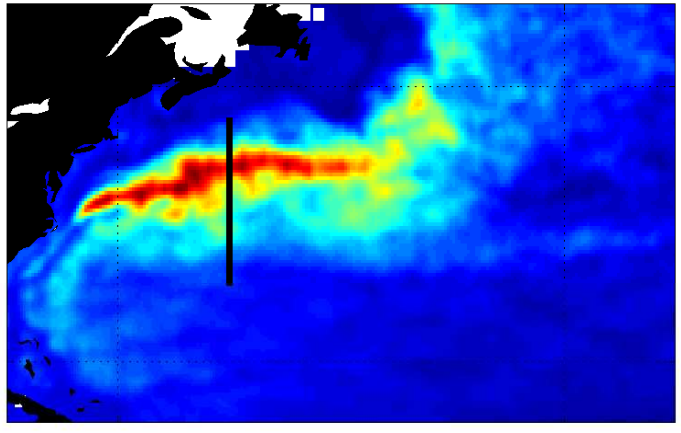
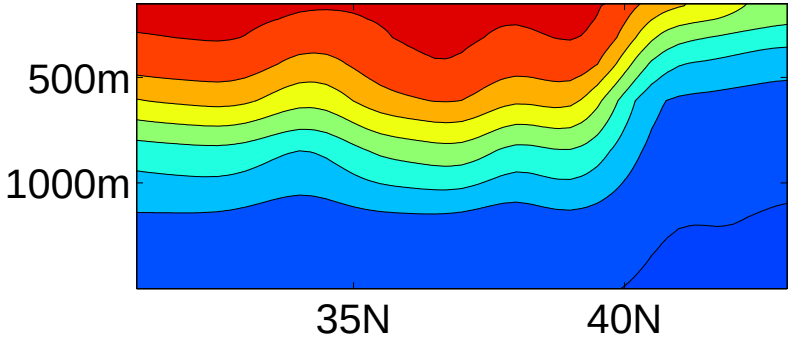


Mesoscale variability



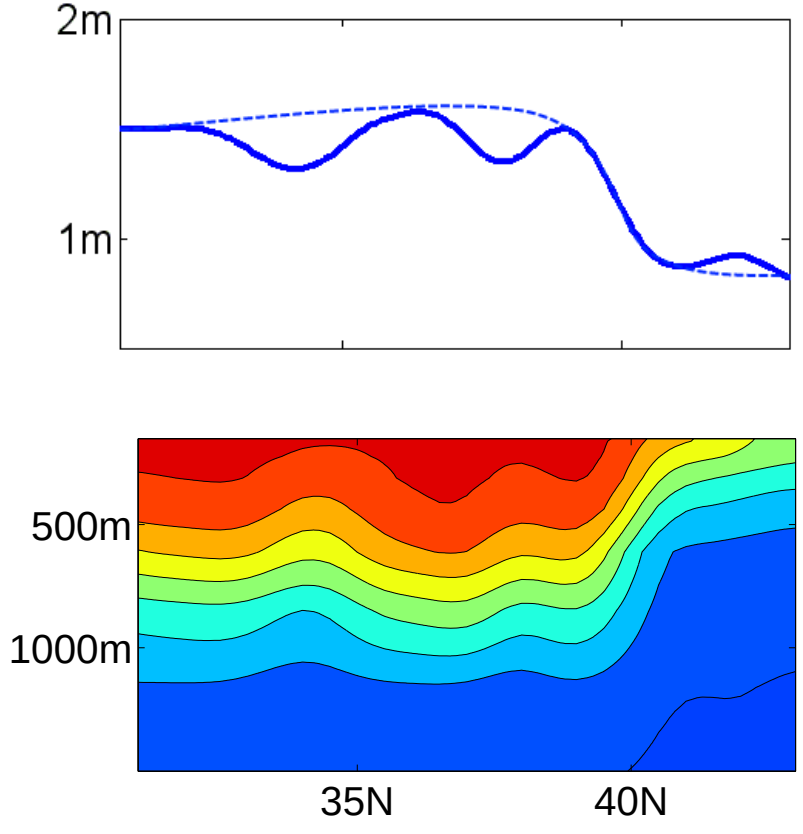


- Variance of altimeter sea surface heights.
- High variability along Gulf Stream ($\sim$40cm).

- Temperature section along 60°W from Argo (April).
- Eddy-like features visible with vertical displacment of isotherms.

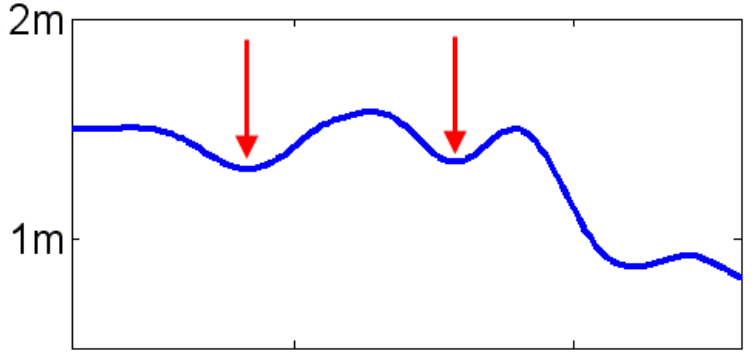
The scheme

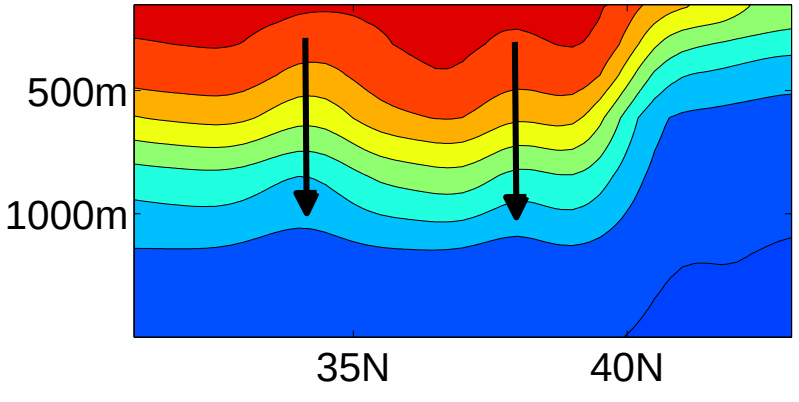
- Try to remove the mesoscale variability.
- Isopycnal displacements produce steric height anomalies.
- Exploit the relationship between the two.



The scheme

- Identify anomalies using satellite altimetry....
- ...and displace the water column accordingly.





The vertical adjustment

Motivated by Cooper and Haines (1996):

$$\delta h = \gamma \frac{\rho_t}{\rho_t - \rho_b} \eta_a$$

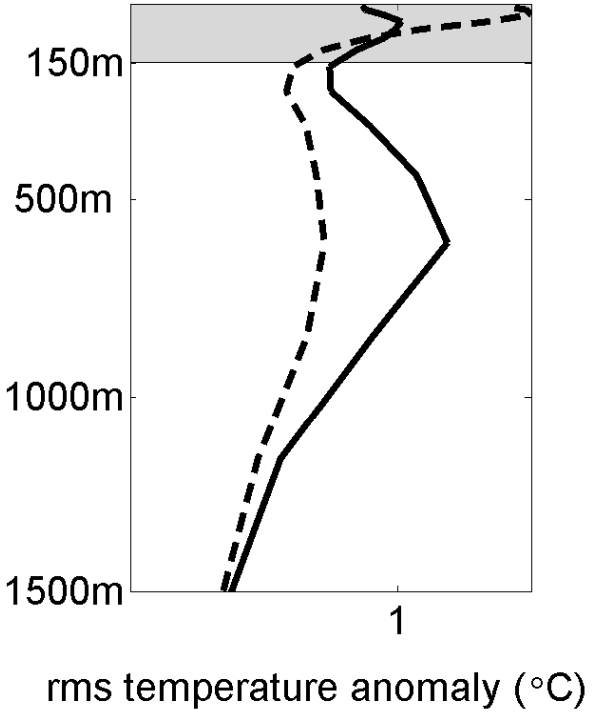
- The displacement δh is uniform with depth.
- ρ_t and ρ_b are potential density at the top and bottom of the water column.
- η_a is the altimeter anomaly.
- γ is an empirical scale factor, constant in space and time.
- For $\gamma = 1$ the adjustment reduces to the CH96 form.

Limitations

Assumptions of the method:

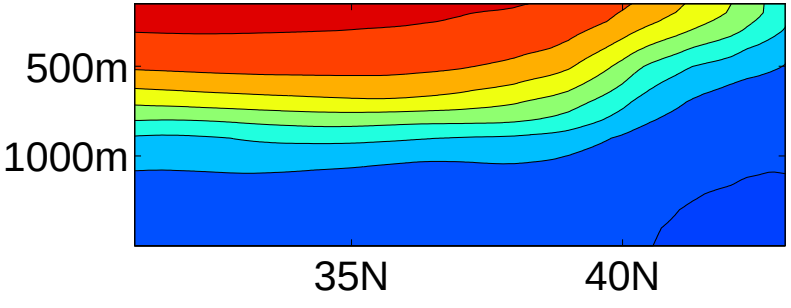
- Displacements are caused by vertical advection.
- Heat and salt inputs, mixing and horizontal transports are ignored.

As a result the method will not work well near the surface or in shallow water.

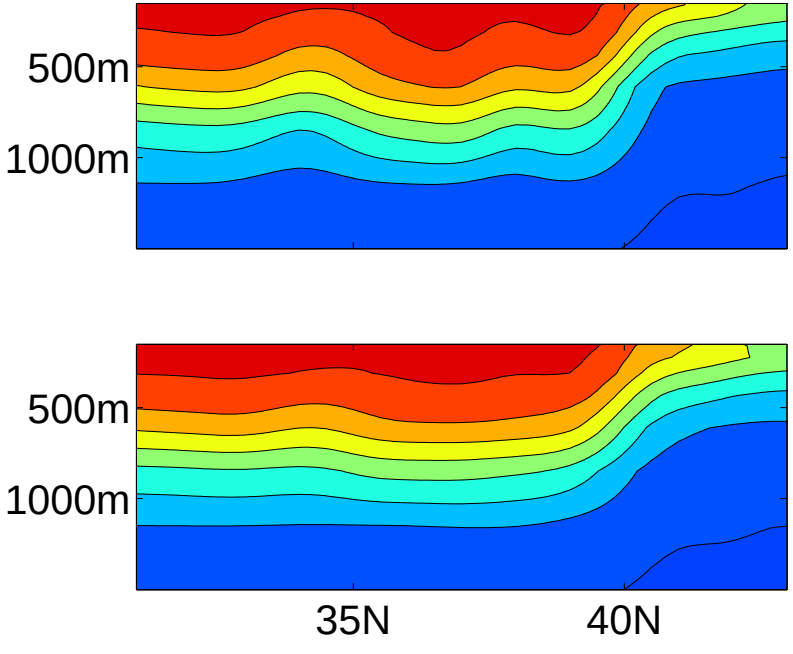


Results: Temperature

Levitus $\frac{1}{4}^\circ$ climatology

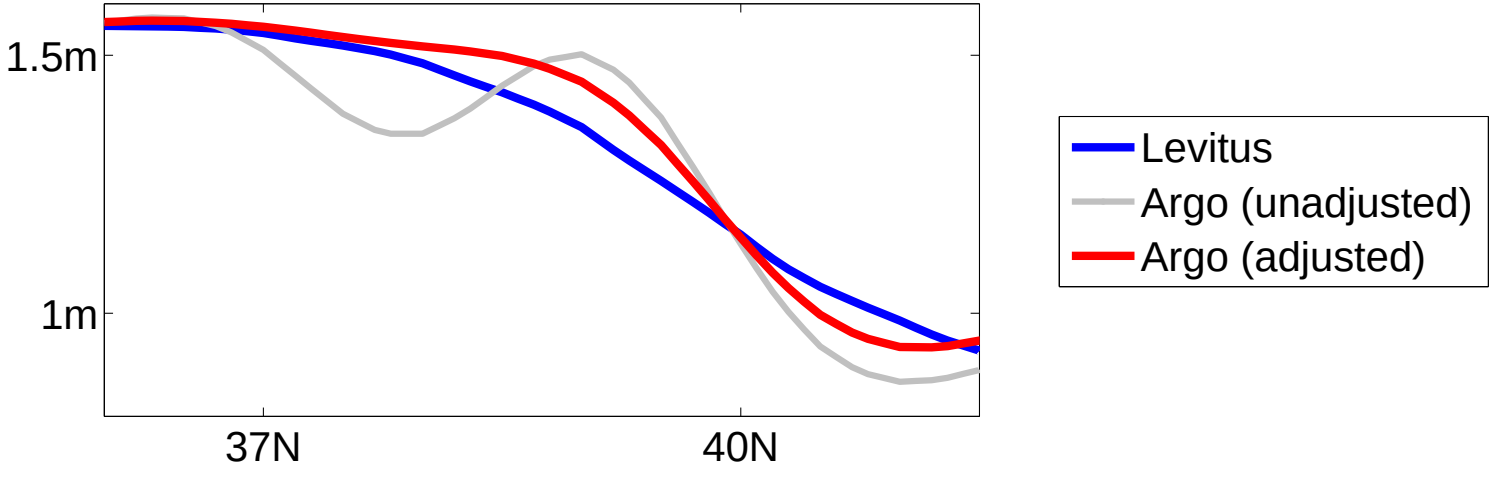


Argo, before and after adjustment

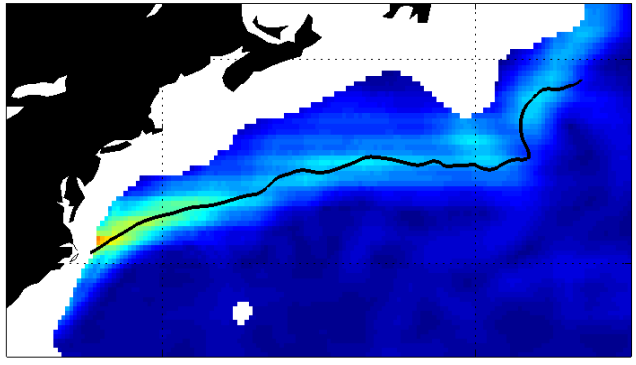


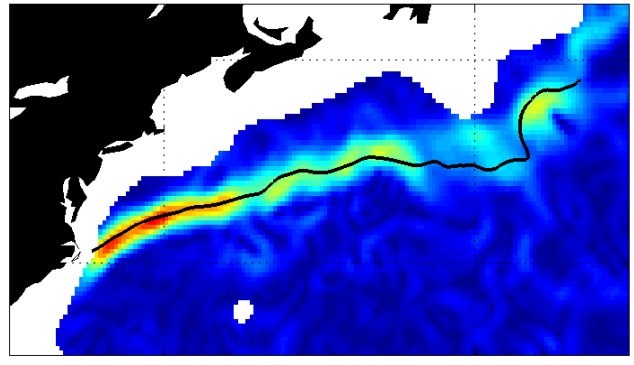
Results: Steric height

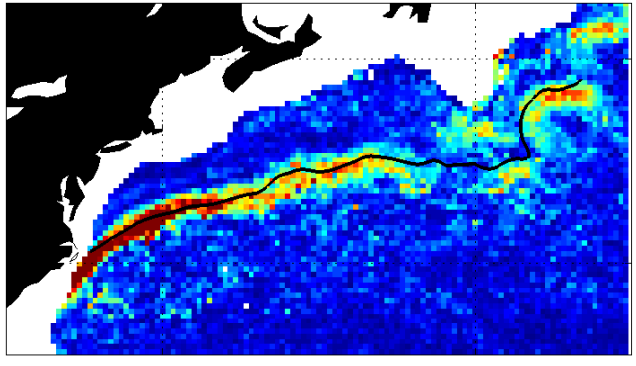
60°W, April:

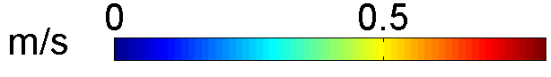


Results: Currents









- Surface currents assuming geostrophy.
- Line of zero skewness for altimeter sea surface height.

Discussion

- A simple method to reduce the mesoscale variability in Argo measurements.
- Reduces TS variance in the Gulf Stream by approximately 50%.
- Used to create a TS climatology for spectral nudging of an operational mesoscale forecast system.
- Short-period climatologies can be used to monitor low-frequency variability, including climate change.
- The future: Apply the method globally and undertake a comparison with results from the GRACE and GOCE geodetic satellite missions.