Strategies to separate internal tides and (sub)mesoscale features

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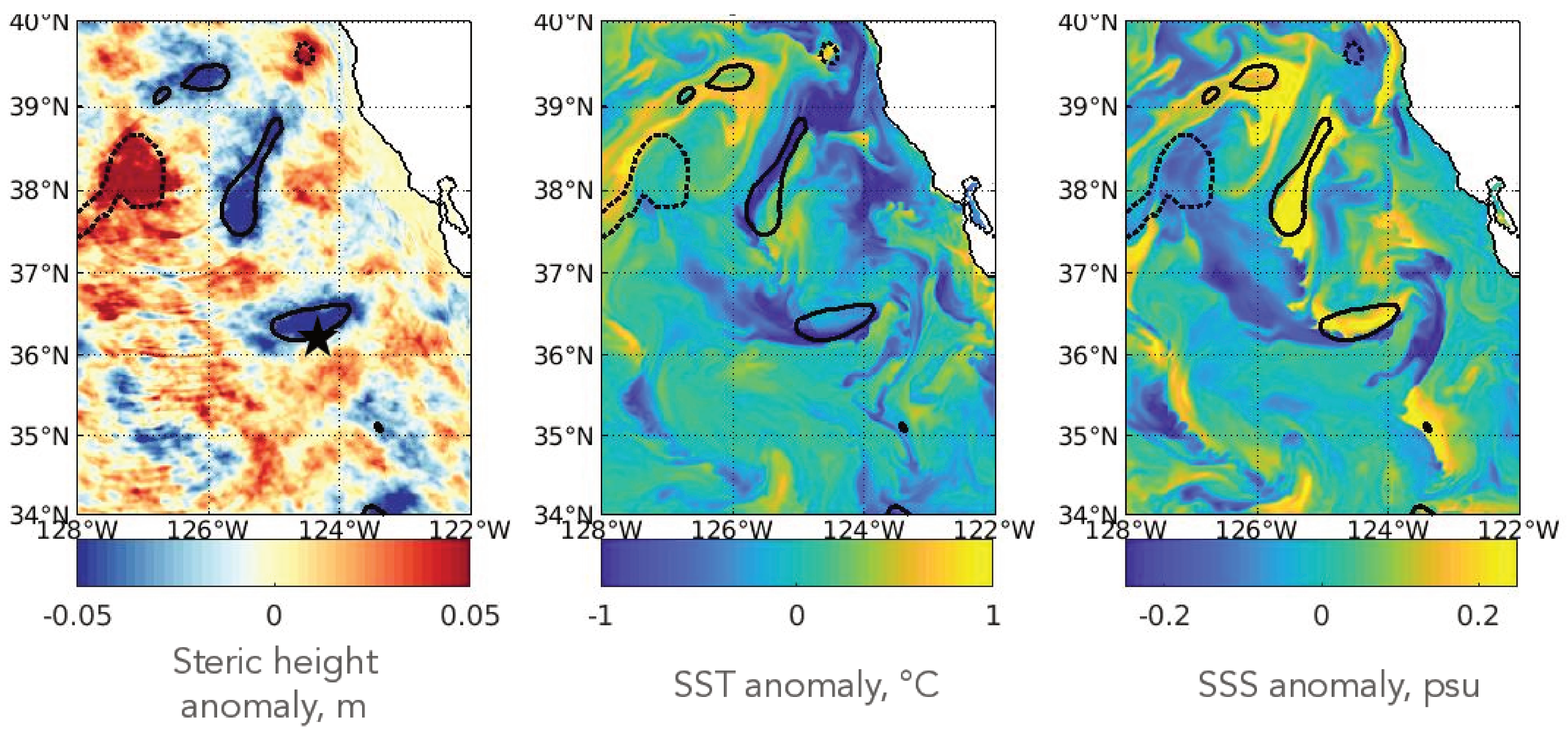
1. Motivation

Extracting useful mesoscale signals from SWOT will require an understanding of all contributions to SSH (mesoscale, internal wave/tide, submesoscale, etc.).

This motivates quantifying the relative strength, scale, and variability of these components.

The California Current is a good testbed, as it is the site –f the S-MODE and SWOT cal/val campaigns, and has strong (sub)mesoscale variability, internal tides, and internal waves.

Snapshot from the MITgcm: California Current, 25 Sept 2012

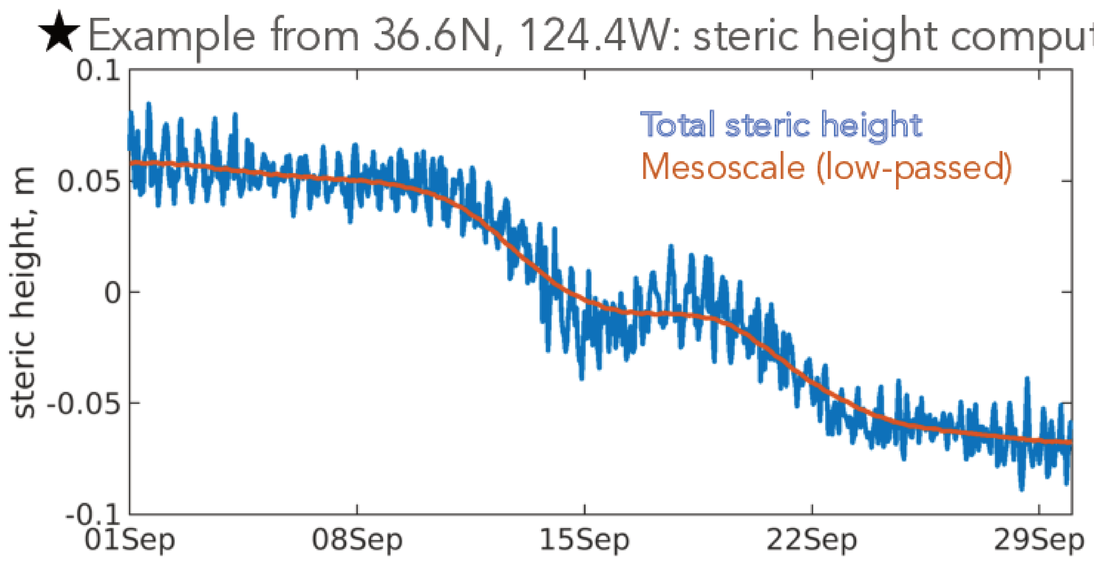


Internal tides, mesoscale features, and smaller-scale variability are all strong.

Submesoscale SST/SSS gradients are strong at the edge of eddies

2. Steric height components

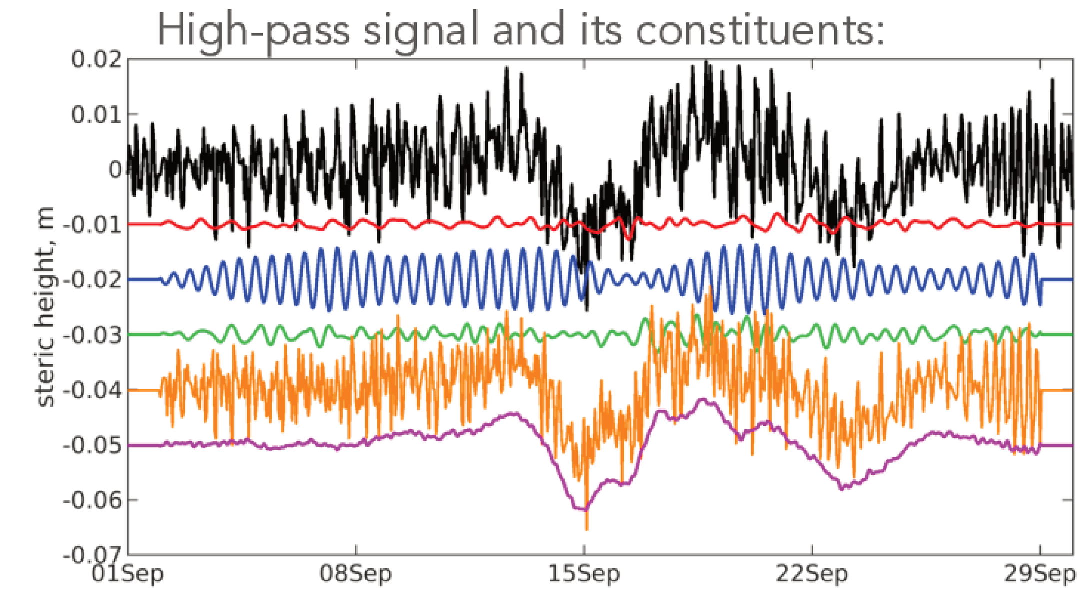
★Example from 36.6N, 124.4W: steric height computed from the MITgcm



Filter in time to separate the mesoscale & high-frequency components of steric height

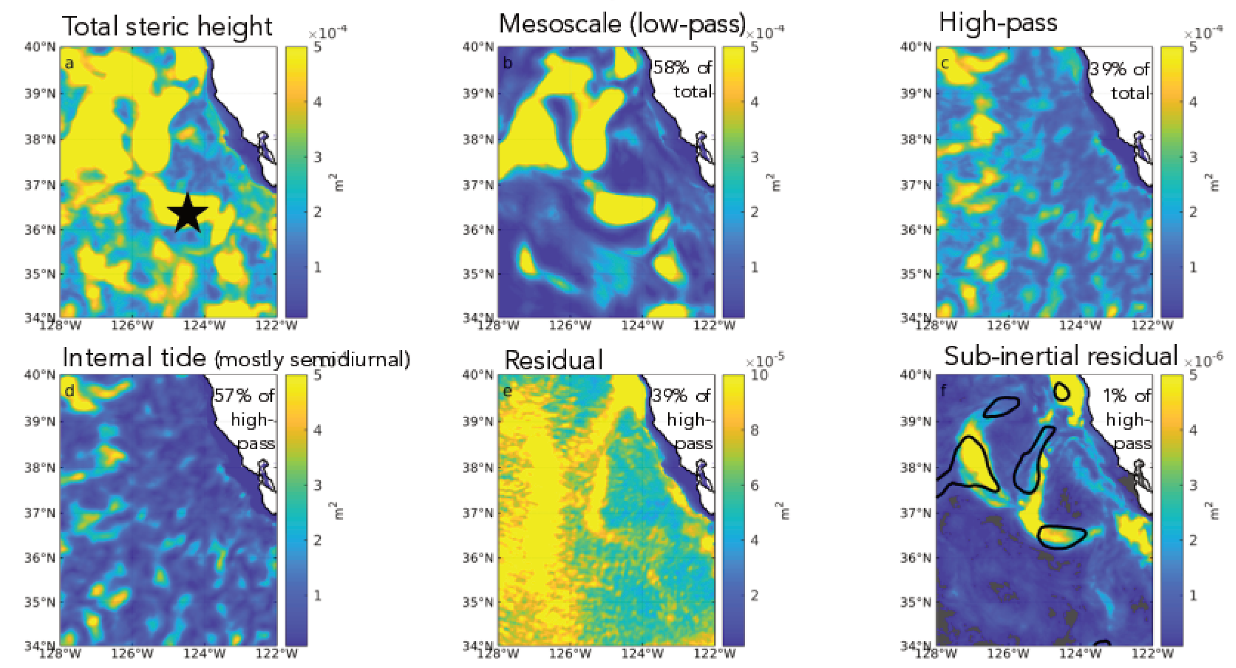
Fit tidal constituents over 3-day windows to separate the internal tide:

High-pass signal and its constituents:



* What's in a residual?
- IGWs (filter out by considering sub-inertial frequencies only)
- Submesoscale signals
- Other tidal frequencies
- Noise

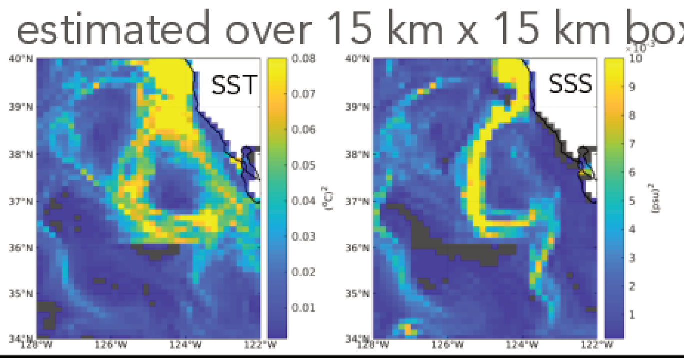
Steric height variance of each component estimated over 1 month (Sept 2012)



Mesoscale & high-frequency variability are both strong: ~40% of the steric height signal is "noise" for SWOT.

Internal tides account for 57% of the high-frequency (non-mesoscale) signal; the residual accounts for 39%. The sub-inertial residual is strong at eddy-edges, i.e., submesoscale signal.

Submesoscale SST/SSS variance estimated over 15 km x 15 km boxes

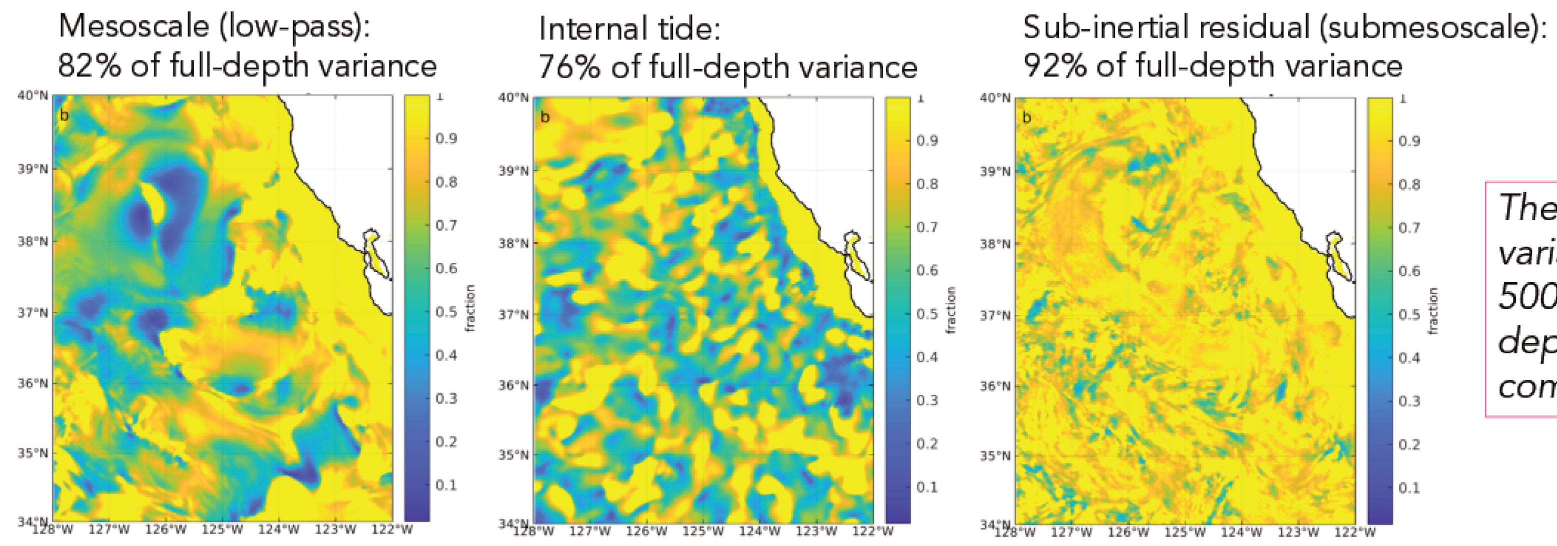


Surface tracer variance is correlated with the sub-inertial residual (submesoscale).

SST variance on this scale can be estimated from satellite measurements.

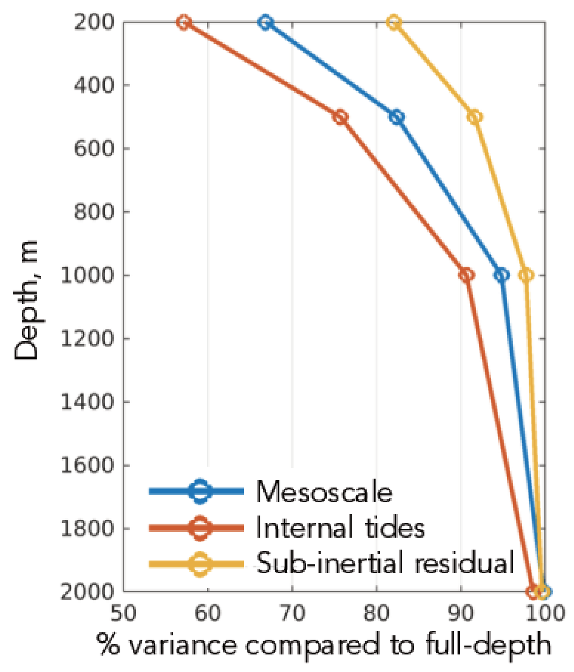
3. Vertical structure

Steric height variance estimated from 500 m to the surface, as a percentage of full-depth SH variance:



The amount of steric height variance captured in the upper 500 m varies spatially and depending on the steric height component.

Percent variance of steric height compared to full-depth, averaged over the domain:



Internal tides: 90% of variance contained in upper 1000 m

Mesoscale: 95% of variance contained in upper 1000 m

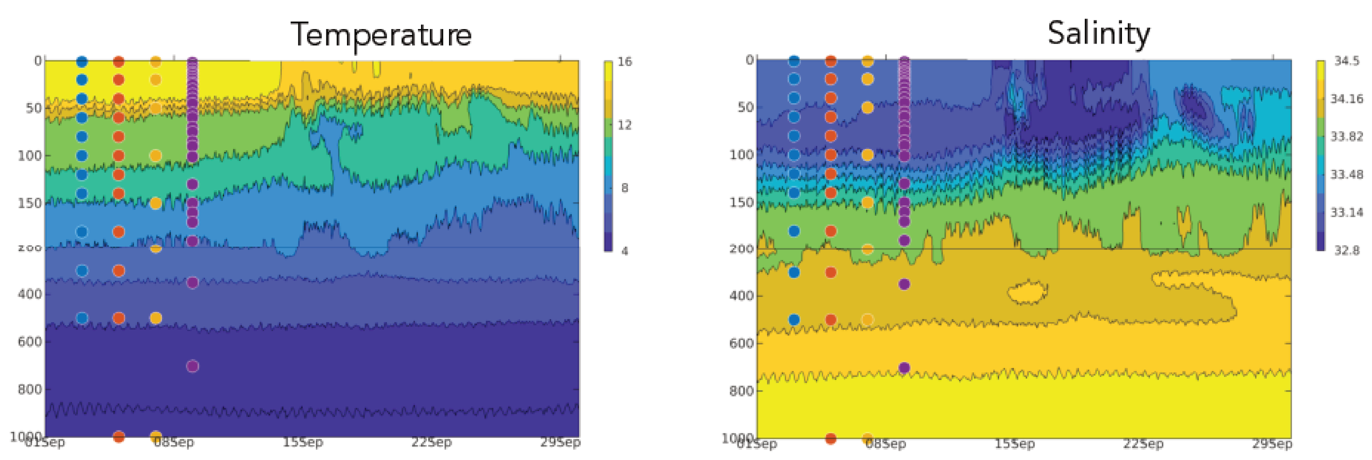
Residual (submesoscale): >80% of variance contained in upper 200 m

To capture mesoscale and internal tide signals, it is necessary to sample to ~1000 m.

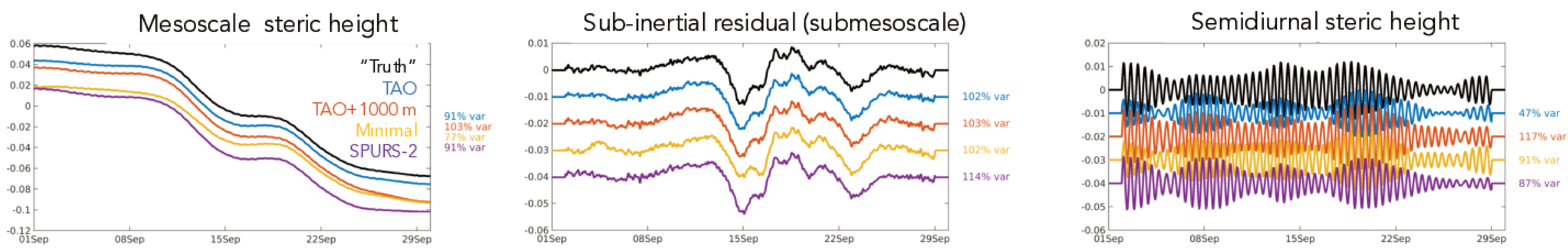
To capture the submesoscale, sampling to 500 m is adequate.

4. Implications: sampling considerations for SWOT cal/val

Vertical T and S sections at 36.6N, 124.4W 36.6N, 124.4W with different mooring configurations (dots)



Steric height components using "data" from the synthetic moorings



A single sensor below ~700 m significantly increases the ability to capture internal tides.

The standard TAO mooring configuration plus one deeper sensor does a good job of capturing most of the steric height variability.

A minimal (relatively inexpensive) mooring configuration with thoughtfully placed sensors can capture most signals of interest.

5. Summary

In the California Current, the mesoscale signals observable by SWOT will account for ~60% of the steric height signal: the rest is due to internal tides and waves, submesoscale variability, and noise.

Surface SST variability (e.g., from satellites) could be useful for inferring the submesoscale component.

To capture the steric height variability due to internal tides, measurements down to 1000 m are necessary; even fairly sparsely instrumented moorings could be adequate for this.

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