Glider & model observations of internal tides

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Summary

Gliders travel slowly enough that they are stationary relative to internal waves, but cover enough ground to map out spatial variability of SSH.

MITgcm 1/48° is subsampled to a 4-month glider path:
– MITgcm reproduces steric height of internal tides and inertial motions well

– ~80% of high-frequency steric height variability is caused by variations in the upper 1000 m and so is captured by gliders sampling to 1000 m

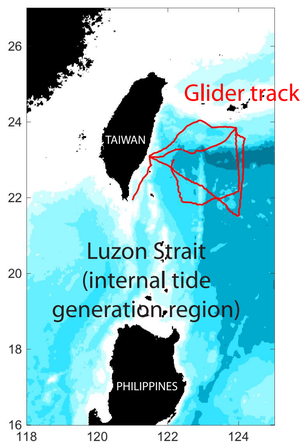
– Wavenumber spectra of glider SH and model-subampled-to-glider SH agree ... but spectra for model snapshots are substantially different

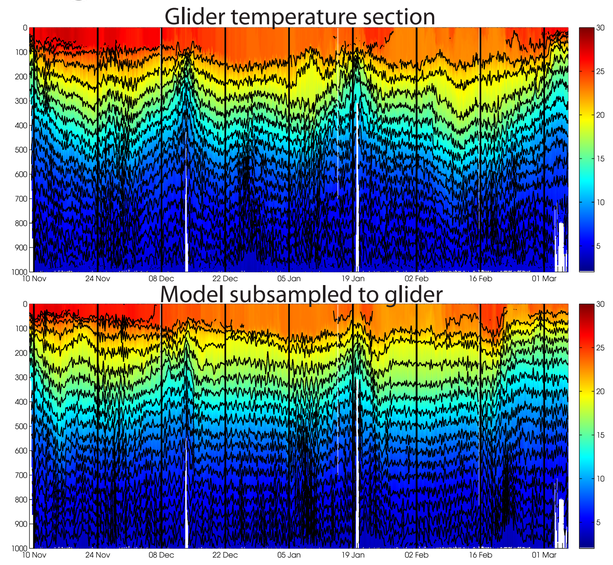
Spatial patterns:
– Semidiurnal internal tides dominate the high-frequency, short-wavelength signal

– Diurnal internal tides are stronger at longer wavelengths

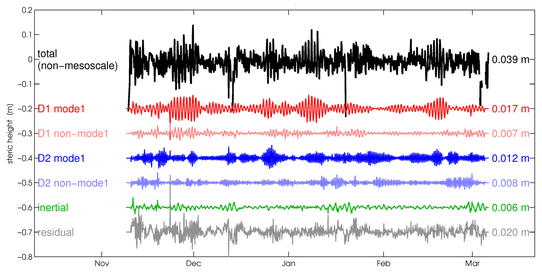
** We can predict the internal tide signal; the residual (the part we can't predict) is <25% of the submesoscale signal everywhere **

Glider–model comparison: model is subsampled to the glider track

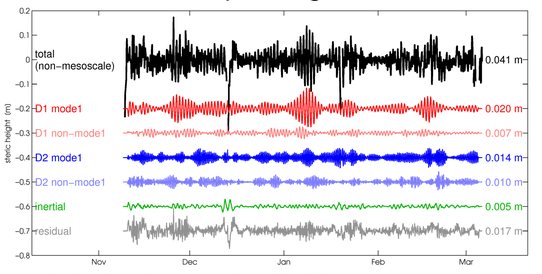


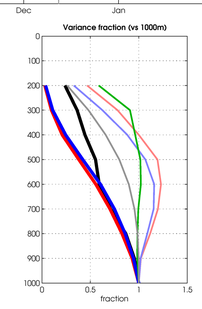


Glider-based steric height:
diurnal, semidiurnal, and inertial components

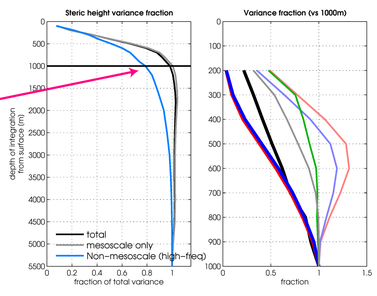


Steric height and its components:
model subsampled to glider track

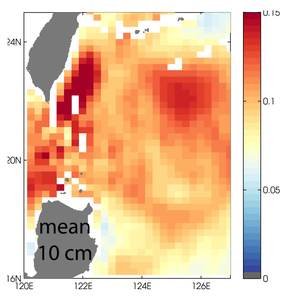




80% of non-mesoscale steric height variance captured in upper 1000 m



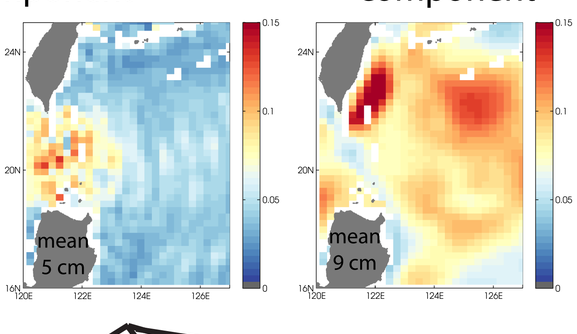
What makes up the steric height signal?



RMS variability of total steric height [m]

High-frequency component

Mesoscale component

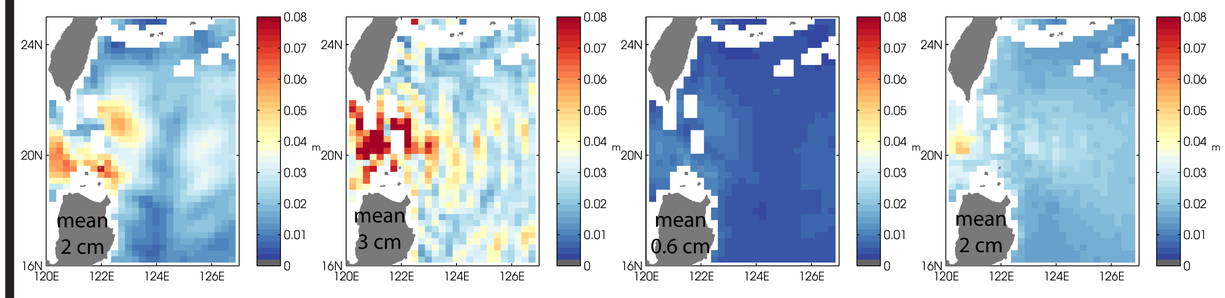


Diurnal SH component

Semidiurnal SH component

Inertial SH component

Residual SH component



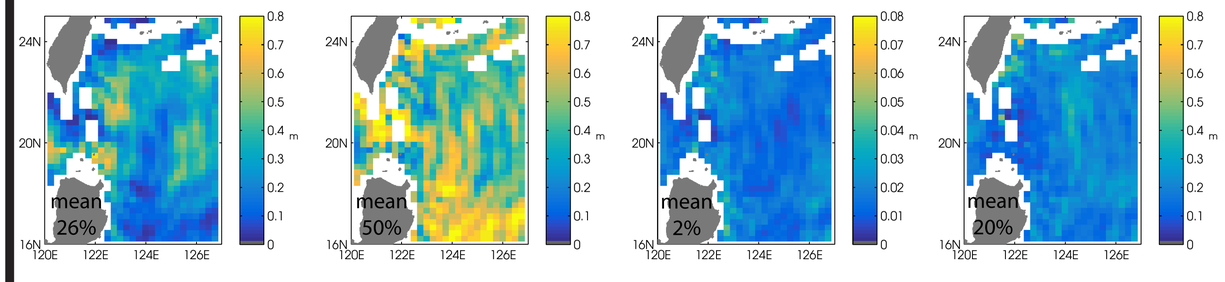
Fraction of high-frequency SH variance:
(*note different scales)

Diurnal

Semidiurnal

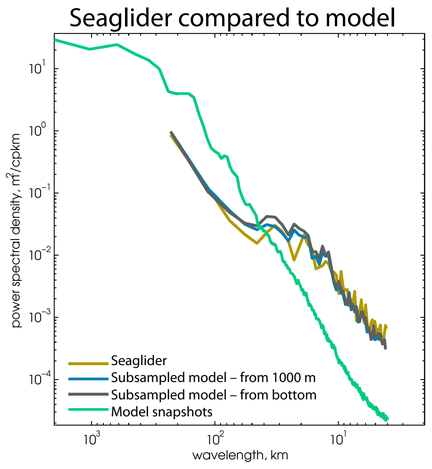
Inertial

Residual

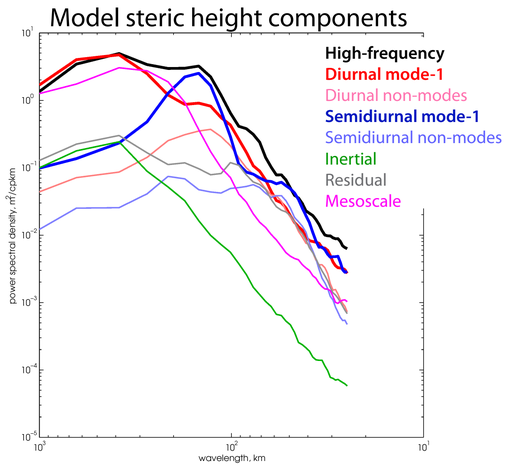


Wavenumber spectra

Seaglider compared to model



Model steric height components



Model captures steric height well at all scales

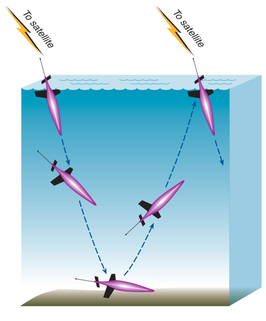
Sampling to 1000 m captures variability at all scales

Internal tide energy is mostly in mode-1

Diurnal signal dominates at wavelengths >200 km, semidiurnal at shorter scales

Residual is always smaller than internal tides

Seagliders:



– 4 km horizontal resolution
– 150–300 km-long transects
– T,S, pressure (measured)
– Dynamic height, geostrophic velocity (derived)

MITgcm model:

– LLC4320 simulation
– ECMWF surface boundary conditions
– 2.2 km horizontal resolution at equator
– 90 vertical levels
– Hourly outputs
– >1 year of output available (so far)
– Includes tides
– Not data constrained