Influence of Stratification on Semidiurnal Tides in Monterey Bay, CA

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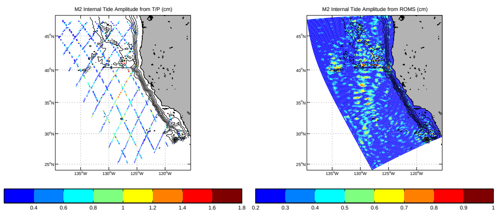
ABSTRACT

As part of our on-going effort in developing a tide-permitting coastal forecasting system, the internal tides in Monterey Bay, CA are investigated by using numerical models and comparing model solutions with altimetry and high-frequency coast radar observations. Models used are configured from the Regional Ocean Modeling System (ROMS) and have horizontal resolutions ranging from 16km to 1.6km.
The amplitudes and phases of internal tides generated by the model around the Mendocino Escarpment have significant correlation coefficients with the altimetry observations from TOPEX and GFO. Numerical experiments from high resolution model for Monterey Bay show that the surface tidal current is sensitive to stratification through the changes in both barotropic and internal tidal current. For given bathymetry and model configuration, surface tidal current can be improved with a better representation of stratification.

Internal Tides around Mendocino Escarpment



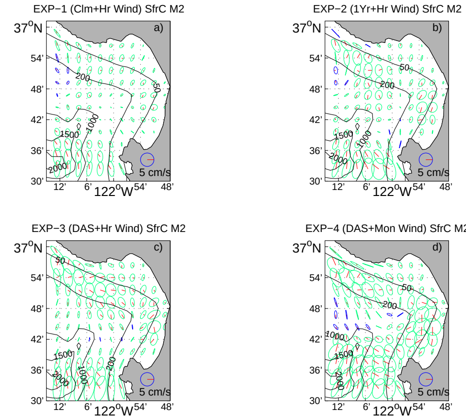
Internal tide amplitude derived from TOPEX altimetry (left) and from model (right) with a resolution of 16km. Both altimetry observation and model results indicate that the internal tides are generated around Mendocino Escarpment and propagate away from the generation sites.

Comparison with Altimetry Observations

Satellite	Sample #	Mean Amp	Std Amp	Corr (Amp)	Corr (Pha)
TOPEX	1013	0.52	0.30	0.195	0.103
T/P-Tandem	1070	0.76	0.41	0.009	0.072
GFO	1855	0.81	0.46	0.101	0.087
ROMS	1013	0.25	0.15	1.000	1.000

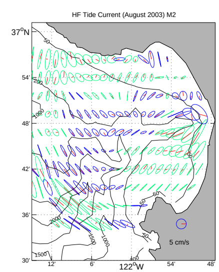
Correlation coefficient for amplitudes and phases greater than 0.08 are significant at 99% level by Monte Carlo simulations. Cycles 4-364 for TOPEX were used; cycles 369-479 for T/P Tandem were used; and cycles 37-168 for GFO were used, A 300km low-pass filter was used to remove barotropic tides.

Surface Tidal Currents with Different Stratification

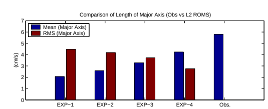


Surface tidal current ellipses for M2 constituent from model runs with a resolution of 6km and with different initial conditions and atmospheric forcing. **Experiment 1** starts from Levitus climatology. **Experiment 2** starts from a 1-year spin-up run from Levitus climatology. **Experiment 3** starts from a data-assimilated initial condition of August 2003 and uses hourly wind stress forcing (so are the Experiments 1 and 2). **Experiment 4** starts from the same initial condition as Experiment 3 but uses monthly wind stress forcing. A tidal current ellipse shows the length of semi-major axis, the length of semi-minor axis, the inclination from due east. Blue ellipses mean that the tip of current vector rotates counterclockwise, and green ellipses mean clockwise rotation. The red line in each ellipse shows the direction of current when the sea surface height reaches its maximum at Monterey tide gauge.

Comparison with HF Coastal Radar Observation

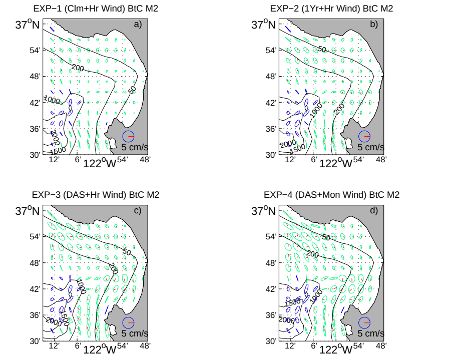


Surface tidal current ellipses for M2 from high-frequency coastal radar observations for August 2003.

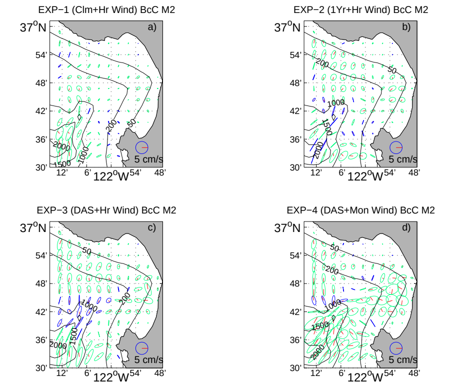


Root-mean-square discrepancy of the length of semi-major axis between model and high-frequency coastal radar observations (red), and the Monterey Bay area average of the length of semi-major axis (blue) for M2 current ellipses. The area average of the length of semi-major axis from observations is also shown.

Barotropic Tidal Current with Different Stratification



Surface Internal Tidal Current with Different Stratification



Subtle changes in stratification can cause changes in both barotropic and internal tidal currents. With better representation of stratification, the internal tide solution cab be improved.

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