Interactions Between Coastal and Offshore Circulation

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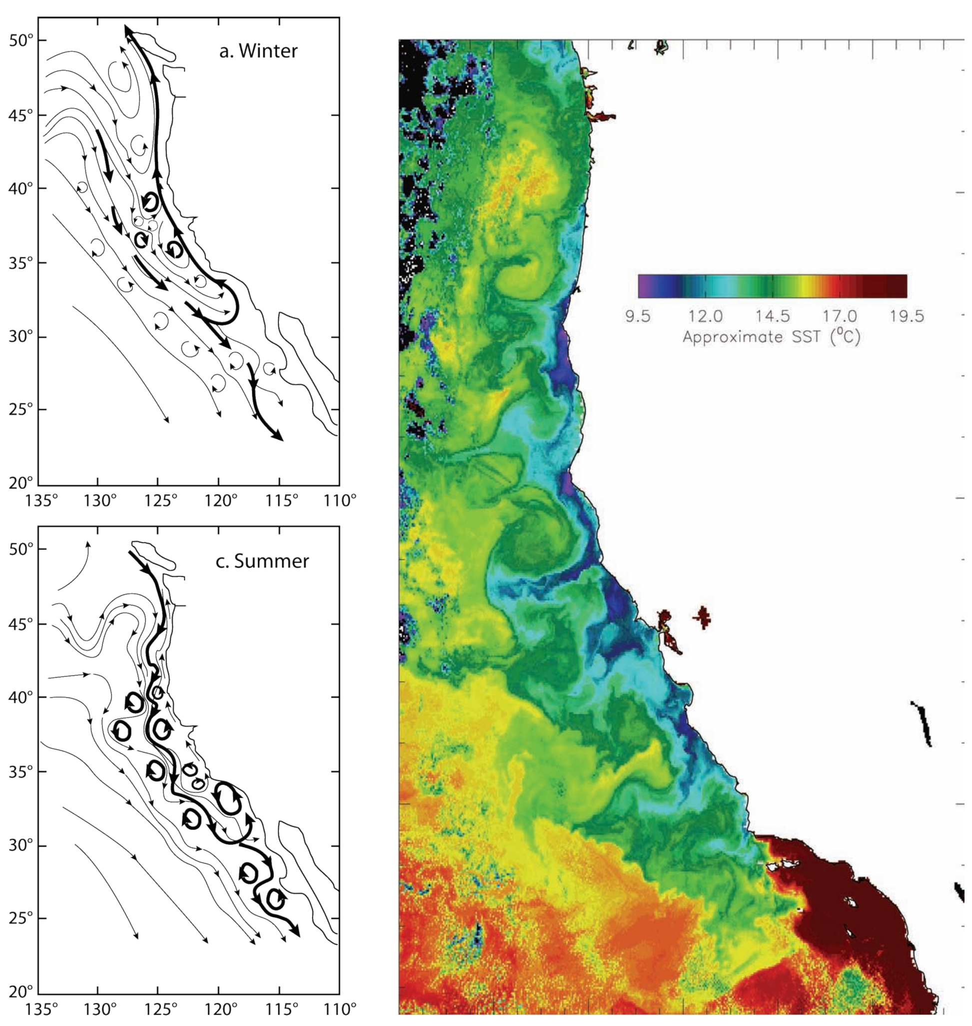
Scientific Objectives: Quantify the extent to which the offshore regional to basin-scale circulation affects the local circulation in three different coastal regions.

Validation Activities: Initial comparisons of Jason-1 and Jason-2 in regions of interest. Uses of J1 and J2 data in extensive scientific analyses provide the most comprehensive tests of the data.

Methodology: Extend the alongtrack SSH data into the region within 0-50 km of the coast. Define coastal circulation statistics and compare to basin-scale modes. Explore details of these interactions with nested regional models.

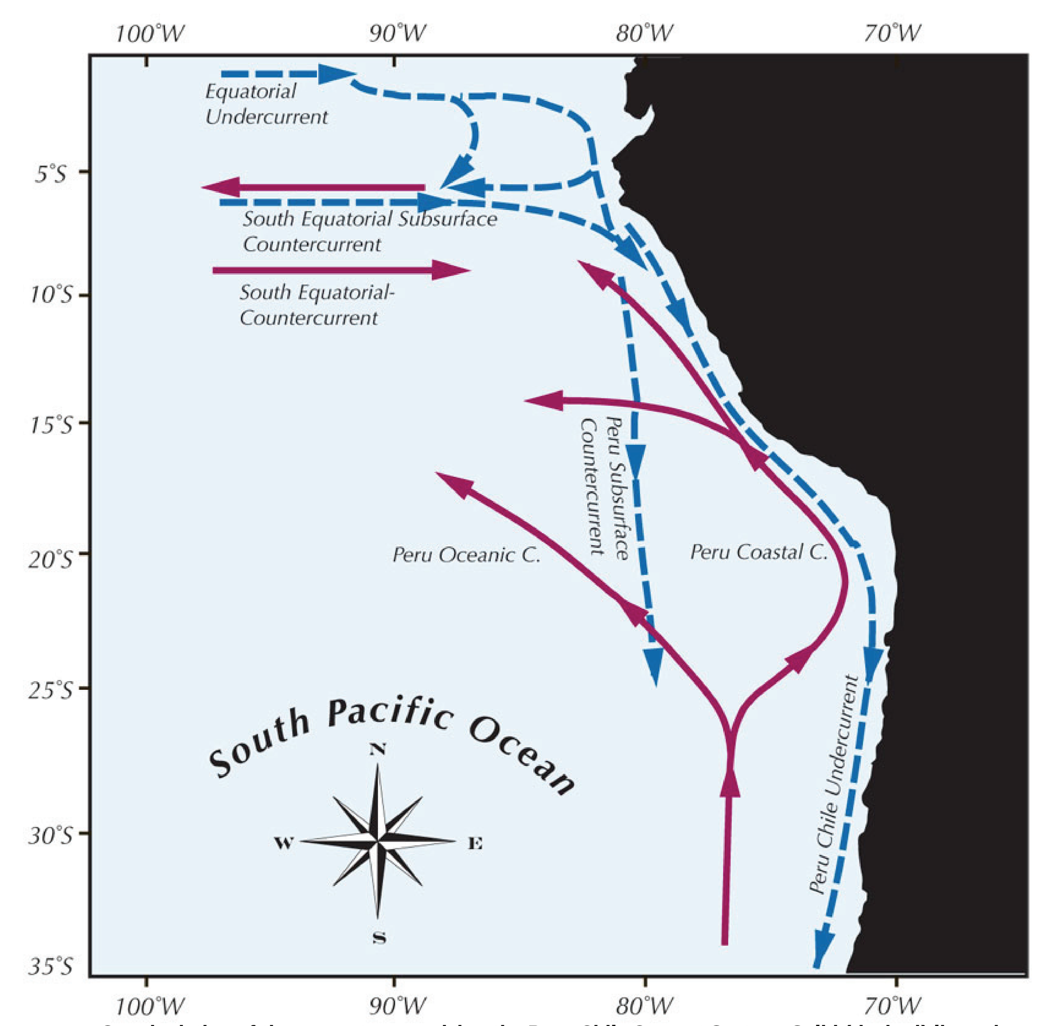
Three Systems of Interest with Different Characteristics

The NE Pacific California Current



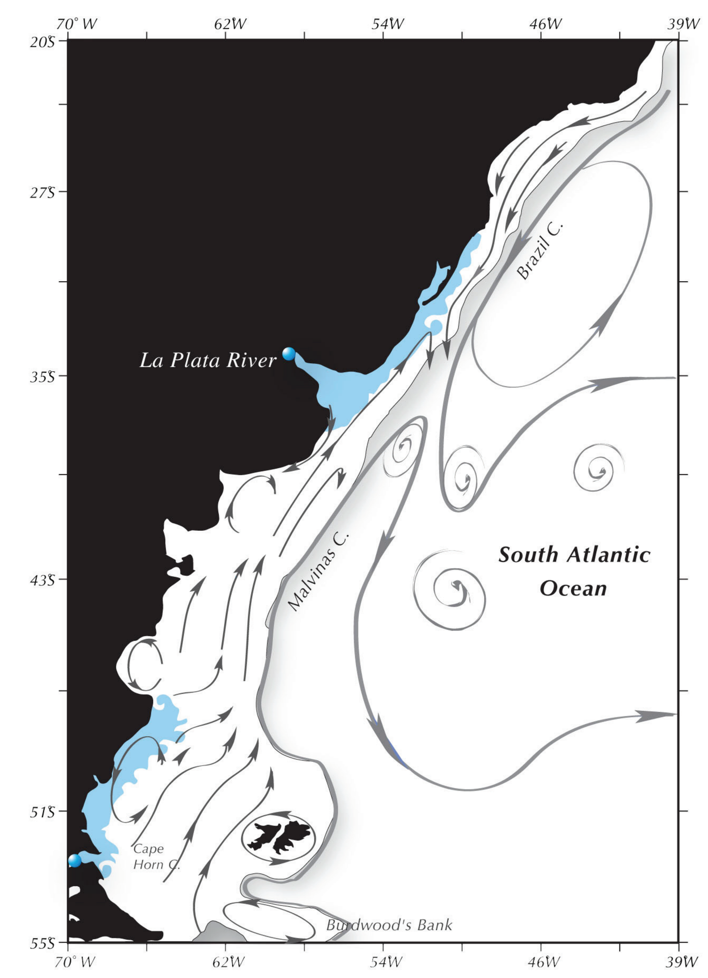
Left: One depiction of the seasonal changes in circulation in the California Current. An equatorward jet that develops next to the coast in spring, moves offshore and develops meanders and eddies in summer, while the coastal jet reverses in winter.
Right: SST (AVHRR) in August 2000.

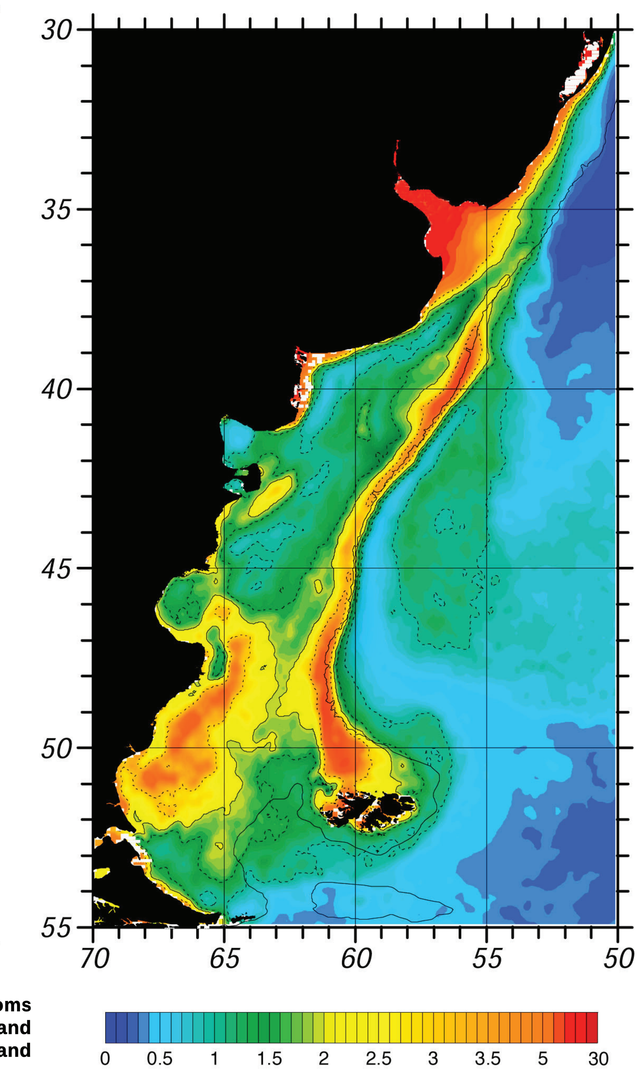
The SE Pacific Peru-Chile Current



One depiction of the currents comprising the Peru-Chile Current System. Solid (dashed) lines show surface (subsurface) currents. Opinions differ as to the offshore distance and latitudinal extent of the different components of the overall system. Seasonal changes in the currents are much weaker than in the California Current, but connections to the Equator are stronger.

The SW Atlantic Brazil and Malvinas Currents



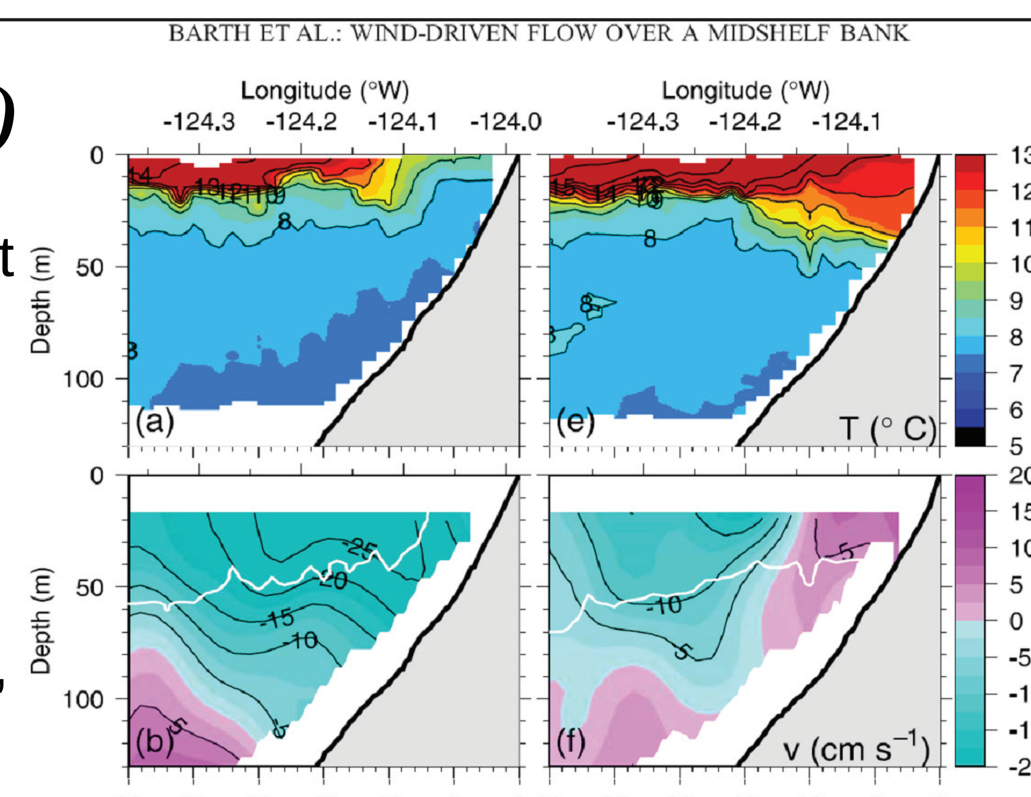


Left: A schematic view of the Brazil and Malvinas Currents.
Right: Surface cholorophyll-a concentrations. Note the productive blooms along the shelf break in the Malvinas Current. Resolving the tidal and coastal circulation over the wide shelf is a challenge for altimetry and models.

The California and Peru-Chile Currents are Eastern Boundary Currents with strong upwelling systems and relatively narrow shelves. The California Current is strongly seasonal, with weak connections to the equator, while the Peru-Chile Current is weakly seasonal, with strong Equatorial connections. The Brazil and Malvinas Currents are opposing Western Boundary Currents with relatively weak seasonal cycles and wide shelves. All three systems are affected by inflow from higher latitudes.

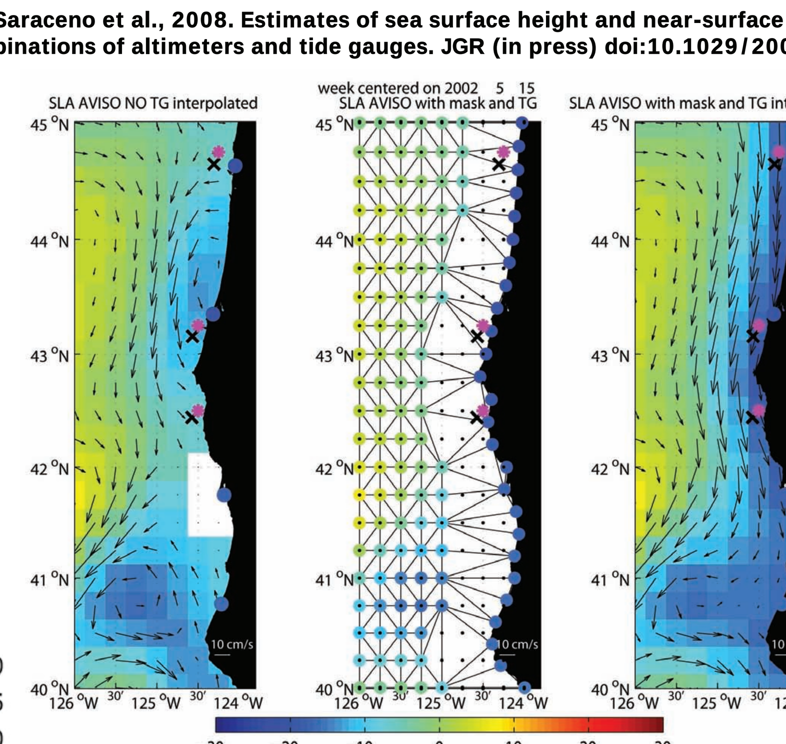
Coastal Circulation (Figures to Right)

The coastal circulation often consists of jets and features within the 50 km next to the coast (left panels), which are not well resolved by traditional altimeter data (middle). A crude approach is to ignore the altimeter data within a coastal band and interpolate across that band to tide gauges (middle). The real solution is to retrieve the alongtrack data closer to the coast, a goal of this project (right panel).

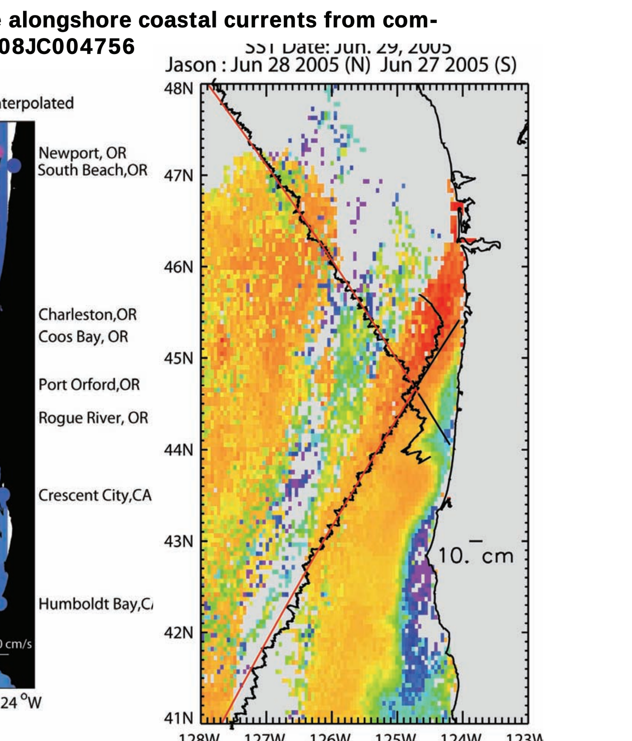


Temperature (top) and alongshore velocity (bottom) off Oregon (45N, August 2001) for upwelling (left) and downwelling (right) favorable winds. The strong coastal jets occur within 30 km of the coast in this region and season.

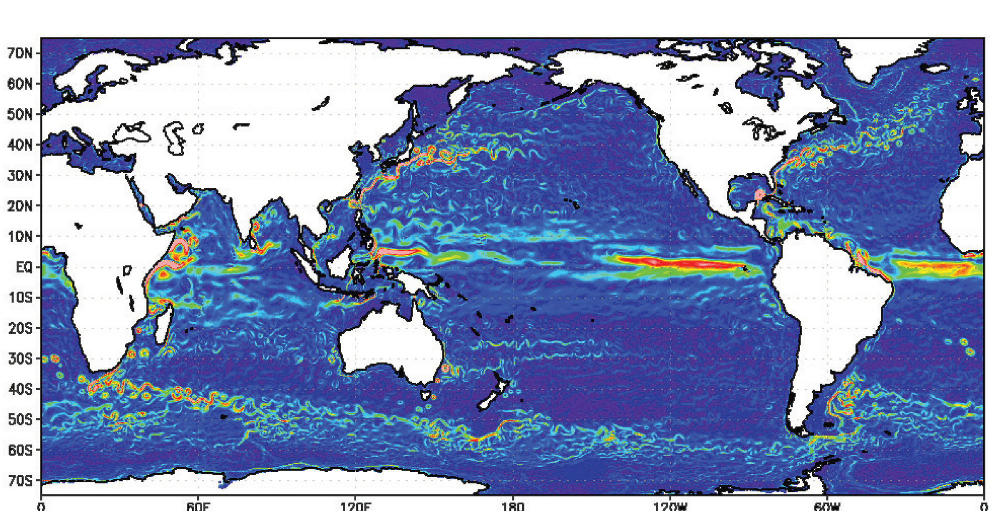
Saraceno et al., 2008. Estimates of sea surface height and near-surface alongshore coastal currents from combinations of altimeters and tide gauges. JGR (in press) doi:10.1029/2008JC004756



Left: Geostrophic velocities (vectors) from AVISO gridded SSH (colors) in May, 2002 (left).
Middle: Grid-points for offshore SSH and interpolated onshore tide gauge SSH, used to interpolated across a coastal band.
Right: Geostrophic velocities and SSH from the newly interpolated SSH field. The offshore fields are unchanged.



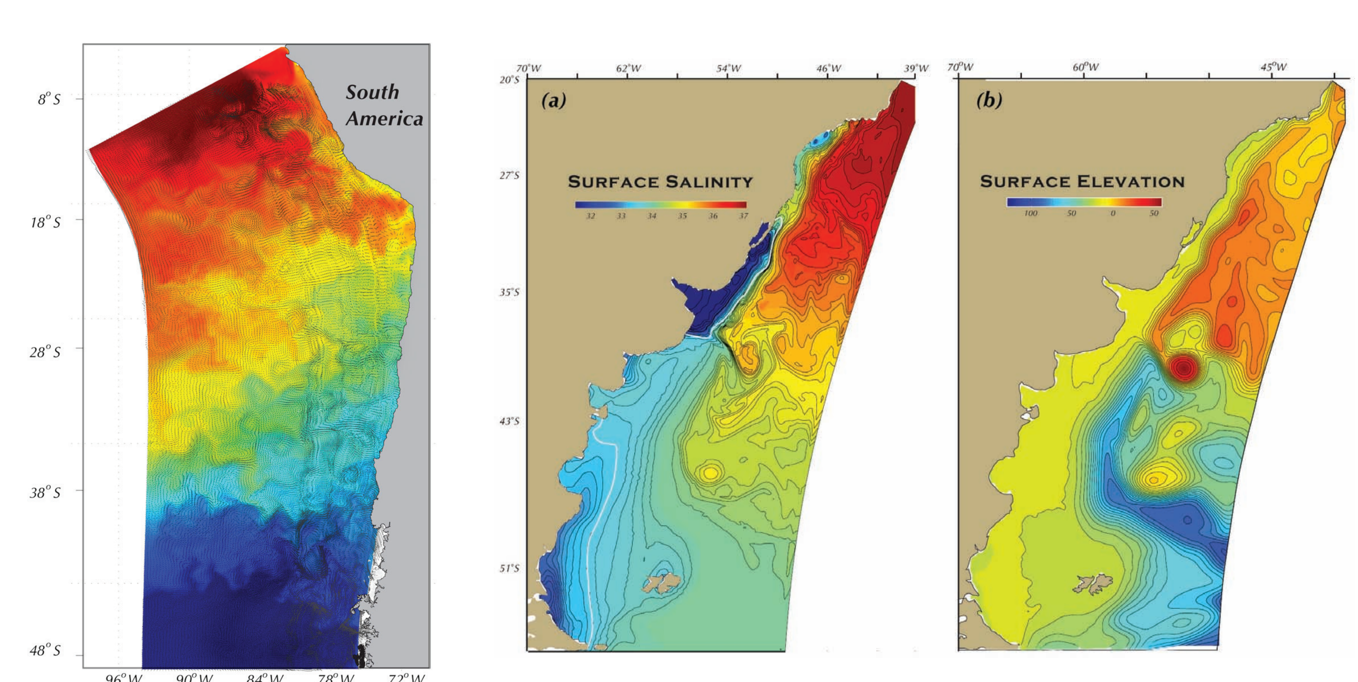
SST (colors, blue is cold, red is warm) and SSH along two Jason-1 tracks in June 2005 off Oregon. "Straight" lines are tracks. Variable lines show alongtrack SSH, low when the trace is to the left of the track. Note the rapid drop in SSH when the track crosses cold coastal water. Standard data is flagged "bad" to the right of the cross-over; it is recovered here by using ECMWF water vapor.



Long-term January mean surface water speed (cm/s) from the OFES model (1980-2006).

Basin-Scale and Regional Modeling (Figures to Left)

Regional models (ROMS) are nested within the global Japanese 1/10 degree OFES model (shown to the left). Maximum horizontal resolution of the regional models (examples shown in the lower left) will be < 5 km, with >30 vertical levels. The period covered is 1980-2008, which includes major El Nino and La Nina periods, as well as changes in the basin-scale circulation structure .



Left: Surface temperature and thermocline velocities in a snapshop from the ROMS model of the Peru-Chile Current.
Middle and Right: Surface salinity and SSH in snapshots from the ROMS model of the Brazil-Malvinas Current Region.

Model-Data Comparisons

Within the altimeter record, the period between 2002-2005 provides coverage from 3-4 altimeters, as well as forcing by QuikSCAT winds. This period will be used to test methods of deriving improved SSH fields in the coastal regions of each system. The California Current is a well-sampled system, allowing verification of the methods in a system without complications from a wide shelf and strong tides. In the Soutwest Atlantic system, the wide shelf will test improved tidal models. Over the complete periods of altimeter coverage (1993-2008) and model runs (1980-2008), the combinations of altimeter and model fields will provide new insights into the interaction of the coastal and deep water circulation during periods of strong climate variability.

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