The application of Jason-1 measurements to estimate the global near surface ocean circulation for climate research

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The major objective of Jason-1 is to provide information about the ocean general circulation and its role in climate. However, satellite altimetry has not been rigorously used for global estimates of ocean currents for a number of reasons. Major problems include an inaccurate geoid reference model, undersampling of the mesoscale, and incomplete and inadequately forced models of the wind driven Ekman layer. During Jason-1 many of these problems will be addressed with new satellite measurements. The main objective of this project is to estimate the global near surface circulation.

We derive the near surface circulation through a synthesis of altimeter derived quasi-geostrophic flows, an Ekman current model based upon surface drift observations, and direct measurements from surface drifting buoys. Our approach is heavily weighted by observations in order to create global ocean current fields that are independent of general circulation models and can be used in their evaluation.

Over the past decade a large number of observations from satellite altimeters and scatterometers, in-situ drifters, floats and current meters, have produced spectacular new views of the ocean. However, no single measurement can provide a complete representation of the global near surface circulation.
In the past few years, it has been demonstrated that these data can be combined to produce a representation of the near surface circulation with a reasonable degree of accuracy on regional and basin scales. A geostrophic current is computed from the atlimeter sea level gradient and the Ekman current is computed from a physical or statistical model (see figure 1). However, to date, neither a complete global algorithm nor a comprehensive map for the near surface circulation has been developed. In this project, we will build new models to combine these measurements in order to map the global circulation and study climate change over the past decade.

Estimation of wind driven currents using a four parameter model has advanced for both the North and South Pacific Oceans.
Two approaches are being used to determine these parameters.
One uses a vorticity constraint and closed path integrals about a field constructed from drifter observations. The other evaluates variance reduction resulting from

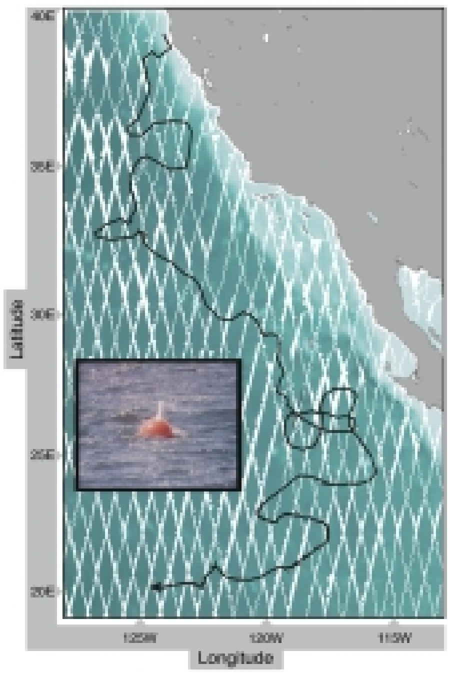

Figure 1: A key element of the surface current model is merging the altimetry with the track of surface drifters in order to build a parametric model with coincident data from the altimeter, the drifter and surface wind fields.

particular wind speed model parameter values and uses both drifter and satellite altimeter observations (see figure 2).

Both approaches make use of NCEP reanalysis winds. We have determined that the winds are problematic in the South Pacific, which is consistent with personal communications from colleagues. We are now investigating other wind products (new NCEP reanalyses, ECMWF reanalyses with 4Dvar of satellite wind speeds).

The second approach above has borne out similar conclusions regarding the along-track averaging length used to process TOPEX/POSEIDON data to those in the submitted manuscript: "Comparisons of velocity variance in the Pacific Ocean using altimetric and surface drifter data". No single along-track averaging length can be used to estimate geostrophic velocities from sea surface height data over all latitudes. Longer smoothing scales are found the tropics and shorter scales are found at higher latitudes.

Future work will evaluate new geoid models based upon CHAMP and GRACE measurements and wind fields from scatterometers, merge multiple altimeter data sets for high resolution grids of sea surface height (see figure 3), and improve the dynamical model of the current. Determining the wind driven currents in the equatorial strip within 3 degrees of the equator remains unsolved. An initial attempt using total vorticity does not solve the problem of the singularity of the Coriolis parameter on the equator. Nevertheless, we are now able to create maps of dynamic height, and associated error for most of the Pacific basin. Over the remaining years of this project, we will extend our analysis into the other ocean basins (Atlantic, Indian, and Southern Oceans) in order to create and study a decade or more time series of the global near surface circulation.

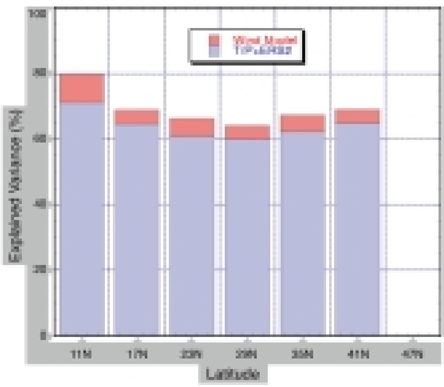

Figure 2: The amount of variance in the North Pacific surface drifter velocity observations that is explained by the along track surface height gradients in the TOPEX/POSEIDON and ERS-2 altimeter data or the Ekman model of surface wind drift.

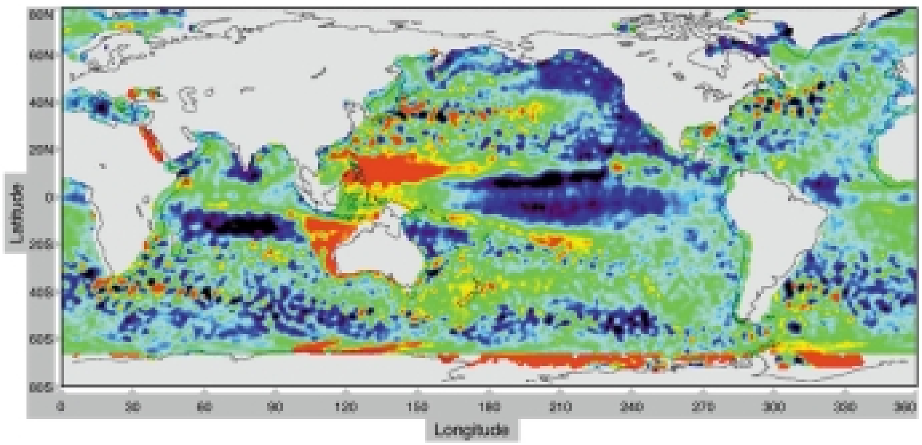

Figure 3: The ubiquitous eddy field will strongly influence near surface current estimates. High resolution gridded fields are needed. The figure shows a 50 km resolution map of the sea surface height anomaly for June, 2000 based upon the one of the first mergers of TOPEX/POSEIDON, ERS-2, and Geosat Follow On mission data.

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