Abstract

The Southern Ocean encompasses the large region of the world's ocean that encircles the Antarctic continent. The region is remote, with strong winds and high sea states, and as a result in situ observations are limited. Satellite sensors that operate in visible and infrared frequencies are blocked by persistent cloud cover, and thus satellite altimetry has emerged as an important tool investigating the circulation of the Southern Ocean. The major current system of the Southern Ocean, the Antarctic Circumpolar Current (ACC), consists of multiple narrow eastward flowing jets that each meander northward and southward over time. Dynamic ocean topography (DOT) can be thought of as defining the streamlines of the surface flow in the ocean, and each jet of the ACC corresponds to a sharp gradient in DOT. Satellite altimeters do a good job of measuring the time-varying component of sea surface height, but they are unable to separate the time-mean DOT (of interest to oceanographers) from the time-invariant geoid (of interest to geodesists). A range of strategies have been developed to compute the mean DOT, either from oceanographic temperature and salinity profiles, from surface drifter data, from gravity measurements, or from hybrid approaches including assimilating ocean state estimates.

This study will intercompare available DOT fields. The proposed work will inventory the characteristics and likely biases of the different fields, the resolved length scales, and the impact of different means on estimates of transient-mean flow interactions. The research aims are particularly focused on evaluating how well DOT products resolve small-scale variations in time-mean DOT associated with the ACC. One result of the analysis will be an estimate of uncertainty in the DOT products.

The proposed research will further evaluate DOT fields by taking advantage of the formal statistical machinery of the 1/6° resolution Southern Ocean State Estimate (SOSE) assimilating model, which is a regional version of the coarser resolution Massachusetts Institute of Technology 1° ocean assimilation effort (Estimating the Circulation and Climate of the Ocean, MIT-ECCO). SOSE will allow us to assess which of the available DOT (or geoid) fields are most consistent with all other available ocean observations, to evaluate a priori uncertainty estimates, and to assess error covariance length scales. The model assimilation itself produces a time-dependent absolute DOT field and an estimate of the mean DOT. This estimate is a synthesis of all available measurements, so has the potential to be superior to other products. SOSE sensitivity studies will provide evidence showing where new in situ measurements of gravity (or other geophysical variables) would be most useful in improving estimates of DOT and correspondingly of Southern Ocean circulation.

The research team brings to this project broad experience in Southern Ocean processes, satellite altimeter data, ocean state estimation, numerical modeling of the ocean, and statistical methods for analyzing ocean data. The PI, Sarah Gille, has focused much of her work on Southern Ocean circulation and Southern Ocean climate, and has made extensive use of satellite altimeter data. Post-doctoral researcher Matt Mazloff has also focused his research interests on the Southern Ocean and is the primary developer of the SOSE. Post-doctoral researcher Alexa Griesel brings to the project extensive experience in analyzing numerical model output and a particular focus on Southern Ocean and Antarctic Circumpolar Current processes. The project members will also benefit from our ongoing collaborations and interactions with other Southern Ocean researchers at Scripps, from our daily ongoing interactions with the Scripps Institution of Oceanography component of ECCO, and from continued involvement with MIT-ECCO.