Jason-1 near real-time applications

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The very successful TOPEX/ POSEIDON and ERS-1 & 2 altimeter missions flown in the 1990s demonstrated the utility of altimeter data for near real-time ocean monitoring. One of the primary objectives of the Jason-1 mission is to build on this success and initiate an era of operational oceanography that will continue well into the 2000s. As a part of our Jason-1 research activities we will continue to provide near real-time data products for research activities and to work toward operational use of altimeter data by the public, industrial and government sectors.

One application of altimetry is to provide observations over sparsely sampled ocean regions to improve weather and climate forecasts. For example, improved forecasts of severe landfalling winter storms on the U.S. West Coast have the potential to prevent serious human and economic losses. It is likely that altimetry-based upper ocean heat content estimates could aid in the refinement of forecast and hindcast simulations of these storms by providing improved model input at the ocean boundary. We have been investigating how well altimetry-based heat content estimates compare with in-situ heat content measurements taken from airborne expendable bathythermographs (AXBTs) off the California coast. Preliminary studies show very good agreement, both in space and time, and we are working closely with the ongoing NOAA observational and modeling programs toward operational applications of altimeter data in the region.

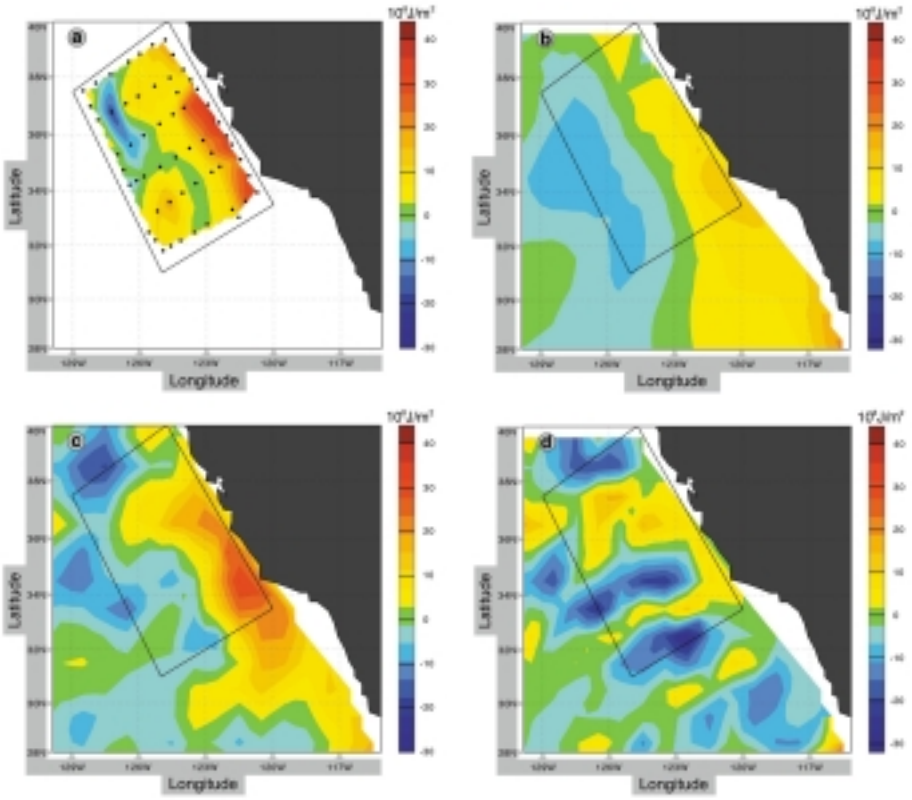

Figure 1: Heat Content Anomaly (HCA) maps for Jan. 20. (a) in-situ AXBT, (b) TOPEX, (c) blended TOPEX/ERS, and (d) mesoscale TOPEX/ERS.

Introduction

The human and economic impact of severe landfalling winter storms on the U.S. West Coast are comparable, on an annual average, to earthquakes. Like hurricanes, the prediction of these storms is hindered because they develop over the ocean where observations are sparse. An important operational application of Jason-1 will be to provide additional ocean observations to improve forecasts of severe weather and climate events.

During the NOAA California Landfalling Jets Experiment (CALJET) in the winter of 1997-1998, data were collected in regions where additional and/or improved observations could potentially help downstream forecasts. A region of sensitivity, found by an adjoint analysis using the MM5 numerical weather model, was the temperature field in the lower atmosphere 1000 km off the California coast. As a result one of the objectives of CALJET was to determine the sensitivity of landfalling storms to the upper-ocean thermal structure, which is still very much a work in progress. In the winter of 1997-1998, NOAA P3 aircraft were used to perform airborne expendable bathythermograph (AXBT) surveys in the region to profile the upper ocean temperature in the region.

Current research and operational weather models rely on satellite-based sea surface temperature (SST) measurements in combination with climatological SST data sets to infer the upper ocean thermal structure and heat content. Our goal is to develop a procedure whereby

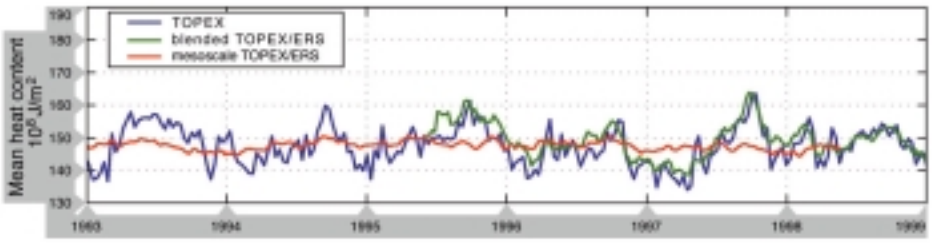

Figure 2: Time Series of the spatial mean heat content in the analysis region; blue: TOPEX, green: blended TOPEX/ERS, red: mesoscale TOPEX/ERS.

altimetry-based heat content estimates can be used to accurately monitor the upper-ocean heat content off the West Coast of the U.S. The ultimate objective is to develop a near real-time capability for estimating the upper-ocean thermal structure from altimetry to use as input into research and operational forecast models.

We have made preliminary comparisons of altimetry-based upper-ocean heat content estimates with in situ measurements from the CALJET study. The extended heat content time series in the study region spanning the entire TOPEX/POSEIDON (T/P) mission is useful for putting into context the warmer conditions observed in the study region that were associated with the 1997-1998 El Niño. We found that resolving the mesoscale oceanographic component of heat content is required to adequately monitor the upper-ocean heat content in the region. The results from this study are being used to help plan additional ocean observations during the NOAA Pacific Landfalling Jets Experiment (PACJET) [Ralph, 2000], a follow-on to CALJET, during the winter of 2000-2001.

Data and Methods

Synoptic AXBT surveys were performed from aircraft to collect upper-ocean temperature profiles off the West Coast of the U.S. during the winter of 1997-1998. Three sets of altimetry-based sea surface height anomalies (SSHA), and the AXBT temperature measurements, were used to compute the heat content in the upper 350 meters of the water column. The AXBT heat content was computed directly from the temperature profiles. Altimetry-based heat content estimates were made using a linear relationship between changes in the surface geopotential anomaly and the underlying heat content variations using the World Ocean Atlas 1998 (WOA 1998) [Hendricks, 1996; Chambers, 1997]. The climatological mean heat content also was used to reference the heat content determined from AXBTs to a long-term mean. Three altimetry data sets were used for comparison with the in-situ measurements. The first altimetric data set was based on TOPEX data alone. The second altimetric data set was obtained by "blending" TOPEX and ERS-2 altimeter data with an emphasis on retaining the longer wavelength oceanographic signals accurately measured by T/P, and the mesoscale signal sampled by both the T/P and ERS-2 satellites (blended TOPEX/ERS). The third data set is an operational data set that is produced by heavily filtering, combining TOPEX with ERS-1 and ERS-2 altimetry data with an emphasis on retaining only mesoscale structure.

References

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