OPERATIONAL ALTIMETER DATA PROCESSING AND ASSIMILATION FOR EL NIÑO FORECASTS

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The TOPEX/POSEIDON (T/P) altimeter satellite has recently become an integral part of NOAA's operational satellite system for monitoring the oceans. The transformation was achieved through the joint efforts of NOAA, JPL, and NAVOCEANO. Since late 1996, this team has produced accurate T/P sea level observations with a delay of only two daysófast enough to be included in NOAA's weekly ocean model run. Operational assimilation began in March 1997. The T/P data improve both the ocean initial conditions and the sea surface temperature forecasts with lead times of up to 6 months.

Introduction

El Niño-related climate variations often have widespread and devastating impacts. These include the frequency and severity of storms and the occurrence of droughts and floods. In the U.S. alone, business losses associated with the 1986-87 El Niño amounted to -15 billion. Although many of the consequences of El Niño cannot be prevented, skillful forecasts enable resource managers in climate-sensitive sectors to alter strategies and reduce economic vulnerability.

Coupled ocean-atmosphere models have attained significant forecast skill during the past decade, but they continue to be limited by insufficient ocean observations. Satellites represent part of the solution. In particular, an operational flow of altimeter data has long been desired by the modeling community as a means of estimating changes in upper ocean heat. Using T/P altimeter data, an operational system was implemented at NOAA in March 1997, just in time to assist in the long-range forecasts associated with the 1997 El Niño.

TOPEX/POSEIDON data processing

Data downlinked from the T/P satellite to the Jet Propulsion Laboratory (JPL) are transmitted continuously to the Naval Oceanographic Office (NAVOCEANO) where interim geophysical data records (IGDRs) are prepared. These data are similar to the final T/P GDRs except that the satellite orbit is a prediction and contains radial errors of several decimeters. However, the problem of quickly determining accurate satellite orbits has been solved by the Global Positioning System (GPS). Lichten et al. [1996] have developed an automated orbit determination program at JPL which computes accurate (5 cm rms) T/P orbits with a delay of only 1-2 days. These orbits are provided to NAVOCEANO, and updated IGDRs are forwarded to NOAA, where an adjustment is performed to further reduce residual orbit error.

Finally, sea level deviations are computed (with respect to the 1993-95 mean), and the analysis is transmitted to NCEP for assimilation. The total delay in the end-to-end T/P system is only 2 days, yet the global IGDR analyses agree with the GDR (available 2 months later) within about 5 cm rms.

Assimilation results

T/P data passed to NCEP are in the form of sea level deviations, averaged along 1-degree segments of the satellite track. Based on this input, the NCEP assimilation system preferentially corrects the model temperature field where the probability of its being in error is greatest, making those corrections in such a way as to bring the model sea surface height into closer agreement with the TOPEX data. The altimeter data keep the ocean model from deviating too far from reality and result in more accurate forecasts [Ji et al., 1997]. A specific example was during 1995-96, when salinity in the western Pacific was unusually low. Because few salinity data are available, the model drifted off substantially, causing sea level errors of up to 10 cm. But tests showed that assimilation of the altimeter measurements would have corrected the situation, yielding a more accurate depiction of the surface circulation and better seasonal forecasts of sea surface temperature (Figure 1).

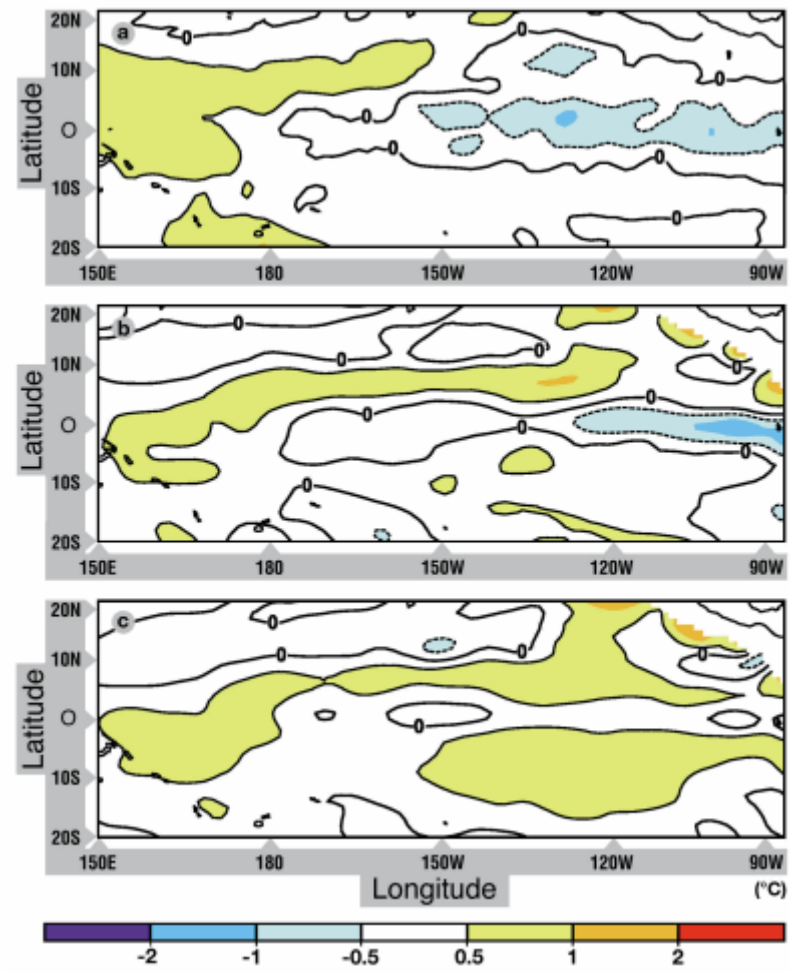

Figure 1
Three-month mean sea surface temperature anomalies for Dec-Feb 1996-97. Observed anomalies are in the upper panel (a).

Six-month-lead NCEP prediction from coupled model with T/P data is in middle (b).

Lower panel is same prediction without T/P (c). The T/P assimilation produces a more accurate prediction of the equatorial cold tongue.

Conclusions

The Laboratory for Satellite Altimetry will participate in three upcoming satellite altimeter missions, all of which will have operational aspects: the Navy's Geosat Follow-On, the CNES/NASA Jason-1, and ESA's Envisat. Based on the success of the T/P assimilation project at NCEP, near-real time processing of altimeter data will continue to be a priority.

References :

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