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THE NESDIS SEA SURFACE HEIGHT SCIENCE TEAM: TRANSITIONING FROM RESEARCH TO OPERATIONS

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1. INTRODUCTION

The NESDIS Sea Surface Height (SSH) Science Team deals almost exclusively with satellite altimeter data. In recent years, the focus of the team has been on the transition from research to operations, both in terms of data processing and ocean applications. Here we show how SSH team activities in three areas - altimeter data sets, ocean dynamics, and bathymetry - reflect the changing nature of satellite oceanography at NOAA.

2. ALTIMETER DATA SETS

The altimetry state of the art has been changing rapidly over the last years, and new and improved orbits and corrections are constantly being generated. While this is certainly good news, it creates a dilemma for users, who must keep their data sets accurate and up to date. In response to this problem, a multi-satellite data base is currently under development at the NOAA Laboratory for Satellite Altimetry. Access is provided through pre-compiled programs or custom-made tools based on a versatile package of Fortran subroutines. The interface with the data base is extremely configurable, such that each user can create a highly customized data stream based on her/his own preferences of data rejection, area, data content, and applied corrections.

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In order to avoid inconsistencies between the different altimeters, all model corrections are provided homogeneously throughout the missions. The data base allows repeated upgrades to any data field, without impact to the user interface. It is up to the user to pick one of the various competing corrections provided.

The added value of combining altimeter data in a homogeneous way, adding the strengths of the different missions and compensating their weaknesses, is worth the trouble of meticulously sorting out several data products. For example, sensible estimates about global sea level rise over the last decade and projections into the future can best be made by combining all altimeter satellites. One reason is that sea level rise may be perceived differently by different altimeters because of tidal aliasing. The current estimate of global sea level rise is illustrated in Figure 1. The overall trend is approximately 2.3 mm/year, but different altimeters indicate slightly different rates. This may be compared with the historical rate of 1.5 - 2.0 mm/year derived from tide gauge data. A fundamental question that we hope to answer is whether global sea level rise is accelerating in response to global warming.

3. SURFACE CURRENTS

As part of a National Oceanographic Partnership Program (NOPP) pilot project, the NESDIS sea surface height team is working with other investigators on a project called OSCAR: Ocean Surface Current Analysis, Real-time. OSCAR is a pilot processing system and data center being developed to provide operational ocean surface velocity fields computed from satellite altimeter and

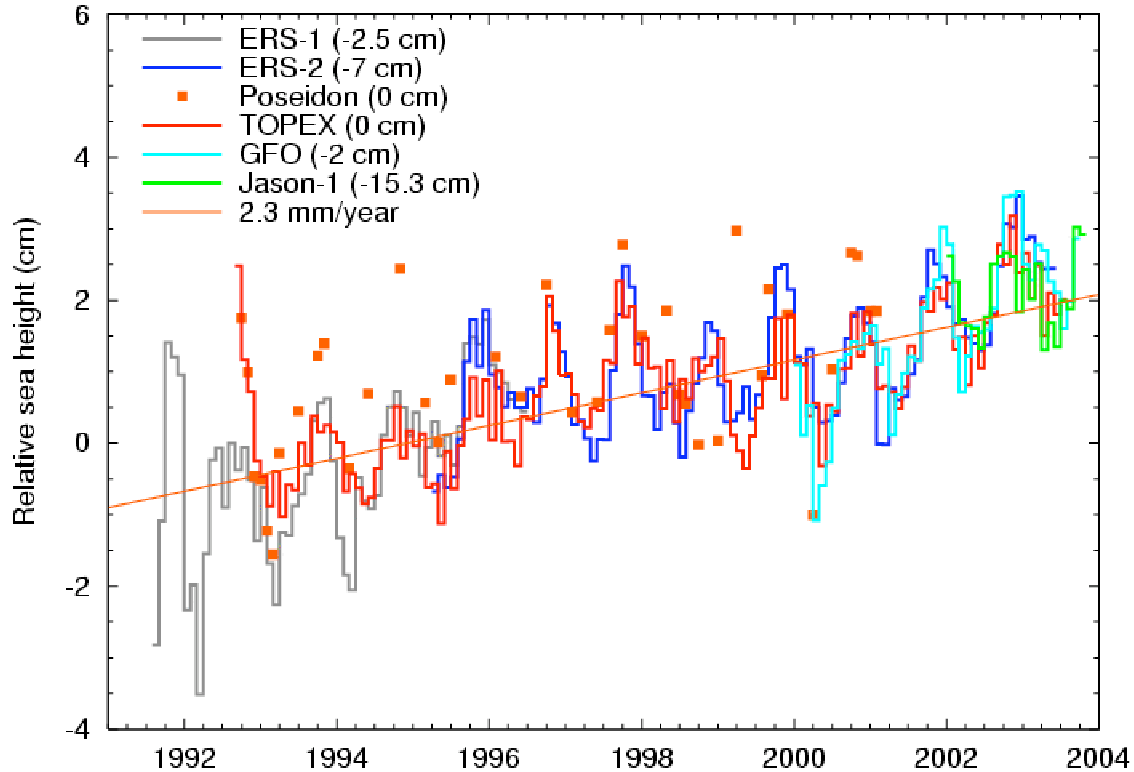

Figure 1. Global sea level rise determined by multiple altimeters: ERS-1, T/P, ERS-2, GFO and Jason. After removing respective biases, the general trend is approximately 2.3 mm/year.

vector wind data in the tropical Pacific. The OSCAR geographic coverage will be expanded to other basins and mid latitudes in the future. Methods to derive surface currents are the outcome of several years of NASA sponsored research by Gary Lagerloef (Earth & Space Research) and Gary Mitchum (University of South Florida). The pilot project will transition that capability to NOAA for operational oceanographic applications.

OSCAR velocity maps are updated on a weekly basis, with a goal for eventual 2-3 day maximum delay from time of satellite measurement. Grid resolution is 100 km for the basin scale. Finer resolution fields will be evaluated in the vicinity of certain Pacific Island regions. Data applications include large scale climate diagnostics and prediction, fisheries management and recruitment, monitoring debris drift, larvae drift, oil spills, fronts and eddies. Additional uses for search and rescue, naval and maritime operations will be investigated.

These velocity fields have been particularly useful in monitoring the recent evolution of ENSO conditions. We find from the analysis of the 10-year Topex/Poseidon record that eastward equatorial surface velocity anomalies lead the Niño SST anomalies by about three months. Since January 2001, we have provided monthly maps for the NOAA/NCEP Climate Diagnostics Bulletin.

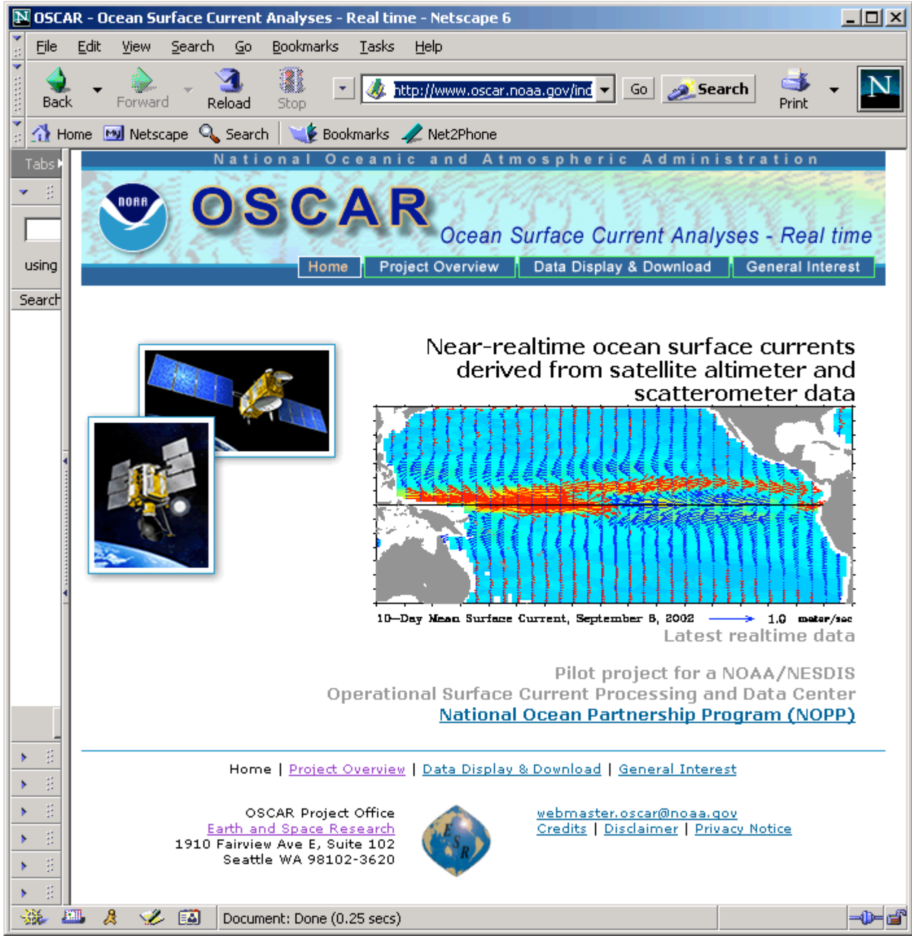

Figure 2. The OSCAR web page http://www.oscar.noaa.gov. In addition to near real-time surface current analyses, the site provides access to a 10-year historical record (1992-2002) for the tropical Pacific.

The OSCAR data are used to monitor the continued evolution of surface currents and the relation to SST. In addition to this monitoring activity, NOAA/NCEP is using the satellite-derived current estimates to verify model currents and diagnose model errors.

Another immediate application of these data relates to fisheries management and marine wildlife research in the region. Movements of several species of sea turtle in the tropical region are being tracked by satellite with System Argos. Results show that some turtle tracks follow meandering portions of the North Equatorial Current and North Equatorial Counter Current. The surface current data allow researchers to examine the oceanography of the habitat these turtles are using, for example, and evaluate to what extent they are using the equatorial currents and regions of surface convergence. Findings indicate that different species/stocks use different habitats. Some forage at or near the surface at convergences and others forage sub-surface away from currents.

Surface currents are computed using a quasi-steady linear hybrid geostrophic-Ekman scheme that is continuous across the equatorial latitudes. This model provides several improvements to an earlier scheme, including the treatment of vertical shear and the equatorial singularity, that yields much better comparisons with mooring and drifter data in the eastern Pacific cold tongue.

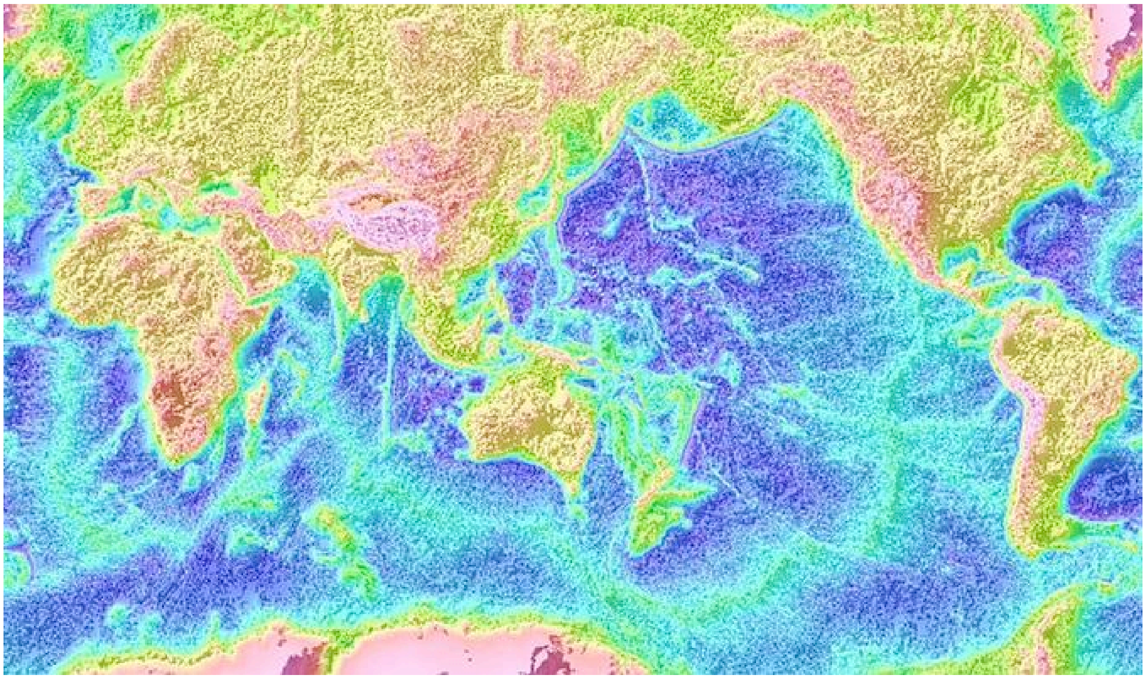

Figure 3. Interactive sea floor topography: http://ibis.grdl.noaa.gov/cgi-bin/bathy/bathD.pl

4. BATHYMETRY

At short (10 to 200 km wavelength) scales, most of the permanent sea surface topography signal in the deep ocean is caused by gravity anomalies reflecting depth variations on the ocean floor. Altimeter data from the non-repeat satellite altimeter missions have therefore provided a wealth of new information on ocean bathymetry. LSA maintains an interactive version of the Smith & Sandwell global ocean bathymetry map, the most complete, high-resolution image of sea floor topography currently available. The map was constructed by blending depth soundings collected from ships with detailed gravity anomaly information obtained from the Geosat and ERS-1 satellite altimetry missions. This combination of data yields a globally uniform level of resolution ideal for displaying major tectonic features, such as mid-ocean spreading ridges or fracture zones.