

**A Web Site for NCEP's Global Ocean Data Assimilation System:
Data Link, Model Validation and Ocean Monitoring Products**

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Project Summary:

The project is to build a web site for the Global Ocean Data Assimilation System (GODAS) developed by the National Centers for Environmental Prediction (NCEP). The project is aimed to fill in the gap in the delivery of ocean analyses as an end product of ocean observation systems. The Environmental Modeling Center of NCEP produced a global ocean reanalysis for 1979-present using GODAS, and made it available to the general public. The Climate Prediction Center of NCEP is in charge of building a web site for GODAS products that serves user communities. The content of the web site is expected to grow in order to satisfy the needs of user communities. Currently, the web site includes data link, model validation and ocean monitoring products.

Background:

One of the main objectives of the in situ network managed by the NOAA's Office of Climate Observation (OCO) is to provide ocean observations to increase our understanding of the dynamics of the seasonal to interannual (SI) variability, and to improve its forecast skill. This has been largely done through a delivery of ocean analysis as an end product of ocean observations. Since 1995, the National Centers for Environmental Prediction (NCEP) has been producing ocean reanalysis for the Pacific Ocean by assimilating observations into an ocean model forced by atmospheric fluxes (Ji et al. 1995). The assimilated observations include temperature profiles from XBT, profiling floats and TAO moorings. The Pacific Ocean reanalysis (referred as RA6 hereafter) has been used to initialize the oceanic component of the NCEP's coupled atmosphere-ocean general circulation model, and has been shown to improve the forecast skill of the SI variability (Behringer et al. 1998). In 2003, a Global Ocean Data Assimilation System (GODAS) was developed that uses the Geophysical Fluid Dynamics Laboratory's (GFDL) Modular Ocean Model version 3 forced with the atmospheric fluxes from the NCEP's Reanalysis 2, and assimilates not only temperature but also synthetic salinity constructed with local temperature-salinity climatology (Behringer and Xue 2004; Behringer and Xue 2007). A retrospective global ocean reanalysis for 1979-2005 has been used to initialize the oceanic component of the new NCEP's Climate Forecast System, which has competitive seasonal forecast skills for ENSO and U.S. temperature and precipitation (Saha et al. 2006). The GODAS produces both pentad and monthly oceanic fields in real time, and is a unique dataset to serve research, application, and operational communities.

To gain a broader dissemination of GODAS data products, and to increase research community's involvement in the assessment of GODAS and the effectiveness of the NOAA's ocean observing systems, OCO sponsors the CPC to construct a comprehensive web site to display the rich information in GODAS. The web site contains numerous images that describe not only the SI variability but also the subseasonal variability. Since the goal of the web site is to serve a broad user community that includes operational

forecast centers, scientific research groups, and the general public, we solicit feedbacks from all users, answer their questions in a timely manner, and improve the web site according to the needs of user communities.

Website: <http://www.cpc.ncep.noaa.gov/products/GODAS/>

Partnership:

This project has been coordinated with the generation of the GODAS data sets by the Environmental Modeling Center of NCEP. We also work with the expert team of OCO to validate model fields against in situ observations.

Accomplishments:

1. Correcting the warm biases in GODAS prior to 1990

We pointed out in our last year report that there was a warm bias in GODAS prior to 1990. It turned out that the warm biases before 1990 were due to a bug in the program that processes the XBT data for the years prior to 1990. After correcting the error, a new GODAS data set was produced in early 2006. The impacts of the corrections are summarized below:

- Most of the changes are in 1979-1989 due to corrections of XBT profiles in that period.
- Average reductions of temperature in 1979-1989 are about 0.5-0.6 degree, distributed approximately evenly in depth.
- Average reductions of sea level are 1-2 cm in tropical Indian and Pacific, and 3-4 cm in western tropical Atlantic.
- Average reductions in depth of 20°C isotherm are as large as 18 meter in midlatitude, but only 1-2 meter in the tropics.
- Correlation with tide gauge observations is improved, and it is about 0.7-0.9 in tropical Pacific, equivalent or better than that of RA6, and 0.4-0.7 in tropical Indian and Atlantic Oceans (see Fig. 1).
- Although the discontinuity in 1989/1990 is largely removed, there are remaining downward trends in 1979-1990, probably due to the warm biases in the forward model (see Fig. 2).

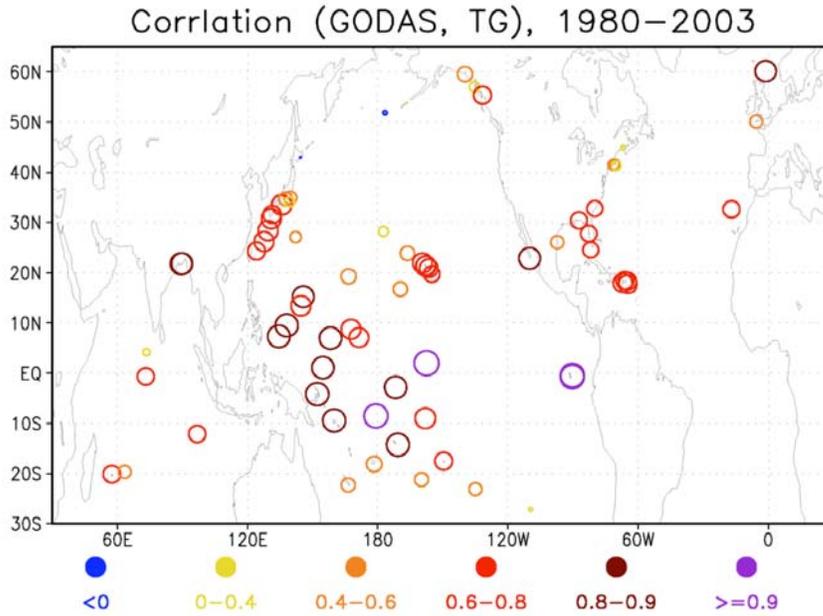


Fig. 1 Correlations between sea level deviations of GODAS and those of tide gauge observations are presented by circles, the sizes of which are proportional to the amplitudes of correlations. The number of years with valid data within 1980-2003 is required to be at least 15 years.

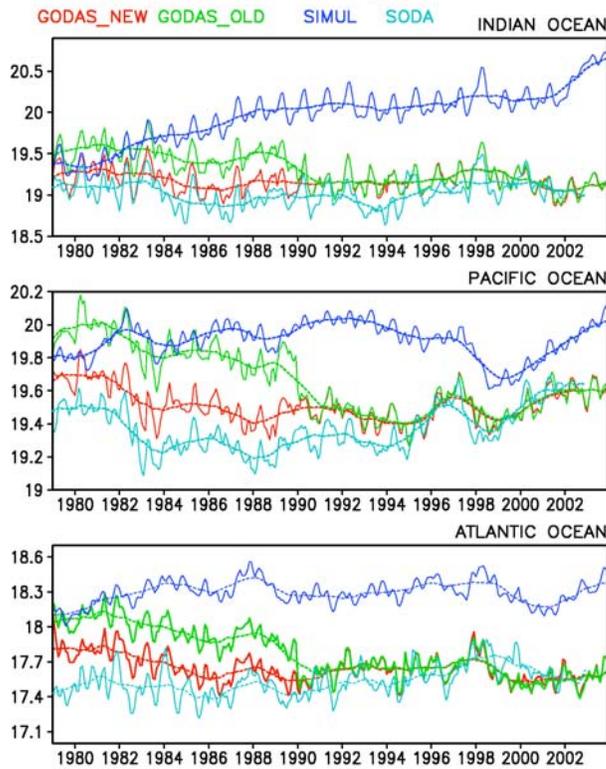


Fig. 2 Upper 300 meter temperature average in 5°S-5°N in the Indian Ocean (upper

panel), the Pacific Ocean (middle panel) and the Atlantic Ocean (lower panel). Monthly value (solid) and 25 month running mean (dash) of the new GODAS (red), the old GODAS (green), the Simple Ocean Data Assimilation System by University of Maryland (Cyan) and the simulation run in which no observations are assimilated (blue) are shown. Note that warm biases in the simulation run are large in all ocean basins. Although the warm biases of the old GODAS prior to 1990 are significant reduced, the new GODAS still has warm biases, relative to SODA, in 1980s and has a downward trend in 1979-1990.

2. Improved GODAS home page for ocean monitoring in real time

The GODAS home page has been modified significantly to best serve the user communities concerning real time monitoring and forecasting of climate variabilities such as ENSO and hurricane. This is done through an informative home page that contains cursor activated animations and plots documenting the current conditions of the ocean state (Fig. 3). The home page contains animations of pentad means for the past three months as well as plots of monthly means for the past 30 days. Because of the easy access to many plots and animations about the current conditions of the ocean state from the GODAS home page, the monthly visits to GODAS web increased from 133 in June 2006 to 582 in July, and slowly increase afterward. As October 2006, the total visits are 743, the total hits are 56077, and total downloaded data are 3.2 Gbytes (Fig. 4).

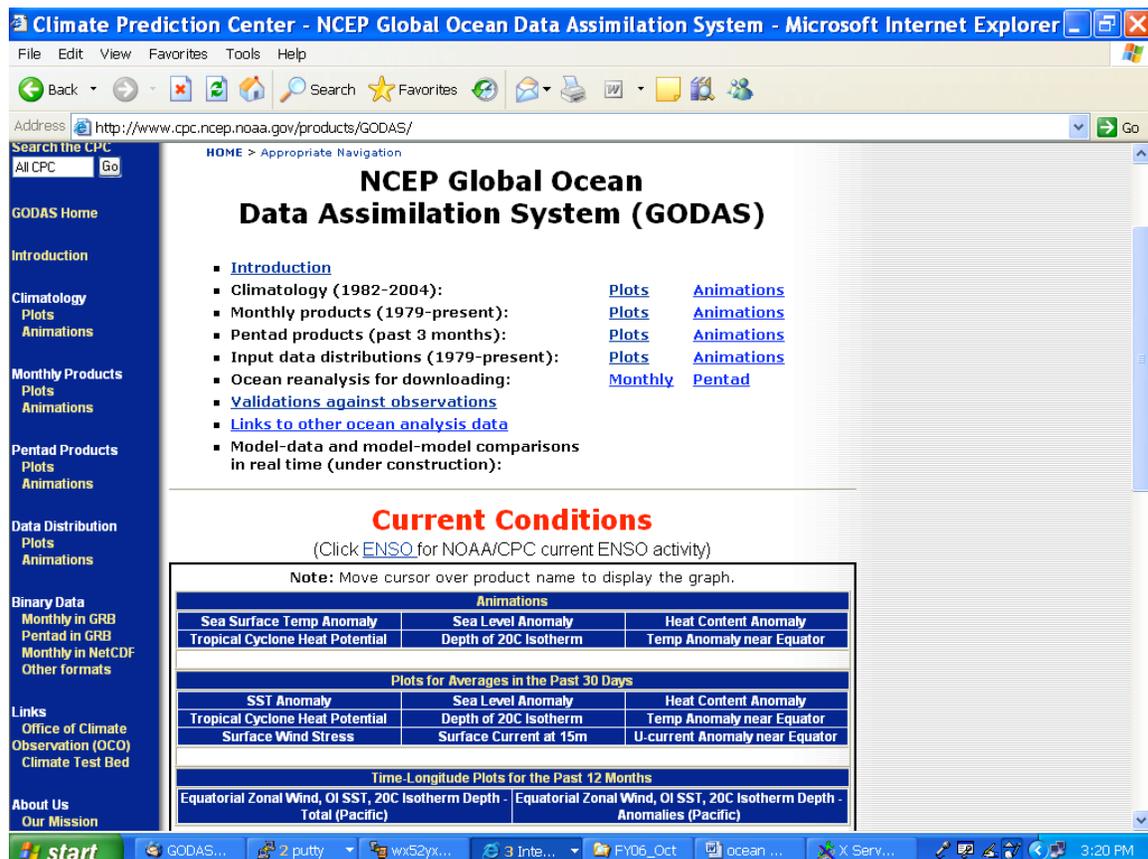


Fig. 3 The home page of the GODAS web site.

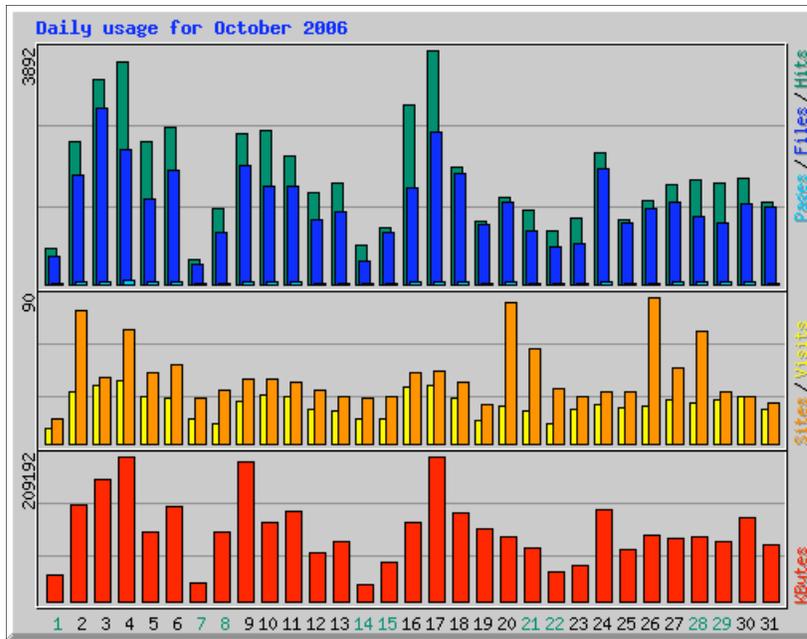


Fig. 4 Daily statistics for the GODAS web site.

3. Adding a subsection on model validation against observations

The quality of the GODAS ocean reanalysis has been evaluated against various independent data sets such as ocean currents from TAO moorings and drifter velocity program, CTD and ADCP data from cruises, tide gauges and altimetry sea level. It is found that the temperature field in GODAS is closer to observations than that in RA6. Although this version of GODAS does not assimilate satellite sea level as RA6 does, GODAS does as well as or better than RA6 in comparisons with altimetry and tide gauge sea level records. Despite of the improvement in the climatological salinity, GODAS seriously underestimates salinity variability. Similar to RA6, the equatorial currents contain large errors, which are suspected to be related to the errors in salinity. Those validation results are critical information for user communities to access the quality of the GODAS data set, but they are not well covered by our limited publications. So the validation results are presented through the web site (Fig. 5). It is worth noting that significant progresses have been made to overcome the defects in the operational GODAS by assimilating altimetry sea level and Argo salinity, and applying a multivariate constraint on geostrophic velocity since the operational GODAS was produced (Behringer, 2007). Those incremental improvements in GODAS will contribute to the future operational GODAS scheduled to be implemented in 2009.

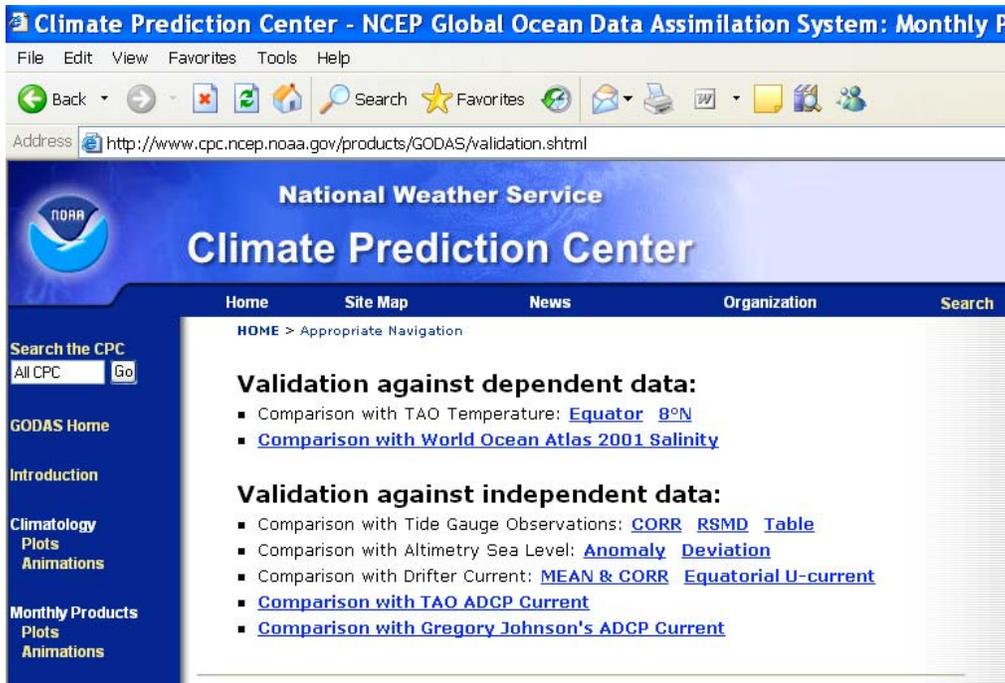


Fig. 5 The web page for model validation against observations.

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