NEAR REAL-TIME GLOBAL JASON-1 AND OSTM SEA SURFACE HEIGHT ANOMALY MAPS HOSTED BY A WEB MAP SERVICE

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ABSTRACT

A near real-time (NRT) global sea surface height anomaly (SSHA) product is being produced from Jason-1 and OSTM/Jason-2 tandem mission data at the Colorado Center for Astrodynamics Research (CCAR). The CCAR Jason-1/Jason-2 Tandem Mission (J1/J2-TM) product combines OSTM/Jason-2 GPS-based Operational Geophysical Data Records Sea Surface Height Anomaly (GPS-OGDR-SSHA) with the Jason-1 NRT SSHA measurements provided on the Jason-1 Operational Sensor Data Record Sea Surface Height Anomaly (OSDR-SSHA). Both of these along-track Jason-1 and Jason-2 altimeter products are produced by the JPL Orbiter and Radiometric Systems Group and are routinely available from the NASA/JPL PO.DAAC in NRT with a data latency of about 7 hours. Daily ¼-degree resolution J1/J2-TM maps are produced at CCAR with a latency of less than 1 days and posted on the CCAR website. Archival versions of the product are also available.

A Web Map Service (WMS) running on CCAR machines also serves images of the daily J1/J2-TM maps to Google Earth applications. This service dynamically rescales the SSHA image resolution and color scale as the image displayed in Google Earth is zoomed, allowing mesoscale features of interest to be viewed to the full resolution of the data. The bandwidth of the CCAR WMS servers is limited; therefore, we have ported the WMS software to run on an Apple Mac Mini running the Snow Leopard server operating system. A Disk Image File (DMG) for installing the software system is freely available from CCAR. After installing the free software download on a Mac Mini server, which costs less than $1,000, the WMS can be run by an end user on a local subnet with very high bandwidth. The CCAR J1-J2/TM gridded data are provided as a demo data set for the WMS system; however, other gridded data sets are easily added by the end user. The CCAR system hosts a wide variety of data sets including altimetry, ocean color, and sea surface temperature.

The CCAR J1/J2-TM data set and WMS software system are provided without restriction to encourage scientific, educational, commercial, and operational use and visualization of satellite altimetry in near real-time.

Enabling Web Map Service Images in Google Earth using Pydap

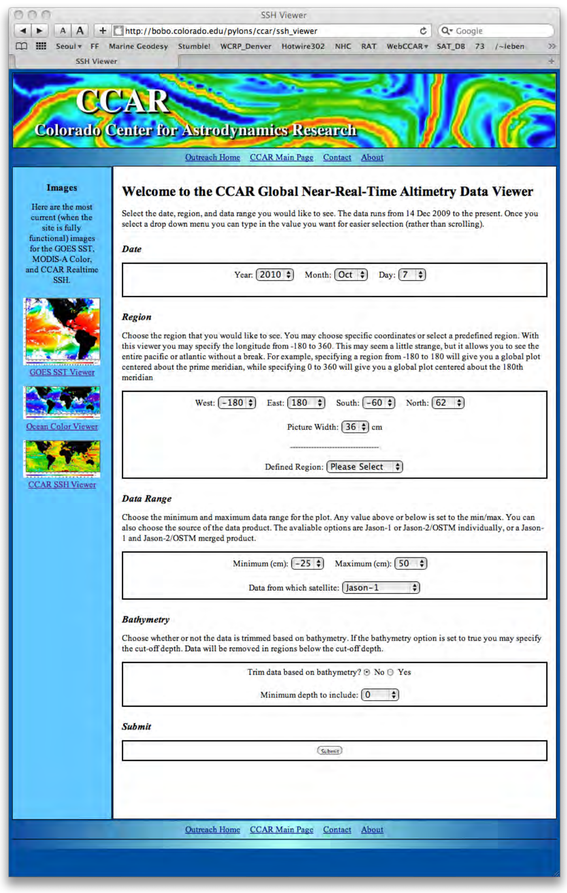
CCAR has implemented a dynamic Web Map Service (WMS) that can be installed and run on an inexpensive off the shelf server. This capability was developed with the help of David Joy, an Aerospace Engineering undergraduate student, who has worked at CCAR the past two years and was supported with NASA/JPL outreach funding. Before graduating last Spring, David ported the WMS server system to a Mac Mini running the Snow Leopard server operating system. The original system has been running on our research and development server "Bobo" since May of 2009. Before leaving CCAR, David completed training of his replacement, Gabe LoDolce, who is updating and improving the system and will assist users in the installation of the software on a Mac Mini server.

Pydap is a Python language implementation of the OPeNDAP data access protocol for serving netCDF-formatted data in real time. It provides a python-based client for accessing remote data sets and a server running under Apache for hosting Comprehensive Ocean-Atmosphere Data Set (COADS) compliant netCDF files. The system is modular and easily extended with additional packages, one of which is an extension for serving gridded data as a WMS server.

The WMS server uses the python imaging library to dynamically produce medium resolution images of user requested regions from hosted data. Most gridded data products can be processed this way, including ocean color, SST, and SSH data products. The original WMS specification was designed to produce static images to host via HTTP web pages, but the specification is flexible enough that WMS images can be called from Google Earth via a KML script. Because of this, the Pydap WMS server provides a rudimentary KML template to produce a global image from any gridded data set and overlay it on the Google Earth map.

The WMS server was initially designed to only host global data, but usually regional data was of more interest. The KML template was modified to allow the data to dynamically rescale when the resolution of the image displayed in Google Earth dropped below a threshold. This was initially accomplished using static altitude regions, but eventually the server was patched sufficiently to allow recalculation from any altitude.

The ability to zoom allowed features to be observed to the full resolution of the data product. However, the images were still color scaled using the global maximum and minimum values of the data type. In practice, this meant that ocean mesoscale features were nearly impossible to detect because their signals were lost in the larger dynamic range of the basin scale ocean signals. The WMS server was therefore modified to dynamically scale the color table so the full range within the zoomed regions was used instead of the global values. This allowed the relevant features to become visible at all scales. Sample images from the system are shown in Figures 4 and 5 . Figure 5 demonstrates the dynamic color scaling.



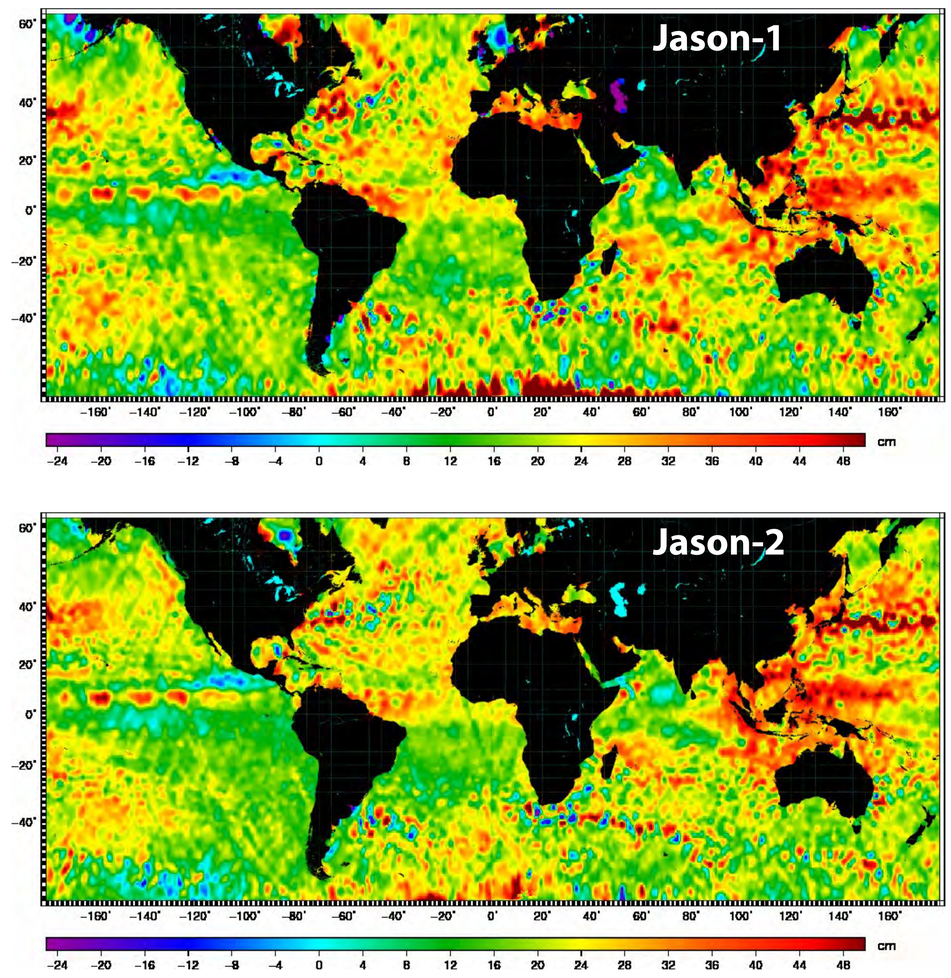


Figure 1. The CCAR J1, J2, and J1/J2-TM realtime products are available from January 1st, 2010 to the current day minus one. The system is updated on a daily basis to provide global gridded data sets of the products based on the CCAR historical gridding scheme. However, the data processing is different from the historical CCAR near real-time mesoscale dataset since we do not remove long wavelength signals given the precision of the along-track Jason-1 and Jason-2 altimetry provided by the NASA/JPL PO.DAAC. The webpage shown above allows custom mapping of CCAR J1, J2, and J1/J2-TM gridded data products. Sample images from 7 Oct 2010 are shown to the right.

Figure 2. Incoming CCAR grad student Gabe LoDolce installing modified pydap server on a Mac Mini. The CCAR implementation of the software is freely available and can be installed on a Mac Mini with Snow Leopard server (right), which costs less than $1000. The system will allow users to host satellite data setson their own dedicated Google WMS data server.

Figure 3. During July 2009, CCAR invited three Boulder area middle school students to receive training in remote sensing data analysis and visualization. Interactive visualization of the hurricane track overlaid on ocean color, SST, and SSH images using the WMS server and Google earth was instrumental in our discovery and analysis of the large hurricane-intensified cyclonic eddy shown in Figure 4 below.

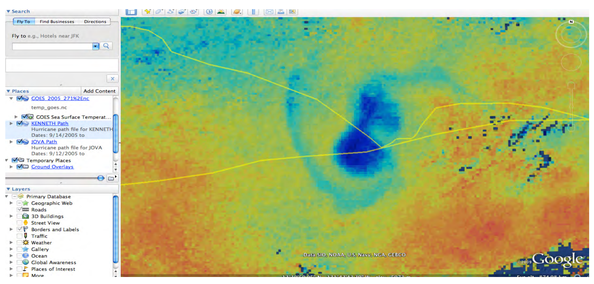


Figure 4. Google Earth/Ocean overlays show the SST temperature signal associated the hurricane-intensified cyclonic eddy formed by Hurricane Kenneth southeast of Hawaii in 2005. The tracks of Hurricanes Jova and Kenneth are shown overlaid on the GOES nightime SST composite image on 28 Septmeber 2005. Tracks and imagery were produced by students using the CCAR WMS server.

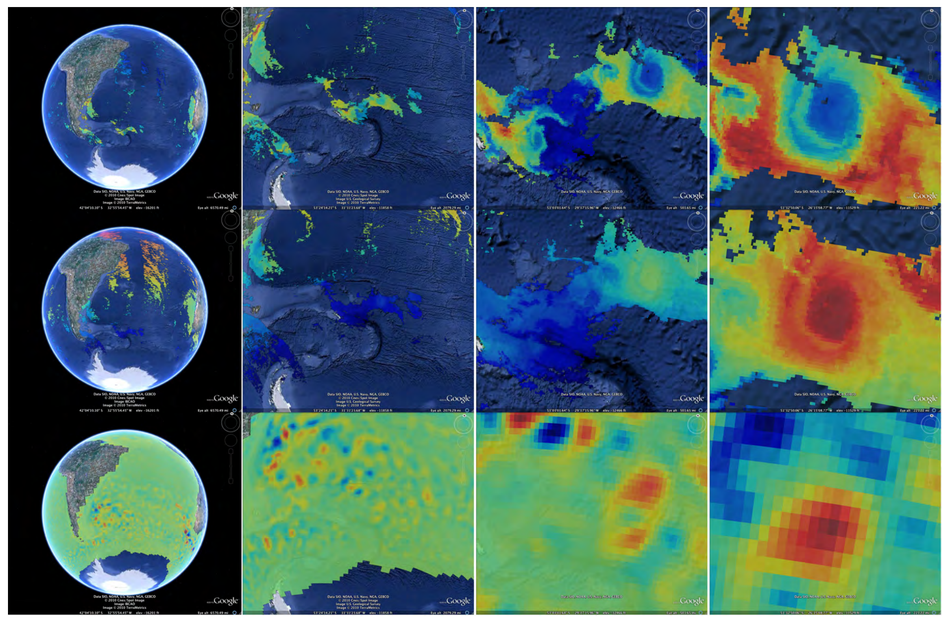


Figure 5. Sample Google Earth/Ocean dynamic zooms of imagery are shown above of a "very cold warm-core eddy" in the Southern Ocean in October 2003 that was highlighted in the Goddard Earth Sciences Data and Information Services Center Science Focus Webpage. Aqua MODIS ocean color (upper panels) and MODIS SST (middle panels) images near South Georgia Island from a rare cloud-free time period on 19 October are shown along with the AVISO merged sea level anomaly from 23 October. A 3°C warm-core eddy with very low chlorophyll concentration "pops" into view in the highest resolution zoom.

References for further information on these eddies can be found at:

Science Focus Webpage, Goddard Earth Sciences Data and Information Services Center (GES DISC), http://disc.sci.gsfc.nasa.gov/oceancolor/additional/science-focus/ocean-color/cold_warm_core_eddy.shtml.

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