Ocean Data Management at NCDC

From Ingest to Archive, Blended Products and Data Services

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1. Abstract

This project covers the ocean data management at NOAA's National Climatic Data Center, from observational data ingest to archive, blended products and data services. The surface marine data include those from ICOADS, VOSClim as well as satellite sea surface winds and air-sea fluxes. Achievement highlights for FY09 include data applications in offshore renewable energy sector and NOAA Coral Reef Watch.

2. Project Summary

The project "Ocean Data Management at NCDC" directly supports the mission of NCDC (NOAA National Climatic Data Center): "To provide stewardship and access to the Nation's resource of global climate and weather related data and information, and assess and monitor climate variation and change." This in turn directly supports the NOAA Mission: "To understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs."

NCDC plays an active and important role in the national and international climate change monitoring and assessment programs [e.g., the US Climate Change Science Program (CCSP) Syntheses]. Climate change monitoring and assessment require meteorological and marine data over both land and ocean. Changes of environmental variables at and near the marine surface are important since they occur over approximately 70% of the Earth's surface and contain important climate change signals. Due to the drastic property differences between water and air (e.g., density and heat capacity), huge amount of water, energy, momentum and gases (e.g., carbon dioxide) are constantly exchanged at the turbulent air-sea interface. These exchanges regulate the weather in the short term and the climate change in the long term. Thus, NCDC has been actively

archiving, serving and utilizing the world's surface marine data, and it will need to continue to do so.

Modern day Global Ocean Observing System (GOOS) consists of multiple platforms and instruments (both in-situ and remote sensing). Each of these observations contributes to the understanding and assessment of climate change signals. However, individual instrument observations have limitations in coverage (in both time and space) and limitations on accuracy (e.g. Zhang et al 2004). To maximize benefits and integrally use all the available observations, it is necessary to blend them together to produce higher resolution and higher accuracy products (Zhang et al 2006; Reynolds et al 2007). For example, research on global water and energy budgets and numerical weather and ocean forecasts demand increasingly higher resolution forcing data (better than daily and 50 km; e.g., WMO/TD-No. 1036, 2000; Curry et al. 2004). The recent international Global Earth Observation System of Systems (GEOSS) and Global Climate Observing System (GCOS) also called for optimal combinations of the above platforms for integrated global observing system and service (Zhang et al 2009).

There are typically three types of errors in observations and blended products: 1) random error; 2) sampling error; and 3) bias error. The bias error is the systematic difference between one instrument (or a set of instruments, e.g., in-situ observations) and another (e.g., remote sensing/satellite observations). The combined error for all terms should be reduced to a required accuracy for meaningful climate change diagnostics. In the satellite era, satellite observations provide dense data coverage, thus in-situ data play a minor role in the reduction of random and sampling errors and in increasing resolutions in blended products. However, in-situ observations provide the "ground-truth", thus play an essential role in correcting the systematic biases of indirect measurements (e.g., remote sensing/satellite observations that are calibrated to in-situ observations, e.g. Zhang et al 2009).

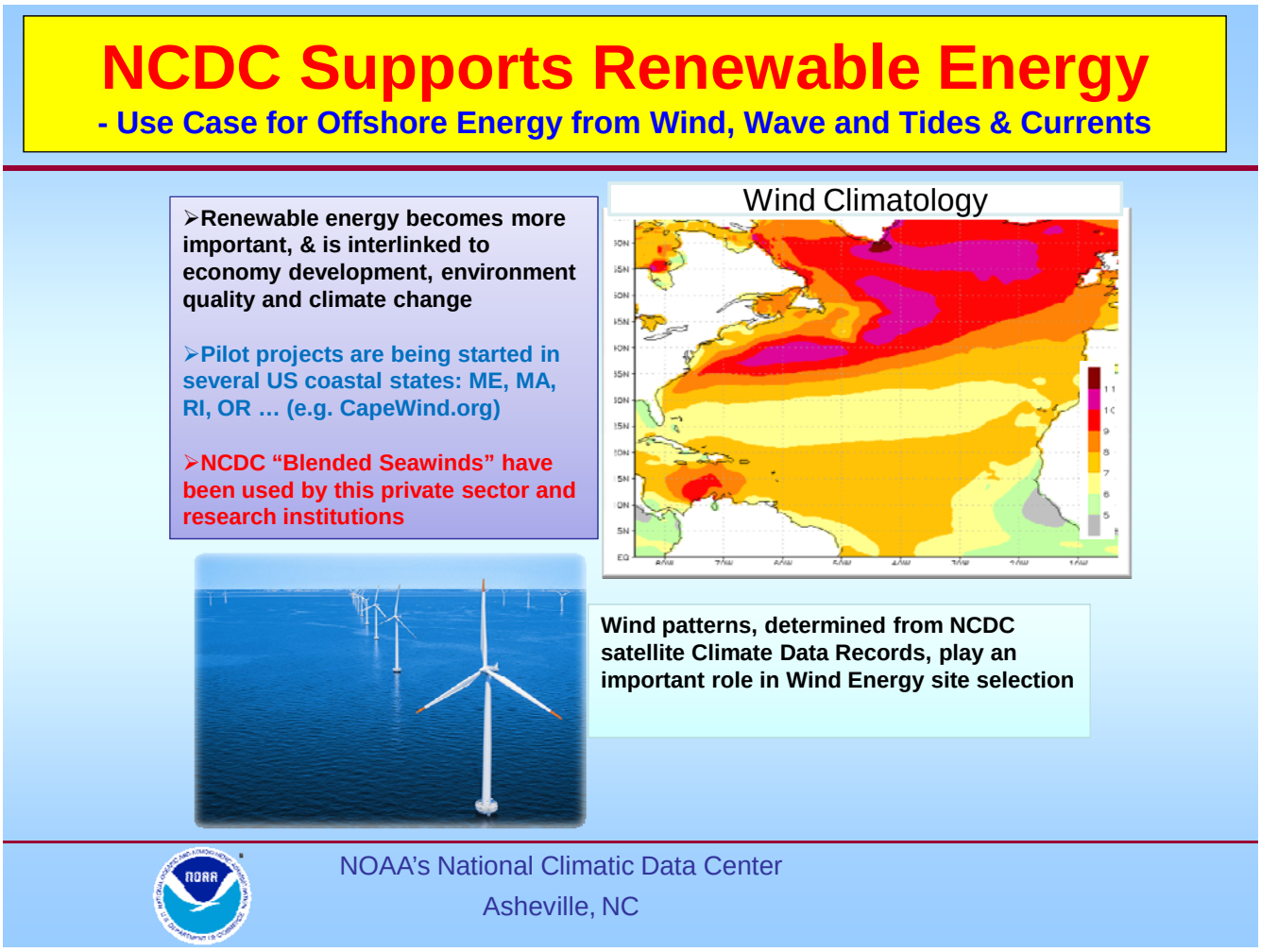
The overall objectives of this project are: 1) to ingest the world's marine observations into the NCDC archives; 2) to quality control the data for various applications (such as for Reanalysis); 3) to produce blended products for optimal use of all the observations; and 4) to improve services for a wide variety of user communities, including marine ecosystem/fisheries and offshore renewable energy. Highlighted accomplishments are described in the next section.

3. Scientific Accomplishments

Accomplishment Highlights

This year, we forged efforts to collaborate with private sectors and other government and research communities to promote data applications and societal benefits. In particular, our Blended Seawinds has been used for the sectors of offshore renewable energy (Fig. 1; Zhang and Sturman 2009) and marine ecosystem. Our global 0.25°, 6-hourly sea winds are neutral winds at 10 m above sea level; a private consulting firm has converted the 10-m winds to the offshore wind turbine heights, e.g. at 50 m, 70 m and 90 m above sea level. Compared against offshore meteorological masts at these heights, the converted winds and mast winds achieved a

correlation of 92%. The PI also worked with a cross-NOAA team to draft a "One-NOAA Energy Initiative for FY12-16 PPBES: Proposed Integrated Plan for NOAA's Roles in Energy in the Coming Decade". In marine ecosystem, our near-real-time Blended Seawinds have been used in NOAA's Coral Reef Watch (http://coralreefwatch.noaa.gov/satellite/doldrums_v2/index.html). Low wind condition significantly contributes to higher water temperatures during bleaching seasons. The wind monitoring (for detecting Doldrums condition) is a very important component of the NOAA's coral reef monitoring.



Specific Deliverables

3.1 ICOADS - Access to historical records; Improved GIS functionality

Available global surface marine data from the late 18th century to date have been assembled, quality controlled, and made widely available to the international research community in products of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). NCDC continues to ingest, archive, quality control and serve the ICOADS data (http://www7.ncdc.noaa.gov/CDO/CDOMarineSelect.jsp).

We expanded customer services, including the complete archive of historical data prior to 2005, made available online (via Climate Data Online—CDO). Prototype GIS Services application was placed in production for ICOADS data access.

3.2 VOSClim - Increased data volume of archive and service; continued VOSClim webpage maintenance updating monthly statistics and data access, and service with the Global Collecting Center (GCC).

VOSClim is an ongoing project within WMO/IOC JCOMM's Voluntary Observing Ships' Scheme. It aims to provide a high-quality subset of marine meteorological data, with extensive associated metadata, to be available in both real-time and delayed mode to support global climate studies.

3.3 Operational production and service of the blended 0.25°, 6-hourly sea winds, with addition of a Near-Real-Time version.

These data are available in various methods described in the website at http://www.ncdc.noaa.gov/oa/rsad/seawinds.html.

3.4 Experimental production of air-sea sensible and latent heat fluxes.

The air-sea turbulent heat fluxes have computed for the time period Jan 2002 to Dec 2008.

3.5 Develop web and data archive and services for SURFA.

The SURFA data archive includes daily ingest of NWP model data from ECMWF and German DWD as well as daily ingest of in-situ data from OceanSITES and other buoys. The data are available by ftp and THREDDS: http://www.ncdc.noaa.gov/oa/rsad/air-sea/surfa.html. A model-data intercomparison paper will be presented at the AGU Fall Meeting (Stanitski et al 2009).

4. Education and Outreach

During this year, the PI, Dr. Zhang, went to two middle school classes talking about his career as meteorologists and oceanographers. Recently he also participated in a middle school career fair on behalf of NOAA's National Climatic Data Center. The PIs, including Zhang, Reynolds, Hall and Freeman, had been (co)authors for several Community Whitepapers for the international OceanObs'09 conference. The PIs had also engaged private sectors, government agencies and

policy makers to promote data use in societal benefits (offshore wind and marine ecosystem, as detailed in Section 3), and policy making and NOAA's PPBES (BAMS Jan 2009 cover story - Zhang et al 2009). Additionally, Dr. Zhang is serving in the AMS STAC on Air-Sea Interaction and WCRP working groups (SEAFLUX and SURFA).

5. Publications and Reports

5.1. Publications by Principal Investigators

Zhang co-authored "***One-NOAA Energy Initiative for FY12-16 PPBES: Proposed Integrated Plan for NOAA's Roles in Energy in the Coming Decade***".

Zhang, H.-M., R.W. Reynolds, R. Lumpkin, R. Molinari, K. Arzayus, M. Johnson, T.M. Smith, 2009: An Integrated Global Ocean Observing System for Sea Surface Temperature Using Satellites and In situ Data: Research-to-Operations, *Bulletin of the American Meteorological Society*, **90** (No. 1), DOI: 10.1175/2008BAMS2577.1

Anderson, D.M., and **H.-M. Zhang**, 2009: Shallow ocean overturning and the heat and carbon content of the Glacial Tropical Ocean. *Global and Planetary Change*, **69**, 29–34, doi:10.1016/j.gloplacha.2009.07.006.

Zhang, H.-M., and R.W. Reynolds, 2009: Sea Surface Wind Patterns from Multiple & Decadal Satellite Observations. *EnergyOcean 2009 Conference* (Guest Speaker), June 18 -18, 2009, Rockport, Maine.

Zhang, H.-M., and J.J. Sturman, 2009: Multiple Satellite Blended Sea Surface Winds and Their Applications to Offshore Renewable Energy. (accepted for oral presentation at the AMS First Conference on Weather, Climate, and the New Energy Economy.)

Fairall, C.W., B. Barnier, D. I. Berry, M. A. Bourassa, E. F. Bradley, C. A. Clayson, G. de Leeuw, W.M. Drennan, S.T. Gille, S.K. Gulev, E.C. Kent, W.R. McGillis, G.D. Quartly, V. Ryabinin, S. R. Smith, R.A. Weller, M.J. Yelland, and **H.-M. Zhang**, 2009: Observations to Quantify Air-Sea Fluxes and Their Role in Climate Variability and Predictability. *OceanObs'09 Community Whitepaper*.

Woodruff, S.D., N. Scott, D. I. Berry, M. A. Bourassa, E. Charpentier, S. K. Gulev, H. Haar, E. C. Kent, R. W. Reynolds, G. Rosenhagen, M. Rutherford, V. Swail, S. J. Worley, **H.-M.**

Zhang, and R. Zöllner, 2009: Surface In Situ Datasets for Marine Climatological Applications. *OceanObs'09 Community Whitepaper*.

Stanitski, D., C. W. Fairall, R. Weller, E.F. Bradley, **H.-M. Zhang**, W. Hankins, and A. Beljaars, 2009: Comparisons of in situ observations of bulk near-surface meteorological variables, turbulent and radiative fluxes, and cloud properties with operational NWP models in the VOCALS region. (to be presented at the 2009 AGU Fall Meeting)

5.2. Other Relevant Publications/Applications

Use in Offshore Renewable Energy: http://www.atmosconsulting.com/services/multi-discipline/windscan/

NOAA Coral Reef Watch: http://coralreefwatch.noaa.gov/satellite/doldrums_v2/index.html

Citations (including wind animations) in *OceanObs'09* plenary presentation and numerous Community White Papers.