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ABSTRACT

NOAA's National Climatic Data Center (NCDC) archives global surface marine data and integrated marine products. Data from tethered and drifting buoys, ships and satellites are archived and distributed. In addition, a comprehensive data rescue program is serving to digitize data that either pre-date the digital era, or more recent data that are not transmitted in near real-time. A comprehensive and coordinated effort is underway to integrate marine products and provide data interoperability using innovative data management and delivery methods.

Continuing challenges in the marine data environment include a wide variety of data formats, metadata availability and design, and sparse or temporally and spatially disparate network coverage. Thoughtful design in our data services will aim to address issues of format inconsistencies and work is underway to increase metadata availability. A focused effort is also in place to digitize data to fill in temporal and spatial gaps in marine data. High quality in-situ data should be widely available to compare to satellite observations and this will be of increasing use in the coming years and decades as more sophisticated satellite observation platforms are launched.

1. INTRODUCTION

NOAA's National Climatic Data Center is one of the World's largest archives for global marine surface weather data and integrated marine weather products. NCDC has a long history of ingesting, quality controlling, archiving and distributing marine data and it plays an active role in marine data rescue through the Climate Data Modernization Program.

Covering two thirds of the globe and encompassing some of the most sensitive global environments, marine surface weather observations are of primary importance in determining global climate conditions and trends, global weather and climate extremes, as well as providing input and validation for numerical weather prediction models. High quality in-situ marine observations also provide verification for satellite-based measurements of marine surface elements.

Significant challenges exist when considering marine observations, not least of which is the relatively inaccessible nature of the environment. Dedicated marine weather observing stations are expensive and difficult to site, relegating many of the moored stations to locations near the coast. Other marine weather 'stations' – ships and drifting buoys - are not at a fixed location and therefore quality control of the data as well as regional climate monitoring is more challenging. In addition, the 'network' of marine stations is sparse and non-uniform in distribution. It is also transient as ships change routes, remain in port, are decommissioned and change ownership. In all likelihood, ships will also avoid the severest weather leading to challenges in producing representative weather and climate observations.

2. HISTORY OF MARINE DATA AT NCDC

NCDC's marine weather sources include merchant and military ships (domestic and foreign), tethered and drifting buoys (domestic and foreign), coastal land-based stations, and satellite-derived information. Partners involved in producing the data stored at NCDC are myriad and diverse, from the U.S. Navy to the National Snow and Ice Data Center, to large international consortia (such as the Global Atmospheric Research Program), to the WMO, NASA and NOAA.

There are currently 41 datasets at NCDC comprising various elements of marine data and covering different time periods. Many of these datasets are also integrated into a global marine dataset – the International Comprehensive Ocean-Atmosphere Dataset (ICOADS) (Woodruff et al. 1987) – a collaboration between agencies in NOAA and with international partners. As of its latest release in spring 2006, ICOADS includes marine data from 1784 through 2005. NCDC has played a large role in ingesting and archiving the near real-time data that comprise ICOADS as well as imaging and keying historical data to fill in data gaps prior to spatially widespread marine observations. The Climate Data Modernization Program (CDMP) was established at NCDC in 2000 and has since placed over 45 million imaged weather observation forms online from land-based and marine weather and environmental records. As of 2005, CDMP was supporting several marine digitization projects including keying and/or imaging World War I and World War II ship records and early 20th century merchant marine ships. It's also actively engaged in digitizing Volunteer Observing Ship records and those from the U.S. Navy. Additional marine data rescue efforts include

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imaging logbooks held at the National Archives and Records Administration, including lightships off the U.S. coast and in the Great Lakes, Simultaneous Ship Observations (1874-1902) and other collections as identified. All the data keyed are merged into national and international marine databases after stringent quality control measures are applied.

time communication via the Global Telecommunication System.

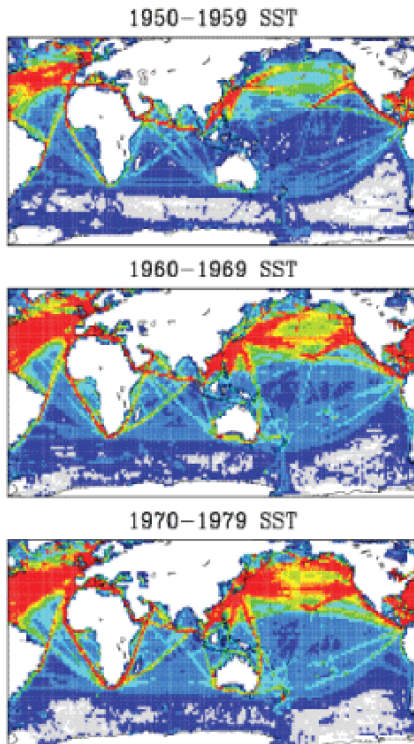
In 1993, two Global Collecting Centers (GCCs) were established as part of the WMO Commission for Marine Meteorology (CMM) and as a Responsible Member (RM) to the CMM, the US has had a responsibility (administered through NCDC) to provide

delayed mode data to the GCCs and to receive and archive international delayed mode data from them in return. The basic premise of the CMM is to coordinate and standardize global marine data providing basic quality and international data flow. NCDC plays a significant role in this effort and is further making improvements in our data flow to and from the GCCs (outlined in section 3). Marine data at the Global Collecting Centers includes that from the Volunteer Observing Ship Fleet, and its high-quality subset, the Volunteer Ships Climatology (VOSCLIM) program, as well as any delayed mode navy vessels.

A large improvement in NCDC's ability to archive and disseminate marine data at higher volumes and with less delay occurred with the direct ingest of data through the GTS and NOAAPORT in the late 1990s. In addition, NCDC's Climate Data Online (CDO) system was deployed in 1999 allowing users faster access to archived data at the Center. Marine data was made available through CDO,

including through a map-based GIS option. Recent improvements in CDO and GIS capabilities will be described in section 3.

Release 1



Release 2.0

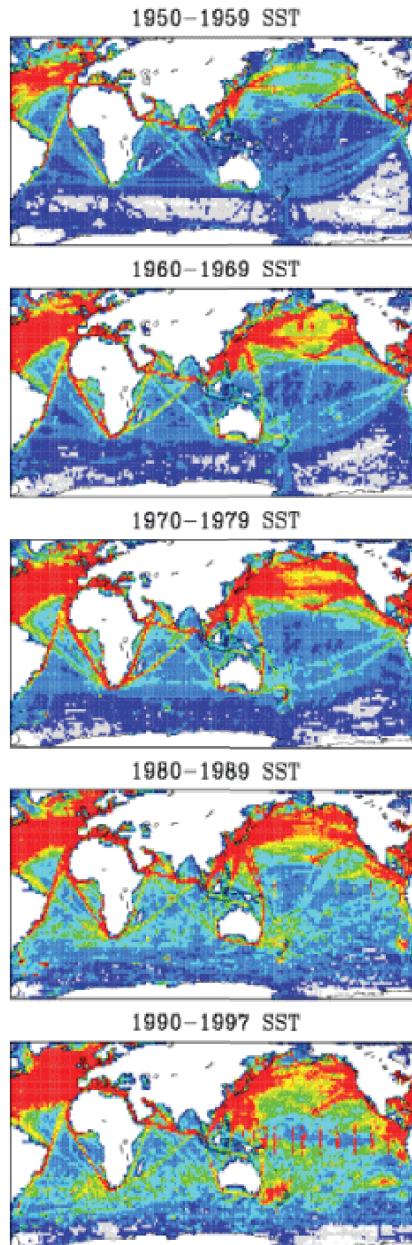


Figure 1. Increase in data coverage (In total observations per decade) for SSTs from first to second release of ICOADS. Scale: blank = 0, grey = 1-10, navy = 11-120, blue = 121-600, cyan = 601-1200, green = 1201-1800, chartreuse = 1801-2400, yellow = 2401-3000, orange = 3001-3600, red = 3601 or more

COADS 2001-12-12

Over approximately the last 10 years, many more observations have been added to ICOADS (see figure 1) through data rescue as well as improved near real-

3. RECENT CHANGES AND NCDC'S VISION FOR MARINE DATA SERVICES

A significant dataset, recently released from NCDC is the Extended Reconstructed Sea Surface Temperature (ERSST) dataset (Smith and Reynolds, 2004), initially released in 2003 and updated in 2004. The ERSST uses ICOADS data and statistical methods that allow stable temperature reconstruction even during periods or regions of sparse data coverage. Extending from 1854, the ERSST will be updated with subsequent ICOADS releases, and comprises the SST portion of the NCDC's official global temperature dataset, which blends land and ocean temperature data.

NCDC is currently undertaking a comprehensive effort to re-evaluate its marine data services and is planning increased coordination over the marine data program. An initial project is re-assessing the VOSclim Project data services. NCDC serves as the global Data Assembly Center for the VOSclim project and improvements to this service will be illustrated during the presentation.

VOSclim ships provide extensive metadata on their instrumentation and observation practices, as well as photographs of instrument location etc. The project's primary function is to provide high-quality, well-documented marine data to verify other marine observations, including in-situ data, satellite retrievals and model forecast output. NCDC is making increasing use of web-services and open source methods to serve up the data and increase its accessibility across the broad range of users. In designing new data services for VOSclim, we are leveraging methods and structure off a recently developed Severe Weather Data Inventory at NCDC. Adding interactive GIS functionality to an Oracle database permits data intercomparison in the spatial domain - a key advantage to the VOSclim project. After initial testing with VOSclim, this will be more widely applied to marine data at NCDC.

Recent improvements in NCDC's online climate data access includes an easily searchable database of all ship and buoy data and a separate search for VOSclim ships. Users may search by ship name, call sign or specify dates between which they would like all available data. In addition we have upgraded a specific website for the VOSclim program also making the data available, in response to requests, in simple ASCII text files. For VOSclim data, there is also access to 'suspect' data, a link to ship pictures, indicating instrument location and ship specifications, and a list of participating ships. Extensive metadata for VOSclim ships is available through a link on the VOSclim webpage to WMO publication 47.

Currently, NCDC's map-based search options (shown in figure 2) are primarily geared towards land-based data and include some, though not all buoy data, and no ship data. The GIS map-services have been improved in recent years to include advanced options

and additional features, layers, and datasets. Plans exist to continue to add features and data.

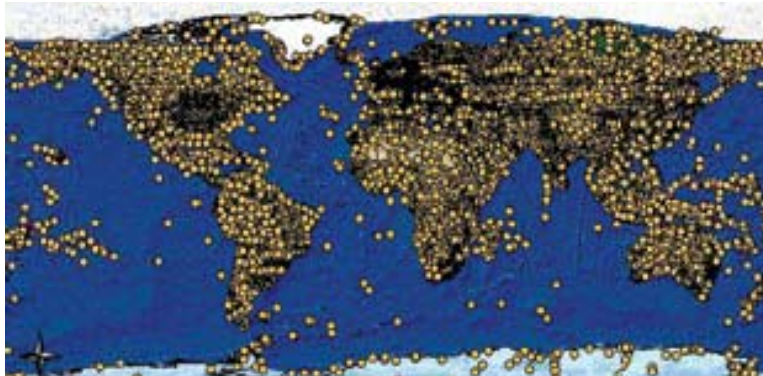


Figure 2. Screen capture from the main page of NCDC's GIS map-based data search capability.

Also recently improved at NCDC is our treatment of format conversion and data exchange, particularly with the Global Collecting Centers. Automating some processes as well as solving details of format conversion programming and updating the latest format versions have been a priority. Ensuring regular and more frequent data exchanges with the Global Collecting Centers has also been achieved. Due to the variety of marine formats at both the observing and the archive level, ensuring accurate format conversion and minimizing data loss is complex and time-consuming. NCDC's marine archive is officially maintained in ICOADS format, yet demand still exists for other formats and we are able to offer our customers a selection of formats based on their needs.

Our vision for the future includes complete data interoperability and seamless data access for our clients. As well as a broad overview of our marine resources at NCDC, this presentation will focus on using the VOSclim project as a test-bed to implement improved data intercomparison capabilities and innovative web-based data services.

4. REFERENCES

International Comprehensive Ocean-Atmosphere Data Set ICOADS:

<http://www.ncdc.noaa.gov/oa/documentlibrary/marine-doc.html>.

NCDC's Climate Data Online service
<http://hurricane.ncdc.noaa.gov/CDO/cdo>.

NCDC's Marine data homepage and data selection home:
<http://www.ncdc.noaa.gov/oa/marine.html>.

Volunteer Observing Ships Climatology project web-site:

<http://www.ncdc.noaa.gov/oa/climate/vo clim/vo clim.html>.

Woodruff, S.D., R.J. Slutz, R.L. Jenne, and P.M. Steurer, 1987: A comprehensive ocean-atmosphere data set. *Bull. Amer. Meteor. Soc.*, **68**, 1239-1250.

Smith, T.M., and R.W. Reynolds, 2004: [Improved Extended Reconstruction of SST \(1854-1997\)](#). *Journal of Climate*, **17**, 2466-2477.