Global Sea Level Observing System

United States National Sea Level Activities

UNESCO, Paris- 5 June 2007

GLOSS GE X

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I. Introduction

The 2007 United States (U.S.) National Report to the Global Sea Level Observing System (GLOSS) Group of Experts (GE) X is a summary of various ongoing U.S. programs and activities that are in support of GLOSS community objectives and goals. The Report addresses programs across the U.S., including Federal agencies and academic institutions and illustrates the breadth of National activities in support of climate and sea level studies. The first section of the Report summaries some of the major international programs such as the Global Earth Observing System of Systems (GEOSS); the second section then looks at programs across the U.S. agencies and institutions; the third and fourth focus on the major U.S. sea level monitoring activities in the National Oceanic and Atmospheric Administration (NOAA) and at the University of Hawaii Sea Level Center (UHSLC); followed by short summaries of other U.S. Federal agencies.

The Report also describes NOAA's commitment to being a U.S. leader for supporting the international climate and sea level community. Through international partnerships, innovative technology, and maintaining the long-term sustained infrastructure for observing systems, NOAA programs support the GLOSS objectives more than ever and look forward to enhancing collaborative efforts with the international community.

II. Multi-agency Activities in support of International Sea Level Observing Systems and the Global Earth Observation System of Systems (GEOSS)

A. World Climate Research Programmme (WCRP) Workshop June 2006

The U.S. played a key role in the success of the international Workshop on Understanding Sea-Level Rise and Variability hosted by the International Oceanographic Commission of United Nations Educational, Scientific and Cultural Organization (UNESCO) in Paris on June 6-9, 2006. The workshop was organized by the World Climate Research Programme (WCRP; http://wcrp.wmo.int) and was conducted in support of the Global Earth Observation System of Systems (GEOSS) 10- year Implementation Plan.

The Steering Committee Co-chairs included Stan Wilson of the National Oceanic and Atmospheric Administration (NOAA) and U.S. membership of the Steering Committee included: Robert Thomas- National Aeronautics and Space Administration (NASA), Mark Merrifield- University of Hawaii Sea Level Center (UHSLC) and Chair GLOSS Group of Experts, Gary

Mitchum – University of South Florida, Ruth E. Neilan-Director, International Global Navigation Satellite System Service Central Bureau (IGS), Jet Propulsion Laboratory (JPL), and Konrad Steffen – University of Colorado. In addition, thirty-three other U.S. scientists from various academic institutions and government agencies participated in the conference of 163 scientists from 29 countries.

B. The U.S. Climate Change Science Program

The U.S. President established the U.S. Climate Change Science Program (CCSP) in 2002 (www.climatescience.gov). In July 2003, the Interagency Committee on Climate Change Science and Technology Integration disseminated two documents: *The U.S. Climate Change Science Program: Vision for the Program and Highlights of the Scientific Strategic Plan* and the complete *Strategic Plan for the Climate Change Science Program.*

Many aspects of the environment and society are significantly affected by climate. The CCSP was established to empower the Nation and the global community with the science-based knowledge to manage risks and opportunities of change in the climate and related environmental systems. CCSP incorporates and integrates the U.S. Global Change Research Program (USGCRP) with the Administration's Climate Change Research Initiative (CCRI).

The USGCRP was established by the Global Change Research Act of 1990 to enhance understanding of natural and human-induced changes in the Earth's global environmental system; to monitor, understand, and predict global change; and to provide a sound scientific basis for national and international decision-making.

Addressing Impacts of Sea Level Rise

Sea level is introduced in Chapter 9 of the Strategic Plan and addresses *Human Contributions and Responses to Environmental Change*. This Chapter was coauthored by the Environmental Protection Agency (EPA) and NOAA. Question 9.2 of this Chapter is posed as: *What are the current and potential future impacts of global environmental variability and change on human welfare, what factors influence the capacity of human societies to respond to change, and how can resilience be increased and vulnerability reduced?*

The EPA, the United States Geological Survey (USGS) and NOAA are co-lead Federal agencies for production of CCSP Synthesis and Assessment Product 4.1. *Coastal Elevations and Sensitivity to Sea Level Rise* (see www.climatescience.gov/Library/sap/sap4-1/default.php). A summary of this U.S activity taken form the prospectus is as follows:

Synthesis and Assessment Product 4.1 will synthesize information from the ongoing mapping efforts by Federal and non-Federal researchers related to the implications of rising sea level. It will overlay the various data layers to develop new results made possible by bringing together researchers that are otherwise working independently. Because of time, data, and resource limitations, the synthesis will focus on a contiguous portion of the U.S. coastal zone (New York to North Carolina). The report will also develop a plan for sea level rise research to answer the questions that are most urgent for near-term decision making. The report will provide information that supports the specific goal in Chapter 9 of the Strategic Plan for the Climate Change Science Program (CCSP, 2003) to analyze how coastal environmental programs can be improved to adapt to sea level rise while enhancing economic growth.

This report will address the implications of sea level rise on three spatial scales by providing:

- An introductory section that puts the report within the nationwide context.
- Data overlays and a state-of-the-art quantitative assessment concerning coastal elevations, shore erosion, wetland accretion, and the areas where shores are likely to be protected for a multi-state study area along the U.S. Atlantic Coast: New York to North Carolina.
- Qualitative discussions that document in greater detail the impact of sea level rise on smaller areas within the mid-Atlantic study area.

Within the multi-state study area, the synthesis product will examine four key questions that address four of the most commonly cited factors contributing to the sensitivity of coastal lands to rising sea level: low elevations, coastal erosion, wetland accretion, and human modifications of the coastal zone. The four key questions are:

1. Which lands are currently at an elevation that could lead them to be inundated by the tides without shore protection measures?

2. How does sea level rise change the coastline? Among those lands with sufficient elevation to avoid inundation, which land could potentially erode in the next century? Which lands could be transformed by related coastal processes?

3. What is a plausible range for the ability of wetlands to vertically accrete, and how does this range depend on whether shores are developed and protected, if at all? That is: will sea level rise cause the area of wetlands to increase or decrease?

4. Which lands have been set aside for conservation uses so that wetlands will have the opportunity to migrate inland; which lands have been designated for uses requiring shore protection; and which lands could realistically be available for either wetland migration or coastal development requiring shore protection?

The product will answer as many of those questions as possible with a state-of-the-art quantitative analysis for the range of uncertainty regarding current coastal elevations and how much sea level may rise along the mid-Atlantic Coast. Where such an analysis is not feasible, the product will rely on older quantitative assessments if possible, or provide a qualitative evaluation. The quantitative assessment may exclude estuarine shores in the case of question 2, and Long Island Sound and North Carolina in the case of question 3.

To ensure comparability with other assessments, the magnitude of sea level rise considered will be expressed in round numbers such as 25, 50, and 100 cm. Although this product will focus on the impacts of a rise between 25 cm and 1 meter, it will also consider the implications of a two meter rise in sea level, for two reasons. First, in much of the U.S., the lowest contour on available topographic maps is 10 feet above the National Geodetic Vertical Datum of 1929 (NGVD29), that is, roughly two meters above the upper edge of tidal wetlands. Therefore, the area inundated by a two meter rise can be more accurately estimated than the area inundated by a rise of 25-100 cm. Second, a two meter rise in sea level is possible over the next two centuries (See e.g. Section 11.5.4 of IPCC 2001). To the extent that impacts depend on the timing of sea level rise, the product will focus primarily on the implications for the 21st century, but it will also consider land potentially vulnerable during the next two centuries.

Questions 1-4 are not the only important questions about coastal elevations and sensitivity to sea level rise. EPA, NOAA, and the USGS have solicited contributing authors to help address several additional questions:

5. What are the potential impacts of sea level rise on coastal floodplains? What issues would the Federal Emergency Management Administration (FEMA), coastal floodplain managers, and coastal communities face as sea level rises?

6. What are the population, infrastructure, economic activity, and value of property within the area potentially inundated by rising sea level given alternative levels of shore protection?

7. How does sea level rise affect the public's access to—and use of—the shore?

8. Which species depend on habitat that may be lost due to sea level rise given various levels of shore protection and other response options?

9. Which decisions and activities (if any) have outcomes sufficiently sensitive to sea level rise so as to justify doing things differently, depending on how much the sea is expected to rise?

10. What adaptation options are being considered by specific organizations that manage land or regulate land use for environmental purposes? What other adaptation options are being considered by Federal, state or local governments? What are the specific implications of each option? What are the institutional barriers to preparing for sea level rise?

The final SAP 4.1 report is due by the end of 2007 after stakeholder reviews and feedback and expert reviews.

C. U.S. Contributions to the Integrated Ocean Observing System (IOOS)

The Integrated Ocean Observing System (IOOS) is envisioned as a coordinated national and international network of observations, data management and analyses that systematically acquires and disseminates data and information on past, present and future states of the oceans and the Nation's Exclusive Economic Zone Integrated Global Environmental Observation and Data Management. IOOS is an important infrastructure that will enable many different users to characterize, understand, predict and monitor changes in coastal and ocean environments and ecosystems. This infrastructure is critical to understanding, responding and adapting to the effects of severe weather, global-to-regional climate variability, and natural hazards. Data types range from biological, chemical, physical, geological and geophysical both *in situ* and remotely sensed.

NOAA IOOS Program Office

NOAA established a IOOS Program with a fulltime Director and staff in January 2007 which will serve as the central focal point for the administration of NOAA's IOOS activities and will work very closely with the National Office for Integrated and Sustained Ocean Observations (Ocean.U.S.) www.oceans.us.

NOAA also established a data integration framework as the initial operating capability. NOAA has a 12 month goal (February 2008) of standing up the framework necessary to integrate five core IOOS variables (temperature, salinity, sea level, surface currents and ocean color), from multiple NOAA observing sources, for rapid and routine operational access and use by NOAA product developers and other end users. Between months 12 and 18, NOAA expects to ingest these integrated variables into four specific data products. NOAA will then systematically test and evaluate product enhancements, and verify, validate, and benchmark new performance specifications for operational use.

Given the number of contributing entities to the IOOS program, and the complexity of the tasks involved in developing IOOS, this requires that the program be developed through strong Federal partnerships. As well integrated regional coastal ocean observing system data and effective regional management structures, are critical components of a fully realized IOOS program. Regional partners are both producers and consumers of data and; therefore, will continue to have a major role in the development of IOOS.

New Web Portal

In partnership with the NOAA established an IOOS oriented web portal in May 2006 (http://opendap.co-ops.nos.noaa.gov). This portal provides users with access to an Open-source Project for a Network Data Access Protocol (OPeNDAP)/Distributed Oceanographic Data Systems (DODS) web page, OPeNDAP for observational water level, meteorological and ancillary data, as well as the model data through OPeNDAP Network Common Data Form (NetCDF) data servers. These server access points make data available to users via well-established and easy to use interfaces. In addition, Web Services are available for NOAA observational currents data, water levels, meteorological and ancillary data. Users may also access real-time listing of active stations and the status of their sensors.

The portal and data access protocols follow IOOS guiding principles (1) interoperability – by using OPeNDAP data servers, open source software and using SOA protocols for the Web Services, (2) open, easy access and discovery – by providing the data in established formats, American Standard Code for Information Interchange (ASCII), binary and Extensible Markup Language (XML), (3) reliable, sustained, and efficient operations – data through these services are available in real time, (4) effective user feedback – the portal provides an effective mechanism in which users of the data and services can provide feedback about the existing services, possible new services and issues they may have in using the services.

In 2007, NOAA is looking to added new Web Services such as benchmark sheets and metadata for program descriptions and station information. In addition, NOAA will be working with existing and new partners in help them with reuse of the Web Services.

D. Pacific Region Integrated Climatology Information Products

The Pacific Region Integrated Climatology Information Products (PRICIP) project will improve the understanding of patterns and trends of storm frequency and intensity - “storminess”- within the Pacific region and develop a suite of integrated information products that can be used by emergency managers, mitigation planners, government agencies and decision-makers in key sectors including water and natural resource management, agriculture and fisheries, transportation and communication, and recreation and tourism (www.pricip.org).

PRICIP is exploring how the climate-related processes that govern extreme storm events are expressed within and between three thematic areas: *heavy rains*, *strong winds*, and *high seas*. It involves analyses of historical records collected throughout the Pacific region, and the integration of these climatological analyses with near-real time observations to put the current weather into a longer-term perspective. This effort is a regional path finding activity towards the development of a U.S. comprehensive coastal climatology program.

Theme-specific data integration and product development teams have been formed to carry out this work. These teams are comprised of recognized agency and university-based experts in the area of climate-related processes that govern storminess. They include representatives from NOAA, as well as the University of Hawaii, University of Alaska, University of Guam, Oregon State University, and the Scripps Institution of Oceanography.

E. U.S. Tsunami Warning Program

Although the frequency of damaging tsunamis in the U.S. is low compared to many other natural hazards, the impacts can be extremely high. In 2005, the National Science and Technology Council (NSTC) and the U.S. Sub-Committee for Disaster Reduction released a report outlining the U.S. President's strategy for reducing the tsunami risk (NSTC, 2005). The NSTC is the principal means for the President to coordinate science and technology policy across the U.S. Federal government. To support the national strategy for minimizing the impact of tsunami, NOAA relies on a network of global data, acquired and processed in real-time, in addition to high-quality global databases supporting advanced scientific modeling. NOAA is upgrading it's sea level stations for near-shore monitoring, upgrading and expanding the network of seismic stations in partnership with the USGS, and expanding the Deep-ocean Assessment and Reporting of Tsunami (DART^{TM}) stations in the Atlantic, Caribbean, Gulf of Mexico and Pacific regions as part of the GEOSS. NOAA, in collaboration with the recently expanded National Tsunami Hazard Mitigation Program (NTHMP), is advancing modeling and mapping activities, hazard assessment and data stewardship, quantitative assessment of socio-economic impacts and increased preparedness.

New and Upgraded Tsunami Capable Tide Stations

Following the 2004 Indian Ocean tsunami disaster, the U.S. has been evaluating and strengthening its national tsunami warning system. NOAA is upgrading existing National Water Level Observation Network (NWLON) tide stations with new Data Collection Platforms (DCPs) and communication technology, and fill gaps in the existing water level network with new tsunami-capable NWLON tide stations (Figure 1Figure 1. NOAA also receives data from GLOSS stations operated by the University of Hawaii Sea Level Center (UHSLC). These tide stations, in addition to international tide stations in multiple countries, comprise an integrated coastal water level observation network, critical for tsunami detection and warning.

In 2005-2006, NOAA undertook the installation of16 new NWLON stations and 33 NWLON station upgrades, in support of the U.S. Tsunami Program. The final installation, at Port Alexander, AK, is scheduled for the summer of 2007. All 33 upgrades have been completed. In addition to these priority locations, NOAA has been systematically upgrading NWLON stations along all U.S. Coasts, including its possessions and territories. As of June 2007, there are 101 NWLON stations operating with full tsunami capabilities. All station upgrades in Alaska, the West Coast, the Pacific Islands, Hawaii and the Caribbean are complete, and the remaining Gulf and East Coast stations are scheduled for completion by the end of Fiscal Year 2007, which will bring the total number of NWLON tsunami stations to just over 140.

NWLON General System Operation

NWLON stations configured for tsunami support collect 1-minute averaged water level values in addition to the standard 6-minute averaged values. Unlike the previous generation of DCPs which transmitted 6-minute average water level values hourly via Geostationary Operational Environmental Satellites (GOES), the new DCPs transmit water level data every 6 minutes. 6-minute GOES transmissions include primary and backup 6-minute averaged water level data, as well as 1-minute water level data. The messages also include data quality parameters (mean, standard deviation and outliers) and data from any meteorological sensors operating at the station, as well as the preceding water level values from the primary and redundant sensors which can be used to fill data gaps should a transmission be missed. Upgraded NWLON stations also collect 15-second data from the backup water level sensor, which are stored at the backup DCP on a flash memory card. 15-second data are not transmitted via GOES, or routinely archived, but are available for post-event analysis and modeling through the DCP's 56K modem or direct serial connection at the DCP. Enhancements are also under development, in order to increase two-way communication capabilities at tsunami stations for diagnostics, firmware upgrades, reconfiguration, trouble shooting, and data retrieval, thereby eliminating the need to travel to the site, and promoting quicker response to problems and outages.

Data Access

Continuous, high-rate data are critical for timely tsunami detection, warning, as is reliable, real-time access to data from multiple sources. NOAA has access to NWLON water level data through three independent sources. All 6-minute and 1-minute data are available via GOES transmission through the NOAA National Weather Service (NWS) Gateway, as well as three redundant Satellites. NOAA has also developed a tsunami web page to provide real-time data access (www.tidesandcurrents.noaa.gov/tsunami).

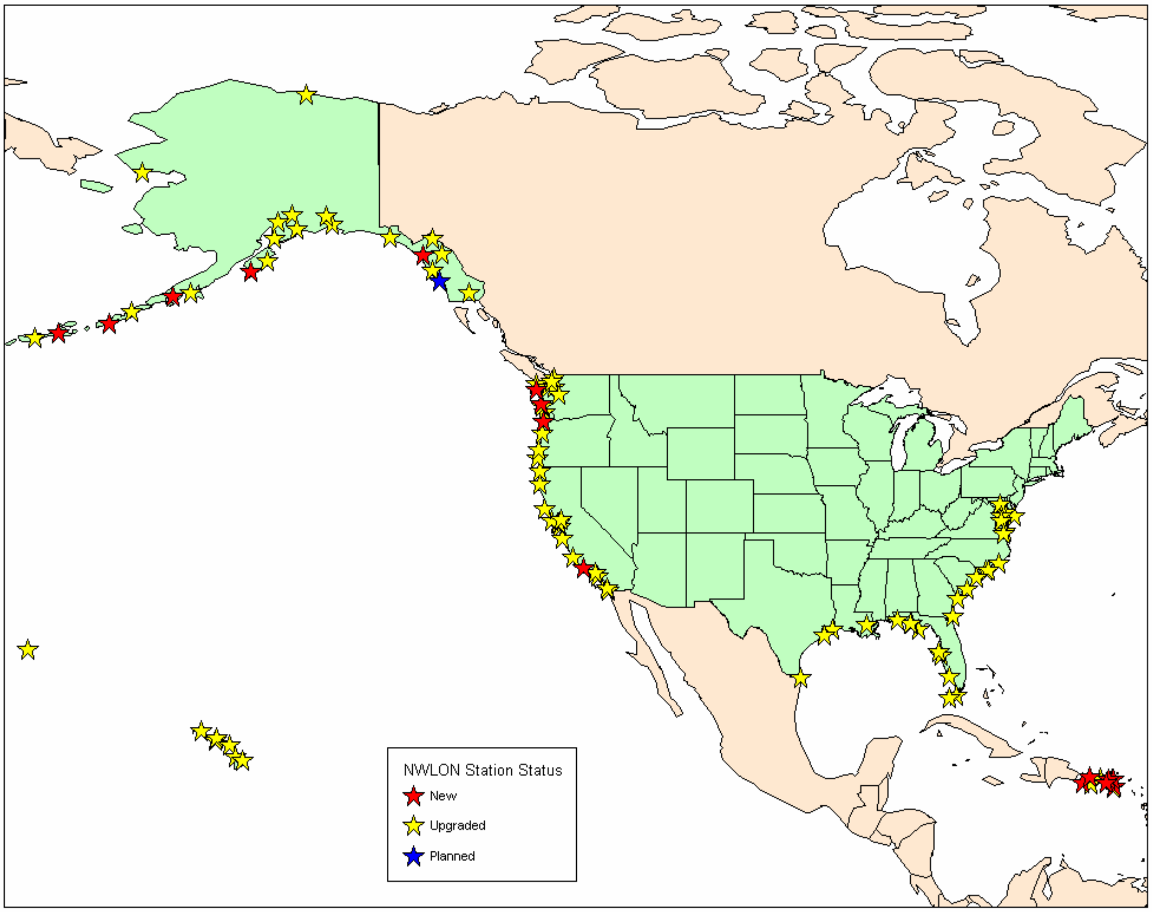

Figure 1. National Ocean Service Tsunami-Capable Tide Stations (excluding 4 Pacific Islands stations).

Deep-ocean Assessment and Reporting of Tsunamis (DART™)

The Deep-ocean Assessment and Reporting of Tsunamis (DART™) is an ongoing, multi-agency cooperative effort to maintain and improve the capability for the early detection and real-time reporting of tsunamis in the open ocean (Figure 2). The DART™ network is an essential component in the provision of timely warnings to U.S. coastal communities (http://www.ndbc.noaa.gov/dart/dart.shtml). DART™ data support the NOAA Tsunami Program observation requirements for Tsunami Offshore Real-Time and Post-event observations, as well as Global Water Level Observations, as described in NOAA's Consolidated Observational Requirements List (CORL).

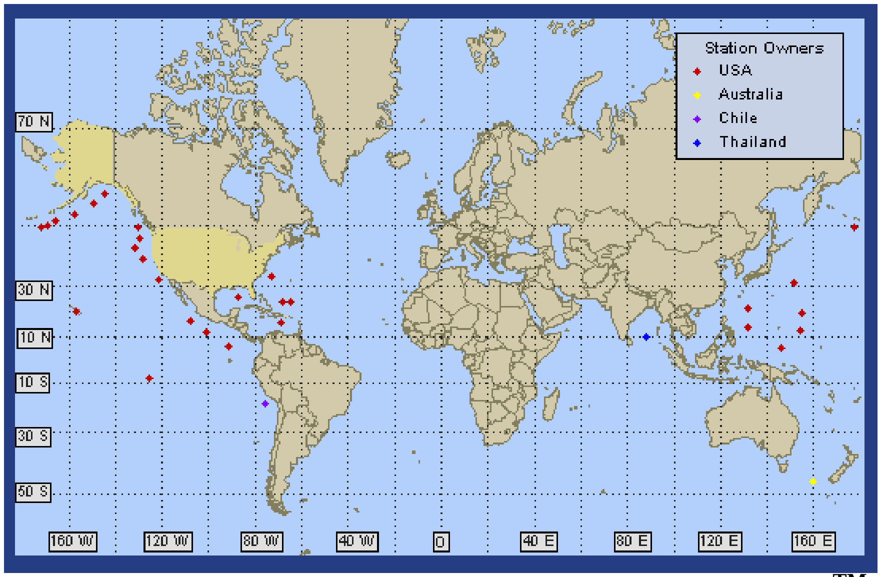

Figure 2. Deep-ocean Assessment and Reporting of Tsunami (DART™) stations

DART™ stations are sited to provide *in situ* tsunami detection and water-level observations for NOAA's tsunami forecast, warning, and mitigation responsibilities (Figure 3). The original six DART™ buoy operational array, completed in 2001, is on schedule to grow to an operational array of 39 DART™ II systems in the Pacific and Atlantic Oceans, the Caribbean Sea, and the Gulf of Mexico by March 2008. Unlike the original DART™ system, DART™ II has the capability of two-way communication.

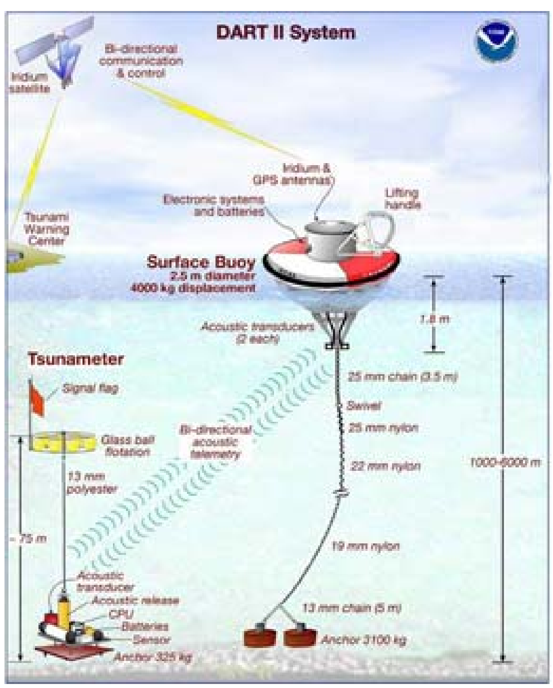

Figure 3. Conceptual diagram of the DART System

Each DART™ system consists of an anchored seafloor Bottom Pressure Recorder (BPR) acoustically coupled to a moored surface buoy. Iridium transceivers and the acoustic modems provide real-time communication between each DART™ system and the NOAA Tsunami Warning Centers (TWC) in Ewa Beach, Hawaii and Palmer, Alaska. Additionally they provide limited communications from the TWC to the BPR.

Sources of potentially damaging tsunamis are widespread, as are the coastal communities they threaten. With a limited number of DART™ systems available to deploy and maintain, it is vital that they be positioned to provide high quality observations at the earliest possible time. Siting of the DART™ buoys involves addressing 1) optimization of site locations based on scientific considerations, 2) logistical needs of deployment, 3) modeling and detection requirements imposed by potential sources of tsunamis, and 4) the identification of at-risk coastal communities.

The TWCs have responsibility for selecting DART™ sites. NOAA's Pacific Marine Environmental Laboratory (PMEL) produces specific site recommendations based on the propagation database to characterize expected travel times and amplitudes for tsunamis. Depth and local bathymetry of the seafloor exclude some sites, as does the threat of submarine landslides – provided by the USGS. Locations within U.S. or International waters are favored to enable unrestricted access for deployment and maintenance. The pre-deployment site maps provide valuable information for shore-side planning and decision-making, and afford a substantial savings in operational time and money. When possible, NOAA conducts a multi-beam bathymetric survey of the area at deployment.

Once deployed, each DART™ system provides a suite of data to fulfill NOAA's responsibilities for timely and effective warnings and creating tsunami resilient communities. DART™ provides internally stored high frequency data, triggered event data, and lower frequency data for system monitoring. NOAA engineers provide system enhancements through continued research and development efforts.

High frequency data consists of temperature and pressure averaged over 15-second intervals for the entire bottom package deployment period. Observations are stored on a flash card in the BPR until the bottom package is retrieved and the data recovered. NOAA processes the high frequency data then add the raw, edited, and processed data to NOAA's National Geophysical Data Center (NGDC) tsunami data archive along with all available metadata. In addition to internally recorded 15-second data, DART systems report a combination of 15-second data and 1-minute averages when triggered to do so by the detection of an event. These data provide NOAA with deep ocean tsunami observations essential for evaluating the potential risk to coastal communities within their jurisdiction. In addition, each DART system delivers spot pressure observations at 15-minute intervals in near real-time for system monitoring.

In addition to the real-time reporting operation modes and the two-way communication interrogation capability, each DART™ BPR records 15-second data internally on a flash card for the entire BPR deployment period, to be analyzed retrospectively. These data are retrieved following scheduled bottom package recovery, typically 2 years after deployment.

NOAA edits the retrospective data, removing the pre-deployment and post-recovery signals and spikes using editing techniques to avoid altering the observations in any way. NOAA examines the record drift and time base stability and performs specific filtering and tidal signal removal for tsunami modeling activities. To convert pressure in psi to metric units, a constant, derived using Levitus climatology to estimate vertically average density, is applied to retrospective data in place of the constant applied to real-time transmissions (Eble et al., 1989). Quality control of the analyses are done by performing a predicted vs. observed residual analysis to check for discontinuities, datum shifts, and invalid data.

F. Satellite Altimeter Activities

The Jet Propulsion Laboratory (JPL) of the California Institute of Technology manages the satellite altimeter programs for the National Aeronautics and Space Administration (NASA) in the U.S. and works with international partners to ensure the success of the missions. From http://sealevel.jpl.nasa.gov/newsroom/features/200612-1.html; "Jason-1 completed its 5th year on orbit on 7 December 2006. From its vantage point 1,330 kilometers (860 miles) above Earth, this follow-on to the highly successful TOPEX/Poseidon mission has provided measurements of the surface height of the world's oceans to an accuracy of 3.3 centimeters (1.3 inches). With this milestone, Jason-1 surpasses both its primary and extended mission phases and continues to collect valuable ocean data for researchers and operational users worldwide. A joint program of NASA and the Centre National d'Etudes Spatiales (CNES) in France, Jason-1 has vastly improved our understanding ocean circulation and its effect on global climate.

The primary objectives of Jason-1 include;

- Extending the ocean-surface topography time measurements begun by Topex/Poseidon into the 21st century
- Increasing our understanding of ocean circulation
- Improving climate forecasting
- Measuring global sea-level change
- Improving coastal tide models

Some of the important ongoing science investigations for Jason-1 include;

- Studying ocean variability on decadal scales and its relations to climate
- Understanding how changes in the ocean's heat content and mass affect global sea level
- Producing better tide models for the coastal oceans where the scales of tides are too small to be resolved by a single altimeter.

- Studying ocean eddies and their effects on large-scale ocean circulation and heat transport.
- Assimilating altimetry data with wind, temperature, and salinity data for improved prediction of El Niño-related climate events.

TOPEX/Poseidon enabled scientists to forecast the impact of the 1997-1998 El Niño. Jason-1 has viewed several less dramatic climate events in the Pacific Ocean, including the current mild El Niño and slow changes in the Pacific Decadal Oscillation.

The next-generation NASA ocean altimetry mission, which will be the follow-on to Jason-1, is the Ocean Surface Topography Mission (OSTM) on Jason-2. This joint mission, with partners CNES, Eumetsat, and NOAA, will extend the ocean-surface topography time series even further, and is scheduled to launch in 2008."

Satellite Altimeter Data Analyses

In August 2002 after 10 years of operation, the Topex/Poseidon satellite was moved to a new ground track. The Jason-1 altimeter, launched in December 2001, continues to collect data along the original TOPEX/Poseidon tracks. The Jason-1 project represents a major step towards operational altimetry, with precision orbits and quick-look data sets being routinely distributed by CNES and NASA.

NOAA took advantage of an opportunity to consolidate and standardize the near-real time sea level analyses that had been offered on-line to the public prior to 2002. . As of August 2002, users are going to the U.S. Navy for mesoscale analyses and to CNES for "climate-scale" analyses. Both groups combine all available altimeter data into a uniform product.

Mesoscale analyses are based on the methods developed at the Naval Research Lab at the Stennis Space Center. They are reliable at scales up to several hundred km, but revert to a climatological seasonal signal for very large scales. They are produced daily, 1-2 days behind real time. General information about these and other near-real time data can be found at the site maintained by the U.S. Navy for the Global Ocean Data Assimilation Experiment www.usgodae.fnmoc.navy.mil

Climate scale analyses are reliable at both mesoscale and basin-scale studies, and are updated on a weekly basis. Information about accessing the CNES data can be found at www.jason.oceanobs.com/html/donnees/welcome_uk.html

The NOAA Center for Satellite Applications & Research, Laboratory for Satellite Altimetry specializes in the analysis of satellite altimeter data related to problems in physical oceanography and marine geophysics and is involved in projects covering (www.grdl.noaa.gov/SAT/SAT.html):

- Near-Real Time Altimeter Data Analyses
- Topex/Poseidon Historical Sea Level
- ERS Altimetry
- Geosat Follow-On
- Geophysics Research
- Sea Floor Topography

Satellite Altimeter Mission Calibration and Verification Support

NOAA National Ocean Service (NOS) support for the TOPEX/Poseidon satellite altimeter mission include provisions of water level measurements relative to the satellite altimeter closure analysis reference frame for calibration monitoring (B. Haines et al, 2003; Figure 4). Additional support included a vertical survey on the Platform necessary to relate the water level sensor reference zeros (near the bottom catwalk) to the Global Positioning System (GPS) reference zero (located up top at the helipad on the Platform). Continuous data are required to monitor effects of waves on the water level measurements and to ensure provision of data during the times of altimeter over-flights every ten days. The original acoustic system was replaced by a digibub pressure system prior to the Jason-1 altimeter launch. Platform Harvest tide gauge operations will continue with the operation of two digital bubbler pressure systems collecting continuous water level data streams surveyed into the Platform and Satellite Orbit Reference frames.

Figure 4. Platform Harvest Verification Site of NOAA NOS Gauges.

III. National Oceanic & Atmospheric Administration (NOAA)

A. NOAA Office for Climate Observation (OCO)

The goal of the NOAA Office of Climate Observations (OCO) is to build and sustain the ocean component of a Global Climate Observing System (GCOS) that will respond to the long term observational requirements of the operational forecast centers, international research programs, and major scientific assessments (www.oco.noaa.gov). The requirements are to:

- document long term trends in sea level change;
- document ocean carbon sources and sinks;
- document the ocean's storage and global transport of heat and fresh water;
- document ocean-atmosphere exchange of heat and fresh water.

In order for NOAA to fulfill its climate mission, the global ocean must be observed. The ocean is the memory of the climate system and is second only to the sun in effecting variability in the seasons and long-term climate change. A global observing system by definition crosses international boundaries, with potential for both benefits and responsibilities to be shared by many nations. All of NOAA's contributions to global ocean observation are managed in cooperation with the Joint World Meteorological Organization (WMO) - Intergovernmental Oceanographic Commission (IOC) of UNESCO Technical Commission for Oceanography and Marine Meteorology (JCOMM). At present, NOAA provides funding for nearly half of the *in situ* elements of the international ocean climate observing system

Sustained Ocean Observing System

The Networks that make up the Sustained Ocean Observing System for Climate are: Tide gauge stations, dedicated ships, ships of opportunity, ocean reference stations, Arctic observing systems, tropical moored buoys, surface drifting buoys, Argo profiling floats, data & assimilation subsystems, product delivery, and continuous satellite missions for sea surface temperature, sea surface height, surface vector winds, ocean color, and sea ice. NOAA OCO contributes to global implementation of all networks except the satellites.

The system design that guides the OCO program is documented in the international Global Climate Observing System *Implementation Plan for the Global Observing System for Climate in support of the UNFCCC* (GCOS-92, 2004) (http://www.wmo.ch/pages/prog/gcos). GCOS-92 was published in October 2004. It has been endorsed by the UNFCCC and by the Group on Earth Observation (GEO). In particular:

1. The UNFCCC, Decision CP.10, "Encourages Parties to strengthen their efforts to address the priorities identified in the [GCOS] implementation plan, and to implement the priority elements …"

2. The *Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan Reference Document* (GEOSS, 2005) targets include: "Support implementation of actions called for in GCOS-92."

NOAA's *Program Plan for Building a Sustained Ocean Observing System for Climate* (NOAA, 2004) is in complete accord with GCOS-92 and provides the framework for NOAA contributions to the international effort. In particular 21 of the specific actions listed in the GCOS-92 ocean chapter (pages 56-84) are being acted upon by the OCO program in cooperation with the implementation panels affiliated with JCOMM – for sea level the implementation panel is the GLOSS Group of Experts (GE). These specific GCOS-92 actions now provide an excellent roadmap to guide observing system work plans. GCOS-92 is accessible via link from the OCO web site: www.oco.noaa.gov -- click on "Reports & Products." All of the work supported by OCO is directed toward implementation of this international plan and the projects are being implemented in accordance with the GCOS Ten Climate Monitoring Principles. The initial system as described in GCOS-92 is presently about 57% complete.

Implementation of the Networks is managed at 19 distributed centers of expertise -- NOAA laboratories, centers, joint institutes, universities and business partners. The composite System is centrally managed at the Project Office. Specifically, OCO's tasks are to:

- Monitor the status of the globally distributed networks; report system statistics and metrics routinely and on demand;
- Evaluate the effectiveness of the system; take action to implement improvements through directed funding;
- Advance the multi-year program plan; evolve the *in situ* networks through directed funding;
- Focus intra-agency, interagency, and international coordination;
- Organize external review and user feedback; and
- Produce annual reports on the state of the ocean and the adequacy of the observing system for climate.

Tide gauge stations are necessary to the climate program for accurately measuring long-term trends in sea level change and for calibration and validation of the measurements from satellite altimeters, which are assimilated into global climate models for predicting climate variability and change. Many tide stations need to be upgraded with modern technology particularly in less developed countries. Permanent GPS receivers are being installed, leading to a geocentrically located subset of 180 GCOS Climate Reference Stations. The 180 Climate Reference Stations are also being upgraded for real-time reporting, not only for climate monitoring, but also to support marine hazard warning (e.g., tsunami warning). This Climate Reference subset of the GLOSS core network is the focus of OCO support.

The University of Hawaii Sea Level Center is a NOAA partner who assists in the coordination of tide gauge operations within the international community. NOAA provides long-term support for the climate work at the UHSLC. The work of the UHSLC is detailed in Section IV of this Report.

B. National Ocean Service National Water Level Program (NWLP)

Operational Status of NOAA National Ocean Service Tide Stations

The Tides and Currents Programs, managed by the NOAA National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS), are used to support the statutory mandates and all NOAA missions. The NOAA National Water Level Program (NWLP), the National Current Observation Program (NCOP), and the Physical Oceanographic Real-Time System (PORTS®) are fundamental coastal ocean observing system programs (http://tidesandcurrents.noaa.gov/). The 200th National Water Level Observation Network (NWLON) station was recently established at Mobile, Alabama. The NWLP is an "end-to-end" system of data collection, quality control, data management, and product delivery with a long-term network of continuously operating stations, the NWLON at the core. The NWLP and its methodologies and standard operating procedures for data collection and production of tidal and water level datum products are seen as national standards for certification of information for legal applications and for technology transfer. Appendix I. has a detailed description of the NWLP.

Appendix 2 is a listing of the tide stations operated by NOAA contributing to the GLOSS network. Notes include the latest entries into the GLOSS database, the type of primary sensor in operation, and the latest date of contribution to the University of Hawaii Sea Level Center (UHSLC) Joint Archive for Sea Level (JASL) database. There are 29 of the 200 NOAA NWLON stations on this list. Appendix 3 is a listing of the tide stations operated by NOAA that are contributing to the JASL database at the present time. All of the GLOSS stations in Appendix 2 contribute to the JASL database. There are 54 total NOAA operational NWLON stations that actively contribute to the JASL archive. The 18 NWLON stations identified at the 1997 International Sea Level Workshop as critical to the global system for monitoring long term sea level trends are also identified in the tables as Climate Reference Network (CRN) stations.

Sea Level Trends Product Enhancement

NOAA produces an annual report on the state of the ocean and the state of the observing system for climate. The most recent one was for Fiscal Year 2005. There were 62 global water level stations identified in the International Sea Level Workshop Report (1997) as being the core global subset for long-term trends (Table 1). The NOAA *Program Plan for Building a Sustained Ocean Observing System for Climate* (NOAA, 2004) refers to them as climate reference stations and includes the following performance measures for these stations:

1. Routinely deliver an annual report of the variations in relative annual mean sea level for the entire length of the instrumental record.

2. Routinely deliver an annual report of the monthly mean sea level trend for the past 100 years with 95% confidence interval.

Since 2003, analyses of sea level trends and variability have been available for 117 long-term NWLON stations at *Sea Levels Online* on the CO-OPS website (tidesandcurrents.noaa.gov/sltrends/sltrends.html). The following figures illustrate the types of analyses available using Honolulu as an example (Figures 5-7).

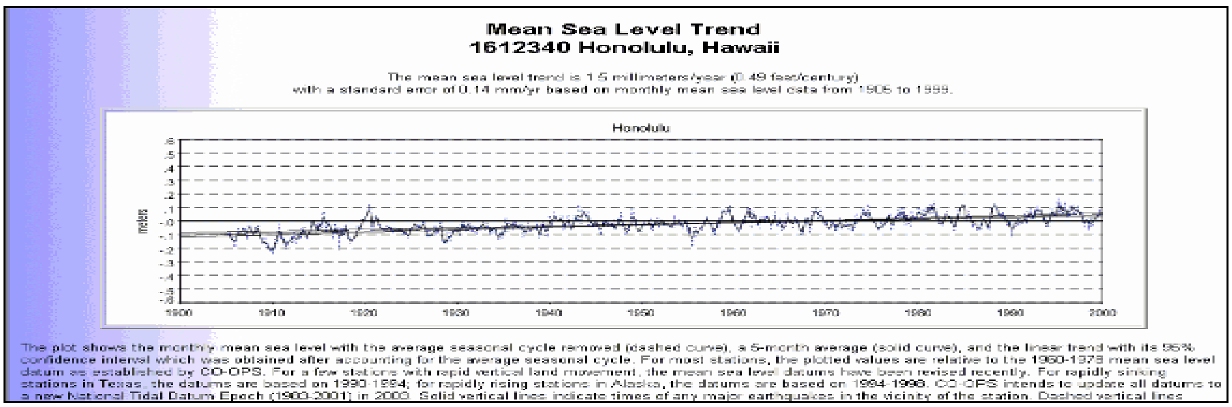

Figure 5. Sea level trend analyses.

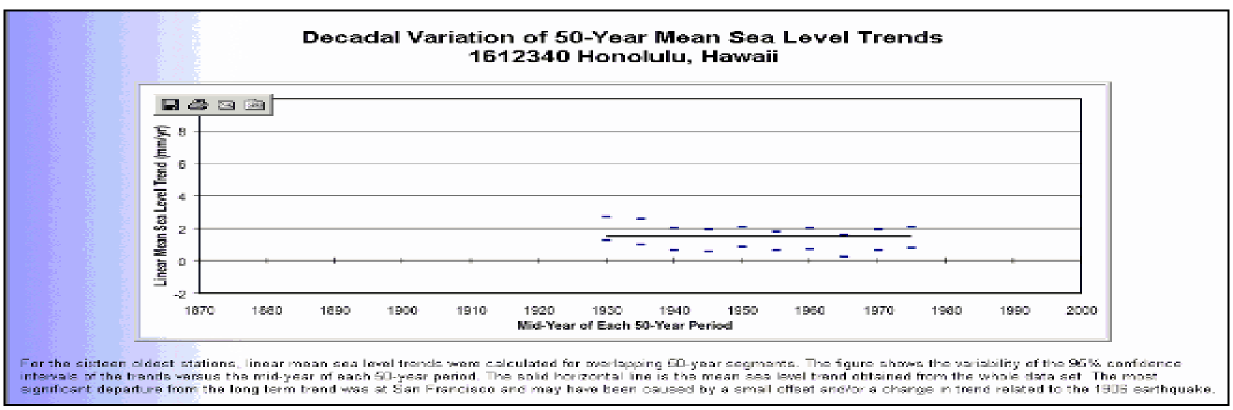

Figure 6. Long-term variation in trends.

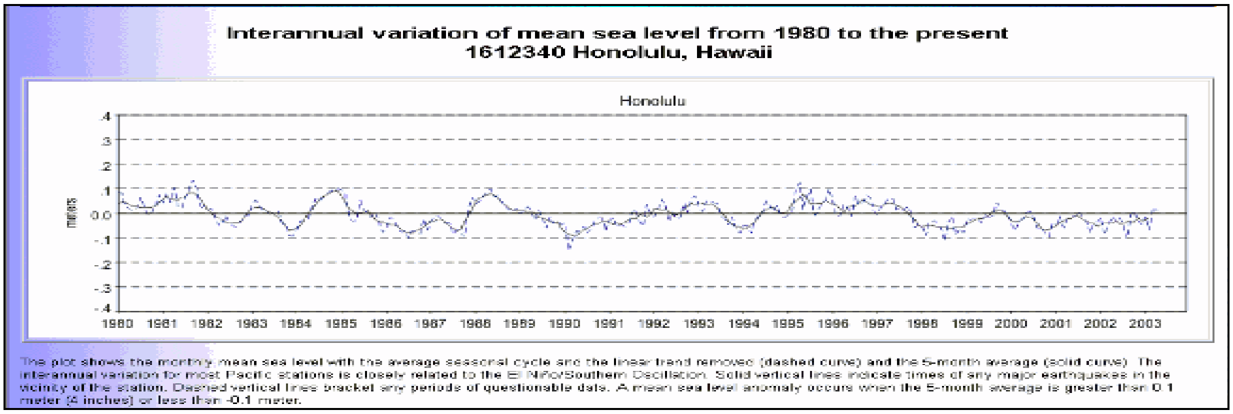

Figure 7. The monthly mean sea level anomalies are updated monthly.

NOAA has extended the sea level trend and variability analyses to the 44 non-NWLON climate reference stations in Table 1 and now presents this global sea level information at (tidesandcurrents.noaa.gov/sltrends/sltrends_global.shtml; Figures 8-9) The monthly mean sea level data for the non-NWLON stations were obtained from the Permanent Service for Mean Sea Level (PSMSL) website (http://www.pol.ac.uk/psmsl). The data set analyzed was their Revised Local Reference (RLR) data which has been carefully quality-controlled for datum continuity.

Table 1. Global Climate Reference Stations with Sea Level Analysis Completed.

Station Name	Country	Year Range
Reykjavik	Iceland	45
Narvik	Norway	73
Bergen	Norway	118
Goteborg	Sweden	116
Stockholm	Sweden	114
Helsinki	Finland	122
Daugavgriva	Latvia	66
Liepaja	Latvia	71
Wismar	Germany	155
Esbjerg	Denmark	108
Cuxhaven	Germany	159
Aberdeen	UK	141
North Shields	UK	108
Newlyn	UK	88
Brest	France	193
Cascais	Portugal	111
Marseille	France	115
Genova	Italy	113
Trieste	Italy	96

Station Name	Country	Year Range
Tuapse	Russia	85
Tenerife	Spain	72
Takoradi	Ghana	41
Aden	Yemen	90
Mumbai/Bombay	India	116
Vishakhapatnam	India	59
Ko Lak	Thailand	62
Xiamen	China	48
Mera	Japan	70
Aburatsubo	Japan	69
Tonoura/Hamada	Japan	108
Wajima	Japan	69
Manila	Philippines	68
Sydney	Australia	117
Fremantle	Australia	106
Auckland	New Zealand	97
Lyttelton	New Zealand	76
Guam	NWLON	53
Kwajalein	NWLON	55
Honolulu	NWLON	96
Ketchikan	NWLON	82
Vancouver	Canada	89
Victoria	Canada	90
Neah Bay	NWLON	67
Crescent City	NWLON	68
San Francisco	NWLON	150
San Diego	NWLON	95
Balboa	Panama	88
Quequen	Argentina	64
Buenos Aires	Argentina	82
Cartagena	Colombia	43
Cristobal	Panama	71
Bermuda	NWLON	59
Pensacola	NWLON	78
Key West	NWLON	88
Fernandina Beach	NWLON	104
Charleston	NWLON	80
Hampton Roads	NWLON	74
Atlantic City	NWLON	90
New York City	NWLON	144
Boston	NWLON	80
Portland	NWLON	89
Halifax	Canada	107

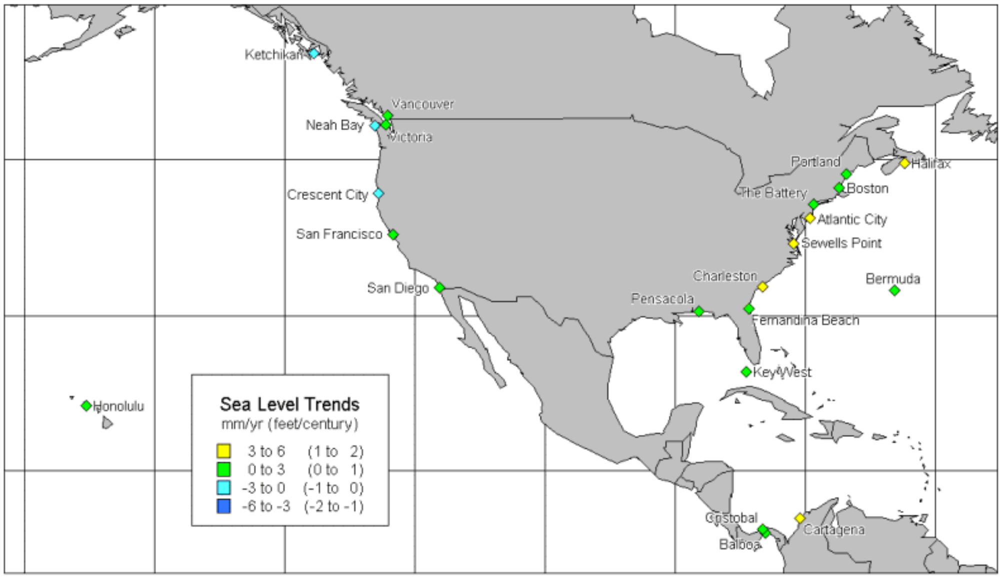

Figure 8. North American Relative Sea Level Trends

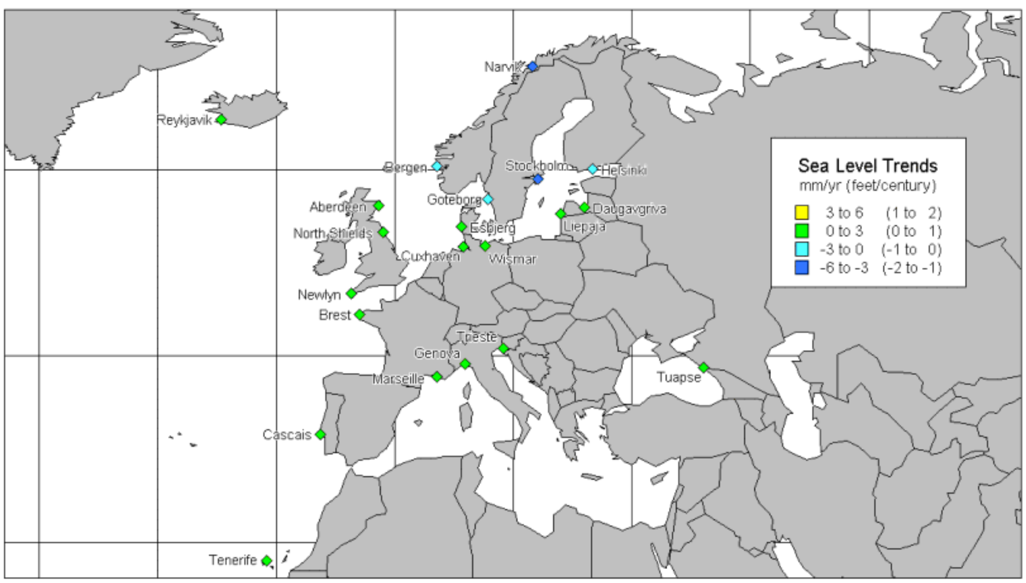

Figure 9. European Relative Sea Level Trends

CO-OPS intends to extend the compilation of the data and the analysis from the 62 climate reference stations to most of the 182 GLOSS-LTT (Long Term Trend) stations identified in Annex IV of the Global Sea Level Observing System (GLOSS) Implementation Plan 1997 (IOC Technical Series No. 50) (http://unesdoc.unesco.org/images/0011/001126/112650eo.pdf). 45 of the GLOSS-LTT stations are NWLON stations and their sea level trends and variations are already available on the *Sea Levels Online* website.

Exceedance Probability Analysis of Extreme Storm Tides

The occurrence of dangerously high or low water levels at coastal locations is an important public concern and is a significant factor in coastal hazard assessment, navigational safety, and ecosystem management. When an extreme event occurs, it is often desirable to compare it with the record of previous extremes at that location in order to put the event in context. Historical water level data can be used to define thresholds beyond the normal daily tidal range that have low but finite probabilities of being exceeded. Many NOAA NWLON stations have been in operation for many decades with some having over a century of data. As historical data are accumulated for each station, more and more rare events are recorded and the tails of the station's probability distribution function are filled in.

Monthly highest and lowest water levels show a clear response to local mean sea level trends. The extreme levels reached by hurricanes and extra-tropical storms of the past can be adjusted for the sea level trend, so that unbiased comparisons can be made. A data set of the annual highest and lowest water levels was derived from the monthly data and used to determine the expected frequency of future storm tides rising above or falling below any given level. The expected statistical distribution of the extreme values of any sequential process or set of observations is described by the Generalized Extreme Value (GEV) theory. The results are a set of annual and monthly exceedance probability levels relative to the tidal datums for each station (Figures 10-12). This information should prove useful for identifying, in real time, when a rare event threshold has been crossed.

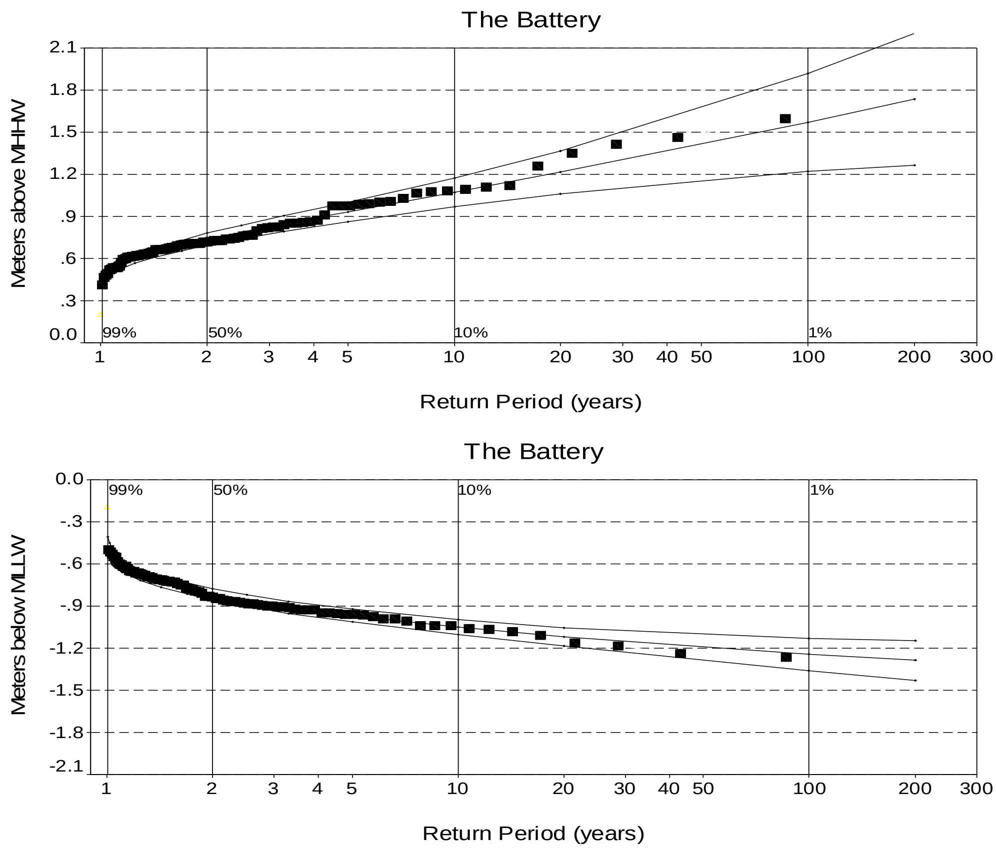

Figure 10. Average return period in years for annual highest and lowest water levels in meters above the tidal datums, Mean Higher High Water (MHHW) or below Mean Lower Low Water (MLLW) at The Battery, New York tide station. Curves are the GEV exceedance probabilities with 95% confidence intervals. Square symbols are annual highest and lowest data. Vertical lines indicate annual exceedance probabilities.

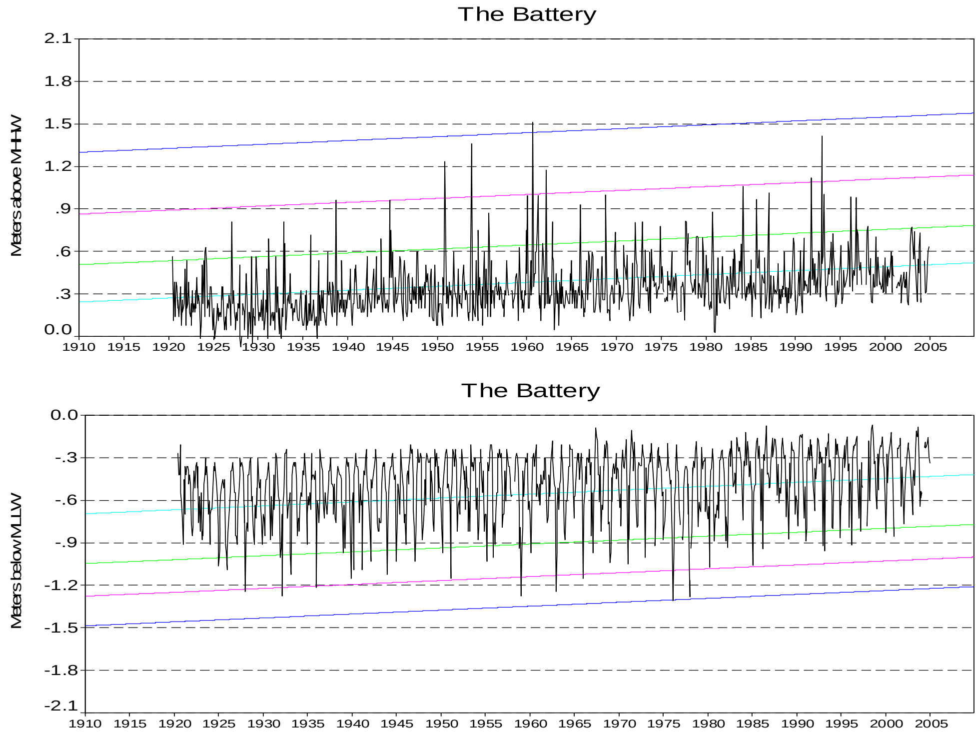

Figure 11. Monthly highest water level above the tidal datums, Mean Higher High Water (MHHW) and lowest water level below Mean Lower Low Water (MLLW) at The Battery, New York tide station. Also shown are the 99% (light blue), 50% (green), 10% (pink), and 1% (dark blue) annual exceedance probability levels.

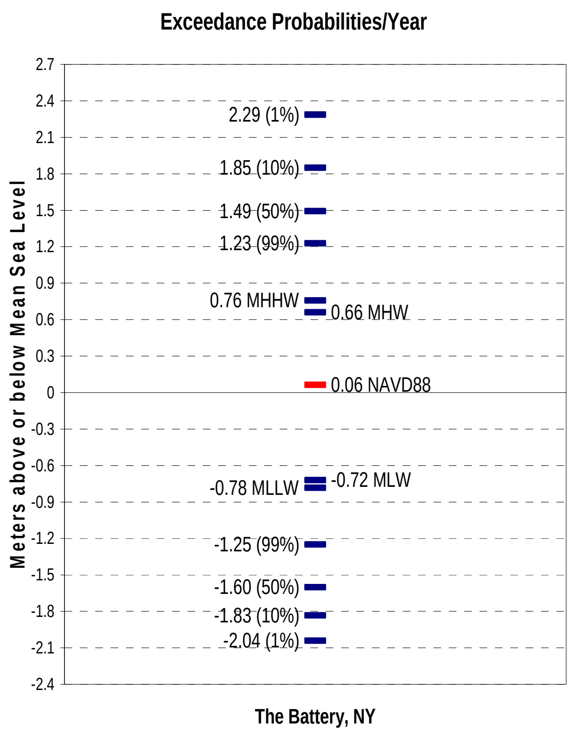

Figure 12. Tidal datums, annual exceedance probability levels, and the geodetic datum North American Vertical Datum (NAVD88) (in red) relative to the tidal datum Mean Sea Level (MSL) at The Battery, New York tide station.

Exceedance thresholds will be established for extreme storm tide events at most long-term U.S. coastal water level stations. Historical monthly highest and lowest water level data are adjusted for sea level trends, so that the resulting monthly and annual extreme value series can be analyzed without bias. Theoretical GEV exceedance probability curves are fit to the data to determine exceedance levels for various average return periods of interest. As more and more data continues to accumulate at more stations, it is expected that these exceedance levels will become better defined. The exceedance probability levels are tied to the position of the present-day tidal datums and can be adjusted in the future to reflect changing sea levels.

Upgrade of NOAA Ocean Island Station Operations

There are several coastal and island NWLON stations critical to the Global Climate Observing System (GCOS). Finding routine flights and flights which are cost effective are becoming increasingly difficult, yet these stations require high standards of annual maintenance to ensure the integrity of their long term data sets. Annual maintenance is even more important, in light of the fact that corrective maintenance is logistically very difficult and expensive.

Although operation of all of the stations is important, Ocean Island stations upgrades are a particular target (Table 2). Upgrades will ensure their continuous operation (program funding and budget initiatives will be used for operation of the coastal stations). These targeted funds will be used for travel costs and for upgrade with completely redundant systems. The upgrades will include high accuracy acoustic or paroscientifc pressure sensors and redundant Data Collection Platforms (DCP's) with equal capability to the existing primary systems. This approach has already proved to be beneficial as illustrated by the tide station at Wake Island surviving a major direct hit by a hurricane this past year without loss of data. The station operations will also be enhanced with Global Positioning System (GPS) connections to geodetic systems followed by installation of GPS Continuously Operating Reference Systems (CORS) at selected sites.

Table 2. The following is a list of the ocean island NOAA NWLON stations (not including Hawaii) which are being upgraded.

Station:	**Upgraded to Date**
Guam	no - 2007
Kwajalein	no - 2007
Pago Pago	yes
Wake	yes
Midway	yes
Adak	yes
Bermuda	no - 2008
San Juan. PR	yes
Magueyes Island, PR	yes
Charlotte Amalie, VI	yes
St Croix, VI	yes

Status and Plans for Microwave Water Level Sensors

Microwave technology offers numerous advantages over the methods currently used in the United States to measure water level. Existing contact water level systems are subject to corrosion, bio-fouling and physical damage due to the harsh marine environment. This can in turn affect the accuracy of data obtained from these systems. The installation costs for existing systems are considerably higher than those for microwave technology, and the maintenance requirements for microwave systems may also prove to be considerably less than for those of existing sensors. Microwave technology also offers a large range and is not affected by fog or rain, as is the case with some other non-contact measurement technologies such as laser altimeters.

Over the past decade, the NOAA National Ocean Service (NOS) has closely followed the developing microwave water level technology as well as monitoring sensor tests and applications of others. Several extensive tests have been conducted on these devices. Our ongoing technology survey includes:

- Four years of microwave air gap testing and demonstration (see http://tidesandcurrents.noaa.gov/publications/tecrpt42.pdf) followed by four years of operational use (http://tidesandcurrents.noaa.gov/ports.html)
- Participation in the GLOSS/IHO/IALA, 2003. Technical Workshop on Water Level Measurements, Paris (see http://unesdoc.unesco.org/images/0013/001377/137705e.pdf)
- European Sea level Service Research & Infrastructure (ESEAS) tests starting in 2002 (see www.pol.ac.uk/psmsl/gauge.experiences/D41.pdf)
- USGS Hydrographic Instrumentation Facility (USGS/HIF)
- U.S. Army Corp of Engineers operational uses
- Korea's National Oceanographic Research Institute use of Miros for water level observations
- NOAA's West Coast and Alaska Tsunami Warning Center use of an Ohmart Vega system in Craig, Alaska

The Miros SM094 sensor was evaluated by ESEAS and determined to meet GLOSS standards. Figure 13 shows this sensor deployed by NOS in 2004 at the U.S. Army Corp of Engineers Field Research Facility in Duck NC. NOAA will conduct bench tests, controlled condition tests, and deploy microwave sensors at different NWLON stations. Reference water level data will be obtained from the existing acoustic, float/shaft angle encoder, and pressure systems already in place.

Figure 13. The Miros SM094 sensor at a USACE testing facility.

New Measurements and Technology in the Arctic and other Remote Areas

The NOAA National Ocean Service (NOS) has been investing in new sensor technologies and station configurations in order to make measurements in key remote areas and geographic areas that are exposed to environmental extremes.

NOS has successfully been using a dual orifice pressure sensor system for installation in shore ice prone areas such as Nome, Alaska where an acoustic system protective well cannot be installed. New investment is in development of an upgraded system that uses a less expensive and more accurate differential pressure sensor system that use air to drive the bubbler system rather than nitrogen.

NOS is attempting to establish new long term measurements along the North Slope of Alaska near Point Barrow. This area has seasonal fast-ice connected to shore that scours the bottom twice seasonally. The ice thickness near shore also prohibits any type of water level measurement during the winter. The plan is to use an offshore bottom pressure system coupled with simultaneous measurements from an on shore station in the summer, the use of GPS surveying, and the use of acoustic modem technology to establish a continuous, vertically controlled, time series that can be used for datum determination.

Performing System-wide Gaps Analysis in Geographic Coverage of the NOAA National Water Level Observation Network (NWLON)

The NOAA National Ocean Service (NOS) is in the process of performing a network design analysis study for the NWLON focused on identifying and quantifying gaps in geographic coverage. This analysis helps guide priorities for establishing new NWLON stations as well as to establish uncertainty estimates to help quantify the impacts of insufficient coverage. The density of stations in the NWLON network design is driven by error budgets of the applications. For instance, given that tidal datums are local in nature and determined at specific locations by water level measurements at tide stations, extrapolation and/or interpolation of datum information from an NWLON station at a given location up and down the shoreline or coast from the station is constrained by errors in the technique for simultaneous comparison between a short-term subordinate station and a long-term NWLON control station. These limits are driven by tolerable uncertainties for the desired application. Errors in determination of tidal datums at short-term stations through the method of simultaneous comparison are known to be generally correlated with geographic distance from the control station and with difference in range of tide and time of tide between control and subordinate stations. Operationally for hydrographic surveys, NOAA uses the International Hydrographic Organization (IHO) error budget to construct error budget analyses for the tides component to the total error. These analyses are used to determine the number and location of subordinate stations required to obtain tide reducers for survey operations for specific areas. The error budget considers measurement error, datum computation error, and tidal zoning (extrapolation) error sub-components. Datum uncertainties need to be on the order of 0.10 ft. for the error budget to be within desired surveying specifications. The estimates of relative sea level trends found are operationally used to estimate errors in tidal datum elevations if sea level trends are not properly taken into account and are used to assess the need to update to a new National Tidal Datum Epoch (NTDE) time period. NTDE periods are assessed for potential update on a nation-wide basis every few decades based on analyses of relative sea level trends. For marine boundary purposes and delineation of the location of the mean high water line, the surveying user community desires known elevation points to the 0.10 ft. uncertainty. Real-time navigation users are now interested in more accurate water levels relative to accurate chart datum and channel depth reference systems because larger and larger vessels with deeper drafts are now coming into most ports. Elevations previously at the several tenths of a foot uncertainty are now desired to the nearest 0.10 ft. for marine operations.

For purposes of this NWLON study, the target value of 0.12 ft (95% confidence interval) has been selected for determination of the extent of coverage for datum determination for each NWLON station. Thus target value would ensure the accuracy of datum determination at subordinate locations would meet most user requirements. The study identifies the geographic region for each NWLON station within which a datum computation at a subordinate station with a 3-month time series will be accurate to less than or equal to 0.12 ft. at the 95% confidence interval. Using GIS derived polygons, areas determined to contain no NWLON coverage are identified as gaps for consideration of new priority NWLON station requirements. Error analysis using a 3-month time series was selected as it is the typical length of time a subordinate station is operational for NOAA shoreline and hydrographic surveys and for outside users such as the U.S. Army Corps of Engineers.

The following figure (Figure 14) shows the output of this NWLON gaps analysis for the U.S State of Florida. Each existing NWLON station is shown with the shaded polygon of coverage. The open areas are locations of gaps in coverage and new NWLON stations are being considered for those areas.

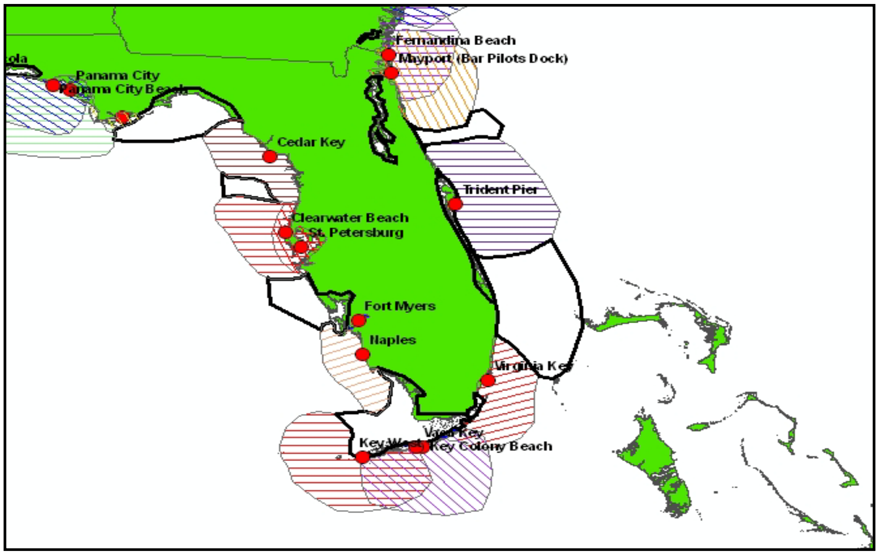

Figure 14. Output from the NWLON GIS gaps analysis for the State of Florida, U.S.

IV. The University of Hawaii Sea Level Center (UHSLC)

The University of Hawaii Sea Level Center (UHSLC) collects, processes, and distributes tide gauge measurements from around the world in support of various climate research activities. Primary support for the UHSLC is provided by the NOAA Office of Climate Observation (OCO). UHSLC datasets are used for a variety of research and operational activities, including assessments of sea level rise and variability, the calibration of altimeter data, and storm surge and tsunami monitoring. In support of satellite altimeter calibration and for absolute sea level rise monitoring, the UHSLC and the Pacific GPS Facility maintain co-located GPS systems at select tide gauge stations (GPS@TG). The UHSLC currently is a designated CLIVAR Data Assembly Center (DAC) and an IOC GLOSS data archive center. The UHSLC distributes data directly from its own web site and through a dedicated OPeNDAP server. The data are redistributed by the National Oceanographic Data Center (NODC), the Permanent Service for Mean Sea Level, the Climate Data Portal (CDP) maintained by the Pacific Marine Environmental Laboratory (PMEL), the National Virtual Ocean Data System (NVODS), the International Pacific Research Center's GODAE data server, and the NOAA Observing System Architecture (NOSA) web site.

The UHSLC collaborates in the operation of 51 tide gauge stations in the global sea level network (Table 3). All of these sites meet GLOSS standards for tsunami monitoring and are currently providing data to appropriate warning centers. In the past year, center serviced 24 sites and installed 7 new stations remotely. The historical data return for the UHSLC network is 93.8%, the 2006 return is 96.4%, and the previous years return 96.8%. The UHSLC in collaboration with the Pacific GPS Facility operates co- located continuous GPS (GPS@TG) receivers at 7 tide gauges, which constitute to the NASA/CNES Science Working Team for altimeter calibration, and provide local estimates of absolute sea level rise.

The UHSLC distributes three sea level data sets:

Joint Archive for Sea Level (JASL)

The Joint Archive for Sea Level JASL data set is designed to be user friendly, scientifically valid, well-documented, and standardized for archiving at international data banks. JASL data are provided internally by the UH Sea Level Network and by over 60 agencies representing over 70 countries. In the past year, the UHSLC increased its JASL holdings to 10,952 station-years of hourly quality assured data. The JASL set now includes 6397 station years of data in 297 series at 228 GLOSS sites.

Fast Delivery Database

The Fast Delivery Database supports various international programs, in particular CLIVAR and

GCOS. The database has been designated by the IOC as a component of the GLOSS program. The fast delivery data are used extensively by the altimeter community for ongoing assessment and calibration of satellite altimeter datasets. The fast delivery sea level dataset now includes 204 stations, 170 of which are located at GLOSS sites.

Near Real-Time Data

Near Real-Time Data (collection + up to a three hour delay, H-3 delay) and daily filtered values (J-2 delay) are provided by the UHSLC in support of GODAE. Approximately 130 stations currently are available in real-time with plans for ongoing expansion.

The UHSLC provides monthly maps of the Pacific sea level fields through the JCOMM. UHSLC also produces quarterly updates of an index of the tropical Pacific upper layer volume and annual updates of indices of the ridge-trough system and equatorial currents for the Pacific Ocean. The analysis includes tide gauge and altimeter sea surface elevation comparisons.

Table 3. Stations for which the UHSLC operates or assists in the operations. GPS@TG indicates which stations have UHSLC GPS co-located at the tide stations.

GLOSS	STATION	COUNTRY	LAT	LONG	
004	Salalah	Oman	16-56N	054-00E	
xxx	Masirah	Oman	20-41N	058-52E	
008	Mombasa	Kenya	04-04S	039-39E	
xxx	Lamu	Kenya	02-16S	040-54E	
018	Port Louis	Mauritius	20-09S	057-30E	
019	Rodrigues	Mauritius	19-40S	063-25E	
026	Diego Garcia	United Kingdom	07-17S	072-24E	
027	Gan	Rep. of Maldives	00-41S	073-09E	
028	Male,Hulule	Rep. of Maldives	04-11N	073-32E	GPS@TG
xxx	Hanimaadhoo	Rep. of Maldives	06-46N	073-10E	
033	Colombo	Sri Lanka	06-57N	079-51E	
107	French Frigate S	USA	23-52N	166-17W	
108	Honolulu	USA	21-18N	157-52W	GPS@TG
109	Johnston	USA Trust	16-44N	169-32W	
115	Pohnpei	Fd St Micronesia	06-59N	158-15E	
117	Kapingamarangi	Fd St Micronesia	01-06N	154-47E	
118	Saipan	N. Mariana Is.	15-14N	145-45E	
119	Yap	Fd St Micronesia	09-31N	138-08E	
120	Malakal	Rep. of Belau	07-20N	134-28E	GPS@TG
123	Noumea	France	22-18S	166-26E	
128	Chatham	New Zealand	43-57S	176-34E	
137	Easter	Chile	27-09S	109-27W	
138	Rikitea	French Polynesia	23-08S	134-57W	
140	Papeete	French Polynesia	17-32S	149-34W	
143	Penrhyn	Cook Islands	08-59S	158-03W	
145	Kanton	Rep. of Kiribati	02-49S	171-43W	
146	Christmas	Rep. of Kiribati	01-59N	157-28W	

161	Cabo San Lucas	Mexico	22-53N	109-55W	
163	Manzanillo	Mexico	19-03N	104-20W	GPS@TG
169	Baltra	Ecuador	00-26S	090-17W	
xxx	Santa Cruz	Ecuador	00-45S	090-19W	
175	Valparaiso	Chile	33-02S	071-38W	GPS@TG
xxx	Salvador	Brazil	12-58S	038-31W	
181	Ushuaia	Argentina	54-48S	068-18W	
185	Mar Del Plata	Argentina	63-24S	056-60W	
211	Settlement Pnt.	Bahamas	26-41N	078-59W	GPS@TG
245	Ponta Delgada	Portugal	37-44N	025-40W	
xxx	Palmeira,C.Verde	Portugal	16-45N	022-59W	GPS@TG
253	Dakar	Senegal	14-41N	017-25W	
273	Pt. La Rue	Seychelles	04-40S	055-32E	
297	Zanzibar	Tanzania	06-09S	039-11E	

V. The United States Geological Survey (USGS)

The United States Geological Survey (USGS) is a U.S. Federal agency that is involved providing water information and water related resources that assist in the understanding of coupled geologic and climate change, long term sea level change, and the impacts of climate change. USGS maintains a nation-wide real-time water data web-site portal, a national data base system for hydrologic data and monitors short-term and long term changes in stream flow conditions. With other State and Federal partners, USGS maintains long-term water level and stream flow networks (see http://water.usgs.gov/). Recent work includes the development of a quick-response capability to install short-term networks of upland water level gauges prior to land-fall of a hurricane that provide a much need denser network for establishing the elevation of and the timing of storm surge as it progresses inland from the rivers and estuaries.

USGS has recently developed two new very useful products for understanding and mitigating the effects of sea level rise. The first product is the development of a global modeling system for "Modeling Sea-Level Rise Effects on Population using Global Elevation and Land-Cover data." (see http://cegis.usgs.gov/sea_level_rise.html). The second is the development of a National Risk Map Service that, among other coastal hazards, users can view sea level vulnerability factors and a Coastal Vulnerability Index for their location of interest. This is accomplished thru a Vulnerability Assessment Interactive Mapping tool.

USGS and NOAA are beginning to collaborate on various projects and within the IOOS structure to integrate efforts on common standards for operating water level stations, maintaining common vertical reference systems, and developing topographic / bathymetric mapping capabilities useful for inundation studies and assessing impacts of sea level rise.

VI. United States Army Corps of Engineers (USACE)

The United States Army Corps of Engineers (USACE) also manages water level observing systems and performs studies on the effects of climate change for coastal engineering and shoreline and channel mapping programs. The USACE manages projects for understanding long-term effects of coastal erosion for shore protection projects and for understanding sea level rise for properly designing coastal wetland restoration. USACE maintains a strong applied research program at an Engineering Research and Development Center that conducts studies in ecosystems, environmental engineering and assessment that all are linked to understanding climate change and sea level change. The Center also conducts research into climate change modeling (www.erdc.usace.army.mil/).

NOAA and USACE are also collaborating on integrating long-term water level monitoring programs for common operating standards and data interchange and performing agency–wide initiatives to define common programs in intersecting projects that will benefit from agency collaboration. This will also support the U.S effort to assess and mitigate impacts of global sea level rise. For a recent study for assessing the impacts Hurricane Katrina, NOAA was able to use some of the long-term USACE observations to estimate local relative sea level trends. Even though the data were taken only for local monitoring for engineering projects, the long-term accumulation of the records allowed for such analysis.

APPENDIX 1: NOAA's National Water Level Program Description

1. Overview (see http://tidesandcurrents.noaa.gov)

The NOAA National Water Level Program (NWLP), managed by the NOAA National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS), are used to support the statutory mandates and all NOAA missions.

The NWLON is the fundamental observing system component of the NWLP. The NWLON has grown in size since the early 1800s in response to the need for tide and water level information in each of the Nation's ports and for the need to determine tide and water level datums (Chart Datums : Mean Lower Low Water (MLLW) and Mean High Water (MHW)) shoreline on a national scale for all U.S. charted waters. The NWLON provides the long-term continuous measurements of water levels required to maintain national tide and water level datum reference systems.

At present, the NWLON is a coastal observing network of 200 stations nationwide, including the Great Lakes as well as Pacific and Atlantic Ocean Island Territories and Possessions. The NWLON has expanded geographically and increased in number over time due to national and local needs. Technological advancements in sensors, data collection, and data communications have enabled near real-time routine automated acquisition and event-driven high rate acquisition over Geostationary Operational Environmental Satellite (GOES). Because of these advancements, the applications of the NWLON data and products have broadened and the capability of the NWLON has expanded to meet other national needs. The NWLON is a key observing system component of the NOAA Tsunami Warning System and the NOAA Storm Surge Warning program.

The NWLON is a reference system designed to provide information of the spatial and time-varying nature of tides and water levels. It provides for the regional description of basic tidal characteristics of time and range of tide and type of tide. The NWLON provides for the reference harmonic constants used in the NOAA Tide Prediction Tables. The tide prediction products themselves are part of a national reference system required to meet NOAA missions for navigation products and services. Because it has the spatial and temporal characteristics of a reference system for tidal datums, it provides control for regional or local observing systems which may have denser local networks.

The NWLON provides information on the spatial and time varying nature of long-term sea level. Many stations have been in operation for over one century. A nation-wide picture of relative sea level trends derived from the NWLON stations is routinely reported on and disseminated (NOS, July 2001 and tidesandcurrents.noaa.gov/sltrends/sltrends.html). Large spatial gradients in relative mean sea level in regions of significant land movement are not resolved with the NWLON, but the stations provide a reference for regional programs. The NWLON data also provide information used to understand the response of sea level to the time-varying climate signals of el Niño and la Niña-type oscillations.

The NWLON is configured as a true, long-term observing network. If one station goes down (*i.e.*, no longer operational), nearby stations can be used for some applications to provide backup sources of information for the particular phenomena of interest (such as control for tidal datums or sea level trends). These backup stations are not completely redundant, as extrapolation or interpolation will increase the uncertainty in the observations. There are some stations for which the closest station is too far away to provide network backup. There are also gaps in NWLON coverage along some areas of the coastline and implementing a denser network nationwide is a long term goal of the program.

2. NWLON OPERATIONS

The NWLON is managed as a long-term, sustained operational observing system to ensure that the attributes listed above can be maintained. The NWLON is operated and managed over the long-term with organizational infrastructure in place to operate and maintain the stations and to manage the continuous data collection, data QC, routine product generation, and data and information dissemination. NOAA maintains a full time Field Operations Division that includes field parties and an instrument shop. All field work is performed using documented standard operating procedures. The components of an NWLON station include:

Physical Structure:

- Robust construction of above and below water components to withstand expected environmental extremes, including wind and rain, lightning, waves, currents, extreme high and low waters, vandalism, marine growth, ice and snow.
- Data collection hardware and electronic modules housed in watertight enclosures.
- Yearly preventive maintenance, including underwater maintenance and any corrective or emergency maintenance.

Sensors:

- Use of precise, calibrated or self calibrating, water level measurement sensors that are accurate over the range of water levels to collect extreme lows and storm surge.

- Use of sensors with measurement ranges greater than the expected range of water level.
- Sensors must not have time or elevation drifts or changes in sensor reference zero.
- Implementation of routine calibration checks and swap-out of sensors.
- Use of an independent backup sensor and data logger.
- Configurations used that minimize measurement error sources due to waves, currents and temperature.
- Systems capable of having up to 11 ancillary meteorological and oceanographic sensors configured in addition to the primary and backup sensors.

Vertical Control:

- Station components and sensors are physically mounted such that they will not move except possibly under the most extreme environmental conditions.
- Primary and backup water level sensors are mounted independently to help monitor for vertical movement.
- Differential Second-order, Class I levels are run to connect the sensor leveling point to nearby bench marks on an annual basis to monitor for vertical stability.
- Emergency levels are run if it is known that vertical movement occurred (after storms or earthquakes, for instance).
- If vertical movement is known to have occurred, the data are corrected to ensure a common vertical reference.

Bench Marks:

A minimum local network of 10 bench marks is established in the vicinity of each NWLON station. Bench marks are spread out such that all will not be destroyed at the same time by construction and development, and are not installed on the same structure such that all will move at the same time. A primary bench mark is designated and leveled to the sensor zero on an annual basis. A minimum of five bench marks are leveled to each year, such that all 10 marks are leveled to on a rotating basis every two years. Vertical stability checks are made and unstable marks are destroyed and replaced by newer bench marks. Leveling and bench marks installation standards are adhered to in accordance with documented standards.

The NWLON tide and water level datums are typically tied into geodetic datums and the NSRS using level connections and GPS occupations on the benchmarks.

At most stations, a valid tie to at least two marks with NAVD88 orthometric heights (marks with PIDs published in the NGS database) is required on each set of levels, where appropriate marks with NAVD88 heights are available within 1.6 km (1 mi) of the station location. The tie is made in accordance with the procedures stated in section 3.4 of the *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations, October 1987*.

For 1st order level runs, a tie with at least three NGS bench marks that have published NAVD 88 elevations is required; for 2nd order and 3rd order level runs, a tie with at least two NGS bench marks that have published NAVD 88 elevations is required.

If the station does not have more than two NAVD88 marks within 1.6 km (1 mi) of the station location, then GPS surveys shall be done to connect tidal datums with geodetic (NAVD88 vertical) datums. If suitable marks are found in the NGS database, and are farther than 1.6 km (1 mi) but less than 10 km (6 mi) from the tide station, then a GPS tie is required to derive the ellipsoid heights. The final objective will be to tie the tidal datums at each NWLON station to geodetic datums (NAVD88) through conventional geodetic leveling first, if feasible; if that is not possible, then a relationship shall be determined through the differential GPS techniques.

For NGS Continuously Operating Reference System (CORS) reference bench marks (typically two) that are located within a 1.6 km leveling distance of a water level station, a direct leveling connection shall be made between the CORS reference bench marks and the tidal bench marks in the water level station network every 5 years. The order and class of the leveling run between the CORS reference marks and tidal bench mark shall be the same as that of leveling run for the local level network. Short term GPS observations will not provide the accuracy required to investigate the long term sea level trends and the correlations with the vertical motion measured at the CORS (Table 4).

Information about NGS CORS stations can be obtained at www.ngs.noaa.gov/CORS/.

Table 4. Long-term NWLON water level stations within 10 kilometers of NOAA GPS-CORS stations

CO-OPS Station ID	GLOSS Code	PSMSL Code	Station Name	NGS CORS ID	Distance (km)
1612340	108 LTT	760031	Honolulu, HI	HNLC	0.0
1617760	287 LTT	760061	Hilo, HI	HILO	1.3
1770000	144 LTT	745001	Pago Pago	ASPA	5.8
1820000	111 LTT	720011	Kwajalein	KWJ1	1.0
2695540	221 LTT	950011	Bermuda	BRMU	0.7
8410140	LTT	960201	Eastport, ME	EPRT	0.8
8413320		960191	Bar Harbor, ME	BARH	1.4
8419870		960177	Seavey Island, ME	POR4	2.8
8452660	290 LTT	960131	Newport, RI	NPRI	0.5
8531680	LTT	960101	Sandy Hook, NJ	SHK5	0.5
8551910		960089	Reedy Point, DE	RED5	0.5
8571892		960073	Cambridge, MD	HNPT	5.7
8577330		960078	Solomons Island, MD	SOL1	0.2
8594900	LTT	960076	Washington, DC	USNO	6.4
8631044			Wachapreague, VA	VIMS	0.2
8637624		960072	Gloucester Point, VA	GLPT	0.2
8651370	219	960063	Duck, NC	DUCK	0.4

CO-OPS Station ID	GLOSS Code	PSMSL Code	Station Name	NGS CORS ID	Distance (km)
8665530	LTT	960041	Charleston, SC	SCCC	1.2
8723170		960001	Miami Beach, FL	AOML and MIA3	4.8
8724580	216 LTT	940071	Key West, FL	KWST	5.5
8735180		940037	Dauphin Island, AL	MOB1	5.5
8761724		940021	Grand Isle, LA	GRIS	0.1
9410170	LTT	823081	San Diego, CA	PLO5	8.4
9435380	157	823016	South Beach, OR	NEWP	4.7
9443090	LTT	823001	Neah Bay, WA	NEAH	7.8
9447130	LTT	823011	Seattle, WA	SEAT	5.9
9455760		821013	Nikiski, AK	KEN1	2.8
9455920		821012	Anchorage, AK	TSEA	5.7
9457292		821011	Kodiak Island, AK	KODK	0.7

LTT indicates that a station is part of the GLOSS-defined subset of stations for long term trends.

NGS has or will be installing new GPS-CORS receivers as close as possible to the water level stations at The Battery (LTT, PSMSL Code 960121), Fort Pulaski (GLOSS Code 289 LTT, PSMSL Code 960031), and Key West (GLOSS Code 216 LTT, PSMSL Code 940071).

General Goals for implementing GPS technology in the NWLP.

GPS technology and procedures will be implemented in the operational plan:

(1) to support the development of a seamless, geocentric reference system for the acquisition, management, and archiving of CO-OPS water level data. This will provide a national and global digital database, which will comply with the minimum geo-spatial metadata standards of the National Spatial Data Infrastructure (NSDI) and connect the CO-OPS water level database to the NGS National Spatial Reference System (NSRS);

(2) to establish transformation functions between CO-OPS chart datum (MLLW) and the geocentric reference system to support CO-OPS 3-dimensional hydrographic surveys, the implementation of Electronic Chart Display and Information Systems (ECDIS), and the CO-OPS Vertical Datum transformation (V-Datum tool) and tidal datum models. Integration of GPS procedures into CO-OPS PORTS® operations will support the development of tidally-controlled Digital Elevation Maps and Models for use in programs such as marsh restoration.

(3) to support water level datum transfers by using GPS derived orthometric heights.

(4) to monitor crustal motions (horizontal and vertical) to support global climate change investigations.

GPS-derived orthometric heights can be accurately determined and used for water level datum transfers according to (a) the established guidelines for 3-D precise relative positioning to measure ellipsoid heights, (b) properly connecting to several NAVD88 bench marks, and ©) using the latest high-resolution modeled geoid heights for the area of interest. In many remote locations, the use of GPS-derived orthometric heights for datum transfer will be more efficient (timely) and more cost-effective than the use of conventional differential surveying techniques and may, under certain circumstances, preclude the installation of additional water level stations to establish a datum.

Data Collection:

The NWLON is managed to collect continuous and valid data series. Accurate monthly means cannot be computed for a month of data with a break in the water level measurement series in excess of three days. Even breaks of significantly less than three days will not allow for interpolation during times when strong meteorological conditions are present and in areas with little periodic tidal influence. Any break in the water level measurement series affects the accuracy of datum computations. At a critical measurement site where the primary water level measurement data cannot be transmitted or monitored, data from an independent backup sensor is used to fill gaps.

- Data collection is managed by standard configurations of operating system software and application software (firmware) in the Data Collection Platform (DCP) that controls all sensor data collection, storage, and formatting of satellite transmissions and alternative DCP outputs.
- Data are collected continuously, automatically and remotely using 6-minute GOES transmissions to a centralized data management system at NOAA headquarters in Silver Spring for near real-time quality control and dissemination and subsequent downstream data processing and product generation. Data are also simultaneously collected and reviewed by redundant systems at field party headquarters.
- The DCP includes telephone modems for automatic back-up for data collection and for remote access for running system diagnostic checks and upgrade of DCP software and configurations.
- DCP storage allows for retrieval of data after temporary data transmission failures and for on-site retrieval by field personnel.
- System allows for high rate GOES data transmission after automated or manually set triggers are invoked during storm events or and every 6-minutes for tsunami events.

- Primary power source for the systems is battery-charger systems with solar panels.
- The backup sensor data are collected by an independent DCP isolated from the primary DCP.

Data Quality Control and Data Processing:

The data that come in over hourly GOES transmissions from each station undergo automatic quality control checks. Flags for these quality control checks are set for each data point and loaded into the Database Management System (DMS). The data and the flags are reviewed on a 24 X 7 basis by a semi-automated Continuously Operating Real-Time Monitoring System (CORMS) in which CORMS operators review data quality and total system operation using 12-hour shifts. The CORMS is beginning to use automated case-based and rules-based decision-making tools to assist with reviewing all of the sensors and systems required. System and data problems are forwarded to appropriate field and headquarters personnel who are on call 24 X 7 to determine and carry out corrective action as required. All data processing and product generation use documented standard operating procedures.

Data Management:

A robust computer hardware and software environment is maintained and upgraded for the data processing, data analysis, datum computations, product generation, and data dissemination. A relational DMS is employed that allows for routine and ad hoc queries, and allows for outside web-site interface access using stored procedures. Six-minute data, hourly heights, high and low waters, daily means and monthly means, are produced and verified on a calendar month basis. All products are independently verified before being accessible to outside users on the web-interface. The monthly products undergo further data quality assurance at yearly time steps to ensure proper long-term operation. The DMS also serves as the permanent archival system for all historical data and derived products. The DMS serves as the source for accepted tidal datums for the Nation. The NWLP requires a substantial data management strategy in which verified data streams are used to compute tidal datums using legally accepted procedures. The DMS contains the time history of station and sensors configurations, station inspection and repair reports, and leveling and bench mark histories that provide the metadata for the observations.

Data and Product Delivery:

The NWLON is also multipurpose and supports other NOAA missions that are national in scope:

- It is a fundamental component of NOAA's capability for storm surge monitoring and warning. The NWLON data are routine data sets to the NOAA Advanced Weather Information Processing System (AWIPS) system. The NWLON stations also can be automatically put into high-rate satellite dissemination on a user-driven or event-driven trigger. These data become part of the National Weather Service (NWS) pipeline for marine forecasts. An increasing percentage of the NWLON stations have meteorological sensors installed.

- It is a fundamental component of NOAA's capability for tsunami warning. The NOAA Tsunami Warning Centers have access to high-rate data through the GOES when events are manually or automatically triggered.

- In addition to meteorological sensors, the NWLON stations are capable of adding other sensors for long-term measurements for water conductivity and temperature and for water quality parameters.

A comprehensive CO-OPS web-site is maintained and allows users full access to all data and products on a 24 X 7 basis (http://tidesandcurrents.noaa.gov). All raw observed data (6-minute data with quality control flags attached) are automatically available over the web-site after the data collection systems receive each hourly transmission and after they undergo the quality control checks. Derived data products are made available through the web-site after verification.

Harmonic analyses are routinely performed and accepted sets of harmonic constants used for tidal prediction are maintained in the database and made available over the web-site. Tide prediction products based upon the accepted sets of harmonic constituents are also made available "on-the-fly" over the web-site.

Great Lakes and Tidal datums are updated over time and system-wide tidal datum updates to new National Tidal Datum Epochs are made using the archived data and derived products in the data base. Accepted tidal datums are maintained and can be accessed over the web-site as well. Tidal datums are computed using documented standard operating procedures. Published bench mark sheets showing bench mark locations and elevations are prepared and updated and accessible over the web-site.

During storm events and other human-induced events, real-time (6-minute) data are made immediately available to users (http://tidesonline.nos.noaa.gov/ and http://glakesonline.nos.noaa.gov/ .

Real-time water level data in context with other real-time data are accessible for some NWLON stations if they are part of a local PORTS® (http://tidesandcurrents.noaa.gov/d_ports.html).

APPENDIX 2: Status of NOAA/CO-OPS GLOSS Stations in the United States

GLOSS ID	Location	Status
111	Kwajelein	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (055A) data through 2005 • CRN station
206	San Juan, PR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (245A) data through 2005
221	Bermuda	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (259A) data through 2005 • CRN station
302	Adak, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (040A) data through 2005
149	Apra Harbor, Guam	• Ongoing, station being rebuilt after a typhoon, currently using a digital/pressure bubbler gauge – redundant DCP to be installed • PSMSL data through 2002 • JASL (053A) data through 2005 • CRN station
219	Duck Pier, NC	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (260A) data through 2005
289	Fort Pulaski, GA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (752A) data through 2005
217	Galveston Pier 21, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JAS L(775A) data through 2005
287	Hilo, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (060A) data through 2005

GLOSS ID	Location	Status
108	Honolulu. HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (057B) data through 2005 • CRN station
109	Johnston Island	No longer operated by NOAA – can no longer travel to the island • PSMSL data through 2002 • JASL (052A) data through 2005
216	Key West, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (242A) data through 2005 • CRN station
159	La Jolla, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (569A) data through 2005 • CRN station
303	Attu Island, AK	No longer operated by NOAA – station may be re-established using Tsunami funding in 2006 • PSMSL data through 1966 • JASL (550A) data through 1966
218	Miami (Haulover Pier)	• Destroyed in 1992 by hurricane – moved to Virginia Key, FL Ongoing, currently using an acoustic gauge with pressure gauge backup – station is not connected to datum at Miami so a new PSMSL station is needed. • JASL Miami data through 1992 • JASL (755A) Virginia Key data 1996 through 2005
106	Midway Island	• Ongoing, currently using an acoustic gauge with pressure gauge backup – redundant DCP to be installed in 2006. • PSMSL data through 2002 • JASL (050A) data through 2005
290	Newport, RI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (253A) data through 2005
74	Nome, AK	• Ongoing, currently using a dual orifice digital/bubbler system • PSMSL data through 2002 • JASL (0595A) data through 2001
144	Pago Pago	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (056A) data through 2005
288	Pensacola, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (762A) data through 2005 • CRN station

GLOSS ID	Location	Status
151	Prudhoe Bay, AK	• Ongoing, currently using an acoustic gauge during the ice – free season and a digital/bubbler system during the winter • PSMSL data through 2002 • JASL (579A) data through 2005
158	San Francisco, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (551A) data through 2005 • CRN station
100	Sand Point, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (574A) data through 2001
150	Seward, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (560C) data through 2005
154	Sitka, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (559A) data through 2005
157	South Beach, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (592A) data through 2005
102	Unalaska, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (041B) data through 2005
220	Atlantic City, NJ	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (264A) data through 2005 • CRN station
105	Wake Island	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (051A) data through 2005

APPENDIX 3: Status of additional operational non- GLOSS JASL NWLON Stations in the United States

JASL ID	Location	Status
039A	Kodiak, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
058A	Nawiliwili, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
059A	Kahului, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
061A	Mokuoloe, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
552A	Kawaihae, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
555A	Monterey, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
556A	Crescent City, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station
557A	Port Orford, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
558A	Neah Bay, WA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station
561A	Seldovia, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
562A	Valdez. AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
564A	Willapa Bay, WA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
565A	Port San Luis, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 •

JASL ID	Location	Status
567A	Los Angeles, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2001
570A	Yakutat, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
571A	Ketchikan, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station
572A	Astoria, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
573A	Arena Cove, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
575A	Charleston, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
576A	Humboldt Bay, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
578A	Santa Monica, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
583B	Cordova, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
594A	Platform Harvest, CA	• Ongoing, currently two DCP's with paroscientific pressure digital bubbler sensors • JASL data through 1999
246A	Magueyes Island, PR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
261A	Charleston, SC	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station
240A	Fernandina Beach, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station
252A	Portland, ME	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station

JASL ID	Location	Status
254A	Limetree bay, VI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
255A	Charlotte Amalie, VI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
279A	Montauk, NY	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
740A	Eastport, ME	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
741A	Boston, MA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station
742A	Woods Hole. MA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
743A	Nantucket, MA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
744A	New London, CT	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
745A	New York, NY	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005 • CRN station
746A	Cape May, NJ	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
747A	Lewes, DE	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
749A	Chesapeake BBT, VA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
750A	Wilmington, NC	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
753A	Mayport, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005

JASL ID	Location	Status
757A	Naples,FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
759A	St. Petersburg, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
760A	Appalachicola, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
761A	Panama City Beach, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
763A	Dauphin Island, AL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
765A	Grand Isle, LA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
766A	Sabine Pass, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
767A	Galveston Pleasure Pier, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
769A	Rockport, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
770A	Corpus Christi, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 1999
772A	Port Isabel, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
773A	Clearwater Beach FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
774A	Port Canaveral, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2005
	Hampton Roads, VA	• CRN station for se level

APPENDIX 4: UHSLC Fast Delivery, JASL and Real-time datasets

The GLOSS/CLIVAR (formerly known as the WOCE) fast sea level data is distributed as hourly, daily, and monthly values. This project is supported by the NOAA Climate and Global Change program, and is one of the activities of the University of Hawaii Sea Level Center.

Joint Archive for Sea Level: Research Quality Data Set

The Joint Archive for Sea Level (JASL), a collaboration between the University of Hawaii Sea Level Center (UHSLC) and the World Data Center-A for Oceanography, the National Oceanographic Data Center (NODC), and the National Coastal Data Development Center (NCDDC), continues to acquire, quality control, manage, and distribute sea level data as initiated by the Tropical Ocean Global Atmosphere (TOGA) Program, which ended in 1994. The TOGA ocean monitoring networks were primarily in the tropics. Since the end of TOGA, the JASL has slowly begun to absorb sea level sites in oceanographically strategic locations beyond the tropics. The JASL is now an official Global Sea Level Observing System (GLOSS) data center. The JASL Research Quality Data Set (RQDS) is the largest global collection of quality-controlled hourly sea level. Efforts are underway to acquire new sites and uncover historic records as available.

The JASL receives hourly data from regional and national sea level networks. The data are inspected and obvious errors such as data spikes and time shifts are corrected. Gaps less than 25 hours are interpolated. Reference level problems are referred back to the originator. If the originators can not resolve the reference level shift, comparisons with neighboring sites or examination of the hourly residuals may warrant an adjustment. Descriptive station information and quality assessments are prepared. The objective is to assemble a scientifically valid, well-documented archive of hourly, daily, and monthly sea level values in standardized formats. These data are annually submitted to the World Data Center-A for Oceanography (WDCA) and the monthly values are provided to the Permanent Service for Mean Sea Level.

General Information for Desired Stations as of January 31, 2007:

Notes on columns:
Pxxx: Pacific Ocean, Axxx: Atlantic Ocean, Ixxx: Indian Ocean
CI: Completeness index or percentage of data span without missing data.
QC-YEARS: years which have received quality control.

JASL	TOGA	GLOSS	STATION	COUNTRY	LAT	LONG	QC-YEARS	CI	CONTRIBUTOR
001A	Pxxx	115	Pohnpei-A	Fd St Micronesia	06-59N	158-14E	1969-1971	100	Scripps Inst. Ocean.

001B	Pxxx	115	Pohnpei-B	Fd St Micronesia	06-59N	158-15E	1974-2004	98	UH Sea Level Center
002A	Pxxx	113	Tarawa-A,Betio	Rep. of Kiribati	01-22N	172-56E	1974-1983	78	UH Sea Level Center
002B	Pxxx	113	Tarawa-B,Bairiki	Rep. of Kiribati	01-20N	173-01E	1983-1988	98	UH Sea Level Center
002C	Pxxx	113	Tarawa-C,Betio	Rep. of Kiribati	01-22N	172-56E	1988-1997	100	UH Sea Level Center
002D	Pxxx	113	Tarawa-D,Betio	Rep. of Kiribati	01-22N	172-56E	1992-2004	91	Nat. Tidal Ctr., BOM
003A	Pxxx	169	Baltra-A	Ecuador	00-26S	090-17W	1968-1977	93	National Ocean Service
003B	Pxxx	169	Baltra-B	Ecuador	00-26S	090-17W	1985-2005	86	UH Sea Level Center
004A	Pxxx	114	Nauru-A	Rep. of Nauru	00-32S	166-54E	1974-1995	95	UH Sea Level Center
004B	Pxxx	114	Nauru-B	Rep. of Nauru	00-32S	166-55E	1993-2004	88	Nat. Tidal Ctr., BOM
005A	Pxxx	112	Majuro-A	Rep. Marshall I.	07-06N	171-22E	1968-1999	92	UH Sea Level Center
005B	Pxxx	112	Majuro-B	Rep. Marshall I.	07-07N	171-22E	1993-2004	97	Nat. Tidal Ctr., BOM
006A	Pxxx	xxx	Enewetok-A	Rep. Marshall I.	11-26N	162-23E	1951-1971	98	Scripps Inst. Ocean.
006B	Pxxx	xxx	Enewetok-B	Rep. Marshall I.	11-26N	162-23E	1974-1979	94	UH Sea Level Center
007A	Pxxx	120	Malakal-A	Rep. of Belau	07-20N	134-29E	1926-1939	92	Japan Ocean. Data Cen.
007B	Pxxx	120	Malakal-B	Rep. of Belau	07-20N	134-28E	1969-2003	95	UH Sea Level Center
008A	Pxxx	119	Yap-A	Fd St Micronesia	09-31N	138-08E	1951-1952	100	Scripps Inst. Ocean.
008B	Pxxx	119	Yap-B	Fd St Micronesia	09-31N	138-08E	1969-2004	92	UH Sea Level Center
009A	Pxxx	66	Honiara-A	Solomon Islands	09-26S	159-57E	1974-1995	98	UH Sea Level Center
009B	Pxxx	66	Honiara-B	Solomon Islands	09-25S	159-57E	1994-2004	97	Nat. Tidal Ctr., BOM
010A	Pxxx	65	Rabaul	Papua New Guinea	04-12S	152-11E	1966-1997	85	UH Sea Level Center
011A	Pxxx	146	Christmas-A	Rep. of Kiribati	01-59N	157-29W	1955-1972	89	Scripps Inst. Ocean.
011B	Pxxx	146	Christmas-B	Rep. of Kiribati	01-59N	157-28W	1974-2003	96	UH Sea Level Center
012A	Pxxx	xxx	Fanning-A	Rep. of Kiribati	03-54N	159-23W	1957-1958	88	Scripps Inst. Ocean.
012B	Pxxx	xxx	Fanning-B	Rep. of Kiribati	03-54N	159-23W	1972-1987	95	UH Sea Level Center
012C	Pxxx	xxx	Fanning-C	Rep. of Kiribati	03-51N	159-22W	1988-1990	78	UH Sea Level Center
013A	Pxxx	145	Kanton-A	Rep. of Kiribati	02-49S	171-43W	1949-1967	99	Scripps Inst. Ocean.
013B	Pxxx	145	Kanton-B	Rep. of Kiribati	02-49S	171-43W	1972-2001	93	UH Sea Level Center
014A	Pxxx	107	French Frigate S	USA	23-52N	166-17W	1974-2001	97	UH Sea Level Center
015A	Pxxx	140	Papeete-A	French Polynesia	17-32S	149-34W	1969-1975	91	UH Sea Level Center
015B	Pxxx	140	Papeete-B	French Polynesia	17-32S	149-34W	1975-2002	98	National Ocean Service
016A	Pxxx	138	Rikitea	French Polynesia	23-08S	134-57W	1969-2003	91	UH Sea Level Center
017A	Pxxx	xxx	Hiva Oa	French Polynesia	09-49S	139-02W	1977-1980	75	UH Sea Level Center
018A	Pxxx	122	Suva-A	Fiji	18-08S	178-26E	1972-1997	91	National Ocean Service
018B	Pxxx	122	Suva-B	Fiji	18-08S	178-26E	1998-2004	99	Nat. Tidal Ctr., BOM
019A	Pxxx	123	Noumea	France	22-18S	166-26E	1967-2003	99	UH Sea Level Center
021A	Pxxx	176	Juan Fernandez-A	Chile	33-37S	078-50W	1977-1984	67	UH Sea Level Center
021B	Pxxx	176	Juan Fernandez-B	Chile	33-37S	078-50W	1985-2002	89	SHOA
022A	Pxxx	137	Easter-A	Chile	27-09S	109-27W	1957-1958	97	SHOA
022B	Pxxx	137	Easter-B	Chile	27-09S	109-27W	1962-1963	100	SHOA
022C	Pxxx	137	Easter-C	Chile	27-09S	109-27W	1970-2002	83	SHOA
023A	Pxxx	139	Rarotonga-A	Cook Islands	21-12S	159-47W	1977-1997	98	UH Sea Level Center
023B	Pxxx	139	Rarotonga-B	Cook Islands	21-12S	159-47W	1993-2004	99	Nat. Tidal Ctr., BOM
024A	Pxxx	143	Penrhyn	Cook Islands	08-59S	158-03W	1977-2003	95	UH Sea Level Center
025A	Pxxx	121	Funafuti-A	Tuvalu	08-32S	179-12E	1977-1999	97	UH Sea Level Center

025B	Pxxx	121	Funafuti-B	Tuvalu	08-30S	179-13E	1993-2004	96	Nat. Tidal Ctr., BOM
026A	Pxxx	xxx	Honolulu,Kewalo	USA	21-18N	157-52W	1978-1986	96	UH Sea Level Center
027A	Pxxx	xxx	Honolulu,Pier 45	USA	21-19N	157-53W	1985-1988	100	UH Sea Level Center
028A	Pxxx	118	Saipan-A	N. Mariana Is.	15-13N	145-44E	1938-1940	97	Japan Ocean. Data Cen.
028B	Pxxx	118	Saipan-B	N. Mariana Is.	15-14N	145-45E	1978-2003	93	UH Sea Level Center
029A	Pxxx	117	Kapingamarangi	Fd St Micronesia	01-06N	154-47E	1978-2003	93	UH Sea Level Center
030A	Pxxx	xxx	Santa Cruz	Ecuador	00-45S	090-19W	1978-2004	95	UH Sea Level Center
031A	Pxxx	142	Nuku Hiva	French Polynesia	08-56S	140-05W	1982-1997	70	UH Sea Level Center
033A	Pxxx	69	Bitung	Indonesia	01-26N	125-12E	1986-2001	43	BAKOSURTANAL
034A	Pxxx	161	Cabo San Lucas	Mexico	22-53N	109-55W	1973-2003	81	CICESE
035A	Pxxx	177	San Felix	Chile	26-17S	080-08W	1987-2002	79	SHOA
036A	Pxxx	160	Guadalupe	Mexico	28-53N	118-18W	1977-1985	75	CICESE
038A	Pxxx	xxx	Nuku'alofa	Tonga	21-08S	175-11W	1990-2004	97	Nat. Tidal Ctr., BOM
039A	Pxxx	xxx	Kodiak,Alaska	USA	57-44N	152-31W	1975-2005	83	National Ocean Service
040A	Pxxx	302	Adak,Alaska	USA	51-52N	176-38W	1950-2005	91	National Ocean Service
041A	Pxxx	102	Dutch Harbor-A,AK	USA	53-53N	166-32W	1950-1955	100	National Ocean Service
041B	Pxxx	102	Dutch Harbor-B,AK	USA	53-53N	166-32W	1982-2005	96	National Ocean Service
043A	Pxxx	xxx	Palmyra	USA Trust	05-53N	162-05W	1947-1949	95	National Ocean Service
046A	Pxxx	917	Port Vila-A	Vanuatu	17-44S	168-19E	1977-1982	87	unconfirmed
046B	Pxxx	917	Port Vila-B	Vanuatu	17-46S	168-18E	1993-2004	92	Nat. Tidal Ctr., BOM
047A	Pxxx	103	Chichijima	Japan	27-06N	142-11E	1975-2003	99	Japan Meteor. Agency
048A	Pxxx	xxx	Anewa Bay	Papua New Guinea	06-11S	155-53E	1968-1977	84	UH Sea Level Center
049A	Pxxx	104	Minamitorishima	Japan	24-18N	153-59E	1997-2003	91	Japan Meteor. Agency
050A	Pxxx	106	Midway	USA Trust	28-13N	177-22W	1947-2004	93	National Ocean Service
051A	Pxxx	105	Wake	USA Trust	19-17N	166-37E	1950-2004	93	National Ocean Service
052A	Pxxx	109	Johnston	USA Trust	16-44N	169-32W	1947-2003	94	National Ocean Service
053A	Pxxx	149	Guam	USA Trust	13-26N	144-39E	1948-2005	92	National Ocean Service
054A	Pxxx	116	Truk	Fd St Micronesia	07-27N	151-51E	1963-1991	89	National Ocean Service
055A	Pxxx	111	Kwajalein	Rep. Marshall I.	08-44N	167-44E	1946-2005	98	National Ocean Service
056A	Pxxx	144	Pago Pago	USA Trust	14-17S	170-41W	1948-2005	95	National Ocean Service
057A	Pxxx	108	Honolulu-A	USA	21-18N	157-52W	1877-1892	32	National Ocean Service
057B	Pxxx	108	Honolulu-B	USA	21-18N	157-52W	1905-2005	98	National Ocean Service
058A	Pxxx	xxx	Nawiliwili	USA	21-58N	159-21W	1954-2005	99	National Ocean Service
059A	Pxxx	xxx	Kahului	USA	20-54N	156-28W	1950-2005	92	National Ocean Service
060A	Pxxx	287	Hilo	USA	19-44N	155-04W	1927-2005	81	National Ocean Service
061A	Pxxx	xxx	Mokuoloe	USA	21-26N	157-48W	1957-2005	79	National Ocean Service
062A	Pxxx	124	Norfolk Island-A	Australia	29-04S	167-57E	1985-1986	98	CSIRO
062B	Pxxx	124	Norfolk Island-B	Australia	29-04S	167-56E	1994-1999	100	CSIRO
063A	Pxxx	xxx	Wewak	Papua New Guinea	03-34S	143-38E	1984-1994	82	CSIRO
064A	Pxxx	xxx	Port Moresby	Papua New Guinea	09-29S	147-08E	1984-1993	98	CSIRO
065A	Pxxx	xxx	Manus	Papua New Guinea	02-01S	147-16E	1984-1994	73	CSIRO
066A	Pxxx	xxx	Madang	Papua New Guinea	05-12S	145-48E	1984-1998	81	CSIRO
067A	Pxxx	xxx	Lae	Papua New Guinea	06-44S	146-59E	1984-1997	83	CSIRO
068A	Pxxx	xxx	Kavieng	Papua New Guinea	02-35S	150-48E	1984-1994	95	CSIRO

069A	Pxxx	63	Alotau	Papua New Guinea	10-10S	150-27E	1984-1995	62	CSIRO
070A	Pxxx	127	Auckland	New Zealand	36-51S	174-46E	1984-1988	100	Royal New Zealand Navy
071A	Pxxx	101	Wellington	New Zealand	41-17S	174-47E	1944-2005	97	Royal New Zealand Navy
072A	Pxxx	129	Bluff	New Zealand	46-36S	168-21E	1984-2005	51	Royal New Zealand Navy
073A	Pxxx	xxx	Tauranga	New Zealand	37-39S	176-11E	1984-2005	84	Royal New Zealand Navy
074A	Pxxx	xxx	Westport	New Zealand	41-44S	171-36E	1984-1985	100	Royal New Zealand Navy
075A	Pxxx	xxx	Wanganui	New Zealand	39-57S	174-59E	1984-1985	97	Royal New Zealand Navy
076A	Pxxx	xxx	Taranaki	New Zealand	39-03S	174-02E	1984-1985	79	Royal New Zealand Navy
077A	Pxxx	xxx	Port Nelson	New Zealand	41-16S	173-16E	1984-1985	97	Royal New Zealand Navy
078A	Pxxx	xxx	Gisborne	New Zealand	38-41S	178-02E	1984-1985	98	Royal New Zealand Navy
079A	Pxxx	128	Chatham	New Zealand	43-57S	176-34W	2001-2003	38	UH Sea Level Center
080A	Pxxx	174	Antofagasta	Chile	23-39S	070-24W	1945-2002	93	SHOA
081A	Pxxx	175	Valparaiso	Chile	33-02S	071-38W	1944-2002	84	SHOA
082A	Pxxx	182	Acajutla	El Salvador	13-35N	089-50W	1971-2001	87	Inst. Geograf. Nacional
083A	Pxxx	xxx	Arica	Chile	18-28S	070-20W	1982-1998	98	SHOA
084A	Pxxx	xxx	Lobos de Afuera	Peru	06-56S	080-43W	1982-2003	97	DHNM
085A	Pxxx	170	Buenaventura	Colombia	03-54N	077-06W	1953-2000	92	IDEAM
086A	Pxxx	xxx	La Union	El Salvador	13-20N	087-49W	1954-1980	77	National Ocean Service
087A	Pxxx	167	Quepos	Costa Rica	09-24N	084-10W	1961-1994	83	SERMAR
088A	Pxxx	xxx	Caldera	Chile	27-04S	070-50W	1980-1998	97	SHOA
089A	Pxxx	xxx	Manta	Ecuador	00-57S	080-44W	1979-1981	100	INOCAR
090A	Pxxx	162	Socorro	Mexico	18-44N	111-01W	1957-1959	81	CICESE
091A	Pxxx	172	La Libertad	Ecuador	02-12S	080-55W	1949-2003	97	INOCAR
092A	Pxxx	xxx	Talara-A	Peru	04-35S	081-17W	1950-1965	92	National Ocean Service
092B	Pxxx	xxx	Talara-B	Peru	04-35S	081-17W	1988-2002	74	DHNM
093A	Pxxx	173	Callao-A	Peru	12-03S	077-09W	1950-1965	97	National Ocean Service
093B	Pxxx	173	Callao-B	Peru	12-03S	077-09W	1970-2003	99	DHNM
094A	Pxxx	xxx	Matarani-A	Peru	17-00S	072-07W	1954-1964	98	National Ocean Service
094B	Pxxx	xxx	Matarani-B	Peru	17-00S	072-07W	1992-2002	81	DHNM
096A	Pxxx	xxx	San Juan	Peru	15-22S	075-12W	1978-2002	80	DHNM
300A	Pxxx	xxx	Naos-A	Panama	08-55N	079-32W	1961-1965	99	Scripps Inst. Ocean.
300B	Pxxx	xxx	Naos-B	Panama	08-55N	079-32W	1991-1997	84	National Ocean Service
301A	Pxxx	xxx	Puerto Quetzal-A	Guatemala	13-55N	090-47W	1983-1984	90	UH Sea Level Center
301B	Pxxx	xxx	Puerto Quetzal-B	Guatemala	13-55N	090-47W	1992-1995	77	UH Sea Level Center
302A	Pxxx	168	Balboa	Panama	08-58N	079-34W	1907-1997	98	Panama Canal Commission
303A	Pxxx	171	Tumaco	Colombia	01-50N	078-44W	1951-2000	86	IDEAM
304A	Pxxx	xxx	Pto. Armuelles-A	Panama	08-16N	082-52W	1955-1968	95	Inst. Geograf. Nac.
304B	Pxxx	xxx	Pto. Armuelles-B	Panama	08-16N	082-52W	1983-2001	94	Inst. Geograf. Nac.
305A	Pxxx	xxx	Cedros Island	Mexico	28-06N	115-11W	1976-1989	75	CICESE
307A	Pxxx	xxx	San Felipe	Mexico	31-01N	114-49W	1982-1986	52	UNAM
308A	Pxxx	xxx	San Quintin	Mexico	30-29N	115-59W	1977-1990	97	CICESE
310A	Pxxx	xxx	Bahia Los Angeles	Mexico	28-58N	113-33W	1973-1994	74	CICESE
313A	Pxxx	xxx	Catalina-A	USA	33-27N	118-29W	1978-1979	96	Scripps Inst. Ocean.

313B	Pxxx	xxx	Catalina-B	USA	33-27N	118-29W	1980-1988	86	Scripps Inst. Ocean.
316A	Pxxx	267	Acapulco-A,Gro.	Mexico	16-50N	099-55W	1952-1995	91	UNAM
316B	Pxxx	267	Acapulco-B,Gro.	Mexico	16-50N	099-55W	1999-2005	88	Secretaria de Marina
317A	Pxxx	xxx	Ensenada	Mexico	31-51N	116-38W	1956-1991	84	UNAM
318A	Pxxx	xxx	Puerto Madero	Mexico	14-43N	092-26W	1986-1988	99	UNAM
319A	Pxxx	xxx	Loreto	Mexico	26-01N	111-22W	1975-1988	73	CICESE
320A	Pxxx	293	Cendering	Malaysia	05-16N	103-11E	1984-2005	99	Dept. Survey/Mapping
321A	Pxxx	xxx	Johor Baharu	Malaysia	01-28N	103-48E	1983-2005	95	Dept. Survey/Mapping
322A	Pxxx	xxx	Kuantan	Malaysia	03-59N	103-26E	1983-2005	98	Dept. Survey/Mapping
323A	Pxxx	xxx	Tioman	Malaysia	02-48N	104-08E	1985-2005	97	Dept. Survey/Mapping
324A	Pxxx	xxx	Sedili	Malaysia	01-56N	104-07E	1986-2005	98	Dept. Survey/Mapping
325A	Pxxx	xxx	Kukup	Malaysia	01-20N	103-27E	1985-2005	97	Dept. Survey/Mapping
326A	Pxxx	xxx	Geting	Malaysia	06-14N	102-06E	1986-2004	99	Dept. Survey/Mapping
327A	Pxxx	44	Keppel Harbour	Singapore	01-16N	103-49E	1981-1990	99	Port Singapore Auth.
328A	Pxxx	39	Ko Lak	Thailand	11-48N	099-49E	1985-2005	95	Naval Hydro. Dept.
329A	Pxxx	77	Hong Kong-A	China	22-18N	114-12E	1962-1985	97	Hong Kong Observatory
329B	Pxxx	77	Hong Kong-B	China	22-18N	114-13E	1986-2006	99	Hong Kong Observatory
331A	Pxxx	58	Brisbane	Australia	27-22S	153-10E	1984-2003	97	Nat. Tidal Ctr., BOM
332A	Pxxx	59	Bundaberg	Australia	24-50S	152-21E	1984-2003	98	Nat. Tidal Ctr., BOM
333A	Pxxx	57	Fort Denison	Australia	33-51S	151-14E	1965-2003	94	Nat. Tidal Ctr., BOM
334A	Pxxx	60	Townsville	Australia	19-16S	146-50E	1984-2002	99	Nat. Tidal Ctr., BOM
335A	Pxxx	56	Spring Bay	Australia	42-33S	147-56E	1985-2003	95	Nat. Tidal Ctr., BOM
336A	Pxxx	61	Booby Island	Australia	10-36S	141-55E	1988-2004	91	Nat. Tidal Ctr., BOM
337A	Pxxx	44	Victoria Dock	Singapore	01-16N	103-49E	1972-1981	95	Port Singapore Auth.
338A	Pxxx	xxx	Macau	Portugal	22-10N	113-33E	1978-1985	80	Inst. Hidro. Marinha
339A	Pxxx	902	Hobart	Australia	42-53S	147-20E	1985-1999	82	Nat. Tidal Ctr., BOM
340A	Pxxx	xxx	Kaohsiung	Rep. of China	22-37N	120-17E	1980-2005	99	Central Weather Bureau
341A	Pxxx	xxx	Keelung	Rep. of China	25-09N	121-45E	1980-2005	82	Central Weather Bureau
347A	Pxxx	327	Abashiri	Japan	44-01N	144-17E	1968-2003	97	Japan Meteor. Agency
348A	Pxxx	326	Hamada	Japan	34-54N	132-04E	1984-2003	95	Japan Meteor. Agency
349A	Pxxx	325	Toyama	Japan	36-46N	137-13E	1967-2003	98	Japan Meteor. Agency
350A	Pxxx	89	Kushiro	Japan	42-58N	144-23E	1963-2003	97	Japan Meteor. Agency
351A	Pxxx	87	Ofunato	Japan	39-01N	141-45E	1965-2003	99	Japan Meteor. Agency
352A	Pxxx	86	Mera	Japan	34-55N	139-50E	1965-2003	93	Japan Meteor. Agency
353A	Pxxx	85	Kushimoto	Japan	33-28N	135-47E	1961-2003	97	Japan Meteor. Agency
354A	Pxxx	82	Aburatsu	Japan	31-34N	131-25E	1961-2003	99	Japan Meteor. Agency
355A	Pxxx	81	Naha	Japan	26-13N	127-40E	1966-2003	100	Japan Meteor. Agency
356A	Pxxx	xxx	Maisaka	Japan	34-41N	137-37E	1968-2003	96	Japan Meteor. Agency
357A	Pxxx	xxx	Miyakejima	Japan	34-04N	139-29E	1964-2003	98	Japan Ocean. Data Cen.
358A	Pxxx	xxx	Hosojima	Japan	32-25N	131-41E	1933-1975	86	Japan Ocean. Data Cen.
359A	Pxxx	911	Naze	Japan	28-23N	129-30E	1957-2003	93	Japan Ocean. Data Cen.
360A	Pxxx	324	Wakkanai	Japan	45-25N	141-41E	1967-2003	98	Japan Meteor. Agency
362A	Pxxx	83	Nagasaki	Japan	32-44N	129-52E	1985-2003	100	Japan Meteor. Agency
363A	Pxxx	912	Nishinoomote	Japan	30-44N	130-60E	1965-2003	98	Japan Meteor. Agency

364A	Pxxx	88	Hakodate	Japan	41-47N	140-44E	1964-2003	93	Japan Meteor. Agency
365A	Pxxx	xxx	Ishigaki	Japan	24-20N	124-09E	1969-2003	100	Japan Meteor. Agency
370A	Pxxx	73	Manila	Philippines	14-35N	120-58E	1984-2002	89	Ocean. Surveys Div.
371A	Pxxx	72	Legaspi	Philippines	13-09N	123-45E	1984-2004	87	Ocean. Surveys Div.
372A	Pxxx	71	Davao	Philippines	07-05N	125-38E	1984-1997	73	Ocean. Surveys Div.
373A	Pxxx	70	Jolo	Philippines	06-04N	121-00E	1984-1995	86	Ocean. Surveys Div.
375A	Pxxx	xxx	Hachinohe	Japan	40-32N	141-32E	1980-2003	100	Japan Meteor. Agency
376A	Pxxx	247	Xiamen	China	24-27N	118-04E	1954-1997	100	PRC NODC
379A	Pxxx	xxx	Cebu	Philippines	10-18N	123-55E	1998-2004	81	Ocean. Surveys Div.
380A	Pxxx	xxx	Puerto Princesa	Philippines	09-45N	118-44E	1998-2002	83	Ocean. Surveys Div.
381A	Pxxx	75	Qui Nohn	Vietnam	13-46N	109-15E	1994-2000	28	Mar. Hydromet. Center
385A	Pxxx	xxx	Tawau	Malaysia	04-14N	117-53E	1987-2005	94	Dept. Survey/Mapping
386A	Pxxx	xxx	Kota Kinabalu	Malaysia	05-59N	116-04E	1987-2005	91	Dept. Survey/Mapping
387A	Pxxx	xxx	Bintulu	Malaysia	03-13N	113-04E	1992-2005	88	Dept. Survey/Mapping
388A	Pxxx	xxx	Miri	Malaysia	04-24N	113-58E	1992-1998	91	Dept. Survey/Mapping
389A	Pxxx	xxx	Sandakan	Malaysia	05-49N	118-04E	1993-2005	97	Dept. Survey/Mapping
391A	Pxxx	165	Clipperton-A	France	10-17N	109-13W	1985-1985	47	NOAA/PMEL
391B	Pxxx	165	Clipperton-B	France	10-17N	109-13W	1986-1988	100	NOAA/PMEL
393A	Pxxx	xxx	Puerto Vallarta	Mexico	20-37N	105-15W	1973-1991	40	UNAM
394A	Pxxx	xxx	Salina Cruz	Mexico	16-10N	095-12W	1952-1991	81	UNAM
395A	Pxxx	163	Manzanillo-A	Mexico	19-03N	104-20W	1953-1982	95	UNAM
395B	Pxxx	163	Manzanillo-B	Mexico	19-03N	104-20W	1992-2001	74	National Ocean Service
396A	Pxxx	xxx	Puntarenas	Costa Rica	09-58N	084-50W	1970-1980	71	SERMAR
397A	Pxxx	xxx	Guaymas	Mexico	27-56N	110-54W	1953-1986	81	UNAM
398A	Pxxx	xxx	Marsden Point	New Zealand	35-50S	174-30E	1984-1985	99	Royal New Zealand Navy
399A	Pxxx	148	Lord Howe-A	Australia	31-31S	159-04E	1958-1967	80	Scripps Inst. Ocean.
399B	Pxxx	148	Lord Howe-B	Australia	31-31S	159-04E	1991-1994	99	Nat. Tidal Ctr., BOM
400A	Pxxx	xxx	Lombrum	Papua New Guinea	02-02S	147-23E	1994-2004	91	Nat. Tidal Ctr., BOM
401A	Pxxx	xxx	Apia-A	Western Samoa	13-49S	171-45W	1954-1971	88	Scripps Inst. Ocean.
401B	Pxxx	xxx	Apia-B	Western Samoa	13-49S	171-45W	1993-2004	98	Nat. Tidal Ctr., BOM
402A	Pxxx	xxx	Lautoka	Fiji	17-36S	177-26E	1992-2004	99	Nat. Tidal Ctr., BOM
403A	Pxxx	xxx	Jackson	New Zealand	43-59S	168-37E	2004-2004	100	Nat. Tidal Ctr., BOM
410A	Pxxx	xxx	Lungsurannaga	Indonesia	02-06N	117-45E	1943-1944	95	Japan Ocean. Data Cen.
411A	Pxxx	xxx	Balikpapan	Indonesia	01-16S	116-48E	1942-1943	100	Japan Ocean. Data Cen.
414A	Pxxx	xxx	Bajor	Indonesia	00-41S	117-25E	1943-1944	97	Japan Ocean. Data Cen.
540A	Pxxx	155	Prince Rupert-A	Canada	54-19N	130-20W	1910-1918	79	MEDS
540B	Pxxx	155	Prince Rupert-B	Canada	54-19N	130-20W	1963-1999	99	MEDS
542A	Pxxx	156	Tofino	Canada	49-09N	125-55W	1963-1999	94	MEDS
543A	Pxxx	xxx	Victoria,BC	Canada	48-25N	123-22W	1909-1964	98	MEDS
550A	Pxxx	303	Massacre Bay,AK	USA	52-50N	173-12E	1943-1966	87	National Ocean Service
551A	Pxxx	158	San Francisco,CA	USA	37-48N	122-28W	1901-2004	99	National Ocean Service
552A	Pxxx	xxx	Kawaihae,HI	USA	20-02N	155-50W	1989-2005	89	National Ocean Service
553A	Pxxx	xxx	Port Allen,HI	USA	21-54N	159-36W	1989-1997	97	National Ocean Service
555A	Pxxx	xxx	Monterey,CA	USA	36-36N	121-53W	1973-2005	99	National Ocean Service

556A	Pxxx	xxx	Crescent City,CA	USA	41-45N	124-11W	1933-2005	90	National Ocean Service
557A	Pxxx	xxx	Port Orford,OR	USA	42-44N	124-30W	1996-2005	69	National Ocean Service
558A	Pxxx	xxx	Neah Bay,WA	USA	48-22N	124-37W	1934-2005	97	National Ocean Service
559A	Pxxx	154	Sitka,AK	USA	57-03N	135-21W	1950-2005	92	National Ocean Service
560A	Pxxx	150	Seward-A,AK	USA	60-07N	149-26W	1925-1932	98	National Ocean Service
560B	Pxxx	150	Seward-B,AK	USA	60-07N	149-26W	1944-1949	76	National Ocean Service
560C	Pxxx	150	Seward-C,AK	USA	60-07N	149-26W	1967-2005	87	National Ocean Service
561A	Pxxx	xxx	Seldovia,AK	USA	59-26N	151-43W	1979-2005	99	National Ocean Service
562A	Pxxx	xxx	Valdez,AK	USA	61-08N	146-22W	1996-2004	98	National Ocean Service
564A	Pxxx	xxx	Willapa Bay,WA	USA	46-43N	123-58W	1996-2005	100	National Ocean Service
565A	Pxxx	xxx	Port San Luis,CA	USA	35-11N	120-46W	1983-2005	86	National Ocean Service
567A	Pxxx	xxx	Los Angeles,CA	USA	33-43N	118-16W	1923-2001	98	National Ocean Service
569A	Pxxx	159	San Diego,CA	USA	32-43N	117-10W	1906-2005	97	National Ocean Service
570A	Pxxx	xxx	Yakutat,AK	USA	59-33N	139-44W	1961-2005	91	National Ocean Service
571A	Pxxx	xxx	Ketchikan,AK	USA	55-20N	131-38W	1918-2005	73	National Ocean Service
572A	Pxxx	xxx	Astoria,OR	USA	46-13N	123-46W	1925-2005	97	National Ocean Service
573A	Pxxx	xxx	Arena Cove,CA	USA	38-55N	123-43W	1996-2005	100	National Ocean Service
574A	Pxxx	100	Sand Point,AK	USA	55-20N	160-30W	1996-2001	100	National Ocean Service
575A	Pxxx	xxx	Charleston,OR	USA	43-21N	124-19W	1978-2004	98	National Ocean Service
576A	Pxxx	xxx	Humboldt Bay,CA	USA	40-46N	124-13W	1993-2005	100	National Ocean Service
577A	Pxxx	xxx	Santa Barbara,CA	USA	34-25N	119-41W	1996-2005	27	National Ocean Service
578A	Pxxx	xxx	Santa Monica,CA	USA	34-01N	118-30W	1995-2005	97	National Ocean Service
579A	Pxxx	151	Prudhoe Bay,AK	USA	70-24N	148-32W	1993-2005	99	National Ocean Service
583A	Pxxx	xxx	Cordova-A,AK	USA	60-34N	145-45W	1949-1953	94	National Ocean Service
583B	Pxxx	xxx	Cordova-B,AK	USA	60-34N	145-45W	1964-2005	85	National Ocean Service
590A	Pxxx	xxx	Matavai	French Polynesia	17-31S	149-31W	1958-1967	65	Scripps Inst. Ocean.
592A	Pxxx	157	South Beach,OR	USA	44-38N	124-03W	1967-2005	99	National Ocean Service
594A	Pxxx	xxx	Harvest Oil P.,CA	USA	34-28N	120-40W	1995-1999	20	National Ocean Service
595A	Pxxx	74	Nome, AK	USA	64-30N	165-26W	1992-2001	68	National Ocean Service
599A	Pxxx	180	Diego Ramirez	Chile	56-31S	068-43W	1991-1997	95	SHOA
626A	Pxxx	309	Providenya-A	Russia	64-24N	173-12E	1977-1985	100	Inst. Hydromet. Infor.
630A	Pxxx	79	Dalian-A	China	38-56N	121-40E	1975-1990	98	PRC NODC
631A	Pxxx	79	Laohutan-A	China	38-52N	121-41E	1991-1997	100	PRC NODC
632A	Pxxx	94	Kanmen-A	China	28-05N	121-17E	1975-1997	100	PRC NODC
633A	Pxxx	283	Lusi-A	China	32-08N	121-37E	1975-1996	98	PRC NODC
635A	Pxxx	78	Zhapo-A	China	21-35N	111-50E	1975-1997	100	PRC NODC
636A	Pxxx	xxx	Beihai	China	21-29N	109-05E	1975-1997	100	PRC NODC
637A	Pxxx	xxx	Dongfang	China	19-06N	108-37E	1975-1997	100	PRC NODC
638A	Pxxx	xxx	Haikou	China	20-01N	110-17E	1976-1997	100	PRC NODC
639A	Pxxx	xxx	Lianyungang	China	34-45N	119-25E	1975-1997	99	PRC NODC
641A	Pxxx	xxx	Shanwei	China	22-45N	115-21E	1975-1997	98	PRC NODC
642A	Pxxx	xxx	Shijiusuo	China	35-23N	119-33E	1975-1997	99	PRC NODC
650A	Pxxx	xxx	Hon Dau-A	Vietnam	20-40N	106-49E	1960-1960	100	Mar. Hydromet. Center
650B	Pxxx	xxx	Hon Dau-B	Vietnam	20-40N	106-49E	1995-1995	75	TEDIPORT

651A	Pxxx	xxx	Vung Ang	Vietnam	18-05N	106-17E	1996-1997	100	TEDIPORT
652A	Pxxx	xxx	Vung Tau	Vietnam	10-20N	107-04E	1992-1992	100	TEDIPORT
670A	Pxxx	xxx	Champerico	Guatemala	14-18N	091-55W	1974-1975	98	Oregon State Univerity
671A	Pxxx	xxx	La Paz	Mexico	24-10N	110-21W	1952-1983	71	UNAM
672A	Pxxx	164	Puerto Angel	Mexico	15-39N	096-30W	1962-1984	74	UNAM
673A	Pxxx	xxx	Mazatlan	Mexico	23-12N	106-25W	1953-1975	97	UNAM
674A	Pxxx	xxx	San Carlos	Mexico	24-47N	112-07W	1968-1983	51	UNAM
675A	Pxxx	xxx	San Jose	Guatemala	13-55N	090-50W	1955-1975	93	Oregon State Univerity
676A	Pxxx	xxx	Topolobampo	Mexico	25-36N	109-03W	1956-1974	93	UNAM
677A	Pxxx	xxx	Yavaros	Mexico	26-42N	109-31W	1970-1973	85	UNAM
678A	Pxxx	xxx	Paita-A	Peru	05-05S	081-10W	1981-1984	100	National Ocean Service
678B	Pxxx	xxx	Paita-B	Peru	05-05S	081-10W	1988-2001	90	DHNM
679A	Pxxx	xxx	Corinto	Nicaragua	12-17N	087-07W	1967-1967	99	National Ocean Service
680A	Pxxx	130	Macquerie Is.-A	Australia	54-29S	158-58E	1912-1913	97	Nat. Tidal Ctr., BOM
680B	Pxxx	130	Macquerie Is.-B	Australia	54-29S	158-58E	1968-1972	45	Nat. Tidal Ctr., BOM
680C	Pxxx	130	Macquerie Is.-C	Australia	54-29S	158-58E	1993-2003	76	Nat. Tidal Ctr., BOM
681A	Pxxx	xxx	San Martin-A	Argentina	68-08S	067-06W	1995-1995	8	Alfred Wegener Inst.
681B	Pxxx	xxx	San Martin-B	Argentina	68-08S	067-06W	1998-1998	5	Alfred Wegener Inst.
681C	Pxxx	xxx	San Martin-C	Argentina	68-08S	067-06W	1998-1999	100	Alfred Wegener Inst.
682A	Pxxx	xxx	Dallmann-A	Argentina	62-14S	058-41W	1996-1997	99	Alfred Wegener Inst.
682B	Pxxx	xxx	Dallmann-B	Argentina	62-14S	058-41W	1997-1997	69	Alfred Wegener Inst.
682C	Pxxx	xxx	Dallmann-C	Argentina	62-14S	058-41W	1998-1999	100	Alfred Wegener Inst.
683A	Pxxx	xxx	Pisco-A	Peru	13-25S	076-08W	1985-1990	67	DHNM
683B	Pxxx	xxx	Pisco-B	Peru	13-25S	076-08W	1991-2003	80	DHNM
684A	Pxxx	178	Puerto Montt	Chile	41-29S	072-58W	1980-2002	93	SHOA
698A	Pxxx	xxx	Tinian	N. Mariana Is.	14-58N	145-37E	1991-1997	93	USGS
699A	Pxxx	44	Tanjong Pagar	Singapore	01-16N	103-51E	1988-2004	94	Port Singapore Auth.
201A	Axxx	199	St. Peter&Paul R.	Brazil	00-55N	029-21W	1982-1985	99	ORSTOM
202A	Axxx	197	Natal-A	Brazil	05-45S	035-12W	1982-1983	100	ORSTOM
202B	Axxx	197	Natal-B	Brazil	05-45S	035-12W	1983-1984	99	ORSTOM
202C	Axxx	197	Natal-C	Brazil	05-45S	035-12W	1984-1985	100	ORSTOM
203A	Axxx	198	Fer. de Nor.-A	Brazil	03-50S	032-24W	1982-1983	100	ORSTOM
203B	Axxx	198	Fer. de Nor.-B	Brazil	03-50S	032-24W	1984-1985	100	ORSTOM
203C	Axxx	198	Fer. de Nor.-C	Brazil	03-50S	032-24W	1985-1986	100	LPAO/INPE
204A	Axxx	265	Trindade	Brazil	20-30S	029-19W	1983-1983	16	ORSTOM
205A	Axxx	xxx	Arrecife-A	Spain	28-57N	013-34W	1959-1973	97	Inst. Espanol Ocean.
205B	Axxx	xxx	Arrecife-B	Spain	28-57N	013-34W	1973-1985	69	Inst. Espanol Ocean.
205D	Axxx	xxx	Arrecife-D	Spain	28-57N	013-34W	1987-1991	90	Inst. Espanol Ocean.
206A	Axxx	xxx	S.Cruz Palma-A	Spain	28-41N	017-45W	1949-1959	99	Inst. Espanol Ocean.
206B	Axxx	xxx	S.Cruz Palma-B	Spain	28-41N	017-45W	1959-1981	93	Inst. Espanol Ocean.
206D	Axxx	xxx	S.Cruz Palma-D	Spain	28-41N	017-45W	1989-1990	93	Inst. Espanol Ocean.
207A	Axxx	249	Ceuta-A	Spain	35-54N	005-19W	1971-1974	97	Inst. Espanol Ocean.
207B	Axxx	249	Ceuta-B	Spain	35-54N	005-19W	1975-1977	97	Inst. Espanol Ocean.
207C	Axxx	249	Ceuta-C	Spain	35-54N	005-19W	1978-1980	92	Inst. Espanol Ocean.

207D	Axxx	249	Ceuta-D	Spain	35-54N	005-19W	1980-1991	89	Inst. Espanol Ocean.
208A	Axxx	xxx	Vigo	Spain	42-14N	008-44W	1943-1990	100	Inst. Espanol Ocean.
209A	Axxx	246	Cascais	Portugal	38-42N	009-25W	1959-2000	88	Inst. Hidro. Marinha
210A	Axxx	244	Flores,Azores	Portugal	39-27N	031-07W	1976-1996	75	Inst. Hidro. Marinha
211A	Axxx	245	Ponta Delgada	Portugal	37-44N	025-40W	1978-2005	67	Inst. Hidro. Marinha
212A	Axxx	xxx	Horta,Azores	Portugal	38-32N	028-37W	1984-1986	87	Inst. Hidro. Marinha
215A	Axxx	xxx	Angra Heroismo-A	Portugal	38-39N	027-14W	1957-1962	100	Inst. Hidro. Marinha
215B	Axxx	xxx	Angra Heroismo-B	Portugal	38-39N	027-14W	1976-1983	94	Inst. Hidro. Marinha
216A	Axxx	254	Porto Grande	Portugal	16-52N	024-59W	1990-1993	38	Inst. Hidro. Marinha
217A	Axxx	251	Las Palmas-A	Spain	28-06N	015-24W	1949-1956	95	Inst. Espanol Ocean.
217B	Axxx	251	Las Palmas-B	Spain	28-06N	015-24W	1971-1982	87	Inst. Espanol Ocean.
217C	Axxx	251	Las Palmas-C	Spain	28-06N	015-24W	1983-1991	73	Inst. Espanol Ocean.
217D	Axxx	251	Las Palmas-D	Spain	28-09N	015-24W	1992-2003	96	Puertos del Estado
218B	Axxx	250	Funchal-B	Portugal	32-39N	016-55W	1976-2006	72	Inst. Hidro. Marinha
220A	Axxx	314	Walvis Bay	Namibia	22-57S	014-30E	1959-1998	65	Dir. of Hydrography
221A	Axxx	268	Simon's Bay	South Africa	34-11S	018-26E	1958-1996	92	Dir. of Hydrography
222A	Axxx	xxx	Praia-A	Cape Verde	14-55N	023-30W	1984-1985	100	ORSTOM
222C	Axxx	xxx	Praia-C	Cape Verde	14-55N	023-31W	1995-1996	64	National Ocean Service
223A	Axxx	253	Dakar-A	Senegal	14-40N	017-26W	1982-1983	100	ORSTOM
223B	Axxx	253	Dakar-B	Senegal	14-40N	017-26W	1983-1985	100	ORSTOM
223C	Axxx	253	Dakar-C	Senegal	14-40N	017-26W	1986-1986	44	ORSTOM
223D	Axxx	253	Dakar-D	Senegal	14-40N	017-26W	1986-1989	94	ORSTOM
223E	Axxx	253	Dakar-E	Senegal	14-41N	017-25W	1996-2003	93	UH Sea Level Center
225A	Axxx	260	Sao Tome	Sao Tome/Principe	00-01N	006-31E	1985-1988	58	ORSTOM
228A	Axxx	xxx	Tenerife	Spain	28-29N	016-14W	1992-2003	93	Puertos del Estado
229A	Axxx	xxx	Belem	Brazil	01-27S	048-30W	1955-1968	96	National Ocean Service
230A	Axxx	257	Abidjan-Vridi	Ivory Coast	05-15N	004-00W	1982-1988	100	ORSTOM
231A	Axxx	xxx	Takoradi	Ghana	04-53N	001-45W	1983-1986	100	ORSTOM
233A	Axxx	259	Lagos-A	Nigeria	06-25N	003-27E	1961-1969	63	POL
233C	Axxx	259	Lagos-C	Nigeria	06-25N	003-25E	1992-1996	74	NIOMR
234A	Axxx	261	Pointe Noire	Congo	04-48S	011-51E	1980-1988	77	ORSTOM
235A	Axxx	329	Palmeira,C.Verde	Portugal	16-45N	022-59W	2000-2001	68	UH Sea Level Center
236A	Axxx	xxx	Luanda	Angola	08-47S	013-14E	1972-1975	99	Inst. Hidro. Marinha
237A	Axxx	262	Lobito	Angola	12-20S	013-34E	1971-1975	88	Inst. Hidro. Marinha
238A	Axxx	xxx	Mocamedes	Angola	15-12S	012-09E	1971-1975	98	Inst. Hidro. Marinha
239A	Axxx	215	Siboney	Cuba	23-06N	082-28W	1990-1990	99	Inst. Cubano De Hidro.
240A	Axxx	xxx	Fernandina Beach	USA	30-40N	081-28W	1985-2005	91	National Ocean Service
241A	Axxx	218	Miami	USA	25-54N	080-07W	1985-1992	96	National Ocean Service
242A	Axxx	216	Key West	USA	24-33N	081-49W	1913-2005	97	National Ocean Service
244A	Axxx	276	Gibara	Cuba	21-07N	076-07W	1985-1992	100	Inst. Cubano De Hidro.
245A	Axxx	206	San Juan	USA	18-28N	066-07W	1985-2005	95	National Ocean Service
246A	Axxx	xxx	Magueyes Island	USA	17-58N	067-03W	1965-2004	97	National Ocean Service
247A	Axxx	328	La Guaira	Venezuela	10-37N	066-56W	1985-1994	97	Inst. Ocean. Venezuela
248A	Axxx	203	Port-of-Spain	Trinidad/Tobago	10-39N	061-31W	1984-1992	81	Trin/Tob. Hydro. Unit

249A	Axxx	xxx	Bridgetown-A	Barbados	13-06N	059-37W	1968-1970	98	National Ocean Service
249B	Axxx	xxx	Bridgetown-B	Barbados	13-06N	059-37W	1990-1991	92	Gov. of Barbados
249C	Axxx	xxx	Bridgetown-C	Barbados	13-06N	059-37W	1993-1996	45	Gov. of Barbados
250A	Axxx	212	Veracruz-A,Ver.	Mexico	19-12N	096-08W	1985-1995	99	UNAM
250B	Axxx	212	Veracruz-B,Ver.	Mexico	19-12N	096-08W	1999-2004	63	Secretaria de Marina
251A	Axxx	904	Guantanamo Bay-A	Cuba	19-54N	075-09W	1937-1948	81	National Ocean Service
251B	Axxx	904	Guantanamo Bay-B	Cuba	19-54N	075-09W	1995-1997	89	National Ocean Service
252A	Axxx	xxx	Portland,ME	USA	43-39N	070-15W	1910-2005	96	National Ocean Service
253A	Axxx	290	Newport,RI	USA	41-30N	071-20W	1930-2005	95	National Ocean Service
254A	Axxx	xxx	Limetree Bay	USA	17-42N	064-45W	1982-2005	90	National Ocean Service
255A	Axxx	xxx	Charlotte Amalie	USA	18-20N	064-55W	1978-2005	90	National Ocean Service
256A	Axxx	12	Exuma Cays	Bahamas	23-46N	076-06W	1992-1993	99	HBOI
257A	Axxx	211	Settlement Pnt.-A	Bahamas	26-43N	078-60W	1985-2002	91	National Ocean Service
257B	Axxx	211	Settlement Pnt.-B	Bahamas	26-41N	078-59W	1985-2003	78	National Ocean Service
259A	Axxx	221	Bermuda-A	United Kingdom	32-22N	064-42W	1932-1949	78	National Ocean Service
259B	Axxx	221	Bermuda-B	United Kingdom	32-22N	064-42W	1985-2005	80	National Ocean Service
260A	Axxx	219	Duck Pier,NC	USA	36-11N	075-45W	1978-2005	99	National Ocean Service
261A	Axxx	xxx	Charleston,SC	USA	32-47N	079-56W	1921-2005	98	National Ocean Service
262A	Axxx	xxx	St. Augustine,FL	USA	29-51N	081-16W	1978-2002	42	National Ocean Service
264A	Axxx	220	Atlantic City,NJ	USA	39-21N	074-25W	1911-2005	94	National Ocean Service
265A	Axxx	207	Cartagena-A	Colombia	10-23N	075-32W	1951-1993	90	IDEAM
265B	Axxx	207	Cartagena-B	Colombia	10-23N	075-32W	1993-2000	81	IDEAM
266A	Axxx	208	Cristobal	Panama	09-21N	079-55W	1907-1997	96	Panama Canal Commission
268A	Axxx	xxx	Limon	Costa Rica	10-00N	083-02W	1970-1981	66	SERMAR
269A	Axxx	xxx	Cochino Pequeno	Honduras	15-57N	086-30W	1995-1996	100	National Ocean Service
270A	Axxx	204	Le Robert	France	14-41N	060-56W	1976-1984	61	SHOM
271A	Axxx	xxx	Fort de France	France	14-35N	061-03W	1976-1985	37	SHOM
272A	Axxx	xxx	Pointe-a-Pitre	France	16-14N	061-32W	1991-1998	96	Meteo-France
274A	Axxx	xxx	Churchill	Canada	58-47N	094-12W	1961-2000	90	MEDS
275A	Axxx	222	Halifax	Canada	44-40N	063-35W	1920-2000	99	MEDS
276A	Axxx	223	St. John's-A	Canada	47-34N	052-42W	1961-1993	96	MEDS
276B	Axxx	223	St. John's-B	Canada	47-34N	052-42W	1993-2000	97	MEDS
279A	Axxx	xxx	Montauk	USA	41-03N	071-58W	1959-2005	89	National Ocean Service
280A	Axxx	195	Rio de Janeiro	Brazil	22-54S	043-10W	1963-2005	94	Dir. Hidro. e Navegacao
281A	Axxx	194	Cananeia	Brazil	25-01S	047-56W	1954-2004	99	Inst. Ocean. USP
283A	Axxx	xxx	Fortaleza-A	Brazil	03-43S	038-29W	1955-1968	95	National Ocean Service
283B	Axxx	xxx	Fortaleza-B	Brazil	03-43S	038-28W	1995-1998	100	LPAO/INPE
284A	Axxx	xxx	Termisa	Brazil	04-49S	037-03W	1993-1995	97	LPAO/INPE
285A	Axxx	xxx	Buenos Aires	Argentina	34-40S	058-30W	1905-1961	100	Ser. Hidro. Naval
287A	Axxx	xxx	Puerto Williams	Chile	54-56S	067-37W	1985-1998	88	SHOA
288A	Axxx	229	Reykjavik	Iceland	64-09N	021-56W	1984-1999	94	Iceland Hydro. Serv.
289A	Axxx	248	Gibraltar	United Kingdom	36-07N	005-21W	1961-2000	77	Hidrographic Office
290A	Axxx	305	Port Stanley-A	United Kingdom	52-42S	057-52W	1964-1974	47	POL

290B	Axxx	305	Port Stanley-B	United Kingdom	51-45S	057-56W	1992-2005	92	POL
291A	Axxx	263	Ascension	United Kingdom	07-55S	014-25W	1993-2001	89	POL
292A	Axxx	264	St. Helena	United Kingdom	15-55S	005-43W	1993-2004	82	POL
293A	Axxx	236	Lerwick	United Kingdom	60-09N	001-08W	1959-2001	99	POL
294A	Axxx	241	Newlyn	United Kingdom	50-06N	005-33W	1915-2001	99	POL
295A	Axxx	238	Stornoway	United Kingdom	58-13N	006-23W	1976-2001	80	POL
296A	Axxx	xxx	Sisimiut	Denmark	66-56N	053-40W	1991-1998	85	Danish Navig./Hydro.
297A	Axxx	228	Ammassalik	Denmark	65-36N	037-00W	1990-1998	78	Danish Navig./Hydro.
298A	Axxx	xxx	Ilulissat	Denmark	69-13N	051-06W	1992-1997	82	Danish Navig./Hydro.
299A	Axxx	xxx	Qaqortoq	Denmark	60-43N	046-02W	1991-1998	83	Danish Navig./Hydro.
600A	Axxx	181	Ushuaia	Argentina	54-48S	068-18W	1996-2003	79	National Ocean Service
601A	Axxx	185	Esperanza	Argentina	63-24S	056-60W	1996-1998	86	National Ocean Service
700A	Axxx	188	Faraday	United Kingdom	65-15S	064-16W	1984-2004	98	POL
701A	Axxx	xxx	Port Nolloth	South Africa	29-15S	016-52E	1991-1994	49	Dir. of Hydrography
702A	Axxx	xxx	Luderitz	South Africa	26-39S	015-09E	1991-1996	34	Dir. of Hydrography
703A	Axxx	xxx	Saldahna Bay	South Africa	33-01S	018-58E	1991-1996	81	Dir. of Hydrography
704A	Axxx	xxx	Granger Bay	South Africa	33-54S	018-25E	1991-1996	55	Dir. of Hydrography
705A	Axxx	153	L. Cornwallis I.	Canada	75-23N	096-57W	1986-1994	99	MEDS
707A	Axxx	xxx	Canavieiras	Brazil	15-40S	038-58W	1956-1961	95	National Ocean Service
708A	Axxx	903	Salvador	Brazil	12-58S	038-31W	1955-1964	92	National Ocean Service
709A	Axxx	195	R.Janeiro,USCGS	Brazil	22-56S	043-08W	1955-1968	70	National Ocean Service
710A	Axxx	xxx	Suape	Brazil	08-21S	034-57W	1982-1984	98	LPAO/INPE
711A	Axxx	xxx	Luis Corriea	Brazil	02-52S	041-40W	1984-1985	100	LPAO/INPE
712A	Axxx	xxx	Recife,USCGS	Brazil	08-03S	034-52W	1955-1968	86	National Ocean Service
714A	Axxx	193	Porto Rio Grande	Brazil	32-08S	052-06W	1981-2003	22	Dir. Hidro. e Navegacao
715A	Axxx	200	Madeira	Brazil	02-34S	044-23W	1988-2003	83	Dir. Hidro. e Navegacao
716A	Axxx	201	Santana-A	Brazil	00-03S	051-11W	1970-1972	100	Dir. Hidro. e Navegacao
716B	Axxx	201	Santana-B	Brazil	00-03S	051-11W	1975-1976	100	Dir. Hidro. e Navegacao
716C	Axxx	201	Santana-C	Brazil	00-03S	051-11W	1984-1985	100	Dir. Hidro. e Navegacao
716D	Axxx	201	Santana-D	Brazil	00-03S	051-11W	1996-1997	100	Dir. Hidro. e Navegacao
717A	Axxx	201	Santana SSN-A	Brazil	00-04S	051-10W	1994-1995	99	Dir. Hidro. e Navegacao
717B	Axxx	201	Santana SSN-A	Brazil	00-04S	051-10W	1999-2000	99	Dir. Hidro. e Navegacao
718A	Axxx	xxx	Imbituba	Brazil	28-08S	048-24W	2001-2005	77	IBGE
719A	Axxx	xxx	Macae	Brazil	22-14S	041-28W	2001-2005	89	IBGE
720A	Axxx	296	South Caicos	UK	21-29N	071-32W	1992-1992	76	NOAA/AOML
721A	Axxx	213	Progreso-A, Yuc.	Mexico	21-17N	089-40W	1980-1984	98	UNAM
721B	Axxx	213	Progreso-B, Yuc.	Mexico	21-17N	089-40W	1999-2004	63	Secretaria de Marina
727A	Axxx	xxx	Nassau	Bahamas	25-05N	077-21W	1904-1905	100	National Ocean Service
728A	Axxx	xxx	Point Fortin	Trinidad/Tobago	10-06N	061-25W	1987-1996	61	Trin/Tob. Hydro. Unit
730A	Axxx	189	Base Prat	Chile	62-29S	059-38W	1984-2002	96	SHOA
740A	Axxx	xxx	Eastport,ME	USA	44-54N	066-59W	1929-2005	93	National Ocean Service
741A	Axxx	xxx	Boston,MA	USA	42-21N	071-03W	1921-2005	99	National Ocean Service
742A	Axxx	xxx	Woods Hole,MA	USA	41-31N	070-40W	1957-2005	89	National Ocean Service
743A	Axxx	xxx	Nantucket,MA	USA	41-17N	070-06W	1965-2005	95	National Ocean Service

744A	Axxx	xxx	New London,CT	USA	41-21N	072-05W	1938-2005	95	National Ocean Service
745A	Axxx	xxx	New York,NY	USA	40-42N	074-01W	1958-2005	85	National Ocean Service
746A	Axxx	xxx	Cape May,NJ	USA	38-58N	074-58W	1965-2005	88	National Ocean Service
747A	Axxx	xxx	Lewes,DE	USA	38-47N	075-07W	1957-2005	96	National Ocean Service
749A	Axxx	xxx	Chesapeake BBT,VA	USA	36-58N	076-07W	1975-2004	99	National Ocean Service
750A	Axxx	xxx	Wilmington,NC	USA	34-14N	077-57W	1935-2005	98	National Ocean Service
752A	Axxx	289	Fort Pulaski,GA	USA	32-02N	080-54W	1935-2005	95	National Ocean Service
753A	Axxx	xxx	Mayport,FL	USA	30-24N	081-26W	1928-2000	99	National Ocean Service
754A	Axxx	xxx	Cocoa Beach,FL	USA	28-22N	080-36W	1994-1996	98	National Ocean Service
755A	Axxx	916	Virginia Key,FL	USA	25-44N	080-10W	1996-2005	99	National Ocean Service
757A	Axxx	xxx	Naples,FL	USA	26-08N	081-48W	1996-2005	95	National Ocean Service
759A	Axxx	xxx	St. Petersburg,FL	USA	27-46N	082-38W	1946-2005	96	National Ocean Service
760A	Axxx	xxx	Apalachicola,FL	USA	29-44N	084-59W	1996-2005	99	National Ocean Service
761A	Axxx	xxx	Panama City Bh,FL	USA	30-13N	085-53W	1993-2005	97	National Ocean Service
762A	Axxx	288	Pensacola,FL	USA	30-24N	087-13W	1923-2005	96	National Ocean Service
763A	Axxx	xxx	Dauphin Island AL	USA	30-15N	088-05W	1996-2005	53	National Ocean Service
764A	Axxx	xxx	South Pass,LA	USA	28-59N	089-08W	1993-1999	90	National Ocean Service
765A	Axxx	xxx	Grand Isle,LA	USA	29-16N	089-57W	1980-2005	98	National Ocean Service
766A	Axxx	xxx	Sabine Pass N, TX	USA	29-44N	093-52W	1992-2005	98	National Ocean Service
767A	Axxx	xxx	Galveston,P.Pier	USA	29-17N	094-47W	1957-2005	96	National Ocean Service
769A	Axxx	xxx	Rockport,TX	USA	28-01N	097-03W	1987-2005	99	National Ocean Service
770A	Axxx	xxx	Corpus Cristi,TX	USA	27-35N	097-13W	1992-1999	99	National Ocean Service
772A	Axxx	xxx	Port Isabel,TX	USA	26-04N	097-13W	1977-2005	96	National Ocean Service
773A	Axxx	xxx	Clearwater Bch,FL	USA	27-59N	082-50W	1996-2005	97	National Ocean Service
774A	Axxx	xxx	Port Canaveral,FL	USA	28-25N	080-36W	1994-2005	98	National Ocean Service
775A	Axxx	217	Galveston,Pier21	USA	29-19N	094-48W	1904-2001	96	National Ocean Service
779A	Axxx	xxx	C.Carmen	Mexico	18-32N	091-50W	1957-1979	57	UNAM
780A	Axxx	xxx	Puerto Cortes	Honduras	15-50N	087-57W	1948-1968	99	National Ocean Service
781A	Axxx	xxx	Belize	British Honduras	17-30N	088-11W	1964-1967	84	National Ocean Service
782A	Axxx	210	Port Royal	Jamaica	17-56N	076-51W	1965-1971	99	National Ocean Service
783A	Axxx	xxx	Fajardo,PR	USA	18-20N	065-38W	1921-1923	95	National Ocean Service
784A	Axxx	xxx	Puerto Castilla	Honduras	16-01N	086-02W	1955-1967	78	National Ocean Service
101A	Ixxx	8	Mombasa	Kenya	04-04S	039-39E	1986-2001	78	UH Sea Level Center
102A	Ixxx	xxx	Dar Es Salaam	Tanzania	06-49S	039-17E	1986-1990	87	UH Sea Level Center
103A	Ixxx	18	Port Louis-A	Mauritius	20-09S	057-29E	1942-1947	90	Inst. Ocean. Sciences
103B	Ixxx	18	Port Louis-B	Mauritius	20-09S	057-29E	1964-1965	86	Inst. Ocean. Sciences
103C	Ixxx	18	Port Louis-C	Mauritius	20-09S	057-30E	1986-2003	99	UH Sea Level Center
104B	Ixxx	26	Diego Garcia-B	United Kingdom	07-14S	072-26E	1969-1969	41	Scripps Inst. Ocean.
104C	Ixxx	26	Diego Garcia-C	United Kingdom	07-17S	072-24E	1988-2000	80	UH Sea Level Center
105A	Ixxx	19	Rodrigues	Mauritius	19-40S	063-25E	1986-2003	96	UH Sea Level Center
106A	Ixxx	xxx	Praslin	Seychelles	04-21S	055-46E	1987-1989	89	UH Sea Level Center
107A	Ixxx	45	Padang	Indonesia	00-57S	100-22E	1986-1998	53	BAKOSURTANAL
108A	Ixxx	28	Male-A	Rep. of Maldives	04-11N	073-31E	1988-1989	100	Lanka Hydraulic Inst.

108B	Ixxx	28	Male-B,Hulule	Rep. of Maldives	04-11N	073-32E	1989-2003	92	UH Sea Level Center
109A	Ixxx	27	Gan	Rep. of Maldives	00-41S	073-09E	1987-2003	88	UH Sea Level Center
110A	Ixxx	xxx	Muscat	Oman	23-38N	058-34E	1987-1993	77	UH Sea Level Center
111A	Ixxx	273	Port Victoria-A	Seychelles	04-37S	055-28E	1977-1982	84	Inst. Ocean. Sciences
111B	Ixxx	273	Port Victoria-B	Seychelles	04-37S	055-28E	1986-1992	96	UH Sea Level Center
113A	Ixxx	xxx	Masirah	Oman	20-41N	058-52E	1996-2003	93	UH Sea Level Center
114A	Ixxx	4	Salalah	Oman	16-56N	054-00E	1989-2003	87	UH Sea Level Center
115A	Ixxx	33	Colombo-A	Sri Lanka	06-56N	079-51E	1953-1965	94	Nat. Aquatic Resources
115B	Ixxx	33	Colombo-B	Sri Lanka	06-57N	079-51E	1989-1992	96	UH Sea Level Center
117A	Ixxx	xxx	Hanimaadhoo	Rep. of Maldives	06-46N	073-10E	1991-2002	98	UH Sea Level Center
121A	Ixxx	273	Pt. La Rue	Seychelles	04-40S	055-32E	1993-2004	97	UH Sea Level Center
122A	Ixxx	xxx	Sibolga	Indonesia	01-45N	98-46E	1989-2004	89	BAKOSURTANAL
127A	Ixxx	95	Syowa	Japan	69-00S	039-36E	1987-2002	99	Japan Ocean. Data Cen.
128A	Ixxx	308	Thevenard	Australia	32-10S	133-40E	1998-2004	98	Nat. Tidal Ctr., BOM
129A	Ixxx	55	Portland,S.Aus.	Australia	38-20S	141-36E	1991-2004	99	Nat. Tidal Ctr., BOM
130A	Ixxx	278	Casey	Australia	66-17S	110-32E	1996-2003	91	Nat. Tidal Ctr., BOM
133A	Ixxx	68	Ambon	Indonesia	03-41S	128-11E	1992-2004	46	BAKOSURTANAL
134A	Ixxx	xxx	Hiron Point	Bangladesh	21-47N	089-28E	1977-2003	99	BIWTA
135A	Ixxx	xxx	Khal #10	Bangladesh	22-16N	091-49E	1983-1992	62	BIWTA
136A	Ixxx	xxx	Cox's Bazaar	Bangladesh	21-27N	091-50E	1983-2000	98	BIWTA
137A	Ixxx	xxx	Teknaf	Bangladesh	20-53N	092-18E	1983-1988	59	BIWTA
138A	Ixxx	36	Charchanga	Bangladesh	22-13N	091-03E	1980-2000	97	BIWTA
139A	Ixxx	xxx	Khepupara	Bangladesh	21-50N	089-50E	1987-2000	96	BIWTA
140A	Ixxx	xxx	Kelang	Malaysia	03-03N	101-22E	1983-2005	98	Dept. Survey/Mapping
141A	Ixxx	xxx	Keling	Malaysia	02-13N	102-09E	1984-2005	99	Dept. Survey/Mapping
142A	Ixxx	xxx	Langkawi	Malaysia	06-26N	099-46E	1985-2005	99	Dept. Survey/Mapping
143A	Ixxx	43	Lumut	Malaysia	04-14N	100-37E	1984-2005	97	Dept. Survey/Mapping
144A	Ixxx	xxx	Penang	Malaysia	05-25N	100-21E	1984-2005	97	Dept. Survey/Mapping
147A	Ixxx	30	Karachi	Pakistan	24-48N	066-58E	1985-1994	83	Nat. Inst. of Ocean.
148A	Ixxx	42	Ko Taphao Noi	Thailand	07-50N	098-26E	1985-2005	96	Naval Hydro. Dept.
149A	Ixxx	xxx	Lamu-A	Kenya	02-16S	040-54E	1989-1989	68	Kenya Marine Fisheries
149B	Ixxx	xxx	Lamu-B	Kenya	02-16S	040-54E	1995-2003	100	UH Sea Level Center
150A	Ixxx	15	Nosy Be	Madagascar	13-24S	048-18E	1987-1998	54	CNRO
151A	Ixxx	297	Zanzibar	Tanzania	06-09S	039-11E	1984-2004	99	UH Sea Level Center
155A	Ixxx	96	Dzaoudzi	Mayotte	12-47S	045-15E	1985-1995	67	SHOM
158A	Ixxx	xxx	Meneng	Indonesia	08-07S	114-23E	1987-1989	94	Center for Ocean. Res.
159A	Ixxx	xxx	Pari	Indonesia	05-51S	106-37E	1987-1990	84	Center for Ocean. Res.
160A	Ixxx	292	Surabaya	Indonesia	07-13S	112-44E	1984-2004	81	BAKOSURTANAL
161A	Ixxx	xxx	Jakarta	Indonesia	06-07S	106-51E	1984-2004	62	BAKOSURTANAL
162A	Ixxx	291	Cilacap	Indonesia	07-45S	109-01E	1984-2004	40	BAKOSURTANAL
163A	Ixxx	49	Benoa	Indonesia	08-45S	115-13E	1988-2004	69	BAKOSURTANAL
164A	Ixxx	17	Reunion	France	20-55S	055-18E	1982-1986	93	SHOM
165A	Ixxx	xxx	Wyndham	Australia	15-27S	128-06E	1984-2005	96	Nat. Tidal Ctr., BOM
166A	Ixxx	40	Broome	Australia	18-00S	122-13E	1986-2004	83	Nat. Tidal Ctr., BOM

167A	Ixxx	52	Carnarvon	Australia	24-54S	113-39E	1984-2005	82	Nat. Tidal Ctr., BOM
168A	Ixxx	62	Darwin	Australia	12-28S	130-51E	1984-2003	97	Nat. Tidal Ctr., BOM
169A	Ixxx	51	Port Hedland	Australia	20-19S	118-34E	1984-2005	97	Nat. Tidal Ctr., BOM
170A	Ixxx	47	Christmas	Australia	10-25S	105-40E	1986-1993	52	CSIRO
171A	Ixxx	46	Cocos	Australia	12-07S	096-53E	1985-2003	94	Nat. Tidal Ctr., BOM
173A	Ixxx	277	Davis	Australia	68-27S	077-58E	1993-2003	97	Nat. Tidal Ctr., BOM
175A	Ixxx	53	Fremantle	Australia	32-03S	115-44E	1984-2005	99	Nat. Tidal Ctr., BOM
176A	Ixxx	54	Esperance	Australia	33-52S	121-54E	1985-2003	97	Nat. Tidal Ctr., BOM
177A	Ixxx	22	Mawson	Australia	67-36S	062-52E	1992-2003	91	Nat. Tidal Ctr., BOM
178A	Ixxx	21	Crozet	France	46-26S	051-52E	1995-2000	47	Inst. Mech. Grenoble
179A	Ixxx	24	Saint Paul	France	38-43S	077-32E	1994-2000	86	Inst. Mech. Grenoble
180A	Ixxx	23	Kerguelen	France	49-21S	070-13E	1993-1998	99	Inst. Mech. Grenoble
181A	Ixxx	13	Durban	South Africa	29-53S	031-02E	1970-2000	76	Dir. of Hydrography
182A	Ixxx	xxx	Mina Sulman	Bahrain	26-14N	050-36E	1979-2005	67	Survey Directorate
184A	Ixxx	76	Port Elizabeth	South Africa	33-58S	025-38E	1985-2000	66	Dir. of Hydrography
185A	Ixxx	xxx	Mossel Bay	South Africa	34-11S	022-08E	1991-1996	91	Dir. of Hydrography
187A	Ixxx	xxx	East London	South Africa	33-01S	027-55E	1991-1996	68	Dir. of Hydrography
188A	Ixxx	xxx	Richard's Bay	South Africa	28-48S	032-05E	1991-1996	47	Dir. of Hydrography
190A	Ixxx	xxx	Maputo-A	Mozambique	26-10S	032-42E	1974-1974	100	Inst. Hidro. Marinha
190B	Ixxx	xxx	Maputo-B	Mozambique	25-59S	032-34E	1981-1986	49	INAHINA
191A	Ixxx	xxx	Antonio Enes	Mozambique	16-14S	039-54E	1967-1967	31	Inst. Hidro. Marinha
192A	Ixxx	11	Pemba-A	Mozambique	12-58S	040-30E	1971-1973	25	Inst. Hidro. Marinha
192B	Ixxx	11	Pemba-B	Mozambique	12-58S	040-29E	1982-1984	64	INAHINA
193A	Ixxx	xxx	Nacala-A	Mozambique	14-28S	040-41E	1975-1975	18	Inst. Hidro. Marinha
193B	Ixxx	xxx	Nacala-B	Mozambique	14-28S	040-41E	1982-1983	100	Inst. Hidro. Marinha

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