The United States National Report
Contributions to GLOSS

GLOSS Core Network defined by GLOSS02

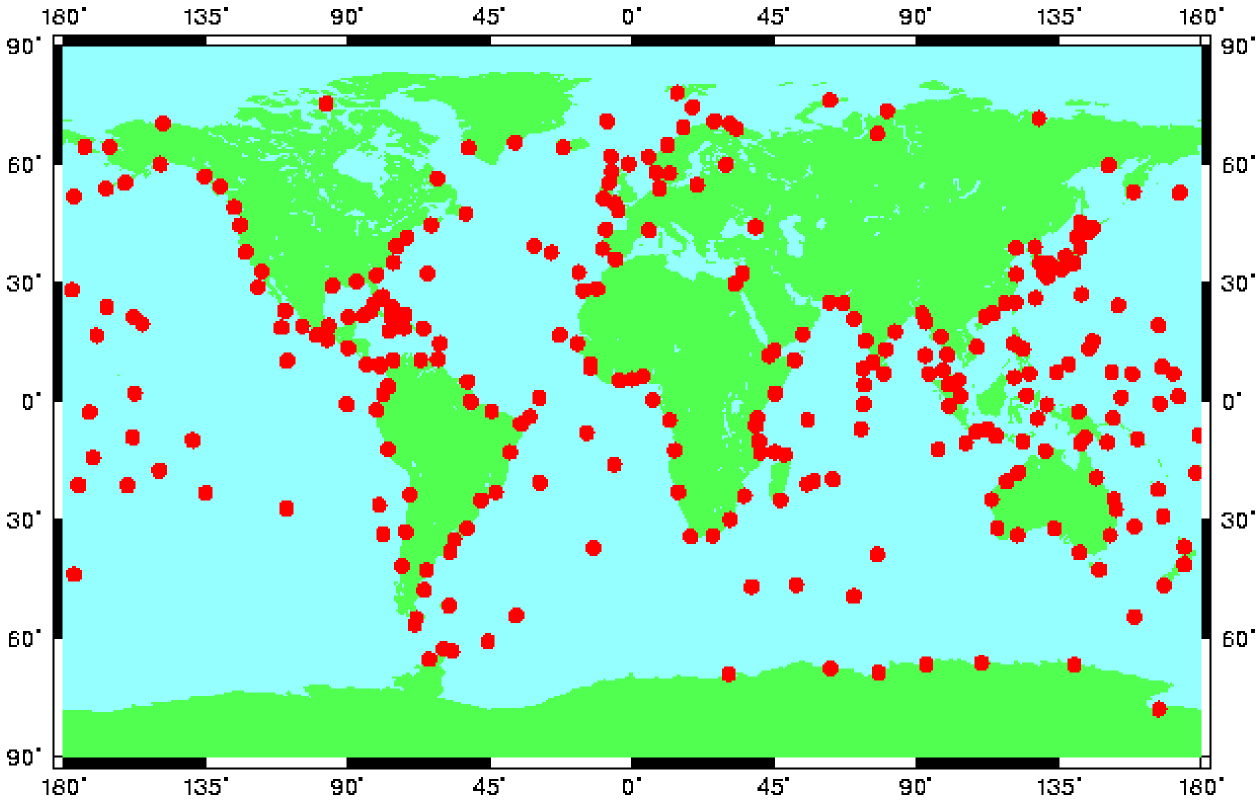

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Table of Contents

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Components of the U.S. National Program in Support of GLOSS

Introduction

This United States National Report is a summary of the operational water level observation programs in the United Sates that provide support to GLOSS and the international community. The three major components of this support are:

- The U. S. National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs Project Office for Climate Observations,
- The NOAA National Ocean Service National Water Level Program managed by the Center for Operational Oceanographic Products and Services, and
- The University of Hawaii Sea Level Center

A) The NOAA Office of Global Programs Project Office for Climate Observations Activities

The goal of the program (http://www.oco.noaa.gov/) is to build and sustain the ocean component of a global climate observing system that will respond to the long term observational requirements of the operational forecast centers, international research programs, and major scientific assessments. The program objectives 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.

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. In order for NOAA to fulfill its climate mission, the global ocean must be observed. At present, the Climate Observation Program is arguably the world leader in supporting implementation of the in situ elements of the global ocean climate observing system.

Present ocean observations are not adequate to deliver these products with confidence. The fundamental deficiency is lack of global coverage by the in situ networks. Present international efforts constitute only about 45% of what is needed in the ice-free oceans and 11% in the Arctic. The *Second Report on the Adequacy of the Global Observing System for Climate in Support of the UNFCCC* concludes that “the ocean networks lack global coverage and commitment to sustained operations…Without urgent action to address these findings, the Parties will lack the information necessary to effectively plan for and manage their response to climate change.” The *Strategic Plan for the U.S. Climate Change Science Program* calls for “complete global coverage of the oceans with moored, drifting, and ship-based networks.” The draft Ocean.US interagency plan for *Implementation of the Initial U.S. IOOS* specifies that “the highest priority for the global component of the IOOS is sustained, global coverage.”

The recent Earth Observation Summit raised to the highest levels of governments the awareness of the need for a global observation system. The climate question is high on the political agendas of many nations and can be answered authoritatively only by sustained earth observation. The Earth Observation Summit reaffirmed NOAA’s leadership and commitment to fulfilling the need for global coverage and the Climate Observation Program is NOAA’s management tool for implementing the ocean component. Appendix 1 is a more detailed description of the Climate Observation Program activities.

B) The NOAA National Ocean Service National Water Level Program Status

1. Operational Status of NOAA National Ocean Service Tide Stations in Support of GLOSS Activities

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 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 National Water Level Observation Network (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. The program is seen as a national authority and NOAA accepts responsibility for the accuracy of its products. Appendix 2. is a detailed description of the NWLP.

Table 1 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 JASL archive database. There are 29 of the 175 NOAA NWLON stations on this list. Table 2 is a listing of the tide stations operated by NOAA that are contributing to the JASL archive data base at the present time. All of the GLOSS stations in Table 1 contribute to the JASL database. There are 54 total NOAA operational NWLON stations that actively contribute to the JASL archive. The 18 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 CRN stations.

2. Planned Efforts to upgrade NOAA tide stations to support the U.S. tsunami warning program.

Xpert General System Operations: The planned Data Collection Platform (DCP) upgrades will include replacing both the primary and redundant DCPs. Each of the NWLON stations has both a primary and redundant (backup) system to help assure continuous data records. The new primary DCP will be equipped with a high-data-rate GOES transmitter which will be operating at 300 baud and the systems will transmit data via GOES every 6 minutes. Each message will contain the most recent water level (WL) measurement from both the primary and redundant systems including data quality parameters (mean, std dev, outliers, for both, and 2 temperature measurements for acoustic sensor). The message will also include data from any meteorological sensors that might be installed at the station, as well as the preceding 6 minute WL measurements from primary and redundant sensors which can be used to fill data gaps should a transmission be missed.

Xpert Tsunami Upgrade for continuous one minute water level data: For stations identified as “tsunami”, the primary DCP will compute 1 minute WL averages and store the most recent 30 days of this higher frequency data. In addition, the most recent 6 - 1 minute WL measurements would be added to the standard GOES message. This would provide continuous 1 minute data sets from these stations every 6 minutes.

Xpert Tsunami Upgrade for 15 second water level data: For stations identified as “tsunami”, the redundant DCP would also be configured to compute and store 15 second WL averages from its pressure based sensor and, as with the primary DCP, the most recent 30 days of this high frequency data would be stored at the DCP on a flash memory card. The 15 second average is the scheme used with the present Sutron 9000/8200 based systems. The data rate could be increased slightly, perhaps 10 second averages, however, this provides extremely noisy data. This data can be retrieved by phone (we will have phone access to both primary and redundant systems) via the system's 56K modem which should provide relatively quick downloads. This data could be retrieved by visiting the station and removing the flash memory card. A third method of accessing the 15 second data will be through the installation of an IP cellular modem. This enables a data collection computer to launch numerous simultaneous telnet sessions when a seismic event occurs and would provide real-time 15 second water level data from stations in the path of a potential tsunami wave.

Planned new NOAA NWLON Stations in Support of the U.S. Tsunami Warning System: In response to the recent tsunami disaster in the Indian Ocean, the U.S. has been evaluating its national tsunami warning system. Based on the evaluation, resources are being targeted towards enhancement of the operational tide gauges used as part of the warning network. Several new stations are being deployed by NOAA over the next few years as summarized in Figures 1 and 2.

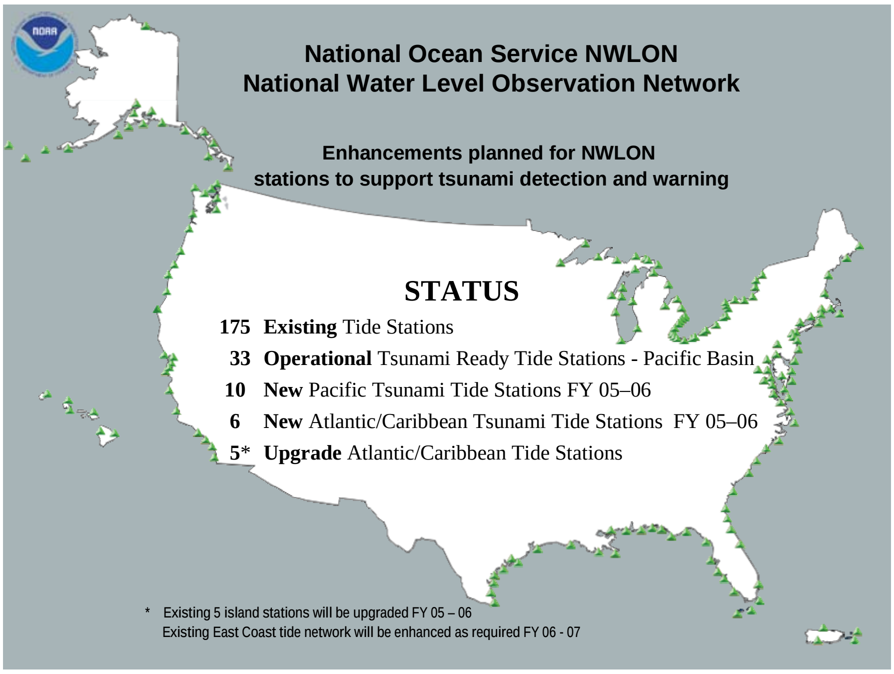

Figure 1. NOAA NWLON Operational Status

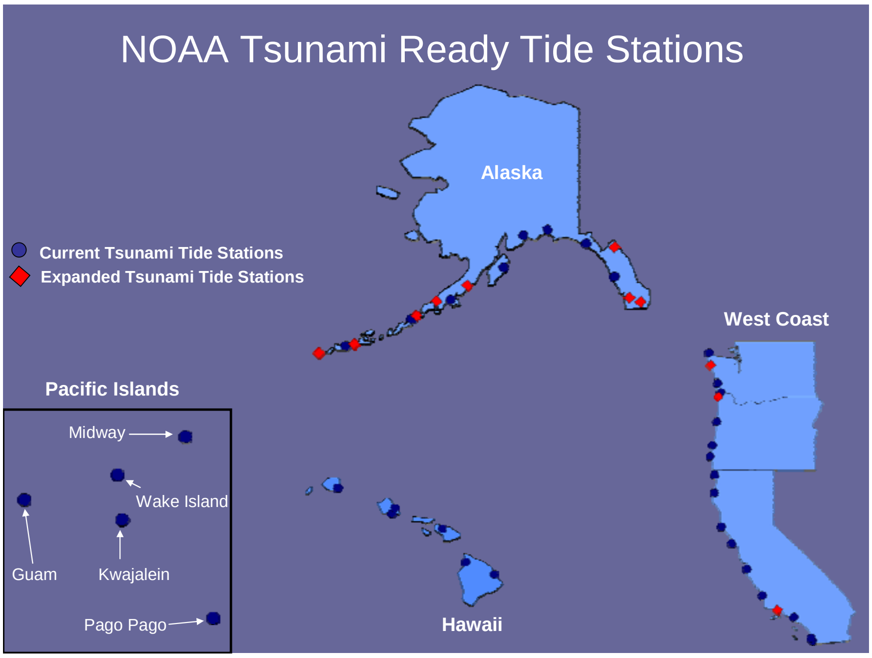

Figure 2. NOAA NWLON Operational Status – Pacific Region

3. Sea level Trends Product Enhancement

There are 18 NOAA National Water Level Observation Network (NWLON) stations identified in the International Sea Level Workshop Report (1997) as being part of the core global subset for long term trends. The NOAA Climate Observations Program Plan calls these climate "reference stations" and includes the following performance measures for the reference 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.

The Climate Observation Program will be producing an annual report on the state of the ocean and the state of the observing system for climate. It is proposed that an annual report on these reference stations that would be one section of that larger report. Over the next 3 years it is required that the report include all 62 global reference stations. The current NOAA report on sea level is being used as a starting template for an annual report.

NOAA began the development efforts for an annual report that includes the 18 NWLON stations listed above. A tailored version of the graphics and analyses from the existing NOAA sea level report has been completed that includes the three fundamental types of analyses where data series allow. The following figures illustrate the types of analyses using Honolulu as an example.

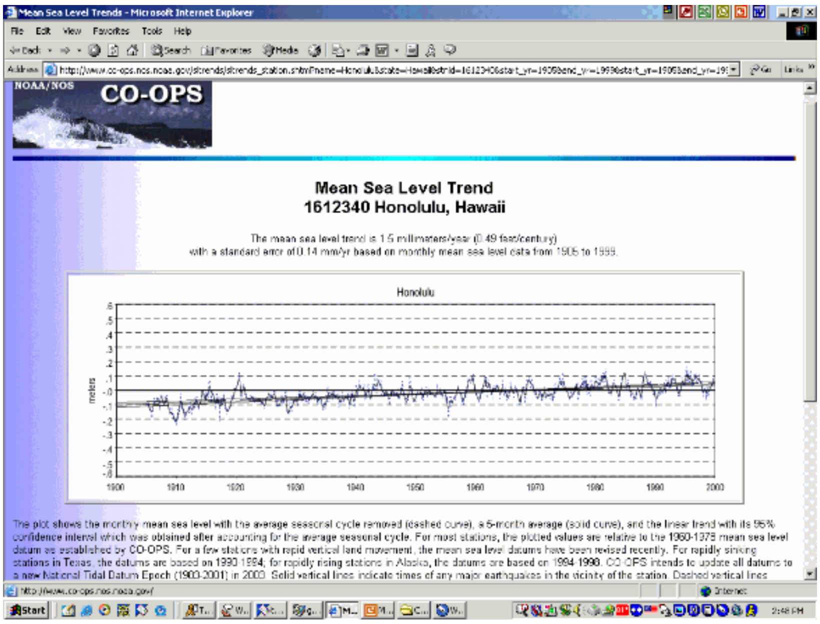

Figure 1. Sea level Trends Analyses would be updated annually.

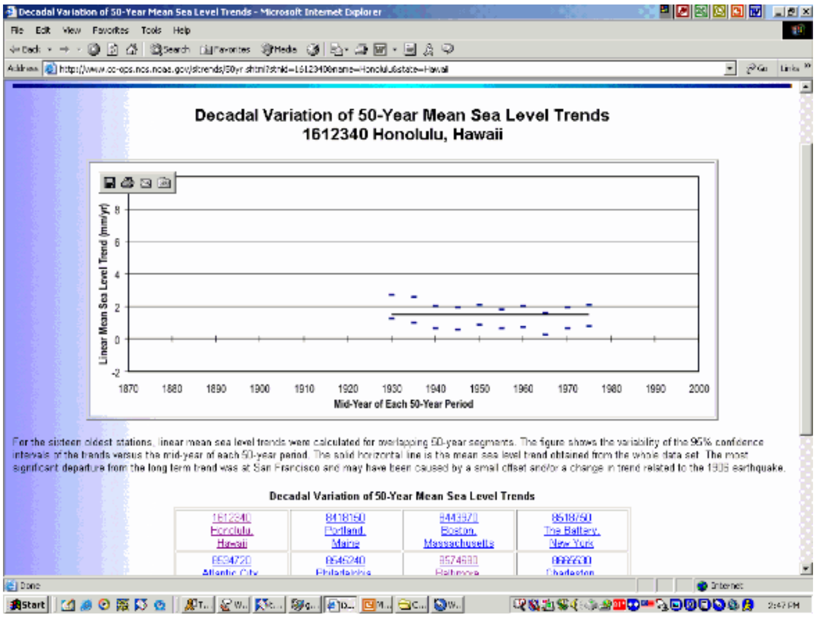

Figure 2. Long-term Variation in Trends would be routinely updated.

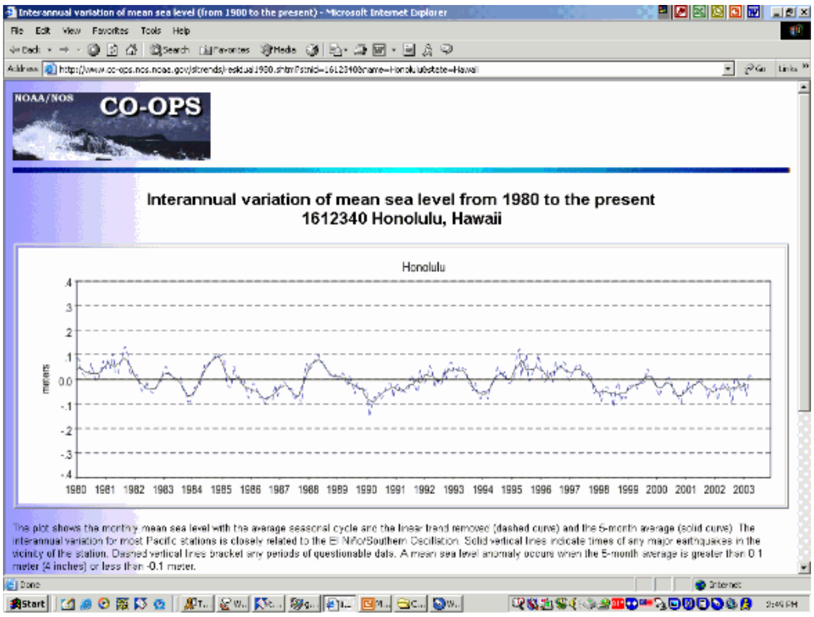

Figure 3. The Monthly Mean Sea Level variations would be updated annually.

CO-OPS will extend the compilation of the data and the reports from the 18 NWLON stations to include all 62 global reference stations assuming routine data availability each year. Efforts will concentrate on getting the data compiled in a timely fashion and generating routine reports established in the first year effort. Success will depend upon the ability to get timely data from all stations. These efforts will be coordinated with PSMSL, GLOSS and UHSLC programs.

4. Upgrade of NOAA Ocean Island Station Operations

There are several coastal and island NWLON stations critical to the Global Climate Observing System. The operation and maintenance of the ocean island stations of the National Water Level Observation Network (NWLON) has been increasingly more difficult over time due to the slow abandonment of the island facilities at which the stations reside. 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, it is proposed that Ocean Island stations begin to be upgraded first with this funding to 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 to backup 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. The station operations will also be enhanced with GPS connections to geodetic systems followed by installation of GPS Continuously Operating Reference Systems (CORS) at selected sites. The following is a list of the ocean island NWLON stations (not including Hawaii) that will considered in this category as priority for upgrade.

Station:	CORS Operating
Guam	Yes
Kwajalein	Yes
Pago Pago	Yes
Wake	No
Midway	No
Adak	No
Bermuda	Yes
San Juan. PR	Yes
Magueyes Island, PR	No
Charlotte Amalie, VI	No
St Croix, VI	Yes

Upgrades will be completed a two critical ocean island stations at Midway and at Guam in 2005.

5. Satellite Altimeter Mission Support

Support for the TOPEX/Poseidon satellite altimeter mission began with installation of an acoustic system and a digibub system on Platform Harvest in 1983 . Using reimbursable funding under MOA with JPL/Caltech, systems operations include provision of water level measurements relative to the satellite altimeter closure analysis reference frame for calibration monitoring (see B. Hanes et al, Special Issue of Marine Geodesy, 2003 "The

Harvest Experiment: Monitoring Jason-1 and TOPEX-Poseidon from a California Offshore Platform".

NOS special support has included a vertical survey on the Platform necessary to relate the water level sensor reference zeros (near the bottom catwalk) to the 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 overflights 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.

6.   The U.S. Climate Change Science Program

The U.S. President established the U.S. Climate Change Science Program (CCSP) in 2002 (http://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*.

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?* Two of the products/milestones are:

- **Elevation maps depicting areas vulnerable to sea level rise and planning maps depicting how state and local governments could respond to sea-level rise (less than two years).**

- **Assessment of how coastal environmental programs can be improved to adapt to sea-level rise while enhancing economic growth (2 - 4 years).**

The U.S. Environmental protection Agency (EPA) is currently listed as the lead for these deliverables and NOAA/National Ocean Service (NOS) is co-leading this effort. NOS has been asked by NOAA management for a report on what it would take to produce these deliverables. The NOAA Climate Office has specifically asked NOS for a report as soon as possible. This document is a draft report on a sea-level deliverable that NOS could provide within the required time frame.

The deliverable would demonstrate how NOS would use the strength of existing partnerships with local communities, existing national infrastructure in surveying, mapping, and existing capabilities for sea level analyses. The existing NOS effort in North Carolina would be used as a template to create a plan for a sea level rise deliverable for the nation.

7. 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. Ocean observations are essential to NOAA's mission and NOAA will lead development of observation and data management systems into an Integrated Ocean Observing System (IOOS). With partners here and abroad, NOAA will incorporate measurements on valuable hydrographic, geodetic, land cover, topographic, and water-level information. NOAA will foster regional collaborations for observing coastal conditions through the U.S. Federal interagency National Ocean Research Leadership Council and Ocean.US. Using IOOS funding from the U.S. Congress, NOAA will be expanding the NWLON with a few stations in 2006 at key locations with data information gaps to meet all users' needs for water level data.

C. The University of Hawaii Sea Level Center Status

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. Funding for the UHSLC is provided by the Office of Climate Observation (OCO), NOAA. UHSLC data are used for the evaluation of numerical models, joint analyses with satellite altimeter datasets, the calibration of altimeter data, the production of oceanographic products through the WMO/IOC JCOMM Sea Level Program in the Pacific (SLP-Pac) program, and research on sea level rise and interannual to decadal climate fluctuations. In support of satellite altimeter calibration and validation 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, 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 operates 37 tide gauge stations in the global sea level network and collaborates with host countries in the operation of 7 more stations. In the past year, HSLC serviced 13 sites, installed 1 new station, and serviced 16 sites remotely. The historical data return for the UHSLC network is 93.8%, the current year's return is 95.3%, 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:

1) **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 10,007 station-years of hourly quality assured data. The JASL set now includes 5617 station years of data in 264 series at 202 GLOSS sites.

2) **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 141 stations, 113 of which are located at GLOSS sites.

3) **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 50 stations currently are available in real-time with plans for ongoing expansion. When operational, we will distribute this product through our public web site, and make it available in a netCDF format via OPeNDAP server for use in forecast models and for satellite altimeter calibration.

The UHSLC provides monthly maps of the Pacific sea level fields through the JCOMM sponsored SLP-Pac. 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 1: Status of GLOSS Stations in the United States operated by NOAA/NOS		
GLOSS ID	**Location**	**Status**
111	Kwajelein	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (055A) data through 2003 • CRN station
206	San Juan, PR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (245A) data through 2003
221	Bermuda	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (259A) data through 2003 • CRN station
302	Adak, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (040A) data through 2003
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 2003 • CRN station
219	Duck Pier, NC	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (260A) data through 2003
289	Fort Pulaski, GA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (752A) data through 2003
217	Galveston Pier 21, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JAS L(775A) data through 2003
287	Hilo, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (060A) data through 2003
108	Honolulu. HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (057B) data through 2003 • CRN station
109	Johnston Island	No longer operated by NOAA • PSMSL data through 2002 • JASL (052A) data through 2003
216	Key West, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (242A) data through 2003 • CRN station

159	La Jolla, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (569A) data through 2003 • 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 2003
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 2003
290	Newport, RI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (253A) data through 2003
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 2003
288	Pensacola, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (762A) data through 2003 • CRN station
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 2003
158	San Francisco, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (551A) data through 2003 • 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 2003
154	Sitka, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (559A) data through 2003

157	South Beach, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (592A) data through 2003
102	Unalaska, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (041B) data through 2003
220	Atlantic City, NJ	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (264A) data through 2003 • CRN station
105	Wake Island	• Ongoing, currently using a acoustic gauge with pressure gauge backup • PSMSL data through 2002 • JASL (051A) data through 2003

Table 2: 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 2003
058A	Nawiliwili, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
059A	Kahului, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
061A	Mokuoloe, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
552A	Kawaihae, HI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
555A	Monterey, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
556A	Crescent City, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
557A	Port Orford, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
558A	Neah Bay, WA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
561A	Seldovia, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
562A	Valdez. AK	• Ongoing, currently using a acoustic gauge with pressure gauge

		backup • JASL data through 2003
564A	Willapa Bay, WA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
565A	Port San Luis, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
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 2003
571A	Ketchikan, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
572A	Astoria, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
573A	Arena Cove, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
575A	Charleston, OR	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
576A	Humboldt Bay, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
578A	Santa Monica, CA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
583B	Cordova, AK	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
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 2003
261A	Charleston, SC	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
240A	Fernandina Beach, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
252A	Portland, ME	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
254A	Limetree bay, VI	• Ongoing, currently using a acoustic gauge with pressure gauge backup

		• JASL data through 2003
255A	Charlotte Amalie, VI	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
279A	Montauk, NY	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
740A	Eastport, ME	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
741A	Boston, MA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
742A	Woods Hole. MA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
743A	Nantucket, MA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
744A	New London, CT	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
745A	New York, NY	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003 • CRN station
746A	Cape May, NJ	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
747A	Lewes, DE	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
749A	Chesapeake BBT, VA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
750A	Wilmington, NC	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
753A	Mayport, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
757A	Naples,FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
759A	St. Petersburg, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
760A	Appalachicola, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
761A	Panama City Beach, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
763A	Dauphin Island, AL	• Ongoing, currently using a acoustic gauge with pressure gauge backup

		• JASL data through 2003
765A	Grand Isle, LA	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
766A	Sabine Pass, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
767A	Galveston Pleasure Pier, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
769A	Rockport, TX	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
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 2003
773A	Clearwater Beach FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
774A	Port Canaveral, FL	• Ongoing, currently using a acoustic gauge with pressure gauge backup • JASL data through 2003
	Hampton Roads, VA	• CRN station for se level

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	

APPENDIX 1. NOAA's Climate Observations Program Description

Program Description (see http://www.oco.noaa.gov/)

Goal and Objectives:
The goal of the program is to build and sustain the ocean component of a global climate observing system that will respond to the long term observational requirements of the operational forecast centers, international research programs, and major scientific assessments. The program objectives 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.

Specific issues, requirements, and customer need motivating the program:
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. In order for NOAA to fulfill its climate mission, the global ocean must be observed. At present, the Climate Observation Program is arguably the world leader in supporting implementation of the in situ elements of the global ocean climate observing system.

The observing system needs to have the capability to deliver continuous instrumental records and analyses accurately documenting:

- Sea level to identify changes resulting from climate variability.
- Ocean carbon content every ten years and the air-sea exchange seasonally.
- Sea surface temperature and surface currents to identify significant patterns of climate variability.
- Sea surface pressure and air-sea exchanges of heat, momentum, and fresh water to identity changes in forcing function driving ocean conditions and atmospheric conditions.
- Ocean heat and fresh water content and transports to identify where anomalies enter the ocean, how they move and are transformed, and where they re-emerge to interact with the atmosphere.
- The essential aspects of thermohaline circulation and the subsurface expressions of the patterns of climate variability.
- Sea ice thickness and concentrations.

Present ocean observations are not adequate to deliver these products with confidence. The fundamental deficiency is lack of global coverage by the in situ networks. Present international efforts constitute only about 45% of what is needed in the ice-free oceans and 11% in the Arctic. The *Second Report on the Adequacy of the Global Observing System for Climate in Support of the UNFCCC* concludes that "the ocean networks lack global coverage and commitment to sustained operations…Without urgent action to address these findings, the Parties will lack the information necessary to effectively plan for and manage their response to climate change." The *Strategic Plan for the U.S. Climate Change Science Program* calls for "complete global coverage of the oceans with moored, drifting, and ship-based networks." The draft Ocean.US interagency plan for *Implementation of the Initial U.S. IOOS* specifies that "the highest priority for the global component of the IOOS is sustained, global coverage."

The recent Earth Observation Summit raised to the highest levels of governments the awareness of the need for a global observation system. The climate question is high on the political agendas of many nations and can be answered authoritatively only by sustained earth observation. The Earth Observation Summit reaffirmed NOAA's leadership and commitment to fulfilling the need for global coverage and the Climate Observation Program is NOAA's management tool for implementing the ocean component.

Partnerships:
The Climate Observation Program is managed as an inter-LO, interagency, and international effort. Presently most NOAA contributions to the global system are being implemented by the OAR laboratories, joint institutes and university partners. NOS, NMFS, and NWS maintain observational infrastructure for ecosystems, transportation, marine services and coastal forecasting that do or have potential to contribute to climate observation. NOS sea level measurements in particular provide one of the best and longest climate records existent. NESDIS data centers are essential. NMAO ship operations are necessary for supporting ocean work. NESDIS and NPOESS continuous satellite missions are needed to provide the remote sensing that complements the in situ measurements.

International and interagency partnerships are central to the Climate Observation Program implementation strategy. All of the Program's contributions to global observation are managed in cooperation internationally with the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), and nationally with the U.S. Integrated Ocean Observing System (IOOS). NSF has initiated their Ocean Observatories Initiative (OOI) which will potentially provide significant infrastructure in support of ocean climate observation, beginning in FY 2006. The ongoing NSF-NOAA cooperative project for CLIVAR-carbon ocean surveys has proved to be an interagency international-interdisciplinary success. ONR maintains a GODAE data server at Monterey that needs to be sustained after the experiment period (2003-2005) as permanent international infrastructure. The UNOLS fleet provides ship support for ocean operations. NASA's development of remote sensing techniques is key.

Focus of the Program:

- Extending the in situ networks to achieve global coverage – moored and drifting buoys, profiling floats, tide gauges stations, and repeated ship lines.
- Building associated data and assimilation subsystems.
- Building observing system management and product delivery infrastructure.

APPENDIX 2. NOAA's National Water Level Program Description

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

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 NWLP is an "end-to-end" system of data collection, quality control, data management, and product delivery. 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. The program is seen as a national authority and NOAA accepts responsibility for the accuracy of its products.

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 175 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 http://www.co-ops.nos.noaa.gov/sltrends/sltrends.shtml). 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 shall be 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. To perform the NGS tie, start leveling from one NGS mark to the other NGS mark and determine the section elevation difference. This section elevation difference must be less than the allowable closure tolerance for that section, computed by multiplying a constant K by square root of the distance for the section. The value of the constant K is equal to 6mm for the 2nd order class 1 levels, and the value of the constant K is equal to 12 mm for the 3rd order levels. If a tie is made, then connect via levels other bench marks in the leveling network from one of the two NGS bench marks.
If a valid tie is not achieved after leveling to the marks designated in the project instructions for that station, the leveling run shall be extended to other NGS marks, if nearby additional marks are available in the NGS database, until a valid tie is achieved. If no tie is validated, the levels can only be used by NGS for updating recovery information, but the heights will not be processed.

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.

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

The following 8 locations have been identified where the CORS site is located near the tide station. The distance displayed below is radial distance and may be different from the actual leveling distance from the tide station to the CORS reference marks.

NWLON Station	**Nearby CORS Designation**	**Approximate Distance (km)**
Eastport ME	EPRT	0.8
Bar Harbor, ME	BARH	1.4
Newport, RI	NPRI	0.5
Sandy Hook, NJ	SHK1	0.5
Solomons Island, MD	SOL1	0.2
Honolulu, HI	HNLC	0.0
Hilo, HI	HILO	<1
Kodiak, AK	KODK	<1

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 NOS 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 NOS water level database to the NGS National Spatial Reference System (NSRS);

(2) to establish transformation functions between NOS chart datum (MLLW) and the geocentric reference system to support NOS 3-dimensional hydrographic surveys, the implementation of Electronic Chart Display and Information Systems (ECDIS), and the NOS 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.

If none of the meteorological sensors (air temperature, barometric pressure, and relative humidity) are available for recording observations, then note any change in the atmospheric conditions on the GPS station/bench mark observation log form under Remarks section.

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 hourly GOES transmissions (Libraro, June 1998) 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 (every 18-minutes) 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 3. University of Hawaii Sea Level Center Program Description

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. Funding for the UHSLC is provided by the Office of Climate Observation (OCO), NOAA. UHSLC data are used for the evaluation of numerical models, joint analyses with satellite altimeter datasets, the calibration of altimeter data, the production of oceanographic products through the WMO/IOC JCOMM Sea Level Program in the Pacific (SLP-Pac) program, and research on sea level rise and interannual to decadal climate fluctuations. In support of satellite altimeter calibration and validation 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, 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 distributes three sea level data sets:

1) **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 10,007 station-years of hourly quality assured data. The JASL set now includes 5617 station years of data in 264 series at 202 GLOSS sites.

2) **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 141 stations, 113 of which are located at GLOSS sites.

3) **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 50 stations currently are available in real-time with plans for ongoing expansion. When operational, we will distribute this product through our public web site, and make it available in a netCDF format via OPeNDAP server for use in forecast models and for satellite altimeter calibration.

The UHSLC provides monthly maps of the Pacific sea level fields through the JCOMM sponsored SLP-Pac. 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 A-3-1 Stations that UHSLC brings into the Fast Delivery 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.

STATION	LAT	LONG	COUNTRY	YEARS
POHNPEI	06 59N	158 15E	Fd. St. Micronesia	1985-2004
BETIO	01 22N	172 56E	Kiribati	1998-2004
BALTRA	00 26S	090 17W	Galapagos Ecuador	1985-2002
NAURU	00 32S	166 54E	Nauru	1995-2004
MAJURO	07 06N	171 22E	Marshall Islands	2000-2004
MALAKAL	07 20N	134 28E	Belau	1985-2004
YAP	09 31N	138 08E	Fd. St. Micronesia	1985-2004
HONIARA	09 26S	159 57E	Solomon Islands	1995-2004
RABAUL	04 12S	152 11E	Papau New Guinea	1985-2004
CHRISTMAS	01 59N	157 28W	Kiribati	1985-2004
KANTON	02 49S	171 43W	Kiribati	1985-2001
FRENCH FR SHALL	23 52N	166 17W	U.S.A. Hawaii	1985-2004
PAPEETE	17 32S	149 34W	French Polynesia	1985-2004
RIKITEA	23 08S	134 57W	French Polynesia	1985-2004
SUVA	18 08S	178 26E	Fiji	1998-2004
NOUMEA	22 18S	166 26E	New Caledonia	1985-2004
JUAN FERNANDEZ	33 37S	078 50W	Chile	1990-1998
EASTER	27 09S	109 27W	Chile	1985-2004
RAROTONGA	21 12S	159 47W	Cook Islands	1997-2004
PENRHYN	08 59S	158 03W	Cook Islands	1985-2004
FUNAFUTI	08 32S	179 13E	Tuvalu	2000-2004
SAIPAN	15 14N	145 45E	Mariana Islands	1985-2004
KAPINGAMARANGI	01 06N	154 47E	Fd. St. Micronesia	1985-2004
SANTA CRUZ	00 45S	090 19W	Galapagos Ecuador	1985-2004
NUKU HIVA	08 56S	140 05W	French Polynesia	1985-1998
CABO SAN LUCAS	22 53N	109 55W	Mexico	1985-2004
SAN FELIX	26 17S	080 08W	Chile	1992-1997
NUKU'ALOFA	21 08S	175 12W	Tonga	1990-2004
KODIAK ISLAND	57 44N	152 31W	U.S.A. Alaska	1985-2004
ADAK ISLAND	51 52N	176 38W	U.S.A. Alaska	1985-2004
DUTCH HARBOR	53 54N	166 30W	U.S.A. Alaska	1992-2004
PORT VILA	17 46S	168 18E	Vanuatu	1993-2004
CHICHIJIMA	27 06N	142 11E	Japan	1985-2004
MINAMITORISHIMA	24 18N	153 58E	Japan	2002-2004
MIDWAY ISLAND	28 13N	177 22W	U.S.A. Trust	1985-2004
WAKE ISLAND	19 17N	166 37E	U.S.A. Trust	1985-2004
JOHNSTON ISLAND	16 45N	169 31W	U.S.A. Trust	1985-2004
GUAM	13 26N	144 39E	U.S.A. Trust	1985-2004
KWAJALEIN	08 44N	167 44E	Marshall Island	1985-2004
PAGO PAGO	14 17S	170 41W	U.S.A. Samoa	1985-2002
HONOLULU	21 18N	157 52W	U.S.A. Hawaii	1985-2004
NAWILIWILI	21 58N	159 21W	U.S.A. Hawaii	1985-2004
KAHULUI	20 54N	156 28W	U.S.A. Hawaii	1985-2004
HILO	19 44N	155 04W	U.S.A. Hawaii	1985-2004
CHATHAM ISLAND	43 57S	176 34W	New Zealand	2000-2003
VALPARAISO	33 02S	071 38W	Chile	1985-2001
ARICA	18 28S	070 20W	Chile	1985-1999
LOBOS DE AFUERA	06 56S	080 43W	Peru	1985-1999
QUEPOS	09 24N	084 10W	Costa Rica	1985-1995
CALDERA	27 04S	070 50W	Chile	1985-2001
SOCORRO	18 44N	111 01W	Mexico	1992-1997

LA LIBERTAD	02 12S 080 55W	Ecuador	1985-2003
TALARA	04 35S 081 17W	Peru	1992-1996
CALLAO	12 03S 077 09W	Peru	1985-2004
MOMBASA	04 04S 039 39E	Kenya	1986-2003
PORT LOUIS	20 09S 057 30E	Mauritius	1986-2004
DIEGO GARCIA	07 17S 072 24E	United Kingdom	2003-2004
RODRIGUES	19 40S 063 25E	Mauritius	1986-2004
HULHULE	04 11N 073 32E	Republic of Maldives	1989-2004
GAN	00 41S 073 09E	Republic of Maldives	1987-2004
MASIRAH	20 41N 058 52E	Oman	1996-2004
SALALAH	16 56N 054 00E	Oman	1989-2004
HANIMAADHOO	06 46N 073 10E	Maldives	2003-2004
POINT LA RUE	04 40S 055 32E	Seychelles	1993-2004
KO TAPHAO NOI	07 50N 098 26E	Thailand	1985-2003
LAMU	02 16S 040 54E	Kenya	1995-2004
ZANZIBAR	06 09S 039 11E	Tanzania	1985-2004
DARWIN	12 28S 130 51E	Australia	1985-2004
COCOS ISLAND	12 07S 096 54E	Australia	1985-2004
ESPERANCE	33 52S 121 54E	Australia	1985-2004
CROZET ISLAND	46 26S 051 52E	France	1995-2001
ST. PAUL	38 43S 077 32E	France	2003-2004
KERGUELEN	49 21S 070 13E	France	1993-2004
RICHARD'S BAY	28 47S 032 06E	South Africa	2003-2004
PONTA DELGADA	37 44N 025 41W	Azores	1994-2004
SIMON'S BAY	34 11S 018 26E	South Africa	2003-2004
DAKAR	14 40N 017 26W	Senegal	1994-2003
LOME	06 08N 001 17E	Togo	1989-1993
SAO TOME	00 21N 006 44E	Sao Tome	2004-2004
CAPE VERDE	16 45N 022 59W	Cape Verde	2000-2002
KEY WEST	24 33N 081 49W	U.S.A. Florida	1985-2004
SAN JUAN	18 28N 066 07W	U.S.A. Puerto Rico	1985-2004
NEWPORT	41 30N 071 20W	U.S.A Rhode Island	1985-2004
SETTLEMENT POINT	26 43N 078 60W	United Kingdom Bahamas	2002-2004
BERMUDA	32 22N 064 42W	United Kingdom	1985-2004
DUCK PIER	36 11N 075 44W	U.S.A. North Carolina	1985-2004
CHARLESTON	32 47N 079 56W	U.S.A. South Carolina	1985-2004
ATLANTIC CITY	39 21N 074 25W	U.S.A. New Jersey	1985-2004
CRISTOBAL	09 21N 079 54W	Panama	2001-2004
BASQUES	47 34N 059 08W	Canada	1997-2004
CHURCHILL	58 47N 094 12W	Canada	1985-2004
HALIFAX	44 40N 063 35W	Canada	1985-2004
ST-JOHN'S	47 34N 052 43W	Canada	1993-2004
ILHA FISCAL	22 54S 043 10W	Brazil	1985-2004
FORTALEZA	03 43S 038 28W	Brazil	1999-2000
PORT STANLEY	51 42S 057 51W	United Kingdom	2003-2004
ASCENSION	07 54S 014 23W	United Kingdom	1993-2001
ST. HELENA	15 58S 005 42W	United Kingdom	2003-2004
LERWICK	60 09N 001 08W	United Kingdom	1985-2002
NEWLYN	50 06N 005 33W	United Kingdom	1985-2004
STORNOWAY	58 13N 006 23W	United kingdom	1985-2004
BALBOA	08 58N 079 34W	Panama	1985-2004
KO LAK	11 48N 099 49E	Thailand	1985-2003
QUARRY BAY	22 18N 114 13E	Hong Kong, PRC	1986-2004
BRISBANE	27 22S 153 10E	Australia	1985-2004
BUNDABERG	24 50S 152 21E	Australia	1985-2004
FORT DENISON	33 51S 151 14E	Australia	1985-2004
TOWNSVILLE	19 15S 146 50E	Australia	1985-2004
SPRING BAY	42 33S 147 56E	Australia	1985-2004
ABASHIRI	44 01N 144 17E	Japan	2001-2004
HAMADA	34 54N 132 04E	Japan	2001-2004
TOYAMA	36 46N 137 13E	Japan	2001-2004

KUSHIRO	42 58N 144 23E	Japan	1985-2004
OFUNATO	39 04N 141 43E	Japan	1985-2004
MERA	34 55N 139 50E	Japan	1985-2004
KUSHIMOTO	33 28N 135 47E	Japan	1985-2004
ABURATSU	31 34N 131 25E	Japan	1985-2004
NAHA	26 13N 127 40E	Japan	1985-2004
WAKKANAI	45 24N 141 41E	Japan	2001-2004
NAGASAKI	32 44N 129 52E	Japan	1985-2004
HAKODATE	41 47N 140 44E	Japan	1985-2004
MANZANILLO	19 03N 104 20W	Mexico	1992-2004
LOMBRUM	02 02S 147 22E	Papua New Guinea	1994-2004
LAUTOKA	17 36S 177 26E	Fiji	1992-2004
JACKSON	43 59S 168 37E	New Zealand	1999-2004
PRINCE RUPERT	54 19N 130 20W	Canada	1985-2004
SAN FRANCISCO	37 48N 122 28W	U.S.A. California	1985-2004
CRESCENT CITY	41 45N 124 11W	U.S.A. California	1985-2004
NEAH BAY	48 22N 124 37W	U.S.A. Washington	1985-2004
SITKA	57 03N 135 21W	U.S.A. Alaska	1985-2004
SEWARD	60 07N 149 26W	U.S.A. Alaska	1985-2004
SAN DIEGO	32 43N 117 10W	U.S.A. California	1985-2004
YAKUTAT BAY	59 33N 139 44W	U.S.A. Alaska	1985-2004
KETCHIKAN	55 20N 131 38W	U.S.A. Alaska	1985-2004
SAND POINT	55 20N 160 30W	U.S.A. Alaska	1996-2004
PRUDHOE BAY	70 24N 148 32W	U.S.A. Alaska	1994-2004
SOUTH BEACH	44 38N 124 03W	U.S.A. Oregon	1985-2004
NOME,NORTON SOUND	64 30N 165 26W	U.S.A. Alaska	1992-2004
DIEGO RAMIREZ	56 31S 068 43W	Chile	1993-1998
USHUAIA	54 48S 068 18W	Argentina	1996-2004
ESPERANZA	63 24S 056 59W	Argentina(Antartica)	2003-2003
TANJONG PAGAR	01 15N 103 51E	Singapore	1985-2004
PORT NOLLOTH	29 17S 016 51E	South Africa	2004-2004
ROCAS,ATOL DAS	03 51S 033 49W	Brazil	1999-2000
FORT PULASKI	32 02N 080 54W	U.S.A. Georgia	1985-2004
PENSACOLA	30 24N 087 13W	U.S.A. Florida	1985-2004
GALVESTON(PIER21)	29 19N 094 48W	U.S.A. Texas	1985-2004
ANDENES	69 19N 016 09E	Norway	2001-2004
HONNINGSVARG	70 59N 025 59E	Norway	2001-2004
MLLOY	61 56N 005 07E	Norway	2001-2004
RORVIK	64 52N 011 15E	Norway	2001-2004
TREGDE	58 00N 007 34E	Norway	2001-2004
VARDO	70 20N 031 06E	Norway	2001-2004
HADERA	32 28N 034 53E	Israel	2003-2004

Table A-3-2. JASL station data

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 recordsas 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.

GLOBAL

Series: 525
Site-years: 10,007

GENERAL INFORMATION FOR DESIRED STATIONS: Pacific Ocean

Series = 283
Site-years = 5958

Notes on columns:
CI: Completeness index or percentage of data span without missing data.
QC-YEARS: years which have received quality control.

GLOS	STATION	COUNTRY	LAT	LONG	QC-YEARS	CI	CONTRIBUTOR
115	Pohnpei-A	Fd St Micronesia	06-59N	158-14E	1969-1971	100	Scripps Inst. Ocean
115	Pohnpei-B	Fd St Micronesia	06-59N	158-15E	1974-2003	98	UH Sea Level Center
113	Tarawa-A,Betio	Rep. of Kiribati	01-22N	172-56E	1974-1983	78	UH Sea Level Center
113	Tarawa-B,Bairiki	Rep. of Kiribati	01-20N	173-01E	1983-1988	98	UH Sea Level Center
113	Tarawa-C,Betio	Rep. of Kiribati	01-22N	172-56E	1988-1997	100	UH Sea Level Center
113	Tarawa-D,Betio	Rep. of Kiribati	01-22N	172-56E	1992-2003	91	Nat. Tidal Facility
169	Baltra-A	Ecuador	00-26S	090-17W	1968-1977	93	National Ocean Service
169	Baltra-B	Ecuador	00-26S	090-17W	1985-2002	98	UH Sea Level Center
114	Nauru-A	Rep. of Nauru	00-32S	166-54E	1974-1995	95	UH Sea Level Center
114	Nauru-B	Rep. of Nauru	00-32S	166-55E	1993-2003	90	Nat. Tidal Facility
112	Majuro-A	Rep. Marshall I.	07-06N	171-22E	1968-1999	92	UH Sea Level Center

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112  Majuro-B          Rep. Marshall I.  07-07N 171-22E 1993-2003  97 Nat.
Tidal Facility
xxx  Enewetok-A        Rep. Marshall I.  11-26N 162-23E 1951-1971  98
Scripps Inst. Ocean.
xxx  Enewetok-B        Rep. Marshall I.  11-26N 162-23E 1974-1979  94 UH
Sea Level Center
120  Malakal-A         Rep. of Belau     07-20N 134-29E 1929-1937  98 Japan
Ocean. Data Cen.
120  Malakal-B         Rep. of Belau     07-20N 134-28E 1969-2003  95 UH
Sea Level Center
119  Yap-A             Fd St Micronesia  09-31N 138-08E 1951-1952 100
Scripps Inst. Ocean.
119  Yap-B             Fd St Micronesia  09-31N 138-08E 1969-2003  93 UH
Sea Level Center
066  Honiara-A         Solomon Islands   09-26S 159-57E 1974-1995  98 UH
Sea Level Center
066  Honiara-B         Solomon Islands   09-25S 159-57E 1994-2003  97 Nat.
Tidal Facility
065  Rabaul            Papua New Guinea  04-12S 152-11E 1966-1997  85 UH
Sea Level Center
146  Christmas-A       Rep. of Kiribati  01-59N 157-29W 1955-1972  89
Scripps Inst. Ocean.
146  Christmas-B       Rep. of Kiribati  01-59N 157-28W 1974-2003  96 UH
Sea Level Center
xxx  Fanning-A         Rep. of Kiribati  03-54N 159-23W 1957-1958  88
Scripps Inst. Ocean.
xxx  Fanning-B         Rep. of Kiribati  03-54N 159-23W 1972-1987  95 UH
Sea Level Center
xxx  Fanning-C         Rep. of Kiribati  03-51N 159-22W 1988-1990  78 UH
Sea Level Center
145  Kanton-A          Rep. of Kiribati  02-49S 171-43W 1949-1967 100
Scripps Inst. Ocean.
145  Kanton-B          Rep. of Kiribati  02-49S 171-43W 1972-2001  93 UH
Sea Level Center
107  French Frigate S  USA               23-52N 166-17W 1974-2001  97 UH
Sea Level Center
140  Papeete-A         French Polynesia  17-32S 149-34W 1969-1975  91 UH
Sea Level Center
140  Papeete-B         French Polynesia  17-32S 149-34W 1975-2000  99
National Ocean Service
138  Rikitea           French Polynesia  23-08S 134-57W 1969-2003  92 UH
Sea Level Center
xxx  Hiva Oa           French Polynesia  09-49S 139-02W 1977-1980  75 UH
Sea Level Center
122  Suva-A            Fiji              18-08S 178-26E 1972-1997  91
National Ocean Service
122  Suva-B            Fiji              18-08S 178-26E 1998-2003  99 Nat.
Tidal Facility
123  Noumea            France            22-18S 166-26E 1967-2003  99 UH
Sea Level Center
176  Juan Fernandez-A  Chile             33-37S 078-50W 1977-1984  67 UH
Sea Level Center
176  Juan Fernandez-B  Chile             33-37S 078-50W 1985-2002  89 SHOA
137  Easter-A          Chile             27-09S 109-27W 1957-1958  97 SHOA
137  Easter-B          Chile             27-09S 109-27W 1962-1963 100 SHOA
137  Easter-C          Chile             27-09S 109-27W 1970-2002  83 SHOA
139  Rarotonga-A       Cook Islands      21-12S 159-47W 1977-1997  98 UH
Sea Level Center
139  Rarotonga-B       Cook Islands      21-12S 159-47W 1993-2003  99 Nat.
Tidal Facility
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143	Penrhyn	Cook Islands	08-59S	158-03W	1977-2001	95	UH Sea Level Center
121	Funafuti-A	Tuvalu	08-32S	179-12E	1977-1999	97	UH Sea Level Center
121	Funafuti-B	Tuvalu	08-30S	179-13E	1993-2003	96	Nat. Tidal Facility
xxx	Honolulu,Kewalo	USA	21-18N	157-52W	1978-1986	96	UH Sea Level Center
xxx	Honolulu,Pier 45	USA	21-19N	157-53W	1985-1988	100	UH Sea Level Center
118	Saipan	N. Mariana Is.	15-14N	145-45E	1978-2003	93	UH Sea Level Center
117	Kapingamarangi	Fd St Micronesia	01-06N	154-47E	1978-2001	92	UH Sea Level Center
xxx	Santa Cruz	Ecuador	00-45S	090-19W	1978-2003	95	UH Sea Level Center
142	Nuku Hiva	French Polynesia	08-56S	140-05W	1982-1997	70	UH Sea Level Center
069	Bitung	Indonesia	01-26N	125-12E	1986-1990	94	BAKOSURTANAL
161	Cabo San Lucas	Mexico	22-53N	109-55W	1973-2003	81	CICESE
177	San Felix	Chile	26-17S	080-08W	1987-2002	79	SHOA
160	Guadalupe	Mexico	28-53N	118-18W	1977-1985	75	CICESE
xxx	Nuku'alofa	Tonga	21-08S	175-11W	1990-2003	97	Nat. Tidal Facility
xxx	Kodiak,Alaska	USA	57-44N	152-31W	1975-2003	81	National Ocean Service
302	Adak,Alaska	USA	51-52N	176-38W	1950-2003	92	National Ocean Service
102	Dutch Harbor-A,AK	USA	53-53N	166-32W	1950-1955	100	National Ocean Service
102	Dutch Harbor-B,AK	USA	53-53N	166-32W	1992-2003	100	National Ocean Service
xxx	Palmyra	USA Trust	05-53N	162-05W	1947-1949	95	National Ocean Service
xxx	Port Vila-A	Vanuatu	17-44S	168-19E	1977-1982	87	unconfirmed
xxx	Port Vila-B	Vanuatu	17-46S	168-18E	1993-2003	92	Nat. Tidal Facility
103	Chichijima	Japan	27-06N	142-11E	1975-2002	100	Japan Meteor. Agency
xxx	Anewa Bay	Papua New Guinea	06-11S	155-53E	1968-1977	85	UH Sea Level Center
xxx	Minamitorishima	Japan	24-18N	153-59E	1997-2002	90	Japan Meteor. Agency
106	Midway	USA Trust	28-13N	177-22W	1947-2003	93	National Ocean Service
105	Wake	USA Trust	19-17N	166-37E	1950-2003	93	National Ocean Service
109	Johnston	USA Trust	16-44N	169-32W	1947-2003	95	National Ocean Service
149	Guam	USA Trust	13-26N	144-39E	1948-2003	92	National Ocean Service
116	Truk	Fd St Micronesia	07-27N	151-51E	1963-1991	89	National Ocean Service
111	Kwajalein	Rep. Marshall I.	08-44N	167-44E	1946-2003	98	National Ocean Service
144	Pago Pago	USA Trust	14-17S	170-41W	1948-2003	95	National Ocean Service

108	Honolulu-A	USA	21-18N	157-52W	1877-1892	32	National Ocean Service
108	Honolulu-B	USA	21-18N	157-52W	1905-2003	98	UH Sea Level Center
xxx	Nawiliwili	USA	21-58N	159-21W	1954-2003	99	National Ocean Service
xxx	Kahului	USA	20-54N	156-28W	1950-2003	92	National Ocean Service
287	Hilo	USA	19-44N	155-04W	1927-2003	81	National Ocean Service
xxx	Mokuoloe	USA	21-26N	157-48W	1957-2003	78	National Ocean Service
124	Norfolk Island-A	Australia	29-04S	167-57E	1985-1986	98	CSIRO
124	Norfolk Island-B	Australia	29-04S	167-56E	1994-1999	100	CSIRO
xxx	Wewak	Papua New Guinea	03-34S	143-38E	1984-1994	82	CSIRO
xxx	Port Moresby	Papua New Guinea	09-29S	147-08E	1984-1993	98	CSIRO
xxx	Manus	Papua New Guinea	02-01S	147-16E	1984-1994	73	CSIRO
xxx	Madang	Papua New Guinea	05-12S	145-48E	1984-1998	81	CSIRO
xxx	Lae	Papua New Guinea	06-44S	146-59E	1984-1997	83	CSIRO
xxx	Kavieng	Papua New Guinea	02-35S	150-48E	1984-1994	95	CSIRO
063	Alotau	Papua New Guinea	10-10S	150-27E	1984-1995	62	CSIRO
127	Auckland	New Zealand	36-51S	174-46E	1984-1988	100	Royal New Zealand Navy
101	Wellington	New Zealand	41-17S	174-47E	1984-1990	91	Royal New Zealand Navy
129	Bluff	New Zealand	46-36S	168-21E	1984-1988	88	Royal New Zealand Navy
xxx	Tauranga	New Zealand	37-39S	176-11E	1984-1985	99	Royal New Zealand Navy
xxx	Westport	New Zealand	41-44S	171-36E	1984-1985	100	Royal New Zealand Navy
xxx	Wanganui	New Zealand	39-57S	174-59E	1984-1985	97	Royal New Zealand Navy
xxx	Taranaki	New Zealand	39-03S	174-02E	1984-1985	79	Royal New Zealand Navy
xxx	Port Nelson	New Zealand	41-16S	173-16E	1984-1985	97	Royal New Zealand Navy
xxx	Gisborne	New Zealand	38-41S	178-02E	1984-1985	98	Royal New Zealand Navy
128	Chatham	New Zealand	43-57S	176-34E	2001-2001	30	UH Sea Level Center
174	Antofagasta	Chile	23-39S	070-24W	1945-2002	93	SHOA
175	Valparaiso	Chile	33-02S	071-38W	1944-2002	84	SHOA
182	Acajutla	El Salvador	13-35N	089-50W	1971-2001	87	Inst. Geograf. Nacional
xxx	Arica	Chile	18-28S	070-20W	1982-1998	98	SHOA
xxx	Lobos de Afuera	Peru	06-56S	080-43W	1982-2001	97	DHNM
170	Buenaventura	Colombia	03-54N	077-06W	1953-2000	93	IDEAM
xxx	La Union	El Salvador	13-20N	087-49W	1954-1980	77	National Ocean Service
167	Quepos	Costa Rica	09-24N	084-10W	1961-1994	83	SERMAR
xxx	Caldera	Chile	27-04S	070-50W	1980-1998	97	SHOA
xxx	Manta	Ecuador	00-57S	080-44W	1979-1981	100	INOCAR
162	Socorro	Mexico	18-44N	111-01W	1957-1959	81	CICESE
172	La Libertad	Ecuador	02-12S	080-55W	1949-2001	97	INOCAR
xxx	Talara-A	Peru	04-35S	081-17W	1950-1965	92	National Ocean Service

xxx	Talara-B	Peru	04-35S	081-17W	1988-2001	74	DHNM
173	Callao-A	Peru	12-03S	077-09W	1950-1965	98	National Ocean Service
173	Callao-B	Peru	12-03S	077-09W	1970-2002	100	DHNM
xxx	Matarani-A	Peru	17-00S	072-07W	1954-1964	98	National Ocean Service
xxx	Matarani-B	Peru	17-00S	072-07W	1992-2001	79	DHNM
xxx	San Juan	Peru	15-22S	075-12W	1978-2001	79	DHNM
xxx	Naos-A	Panama	08-55N	079-32W	1961-1965	99	Scripps Inst. Ocean.
xxx	Naos-B	Panama	08-55N	079-32W	1991-1997	84	National Ocean Service
xxx	Puerto Quetzal-A	Guatemala	13-55N	090-47W	1983-1984	90	UH Sea Level Center
xxx	Puerto Quetzal-B	Guatemala	13-55N	090-47W	1992-1995	77	UH Sea Level Center
168	Balboa	Panama	08-58N	079-34W	1907-1997	98	Panama Canal Commission
171	Tumaco	Colombia	01-50N	078-44W	1951-2000	86	IDEAM
xxx	Pto. Armuelles-A	Panama	08-16N	082-52W	1955-1968	95	Inst. Geograf. Nac.
xxx	Pto. Armuelles-B	Panama	08-16N	082-52W	1983-1998	94	Inst. Geograf. Nac.
xxx	Cedros Island	Mexico	28-06N	115-11W	1976-1989	75	CICESE
xxx	San Felipe	Mexico	31-01N	114-49W	1982-1986	52	UNAM
xxx	San Quintin	Mexico	30-29N	115-59W	1977-1990	97	CICESE
xxx	Bahia Los Angeles	Mexico	28-58N	113-33W	1973-1994	74	CICESE
xxx	Catalina-A	USA	33-27N	118-29W	1978-1979	96	Scripps Inst. Ocean.
xxx	Catalina-B	USA	33-27N	118-29W	1980-1988	86	Scripps Inst. Ocean.
267	Acapulco	Mexico	16-50N	099-55W	1952-1995	91	UNAM
xxx	Ensenada	Mexico	31-51N	116-38W	1956-1991	84	UNAM
xxx	Puerto Madero	Mexico	14-43N	092-26W	1986-1988	99	UNAM
xxx	Loreto	Mexico	26-01N	111-22W	1975-1988	73	CICESE
293	Cendering	Malaysia	05-16N	103-11E	1984-2002	99	Dept. Survey/Mapping
xxx	Johor Baharu	Malaysia	01-28N	103-48E	1983-2002	95	Dept. Survey/Mapping
xxx	Kuantan	Malaysia	03-59N	103-26E	1983-2002	99	Dept. Survey/Mapping
xxx	Tioman	Malaysia	02-48N	104-08E	1985-2002	97	Dept. Survey/Mapping
xxx	Sedili	Malaysia	01-56N	104-07E	1986-2002	98	Dept. Survey/Mapping
xxx	Kukup	Malaysia	01-20N	103-27E	1985-2002	98	Dept. Survey/Mapping
xxx	Geting	Malaysia	06-14N	102-06E	1986-2002	99	Dept. Survey/Mapping
044	Keppel Harbour	Singapore	01-16N	103-49E	1981-1990	99	Port Singapore Auth.
039	Ko Lak	Thailand	11-48N	099-49E	1985-2002	96	Naval Hydro. Dept.
077	Hong Kong-A	China	22-18N	114-12E	1962-1985	97	Hong Kong Observatory
077	Hong Kong-B	China	22-18N	114-13E	1986-2003	99	Hong Kong Observatory

058	Brisbane	Australia	27-22S	153-10E	1984-2003	97	Nat. Tidal Facility
059	Bundaberg	Australia	24-50S	152-21E	1984-2003	98	Nat. Tidal Facility
057	Fort Denison	Australia	33-51S	151-14E	1965-2003	94	Nat. Tidal Facility
060	Townsville	Australia	19-16S	146-50E	1984-2002	99	Nat. Tidal Facility
056	Spring Bay	Australia	42-33S	147-56E	1985-2003	95	Nat. Tidal Facility
061	Booby Island	Australia	10-36S	141-55E	1988-1999	88	Nat. Tidal Facility
044	Victoria Dock	Singapore	01-16N	103-49E	1972-1981	95	Port Singapore Auth.
xxx	Macau	Portugal	22-10N	113-33E	1978-1985	80	Inst. Hidro. Marinha
xxx	Hobart	Australia	42-53S	147-20E	1985-1999	83	Nat. Tidal Facility
xxx	Kaohsiung	Rep. of China	22-37N	120-18E	1980-1999	98	Central Weather Bureau
xxx	Keelung	Rep. of China	25-09N	121-45E	1980-1999	93	Central Weather Bureau
327	Abashiri	Japan	44-01N	144-17E	1968-2002	97	Japan Meteor. Agency
326	Hamada	Japan	34-54N	132-04E	1984-2002	95	Japan Meteor. Agency
325	Toyama	Japan	36-46N	137-13E	1967-2002	98	Japan Meteor. Agency
089	Kushiro	Japan	42-58N	144-23E	1963-2002	97	Japan Meteor. Agency
087	Ofunato	Japan	39-01N	141-45E	1965-2002	100	Japan Meteor. Agency
086	Mera	Japan	34-55N	139-50E	1965-2002	93	Japan Meteor. Agency
085	Kushimoto	Japan	33-28N	135-47E	1961-2002	97	Japan Meteor. Agency
082	Aburatsu	Japan	31-34N	131-25E	1961-2002	100	Japan Meteor. Agency
081	Naha	Japan	26-13N	127-40E	1966-2002	100	Japan Meteor. Agency
xxx	Maisaka	Japan	34-41N	137-37E	1968-2002	96	Japan Meteor. Agency
xxx	Miyakejima	Japan	34-04N	139-29E	1965-2001	99	Japan Ocean. Data Cen.
xxx	Hosojima	Japan	32-25N	131-41E	1933-1975	86	Japan Ocean. Data Cen.
xxx	Naze	Japan	28-23N	129-30E	1961-2003	94	Japan Ocean. Data Cen.
324	Wakkanai	Japan	45-25N	141-41E	1967-2002	99	Japan Meteor. Agency
083	Nagasaki	Japan	32-44N	129-52E	1985-2002	100	Japan Meteor. Agency
xxx	Nishinoomote	Japan	30-44N	130-60E	1965-2003	98	Japan Meteor. Agency
088	Hakodate	Japan	41-47N	140-44E	1964-2002	93	Japan Meteor. Agency
xxx	Ishigaki	Japan	24-20N	124-09E	1969-2002	100	Japan Meteor. Agency
073	Manila	Philippines	14-35N	120-58E	1984-2002	96	Ocean. Surveys Div.

072	Legaspi	Philippines	13-09N	123-45E	1984-2002	91	Ocean. Surveys Div.
071	Davao	Philippines	07-05N	125-38E	1984-1997	81	Ocean. Surveys Div.
070	Jolo	Philippines	06-04N	121-00E	1984-1995	86	Ocean. Surveys Div.
xxx	Hachinohe	Japan	40-32N	141-32E	1980-2002	100	Japan Meteor. Agency
247	Xiamen	China	24-27N	118-04E	1954-1997	100	PRC NODC
xxx	Cebu	Philippines	10-18N	123-55E	1998-2002	93	Ocean. Surveys Div.
xxx	Puerto Princesa	Philippines	09-45N	118-44E	1998-2002	84	Ocean. Surveys Div.
xxx	Tawau	Malaysia	04-14N	117-53E	1987-2002	94	Dept. Survey/Mapping
xxx	Kota Kinabalu	Malaysia	05-59N	116-04E	1987-2002	92	Dept. Survey/Mapping
xxx	Bintulu	Malaysia	03-13N	113-04E	1992-2002	85	Dept. Survey/Mapping
xxx	Miri	Malaysia	04-24N	113-58E	1992-1998	91	Dept. Survey/Mapping
xxx	Sandakan	Malaysia	05-49N	118-04E	1993-2002	96	Dept. Survey/Mapping
165	Clipperton-A	France	10-17N	109-13W	1985-1985	47	NOAA/PMEL
165	Clipperton-B	France	10-17N	109-13W	1986-1988	100	NOAA/PMEL
xxx	Puerto Vallarta	Mexico	20-37N	105-15W	1973-1991	40	UNAM
xxx	Salina Cruz	Mexico	16-10N	095-12W	1952-1991	81	UNAM
163	Manzanillo-A	Mexico	19-03N	104-20W	1953-1982	95	UNAM
163	Manzanillo-B	Mexico	19-03N	104-20W	1992-2001	74	National Ocean Service
xxx	Puntarenas	Costa Rica	09-58N	084-50W	1970-1980	71	SERMAR
xxx	Guaymas	Mexico	27-56N	110-54W	1953-1986	81	UNAM
xxx	Marsden Point	New Zealand	35-50S	174-30E	1984-1985	99	Royal New Zealand Navy
148	Lord Howe-A	Australia	31-31S	159-04E	1958-1967	80	Scripps Inst. Ocean.
148	Lord Howe-B	Australia	31-31S	159-04E	1991-1994	99	Nat. Tidal Facility
xxx	Lombrum	Papua New Guinea	02-02S	147-23E	1994-2003	90	Nat. Tidal Facility
xxx	Apia-A	Western Samoa	13-49S	171-45W	1954-1971	88	Scripps Inst. Ocean.
xxx	Apia-B	Western Samoa	13-49S	171-45W	1993-2003	98	Nat. Tidal Facility
xxx	Lautoka	Fiji	17-36S	177-26E	1992-2003	99	Nat. Tidal Facility
xxx	Lungsurannaga	Indonesia	02-06N	117-45E	1943-1944	95	Japan Ocean. Data Cen.
xxx	Balikpapan	Indonesia	01-16S	116-48E	1942-1943	100	Japan Ocean. Data Cen.
xxx	Bajor	Indonesia	00-41S	117-25E	1943-1944	97	Japan Ocean. Data Cen.
155	Prince Rupert-A	Canada	54-19N	130-20W	1910-1918	79	MEDS
155	Prince Rupert-B	Canada	54-19N	130-20W	1963-1999	99	MEDS
156	Tofino	Canada	49-09N	125-55W	1963-1999	94	MEDS
xxx	Victoria,BC	Canada	48-25N	123-22W	1909-1964	98	MEDS

303	Massacre Bay,AK	USA	52-50N	173-12E	1943-1966	88	National Ocean Service
158	San Francisco,CA	USA	37-48N	122-28W	1901-2003	100	National Ocean Service
xxx	Kawaihae,HI	USA	20-02N	155-50W	1989-2003	87	National Ocean Service
xxx	Port Allen,HI	USA	21-54N	159-36W	1989-1997	98	National Ocean Service
xxx	Monterey,CA	USA	36-36N	121-53W	1973-2003	99	National Ocean Service
xxx	Crescent City,CA	USA	41-45N	124-11W	1933-2003	90	National Ocean Service
xxx	Port Orford,OR	USA	42-44N	124-30W	1996-2003	59	National Ocean Service
xxx	Neah Bay,WA	USA	48-22N	124-37W	1934-2003	97	National Ocean Service
154	Sitka-A,AK	USA	57-03N	135-21W	1950-2003	92	National Ocean Service
150	Seward-A,AK	USA	60-07N	149-26W	1925-1932	98	National Ocean Service
150	Seward-B,AK	USA	60-07N	149-26W	1944-1949	77	National Ocean Service
150	Seward-C,AK	USA	60-07N	149-26W	1967-2003	86	National Ocean Service
xxx	Seldovia,AK	USA	59-26N	151-43W	1979-2003	100	National Ocean Service
xxx	Valdez,AK	USA	61-08N	146-22W	1996-2003	100	National Ocean Service
xxx	Willapa Bay,WA	USA	46-43N	123-58W	1996-2003	100	National Ocean Service
xxx	Port San Luis,CA	USA	35-11N	120-46W	1983-2003	85	National Ocean Service
xxx	Los Angeles,CA	USA	33-43N	118-16W	1923-2001	99	National Ocean Service
159	San Diego,CA	USA	32-43N	117-10W	1906-2003	97	National Ocean Service
xxx	Yakutat,AK	USA	59-33N	139-44W	1961-2003	91	National Ocean Service
xxx	Ketchikan,AK	USA	55-20N	131-38W	1918-2003	73	National Ocean Service
xxx	Astoria,OR	USA	46-13N	123-46W	1925-2003	97	National Ocean Service
xxx	Arena Cove,CA	USA	38-55N	123-43W	1996-2003	100	National Ocean Service
100	Sand Point,AK	USA	55-20N	160-30W	1996-2001	100	National Ocean Service
xxx	Charleston,OR	USA	43-21N	124-19W	1978-2003	98	National Ocean Service
xxx	Humboldt Bay,CA	USA	40-46N	124-13W	1993-2003	100	National Ocean Service
xxx	Santa Barbara,CA	USA	34-25N	119-41W	1996-1998	98	National Ocean Service
xxx	Santa Monica,CA	USA	34-01N	118-30W	1996-2003	96	National Ocean Service
151	Prudhoe Bay,AK	USA	70-24N	148-32W	1993-2003	100	National Ocean Service
xxx	Cordova-A,AK	USA	60-34N	145-45W	1949-1953	94	National Ocean Service
xxx	Cordova-B,AK	USA	60-34N	145-45W	1964-2003	84	National Ocean Service

xxx	Matavai	French Polynesia	17-31S	149-31W	1958-1967	65	Scripps Inst. Ocean.
157	South Beach,OR	USA	44-38N	124-03W	1967-2003	99	National Ocean Service
xxx	Harvest Oil P.,CA	USA	34-28N	120-40W	1995-1999	20	National Ocean Service
074	Nome, AK	USA	64-30N	165-26W	1992-2001	68	National Ocean Service
180	Diego Ramirez	Chile	56-31S	068-43W	1991-1997	95	SHOA
079	Dalian-A	China	38-56N	121-40E	1975-1990	98	PRC NODC
079	Laohutan-A	China	38-52N	121-41E	1991-1997	100	PRC NODC
094	Kanmen-A	China	28-05N	121-17E	1975-1997	100	PRC NODC
283	Lusi-A	China	32-08N	121-37E	1975-1996	98	PRC NODC
078	Zhapo-A	China	21-35N	111-50E	1975-1997	100	PRC NODC
xxx	Beihai	China	21-29N	109-05E	1975-1997	100	PRC NODC
xxx	Dongfang	China	19-06N	108-37E	1975-1997	100	PRC NODC
xxx	Haikou	China	20-01N	110-17E	1976-1997	100	PRC NODC
xxx	Lianyungang	China	34-45N	119-25E	1975-1997	100	PRC NODC
xxx	Shanwei	China	22-45N	115-21E	1975-1997	98	PRC NODC
xxx	Shijiusuo	China	35-23N	119-33E	1975-1997	100	PRC NODC
xxx	Hon Dau-A	Vietnam	20-40N	106-49E	1960-1960	100	Mar. Hydromet. Center
xxx	Hon Dau-B	Vietnam	20-40N	106-49E	1995-1995	75	TEDIPORT
xxx	Vung Ang	Vietnam	18-05N	106-17E	1996-1997	100	TEDIPORT
xxx	Vung Tau	Vietnam	10-20N	107-04E	1992-1992	100	TEDIPORT
xxx	Champerico	Guatemala	14-18N	091-55W	1974-1975	98	Oregon State Univerity
xxx	La Paz	Mexico	24-10N	110-21W	1952-1983	71	UNAM
xxx	Puerto Angel	Mexico	15-39N	096-30W	1962-1984	74	UNAM
xxx	Mazatlan	Mexico	23-12N	106-25W	1953-1975	97	UNAM
xxx	San Carlos	Mexico	24-47N	112-07W	1968-1983	51	UNAM
xxx	San Jose	Guatemala	13-55N	090-50W	1955-1975	93	Oregon State Univerity
xxx	Topolobampo	Mexico	25-36N	109-03W	1956-1974	94	UNAM
xxx	Yavaros	Mexico	26-42N	109-31W	1970-1973	85	UNAM
xxx	Paita-A	Peru	05-05S	081-10W	1981-1984	100	National Ocean Service
xxx	Paita-B	Peru	05-05S	081-10W	1988-2001	90	DHNM
xxx	Corinto	Nicaragua	12-17N	087-07W	1967-1967	99	National Ocean Service
xxx	San Martin-A	Argentina	68-08S	067-06W	1995-1995	8	Alfred Wegener Inst.
xxx	San Martin-B	Argentina	68-08S	067-06W	1998-1998	5	Alfred Wegener Inst.
xxx	San Martin-C	Argentina	68-08S	067-06W	1998-1999	100	Alfred Wegener Inst.

xxx	Dallmann-A	Argentina	62-14S	058-41W	1996-1997	99	Alfred Wegener Inst.
xxx	Dallmann-B	Argentina	62-14S	058-41W	1997-1997	69	Alfred Wegener Inst.
xxx	Dallmann-C	Argentina	62-14S	058-41W	1998-1999	100	Alfred Wegener Inst.
xxx	Pisco-A	Peru	13-25S	076-08W	1985-1990	67	DHNM
xxx	Pisco-B	Peru	13-25S	076-08W	1991-2001	82	DHNM
178	Puerto Montt	Chile	41-29S	072-58W	1980-2002	93	SHOA
xxx	Tinian	N. Mariana Is.	14-58N	145-37E	1991-1997	93	USGS
044	Tanjong Pagar	Singapore	01-16N	103-51E	1988-2001	93	Port Singapore Auth.

GENERAL INFORMATION FOR DESIRED STATIONS: Indian Ocean

Series: 71
Site-years: 737

column notes:
CI: Completeness index or percentage of data span without missing data.
QC-YEARS: years which have received quality control.

GLOS	STATION	COUNTRY	LAT	LONG	QC-YEARS	CI	CONTRIBUTOR
008	Mombasa	Kenya	04-04S	039-39E	1986-2001	78	UH Sea Level Center
xxx	Dar Es Salaam	Tanzania	06-49S	039-17E	1986-1990	87	UH Sea Level Center
018	Port Louis-A	Mauritius	20-09S	057-29E	1942-1947	90	Inst. Ocean. Sciences
018	Port Louis-B	Mauritius	20-09S	057-29E	1964-1965	86	Inst. Ocean. Sciences
018	Port Louis-C	Mauritius	20-09S	057-30E	1986-2001	99	UH Sea Level Center
026	Diego Garcia-B	United Kingdom	07-14S	072-26E	1969-1969	41	Scripps Inst. Ocean.
026	Diego Garcia-C	United Kingdom	07-17S	072-24E	1988-2000	80	UH Sea Level Center
019	Rodrigues	Mauritius	19-40S	063-25E	1986-2001	96	UH Sea Level Center
xxx	Praslin	Seychelles	04-21S	055-46E	1987-1989	89	UH Sea Level Center
045	Padang	Indonesia	01-00S	100-22E	1986-1990	86	BAKOSURTANAL
028	Male-A	Rep. of Maldives	04-11N	073-31E	1988-1989	100	Lanka Hydraulic Inst.
028	Male-B,Hulule	Rep. of Maldives	04-11N	073-32E	1989-2001	90	UH Sea Level Center
027	Gan	Rep. of Maldives	00-41S	073-09E	1987-2001	87	UH Sea Level Center

xxx	Muscat	Oman	23-38N	058-34E	1987-1993	77	UH Sea Level Center
273	Port Victoria-A	Seychelles	04-37S	055-28E	1977-1982	84	Inst. Ocean. Sciences
273	Port Victoria-B	Seychelles	04-37S	055-28E	1986-1992	96	UH Sea Level Center
xxx	Masirah	Oman	20-41N	058-52E	1996-2003	94	UH Sea Level Center
004	Salalah	Oman	16-56N	054-00E	1989-2003	87	UH Sea Level Center
033	Colombo-A	Sri Lanka	06-56N	079-51E	1953-1965	94	Nat. Aquatic Resources
033	Colombo-B	Sri Lanka	06-57N	079-51E	1989-1992	96	UH Sea Level Center
xxx	Hanimaadhoo	Rep. of Maldives	06-46N	073-10E	1991-2002	98	UH Sea Level Center
273	Pt. La Rue	Seychelles	04-40S	055-32E	1993-2001	98	UH Sea Level Center
xxx	Hiron Point	Bangladesh	21-47N	089-28E	1977-2000	99	BIWTA
xxx	Khal #10	Bangladesh	22-16N	091-49E	1983-1992	62	BIWTA
xxx	Cox's Bazaar	Bangladesh	21-27N	091-50E	1983-2000	98	BIWTA
xxx	Teknaf	Bangladesh	20-53N	092-18E	1983-1988	59	BIWTA
036	Charchanga	Bangladesh	22-13N	091-03E	1980-2000	97	BIWTA
xxx	Khepupara	Bangladesh	21-50N	089-50E	1987-2000	96	BIWTA
xxx	Kelang	Malaysia	03-03N	101-22E	1983-2002	99	Dept. Survey/Mapping
xxx	Keling	Malaysia	02-13N	102-09E	1984-2002	99	Dept. Survey/Mapping
xxx	Langkawi	Malaysia	06-26N	099-46E	1985-2002	99	Dept. Survey/Mapping
043	Lumut	Malaysia	04-14N	100-37E	1984-2002	97	Dept. Survey/Mapping
xxx	Penang	Malaysia	05-25N	100-21E	1984-2002	97	Dept. Survey/Mapping
030	Karachi	Pakistan	24-48N	066-58E	1985-1994	83	Nat. Inst. of Ocean.
042	Ko Taphao Noi	Thailand	07-50N	098-26E	1985-2002	97	Naval Hydro. Dept.
xxx	Lamu-A	Kenya	02-16S	040-54E	1989-1989	68	Kenya Marine Fisheries
xxx	Lamu-B	Kenya	02-16S	040-54E	1995-2003	100	UH Sea Level Center
015	Nosy Be	Madagascar	13-24S	048-18E	1987-1998	54	CNRO
297	Zanzibar	Tanzania	06-09S	039-11E	1984-2001	99	UH Sea Level Center
096	Dzaoudzi	Mayotte	12-47S	045-15E	1985-1995	67	SHOM
xxx	Meneng	Indonesia	08-07S	114-23E	1987-1989	94	Center for Ocean. Res.
xxx	Pari	Indonesia	05-51S	106-37E	1987-1990	84	Center for Ocean. Res.
292	Surabaya	Indonesia	07-13S	112-44E	1988-1990	93	BAKOSURTANAL
xxx	Jakarta	Indonesia	06-06S	106-53E	1984-1985	100	BAKOSURTANAL
049	Benoa	Indonesia	08-45S	115-13E	1988-1990	97	BAKOSURTANAL
017	Reunion	France	20-55S	055-18E	1982-1986	93	SHOM
xxx	Wyndham	Australia	15-27S	128-06E	1984-1999	97	Nat. Tidal Facility
040	Broome	Australia	18-00S	122-13E	1986-1999	78	Nat. Tidal Facility

052	Carnarvon	Australia	24-54S	113-39E	1984-1999	75	Nat. Tidal Facility
062	Darwin	Australia	12-28S	130-51E	1984-2003	97	Nat. Tidal Facility
051	Port Hedland	Australia	20-19S	118-34E	1984-1999	97	Nat. Tidal Facility
047	Christmas	Australia	10-25S	105-40E	1986-1993	52	CSIRO
046	Cocos	Australia	12-07S	096-53E	1985-2003	94	Nat. Tidal Facility
053	Fremantle	Australia	32-03S	115-43E	1984-1999	99	Nat. Tidal Facility
054	Esperance	Australia	33-52S	121-54E	1985-2003	97	Nat. Tidal Facility
021	Crozet	France	46-26S	051-52E	1995-2000	47	Inst. Mech. Grenoble
024	Saint Paul	France	38-43S	077-32E	1994-2000	87	Inst. Mech. Grenoble
023	Kerguelen	France	49-21S	070-13E	1993-1998	99	Inst. Mech. Grenoble
013	Durban	South Africa	29-53S	031-02E	1970-1996	82	Dir. of Hydrography
xxx	Mina Sulman	Bahrain	26-14N	050-36E	1979-1997	88	Survey Directorate
076	Port Elizabeth	South Africa	33-58S	025-38E	1985-1996	78	Dir. of Hydrography
xxx	Mossel Bay	South Africa	34-11S	022-08E	1991-1996	91	Dir. of Hydrography
xxx	East London	South Africa	33-01S	027-55E	1991-1996	68	Dir. of Hydrography
xxx	Richard's Bay	South Africa	28-48S	032-05E	1991-1996	47	Dir. of Hydrography
xxx	Maputo-A	Mozambique	26-10S	032-42E	1974-1974	100	Inst. Hidro. Marinha
xxx	Maputo-B	Mozambique	25-59S	032-34E	1981-1986	49	INAHINA
xxx	Antonio Enes	Mozambique	16-14S	039-54E	1967-1967	31	Inst. Hidro. Marinha
011	Pemba-A	Mozambique	12-58S	040-30E	1971-1973	25	Inst. Hidro. Marinha
011	Pemba-B	Mozambique	12-58S	040-29E	1982-1984	64	INAHINA
xxx	Nacala-A	Mozambique	14-28S	040-41E	1975-1975	18	Inst. Hidro. Marinha
xxx	Nacala-B	Mozambique	14-28S	040-41E	1982-1983	100	Inst. Hidro. Marinha

GENERAL INFORMATION FOR DESIRED STATIONS: Atlantic Ocean

Series: 171
Site-years: 3312

column notes:
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QC-YEARS: years which have received quality control.

GLOS	STATION	COUNTRY	LAT	LONG	QC-YEARS	CI	CONTRIBUTOR
199	St. Peter&Paul R.	Brazil	00-55N	029-21W	1982-1985	99	ORSTOM
197	Natal-A	Brazil	05-45S	035-12W	1982-1983	100	ORSTOM

197	Natal-B	Brazil	05-45S	035-12W	1983-1984	99	ORSTOM
197	Natal-C	Brazil	05-45S	035-12W	1984-1985	100	ORSTOM
198	Fer. de Nor.-A	Brazil	03-50S	032-24W	1982-1983	100	ORSTOM
198	Fer. de Nor.-B	Brazil	03-50S	032-24W	1984-1985	100	ORSTOM
198	Fer. de Nor.-C	Brazil	03-50S	032-24W	1985-1986	100	LPAO/INPE
265	Trindade	Brazil	20-30S	029-19W	1983-1983	16	ORSTOM
xxx	Arrecife-A	Spain	28-57N	013-34W	1959-1973	98	Inst. Espanol Ocean.
xxx	Arrecife-B	Spain	28-57N	013-34W	1973-1985	69	Inst. Espanol Ocean.
xxx	Arrecife-D	Spain	28-57N	013-34W	1987-1991	90	Inst. Espanol Ocean.
xxx	S.Cruz Palma-A	Spain	28-41N	017-45W	1949-1959	100	Inst. Espanol Ocean.
xxx	S.Cruz Palma-B	Spain	28-41N	017-45W	1959-1981	93	Inst. Espanol Ocean.
xxx	S.Cruz Palma-D	Spain	28-41N	017-45W	1989-1990	93	Inst. Espanol Ocean.
249	Ceuta-A	Spain	35-54N	005-19W	1971-1974	98	Inst. Espanol Ocean.
249	Ceuta-B	Spain	35-54N	005-19W	1975-1977	97	Inst. Espanol Ocean.
249	Ceuta-C	Spain	35-54N	005-19W	1978-1980	92	Inst. Espanol Ocean.
249	Ceuta-D	Spain	35-54N	005-19W	1980-1991	90	Inst. Espanol Ocean.
xxx	Vigo	Spain	42-14N	008-44W	1943-1990	100	Inst. Espanol Ocean.
246	Cascais	Portugal	38-42N	009-25W	1960-1991	85	Inst. Hidro. Marinha
244	Flores-A,Azores	Portugal	39-27N	031-07W	1976-1977	100	Inst. Hidro. Marinha
244	Flores-B,Azores	Portugal	39-27N	031-07W	1984-1994	63	Inst. Hidro. Marinha
245	Ponta Delgada-A	Portugal	37-44N	025-40W	1978-1991	68	Inst. Hidro. Marinha
245	Ponta Delgada-B	Portugal	37-44N	025-40W	1998-2001	98	UH Sea Level Center
xxx	Horta,Azores	Portugal	38-32N	028-37W	1984-1986	87	Inst. Hidro. Marinha
xxx	Angra Heroismo-A	Portugal	38-39N	027-14W	1957-1962	100	Inst. Hidro. Marinha
xxx	Angra Heroismo-B	Portugal	38-39N	027-14W	1976-1983	94	Inst. Hidro. Marinha
254	Porto Grande	Portugal	16-52N	024-59W	1990-1993	38	Inst. Hidro. Marinha
251	Las Palmas-A	Spain	28-06N	015-24W	1949-1956	95	Inst. Espanol Ocean.
251	Las Palmas-B	Spain	28-06N	015-24W	1971-1982	88	Inst. Espanol Ocean.
251	Las Palmas-C	Spain	28-06N	015-24W	1983-1991	73	Inst. Espanol Ocean.
251	Las Palmas-D	Spain	28-09N	015-24W	1992-1999	97	Puertos del Estado

250	Funchal-B	Portugal	32-38N	016-54W	1976-1994	59	Inst. Hidro. Marinha
267	Walvis Bay	Namibia	22-57S	014-30E	1959-1993	67	Dir. of Hydrography
268	Simon's Bay	South Africa	34-11S	018-26E	1958-1996	93	Dir. of Hydrography
xxx	Praia-A	Cape Verde	14-55N	023-30W	1984-1985	100	ORSTOM
xxx	Praia-C	Cape Verde	14-55N	023-31W	1995-1996	64	National Ocean Service
253	Dakar-A	Senegal	14-40N	017-26W	1982-1983	100	ORSTOM
253	Dakar-B	Senegal	14-40N	017-26W	1983-1985	100	ORSTOM
253	Dakar-C	Senegal	14-40N	017-26W	1986-1986	44	ORSTOM
253	Dakar-D	Senegal	14-40N	017-26W	1986-1989	94	ORSTOM
253	Dakar-E	Senegal	14-41N	017-25W	1996-2001	92	UH Sea Level Center
260	Sao Tome	Sao Tome/Principe	00-01N	006-31E	1985-1988	58	ORSTOM
xxx	Tenerife	Spain	28-29N	016-14W	1992-1999	92	Puertos del Estado
xxx	Belem	Brazil	01-27S	048-30W	1955-1968	96	National Ocean Service
257	Abidjan-Vridi	Ivory Coast	05-15N	004-00W	1982-1988	100	ORSTOM
xxx	Takoradi	Ghana	04-53N	001-45W	1983-1986	100	ORSTOM
259	Lagos-A	Nigeria	06-25N	003-27E	1961-1969	63	POL
259	Lagos-C	Nigeria	06-25N	003-25E	1992-1996	74	NIOMR
261	Pointe Noire	Congo	04-48S	011-51E	1980-1988	77	ORSTOM
xxx	Palmeira,C.Verde	Portugal	16-45N	022-59W	2000-2001	68	UH Sea Level Center
xxx	Luanda	Angola	08-47S	013-14E	1972-1975	100	Inst. Hidro. Marinha
262	Lobito	Angola	12-20S	013-34E	1971-1975	88	Inst. Hidro. Marinha
xxx	Mocamedes	Angola	15-12S	012-09E	1971-1975	98	Inst. Hidro. Marinha
xxx	Fernandina Beach	USA	30-40N	081-28W	1985-2003	91	National Ocean Service
218	Miami	USA	25-54N	080-07W	1985-1992	96	National Ocean Service
216	Key West	USA	24-33N	081-49W	1913-2003	97	National Ocean Service
276	Gibara	Cuba	21-07N	076-07W	1985-1992	100	Inst. Cubano De Hidro.
206	San Juan	USA	18-28N	066-07W	1985-2003	94	National Ocean Service
xxx	Magueyes Island	USA	17-58N	067-03W	1985-2003	97	National Ocean Service
xxx	La Guaira	Venezuela	10-37N	066-56W	1985-1994	97	Inst. Ocean. Venezuela
203	Port-of-Spain	Trinidad/Tobago	10-39N	061-31W	1984-1992	81	Trin/Tob. Hydro. Unit
xxx	Bridgetown-A	Barbados	13-06N	059-37W	1968-1970	98	National Ocean Service

xxx	Bridgetown-B	Barbados	13-06N	059-37W	1990-1991	92	Gov. of Barbados
xxx	Bridgetown-C	Barbados	13-06N	059-37W	1993-1996	45	Gov. of Barbados
212	Veracruz	Mexico	19-12N	096-08W	1985-1995	99	UNAM
xxx	Guantanamo Bay-A	Cuba	19-54N	075-09W	1937-1948	81	National Ocean Service
xxx	Guantanamo Bay-B	Cuba	19-54N	075-09W	1995-1997	89	National Ocean Service
xxx	Portland,ME	USA	43-39N	070-15W	1910-2003	97	National Ocean Service
290	Newport,RI	USA	41-30N	071-20W	1930-2003	95	National Ocean Service
xxx	Limetree Bay	USA	17-42N	064-45W	1982-2003	89	National Ocean Service
xxx	Charlotte Amalie	USA	18-20N	064-55W	1978-2003	87	National Ocean Service
012	Exuma Cays	Bahamas	23-46N	076-06W	1992-1993	99	HBOI
211	Settlement Pnt.-A	Bahamas	26-43N	078-60W	1985-2002	91	National Ocean Service
211	Settlement Pnt.-B	Bahamas	26-41N	078-59W	1985-2003	78	National Ocean Service
221	Bermuda	United Kingdom	32-22N	064-42W	1985-2003	78	National Ocean Service
219	Duck Pier,NC	USA	36-11N	075-45W	1978-2003	99	National Ocean Service
xxx	Charleston,SC	USA	32-47N	079-56W	1921-2003	98	National Ocean Service
xxx	St. Augustine,FL	USA	29-51N	081-16W	1978-2002	42	National Ocean Service
220	Atlantic City,NJ	USA	39-21N	074-25W	1911-2003	94	National Ocean Service
207	Cartagena-A	Colombia	10-23N	075-32W	1951-1993	90	IDEAM
207	Cartagena-B	Colombia	10-23N	075-32W	1993-2000	81	IDEAM
208	Cristobal	Panama	09-21N	079-55W	1907-1997	96	Panama Canal Commission
xxx	Limon	Costa Rica	10-00N	083-02W	1970-1981	66	SERMAR
xxx	Cochino Pequeno	Honduras	15-57N	086-30W	1995-1996	100	National Ocean Service
204	Le Robert	France	14-41N	060-56W	1976-1984	61	SHOM
xxx	Fort de France	France	14-35N	061-03W	1976-1985	37	SHOM
xxx	Pointe-a-Pitre	France	16-14N	061-32W	1991-1998	96	Meteo-France
xxx	Churchill	Canada	58-47N	094-12W	1961-2000	90	MEDS
222	Halifax	Canada	44-40N	063-35W	1920-2000	99	MEDS
223	St. John's-A	Canada	47-34N	052-42W	1961-1993	96	MEDS
223	St. John's-B	Canada	47-34N	052-42W	1993-2000	97	MEDS
xxx	Montauk	USA	41-03N	071-58W	1959-2003	90	National Ocean Service
195	Rio de Janeiro	Brazil	22-54S	043-10W	1963-2003	94	Dir. Hidro. e Navegacao
194	Cananeia	Brazil	25-01S	047-56W	1954-2000	100	Inst. Ocean. USP
xxx	Fortaleza-A	Brazil	03-43S	038-29W	1955-1968	95	National Ocean Service
xxx	Fortaleza-B	Brazil	03-43S	038-28W	1995-1998	100	LPAO/INPE
xxx	Termisa	Brazil	04-49S	037-03W	1993-1995	97	LPAO/INPE

xxx	Buenos Aires	Argentina	34-40S	058-30W	1905-1961	100	Ser. Hidro. Naval
180	Puerto Williams	Chile	54-56S	067-37W	1985-1998	88	SHOA
305	Port Stanley-A	United Kingdom	52-42S	057-52W	1964-1974	47	POL
305	Port Stanley-B	United Kingdom	51-45S	057-56W	1992-2003	90	POL
263	Ascension	United Kingdom	07-55S	014-25W	1993-2001	89	POL
264	St. Helena	United Kingdom	15-55S	005-43W	1993-2001	90	POL
236	Lerwick	United Kingdom	60-09N	001-08W	1959-2001	99	POL
241	Newlyn	United Kingdom	50-06N	005-33W	1915-2001	99	POL
238	Stornoway	United Kingdom	58-13N	006-23W	1976-2001	80	POL
xxx	Sisimiut	Denmark	66-56N	053-40W	1991-1995	93	Danish Navig./Hydro.
228	Ammassalik	Denmark	65-36N	037-00W	1990-1995	81	Danish Navig./Hydro.
xxx	Ilulissat	Denmark	69-13N	051-06W	1992-1995	90	Danish Navig./Hydro.
xxx	Qaqortoq	Denmark	60-43N	046-02W	1991-1995	99	Danish Navig./Hydro.
181	Ushuaia	Argentina	54-48S	068-18W	1996-2001	80	National Ocean Service
185	Esperanza	Argentina	63-24S	056-60W	1996-1998	86	National Ocean Service
188	Faraday	United Kingdom	65-15S	064-16W	1984-1999	98	POL
xxx	Port Nolloth	South Africa	29-15S	016-52E	1991-1994	49	Dir. of Hydrography
xxx	Luderitz	South Africa	26-39S	015-09E	1991-1996	34	Dir. of Hydrography
xxx	Saldahna Bay	South Africa	33-01S	018-58E	1991-1996	81	Dir. of Hydrography
xxx	Granger Bay	South Africa	33-54S	018-25E	1991-1996	55	Dir. of Hydrography
153	L. Cornwallis I.	Canada	75-23N	096-57W	1986-1994	100	MEDS
xxx	Canavieiras	Brazil	15-40S	038-58W	1956-1961	95	National Ocean Service
xxx	Salvador	Brazil	12-58S	038-31W	1955-1964	92	National Ocean Service
195	R.Janeiro,USCGS	Brazil	22-56S	043-08W	1955-1968	70	National Ocean Service
xxx	Suape	Brazil	08-21S	034-57W	1982-1984	98	LPAO/INPE
xxx	Luis Corriea	Brazil	02-52S	041-40W	1984-1985	100	LPAO/INPE
xxx	Recife,USCGS	Brazil	08-03S	034-52W	1955-1968	86	National Ocean Service
193	Porto Rio Grande	Brazil	32-08S	052-06W	1981-2003	22	Dir. Hidro. e Navegacao
200	Madeira	Brazil	02-34S	044-23W	1988-2003	81	Dir. Hidro. e Navegacao
201	Santana-A	Brazil	00-03S	051-11W	1970-1972	100	Dir. Hidro. e Navegacao
201	Santana-B	Brazil	00-03S	051-11W	1975-1976	100	Dir. Hidro. e Navegacao
201	Santana-C	Brazil	00-03S	051-11W	1984-1985	100	Dir. Hidro. e Navegacao
201	Santana-D	Brazil	00-03S	051-11W	1996-1997	100	Dir. Hidro. e Navegacao
201	Santana SSN-A	Brazil	00-04S	051-10W	1994-1995	99	Dir. Hidro. e Navegacao
201	Santana SSN-A	Brazil	00-04S	051-10W	1999-2000	99	Dir. Hidro. e Navegacao

xxx	Nassau	Bahamas	25-05N	077-21W	1904-1905	100	National Ocean Service
xxx	Point Fortin	Trinidad/Tobago	10-06N	061-25W	1987-1996	61	Trin/Tob. Hydro. Unit
189	Base Prat	Chile	62-29S	059-38W	1984-2002	96	SHOA
xxx	Eastport,ME	USA	44-54N	066-59W	1929-2003	93	National Ocean Service
xxx	Boston,MA	USA	42-21N	071-03W	1921-2003	99	National Ocean Service
xxx	Woods Hole,MA	USA	41-31N	070-40W	1957-2003	89	National Ocean Service
xxx	Nantucket,MA	USA	41-17N	070-06W	1965-2003	95	National Ocean Service
xxx	New London,CT	USA	41-21N	072-05W	1957-2003	93	National Ocean Service
xxx	New York,NY	USA	40-42N	074-01W	1958-2003	85	National Ocean Service
xxx	Cape May,NJ	USA	38-58N	074-58W	1965-2003	87	National Ocean Service
xxx	Lewes,DE	USA	38-47N	075-07W	1957-2003	96	National Ocean Service
xxx	Chesapeake BBT,VA	USA	36-58N	076-07W	1975-2003	99	National Ocean Service
xxx	Wilmington,NC	USA	34-14N	077-57W	1935-2003	98	National Ocean Service
289	Fort Pulaski,GA	USA	32-02N	080-54W	1935-2003	95	National Ocean Service
xxx	Mayport,FL	USA	30-24N	081-26W	1928-2000	99	National Ocean Service
xxx	Cocoa Beach,FL	USA	28-22N	080-36W	1994-1996	98	National Ocean Service
xxx	Virginia Key,FL	USA	25-44N	080-10W	1996-2003	99	National Ocean Service
xxx	Naples,FL	USA	26-08N	081-48W	1996-2003	96	National Ocean Service
xxx	St. Petersburg,FL	USA	27-46N	082-38W	1946-2003	96	National Ocean Service
xxx	Apalachicola,FL	USA	29-44N	084-59W	1996-2003	98	National Ocean Service
xxx	Panama City Bh,FL	USA	30-13N	085-53W	1993-2001	96	National Ocean Service
288	Pensacola,FL	USA	30-24N	087-13W	1923-2003	97	National Ocean Service
xxx	Dauphin Island AL	USA	30-15N	088-05W	1996-2003	47	National Ocean Service
xxx	South Pass,LA	USA	28-59N	089-08W	1993-1999	90	National Ocean Service
xxx	Grand Isle,LA	USA	29-16N	089-57W	1980-2003	99	National Ocean Service
xxx	Sabine Pass N, TX	USA	29-44N	093-52W	1992-2003	99	National Ocean Service
xxx	Galveston,P.Pier	USA	29-17N	094-47W	1957-2003	96	National Ocean Service
xxx	Rockport,TX	USA	28-01N	097-03W	1987-2003	99	National Ocean Service
xxx	Corpus Cristi,TX	USA	27-35N	097-13W	1992-1999	100	National Ocean Service
xxx	Port Isabel,TX	USA	26-04N	097-13W	1977-2003	96	National Ocean Service
xxx	Clearwater Bch,FL	USA	27-59N	082-50W	1996-2003	96	National Ocean Service

xxx	Port Canaveral,FL	USA	28-25N	080-36W	1994-2003	98
National Ocean Service						
217	Galveston,Pier21	USA	29-19N	094-48W	1904-2001	96
National Ocean Service						
xxx	Puerto Cortes	Honduras	15-50N	087-57W	1948-1968	99
National Ocean Service						
xxx	Belize	British Honduras	17-30N	088-11W	1964-1967	84
National Ocean Service						
210	Port Royal	Jamaica	17-56N	076-51W	1965-1971	99
National Ocean Service						
xxx	Fajardo,PR	USA	18-20N	065-38W	1921-1923	95
National Ocean Service						
xxx	Puerto Castilla	Honduras	16-01N	086-02W	1955-1967	78
National Ocean Service						