# U.S. National Report

## Contributions to the Global Sea Level Observing System

University of Hawai`i Sea Level Center

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## I. Introduction

The 2009 United States (U.S.) National Report to the Global Sea Level Observing System (GLOSS) Group of Experts (GE) XI is a summary of various ongoing U.S. programs and activities that support GLOSS goals and objectives as outlined in the GLOSS Implementation Plan. While programs and activities addressing sea level in the U.S. extend from federal to academic, this report focuses on four primary U.S. contributions to GLOSS:

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

The first section of the report provides an overview of the U.S. contribution to GLOSS through NOAA's Office of Climate Observations; the second section provides updates on operating status of the various components of the system. The third section provides updates on product development and delivery of data, including database support and web products, followed by the fourth section providing information on advancements in technology. Finally, the fifth section discusses regional activities in support of GLOSS.

The U.S. continues to be a leader and primary contributor to the international climate and sea level community. Vital to this continued support are international partnerships, innovative technological solutions, and sustained infrastructure for observing systems. The U.S. looks forward to continuing and enhancing collaborative sea level efforts with the international community.

### NOAA Office of Climate Observations

The Global Climate Observing System (GCOS) is intended to be a long-term, user-driven operational system capable of providing the comprehensive observations required for:

- Monitoring the climate system,
- Detecting and attributing climate change,
- Assessing impacts of, and supporting adaptation to, climate variability and change,
- Application to national economic development,
- Research to improve understanding, modeling and prediction of the climate system.

GCOS addresses the total climate system including physical, chemical and biological properties, and atmospheric, oceanic, terrestrial, hydrologic, and cryospheric components. GLOSS is a primary component of GCOS.

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

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

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

## Sustained Ocean Observing System

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

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

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

OCO is directed toward implementation of this international plan and the projects are being implemented in accordance with the GCOS Ten Climate Monitoring Principles. The initial system as described in GCOS-92 is presently about 60% complete.

Implementation of the Networks is managed at 22 distributed centers of expertise -- NOAA laboratories, centers, joint institutes, universities and business partners. The composite System is centrally managed at the OCO Project Office. Specifically, OCO's tasks are to:

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

Tide gauge stations are necessary to the climate program for accurately measuring long-term trends in sea level change and for calibration and validation of the measurements from satellite altimeters, which are assimilated into global climate models for predicting climate variability and change. Many tide stations need to be upgraded with modern technology particularly in less developed countries. Permanent GPS receivers are being installed, leading to a geocentrically located subset of 170 GCOS Climate Reference Stations. The 170 Climate Reference Stations are also being upgraded for real-time reporting, not only for climate monitoring, but also to support marine hazard warning (e.g., tsunami warning). This Climate Reference Station subset of the GLOSS core network is the focus of OCO support.

The University of Hawaii Sea Level Center is a NOAA partner who assists in the coordination of tide gauge operations within the international community. NOAA provides long-term support for the climate work at the UHSLC. Sea level stations within the U.S. are primarily operated by NOAA's Center for Operational Oceanographic Products and Services (CO-OPS).

# II. Global Sea Level Observing Network Components and Operating Status

## A. Tide Station Networks

# NOAA National Ocean Service

NOAA has operated and maintained a network of coastal sea level (tide gauge) stations for over 150 years, and is the legal authority for sea level in the U.S. The NOAA National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) operates 205 long-term sea level stations, called the National Water Level Observation Network (NWLON), the primary backbone of the National Water Level Program (NWLP). CO-OPS sea level stations are multi-purpose, supporting multiple applications with both real-time and long-term data, from safe and efficient navigation and coastal hazard mitigation to coastal zone management and climate observation. CO-OPS provides an "end-to-end" system of data collection, quality control, data management, and product delivery. CO-OPS maintains a rigorous set of standards and methodologies and is recognized for the high level of accuracy and reliability in data delivery. Information on CO-OPS standards and protocols can be found at: http://tidesandcurrents.noaa.gov/pub.html

In addition to maintenance of this long-term network, CO-OPS has been tasked with three primary activities in support of NOAA's Office of Climate Observations, together comprising its primarily contribution to GLOSS:

1) Develop and implement a routine annual sea level and extreme event analysis reporting capability that meets the requirements of the Climate Observation Program.

2) Upgrade the operation of selected National Water Level Observation Network Stations to ensure continuous operation and connection to geodetic reference frames.

3) Operate and maintain water level measurement systems on Platform Harvest in support of calibration of the TOPEX/Poseidon and Jason 1 satellite altimeter missions.

Several NWLON stations have been identified as critical components of GLOSS (See Appendix 1 for a full listing). 29 of the 205 NOAA NWLON stations are considered GLOSS stations, and contribute to the Joint Archive for Sea Level (JASL). Appendix 2 is a listing of additional NOAA sea level stations currently contributing to the JASL database. There are 54 total NOAA operational NWLON stations that actively contribute to the JASL archive. The 18 NWLON stations identified at the 1997 International Sea Level Workshop as critical to the global system for monitoring long term sea level trends are also identified in the tables as Climate Reference Network (CRN) stations.

## Upgrade of NOAA Ocean Island Station Operations

Several coastal and island NWLON stations are critical to the Global Climate Observing System (GCOS). Annual maintenance is extremely important at these often remote locations, due to the fact that corrective maintenance is logistically very difficult and expensive. Redundancy in data collection and transmission is also critical, as these data sets are very important, and their continuity and integrity must be maintained.

Although operation of all of the long-term NWLON and GLOSS stations is important, NOAA NWLON Ocean Island stations were targeted for priority upgrade to ensure their continuous operation. These upgrades have included high accuracy acoustic or paroscientifc pressure sensors and redundant Data Collection Platforms (DCPs) with equal capability to the existing primary systems. Now that hardware upgrades of most of the highest priority stations are complete, stations will continue to be enhanced where needed with connections to geodetic reference systems (through leveling and/or GPS), followed by installation of NGS Continuously Operating Reference Systems (CORS) at selected sites. Table 1 provides a list of the ocean island NWLON stations (not including Hawaii) that were considered in this category as priority for upgrade. Stations with outstanding work in geodetic connections and CORS are marked "No" in the respective category and will be addressed over the next two years.

**Table 1. Ocean island NOAA NWLON stations (not including Hawaii) which are being upgraded.**

| Station | Upgraded | Geodetic Connection | CORS (GPS) |
|---|---|---|---|
| Guam | Yes | Yes | Yes |
| Kwajalein | Yes | Yes | Yes |
| Pago Pago | Yes | Yes | Yes |
| Wake Island | Yes | Yes | No |
| Midway | Yes | No | No |
| Adak | No | Yes | No |
| Bermuda | Yes | Yes | Yes |
| San Juan, PR | Yes | Yes | Yes |
| Magueyes Island, PR | Yes | Yes | Yes |
| Charlotte Amalie, VI | Yes | Yes | Yes |
| St. Croix, VI | Yes | Yes | Yes |

## University of Hawaii Sea Level Center

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

The UHSLC collaborates in the operation of 64 tide gauge stations in the global sea level network. All of these sites meet GLOSS standards for tsunami monitoring and are currently providing data to appropriate warning centers. The UHSLC in collaboration with the Pacific GPS Facility operates co- located continuous GPS (GPS@TG) receivers at 7 tide gauges, which constitute to the NASA/CNES Science Working Team for altimeter calibration, and provide local estimates of absolute sea level rise.

The UHSLC distributes three sea level data sets: Joint Archive for Sea Level (JASL), Fast Delivery Database, and Near Real-Time Data (See Section III: Product Development and Delivery).

**Table 2. Stations currently operated by UHSLC.**

| GLOSS | STATION | COUNTRY | LAT | LONG | GPS? |
|---|---|---|---|---|---|
| 267 | Acapulco | Mexico | 16º 59'N | 099º 55'W | |
| 068 | Ambon | Indonesia | 03º 41'S | 128º 11'E | |
| 169 | Baltra | Ecuador | 00º 26'S | 090º 17'W | |
| 049 | Benoa | Indonesia | 08º 46'S | 115º 13'E | |
| 069 | Bitung | Indonesia | 00º 27'N | 125º 12'E | |
| 036 | Chittagong | Bangladesh | 22º 20'N | 091º 38'E | |
| 146 | Christmas | Rep. of Kiribati | 01º 59'N | 157º 28'W | |
| 291 | Cilacap (Cillcap) | Indonesia | 07º 45'S | 109º 00'E | |
| 033 | Colombo | Sri Lanka | 06º 57'N | 079º 51'E | |
| 253 | Dakar | Sénégal | 14º 41'N | 017º 25'W | |
| 071 | Davao | Philippines | 07º 50'N | 125º 38'E | |
| 026 | Diego Garcia | United Kingdom | 07º 17'S | 072º 24'E | |
| 245 | Fortaleza | Brazil | 03º 43'S | 38º 28'W | |
| 107 | French Frigate S | USA | 23º 52'N | 166º 17'W | |
| 027 | Gan | Rep. of Maldives | 00º 41'S | 073º 09'E | |
| xxx | Hanimaadhoo | Rep. of Maldives | 06º 46'N | 073º 10'E | |
| 109 | Johnston | USA Trust | 16º 44'N | 169º 32'W | |
| 145 | Kanton | Rep. of Kiribati | 02º 49'S | 171º 43'W | |
| 117 | Kapingamarangi | Fd St Micronesia | 01º 06'N | 154º 47'E | |
| 042 | Ko Taphao Noi | Thailand | 07º 49'N | 098º 25'E | |
| xxx | Lamu | Kenya | 02º 16'S | 040º 54'E | |
| xxx | Langkawi | Malaysia | 06º 52'N | 099º 46'E | |

| | | | | | |
|---|---|---|---|---|---|
| xxx | Lombok (Lembar) | Indonesia | 08º 45’S | 116º 04’E | |
| 120 | Malakal | Rep. of Belau | 07º 20’N | 134º 28’E | GPS@TG |
| 028 | Male (Hulhule) | Rep. of Maldives | 04º 11’N | 073º 32’E | GPS@TG |
| 073 | Manila | Philippines | 14º 38’N | 121º 05’E | |
| 163 | Manzanillo | Mexico | 19º 03’N | 104º 20’W | GPS@TG |
| 192 | Mar Del Plata | Argentina | 38º 02’S | 057º 32’W | |
| xxx | Masirah | Oman | 20º 41’N | 058º 52’E | |
| 008 | Mombasa | Kenya | 04º 04’S | 039º 39’E | |
| 141 | Moulmein | Myanmar | 16º 29’N | 097º 37’E | |
| 142 | Nuku Hiva | French Polynesia | 08º 55’S | 140º 06’W | |
| 045 | Padang | Indonesia | 00º 57’S | 100º 22’E | |
| 329 | Palmeira (C.Verde) | Portugal | 16º 45’N | 022º 59’W | GPS@TG |
| 140 | Papeete | French Polynesia | 17º 32’S | 149º 34’W | |
| 137 | Pascua Is. (Easter) | Chile | 27º 09’S | 109º 27’W | |
| 143 | Penrhyn | Cook Islands | 08º 59’S | 158º 03’W | |
| 245 | Ponta Delgada | Portugal | 37º 44’N | 025º 40’W | |
| 018 | Port Louis | Mauritius | 20º 09’S | 057º 30’E | |
| xxx | Prigi | Indonesia | 08º 17’S | 111º 44’E | |
| 273 | Pt. LaRue | Seychelles | 04º 40’S | 055º 32’E | |
| 075 | Qui Nhon | Vietnam | 13º 47’N | 109º 15’E | |
| 138 | Rikitea | French Polynesia | 23º 08’S | 134º 57’W | |
| 019 | Rodrigues | Mauritius | 19º 40’S | 063º 25’E | |
| xxx | Sabang | Indonesia | 05º 50’N | 095º 20’E | |
| 118 | Saipan | USA | 15º 14’N | 145º 45’E | |
| 004 | Salalah | Oman | 16º 56’N | 054º 00’E | |
| xxx | Salvador | Brazil | 12º 58’S | 038º 31’W | |
| xxx | Santa Cruz | Ecuador | 00º 45’S | 090º 19’W | |
| xxx | Saumlaki | Indonesia | 08º 00’S | 131º 18’E | |
| 211 | Settlement Pnt. | Bahamas | 26º 41’N | 078º 59’W | GPS@TG |
| xxx | Sibolga | Indonesia | 01º 44’N | 098º 48’E | |
| 037 | Sittwe | Myanmar | 20º 09’N | 092º 54’E | |
| xxx | Subic Bay | Philippines | 14º 49’N | 120º 17’E | |
| 175 | Valparaiso | Chile | 33º 02’S | 071º 38’W | GPS@TG |
| xxx | Vung Tau | Vietnam | 10º 20’N | 107º 15’E | |
| 119 | Yap | Fd St Micronesia | 09º 31’N | 138º 08’E | |
| 297 | Zanzibar | Tanzania | 06º 09’S | 039º 11’E | |

Note: GPS@TG indicates which stations have UHSLC GPS co-located at the tide stations.

## B. Satellite Altimeter Activities

### Satellite Altimeter Operations

The launch of the Jason-2/Ocean Surface Topography Mission (Figure 1), on June 20, 2008, marks an important turning point in the evolution of satellite radar altimetry. Jason-2/OSTM is a joint effort of NOAA, NASA, France's Centre National d'Etudes Spatial (CNES), and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). Its primary goal is to maintain continuity of the nearly two-decade record of ocean surface topography measurements established by the TOPEX/Poseidon and Jason-1 altimeter missions. These observations have proven be invaluable in the study of global mean sea level change, showing sea level rising at approximately 3.1 mm/yr between 1993 and 2009, more than 50% faster than over the past century, as well as revealing important new insights into eddy variability in the ocean and large-scale circulation changes. However, Jason-2/OSTM is different than its predecessors in that two operational agencies, NOAA and EUMETSAT, are participating for the first time. Plans are underway for a follow-on Jason-3 mission, to be launched in 2013 as a joint effort of NOAA, EUMETSAT and CNES.

**Figure 1. Launch of Jason-2.**

During the first 6 months of operation, known as the Tandem Mission, Jason-2/OSTM was flown along the same repeat orbit as Jason-1, but separated by 1 minute. In mid-February, 2009, Jason-1 was moved to an orbit that interleaves and lags Jason-2/OSTM by 5 days, effectively doubling the resolution of observations (157 km vs 315 km track spacing at equator, 5 day vs 10 day repeat period), thereby greatly improving the ability to monitor meso-scale sea level variability. The two satellites will continue this mode of operation, known as the Interleave Mission, indefinitely.

NOAA, working with CNES, is providing ground system support for Jason-2/OSTM. This includes command and control of the satellite, downloading telemetry, producing near-real time data products (OGDRs) and archiving and distributing all data products. EUMETSAT is sharing with NOAA the responsibility for downloading telemetry and producing OGDRs. CNES is producing all interim and final science data products (IGDRs and GDRs), as well as archiving and distributing them.

## Satellite Data Analysis and Altimeter Drift Estimation

From the beginning of the TOPEX/Poseidon (T/P) mission, methods to estimate altimeter drift from comparisons with the global tide gauge network have continuously evolved, first in a research mode with NASA funding, and later becoming more general and operationally-oriented with some additional support from NOAA.

By the year 2000 the fundamental statistical footing for the method was firmly established, and it had been found that land motion at the tide gauges was the largest remaining source of error when estimating linear drift rates for the altimeters. To this point, however, the method, despite being quite general had only been applied on a regular basis to the TOPEX/Poseidon dataset. Also, a variety of versions of the basic programs existed for estimations based on data from different groups around the country.

With NOAA support, the University of South Florida (USF) has been able to take on the task of unifying the procedures for use on any altimeter dataset, and begin to put together a system that would enable taking in datasets from any source with relatively little difficulty.

USF now has in place an operational facility for comparing any available altimeter dataset to the global set of tide gauges using consistent, and proven, methods. These comparisons allow the estimation of any temporal drifts in the altimeter datasets, and allow us to combine the different altimeter datasets into a single consistent sea surface height database. This last point follows from the fact that these comparisons will be semi-absolute, in the sense that vertical offsets between different altimeters, even those which do not overlap in time, are determined as part of the procedure.

On a quasi-monthly basis USF downloads, processes and quality controls all of the tide gauge datasets that are used in USF products. These datasets are updated on a monthly basis at the University of Hawaii Sea Level Center, and this timing sets a natural updating frequency for our products. In addition to updating the tide gauge datasets, code to translate any new altimeter products into the format required by our general routine must be written. This has been done for several altimeter products.

## Satellite Altimeter Calibration

NOAA National Ocean Service (NOS) support for the TOPEX/Poseidon satellite altimeter mission through operation of a tide gauge station at Platform Harvest provides water level measurements relative to the satellite altimeter closure analysis reference frame for calibration monitoring (B. Haines et al, 2003; Figure 2). Additional support includes vertical surveys on the Platform necessary to relate the water level sensor reference zeros (near the bottom catwalk) to the Global Positioning System (GPS) reference zero (located up top at the helipad on the Platform). Continuous data are required to monitor effects of waves on the water level measurements and to ensure provision of data during the times of altimeter over-flights every ten days. Platform Harvest tide gauge operations currently includes two digital bubbler pressure systems collecting continuous water level data streams surveyed into the Platform and Satellite Orbit Reference frames. Platform Harvest is one of several calibration sites located around the globe.

**Figure 2. Platform Harvest Verification Site of NOAA NOS Gauges.**

## C. Geodesy and Positioning

The National Geodetic Survey (NGS), an office of NOAA's National Ocean Service (NOS), is responsible for defining, maintaining and providing access to the National Spatial Reference System (NSRS). The NSRS is used by all civilian federal agencies and most of the public to establish coordinates for legal purposes. In the last 10 years the geometric component of the

NSRS, latitude, longitude and ellipsoidal heights (NAD83) has been defined via space geodetic techniques, especially GPS.

In 1986 NGS established a Continuously Operating GPS reference station network called the Cooperative International GPS Network (CIGNET) with three stations. By 1991 CIGNET had grown to 21 stations and in 1994 it was transferred to the International GPS Service now the International GNSS Service (IGS). Also in 1994 NGS established a new GPS network focused in the United States called the Continuously Operating Reference Station (CORS) network. It provides Global Navigation Satellite Systems (GNSS) data consisting of carrier phase and code range measurements in support of three dimensional positioning, meteorology, space weather, and geophysical applications throughout the United States, its territories, and a few foreign countries. Surveyors, GIS users, engineers, scientists, and the public at large that collect GPS data can use CORS data to improve the precision of their positions.

CORS-enhanced post-processed coordinates approach a few centimeters relative to the NSRS, both horizontally and vertically. The CORS network is a multi-purpose cooperative endeavor involving government, academic, and private organizations that independently own and operate each CORS. Each agency shares their data with NGS, and NGS in turn analyzes and distributes the data free of charge. As of April 2009, the CORS network contains over 1,300 stations, contributed by over 200 different organizations, and the network is growing at a rate of approximately 15 stations per month.

From the basic foundation established by the CORS network, NGS participates in a number of ways to support positioning of water level/tide gauge stations.

- NGS, in collaboration with CO-OPS and others, has established and operates a number of CORS located within 1 km of current CO-OPS National Water Level Observation Network (NWLON) stations. Most recently NGS installed a CORS at Battery Park, New York and in Key West, Florida.

- In addition NGS has successfully collaborated with CORS network partners to establish CORS near NWLON stations at a few locations, most recently in Galveston, Texas, and Charleston, South Carolina.

- NGS analyzes the data from all CORS and publishes their daily coordinates and long-term velocities in both ITRF and NAD83.

- NGS defines the standards and guidelines for geodetic leveling that CO-OPS and its contractors use to level between tide gauge/water level stations and reference bench marks.

- NGS is a founding member of the IGS, is one of the 10 Analysis Centers and contributes rapid and final GPS orbits to IGS. It is also an IGS Regional Data Center.

- Currently NGS is also the IGS Analysis Center Coordinator (ACC) for the period 2008-2012. Of the 10 current IGS Analysis Centers, one is selected to perform the main product combination and quality control operations. The core efforts are the Ultra-rapid (used by real-time users), Rapid (for high-accuracy, near-real time uses), and Final (for definitive products) products which consist of satellite orbits, clock and associated Earth orientation parameters.

- NGS is reprocessing all GPS orbits in conjunction with other IGS Analysis Centers from 1994 to present to create a new uniform Final GPS orbit data set as well as to support the future versions of International Terrestrial Reference Frame (ITRF). One step in this effort was that in January 2009 all AC's submitted reprocessed GPS data from 2000-to present that will be used along with Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) data for creating ITRF2008 which should be released in the fall of 2009. Simultaneously NGS is also reprocessing all CORS network data in its holdings and anticipates having results at the end of 2010. NGS will use these results to quantify vertical crustal motion throughout the United States and this information can then be used in conjunction with global and local sea level change estimates to estimate changes in flooding in coastal areas.

- Within the NGS reprocessing effort, we have included most of the IGS Tide Gauge Benchmark Monitoring (TIGA) Pilot project omitting mostly sites in Europe and will publish weekly SINEX files with their coordinates in ITRF as well as stacked solution using the CATREF software.

- NGS is the primary source of data for five GPS stations contained in the ~120 fiducial reference frame stations used to define the ITRF that is maintained by the International Earth Rotation and Reference System Service (IERS).

- NGS provides a collection of Web services called Online Positioning User Service (OPUS). These services allow a user to upload GPS data that they have collected to NGS and receive back a coordinate based on automated processing by NGS on its servers using its own software. The two main services are OPUS-Static (OPUS-S) that allows a user to upload a data set that is at least two hours in duration and OPUS-RapidStatic (OPUS-RS) which requires a minimum of only 15 minutes of data. One of the most recent of the OPUS services is called OPUS-Database (OPUS-DB) which allows a user to upload a data set with associated metadata and store it in an NGS database and publish the coordinates for use by others. CO-OPS and NGS plan to use OPUS-DB to process and archive the GPS data collected by CO-OPS on benchmarks at NWLON stations.

# III. Product Development and Delivery

## A. Current Sea Level Research and Derived Products

### University of South Florida Altimeter Products

The University of South Florida has expanded and improved its suite of products available to users over the past few years. A set of time series describing the differences of the various altimeter datasets relative to the global tide gauge network is now available. These series are defined on a zero that is essentially the mean of the TOPEX Side A altimeter dataset. This work has been completed and a manuscript is presently in preparation.

There has also been a concerted effort to reduce the land motion uncertainties. This work has been done in collaboration with the TIGA work of Guy Wöppelmann and Tilo Schöne . These errors are presently the largest source of uncertainty in the altimeter drift estimation, but this error component is steadily decreasing thanks to the expansion of the set of continuously operating GPS receivers at tide gauges, and the lengthening of the GPS time series. The products that are now available use the present best information on land motion derived from a set of about nearly 100 GPS receivers. In addition, FSU has made substantial progress in putting proper error bars on these land motion estimates and matching these to individual tide gauges. A second manuscript is in preparation describing these results.

The system USF has in place assumes that there are a finite number of altimeter databases that will be updated on a roughly monthly basis, assuming changes to that database had occurred, of course. This led to a well-defined set of codes. What has become apparent, however, is that users of this system increasingly want to use these tide gauge analyses as a way of checking and improving their development of the altimeter sets rather than simply as hindsight check on how they are doing. This is particularly true for users developing Jason-1/2 datasets.

For example, if someone is developing alternate sea state bias corrections, they would like to send a dataset, have an analysis done, examine the results, modify their corrections, and repeat. This sort of iterative cycle can be repeated many times. USF is also doing these sorts of calculations for multiple altimeter groups. The net result is the need for a much more responsive system and the ability to handle multiple versions of the same altimeter databases. This will require substantial additional coding and the development of more sophisticated database management methods by the PI and his group. Good progress has been made and the work is expected to be completed by the end of the summer of 2009.

USF is also in the process of streamlining the annual updating and selection of the tide gauges used in the analyses. USF expects to be able (on the same time frame) to utilize a set of nearly 100 gauges (c.f., the present set of 64) that have an improved global coverage, particularly in the Southern Hemisphere, and make use of improved land motion corrections.

Finally, after the system was set up, feedback from users has led to work on several changes and improvements. First, the decision to reference to a "standard" TOPEX dataset was very unpopular and we are re-coding to replace this with a reference to whichever TOPEX dataset the user specifies. Second, as the time series have lengthened, questions about the handling of long period tides, particularly the Msf and Mf components, have been raised and we are adapting our methods appropriately. Third, in order to be able to treat new missions as soon as possible (i.e., after only two cycles were in hand), the optimization procedure was changed for determining the altimeter, tide gauge height differences. This led to somewhat larger random errors, which is not necessary. USF is presently doing simulations that will allow us to decide quantitatively when a given altimeter series is long enough to use the original method, and the code will be modified to make this switchover automatically once that happens. These changes are expected to be completed by the end of the summer of 2009.

## University of Hawaii Sea Level Center Research

The UHSLC directly assists less developed countries in the maintenance and operation of 64 sea level stations. In 2008, the UHSLC developed a method for estimating the global sea level trend using the GCOS Climate Reference Network of sea level stations. This analysis is consistent with altimetry over the satellite period and also includes gauge records prior to satellite measurements. It has potential to provide continuous trend analysis should there be a future break in the altimeter record.

## NOAA Research

Under the NOAA NCDC Integrated Data and Environmental Applications (IDEA) Center's nascent Pacific Region Integrated Climatology Information Products (PRICIP) project sea level station records in the Pacific are being analyzed to delineate sea level patterns and trends within and between locations and regions, how they have been expressed historically, and may be expected to be expressed in a changing climate (i.e.., via trend analysis, extreme-value analysis, and cross-correlations to climate indices). PRICIP is a collaborate effort that includes representatives from NCDC, CO-OPS, CSC, and the NWS, as well as the University of Hawai`i, University of Alaska, University of Guam, and Oregon State University, NASA, and the USGS.

Additionally, a small working group was recently formed to coordinate NOAA efforts to study such problems and improve the prediction of the global average rate of sea level rise. The group includes representatives from CPO, GFDL, PMEL, NODC, and LSA at present. Work to date includes:

- LSA researchers have recent publication of the first closed estimate of the sea level rise budget with altimeter, Argo, and GRACE observations;
- A retrospective analysis of IPCC projections of sea level rise, supported by CPO funds awarded to STAR's cooperative institute at the University of Maryland; and

- GFDL' work on an improved state-of-the-art Earth System Model that will predict with quantified uncertainties global sea level rise and the spatial variability in sea level change due to ocean dynamics.

## B. Data Delivery

### Database Support and Maintenance

### *Permanent Service for Mean Sea Level (PSMSL)*

Since 1933, the Permanent Service for Mean Sea Level (PSMSL) has been responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges. Both NOAA and the University of Hawaii Sea Level Center contribute sea level data to PSMSL for long-term archival. http://www.pol.ac.uk/psmsl/.

### *NOAA Database and Delivery*

The NESDIS National Data Centers (NCDC, NODC, and NGDC) archive and disseminate the basic datasets used to determine both global (absolute) SLR and local (relative) SLR. These include all NOAA satellite and in-situ station data used in constructing SLR analyses (altimetry, geodetic control, atmospheric observations, SSTs and ocean thermal properties, etc.).

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.

Access to 1-minute water level data is now available through CO-OPS' tsunami website: http://tidesandcurrents.noaa.gov/tsunami/. This site was developed in collaboration with the NOAA Tsunami Warning Centers and the Pacific Marine Environmental Laboratory (PMEL) to support tsunami warning and modeling efforts.

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).

A number of 6 and 1-minute data products are available through the Integrated Ocean Observing System (IOOS) Web Portal, available through an OPeNDAP Server in a variety of formats. http://opendap.co-ops.nos.noaa.gov/content/

Sea level data associated sea level products are all available over the web-site for use by PSMSL, UHSLC, and the WOCE communities.

## *University of Hawaii Sea Level Center*

The UHSLC distributes three sea level data sets. For a detailed station listing, please refer to the Appendices.

### Joint Archive for Sea Level (JASL)

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

### Fast Delivery Database

The Fast Delivery Database supports various international programs, in particular CLIVAR and GCOS. The database has been designated by the IOC as a component of the GLOSS program. The fast delivery data are used extensively by the altimeter community for ongoing assessment and calibration of satellite altimeter datasets. The fast delivery sea level dataset now includes 251 stations, 190 of which are located at GLOSS sites.

### Near Real-Time Data

Near Real-Time Data (collection + up to a three hour delay, H-3 delay) and daily filtered values (J-2 delay) are provided by the UHSLC in support of GODAE. Approximately 64 stations currently are available in real-time with plans for ongoing expansion.

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

## Web Products

### NOAA Sea Levels Online

NOAA's primary delivery method of local sea level trends to the public is through its *Sea Levels Online* website (http://tidesandcurrents.noaa.gov/sltrends). This site provides access both to NOAA long-term NWLON stations and to international stations. In 2008, the Sea Levels Online website was redesigned and a new Google Map interface was introduced to provide easier access for users to water level stations in their region of interest (Figures 3 and 4).

In 2008, linear sea level trends were recalculated for all NWLON stations with trends published in the previous NOAA Technical Se Level Trends Report (Zervas, 2001), as well as analyses of 12 additional U.S. stations using all available data up to the end of 2006. Analyses of sea level trends and variability are currently available for 128 long-term NWLON stations at *Sea Levels Online*. Figures 5-7 illustrate the types of analyses available for all long-term stations.

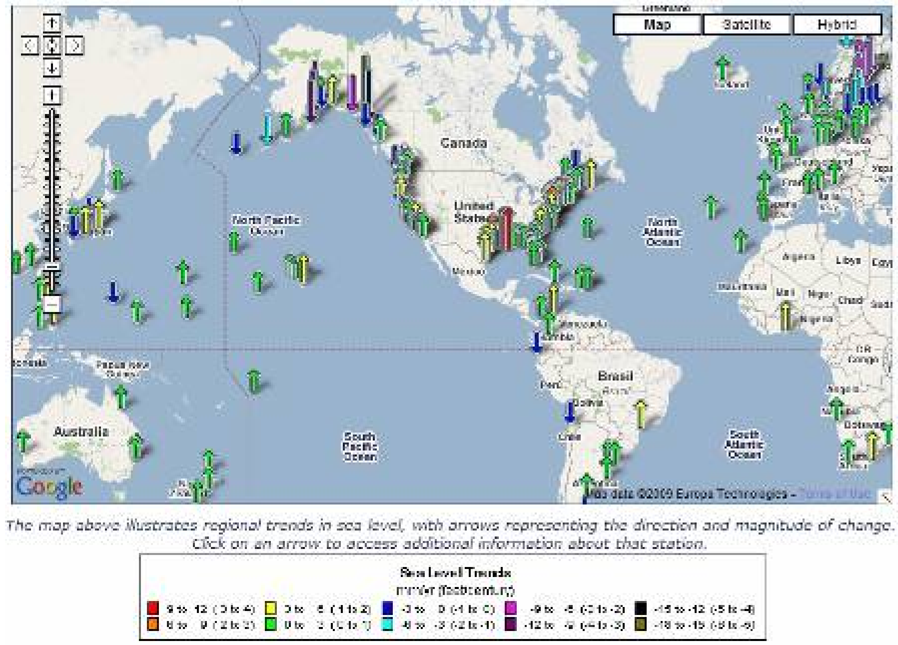


**Figure 3. New Google map interface for Relative Sea Level Trends.**

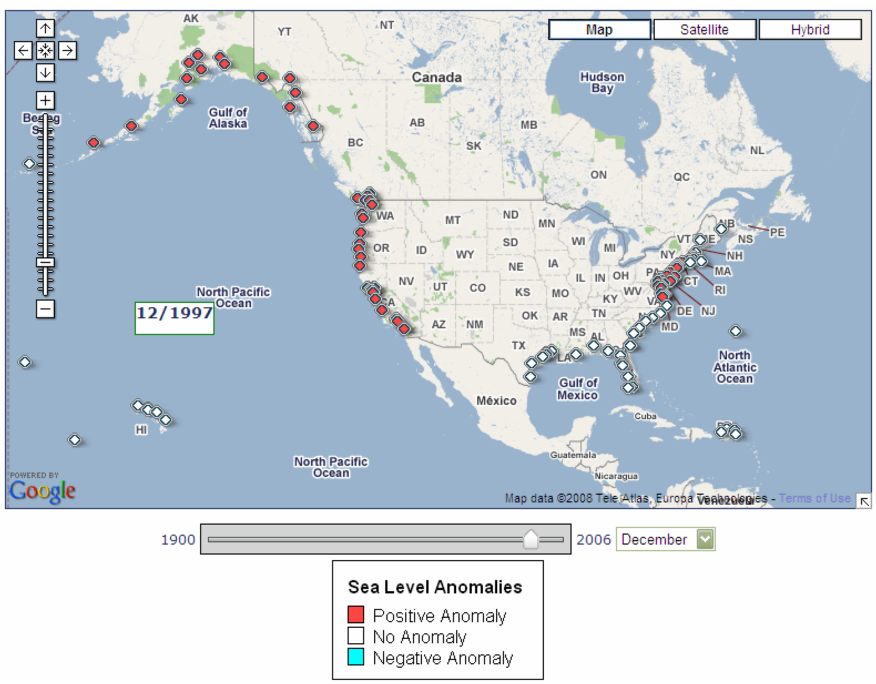


**Figure 4. New Google map interface for Sea Level Anomalies (shown for December 1997).**

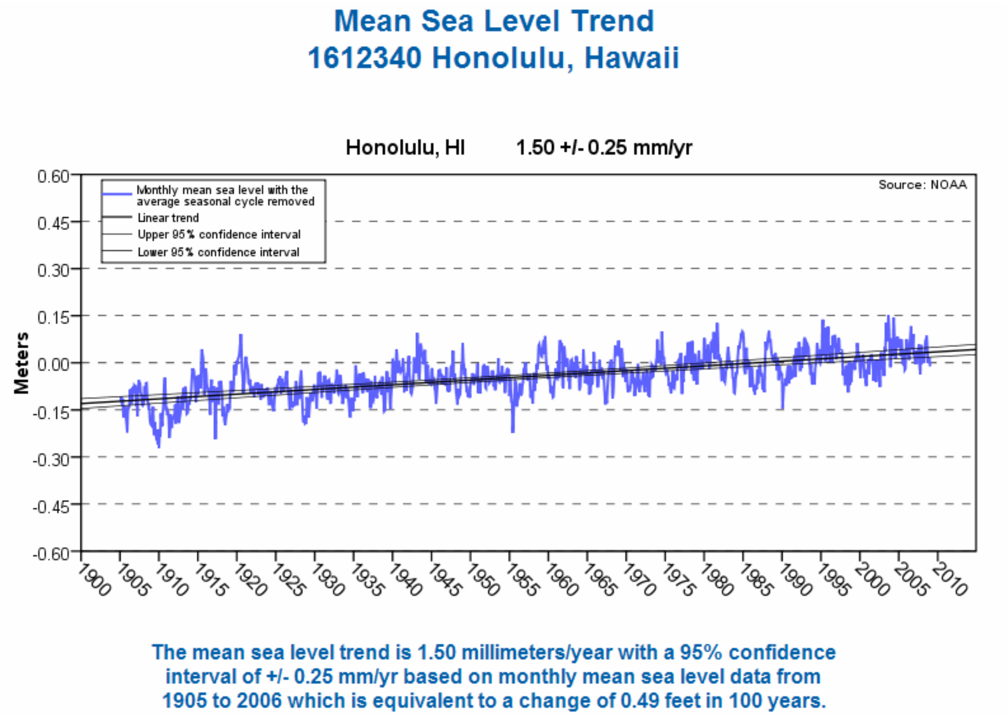


**Figure 5. Sea level trend analyses.**

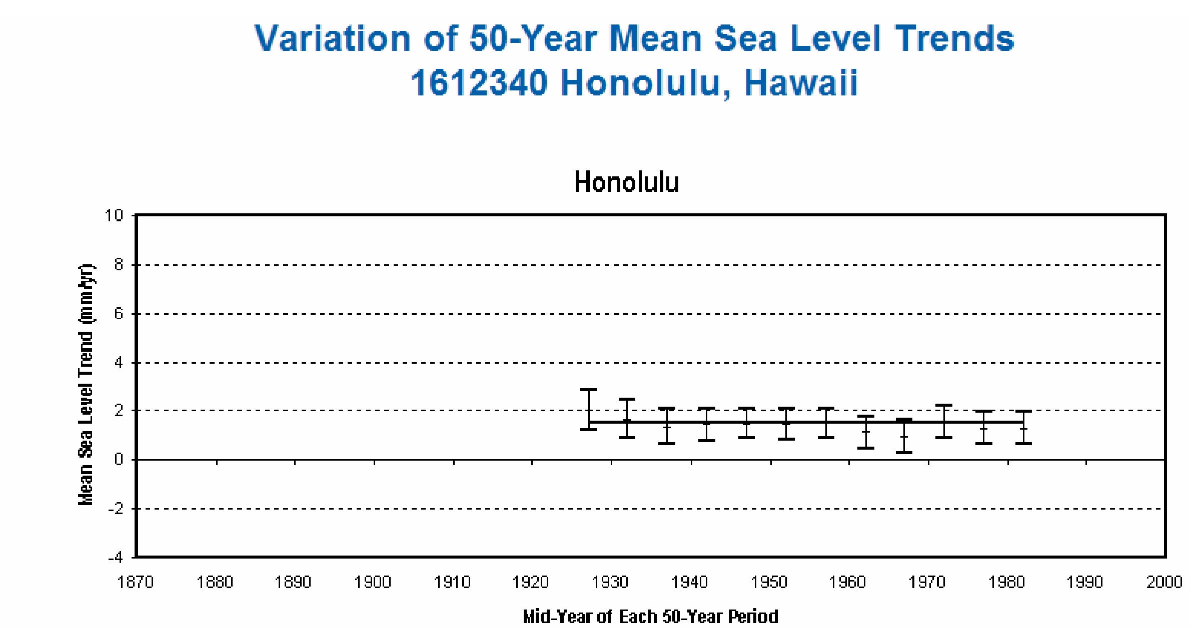


**Figure 6. Long-term variation in trends.**

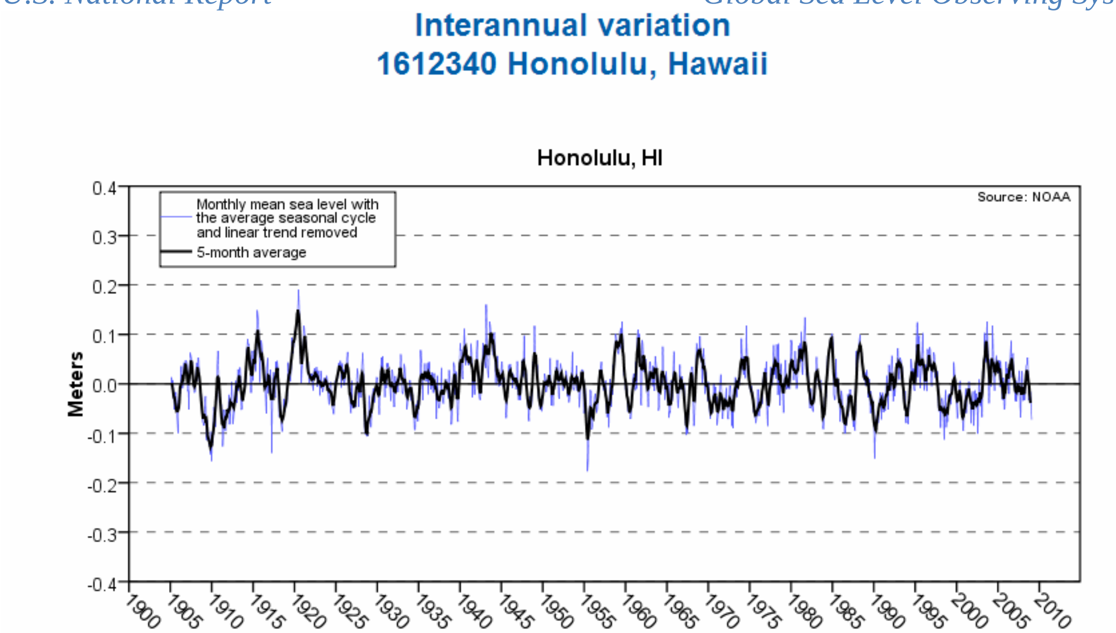


**Figure 7. The monthly mean sea level anomalies are updated monthly.**

## *Climate Reference Stations*

62 water level stations were identified in the International Sea Level Workshop Report (1997) as a core global subset for long-term sea level trends. The 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 CO-OPS technical report on sea level trends (Zervas, 2001) has been used as a starting template for an annual report. In addition to the analysis of long-term sea level trends and monthly mean sea level analyses, a new product is being developed to present summaries of the exceedance probabilities at selected stations.

In 2006, CO-OPS completed the development component of the routine analyses of these 62 reference stations, including 18 NWLON stations and 44 non-NOAA global stations. The monthly mean sea level data for the non-NOAA stations were obtained from the Permanent Service for Mean Sea Level (PSMSL) website. The data set obtained was their Revised Local Reference (RLR) data which has been carefully quality-controlled for datum continuity.

http://tidesandcurrents.noaa.gov/sltrends/sltrends_global.shtml

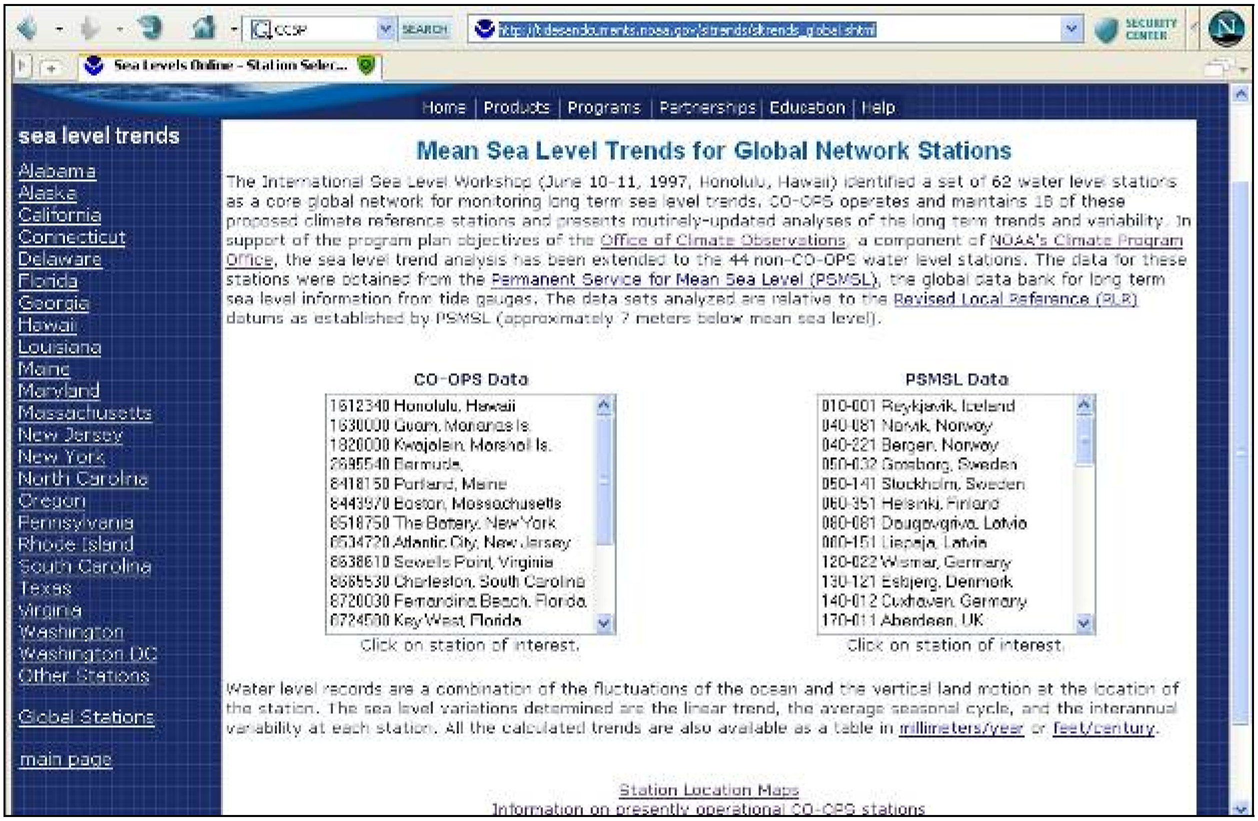


**Figure 8. The NOAA web-site for viewing information on sea level trends and monthly mean sea level anomalies at global tide stations.**

CO-OPS has now extended the compilation of the data and the reports from the 62 global reference stations to nearly all of the 182 stations identified in Annex IV of the Global Sea Level Observing System (GLOSS) Implementation Plan 1997 (IOC Technical Series No. 50) (http://unesdoc.unesco.org/images/0011/001126/112650eo.pdf ) as GLOSS-LTT (Long Term Trend) (Table 3). 45 of the GLOSS-LTT stations are CO-OPS stations and their sea level trends and variations were already available on Sea Levels Online.

**Table 3. Global Climate Reference Stations with Sea Level Analysis Completed.**

| **Linear mean sea level (MSL) trends and 95% confidence intervals (in mm/yr)**<br>Source of data: PSMSL and NOAA; Analysis: NOAA | | | | | |
|---|---|---|---|---|---|
| **Station Name** | **First Year** | **Last Year** | **Year Range** | **MSL Trend** | **95% Confidence Interval (+/-)** |
| Reykjavik, Iceland | 1956 | 2001 | 46 | 2.34 | 0.71 |
| Barentsburg, Norway | 1948 | 2006 | 59 | -2.99 | 0.67 |
| Murmansk, Russia | 1952 | 2006 | 55 | 3.92 | 1.00 |

**Linear mean sea level (MSL) trends and 95% confidence intervals (in mm/yr)**
Source of data: PSMSL and NOAA; Analysis: NOAA

| | | | | | |
|---|---|---|---|---|---|
| Narvik, Norway | 1928 | 2001 | 74 | -3.09 | 0.59 |
| Heimsjo, Norway | 1935 | 2006 | 72 | -1.61 | 0.40 |
| Maloy, Norway | 1945 | 2006 | 62 | 0.93 | 0.52 |
| Bergen, Norway | 1883 | 2001 | 119 | -0.52 | 0.23 |
| Stavanger, Norway | 1881 | 2006 | 126 | 0.42 | 0.21 |
| Oslo, Norway | 1885 | 2006 | 122 | -4.53 | 0.34 |
| Smogen, Sweden | 1911 | 2007 | 97 | -1.92 | 0.27 |
| Goteborg, Sweden | 1887 | 2003 | 117 | -1.30 | 0.36 |
| Klagshamn, Sweden | 1929 | 2007 | 79 | 0.53 | 0.48 |
| Kungholmsfort, Sweden | 1887 | 2007 | 121 | 0.00 | 0.27 |
| Landsort, Sweden | 1887 | 2007 | 121 | -2.85 | 0.32 |
| Stockholm, Sweden | 1889 | 2003 | 115 | -3.94 | 0.35 |
| Ratan, Sweden | 1892 | 2007 | 116 | -7.75 | 0.41 |
| Furuogrund, Sweden | 1916 | 2007 | 92 | -8.17 | 0.61 |
| Kemi, Finland | 1920 | 2006 | 87 | -7.01 | 0.67 |
| Oulu/Uleaborg, Finland | 1889 | 2006 | 118 | -6.38 | 0.43 |
| Raahe/Brahestad, Finland | 1922 | 2006 | 85 | -6.81 | 0.71 |
| Pietarsaari/Jakobstad, Finland | 1914 | 2006 | 93 | -7.32 | 0.61 |
| Vaasa/Vasa, Finland | 1883 | 2006 | 124 | -7.36 | 0.36 |
| Kaskinen/Kasko, Finland | 1926 | 2006 | 81 | -6.54 | 0.73 |
| Mantyluoto, Finland | 1910 | 2006 | 97 | -5.96 | 0.53 |
| Turku/Abo, Finland | 1922 | 2006 | 85 | -3.71 | 0.66 |
| Degerby, Finland | 1923 | 2006 | 84 | -3.77 | 0.64 |
| Hanko/Hango, Finland | 1887 | 1997 | 111 | -2.76 | 0.42 |
| Helsinki, Finland | 1879 | 2001 | 123 | -2.41 | 0.37 |
| Hamina, Finland | 1928 | 2006 | 79 | -1.03 | 0.85 |
| Daugavgriva, Latvia | 1872 | 1938 | 67 | 0.16 | 0.99 |
| Liepaja, Latvia | 1865 | 1936 | 72 | 0.88 | 0.72 |
| Kaliningrad, Russia | 1926 | 1986 | 61 | 1.84 | 0.89 |
| Warnemunde, Germany | 1855 | 2005 | 151 | 1.20 | 0.12 |
| Wismar, Germany | 1848 | 2003 | 156 | 1.38 | 0.10 |
| Gedser, Denmark | 1898 | 2006 | 109 | 0.94 | 0.19 |
| Kobenhavn, Denmark | 1889 | 2006 | 118 | 0.49 | 0.21 |
| Hornbaek, Denmark | 1898 | 2006 | 109 | 0.25 | 0.23 |
| Korsor, Denmark | 1897 | 2006 | 110 | 0.75 | 0.19 |
| Slipshavn, Denmark | 1896 | 2006 | 111 | 0.93 | 0.17 |
| Fredericia, Denmark | 1889 | 2006 | 118 | 1.03 | 0.12 |
| Aarhus, Denmark | 1888 | 2006 | 119 | 0.56 | 0.12 |
| Frederikshavn, Denmark | 1894 | 2006 | 113 | 0.16 | 0.16 |
| Hirtshals, Denmark | 1892 | 2006 | 115 | -0.20 | 0.22 |
| Esbjerg, Denmark | 1889 | 1997 | 109 | 1.05 | 0.31 |
| Cuxhaven, Germany | 1843 | 2002 | 160 | 2.44 | 0.17 |
| Aberdeen, UK | 1862 | 2003 | 142 | 0.66 | 0.10 |
| North Shields, UK | 1895 | 2003 | 109 | 1.88 | 0.16 |
| Sheerness, UK | 1832 | 2006 | 175 | 1.64 | 0.10 |
| Newlyn, UK | 1915 | 2003 | 89 | 1.71 | 0.20 |
| Brest, France | 1807 | 2000 | 194 | 1.00 | 0.08 |
| La Coruna, Spain | 1943 | 2006 | 64 | 1.31 | 0.47 |
| Cascais, Portugal | 1882 | 1993 | 112 | 1.27 | 0.15 |

| **Linear mean sea level (MSL) trends and 95% confidence intervals (in mm/yr)**<br>Source of data: PSMSL and NOAA; Analysis: NOAA | | | | | |
|---|---|---|---|---|---|
| Lagos, Portugal | 1908 | 1999 | 92 | 1.50 | 0.24 |
| Marseille, France | 1885 | 2000 | 116 | 1.20 | 0.16 |
| Genova, Italy | 1884 | 1997 | 114 | 1.20 | 0.14 |
| Trieste, Italy | 1905 | 2001 | 97 | 1.15 | 0.22 |
| Tuapse, Russia | 1917 | 2002 | 86 | 2.24 | 0.65 |
| Ponta Delgada, Portugal | 1978 | 2005 | 28 | 2.55 | 1.09 |
| Tenerife, Spain | 1927 | 1999 | 73 | 1.53 | 0.31 |
| Takoradi, Ghana | 1929 | 1970 | 42 | 3.35 | 0.50 |
| Walvis Bay, Namibia | 1958 | 1998 | 41 | 0.33 | 1.44 |
| Simons Bay, South Africa | 1957 | 2007 | 51 | 1.59 | 0.28 |
| Port Elizabeth, South Africa | 1978 | 2007 | 30 | 3.13 | 1.40 |
| Durban, South Africa | 1971 | 2007 | 37 | 0.63 | 0.62 |
| Aden, Yemen | 1879 | 1969 | 91 | 1.23 | 0.20 |
| Karachi, Pakistan | 1916 | 1994 | 79 | 0.48 | 0.53 |
| Mumbai/Bombay, India | 1878 | 1994 | 117 | 0.74 | 0.12 |
| Cochin, India | 1939 | 2004 | 66 | 1.37 | 0.32 |
| Chennai/Madras, India | 1916 | 2003 | 88 | 0.31 | 0.41 |
| Vishakhapatnam, India | 1937 | 1996 | 60 | 0.54 | 0.52 |
| Ko Taphao Noi, Thailand | 1940 | 2006 | 67 | 0.49 | 1.06 |
| Ko Lak, Thailand | 1940 | 2002 | 63 | -0.48 | 0.26 |
| Macau, China | 1925 | 1985 | 61 | 0.25 | 0.50 |
| Xiamen, China | 1954 | 2002 | 49 | 1.02 | 0.60 |
| Yuzhno Kurilsk, Russia | 1948 | 1994 | 47 | 2.74 | 0.62 |
| Mera, Japan | 1931 | 2001 | 71 | 3.66 | 0.24 |
| Aburatsubo, Japan | 1930 | 1999 | 70 | 3.33 | 0.27 |
| Kushimoto, Japan | 1957 | 2007 | 51 | 3.09 | 0.62 |
| Hosojima, Japan | 1930 | 2007 | 78 | -0.53 | 0.32 |
| Tonoura/Hamada, Japan | 1894 | 2002 | 109 | 0.38 | 0.24 |
| Wajima, Japan | 1930 | 1999 | 70 | -0.80 | 0.26 |
| Manila, Philippines | 1901 | 1969 | 69 | 1.78 | 0.35 |
| Legaspi, Philippines | 1947 | 2005 | 59 | 5.22 | 0.80 |
| Davao, Philippines | 1948 | 2005 | 58 | 5.32 | 1.30 |
| Jolo, Philippines | 1947 | 1996 | 50 | 0.19 | 1.12 |
| Townsville, Australia | 1959 | 2006 | 48 | 1.11 | 0.44 |
| Newcastle, Australia | 1925 | 1988 | 64 | 2.19 | 0.48 |
| Sydney, Australia | 1886 | 2003 | 118 | 0.59 | 0.11 |
| Fremantle, Australia | 1897 | 2003 | 107 | 1.48 | 0.27 |
| Auckland, New Zealand | 1903 | 2000 | 98 | 1.29 | 0.20 |
| Wellington, New Zealand | 1944 | 2005 | 62 | 2.41 | 0.35 |
| Lyttelton, New Zealand | 1924 | 2000 | 77 | 2.36 | 0.29 |
| Guam, Marianas Islands | 1948 | 1993 | 46 | -1.05 | 1.72 |
| Chuuk, Caroline Islands | 1947 | 1995 | 49 | 0.60 | 1.78 |
| Kwajalein, Marshall Islands | 1946 | 2006 | 61 | 1.43 | 0.81 |
| Wake Island | 1950 | 2006 | 57 | 1.91 | 0.59 |
| Pago Pago, American Samoa | 1948 | 2006 | 59 | 2.07 | 0.90 |
| Midway Atoll | 1947 | 2006 | 60 | 0.70 | 0.54 |
| Johnston Atoll | 1947 | 2003 | 57 | 0.75 | 0.56 |
| Honolulu, USA | 1905 | 2006 | 102 | 1.50 | 0.25 |
| Hilo, USA | 1927 | 2006 | 80 | 3.27 | 0.35 |

**Linear mean sea level (MSL) trends and 95% confidence intervals (in mm/yr)**
Source of data: PSMSL and NOAA; Analysis: NOAA

| | | | | | |
|---|---|---|---|---|---|
| Adak Island, USA | 1957 | 2006 | 50 | -2.75 | 0.54 |
| Seward, USA | 1964 | 2006 | 43 | -1.74 | 0.91 |
| Sitka, USA | 1924 | 2006 | 83 | -2.05 | 0.32 |
| Ketchikan, USA | 1919 | 2006 | 88 | -0.19 | 0.27 |
| Prince Rupert, Canada | 1909 | 2006 | 98 | 1.09 | 0.27 |
| Vancouver, Canada | 1910 | 1999 | 90 | 0.37 | 0.28 |
| Victoria, Canada | 1909 | 1999 | 91 | 0.80 | 0.25 |
| Tofino, Canada | 1909 | 2006 | 98 | -1.59 | 0.32 |
| Neah Bay, USA | 1934 | 2006 | 73 | -1.63 | 0.36 |
| Friday Harbor, USA | 1934 | 2006 | 73 | 1.13 | 0.33 |
| Seattle, USA | 1898 | 2006 | 109 | 2.06 | 0.17 |
| Astoria, USA | 1925 | 2006 | 82 | -0.31 | 0.40 |
| Crescent City, USA | 1933 | 2006 | 74 | -0.65 | 0.36 |
| San Francisco, USA | 1897 | 2006 | 110 | 2.01 | 0.21 |
| Los Angeles, USA | 1923 | 2006 | 84 | 0.83 | 0.27 |
| La Jolla, USA | 1924 | 2006 | 83 | 2.07 | 0.29 |
| San Diego, USA | 1906 | 2006 | 101 | 2.06 | 0.20 |
| Balboa, Panama | 1908 | 1996 | 89 | 1.38 | 0.27 |
| Buenaventura, Colombia | 1941 | 1969 | 29 | 0.96 | 1.22 |
| La Libertad, Ecuador | 1948 | 2003 | 56 | -1.22 | 0.97 |
| Antofagasta, Chile | 1945 | 2006 | 62 | -0.75 | 0.48 |
| Puerto Deseado, Argentina | 1970 | 2002 | 33 | -0.06 | 1.93 |
| Puerto Madryn, Argentina | 1944 | 2000 | 57 | 1.50 | 0.79 |
| Quequen, Argentina | 1918 | 1982 | 65 | 0.85 | 0.31 |
| Buenos Aires, Argentina | 1905 | 1987 | 83 | 1.57 | 0.30 |
| Montevideo, Uruguay | 1938 | 1995 | 58 | 1.21 | 0.69 |
| Cananeia, Brazil | 1954 | 2006 | 53 | 4.20 | 0.63 |
| Cartagena, Colombia | 1949 | 1992 | 44 | 5.31 | 0.37 |
| Cristobal, Panama | 1909 | 1980 | 72 | 1.41 | 0.22 |
| Galveston Pier 21, USA | 1908 | 2006 | 99 | 6.39 | 0.28 |
| Pensacola, USA | 1923 | 2006 | 84 | 2.10 | 0.26 |
| Key West, USA | 1913 | 2006 | 94 | 2.24 | 0.16 |
| Bermuda | 1932 | 2006 | 75 | 2.04 | 0.47 |
| Mayport, USA | 1928 | 2006 | 79 | 2.40 | 0.31 |
| Fernandina Beach, USA | 1897 | 2006 | 110 | 2.02 | 0.20 |
| Fort Pulaski, USA | 1935 | 2006 | 72 | 2.98 | 0.33 |
| Charleston, USA | 1921 | 2006 | 86 | 3.15 | 0.25 |
| Wilmington, USA | 1935 | 2006 | 72 | 2.07 | 0.40 |
| Sewells Point, USA | 1927 | 2006 | 80 | 4.44 | 0.27 |
| Washington, USA | 1924 | 2006 | 83 | 3.16 | 0.35 |
| Annapolis, USA | 1928 | 2006 | 79 | 3.44 | 0.23 |
| Baltimore, USA | 1902 | 2006 | 105 | 3.08 | 0.15 |
| Philadelphia, USA | 1900 | 2006 | 107 | 2.79 | 0.21 |
| Atlantic City, USA | 1911 | 2006 | 96 | 3.99 | 0.18 |
| Sandy Hook, USA | 1932 | 2006 | 75 | 3.90 | 0.25 |
| The Battery, USA | 1856 | 2006 | 151 | 2.77 | 0.09 |
| Kings Point/Willets Point, USA | 1931 | 2006 | 76 | 2.35 | 0.24 |
| Newport, USA | 1930 | 2006 | 77 | 2.58 | 0.19 |
| Woods Hole, USA | 1932 | 2006 | 75 | 2.61 | 0.20 |

| **Linear mean sea level (MSL) trends and 95% confidence intervals (in mm/yr)** Source of data: PSMSL and NOAA; Analysis: NOAA | | | | | |
|---|---|---|---|---|---|
| Boston, USA | 1921 | 2006 | 86 | 2.63 | 0.18 |
| Portland, USA | 1912 | 2006 | 95 | 1.82 | 0.17 |
| Eastport, USA | 1929 | 2006 | 78 | 2.00 | 0.21 |
| Saint John, Canada | 1914 | 1999 | 86 | 2.75 | 0.33 |
| Halifax, Canada | 1895 | 2002 | 108 | 3.16 | 0.15 |
| Pointe-Au-Pere, Canada | 1900 | 1983 | 84 | -0.36 | 0.40 |
| Quebec, Canada | 1910 | 2006 | 97 | -0.17 | 0.49 |
| Neuville, Canada | 1914 | 2006 | 93 | 0.17 | 0.79 |
| Argentine Islands, Antarctica | 1958 | 2006 | 49 | 1.72 | 0.49 |

A review of the PSMSL data available showed that a few of the GLOSS-LTT stations do not have enough data yet to obtain a reliable sea level trend. There are also a number of Scandinavian stations with long data sets that are no longer in operation; given the number of other stations in that region, these defunct stations were not analyzed. There are also a few river stations on the St. Lawrence River where sea level trends are not meaningful with respect to climate observations. The expanded global reference station network now consists of 159 stations, which means that a total of 97 stations have been added to the previous 62 climate reference stations.

### *University of Hawaii Sea Level Center*

The University of Hawaii Sea Level Center website hosts a variety of products, in addition to providing access to raw sea level data. Products include: global sea level deviations, tide gauge-altimeter analysis (deviations and anomalies), upper ocean volume, current indices, and topography. http://uhslc.soest.hawaii.edu/

### *NOAA Laboratory for Satellite Altimetry*

NOAA's Laboratory for Satellite Altimetry website includes resources and links to a variety of satellite altimeter products. Projects included on the site include: satellite altimeter sea level rise data, near real-time processed analysis, historical sea level, ERS altimetry data, information on Geosat, geophysics research, and sea floor topography. It also provides updates on new research, and provides access to partner agency websites. http://ibis.grdl.noaa.gov/SAT/SAT.html

## *IV. New Technology*

### A. GPS on Tide Gauges

For NGS Continuously Operating Reference System (CORS) reference bench marks (typically two) that are located within a 1.6 km leveling distance of a NOAA water level station, a direct leveling connection will 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.

**Table 4. Long-term CO-OPS water level stations within 10 kilometers of National Geodetic Survey (NGS) CORS-GPS stations.**

| CO-OPS Station ID | GLOSS Code | PSMSL Code | Station Name | NGS CORS ID | Distance (km) |
|---|---|---|---|---|---|
| 1612340 | 108 LTT | 760031 | Honolulu, HI | HNLC | 0.0 |
| 1617760 | 287 LTT | 760061 | Hilo, HI | HILO | 1.3 |
| 1770000 | 144 LTT | 745001 | Pago Pago | ASPA | 5.8 |
| 1820000 | 111 LTT | 720011 | Kwajalein | KWJ1 | 1.0 |
| 2695540 | 221 LTT | 950011 | Bermuda | BRMU | 0.7 |
| 8410140 | LTT | 960201 | Eastport, ME | EPRT | 0.8 |
| 8413320 | | 960191 | Bar Harbor, ME | BARH | 1.4 |
| 8419870 | | 960177 | Seavey Island, ME | POR4 | 2.8 |
| 8452660 | 290 LTT | 960131 | Newport, RI | NPRI | 0.5 |
| 8531680 | LTT | 960101 | Sandy Hook, NJ | SHK5 | 0.5 |
| 8551910 | | 960089 | Reedy Point, DE | RED5 | 0.5 |
| 8571892 | | 960073 | Cambridge, MD | HNPT | 5.7 |
| 8577330 | | 960078 | Solomons Island, MD | MDSI | 0.2 |
| 8594900 | LTT | 960076 | Washington, DC | USNO | 6.4 |
| 8631044 | | | Wachapreague, VA | VIMS | 0.2 |
| 8637624 | | 960072 | Gloucester Point, VA | GLPT | 0.2 |
| 8651370 | 219 | 960063 | Duck, NC | DUCK | 0.4 |
| 8665530 | LTT | 960041 | Charleston, SC | SCHA | 0.2 |
| 8723170 | | 960001 | Miami Beach, FL | AOML and MIA3 | 4.8 |
| 8724580 | 216 LTT | 940071 | Key West, FL | CHIN | 0.4 |
| 8735180 | | 940037 | Dauphin Island, AL | MOB1 | 5.5 |
| 8761724 | | 940021 | Grand Isle, LA | GRIS | 0.1 |
| 8771510 | | | Galveston Pleas. Pier | TXGV | 0.0 |
| 9410170 | LTT | 823081 | San Diego, CA | PLO5 | 8.4 |
| 9435380 | 157 | 823016 | South Beach, OR | NEWP | 4.7 |
| 9443090 | LTT | 823001 | Neah Bay, WA | NEAH | 7.8 |
| 9447130 | LTT | 823011 | Seattle, WA | SEAT | 5.9 |
| 9455760 | | 821013 | Nikiski, AK | KEN1 | 2.8 |
| 9455920 | | 821012 | Anchorage, AK | TSEA | 5.7 |
| 9457292 | | 821011 | Kodiak Island, AK | KODK | 0.7 |

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

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

For a full list of distances between CORS and tide stations, see http://www.ngs.noaa.gov/CORS/Tiga/tiga_link.html.

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

(2) to establish transformation functions between NOAA chart datum (MLLW) and the geocentric reference system to support NOAA 3-dimensional hydrographic surveys, the implementation of Electronic Chart Display and Information Systems (ECDIS), and the NOAA Vertical Datum transformation (V-Datum tool) and tidal datum models. Integration of GPS procedures into NOAAPORTS® 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.

## B. New Sensor Testing

## Microwave Sensor Testing

An important objective of CO-OPS is to ensure that the most up-to-date water level products and services are provided to users. As measurement technology evolves and improved methods for observing the environment are developed, CO-OPS selects newly developed sensors to bring into a monitoring setting. The CO-OPS Ocean System Test and Evaluation Program (OSTEP) involves a team of scientists and technicians dedicated to conducting rigorous testing of newly selected oceanographic and meteorological sensors and related systems, typically both in a laboratory and field setting. OSTEP analyzes test results to demonstrate operational capability, quantify accuracy, and assess the possibility of incorporating new sensors into NWLON stations. Pending successful test results the team also facilitates the transition of new sensors to an operational setting, which involves developing deployment guidelines, routine maintenance requirements, and data quality control procedures.

Over the past several years CO-OPS has been monitoring developments in microwave altimeter technology along with related testing currently being conducted throughout various international physical science communities. As a result, CO-OPS has recognized the many potential benefits of using microwave range sensors to collect long-term sea level measurements in various coastal regions. Such sensors offer the opportunity to overcome one of the largest disadvantages of currently-used water level sensors by avoiding contact with the harsh marine environment. Recently developed microwave range sensors can be deployed on structures in coastal areas, such as piers or pilings, in order to measure the ocean surface remotely, from above. As a result, many typical problems related to collecting long term sea level observations can be avoided, such as biological fouling, corrosion, and damage from vessel traffic. Easy access resulting from and out-of-the-water setup can also potentially simplify deployment and maintenance requirements.

CO-OPS recognizes that when introducing a new sensor technology into a pre-existing operational ocean observatory such as NWLON, it is critical to complete thorough testing in order to fully understand how the sensors will perform in the field over the wide range of environmental conditions experienced at various observatory locations. Over the past several months, OSTEP has been conducting a series of laboratory and field tests of four different types microwave range sensors in order to gain a better understanding of their performance capabilities and to determine whether or not such sensors are suitable for integration into NWLON stations. Sensor selection was based upon experience both within NOAA and outside organizations

OSTEP developed a microwave sensor test plan that was primarily based on the unique applications and stringent requirements of NWLON, however, information on other microwave sensor testing conducted to date throughout the sea level community was taken into account in an attempt to build off other's useful results, cover new ground by addressing questions that remain somewhat open, and to provide potentially valuable contributions to the international sea level community. Information on previous, similar microwave sensor testing was obtained through journal articles, various conference presentations, and personal communications with the individuals currently involved in tests.

NWLON stations are located in many different coastal areas throughout the United States and its territories, covering a variety of different environments. Testing needs to address how different environmental parameters will impact the performance of these sensors. Sea level data collected at NWLON stations are used in multiple applications, all of which are very important to the public, including transmission of real-time data to enhance navigational safety, development of tidal prediction models, the coastal element of tsunami detection systems, and long term monitoring of sea level change to assess impacts of climate change. Water level data collected during the series of tests need to be used to determine the best way to process raw microwave range observations to derive sea level changes at the various temporal scales of interest.

Thorough analysis of incoming field data will be critical to prove with high confidence that sea level records measured by microwave range sensors meet CO-OPS accuracy requirements and to avoid introducing any systematic change in long term sea level records corresponding to the possible integration of these new sensors into GLOSS observatories. Since the series of tests will span more than a year, CO-OPS will compile results in a series of bi-annual interim reports that will be available for external distribution. The first report of the series was completed in March 2009, and results and status of this ongoing test effort were will be presented at the May 2009 GLOSS GE XI meeting in Paris.

The UHSLC sea level stations are currently utilizing radar gauges as a backup sensor. After appropriate time series are generated, the UHSLC plans to study the effectiveness of these sensors and comment on their use for the collection of long-term sea level data.

## C. Hardening of NOAA Stations

By virtue of their location at the ocean's edge, water level observing stations are exposed to severe damage by the very storms which make their operation so important. Strengthening key NOAA NWLON stations ensures that observations of water level, wind speed and direction, barometric pressure, and air and water temperature will be available when the information is needed most. NOAA Sentinels are deployed in coastal areas most vulnerable to severe storms such as land-fall hurricanes in the US Gulf of Mexico. Sentinels have been established at four locations which were selected based on two objectives; re-establish NWLON stations either destroyed or heavily damaged by recent hurricanes; and establish new stations in areas identified as gaps in the NWLON. Additional Sentinels will be established as funding becomes available.

NOAA Sentinels are large single-pile structures (see Figure 8). A single-pile structure presents a minimal profile to a storm coming from any direction. Engineering specifications based on Category 4 generated wind and wave action analysis determined that the platforms stand at least 25 feet above the sea surface on a 4-foot diameter single pile. The piles are driven 60-80 feet into the seafloor to ensure stability. The Sentinels are expected to enhance GLOSS objectives by ensuring continuous records during storm events and reducing the number of long data gaps due to storm damage. These stations will also improve the ability to record maximum water levels.

**Figure 9. One of the US NOAA Sentinel Tide Stations in the Gulf of Mexico.**

## D. Arctic Bottom-Mounted Pressure Sensors

NOAA continues to operate and maintain an NWLON tide station at Prudhoe Bay Alaska which has now been in continuous operation on the North Slope since late 1993 and has been increasing the number of shorter seasonal deployments for updated shoreline surveys in the Chukchi Sea for the past few years.

NOAA has also been working to develop tide station configurations that will withstand the harsh winter environment. In August 2008, two bottom mounted offshore platforms were deployed beyond the bottom ice scouring about 3 km offshore in about 30 meters of water at Point Barrow, AK. Each platform houses an internally recording pressure measuring system outfitted with acoustic modems for a periodically uploading the data to the surface. The surface receiver would be either on a boat when there was open water, or a snow machine after boring a hole through the ice after solid freeze over (See Figure 10). The platforms are periodically referenced to benchmarks via staff shots and differential GPS. The platforms are each equipped with an acoustic release, and platform recovery is scheduled around August 2009. These offshore data once matched with on-shore data during the ice-free season will result in year-around sea level measurements at that location.

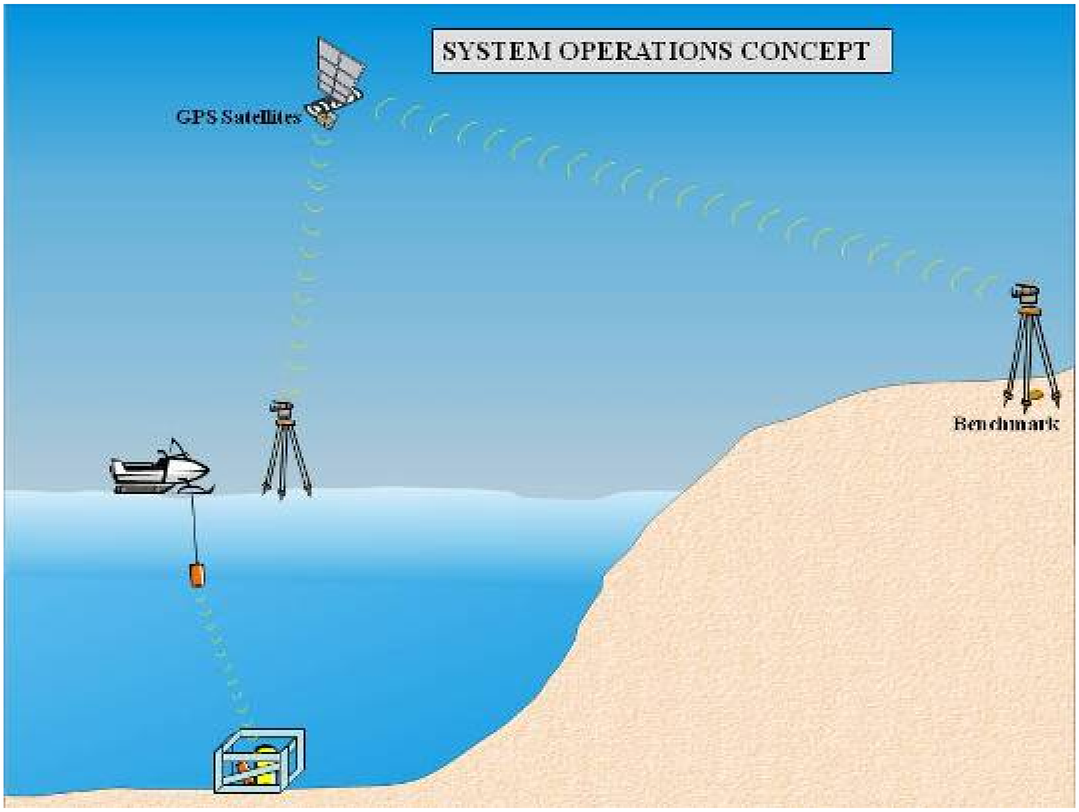


**Figure 10. Schematic of Point Barrow Testing Configuration.**

## E. Deep-ocean Assessment and Reporting of Tsunamis (DART®)

The Deep-ocean Assessment and Reporting of Tsunamis (DART®) is an ongoing, multi-agency cooperative effort to maintain and improve the capability for the early detection and real-time reporting of tsunamis in the open ocean. The DART® network is an essential component in the provision of timely warnings to U.S. coastal communities (http://www.ndbc.noaa.gov/DART/DART.shtml). DART® stations are sited to provide *in situ* tsunami detection and water-level observations for NOAA's tsunami forecast, warning, and mitigation responsibilities. DART® data support the NOAA Tsunami Program observation requirements for Tsunami Offshore Real-Time and Post-event observations, as well as GLOSS, as described in NOAA's Consolidated Observational Requirements List (CORL). DART® became operational in 2003, but beginning in 2005, a transition was made to the DART II system, which has two way communication capabilities. The U.S. currently operates 39 DART® systems in the Atlantic and Pacific Oceans, the Caribbean Sea, and the Gulf of Mexico (See Figure 11).

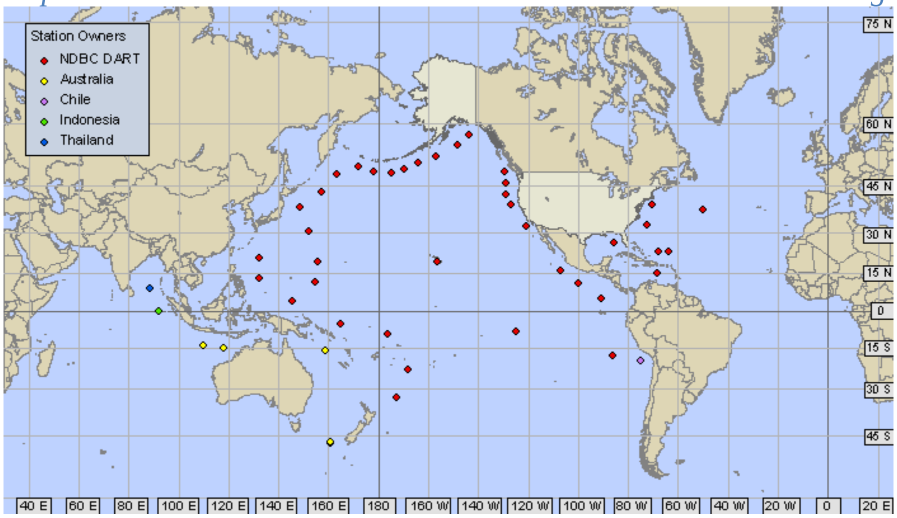


**Figure 11. Deep-ocean Assessment and Reporting of Tsunami (DART®) stations.**

Each DART® system consists of an anchored seafloor Bottom Pressure Recorder (BPR) acoustically coupled to a moored surface buoy (See Figure 12). Iridium transceivers and the acoustic modems provide real-time communication between each DART® system and the NOAA Tsunami Warning Centers (TWC) in Ewa Beach, Hawaii and Palmer, Alaska. Additionally they provide limited communications from the TWC to the BPR.

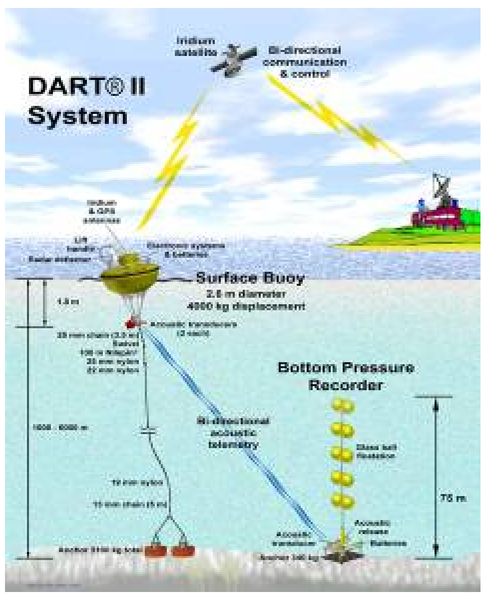


**Figure 12. Conceptual diagram of the DART® System.**

Sources of potentially damaging tsunamis are widespread, as are the coastal communities they threaten. With a limited number of DART® systems available to deploy and maintain, it is vital that they be positioned to provide high quality observations at the earliest possible time. Siting of the DART® buoys involves addressing:

- optimization of site locations based on scientific considerations
- logistical needs of deployment
- modeling and detection requirements imposed by potential sources of tsunamis
- the identification of at-risk coastal communities

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

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

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

While DART® technology was primarily developed to support tsunami warning and modeling, this and similar bottom-mounted pressure sensors have the capacity to play a significant role in the calibration of global climate models.

## V. Regional Activities

## A. Support of Regional Tsunami Warning Systems

### U.S. Tsunami Program

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

### New and Upgraded Tsunami Capable Tide Stations

Following the 2004 Indian Ocean tsunami disaster, the U.S. evaluated and strengthened its national tsunami warning system. NOAA is upgraded its existing National Water Level Observation Network (NWLON) tide stations with new Data Collection Platforms (DCPs) and communication technology, and fill gaps in the existing water level network with new tsunami-capable NWLON tide stations. NOAA's Tsunami Warning Centers also receive sea level data (1-minute averages transmitted every 5 minutes) from GLOSS stations operated by the University of Hawaii Sea Level Center (UHSLC). These tide stations, in addition to international tide stations in multiple countries, comprise an integrated coastal water level observation network, critical for tsunami detection and warning.

From 2005-2007, NOAA installed of16 new NWLON stations and 33 NWLON station upgrades, in support of the U.S. Tsunami Program. In addition to these priority locations, NOAA has been systematically upgrading NWLON stations along all U.S. Coasts, including its possessions and territories. There are currently 142 NWLON stations operating with full tsunami capabilities.

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

## IOC Tsunami Warning Systems

The IOC of UNESCO has successfully coordinated the Pacific Tsunami Warning System since 1965. After the 2004 Sumatra tsunami, IOC was mandated to assist Indian Ocean Member States in development of an Indian Ocean Tsunami Warning System. The effort began at the same time to develop Early Warning Systems for tsunami and other coastal hazards in both the Caribbean (CARIBE-EWS) and the Mediterranean and Northeast Atlantic Ocean (NEAMTWS). These TWSs, owned and operated by the Member States, collect, analyze, and disseminate seismic and sea level data in support of warning and preparedness. The U.S. has played an active role in the PTWS, IOTWS, and the CARIBE-EWS, both through collection of observations and providing tsunami warnings, and through provision of technical expertise.

## Sustainable Sea Level Observations

In support of the CARIBE-EWS, the U.S. through NOAA's National Ocean Service, plans to install a new, sustainable sea level station in the wider Caribbean region by 2010. Site selection was focused on providing maximum benefit to the region through enhanced warning products, and was founded on scientifically-assessed vulnerability. The primary candidate for the location of this tide station is Barbuda, in the country of Antigua and Barbuda. A site reconnaissance in 2009 will confirm the suitability of the site to sustaining a hardened sea level station for the foreseeable future.

## Puerto Rico Seismic Network of the University of Puerto Rico at Mayaguez

The Puerto Rico Seismic Network (PRSN) of the University of Puerto Rico at Mayagüez (UPRM) operates 6 sea level stations in Puerto Rico. The 6 tide gauge stations are NOS compliant and were funded by FEMA and the UPRM and installed and with the support and guidance of NOS/NOAA between 2006 and 2008 (Table 5). All of these stations also meet GLOSS standards for sea level observations and are currently providing data to appropriate warning centers and weather service offices. The data are transmitted every 6 minutes on GOES. The data can be accessed on the home page of the PRSN, http://redsismica.uprm.edu, Tides and Currents site of NOAA, http://tidesandcurrents.noaa.gov and Tides on Line site of NOAA http://tidesonline.nos.noaa.gov/monitor.html.

**Table 5. PRSN Sea Level Stations in Puerto Rico, USA.**

| Station | State | GOES ID | Transmission Interval | Station Number | Lat | Long |
|---|---|---|---|---|---|---|
| ARECIBO | PR | 3366454E | 6 min | 975-7809 | 18.48 N | 66.70 W |
| FAJARDO | PR | 3366C35A | 6 min | 975-3216 | 18.33 N | 65.63 W |
| MAYAGUEZ | PR | 336633DE | 6 min | 975-9394 | 18.22 N | 67.16 W |
| VIEQUES | PR | 3366D02C | 6 min | 975-2619 | 18.15 N | 65.44 W |
| PENUELAS | PR | 3366A6BC | 6 min | 975-B053 | 17.97 N | 66.76 W |
| YABUCOA | PR | 3366B5CA | 6 min | 975-422B | 18.05 N | 65.83 W |

Each station is equipped with an acoustic and pressure sensor, 2 DCP's, air and water temperature sensors. All stations also have a meteorology package consisting of a wind, air temperature/relative humidity, barometric and rain gauges. The power of the station is autonomous and runs off solar panels. Timing is provided with a GPS. For leveling purposes, each sea level station has 5 benchmarks which have all been observed with GPS. Second-order, class I levels were used in connections at all the stations.

A GOES receiver and central recording system is operational at the Puerto Rico Seismic Network to receive the data from these and 13 other sea level stations operated by NOAA and other sea level operators in the Caribbean and Adjacent regions. These stations are monitored 24/7 as part of the PRSN Earthquake and Tsunami Information and Warning System. XCONNECT software of Sutron is used for display and quality control of the data. The West Coast and Alaska Tsunami Warning Center software, Tide View, is used to mesh observed tsunami information with the forecast model and compare observed waves with predicted tide and estimated tsunami arrival times, as well as digitally filter the tsunami signal.

The PRSN also supports efforts to improve sea level observations in the Caribbean for tsunami and other coastal hazards. In 2008 it hosted the IOC-GLOSS-PRSN Caribbean Training Course for Operators of Sea Level Stations. In 2008 it also installed a NOAA/NOS and GLOSS compliant station in the Dominican Republic and provided the support for the installation of a similar station in Road Town, Tortola, British Virgin Islands. It maintains an inventory of sea level stations in the Caribbean and Adjacent regions for the UNESCO Intergovernmental Coordination Group for Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions.

## B. Climate Change Science Program

The U.S. Climate Change Science Program (CCSP) was launched in February 2002 as a collaborative federal interagency program, under a new cabinet-level organization designed to improve the government-wide management and dissemination of climate change science and related technology development. The mission of the CCSP is to “facilitate the creation and application of knowledge of the Earth’s global environment through research, observations, decision support, and communication”. Twenty-one (21) synthesis and assessment products (SAPs) were identified in the 2003*Strategic Plan for the U.S. Climate Change Science Program*, written to help achieve this mission. SAP (4.1), for which NOAA was one of the lead Agencies responsible for production of the report, is *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. The SAPs are intended to support informed discussion and decisions by policymakers, resource managers, stakeholders, the media, and the general public. The products help meet the requirements of the Global Change Research Act of 1990, which directs agencies to “produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change” and to undertake periodic scientific assessments. One of the major goals within the mission is to understand the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate and related global changes.

SAP (4.1), *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*, addresses this goal by providing a detailed assessment of the effects of sea-level rise on coastal environments and presenting some of the challenges that need to be addressed in order to adapt to sea-level rise while protecting environmental resources and sustaining economic growth. It is intended to provide the most current knowledge regarding the implications of rising sea level and possible adaptive responses, particularly in the mid-Atlantic region of the United States. The focus of this Product is to identify and review the potential impacts of future sea-level rise based on present scientific understanding. To do so, this Product evaluates several aspects of sea-level rise impacts to the natural environment and examines the impact to human land development along the coast. In addition, the Product addresses the connection between sea-level rise impacts and current adaptation strategies, and assesses the role of the existing coastal management policies in identifying and responding to potential challenges.

Another CCSP SAP that addresses impacts of sea-level rise is SAP 4.7 *Impacts of Climate Change and variability on Transportation Systems and Infrastructure: Gulf Coast Study.* This report includes specific discussion of impacts of sea level rise on the human built environment was well as other climate variables.

See http://www.climatescience.gov/.

## C. Contributions to an Arctic Observing System

NOAA has recently completed a draft action plan for the Arctic to specifically address climate change impacts. The study has found that a top priority requirement of virtually all stakeholders is a better understanding of what the future holds in terms of climate forecasts, sea ice and sea level projections. This information underpins decision-making in all sectors. Alaska’s state government, for example, is at the forefront of calls to action on addressing and mitigating impacts of climate change. The State of Alaska, academia, US Federal agencies with Alaskan and Arctic responsibilities (such as the Department of Interior, the U.S. Army Corps of Engineers and U.S. Coast Guard), industry, international partners and other users, have expressed concern that current NOAA and other available climate data are at too global a scale to guide Arctic management decisions. Higher resolution regional models are needed for guidance on climate change at scales important for planning, mitigating and adapting. Furthermore, the observed rate of warming and loss of sea ice over the past decade exceed all model projections, highlighting the need for improved global and regional models of climate change, sea ice loss and sea level rise.

Specifically to support the objectives of the action plan, the US should “Deliver the Fundamental Geospatial Framework supporting marine transportation, coastal community resilience, climate monitoring and assessments, sea level rise and storm surge levels, and many other uses by:

- Establishing an accurate vertical reference system for the region by collecting gravity data via airborne sensors for Alaska and the Arctic to efficiently allow Global Positioning System measurements to an accuracy of approximately 2cm
- Exploring potential cost-saving alternatives with partners such as USGS, the Naval Research Laboratory, and the state of Alaska for either direct funding to defray some of the cost and/or providing flight hours, equipment, and other types of in-kind support.
- Establishing Continuously Operating GPS Reference Stations (CORS) in Alaska for cost-effective, efficient and easy access to precise positioning; and co-locate tide stations with CORS to enable measurement and monitoring of sea level change
- Continuing development of new technology and procedures to acquire long term measurements of water level data in remote regions currently not possible with existing capabilities
- Siting 29 new National Water Level Observation Network stations per implementation plan to address gaps in water level data in the State of Alaska
- Updating tidal current predictions through tidal current surveys and short term observations

# *VI. APPENDIX 1: Status of NOAA/CO-OPS GLOSS Stations in the United States*

| GLOSS ID | Location | Status |
|---|---|---|
| 111 | Kwajelein | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (055A) data through 2005<br>• CRN station |
| 206 | San Juan, PR | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (245A) data through 2005 |
| 221 | Bermuda | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (259A) data through 2005<br>• CRN station |
| 302 | Adak, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (040A) data through 2005 |
| 149 | Apra Harbor, Guam | • Ongoing, station being rebuilt after a typhoon, currently using a digital/pressure bubbler gauge – redundant DCP to be installed<br>• PSMSL data through 2007<br>• JASL (053A) data through 2005<br>• CRN station |
| 219 | Duck Pier, NC | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (260A) data through 2005 |
| 289 | Fort Pulaski, GA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (752A) data through 2005 |
| 217 | Galveston Pier 21, TX | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JAS L(775A) data through 2005 |
| 287 | Hilo, HI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (060A) data through 2005 |
| 108 | Honolulu. HI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (057B) data through 2005<br>• CRN station |
| 109 | Johnston Island | No longer operated by NOAA – can no longer travel to the island |

| GLOSS ID | Location | Status |
|---|---|---|
| | | • PSMSL data through 2007<br>• JASL (052A) data through 2005 |
| 216 | Key West, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (242A) data through 2005<br>• CRN station |
| 159 | La Jolla, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (569A) data through 2005<br>• CRN station |
| 303 | Attu Island, AK | No longer operated by NOAA – station may be re-established using Tsunami funding in 2006<br>• PSMSL data through 1966<br>• 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.<br>• JASL Miami data through 1992<br>• JASL (755A) Virginia Key data 1996 through 2005 |
| 106 | Midway Island | • Ongoing, currently using an acoustic gauge with pressure gauge backup – redundant DCP to be installed in 2006.<br>• PSMSL data through 2007<br>• JASL (050A) data through 2005 |
| 290 | Newport, RI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (253A) data through 2005 |
| 74 | Nome, AK | • Ongoing, currently using a dual orifice digital/bubbler system<br>• PSMSL data through 2007<br>• JASL (0595A) data through 2001 |
| 144 | Pago Pago | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (056A) data through 2005 |
| 288 | Pensacola, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (762A) data through 2005<br>• 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<br>• PSMSL data through 2007<br>• JASL (579A) data through 2005 |
| 158 | San Francisco, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (551A) data through 2005 |

| GLOSS ID | Location | Status |
|---|---|---|
| | | • CRN station |
| 100 | Sand Point, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (574A) data through 2001 |
| 150 | Seward, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (560C) data through 2005 |
| 154 | Sitka, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (559A) data through 2005 |
| 157 | South Beach, OR | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (592A) data through 2005 |
| 102 | Unalaska, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (041B) data through 2005 |
| 220 | Atlantic City, NJ | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (264A) data through 2005<br>• CRN station |
| 105 | Wake Island | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• PSMSL data through 2007<br>• JASL (051A) data through 2005 |

# VII. APPENDIX 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<br>• JASL data through 2005 |
| 058A | Nawiliwili, HI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 059A | Kahului, HI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 061A | Mokuoloe, HI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 552A | Kawaihae, HI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 555A | Monterey, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 556A | Crescent City, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 557A | Port Orford, OR | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 558A | Neah Bay, WA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 561A | Seldovia, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 562A | Valdez. AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 564A | Willapa Bay, WA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 565A | Port San Luis, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 567A | Los Angeles, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2001 |
| 570A | Yakutat, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup |

| **JASL ID** | **Location** | **Status** |
|---|---|---|
| | | • JASL data through 2005 |
| 571A | Ketchikan, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 572A | Astoria, OR | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 573A | Arena Cove, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 575A | Charleston, OR | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 576A | Humboldt Bay, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 578A | Santa Monica, CA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 583B | Cordova, AK | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 594A | Platform Harvest, CA | • Ongoing, currently two DCP's with paroscientific pressure digital bubbler sensors<br>• JASL data through 1999 |
| 246A | Magueyes Island, PR | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 261A | Charleston, SC | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 240A | Fernandina Beach, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 252A | Portland, ME | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 254A | Limetree bay, VI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 255A | Charlotte Amalie, VI | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 279A | Montauk, NY | • Ongoing, currently using a acoustic gauge with pressure gauge |

| JASL ID | Location | Status |
|---|---|---|
| | | backup<br>• JASL data through 2005 |
| 740A | Eastport, ME | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 741A | Boston, MA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 742A | Woods Hole. MA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 743A | Nantucket, MA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 744A | New London, CT | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 745A | New York, NY | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005<br>• CRN station |
| 746A | Cape May, NJ | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 747A | Lewes, DE | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 749A | Chesapeake BBT, VA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 750A | Wilmington, NC | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 753A | Mayport, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 757A | Naples,FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 759A | St. Petersburg, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 760A | Appalachicola, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 761A | Panama City Beach, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 763A | Dauphin Island, AL | • Ongoing, currently using a acoustic gauge with pressure gauge |

| JASL ID | Location | Status |
|---|---|---|
| | | backup<br>• JASL data through 2005 |
| 765A | Grand Isle, LA | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 766A | Sabine Pass, TX | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 767A | Galveston Pleasure Pier, TX | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 769A | Rockport, TX | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 770A | Corpus Christi, TX | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 1999 |
| 772A | Port Isabel, TX | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 773A | Clearwater Beach FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| 774A | Port Canaveral, FL | • Ongoing, currently using a acoustic gauge with pressure gauge backup<br>• JASL data through 2005 |
| | Hampton Roads, VA | • CRN station for se level |

# VIII. APPENDIX 3: UHSLC Fast Delivery, JASL and Real-time datasets

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

**Joint Archive for Sea Level: Research Quality Data Set**

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

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

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

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

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 001A | Pxxx | 115 | Pohnpei-A | Fd St Micronesia | 06-59N | 158-14E | 1969-1971 | 100 | Scripps Inst. Ocean. |
| 001B | Pxxx | 115 | Pohnpei-B | Fd St Micronesia | 06-59N | 158-15E | 1974-2004 | 98 | UH Sea Level Center |
| 002A | Pxxx | 113 | Tarawa-A,Betio | Rep. of Kiribati | 01-22N | 172-56E | 1974-1983 | 78 | UH Sea Level Center |
| 002B | Pxxx | 113 | Tarawa-B,Bairiki | Rep. of Kiribati | 01-20N | 173-01E | 1983-1988 | 98 | UH Sea Level Center |
| 002C | Pxxx | 113 | Tarawa-C,Betio | Rep. of Kiribati | 01-22N | 172-56E | 1988-1997 | 100 | UH Sea Level Center |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 002D | Pxxx | 113 | Tarawa-D,Betio | Rep. of Kiribati | 01-22N | 172-56E | 1992-2004 | 91 | Nat. Tidal Ctr., BOM |
| 003A | Pxxx | 169 | Baltra-A | Ecuador | 00-26S | 090-17W | 1968-1977 | 93 | National Ocean Service |
| 003B | Pxxx | 169 | Baltra-B | Ecuador | 00-26S | 090-17W | 1985-2005 | 86 | UH Sea Level Center |
| 004A | Pxxx | 114 | Nauru-A | Rep. of Nauru | 00-32S | 166-54E | 1974-1995 | 95 | UH Sea Level Center |
| 004B | Pxxx | 114 | Nauru-B | Rep. of Nauru | 00-32S | 166-55E | 1993-2004 | 88 | Nat. Tidal Ctr., BOM |
| 005A | Pxxx | 112 | Majuro-A | Rep. Marshall I. | 07-06N | 171-22E | 1968-1999 | 92 | UH Sea Level Center |
| 005B | Pxxx | 112 | Majuro-B | Rep. Marshall I. | 07-07N | 171-22E | 1993-2004 | 97 | Nat. Tidal Ctr., BOM |
| 006A | Pxxx | xxx | Enewetok-A | Rep. Marshall I. | 11-26N | 162-23E | 1951-1971 | 98 | Scripps Inst. Ocean. |
| 006B | Pxxx | xxx | Enewetok-B | Rep. Marshall I. | 11-26N | 162-23E | 1974-1979 | 94 | UH Sea Level Center |
| 007A | Pxxx | 120 | Malakal-A | Rep. of Belau | 07-20N | 134-29E | 1926-1939 | 92 | Japan Ocean. Data Cen. |
| 007B | Pxxx | 120 | Malakal-B | Rep. of Belau | 07-20N | 134-28E | 1969-2003 | 95 | UH Sea Level Center |
| 008A | Pxxx | 119 | Yap-A | Fd St Micronesia | 09-31N | 138-08E | 1951-1952 | 100 | Scripps Inst. Ocean. |
| 008B | Pxxx | 119 | Yap-B | Fd St Micronesia | 09-31N | 138-08E | 1969-2004 | 92 | UH Sea Level Center |
| 009A | Pxxx | 66 | Honiara-A | Solomon Islands | 09-26S | 159-57E | 1974-1995 | 98 | UH Sea Level Center |
| 009B | Pxxx | 66 | Honiara-B | Solomon Islands | 09-25S | 159-57E | 1994-2004 | 97 | Nat. Tidal Ctr., BOM |
| 010A | Pxxx | 65 | Rabaul | Papua New Guinea | 04-12S | 152-11E | 1966-1997 | 85 | UH Sea Level Center |
| 011A | Pxxx | 146 | Christmas-A | Rep. of Kiribati | 01-59N | 157-29W | 1955-1972 | 89 | Scripps Inst. Ocean. |
| 011B | Pxxx | 146 | Christmas-B | Rep. of Kiribati | 01-59N | 157-28W | 1974-2003 | 96 | UH Sea Level Center |
| 012A | Pxxx | xxx | Fanning-A | Rep. of Kiribati | 03-54N | 159-23W | 1957-1958 | 88 | Scripps Inst. Ocean. |
| 012B | Pxxx | xxx | Fanning-B | Rep. of Kiribati | 03-54N | 159-23W | 1972-1987 | 95 | UH Sea Level Center |
| 012C | Pxxx | xxx | Fanning-C | Rep. of Kiribati | 03-51N | 159-22W | 1988-1990 | 78 | UH Sea Level Center |
| 013A | Pxxx | 145 | Kanton-A | Rep. of Kiribati | 02-49S | 171-43W | 1949-1967 | 99 | Scripps Inst. Ocean. |
| 013B | Pxxx | 145 | Kanton-B | Rep. of Kiribati | 02-49S | 171-43W | 1972-2001 | 93 | UH Sea Level Center |
| 014A | Pxxx | 107 | French Frigate S | USA | 23-52N | 166-17W | 1974-2001 | 97 | UH Sea Level Center |
| 015A | Pxxx | 140 | Papeete-A | French Polynesia | 17-32S | 149-34W | 1969-1975 | 91 | UH Sea Level Center |
| 015B | Pxxx | 140 | Papeete-B | French Polynesia | 17-32S | 149-34W | 1975-2002 | 98 | National Ocean Service |
| 016A | Pxxx | 138 | Rikitea | French Polynesia | 23-08S | 134-57W | 1969-2003 | 91 | UH Sea Level Center |
| 017A | Pxxx | xxx | Hiva Oa | French Polynesia | 09-49S | 139-02W | 1977-1980 | 75 | UH Sea Level Center |
| 018A | Pxxx | 122 | Suva-A | Fiji | 18-08S | 178-26E | 1972-1997 | 91 | National Ocean Service |
| 018B | Pxxx | 122 | Suva-B | Fiji | 18-08S | 178-26E | 1998-2004 | 99 | Nat. Tidal Ctr., BOM |
| 019A | Pxxx | 123 | Noumea | France | 22-18S | 166-26E | 1967-2003 | 99 | UH Sea Level Center |
| 021A | Pxxx | 176 | Juan Fernandez-A | Chile | 33-37S | 078-50W | 1977-1984 | 67 | UH Sea Level Center |
| 021B | Pxxx | 176 | Juan Fernandez-B | Chile | 33-37S | 078-50W | 1985-2002 | 89 | SHOA |
| 022A | Pxxx | 137 | Easter-A | Chile | 27-09S | 109-27W | 1957-1958 | 97 | SHOA |
| 022B | Pxxx | 137 | Easter-B | Chile | 27-09S | 109-27W | 1962-1963 | 100 | SHOA |
| 022C | Pxxx | 137 | Easter-C | Chile | 27-09S | 109-27W | 1970-2002 | 83 | SHOA |
| 023A | Pxxx | 139 | Rarotonga-A | Cook Islands | 21-12S | 159-47W | 1977-1997 | 98 | UH Sea Level Center |
| 023B | Pxxx | 139 | Rarotonga-B | Cook Islands | 21-12S | 159-47W | 1993-2004 | 99 | Nat. Tidal Ctr., BOM |
| 024A | Pxxx | 143 | Penrhyn | Cook Islands | 08-59S | 158-03W | 1977-2003 | 95 | UH Sea Level Center |
| 025A | Pxxx | 121 | Funafuti-A | Tuvalu | 08-32S | 179-12E | 1977-1999 | 97 | UH Sea Level Center |
| 025B | Pxxx | 121 | Funafuti-B | Tuvalu | 08-30S | 179-13E | 1993-2004 | 96 | Nat. Tidal Ctr., BOM |
| 026A | Pxxx | xxx | Honolulu,Kewalo | USA | 21-18N | 157-52W | 1978-1986 | 96 | UH Sea Level Center |
| 027A | Pxxx | xxx | Honolulu,Pier 45 | USA | 21-19N | 157-53W | 1985-1988 | 100 | UH Sea Level Center |
| 028A | Pxxx | 118 | Saipan-A | N. Mariana Is. | 15-13N | 145-44E | 1938-1940 | 97 | Japan Ocean. Data Cen. |
| 028B | Pxxx | 118 | Saipan-B | N. Mariana Is. | 15-14N | 145-45E | 1978-2003 | 93 | UH Sea Level Center |
| 029A | Pxxx | 117 | Kapingamarangi | Fd St Micronesia | 01-06N | 154-47E | 1978-2003 | 93 | UH Sea Level Center |
| 030A | Pxxx | xxx | Santa Cruz | Ecuador | 00-45S | 090-19W | 1978-2004 | 95 | UH Sea Level Center |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 031A | Pxxx | 142 | Nuku Hiva | French Polynesia | 08-56S | 140-05W | 1982-1997 | 70 | UH Sea Level Center |
| 033A | Pxxx | 69 | Bitung | Indonesia | 01-26N | 125-12E | 1986-2001 | 43 | BAKOSURTANAL |
| 034A | Pxxx | 161 | Cabo San Lucas | Mexico | 22-53N | 109-55W | 1973-2003 | 81 | CICESE |
| 035A | Pxxx | 177 | San Felix | Chile | 26-17S | 080-08W | 1987-2002 | 79 | SHOA |
| 036A | Pxxx | 160 | Guadalupe | Mexico | 28-53N | 118-18W | 1977-1985 | 75 | CICESE |
| 038A | Pxxx | xxx | Nuku'alofa | Tonga | 21-08S | 175-11W | 1990-2004 | 97 | Nat. Tidal Ctr., BOM |
| 039A | Pxxx | xxx | Kodiak,Alaska | USA | 57-44N | 152-31W | 1975-2005 | 83 | National Ocean Service |
| 040A | Pxxx | 302 | Adak,Alaska | USA | 51-52N | 176-38W | 1950-2005 | 91 | National Ocean Service |
| 041A | Pxxx | 102 | Dutch Harbor-A,AK | USA | 53-53N | 166-32W | 1950-1955 | 100 | National Ocean Service |
| 041B | Pxxx | 102 | Dutch Harbor-B,AK | USA | 53-53N | 166-32W | 1982-2005 | 96 | National Ocean Service |
| 043A | Pxxx | xxx | Palmyra | USA Trust | 05-53N | 162-05W | 1947-1949 | 95 | National Ocean Service |
| 046A | Pxxx | 917 | Port Vila-A | Vanuatu | 17-44S | 168-19E | 1977-1982 | 87 | unconfirmed |
| 046B | Pxxx | 917 | Port Vila-B | Vanuatu | 17-46S | 168-18E | 1993-2004 | 92 | Nat. Tidal Ctr., BOM |
| 047A | Pxxx | 103 | Chichijima | Japan | 27-06N | 142-11E | 1975-2003 | 99 | Japan Meteor. Agency |
| 048A | Pxxx | xxx | Anewa Bay | Papua New Guinea | 06-11S | 155-53E | 1968-1977 | 84 | UH Sea Level Center |
| 049A | Pxxx | 104 | Minamitorishima | Japan | 24-18N | 153-59E | 1997-2003 | 91 | Japan Meteor. Agency |
| 050A | Pxxx | 106 | Midway | USA Trust | 28-13N | 177-22W | 1947-2004 | 93 | National Ocean Service |
| 051A | Pxxx | 105 | Wake | USA Trust | 19-17N | 166-37E | 1950-2004 | 93 | National Ocean Service |
| 052A | Pxxx | 109 | Johnston | USA Trust | 16-44N | 169-32W | 1947-2003 | 94 | National Ocean Service |
| 053A | Pxxx | 149 | Guam | USA Trust | 13-26N | 144-39E | 1948-2005 | 92 | National Ocean Service |
| 054A | Pxxx | 116 | Truk | Fd St Micronesia | 07-27N | 151-51E | 1963-1991 | 89 | National Ocean Service |
| 055A | Pxxx | 111 | Kwajalein | Rep. Marshall I. | 08-44N | 167-44E | 1946-2005 | 98 | National Ocean Service |
| 056A | Pxxx | 144 | Pago Pago | USA Trust | 14-17S | 170-41W | 1948-2005 | 95 | National Ocean Service |
| 057A | Pxxx | 108 | Honolulu-A | USA | 21-18N | 157-52W | 1877-1892 | 32 | National Ocean Service |
| 057B | Pxxx | 108 | Honolulu-B | USA | 21-18N | 157-52W | 1905-2005 | 98 | National Ocean Service |
| 058A | Pxxx | xxx | Nawiliwili | USA | 21-58N | 159-21W | 1954-2005 | 99 | National Ocean Service |
| 059A | Pxxx | xxx | Kahului | USA | 20-54N | 156-28W | 1950-2005 | 92 | National Ocean Service |
| 060A | Pxxx | 287 | Hilo | USA | 19-44N | 155-04W | 1927-2005 | 81 | National Ocean Service |
| 061A | Pxxx | xxx | Mokuoloe | USA | 21-26N | 157-48W | 1957-2005 | 79 | National Ocean Service |
| 062A | Pxxx | 124 | Norfolk Island-A | Australia | 29-04S | 167-57E | 1985-1986 | 98 | CSIRO |
| 062B | Pxxx | 124 | Norfolk Island-B | Australia | 29-04S | 167-56E | 1994-1999 | 100 | CSIRO |
| 063A | Pxxx | xxx | Wewak | Papua New Guinea | 03-34S | 143-38E | 1984-1994 | 82 | CSIRO |
| 064A | Pxxx | xxx | Port Moresby | Papua New Guinea | 09-29S | 147-08E | 1984-1993 | 98 | CSIRO |
| 065A | Pxxx | xxx | Manus | Papua New Guinea | 02-01S | 147-16E | 1984-1994 | 73 | CSIRO |
| 066A | Pxxx | xxx | Madang | Papua New Guinea | 05-12S | 145-48E | 1984-1998 | 81 | CSIRO |
| 067A | Pxxx | xxx | Lae | Papua New Guinea | 06-44S | 146-59E | 1984-1997 | 83 | CSIRO |
| 068A | Pxxx | xxx | Kavieng | Papua New Guinea | 02-35S | 150-48E | 1984-1994 | 95 | CSIRO |
| 069A | Pxxx | 63 | Alotau | Papua New Guinea | 10-10S | 150-27E | 1984-1995 | 62 | CSIRO |
| 070A | Pxxx | 127 | Auckland | New Zealand | 36-51S | 174-46E | 1984-1988 | 100 | Royal New Zealand Navy |
| 071A | Pxxx | 101 | Wellington | New Zealand | 41-17S | 174-47E | 1944-2005 | 97 | Royal New Zealand Navy |
| 072A | Pxxx | 129 | Bluff | New Zealand | 46-36S | 168-21E | 1984-2005 | 51 | Royal New Zealand Navy |
| 073A | Pxxx | xxx | Tauranga | New Zealand | 37-39S | 176-11E | 1984-2005 | 84 | Royal New Zealand Navy |
| 074A | Pxxx | xxx | Westport | New Zealand | 41-44S | 171-36E | 1984-1985 | 100 | Royal New Zealand Navy |
| 075A | Pxxx | xxx | Wanganui | New Zealand | 39-57S | 174-59E | 1984-1985 | 97 | Royal New Zealand Navy |
| 076A | Pxxx | xxx | Taranaki | New Zealand | 39-03S | 174-02E | 1984-1985 | 79 | Royal New Zealand Navy |
| 077A | Pxxx | xxx | Port Nelson | New Zealand | 41-16S | 173-16E | 1984-1985 | 97 | Royal New Zealand Navy |
| 078A | Pxxx | xxx | Gisborne | New Zealand | 38-41S | 178-02E | 1984-1985 | 98 | Royal New Zealand Navy |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 079A | Pxxx | 128 | Chatham | New Zealand | 43-57S | 176-34W | 2001-2003 | 38 | UH Sea Level Center |
| 080A | Pxxx | 174 | Antofagasta | Chile | 23-39S | 070-24W | 1945-2002 | 93 | SHOA |
| 081A | Pxxx | 175 | Valparaiso | Chile | 33-02S | 071-38W | 1944-2002 | 84 | SHOA |
| 082A | Pxxx | 182 | Acajutla | El Salvador | 13-35N | 089-50W | 1971-2001 | 87 | Inst. Geograf. Nacional |
| 083A | Pxxx | xxx | Arica | Chile | 18-28S | 070-20W | 1982-1998 | 98 | SHOA |
| 084A | Pxxx | xxx | Lobos de Afuera | Peru | 06-56S | 080-43W | 1982-2003 | 97 | DHNM |
| 085A | Pxxx | 170 | Buenaventura | Colombia | 03-54N | 077-06W | 1953-2000 | 92 | IDEAM |
| 086A | Pxxx | xxx | La Union | El Salvador | 13-20N | 087-49W | 1954-1980 | 77 | National Ocean Service |
| 087A | Pxxx | 167 | Quepos | Costa Rica | 09-24N | 084-10W | 1961-1994 | 83 | SERMAR |
| 088A | Pxxx | xxx | Caldera | Chile | 27-04S | 070-50W | 1980-1998 | 97 | SHOA |
| 089A | Pxxx | xxx | Manta | Ecuador | 00-57S | 080-44W | 1979-1981 | 100 | INOCAR |
| 090A | Pxxx | 162 | Socorro | Mexico | 18-44N | 111-01W | 1957-1959 | 81 | CICESE |
| 091A | Pxxx | 172 | La Libertad | Ecuador | 02-12S | 080-55W | 1949-2003 | 97 | INOCAR |
| 092A | Pxxx | xxx | Talara-A | Peru | 04-35S | 081-17W | 1950-1965 | 92 | National Ocean Service |
| 092B | Pxxx | xxx | Talara-B | Peru | 04-35S | 081-17W | 1988-2002 | 74 | DHNM |
| 093A | Pxxx | 173 | Callao-A | Peru | 12-03S | 077-09W | 1950-1965 | 97 | National Ocean Service |
| 093B | Pxxx | 173 | Callao-B | Peru | 12-03S | 077-09W | 1970-2003 | 99 | DHNM |
| 094A | Pxxx | xxx | Matarani-A | Peru | 17-00S | 072-07W | 1954-1964 | 98 | National Ocean Service |
| 094B | Pxxx | xxx | Matarani-B | Peru | 17-00S | 072-07W | 1992-2002 | 81 | DHNM |
| 096A | Pxxx | xxx | San Juan | Peru | 15-22S | 075-12W | 1978-2002 | 80 | DHNM |
| 300A | Pxxx | xxx | Naos-A | Panama | 08-55N | 079-32W | 1961-1965 | 99 | Scripps Inst. Ocean. |
| 300B | Pxxx | xxx | Naos-B | Panama | 08-55N | 079-32W | 1991-1997 | 84 | National Ocean Service |
| 301A | Pxxx | xxx | Puerto Quetzal-A | Guatemala | 13-55N | 090-47W | 1983-1984 | 90 | UH Sea Level Center |
| 301B | Pxxx | xxx | Puerto Quetzal-B | Guatemala | 13-55N | 090-47W | 1992-1995 | 77 | UH Sea Level Center |
| 302A | Pxxx | 168 | Balboa | Panama | 08-58N | 079-34W | 1907-1997 | 98 | Panama Canal Commission |
| 303A | Pxxx | 171 | Tumaco | Colombia | 01-50N | 078-44W | 1951-2000 | 86 | IDEAM |
| 304A | Pxxx | xxx | Pto. Armuelles-A | Panama | 08-16N | 082-52W | 1955-1968 | 95 | Inst. Geograf. Nac. |
| 304B | Pxxx | xxx | Pto. Armuelles-B | Panama | 08-16N | 082-52W | 1983-2001 | 94 | Inst. Geograf. Nac. |
| 305A | Pxxx | xxx | Cedros Island | Mexico | 28-06N | 115-11W | 1976-1989 | 75 | CICESE |
| 307A | Pxxx | xxx | San Felipe | Mexico | 31-01N | 114-49W | 1982-1986 | 52 | UNAM |
| 308A | Pxxx | xxx | San Quintin | Mexico | 30-29N | 115-59W | 1977-1990 | 97 | CICESE |
| 310A | Pxxx | xxx | Bahia Los Angeles | Mexico | 28-58N | 113-33W | 1973-1994 | 74 | CICESE |
| 313A | Pxxx | xxx | Catalina-A | USA | 33-27N | 118-29W | 1978-1979 | 96 | Scripps Inst. Ocean. |
| 313B | Pxxx | xxx | Catalina-B | USA | 33-27N | 118-29W | 1980-1988 | 86 | Scripps Inst. Ocean. |
| 316A | Pxxx | 267 | Acapulco-A,Gro. | Mexico | 16-50N | 099-55W | 1952-1995 | 91 | UNAM |
| 316B | Pxxx | 267 | Acapulco-B,Gro. | Mexico | 16-50N | 099-55W | 1999-2005 | 88 | Secretaria de Marina |
| 317A | Pxxx | xxx | Ensenada | Mexico | 31-51N | 116-38W | 1956-1991 | 84 | UNAM |
| 318A | Pxxx | xxx | Puerto Madero | Mexico | 14-43N | 092-26W | 1986-1988 | 99 | UNAM |
| 319A | Pxxx | xxx | Loreto | Mexico | 26-01N | 111-22W | 1975-1988 | 73 | CICESE |
| 320A | Pxxx | 293 | Cendering | Malaysia | 05-16N | 103-11E | 1984-2005 | 99 | Dept. Survey/Mapping |
| 321A | Pxxx | xxx | Johor Baharu | Malaysia | 01-28N | 103-48E | 1983-2005 | 95 | Dept. Survey/Mapping |
| 322A | Pxxx | xxx | Kuantan | Malaysia | 03-59N | 103-26E | 1983-2005 | 98 | Dept. Survey/Mapping |
| 323A | Pxxx | xxx | Tioman | Malaysia | 02-48N | 104-08E | 1985-2005 | 97 | Dept. Survey/Mapping |
| 324A | Pxxx | xxx | Sedili | Malaysia | 01-56N | 104-07E | 1986-2005 | 98 | Dept. Survey/Mapping |
| 325A | Pxxx | xxx | Kukup | Malaysia | 01-20N | 103-27E | 1985-2005 | 97 | Dept. Survey/Mapping |
| 326A | Pxxx | xxx | Geting | Malaysia | 06-14N | 102-06E | 1986-2004 | 99 | Dept. Survey/Mapping |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 327A | Pxxx | 44 | Keppel Harbour | Singapore | 01-16N | 103-49E | 1981-1990 | 99 | Port Singapore Auth. |
| 328A | Pxxx | 39 | Ko Lak | Thailand | 11-48N | 099-49E | 1985-2005 | 95 | Naval Hydro. Dept. |
| 329A | Pxxx | 77 | Hong Kong-A | China | 22-18N | 114-12E | 1962-1985 | 97 | Hong Kong Observatory |
| 329B | Pxxx | 77 | Hong Kong-B | China | 22-18N | 114-13E | 1986-2006 | 99 | Hong Kong Observatory |
| 331A | Pxxx | 58 | Brisbane | Australia | 27-22S | 153-10E | 1984-2003 | 97 | Nat. Tidal Ctr., BOM |
| 332A | Pxxx | 59 | Bundaberg | Australia | 24-50S | 152-21E | 1984-2003 | 98 | Nat. Tidal Ctr., BOM |
| 333A | Pxxx | 57 | Fort Denison | Australia | 33-51S | 151-14E | 1965-2003 | 94 | Nat. Tidal Ctr., BOM |
| 334A | Pxxx | 60 | Townsville | Australia | 19-16S | 146-50E | 1984-2002 | 99 | Nat. Tidal Ctr., BOM |
| 335A | Pxxx | 56 | Spring Bay | Australia | 42-33S | 147-56E | 1985-2003 | 95 | Nat. Tidal Ctr., BOM |
| 336A | Pxxx | 61 | Booby Island | Australia | 10-36S | 141-55E | 1988-2004 | 91 | Nat. Tidal Ctr., BOM |
| 337A | Pxxx | 44 | Victoria Dock | Singapore | 01-16N | 103-49E | 1972-1981 | 95 | Port Singapore Auth. |
| 338A | Pxxx | xxx | Macau | Portugal | 22-10N | 113-33E | 1978-1985 | 80 | Inst. Hidro. Marinha |
| 339A | Pxxx | 902 | Hobart | Australia | 42-53S | 147-20E | 1985-1999 | 82 | Nat. Tidal Ctr., BOM |
| 340A | Pxxx | xxx | Kaohsiung | Rep. of China | 22-37N | 120-17E | 1980-2005 | 99 | Central Weather Bureau |
| 341A | Pxxx | xxx | Keelung | Rep. of China | 25-09N | 121-45E | 1980-2005 | 82 | Central Weather Bureau |
| 347A | Pxxx | 327 | Abashiri | Japan | 44-01N | 144-17E | 1968-2003 | 97 | Japan Meteor. Agency |
| 348A | Pxxx | 326 | Hamada | Japan | 34-54N | 132-04E | 1984-2003 | 95 | Japan Meteor. Agency |
| 349A | Pxxx | 325 | Toyama | Japan | 36-46N | 137-13E | 1967-2003 | 98 | Japan Meteor. Agency |
| 350A | Pxxx | 89 | Kushiro | Japan | 42-58N | 144-23E | 1963-2003 | 97 | Japan Meteor. Agency |
| 351A | Pxxx | 87 | Ofunato | Japan | 39-01N | 141-45E | 1965-2003 | 99 | Japan Meteor. Agency |
| 352A | Pxxx | 86 | Mera | Japan | 34-55N | 139-50E | 1965-2003 | 93 | Japan Meteor. Agency |
| 353A | Pxxx | 85 | Kushimoto | Japan | 33-28N | 135-47E | 1961-2003 | 97 | Japan Meteor. Agency |
| 354A | Pxxx | 82 | Aburatsu | Japan | 31-34N | 131-25E | 1961-2003 | 99 | Japan Meteor. Agency |
| 355A | Pxxx | 81 | Naha | Japan | 26-13N | 127-40E | 1966-2003 | 100 | Japan Meteor. Agency |
| 356A | Pxxx | xxx | Maisaka | Japan | 34-41N | 137-37E | 1968-2003 | 96 | Japan Meteor. Agency |
| 357A | Pxxx | xxx | Miyakejima | Japan | 34-04N | 139-29E | 1964-2003 | 98 | Japan Ocean. Data Cen. |
| 358A | Pxxx | xxx | Hosojima | Japan | 32-25N | 131-41E | 1933-1975 | 86 | Japan Ocean. Data Cen. |
| 359A | Pxxx | 911 | Naze | Japan | 28-23N | 129-30E | 1957-2003 | 93 | Japan Ocean. Data Cen. |
| 360A | Pxxx | 324 | Wakkanai | Japan | 45-25N | 141-41E | 1967-2003 | 98 | Japan Meteor. Agency |
| 362A | Pxxx | 83 | Nagasaki | Japan | 32-44N | 129-52E | 1985-2003 | 100 | Japan Meteor. Agency |
| 363A | Pxxx | 912 | Nishinoomote | Japan | 30-44N | 130-60E | 1965-2003 | 98 | Japan Meteor. Agency |
| 364A | Pxxx | 88 | Hakodate | Japan | 41-47N | 140-44E | 1964-2003 | 93 | Japan Meteor. Agency |
| 365A | Pxxx | xxx | Ishigaki | Japan | 24-20N | 124-09E | 1969-2003 | 100 | Japan Meteor. Agency |
| 370A | Pxxx | 73 | Manila | Philippines | 14-35N | 120-58E | 1984-2002 | 89 | Ocean. Surveys Div. |
| 371A | Pxxx | 72 | Legaspi | Philippines | 13-09N | 123-45E | 1984-2004 | 87 | Ocean. Surveys Div. |
| 372A | Pxxx | 71 | Davao | Philippines | 07-05N | 125-38E | 1984-1997 | 73 | Ocean. Surveys Div. |
| 373A | Pxxx | 70 | Jolo | Philippines | 06-04N | 121-00E | 1984-1995 | 86 | Ocean. Surveys Div. |
| 375A | Pxxx | xxx | Hachinohe | Japan | 40-32N | 141-32E | 1980-2003 | 100 | Japan Meteor. Agency |
| 376A | Pxxx | 247 | Xiamen | China | 24-27N | 118-04E | 1954-1997 | 100 | PRC NODC |
| 379A | Pxxx | xxx | Cebu | Philippines | 10-18N | 123-55E | 1998-2004 | 81 | Ocean. Surveys Div. |
| 380A | Pxxx | xxx | Puerto Princesa | Philippines | 09-45N | 118-44E | 1998-2002 | 83 | Ocean. Surveys Div. |
| 381A | Pxxx | 75 | Qui Nohn | Vietnam | 13-46N | 109-15E | 1994-2000 | 28 | Mar. Hydromet. Center |
| 385A | Pxxx | xxx | Tawau | Malaysia | 04-14N | 117-53E | 1987-2005 | 94 | Dept. Survey/Mapping |
| 386A | Pxxx | xxx | Kota Kinabalu | Malaysia | 05-59N | 116-04E | 1987-2005 | 91 | Dept. Survey/Mapping |
| 387A | Pxxx | xxx | Bintulu | Malaysia | 03-13N | 113-04E | 1992-2005 | 88 | Dept. Survey/Mapping |
| 388A | Pxxx | xxx | Miri | Malaysia | 04-24N | 113-58E | 1992-1998 | 91 | Dept. Survey/Mapping |
| 389A | Pxxx | xxx | Sandakan | Malaysia | 05-49N | 118-04E | 1993-2005 | 97 | Dept. Survey/Mapping |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 391A | Pxxx | 165 | Clipperton-A | France | 10-17N | 109-13W | 1985-1985 | 47 | NOAA/PMEL |
| 391B | Pxxx | 165 | Clipperton-B | France | 10-17N | 109-13W | 1986-1988 | 100 | NOAA/PMEL |
| 393A | Pxxx | xxx | Puerto Vallarta | Mexico | 20-37N | 105-15W | 1973-1991 | 40 | UNAM |
| 394A | Pxxx | xxx | Salina Cruz | Mexico | 16-10N | 095-12W | 1952-1991 | 81 | UNAM |
| 395A | Pxxx | 163 | Manzanillo-A | Mexico | 19-03N | 104-20W | 1953-1982 | 95 | UNAM |
| 395B | Pxxx | 163 | Manzanillo-B | Mexico | 19-03N | 104-20W | 1992-2001 | 74 | National Ocean Service |
| 396A | Pxxx | xxx | Puntarenas | Costa Rica | 09-58N | 084-50W | 1970-1980 | 71 | SERMAR |
| 397A | Pxxx | xxx | Guaymas | Mexico | 27-56N | 110-54W | 1953-1986 | 81 | UNAM |
| 398A | Pxxx | xxx | Marsden Point | New Zealand | 35-50S | 174-30E | 1984-1985 | 99 | Royal New Zealand Navy |
| 399A | Pxxx | 148 | Lord Howe-A | Australia | 31-31S | 159-04E | 1958-1967 | 80 | Scripps Inst. Ocean. |
| 399B | Pxxx | 148 | Lord Howe-B | Australia | 31-31S | 159-04E | 1991-1994 | 99 | Nat. Tidal Ctr., BOM |
| 400A | Pxxx | xxx | Lombrum | Papua New Guinea | 02-02S | 147-23E | 1994-2004 | 91 | Nat. Tidal Ctr., BOM |
| 401A | Pxxx | xxx | Apia-A | Western Samoa | 13-49S | 171-45W | 1954-1971 | 88 | Scripps Inst. Ocean. |
| 401B | Pxxx | xxx | Apia-B | Western Samoa | 13-49S | 171-45W | 1993-2004 | 98 | Nat. Tidal Ctr., BOM |
| 402A | Pxxx | xxx | Lautoka | Fiji | 17-36S | 177-26E | 1992-2004 | 99 | Nat. Tidal Ctr., BOM |
| 403A | Pxxx | xxx | Jackson | New Zealand | 43-59S | 168-37E | 2004-2004 | 100 | Nat. Tidal Ctr., BOM |
| 410A | Pxxx | xxx | Lungsurannaga | Indonesia | 02-06N | 117-45E | 1943-1944 | 95 | Japan Ocean. Data Cen. |
| 411A | Pxxx | xxx | Balikpapan | Indonesia | 01-16S | 116-48E | 1942-1943 | 100 | Japan Ocean. Data Cen. |
| 414A | Pxxx | xxx | Bajor | Indonesia | 00-41S | 117-25E | 1943-1944 | 97 | Japan Ocean. Data Cen. |
| 540A | Pxxx | 155 | Prince Rupert-A | Canada | 54-19N | 130-20W | 1910-1918 | 79 | MEDS |
| 540B | Pxxx | 155 | Prince Rupert-B | Canada | 54-19N | 130-20W | 1963-1999 | 99 | MEDS |
| 542A | Pxxx | 156 | Tofino | Canada | 49-09N | 125-55W | 1963-1999 | 94 | MEDS |
| 543A | Pxxx | xxx | Victoria,BC | Canada | 48-25N | 123-22W | 1909-1964 | 98 | MEDS |
| 550A | Pxxx | 303 | Massacre Bay,AK | USA | 52-50N | 173-12E | 1943-1966 | 87 | National Ocean Service |
| 551A | Pxxx | 158 | San Francisco,CA | USA | 37-48N | 122-28W | 1901-2004 | 99 | National Ocean Service |
| 552A | Pxxx | xxx | Kawaihae,HI | USA | 20-02N | 155-50W | 1989-2005 | 89 | National Ocean Service |
| 553A | Pxxx | xxx | Port Allen,HI | USA | 21-54N | 159-36W | 1989-1997 | 97 | National Ocean Service |
| 555A | Pxxx | xxx | Monterey,CA | USA | 36-36N | 121-53W | 1973-2005 | 99 | National Ocean Service |
| 556A | Pxxx | xxx | Crescent City,CA | USA | 41-45N | 124-11W | 1933-2005 | 90 | National Ocean Service |
| 557A | Pxxx | xxx | Port Orford,OR | USA | 42-44N | 124-30W | 1996-2005 | 69 | National Ocean Service |
| 558A | Pxxx | xxx | Neah Bay,WA | USA | 48-22N | 124-37W | 1934-2005 | 97 | National Ocean Service |
| 559A | Pxxx | 154 | Sitka,AK | USA | 57-03N | 135-21W | 1950-2005 | 92 | National Ocean Service |
| 560A | Pxxx | 150 | Seward-A,AK | USA | 60-07N | 149-26W | 1925-1932 | 98 | National Ocean Service |
| 560B | Pxxx | 150 | Seward-B,AK | USA | 60-07N | 149-26W | 1944-1949 | 76 | National Ocean Service |
| 560C | Pxxx | 150 | Seward-C,AK | USA | 60-07N | 149-26W | 1967-2005 | 87 | National Ocean Service |
| 561A | Pxxx | xxx | Seldovia,AK | USA | 59-26N | 151-43W | 1979-2005 | 99 | National Ocean Service |
| 562A | Pxxx | xxx | Valdez,AK | USA | 61-08N | 146-22W | 1996-2004 | 98 | National Ocean Service |
| 564A | Pxxx | xxx | Willapa Bay,WA | USA | 46-43N | 123-58W | 1996-2005 | 100 | National Ocean Service |
| 565A | Pxxx | xxx | Port San Luis,CA | USA | 35-11N | 120-46W | 1983-2005 | 86 | National Ocean Service |
| 567A | Pxxx | xxx | Los Angeles,CA | USA | 33-43N | 118-16W | 1923-2001 | 98 | National Ocean Service |
| 569A | Pxxx | 159 | San Diego,CA | USA | 32-43N | 117-10W | 1906-2005 | 97 | National Ocean Service |
| 570A | Pxxx | xxx | Yakutat,AK | USA | 59-33N | 139-44W | 1961-2005 | 91 | National Ocean Service |
| 571A | Pxxx | xxx | Ketchikan,AK | USA | 55-20N | 131-38W | 1918-2005 | 73 | National Ocean Service |
| 572A | Pxxx | xxx | Astoria,OR | USA | 46-13N | 123-46W | 1925-2005 | 97 | National Ocean Service |
| 573A | Pxxx | xxx | Arena Cove,CA | USA | 38-55N | 123-43W | 1996-2005 | 100 | National Ocean Service |
| 574A | Pxxx | 100 | Sand Point,AK | USA | 55-20N | 160-30W | 1996-2001 | 100 | National Ocean Service |
| 575A | Pxxx | xxx | Charleston,OR | USA | 43-21N | 124-19W | 1978-2004 | 98 | National Ocean Service |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 576A | Pxxx | xxx | Humboldt Bay,CA | USA | 40-46N | 124-13W | 1993-2005 | 100 | National Ocean Service |
| 577A | Pxxx | xxx | Santa Barbara,CA | USA | 34-25N | 119-41W | 1996-2005 | 27 | National Ocean Service |
| 578A | Pxxx | xxx | Santa Monica,CA | USA | 34-01N | 118-30W | 1995-2005 | 97 | National Ocean Service |
| 579A | Pxxx | 151 | Prudhoe Bay,AK | USA | 70-24N | 148-32W | 1993-2005 | 99 | National Ocean Service |
| 583A | Pxxx | xxx | Cordova-A,AK | USA | 60-34N | 145-45W | 1949-1953 | 94 | National Ocean Service |
| 583B | Pxxx | xxx | Cordova-B,AK | USA | 60-34N | 145-45W | 1964-2005 | 85 | National Ocean Service |
| 590A | Pxxx | xxx | Matavai | French Polynesia | 17-31S | 149-31W | 1958-1967 | 65 | Scripps Inst. Ocean. |
| 592A | Pxxx | 157 | South Beach,OR | USA | 44-38N | 124-03W | 1967-2005 | 99 | National Ocean Service |
| 594A | Pxxx | xxx | Harvest Oil P.,CA | USA | 34-28N | 120-40W | 1995-1999 | 20 | National Ocean Service |
| 595A | Pxxx | 74 | Nome, AK | USA | 64-30N | 165-26W | 1992-2001 | 68 | National Ocean Service |
| 599A | Pxxx | 180 | Diego Ramirez | Chile | 56-31S | 068-43W | 1991-1997 | 95 | SHOA |
| 626A | Pxxx | 309 | Providenya-A | Russia | 64-24N | 173-12E | 1977-1985 | 100 | Inst. Hydromet. Infor. |
| 630A | Pxxx | 79 | Dalian-A | China | 38-56N | 121-40E | 1975-1990 | 98 | PRC NODC |
| 631A | Pxxx | 79 | Laohutan-A | China | 38-52N | 121-41E | 1991-1997 | 100 | PRC NODC |
| 632A | Pxxx | 94 | Kanmen-A | China | 28-05N | 121-17E | 1975-1997 | 100 | PRC NODC |
| 633A | Pxxx | 283 | Lusi-A | China | 32-08N | 121-37E | 1975-1996 | 98 | PRC NODC |
| 635A | Pxxx | 78 | Zhapo-A | China | 21-35N | 111-50E | 1975-1997 | 100 | PRC NODC |
| 636A | Pxxx | xxx | Beihai | China | 21-29N | 109-05E | 1975-1997 | 100 | PRC NODC |
| 637A | Pxxx | xxx | Dongfang | China | 19-06N | 108-37E | 1975-1997 | 100 | PRC NODC |
| 638A | Pxxx | xxx | Haikou | China | 20-01N | 110-17E | 1976-1997 | 100 | PRC NODC |
| 639A | Pxxx | xxx | Lianyungang | China | 34-45N | 119-25E | 1975-1997 | 99 | PRC NODC |
| 641A | Pxxx | xxx | Shanwei | China | 22-45N | 115-21E | 1975-1997 | 98 | PRC NODC |
| 642A | Pxxx | xxx | Shijiusuo | China | 35-23N | 119-33E | 1975-1997 | 99 | PRC NODC |
| 650A | Pxxx | xxx | Hon Dau-A | Vietnam | 20-40N | 106-49E | 1960-1960 | 100 | Mar. Hydromet. Center |
| 650B | Pxxx | xxx | Hon Dau-B | Vietnam | 20-40N | 106-49E | 1995-1995 | 75 | TEDIPORT |
| 651A | Pxxx | xxx | Vung Ang | Vietnam | 18-05N | 106-17E | 1996-1997 | 100 | TEDIPORT |
| 652A | Pxxx | xxx | Vung Tau | Vietnam | 10-20N | 107-04E | 1992-1992 | 100 | TEDIPORT |
| 670A | Pxxx | xxx | Champerico | Guatemala | 14-18N | 091-55W | 1974-1975 | 98 | Oregon State Univerity |
| 671A | Pxxx | xxx | La Paz | Mexico | 24-10N | 110-21W | 1952-1983 | 71 | UNAM |
| 672A | Pxxx | 164 | Puerto Angel | Mexico | 15-39N | 096-30W | 1962-1984 | 74 | UNAM |
| 673A | Pxxx | xxx | Mazatlan | Mexico | 23-12N | 106-25W | 1953-1975 | 97 | UNAM |
| 674A | Pxxx | xxx | San Carlos | Mexico | 24-47N | 112-07W | 1968-1983 | 51 | UNAM |
| 675A | Pxxx | xxx | San Jose | Guatemala | 13-55N | 090-50W | 1955-1975 | 93 | Oregon State Univerity |
| 676A | Pxxx | xxx | Topolobampo | Mexico | 25-36N | 109-03W | 1956-1974 | 93 | UNAM |
| 677A | Pxxx | xxx | Yavaros | Mexico | 26-42N | 109-31W | 1970-1973 | 85 | UNAM |
| 678A | Pxxx | xxx | Paita-A | Peru | 05-05S | 081-10W | 1981-1984 | 100 | National Ocean Service |
| 678B | Pxxx | xxx | Paita-B | Peru | 05-05S | 081-10W | 1988-2001 | 90 | DHNM |
| 679A | Pxxx | xxx | Corinto | Nicaragua | 12-17N | 087-07W | 1967-1967 | 99 | National Ocean Service |
| 680A | Pxxx | 130 | Macquerie Is.-A | Australia | 54-29S | 158-58E | 1912-1913 | 97 | Nat. Tidal Ctr., BOM |
| 680B | Pxxx | 130 | Macquerie Is.-B | Australia | 54-29S | 158-58E | 1968-1972 | 45 | Nat. Tidal Ctr., BOM |
| 680C | Pxxx | 130 | Macquerie Is.-C | Australia | 54-29S | 158-58E | 1993-2003 | 76 | Nat. Tidal Ctr., BOM |
| 681A | Pxxx | xxx | San Martin-A | Argentina | 68-08S | 067-06W | 1995-1995 | 8 | Alfred Wegener Inst. |
| 681B | Pxxx | xxx | San Martin-B | Argentina | 68-08S | 067-06W | 1998-1998 | 5 | Alfred Wegener Inst. |
| 681C | Pxxx | xxx | San Martin-C | Argentina | 68-08S | 067-06W | 1998-1999 | 100 | Alfred Wegener Inst. |
| 682A | Pxxx | xxx | Dallmann-A | Argentina | 62-14S | 058-41W | 1996-1997 | 99 | Alfred Wegener Inst. |
| 682B | Pxxx | xxx | Dallmann-B | Argentina | 62-14S | 058-41W | 1997-1997 | 69 | Alfred Wegener Inst. |
| 682C | Pxxx | xxx | Dallmann-C | Argentina | 62-14S | 058-41W | 1998-1999 | 100 | Alfred Wegener Inst. |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 683A | Pxxx | xxx | Pisco-A | Peru | 13-25S | 076-08W | 1985-1990 | 67 | DHNM |
| 683B | Pxxx | xxx | Pisco-B | Peru | 13-25S | 076-08W | 1991-2003 | 80 | DHNM |
| 684A | Pxxx | 178 | Puerto Montt | Chile | 41-29S | 072-58W | 1980-2002 | 93 | SHOA |
| 698A | Pxxx | xxx | Tinian | N. Mariana Is. | 14-58N | 145-37E | 1991-1997 | 93 | USGS |
| 699A | Pxxx | 44 | Tanjong Pagar | Singapore | 01-16N | 103-51E | 1988-2004 | 94 | Port Singapore Auth. |
| 201A | Axxx | 199 | St. Peter&Paul R. | Brazil | 00-55N | 029-21W | 1982-1985 | 99 | ORSTOM |
| 202A | Axxx | 197 | Natal-A | Brazil | 05-45S | 035-12W | 1982-1983 | 100 | ORSTOM |
| 202B | Axxx | 197 | Natal-B | Brazil | 05-45S | 035-12W | 1983-1984 | 99 | ORSTOM |
| 202C | Axxx | 197 | Natal-C | Brazil | 05-45S | 035-12W | 1984-1985 | 100 | ORSTOM |
| 203A | Axxx | 198 | Fer. de Nor.-A | Brazil | 03-50S | 032-24W | 1982-1983 | 100 | ORSTOM |
| 203B | Axxx | 198 | Fer. de Nor.-B | Brazil | 03-50S | 032-24W | 1984-1985 | 100 | ORSTOM |
| 203C | Axxx | 198 | Fer. de Nor.-C | Brazil | 03-50S | 032-24W | 1985-1986 | 100 | LPAO/INPE |
| 204A | Axxx | 265 | Trindade | Brazil | 20-30S | 029-19W | 1983-1983 | 16 | ORSTOM |
| 205A | Axxx | xxx | Arrecife-A | Spain | 28-57N | 013-34W | 1959-1973 | 97 | Inst. Espanol Ocean. |
| 205B | Axxx | xxx | Arrecife-B | Spain | 28-57N | 013-34W | 1973-1985 | 69 | Inst. Espanol Ocean. |
| 205D | Axxx | xxx | Arrecife-D | Spain | 28-57N | 013-34W | 1987-1991 | 90 | Inst. Espanol Ocean. |
| 206A | Axxx | xxx | S.Cruz Palma-A | Spain | 28-41N | 017-45W | 1949-1959 | 99 | Inst. Espanol Ocean. |
| 206B | Axxx | xxx | S.Cruz Palma-B | Spain | 28-41N | 017-45W | 1959-1981 | 93 | Inst. Espanol Ocean. |
| 206D | Axxx | xxx | S.Cruz Palma-D | Spain | 28-41N | 017-45W | 1989-1990 | 93 | Inst. Espanol Ocean. |
| 207A | Axxx | 249 | Ceuta-A | Spain | 35-54N | 005-19W | 1971-1974 | 97 | Inst. Espanol Ocean. |
| 207B | Axxx | 249 | Ceuta-B | Spain | 35-54N | 005-19W | 1975-1977 | 97 | Inst. Espanol Ocean. |
| 207C | Axxx | 249 | Ceuta-C | Spain | 35-54N | 005-19W | 1978-1980 | 92 | Inst. Espanol Ocean. |
| 207D | Axxx | 249 | Ceuta-D | Spain | 35-54N | 005-19W | 1980-1991 | 89 | Inst. Espanol Ocean. |
| 208A | Axxx | xxx | Vigo | Spain | 42-14N | 008-44W | 1943-1990 | 100 | Inst. Espanol Ocean. |
| 209A | Axxx | 246 | Cascais | Portugal | 38-42N | 009-25W | 1959-2000 | 88 | Inst. Hidro. Marinha |
| 210A | Axxx | 244 | Flores,Azores | Portugal | 39-27N | 031-07W | 1976-1996 | 75 | Inst. Hidro. Marinha |
| 211A | Axxx | 245 | Ponta Delgada | Portugal | 37-44N | 025-40W | 1978-2005 | 67 | Inst. Hidro. Marinha |
| 212A | Axxx | xxx | Horta,Azores | Portugal | 38-32N | 028-37W | 1984-1986 | 87 | Inst. Hidro. Marinha |
| 215A | Axxx | xxx | Angra Heroismo-A | Portugal | 38-39N | 027-14W | 1957-1962 | 100 | Inst. Hidro. Marinha |
| 215B | Axxx | xxx | Angra Heroismo-B | Portugal | 38-39N | 027-14W | 1976-1983 | 94 | Inst. Hidro. Marinha |
| 216A | Axxx | 254 | Porto Grande | Portugal | 16-52N | 024-59W | 1990-1993 | 38 | Inst. Hidro. Marinha |
| 217A | Axxx | 251 | Las Palmas-A | Spain | 28-06N | 015-24W | 1949-1956 | 95 | Inst. Espanol Ocean. |
| 217B | Axxx | 251 | Las Palmas-B | Spain | 28-06N | 015-24W | 1971-1982 | 87 | Inst. Espanol Ocean. |
| 217C | Axxx | 251 | Las Palmas-C | Spain | 28-06N | 015-24W | 1983-1991 | 73 | Inst. Espanol Ocean. |
| 217D | Axxx | 251 | Las Palmas-D | Spain | 28-09N | 015-24W | 1992-2003 | 96 | Puertos del Estado |
| 218B | Axxx | 250 | Funchal-B | Portugal | 32-39N | 016-55W | 1976-2006 | 72 | Inst. Hidro. Marinha |
| 220A | Axxx | 314 | Walvis Bay | Namibia | 22-57S | 014-30E | 1959-1998 | 65 | Dir. of Hydrography |
| 221A | Axxx | 268 | Simon's Bay | South Africa | 34-11S | 018-26E | 1958-1996 | 92 | Dir. of Hydrography |
| 222A | Axxx | xxx | Praia-A | Cape Verde | 14-55N | 023-30W | 1984-1985 | 100 | ORSTOM |
| 222C | Axxx | xxx | Praia-C | Cape Verde | 14-55N | 023-31W | 1995-1996 | 64 | National Ocean Service |
| 223A | Axxx | 253 | Dakar-A | Senegal | 14-40N | 017-26W | 1982-1983 | 100 | ORSTOM |
| 223B | Axxx | 253 | Dakar-B | Senegal | 14-40N | 017-26W | 1983-1985 | 100 | ORSTOM |
| 223C | Axxx | 253 | Dakar-C | Senegal | 14-40N | 017-26W | 1986-1986 | 44 | ORSTOM |
| 223D | Axxx | 253 | Dakar-D | Senegal | 14-40N | 017-26W | 1986-1989 | 94 | ORSTOM |
| 223E | Axxx | 253 | Dakar-E | Senegal | 14-41N | 017-25W | 1996-2003 | 93 | UH Sea Level Center |
| 225A | Axxx | 260 | Sao Tome | Sao Tome/Principe | 00-01N | 006-31E | 1985-1988 | 58 | ORSTOM |
| 228A | Axxx | xxx | Tenerife | Spain | 28-29N | 016-14W | 1992-2003 | 93 | Puertos del Estado |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 229A | Axxx | xxx | Belem | Brazil | 01-27S | 048-30W | 1955-1968 | 96 | National Ocean Service |
| 230A | Axxx | 257 | Abidjan-Vridi | Ivory Coast | 05-15N | 004-00W | 1982-1988 | 100 | ORSTOM |
| 231A | Axxx | xxx | Takoradi | Ghana | 04-53N | 001-45W | 1983-1986 | 100 | ORSTOM |
| 233A | Axxx | 259 | Lagos-A | Nigeria | 06-25N | 003-27E | 1961-1969 | 63 | POL |
| 233C | Axxx | 259 | Lagos-C | Nigeria | 06-25N | 003-25E | 1992-1996 | 74 | NIOMR |
| 234A | Axxx | 261 | Pointe Noire | Congo | 04-48S | 011-51E | 1980-1988 | 77 | ORSTOM |
| 235A | Axxx | 329 | Palmeira,C.Verde | Portugal | 16-45N | 022-59W | 2000-2001 | 68 | UH Sea Level Center |
| 236A | Axxx | xxx | Luanda | Angola | 08-47S | 013-14E | 1972-1975 | 99 | Inst. Hidro. Marinha |
| 237A | Axxx | 262 | Lobito | Angola | 12-20S | 013-34E | 1971-1975 | 88 | Inst. Hidro. Marinha |
| 238A | Axxx | xxx | Mocamedes | Angola | 15-12S | 012-09E | 1971-1975 | 98 | Inst. Hidro. Marinha |
| 239A | Axxx | 215 | Siboney | Cuba | 23-06N | 082-28W | 1990-1990 | 99 | Inst. Cubano De Hidro. |
| 240A | Axxx | xxx | Fernandina Beach | USA | 30-40N | 081-28W | 1985-2005 | 91 | National Ocean Service |
| 241A | Axxx | 218 | Miami | USA | 25-54N | 080-07W | 1985-1992 | 96 | National Ocean Service |
| 242A | Axxx | 216 | Key West | USA | 24-33N | 081-49W | 1913-2005 | 97 | National Ocean Service |
| 244A | Axxx | 276 | Gibara | Cuba | 21-07N | 076-07W | 1985-1992 | 100 | Inst. Cubano De Hidro. |
| 245A | Axxx | 206 | San Juan | USA | 18-28N | 066-07W | 1985-2005 | 95 | National Ocean Service |
| 246A | Axxx | xxx | Magueyes Island | USA | 17-58N | 067-03W | 1965-2004 | 97 | National Ocean Service |
| 247A | Axxx | 328 | La Guaira | Venezuela | 10-37N | 066-56W | 1985-1994 | 97 | Inst. Ocean. Venezuela |
| 248A | Axxx | 203 | Port-of-Spain | Trinidad/Tobago | 10-39N | 061-31W | 1984-1992 | 81 | Trin/Tob. Hydro. Unit |
| 249A | Axxx | xxx | Bridgetown-A | Barbados | 13-06N | 059-37W | 1968-1970 | 98 | National Ocean Service |
| 249B | Axxx | xxx | Bridgetown-B | Barbados | 13-06N | 059-37W | 1990-1991 | 92 | Gov. of Barbados |
| 249C | Axxx | xxx | Bridgetown-C | Barbados | 13-06N | 059-37W | 1993-1996 | 45 | Gov. of Barbados |
| 250A | Axxx | 212 | Veracruz-A,Ver. | Mexico | 19-12N | 096-08W | 1985-1995 | 99 | UNAM |
| 250B | Axxx | 212 | Veracruz-B,Ver. | Mexico | 19-12N | 096-08W | 1999-2004 | 63 | Secretaria de Marina |
| 251A | Axxx | 904 | Guantanamo Bay-A | Cuba | 19-54N | 075-09W | 1937-1948 | 81 | National Ocean Service |
| 251B | Axxx | 904 | Guantanamo Bay-B | Cuba | 19-54N | 075-09W | 1995-1997 | 89 | National Ocean Service |
| 252A | Axxx | xxx | Portland,ME | USA | 43-39N | 070-15W | 1910-2005 | 96 | National Ocean Service |
| 253A | Axxx | 290 | Newport,RI | USA | 41-30N | 071-20W | 1930-2005 | 95 | National Ocean Service |
| 254A | Axxx | xxx | Limetree Bay | USA | 17-42N | 064-45W | 1982-2005 | 90 | National Ocean Service |
| 255A | Axxx | xxx | Charlotte Amalie | USA | 18-20N | 064-55W | 1978-2005 | 90 | National Ocean Service |
| 256A | Axxx | 12 | Exuma Cays | Bahamas | 23-46N | 076-06W | 1992-1993 | 99 | HBOI |
| 257A | Axxx | 211 | Settlement Pnt.-A | Bahamas | 26-43N | 078-60W | 1985-2002 | 91 | National Ocean Service |
| 257B | Axxx | 211 | Settlement Pnt.-B | Bahamas | 26-41N | 078-59W | 1985-2003 | 78 | National Ocean Service |
| 259A | Axxx | 221 | Bermuda-A | United Kingdom | 32-22N | 064-42W | 1932-1949 | 78 | National Ocean Service |
| 259B | Axxx | 221 | Bermuda-B | United Kingdom | 32-22N | 064-42W | 1985-2005 | 80 | National Ocean Service |
| 260A | Axxx | 219 | Duck Pier,NC | USA | 36-11N | 075-45W | 1978-2005 | 99 | National Ocean Service |
| 261A | Axxx | xxx | Charleston,SC | USA | 32-47N | 079-56W | 1921-2005 | 98 | National Ocean Service |
| 262A | Axxx | xxx | St. Augustine,FL | USA | 29-51N | 081-16W | 1978-2002 | 42 | National Ocean Service |
| 264A | Axxx | 220 | Atlantic City,NJ | USA | 39-21N | 074-25W | 1911-2005 | 94 | National Ocean Service |
| 265A | Axxx | 207 | Cartagena-A | Colombia | 10-23N | 075-32W | 1951-1993 | 90 | IDEAM |
| 265B | Axxx | 207 | Cartagena-B | Colombia | 10-23N | 075-32W | 1993-2000 | 81 | IDEAM |
| 266A | Axxx | 208 | Cristobal | Panama | 09-21N | 079-55W | 1907-1997 | 96 | Panama Canal Commission |
| 268A | Axxx | xxx | Limon | Costa Rica | 10-00N | 083-02W | 1970-1981 | 66 | SERMAR |
| 269A | Axxx | xxx | Cochino Pequeno | Honduras | 15-57N | 086-30W | 1995-1996 | 100 | National Ocean Service |
| 270A | Axxx | 204 | Le Robert | France | 14-41N | 060-56W | 1976-1984 | 61 | SHOM |
| 271A | Axxx | xxx | Fort de France | France | 14-35N | 061-03W | 1976-1985 | 37 | SHOM |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 272A | Axxx | xxx | Pointe-a-Pitre | France | 16-14N | 061-32W | 1991-1998 | 96 | Meteo-France |
| 274A | Axxx | xxx | Churchill | Canada | 58-47N | 094-12W | 1961-2000 | 90 | MEDS |
| 275A | Axxx | 222 | Halifax | Canada | 44-40N | 063-35W | 1920-2000 | 99 | MEDS |
| 276A | Axxx | 223 | St. John's-A | Canada | 47-34N | 052-42W | 1961-1993 | 96 | MEDS |
| 276B | Axxx | 223 | St. John's-B | Canada | 47-34N | 052-42W | 1993-2000 | 97 | MEDS |
| 279A | Axxx | xxx | Montauk | USA | 41-03N | 071-58W | 1959-2005 | 89 | National Ocean Service |
| 280A | Axxx | 195 | Rio de Janeiro | Brazil | 22-54S | 043-10W | 1963-2005 | 94 | Dir. Hidro. e Navegacao |
| 281A | Axxx | 194 | Cananeia | Brazil | 25-01S | 047-56W | 1954-2004 | 99 | Inst. Ocean. USP |
| 283A | Axxx | xxx | Fortaleza-A | Brazil | 03-43S | 038-29W | 1955-1968 | 95 | National Ocean Service |
| 283B | Axxx | xxx | Fortaleza-B | Brazil | 03-43S | 038-28W | 1995-1998 | 100 | LPAO/INPE |
| 284A | Axxx | xxx | Termisa | Brazil | 04-49S | 037-03W | 1993-1995 | 97 | LPAO/INPE |
| 285A | Axxx | xxx | Buenos Aires | Argentina | 34-40S | 058-30W | 1905-1961 | 100 | Ser. Hidro. Naval |
| 287A | Axxx | xxx | Puerto Williams | Chile | 54-56S | 067-37W | 1985-1998 | 88 | SHOA |
| 288A | Axxx | 229 | Reykjavik | Iceland | 64-09N | 021-56W | 1984-1999 | 94 | Iceland Hydro. Serv. |
| 289A | Axxx | 248 | Gibraltar | United Kingdom | 36-07N | 005-21W | 1961-2000 | 77 | Hidrographic Office |
| 290A | Axxx | 305 | Port Stanley-A | United Kingdom | 52-42S | 057-52W | 1964-1974 | 47 | POL |
| 290B | Axxx | 305 | Port Stanley-B | United Kingdom | 51-45S | 057-56W | 1992-2005 | 92 | POL |
| 291A | Axxx | 263 | Ascension | United Kingdom | 07-55S | 014-25W | 1993-2001 | 89 | POL |
| 292A | Axxx | 264 | St. Helena | United Kingdom | 15-55S | 005-43W | 1993-2004 | 82 | POL |
| 293A | Axxx | 236 | Lerwick | United Kingdom | 60-09N | 001-08W | 1959-2001 | 99 | POL |
| 294A | Axxx | 241 | Newlyn | United Kingdom | 50-06N | 005-33W | 1915-2001 | 99 | POL |
| 295A | Axxx | 238 | Stornoway | United Kingdom | 58-13N | 006-23W | 1976-2001 | 80 | POL |
| 296A | Axxx | xxx | Sisimiut | Denmark | 66-56N | 053-40W | 1991-1998 | 85 | Danish Navig./Hydro. |
| 297A | Axxx | 228 | Ammassalik | Denmark | 65-36N | 037-00W | 1990-1998 | 78 | Danish Navig./Hydro. |
| 298A | Axxx | xxx | Ilulissat | Denmark | 69-13N | 051-06W | 1992-1997 | 82 | Danish Navig./Hydro. |
| 299A | Axxx | xxx | Qaqortoq | Denmark | 60-43N | 046-02W | 1991-1998 | 83 | Danish Navig./Hydro. |
| 600A | Axxx | 181 | Ushuaia | Argentina | 54-48S | 068-18W | 1996-2003 | 79 | National Ocean Service |
| 601A | Axxx | 185 | Esperanza | Argentina | 63-24S | 056-60W | 1996-1998 | 86 | National Ocean Service |
| 700A | Axxx | 188 | Faraday | United Kingdom | 65-15S | 064-16W | 1984-2004 | 98 | POL |
| 701A | Axxx | xxx | Port Nolloth | South Africa | 29-15S | 016-52E | 1991-1994 | 49 | Dir. of Hydrography |
| 702A | Axxx | xxx | Luderitz | South Africa | 26-39S | 015-09E | 1991-1996 | 34 | Dir. of Hydrography |
| 703A | Axxx | xxx | Saldahna Bay | South Africa | 33-01S | 018-58E | 1991-1996 | 81 | Dir. of Hydrography |
| 704A | Axxx | xxx | Granger Bay | South Africa | 33-54S | 018-25E | 1991-1996 | 55 | Dir. of Hydrography |
| 705A | Axxx | 153 | L. Cornwallis I. | Canada | 75-23N | 096-57W | 1986-1994 | 99 | MEDS |
| 707A | Axxx | xxx | Canavieiras | Brazil | 15-40S | 038-58W | 1956-1961 | 95 | National Ocean Service |
| 708A | Axxx | 903 | Salvador | Brazil | 12-58S | 038-31W | 1955-1964 | 92 | National Ocean Service |
| 709A | Axxx | 195 | R.Janeiro,USCGS | Brazil | 22-56S | 043-08W | 1955-1968 | 70 | National Ocean Service |
| 710A | Axxx | xxx | Suape | Brazil | 08-21S | 034-57W | 1982-1984 | 98 | LPAO/INPE |
| 711A | Axxx | xxx | Luis Corriea | Brazil | 02-52S | 041-40W | 1984-1985 | 100 | LPAO/INPE |
| 712A | Axxx | xxx | Recife,USCGS | Brazil | 08-03S | 034-52W | 1955-1968 | 86 | National Ocean Service |
| 714A | Axxx | 193 | Porto Rio Grande | Brazil | 32-08S | 052-06W | 1981-2003 | 22 | Dir. Hidro. e Navegacao |
| 715A | Axxx | 200 | Madeira | Brazil | 02-34S | 044-23W | 1988-2003 | 83 | Dir. Hidro. e Navegacao |
| 716A | Axxx | 201 | Santana-A | Brazil | 00-03S | 051-11W | 1970-1972 | 100 | Dir. Hidro. e Navegacao |
| 716B | Axxx | 201 | Santana-B | Brazil | 00-03S | 051-11W | 1975-1976 | 100 | Dir. Hidro. e Navegacao |
| 716C | Axxx | 201 | Santana-C | Brazil | 00-03S | 051-11W | 1984-1985 | 100 | Dir. Hidro. e Navegacao |
| 716D | Axxx | 201 | Santana-D | Brazil | 00-03S | 051-11W | 1996-1997 | 100 | Dir. Hidro. e Navegacao |
| 717A | Axxx | 201 | Santana SSN-A | Brazil | 00-04S | 051-10W | 1994-1995 | 99 | Dir. Hidro. e Navegacao |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 717B | Axxx | 201 | Santana SSN-A | Brazil | 00-04S | 051-10W | 1999-2000 | 99 | Dir. Hidro. e Navegacao |
| 718A | Axxx | xxx | Imbituba | Brazil | 28-08S | 048-24W | 2001-2005 | 77 | IBGE |
| 719A | Axxx | xxx | Macae | Brazil | 22-14S | 041-28W | 2001-2005 | 89 | IBGE |
| 720A | Axxx | 296 | South Caicos | UK | 21-29N | 071-32W | 1992-1992 | 76 | NOAA/AOML |
| 721A | Axxx | 213 | Progreso-A, Yuc. | Mexico | 21-17N | 089-40W | 1980-1984 | 98 | UNAM |
| 721B | Axxx | 213 | Progreso-B, Yuc. | Mexico | 21-17N | 089-40W | 1999-2004 | 63 | Secretaria de Marina |
| 727A | Axxx | xxx | Nassau | Bahamas | 25-05N | 077-21W | 1904-1905 | 100 | National Ocean Service |
| 728A | Axxx | xxx | Point Fortin | Trinidad/Tobago | 10-06N | 061-25W | 1987-1996 | 61 | Trin/Tob. Hydro. Unit |
| 730A | Axxx | 189 | Base Prat | Chile | 62-29S | 059-38W | 1984-2002 | 96 | SHOA |
| 740A | Axxx | xxx | Eastport,ME | USA | 44-54N | 066-59W | 1929-2005 | 93 | National Ocean Service |
| 741A | Axxx | xxx | Boston,MA | USA | 42-21N | 071-03W | 1921-2005 | 99 | National Ocean Service |
| 742A | Axxx | xxx | Woods Hole,MA | USA | 41-31N | 070-40W | 1957-2005 | 89 | National Ocean Service |
| 743A | Axxx | xxx | Nantucket,MA | USA | 41-17N | 070-06W | 1965-2005 | 95 | National Ocean Service |
| 744A | Axxx | xxx | New London,CT | USA | 41-21N | 072-05W | 1938-2005 | 95 | National Ocean Service |
| 745A | Axxx | xxx | New York,NY | USA | 40-42N | 074-01W | 1958-2005 | 85 | National Ocean Service |
| 746A | Axxx | xxx | Cape May,NJ | USA | 38-58N | 074-58W | 1965-2005 | 88 | National Ocean Service |
| 747A | Axxx | xxx | Lewes,DE | USA | 38-47N | 075-07W | 1957-2005 | 96 | National Ocean Service |
| 749A | Axxx | xxx | Chesapeake BBT,VA | USA | 36-58N | 076-07W | 1975-2004 | 99 | National Ocean Service |
| 750A | Axxx | xxx | Wilmington,NC | USA | 34-14N | 077-57W | 1935-2005 | 98 | National Ocean Service |
| 752A | Axxx | 289 | Fort Pulaski,GA | USA | 32-02N | 080-54W | 1935-2005 | 95 | National Ocean Service |
| 753A | Axxx | xxx | Mayport,FL | USA | 30-24N | 081-26W | 1928-2000 | 99 | National Ocean Service |
| 754A | Axxx | xxx | Cocoa Beach,FL | USA | 28-22N | 080-36W | 1994-1996 | 98 | National Ocean Service |
| 755A | Axxx | 916 | Virginia Key,FL | USA | 25-44N | 080-10W | 1996-2005 | 99 | National Ocean Service |
| 757A | Axxx | xxx | Naples,FL | USA | 26-08N | 081-48W | 1996-2005 | 95 | National Ocean Service |
| 759A | Axxx | xxx | St. Petersburg,FL | USA | 27-46N | 082-38W | 1946-2005 | 96 | National Ocean Service |
| 760A | Axxx | xxx | Apalachicola,FL | USA | 29-44N | 084-59W | 1996-2005 | 99 | National Ocean Service |
| 761A | Axxx | xxx | Panama City Bh,FL | USA | 30-13N | 085-53W | 1993-2005 | 97 | National Ocean Service |
| 762A | Axxx | 288 | Pensacola,FL | USA | 30-24N | 087-13W | 1923-2005 | 96 | National Ocean Service |
| 763A | Axxx | xxx | Dauphin Island AL | USA | 30-15N | 088-05W | 1996-2005 | 53 | National Ocean Service |
| 764A | Axxx | xxx | South Pass,LA | USA | 28-59N | 089-08W | 1993-1999 | 90 | National Ocean Service |
| 765A | Axxx | xxx | Grand Isle,LA | USA | 29-16N | 089-57W | 1980-2005 | 98 | National Ocean Service |
| 766A | Axxx | xxx | Sabine Pass N, TX | USA | 29-44N | 093-52W | 1992-2005 | 98 | National Ocean Service |
| 767A | Axxx | xxx | Galveston,P.Pier | USA | 29-17N | 094-47W | 1957-2005 | 96 | National Ocean Service |
| 769A | Axxx | xxx | Rockport,TX | USA | 28-01N | 097-03W | 1987-2005 | 99 | National Ocean Service |
| 770A | Axxx | xxx | Corpus Cristi,TX | USA | 27-35N | 097-13W | 1992-1999 | 99 | National Ocean Service |
| 772A | Axxx | xxx | Port Isabel,TX | USA | 26-04N | 097-13W | 1977-2005 | 96 | National Ocean Service |
| 773A | Axxx | xxx | Clearwater Bch,FL | USA | 27-59N | 082-50W | 1996-2005 | 97 | National Ocean Service |
| 774A | Axxx | xxx | Port Canaveral,FL | USA | 28-25N | 080-36W | 1994-2005 | 98 | National Ocean Service |
| 775A | Axxx | 217 | Galveston,Pier21 | USA | 29-19N | 094-48W | 1904-2001 | 96 | National Ocean Service |
| 779A | Axxx | xxx | C.Carmen | Mexico | 18-32N | 091-50W | 1957-1979 | 57 | UNAM |
| 780A | Axxx | xxx | Puerto Cortes | Honduras | 15-50N | 087-57W | 1948-1968 | 99 | National Ocean Service |
| 781A | Axxx | xxx | Belize | British Honduras | 17-30N | 088-11W | 1964-1967 | 84 | National Ocean Service |
| 782A | Axxx | 210 | Port Royal | Jamaica | 17-56N | 076-51W | 1965-1971 | 99 | National Ocean Service |
| 783A | Axxx | xxx | Fajardo,PR | USA | 18-20N | 065-38W | 1921-1923 | 95 | National Ocean Service |
| 784A | Axxx | xxx | Puerto Castilla | Honduras | 16-01N | 086-02W | 1955-1967 | 78 | National Ocean Service |
| 101A | Ixxx | 8 | Mombasa | Kenya | 04-04S | 039-39E | 1986-2001 | 78 | UH Sea Level Center |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 102A | Ixxx | xxx | Dar Es Salaam | Tanzania | 06-49S | 039-17E | 1986-1990 | 87 | UH Sea Level Center |
| 103A | Ixxx | 18 | Port Louis-A | Mauritius | 20-09S | 057-29E | 1942-1947 | 90 | Inst. Ocean. Sciences |
| 103B | Ixxx | 18 | Port Louis-B | Mauritius | 20-09S | 057-29E | 1964-1965 | 86 | Inst. Ocean. Sciences |
| 103C | Ixxx | 18 | Port Louis-C | Mauritius | 20-09S | 057-30E | 1986-2003 | 99 | UH Sea Level Center |
| 104B | Ixxx | 26 | Diego Garcia-B | United Kingdom | 07-14S | 072-26E | 1969-1969 | 41 | Scripps Inst. Ocean. |
| 104C | Ixxx | 26 | Diego Garcia-C | United Kingdom | 07-17S | 072-24E | 1988-2000 | 80 | UH Sea Level Center |
| 105A | Ixxx | 19 | Rodrigues | Mauritius | 19-40S | 063-25E | 1986-2003 | 96 | UH Sea Level Center |
| 106A | Ixxx | xxx | Praslin | Seychelles | 04-21S | 055-46E | 1987-1989 | 89 | UH Sea Level Center |
| 107A | Ixxx | 45 | Padang | Indonesia | 00-57S | 100-22E | 1986-1998 | 53 | BAKOSURTANAL |
| 108A | Ixxx | 28 | Male-A | Rep. of Maldives | 04-11N | 073-31E | 1988-1989 | 100 | Lanka Hydraulic Inst. |
| 108B | Ixxx | 28 | Male-B,Hulule | Rep. of Maldives | 04-11N | 073-32E | 1989-2003 | 92 | UH Sea Level Center |
| 109A | Ixxx | 27 | Gan | Rep. of Maldives | 00-41S | 073-09E | 1987-2003 | 88 | UH Sea Level Center |
| 110A | Ixxx | xxx | Muscat | Oman | 23-38N | 058-34E | 1987-1993 | 77 | UH Sea Level Center |
| 111A | Ixxx | 273 | Port Victoria-A | Seychelles | 04-37S | 055-28E | 1977-1982 | 84 | Inst. Ocean. Sciences |
| 111B | Ixxx | 273 | Port Victoria-B | Seychelles | 04-37S | 055-28E | 1986-1992 | 96 | UH Sea Level Center |
| 113A | Ixxx | xxx | Masirah | Oman | 20-41N | 058-52E | 1996-2003 | 93 | UH Sea Level Center |
| 114A | Ixxx | 4 | Salalah | Oman | 16-56N | 054-00E | 1989-2003 | 87 | UH Sea Level Center |
| 115A | Ixxx | 33 | Colombo-A | Sri Lanka | 06-56N | 079-51E | 1953-1965 | 94 | Nat. Aquatic Resources |
| 115B | Ixxx | 33 | Colombo-B | Sri Lanka | 06-57N | 079-51E | 1989-1992 | 96 | UH Sea Level Center |
| 117A | Ixxx | xxx | Hanimaadhoo | Rep. of Maldives | 06-46N | 073-10E | 1991-2002 | 98 | UH Sea Level Center |
| 121A | Ixxx | 273 | Pt. La Rue | Seychelles | 04-40S | 055-32E | 1993-2004 | 97 | UH Sea Level Center |
| 122A | Ixxx | xxx | Sibolga | Indonesia | 01-45N | 98-46E | 1989-2004 | 89 | BAKOSURTANAL |
| 127A | Ixxx | 95 | Syowa | Japan | 69-00S | 039-36E | 1987-2002 | 99 | Japan Ocean. Data Cen. |
| 128A | Ixxx | 308 | Thevenard | Australia | 32-10S | 133-40E | 1998-2004 | 98 | Nat. Tidal Ctr., BOM |
| 129A | Ixxx | 55 | Portland,S.Aus. | Australia | 38-20S | 141-36E | 1991-2004 | 99 | Nat. Tidal Ctr., BOM |
| 130A | Ixxx | 278 | Casey | Australia | 66-17S | 110-32E | 1996-2003 | 91 | Nat. Tidal Ctr., BOM |
| 133A | Ixxx | 68 | Ambon | Indonesia | 03-41S | 128-11E | 1992-2004 | 46 | BAKOSURTANAL |
| 134A | Ixxx | xxx | Hiron Point | Bangladesh | 21-47N | 089-28E | 1977-2003 | 99 | BIWTA |
| 135A | Ixxx | xxx | Khal #10 | Bangladesh | 22-16N | 091-49E | 1983-1992 | 62 | BIWTA |
| 136A | Ixxx | xxx | Cox's Bazaar | Bangladesh | 21-27N | 091-50E | 1983-2000 | 98 | BIWTA |
| 137A | Ixxx | xxx | Teknaf | Bangladesh | 20-53N | 092-18E | 1983-1988 | 59 | BIWTA |
| 138A | Ixxx | 36 | Charchanga | Bangladesh | 22-13N | 091-03E | 1980-2000 | 97 | BIWTA |
| 139A | Ixxx | xxx | Khepupara | Bangladesh | 21-50N | 089-50E | 1987-2000 | 96 | BIWTA |
| 140A | Ixxx | xxx | Kelang | Malaysia | 03-03N | 101-22E | 1983-2005 | 98 | Dept. Survey/Mapping |
| 141A | Ixxx | xxx | Keling | Malaysia | 02-13N | 102-09E | 1984-2005 | 99 | Dept. Survey/Mapping |
| 142A | Ixxx | xxx | Langkawi | Malaysia | 06-26N | 099-46E | 1985-2005 | 99 | Dept. Survey/Mapping |
| 143A | Ixxx | 43 | Lumut | Malaysia | 04-14N | 100-37E | 1984-2005 | 97 | Dept. Survey/Mapping |
| 144A | Ixxx | xxx | Penang | Malaysia | 05-25N | 100-21E | 1984-2005 | 97 | Dept. Survey/Mapping |
| 147A | Ixxx | 30 | Karachi | Pakistan | 24-48N | 066-58E | 1985-1994 | 83 | Nat. Inst. of Ocean. |
| 148A | Ixxx | 42 | Ko Taphao Noi | Thailand | 07-50N | 098-26E | 1985-2005 | 96 | Naval Hydro. Dept. |
| 149A | Ixxx | xxx | Lamu-A | Kenya | 02-16S | 040-54E | 1989-1989 | 68 | Kenya Marine Fisheries |
| 149B | Ixxx | xxx | Lamu-B | Kenya | 02-16S | 040-54E | 1995-2003 | 100 | UH Sea Level Center |
| 150A | Ixxx | 15 | Nosy Be | Madagascar | 13-24S | 048-18E | 1987-1998 | 54 | CNRO |
| 151A | Ixxx | 297 | Zanzibar | Tanzania | 06-09S | 039-11E | 1984-2004 | 99 | UH Sea Level Center |
| 155A | Ixxx | 96 | Dzaoudzi | Mayotte | 12-47S | 045-15E | 1985-1995 | 67 | SHOM |
| 158A | Ixxx | xxx | Meneng | Indonesia | 08-07S | 114-23E | 1987-1989 | 94 | Center for Ocean. Res. |
| 159A | Ixxx | xxx | Pari | Indonesia | 05-51S | 106-37E | 1987-1990 | 84 | Center for Ocean. Res. |

| JASL | TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS | CI | CONTRIBUTOR |
|---|---|---|---|---|---|---|---|---|---|
| 160A | Ixxx | 292 | Surabaya | Indonesia | 07-13S | 112-44E | 1984-2004 | 81 | BAKOSURTANAL |
| 161A | Ixxx | xxx | Jakarta | Indonesia | 06-07S | 106-51E | 1984-2004 | 62 | BAKOSURTANAL |
| 162A | Ixxx | 291 | Cilacap | Indonesia | 07-45S | 109-01E | 1984-2004 | 40 | BAKOSURTANAL |
| 163A | Ixxx | 49 | Benoa | Indonesia | 08-45S | 115-13E | 1988-2004 | 69 | BAKOSURTANAL |
| 164A | Ixxx | 17 | Reunion | France | 20-55S | 055-18E | 1982-1986 | 93 | SHOM |
| 165A | Ixxx | xxx | Wyndham | Australia | 15-27S | 128-06E | 1984-2005 | 96 | Nat. Tidal Ctr., BOM |
| 166A | Ixxx | 40 | Broome | Australia | 18-00S | 122-13E | 1986-2004 | 83 | Nat. Tidal Ctr., BOM |
| 167A | Ixxx | 52 | Carnarvon | Australia | 24-54S | 113-39E | 1984-2005 | 82 | Nat. Tidal Ctr., BOM |
| 168A | Ixxx | 62 | Darwin | Australia | 12-28S | 130-51E | 1984-2003 | 97 | Nat. Tidal Ctr., BOM |
| 169A | Ixxx | 51 | Port Hedland | Australia | 20-19S | 118-34E | 1984-2005 | 97 | Nat. Tidal Ctr., BOM |
| 170A | Ixxx | 47 | Christmas | Australia | 10-25S | 105-40E | 1986-1993 | 52 | CSIRO |
| 171A | Ixxx | 46 | Cocos | Australia | 12-07S | 096-53E | 1985-2003 | 94 | Nat. Tidal Ctr., BOM |
| 173A | Ixxx | 277 | Davis | Australia | 68-27S | 077-58E | 1993-2003 | 97 | Nat. Tidal Ctr., BOM |
| 175A | Ixxx | 53 | Fremantle | Australia | 32-03S | 115-44E | 1984-2005 | 99 | Nat. Tidal Ctr., BOM |
| 176A | Ixxx | 54 | Esperance | Australia | 33-52S | 121-54E | 1985-2003 | 97 | Nat. Tidal Ctr., BOM |
| 177A | Ixxx | 22 | Mawson | Australia | 67-36S | 062-52E | 1992-2003 | 91 | Nat. Tidal Ctr., BOM |
| 178A | Ixxx | 21 | Crozet | France | 46-26S | 051-52E | 1995-2000 | 47 | Inst. Mech. Grenoble |
| 179A | Ixxx | 24 | Saint Paul | France | 38-43S | 077-32E | 1994-2000 | 86 | Inst. Mech. Grenoble |
| 180A | Ixxx | 23 | Kerguelen | France | 49-21S | 070-13E | 1993-1998 | 99 | Inst. Mech. Grenoble |
| 181A | Ixxx | 13 | Durban | South Africa | 29-53S | 031-02E | 1970-2000 | 76 | Dir. of Hydrography |
| 182A | Ixxx | xxx | Mina Sulman | Bahrain | 26-14N | 050-36E | 1979-2005 | 67 | Survey Directorate |
| 184A | Ixxx | 76 | Port Elizabeth | South Africa | 33-58S | 025-38E | 1985-2000 | 66 | Dir. of Hydrography |
| 185A | Ixxx | xxx | Mossel Bay | South Africa | 34-11S | 022-08E | 1991-1996 | 91 | Dir. of Hydrography |
| 187A | Ixxx | xxx | East London | South Africa | 33-01S | 027-55E | 1991-1996 | 68 | Dir. of Hydrography |
| 188A | Ixxx | xxx | Richard's Bay | South Africa | 28-48S | 032-05E | 1991-1996 | 47 | Dir. of Hydrography |
| 190A | Ixxx | xxx | Maputo-A | Mozambique | 26-10S | 032-42E | 1974-1974 | 100 | Inst. Hidro. Marinha |
| 190B | Ixxx | xxx | Maputo-B | Mozambique | 25-59S | 032-34E | 1981-1986 | 49 | INAHINA |
| 191A | Ixxx | xxx | Antonio Enes | Mozambique | 16-14S | 039-54E | 1967-1967 | 31 | Inst. Hidro. Marinha |
| 192A | Ixxx | 11 | Pemba-A | Mozambique | 12-58S | 040-30E | 1971-1973 | 25 | Inst. Hidro. Marinha |
| 192B | Ixxx | 11 | Pemba-B | Mozambique | 12-58S | 040-29E | 1982-1984 | 64 | INAHINA |
| 193A | Ixxx | xxx | Nacala-A | Mozambique | 14-28S | 040-41E | 1975-1975 | 18 | Inst. Hidro. Marinha |
| 193B | Ixxx | xxx | Nacala-B | Mozambique | 14-28S | 040-41E | 1982-1983 | 100 | Inst. Hidro. Marinha |

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