9.11 THE UNIVERSITY OF HAWAII SEA LEVEL CENTER DATA PORTAL

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ABSTRACT

The University of Hawaii Sea Level Center has been collecting, processing and distributing in situ sea level data for major scientific projects for over 25 years. Experiments supported include NORPAX, TOGA, WOCE, and CLIVAR. Recently, the Center has upgraded the technology used to observe sea level including the installation of co-located GPS units for the measurement of absolute sea level. The methods used to collect, process, and distribute real-time and near real-time data are reviewed. The UHSLC has developed a quasi-real time dataset of hourly (collection plus up to a three hour delay, H-3 delay) and daily filtered values (J-2 delay) in support of GODAE. These products are available through our internet site and an OPeNDAP server. The center also distributes in situ sea level products through PMEL's Climate Data Portal, NOPP's National Virtual Ocean Data System, and the NOAA Observing System Architecture site.

1. INTRODUCTION

The University of Hawaii Sea Level Center (UHSLC) currently provides a single point of entry to much of the open ocean in situ sea level information available to research scientist. To understand how the center became a data portal for this oceanic variable, we have to examine its historical perspective. In the mid 1970s, Klaus Wyrtki as part of the North Pacific Experiment (NORPAX) established a network of gauges in the equatorial Pacific to study the potential of sea level observations for ocean monitoring (Wyrtki, 1979a). In subsequent years, this newly created network was successfully used to monitor the large water-mass displacements during the 1976 and the 1982-83 El Nino events (Wyrtki, 1979b; Wyrtki, 1985), and was considered to be sufficiently important for the monitoring, analysis, and understanding of oceanic processes, that the Tropical Ocean-Global Atmosphere project (TOGA) with support from National Oceanographic and Atmospheric Administration (NOAA) continued its operation as the International TOGA Sea Level Center (TSLC). The TSLC was charged with collecting, processing and quality controlling, and archiving sea level information in the tropics, and distributing the dataset within 18 months. As the quantity of data collected by the TSLC increased, expertise in data management was provided by the U.S. National Oceanographic Data Center (NODC) with the establishment, in 1987, of the Joint Archive for Sea Level (JASL) at the UHSLC. The UHSLC was also active in the formation of the Global Sea Level Observing System (GLOSS), which is a program dedicated to developing a worldwide network of in situ sea level gauges. Figure 1 shows the current JASL and GLOSS designated sites.

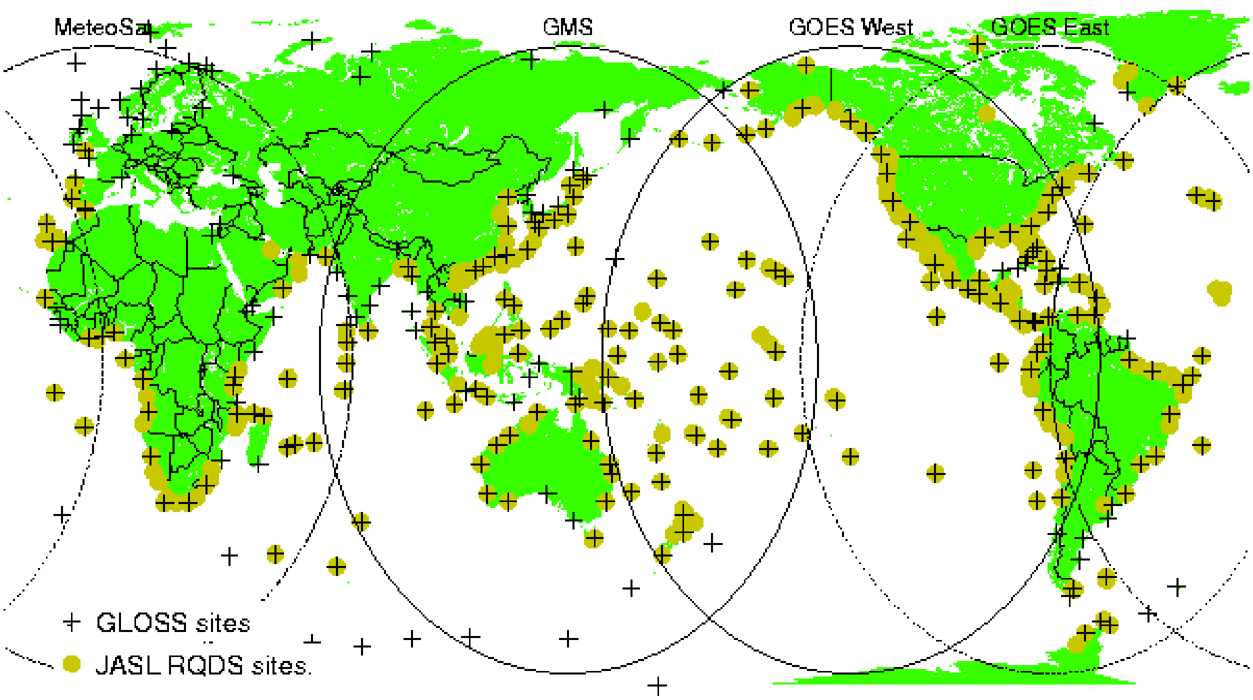

Figure 1. Sites where the JASL RQDS contains data. GLOSS designation indicated.

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The effects of the oceans on climate, specifically the effects of El Nino on weather, led to a dramatic increase in the demands for timely sea level data, and directly led to the production of synoptic maps of sea level for the Pacific Ocean. As part of the effort to meet this requirement, starting in 1982 the University of Hawaii upgraded over 20 stations in the Pacific to upload data via the NOAA's Geostationary Operational Environmental Satellite (GOES) Data Collection System (DCS), with the installation of satellite platforms and redundant instruments (Kilonsky, 1984). Additionally, the UHSLC also started processing data from satellite transmitting gauges installed and maintained by other groups, such as, the Pacific Tsunami Warning Center (PTWC), the Atlantic Oceanographic and Meteorological Laboratories (AOML), and NOAA's National Ocean Services (NOS).

The success of the Pacific network also spawned a similar network in the Indian Ocean, and since 1985 more than 20 sea level sites have been newly established or reactivated by the University of Hawaii. In the early 1990s, in cooperation with host country national agencies, a program was undertaken to upgrade these sites with redundant sensors and satellite platforms. Currently the UHSLC maintains 12 upgraded stations in the Indian Ocean, and the data are transmitted to the center via the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) Meteorological Satellite (METEOSAT) DCS and the Global Telecommunication System (GTS) of the World Meteorological Organization (WMO). This network, the Global Sea Level Network (GSLN), was expanded in the Atlantic Ocean in the mid 1990's when the UHSLC became responsible for sites initially established by NOS. Also, in the late 1990's, to support satellite altimeter calibration and validation and for absolute sea level rise monitoring, the UHSLC and the Pacific GPS Facility have established and maintained co-located GPS systems at select tide gauge stations (GPS@TG).

With the onset of the World Ocean Circulation Experiment (WOCE) and the launching of satellites altimeters capable of monitoring the sea surface topography, the UHSLC attained a new dimension (Merrifield and Kilonsky, 2002). The WOCE Implementation Plan stated that in situ sea level data are required for two major purposes. First, the observations made during the WOCE period must be compared to longer time series in order to evaluate the representativeness of the WOCE time frame. Sea level has been observed at many sites for well over 100 years, and these data comprise the most extensive set of long time series of an oceanographic parameter existing today. Second, the sea level data would be needed for joint use with satellite altimeters. The WOCE plan called for a heavy reliance on sea surface height measurements derived from satellite-borne altimeters. The altimeter data needed to be checked where possible against the more traditional and well-understood sea level data from tide gauges. It was recognized, however, that this second requirement meant that sea level data had to be collected, processed, and made available to scientists much more quickly than had been done in the past. The altimetry data was available within a month or so of collection; and if the sea level data were to be of maximum utility, then it must be made available on a comparable time scale. The UHSLC was a logical choice for the placement of this center for many reasons. The UHSLC had access to a large fraction of the open ocean gauges that were capable of reporting sea level data quickly enough to meet the near real-time requirement. This is still true today. The UHSLC had developed a robust station design, that emphasized redundancy of measurements, including an automated switch that produced reference level information, and had demonstrated the feasibility of producing long-term sea level monitoring accurately related to a datum at the millimeter level using inexpensive float-operated gauges (Mitchum et al.,1994). Finally, the UHSLC also had experience with distributing data and data products on the required time scale via an Integrated Global Ocean Services System (IGOSS) sea level project, that is currently run under the Joint Commission for Oceanography and Marine Meteorology (JCOMM) program. Thus, in 1993, the UHSLC was funded to establish a WOCE Data Assembly Center (DAC) for the delivery of near real-time (fast) sea level information. With the end of the data collection phase of WOCE, this DAC has evolved into the CLImate VARiability and Predictability (CLIVAR) DAC. Figure 2 shows the current UHSLC operated sites and the CLIVAR/GLOSS fast delivery network. These UHSLC sites form the backbone of new quasi-real time datasets of hourly (collection plus up to a three hour delay, H-3 delay) and daily filtered values (J-2 delay) that are being developed in support of the Global Ocean Data Assimilation Experiment (GODAE).

In summary, the UHSLC not only operates its own network of sea level gauges, but also collects, processes and quality controls, and distributes data in collaboration with other agencies and countries. This makes for a very interesting data flow through the portal, as the data can arrive at the UHSLC with delays varying from minutes to years, in various ASCII and binary formats, and via different electronic, storage and hard copy media.

2. TIME LINES, FORMATS, AND PATHS OF INCOMING DATA

To understand the methods used to collect, process, and distribute in situ sea level data, we examine the time lines, formats, and paths of the incoming data streams. For the purposes of this paper, data designated as real-time are received and processed within two days of collection, near real-time (fast) data are usually received between a month and a month and a half after its collection, and delayed-mode data within a year to several years after collection.

The highest frequency data that the UHSLC receives are also the data stream that it receives in real-time. Most

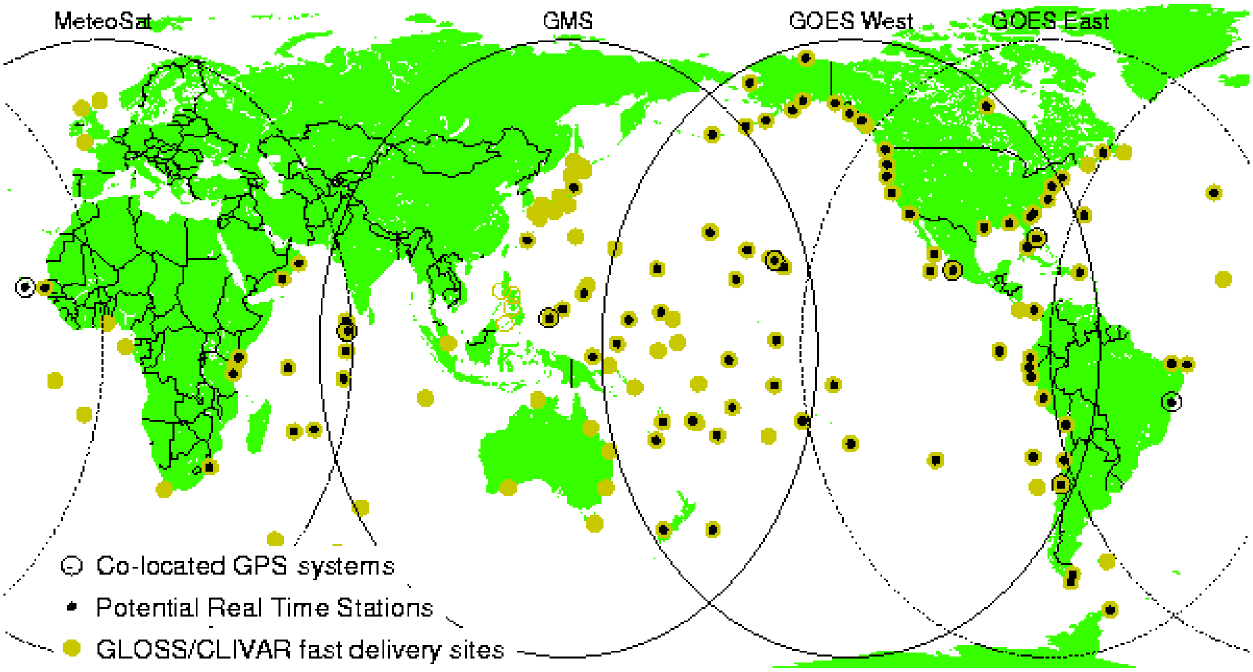

Figure 2. Real-Time and CLIVAR fast sites, and co-located GPS systems.

real-time data received at the center are transmitted from sea level stations that upload their data to a geostationary satellite. The data are downloaded from the satellite by the appropriate national agency and then transferred to the center via dedicated National Weather Service (NWS) communication lines. There is also alternate data paths to the NWS line. Servers at the NOAA National Environmental Satellite, Data and Information Service (NESDIS) Central Data Distribution Facility (CDDF) and EUMETSAT are accessed hourly and the data transferred via the internet. The real-time data messages fall into two categories; messages sent from UHSLC stations and those sent from stations maintained by other agencies. A typical data message has 400-500 hundred standard ASCII characters. The UHSLC messages contain high frequency data from two separate sea level gauges with the sampling interval varying from two to 15 minute averages. They also have information from two reference level switches, battery voltages, and other information useful for monitoring the health of the station. Most of the UHSLC stations transmit on an hourly cycle, though there are a few still transmitting on a three hour cycle. As the messages are received at the UHSLC, usually within minutes of being transmitted, they are logged into engineering data files on several workstations. Real-time data messages received from other agencies include those from PTWC, AOML, and NOS, and Australia's National Tidal Facility (NTF) satellite transmitting sites, and some Japanese sites that do not transmit their data via satellite.

As most of the PTWC and AOML sites have been based on the UHSLC sea level station design, their messages have the same general format as those of the UHSLC. These stations also transmit on a one or three hour cycle, and the UHSLC receives the data via the same NWS circuits or the internet. As they are received, these messages are logged into the same engineering data files as the UHSLC message. As with the UHSLC messages the time delay from transmission to logging the data is on the order of minutes.

Satellite transmitted messages received from NOS are somewhat different. While they use standard ASCII characters, these messages are not in a standard ASCII format. They utilize the GOES Binary Data Transmission scheme which allows for six bit/byte to be used for data (ASCII 64 > 127) or 64 unique states, in other words a pseudo base 64 coding scheme. The NOS messages usually include time tags, Primary (3 minute average every 6 minutes) and Backup (half hour sampling) water level readings, redundant Primary water level readings, wind, air temperature, water temperature, and barometric pressure. They can also contain data from pressure gauges, conductivity, currents, dew point, rainfall, solar radiation, and other analog sensors. These messages are usually transmitted on a three hour cycle, and the UHSLC receives and logs them in the same manner as described above.

The final real-time data received by the UHSLC are contributed from a set of stations established by the Japanese Meteorological Agency (JMA). Data from stations are transmitted to UHSLC and PTWC on an hourly cycle via the GTS. They are in an ASCII format and the message format is similar to the UHSLC format. They are also logged in engineering data files as they arrive.

The real-time data flow was developed to more closely monitor the UHSLC sea level stations, and to acquire data from stations run by agencies that were not processing their data for sea level studies, such as PTWC. The fast data flow was developed as a response to the need for in situ sea level data for monitoring oceanic variability and to help check the products produced by satellite altimeters. Again there are two categories: data produced by the UHSLC from its real-time data stream, which provides the nucleus of the CLIVAR/GLOSS "fast delivery" dataset, and data received from other agencies.

Currently data from over 100 satellite-transmitting stations are received and processed at the UHSLC. Typically, each station has at least two separate data paths; real-time via satellite, and near real-time using on-site data loggers. Data logged locally at UHSLC stations are forwarded, along with tide staff information, to the center on a monthly cycle. After a month's data are logged, for each station an ASCII file is created that contains all redundant data (each separate source of data at a station is called a data channel) and the predicted tides. The file also contains reference level information for each channel, and serves as the merging point for the real-time and fast data. For UHSLC and other real-time stations these files are available within several weeks after the end of the data collection month.

The UHSLC also receives fast data in varying formats and stages of processing from collaborating national agencies on a monthly cycle. Punch paper tape and analog rolls from gauges are collected and digitized inhouse. Diskettes from sites are received and quality controlled, and processed data are obtained from other agencies via mail, both conventional and electronic. Data files are also deposited in our anonymous ftp site. As with the UHSLC fast data, these near real-time data channels are merged into the station files usually with a delay of one to two months.

The last stream of data is delayed-mode. These data have usually had some basic quality control, and are received by the UHSLC on a yearly cycle, usually with a one to two year delay. Again there are two basic categories of input--one produced by the UHSLC from its real-time and near real-data, which provides the nucleus, and one consisting of data received from other agencies. The JASL dataset is the recommended set for use in research.

3. PROCESSING AND QUALITY CONTROL

The quality assurance of the UHSLC real-time data begins at the sea level station. Redundancy of instrumentation is essential for reducing data gaps and level shifts. Typically, each station has at least two independent sea level sensors. The UHSLC stations and some PTWC stations also provide additional leveling information from specially designed switches that are surveyed to the tide staff. These reference level switches measure the time the sea level passes the switch, and can be used to determine the vertical location of the sensor (Kilonsky and Merrifield, 1998).

As the real-time data arrive at the UHSLC, they are logged onto a network of microcomputers. A daily review of the satellite transmitted data is conducted, and station operators notified of problems when appropriate. The real-time data are then converted to a common format and processed with an automated program that checks for data spikes. Hourly values are then calculated using a binomial filter. Plots of the data are produced and reviewed for consistency with past data from that station. These hourly values are then added to the hourly values from the near real-time (fast) date set to produce the real-time data (collection plus up to a three hour delay, H-3 delay), which is currently redistributed via the UHSLC internet site. The hourly data are then used to compute daily sea level values that preserve sea level variability at time scales longer than about 2.5 days. The daily values are computed by subtracting estimates of the major diurnal and semi-diurnal tides, then applying a convolution-type numerical filter. Thus, the long period tides are not removed from daily values. This process produces the dataset of daily filtered (J-2 delay) values. Note that the only redistribution of high frequency (sampling 2-6 minutes per observation) real-time data is to PTWC for their use in the tsunami warning network.

The basic quality control occurs on a monthly basis and includes the real-time and fast data streams. Quality control procedures include further inspection of the data for consistency with past data from that station, the setting of reference levels, and the correction of any obviously inaccurate data. Emphasis at this stage is on verifying the timing of the samples and the linking of the data to a stable reference level. For each station, a file is created that contains all redundant data (each separate source of data at a station is called a data channel) and the predicted tides. From these files, time series plots are made of the observed high-frequency data, the residuals between different channels, and the predicted tides, and then analyzed for possible problems. Detectable errors include random erroneous signals, reference level shifts, timing errors, and data gaps. All of these errors are generally evident in the residual plots, and usually can be resolved using the redundant data to produce a quality dataset.

Datum shifts can be monitored by several methods for the real-time data stream. Datum shifts appear as quasi-step functions in the plots of residuals, and are thus easily identified. Examination of redundant channels will usually indicate which instrument has a problem and can often be used to provide a correction. The reference level switch data also provide calibration information with typically about 60 values per month per channel for analysis. The monthly standard deviation of the differences of the values is on the order of 0.003 meters. For the real-time data, the switch provides a preliminary calibration constant and information on the stability of the reference level of each channel. Datum shifts that are identified in the plots or switch data are documented and temporarily adjusted.

Additional processing and quality control are triggered with the arrival of a station's fast data stream. These data are merged into the station file as they arrive and additional time series plots are produced and analyzed for possible errors. If available, the tide staff readings are paired with gauge values and plotted on scatter diagrams. A statistical summary of the staff reading/gauge data pairs is calculated and used to obtain the additive constant for the zero reference level. This correction is logged in the station file. It should be pointed out here that the final calibration constant for the sea level data is not chosen until after an annual assessment of the reference level by UHSLC and JASL staff.

Here a brief discussion of the fast data provided by other agencies is warranted. The UHSLC receives data in varying formats and stages of processing. Punch paper tape and analog rolls from gauges are collected and digitized inhouse. Diskettes from PTWC, AOML, and NOS sites are received and quality controlled, and processed data are obtained from other agencies via mail, both conventional and electronic. For processed data from sites that are not part of the UHSLC network or do not belong to a cooperating agency that is utilizing UHSLC reference level switches, we do not require any specific leveling information. We assume that correction and calibration were applied by the originators and that the data were received in good quality. However, it does happen that our quality assurance finds an occasional error. When this happens, the problem is referred to the data originator. We have found that most organizations can provide corrected values in a timely manner because their original data are usually close at hand.

After all the high frequency data (both real-time and fast) for a station has been collected, usually a 1-2 month time delay, the high frequency data are filtered to obtain hourly data, which is the first standard sampling interval. Gaps and errors in the primary data channel are replaced by data from redundant sensors. The hourly data are used to compute daily sea level values using the same technique described fo the real-time data, and these values are averaged to obtain traditional monthly means. Each time series is then checked visually by the data manager. Plots of differences among adjacent stations are examined, and the data are compared to a time series of altimetry data. Experience has shown us that one of the best possible quality control checks is inspection by a scientist familiar with the dataset.

While the real-time data set is updated as soon as the data are received, the CLIVAR/GLOSS fast dataset is updated monthly and once a year the UHSLC performs an annual assessment of its data and prepares it for permanent archive. The UHSLC director reviews the complete twelve months of data from the last calendar year and assigns the final referencing of the sea level heights to tide-staff zero and the primary benchmark of the site. The basic assumptions in selecting an offset are that the gauge data are stable, and that significant changes during a given year are normally associated with replacement or maintenance of the gauges or satellite platforms. Thus, the reference level of the data does not track the small month-to-month changes in the staff readings, but is only changed upon evidence that the level has moved in the vertical. These data are then submitted to JASL for final processing, and the final JASL research quality data merged back into the CLIVAR/GLOSS "fast delivery" set replacing the preliminary data that had only the basic quality control.

This takes us to our final processing cycle, that of the delayed-mode data. The JASL dataset is designed as a user friendly, scientifically valid, well-documented, standardized set of hourly, daily, and monthly sea level values, suitable for archiving at international data banks. As the database is an extension of the TOGA sea level dataset, it currently emphasizes the tropical and subtropical regions, with data from 335 stations. Over the years, its development and format have been guided by the needs of scientists; first at the University of Hawaii, and later by investigators in ephemeral programs, such as NORPAX, TOGA, WOCE, and CLIVAR, as well as the needs of GLOSS. Data used in the JASL set are provided internally by the UHSLC and additionally by collaboration with over 60 agencies representing over 70 countries.

As each dataset is received, usually on a yearly cycle, the data are converted to the JASL standard format and the hourly values plotted. This preview verifies the scientific units and completeness of the data. For updates that have a common time span with previous submissions, comparisons during time overlaps are made as a test of consistency.

Harmonic constituents from a routinely updated data base are used to calculate predicted tides, which are subtracted from the observations to form residuals. Plots of the hourly residuals are a primary quality control tool. They are inspected by an experienced data processor to correct or flag erroneous features in the observed data. Data spikes, timing offsets, instrument malfunctions, and datum shifts are readily identified in the hourly residuals.

Spurious outliers normally consist of one or a few consecutive points that are grossly out of the normal range of variance, and are usually caused by telemetry, instrumentation, digitization, or processing errors. Timing errors are usually due to bad initialization of the instrument, processing errors, or drifts of the clock. The residuals can show a variety of other spurious signals. For example, sources of error for a float gauge can include the blockage of the stilling well by sand or marine organisms, overgrowth of marine organisms on the float and in the well, faulty float cables, leaky floats, and many other problems. These errors are handled on a case-by-case basis and corrections are applied if warranted

Data spikes are flagged and subsequently filled with redundant data or are interpolated. Timing errors are adjusted if the drift is an exact increment of an hour or if properly timed redundant data are available. Otherwise, the feature is not corrected, but is documented in the metadata file for that station. Gaps in the data are filled with redundant data when available. Otherwise, short gaps of a span of 24 hours or less filled with linear interpolated plus predicted tides.

Plots of daily and monthly values and plots of differences among adjacent stations are used primarily for monitoring reference level stability. Daily plots occasionally show erroneous spikes caused by incorrect data over a span of hours to a few days. When available, bulletins which provide summaries of storm tracks, such as the Mariners Weather Log or the Darwin Tropical Diagnostic Statement, are studied to verify if the extreme sea level heights are related to meteorological events, and appropriate comments are added to the metadata file.

In some cases, quasi-step function signatures are identified that are associated with natural events, such as the arrival of Kelvin waves or westerly wind bursts at Nauru in the equatorial western Pacific. For these cases, comments are added to the metadata file. There are other times when the lack of a change in sea level may warrant suspicion. If a station lacks a signal present at adjacent stations, data from redundant sensors are checked. If the station has no redundant data, then the only means of confirming and/or resolving the anomaly is to ask the data contributors to investigate the original data sources and the tide staff readings.

For other non subtle datum shifts, that is where the hourly residuals clearly show quasi-step function signatures. The original tide staff observation and station maintenance sheets usually provide the necessary information for correction; otherwise, the data are flagged. Datum shifts are not corrected unless calibration information is available. All adjustments to the reference level and any suspicious signatures are thoroughly documented in the station's metadata file.

Finally for those stations with historic datasets, comparisons are made with data held by other archiving agencies. The datasets are then returned to the originating agency for their review. If necessary, unresolved features are highlighted for inspection of the original records, and inquiries are made for specific information about the sea level station and processing techniques.

After quality control is complete for the hourly values, these data are filtered to daily values with a convolution filter. Monthly values are determined from the daily values with a simple average, and archived along with a count of the number of days available for the calculation. If more than seven days are missing per month, the monthly value is not calculated and is replaced with a missing data flag. All stations that had suspect or anomalous data are then submitted to the UHSLC director for review.

On an annual basis, usually in July or August, the quality assured and documented datasets of hourly, daily, and monthly values are submitted to international data banks, and a new set of requests is sent to the data contributors.

For each site, a metadata file is maintained, which accompanies the data in the final archive. This file contains pertinent information about the station, a quality assessment of the data, and a log of corrections made to the data.

The JASL quality assurance methodology was directly influenced by the lessons we learned running the UHSLC network. It mirrors the UHSLC data processing steps, and in many cases uses variants of the same software. Some of the concepts we have incorporated from our UHSLC processing are the use of redundant data, the emphasis on the timeliness of data acquisition, and the structure of our "fully corrected" data.

We have aggressively sought redundant data sources. It is not uncommon to find other agencies, such as the Pacific Tsunami Warning Center (PTWC), who, for their own purposes, have instruments installed at sea level stations. Data from these agencies can serve as important secondary and tertiary sources of information, allowing JASL to fill gaps and recognize and correct level shifts in the primary originator's data.

Additionally, we have made every effort to acquire the originators' data as rapidly as possible, often processing satellite-transmitted data as they become available. This has enabled us to give the contributing agency timely feedback on the quality of their data, which allows them to provide additional information that can be used to correct the data.

Finally, our experience using and distributing the UHSLC network data, and subsequently the TOGA and WOCE datasets, has convinced us of the need to construct a "corrected" dataset. The vast majority of the investigators we have worked with prefer data that they can use immediately. To this end, we not only flag erroneous or questionable data, but make every effort to correct them.

4. UHSLC DATA DISSEMINATION

In situ sea level information that passes through the UHSLC data portal is disseminated in cooperative efforts with other programs and directly through internet from a dedicated site. The UHSLC has collaborated with the Pacific Marine Environmental Laboratory (PMEL) and the NODC to support the Climate Data Portal (CDP), consisting of a networked system connecting diverse, distributed servers at PMEL (TAO El Nino buoys), UHSLC, and NODC (the Global Temperature-Salinity Profile Program or GTSPP dataset). The CDP enables researchers and others to access the products developed by the various elements of the ENSO Observing System over the internet without having to log on to multiple internet sites (Soreide, et al. 2003). This program has also produced ncBrowse, a graphical netCDF file browser that can be used to preview the UHSLC CLIVAR/GLOSS fast delivery dataset (Denbo, et al. 2002; Kilonsky, et al. 2002).

The CLIVAR/GLOSS dataset has also been added to the NOPP's National Virtual Ocean Data System (NVODS)(Cornillon and Kilonsky, 2002). Our participation in the NVODS is to promote wider use of UHSLC products and to stay current with evolving distribution strategies. To add this dataset to the NVODS, netCDF files were developed and an OPeNDAP server for these files installed at the UHSLC.

The UHSLC also maintains an anonymous ftp account and a dedicated internet site for data dissemination. Data can be downloaded in bulk from the ftp account or browsed on the internet site through the use of interactive maps and lists. Files can be downloaded in ASCII or netCDF formats, and various products created from the in situ data can be displayed. Finally, the CLIVAR/GLOSS and JASL data can be accessed directly from the UHSLC internet site through the NOAA Observing System Architecture program.

5. SUMMARY

The UHSLC collects and distributes three basic sea level datasets; the JASL research quality dataset, the CLIVAR/GLOSS "fast delivery" dataset, and the real-time dataset for use in GODAE. The JASL/UHSLC is charged with collecting sea level information, processing and quality controlling these data, and distributing them within 18 months. Beginning in the fall of 2000, the JASL is supported by NOAA's National Coastal Data Development Center. In the past year, the UHSLC increased its JASL holdings to 9213 station-years, including 5103 station-years at 195 GLOSS sites. Of the 101 GLOSS stations that are presently operating on islands, 93 are available through the JASL. Though the typical time lag from collection to public dissemination is typically on the order of a few years, The 2002 submission of the JASL data to the World Data Center-A for Oceanography included 105 series that contained measurements through the year 2001. The dataset is distributed directly from the UHSLC and NOSA internet sites, and is also provided to the World Data Center system and the NODC for redistribution.

The fast delivery database is maintained in support of various national and international programs (e.g., GODAE, CLIVAR). To ensure active participation and coordination with the international community, the database has been designated by the IOC as a component of the GLOSS program. The fast delivery data also are used extensively by the altimeter community for ongoing assessment and calibration of satellite altimeter datasets. In particular, fast delivery data are used for monitoring the latest Jason altimeter and for the tie between Jason, TOPEX/Poseidon, ERS, and GEOSAT satellites. The fast delivery sea level dataset now includes 141 stations, 113 of which are located at GLOSS sites.

The UHSLC has continued development of a quasi-real time dataset of hourly (collection plus up to a three hour delay, H-3 delay) and daily filtered values (J-2 delay) in support of GODAE. Approximately 50 stations currently are available in real-time with plans for ongoing expansion. This product is distributed through our internet site, and made available in a netCDF format via an OPeNDAP (formerly DODS) server .

As part of the JCOMM SLP-Pac, the UHSLC operates a Specialized Oceanographic Center that produces sea surface topography maps (monthly) and diagnostic time series (quarterly) for the Pacific Ocean. This activity is a continuation of one of the earliest examples of operational oceanography. The UHSLC presently distributes these products through the internet and by mail to users. The net result is that approximately five weeks after the end of a month, hundreds of users throughout the world receive an analysis of the state of the Pacific Ocean sea surface topography for that month. The analysis includes comparisons of tide gauge and altimeter sea surface elevations that are available through the UHSLC internet site.

6. SOME USEFUL URLs

The UHSLC internet site is found at:

http://uhslc.soest.hawaii.edu/

The Climate Data Portal at:

http://www.epic.noaa.gov/cdp/cdpjava.htm

The National Virtual Ocean Data System at:

http://ferret.pmel.noaa.gov/NVODS/servlets/dataset

Other useful links are found at the UHSLC home page.

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