5B.1 CO-OPS EXPANDS METEOROLOGICAL SENSOR NETWORK AND QUALITY CONTROL

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ABSTRACT

The NOAA/NOS Center for Operational Oceanographic Products and Services (CO-OPS) collects real-time water level, currents, meteorological and other oceanographic data along the U.S. coast, including the Great Lakes and Pacific and Caribbean islands. Recently, CO-OPS received funding as part of the NOAA Weather and Water Goal team initiative to install meteorological sensors (winds, air pressure, and air temperature) at 90 additional National Water Level Observation Network (NWLON) stations managed by CO-OPS. As a result, these installations will increase the spatial density of CO-OPS meteorological observations. Previously, most of the deployed meteorological sensors were located at the CO-OPS Physical Oceanographic Real-Time System (PORTS®) water level stations, where real-time data are essential to navigation safety. By the end of Fiscal Year 2010, almost all of the 250 NWLON and PORTS® stations will contain meteorological sensors. Over one-third of these stations will be located in urban areas. Furthermore, the increased coverage will provide better information on local weather conditions affecting water levels and port operations. In tandem with this recent data expansion, CO-OPS plans to apply a more rigorous quality control (QC) procedure to the meteorological data. Currently, the procedure in place primarily consists of turning data dissemination on or off by a 24x7 monitoring team. In addition to this existing data control, there will be real-time automated checks as well as monthly processing and QC, resulting in higher quality data overall. This enhanced QC and processing effort will extend higher quality assurance to users of both real-time and historical data. Beginning in 2010, users will have access to a wider range of stations with long-term meteorological data, yielding more reliable results and broader applications.

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1. INTRODUCTION

The Center for Operational Oceanographic Products and Services (CO-OPS) specializes in the observation of water levels and currents, and also maintains a rapidly growing network of meteorological observations collected at water level stations. The majority of the CO-OPS water levels stations were installed as part of two programs: the Physical Oceanographic Real-Time System (PORTS®) and the National Water Level Program (NLWP). CO-OPS initiated the PORTS® program to promote safe marine navigation via the dissemination of real-time water level, current, and meteorological data in major urban ports and harbors around the U.S. coast. This program also marked the beginning of CO-OPS real-time meteorological data collection, as requested by local marine pilots. The PORTS® water level stations almost always include a full suite of meteorological sensors (dual anemometers, air temperature thermistor, and barometer). In some cases, CO-OPS installed a PORTS® "met-only" station, where the sensors are not co-located with a water level station, but instead stand alone. These stations may also contain a full suite of meteorological sensors, or they may be wind-only stations. Figure 1 shows an example of a wind-only station and a standard PORTS® station. Since the inception of the PORTS® program, the number of PORTS® systems quickly climbed from 6 to 18 by 2008 (figure 2), and the total number of PORTS® water level stations (with at least one meteorological sensor) increased to about 50.

The National Water Level Observation Network (NWLON) is the fundamental observing system of the NWLP and presently consists of over 200 continuously operating water level stations that disseminate real-time data for a variety of users, from recreational boaters to state and federal offices. Unlike the PORTS® stations, which are concentrated in various ports and harbors, the NWLON stations are distributed around the entire U.S. coast, including Alaska and oceanic islands (figure 3). The number of NWLON stations has also been steadily rising and, pending increased base funding, is planned to reach 300

stations by the next decade. At the time of the 200th NWLON installation in 2008, however, only about half of the NWLON stations contained meteorological sensors.

In 2007, CO-OPS received NOAA funding to upgrade the NWLON stations with meteorological sensors, thereby increasing the spatial density of CO-OPS coastal meteorological observations. As a result of this expansion, CO-OPS also decided that a more rigorous quality control method was needed for the influx of meteorological data now available to users.

2. METEOROLOGICAL UPGRADES

Upgrading an NWLON station entails installing a full suite of meteorological sensors (i.e. dual anemometers, air temperature thermistors, barometers) at up to 94 existing NWLON stations around the U.S. coast during fiscal years (FY) 2008, 2009 and 2010. These water level stations either have only an air temperature thermistor and/or a barometer or no meteorological sensors at all. Station selections were simply based on which NWLON stations were missing meteorological sensors, and the stations to receive the first upgrades were those that were the most time- and cost-efficient. The NWS also provided CO-OPS with a prioritized list of areas where observations were needed, which was taken into account. Not all stations will receive anemometers, however, as some stations did not meet the siting criteria due to nearby obstructions, such as trees or buildings. Also, a small number of stations will not receive any meteorological sensors due to their proximity to another nearby NWLON station, primarily in the Great Lakes Detroit region. Throughout FY2008, 28 stations received an upgrade, and by the end of FY2010, approximately another 65 to 70 stations will be upgraded as well.

Previously, meteorological upgrades of this nature had been done as part of partnership agreements (e.g. PORTS®, and the NOAA Coastal Storms Initiative Program). The National Weather Service (NWS) began requesting the addition of meteorological sensors to NWLON stations in 2001 and again in 2006 in the Gulf Coast and the Caribbean in support of forecasting requirements, particularly during the hurricane season when coastal meteorological observations co-located with water level observations are especially critical. In 2004, the NWS Central Region also requested upgrades to the Great Lakes NWLON stations to meet their forecasting needs. Previously, a few Great Lakes Stations were upgraded with meteorological sensors and geodetic Continuously Operating Reference Stations' sensors funded through an NOS Partnership Proposal. These upgrades included relative humidity sensors, which were not installed in any other region. Then, after Hurricane Isabel wreaked havoc on the Chesapeake Bay area in 2003, the NWS Eastern Region office, based on findings from the Hurricane Isabel Assessment team, provided funding to upgrade the Chesapeake Bay NWLON stations with meteorological sensors.

The CO-OPS meteorological data provided by the NWLON and PORTS® networks have become critical to coastal weather forecasting efforts. The data, as a result of the latest upgrades, will ultimately fill spatial gaps and thus help to improve forecast accuracy. The real-time data will also provide forecast verification for a variety of models as well as safe marine navigation for shipping vessels.

By the end of FY2010, CO-OPS will be disseminating meteorological data from a total of 237 of the 255 NWLON and PORTS® stations, with over one-third of these stations located in urban areas.

3. QUALITY CONTROL

As a result of the large amount of meteorological data that CO-OPS will soon be collecting, CO-OPS is also upgrading its meteorological data quality control (QC) procedures by establishing an automated real-time and monthly QC process. Currently, the CO-OPS meteorological data do not receive any internal QC beyond the Continuous Operational Real-Time Monitoring System (CORMS) operators' 24x7 control over public dissemination, and an automated range filter that only affects data displayed on the CO-OPS web site. The CORMS controls are effective for preventing erroneous data from reaching the public, but this method is limited because it results in turning off dissemination for an entire data set. It does not treat data in context; for instance if the data set contained spikes, then the quality data in between these points would not be available to users. These users include the National Data Buoy Center (NDBC) which retrieves CO-OPS data via ftp as part of an ongoing partnership with CO-OPS.

3.1 THE CO-OPS/NDBC PARTNERSHIP

In 2003, CO-OPS established a partnership with NDBC, allowing it to ingest and QC the CO-

OPS meteorological data for display on the NDBC website. The NDBC retrieves the CORMS-controlled CO-OPS data via ftp; automated gross quality control checks are applied as well as manual daily QC by NDBC analysts. This partnership between CO-OPS and NDBC is ongoing, and it allows NDBC users access to quality-controlled CO-OPS data of NWS standards on the NDBC web site. The data are disseminated through NWS gateway to AWIPS and the Global Telecommunications System after undergoing the automated gross QC checks. Initially, CO-OPS found that this partnership supplanted the need for any in-house QC beyond the CORMS controls. Although NDBC provides an excellent medium for access to quality-controlled CO-OPS data, there are other ways for users to obtain the raw meteorological data that have not been subject to the NDBC QC process. Thus, there is much impetus for CO-OPS to apply additional QC that will set the stage for archivable data and downstream product generation.

3.2 CO-OPS QUALITY CONTROL PLANS

Establishing a real-time and monthly meteorological QC process will tighten the filters that prevent erroneous data from displaying on the CO-OPS web site.

The real-time automated QC process is near completion and will go live this fiscal year. This QC centers around preset case-based scenarios for which data violating the rules within a particular case are flagged. Automated checks will be enhanced to include rate of change checks and flat data checks that will also automatically filter erroneous data points from the CO-OPS website. The other major benefit of this new real-time QC software is that when an issue is automatically identified, the program will send a notice to the CORMS operators detailing the problem. From there, the operator will make the ultimate decision about the data stream in the same manner as he/she does now, except that the process will be more expedient. The range, rate of change, and flat data checks will give the operators the option of leaving a data set turned on, as the erroneous data points would be filtered, and thus would not be displayed on the CO-OPS web site for users to see.

The real-time QC method of storing error flags in the database allows for easy implementation of an automated monthly QC process. This process will entail using the flags from the previous month to delete erroneous data from a working data set. After this higher-quality data set is verified by CO-OPS personnel, it would then be available on the CO-OPS web site, in the same manner that processed and verified water level data are available now.

4. CONCLUSION

CO-OPS is upgrading 94 NWLON stations with meteorological sensors, resulting in a total of 237 NWLON and PORTS® stations overall that record meteorological data. Many of these stations are located in urban areas where coastal forecasting can be especially critical during storm events. Because CO-OPS has become such a major source for meteorological observations, the need has arisen for the application of higher data quality standards. Therefore, by the end of FY2010, CO-OPS will be disseminating meteorological data from over 90% of its stations as well as applying a QC process to both real-time and historical data. Quality control flags will be stored with the data, and the higher-quality data can be used appropriately in future applications of the data and derived product generation.

5. REFERENCES

1. CO-OPS Tides Online web site
http://tidesonline.nos.noaa.gov/

2. CO-OPS Tides & Currents web site
http://www.tidesandcurrents.noaa.gov/

3. NDBC web site
http://www.ndbc.noaa.gov/

Figure 1. Left: Oakland Middle Harbor, CA wind-only station, with the San Francisco-Oakland Bay Bridge in the background. Right: West Pier, Port of Gulfport, MS is a standard PORTS water level station containing a full suite of meteorological sensors, complete with dual anemometers.

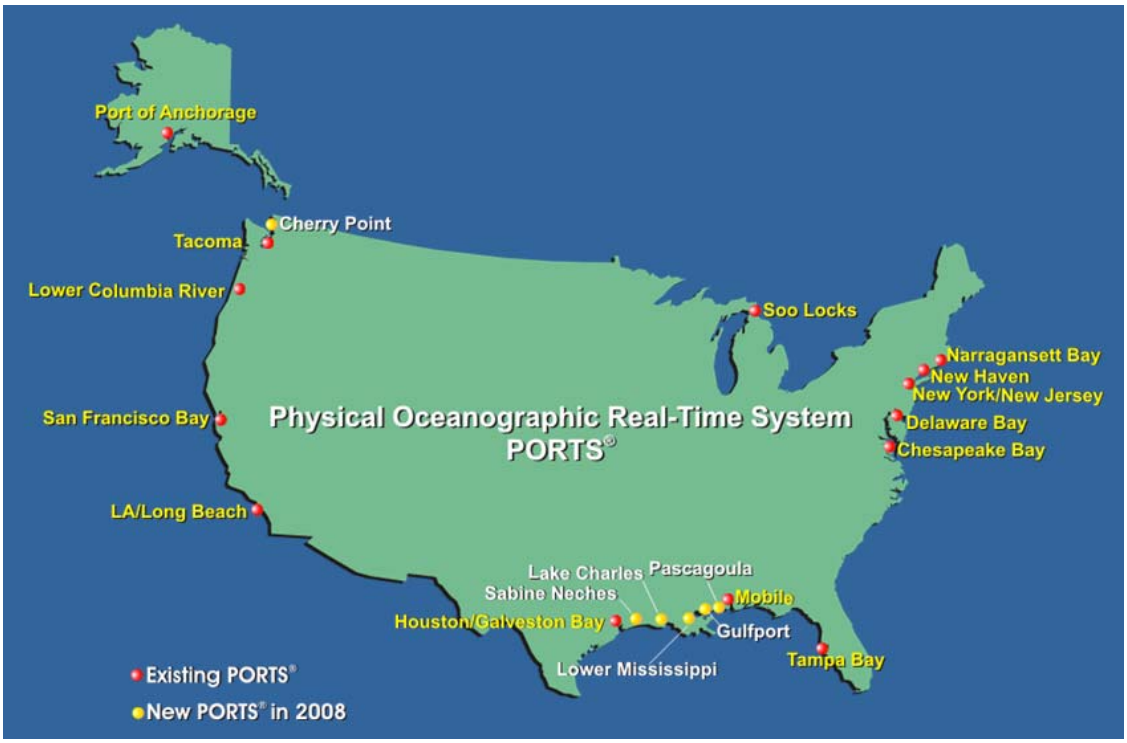

Figure 2. CO-OPS PORTS systems, including newly installed PORTS as of 2008 (yellow dots).

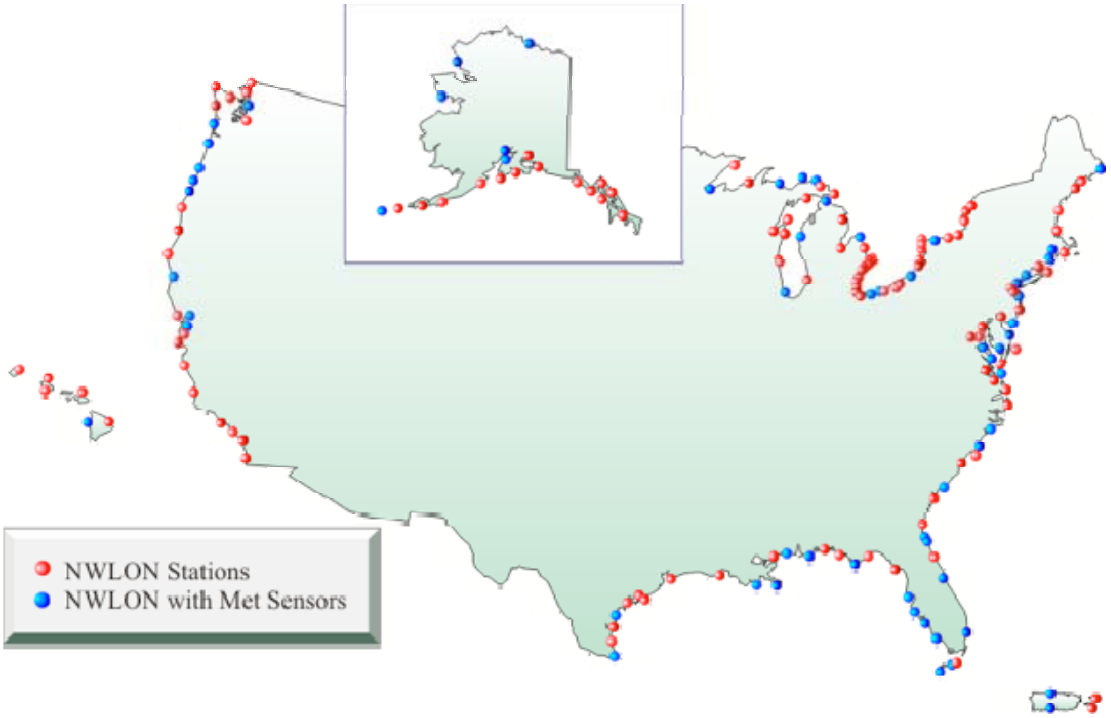

Figure 3. NWLON stations displayed around the U.S. coast and oceanic islands. There are currently 205 stations (red) and about half of these stations contain meteorological sensors (blue).