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Solutions Network Formulation Report

Improving NOAA's NWLON Through Enhanced Data Inputs from NASA's Ocean Surface Topography

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1. **Candidate Solution Constituents**

a. Title: Improving NOAA's NWLON Through Enhanced Data Inputs from NASA's Ocean Surface Topography Mission

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c. Identified Partners: NOAA (National Oceanic and Atmospheric Administration)

d. Specific DST/DSS: NOAA NWLON (National Water Level Observation Network)

e. Alignment with National Application: Coastal Management, with some support to Disaster Management and Public Health

f. NASA Research Results – Table 1:

Missions	Sensors/Models	Data Product
OSTM (Ocean Surface Topography Mission)	Poseidon-3 Altimeter (C- and Ku-band)	Sea surface height
GSFC	*GSFC00 Model*	Mean sea surface

g. Benefit to Society: Increased accuracy in tidal predictions, enhanced tsunami and storm surge warnings, and augmented information for maritime navigation and for wetland restoration.

2. **Abstract**

This report assesses the benefit of incorporating NASA's OSTM (Ocean Surface Topography Mission) altimeter data (C- and Ku-band) into NOAA's (National Oceanic and Atmospheric Administration) NWLON (National Water Level Observation Network) DSS (Decision Support System). This data will enhance the NWLON DSS by providing additional information because not all stations collect all meteorological parameters (sea-surface height, ocean tides, wave height, and wind speed over waves). OSTM will also provide data where NWLON stations are not present. OSTM will provide data on sea-surface heights for determining sea-level rise and ocean circulation. Researchers and operational users currently use satellite altimeter data products with the GSFC00 NASA data model to obtain sea-surface height and ocean circulation information. Accurate and timely information concerning sea-level height, tide, and ocean currents is needed to improve coastal tidal predictions, tsunami and storm surge warnings, and wetland restoration.

3. **Detailed Description of Candidate Solution**

a. Purpose/Scope

This report examines the use of NASA satellite altimeter data to enhance the NOAA NWLON DSS. The Nation uses water-level data for a variety of practical purposes, including hydrography, coastal engineering, tsunami and storm surge warnings, wetland restoration, nautical charting, and maritime navigation (NOAA, 2002; Digby et al., 1999; NOAA, 2003). Accurate and timely tide and ocean

current information is needed to understand their effects on coastal management, disaster management, and public health. Satellite altimeter data products are currently used by hundreds of researchers and operational users to monitor ocean circulation and to improve understanding of the role of the oceans in climate and weather. Ocean altimeter data has many societal benefits and has proven invaluable in many practical applications, including weather forecasting and El Niño prediction, hurricane forecasting, ship routing, precision marine operations, and sea-level mapping, as well as many other applications. Researchers and operational users currently use satellite altimeter data products to obtain sea surface height and ocean circulation information (Srinivasan and Leben, 2004).

b. Identified Partner(s)

NOAA plays a vital role in ocean monitoring by compiling satellite observations, meteorological and oceanographic data, and numerical modeling results to provide critical information to stakeholders, including citizens and federal, state, and local decision makers. The NOAA/NOS CO-OPS (Center for Operational Oceanographic Products and Services) manages the NWLP (National Water Level Program) to meet NOAA's mission and goal requirements for water-level information (NOAA, 2006c). The fundamental observational component of the NWLP is the NWLON. NWLON stations are the reference stations for NOAA's tide prediction products and serve as controls in determining tidal data for all short-term, water-level stations. NWLON data and products are a key part of the NOAA Tsunami Warning System and the NOAA Storm Surge Warning System. Because much of the densely populated Atlantic and Gulf coastlines lie less than 10 feet above mean sea level, the danger from storm tides is tremendous. Storm tides or storm surges were a significant cause of the Gulf Coast flooding following Hurricane Katrina and often are the source of general flood destruction as well as the source of more human injury and deaths than a hurricane's winds (NOAA, 2006d). The next two decades will bring an increased focus for NOAA on integrating tide data with data and observations of physical, geological, chemical, and biological aspects of the coastal environment. Information integration will help to protect coastal communities as well as to improve marine navigation safety and to reduce the risks to the coastal environment resulting from increased marine commerce (NOAA, 2006b).

c. NASA Earth-science Research Results

The Ocean Surface Topography Mission, also known as Jason-2, is a follow-on to NASA's Jason-1 mission and will provide continuity of ocean topography measurements beyond Jason-1 and its predecessor, TOPEX/Poseidon (NASA, 2005c; 2005a; 2006). A primary objective of OSTM is to provide timely support to global and regional operational applications (Srinivasan and Leben, 2004). Like its predecessors, OSTM will be placed onto a 66° orbit at an altitude of 1336 km (NASA, 2005a). It will follow the same reference ground tracks as Jason-1, repeating these tracks every 10 days. Performance and data delivery latency will be the same as Jason-1. The resolution will be at least the same as Jason-1 (3.3 cm) with a goal of 2.5 cm. The scheduled launch date is June 2008.

The Poseidon-3 Altimeter (C- and Ku-band) onboard the OSTM will provide data on sea-surface heights for determining ocean circulation, climate change, and sea-level rise (NASA, 2005c; Wang, 2001). The data will be provided in a binary format in accordance with the "big-endian" bit and byte array ordering convention.

d. NASA Earth-Science Models

The NASA GSFC00 model developed at the Goddard Space Flight Center produces mean sea-surface data products from satellite altimeter data (Wang, 2001). The model is a 2′x2′ grid, and SSH (sea surface height) values are interpolated to retrieve values at the location of the altimeter measurement (Spence and Foley, 2005). Environmental corrections are also applied to the mean SSH to account for predictable changes in SSH due to tides, barometric pressure, and high frequency wind response. The

model is also capable of generating such sea surface derivatives as gravity anomaly and vertical gravity gradient.

e. Proposed Configuration's Measurements and Models

NOAA has been monitoring tides since the 1800s (NOAA, 2006b). Tidal data and the resulting tidal currents have always been intricately linked to the vitality of this Nation's economy, ensuring that ships carrying goods are able to navigate waterways safely. This information is also used in coastal engineering projects, tsunami and storm surge warnings, and long-term ocean and climate research (NOAA, 2006b). The NWLON DSS gives near-real-time data and is critically important in areas where coastal storms and flooding can seriously affect a community's public safety and economy. The NWLON is a network of 175 long-term, continuously operating water-level stations throughout the USA, including its island possessions and territories and the Great Lakes (NOAA, 2006c). The data is accessed by GOES Geostationary Operational Environmental Satellites instrument and telephone modems. NWLON stations are the foundation for major observational programs within NOS and serves as a component for the Integrated Ocean Observing System. Technological advancements in sensors, data collection, and data communications have enabled routine, real-time, automated and event-driven data acquisition using GOES. NWLON data-collection platforms are now capable of measuring other oceanographic parameters in addition to water levels, including meteorological parameters. The data continuity, the vertical stability, and the careful referencing of NWLON stations have enabled the data to be used to estimate relative sea-level trends for the Nation. NWLON data is also used to analyze the severity and duration of decadal climate events, such as El Niño and the changing evapotranspiration cycle in the Great Lakes (NOAA, 2006b).

The OSTM data will enhance the NWLON DSS by providing satellite altimeter data from which sea-surface height, ocean tides, ocean circulation, wave height, and wind speed over waves data can be derived. The NASA GSFC00 model can be used to generate mean sea surface data depending on NOAA's NWLONs specific input requirements. Fluctuations in sea level, including the daily rise and fall of tides, are key to understanding our oceans and coasts (NOAA, 2006b).

Currently, NOAA's NWLON DSS is not using NASA satellite altimeter data in its measurements, observations, and predictions of water levels, currents, and meteorological parameters (e.g., winds, atmospheric pressure, air and water temperatures). The OSTM data will augment NOAA's NWLON DSS by providing satellite altimeter data with an accuracy of <4 cm (NASA, 2005c). Even though the OSTM repeat time is 10 days, this data will enhance the DSS by providing additional information on sea level height that can be compared to the in-situ data and can be checked for discrepancies and/or malfunction. OSTM data will also provide information on surface currents and sea-level change, because not all NWLON instruments are able to collect this type of data. The proposed integration of NASA's OSTM altimeter data into NOAA's NWLON DSS may improve accuracy in sea-level predictions and may afford both validation and redundancy for the NWLON water-level stations.

The concept of using a spaceborne radar altimeter to measure ocean topography was formulated in the late 1960s. With the launch of TOPEX/Poseidon in August 1992 and Jason-1 in 2001, NASA has a legacy of collecting ocean altimeter data continuously since 1992 (NASA, 2005b). OSTM is expected to launch in 2008 with a life expectancy of 3 to 5 years. With the value of ocean altimeter data established, data continuity is expected to continue with future NASA missions.

4. Programmatic and Societal Benefits

Solutions Network products that clearly establish the use of NASA altimetry for sea-level height strongly support Coastal Management and to some extent support the Disaster Management and Public Health National Applications. Ocean altimeter data has many societal benefits, including enhanced tidal predictions, tsunami and storm surge warning, and maritime navigation. NOAA plans to integrate tide data with data and observations of physical, geological, chemical, and biological aspects of the coastal

environment. Information integration will help to protect coastal communities, to improve marine navigation safety, and to reduce the risks to the coastal environment resulting from increased marine commerce (NOAA, 2006b).

5. References

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