Solutions Network Formulation Report

Improving NOAA's PORTS® Through Enhanced Data Inputs from NASA's Ocean Surface Topography Mission

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1. Candidate Solution Constituents

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

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c. Identified Partners: National Oceanic and Atmospheric Administration

d. Specific DST/DSS: National Oceanic and Atmospheric Administration Physical Oceanographic Real-Time System®

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

f. NASA Research Results – Table 1:

Mission	Sensors/Models	Data Product
Ocean Surface Topography Mission	Poseidon-3 Altimeter (C- and Ku-band)	Sea surface height
Goddard Space Flight Center	GSFC00 Model	Mean sea surface

g. Benefit to Society: Improve data for ship routing and for mapping currents, eddies, and vector winds; promote navigation safety; improve the efficiency of U.S. ports and harbors.

2. Abstract

The Nation uses water-level data for a variety of practical purposes, including nautical charting, maritime navigation, hydrography, coastal engineering, and tsunami and storm surge warnings. Long-term applications include marine boundary determinations, tidal predictions, sea-level trend monitoring, oceanographic research, and climate research. Accurate and timely information concerning sea-level height, tide, and ocean current is needed to understand their impact 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 scientists' understanding of the role of the oceans in climate and weather. The NOAA (National Oceanic and Atmospheric Administration) National Ocean Service has been monitoring sea-level variations for many years. NOAA's PORTS® (Physical Oceanographic Real-Time System) DST (decision support tool), managed by the Center for Operational Oceanographic Products and Services, supports safe and cost-efficient navigation by providing ship masters and pilots with accurate real-time information required to avoid groundings and collisions. This report assesses the capacity of NASA's satellite altimeter data to meet societal decision support needs through incorporation into NOAA's PORTS.

NASA has a long heritage of collecting data for ocean research, including its current Terra and Aqua missions. Numerous other missions provide additional important information for coastal management issues, and data collection will continue in the coming decade with such missions as the OSTM (Ocean

Surface Topography Mission). OSTM will provide data on sea-surface heights for determining ocean circulation, climate change, and sea-level rise.

We suggest that NASA incorporate OSTM altimeter data (C- and Ku-band) into NOAA's PORTS® DST in support of NASA's Coastal Management National Application with secondary support to the Disaster Management and Public Health National Applications.

3. Detailed Description of Candidate Solution

a. Purpose/Scope

This report examines the use of NASA altimeter data to enhance the NOAA PORTS® DST. The Nation uses water-level data for a variety of practical purposes, including nautical charting, maritime navigation, hydrography, coastal engineering, and tsunami and storm surge warnings (NOAA, 2002a). Mariners use the information to advantageously time their approach to and exit from ports (Digby et al., 1999). Long-term applications include sea-level trend monitoring, marine boundary determination, tidal predictions, oceanographic research, and climate research. Accurate and timely tide and ocean current information is needed to understand their impact 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 scientists' 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 ship routing; precision marine operations, such as cable-laying and oil production; sea-level mapping; ocean forecasting systems; climate research and forecasting; fisheries management; marine mammal habitat monitoring; hurricane forecasting and tracking; and debris tracking. The data has been cited in nearly 2,000 research and popular articles since the launch of TOPEX/Poseidon in 1992, and almost 200 scientific users receive the global coverage altimeter data on a monthly basis (Srinivasan and Leben, 2004).

b. Partner Agency

NOAA's NOS (National Ocean Service) has been monitoring water-level variations for over 100 years (NOAA, 2006a). The modeling of tides, currents, and water levels requires input from several types of databases. The NOS CO-OPS (Center for Operational Oceanographic Products and Services) contributes to the NOAA effort by providing critical water-level information. During the 2005 hurricane season, CO-OPS played a key role in providing real-time information on storm tide and in assisting the ports and industries within the Gulf Coast region to resume their operations as quickly as possible (NOAA, 2005).

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. By providing ship masters and pilots with accurate, real-time, sea-level information required to avoid groundings and collisions, NOAA provides essential real-time information for safe and cost-effective navigation, hazardous material and oil-spill prevention and response, search-and-rescue, and scientific research. Economic benefits and navigation safety are linked in that just one grounding can easily block a major channel and shut down a seaport, resulting in the loss of millions of dollars each day (NOAA, 2002b). The objectives of the PORTS® program are to promote navigation safety, to improve the efficiency of U.S. ports and harbors, and to ensure the protection of coastal marine resources (NOAA, 2006c).

c. NASA Earth-science Research Results

The OSTM, 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. 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, 2005b). The satellite will follow the same reference ground tracks, repeating these tracks every 10 days. Performance and data delivery latency will be the same as Jason-1.

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

e. Proposed Configuration’s Measurements and Models

The PORTS DST improves the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts, and other geospatial information (NOAA, 2006c). NOAA's National Ocean Service supports safe and cost-efficient navigation by providing ship masters and pilots with accurate, real-time information required to avoid groundings and collisions. PORTS includes centralized data acquisition and dissemination systems that provide real-time water levels, currents, and other oceanographic and meteorological data from bays and harbors to the maritime user community. PORTS also provides nowcasts and predictions of these parameters using numerical circulation models. Telephone voice access to accurate, real-time, water-level information allows U.S. port authorities and maritime shippers to make sound decisions regarding loading of tonnage (based on available bottom clearance), maximizing loads, and limiting passage times without compromising safety (Wilmot et al., 1997). PORTS also provides essential real-time information for safe and cost-effective navigation, hazardous material and oil-spill prevention and response, search and rescue, and scientific research (USF, 1998). The PORTS DST is currently installed at the following 13 locations: San Francisco Bay, New York/New Jersey Harbor, Houston/Galveston, Tampa Bay, Chesapeake Bay, Narragansett Bay, Soo Locks, Los Angeles/Long Beach, Delaware River and Bay, Tacoma, Port of Anchorage, New Haven, and Lower Columbia River (NOAA, 2006b).

The OSTM data will enhance the PORTS® DST 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 could be used to generate mean sea surface data depending on NOAA’s PORTS specific input requirements. Knowledge of the currents, water levels, winds, waves, visibility, and density of the water can increase the amount of cargo moved through a port and harbor by enabling mariners to safely use every inch of dredged channel depth (NOAA, 2002b).

Currently, NOAA’s PORTS DST is not using NASA satellite altimeter data in its measurements, observations and predictions of water levels, currents, salinity, and meteorological parameters (e.g., winds, atmospheric pressure, air and water temperatures) that mariners need to navigate safely. NOAA provides these measurements from 13 PORTS systems that are a variety of sizes and configurations, each specifically designed to meet local user requirements. The largest of NOAA’s existing PORTS installations comprises over 50 separate instruments; the smallest is a single water-level gauge and associated meteorological instruments (e.g., winds, barometric pressure, etc.) (NOAA, 2006c). The OSTM data will augment NOAA’s PORTS® DST by providing satellite altimeter data with an accuracy of <4 cm (NASA, 2005a). This data will enhance the DST by providing additional information on sea level height, surface currents, and the rate of global sea-level change. The proposed integration of NASA’s OSTM altimeter data into NOAA’s PORTS DST may improve accuracy in sea-level predictions and afford both validation and redundancy for the PORTS DST.

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; 2006). 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 the Coastal Management and to some extent support the Disaster Management and Public Health National Applications. Ocean altimeter data has many societal benefits and has proven invaluable in many practical applications, including ship routing; precision marine operations, such as cable-laying and oil production; sea-level mapping; ocean forecasting systems; climate research and forecasting; fisheries management; marine mammal habitat monitoring; hurricane forecasting and tracking; and debris tracking (NASA, 2005b).

5. References

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