

## Solutions Network Formulation Report

# Improving NOAA's Tides & Currents Through Enhanced Data Inputs from NASA's Ocean Surface Topography Mission

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### 1. Candidate Solution Constituents

- a. Title: Improving NOAA's Tides & Currents Through Enhanced Data Inputs from NASA's Ocean Surface Topography Mission
- b. Author: DeNeice C. Guest, Science Systems and Applications, Inc., John C. Stennis Space Center
- c. Identified Partners: NOAA (National Oceanic and Atmospheric Administration)
- d. Specific DST/DSS: NOAA Tides & Currents
- 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
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: Better understanding of sea-level trends and impact on coastal environment; improved data for ship routing and for mapping currents, eddies, and vector winds; improved tide and current data

### 2. Abstract

The Nation uses water-level data for a variety of practical purposes, including hydrography, nautical charting, maritime navigation, coastal engineering, and tsunami and storm surge warnings (NOAA, 2002; Digby et al., 1999). 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, 2006). NOAA's Tides & Currents DST (decision support tool, managed by the Center for Operational Oceanographic Products and Services, is the portal to a vast collection of oceanographic and meteorological data (historical and real-time), predictions, and nowcasts and forecasts. This report assesses the capacity of NASA's satellite altimeter data to meet societal decision support needs through incorporation into NOAA's Tides & Currents.

NASA has a long heritage of collecting data for ocean research, including its current Terra and Aqua missions (NASA, 2006a). 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 (NASA, 2005a).

We suggest that NASA incorporate OSTM altimeter data (C- and Ku-band) into NOAA's Tides & Currents 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 (National Oceanic and Atmospheric Administration) Tides & Currents DST (decision support tool). The Nation uses water-level data for a variety of practical purposes, including hydrography, nautical charting, maritime navigation, coastal engineering, and tsunami and storm surge warnings (NOAA, 2002). 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 sea-level mapping; ocean forecasting systems; climate research and forecasting; ship routing; precision marine operations, such as cable-laying and oil production; 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).

#### **Partner Agency**

NOAA's NOS (National Ocean Service) has been monitoring water-level variations for over 100 years (NOAA, 2006). 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 making sea-level and tide data information available to the public, NOAA provides decision makers the necessary information to address coastal problems and issues, communicate and mitigate trends/issues/problems to the public, and provide information for disaster management.

#### **b. NASA Earth-science Research Results**

The OSTM (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. A primary objectives 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). It 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.

c. 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.

d. Proposed Configuration’s Measurements and Models

NOAA's Tides & Currents DST provides stakeholders with the following data products: Sea Level Trends, Currents, Operational Forecast Systems, Astronomical, and nowCOAST. Of particular interest is Sea Level Trends, which delivers monthly mean sea-level data used to produce linear trends, average seasonal cycle, and interannual variations (NOAA, 2006). The OSTM data will enhance the Tides & Currents 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 a mean sea surface depending on NOAA’s Tides & Currents specific input requirements.

Currently, NOAA’s Tides & Currents DST is not using NASA satellite altimeter data for Sea Level Trends. NOAA provides mean sea-level trends from 117 long-term water-level stations (NOAA, 2006). Monthly mean sea-level data are used to obtain the linear trend, the average seasonal cycle, and interannual variations. The OSTM data will augment NOAA’s Tides & Currents 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 the rate of global sea-level rise and on surface currents. The proposed integration of NASA’s OSTM altimeter data into NOAA’s Tides & Currents DST may improve accuracy in sea-level mapping and afford decision and policy makers more comprehensive products to make better near-term management decisions and to set more realistic long-term management policies.

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 and has proven invaluable in many practical applications, including sea-level mapping; ocean forecasting systems; climate research and forecasting; ship routing; precision marine operations, such as cable-laying and oil production; fisheries management; marine mammal habitat monitoring; hurricane forecasting and tracking; and debris tracking (NASA, 2005b).

## 5. References

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