NWS Science and Technology Roadmap

Tsunami

Team Composition

- Jenifer Rhoades, NWS/OCWWS/MSD – Team Leader
- Susan McLean NESDIS/NGDC/MGGD – Contributor
- Eddie Bernard OAR/PMEL – Contributor
- Paul Whitmore NWS/AR/ARS/TWC/Palmer AK – Contributor
- Chip McCreery NWS/PR/PRS/PTWC/Ewa Beach HI – Contributor
- Art Taylor NWS/OST/MDL – Future Contributor

Vision/Benefits/Impacts

- **Team Vision**
  - For NOAA to: provide timely and accurate warnings; communicate effectively to elicit appropriate responses; and promote the development of tsunami-resilient coastal communities to mitigate the impacts of and quickly recover from the next tsunami

- **Benefits**
  - More timely and accurate tsunami forecast and warning products
  - Understandable and useable tsunami products to save lives
  - Reliable and coordinated data, communications, and dissemination infrastructure
  - Capability to acquire and exchange relevant tsunami data and information
  - Reduce elapsed time from earthquake to Tsunami Product Issuance
    - Local and Regional events 5 minutes
    - Distant events 16 minutes

- **Impacts:**
  - Tsunami information and products to support improved decision making
  - Tsunami information that minimizes societal impacts resulting in less economic impact and loss of life.
  - Reduce the geographical extent of tsunami warnings by 47 percent. This results in a reduced economic cost avoidance based on the reduction of unnecessary evacuations including transportation, lost wages, closed businesses and other economic disruptions. The program's target for this is reflected in the Tsunami PART as a reduction from the FY05 baseline of $887M to a target of $71M by FY13.

Goals/Targets:
Emerging Science & Technology

Goal	Outstanding Issues
Improved accuracy of tsunami detection capacity	• Lack of robust observational networks (seismic and sea-level) • Expand sea-level monitoring so that non-seismic source waves can be observed prior to impact •Lack of understanding of earthquake pre-cursors
Improved tsunami forecasts through improved accuracy of tsunami wave arrival time fcst, duration of the tsunami wave activity fcst and tsunami wave height fsct	•Insufficient methodologies to constrain tsunami sources •Lack of techniques to indentify non-tectonic tsunami sources •Lack of NCEP Supercomputer for model runs (including SIFT) in support of TWC operations • Lack of real-time and ensemble modeling capability • Data assimilation not optimal
Improved graphical product resolution to meet high resolution of data available	•Enhance graphical products with geographic information systems capability •Add energy plots to forecast products •Utilize site specific impact models and maps to develop forecast/warning products

Goals/Targets:
Customer Needs

Goal/Target	Outstanding Issues
Provide tsunami products that lead to an appropriate response by the public	•Social science not being used to target specific community's unique characteristics and needs •Social science is not being used to clearly communicate hazard to emergency managers to aide their decisions •Lack of integrated tsunami information and product services
Resilient communities inhabited by a public that is educated to take appropriate actions	•Preparedness program sub-optimal •Insufficient understanding of tsunami risk

Key Information Gaps

Gap	Solution Alternative	Impact
1. Insufficient Observations • Seismic • Water level (Deep-ocean and coastal)	1.1 Upgrade Pacific Sea-level network and expand Caribbean and Hawaii Sea-level network 1.2 Upgrade Hawaii Seismic network 1.3 Leverage existing observational platforms – multi-purpose deep-ocean detection buoys 1.4 Evaluate alternative operational models for deep-ocean, sea-level DART network	1.1 High – improved analysis of potential tsunami impacts and improved accuracy of tsunami wave arrival time, duration, of the tsunami wave activity and tsunami wave height forecasts 1.2 High – Improved detection of potential local tsunamigenic earthquakes in Hawaii 1.3 High – potential to reduce operational cost of DART Network 1.4 High– potential to reduce operational cost of DART Network

Key Information Gaps

Gap	Solution Alternative	Impact
2. Insufficient knowledge of tsunami factors: • Currents • Seismic • Non-tectonic tsunami sources	2.1 Conduct research to analyze impact of tsunami currents in harbors and bays 2.2 Enhance seismic array processing 2.3 Expand research into new technologies to improve tsunami detection methodologies 2.4 Develop forecasting methodology for meteo-tsunamis (see notes)	2.1 High – Improves prediction capabilities 2.2 High – Improves detection and prediction capabilities 2.3 Med – Improves detection capabilities 2.4 Med – Improves detection capabilities

Key Information Gaps

Gap	Solution Alternative	Impact
3. Insufficient knowledge of uncertainty of impact of given obs and forecasts • Need to evaluate the uncertainty of the impact of given observations on forecast accuracy	3.1 Develop a capability to evaluate the value of observations and instruments on forecast accuracy and timeliness	3.1 High
	3.2 Advise NOAA on its investment decisions [(Observing System Experiments (OSE) and Observing System Simulation Experiments (OSSE)]	3.2 High
	3.3 Conduct field experiments focusing on key physical processes to support forecast improvements	3.3 High – validates models to initiate transition to Ops
	3.4 Develop ensemble forecasting capability	3.4 High – enables evaluation of models for uncertainty as well as improved forecasting capability

Key Information Gaps

Gap	Solution Alternative	Impact
4. Insufficient modeling - Inadequate resolution and physics of operational models - Lack of higher resolution inundation water levels for inundation events - Data assimilation does not meet needs - Lack of community modeling capability	4.1 Complete transition of Site-specific inundation forecast tool from PMEL to TWC operations (3.1) 4.2 Develop high resolution Digital Elevation Models for coastal areas (3.1) 4.3 Transition operational models to NCEP Supercomputer for processing (3.2) 4.4 Develop and Implement Next Generation inundation models (3.1) 4.5 Develop web-enabled interfaces to forecast technology (3.3) 4.6 Implement Tsunami R&D Test Bed (3.1 and 3.3)	4.1 High 4.2 High 4.3 High 4.4 High 4.5 High 4.6 High

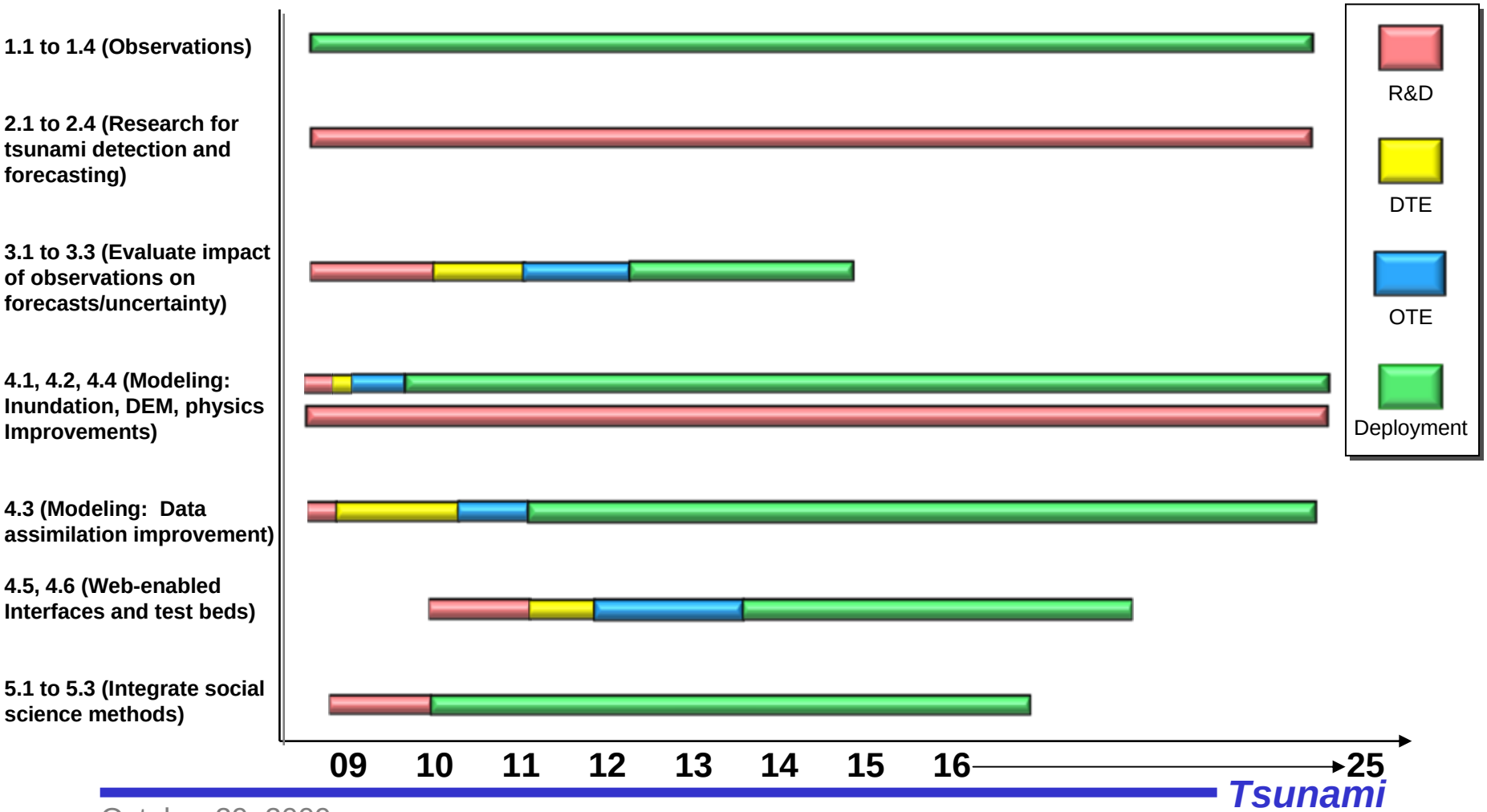
Key Information Gaps

Gap	Solution Alternative	Impact
5. Insufficient Outreach and Education - Need to address Customer-driven product requirements - Cannot provide products with criteria that support specific targeted emergency manager response - Cannot support TsunamiReady Program recognitions and improvement	5.1 Utilize social science to improve Tsunami Warning Center (TWC) products, including warnings, advisories, watches and information statements 5.2 Apply social science methods to support the TsunamiReady Program Improvement Plan and criteria review 5.3 Assess previous and on-going social science studies for tsunami, including state and local efforts, to determine how to integrate at the national level.	5.1 High – Provides the opportunity to develop new products and services based on customer and partner information needs 5.2 High – Opportunity to improve community preparedness for a tsunami 5.3 High – Provides a one-stop location for tsunami related social science information and enables the integration of tsunami social science related findings

Research Needs and Opportunities

- **Near Term (FY10-16)**
  - Enhancement and evaluation of observing systems
  - Improve and expand modeling of tsunami currents and near-shore impacts
  - Improve understanding and modeling of non-tectonic sources to improve forecast methodologies
  - Enhance seismic array processes
  - Expand and improve tsunami detection methodologies
  - Develop Next Generation Tsunami Models and DEMs
  - Support expanded Operational Model processing
  - Develop new methods to deliver NWS Tsunami products for decision support serves
- **Long Term (FY16-25)**
  - Implement Ensemble Modeling Capability
  - Implement techniques to identify precursors to tsunamigenic earthquakes

Tsunami Alternative Solutions



Focus Area Team Summary: Tsunami

R&D Needs & Opportunities

- Deliver high resolution and advance physics for near-shore high impact tsunami events
- Improve forecast accuracy/speed through enhanced obs, model development and data assimilation
- Employ community modeling to advance R&D
- Social Science Studies/Assessments

Vision

Provide timely warnings and forecasts, and promote development of tsunami-resilient communities

Increasing Impact

Current Status:

- Improved model physics and resolution
- Improved obs & situational awareness
- Incorporate social science principles
- Use of NCEP SC for model fcsts

Near-Term:

- TWC IT Modernization
- Enhanced seismic array processing
- Improved tsunami detection
- Forecasts for non-tectonic sources
- Web interfaces
- Tsunami Test Bed
- DSS Tools
- Community Modeling

Long-Term:

- Implementation of Next Gen Modeling capability
- Improved observations and detection capability
- Leverage emerging social science technology to improve forecasts process and decision support tools

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Tsunami

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Tsunami Team Additional Information

Performance Measures: Tsunami

Proposed	Current (2009)	FY 16 Target Example	FY 25 Target Example
Maintain Probability of detection for a destructive tsunami within the TWC area of responsibility	**100%**	**100%**	
Accurately estimate AOR earthquake magnitude within .17M	**.19M**	**.17M**	
Reduce elapsed time from earthquake to Tsunami Message Product issuance for distant events	**22 mins**	**16 mins**	
Reduce elapsed time from earthquake to Tsunami Message Product issuance for regional events	**10 mins**	**5 mins**	
Reduce time to cancel a Tsunami Warning or Watch	**3 hrs**	**2 hrs**	
Reduce the Geographical extent of tsunami warnings	**25% Reduction**	**47% Reduction**	
Economic Impact from Tsunami Warnings (Millions of Dollars)	**$213M**	**$71M**	
Increase the data available from observational networks	**87%**	**90%**	