February, 2015
NTHMP
Warning Coordination Subcommittee Meeting

Agenda

- Introductions
- 2014-Action Item Review
- WCS Strategic Plan Tasks
- TWC Products
  - Proposed message changes
  - PTWC international product update
  - NWR/EAS
  - WEA Polygons
  - Canada tsunami prep and Twitter study
  - EAS activation for advisories
  - Social Science recs. on initial bulletin
  - Threat data base example; Cascadia

Agenda

- Exercises
  - 2015 National exercises
  - Comms tests
  - Others?
  - 2016 plans
- 2014 tsunami alerts
  - April – Chile
  - June - Alaska
- Warning Effectiveness Survey for Alaska event
- IT Mod. update
- Meteotsunami forecast protocol
- Sea level gages
- New Action Items

Action Item Review

WCS Strategic Plan Tasks

Products – New Format

- Adopt Complex Coast recs.?
- How will addition of NWS Marine Zones impact EAS activation?

Complex Coast Zones

- Start in Pacific
  - South Alaska
  - Southeast Alaska
  - British Columbia
  - Washington/Oregon
  - California

Products – New Format

- Adopt NOAA Social Science recs. as distributed in November?
- Spanish products now are live

Products – PTWC International

NTHMP Warning Coordination Subcommittee Meeting
Portland, Oregon, February 10, 2015

Pacific Tsunami Warning Center International Products Update

Charles McCreery, Director
Pacific Tsunami Warning Center

Context

- PTWC has responsibility through the Tsunami Program of the UNESCO Intergovernmental Oceanographic Commission to provide operational tsunami threat guidance to the countries of the
  - Pacific Ocean and its Marginal Seas (PTWS)
  - Caribbean Sea and Adjacent Regions (CARIBE-EWS)
- PTWC products issued for those areas is advice – the countries are responsible for issuing alerts (warnings, watches, advisories, etc.)

PTWC International Products Changes

- From 1965 through September 2014 the PTWC products for the Pacific were text products with the following alert recommendations for each country:
  - Information – big earthquake with no tsunami threat
  - Tsunami Watch – tsunami threat under evaluation
  - Tsunami Warning – destructive tsunami expected
- On October 1, 2014, after several years of product development through the PTWS and following training and exercises with the PTWS countries, PTWC transitioned to new text and graphical products that do not have alert recommendations but only forecast tsunami amplitudes:
  - < 0.3 meters
  - 0.3 - 1 meter
  - 1 – 3 meters
  - > 3 meters

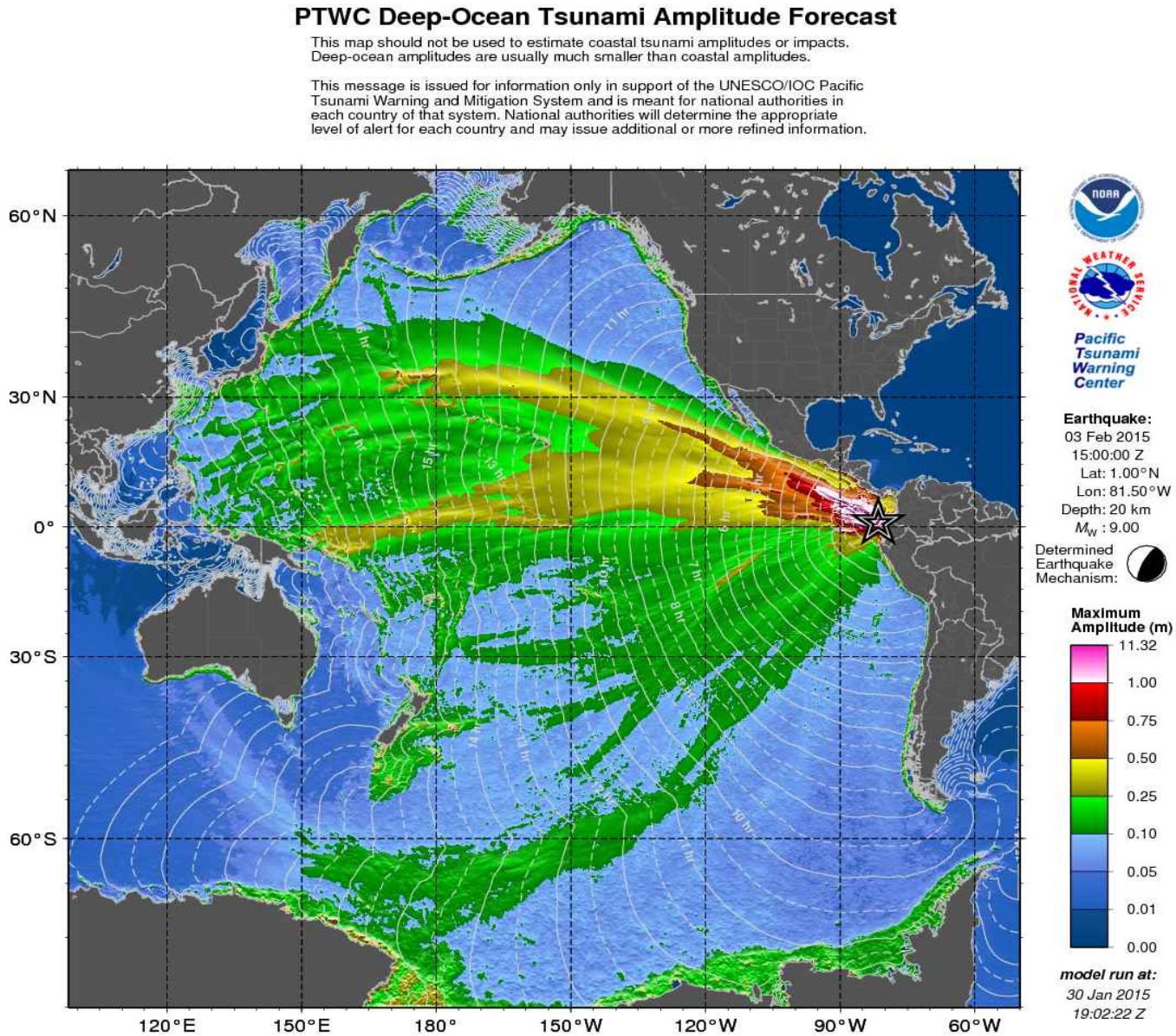
PTWC New International Products

- New PTWS International Product Suite for the Pacific
  - Revised Text Product
  - Threat Overview Map
  - Propagation Forecast Map
  - Coastal Forecast Maps
  - Coastal Forecast KMZ file
  - Table of Forecast Statistics
- Text product is still distributed publicly through the WMO GTS
- Graphical forecast products and statistics table are distributed privately via email only to each country's designated Tsunami Warning Focal Point

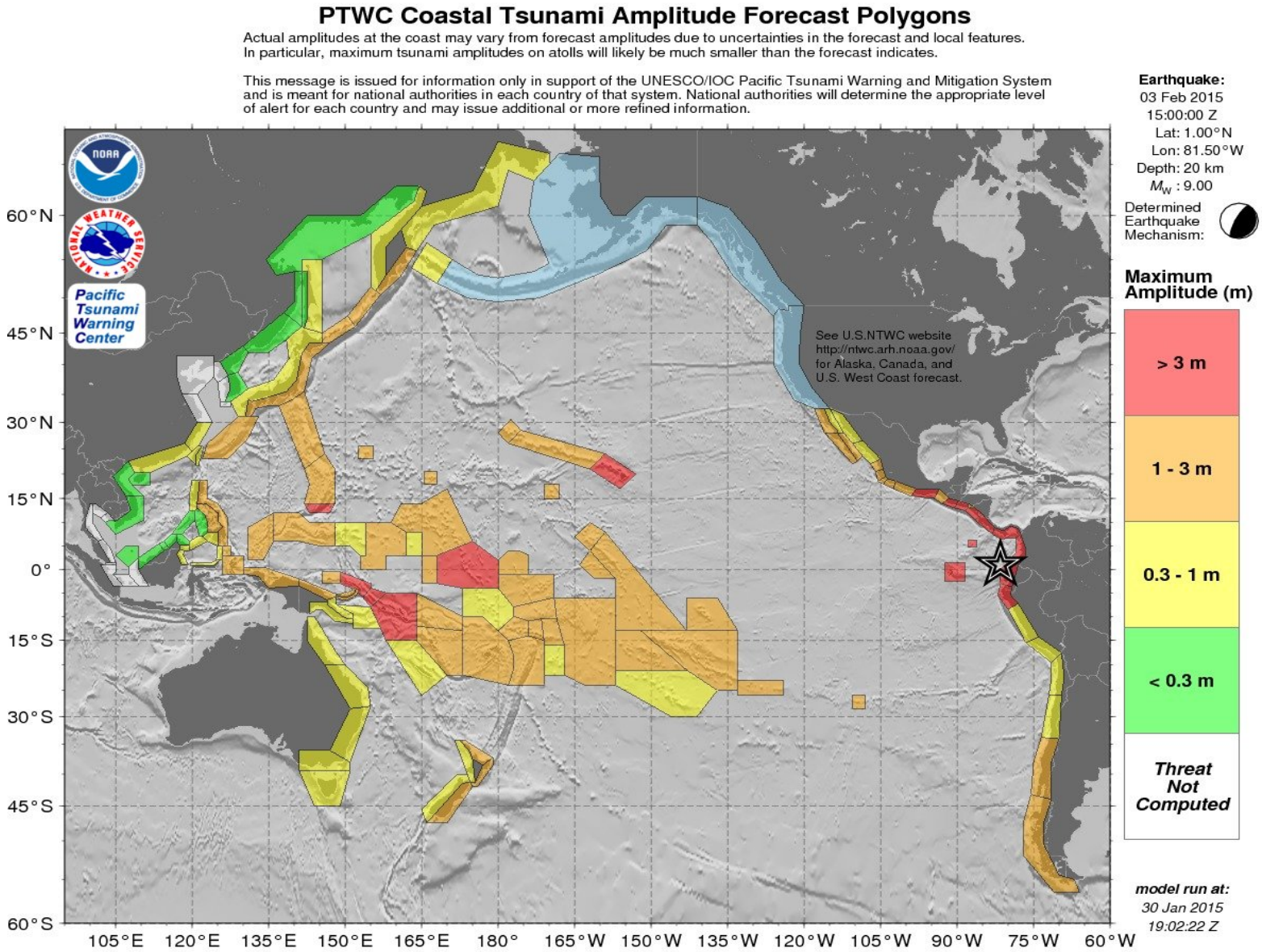
Text Product (sample text)

```
TSUNAMI THREAT FORECAST...UPDATED
---------------------------------

  * TSUNAMI WAVES REACHING MORE THAN 3 METERS ABOVE THE TIDE
    LEVEL ARE POSSIBLE ALONG SOME COASTS OF

      MEXICO... EL SALVADOR... GUATEMALA... COSTA RICA...
      NICARAGUA... PANAMA... COLOMBIA... ECUADOR... PERU... GUAM...
      KIRIBATI... SOLOMON ISLANDS... PAPUA NEW GUINEA... AND HAWAII.

  * TSUNAMI WAVES REACHING 1 TO 3 METERS ABOVE THE TIDE LEVEL ARE
    POSSIBLE ALONG SOME COASTS OF

      HONDURAS... CHILE... ANTARCTICA... JAPAN... PHILIPPINES...
      NEW ZEALAND... NORTHERN MARIANAS... PALAU... YAP... POHNPEI...
      MARSHALL ISLANDS... FIJI... SAMOA... AMERICAN SAMOA... COOK
      ISLANDS... TOKELAU... VANUATU... FRENCH POLYNESIA... NAURU...
      WAKE ISLAND... MIDWAY ISLAND... JOHNSTON ISLAND... JARVIS
      ISLAND... PALMYRA ISLAND... HOWLAND AND BAKER... TONGA... WALLIS
      AND FUTUNA... PITCAIRN ISLANDS... INDONESIA... RUSSIA... AND NW
      HAWAIIAN ISLANDS.
```

Propagation Forecast Map



Coastal Forecast Map - Overview

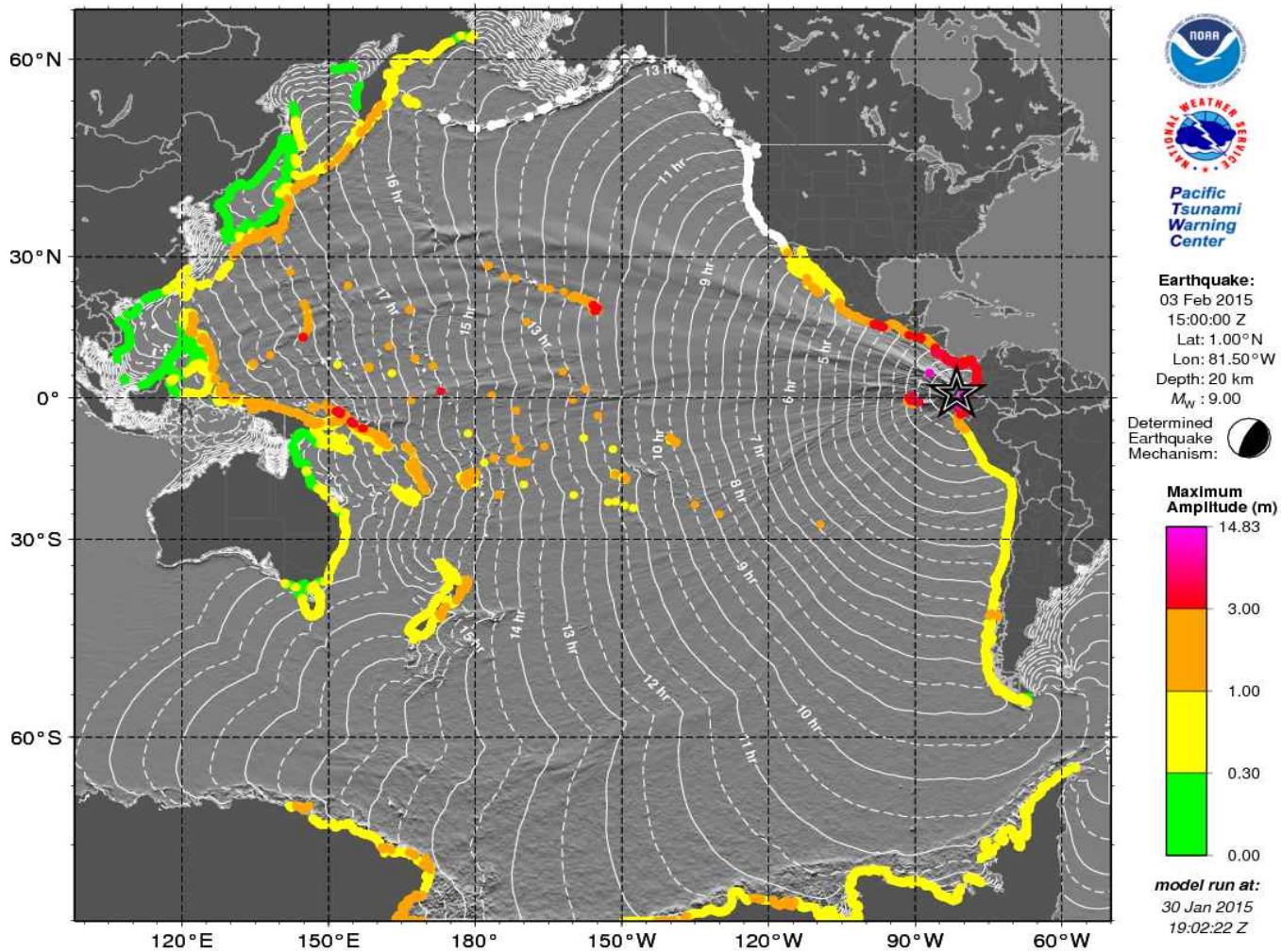


Coastal Forecast Map - Pacific

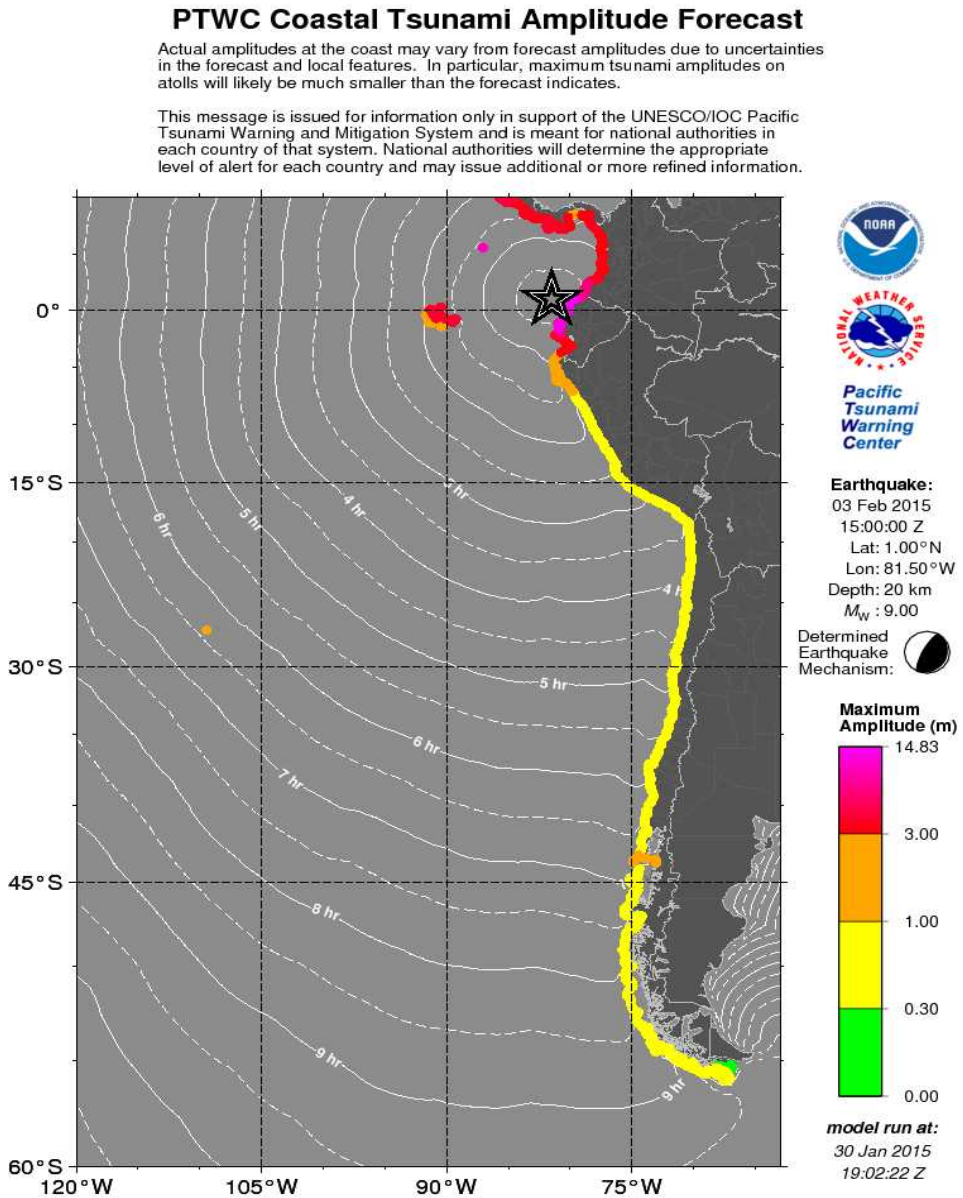
PTWC Coastal Tsunami Amplitude Forecast

Actual amplitudes at the coast may vary from forecast amplitudes due to uncertainties in the forecast and local features. In particular, maximum tsunami amplitudes on atolls will likely be much smaller than the forecast indicates.

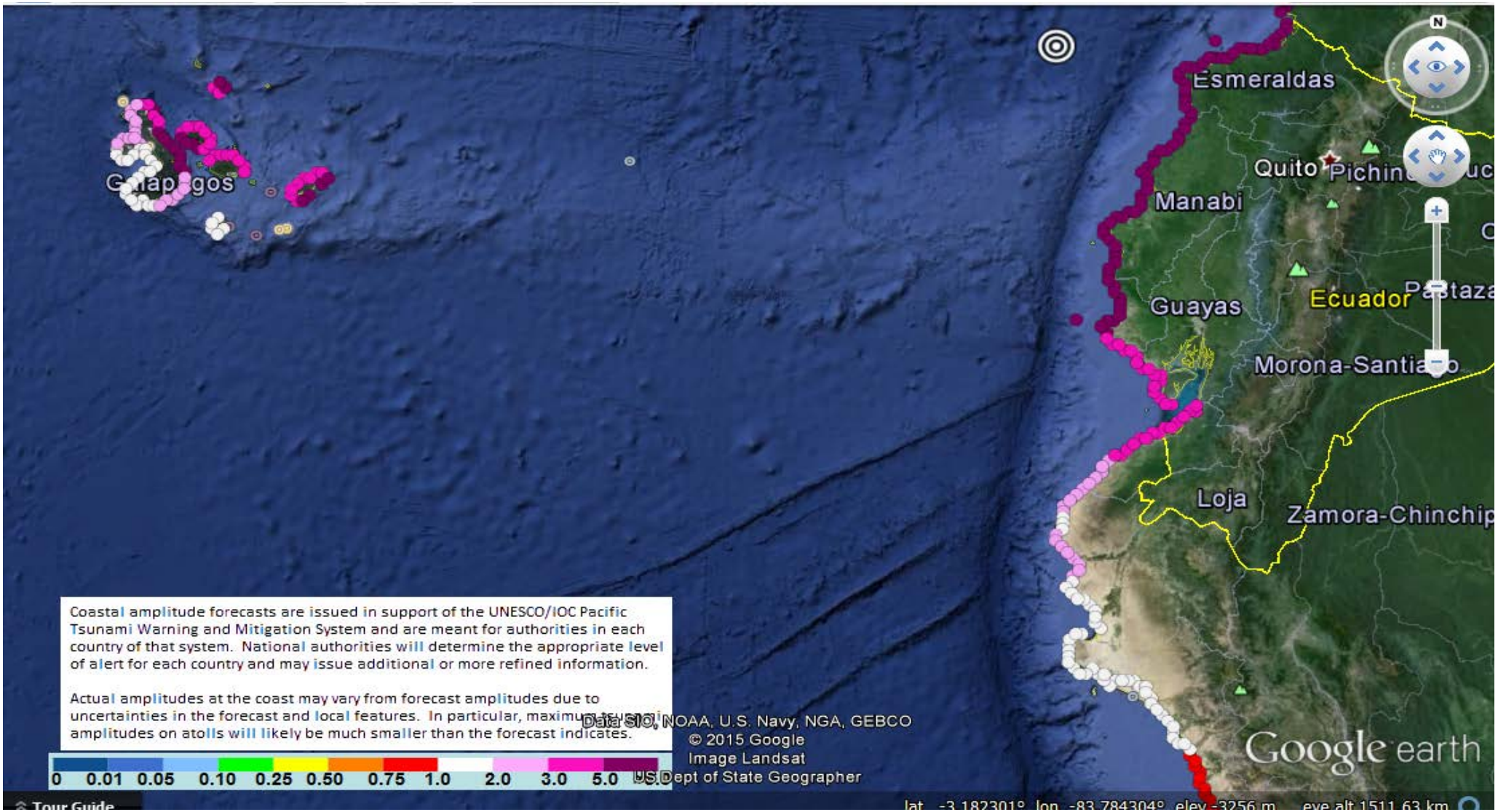
This message is issued for information only in support of the UNESCO/IOC Pacific Tsunami Warning and Mitigation System and is meant for national authorities in each country of that system. National authorities will determine the appropriate level of alert for each country and may issue additional or more refined information.



Coastal Forecast Map - Regional



Coastal Forecast Map - KMZ



PTWC New International Products

- American Samoa and Guam/CNMI formerly covered by PTWC's international product now have new domestic products
  - American Samoa began March 17, 2014
  - Guam/CNMI began September 22, 2014
- New Pacific products initiated on October 1, 2014
- So far there have been
  - 9 informational events
  - 3 threat events
- PacWave15 – The third Pacific exercise with the new products was just held on February 2 – 5, 2015.

- Similar products for the Caribbean are under development and will begin to be issued in parallel with existing products in the first quarter of 2015.

NWR-EAS Auto-activation

Western Region Tsunami GUI/SPS Formatter Update

Jeff Lorens

Feb 10, 2015

Background

- Project begun 2012
  - Slow but steady progress
- Goal: Automate and standardize method to issue initial Tsunami Watches, Warnings, and local statements (SPS) at WR coastal WFOs:
  - GUI:
    - EAS activation
    - Initial information broadcast (NWR)
  - Local Statement Generation (SPS)
- Information parsed from NTWC bulletins

Current Status (GUI)

- WFO Portland: Operational
  - Staff trained; waiting for event
- WFO Oxnard: In-process
  - Update SDM
  - Management reviewing
  - Staff training
- WFO Monterey
  - Installed & configured
  - Awaiting internal system test (unplug transmitters from CRS & send from GUI)

Current Status (cont.)

- WFO Seattle:
  - Installed; in process of configuring
- Next: WFOs Eureka, San Diego, and Medford
- Working one-on-one with WFOs as needed
  - Ryan Kittell (LOX): GUI
  - Bill Schneider (PQR): CRS

Current Status: Local Statement Formatter (SPS)

- AWIPS1: Complete
- AWIPS2: Functional, but some work still needed
  - Installation instructions

EAS Issue

- How to handle inland counties which are not in the watch/warning area?

Questions & Discussion

WEA Polygons

Twitter and BC Preparedness

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Canadian Safety and Security Program

Improving End-To-End Tsunami Warning for Risk Reduction Along Canada's West Coast

National Tsunami Hazard Mitigation Program
February 10, 2015

Peter Anderson
Simon Fraser University
anderson@sfu.ca

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Emergency ManagementBC

Canadian Safety and Security Program

Improving End-To-End Tsunami Warning for Risk Reduction on Canada's West Coast Project

Supported through the

Canadian Safety and Security Project

- **Technical Authority** – Defense Research and Development Canada, Centre for Security Science
- **Province of British Columbia Representative and Project Champion** - Emergency Management British Columbia
- **Research Lead –** Simon Fraser University

Project Schedule

- PHASE 1: (April – December, 2014)
  - Study to inventory and assess existing coastal warning and communication networks and last-mile segments.
- PHASE 2: (January 2015 – March 2016)
  - Piloting and evaluation of new techniques and technologies that can support region-wide and localized needs.
  - Revising and expanding the Tsunami Warning Methods Planning Tool Kit Guide and assist with community technology implementation and training.

Special Challenges for British Columbia's Tsunami Notification System

- Most effective in the case of far-field or telegenic tsunamis
- Not designed for locally generated tsunamis

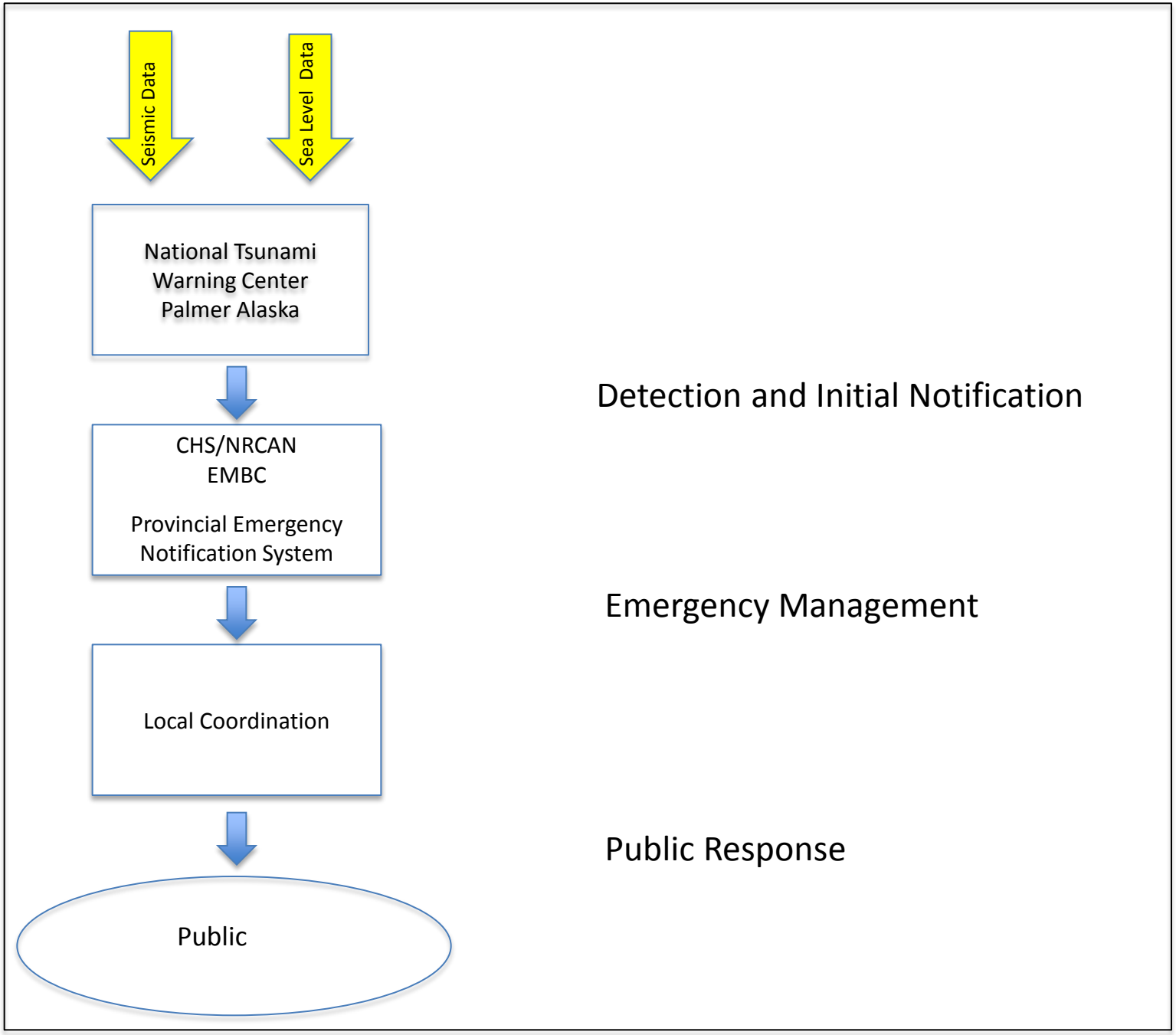
Noted Canadian West Coast Tsunami Warning System Limitations

- Coverage – community variations
- Coverage – terrain
- Coverage – geography – 26,000+ kms of coastline
- Coverage – means of communication and warning
- Community and industry preparedness
- Public education and awareness

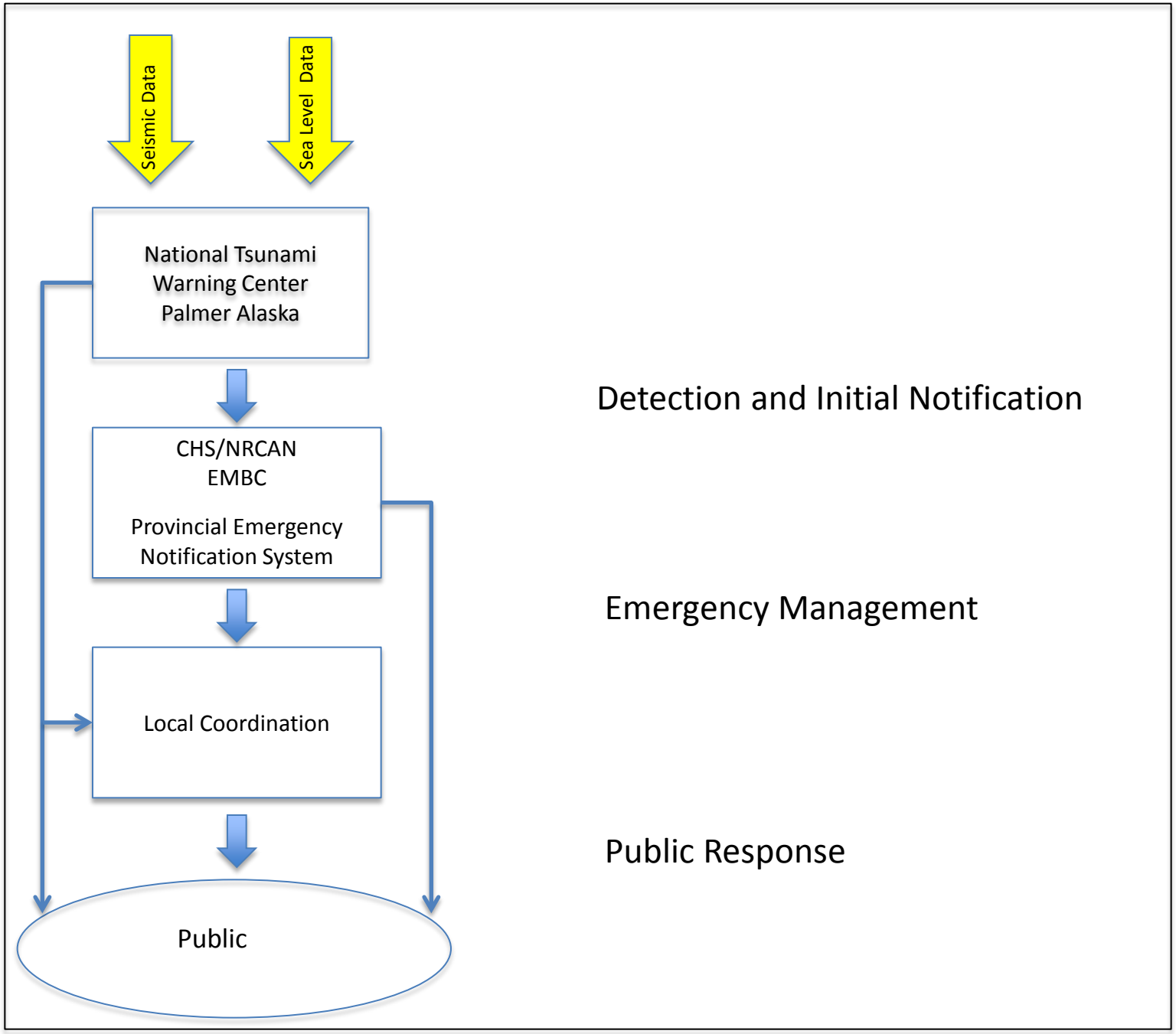
New Challenges

- Changing coastal socio-economic considerations
- Transformations of traditional industries such as logging and fishing
- New industries:
  - Import/export terminals
  - Proposed LNG plants
  - Aquaculture
  - Eco-tourism and recreation
- More people residing or traversing along the coast throughout the year
- Increased diversity in public tsunami notification

Traditional Notification Approach



New Notification Approach
Impact of Social Media



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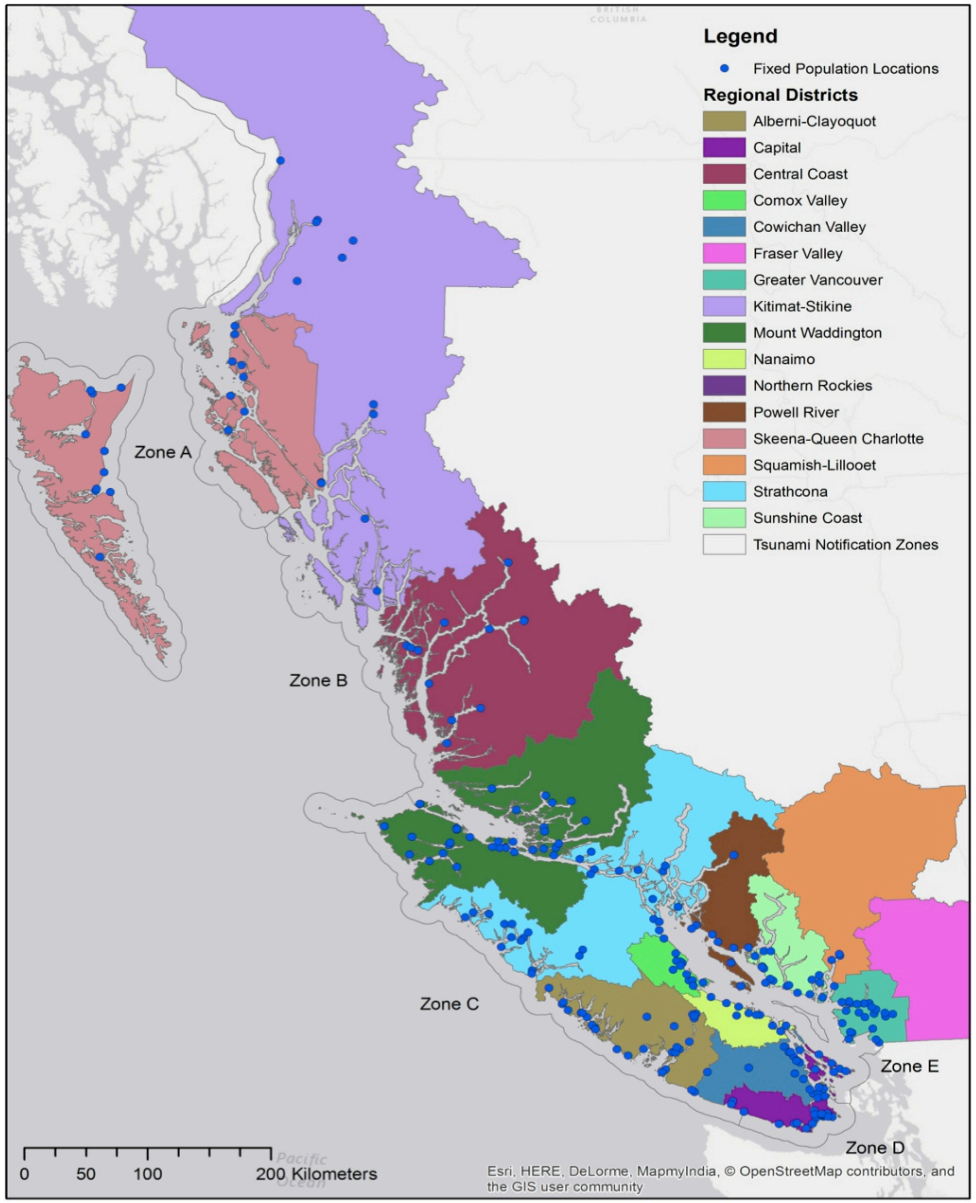
COMMUNITY NOTIFICATION MATRIX

Building a B.C. Coastal Profile

280 Fixed Locations Identified



Identifying and Recording Current Warning Methods – EMBC – NTWC to Communities and Remote Populations

- Telephone notification (dial-down) systems
  - Fixed telephone
  - Mobile telephone
  - Satellite telephone
- Facsimile
- Electronic mail
- Social media- Twitter @emergencyinfobc, @NWS_NTWC
- SMS @NWS_NTWC gateway and @emergencyinfobc
- Canadian Coast Guard Marine VHF Channel 16 and MF 2182 kHz
- Environment Canada Weatheradio and Weather website
- Agency/aviation radio
- Local and regional broadcast stations
- Amateur Radio

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Community Notification Matrix - External Notification Sources Pt 1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Tsunami Notification Zone	Fixed Locations	Regional District	PREOC Email	ECC Email	IVR Tel	Fax	Email	Telephone	Email	Other	RCMP	FD Dispatch	CCG Ch16	BCAS	EC Alert Email	Weather Radio
2				EMBC		EMBC - PENS			Regional District			First Response				Environment Canada	
4	B	Alert Bay	MWRD														
5	B	Bull Harbour	MWRD														
6	B	Da'Naxda'xw (Awaetlala) FN	MWRD														
7	B	Gwa'Sala-'Nakwaxda'Xw FN	MWRD														
8	B	Gwanaenuk (Kwa-wa-aineuk) FN	MWRD														
9	B	Hyde Creek	MWRD														
10	B	Kincome	MWRD														
11	B	Kincome - Dzawada'enuxw FN	MWRD														
12	B	Kincome - Tsawataineuk FN	MWRD														
13	B	Kwakiutl FN	MWRD														
14	B	Kwicksutainseuk-Ah-Kwaw-Ah-Mish FN	MWRD														
15	B	Mamalilikulla-Qwe'Qwe'Sot'Em FN	MWRD														
16	B	Mitchel Bay	MWRD														
17	B	Namgis FN	MWRD														
18	B	Port Hardy	MWRD														
19	B	Port McNeil	MWRD														
20	B	Sointula	MWRD														
21	B	Sullivan Bay	MWRD														
22	B	Telegraph Cove	MWRD														
23	B	Tlatlasikwala FN	MWRD														
24	B	Warner Bay	MWRD														
25	C	Mount Waddington Regional District	MWRD														
26	C	Cape Scott	MWRD														
27	C	Coal Harbour	MWRD														
28	C	Holberg	MWRD														
29	C	Mahatta River	MWRD														
30	C	Port Alice	MWRD														
31	C	Quatsino	MWRD														
32	C	Quatsino FN	MWRD														
33	C	Winter Habour	MWRD														
34	E	Mount Waddington Regional District	MWRD														
35	E	Bones Bay	MWRD														
36	E	Cracroft	MWRD														
37	E	Echo Bay	MWRD														
38	E	Karlukwees	MWRD														
39	E	Ministrel Island	MWRD														
40	E	Thompson Sound	MWRD														

Identifying and Recording Current Local Community Warning Methods

- Fixed sirens, speakers and horns
- Local and regional broadcasting stations
- Vehicle and boat sirens and public address systems
- Telephone notification (dial-down) systems
- Indoor public address systems
- Outdoor mobile electronic signs
- Fixed signage with flashing lights and instructions (e.g., "Emergency Info when Flashing: Proceed Inland and Away from Water")
- Door-to-door verbal notification and leafleting
- Marine and local two-way radio
- SMS – text messaging
- Social networks- Twitter, Facebook, etc.

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Community Notification Matrix - Local Notification Methods

	A	B	C	D	E	F	G	H	I	J
1	Tsunami Notification Zone	Fixed Locations	Regional District	Siren	Pager	Marine Radio	Local Broadcast Radio	Local Broadcast TV	Telephone Notification	Door-to-door
2	B	Mount Waddington Regional District	MWRD							
3	B	Alert Bay	MWRD							
4	B	Bull Harbour	MWRD							
5	B	Da'Naxda'xw (Awaetlala) FN	MWRD							
6	B	Gwa'Sala-'Nakwaxda'Xw FN	MWRD							
7	B	Gwanaenuk (Kwa-wa-aineuk) FN	MWRD							
8	B	Hyde Creek	MWRD							
9	B	Kincome	MWRD							
10	B	Kincome - Dzawada'enuxw FN	MWRD							
11	B	Kincome - Tsawataineuk FN	MWRD							
12	B	Kwakiutl FN	MWRD							
13	B	Kwicksutainseuk-Ah-Kwaw-Ah-Mish FN	MWRD							
14	B	Mamalilikulla-Qwe'Qwe'Sot'Em FN	MWRD							
15	B	Mitchel Bay	MWRD							
16	B	Namgis FN	MWRD							
17	B	Port Hardy	MWRD							
18	B	Port McNeil	MWRD							
19	B	Sointula	MWRD							
20	B	Sullivan Bay	MWRD							
21	B	Telegraph Cove	MWRD							
22	B	Tlatlasikwala FN	MWRD							
23	B	Warner Bay	MWRD							
24	C	Mount Waddington Regional District	MWRD							
25	C	Cape Scott	MWRD							
26	C	Coal Harbour	MWRD							
27	C	Holberg	MWRD							
28	C	Mahatta River	MWRD							
29	C	Port Alice	MWRD							
30	C	Quatsino	MWRD							
31	C	Quatsino FN	MWRD							
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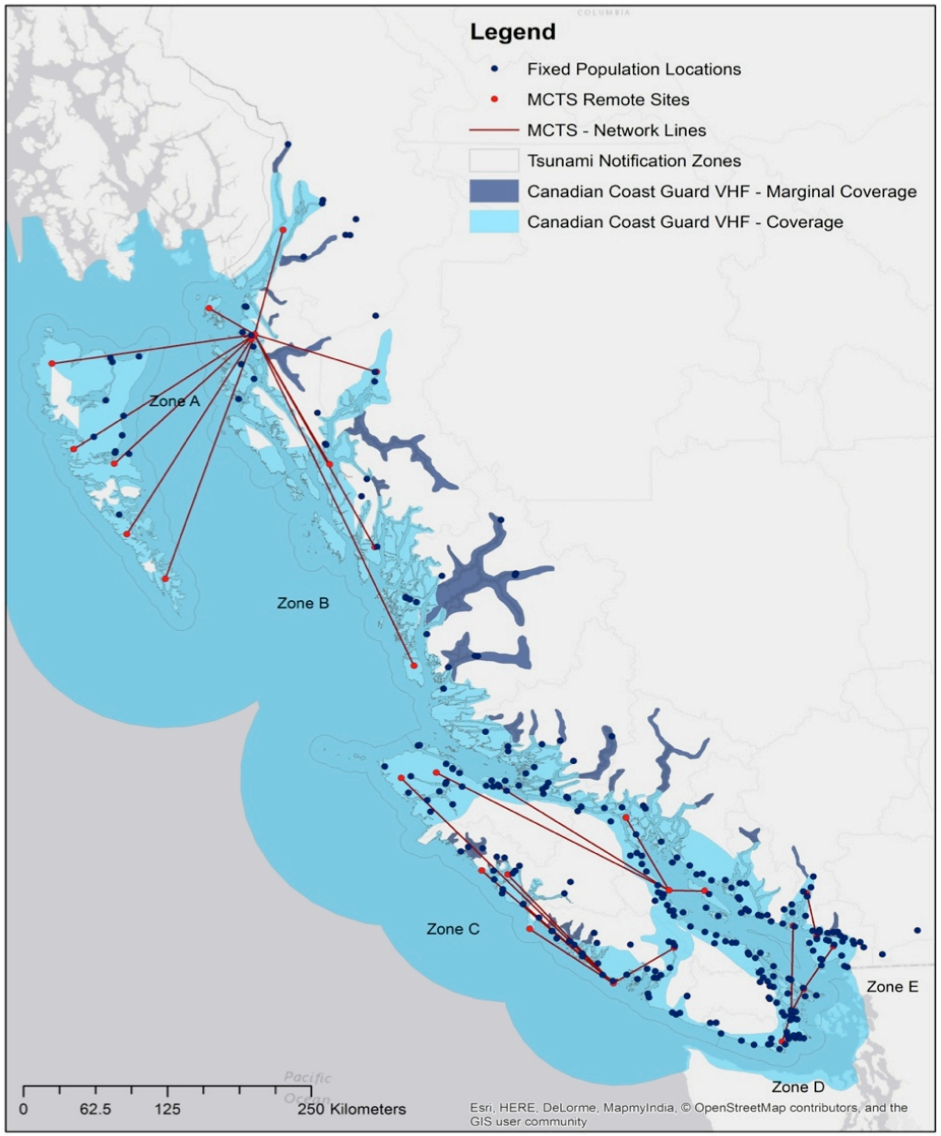
33	E	Mount Waddington Regional District	MWRD							
34	E	Bones Bay	MWRD							
35	E	Cracroft	MWRD							
36	E	Echo Bay	MWRD							
37	E	Karlukwees	MWRD							
38	E	Minstrel Island	MWRD							
39	E	Thompson Sound	MWRD							

GIS Integration

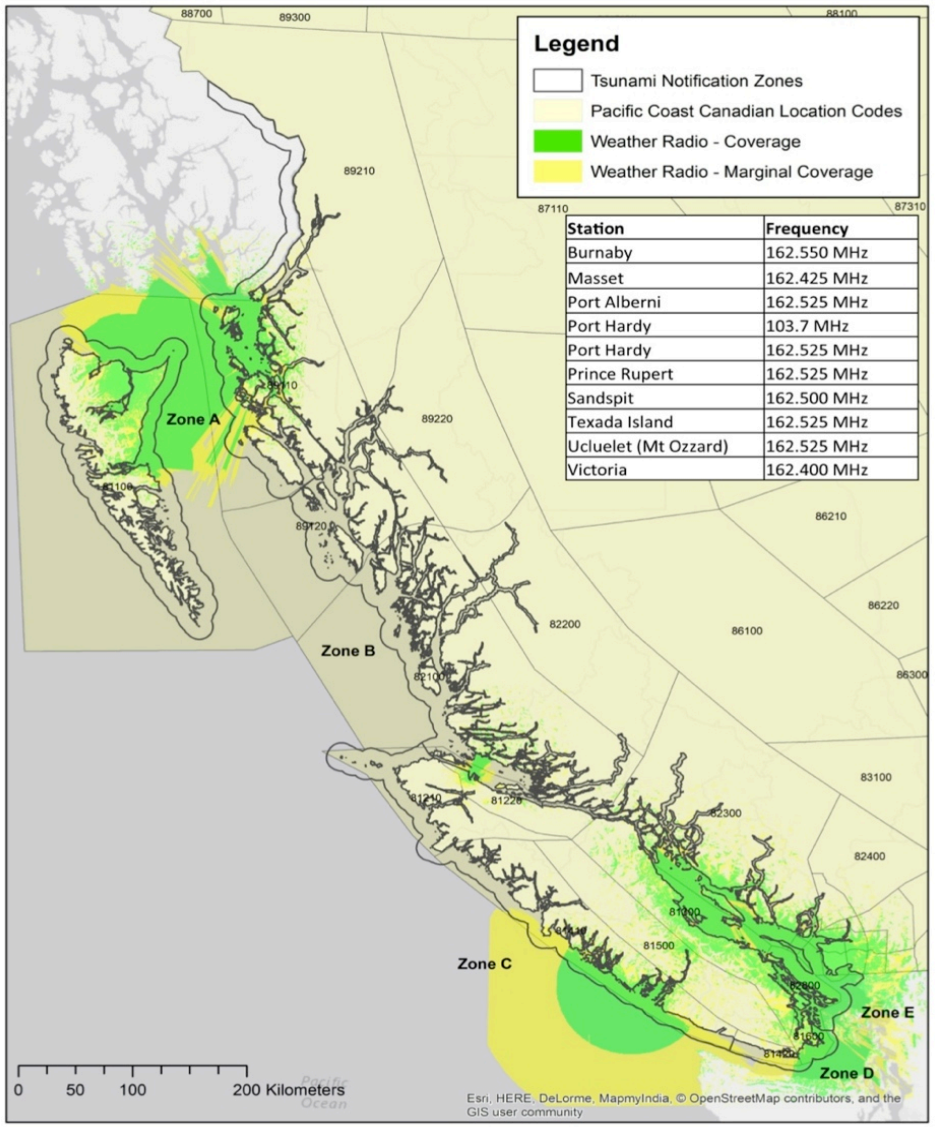
- Geographic features
- Socio-economic data
- Community Notification Matrix data
- Hidden resources
- Gap analysis

Recording and Mapping Communication Coverage

Canadian Coast Guard VHF Coverage

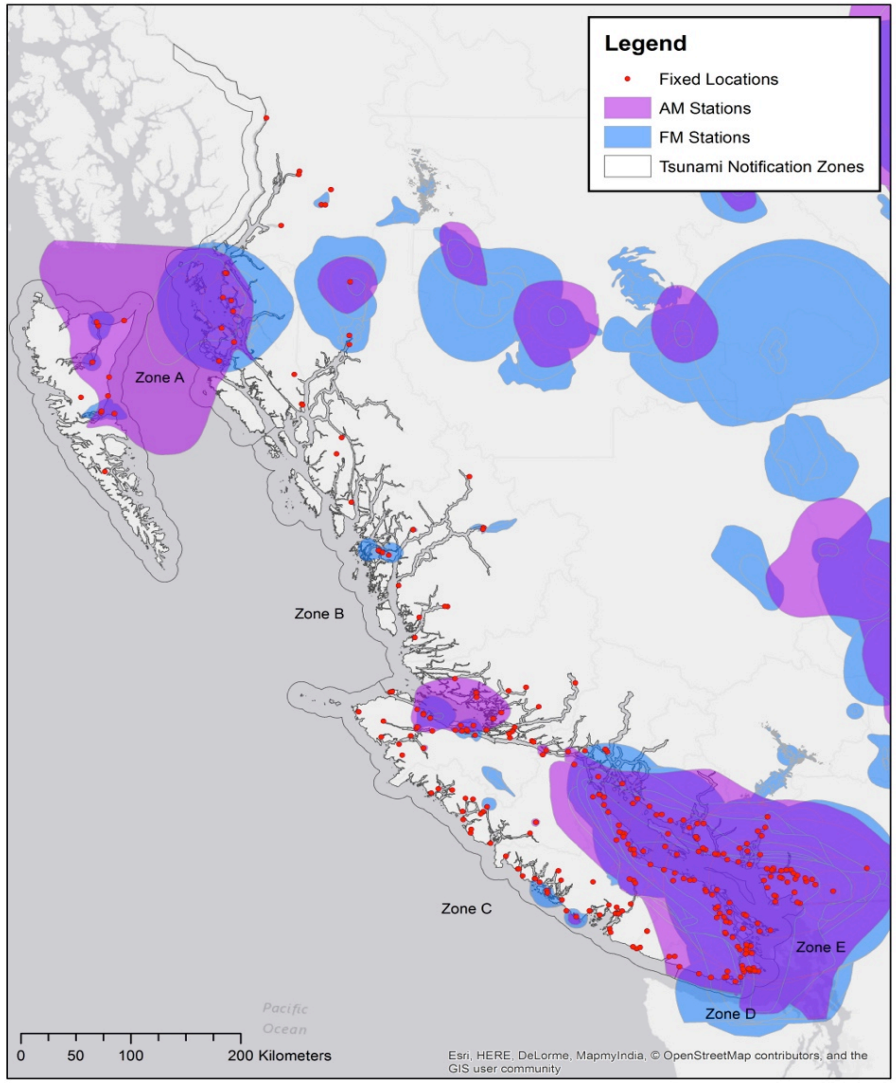


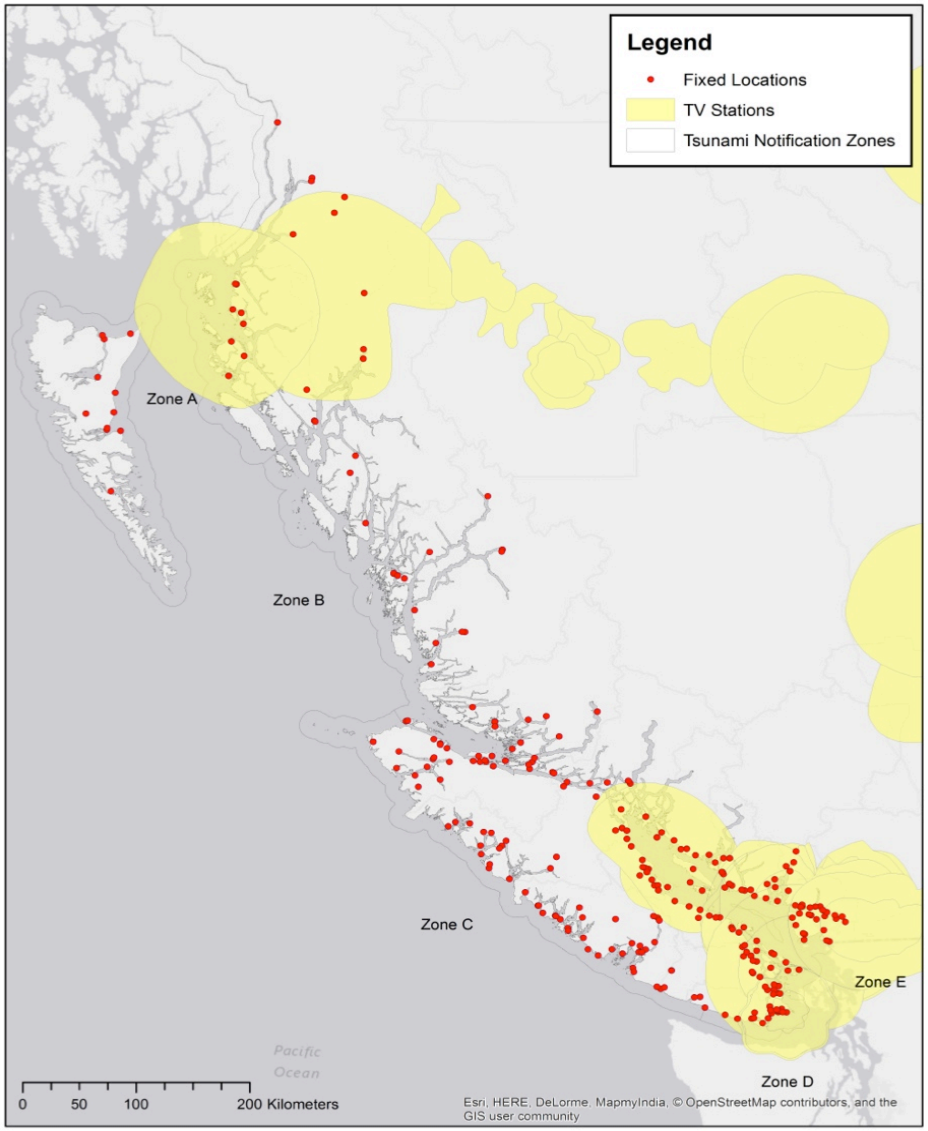
Environment Canada Weatheradio



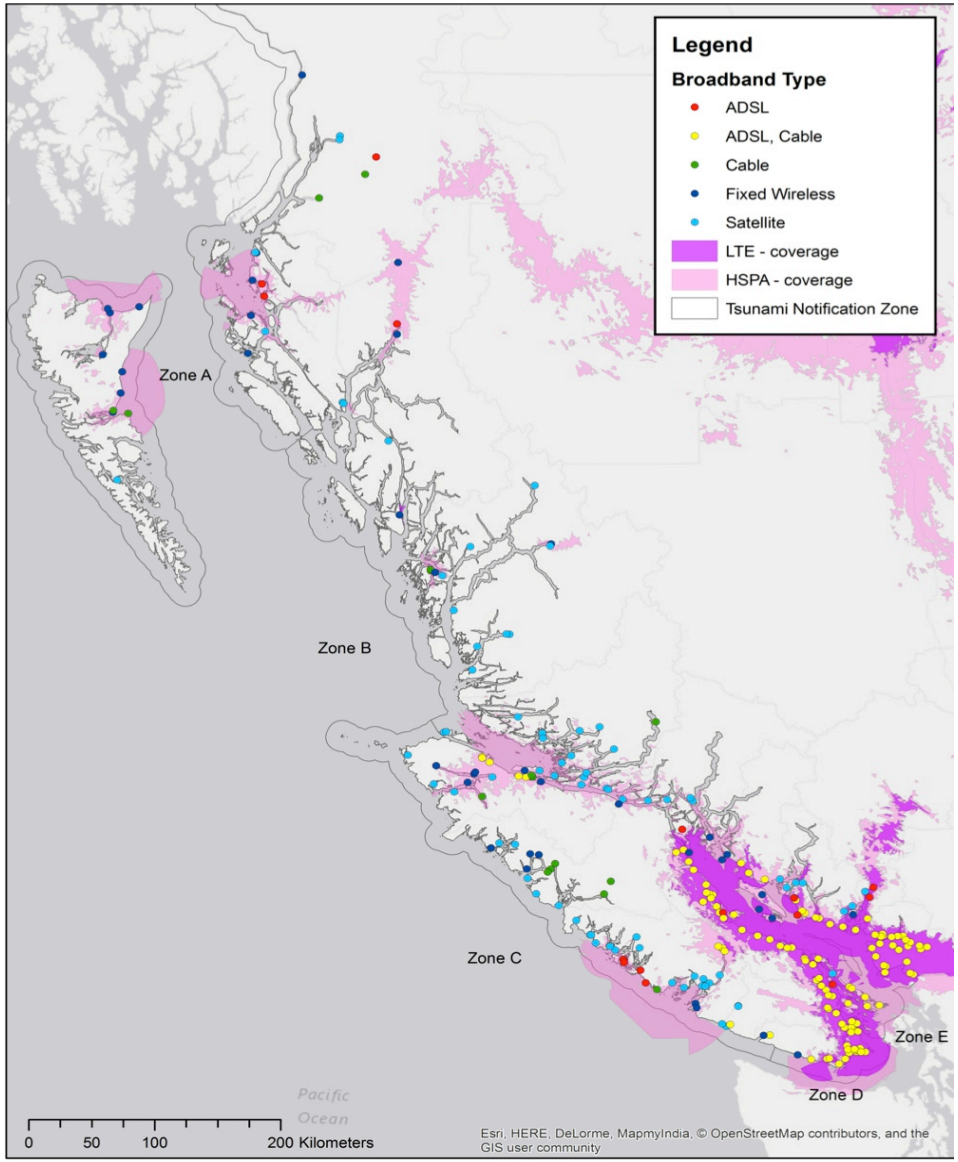
Station	Frequency
Burnaby	162.550 MHz
Masset	162.425 MHz
Port Alberni	162.525 MHz
Port Hardy	103.7 MHz
Port Hardy	162.525 MHz
Prince Rupert	162.525 MHz
Sandspit	162.500 MHz
Texada Island	162.525 MHz
Ucluelet (Mt Ozzard)	162.525 MHz
Victoria	162.400 MHz

OTA Broadcasting Coverage



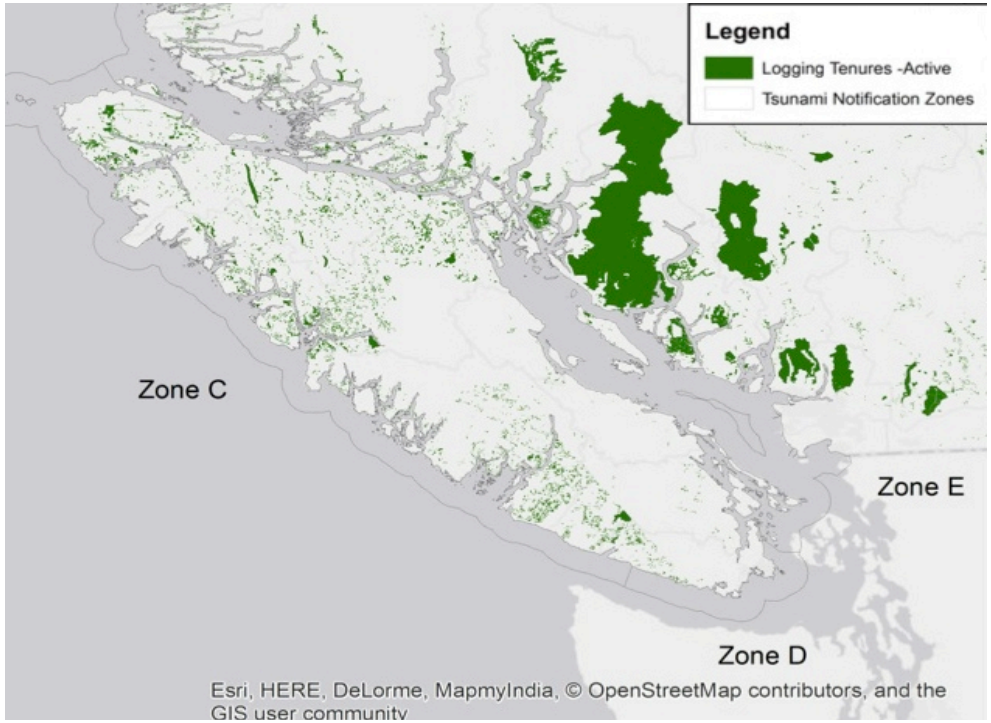


Broadband and Cellular Coverage

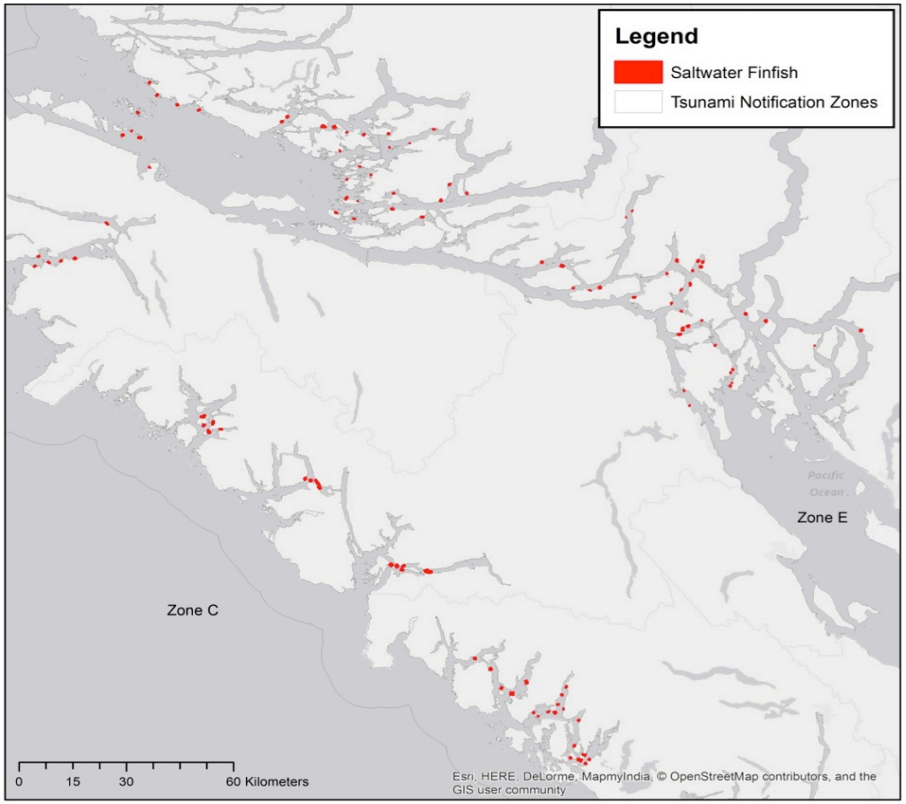


Identification of Transient Populations

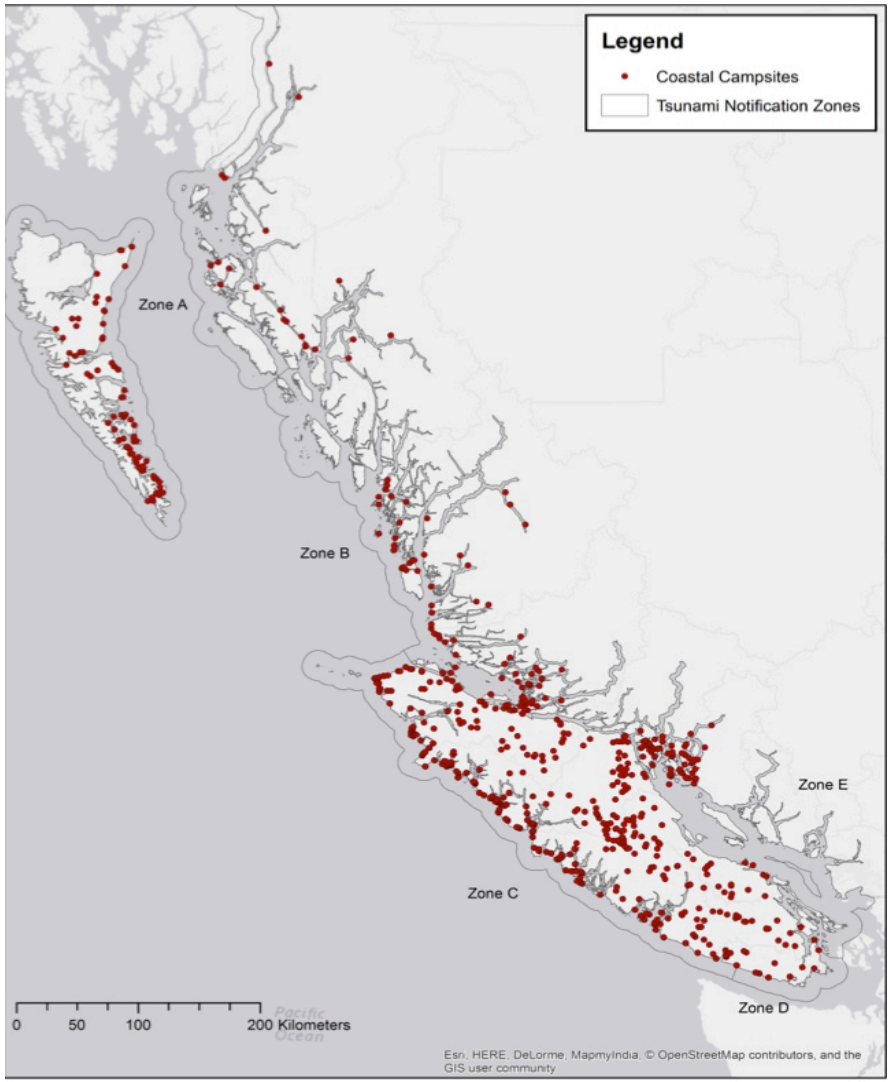
Coastal Logging



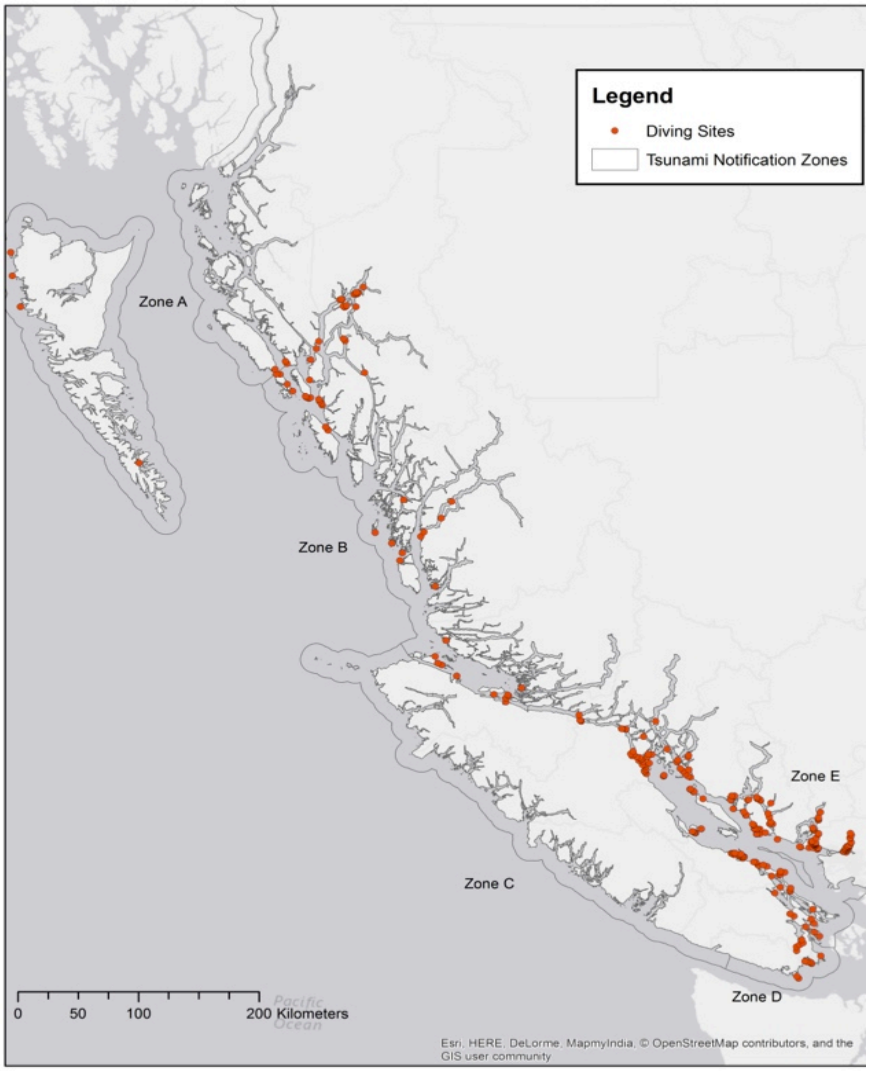
Aquaculture



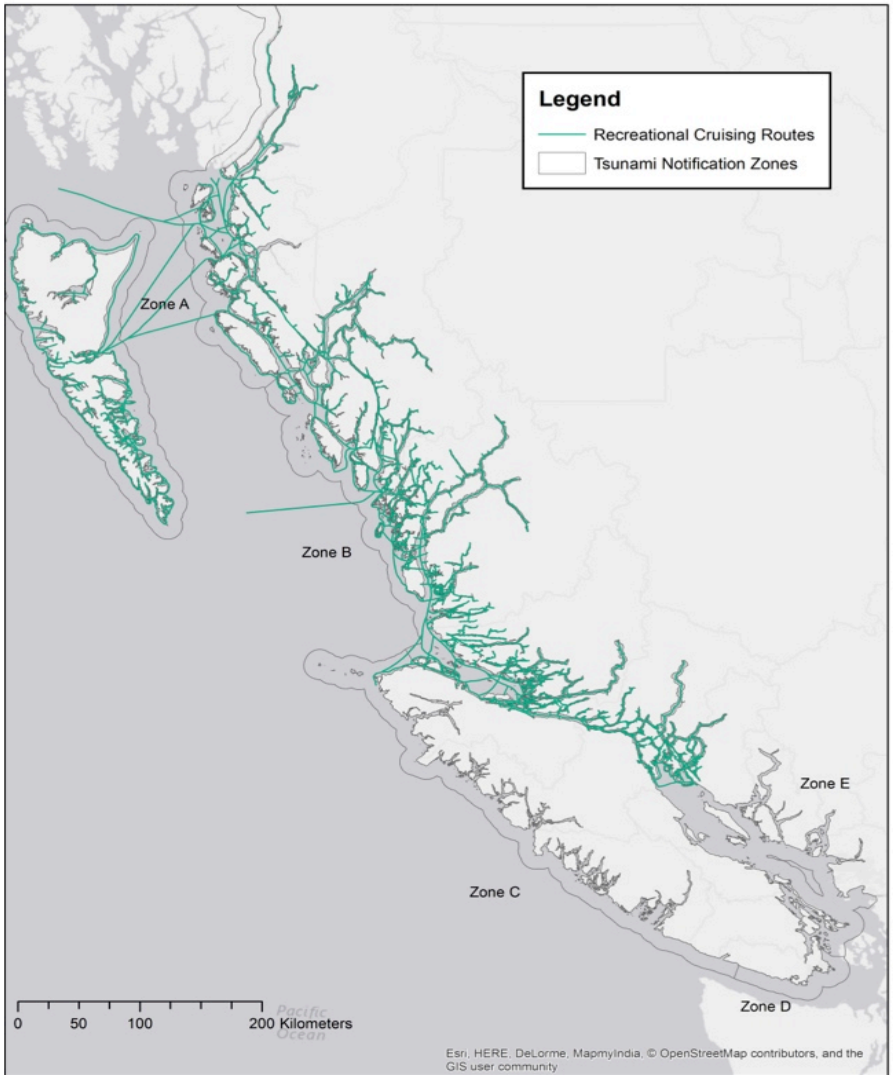
Coastal Campsites



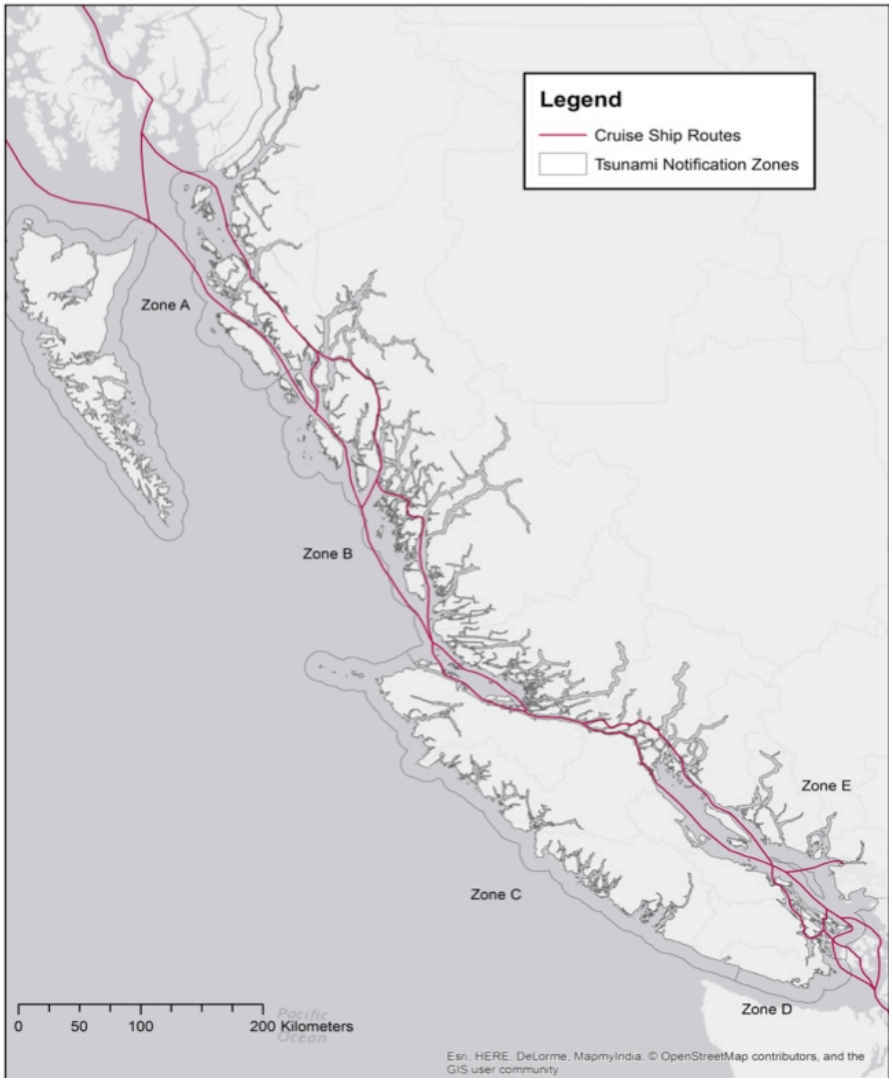
Diving Sites



Recreational Cruising Routes



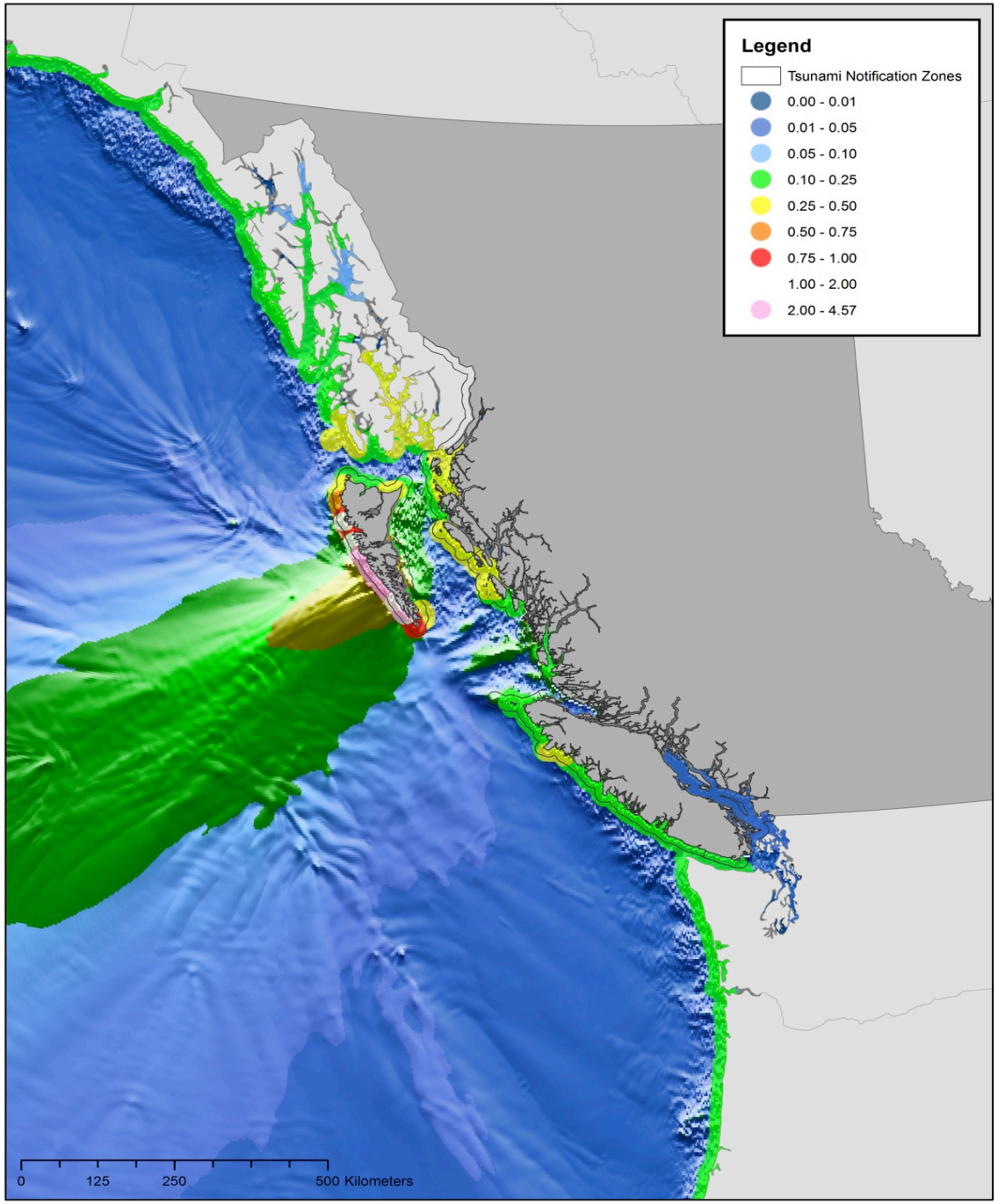
Cruise Ship Routes



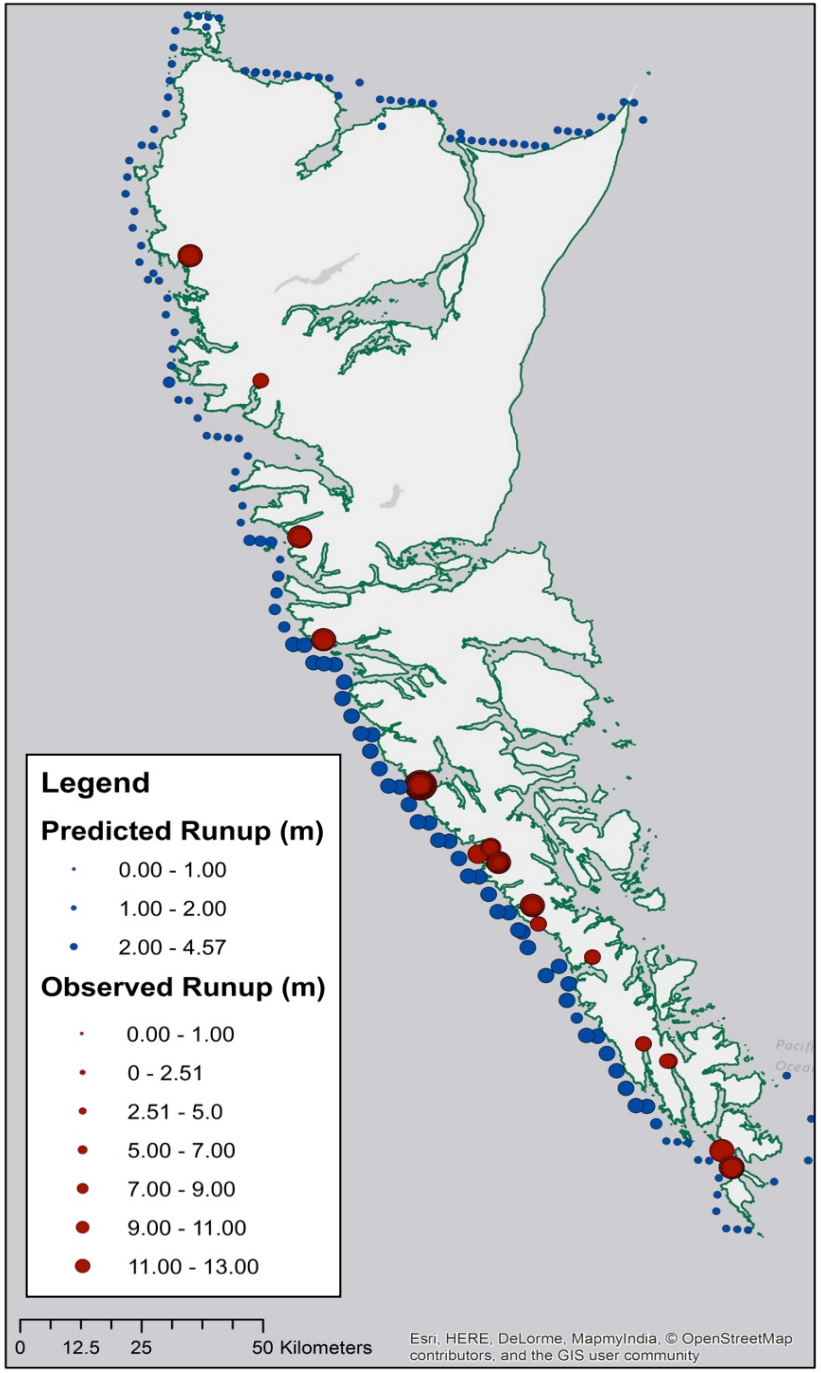
Identification and Notification of Transient Populations

October 27, 2012 8:04 PM PDT
Haida Gwaii M7.7

PTWC RIFT forecast using
the USGS automatic W-phase CMT



PTWC Initial Wave Forecasts and NRCAN Post-event Field Reconnaissance Measurements

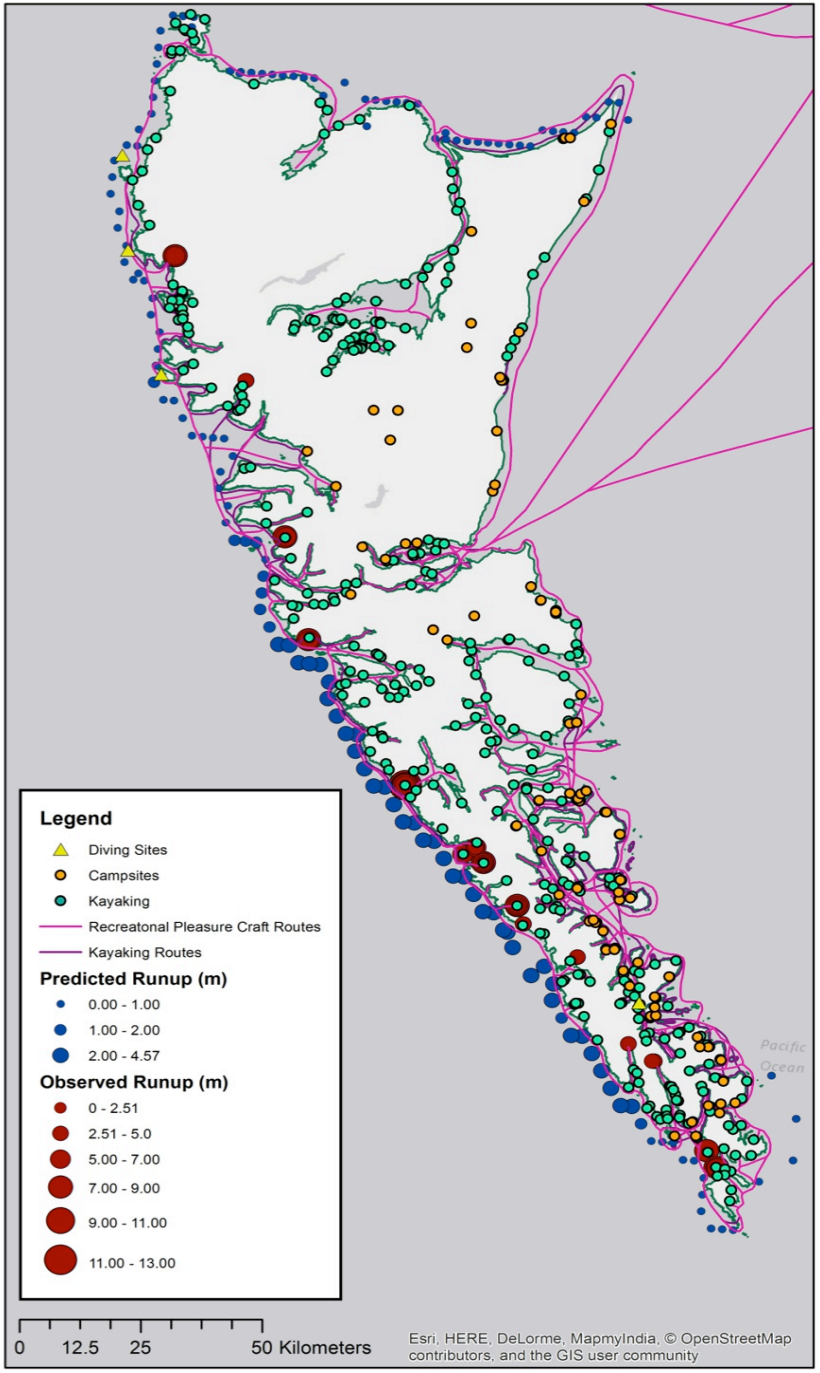


Reference: LEONARD, L.J., and BEDNARSKI, J.M. (2014), Field survey following the 27 October 2012 Haida Gwaii tsunami, Pure Appl. Geophys., 171, doi:10.1007/s00024-014-0792-0.

Who might have been at risk

had the event occurred

two months earlier?



Role of Social Media - Twitter

@NWS_NTWC and @emergencyinfobc

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Tweet the Alarm

Identifying @NWS_NTWC's Early Warning Network

Amanda Oldring | MA Student
Simon Fraser University
School of Communications
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Charted Territory

- Most Twitter activity occurs outside impact areas.
- Most users are urban.
- Local info is typically subsumed by general public info.
- Locals and authorities create new content.
- Most participants retweet content.
- Hashtags (#) develop almost immediately.
- “Opinion leaders” usually outside of EM community at outset.

Uncharted Territory

- Most studies focus on post-event keywords or #s.
- No West Coast early warning Twitter network datasets.
- Very little information on early warning stakeholders.
- No standard method for detecting opinion leaders pre-onset.

@NWS_NTWC is Twitter's first point of entry for official West Coast of North America (WCNA) tsunami risk info.

Design

- Purpose:
  - Locate pre-event a network
  - Explore, describe, and define
  - Frame
- Methodology:
  - Social Network Analysis (SNS)
  - Content Analysis
  - Opinion Leader Survey
- Goals:
  - Network diagrams/metrics
  - Original geographic user maps
  - Easy opinion leader identification
  - Survey & network data comparison

Research Questions:

1. **What does a pre-event WCNA tsunami early warning network look like?**
2. **Who are the stakeholders and opinion leaders?**
3. **How are they distributed across communities and regions?**

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Twitter Tsunami

Study Date: 02/14/14

Population

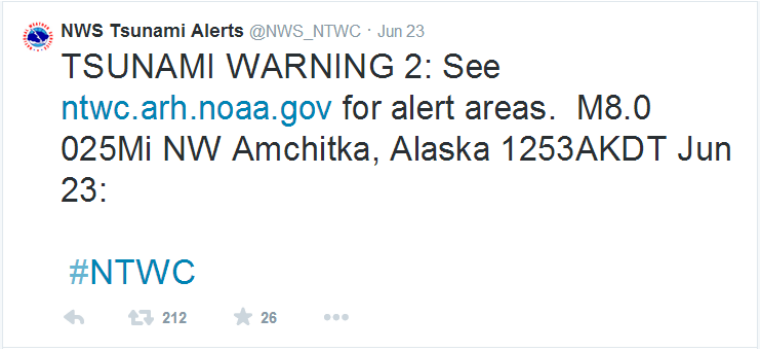
- Profile: Users interested in tsunami risk.
- Source: **@NWS_NTWC**.
- Status: 11.1k Followers, 296 Tweets.

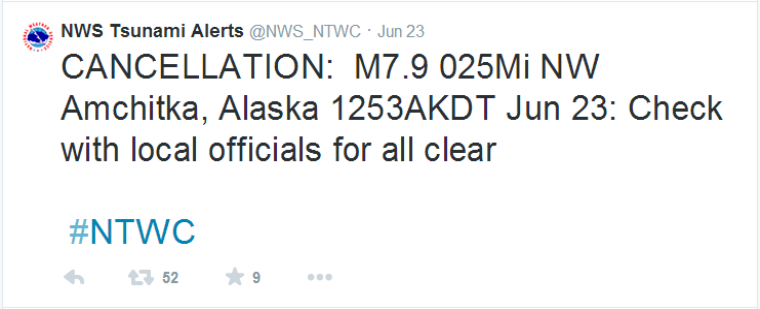
Sampling Frame:

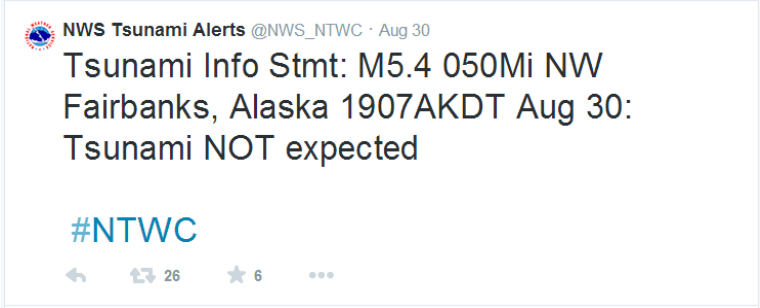
- Software: NodeXL.
- Method: Import Twitter User Network.
- Network Type: 1.5 Level Followers-Only.

Sample

- Nodes: 9,999 followers.
- Edges: 76,000 follower ties.
- Coverage: 86%.







What does the WCNA look like?

WCNA Subnetwork

01/04/14 – 06/30/14

- Coding
  - Location (Country, Province/State, and Municipality)
  - Community Type (Rural or Urban)
  - Stakeholder Group

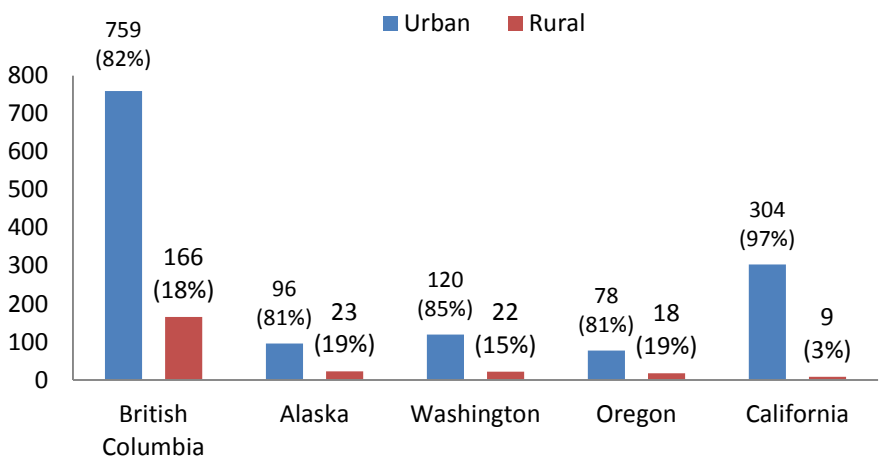
Group	Example
Academia	K – 12 teachers, students, faculty and administration, research centres, libraries.
Citizen	No other affiliation specified.
First Responder	SAR, Fire Fighters/Departments, Police/Departments, Paramedics
Government	Federal, State/Provincial, Municipal civil servants
Hobbyist	HAM Operators, Skywarn, Outdoors enthusiasts
Media	News, film, social media, editing or writing producers
Private Sector	Restaurants and hotels, real estate agents, construction.
Public Sector	Public utilities (BCHydro), NGOs, EMOs, NFPs
Professional	Identified a profession without an affiliation (i.e. ‘lawyer’)
Not Available	Not enough information.

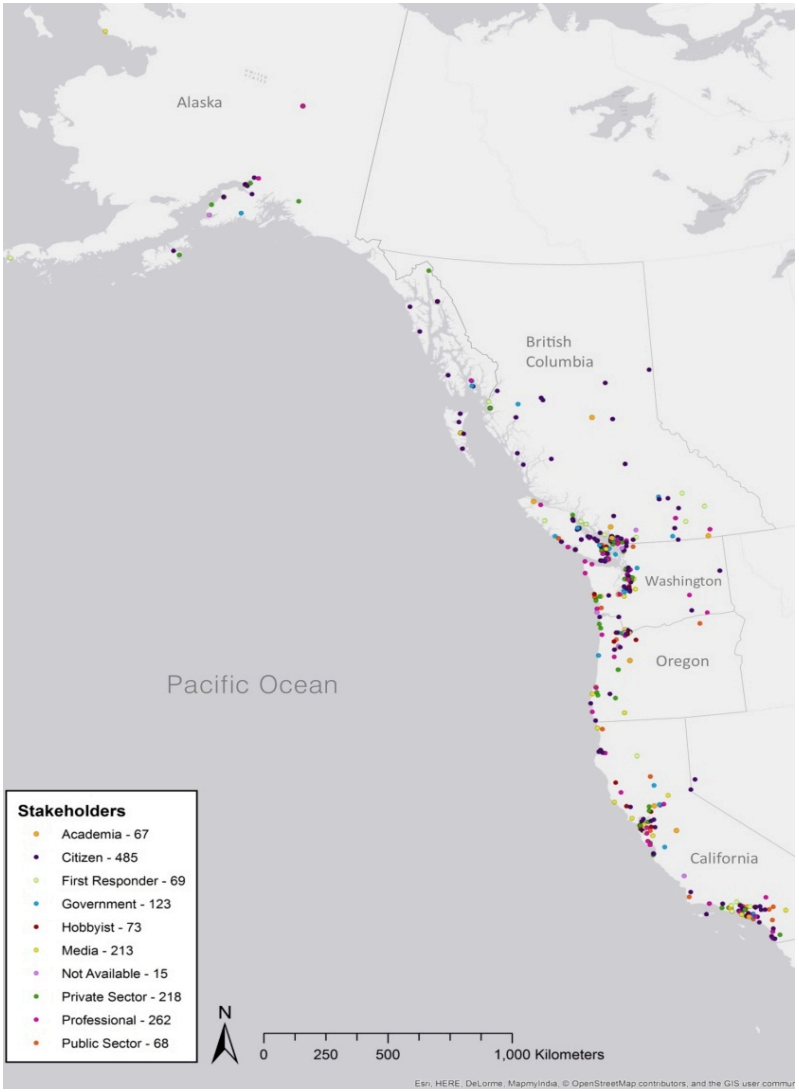
Who are the stakeholders?

Where are they located?

Place-Based Location

- Place is not just where a device happens to be, its a user's home.
- 64% self-report
- 2.1% geolocate





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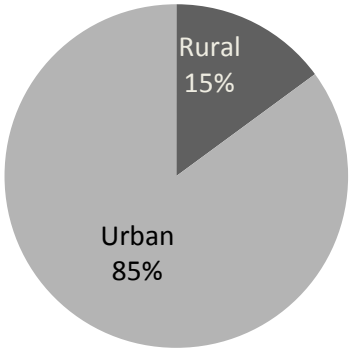
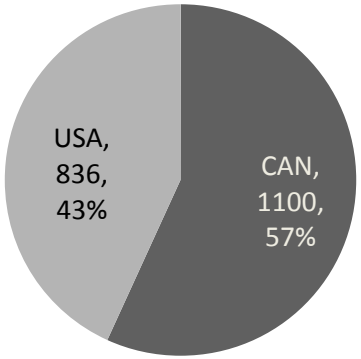
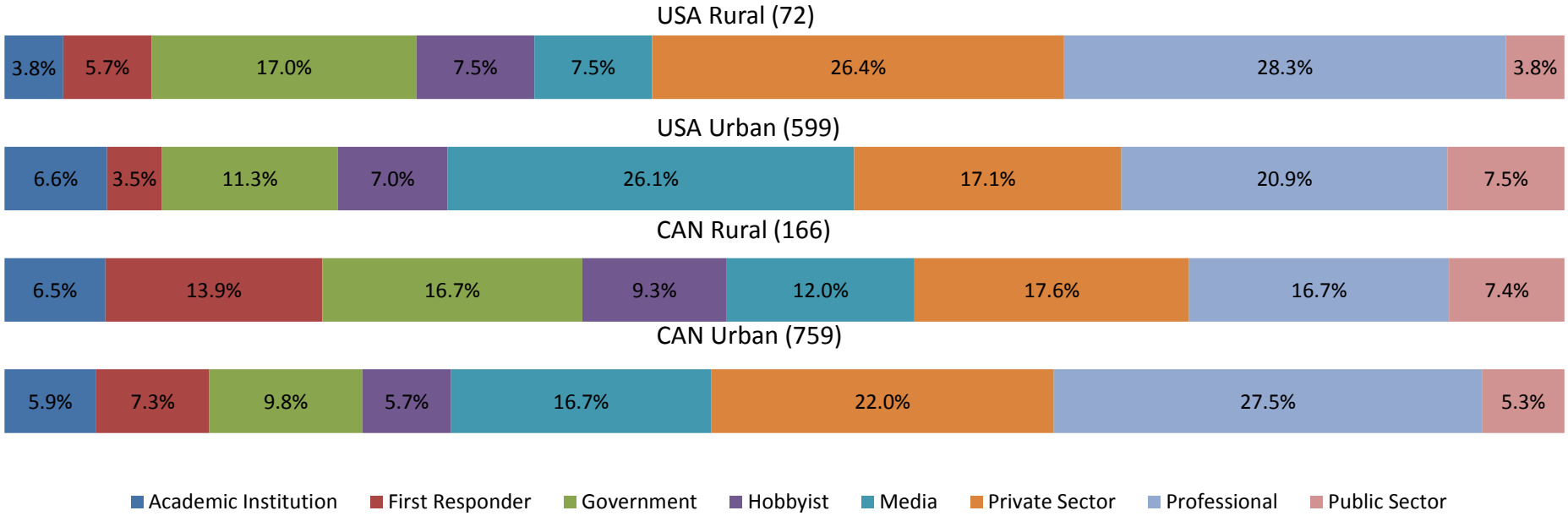
Emergency ManagementBC

Canadian Safety and Security Program

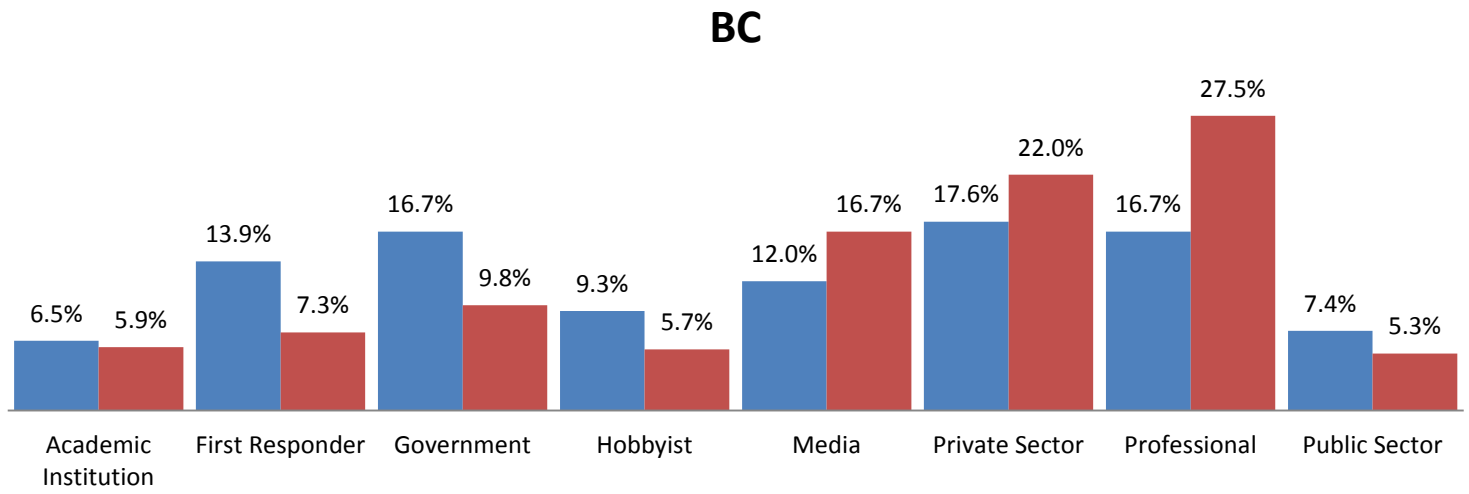
Stakeholder Distributions

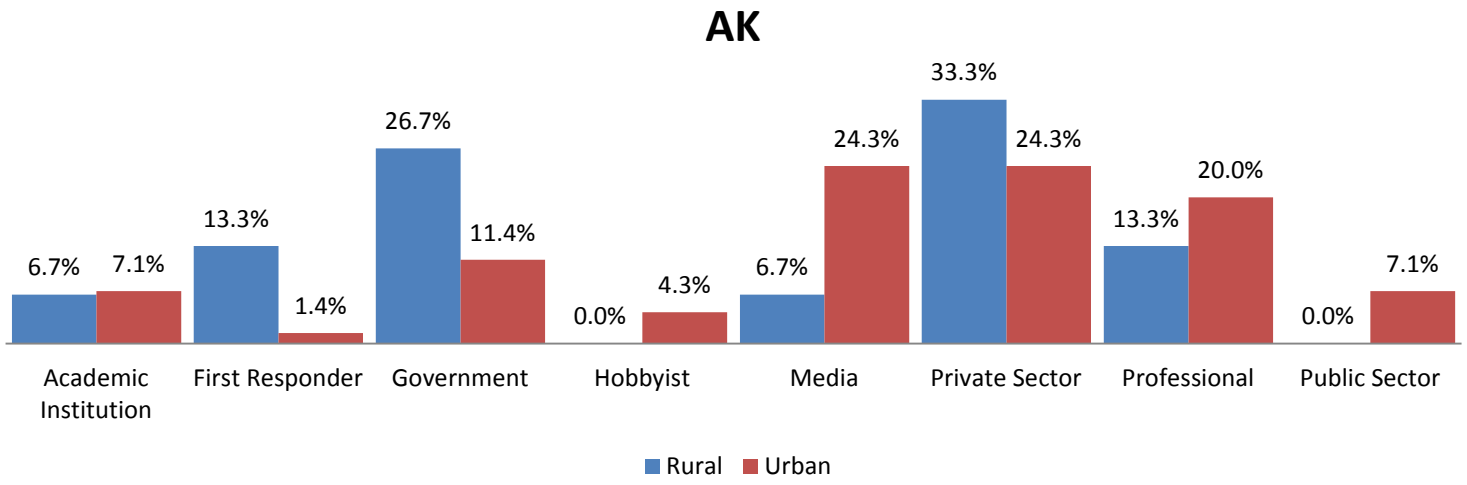






Stakeholder Communities





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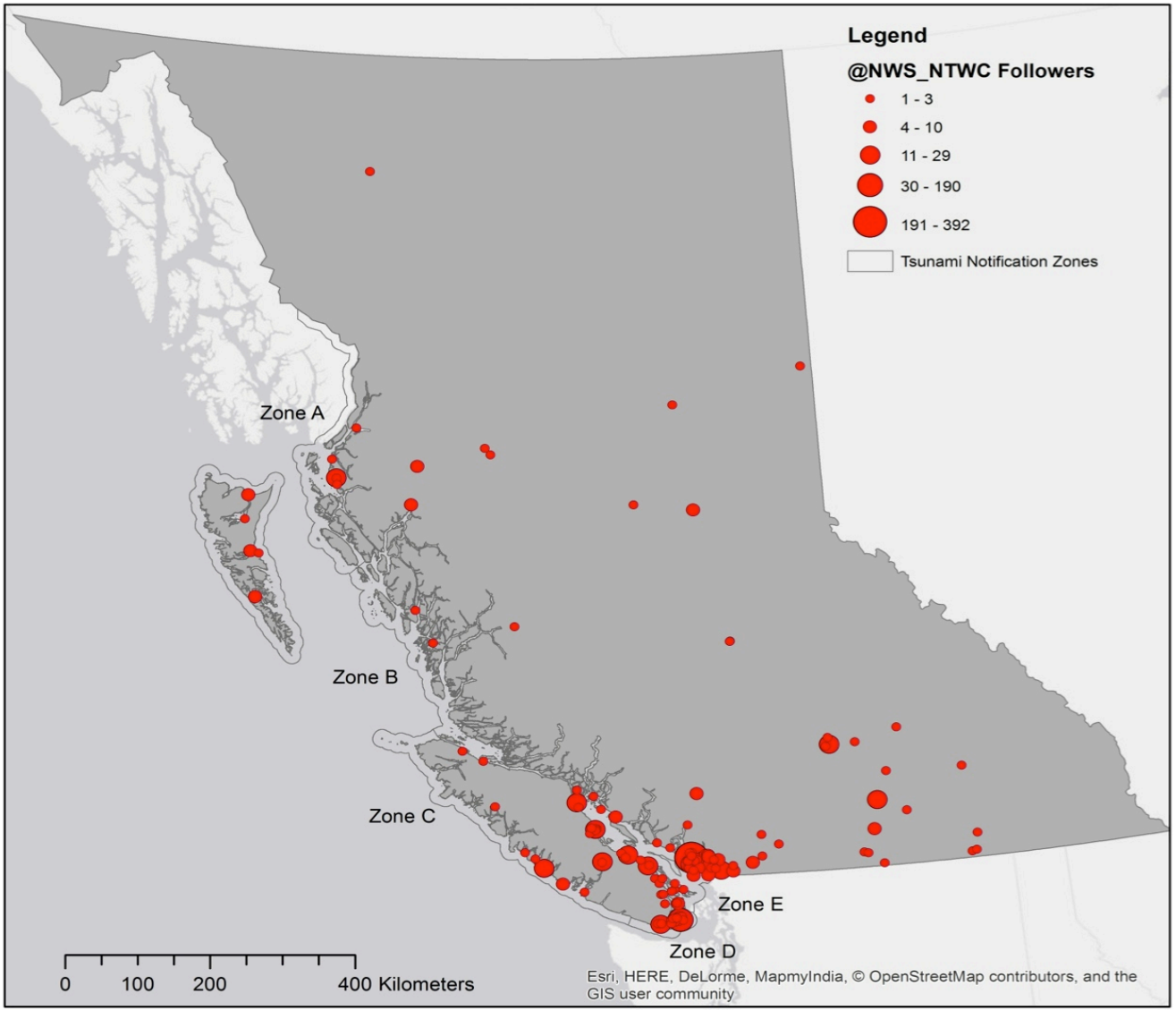
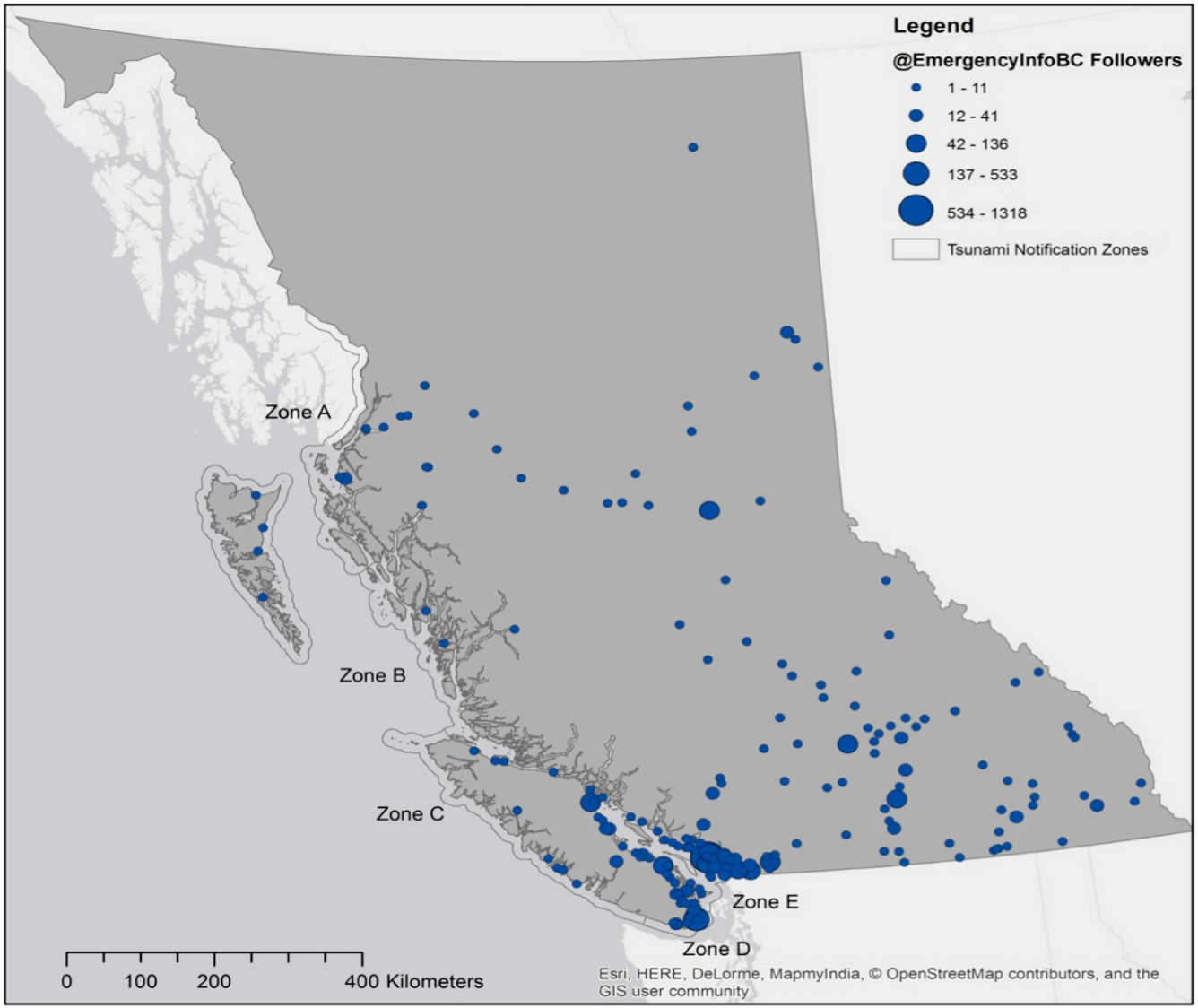
Canadian Safety and Security Program

Locations of Sampled BC @NWS_NTWC Twitter Followers



Locations of Sampled @EmergencyInfoBC Twitter Followers

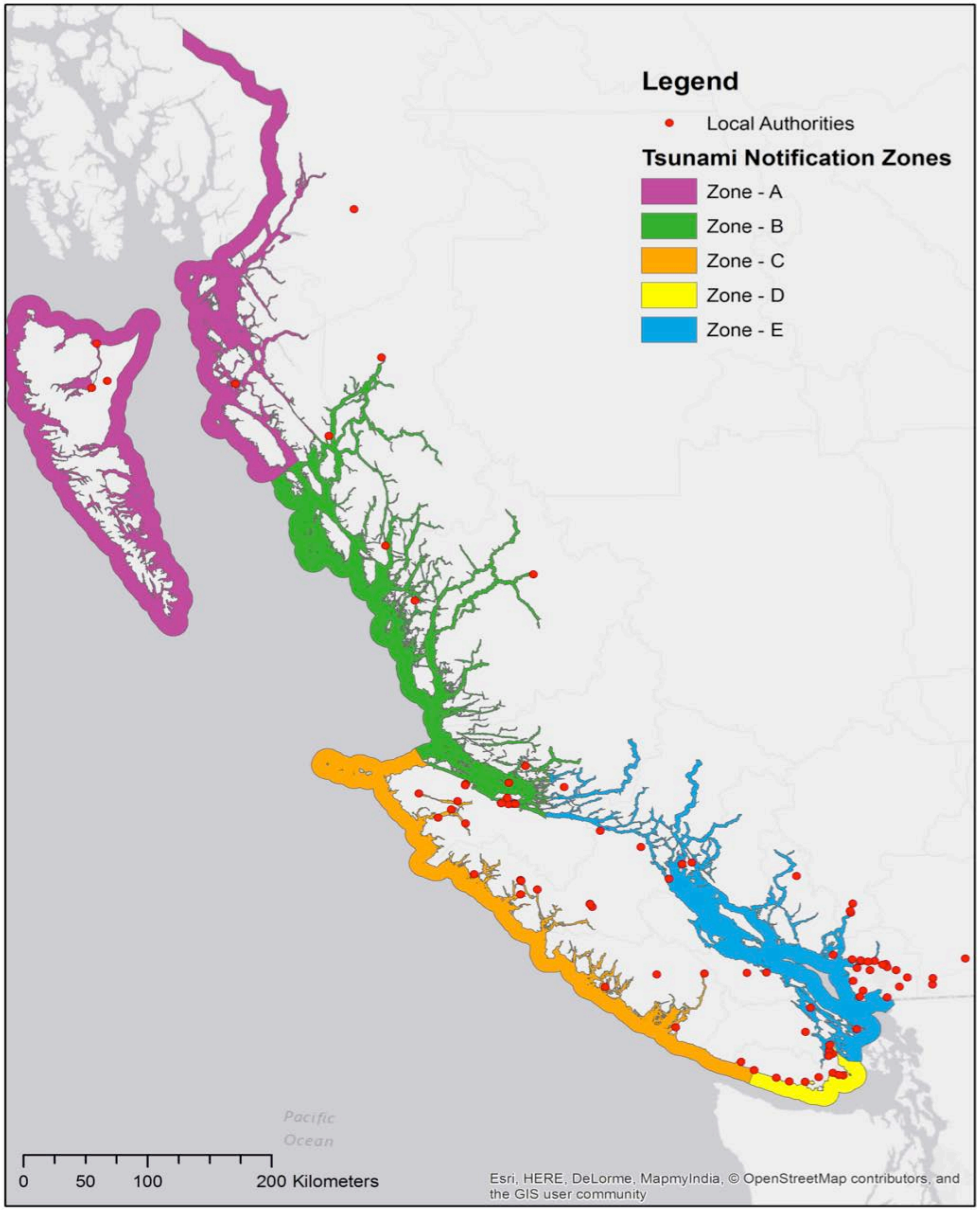


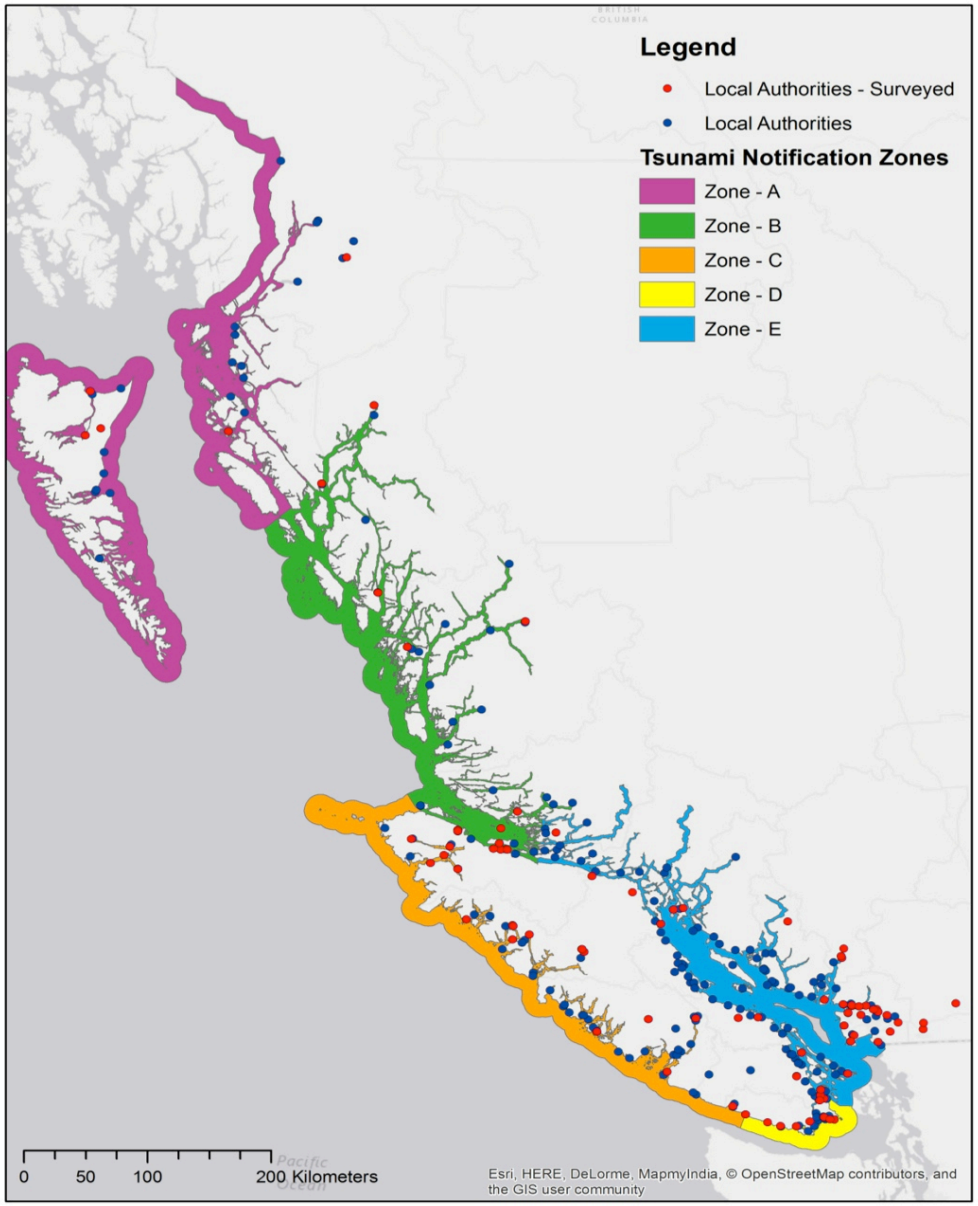
On-line Local Authority Notification Survey

On-line Survey

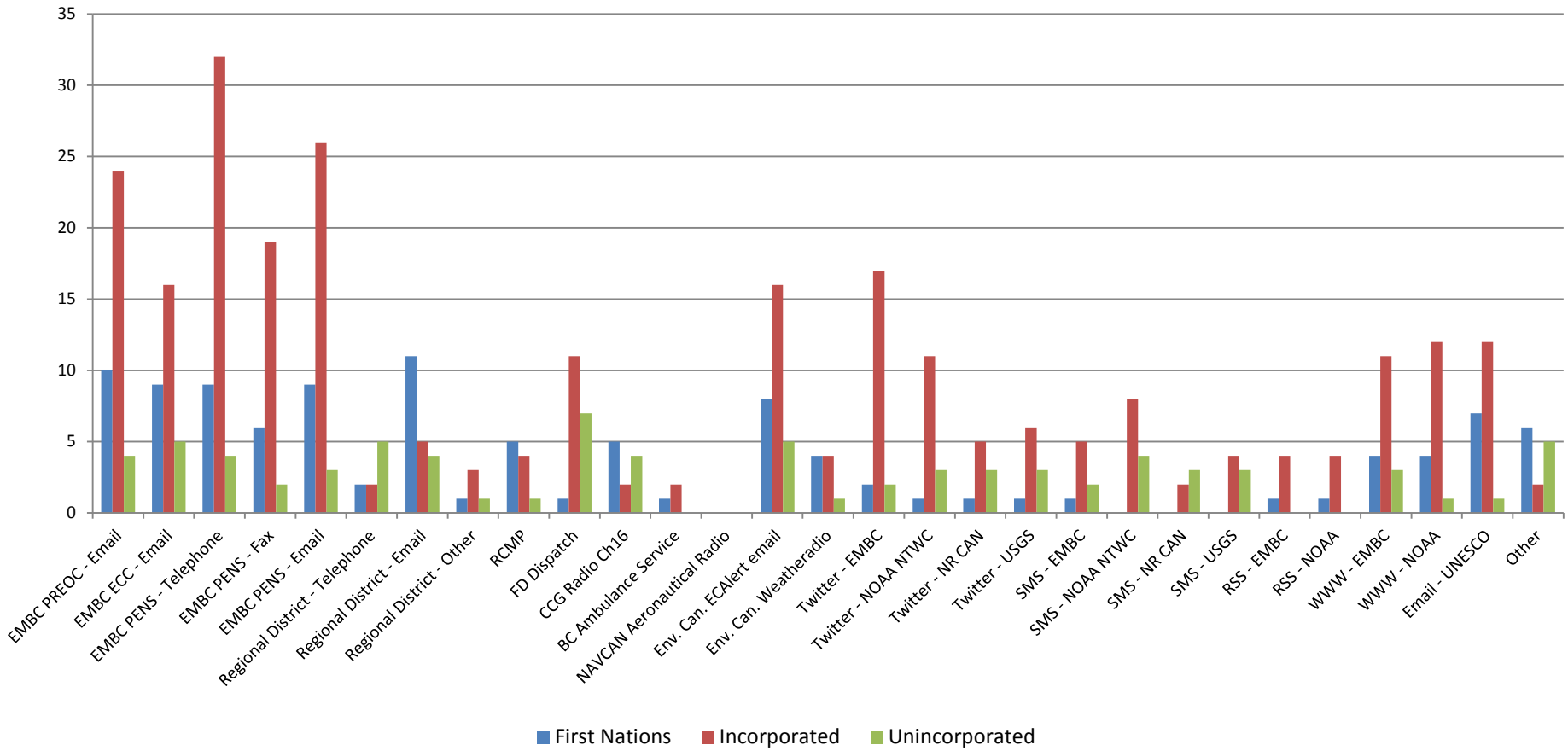
- Invitations send out through EMBC Regional Managers
- Timely as EMBC works on PENS upgrade
- 84 responses
- Good representation from all along the coast

Survey Respondents

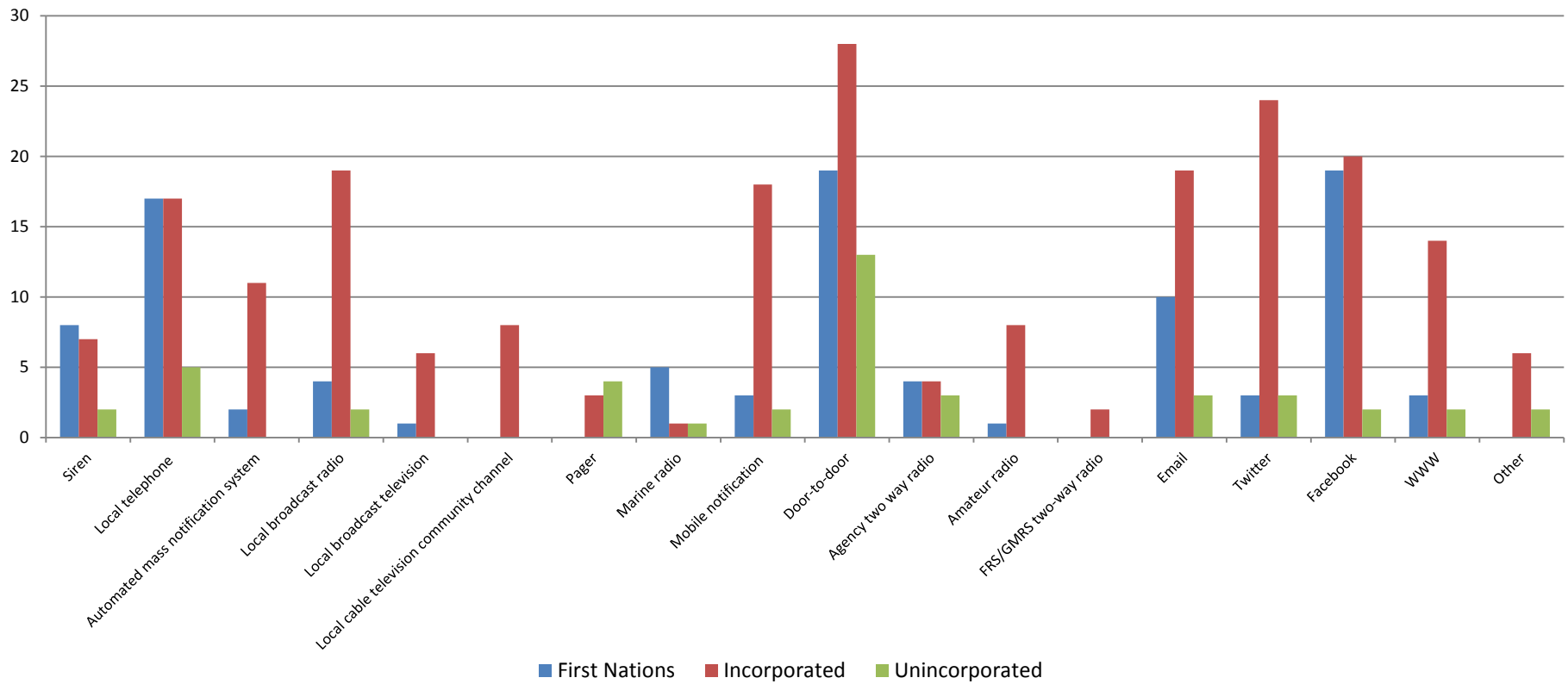




Methods by which Local Authorities Receive External Notifications



Local Notification Methods by Local Authority



Community Preparedness

My community has:

• an emergency communications plan	51	61%
• a tsunami action plan	44	52%
• a means to receive external tsunami notifications and carry out necessary actions on a 24/7 basis	44	52%
• a means to disseminate local tsunami messages on a 24/7 basis	34	40%
• a tsunami education/awareness program	34	40%

Next Steps

- Further refinement of the Community Notification Matrix data base to support Phase 2.
- Data analysis and stakeholder consultations to select potential pilot locations representative of a cross-section of communities that have geographic, ethnic, socioeconomic diversity and different levels of infrastructural development.

EAS Activation For Advisories

Initial Tsunami Message

Short Tsunami Warning Alert level messages in local tsunami events

Chris E. Gregg

Dept. of Geosciences, East Tennessee State Univ., Johnson City, TN USA

John Sorensen & Barbara Vogt-Sorensen

Hazards Inc., Knoxville, TN USA

David M. Johnston

Joint Centre for Disaster Research, Wellington NZ

Paul Whitmore

NWS National Tsunami Warning Center, Palmer, AK USA

Funding: NWS Award: NA10NWS4670015

Rational

- NTWC interest in a supply of short tsunami messages
  - Short messages appropriate for local tsunami events
    - Very little time to act on warning
    - People still need to confirm, personalize environmental & social cues and informal warnings
  - Trend to shorter initial messages – WEAS, TWITTER, EAS
- Proposing 2 rapidly disseminated short messages followed by a full length message:
  - Message 1: Short Warning
  - Message 2: Short Advisory
  - Message 3: Full Length Message

Three Prototype Messages

- Message 1 requires accurate pre-events beliefs & perceptions, since little information to meet Milling demands (~ PAs, Guidance, Hazard, Consequences, etc)
- Message 2 targets Advisory areas and contains more PAs and Guidance where there is greater time for PA
- Message 3 is comprehensive and covers all relevant information with precise and detailed language

Key literature and the Warning Message Metric

1. Mileti et al (1975). First summary of warnings literature.
2. Mileti and Sorensen (1990). Catalog of warning response findings.
3. Sorensen (2000). Review of twenty years of warning systems in the USA.
4. Perry and Lindell (2004). Comprehensive review of authors' warning research.
5. Lindell and Perry (2012). Protective Action Decision Model reviewed.
6. Bean et al. (2015). Comprehensive testing of WEA alerts and warnings.

Topic	Element	Weight *	Suggested Order	Actual Order
MESSAGE CONTENT				
Who	Source of message	3	1	1
What	Alert level : warning, adv., watch	3	2	2
Why	Initiating event	2	3	
What	Hazards & Consequences: - Nature & magnitude of threat & consequences (Risk) - Consequences of unprotected exposure (death by drowning/blunt trauma)	1	4	4
Where	Locations in which different actions are recommended	1	5	3
What	Protective Action Recommendations (PARs)- evacuate inland or vertically	1	6	5, 6, 7
How	Guidance on implementing PARs	1	7	5, 6, 7
Why	Benefits from taking PARs	1	8	5, 6, 7

*** Weights: Most Critical (1), Intermediate (2), Least Critical (3)**

Topic	Element	Weight*	Suggested Order	Actual Order
When	Time to take action & time to impact	2	9	8
What	Environmental cues people may see/hear/feel and appropriate responses	1	10	9
What	Children or animal strategies	3	11	10
MESSAGE CHARACTERISTICS				
Style	Clearly worded without jargon	2	NA	
Length	Optimum length (not too short, not too long)	1	NA	
Consistency	Updates are clearly identified	3	NA	
Frequency	Every 5 -10 - 20 minutes	3	NA	

*** Weights: Most Critical (1), Intermediate (2), Least Critical (3)**

Application: Refined NTWC Messages

- Message 1 … Urgent Local Tsunami Warning
  - Take immediate protective action
- Message 2 …Advisory in Effect
  - Be aware of potential hazards
- Message 3 … Full Length Integrated Message
  - Updates Initial Warning & Advisory Message with comprehensive information

CONCISE TSUNAMI MESSAGE SEQUENCE

? Header
? Header

BULLETIN
PUBLIC URGENT LOCAL TSUNAMI MESSAGE NUMBER 1
NWS NATIONAL TSUNAMI WARNING CENTER PALMER AK
905 AM PST SUN FEB 3 2013

...AN URGENT LOCAL TSUNAMI WARNING IS NOW IN EFFECT...

THE WARNING IS IN EFFECT FOR THE COAST BETWEEN SAN FRANCISCO BAY AND VANCOUVER ISLAND.

A TSUNAMI MAY HAVE BEEN GENERATED BY A LARGE EARTHQUAKE OF MAGNITUDE 7.9 OFF THE COAST OF CENTRAL OREGON... AND IF GENERATED... IS EXPECTED TO ARRIVE AT LINCOLN CITY BY 915 AM... CANNON BEACH BY 9:23 AM AND CRESENT CITY BY 940 AM. A TSUNAMI PRODUCES STRONG AND UNUSUAL WAVES AND CURRENTS AND INLAND FLOODING FILLED WITH DAMAGING DEBRIS THAT CAN DROWN OR INJURE PEOPLE AND WEAKEN OR DESTROY STRUCTURES ON LAND AND IN WATER. WAVE HEIGHTS UP TO 4 FEET OR HIGHER COULD OCCUR.IMMEDIATELY EVACUATE BY FOOT INLAND OR TO HIGHER GROUND ABOVE AND BEYOND DESIGNATED TSUNAMI HAZARD ZONES OR MOVE TO THE THIRD FLOOR OR HIGHER OF A MULTI-STORY BUILDING DEPENDING ON YOUR SITUATION. YOU SHOULD TAKE THESE ACTIONS TO AVOID POTENTIAL DEATH OR INJURY CAUSED BY WAVES... CURRENTS AND DEBRIS-FILLED WATER.

BE ALERT TO RECEDING OCEAN WATERS OR UNUSUAL WAVES OR CURRENTS. A TSUNAMI MAY BE OCCURRING AND IMMEDIATE ACTION SHOULD BE TAKEN. THIS INFORMATION WILL BE REPEATED IN 15 MINUTES OR SOONER IF NEW INFORMATION IS AVAILABLE. A TSUNAMI ADVISORY MESSAGE FOR AREAS OUTSIDE THE TSUNAMI WARNING AREAS DESCRIBED ABOVE WILL BE ISSUED IN 5 MINUTES OR LESS..

Short Message 1

Short Message 2

```
????? Header
????? Header

BULLETIN
PUBLIC LOCAL TSUNAMI MESSAGE NUMBER 2
NWS NATIONAL TSUNAMI WARNING CENTER PALMER AK
910 AM PST SUN FEB 3 2013

...AN URGENT LOCAL TSUNAMI WARNING REMAINS IN EFFECT...

...A TSUNAMI ADVISORY IS NOW IN EFFECT...


THE URGENT LOCAL TSUNAMI WARNING REMAINS IN EFFECT FOR THE COAST
BETWEEN SAN FRANCISCO BAY AND VANCOUVER ISLAND.

THE ADVISORY IS IN EFFECT FOR THE CALIFORNIA COAST SOUTH OF SAN
FRANCISCO TO XXXX...THE COAST OF BRITISH COLUMBIA AND THE COAST OF SE
ALASKA.

A TSUNAMI MAY HAVE BEEN GENERATED BY A LARGE EARTHQUAKE OF MAGNITUDE
7.9 OFF THE COAST OF CENTRAL OREGON.  A TSUNAMI WITH STRONG WAVES AND
CURRENTS IS POSSIBLE. WAVES AND CURRENTS CAN DROWN OR INJURE PEOPLE IN
THE WATER.  CURRENTS AND WAVES ON BEACHES AND IN HARBORS... MARINAS...
BAYS... AND INLETS MAY BE ESPECIALLY DANGEROUS.


IF YOU ARE IN THE ADVISORY AREAS...

  * MOVE OUT OF THE WATER... OFF THE BEACH AND AWAY FROM HARBORS...
    MARINAS... BAYS AND INLETS.

  * TAKE THESE ACTIONS IS AVOID POTENTIAL DEATH OR INJURY CAUSED BY
    WAVES... CURRENTS AND DEBRIS FILLED WATER.


IN BOTH THE TSUNAMI WARNING AND ADVISORY AREAS...

  * SOME IMPACTS MAY CONTINUE FOR MANY HOURS TO DAYS AFTER ARRIVAL OF
    THE FIRST WAVE.

  * THE FIRST WAVE MAY NOT BE THE LARGEST SO LATER WAVES MAY BE LARGER.

  * EACH WAVE MAY LAST 5 TO 45 MINUTES AS A WAVE ENCROACHES AND RECEDES.

  * COASTS FACING ALL DIRECTIONS ARE THREATENED BECAUSE THE WAVES CAN
    WRAP AROUND ISLANDS AND HEADLANDS AND INTO BAYS.

THIS INFORMATION WILL BE REPEATED IN 15 MINUTES OR SOONER IF NEW
INFORMATION IS AVAILABLE..

$$
```

Discussion

- Initial Short Warning Message 1
  - Advantages?
  - Disadvantages/concerns?
  - More/less information?
- Short Advisory Message 2
  - Advantages?
  - Disadvantages?
  - More/less information?

Extra Slides

Other relevant recent work

Bean et al (2015) sought answers to 6 research questions for WEA alert & warning messages:

1. what is the optimized order for contents?
2. is there an optimized source for alert and warning messages?
3. are there public perception and response benefits from including a map?
4. what is the relative importance of content elements
   - do some matter more than others?
5. do conclusions generalize across hazard types or
   - do different communication principles apply for different hazards?
6. do different lengths have different levels of effectiveness on outcomes?

Bean, H; Liu, B; Madden, S; Mileti, D; Sutton, J; Wood, M
Comprehensive testing of imminent threat public messages for mobile devides. START Report, January, 2015, p. 7.

Other relevant recent work

Bean et al (2015) sought answers to 7 addition questions:

1. Is there benefit from including a URL?
2. How familiar are people with WEAs?
3. Do people understand acronyms in WEAs?
4. How might "time" best be expressed?
5. How might "location" best be expressed?
6. Is there an optimum level of fear arousal?
7. How well do people understand the alert & warning concepts used in messages?

Bean, H; Liu, B; Madden, S; Mileti, D; Sutton, J; Wood, M
Comprehensive testing of imminent threat public messages for mobile devides. START Report, Jan 2015, p. 7.

Tsunami Threat Database

- Used to refine initial tsunami alert zones
- Cascadia example

Exercises

- CaribeWave15 – 1400UTC March 25, 2015
- Lantex15 – 1300UTC March 25, 2015
- Pacifex15 – 1500UTC March 25, 2015
  - Link to Plans
- PacWave Plans
- EAS/NWR Test Plans
- 2016 Exercises
  - Pacific –
    - Cascadia Rising June 6, 2016
    - Early for Pacifex?
  - Atlantic – Wednesday March 23, 2016?

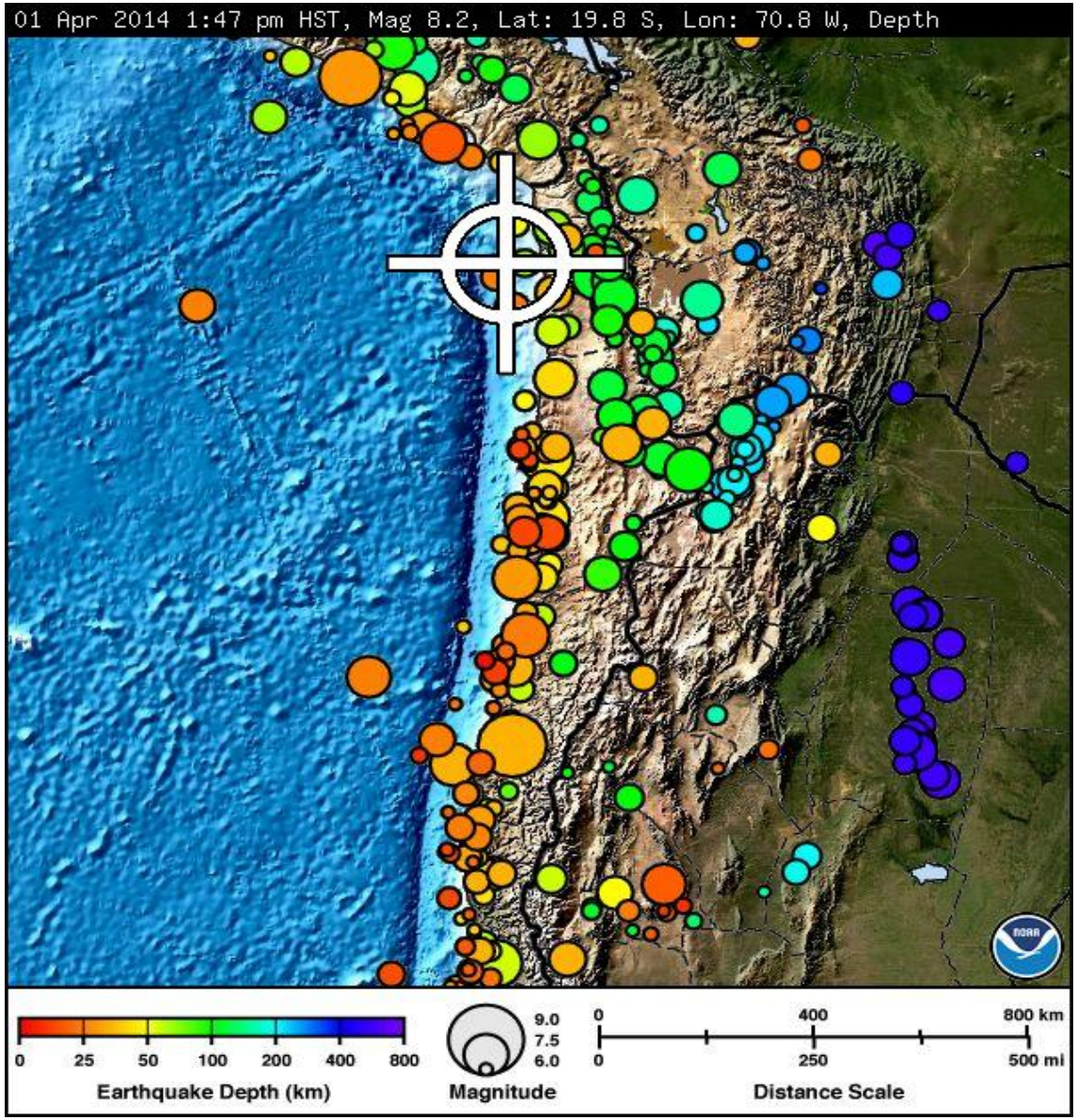
2014 Tsunami Alerts - Chile

NTHMP Warning Coordination Subcommittee Meeting
Portland, Oregon, February 10, 2015

April 2014 Chile Tsunami Lessons Learned

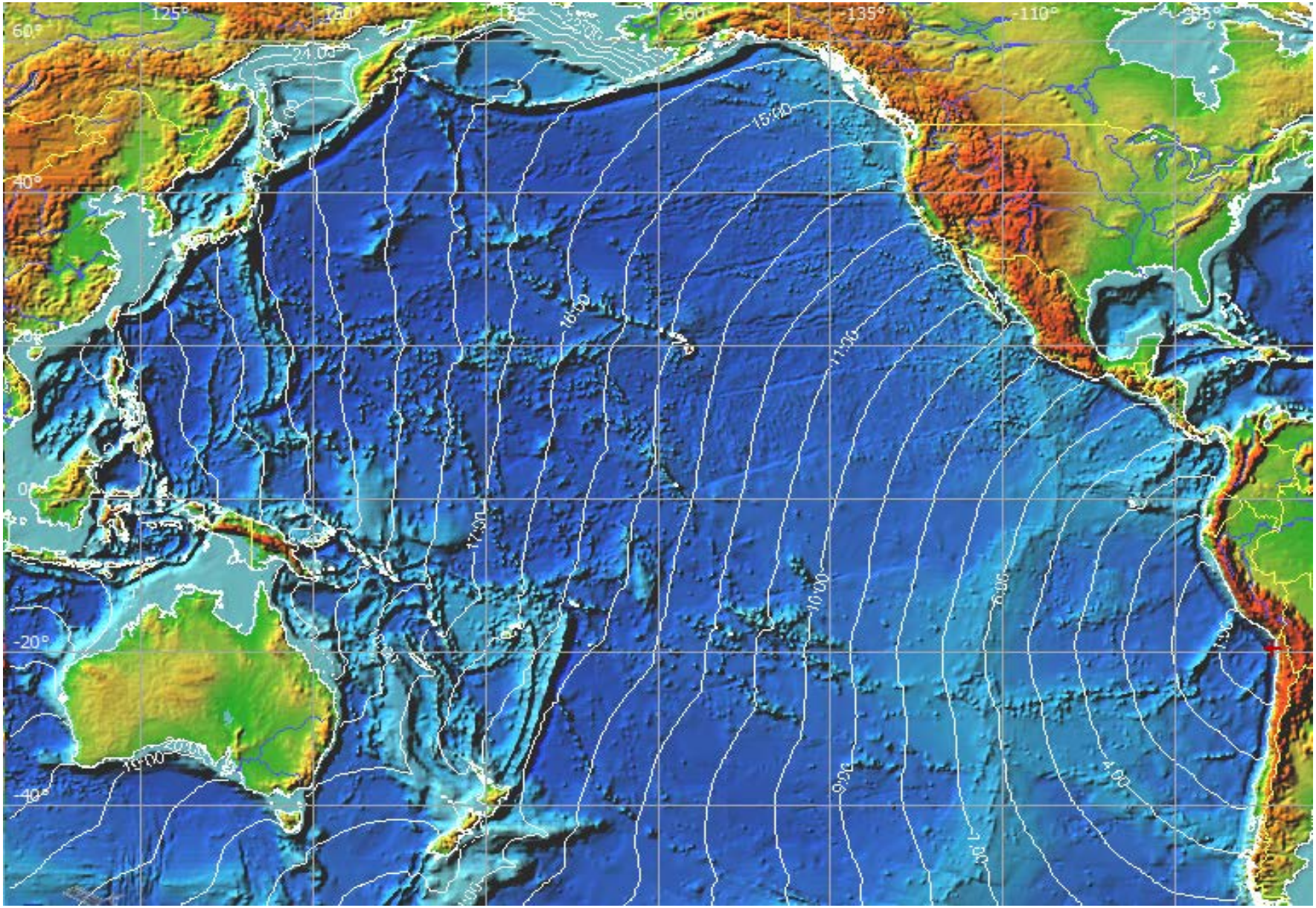
Charles McCreery, Director
Pacific Tsunami Warning Center

April 1, 2014 Chile Earthquake & Tsunami



1:47PM HST
Mw = 8.2
19.6°S, 70.8°W
25km depth
Off the coast of N. Chile

April 1, 2014 Chile Earthquake & Tsunami



Hawaii Timeline

Product	Time	Elapsed	Event
	1:47 PM	0:00	8.2 Chile Earthquake Occurs
1	1:56 PM	0:09	Information Statement
5	4:47 PM	3:00	Information Statement
6	5:46 PM	3:59	Advisory Message
15	2:57 AM	13:10	Advisory Message
	3:24 AM	13:37	Tsunami Arrival in Hawaii
16	4:01 AM	14:14	Advisory Message
20	7:26 AM	17:39	Advisory Cancellation

Hawaii Issues and Procedure Changes

- **Issue - Information Statements for first 4 hours**
  - By procedure – issue Tsunami Watch only when still evaluating and ETA within 6 hours
  - Chile DART problem so PTWC waiting for data from DART gauge near the Galapagos – well in advance of 6 hour limit
  - Tsunami Information and Watch definitions confused some and new county EMs did not recall the Watch procedure
  - Hawaii EM agencies had to make decision to keep staff or let go home due to end of workday

- **Resulting Changes in Hawaii Procedures**
  - PTWC will issue Watch as soon as a possible threat to Hawaii is under evaluation
  - PTWC will consult with Hawaii EMs regarding any special constraints they may have regarding timing of alert levels

2014 Tsunami Alerts - Alaska

- 4’ - Message 1 – M=7.1; Limited Warning
- 21’ - Message 2 – M=8.0;
  - Manual Over-ride of automatic procedures
    - Depth
    - Precomputed models
- 35’ – Scaled ATFM Forecast
- 60’ – Combined SIFT/ATFM Forecast
- 71’ – Conference call – Observable effects at Adak
- 91’ – Message 4 – Downgrade; issue forecasts
- 222’ - Cancellation

Message 1 – 4 minutes

Warning

Event Details

Location: 30 miles NW of Amchitka, Alaska
Magnitude: 7.1, **Depth:** 57.8 (Mi.)
Lat: 51.9 ° N **Lon:** 178.8 ° E
Origin Time: 6/23/2014 12:53:10 PM

Message 2 – 21 minutes

Warning

Event Details

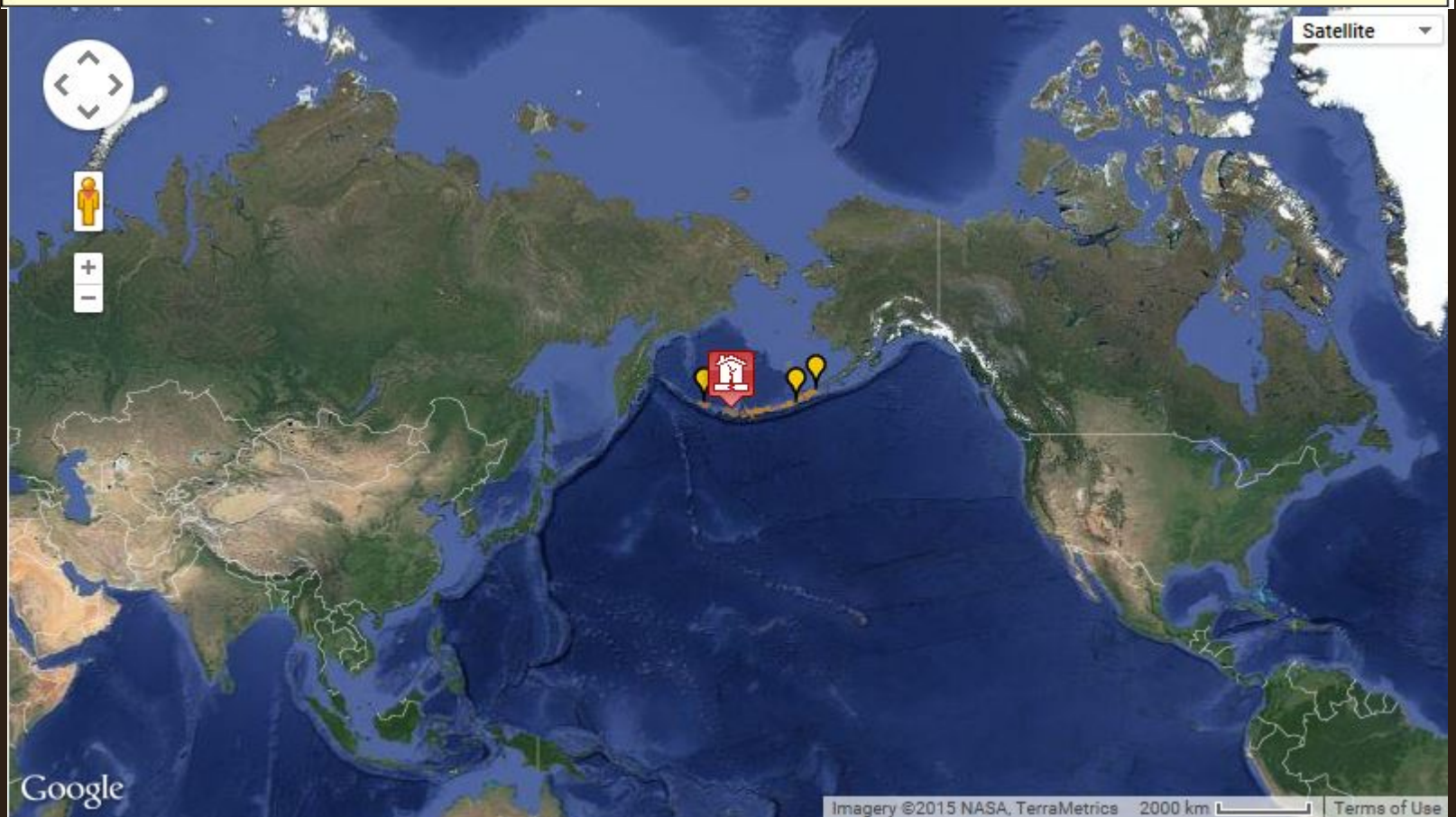
Location: 25 miles NW of Amchitka, Alaska
Magnitude: 8, **Depth:** 68.4 (Mi.)
Lat: 51.8 ° N **Lon:** 178.7 ° E
Origin Time: 6/23/2014 12:53:10 PM

Message 4 – 91 minutes

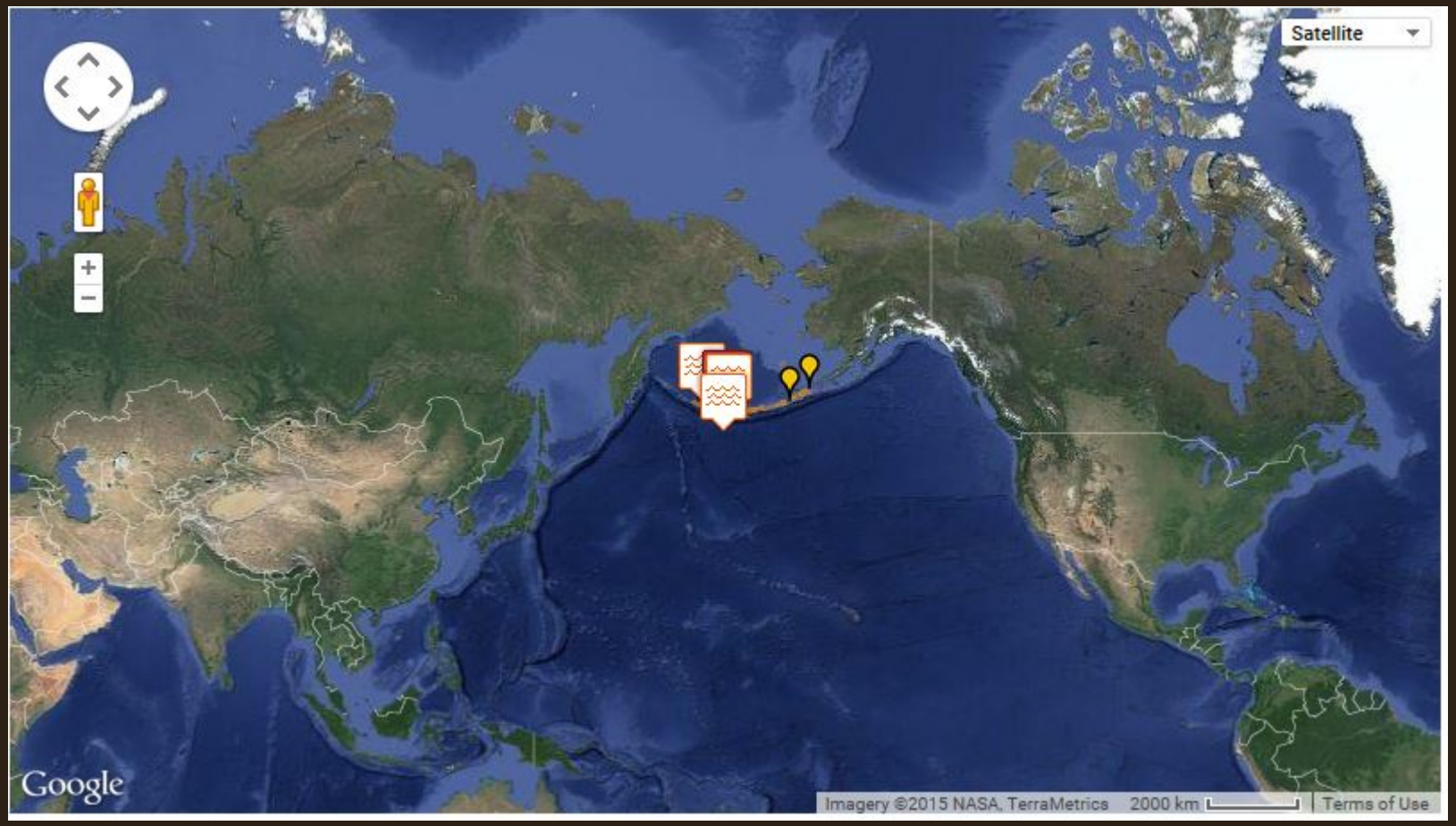
Advisory

Event Details

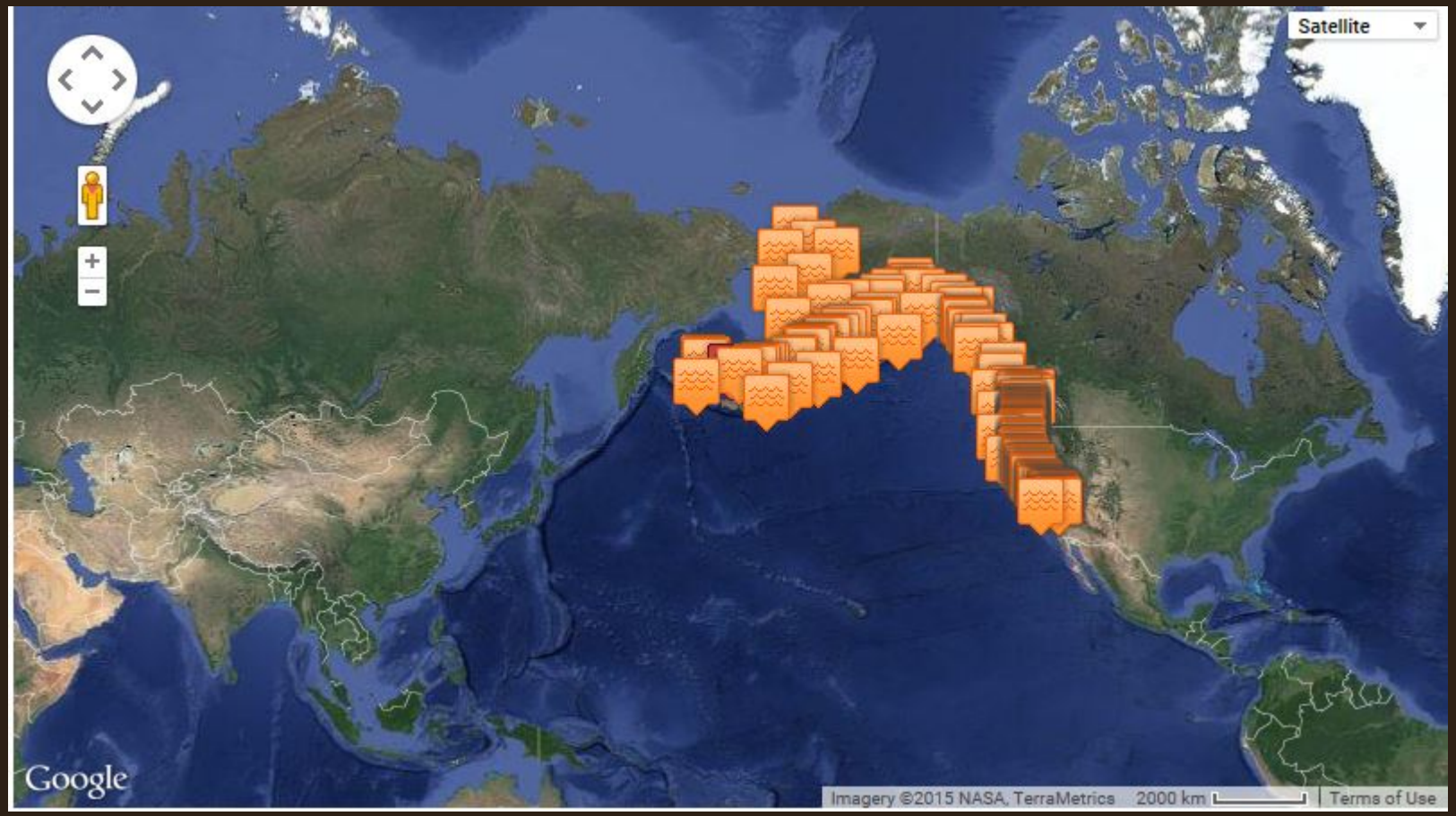
Location: 25 miles NW of Amchitka, Alaska
Magnitude: 8, **Depth:** 68.4 (Mi.)
Lat: 51.8 ° N **Lon:** 178.7 ° E
Origin Time: 6/23/2014 12:53:10 PM



Message 4 - Observations



Message 4 - Forecasts



Lessons Learned

- Automatic procedures called for too large of an alert
  - Expand Threat Database
- NTWC earthquake depth criteria look OK
- Unclear advice for distant regions
  - Refined with more specific info
- Auto EAS worked well at WFO Anch.
- WEA went through NWS->FEMA->cells
  - No one received a WEA though

Post-Warning Survey

- Survey performed after June tsunami warning
- Led by State of AK, using Survey hosted at state of WA
- Link to survey
- Results

TWC IT Improvements

- TOPS Update
- Other Forecast Projects
  - Tweb
    - ATFMv2
      - Max Height
      - Max Current
    - SIFT
    - RIFT
  - Consensus Forecast Tool
  - NCEP
  - Model Output
    - Sea level with tide added

Meteotsunami Alerts

Meteotsunami Forecast - Steps

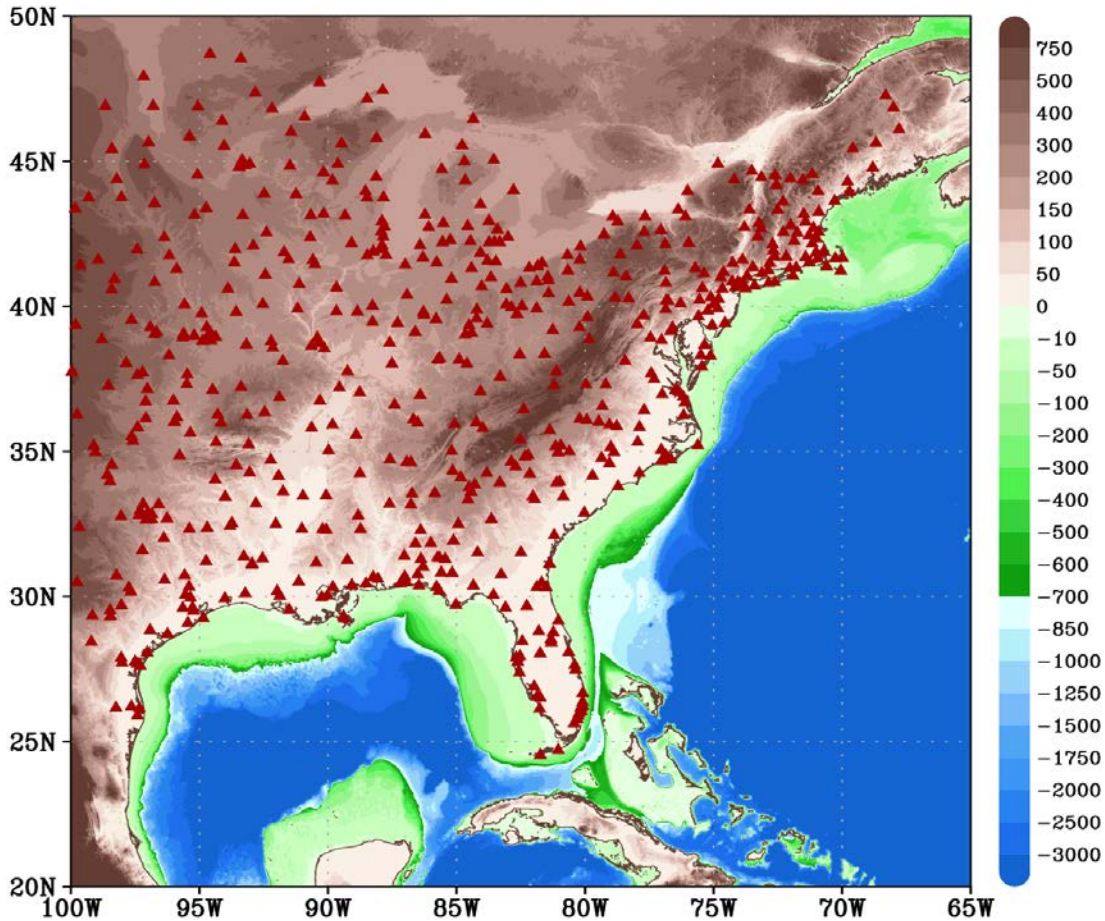
1. Identify Mesoconvective Sytem (MCS)
2. Detect AGW in system
3. Compute speed/extent/direction of AGW
4. Is speed conducive to resonance?
5. If yes, feed AGW parameters into ATFM
6. Based on ATFM output, issue information

Step 1 – Identify MCS

- MCS are routinely forecasted by NWS
- MCS which contain persistent and extensive AGWs have been identified as the likely generator for meteotsunamis
- Use this to constrain Step 2

Step 2 – Detect AGW

- Use ASOS data



Step 2 – Detect AGW

- Detect presence of AGW based on air pressure (AP), wind gust (WG), and air temperature (AT) tendencies.
- Tendencies are estimated by 6 minute rates of changes of AP, WG, and AT from ASOS 1' data.
  - $\Delta WG = WG(i+6) - WG(i)$; $\Delta AP = AP(i+6) - AP(i)$; $\Delta AT = AT(i+6) - AT(i)$
- In normal conditions, these tendencies are not well correlated (<0.1)
- In certain cases ($\Delta WG > 4$m/s, $\Delta AP > 0.5$mb, $\Delta AT < 0$) correlation increases (>0.6)
- Based on empirical testing $\Delta WG > 4$m/s, $\Delta AP > 1$mb, and $\Delta AT < 0$ indicate the presence of AGW

Step 3 – Compute Speed/Direction/Extent of AGW

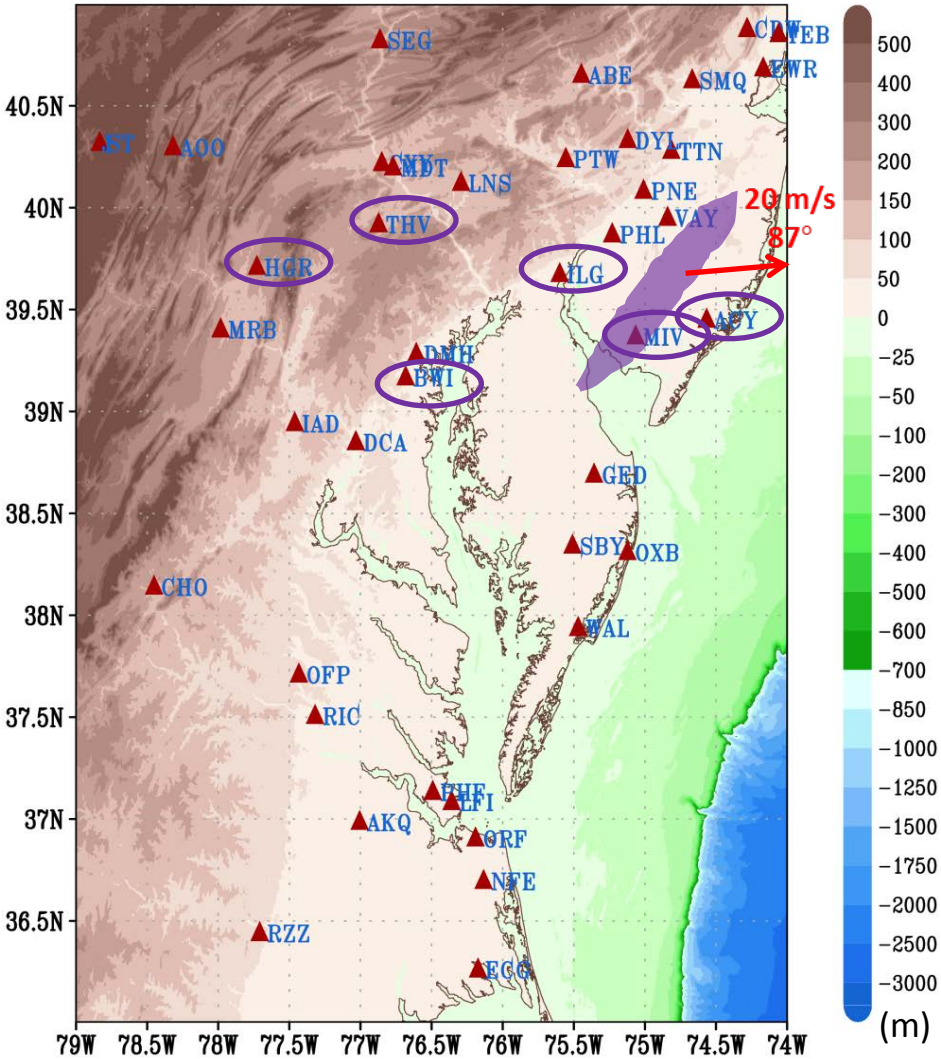
- The speed *C* and direction α are estimated:
  - based on observations on a triangular array of ASOS stations with coordinates ($x1$, $y1$), ($x2$, $y2$) and ($x3$, $y3$) assuming:
    - the disturbance does not change during its travel over the domain (it propagates as a plane wave), and
    - the disturbance has a constant speed *C* and direction α.
  - $\tan\alpha = a = \frac{t_{1,2}dy_{1,3} - t_{1,3}dy_{1,2}}{t_{1,3}dx_{1,2} - t_{1,2}dx_{1,3}}$

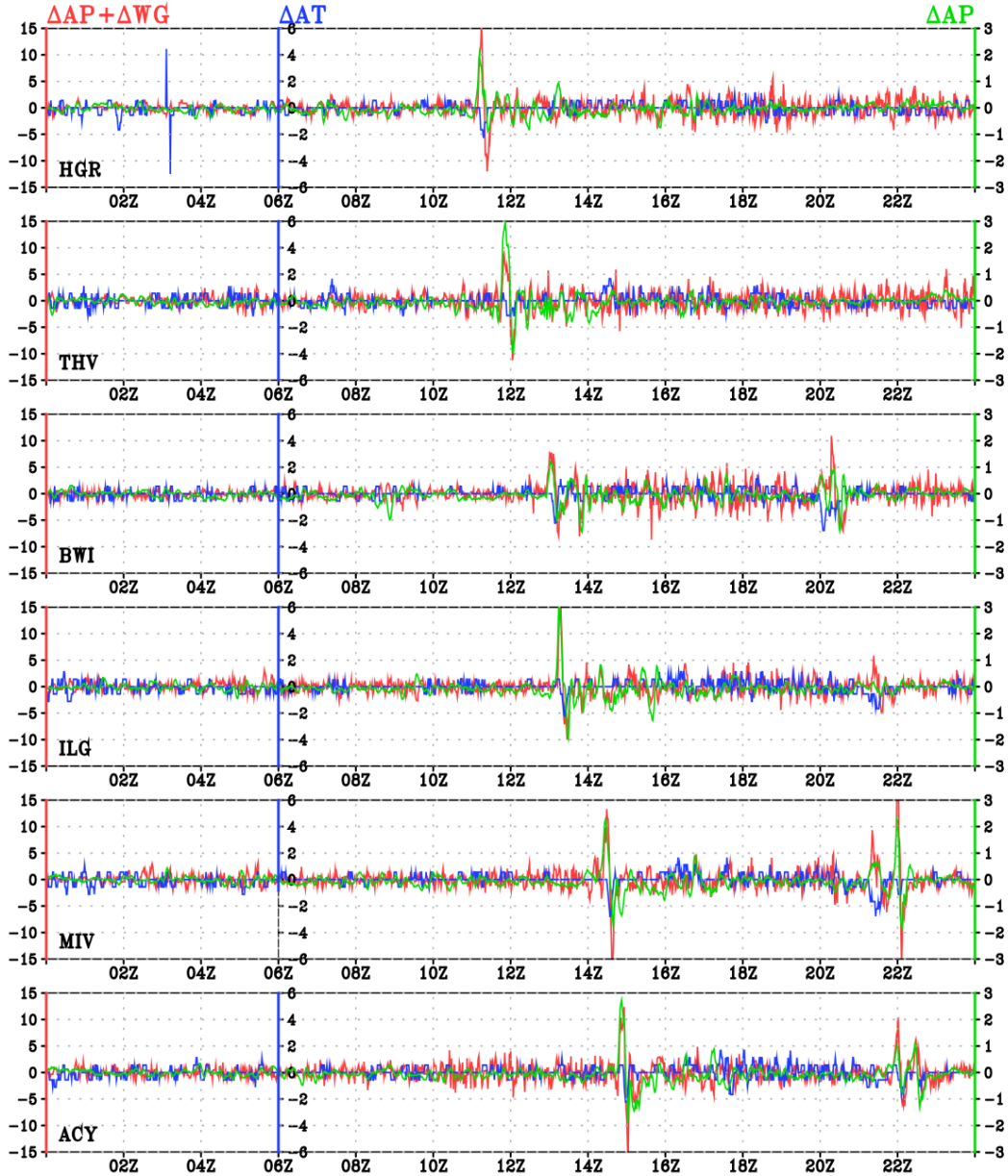
    $C = \frac{1}{t_{1,2}} \frac{dy_{1,2} + a \cdot dx_{1,2}}{\sqrt{1+a^2}} = \frac{1}{t_{1,3}} \frac{dy_{1,3} + a \cdot dx_{1,3}}{\sqrt{1+a^2}}$
  - Where:
    - $dx_{1,2}$, $dy_{1,2}$, $dx_{1,3}$, $dy_{1,3}$ are distances between stations 1 and 2 and between stations 1 and 3 in the north-south and east-west direction, respectively
    - $t_{1,2}$ and $t_{1,3}$ are measured time lags of a threshold-exceeding tendencies (rates of change) between stations 2 and 3 and station 1, respectively.

Step 3 – Compute Speed/Direction/Extent of AGW

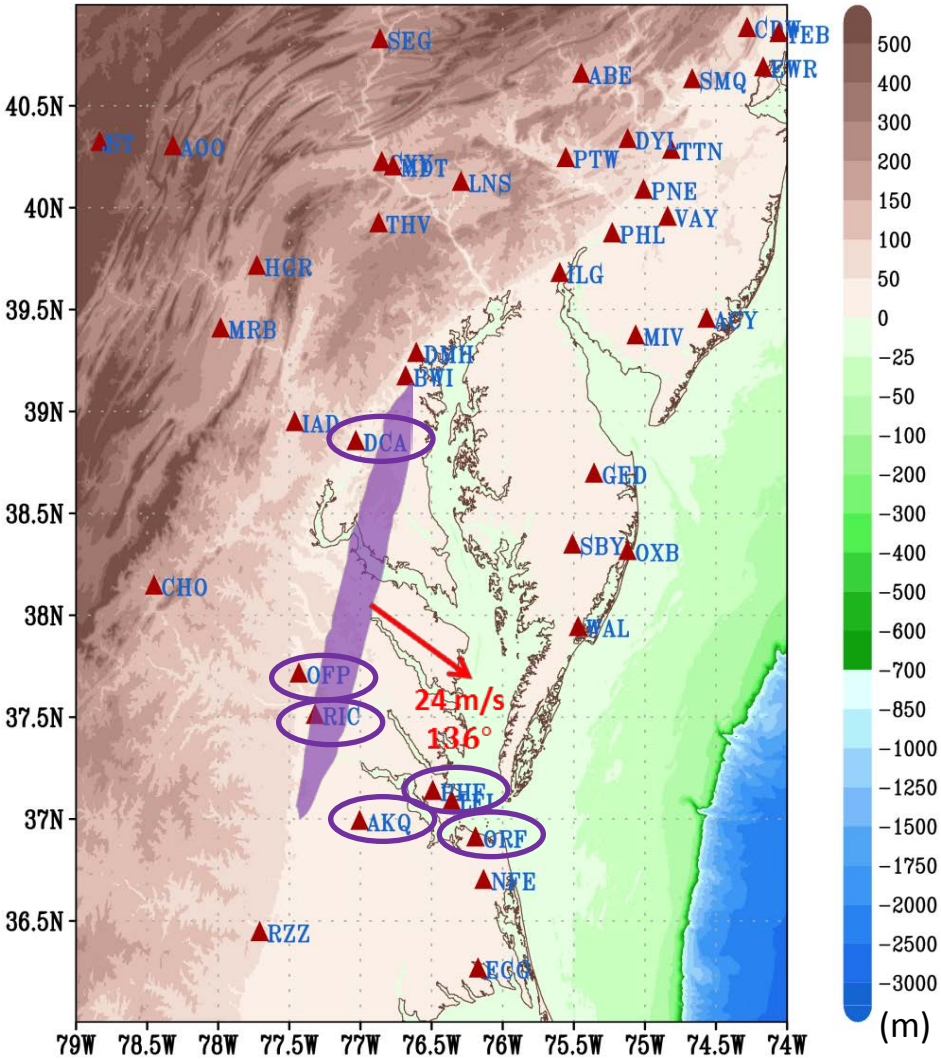
- The extent (length and width) of the AGW is estimated from observations
- A Gaussian profile is assumed.

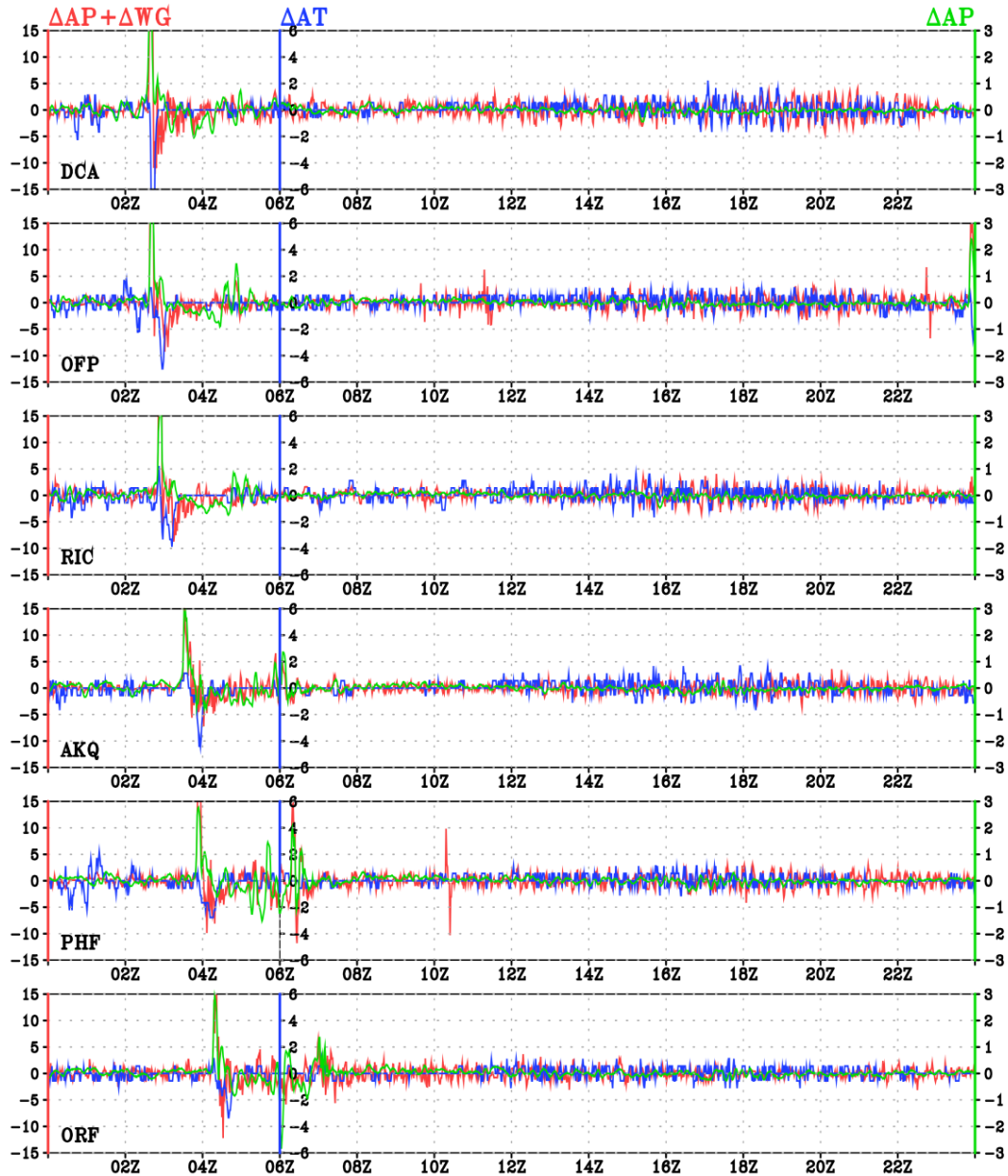
June 13, 2013 Event





June 30, 2012 Event



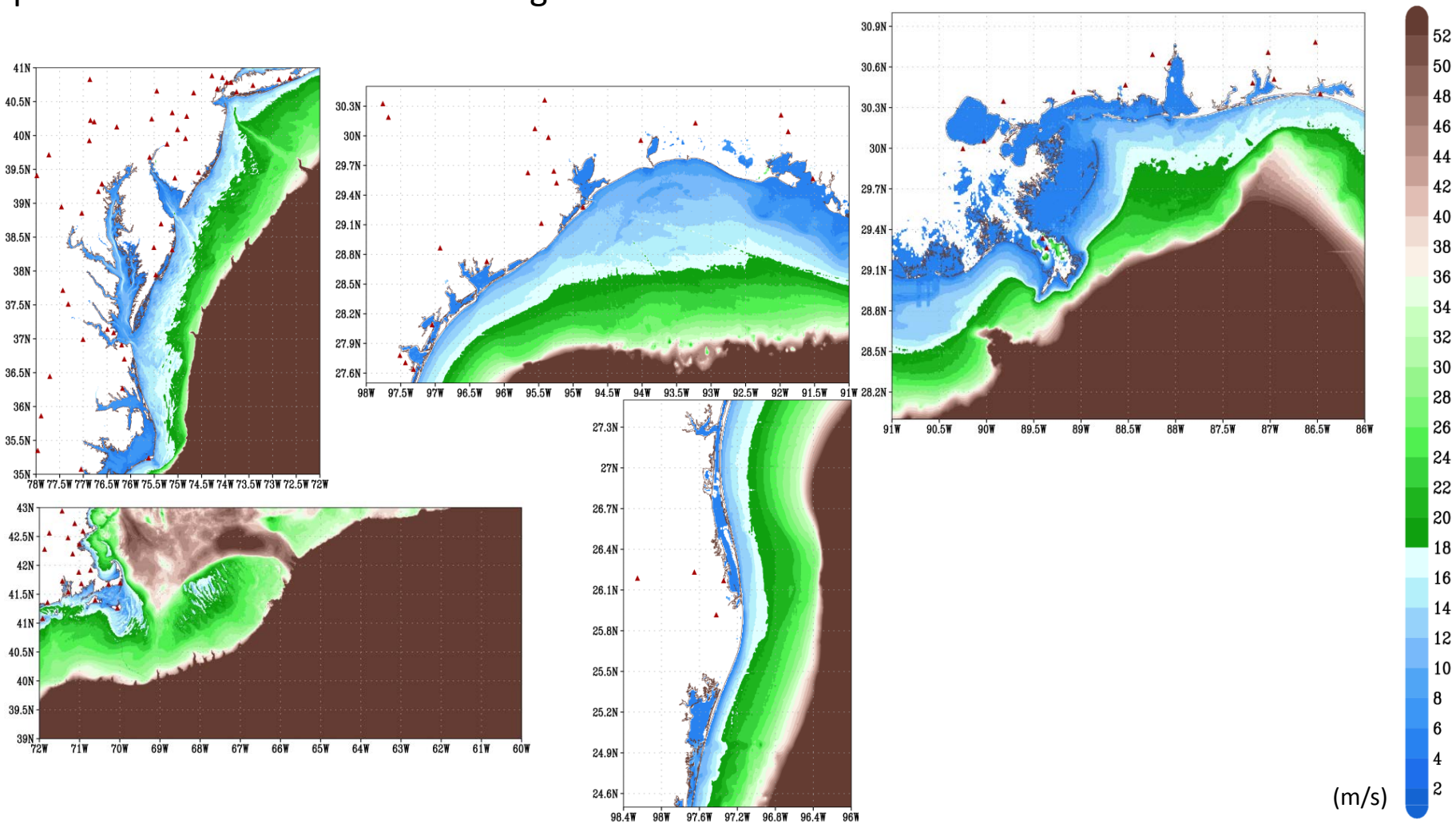


Step 4: Is AGW speed conducive to resonance?

- An initial comparison to long wave speed is made with the tool on the next slide.
- If yes, proceed to Step 5.

Maps of long wave speed

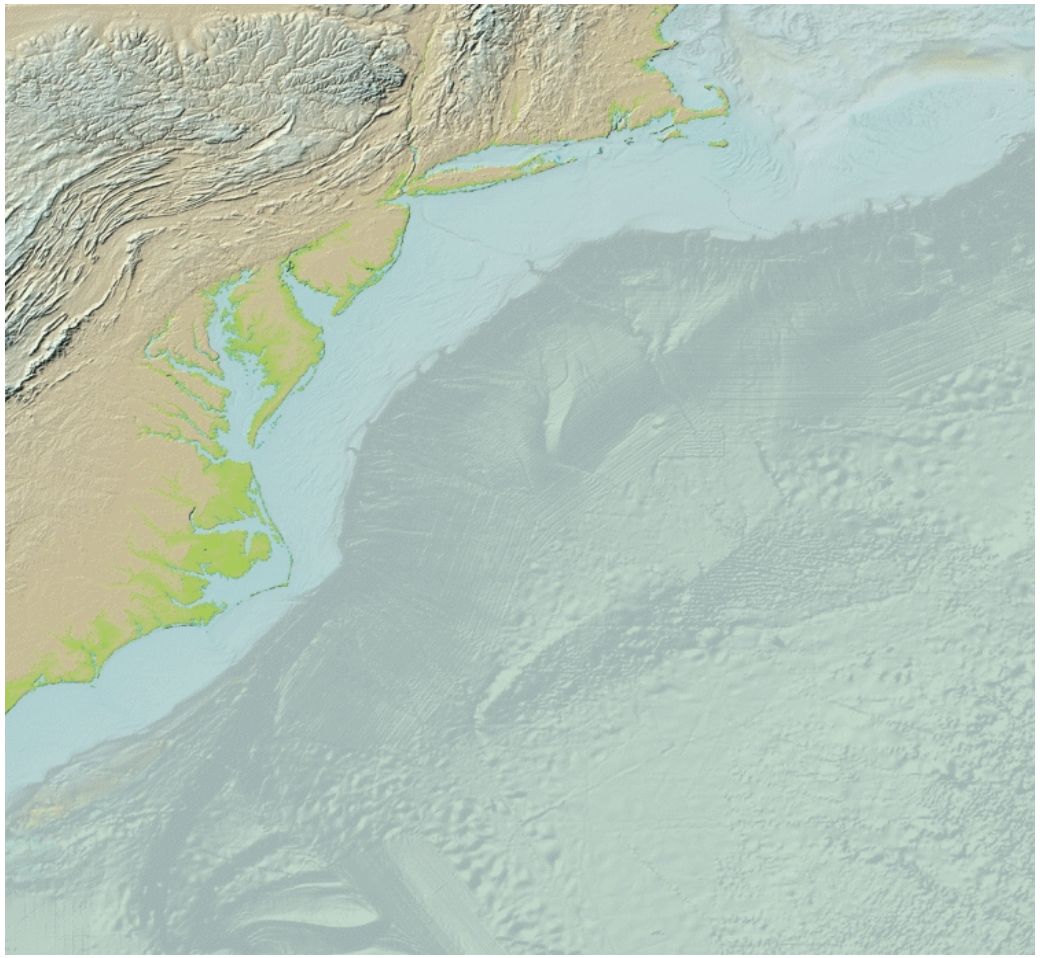
A tool to help determine whether Proudman resonance may occur along the East Coast and Gulf of Mexico continental shelves was developed. This tool shows the appropriate speed for optimal Proudman resonance along the shelf.



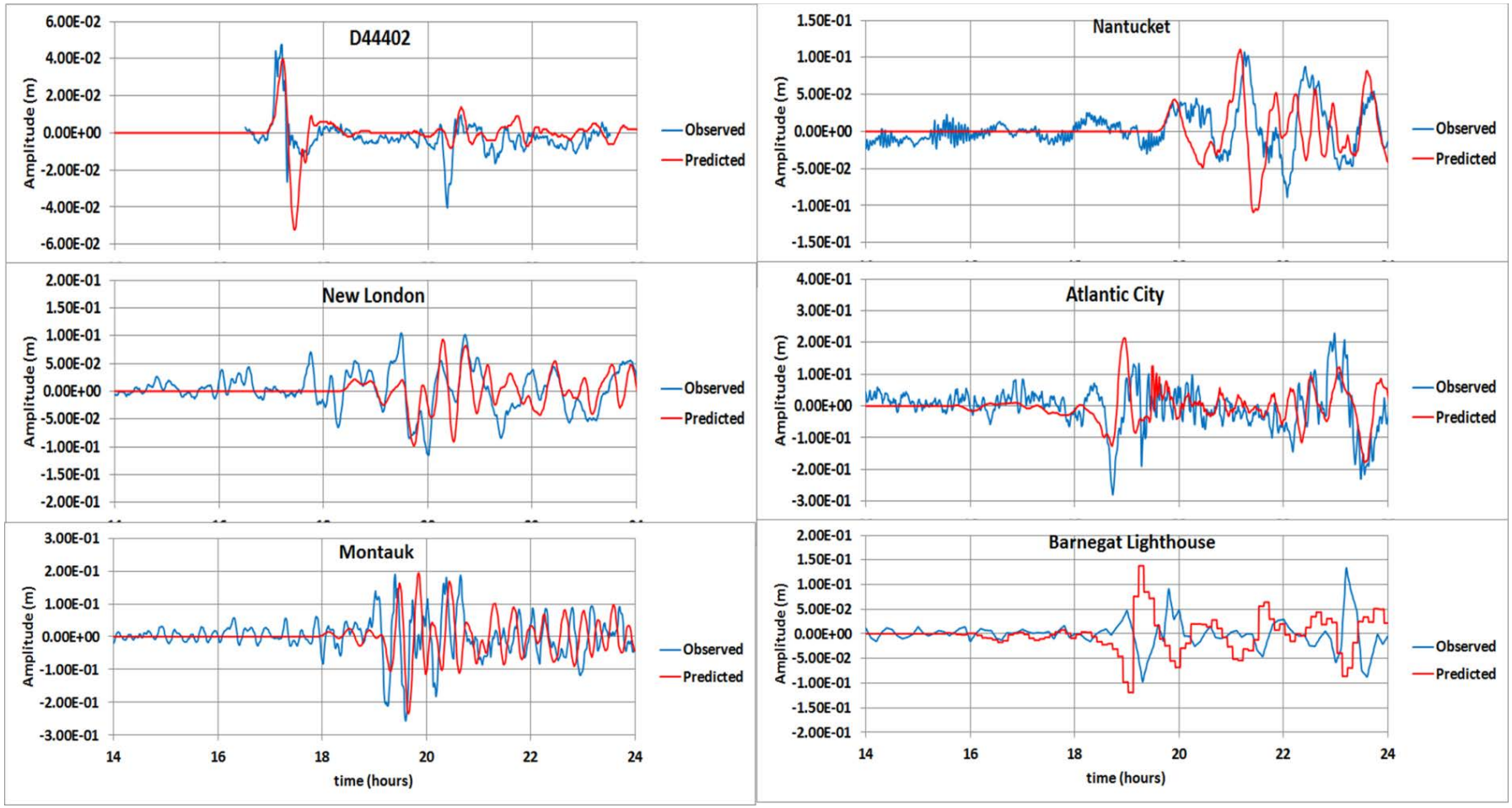
Step 5: Model tsunami with ATFM

- Parameters speed, direction, length, width, and amplitude in mb are provided as control.
- ATFM output is sea level time series at points of interest and maximum amplitudes throughout grid.
- If output indicates threat, go to Step 6.

Step 5: Model tsunami with ATFM



Step 5: Model tsunami with ATFM



Step 6: Issue Information

- Work with appropriate WFO to issue statement (next slide)
- Statement based on NOAA Social Science review

Step 6: Issue Information

- ...ABNORMAL AND POTENTIALLY DANGEROUS OCEAN SURGES ARE EXPECTED TODAY ALONG THE COAST AND INLET AREAS...

- AIR PRESSURE SENSOR AND TIDE GAGE READINGS IN AND NEAR THE COASTAL WATERS INDICATE THAT A WEATHER-GENERATED TSUNAMI WAS TRIGGERED BY A STORM SYSTEM AS IT MOVED OVER THE OCEAN. WATER LEVEL FLUCTUATIONS OF SEVERAL INCHES TO ONE FOOT ABOVE NORMAL TIDE IN LOCALIZED AREAS CAN BE EXPECTED AT THE SHORE FOR THE NEXT SEVERAL HOURS AS A SERIES OF SURGES STRIKE THE COAST. WHILE NO COASTAL FLOODING IS EXPECTED... THE STRONG CURRENTS ASSOCIATED WITH THESE SURGES COULD POSE DANGER TO THOSE IN OR NEAR THE WATER. RECOMMENDED ACTIONS ARE LISTED BELOW.

- IMPACTS ARE EXPECTED ALONG THE COAST FROM xxx TO yyy.

- BOAT OWNERS…
- * PREPARE NOW FOR THE FOLLOWING HAZARDS...
- * STRONG UNPREDICTABLE CURRENTS.
- * SURGING UP TO ONE FOOT ABOVE NORMAL SEA LEVEL.

- SWIMMERS… SURFERS… AND BOATERS…
- * IT IS RECOMMENDED YOU LEAVE THE BEACH NOW TO AVOID THE FOLLOWING HAZARDS…
- * STRONG CURRENTS
- * POTENTIALLY DANGEROUS SURGES OF WATER
- * DO NOT RETURN TO THE WATER FOR xxx HOURS OR UNTIL NOTIFIED BY LOCAL
- EMERGENCY OFFICIALS OR THE NATIONAL WEATHER SERVICE THAT THE DANGER HAS
- PASSED.

- DURATION OF EVENT...
- * THE DURATION OF THE EVENT IS UNCERTAIN… THOUGH SIMILAR EVENTS HAVE LASTED FROM SEVERAL HOURS TO ONE DAY.

- THIS KIND OF TSUNAMI IS GENERATED BY ABRUPT CHANGES OF ATMOSPHERIC PRESSURE IN THE STORM SYSTEM. THE COMBINATION OF THE AIR PRESSURE EFFECT ON THE OCEAN SURFACE AND THE SPEED AT WHICH THE PRESSURE DISTURBANCE TRAVELS CAN GENERATE TSUNAMI-LIKE WAVES IN CERTAIN SITUATIONS. THE NATIONAL TSUNAMI WARNING CENTER IS MONITORING THIS EVENT. ADDITIONAL STATEMENTS WILL BE ISSUED AS NECESSARY THROUGH YOUR LOCAL NATIONAL WEATHER SERVICE OFFICE.

Sea level gages

- New gage installed by NTWC in Ventura, CA
  - Data live on NOS site
- Permits requested for Newport Beach and Fort Bragg
- Site surveys completed for Long Beach and Santa Cruz
- OR, WA next?

New Actions

- Products
  - Implement Social Science recs.?
  - Complex Coast recs.?
  - WEA Polygons?
  - EAS Activation for Advisories?
- Establish date and scenario for 2015 Exercises
- Training?
- Meteotsunami alerts?
- New Tide gage sites?