Interim Overview

Atlantic Tsunami / Storm Surge Warning System

East Coast Canada

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A Progress Report *with contributions from:*

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Assumptions

- Politically driven
- No new money
- Low probability / high impact of a major basin scale tsunami
- Continuous 7/24 operation required
- Federal-provincial cooperation
  - DFO, NRCan, PSEPC, Env. Canada
  - EMOs of NS, NB, PEI, NFLD

Current State

- Alaskan Tsunami Warning Center (NOAA)
- Tsunami Warning System – Pacific
- USA East Coast Planning
- IOC Caribbean Natural Hazard Warning Plan
- Creditable Program Essential

Monitoring

- East Coast Seismic Monitoring
- East Coast Sea Level Monitoring
- East Coast Storm Surge Warning
- Modelling Assisted

Preparedness

- Warning the “Warners”
- Public Warning Dissemination
- Outreach/Education
- Horizontal Risk Assessment

Modelling Breakout Group

- Tsunami warnings – new capability
- Storm surge warnings – enhance existing MSC capability
- Coastal bathymetry, coastline - modifications of tsunamis / surges (DFO)
- Coastal inundation
- Integrated surge and tsunami prediction

Atlantic Tsunami Warning Process Diagram

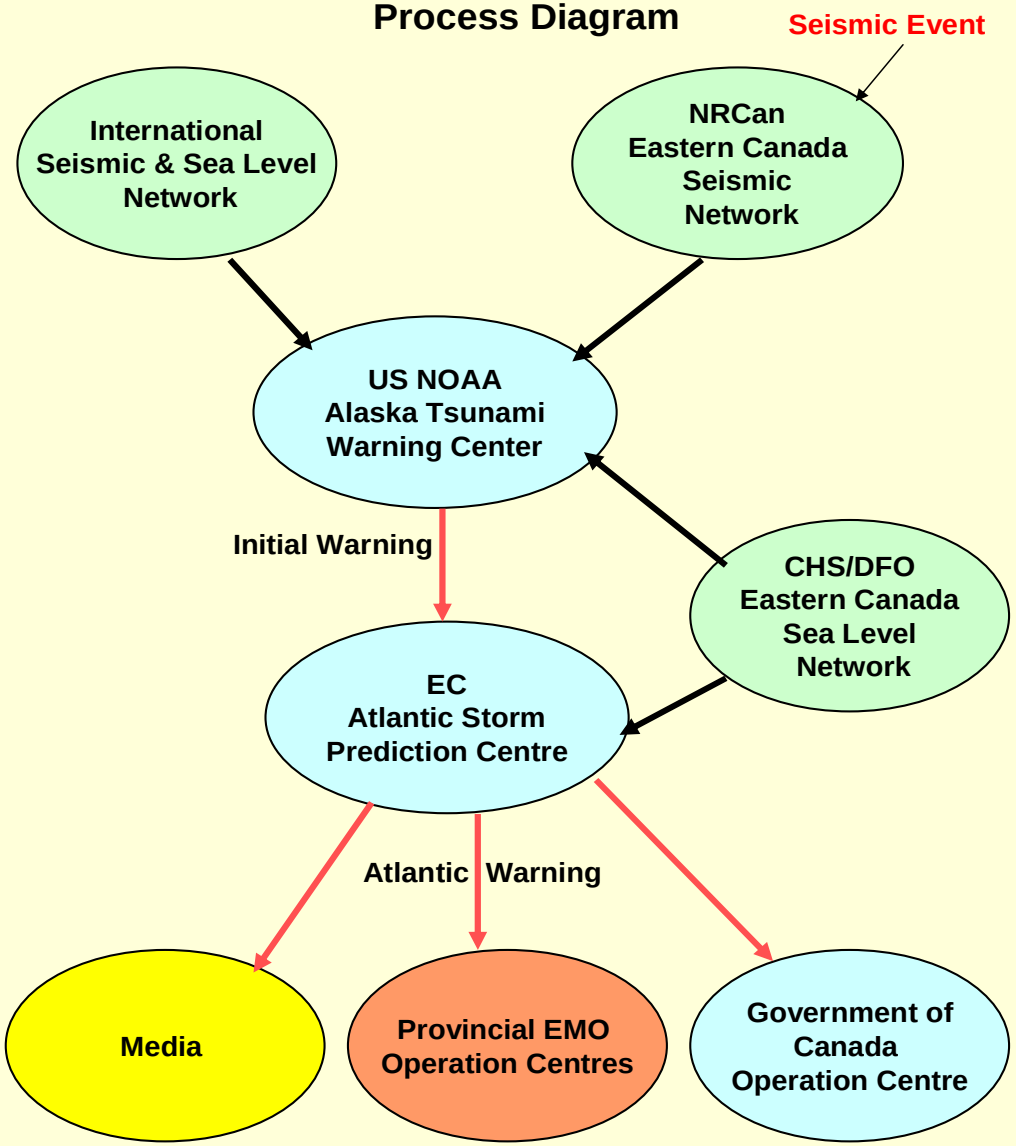


Figure 1

Message Alert Severity

- ***Warning:*** Earthquake occurred. Tsunami may have been generated. Arrival times <2 hours
- ***Watch:*** Earthquake occurred. Potential resultant tsunami not measured. Arrival times > 3 to 6 hours
- ***Info Bulletin:*** Earthquake occurred but not sufficient to generate a damaging tsunami
- ***Info Message:*** Earthquake occurred but not magnitude too weak to generate tsunami.

Messages

- As Rec'd from ATWC
- WEXX20 Tsunami Warning – large message with breakpoints
- WEXX20 Tsunami Watch
- WEXX22 Tsunami Information Bulletin
- SEXX20 Tsunami Information Message

- As Issued from ASPC
- WECN41 Tsunami Warning – Shorter message with Fcst. Rgns.
- WECN41 Tsunami Watch
- WECN43 Tsunami Info. Bulletin
- SECN43 Tsunami Info. Message

Current Message Format

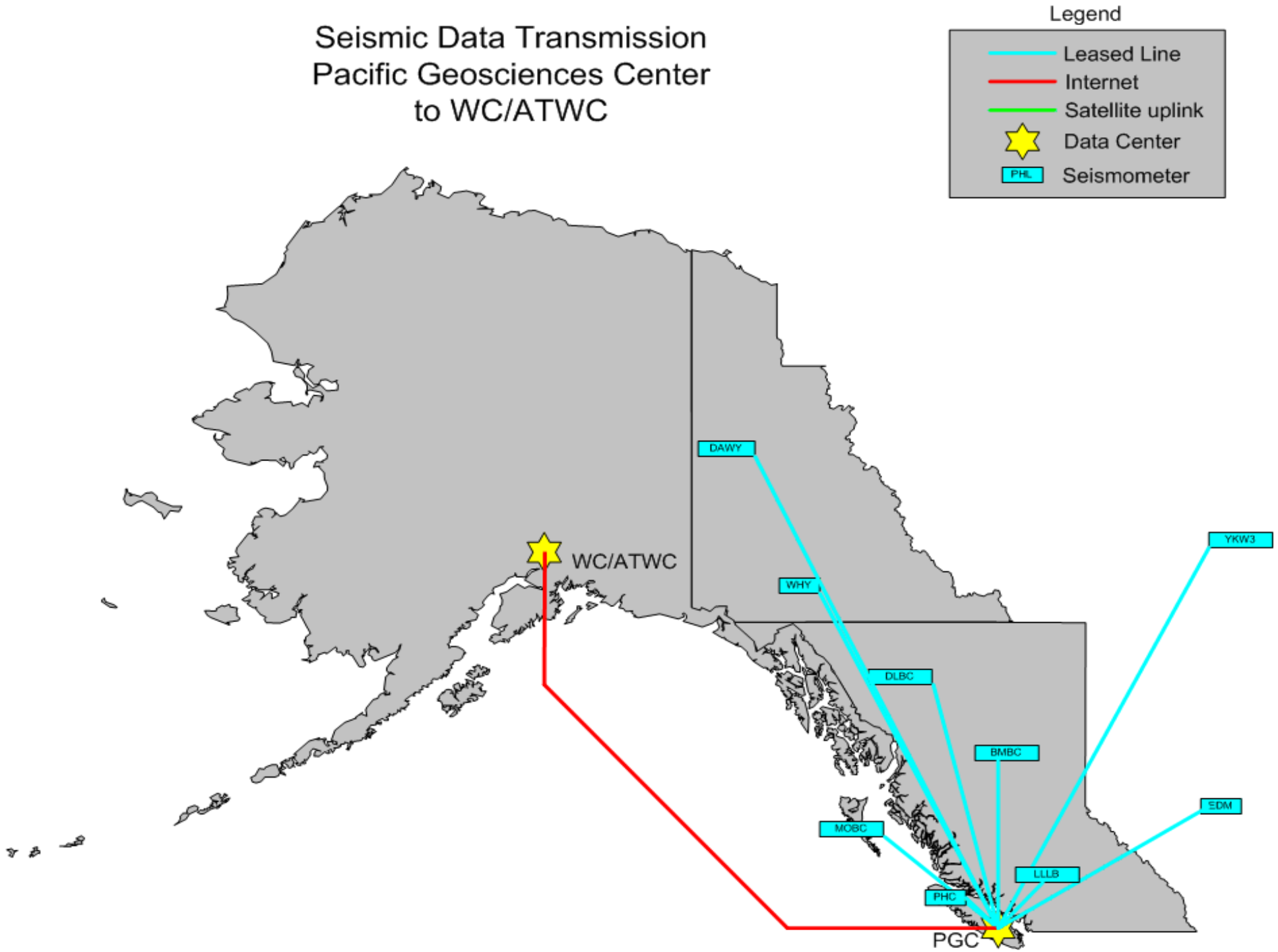
- Based on current Weather Warning messages.
  - Header
  - Message title
  - Issue time / date
  - Regions affected
  - Discussion
  - Estimated times of arrival
  - In effect duration time
  - Contact info.

Progress

- Message Format
  - Internal coding work in progress (processing of ATWC messages and re-transmission)
  - Need to finalize message wording (esp. for translation purposes)
  - Need to finalize short message format for Wx Radio and ATADS
- Testing of Communications system
- Operating Procedures for ASPC (being drafted)
  - Infrequent event
  - Bulletin preparation
  - Getting the message out
  - Tidal gauge verification
- Contingency Plans for ASPC operations
- Dissemination Methodology

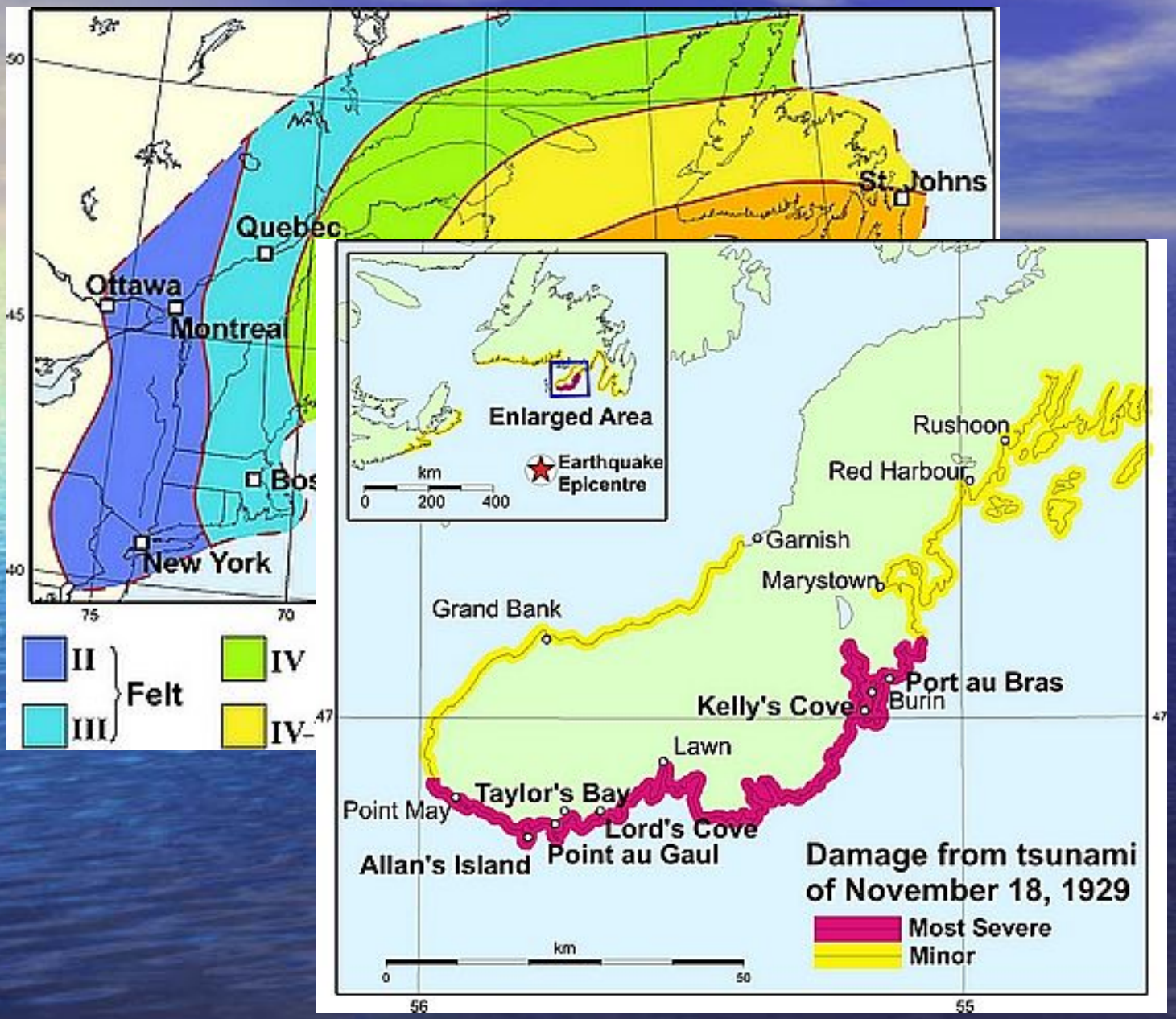
Seismic Monitoring

- Continuous data sent to two independent data centre (PGC, OBS-OTT)
- Multiple comms paths (C-band, Ku-band VSAT, terrestrial IP WAN, IP over VSAT)
- 24/7 automated analysis and alerting
  - 3-5 minutes
- 2 seismologists-on-call (SOCs)
  - 1 PGC based
  - 1 Ottawa based
- CREST data flow to ATWC is not currently robust

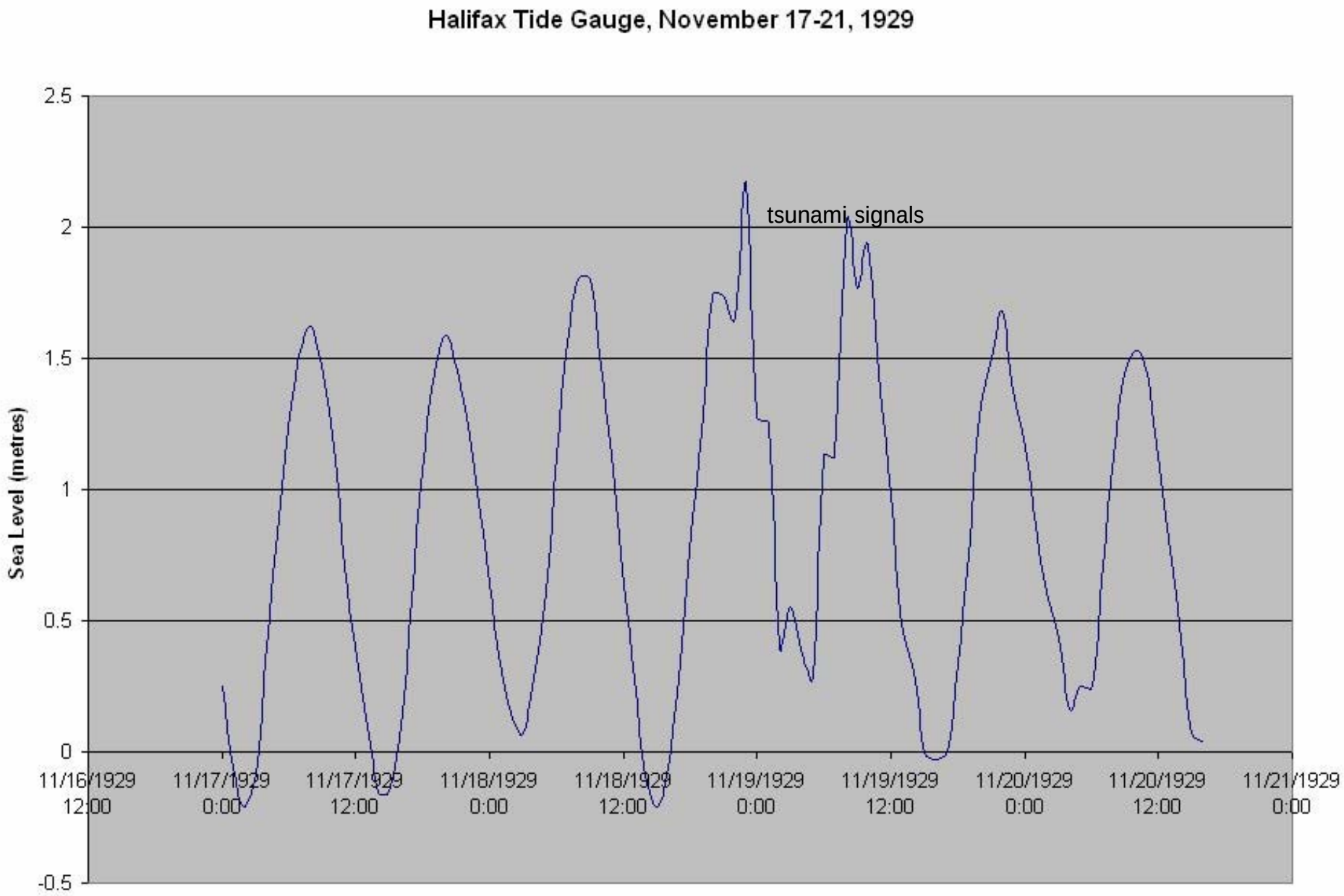

Seismic Data Transmission
Pacific Geosciences Center
to WC/ATWC
Legend
Leased Line
Internet
Satellite uplink
Data Center
PHL
Seismometer
WC/ATWC
DAWY
WHY
DLBC
BMBC
MOBC
PHC
LLLB
EDM
YKW3
PGC

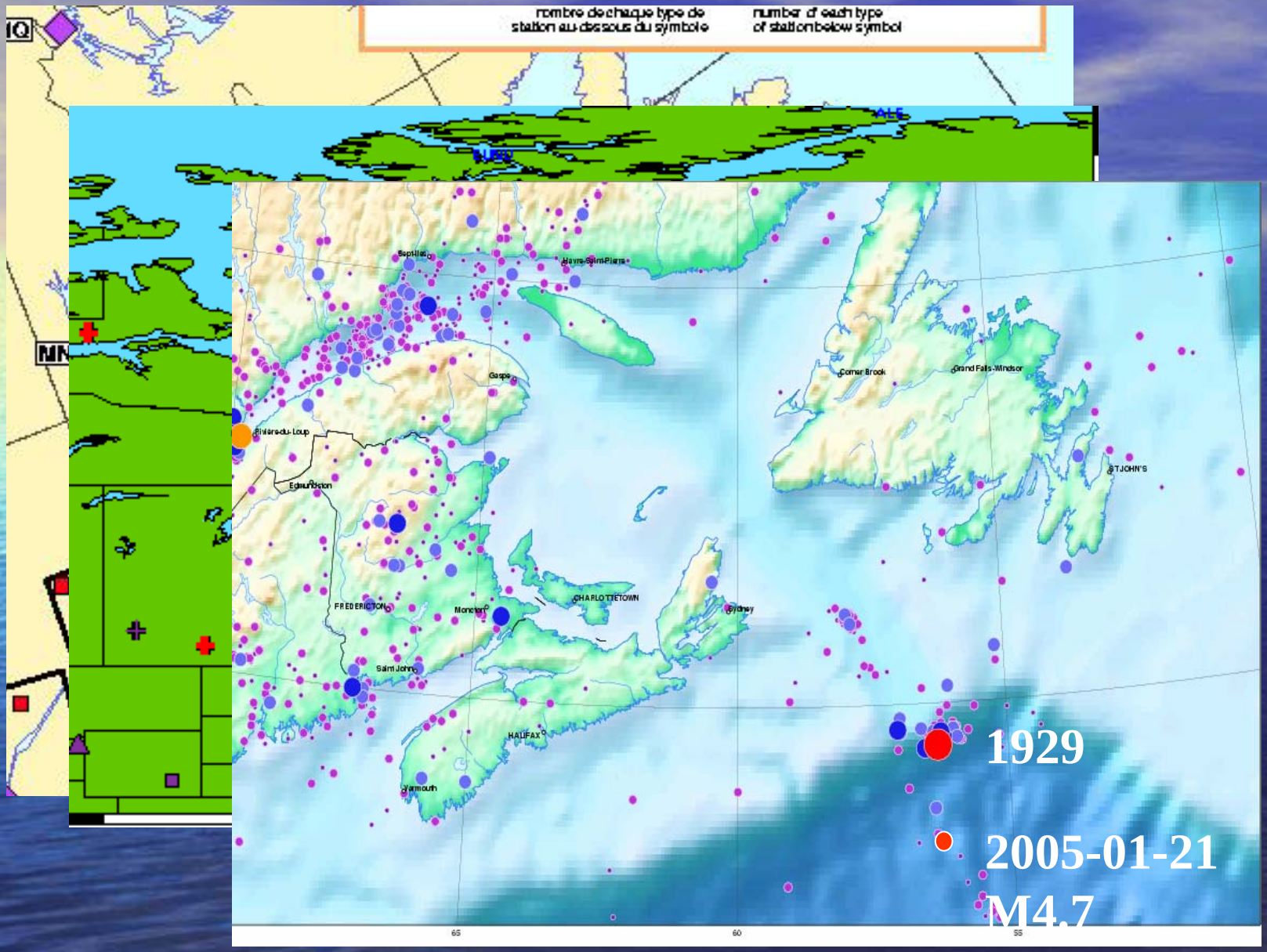
Interim Atlantic Tsunami System

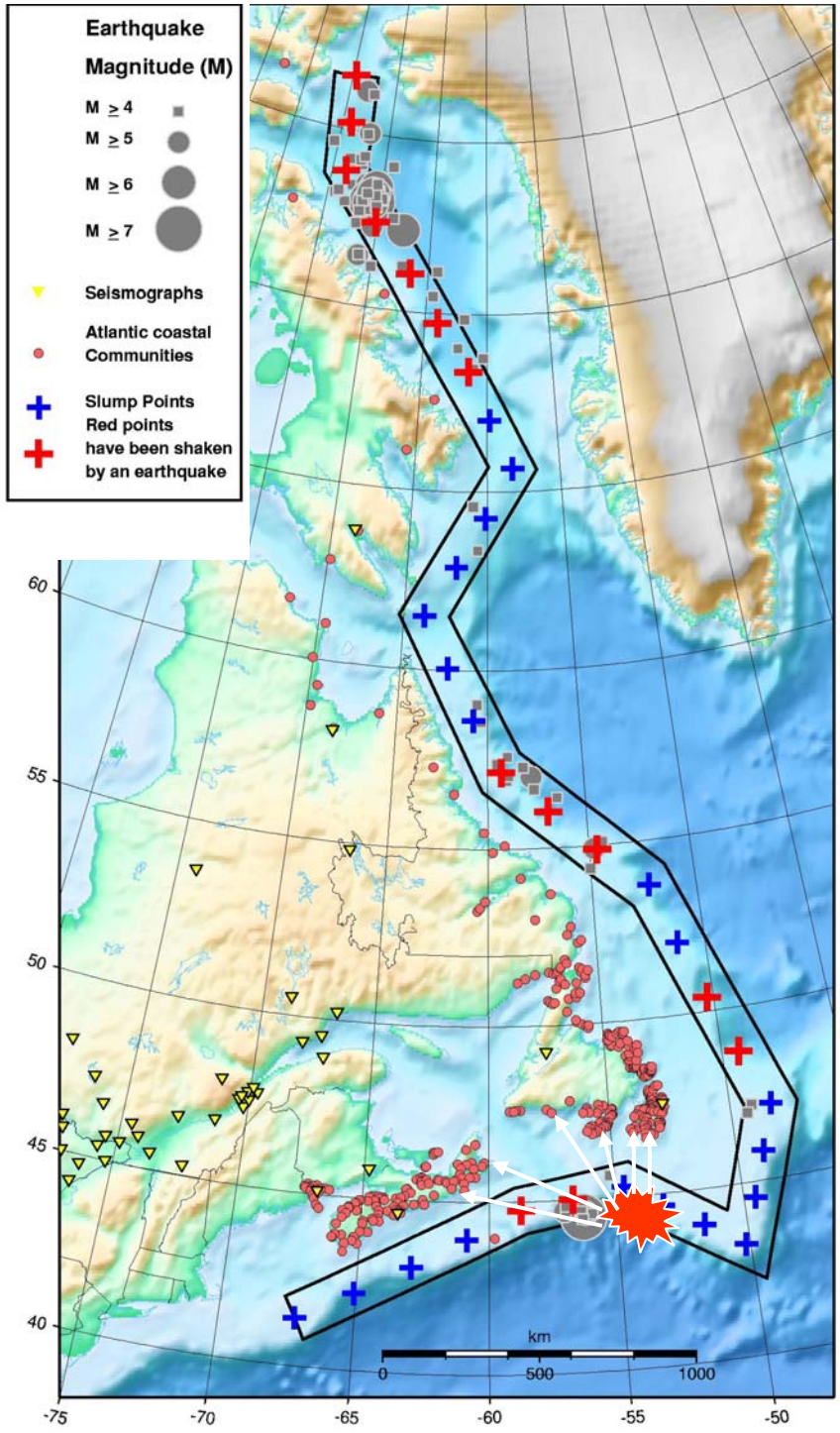
- Purely seismic based
  - Earthquake-triggered tsunamis only
- Assumes liquefaction => slumping => tsunami
  - Threshold mb 5.5
  - 1 real event per decade
  - Exercised for mb 3.5


St. Johns
Quebec
Ottawa
Montreal
Bos
New York
75
70
II
III
Felt
IV
IV-
Enlarged Area
Earthquake Epicentre
km
0
200
400
Rushoon
Red Harbour
Garnish
Marystown
Grand Bank
Port au Bras
Burin
Kelly's Cove
Lawn
Taylor's Bay
Point May
Lord's Cove
Point au Gaul
Allan's Island
Damage from tsunami of November 18, 1929
Most Severe
Minor
km
0
50
56
55

Canada East Coast (1929)




nombre de chaque type de station au-dessous du symbole
number of each type of station below symbol
Sept-Iles
Havre-Saint-Pierre
Gaspe
Riviere-du-Loup
Edmundston
Corner Brook
Grand Falls-Windsor
ST JOHN'S
FREDERICTON
Moncton
CHARLOTTETOWN
Sydney
Saint John
HALIFAX
Yarmouth
1929
2005-01-21
M4.7
65
60
55



TEST ATWS Earthquake and Possible Tsunami Notice

EARTHQUAKE REPORT

Date : 2005/02/03 Time/Heure : 00:00:44 UT

Epicenter : 45.07 -55.63 Region : Newfoundland and Labrador

Magnitude : 5.0 Richter Status : Q25 /OA

33 KM SW of SOMEWHERE

Action

PRECAUTIONARY TSUNAMI WATCH

until verification has been completed and appropriate confirmation issued by proper authority

Possible extreme wave activity may be experienced

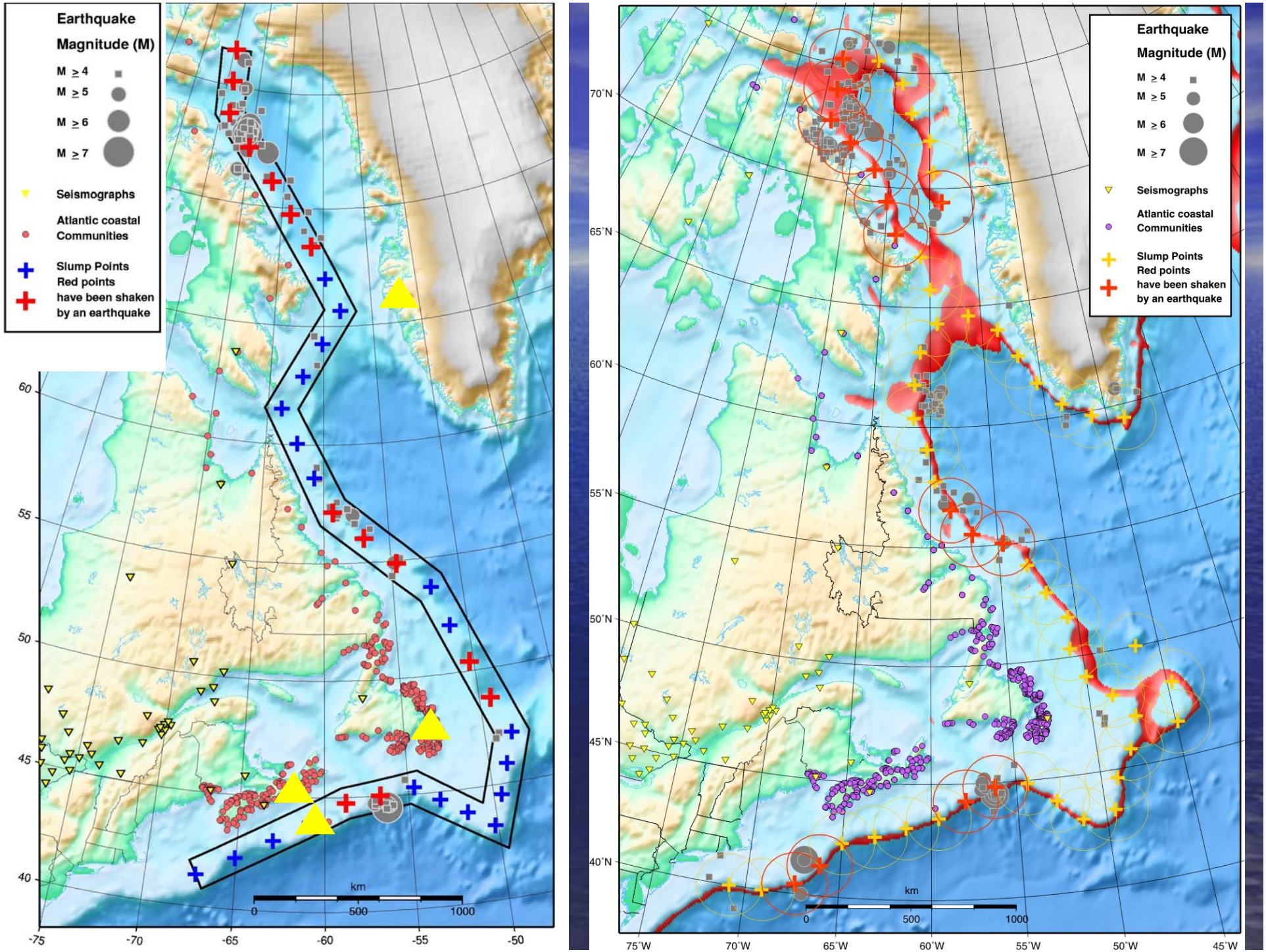
From/de To/à at Community

Between 00:42 and 03:01 (UT) at St. Shott's Nfld.

Between 00:43 and 02:44 (UT) at Point Lance Nfld.

Between 00:45 and 03:10 (UT) at St. Vincent's-St.Stephen's Nfld.

Between 00:46 and 02:56 (UT) at Branch Nfld.

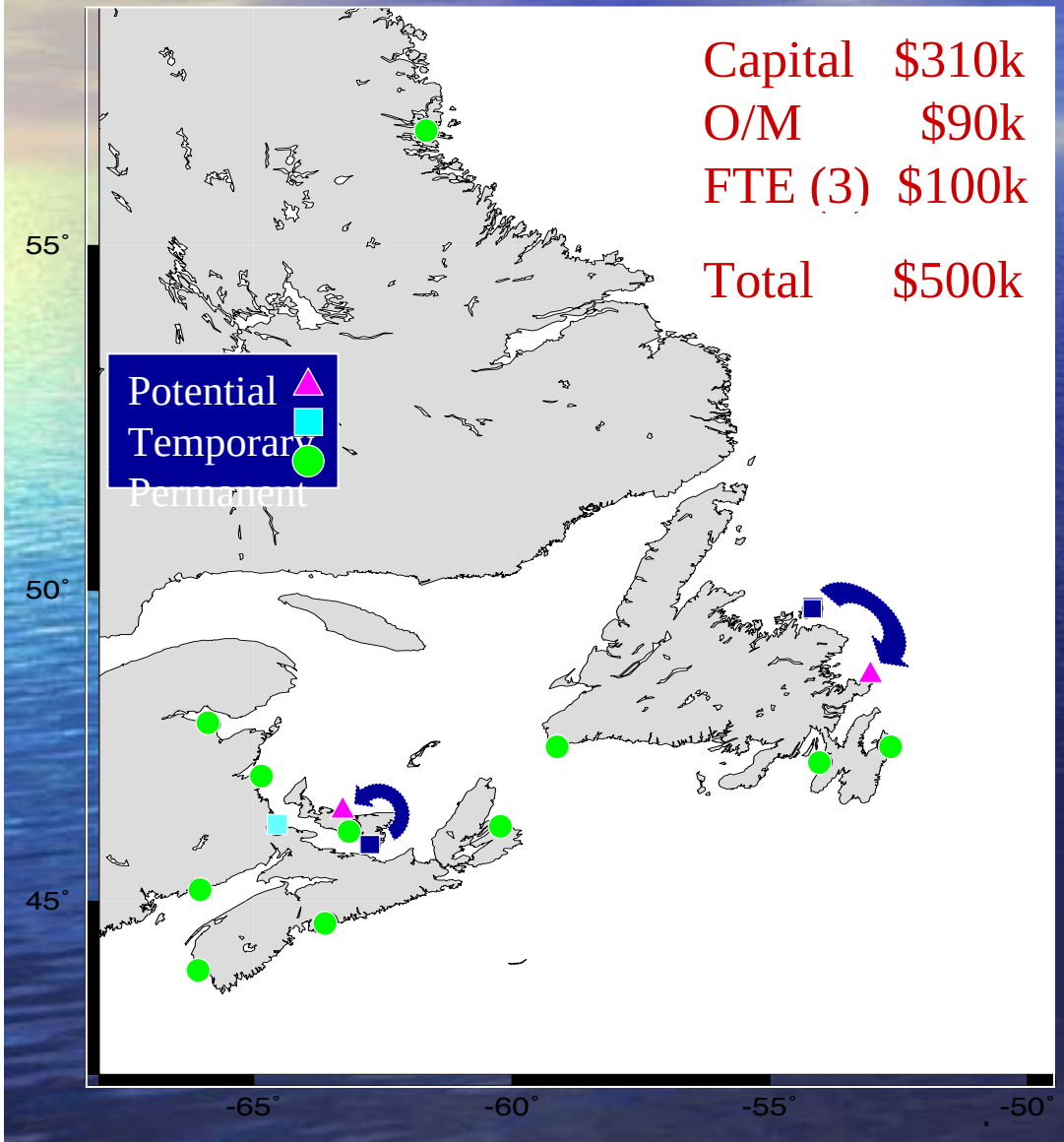

Earthquake
Magnitude (M)
M ≥ 4
M ≥ 5
M ≥ 6
M ≥ 7
Seismographs
Atlantic coastal
Communities
Slump Points
Red points
have been shaken
by an earthquake
km
0
500
1000
60
55
50
45
40
-75
-70
-65
-60
-55
-50
70°N
65°N
60°N
55°N
50°N
45°N
40°N
75°W
70°W
65°W
60°W
55°W
50°W
45°W

Tsunamis occur in Atlantic Ocean & Carribean

- November 1, 1755 - Lisbon, Portugal
- October 11, 1918 - Puerto Rico
- November 18, 1929 - Newfoundland
- August 4, 1946 - Dominican Republic
- August 18, 1946 - Dominican Republic
- November 14, 1840 - Great Swell on Delaware River
- November 17, 1872 - Maine
- January 9, 1926 - Maine
- May 19, 1964 - Northeast USA POSSIBLE TSUNAMI
- June 9, 1913 - Longport, NJ
- August 6, 1923 - Rockaway Park, Queens, NY
- August 8, 1924 - Coney Island, NY
- August 19, 1931 - Atlantic City, NJ
- September 21, 1938 - Hurricane, NJ coast
- July 3-4, 1992 - Daytona Beach, FL
- Asteroid Strikes - Toms Canyon, NJ and mouth of Chesapeake Bay

http://www.erh.noaa.gov/er/phi/reports/tsunami.htm

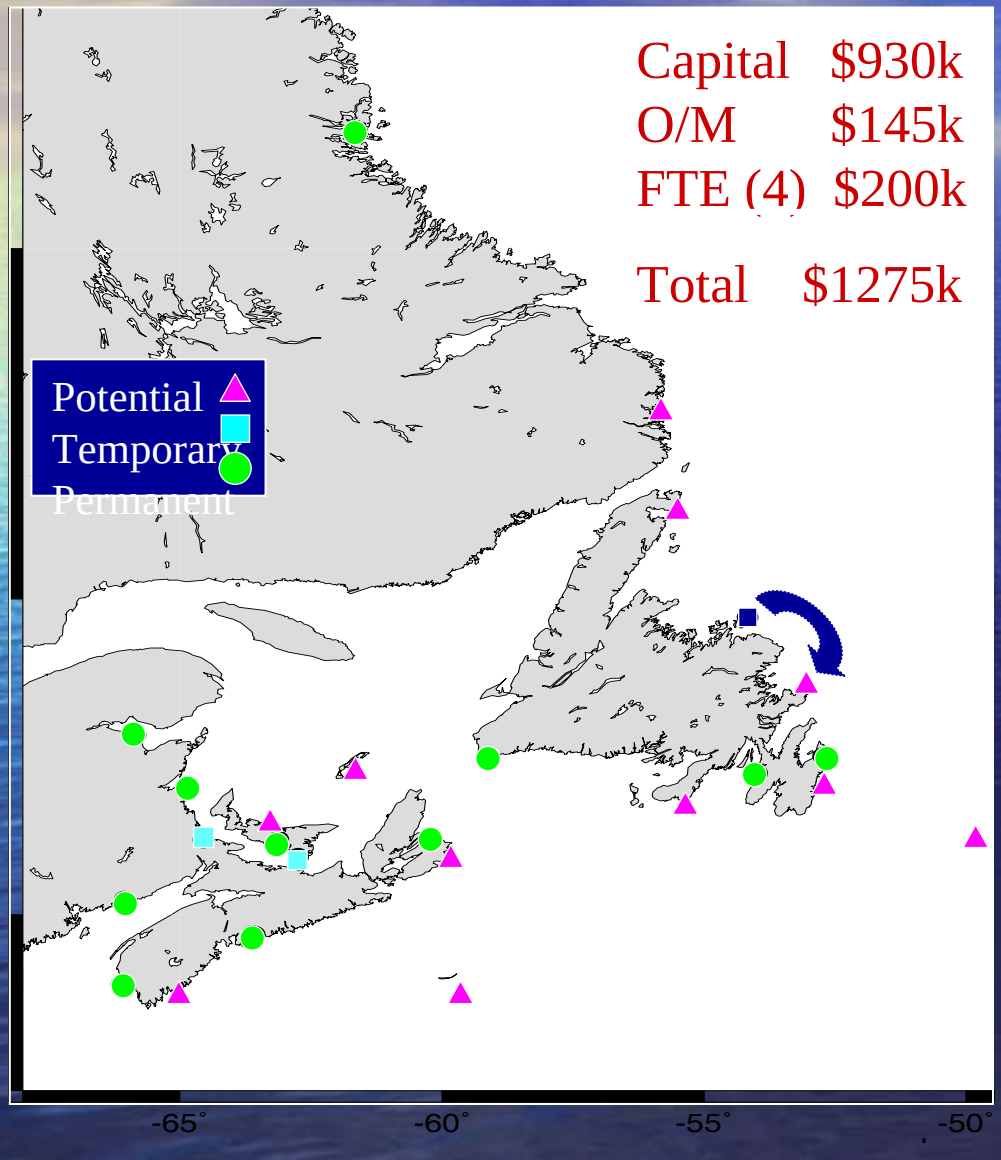
CHS Proposal C (14 sites)



Costs Breakdown

- Capital
  - i. new site infra. (2@30k)
  - ii. new inst. (250k)
- O/M
  - i. Southern sites (14@5k)
  - ii. Labrador sites (1@20k)
- FTE
  - i. Existing (2@50k)

CHS Proposal A (24 sites)



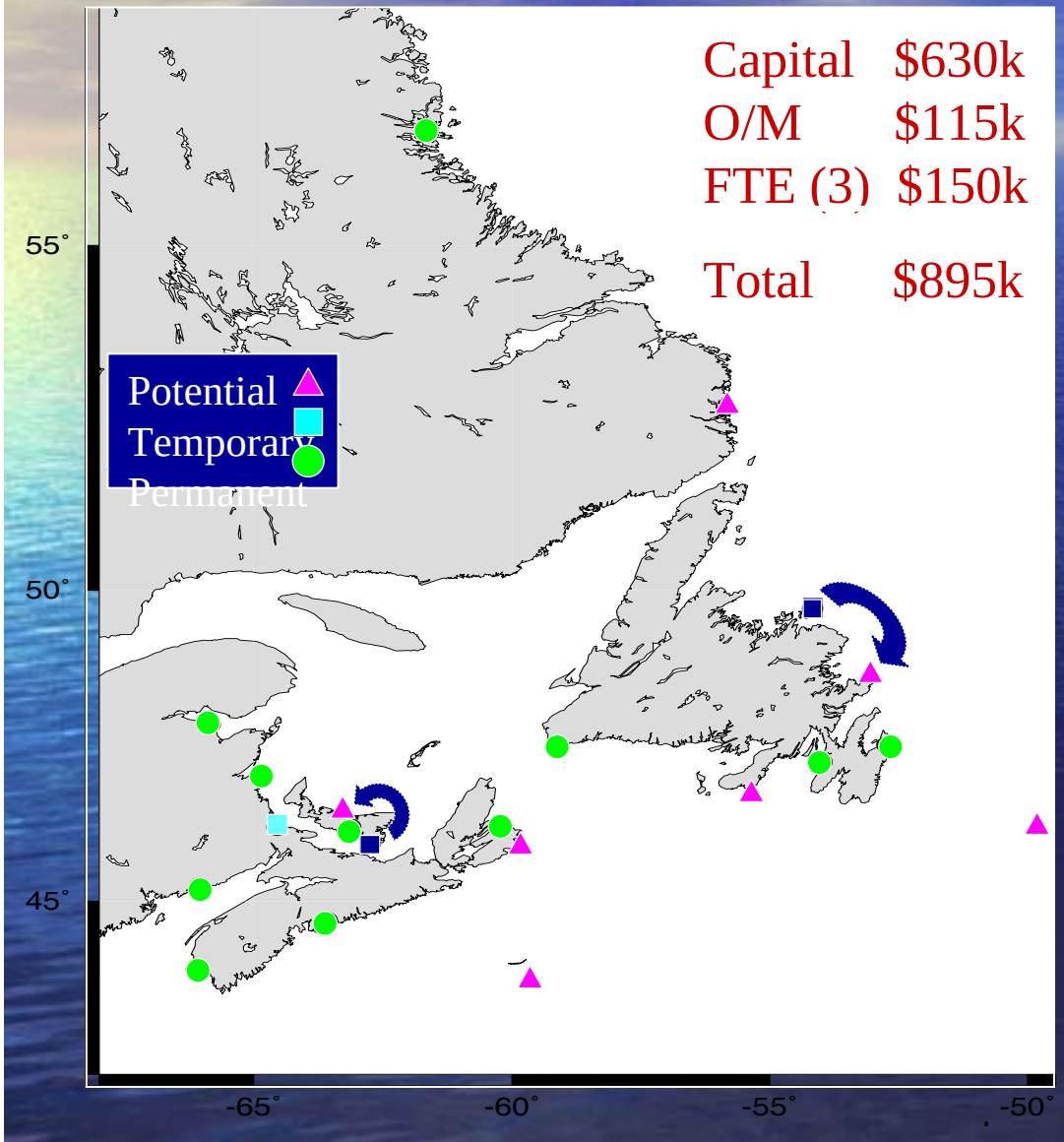
Capital $930k
O/M $145k
FTE (4) $200k

Total $1275k

Costs Breakdown

- Capital
  i. new site infra. (12@30k)
  ii. new inst. (570k)
- O/M
  i. Southern sites (23@5k)
  ii. Labrador sites (2@15k)
- FTE
  i. Existing (2@50k)
  ii. New (2@50k)

CHS Proposal B (19 sites)

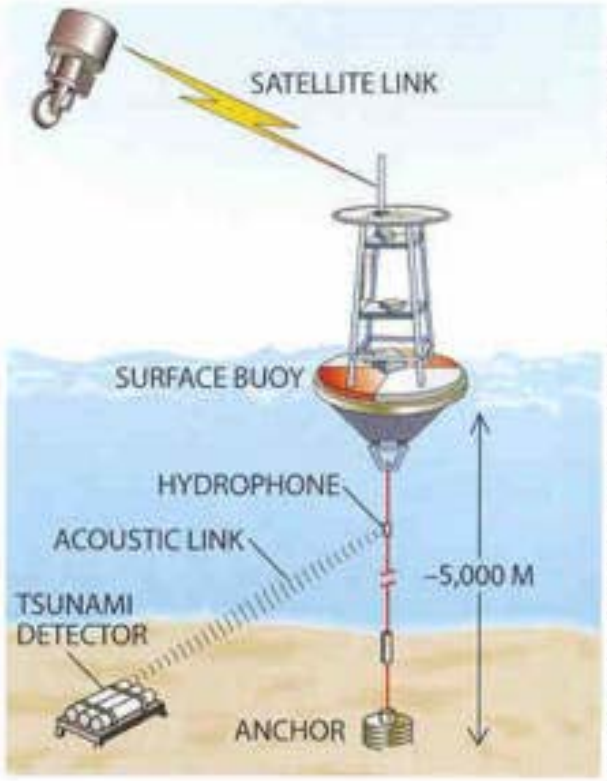


Costs Breakdown

- Capital
  - i. new site infra. (7@30k)
  - ii. new inst. (420k)
- O/M
  - i. Southern sites (17@5k)
  - ii. Labrador sites (2@15k)
- FTE
  - i. Existing (2@50k)
  - ii. New (1@50k)

Deep Ocean Tsunami Detection

- Monitors rapid pressure changes
- NOAA is increasing 5 to 35 in Pacific, plus 6 new deployments in Atlantic

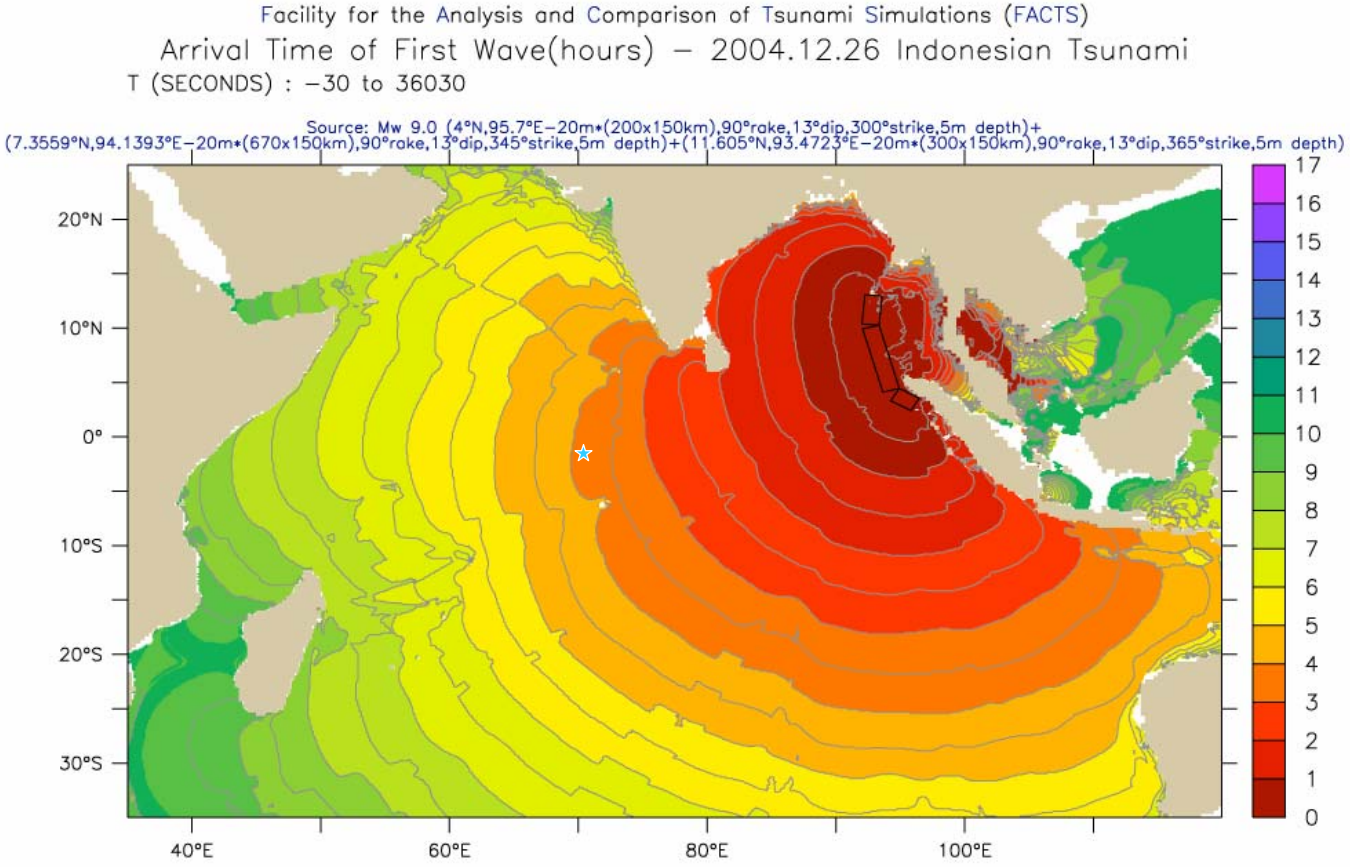


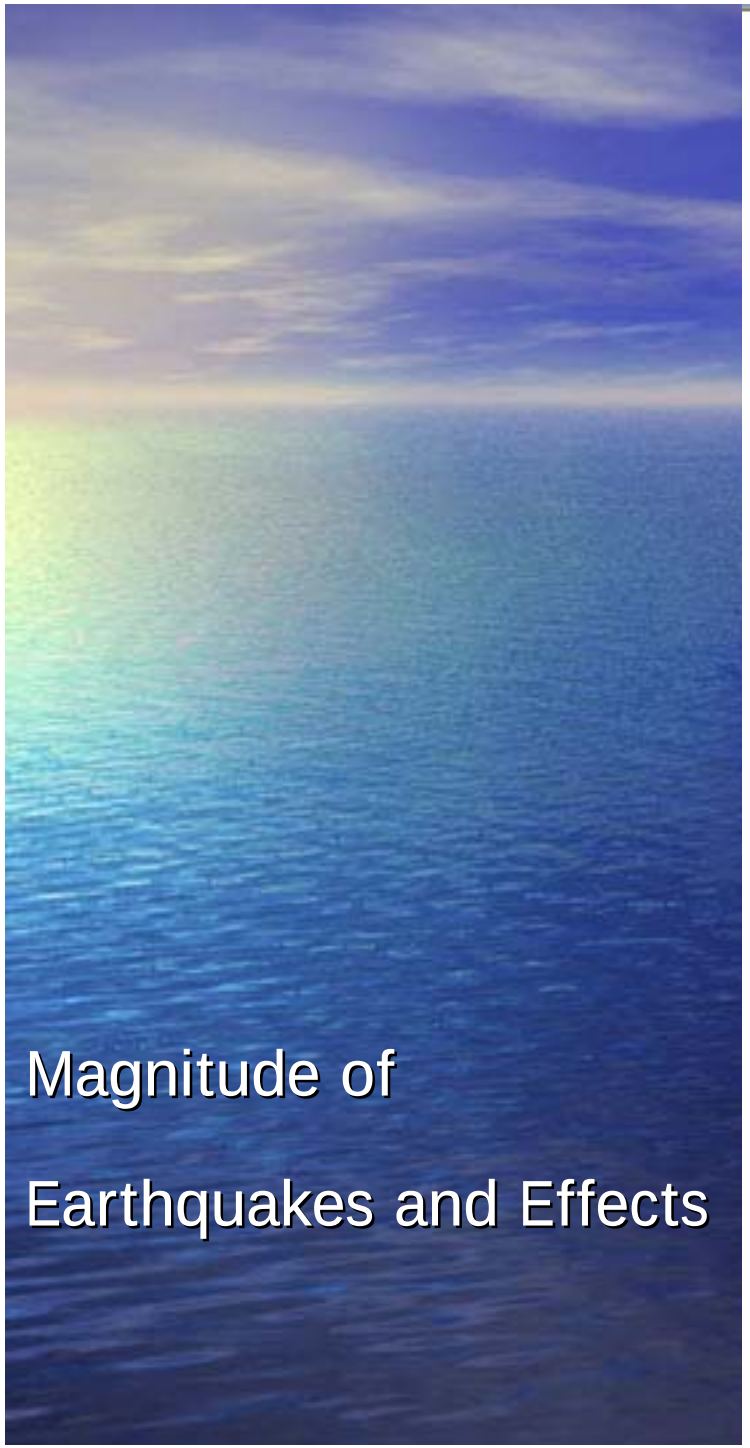
ILLUSTRATIONS BY KAREN BIRCHFIELD, ARIES GALINDO AND LAURIE GRACE

MICHELE G. BULLOCK/NOAA Ceysi

Indian Ocean Tsunami

Wave Propagation in Hours

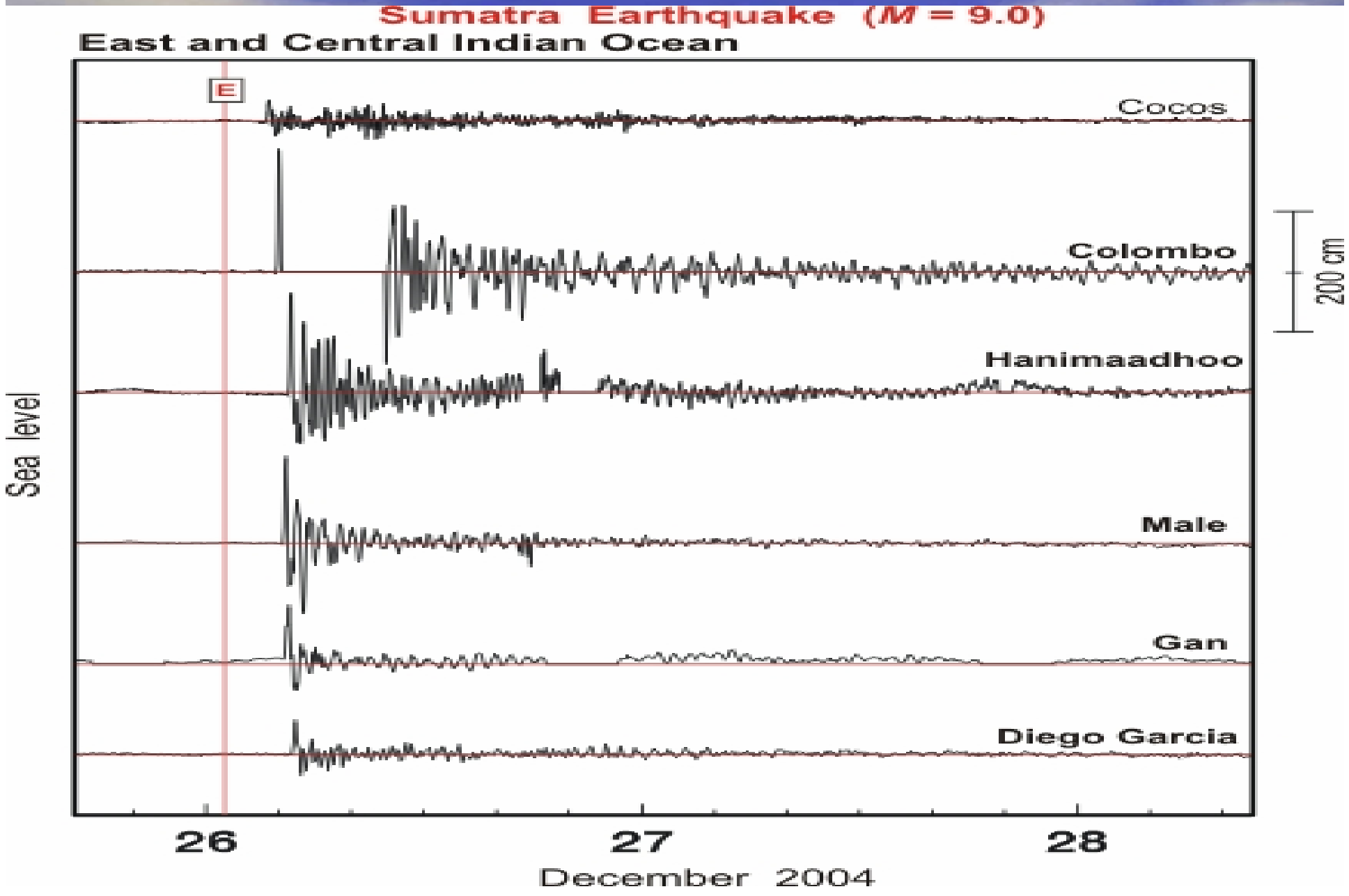




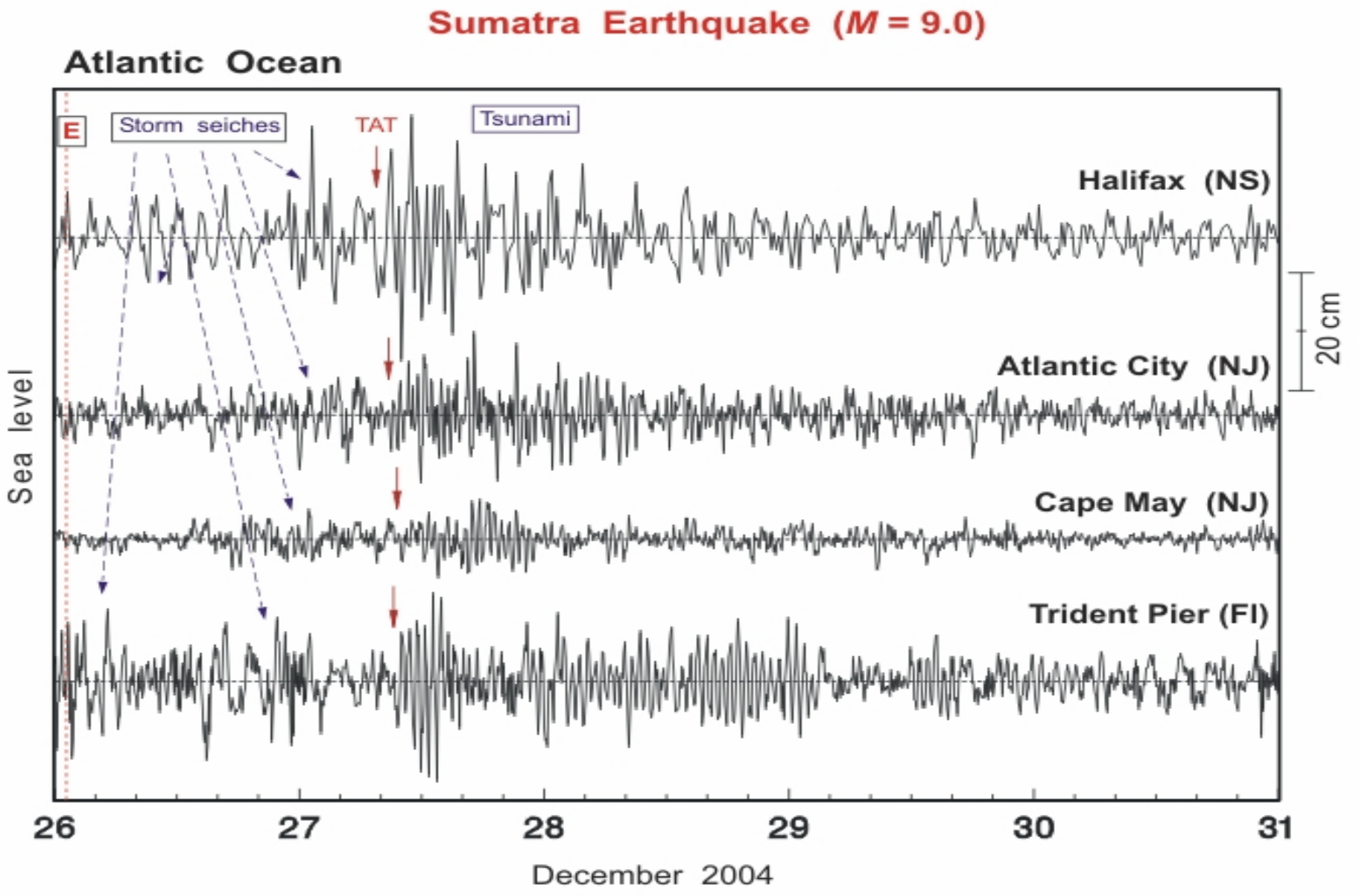
Magnitude of Earthquakes and Effects

Mag	Effects on Humans in close proximity to the epicentre	Effects on Buildings	Effects on the Environment	Examples in Eastern Canada
less than 2.5	None Registered only by seismographs	None	None	Several hundred a year
2,5	A low rumble can be heard by people at rest	None	None	Several dozen a year
3.0	Low rumble heard	None	None	Several dozen a year
4.0	Minor vibrations felt	None	None	3 or 4 a year
5.0	Vibrations felt	Movement of light objects	None	Côte-Nord (1999; M 5,0) Cap-Rouge (1997; M 5,1) Mont-Laurier (1990; M 5,0) Charlevoix (1979; M 5,0) Miramichi, N.B. (1982; M 5,7)
6.0	Vibrations strongly felt, injuries caused by the movement of objects	Movement of objects Fallen chimneys	Possibility of landslides, rockfalls	Saguenay (1988; M 6,2) Cornwall (1944; M 5,6) Témiscaming (1935; M 6,2) Charlevoix (1925; M 6,2)
7.0 and higher	Widespread fear, casualties	Partial destruction of old buildings Modern buildings affected	Landslides Widespread damage Possibility of a tsunami if the epicentre is offshore	Nahanni (1985; M 6,6 et 6,9) Grands Bancs de Terre-Neuve (1929; M 7,2) Charlevoix (1663; M ~ 7)

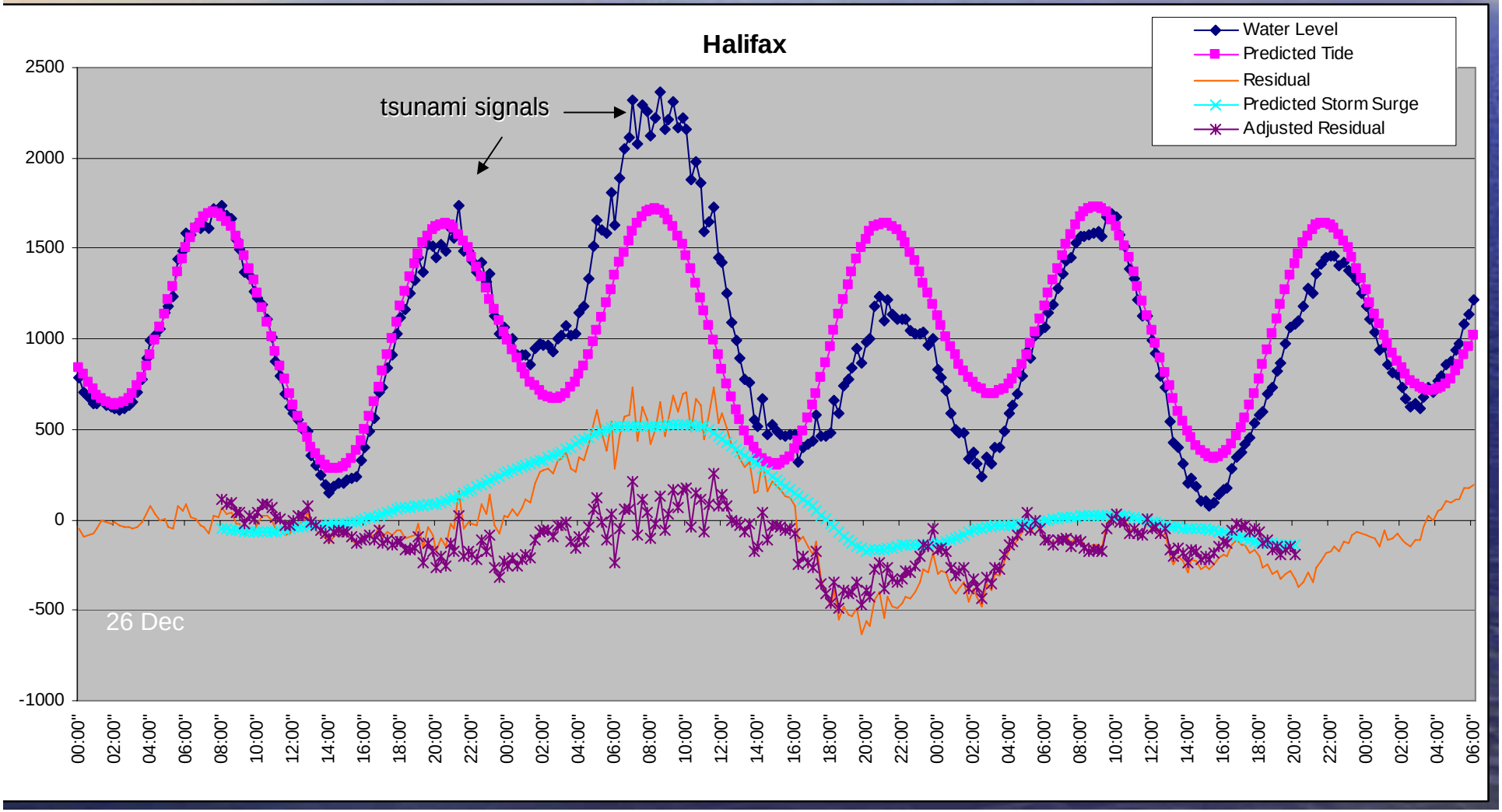
Sumatra Event - Indian Ocean Sites



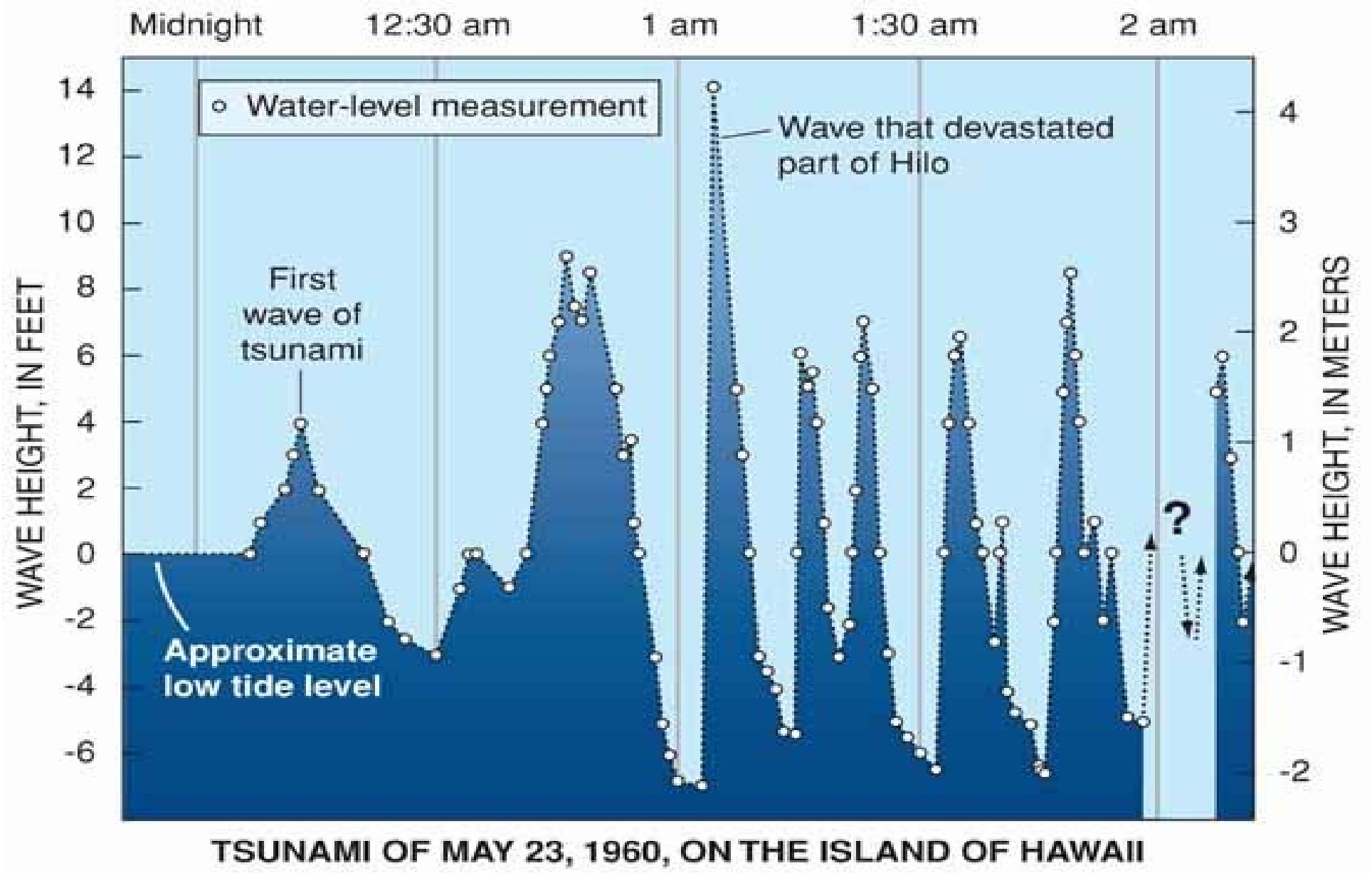
Sumatra Event Atlantic Sites (inc. Halifax)



Sumatra Event - Halifax

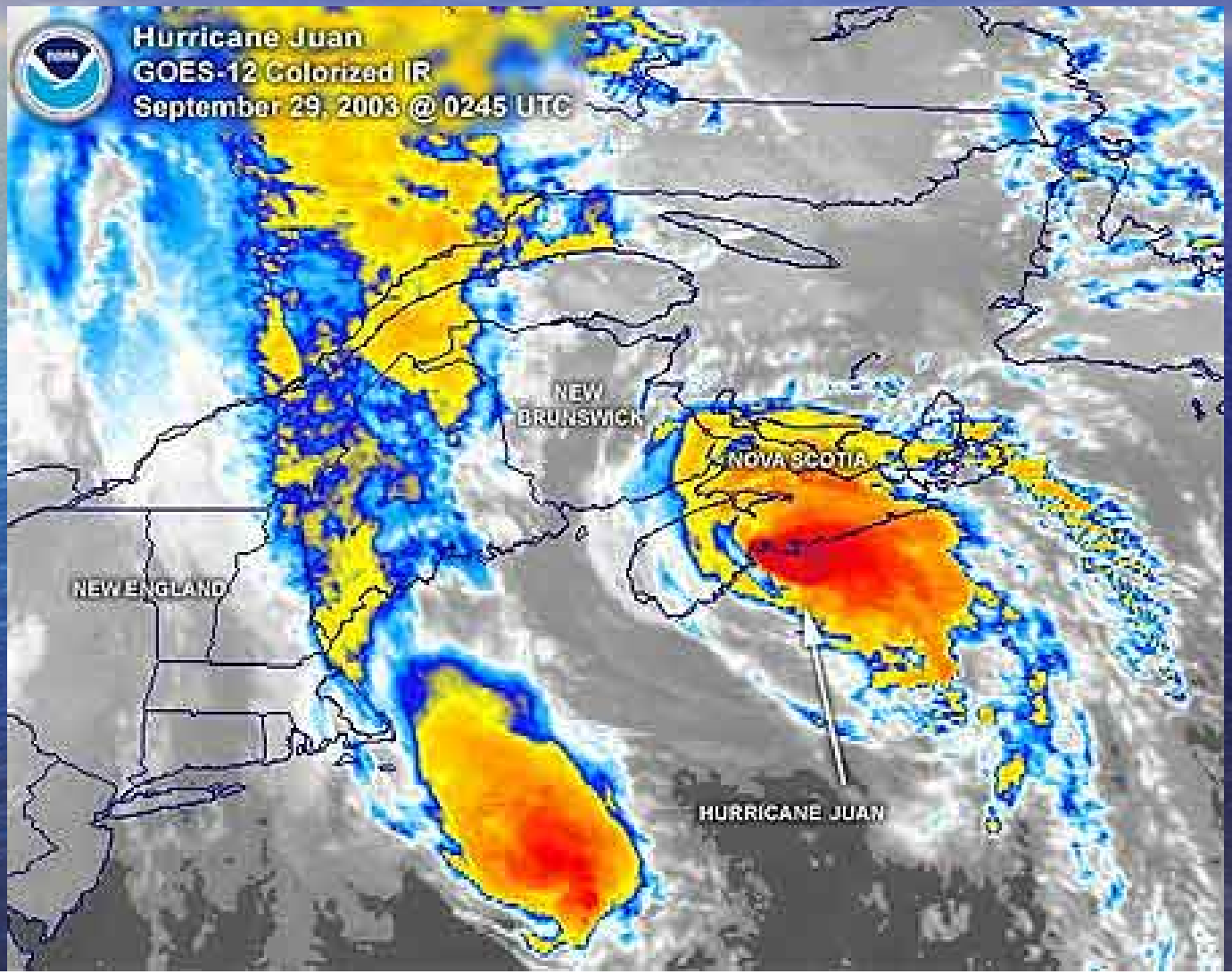


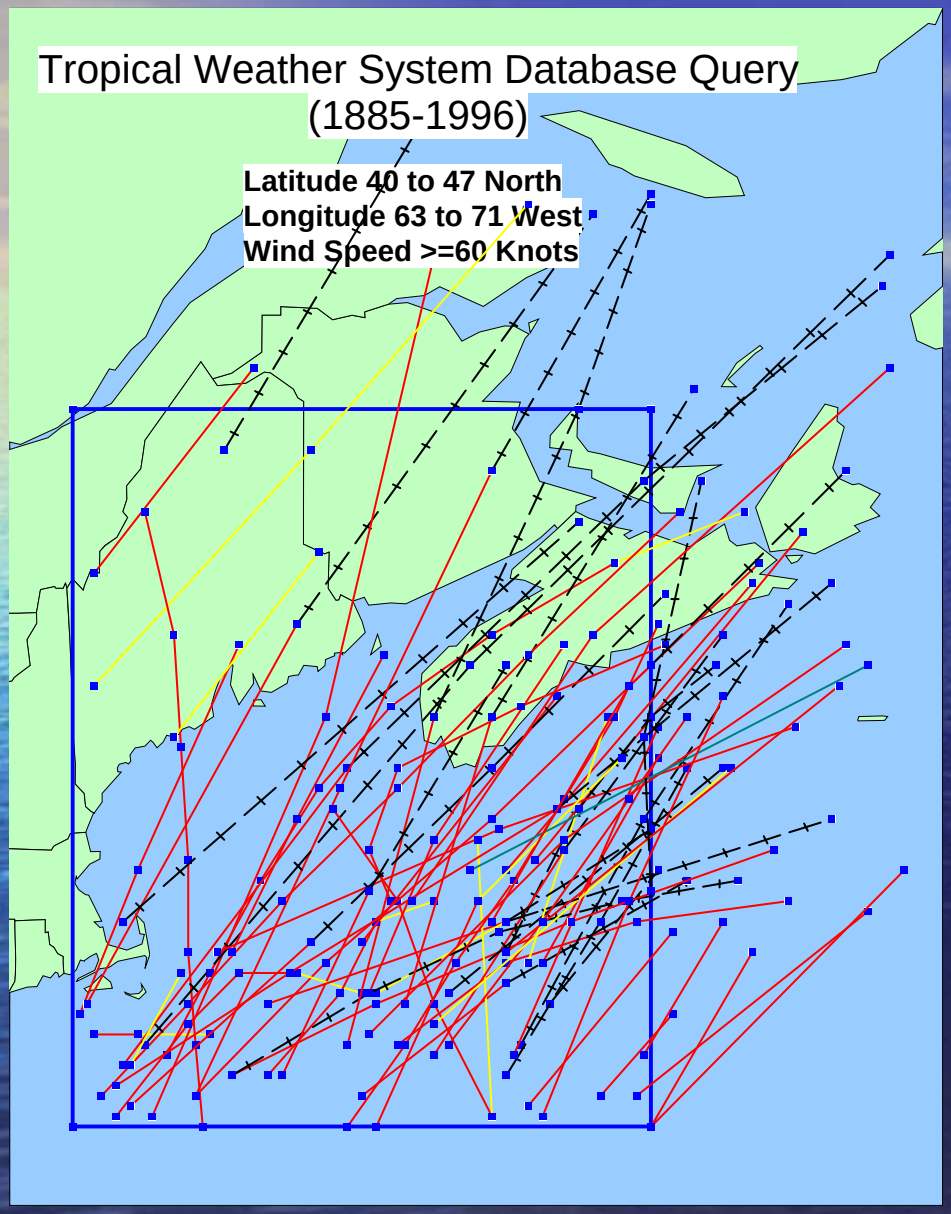
Wave trains



TSUNAMI OF MAY 23, 1960, ON THE ISLAND OF HAWAII

Extreme Weather / Surge Levels



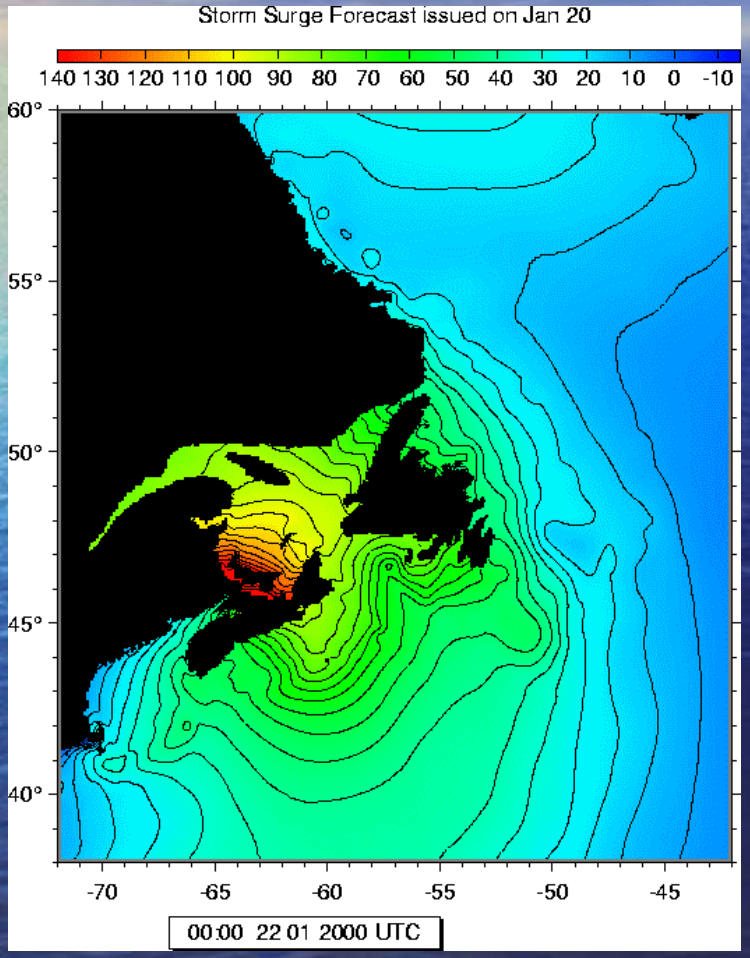


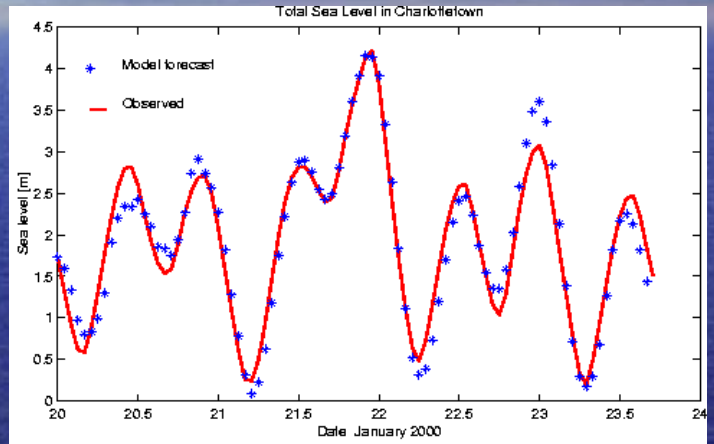
All data are extracted from the National Hurricane Centre's official tropical storm track file.

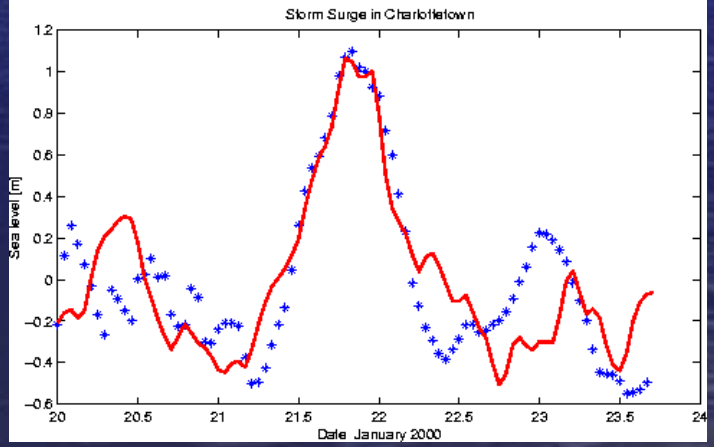
Track segments are displayed on the map to the left. These were the storms that moved through the bounding box (blue) at some point in their life cycle and had maximum wind speeds of at least 60 knots at some point while inside of the box.

Surge Forecast -Atlantic Canada (24 Hr)

Jan 20, 2000

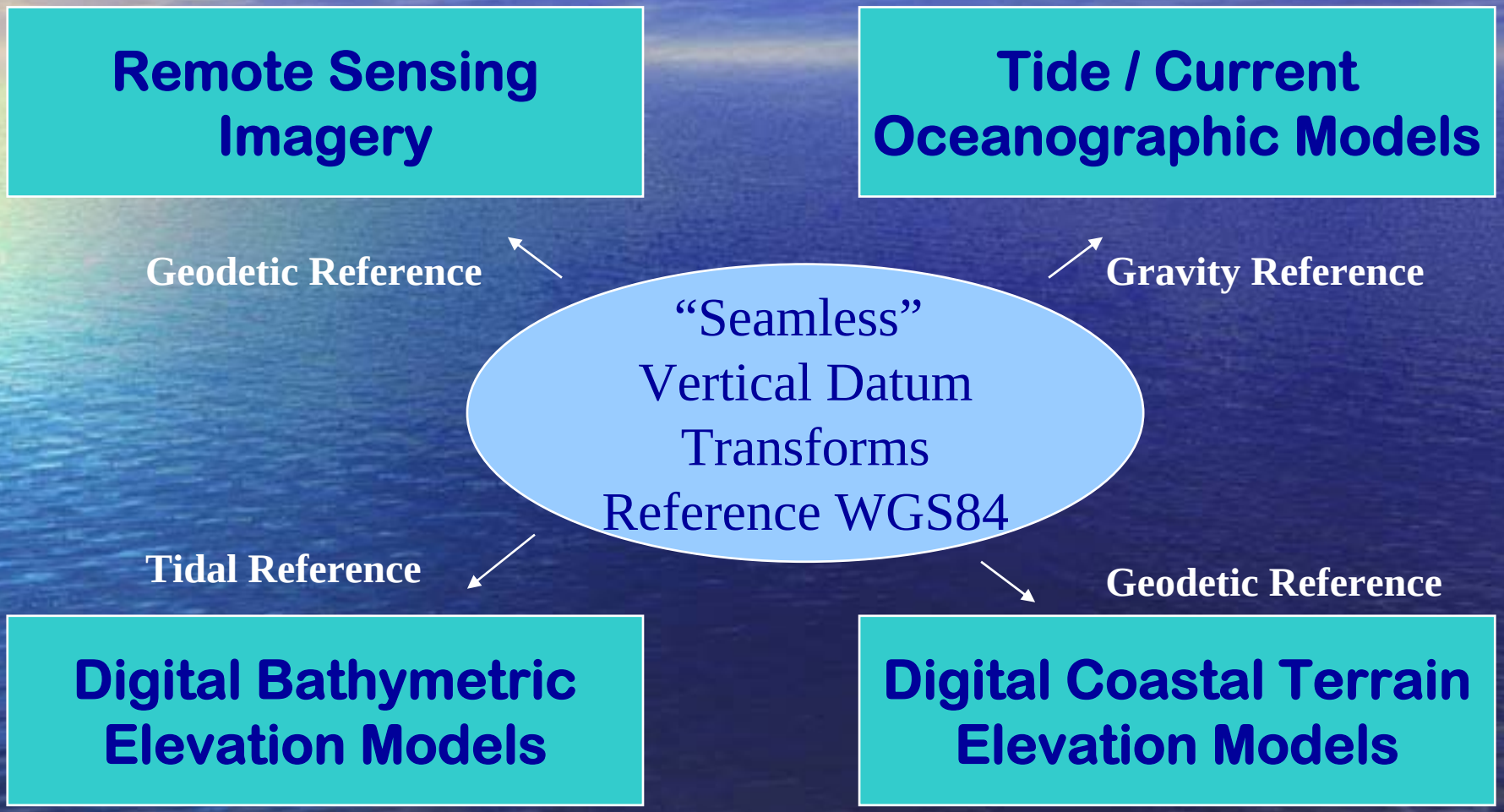






4-D Data Integration

"Joining Land and Sea"



LIDAR DTM

Truro, NS

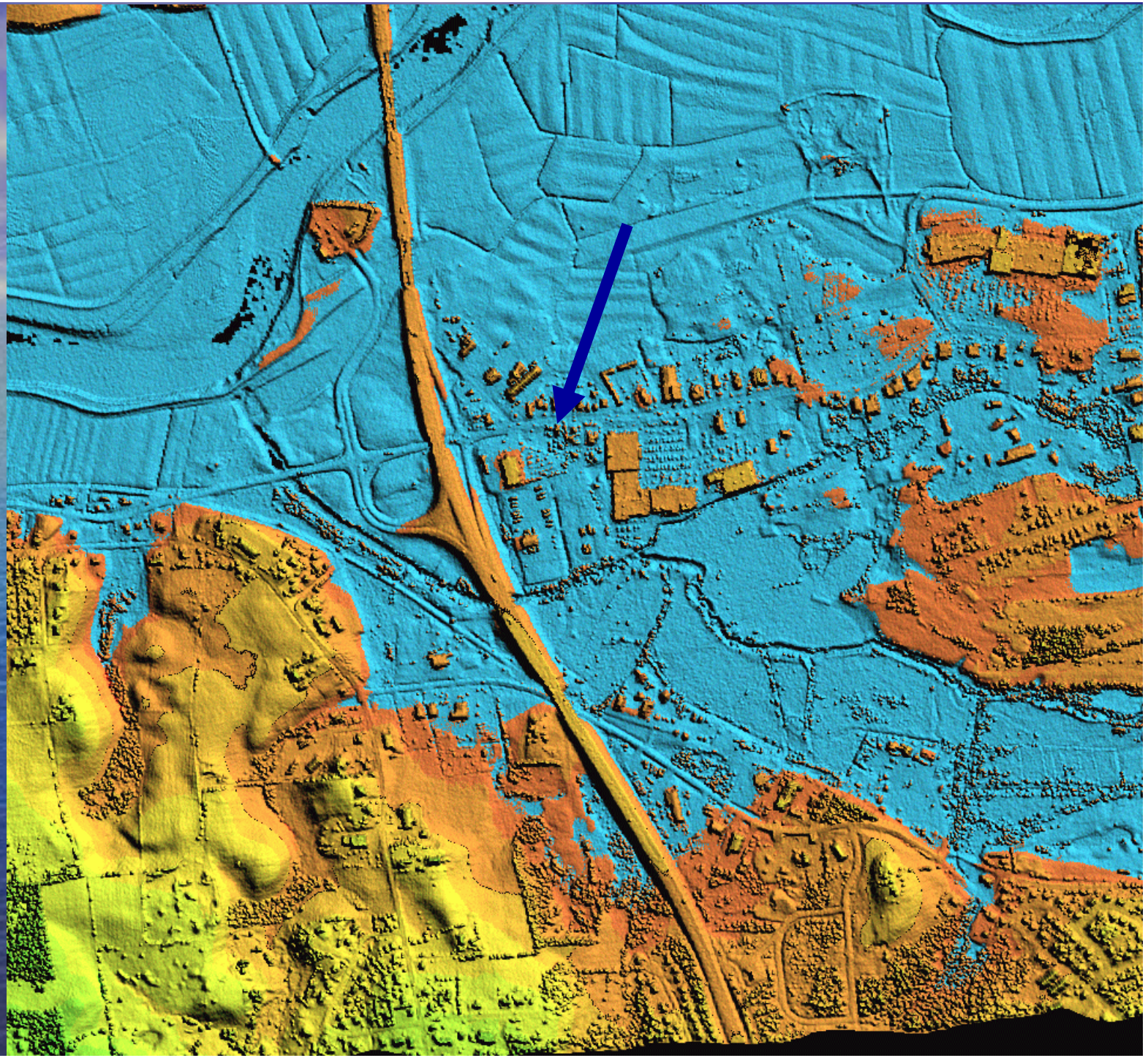
Perigean High Water (1998)

LIDAR DTM

Two Meter Surge

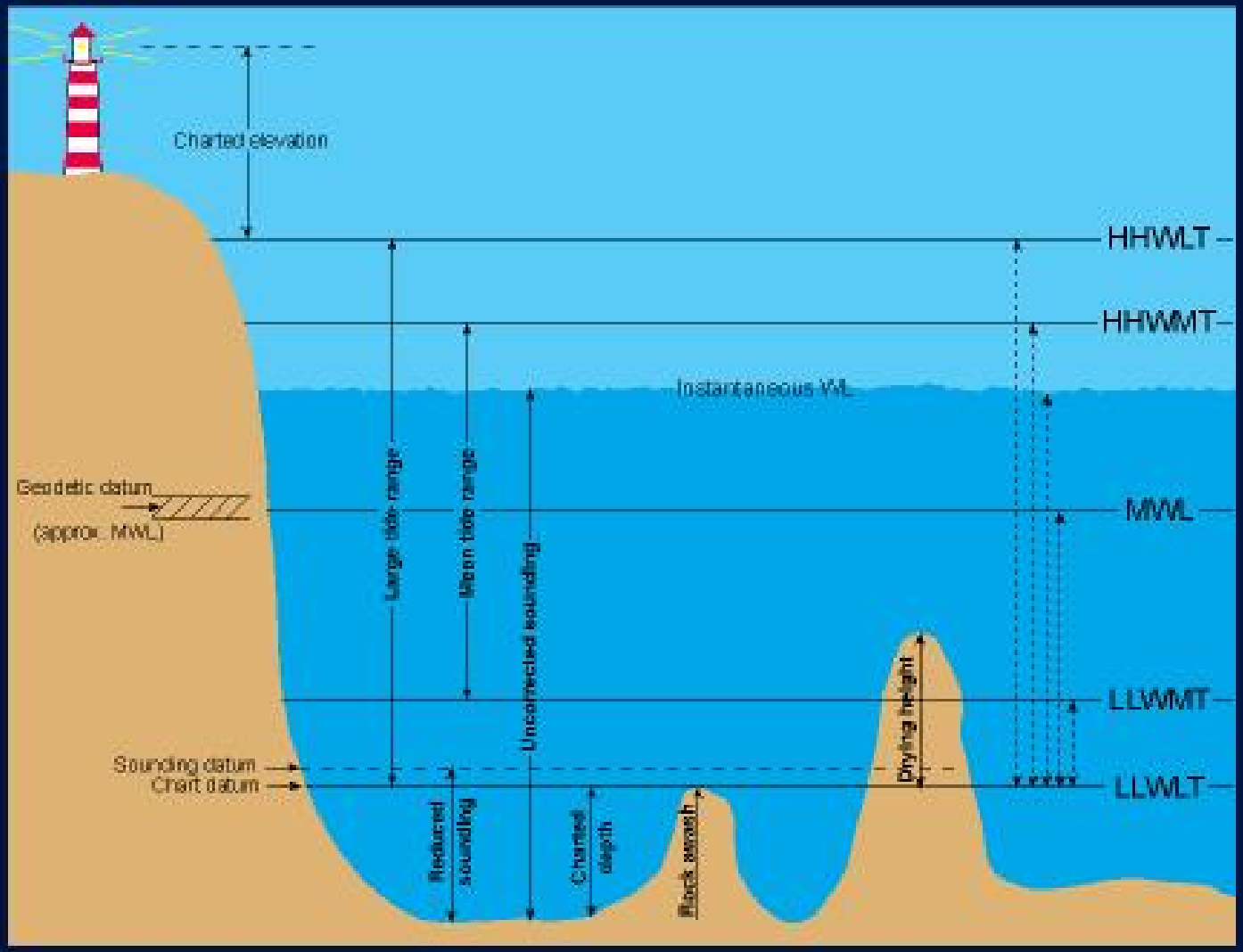
Truro, NS

referred to Perigean High Water (1998)

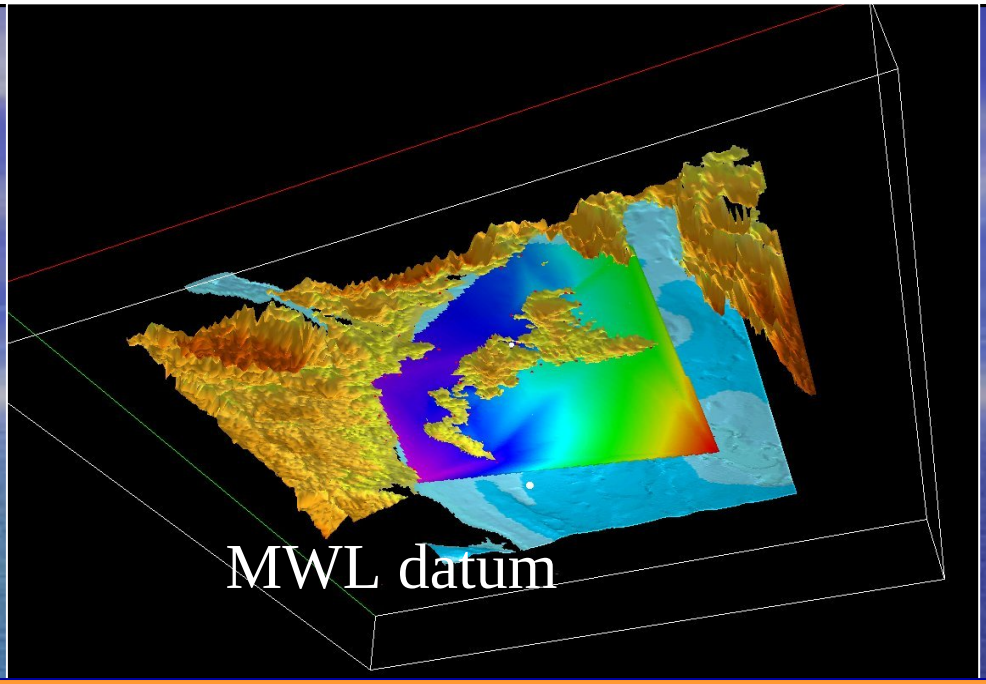


Saxby Flood Level
Truro (Robie Street)

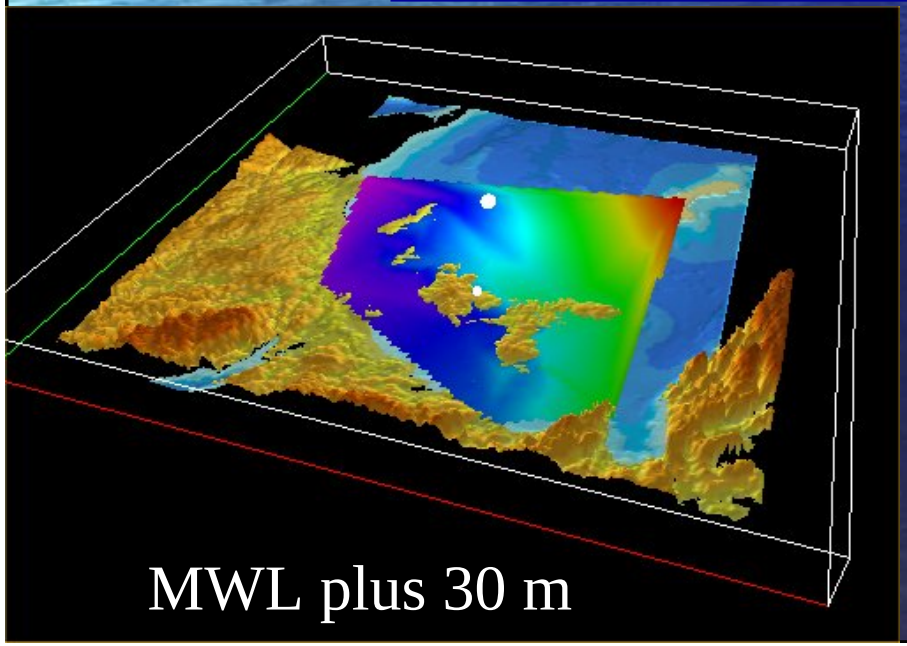
Hydrographic Vertical Datums

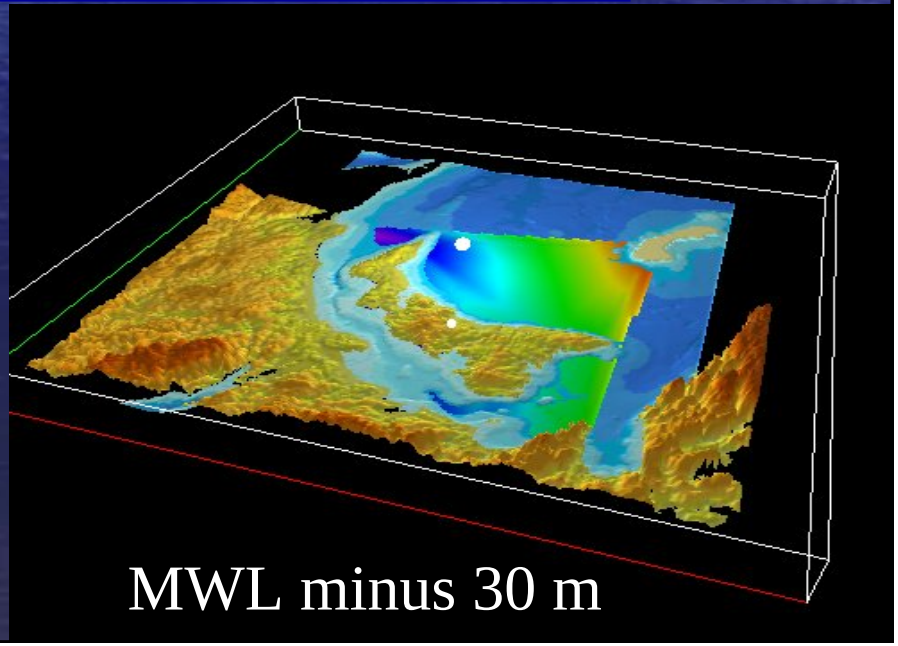


Canadian Hydrographic Service

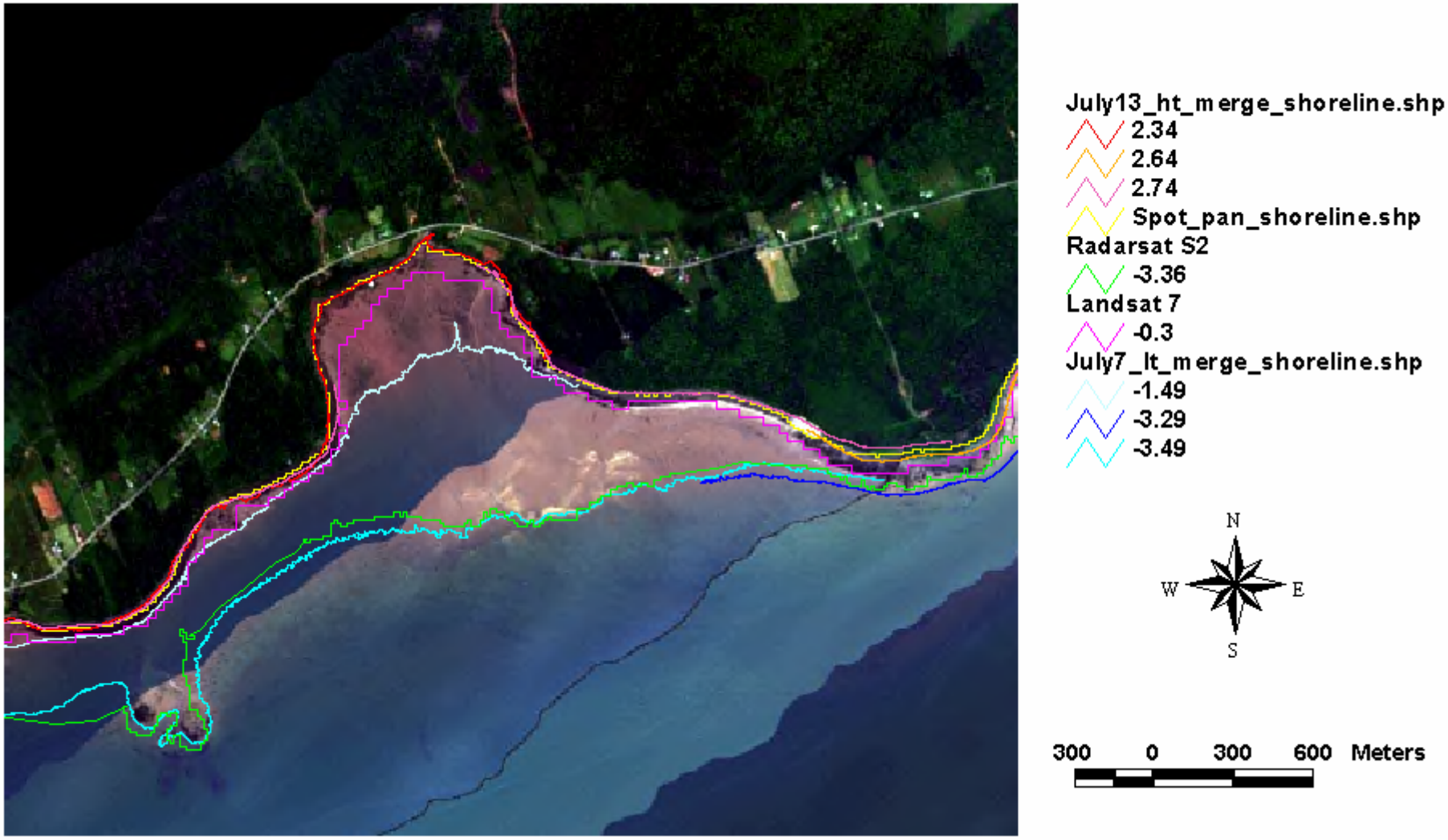


Datum Surface Transforms





Extracted 3D Shorelines (Take Your Pick!)



Defences and Mitigation

- Warning systems (several hours possible)
  - seismometers and special tide gauges
  - Presently in Pacific Ocean (since 1946)
  - Western Canada (CHS has 3 gauges)
  - Expand to Indian Ocean and Atlantic (Global system ?)
  - Media and Air Raid Sirens
- Public Education
- Evacuation plans and building codes
- Restricted Coastal Zone Development
- Coastal Flood Mapping - Digital Terrain Models

NOAA

What is TsunamiReady?

- "Grass roots" *program that promotes tsunami hazard readiness.*
- *Collaborative effort between federal, state, and local emergency management, and the public.*
- *Improves public safety during tsunami emergencies.*
- *Prepares communities for tsunami hazard.*
- *Part of the NWS StormReady Program.*

Why do we need TsunamiReady?

- *The December 2004 Indian Ocean Tsunami reminded us of the horrible devastation a tsunami can cause!*

TsunamiReady Objectives

- Create minimum standard community guidelines for adequate tsunami readiness.
- Increase public awareness and understanding of tsunami hazard.
- Improve community pre-planning for tsunami disasters .
- Encourage consistency in educational materials and response.
- Recognize communities that have adopted TsunamiReady guidelines.

How does a Community become TsunamiReady? (contd)

- Increase Community Preparedness
  - NWS staff provide Tsunami safety presentations
  - Designate/establish tsunami area in safe zone
  - Designate tsunami evacuation areas and evacuation routes, and install evacuation route signs
  - Provide written, locality specific, tsunami hazard response material to public
  - Schools: encourage tsunami hazard curriculum, practice evacuations, and provide safety material to staff and students

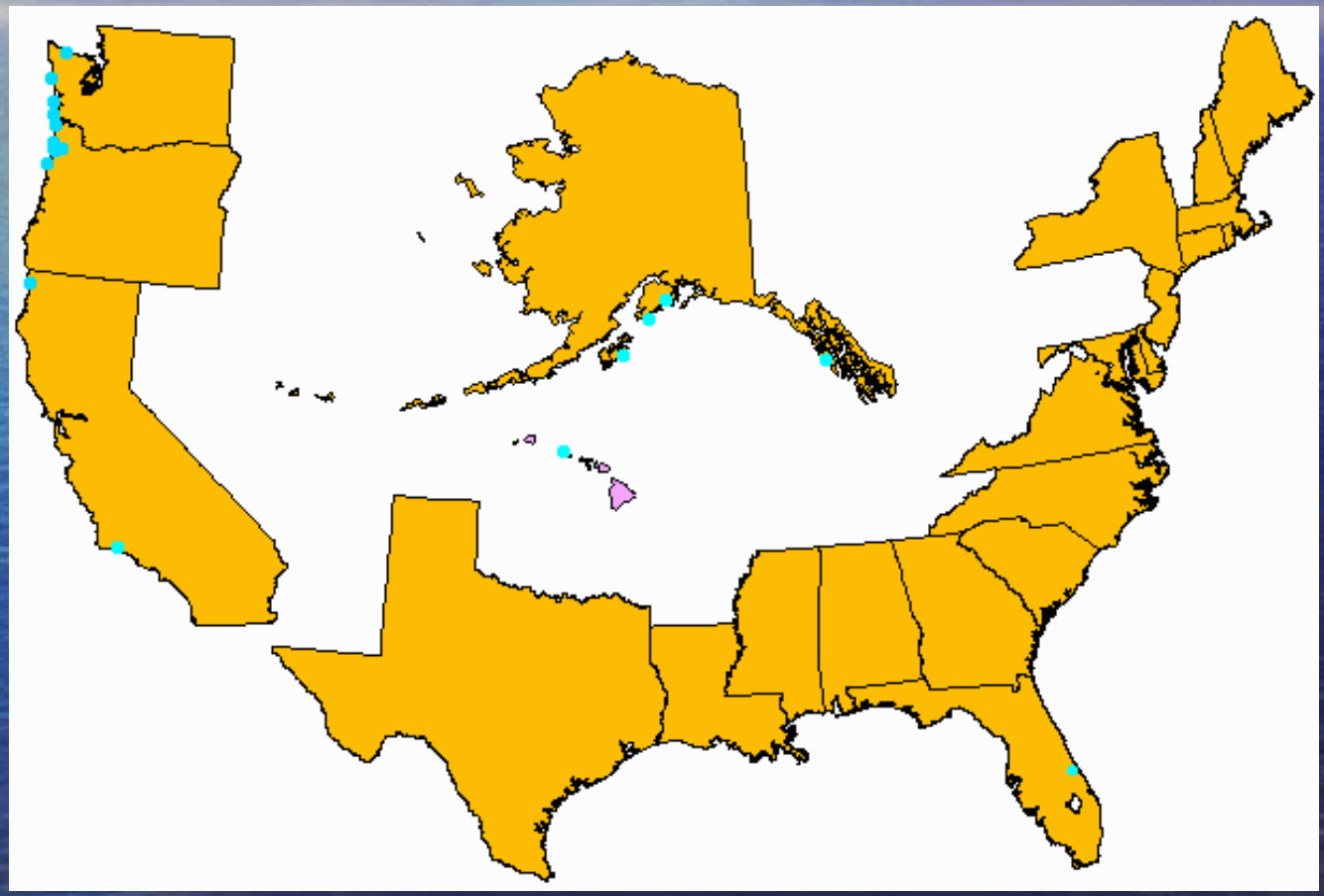
TsunamiReady Recognition Process

- *Community applies to local NOAA NWS Office.*
- *Local TsunamiReady Advisory Board reviews application.*
- *Local TsunamiReady Advisory Board performs on-site verification visit.*
- *If guidelines are not met, Local TsunamiReady Advisory Board suggests improvements and works to implement changes.*
- *Once guidelines are met, a recognition Ceremony and Press Conference is held for community.*
- *Similar to ISO9000 process*

Successful Applicants Receive:

- *TsunamiReady recognition - valid for 3 years.*
- *Two official TsunamiReady signs.*
- *Authorization to use the TsunamiReady logo.*
- *Instructions for acquiring additional signs.*
- *Information on how to notify the ISO for possible flood insurance rate adjustment (for StormReady).*
- *Listing on StormReady, Pacific Tsunami Warning Center, and West Coast Alaska Tsunami Warning Center web sites.*

As of November 2005 there are 23 TsunamiReady Communities in 6 States



Tsunami Animations

- 1929 Nfld Event
- Canary Islands Event
- Asteroid Event

Thank You

Questions ?

“Tsu” = “Harbour”

“Nami” = “Wave”

Surge / Tsunami Website

- http://bluefin.mar.dfo-mpo.gc.ca/rtwl/index-e.jsp