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LEVERAGING RESEARCH AND RESEARCH INFRASTRUCTURE FOR SOCIETAL BENEFITS: IMPLEMENTING EARTHQUAKE EARLY WARNING FOR BC

Benoît Pirenne, 25 April 2017

OUTLINE

- What is Ocean Networks Canada?
- What is Earthquake Early Warning?
- Benefits of Earthquake Early Warning
- Earthquake Early Warning for Southwestern BC
- BCNet and BCNet partners involvement
- Implementation:
  - Field instrumentation
  - Software Architecture
  - Stakeholder use of the warnings

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Ocean Networks Canada enhances life on Earth by providing knowledge and leadership that deliver solutions for science, society, and industry.

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Real Time Data from Remote Environments

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TECHNOLOGIES

Extending the Internet Underwater

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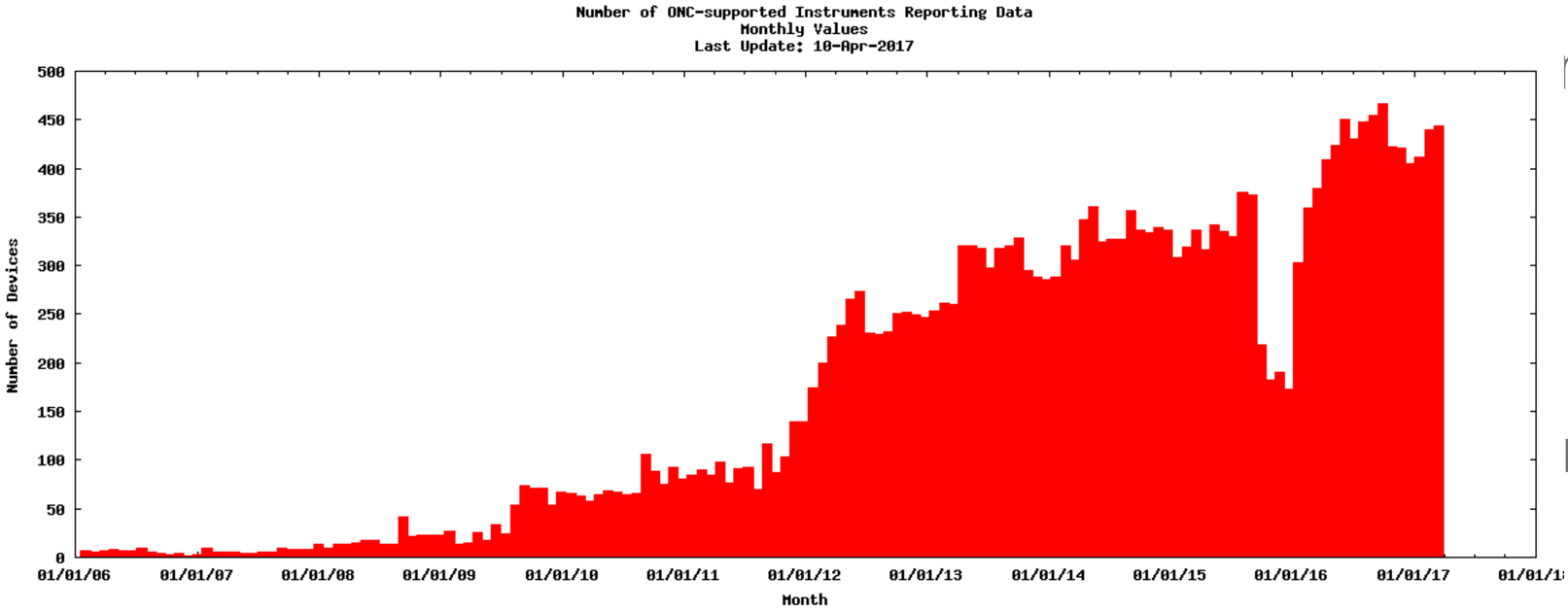


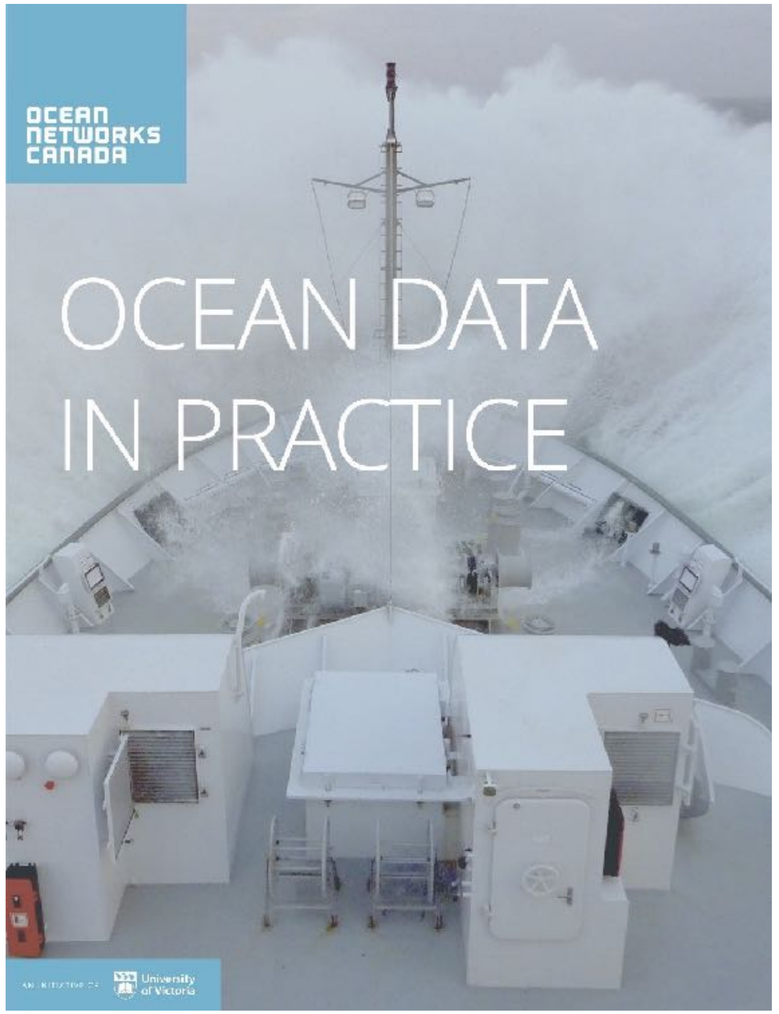
OCEANS 2.0: MEMBER OF THE WORLD DATA SYSTEMS

E-BOOK #1 - OCEAN DATA IN PRACTICE

An interactive overview of community observatories and data products.

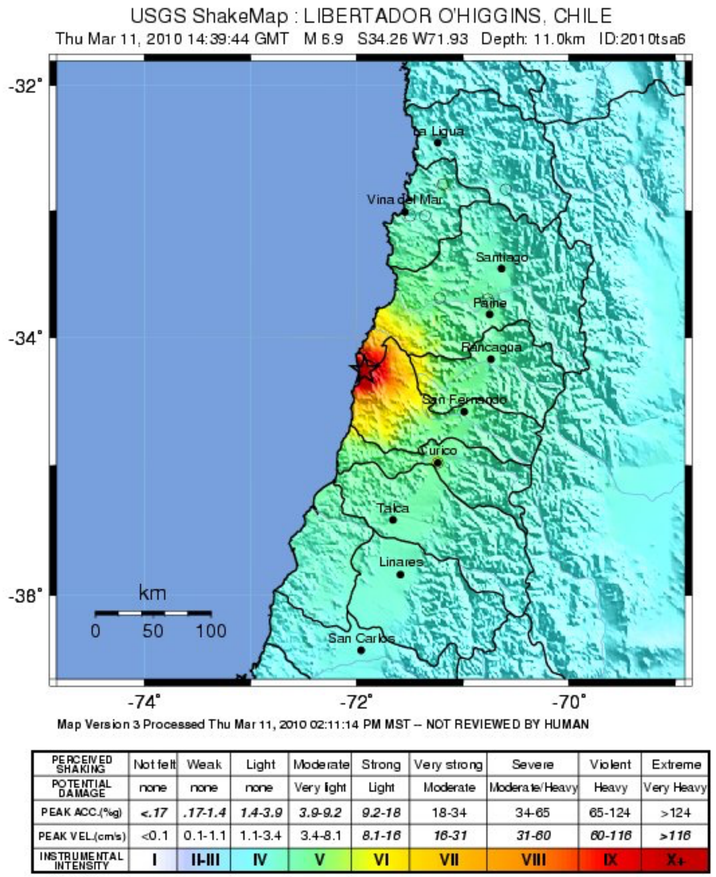
Contents:

- Ocean Networks Canada
- Overview of each community observatory site
- Easy to understand guide to selected ocean instrumentation
- Description of Marine Safety, Marine Traffic, and Ocean Health data products
- Oceans 2.0 - Data access guide



SEISMIC RESPONSES

- Prepare for earthquakes using different tools:
  - **Earthquake Early Warning**: try to provide (tens of) seconds of warning **prior** to the start of shaking
  - Response prioritization: **emergency responders** dispatched according to plan
  - Expected shaking intensity in a region (**shake map**)
  - **Infrastructure impact** measurements
- Seismic responses involve a combination of scientists, civil engineers, emergency responders

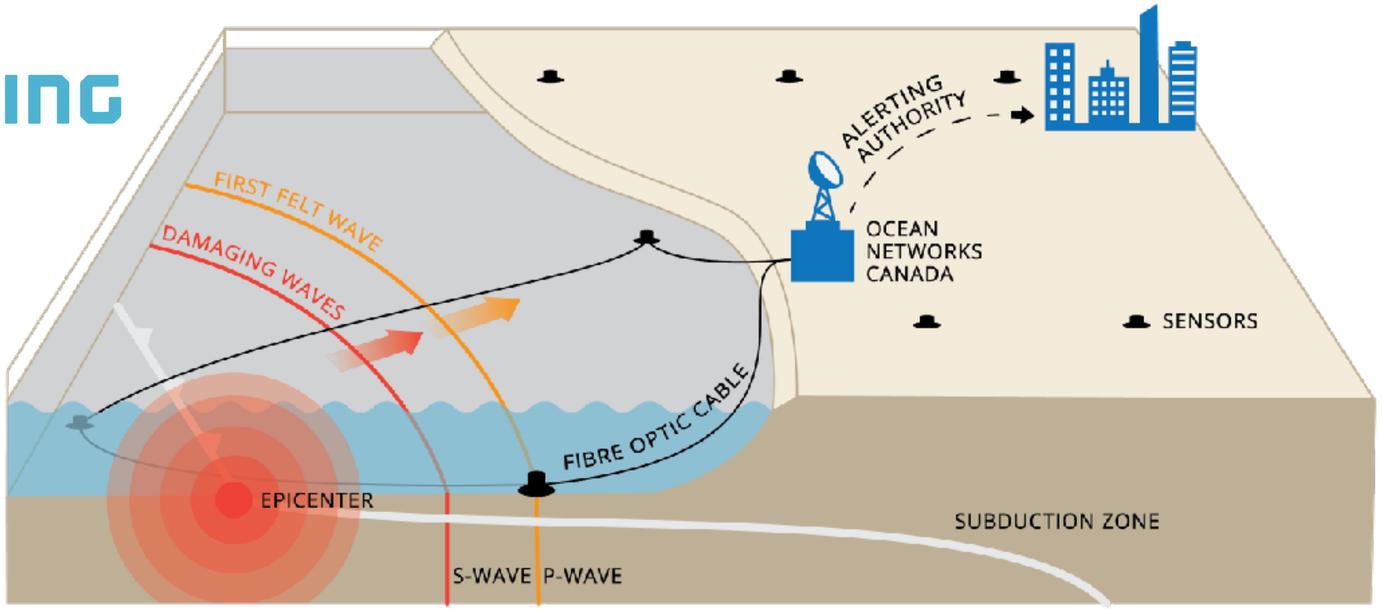


EARTHQUAKE EARLY WARNING

Ocean Networks Canada's sensor technology, coupled with the latest science can rapidly detect an earthquake as it begins to happen.

- **Rationale:** Provide **rapid warning** of upcoming earthquakes to urban centres in BC to **mitigate** their impact
- **Novelty: First implementation** in Canada; simultaneous combination of acceleration and displacement will be a **world first**
- **Delivery:** Computer-to-computer notifications sent **to critical infrastructure operators**; public informed through alerts from EMBC
- **Benefit to BC:** Protection of critical infrastructure will lead to limited fires, spills and **faster recovery** after an event
- **Operationalize for the future:** March 2019

EARTHQUAKE EARLY WARNING



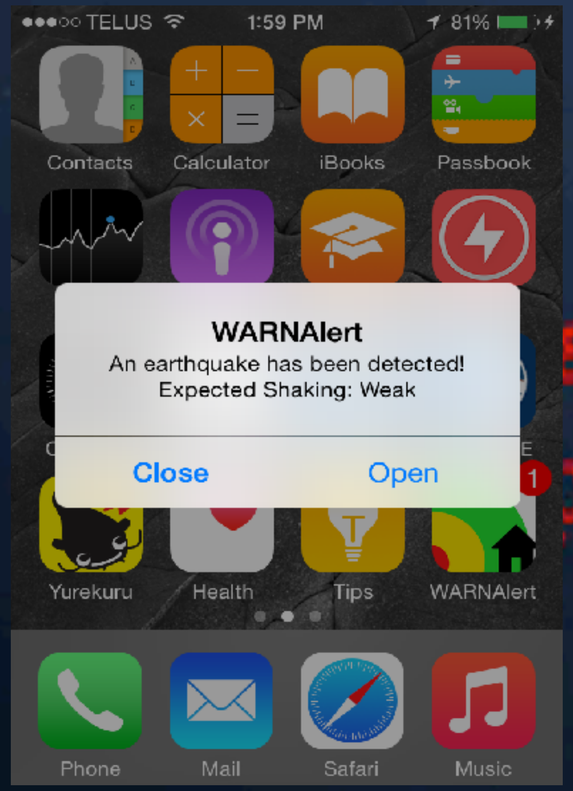
- Use **land-based and underwater accelerometers** and **GPS receivers** to detect, analyze ground motion & displacement locally
- Central **correlation** of individually detected events to determine **epicentre** and **magnitude**
- **Subscription**-based **client-server** model for **notification delivery**

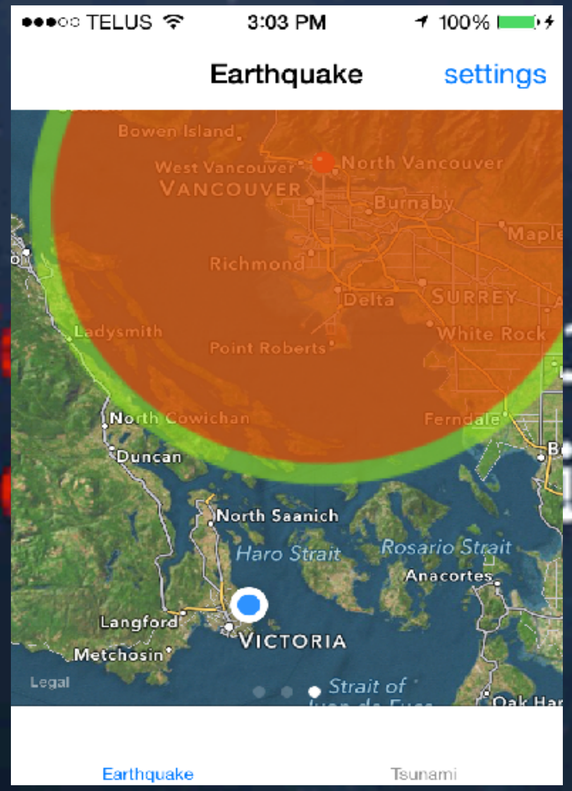
EARTHQUAKE EARLY WARNING

- Emergency Management BC **investment of $5M** to leverage existing ONC infrastructure (sensors, hardware, networks)
- Initially, a regional system, focusing on the **Cascadia subduction zone** possible **megathrust events**
- Scaling up of existing prototype

EARTHQUAKE EARLY WARNING

- **Data Exchange** with other partners in BC (UBC, Ministry of Transportation and Infrastructure) and in the US
- Strongest collaboration with **NRCan**
- **Testing** with stakeholders and other prospective users
- Provides **30 to 90 seconds of warning** for Victoria and the Lower Mainland





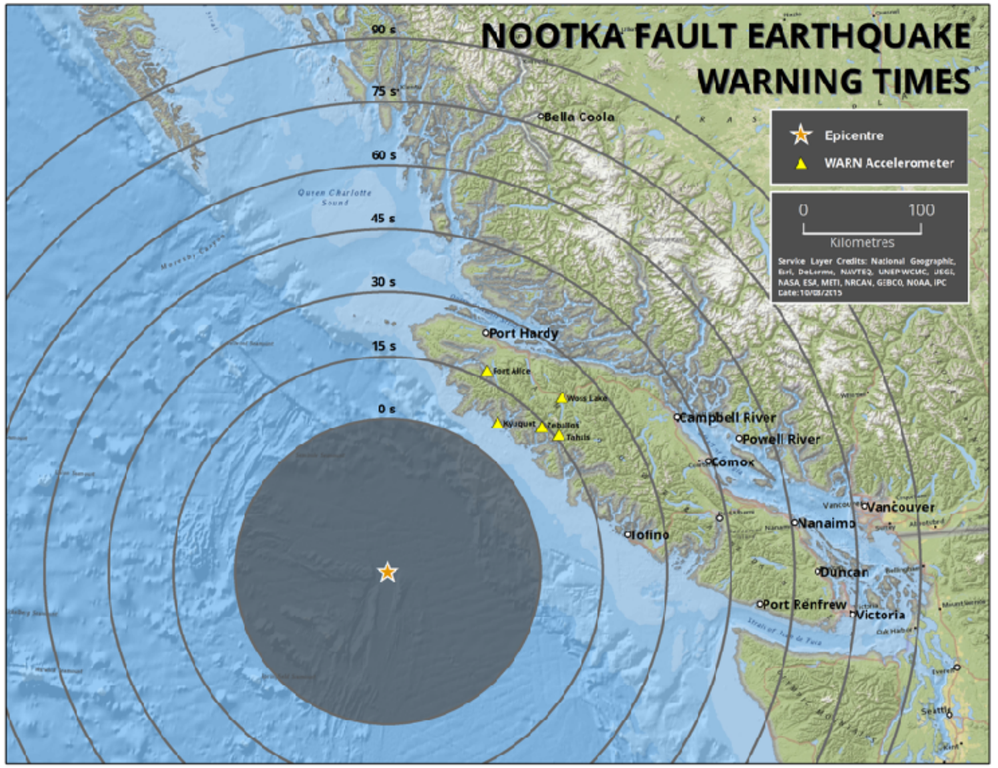
10% chance over next 50 years

- Mega-thrust earthquake alert
- Installations underway
- Delivery March 2019
- Partnering with NRCan & BC & US
- Transport funds leveraged
  Province of British Columbia ($5M)

BENEFITS OF EARTHQUAKE EARLY WARNING

- **30 to 90 seconds of warning** allow to:
  - Slow down trains
  - Call back elevators
  - Turn lights to red at bridges and tunnels
  - Close valves on gas pipelines, lower pressure on chemical, oil pipelines
  - Halt surgery procedures
  - Stop loading of ships

- **Ring sirens to get workers to safety areas, kids under the bench in the classrooms**
- **Get telcos to broadcast alert to cell phones**



WHAT STAKEHOLDERS SAY

FORTIS BC™

Mujib Rahman, M.Eng., P.Eng.
Senior Integrity Engineer – Geotechnical

"**Early earthquake alerts** would allow our gas control system to remotely **shut down gas lines** to limit the physical consequences of a pipeline rupture resulting from a damaging earthquake event.

It would also **increase the effectiveness** of our pipeline monitoring program and **allow our own infrastructure monitoring systems to be integrated into a network**, resulting in more accurate and reliable alerts for us and for British Columbians"

NEW GRAIN TERMINAL

Manitoba Co-operator

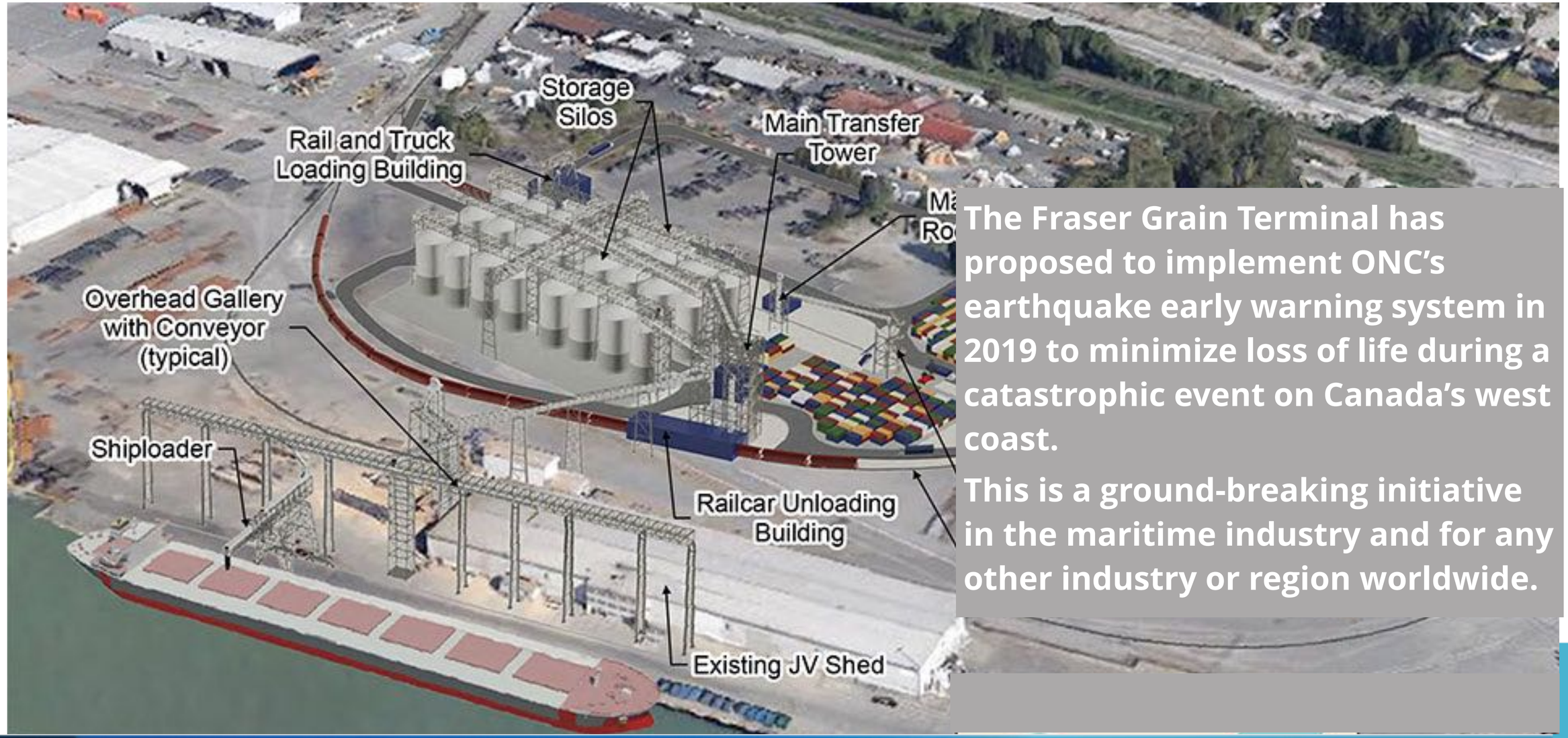
Proposed Vancouver grain terminal has great rail connections

The Fraser River Terminal will be served by four railways and there are no bottlenecks, a company official says

By Allan Dawson FOLLOW
Reporter

Published: December 19, 2016
Cereals, News, Oilseeds
0 comments

WHAT STAKEHOLDERS SAY



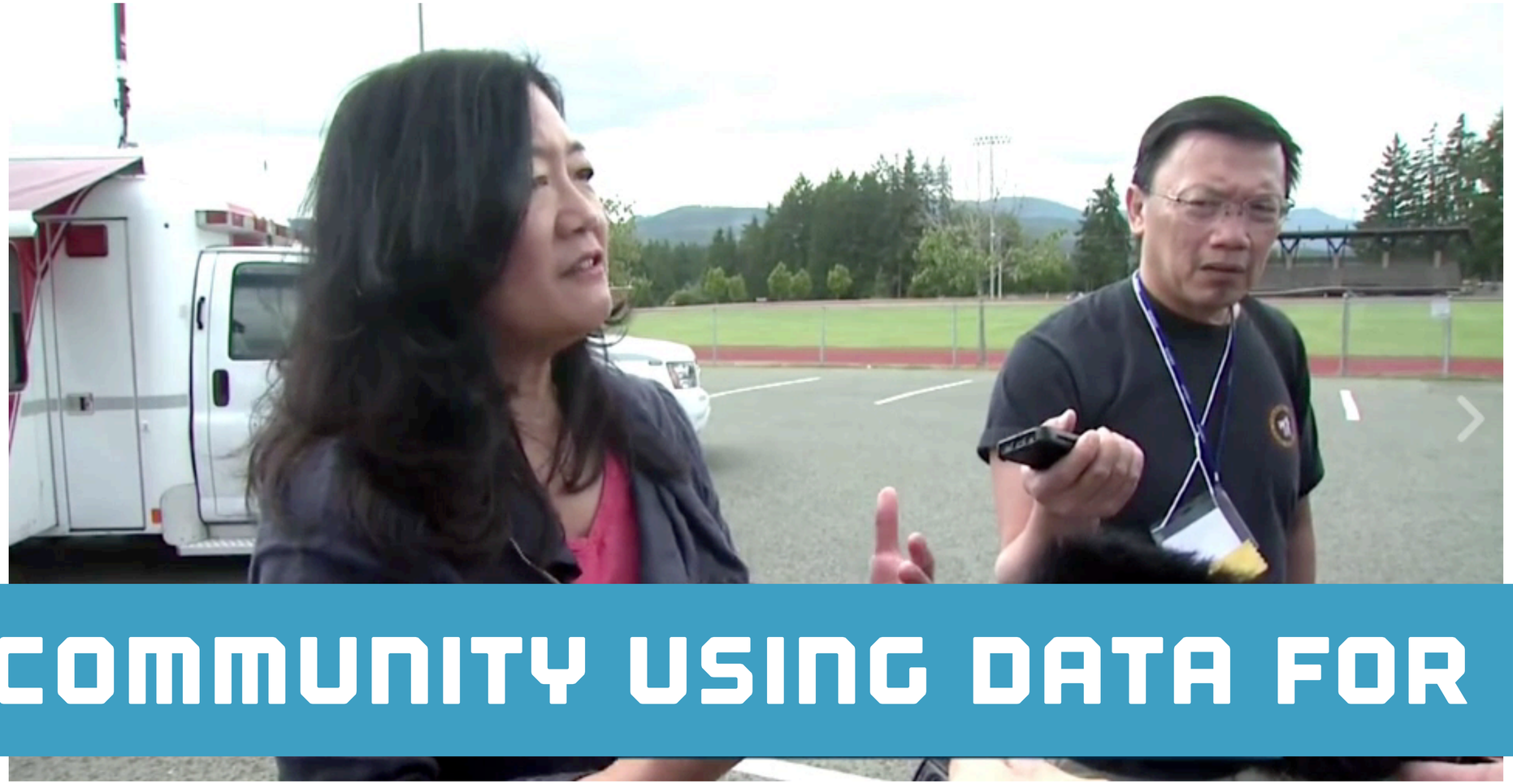
The Fraser Grain Terminal has proposed to implement ONC's earthquake early warning system in 2019 to minimize loss of life during a catastrophic event on Canada's west coast.

This is a ground-breaking initiative in the maritime industry and for any other industry or region worldwide.

EARTHQUAKE EARLY WARNING - STAKEHOLDERS

- BC Earthquake Alliance
- BC Ferries
- BC Hydro
- District of Tofino
- Edelman
- Fortis
- Hupacasath Nation
- IBM
- Insurance Bureau of Canada
- Lloyds
- Natural Resources Canada
- Public Safety Canada
- Port of Prince Rupert
- Tsleil-Waututh Nation
- Tseshaht Nation

PORT ALBERNI'S FULL SCALE EARTHQUAKE & TSUNAMI WARNING DRILL



- ONC participated in June 2016
- Last tsunami was 1964
- Attended by the BC Minister of State for Emergency Preparedness, Hon. Naomi Yamamoto

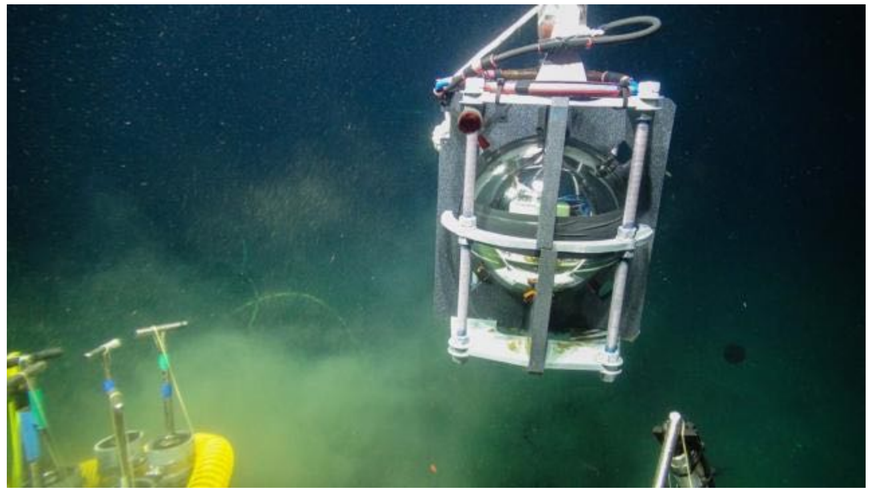
COMMUNITY USING DATA FOR PLANNING

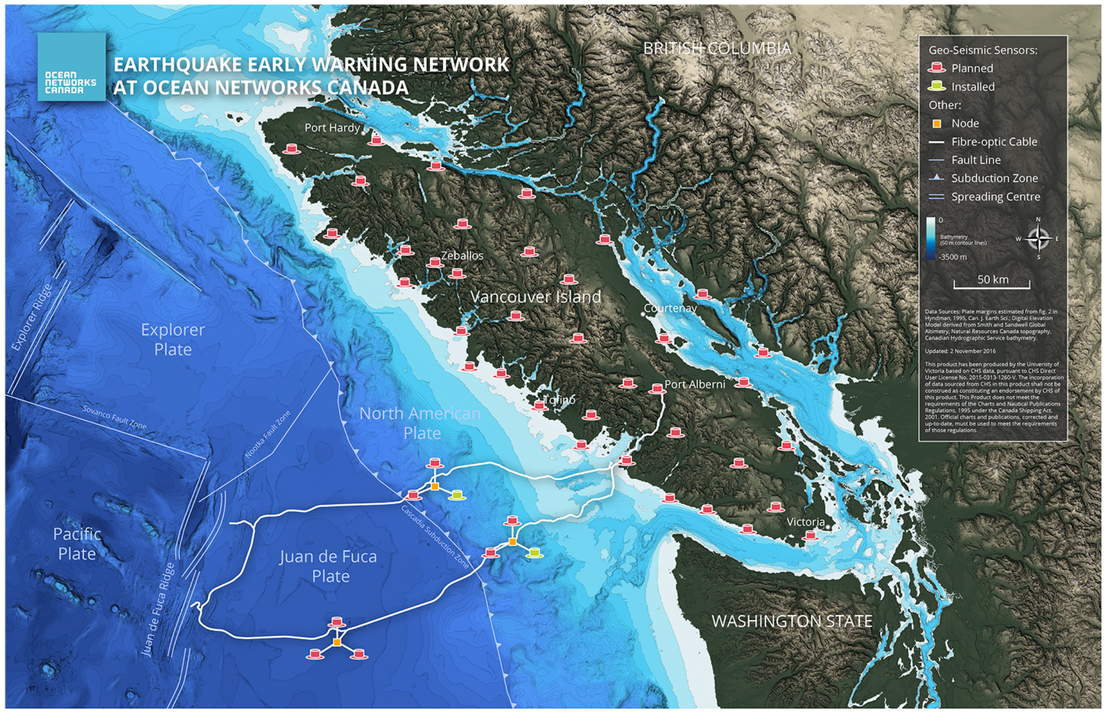
BC NET AND PARTNER INVOLVEMENT

- Use of BCNet's networks presence on Vancouver Island as data backhaul where possible
- Use of BCNet's Kamloops data centre as primary of backup data centre for calculating earthquake parameters
- Use of BCNet's Data Centre and network to deliver notifications to subscribers
- Universities involved through research conducted in the areas of seismology, social sciences (delivery of notifications; public education)

SYSTEM IMPLEMENTATION

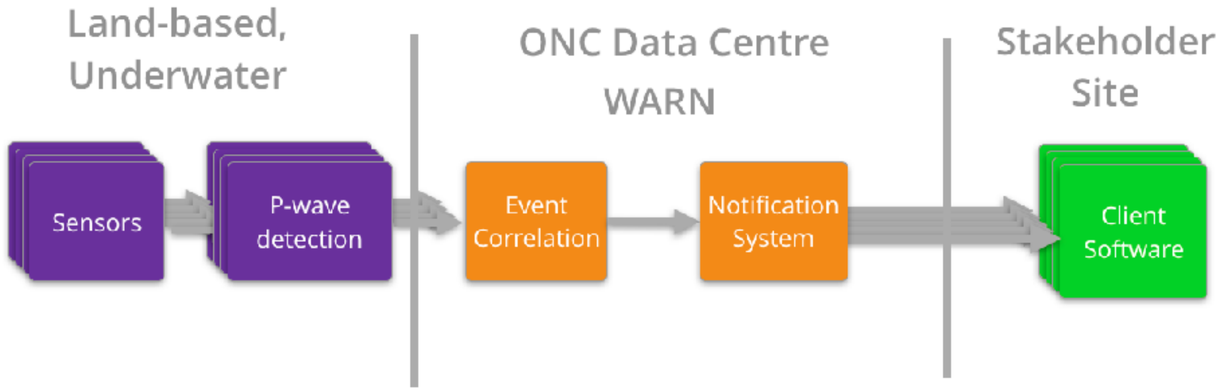
- Up to 8 underwater instruments connected to the NEPTUNE observatory
- Up to 30 land-based instruments on Vancouver Island in collaboration with NRCan.





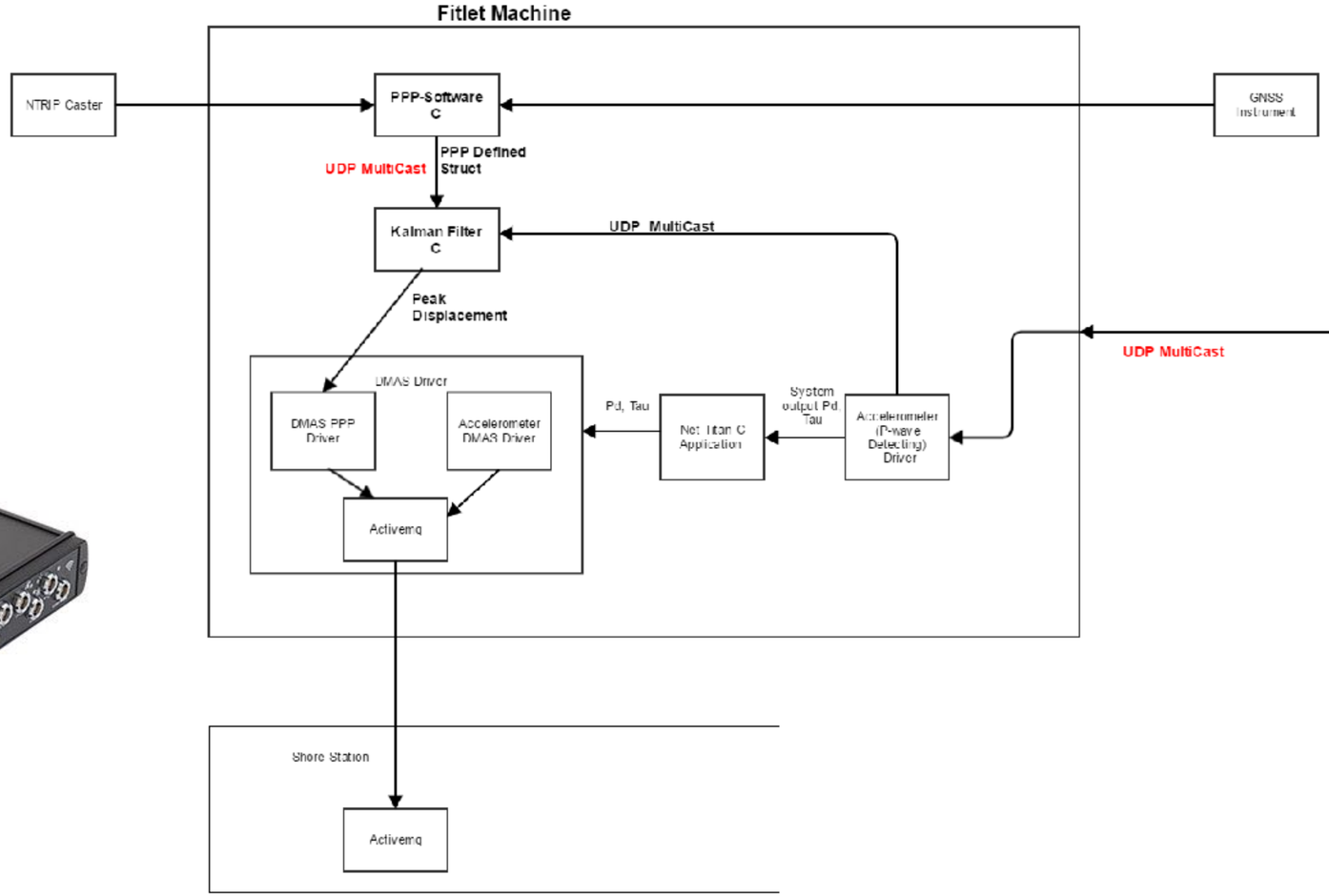
SYSTEM IMPLEMENTATION

- An advanced network and software architecture:
  - Sites equipped with redundant, independent communication paths
  - Distributed computing, with key parameters computed on-site
  - Central data centre to correlate coincident events and report their key characteristics
  - Notification system using a publisher-subscriber model with local impact and decision (reaction) left to end-user



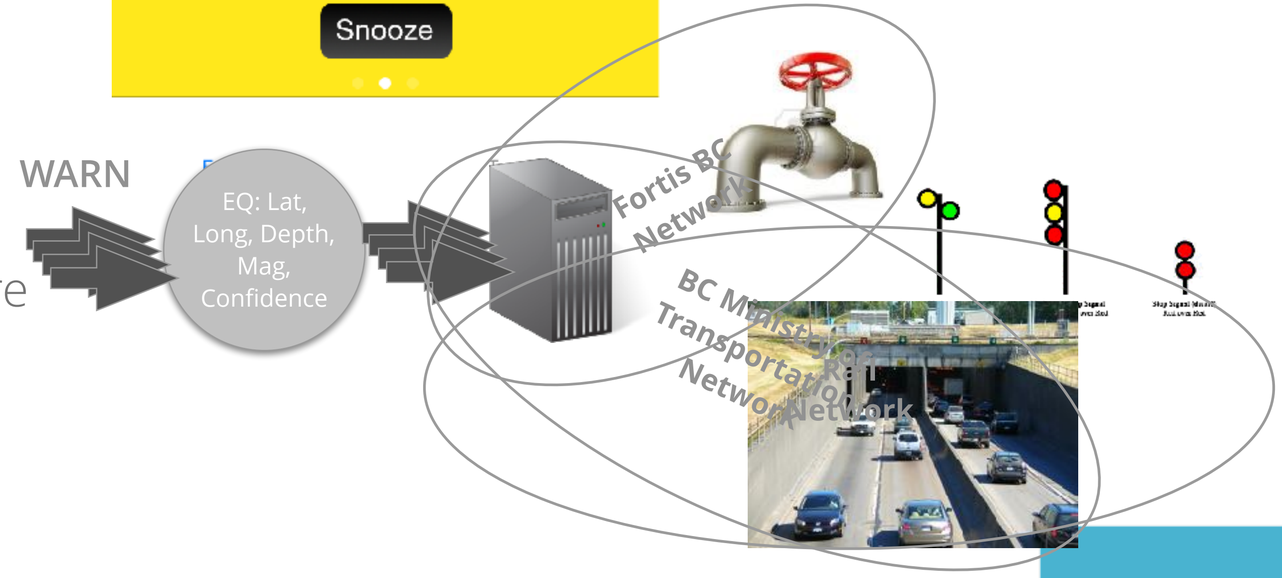
SYSTEM IMPLEMENTATION

- Unique characteristics:
  - Simultaneous processing of GNSS and acceleration data on land-based sites to better quantify the actual peak displacement during an event



SYSTEM IMPLEMENTATION

- Client Software:
  - Java API installed on a computer at the user's
  - Listens to notifications
  - Calculates distance from epicentre for each of the monitored assets (e.g., network of pipeline valves, train signals, bridges or tunnels)
  - Calculates Time of Arrival for each event
  - Re-calculates parameters every time new values are received
  - Implements decisions/actions according pre-established scenarios
- *No time for humans in the loop!!*

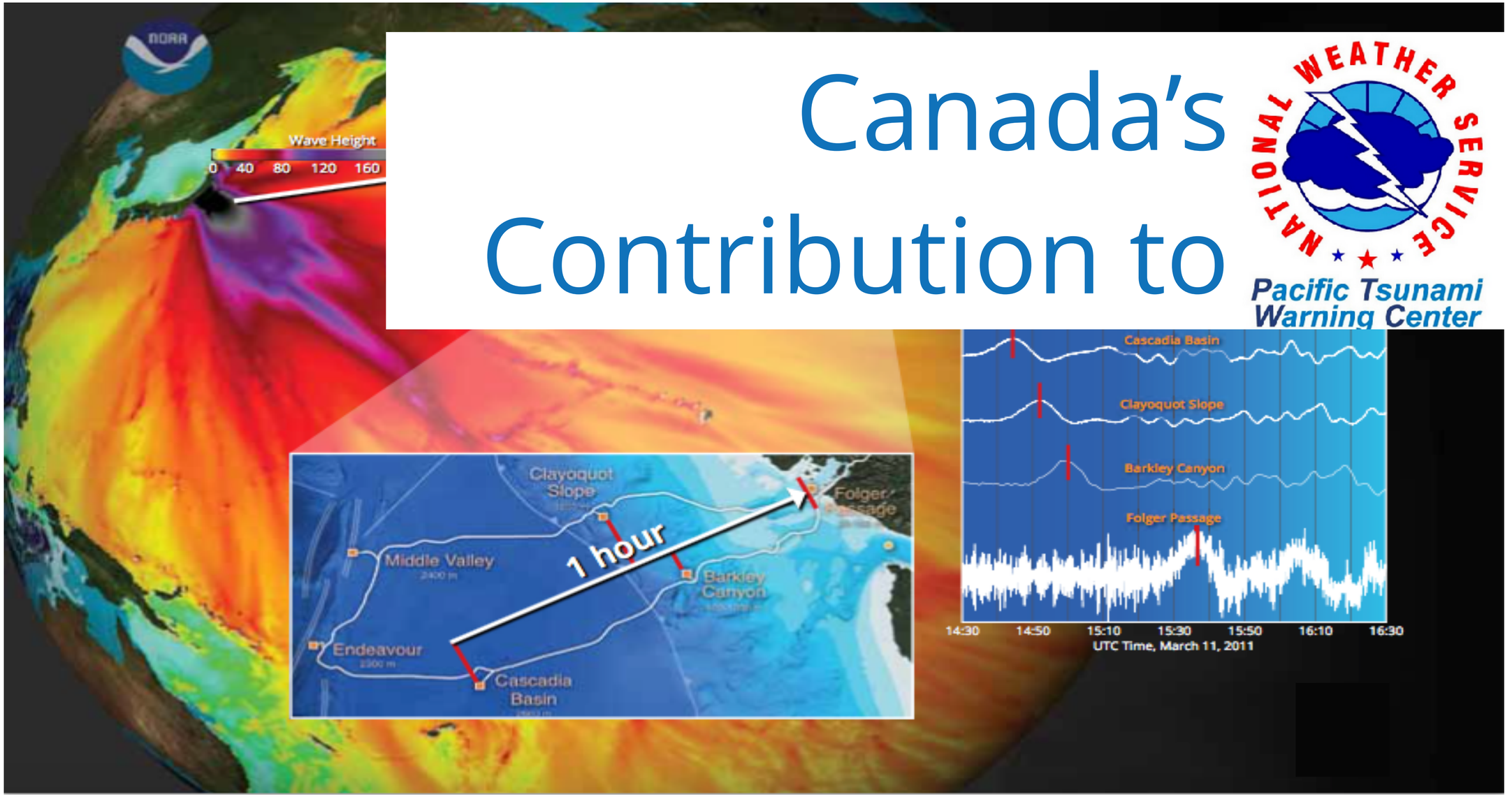


TSUNAMI DETECTION, NOTIFICATION AND MODELLING

Long-range, high-frequency radar installed in Tofino tested for its potential to contribute to real-time tsunami detection. Information from this system will augment data from bottom pressure sensors already in place off the coast of Vancouver Island. Modelling of tsunami impact assessment for various coastal communities.

- **Rationale:** Provide near-field and far-field **tsunami detections** to NOAA, EMBC; providing municipality emergency responders with different **inundation scenarios** for their communities
- **Novelty:** Long-range radar use is very new; models are the **most advanced** in the world
- **Delivery:** Data sent to **NOAA** for integration with other sources; **inundation scenarios** for various municipalities along the coast
- **OPP link:** Preparation for coastal resilience, **integrated incident response**
- **Operationalize for the future:** Complete commissioning of long-range radar; deliver on more scenarios for more coastal communities

FAR-FIELD TSUNAMIS



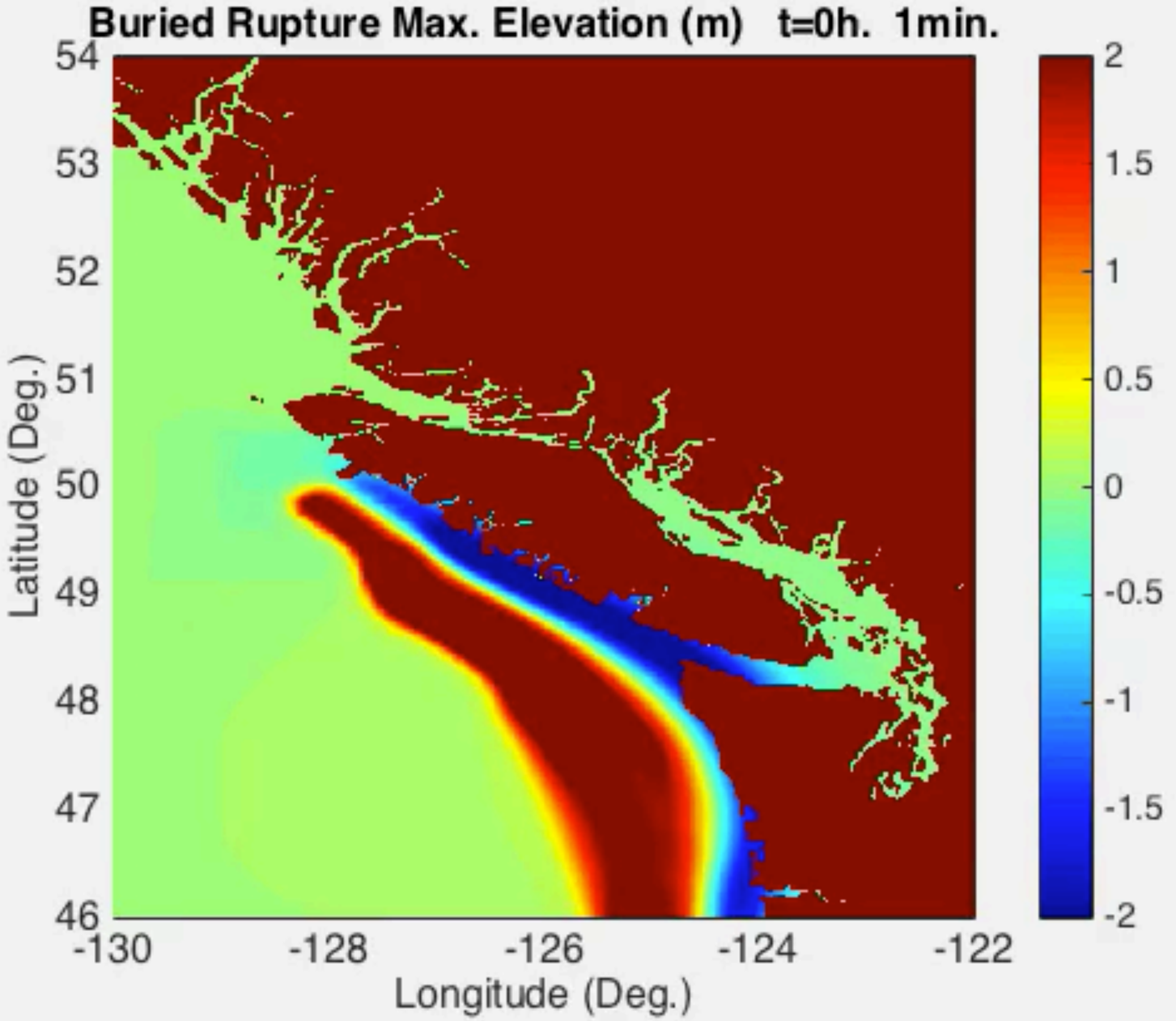
Canada's Contribution to

NATIONAL WEATHER SERVICE

Pacific Tsunami Warning Center

NEAR-FIELD TSUNAMIS

- Tofino radar detects near-field waves
- Model simulations inform communities



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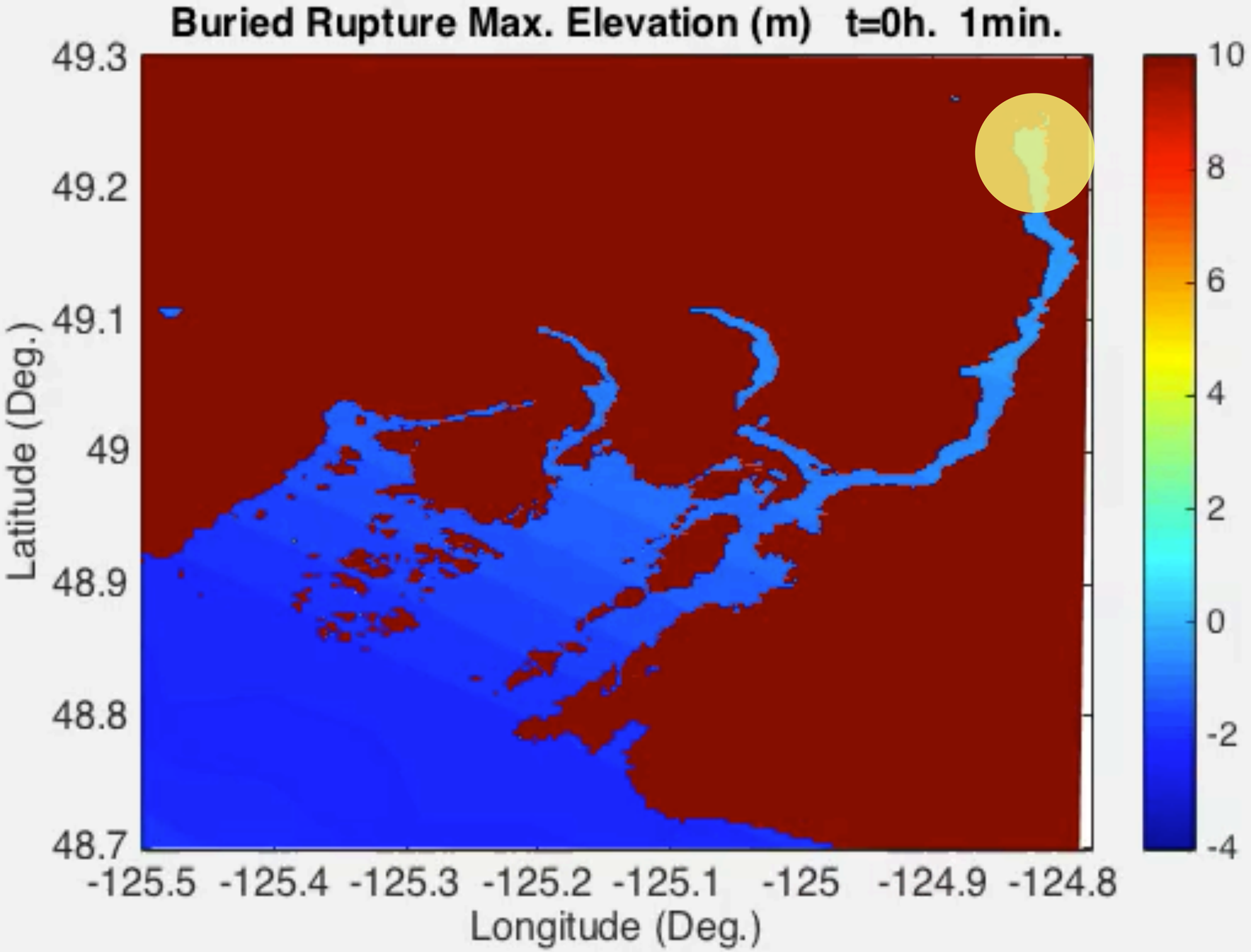

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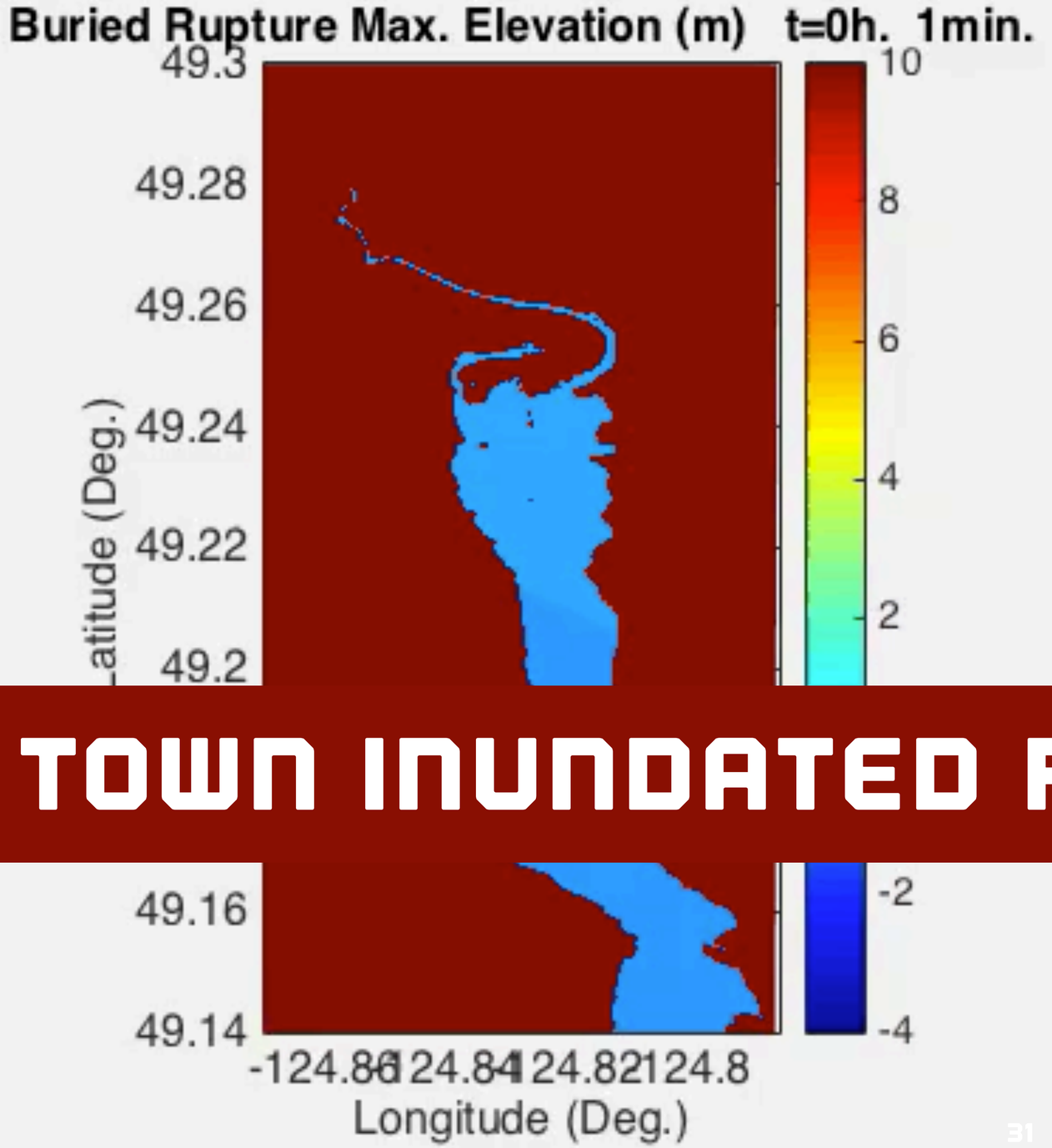

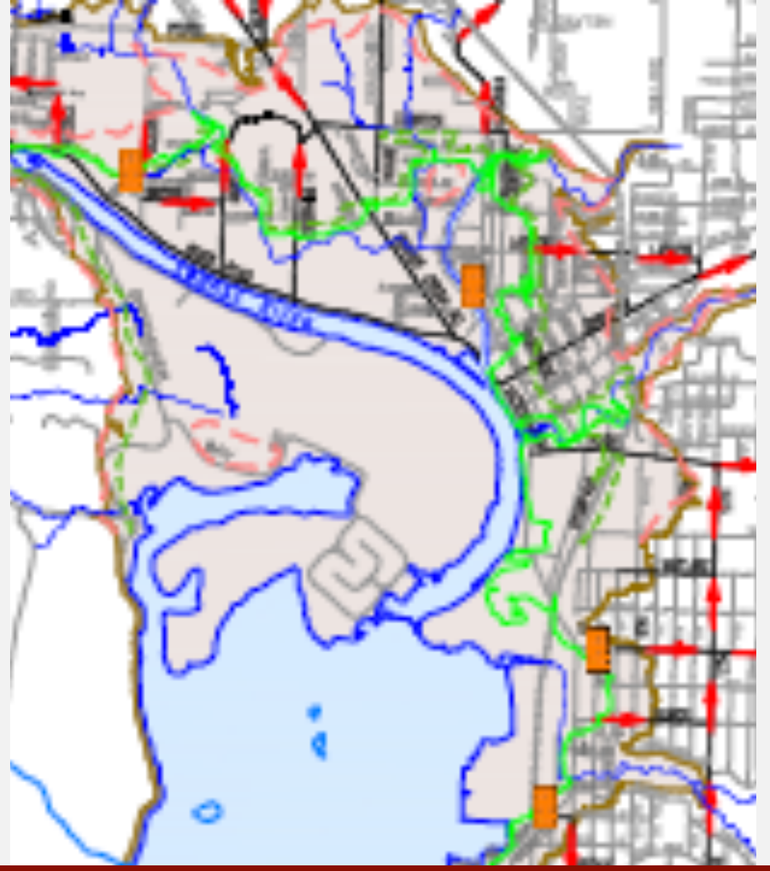

TOWN INUNDATED FOR OVER 6 HOURS

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VIDEO #1 - COASTAL COMMUNITIES AND OCEAN HEALTH

VIDEO #2- OCEANOGRAPHIC RADARS AND OCEAN SAFETY

VIDEO #3 - MARINE TRAFFIC AND OCEAN SAFETY

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THANK YOU! MERCI!

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BACKUP SLIDES