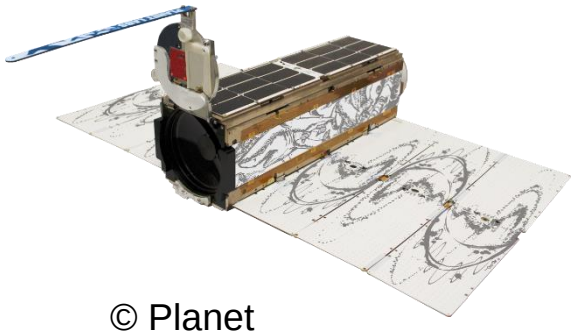
Earth Observation: A complementary tool to existing information to support strategic decisions in Transportation

Observation de la Terre : Un outil complémentaire aux données existantes pour appuyer les décisions stratégiques en matière de transport

Overview

1- What is Earth Observation EO?

2- Possible Applications to Transport Canada

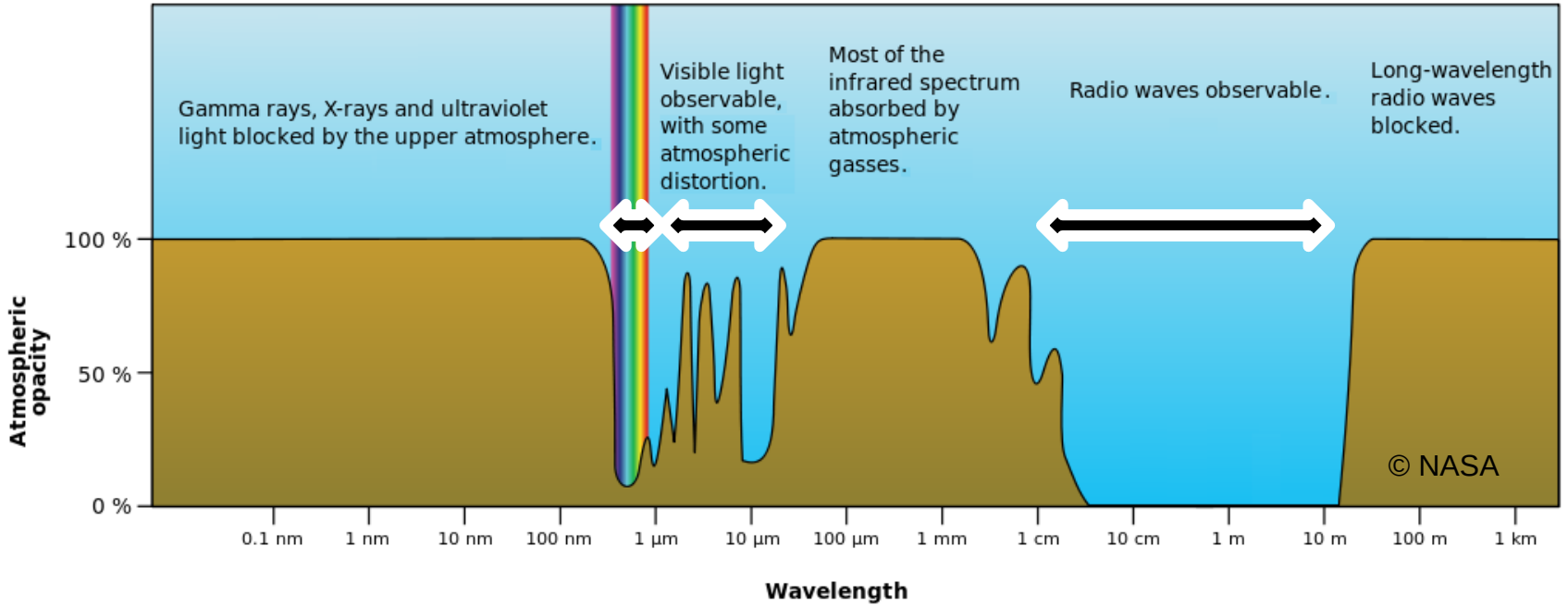


What is Earth Observation? (1)

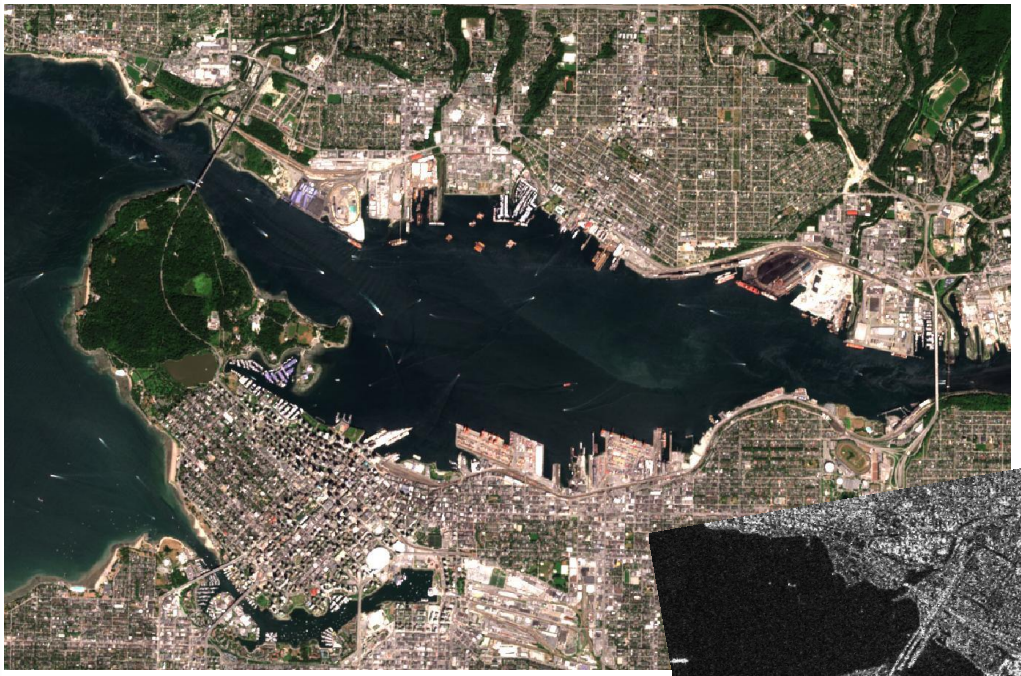
- **Earth Observation (EO)** is defined as the process of acquiring observations of the Earth's surface and atmosphere via remote sensing instruments or in-situ measurements.
- Remote sensing uses **different platforms**, each presenting its own advantages and limitations:
  - **Aerial** provides the best resolutions, is adjustable to the users' needs, but expensive.
  - **Drones** are a fast-growing technology that tackles this cost problem, but have regulations issues and low carrying capacity.
  - **Satellites** allow for reliable, true global coverage even above the most remote locations enabling regular repeat observations.

What is Earth Observation? (2)

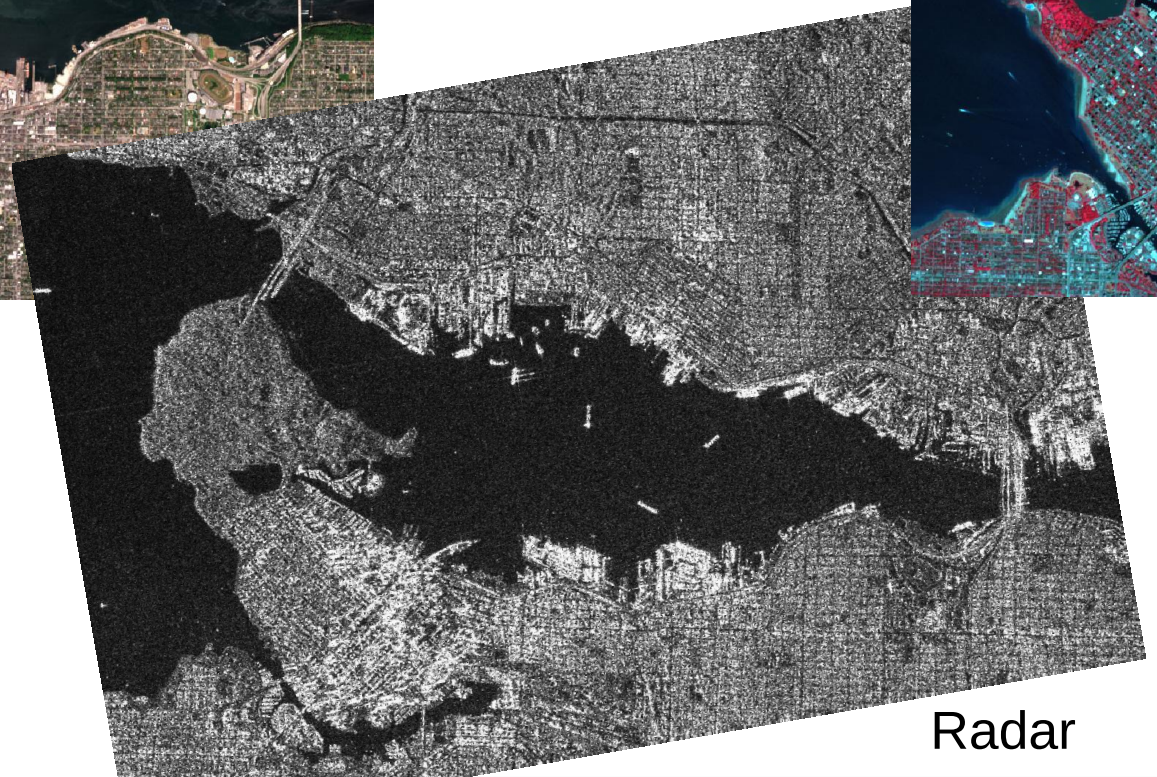
- **The electromagnetic transparency of the atmosphere allows for the observation of Earth's surface:**
  - in the **visible spectrum** (0.39 to 0.70 µm),
  - in a part of the **infrared spectrum** (from 0.70 to 14 µm) and,
  - in the **radio wave range** (from 1 cm to 11m).



Example of EO data – Vancouver harbour



Optical



Radar

False-Color Infrared

EO Applications

Maritime:

- Vessel detection
- Iceberg monitoring
- Maritime Pollution Monitoring
- Coastal Monitoring

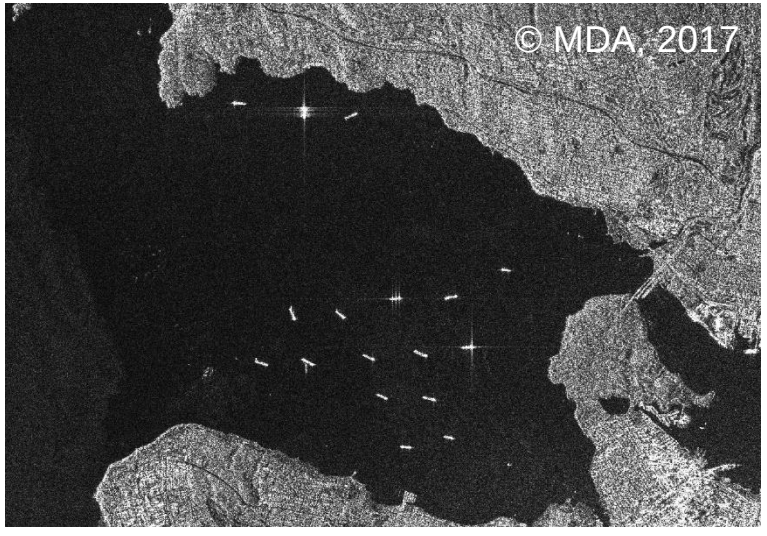
Ice:

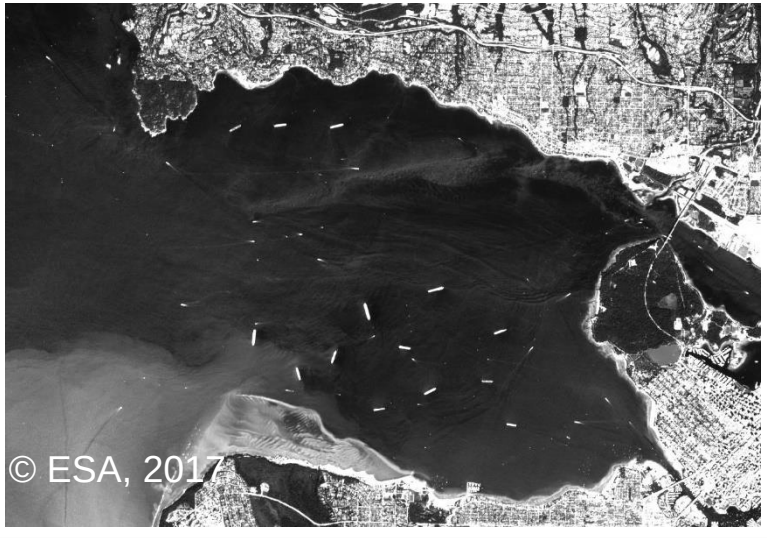
- Bottom fast ice
- Snow monitoring
- Floe edge
- Lake and River ice monitoring
- Glacier monitoring

Land:

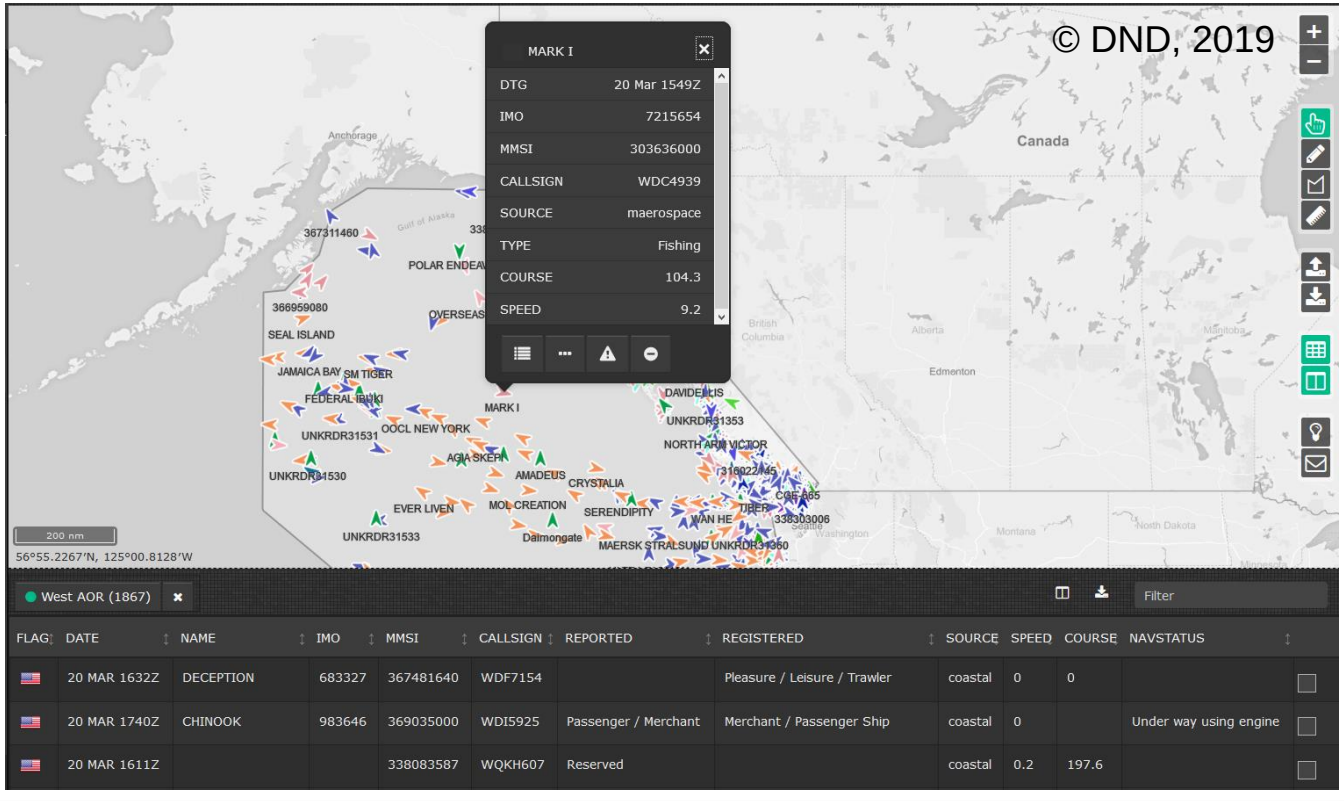
- Land cover maps
- Security: right-of-way intrusion
- Terrain stability: Permafrost degradation, Land-/Rock-slide
- Infrastructure stability: bridge, overpass, buildings, urban areas.
- Ecosystem monitoring: fire, flooding.
- Topography: DSM, LiDAR.
- Water quality: sediment, temperature
- Agricultural: estimation of crop yield
- Monitoring Green House Gas Emissions

EO Applications: Marine Surveillance





Tracking Vessel activity from Satellite Images in combination with terrestrial dataset.
2017 image from Radar (top left), Optical (bottom left), GeoServer with Spaceborne AIS data fused with other data source (bottom right).



EO Applications: Ice break up – Mackenzie River

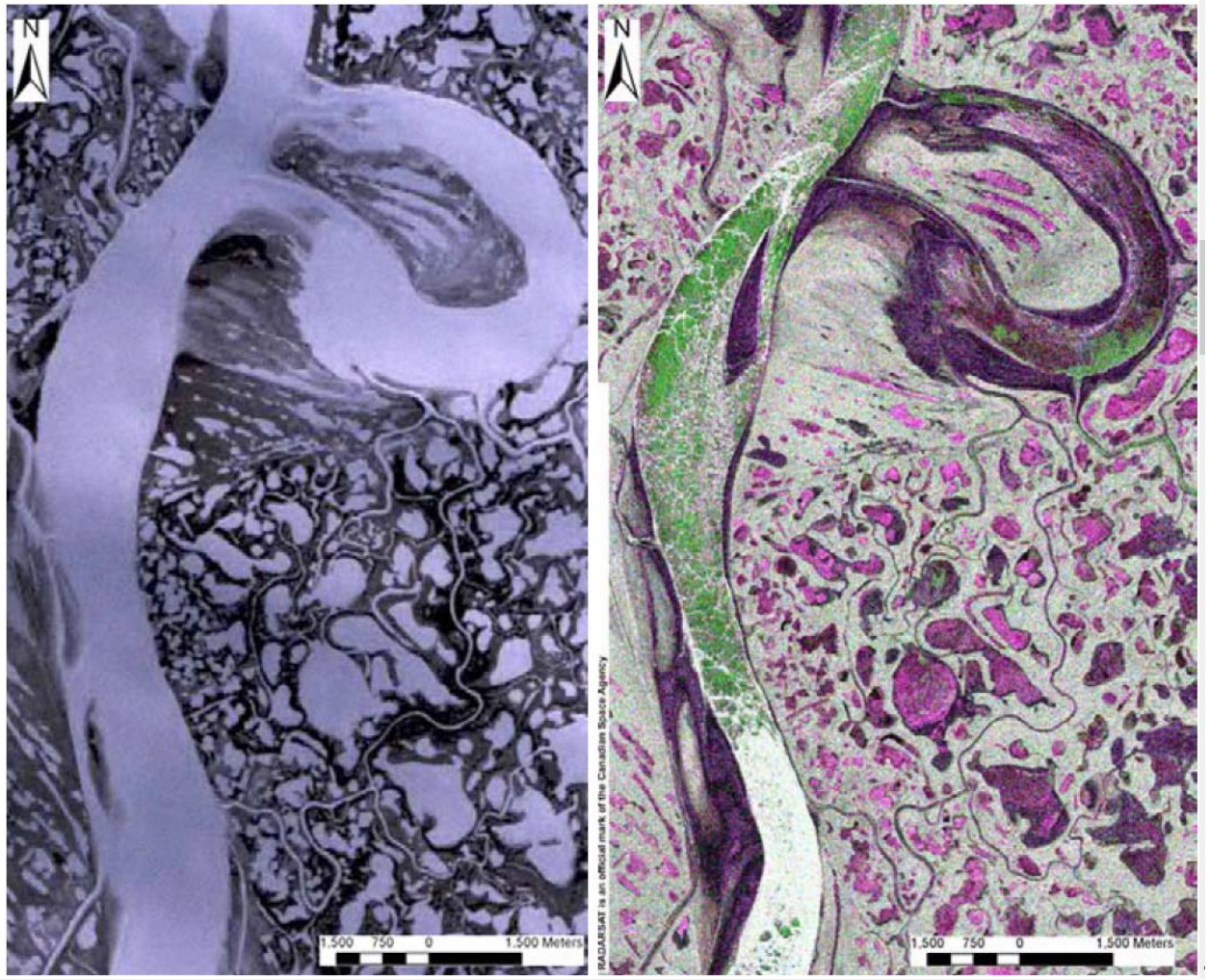
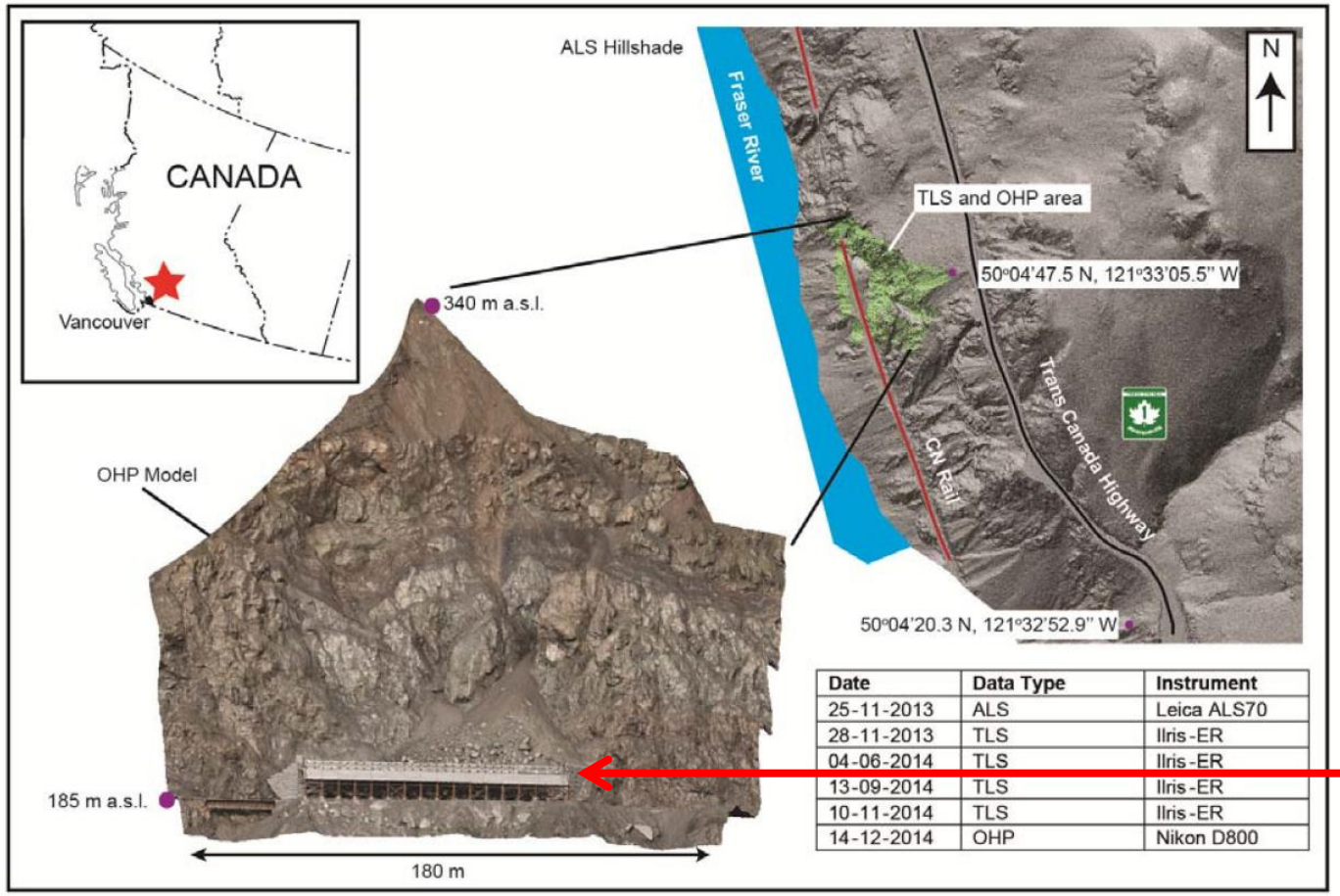


Image subsets showing the Mackenzie River near Inuvik, NWT, Canada

(a) Landsat Visible vs (b) **RADARSAT-2 Polarized image**.

Radar image shows many ice cover details that **are not visible** in the Landsat TM image nor **to the human eye**.

EO Applications: Rock Slope failure using LiDAR



Date	Data Type	Instrument
25-11-2013	ALS	Leica ALS70
28-11-2013	TLS	Ilris-ER
04-06-2014	TLS	Ilris-ER
13-09-2014	TLS	Ilris-ER
10-11-2014	TLS	Ilris-ER
14-12-2014	OHP	Nikon D800

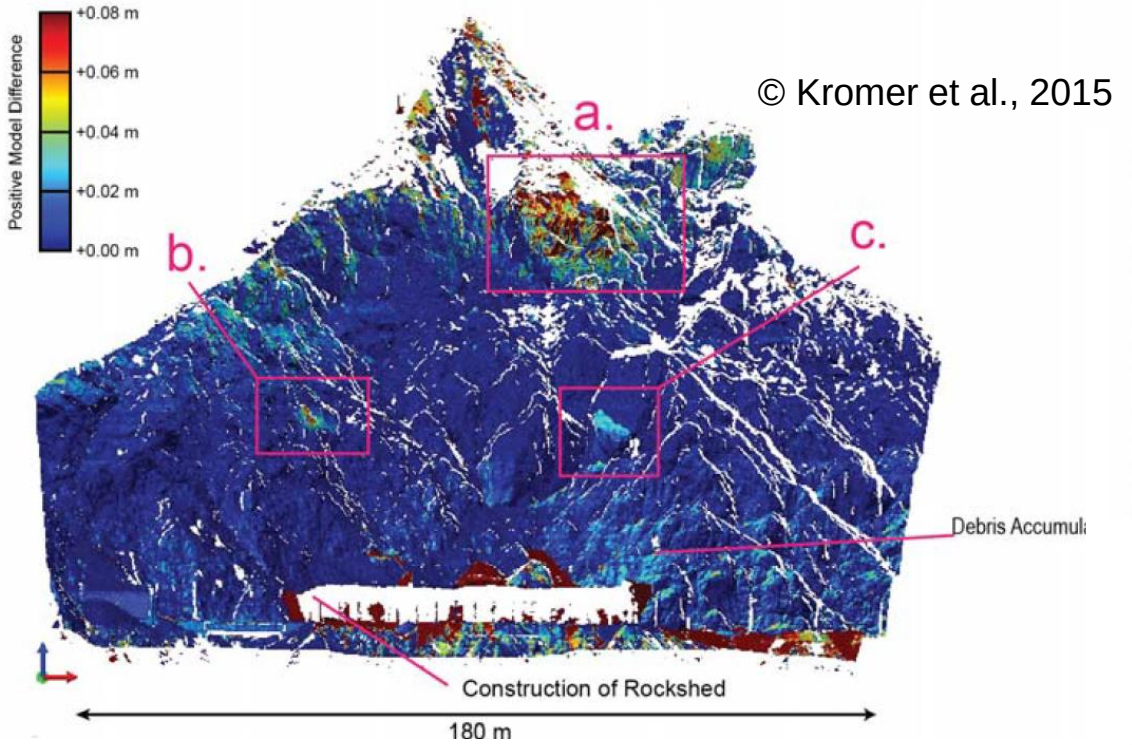
Figure 1: Location of study site and data sets collected. Oblique view of ALS data set (top right), Oblique Helicopter Photos (OHP) and data collection dates (bottom right).

Prediction of rockfall, which represents one of the **highest risks to transportation corridors** in mountainous terrain.
Aerial Lidar Digital Elevation Model top right showing geomorphology, CN railway and Highway 1 locations.

Monitoring of a slope along the CN Rail line in the Fraser River Valley, BC using terrestrial laser scanning (TLS) and photogrammetry in 2013-2014.
=> **3D Deformation**

rockfall protection structure

EO Applications: Rock Slope failure using LiDAR



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Acceleration of Deformation before December 2014 failure

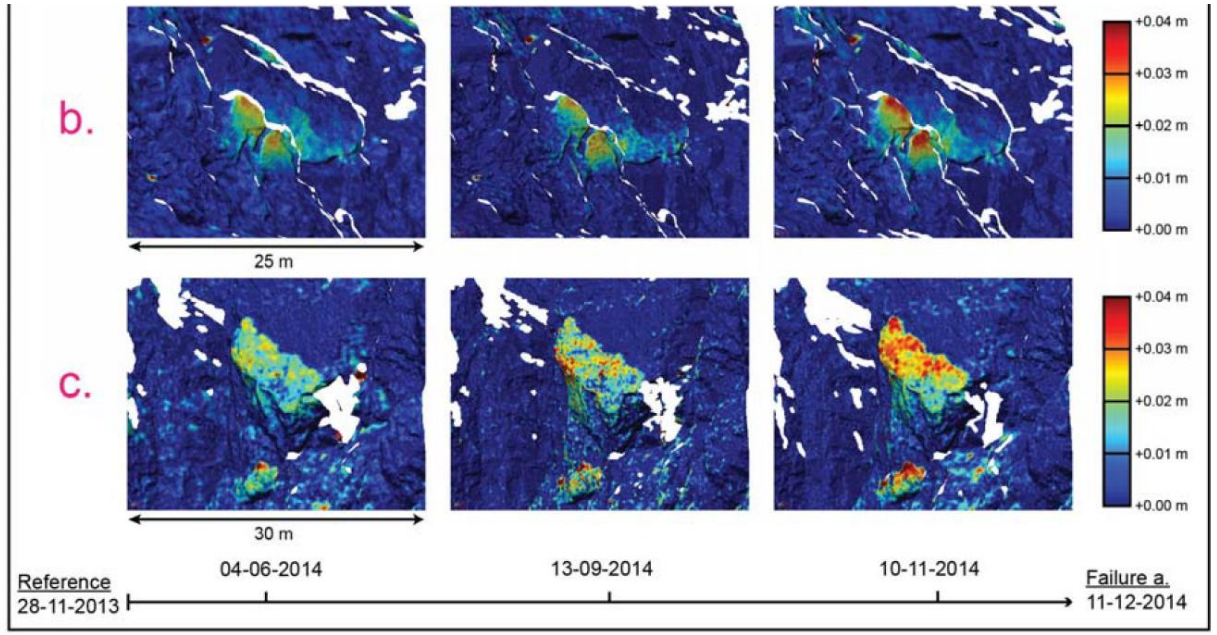

Figure 2: Three-dimensional analysis of slope deformation and deformation time series. Top: Filtered deformation image for the whole slope comparing reference scan 28-11-2013 with 10-11-2014 indicating deforming rock blocks identified prior to the failure. Bottom: Time series of identified areas of change prior to rockfall failure. Other observed slope change due to construction of rockfall protection structure (bottom) and accumulation of rock debris and soil.

Dark red polygons indicates material accumulation in b and c locations before failure and at the toe of the slide.