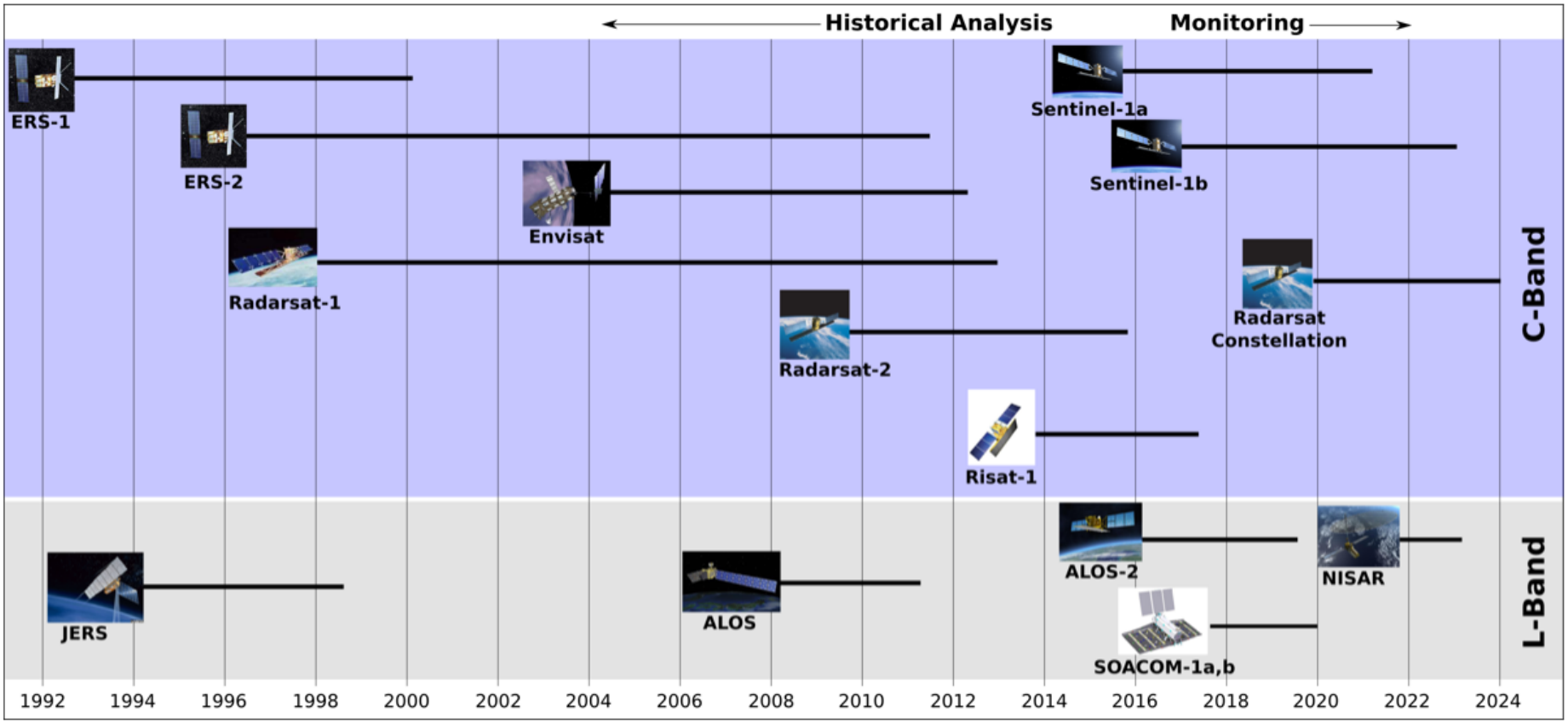
Lecture 1:
SAR Teaser

Carleton UNIVERSITY
Canada's Capital University
Natural Resources Canada
Ressources naturelles Canada
CSA ASC
Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Evolution of SAR Sensors

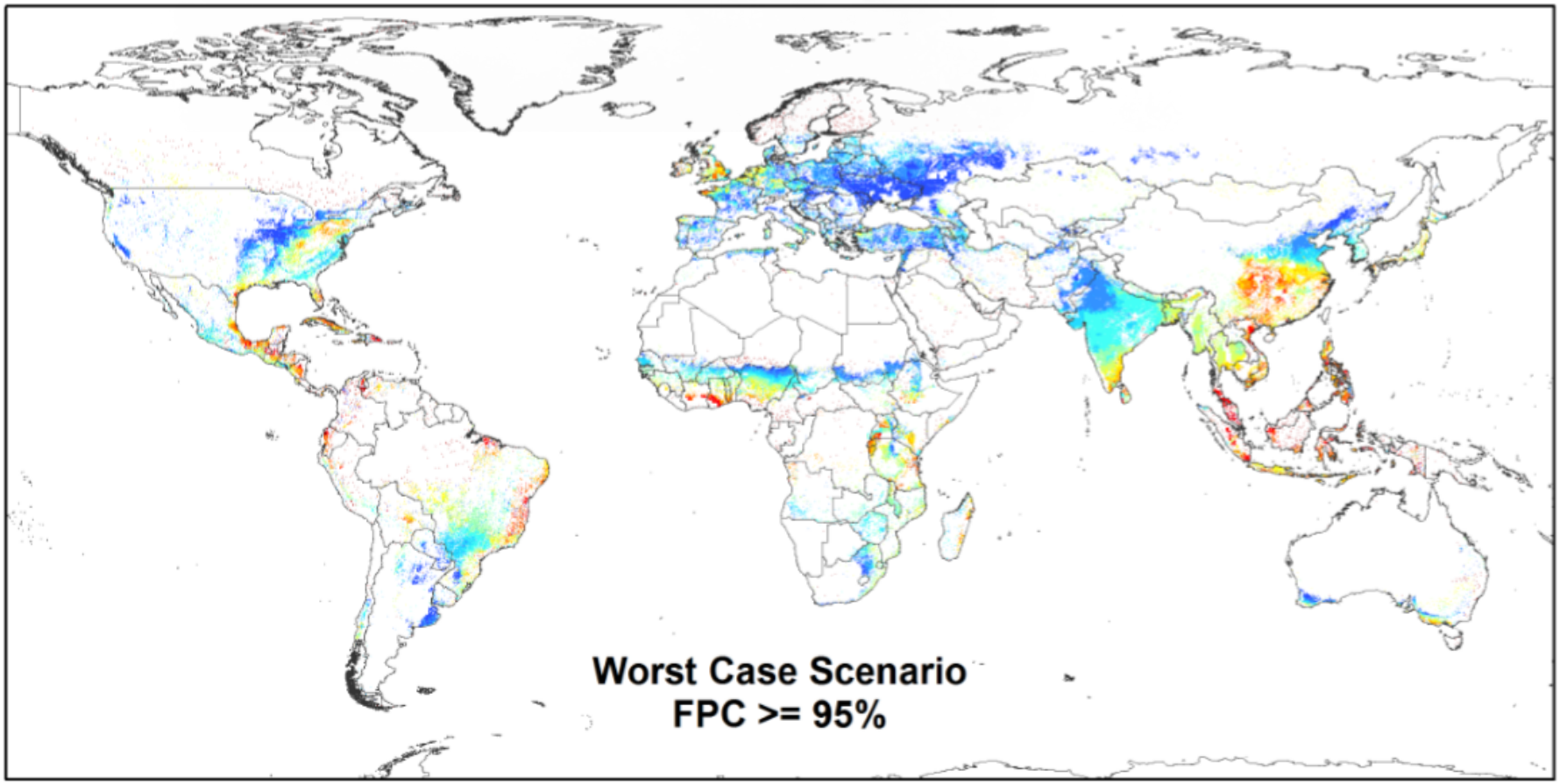
- Early sensors provided only single dimensional data (for example, HH with RADARSAT-1 or VV with ERS-1/2).
- New SAR sensors have dual and full polarization capability.
- Sentinel-1 mission is providing data under a free and open license. With Sentinel-1A/B, exact revisit of 6 days.



(https://www.unavco.org/instrumentation/geophysical/imaging/sar-satellites/sar-satellites.html)

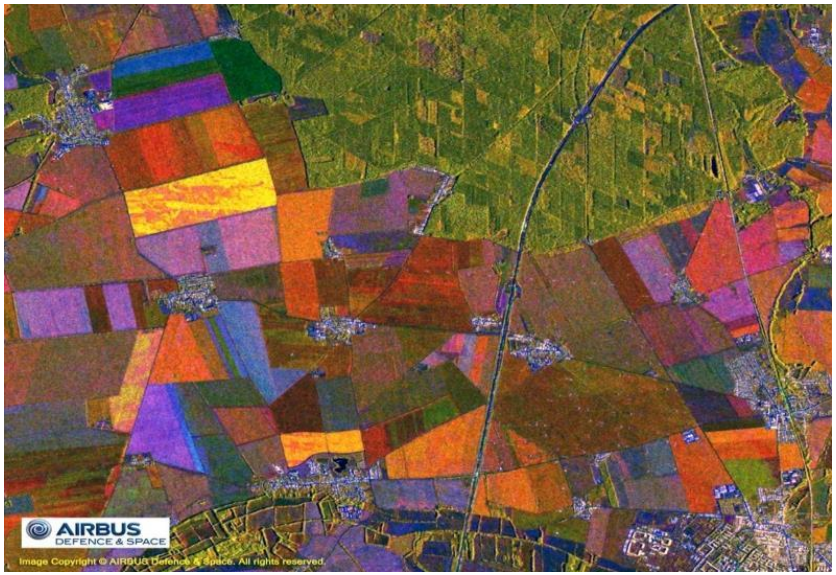
Synthetic Aperture Radar

The number of months for which there is a failure in capabilities of existing moderate spatial resolution optical remote sensing due to persistent cloud coverage.



(Source: Whitcraft et al., 2015)

Information about Crops and Soils



TerraSAR-X image of the agricultural area near Dessau, Germany created by combining three dates of data and assigning each image to one of red, green and blue colours.

Source: Airbus Defence and Space and Satellite Imaging Corporation.

Survival of chicory seedlings depends on adequate access to soil moisture

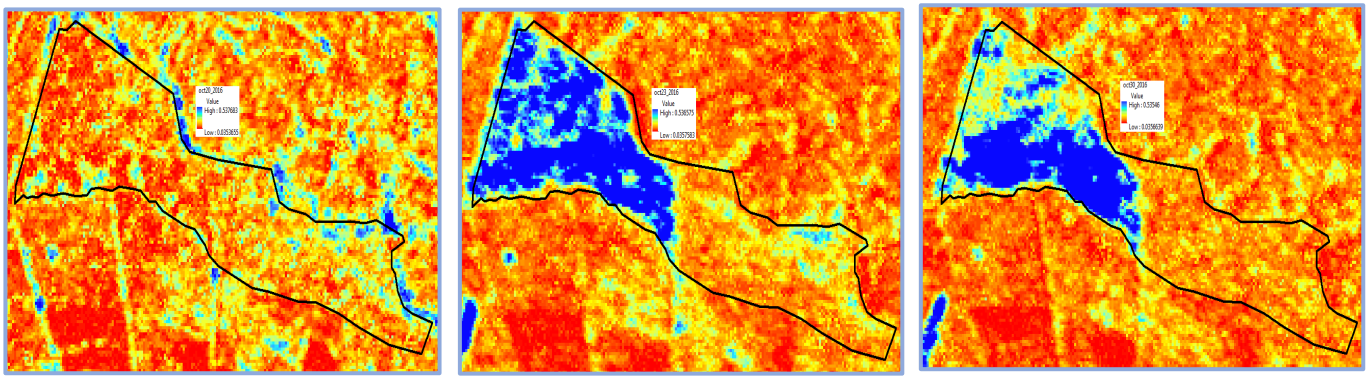
Precision Irrigation in Chile

Maps of percent soil moisture from RADARSAT-2 (**wet=blue**)

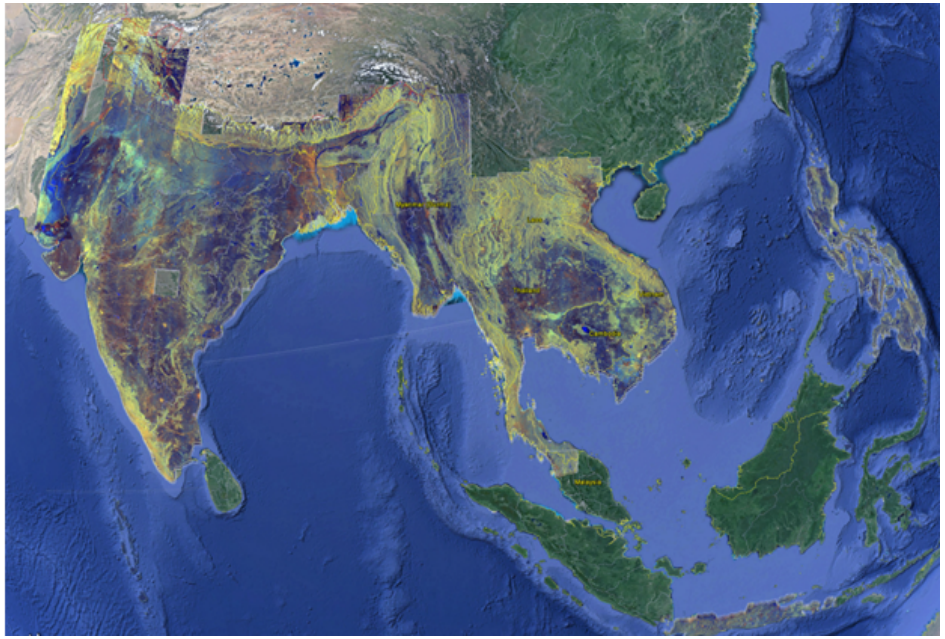
Dry conditions:
20 October

Irrigation occurs:
23 October

Post-irrigation drying:
30 October



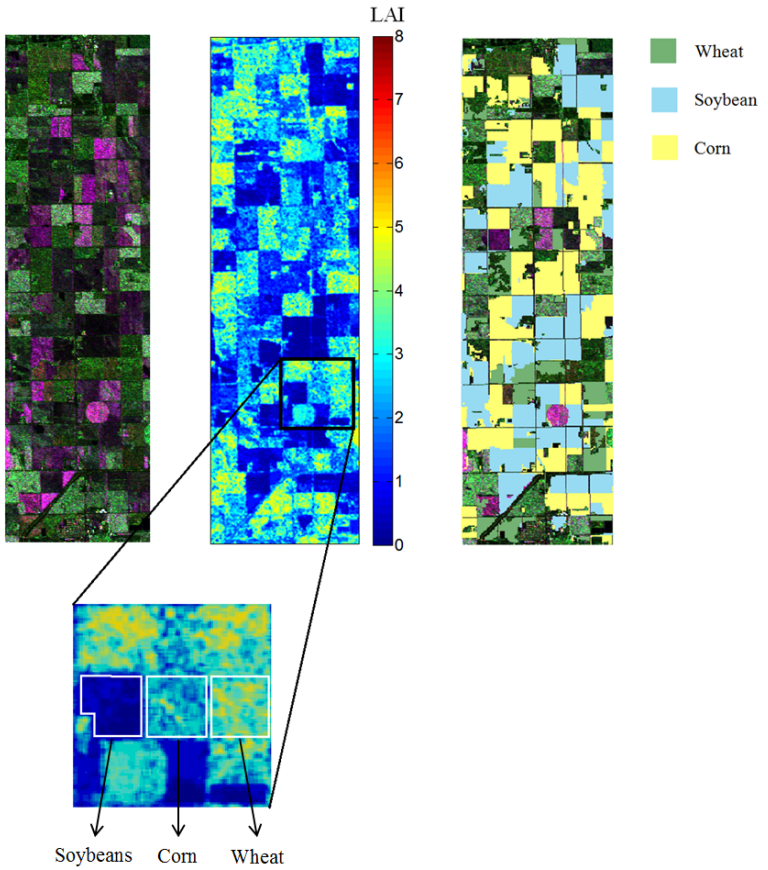
Monitoring Crops



Sentinel-1A mosaic stretching from Pakistan to the Philippines.

(SAR imagery from ESA: Sentinel-1A ©Copernicus data (2015). Background from Google Earth © Google Inc.)

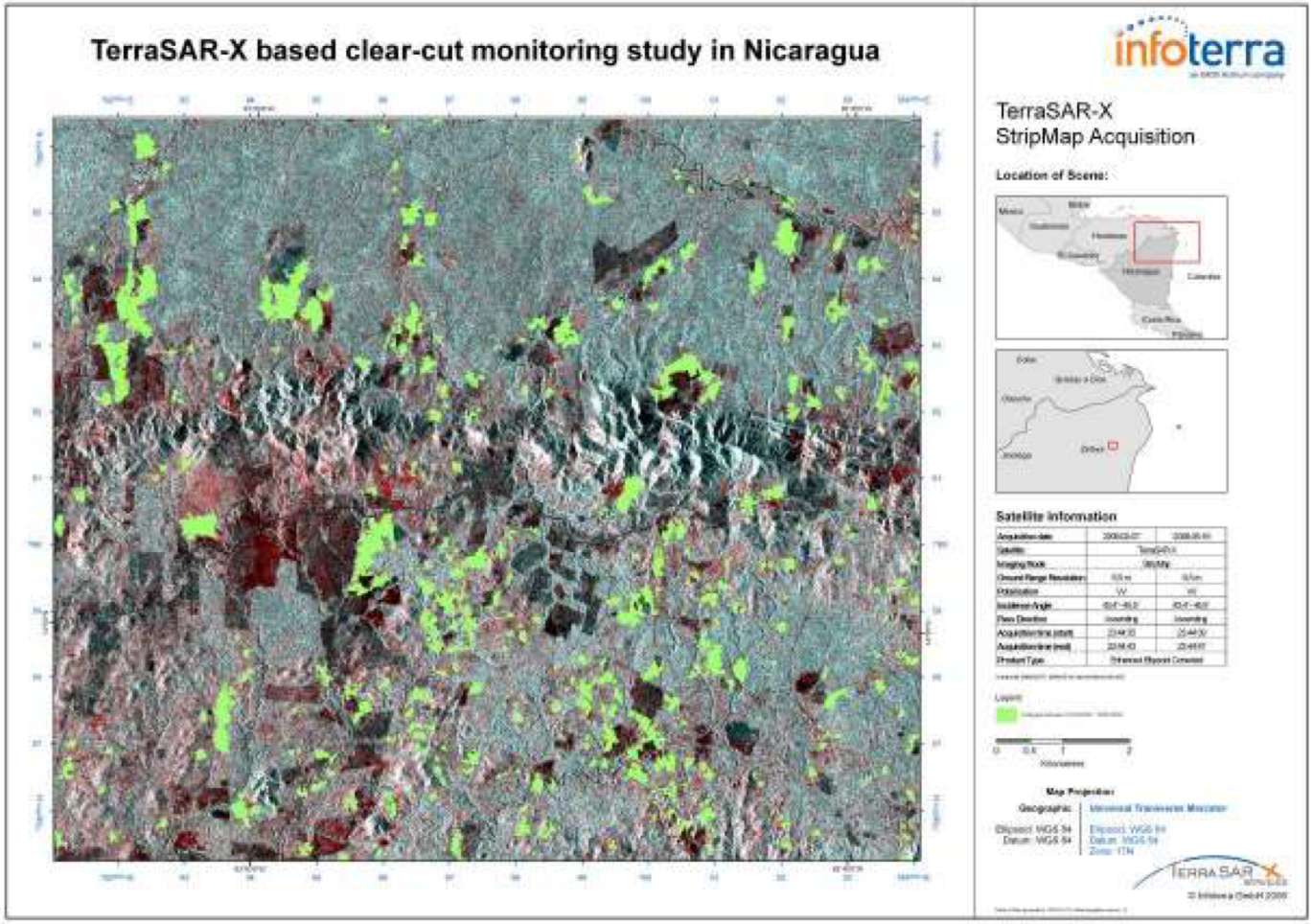
(irri.org/news/media-releases/satellite-imagery-to-soon-enable-large-scale-monitoring-of-asia-s-rice-areas)



Manitoba, 2012
LAI estimates for corn and soybeans from RADARSAT-2

Hosseini, M., McNairn, H., Merzouki, A., and Pacheco, A., "Estimation of Leaf Area Index (LAI) in corn and soybeans using multi-polarization C- and L-band radar data", Remote Sensing of Environment, vo. 170, pp. 77-89, 1 December 2015.

Mapping Forest Clear Cuts

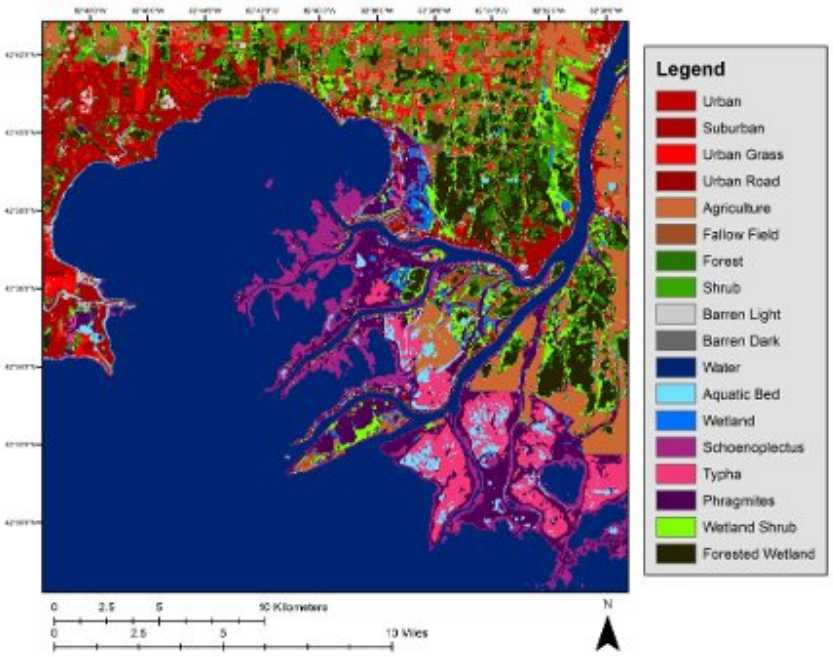


Forest clear-cuts are identified using multi-temporal TerraSAR-X data in Nicaragua. Light green areas indicate classified areas of clear cuts which occurred between February 7, 2008 and May 16, 2008.

Source: Kuntz, 2010.

Monitoring Wetlands

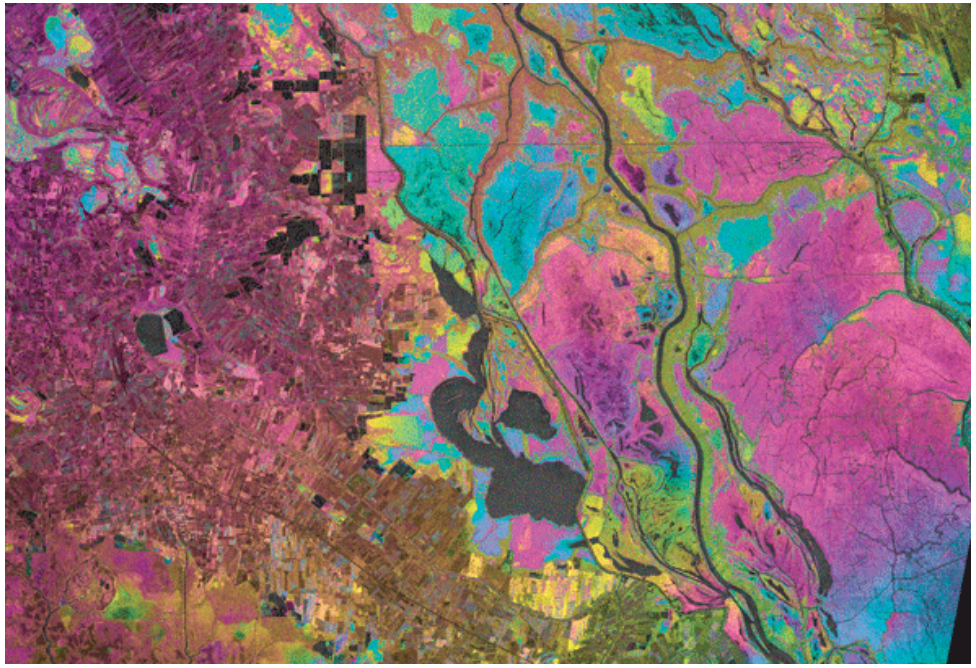
Mapping Wetlands



A map generated using Landsat TM optical and PALSAR L-band (HH and HV) satellite imagery and the Great Lakes wetland mapping tools developed at Michigan Tech Research Institute.

Credit: Michigan Technological University (www.fondriest.com/news/great-lakes-wetland-map-to-help-scientists-tackle-losses.htm)

Measuring Changes in Wetland Water Levels

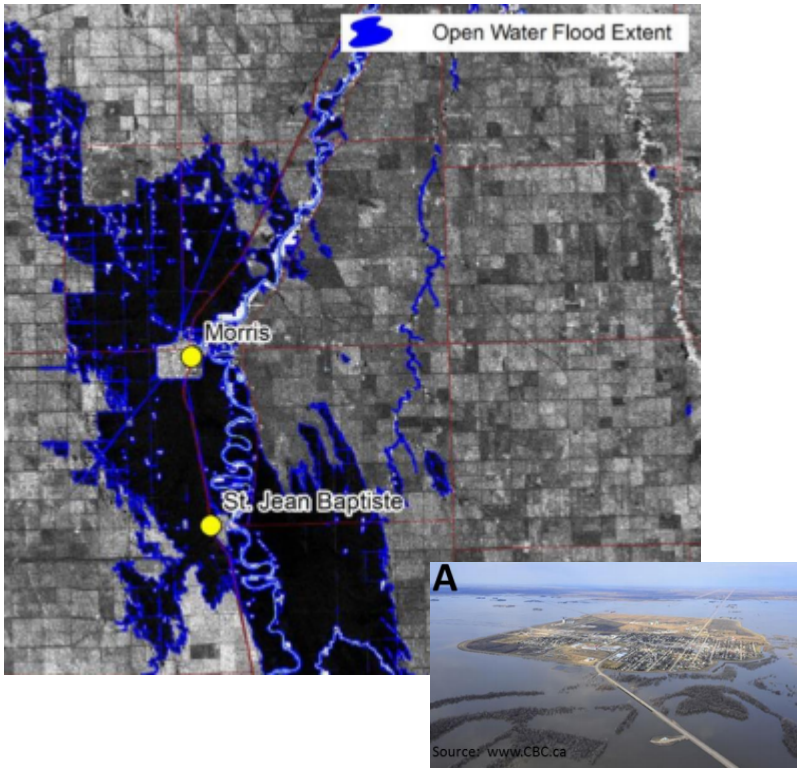


Water-level changes over swamp forest in southeastern Louisiana revealed in this interferogram, created using ALOS PALSAR data acquisitions of January 29 and March 16, 2007. Each interferogram fringe (a full cycle of colors) represents a water-level change of about 13 cm.

Credit: Zhong Lu, USGS (www.asf.alaska.edu/sar-data/insar/)

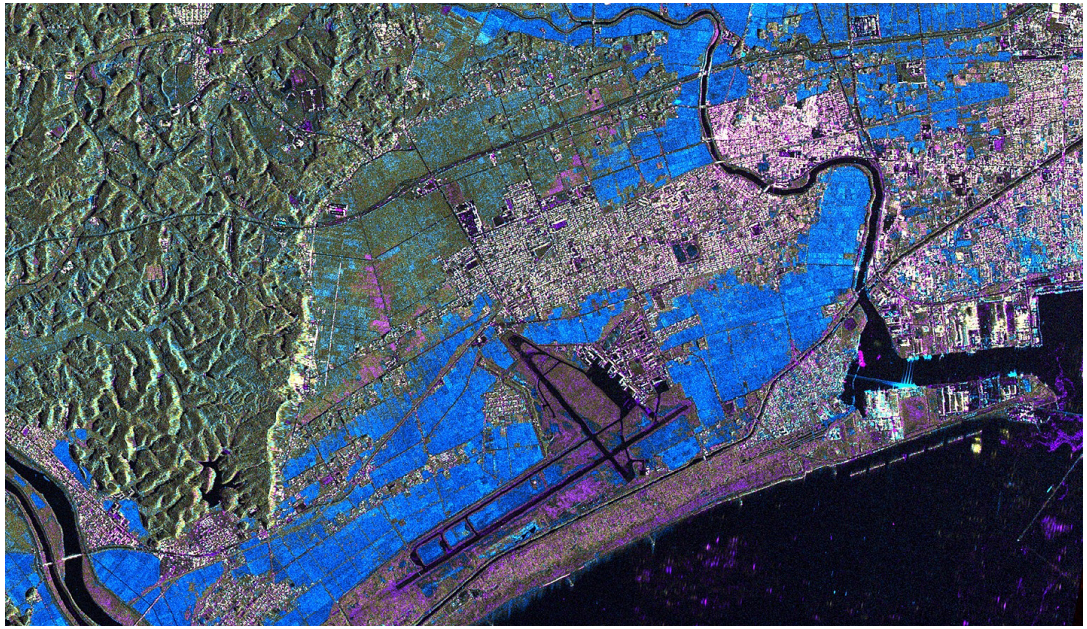
Flood Monitoring and Emergency Management

Flooding in Manitoba, Canada
RADARSAT-2
April 28, 2011



Dike protecting village of Morris

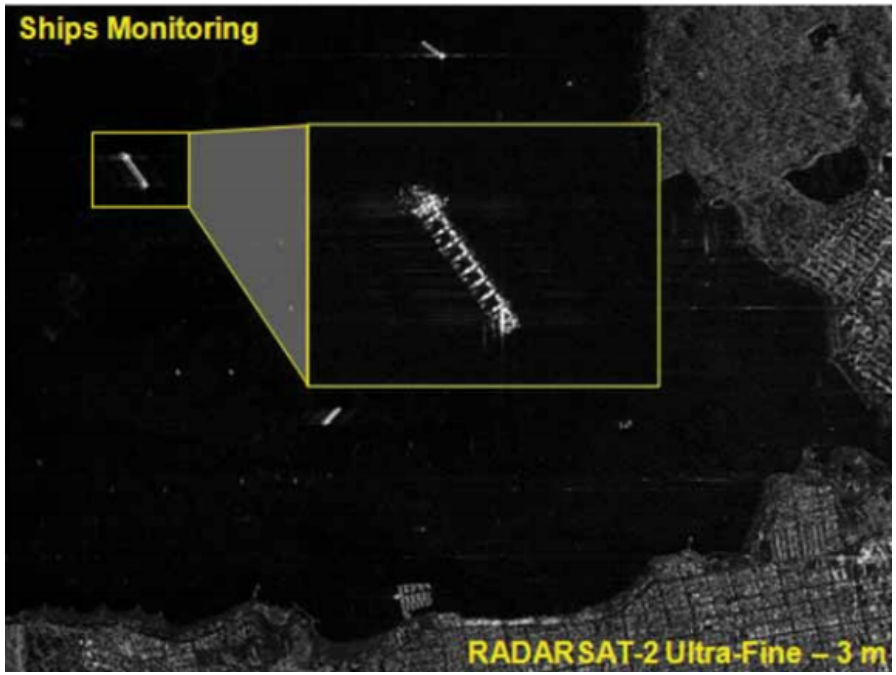
Source: ftp.neodf.nrcan.gc.ca



Impact of tsunami on Higashi-Matsushima Airport and the port of Ishinomaki, near Sendai captured by TerraSAR-X on 12 March 2011. The blue areas indicate the flooding; the magenta-coloured areas show the extent of the destroyed infrastructure.

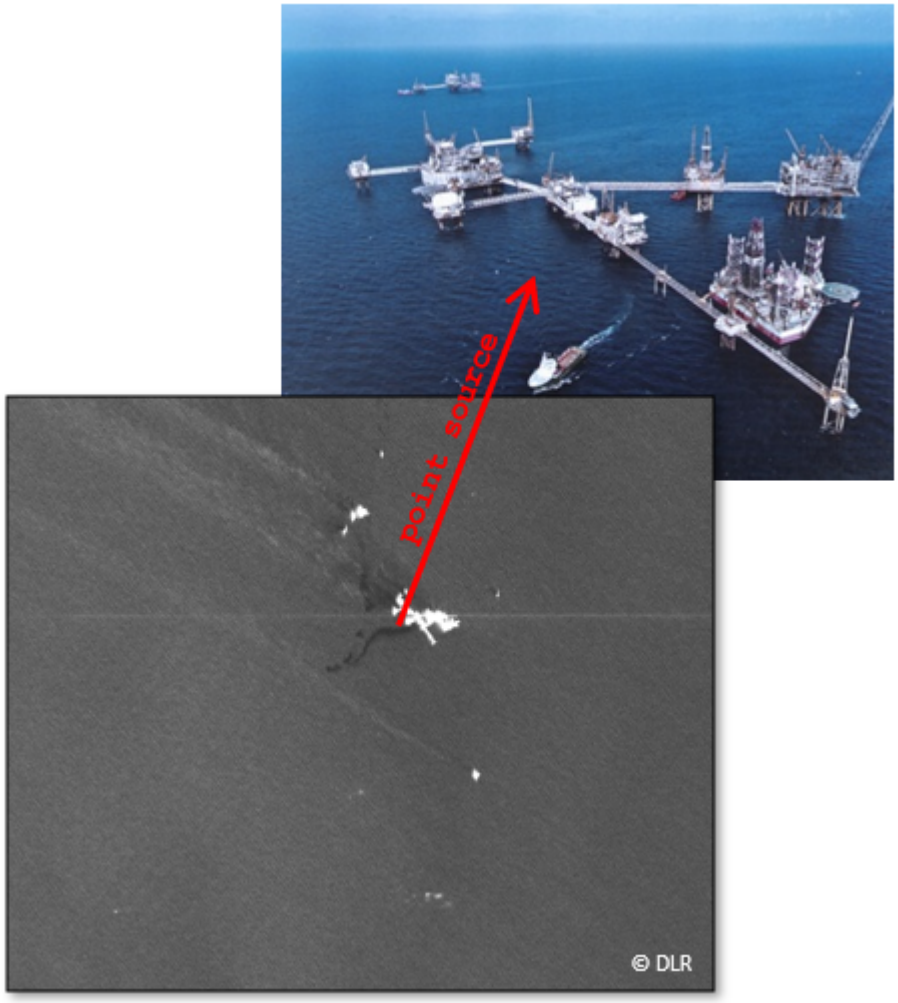
Credit: DLR (https://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10212/332_read-761/#/gallery/1538)

Ocean Monitoring



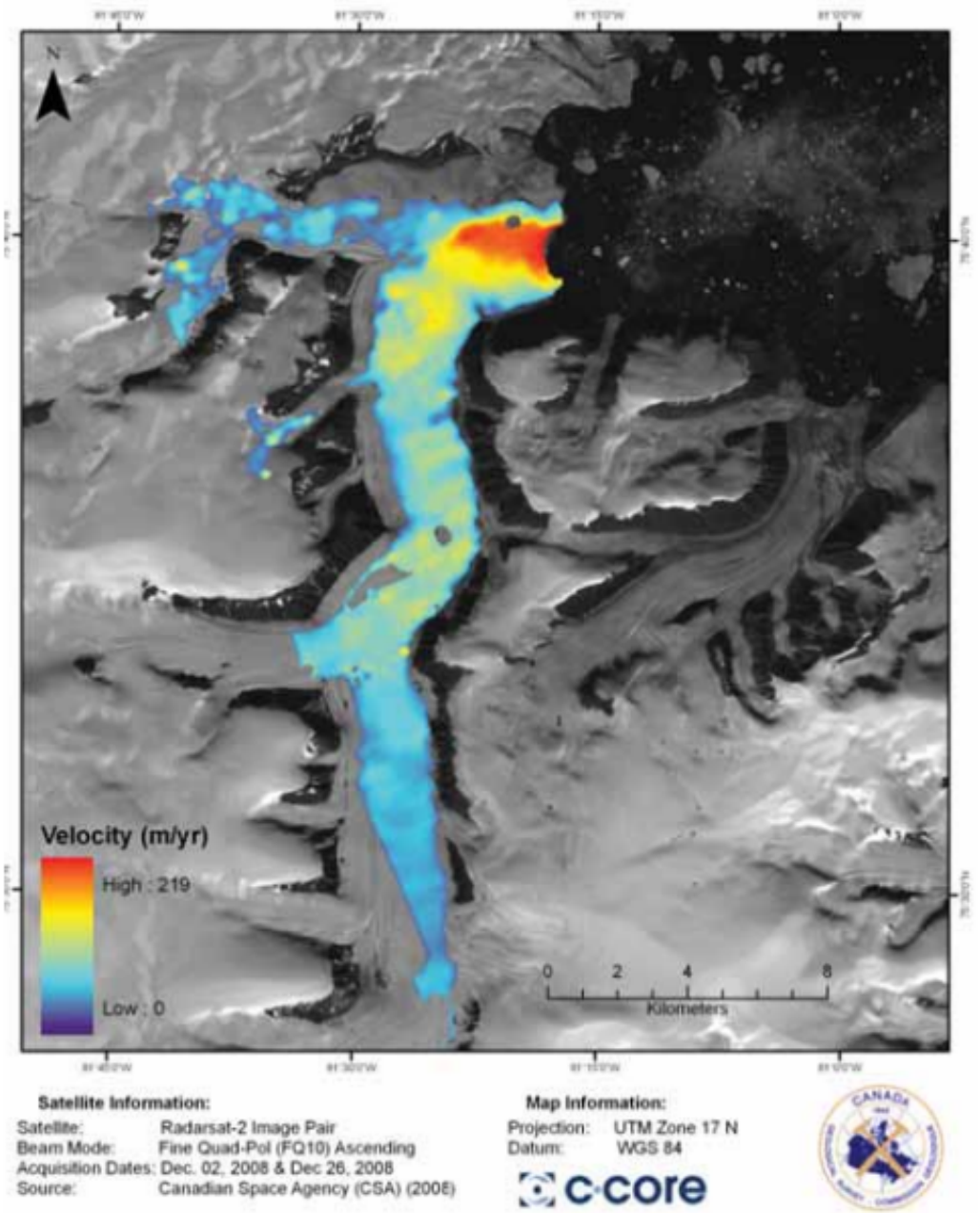
Ship in the harbor of Vancouver, British Columbia captured using the Radarsat-2 ultra-fine mode. The enlarged frame shows more details of the ship allowing the identification of the type of ship.

(www.asc-csa.gc.ca/pdf/solintermed-manuel-eng.pdf)



Ekofisk Platform in the North Sea. TerraSAR-X Spotlight image.
(Credit: DLR)

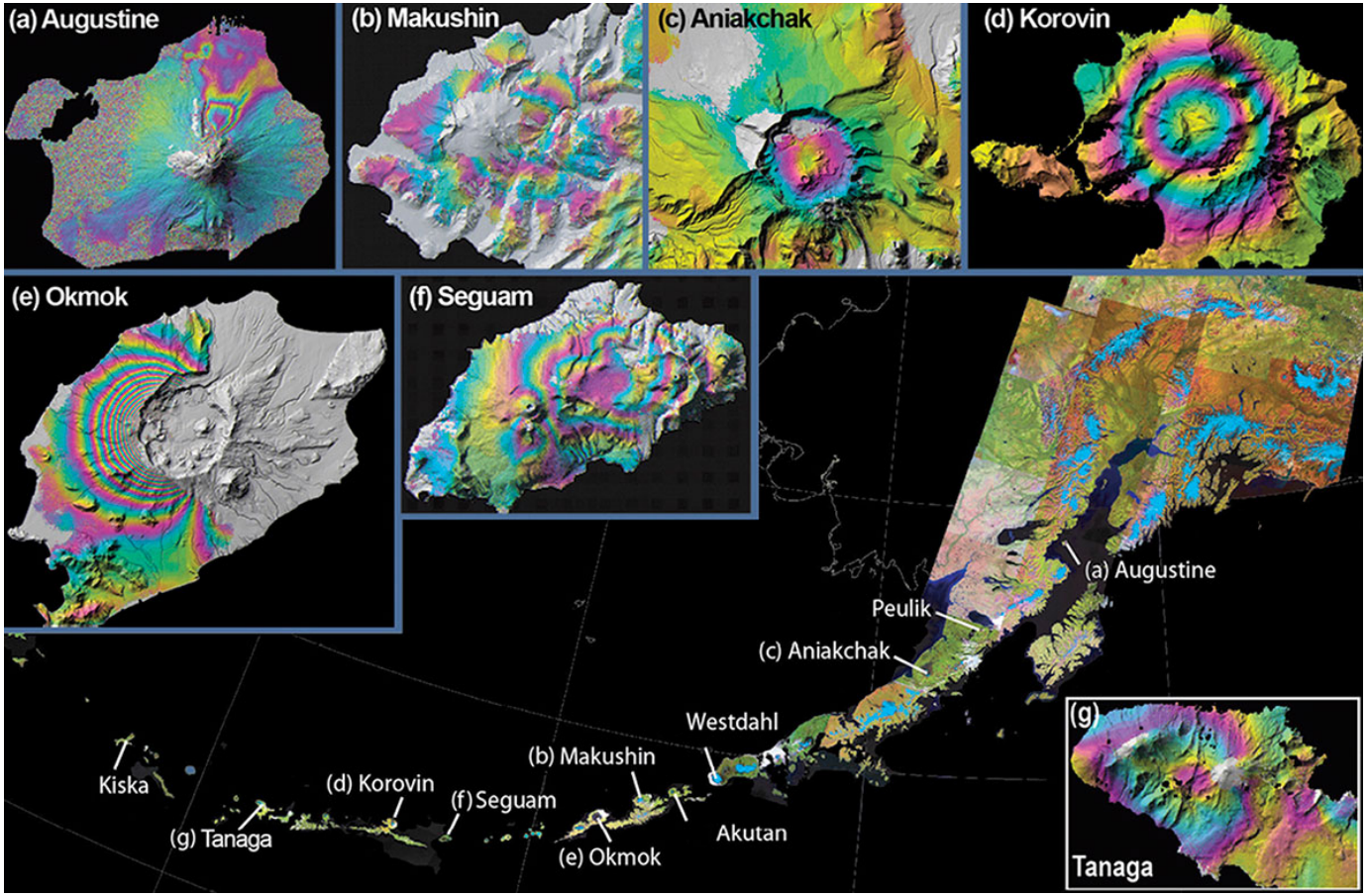
Monitoring Glaciers



Glacier velocity measured at the Belcher Glacier, located on Devon Island, Canada. The results were derived from a pair of RADARSAT-2. Fine beam images captured in December 2008. Areas in red indicate high velocity movement (±100 to 219 meters/year). Those areas coloured in purple and blue indicate low velocity (±0 to 100 meters/year).

(www.asc-csa.gc.ca/pdf/solintermed-manuel-eng.pdf)

Volcanic Activity in the Aleutian Arc



InSAR images from ERS-1, ERS-2, RADARSAT-1, and Envisat data show deformation of Aleutian volcanoes: Augustine compaction of 1986 and 2006 pyroclastic flow deposits; Makushin ~ 7 cm of surface uplift associated with a 1995 eruption; Aniakchak caldera subsidence at ~ 10 mm/year; Korovin more than 6 cm of inflation in 2006; Okmok deflation of > 50 cm during the 2008 eruption; Seguam surface uplift of > 6 cm from 1999 to 2000; Tanaga > 5 cm of inflation during the 2005 seismic swarm.

Source: Lu and Dzurisin, 2014

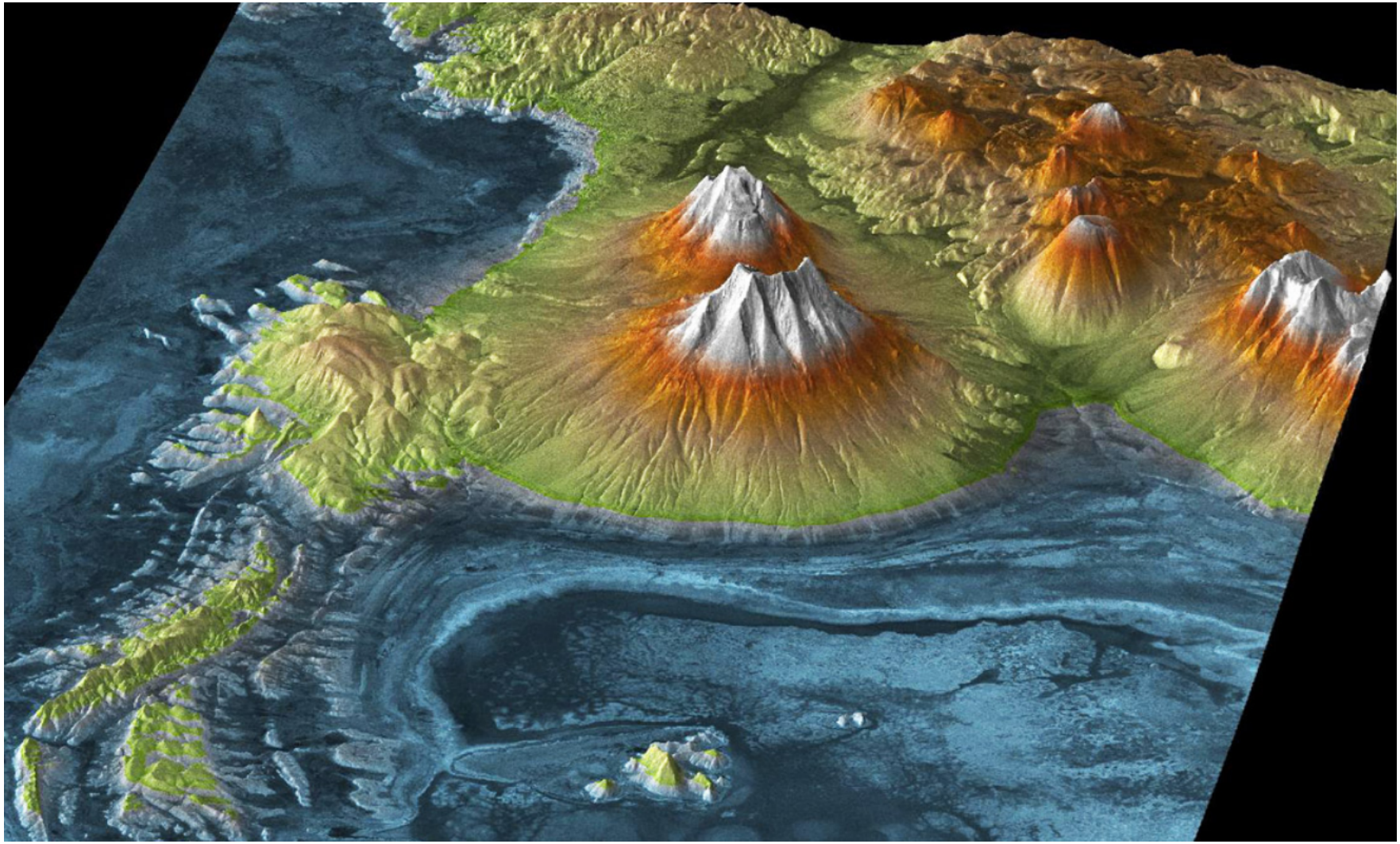
Urban Landscapes

Credit: e-GEOS
(www.esa.int/Our_Activities/Observing_the_Earth/Highlights/Earth_shifts_in_colour)

Satellite radar can detect heights in buildings and other structures, such as Saint Peter's Basilica in the heart of Rome, Italy. Red correlates to higher surfaces (above 60 m) while dark blue depicts lowers surfaces (less than 15 m).

To create this image, radar data from Italy's Cosmo-SkyMed mission were processed using 'persistent scatterer pair interferometry', a technique that can pinpoint surface deformations and heights over wide areas, with millimetre and metre precision, respectively.

DEM Generation



This TanDEM-X image shows Salar de Uyuni, the largest salt flats in the world covering 10,000 square kilometres, located next to the volcanic region of the Atacama Desert in Chile. The blue to dark blue areas show the lowest lying parts of the salt flats.

(www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10387#gallery/2526)

References

- Whitcraft, A. K., Becker-Reshef, I., Killough, B. D., & Justice, C. O. (2015). Meeting earth observation requirements for global agricultural monitoring: An evaluation of the revisit capabilities of current and planned moderate resolution optical earth observing missions. Remote Sensing, 7(2), 1482–1503.
- Kuntz, S. (2010). Potential of spaceborne SAR for monitoring the tropical environments. Tropical Ecology, 51(1), 3–10.