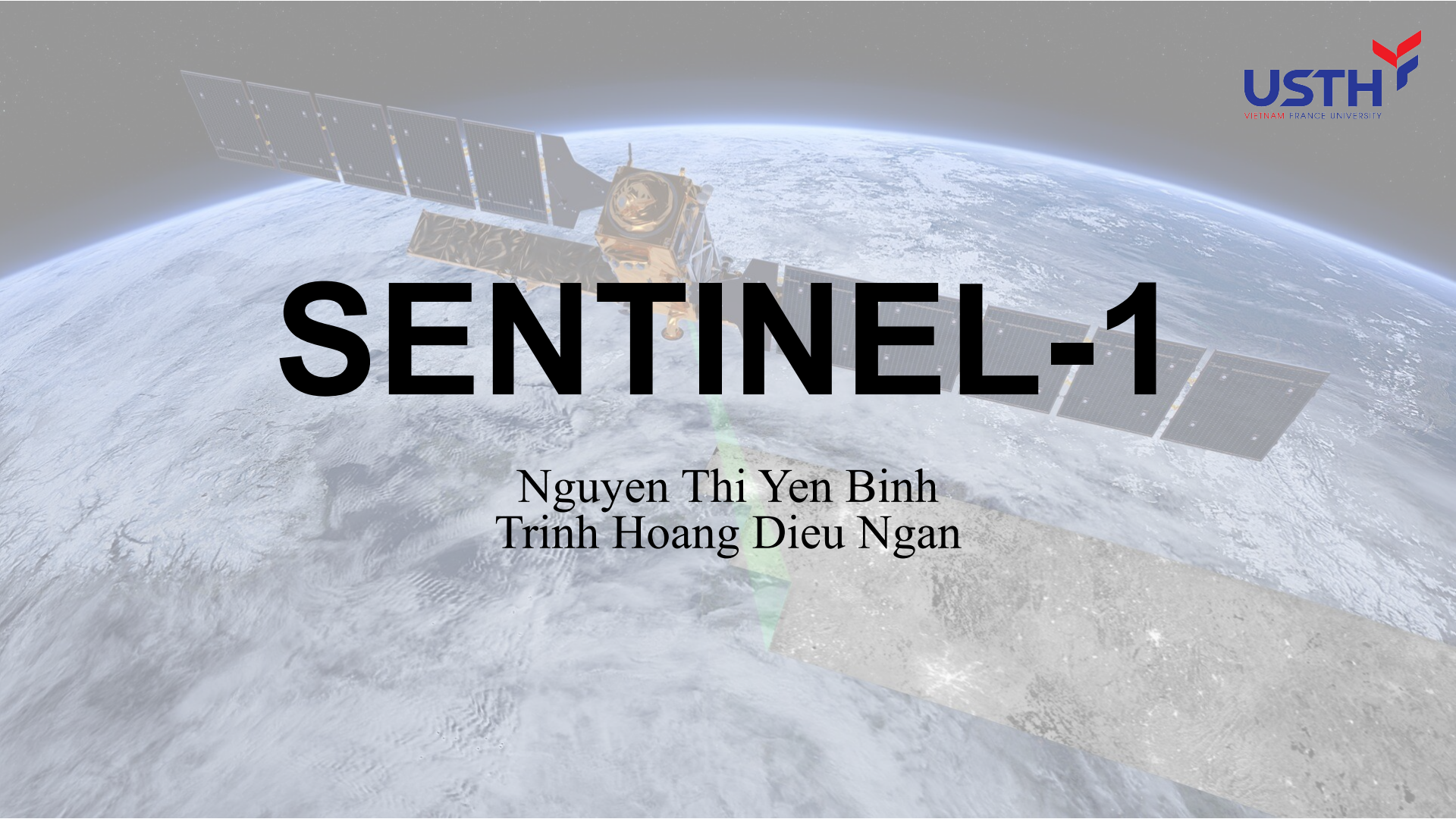


SENTINEL-1

Nguyen Thi Yen Binh
Trinh Hoang Dieu Ngan

Overview

- The first in the Sentinels series.
- The **Sentinel-1** satellites carry advanced **radar instruments**
  - Provide an all-weather, day-and-night images of Earth’s surface.

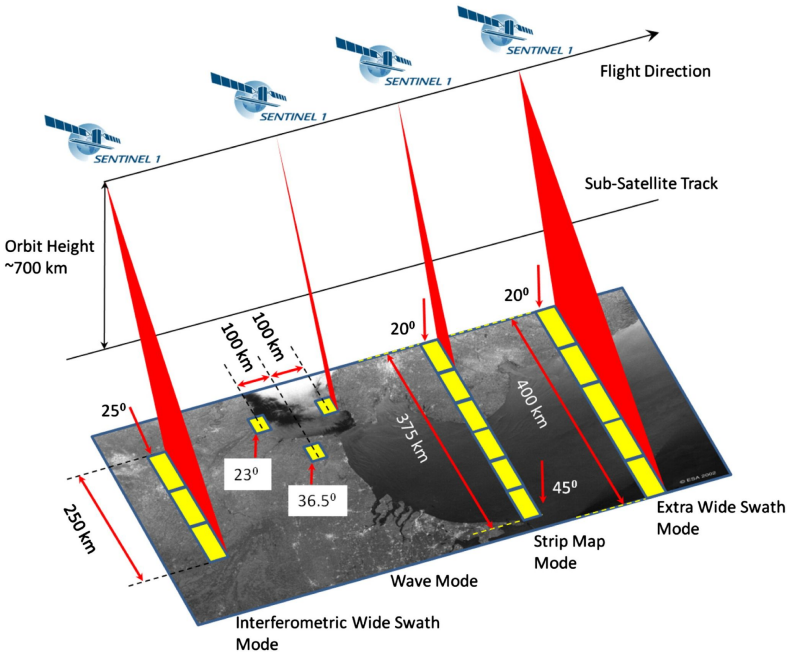
Overview

- **Sentinel-1** is the result of a huge collaboration:
  - **European Space Agency (ESA)**
  - European Commission (EC)
  - Industry, service providers and data users.
- Designed and built by a consortium of around **60 companies**.
  - led by Thales Alenia Space and Airbus Defence & Space.

Frequency Band

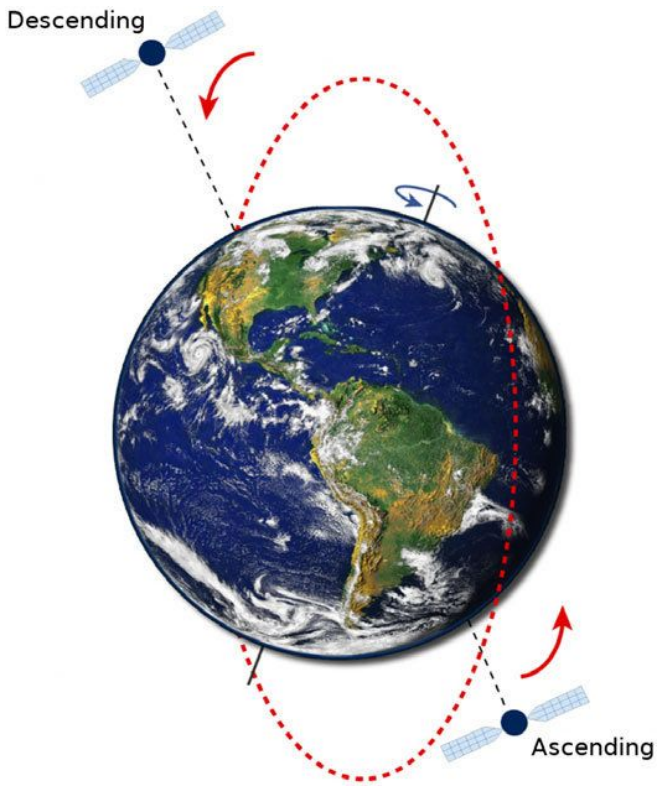
SENTINEL-1 carries a single **C-band** synthetic aperture radar instrument

- Centre frequency: 5.405 GHz
- Wavelength: ~5.5 centimeters
- Microwave portion of the electromagnetic spectrum



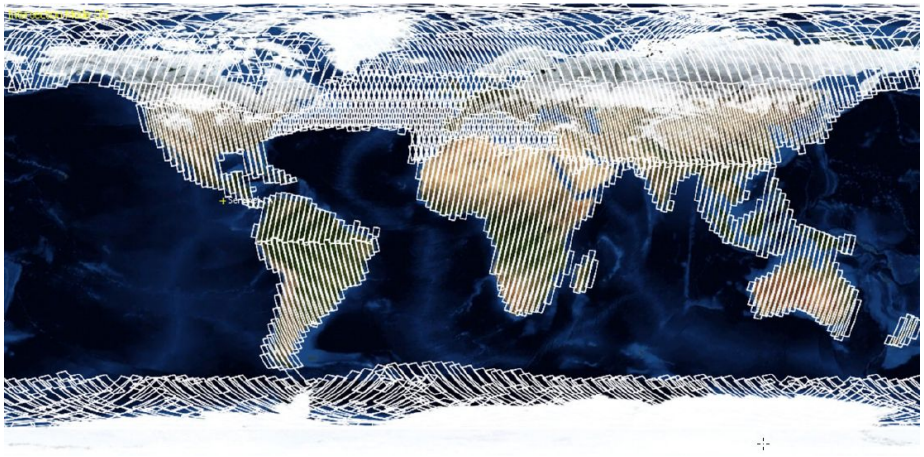
Number of satellites and Orbit

- The baseline mission concept under development is a **two-satellite constellation.**
- The identical satellites orbit Earth 180° apart and at an altitude of almost **700 km**.
  - Optimising coverage
  - Offering a global revisit time of just **six days**.



Number of satellites and Orbit

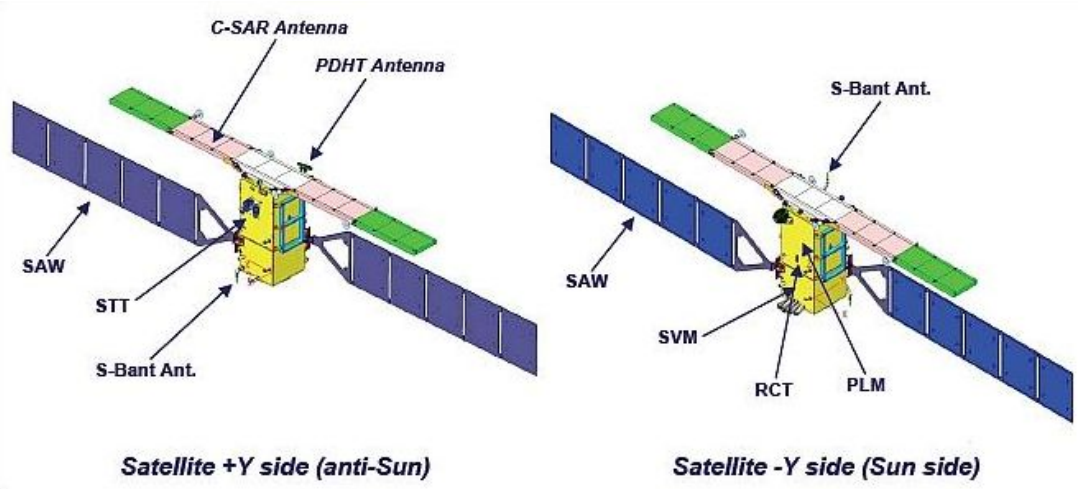
Orbit: Sun-synchronous near-polar orbit, repeat cycle of 12 days, cycle length of 175 days



SENTINEL-1 Coverage

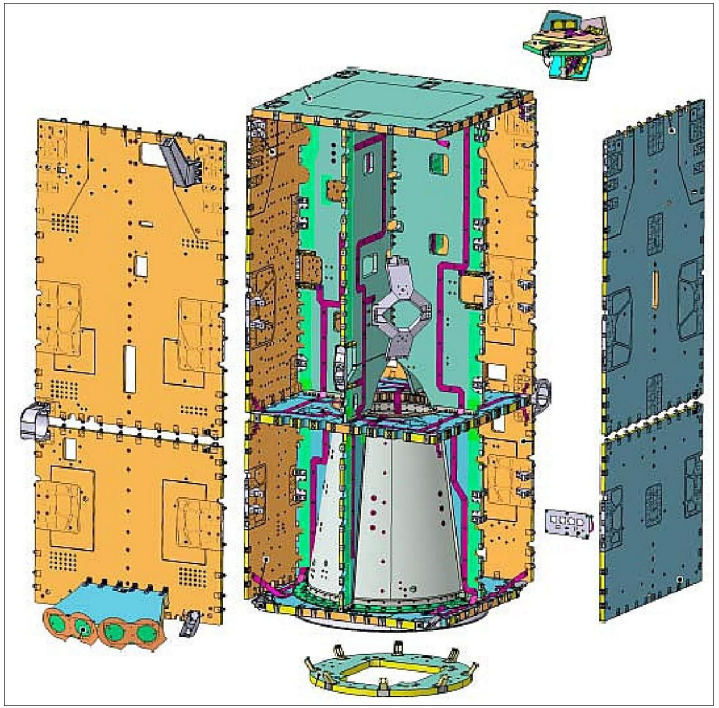
Satellite Description and Technologies

- The spacecraft is a three-axis, stabilised satellite
  - Sun, star, gyro and magnetic field sensors
  - A set of four reaction wheels dedicated to orbit and attitude control
  - Three torque rods as actuators to provide steering capabilities on each axis.
- The satellite is equipped with **two solar array wings** capable of producing 5 900 W (at end of life) to be stored in a modular battery.



Satellite +Y side (anti-Sun) *Satellite -Y side (Sun side)*

Satellite Description and Technologies

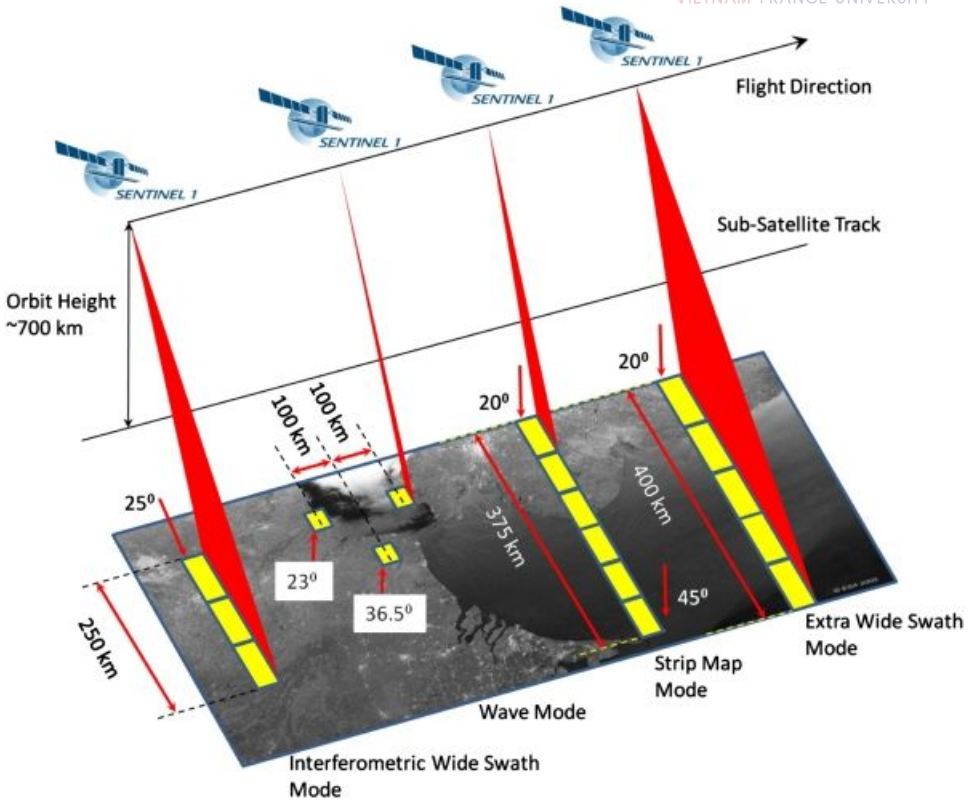


- Each satellite, weighing **2300 kg**, has been designed for a minimum lifetime of **seven years** in orbit.
- The design has benefited from experience gained with Canada's Radarsat-2 and Italy's Cosmo-SkyMed and uses the **Piattaforma Italiana Multi Applicativa (PRIMA)** bus.
- The satellite platform provides features
  - Management of the attitude and orbit control systems
  - Data handling
  - Propulsion
  - Power
  - Thermal control
  - Spacecraft autonomy
  - Failure detection identification and recovery
  - Communication with the ground

Acquisition modes

- **Stripmap (SM):** The ground swath is illuminated by a continuous sequence of pulses while the antenna beam is pointing to a fixed azimuth angle

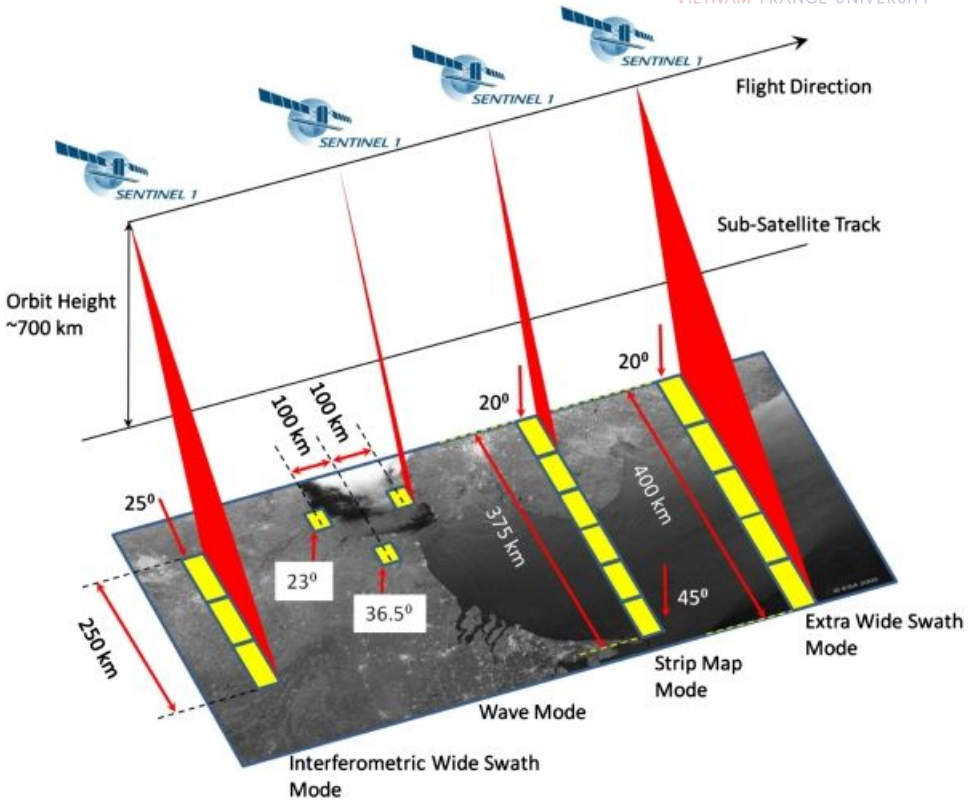
- **Interferometric Wide swath (IW):** captures three sub-swaths



Acquisition modes

- **Extra-Wide swath (EW):** Similar to the IW mode, acquire data over a wider area than for IW mode using five sub-swaths

- **Wave (WV):** consist of several vignettes, with each vignette processed as a separate image.



Resolutions

Spatial resolutions depend on the acquisition mode and the level of processing.

Level-1 SLC

(Singe Look Complex)

Mode	Resolution (rg x az)
SM	1.7x4.3 m to 3.6x4.9 m
IW	2.7x22 m to 3.5x22 m
EW	7.9x43 m to 15x43 m
WV	2.0x4.8 m and 3.1x4.8m

Resolutions

Level-1 GRD (Ground Range Detected)

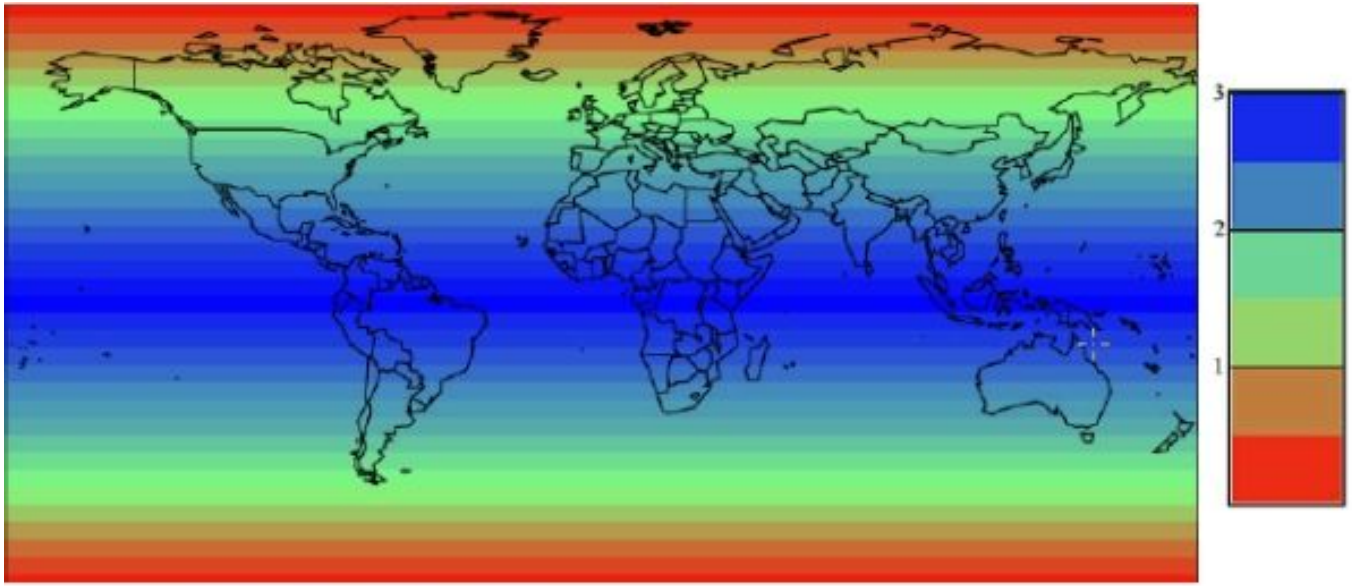
- Full Resolution (FR) for SM mode: 9x9 m
- High Resolution (HR) for SM, IW and EW modes: 20x22, 23x23, 50x50 (m)
- Medium Resolution (MR) for SM, IW, EW and WV modes: 52x51, … 93x87 (m)

Resolutions

Level-2 OCN (Ocean)

- Swell spectra (OSW): 20x20 km.
- Wind fields (OWI) and surface radial velocity (RVL): 1x1 km (for SM/IW/EW).
- WV: 20x20 km

Revisit & Coverage



- ✓ Two satellites in a 12 day orbit
- ✓ Repeat frequency: 6 days (important for coherence)
- ✓ Revisit frequency: (asc/desc & overlap): 3 days at the equator, <1 day at high latitudes (Europe ~ 2 days)

Applications: Maritime Monitoring

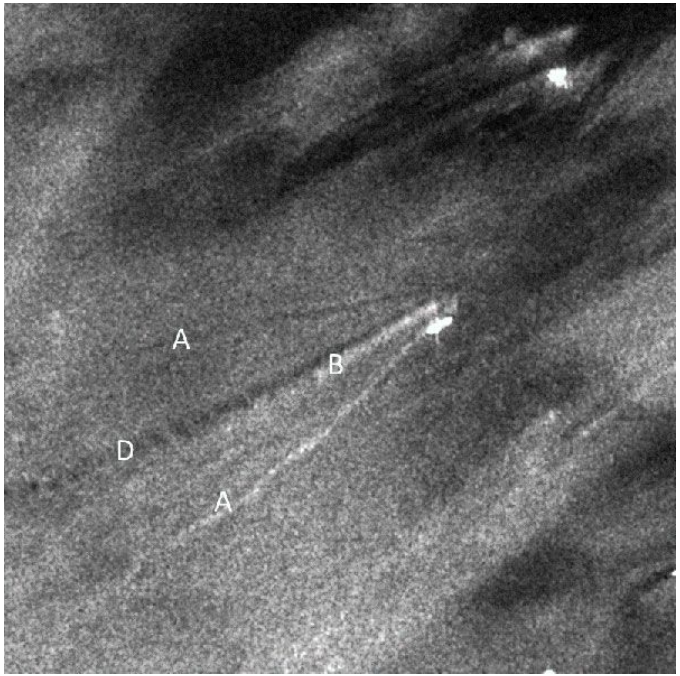
Ice Monitoring: Ice classification and iceberg data to national coast guards, navies and shipping companies

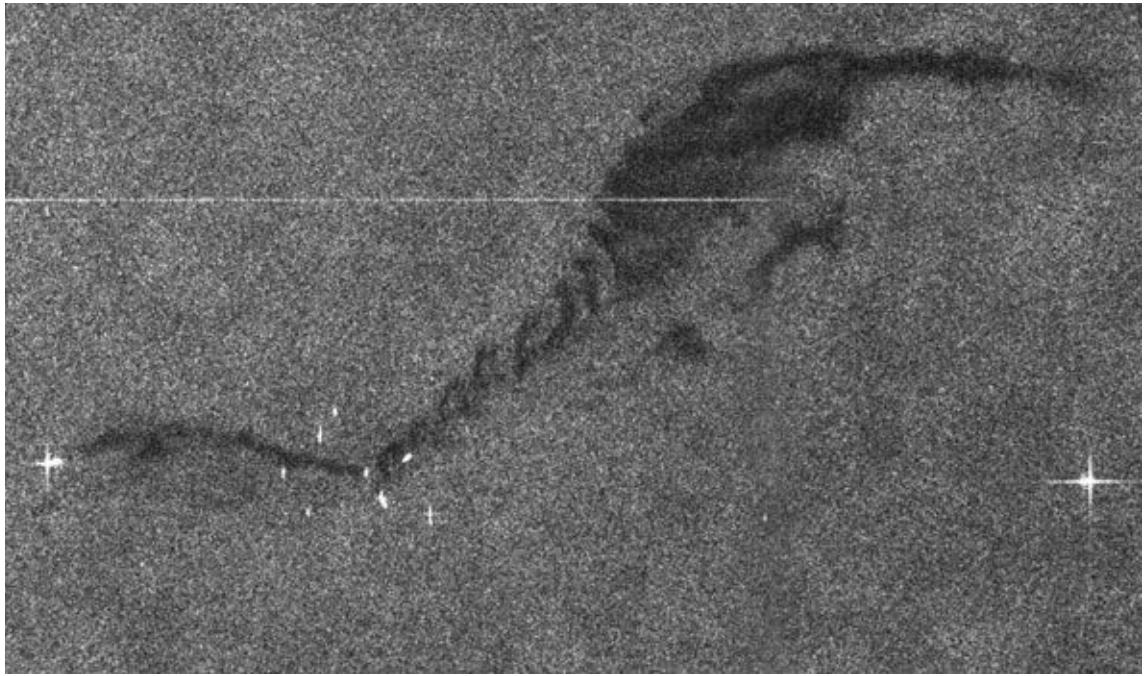
Ship Monitoring: Detect ships. Observe in all weather and in day or night time, makes it ideal for precise cueing and location of ship activities at sea.

Oil Pollution Monitoring

Marine Winds: Sensitive to spatially varying surface roughness patterns caused by winds on the ocean surface → direction, wavelength and heights of waves on the open oceans

Applications: Maritime Monitoring





Ship wake pattern on SAR imagery & Oil spill observed off the Belgian coast near Zeebrugge on 08/10/2015 after a collision between two vessels.

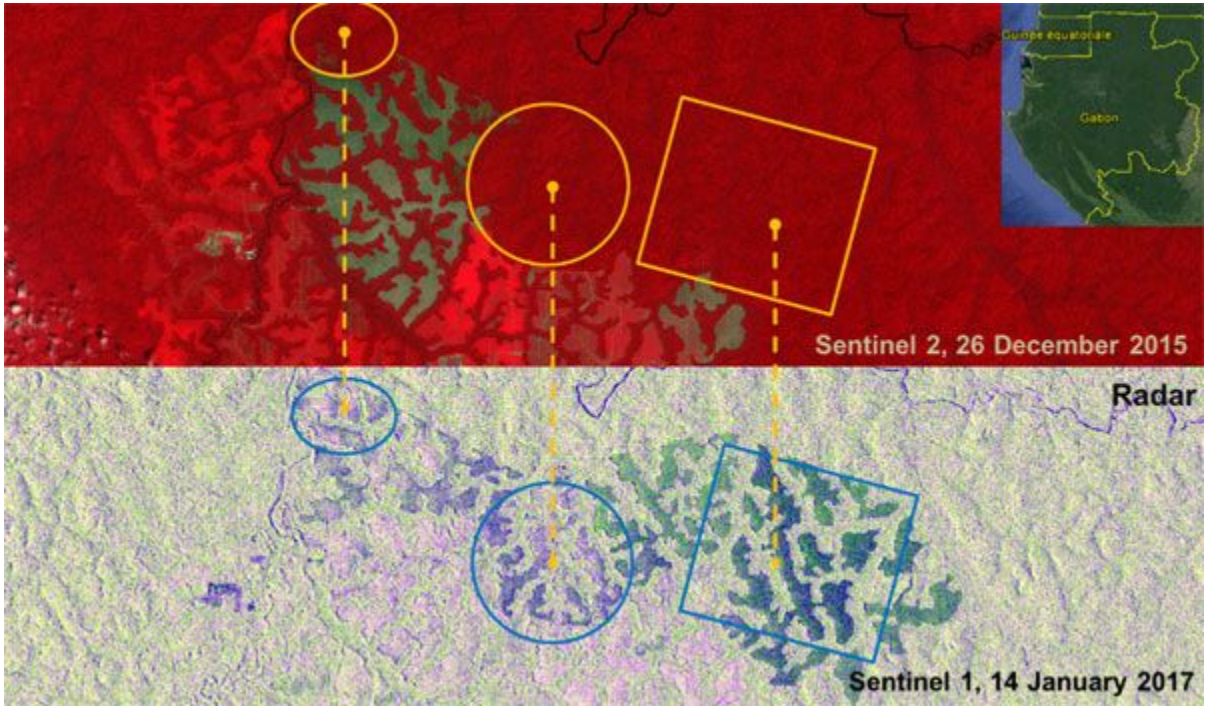
Applications: Land Monitoring

Forestry: detection, forest type classification, biomass estimation and disturbance detection. For climate change, mapping of forest fire scars → mapping the carbon history of a forest → estimation of carbon emissions.

Agriculture: Monitoring of crop conditions, soil properties and mapping tillage activities → assess land use, predict harvests, monitor seasonal changes

Urban Deformation Mapping: detect surface movements with an accuracy of a few millimetres per year → monitoring of land subsidence, structural damage and underground construction
→ improve safety and reduce economic loss.

Applications: Land Monitoring



Monitoring of expansion of rubber plantation

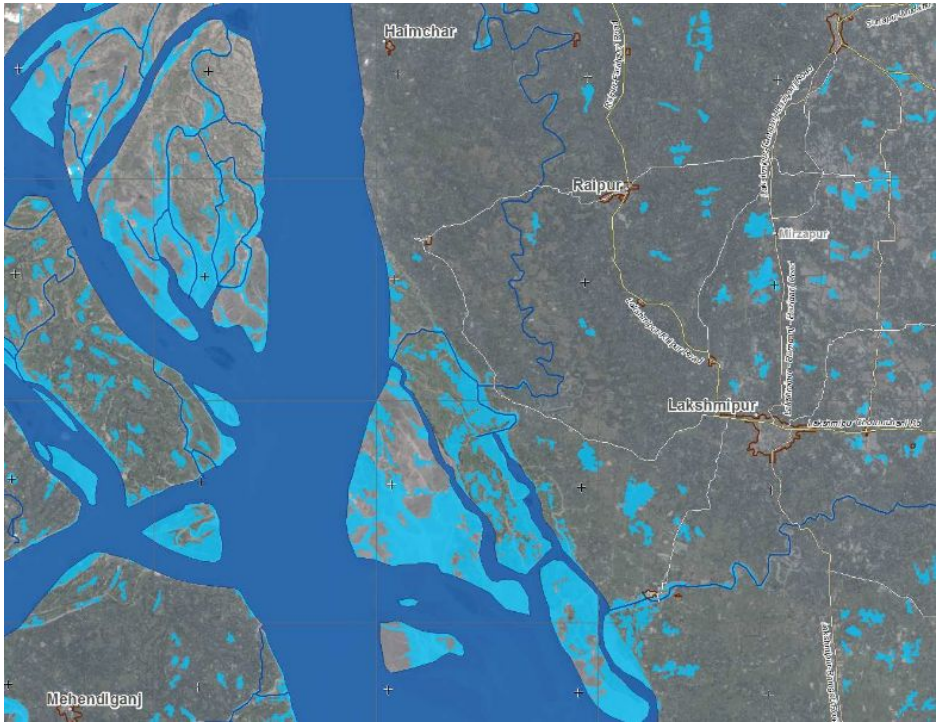
Applications: Emergency Management

Flood Monitoring: assess the extent of flooded areas and the impact on human, economic and environmental loss.

Earthquake Analysis: Maps of earthquake deformations → monitoring of earthquake-prone areas active → potential risks

Landslide Monitoring: Locate areas prone to landslides and monitor surface deformation → early warning of potential disasters and monitoring of critical infrastructure

Applications: Emergency Management



Mapping of flooded areas in Bangladesh in 2016 from semi-automatic classification of Sentinel-1 data


Thank you for listening