Satellite Data Offered in Southern Africa by Copernicus

Sentinel Missions

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Introduction

- Remote sensing is the acquisition of information about an object without making physical contact with the object.
- It is used in land surveying, geography, most earth science disciplines, military, intelligence, commercial, economic, planning, and humanitarian applications.
- In current usage, remote sensing refers to the use of satellite technologies to detect and classify objects on Earth (surface, atmosphere, oceans).
- Satellite imagery refers to images of Earth or other planets collected by imaging satellites.

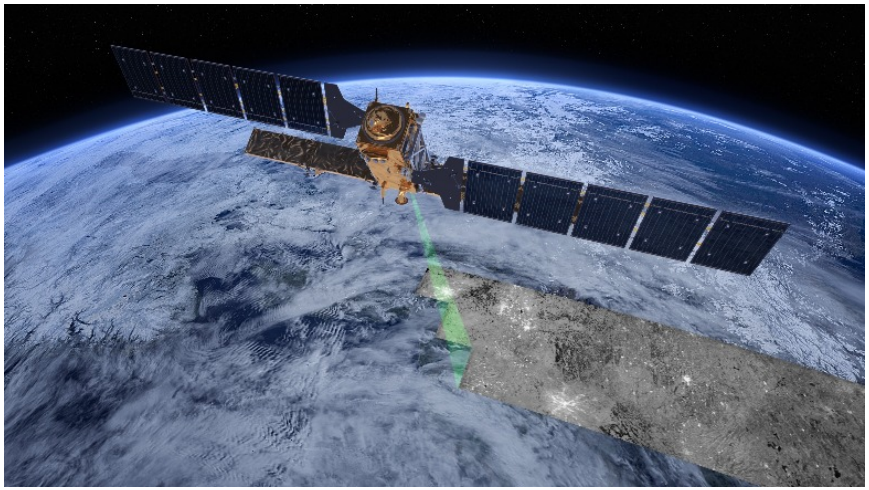
Copernicus

- The Copernicus sentinel program is an initiative by the European Space Agency (ESA) aimed at providing access to Earth Observation (EO) data for public and private consumption.
- The program divided into missions. Sentinel- 1, Sentinel-2, Sentinel-3, Sentinel-4, Sentinel-5, Sentinel-5P each operating its own satellite.
- Each of these missions provides a different set of data that can be used according to the needs of the client.
- Many providers of satellite data: **Private**: GeoEye, DigitalGlobe, Spot Image, BlackBridge, ImageSat International, China Siwei, **Public**: Meteosat, ASTER, MODIS, Landsat, Sentinel.
- Only Sentinel-1 and Sentinel-2 data is of interest to us.

Sentinel-1

SENTINEL-1 is an imaging radar mission providing continuous all-weather, day-and-night imagery which can be used for:

- Marine monitoring
  - Sea-ice levels and conditions
  - Ocean oil spills
  - Ship activity
  - Marine Winds
- Land monitoring
  - Agriculture
  - Forestry
- Emergency services
  - Flooding
  - Landslide and volcanic
  - Earthquakes

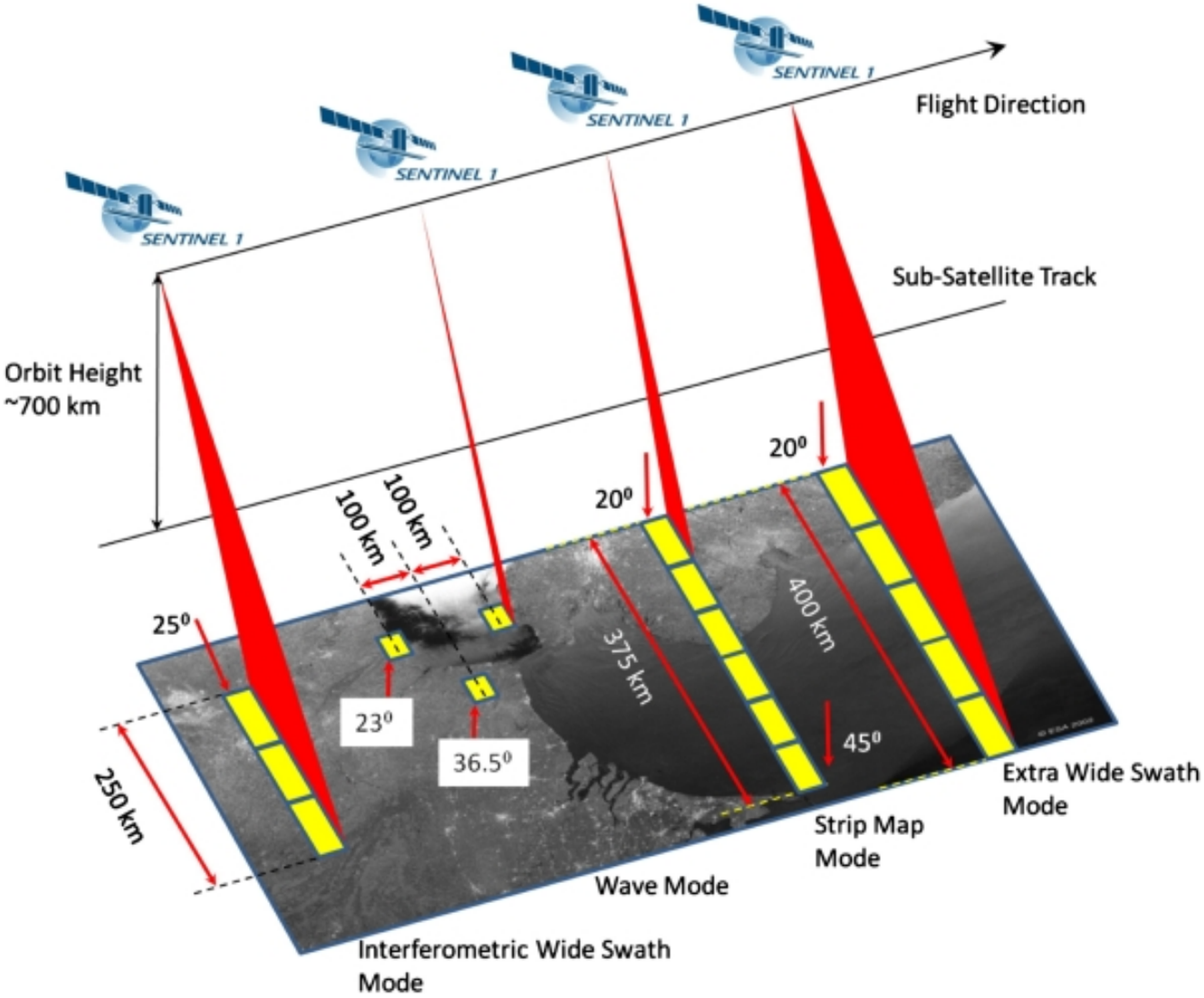


Sentinel-1 Operational Modes

Sentinel-1 has four operational (acquisition) modes:

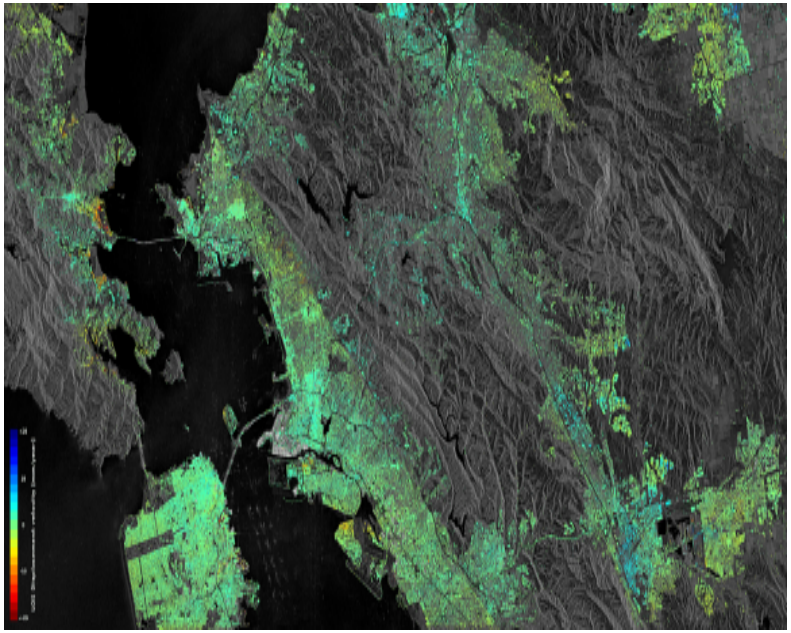
- Strip Map (SM): 5-by-5-metre spatial resolution and an 375 km swath.
  - Small islands, emergency management
- Interferometric Wide Swath (IW): 5-by-20-metre spatial resolution and a 250 km swath.
  - Operational mode over land
- Extra Wide Swath (EW): 25-by-100-metre spatial resolution and a 400 km swath.
  - Monitor wide coastal areas, shipping traffic and potential environmental hazards (oil spills, changes in sea ice)
- Wave (WV): 5-by-20-metre resolution. Produces 20 by 20 km sample images along the orbit at intervals of 100 km.

Sentinel-1 Operational Modes



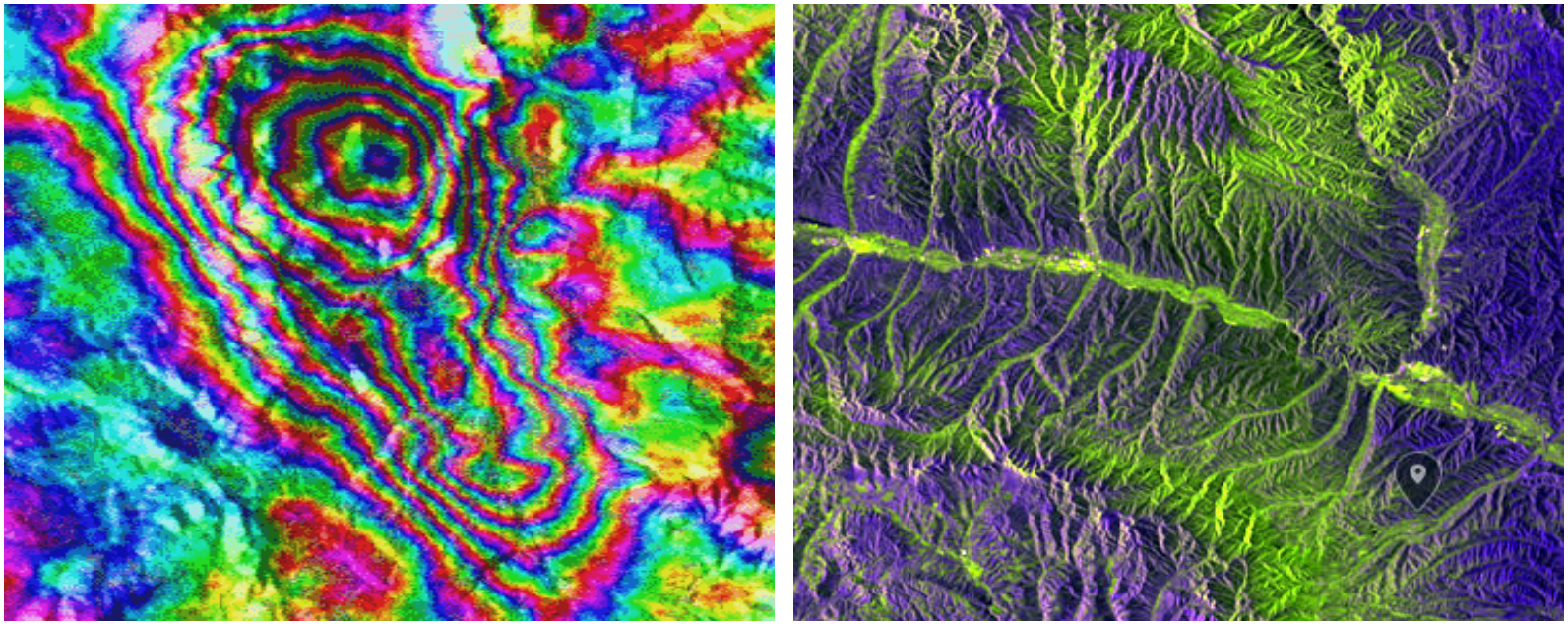
Sentinel-1 Images

- S-1 showing sinking and rising areas in cities



Sentinel-1 Images

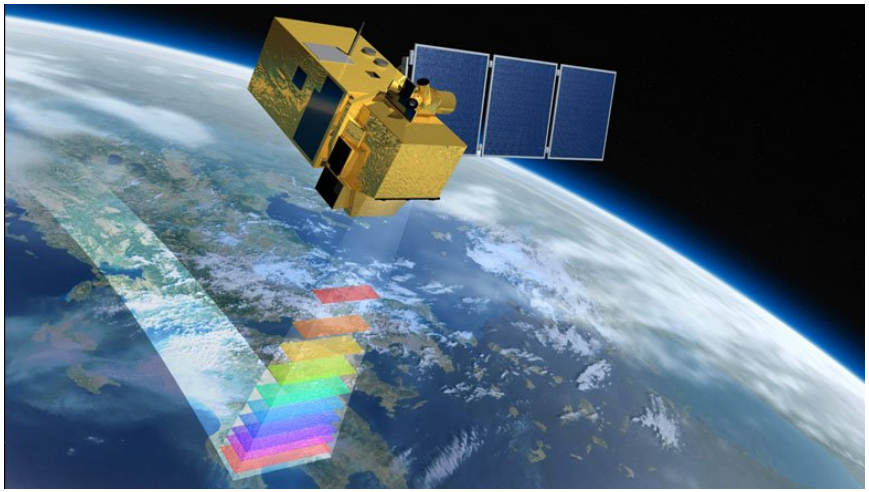
- S-1 data showing an earthquake



Sentinel-2

SENTINEL-2 is a wide-swath, high-resolution, MSI mission. It is a constellation of twin satellites, Sentinel-2A and Sentinel-2B. It is mainly used for:

- Spatial planning
- Agro-environmental monitoring
- Water monitoring
- Forest and vegetation monitoring
- Land carbon, natural resource monitoring
- Global crop monitoring



Sentinel-2A Spectral Bands

Bands	wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
Band 1	442.7	21	60
Band 2	492.4	66	10
Band 3	559.8	36	10
Band 4	664.6	31	10
Band 5	704.1	15	20
Band 6	740.5	15	20
Band 7	782.8	20	20
Band 8	832.8	106	10
Band 8A	864.7	21	20
Band 9	945.1	20	60
Band 10	1373.5	31	60
Band 11	1613.7	91	20
Band 12	2202.4	175	20

Sentinel-2 Images

- Examples of sentinel-2B "RGB" image viewed with bands B2, B3, B4

Sentine-2 Images

- Examples of sentinel-2B "RGB" image viewed with bands B3, B4, B8

Data Processing Levels

SENTINEL data is divided into three levels:

- Level 0
  - Reconstructed unprocessed data, full space-time resolution used in subsequent processing.
- Level 1
  - Reconstructed data, full resolution, time-referenced, with ancillary information: radiometric and geometric calibration coefficients and geo-referencing parameters.
- Level 2
  - Derived geophysical parameters derived from Level-1 data.
- Depending on the mission, different levels are available to the public. we are more interested in level 1.

Outlook

- Capegemini developed a Machine Learning framework that uses synthetic aperture radar (SAR) satellite imagery to identify woodland with newly planted trees.
- Researchers at Stanford University developed a Machine Learning model that can predict poverty. The model uses satellite imagery to gather data and then executes an algorithm.
- For demographers and urban planners who rely on the interpretation of satellite imagery, Machine Learning can be used to predict population patterns, urban-rural distribution and poverty levels.
- Satellite image classifiers is used for many applications such as modern city planning, agriculture and environmental monitoring.
- We intend to use Machine Learning Classifiers on satellite data.

Backup

Bands	wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
Band 1	442.2	21	60
Band 2	492.1	66	10
Band 3	559.0	36	10
Band 4	664.9	31	10
Band 5	703.8	16	20
Band 6	739.1	15	20
Band 7	779.7	20	20
Band 8	832.8	106	10
Band 8A	864.0	22	20
Band 9	943.2	21	60
Band 10	1376.9	30	60
Band 11	1610.4	94	20
Band 12	2185.7	185	20

Study area

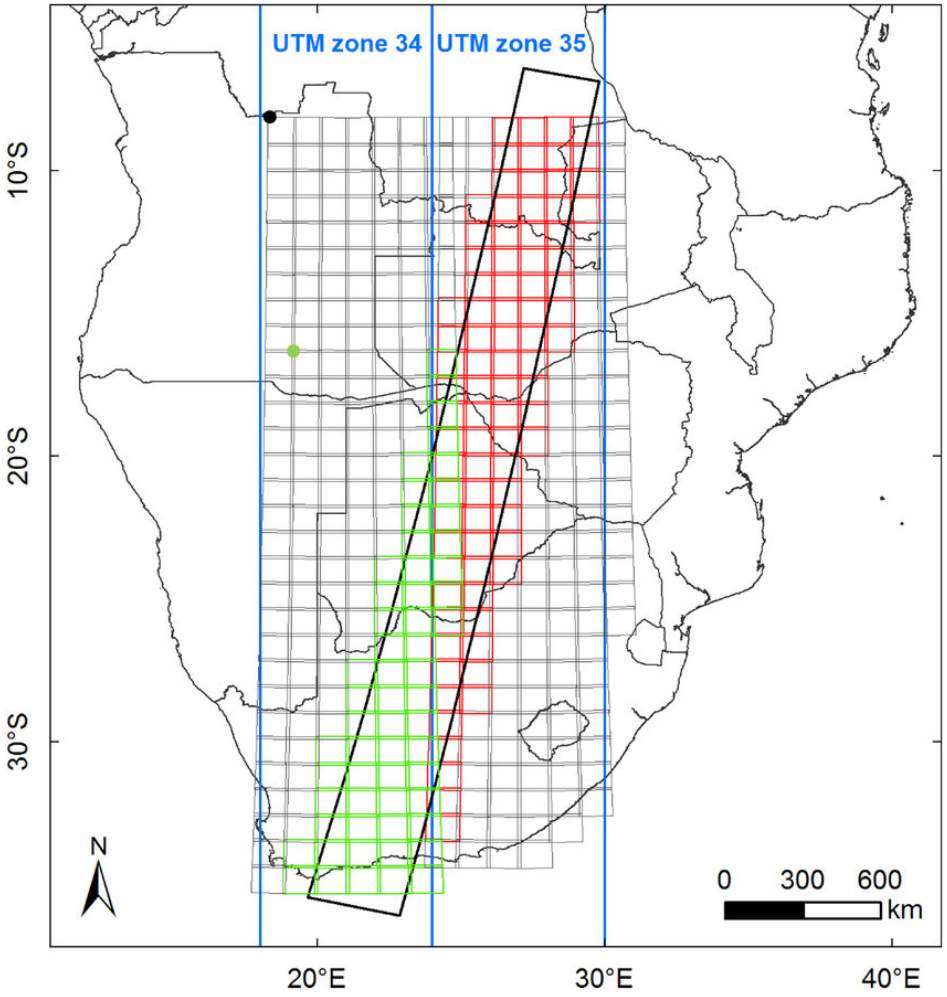


Figure: Tiles and granules