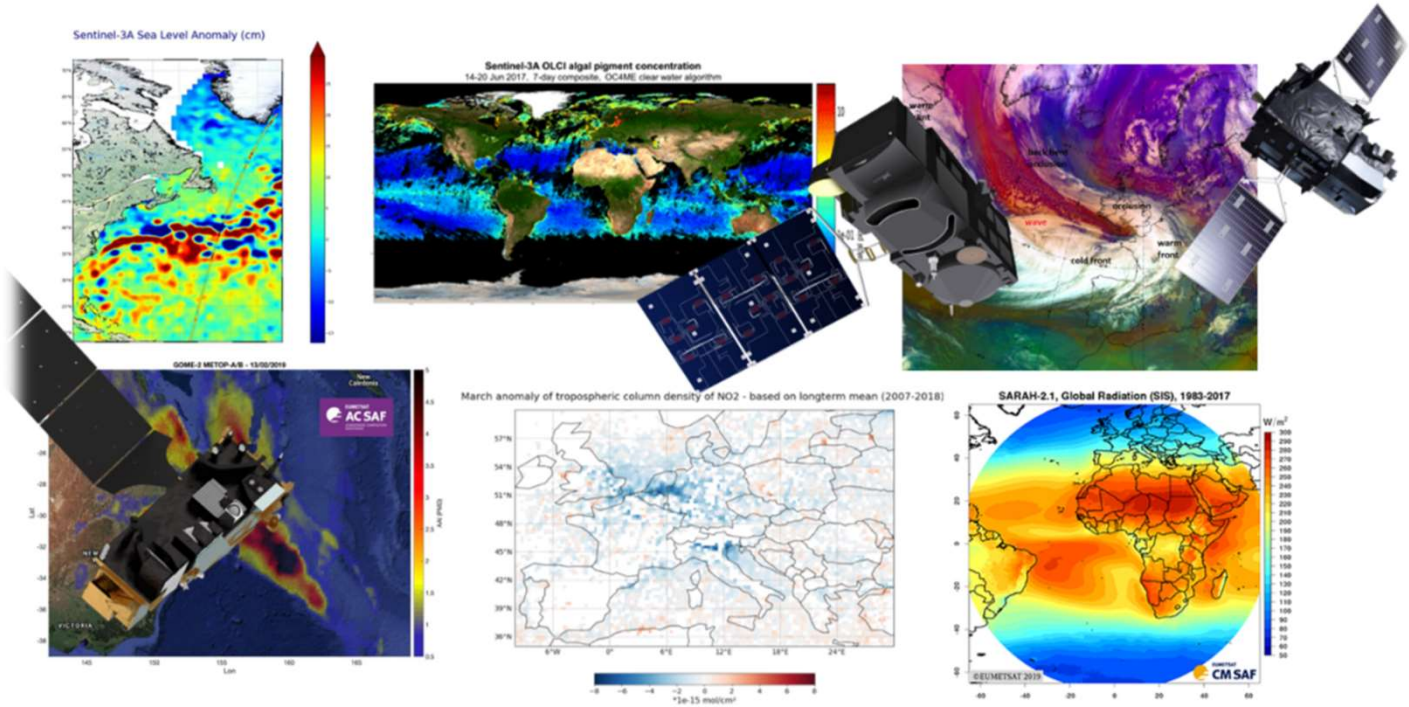
Welcome to the 32th short online course in the series
The session will begin at 12 UTC



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For **Q&A**: go to Slido.com – event code: **#EUMSC32**

Upcoming Short Courses

- **15 June,** 12:00 UTC **- Recent Developments in Altimetry Measurements - Sentinel-6 Michael Freilich**, with Ben Loveday, Vinca Rosmorduc, Christine Traeger Chatterjee and Hayley Evers-King

- **30 June,** 12:00 UTC **- Data Access How-to Sessions - New S3 Data (II)** Instructors: Ben Loveday, Niklas Jordan
  Facilitated by: Pablo Benedicto

- **8 September,** 12:00 UTC **- Data Access How-to Sessions - New S3 Data (II)** Instructors: Ben Loveday, Niklas Jordan
  Facilitated by: Pablo Benedicto

https://training.eumetsat.int/
→Events → Short Courses

Register at:
https://training.eumetsat.int/course/index.php?categoryid=97

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Tasks

- Develop, maintain, exploit European systems of meteorological satellites, taking into account as far as possible the recommendations of WMO.
- Contribute to operational climate monitoring and the detection of global climatic changes.

Current EUMETSAT Satellites

METOP-B, & -C

LOW EARTH, SUN-SYNCHRONOUS ORBIT

EUMETSAT POLAR SYSTEM (EPS)

SENTINEL-3 A & B

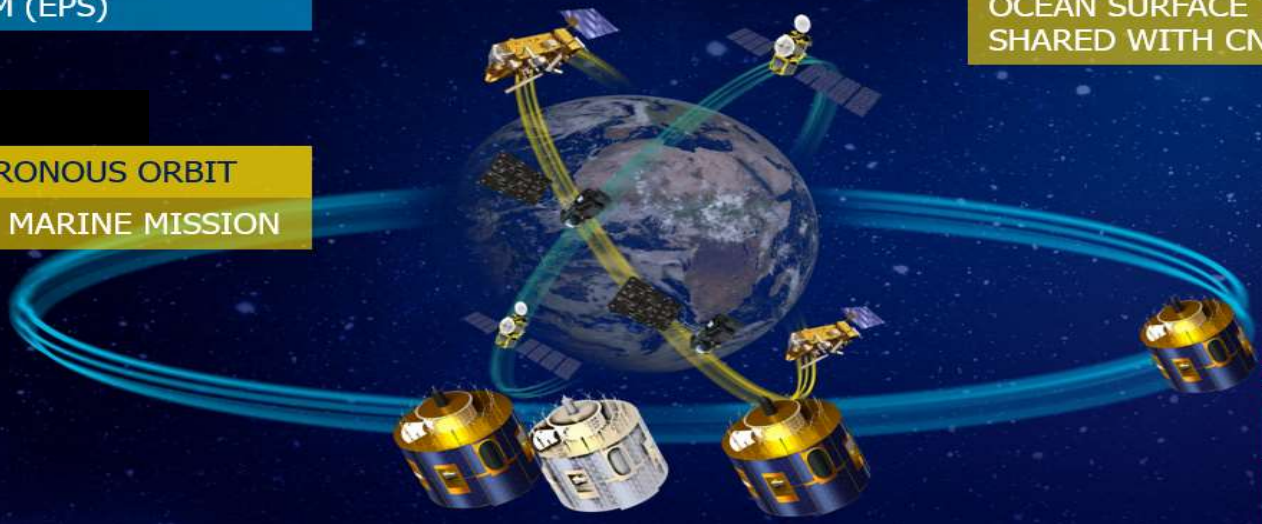
LOW EARTH, SUN-SYNCHRONOUS ORBIT

COPERNICUS SENTINEL-3 MARINE MISSION

JASON-2 & -3, Sentinel-6

LOW EARTH, NON-SYNCHRONOUS ORBIT

OCEAN SURFACE TOPOGRAPHY MISSION, SHARED WITH CNES/NOAA/EU



METEOSAT-8

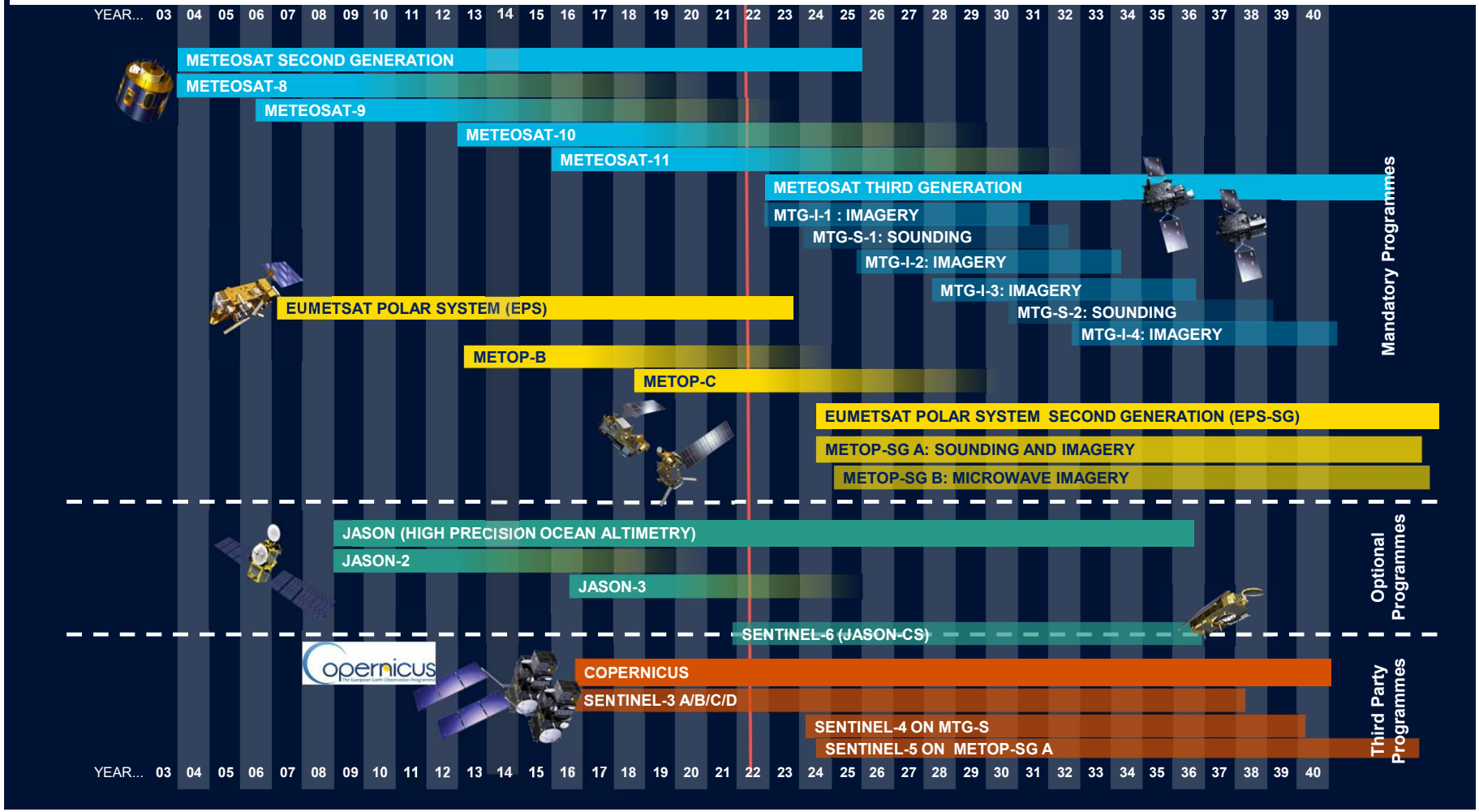
GEOSTATIONARY ORBIT

METEOSAT-9 REPLACING METEOSAT-8 FROM 1 JUNE 2022

METEOSAT-9, -10, -11

GEOSTATIONARY ORBIT	TWO-SATELLITE SYSTEM
METEOSAT 2ND GENERATION	FULL DISC IMAGERY SERVICE (15 MINS): METEOSAT-11 (0°)
	RAPID SCAN SERVICE OVER EUROPE (5 MINS): METEOSAT-10 (9.5° E)
	METEOSAT Third Generation (MTG), launch 2022

https://www.eumetsat.int/



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Discussion Q&A on: slido.com #EUMSC32

Course Material: https://training.eumetsat.int/course/view.php?id=442

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EUMETSAT

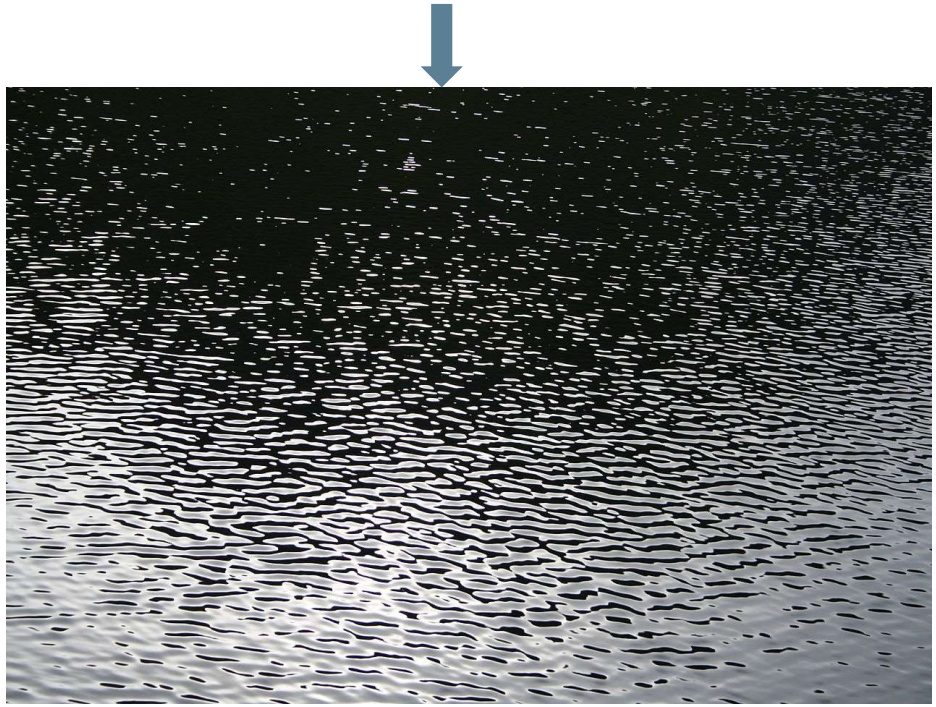
Marine Weather Forecasting

Carla Barroso and Ivan Smiljanic
EUMETSAT

8 June 2022

How is wind measured from Scatterometers?

- Wind across the water surface sets up stresses

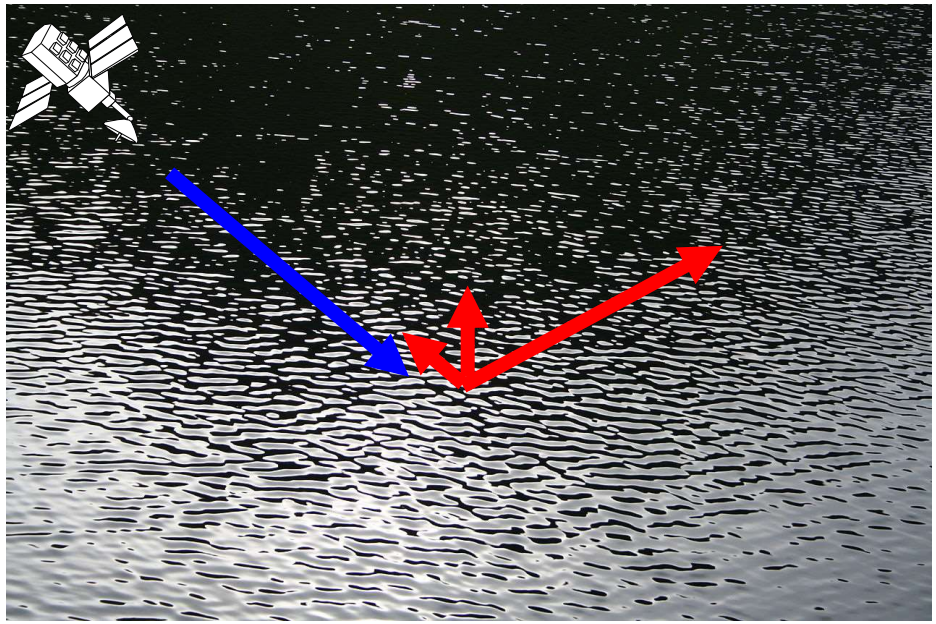


By Blue Elf - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=3680068

- ripples or gravity-capillary waves
- wavelength ~ 2 to several centimetres

How do Scatterometers work?

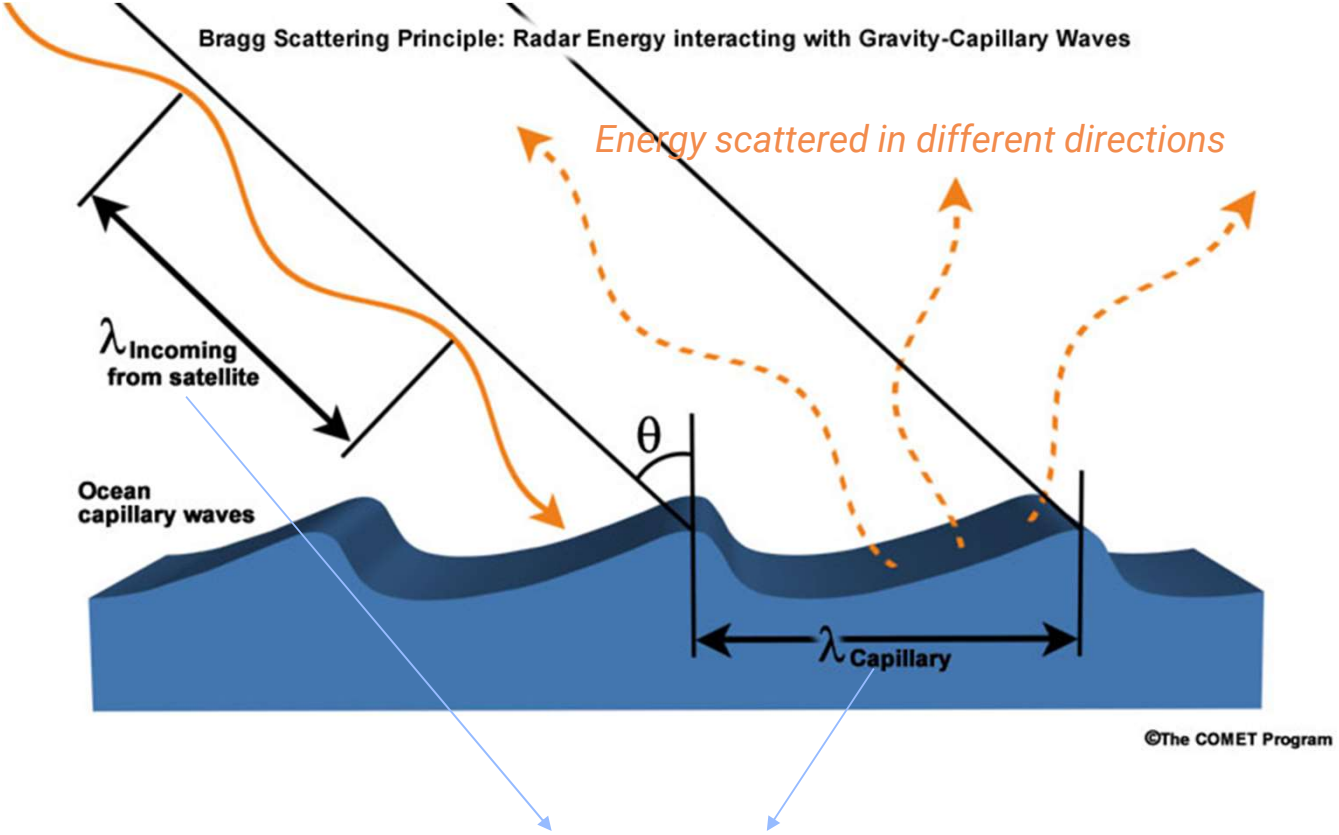
- active remote sensing instruments emitting microwave radiation and detecting its scattering



By Blue Elf - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=3680068

- Scatterometers are not sensitive to large water waves
- Detect the energy returned from the wind-driven, centimetre-scale ripples
- The more ripples over a given area and the greater their amplitude, the stronger the scattering effect.

Bragg Principle



- Sensitive to θ
- Scatterometers only see the ocean surface from the side, never directly from above

When the scales of the emitted microwaves and ripples are similar, a resonance occurs between them and radar energy is scattered in different directions

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Taking Bragg principle into account what should be the typical wavelengths of microwave radiation used by scatterometers?

ⓘ Start presenting to display the poll results on this slide.

Microwave Radars

Scatterometers and **Altimeters** are **Microwave** Radars on Polar orbiters

- C-band ~5GHz (~5cm)
- Ku-band ~14GHz (~2cm)

- Measurements are not affected by clouds

- Retrievals are impacted by rain (less in C-band than in Ku-band)

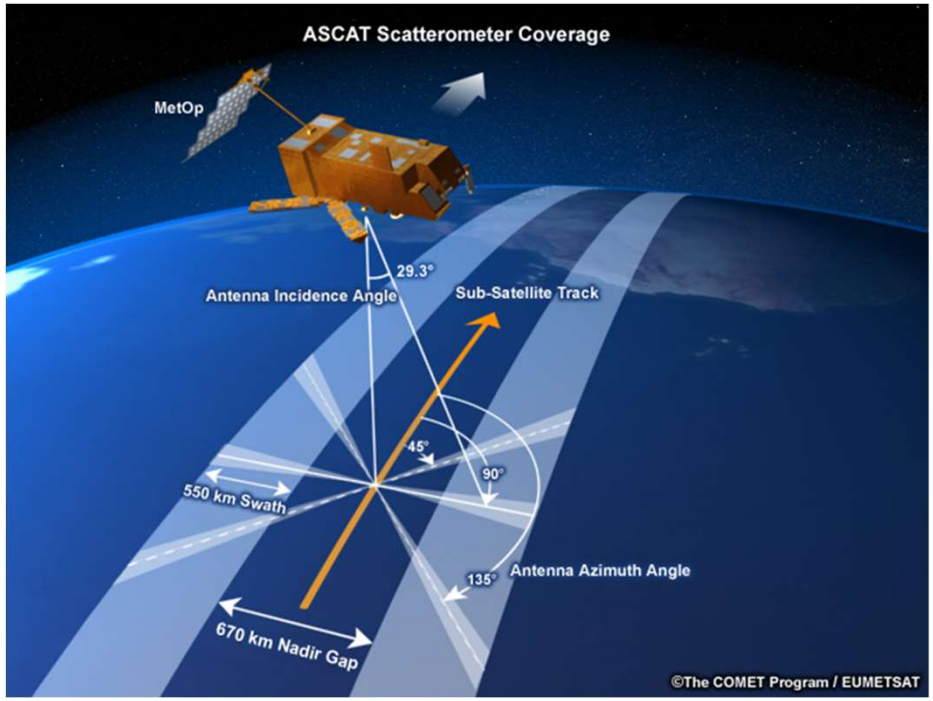
Wind direction – dependence with azimuth angles

Scatterometers **can provide wind direction** because they are designed to view a fixed location **from different azimuth angles**.

ASCAT - Advanced Scatterometer (metop) is composed of **two** sets of **three** antennas that cover two distinct areas:

- located to the left (one set)
- to the right (the other set)

of the satellite track - **double swath scatterometer**



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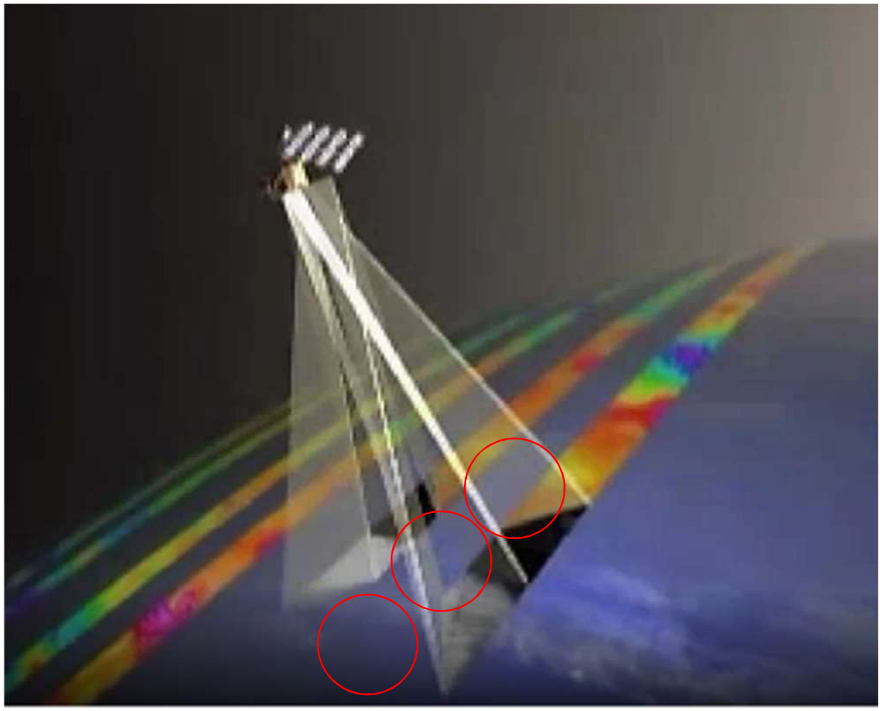
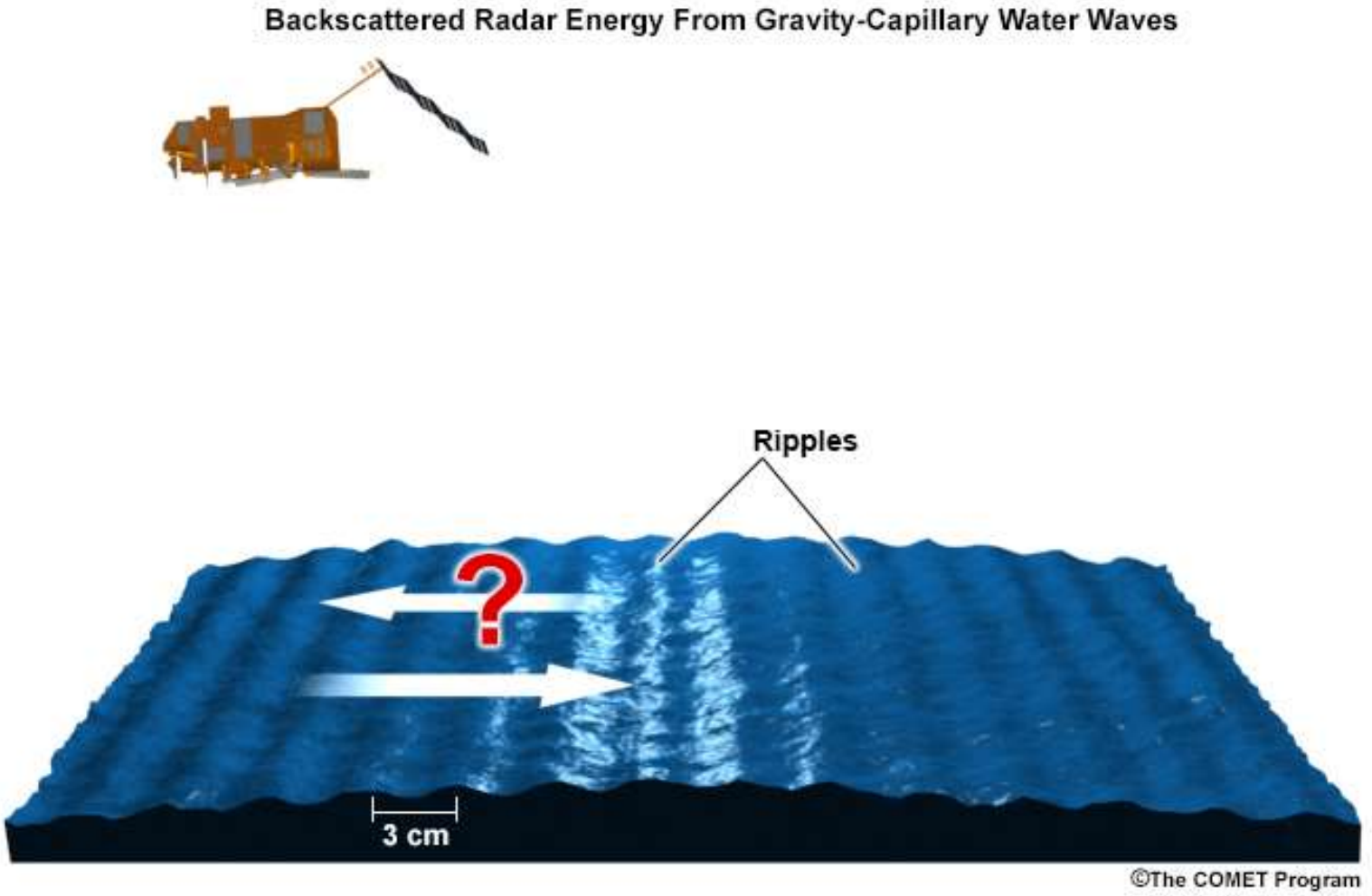
- to the right (the other set)

of the satellite track - **double swath scatterometer**

- Every point is scanned at three different azimuth angles (with 45 degrees between them) (i.e., three times) as the satellite moves
  - it's possible to define a most likely solution



Wind direction – The ambiguity problem



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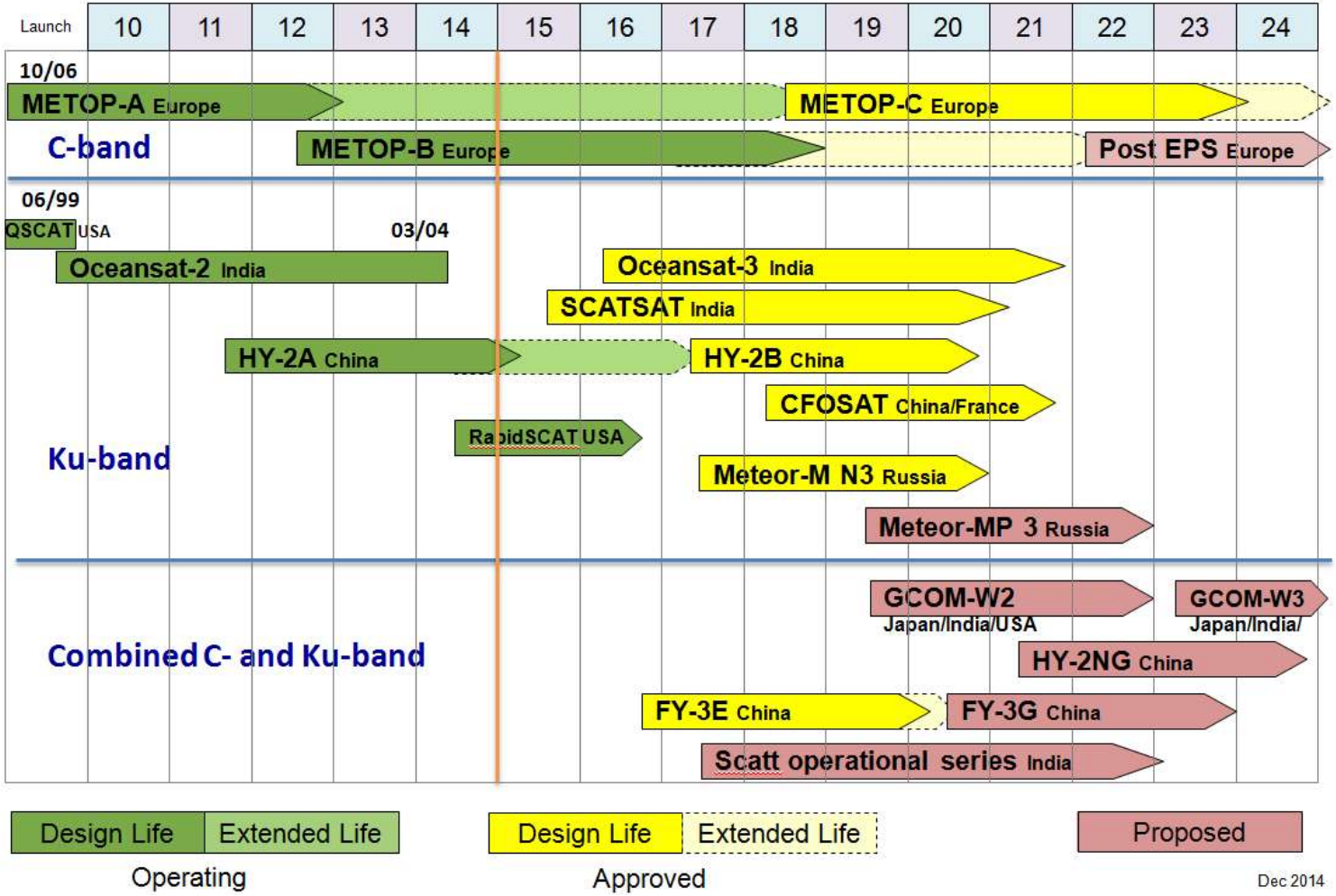
Which swaths correspond to the same orbit?

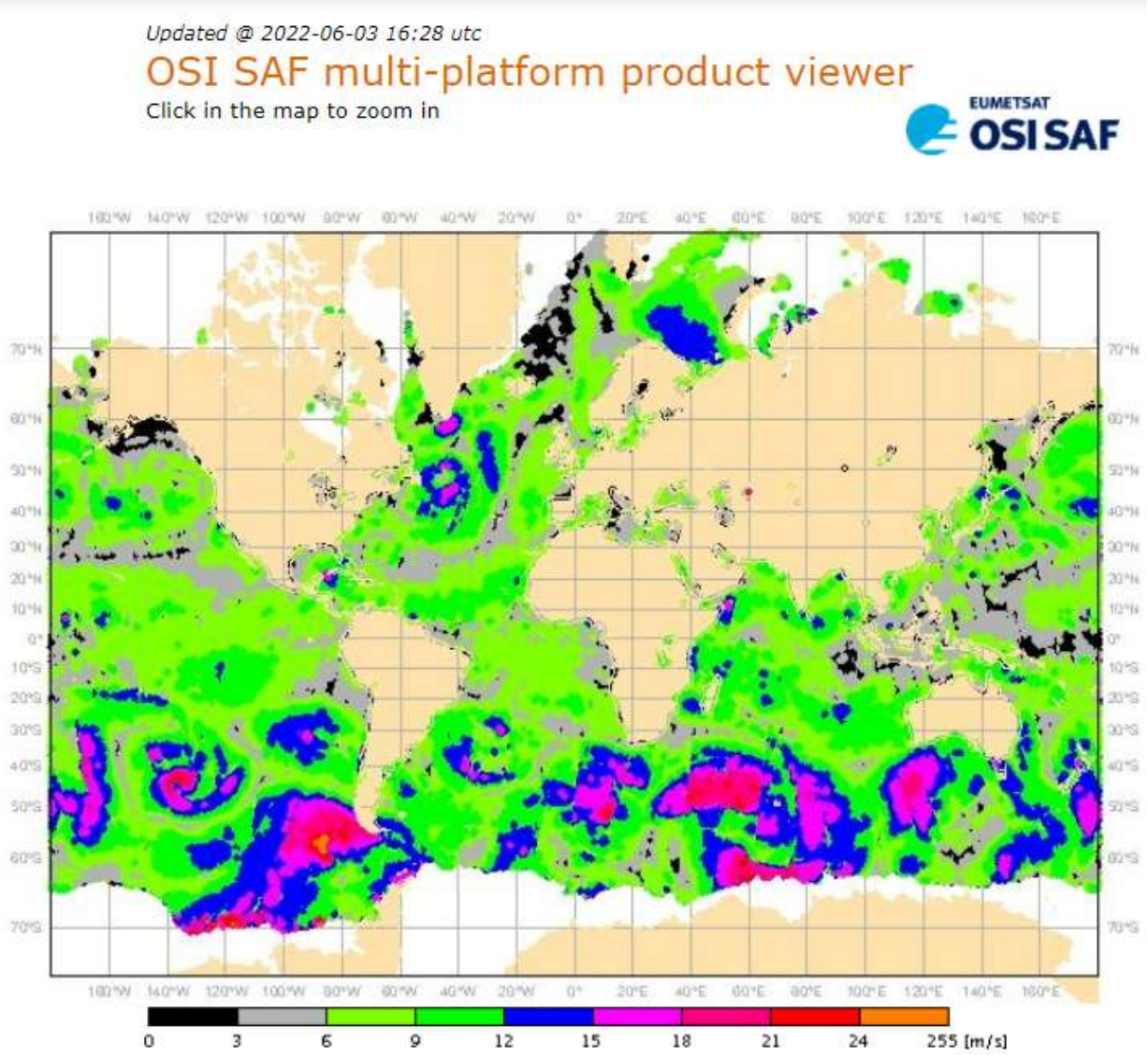
ⓘ Start presenting to display the poll results on this slide.

History of Scatterometers



https://ceos.org/ourwork/virtual-constellations/osvw/

Wind Data Visualization Platforms



OSI SAF near real time Wind Products

- ASCAT-B 25 km winds
  - Operational status
- ASCAT-B Coastal winds
  - Operational status
- ASCAT-C 25 km winds
  - Operational status
- ASCAT-C Coastal winds
  - Operational status
- HY-2B 25 km winds
  - Operational status
- HY-2B 50 km winds
  - Operational status
- HY-2C 25 km winds
  - Operational status
- HY-2C 50 km winds
  - Operational status

- **Data corresponds to a 22 h buffer**
- **Processing software for the wind products developed in the EUMETSAT Numerical Weather Prediction Satellite Application Facility (NWP SAF) and OSI SAF.**

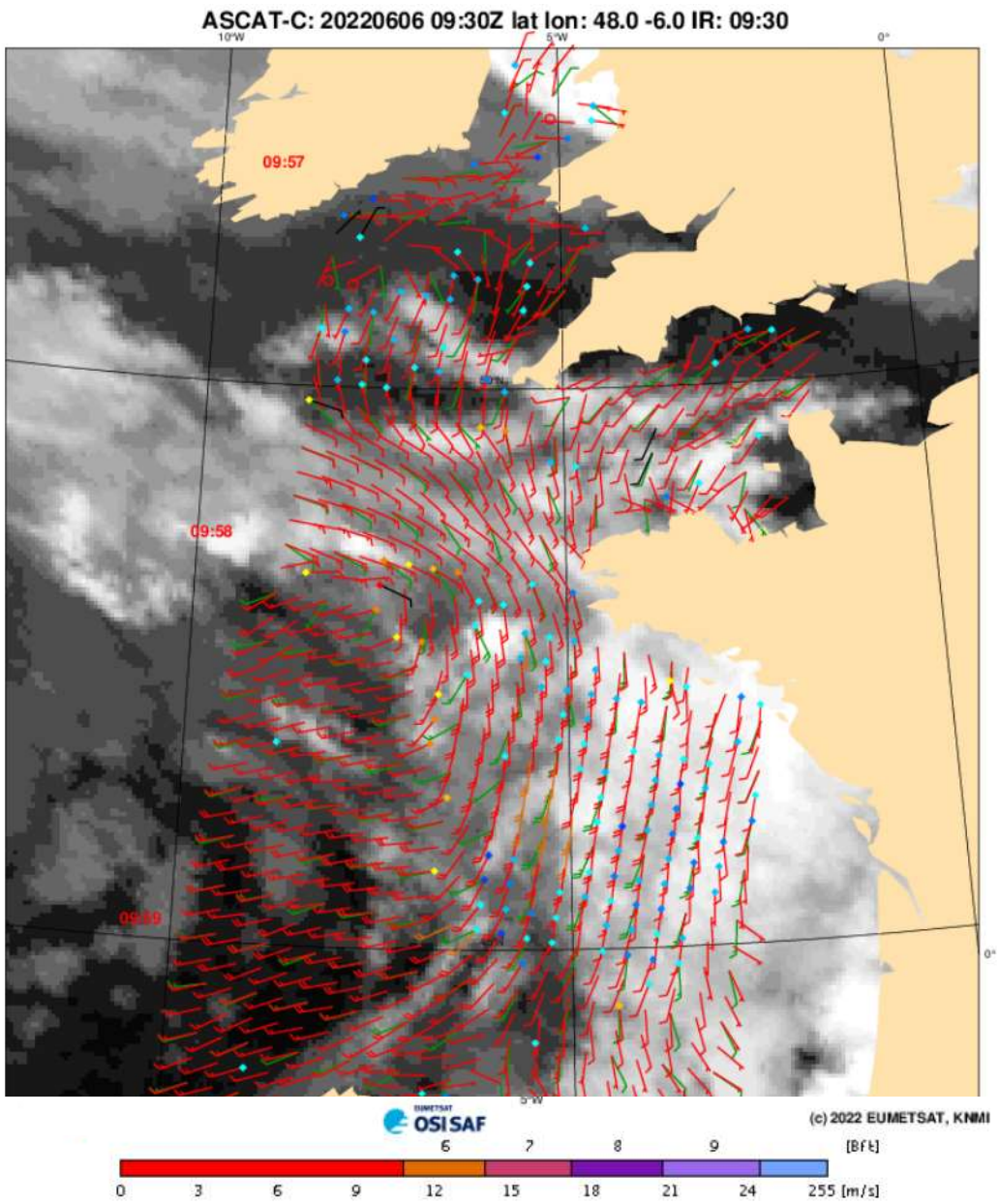
https://scatterometer.knmi.nl/tile_prod/

Wind Data Visualization Platf

- Scatterometer winds (in flags), coloured according to the Beaufort scale + infrared satellite image (from METEOSAT, GOES or Himawari)

- Numerical weather prediction model forecast winds from ECMWF in **green**.

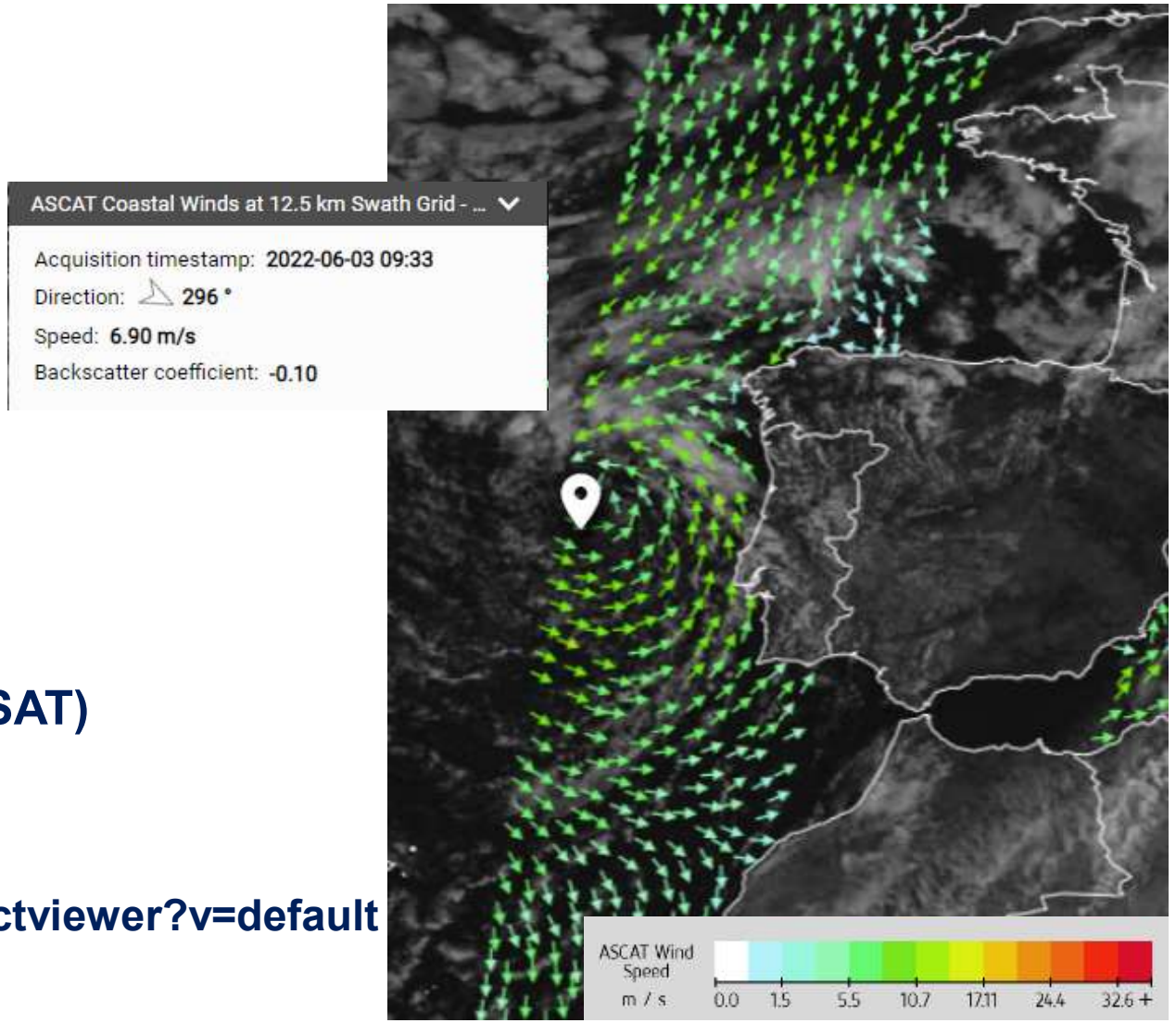
- A **black** flag indicates that the KNMI QC flag is set, such **winds** are likely to be **unreliable** but they may provide extra information to experienced users.



Wind Data Visualization Platforms

www.eumetsat.int

EUMETSAT EUMETVIEW

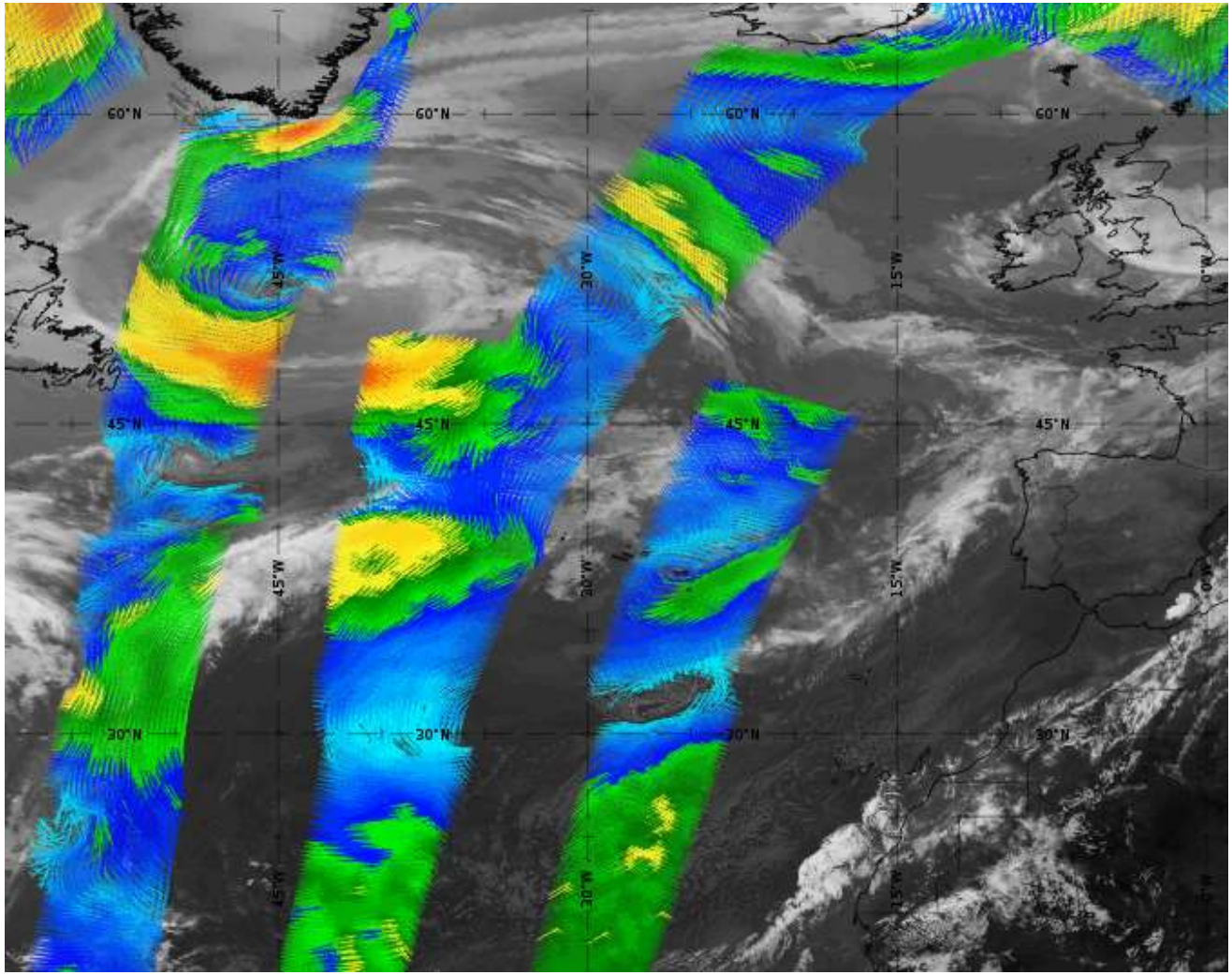


ASCAT C Coastal Winds +
Visible Image (from METEOSAT)

https://view.eumetsat.int/productviewer?v=default

Wind Data Visualization Platforms

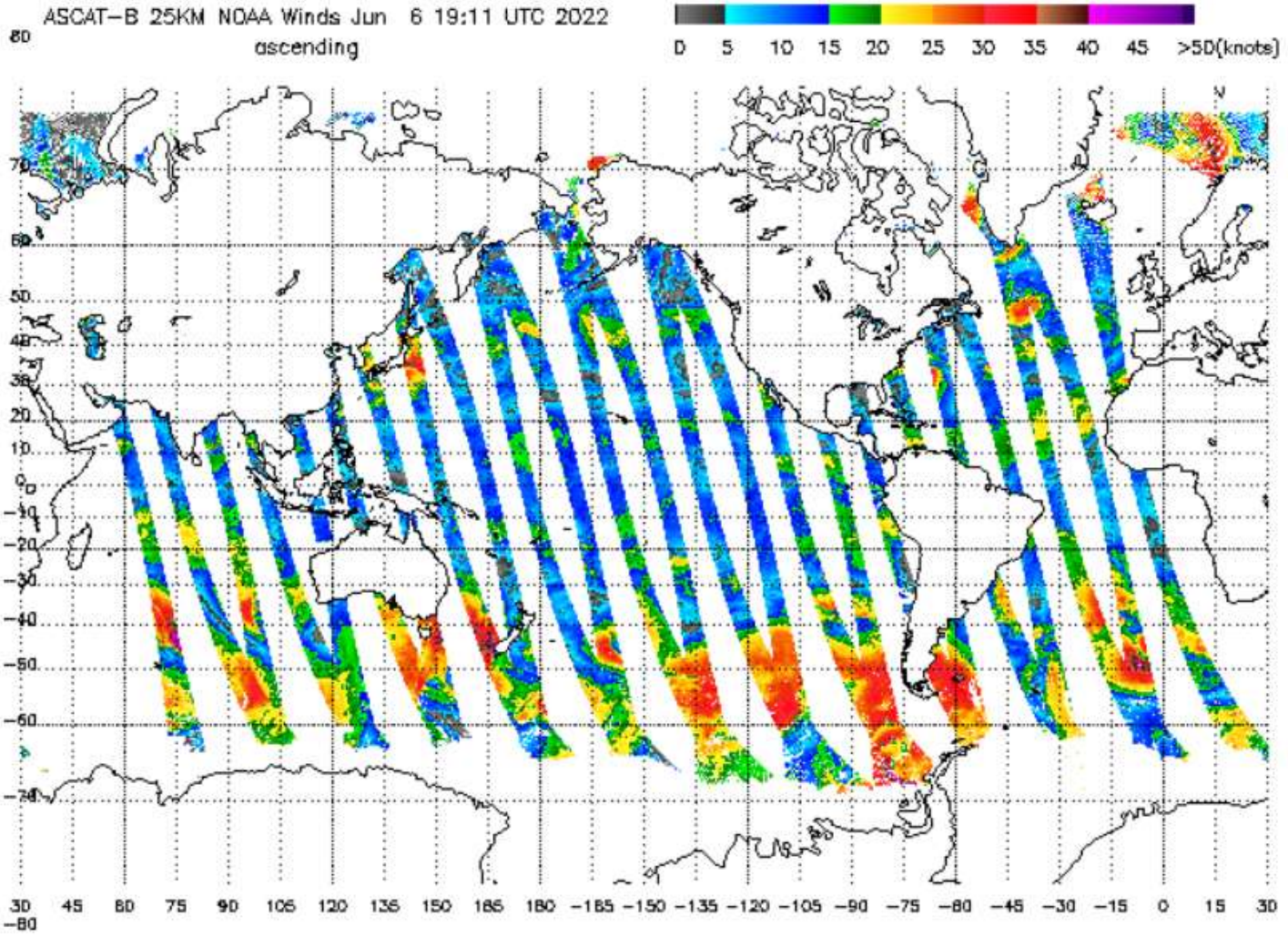
EumeTrain ePort pro



ASCAT B and C +
Infrared Image (from METEOSAT)

http://www.eumetrain.org/

Wind Data Visualization Platforms



- **Data corresponds to a 22 h buffer**

https://manati.star.nesdis.noaa.gov/datasets/ASCATBData.php

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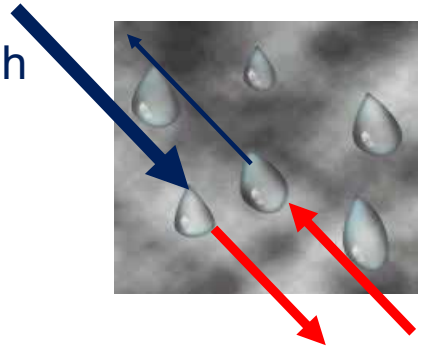
What can be the effect of rain on scatterometer winds?

ⓘ Start presenting to display the poll results on this slide.

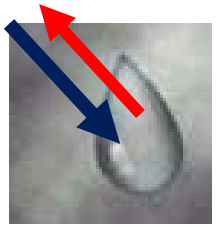
Limitation of Ku-band Scatterometers

Three main effects of rain on scatterometer measurements are:

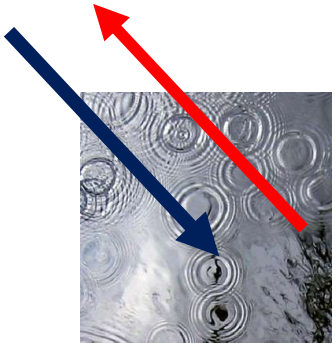
1) Double attenuation of the radar signal while passing through the atmosphere:
   - Retrieved wind speed ↓



2) Enhancement of the radar return due to volume scattering from rain drops:
   - Wind speed ↑



3) Enhancement of the radar return due to rain modified ocean surface roughness:
   - Wind speed ↑
   - Wind direction can be lost



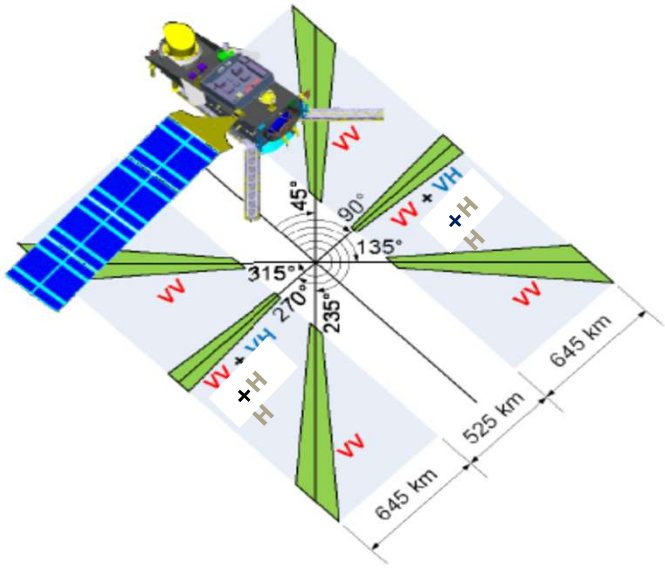
Limitations

ASCAT winds are:

- 25-km areal winds
- practically instantaneous
- Less detection in the higher wind range (> 60 kt)
- Land contamination. The smallest coastal distance in the ASCAT-coastal product is 20 km
- Retrievals are impacted by rain (less in C-band than in Ku-band)

EPS-SG Scatterometer

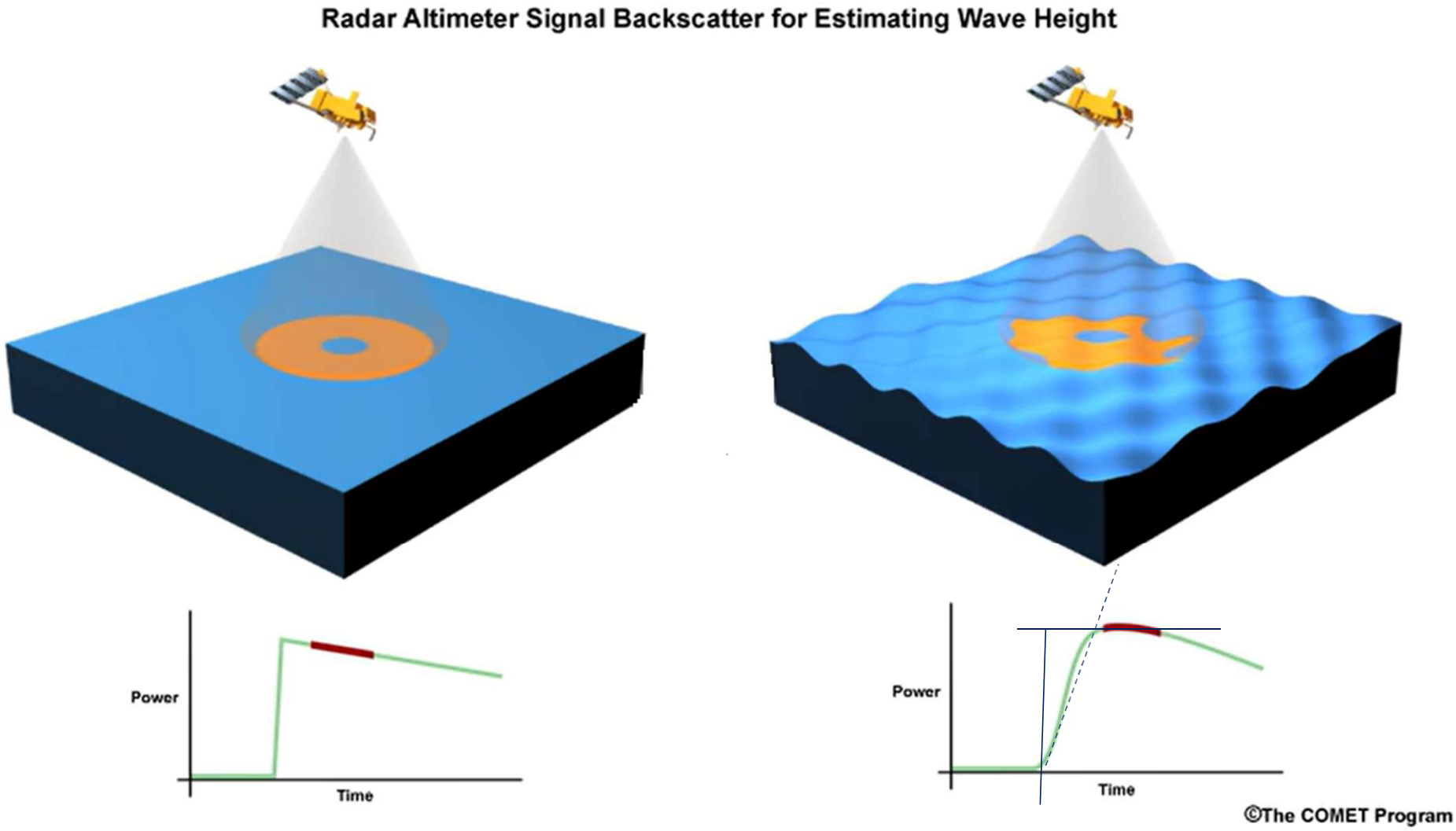
- **Improvements of Metop-SG SCA over current Metop ASCAT**
  - Better swath width (~650 km), thus improving the coverage and better resolving coastal winds
  - **ASCAT sends and receives only vertical polarisation, whereas SCA has HH polarisation and cross-polarisation (HV and VH)**
    - Improves the sensitivity to higher wind speeds. **VV channels saturate at about 25 m/s.**



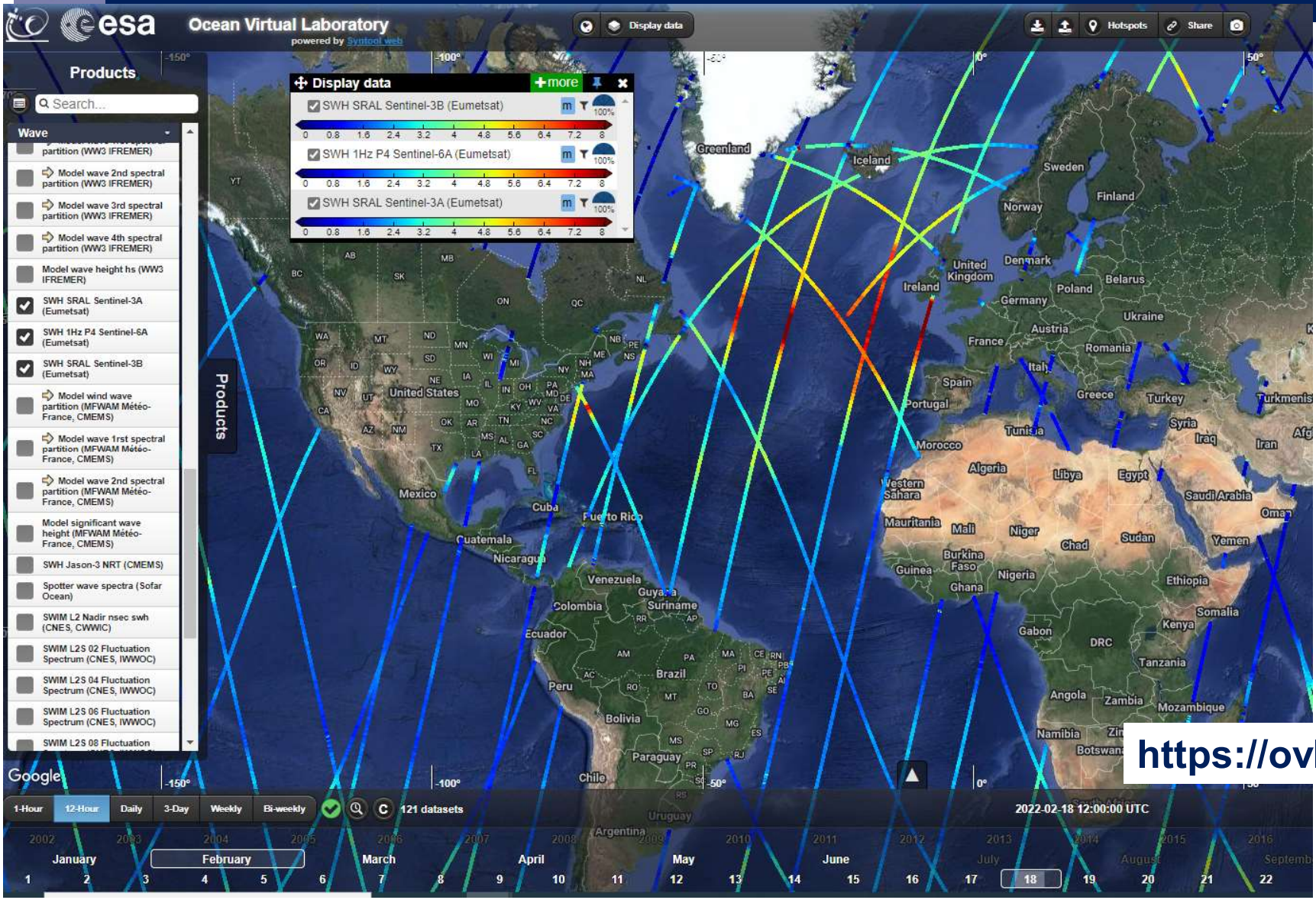
Altimeters – Significant Wave Height

- Altimeters emit a pulse of microwave radiation with known power toward the surface
- The pulse interacts with the surface and part of the incident radiation is reflected back to the altimeter.
- The arrival time is related to the wind speed; the shape of the backscatters waveform allows to retrieve the several altimetry parameters (eg. SWH)

Altimeters – Estimating Significant Wave Height

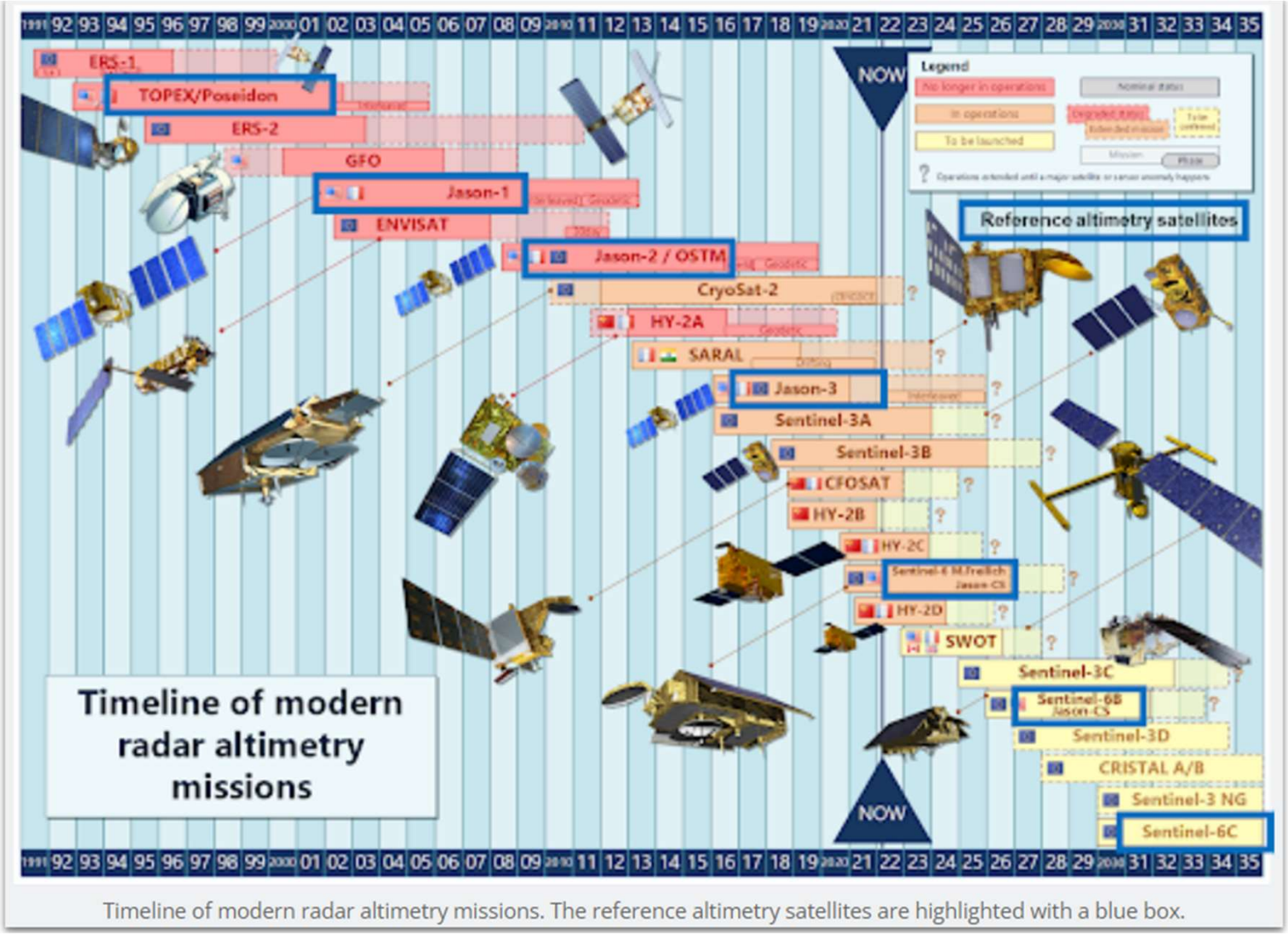


Visualization Platforms



https://ovl.oceandatalab.com/

History of Altimeters



Timeline of modern radar altimetry missions. The reference altimetry satellites are highlighted with a blue box.

Thank you!

- **15 June,** 12:00 UTC **- Recent Developments in Altimetry Measurements - Sentinel-6 Michael Freilich**, with Ben Loveday, Vinca Rosmorduc, Christine Traeger Chatterjee and Hayley Evers-King