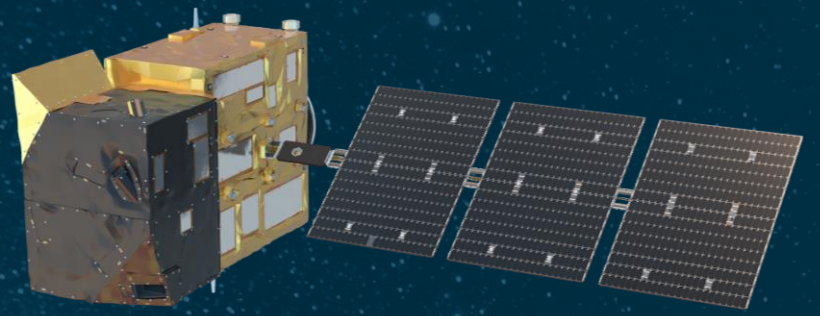


Status of Copernicus CO2M mission development

Anthropogenic greenhouse gas monitoring from space

Dr Yasjka Meijer
European Space Agency (ESA)
CO2M Mission Scientist

ATMOS-2024, Bologna, IT

CO_2 Monitoring (CO2M) Mission

1. **Detection of emitting hot spots**
2. **Monitoring the hot spot emissions**
3. **Assessing emission changes against local reduction targets**
4. **Assessing the national emissions and changes**

System requirements → Mission Requirements → Implementation → Performance

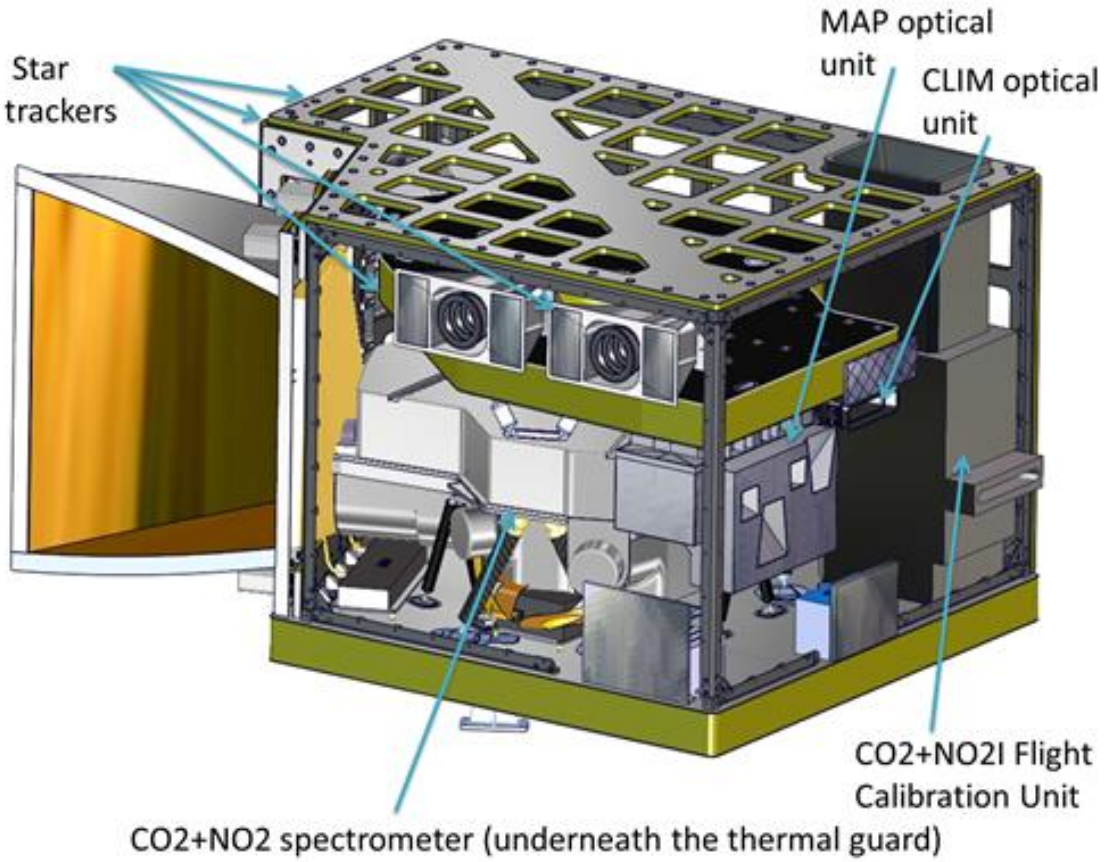
NB mission requirements need to be met 3-sigma & anywhere in the swath

Today implementation status & performance will presented

Payload Implementation

Payload Components

- **CO2 I**mager **(CO2I)**: 3 band (1 NIR, 2 SWIR) co-located push-broom imaging spectrometer
- **NO2 I**mager **(NO2I)**: VIS band implemented as fourth band in CO2I instrument
- **M**ulti**-A**ngle **P**olarimeter **(MAP)** for aerosol observations
- **CL**oud **IM**ager **(CLIM)** for low cloud & cirrus detection



Credits: TASiF

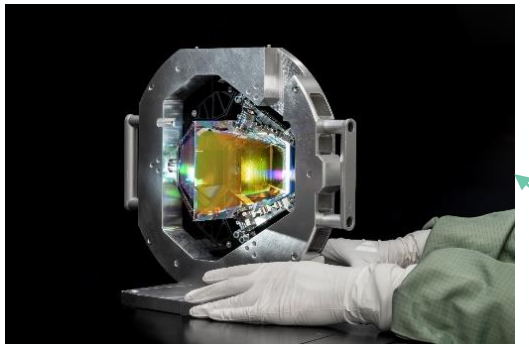
CO_2 & NO_2 Imager implementation (TAS-F)

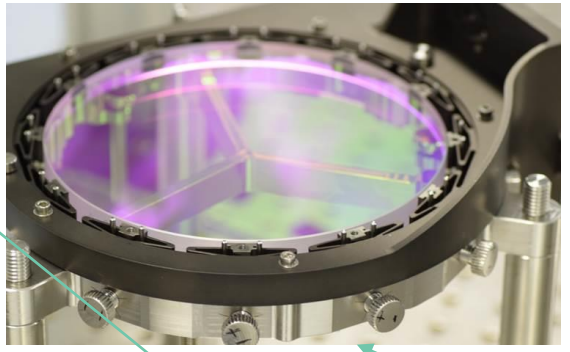
Push-broom multi-band imaging spectrometer

Band	Spectral range
VIS	405–490 nm
NIR	747–773 nm
SWIR-1	1590–1675 nm
SWIR-2	1990–2095 nm

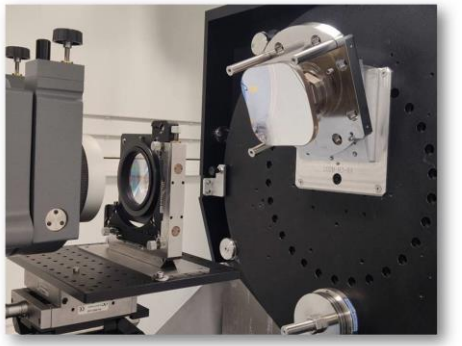
Credits: IOF

Credits: LYNRED





Credits: TASiF / TSESO



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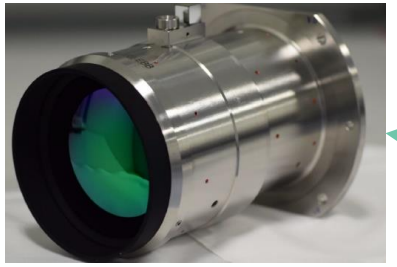

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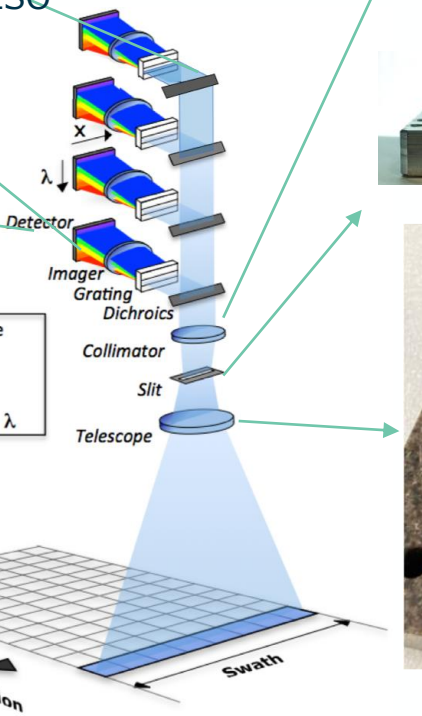
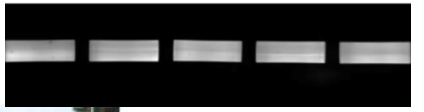
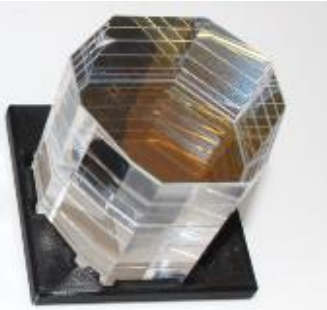




Credits: Optec

Credits: Media Lario



Credits: Bernhard Halle

Telescope	Common telescope with polarisation scrambler
Slit	110 Fibres are used to homogenise the scene; one per sample
Collimator	One reflective collimator, common for all bands
Band separation	3 Dichroic plates used in collimated beam
Diffraction grating	4 Prism-Grating-Prism assemblies
Imagers	Glass (VIS/NIR) and silicon (SWIR-1/SWIR-2); band-pass filters
Detectors	MCT CMOS detectors in SWIR;

CO2I & NO2I performance

Critical design review (**CDR**) is passed & integration has started

Performances are met with some minor points, but also with good exceptions:

- Swath width **266–276 km** (orbit variation)
- Spatial co-registration bands **+++**
- Spectral ch. position variation **very low**
- ISRF shape **well-known**
- Polarisation sensitivity **very low**
- Absolute radiometric accuracy **+++**
- Residual offset **very low**

CDR ✅

Multi Angle Polarimeter (TASiUK)

MAP Band	Wavelength
VNIR-1	410 nm
VNIR-2	443 nm
VNIR-3	490 nm
VNIR-4	555 nm
VNIR-5	670 nm
VNIR-6*	753 nm
VNIR-7	865 nm

Multi-angle polarimeter (MAP) implementation:
Compact push broom imager:

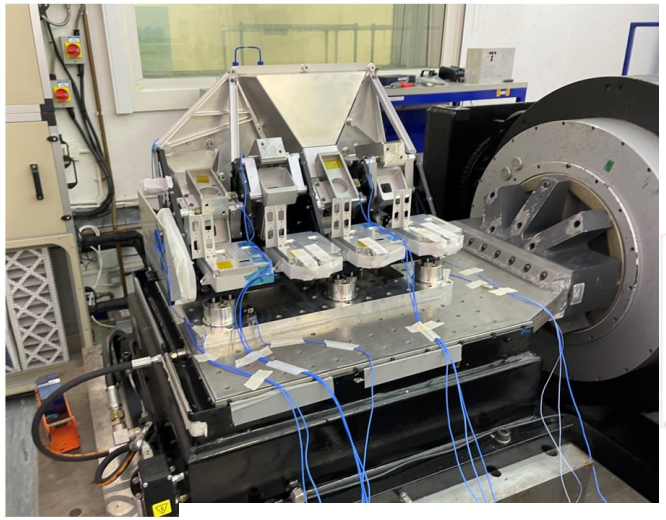
- 40 viewing angles (+/- 60º), plus 8 more @larger angles
- Spatial resolution: 4x4 km2 and sampling < 1x1 km2

One focal plane assembly combining polarization & spectral filtering

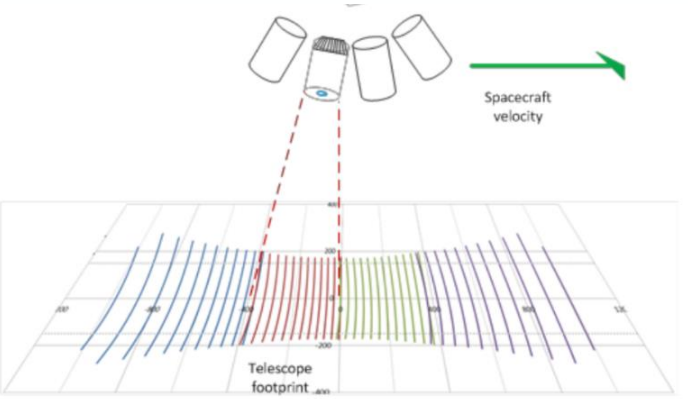
- 6 spectral bands in VIS and NIR (+1 for co-reg with CO2I)
- 3 polarisations (0º, 60º, 120º) sampled by µ-polarizers at detector pixel-level

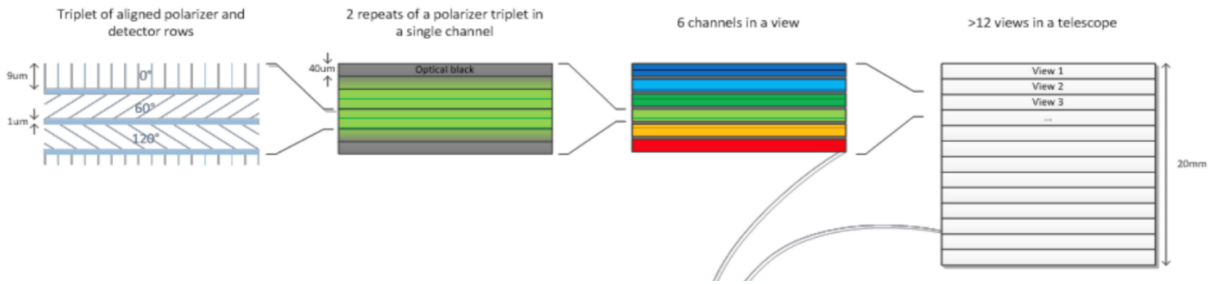
CDR

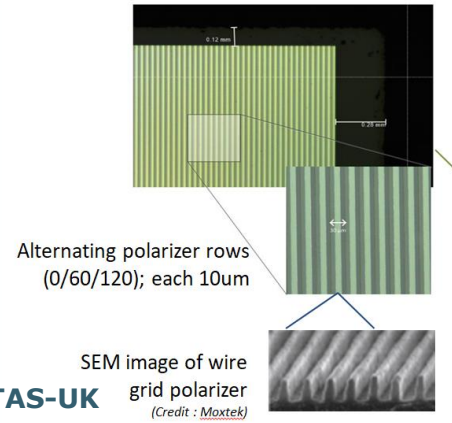
Credits: TAS-UK



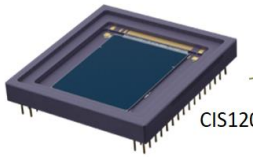
MAP OU STM in mechanical testing

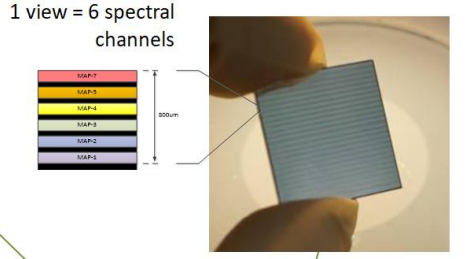


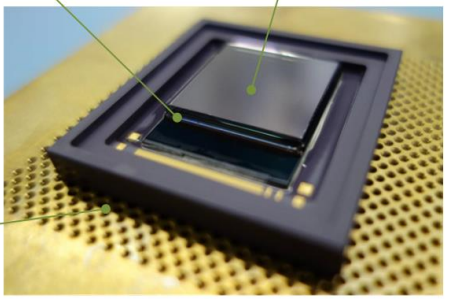




Credit © TAS-UK







CO2M: Cloud Imager: CLIM (OIP Belgium)

Cloud Imager based on Proba-V

- Binning on-ground, specs @400m
- Three mirror telescope with Aluminium mirrors
- InGaAs Xenics (CLIM-3) & Si CCD Teledyne E2V (CLIM-1 & CLIM-2)

Band	Band center	Band width	Native sampling (ALTxACT)
CLIM-1	670 nm	20 nm	94m x 87m
CLIM-2	753 nm	9 nm	94m x 87m
CLIM-3	1378 nm	15 nm	376m x 163m

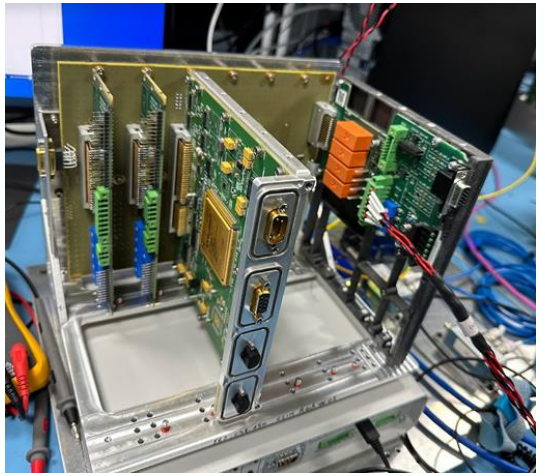
SSRD	Required	Compliance status
SNR @Lref	SNR>200	CLIM-1 >542 (3sigma) CLIM-2 >533 (3sigma) CLIM-3 >240 (3sigma)

CDR ✅

Credits: AMOS

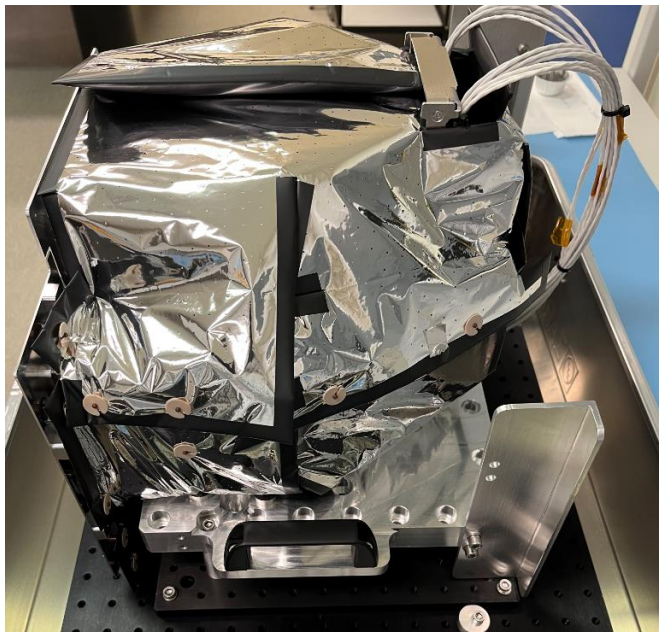
CLIM OU PFM Telescope

Credits: OIP



CLIM EU EM1 boards Testing

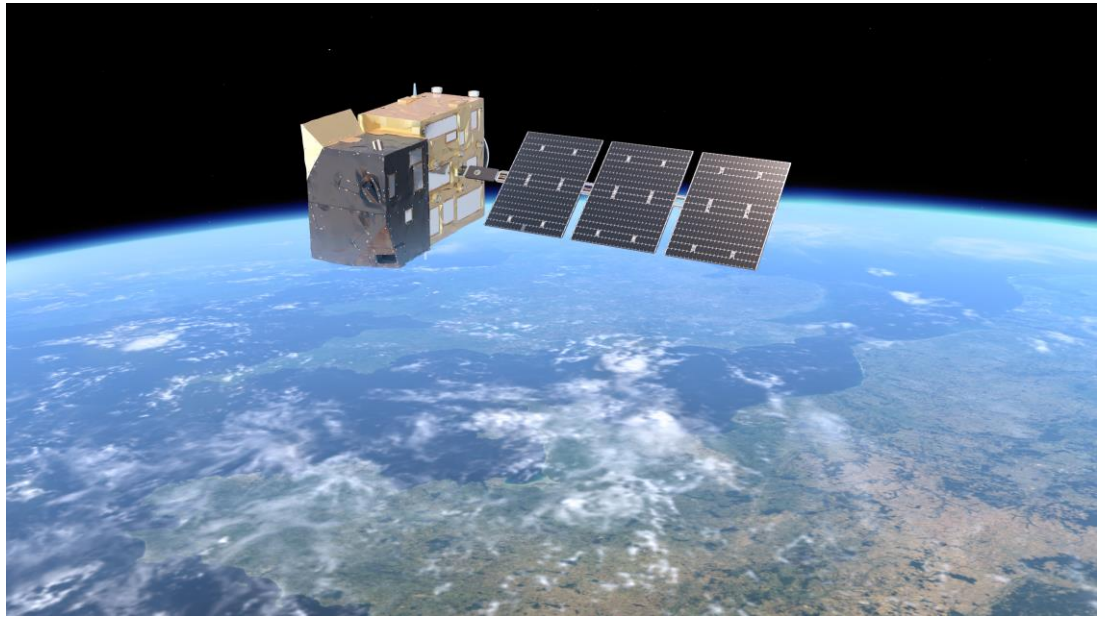
Credits: OIP



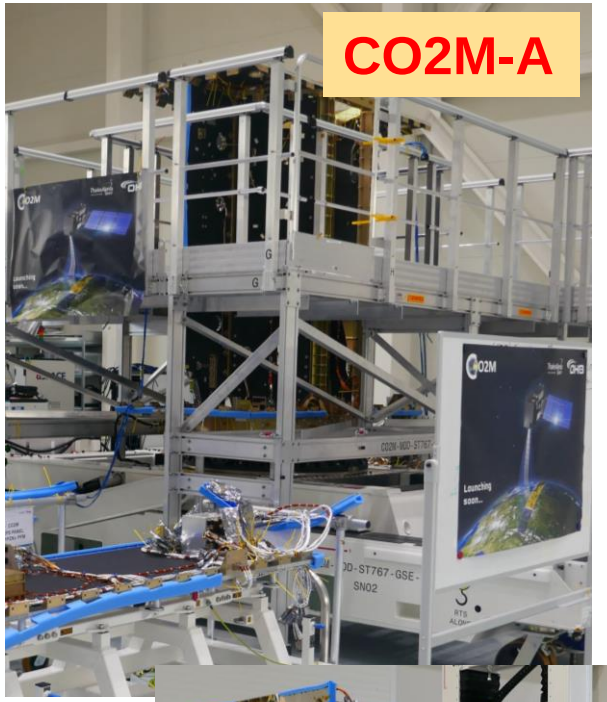
CLIM OU wrapped in MLI for thermal test

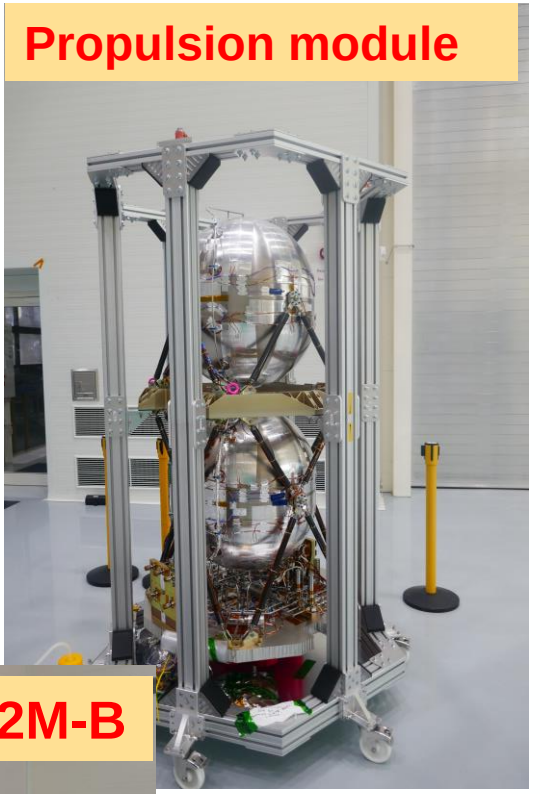
CO2M Space Segment - key features

Orbit	Altitude: 735 km, LTDN: 11:30 hr
Repeat cycle	Full coverage 11 days with 1 satellite improved to 5.5 days with 2 satellites
Lifetime	7.5 years , extendable to 12 years
Mass	~1.65 tons dry, plus 250 kg propellant
Launcher	Baseline: Vega-C, backup: Ariane 6



Credits: EMPA





Copernicus CO2M Mission – Status

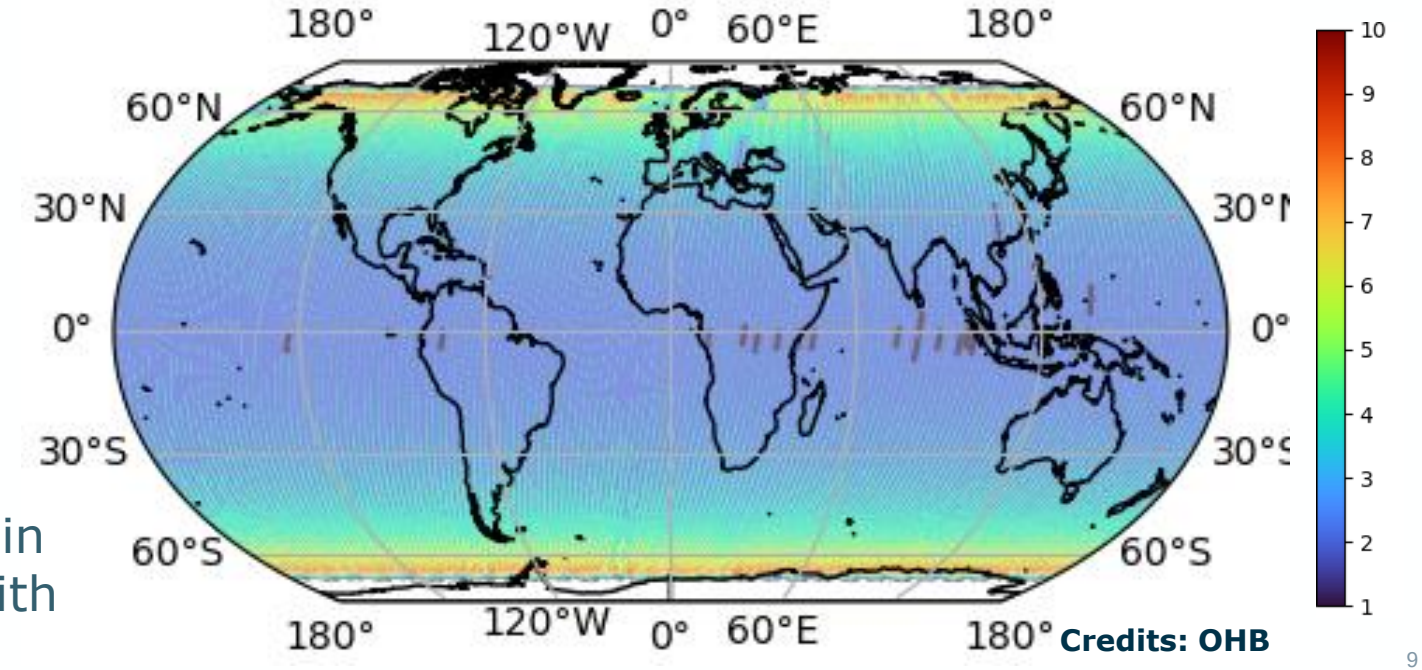
Project status:

- **Constellation** of satellites
- Each satellite **>266 km swath**
- First and second satellite will have their Flight Acceptance expected **mid 2026**
- **Third satellite → APPROVED!!**

Copernicus data is made freely available to any person and organisation around the world

EUMETSAT performs operational data processing

Product	Spatial	Precision
CO_2	4 km^2	0.7 ppm
CH_4	4 km^2	10 ppb
NO_2	4 km^2	1.5 10^{15} molecules cm^{-2}
Vegetation SIF	4 km^2	0.7 mW m^{-2} sr^{-1} nm^{-1}
Aerosol params	16 km^2	0.05 AOD, 500 m LH



Number of observations in one month with two satellites

PROGRAMME OF THE EUROPEAN UNION

co-funded with esa

THANK YOU