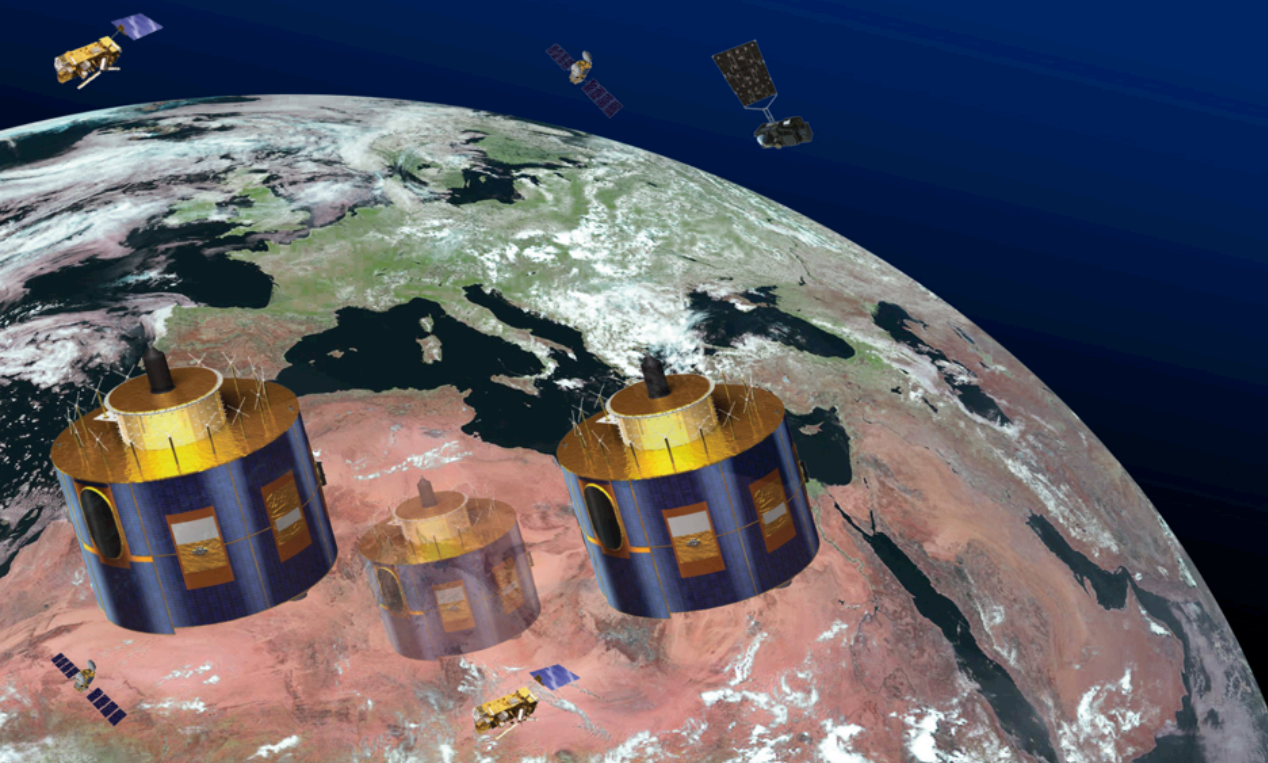
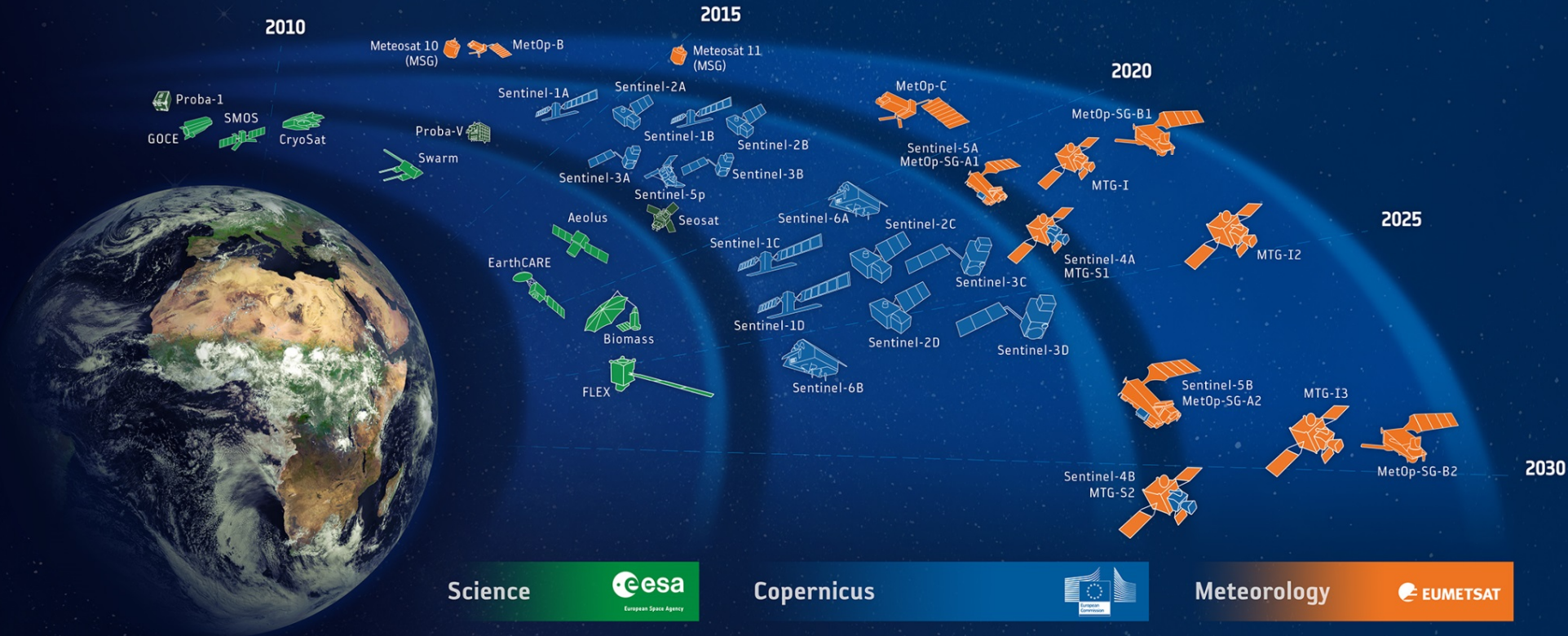


New European capabilities from space

Jörg Schulz
EUMETSAT
and many contributors



ESA-DEVELOPED EARTH OBSERVATION MISSIONS

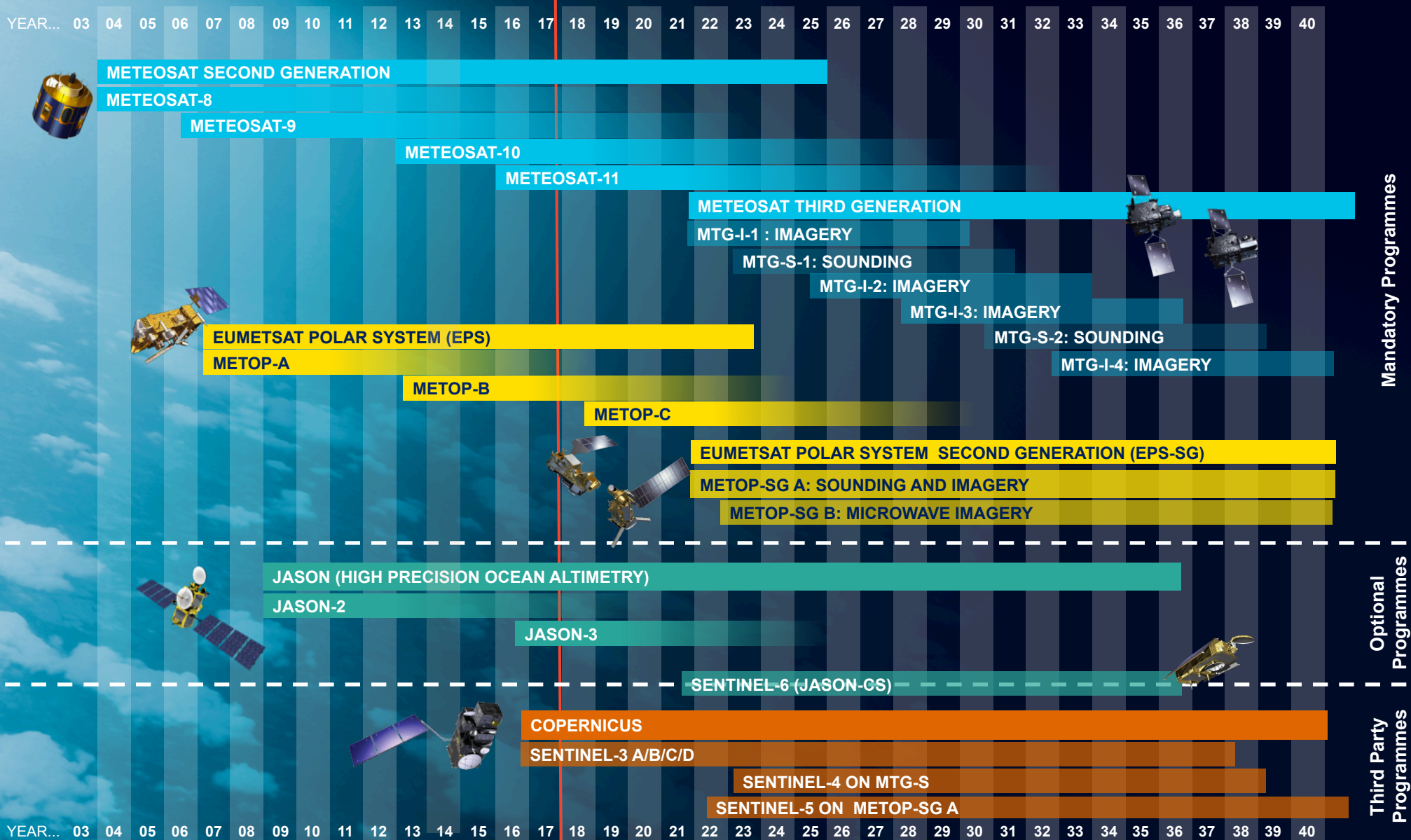


27 satellites in development, 12 in operations

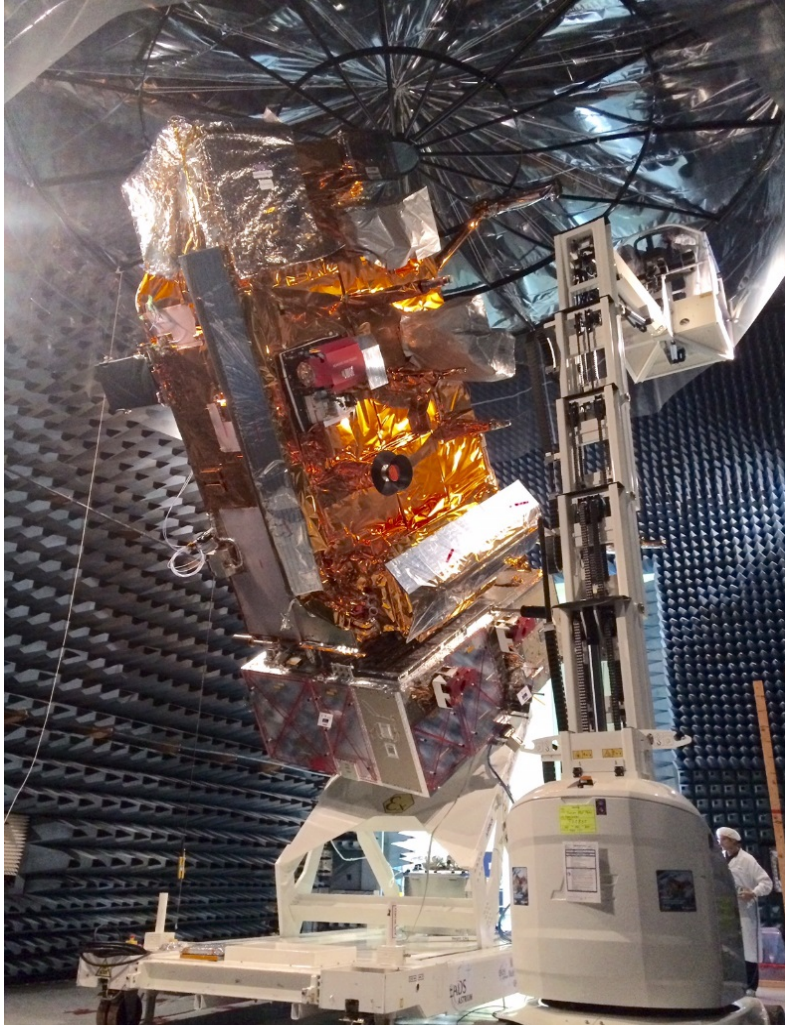
www.esa.int

European Space Agency

EUMETSAT Mission Planning



Preparing for Metop-C Launch



- Satellite tests ongoing
- MHS & GOME-2 instruments to be reintegrated after repair/re-calibration
- Virtualised ground segment configuration qualified for three-Metop operations
- System validation tests and operations preparation ongoing
- Target launch date advanced to 20 September 2018
- Three-Metop constellation from 2019 to 2022

Meteosat Third Generation: Mission Overview



- Imagery Mission implemented by a two-satellite MTG-I system:
 - Full disk imagery (FCI) every 10 minutes in 16 spectral bands
 - Fast imaging of European weather every 2.5 minutes
 - New Lightning Imager (LI)
- Hyperspectral Infrared Sounding (IRS) Mission:
 - Full disk 4-D weather cube: temperature, water vapour, O₃ (every 30 minutes over Europe)
 - Air quality monitoring and atmospheric chemistry in synergy with Sentinel-4
- Start of operations in 2021 and 2023
- Operational exploitation: 2021 - 2042+

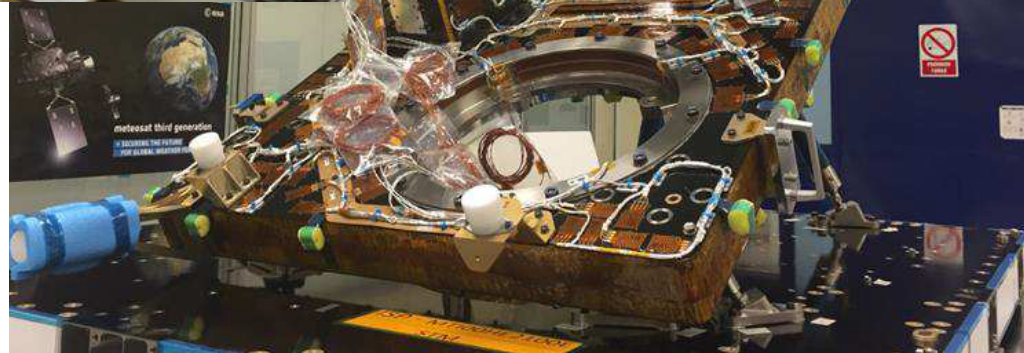
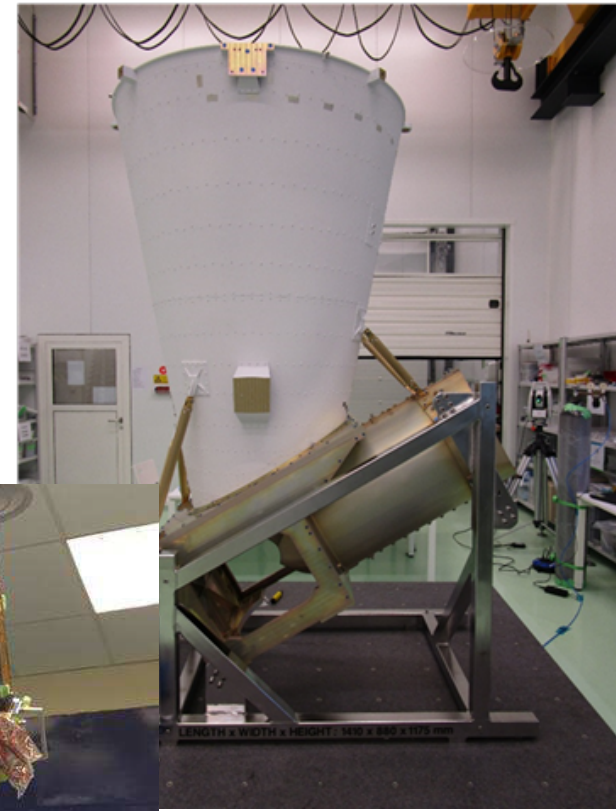
Meteosat Third Generation



Space Segment

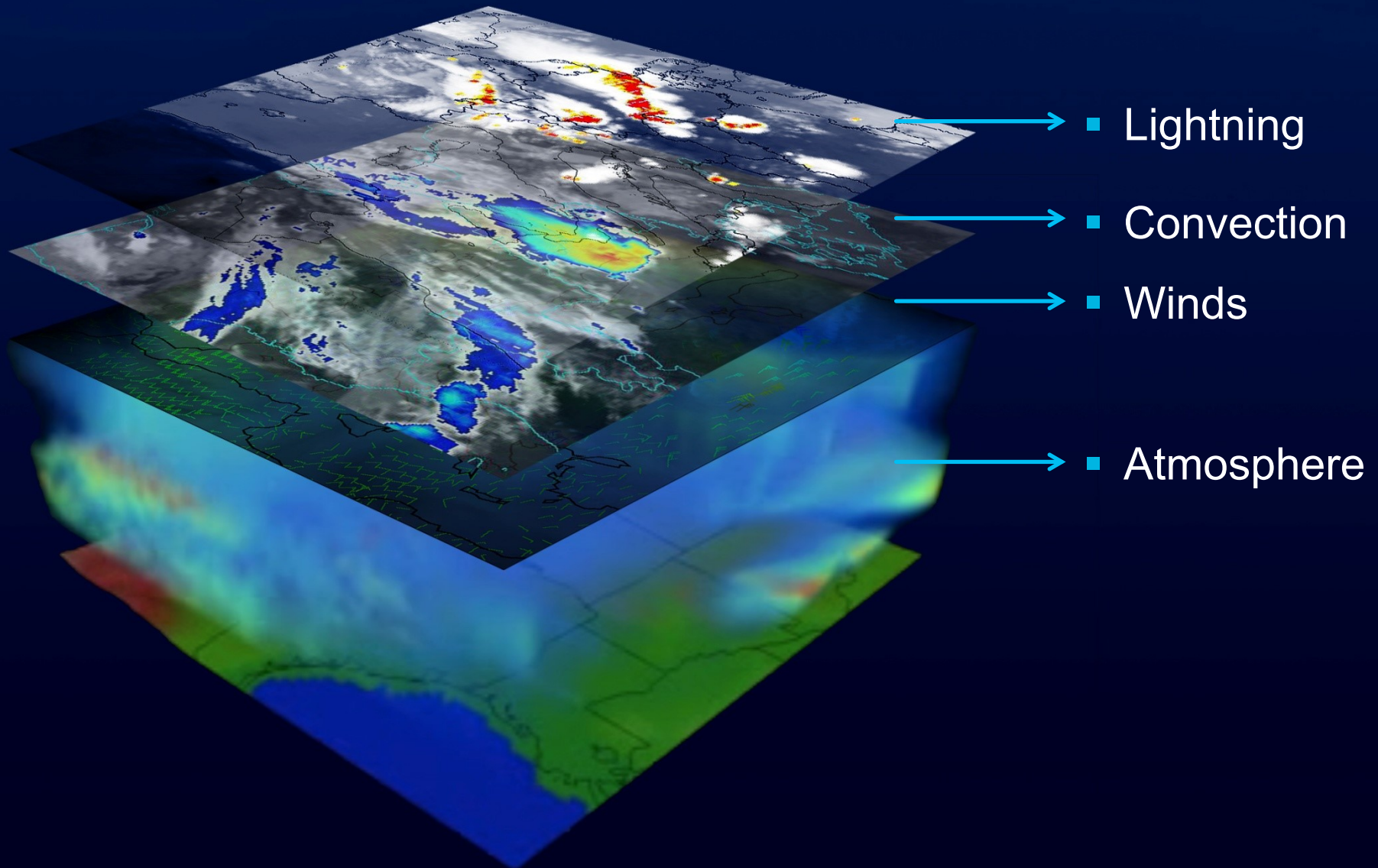
FCI External Baffle Assembly →

FCI Optical Bench Assembly ↓















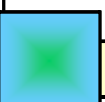

















↑
Platform before the
Thermal Vacuum
(TVAC) Test at IABG
in Munich

4D weather cube with MTG-I and MTG-S

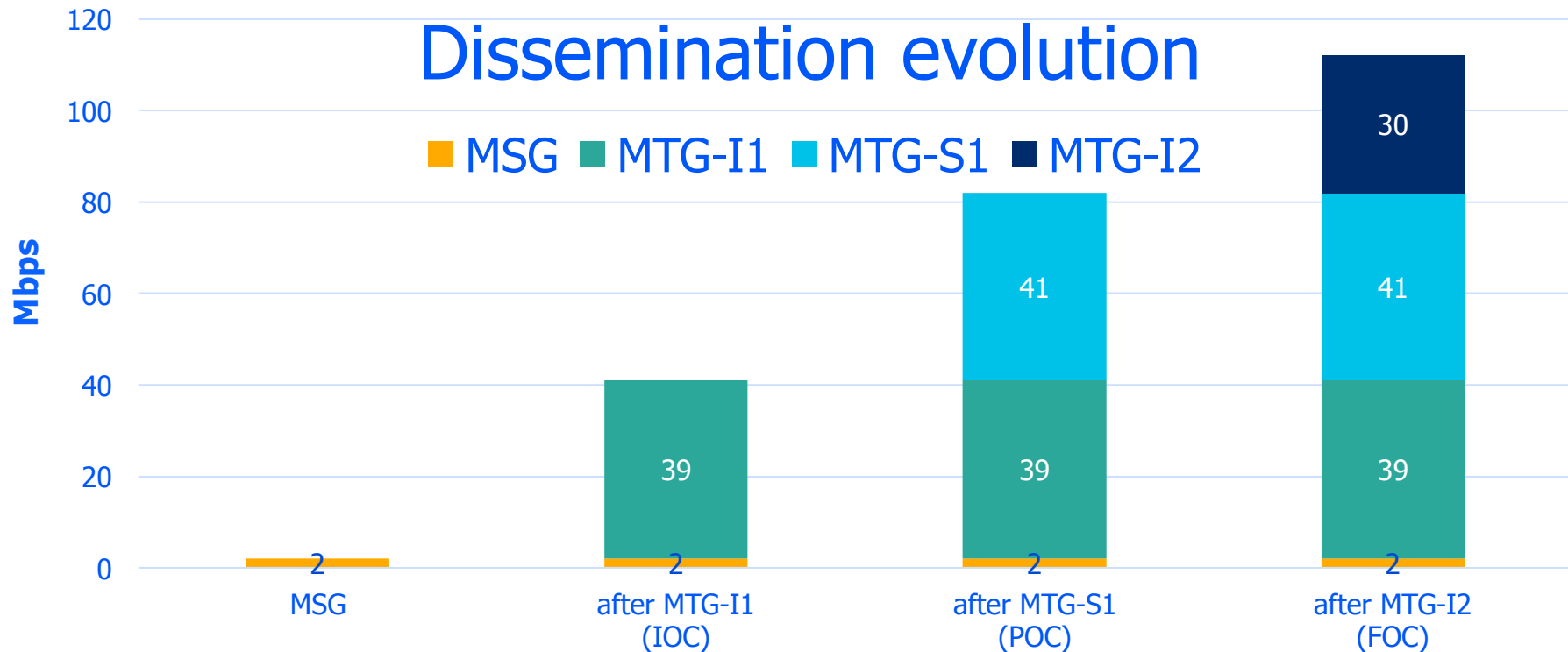


Evolution of the imaging capability

'Core' channels	Meteosat 1 st Generation			Meteosat 2 nd Generation			Meteosat 3 rd Generation		
	Central wavelength (Hm)	Width (FWHM) (Hm)	Spatial Sampling (km)	Central wavelength (Hm)	Width (FWHM) (Hm)	Spatial Sampling (km)	Central wavelength (Hm)	Width (FWHM) (Hm)	Spatial Sampling (km)
FC-VIS 0.4							0.444	0.06	 1.0
FC-VIS 0.5							0.510	0.05	 1.0
FC-VIS 0.6	0.7	0.35	 2.5	0.635	0.08	 3.0	0.645	0.08	 0.5
FC-VIS 0.8				0.81	0.07	 3.0	0.86	0.07	 1.0
FC-NIR 0.9							0.96	0.06	 1.0
FC-NIR 1.3							1.375	0.03	 1.0
FC-NIR 1.6				1.64	0.14	 3.0	1.61	0.06	 1.0
FC-NIR 2.2							2.26	0.05	 0.5
FC-IR 3.8 *				3.9	0.44	 3.0	3.8	0.40	 1.0
FC-IR 6.2	6.1	1.3	 5.0	6.2	1.0	 3.0	6.2	1.00	 2.0
FC-IR 7.3				7.35	0.5	 3.0	7.35	0.50	 2.0
FC-IR 8.7 *				8.7	0.4	 3.0	8.7	0.40	 2.0
FC-IR 9.7				9.66	0.3	 3.0	9.66	0.30	 2.0
FC-IR 10.8	11.5	1.9	 5.0	10.8	1.0	 3.0	10.5	0.7	 1.0
FC-IR 12.0				12.0	1.0	 3.0	12.3	0.5	 2.0
FC-IR 13.3				13.4	1.0	 3.0	13.3	0.60	 2.0
Repeat Cycle :	30 min			15 min			10 min		

*
Dynamical range of FC-IR 3.8 channel extended to serve the fire community

Dissemination of data – MTG vs MSG: a challenge



- Huge step after each launch:
 - MSG is negligible in volume compared to MTG
 - Select the right products to satisfy user needs
 - Ensure continuity and a smooth transition
 - Ensure affordability for End users and EUMETSAT

New capabilities of MTG for climate monitoring

- By 2040 Meteosat imaging provides >60 years time series;
- Improved imaging capability contributes to:
 - research on the global circulation (storm tracks including hurricanes, life cycle of storms, long term change in polar front position, etc.);
 - surface properties and aerosols;
 - better fire detection products and an increase in the quality of climate-relevant products such as fire radiative energy and power, which can be used to calculate carbon dioxide emissions from fires.
- MTG IR sounder opens new opportunities:
 - for 3D AMV time series in conjunction with IASI/IASI-NG and AVHRR/MetImage;
 - for reanalyses with NWP models operating at regional scale and assimilating high resolution temperature, humidity and cloud information.
- Lightning imager may contribute to quantification of naturally occurring NO_x and aircraft-induced NO_x;
- Improved spatiotemporal sampling addresses analysis of extreme events at local scale, e.g., thunderstorms.

EPS Second Generation

- Primary mission: further improve Numerical Weather Prediction
- Significant contributions to other real time applications:

Nowcasting at high latitudes

Marine meteorology and operational oceanography

Operational hydrology

Air quality monitoring and atmospheric chemistry in synergy with Sentinel-5 (refer also to Copernicus slides)

Start of operations in 2021 and 2023

Operational exploitation: 2021 - 2042+

- Climate monitoring: expand by 20+ years the climate data records initiated in 2006 with EPS

EPS Second Generation – Instruments' Heritage

Metop-SG A Optical Imagery and Sounding	Instrument	Predecessor on Metop
Infrared Atmospheric Sounding (IAS)	IASI-NG	IASI
Microwave Sounding (MWS)	MWS	AMSU-A, MHS
Visible-infrared Imaging (VII)	METimage	AVHRR
Radio Occultation (RO)	RO	GRAS
UV/VIS/NIR/SWIR Sounding (UVNS)	Sentinel-5	GOME-2
Multi-viewing, -channel, -polarisation Imaging (3MI)	3MI	-/-

Metop-SG B Microwave Laboratory	Instrument	Predecessor on Metop
Scatterometer (SCA)	SCA	ASCAT
Radio Occultation (RO)	RO	GRAS
Microwave Imaging for Precipitation (MWI)	MWI	-/-
Ice Cloud Imager (ICI)	ICI	-/-
Advanced Data Collection System (ADCS)	Argos-4	A-DCS

New mission 3MI imaging polarimeter on Metop SG A

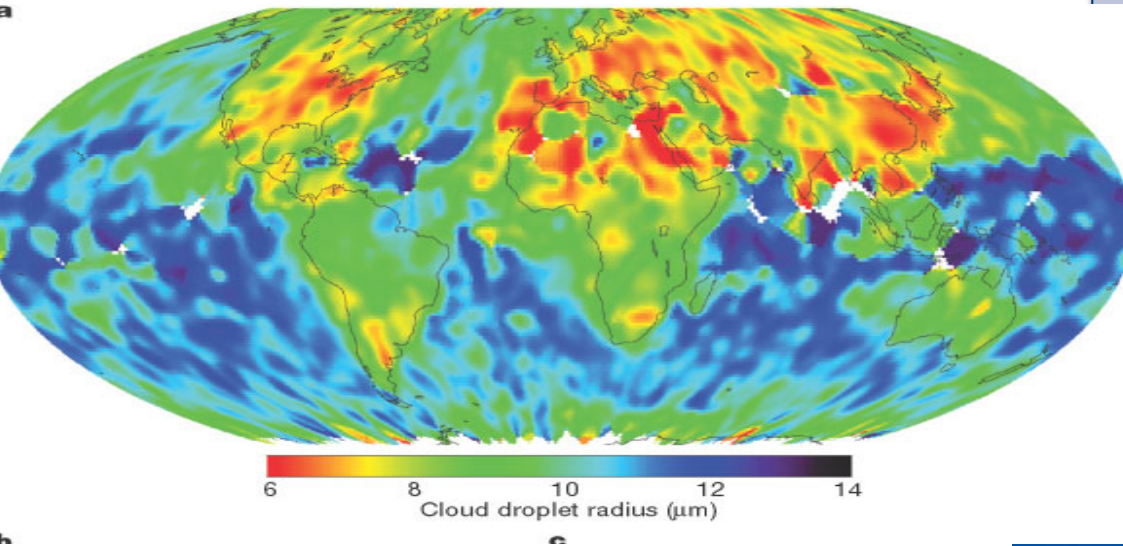
Mission objectives

- Aerosols
- Phase, altitude, properties of clouds
- Albedo, radiative budget (BRDF)

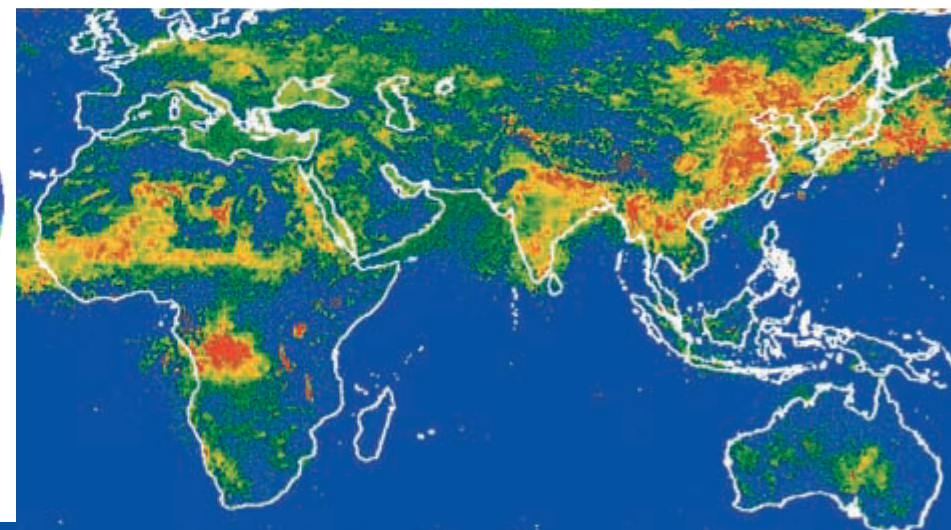
First operational polarimeter

Major improvements over POLDER

- Horizontal Resolution: 4 km
- 11 channels, extension to SWIR: Better aerosol characterisation
- Higher angular resolution (14 view angles)



Kaufman et al. (2002)



AI = 0.00

AI = 0.50

EUMETSAT

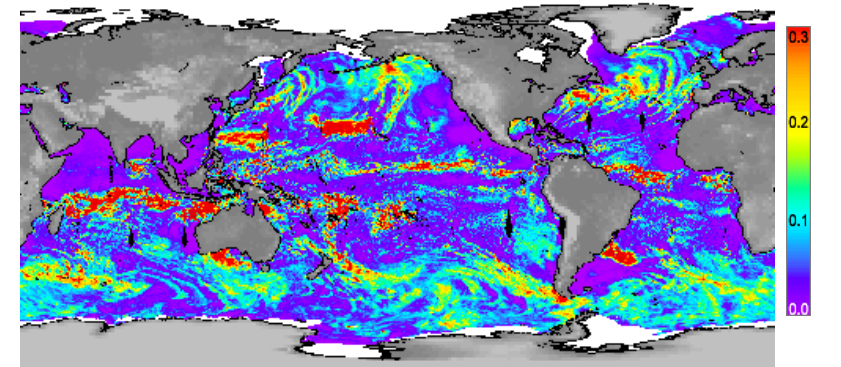
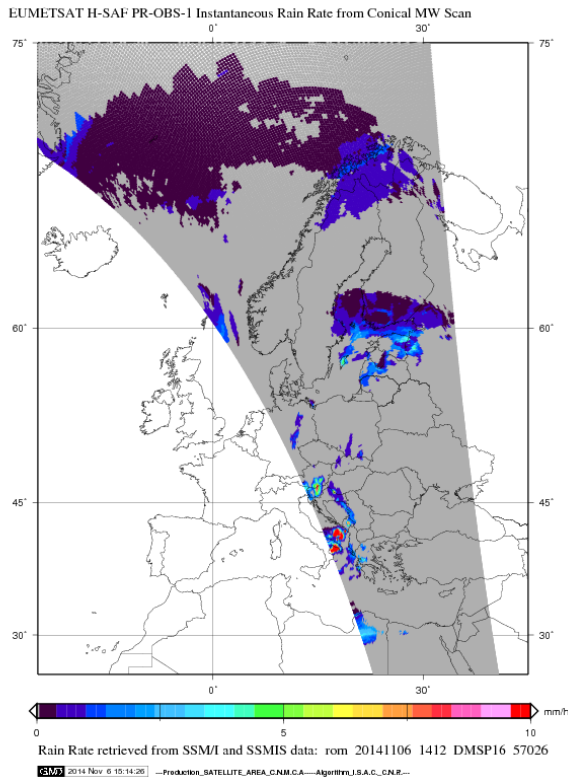
New mission: Micro-Wave Imager (MWI) on Metop-SG B

Mission objectives

- Precipitation and clouds
- Imagery and H2O profiles
- Sea ice, surface snow

19 channels (18.7 - 183 GHz)

- Enhancement wrt SSMI/S
- Addition of sounding channels
 - Improve estimation of precipitation
 - Water vapour and clouds
- European part of future GPM constellation



Cloud Liquid Column mm

New mission: Ice-Cloud Imager (ICI) on Metop-SG B

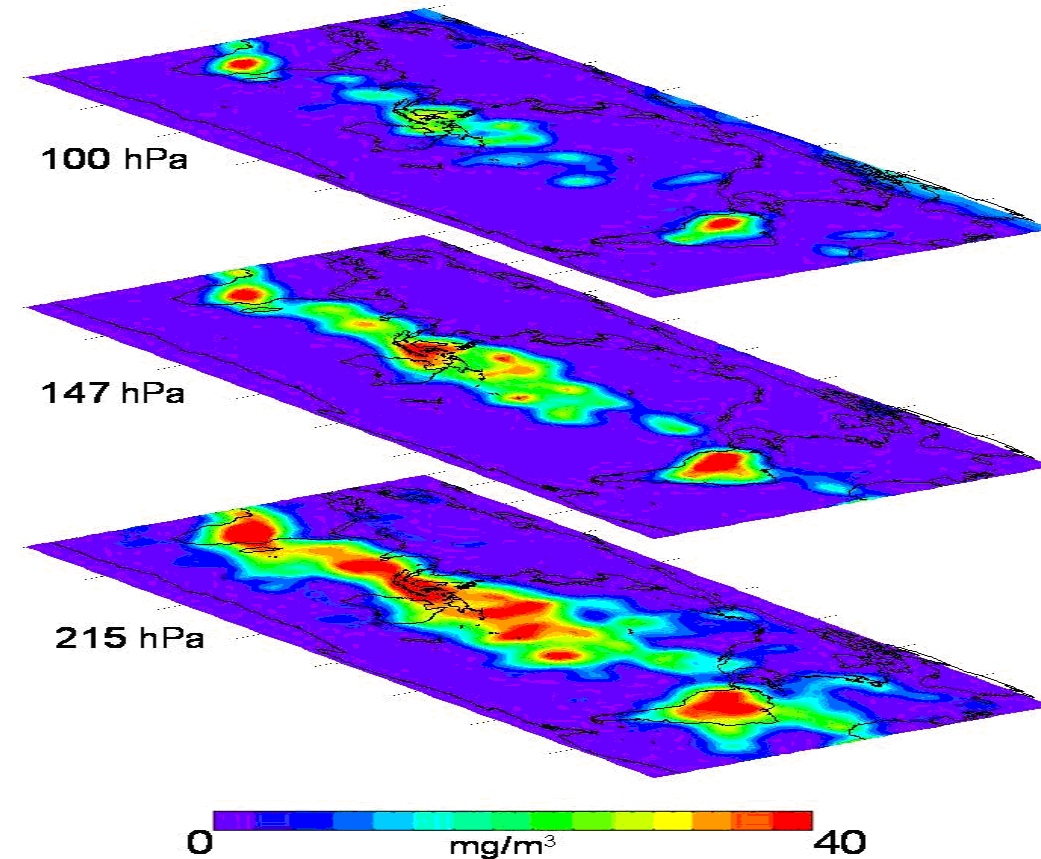
Mission Objectives

- Clouds (ice phase)
- Detection of snow

11 channels (183 – 664 GHz)

- First operational ice cloud imagery mission
- Meteorology and climate (Cirrus)

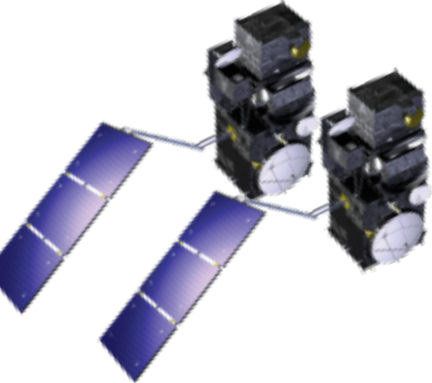
Mean Cloud Ice, December, 2004



NASA: Aura/MLS

Contributions to Copernicus

- Sentinel-3 Marine mission

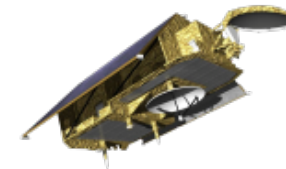


Sentinel-3A: routine operations since 16 October

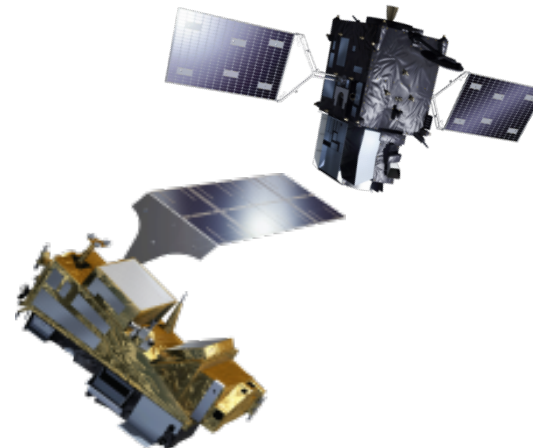


Sentinel-3B: launch in March 2018

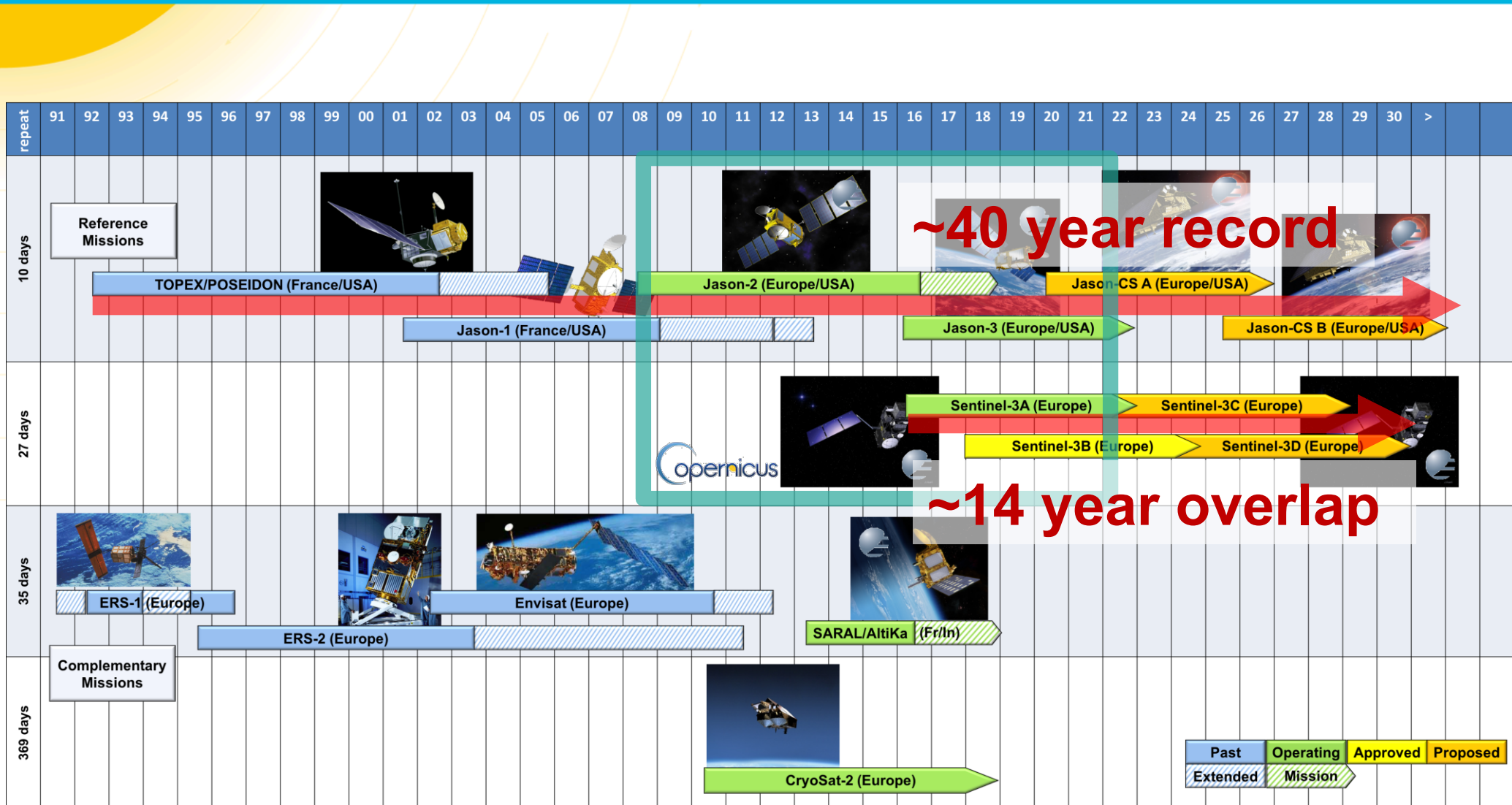
- Jason-3 and Sentinel-6/Jason-CS cooperative missions



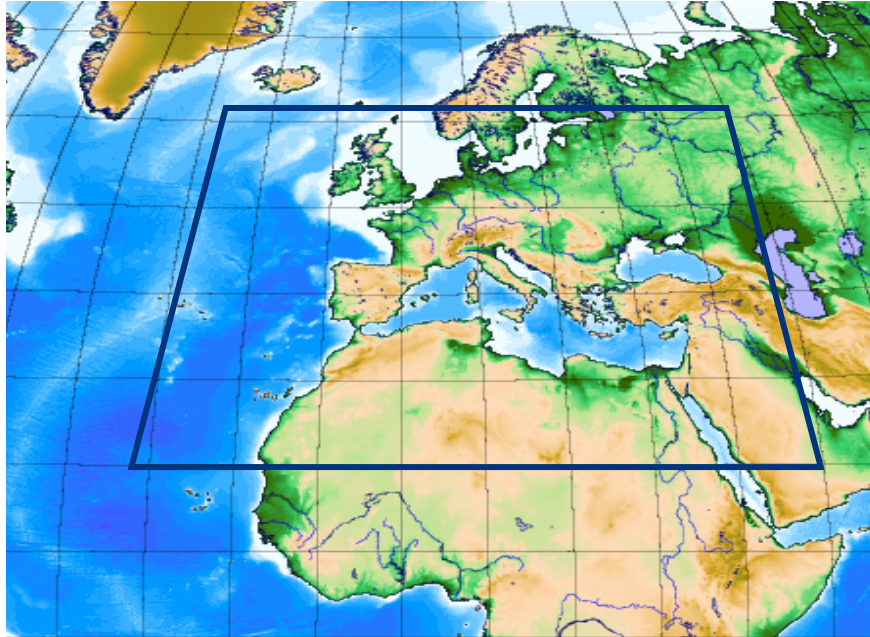
- Sentinel-4 as part of MTG(-S) system
- Sentinel-5 as part of EPS-SG system
- Data access



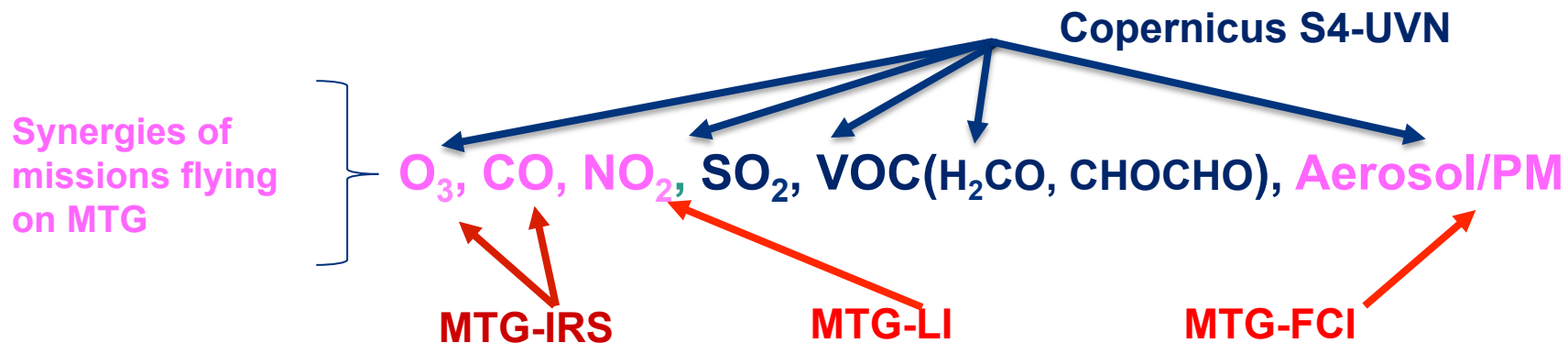
“Continuity of Service”



MTG Mission: Hosting Copernicus Sentinel-4



- The Copernicus Sentinel-4 sounding mission is achieved through the Ultraviolet, Visible & Near-infrared (UVN) Instrument accommodated on the MTG-S satellites
 - covering Europe every hour
 - taking measurements in three spectral bands (UV: 305 - 400 nm; VIS: 400 - 500 nm, NIR: 750 - 775 nm)
 - with a resolution around 8km.
- The primary data products are O₃, NO₂, SO₂, HCHO and aerosol optical depth.



Expansion Missions (Sentinel 7, 8, 9, ...)

➤ Phase A/B1 studies of Potential New Sentinels - responding to EU policy and user priorities:

- ✓ Anthropogenic CO2 Monitoring
- ✓ Agriculture/Urban – Thermal Infrared
- ✓ Polar Ice and Snow – Topographic mission
- ✓ Polar floating sea ice - Passive Microwave Imaging
- ✓ Agriculture/Mining – HyperSpectral
- ✓ Agriculture/Polar – L-Band SAR

Conclusion

- Europe has an integrated observational approach that is targeted on key challenges and promotes the fusion of theory, models and observations;
- EUMETSAT past, current and new programmes provide the needed long-term continuity for many long-term climate data records;
- Allows also the establishment/enhancement of new data records for atmosphere, ocean and land ECVs;
- Preparations for further Sentinel missions have already started.

Thank you for your attention!

