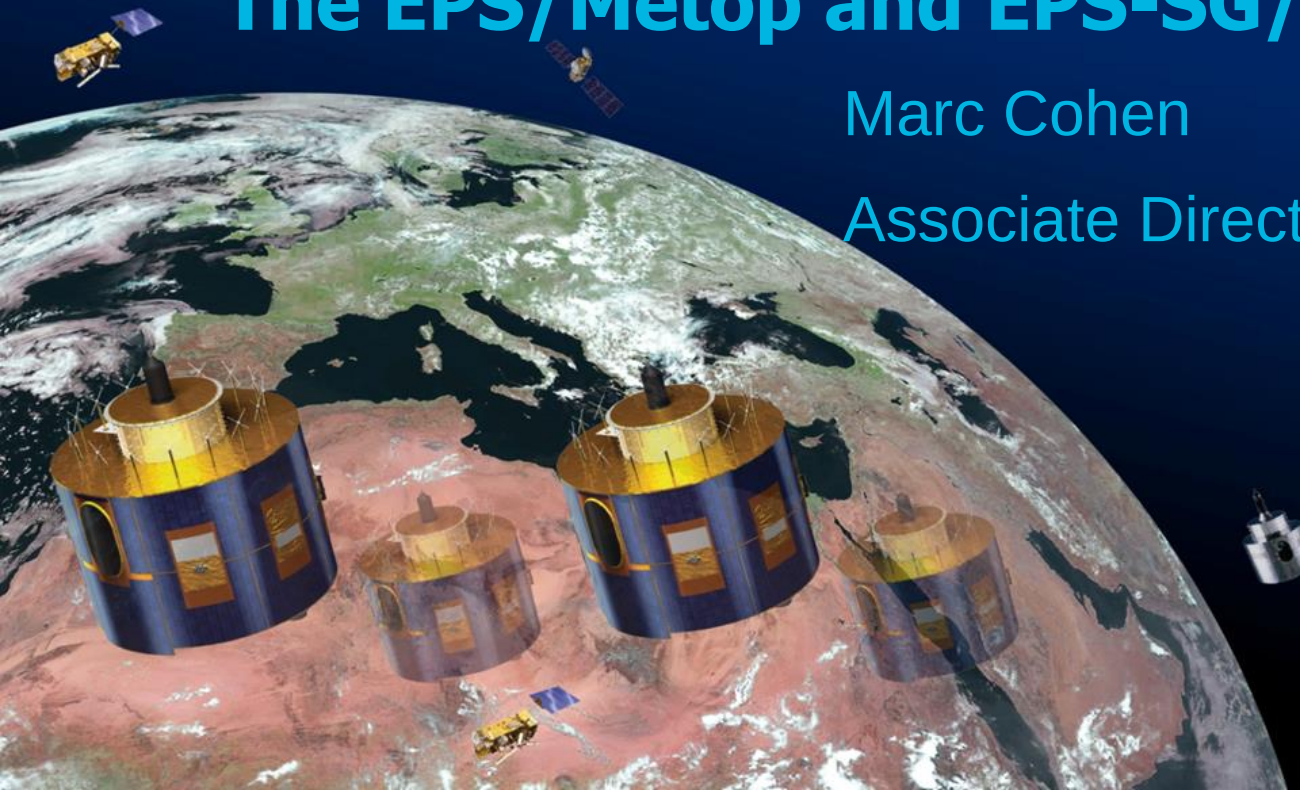
The EPS/Metop and EPS-SG/Metop-SG Systems

Marc Cohen

Associate Director for LEO Programmes



EUMETSAT is an intergovernmental organisation with 30 Member States and 1 Cooperating State

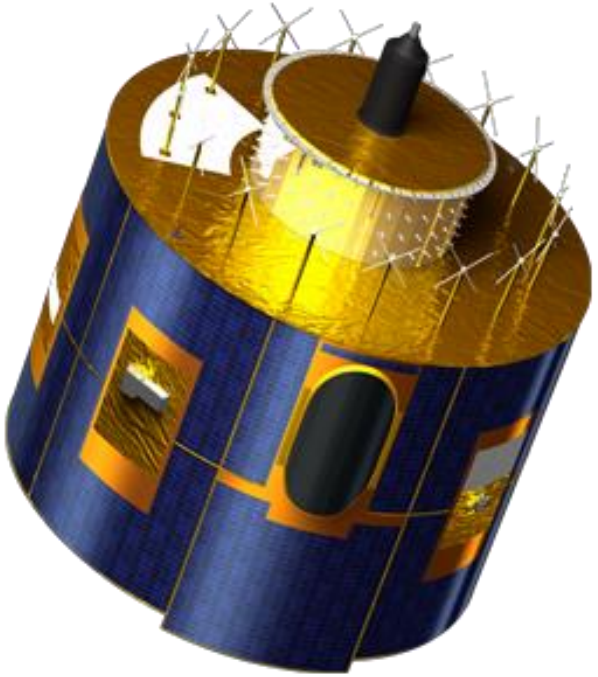
EUMETSAT's Mission

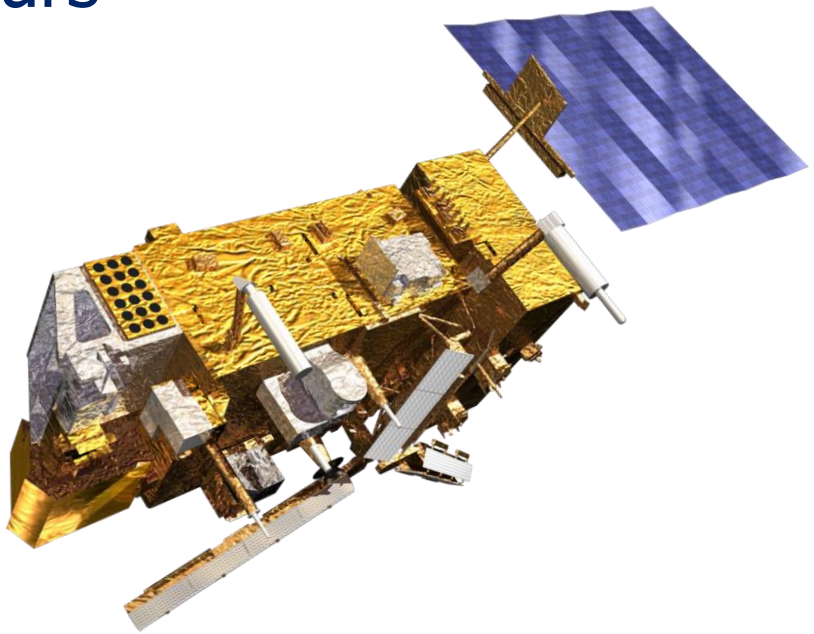
- Primary objective: establish, maintain and exploit European systems of operational meteorological satellites, taking into account as far as possible the recommendations of WMO

- Further objective: contribute to the operational monitoring of the climate change

Need for two types of meteorological satellites

Geostationary orbit
Vital for forecasts up to a few hours





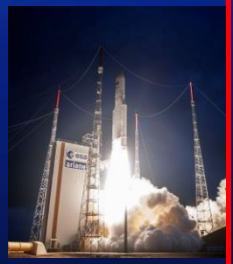
Polar orbit: critical for forecasts up to 10 days

Deployment of current generation satellites

MSG-1 (Meteosat-8) launch 28 August 2002

MSG-2 (Meteosat-9) launch 21 December 2005

MSG-3 (Meteosat-10) launch 5 July 2012



MSG-4 launch 15 July 2015

METEOSAT SECOND GENERATION

METEOSAT-8

METEOSAT-9

MSG-3/METEOSAT-10

MSG-4/METEOSAT-11*

YEAR... 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

EUMETSAT POLAR SYSTEM (EPS)

METOP-A

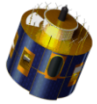
METOP-B

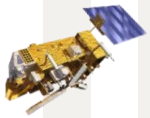
METOP-C

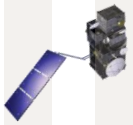
Metop-A launch 19 October 2006

Metop-B launch 17 September 2012

Operational services call for long term commitments..







YEAR... 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

METEOSAT SECOND GENERATION
METEOSAT-8
METEOSAT-9
MSG-3/METEOSAT-10
MSG-4/METEOSAT-11*
METEOSAT THIRD GENERATION
MTG-I-1 : IMAGERY
MTG-S-1: SOUNDING
MTG-I-2: IMAGERY
MTG-I-3: IMAGERY
MTG-S-2: SOUNDING
MTG-I-4: IMAGERY

Mandatory Programmes

EUMETSAT POLAR SYSTEM (EPS)
METOP-A
METOP-B
METOP-C
EUMETSAT POLAR SYSTEM SECOND GENERATION (EPS-SG)
METOP-SG A: SOUNDING AND IMAGERY
METOP-SG B: MICROWAVE IMAGERY

JASON (HIGH PRECISION OCEAN ALTIMETRY)
JASON-2
JASON-3
SENTINEL 6 (JASON-CS)

Optional Programmes

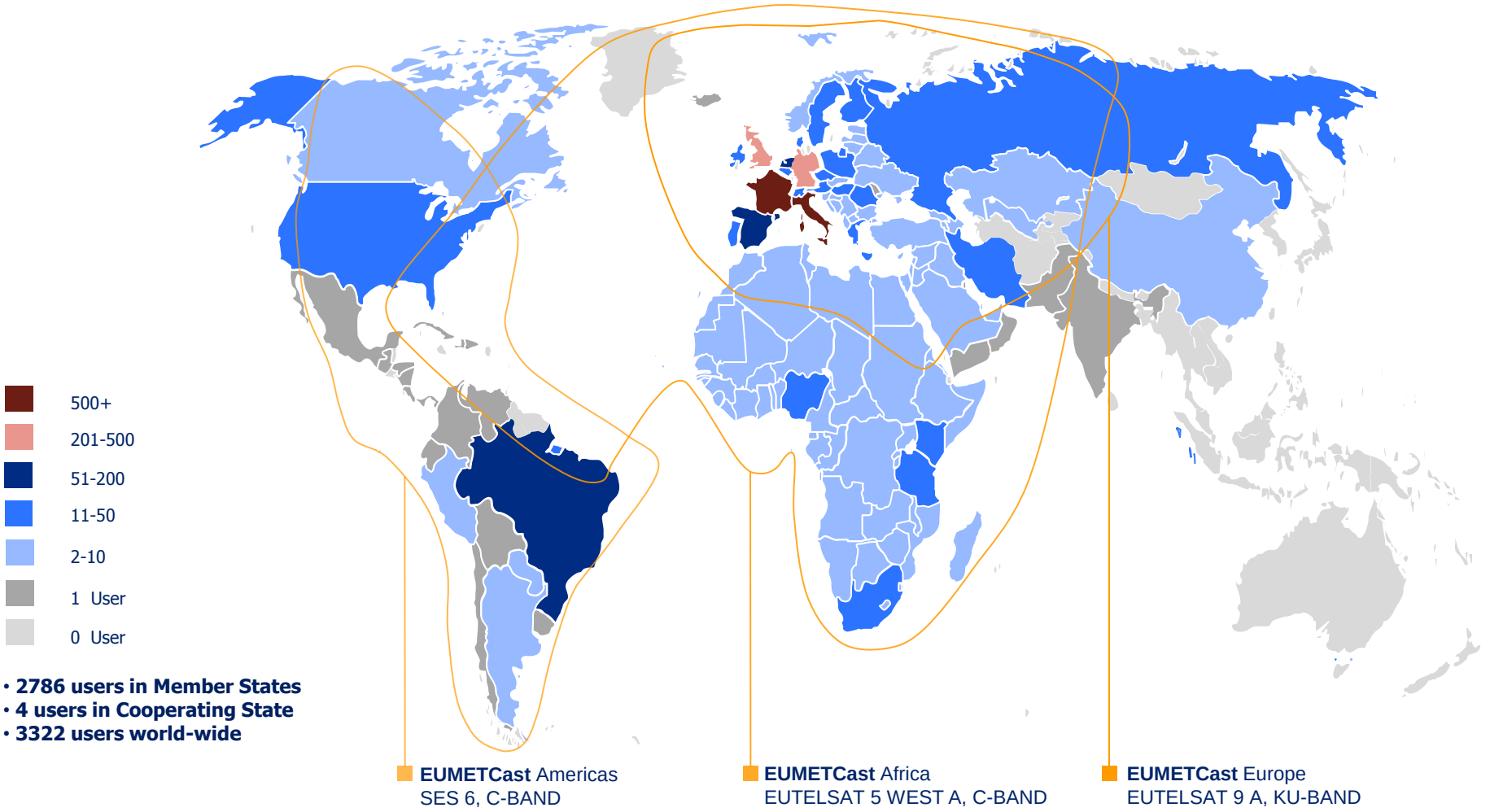
COPERNICUS
SENTINEL-3 A/B/C/D
SENTINEL-4 ON MTG-S
SENTINEL-5 ON METOP-SG A

Third Party Programmes

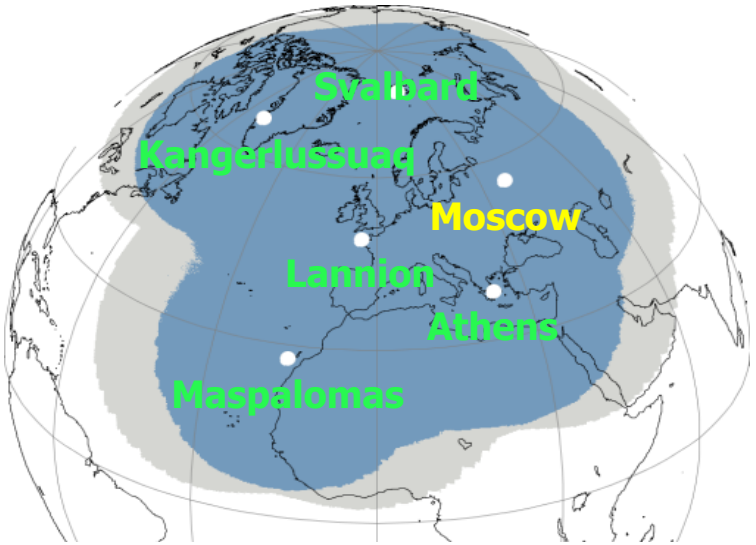
YEAR... 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

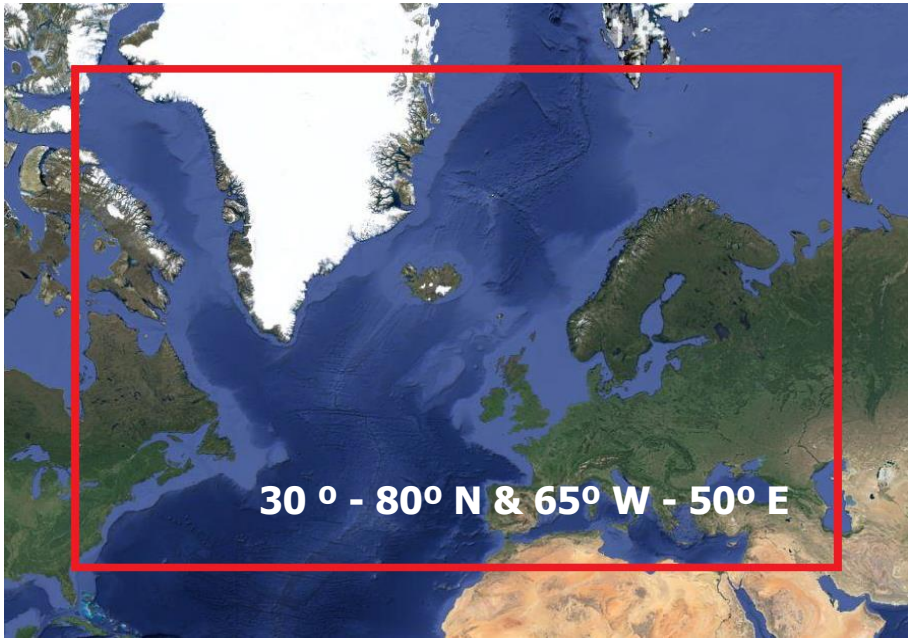
Delivering to users worldwide in real time

EUMETCast Users Worldwide as of 30 June 2015



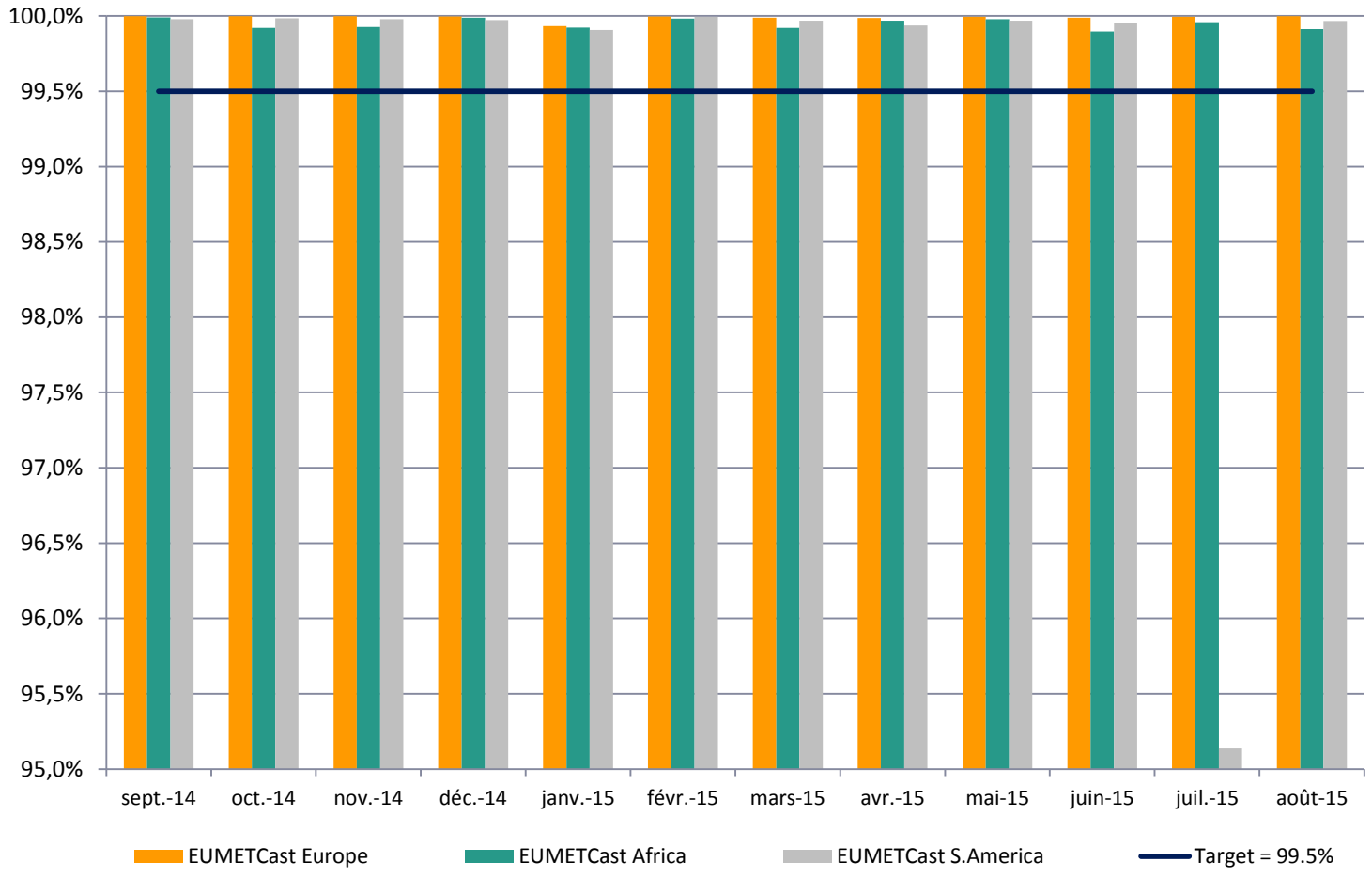
EARS: regional real time data services for regional NWP



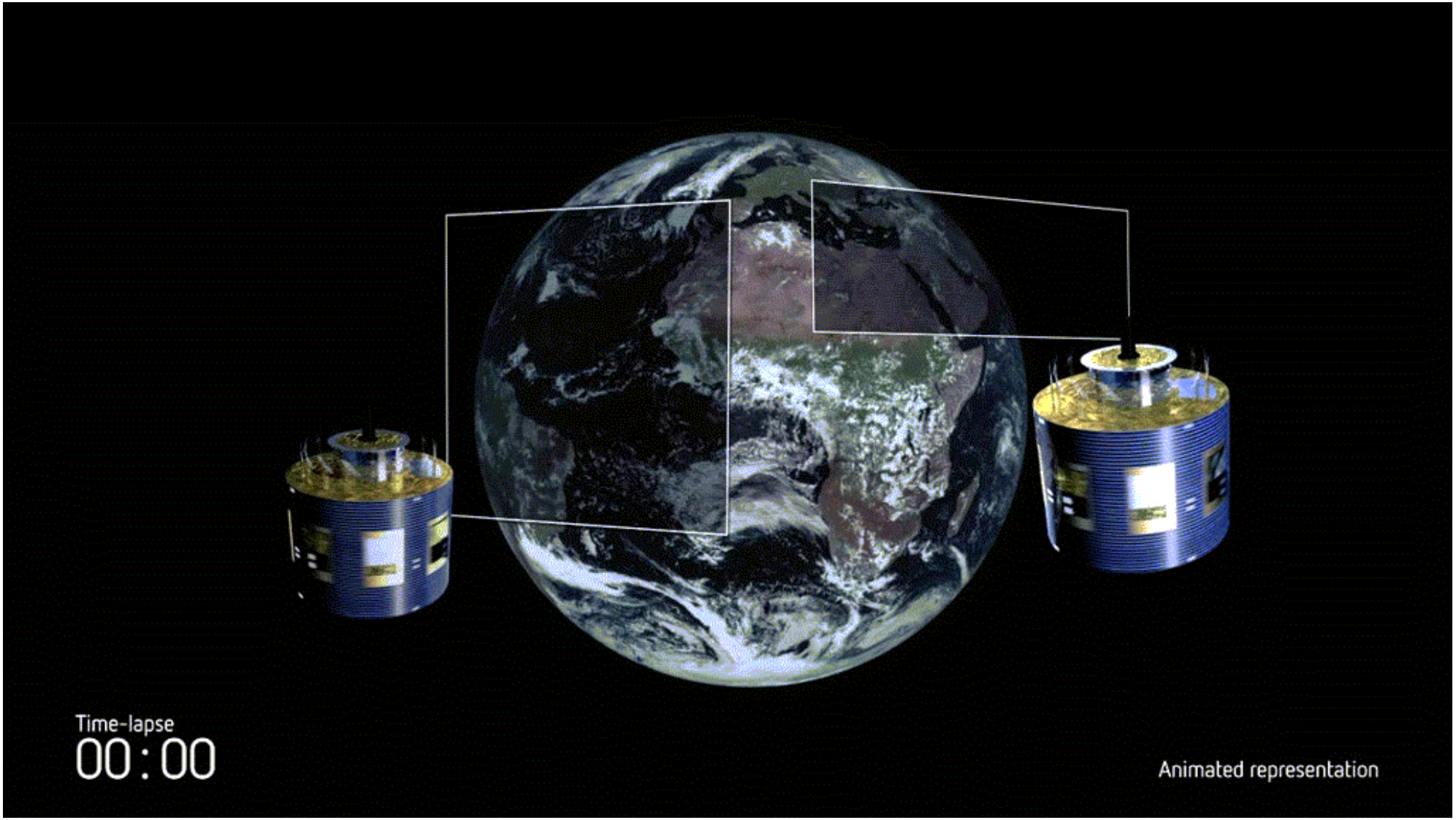


- Direct broadcast data acquired/processed at stations
- Products collected from network, disseminated within 15 to 30 minutes from sensing

Meeting operational availability targets

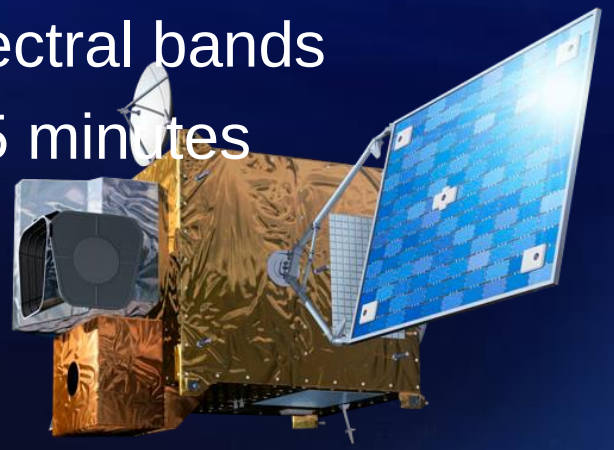


Meteosat Second Generation: a two-satellite operational system



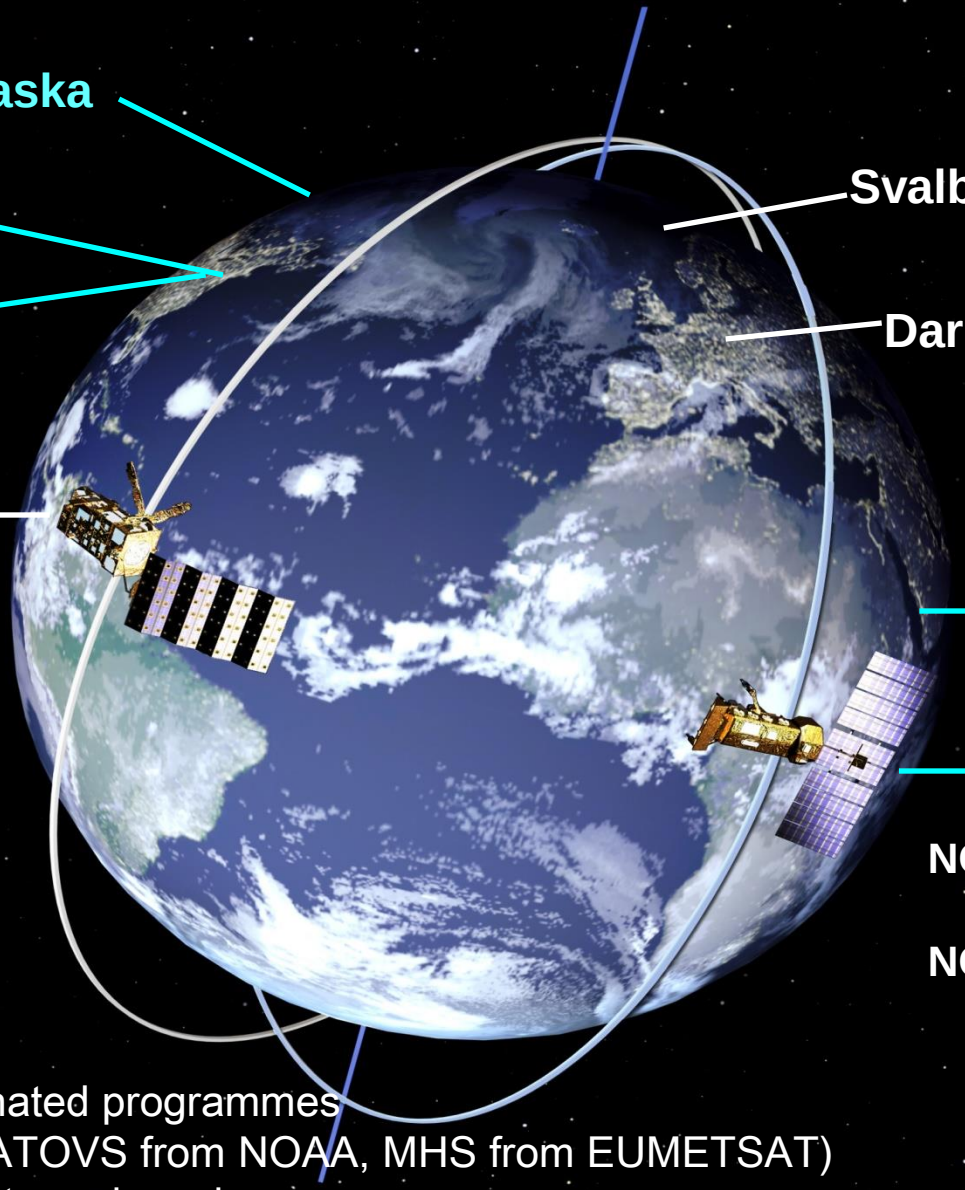
Meteosat Third Generation: MTG-I and MTG-S missions

- MTG-I imagery mission implemented by a two-satellite system:
  - Advanced imager (FCI)
    - Full disk imagery every 10 minutes in 16 spectral bands
    - Fast imaging of European weather every 2.5 minutes
  - New Lightning Imager (LI)



- MTG-S sounding mission:
  - Hyperspectral infrared (IRS):
    - 3D mapping of water vapour, temperature, O3 every 30 minutes over Europe
  - Will carry the Copernicus Sentinel-4 Ultraviolet sounder
    - Air quality monitoring, in synergy with IRS instrument

EPS/Metop is part of the Initial Joint Polar System (IJPS)



Fairbanks, Alaska

Wallops Island, MD

Suitland, MD

Svalbard, Norway

Darmstadt, Germany

Metop

Metop-A (2006)
Metop-B (2012)
Metop-C (Oct 2018)

Suomi-NPP
(in orbit)

POES

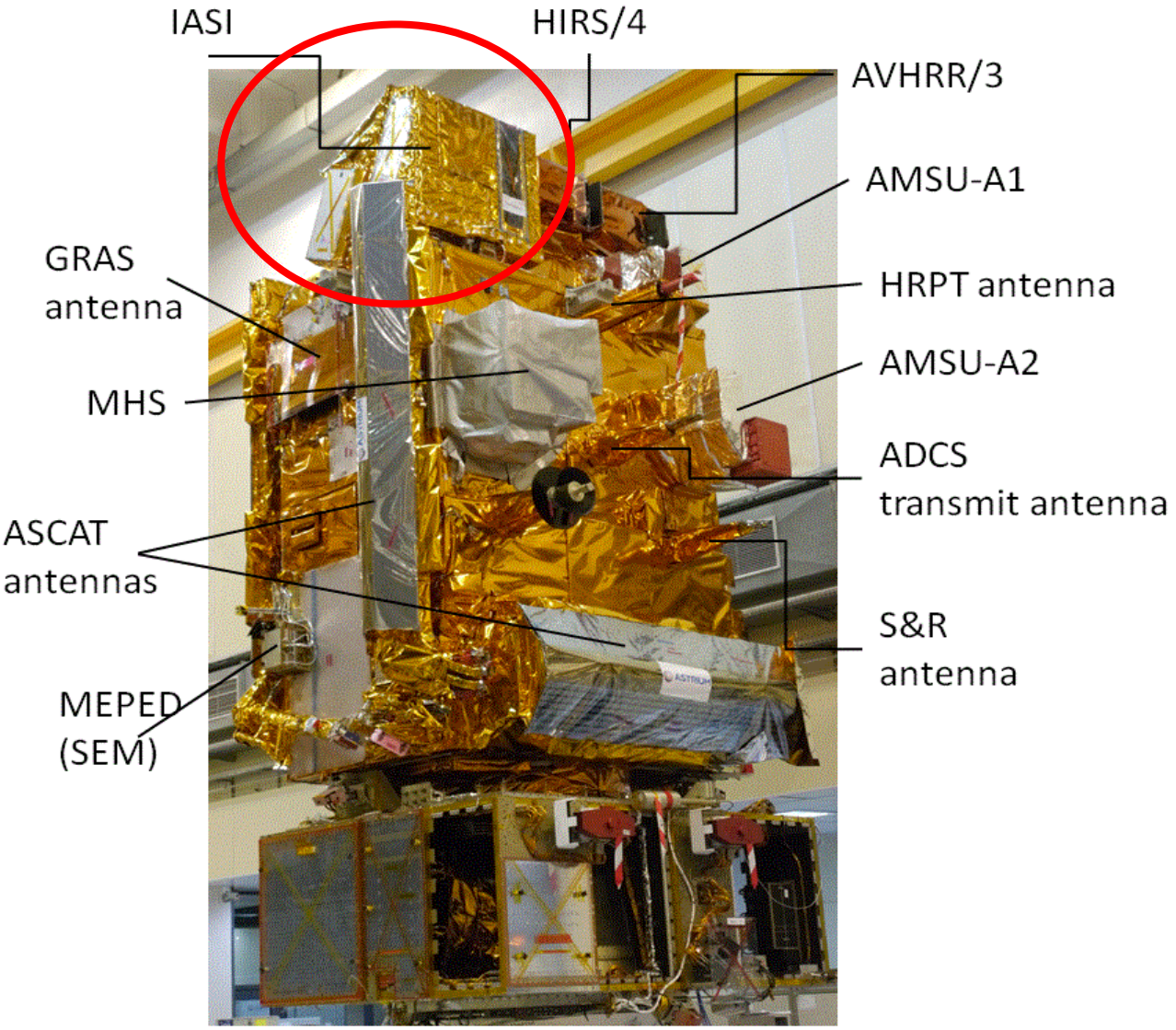
NOAA-18)

NOAA-19

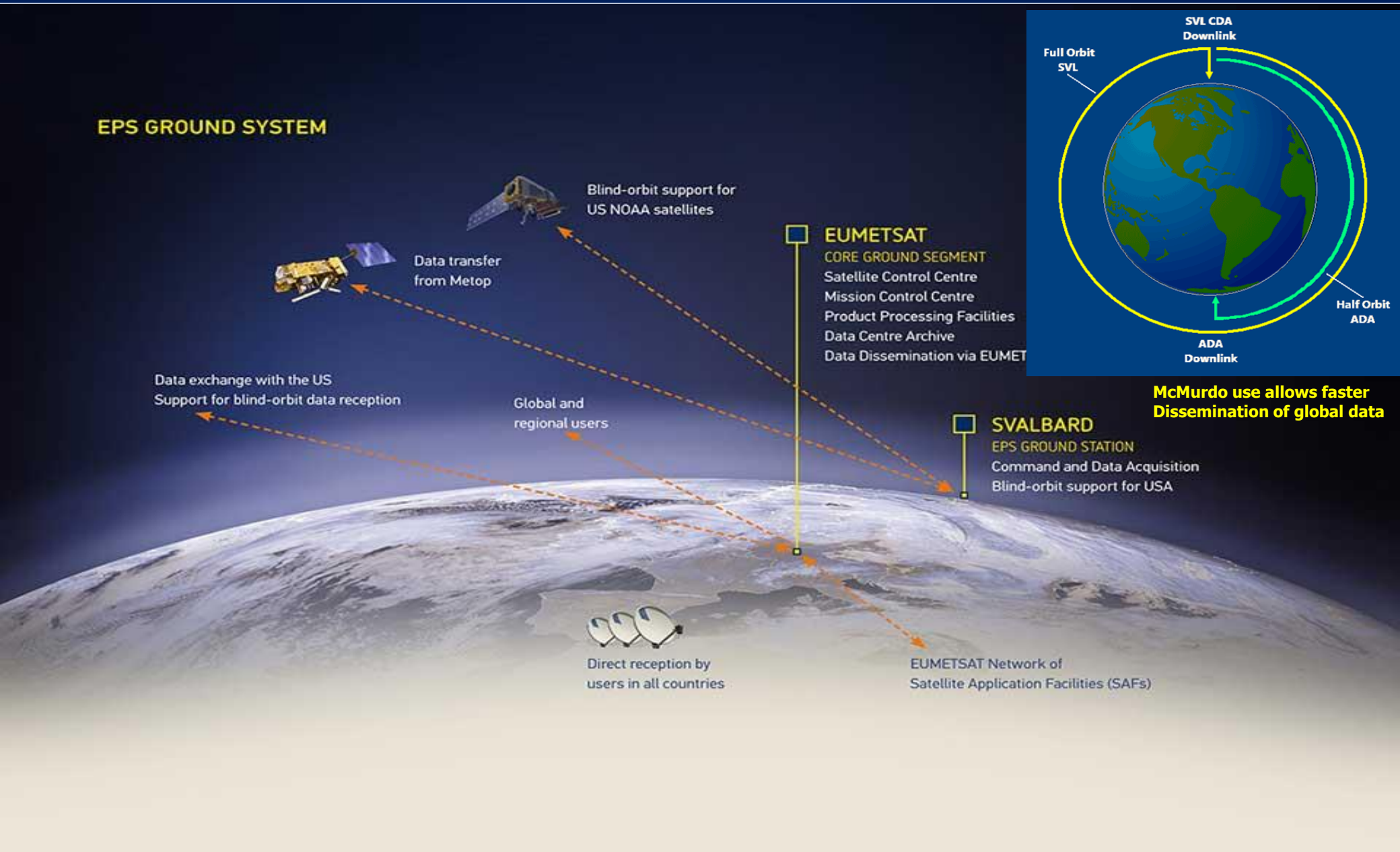
- EUMETSAT-NOAA coordinated programmes
- Exchange of instruments (ATOVS from NOAA, MHS from EUMETSAT)
- Coordinated operations, data and services
- Extended agreement in 2003 to include Metop-C

Sun-synchronous
Orbit of 102 minutes
14.1 orbits per day

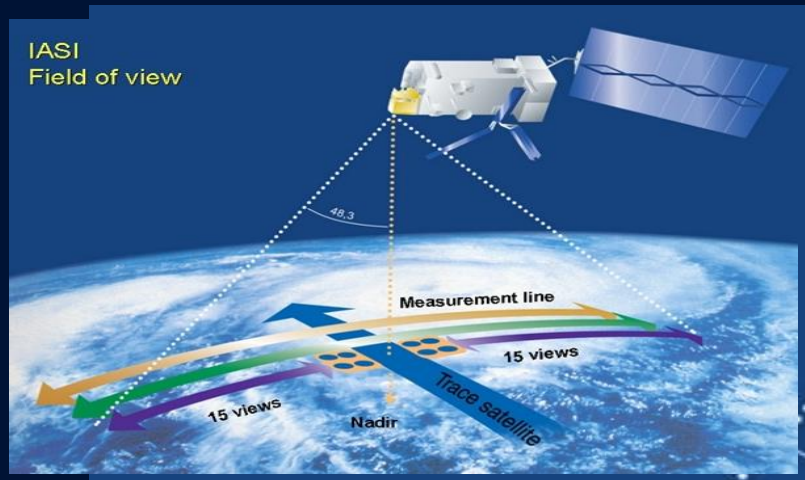
The Metop Satellite (Metop-B 2012)



EPS Ground System



Atmospheric Profiling with IASI: Acquisition characteristics



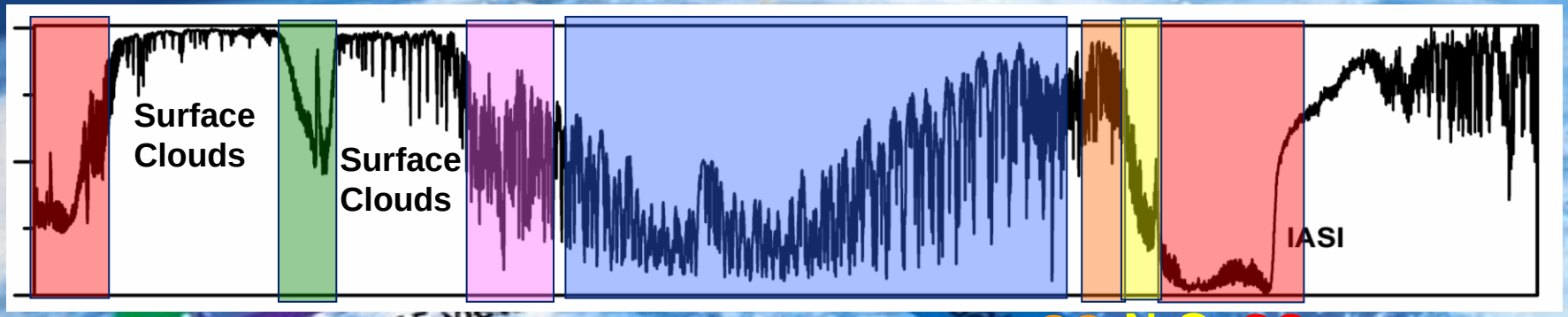
Infrared Fourier transform interferometer

Spectral range: 645 to 2760 cm^{-1} (15.5-3.62 µm)

Spectral sampling: 0.25 cm^{-1}

Footprint: 12 km (Nadir)

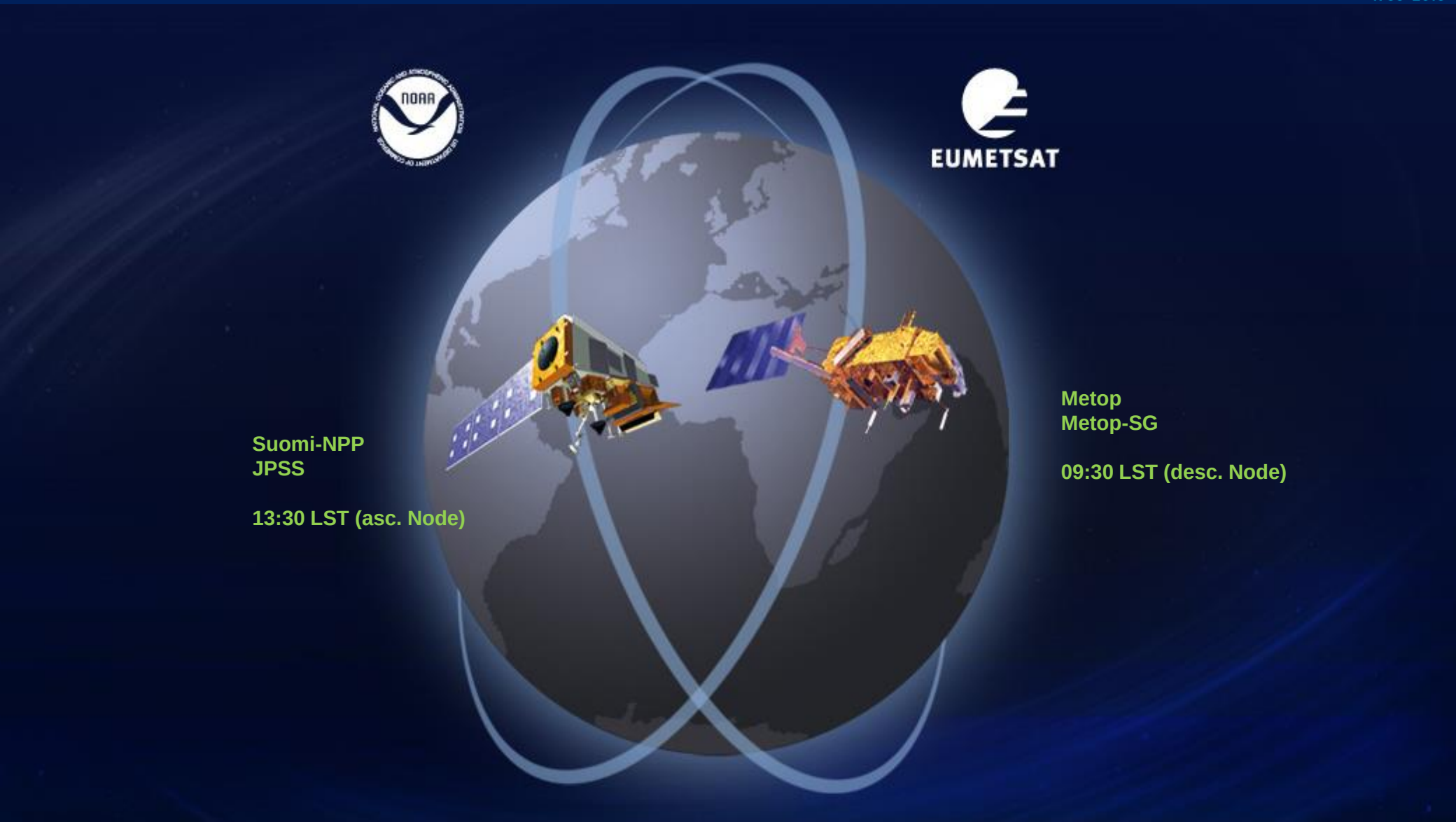
Swath: ±1000km (± 48.3°)



Credit: Th. August, 2014

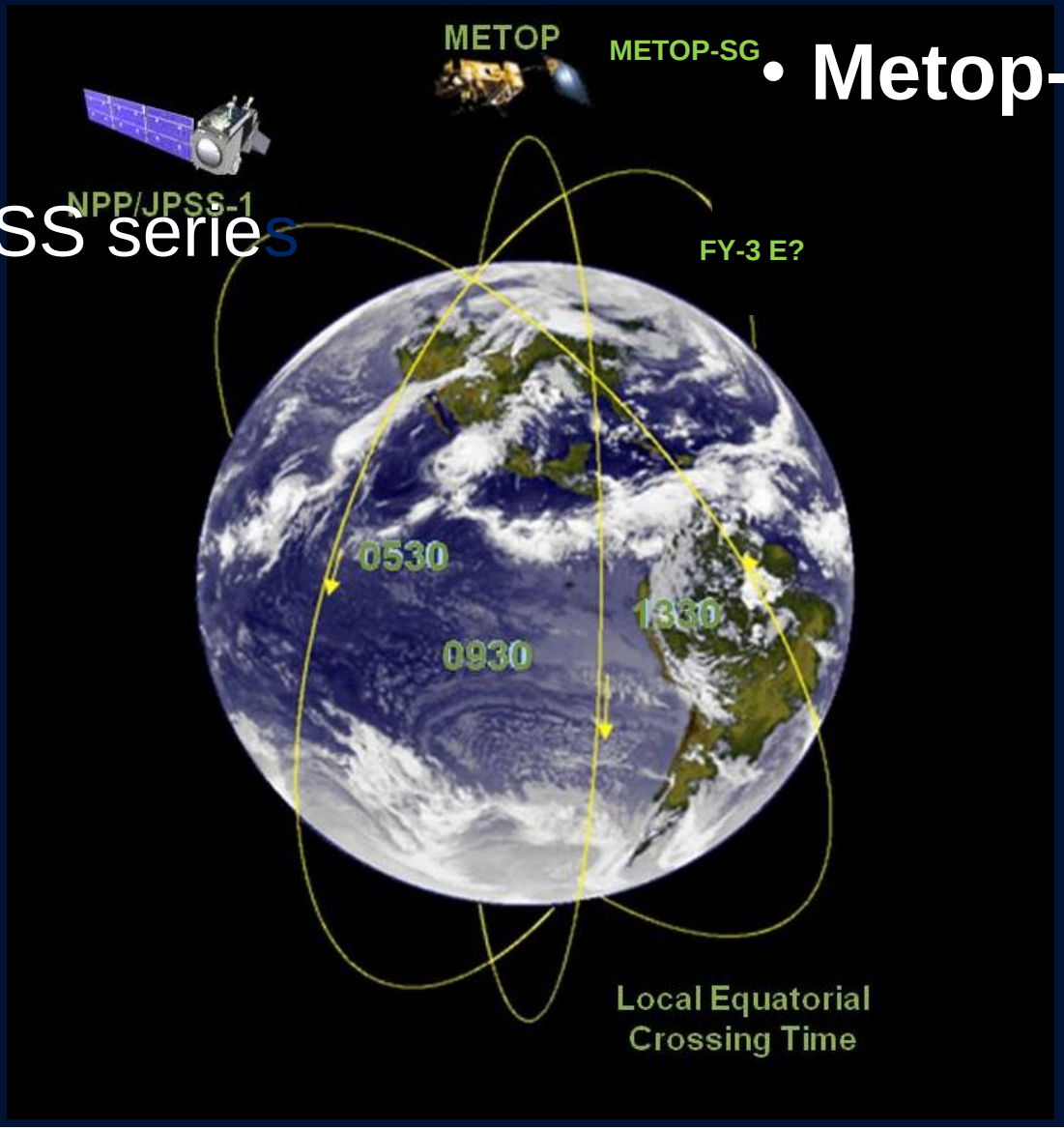
EPS-SG in the Joint Polar System shared with the US

30 YEARS 1986-2016



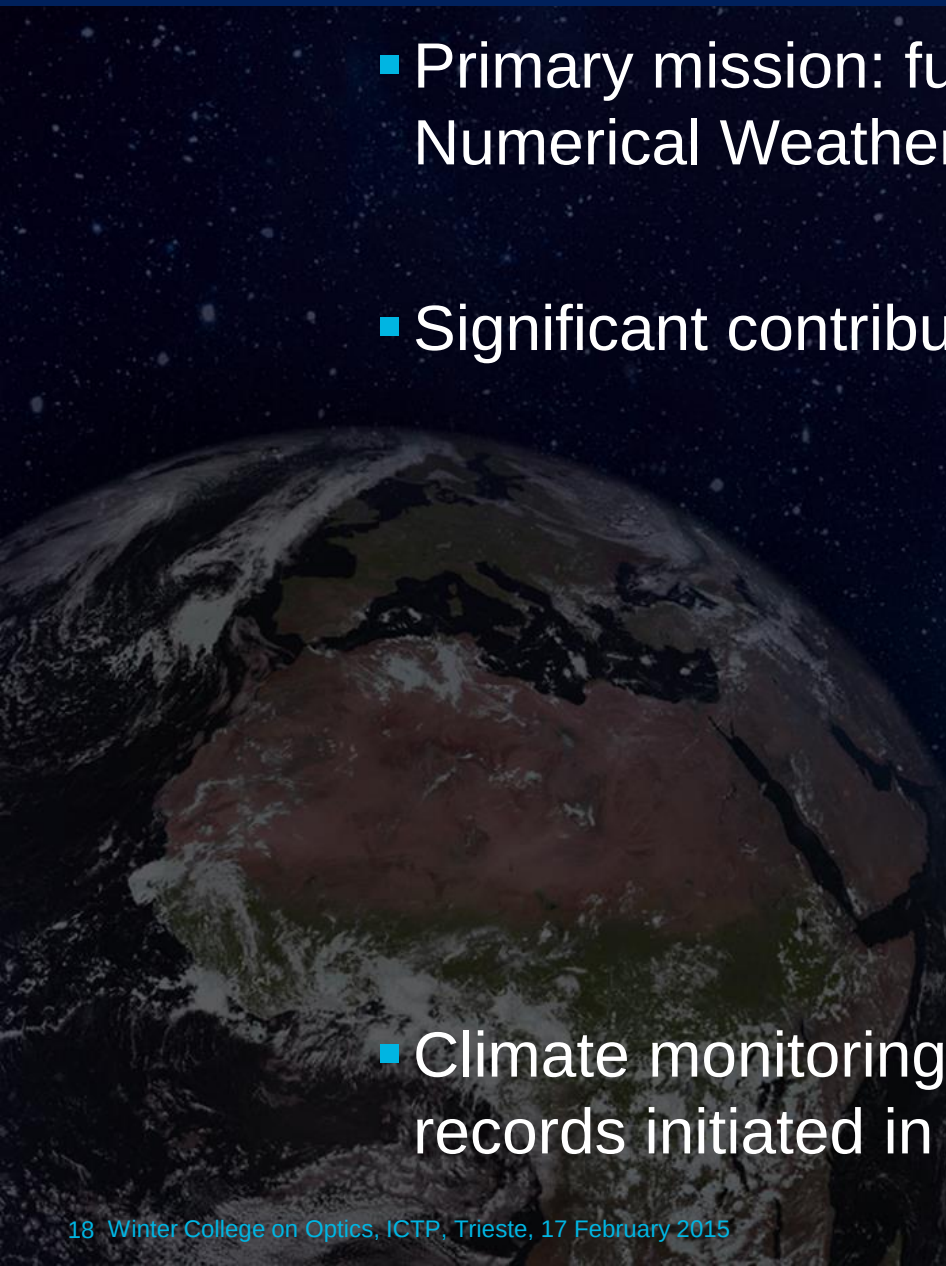
EUMETSAT

EPS-SG in the Joint Polar System shared with the US



- JPSS series
- Metop-SG series

EPS Second Generation (EPS-SG)



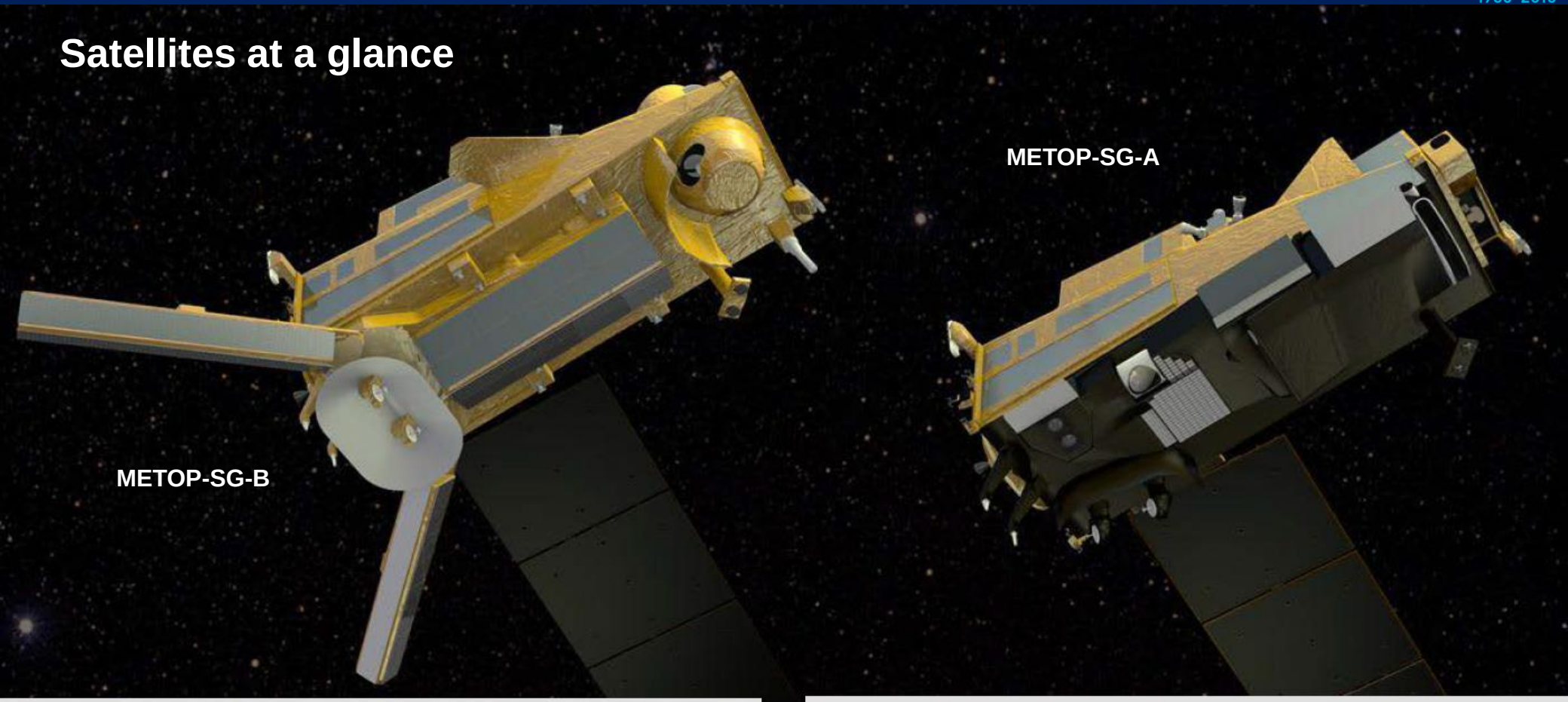
- Primary mission: further improve observational inputs to Numerical Weather Prediction models
- Significant contributions to other real time applications
  - Nowcasting at high latitudes
  - Marine meteorology and operational oceanography
  - Operational hydrology
  - Air quality monitoring
- Climate monitoring: expand by 20+ years the climate data records initiated in 2006 with EPS

EPS Second Generation

- Continuation and enhancement of service from mid morning polar orbit in 2021 – 2040
- Twin satellite in-orbit configuration:
  - Metop-SG A: optical imagery and sounding mission
    - Flies the Copernicus Sentinel-5 instrument
  - Metop-SG B: microwave imaging mission
- Two series of 3 successive satellites for 21 years of operations
- European contribution to the Joint Polar System (JPS) shared with the US/NOAA

Next Generation EPS/Metop-SG

Satellites at a glance

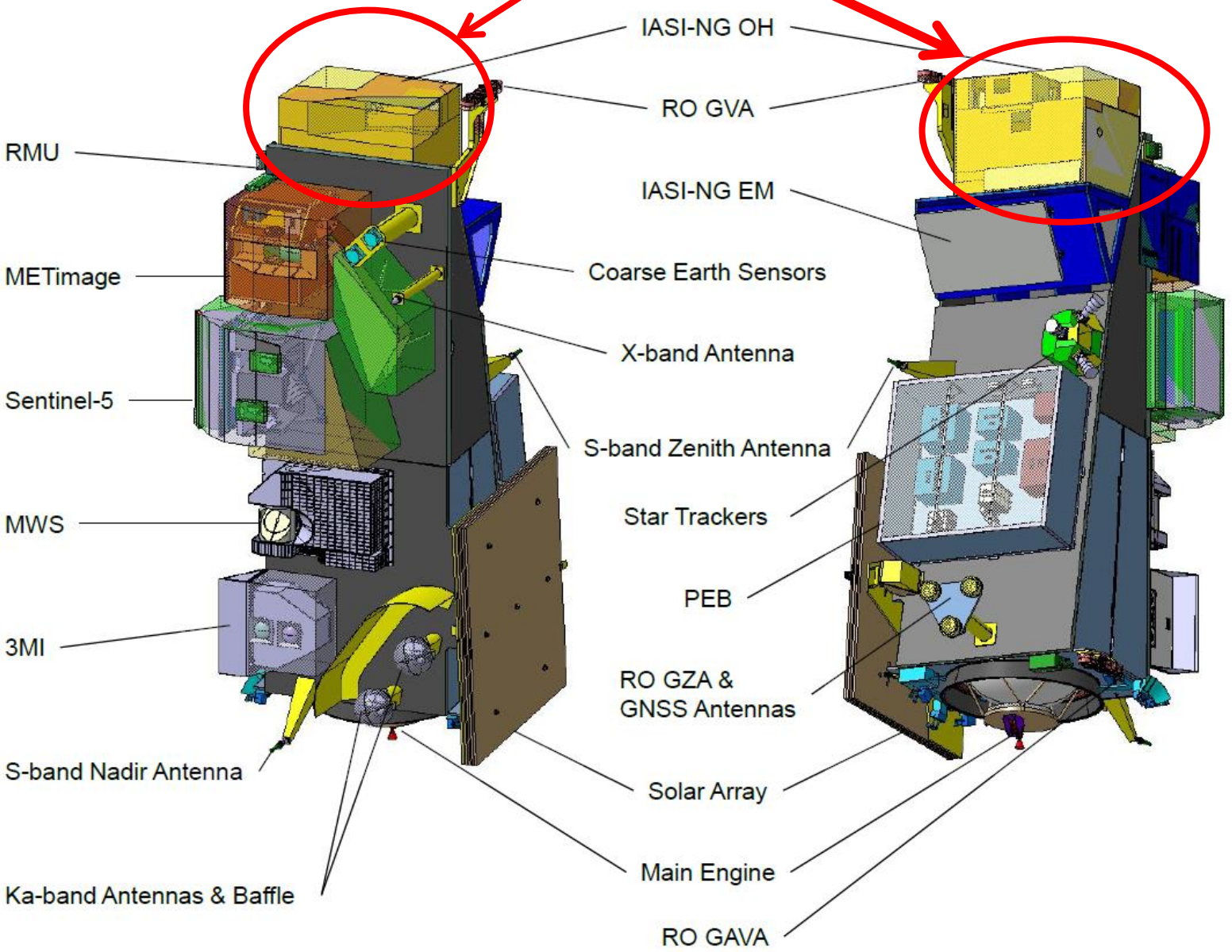


- Launch mass = 3.79 tons
- Mean power consumption = 2.7 kW
- Data rate = day / night / peak
  14 / 14 / 17 Mbps

- Launch mass = 4,08 tons
- Mean power consumption = 3.4 kW
- Data rate = day / night / peak
  60 / 22 / 77 Mbps

- Launcher: Soyuz in Kourou / Falcon 9 / Ariane 5
- Orbit: MetOp Sun Synchronous Orbit 817 km, 9h30 Local Time at Descending Node
- Controlled re-entry into the South Pacific Ocean Uninhabited Area

Metop-SG-A embarks IASI-NG



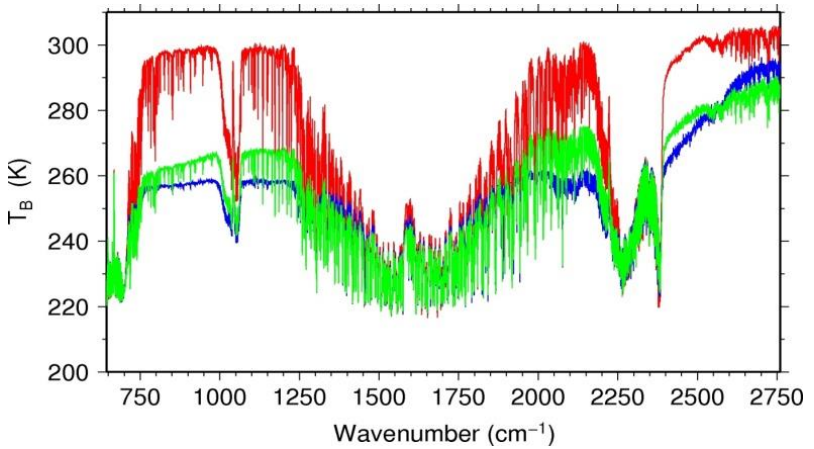
EPS-SG mission capabilities

- Major improvements to all EPS observation missions
  - Infrared and microwave sounding
  - Optical imagery (METImage)
  - Scatterometer
  - Radio-occultation
- New imagery missions
  - 3MI: first operational imaging polarimeter
  - Microwave imager (MWI): imagery of precipitation
  - Ice Cloud Imager (ICI): ice clouds

IASI-NG, MWS & Sentinel-5/Metop-SG A : the sounding mission

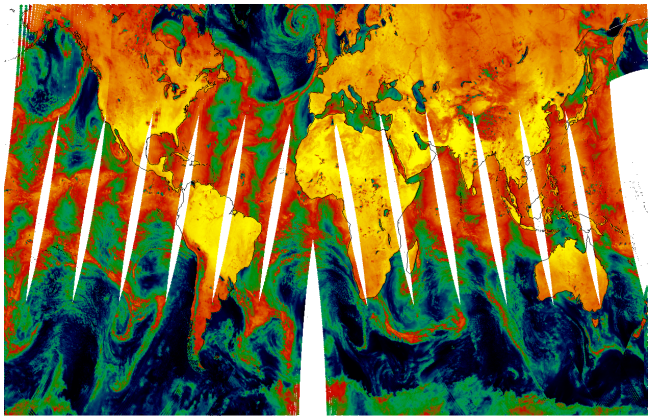
IASI-NG Objectives

- Temperature and Humidity Profiles
- Trace gases (O_3, CO, CH_4, CO_2.)
- Aerosols, volcanic ash
- Reference IR instrument for climate monitoring



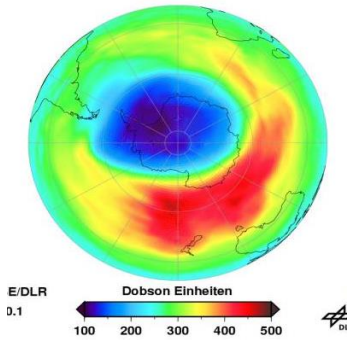
MWS Objectives

- T and HU profiles (all weather)
- Cloud liquid water total column



Sentinel 5 Objectives

- O3 profiles
- CO_2,SO_2, NO_2, H_2O, CO, CH_4, BrO, HCHO, OCHCHO

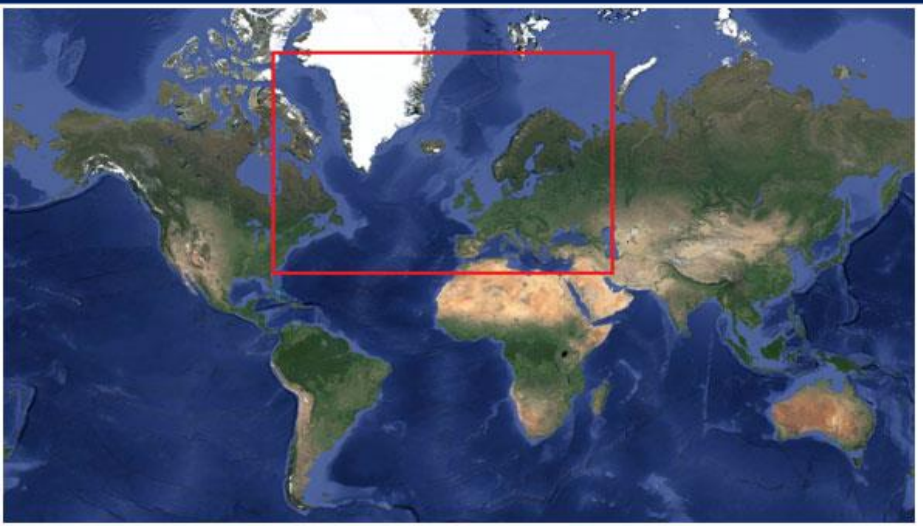


EUMETSAT

IASI-NG in the heritage of IASI

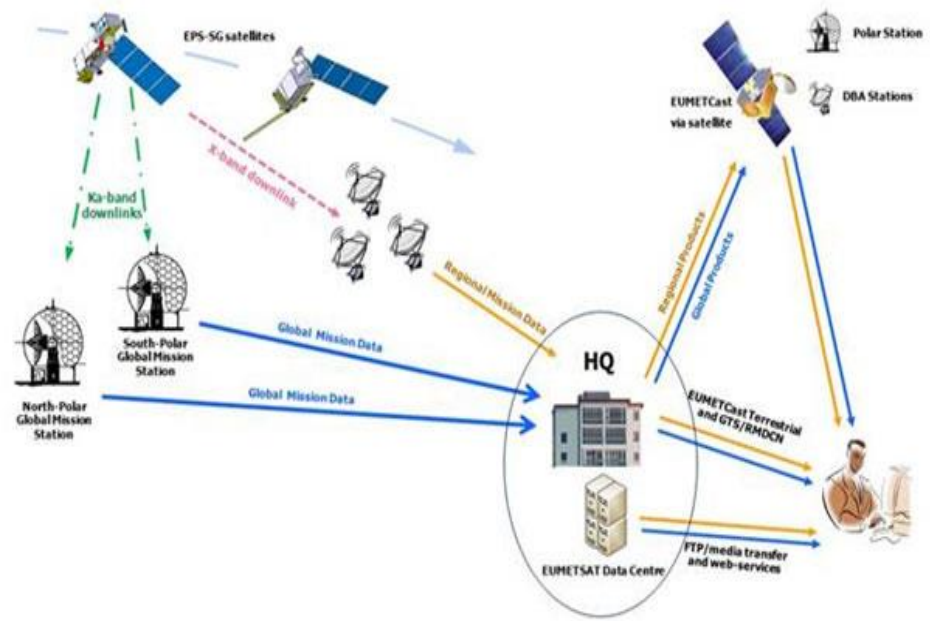
- As for IASI EUMETSAT co-operation agreement with CNES
- Proto flight model developed/co-funded by CNES/EUMETSAT
- Following two flight models procured by CNES, fully funded by EUMETSAT
- Level 1 operational processor developed by CNES
- Technical Expertise Centre operated by CNES
- EPS-SG System operated by EUMETSAT

Data service to Users of EPS-SG, hence for IASI-NG



Regional data delivery service

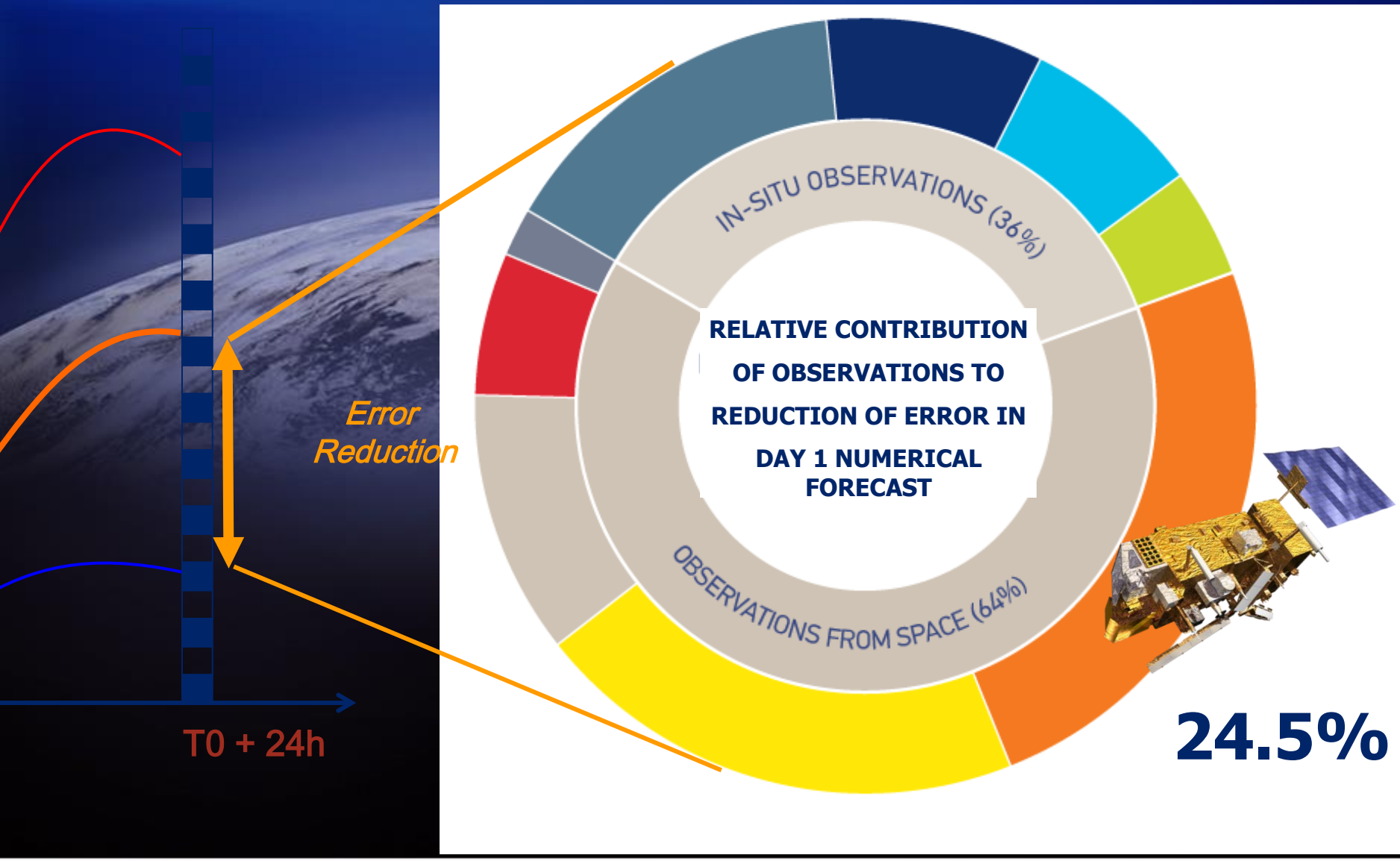
- Area of Interest (AOI)
- timeliness of 30 minutes versus 70 min (global data).
- network of direct broadcast ground stations
- AOI currently covers the North Atlantic and European regions between 30° to 80° North and 65° West to 50° East,
- Re-use selected existing EPS EARS stations sites



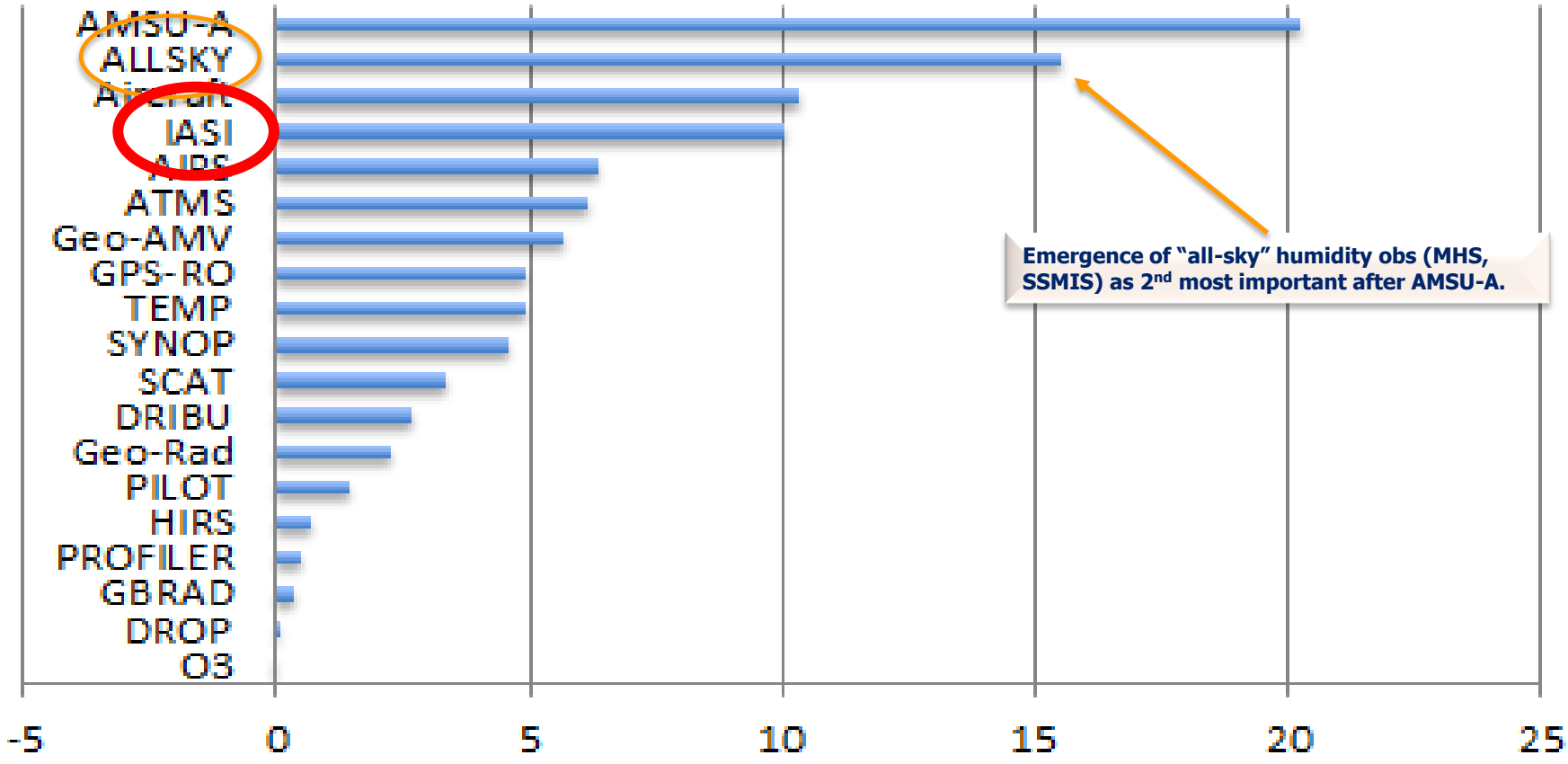
Global data delivery

• Svalbard and Mc Murdo stations
•Instrument data provided to users in near real-time,
• The time between observation and delivery to users, via EUMETCast, is nominally be 70 minutes or better.
• Processed data to users via EUMETCast
• Meteorological data and products also be sent and relayed via WMO GTS and RMDCN) to National Meteorological Services and ECMWF.
•

Major impact of Metop-A on Day 1 forecast



Impact of Satellite Observations by "FSO"
a global measure of 24 hour forecast impact



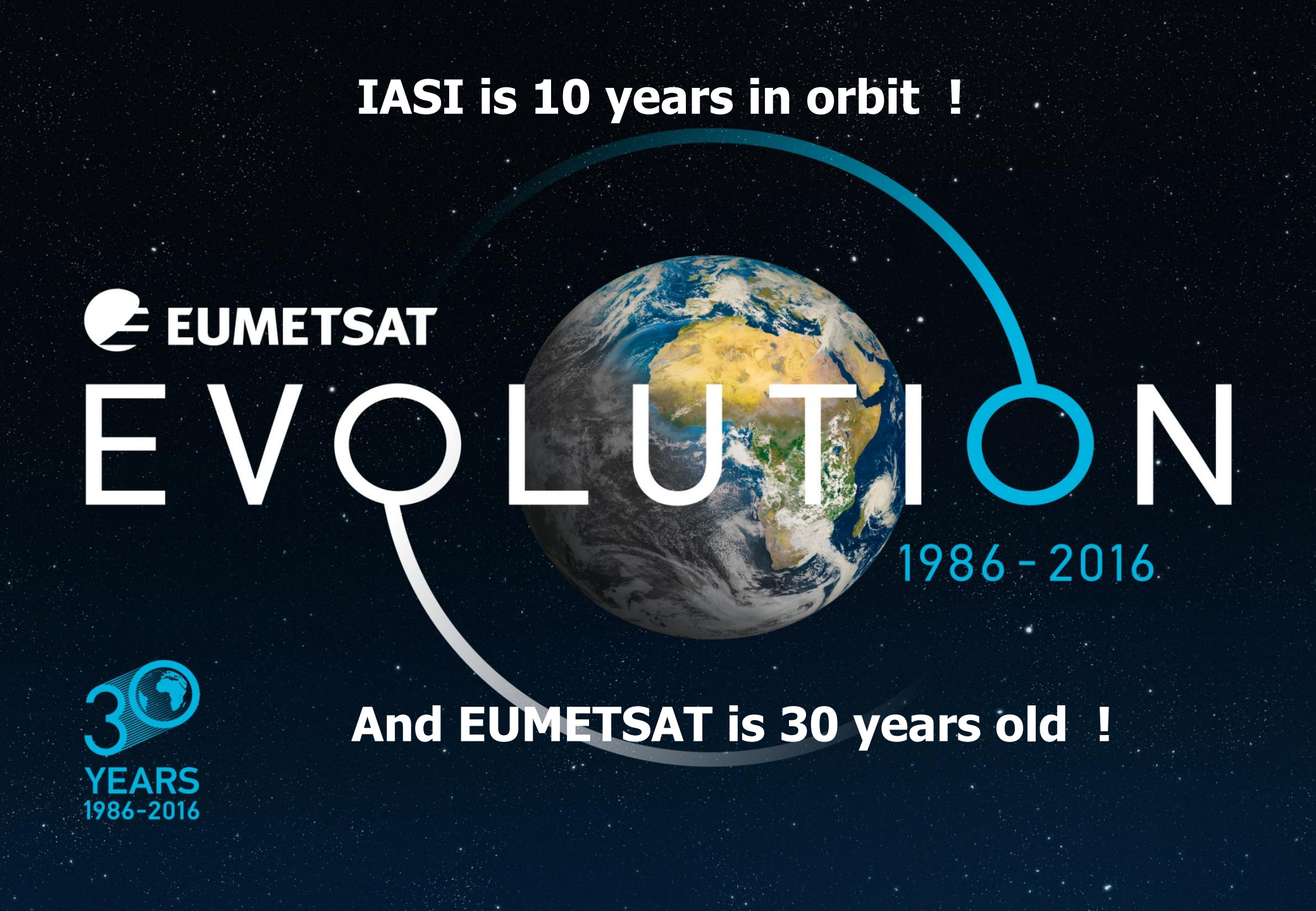
Courtesy ECMWF, 2016

Effort from Katrin Lonitz, EUMETSAT Fellow as well as NWPSAF RTTOV developments led by Alan Geer.

Outlook and conclusions

- **-> IASI is one of the most important mission for NWP**
- Thanks to the scientific community, more and more information extracted from IASI data on trace gases and greenhouse gases, and some products have now reached operational maturity
- IASI is also a very stable infrared reference instrument used worldwide to cross-calibrate other infrared measurements, in particular infrared imagery of all GEO satellites around the “ring” through the GSICS cooperative project.
- **-> IASI is thus a very important instrument for climate change monitoring (CCCD off to improve quality of IASI measurements for climate monitoring)**
- We are now preparing Metop-C (October 2018)
- Beyond, continuity is assured with IASI-NG on EPS-SG/Metop-SG-A form 2022 onwards into the 2040s
- Partnership,cinternational cooperation and industrial competence is key !

IASI is 10 years in orbit !



And EUMETSAT is 30 years old !