

Views on the future Arctic Observations from Satellite

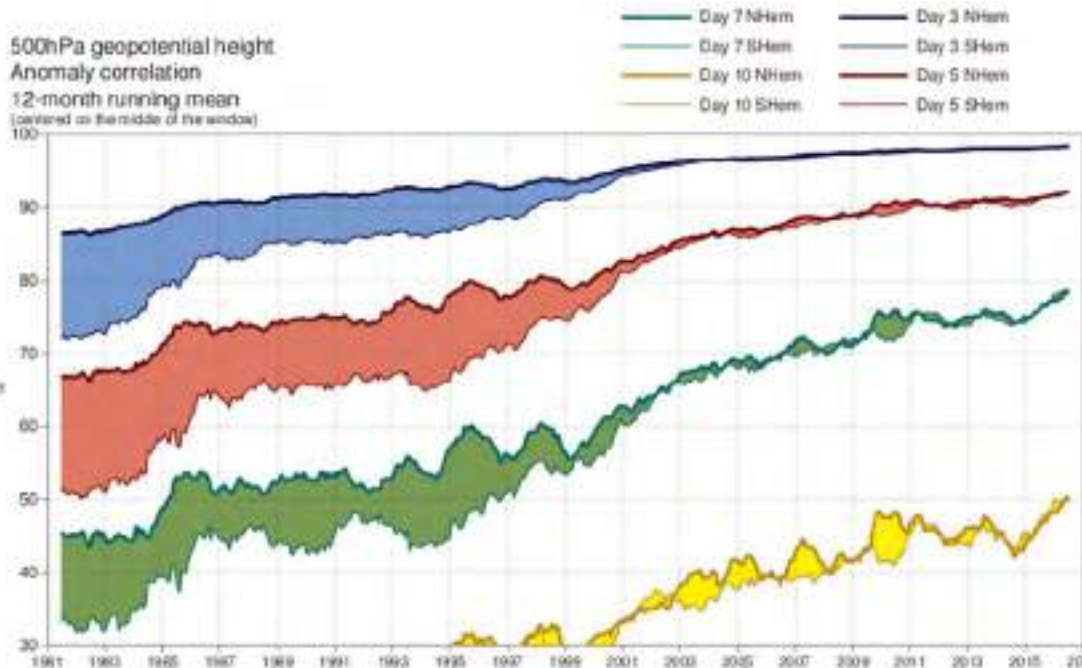
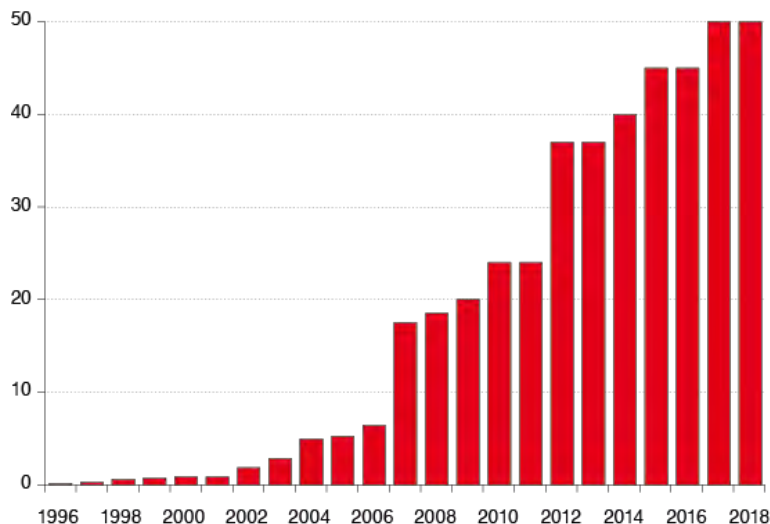


Kenneth Holmlund
Chief Scientist



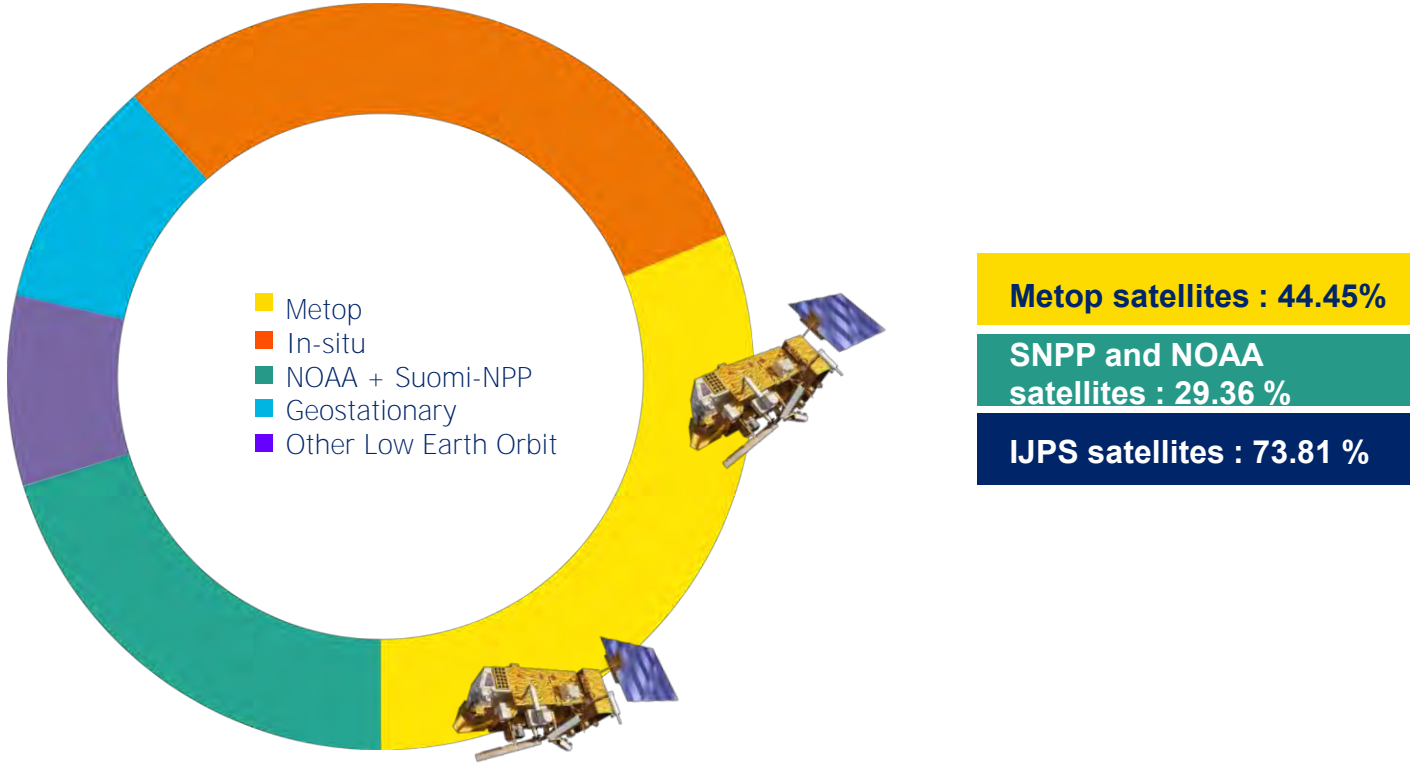
With ECMWF, Europe is World leader of medium range numerical weather prediction

Total number of observations monitored at ECMWF



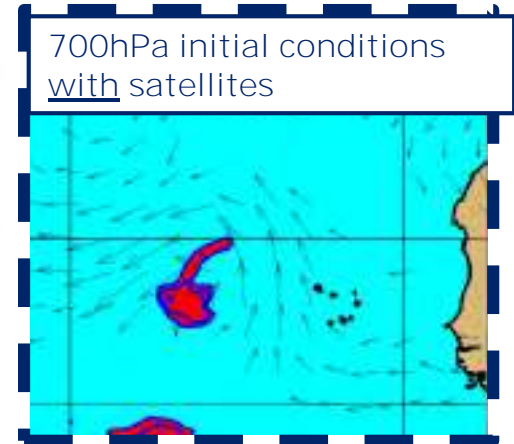
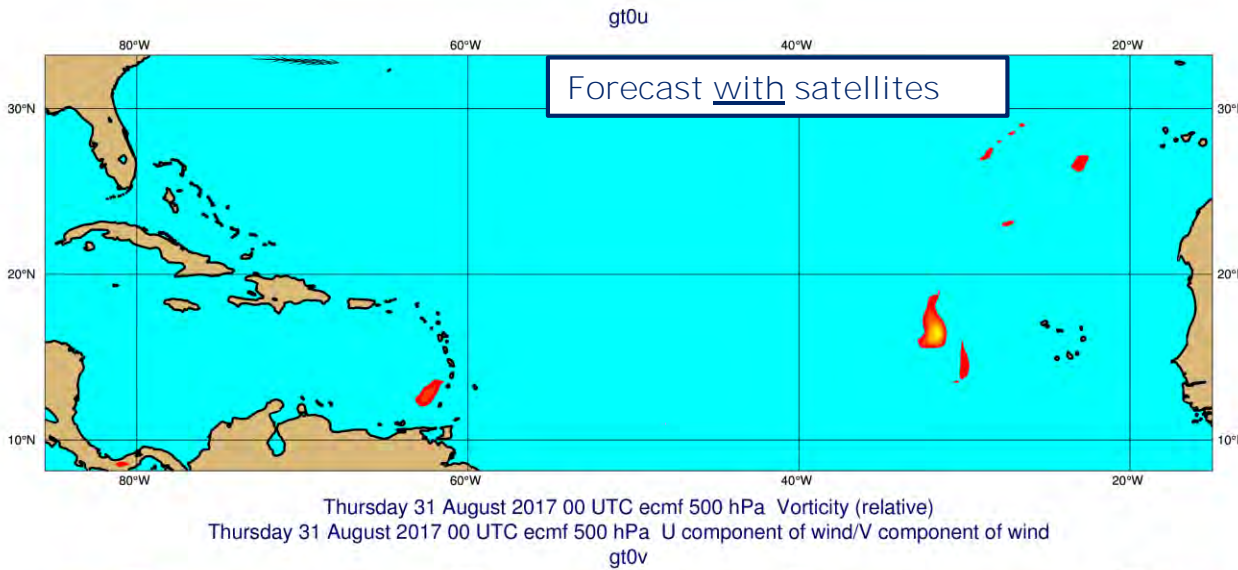
... and observations of EUMETSAT satellites play a key role !

Contribution of IJPS satellites to reduction of day-1 forecasts

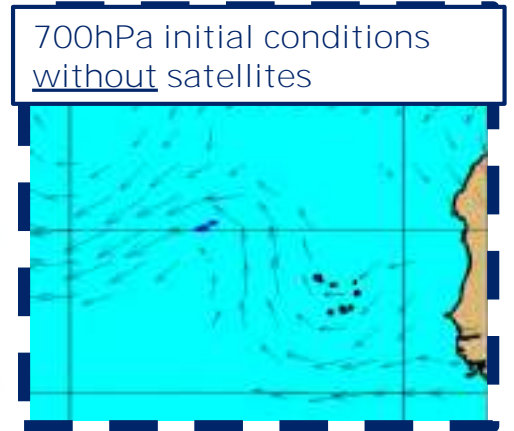
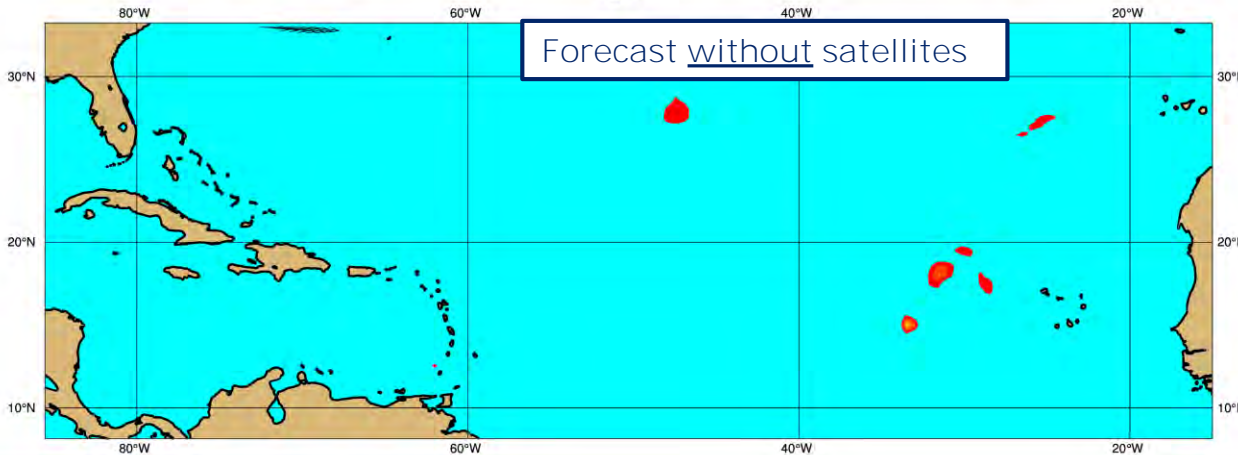


From climate to weather: impacts and adaptations

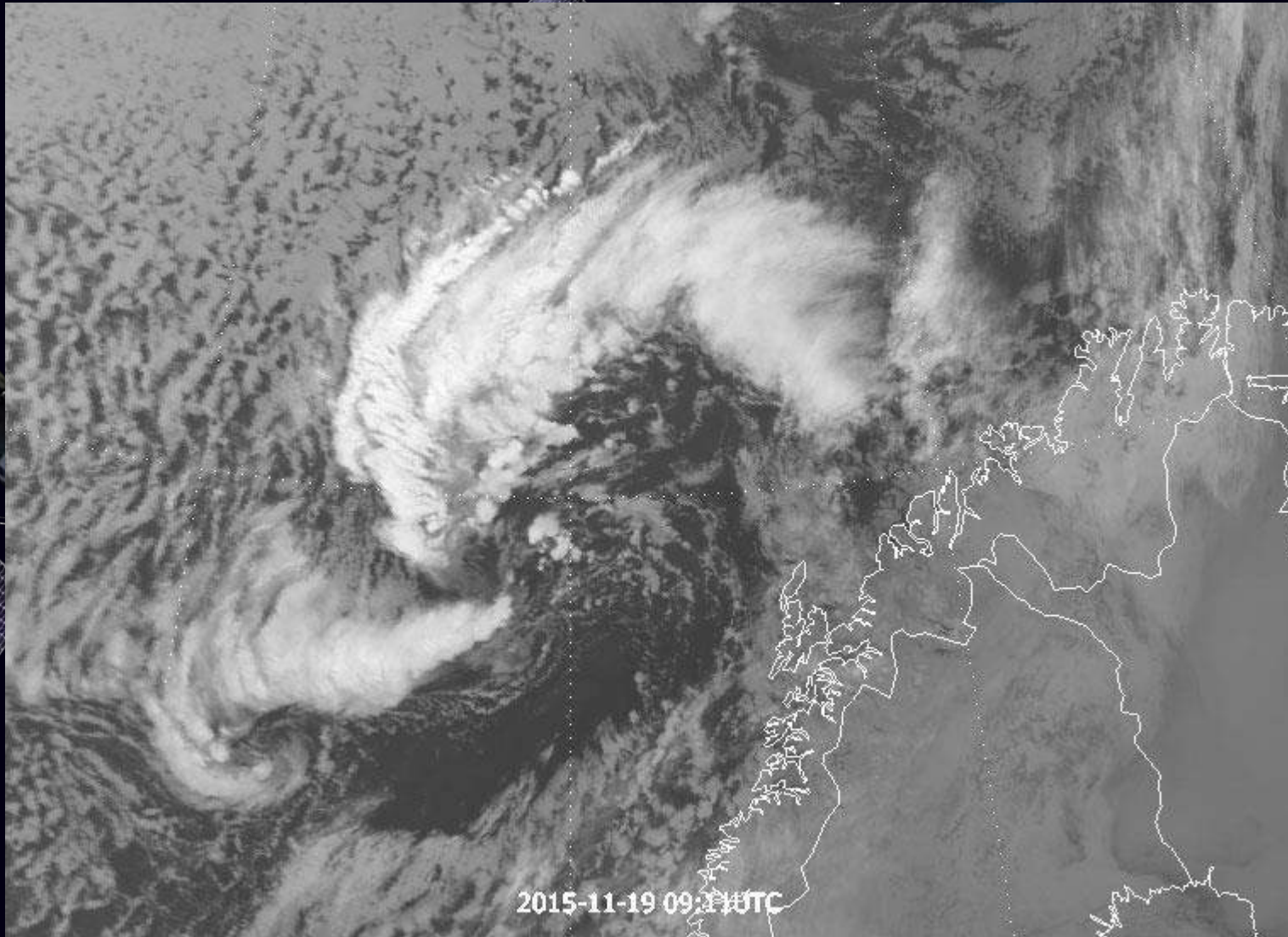
Forecasting/early warnings for preparedness



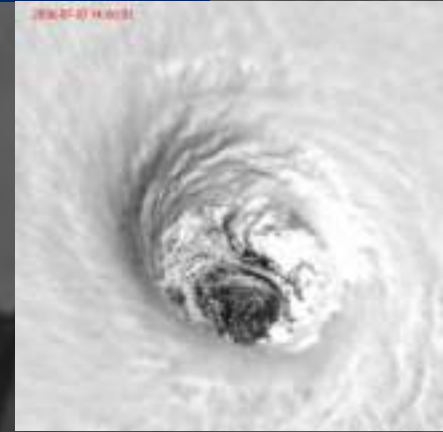
Red shading humidity > 95%



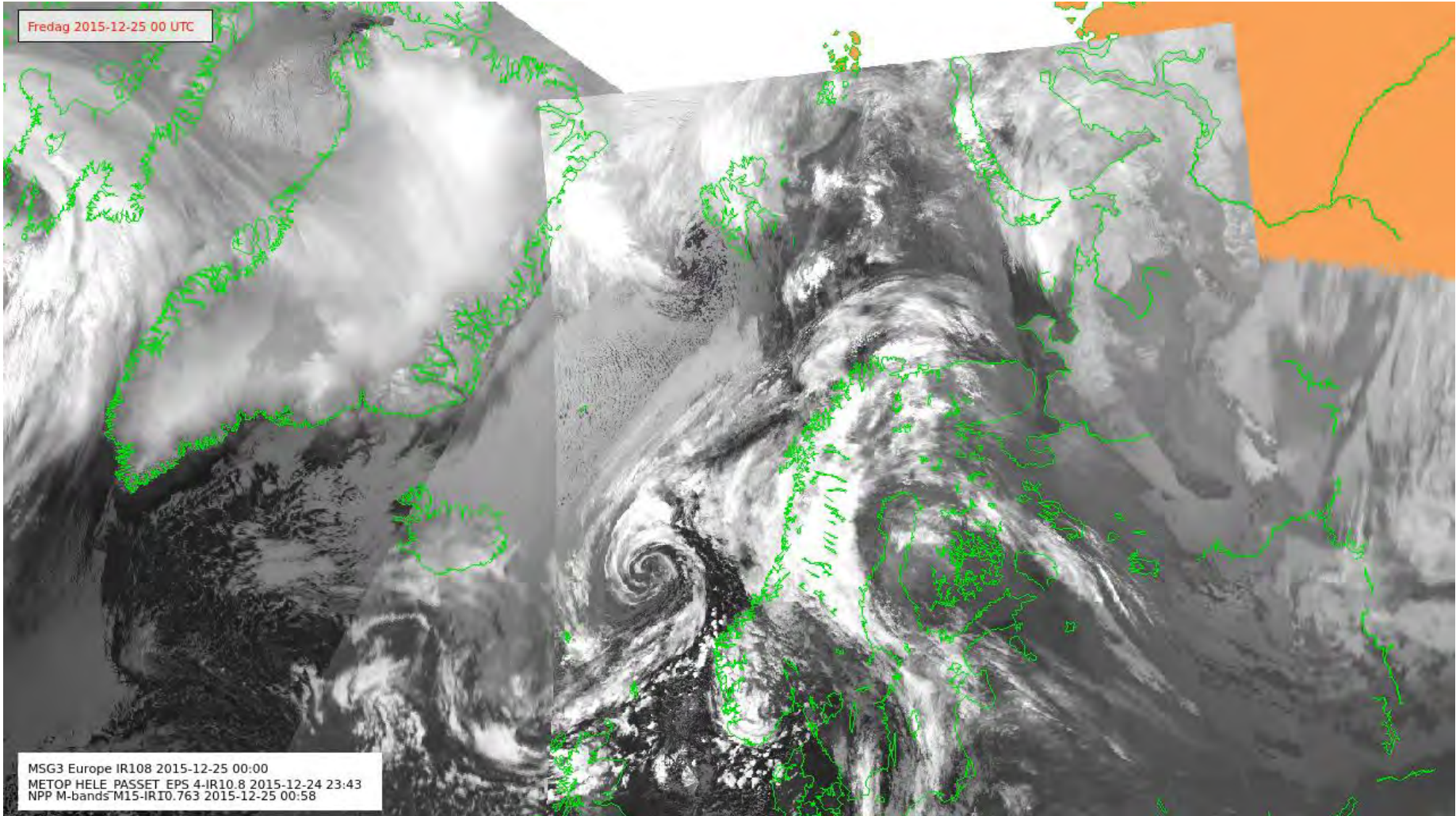
Arctic Bombs/Arctic observations



Von Kármán vortex streets Met-8, 08 June 2005

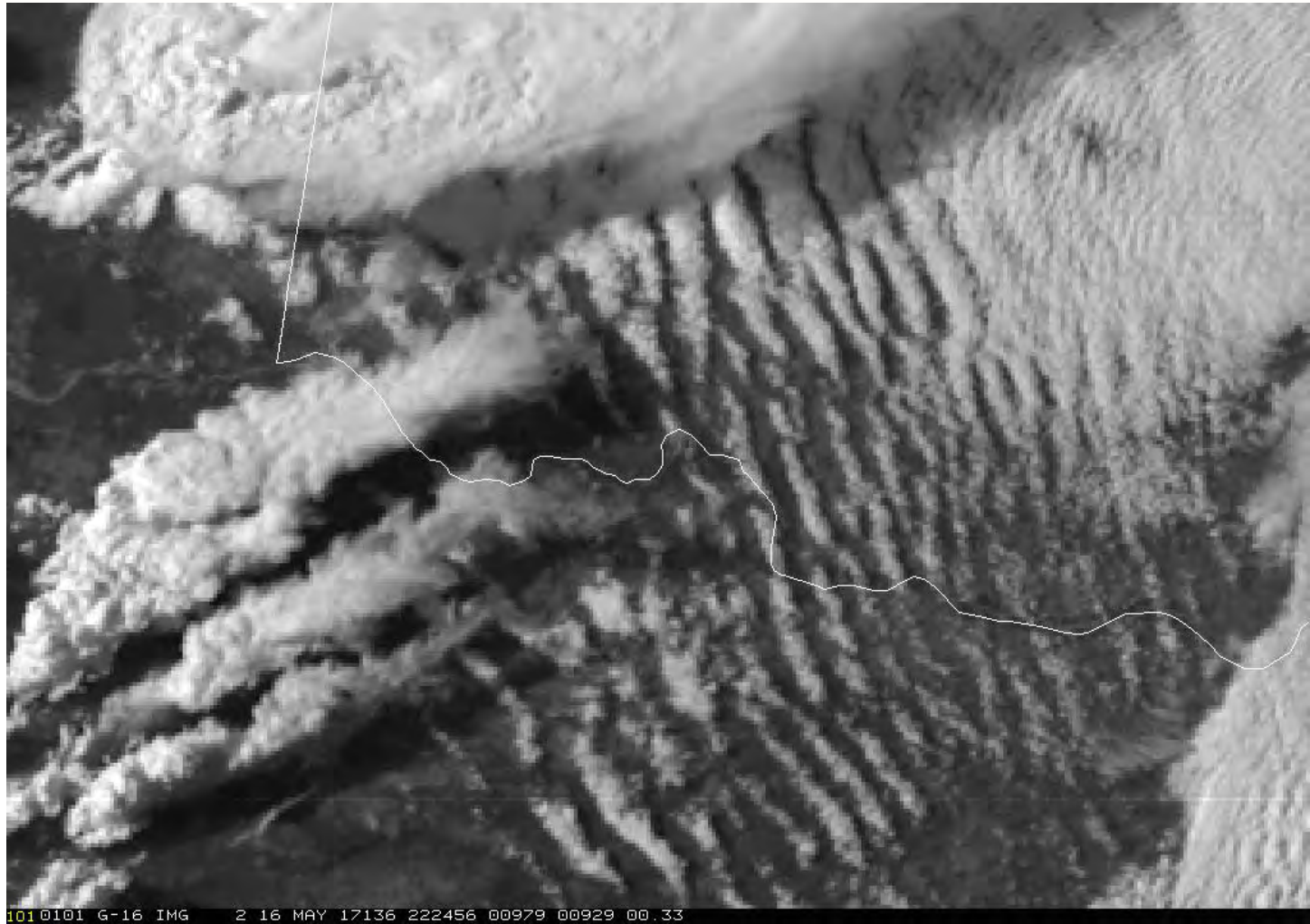


Combined polar and geo imagery (Courtesy T. Aspenes, met.no)



Bringing the Vorticity equation to life

— courtesy Dr. J. Purdom

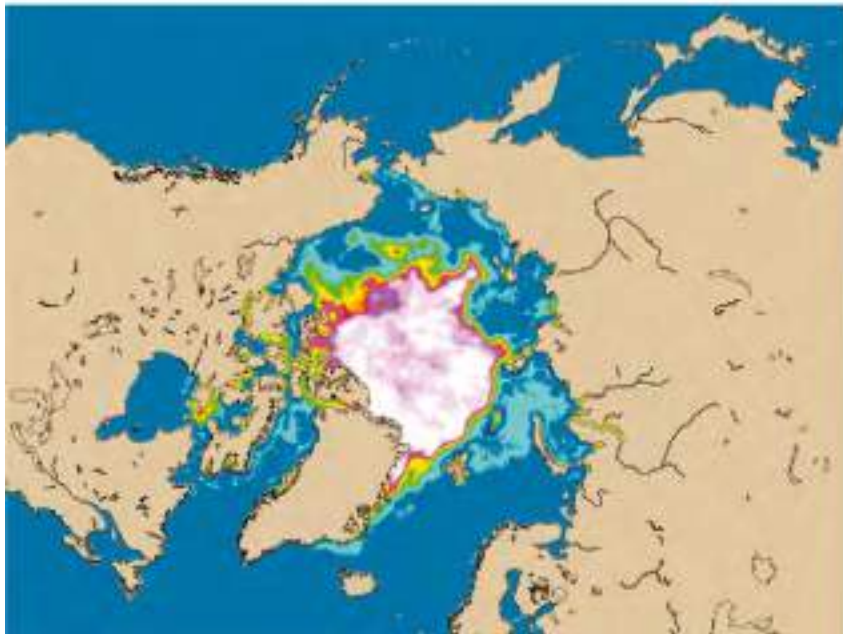


EUMETSAT'S MISSION

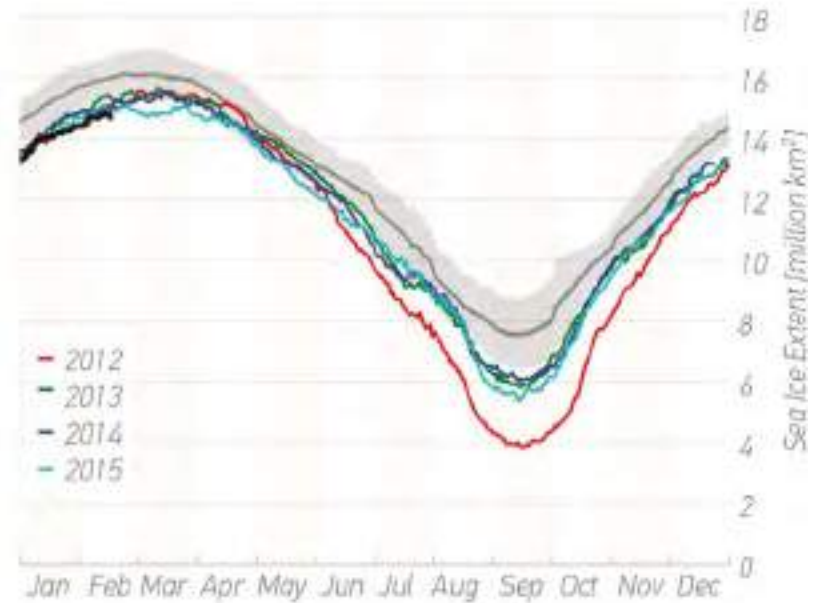
- The primary objective is to establish, maintain and exploit European operational meteorological satellite systems, taking into account as far as possible the recommendations of the WMO
- A further objective is to contribute to operational climate monitoring and detection of global climatic changes
- Through fulfilling these objectives, contribute to environmental monitoring, where interactions with the ocean and the atmosphere are involved

Thematic climate data records: sea ice

Sea Ice Concentration - Reproc NH / 2015-09-11 12:00:00



Arctic Sea Ice Extent



MSV Nordica – Earliest ever Northwest passage July-17

Courtesy Arctia/Nordica

<https://www.youtube.com/watch?v=SoZAI9z2cCY>



Implications of Ice-free Arctic

- Shipping
 - Cruise Ships
 - Fishing
 - Oil-drilling
- It is imperative to have the observational infrastructure in place to
- Ensure safe operations
 - Sufficient support in case of emergencies

And further

- Impact on indigenous people are their livelihood

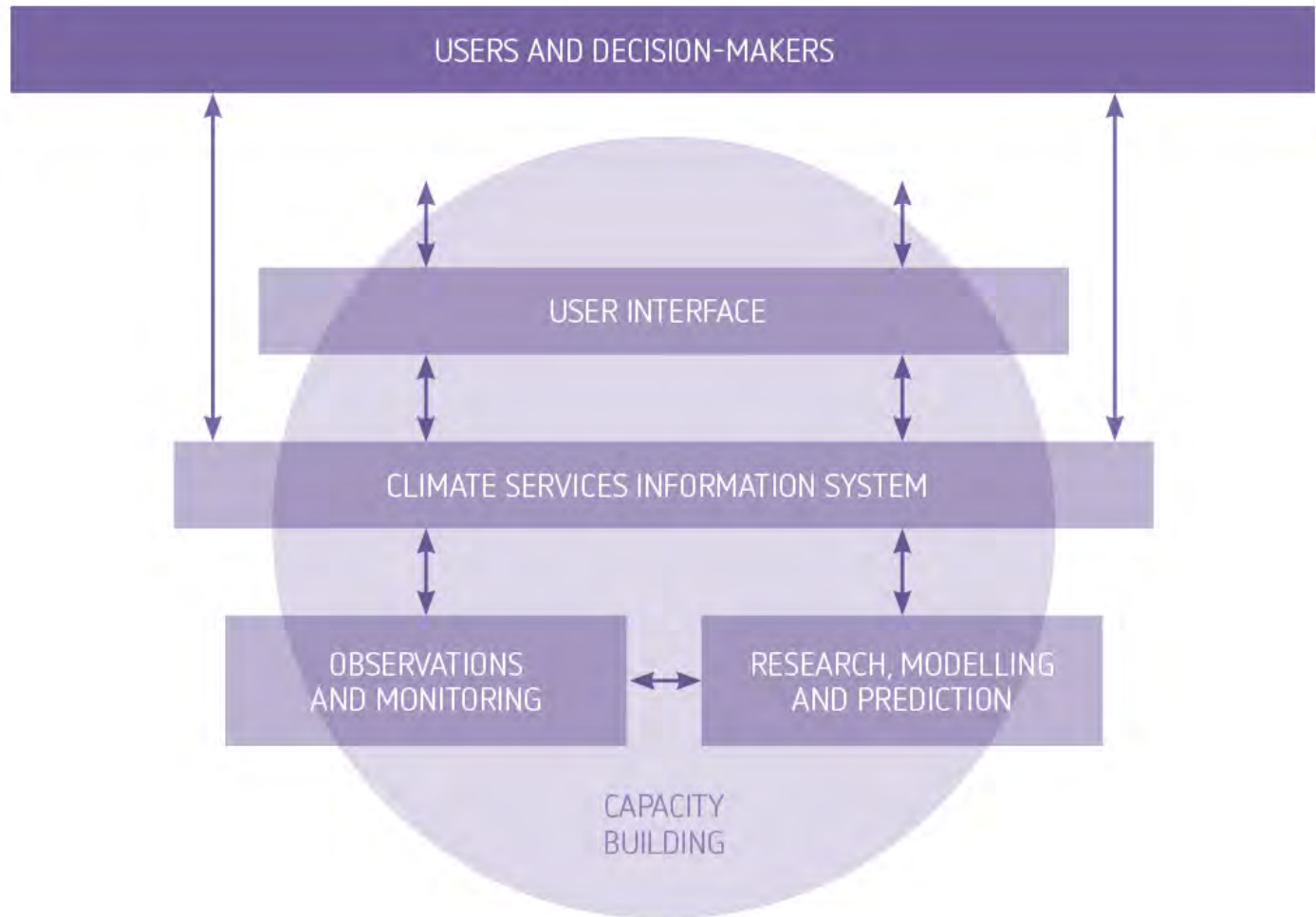
Anders Oskal

President of the International Centre for Reindeer
Husbandry

'It is not about protecting the environment from
(Climate Change), but what we are protecting it for'

- Changes in the sub-arctic region
 - E.g. Permafrost thawing
- As climate change already is a reality, the impact needs to be managed through suitable adaptation policies.

For Decision Making (The GFCS Five Pillars)

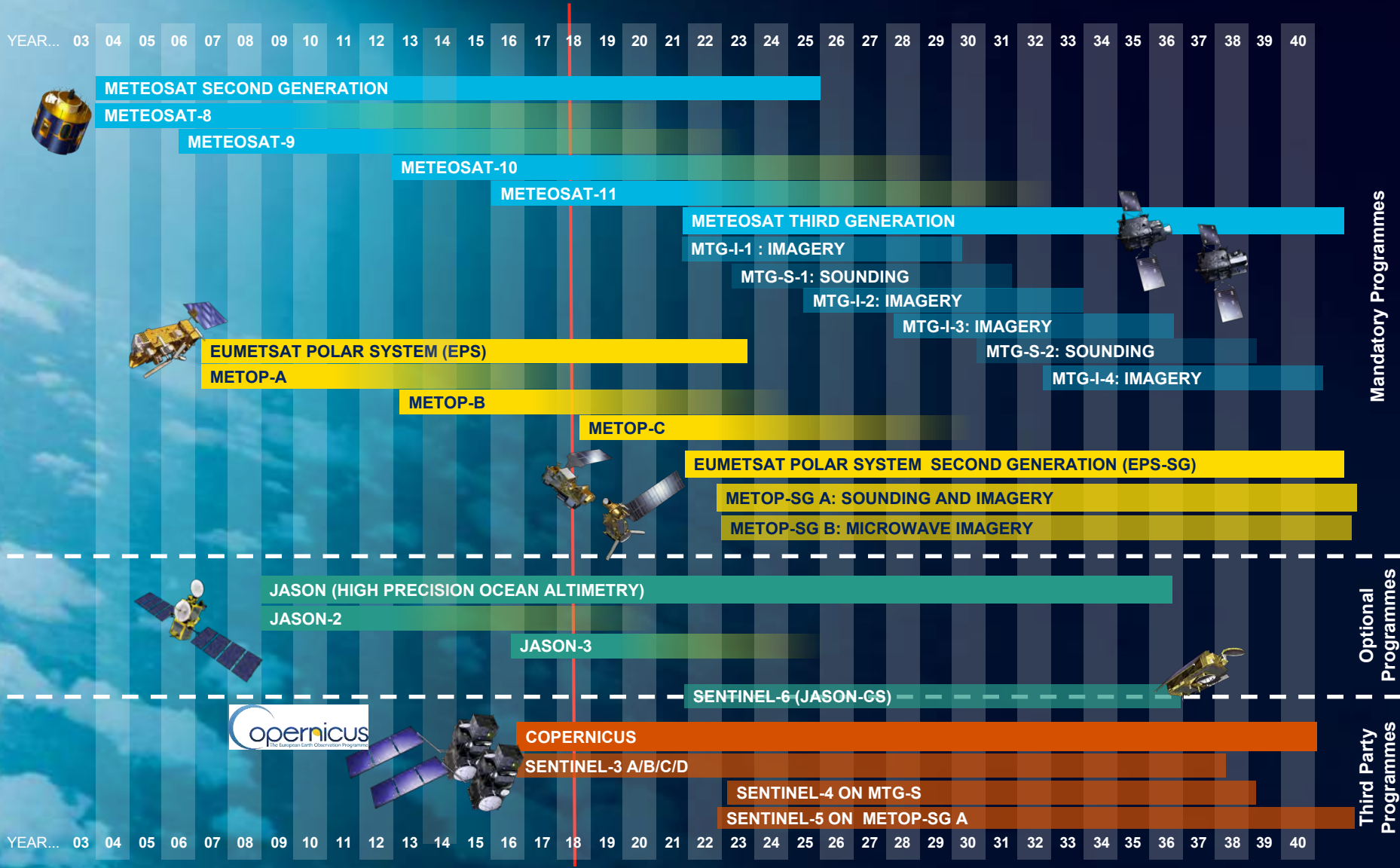


EUMETSAT AND COPERNICUS

The scope of the Copernicus missions to be considered for operations by EUMETSAT as *“the GMES (now Copernicus) missions that are complementary to EUMETSAT programmes, and serve the needs of the oceanography, atmospheric composition, hydrology, climate and environmental monitoring user communities”*

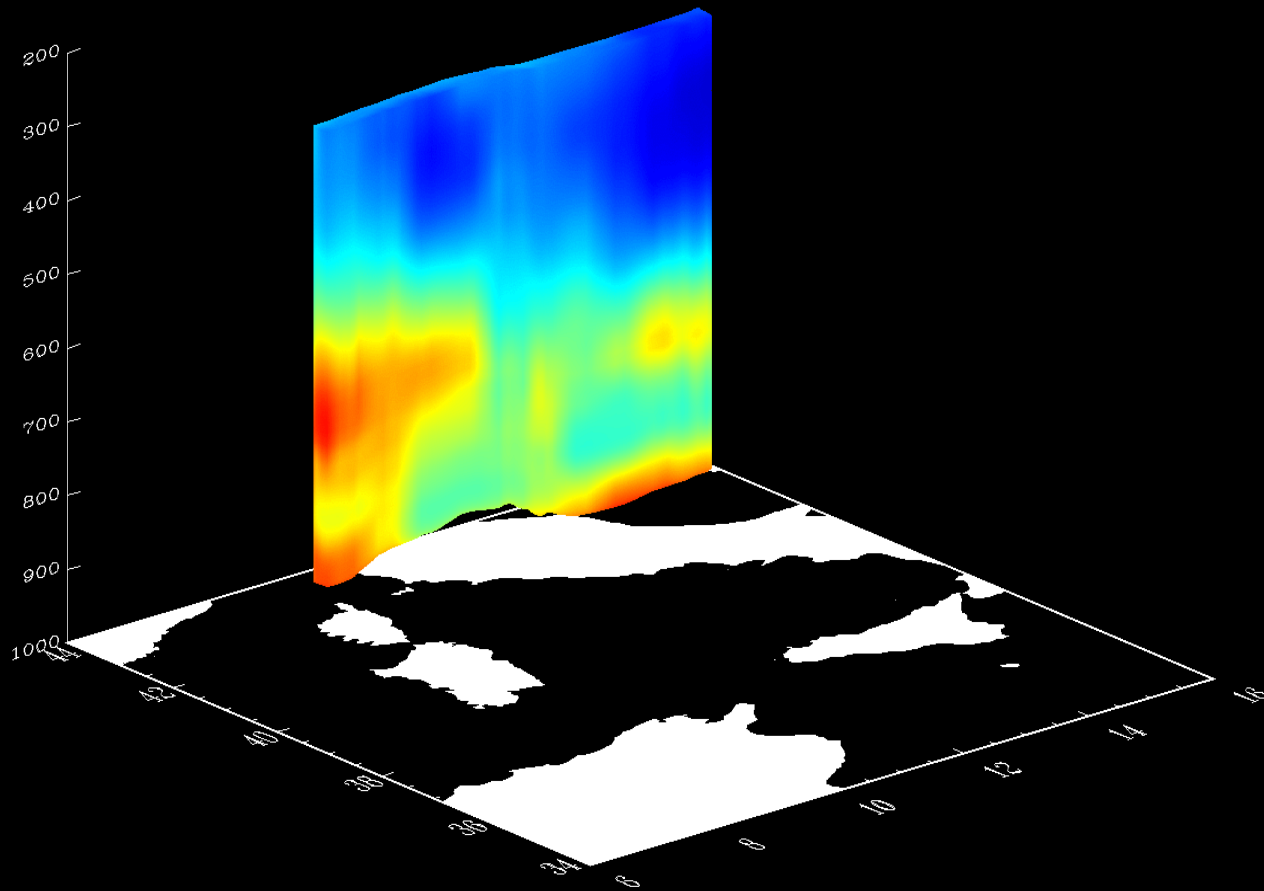
Copernicus Regulation: *“the Commission should also rely on EUMETSAT for the operation of dedicated missions in accordance with its expertise and mandate.”*

EUMETSAT mission planning



With IRS the ambition is to generate 3D humidity fields -example provided using IASI data

EARS-IASI L2 :: RH :: M01_20170513195732Z_20170513200907Z



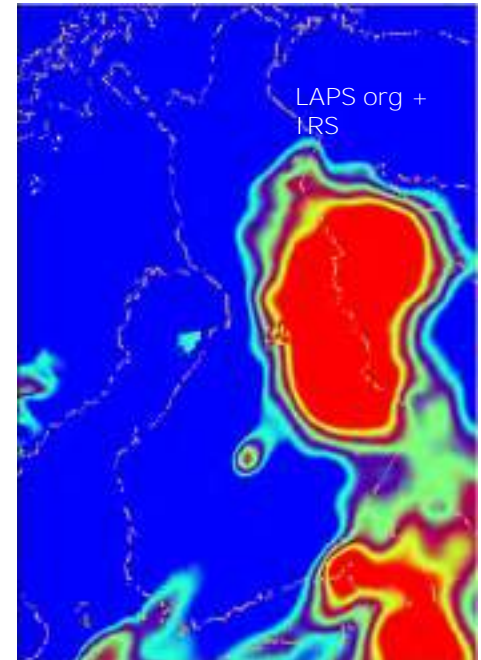
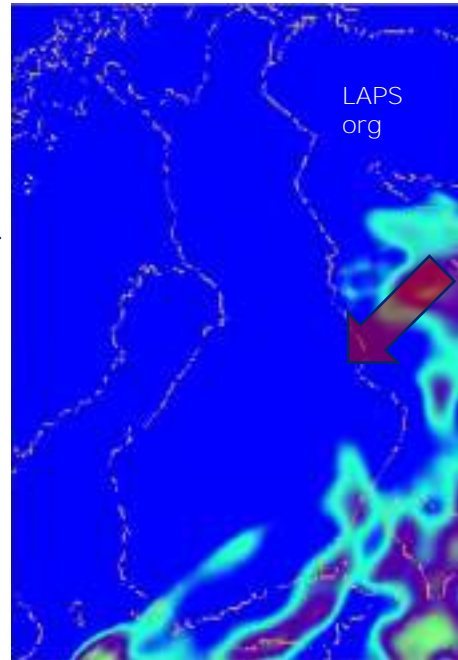
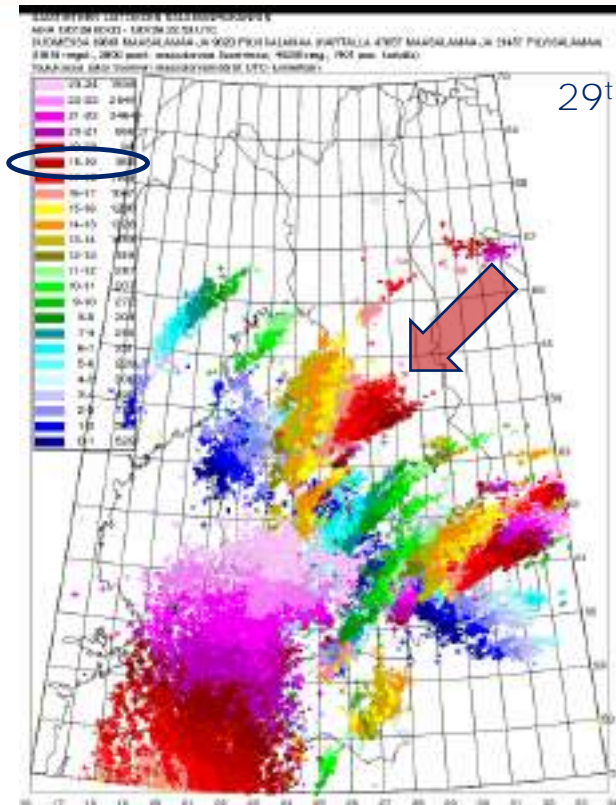
MTG-IRS: NWC Demonstration Projects (E. Gregow)

29th July 2012

TT-index values

$$TT = T_{850} + Td_{850} - 2T_{500}$$

- > 50 moderate-severe thunderstorms
- > 60 severe thunderstorms

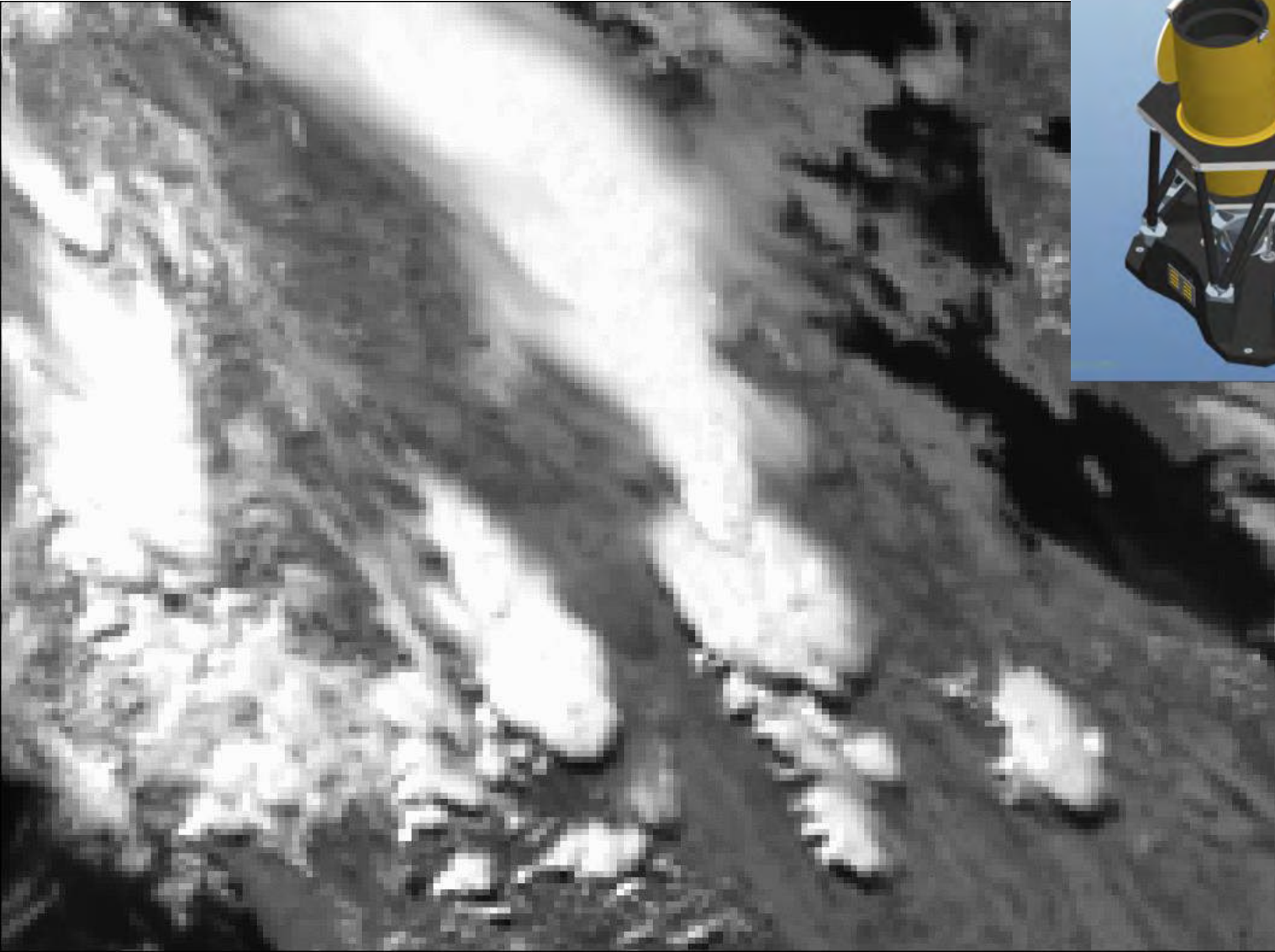


TT scale

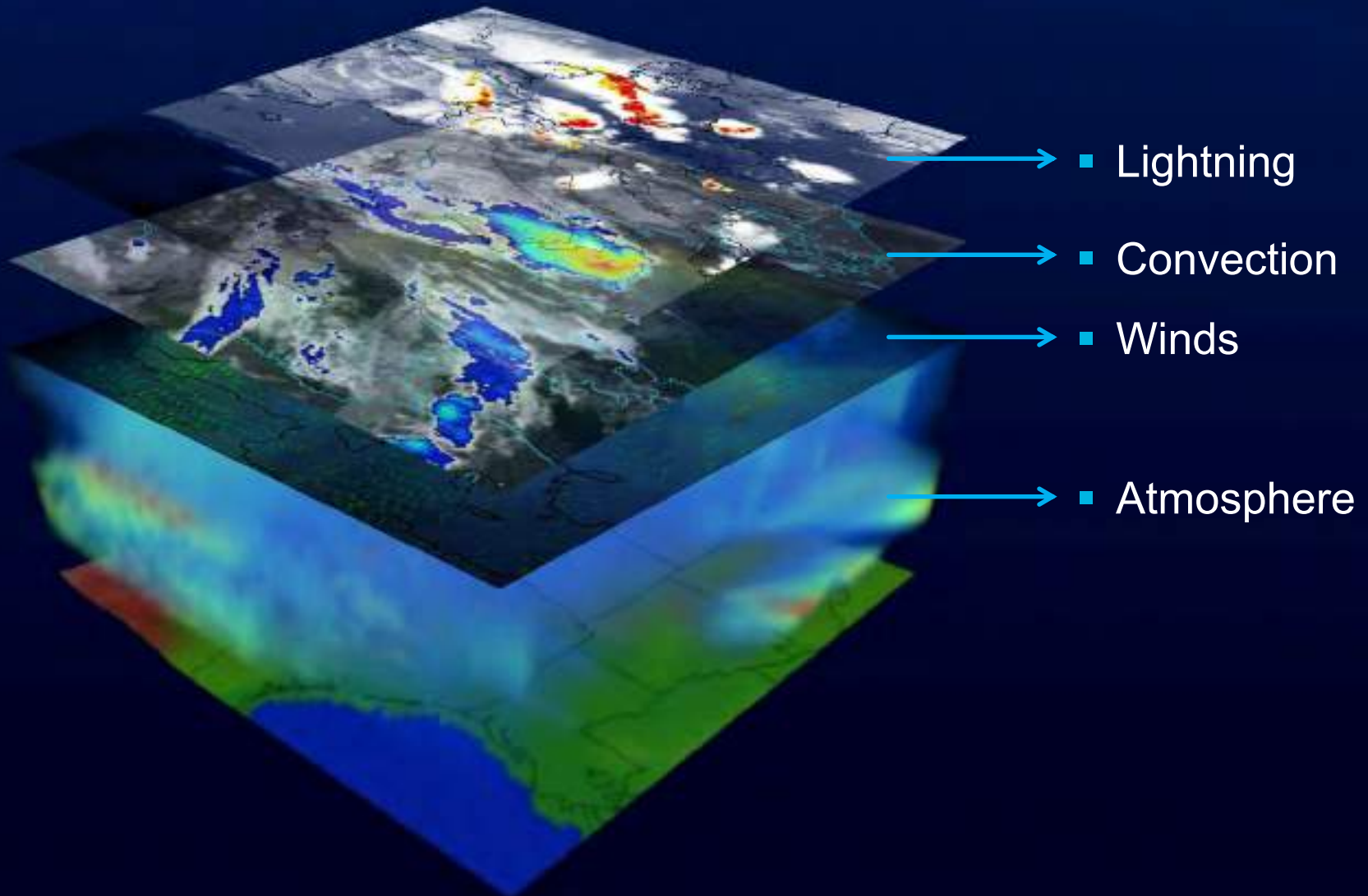
LAPS = The Local Analysis and Prediction System of FMI

The MTG Lightning Imager (simulation)

Courtesy Sauli Joro, EUM



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



EOS-SG Observation Missions

Mission	Instrument	Applications Benefitting
Hyper-spectral Infrared Sounding	IASI-NG	NWP, NWC, Air Quality, CM
Visible/Infra-red Imaging	METImage	NWC, NWP, CM, Hydrology, Oceanography
Microwave Sounding	MWS	NWP, NWC, CM
Radio Occultation Sounding	RO	NWP, CM
Nadir viewing UV/VIS/NIR/SWIR Sounding	Sentinel 5	Ozone-UV, Air Quality, CM, Composition-Climate interactions
Multi-viewing, -channel, -polarisation Imaging	3MI	Air Quality, CM, NWC
Scatterometry	SCA	NWP, NWC, Oceanography, Hydrology
Microwave Imaging	MWI	NWP, NWC, Hydrology, CM, Oceanography
Ice Cloud Imaging	ICI	NWP, NWC, Hydrology, CM

New mission: 3MI imaging polarimeter on Metop SG A

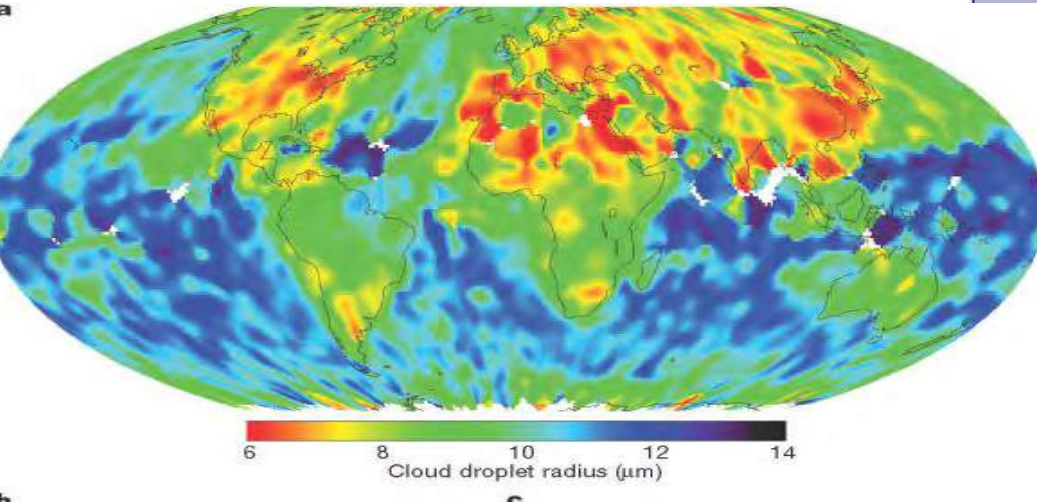
Mission objectives

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

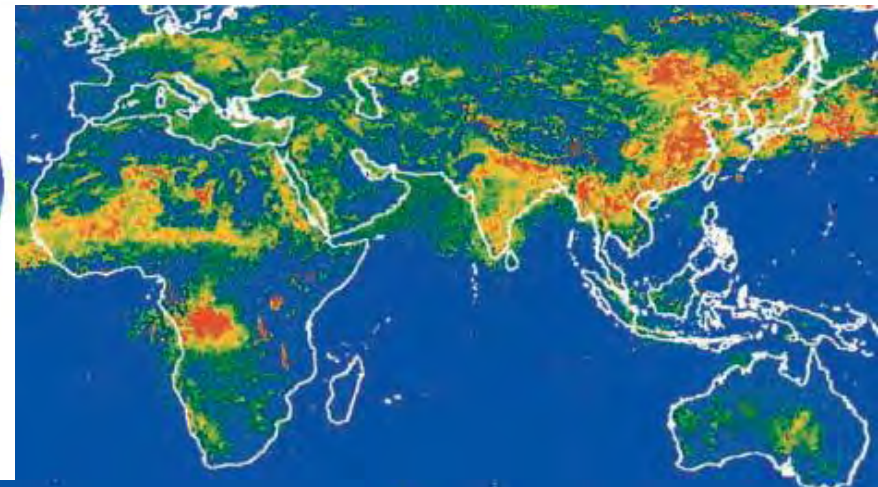
First operational polarimeter

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

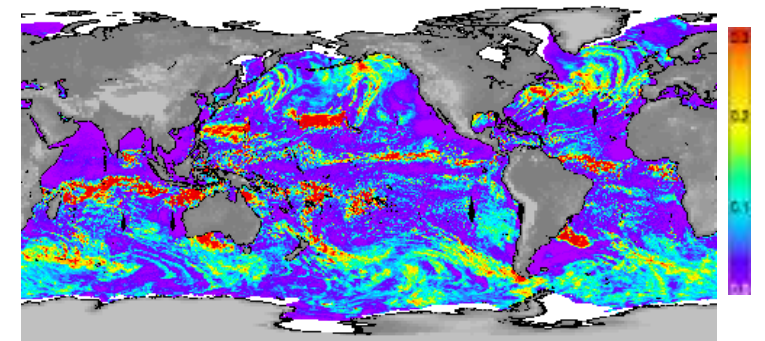
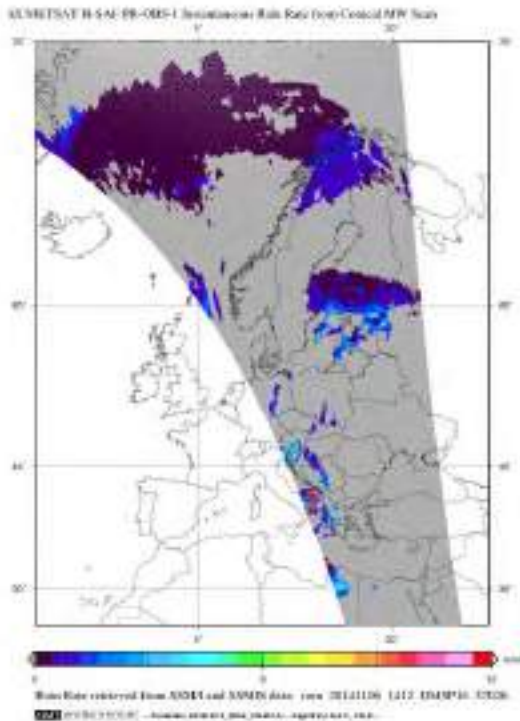
AI = 0.50

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

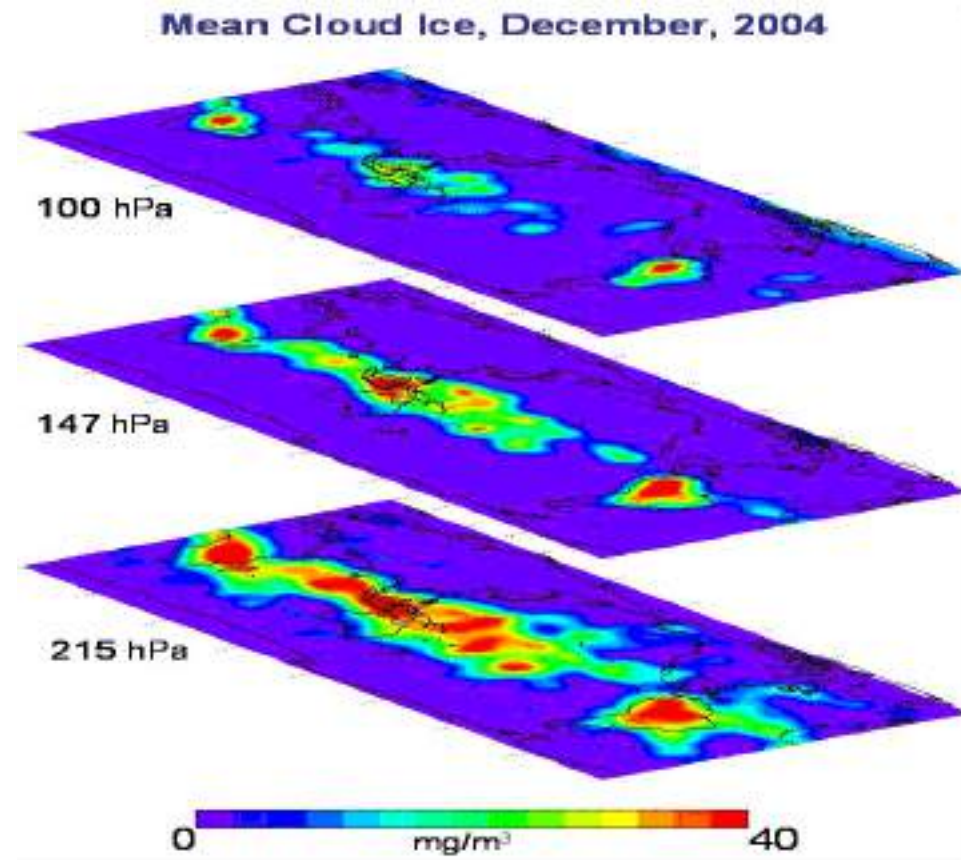
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Mission Objectives

- Clouds (ice phase)
- Detection of snow

11 channels (183 – 664 GHz)

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



NASA: Aura/MLS

- The following observation needs will be further investigated for environmental observations:
- Priority 1:
 - **Greenhouse gas monitoring**, specifically on anthropogenic CO2 emissions, for which currently no satellite observations are available
- Priority 2:
 - **Monitoring the Polar regions**, specifically the arctic for sea ice and weather
 - **Monitoring Agriculture**, specifically on parameters, which potentially could be addressed through thermal infrared observations
- Priority 3:
 - Mining, biodiversity, soil moisture and other parameters, requiring observations in additional bands, currently not available

Observation Missions

Snow and Ice Capabilities

Mission	Instrument	Applications Benefitting
Hyper-spectral Infrared Sounding	IASI-NG	NWP, NWC, Air Quality, CM
Visible/Infra-red Imaging	METImage	NWC, NWP, CM, Hydrology, Oceanography
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Observation Missions

Ice Surface Temperature

Mission	Instrument	Applications Benefitting
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Visible/Infra-red Imaging	METImage	NWC, NWP, CM, Hydrology, Oceanography
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Copernicus Expansion

Potential Cryosat Follow-on Mission

- Cryosat-type mission for ice/ocean/climate monitoring
 - High synergies with the Jason-CS/Sentinel-6 and Sentinel-3 marine missions
 - Both operated by EUMETSAT
- A constellation
 - These three missions could altogether be viewed by one single constellation
- Copernicus Integrated Ground Segment
 - Cost-efficient implementation through synergetic use of EUMETSAT ground infrastructure for relevant missions
 - Example: Jason-CS implementation at EUMETSAT
 - Synergies with EPS, Jason-3 and Sentinel-3 ground segments
- Altimetry operations
 - Operation also over the oceans!
 - Complementary orbits in synergy with other altimeter missions Jason/.Sentinel-6

Copernicus Expansion

Potential SMOS Follow-on Mission

- Synergies with EPS and EPS-SG (soil moisture), Sentinel-3 and Jason
- Strong expertise in the EUMETSAT SAFs
- Copernicus Integrated Ground Segment
 - Cost-efficient implementation through synergetic use of EUMETSAT ground infrastructure for relevant missions
 - Example: Jason-CS implementation at EUMETSAT
 - Synergies with Jason-3 and Sentinel-3 ground segments

Copernicus Expansion

Passive Microwave Radiometer

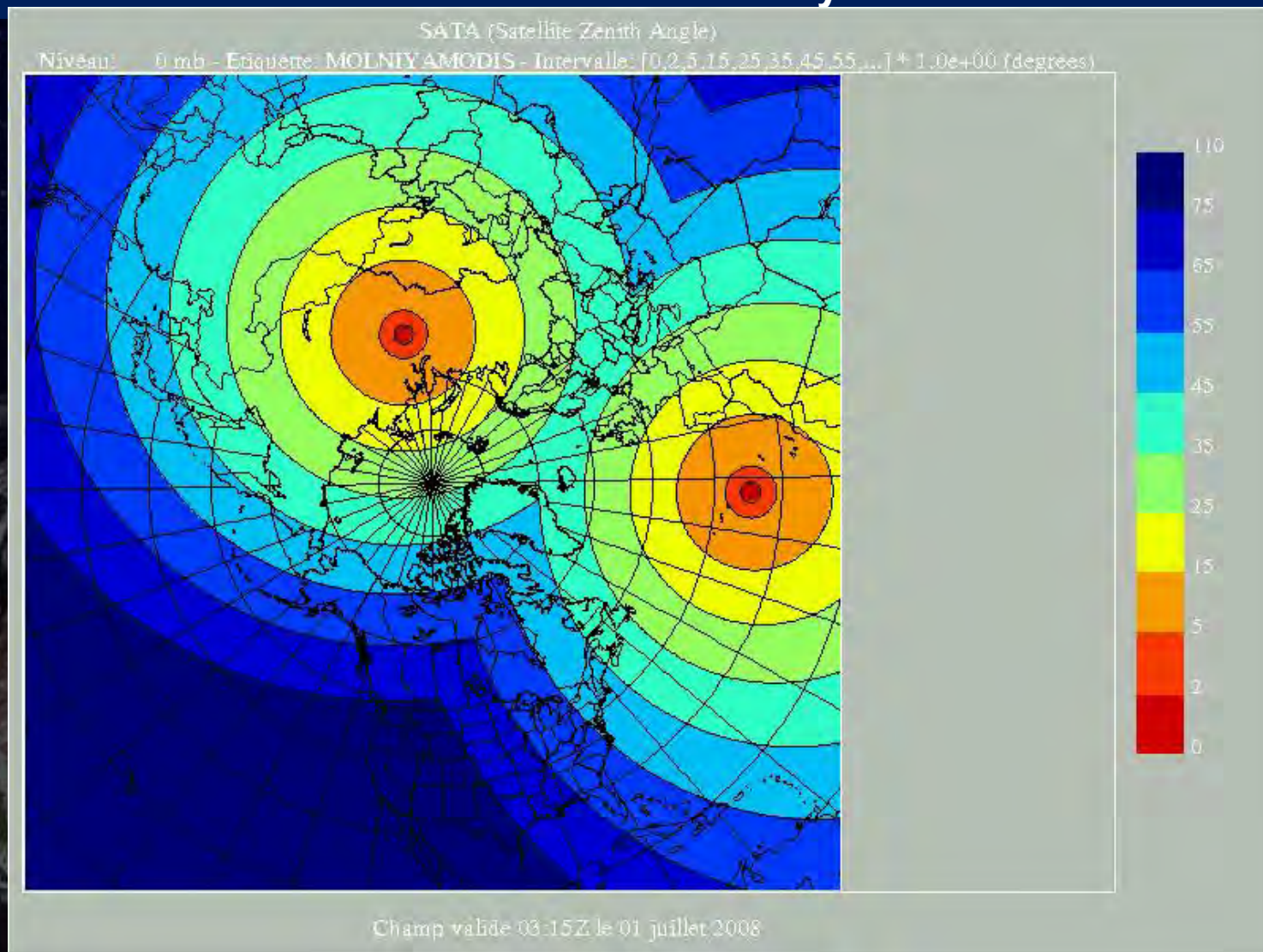
- Uncertainty due to
 - termination of DMSP (SSM/I/S)
 - Continuation of AMSR
 - Jaxa has concluded (positively) initial studies for a hosted payload on Gosat-3
- Strong operational priority
 - Continuity of all sky sea and ice monitoring with 6.9 (+1.8) GHz
 - Mitigation through other microwave imagers limited due to lack of required channels and/or sufficient resolution

Highly Elliptical Orbit (Molniya) missions



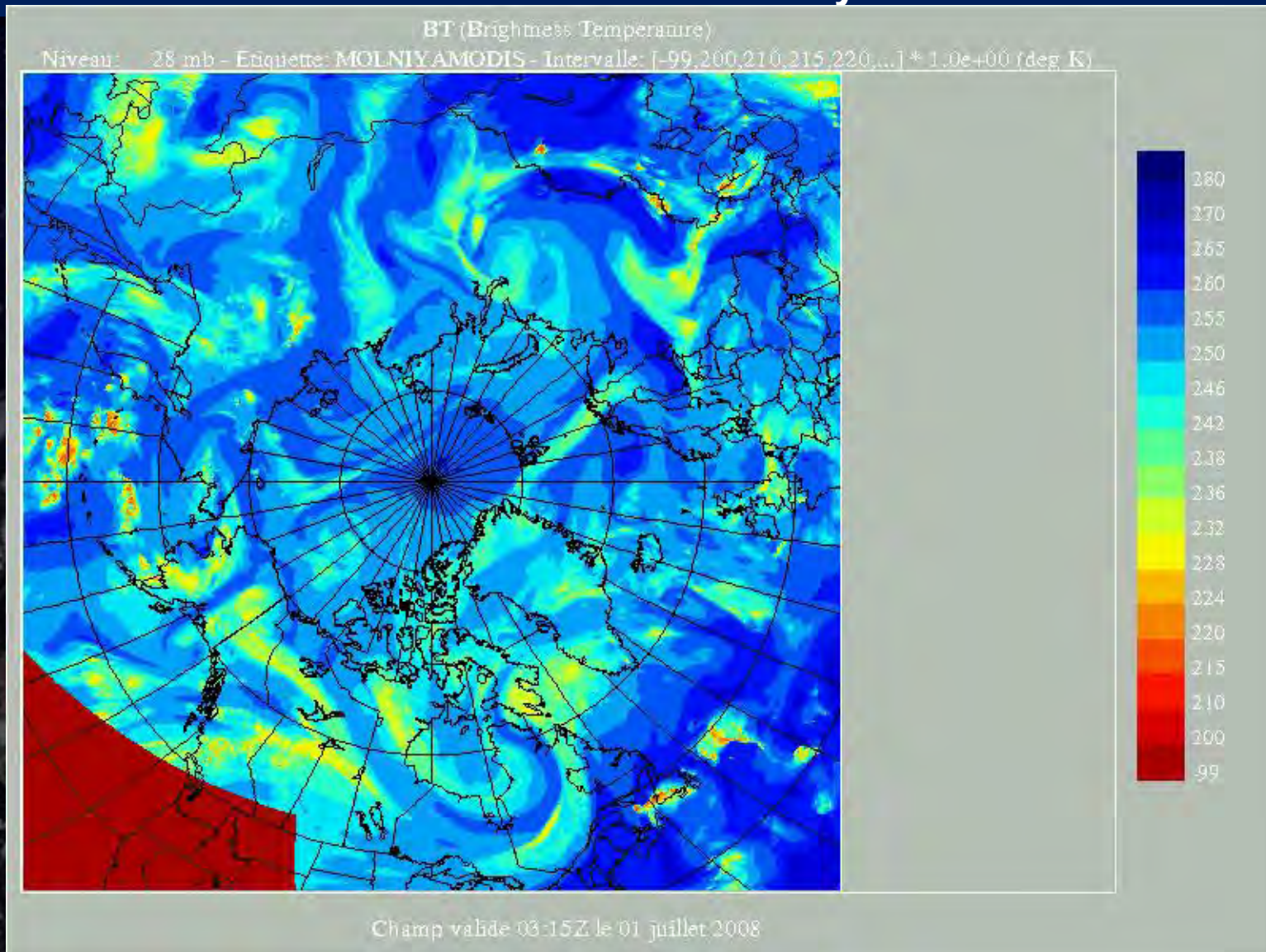
HEO Coverage/Viewing Angles

Courtesy Environment Canada



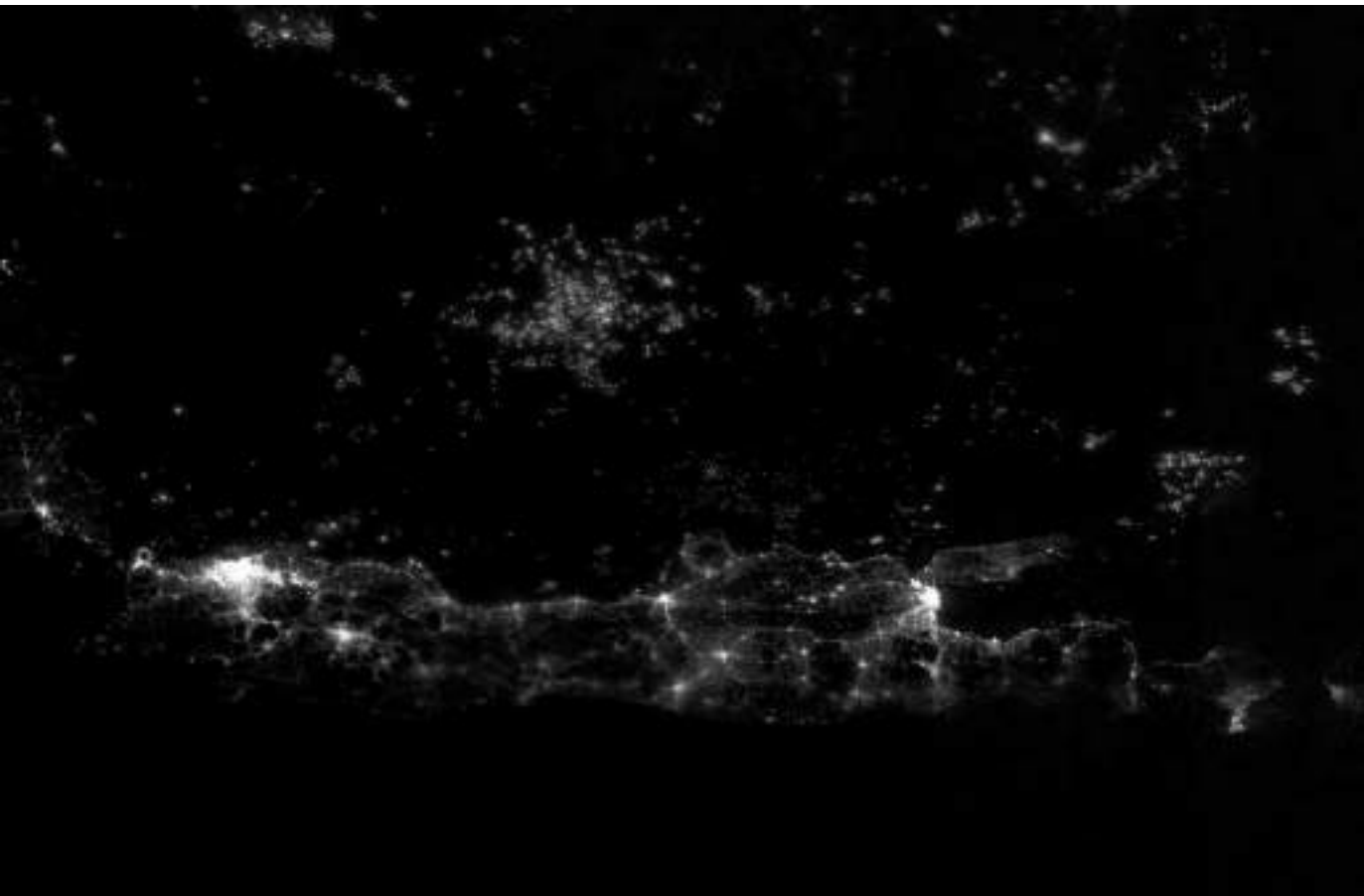
Simulated view of observations from HEO

Courtesy Environment Canada



Low Light Imaging with VIIRS/Suomi-NPP

Application Boat Detection (Courtesy M. Goldberg, NOAA)



The Visible Infrared Imaging Radiometer suite has a unique capability to detect lights at the earth's surface. This includes heavily lit boats.

NCEI has been working on algorithms for reporting boat detections since September 2014.

Supported by the JPSS program office and USAID.

Summary:

Ground Segment development and Data Access

- Future mission implementation in the Copernicus Integrated Ground Segment using EUMETSAT Capacities
- Global ocean thematic data access platform in cooperation with the CMEMS and the SAF on Ocean and Sea Ice, with synergies to be explored with the C3S and CAMS services, as a possible Copernicus IGS pathfinder

Summary

- EUMETSAT has a strong user focus and programmes driven by elaborated user requirements
- EUMETSAT provides continuity of relevant operational missions through EPS-SG and MTG
- EUMETSAT is the operational agency for key Copernicus missions: Sentinel 3 – 6
- EUMETSAT's international partnerships brings coordination and optimisation of the operational EO-missions
- EUMETSAT and ESA partnership provides efficient system development into operations

Conclusions

- Europe shall look at these missions in details
- Analysis shall be open and issues such as optimisation of existing instrumentation, definition of optimal orbit plans considering existing observations,... Shall be looked at as part of the analysis
- EUMETSAT is ready to support this analysis with its expertise and those present in its SAFs
- EUMETSAT interest is to operate these missions in maximum synergies with its own and Copernicus missions already operated
→ synergies on ground segment will create efficiency
- In doing so, links with user and science communities will also be optimised reinforcing the idea of one single multi-mission data stream to targeted user / scientific communities

Conclusions

- KIITOS – TACK
- Questions

