



From Research and Development to Operations and Applications: The EUMETSAT Perspective

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and with support from other colleagues

EUMETSAT
Darmstadt



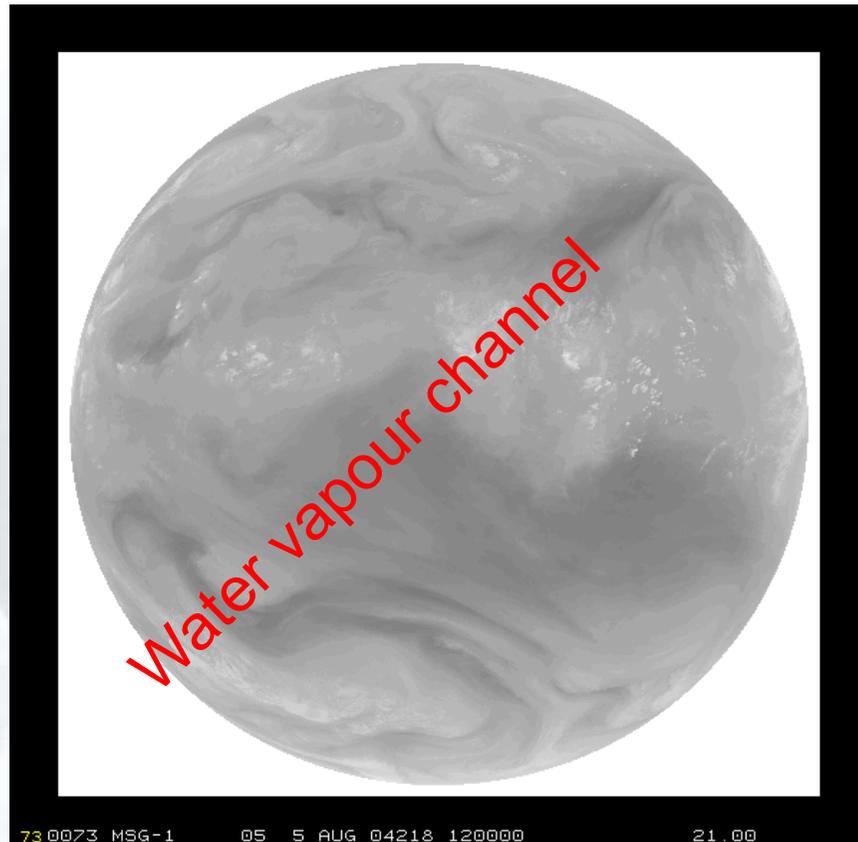
Messages:

- **Overall theme of the 92nd AMS Annual Meeting: 'Technology in Research and Operations - How we got there and where we're going'**
- **R & D serves operational applications**
- **Improvements to operational processing: Day-2 development**
- **Toward a new satellite programme: EUMETSAT User Consultation Process**
- **Continuous R&D on operational data enhances usefulness for climate analyses => requires reprocessing of the data**

How do we make progress?

Someone takes the lead, demonstrates usefulness => others follow

Example: ESA had 1st Water Vapour channel in a geostationary orbit on Meteosat



correspondence

A New Insight into the Troposphere with the Water Vapor Channel of Meteosat

Pierre Morel, Michel Desbois, and Gérard Szejwach,
Laboratoire de Météorologie Dynamique, Centre National de la Recherche Scientifique, École Polytechnique, Palaiseau, France 91120

Abstract

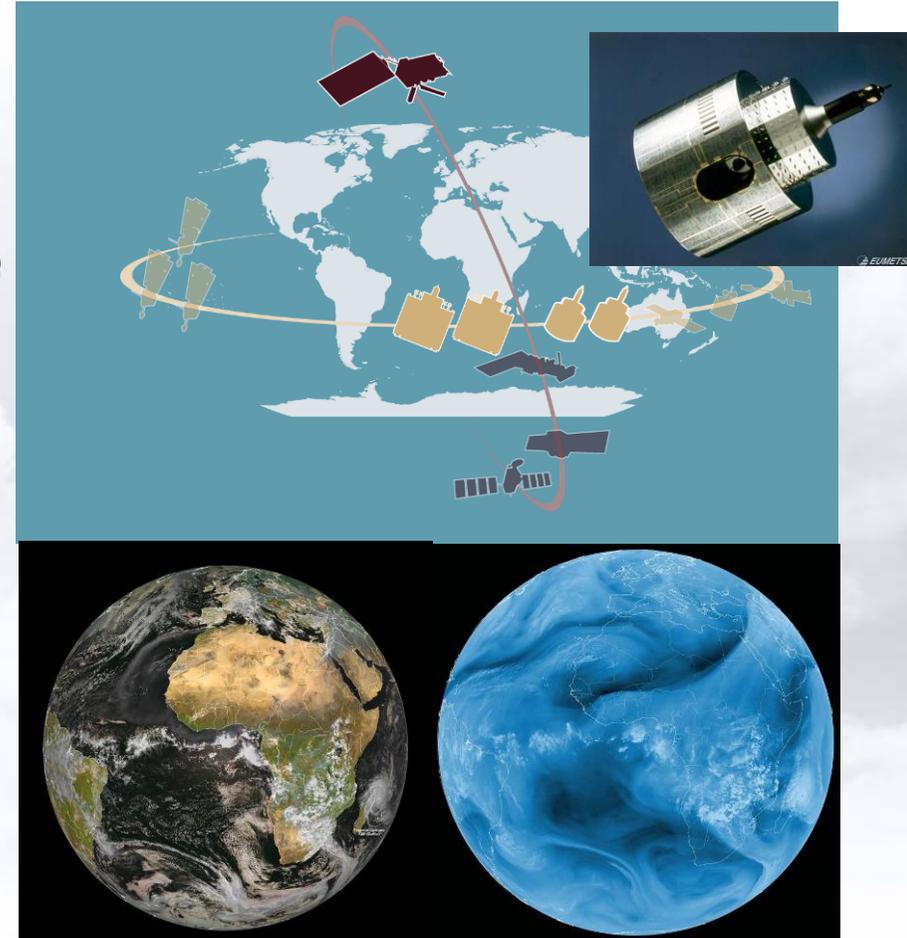
Meteosat images in the three channels—visible ($0.4\text{--}1.1\ \mu\text{m}$), thermal infrared ($10.5\text{--}12.5\ \mu\text{m}$), and water vapor ($5.7\text{--}7.1\ \mu\text{m}$)—are presented. The new possibilities offered by the water vapor channel on a geostationary satellite are outlined.

Morel et al., BAMS, 1978

Research Space Agencies play a key role

Evolution of European operational geostationary satellites

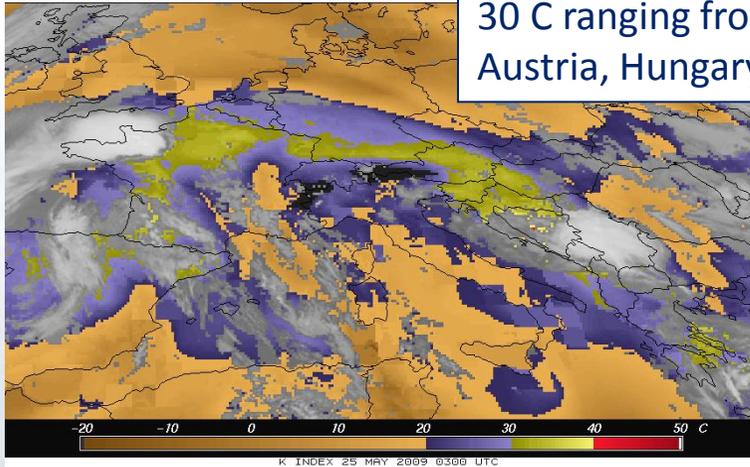
- **Meteosat First Generation:** Three channels and 30 minute imaging
- **Meteosat Second Generation:** Twelve channels and 15 min. imaging (plus better spatial resolution and on-board calibration for thermal IR)
- **Meteosat Third Generation (MTG):**
 - Sixteen channels (better spatial and temporal resolution) and Lightning Imager;
 - On second satellite hyperspectral sounder plus UVN (air chemistry) mission by ESA



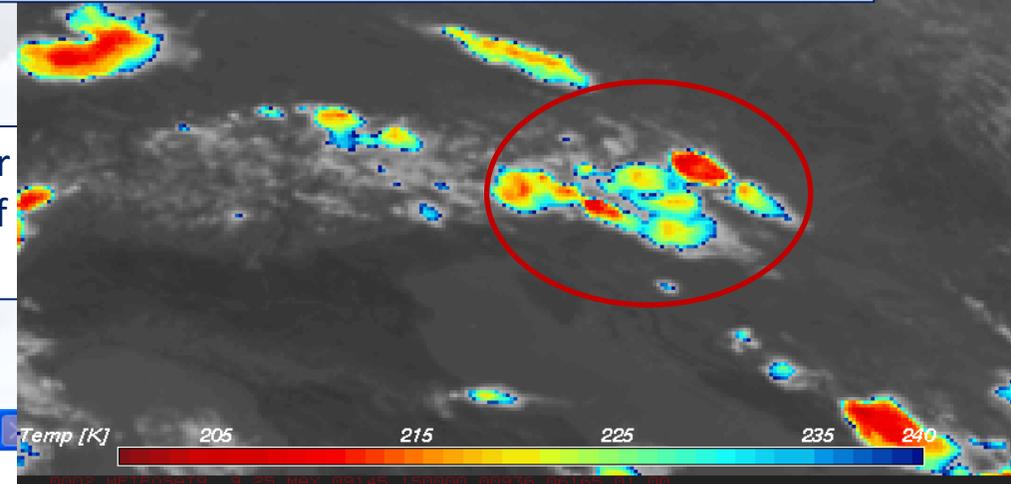
Quantitative Applications for Nowcasting => Dedicated NWCSAF and work with external researchers

Meteosat-9: Three stages of convection (25 May 2009) (M. König, 2010)

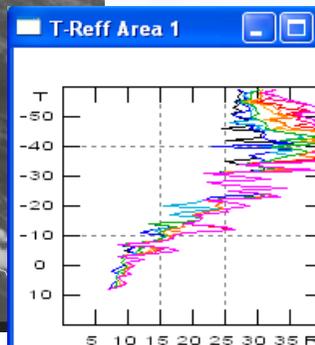
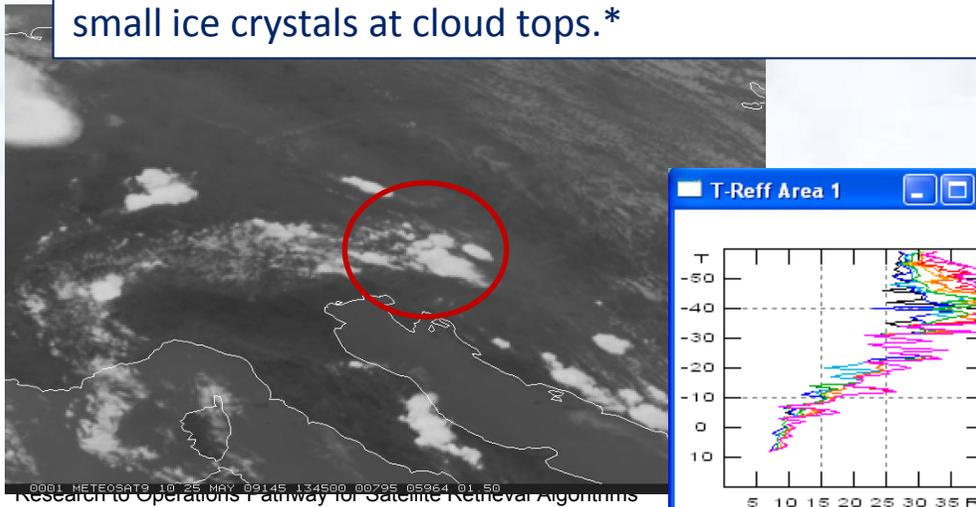
K-Index retrieved from 0300 UTC MSG image shows K > 30 C ranging from France over southern Germany to Austria, Hungary and Slovenia



Mature convective clouds show low cloud top temperatures and overshooting top regions (1500 UTC). A hail storm was report in Slovenia.



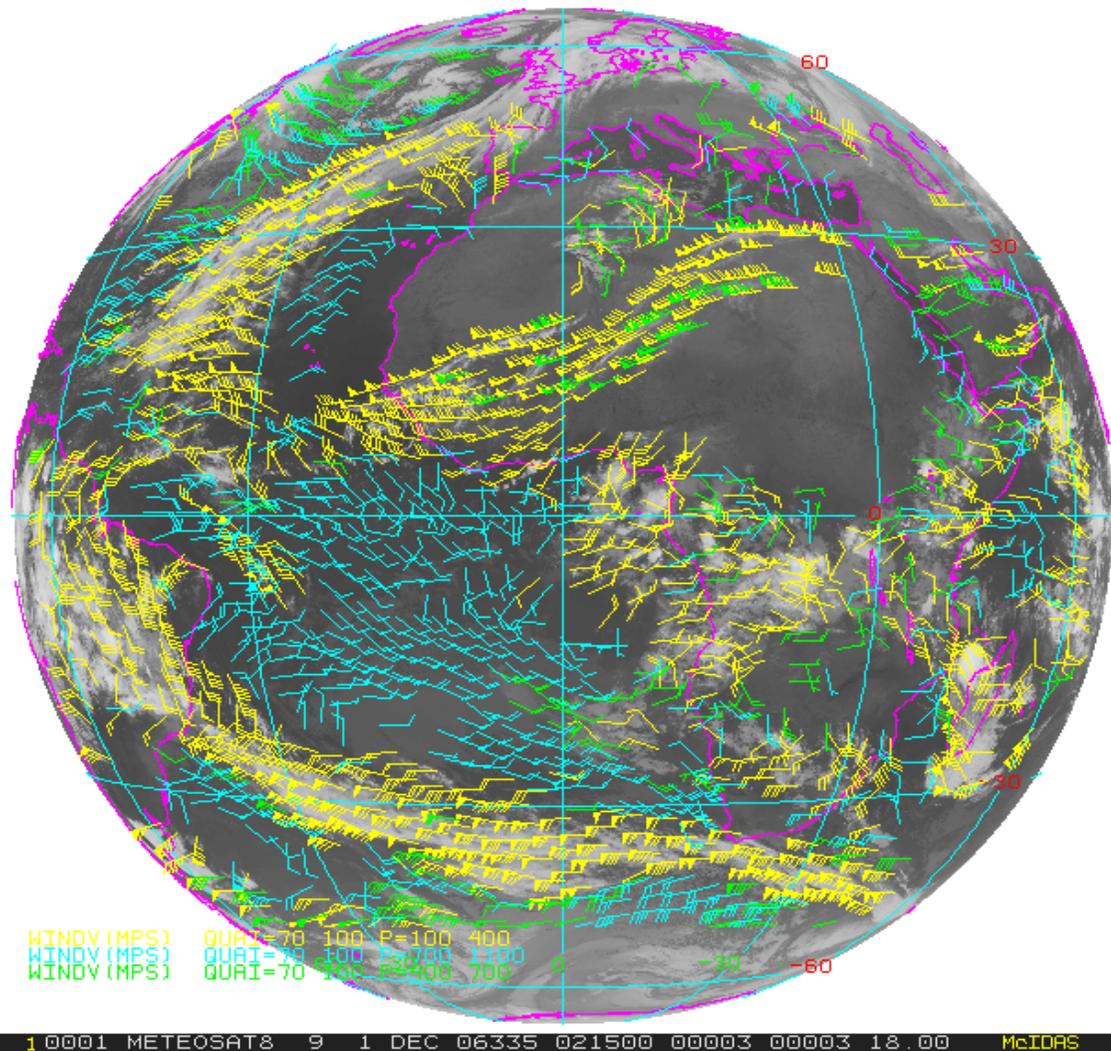
Cloud microphysical analysis over developing Cu over Slovenia (1345 UTC) shows severe storm signature of small ice crystals at cloud tops.*



Courtesy D. Rosenfeld

JMETSAT

Winds from geostationary Satellites: Recent research and development improved positive impact on NWP

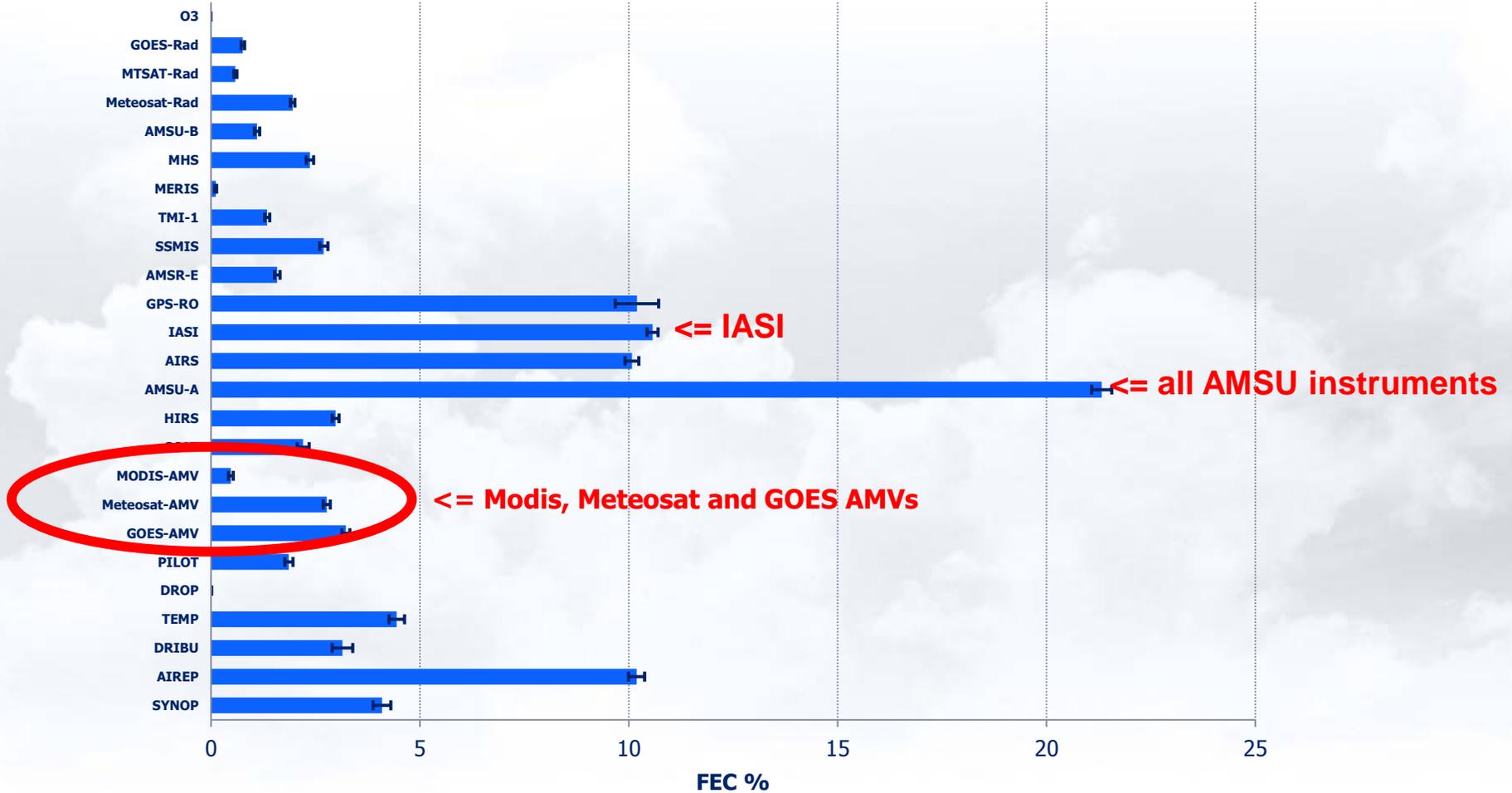


**Winds from tracking
atmospheric motions**

**Idea goes back to
Prof. Verner Suomi
in the 1960-ties**

**Example here:
Atmospheric Motion Vectors
from 10.8 μm channel**

24 h 'Forecast Error Contribution' of Individual Components of the Global Observing System for June 2011 (C. Cardinali, ECMWF)

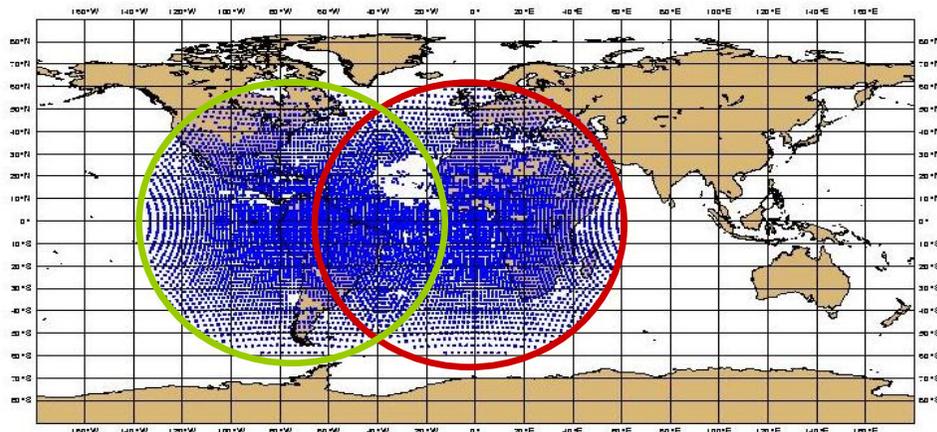


Reprocessing of long-term data of Meteosat Atmospheric Motion Vectors:

Important contribution to Re-analyses at NWP Centers

=> Substantially improved coverage and impact of re-processed winds from Meteosat satellites (C. Delsol, ECMWF, 2008)

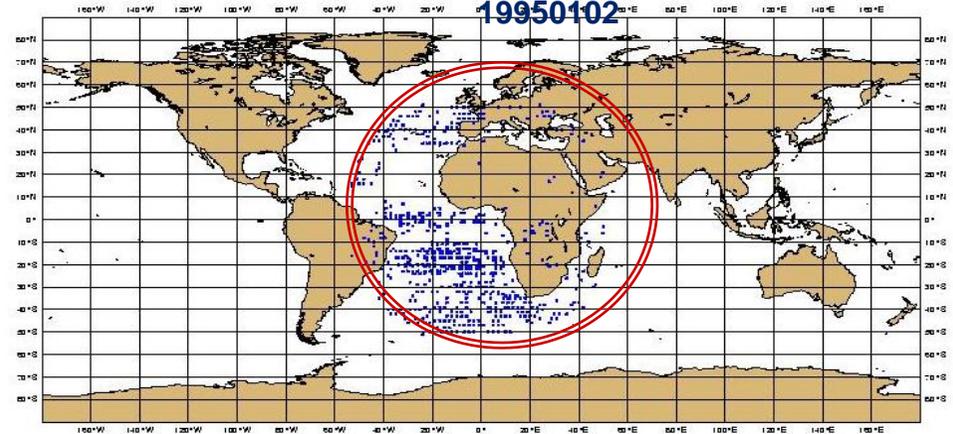
Period corresponds to time when Meteosat-5 was operational at 0° and Meteosat-3 supported NOAA because there was only one GOES satellite.



Reprocessed Met3 and Met5

Example of coverage:

19950102



Original Met5



Example:

Aligned R&D on of future advanced geostationary imagers

- Many CGMS operators will fly advanced imagers on their next generation of geostationary satellites
- For instance: NOAA => ABI, JMA => Himawari-8/9 (ABI like), EUMETSAT => MTG/FCI, CMA and KMA
- For example common objectives for JMA, NOAA and EUMETSAT include improved and new operational products such as:
 - **Cloud Analysis based on optimum estimation, e.g. for AMV height assignment**
 - **Volcanic ash detection and estimation of ash density**
 - **Instability monitoring and convective cloud development**



EUMETSAT Polar System (EPS): Metop Instruments

Excellent cooperation with NOAA including the R&D component

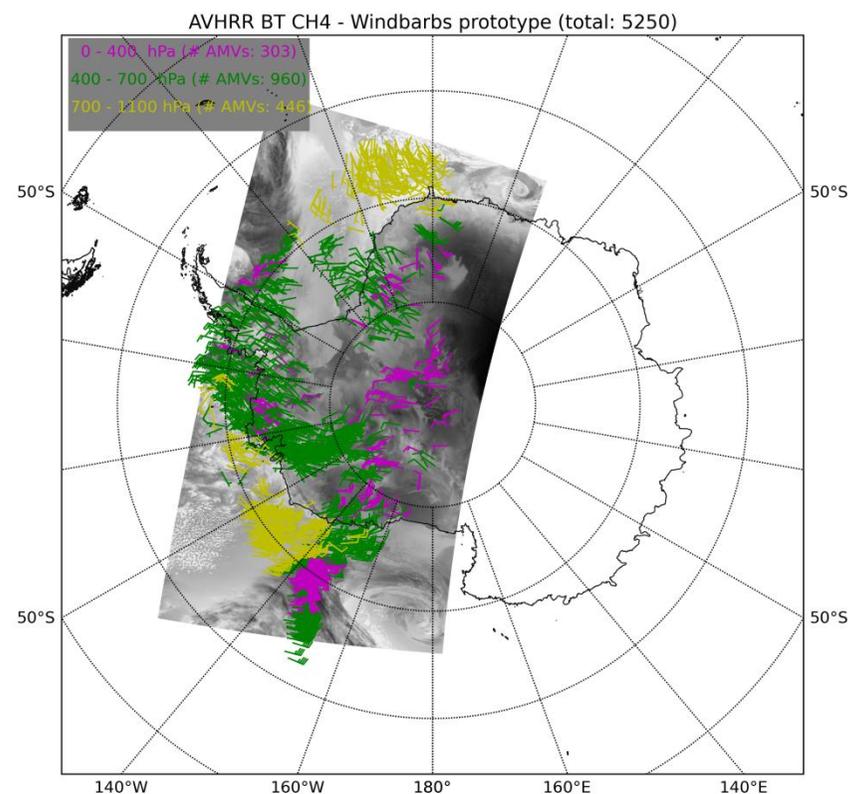
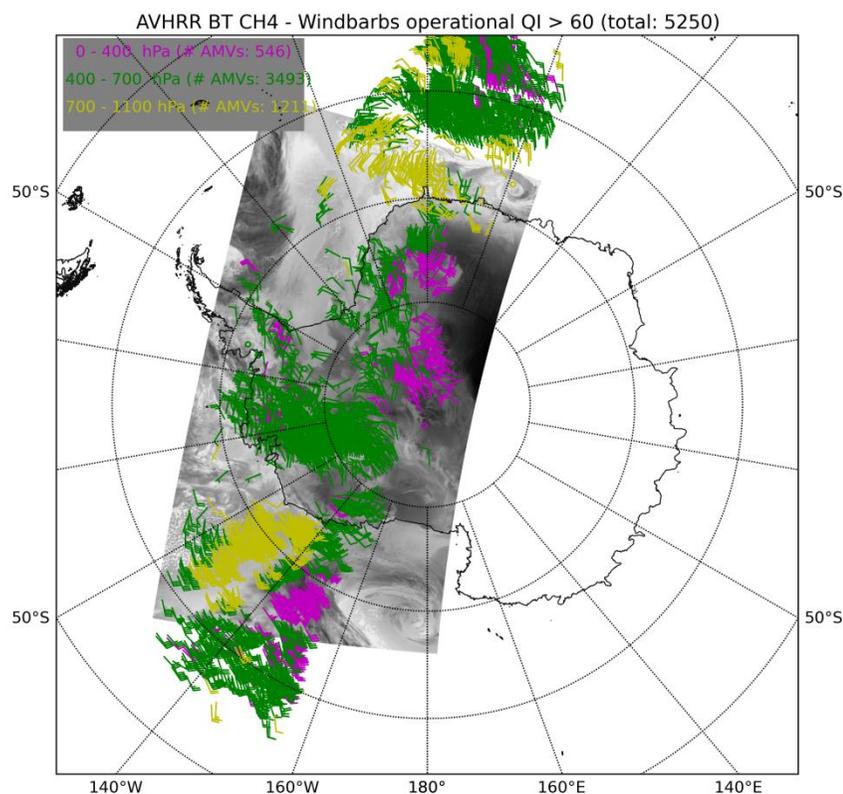


- Atmospheric Sounding (temperature, moisture, O₃/species):
 - IR/MW imaging sounders: **HIRS-4/IASI, AMSU-A/MHS**
 - UV/VIS imaging sounder: **GOME-2**
 - limb viewing radio-occultation sounder: **GRAS**
- Global VIS/IR Imagery: **AVHRR/3**

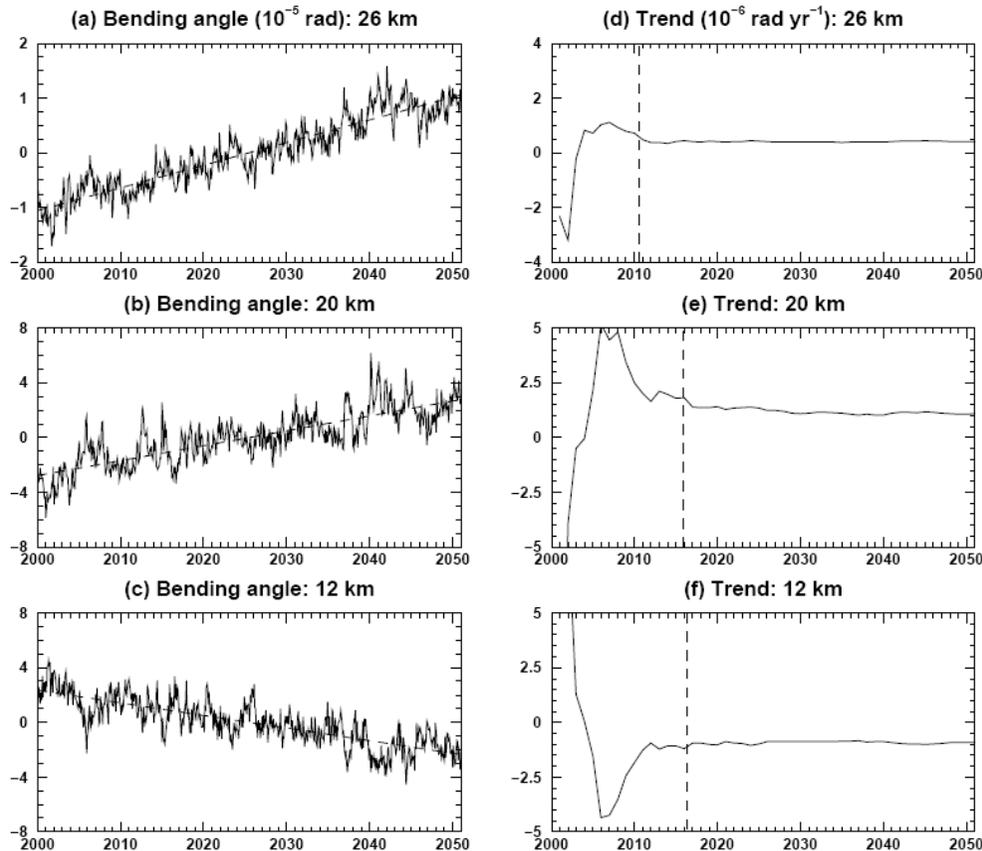
- 2-D wind field at the ocean surface: **ASCAT**
- Data Location and Collection: **ARGOS** terminal
- Global and Local Data Access: solid state recorder /HRPT/LRPT
- Search & Rescue Terminal

Polar AMVs from AVHRR on Metop-A: Two algorithms: EUMETSAT and CIMSS/NOAA

Antarctica 4 April 2008, 07:58 UTC



Monitoring 21st Century Climate Using GPS Radio Occultation (Ringer and Healy, 2008)



- Time series of the monthly mean bending angle at equator at impact heights of 12, 20 and 26 km, respectively

- Trend is discernable (temperature change)
- Detection times with 95% confidence:

- at 12 km: 14.6 - 18.2 years
- at 20 km: 13.6 - 18.7 years
- at 26 km: 9.7 - 11.7 years

EUMETSAT Network of Satellite Application Facilities (SAFs): => Continuous Development and Operations



SAF

The EUMETSAT
SAF Network



OSI SAF



H SAF



NWP SAF



O3M SAF



GRAS SAF



LSA SAF



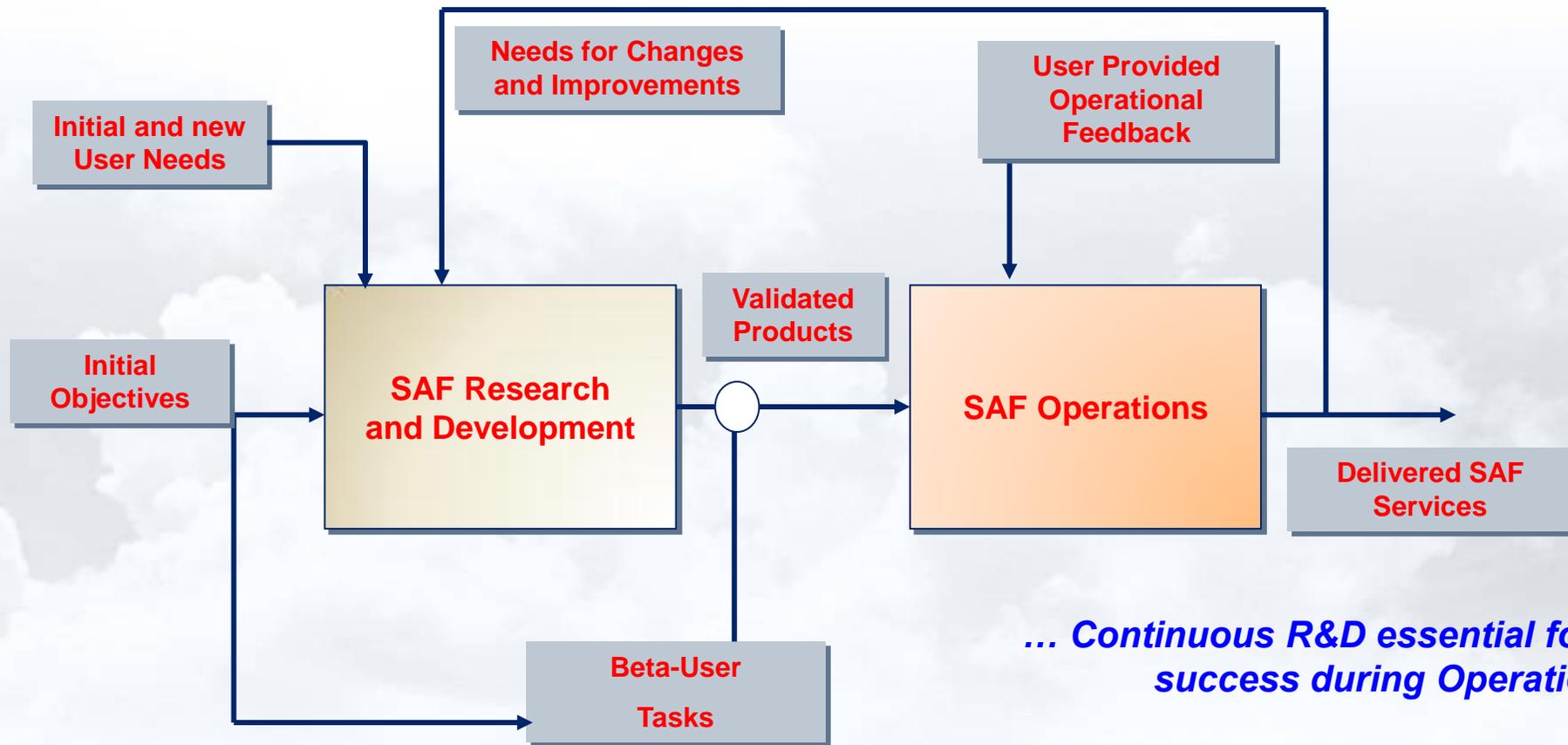
CM SAF



NWC SAF

- SAF = Satellite Application Facility
- providing products and services to users on an operational basis with a long-term perspective
- specialised on topics and themes
- located at Weather Services in EUMETSAT Member and Co-operating States
- developed and operated by consortium of partners
- part of the EUMETSAT application ground segment
- complement production of standard meteorological products at EUMETSAT central facility in Darmstadt
- Data and software are usable free of charge

SAF Development and Operations Model



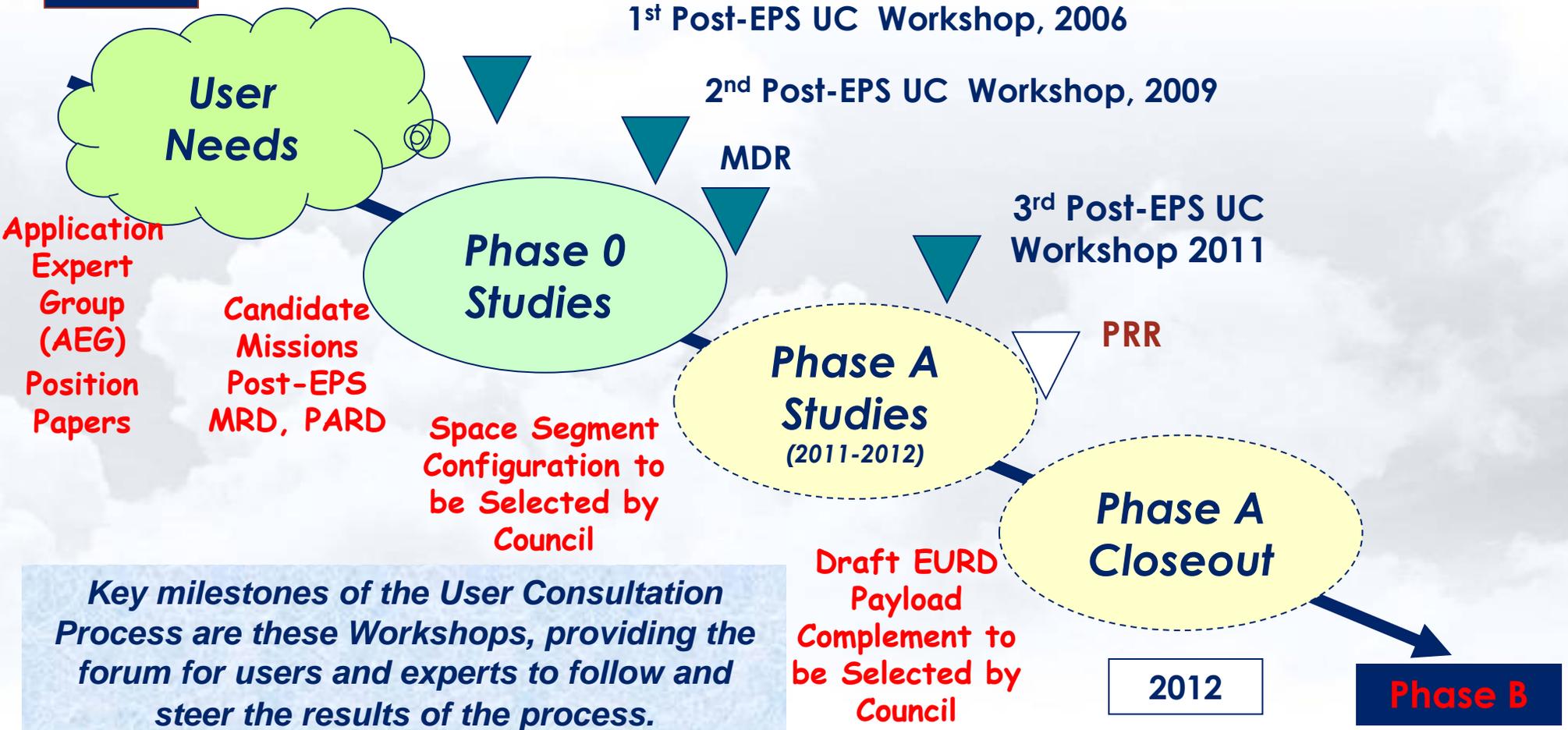
... Continuous R&D essential for SAF success during Operations ...

... Very large group of scientists involved in the support to SAF Projects ...



Toward a new generation of operational satellites: The EUMETSAT User consultation Process (here for EPS/Metop)

2005



Key milestones of the User Consultation Process are these Workshops, providing the forum for users and experts to follow and steer the results of the process.



Summary

- **Research & Development and Operations & Applications** are an **integrated process**
- **Day-2 development** (i.e. during operational phase) is essential to fully exploit use of satellite data
- EUMETSAT has very positive experience with the formal **User Consultation Process** in support of working toward new satellite programmes (Meteosat Third Generation and EPS/Metop Second Generation)
- For operational reprocessing (for climate re-analyses) the R&D on the existing data is essential
- **Coordinated development among operational satellite agencies** (within **CGMS**) fosters **R & D and Operations & Applications**