Meteorological Products Derived from MSG Imagery

MPEF and SAFs

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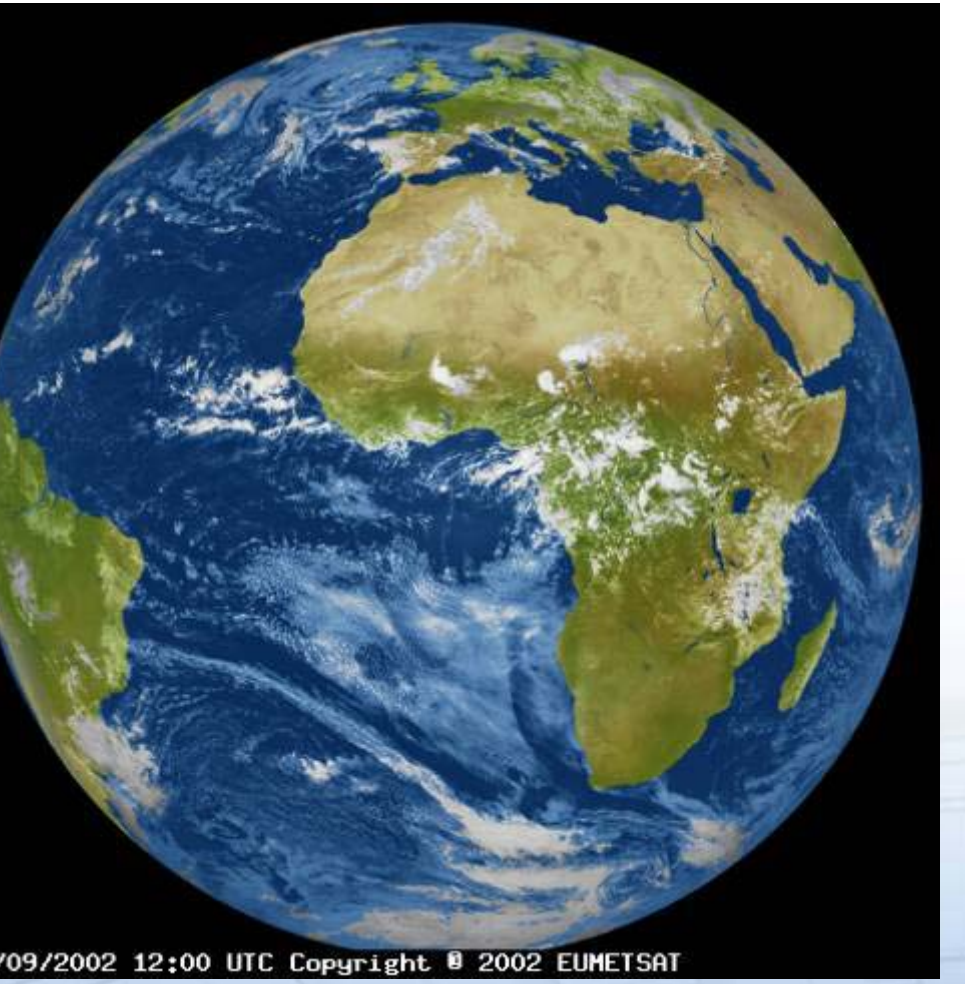
SEVIRI Instrument: Geographical Coverage

3712 x 3712

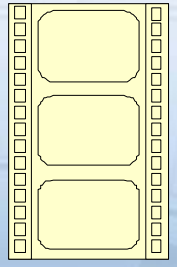


All Channels, except HRV

11136 x 5568

HRV : Day 1
scanning patte

HRV since
June 2005



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The MSG MPEF: Meteorological Products Extraction Facility

- MPEF is part of the Application Ground System and constitutes, together with the Satellite Application Facilities (SAF) the source of the Meteorological Products provided by the MSG system
- The list of products to be extracted from the MSG imagery has been agreed by EUMETSAT member states
- As a general principle, the MPEF will extract products on a synoptic scale (< 100 km)
- Important driver for the MPEF development:
  - Evolution of products and algorithms
  - Flexibility to add new products and algorithms

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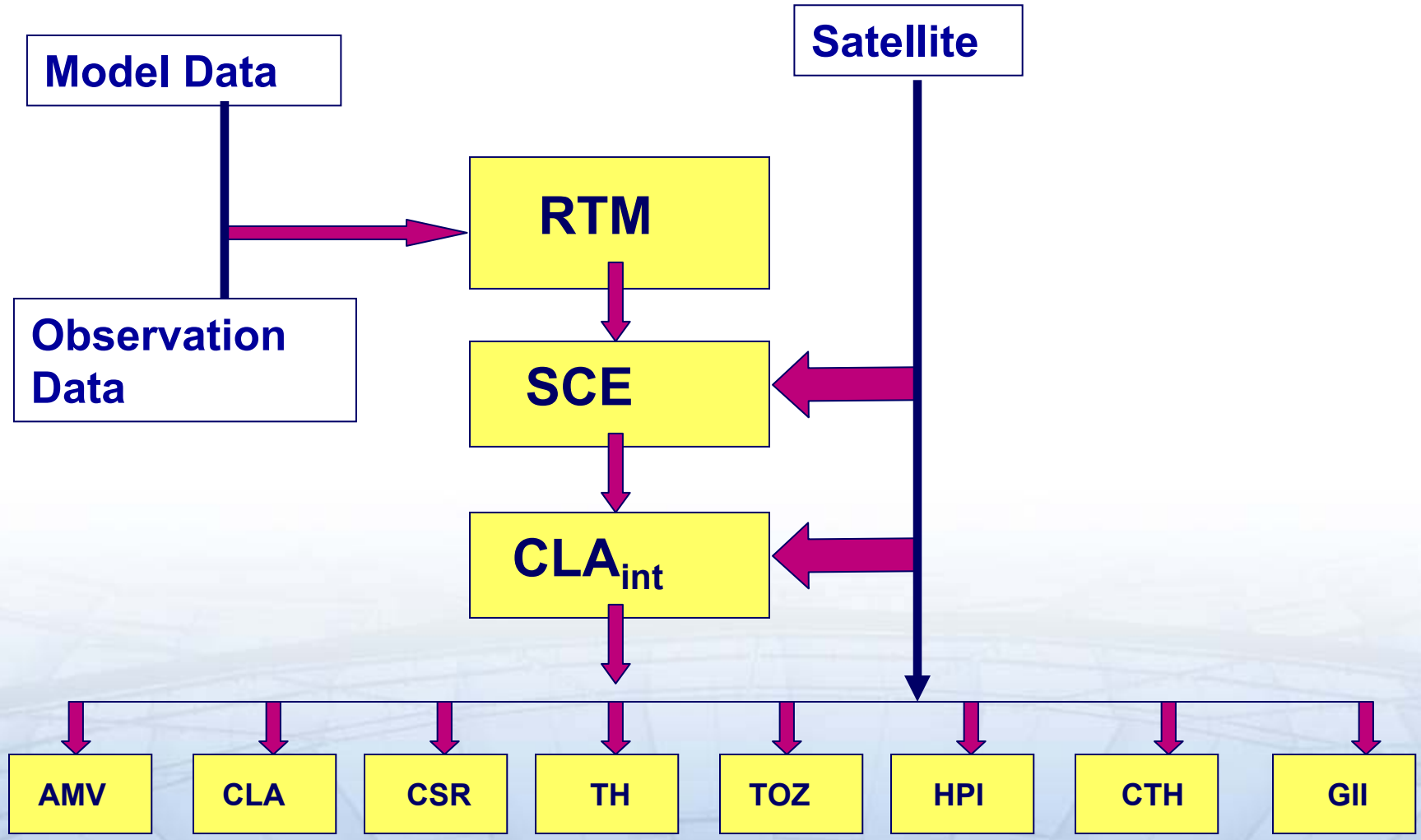
Algorithm Overview - Principle

- The interpretation of the satellite data is facilitated by the use of a radiative transfer model RTM, which uses forecasted temperature and humidity profiles
- Comparisons between the actual measurement and the RTM result already gives a good indication of the “pixel identification” (scenes analysis) which decides whether a pixel is cloudy or not
- This scenes analysis is the basis for almost all other parameters

Algorithm Overview



MSG MPEF Products Baseline (GTS/EUMETCast/UMARF)

- Atmospheric Motion Vectors (AMV)
- Calibration Monitoring (CAL-MON)
- Clear Sky Radiance (CSR)
- Clear Sky Reflectance Map (CRM)
- Climate Data Set (CDS)
- Cloud Analysis (CLA)
- Cloud Top Height (CTH)
- Global Instability Index (GII)
- ISCCP Dataset (IDS)
- Precipitation Index (PI)
- Total Ozone (TOZ)
- Tropospheric Humidity (TH)

Some internal Products:

- Sea Surface temperature (SST)
- Scenes Analysis (SCE)
- Radiative Transfer Model (RTM)

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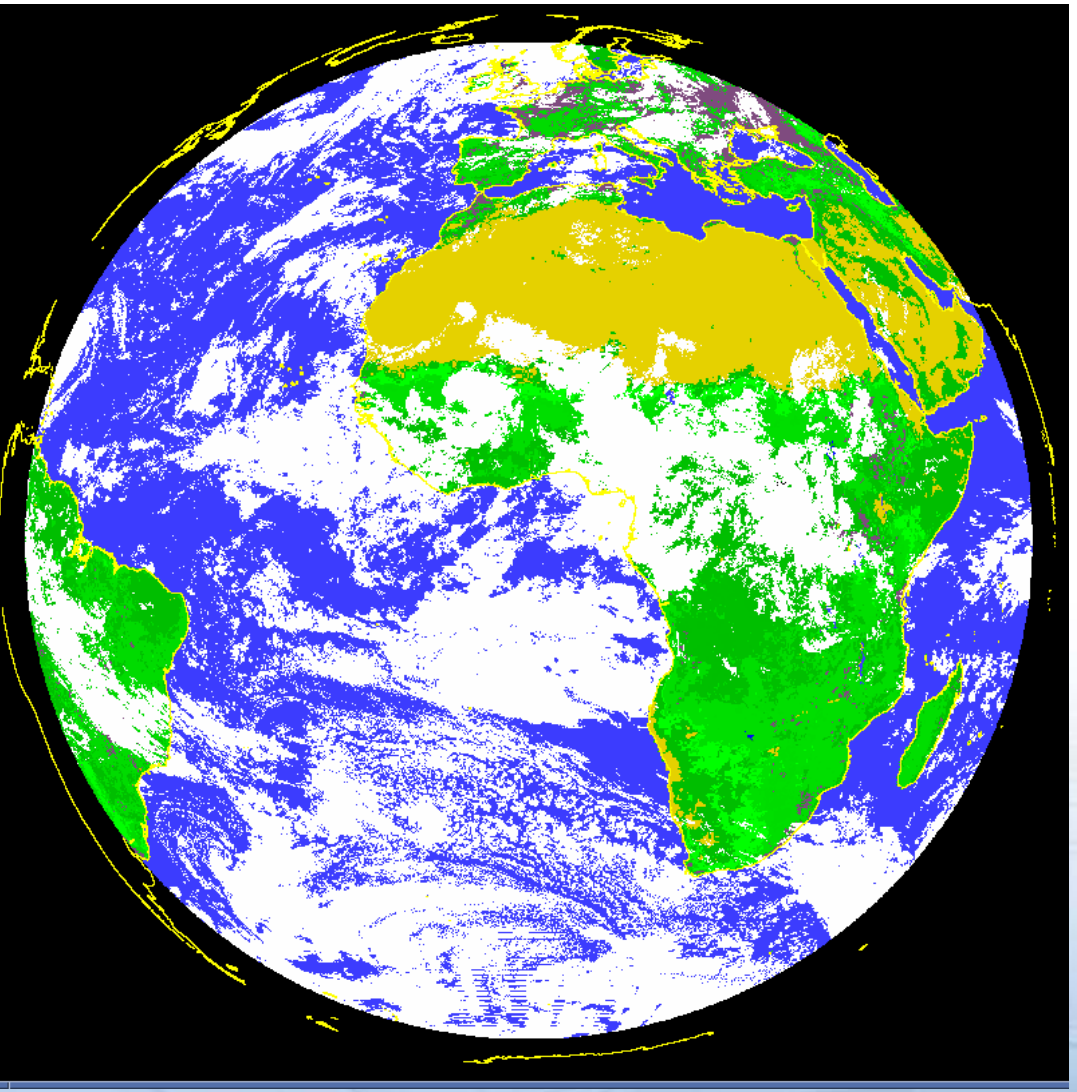
MSP MPEF Product: Radiative Transfer Model

- The infrared radiative transfer model runs on 1 x 1 deg grid forecast profiles from ECMWF (31 levels)
- Model runs are initiated based on the forecasts for 00/06/12/18 UTC every day
- The model results are interpolated to the actual image time and the exact pixel location
- The model produces a set of “theoretical” brightness temperatures in the MSG channels for clear sky and a number of cloud levels between the surface and 100hPa

MPEF Product Example: Scenes Analysis SCE



02 September 2003, 07:30 UTC
Scenes analysis (cloud detection

colours refer to clouds and different surfaces (from background information)

Details of the underlying algorithm: see section on “Cloud Introduction”

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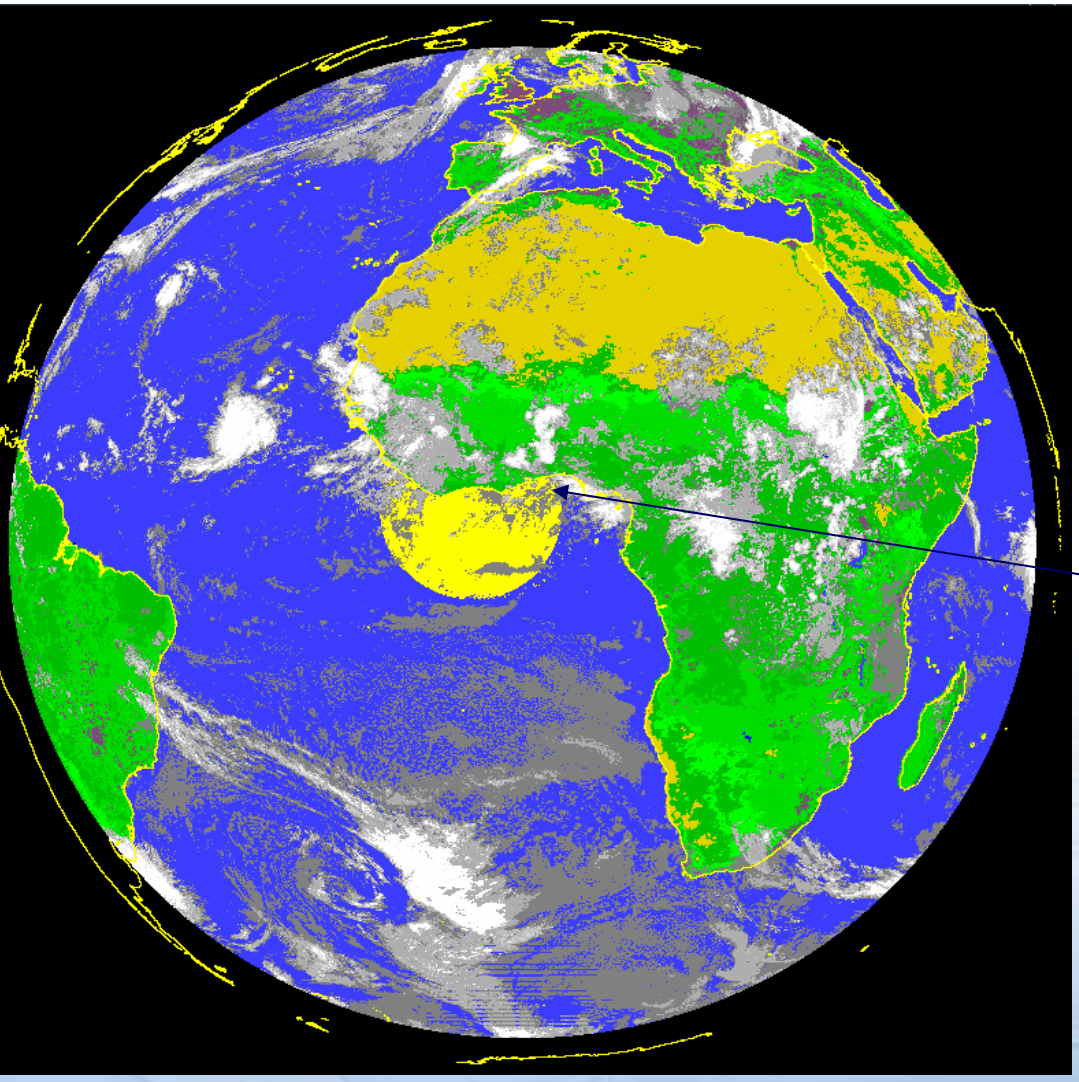
MSG MPEF Product Example: Cloud Anlaysis CLA



04 September 2003, 11:45 UTC
Cloud analysis (cloud height);
CLA also contains cloud phase

colours refer to clouds in three different heights and different surfaces (from background information)

sunglint area

Details of the underlying algorithm: see section on “Cloud Introduction”

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MSG MPEF Product: Clear Sky Radiance CSR

- CSR is an important assimilated parameter for NWP
- CSR is directly derived from the SCE data: A segment CSR is the mean radiance over all cloud-free pixels in a segment (= 16 x 16 image pixels)
- CSR is derived from 0.8, 1.6 (day), 6.2, 7.3, 10.8, and 12.0μm data (day and night)
- Extracted every three hours for dissemination, and every 15 minutes for internal use

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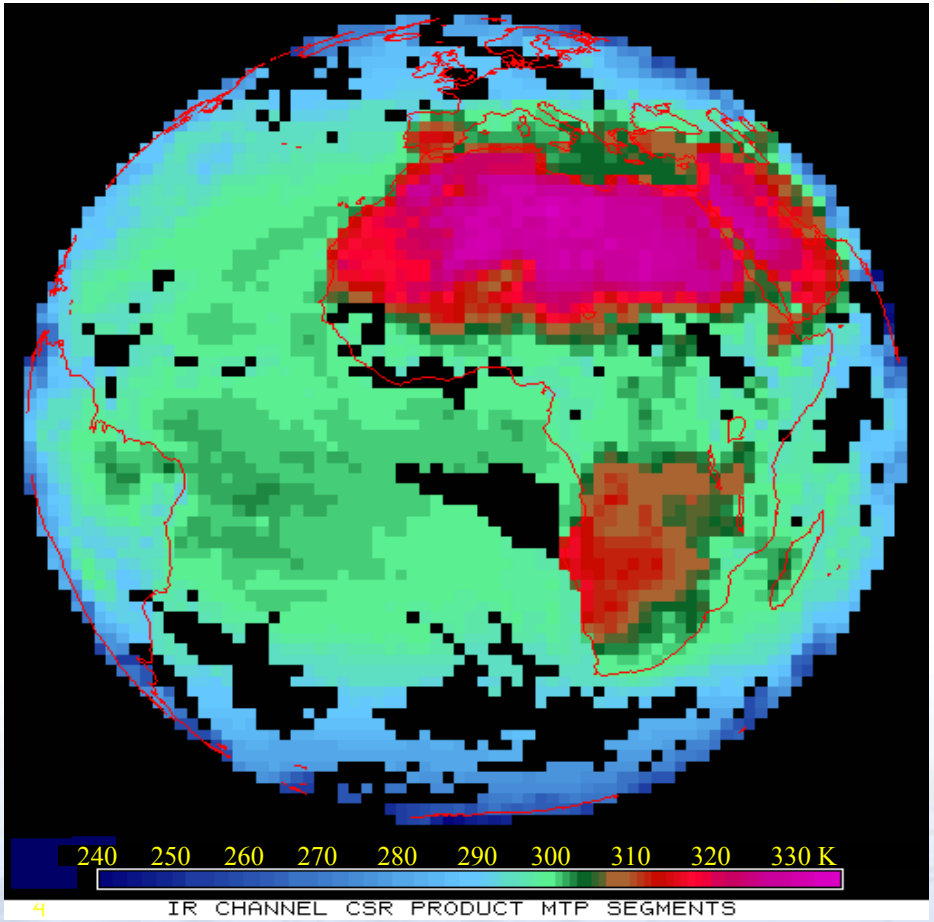
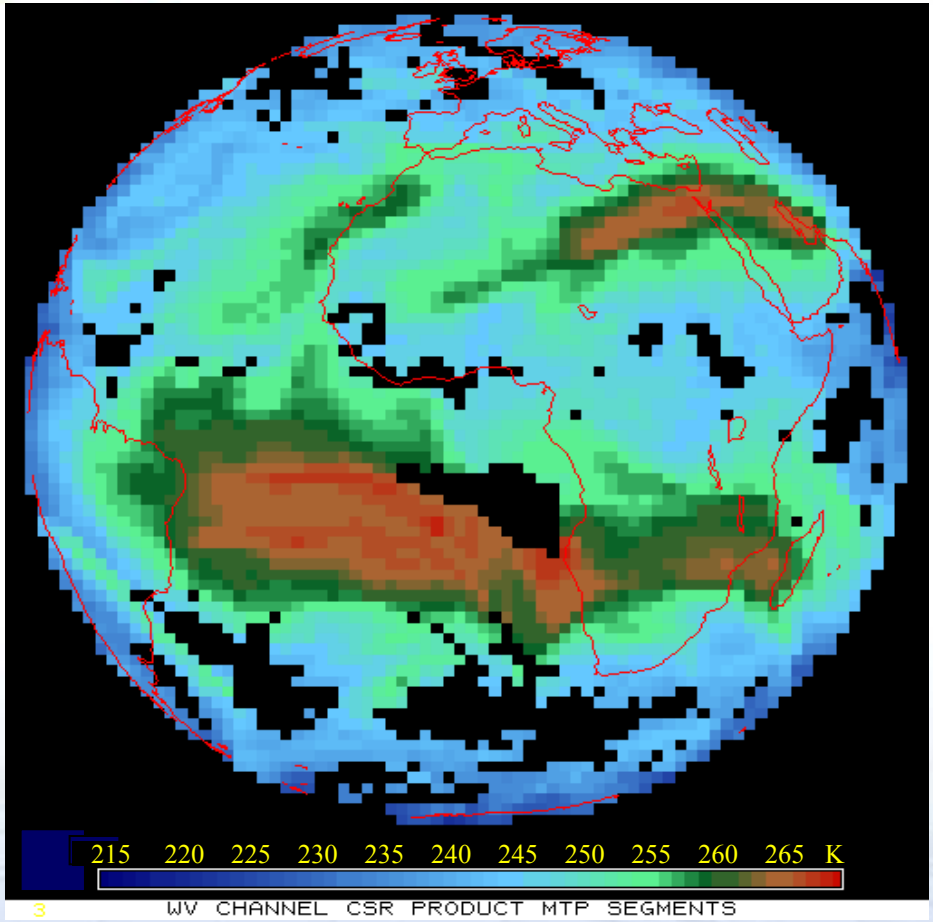
MSG MPEF Product: CSR, as Brightness Temperatures



IR10.8



WV6.2

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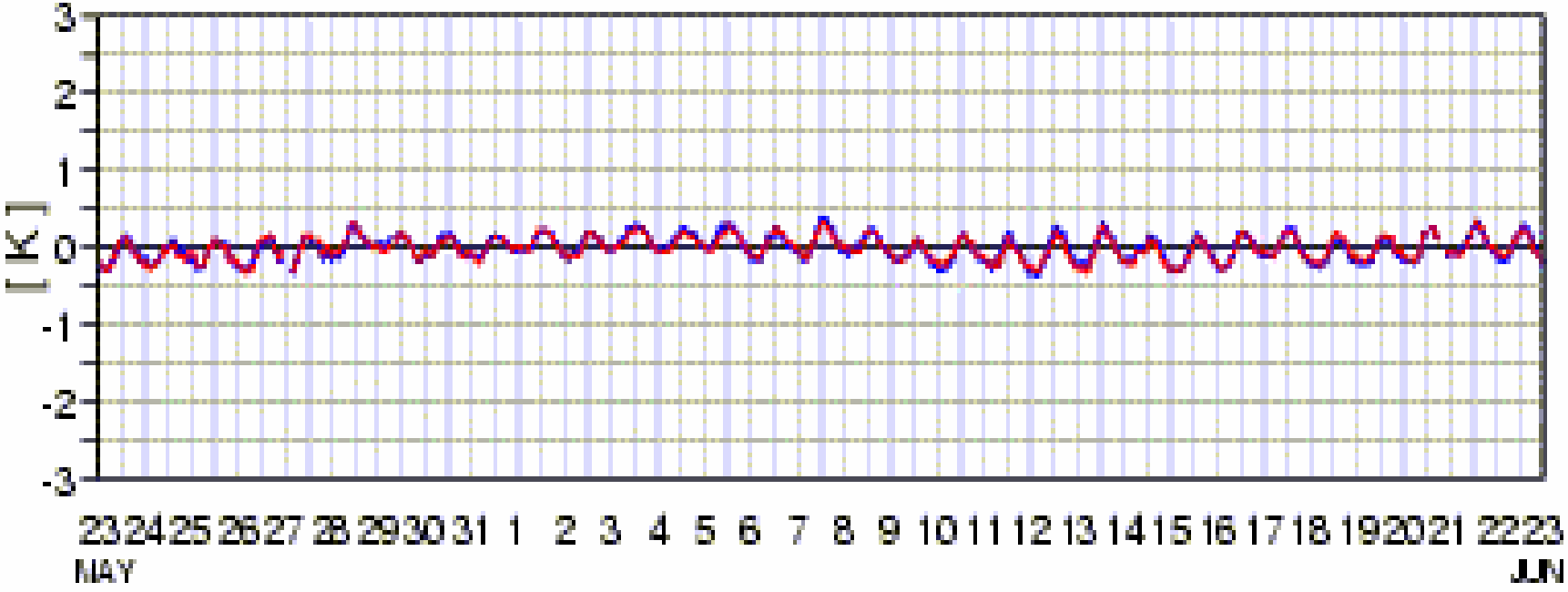
MSG MPEF Product: CSR and its Use in NWP



IR10.8: Observation - Analysis, as monitored by ECMWF

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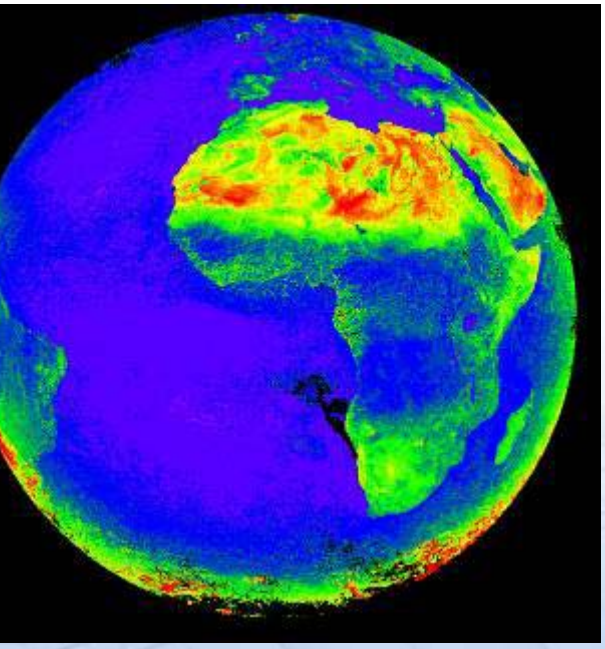
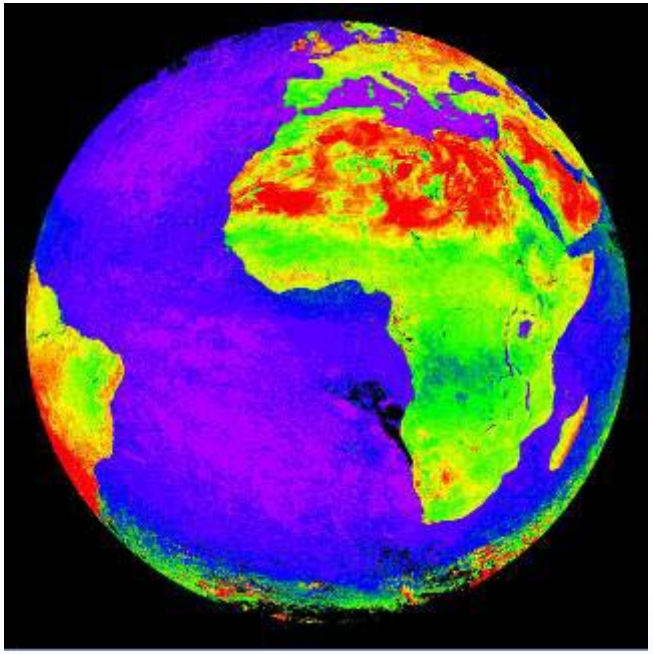
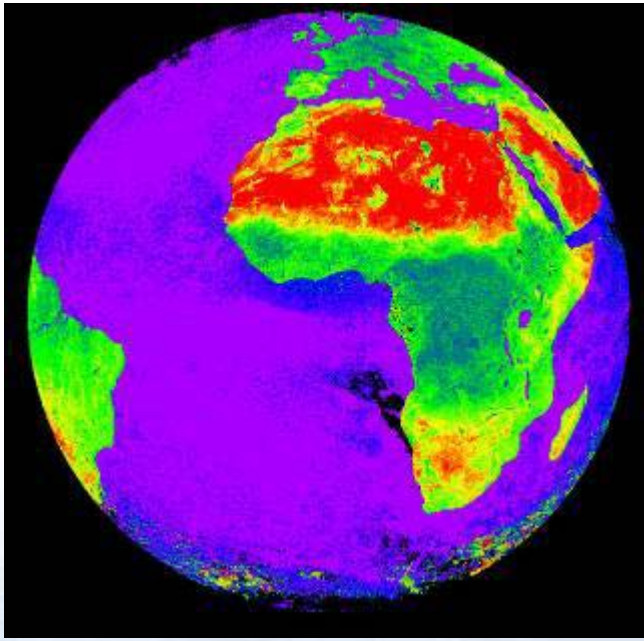
MSG MPEF Product: Clear Sky Reflectance Map CRM



Channel VIS 0.6



Channel VIS 0.8



Channel NIR 1.6

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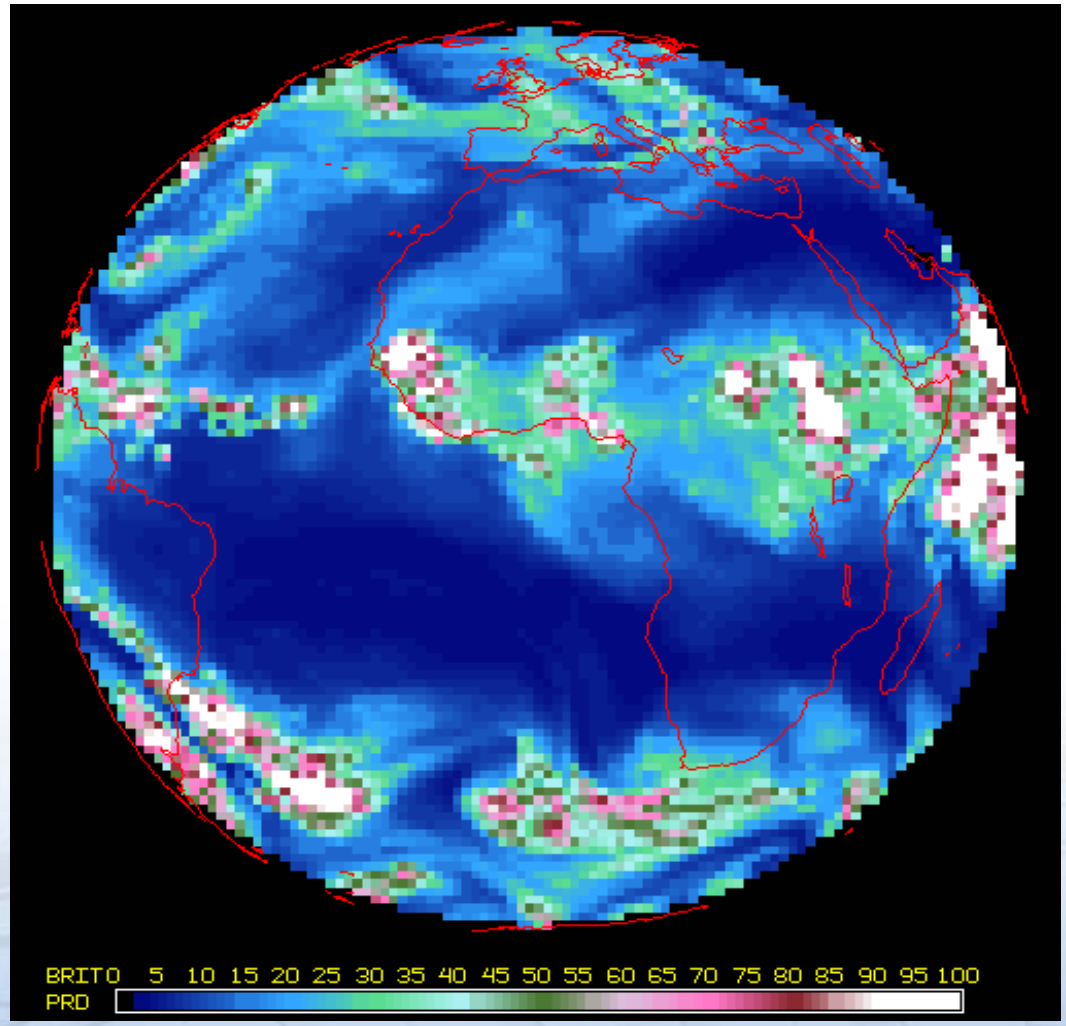
MSG MPEF Product: Tropospheric Humidity TH

- Using the WV6.2 channel the mean humidity between 600 and 300hPa is estimated
- Using the WV7.3 channel the mean humidity between 850 and 600hPa is estimated
- Resolution: 100 km, every 30 minutes
- The MPEF processing scheme is based on the RTM calculations for different humidity profiles

MSG MPEF Product: Tropospheric Humidity TH



WV6.2 TH on
segment resolution

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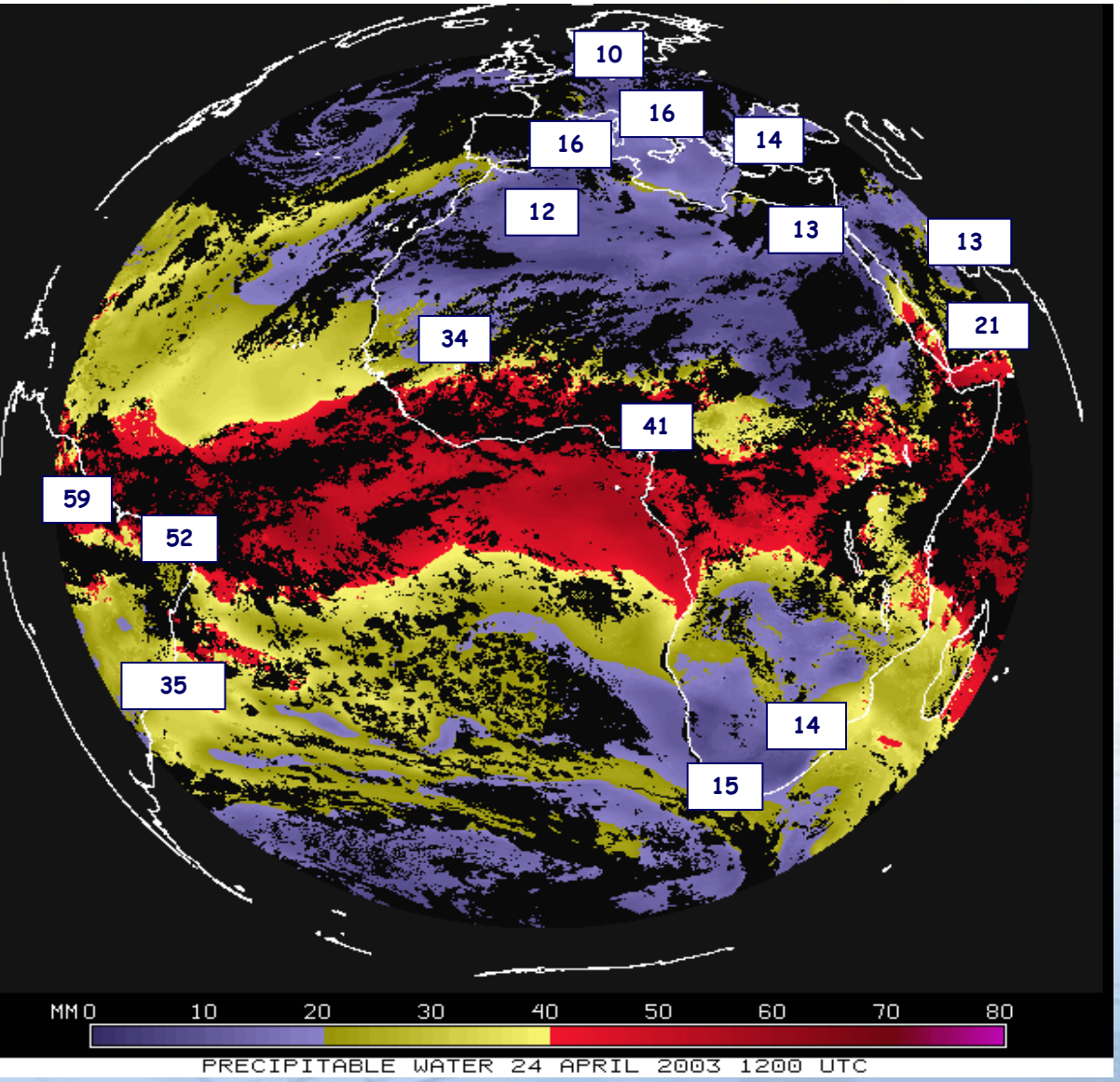
MSG MPEF Product: Global Instability Index GII

- Together with a forecasted temperature and humidity profile as a priori information, the MSG infrared channels are used to infer updated profiles (only for cloud-free conditions)
- Four empirical instability parameters are inferred from these profiles (Lifted Index, K-Index, KO-Index, Maximum Buoyancy)
- The Total Precipitable Water Content is a further air-mass parameter, inferred from the humidity profile and part of the GII product

MSG MPEF Product: Global Instability Index GII



Example of a total precipitable water retrieval, collocated radiosonde observations are also shown

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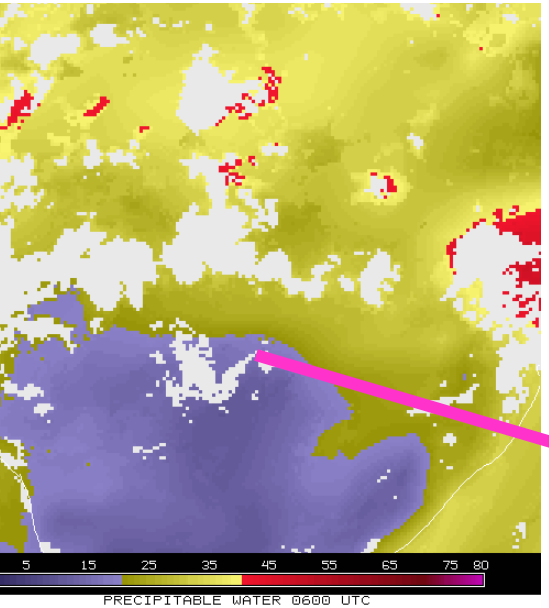
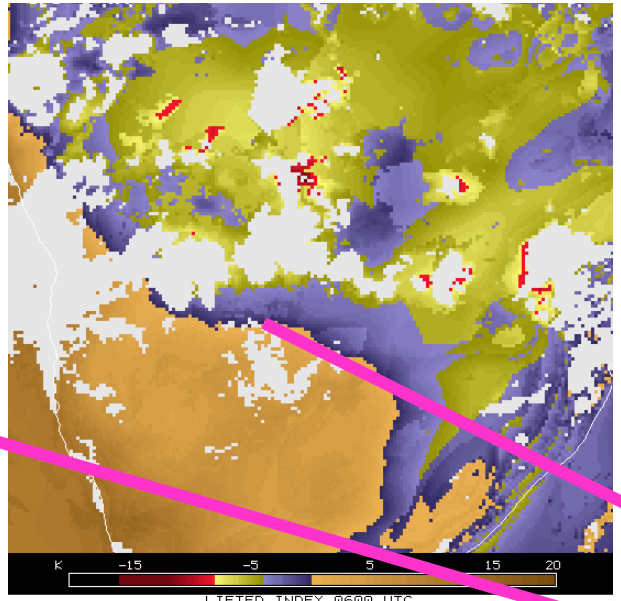
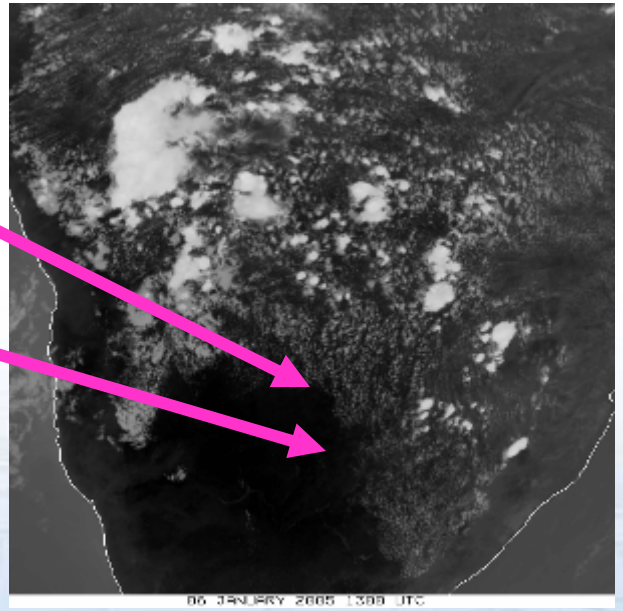
MSG MPEF Products: Global Instability Index GII







boundary of convection zone nicely
depicted in LI and PW - 7 hours before occurrence

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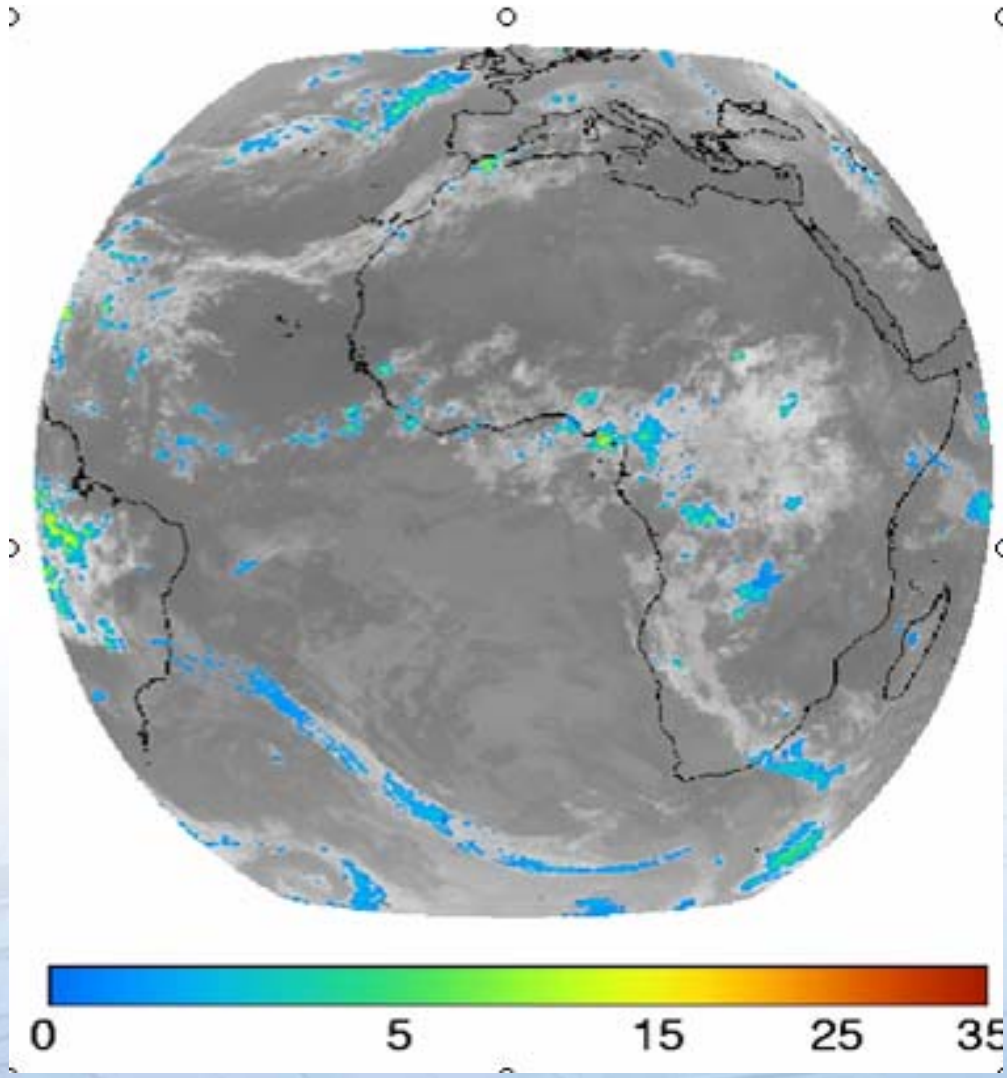
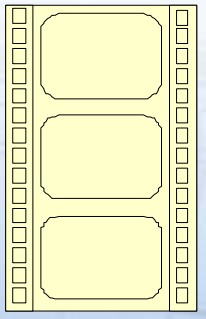
MSG MPEF Products: Precipitation Index PI



Experimental, half-hourly **rain rate** product for 22 Oct 2004, 0000-0730 UTC, based on Meteosat IR data calibrated against SSM/I rain rate da



Click here to loop

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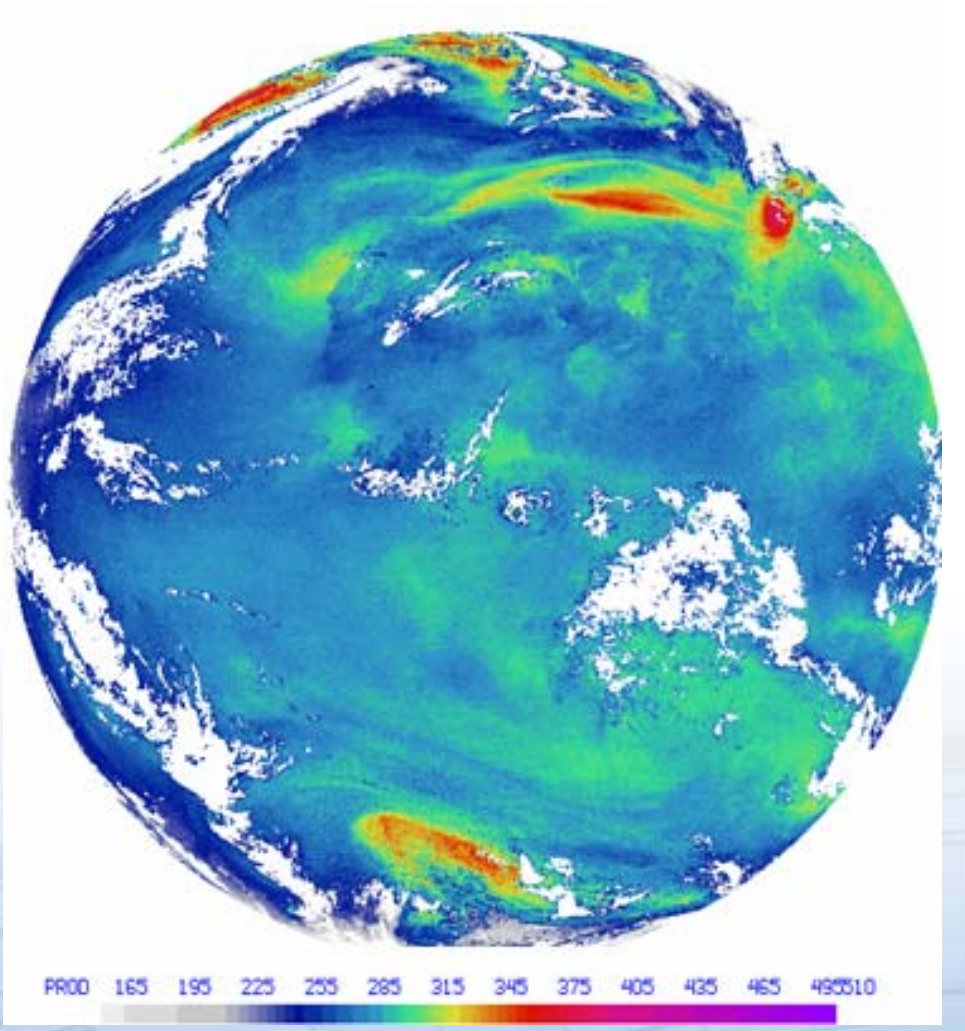
MSG MPEF Products: Total Ozone TOZ



- from the SEVIRI IR9.7 channel
- Resolution: 100km, every hour
- The brightness temperature in IR9.7 is composed of the cold emission of the stratospheric ozone and of the warm emission of the surface, attenuated by the ozone

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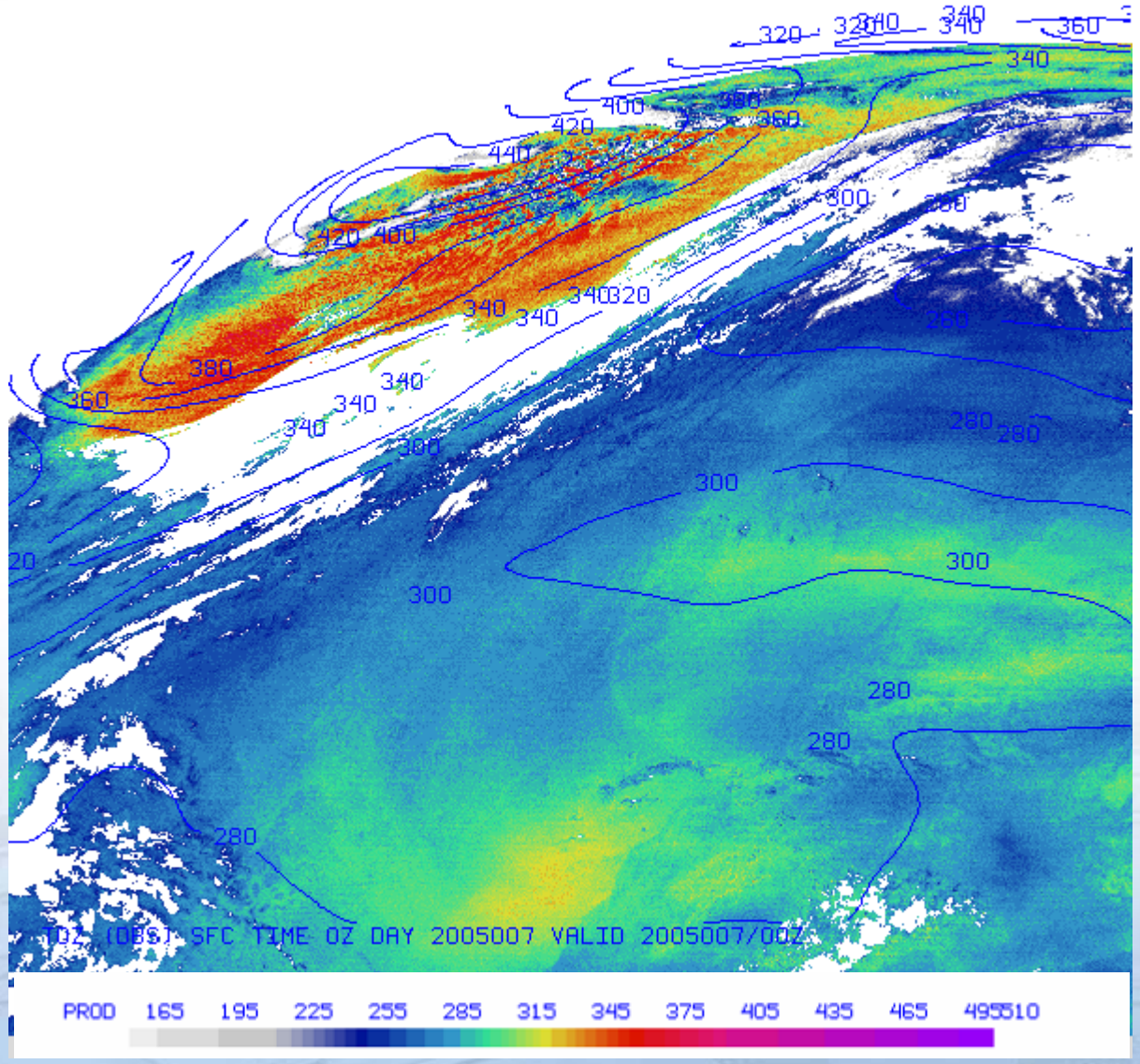
MSG MPEF Products: Total Ozone TOZ



Comparison to ECMWF Analysis

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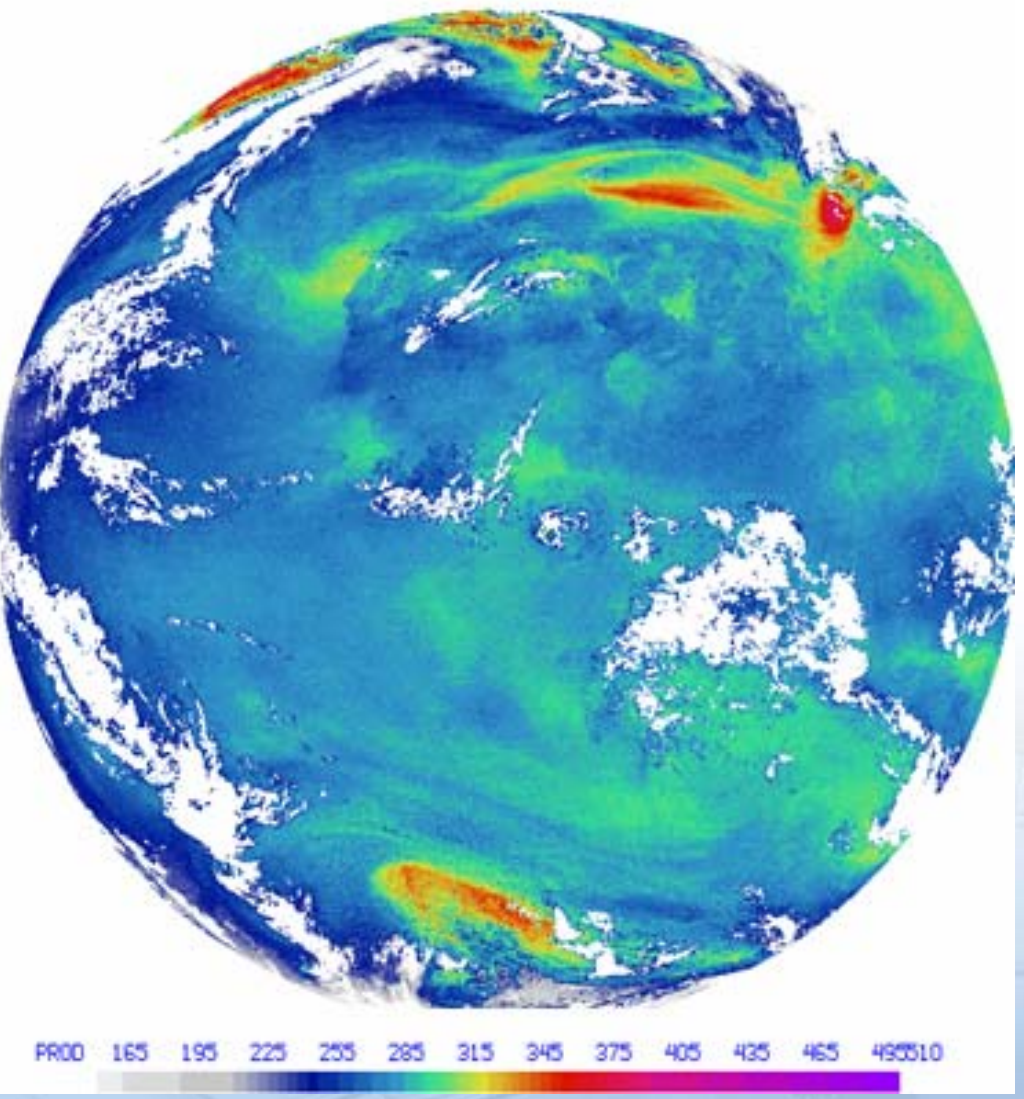
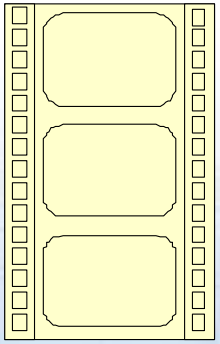
MSG MPEF Products: Total Ozone TOZ



Animation of TOZ: tracking midlatitude troughs



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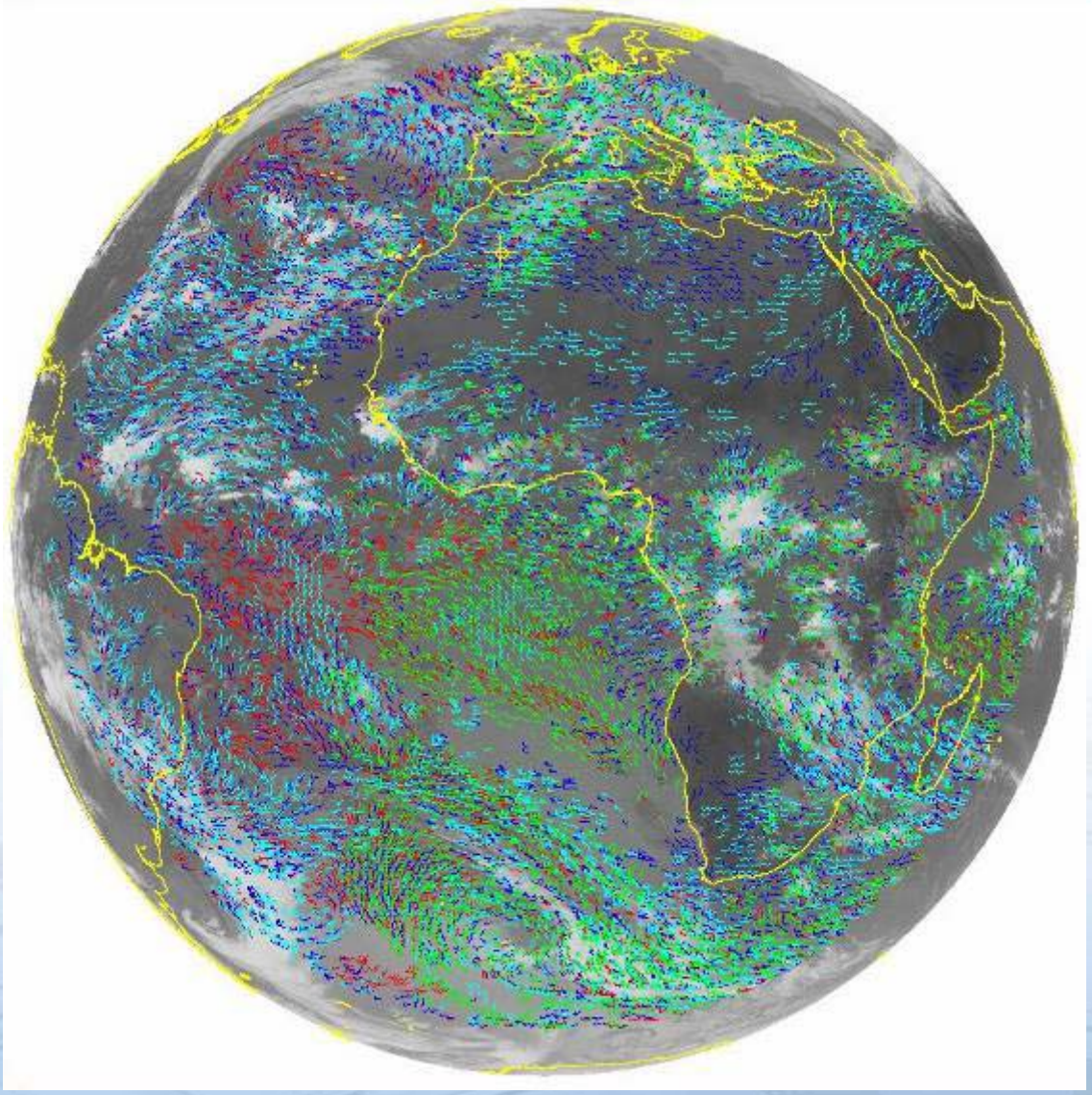
MSG MPEF Products: Atmospheric Motion Vectors AMV

- 100 km AMV resolution
- Atmospheric Motion Vectors are extracted from a series of images by tracking clouds (or water vapour features in the WV channels)

MSG MPEF Products: Atmospheric Motion Vectors AMV

- Using the channels
  - VIS0.8 during daytime, HRV during daytime for low clouds
  - IR10.8, WV6.2. WV7.3
- Wind product consists of
  - speed, direction, height
  - quality indicator
- Verification against reliable in-situ measurements
- Important assimilated parameter for NWP

MSG MPEF Products: AMV Final Product Example



Global wind coverage:

Winds of quality > 0.7
green: VIS0.8
light blue: WV6.2
dark blue: WV7.3
red: IR10.8

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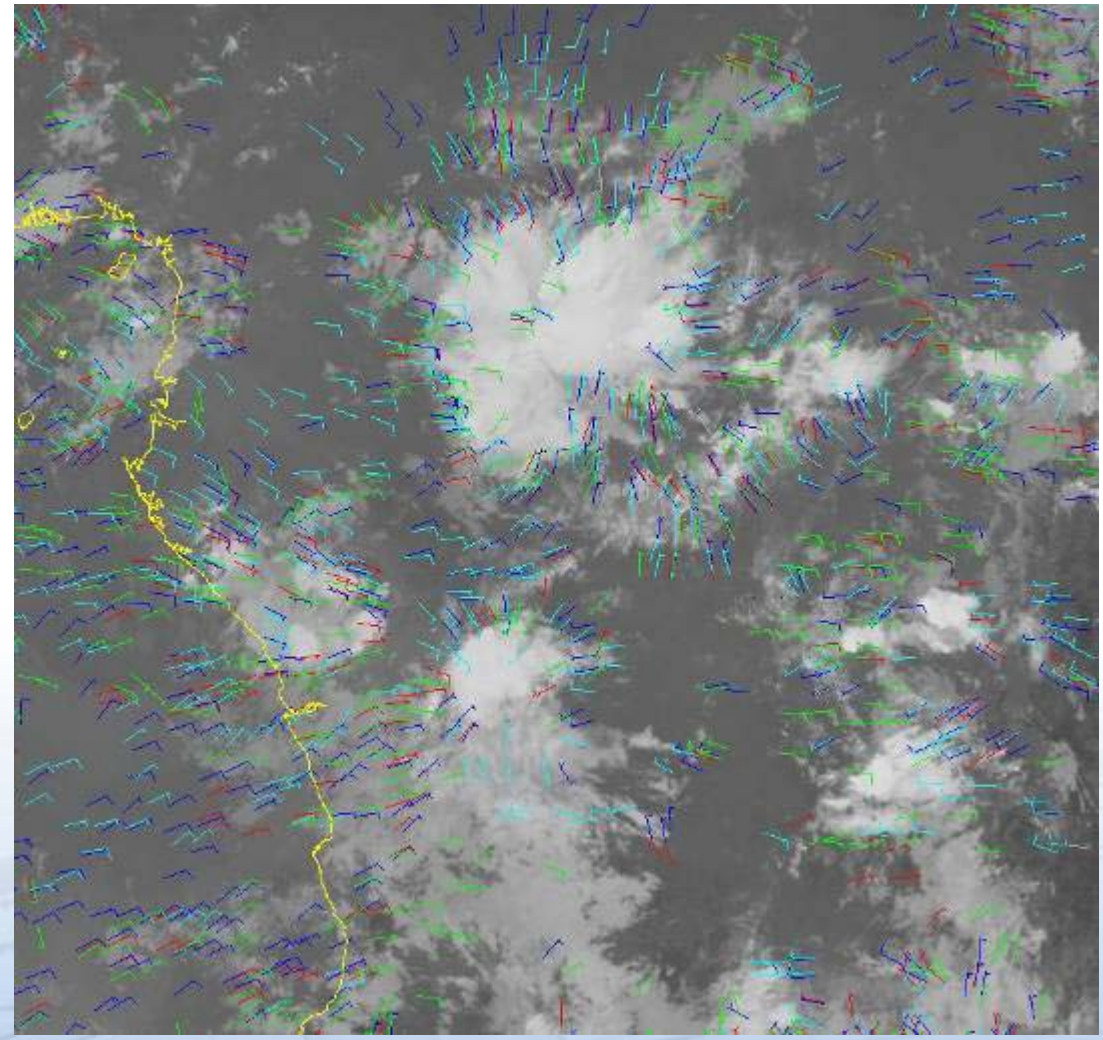
MSG MPEF Products: AMV Final Product Example



Cb Outflow:

Winds of quality > 0.7
green: VIS0.8
light blue: WV6.2
dark blue: WV7.3
red: IR10.8

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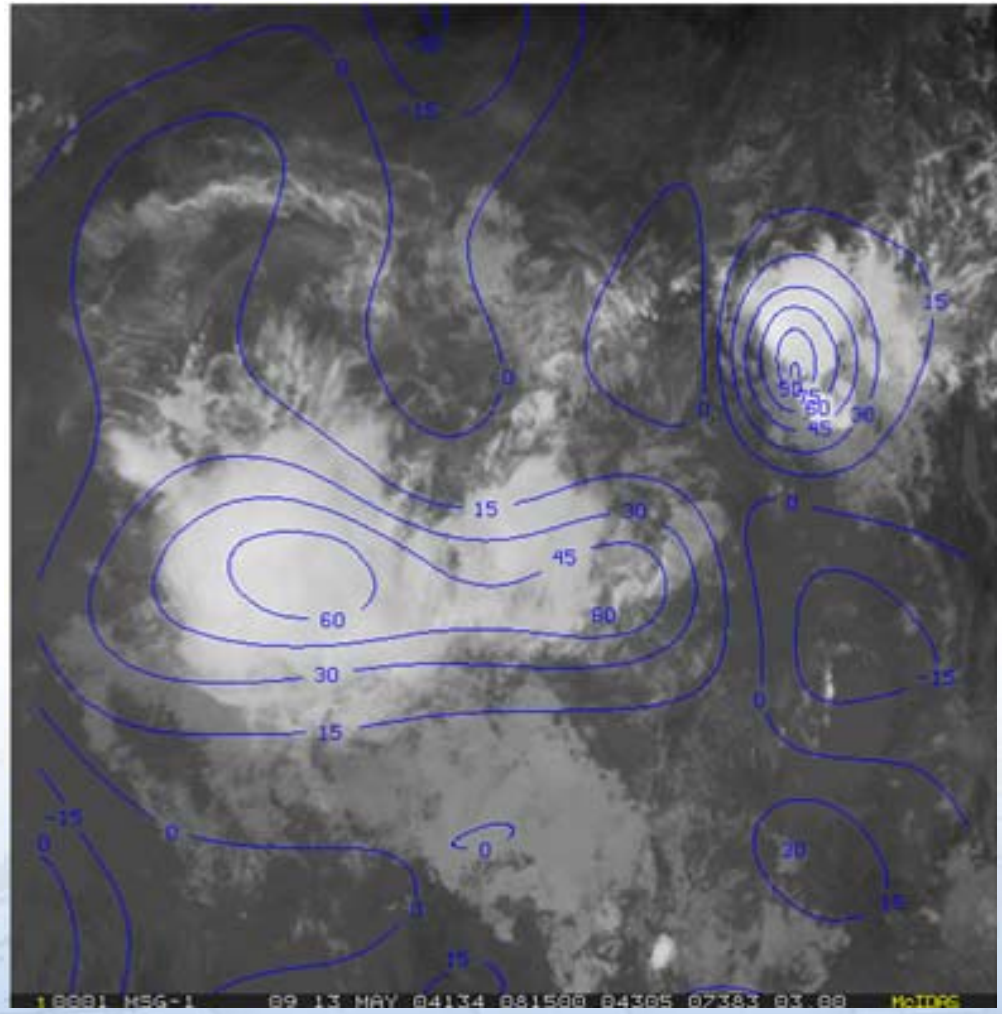
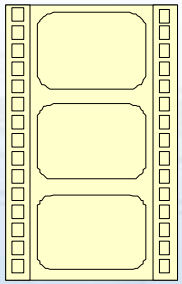
MSG MPEF Products: AMV Final Product Example



Case of a tropical convective cell: Divergence computations from AMVs between 0815 and 2045 UTC, 13 May 2004



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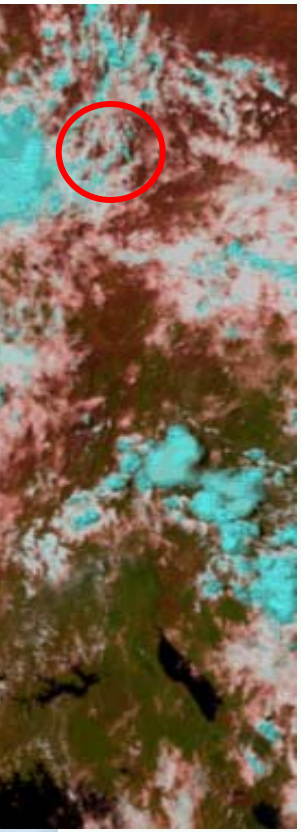
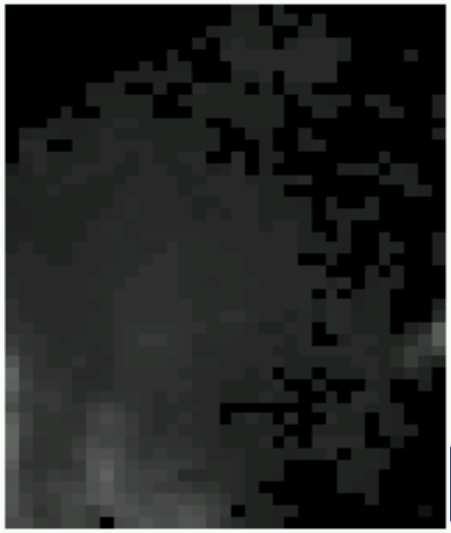
Future MSG MPEF Product: Cloud Microphysics

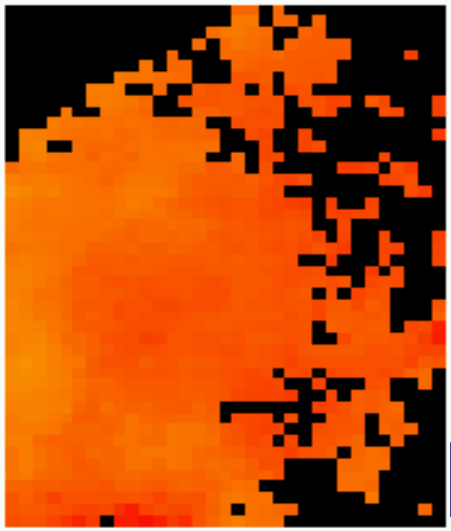
- Parameters of interest: cloud phase, cloud top height, effective particle size, optical depth
- Method uses a different approach (“optimal estimation”, more details given in section “Cloud Introduction”)

Future MSG MPEF Product: Cloud Microphysics Example

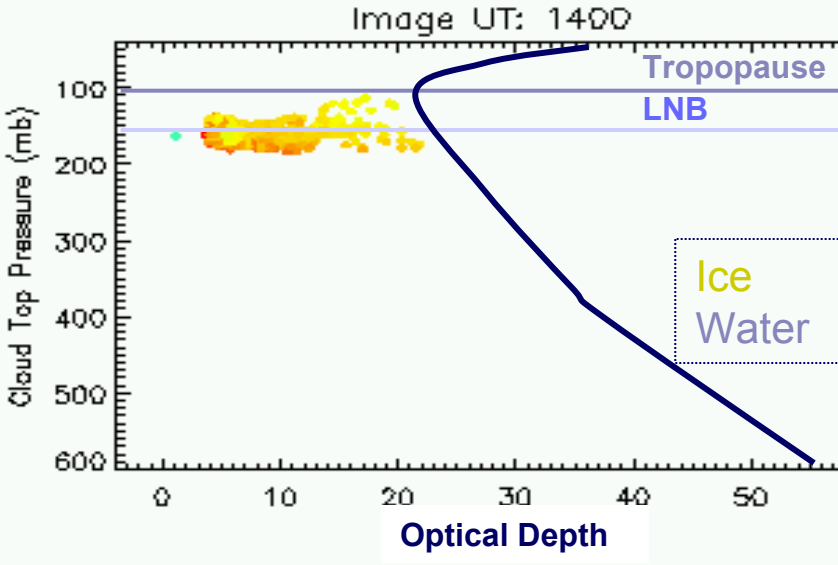


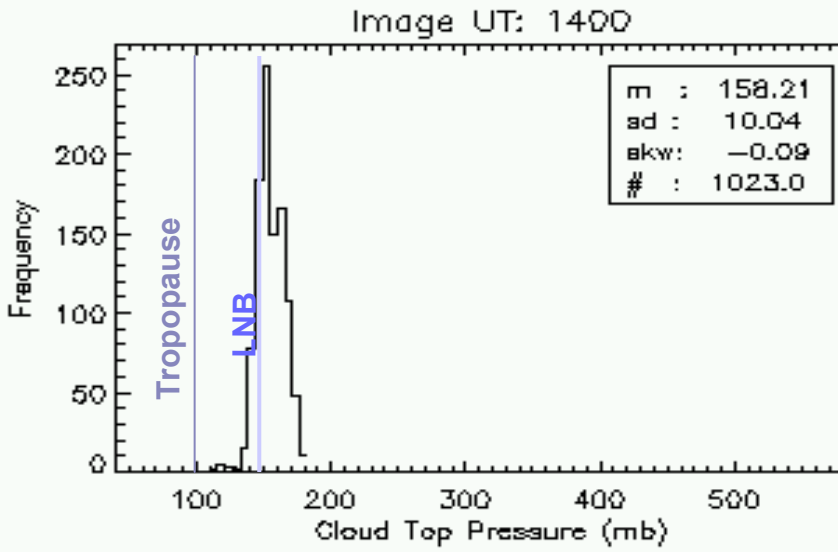


Optical D



Pressure





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MSG MPEF in Summary

- MSG provides a wealth of observational data
- The data can only be processed by automatic, objective criteria
- The development of new MSG MPEF products takes into account the user needs for improved temporal and spatial coverage and of entirely new products
- Further research and development is necessary to ensure the improvement of the new product suite to its full extent

The Satellite Application Facilities - A Short Overview

- SAF on Support of Nowcasting an Very Short Range Forecasting (Madrid/Spain, 1997)
- SAF on Ocean and Sea Ice (Lannion/France, 1997)
- SAF on Ozone Monitoring (Helsinki/Finland, 1997)
- SAF on Climate Monitoring (Offenbach/Germany, 1999)
- SAF on Numerical Weather Prediction (Exeter/UK, 1999)
- SAF on GRAS Meteorology Copenhagen/Denmark, 1999)
- SAF on Land Surface Analysis (Lisbon/Portugal, 1999)

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The SAFs Will Deliver:

Type A Products	**Distribution of user software packages for operational applications or local data processing**
Type B Products	**Off line product services, including off line production, archiving and distribution**
Type C Products	**Real Time product services**

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Type A SAF Products

VIRI
- Cloud Mask
- Cloud Type
- Cloud Top Temp. & Height
- Precipitating Clouds
- Convective Rainfall Rate
- Total Precipitable Water
- Layer Precipitable Water
- Stability Analysis Imagery
- High Resolution Winds
- Aut. Sat. Image Interpr.
- Rapid Dev. Thunderstorms
- Air Mass Analysis
- Improved Obs. Operators (for AMVs)
- Geostationary Rad. Assimilation

AVHRR/AMSU/MHS/HIRS
- Cloud Mask
- Cloud Type
- Cloud Top Temp. & Height
- Precipitating Clouds
- Improved & Extended RTMs

IASI
- Fast RTM & Obs. Operators

GOME
- Obs. Operators

ASCAT/SeaWinds
- Improved Obs. Operators

SSM/I
- 1DVar Retrieval System (for wind speed, cloud water) Fast RTM

SSMIS
- 1DVar Retrieval System (for wind speed, cloud water etc.)
- Fast RTM

AIRS
- 1DVAR Retrieval System

AAPP

Improved and extended versions
annual distribution (e.g. upda
ingest function, updated clou
detection, added ICI retrieval
module etc.)

Extension to processing
IASI+AMSU+AVHRR

NWC SAF
NWP SAF

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Type B SAF Products

MSG

Surface Albedo & Aerosol
Scattered Radiance Field
Surface Short-wave Fluxes
Land Surface Temperature
Surface Emissivity
Surface Long-wave Fluxes

EPS

Total Ozone
Trace Gases
Ozone Profiles
UV Fields with Clouds & Albedo
Surface Albedo & Aerosol
Scattered Radiance Field
Surface Short-wave Fluxes
Land Surface Temperature
Surface Emissivity
Surface Long-wave Fluxes
Refractivity Profiles
Temperature, Humidity and Pressure Profiles
Integrated Water Vapour

Multi-mission

Land Surface Temperature
Surface Emissivity
Surface Long-wave Fluxes
NDVI, FGV, fPAR, LAI
Fractional Cloud Cover
Cloud Classification
Cloud Top Temp. & Height
Cloud Optical Thickness
Cloud Phase
Cloud Water Path
Surface Rad. Budget
Surface Albedo
Rad. Budget at TOA
Sea Surface Temperature
Sea Ice Cover

Humidity Profile [TBC]

O3M SAF
CLM SAF
GRM SAF
LSA SAF

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Type C SAF Products

MSG

Surface Albedo
Aerosol
Scattered Radiance Field
Surface Short-wave Fluxes
Land Surface Temperature
Surface Emissivity
Surface Long-wave Fluxes
Soil Moisture
Evapotranspiration Rate

OSI SAF
O3M SAF
CLM SAF
GRM SAF
LSA SAF

EPS

Near Surface Wind Vector
Regional SST
Atlantic High Latitude Rad. Fluxes
Total Ozone
Ozone Profiles
Aerosol Indicator
Surface Albedo & Aerosol
Scattered Rad. Field
Surface Short-wave Fluxes
Land Surface Temperature
Surface Emissivity
Surface Long-wave Fluxes
Evapotranspiration Rate
N. Europe Snow Cover
Refractivity Profiles
Temp., Hum. & Pressure Profiles
Integrated Water Vapour

Multi-mission

Atlantic SST
Atlantic Surf. Rad. Fluxes
Sea Ice Edge
Sea Ice Cover
Sea Ice Type
Clear-Sky UV Fields
Land Surface Temperature
Surface Emissivity
Surface Long-wave Fluxes
S. & C. Europe Snow Cover

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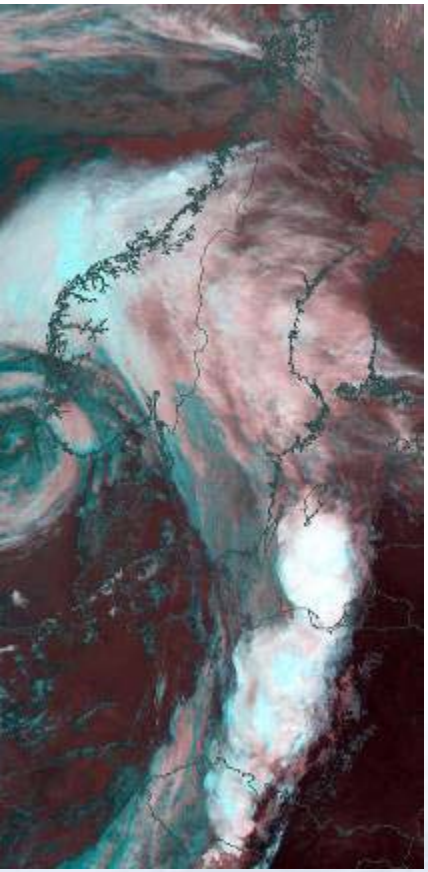
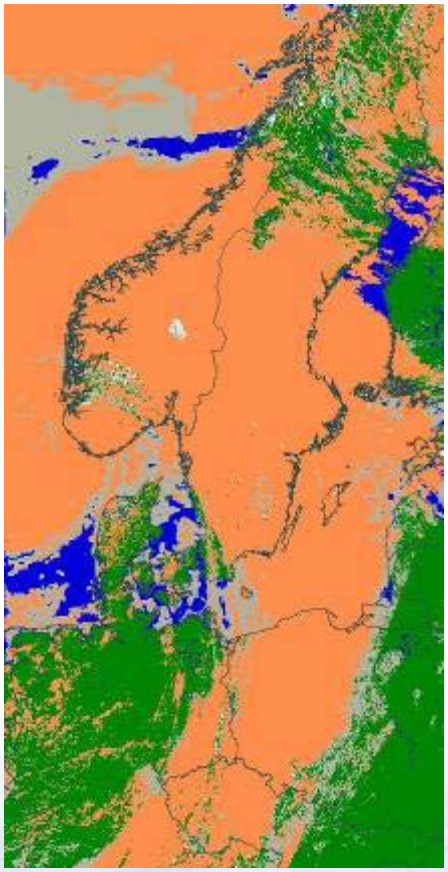
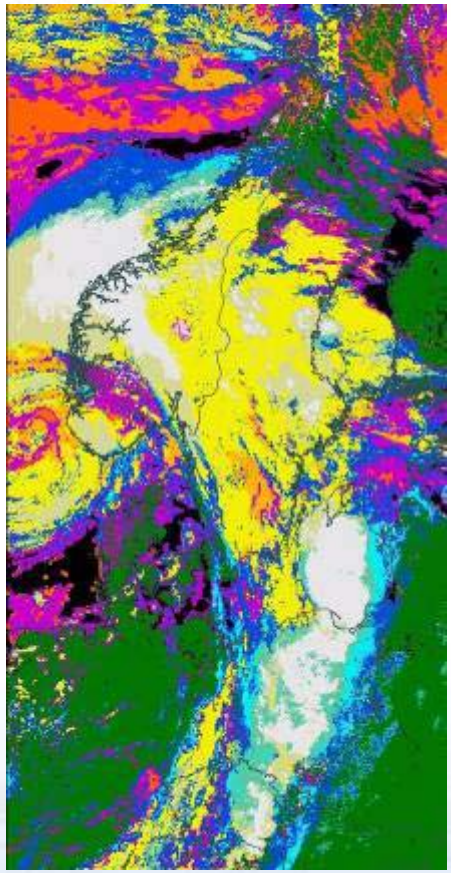
Nowcasting SAF Cloud Product



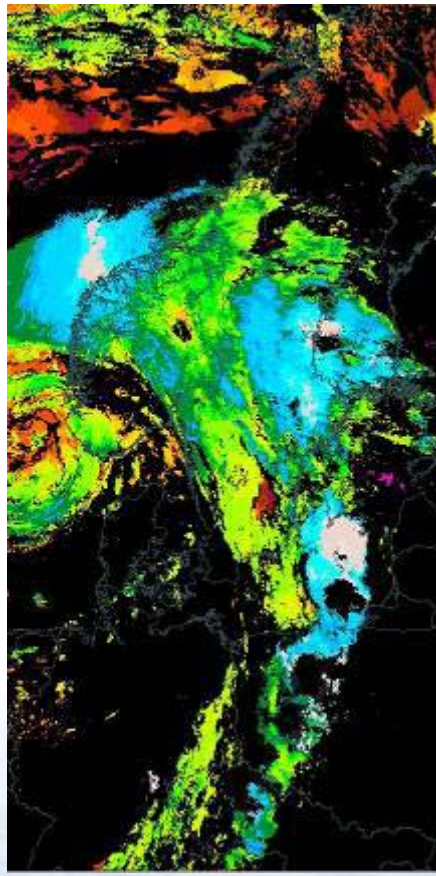
RGB Image



Cloud Mask



Cloud Type



Cloud Top Temp.

High-resolution cloud products from NOAA AVHRR data
27 May 2000, 17.22 UTC, from the Nowcasting SAF (SMHI)

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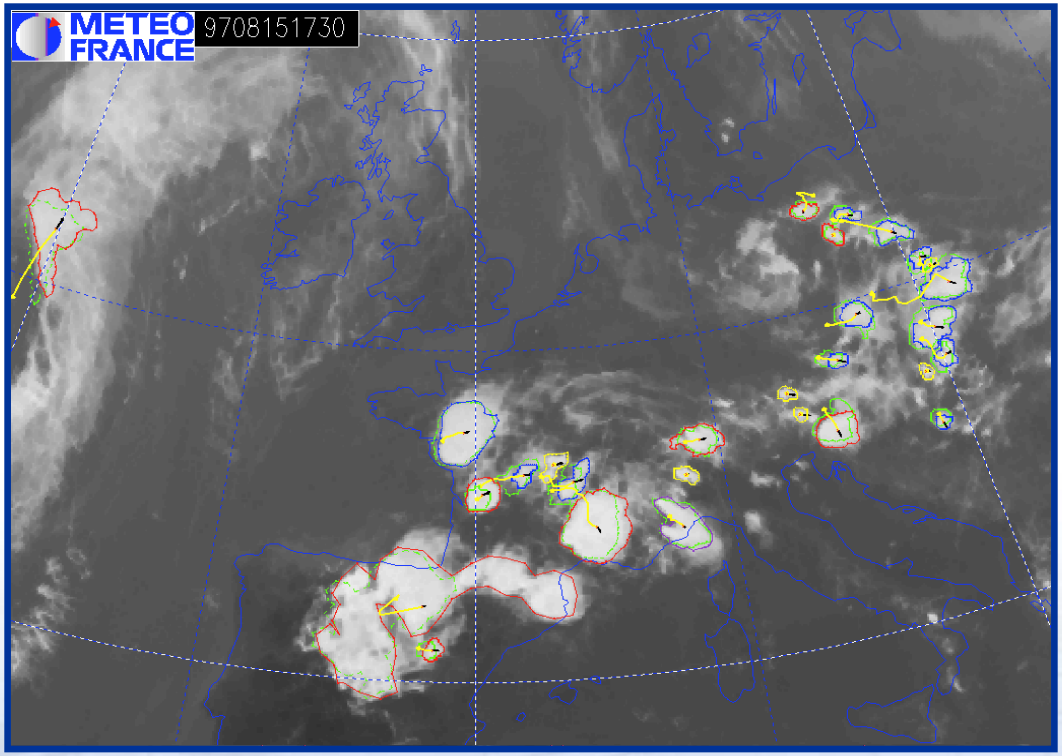
Nowcasting SAF Thunderstorm Product

Rapidly Developing Thunderstorms



The RDT product will provide information about significant convective systems from single storm to mesoscale

Output:
Numerical data describing the identified objects in BUFR Format

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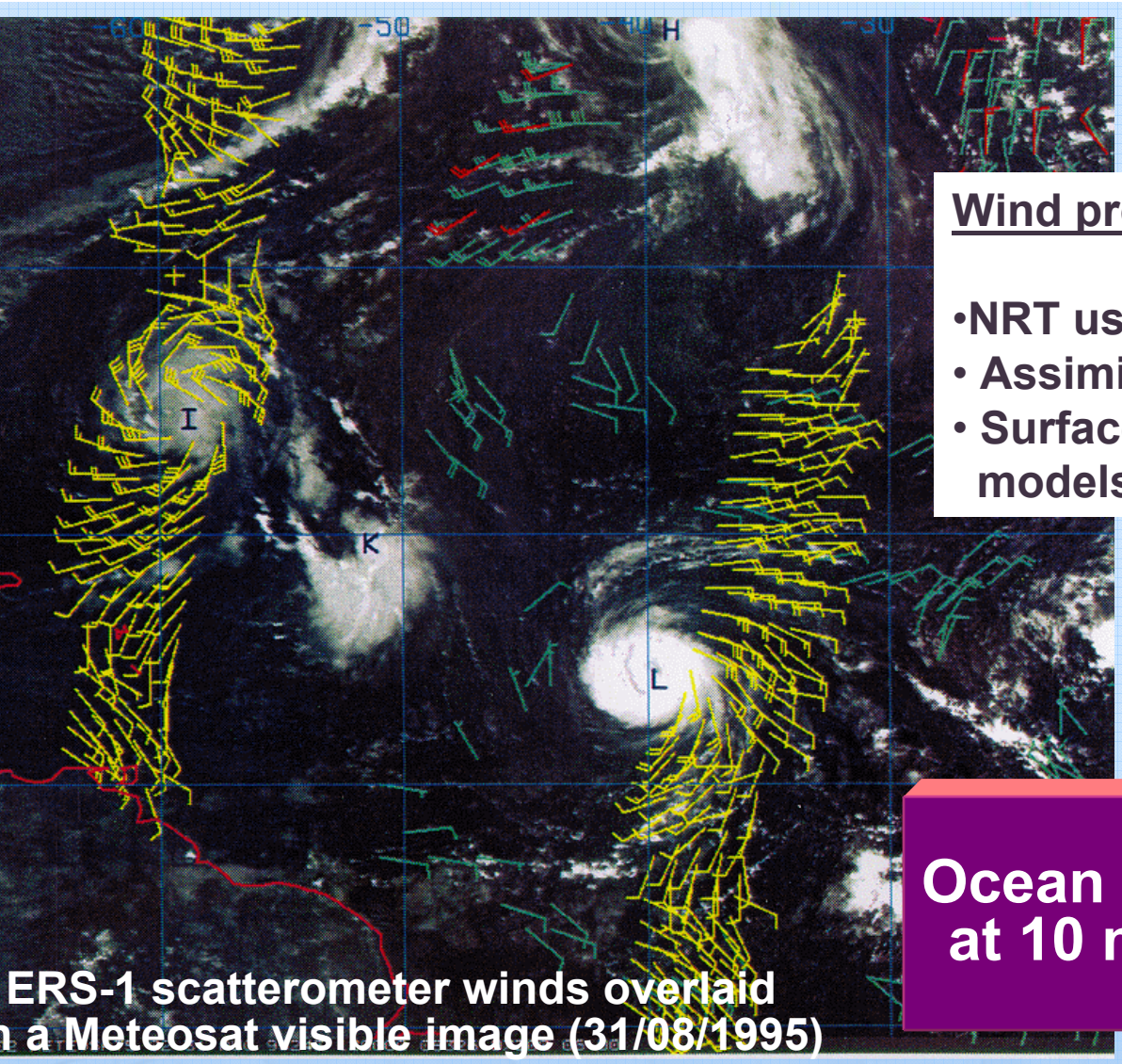
SAF on Ocean and Sea Ice

Products:

- Atlantic SST, coverage: Atlantic Ocean, 10km resolution
- Atlantic radiative fluxes, coverage: Atlantic Ocean, 10km resolution
- Regional SST, coverage: European seas, 2km resolution
- Surface wind vectors, global coverage (sea), 25 to 50km resolution
- Atlantic sea ice (type, coverage, edge), coverage: NE Atlantic, 10km resolution

SAF on Ocean and Sea Ice: Surface Wind Product



ERS-1 scatterometer winds overlaid
n a Meteosat visible image (31/08/1995)

Wind products are useful for:

- NRT use by forecasters
- Assimilation into NWP models
- Surface forcing of ocean models

Output:
Ocean surface wind vectors at 10 m height at 50/25 km resolution

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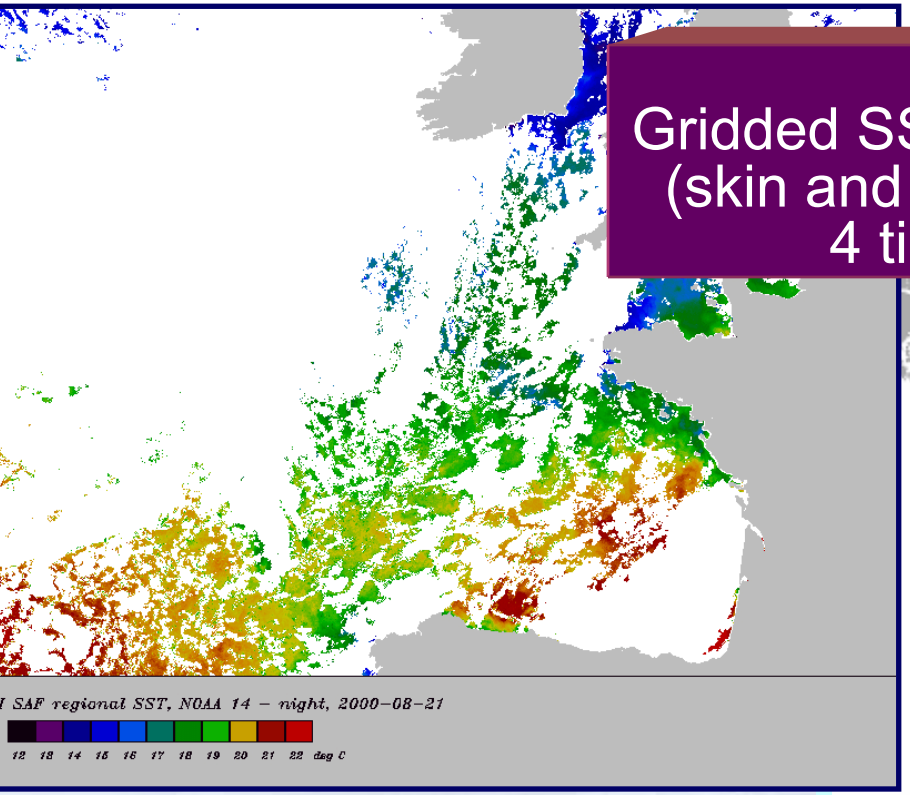
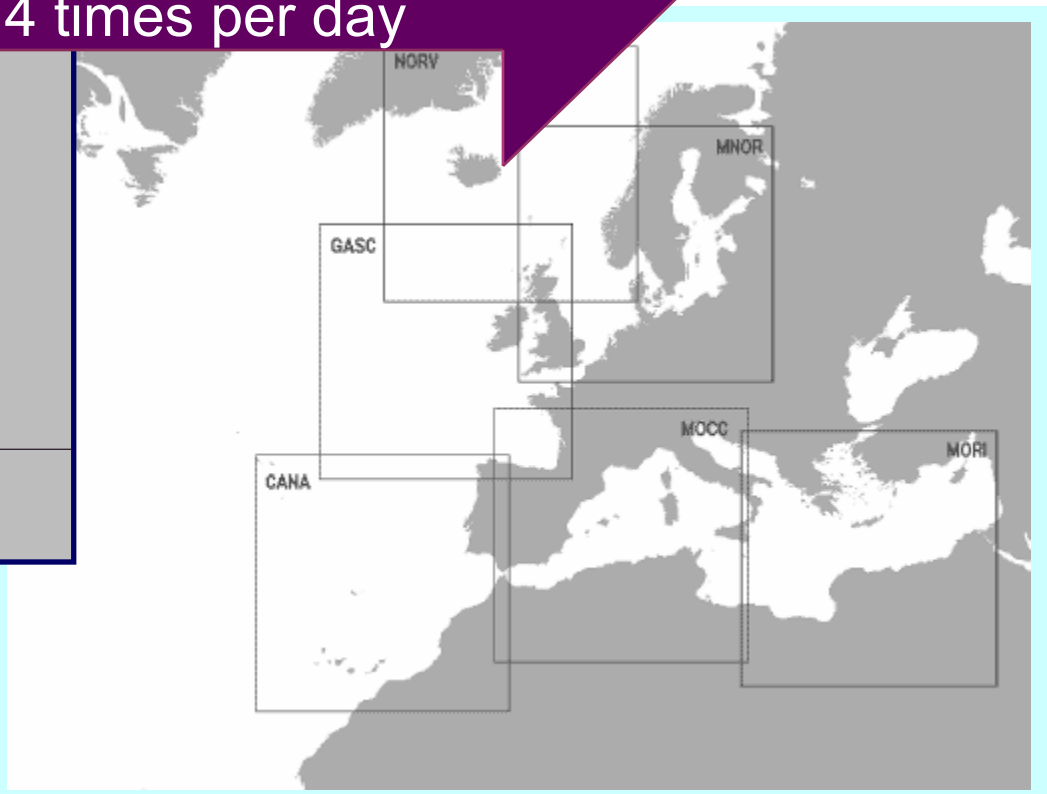
SAF on Ocean and Sea Ice: Regional SST Product



Output:
Gridded SST fields at 2 km res.
(skin and bulk temperature)
4 times per day



The Regional SST product
will be provided
for six different areas

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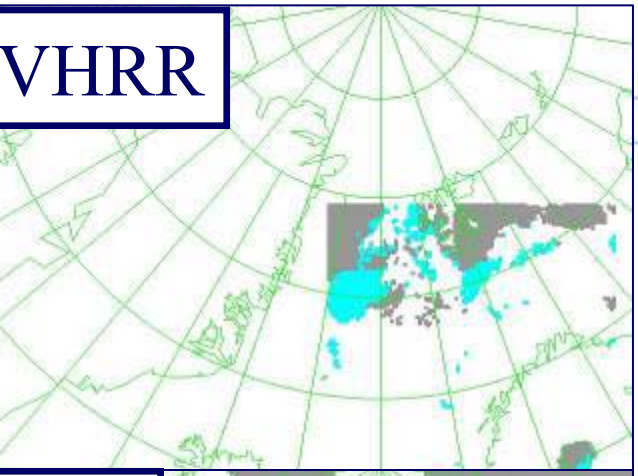
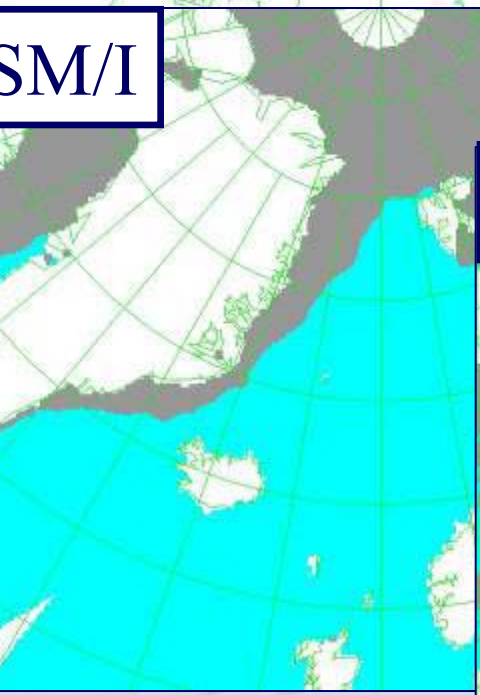
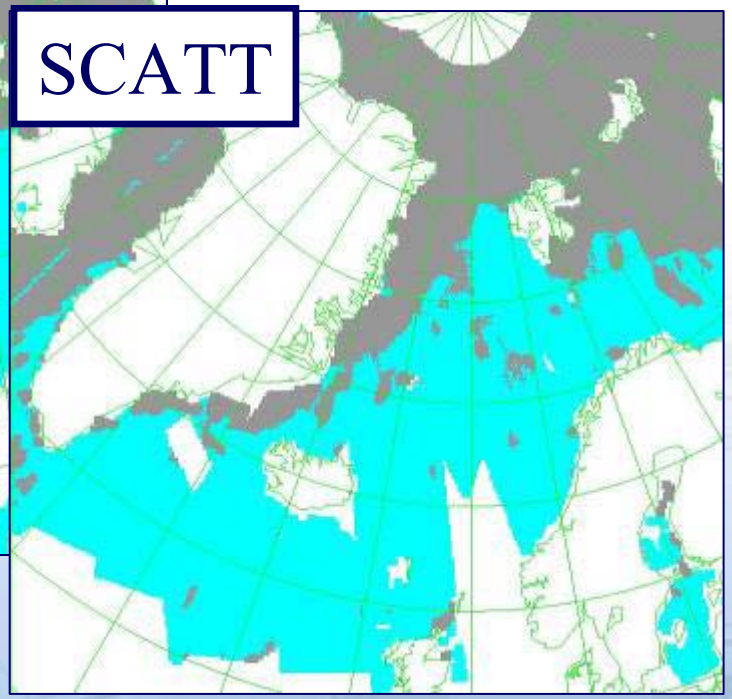
SAF on Ocean and Sea Ice: Sea Ice Product

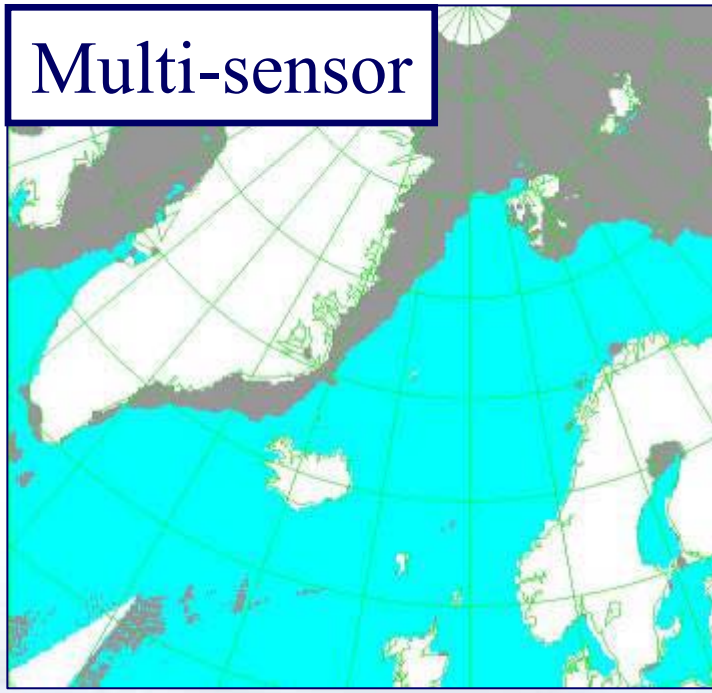
- Multi-sensor approach
- Cloud masking
- Ice probability calculations for each pixel
- Mapping on 10km grid

SAF on Ocean and Sea Ice: Sea Ice Produc









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SAF on Land Surface Analysis

Products (from MSG):

- Surface albedo, global coverage 5km resolution
- Surface shortwave and longwave fluxes, global coverage, 10km resolution
- Land surface temperature, global coverage, 5km resolution
- Soil moisture, regional coverage, 5km resolution
- Snow cover, regional coverage, 3km resolution
- Evapotranspiration rate, regional coverage, 5km resolution
- Vegetation parameters, regional coverage, 5km resolution

SAF on Land Surface Analysis: Vegetation Index

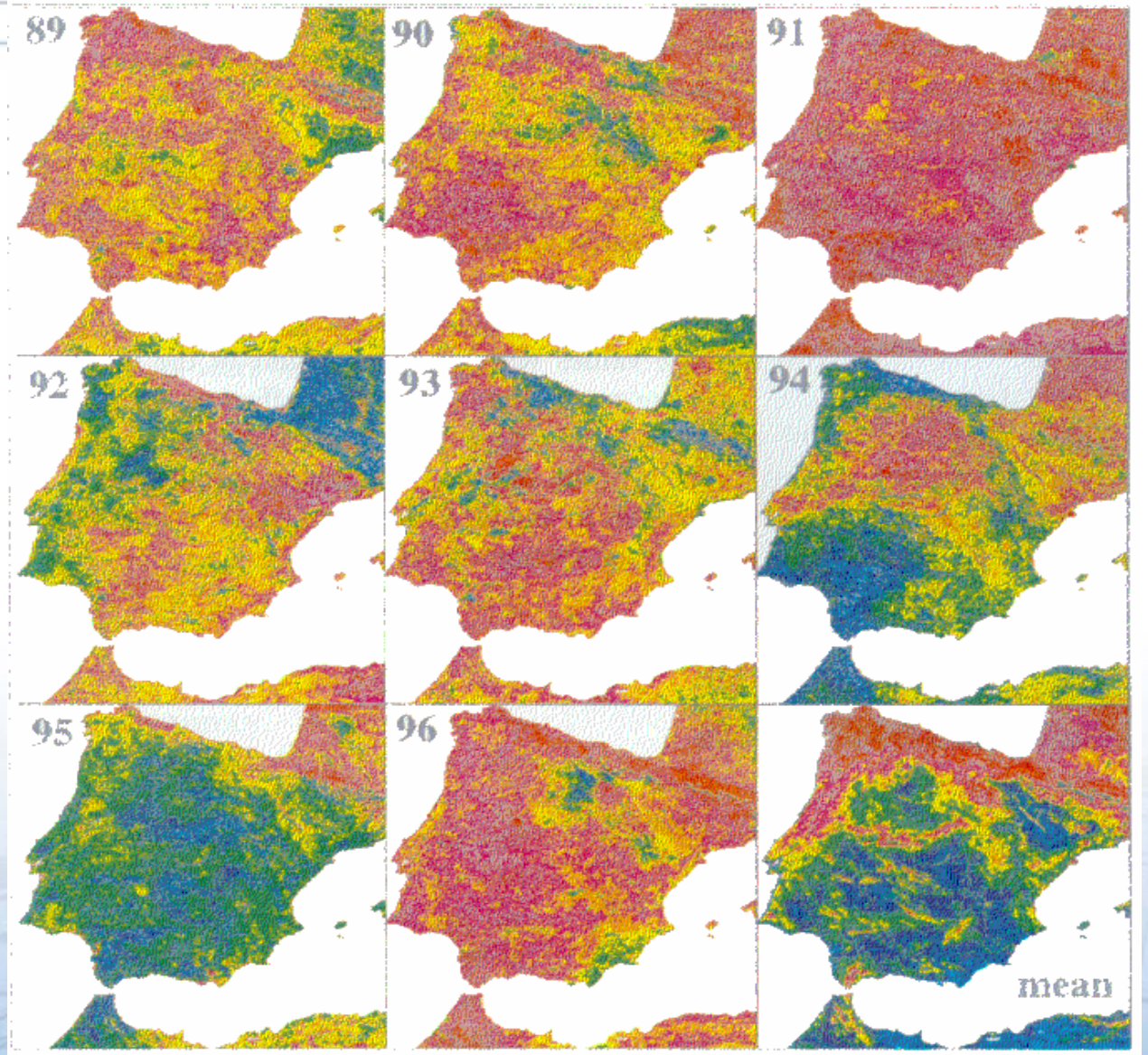

Fig. 10 Iberian Peninsula NDVI differences from mean June 1989 - June 1996

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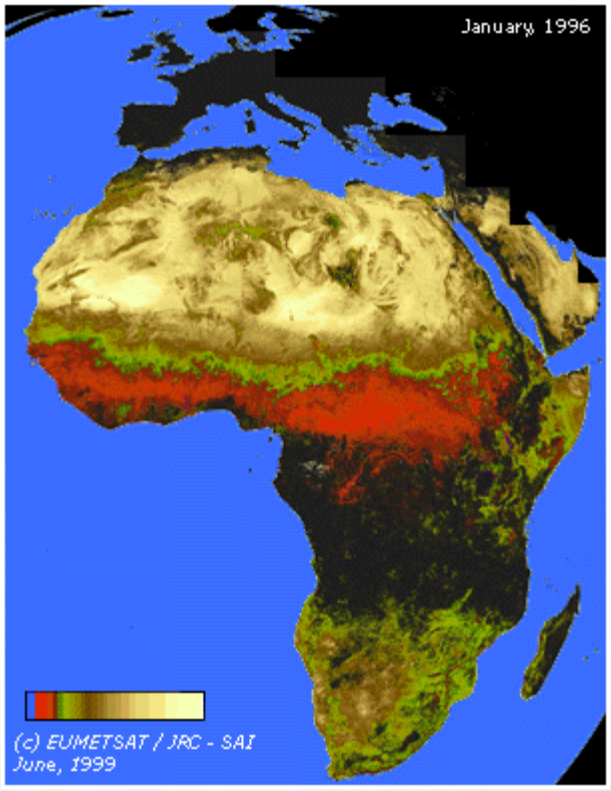
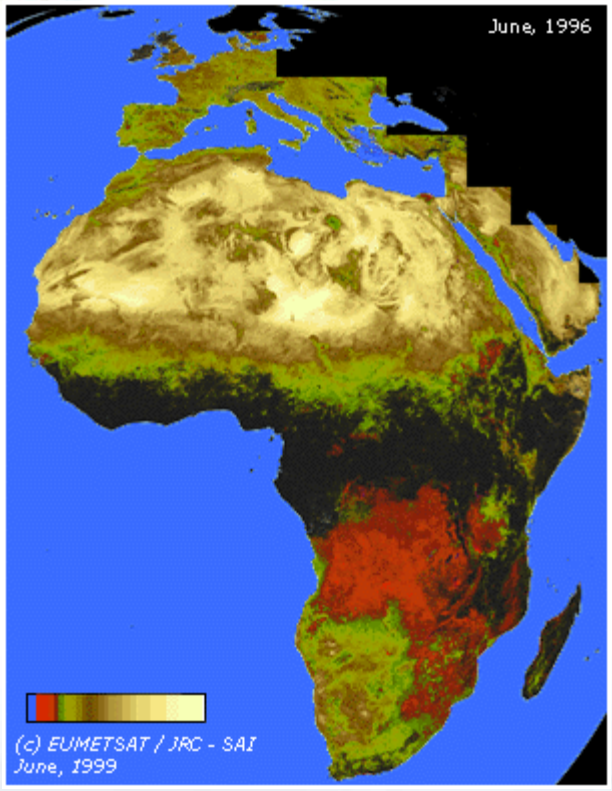
SAF on Land Surface Analysis: Surface Albedo





10-days composite albedo for period 1-10 Jan 1996 (left) and 31 May - 9 Jun. 1996 (right) computed from Meteosat-5 visible channel. The albedo scale runs from 0 (left) up to 0.6 (right). Black colour corresponds to unprocessed pixels.

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SAF on Land Surface Analysis: Snow Cover

Situation after heavy snowfall in Denmark and Northern Germany (AVHRR)

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Thanks

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