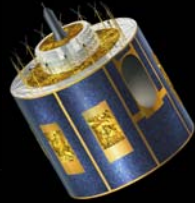




Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Satellite Meteorology



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Dr. Gabriela Seiz

Federal Office of Meteorology and Climatology MeteoSwiss

www.meteoswiss.ch | gabriela.seiz@meteoswiss.ch

ESA Summer School 2010, Frascati (I), 5 August 2010

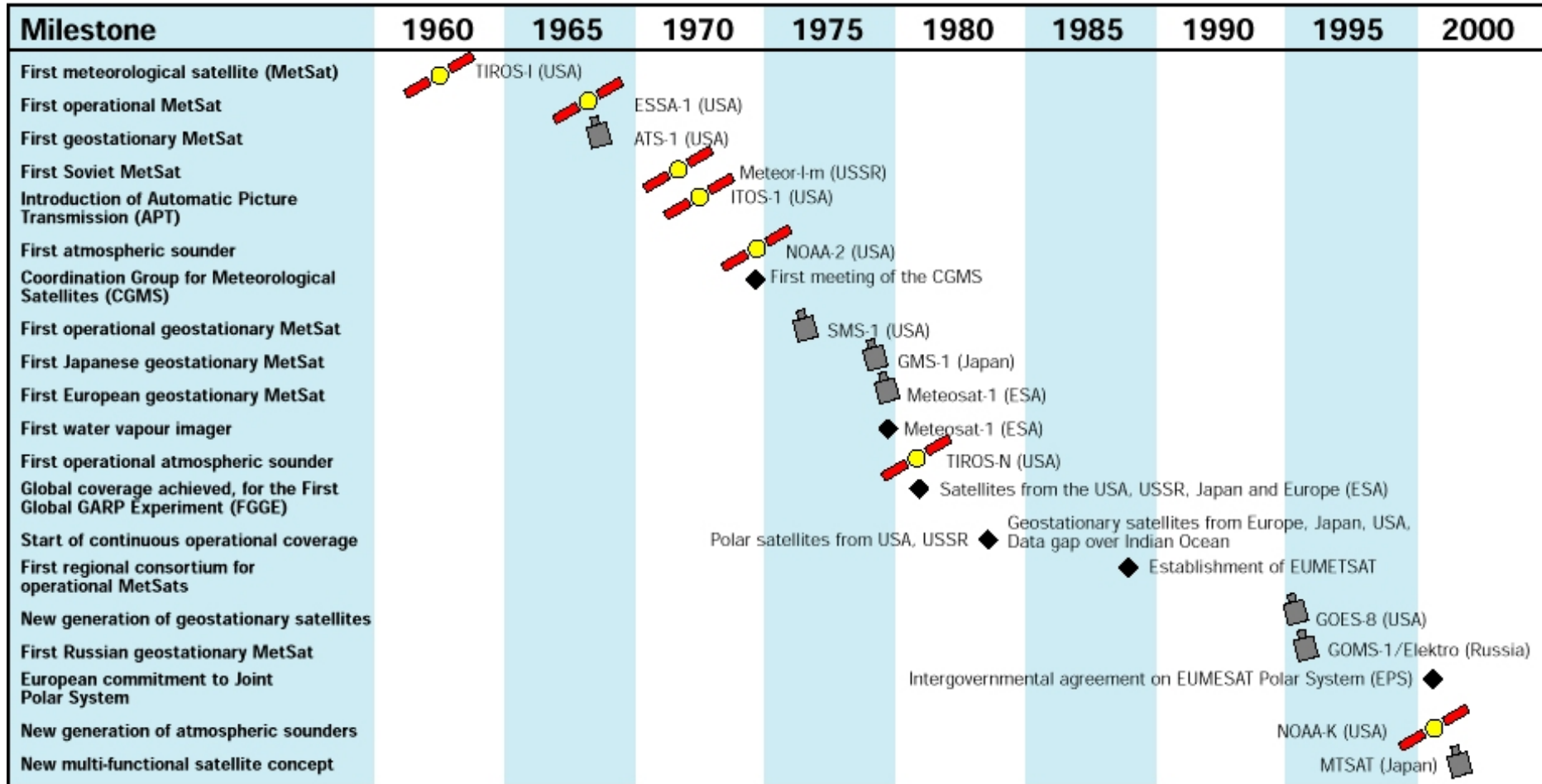


Outline

- History
- Geostationary meteorological satellites
- From MFG to MSG
- Polar-orbiting meteorological satellites
- Applications / Use at MeteoSwiss
- Outlook



History





History



Launch TIROS-I: 1 April 1960

New York Times. CITY EDITION
 U. S. Weather Bureau Report (Page 28) forecasts: Chance of rain today. Windy. Mild, chance of showers tomorrow. Temp. range: 56-45; yesterday: 63-45.5.

NEW YORK, SATURDAY, APRIL 2, 1960. 10 cents beyond 50-mile zone from New York City except on Long Island. Higher in Air Delivery Cities. M FIVE CENTS

U.S. ORBITS WEATHER SATELLITE; IT TELEVISES EARTH AND CLOUDS; NEW ERA IN METEOROLOGY SEEN

2 CAMERAS USED
270-Pound Vehicle to Transmit Pictures for 3 Months

By RICHARD WITKIN
 Special to The New York Times.
 CAPE CANAVERAL, Fla., April 1—The first artificial satellite able to provide detailed photographs of the earth's weather was fired into orbit here today by the United States. Two television cameras looking down from an altitude of about 450 miles made initial pictures of the earth's cloud patterns during the satellite's second orbital trip.

Four pictures, taken by the wider-viewing and therefore less-precise camera of the two, were promptly distributed this evening by the National Aeronautics and Space Administration. The space agency has over-all responsibility for the project.

The pictures showed the cloud cover that lay over the Northeast United States and the adjacent area of Canada this morning. They also showed an identifiable outline of the gulf of the St. Lawrence River. The curvature of the earth was clearly recognizable.

President Sees Photos Before Being Made Public, the pictures had been taken to the White House by Dr. T. Keith Glennan, the head of the agency.

SENT BY SATELLITE: One of TV pictures from Tiros I. CLOUDS: White mass is cloud cover on U. S. and Canada.

1,014 BILLS LEFT FOR ROCKEFELLER
 Albany Weighs Effects of Legislative Session on Prestige of Leaders

Summary of the 1960 session is printed on Page 10.

By WARREN WEAVER Jr.
 Special to The New York Times.
 ALBANY, April 1—The adjournment of the Legislature early today left conflicting and confused opinions as to who had

SENATE REJECTS A REFEREE CURB
 Quarreling Marks Debate as Kefauver Plan Fails—Courts to Set Hearings

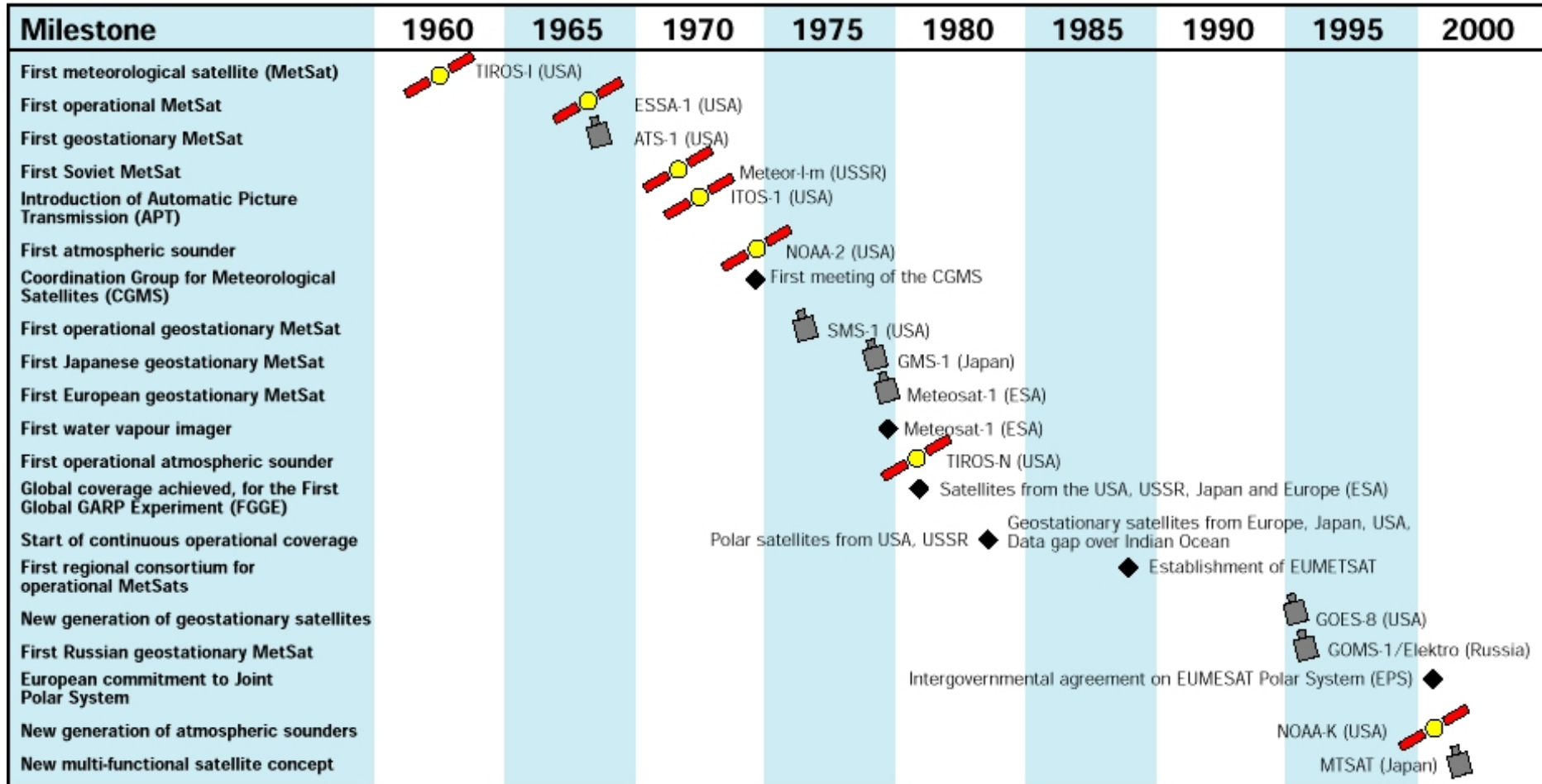
By RUSSELL BAKER
 Special to The New York Times.
 WASHINGTON, April 1—In an afternoon of angry personal quarreling, the Senate killed the Kefauver amendment to the civil-rights bill today. The vote was 69 to 22.

The amendment, sponsored by Senator Peter Kefauver

AREA: Same places as in TV photos, depicted on a globe



History





History

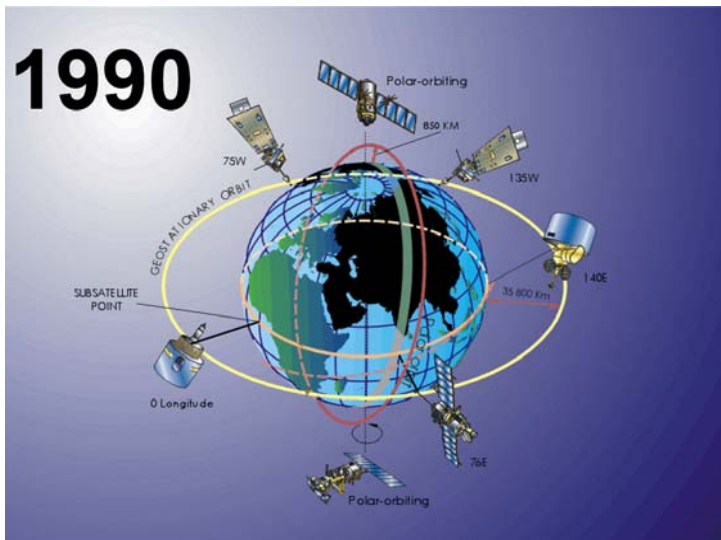
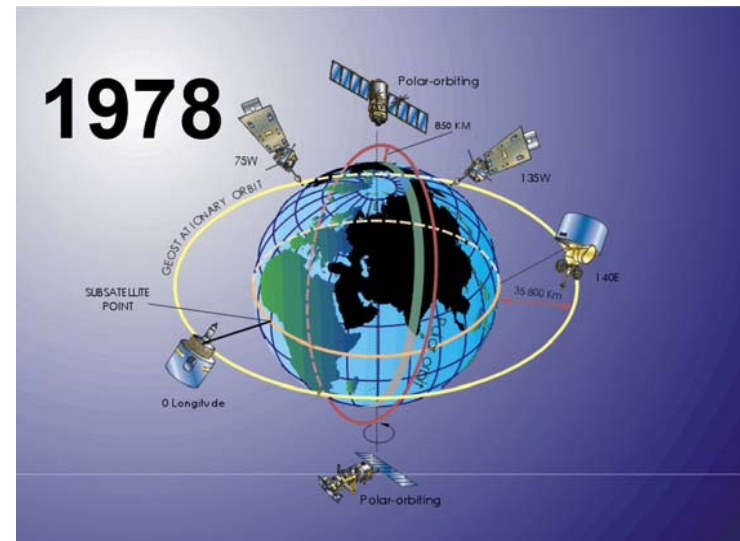
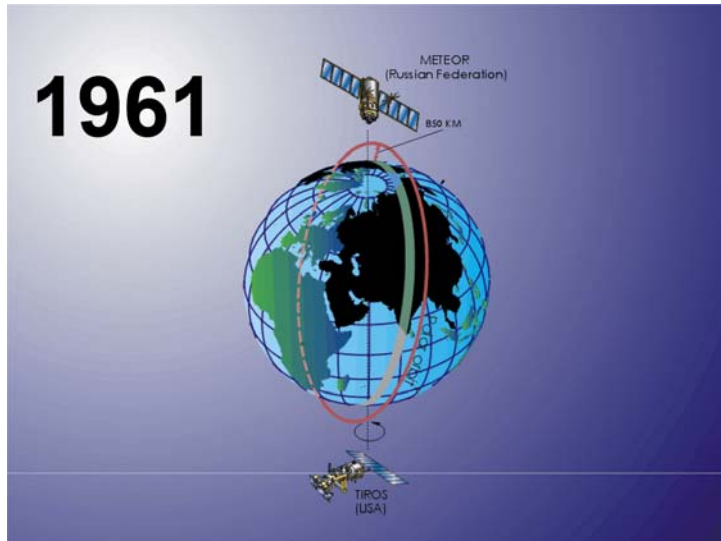


Launch **Meteosat-1**: 23 Nov 1977

→ European Organisation for the Exploitation of Meteorological Satellites (**EUMETSAT**): since 19 Jun 1986 (1 Jan 1987)

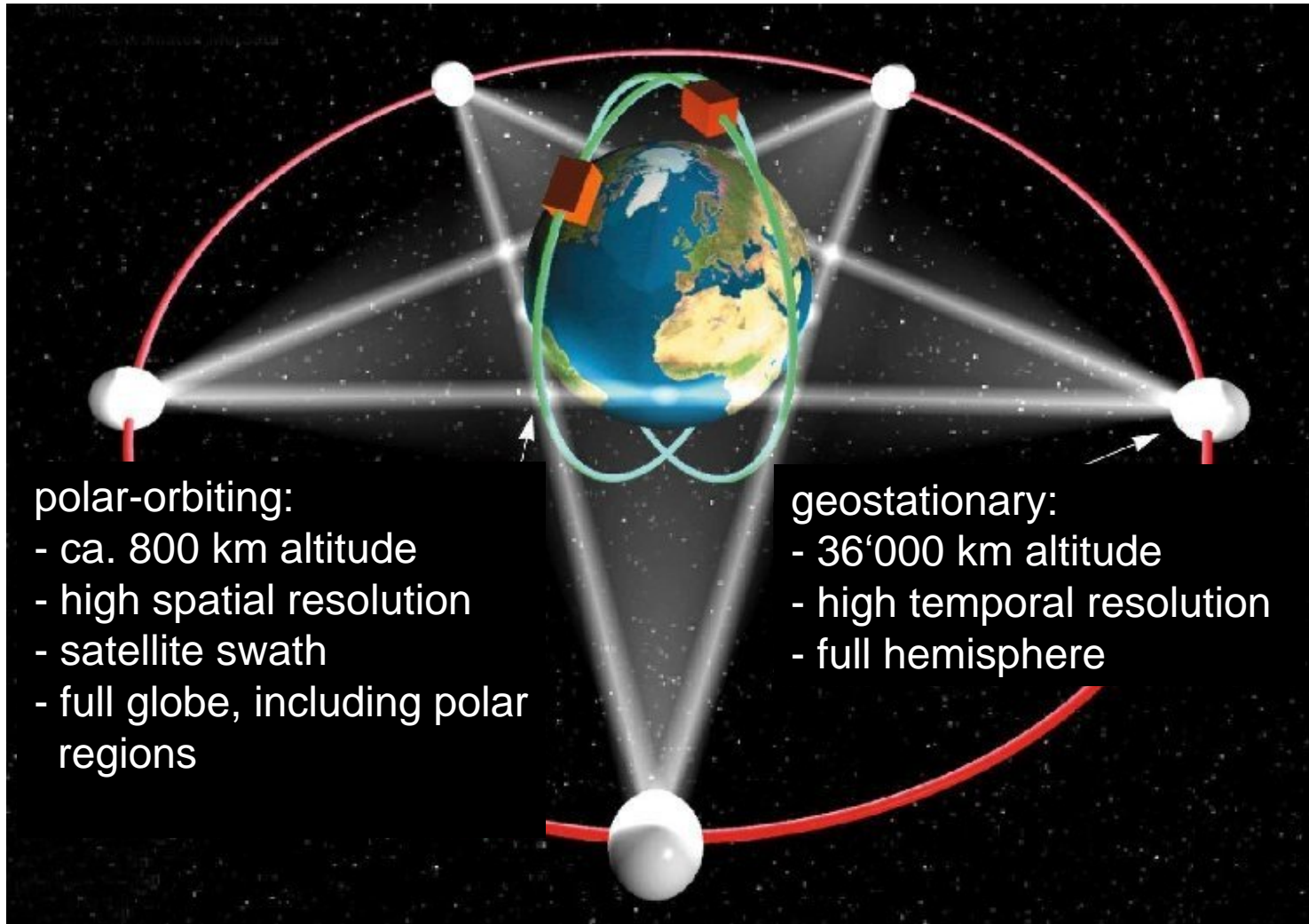


History



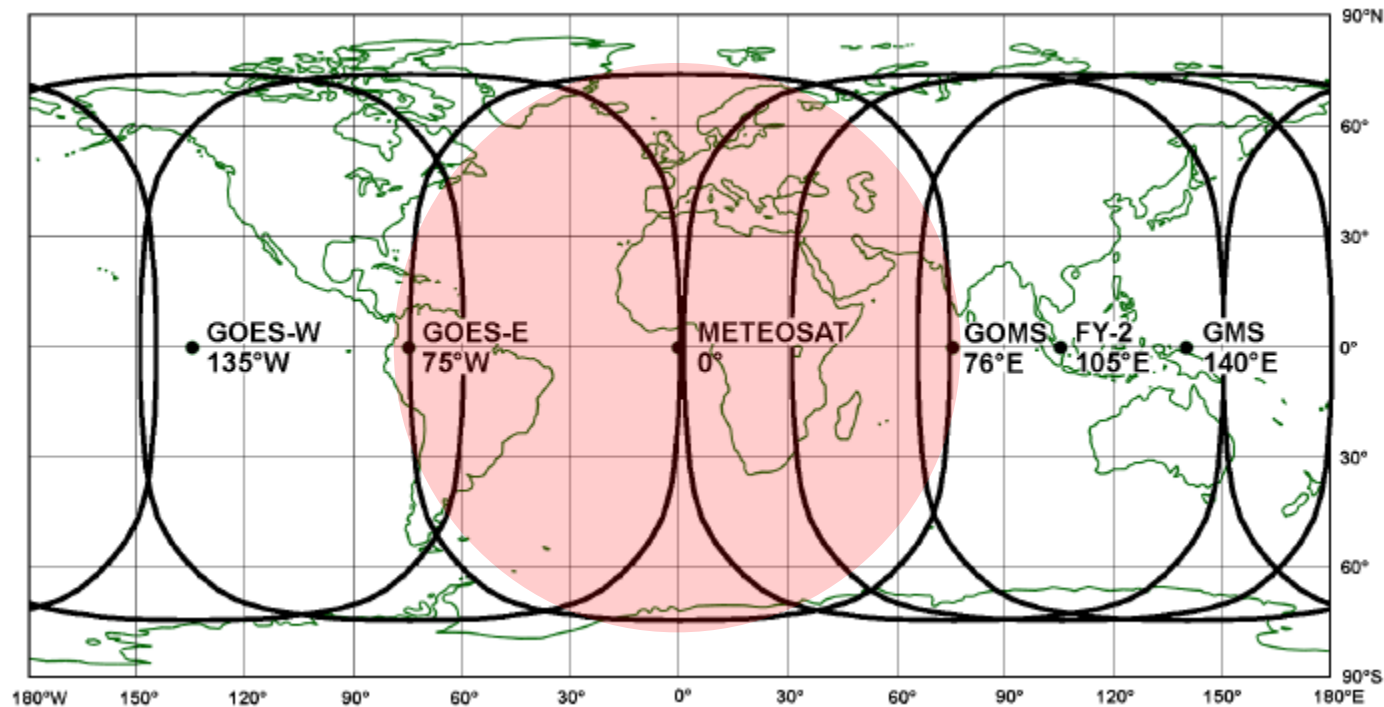


Types of meteorological satellites





Geostationary meteorological satellites

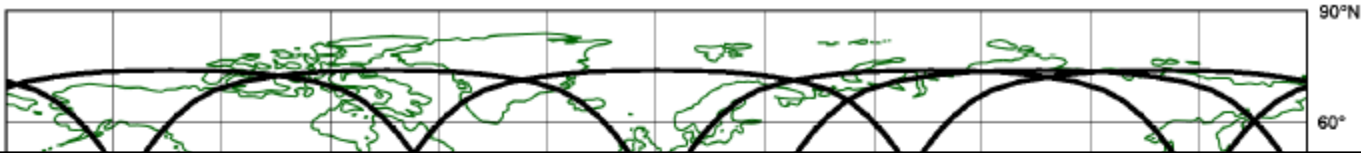


METEOSAT: <http://www.eumetsat.int/>

GOES: <http://rsd.gsfc.nasa.gov/goes/>



Geostationary meteorological satellites



Meteosat satellites

- Meteosat-1 to -4 → not in operation since 1979/ 1991/ 1995/ 1995
- Meteosat-5 → not in operation since 2007
- Meteosat-6 → 57.5°E, Indian Ocean Data Coverage (IODC) (Backup)
- Meteosat-7 → 57.5°E, IODC

- Meteosat-8 → 9.5°E, Operational Meteosat satellite (Backup),
Rapid Scan Service (RSS; 5min)
- Meteosat-9 → 0°, Operational Meteosat satellite

- Meteosat-10 (MSG-3), Meteosat-11 (MSG-4)

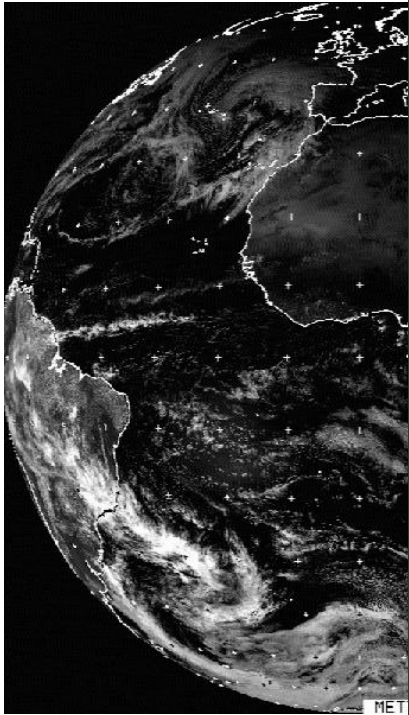


From Meteosat First Generation to Meteosat Second Generation

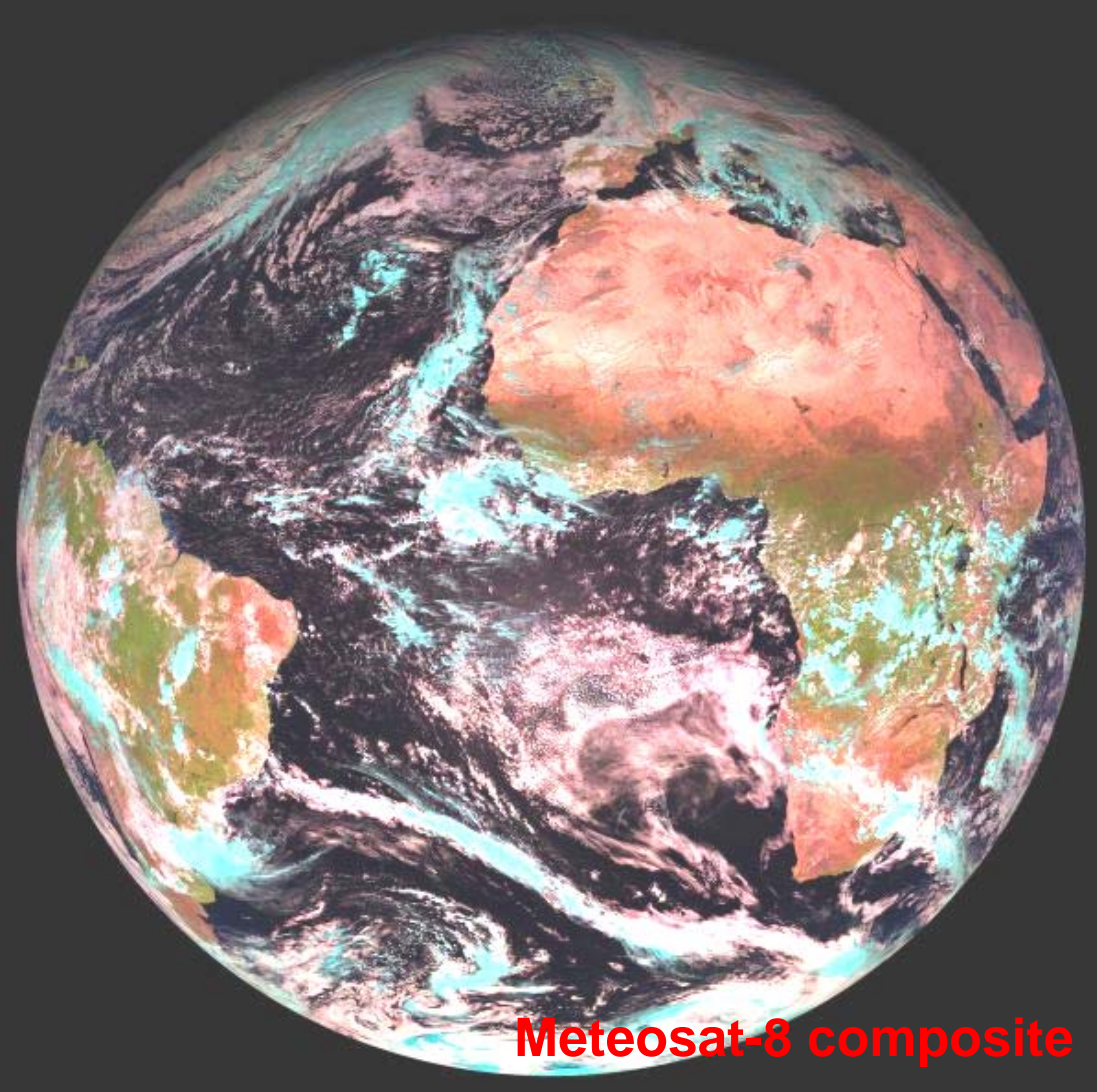
		MFG (until Meteosat-7)	MSG (Meteosat-8, etc.)
Canaux Channels	Visible	0.5 - 0.9	HRV VIS 0.6 VIS 0.8 IR 1.6
	Vapeur d'eau Water Vapour	WV 6.4	WV 6.2 WV 7.3
	Infrarouge IR window	IR 11.5	IR 3.8 IR 8.7 IR 10.8 IR 12.0
	Pseudo sondage Pseudo sounding		IR 9.7 IR 13.4
	Distance d'échantillonnage Sampling distance	2.25 km (Visible) 4.5 km (IR + WV)	1 KM (HRV) 3 KM (others)
	Frequency	30 min	15 min



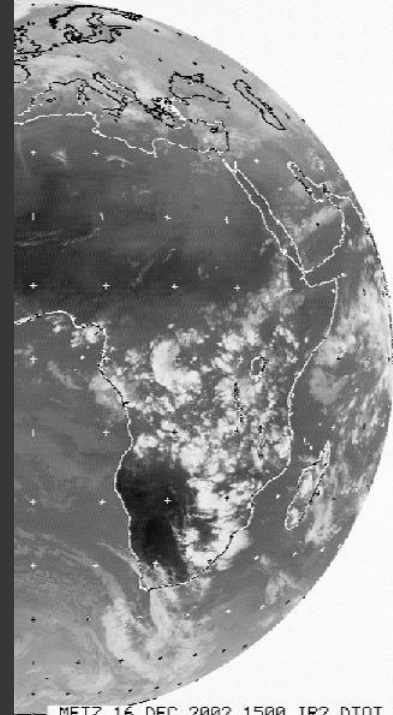
From MFG to MSG



VIS



Meteosat-8 composite



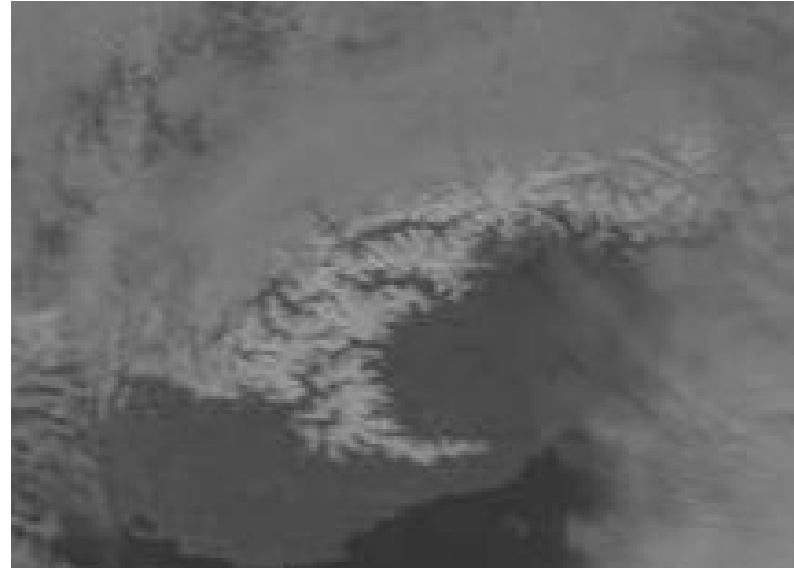
IR



From MFG to MSG



MFG IR Channel ~ 5 km



MFG VIS Channel ~ 2.5 km



MSG HRV channel ~ 1 km

MSG: IMPROVED SPATIAL SAMPLING
(Example: 4 December 2002, 12:30 UTC)



From MFG to MSG



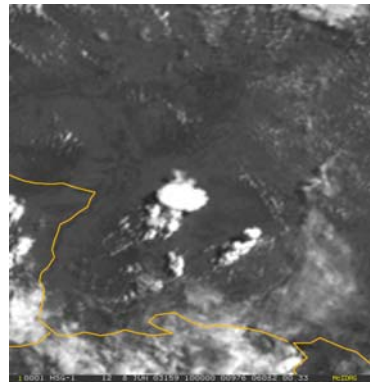
10:00
MFG VIS, 30 min sampling



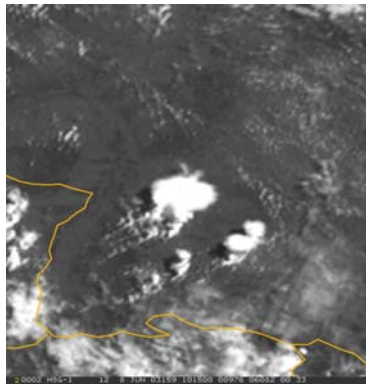
10:30



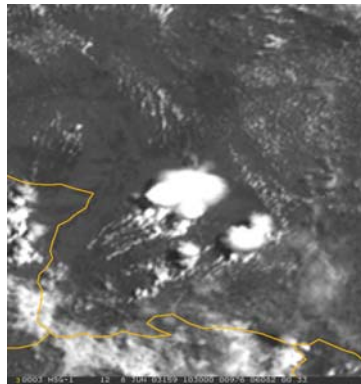
11:00



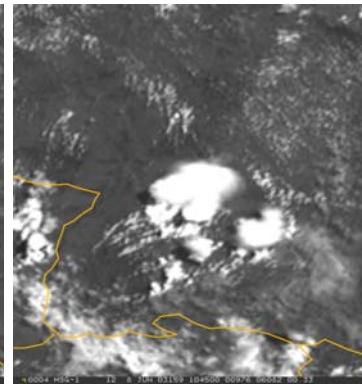
10:00
MSG HRVIS, 15 min sampling



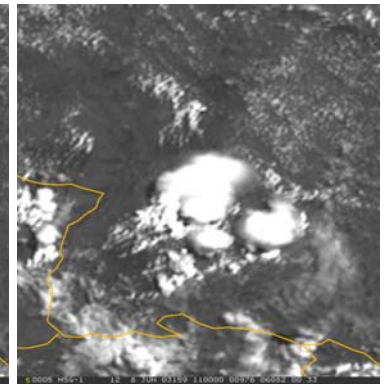
10:15



10:30



10:45



11:00

MSG: IMPROVED TIME SAMPLING
(Example: 8 June 2003)



Polar-orbiting meteorological satellites

- NOAA

<http://www.oso.noaa.gov/poes/>

- Envisat

<http://envisat.esa.int/>



Metop/EPS: Initial Joint Polar System (IJPS)

<http://www.eumetsat.int/Home/Main/Satellites/Metop>

**Metop-A
launched on
19 October 2006**

- EOS-Terra

http://www.nasa.gov/mission_pages/terra/index.html

- EOS-Aqua

http://www.nasa.gov/mission_pages/aqua/index.html



Polar-orbiting meteorological satellites

- NOAA

<http://www.oso.noaa.gov/poes/>

- Envisat

<http://envisat.esa.int/>



Metop/EPS: Initial Joint Polar System (IJPS)

<http://www.eumetsat.int/Home/Main/Satellites/Metop>

**Metop-A
launched on
19 October 2006**

ESA Earth Explorer satellites

- **SMOS** (Soil Moisture and Ocean Salinity)
launched on **2 Nov 2009**

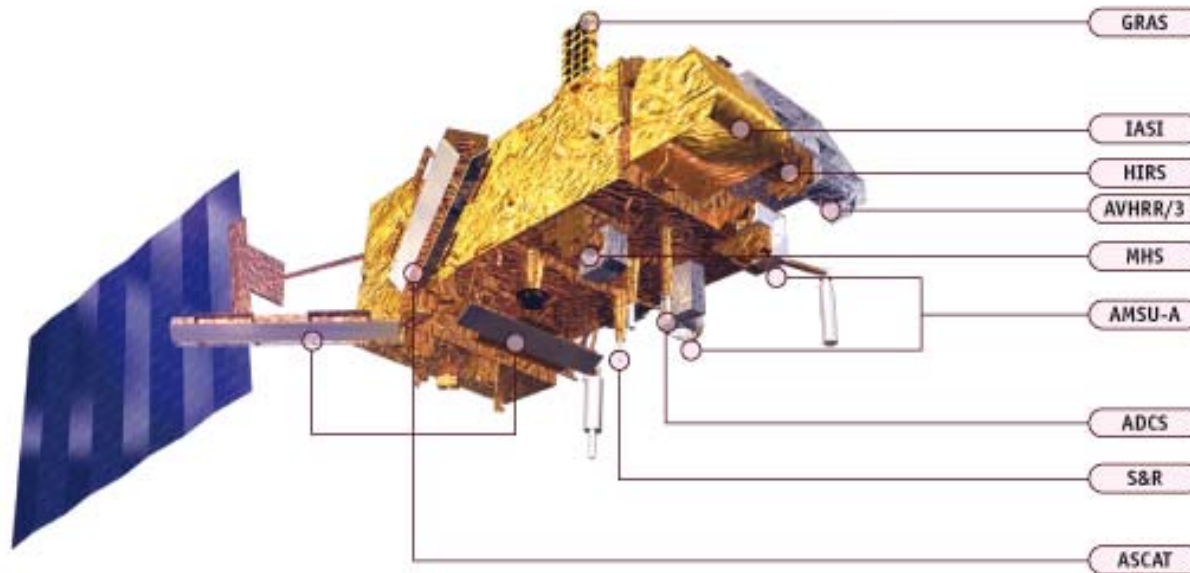


Courtesy: ESA – AOES Medialab



Instruments

- NOAA: AVHRR, AMSU
- Envisat (ERS-2): MERIS, AATSR (ATSR2), GOMOS (GOME), SCIAMACHY
- ➔ Metop: AVHRR, IASI, GOME-2, AMSU





Applications

- **EUMETSAT Central Application Facilities (CAF)**
 - Operational EUMETSAT products, available via EUMETCast



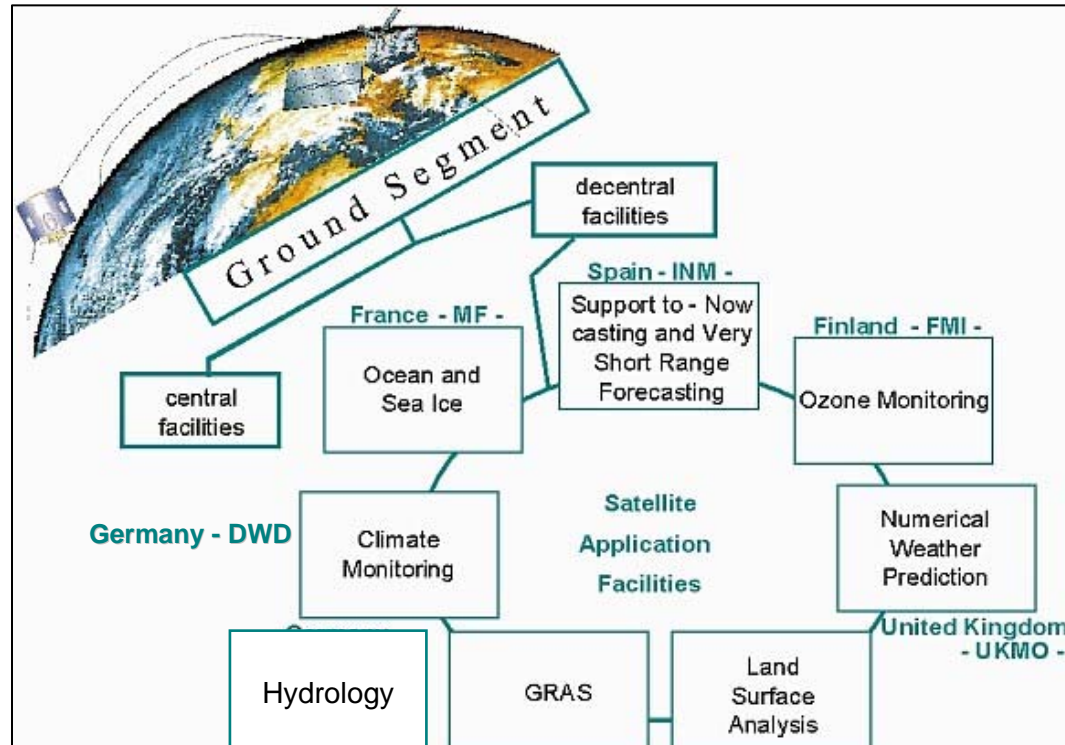
GEONETCast

- EUMETCast → Europe, Africa (EUMETSAT)
- NOAACast → North and South America (NOAA)
- FengYunCast → Asia/Pacific Region (Chinese Meteorological Agency CMA)



Applications

- **EUMETSAT Central Application Facilities (CAF)**
 - Operational EUMETSAT products, available via EUMETCast
- **EUMETSAT Satellite Application Facilities (SAF)**
 - Extension of the operational EUMETSAT products
 - 8 thematical SAFs
 - Decentralized
 - Initial Developments and Operations: 1996-2006
CDOP: 2007-2012
CDOP-2: 2012-2017
 - MeteoSwiss:
 - Climate Monitoring SAF (DWD, Germany)

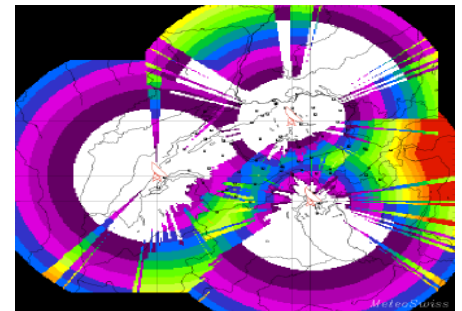


<http://www.eumetsat.int/Home/Main/Satellites/GroundNetwork/ApplicationGroundSegment/SAFs/index.htm?l=en>



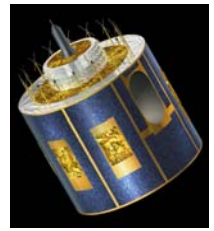
Applications at MeteoSwiss

- Meteorological stations (130)
- Radiosonde station (1)
- Precipitation radars (3)
- Windprofilers (3),
Microwave Radiometers (T, RH) (3)





Applications at MeteoSwiss



- Nowcasting and Short-Term Forecasting (eg. air masses, clouds, storms)
- Aviation Weather (eg. fog, volcanic ash)
- Numerical Weather Prediction NWP
 - Global NWP model (ECMWF)
 - Regional NWP model (COSMO)
- Atmosphere Monitoring (eg. water vapour, ozone)
 - GRUAN station Payerne
- Land Surface Analysis (eg. snow)
- Climate Monitoring (eg. radiation, clouds, snow)



Application: Snow

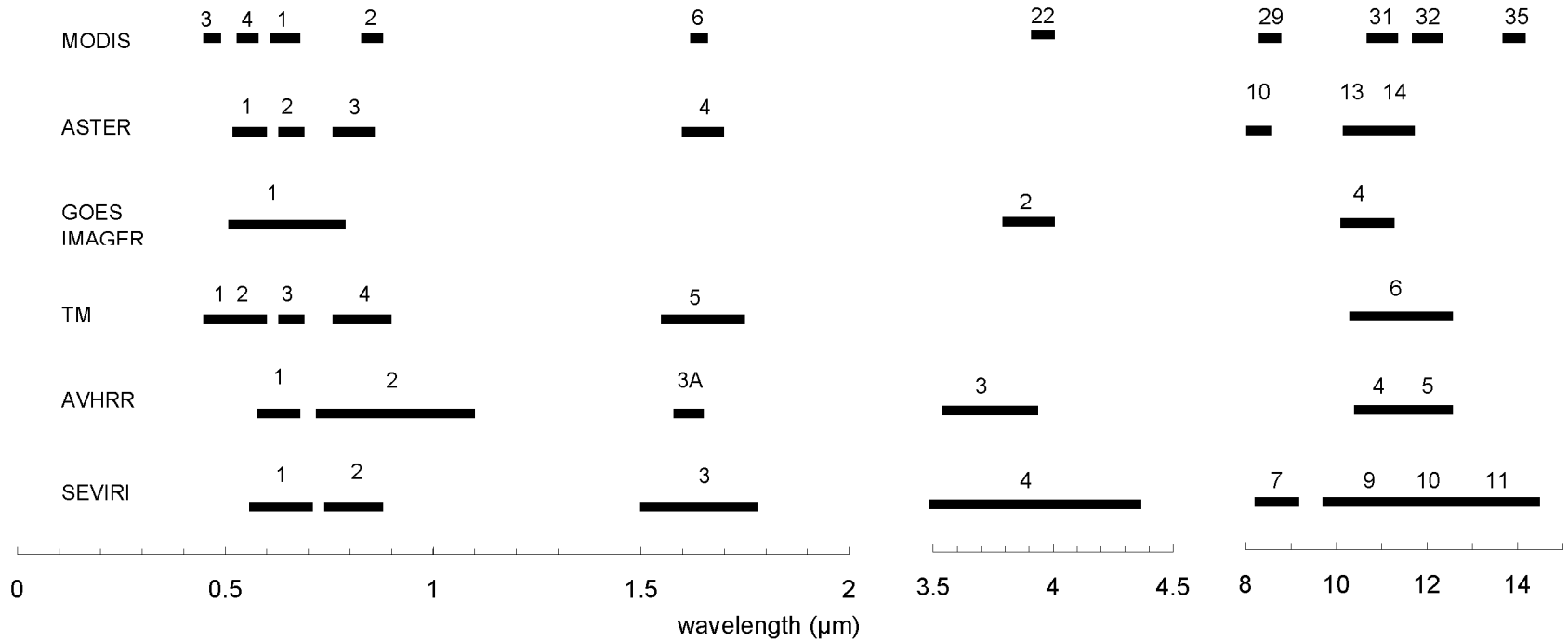
- **Eumetsat Fellowship Project, 2004-2007**
ETHZ - Institute of Geodesy and Photogrammetry
MeteoSwiss
- **Objective:** improved snow analysis as input for the operational MeteoSwiss NWP model COSMO
(= Consortium for Small-scale Modeling: D, CH, I, GR, Poland, Romania, Russia)
 - Take advantage of the additional spectral channels (vs. Meteosat-7) and of the high temporal resolution (vs. NOAA AVHRR) of MSG
 - Assimilation of the snow data in the operational COSMO version: a) 7 km, b) 2.2 km
- Operational processing chain: since Oct 2005
Operational use in NWP model COSMO: since Nov 2006

Ruyter, Seiz and Gruen (RSE, 2007)



Application: Snow

Meteosat-8 (SEVIRI) vs. other instruments

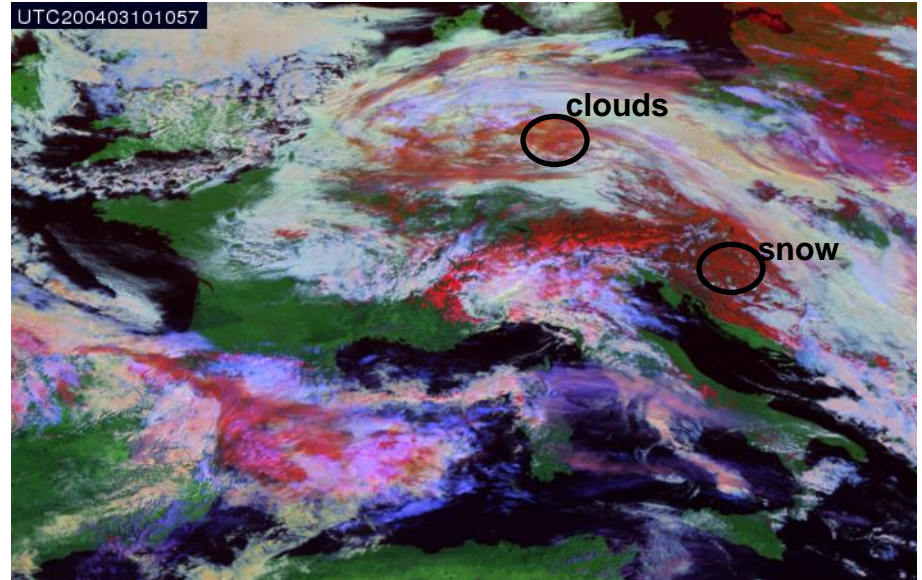
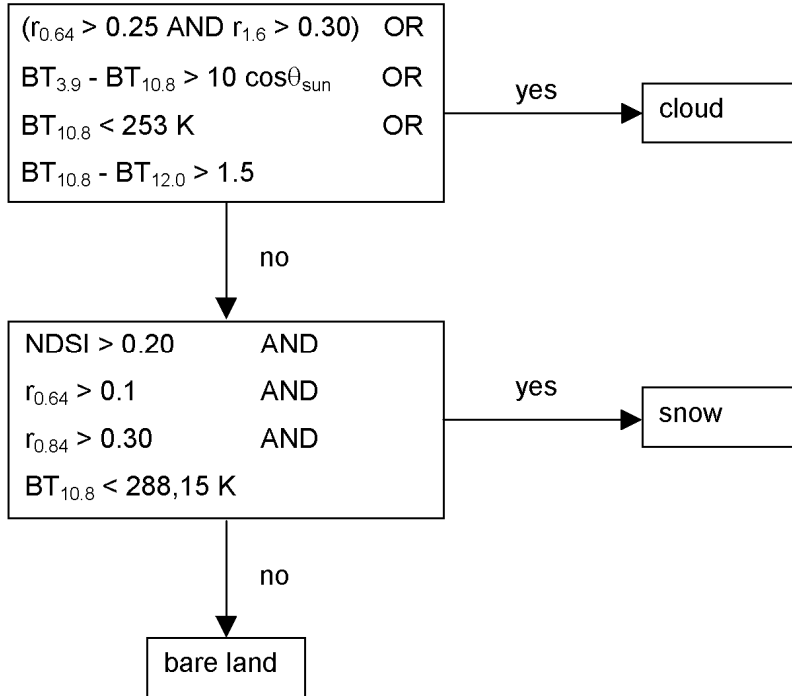


(Ruyter et al., 2007)

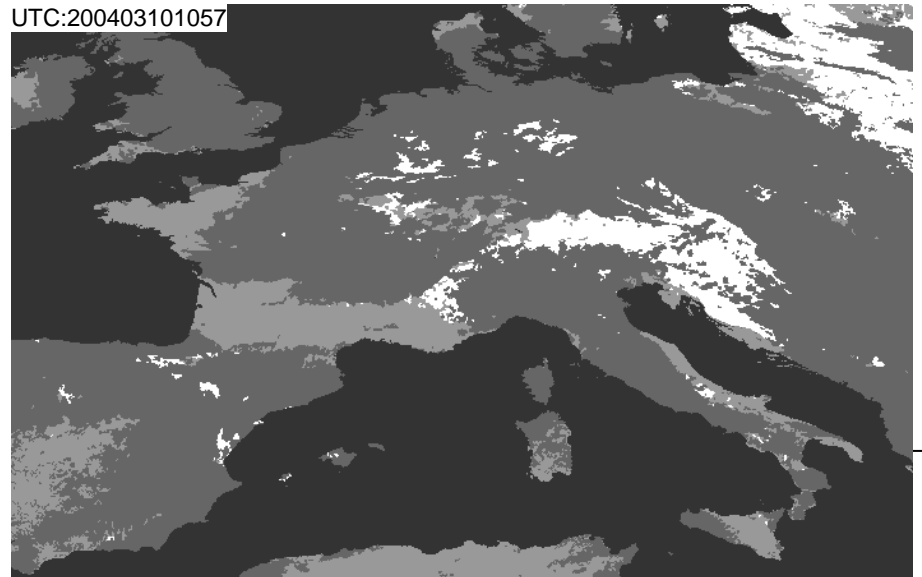


Application: Snow

Spectral classification



classification result:

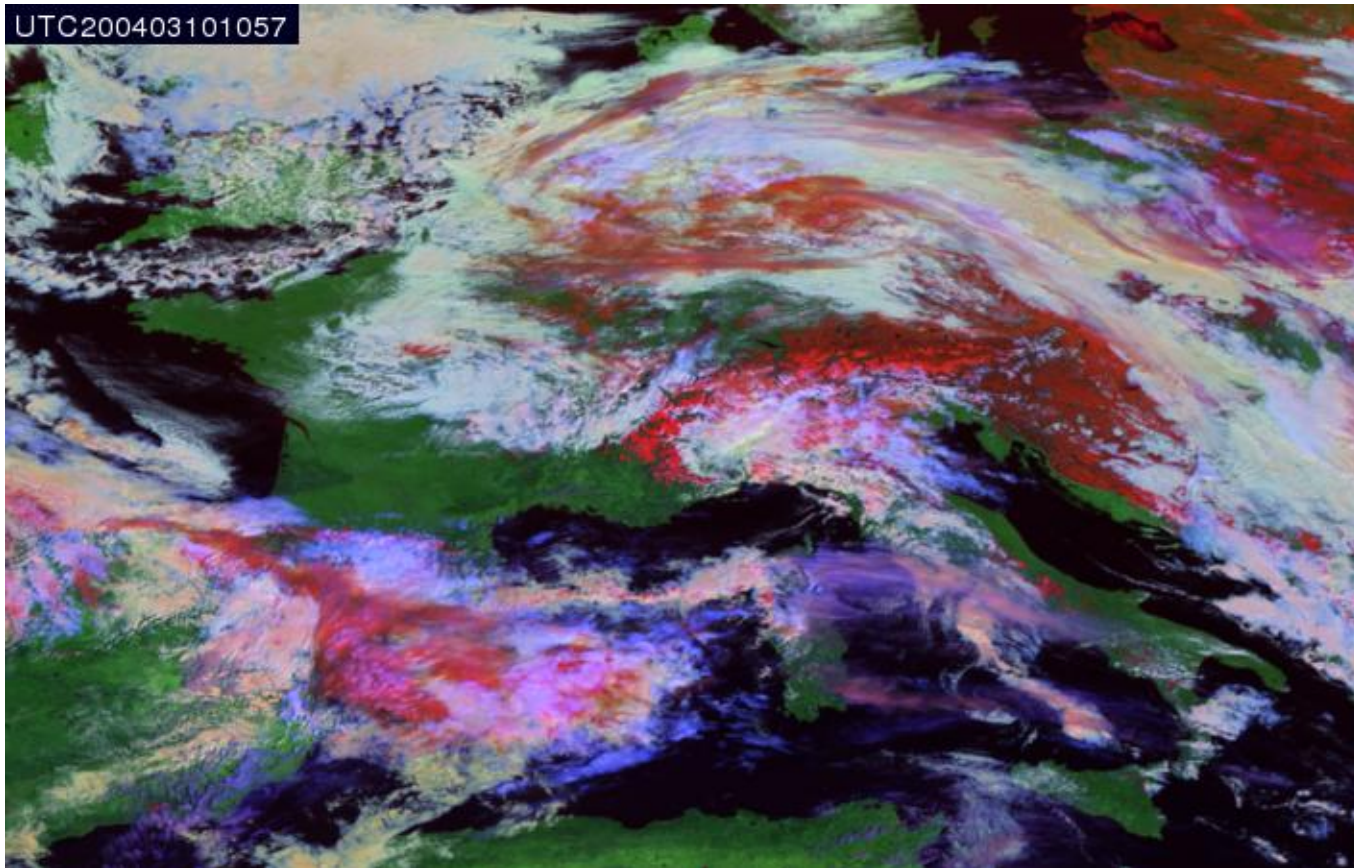


white : snow
 dark gray : clouds
 light gray : snow-free land
 black : sea



Application: Snow

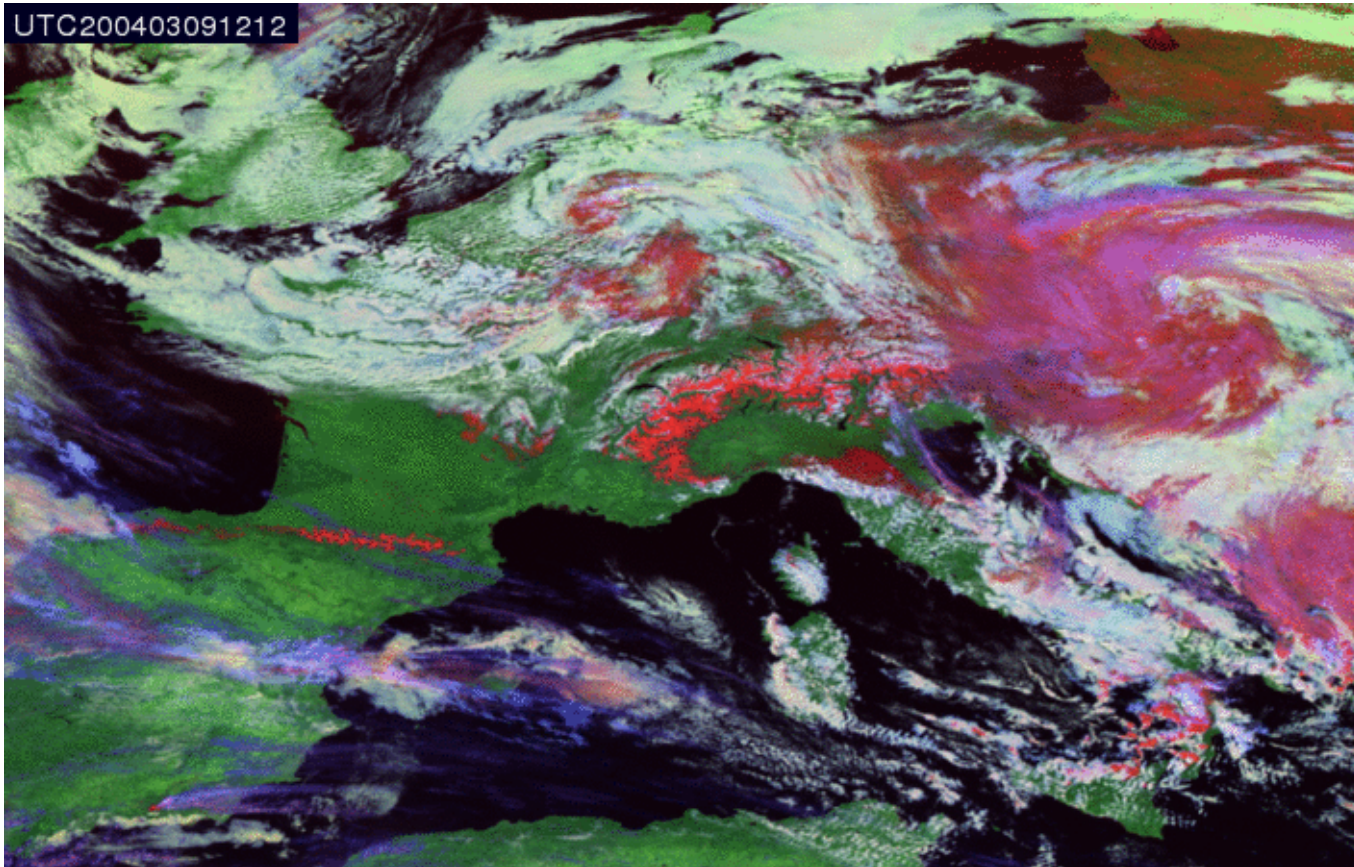
Temporal classification?





Application: Snow

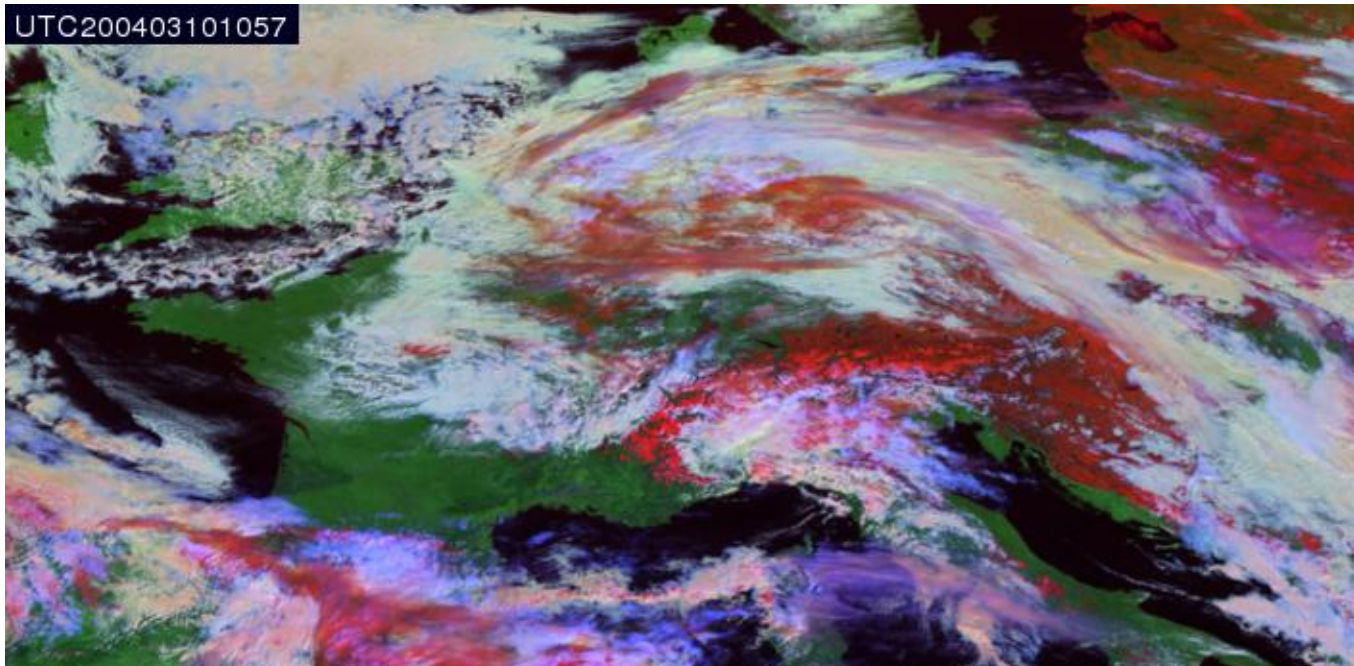
Temporal classification?





Application: Snow

Temporal classification?



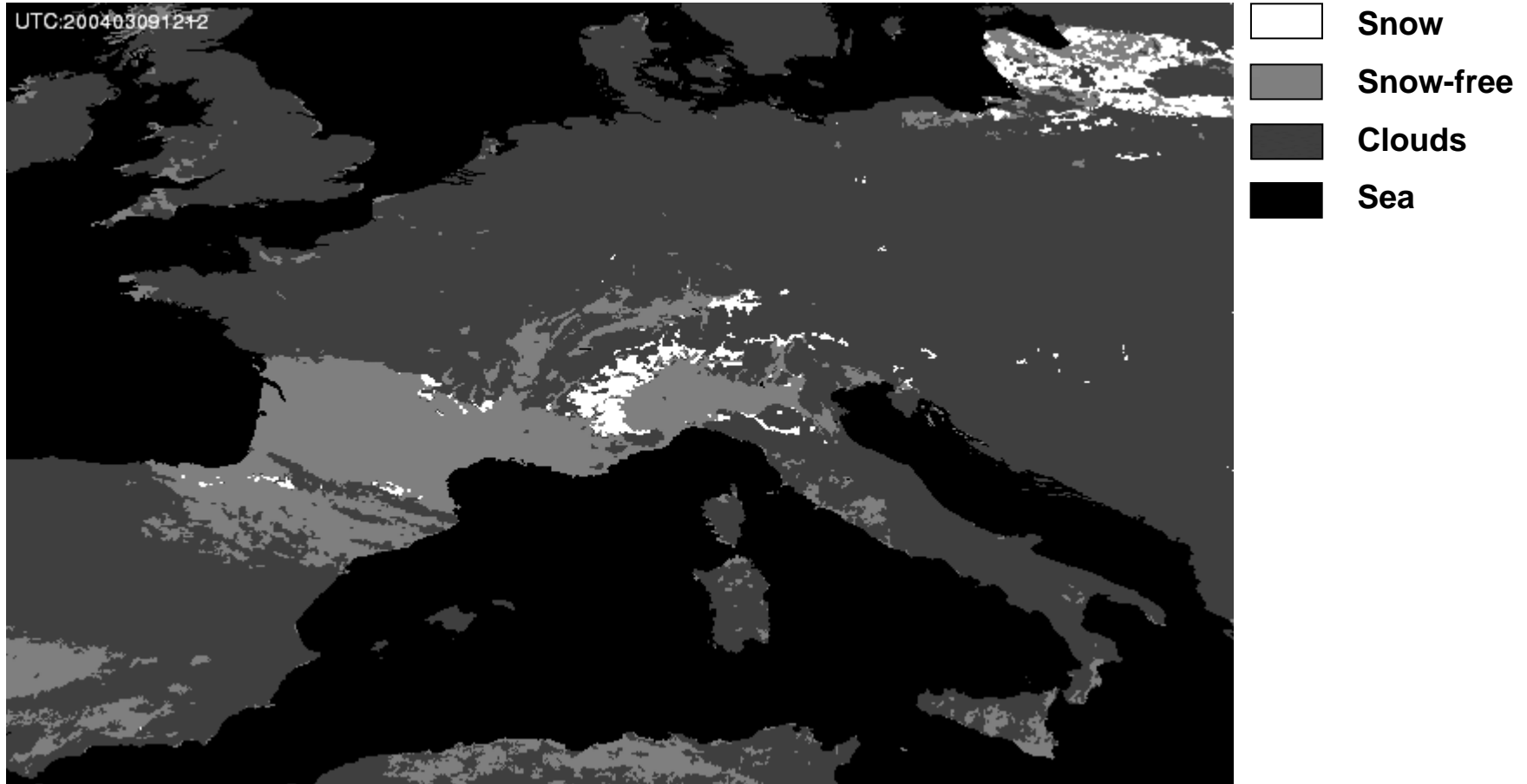
→ **Use of high temporal resolution**

- a) Temporal classification (image \pm 2 images; 8 surrounding pixels)
- b) Reduction of cloud coverage by composite maps



Application: Snow

Cloud coverage → Composite snow maps



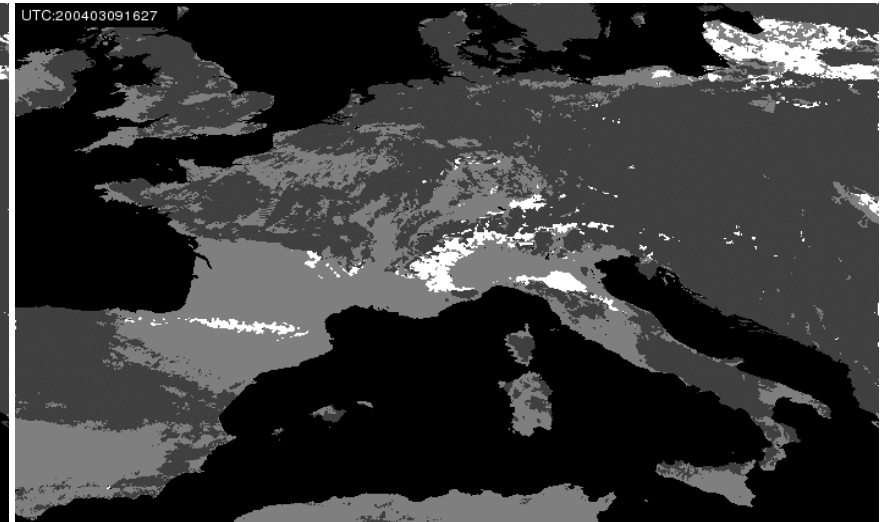
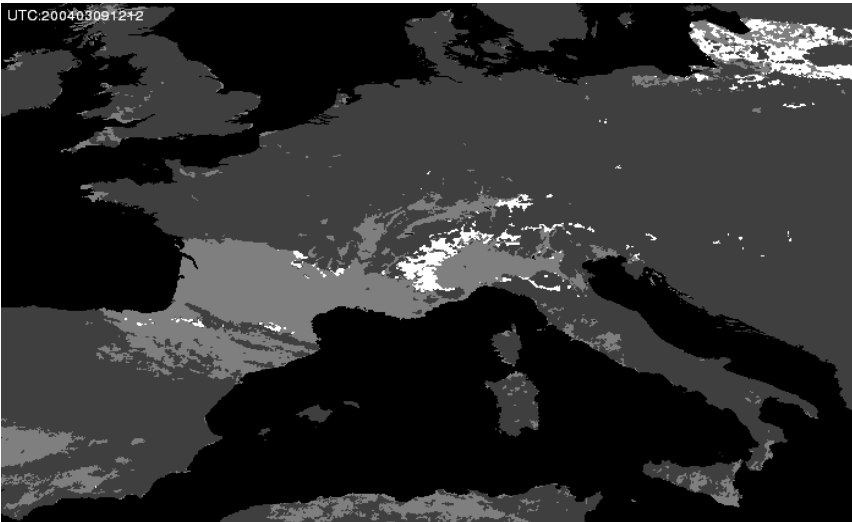


Application: Snow

Cloud coverage → Composite snow maps

1 Dataset: 12:15

Data period: 12:15 to 16:30



-  **Snow**
-  **Snow-free land**
-  **Clouds**
-  **Sea**

→ Cloud coverage can be substantially reduced with composite snow maps

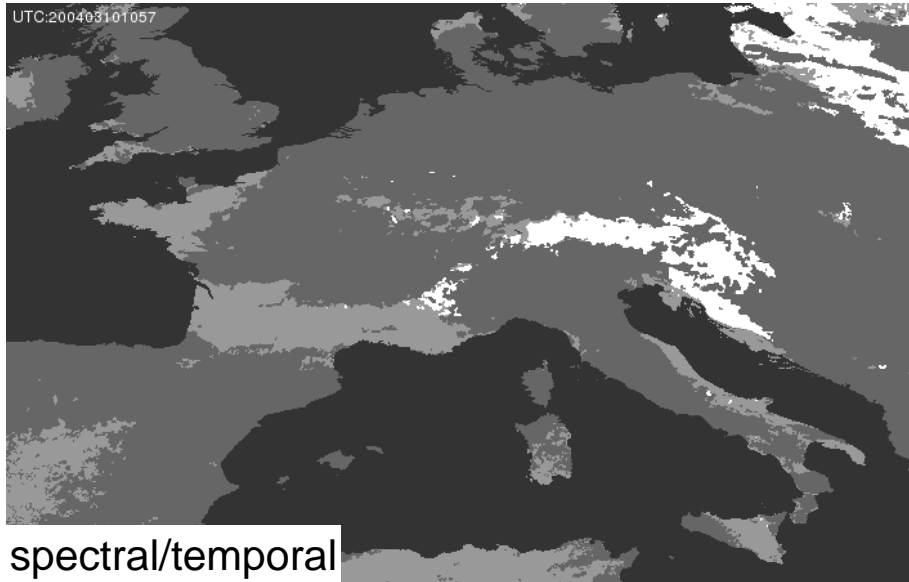
→ Different age of pixels → quality index



Application: Snow

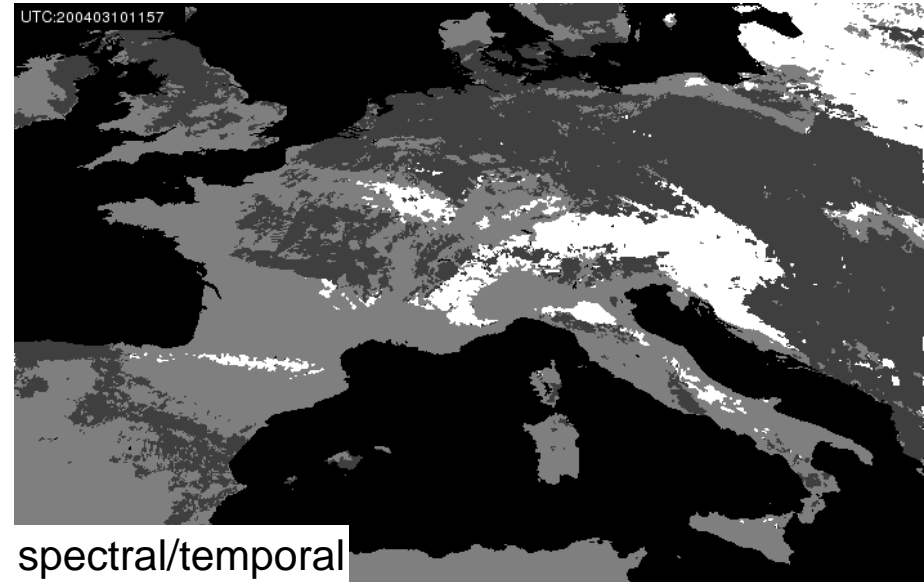
1 image:

10-3-2004, 10:57 UTC



24-hour period:

9-3-2004 12:00 UTC - 10-3-2004 12:00 UTC



-  **Snow**
-  **Snow-free land**
-  **Clouds**
-  **Sea**

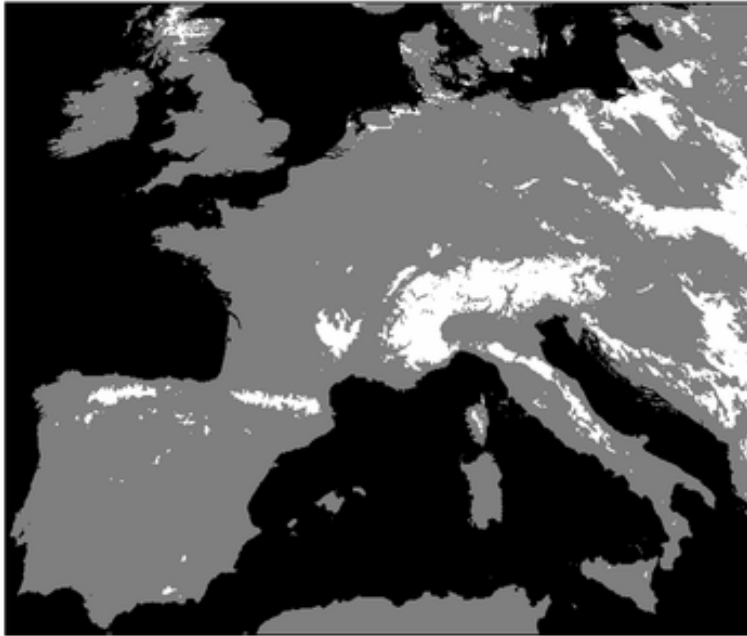


Application: Snow

snow_cover

dec_31_2008

quality_index



15 November – 31 December 2008



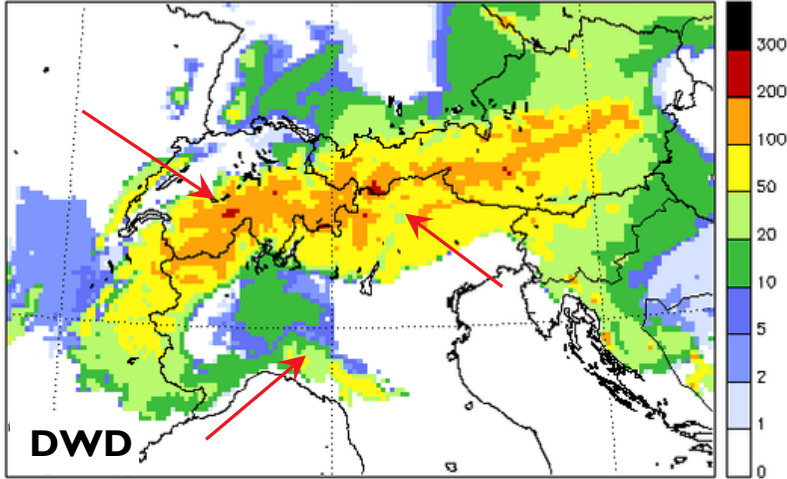
quality index = f (days, SZA)



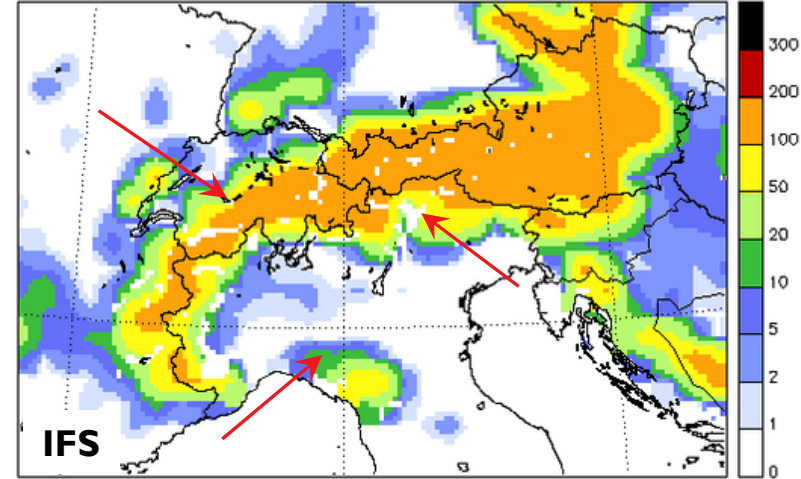
Application: Snow

Case study 02.02.2006: Alps

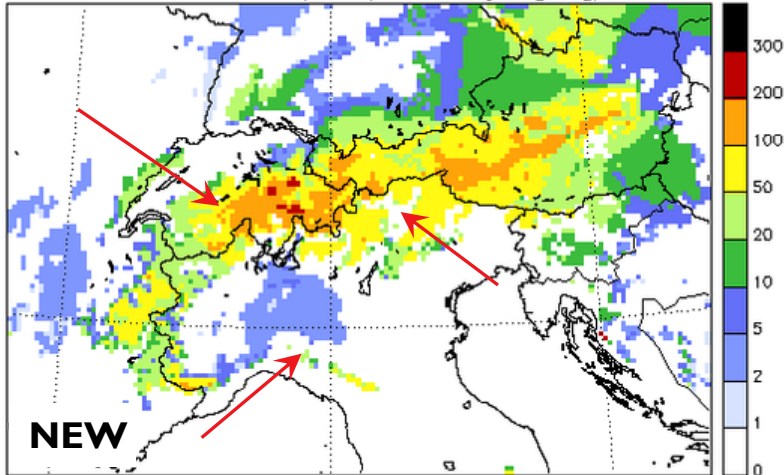
dLMO (opr) Snow analysis (snow height [cm])



IFS Snow analysis (snow height [cm])



MCH Snow analysis (snow height [cm])



- Three products for 02.02.2006, 06UTC:

- interpolated IFS analysis
- operational DWD analysis
- new MeteoSwiss product

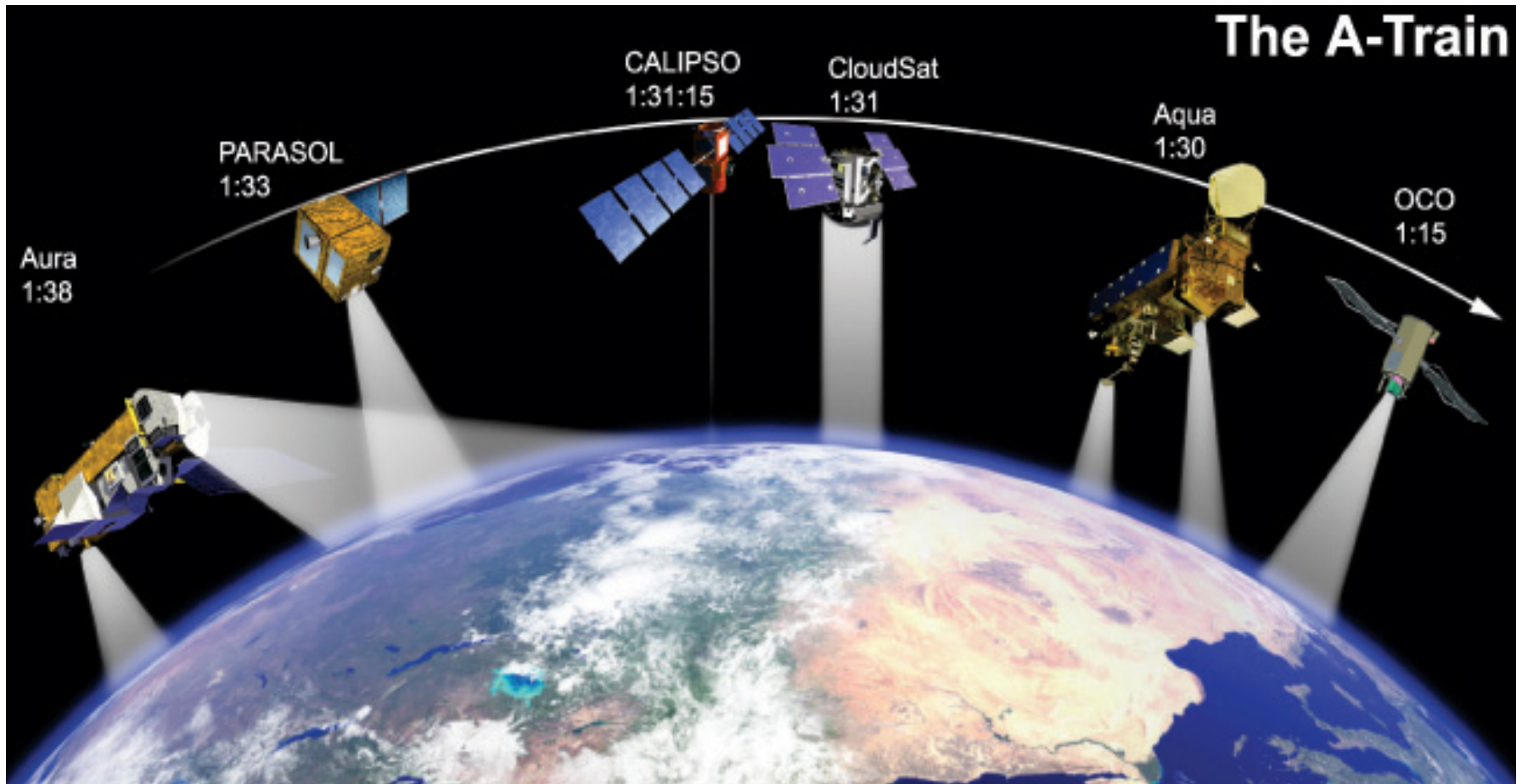
→ More realistic, small scale structures generated by MSG snow mask are visible in the new product.



Outlook

- Active Sensors: **Calipso** (lidar), **Cloudsat** (cloud radar)

Launched on 28 April 2006

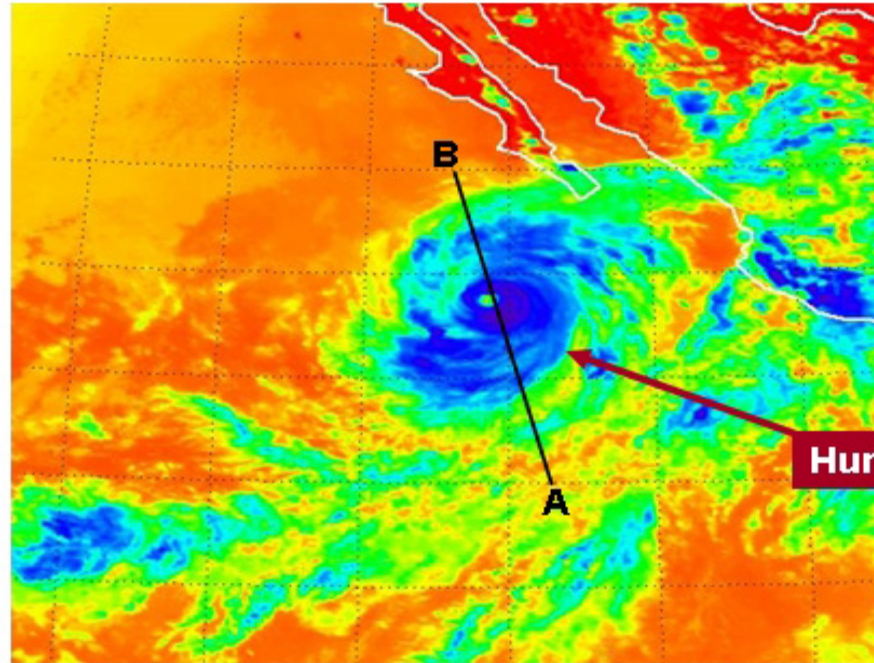


Courtesy: NASA



Cloudsat (cloud radar)

23 Aug 2006 GOES-11 21:00 UTC



Hurricane Ileana

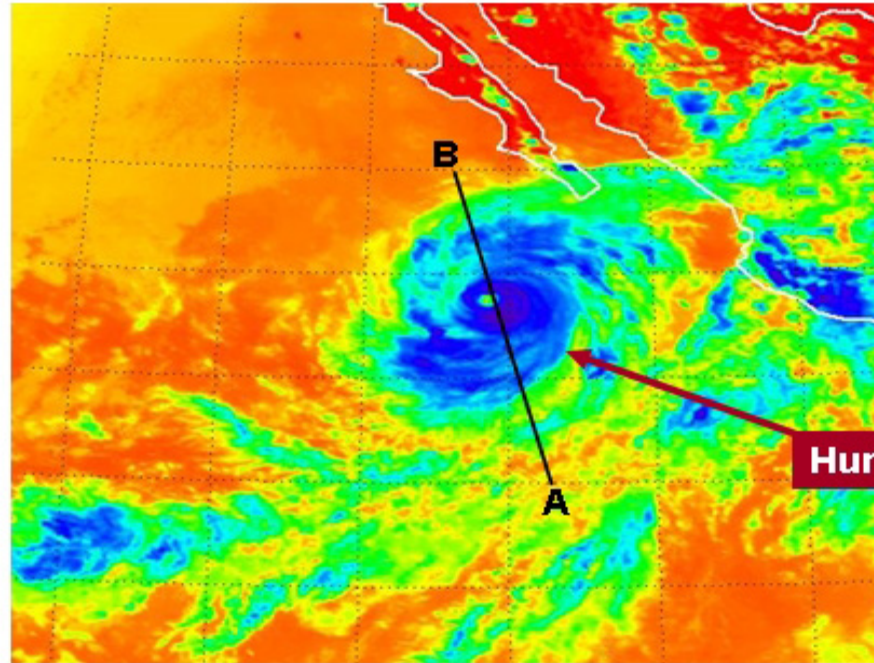
Brightness Temperature (°C)





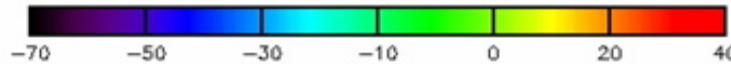
Cloudsat (cloud radar)

23 Aug 2006 GOES-11 21:00 UTC



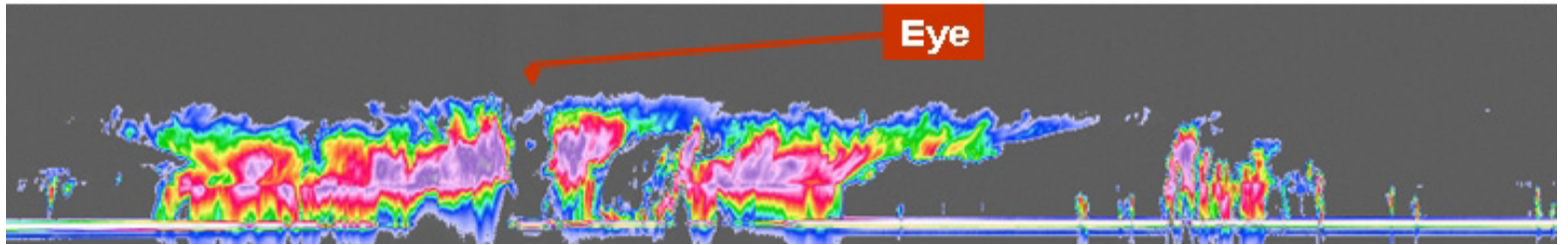
Hurricane Ileana

Brightness Temperature (°C)



B

A



Eye



Outlook

- Active Sensors: **Calipso** (lidar), **Cloudsat** (cloud radar)
Launched on 28 April 2006
- **Meteosat Third Generation (MTG)**
 - 2 platforms, MTG-I (imager) and MTG-S (sounder)
 - 3-axis-stabilised
 - 10min (+ rapid scanning 2.5min)
500m+ resolution
additional spectral channels
 - launch in 2016 and 2018
- **Post-EPS** (launch ~2019)
- **ESA Earth Explorers** (eg. SMOS, ADM-Aeolus, EarthCare)
and **GMES Sentinels** (in particular Sentinel-3, -4 and -5)



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Thank you for your attention!



Dr. Gabriela Seiz

Federal Office of Meteorology and Climatology MeteoSwiss
www.meteoswiss.ch | gabriela.seiz@meteoswiss.ch

ESA Summer School 2010, Frascati (I), 5 August 2010