ISCCP's Contribution to Shaping the Work of Meteorological Satellite Operators

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Content

- Where do we come from? - Meteosat operations 20 - 25 years ago
- Cloud Motion Winds: benefit from regional ISCCP experiment called ICE (International Cirrus Experiment - led by E. Raschke)
- The need for adequate instrument characterisation an d calibration
- Cloud analysis: ISCCP confirmed the operational ESA algorithm

- The FUTURE:
- GSICS (Global Space-based Intercalibration System)
- Essential Climate Variables (ECVs)
- R/SSC-CM (Regional Specialised Satellite Centers - Climate Monitoring)
- GCOS actions

Meteosat archiving

- When Meteosat was conceived weather services thought a ‘rolling archive’ over six months would be sufficient
- Fortunately ESA did archive the data
- Nowadays benefits of good archive are obvious => e.g. reprocessing for climate applications such as Essential Climate Variables (ECV), support to re-analyses, …
- Archiving is essential part of an applications ground segment

> **ISCCP helped to shape good archiving**

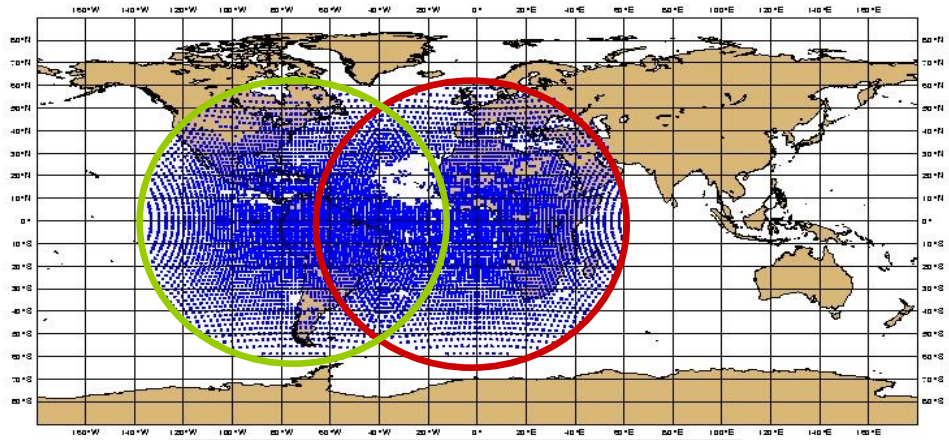
> **Credit to: Brian Mason, Jean LeBer, Ed Brady (at ESA 1983 - 1995), then later R. Husband, F. Cade, V. Gaertner and others at EUMETSAT**

Reprocessing of Meteosat Atmospheric Motion Vectors (AMVs) from archived data: Important contribution to Re-analyses at NWP Centers

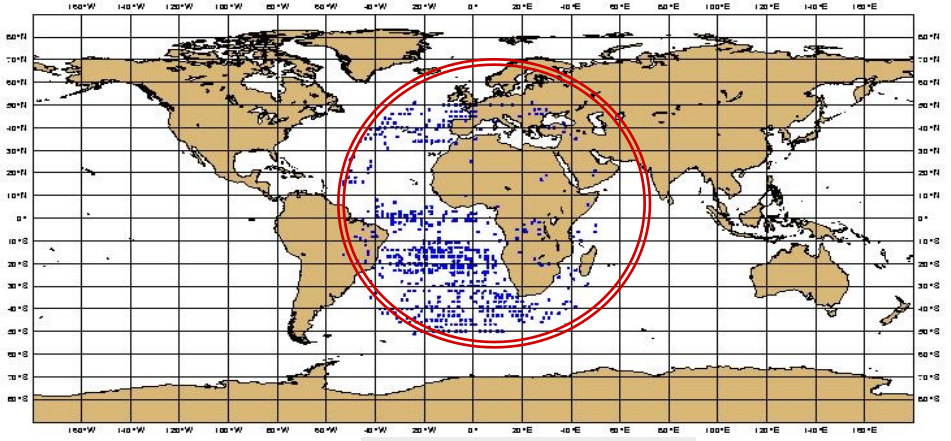
=> Substantially improved coverage and impact of re-processed winds from Meteosat satellites (C. Delsol, ECMWF, 2008)

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

Example of coverage: 19950102



Reprocessed Met3 and Met5



Original Met5

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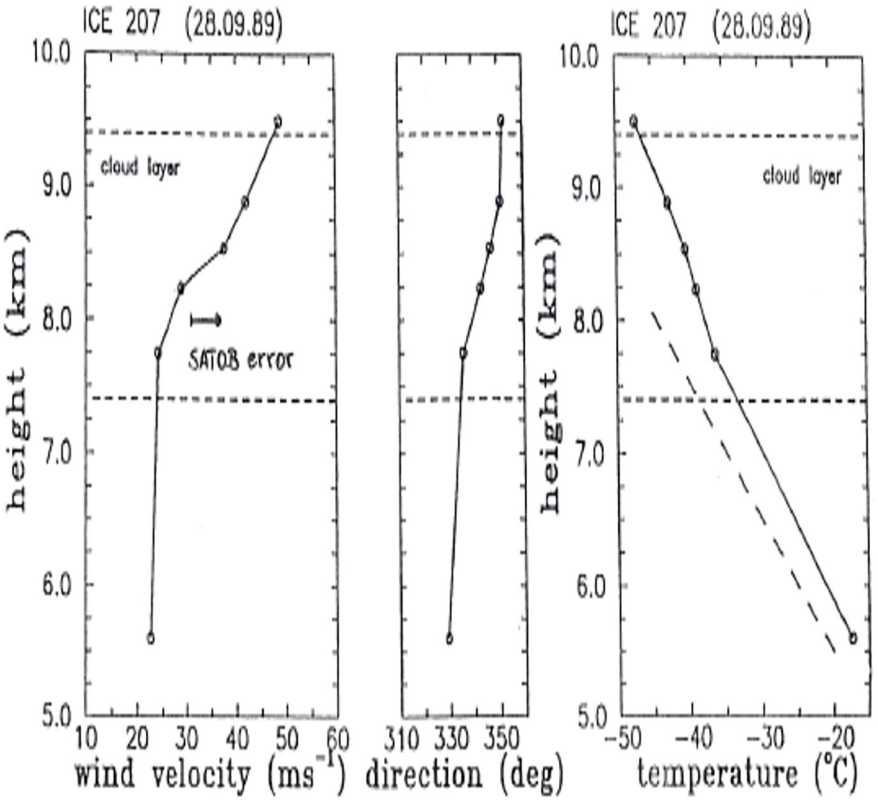
International Cirrus Experiment: Autumn 1987 and 1989: A European contribution to ISCCP => Detailed measurements of cirrus characteristics;



=> from International Cirrus Experiment (ICE) led by E.Raschke,

helped to understand the Cloud Wind bias problem

Development and Implementation of ISCCP software at the European Space Agency (ESA)

Monthly Mean Cloudiness Observed from METEOSAT-2

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(Manuscript received 18 February 1984, in final form 30 July 1984)

ABSTRACT

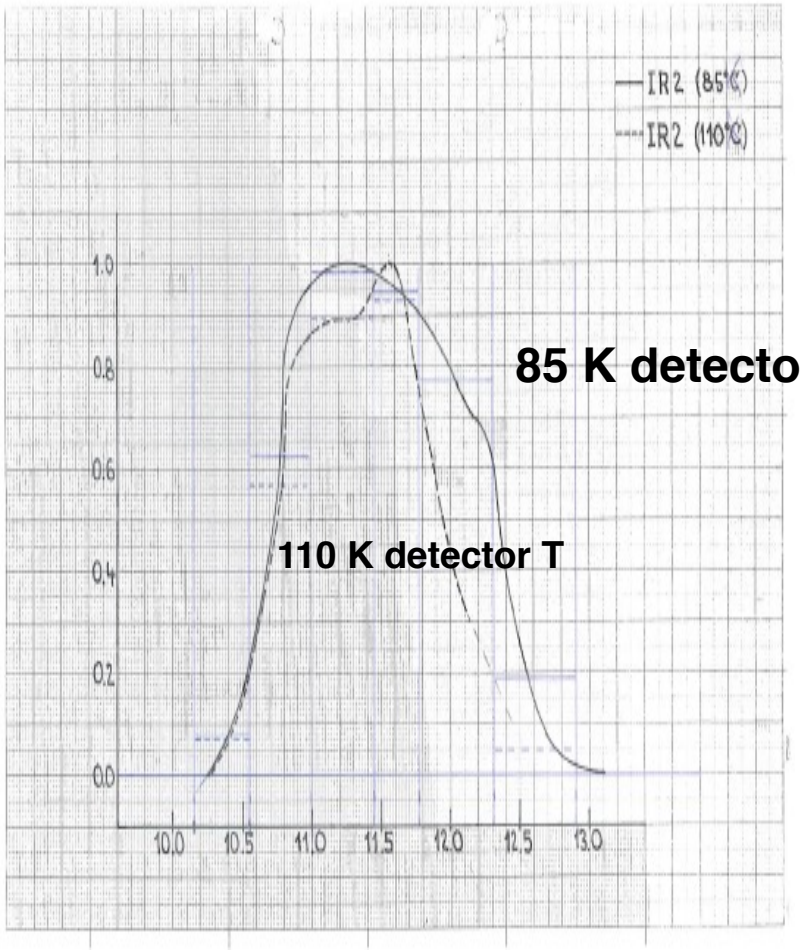
For this study, a sampled dataset from the original METEOSAT images was taken over a seven-month period for areas with a variety of different surface types and geographical locations. This was the initial B1 dataset requested for the International Satellite Cloud Climatology Project (ISCCP). Cloud amounts were derived from these raw radiances from a scheme which utilized all three METEOSAT channels. For the daylight slots the visible channel was used to discriminate between low cloud and surface. In addition, a "spatial coherence technique" was employed to detect cloud, relying on the assumption that the cloud tops do not have a uniform temperature over small distances (~20 km). The monthly mean cloudiness and mean diurnal variability for three months (April, July and October 1983) computed from the radiance data are described here. Significant seasonal variations in cloudiness were observed, such as the latitudinal movement of the ITCZ and the enhancement of the southern subtropical jet during July. The diurnal cycle of cloudiness was observed over equatorial Africa, particularly for the high cloud coverage.

done by R. Saunders (UK Met Office) as visiting scientist

and R. Bowen at ESA

(JCAM, 1985)

ISCCP helped to establish the need for adequate instrument characterisation: e.g. sufficiently accurate spectral response functions



In the early days of satellites information on spectral response functions were not very accurate … nor was the need appreciated

<= example for the IR-window channel

(Operating temperature was 90 K)

Meteosat Calibration in 1983

- A quote from Prof. H. Grassl: ‘ … Meteosat is a UFO - an Uncalibrated Flying Object’

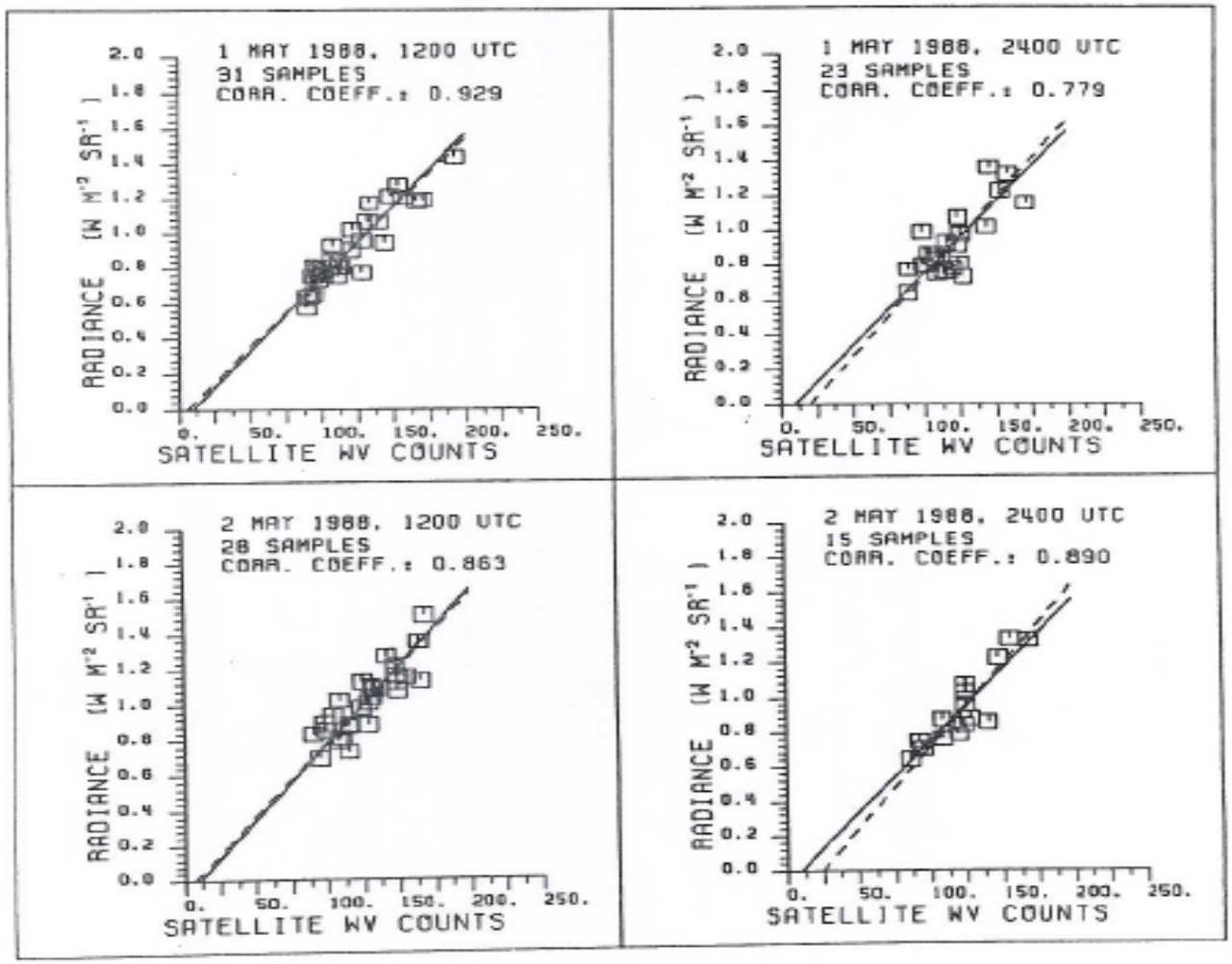
- There was some sort of blackbody calibration only for IR window channel
- No on-board calibration for solar and WV channels
- Vicarious calibration using ship SST (IR), product adjustment (WV), and an aircraft campaign for VIS channel calibration

➢ The above alone was probably reason enough for ISCCP to perform their own calibration/normalisation

Major Calibration Improvements => Meteosat First Generation vicarious calibration in 1986 and 1987

- Operational radiation calculations for IR and WV channel
- IR channel: Use of SST from AVHRR (Reynolds) as lower boundary and profiles from ECMWF short-term forecast
- WV channel: Use of radiosonde temperature and humidity profiles and collocated clear-sky WV observations
- Essential: good quality control

First operational calibration of the Meteosat WV channel: RT model with radiosonde profiles and collocated clear-sky WV raw radiances (counts), *from Applied Optics, 1989*



The new operational WV calibration led to:

- A large improvement of Cloud Motion Winds via the semi-transparency correction (see Journal of Applied Meteorology, 1993)
- Quantitative use of the WV channel for UTH retrieval (JAM, 1988; GRL, 1994, etc.)

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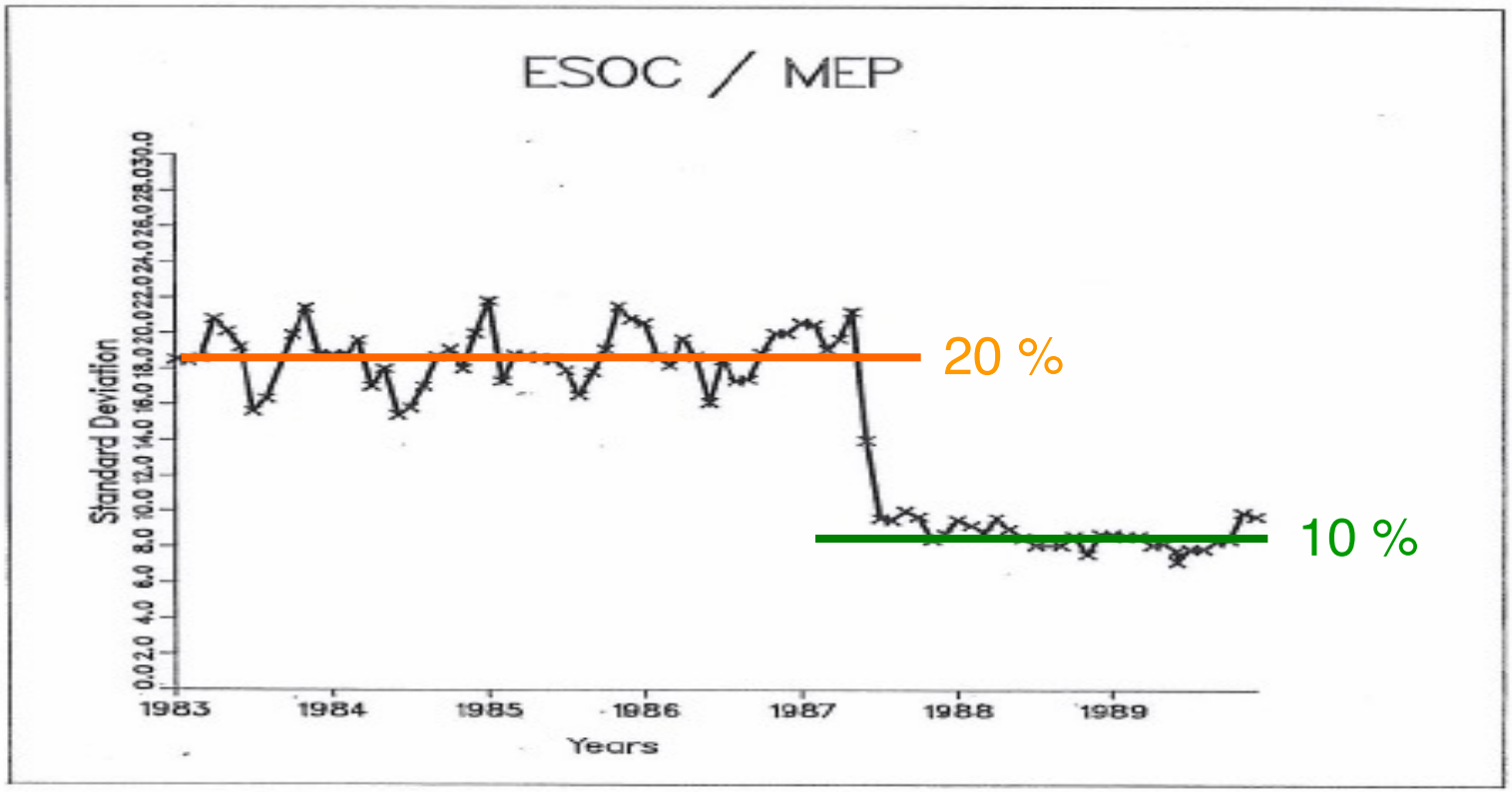
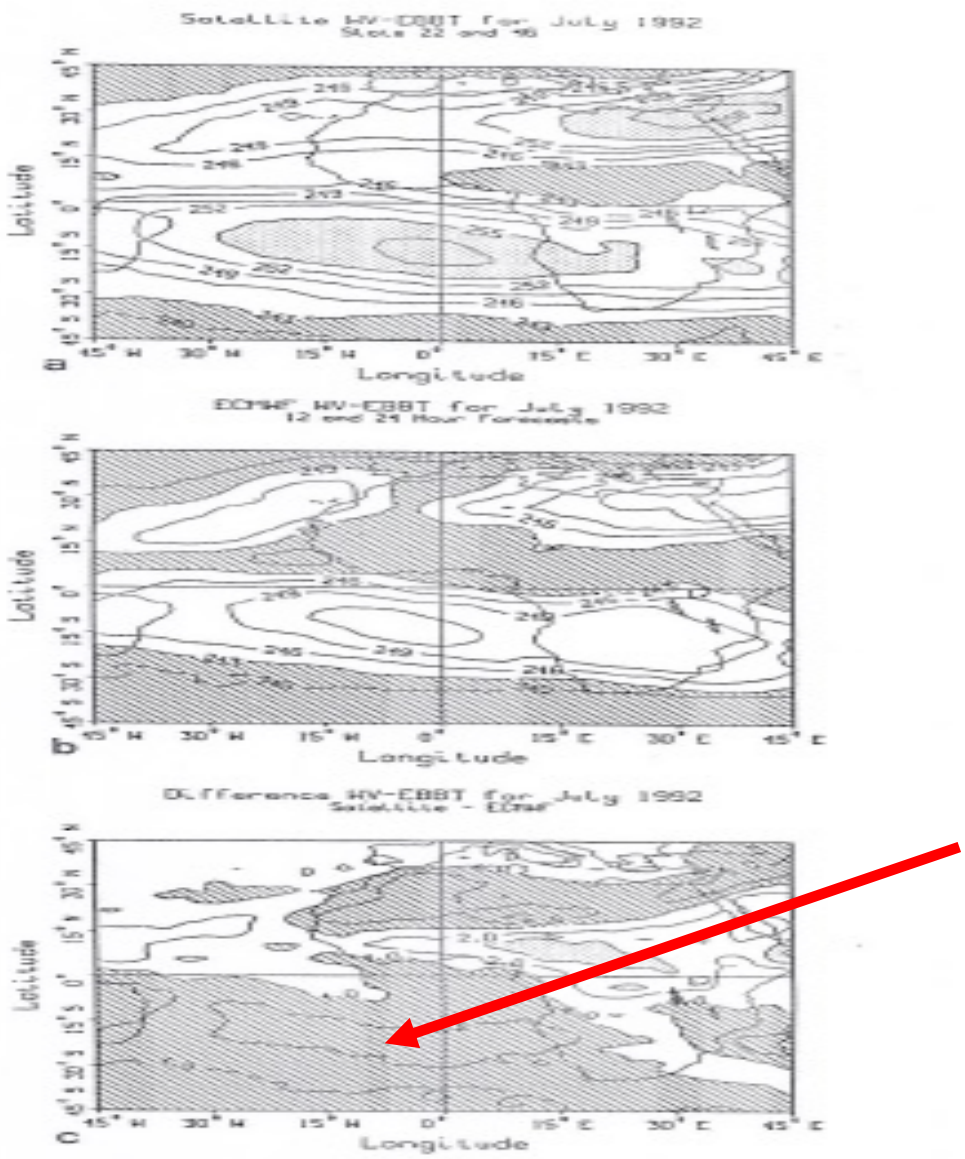
Upper tropospheric humidity (UTH) product: Improvement after introducing new WV calibration

Standard deviation radiosonde vs. Meteosat UTH (%)



Time from 1983 until end of 1989



Large bias in upper tropospheric humidity in ECMWF NWP model (before 1992)

High bias of more than 60% in ECMWF UTH in subtropics (before ATOVS radiance assimilation); corresponding to > 6 K difference in brightness temperature
(GRL, 1994)

ISCCP algorithm confirmed ESA/ESOC operational approach

VOL. 24, NO. 9 JOURNAL OF CLIMATE AND APPLIED METEOROLOGY SEPTEMBER 1985

ISCCP Cloud Algorithm Intercomparison

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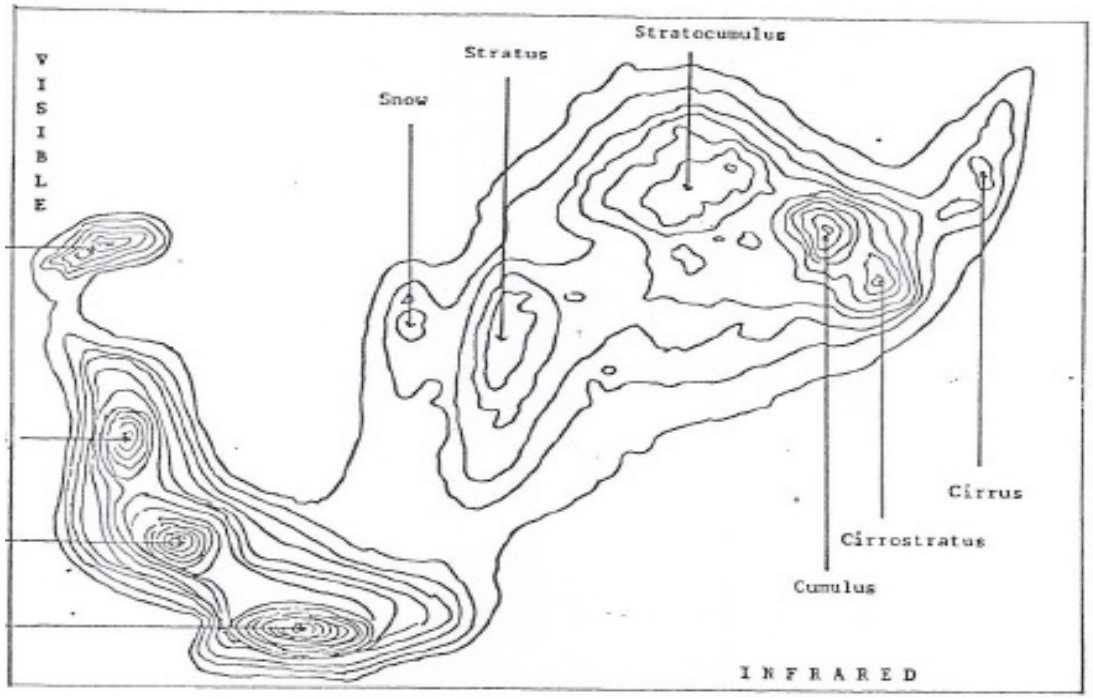
(Manuscript received 31 July 1984, in final form 5 April 1985)

The algorithm of Simmer and Ruprecht was an adaptation of the dynamic clustering method of Tomassini (1980)

ESA/ESOC operational scene analysis: Dynamic histogram analysis – C. Tomassini, 1980 (in: Proceedings of the 2nd course on 'Satellite Meteorology of the Mediterranean', ESA SP-159, p. 73 – 78)



Bright

VIS

Dark

Warm

Infrared

Cold

- This operational method used the IR, WV and VIS channels
- Method was very robust and provided excellent results
- The only fundamental piece of science software that we never changed until the hand-over of operations from ESA to EUMETSAT in 1995

GSICS (Global Space-based Intercalibration System)

Opportunities for mutual benefit and interaction between ISCCP and GSICS

- **Global Space-Based Intercalibration System (GSICS) creates an operational system that monitors and evaluates the calibration of the global meteorological satellite observing system in a coherent and systematic manner.**
- **GSICS is embedded in the WMO Space Programme and CGMS (Coordination Group for Meteorologcal Satellites) => endorsed Implementation Plan**
- **GSICS participants are meteorological satellite operators**
- **GSICS is an existing element of GEOSS and seen as one of the early achievements of GEO**
- **GSICS coordination center in NOAA/NESDIS (GSICS Chair: M. Goldberg)**
- http://www.star.nesdis.noaa.gov/smcd/spb/calibration/icvs/GSICS/index.html

GSICS Objectives

- To improve the use of space-based global observations for weather, climate and environmental applications through operational inter-calibration of satellite sensors.
- Improve global satellite data sets by ensuring observations are well calibrated through operational analysis of instrument performance, satellite intercalibration, and validation over reference sites
- Provide ability to re-calibrate archived satellite data with consensus GSICS approach, leading to stable fundamental climate data records (FCDR)
- Ensure pre-launch testing is traceable to SI standards

The early start of GSICS: Recalling some Actions on Satellite Intercalibration from CGMS 25 in 1997 (St. Petersburg)

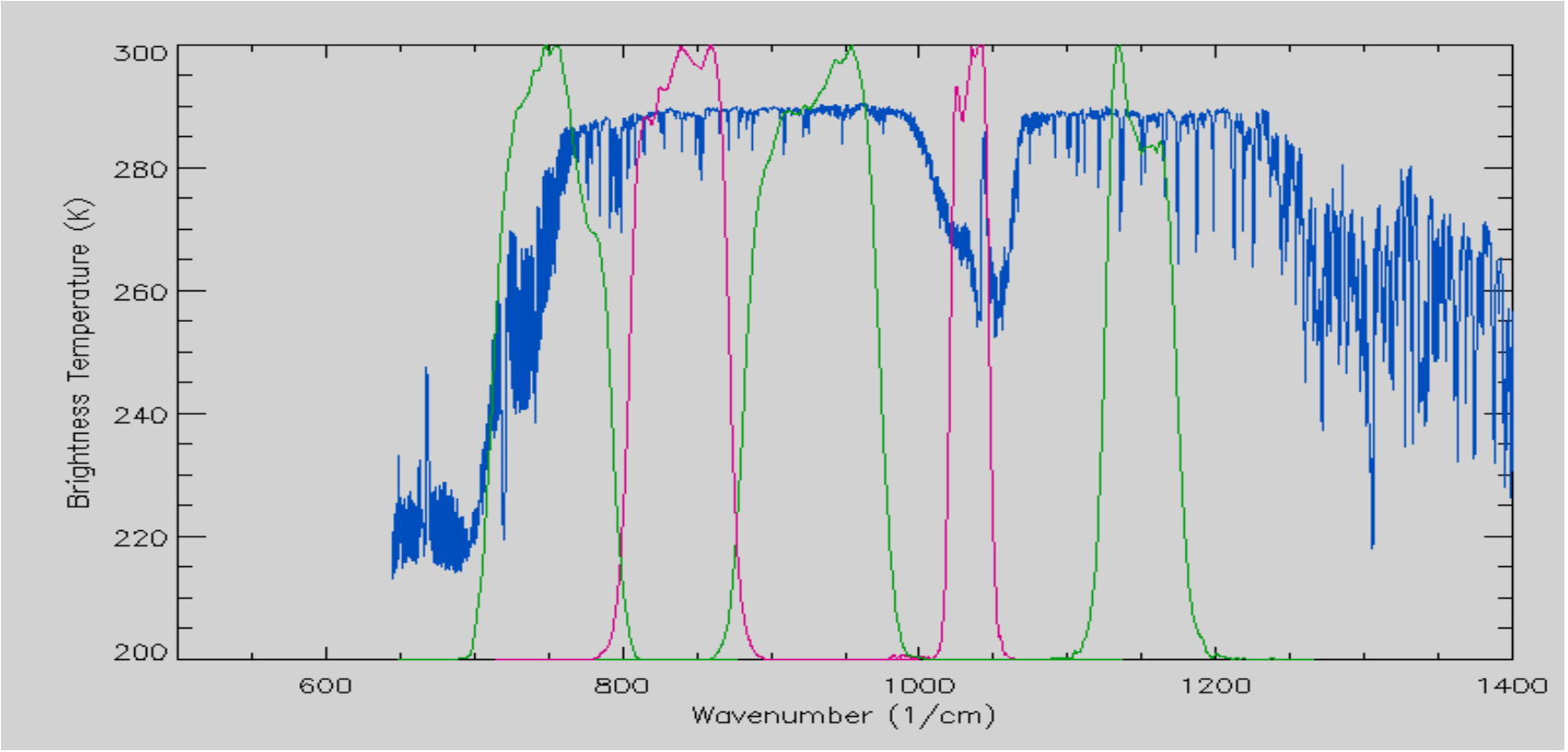
- Action 25.29 - Each CGMS operator to commence satellite intercalibration activities and to identify a coordinator for such activity before CGMS XXVI.
- => Closing of action: EUMETSAT, NOAA/NESDIS, JMA and PRC have commenced intercalibration activities. …. designated coordinators from NOAA, EUMETSAT, Russia (Roshydromet), China (CMA), Japan (JMA) and India (IMD).

- Action 25.30: All CGMS satellite operators to request an AVHRR data set with the assistance of NOAA/NESDIS, for cross-calibration with their geostationary satellite, by 31 October 1997 and NOAA/NESDIS to provide the data on request.

=> Closing of action: … various papers from NOAA, JMA, CMA and EUMETSAT

Example from GSICS: Intercalibrating MSG with IASI

IASI: hyperspectral sounder on Metop-A (09:30h orbit)



IR13.4 **IR12.0** **IR10.8** **IR9.7** **IR8.7**

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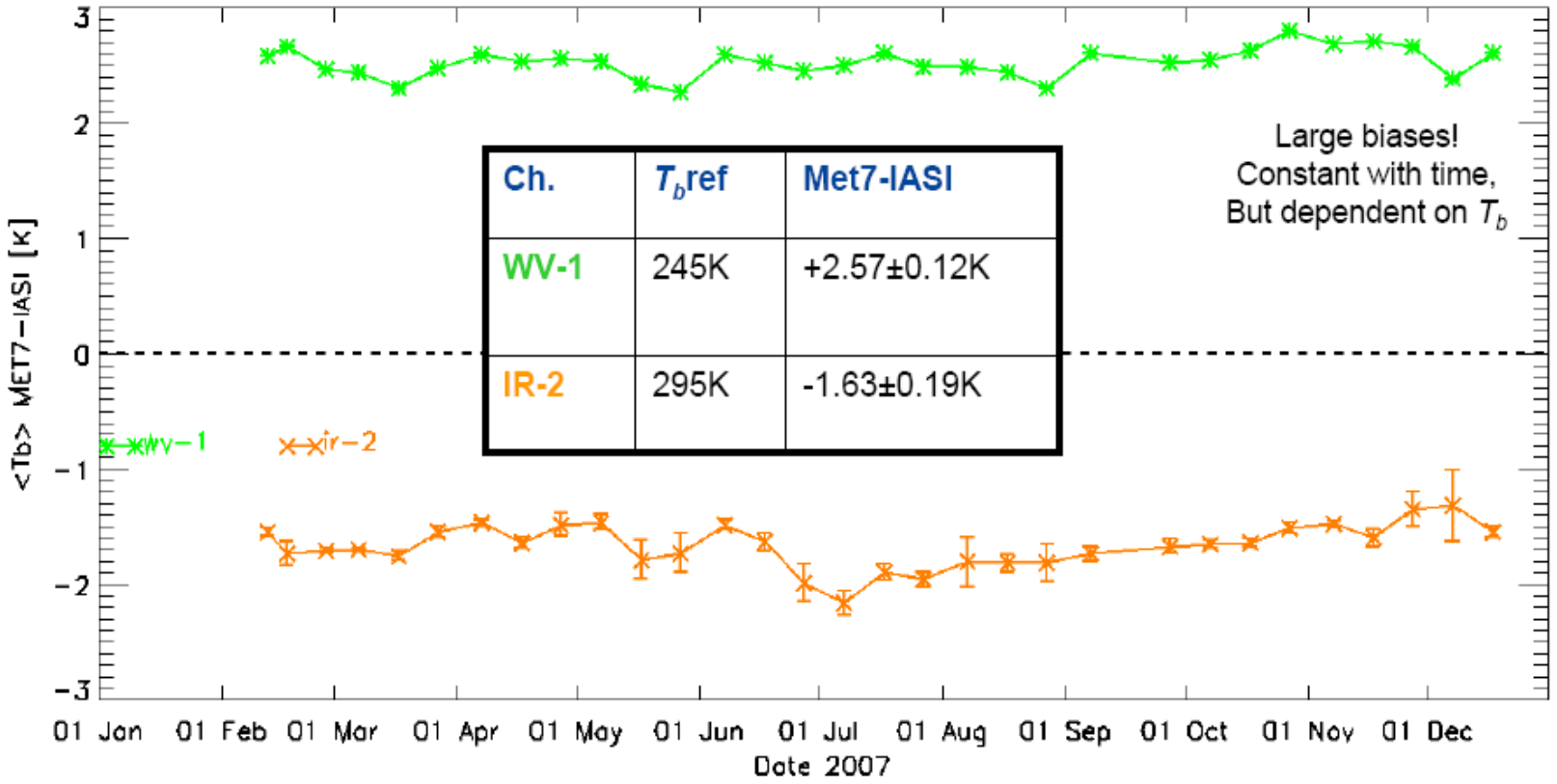
IASI is an excellent reference for satellite inter-calibration

Channel	ΔT IASI – Meteosat-8*	ΔT IASI – Meteosat-9 *
IR3.9	-0.17	-0.20
WV6.2	-0.24	-0.40
WV7.3	-0.51	-0.14
IR8.7	0.15	0.15
IR9.7	0.17	0.20
IR10.8	0.16	0.07
IR12.0	0.19	0.08
IR13.4	0.44	1.7

from Hewison and König, 2008, GSICS Quarterly

GSICS recalibration of 1 year of Meteosat-7 with IASI

=> use for product derivation, e.g. OLR or UTH



Ch.	$T_b$ref	Met7-IASI
WV-1	245K	+2.57±0.12K
IR-2	295K	-1.63±0.19K

T. Hewison, 2008

Potential future service of GSICS to ISCCP

- Provision of consistent calibration information for all satellites used in ISCCP
- Provision of information on satellite sensor characterisation
- Regular provision of information on instrument status and performance

- ISCCP could be a prime user and a key evaluator of GSICS

A new initiative: R/SSC-CM

(Regional Specialised Satellite Centers on Climate Monitoring)

- Regional/Specialised Satellite Centres on Climate Monitoring (R/SSC-CM), defined in the WMO framework.

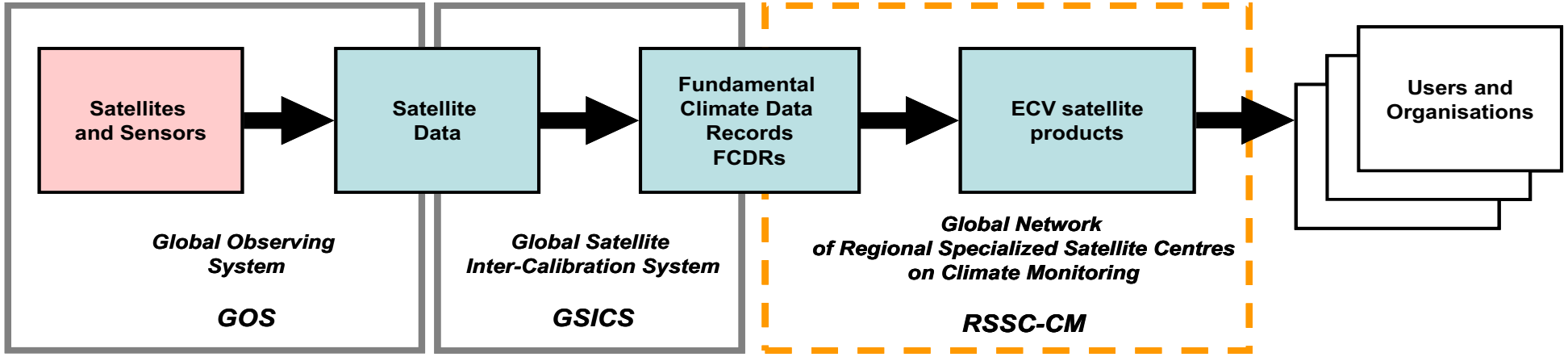
- The main objective of the R/SSC-CM Network is to provide high quality long-term data sets of what GCOS has defined as Essential Climate Variables using observations from space. Existing activities of space agencies are the starting point.

- Main contributions of EUMETSAT to the R/SSC-CM are the coordinated activities (climate product generation through reprocessing of archived data) of its Central Facility and the SAF Network.

- EUMETSAT has also been nominated secretariat of the R/SSC-CM Network.

R/SSC-CM
Regional Specialised Satellite Centers on Climate Monitoring
=> the way toward operational production of ECVs

- The R/SSC-CM Network will be:
  - **Based on activities of existing initiatives (GOS, GCOS and GSICS)**
  - **Build upon existing operational infrastructures**
  - **Serve users and other organisations (e.g. WMO Regional Climate Centres RCC, National Weather Services)**



26 Essential Climate Variables (ECVs)

Atmospheric

- Precipitation, Earth radiation budget (including solar irradiance), Wind speed and direction, Water vapour, Upper-air temperature, **Cloud properties**, Carbon dioxide, Ozone, Other long-lived greenhouse gases, Aerosol properties

Oceanic

- Sea-surface temperature, Ocean salinity, Sea level, Sea state, Sea ice, Ocean colour

Terrestrial

- Lakes, Snow cover, Glaciers and ice caps, Albedo, Land cover, Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI), Biomass, Fire disturbance, [Soil moisture]

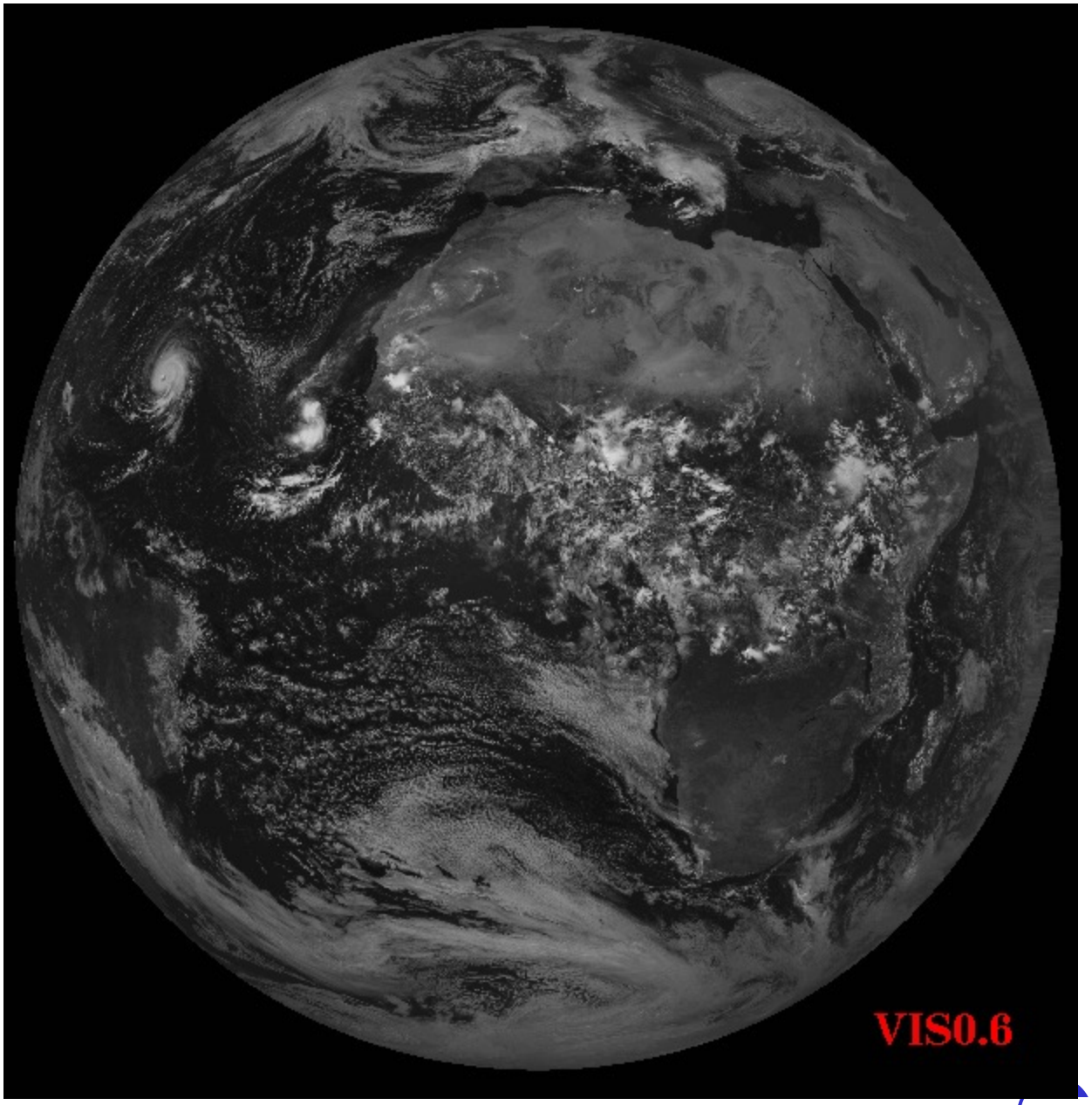
2008 GCOS Report
=> relevant to ISCCP

GCOS-WCRP-IGBP Sydney Workshop: "Urgent Needs" include

- Identification of regions where society is most vulnerable to climate change ("climate hot spots");
- Identification of thresholds beyond which potentially "dangerous" changes (to society) will occur ("climate tipping points")
- An authoritative set of information at the scales relevant for adaptation policy;
- Better understanding of ice-sheet dynamics;
- Impacts, adaptation and vulnerability communities' needs for research and observations, and addressing these needs based on current capabilities and prospects;
- Better regional information on past and future climate change;
- Methodologies to define, determine and communicate uncertainties and limitations in regional observations and model products in a context-sensitive manner;
- Quantification of radiative forcing due to aerosols and clouds by comprehensive model-model and model-observation comparisons;
- Better understanding of the hydrological cycle, especially convection and precipitation processes;
- Ensuring sustained observations of the oceans and the land surface;
- **Continuity of key satellite missions for climate;**
- **Ensuring analysis, reanalysis and reprocessing of all climate data, with attention to observing system changes.**

Future aspects for an operational ISCCP (1)

- **Continuity needed - Action 22 from Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (GCOS - 92, 2004 => Ensure climate records of Vis and IR radiances, e.g. from ISCCP and include additional data streams when they become available**
- **Integration of more spectral information from geostationary orbit (most imagers have 5 channels, Meteosat-8 and -9 have 12 channels, … future GOES-R, GOMS, … with more channels, and higher frequency in time for process studies?)**
- **Integration of more spectral information from polar satellites (hyperspectral information, MODIS and follow-on … situation is difficult w/r to continuity, only AVHRR on Metop, and VIIRS has no WV channel)**



Meteosat Second Generation:
- 12 channels
- full disk every 15 minutes

Meteosat-8 (MSG-1)
all channels

8. September 2003

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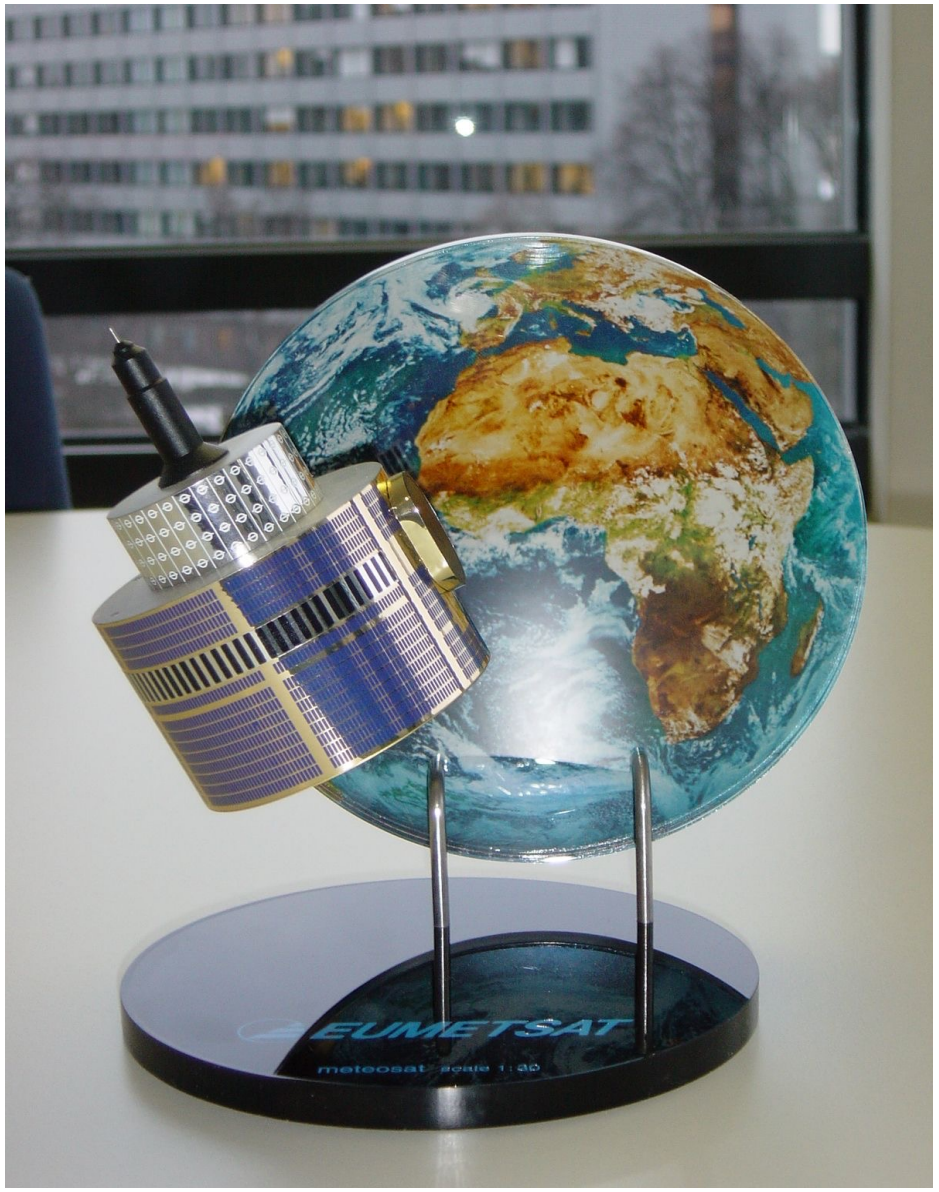
Future aspects for an operational ISCCP (2)

- **Use of GSICS as source for calibration information within the operational ISCCP => ISCCP could act as 'prime' customer and evaluator**
- **Operational ISCCP could be a 'test-bed' for an integrated approach to derive the Essential Climate Variables (cloud properties)**
- **One could 'associate' ISCCP with the R/SSC-CM … (NOAA is part of R/SSC-CM)**



Congratulations to ISCCP

In recognition of 25 years of success and leadership

from EUMETSAT

2008

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