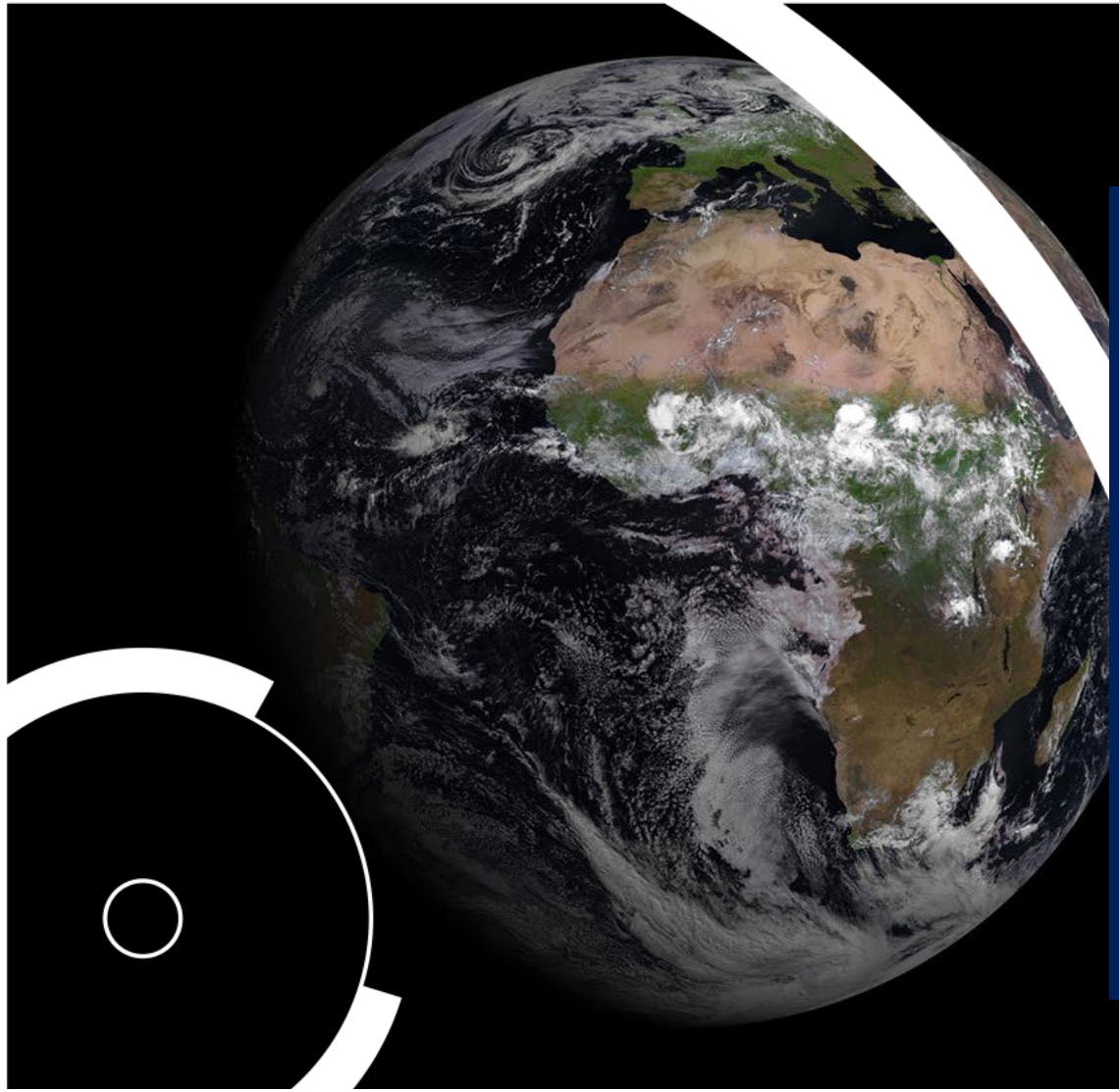


Development of a quasi-global Fundamental Climate Data Record from observations from geostationary satellites

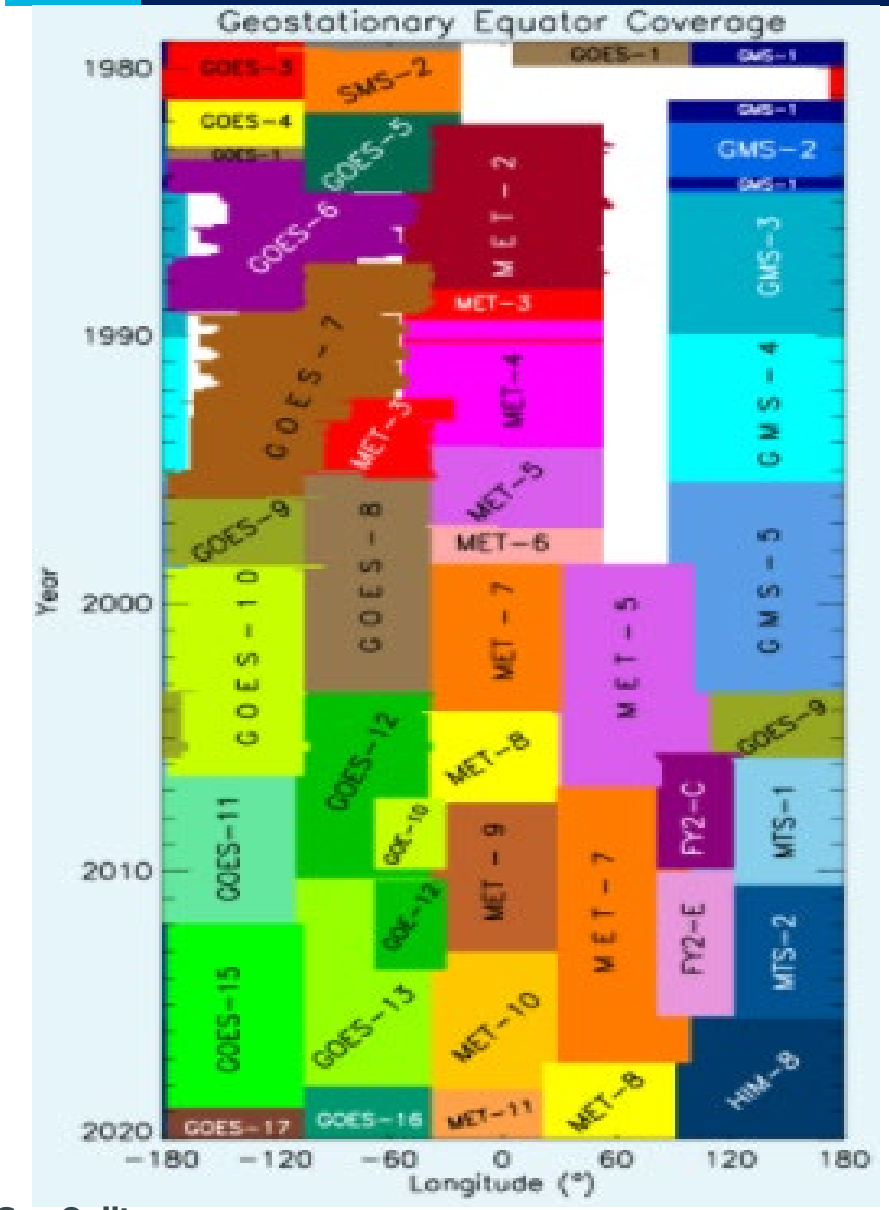
J. Schulz[1], V. John[1], T. Tabata[2], K. Knapp[3], M. Grant[1], T. Hanschmann[1], J. Onderwaater[1], P. Poli[1], R. Roebeling[1], F. Rüthrich[1], A. Heidinger[2]

[1] European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

[2] Japan Meteorological Agency (JMA)

[3] National Oceanic and Atmospheric Administration (NOAA)

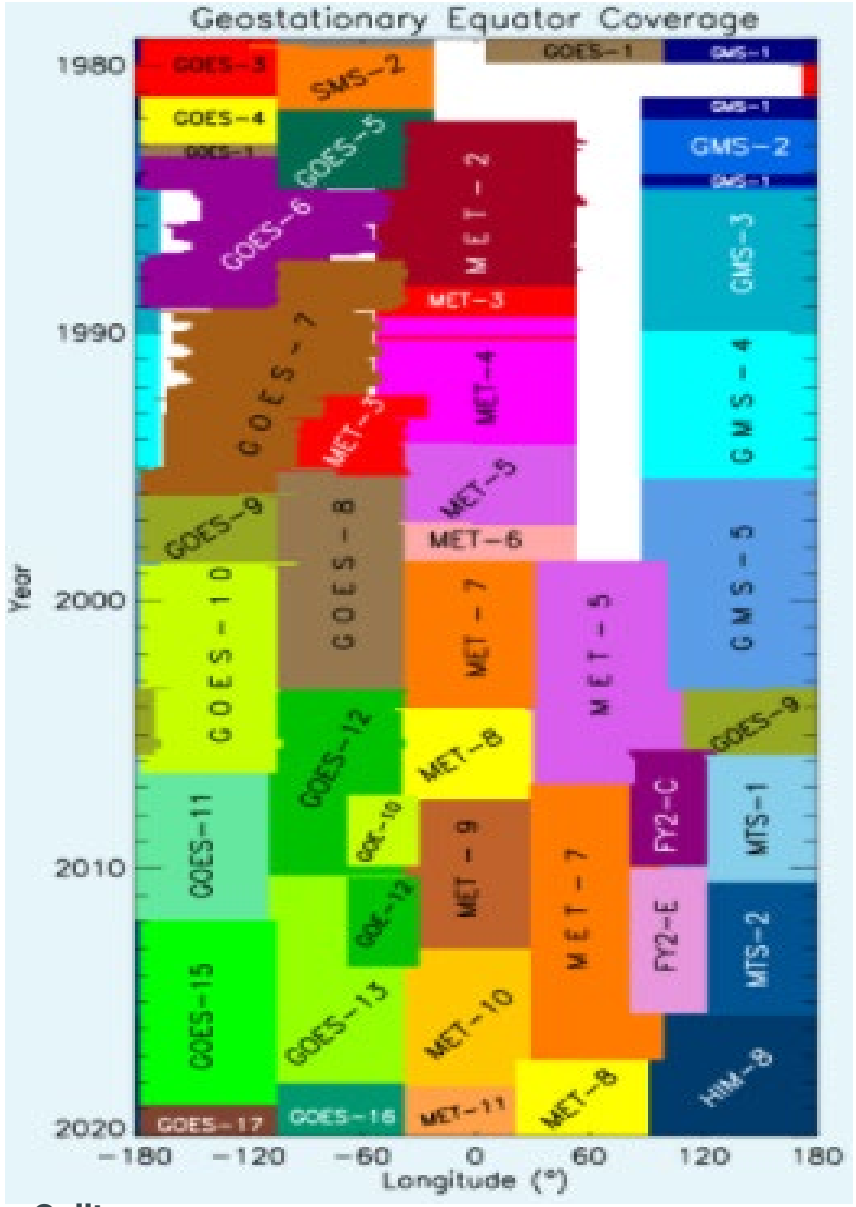
Global observations from missions in geostationary orbit



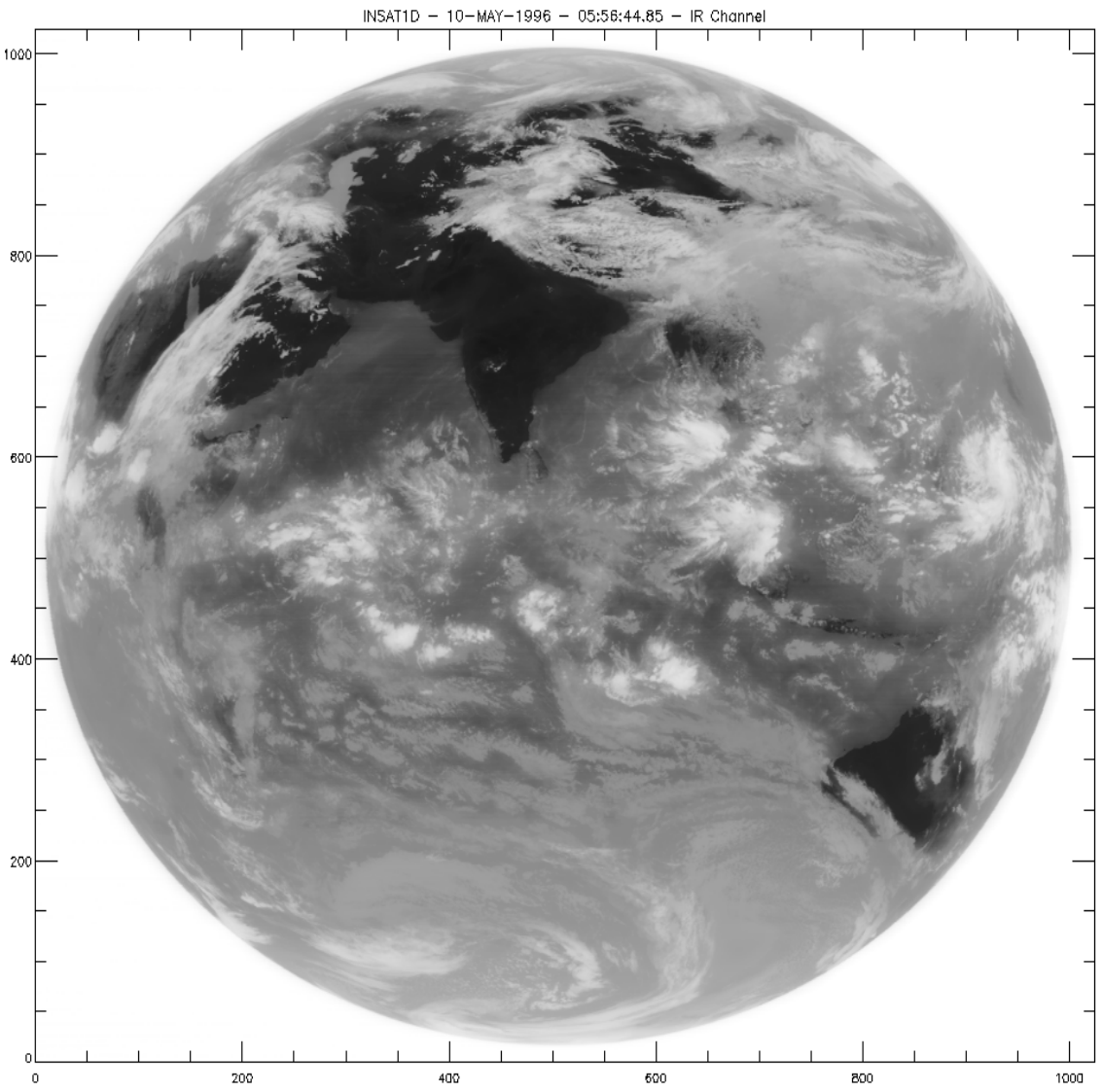
Geo Quilt (from https://www.ncdc.noaa.gov/gridsat/isccp-b1-info.php)

- Long history of measurements provide a treasure and are essential for climate science and services with thousands of users
- Measurements continue with more and more satellites having enhanced capabilities, with data volumes increasing sharply and access becoming more difficult for users
- Utilisation of past, current, and future observations for climate monitoring is a challenge as up to 50 geostationary satellite missions are part of the record with a variety of instrumentation since the 1970s
- For climate a consistently quality controlled, recalibrated, and remapped radiance data set from all geostationary satellites is required and modern methods are available
- Coordination and cooperation with other space agencies is a must
- Cloud infrastructure appears very advantageous as a means of consolidating the historical data and provides continuity to current and new missions including organised product access

Data Rescue



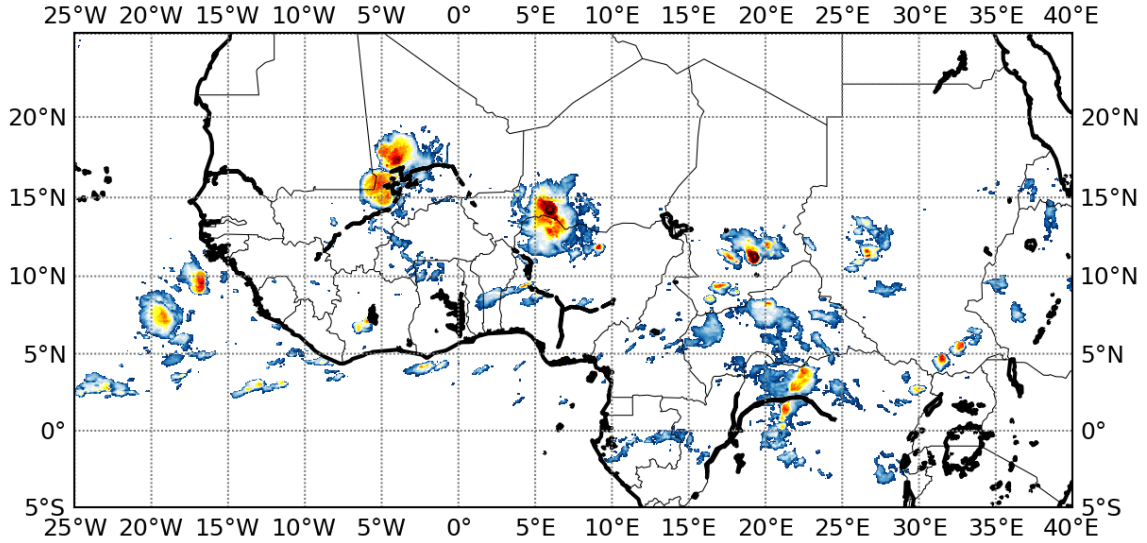
Geo Quilt (from https://www.ncdc.noaa.gov/gridsat/isccp-b1-info.php)



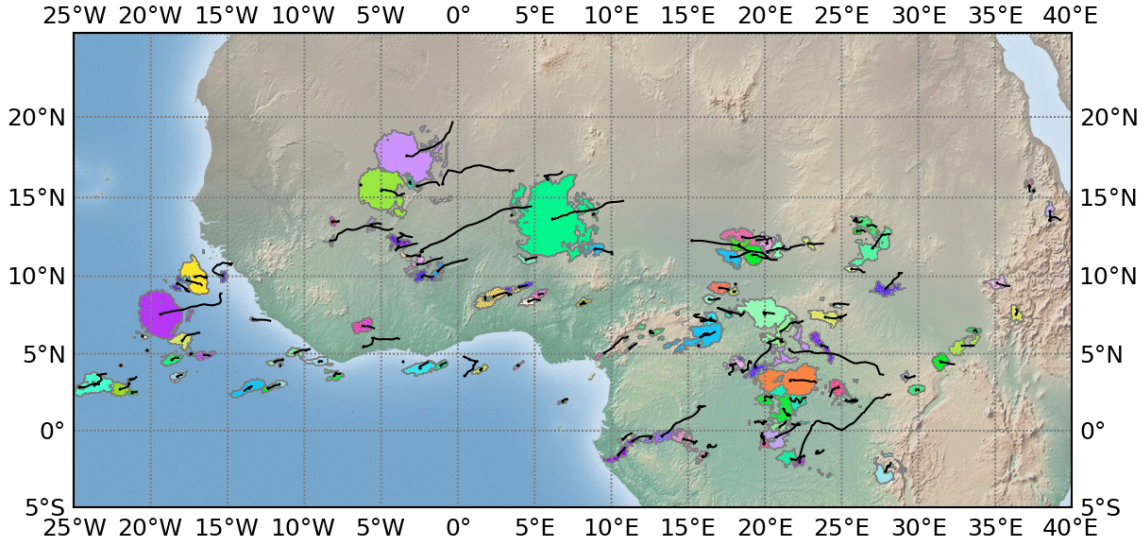
Climate information products

Objective: Elaboration of a 30min/full resolution global tropical and homogeneous Database of MCS for as many as possible geostationary satellites starting late 1970s.

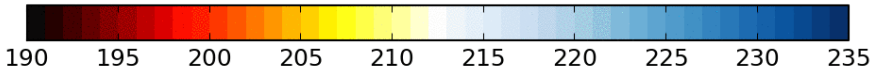
1999/07/10-01



TOOCAN MCS



Brightness Temperatures

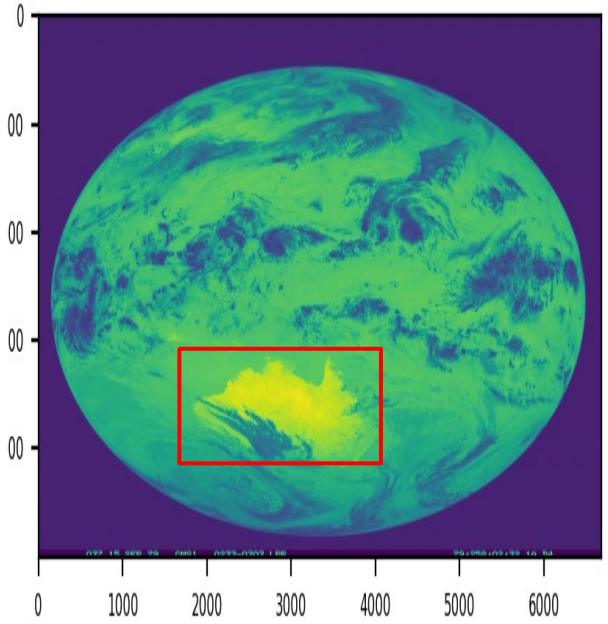


Collaboration on the European Weather Cloud with:
T. Fiolleau, R. Roca, D. Bouniol, S. Cloché, P. Raberanto
LEGOS/CNRS, Toulouse, France

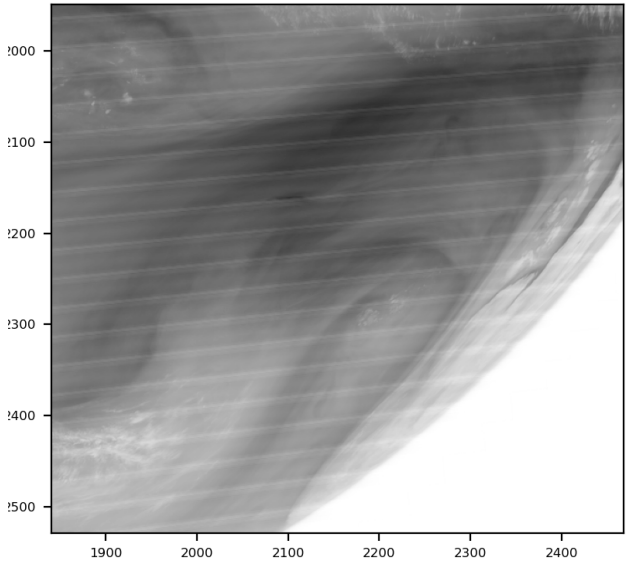
Data rescue – EUMETSAT and JMA

Performed two studies on automated radiometric anomaly detection in imagery of all Meteosat 1-11 and GMS/MTSAT satellites

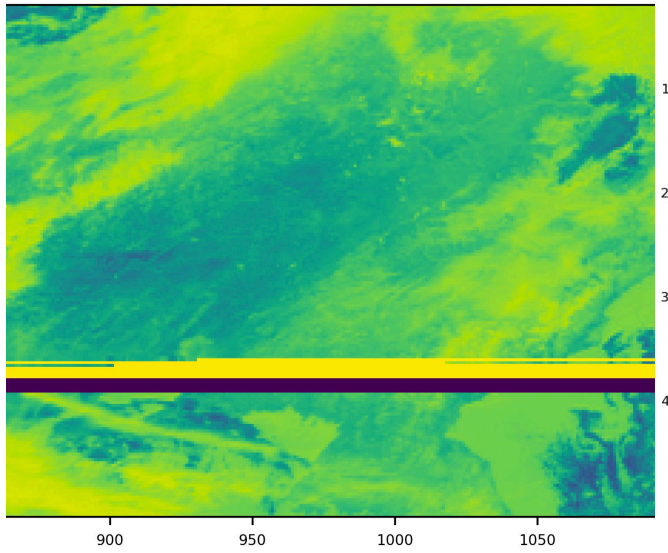
GMS-1 over illumination IR
15 Sep 1979



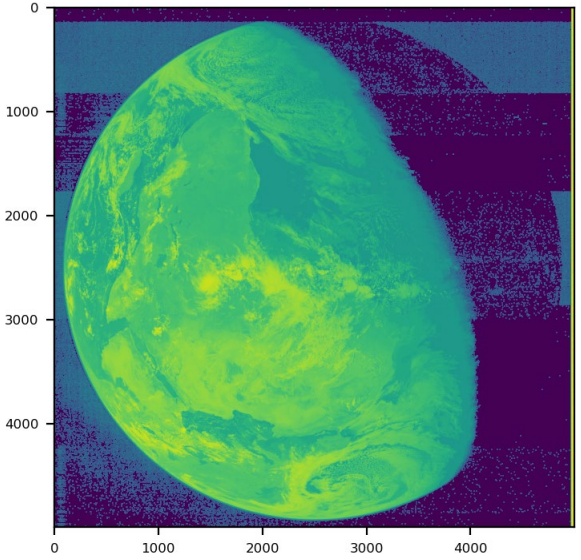
MTSAT-1R moonlight contamination WV,
27 May 2007



MTSAT-2 IR data loss
16 Nov 2006



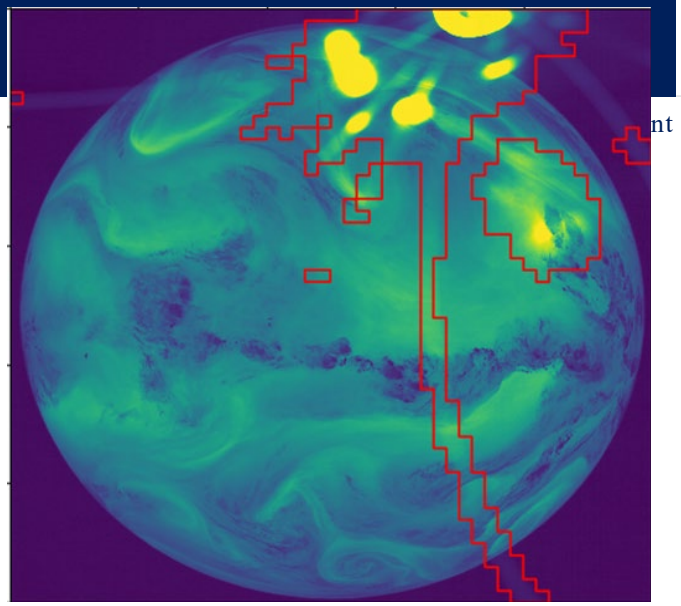
Meteosat-1 VIS
non-uniform background noise
16 Dec 1978



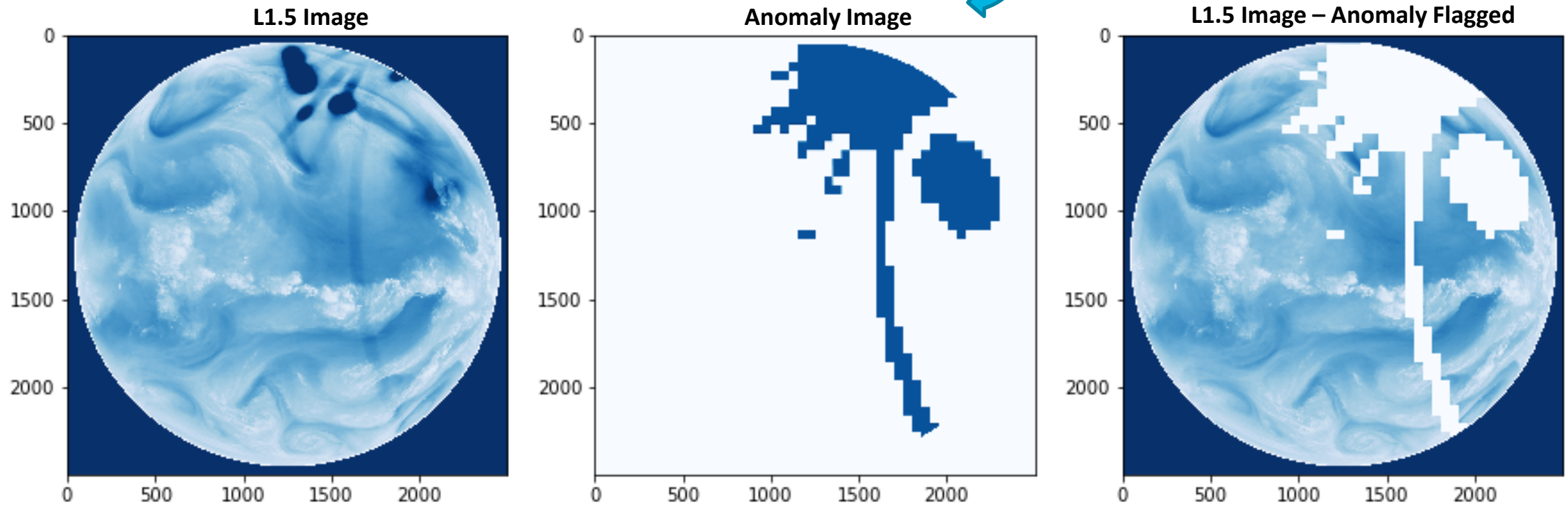
Collaboration on data rescue is ongoing with NOAA and JMA analysing US GOES and Himawari 8/9 data at EUMETSAT

Raw data with flagged radiometric image anomaly

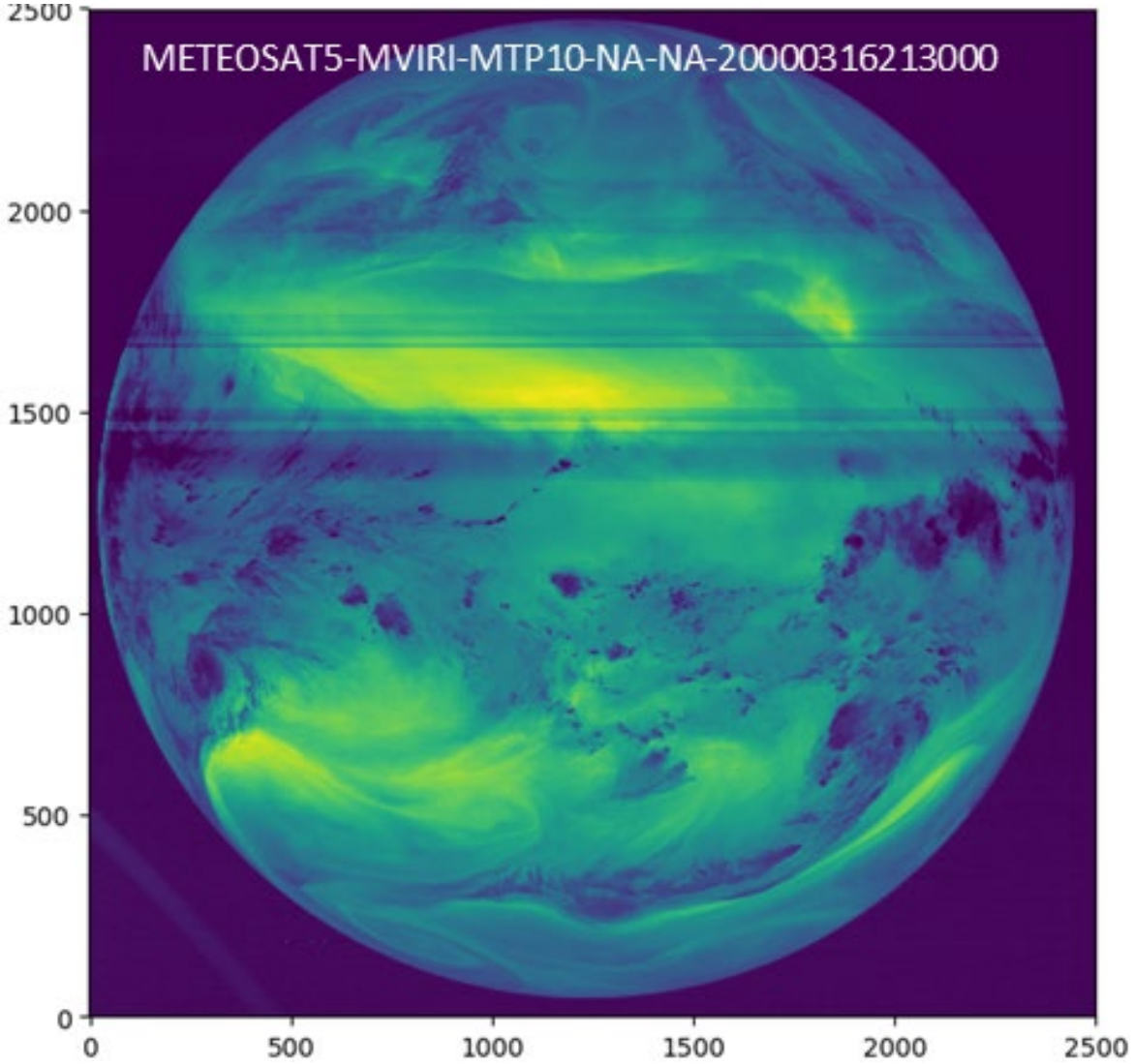
- Anomalies have been detected in Level 1.0 (unrectified images)
- Anomaly images have been constructed at L1.0 grid
- Anomaly images are then rectified in the same way as normal images
- Anomaly images are included as new variables in the FCDR
- Anomaly images are available per channel – VIS, IR, and WV



Anomaly detection related software could be applied to all instruments



Why does it matter? (1)



There are 7 files available for ordering (33,307,582 bytes of data).

Choose From Order Options

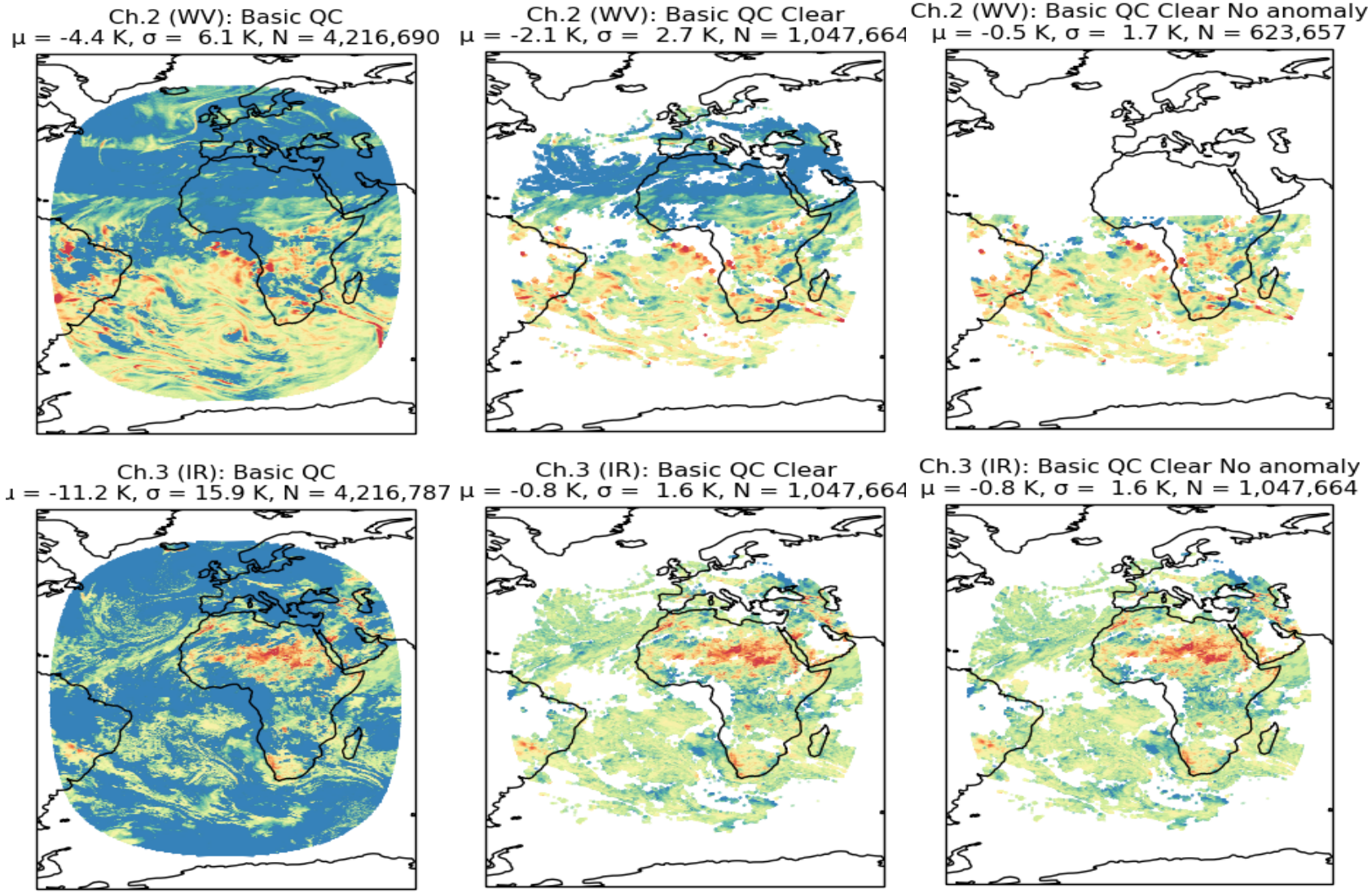
- (•) Order All Available Files
- OR -
- ( ) Order Specific Files Only (make selections below)

ISCCP.B1.0.MET-5.2000.03.16.0230.EUM - 4758226
ISCCP.B1.0.MET-5.2000.03.16.0530.EUM - 4758226
ISCCP.B1.0.MET-5.2000.03.16.0830.EUM - 4758226
ISCCP.B1.0.MET-5.2000.03.16.1130.EUM - 4758226
ISCCP.B1.0.MET-5.2000.03.16.1430.EUM - 4758226
ISCCP.B1.0.MET-5.2000.03.16.1730.EUM - 4758226
ISCCP.B1.0.MET-5.2000.03.16.2330.EUM - 4758226

Proceed With Order

Why does it matter? (2)

www.eumetsat.int

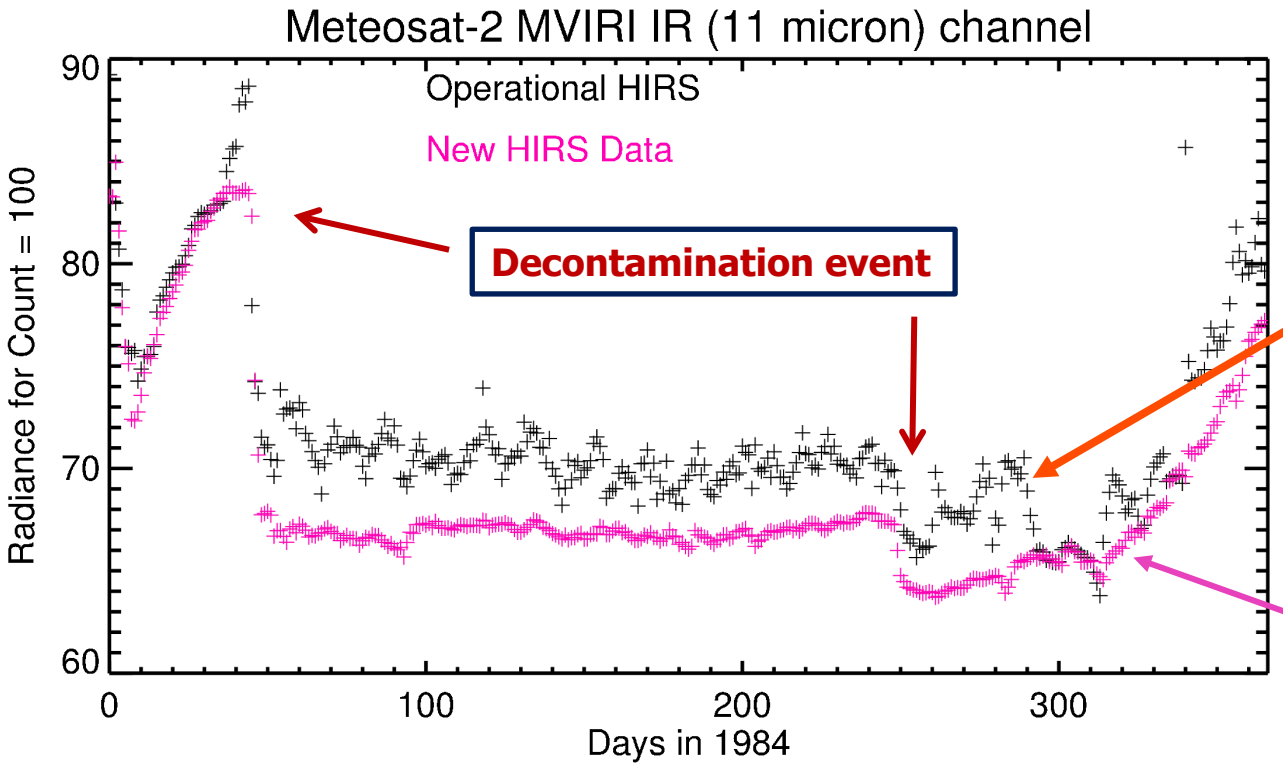


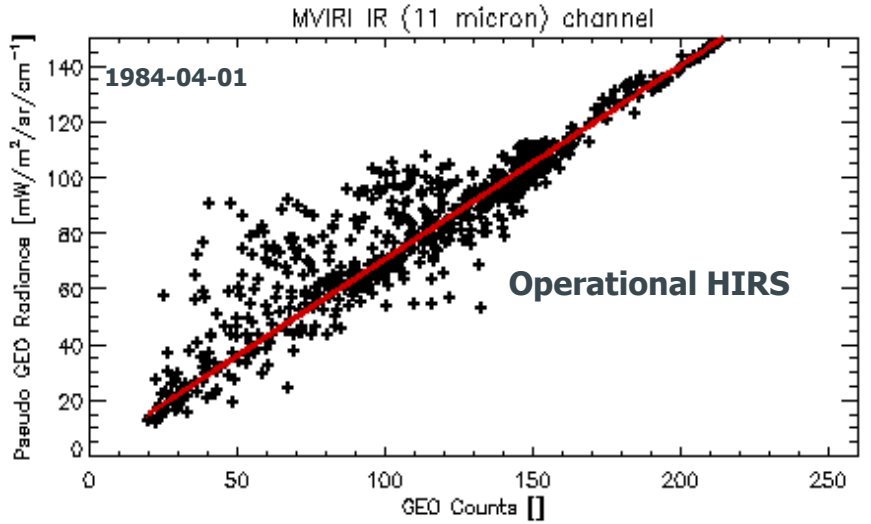
Meteosat-7; 01 April 2000 02:00 UTC

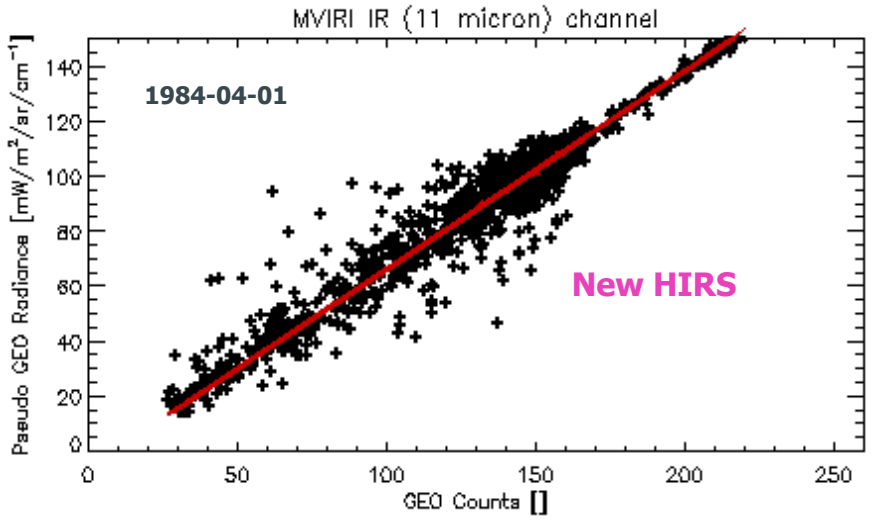
Poli et al., 2020

- Shown is the difference between observations and simulations based on ERA5 reanalysis data;
- QC flags based on anomaly database together with cloud clearance reduces the bias significantly;
- Anomalous pixels related to “indirect stray-light” effects and “hot pixel” patterns are removed in the WV channel.

Improvements of instrument calibration

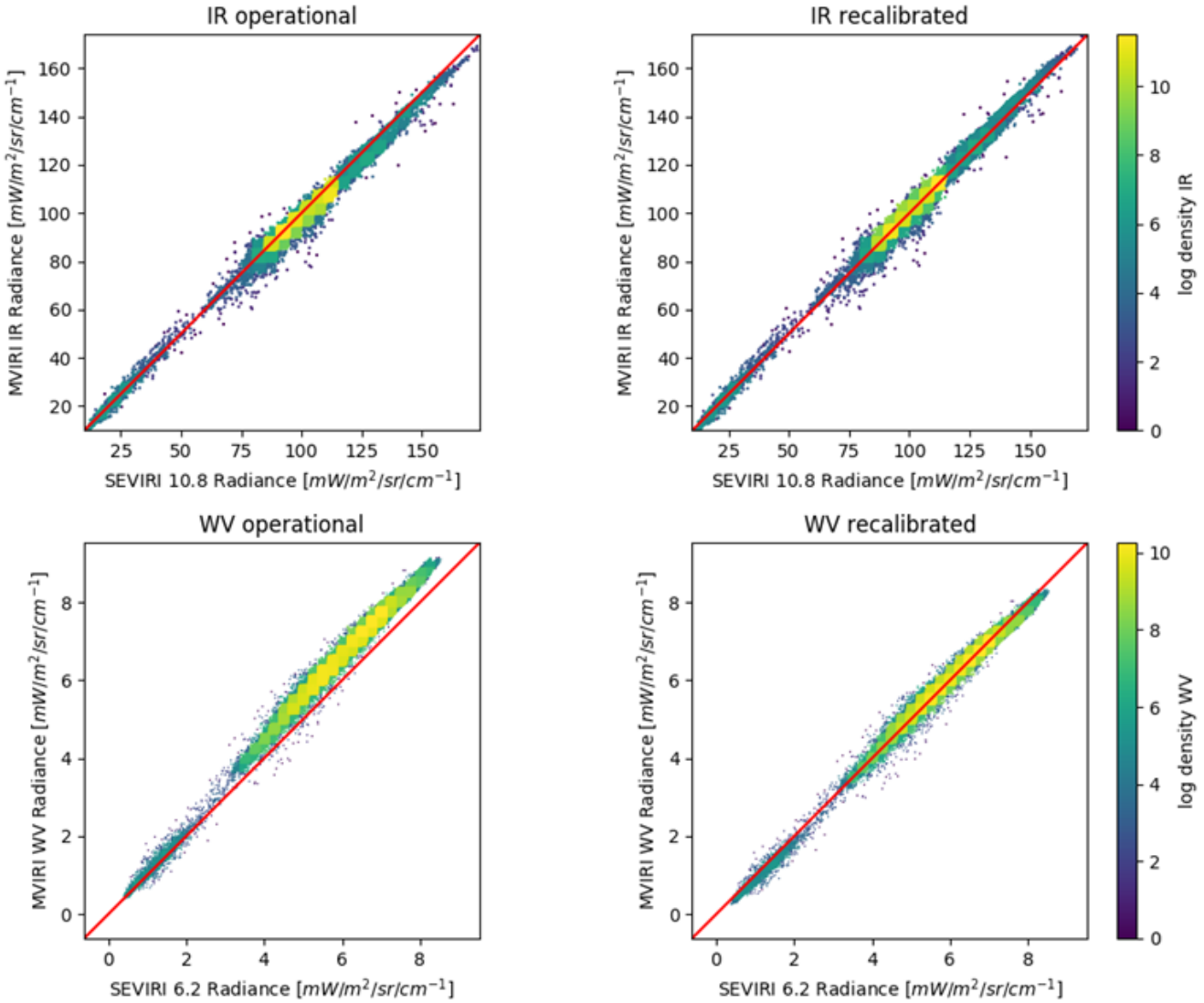






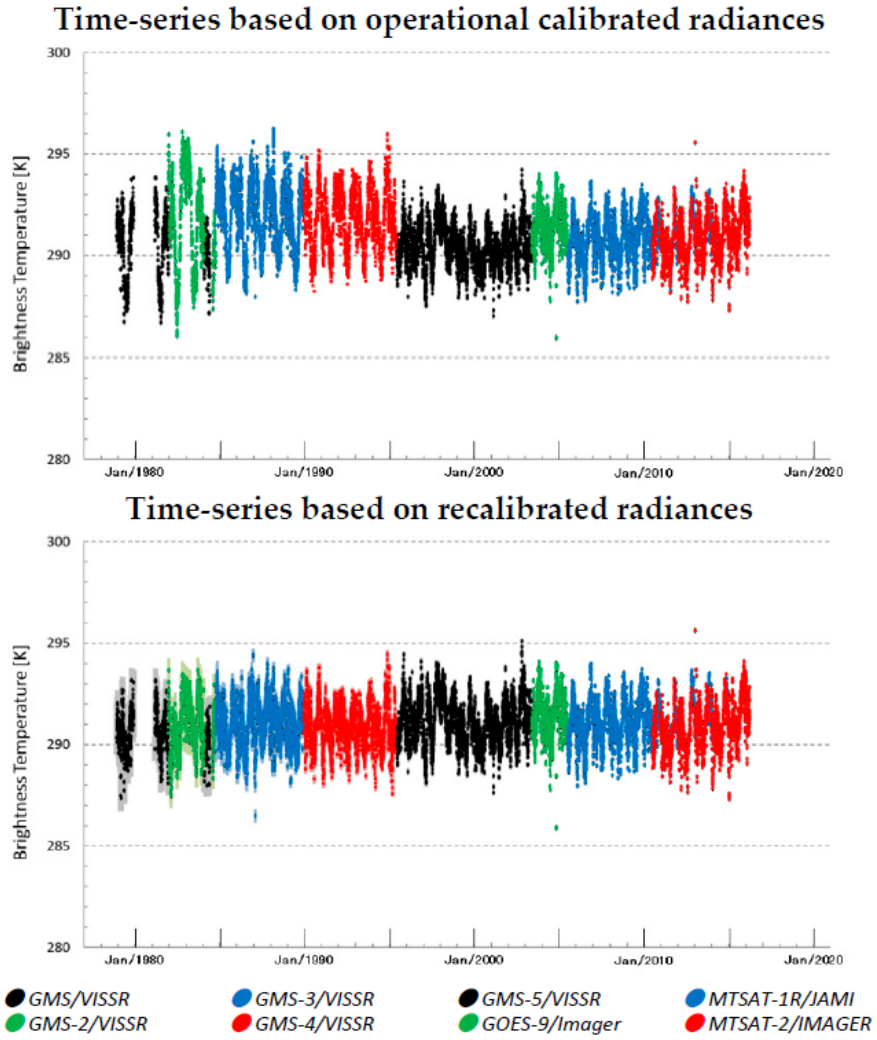
Methods and software developed in one place could be applied in several places to harmonise calibration across the georing

Recalibration – Meteosat and JMA Satellites



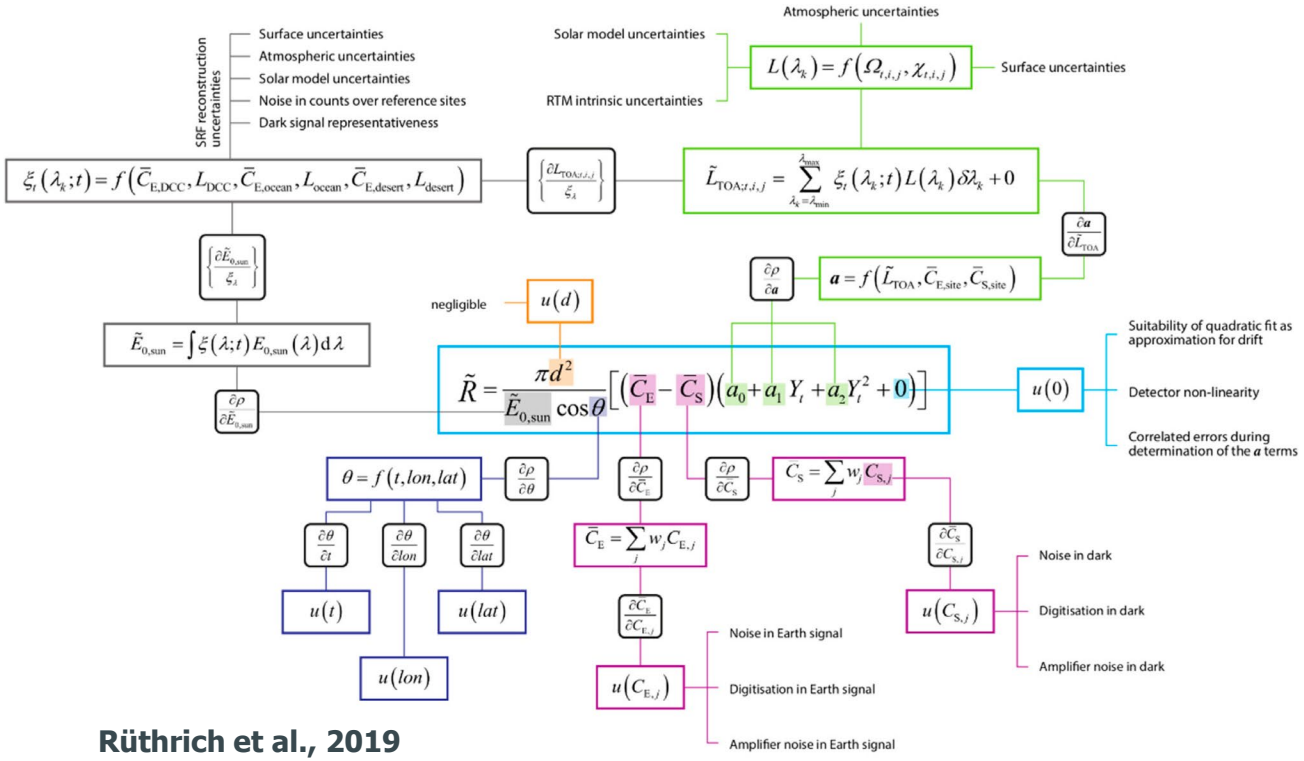
John, Viju O.; Tabata, Tasuku; Rüthrich, Frank; Roebeling, Rob; Hewison, Tim; Stöckli, Reto; Schulz, Jörg. 2019. "On the Methods for Recalibrating Geostationary Longwave Channels Using Polar Orbiting Infrared Sounders" Remote Sens. 11, no. 10: 1171. https://doi.org/10.3390/rs11101171

t.int

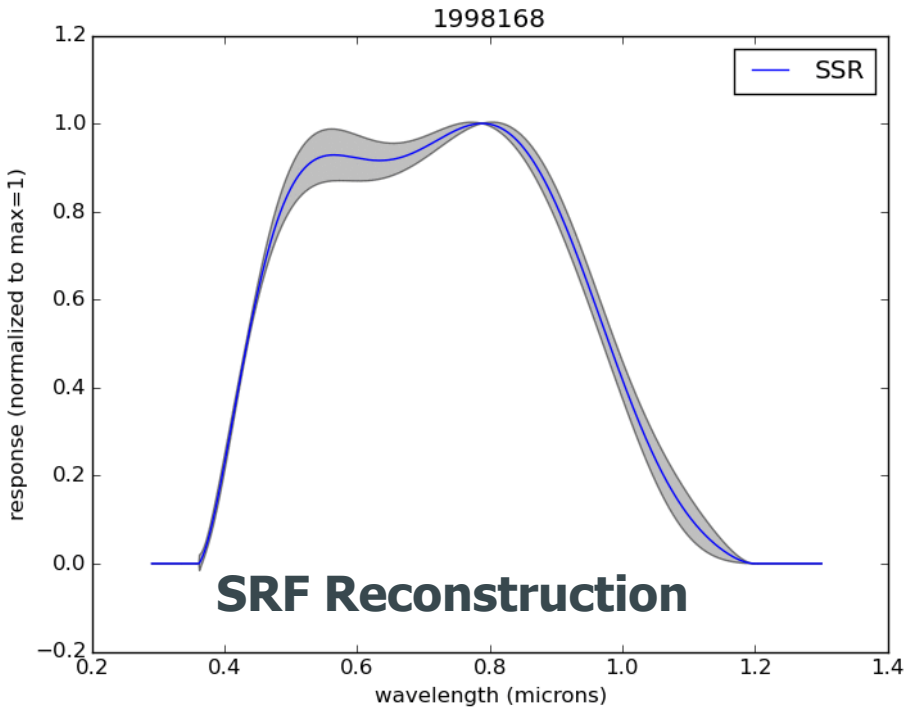


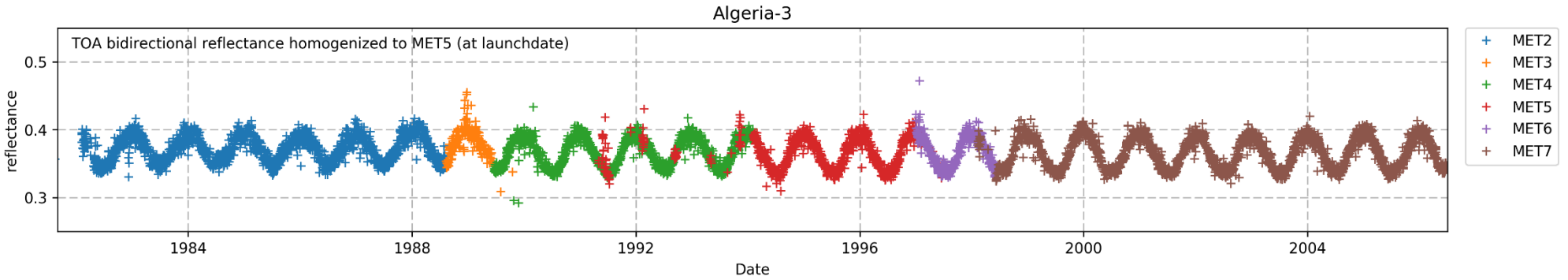
Tabata, T.; John, V.O.; Roebeling, R.A.; Hewison, T.; Schulz, J. Recalibration of over 35 Years of Infrared and Water Vapor Channel Radiances of the JMA Geostationary Satellites. Remote Sens. 2019, 11, 1189. https://doi.org/10.3390/rs11101189

Uncertainty Characterisation – MVIRI VIS Channel FCDR



Rüthrich et al., 2019



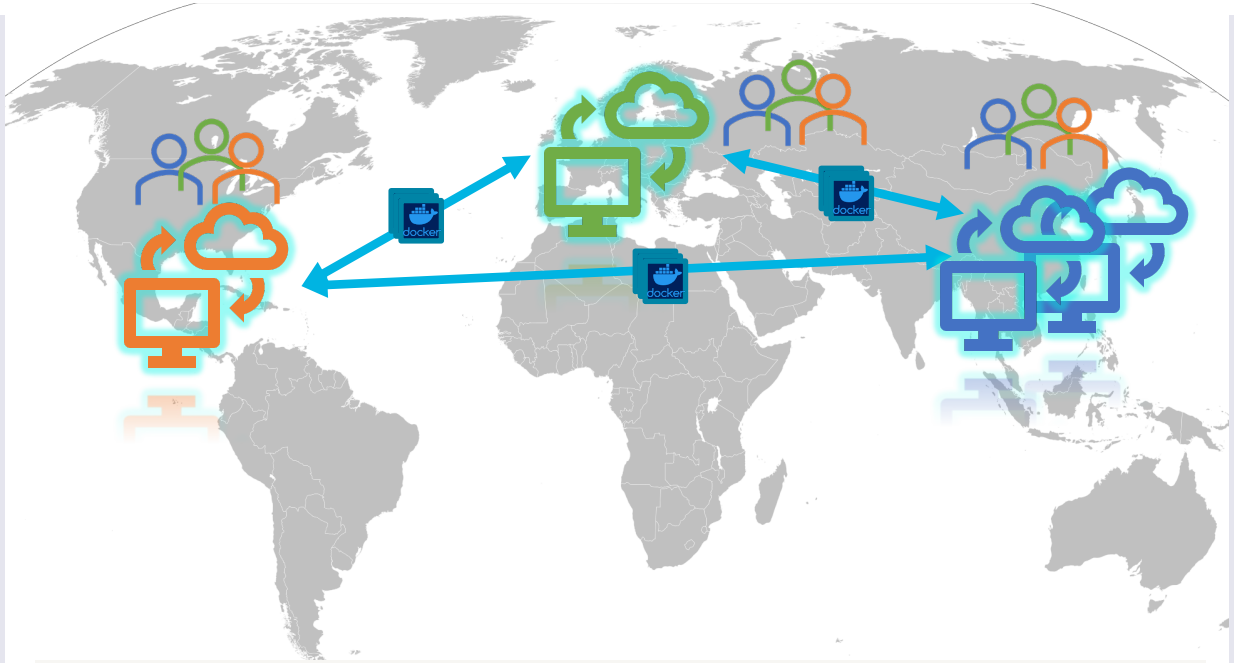


Potential benefits of using cloud infrastructure in a collaboration

Processing to the data

Share "best-of-breed" code
- QC including image anomaly detection
- Instrument cross-calibration
- Data processing
- Product validation
- …

Use of containers
- Interoperability in different cloud environments
- Allows local customisation



Possibility of mutual access to remote processing infrastructure
- to provide support in running processing code
- to facilitate remote validation work

Output data

Global gridded product
- Consistent and available from several agencies

Opens opportunity for later analysis-ready data and/or data cube approaches
- Simplifies usage
- Supports using subsets of the data, e.g., for local area analyses

Data used by other agencies and academia for downstream applications

Conclusion

- The archive of data from geostationary orbit continued by more modern instrumentation is a treasure to climate science and services
- More effective methods to detect radiometric anomalies in images have been developed and can be applied to all geo sensors. This supports data rescue and allows usage of partly damaged images
- Cross-calibration with polar orbiting sensors based on IASI, AIRS and an improved HIRS data records lead to harmonised time series for each orbit position. This method can also be applied to the whole ring
- Uncertainty characterisation based on metrology has been developed and can be extended to all past geostationary satellites
- Cloud infrastructure can be used to apply these methods in a more efficient way and allow space agencies to deliver the reduced volume products such as the planned ISCCP L1g to users in formats that allow easy use