



Satellite Data Reprocessing at EUMETSAT

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Plus endless people that helped along



WP3 EARTH SYSTEM OBSERVATIONS

Task 3.2: Satellite data rescue, reprocessing, and inter-calibration

- To provide consolidated radio occultation data records for Metop A and Metop-B instruments, and third-party instruments (CHAMP, COSMIC, and GRACE) (D3.14);
- To create an FCDR of SSM/T2 and AMSU-B/MHS radiances in collaboration with CMSAF and UK MetOffice (D3.11);
- Polar wind retrievals from AVHRR data record back to 1982 (D3.10);
- To inter-calibrate of radiance measurements from Meteosat First and Meteosat Second Generation, and for other geostationary satellites in collaboration with NOAA and JMA within SCOPE-CM (D3.12);
- To improve the AMV data records from Meteosat First Generation and Second Generation (D3.13).

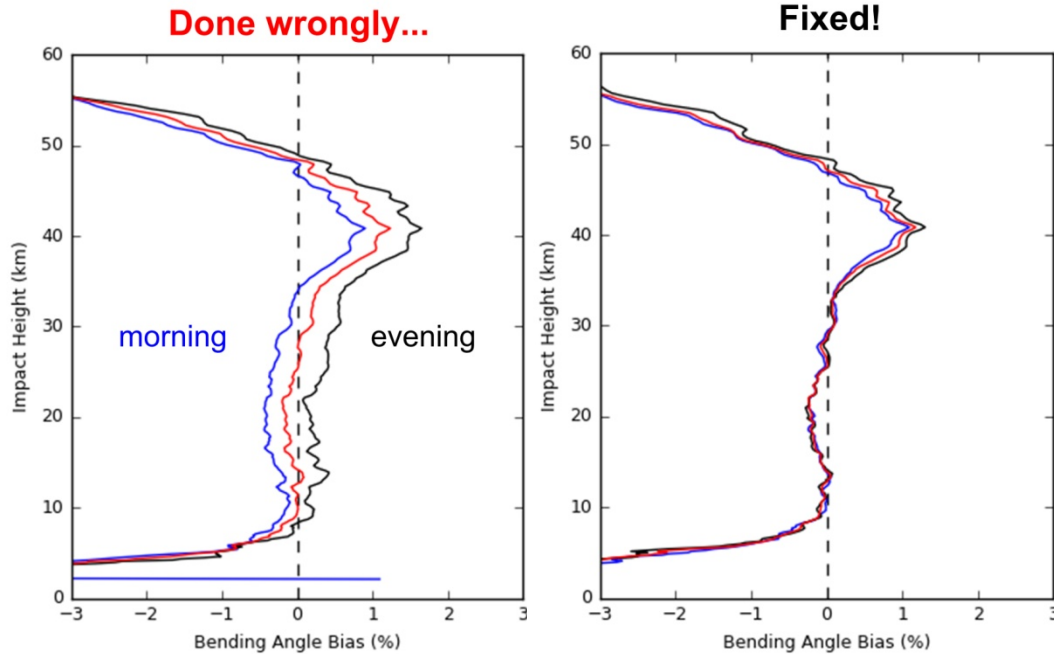
Done

- Completed the update to **WaveOptics** based processor for GRAS on Metop;
- Processed GRAS data (Metop-A and Metop-B) with the **WaveOptics** processor;
- Validation of GRAS bending angles revealed systematic error in height referencing due to non consideration of 26,000 year Earth precession;
- Corrected and reprocessed Metop-A (27/10/2016-31/12/2015) and Metop-B (29/09/2012-31/12/2015) with a further improved **WaveOptics** processor (improved vertical smoothing);
- Consequence: Preparations and processing of CHAMP/COSMIC data are delayed.

Planned

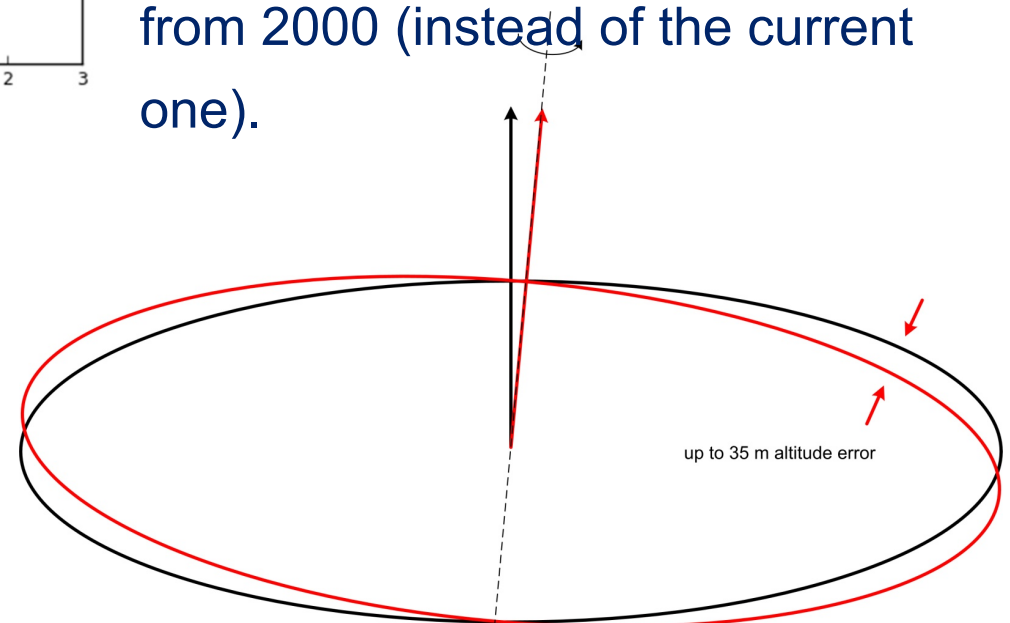
- Distribute updated GRAS data to ECMWF and ROM SAF for validation;
- COSMIC reprocessing to begin ~ March 2017
- CHAMP reprocessing Q2-3/2017
- Final delivery in Q4/2017.

Seeing the Earth Wobble



- Effect should have grown over the lifetime of Metop satellites (actually, doubled from 2007 - 2014);
- Orbit plane rotates around Earth axis, so there should be an annual cycle...

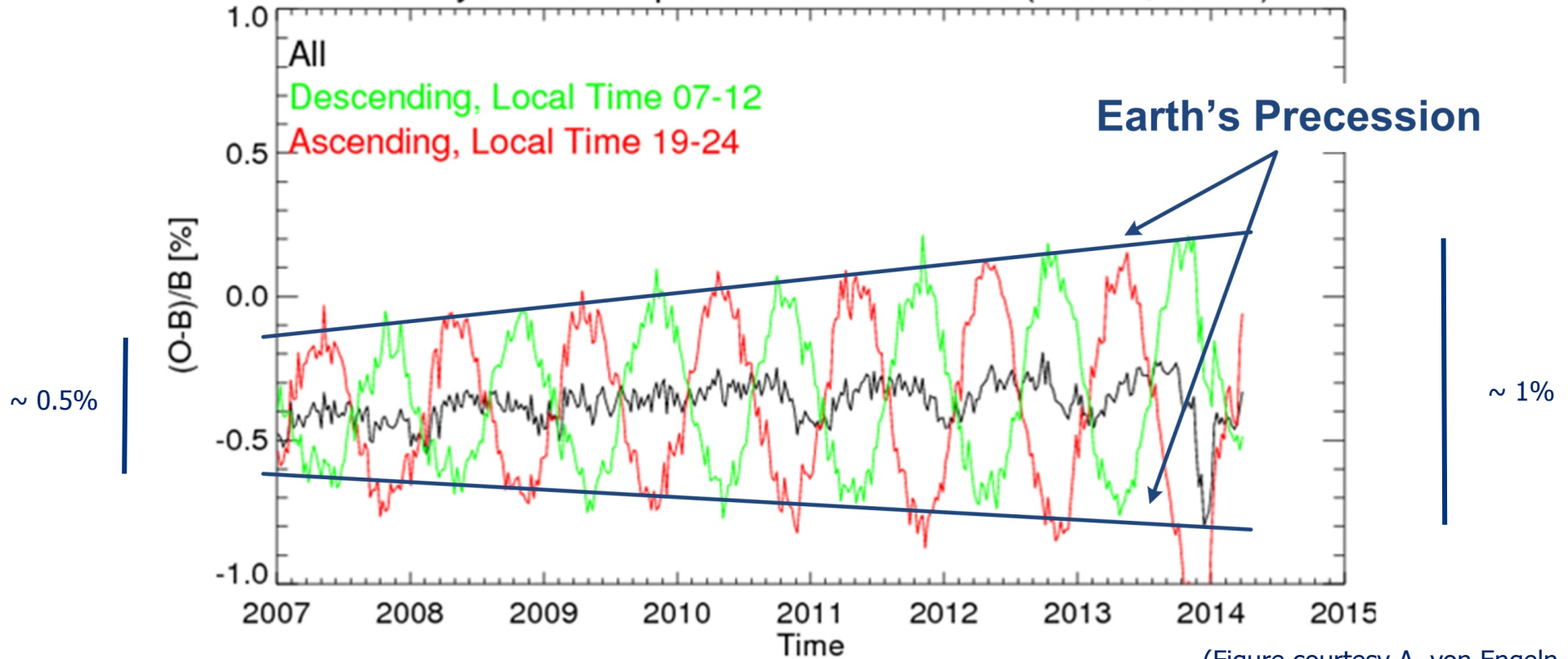
- S. Syndergaard (ROM SAF): Earth's 26.000-year precession, if not taken into account, causes an error in the altitude referencing, consistent with the biases found.
- We had used Earth's axis orientation from 2000 (instead of the current one).



(Figure courtesy S. Syndergaard, DMI)

Seeing the Earth Wobble (cont'd)

Weekly GRAS Repro vs. ECMWF Bias (NHML, 20km)



(Figure courtesy A. von Engel, EUM)

- Metop A (reprocessing) weekly biases against ECMWF Re-analysis
- Annual cycle in biases (as expected)
- Precession effect has about doubled since 2007 (as expected)

GRAS second reprocessing

Resulted in 2,930,776 occultations of 2,645,368 are of good quality.



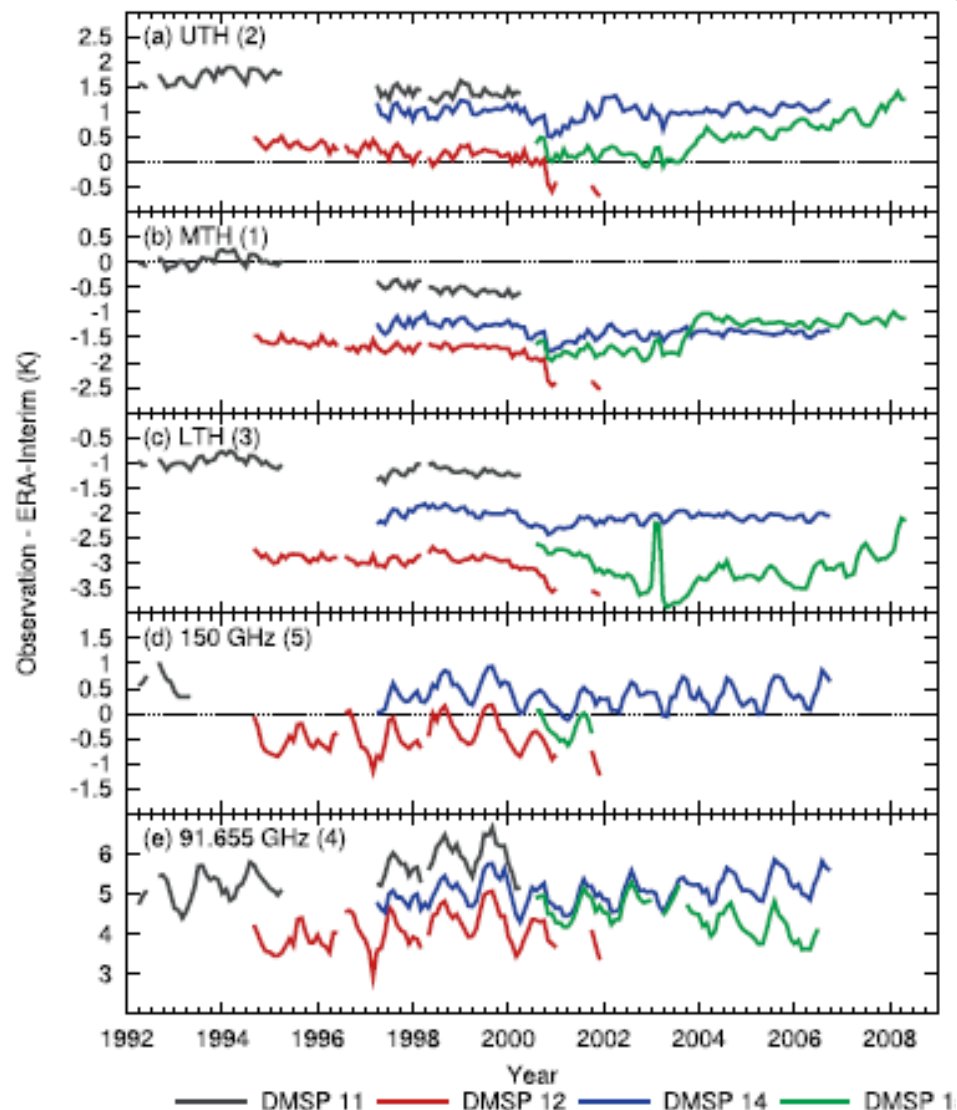
Fig. 2.2: Daily number of “good” (i.e., successfully processed; blue) and “bad” (red) occultations from the GRAS instruments onboard Metop-A (top) and -B (bottom) during the reporting period.

Done:

- CM SAF evaluated the following issues: scan & time dependent biases, diurnal cycle aliasing (orbit drift), assessment of inter-calibration method;
- CM SAF prepared inter-calibration ATBD for SSM/T2, AMSU-B and MHS, and delivered first data record;
- Evaluation shows that method seems not sufficient and needs to be reworked.

Planned:

- Update method;
- Generate and validate FCDR (Q2/2017).



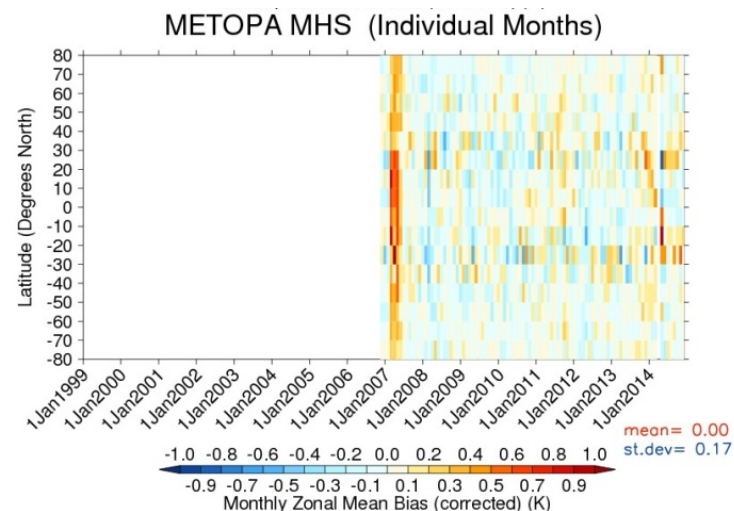
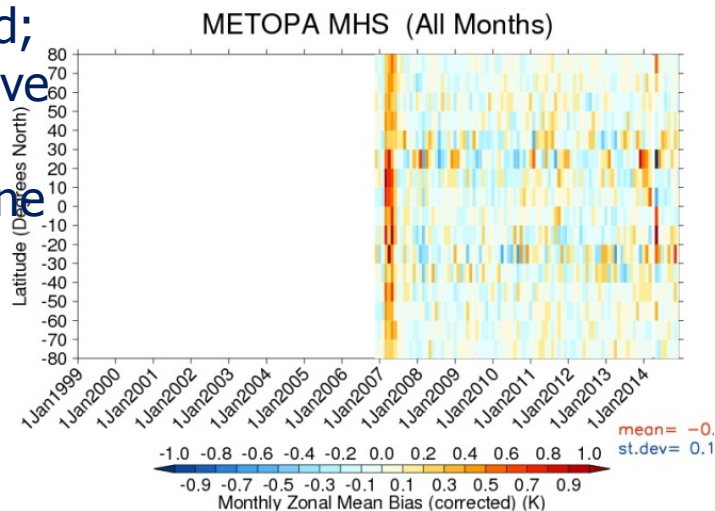
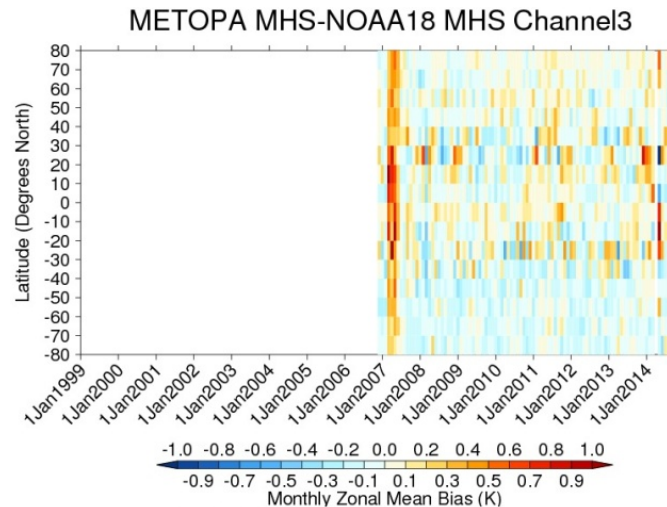
Courtesy Shinya Kobayashi, Paul Poli and Viju John

Figure: Departures of the upper tropospheric channel over tropical ocean (30N-30S) before correction.

- There are no reference instruments available for MW humidity sounders;
- One has to choose one of the available instruments as the reference (very similar approach to what is used for conical microwave imagers such as SSM/I);
- NOAA-18 MHS was selected to be the reference for all other radiometers due to two reasons:
 - The longest available dataset;
 - Found to be stable against ERA-Interim;
- Available methods for inter-calibration are:
 - Simultaneous Nadir Overpasses;
 - Vicarious calibrations using stable targets such as tropical ocean;
 - **Zonal average differences.**

Metop-A – NOAA18 MHS Biases

- Channel 3: 183 ± 1 Ghz (water vapour absorption)
- Individual months correction better because of not averaging out time varying biases;
- But checkerboard pattern due to the use of zonal/monthly average method;
- Work in progress to derive inter-satellite biases as smooth functions of scene temperature and time.



Monthly nadir view zonal mean biases for METOP-A compared to NOAA18 over years 2007-2014. Uncorrected biases are shown in the top panel, the remaining zonal mean bias after zonal means have been corrected in the other panels. Specifically, correction with the time mean zonal bias (ALLMONTHS) for all-sky (bottom left), and correction with time mean zonal bias for each calendar month (INDIVIDUAL MONTHS) for all-sky (lower right).

Done

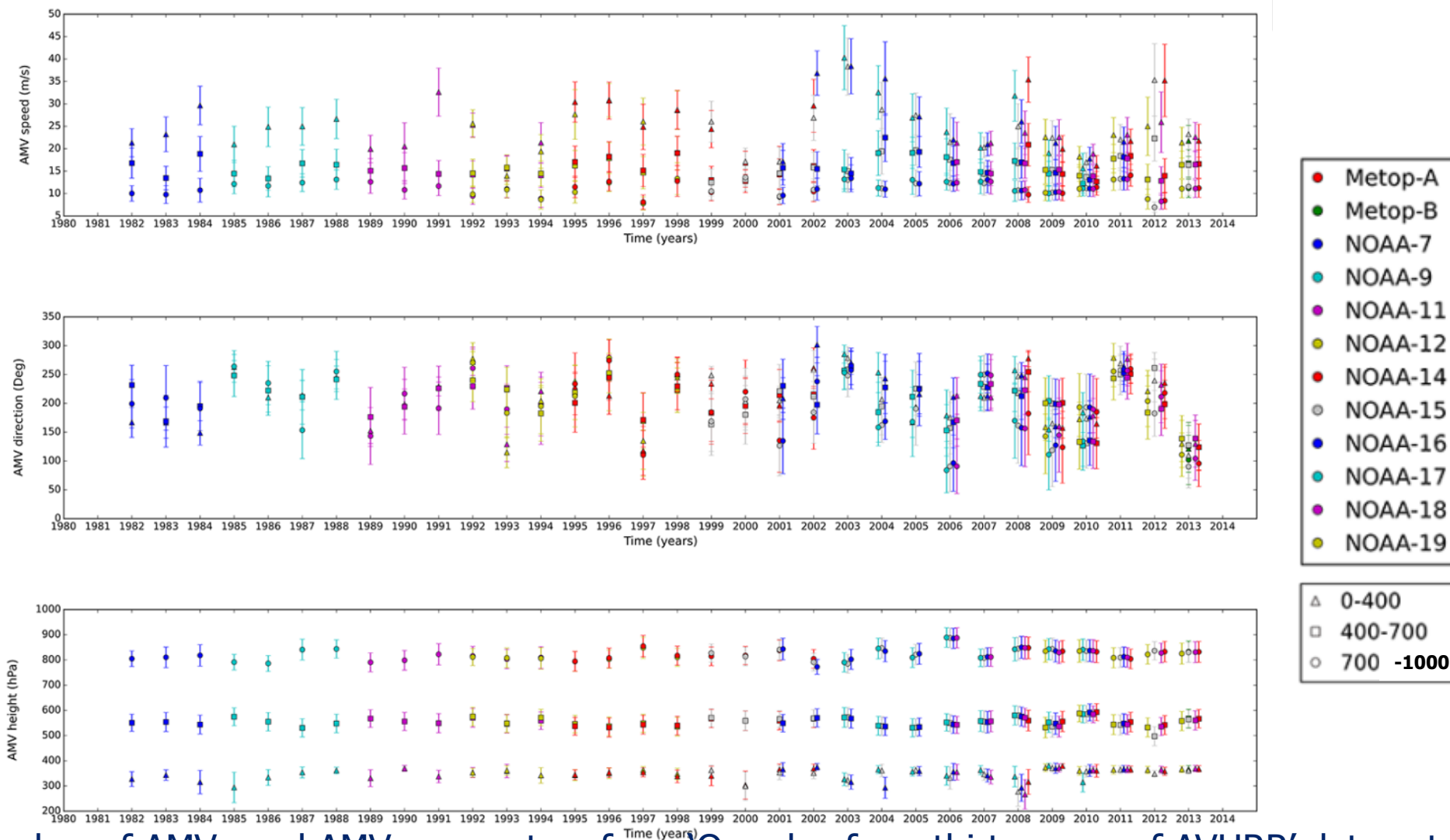
- Collected AVHRR GAC data (1982-2014) from the CM SAF (based on PATMOS-X);
- Modified the Cooperative Institute for Meteorological Satellite Studies (CIMSS) processing chain for polar winds retrievals from AVHRR Global Area Coverage (GAC) data;
- Implementation, testing and verification of AVHRR-GAC based polar winds;
- Ingestion of AVHRR GAC data into EUMETSAT algorithm;
- Adaptation of EUMETSAT algorithm to AVHRR GAC resolution;
- Implementation, test and verification of EUMETSAT algorithm (**ongoing**);

Planned

- Processing with CIMSS algorithm (Q1/2017);
- Processing with EUMETSAT algorithm (Q2/2017).

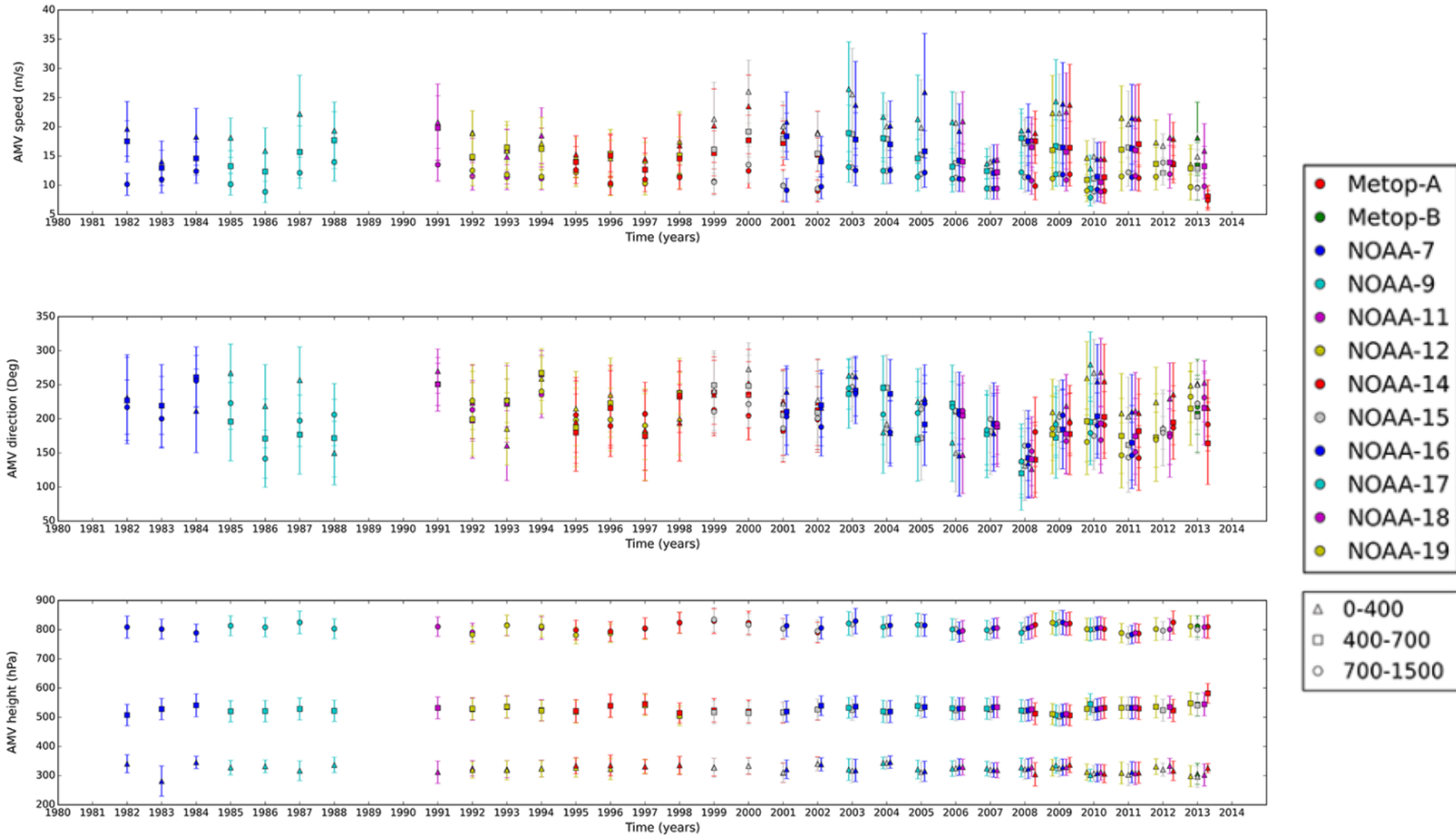
Note: Late availability of compute environment prohibited any integration of the EUMETSAT algorithm before late 2016.

AVHRR Polar Winds



Number of AMVs and AMV parameters from 'One day from thirty years of AVHRR' data set for Arctic AMVs with QI (quality) > 60, speed > 2.5m/s.

AVHRR Polar Winds



Number of AMVs and AMV parameters from one day from thirty years of AVHRR data set for Antarctic, AMVs with QI (quality) > 60, speed > 2.5m/s.

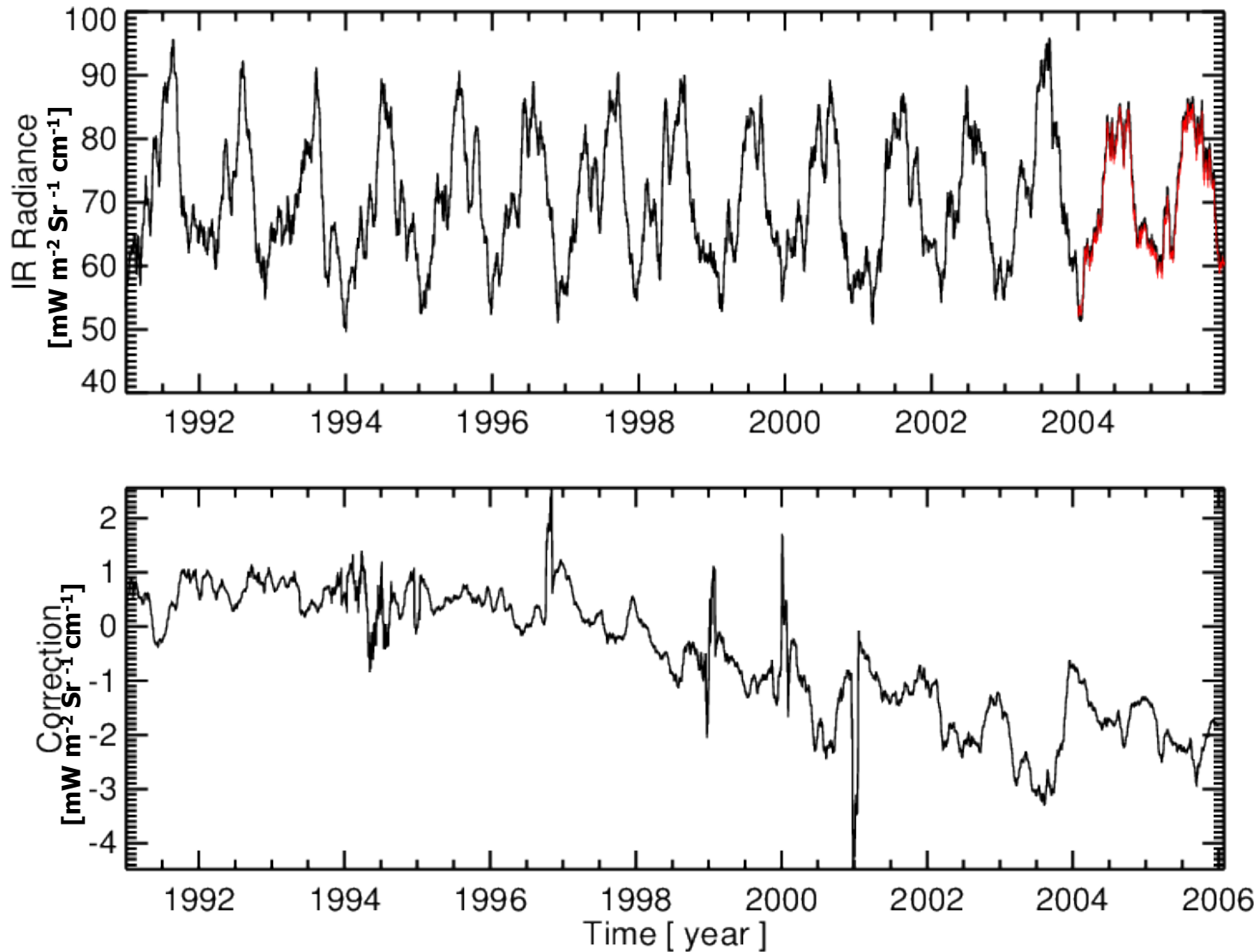
Done:

- Developed infra-red (IR) and water vapour (WV) re-calibration method;
- Generated IR and WV re-calibration coefficients for each individual MFG and MSG instrument (could not finish until end of 2016 because of not enough disc space for IASI data in the old compute environment);
- Generated band adjustment factor matrix (to enable homogenisation of the time series to any of the Meteosat satellites);
- Presented method in several conferences (EUMETSAT, ESA Living Planet, SPIE Asia), publication in preparation;
- Verified impact of re-calibrated IR/WV data for land surface temperature retrieval (CM SAF);
- Defined standard NetCDF format of the FCDR of MFG and MSG radiances.

Planned:

- Generate the MFG and MSG image files containing the re-calibration coefficients in standard NetCDF format;

Homogenised MFG and MSG radiances

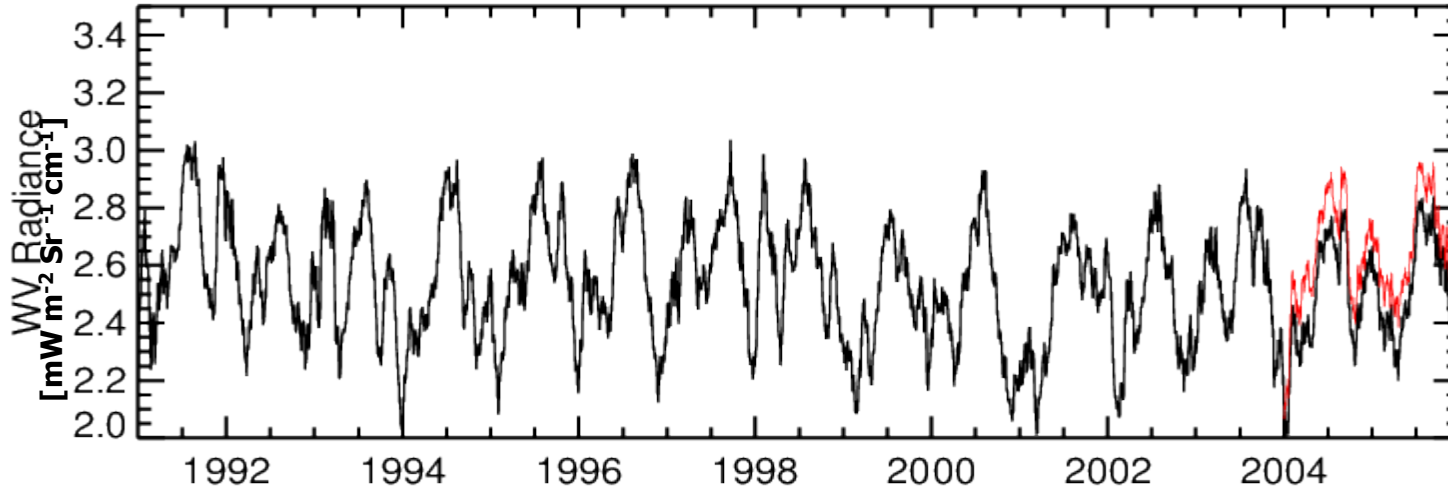


MFG

MSG

Homogenised IR
10.8 μm at Payerne
site with original
calibration (top) and
absolute correction
(bottom).

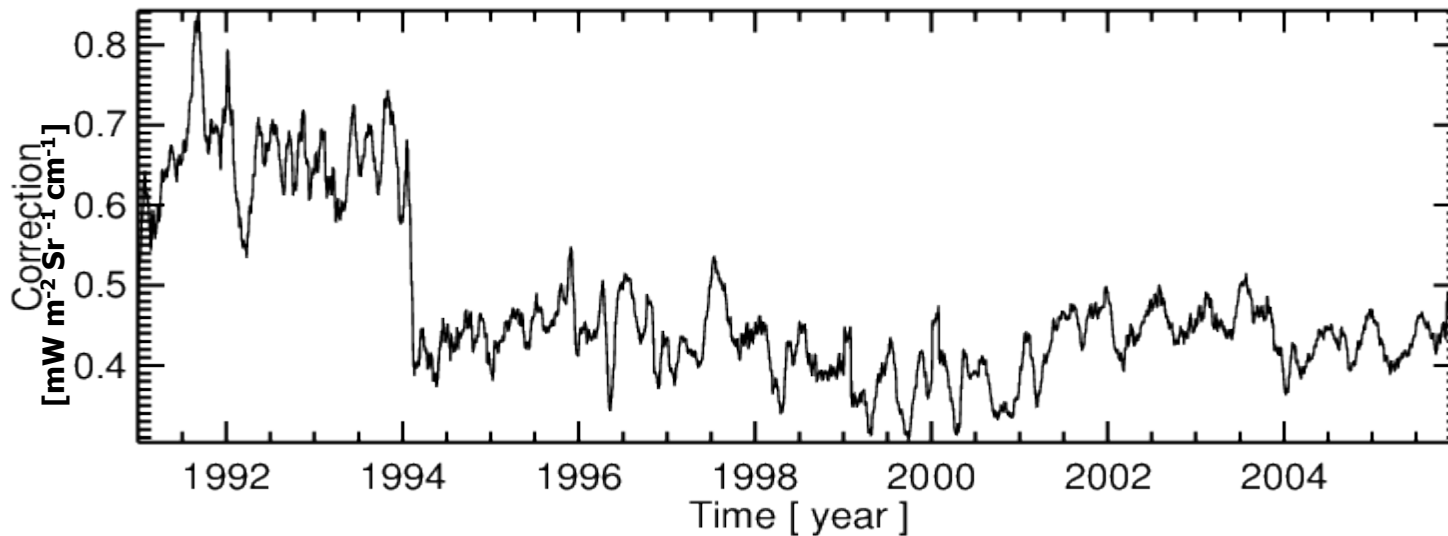
Homogenised MFG and MSG radiances



MFG

MSG

Homogenised IR 6.3 μm at Payerne site with original calibration (top) and absolute correction (bottom).



D3.13 - TCDR MFG and MSG AMVs (1982 - 2014)

Item	Development	Testing	Integration
Processing Environment	Modified framework on new infrastructure	Completed	Completed
Cloud Detection	Integration of CM SAF algorithm for MFG/MSG	Completed	Completed
Cloud Top Height	MFG development, MSG exist (based on EUMETSAT method)	Ongoing	None
ASR	None (reuse of EUMETSAT method)	Ongoing	Ongoing
CSR	None (reuse of EUMETSAT method)	Ongoing	None
AMV	Adaptation of MSG algorithm to MFG	Ongoing	None

- The integration could only be started after the new compute environment became available in late October 2016;
- Needs new images (D3.12);
- Deliverable postponed to Q4/2017.

- Good progress in all development activities. However, all processing tasks were hampered by the delayed availability of the new EUMETSAT compute environment which only became available in late October 2016;
 - Radio Occultation Bending Angle Profiles: Metop-A GRAS completed but validation detected error that triggered full reprocessing which has been finished for Metop-A and B up to December 2015. COSMIC and CHAMP wave optics processing in Q2 and Q3/2017. Delivery of all data in Q4/2017;
 - Microwave Sounder Radiances: Evaluation revealed needed change in inter-satellite calibration algorithm, updated algorithm expected in Q1/2017, delivery in Q2/2017;
 - AVHRR winds: algorithm implemented and tested, processing in Q1-Q2/2017, delivery Q4/2017;
 - Meteosat radiances: Re-calibration completed, images generation will be finished in Q1/2017, documentation and delivery in Q2/2017;
 - Meteosat Winds: Cloud analysis implemented, awaits new Meteosat images, processing in Q2-Q3/2017, delivery Q4/2017;
- Impact of delays is small as no other WP of ERA-CLIM2 is impacted and data will only be used in C3S ERA-6 that will not run before 2019;
- Present final data records at Re-analysis conference;
- Draft papers for each data record for ESSD or similar.

4th February 1979

15 images

Every hour from 08:30 UTC
until 23:30 UTC (*missing
images at 18:30 UTC*)

*Meteosat -1 was launched
on 23 November 1977. The
data discovered at the
Space Science and
Engineering Center at the
University of Wisconsin,
Madison, USA cover from 1
December 1978 to 24
November 1979.*

