The EUMETSAT Network of Satellite Application Facilities

CM SAF
Climate Monitoring

CDR's from EUMETSAT's CM-SAF -an update-

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Deutscher Wetterdienst (DWD)
With contributions from the full team

http://www.cmsaf.eu

EUMETSAT
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD
KNMI
RMI
SMHI
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Met Office

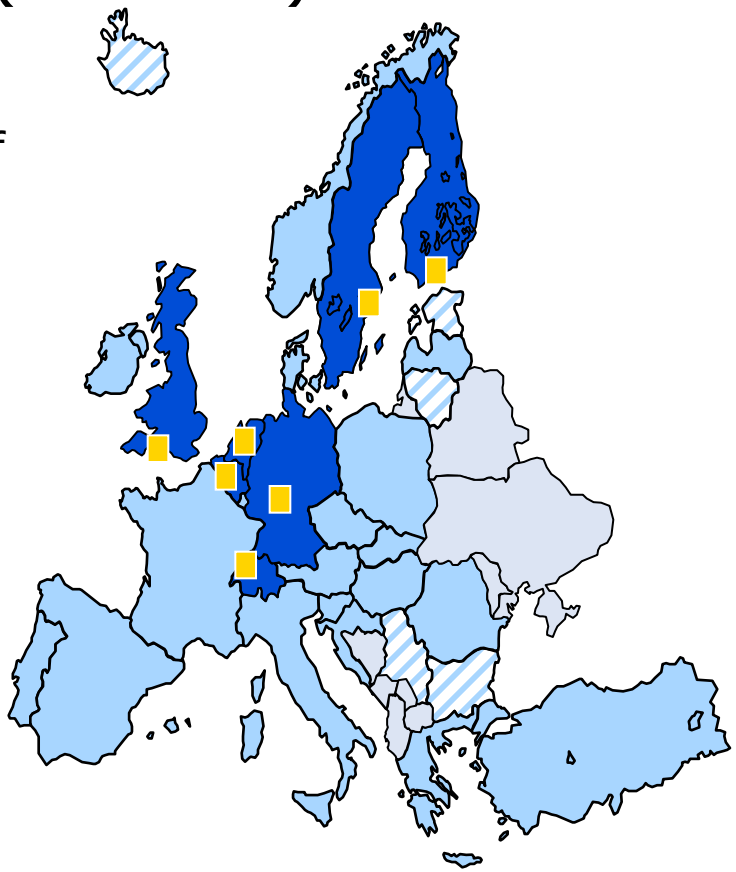
Content

- **EUMETSAT's CM SAF**
- **Overview of CM SAF'S generated ECV's**
- **CM SAF CDR process**
- **CM SAF FCDR on SSM/I, CDR on Humidity and Temperature, FTH geostationary CDR**
- **Summary**

CM SAF overview

EUMETSAT **S**atellite **A**pplication **F**acility on **C**limate **M**onitoring (CM SAF)

- With other SAF and CF part of EUMETSAT Ground segment
- Sustained Operational Facility
- Co-funding scheme between partners and EUMETSAT
- ~20 scientist involved



EUMETSAT Member States

EUMETSAT Cooperating States

CM SAF Member States

SMHI

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

RMI

Met Office

Deutscher Wetterdienst DWD

Targeted User Communities

- **Global and regional climate trends and variability analysis**
  - high quality Climate Data Records (CDR) are expected e.g. for climate studies in contribution to IPCC.
  - Thematic Climate Data Records (TCDR) from CM SAF will provide consistent information on Essential Climate Variables (ECV) related to the global energy and water cycle supporting closure studies

- **Support to global and regional climate modelling**
  - use of Climate Data Records for model evaluations, feedback studies, and uncertainty studies
  - these datasets needed at high(er) temporal and spatial resolutions
  - most recent satellite instrument, only cover short time periods.

- **Operational climate monitoring and infrastructure planning**
  - long term Climate Data Records (of ECVs) AND near real time operational products required
  - Consistent climate datasets and according near real time operational products needed (identical algorithm and auxilliary data)

The EUMETSAT Network of Satellite Application Facilities

CM SAF Climate Monitoring

CM SAF CDR Product portfolio

Sensor, Satellite resp.	Parameter	Release	Period	Coverage
Fundamental **C**limate **D**ata **R**ecord (FCDR)				
SSM/I, SSMIS	Microwave Radiances	**2012** 2014 (16)	**1987 – 2008** 1987 – 2012 (14)	global
Climate Data Record (CDR)				
SEVIRI	Cloud parameters, surface rad., aerosol optical depth ECV A04, A06, A09, T22	**2013** 2015	**2004 – 2011** 2004 – 2014	Europe & Africa
GERB/SEVIRI	Top of atmosphere radiative fluxes ECV A06	**2013** 2015	**2004 – 2011** 2004 – 2014	Europe & Africa
MVIRI/SEVIRI	Cloud parameters, surface radiation parameters, land surface temp., FTH ECV A04, A06, A03	**2011** 2014 2016	**1983 – 2005** 1983 – 2012 1983 – 2015	Europe & Africa
MVIRI/SEVIRI/ GERB	Top of atmosphere radiative fluxes ECV A06	2015	1982 – 2014	Europe & Africa
AVHRR GAC	Cloud parameters, surface radiation parameters, incl. albedo ECV A04, A06, T22	**2012** 2015	**1982 – 2009** 1982 – 2014	global
TOVS/ATOVS	(high) cloud amount and top ECV A04	2016	1984 – 2009	global
ATOVS	Water vapour and Temperature profile ECV A03	2013	**1998 – 2008**	global
SSM/I, SSMIS	HOAPS (precip, evap, hum., wind, …) ECV A01, A03, A05	**2011** 2015 (17)	**1987 – 2008** 1987 – 2012 (14)	global ice free ocean

CM SAF CDR
Product portfolio

Sensor, Satellite resp.	Parameter	Release date	Period	Coverage
Fundamental **C**limate **D**ata **R**ecord (FCDR)				
SSM/I, SSMIS	Microwave Radiances	2012 2014 2016	1987 – 2008 1987 – 2012 1987 – 2014	**Released**
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GERB/SEVIRI	Top of atmosphere radiative fluxes	2012 2015	2004 – 2009 2004 – 2014	**Released**
MVIRI/SEVIRI	Cloud parameters, surface radiation parameters, land surface temp., FTH	**2011** 2014 2016	**1983 – 2005** 1983 – 2012 1983 – 2015	**Released**
MVIRI/SEVIRI/GERB	Top of atmosphere radiative fluxes	2015	1982 – 2014	Europe & Africa
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TOVS/ATOVS	(high) cloud amount and top	2016	1984 – 2009	global
SSM/I, SSMIS	HOAPS (precip, evap, hum., wind, …)	**2011** 2015 2017	**1987 – 2008** 1987 – 2012 1987 – 2014	**Released**

CM SAF CDR's
A structured process

Setting the requirements in the beginning
(RR, requirement review)

The EUMETSAT Network of Satellite Application Facilities
CM SAF
Climate Monitoring

Requirements Review

Meteosat Shortwave Radiation Products

CM-23081, CM-23201, CM-23231

Reference Number:	SAF/CM/DWD/RR21
Issue/Revision Index:	1.0
Date:	27.05.2013

CM-144	**Precipitation**		**PRE_HOAPS**
Type	Dataset		
Applications and users	* Climate Research * NMHSs		
Characteristics and Methods	Composite Monthly Mean		
Comments	Target time series covers 1987-2008. Accuracy numbers are given for global mean values. Regional larger deviations may occur.		
Traceability of Requirements	See section 10.4 for details.		
Generation frequency	N/A		
Input satellite data	SSM/I		
Dissemination			
Format	Means	Type	
Netcdf CF	FTP	offline	
Accuracy			
Threshold	Target	Optimal	
0.03 mm/d decadal stability 1.6 mm/d bias 2.25 mm/d rms	0.015 mm/d decadal stability 0.25 mm/d bias 0.5 mm/d rms	0.002 mm/d decadal stability 0.1 mm/d bias 0.2 mm/d rms	
Verification method	Comparison to ship and buoy based measurements		
Coverage, resolution and timeliness			
Spatial coverage	Spatial resolution	Vertical resolution	Timeliness
global ice free ocean	0.5°	n/a	N/A

Definition of requirements

Traceability, detailed definition of requirements

CM SAF CDR's
A structured process

Setting the requirements in the beginning
(RR, requirement review)

Algorithms

Consolidate the product
(PCR, Product consolidation review)

EUMETSAT Satellite Application Facility on Climate Monitoring

Algorithm Theoretical Basis Document

Fundamental Climate Data Record of SSM/I Brightness Temperatures

CM-150 FCDR_SSMI

Reference Number:	SAF/CM/DWD/ATBD/FCDR_SSMI
Issue/Revision Index:	1.0
Date:	05.11.2011

CM SAF CDR's
A structured process

Setting the requirements in the beginning
(RR, requirement review)

Consolidate the product
(PCR, Product consolidation review)

Implementation and processing

Data set readiness
(DRR, Data set Readiness review)

EUMETSAT Satellite Application Facility on Climate Monitoring

EUMETSAT Satellite Application Facilit

Product User Manual

Fundamental Climate Data Record of
SSM/I Brightness Temperatures

EUMETSAT Satellite Application Facility on Climate Monitoring

Algorithm Theoretical Basis Document

Fundamental Climate Data Record of
SSM/I Brightness Temperatures

CM-150 FCDR_SSMI

Validation Report

Fundamental Climate Data Record of
SSM/I Brightness Temperatures

Reference Number: SAF/CM/DWD/ATBD/FCDR_SSMI
Issue/Revision Index: 1.0
Date: 05.11.2011

ATBD
Product User Manual
Validation Report
System description
Data set

CM SAF CDR's
A structured process

Setting the requirements in the beginning
(RR, requirement review)

↓

Consolidate the product
(PCR, Product consolidation review)

↓

Data set readiness
(DRR, Data set review)

↓

Data set public available
www.cmsaf.eu & DOI

DOI for scientific and technical data
10.5676/EUM_SAF_CM/FCDR_SSMI/V001

Title
Fundamental Climate Data Record of SSM/I Brightness Temperatures

Citation
Fennig, Karsten; Andersson, Axel; Schröder, Marc (2013): Fundamental Climate Data Record of SSM/I Brightness Temperatures - . Satellite Application Facility on Climate Monitoring. DOI:10.5676/EUM_SAF_CM/FCDR_SSMI/V001. http://dx.doi.org/10.5676/EUM_SAF_CM/FCDR_SSMI/V001

Publisher
Satellite Application Facility on Climate Monitoring (CM SAF)

Publication year
2013

Author(s)
Fennig, Karsten; Andersson, Axel; Schröder, Marc

Description
The CM SAF Fundamental Climate Data Record of SSM/I Brightness Temperatures covers the time period from July

Size
1.8 TB

Documentation
Algorithm Theoretical Basis Document (ATBD)
Product User Manual (PUM)
Validation Report

Dataset details and ordering
Brightness Temperatures (BTR) from SSM/I F08
Brightness Temperatures (BTR) from SSM/I F10
Brightness Temperatures (BTR) from SSM/I F11
Brightness Temperatures (BTR) from SSM/I F13
Brightness Temperatures (BTR) from SSM/I F14
Brightness Temperatures (BTR) from SSM/I F15

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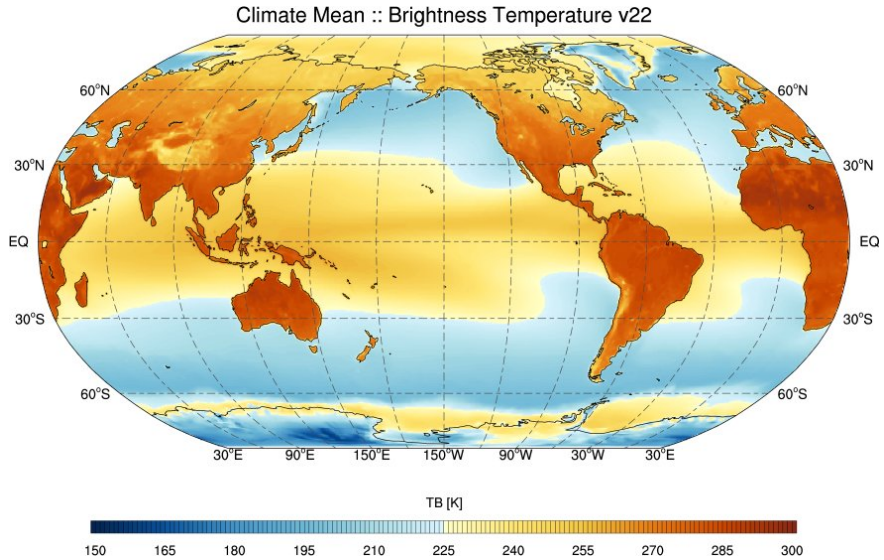
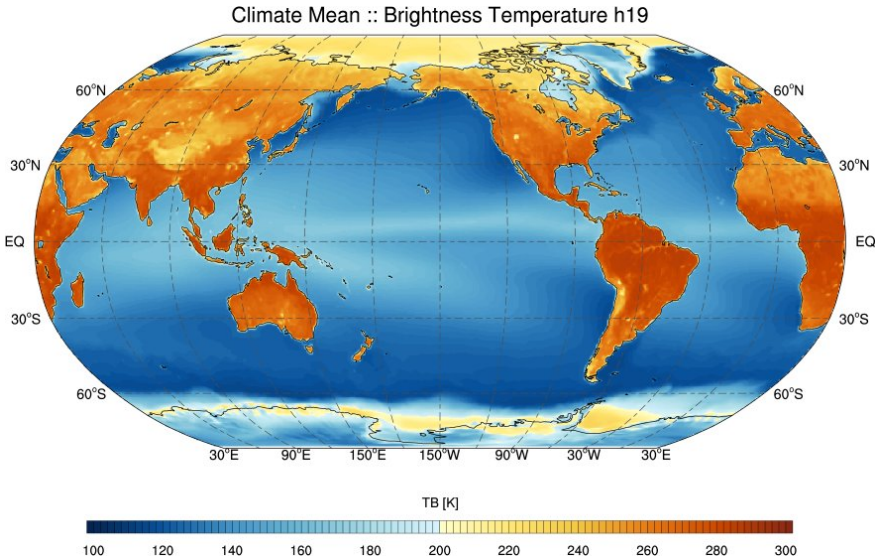
CM SAF FCDR of SSM/I Brightness Temperatures





DOI: 10.5676/EUM_SAF_CM/FCDR_SSMI/V001

- **July 1987 – December 2008.**
- Calibration with smoothed cold and hot load readings
- geo-location based on smoothed TLEs.
- Data processing accounts for known issues:
  - Moonlight-intrusions,
  - Sunlight-intrusions,
  - Along-scan non-uniformity.

- 85 GHz Brightness temperatures averaged to 37 GHz antenna pattern.
- Synthetic 85 GHz data over ocean for F08.
- Earth incidence angle normalization
- Non-linearity calibration coefficient.
- Scene dependent inter-calibration to F11.

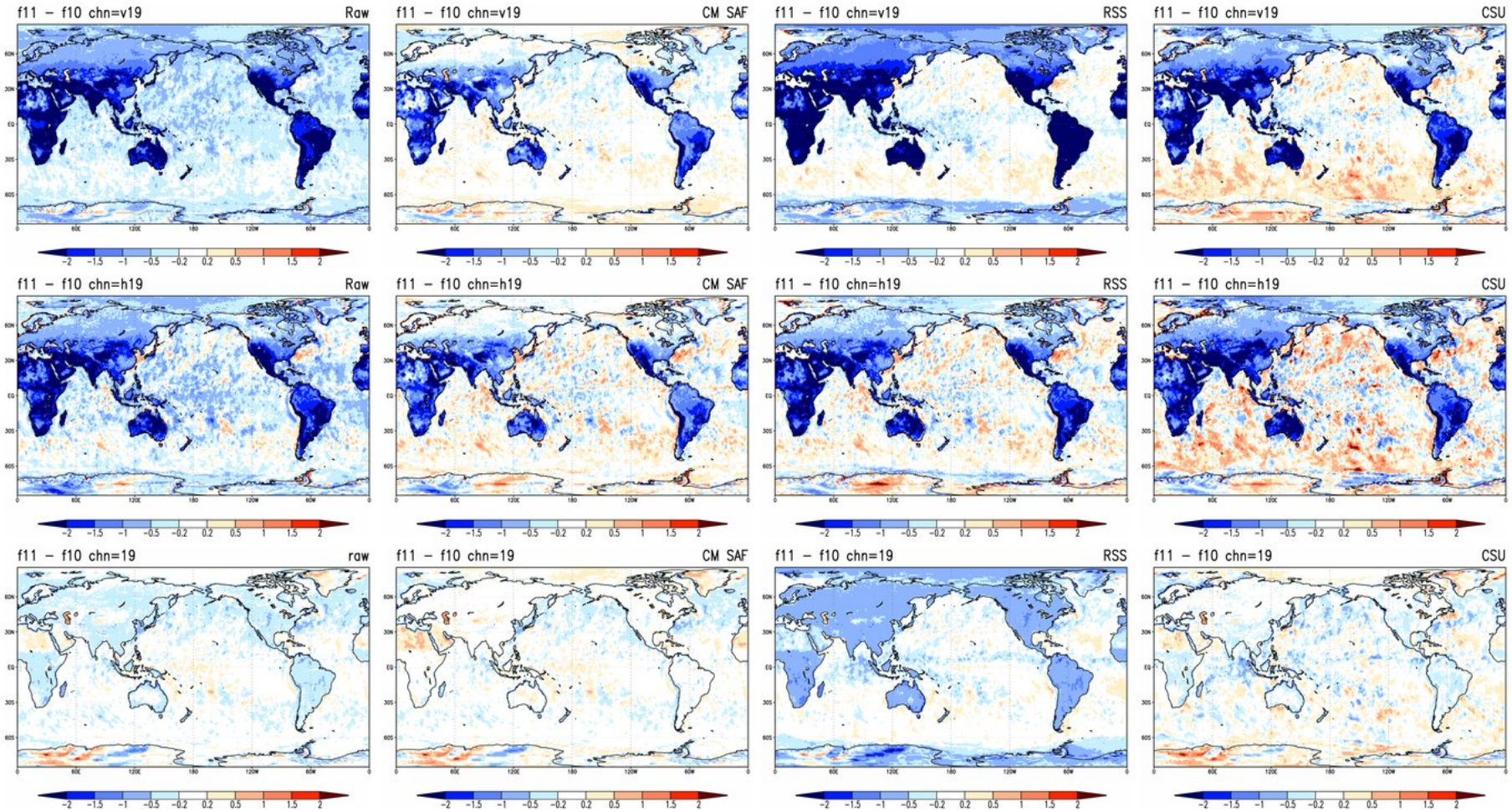
Inter-calibration Results: Global Maps

F11 – F10 RDR CM SAF FCDR RSS FCDR CSU FCDR

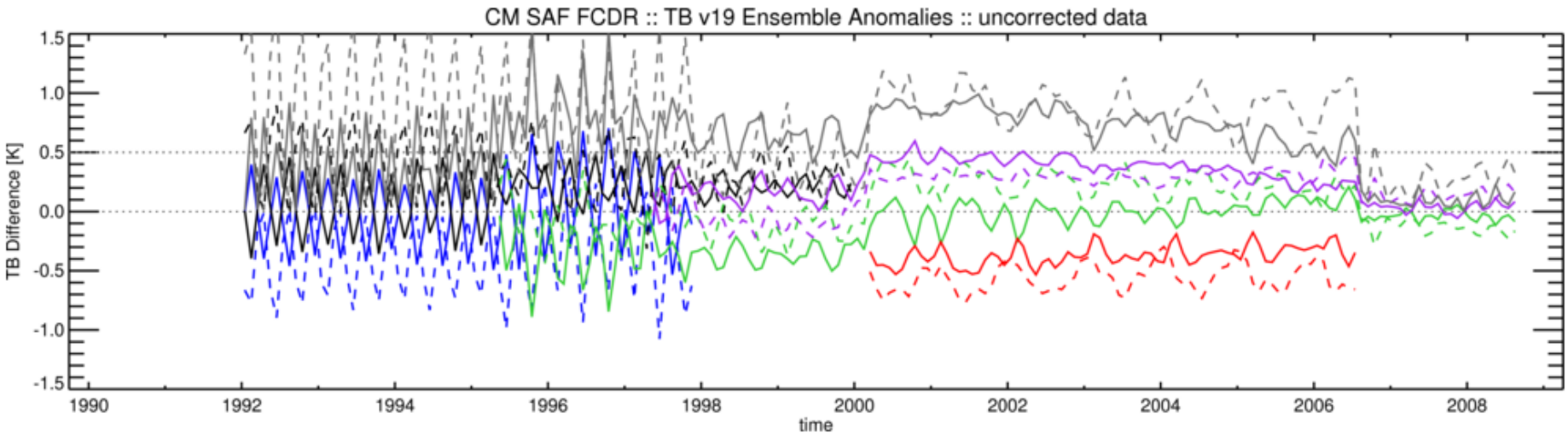
19v

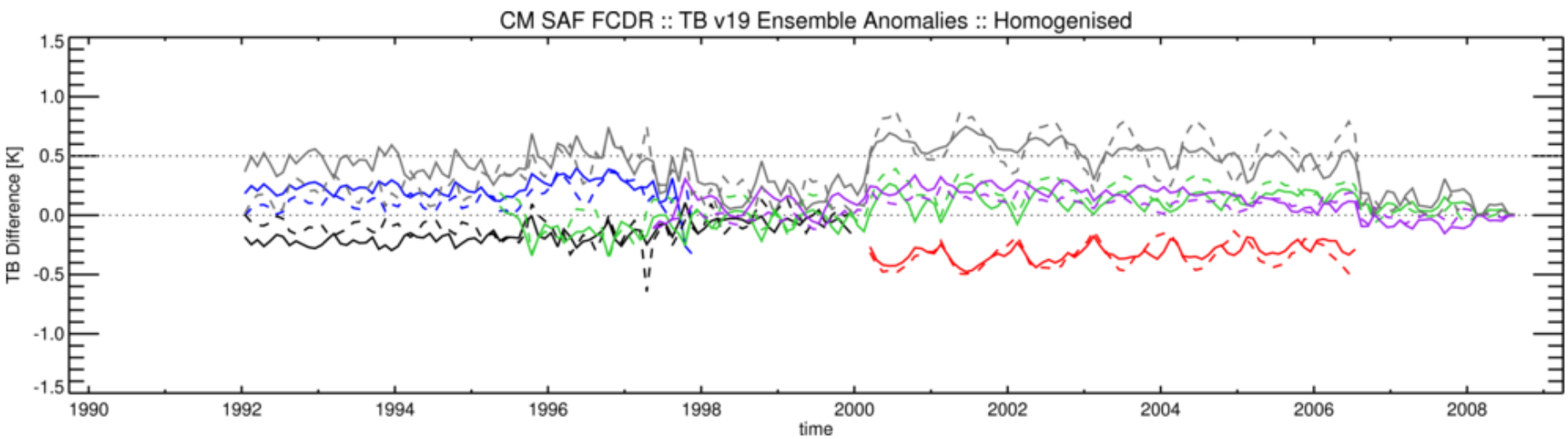
19h

19v - 19h

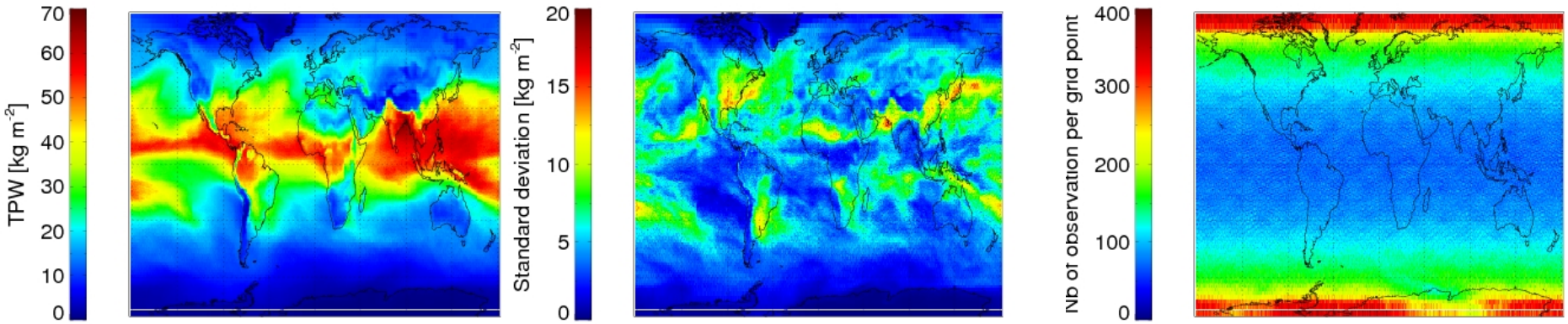


Evaluation TB v19:Homogenisation





CM SAF TCDR of Water vapour and Temperature



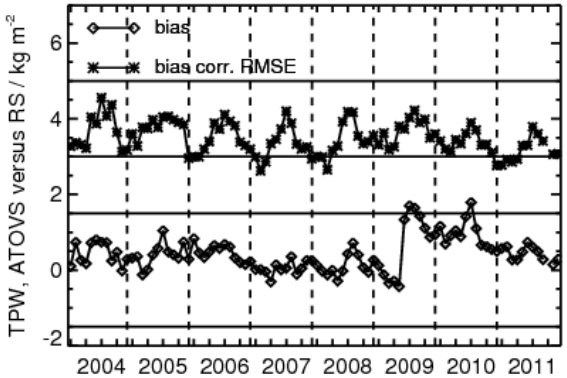
- DOI: 10.5676/EUM_SAF_CM/WVT_ATOVS/V001

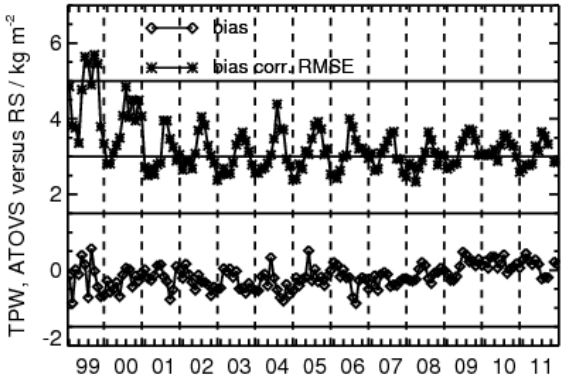
- Time period: 1999 – 2011, 90 km × 90 km, NetCDF, CF and metadata Convention v1.5, Monthly and daily products

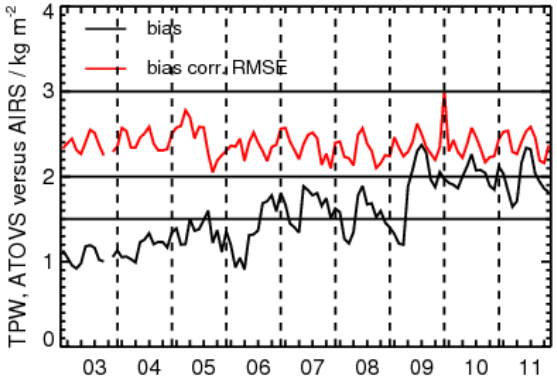
- Global humidity and temperature products:
    - HTW: total precipitable water vapour
    - HLW: layered precipitable water vapour and temperature in 5 layers
    - HSH: Specific humidity and temperature at 6 levels

- Derived from the ATOVS instruments (AMSU-A, -B, MHS, HIRS) flying onboard the NOAA and Metop polar orbiting satellites

CM SAF TCDR of Water vapour and Temperature



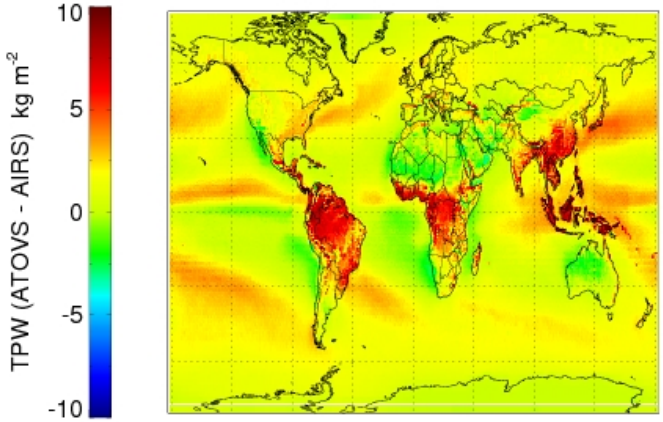




- Comparison against the corresponding CM SAF ATOVS operational products
- Validation against GUAN radiosonde data
- Validation against AIRS satellite data

- Good agreement with GUAN
- Some issues that are well understood in the AIRS validation

- Increased bias in AIRS relative to GUAN was also documented in other studies (e.g. ESA's GlobVapour)



CM SAF TCDR of Free tropospheric humidity (FTH)

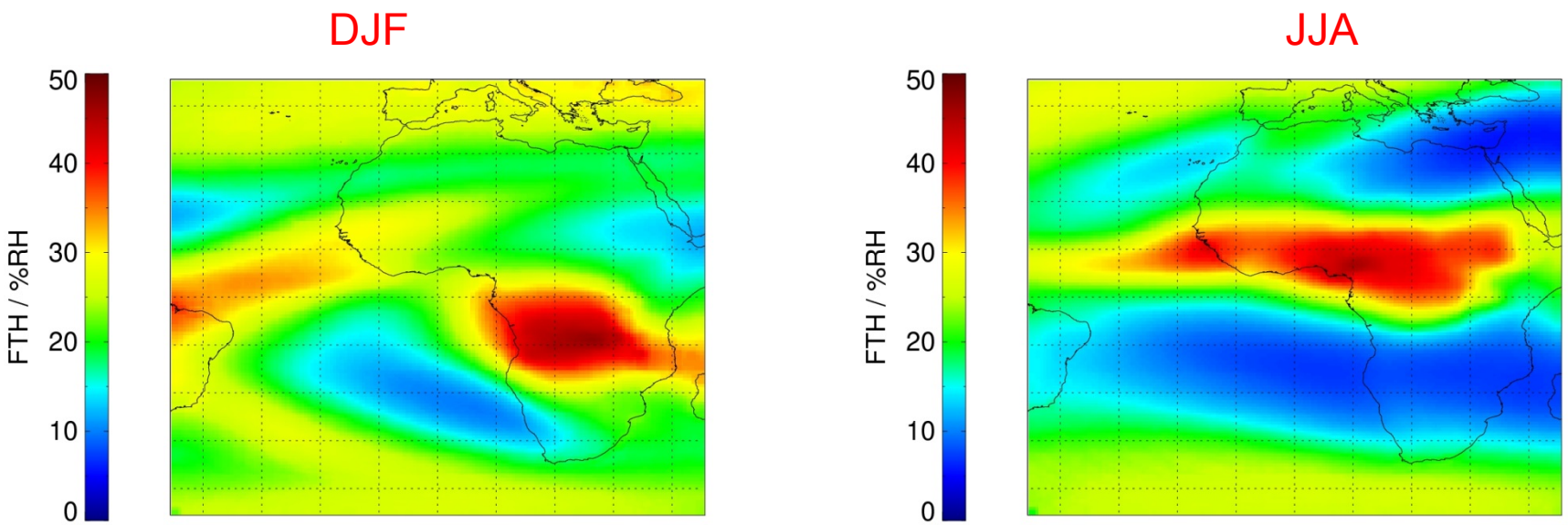
DOI: 10.5676/EUM_SAF_CM/FTH_METEOSAT/V001

Instruments used: MVIRI + SEVIRI: METEOSAT 2-5, 7-9.

July 1983 – December 2009, Tropical Africa/Atlantic: 45°N/S/E/W in 0.625° spatial resolution, 3 hourlies, monthly averages.

Input: ISCCP radiances, SEVIRI radiances from DWD archive, ERA-Interim, ISCCP cloud mask and cloud top pressure.

Retrieval after (Roca et al., 2009), homogenisation after Picon et al. (2003), inter-calibration after Breon et al. (2000).



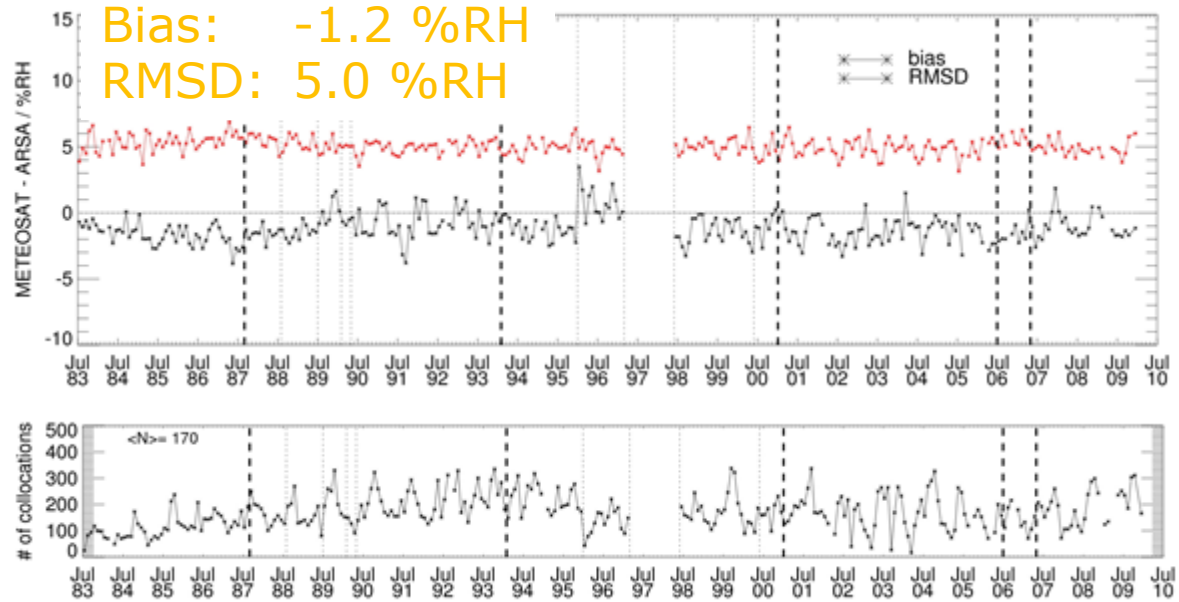
FTH: Homogenisation & Validation

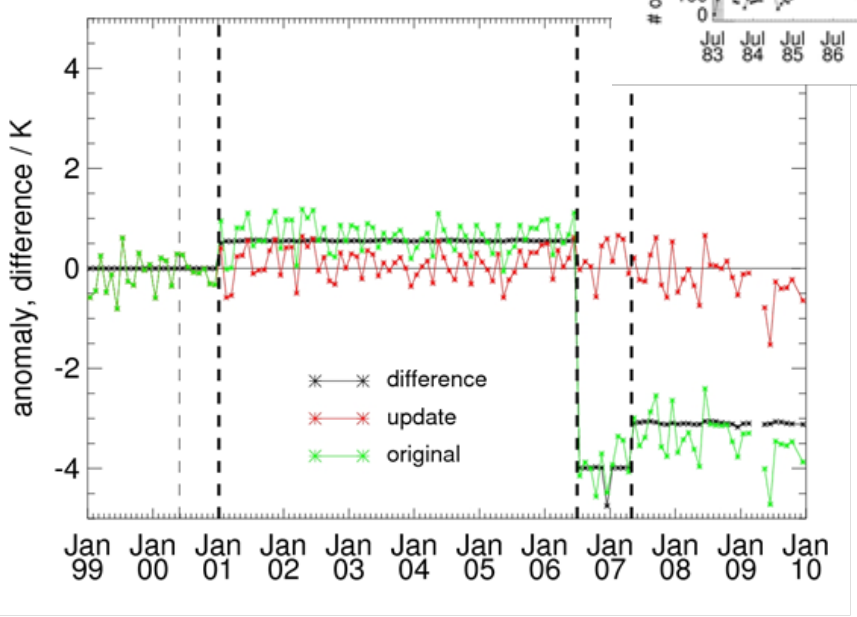
Homogenisation 2000-2009:

Breakpoints due to:

- Change in black-body calibration
- MET7-MET8
- MET8-MET9

(method: Brogniez et al. (2009))



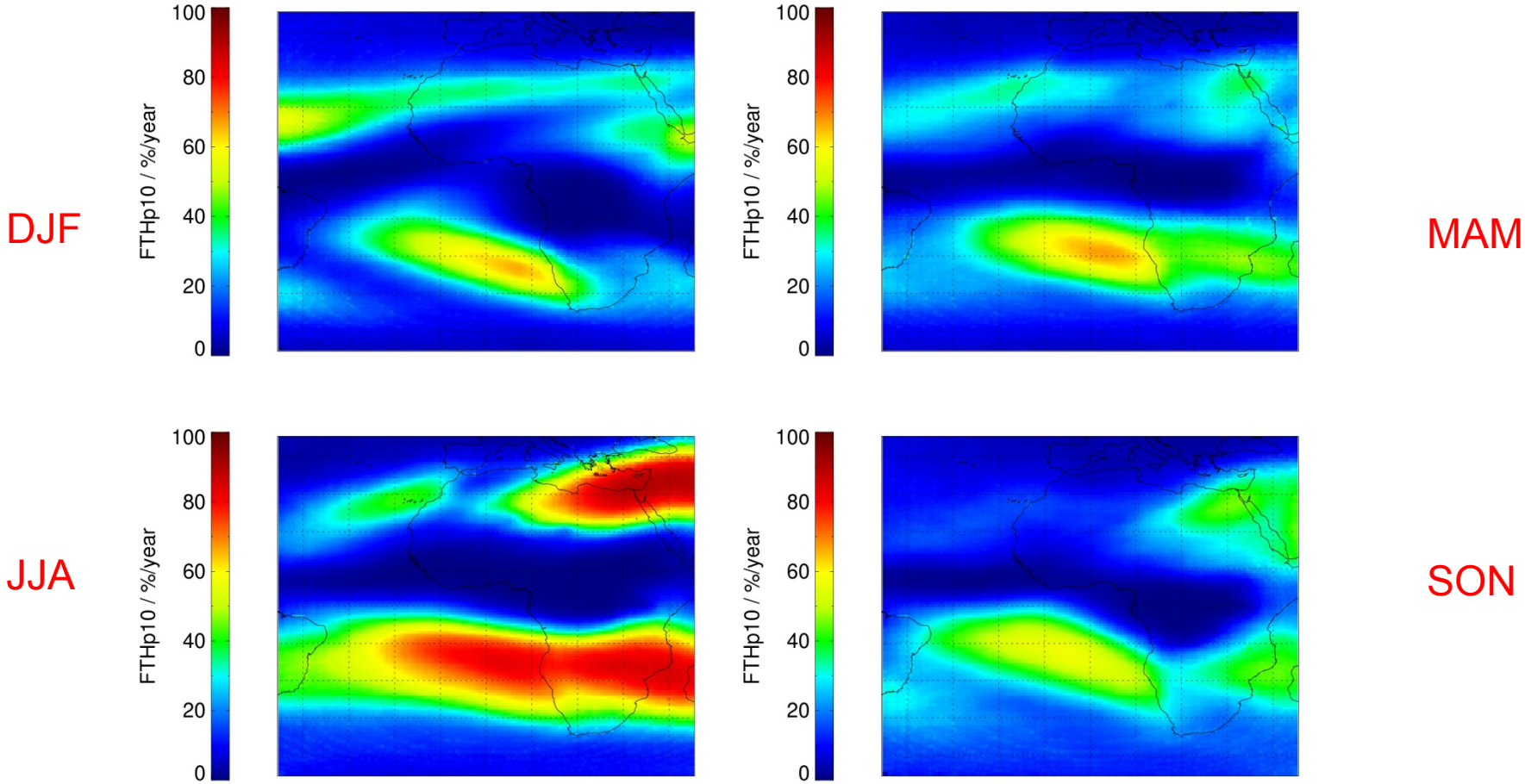


Validation: ARSA (Analysed RadioSoundings Archive, from ARA-LMD) as input to RTTOV (from NWP SAF), simulate METEOSAT obs at 6.3 microns, compare to observations using Jacobians to validate FTH (after Brogniez et al., 2006).

Also comparisons to UTH from HIRS and AMSU-B

FTH: Application / Analysis

FTHp10: Frequency of occurrence of FTH<10%



Summary

- **CM SAF** exploits satellite based remote sensing data to derive Climate Data Records (CDR) for Essential Climate Variables (ECV) with special emphasis on three target user groups
    - **Global and regional climate trends and variability analysis**
    - **Support to global and regional climate modelling**
    - **Climate service and infrastructure planning**

- **CM SAF** develops and improves methods to derive CDRs on an operational basis and in a sustained mode with regular update cycles.

- **CM SAF** maintains and provides an operational and sustained infrastructure that can e.g. serve the community within the transition of mature CDR products from the research into operational environments.

- **CM SAF** interaction and co-operation with NOAA's CDR program is essential and provides benefits to both side

- **CM SAF** is interested in AVHRR FCDR