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A satellite-based long-term **Land Surface Temperature** Climate Data Record

Anke Duguay-Tetzlaff, Virgílio A. Bento, Frank M. Göttsche, Reto Stöckli, João P. A. Martins, Isabel Trigo, Folke Olesen, Jędrzej S. Bojanowski and Carlos da Camara

The EUMETSAT Network of Satellite Application Facilities
LSA SAF
Land Surface Analysis

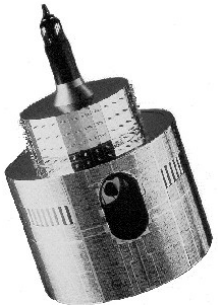
The EUMETSAT Network of Satellite Application Facilities
CM SAF
Climate Monitoring

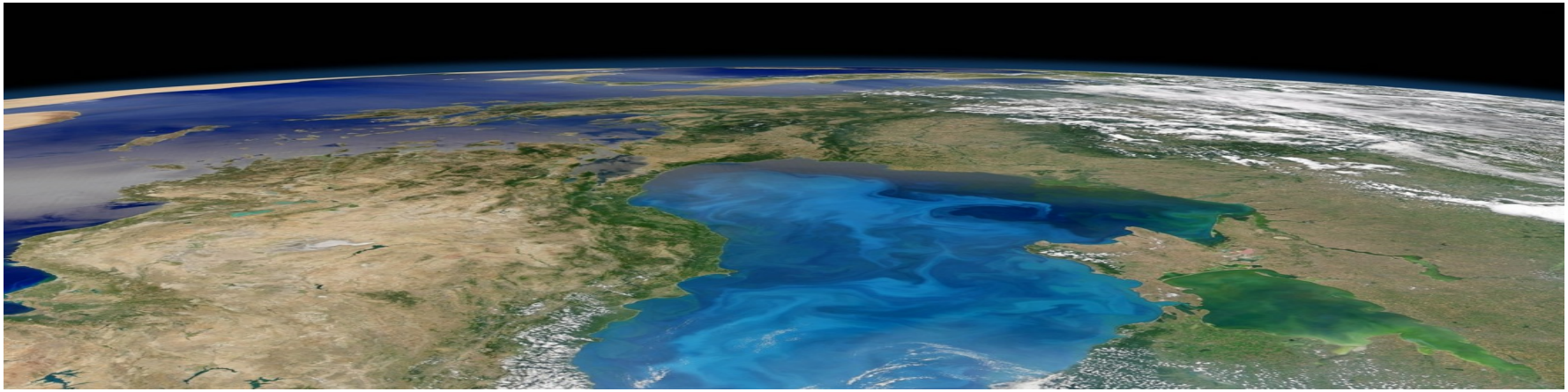
Satellite-based Land Surface Temperature

“Skin temperature”

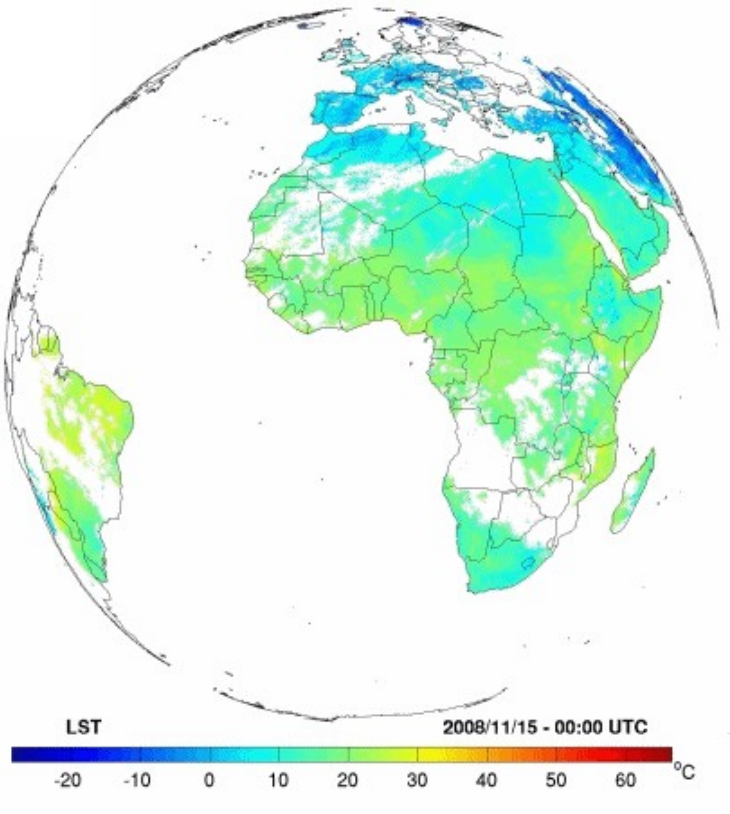
Clear sky temperature of the earth surface.

It represents the interface between soil and atmosphere.





LSA SAF & CM SAF
Land Surface Temperature Climate Data

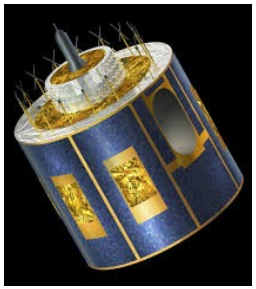


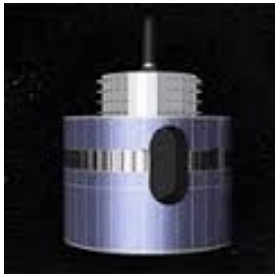
- 25 year+ Climate Data Record (1990 – 2015)
- Africa and Europe (Meteosat disk)
- 5 x 5 km spatial resolution
- hourly data & monthly diurnal cycle (15 min data on request)

The EUMETSAT Network of Satellite Application Facilities
LSA SAF Land Surface Analysis

The EUMETSAT Network of Satellite Application Facilities
CM SAF Climate Monitoring

EUMETSAT's Meteosat Satellites

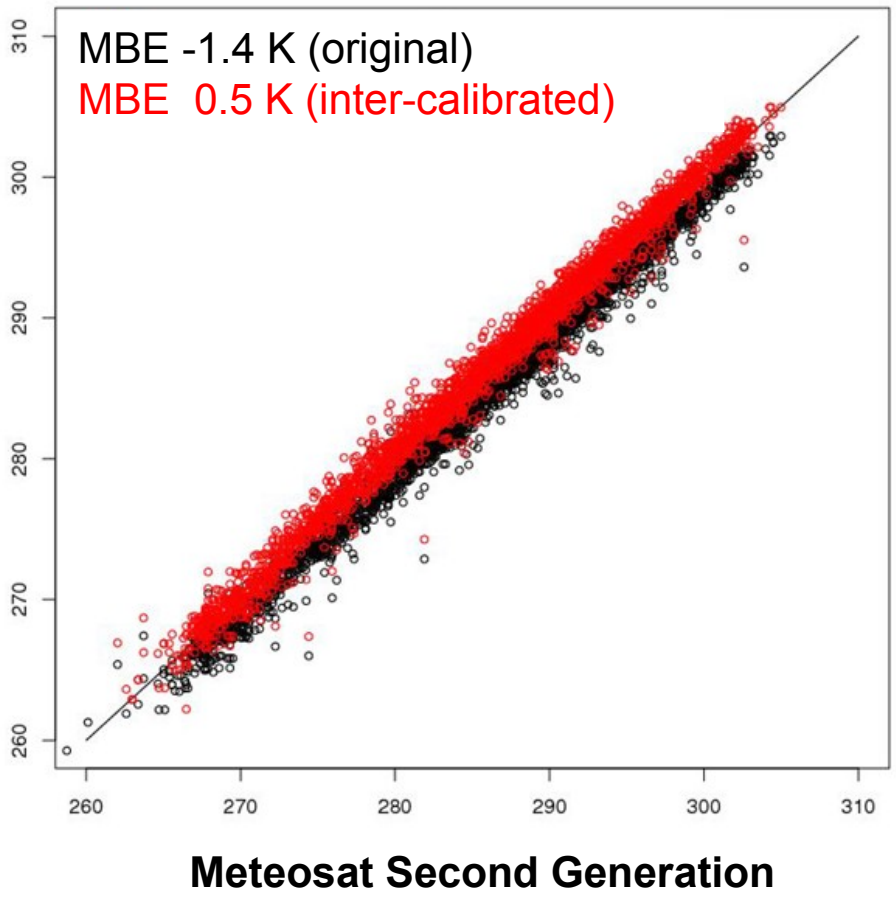




Meteosat First Generation (1983-2005)	Meteosat Second Generation (2005-now)
MVIRI Sensor **Spectral bands:** **Visible (VIS), Thermal (TIR), Water vapour (WV)**	**SEVIRI Sensor** **Spectral bands:** **VIS 0.6, VIS 0.8, IR 1.6, IR 3.9, IR 8.7, IR 10.8, IR 12.0, WV 6.2, WV 7.3, IR 9,7, IR 13.4**

Meteosat Data Calibration

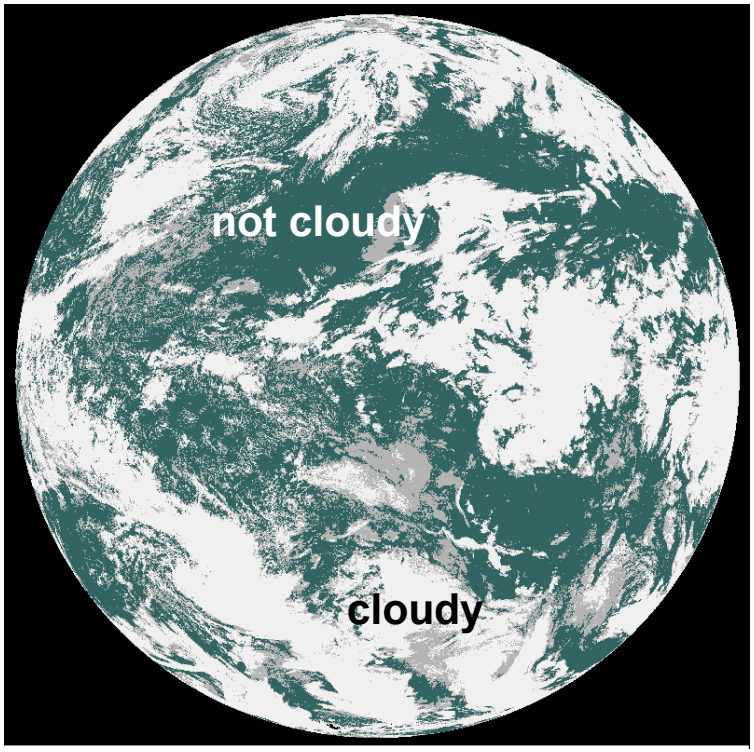
Land Surface Temperature



Recalibration of the Meteosat First Generation thermal channel against the High Resolution Infrared Radiation Sounder (HIRS, Viju John).

EUMETSAT

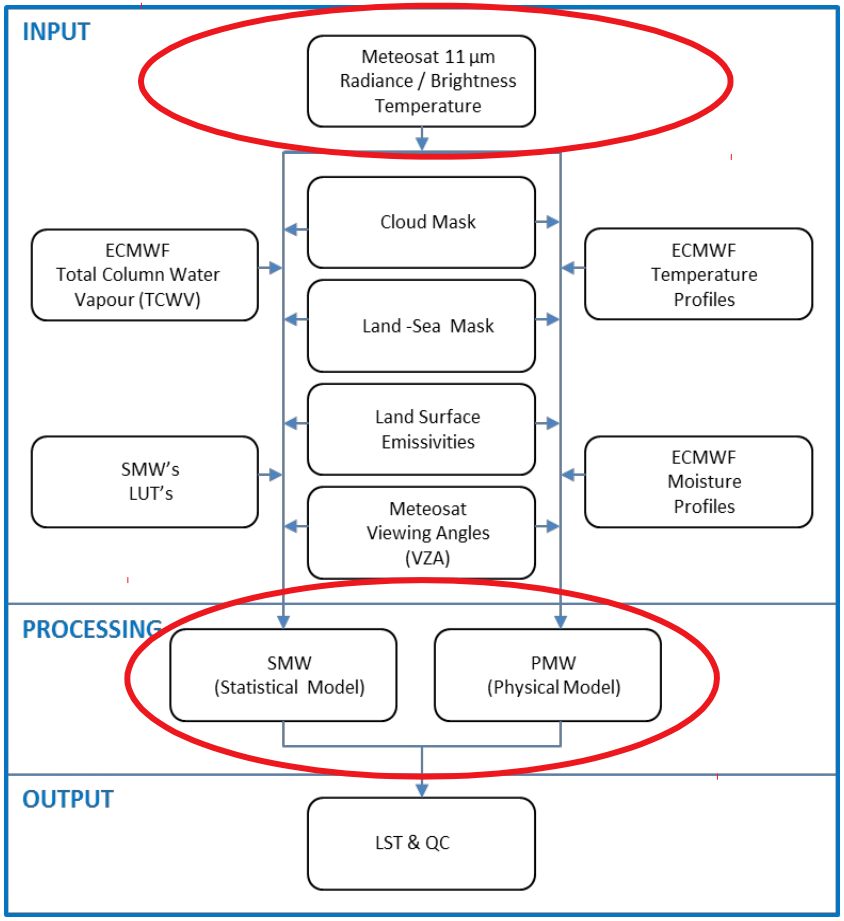
Land Surface Temperature Climate Data Cloud Masking



CM SAF 25 years+ Meteosat Cloud Climate Data Record
(Reto Stöckli, to be issued 2016/2017)

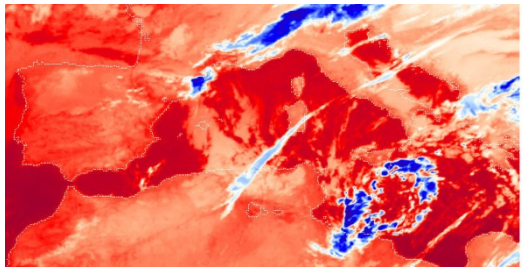
Novel cloud masking approach which replaces missing spectral information by exploiting combined spatio-temporal information's.

Land Surface Temperature Climate Data Algorithm



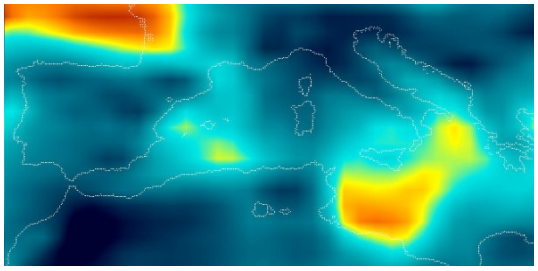
Land Surface Temperature Climate Data Statistical Model

Meteosat Top-of-Atmosphere Temperature



220 K 290

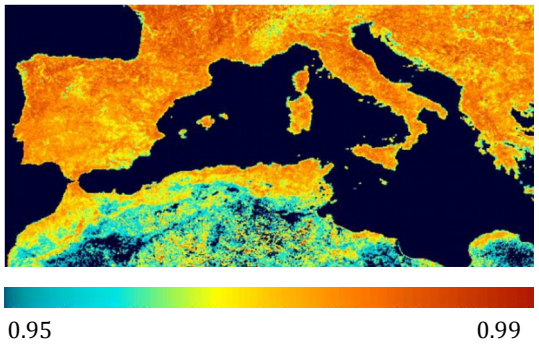
ECMWF Total Column Water



5 mm 20

$$LST = A\,\frac{T_{ToA,X}}{\varepsilon_{SFC,x}} + B\,\frac{1}{\varepsilon_{SFC,x}} + C$$

Spectral Emissivity



0.95 0.99

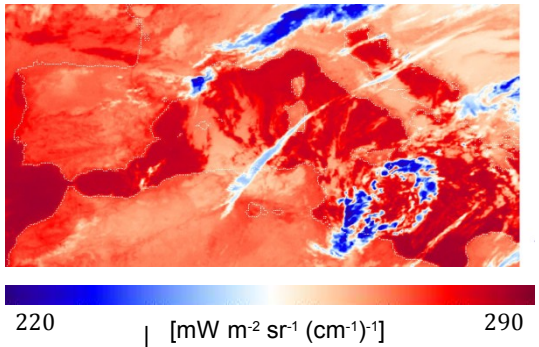
Source: University of Wisconsin (UW) Baseline Fit Emissivity

$$\varepsilon_{SFC,x} = \int_{x_1}^{x_2} \varepsilon_x \frac{f_x}{\int_{x_1}^{x_2} f_x}$$

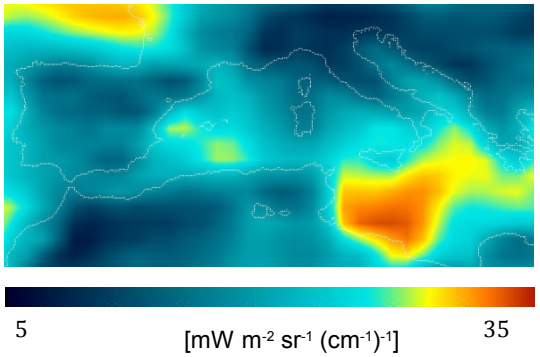
Duguay-Tetzlaff, A. et al. Meteosat Land Surface Temperature Climate Data Record: Achievable Accuracy and Potential Uncertainties. Remote Sens. 2015, 7, 13139-13156.

Land Surface Temperature Climate Data Radiative Transfer-based Model

Meteosat Top-of-Atmosphere Radiance

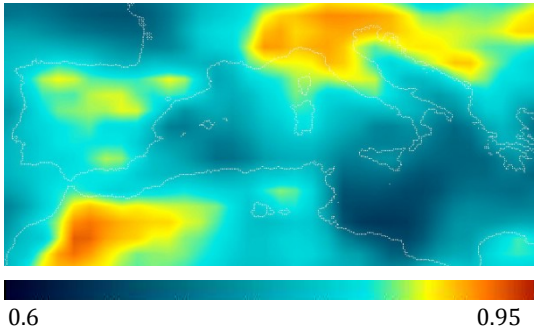


Upwelling Atmospheric Emission



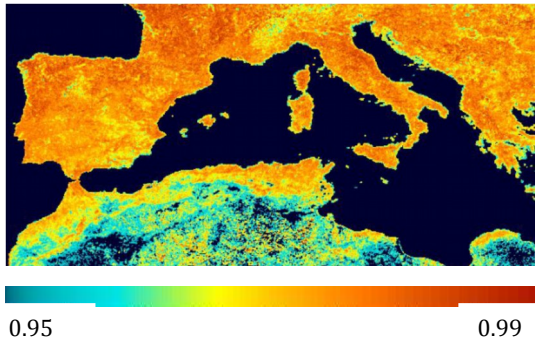
$$L_{ToA,x} = L_{SFC,x}\,\tau_{ATM,x} + L^{\uparrow}_{ATM,x} + L^{\downarrow}_{ATM,x}(1-\varepsilon_{SFC})\,\tau_{ATM,x}$$

Atmospheric Transmissivity



$$L_{SFC,x} = B\,(LST)$$

Spectral Emissivity

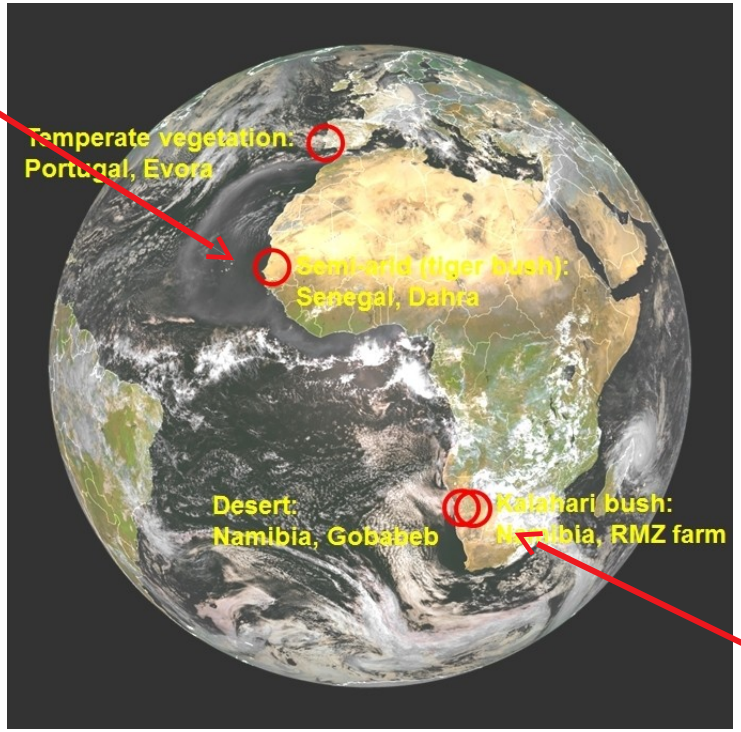


Source: University of Wisconsin (UW) Baseline Fit Emissivity

Duguay-Tetzlaff, A. et al. Meteosat Land Surface Temperature Climate Data Record: Achievable Accuracy and Potential Uncertainties. Remote Sens. 2015, 7, 13139-13156.

Land Surface Temperature Climate Data Example

Land Surface Temperature Climate Data Validation



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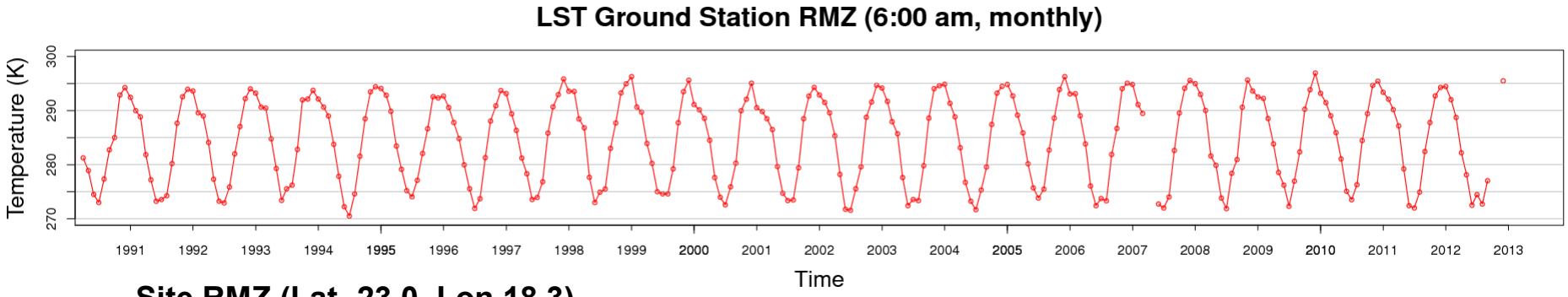
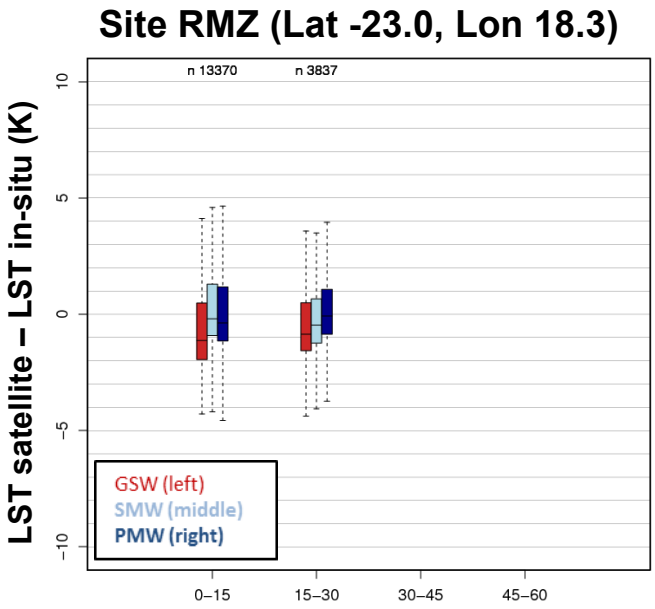
Land Surface Temperature Climate Data Validation





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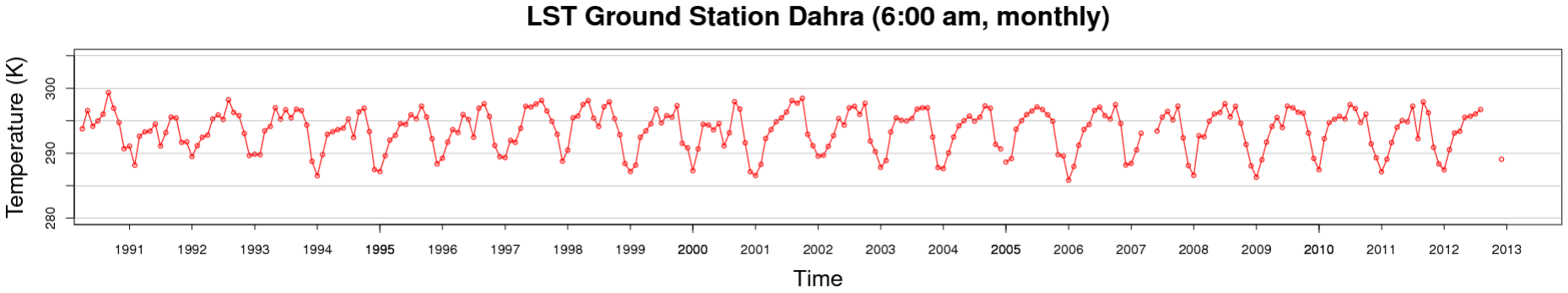
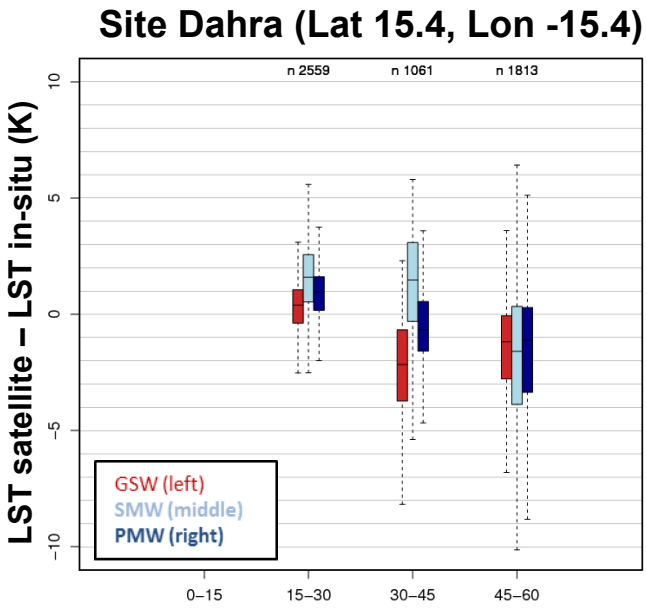
Legend:
LSA SAF Model
Statistical Model
Radiative transfer-based Model

Land Surface Temperature Climate Data Validation





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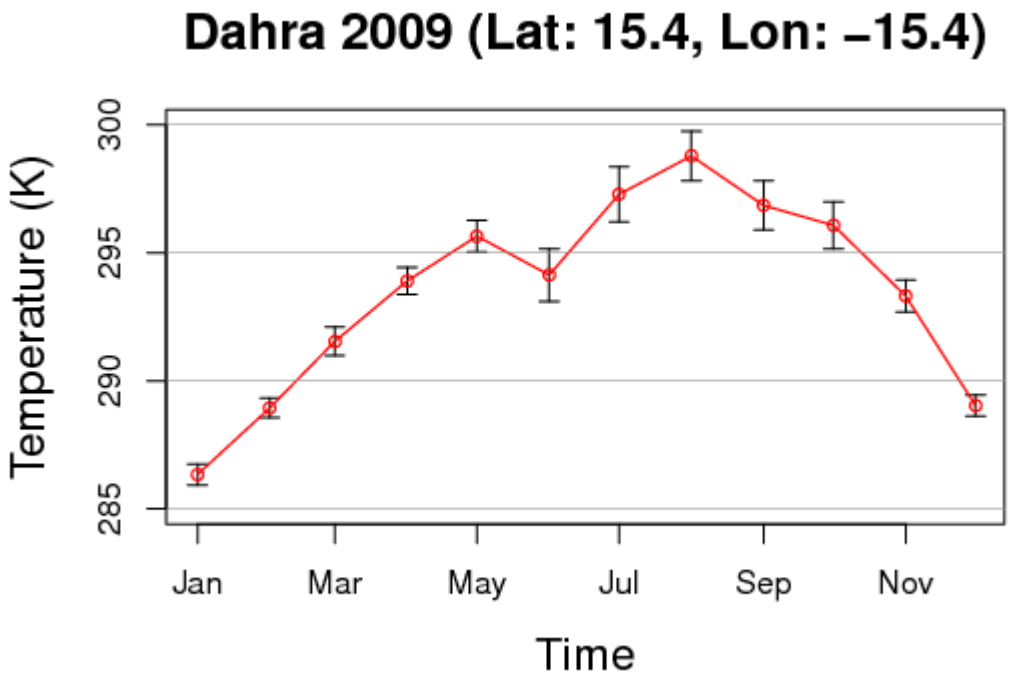
Legend:
LSA SAF Model
Statistical Model
Radiative transfer-based Model

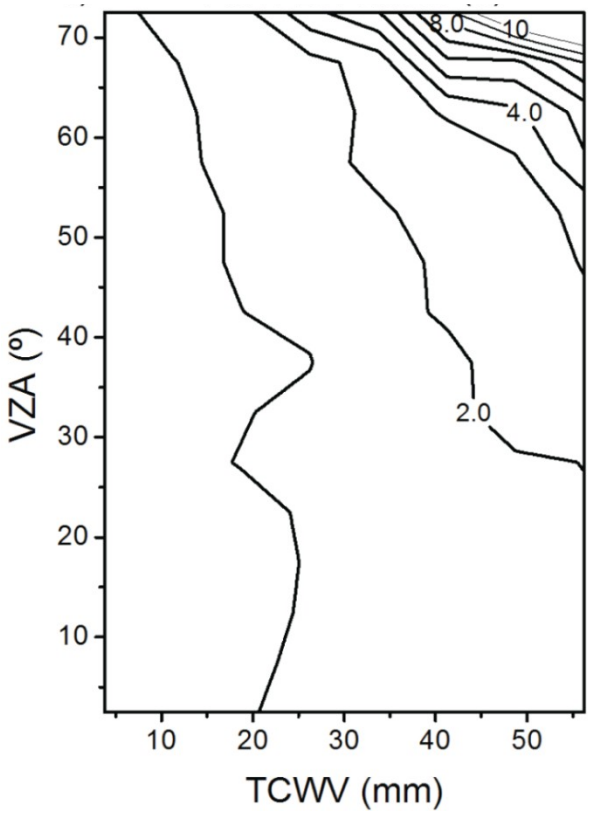
Land Surface Temperature Climate Data Uncertainties



$$S_{LST} = \sqrt{S^2_{noise} + S^2_{emissivity} + S^2_{model} + S^2_{NWP}}$$

Land Surface Temperature Climate Data Uncertainties

Radiative transfer-based Model



Virgilio Bento (IDL, Univ. Lissabon)

Summary & Outlook

- The EUMETSAT LSA SAF & CM SAF are developing a new LST Climate Data Record (5 km spatial resolution, Africa and Europe, 15 min temporal resolution)
- A comprehensive validation study demonstrated that the LST retrievals are within or very close to the 2 K target accuracy, except for very moist atmospheres (TCWV > 45 mm)
- Independent product validations will be carried out in 2016
- First product release is planned for 2016/2017 (http://www.cmsaf.eu/)
- Plans to continue the development in 2017 – 2012