Evaluation of the EUMETSAT Meteosat Surface Albedo Climate Data Record

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Abstract

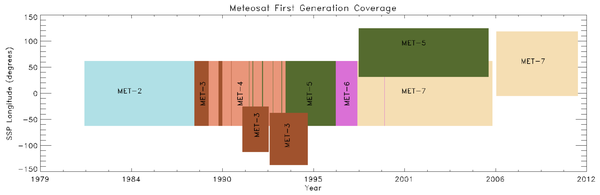
Observing the climate system for an improved understanding of its variability and changes, requires a joint long-term international commitment from research and governmental institutions. The Global Climate Observing System (GCOS) formulated scientific requirements for the needed global observations and products including a list of relevant parameters, the so called Essential Climate Variables (ECVs).
Within the Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) initiative EUMETSAT has generated the Meteosat Surface Albedo (MSA) Climate Data Record (CDR) comprising up to 25 years (1982-2010) of continuous coverage.
This poster discusses the results of a validation study (ALBEDOVAL) for the MSA CDR that has been performed by independent researchers in Europe and the US. The analysis considered four aspects: temporal consistency, inter-comparison with other satellites, validation against in situ, and uncertainty assessment .

Product content and coverage

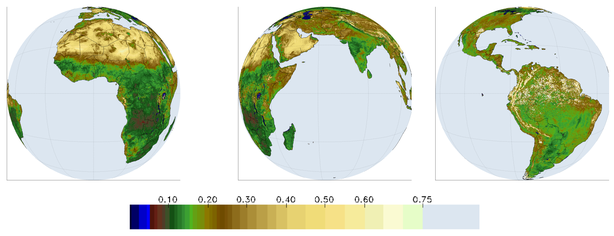
The MSA algorithm has been developed following a method proposed by Pinty et al., 2000.

The climate data record generated with this algorithm covers:

- 1982-2006, prime 0° Sub Satellite Point (SSP) coverage (6 satellites);
- 1998-2010 Indian Ocean Data Coverage at 57°E and 63°E SSPs (2 satellites);
- 1991-1995, (Extended) Atlantic Data Coverage at 50°W and 75°W SSPs;



Prime Mission centred over Africa ***Indian Ocean Data Coverage*** ***Atlantic Data Coverage***



This dataset and user manual are available free of charge from the EUMETSAT Data Centre at: http://www.eumetsat.int/ **-> Product Navigator**

The products are provided in **BUFR** and **HDF4** formats and comprise:

- The GSA product (BHR, DHR30, DRH30_10D_Error, Probability);
- The ancillary data containing in particular the retrieval uncertainty;

Note that in HDF4 the variables are provided in separate files while they are provided in a single file in BUFR.

References

GCOS-154 (2011). Systematic Observation Requirements for Satellite-based Products for Climate Supplemental details to the satellite-based component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC - 2011 Update, WMO, Geneva, Switzerland.

Fell et al., 2012 Evaluation of the Meteosat surface albedo climate data record (ALBEDOVAL): Final report, 119 pp. [available from alessio.lattanzio@eumetsat.int]

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Loew. A and Govaerts Y. Toward Multidecadal consistent Meteosat Surface Albedo Time Series. **Remote Sensing**, 2010, 2, 957-967.

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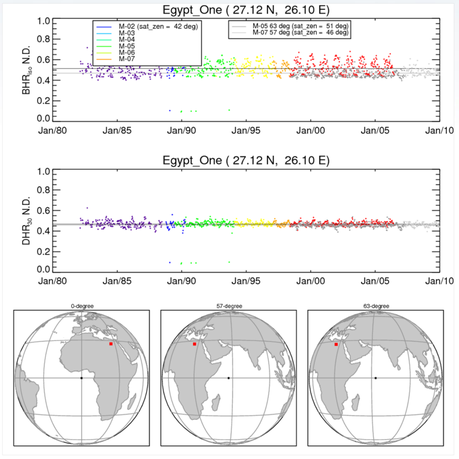
ALBEDOVAL results

- The evaluation of the MSA CDR (Fell et al., 2012) showed that the MSA CDR agrees well with corresponding values from other satellite-derived and ground-based observing systems under many observation conditions. In particular, the temporal stability of the CDR is fulfilling GCOS requirements.
- Some issues on the MSA CDR quality that were reported are caused by: less accurate cloud detection over vegetated areas due to high cloud occurrence, and aerosol related effects resulting from using a model with only continental aerosol and a limited set of pre-defined values.
- The strengths underline the already high value of the MSA CDR for climate applications. The weaknesses need to be considered for specific applications and will be addressed in the context of a future re-processing within SCOPE-CM.
- The recommendations devised by the independent experts strongly support the improvement of the MSA CDR quality and its utility.

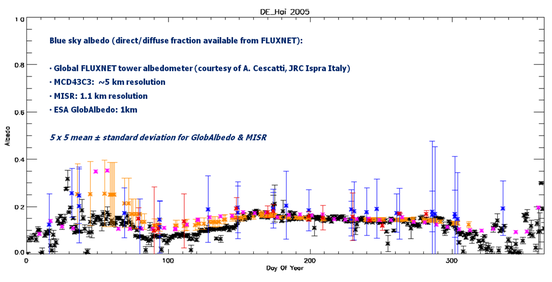
Temporal consistency



Name	0DEG		IODC	
	BHR [1/decade]	DHR [1/decade]	BHR [1/decade]	DHR [1/decade]
Murzuq desert	-0.0084	**-0.0325**	0.0102	0.0099
desert	0.0037	-0.0085	-0.0011	-0.0011
Egypt One	0.0083	0.0071	-0.0006	-0.0006
Omani desert	**0.0170**	**0.0133**	**0.0437**	**0.0421**

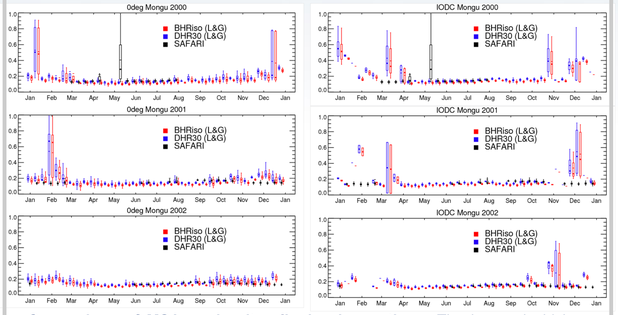
Regression slopes: IODC data are restricted to the 63° coverage to avoid potential effects caused by the different observation angles of IODC_63 and IODC_57. Regression slopes exceeding ±0.01/decade are shown in bold.

Inter-comparison



Comparison with FLUXNET ground truth data ("Tower"): surface albedo products from GlobAlbedo, MODIS ("MCD43C3"), MISR, MSA on MVIRI_5 (IODC) and MVIRI_7 (0DEG) for one site in Germany (DE_HAI, IGBP: deciduous broadleaf forest).

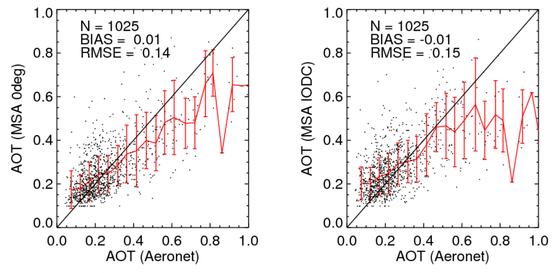
Validation against in situ



Comparison of MSA vs. in situ albedo observations: The box-and-whisker diagrams represent the spatial variability of the MSA observations (Loew and Govaerts, 2010 spectral conversion coefficients applied) within a 3x3 window centred at Mongu (Zambia). For the in situ observations (black), the diagrams represent the temporal variability within a ten-day observation period.

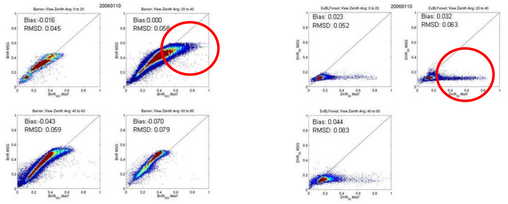
Uncertainty assessment

Aerosol retrieval



Comparison of AERONET and MSA aerosol optical depth (AOD). Left: 0DEG coverage, right: IODC_57 and IODC_63.

Cloud contamination



Left Panel: BHR_{ISO} / white-sky albedo (MSA x-axis, SEVIRI y-axis) for pixels classified as "Barren" Pixels are grouped according to MSA viewing angle ranges indicated in the top of each panel.

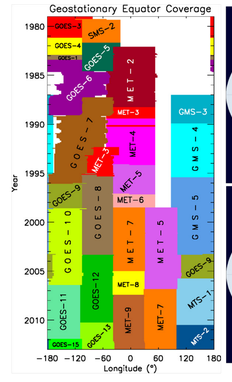
Right Panel: DHR_{30} / black-sky albedo for evergreen broadleaf forest.

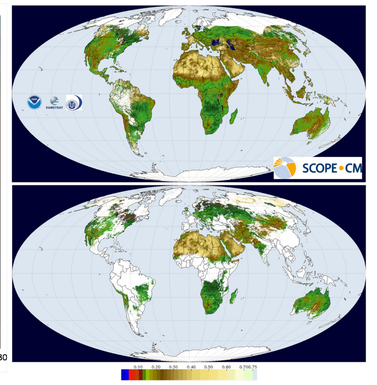
Requirements

ID	Requirement	Source	Fulfilled
GCMP-SAT_01	Consistent sampling within diurnal cycle	GCOS-154	Y
GCMP-SAT_02	Overlap period for old and new satellite systems	GCOS-154	Y
GCMP-SAT_03	Continuity of satellite measurements	GCOS-154	Y
GCMP-SAT_04	Rigorous pre-launch instrument calibration and characterization	GCOS-154	Depending on satellite
GCMP-SAT_05	On-board calibration adequate for climate system observations	GCOS-154	N, vicarious calibr.
GCMP-SAT_06	Sustained operational production of priority climate products	GCOS-154	Does not apply
GCMP-SAT_07	Data systems to facilitate user access	GCOS-154	Y
GCMP-SAT_08	Use of functioning baseline instrument meeting calibration and stability requirements	GCOS-154	Does not apply
GCMP-SAT_09	Complementary in situ baseline observations	GCOS-154	Do not exist
GCMP-SAT_10	Identification of random errors and time dependent biases	GCOS-154	Y, e.g. in ALBEDOVAL
GCOS-HRES	Horizontal resolution (1 km)	GCOS-154	N
GCOS-TRES	Temporal resolution (1-7 days)	GCOS-154	N, but can be achieved
GCOS-ACCU	Accuracy (MAX (5%, 0.0025))	GCOS-154	N (plausib.. consideration)
GCOS-STAB	Stability (MAX (1%, 0.0001))	GCOS-154	Y (for bright surfaces)
WMO_TH_UCRT	Threshold: Uncertainty (10%)	WMO_ORDB	Y (for bright surfaces)
WMO_TH_HRES	Threshold: Horiz. resolution (10 km)	WMO_ORDB	Y
WMO_TH_OBCY	Threshold: Observing cycle (30 d)	WMO_ORDB	Y
WMO_TH_TIME	Threshold: Timeliness (90 d)	WMO_ORDB	N, but can be achieved

Selection of important requirements to be met by the MSA data record. WMO_ORDB indicates the WMO Observing Requirements Database. The long-term consistency is very high and meets the GCOS stability requirements for desert reference sites. It also meets WMO observing thresholds requirements (provided by the WMO Rolling Review of Requirements process) for spatial and temporal resolution as well as uncertainty.

SCOPE-CM





Temporal and longitudinal coverage of the GEO satellites planned to be used within SCOPE-CM initiative

GSAL3 DHR30 (or black sky albedo BB (0.3-3.0 µm)
Satellites: GMS-5, MET-5,MET-7,GOES-8, GOES-10

MODIS: MCD43C3 0.05 deg quality flag 0,1
(min 75% full inversion retrieval)

- The SCOPE-CM activity, is answering GCOS requirements by establishing an international network of facilities to ensure a continuous and sustained generation of high-quality Climate Data Records (CDR) from satellite data in compliance with the GCOS principles and guidelines.
- SCOPE-CM represents a partnership between operational space agencies to coordinate the generation of CDRs but is open to the participation of research organisations as well.
- As part of the SCOPE-CM activity on land surface albedo (Lattanzio et al., 2013), involving the operational meteorological satellite agencies in Europe (EUMETSAT), in Japan (JMA: Japanese Meteorological Agency) and in the USA (NOAA: National Oceanic and Atmospheric Administration), the MSA CDR contributes to the creation of a global harmonised surface albedo record derived from all satellites in geostationary orbit.