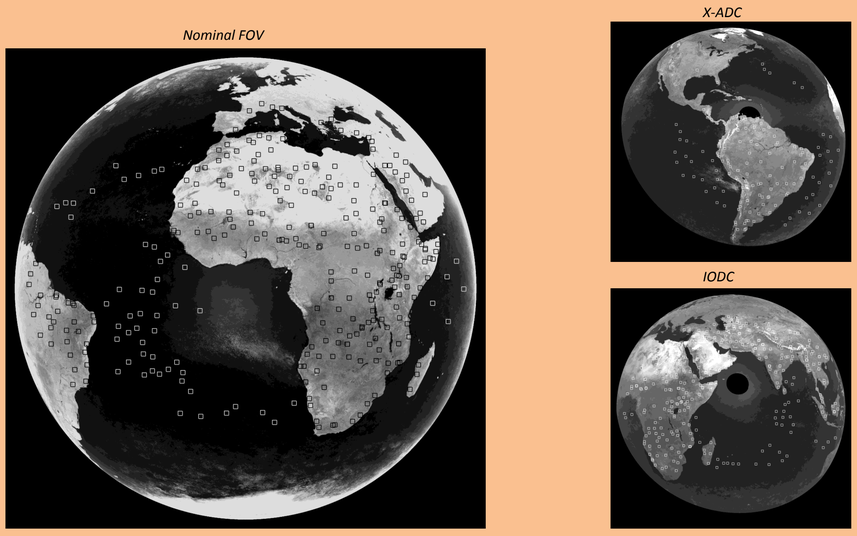
Modeling the spectral aging of the Meteosat/MVIRI visible channel: possible use for CM SAF datasets generation

Ilse Decoster, Nicolas Clerbaux, Stijn Nevens, Alessandro Ipe, Almudena Velazquez Blazquez, Edward Baudrez

Royal Meteorological Institute of Belgium (RMIB)

Method : Extract time series for a large number of clear sky and cloudy targets



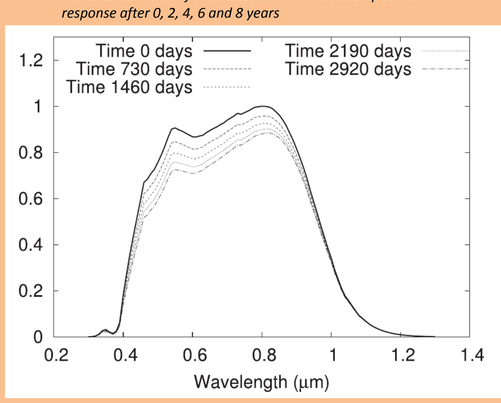
and fit a semi-physical model of the spectral response with 3 parameters α,β,γ

$$\emptyset(\lambda,t) = \emptyset(\lambda,0)\left(e^{-\alpha t} + \beta(1-e^{-\alpha t})\right)(1+\gamma t(\lambda-\lambda_0))$$

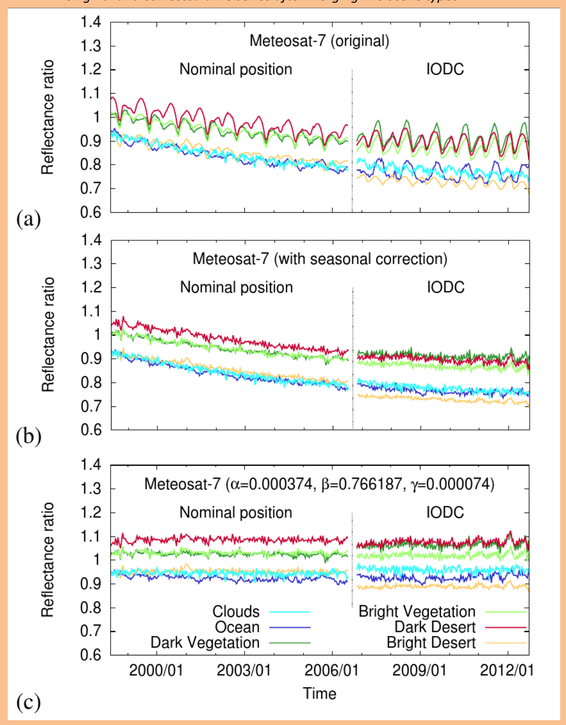
to obtain flat time series when compared with a model of the radiance. For meteosat-7, the optimization gives

α = 0.000373 day^{-1}
β = 0.7662
γ = 0.000074 µm day^{-1}

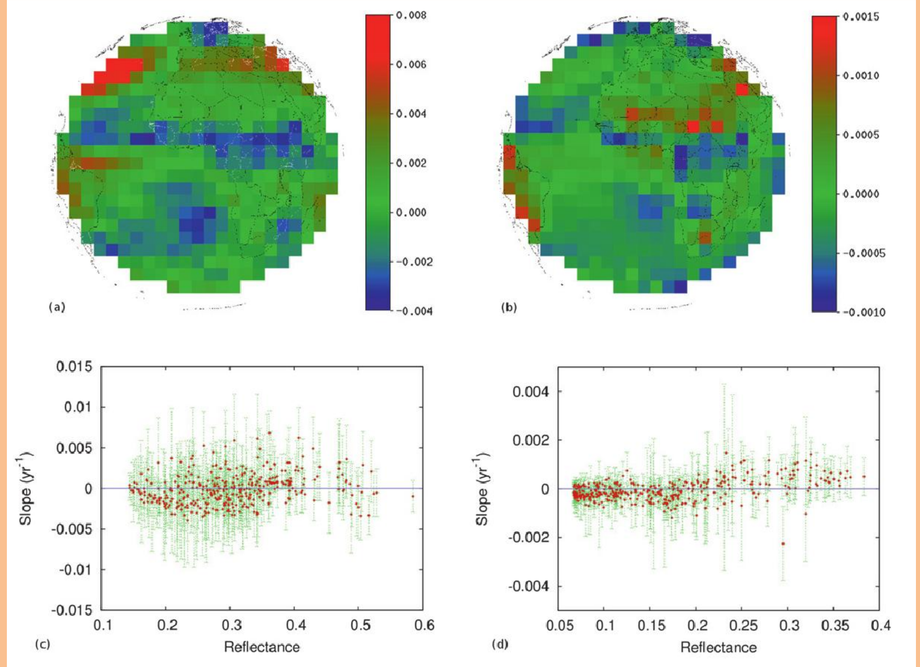
Modeled variation of the Meteosat-7 VIS channel spectral response after 0, 2, 4, 6 and 8 years



Original and corrected time series after merging in 6 scene types

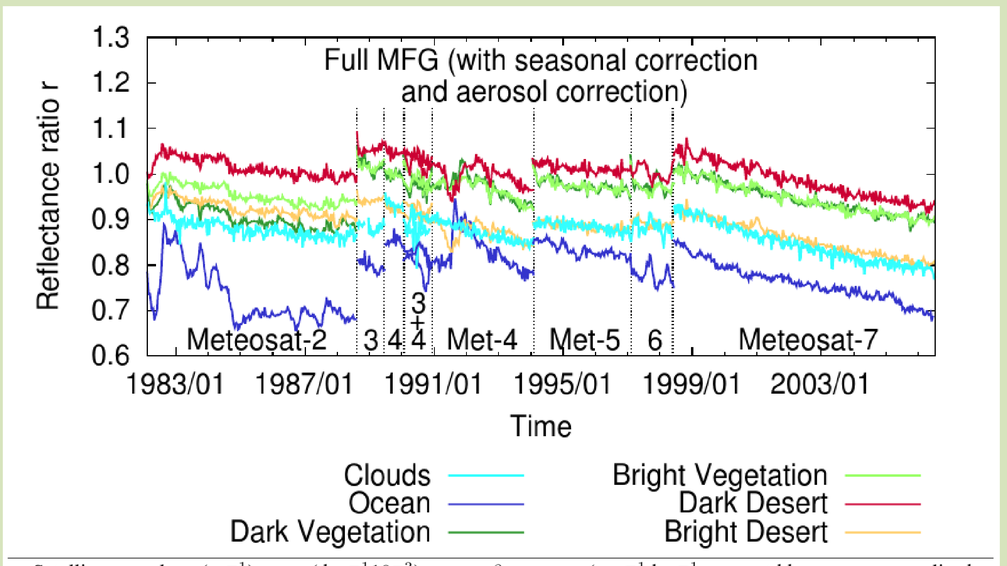


Validation: the stability is computed over the full FOV in all sky and after cloud screening (clearsky) conditions in boxes of 200x200 pixels. In clearsky the stability is ±0.66%/decade, at 2 standard deviations. In all sky the stability is worst (±3%/decade) due to inetrannual variability in cloudiness.

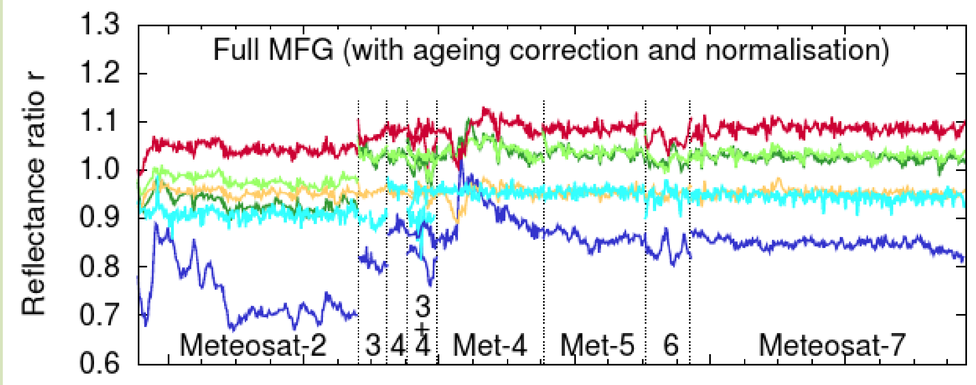


Applying the method on Met-2,-3,-4,-5,-6 provides good results (Decoster et al, 2014) but:

- The effect of volcanic eruptions (e.g. El Chichon, Pinatubo) should be considered over dark surfaces
- The VIS spectral responses of Met-2 and Met-3 seem not to be consistent with the ones of Met-4, -5, -6, -7. Scene type dependent jumps are observed (not for bright desert as this scene type is used for the SSCC calibration).



Satellite	slope (yr^{-1})	α (day^{-1}10^{-3})	β	γ (µm^{-1}day^{-1} 10^{-3})	stddev	normalised calibration
Meteosat-2	-0.017 ± 0.008	0.44 ± 0.34	0.90± 0.26	0.000 ± 0.000	0.023 ± 0.012	0.645 / 0.539
Meteosat-3	-0.009 ± 0.027	0.10 ± 0.29	0.75 (fixed)	0.000 ± 0.396	0.024 ± 0.047	0.634 / 0.764
Meteosat-4	-0.026 ± 0.002	0.28 ± 0.08	0.74 ± 0.15	0.049 ± 0.037	0.020 ± 0.014	0.746
Meteosat-5	-0.011 ± 0.001	0.12 ± 0.01	0.75 (fixed)	0.055 ± 0.020	0.017 ± 0.003	0.839
Meteosat-6	-0.023 ± 0.018	0.25 ± 0.05	0.75 (fixed)	0.100 ± 0.025	0.030 ± 0.001	0.829
Meteosat-7	-0.032 ± 0.002	0.37 ± 0.06	0.77 ± 0.02	0.074 ± 0.011	0.017 ± 0.011	0.918



Variability of the signal < 2% for the 6 scene types once Met-2 and -3 discarded. Clearly worst when Met-2 and -3 are considered.

Surface type	Meteosat-4 – 7 (17 yrs)	Meteosat-2 – 7 (24 yrs)
convective clouds	0.0123	0.0239
ocean	0.0167	0.0611
dark vegetation	0.0140	0.0437
bright vegetation	0.0120	0.0266
dark desert	0.0142	0.0230
bright desert	0.0098	0.0099

Use in CM SAF

A dataset of MVIRI/SEVIRI/GERB Top-Of-Atmopshere Reflected Solar flux is being developed in CM SAF. The model of spectral degradation presented here will be considered to recalibrate the MVIRI visible data. The stability of the dataset is expected to be of the order of 1 W/m²/decade.

Further reading

- I. Decoster, N. Clerbaux, E. Baudrez, S. Dewitte, A. Ipe, S. Nevens, A. Velazquez-Blazquez, J. Cornelis (2013): A Spectral Aging Model for the Meteosat-7 Visible Band, Journal of Atmospheric and Oceanic Technology, 30(3), 496-509.
- I. Decoster, N. Clerbaux, Y. Govaerts, E. Baudrez, S. A. Ipe, S. Dewitte, S. Nevens, A. Velazquez-Blazquez, J. Cornelis (2013): Evidence of pre-launch characterization problem of Meteosat-7 visible spectral response, Remote Sensing Letters, 4(10), 1008-1017.
- I. Decoster, N. Clerbaux, E. Baudrez, S. Dewitte, A. Ipe, S. Nevens, A. Velazquez-Blazquez, J. Cornelis (2014): Spectral ageing model applied to Meteosat First Generation visible band, In print to Remote Sensing.