Creating Fidelitous Climate Data Records from Meteosat First Generation Observations

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FIDUCEO
Fidelity and Uncertainty in Climate Data Records from Earth Observation
www.fiduceo.eu

FastOpt
Fast Optimisation and Sensitivities

rayference

EUMETSAT

The **Meteosat First Generation (MFG)** satellites have been acquiring a continuous record of Earth observations for more than 30 years. The **Meteosat Visible and Infrared Imager (MVIRI)** on-board the MFG geostationary satellites acquires radiance twice per hour in a broad reflectance channel referred to as the **visible (VIS)** band.

The temporal frequency of observations facilitates to disentangle surface from atmospheric effects and makes the MVIRI data pre-eminently suited for producing long-term data records of surface albedo and aerosol optical depth. The surface albedo data records that have been generated hitherto from MVIRI observations exhibit temporal inconsistencies due to an inaccurate pre-launch spectral response characterisation.

This inaccurate characterisation restricts the use of calibrated MVIRI data records for climate applications in general, and prevents a retrieval of aerosol optical depth in particular.

The **Fidelity and Uncertainty in Climate data records from Earth Observations (FIDUCEO)** Horizon 2020 project aims to reduce and quantify the uncertainty on the instrument spectral response characterisation to facilitate the creation of long-term consistent and-high-quality data records of surface albedo and aerosol optical depth for climate applications.

Within FIDUCEO, a novel method for reconstructing the VIS **sensor spectral response (SSR)** is being developed. Selected test cases combine simulated spectral radiance data with simulated and actual sensor recordings. Advanced inverse modelling methods are applied to reconstruct the spectral response and its ageing characteristics, including uncertainties and covariance.

Decoster, Clerbaux, Govaerts, … (2013) Evidence of pre-launch characterization problem of Meteosat-7 visible spectral response dx.doi.org/10.1080/2150704X.2013.828181

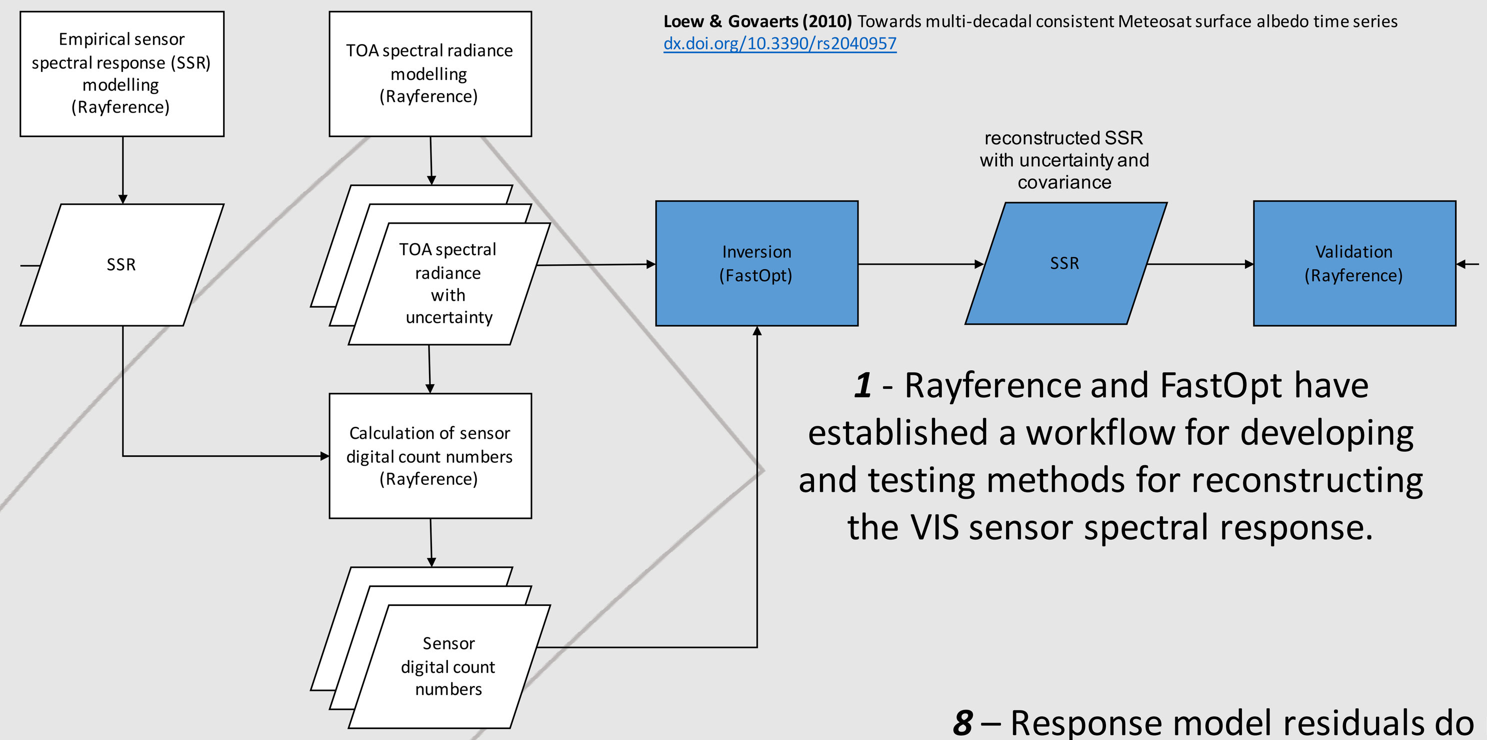
Govaerts (1999) Correction of the Meteosat-5 and -6 radiometer solar channel spectral response with the Meteosat-7 sensor spectral characteristics dx.doi.org/10.1080/014311699211273

Govaerts, Clerici & Clerbaux (2004) Operational calibration of the Meteosat radiometer VIS band dx.doi.org/10.1109/TGRS.2004.831882

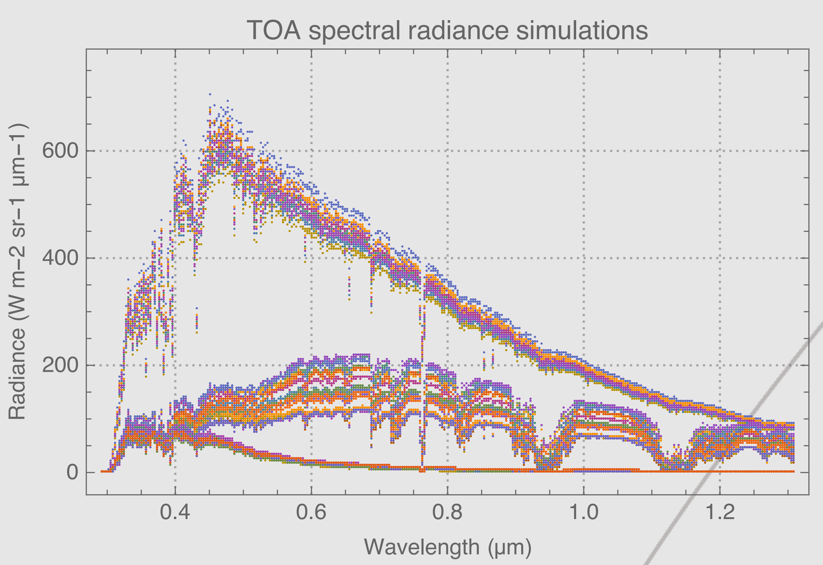
Govaerts & Lattanzio (2007) Retrieval error estimation of Surface Albedo derived from geostationary large band satellite observations … dx.doi.org/10.1029/2006JD007313

Lattanzio, Schulz, Matthews, … (2013) Land Surface Albedo from geostationary satellites: a multiagency collaboration within SCOPE-CM dx.doi.org/10.1175/BAMS-D-11-00230.1

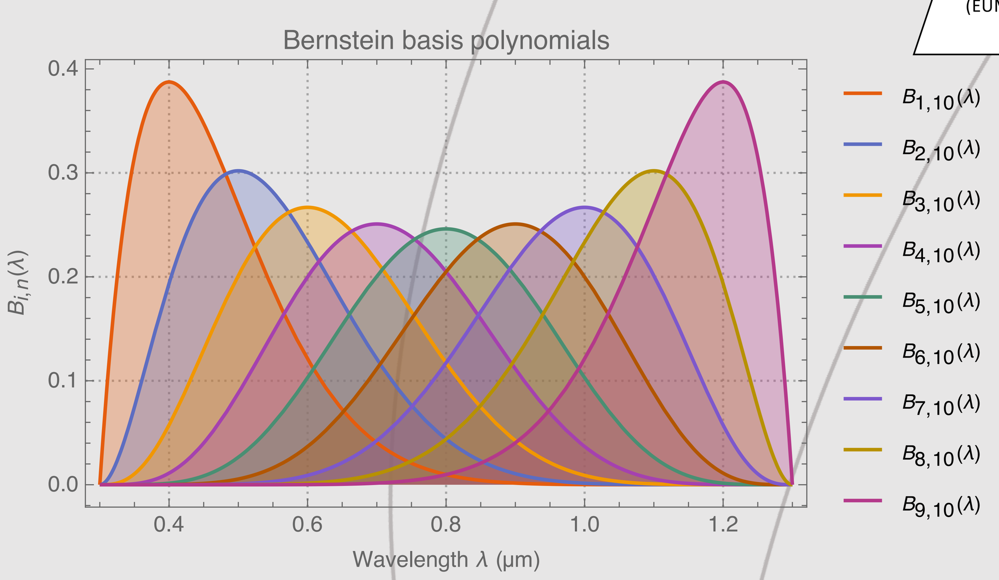
Loew & Govaerts (2010) Towards multi-decadal consistent Meteosat surface albedo time series dx.doi.org/10.3390/rs2040957



1 - Rayference and FastOpt have established a workflow for developing and testing methods for reconstructing the VIS sensor spectral response.

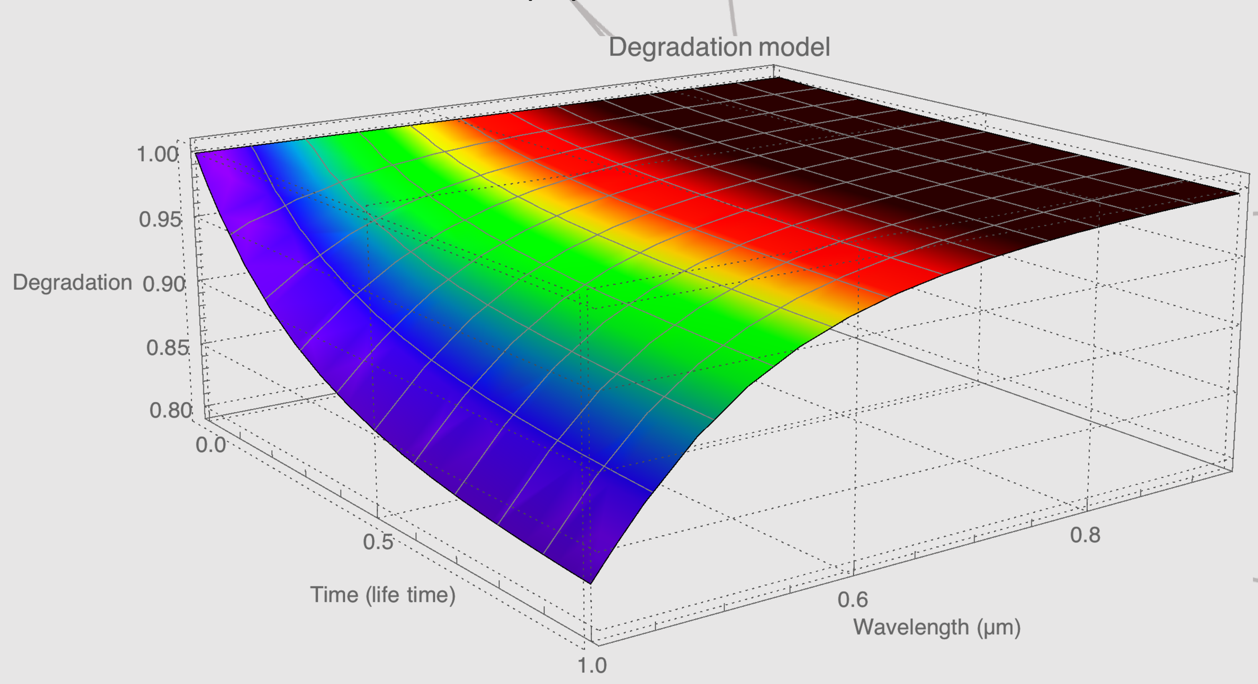


2 - Simulated **top of atmosphere (TOA)** spectral radiance over pseudo-invariant calibration sites like **deep convective cloud (DCC)**, bright desert and open ocean targets viewed under different illumination conditions are the basis of the reconstruction procedure. Simulations include uncertainty and covariance information.

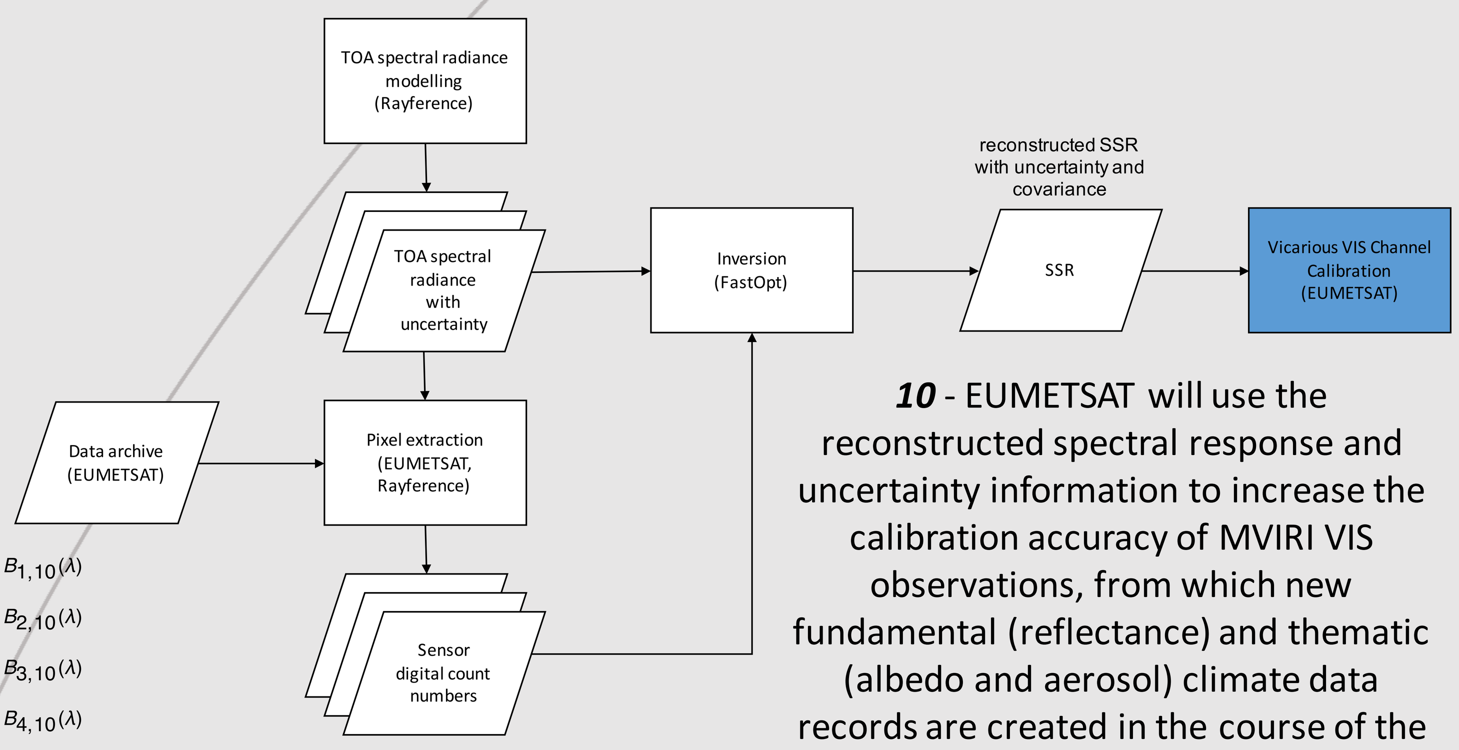


3 - Linear combinations of Bernstein basis polynomials are used to model the VIS spectral response.

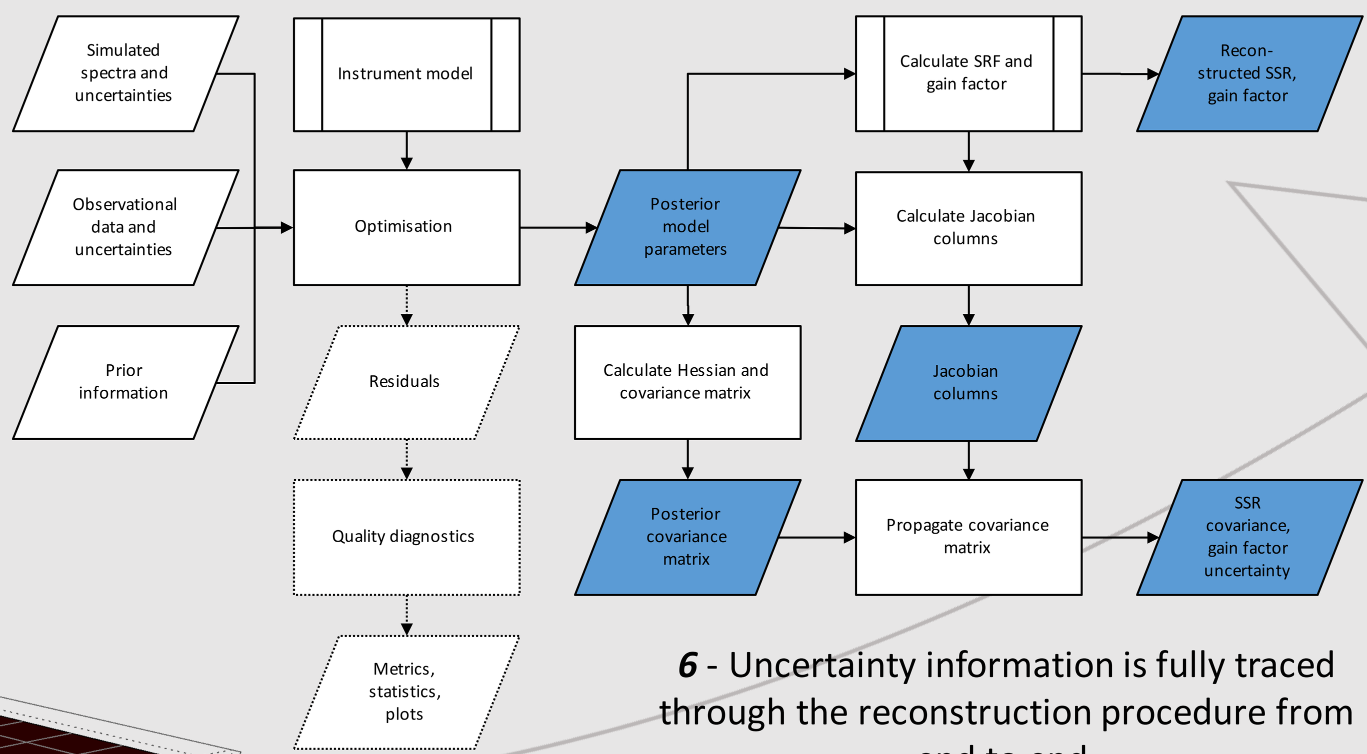
4 - Approaches to model the degradation of the VIS spectral response are motivated empirically and in terms of physics.



Based on data courteously provided by **Xiong, Fulbright, Angal, … (2015)** Assessment of MODIS and VIIRS solar diffuser on-orbit degradation dx.doi.org/10.1117/12.2185817



10 - EUMETSAT will use the reconstructed spectral response and uncertainty information to increase the calibration accuracy of MVIRI VIS observations, from which new fundamental (reflectance) and thematic (albedo and aerosol) climate data records are created in the course of the FIDUCEO project.

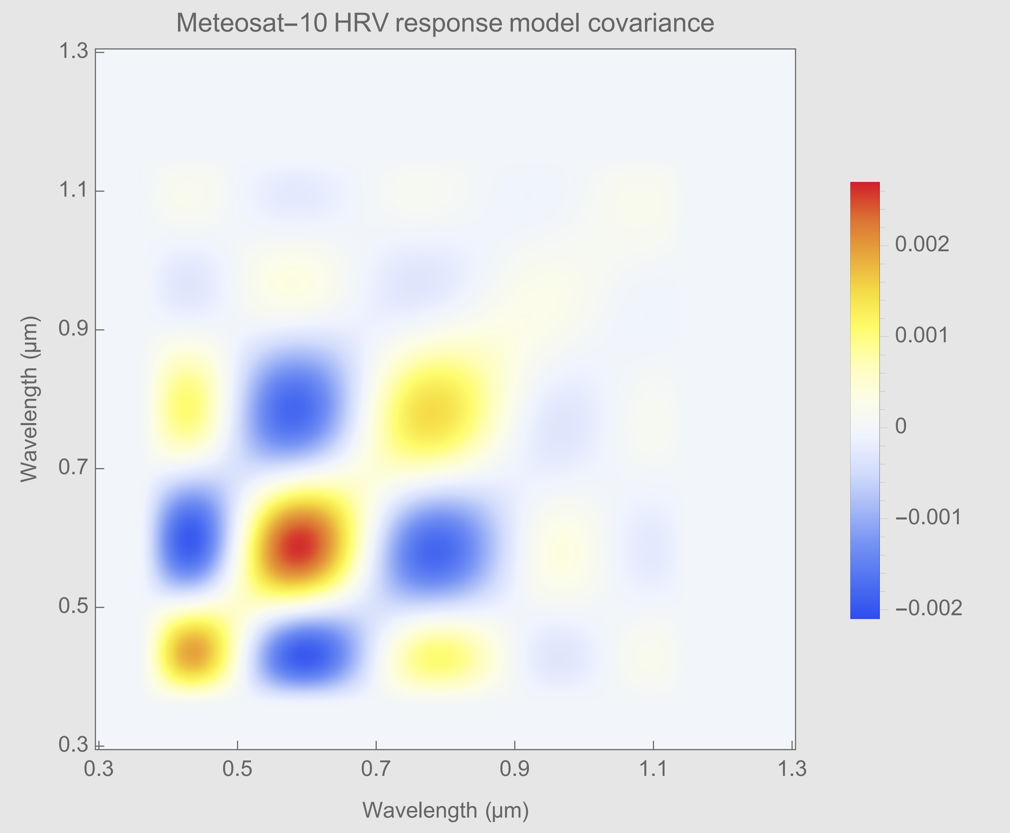


6 - Uncertainty information is fully traced through the reconstruction procedure from end to end.

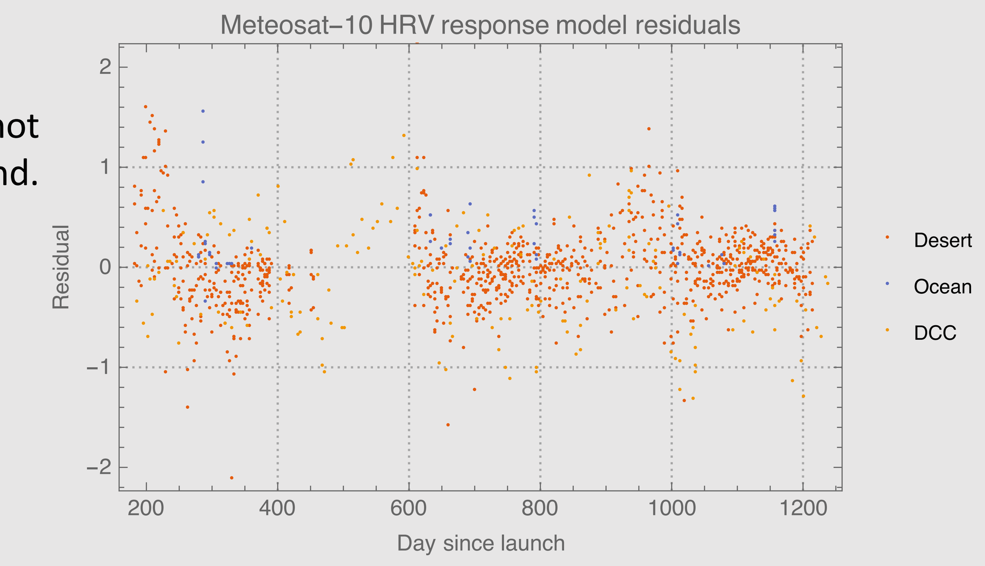
5 - FastOpt's **Transformation of Algorithms in Fortran (TAF)** auto-generates the source code to evaluate Jacobian columns and Hessian matrices. The derivative code is needed to calculate uncertainties and covariance efficiently.

Giering & Kaminski (2003) Applying TAF to generate efficient derivative code of Fortran 77-95 programs dx.doi.org/10.1002/pamm.200310014

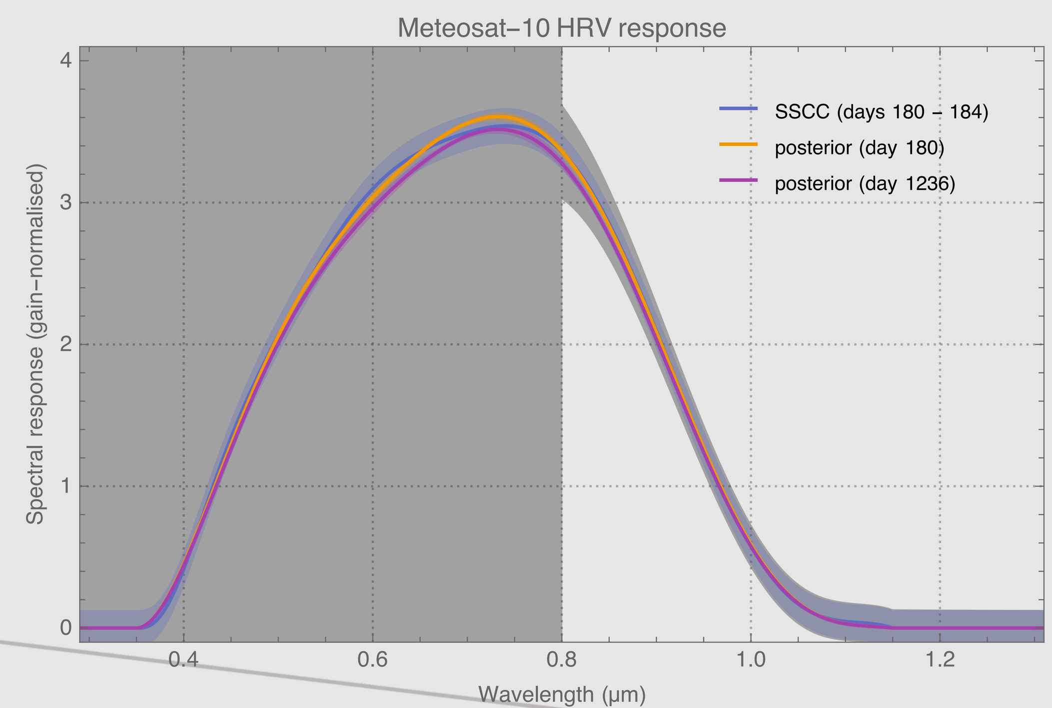
Try out Transformation of Algorithms in Fortran www.fastopt.de/test/taf/tafdemo.html



9 – The full covariance matrix shall be used to propagate uncertainties to subsequent calibration steps. For instance, neglecting the off-diagonal elements results in an uncertainty of the gain factor that is underestimated by a factor of three.



8 – Response model residuals do not exhibit a bias or trend.



7 – Reproducing the spectral response of the Meteosat-10 **high-resolution VIS (HRV)** band determined by EUMETSAT's vicarious **SEVIRI solar channel calibration (SSCC)** constitutes the first real-world benchmark for the reconstruction method. Complemented by prior information in the NIR, the method yields a maximum posterior probability estimate that is consistent with the pre-launch response and expected degradation. Data in the overlapping period of Meteosat-7 and -8 constitute the next benchmark.

Poster QR code

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