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Relevant Sources of Uncertainty in a Climate Data Record from the Meteosat Visible Channel

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The Meteosat Visible and Infrared (MVIRI) sensor employed on Meteosat First Generation (MFG) satellites (1982 – 2017) measured "visible" (VIS) radiances in a broad spectral band (0.4 to 1.1μm). In the course of the MFG programme, which covered more than 35 years, the pre-launch sensor spectral response function (SRF) characterization improved, resulting in considerably higher quality radiances towards more recent dates. This has made observations from MVIRI instruments on the MFG satellites more and more valuable for climate studies, and increased the need for well calibrated and well characterised measurements from these satellites. Among others, the physical quantity of interest of the visible channel on MVIRI is the Top-Of-Atmosphere (TOA) Bidirectional Reflectance Factor (BRF). This quantity is required for example to compute surface albedo, aerosol-, and cloud properties. This makes TOA BRF is a key parameter for deriving several so-called "Essential Climate Variables" (ECVs), as defined in the scope of the Global Climate Observing System (GCOS).

The H2020 Fidelity and Uncertainty in Climate Data Records from Earth Observation (FIDUCEO) project aims to generate temporally and spatially consistent data records of recalibrated sensor radiances. Therefore the project, on the one hand has developed more accurate procedures to calculate the TOA BRF, and on the other hand has applied metrology to rigorously determine its remaining uncertainties. With the increased temporal and spatial scales that are of interest for climate studies, it has become more relevant to distinguish uncertainty effects based on the category of the underlying errors, i.e. to discriminate systematic and random uncertainty. In this scope, the uncertainty analysis of MVIRI has identified six relevant uncertainty effects, i.e. the electronics noise, the uncertainty of the dark signal, the uncertainty of the SRF, the uncertainty of the image geometry, and the uncertainties of the offset and slope of the calibration parameters.

In this presentation we assess the impact of each individual effect, illustrate their contribution to the overall TOA BRF uncertainty, and discuss their attribution to random and systematic uncertainty categories. We show that uncertainties are dominated by geometry effects on short timescales, while the relevance of the calibration parameter uncertainties emerges when analysing longer timescales. Finally, we present the efforts made towards a reduction of systematic uncertainty, particularly by reverse engineering the shape and degradation of the SRF.