An improved hyperspectral surface reflectance datasets and aerosol model over four selected PICS.

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Abstract

Vicarious calibration systems make use of Pseudo-Invariant Calibration Site (PICS) for the post-launch calibration verification of sensors. The system currently in place at EUMETSAT, developed by Govaerts et al., 2004, uses 20 desert sites based on the work by Cosnefroy et al., 1996.
The surface reflectance over the PICS is characterize through the Rahman-Pinty-Verstraete (RPV) model (Rahman et al., 1993) which has four parameters: ρ_0 which determines the magnitude of the BRF, k and θ which control the BRF anisotropy and finally ρ_c which determine the magnitude of the hot-spot effect. Satellite time series are then simulated through a radiative transfer model, considering an aerosol model obtained from AERONET analysis for the aerosol micro-physical and single-scattering properties.

To reduce the uncertainty associated to this vicarious calibration method, a new dataset of RPV parameters and an improved aerosol model are prepared in the framework of the RPV4PICS project. This project involves the acquisition of several time series over selected PICS (Libya4, Algeria5, Niger2, Arabia2) at 20 and 50 km, obtained from sensors operating in the 350-2500 nm spectral region, such as the MultiSpectral Instrument (MSI) on board Sentinel-2. These time series are inverted with the CISAR algorithm developed by Rayference (Govaerts and Luffarelli, 2018, Luffarelli and Govaerts, 2019) to retrieve a set of RPV parameters in all the available sensors' spectral bands, which are then spectrally interpolated at 1nm resolution between 350 and 2500nm.

The surface topography effects over the targets are observed by means of the Copernicus Digital Elevation Model (DEM). Through simulations obtained with the Eradiate radiative transfer model developed at Rayference, the effects of the topography over surface reflectance anisotropy is analysed. It will be shown that some of these effects over some of the selected PICS (e.g. Niger2) is close to the one of a Lambertian surface, suggesting the possibility of reducing the pixel size for calibration purposes. The obtained RPV datasets at 20 and 50 km reflect these findings, showing smaller difference at the different resolutions over more homogenous targets.

A new aerosol model is also prepared by analysing AERONET V3 L1.5 Inversion Product. In particular, different aerosol model are prepared, accounting for the observed geographical differences, such as over the Sahara or the Arabia region.

The improved RPV dataset and aerosol models are validated through simulations of VIIRS simulations using an accurate radiative transfer model, such as RTMOM or Eradiate.

Cosnefroy H., Leroy M., Briottet X., Selection and characterization of Saharan and Arabian desert sites for the calibration of optical satellite sensors, 1996, Remote Sensing of Environment 58(1):101-114.

Luffarelli, M. and Govaerts, Y.: Joint retrieval of surface reflectance and aerosol properties with continuous variation of the state variables in the solution space – Part 2: application to geostationary and

polar-orbiting satellite observations, Atmos. Meas. Tech., 12, 791–809, https://doi.org/10.5194/amt-12-791-2019, 2019.

Rahman, H., B. Pinty, and M. M. Verstraete. 1993. “Coupled Surface-atmosphere Reflectance (CSAR) Model. 2. Semiempirical Surface Model Usable with NOAA Advanced Very High-Resolution Radiometer Data.” Journal of Geophysical Research 98 (D11): 20,791–20,801.

Y. M. Govaerts, M. Clerici and N. Clerbaux, "Operational calibration of the Meteosat radiometer VIS band," in IEEE Transactions on Geoscience and Remote Sensing, vol. 42, no. 9, pp. 1900-1914, Sept. 2004, doi: 10.1109/TGRS.2004.831882.

Govaerts, Y. and Luffarelli, M.: Joint retrieval of surface reflectance and aerosol properties with continuous variation of the state variables in the solution space – Part 1: theoretical concept, Atmos. Meas. Tech., 11, 6589–6603, https://doi.org/10.5194/amt-11-6589-2018, 2018.

Sinyuk, A., Holben, B. N., Eck, T. F., Giles, D. M., Slutsker, I., Korkin, S., Schafer, J. S., Smirnov, A., Sorokin, M., and Lyapustin, A.: The AERONET Version 3 aerosol retrieval algorithm, associated uncertainties and comparisons to Version 2, Atmos. Meas. Tech., 13, 3375–3411, https://doi.org/10.5194/amt-13-3375-2020, 2020