PhD opportunity on remote sensing from geostationary meteorological satellites

Host laboratory: CNRM (Météo-France/CNRS) – UMR 3589, Toulouse, France

Title: Atmospheric correction of shortwave observations from the Flexible Combined Imager on Meteosat Third Generation-Imager satellite for land surface retrieval

Duration: 3 years – starting date between October 2023 and February 2024

Funding: CNRS/EUMETSAT – no need of applying for fellowships

Advisors:
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Summary

Satellites operating from the geostationary orbit are pivotal for meteorology thanks to their observation of the Earth several times per day. This unique feature compared to traditional low Earth orbit satellites enables the monitoring of atmospheric and surface processes at high temporal resolution. The European organization for the exploitation of meteorological satellites (EUMETSAT) launched on 13 December 2022 the first of the Meteosat Third Generation-Imager (MTG-I) series. This meteorological mission will take the place of the Meteosat Second Generation (MSG) satellites, which have operated from the geostationary orbit at 0° of longitude since 2002. The Flexible Combined Imager (FCI, https://www.eumetsat.int/mtg-flexible-combined-imager-fci) on MTG-I will acquire advanced images from the Earth at a resolution of 1 km (3 times that of the Spinning Enhanced Visible and Infrared Imager, SEVIRI, on MSG), in 16 spectral channels (5 more compared to SEVIRI), and every 10 minutes (instead of 15 for SEVIRI) [1].

The improved performances of FCI are expected to provide high-quality observations of land properties such as surface albedo, which is the ratio of outgoing to incoming shortwave radiation and was defined as an essential climate variable by the Global Climate Observing System from the World Meteorological Organization [2]. However, the retrieval of surface properties requires the prior compensation of satellite measurements for atmospheric effects, with those arising from the often-difficult-to-detect particles known as aerosols being the main challenge. Although the new channels from FCI in the visible domain will increase the sensitivity to aerosols with respect to SEVIRI, other challenges will need to be addressed such as the greater Rayleigh scattering, polarization, and aerosol-gas coupling happening at shorter wavelengths.

The main goal of the PhD will be to develop a methodology for atmospherically correcting MTG-I/FCI shortwave images (from 0.4 to 2.2 microns) with the purpose of providing advanced observations of land surfaces. This work will benefit from the research conducted at CNRM since some years on the near real time retrieval of surface albedo from MSG/SEVIRI within the EUMETSAT Satellite Application Facility on Land Surface Analysis (LSA-SAF, https://landsaf.ipma.pt/en/) [3]. The limitations of the atmospheric correction currently performed in this project (including the use of external data to characterize aerosols) will be tackled based on the knowledge recently acquired by CNRM on the simultaneous retrieval of surface and aerosol properties from MSG/SEVIRI [4].

The following points are expected to be addressed during the PhD:

1. Development of a method to compensate FCI shortwave images for atmospheric effects. Innovative solutions will be proposed based on the state of the art in atmospheric correction and the algorithms existing at CNRM. The use of efficient radiative transfer models will be investigated, with special attention to those addressing the limitations that particularly affect geostationary data (e.g., high zenith angles, Earth's sphericity effects).
2. Integration of the resulting method into the algorithms being developed at CNRM to simultaneously retrieve surface and aerosols properties from FCI. This will be done in the framework of the Day-2 MTG-I surface albedo product that CNRM will develop within the LSA-SAF.
3. Analysis of the value added by the new atmospheric correction to the quality of the surface albedo retrieved from FCI. This will be done through comparison to ground-based data and state-of-the-art satellite products. The impact of the new satellite surface observations on other scientific topics (e.g., quantification of the Earth's radiative budget, retrieval of aerosol properties) may be assessed in a final and optional stage.

This PhD will be framed within the research activities conducted at CNRM in the LSA-SAF and other projects in collaboration with EUMETSAT and other national and international institutes.

How to apply

The desired PhD candidate will have a MSc or engineering degree. She/he will be familiar with one or more of the following fields: quantitative remote sensing, atmospheric radiative transfer, and atmospheric/surface processes. Good programming and English skills are required. Candidates willing to apply will send by email the following documents:

- CV/résumé detailing academic background, research experiences, and technical skills
- Motivation letter
- Names and email address of two professional references

Further reading

[1] Holmlund, K. et al.: Meteosat Third Generation (MTG): Continuation and innovation of observations from geostationary orbit. Bull. Am. Meteorol. Soc., 102(5), E990–815 E1015, doi:10.1175/BAMS-D-19-0304.1, 2021.

[2] World Meteorological Organization, State of the Global Climate, 2021 (WMO-No. 1920), 2021

[3] Juncu, D. et al.: Upgrade of LSA-SAF Meteosat Second Generation daily surface albedo (MDAL) retrieval algorithm incorporating aerosol correction and other improvements, Geosci. Instrum. Method. Data Syst., 11, 389–412, https://doi.org/10.5194/gi-11-389-2022, 2022.

[4] Ceamanos, X. et al.: Instantaneous aerosol and surface retrieval using satellites in geostationary orbit (iAERUS-GEO) – Estimation of 15-min AOD from MSG/SEVIRI and evaluation with reference data, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2023-1, 2023.