

"Eppur si muove" Galileo

Preparing for the assimilation of the future MTG-IRS sounder into the Numerical Weather Prediction & Chemistry Transport Models

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IRS (InfraRed Sounder) is an infrared Fourier transform spectrometer that will be on board the Meteosat Third Generation series of the future EUMETSAT geostationary satellites. After its launch planned in 2024, it will be able of measuring the radiance emitted by the Earth at the top of the atmosphere using 1960 channels in two spectral bands between $680 - 1210 \text{ cm}^{-1}$ (long-wave infrared) and $1600 - 2250 \text{ cm}^{-1}$ (mid-wave infrared). It will perform measurements over the full Earth disk with a spatial and temporal resolution of 4 km at nadir and 30 minutes over Europe respectively. The assimilation of these new observations represents a great challenge for the improvement of numerical weather and environmental prediction models, especially for convective-scale area model such as AROME-France.

The main objective is to evaluate the impact of IRS observations assimilation in the regional AROME model. To carry out this work, we are building an OSSE (Observing System Simulation Experiments) framework. Thus, we describe here the first step which consists in setting up a realistic atmospheric state (Nature Run) for the global ARPEGE and regional AROME models, which is used for the simulation of the observing system including IRS radiances and radars for the first time. This NR AROME is used to accurately simulate all the observations assimilated in this model (conventional observations, satellite data and radars). It is important to be as close as possible to the operational assimilation system with simulated one in order to reproduce the real impact of the different types of observations. We compare the weight of the OSSE observations compared to the operational one and we evaluate the contribution of the different observations by adjusting their errors. The IRS observations are also simulated from this realistic atmospheric forecast.

This study provides the set of tools for the assimilation of the future IRS sounder in a mesoscale NWP system such as AROME at Météo-France. We detail the consideration of reconstructed radiances after decompression of principal component analyses, the diagnostics of observation errors, the cloud detection scheme and the configuration for IRS in the 3D-Var. An evaluation of the forecast skills based on the assimilation of the operational set of observation is made as well as the impact of the addition of IRS on the forecasts using forecast scores over two distinct periods. The results show strong positive impacts of IRS on weather forecasts, especially in summer, supporting the idea that this instrument will allow a significant improvement of our NWP system in the years to come.

A similar study was carried out by Francesca Vittorioso during her PhD thesis on IRS assimilation for improving ozone fields in the MOCAGE Chemistry Transport model. This work shows the benefits that IRS will generate for ozone forecasting as well as for other species such as carbon monoxide. We conclude with a non-exhaustive list of the broad prospects that IRS will bring us in the very near future.

Coopmann, O., Fourrié, N., & Guidard, V. (2022). Analysis of MTG-IRS observations and general channel selection for numerical weather prediction models. *Quarterly Journal of the Royal Meteorological Society*, 148(745), 1864-1885.

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