

The FORUM End-to-End Simulator project: exploring the potentialities of EE9 mission





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The FORUM Mission:

FORUM (Far-infrared Outgoing Radiation Understanding and Monitoring) is a Fourier Transform Spectrometer (FTS) that will fly as the 9th ESA's Earth Explorer mission. FORUM will sound the atmosphere in the 100-1600 cm⁻¹ region, covering the Far Infrared (FIR) and part of the Middle Infrared (MIR), accounting for more than 95% of the outgoing longwave flux lost by our planet. The FORUM data will allow a better insight into the following targets:

- Upper Troposhpere Lower Stratosphere (UTLS) Water Vapour • Cirrus cloud characteristics
- Surface emissivity in polar and dry regions

The FORUM End-to-End Simulator (FE2ES)

The FE2ES is a chain of codes that simulates the operative conditions of FORUM, in order to evaluate the impact of instrument characteristics and scene conditions on the quality (precision, accuracy) of the retrieved products. The radiative transfer used in the simulation and retrieval is the same (LBLRTM + LBLDIS), so no model errors are added. On the other hand several conditions that can happen in operative conditions can be simulated, such as: • Sensitivity to thin cirrus clouds • Heterogeneity in the field of view

Cloud contamination of clear sky

• Tests based on MODIS L2 data

FE2ES Structure

The FE2ES chain is structured with the following modules:

- The Geometry Module (GM) calculates the true and error affected geographical coordinates of the field of view based on satellite location and pointing.
- The Scene Generator Module (SGM) calculates the high resolution radiances reaching the instrument, using the exact geographical coordinates and the prescribed atmospheric parameters. These constitute the true state.
- The Observing System Simulator (OSS) simulates the acquisition process of the instrument. Two different configurations reproduce two different hardwire instrument concepts specifications.
- The Level 2 Module (L2M) uses the spectrum generated by the OSS and the noisy geographical coordinates to retrieve atmospheric parameters.
- The Performance Assessment Module (PAM) compares the true versus the retrieved LI and L2 products and produces a report on the discrepancies.

FE2ES Chain Validation:

The FE2ES chain has been validated using the KLIMA code for the clear sky cases, and the SACR code for the cloudy sky cases. We used seven homogeneous clear sky cases and five homogeneous cloudy sky cases.

• In clear sky, the L2M retrieves simultaneously surface temperature and emissivity, and vertical profiles of temperature and water vapour. In cloudy sky, at this stage the L2M retrieves the cloud parameters using perturbed atmospheric and soil conditions.





Effect on the retrieval error for temperature and water vapour

Selection of results:



Inhomogeneity in the soil:

Effect on the retrieval error for temperature and water vapour



Critical case: Emissivity retrieval over desert:



Emissivity retrieval (right panel) and emissivity accuracy compared with retrieval error (left panel).

The retrieval shows positive bias of about +0.01. Retrieved tskin has a bias of -0.8 K. This is due to a negative correlation between surface temperature and surface emissivity. While this is always present in all cases, it reaches its maximum in the desert case.

A possible solution:

Use a larger a-priori error (0.2), with no correlations. This choice triggers oscillations in the retrieved profile, so that an a-posteriori regularization (the IVS scheme) has to be applied.



