



## **The Far-infrared-Outgoing-Radiation Understanding and Monitoring (FORUM) candidate mission for the ESA Earth Explorer - 9**

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The far infrared (FIR) spectral region from  $100$  to  $667\text{ cm}^{-1}$  ( $100$ - $15\text{ }\mu\text{m}$ ) of the Earth's outgoing longwave radiation (OLR) has never been spectrally observed from space. However, from the energetic point of view, more than 50% of the global OLR exits to space from this spectral region. The modulation of this flux, mainly due to water vapour in the upper troposphere and thin cirrus, produces a large effect on the energy balance that is currently under-constrained in climate models owing to the lack of spectral measurements relating this variation to the underlying physical processes.

The Far-infrared-Outgoing-Radiation Understanding and Monitoring (FORUM) mission will, as its main goal, fill the long-standing gap in the FIR spectral observations from space. FORUM will deliver an improved understanding of the climate system to respond to society's demand for improved climate model predictive capabilities by supplying, for the first time, a complete characterisation of the Earth's OLR spectrum. This goal is achieved by measuring the Earth's top-of-atmosphere emission spectrum from  $100$  to  $1600\text{ cm}^{-1}$  ( $100$ - $6.25\text{ }\mu\text{m}$ ), with a nominal resolution of  $0.3\text{ cm}^{-1}$ , benchmarked against international standards with an absolute accuracy of  $0.1\text{ K}$  in TOA brightness temperature. The satellite is proposed to fly for 3 years in tandem with Metop-SG to complement the mid-infrared spectral measurements performed in the  $645$ - $2760\text{ cm}^{-1}$  range by IASI-NG. In this way, FORUM and IASI-NG together will deliver a truly unique dataset of the Earth's entire emission spectrum from  $100$  to  $2760\text{ cm}^{-1}$  ( $3.62$ - $100\text{ }\mu\text{m}$ ), which can be used to provide a stringent test of our understanding of, and ability to model, the links between key underlying physical processes driving climate change, their spectral signatures and the Earth's Radiation Budget.

Mission objectives include the generation of:

- spectral OLR fluxes with a precision of 1%;
- surface temperatures in clear sky conditions with an accuracy of at least  $0.5\text{ K}$ ;
- spectral emissivity of frozen surfaces in polar regions with an accuracy of at least 0.01 over the under-explored FIR range and the mid-IR transparency region;
- humidity profiles with a vertical resolution of  $2\text{ km}$  and accuracy of 10% ( $1\text{ ppmv}$ ) in the lower-mid (upper) troposphere;
- temperature profiles with a vertical resolution of  $2\text{ km}$  and accuracy of  $1\text{ K}$  throughout the troposphere;
- improved retrievals of cirrus cloud properties such as cloud top height, ice water path, effective particle size and optical depth, achieved by exploiting the unique information on ice optical properties contained in the FIR;
- a climatology of the fundamental parameters of cirrus capable of matching observed ice cloud radiative signatures consistently across the entire IR spectrum.

Here we present the FORUM mission, which has recently been selected by ESA as one of two candidates for the Earth Explorer 9 mission programme. The mission will undergo the industrial and scientific Phase-A study in 2018-19.