

Retrieval studies using the Far-IR spectral measurements performed by FIRMOS-B from stratospheric balloon flights

Luca Palchetti ⁽¹⁾, Marco Barucci ⁽¹⁾, Claudio Belotti ⁽¹⁾, Francesco D'Amato ⁽¹⁾, Samuele Del Bianco ⁽²⁾, Gianluca Di Natale ⁽¹⁾, Bianca Maria Dinelli ⁽³⁾, Marco Ridolfi ⁽¹⁾, Silvia Viciani ⁽¹⁾

⁽¹⁾ *Istituto Nazionale di Ottica - Consiglio Nazionale delle Ricerche*

Via Madonna del Piano 10, 50019, Sesto Fiorentino, Italy

EMail: Luca.Palchetti@cnr.it

⁽²⁾ *Istituto di Fisica Applicata "Carrara"- Consiglio Nazionale delle Ricerche*

Via Madonna del Piano 10, 50019, Sesto Fiorentino, Italy

EMail: s.delbianco@ifac.cnr.it

⁽³⁾ *Istituto di Scienze dell'Atmosfera e del Clima - Consiglio Nazionale delle Ricerche*

Via Via Piero Gobetti, 101, 40129, Bologna, Italy

EMail: bm.dinelli@isac.cnr.it

ABSTRACT

FIRMOS-B is the balloon adaptation of the Far-Infrared Radiation Mobile Observation System, developed by CNR-INO with ESA and ASI support for the preparation of the FORUM Earth Explorer 9 mission, planned for launch in 2027.

The instrument was deployed during the Strato-Science 2022 campaign at the ASC/CSA stratospheric balloon base in Timmins (Canada) in August 2022 and it is planned to be launched in June 2024 from the SSC facility in Kiruna within the TRANSAT 2024 campaign.

All the acquired measurements were qualified in terms of noise equivalent spectral radiance (NESR) and instrument parameters (frequency scale and line shape) using radiative transfer and inversion models for a few case studies, both in clear and cloudy sky conditions. On ground, a NESR of less than $1 \text{ mW}/(\text{m}^2 \text{ sr cm}^{-1})$ was obtained in the FIR range, with an integration time of 1 min. During the flight, the standard deviation of the imaginary part of the Fourier-transformed interferograms of a sequence of measurements was used as the best estimate of the measurement NESR.

In this presentation, the retrieval in clear sky of water vapour and temperature profiles, and the surface temperature and emissivity is compared with the ERA5 fields and the available local radiosounding measurements. The analysis in cloudy sky shows results consistent with the ones obtained in the clear sky analysis for the instrument parameters. Furthermore, the retrieval shows good sensitivity to the atmospheric parameters (water vapour and temperature profiles), the surface temperature, and the cloud optical depth and position, whereas the cloud microphysics and the ice fraction retrievals show larger errors.

The measurements provided by FIRMOS-B during these campaigns are valuable for assessing new algorithms that are under development for the data analysis of the FORUM mission, e.g. the fast radiative transfer and inversion codes that are under study within the FIT-FORUM project funded by ASI.