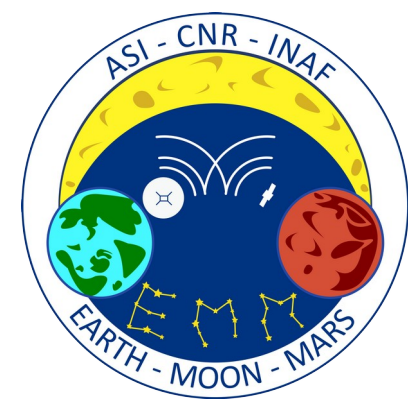




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“LETO on the Moon: Extending FORUM Climate Datasets with Disk-Integrated Far-Infrared Observations”

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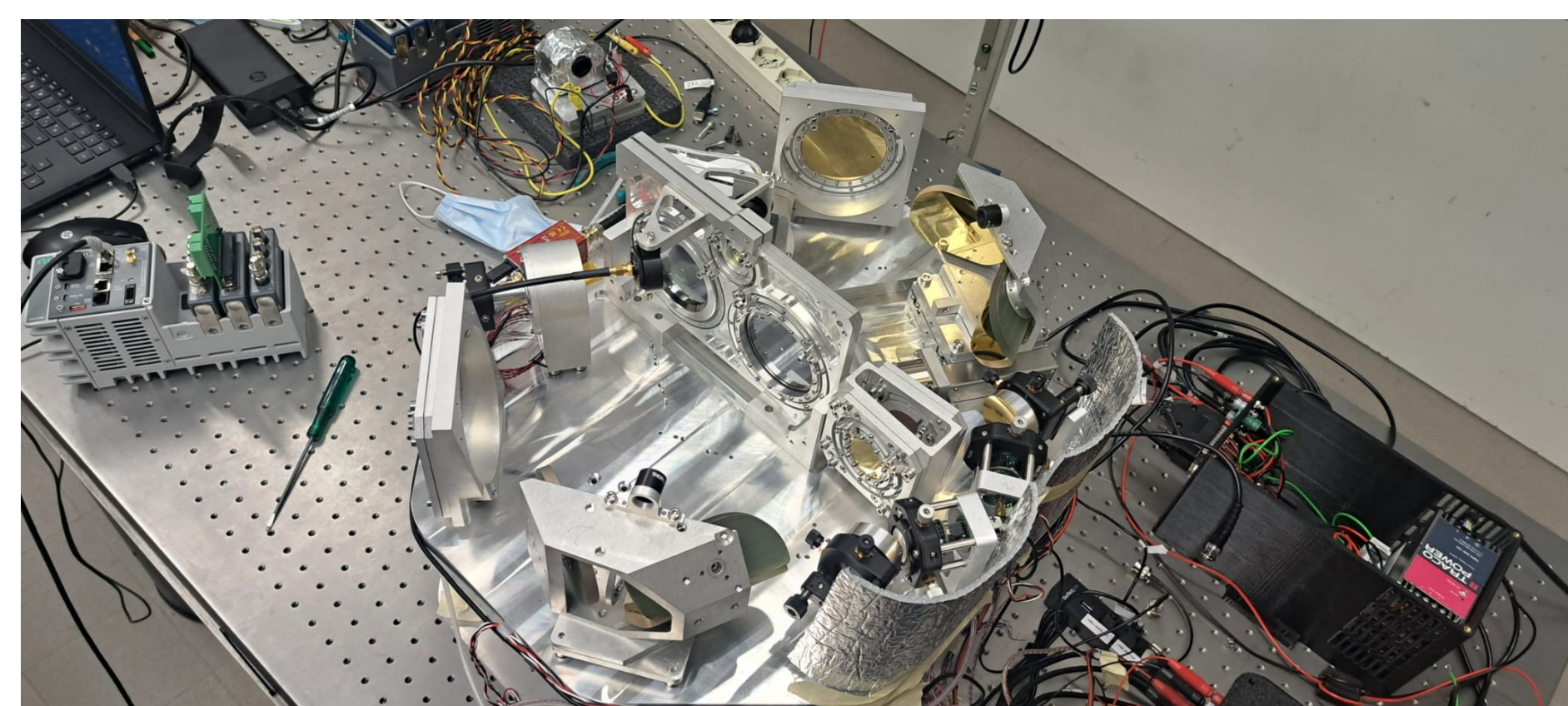
1. CNR-INO 2. CNR-IFAC

3. University of Bologna

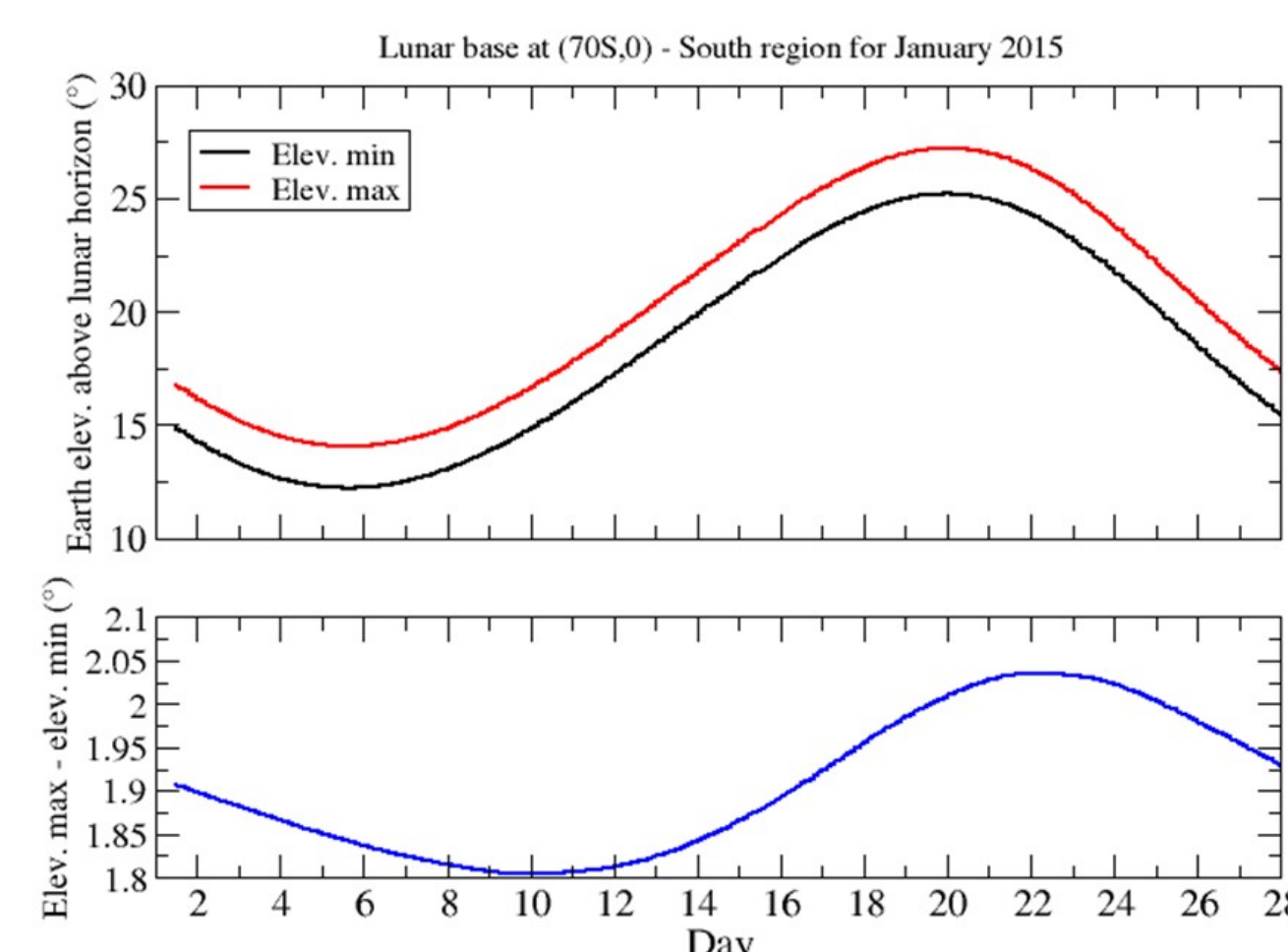
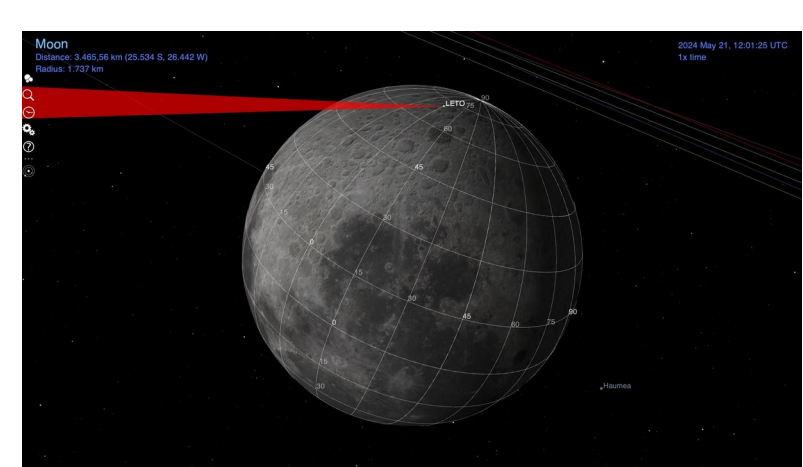
4. University of Basilicata

ABSTRACT The Earth-Moon-Mars (EMM) project has been recently selected under the Italian National Recovery and Resilience Plan (PNRR). The initiative, led by the Italian National Institute of Astrophysics (INAF) in collaboration with the Italian Space Agency (ASI) and the National Research Council (CNR), includes among its objectives the realization of an infrastructure to be deployed on the lunar surface. Within this framework, CNR is contributing to the development of an Earth-observing system called LETO (Lunar Earth Temperature Observatory), which comprises a Fourier Transform Spectro-radiometer (LETO-FTS) and an imager (LETO-IMG). These two instruments, conceptually similar to those onboard the FORUM mission, will provide continuous monitoring of the Earth's entire disk, measuring both the brightness temperature and the outgoing longwave radiation (OLR) flux. In particular, the LETO spectro-radiometer will record the spectral radiance emitted by the full Earth disk across the far-infrared (FIR) and mid-infrared (MIR) spectral regions, approximately between 100 and 1600 cm⁻¹ (corresponding to wavelengths from 6 to 100 μm). The accompanying imaging system will enable the identification of thermal anomalies associated with extreme events — such as wildfires, volcanic eruptions, and other large-scale phenomena — that could influence the overall Earth brightness temperature measured by the FTS.

1. LETO Instrument for EMM infrastructure



2. Visibility study from 70° S on the Moon



3. Scheme of the LETO average spectral radiance simulation

Cloud and atmospheric profiles and all surface properties from ECMWF Reanalysis v5 (ERA5) database. Soil spectral emissivity down to the FIR band from Huang et al. 2016 database

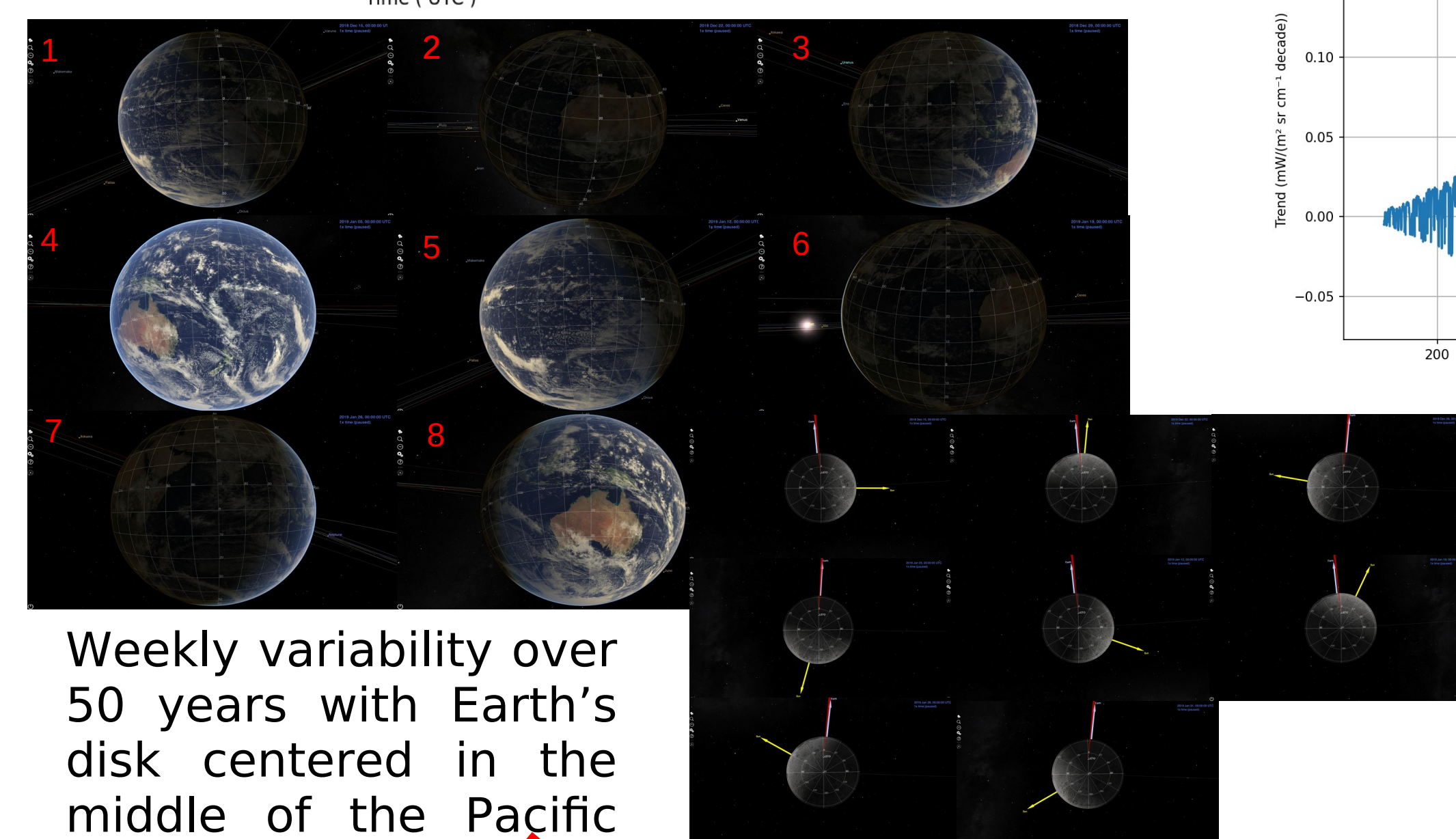
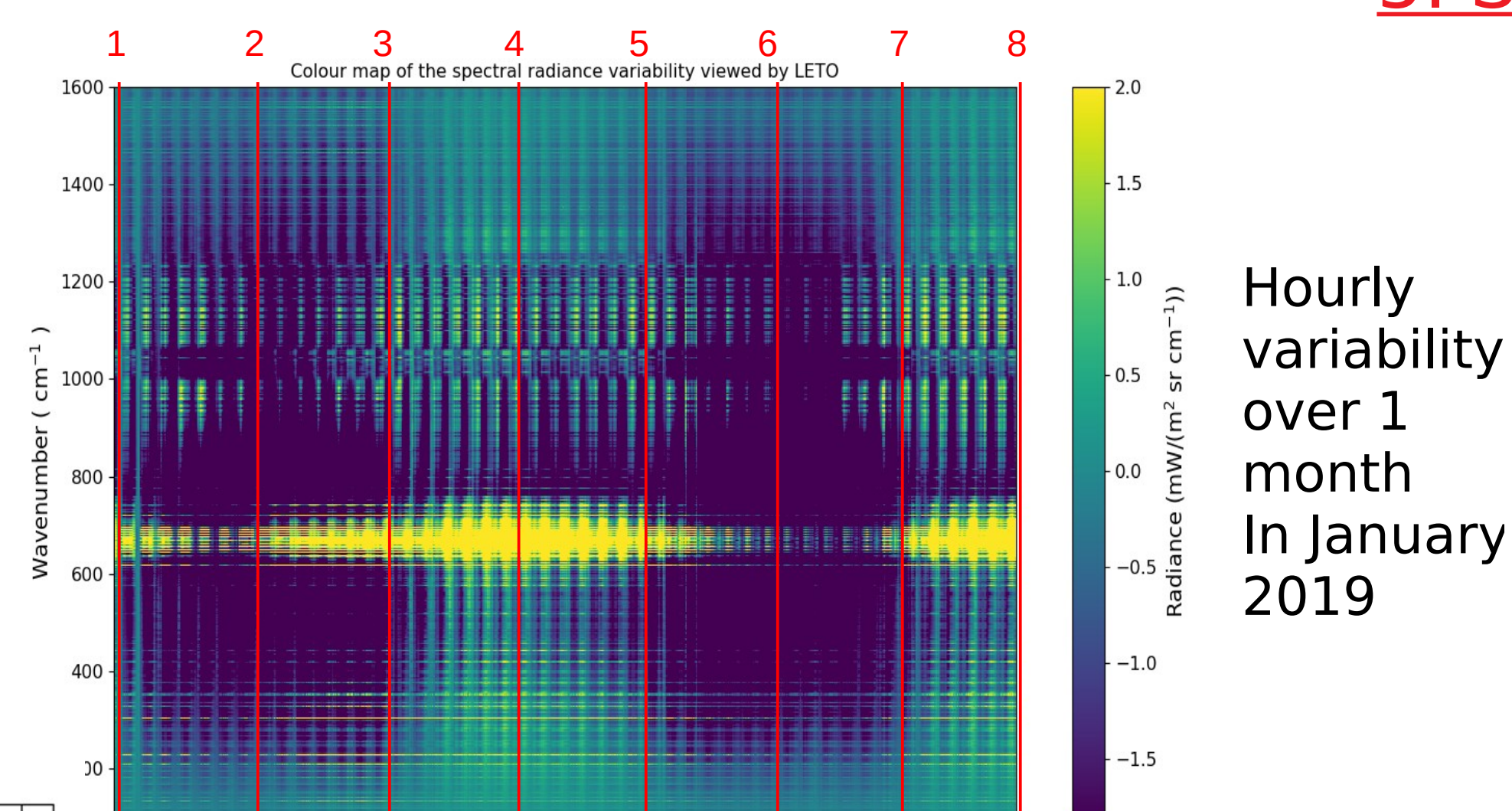
Building the files setting, profiles and emissivities for each pixel

Radiative transfer model

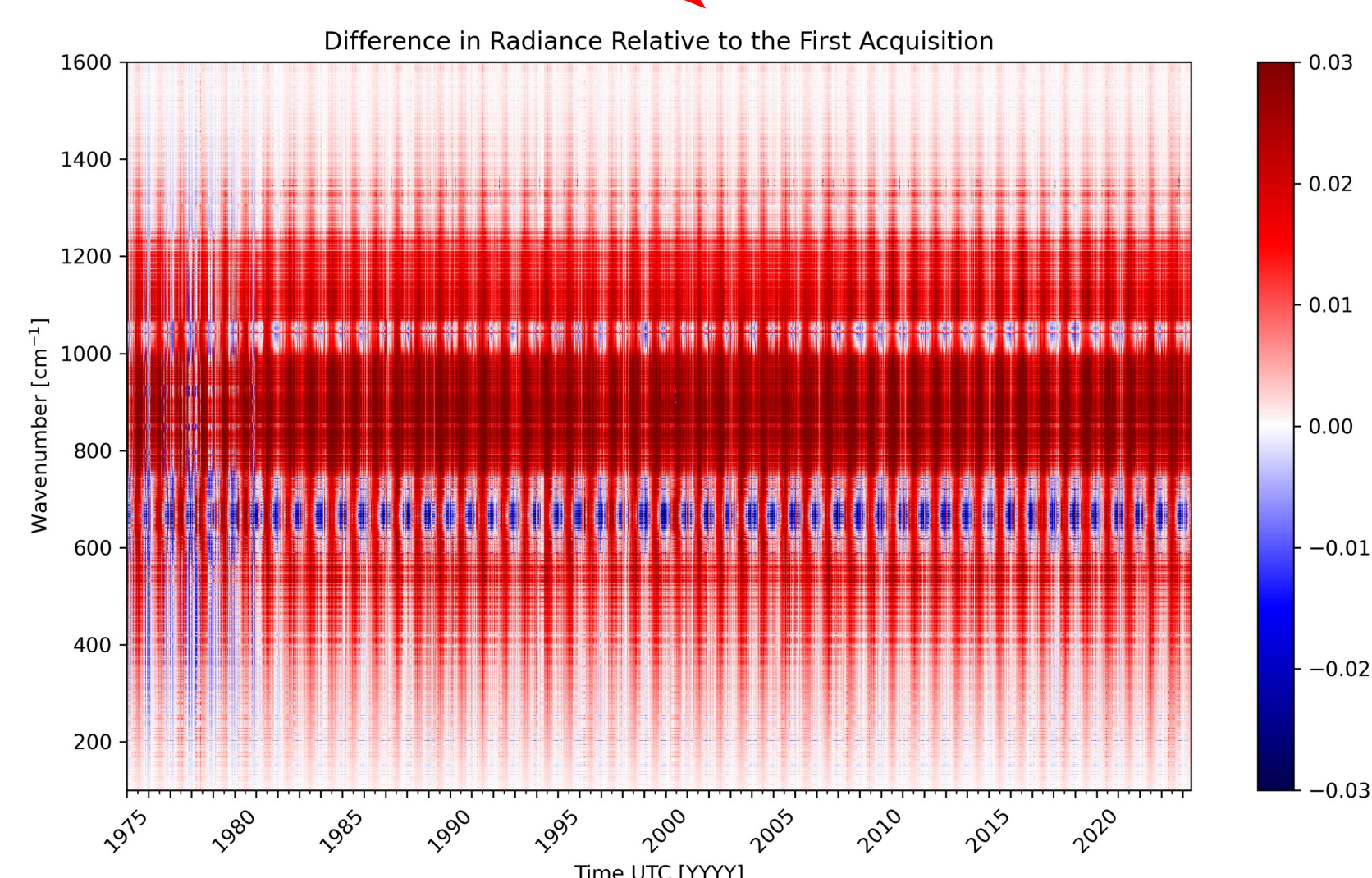
Integration of the radiance over the Earth's disk

Average spectral radiance

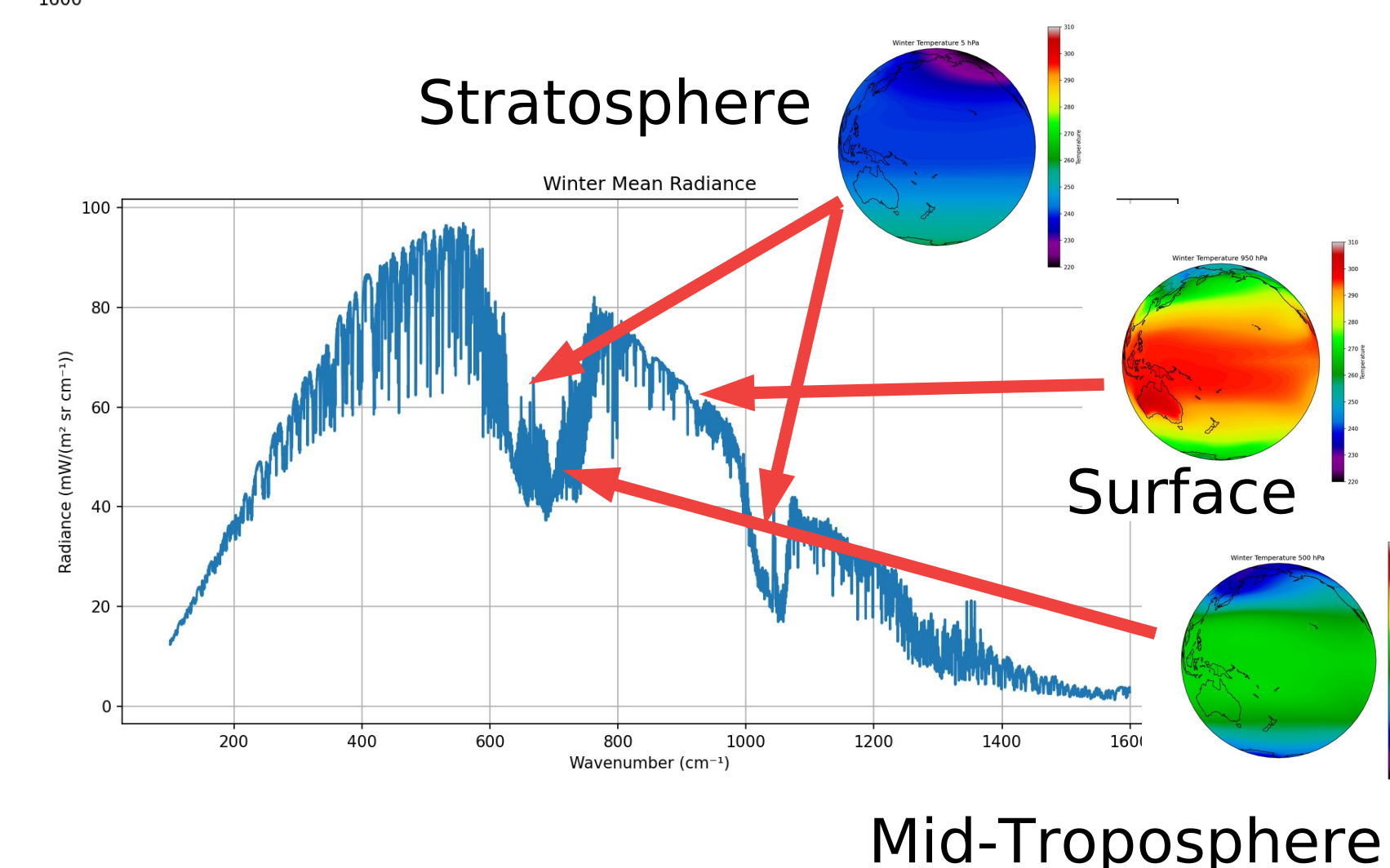
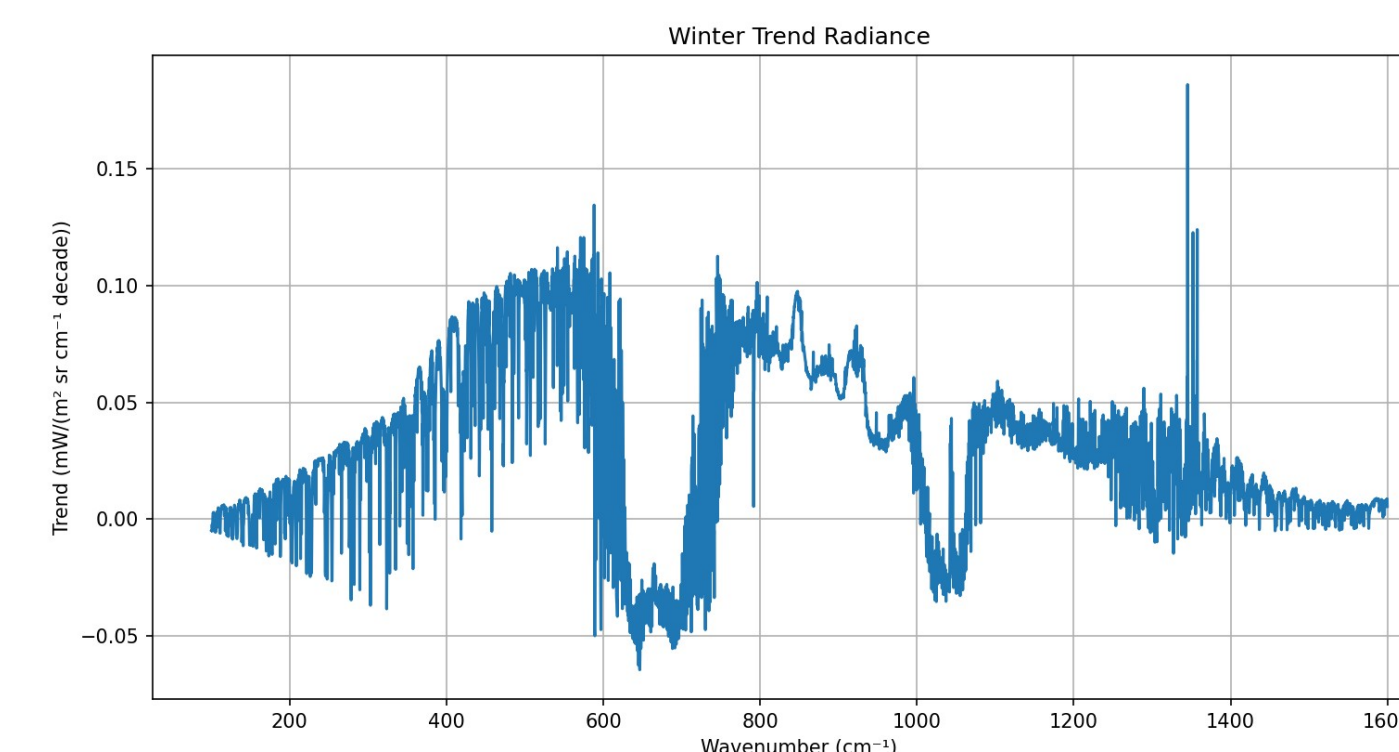
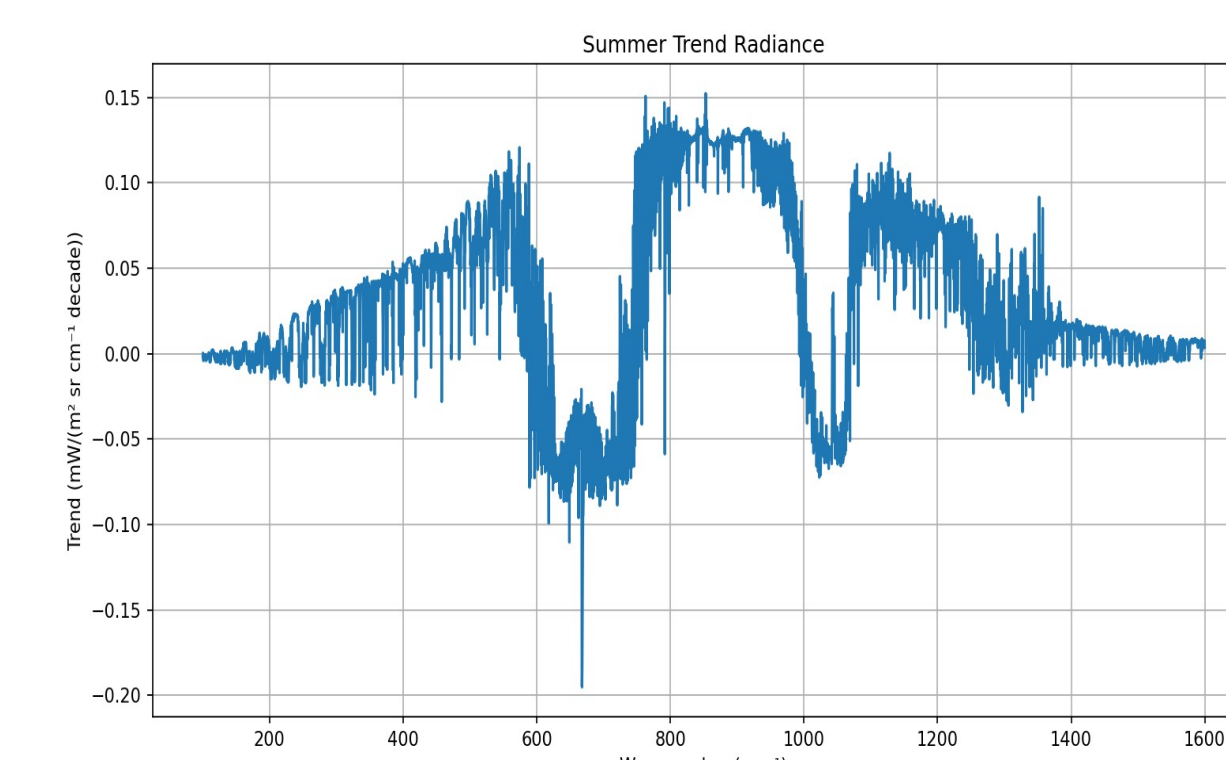
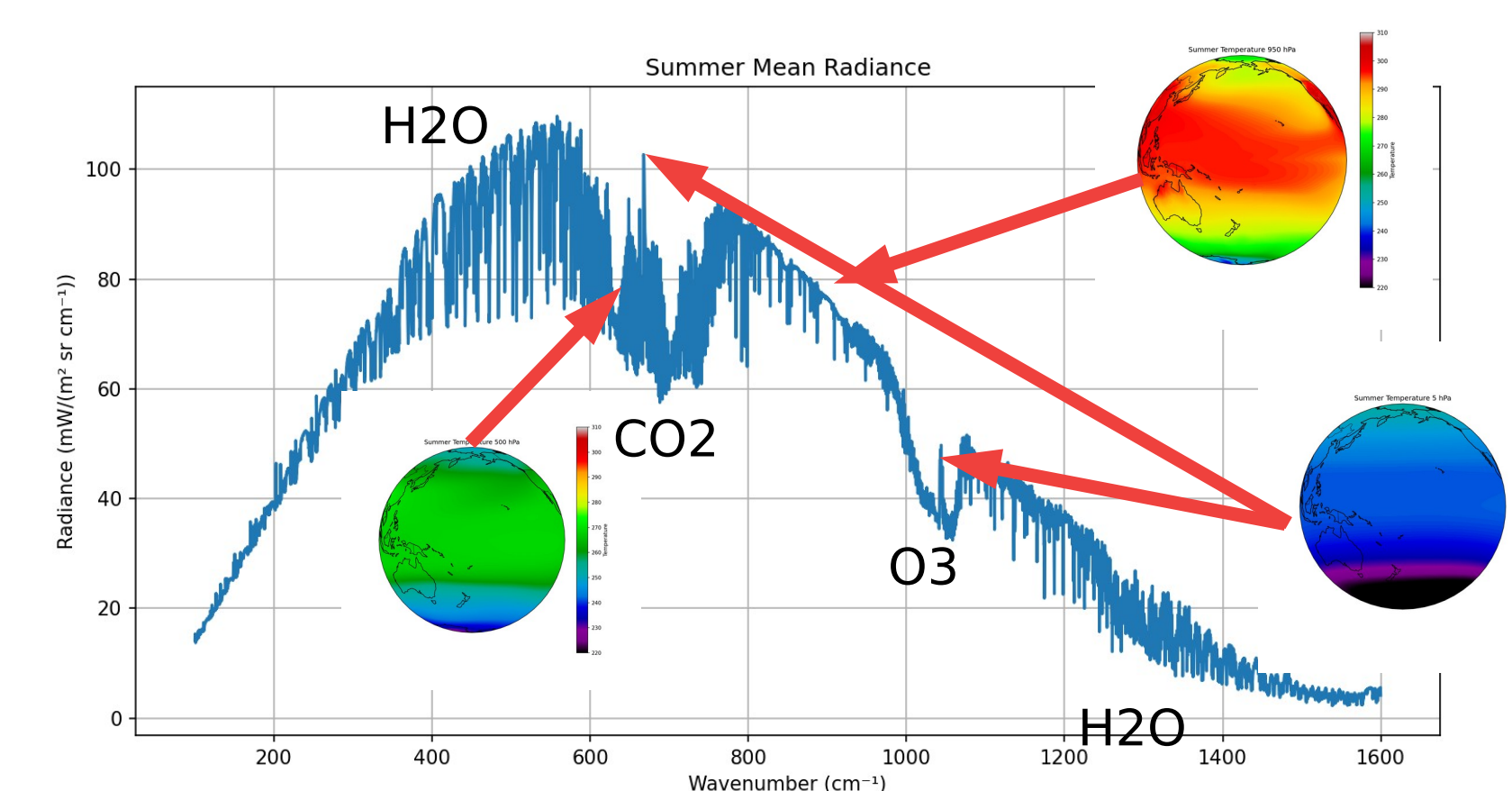
4. Variability of LETO signal



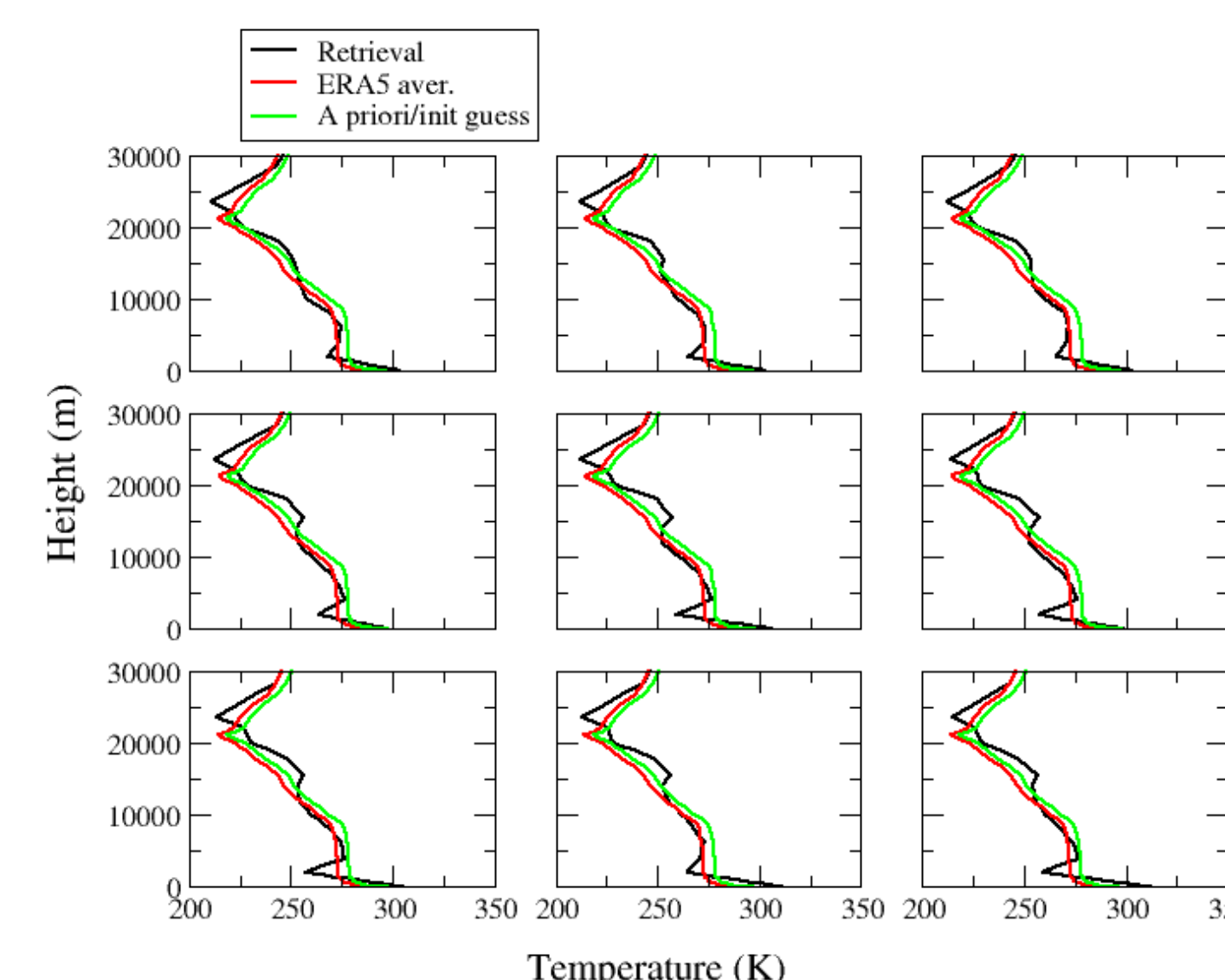
Weekly variability over 50 years with Earth's disk centered in the middle of the Pacific Ocean



5. Seasonal LETO average spectra & trends over 50 years since 1975



6. First retrieval tests of the effective temperature profile



SUMMARY

LETO will be deployed on the Moon within the framework of the PNRR EMM project. The simulated radiances will be used to reproduce the measurements, which will be collected every 1-2 minutes to minimize the impact of the Earth's rotation on the observed scene. The temporal variations of the signal will enable us to track the global mean temperature trend and, potentially, to monitor changes in the overall coverage of clouds, ice, and vegetation.

Acknowledgements

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