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Optimal trade off between spectral and radiometric resolution in order to optimize the performances of a radiometer in the far infrared region

Current observations used in numerical weather prediction systems come mostly from spaceborne thermal infrared sounders such as AIRS, IASI and CrIS. However, the thermal infrared only constitutes half of the Earth's emitted radiance, the other half being the far infrared (far-IR), ranging from 15 to 100 µm. In recent years, some theoretical studies have shown the added-value of far-IR observations for remote sensing of water vapor and clouds, especially in dry and cold regions. Satellite missions sounding in the far-IR, such as TICFIRE, FORUM and PREFIRE, are also emerging from various space agencies.

In this study, the objectives were to evaluate the potential of far-IR spaceborne measurements to provide information for temperature and humidity and to analyze the optimal trade-off between spectral and radiometric resolution. A radiometer was used since it allows to have bands with different spectral widths, which means that the bands can be selected where the Jacobians are strongest. A simple 1D framework was used to compare the impact of far-IR and mid-IR measurements through the reduction of the analysis error variance obtained by assimilating those. Information content (or Degrees of Freedom per Signal, DFS) was used as the metric to examine synthetic measurements for different number and widths of spectral bands, and measurement error. In this framework, it was assumed that there is no bias in the observation error and the a priori background state. The results indicate that a few broader bands in the far-IR bring as much information as AIRS. Also, there is a complementarity in assimilating measurements in the far-IR and measurements in the mid-IR, since the DFS increases when far-IR measurements were assimilated on top of AIRS. It was shown that too many bands with a large noise do not give enough information on the atmosphere.

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