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Retrieval of Elevated Moist Layers using Hyperspectral Infrared Sounders

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Satellite based hyperspectral infrared (IR) sounders like IASI, AIRS and CrIS offer a wealth of information about the atmospheric composition and vertical structure. A key quantity these instruments are able to capture is the vertical profile of water vapor in clear-sky and partly cloudy conditions. The work presented here revolves around mid tropospheric layers of increased humidity, so called Elevated Moist Layers (EMLs). EMLs frequently emerge in the vicinity of deep convection in the tropics as they are thought to originate from detrained moisture of convective plumes near the stable freezing level at around 5 km altitude. Previous retrieval case studies indicate limited retrievability of EMLs based on hyperspectral IR observations depending on the exact retrieval method, retrieval setup and the atmospheric conditions. Since EMLs severely influence the local radiation budget of the atmosphere, we need to understand what operational retrievals capture and what they may miss about EMLs.

As a starting point, we present an EML case study from the NARVAL-2 measurement campaign to directly compare IASI and AIRS retrieval products to in-situ soundings. We also introduce ERA5 as an additional reference to assess whether limitations in the retrieval product propagate to the reanalysis. As a next step, we conduct a first systematic statistical assessment of EML retrievability based on long term operational retrieval data. As reference, we use radiosonde data from the GRUAN database and ERA5. The EMLs in the different datasets are first identified by introducing smooth reference humidity profiles. The EMLs are then characterized by their layer averaged anomalous humidity, their thickness and altitude. These EML characteristics are compared statistically to assess what type of EMLs the retrievals capture well and where there might be systematic issues. We also calculate radiative heating profiles and assess the impact of EML retrievability on radiative heating.