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TROPoe: Tropospheric Remotely Observed Profiling via Optimal Estimation

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Ground-based remote sensing instruments provide a unique and powerful view of the thermodynamic structure and evolution of the atmospheric boundary layer. A range of different technologies have been developed over the past 40 years to observe profiles of temperature and humidity from the ground. These methods include passive techniques, such as single- and multi-channel microwave radiometers (MWRs) and infrared spectrometers (IRS), and active approaches, such as Raman lidars (RLID), differential absorption lidars (DIALs), and radio acoustic sounding systems (RASS). All of these techniques have strengths and weaknesses, and it can be challenging to evaluate the relative differences in their information content in a consistent way. Furthermore, this leads to questions on how to combine observations from multiple instruments synergistically. Additionally, the profiles derived from many remote sensors have correlated errors between different height levels, and thus the covariance of the profile needs to be understood if the profiles are to be properly assimilated into a weather forecast model.

To address these questions, we have developed the TROPoe retrieval software package. TROPoe is a 1-dimensional variational algorithm, based upon optimal estimation, that incorporates forward models for all of these instruments to allow an iterative solution to be determined. A climatology, usually of historical radiosondes launched near the instrumented site, is used to provide a constraint to the retrieved solution. Uncertainties from the observations, the sensitivity of the forward models, and the uncertainty in the prior are all propagated to provide a full error covariance matrix for each retrieved thermodynamic profile. Retrievals using single instrument configurations (e.g., MWR-only, IRS-only, DIAL-only) as well as multi-instrument retrievals (e.g., MWR+IRS, MWR+DIAL, IRS+RLID, MWR+IRS+DIAL) have been performed. Since the same retrieval framework and prior dataset was used, the uncertainties and information content for each instrument complement can be directly compared. We will present some examples in the differences in the information content among these different instrument combinations.

The TROPoe software is being packaged into a Docker container, which will facilitate the use of the software easily by a wide range of users. We will present our vision for how TROPoe could be used to provide consistent retrievals for the ground-based remote sensing community, including how to assimilate these data, regardless of the actual instrument datasets used in the analysis.