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Statistical Characterization of Temperature and Pressure Vertical Profiles for the Analysis of Laser Heterodyne Data

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We present an analysis of historic pressure and temperature profiles from radiosonde launches that will be used in retrieval of mixing fractions for greenhouse gases (GHGs, including carbon dioxide, methane, and water vapor) in Laser Heterodyne Radiometry (LHR) data. With over 2,700 stations worldwide, the global coverage for weather balloon observations is extensive. Radiosonde stations included in the Integrated Global Radiosonde Archive (IGRA), are launched simultaneously twice daily at 00:00 and 12:00 UTC. Global stations span all time zones in both the Northern and Southern Hemisphere.

Mesa Photonics and George Washington University are developing a variant of LHR known as Precision Heterodyne, Oxygen-Corrected Spectroscopy (PHOCS) that simultaneously collects high-resolution, oxygen spectral line shape data. Because oxygen concentrations in the troposphere and lower stratosphere are constant, these line shapes are uniquely sensitive to both temperature and pressure profiles and constrained fitting of these line shapes enables more precise GHG concentration retrievals.

Our approach is to collect historic data over several years (typically the prior decade) for a particular date window surrounding a PHOCS measurement date for stations across the globe, and mine this data for observation probability distributions as a function of level altitude, local time of day of launch, latitude, etc. These distributions will then be used as Bayesian priors to constrain temperature and pressure fits during the oxygen spectral fitting routine. Subsequently, these priors will be used to estimate uncertainties in vertically-resolved GHG mixing ratios.