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Performance of the line-by-line radiative transfer model (LBLRTM) for satellite retrievals of temperature and water vapor: Recent spectroscopy updates evaluated using IASI case studies

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Here we describe recent updates to AER's line-by-line radiative transfer model LBLRTM, used from the submillimeter to the visible. AER's line-by-line models are widely regarded as a reference standard within the atmospheric community, with users across a range of disciplines in government agencies, industry, and academia. LBLRTM has been used as the basis of the forward models for the Infrared Atmospheric Sounding Interferometer (IASI), designed with both meteorological and atmospheric chemistry goals in mind, and the NASA Tropospheric Emission Spectrometer (TES), designed for the retrieval of trace gases relevant to atmospheric chemistry and air quality studies.

The accuracy with which it is possible to model gaseous absorption with line-by-line radiative transfer models is currently limited mainly by uncertainties in the knowledge of spectroscopic parameters, lineshape and continua. Therefore, continual improvements to spectroscopic parameters and continua are crucial to ensure future scientific progress. Spectral line parameters used in LBLRTM are now based on the HITRAN 2008 compilation, with selected notable exceptions, made only after extensive validation. Exceptions to HITRAN in the infrared include updated CO_2 line positions and intensities, updated line mixing coefficients for CO_2 and CH_4 and improvements to the H_2O line positions and intensities. Recent updates to the MT_CKD continuum used by LBLRTM include updates to the CO_2 and self-broadened H_2O continua in the 2400 cm^{-1} region.

We will show the results of a rigorous validation of these updates to LBLRTM against a global dataset of 130 clear-sky, nighttime, ocean, near-nadir IASI measurements during April 2008. We will evaluate the consistency of the residuals across the IASI spectral range, with a special focus on the consistency of the spectroscopy in (1) the CO_2 ν_2 and ν_3 bands used for temperature retrievals and (2) the P and R branches of the H_2O ν_2 band used to retrieve water vapor. We will also evaluate the consistency between the temperature profiles retrieved using the CO_2 ν_2 and ν_3 bands separately, as well as the water vapor profiles retrieved using the P branch versus using both the P and R branches of the H_2O ν_2 band.

The AER radiative transfer models and the associated databases (e.g., line parameters, continua, and molecular cross-sections) are publicly available from AER (http://www.rtweb.aer.com).