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Monitoring greenhouse gases with astronomical observations

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Modern telescopes are equipped with high-precision multi-mode spectrographs. To obtain proper calibration, astronomers observe the plain night sky and specific telluric standard stars (TS stars) to estimate the influence of the Earth atmosphere on astronomical observations. TS stars are usually white dwarfs, as their spectra are not time dependent and hardly contain any spectral features.

Since the atmospheric emission in the thermal infrared and the absorption of stellar radiation reflect molecular abundances in the lower atmosphere, plain night sky and TS spectra can be used to obtain column densities of greenhouse gases. We present a method for determining this, incorporating the radiative transfer code LBLRTM and the HITRAN database. We fit specific molecular absorption and emission features by varying the corresponding abundance profiles iteratively implementing a Levenberg-Marquardt χ^2 minimisation algorithm.

This method was originally developed to estimate the amount of precipitable water vapour, which strongly influences infrared observations, above the observing site of the ESO Very Large Telescope, Cerro Paranal. We are currently in the process of extending this procedure to other greenhouse gases. As plain sky and TS stars are observed several times per night these spectra can be used to monitor molecular column densities on a long term basis.