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Effects of Clouds on High Resolution Thermal Emission Spectra of Terrestrial Exo-Planets

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For an investigation of the potential habitability of terrestrial exo-planets the spectroscopic characterization of the planetary atmosphere and the identification of biomarker signatures is crucial. The radiative transfer is critically dependent on atmospheric (pressure, temperature, composition) and surface conditions. In particular, clouds can have a large impact on the planetary spectra (intensities and shapes) due to extinction events.

Here the effects of the presence of clouds in Earth-like planetary atmosphere are studied with a high resolution radiative transfer model and compared to low and moderate resolution spectra.

Infrared transmission and emission spectra are modeled using a combination of a line-by-line (lbl) molecular absorption code with a multiple scattering radiative transfer solver. Temperature profiles and low resolution spectra for Earth-like planets around different types of central stars have been taken from a radiative-convective climate model with a parametrized cloud description (see Kitzmann et al. 2010, AA, Vol 511, A66).

The new lbl-multiple scattering code was tested successfully with respect to consistency to a low resolution radiative transfer code and by comparisions with Venus observations. The dependency of biomarker signatures on the presence of low-level water and high-level ice clouds is studied, e.g. for the thermal infrared band of ozone at 9.6 micrometer. Results indicate the important impact of clouds on the detectability of biomarker molecules by dampening their spectral signatures. Furthermore, biosignatures may be lost in low resolution spectra leading to false negative classification, i.e. high resolution lbl modeling is mandatory for an assessment of detection feasibility. Hence systematic high resolution studies have to be pursued covering other (UV, Vis, NIR) spectral ranges of interest (other biomolecules).

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