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Transiting Earth: UV-NIR model transmission spectrum.

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Abstract

Transmission spectroscopy is a powerful technique to characterize the atmospheres of exoplanets. We model the atmospheric cross section from 115 to 1000 nm of Earth viewed as a transiting exoplanet around a Sun-like star to guide instrument studies for future mission concepts. We build upon the model developed by Kaltenegger & Traub (2009) [1], for the Earth seen in a transit geometry, with a new database of continuous absorbers' cross sections. We also add Rayleigh scattering and refraction from N_2, O_2, Ar, and CO_2, and show their effects on the spectrum as well as the spectral signatures of each major atmospheric species. Clouds do not significantly affect this picture because refraction prevents the lowest 12.75 km of the atmosphere to be sampled by a distant observer.

The model spectrum shows prominent features of O_2 and O_3 above a Rayleigh scattering/Refraction background. Below 200 nm, ultraviolet (UV) O_2 absorption increases the effective planetary radius by up to 185 km versus 14 km in the near-infrared (NIR) due predominantly to refraction. This apparent change of about 2.7% of the Earth's radius from the UV to the NIR shows that broad spectral coverage is essential to characterize exoplanetary atmospheres and that the ultraviolet is an interesting spectral region for future space missions.

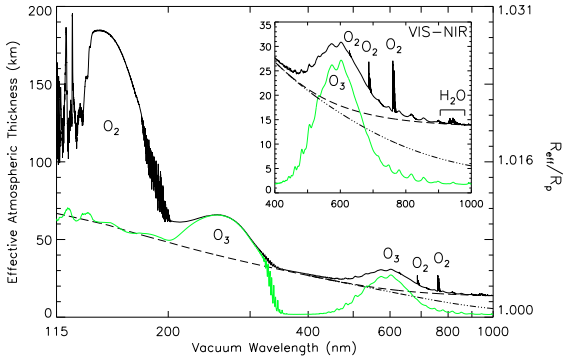

Figure 1: Effective atmospheric thickness and effective planetary radius, R_{eff} (expressed in Earth radii, R_p), of a transiting Earth from the UV to the NIR (main panel), and from the visible to the NIR (small inserted panel). The solid curve shows the overall spectrum while the green curve shows the individual contribution of O_3. Prominent spectral features from O_2, O_3, and H_2O, are identified. The combined effects of refraction and Rayleigh scattering (dashed line) by N_2, O_2, Ar and CO_2, and that of Rayleigh scattering alone (triple dot-dashed line) are also shown.

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References

[1] Kaltenegger, L., & Traub, W. A. 2009, ApJ, 698, 519