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Photometric variability of the disk-integrated thermal emission of terrestrial planets

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Our interest is focused on the characterization of earth-like planets with very low spectral resolution observations. We present an analysis of the globally-integrated mid-infrared flux using emission maps (longitude, latitude, time) of top-of-the-atmosphere from the NASA/GEWEX SRB program in the case of the Earth and from Global Circulation Model flux data developed by the Laboratoire de Météorologie Dynamique de Paris in the case of solar system planets or exoplanets (collaboration with F. Forget, R.Wordsworth and F. Codron). Our model calculates the planetary disk exposed to a remote observer and computes the integrated flux to simulate the point-like signal detected. We have studied the annual, seasonal, rotational and diurnal variability to determine which planetary and atmospheric properties can be inferred from this signal. In order to study the intrinsic parameters of the planet, it is useful to construct time folded light curves. We have performed the periodicity analysis of the signal in order to determine the rotational period. The duration of the statistically significant peaks in the autocorrelation time series can give us an estimation of the lifetime of the cloud structures, typically of around one week for Earth clouds (Pallé et al. 2003), (Pallé et al., 2008). The atmosphere of the Earth is optically thin enough in some windows of the thermal infrared to observe the influence of surface features in the signal for this reason rotation light curves are interesting. We have found that the rotational variations in mid-infrared emission flux have an amplitude of several percent, which is comparable to that of the seasonal variations. It is important to remark, however, the strong influence of the weather patterns in the rotational variability of the emitted flux, which are sometimes able to completely obscure the 24-hour rotation periodicity signal for several days at a time. The Earth does not exhibit phases but the signal is dominated by the seasonal variability due to the inhomogeneous distribution of land masses (Gómez-Leal et al. 2012). The model implements the case of an Earth-Moon system. We find that correlated phases of a Moon-like satellite can cause the misinterpretation of the signal in the absence of spectral information. We will discuss the relevance of several effects on the signal: atmospheric thickness, density, clouds, the spectral band range of the observations, the distribution of surface features and the instrumental requirements.

References

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