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A high-resolution extraterrestrial solar spectrum in the near-infrared from sun-pointing ground-based Fourier transform spectroscopy measurements

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Knowledge of the detailed spectrally-resolved extraterrestrial solar spectrum is important for line-by-line radiative transfer modelling in the near-infrared (near-IR), which constitutes about 52% of solar energy. Very few high-resolution measurements of the near-IR extraterrestrial solar spectrum are available. The theoretically-calculated extraterrestrial solar spectrum by Kurucz has been adopted for you use in many line-by-line radiative transfer models but this needs to be evaluated using measurements. We will present a near-IR extraterrestrial solar spectrum (called the CAVIAR solar spectrum here) derived using the Langley technique applied to calibrated observations from a ground-based high-resolution Fourier transform spectrometer (FTS). The resolution of this FTS is $0.03\,\mathrm{cm}^{-1}$ and the spectrum was derived in atmospheric windows between 2000-10 000 cm^{-1}. The results show that the Kurucz spectrum does not represent the solar absorption lines strengths and positions properly in some spectral regions in the near-IR with the absolute irradiance differing by up to 10% difference. In their region of overlap, there is good agreement between the strength and position of solar lines in the CAVIAR solar spectrum and that derived from the ACE-FTS satellite instrument; however, as the ACE-FTS solar spectrum was not calibrated it is not possible to compare the absolute levels in the two spectra. The CAVIAR spectrum is also compared with three other solar spectra: a composite spectrum obtained from Atmospheric Laboratory for Applications and Science (ATLAS) satellite in the near-IR and other sources ("Thuillier"), a spectrum obtained using semi-empirical models ("Fontenla") and the spectrum derived by Kurucz using FTS measurements in two near-IR windows ("observed Kurucz"). There is a good agreement between the structure in the observed Kurucz and CAVIAR spectra, but there are significant differences in the structure between the CAVIAR and Fontenla spectra. As Thuillier spectrum is relatively low resolution, no detailed comparison of its spectral structure is possible. However we found an up to 8% difference in the absolute irradiance and hence the wavenumber-integrated CAVIAR and Thuillier spectra which is apparently outside the uncertainty estimates for both sets of measurements. A similar difference has also been reported between the Thuillier and Spectral Irradiance Monitor (SIM) spectra. If the CAVIAR and SIM spectra are correct, this would have significant implications for the radiative transfer calculations and would also indicate that the "loss" of solar energy in the near-IR, would have to be compensated by an increase in other wavelength regions, as the total solar irradiance is much better constrained.