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A machine learning approach to derive surface solar irradiance spectra directly from satellite

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We present a sophisticated machine learning system for nowcasting high resolution solar irradiance spectra at the surface directly from satellite cloud and aerosol inputs. The system revolves around a state-of-the-art neural network trained on a large-scale (2.5M record) look-up table (LUT) of clear and cloudy sky radiative transfer simulations to convert satellite cloud and aerosol products directly into high spectral resolution (1nm) direct normal, global horizontal and diffuse horizontal irradiance (DNI, GHI and DHI respectively) spectra. Application of the system to data from the Spinning Enhanced Visible and Infrared Imager (SEVIRI) onboard the Meteosat Second Generation 3 (MSG3) satellite that is of high frequency (15-minutes) and high spatial resolution (0.05 x 0.05 degrees), demonstrates that the speed-up offered by the neural network, makes real-time mapping of solar energy for now casting purposes feasible. We present a sensitivity analysis of the accuracy of the output spectra for a broad range of atmospheric conditions at the local, regional and continental spatial scales. The inclusion of cloud and aerosol effects means that this approach is ideal for correct assessments of solar power operational loads.