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Estimating Spectrally Resolved DNI for Solar Energy Applications from Earth Observations

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Multi-junction solar cells in concentrator photovoltaic systems (CPV) offer the potential for highly efficient, low-cost electricity generation. However, these systems are typically designed and rated against reference spectra or for standard atmospheric conditions which are often not representative of the real deployment environments. Indeed, it has been shown that the use of unrealistic spectra can impact annual energy yield estimations by up to 75%. Hence there is a need to routinely generate spectrally resolved direct normal irradiance (DNI) estimates that are based on real observations so that CPV systems can be optimised appropriately for different locations.

Here we will first present an automated scheme to estimate spectrally resolved DNI based on the integrated use of a radiative transfer model, AERONET ground-based observations and analyses from the European Centre for Medium Range Weather Forecasting Copernicus Atmospheric Monitoring Service (ECMWF CAMS). Our approach takes particular care to account for aerosol effects, circumsolar irradiance and other relevant atmospheric parameters. The results are tested against ground-based observations from Santiago, Chile, and has shown that broadband DNI can be simulated with an average bias of less than 2%.

We will then present our preliminary work on integrating the above spectrally resolved DNI estimation scheme with satellite retrieved aerosol optical depths from the Oxford-RAL Aerosol and Cloud (ORAC) retrieval scheme using (A)ATSR / SLSTR observations, and Solcore, a semiconductor solver for CPV power output estimations. This will enable a global, long-term assessment of CPV solar energy generation, and even the possibility of near-real-time power estimates.