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Fast Broadband and Spectral Models for Satellite Applications to Solar Energy

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Traditionally atmospheric radiative transfer models have been developed for meteorological applications including weather and climate studies. In general, these models can be classified into two categories – broadband and spectral. Due to the nature of the applications in weather and climate modeling these models need to produce both surface radiation and heating rates at various layers in the atmosphere. On the other hand, radiative transfer models for solar energy applications only require surface radiation as an output. Also, energy applications require solar radiation estimates at various tilt-angles to represent the orientations at which photovoltaic panels are deployed. As these radiative transfer models are deployed for satellite applications to solar energy, they require the ability to run calculations for millions of pixels for multiple years at sub-hourly resolution. Therefore, these models have to be extremely fast and efficient and traditional radiative transfer models are unable to meet the requirements.

Historically fast broadband clear sky models have been built by various researchers to partially fulfil the needs of the solar energy community. More recently NREL developed the Fast All-sky Radiation Model for Solar Applications (FARMS) which has been used to develop the National Solar Radiation Data Base (NSRDB) (https://nsrdb.nrel.gov). This model can efficiently calculate broadband solar radiation under all sky conditions.

More recently PV researchers have expressed the need to have access to spectral information in the plane-of-array (POA) at which PV panels can be deployed. This requires the ability to compute the distribution of spectral diffuse radiation across the sky in order to compute the POA spectral radiation. Additionally, the computations require sufficient efficiency to provide spectral POA information at an hourly resolution for multiple years at a time within a reasonable timeframe. To address this need, NREL has developed a new efficient spectral model called the FARMS for Narrowband Irradiances over Tilted surfaces (FARMS-NIT). FARMS-NIT can compute plane-of-array (POA) irradiances in 2,002 narrow wavelength bands and is currently being implemented in the NSRDB to make spectral data publicly available on demand. The FARMS-NIT has further been extended for bifacial PV panels that collect solar radiation from both front- and back-sides of the modules. This presentation will focus on the development of FARMS and FARMS-NIT, its validation and applications.