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Cloud Shadows in Satellite-Based Solar irradiance Estimation: Improved Correction using EUMETSAT's Cloud Top Height Data

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The estimation of solar surface irradiance at high spatio-temporal resolution from geo-stationary satellite images is a well-established technique, for example by using the Heliosat method. The method has widely reduced the need for expensive ground measurements, especially in remote regions. However, the location of cloud shadows at the ground is difficult to determine and thus a significant source of errors when either the distance from the sub-satellite point or the cloud top height (CTH) increases. Although several methods have been proposed in the literature to reduce these errors, it is still an issue. We present a novel approach to correct the cloud shadow location based on the satellite-cloud-sun geometry using the CTH maps from the EUMETSAT data archive. It uses satellite viewing angles and solar position angles to determine the correct cloud shadow location for each cloudy pixel. The method is tested on cloud index (CI) maps for the months of July, August and September 2018 derived by applying the Heliosat method on the 0.6 um visible channel images from Meteosat-8 located at 41.5°E. Convective clouds with large CTHs are frequently observed over the Indian subcontinent in these three months due to the Indian summer monsoon. The global horizontal solar irradiance (GHI) obtained from the corrected CI image is validated at two BSRN stations. The normalized root mean square error (nRMSE) is reduced from 23.2% to 20.9% for the Gurgaon station and from 15.4% to 13.9% at Tiruvallur. In general, correcting the cloud shadow location on CI map improved the accuracy of the estimated GHI. Nonetheless, the method is sensitive to the accuracy of the CTH dataset and individual cases were found for which the correction reduced the accuracy.