

Supplementary

Validation of the SARAHE Satellite-Based Surface Solar Radiation Estimates over India

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Abstract: We evaluate the accuracy of the satellite-based surface solar radiation dataset called Surface Solar Radiation Data Set - Heliosat (SARAHE) against in situ measurements over a variety of sites in India between 1999 and 2014. We primarily evaluate the daily means of surface solar radiation. The results indicate that SARAHE consistently overestimates surface solar radiation, with a mean bias of 21.9 W/m². The results are complicated by the fact that the estimation bias is stable between 1999 and 2009 with a mean of 19.6 W/m² but increases sharply thereafter as a result of rapidly decreasing (dimming) surface measurements of solar radiation. In addition, between 1999 and 2009, both in situ measurements and SARAHE estimates described a statistically significant (at 95% confidence interval) trend of approximately -0.6 W/m²/year, but diverged strongly afterward. We investigated the cause of decreasing solar radiation at one site (Pune) by simulating clear-sky irradiance with local measurements of water vapor and aerosols as input to a radiative transfer model. The relationship between simulated and measured irradiance appeared to change post-2009, indicating that measured changes in the clear-sky aerosol loading are not sufficient to explain the rapid dimming in measured total irradiance. Besides instrumentation biases, possible explanations in the diverging measurements and retrievals of solar radiation may be found in the aerosol climatology used for SARAHE generation. However, at present, we have insufficient data to conclusively identify the cause of the increasing retrieval bias. Users of the datasets are advised to be aware of the increasing bias when using the post-2009 data.

Keywords: surface solar radiation; remote sensing; validation; India; solar radiation trends

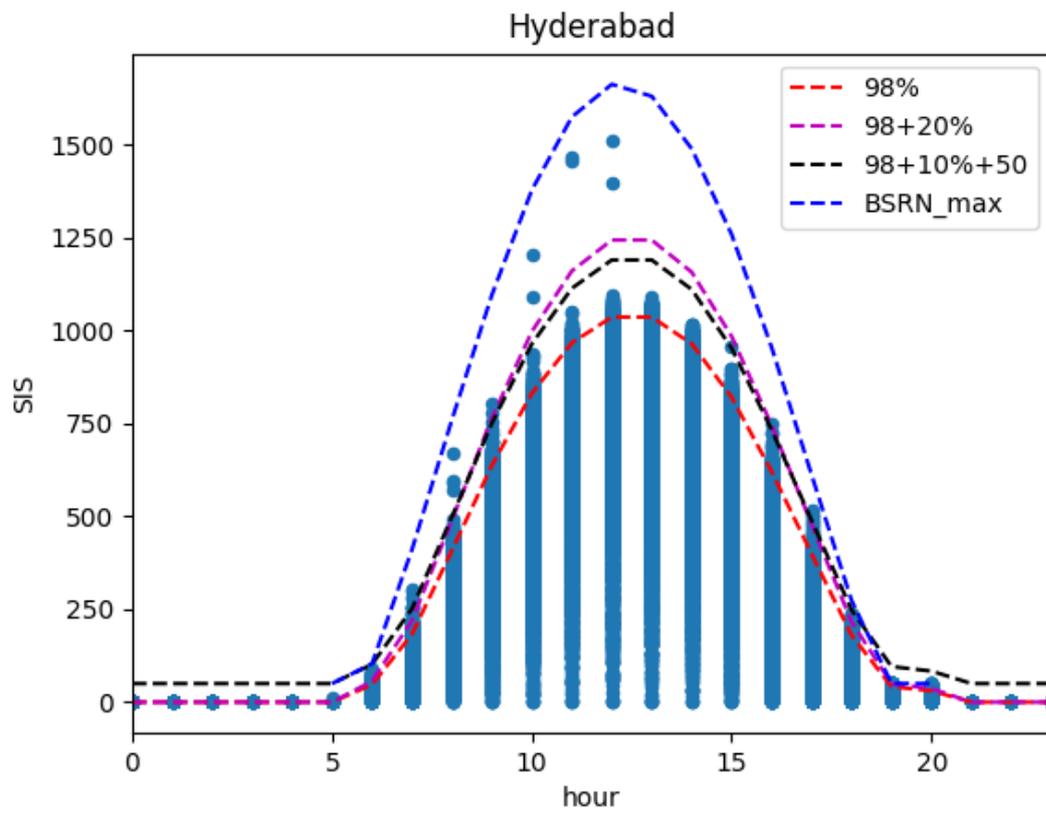


Figure S1. An illustration of the QA measures taken with the in situ data for one example site (Hyderabad) for one month of data. Circles indicate hourly mean SSR at the site versus measurement time (Indian time, night set to zero SSR). The graphs indicate the maximum allowable SSR by the various QA phases.