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Characterizing and correcting Heliosat Surface Solar Radiation bias on intra-day time scales with deep neural networks

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Accurate intraday forecasts of surface solar radiation (SSR) are essential for utility companies and electricity grid operators. However, satellite SSR estimates can suffer from surprisingly low accuracies on short observation time scales and from significant spatial and temporal biases when compared to ground-based SSR measurements.

We present a bias assessment of two high-resolution satellite SSR products for intra-day application time scales. The satellite SSRs are retrieved with the Heliosat SARAH-2 and the HelioMont algorithms (Müller et al., 2015; Stöckli, 2013). We investigate intra-day and intra-hour estimates for altitudes from 200 to 3570 m a.s.l. We make use of 133 ground stations of the high-precision monitoring network SwissMetNet for the bias analysis. For solar zenith angle (SZA) lower than 90 degrees, we find that Heliosat SARAH-2 underestimates SSR at high altitudes (over 1000m) with an instantaneous root mean squared deviation (RMSD) of 179 W/m2and a mean bias deviation (MBD) of -68 W/m2 in the winter half year. The bias magnitude is approximately the double w.r.t. low altitude stations, due to difficulties in distinguishing snow-covered surfaces from clouds.

We also present an intra-hour bias correction approach: a deep neural network exploiting time-encoding features to model the bias in the time dimension. Our model achieves up to 30% RMSE reduction in the case of Heliosat SARAH-2, especially in mountainous regions. Moreover, we highlight the importance of the clear-sky index for bias correcting the Heliosat SSR estimates. Including a clear-sky index as a regressor in the bias correction improves the bias correction on average from 15.5% to 21.9% RMSE reduction. We also discuss the relevance of bias correcting satellite-derived SSR maps for short-term forecasting applications of SSR.

References

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