remote sensing

MDPI

(Supplementary)

Validation of Hourly Global Horizontal Irradiance for Two Satellite-Derived Datasets in Northeast Iraq

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Abstract: Several sectors need global horizontal irradiance (GHI) data for various purposes. However, the availability of a long-term time series of high quality in situ GHI measurements is limited. Therefore, several studies have tried to estimate GHI by re-analysing climate data or satellite images. Validation is essential for the later use of GHI data in the regions with a scarcity of ground-recorded data. This study contributes to previous studies that have been carried out in the past to validate HelioClim-3 version 5 (HC3v5) and the Copernicus Atmosphere Monitoring Service, using radiation service version 3 (CRSv3) data of hourly GHI from satellite-derived datasets (SDD) with nine ground stations in northeast Iraq, which have not been used previously. The validation is carried out with station data at the pixel locations and two other data points in the vicinity of each station, which is something that is rarely seen in the literature. The temporal and spatial trends of the ground data are well captured by the two SDDs. Correlation ranges from 0.94 to 0.97 in all-sky and clear-sky conditions in most cases, while for cloudy-sky conditions, it is between 0.51–0.72 and 0.82–0.89 for the clearness index. The bias is negative for most of the cases, except for three positive cases. It ranges from −7% to 4%, and −8% to 3% for the all-sky and clear-sky conditions, respectively. For cloudy-sky conditions, the bias is positive, and differs from one station to another, from 16% to 85%. The root mean square error (RMSE) ranges between 12–20% and 8–12% for all-sky and clear-sky conditions, respectively. In contrast, the RMSE range is significantly higher in cloudy-sky conditions: above 56%. The bias and RMSE for the clearness index are nearly the same as those for the GHI for all-sky conditions. The spatial variability of hourly GHI SDD differs only by 2%, depending on the station location compared to the data points around each station. The variability of two SDDs is quite similar to the ground data, based on the mean and standard deviation of hourly GHI in a month. Having station data at different timescales and the small number of stations with GHI records in the region are the main limitations of this analysis.

Keywords: solar radiation; global horizontal irradiance; satellite-derived dataset; validation

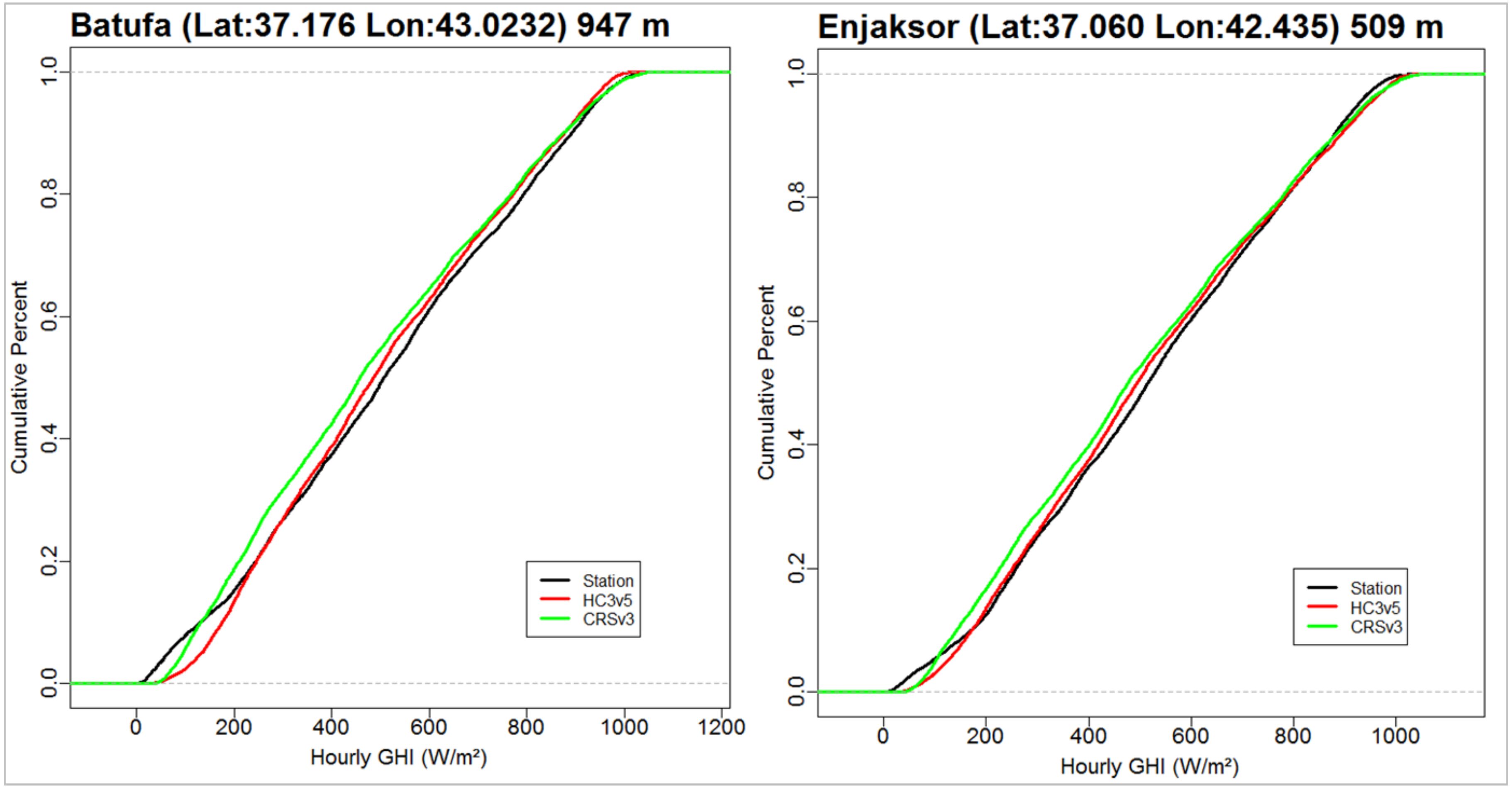

Figure S1. Cumulative frequency function of ground data compared to SDDs for all-sky conditions for the available period of data pairs. The closer red and green line (SDDs) are to the black line (ground data) shows better performance of SDDs. A difference between lines shows the errors.

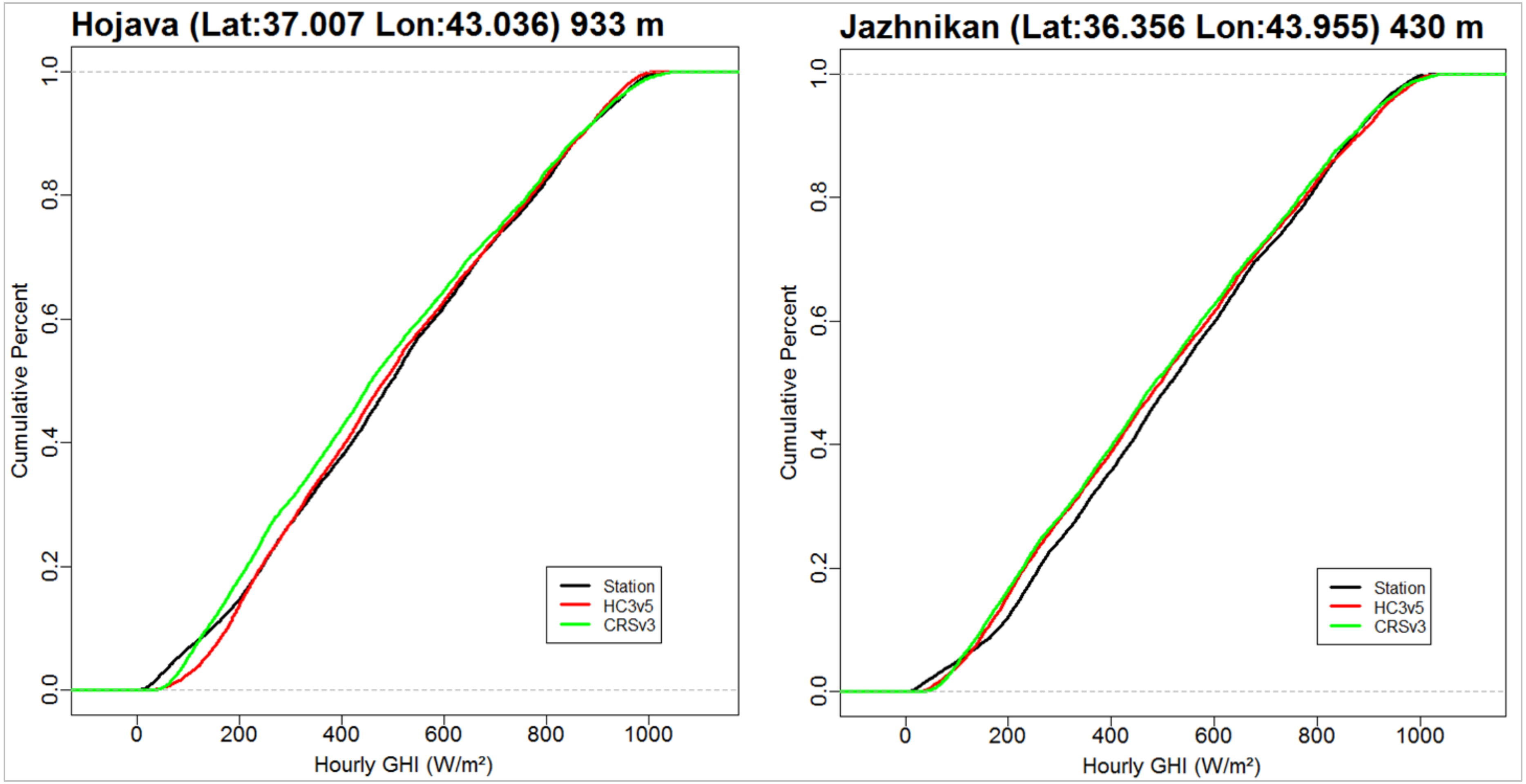

Figure S2. As in Figure S1, but for different stations.

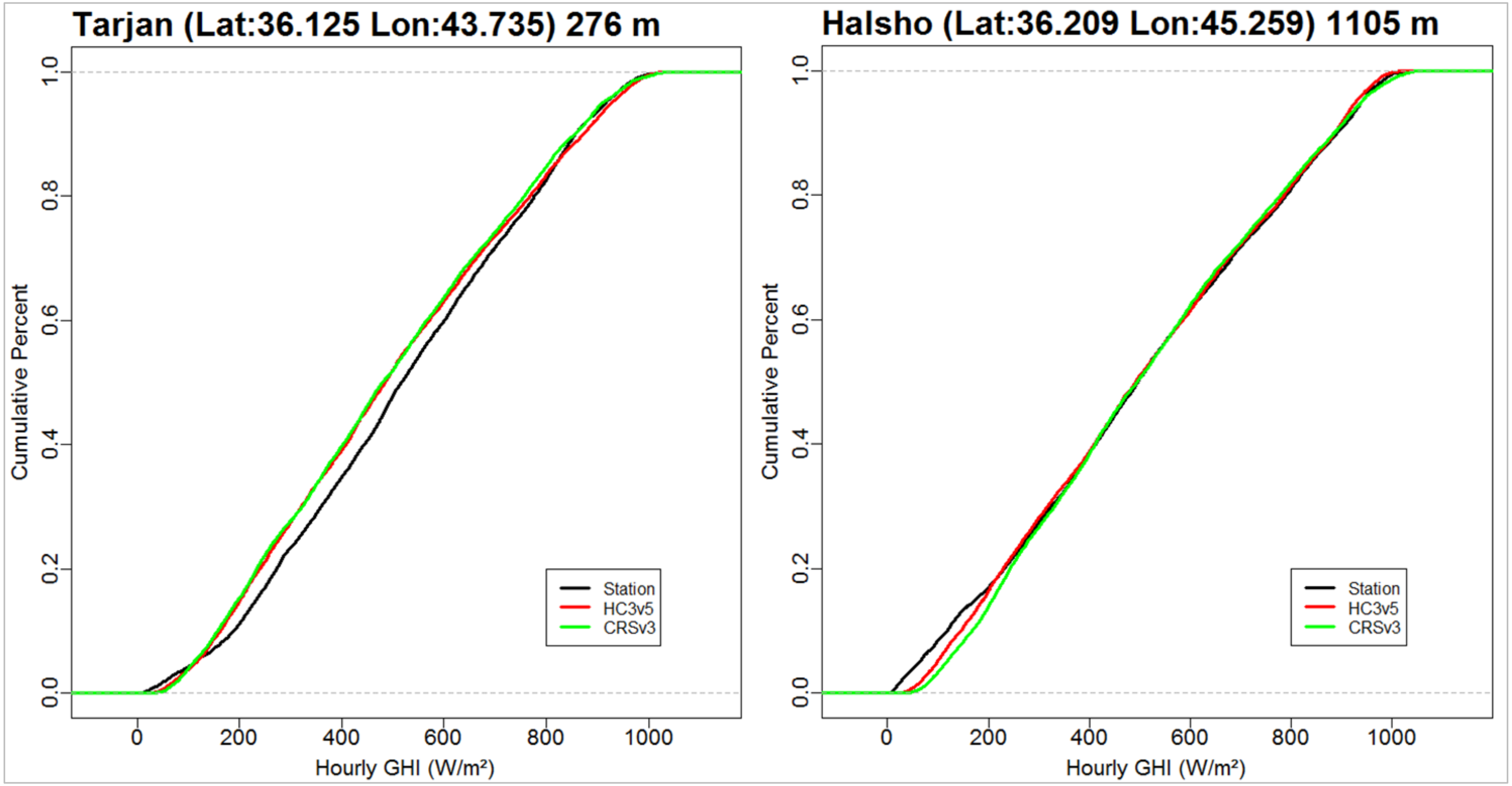

Figure S3. As in Figure S1, but for different stations.

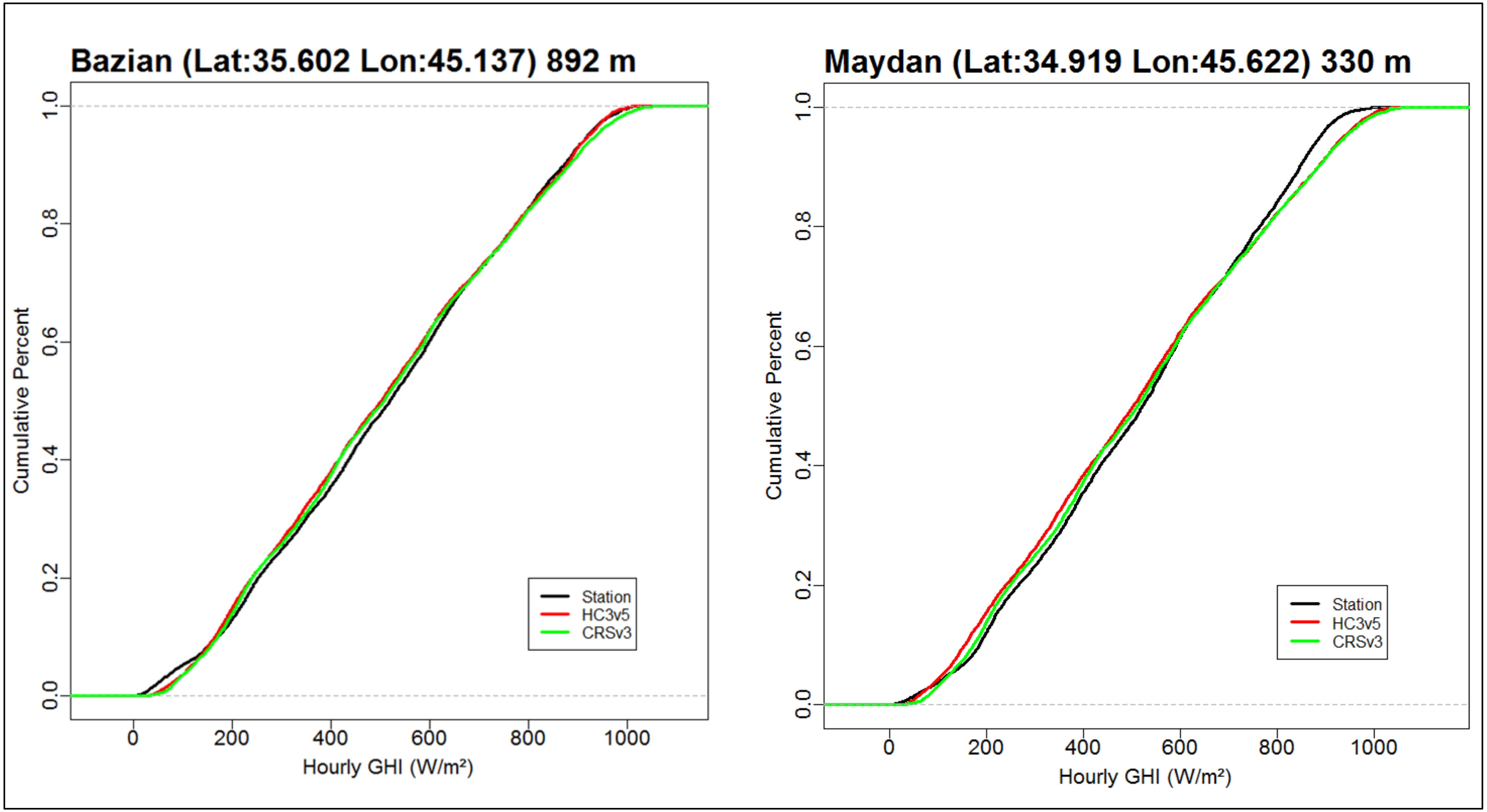

Figure S4. As Figure S1, but for different stations.

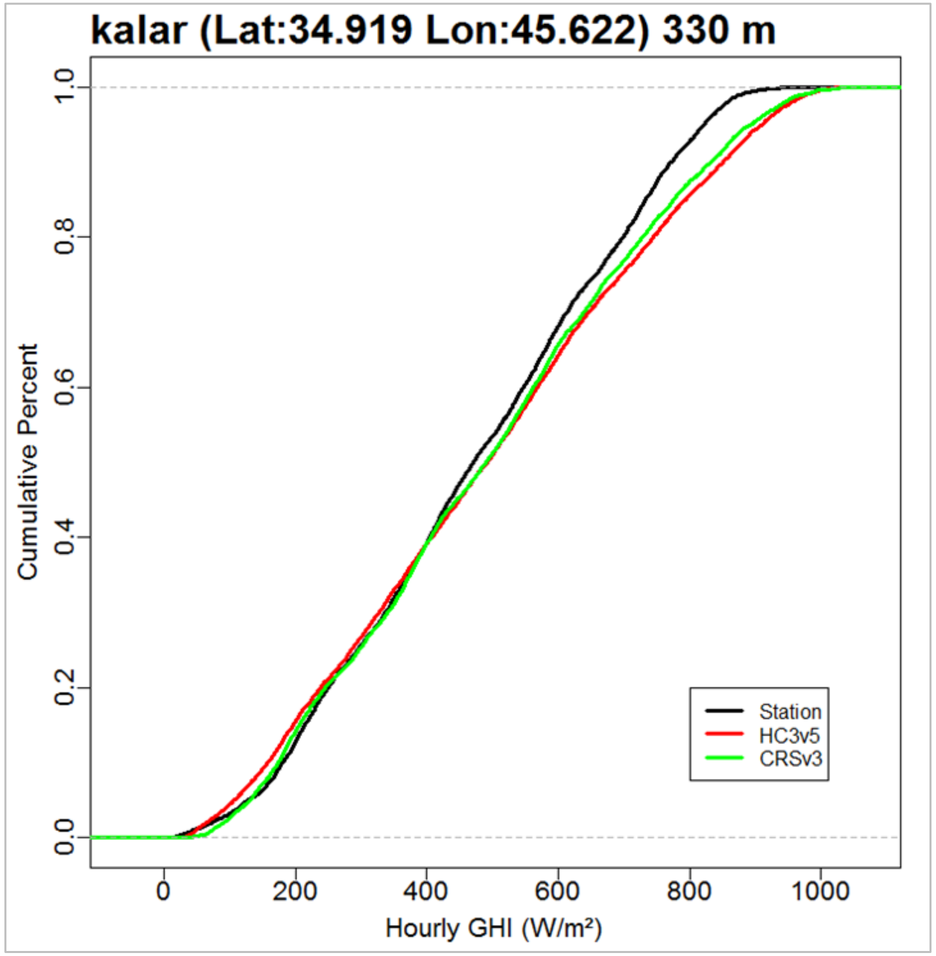

Figure S5. As Figure S1, but for different station.

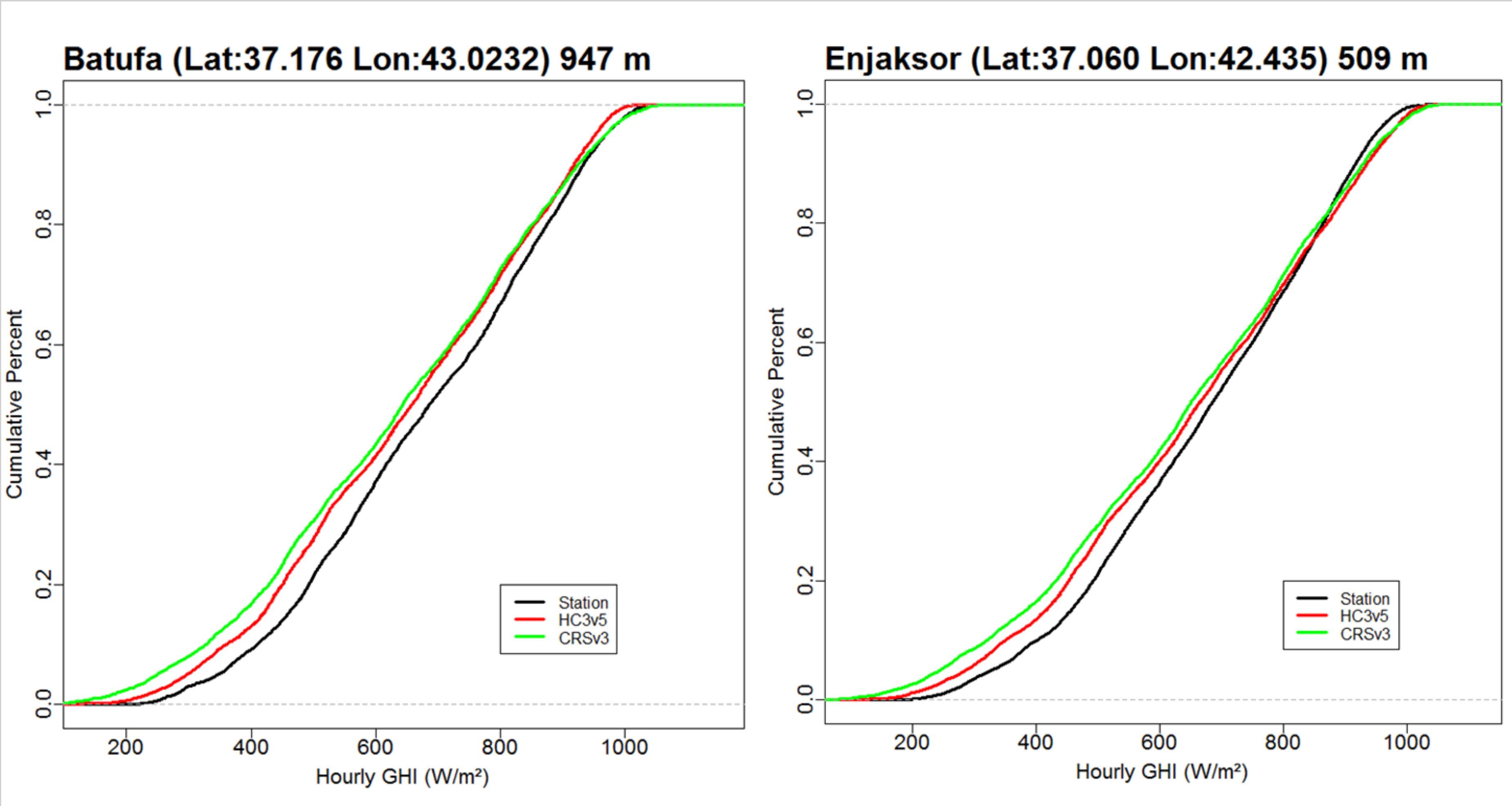

Figure S6. Cumulative frequency function of ground data compared to SDDs for clear-sky conditions for the available period of data pairs. The closer red and green line (SDDs) are to the black line (ground data) shows better performance of SDDs. A difference between lines shows the errors.

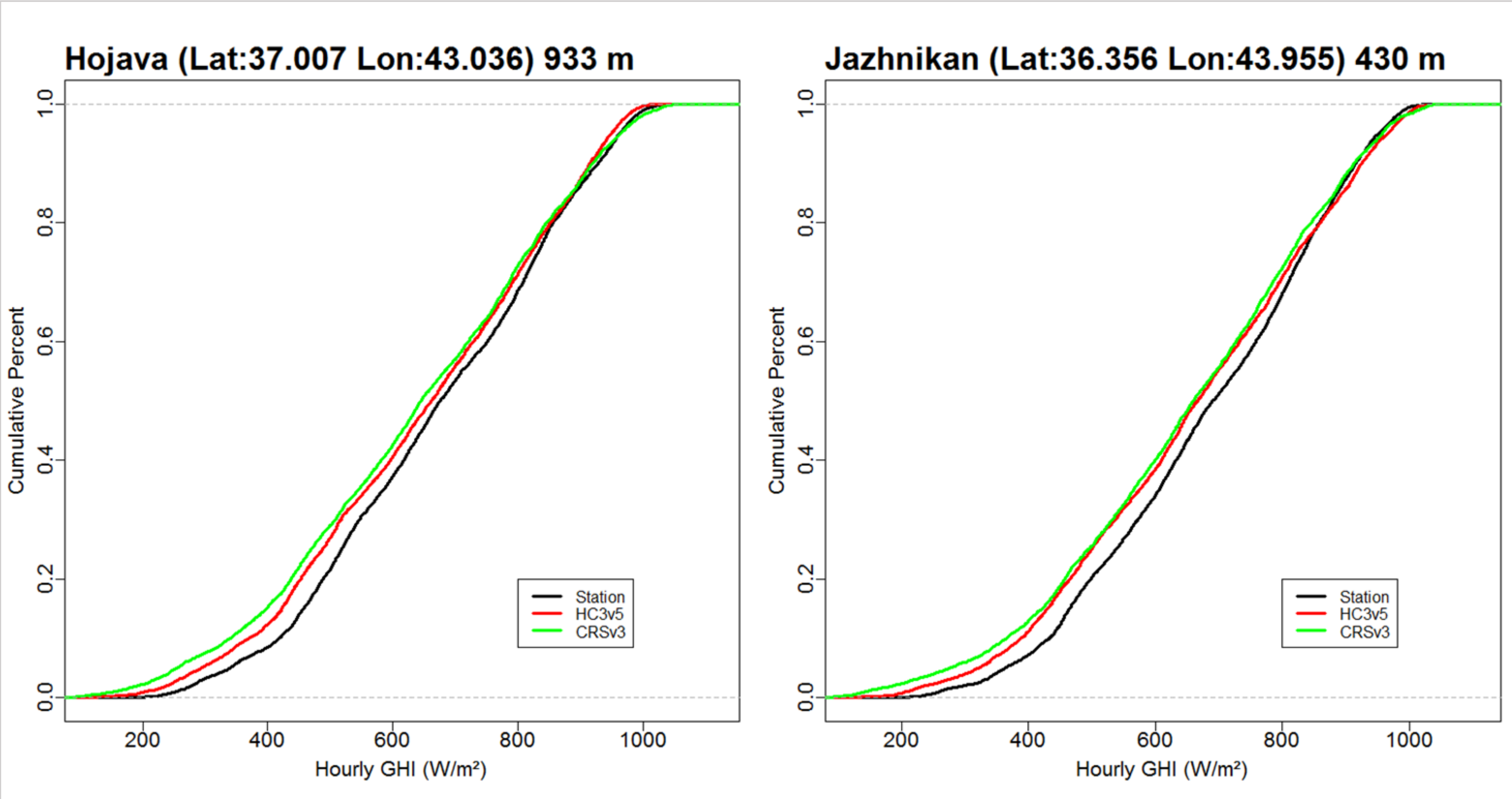

Figure S7. As Figure S6, but for different stations.

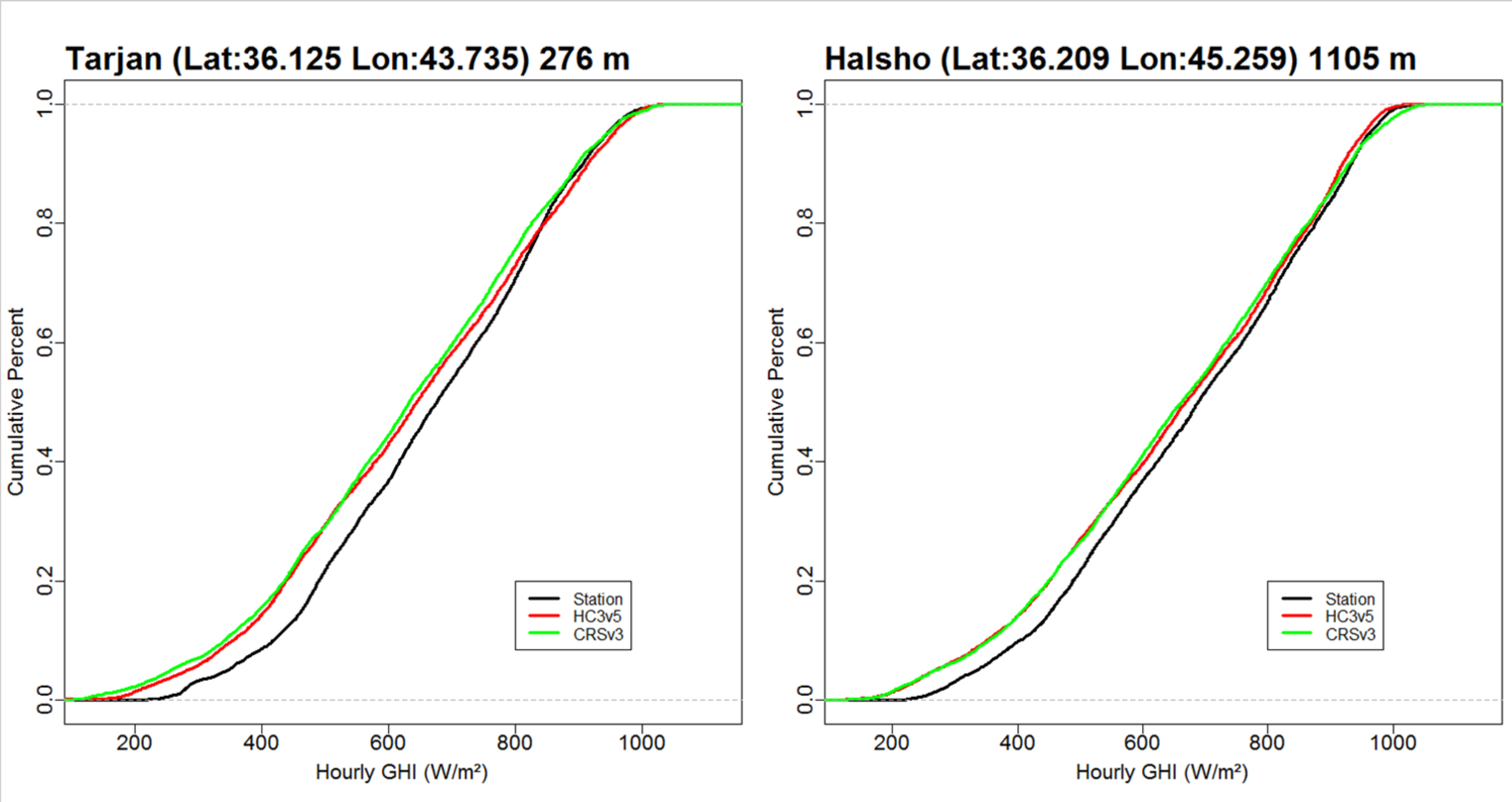

Figure S8. As Figure S6, but for different stations.

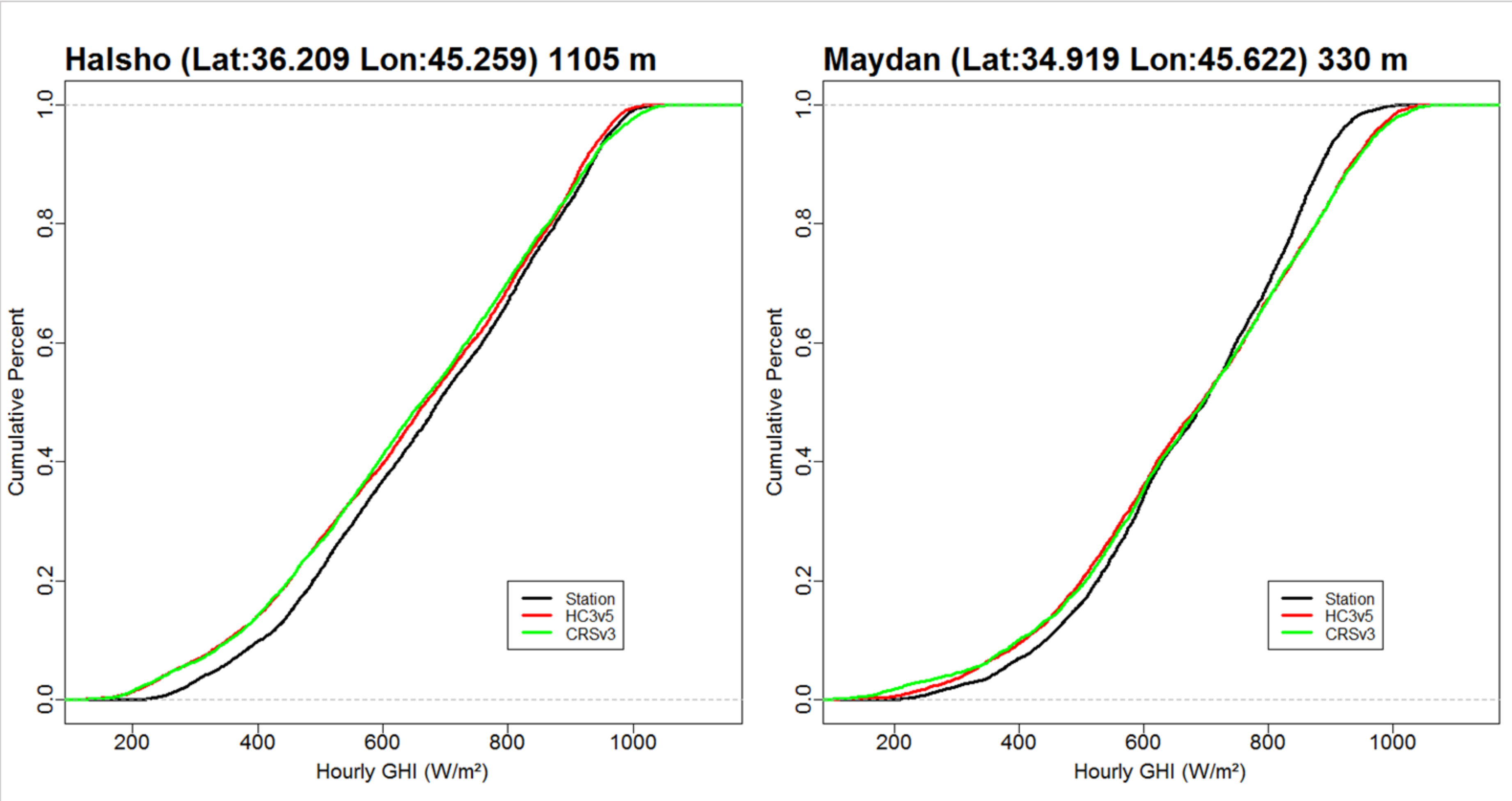

Figure S9. As Figure S6, but for different stations.

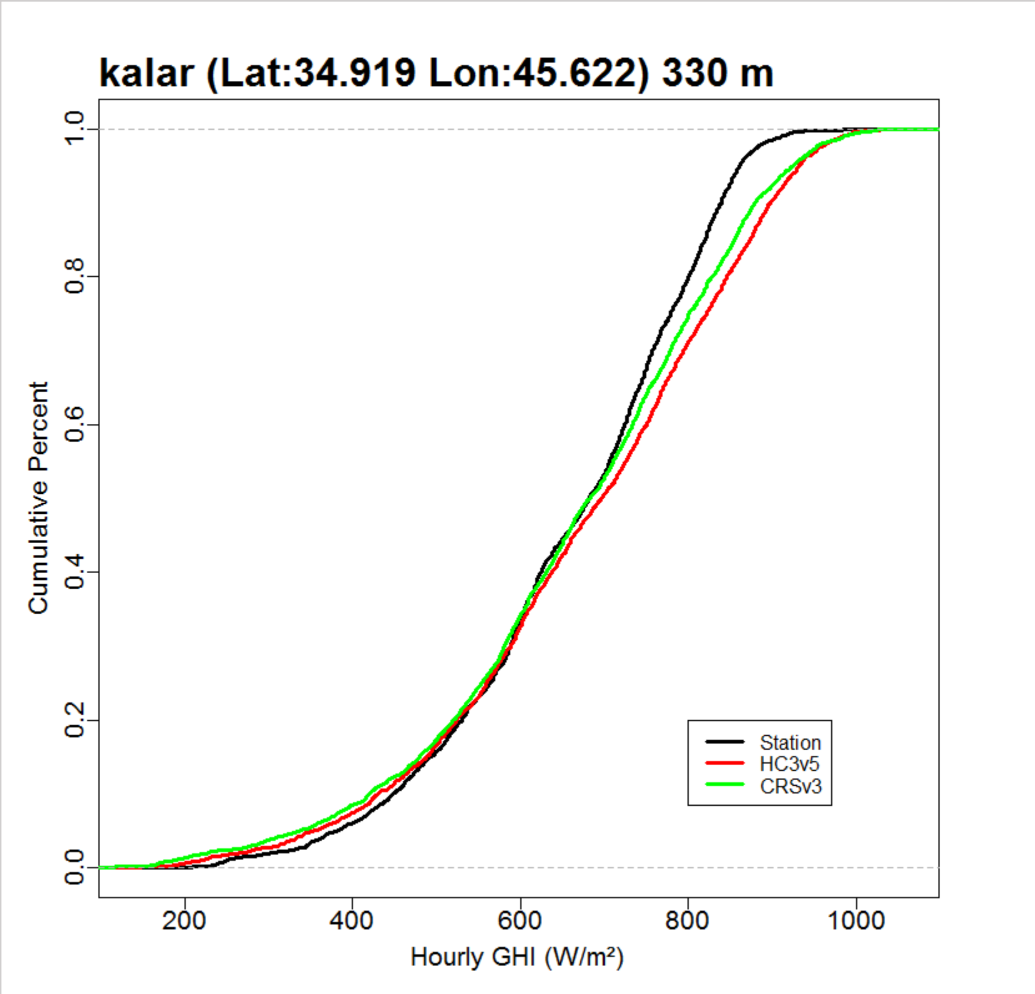

Figure S10. As Figure S6, but for different station.

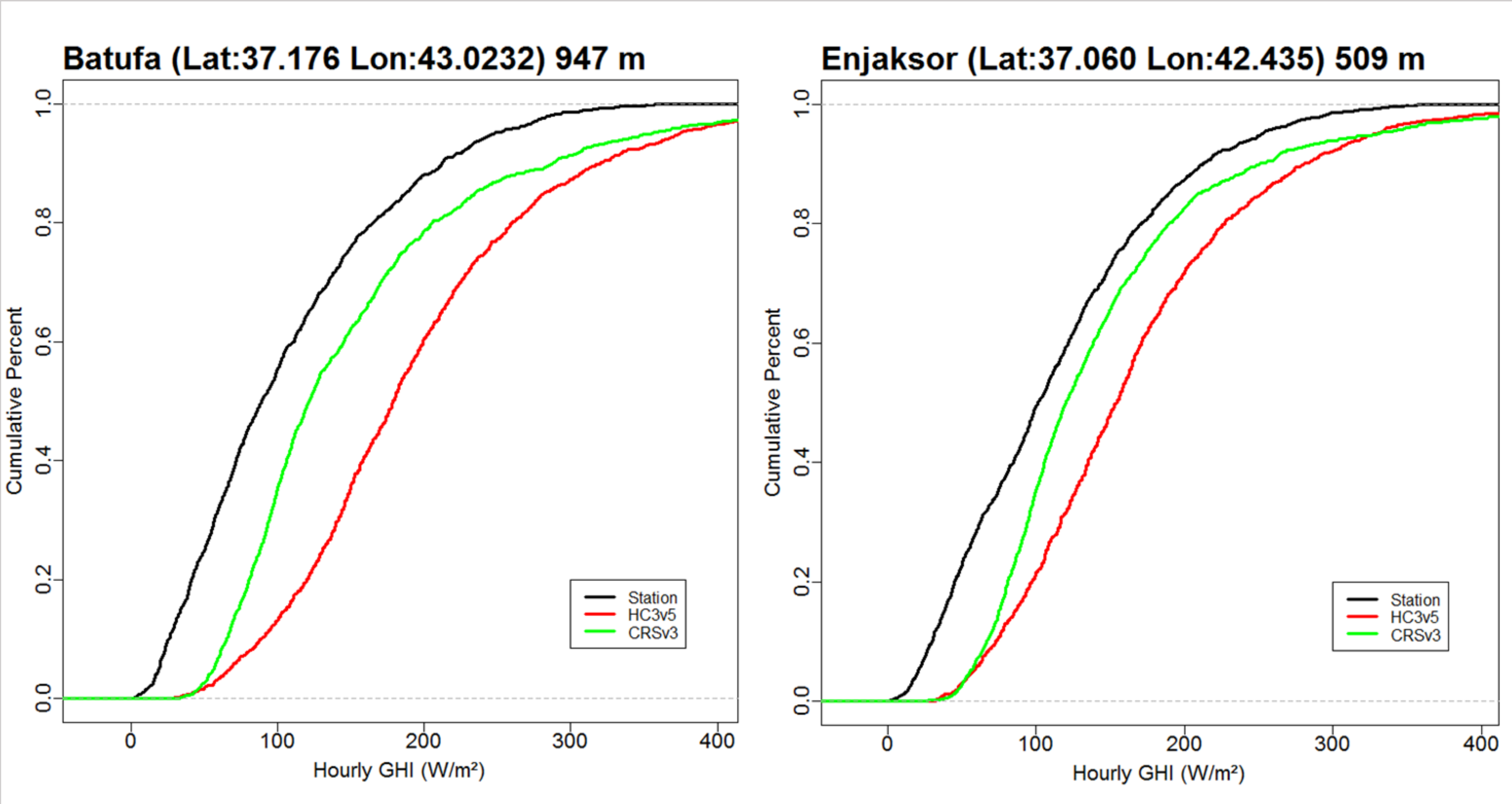

Figure S11. Cumulative frequency function of ground data compared to SDDs for cloudy-sky conditions for the available period of data pairs. The closer red and green line (SDDs) are to the black line (ground data) shows better performance of SDDs. A difference between lines shows the errors.

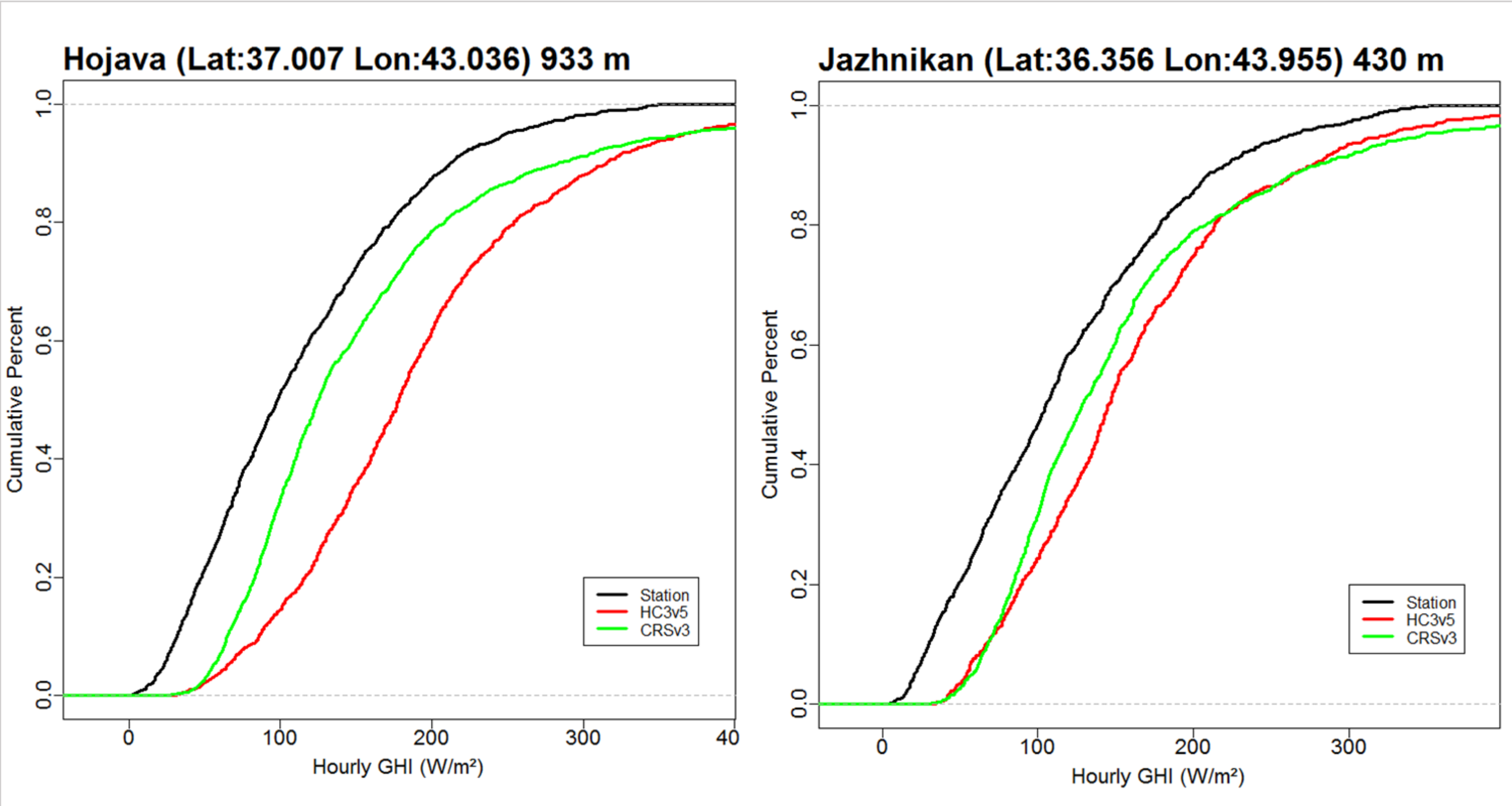

Figure S12. As Figure S11, but for different stations.

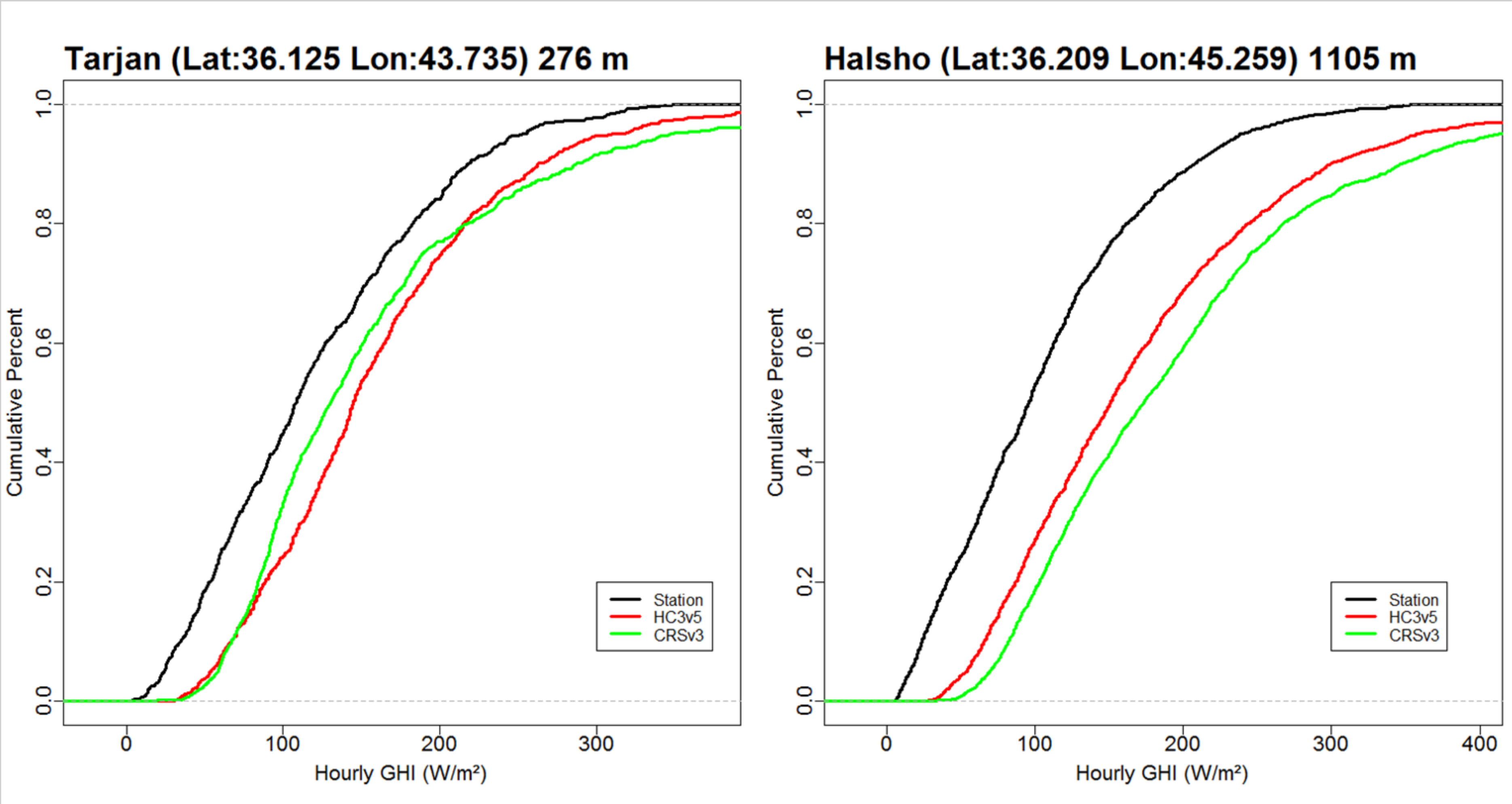

Figure S13. As Figure S11, but for different stations.

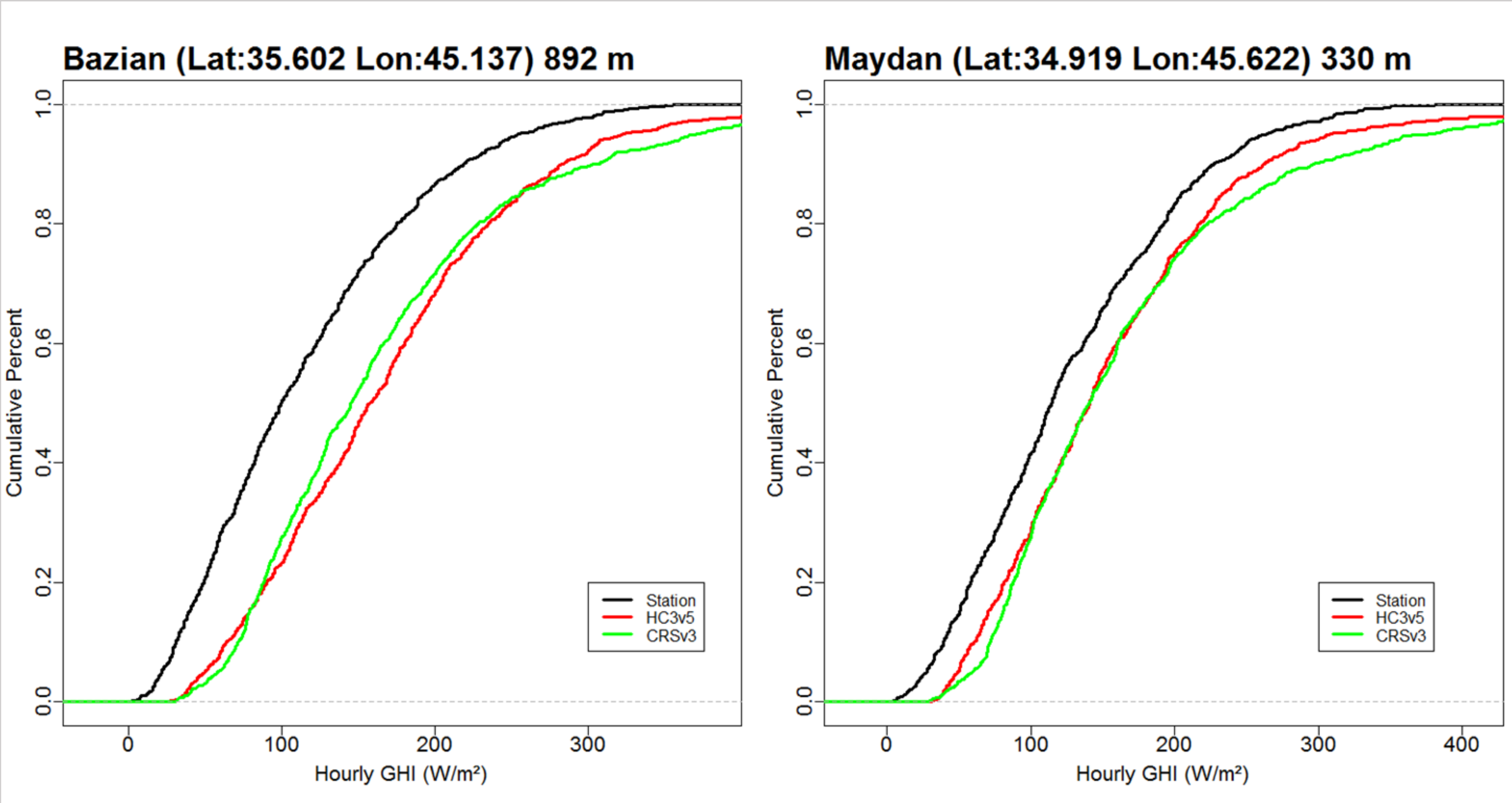

Figure S14. As Figure S11, but for different stations.

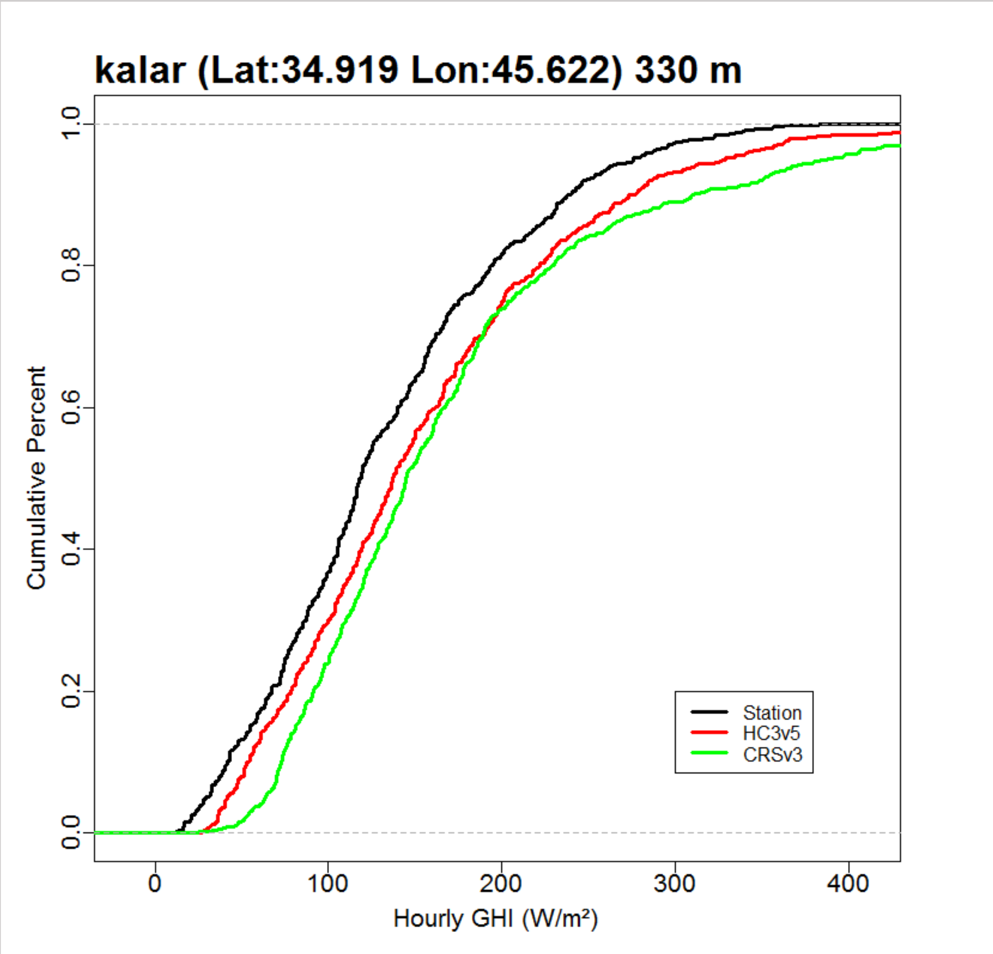

Figure S15. As Figure S11, but for different station.