Evaluation of Global Irradiance Retrieval Methods from Meteosat Second Generation Satellite

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SITE INSTRUMENTAL DE RECHERCHE PAR TÉLÉDÉTECTION ATMOSPHÉRIQUE

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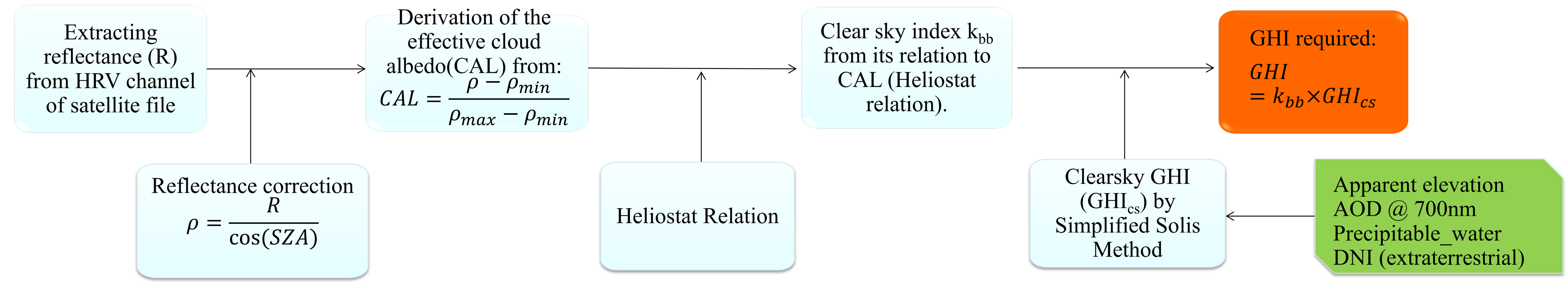
INTRODUCTION

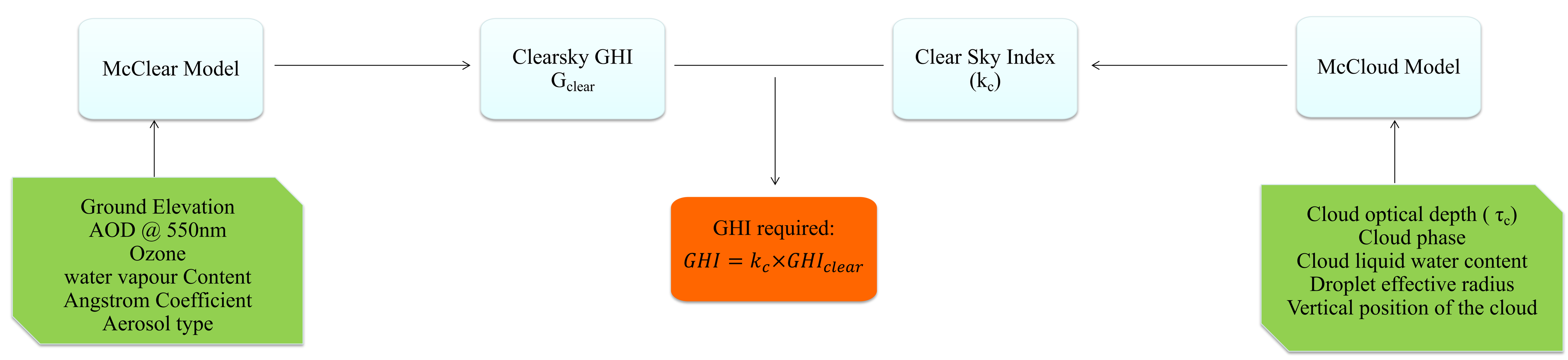
- Solar Energy is important in the quest of sustainable energy, hence the need for high quality solar irradiance data
- Setting up ground monitoring centers on several locations proves difficult due to cost, technicality and accessibility.
- Geostationary satellites provide a more feasible alternative.
- We consider a process proposed by Mueller et al (2012) and the Heliostat-4 method as used by the Copernicus Atmosphere Monitoring Service (CAMS).
- The retrieval process is evaluated and compared with ground measurements obtained at SIRTA ground observatory to verify the validity accuracy and reliabillity of both methods.

METHODS

Mueller et al (2012)-Hammer et al (2003)-Solis Model from Ineichen (2008). (MHS): Satellite images used are from the high resolution visible (HRV) channel of the Meteosat-11 second generation(MSG) satellite. A temporal shift is implemented here to ensure that the SIRTA value used to evaluate its accuracy corresponds to the time at which the satellite scans the SIRTA pixel.



Heliostat 4 - McClear and McCloud Models (CAMS): Satellite images used are from the low resolution (LR) channels (visible and infrared channels) of the MSG satellite.

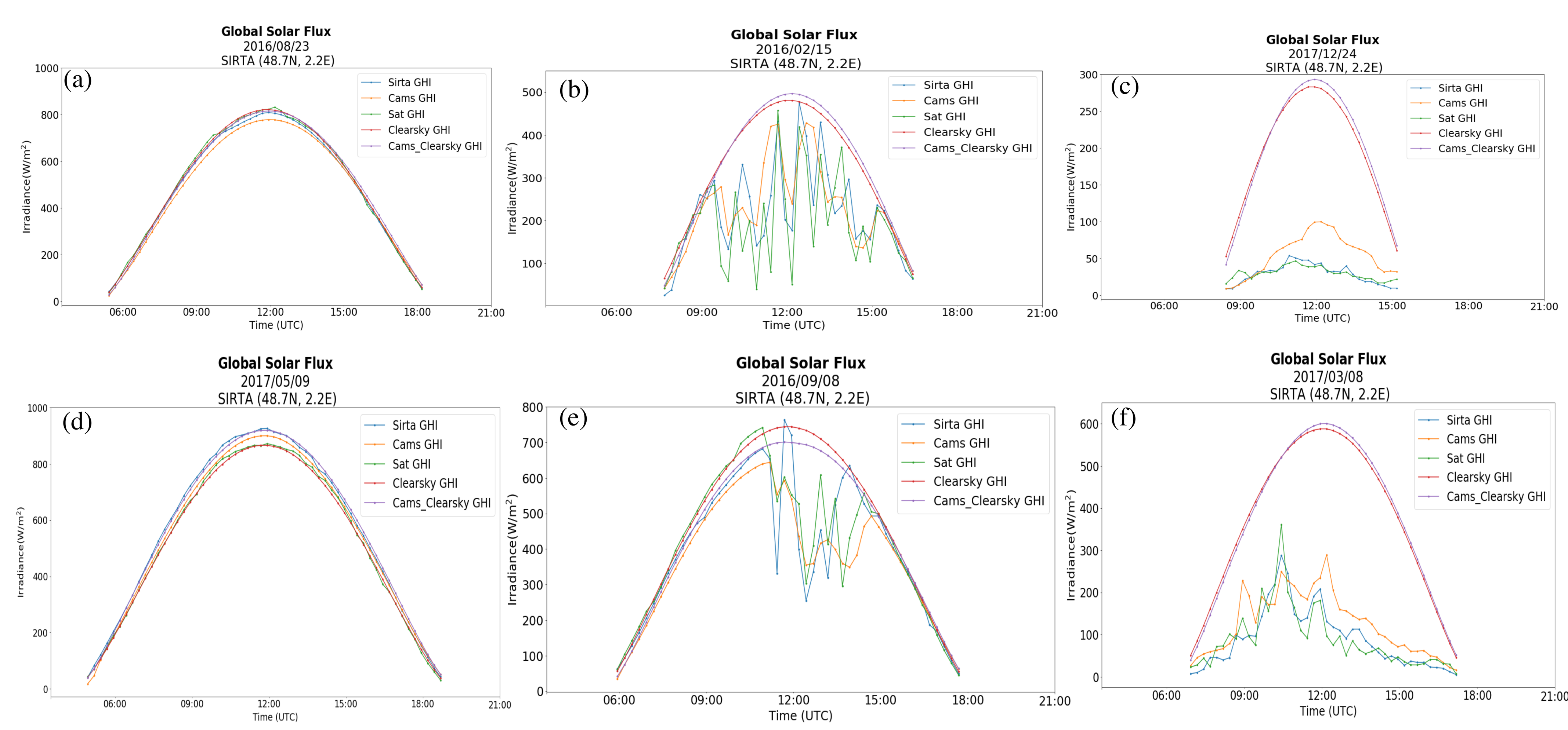


RESULTS

Daily Global Solar Flux

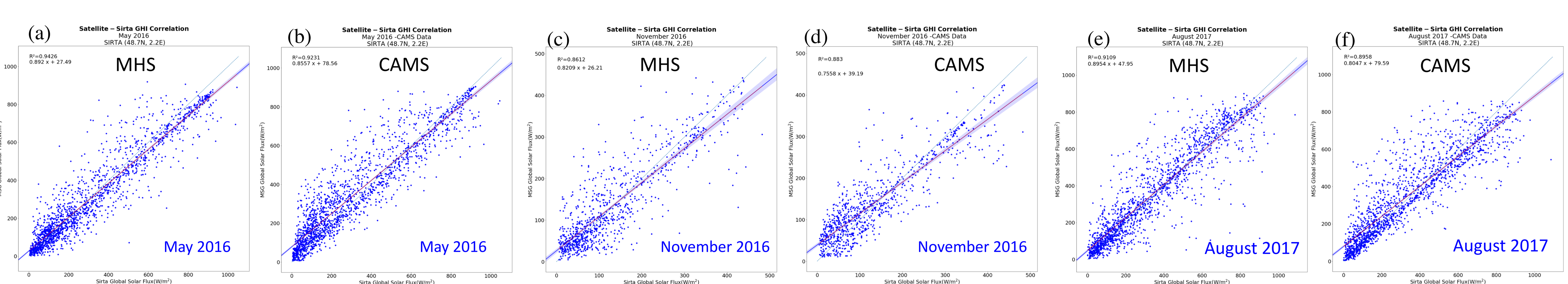
- Deviation from SIRTA ground measurements for both methods is low in **stable** weather conditions (*figs. a,d,c,f*) and can high for **variable** conditions (figs. b,e).
- Same average pattern of irradiation is observed for the satellite and SIRTA in days with sudden weather fluctuations (*figs. b,e*). CAMS has a smoothening effect in this case. This arises from the fact that it uses images from the low resolution channels, hence a more homogeneous spread over the pixels.
- MHS closely mirrors the conditions seen at SIRTA (fig. f) with lesser deviations in overcast conditions (*fig. c*). CAMS showed more deviations in this case.

The components of the clearsky models used by both methods contributes to the disparity in both estimates. The Solis model used in MHS was observed to be highly sensitive to the Aerosol Optical depth (AOD), hence using the exact input parameters per time would help increase accuracy of the clearsky GHI.



Irradiance Correlation

- There is less dispersion at very low and high irradiances. The behaviour at very low irradiances is as a result of cloud spread over large areas over long period of time; hence the variability in such conditions is reduced. Both methods underestimate GHI at overcast conditions with low irradiances.
- Winter Months with higher probability of having clouds showed less correlation for both procedures (*See (fig. (c) &(d)*).

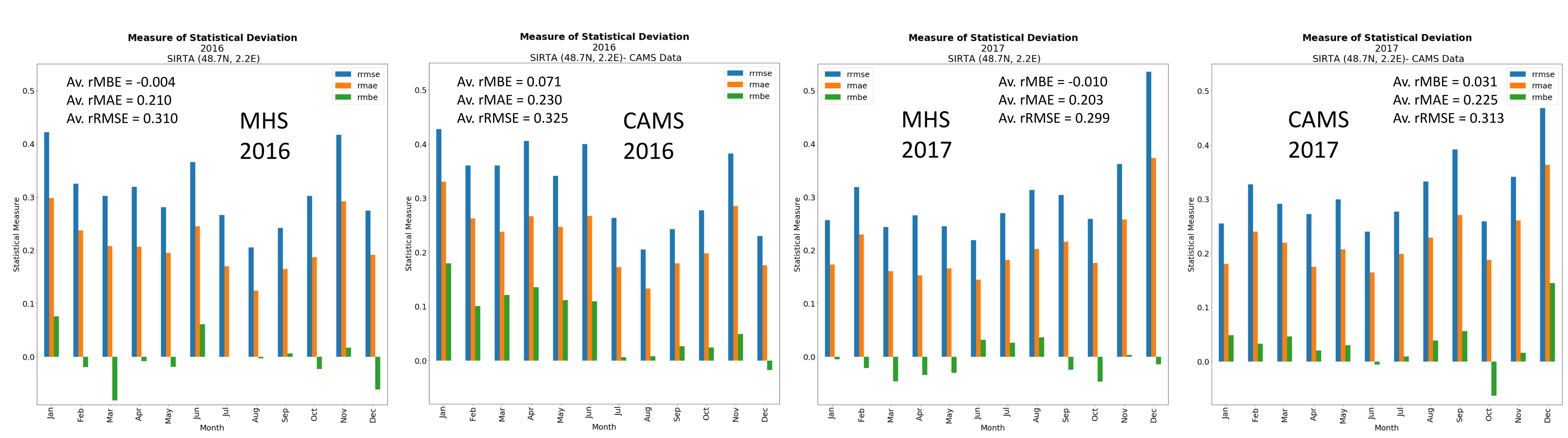


Error metrics

$$rRMSE = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(p_i - m_i)^2}}{\frac{1}{n}\sum_{i=1}^{n} m}$$

$$rMBE = \frac{\sum_{i=1}^{n}(p_i - m_i)}{\sum_{i=1}^{n} m_i}$$

$$rMAE = \frac{\sum_{i=1}^{n}|p_i - m_i|}{\sum_{i=1}^{n} m_i}$$



- Both methods show similar behaviour for the statistical tools. CAMS returned higher average errors. This may arise from the fact that spatial bias corrections and temporal axis shift was implemented in MHS.
- Spring-summer months had the least deviation values due to overall higher irradiance and convective clouds present during this period.

CONCLUSION

This study highlighted the following points:

- Highest reliability is found for clear-sky conditions for both methods.
- Both methods also tend to underestimate at low irradiances and overestimate at high irradiances.
- In overcast conditions, MHS is observed to yield less deviations as it shows higher correlation to irradiance at the ground site.
- In both years, the average measure CAMS returned higher averages measures of statistical deviations

PERSPECTIVES

To improve the accuracy of the MHS method, the following should be addressed:
- Effect of cloud shadows from neighbouring pixels that impact on the direct irradiance measured at ground site.
- Implementing daily spatial navigation and temporal averaging around the scanning time of the satellite.
- Assement of the neighbouring set of pixels to determine which leads to the best fit .

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