Solar resource forecasting and variability

an update on IEA SHC Task 46

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The International Energy Angency (IEA) Solar Heating and Cooling (SHC) Task 46: "Solar Resource Assessment and Forecasting" addresses four basic objectives in improving our understanding of solar resources:

A) Evaluating solar resource variability that impacts large penetrations of solar technologies;
B) Standardizing and integrating procedures for data bankability;
C) Improving procedures for short-term solar resource forecasting; and
D) Advancing solar resource modeling procedures based on physical principles to provide improve evaluation of large-scale solar systems using both solar thermal as well as PV and solar concentrating technologies.

The task runs from 2011 to 2016.

Why is this important for NWP?

1) The variability of solar irradiances are caused primarily by clouds. New methods of solar ressource assessment give us better methods for verifying cloud physics that cannot be obtained from "cloud cover" observations alone and are more precise than remotely sensed data.
2) High temporal resolution measurements of global irradiances (GHI) and direct irradiances also give information about the sub-grid scale cloud variability (*Skartveit et al. 1998*) as illustrated in Fig. 1.

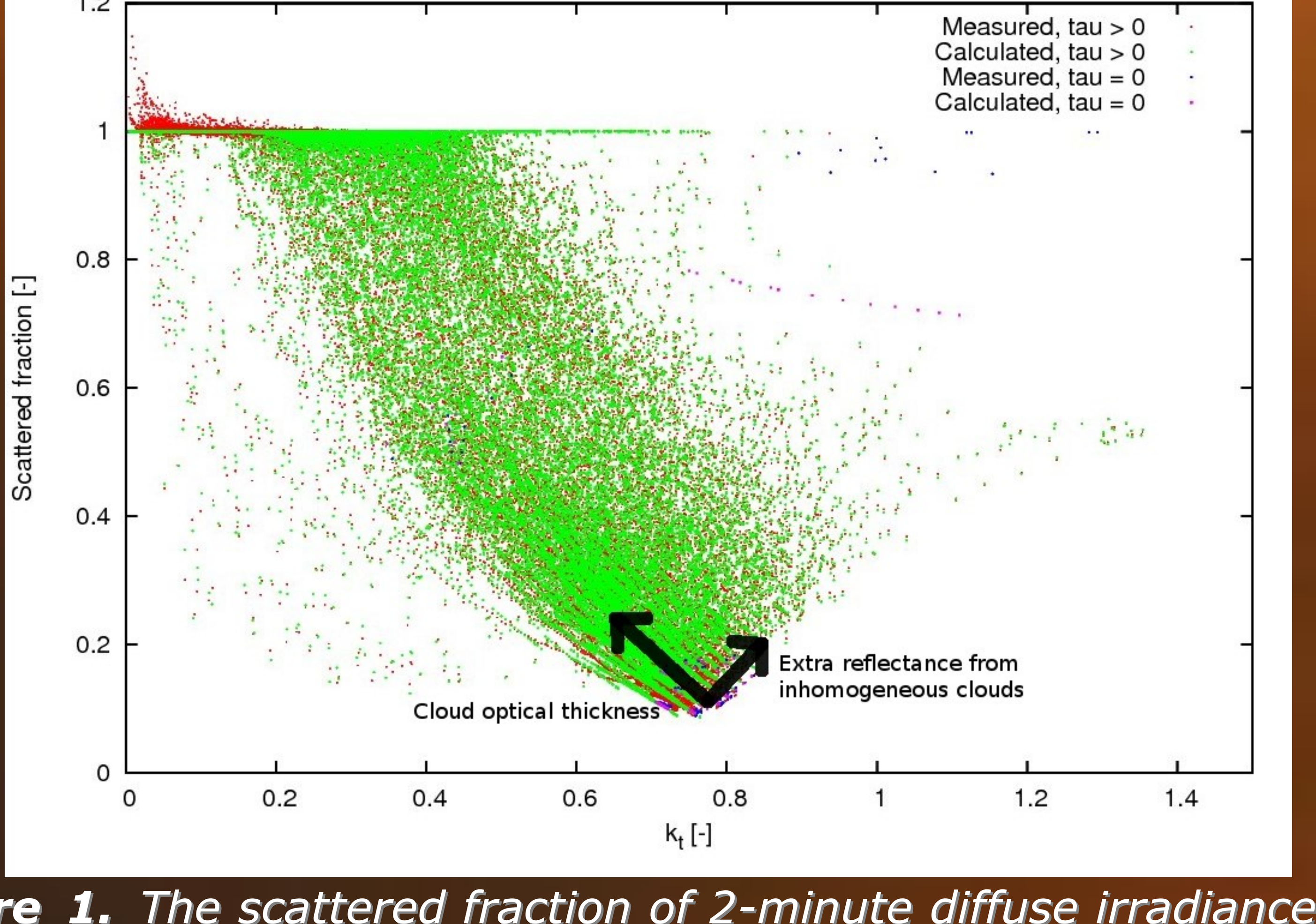

Figure 1. *The scattered fraction of 2-minute diffuse irradiances as a function of the atmospheric transmittance (k_t) of global radiation.*

Solar irradiance forecasting

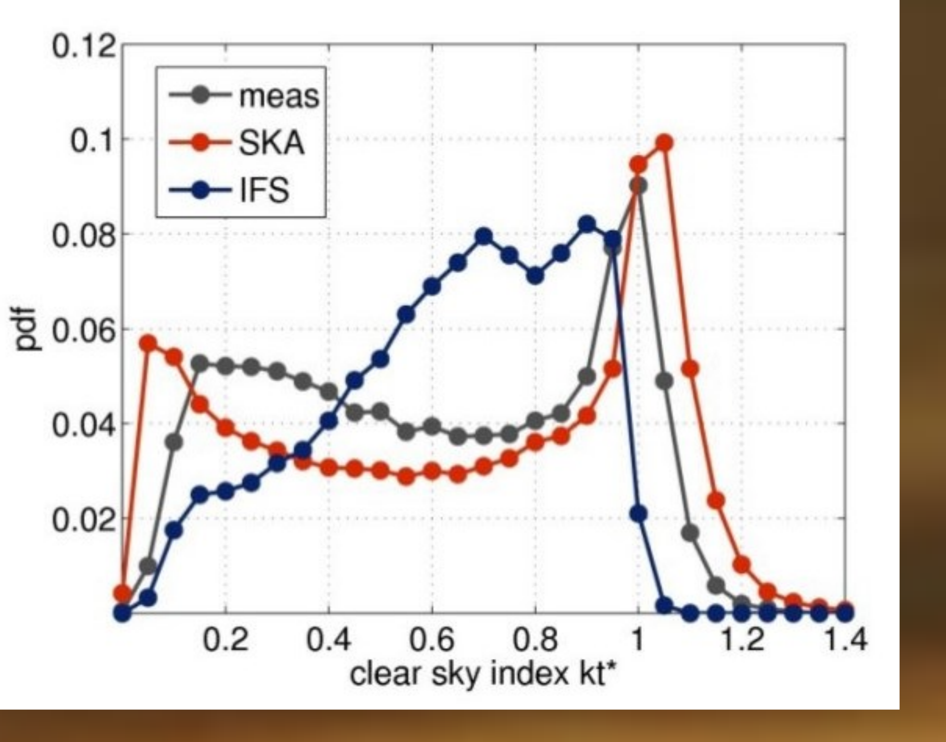

Figure 2. *Frequency distributions of the index k_t^*=GHI/GHI$_{clear\ sky}$ for 1 years (2013-03—2014-02) hourly GHI data from 18 German stations and the equivalent forecast data from IFS and HIRLAM SKA.*

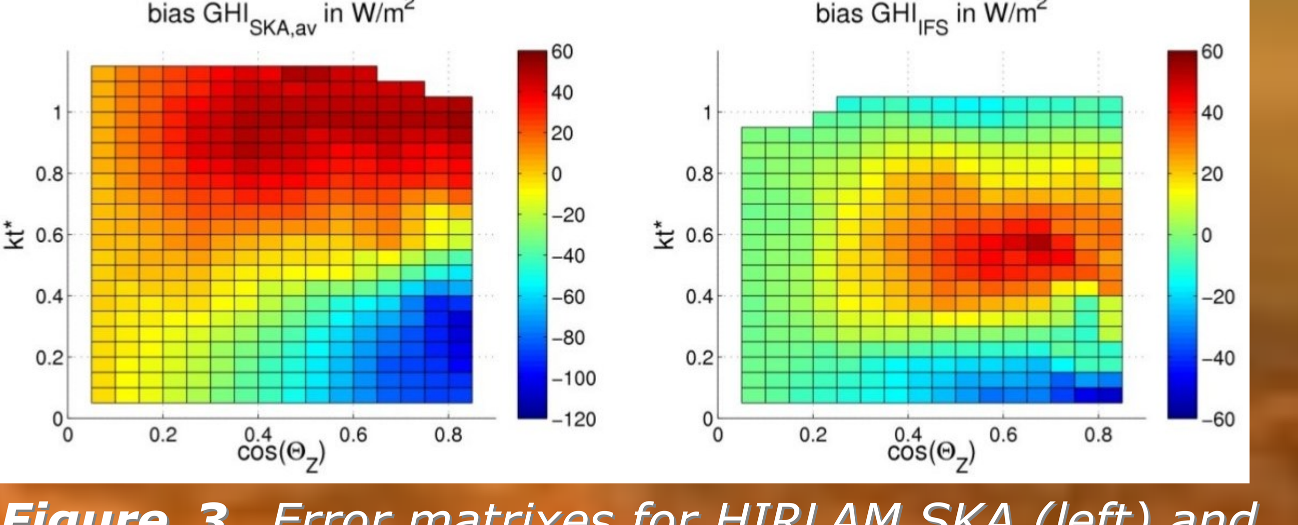

Figure 3. *Error matrixes for HIRLAM SKA (left) and IFS (right) showing the GHI error as a function of clear sky index k_t^* and the cosine of the solar zenith angle.*

The results in Figs. 3 and 4 (*Sengupta et al. 2015*) show that the IFS model has very good GHI forecasts in average but that these do not accurately model extreme clear sky or cloudy sky situations. This is likely to be due to the temporal, spatial and statistical smoothing inherent in the current (cy40) IFS model.

HIRLAM tends to have too thick clouds in cloudy situations. By using the error matrix this error can, however, be corrected when forecasting.

Conclusions

- Verification of solar irradiances gives very useful information about the NWP cloud modelling perfomance.
- High temporal resolution irradiance data gives information about sub-grid scale cloud variability.

References

Sengupta, M. et al.: "*Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications*," Tech. Report NREL/TP-5D00-63112, NREL, Golden, Co., USA, 2015.

Skartveit, A., J. A. Olseth & M. E. Tuft: "An hourly diffuse fraction model with correction for variability and surface albedo," *Solar Energy*, 1998; 63 (3): 173-183.

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