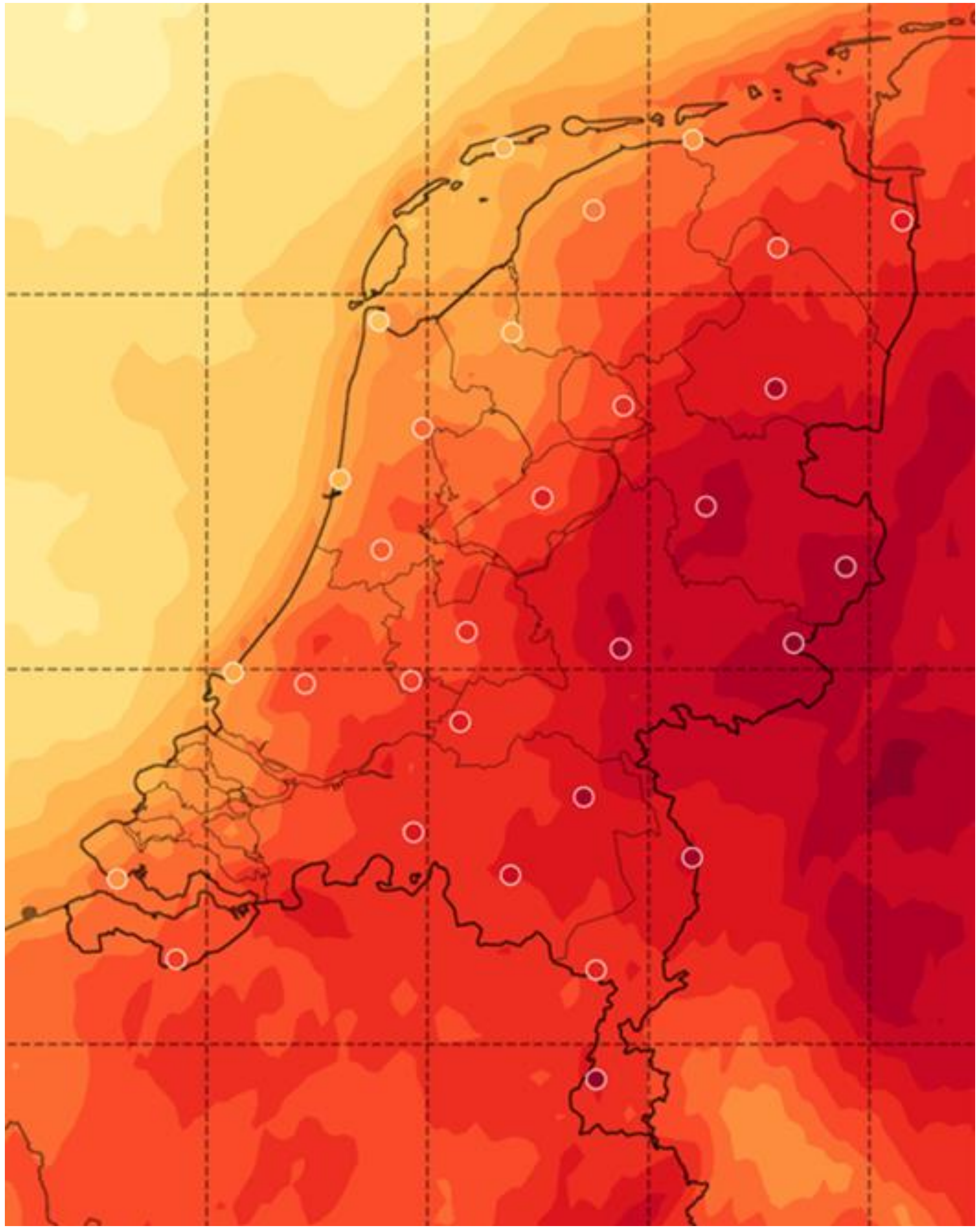


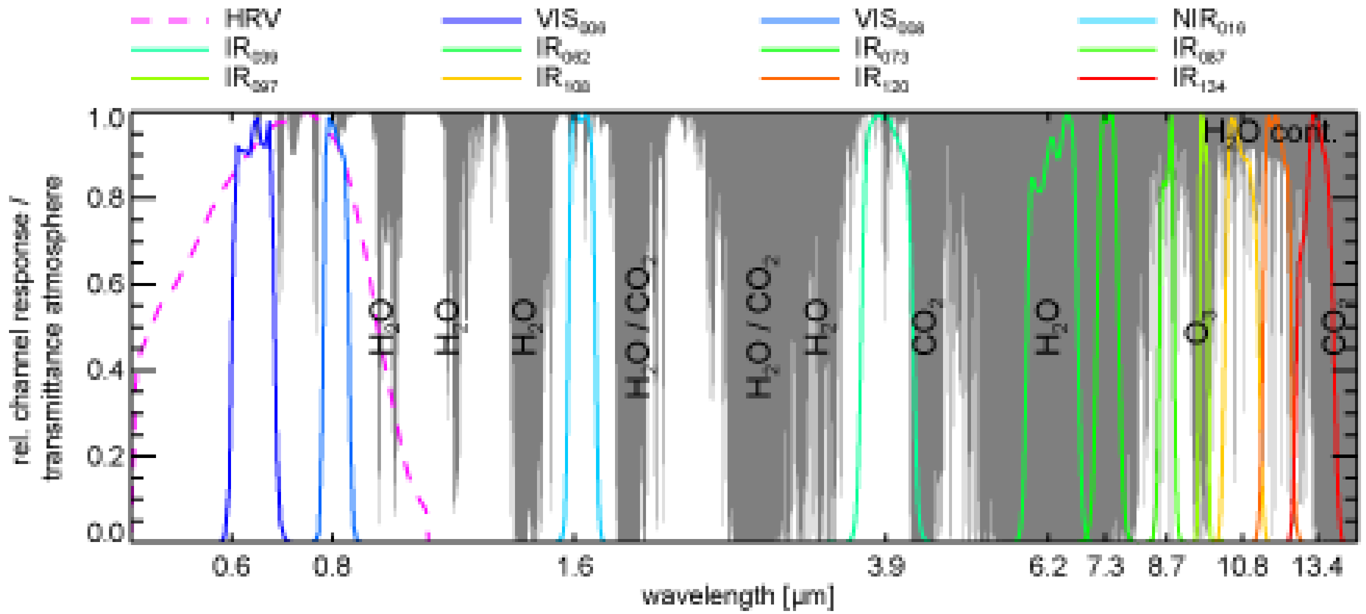
Royal Netherlands
Meteorological Institute
Ministry of Infrastructure and the Environment

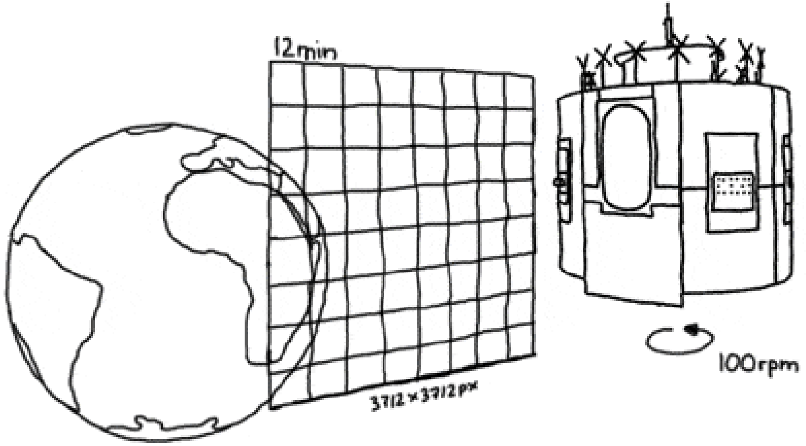
Observing and forecasting surface solar irradiance with Meteosat

Wouter Knap
Jan Fokke Meirink
Ping Wang
Rudolf van Westrhenen
Sibbo van der Veen

MSG-SEVIRI

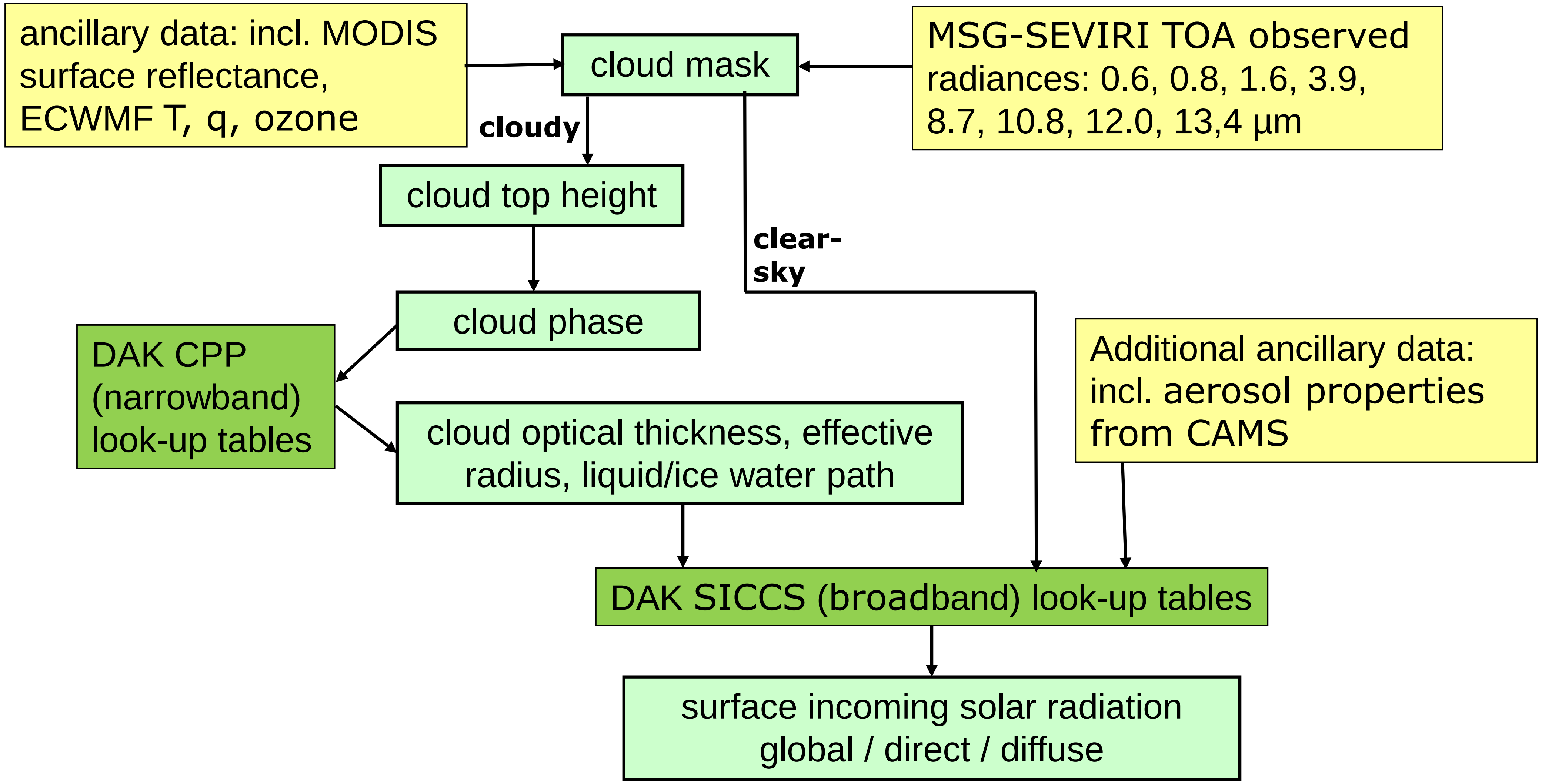
- Geostationary imager
- 12 spectral channels
- 3 x 3 km resolution sub-satellite
- 15 min repeat frequency





moments-from-space.com

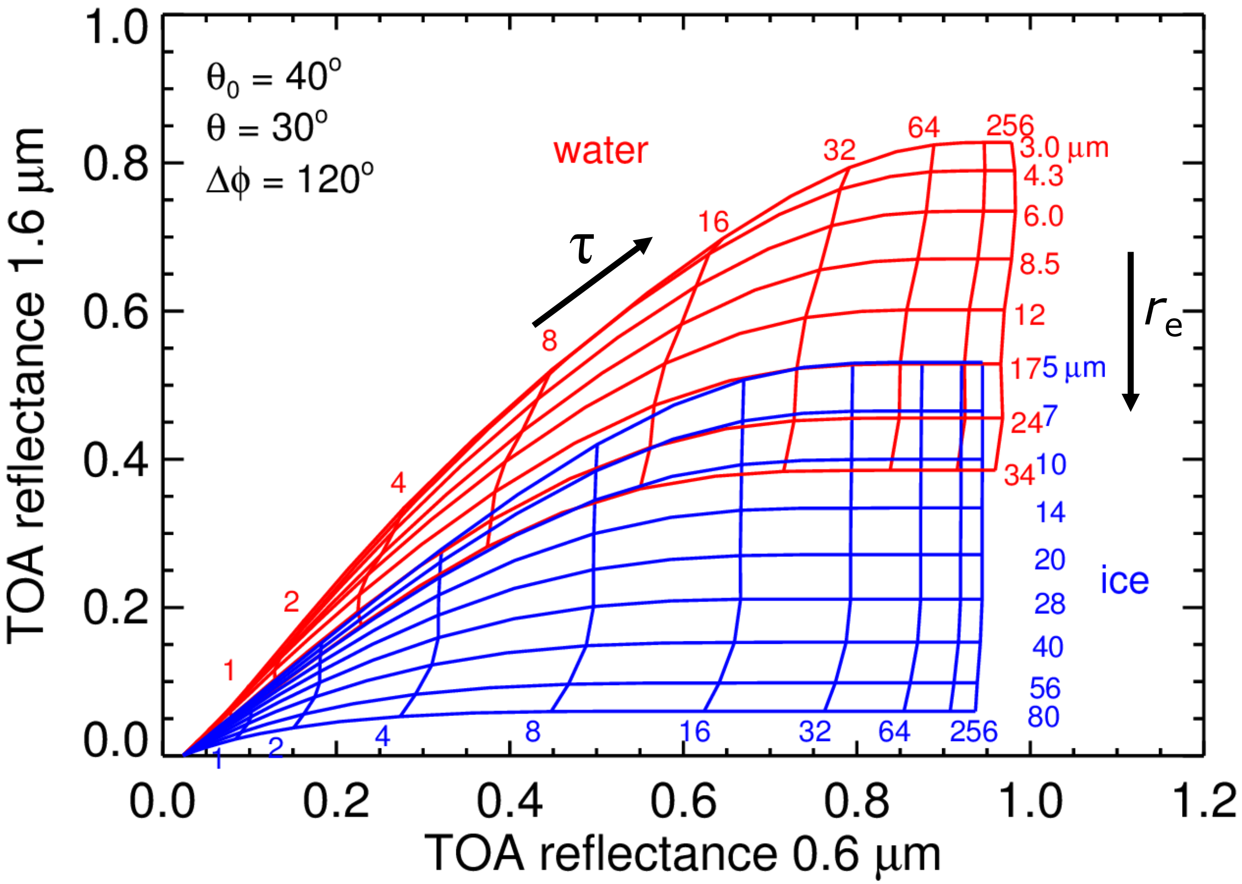
CPP-SICCS algorithm



Cloud optical thickness and effective radius

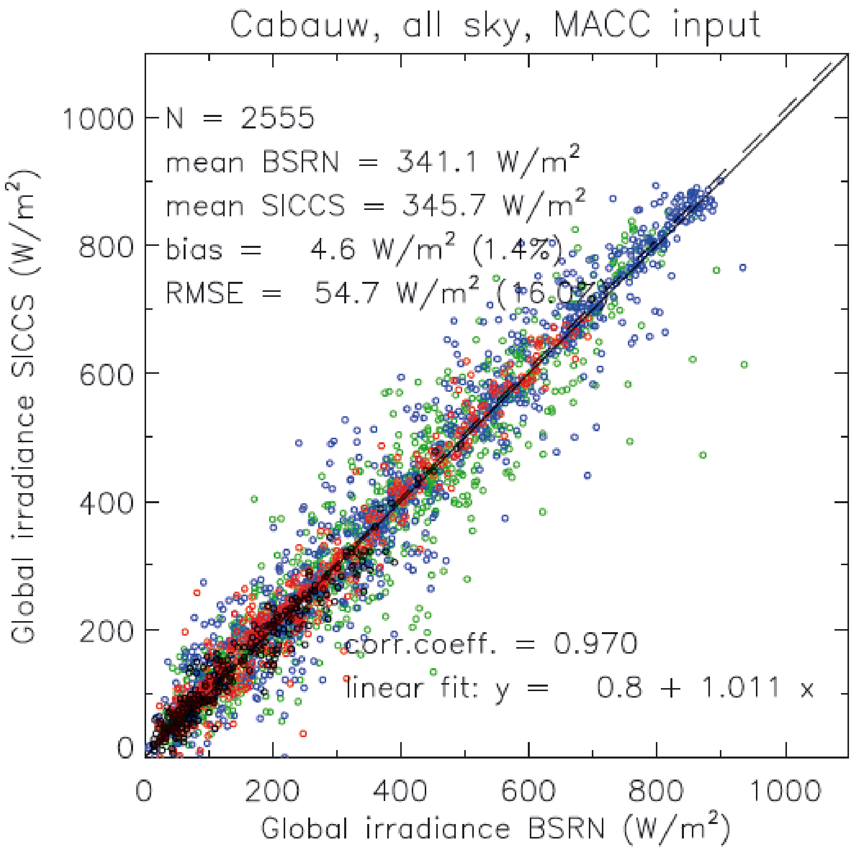
- 0.6 / 0.8 µm
  - Scattering
  - No absorption
  - $R_{0.6} = f_1(\tau)$
- 1.6 / 2.1 / 3.8 µm
  - Scattering
  - Absorption
  - $R_{1.6} = f_2(SSA) = f_3(\text{phase}, r_e)$
- Retrieval by matching observed and simulated refl. pairs

'Nakajima-King' diagram

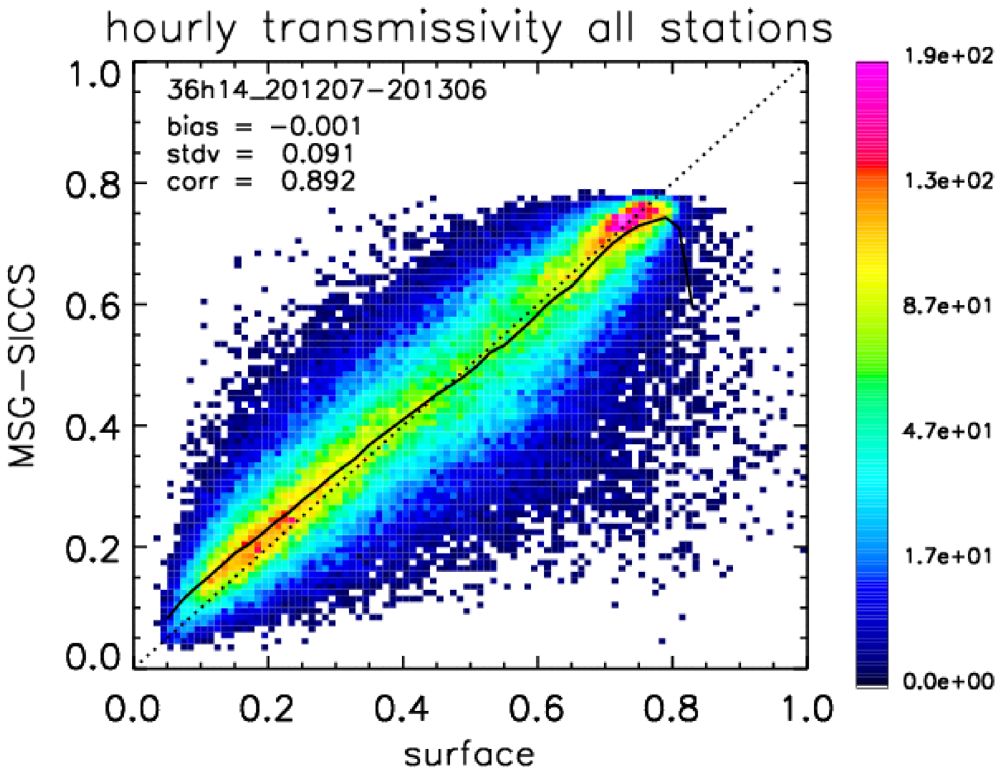


SICCS validation

BSRN Europe

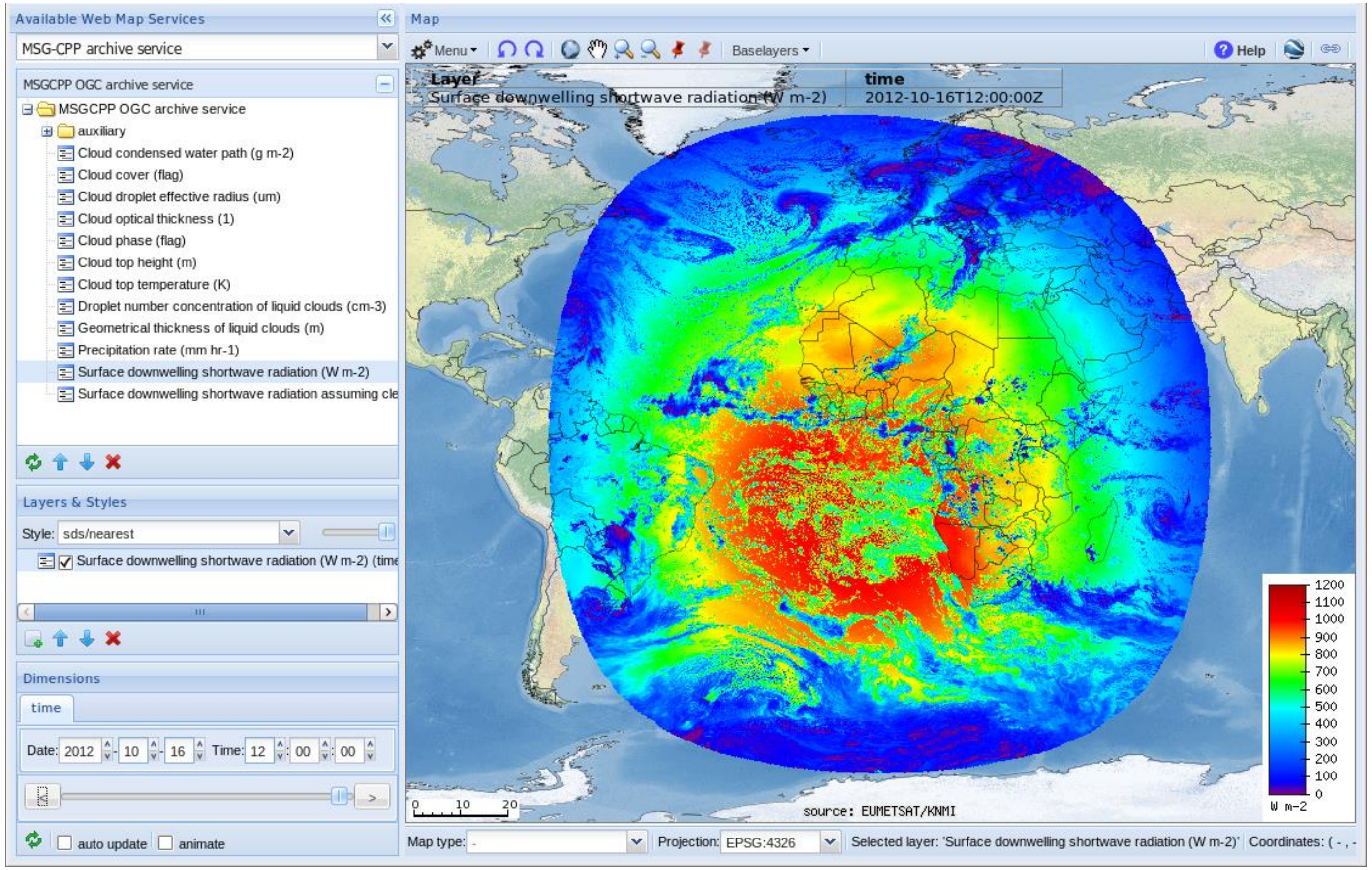


Dutch pyranometer network



Greuell et al., J. Geophys. Res., 2013: median bias 2%; median hourly RMSE 18%

Near-real time data



msgcpp.knmi.nl

- Full MSG-disc
- Interactive visualization
- OpenGC services
- 2-year archive online

Practical applications

Greenhouse cultivation

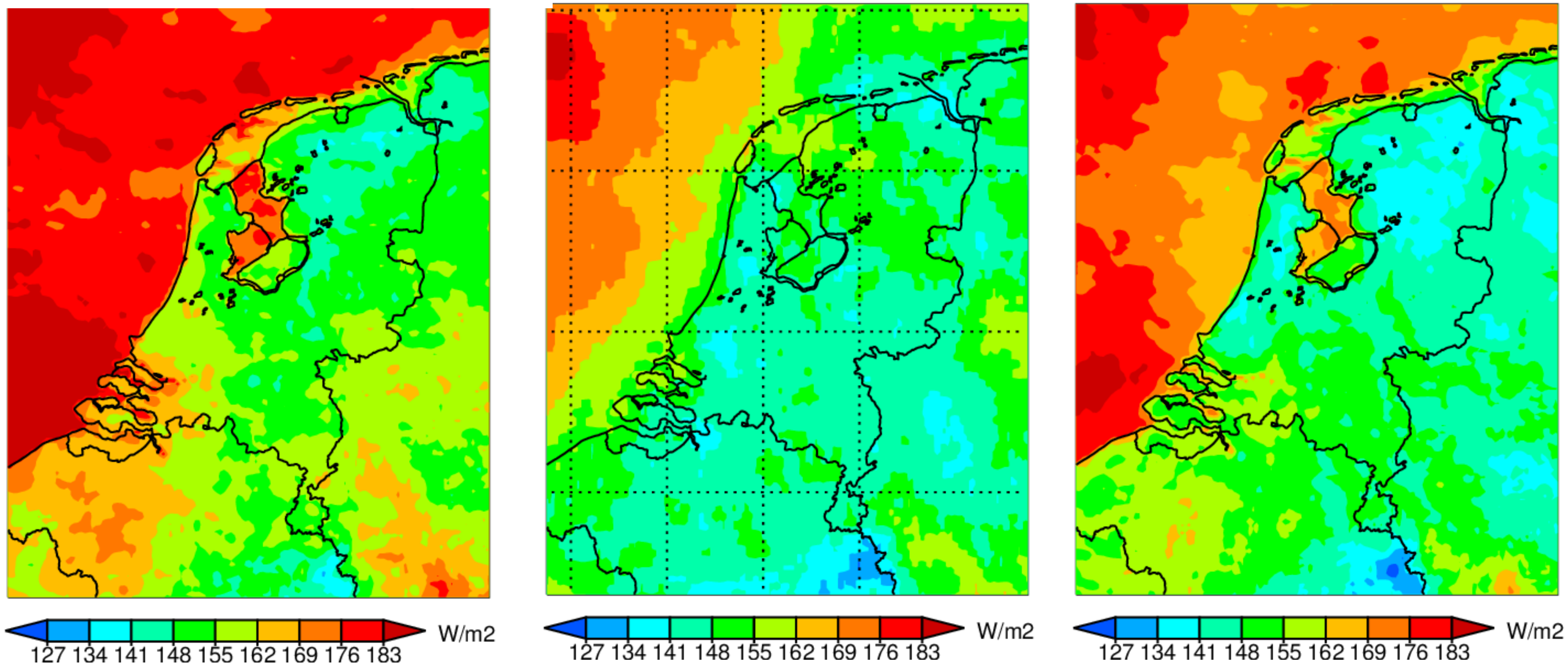
Solar energy

Hydrology (evaporation)

Application at KNMI: HARMONIE weather model evaluation

- Cloud inhomogeneity
- Cloud properties
- Turbulence

HARMONIE v38h12 | **MSG** | **HARMONIE v38h12 with updates**

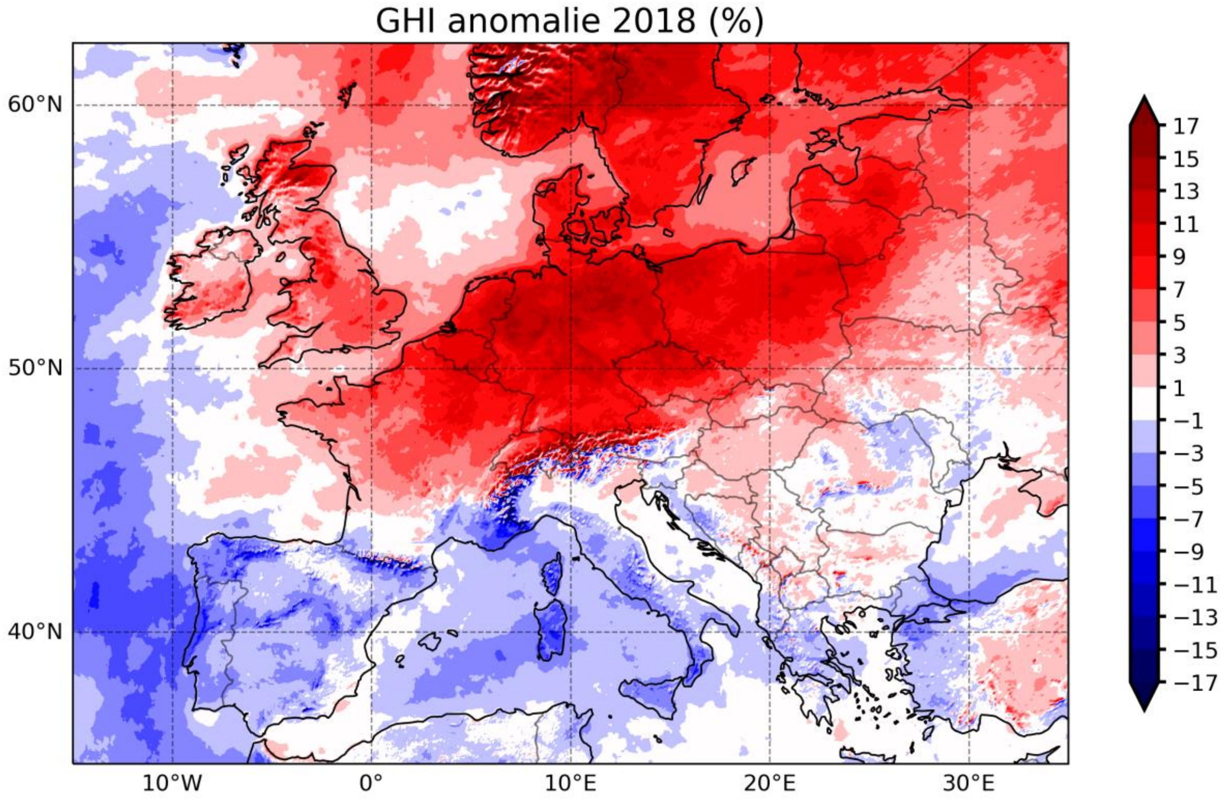


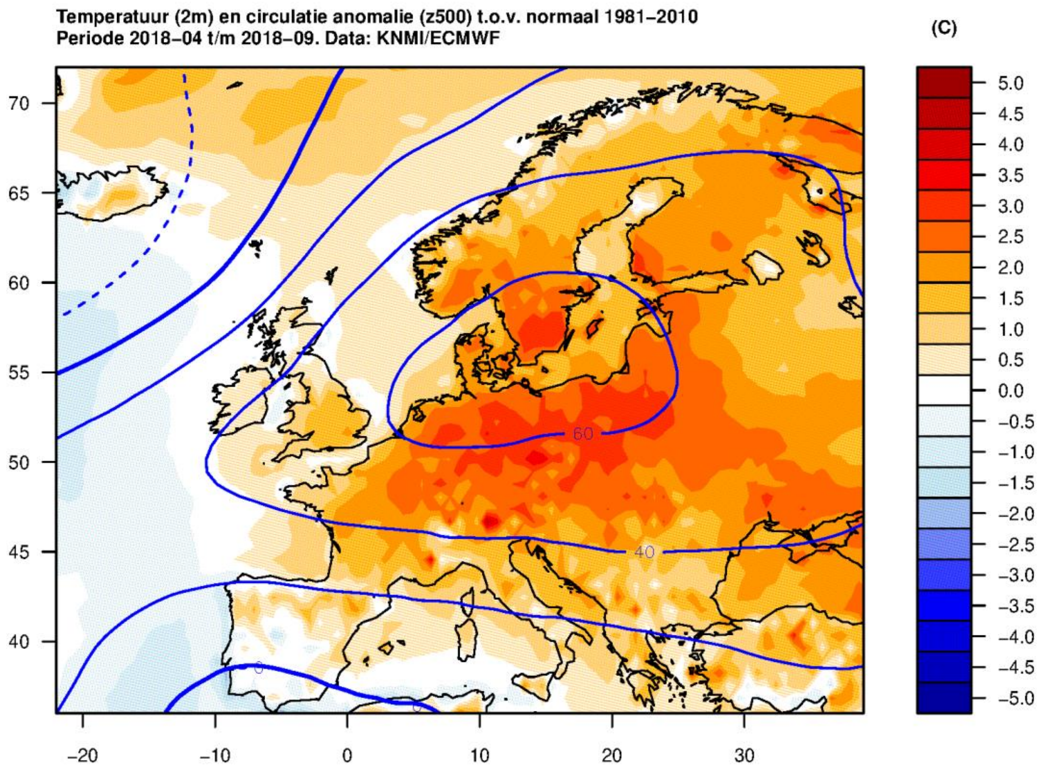
August 2006

Strong positive bias in HARMONIE surface solar radiation removed by updates in radiation and turbulence schemes

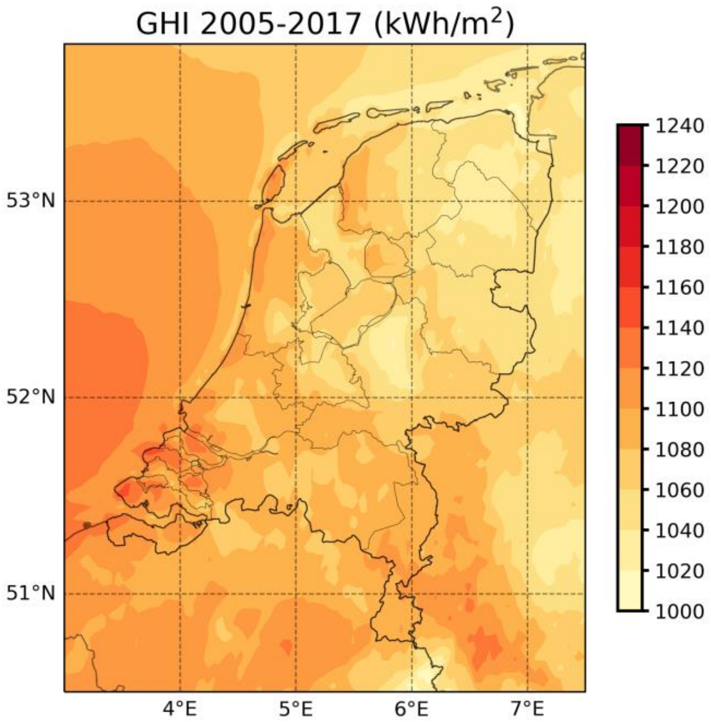
De Rooij and de Vries et al., Hirlam-Aladin tech. rep. No. 70, 2017

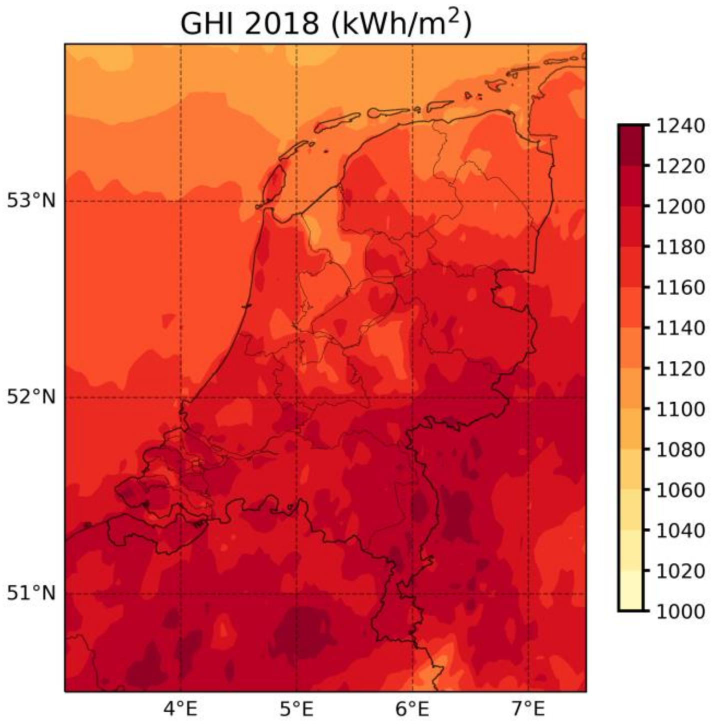
Anomalous GHI 2018

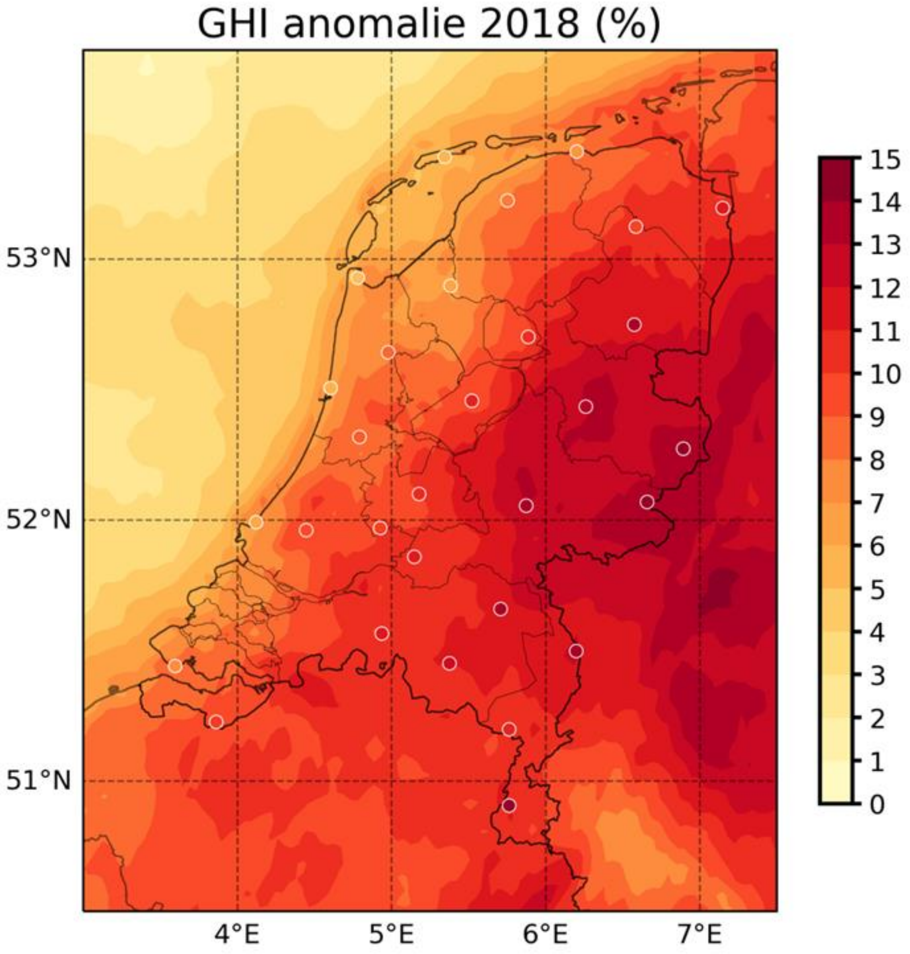




Anomalous GHI 2018

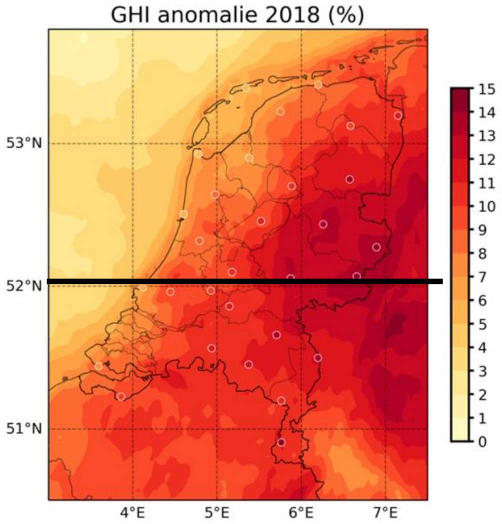


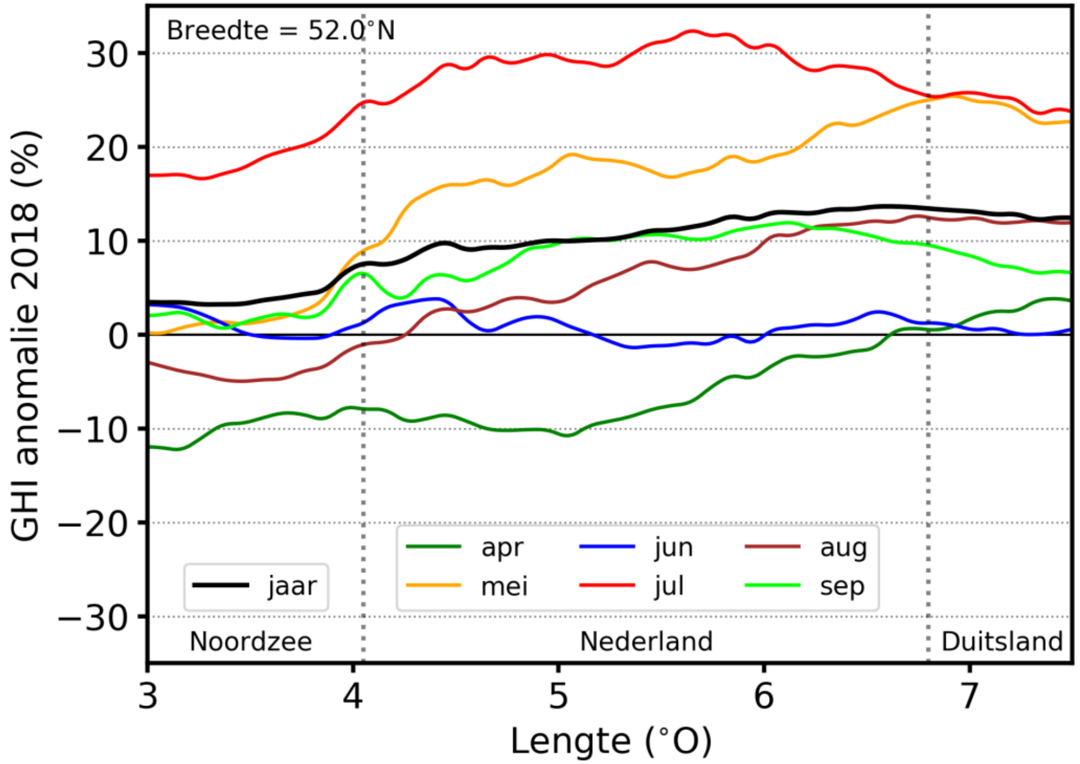




Anomalous GHI 2018

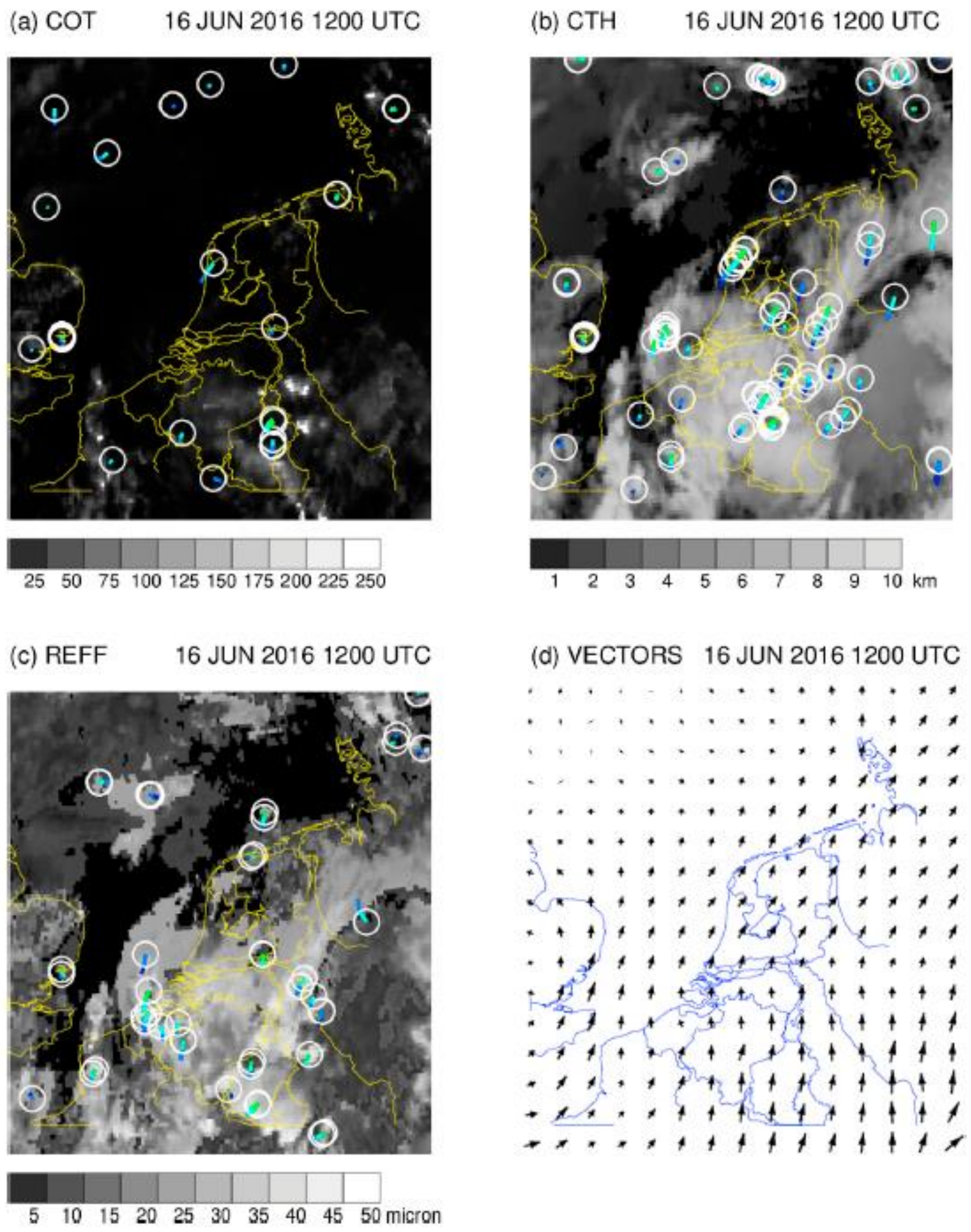
20 May 2018, 13:30h





Satellite-based forecasting

- 5 subsequent SEVIRI images (1 hour)
- Cloud motion vectors derived from different cloud properties
- Vectors from different time steps and cloud properties combined
- Completed with model wind vectors
- Cloud properties advected in 15-minute time steps (no smoothing applied), 2 hours ahead
- SSI (global and direct) calculated from advected clouds using SICCS

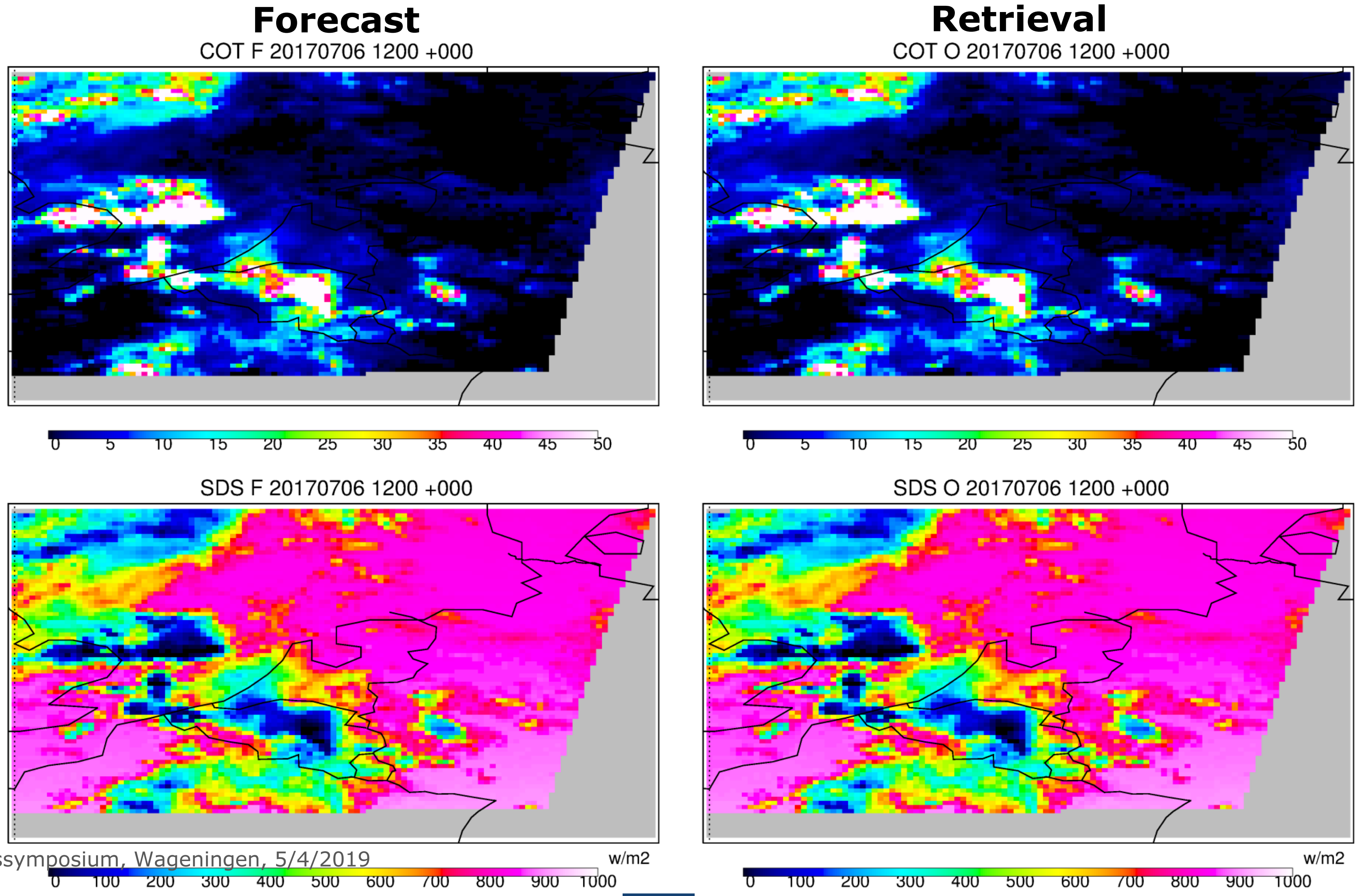


Wang et al., Solar Energy, 2019

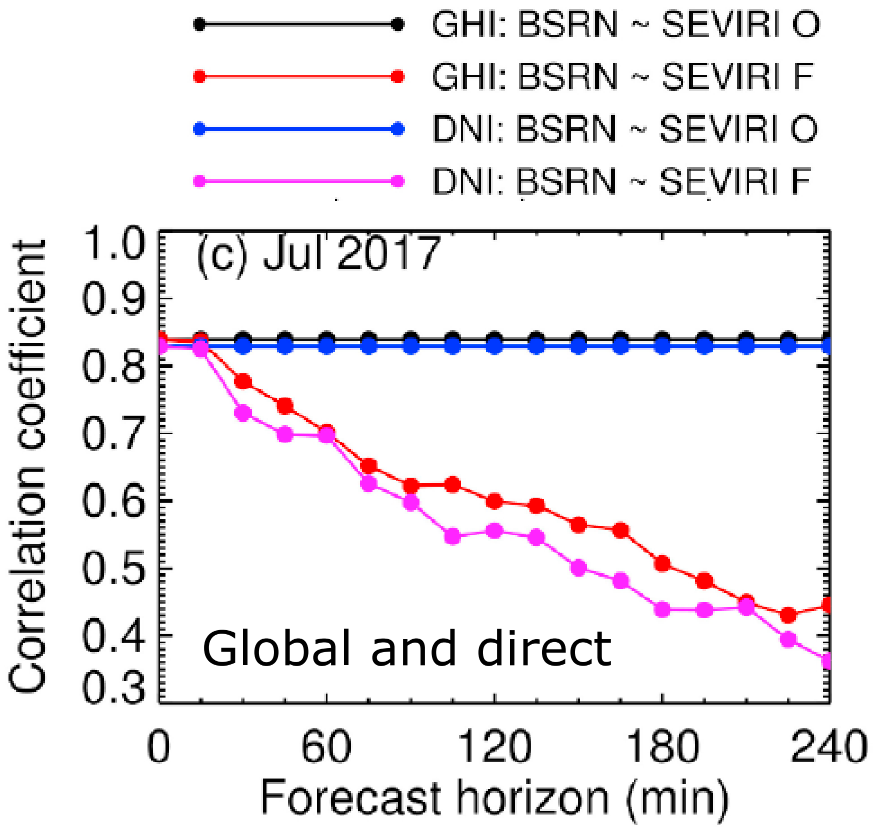
Forecast example

COT

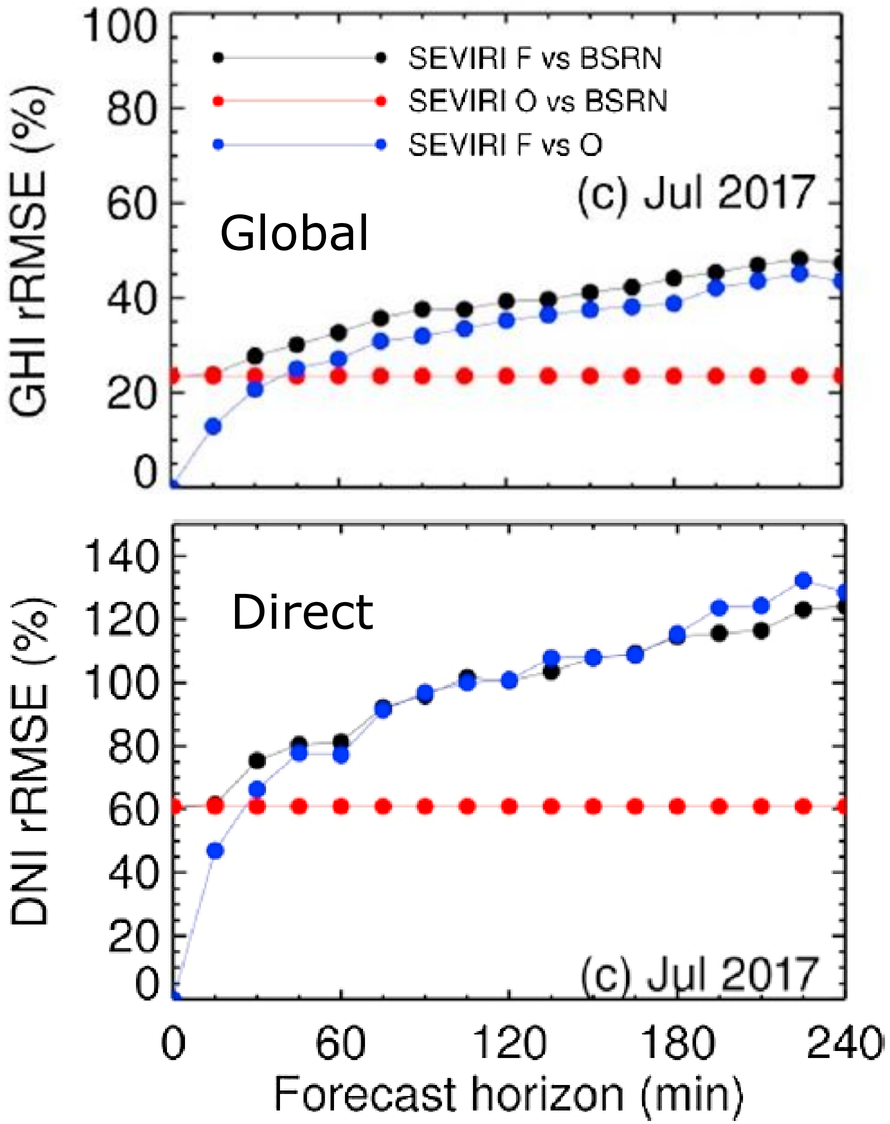
Global radiation



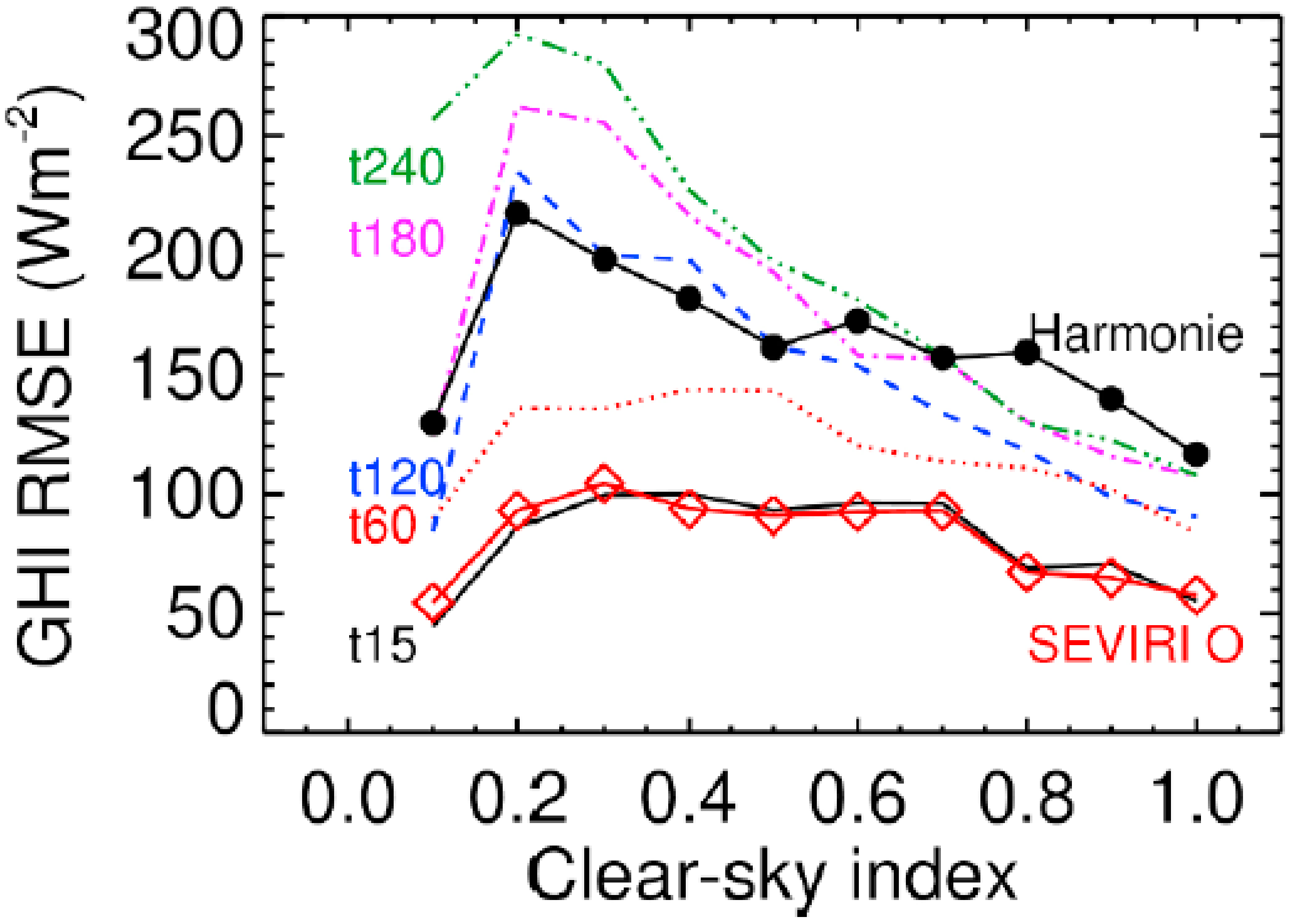
Forecast statistics
evaluation at BSRN Cabauw



RMSE (%)



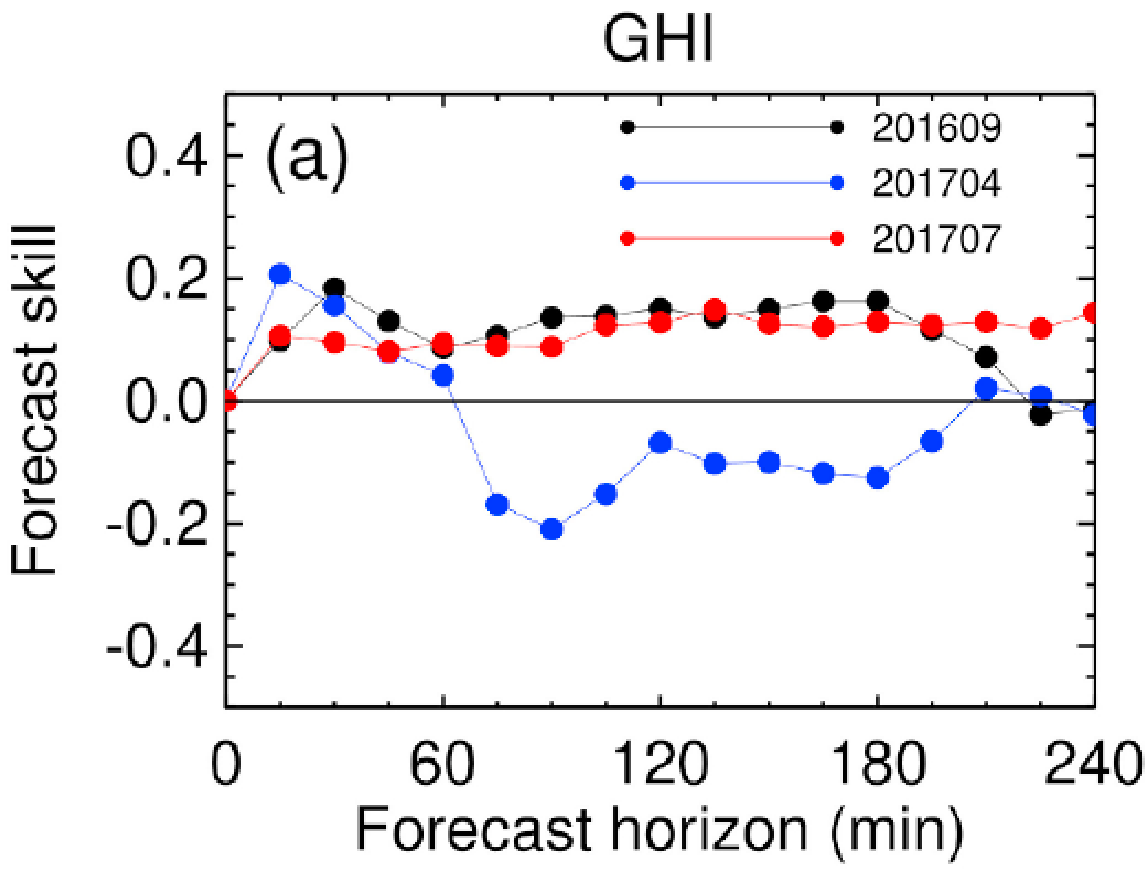
Forecast statistics



Satellite-based forecast outperforms Harmonie:

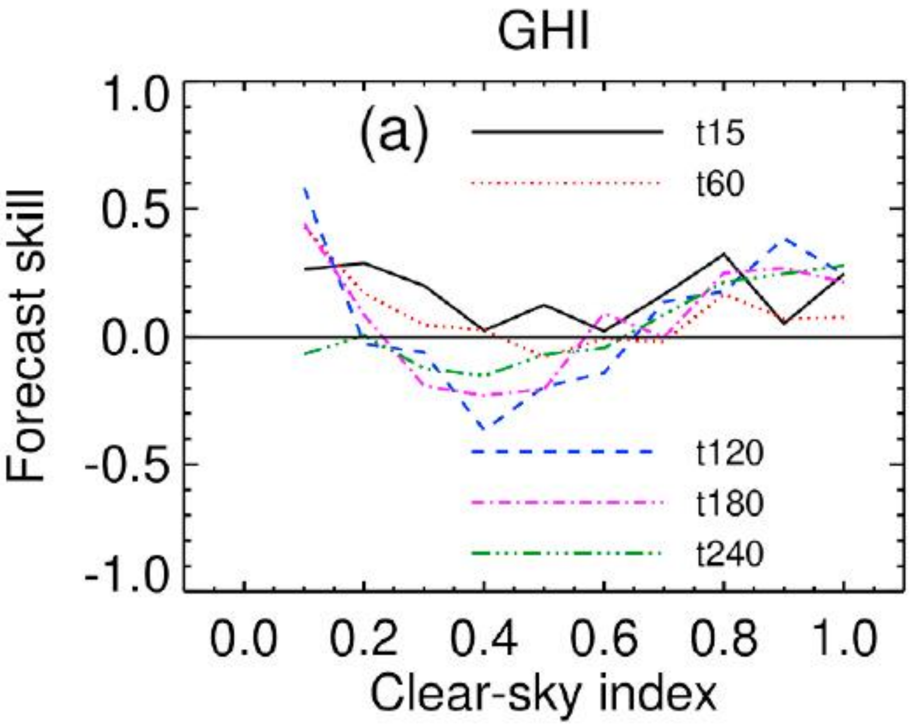
- always for clear-sky index > 0.7
- Up to about 2h ahead for more cloudy situations

Forecast statistics



Forecast Skill:

$$FS = 1 - \frac{RMSE_{forecast}}{RMSE_{persistence}}$$



Verder lezen:

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ELSEVIER

Surface solar radiation forecasts by advecting cloud physical properties derived from Meteosat Second Generation observations

Ping Wang*, Rudolf van Westrhenen, Jan Fokke Meirink, Sibbo van der Veen, Wouter Knap

Royal Netherlands Meteorological Institute (KNMI), P.O. Box 201, 3730 AE De Bilt, the Netherlands

ARTICLE INFO

Keywords:
Surface solar radiation forecasts
Cloud physical properties
Meteosat second generation

ABSTRACT

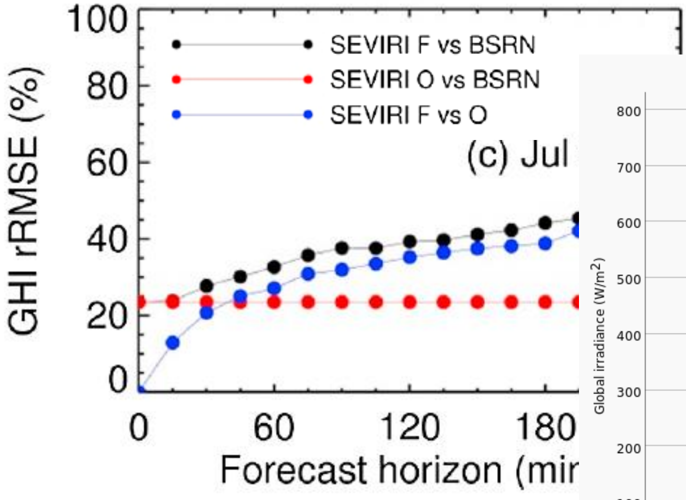
A surface solar radiation forecast algorithm is developed using cloud physical properties from the Spinning Enhanced Visible and Infrared Imager (SEVIRI) on board of the Meteosat Second Generation (MSG) geostationary satellite. The novelty of the algorithm is the derivation of cloud motion vectors using cloud physical properties. The solar radiation forecast products include global horizontal irradiance (GHI) and direct normal irradiance (DNI). The forecast horizon is 0–4 h at a 15 min temporal resolution. The forecast is currently tested for the Netherlands at a spatial resolution of about 4 km × 6 km. Compared to measurements of the Baseline Surface Radiation Network (BSRN) site of Cabauw, the root mean square error (RMSE) is about 31–44% for GHI and 59–100% for DNI at a forecast horizon of 2 h. For a forecast horizon of 15 min, the RMSE is 22–24% for GHI and 43–61% for DNI. The correlation coefficients between the forecasts and BSRN measurements are similar for GHI and DNI, and decrease from about 0.8–0.9 at 15 min to 0.45–0.75 at 2 h. The SEVIRI forecast outperforms the HARMONIE numerical weather prediction model forecast in the first 2–3 h. The quality of the forecast depends on the sky conditions: for clear-sky indices larger than 0.7, the SEVIRI GHI forecast is better than both smart persistence and the HARMONIE forecast in the first 4 h.

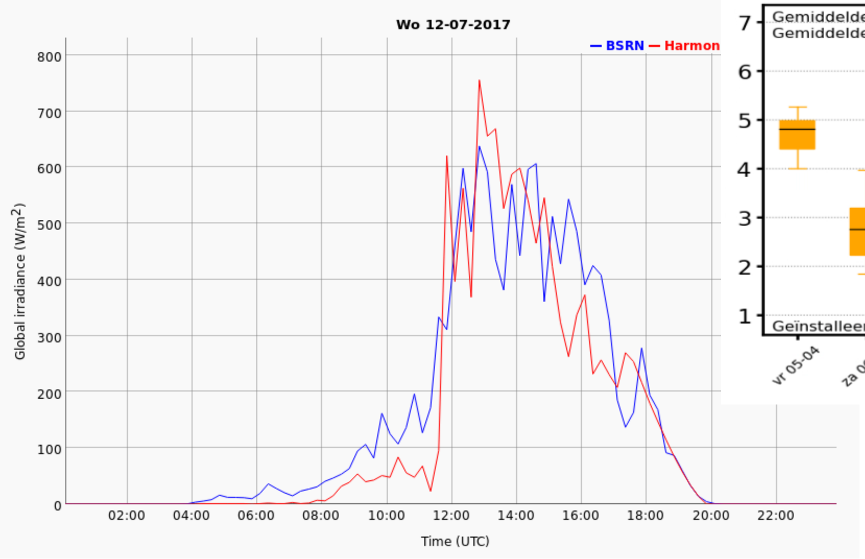
Combined forecasts

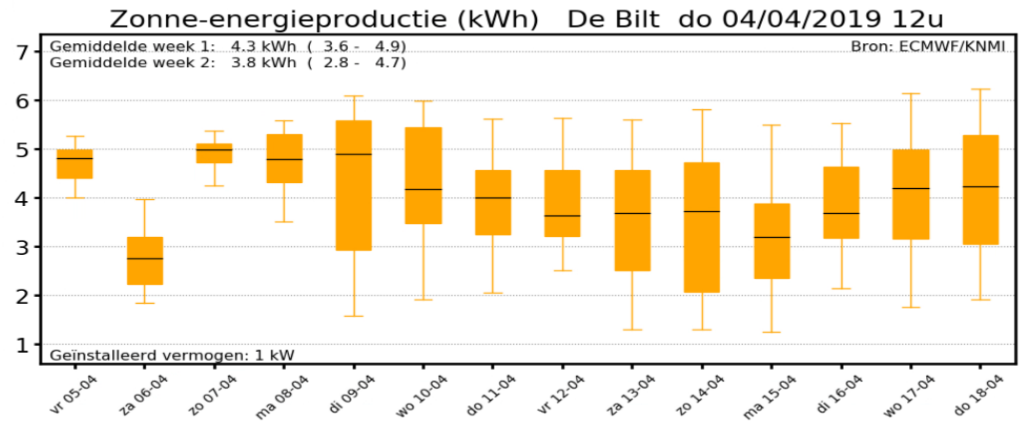
timescale

Satellite | Harmonie deterministic | ECMWF ensemble prediction

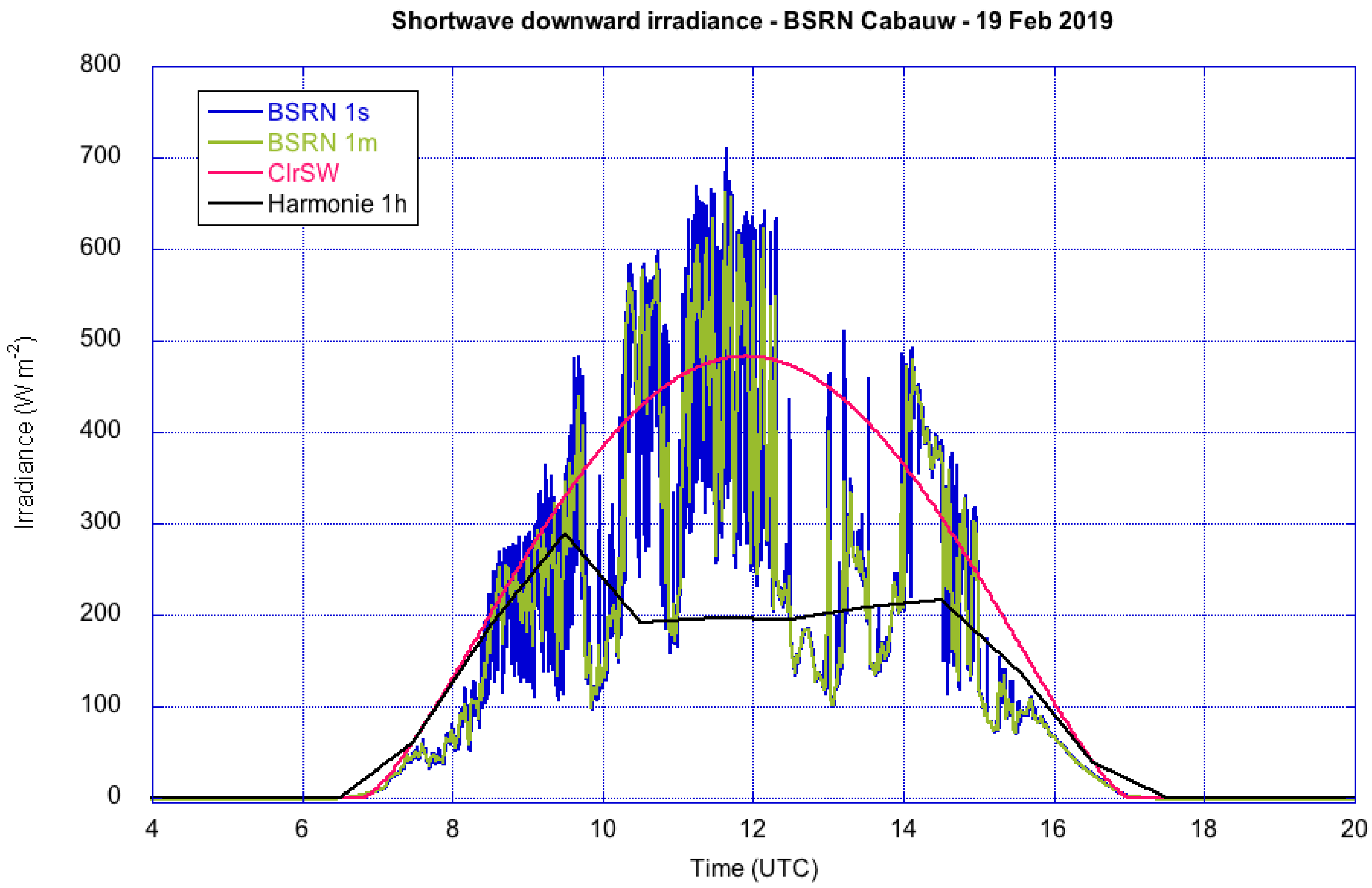
15 min | hour | 4 hour | day | 4 day | 2 week



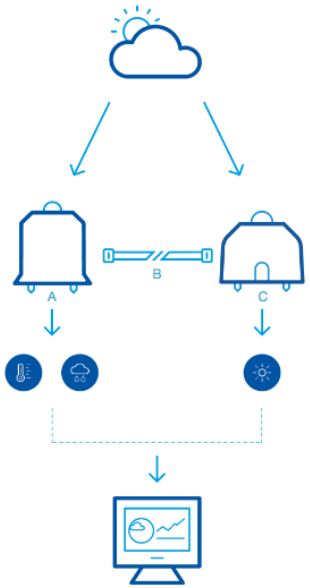


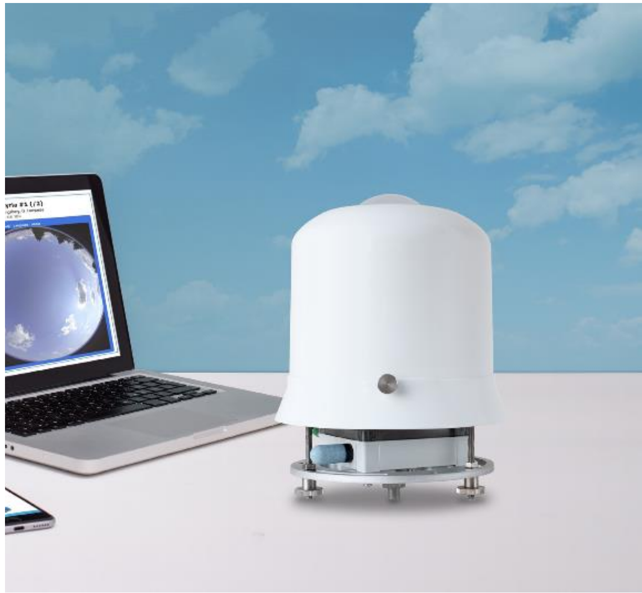


Nowcasting



Ruisdael radiation/skycam network





Forecast work in progress

› Statistical postprocessing of Harmonie solar radiation forecasts

Comparison of statistical post-processing methods for probabilistic NWP forecasts of solar radiation

Kilian Bakker, Kirien Whan, Wouter Knap, Maurice Schmeits*

Royal Netherlands Meteorological Institute (KNMI), P.O. Box 201, 3730AE De Bilt, the Netherlands

Abstract

The increased usage of solar energy places additional importance on forecasts of solar radiation. Solar panel power production is primarily driven by the amount of solar radiation and it is therefore important to have accurate forecasts of solar radiation. Accurate forecasts that also give information on the forecast uncertainties can help users of solar energy to make better solar radiation based decisions related to the stability of the electrical grid. To achieve accurate forecasts

› Cloud initialization Harmonie