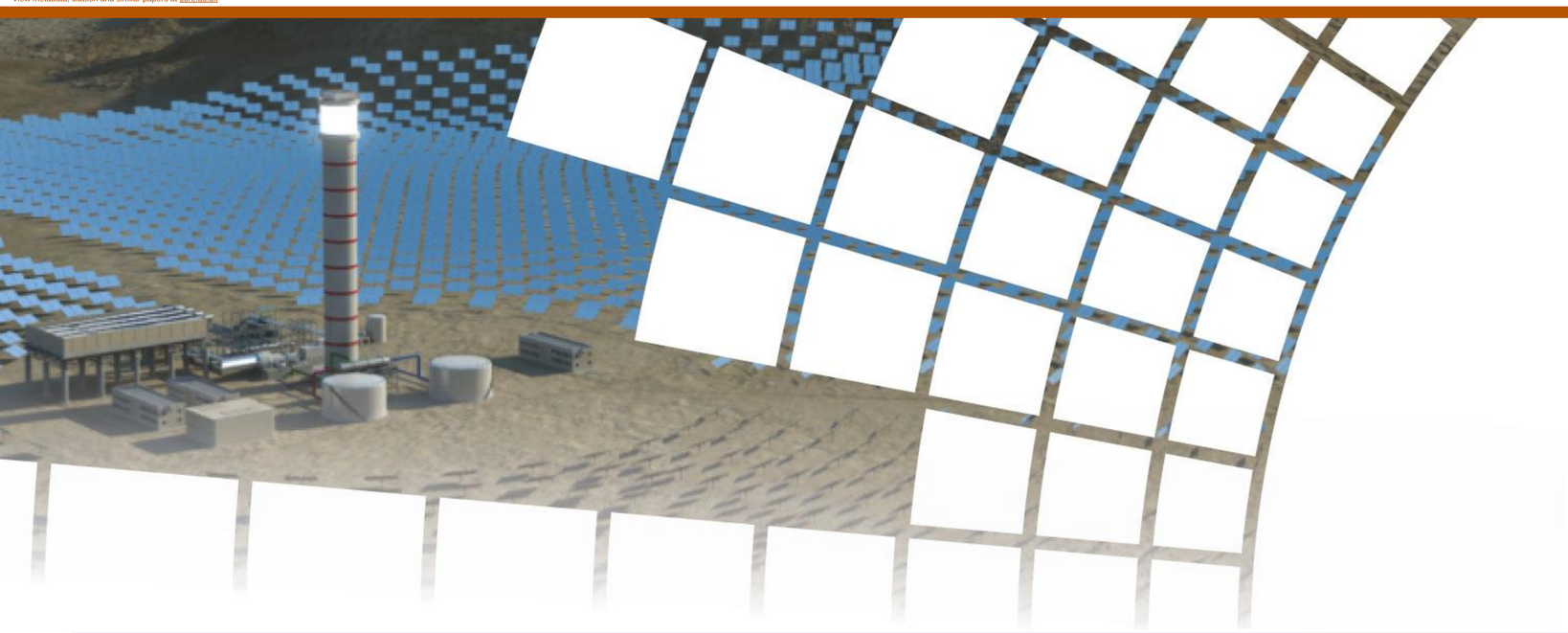


PreFlexMS
PREDICTABLE&FLEXIBLE SOLAR POWER WITH MOLTEN SALT ENERGY STORAGE

Evaluation of the accuracy of GHI and DNI forecasts by IFS and Harmonie models over Spain

Jose L. Casado-Rubio[1], Isabel Martínez[1], María Postigo[1], M. A. Revuelta[1], Cristina Robles-González[1], Carlos M. Fernández-Peruchena[2], Martin Gastón[2]

1- State Agency for Meteorology (AEMET) 2- National Renewable Energy Centre (CENER)

AEMet Agencia Estatal de Meteorología

CENER ADItech

Introduction

Direct normal irradiance (DNI) can be obtained from numerical weather prediction (NWP) models in two different ways: indirectly from the global horizontal irradiance (GHI), or directly from the direct horizontal irradiance, a parameter included recently in most NWPs.

This poster aims to verify the accuracy of NWPs when forecasting these parameters in the Iberian Peninsula, to assess whether they can be used operationally in the PreFlexMS project.

Methodology

Two meteorological models have been used for this study: the mesoscale Arome-HARMONIE (Hirlam Aladin Regional/Meso-scale Operational NWP In Europe) model, run by AEMET, with a 2.5 km horizontal resolution and 65 vertical levels, and hourly outputs; and the global IFS (Integrated Forecasting System) model, run by ECMWF, with a 16 km horizontal resolution (9 km from April 2016) and 137 vertical levels, and outputs every three hours.

Global and direct horizontal irradiance have been forecasted for the first two days (D+1 and D+2), using 0 UTC runs for the period 1st February 2015 – 31st January. Three-hourly IFS forecasts have been interpolated in time to get hourly values. The direct horizontal irradiance has been converted into DNI afterwards dividing by the cosine of the zenital angle.

To be able to compare both models in a fair way, the GHI and DNI predicted have been smoothed in space averaging the radiation in a square with different side lengths, to minimize the double penalty problem and decrease the RMSE.

Conclusions

These conclusions can be drawn from the results:

- There is an improvement when spatial averaging is made. This effect is specially remarkable for Harmonie.
- IFS produces slightly better forecasts for GHI (RMSE around 30-120 W/m^2; 10-50% in relative terms) than Harmonie. On the other hand, DNI error is similar for both models (RMSE around 120-250 W/m^2; 30-100% in relative terms) when they are compared at the same spatial scale.
- IFS has a positive bias for DNI, while Harmonie bias is closer to zero.
- Both models give better results than persistence for both GHI and DNI.
- RMSE varies considerably for different months, due to the low predictability of cloudiness and aerosols (this is hinted by the persistence). The relative RMSE (not plotted here) shows there is a larger error in winter and smaller in summer, as expected.
- Although aerosol variability is not predicted by current models, scores are usually not affected by it, since aerosols only decrease the DNI significantly in days with high aerosol content. Anyway, their impact can be huge in months with very intense and long African dust outbreaks. This happened for example in August 2015, specially in the southern coast (Arenosillo station).

Notice that RMSE favours smooth forecasts. If a realistic variability is required, it is recommended to use other scores, more suitable for that.

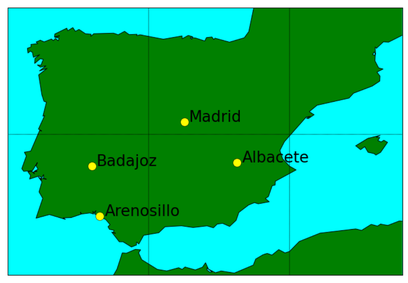
References

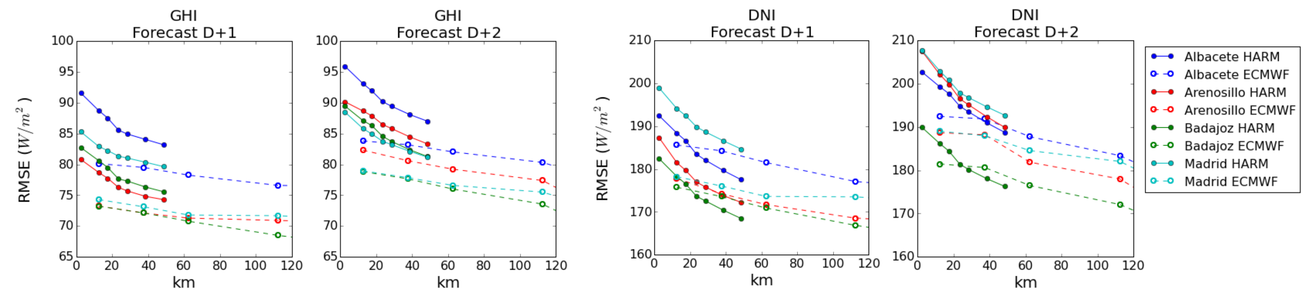
- Lara-Fanego, J.A. Ruiz-Arias, D. Pozo-Vazquez, F.J. Santos-Alamillos, and J. Tovar-Pescador, 2012: Evaluation of the WRF model solar irradiance forecasts in Andalusia (southern Spain). Sol. Energy, 86, 2200-2217, doi:10.1016/j.solener.2011.02.014
- Perez, and Coauthors, 2013: Comparison of numerical weather prediction solar irradiance forecasts in the US, Canada and Europe. Sol. Energy, 94, 305-326, doi:10.1016/j.solener.2013.05.005
- Schroedter-Homscheidt, M., N. Killius, G. Gesell, A. Benedetti, 2014: Assessment report for global and direct normal irradiance forecasts, D123.1 report, MACC-II, MACCII_RAD_DEL_D123.1_final.pdf, http://www.gmes-atmosphere.eu

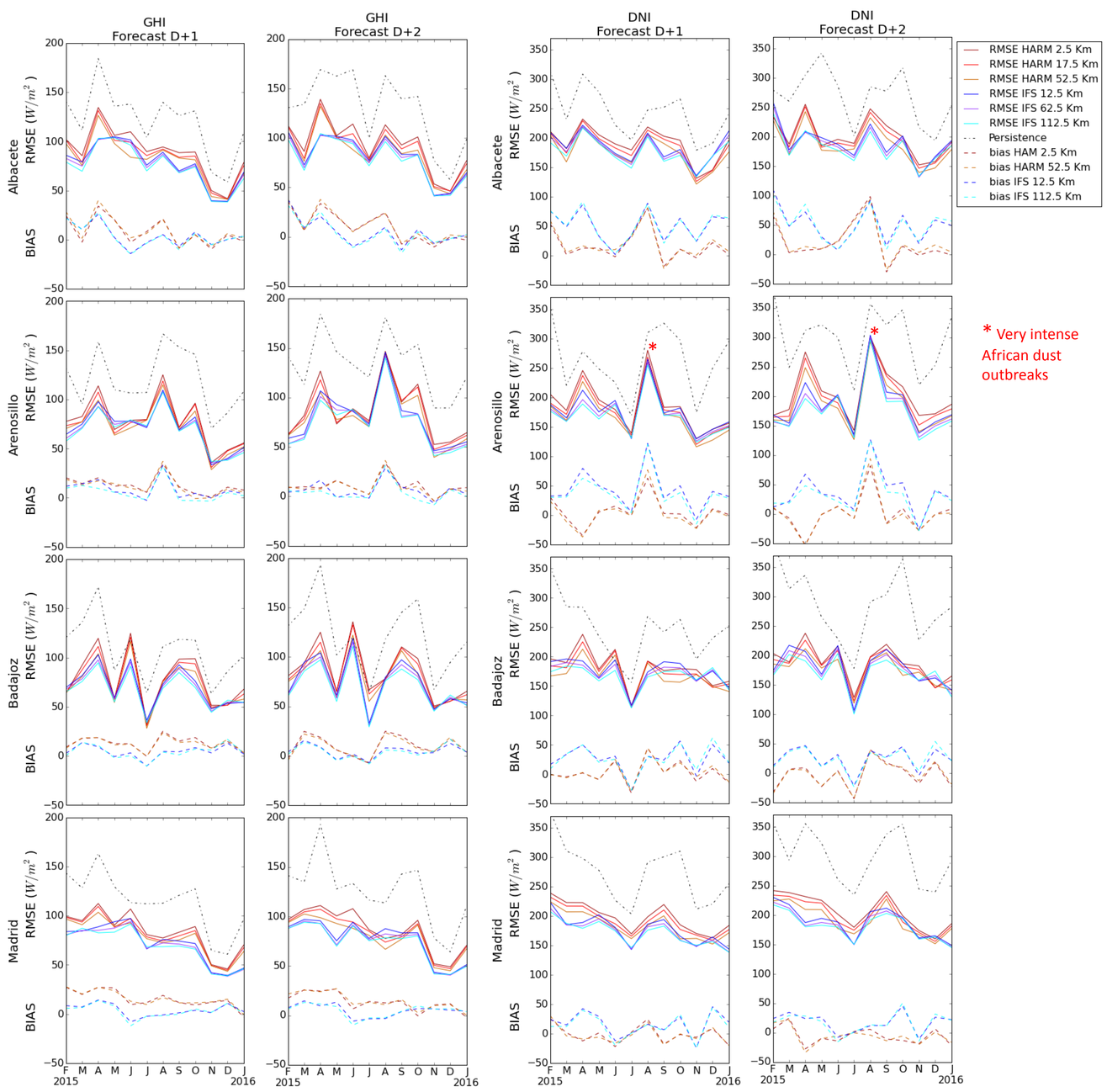
Results

The verification has been made comparing with measurements from four AEMET stations in southern Spain.

The plots show the RMSE vs. the side of the square used to average (top graphs), as well as the scores for every month of the period studied for the four stations (bottom graphs). Absolute scores are shown to highlight the difference between models.







* Very intense African dust outbreaks

PreFlexMS is a consortium of 13 partners from 8 European countries. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654984. Swiss partners are funded by the State Secretariat for Education, Research and Innovation of the Swiss Confederation.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

FR General Electric France
CH General Electric Switzerland
IT Politecnico di Milano. Dept. of Electronics, Information and Bioengineering
ESE Engineering. Services for Energy S.r.l.
STF Salvatore Trifone e Figli S.p.A.
PL AGH University of Science and Technology. Dept.of Applied Computer Science
EC Systems AMC
DE DLR German Aerospace Center. Remote Sensing Data Center
DLR German Aerospace Center. Institute of Solar Research
University of Stuttgart Dept. of Life Cycle Engineering (GaBi)
SK GeoModel Solar s.r.o.
PT University of Evora. Renewable Energies Chair
ES AEMET State Agency for Meteorology
CENER National Renewable Energy Centre