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FORECAST OF SHORT-TERM SOLAR IRRADIATION IN BRAZIL USING NUMERICAL MODELS AND STATISTICAL POST-PROCESSING

Summary

This work aims at establishing a methodology to get reliable solar irradiation forecasts for the Brazilian Northeastern region by using WRF model together with statistical methods for pre and post-processing data. The major difficulty is related to the diversity of climate features occurring in the region presenting the largest solar energy resource in Brazil. The solar irradiance forecasts for 24h in advance were obtained using the WRF model. Comparisons analysis between WRF forecasts and ECMWF model outputs were performed to identify the model skill to predict observed solar irradiation. In order to reduce forecasts deviations, principal components and cluster analysis are being employed to find out areas presenting similar climate features. Different numerical parameterizations are being settled for each area. Post-processing of WRF outputs are using artificial neural networks and multiple regression methods in order to refine solar irradiation forecasts.

Keywords: Solar irradiation; Short-term forecasts; Numerical modeling, Brazilian Northeastern region

1. Introduction

In contrast with other renewable energy sources (wind, biomass, and small hydroelectric plants) that have specific support by government incentives and polices, the penetration of the solar technology in Brazil is coming far behind. There have been some important efforts to increase the available information on the Brazilian solar energy resources (Martins and Pereira, 2011). Figure 1 presents a relative comparison between solar energy resources in Brazil and in countries where the solar energy market is far more advanced, such as Germany and countries in the Iberian Peninsula. It also shows the mean annual solar resources for each of the five Brazilian geopolitical regions. Besides the large annual solar irradiation, its seasonal and inter-annual variability are low due to the fact that much of the Brazilian territory is located in a tropical region. Earlier studies have pointed out that the solar technology could be cost-effective all over Brazilian territory regarded particular conditions for each region (Viana et al., 2011). Applications like PV plants in remote areas of the Amazon region and CSP plants in the arid area of Northeastern region are examples for feasible exploitation of solar resources (Pereira et al., 2006).

2. Methodology

The observational data for hourly solar irradiation used in this study were acquired through Automatic Weather Stations (AWS) along time periods with different climate characteristics in Ceará, located in the Brazilian Northeastern region. Data for the rainy season were acquired in March and April. Along the dry season, data was acquired in September and October. The first step was to check the quality of observed data. This procedure was necessary to minimize the chances of a biased analysis due to the low reliability of observed data. The quality criteria used in BSRN (Baseline Surface Radiation Network) were employed. The solar irradiance forecasts for 24h in advance were obtained using the WRF model. Comparisons analysis between WRF forecasts and ECMWF model outputs were performed to identify the ability of models to predict observed solar irradiation. Figure 2 illustrates basically the methodology used in this research.

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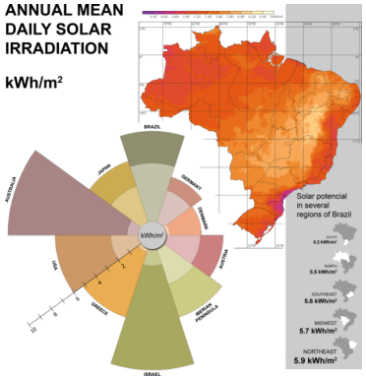

Fig. 1. Mean annual range of the solar energy resources in Brazil compared to other countries (Source: Pereira et al., 2006).

Figure 2. Schematic diagram of comparison analysis of solar irradiation forecasts provided by WRF and ECMWF models and observations at AWS.

3. Results and Remarks

Comparing the ECMWF and WRF outputs, the ECMWF model performance was better than the WRF. The WRF model overestimated the solar irradiation in all AWS locations, while the ECMWF provided irradiation forecasts closer to the observations. The WRF model was unable to simulate the solar irradiation at the surface during the rainy season. Probably, the choice of physical parameterizations was not adequate to simulate the cloud radiative processes occurring during this season. Even in dry season, ECMWF presented a better performance: WRF forecasts presented RMSE and BIAS deviations two times larger than ECMWF estimates.

Now, the authors are evaluating different numerical parameterizations to represent convection and cloud microphysics processes in WRF runnings. In addition, the Brazilian Northeastern region is being separated in small areas presenting similar climate characteristics. Statistics methods like principal components and Cluster Analysis are being used to evaluate the similarity in a pre-processing step. Following these steps, the preliminary results are presenting lower BIAS and RMSE deviations because the model setup is more appropriate to climate characteristics in all areas. The final results and major remarks will be published soon and presented at EUROSUN.

4. References

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