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Solar radiation temporal and spatial variability and correlations with trade wind characteristics over Reunion Island (21S, 55.5E)

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Improving the reliability of solar resource short-term forecast is one of the greatest challenges for the penetration of solar energy in electrical grids. The spatial and temporal variability of solar radiation is under study to improve this forecast for the case of Reunion Island. Such improvement, a major objective of the PEGASE project, will allow up to 30% of Reunion Island energy needs to be covered by solar energy by 2050, hence contributing to the energetic autonomy of the island. In this work, we investigate the effect of the large scale winds on this solar variability.

The Island is continuously exposed to the E-S-E trade winds the great majority of time. The trade wind direction forces three different regions with different wind and cloudiness conditions over the island: the windward region (very rainy and with calm winds), the leeside (mostly cloudy and with calm winds too) and the parallel coasts (sunny and windy).

In the presented work, trade winds are divided in bins of direction and strength and sensitivity analyses are performed. First, sensitivity of the local winds (measured in 19 widely spread meteorological ground stations) to the change of the global wind is investigated. Secondly, sensitivity analyses are performed on the solar irradiance measured at 21 ground stations around the island. Time resolution is 1h. These analyses are done over three daily parameters, which are defined to account for: 1) The daily integrated solar irradiation 2) The morning-afternoon asymmetry in solar irradiation and 3) the randomness of solar irradiation. Using these parameters, 5 station-based daily regimes of solar radiation have been defined (from cluster analyses): Clear, AM (morning) Clear, Overcast, PM (afternoon) Clear and Random. The occurrence of these regimes is studied in relation to trade wind directions and strengths. Finally, Island-based daily regimes of solar radiation are explored using the ensemble of measurements from the 21 ground stations. Seasonality is considered for all the analyses.

Results show that the trade wind characteristics are first-degree indicators of the solar radiation variability received over the island.