Geophysical Research Abstracts, Vol. 7, 05545, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05545

The influence of low-frequency climate variability in the renewable energy production: solar energy and hydroelectricity

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A considerable amount of the low frequency climatic variability (from years to decades) observed over the North Atlantic region can be associated with a quasi-oscillatory climatic phenomenon called the North Atlantic Oscillation (NAO). The phase of this quasi-oscillation is associated with basin-wide changes in the intensity and location of the North Atlantic jet stream and storm track, and changes in the patterns of zonal and meridional heat and moisture transport from the Atlantic Ocean to the continental areas of Europe. Particularly, the NAO accounts for a large amount of the precipitation and cloud cover variability which takes place in Europe on interannual scales.

We analyze the influence of the NAO on the solar radiation spatio-temporal variability over the European continent. We have also analyzed the impact of the NAO changes in the hydroelectricity generation in the Iberian Peninsula, one of the areas most influenced by the NAO as far as precipitation is concerned. For this purpose, we use observed monthly sums of sunshine duration, a proxy for global solar radiation, short

wave downward solar flux reanalysis data and cloud cover data. Total potential hydroelectric production (PHP) of the entire Spanish hydroelectric production system from December through March has been also analyzed for the period that spans between 1923 and 1998.

Results show, firstly, that the NAO is the main responsible for the solar radiation interannual variability in Europe and that solar radiation in Northern and Southern Europe can change as much as 30% from winter to winter due to changes in the phase of the NAO, with the subsequent implications regarding a proper design of the solar-based energy production facilities. Secondly, that PHP shows, during the positive phase of the NAO, an average decrease of 25% (around 925 GWh below the mean, which is 4049 GWh). On the other hand, during the negative phase of the NAO, an average increase of 30% (1254 GWh above the mean) can be anticipated.

Finally, it is believed by the authors that the notably development that renewable energy will have in the next years, under the support of the European Union, merits more research on this field.