UNDERSTANDING REGIONAL CLIMATE VARIABILITY FOR SOLAR ENERGY DEVELOPMENT IN WEST AFRICA

KEY INFORMATION

Institution **University Grenoble Alpes**
Doctoral School **Earth, Universe, Environment**
Specialty **Ocean, Atmosphere, Hydrology**
Research unit Institute **of Environmental Geosciences**
Director of the thesis Sandrine *ANQUETIN Co-supervisor* Arona DIEDHIOU
Funding
from 01-10-2017 to 30-09-2020 *Source of funds:* **MESR**
Employer: **UGA**
Contest for a doctoral contract
Beginning of the thesis on **1 October 2017**
Application **deadline May 31, 2017**

- French version
- French Version

Understanding regional climate variability for solar energy development in West Africa

Keywords

Regional Climate Processes, Energy Transition, West Africa

Profile and skills required

The candidate must hold a Master 2 and have the following qualities:
- Knowledge of hydrometeorology and atmospheric physics;
- Strong knowledge of statistics;
- Interest and ease in the numerical calculation and manipulation of digital files;
- Attractiveness for West Africa;
- Curiosity and interest to work on a topic at the climate-society interface and vulnerability to climate change;
- Fluency in English recommended and editorial quality for dissemination of results;
- Autonomy and taste of team work.

Description of the research problem

Since the Paris Agreement, solar energy development projects in Africa have met with increasing interest from the states and industrialists in this new market. However, in the sub-Sahelian regions along the coast of the Gulf of Guinea, cloud cover and desert dust may constitute real

obstacles to the development of solar energy and very few studies are interested in the variability Of the cloud cover of this tropical region in this perspective [1, 2, 3, 4].
Indeed, unlike the Sahel, where nearly 20 years of observation were crowned by the AMMA program, they have gained a good knowledge of convection in these regions, in the southern Sahel, since the COPT experiment in 1981 (in the Sudanian zone In Korhogo, North Côte d'Ivoire), There have been no observational surveys and very few studies have investigated the variability of convection and cloud systems that would characterize the cloudiness in these regions and the impact on surface solar radiation .
Systems cloudy outside the rainy season remain little studied in West Africa. During the rainy season, unlike the Sahelian regions where there was a lot of studies and where 80% of the rain is explained by convective mesoscale systems that spread from east to west mainly from May to October, Sub-Sahelian regions, meteorology is more complex with alternating (i) low layer clouds that appear to be related to moisture flows from the Atlantic over the Gulf of Guinea, (Ii) deep cloud systems that propagate from east to west, and (iii) local convection connected to continental surface states.

The share of these three types of cloud systems in the variability of cloudiness in the sub-Sahelian region is still unknown, as well as their past and future evolution. West-wide satellite cloud classifications exist [5], but they must be confronted with radiosondage and few studies have addressed the climatology of these different cloud systems in this perspective. Similarly, the atmospheric factors associated with their occurrence and their life cycle are still poorly known, as well as the surface solar radiation associated with each type of cloud system [6,7]. Global models still have difficulty in adequately representing cloud systems in these regions and their evolution, and in particular those of low layers [8]. An advanced hypothesis is the role of the continental and oceanic boundary layer poorly represented in the GCMs but also the influence of ocean-continent surface gradients on the triggering and variability of these different types of cloud systems. Hence the value of using regional climate models with better characterization of surface states as envisaged in this thesis project [9,10]. The predictability of cloud variability and surface solar radiation remain a challenge for the development of solar energy, both in the dry season and in the rainy season [11, 12, 13].
In this perspective, the aim is to use the satellite cloud classifications developed by IPSL to (i) document the atmospheric re-analysis of the synoptic environment associated with the different cloud systems encountered in the sub-Sahelian zone; (Ii) using high-resolution simulations of the WRF-NEMO coupled regional model to evaluate the model's ability to reproduce the environment of these different types of cloud systems and to make assumptions about the factors And (iii) using the MAR model of the IGE to test these hypotheses by studies of sensitivity to surface conditions and ocean-continent gradients. At each step,

Context

This thesis will be conducted within the Hydrometeorology, Climate and Interactions with Societies (HMCIS) team of the Institute of Environmental Geosciences (IGE) of Grenoble.It will benefit from the complementary expertise of the two supervisors, Sandrine Anquetin, Hydroclimatologist, Atmosphere physicist, and Arona Diedhiou, Climatologist, specialist in regional climate in West Africa. This thesis project is part of two initiatives carried out by the

team.
The first concerns the coordination of the modeling platform under the international CORDEX-2 program, Flagship Pilot Studies, where it is necessary to coordinate regional climate simulations conducted by the international partners in close interaction with the Ivorian partners to carry out Studies, Evolution of water resources in West Africa.
This work is being carried out jointly by Arona Diedhiou, currently expatriated in Côte d'Ivoire and Sandrine Anquetin, who will benefit from a long-term mission in Abidjan in 2017. The second project concerns the ERACSES project, a European project currently under evaluation and Coordinated by Arona Diedhiou. This project aims to set up various climate services to help develop intermittent renewable energies in West Africa (prospective aspects for designing energy mixes for different configurations of electrical systems (grids, mini grids, systems Autonomous outside grids) Their integration into the current electrical system (operational aspects of forecasting and assistance in the management of hydroelectric resources impacted by the future development of solar and wind power).
In Côte d'Ivoire, this thesis falls within the priorities of the Center of Excellence "Climate Change, Biodiversity and Sustainable Agriculture" of the Félix Houphouët Boigny University (UFHB) financed by the World Bank and where the IGE and LAPA- MF (Laboratory of Atmospheric Physics and Fluid Mechanics, UFHB) are planning this year to set up a Young Team Associated with the IRD on the theme of climate services for various sectors including that of energy.
In France,

Precision on framing

A thesis committee will accompany the follow-up of this thesis.

Scientific conditions (specific safety conditions)
and financial aspects of the research project

The thesis will be conducted mainly in Grenoble within the Institute of Environmental Geosciences. Missions in Abidjan are planned and do not require a specific security condition

Objectives of valorization of the research work of the doctoral student: dissemination, publication and confidentiality, right to intellectual property, ...

The results of the thesis work will be disseminated widely through communications at international congresses and publications in international newspapers.

References

[1] Patt, A., Pfenninger, S., & Lilliestam, J. (2013). Vulnerability of solar energy infrastructure and output to climate change. Climatic change, 121 (1), 93-102.
[2] Ohunakin, OS, Adaramola, MS, Oyewola, OM, Matthew, OJ, & Fagbenle, RO (2015). The effect of climate change on solar radiation in Nigeria. Solar Energy, 116, 272-286.
[3] Wild, M., Folini, D., Henschel, F., Fischer, N., & Müller, B. (2015). Projections of long-term changes in solar radiation based on CMIP5 climate models and their influence on energy yields of photovoltaic systems. Solar Energy, 116, 12-24.
[4] Dajuma, A., Yahaya, S., Toure, S., Diedhiou, A., Adamou, R., Konaré, A., & Golba, M. (2016). Sensitivity of Solar Photovoltaic Panel Efficiency to Weather and Dust over West Africa: Comparative Experimental Study between Niamey (Niger) and Abidjan (Ivory Coast).
[5] Hill, PG, Allan, RP, Chiu, JC, & Stein, TH (2016). A multisatellite climatology of clouds, radiation, and precipitation in southern Africa. Journal of Geophysical Research: Atmospheres,

121 (18).
[6] Kasten, F., & Czeplak, G. (1980). Solar and terrestrial radiation dependent on the amount and type of cloud. Solar energy, 24 (2), 177-189.
[7] Dave, JV, & Braslau, N. (1975). Effect of cloudiness on the transfer of solar energy through realistic model atmospheres. Journal of Applied Meteorology, 14 (3), 388-395.
[8] Hannak, L., Knippertz, P., Fink, AH, Kniffka, A., & Pante, G. (2016). Why Do Global Climate Models Struggle to Represent Low-Level Clouds in the West African Summer Monsoon? Journal of Climate, (2016).
[9] Klutse, NAB, Sylla, MB, Diallo, I., Sarr, A., Dosio, A., Diedhiou, A., & Owusu, K. (2016). West African summer monsoon precipitation in CORDEX simulations. Theoretical and Applied Climatology, 123 (1-2), 369-386.
[10] Pohl, B., Ramarohetra, J., Sultan, B., Diedhiou, A., De Coëtlogon, G., Janicot, S., ... & Fontaine, B. (2013, January). Downscaling West African climate: uncertainties, sensitivity to the model physics and regional variability. In Atmosphere Modeling Workshops 2013: Continental Surface Modeling & Intrasasonal Variability and Predictability.
[11] Armstrong, S., & Hurley, WG (2010). A new methodology to optimize solar energy. Renewable Energy, 35 (4), 780-787.
[12] Kosmopoulos, PG, Kazadzis, S., Lagouvardos, K., Kotroni, V., & Bais, A. (2015). Solar energy prediction and verification using operational model and solar measurements. Energy, 93, 1918-1930.
[13] Kazantzidis, A., Nikitidou, E., Salamalikis, V., Tzoumanikas, P., & Zagouras, A. (2017). New challenges in solar energy resource and forecasting in Greece. International Journal of Sustainable Energy, 1-8. Solar energy prediction and verification using operational model and solar measurements. Energy, 93, 1918-1930. [13] Kazantzidis, A., Nikitidou, E., Salamalikis, V., Tzoumanikas, P., & Zagouras, A. (2017). New challenges in solar energy resource and forecasting in Greece. International Journal of Sustainable Energy, 1-8. Solar energy prediction and verification using solar measurements. Energy, 93, 1918-1930. [13] Kazantzidis, A., Nikitidou, E., Salamalikis, V., Tzoumanikas, P., & Zagouras, A. (2017). New challenges in solar energy resource and forecasting in Greece. International Journal of Sustainable Energy, 1-8.
Beginning of the thesis on 1 October 2017
Last updated on March 22, 2017