Solar resource assessment and forecasting in Uruguay using GOES-East satellite images

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Geostationary satellite images provide valuable information on the state of the Earth's atmosphere. One of the multiple applications of these images is to estimate downward solar irradiance at ground level [1,2,3]. Based on GOES-East satellite images and local ground measurements, a satellite-based solar irradiance model was implemented in Uruguay some years ago [4,5], and has recently led to the second version of Uruguay's solar map [6]. This new map, based on 17 years of satellite images and 5 years of local measurements, significantly improves the spatial resolution and uncertainty with which the local long-term solar resource is known. Images can also be used to nowcast solar irradiation up to 5-6 hours ahead [7,8,9]. Due to the high intermittence of solar irradiation caused by the cloudiness, accurate forecasting of the solar energy is one of the main obstacles to increase its contribution into electricity grids [10]. The key part of a satellite-based nowcasting methodology is the estimation of the cloud motion field (CMF), which is derived from the previous and the present time images. Then, the CMF is used to predict the next images, that are converted to a solar irradiation forecast using the satellite-to-irradiation model. We are currently developing a technique for cloud motion estimation based on an Optical Flow algorithm that introduces regularization terms for the displacement vector field on its formulation. This technique follows very recent advances in Optical Flow estimation. Results show that the approach is promising for hourly solar forecasting.

[1] Pinker, R., and Laszlo, I., 1992. Modeling surface solar irradiance for satellite applications on global scale. J. Appl. Meteorol., 31, pp. 194–211.

[2] Perez., R., 2012. A new operational model for satellite-derived irradiances: description and validation. Solar Energy, 73, pp. 307–317.

[3] Rigollier, C., 2004. The method heliosat-2 for deriving shortwave solar radiation from satellite images. Solar Energy, 77, pp. 159–169.

[4] Alonso-Suárez, R., Siri, R., Abal, G. and Muse, P., 2011. Global solar irradiation assesment in Uruguay using Tarpley's model and GOES-satellite images. Proceedings of ISES Solar World Congress 2011, Resource Assessment, pp. 162-173.

[5] Alonso-Suárez, R., Abal, G., Siri, R., and Musé, P., 2012. Brightness-dependent Tarpley model for global solar radiation estimation using GOES satellite images: Application to Uruguay. Solar Energy, 86-11, pp. 3205-3215.

[6] Alonso-Suárez, R., Abal, G., Musé, P., and Siri, R., 2014. Satellite-derived Solar Irradiation Map for Uruguay. Energy Procedia, 57, pp. 1237-1246.

[7] Perez, R., and Hoff, T.E., 2013. Chapter 10 - SolarAnywhere Forecasting, In Solar Energy Forecasting and Resource Assessment, edited by Jan Kleissl, Academic Press, Boston, pp. 233-265.

[8] Diagne, M., David, M., Lauret, P., Boland, J., and Schmutz, N., 2013. Review of solar irradiance forecasting methods and a proposition for small-scale insular grids. Renewable and Sustainable Energy Reviews, 27, pp. 65-76.

[9] Inman, R., Pedro, H., and Coimbra, C., 2013. Solar forecasting methods for renewable energy integration. Progress in Energy and Combustion Science, 39-6, pp. 535-576.

[10] IEA publication. Technology Roadmap: Solar Photovoltaic Energy, 2014 edition.