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High resolution climatology
- towards climate change services

A computer vision approach for solar radiation nowcasting using MSG images

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Cloud structures and haze are the two main atmospheric phenomena that reduce the performance of solar power plants, since they absorb solar energy reaching terrestrial surface. Thus, accurate forecasting of solar radiation is a challenging research area that involves both a precise localization of cloud structures and haze, as well as the attenuation introduced by these artifacts.

Our work presents a novel approach for nowcasting services based on image processing techniques applied to MSG satellite images provided by the EUMETSAT Rapid Scan Service (RSS) service. These data are an interesting source of information for our purposes since every 5 minutes we obtain actual information of the atmospheric state in nearly real time. However, a workaround must be given in order to forecast solar radiation.

To that end, we synthetically forecast MSG images forecasts from past images applying computer vision techniques adapted to fluid flows in order to evolve atmospheric state.

First, we classify cloud structures on two different layers, corresponding to top and bottom clouds, which includes haze. This two-level classification responds to the dominant climate conditions found in our region of interest, the Canary Islands archipelago, regulated by the Gulf Stream and Trade Winds. Vertical structure of Trade Winds consists of two layers, the bottom one, which is fresh and humid, and the top one, which is warm and dry. Between these two layers a thermal inversion appears that does not allow bottom clouds to go up and naturally divides clouds in these two layers.

Top clouds can be directly obtained from satellite images by means of a segmentation algorithm on histogram heights. However, bottom clouds are usually overlapped by the former, so an inpainting algorithm is used to recover overlapped areas of bottom clouds.

For each layer, cloud motion is estimated through a correlation based optic flow algorithm that provides a vector field that describes the displacement field in each layer between two consecutive images in a sequence. Since RSS service from EUMETSAT provides images every 5 minutes (Δt), the cloud motion vector field between images at time t_0 and $(t_0 - \Delta t)$ is quite similar to that between $(t_0 - \Delta t)$ and $(t_0 - 2\Delta t)$. Under this assumption, we infer the motion vector field for the next image in order to build a synthetic version of the image at time $(t_0 + \Delta t)$. The computation of this future motion vector field takes into account terrain orography in order to produce more realistic forecasts. In this sense, we are currently working on the integration of information from NWP outputs in order to introduce other atmospheric phenomena.

Applying this algorithm several times we are able to produce short-term forecasts up to 6 hours with encouraging performance. To validate our results, we use both, comparison of synthetically generated images with the corresponding images at a given time, and direct solar radiation measurement with the set of meteorological stations located at several points of the canarian archipelago.