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Tracking fog dissipation processes through trends in satellite observations

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Fogs and very low stratus clouds impact photovoltaic production, visibility, air quality and transports. The study of physical processes driving their intraday life cycle is of high scientific interest, especially their spatio-temporal patterns at local and regional scales. In contrast to weather forecasts based on numerical models, this work explores a new observation-driven and process-oriented approach aiming at providing support for fog and low stratus intraday forecasting.

Geostationary satellites provide time series of fog and low stratus spatial heterogeneity and extent. Studying low-altitude layers of the atmosphere remains nevertheless challenging because of frequent occurrence of high-altitude clouds. To overcome this, a multi-pixel analysis is used to provide continuous tracking of both clear and cloudy pixels. In addition, a refined segmentation of cloud types is done to gather pixels into dynamical classes and study their spatially-averaged temporal evolution.

Coherent groups of geostationary satellite observation-based variables are defined to track (temporally and spatially) physical processes that drive fog and stratus dissipation: (1) surface warming feedback (from below) based on variations of IR brightness temperature; (2) transparency of clouds is tracked based on a normalized cloud albedo; (3) high-altitude cloud warming feedback (from above) is tracked through variations of classified pixel fractions; (4) advection (from aside) is tracked through the shift of fog edge. Temporal behaviours of these variables are analysed: fog dissipation is characterized by significant trends, while fog persistence translates into flat signals due to lack of trend.

Statistics of density of probability and correlations between variables are calculated in order to try to identify recurrent schemes of evolution. Satellite variables identified as having a potential for some photovoltaic predictive applications are compared to corresponding variables based on ground observations, in order to assess their ability to estimate local conditions at ground level directly from space. Complementary information is also provided by ground instruments to support interpretation of the results in terms of processes.

This presentation will describe the methodology and provide a quick overview of the data – 126 fog and low stratus cloud cases characterized from geostationary satellite and SIRTA research atmospheric observatory near Paris, France. Representative examples of scenarios of evolution of fog will be presented, followed by a statistical assessment of the anticipation capability of the method given different scenarios. The following questions will be addressed in the conclusions: (1) Do selected variables present values that contrast clearly dissipation from persistence of fog? (2) What is the predictability potential according to duration of anticipation?