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Tracking fog dissipation processes through trends of satellite indicators

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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 life cycle is of scientific interest, in particular the spatio-temporal patterns and configurations of these processes at local and regional scales. However, weather forecasts of fog and stratus clouds based on numerical models face accuracy issues even for intraday predictions. Their formation and dissipation are very sensitive to initial conditions and small variations of physical parameters, which are often not enough spatially constrained by data from meteorological stations and other remote-sensing instruments. 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 geo-satellite indicators 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 reflectance; (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. These processes are tracked by analyzing temporal behaviors of indicators. Fog dissipation is characterized by significant trends in one or more indicators, while fog persistence translates into flat signals due to lack of trend. Satellite indicators identified as having a potential for some photovoltaic predictive applications are compared to corresponding indicators based on ground observations, in order to assess their ability to estimate local conditions at ground level directly from space. Some 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 – 130 fog and low stratus cloud cases characterized from geostationary satellite and a research atmospheric observatory near Paris, France. Representative examples of scenarios of evolution of fog will be presented, followed by an assessment of the anticipation capability of the method given different scenarios. The following questions will be addressed in the conclusions: (1) Do indicators present values that contrast clearly dissipation from persistence of fog? (2) What is the predictability potential according to duration of anticipation?