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Methodology and synergetic approach to better understand and forecast the fog life cycle based on ground-based remote sensing instruments and in-situ sensors.

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Low visibility during fog events is a result of complex radiative, turbulent and microphysical processes as well as interactions between the atmospheric boundary layer (ABL) and the underlying surface. The mechanisms of fog formation, development and dissipation are very complex and have been extensively studied with a series of numerical simulations and comprehensive observational programs including in-situ measurements and remote sensing instruments.

Our study is based on multiple observation sources. Firstly, backscatter profiles of ceilometer (and automatic lidars) to trace aerosol hydration in clear atmosphere, a precursor to fog formation, and the transition from fog to low stratus. In Europe, these ceilometers are found every 100km, and in some areas every 10km. Secondly, Doppler lidar and sodar to trace the vertical structure of dynamics (wind speed, TKE, CT2) and identify thresholds leading to clear-sky stratification or fog dissipation. Thirdly, cloud radar and microwave radiometer measurements can accurately characterize processes within the fog layers. The radar retrieves high-resolution profiles of reflectivity and Doppler velocity, while scanning cloud radars can perform 3D observations of these quantities. Radars and radiometers are deployed on about fifteen super-sites in Europe as part of the ACTRIS research infrastructure that strives to improve instrument calibration and data quality. These devices will likely become more numerous in the future.

We present three major results, (1) the Parafog algorithm that uses the temporal evolution of attenuated backscatter measurements to derive pre-fog formation alerts, (2) a tool to estimate vertical profiles of fog properties combining one calibrated cloud radar and in-situ granulometer to better document and understand the physical processes, and (3) some preliminary results concerning the turbulence parameters that can have a significant impact on the fog life cycle, based on more than 100 fog events observed at the SIRTA observatory (Palaiseau, France).

This instrumental synergy provides us the opportunity to better document the spatiotemporal heterogeneities of fog at several scales, thus enabling us to progress in the development of a decision support tool for nowcasting of formation and dissipation of radiative fog and stratus lowering fog. Such a tool would be complementary to prediction tools based on NWP models.