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Thermal inversion influence on the mixing layer height during a record pollutant event at Paris megacity

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A network composed of three CL31 ceilometers was deployed along a 40-km South-West to North-East transect across the Paris megacity (France). This network together with information obtained from the SIRTA observatory (Doppler lidar, microwave radiometer and radiosondes) is used to monitor the atmospheric column during a record-high pollution event that occurred from 29^{th} November to 7^{th} December 2016 in Paris. The AIRPARIF network (in charge of the air quality monitoring of the Paris region) reported peak daily mean PM10 concentrations close to 150 μg/m^3 at several stations in Paris city center during this event, which is the largest value observed in the past decade. At SIRTA, located 20 km away from Paris center, hourly PM10 concentrations rose up to 80 μg/m^3.This event presented among the largest PM10 concentrations in the center of Paris in the last decade.

Microwave radiometer measurements allowed us to study atmospheric stability based on the high temporal resolved temperature profile. To this aim, we developed a new methodology which quantifies the thermal inversion strength through two parameters explained below. Assuming a thermal inversion, we define T_{max} as the local maximum of the temperature profile below 2 km at height R(T_{max}). According to the parcel's method, to allow a surface air mass of temperature Tsurf to rise to R(T_{max}), its temperature must be raised to the adiabatic temperature of T_{max}, named θ_{max}. The parameter we define to evaluate the atmospheric stability, called inhibitor parameter, is the difference between θ_{max} and T_{surf}. We observe that the thermal inversions prevented mixing layer development confining the aerosol load near the surface. This fact together with low wind speed due to high pressure caused the large PM concentration at surface level in the Paris megacity. The spatial distribution of the ceilometer network allows us to extrapolate the analysis performed at SIRTA to the Paris regional dimension. This study highlights the relevance of the synergetic combination of backscatter and Doppler lidars and microwave radiometer measurements, providing a deeper understanding of the relationship between the dynamical processes and the PM concentration at surface level.