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Advection fog and its microphysical properties: A case study in Tianjin, China

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Fog is an atmospheric phenomenon with a certain thickness and vertical structure. Traditional field observations of fog microphysics are usually carried out on the ground, so only the knowledge about the bottom of the fog layer is obtained. In the winter of 2016/2017, a field experiment focused on the microphysical properties of the advection fog was conducted in Tianjin. With the data set of fog droplet spectrum at 66 m height above the ground and the atmospheric boundary layer observation from a 250 m meteorological tower, the life cycle phases of two advection fog events occurring successively after severe haze were objectively differentiated by the use of non-parametric change-point detection and trend tests. The main objective is to reveal the observational characteristics of the microphysics and size distribution of fog droplets at a certain height inside the fog layer, and the relation with fog evolution.

The results show that the non-parametric test method combined with subjective discrimination can objectively determine the exact moment of the phase change points of advection fog evolution. The saturated layer first formed in the air and expanded to the ground, and then the microphysical parameters at 66 m height changed in quasi-synchronism with the ground visibility. The mature phases of the fog events were accompanied by the southwest warm and moist air, and the temperature increased within the tower height, and the fog layer is under weak unstable or nearly neutral conditions. At the sampling height, the high concentration of fog droplets appeared at the beginning of the mature phases. The liquid water content and characteristic diameter continued to increase during the mature phases, and reached the maximum value before the end of mature phases, but at this time, the concentration of the droplets decreased, and the surface visibility slightly increased. During the entire fog period, although the characteristic parameters had low value, large droplets had always existed. During the fog life cycles, the numbers of droplets with different size increased and decreased synchronously, the interaction between the droplets is weak, and the effect of droplet evaporation in the dissipation phases is obvious.