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Impact of Turbulence on Radiation Fog

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Fog is a common weather phenomenon occurring in the boundary layer, and its formation, development, and dissipation are closely related with the air motion and the radiation balance of the boundary layer. The transition period between autumn and winter (November-December) is the time period of the highest fog frequency in one year in Nanjing, China. Turbulence characteristics within the surface layer and its impact on radiation fog in the north suburb of Nanjing City in autumn-winter season were analyzed using the boundary layer comprehensive observations at a site in Nanjing University of Information Science and Technology (NUIST) from 13 December to 15 December 2007. A three-dimensional sonic anemometer-thermometer instrument(CSAT3, Campbell, USA) with a sampling frequency 10 Hz was used in the experiment to measure the fluctuations of u, v, w components and acoustic virtual temperature, and a Fog Monitor(FM-100) to measure the fog particle size spectrum, and a automatic weather system to measure temperature, humidity and wind near the surface.

The critical turbulent exchange coefficient (Kc) was used to analyze these two fog processes, and found that Kc was larger than the actual turbulence exchange coefficient (K) in the formation, development, and mature fog stage, but smaller than K before the fog formation. This parameter can be used to forecast the formation of radiation fog. The explosive strengthen of the radiation fog corresponds with the obvious increase in turbulence intensity. Stronger turbulence is beneficial to produce larger droplets, broaden the fog particle size spectrum, and heighten the fog layer. During the fog development stage, the fog explosively strengthens near the surface first, and then explosively heightens. Based on the synthesized analysis of turbulence, radiation, macro- and microphysics parameter, it is found that longwave radiation is the main factor for cooling and condensation during the development of radiation fog, the turbulence caused by droplets condensation is the dynamic factor to increase the vertical development of fog, but the near-surface layer warming and turbulent motion caused by increasing solar shortwave radiation directly prompts the fog dispersal.