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Characteristics of Atmospheric Boundary Layer during a Dense Fog over the Bohai Rim

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A dense coastal fog episode that occurred over the Bohai Rim on 18-19 November 2016 is investigated. The coastal fog patch, with a spatial scale of 900 kilometers from Hebei to Jilin province with southwest-northeast direction along the west coastline of the Bohai, the width of fog region from 100 km along coastal areas at its formation stage to the whole Bohai area and the north-west of the Yellow sea at its mature stage, reduced visibility to 133m or much less. The fog is a kind of special weather phenomenon and is closely related with structures of the atmospheric boundary layer. Based on Himawari8 satellite, NCEP reanalysis data and Various boundary data such as surface and offshore platform observations, wind profile radar, microwave radiometer, five layer eddy correlation , three Four-component radiation and Tianjin boundary gradient observation, we analyze the dense Fog. The analysis indicates that the fog can be categorized as frontal cooling fog with fog top up to 700m. Due to the stable westerly wind of the bottom of the polar clod cyclone and high-pressure system locating at the East Sea in China, southwesterly warm/moist advection resulted to longtime inversion high to 1500m. With the passage of western weak cold front coming together night long wave radiation cooling, the fog occurs at inland areas firstly before dawn, then extends to offshore and occupies further to the north of the Yellow sea finally, although the local Air-sea temperature difference is up to 7 Celsius. The fog belt is 600km far away from the LLJ and moves to the east along with LLJ withdrawing eastward. The longtime fog is comprised of different state, thin fog about 80m thickness, fog and low cloud separation, fog and low cloud coupling. Fog thickness is about 200m and the top of low cloud extending 700-1,200m during the latter two stages. Only strong single ground inversion layer existed during the thin fog. While two strong inversion layer showed during the fog/low clouds separation and coupling phase, with another low-altitude inversion layer steadily suspending at 0.3-1km layer. The existence of ground inversion is the necessary condition for fog formation. The height of fog/low clouds is closely related to the thickness of inversion. Fog concentration is no direct relationship to the intensity and thickness of the inversion. Ground inversion is stronger during separation state comparing to the coupling of fog and low cloud. The longwave radiation is nearly balance in the thick fog/cloud. From the vertical turbulent energy transmission during three phases, due to its nearly neutral stability inside the fog while weakly unstable stratification at the bottom of the cloud, the sensible heat exchange in fog is nearly zero. And the latent heat exchange of the higher layer is larger than the lower layer.