8th International Conference on Fog, Fog Collection and Dew
Taipei, Taiwan, 14–19 July 2019
IFDA2019-46

The boundary layer character of spring sea fog inland penetration over the coastal area of Qingdao

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Sea fog refers to the fog that takes place under the oceanic effects and occurs worldwide, including over open sea and coastal areas. Sea fog sometimes penetrates inland, the low visibility will influence on traffic along the coast or on the bridge and aircraft landing, leading to insecurity and economic loss. On the other hand, sea fog inland penetration brings liquid water vapor to land and benefits terrestrial ecosystems in the coastal arid and desert regions. Therefore, understanding and predicting this phenomenon, which we term as sea fog penetration (SFP) hereinafter, is important for human activity and ecosystem over the coastal regions. The sea fog could be directly transported into land by sea breeze especially, which is caused by land warming during daytime. Besides, the land warming increases temperature and atmospheric instability and decreases relative humidity (RH), preventing sea fog from maintaining on land and marching inland from the coast.

Yellow Sea is a foggy area particularly in spring, where about 80%-90% of sea fog belongs to advection fog (Wang 1985). Many previous studies investigate the mechanisms for formation, continuation and dissipation of sea fog here (Gao et al. 2007, Zhang et al. 2009, 2012, Heo and Ha 2010, Kim and Yum 2010). Sometimes sea fog would penetrate inland over tens of kilometers (Jiang et al. 2008), covering nearly half of Qingdao region and affecting inland traffic safety seriously. Yet only a few studies focus on the SFP. Even Sun et at. (2017) found that the one with warmer and moister advection, in conjunction with intensified radiative cooling effect at fog-top can move into land farther, compared two springtime SFP events in Qingdao. However, we do not know either the statistically characteristics or the climatological characteristics associated with different intensity of SFP.

The present study uses observations of automatic weather stations (AUWES) to detect the inland penetration of sea fog, combined with several sets of observation and reanalysis, to quantitatively analyze the general features and preferable climatological boundary layer conditions of SFP. Our investigation wish to address the question that what is the key factor related to the intensity of springtime SFP in Qingdao? The results emphasize the humidifying, rather than cooling, plays a crucial role in the initial process of springtime SFP in Qingdao coastal region. This work promotes the forecast of SFP and helps to advance the knowledge of the SFP mechanism.