

## **Atmospheric Conditions for Advection-Radiation Fog Over the Western Yellow Sea**

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Advection fog occurs usually when warm and moist air flows over cold sea surface. The classic view thinks that cooling of unsaturated air by relatively cold sea surface causes advection fog and thus the air temperature is usually higher than sea surface temperature in advection fog. However, it is occasionally reported that the fog air temperature falls below sea surface temperature (called here the sea fog with sea surface heating [ssH]) due to longwave radiation cooling at fog top. Using 8-year buoy observations, this study reveals that about 33% of the time, the advection fog is with ssH in the western Yellow Sea. By synthesizing long-term observations from meteorological stations, atmospheric soundings, and offshore buoys, this study further investigates the marine atmospheric boundary layer (MABL) structure and atmospheric circulation associated with the ssH sea fog. Composite analysis shows that a local anomalous high pressure favors widespread formation of the ssH sea fog. The subsidence in the high pressure intensifies the thermal and moist stratification between the MABL and free atmosphere through adiabatic warming. The dry air above helps cool the fog layer by enhancing the longwave radiative cooling at the fog top and the vertical mixing beneath, causing air temperature to drop below sea surface temperature. The ratio of sea fog with ssH to total sea fog decreases from spring to summer as the descending motion and MABL stratification both weaken. This study highlights the importance of longwave radiative cooling at the advection fog top and suggests a way to improve sea fog forecast in the Yellow Sea.