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Detection of Fog Involving Heavy Pollutants by Using the New Geostationary satellite Himawari-8

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Himawari-8 is the new geostationary satellite of the Japan Meteorological Agency (JMA) and carries the Advanced Himawari Imager (AHI), which is greatly improved over past imagers in terms of its number of bands and its temporal/spatial resolution. In this work, two different methods for the detection of the different levels of fog involving heavy pollutants by using the Himawari-8 were developed in China. The two different methods are the method of the difference between the 11.2 mm and 3.9 mm brightness temperatures ($BTD_{3.9\text{-}11.2}$) and the method of 3.9 mm Pseudo-Emissivity ($ems_{3.9}$). The 3.9 mm Pseudo-Emissivity is the ratio of the observed 3.9 mm radiance and the 3.9 mm blackbody radiance calculated using the 11.2 mm brightness temperature. We identified the parameters optimal threshold at the 2400 stations and the grid points using the $BTD_{3.9\text{-}11.2}$ and $ems_{3.9}$ for different levels of fog involving heavy pollutants. Results on land and sea from the two methods were compared with surface observations from 2400 weather stations in China and CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation) VFM (Vertical Feature Mask) products. The results show that both the method of $BTD_{3.9\text{-}11.2}$ and the method of $ems_{3.9}$ can accurately identify the different levels of fog involving heavy pollutants and the accuracy of $ems_{3.9}$ method is slightly better than the $BTD_{3.9\text{-}11.2}$. The accuracy of two methods has increased significantly and the false alarm rate has significantly decreased with the decrease of the visibility. When the visibility is less than 50 m, the HR, FAR and KSS of the $BTD_{3.9\text{-}11.2}$ method (the $ems_{3.9}$ method) were 0.89 (0.90), 0.15 (0.15) and 0.74 (0.75), respectively. When mid- or high-level clouds were removed using surface temperature of the ground observations, the HR and KSS of two methods for the different levels of fog has increased significantly, and the FAR has significantly decreased. When the visibility is less than 1000 m, the HR of the $BTD_{3.9\text{-}11.2}$ method (the $ems_{3.9}$ method) is increased to 0.81(0.85) from 0.71 (0.74), the FAR is decreased to 0.12 (0.13) from 0.27 (0.28), and the KSS is increased to 0.69 (0.72) from 0.44 (0.46). The KSS of two method increase by 0.23 and 0.26, respectively. Three cases analysis show that the fog area can be clearly identified by using the $BTD_{3.9\text{-}11.2}$, $ems_{3.9}$ and RGB composite image. The results of the detection of sea fog by using Himawari-8 data and using CALIPSO VFM products have consistency.