An Improved Method for Assimilating MTSAT-Derived Humidity in Nowcasting Sea Fog over the Yellow Sea

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In our previous study, an extended three-dimensional variational data assimilation (3DVAR) method based on the Weather Research and Forecasting Model (WRF) was developed to assimilate satellite-derived humidity from sea fog at its initial stage over the Yellow Sea. The sea fog properties, including its horizontal distribution and thickness, are retrieved empirically from the infrared and visible cloud imageries of the Multifunctional Transport Satellite (MTSAT). Assuming a relative humidity of 100% in fog, the MTSAT-derived humidity is firstly converted to absolute humidity (e.g., water vapor), and then assimilated by the extended 3DVAR assimilation method. Assimilation of the MTSAT-derived humidity can greatly improve the sea fog forecast area, and the improvement is attributed to a more realistic representation of the marine boundary layer (MBL) and better descriptions of moisture profiles. However, the MBL moisture is often overestimated due to lack of the limitation of temperature information within and outside fog, resulting in overpredicted fog area. In this study, in order to decrease the bias of moisture overestimation, the assimilation method is improved by putting extra temperature profiles that are statistically determined for sea fog area. For a typical advection sea fog case in April 2008, the new method makes improvement on the ETS (Equitable Threat Score) of forecasted fog area by 35%, owing to larger hit area and smaller false area. Additional data assimilation experiments of 10 sea fog cases show that the new method gets the average bias and ETS improved by 16.2% and 16.9% relative to the previous method.