Observational Quantification of Non-Gaussian Errors Within a Humidity-Temperature 1DVAR Retrieval System over Japan.

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The major assumption made in both variational and ensemble based data assimilations systems is that the background and observational errors are Gaussian distributed. 1DVAR humidity retrieval systems also make this assumption. One such system is the CIRA 1-Dimensional Optimal Estimator (C1DOE). This is a satellite microwave brightness temperature retrieval system that is designed to find the best Gaussian estimation for temperature and moisture. However, we know that moisture variables are not always Gaussian distributed throughout the year or across the whole domain of the Earth (e.g., humidity > 0%). However, assuming a Gaussian distribution for positive definite variables can allow unphysical negative values as a possible solution to the 1DVAR scheme. A logarithmic transform can be used to overcome this, but may not be consistent with the modal solution of the maximum likelihood estimation problem. In this work, we test three different approaches over Japan against a GPS network for validation, investigating seasonal variability. The three approaches are: 1) assumed Gaussian, 2) logarithmic transform and 3) the mixed Gaussian-lognormal distribution. Using each approach and the independent GPS validation data source, we quantify the observed non-Gaussian error behaviors.