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Improving strategies with constraints regarding non-Gaussian statistics in MOVE/MRI.COM

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The ocean data assimilation and prediction system, MOVE/MRI.COM, has been developed in Meteorological Research Institute of Japan Meteorological Agency (JMA), and has been used for the operation in JMA since March 2008. The system is composed of the ocean general circulation model (MRI.COM) and the data assimilation system with a variational analysis scheme (MOVE). In this study, we focus on the Mixed Water Region (MWR) off the east coast of Japan which exhibits complicated frontal structures. A Probability Density Function (PDF) of temperature innovation in the MWR shows a non-Gaussian shape particularly for the Oyashio water, mostly originated in error of front position in the first guess field. It is revealed that assimilated results with a standard 3DVAR scheme based on the Gaussian error assumption have some issues in the MWR due to the non-Gaussianity of errors. The assimilated Oyashio water sometimes becomes unrealistically cold. Double peaks seen in an observed subsurface temperature PDF at the MWR, representing the Kuroshio and Oyashio waters, are not reproduced. In order to reproduce the observed temperature PDF, we introduce two kinds of constraints to the cost function. One constraint is to prevent the unrealistically cold Oyashio water. The other is to reproduce the observed PDF with double peaks. The assimilated temperature PDF using these constraints is effectively improved. In addition, not only subsurface temperature but also whole level temperature and salinity (T-S) fields are improved by adopting these constraints to a multivariate 3DVAR scheme with vertical coupled T-S empirical orthogonal function modes.