Development of the optimal data assimilation system for the whole neutral atmosphere

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Observations in the mesosphere are sparser than those in the troposphere and stratosphere. Moreover, the model predictability is not sufficient to simulate behaviors of the mesosphere of the real atmosphere. Thus, global data in the real atmosphere including the mesosphere estimated by the data assimilation system is a key for quantitative evaluation of the momentum budget. However, such assimilation has not yet been common. The purpose of this study is to develop the assimilation system so as to make global data for a wide height range from the ground to the lower thermosphere. A conventional observation data set called PREPBUFR (available at https://rda.ucar.edu/datasets/ds337.0/) and satellite temperature retrieval data from Aura Microwave Limb Sounder (MLS; Livesey et al., 2017) were used for the assimilation.

We adopted the 4-D Local Ensemble Transform Kalman Filter (4D-LETKF) developed by Miyoshi and Yamane (2006). Relevant values of the parameters for the data assimilation system were examined. First, the model performance was improved by modifying the vertical profile of the horizontal diffusion coefficient and the source intensity in the gravity wave parameterization. Second, parameters were tuned by using three criteria of the assimilation performance. Parameters related to the treatment of observation data are the degree of gross error check and the localization length. Parameters related to the assimilation itself are the inflation factor, the assimilatoin window, and the number of ensemble members. The data assimilation was made for the time period from 10 January to 20 February 2017, when an international observation campaign called ICSOM (Interhemispheric Coupling Study by Observations and Modeling) was performed.

Next, the assimilation with the best parameter setting was performed. By comparing with the MLS observation and MERRA-2 reanalysis data for the available height region, it was confirmed that the obtained analysis data were plausible. The characteristics of the mean fields before and after the sudden stratospheric warming (SSW) event were roughly consistent with the proposed mechanism of an interhemispheric coupling initiated by the SSW (Körnich and Becker, 2010).

References

Körnich, H. and E. Becker, A simple model for the interhemispheric coupling of the middle atmosphere circulation, In Advances in Space Research, 45 (5), 661-668, 2010, ISSN 0273-1177, https://doi.org/10.1016/j.asr.2009.11.001.

Livesey, N. J., Read, W. G., Wagner, P. A., Froidevaux, L., Lam-bert, A., Manney, G. L., Valle, L. F. M., Pumphrey, H. C., San-tee, M. L., Schwartz, M. J., Wang, S., Fuller, R. A., Jarnot, R. F., Knosp, B. W., and Martinez, E., EOS Aura-MLS Version 4.2x Level 2 data quality and description document, JPL D-33509Rev. B, 1–164, 2017.

Miyoshi, T. and S. Yamane, Local Ensemble Transform Kalman Filtering with an AGCM at a T159/L48 Resolution. Mon. Wea. Rev., 135, 3841–3861, 2007, https://doi.org/10.1175/2007MWR1873.1.