Dynamical consistency of reanalysis data sets in the extratropical stratosphere

Patrick Martineau[1], Seok-Woo Son[2], and Masakazu Taguchi[3]

[1] *Department of Atmospheric and Oceanic Sciences, McGill University, Montreal, Canada*

[2] *School of Earth and Environmental Sciences, Seoul National University, Korea*

[2] *Department of Earth Sciences, Aichi University of Education, Japan*

The dynamical consistency of reanalysis data is evaluated in terms of stratospheric polar vortex variability. As a measure of consistency, the residue is defined as the zonal wind tendency that cannot be explained by the zonal-mean zonal momentum equation on a daily time scale. Both the Eulerian and transformed Eulerian mean equations are considered. In general, the residue is small in the lower stratosphere but increases significantly aloft in both hemispheres poleward of 45°, where the effect of parameterized gravity wave drag becomes important.

A significant inter-data spread in the residue is found at all levels in the stratosphere. This is mainly caused by uncertainty in the Coriolis torque acting on the ageostrophic meridional circulation. A comparison of early and more recent reanalysis data sets further revealed that the residue is significantly reduced over generations; i.e., from ERA40 to ERA-Interim, JRA25 to JRA55, and in NCEP data sets. This improvement results from a more adequate representation of the Coriolis torque and non-quasi-geostrophic terms. This result is largely insensitive to the period of analysis, indicating that the increase in satellite data assimilation over the past few decades does not significantly affect the momentum budget in the extratropical stratosphere.

The residue and momentum forcing terms are further examined during the vortex vacillation cycle, a quasi-periodic intensification and weakening of the polar vortex at 30 hPa. It is found that during the early deceleration and acceleration phases of the polar vortex, recent reanalysis data sets take a greater advantage of the non-quasi-geostrophic terms, such as vertical motion, to improve the dynamical consistency.

Key words: reanalysis data, polar vortex, momentum budget