

Momentum Budget of the Quasi-Biennial Oscillation in a GCM and Reanalyses

Young-Ha KIM¹ and Hye-Yeong CHUN¹

¹ *Yonsei University, Seoul, Korea*

Momentum forcing of the quasi-biennial oscillation (QBO) by equatorial waves is estimated using the HadGEM2 model and four recent reanalyses (ERA-Interim, MERRA, CFSR, and JRA-55). In HadGEM2, the QBO is internally simulated with realistic periods, driven by the model-resolved waves and parameterized gravity waves. The amplitude of the simulated QBO in the middle stratosphere is comparable with the observed, and that in the lower stratosphere is 30–40% smaller than the observed. The equatorial wave modes are identified based on their distinct characteristics associated with momentum and heat fluxes as well as their spatiotemporal scales. At the tropopause, the Kelvin waves and parameterized gravity waves (PGWs) transport westerly momentum into the equatorial stratosphere by ~ 0.35 and 0.8 mPa, respectively, while easterly momentum is carried primarily by the PGWs (~ 0.75 mPa). The resolved inertio-gravity (IG) waves transport both easterly and westerly momentum by ~ 0.2 mPa. The Kelvin waves induce zonal forcing in the lower to middle stratosphere by ~ 5 m s⁻¹ month⁻¹, and the PGWs provide forcing in the middle to upper stratosphere by ~ 17 m s⁻¹ month⁻¹. The forcing by the IG waves and mixed Rossby-gravity waves is small in HadGEM2. In the reanalyses, the momentum forcing by the resolved-scale equatorial waves is generally larger than that in HadGEM2, by $2\text{--}5$ m s⁻¹ month⁻¹ for Kelvin waves and by $1\text{--}2$ m s⁻¹ month⁻¹ for IG waves. It is suggested that the under-representation of the (resolved) equatorial wave forcing in HadGEM2 would be responsible for the small amplitude of the simulated QBO in the lower stratosphere, provided that the PGWs induce zonal forcing mainly in the middle to upper stratosphere. Finally, the uncertainties in the wave forcing estimates from the reanalyses are discussed.

Key words: QBO, equatorial wave, gravity wave, Kelvin wave