

ENSO modulation of the QBO: Results from MIROC models with and without nonstationary gravity wave parameterization

*Yoshio Kawatani¹, Kevin Hamilton², Kaoru Sato³, Timothy J Dunkerton⁴, Shingo Watanabe¹, Kazuyoshi Kikuchi²

1. Japan Agency for Marine-Earth Science and Technology, 2. International Pacific Research Center, University of Hawaii, 3. Graduate School of Science, The University of Tokyo, 4. Northwest Research Associates

Observational studies have shown that, on average, the QBO exhibits faster phase progression and shorter period during El Nino and slower progression and longer period during La Nina (e.g., Taguchi 2010). In order to investigate the possible mechanism of QBO modulations associated with ENSO, two sets of AGCM experiments were conducted. One employed the T106L72 MIROC-AGCM without non-stationary gravity wave parameterization and the other used the T42L80 MIROC-ESM with Hines type gravity wave parameterization. Both models can simulate QBO-like oscillations (Kawatani et al. 2011, Watanabe et al. 2011). In this study, each model was integrated in 100-year “perpetual El Nino” and “perpetual La Nina” experiments. The imposed SSTs in each case were annually repeating and based on composited observed El Nino and La Nina conditions.

The MIROC-AGCM experiments display ~2 months shorter QBO periods in El Nino versus La Nina conditions. Differences of the Walker circulation and equatorial precipitation between El Nino and La Nina are realistically simulated. The simulated precipitation differences are largest over the equator, consistent with observations. Near the equator the vertical wave fluxes of zonal momentum in the upper troposphere and lower stratosphere are larger in the El Nino simulation. The tropical upwelling associated with the Brewer-Dobson circulation is also stronger in the El Nino simulation. The effects of the enhanced Brewer-Dobson circulation during El Nino must somehow be overcome by enhanced wave driving in order to shorten the QBO period. On the other hand, in the MIROC-ESM ENSO experiments, the average QBO periods are nearly identical in the El Nino and La Nina simulations. Because parameterized gravity wave sources are fixed in the MIROC-ESM only resolved waves with horizontal wavenumber up to 42 could be modulated by ENSO.

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