

Three dimensional structure of planetary wave activity from tropical to extratropical regions in ENSO

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It is known that the distribution of extratropical column ozone is modulated with El Niño Southern Oscillation (ENSO) (Hitchman and Rogal 2010a, b). This modulation is recognized as the 10 ~20 day-scale responses including "Tropical convective outflow into the upper troposphere and lower stratosphere", "amplification of subtropical anticyclone associated with transport of low potential vorticity" and "modulated synoptic scale disturbances in extratropical regions". On the other hand, it is suggested that planetary scale disturbances influence the distribution of extratropical column ozone. However, this is yet to be identified. The present study examines the modulation of planetary wave activity associated with ENSO from upper troposphere to stratosphere using the formulae describing wave-mean interaction in three dimensions and analytical techniques derived by Kinoshita and Sato (2013a, 2013b), Sato et al. (2013).

First, we use the ERA-Interim reanalysis data and focus from August to October. Based on the Ocean Niño Index by NOAA, 1991, 1997, 2002, 2004, 2006, 2009 are selected as El Niño seasons and 1998, 1999, 2000, 2007 are selected as La Niña seasons. The Planetary scale disturbances are defined as the waves with zonal wavenumbers 1 ~3 and periods more than 30 days.

We calculated the three dimensional wave activity flux and its divergences associated with the planetary scale disturbances. The results show that the planetary wave activity is amplified around Asian monsoon regions in La Niña seasons and the planetary wave propagates from tropical upper troposphere to polar stratosphere. The planetary wave activity in El Niño seasons is weak in this region. On the other hand, in the eastern Pacific regions, the planetary wave activity in El Niño seasons is amplified and the planetary wave propagates from tropical upper troposphere to polar stratosphere, while the activity in La Niña seasons is weak. It is suggested that the source of tropospheric planetary waves is different between tropical and polar regions in both seasons. We plan to calculate the three dimensional material transport associated with the planetary waves and compare the transport and that associated with the mechanism shown by Hitchman and Rogal (2010a, b).

Keywords: middle atmosphere, planetary wave, wave activity flux, residual mean circulation