# The climatology of quasi-stationary waves with zonal wavenumber 1 in the Southern Hemisphere stratosphere and its relation with tropospheric condition

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Amplitudes of quasi-stationary waves with zonal wavenumber 1 (QS wave-1) in the Southern Hemisphere (SH) stratosphere attain local maxima in early winter and spring, and a local minimum in mid-winter. The seasonal evolution of the QS wave-1 amplitudes in the SH stratosphere has been considered from the different viewpoints including wave transmission properties of the mean flow (Scott and Haynes 2002). Randel (1988) showed that the seasonal evolution of the QS wave-1 amplitudes does not correspond to that of refractive index using analysis data for 8 years (1979–1986). We examine the climatological seasonal evolution of stratospheric QS wave-1 amplitudes, and their relation with tropospheric QS wave-1 amplitudes and refractive index using reanalysis data for 38 years (1980–2017).

The data used in this study are 3-hourly wind, geopotential height, and temperature from the Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2; Gelaro et al. 2017). The data are provided for 42 pressure levels (from 1000 hPa to 0.1 hPa) with a horizontal interval of 1.25°. The QS wave-1 is defined as 30-day low-pass filtered geopotential height with a zonal wavenumber 1 averaged over 75.625°S–46.875°S at each pressure level.

Seasonal evolution of the QS wave-1 amplitudes is shown in Figure 1. Above 3 hPa, the QS wave-1 amplitudes attain a local maximum in April, a local minimum in June, and a maximum in September–October. On the other hand, below 3 hPa, the QS wave-1 amplitudes increase gradually from April to July, and reach a maximum in September–October. Latitude-pressure cross sections of refractive index are shown in Figure 2. Refractive index around 60°S above 3 hPa is positive in April, negative in June, positive again in August and October, while that below 3 hPa increases gradually from winter to spring. These facts indicate that the seasonal evolution of the QS wave-1 amplitudes and that of refractive index are qualitatively consistent throughout the stratosphere. However, the maximum in wave amplitudes during the austral spring cannot be explained by refractive index alone. Amplitudes of tropospheric QS wave-1 attain a maximum in September (Figure 3). This indicates possible contribution of amplification in the tropospheric QS wave-1 in addition to the increase in refractive index to the maximum in stratospheric QS wave-1 amplitudes.

It should be noted that the local maximum in QS wave-1 amplitudes below 3 hPa in June–July, which is pointed out by Randel (1988), is not observed in the present study (Figure 1). This may be because interannual variability of stratospheric QS wave-1 amplitudes attain a local maximum in June–July. We will investigate the interannual variability of QS wave-1 in mid-winter not only in the stratosphere but also in the troposphere.

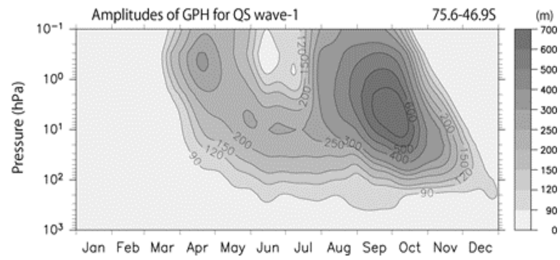


Figure 1: A time-pressure cross section of amplitudes of QS wave-1.

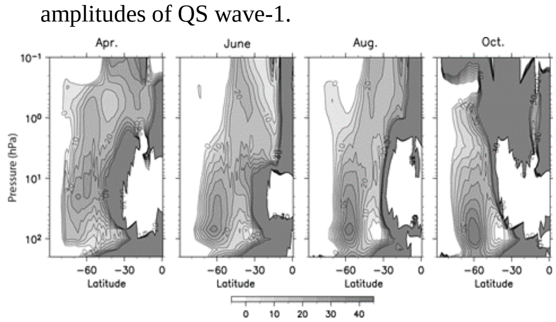


Figure 2: Latitude-pressure sections of refractive index squared multiplied by Earth's radius squared for stationary waves with zonal wavenumber 1.

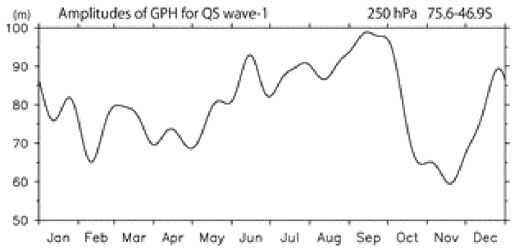


Figure 3: Time series of amplitudes of QS wave-1 at 250 hPa.

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