

QBO and QBO-Annual Beat in the Tropical Total Column Ozone: A Two-Dimensional Model Simulation

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1. Introduction

The auxiliary material in this electronic supplement provides information on the transformed Eulerian-mean (TEM) circulation and correlation coefficients between monthly mean column ozone from MOD and model.

2. Transformed Eulerian-mean circulation

For the quasi-geostrophic approximation, the residual velocity is defined by (Andrew *et al.*, 1987)

$$\overline{v^*} = \overline{v} - \rho_0^{-1} \partial(\rho_0 \overline{v'\theta'} / \theta_{0z}) / \partial z$$

$$\overline{w^*} = \overline{w} + \partial(\overline{v'\theta'} / \theta_{0z}) / \partial y$$

where v and w are the meridional and vertical velocity, ρ_0 is the density, θ is the potential temperature, θ_{0z} is the vertical derivative of potential temperature. The over bar and prime denote the zonal average and its deviation from zonal mean, respectively. A residual stream function for the TEM circulation can be determined by

$$\overline{v^*} = -\partial\overline{\psi^*} / \partial z, \overline{w^*} = \partial\overline{\psi^*} / \partial y.$$

The resulting residual meridional circulation in the stratosphere is shown in Figure 1.

3. Correlation Coefficients

Correlation coefficients and confidence levels between monthly mean column ozone from MOD and model over the period from 1979 to 2002 are shown in the Figure 2. The correlation coefficients are high in most areas and are significant. The correlations are poor in the summer high latitudes and a narrow band around 15°N. Both of regions have a weak QBO signals. The northern summer is weak since there is only a weak summer Brewer-Dobson circulation for the QBO to modulate. The subtropic band is weak for it is the node of the ozone QBO signal. The correlation coefficients are small in the high latitude of the southern hemisphere (SH). This is primarily due to the poor quality of the meridional wind in the NCEP/DOE Reanalysis 2 data set in the SH. In addition, we do not include the heterogeneous chemistry in the model. This will cause some biases in the spring of the polar region.

Figure Captions:

Figure 1: Stratospheric Transport Eulerian mean (TEM) stream function in 1985. (a) January, (b) April, (c) July, and (d) October. Units are m^2/s .

Figure 2: (a) Correlation coefficients between monthly mean column ozone from MOD and model over the period from 1979 to 2002, (b) Significance levels of the correlation coefficients.

Figure 1:

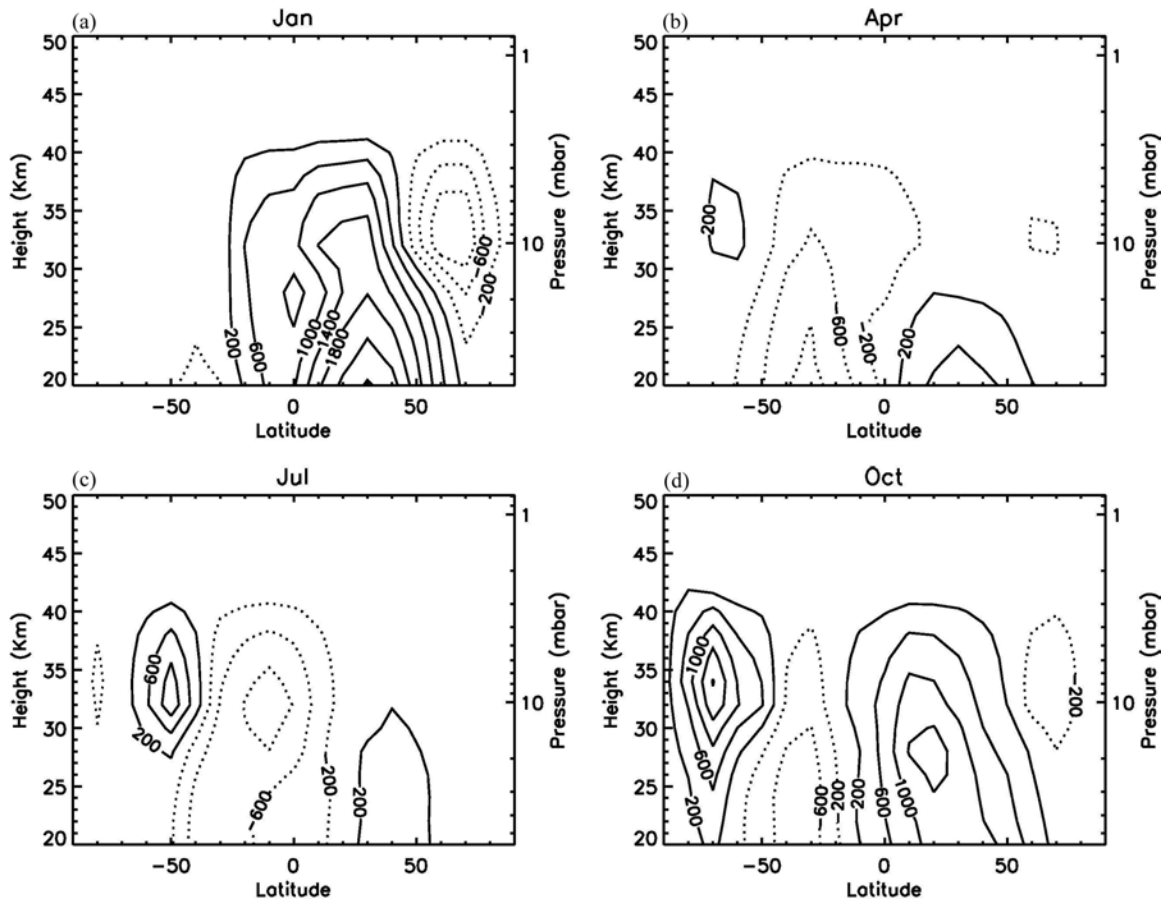


Figure 2:

