

## QBO-like oscillation in a radiative-convective equilibrium state obtained with a two-dimensional moist convection model

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Quasi-Biennial Oscillation (QBO) is a prominent internal variations in the equatorial stratosphere due to the interactions between a mean zonal wind and waves that propagate upward in the stratosphere. Over two decades ago, Held et al. (1993) investigated radiative-convective equilibrium states with a two-dimensional explicit moist convection model and obtained a QBO-like oscillation. Their model contains the fundamental dynamical processes of the QBO, though it is a highly-idealized two-dimensional model for a periodic domain without Coriolis effects. In this study, we re-examine the QBO-like oscillation found by H93 with a long enough integration period over two years, by using Advanced Research WRF Modeling System. We also investigate the sensitivity of the QBO-like oscillation in regards of different factors such as domain size, resolution and boundary conditions (e.g., prescribed zonal wind at the top and sea surface temperature).

The control experiment has a similar configuration to that of Held et al.; 640km domain width with a resolution of 5km, 130 vertical levels up to 26km. Convective parameterization is turned off in all simulations and only a cloud microphysics scheme is used. Other physics options are standard ones for short- and long-wave radiations, surface fluxes, planetary boundary layer, turbulence and diffusion, and Rayleigh damping near the top boundary. After spin up, the mean zonal wind shows a clear QBO-like oscillation with a period of 120.6 days. Unlike the observed QBO, the oscillation has a clear signal in the troposphere, in which moist convections dominate and gravity waves are generated. Such convectively generated gravity waves propagate into the stratosphere to produce the QBO-like oscillation in the stratosphere. On the other hand, intensity and propagation of organized convective systems, including zonal mean precipitation, are modulated in accordance with the oscillation of mean zonal wind in the troposphere.

Keywords: QBO, radiative-convective equilibrium, wave-mean flow interaction, two-dimensional moist convection model, stratosphere-troposphere dynamical coupling