

Modulation of the Semiannual Oscillation Induced by Sudden Stratospheric Warming Events

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In the equatorial middle atmosphere, there exists the semiannual oscillation (SAO) with two separate out-of-phase amplitude maxima centered near the stratopause (SSAO) and the middle mesosphere (MSAO). Climatologically, the SSAO (MSAO) in zonal winds has easterly (westerly) maxima around solstices and westerly (easterly) maxima around equinoxes, respectively; the seasonal march of the SAO shows significant interannual variations. Although earlier studies reported the modulation of the SAO due to the quasi-biennial oscillation (QBO) in the equatorial lower stratosphere, features of the interannual variability are complex and their causing mechanisms are still unclear. In this study, such interannual variability related to sudden stratospheric warming (SSW) events is examined on the basis of geopotential and temperature fields derived from Aura Microwave Limb Sounder (MLS) observations for the period from June 2004 to December 2013. Here, we estimate equatorial zonal winds using the gradient wind approximation. Resultantly, the significant amplification of the SAO is observed during mid-winter SSW events when the SSAO and the MSAO have easterly and westerly maxima, respectively. On the other hand, the SAO is significantly weakened in the case of the SSW occurrence in March. SSW events are accompanied by enhanced residual mean meridional circulation. The enhanced circulation brings about equatorial temperature perturbations which consist of a cooling in the upper stratosphere and a warming in the lower mesosphere. These temperature perturbations are found to modulate the SSAO and MSAO zonal winds through the thermal wind balance.

Key words: semiannual oscillation, sudden stratospheric warming, meridional circulation