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Equatorial semiannual oscillations on Mars indicated in a general circulation model

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Semiannual oscillations (SAO) of the zonal wind in the equatorial region are seen in the terrestrial upper stratosphere and mesosphere. According to the studies of terrestrial SAO up to now, the cross-equatorial meridional circulation and planetary waves drive easterly wind, Kelvin waves propagating from below drive westerly winds, and gravity waves also contribute to drive both easterly and westerly winds. Mars has equivalent equator inclination and rotation speed to Earth, so it can be expected that they have similar meteorological phenomena. We found SAO structures in our Martian general circulation model (GCM), so in this presentation we report on its main features, examine its forcing mechanism and discuss it in comparison with the terrestrial SAO.

The Martian GCM used in this study is based on the CCSR/NIES (Center for Climate System Research/ National Institute for Environmental Studies) AGCM 5.6, and have been used to investigate the mechanisms for some dynamical features seen in the observational data, e.g. baroclinic waves in northern hemisphere [*Kuroda et al.*, 2005; 2007]. The horizontal resolution is set at about 5.6 degrees for both longitude and latitude (T21, ~333 km at the equator), the vertical grid consist of 30 sigma-levels with the model top at about 80 km. The model accounts for the realistic topography, albedo and thermal inertia data at the surface, and for the CO_2 condensation/sublimation processes including the change of the air mass and the surface CO_2 snow cover. Radiative effects of the carbon dioxide (under the local thermodynamic equilibrium) and of the airborne dust in solar and infrared wavelengths are taken into account. Note that the gravity wave drag parameterization is not included.

The model results show that the equatorial SAO are seen in the altitude between 0.2-4 mb (approximately 5-35 km), with westerlies in equinoxes and easterlies in solstices which is the same as the terrestrial stratospheric SAO. The simulated Martian SAO has larger seasonal asymmetry with respect to the equator than the terrestrial SAO, due to the net south-north tilt of the topography and the associated differences in the strength of the solstitial meridional circulation. The analysis of the forcing mechanism of the Martian SAO from the transformed Eulerian mean (TEM) formalism shows that the easterly wind in equinoxes is driven mainly by the cross-equatorial meridional advection, and the westerly wind in solstices is forced by the upward advection and westward-propagating diurnal thermal tides. The contribution of the planetary waves to the forcing is small. Kelvin waves on Mars are made by a quite different mechanism from those on Earth, and the contribution to the SAO is small. This study points out to a possible important dynamical feature of the equatorial atmosphere of the planet, which is worth of closer investigation when direct wind measurements on Mars become available.