Waves encircling the summer pole of Mars observed by MGS TES

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This study investigates the atmospheric dynamics in the summer polar region of Mars by using atmospheric temperature profiles acquired by Thermal Emission Spectrometer (TES) onboard Mars Global Surveyor (MGS). The analysis showed the occurrence of isolated disturbances with the zonal wavenumber of 1 in the summer southern polar region in three consecutive years. These newly found disturbances have phase structures tilted westward with height, and are connected with near surface temperature anomalies with zonal wavenumber 1. The anomalies seem to be caused by the CO_2 polar cap which becomes asymmetric to the pole in this season. The zonal-mean zonal wind derived from the temperature distribution is weakly eastward below 2.2 hPa in this region due to the poleward decrease of the near-surface atmospheric temperature, which would be created by the temperature contrast between the CO_2 polar cap and the surrounding ice-free regolith. The phase structure of the disturbances, which is tilted westward with height and fixed relative to the ground surface, and the background eastward wind suggest that the disturbances are forced planetary waves. According to the dispersion relation of forced planetary wave, the observed vertical wavelengths are consistent with the observed weak eastward wind in the polar region. The upward EP fluxes observed around the polar region during this period also suggest the existence of planetary waves. On the other hand, in the summer northern polar region, the amplitude of disturbances is smaller than that of the southern polar region. The disturbances are not isolated in polar region but seem to be the continuations of the disturbances at lower latitudes. The poleward decrease of the near-surface atmospheric temperature is not prominent in the northern polar region probably because the CO_2 polar cap disappears in summer, and consequently, eastward wind does not persist at lower altitudes during this season. Upward EP fluxes, which are expected for planetary waves, are not observed.

The planetary waves influence the atmospheric structure in the southern polar region. The residual mean meridional circulation was derived from the divergences of the observed EP fluxes, and the result shows a wave-driven polar circulation with rising motion at $70^\circ\mathrm{S}-80^\circ\mathrm{S}$ and sinking at higher latitudes. The meridional circulation will increase the atmospheric temperature by $\sim$10 K near the pole and transport dusts which are lifted up by local dust storms. This polar circulation, which owes its existence to the asymmetric recession of the CO_2 polar cap, has never been pointed out.