R009-23
Zoom meeting D ：11/2 AM1 (9:00-10:30)
09:15-09:30

Intense zonal wind in the Martian mesosphere during the 2018 planet-encircling dust event observed by IR heterodyne spectroscopy

#Akiho Miyamoto[1), Hiromu Nakagawa[1), Takeshi Kuroda[1), Kosuke Takami[1), Isao Murata[1), Nao Yoshida[1), Katsushige Toriumi[1), Shohei Aoki[2), Hideo Sagawa[3), Yasumasa Kasaba[1), Naoki Terada[1)
[1)Science, Tohoku Univ.,[2)BIRA-IASB,[3)Kyoto Sangyo University

In the Martian atmosphere, the suspended dust absorbs incoming sunlight and contributes to localized atmospheric heating. On June 2018, a planet-encircling dust event (PEDE) occurred on Mars. The growth phase of the dust event is Ls=195-220 and the decay phase is Ls=220-260 [Aoki et al., 2019]. The water vapor has been transported up to 100 km during the dust event in both north and south hemispheres [Fedorova et al., 2020]. The model predicted that the distribution of water vapor is associated with that of Hadley circulation reinforced by the dust event [Neary et al., 2019]. Mesospheric circulation on Mars is largely influenced by PEDEs. However the measurement of mesospheric wind is very few. Moreno et al. (2009) observed zonal wind around 50 km during 2001 PEDE by IRAM, which implied prograde acceleration by the dust event. On the other hand, the region around 80 km altitude remains the least explored region with a highly variable nature that deserves extensive measurements during the dust event.

In order to understand the mesospheric dynamics during PEDEs, we have performed the direct measurement of zonal winds around 80 km from June to September 2018 by ground-based infrared heterodyne spectroscopy. The beam size is 4 arcsec for Martian angular diameter about 20 arcsec. The observed CO2 non-local thermodynamic-equilibrium (non-LTE) emission lines at 10 micron are contributed from the mesosphere, peaking at ~ 80 km altitude [Lopez et al., 2011]. The zonal wind velocity was directly derived from line-of-sight (LOS) Doppler shift of emission cores between equational limb of dayside and disk center.

The observed LOS Doppler wind implies retrograde zonal wind in the mesosphere, which agrees with the results observed by previous studies during clear sky [Sonnabend et al., 2012]. By contrast, we detected the large doppler shifts to be 222 m/s on average with the standard variation of about 101 m/s. The observed wind velocities are much larger than those in clear sky (~140 m/s) [Sonnabend et al., 2012].

The uncertainty of retrieved value was roughly estimated to be 46% due to the fitting error, pointing error, and wavelength calibration uncertainty. Even with the large uncertainty, our result suggests an intense retrograde wind in the mesosphere during 2018 PEDE.

Our result was compared with the prediction by the general circulation models (GCMs) [Medvedev et al., 2013; Kuroda et al., 2019]. The models consider zonally averaged latitude-time dust distributions during 2001 and 2018 PEDE observed by MGS, respectively. The models predicted an intense retrograde wind (~80-180 m/s) during the dust event around 0.1 Pa (around 80 km). Our result supports their prediction.

In order to clarify the mechanism to accelerate the zonal wind, we use the horizontal momentum equation in the transformed Eulerian mean (TEM) formalism [Andrews et al., 1987]. By applying the visual confirmation results of Medvedev et al. (2013) and the results of Kuroda et al. (2019) for the formula, it was found that the effects of meridional advection, vertical advection and gravity waves (horizontal total wavenumber of larger than 60) are about 45 m/s・sol, 4 m/s・sol and about 30 m/s・sol at the corresponding region, respectively. The total effect on retrograde wind acceleration is about 80 m/s・sol.

Consequently, it is possible to get the observed retrograde wind velocity (~140 m/s acceleration) for 2~3 sols after the occurrence of 2018 PEDE theoretically mainly due to the gravity waves and the enhanced Hadley cell across the equator during 2018 PEDE. Further observations are needed to confirm our implication.