CO_2 SUPERSATURATION BY ATMOSPHERIC WAVES IN THE MARTIAN POLAR NIGHTS

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Introduction: In the Martian atmosphere, the main component is carbon dioxide (CO_2). Since the air temperature often falls below the condensation temperature of CO_2 in the polar night regions on Mars, it is supposed that the supersaturation and/or condensation of CO_2 can occur in the atmosphere [1]. Previous studies showed that CO_2 supersaturation is caused by atmospheric gravity waves in the mesosphere, mountain waves, transient waves (baroclinic waves) and stationary waves.

The Radio occultation (RO) measurements by Mars Global Surveyor (MGS) [2] provided more than 20,000 profiles of temperature and pressure on Mars during 1998-2007 (Mars Year 24-28) and those data are suitable for the studies of atmospheric thermal structures including CO_2 supersaturation.

The present study investigates the effects of transient waves and stationary waves on CO_2 supersaturation in the Martian atmosphere by using the MGS RO data. We show the spatio-temporal distribution of the occurrence of CO_2 supersaturation, focusing on the northern polar nights regions (60-70N), where enough profiles of temperature and pressure of the MGS RO data are available. We also compare the MGS RO results with numerical simulation results.

Data: The MGS RO data includes altitude, temperature, pressure and air number density, and are provided at the website of the Planetary Data System, NASA. For comparison, we utilized simulation results from the numerical models, Martian Climate Database (MCD) [3] and Dynamics, RAdiation, MAterial Transport and their mutual InteraCtions (DRAMATIC) [4].

Results: At higher altitudes (above ~400Pa), CO_2 supersaturation appears at longitudes 90-180E and 270-360E, and no saturation can be seen in other longitude domains (Figure 1a). The longitudinal sections where CO_2 supersaturation occurs overlap with zonal temperature minima with wave number 2 (s=2). The results from the numerical model, DRAMATIC, are consistent with the observations (Figure 1b) and suggest more frequent occurrence of CO_2 supersaturation even above 100 Pa, where much smaller number of CO_2 supersaturation events were observed by the MGS RO measurements.

At the lower altitudes, CO_2 supersaturation occurs at all the longitude sections, although the effect of the stationary wave still remains. Past studies showed that transient waves with s=1,2 and 3 frequently appear in the mid- to high latitudes during autumn and winter [5,6]. We conducted wave number analyses to extract the fluctuation components of

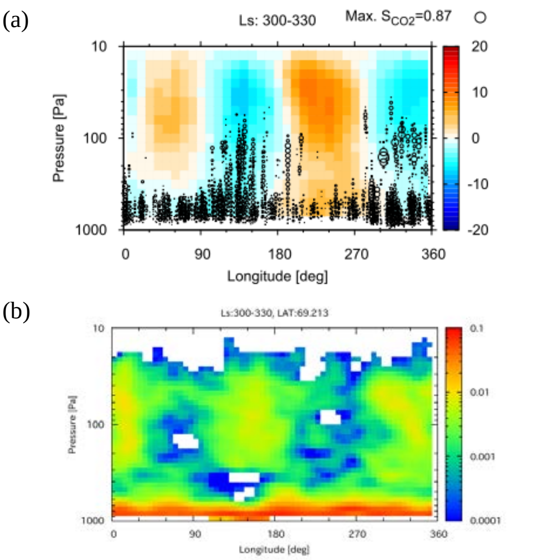

Figure 1: (a) CO_2 supersaturation occurrence (black circles) with zonal deviation of temperature observed by the MGS RO measurements for (Ls=300-330, 60-70N). (b) Mean of the degree of CO_2 supersaturation simulated by the DRAMATIC model (Ls=300-330, 69N).

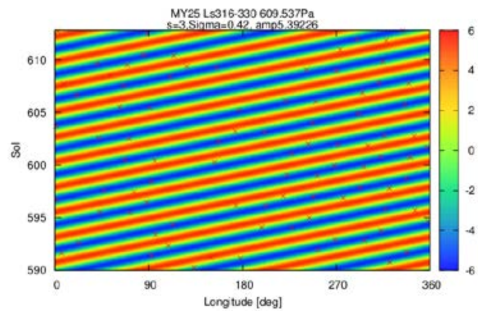

Figure 2: Temperature fluctuation components of a transient wave (s=3, P=2.4 sol) on the pressure level of 610 Pa during Ls=316-330 in MY 25. Red crosses indicate CO_2 supersaturation events observed by the MGS RO measurements.

temperature caused by transient waves [6]. Figure 2 shows an example of the fluctuation components caused by a transient wave with s=3 and a period (P) of 2.4 sol. Many CO_2 supersaturation events occur in the temperature minima of the transient wave. This suggests a strong influence of transient waves on CO_2 supersaturation in the lower altitudes.

References: [1] Kieffer et al. (1977) *JGR, 82(28),* 4249–4291. [2] Hinson et al. (1999) *JGR, 104(E11),* 26,997–27,012. [3] Millour et al. (2012) *EPS Congress, Abstract Vol. 7, EPSC2012-302*. [4] Kuroda et al. (2005) *J. Meteorol. Soc. Japan, 83(1)*, 1–19. [5] Banfield et al. (2003) *Icarus, 161(2)*, 319-345. [6] Hinson et al. (2006) *JGR, 111*, E05002.