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Martian mesospheric CO_2 clouds: OMEGA and HRSC data, the LMD-MGCM and possibility for mesospheric convection

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We will present 3 Martian years (Mars Years 27-29) of high-altitude CO2 cloud data from MEx/OMEGA and selected results from Mex/HRSC. OMEGA observed these clouds on 51 and HRSC in 28 orbits with 11 simultaneous observations. The 3-year dataset shows that the cloud activity starts latest at Ls=0° (with the earliest occurrence observed at the end of MY 29 at Ls=330°), and continues until Ls=60° when ceasing for a period before the summer solstice. The activity starts again at or after Ls=90°, and after Ls=120° the equatorial clouds are nearly absent in our dataset. Three cases of midlatitude autumn/winter clouds have been observed: one in the northern hemisphere and two in the southern. The spatial distribution of the clouds is limited in a latitude range of 20°S-20°N (with the exceptions of the midlatitude clouds) and a longitude range -120 – 30°E (3 exceptions). The HRSC stereo observations enable accurate cloud altitude measurements, yielding values between 60 and 85 km (+/-2 km) for the near-equatorial clouds. The clouds speeds, related to the prevailing east-west winds, range from 15 to 107 m/s (+/-15 m/s). Two cloud shadow observations show that cloud opacities can go up to =0.6 and the cloud particle effective radii are mainly in the range reff=1-2 μm. A comparison with the LMD Mars Global Climate Model shows a good agreement between the model-predicted winds and those observed by the HRSC. The LMD-MGCM predicts a strong diurnal variation of temperature at the cloud observation altitudes due to the propagation of the diurnal thermal tide. The coldest temperatures in the near-equator cloud altitude range (60-85 km) are observed towards the end of the afternoon, whereas the warmest temperatures are found in the early morning hours. Most of the observed clouds are cirrus-type, filamented clouds, but in some OMEGA observations the clouds exhibit round, clumpy structures that have been suggested to be of convective origin. We assess the plausibility of the hypothesis of mesospheric convection in light of the observations and theoretical Convective Available Potential Energy calculations. Estimates of convective potential and vertical velocities based on observed cloud properties suggest that the convective clouds could most likely be clusters of smaller scale convective updrafts. To attain the estimated values of CAPE and vertical velocity, most probably only moderate deviations from saturation are required. Based on nucleation modeling, such deviations may imply cloud formation via heterogeneous nucleation onto small condensation nuclei.