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CO2 ice clouds in the upper equatorial atmosphere of Mars

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A unique feature of the Martian climate is the possibility for carbon dioxide, the main atmospheric constituent, to condense as ice. CO2 ice is usually detected as frost but is also known to exist as clouds. This paper presents the first unambiguous observation of CO2 ice clouds on Mars (Figure 1). These images were obtained by the visible and nearinfrared imaging spectrometer OMEGA onboard Mars Express. The dataset encompasses 19 different occurrences. Compositional identification is based on the detection of a diagnostic spectral feature around 4.26 μm which is produced by resonant scattering of solar photons by mesospheric CO2 ice particles in a spectral interval otherwise dominated by saturated gaseous absorption. Observed clouds exhibit a strong seasonal and geographic dependence; concentrating in the near-equatorial regions during two periods before and after northern summer solstice (Ls 45° and 135°). Radiative transfer modeling indicates that the 4.26 μm feature is very sensitive to cloud altitude, opacity and particle size, thereby explaining the variety of

spectra associated with the cloud images. On two orbits, the simultaneous detection of clouds with their shadow provides straightforward and robust estimates of cloud properties. These images confirm the conclusions established from modelling: clouds are thick, with normal opacities greater than 0.2 in the near infrared, and are lofted in the mesosphere above 80 km. The mean radius of CO2 ice crystals is found to exceed 1 μm, an unexpected value considering this altitude range. This finding implies the existence of high altitude atmospheric updrafts which are strong enough to counteract the rapid gravitational fall of particles. This statement is consistent with the cumuliform

morphology of the clouds which may be linked to a moist convective origin generated by the latent heat released during CO_2 condensation.