CO_2 JETS AND THEIR INFLUENCE ON THE MARTIAN POLAR ATMOSPHERE

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Intoduction: Every local spring, CO_2 gas jets erupt in the south polar region of Mars. They deposit ground material on top of the bright reflective CO_2 ice, rendering dark appearing jet deposits in orbiting remote sensing images, like shown in Fig. 1. Despite the fact that their nature seems to be well understood as a phenomenon related to basal sublimation of the seasonal CO_2 ice layer [1, 2], the actual eruptions have never been observed. The energetic conditions most conducive to these eruptions are calculated to be best from noon (at spring equinox) towards earlier local times in the days following equinox [3]. However, all remote sensing missions with instruments that could have observed these jets being active (MEX, MGS, and MRO) had a sun-synchronous orbit with local times in the afternoons.

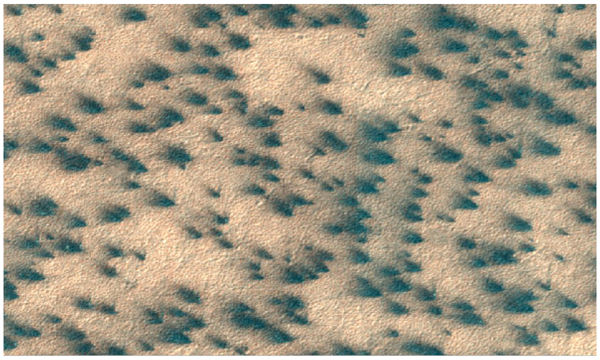

Figure 1 Subsection of HiRISE image `ESP_011296_0975`.

It is important to quantify the influence these jets have on the local atmosphere, which are twofold. First, jets inject dust into the boundary layer which causes changes in the local heat budget by increased absorption. Second, the dark jet deposits on top of a highly reflective surface is changing the amount and spectral composition of the backscattered radiation of the surface. This again affects the local energy budget of the lower atmosphere.

These effects are important to study for a better understanding of the polar atmosphere at Mars. The polar atmosphere influences greatly, if not dominates, the atmosphere development of the whole planet, specifically in spring when 30 % of the atmosphere is being exchanged with the surface at the poles. Because of the created density variations in the polar atmosphere from local heating by dust, improving the understanding of these phenomena could even improve the safety for polar surface missions during the entry phase.

Proposed R&A activities: The dust injection is proportional to the power the CO_2 jets possess, but the observed deposits' area is a convoluted funcion of jet height and wind strength at the time of eruption. We need to create geophysical jet models embedded into realistic background wind scenarios to constrain the amount of dust that is entered into the atmosphere. Furthermore, we need to study the effect of the jets on the vertical and horizontal dust distribution and how this affects local and polar weather as a whole via meso-scale simulations embedded into higher resolution GCMs.

Proposed mission activities Advances in SmallSat technologies like attitude control and camera readout electronics have made it possible to reduce the size of science-producing cameras to $\approx$ 3x1 U (i.e. 30 x 10 x 10 cm) (see Fig.2). We are studying a SmallSat mission that would primarily focus on Martian south polar processes. Advantages of a SmallSat are low inertia, enabling stereo-imaging by rotating the S/C, and an orbit control enabling the change of observed local time within the same spring season. In addition to the above described prime objectives that can be addressed, such mission can also monitor water ice clouds that have a strong dependence on local time. We partnered with SmallSat bus provider ExoTerra that is able to provide an ion-driven propulsion system with solar panels that provide adequate power at the Mars orbit. We have developed a preliminary optical design for a telescope that is reaching imaging capabilities near that of the MRO CTX camera and are investigating a telescope-spectrometer combo sharing the same telescope. Planning this mission with a SmallSat enables us to adapt the local orbit to react on observations made.

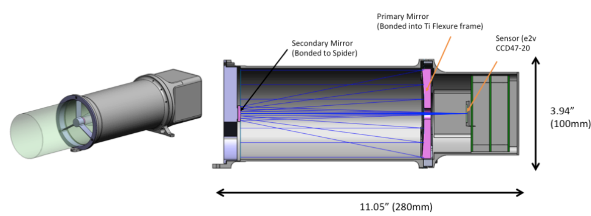

Figure 2 Preliminary instrument design.

References: [1] Kieffer, HH. *Journal of Geophysical Research*, 112:08005 (2007). doi:10.1029/2006JE002816. [2] Hansen, CJ, Thomas, N, Portyankina, G, et al. *Icarus*, 205:283–295 (2010). doi:10.1016/j.icarus.2009.07.021. [3] Portyankina, G, Markiewicz, WJ, Thomas, N, et al. *Icarus*, 205:311–320 (2010). doi:10.1016/j.icarus.2009.08.029.