SEARCHING FOR SEASONAL JETS ON MARS IN CASSIS AND HIRISE IMAGES. C. J. Hansen[1], S. Conway[2], G. Portyankina[3], N. Thomas[4], A. McEwen[5], J. Perry[5], [1]Planetary Science Institute, Arizona, USA (cjhansen@psi.edu), [2]CNRS, Université de Nantes, France, [3]University of Colorado, Boulder, CO, USA, [4]University of Bern, Switzerland, [5]University of Arizona, Tucson, Arizona USA.

Introduction: Spring is a very active time on Mars as the CO_2 seasonal cap sublimates. Stereo images from HiRISE and CaSSIS have been collected to search for the gas jets that produce seasonal fans visible every spring. Every year in the spring these fans appear on Mars' seasonal polar cap. The generally accepted Kieffer model [1] is that sunlight penetrates the translucent layer of CO_2 ice, and warms the surface, which causes basal sublimation of the layer of seasonal ice. Gas trapped below the ice builds up pressure until the overlying ice ruptures and the gas escapes, entraining material from the surface. The particles are carried out, get blown downwind, and fall to the surface in fan-shaped deposits (see Figure 1).

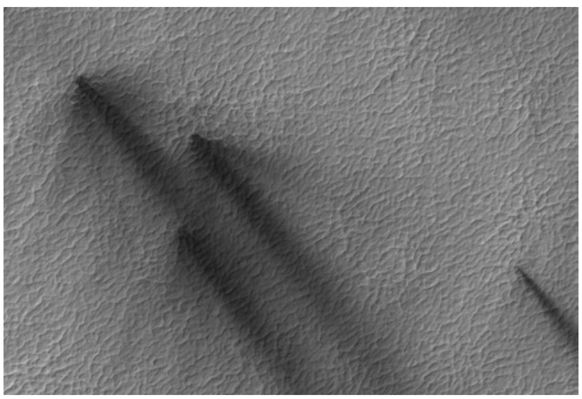

Figure 1: Fan-shaped deposits appear on top of the seasonal layer of ice every spring. This image, ESP_011671_0935, was taken at 86.4S / 99.0E, at L_s 196 in a region informally known as Manhattan.

Seasonal activity has been studied with the High Resolution Imaging Science Experiment (HiRISE) on the Mars Reconnaissance Orbiter (MRO) for 7 Mars years, and images are largely consistent with the Kieffer model [2, 3, 4]. However, the ultimate proof would be to capture a jet fountaining up with its load of surface dust. In pursuit of this goal we can now deploy the Colour and Stereo Surface Imaging System (CaSSIS) on the ExoMars Trace Gas Orbiter (TGO).

HiRISE Search for Jets: Every spring tens of thousands of fans appear on the seasonal cap. Ideally a stereo pair of HiRISE images would detect the jet of particles shooting above the surface. It turns out to be surprisingly difficult to achieve this seemingly simple objective. The amount of gas released is limited by the supply, and a jet might last just minutes to hours. The closest spacing for HiRISE images is on adjacent orbits, with ~2 hr separation, but only at latitudes poleward of 80°. Given other constraints on sequencing it is typical to get just one of these stereo pairs per week. At the most active time in the spring that means that only 2 – 5 stereo pairs may be scheduled. In the last 7 Mars years of MRO operation only ~23 pairs have been returned. While the stereo data shows very interesting detail on surface morphology no jets have been detected.

Another limitation is that the MRO orbit is fixed at a mean local solar time of ~3 pm. It is possible that the jets are more likely to erupt in the morning or mid-day. If that is the case HiRISE will never be able to image them.

The most promising HiRISE image to-date is shown in Figure 2, in Russell Crater dunes. Dust appears to be billowing from one of the linear gullies. At ~54° south latitude these dunes are covered with a seasonal layer of ice every winter, and show typical spring activity with fans and blotches. But is this an example of gas being released and carrying material out in the manner hypothesized in the Kieffer model? Without stereo data to pin down the source and vent structure it is difficult to be certain.

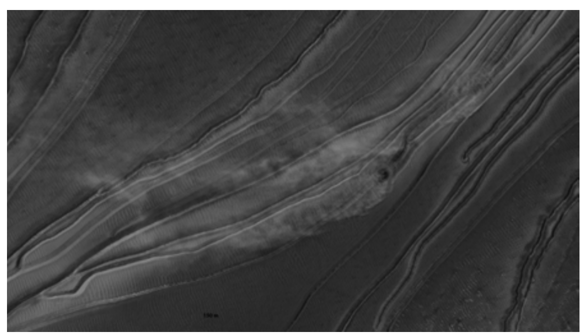

Figure 2: This image of Russell crater dunes, ESP_047078_1255, was taken at 54.3S / 12.9E, L_s 202. A thin cloud of dust might be coming from a rupture in the ice.

CaSSIS Opportunities: The CaSSIS camera [5] has the ability to complete a stereo pair within minutes. The most poleward latitude is limited by the inclination of the TGO orbit to 74°, but the full range of latitudes equatorward of this limit can be imaged in stereo quickly. Furthermore, the TGO orbit evolves through local time, giving us the opportunity to image over the full range of a martian day.

A particularly opportune time took place from May to July of 2018, when high latitudes were visible at local morning between 6 and 10 local time. A total of 27 anaglyphs from stereo pairs have been analyzed to look for plumes. As of yet none have been identified, but the mere fact that we have as many stereo pairs to look at in one year compared to the entire 7 Mars years of HiRISE observations bodes well.

One limitation that works against CaSSIS is its lower resolution (~5m) relative to HiRISE (~1m). Fans are typically shorter at the latitudes CaSSIS observes, which may be related to the gas supply and the thickness of the seasonal ice layer. If this is related to the height the jets achieve, which is likely [6], then it will be more difficult to identify a jet with certainty in the CaSSIS stereo images. Estimates for jet height are on the order of 70m [6], but this is relevant to the higher latitudes and longer fans.

Figure 3 shows an example of a CaSSIS stereo image. In this particular one although no jets were detected, there does seem to be a haze over the fans on the surface.

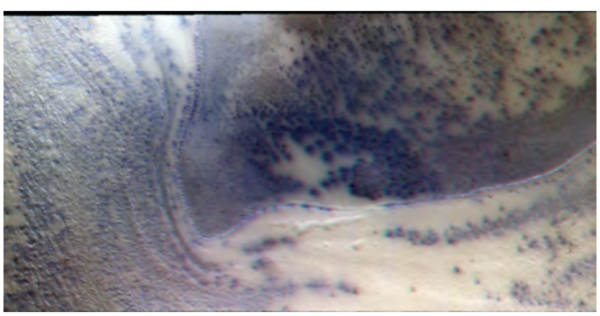

Figure 3. This CaSSIS image, MY34_2191_269, taken at lat / lon -73.5 / 176.4E, Ls 179, is an intriguing possibility for detection of seasonal activity. It looks like there is dust suspended in the air over the fans on the surface, but no plumes are visible.

Summary and Conclusions: The combination of HiRISE and CaSSIS means that almost all latitudes are accessible with stereo. HiRISE has the advantage of higher resolution and larger fans to observe than CaSSIS, but CaSSIS offers more opportunities to acquire stereo pairs in the spring. The likely brief duration of a jet means a fair amount of luck is required to catch an eruption underway, so increasing the probability of catching one with more observation opportunities helps.

It is also possible that jets will never be imaged if the dust load is not opaque enough to be visible in images acquired at relatively low phase angles. The opacity of the jet may just not be enough to be detectable, but we will continue to look.

Another southern spring is approaching on Mars and both the CaSSIS and HiRISE imagers will collect new stereo pairs. With a little luck one of the two will image a jet and the Kieffer model will be definitively confirmed.

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References:

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