LOW-LATITUDE SEASONAL FROST ON MARS. C. M. Dundas[1], S. J. Conway[2], A. Valantinas[3], V. G. Rangarajan. [1]U.S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Dr., Flagstaff, AZ, 86001. [2]Laboratoire de Planétologie et Géosciences, Nantes, France. [3]Department of Earth, Environmental and Planetary Sciences, Brown University, USA. [4]Institute of Planetary Research, DLR, Berlin, Germany.

Introduction: Surface water frosts on Mars, while thin, are an important component of the water cycle, and their timing and abundance provide valuable information about when and where condensation occurs. The lowest latitudes are the least favorable for such frosts and thus provide important constraints.

Widespread early-morning water frost, unlikely to last much past dawn, has been observed on Arsia Mons near 8.7°S [1] around L_S=45–150°. Indirect evidence for nighttime frost in Gale crater (4.5°S) has also been reported near winter solstice [2], although they estimated thicknesses <1 micron which would be unlikely to last long past sunrise. Early-morning water frost was observed on the deck of the Opportunity rover at 2°S, but not on the nearby regolith due to superior radiative cooling for metal surfaces [3].

Detections of afternoon frost, likely to indicate seasonal H_2O frost persisting through the day, have thus far been at somewhat higher latitudes than the morning frost detections. Thermal and near-infrared spectral data have revealed afternoon water frost on steep pole-facing slopes at latitudes as low as 13°S [4–7]. Vincendon et al. [6] conducted climate modeling that broadly matched their spectral observations but also predicted occurrences of thin frost (2–5 microns thick) at 3 PM on pole-facing slopes at even lower latitude. Those predicted frost deposits would occur around Noctis Labyrinthus and Arsia Mons around L_S=80–100° at latitudes near 5°S but were not observed in their data.

In this abstract, we report observations of afternoon water frost in both Noctis Labyrinthus and Arsia Mons, located in and near shadows cast by steep local slopes. This corroborates the predictions of [6] and provides the lowest-latitude evidence of seasonal water frost persisting through the day on Mars observed to date.

Observations: We inspected color observations from the High Resolution Imaging Science Experiment (HiRISE [8]) to look for evidence of frost. HiRISE has three color channels (near-infrared, red, and blue-green), and frost generally appears bluish to white in composite color products from these data. We selected two study areas (5–13°S, 250–267°E and 6–14°S, 236–242°E) corresponding to areas of interest with steep slopes in Noctis Labyrinthus and Arsia Mons, and surveyed HiRISE data acquired between L_S=60–120°. We examined steep slopes with shadows in those images, first inspecting the area just outside shadows and then re-stretching the images to check for possible frost within the shadows (Fig. 1). We tabulated the presence of discrete patches with color signatures consistent with frost (Fig. 2).

We also used the same seasonal and locational constraints to search for frosts in images from the Colour and Stereo Science Imaging System (CaSSIS) at a lower spatial resolution of ~4 m/pix. CaSSIS has one additional color channel compared to HiRISE, and images are taken at varying local time. We used the same procedure as for HiRISE to detect frosts, but due to the lower spatial resolution only the largest frost patches could be tentatively identified (as confirmed by images taken on the same day by the two instruments).

Discussion: We commonly observed frost in or immediately adjacent to shadows in our study areas and season, reaching as far equatorward as 5.3°S. This is near the edge of our study areas, but large-scale steep slopes are not common closer to the equator in this region (Fig. 3). We cannot rule out the possibility of frost occurring on smaller slopes at even lower latitudes. Although HiRISE and CaSSIS provide minimal spectral information, this frost is likely H_2O rather than CO_2 given its correspondence with predicted water frost locations [6] and the lack of any previous detection of afternoon CO_2 frost equatorward of 34°S [9]. While CaSSIS observes at various local times, HiRISE always observes near 3 PM, so frost observed in HiRISE data has survived most of the day and is present for days or weeks rather than hours. Unsurprisingly [6, 10], steep slopes and associated shadows are essential to the occurrence of afternoon frost at these low latitudes.

The observed frost patches are insignificant compared with the H_2O mass in the atmosphere or with perennial ice deposits. However, their existence provides an important calibration point for planetary-scale models of frost deposition and the water cycle. Additionally, this lowest-latitude frost could experience warmer peak temperatures than observed for other seasonal deposits [7], representing a potentially habitable environment or "Special Region" [11] depending on the annual temperature history.

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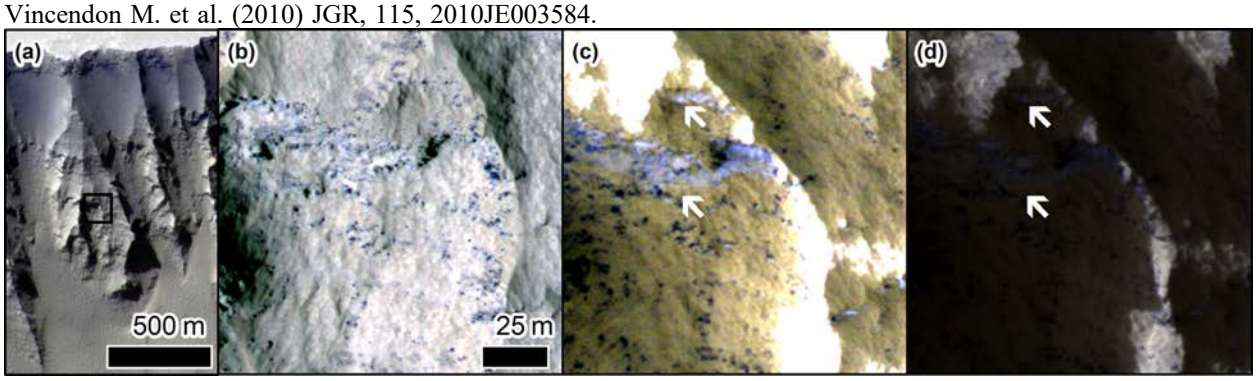

Figure 1: *(a) CaSSIS image MY37_025621_347_0 taken at Ls 107.8° showing the topographic context of the following panels, (b) HiRISE image ESP_083914_1690 taken at Ls 278.6° showing no signs of frost, (c) HiRISE image ESP_080024_1690 at Ls 108.3° contrast stretched to show frost in the shadows as indicated by the white arrows, and (d) same as panel c but with the default contrast stretch.*

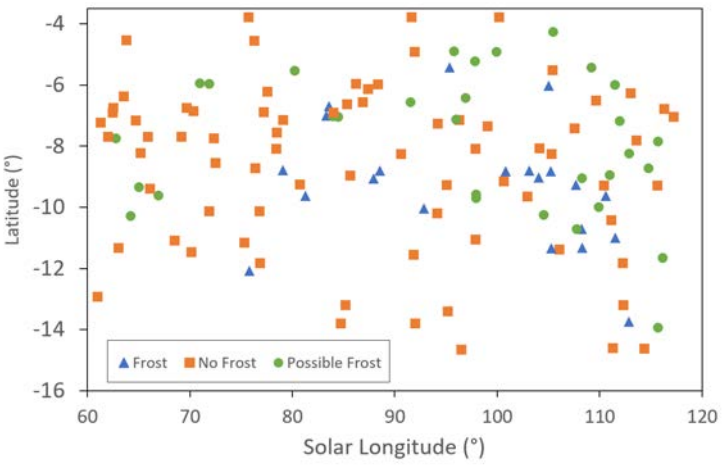

Figure 2 (left): *Plot of HiRISE and CaSSIS images examined as a function of latitude and time, showing frost near the southern winter solstice.*

Figure 3 (below): *HiRISE and CaSSIS footprints colored according to presence/absence of frost in shadows, overlain on hill-shaded color topographic map from MOLA where red is high elevation.*