NEAR-SURFACE WINDS AND SEASONAL SURFACE PHENOMENA ANALYZED BY PLANET FOUR PROJECT. G. Portyankina[1], K.-M. Aye[1], M. E. Schwamb[2], C. J. Hansen[3], T. Michaels[4], [1]Laboratory for Atmospheric and Space Physics, University of Colorado in Boulder, 3665 Discovery Drive, Boulder, CO, 80303 (Ganna.Portyankina@lasp.colorado.edu), [2]Astrophysics Research Centre, Queen's University Belfast, Belfast BT7 1NN,UK, [3]Planetary Science Institute, Tucson, AZ, [4]SETI Institute, Mountain View, CA

Introduction: We used a catalog of seasonal fans and blotches measured by citizen scientists participating in the project Planet Four to analyze the spring evolution of deposits from CO_2 jets in the southern polar regions of Mars.

Martian polar areas in spring display a broad diversity of surface changes. Interplay between sublimation and re-condensation of water and CO_2 ices, occasional snowfall and subsequent transformation between different ice forms, dust lifting and sedimentation, wind erosion of icy surfaces and of permanent substrate or dunes – all these processes happen during spring in the Martian polar regions. Paired with varying atmospheric conditions, they pose a complex riddle to the occasional remote observer.

The High Resolution Imaging Science Experiment (HiRISE) on the Mars Reconnaissance Orbiter (MRO) monitored the selected set of regions of interest (ROIs) in the southern polar regions every spring over 6 martian years. This dataset provides abundant information on seasonal and inter-annual development of transient surface features – fans and blotches – considered to be deposits from CO_2 jet eruptions [1, 2, 3]. For the purpose of this study it is important that the deposits are from material that has been aloft in the atmosphere and thus their directions and sizes retain information about eruption physics as well as about the state of the martian atmosphere at the time of eruption.

Method: A given HiRISE image can have hundreds to thousands of fans and blotches or none at all. Every ROI has up to a dozen HiRISE images per year. To analyze this dataset numerically we have created the citizen science project Planet Four (P4). Participants of P4 mark seasonal deposits in sub-frames of HiRISE images with online geometric tools. Locations, directions, and sizes of the markings are stored in a database. A processing pipeline is used to remove mistaken markings and to reduce multiple markings of the same object to one composite marking per object. The complete description of P4 and the pipeline is in [4].

The result of the pipeline is a catalog of fan and blotch markings with their coordinates, directions and sizes linked to HiRISE images (and thus time) during the spring season. The catalog provides a means to statistically study development of the seasonal activity. The P4-derived values that will be discussed below are averages over a given HiRISE image. For example, when wind direction is reported for a given image (and thus a corresponding L_s) this is a number that averages directions of all existing fan markings recorded for that image. The deviations from the mean in this case represent the spread of orientations of multiple markings inside that image and not the error in citizen science markings or pipeline processing [4].

Results: Using assumptions about CO_2 jet eruption physics based on models (such as [5]), we are able to convert fan lengths to near-surface wind speeds. Wind directions are estimated from orientation of fan markings. Both of these are derived in relation to time in multiple ROIs monitored by HiRISE.

Wind directions: An example of simultaneous wind speed and direction development in ROI Giza is shown in Fig. 1. We can be confident that in subsequent images we measure newly developed deposits because their direction shifts continuously towards east. Thus we can state that the near-surface wind direction in this ROI has shifted by over 60 degrees between L_s 180° and L_s 230°. At the same time the wind speed decreased. After L_s 240° the direction of wind shift has reversed and wind speed has increased. This indicates a switch between atmospheric regimes between L_s 230° and L_s 240°, most

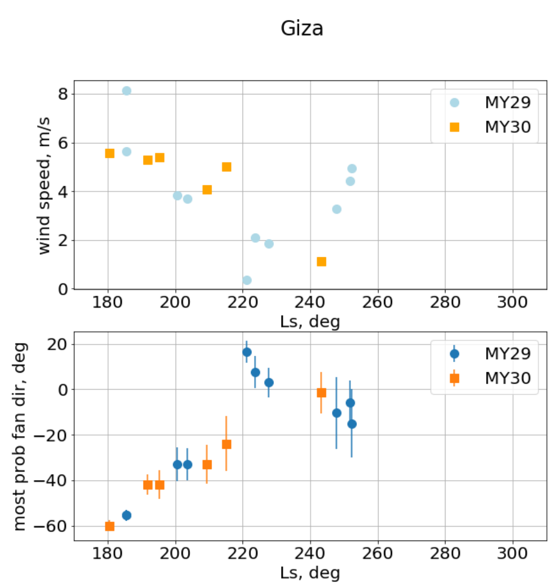

Figure 1 Near-surface wind speeds (top) and directions (bottom; clockwise from N) vs L_s, derived from P4 results in ROI Giza (84.8°S, 65.8°E).

probably associated with sublimation of surface CO_2 ice.

On the larger scale, ROIs located between longitudes 60°E and 150°E show a consistent shift in the most probable wind direction towards the east. ROIs outside this longitudinal bin either do not show this trend (e.g., Buenos Aires at 4.8°E, Ithaca at 180.7°E, Portsmouth at 167.8°E, Inca City at 295.8°E) or have an insufficient number of seasonal images (i.e., Wellington at 225.2°E).

Wind speeds: Caution must be used when interpreting wind speed data from this dataset because the estimates depend on a number of assumptions such as the size distribution of mineral grains lifted by the CO_2 jet eruptions, static stability of the near-surface atmosphere, jet eruption strength, etc. Whenever possible we stayed with the most conservative assumptions and thus the wind speeds discussed here are lower estimates. The strongest winds were detected in the longitude band 60°E–150°E, where (considering all ROIs during all of spring) the wind speed peaks at ~9 m/s at earlier L_s (< 220°). Winds outside that longitude band stay below 5 m/s for the whole season. We have not detected significant inter-annual variability between the 2 MYs that we have so far analyzed (MY 29 and MY 30).

Comparison to atmospheric models: We have run the Mars Regional Atmospheric Modeling System (MRAMS; [6]) at the same ROIs and season to compare its estimated winds to values derived from P4. An example of such a comparison is shown in Fig. 2.

A major complication of comparing observed and modeled results comes from the fact that we do not know at what exact time(s) of day CO_2 eruptions happened, creating the deposits. According to MRAMS simulations, near-surface winds may significantly change through the martian day (as can be seen in Fig. 2 where each dot represents wind during a 10 Mars-minute window). The amount and amplitude of variations depends on the exact location of the ROI, with topographic forcing playing a major role.

Conclusions: P4 data provide us with a new way to investigate seasonal processes on Mars, with potential for quantitative analysis. The significant degree of correlation between modeled and P4-derived wind speed/direction strongly suggest that fan deposits do indeed mark the directions of changing near-surface winds. The directions considerably shift during spring (and during each sol) which reflects the volatile nature of weather in the southern polar regions during spring.

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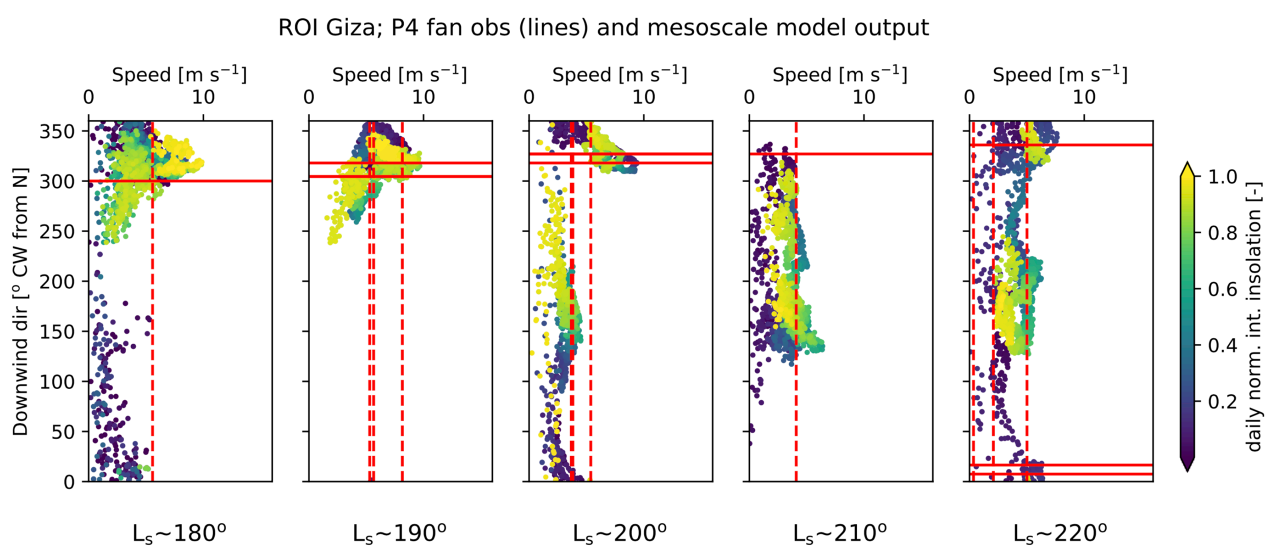

Figure 2 Comparison of P4-derived wind speeds and directions (red lines) to MRAMS output (dots; colorized by normalized daily time-integrated insolation, with cool colors in the morning and warm colors in the later afternoon) at ROI Giza (84.8°S, 65.8°E). Each dot represents a local time slot of 10 Mars-minutes.