INVESTIGATION OF POLAR SEASONAL FAN DEPOSITS USING CROWDSOURCING K.-M. Aye[1], M. E. Schwamb[2], C. J. Hansen[3] , G. Portyankina[4]. [1]Dept. Earth, Planetary, and Space Sciences, UCLA, Los Angeles, CA, USA (michael.aye@ucla.edu), [2]Institute of Astronomy and Astrophysics, Academia Sinica, 11F of Astronomy-Mathematics Building, National Taiwan University. No.1, Sec. 4, Roosevelt Rd, Taipei 10617, Taiwan, [3]Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson 85719, AZ, USA, [4]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, USA

Introduction: We report preliminary results of the analysis of crowd-sourcing data on fan-shaped deposits that are produced by CO_2 gas jets depositing sand and dust on top of the seasonal CO_2 ice layer at the Martian south pole (Fig. 1). A database of over 98,000 HiRISE subframes has been produced that is embedded into a web-based graphical interface for marking the position and outline of the fan deposits. Clustering techniques are used to combine these data into coordinates and orientations to provide data on the intra- and inter-seasonal developments of the fan-shaped deposits in several active south polar regions.

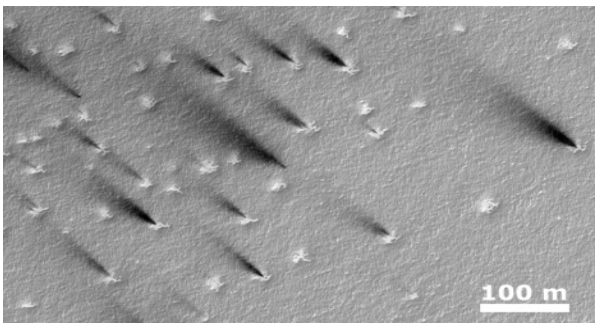

Figure 1: A subframe of HiRISE image ESP_020597_0925 in the southern polar areas showing dark fan deposits left by CO2 jet eruptions.

Planet Four project: Planet Four (www.planet-four.org) is one of many crowd-sourcing projects initiated by the Citizen Science Alliance and augmented with institutional support from the Universities of Oxford, Nottingham, and Minnesota, John Hopkins University, the National Maritime Museum, and Adler Planetarium. The Citizen Science Alliance provides the web portal, infrastructure, and technical expertise for involving large numbers of volunteers in research projects (the "zooniverse", described at www.zooniverse.org). Through this collaboration ten-thousands of citizen scientists cataloged the location, size, shape and direction of the fans and their development over time, as visible in over 200 large HiRISE observations, and the zooniverse team provided us with the resultant database of measurements.

Data used HiRISE images are large, typically several Gb. More than 200 high quality images from the first, second and third spring seasons were divided into 98,096 subframes of approx. 800x600 pixels that are manageable by typical web-browsers. The subframes were then served up on the Planet Four website. Once 100 citizens (initially, now lowered to 30) have worked on a subframe it will be 'retired', but still will be served with lower priority to improve its statistics. The huge advantage of human classifiers is their ability to recognize patterns in variable signal-to-noise backgrounds for which computer search algorithms either fail or are very hard to achieve the same efficiency. Having hundreds of eyes classifying fans in one frame creates statistical data about each classified object (see Fig. 3). A tutorial on the website walks the volunteer through the process of identifying and measuring fans, blotches and of marking other interesting objects. The citizen scientist is provided with a tool to locate and outline fans that show a discernible direction. If no direction can be defined, the object is classified as a blotch and another tool is used to draw ellipsoidal outlines for blotches (Fig. 2).

Science objectives: The spatial and temporal frequency of the fan deposits, the area covered and changes in direction and contrast with the underlying CO_2 ice layer all provide a wealth of information on the spring CO_2 sublimation process. The length, width and direction of fans are snapshots in time of the local wind direction, their strengths and variability, convoluted with the strengths and shape of the CO_2 gas jets that created those fans. The directions are mostly dominated by the boundary layer winds, therefore a comprehensive mapping of fan deposit directions will generate time-dependent wind maps. These maps provide valuable input to General Circulation and mesoscale models. Future work will address comparison of Planet Four results with local mesoscale modeling that takes into account topography data acquired from HiRISE digital elevation maps via stereo imaging.

Dust transport Aside from these insights into the present climate of the Martian poles, another major significance of mapping the deposits is that an improved understanding of the amount of material being moved around will allow evaluations of the CO_2 gas jet contributions to the circulation of non-volatile materials (dust and sand), with the lighter dust brought up by the jets being injected int the polar atmosphere and deposited in a widespread fashion. This wider distribu-

Figure 2: Planet FOUR interface that shows how to identify and outline fans and blotches in each image subframe. The ellipses are the results of the 'blotch' tool to be used when there is no discernible wind direction

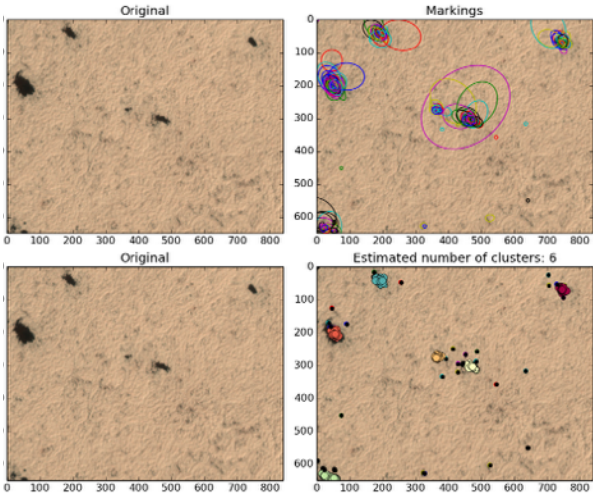

Fig. 3 First results of clustering analysis for the center coordinates of clusters. Note how the algorithms is capable of distinguishing noise entries (colored in black) from data that is taken into account for determining the resulting coordinates (colorful colors).

tion is changing the surface albedo and thus the local energy budget, but also, as an atmospheric aerosol, is contributing to the total atmospheric thermal budget and therefore an important parameter for the characterization of the Martian atmosphere, while its relative contribution to the material circulation is currently weakly constrained. (Initial estimations in [2])

Analysis: Ongoing work is to determine the best clustering algorithm to separate noise entries from useful markings and how to mathematically combine the remaining into cluster (ergo fan or blotch) coordinates and directions (for fans only). Fig. 3 shows preliminary results on these analyses. Upcoming tasks will be to define a quality measure of the chosen clustering scheme against a 'gold standard' set of data that was marked by members of the science team. We estimate to submit a first paper on our results after the summer of 2014.

References: [1] Hansen, C.J., Thomas, N., Portyankina, G., McEwen, A., Becker, T., Byrne, S., Herkenhoff, K., Kieffer, H., Mellon, M., 2010. HiRISE observations of gas sublimation-driven activity in Mars' southern polar regions: I. Erosion of the surface. Icarus 205, 283–295. [2] Piqueux, S., Christensen, P.I.R., 2008. North and south subice gas flow and venting of the seasonal caps of Mars: A major geomorphological agent. Journal of Geophysical Research 113, E06005.