PLANET FOUR: TERRAINS – A CITIZEN SCIENCE PROJECT TO STUDY THE SOUTH POLAR REGION OF MARS C. J. Hansen[1], M. E. Schwamb[2], G. Portyankina[3], K.-M. Aye[3], A. Martin[4], and R. Perry[4], [1]Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson, AZ 85719, cjhansen@psi.edu, [2]Institute of Astronomy and Astrophysics, Academia Sinica, National Taiwan University, Taiwan, [3]Laboratory for Atmosphere and Space Physics, [3]University of Colorado, Boulder, CO, [4]Planetfour volunteer contributors.

Introduction: Planet Four is a citizen science project started 3 years ago. It has the objective of identifying and measuring seasonal fans that cover the polar regions in the south in the spring. At this point in time 135,533 people have participated and almost 5 million cutouts from Mars Reconnaissance Orbiter (MRO) High Resolution Imaging Science Experiment (HiRISE) images have been analyzed, via the web portal "Planet Four" at http://www.planetfour.org. This website is part of the Zooniverse collection of online citizen science projects. Initial results have been reported and a paper is in process [1].

New Planet Four Task. Planet Four: Terrains is an offshoot of the original Planet Four project, found at http://terrains.planetfour.org. We have 5 Mars years of comprehensive HiRISE temporal coverage of the seasonal processes active in southern spring, but only at a limited number of sites. The objective of Planet Four: Terrains is to identify more sites for HiRISE to image, to broaden the overall number and distribution of sites of interest. In particular we are interested in the channels that form due to the sublimation of seasonal dry ice. These are known colloquially as "spiders", more rigorously called araneiform terrain.

Seasonal Activity. Every year dynamic seasonal activity occurs in Mars' polar regions associated with spring sublimation of the seasonal CO_2 polar cap. As the seasonal CO_2 ice cap sublimates a variety of phenomena are observed, well-described by the Kieffer cold jet model [2]. In the Kieffer model penetration of sunlight through translucent CO_2 ice warms the surface below, which leads to basal sublimation of the ice layer. Trapped gas escapes through ruptures at weak spots, entraining surface material which then settles out in fan-shaped deposits oriented by wind or slopes on top of the ice. Gradually troughs are eroded in the surface, often radially organized, or sometimes connected in networks [3, 4].

Planet Four: Terrains: Six months ago we started the Planet Four: Terrains citizen science project. The goal is to use MRO's Context Camera (CTX) images to find interesting places to observe with HiRISE. HiRISE images are very high resolution (~0.5m) but cover only ~6 x 12 km. CTX images cover 30 x 60 km with a spatial scale of ~6 m. [Mars Observer Camera images from the Mars Global Surveyor mission are helpful but the coverage is not extensive enough for this objective.]

Scientifically, more widely distributed coverage will allow us to improve our maps of where araneiform terrain forms and what conditions are key to its development. We can compare the properties of the regions to find trends associated with weather, types of terrain, erodibility of the ground, latitude, etc. Many of the sites HiRISE images regularly are clustered in the cryptic terrain [2] (a region that remains at the CO_2 ice temperature in spite of its dark albedo in the spring), however we have examples of araneiform terrain outside the cryptic region [4].

Figure 1 shows current HiRISE monitoring sites, compared to the widely distributed CTX images selected for this study.

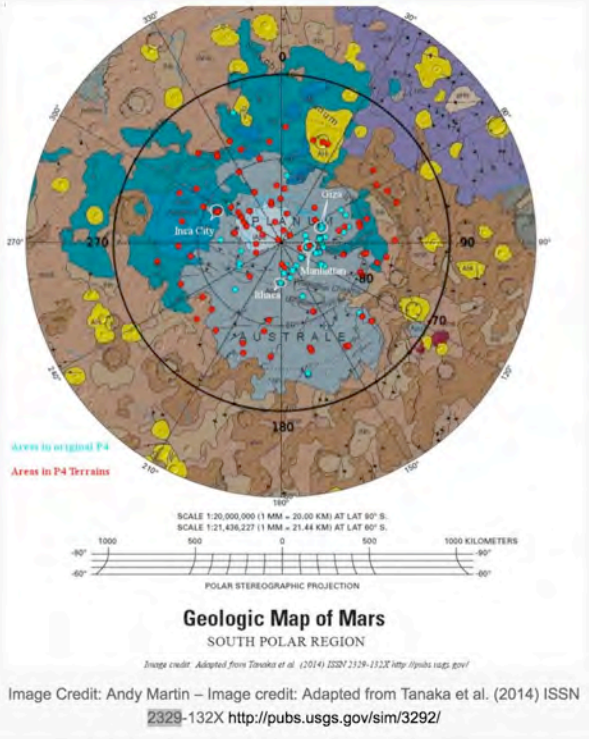

Figure 1. Blue dots mark sites that HiRISE images routinely every year. They tend to be clustered in the cryptic terrain. Red dots mark the CTX image locations selected for this project to broaden the sample distribution across the south polar region.

Each CTX image was subdivided into a number of 800 x 600 pixel cutouts easily managed on a typical home computer. 20,122 cutouts from 91 frost-free CTX images have been staged to-date on the Planet Four:Terrains website at http://terrains.planetfour.org. The site has a brief tutorial to describe the project and spring on Mars. There are chat threads with lively discussions where volunteers can talk about what they see in the images. A user's guide describes more about the features to look for in the images.

Volunteers are asked to identify the following features in the images: spiders, baby spiders, networks of channels, craters, and/or swiss cheese terrain. At this time 10,234 registered volunteers have classified over 380,934 sub-images. Once 20 volunteers have evaluated a sub-image it is retired, and to-date over 14,729 cutouts have been retired. We expect to have the entire data set analyzed by May 2016.

We will then look at the CTX images identified to have spiders, baby spiders and channel networks. The most interesting will be selected for high resolution imaging by HiRISE in the upcoming Mars spring.

Results to-date: A number of images have been identified that show the features we're interested in. We will review this subset of CTX images prior to 5 July 2016, when L_s=180, the beginning of southern spring, to identify new HiRISE targets to enter in our target catalog. We are particularly interested in spiders forming on terrain types not previously analyzed, or at locations away from the current collection of HiRISE monitoring sites. Examples are shown in Figures 2 and 3.

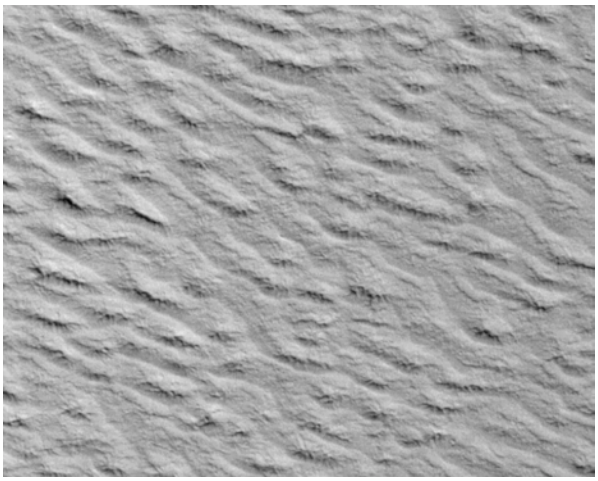

Figure 2. This CTX image from 80S / 204W shows radially-organized channels on underlying terrain that was likely shaped by eolian processes in an area not previously imaged by HiRISE (CTX image ID: D13_032278_0991_XN_80S204W).

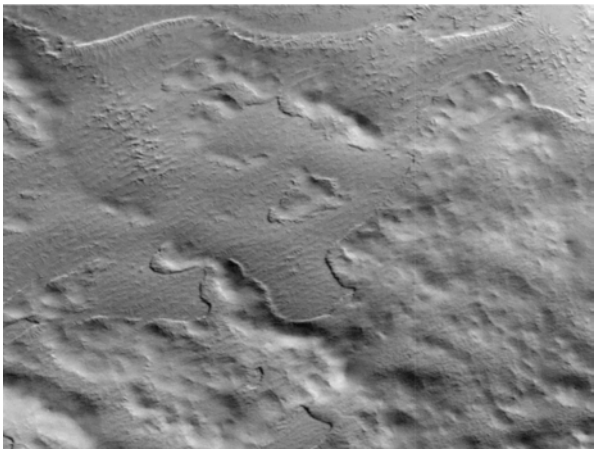

Figure 3. In this CTX image araneiform terrain is forming on the flow but not the underlying surface (CTX image ID: P13_006148_1028_XN_77S342W).

In addition to spiders we will also map the distribution of "Swiss cheese" features, which are pits on the south polar residual CO_2 ice cap. HiRISE has monitored the growth of these pits over time and their sizes and growth rates can inform us of recent martian climate [5].

Noting the location of craters is useful because previous catalogs have not had the resolution of CTX so we expect (and are already finding) that smaller craters are being identified. A total of 450 craters have been identified so far with a confidence level >70%. The crater size / frequency distribution will be used to update the age of the south polar layered deposits.

Citizen Science Alliance: The Citizen Science Alliance is dedicated to involving the public in science and data analysis. They provide the web portal and technical expertise for involving large numbers of volunteers in research projects online (the Zooniverse, described at http://www.zooniverse.org). They have numerous active projects. The zooniverse team developed the Planet Four web portal to engage citizen scientists in the task of cataloguing fans in images from the first 3 southern springs on Mars imaged by HiRISE.

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References: [1] Aye, K.-M. et al., (2015) DPS 47, 420.01; [2] Kieffer, H. H. (2007), JGR 112, E08005; [3] Piqueux, S. et al., (2007) JGR 108, (E8):3-1; [4] Hansen, C. J. et al., (2010) Icarus 205:283-295; [5] Byrne et al. (2015), LPSC 46, 1657.