FACTORS INFLUENCING THE LOCATION OF SUSTAINED COLD, BRIGHT SPOTS IN THE NORTH RESIDUAL CAP OF MARS. J. M. Pocock and W. M. Calvin, University of Nevada, Reno, Geological Sciences/MS172, Reno, NV 89557 (pocock@unr.nevada.edu).

Introduction: Located on the northern residual polar deposits of Mars are a number of high albedo, low temperature areas. The seasonal variations of albedo in these areas were first noted in summer season Viking images, and are consistent with albedo changes found in Mariner 9, MOC and OMEGA imagery [1-8]. The origins and mechanisms controlling these areas remain relatively unknown. Paige et al. [2] viewed the seasonal variations as a response to global dust storms; however, Bass et al. [3] and Cantor et al. [4] noted considerable smaller-scale variations within a season that may not be related to the global circulations.

Area Location: Two persistent bright and cool areas, McMurdo and Vostok, are examined in this study. McMurdo is located at the "source" of Chasma Boreale (~15E, 85N) and Vostok is located at ~ 330E, 87N [9] (Fig. 1). The two spots are identified using the bolometric albedo and brightness temperature channels of the Thermal Emission Spectrometer (TES) on the Mars Global Surveyor spacecraft. They fluctuate in size during the summer, but they have a consistent end of summer high albedo [9].

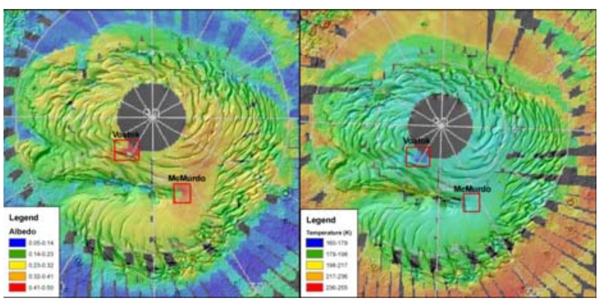

Figure 1: Locations of two bright and cool areas McMurdo and Vostok. Left image: Albedo; Right image: Brightness Temperature. Both datasets overlay MOLA topography. Adapted from [9].

Datasets: Processes thought to contribute to the location and appearance of the two seasonally anomalous areas include surface albedo and temperature, slopes, winds, solar insolation history, grain size, amount of incorporated dust, and surface or subsurface physical properties. In order to explore the contributions from each of these potential factors, datasets are chosen that either directly measure these properties or are related by proxy. Datasets include MOLA elevation, TES albedo and temperature, solar insolation, thermal inertia and GCM wind models.

MOLA data provides a means of identifying and evaluating the topography around the bright and icy areas. The slopes surrounding the areas may reveal mechanisms for cold trapping or directing the circulating winds, which transport ices and dust around the polar cap. The slopes can also distinguish the amount and direction of incoming sunlight, which influences the sublimation and deposition of the ices.

TES data is used in locating the areas, as well as tracking their albedo and temperature changes throughout the summer seasons and from year to year. Additional information on albedo will be derived from MARCI images. Thermal inertia is derived by Putzig et al. [10] from the TES brightness temperature data. Thermal inertia controls the seasonal temperature variations in the near surface and may reveal porosity or compaction properties that lead to sustained low temperatures and subsequent cold-trapping.

Solar insolation data is used to evaluate the amount, intensity and direction of sunlight incident on the bright and icy areas, relative to their surroundings. This information, along with the slope analyses and thermal inertia properties of the ices, can be used to evaluate ice sublimation and deposition in these areas.

OMEGA data is used to reveal the average grain size of water ice and the amount of dust in the ice [11]. Differences in these properties between the immediate bright and icy areas and their surroundings may account for their higher albedos and lower temperatures.

Modeled wind data provides insight into the forces controlling the polar caps [12]. Larger scaled wind models offer a look into mass movement as well as deposition and circulation rates over the entire pole. More localized wind models offer a look at the topographic influences on deposition, circulation and movement at and around the bright and icy areas.

Dataset Correlation: Each data set is integrated into a GIS database using latitude and longitude with MOLA elevation data as a base map. Data sets are integrated using ArcGIS and imported as raster images. To date, MOLA, TES, albedo and temperature data have been incorporated. A model of solar insolation, modeled after Ward [13], has been developed in MatLab and run for selected Ls and latitude ranges. The model assumes a spherical Mars, and calculates the average daily insolation as a function of latitude.

Kriging is used to convert the non-gridded vector data into digital images by estimating the spatial data at nodes of a regular grid. Kriging is a Gaussian, least squares estimation method for spatial data, and applying this algorithm to each dataset standardizes the resolution, and allows for statistical correlations. The spatial correlation of the datasets is revealed using a variogram model. The variogram computes the difference between data values, then squares that difference to obtain a positive or zero result [14]. The resulting model is a measure of the similarity of data values as they increase in distance from each other. The model can also reveal significant trends in the data. The variogram model is further used to define the weights of the kriging function.

Color coding the datasets and building composite images enhances features not originally obvious in the datasets alone.

Initial Results: Preliminary results integrating MOLA, albedo and temperature data shows that the two areas have elevations and slopes (Fig. 2) typical of the polar cap, but different from each other. Vostok is located approximately 500m higher in elevation than McMurdo, which demonstrates that absolute elevation does not appear to be a controlling factor. As seen in Figure 2, both Vostok and McMurdo are located on relatively flat surfaces adjacent to steep scarps. There are numerous other places throughout the polar cap that are located adjacent to similar scarps, yet do not show the bright and cool characteristics of Vostok and McMurdo.

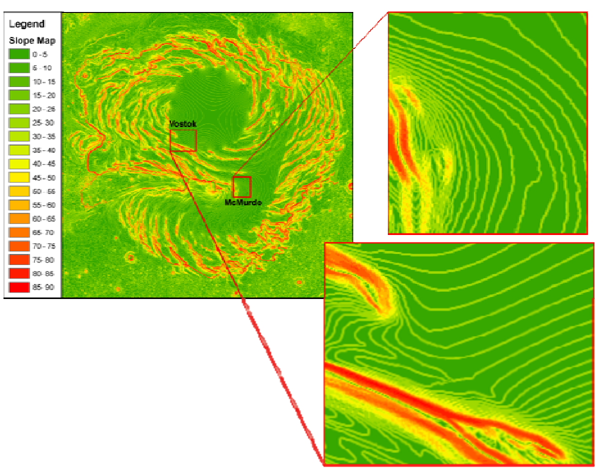

Figure 2: Slope map created from MOLA dataset.

Vostok is located at the terminus of a bright fine-grained ridgeline observed in MARCI and OMEGA data [15], but McMurdo is not seen to have surrounding high albedo areas in higher resolution datasets. At the same time, McMurdo shows more inter-annual variability than Vostok.

An initial look at modeled wind data [12] reveals higher velocity winds circulating the outer extents of the polar cap, and slowing in velocity as they circulate over the cap itself. This slowed flow may lead to an atmospherically calm environment surrounding the two bright and cool areas. The slower flow may also cause heavier dust particles to fall to the ground, affecting the albedo of the surface, and thus, the sublimation rate of the surface ice. The transition from the steeply sloped scarps adjacent to the bright and cool areas to the flat terrain of the areas themselves creates surface wind stresses and pressure gradients, which may affect the deposition rates of frosts over these areas.

We will use regression analysis to examine the relationship between two datasets at a time, while a principal components transform will be used to explore which data sets contribute the largest control on the variance. Initial runs for selected seasons have been performed and we expect to evaluate these statistical correlations both throughout the summer season and between Martian years, and present these results at the conference.

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