COMPARISON OF NORTH AND SOUTH POLAR COLD SPOTS OF MARS: IMPLICATIONS FOR THE GLOBAL DUST STORM OF 2001. C. Cornwall[1,2] and T. N. Titus[2], [1]Department of Geology, Northern Arizona University, Flagstaff, Arizona 86001 (cc269@nau.edu), [2]United States Geological Survey, Flagstaff, Arizona.

Introduction: Cold spots were first observed in the 1970s in the polar regions of Mars by Mariner and Viking [1]. These cold spots were manifested as areas with winter brightness temperatures below the expected kinetic temperatures for CO_2 ice sublimation [1]. Studies of Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) data [2, 3] and Mars Orbital Laser Altimeter (MOLA) data [2, 4] indicate that these cold spots are surface depositions from CO_2 atmospheric condensates and, on rare occasions, are active CO_2 snow storms [2].

This study focuses on some of the spatial and temporal differences found between cold spots in the North and South Polar Ring (86°-87.2° latitude), as well as the effects of the global dust storm of 2001 on southern cold spots. Our analysis shows that the global dust storm may have affected southern cold spot formation long after the storm had ended. South Polar Ring cold spots also showed deviations from normal behavior prior to the storm, which may indicate conditions that allow global dust storms to occur.

Data: Three Mars years of data from MGS TES were used in this study. The observations were divided into two subsets to better observe spatial and temporal values of the Martian cold spots. The first subset contained the polar ring data (latitude 86°S to 87.2°S) and the second subset was "cold spot only" data, where bolometer brightness temperatures less than 135 K were selected.

Polar ring data allowed for more accurate size and half-life estimations due to the high-frequency of repeat coverage. "Cold spot only" data were used primarily to evaluate seasonal and spatial distributions of cold spots outside the polar ring.

Analysis Techniques: For this study, we use data from the TES database and a brightness temperature difference between 18μm and 25μm (T_{18}-T_{25}) to study the spatial and temporal values of the cold spots [2]. Spatial and temporal values are obtained by fitting the TES data to a two dimensional spatial Gaussian convolved with a temporal exponential decay. These fits provide estimates for both radius and amplitude, or intensity, of a cold spot.

Results:

Differences between North and South Polar Ring cold spots. In the South Pole, cold spots are generally restricted to the location of the perennial cap [5,6]. Topographic cold spot activity (caused by orographic lifting near scarps or craters) was less common on the perennial cap than non-topographic activity (forming independently from topography). Intense activity, where one cold spot was indistinguishable from neighboring cold spots, was virtually nonexistent in the south, whereas in the north, intense cold spot activity was extremely common [6, 7]. South Polar topographic cold spot amplitudes were generally lower in amplitude than topographic cold spot amplitudes in the north (see Table 1). Non-topographic cold spot amplitudes were the same in the north and south.

Cold spot sizes (in radii) for the South Polar Region were generally smaller than cold spot sizes for the North Polar Region [6, 7]. South polar topographic cold spot half-lives were equivalent to those in the North Polar Region. South Pole non-topographic cold spots lasted longer than the North Pole non-topographic cold spots by an average of three days.

Averages	South Polar Ring Cold Spots	North Polar Ring Cold Spots
Topographic Amplitude	19°C	23°C
Non-topographic Amplitude	22°C	22°C
Topographic Radius	48km	62km
Non-topographic Radius	51km	78km
Topographic half-life	6 days	5 days
Non-topographic half-life	8 days	5 days

Table 1. Average values for amplitude, size and half-life for north and South Polar Ring cold spots.

Differences between northern and southern "cold spot only" data. Cold spot activity outside the South Polar Ring exhibited 3 times more activity than northern cold spots. Most cold spots formed during the polar night. In the north, cold spots that formed outside the polar night were closely tied to topography [7]. A relationship to topography for southern cold spots was obscured due to the heavily cratered terrain, which may explain the increased activity found in the south. In particular, the informally named Mountains of Mitchel showed extensive cold spot activity year after year, especially in the autumn, which could be related to the bright albedo observed during the spring season [5,8].

Effects of the dust storm on South Polar Ring cold spots. The global dust storm began around L_s ~180°

and ended L_s ~270°[9]. The storm significantly impacted northern cold spot activity and also seems to have affected southern cold spot activity after its occurrence [6,7]. Also, variations in cold spot activity prior to the dust storm may suggest a precursor to the ensuing storm. During the year prior to the storm, there were subtle changes in southern cold spot behavior; topographic activity increased and ended later in the season than the prior winter and also in the years following the dust storm. Amplitudes for topographic cold spots also increased slightly. In MY 26, the year following the dust storm, topographic cold spot radii increased by an average of 22.5 km and non-topographic cold spot radii increased by an average of 15 km. Amplitudes for topographic cold spots continued to rise and by the end of MY 26, there was a difference of 6°C from the cold spot amplitudes studied in MY 24. Non-topographic cold spot amplitudes remained unaffected. Average topographic and non-topographic cold spot sizes were larger in the autumn of MY 26 and MY 26 was the only year, in the south, where intense cold spot activity was present.

Effects of the dust storm on "cold spot only" cold spots. The dust storm had a slightly different effect on the southern cold spots outside the Polar Ring. For the most part, activity was reduced. Cold spots ceased to form equatorial ward of 62ºS latitude, whereas prior to the storm, cold spots were forming as far north as 54ºS latitude. There was also a 52% decrease in activity in the autumn of MY 26 as well as a substantial decrease in cold spot activity in the winter of MY 25 (Fig. 1).

Significance: Among the differences found between the North and the South Polar Ring cold spots, the difference in half-life and size are the most prominent. The longer half-life for South Polar Ring can possibly be attributed to the elevation difference between the northern and southern hemispheres. Outside the Polar Ring, the most obvious difference between the North and South was the amount of cold spot activity, which was probably due to an increase of topographic cold spot activity in the South. The extensive cold spot activity observed on the Mountains of Mitchel, during the autumn and winter seasons, could contribute to the high-albedo features displayed in the spring [5,8].

The changes in cold spot behavior for the South Polar Ring as well as outside the polar ring can be attributed to effects from the global dust storm of 2001. These changes could be due to the blockage of sunlight caused by lingering dust particles in the atmosphere.

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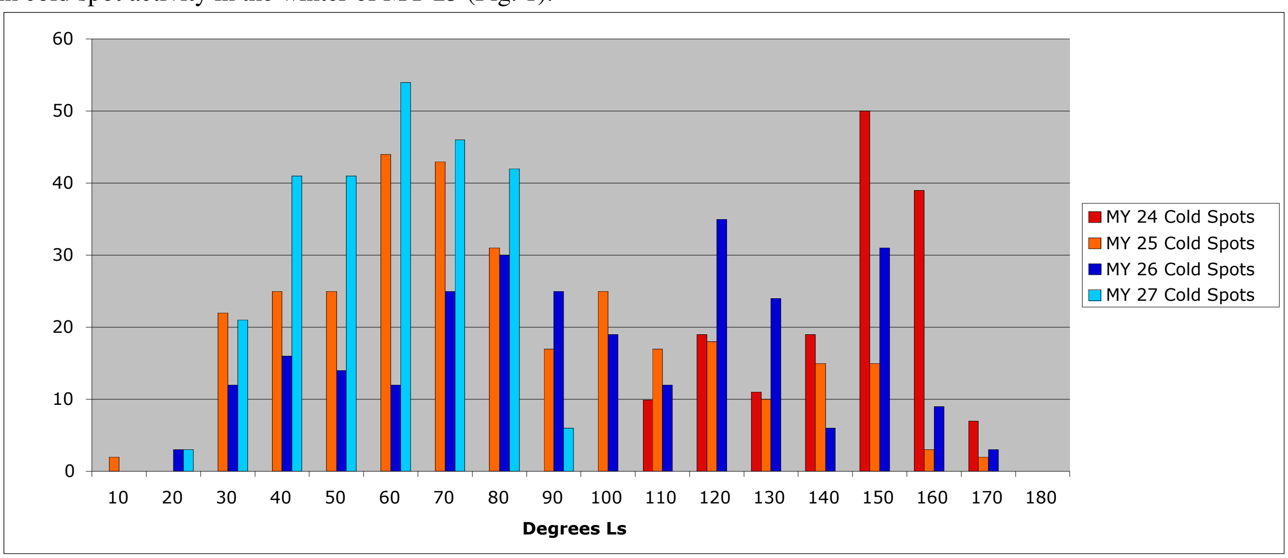

Figure 1: Cold spot activity outside the polar ring for three Mars years as a function of season (Degrees L_s). Mars years 24 and 27 are incomplete due to lack of data.