SOUTH POLAR CRYPTIC REGION REVISTED: THEMIS OBSERVATIONS. T. N. Titus[1], H. H. Kieffer[1], J. J. Plaut[2], P. R. Christensen[3], A. B. Ivanov[2], and the THEMIS Science Team[3], [1]USGS, 2255 N. Gemini Dr., Flagstaff, AZ 86001; email: ttitus@usgs.gov, [2] JPL, Pasadena, CA, [3] ASU, Tempe, AZ.

Introduction: The early part of the Mars Global Surveyor mission provided good TES coverage of the Mars south polar region. These data allow mapping of the polar cap recession, surface and atmospheric temperatures, and albedo features found within the seasonal cap itself [1,2] over L_s = 180° – 270°. During this period, the seasonal south polar cap retreated continuously and asymmetrically around the geographic pole, similar to the observations of Viking in 1976-1977 [3]. A prominent albedo feature on the seasonal cap is a region that appears almost as dark as bare ground, yet remains cold. (See Figure 1.) We refer to this region, generally located between latitudes 85°S and 75°S and longitudes 150°W and 310°W, as the Cryptic region.

Past Observations: A re-examination of the IRTM data revealed that the Cryptic Region was not unique to the TES era, but also was apparent during the Viking IRTM era. (See Figure 2.) Interestingly, Antoniadi [4] observed dark regions forming on the seasonal cap that loosely correlate to the Cryptic region: Depressio Magna (1909) and Depressio Parva (1929). These *depressios* were located at 270° W, 78°S and 166° W, 76°S, respectively.

Analysis of both the TES and IRTM data indicate that the Cryptic region is unique in its thermophysical properties relative to the rest of the cap. The region occupies the same general area from year to year. It is darker and slightly warmer than the rest of the south polar cap. Even though the Cryptic region is slightly warmer, it must still be CO_2-buffered since it remains "cold" for several days.

Spectral analysis of the TES data longward of the 15-micron atmospheric band shows that the Cryptic Region shows less spectral contrast than the rest of the polar cap. This suggests that the region may be composed of "ice," as opposed to snow or frost [5].

The Vent Hypothesis: Since the initial discovery of the Cryptic Region, several surface features, referred to as spiders, fans, and Dalmatian spots on the basis of their appearance, have been seen. The fans and spiders correlate to the location of the Cryptic Region [6]. Kieffer [7,8] suggested that the spiders, fans, and Dalmatian spots are the result of CO_2 vents, caused by basal heating of CO_2 deposits. This can only be possible if the CO_2 is at least partially transparent to visible solar radiation and opaque to thermal IR, thus creating a solid greenhouse effect. The CO_2 would sublimate from the bottom of the ice slab, thus building up pressure until the gas can be released through a vent. The gas would transport dust from underneath the ice, through the vent, resulting in dust plumes. This hypothesis is consistent with past observations.

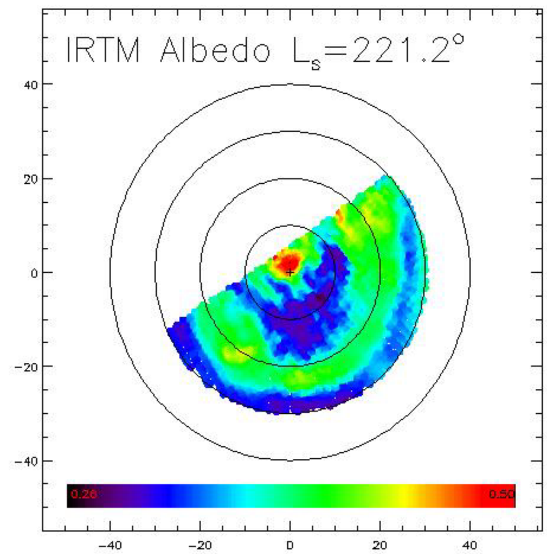

Figure 1: Viking IRTM Albedo Mosaic. This is a mosaic of IRTM visible data taken at L_s = 221.2°. The dark blue feature near the center of the image is the Cryptic region. The latitude lines are drawn at 10° intervals and 0° longitude is up. The region poleward of 65°S is at CO_2 temperatures.

THEMIS Results: THEMIS has the advantage over previous observations in being capable of taking VIS and IR images simultaneously at 18-meter and 100-meter resolution, respectively. Early in the spring, THEMIS observations of Dalmatian spots showed no thermal structure that differentiated the dark albedo areas from the rest of the surrounding seasonal cap. However, by L_s = 206°, thermal structure could be seen. (See Figure 2.) The warmer areas have an increase in brightness temperature of only 5 K over thermally bland areas that are covered by seasonal CO_2 deposits, which is consistent with TES observations at the 3 km scale [9]. These warm areas loosely correlate to the darker albedo areas, as seen in Figures 2 and 3. The spectra of a thermally bland area and an area interior to the three-legged "starfish" show an increase in brightness temperature over the spectral range of 9 μm to 12.5-μm. There are two possible causes for the increase in brightness temperature between these two areas: either the "starfish" surface is warmer than

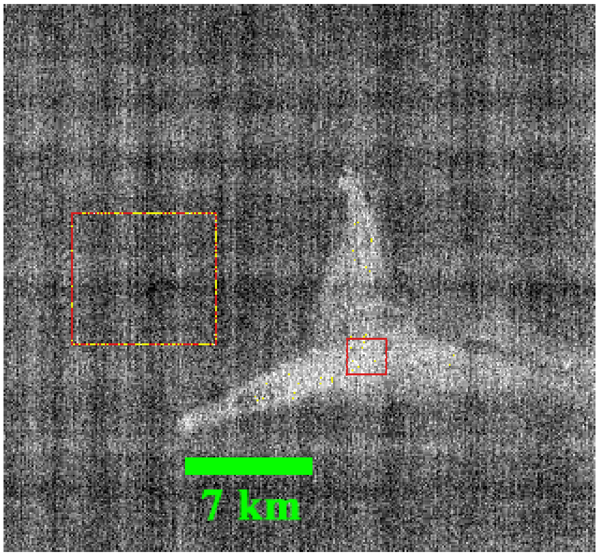

Figure 2: THEMIS IR Image I06707008 (Band 9). This THEMIS IR image shows thermal structure on the seasonal CO2 cap. Spectra were extracted from two locations, the center of the "starfish" and a thermally bland region, representative of seasonal CO_2.

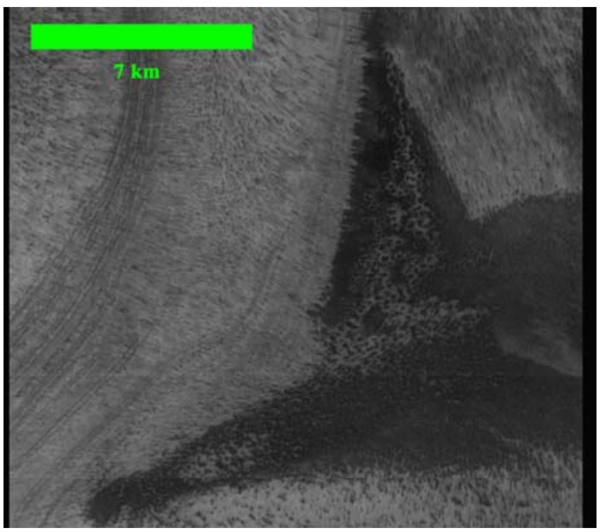

Figure 3: A THEMIS VIS Image V06707009. This THEMIS VIS image shows the same location as the IR image in Figure 2. Notice that the dark albedo region only loosely correlated to the thermal structure seen in Figure 2.

the surrounding area or the local atmospheric opacity is greater than the surrounding atmosphere. If the increase in brightness temperature is due to an increase in the kinetic temperature of the surface, then the spectra have an absorption feature at 11-12 µm. However, if the increase in brightness temperature is due to in increase of atmospheric opacity, perhaps from a nearby dust plume, then the spectra have emission features at 9-10 µm and 12.5 µm. The 9-10 µm spectral region is where atmospheric dust has a peak in opacity. The 12.5-µm region is where water ice clouds have a peak in opacity. The combination of these two spectral peaks in brightness temperature is suggestive of water ice-coated dust grains. Atmospheric emission features are a more plausible explanation of the THEMIS spectra than is an absorption feature at 11-12 µm. The atmospheric opacity explanation of the THEMIS spectra is consistent with the geyser hypothesis.

Summary: We will present the most current THEMIS observations of the Cryptic region. These data, combined with TES data and MOC imaging, will be used to test the Kieffer geyser model.

References: [1] Kieffer, et al. (1998) In LPSC XXIX, Abstract #1481. [2] Titus, T., et al. (1998), BAAS, vol. 30, no. 3, 1049-1050. [3] Kieffer, H.H. (1977) JGR, 82, 4249-4291. [4] Blunck, J (1977) "Mars and its Satellites: A detailed Commentary on the Nomenclature". [5] Hansen,G. (1998) JGR, 104 , 16,471. [6] Piqeux, S. (2003) JGR, Submitted. [7] Kieffer, H. H. (2001) Second International Conf. On Mars Polar Sci. and Exploration, #1057. [8] Kieffer, H. H. (2003), Sixth International Conference on Mars, #3158. [9] Kieffer, H. H. et al. (2000) JGR, 105, 9653.

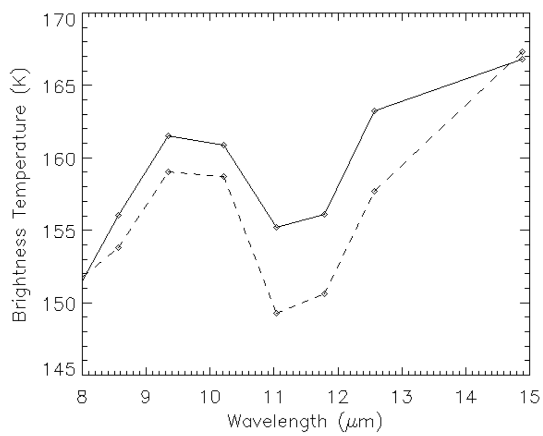

Figure 4: THEMIS IR Spectra. This is a plot of two spectra extracted from THEMIS image I06707008. The solid line is the spectrum extracted from the area inside the small red box (Figure 2). The dashed line is the spectrum extracted from the area in the larger red-yellow box (Figure 2). The 15 µm brightness temperature is an atmospheric temperature.