ESTIMATION OF CO₂ COVERAGE ON MARS' SOUTH POLE: AN INTERANNUAL ASSESSMENT.
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Introduction:
Mars has a south polar perennial cap that is probably water ice covered by a veneer of CO₂ ice. Summer observations of the south polar residual cap suggest that the thin veneer of CO₂ might be disappearing. [3] If indeed the CO₂ is disappearing, this effect should be apparent in interannual variation of the residual CO₂ areal coverage. If the areal coverage of the CO₂ ice in the summer is decreasing, this may suggest a warming trend at the south polar cap.

Interannual differences in the polar caps have also been observed by both terrestrial telescopes and orbital spacecraft. By analysis of thermal radiance as observed by Mars Odyssey Thermal Emission Imaging System (THEMIS), we are able to estimate the areal CO₂ coverage in mid-summer. By tracking interannual differences, we can monitor changes in the areal coverage of CO₂ ice.

Data:
Preliminary results shown here were taken with calibrated THEMIS infrared images for Mars years 25, 26, and 27. [4] We restricted the analysis to the mid-summer season for greatest contrast in thermal radiance between three thermal units of interest: CO₂ ice, suspected H₂O ice, and volatile free regolith. For interannual comparison between years 25 and 26, only Ls 330° to 334° data is available. Similarly for years 25 and 27, only Ls 318° to 323° could be used. There is not enough temporal overlap to make comparisons between years 25 and 26. See figure 1.

Data Analysis:
Four regions were selected for analysis of interannual comparisons. These regions were confined to areas with multiyear image overlap and selected for greatest variance in geographical location on the edge of the perennial cap. Side-by-side comparisons of these selected regions are shown in figures 2 through 7.

Results:
Regions A (4.0° E, ¯86.0° N) and B (283.3° E, ¯84.2° N), from years 25 and 27, demonstrate an increased coverage of CO₂ ice. This is best seen on the boundaries between CO₂ ice and the volatile free regolith; see the bottom of figure 3a) and the top of figure 4a). Temperatures consistent with water ice dominate the areal coverage on this boundary in year 25. In year 27, the green area where we saw temperatures of ~180K remains covered by CO₂ ice; see figures 3b) and 4b).

Regions C (324.0° E, ¯84.4° N) and D (340.6° E, ¯85.7° N) are even more dramatic. The increase in overall contrast advocates that the CO₂ coverage has increased, and is not an artifact of image calibration. This is the most significant interannual regional comparison; a very large region that was once likely exposed water ice on the right hand side of figure 6a) is now nearly completely covered by CO₂ ice in figure 6b). Likewise in figure 7a), the probable surface water ice on the top left is replaced by CO₂ ice in figure 7b). Regions C and D also have the smallest variation in solar longitude.

Conclusion:
Initial results suggest that the areal coverage of the CO₂ veneer on the edge of the polar cap maybe expanding, and is certainly not likely shrinking. This is shown in the interannual differences between both year pairs in all four regions selected. Possible seasonal effects still need to be investigated. We also will present comparisons of the THEMIS images shown here with OMEGA and Mars Orbital Camera (MOC) images for greater temporal and spatial coverage.

References:
Figure 2: Selected regions for interannual comparison between years 25 - 27. The large latitudinal separation provides for a good opportunity to distinguish any longitudinal translation in the CO2 veneer.

Figure 5: Selected regions for interannual comparison between years 26 - 27. Though not highly pronounced, the ~2° N separation between selected regions here allows us to observe latitudinal movement.

Figure 3: Region A, 4.0° E, ¯86.0° N. This region shows signs of an increase in CO2 coverage. This is best seen in the lower part of both frames. In year 25, there is a large edge at ~180K (seen in green) between the CO2 and regolith. In year 27, that edge is significantly reduced; the CO2 ice now occupies much of the area where we suspect water ice once was.

Figure 6: Region C, 324.0° E, ¯84.4° N. This region shows very strong and well-pronounced signs of regional cooling. The CO2 ice is largely more expansive in year 27, occupying what was originally an intermediary section. Although there is a 2° difference in LS, the contrast between the two years is great enough that this is probably not an intraannual effect.

Figure 4: Region B, 283.3° E, ¯84.2° N. This region also does not show signs of CO2 ice reduction; rather, it shows more CO2 ice in year 27. Once again, the CO2 ice has infringed where the intermediate thermal section once was. Because we do not see a reduction here coupled with an increase in Region A, or vise versa, we cannot suggest that the cap is moving. This evidence suggests that the cap is instead growing in size.

Figure 7: Region D, 340.6° E, ¯85.7° N. The water ice here has been largely replaced with CO2 ice in year 27. Because we see an increase in over all contrast, the effects shown are not likely from any calibration error in THEMIS thermal radiance.