EVOLUTION OF THE MARTIAN SOUTHERN SEASONAL POLAR CAP EMISSIVITY DURING SPRING OF MY24-26. A. Pankine\textsuperscript{1,} \textsuperscript{1}Space Science Institute, 4765 Walnut St, Suite B, Boulder, CO 80301 (apankine@spacescience.org).

**Introduction:** Seasonal Polar Caps (SPC) form on Mars from condensing atmospheric CO\textsubscript{2} each winter and recede during spring. A small patch of CO\textsubscript{2} ice dubbed Southern Polar Residual Cap (SPRC) is present year-round near the south pole. The temperature of the surface CO\textsubscript{2} ice in equilibrium with atmosphere is maintained near 140 K. Early observations from orbiting spacecraft revealed brightness temperatures significantly below the equilibrium temperature over portions of the SPC [1]. Later analysis [2, 3] suggested that this ‘cold spots’ are due to low surface emissivity associated with the presence of fine-grained CO\textsubscript{2} ice on the ground. This work presents the first systematic retrievals of SPC surface emissivity during southern spring (Ls=180–270\degree) using data collected by Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) [4] in Mars Years (MY) 24, 25 and 26. Evolution of the SPC in the Southern Polar region (SPR) was analyzed in [5] using TES data from the pre-mapping aero-braking phase of the mission (MY23 Ls=180–360\degree MY24 Ls=0–24\degree). This work expands this analysis to data collected during the mapping phase of the mission and uses a different retrieval approach. MY24 and MY26 were ‘typical’ Mars year with relatively low dust opacities over southern SPC during spring, while in MY25 a Global Dust Storm (GDS) developed in the early spring (at Ls~185\degree) significantly increasing dust opacities over SPC until late spring.

**Retrieval methodology:** Retrievals of surface emissivity and atmospheric dust opacity over Martian SPCs is a difficult problem. Low surface and atmospheric temperatures result in a low thermal contrast between atmosphere and surface, and a weak spectral signal for surface emissivity and atmospheric dust (see Figure 1 for examples of TES spectra over southern SPC). In addition, TES spectra of cold targets are significantly affected by a radiometric error at wavenumbers larger than ~800 cm\textsuperscript{-1}, which produces an upward slope or very low radiances at this spectral range [6]. To alleviate these problems, the dust opacity \(\tau\) and surface emissivity \(\varepsilon\) are retrieved using TES radiances observed at wavenumbers 264 cm\textsuperscript{-1} and 508 cm\textsuperscript{-1} (corresponding to wavelengths of ~40 \(\mu\)m and ~20 \(\mu\)m, respectively). At these wavenumbers the dust extinction differs by a factor of ~2, while the CO\textsubscript{2} frost emissivity is similar for a wide range of ice grain sizes [5]. This allows distinguishing the effects of atmospheric dust from surface effects in the TES spectra. The surface temperature was fixed to the condensation temperature of the CO\textsubscript{2} ice over the SPC. To improve the quality of the data, 10 consecutive spectra were averaged. To improve retrieval accuracy, only the data collected between local times of 8 am and 8 pm, and only when the sun is above the horizon, were used in the retrieval. Figure 1 shows examples of TES spectra and retrievals over southern SPC in MY24.

**Results:** Figure 2 shows polar maps of retrieved thermal reflectance (1-\(\varepsilon\)) at 20 \(\mu\)m at selected time periods during southern hemisphere spring (results for atmospheric dust retrieval will be presented elsewhere). CO\textsubscript{2} emissivity varies across the SPC and with time. At the beginning of spring high reflectance (low emissivity) areas are found near the outer edge of the SPC between longitudes 225\degree–360\degree–45\degree E. After Ls~245\degree high reflectance area occupies most of the area of the receding SPC. The spatial and temporal evolution of CO\textsubscript{2} emissivity is remarkably similar in the observed years (MY24–MY26) and also consistent with the evolution observed in MY23 [5]. The areas of high reflectance (low emissivity) were previously interpreted [2,3,5] as areas with small CO\textsubscript{2} ice grains. From comparison with emissivity estimates based on Mie modeling [7] the CO\textsubscript{2} particles in these areas have sizes between 1 mm and 1 cm with possible admixture of H\textsubscript{2}O.
ice and/or dust. The areas of high emissivity are interpreted as CO$_2$ grains larger than 1 cm and slab ice.

Figure 2. Polar maps of retrieved surface thermal reflectance (1-ε) at 20 μm in the SPR for Ls=195-260° in MY24–26. Outer edge of the map is at latitude -50°. East longitudes increase clockwise from top. Light contours are MOLA topography, heavy contour is approximate edge of the SPC.

The peculiar asymmetry in distribution of CO$_2$ grain sizes across SPC was previously interpreted as being due to two different deposition regimes arising from atmospheric circulation modified at the SPR by the large-scale topography of the Hellas impact basin (centered on 25° S and 65° E, upper right on maps in Figure 2) [8]. Over areas west of the Hellas, where low CO$_2$ emissivity areas are found, atmospheric precipitation dominates over surface deposition, forming smaller grains. East of the Hellas frost is accumulated by direct deposition, forming larger grains and dark CO$_2$ slab ice.

References: