CLIMATOLOGICAL GROWTH AND RECESSION CYCLES OF THE MARTIAN SEASONAL CAPS USING THERMAL EMISSION SPECTROMETER (TES) AND MARS CLIMATE SOUNDER (MCS) DATA.
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Introduction: Nearly five decades after the pioneering results of Leighton and Murray [1], accurate modeling of the martian CO_2 caps' behavior still represents a significant challenge linked to the difficulty of balancing the polar energy budgets. Important efforts are currently undertaken by the community to better constrain the albedo and emissivity of the polar materials [2, 3], the exchange of heat with the atmosphere and subsurface [3, 4], as well as other fluxes [5, 6]. This work contributes to this effort by providing climatological (i.e. median) seasonal CO_2 cap edge maps derived from eight Mars Years (MY) of surface observations by TES and MCS during clear years.

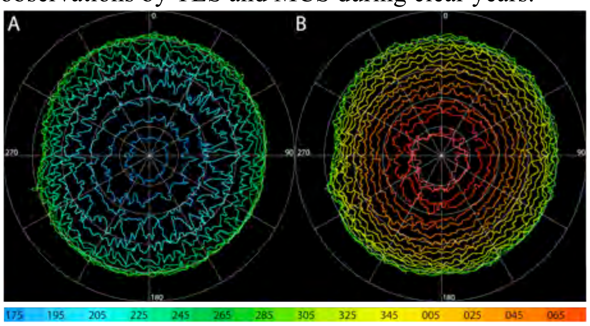

Figure 1: Example of North cap edges for a complete growth (A) and recession (B) cycle. MCS, MY30-31.

Methods: The cap edges are defined using the method presented by [7]. It is based on comparing PM and AM surface brightness temperature maps acquired at ~32μm (MCS channel B1) to identify terrains with limited (i.e. <5K) diurnal temperature variations: bare soil experiences large diurnal temperature variations (10's of K) whereas CO_2 ice temperature is virtually constant. MCS channel B1 is selected for its advantages with polar material identification: mapping independent of illumination conditions, CO_2 and H_2O ices discriminated based on their thermal behaviors, high transparency of the atmosphere, possibility to emulate a B1-like filter with TES to extend the record to MY24, and brightness temperatures closer to surface kinetic temperatures than otherwise derived with previously used shorter wavelengths windows. Examples of cap edges are shown in Figure 1.

While a sufficient record of cap behaviors during and after global dust storms is not yet available (only two major events monitored, in MY25 and MY28), sufficient data is available for clear years to define median cap edge behaviors.

Existing cap edge maps show localized seasonal and inter-annual variability associated with 1) seemingly randomly located changes with no apparent connection with regional/global climate [7,8], and 2) variability that may be primarily due to the data acquisition and treatment methodology. This localized variability may not be meaningful in the context of climate modeling or general cap edge location prediction and will be eliminated to retain first order seasonal changes.

Our approach consisting in averaging data over multiple clear MY mitigates these known issues 1) by filtering out small-scale non-repeatable edge patterns (Figure 2), 2) by eliminating non-realistic etched edges at the time of extreme growth rate (Figure 1), and 3) by averaging local variations in dust/sand distribution on the cap in Cryptic terrains (Figure 2).

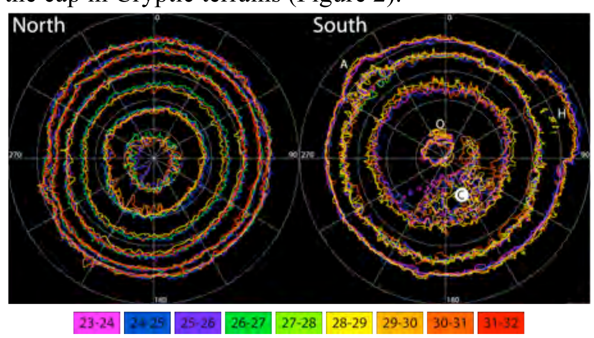

Figure 2: Example of seasonal and inter-annual variability of North and South cap edges. H: Hellas; A: Argyre; C: Cryptic Region; O: Water Ice Outlier.

Outlook: We will present climatological cap edge maps as a function of the season (1 ppd and 10° L_s resolution), which will be useful benchmarks for climate models. These maps will also be available in electronic format as auxiliary material with [7].

References: [1] Leighton, R.B. et al., (1966), Science, 153, 136-144. [2] Paige, D., et al., (1992), Icarus, 99,15-27. [3] Wood, S., et al., (1992), Icarus, 99, 1-14. [4] Haberle et al. (2008), Plan. Space Sci., 56, 251-255. [5] Brown, A. et al. (submitted). [6] Hayne, P., et al. (2012), JGR-Planets, 117, 10.1029/2011je004040. [7] Piqueux, S., et al., (submitted), Icarus. [8] Benson, J., et al., (2005), Icarus, 174, 513-523.