ESTIMATING THE RATE OF GROWTH OR SHRINKAGE OF THE AMUNDSEN CRATER PSR AREA

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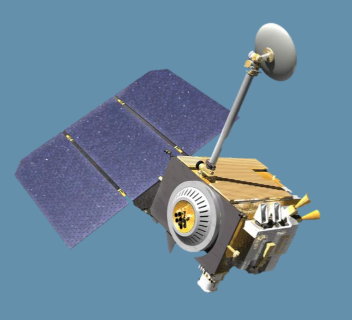


INTRODUCTION

- Permanently shadowed regions (PSRs) contain some areas [Figure 1] where frozen volatiles can be observed at the lunar poles. They have maximum surface temperatures < 100 K [1, 2].
- Surface temperatures in these shadowed regions are largely controlled by reflected sunlight and irradiated infrared light from adjacent topography [3-6]. These areas are cold traps, capable of accumulating water and other volatile compounds over time [7].
- There is a lack of understanding regarding the surface thermal changes at these PSRs, particularly how these pockets of < 100 K temperatures change on a yearly basis and may inhibit growth or shrinkage of volatile accumulation or ablation, respectively.
- Here, we measure the bolometric temperatures derived from Diviner over several years (2010-2016).

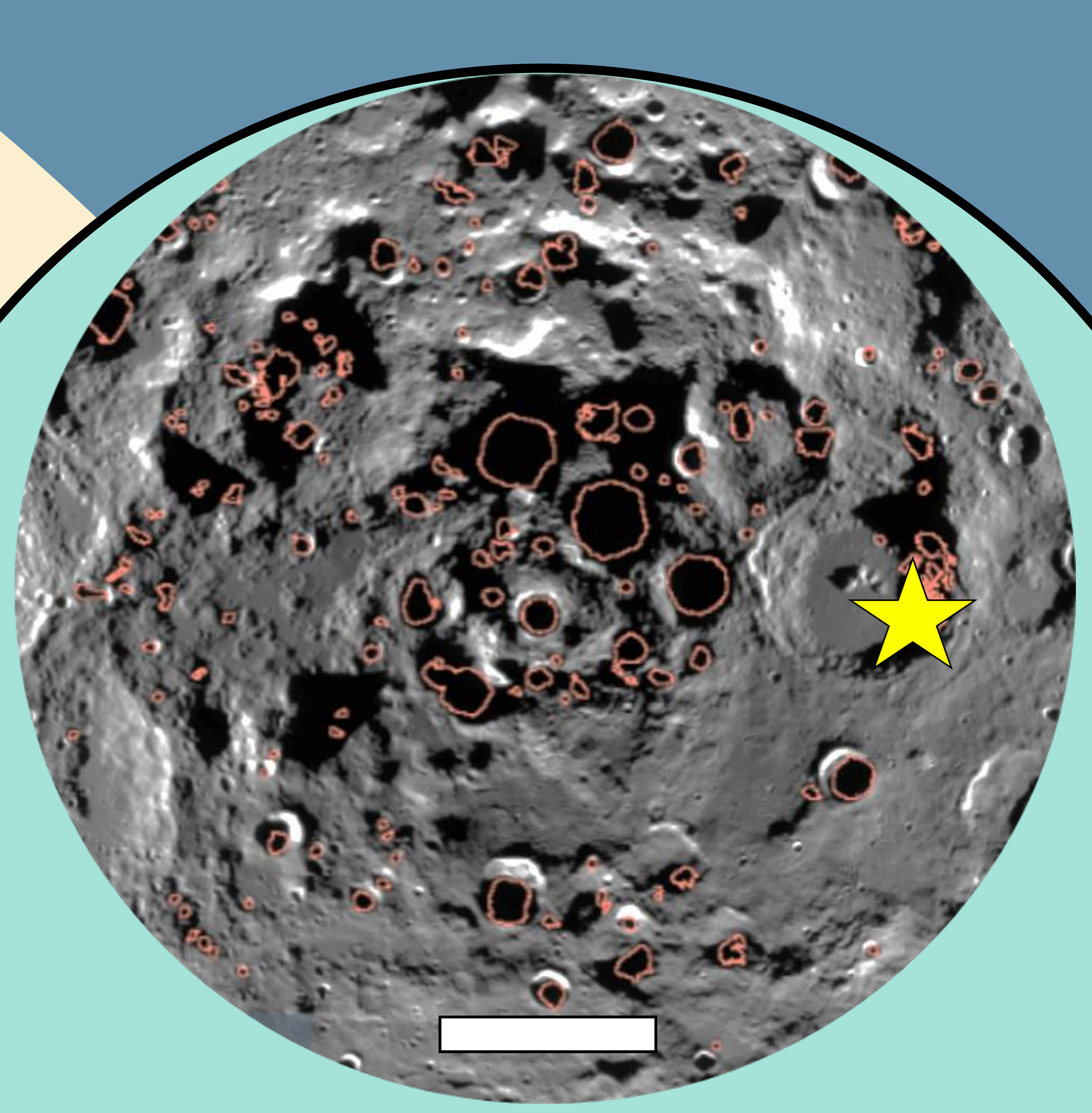


FIG 1: PSR map of the lunar south pole (from LROC QuickMap), with Amundsen PSR at star. Scale bar = 100 km

METHODOLOGY

- LROC Wide Angle Camera (WAC) and Diviner data were used, all publicly available on the Planetary Data System (PDS) Geosciences Node, together with the Java Mission-planning and Analysis for Remote Sensing (JMARS) software.
- Average Diviner temperature data was available at a resolution of 500 m/px [8]. The day and night bolometric temperatures (brightness temperatures of the individual Diviner spectral channels) were measured.
- The temperatures [Figure 2] were then used to form part of the PSR "profile" [Figure 3]- which consists of the length of the PSR from a designated central point and the temperature.
- The snow line [Black line in Figure 3], adapted [9], separates colder areas (Accumulation Areas) and from warmer regions (Ablation areas) where the melting exceeds the accumulation of ice and thus the PSR will experience a loss of ice, defined as "*shrinkage*".
- Temperature fluctuations could influence the accumulation dynamics of the PSR cold spot area. Excessive illumination and rise in temperatures would potentially cause the PSR to decrease in area (and vice versa with colder temperatures) [Figure 4].
- Here, we measure the bolometric temperatures derived from Diviner over several years (2010-2016).

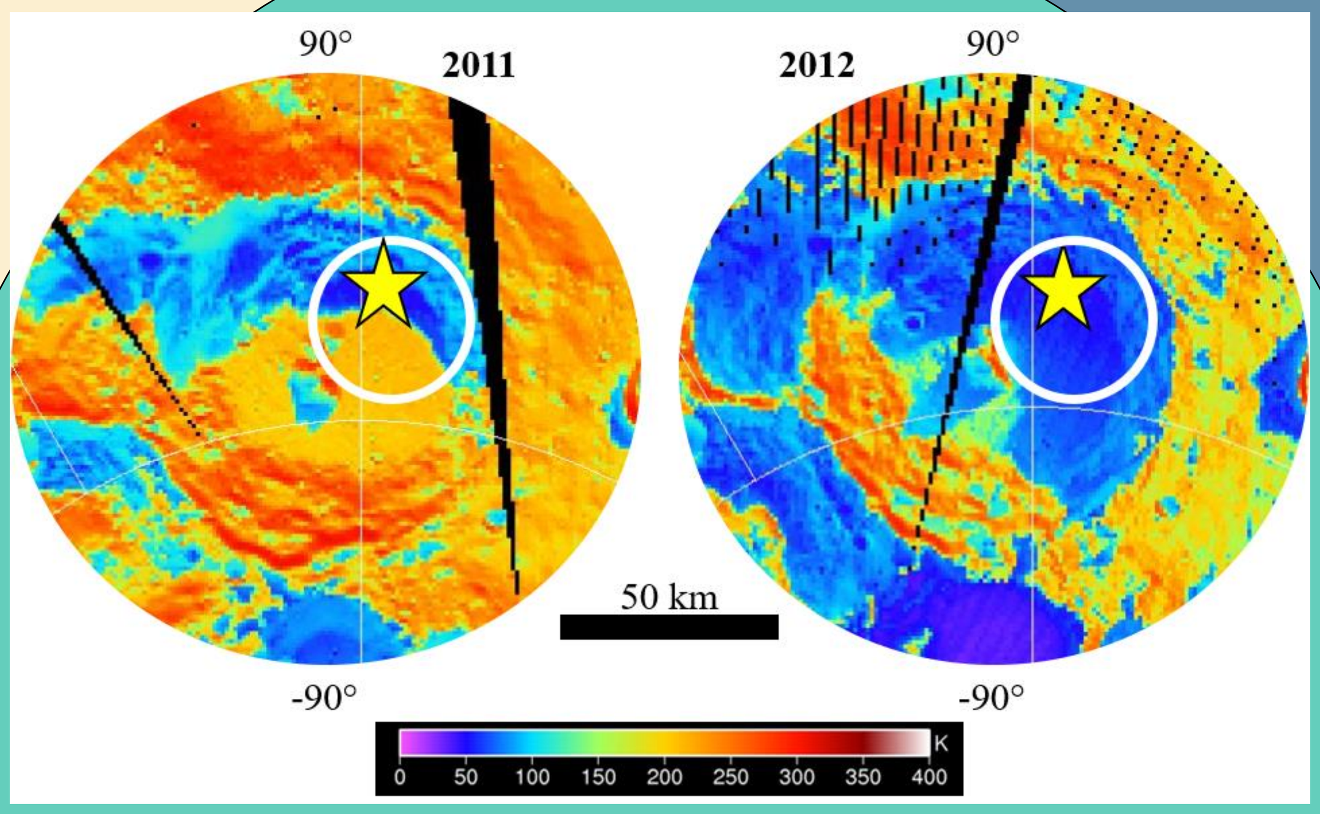


FIG 2: Amundsen crater with Diviner temperature overlay, with the darker blue areas exhibiting colder (< 60 K) temperatures. White circle shows the measured area within Amundsen, with the yellow star indicating the observed PSR location.

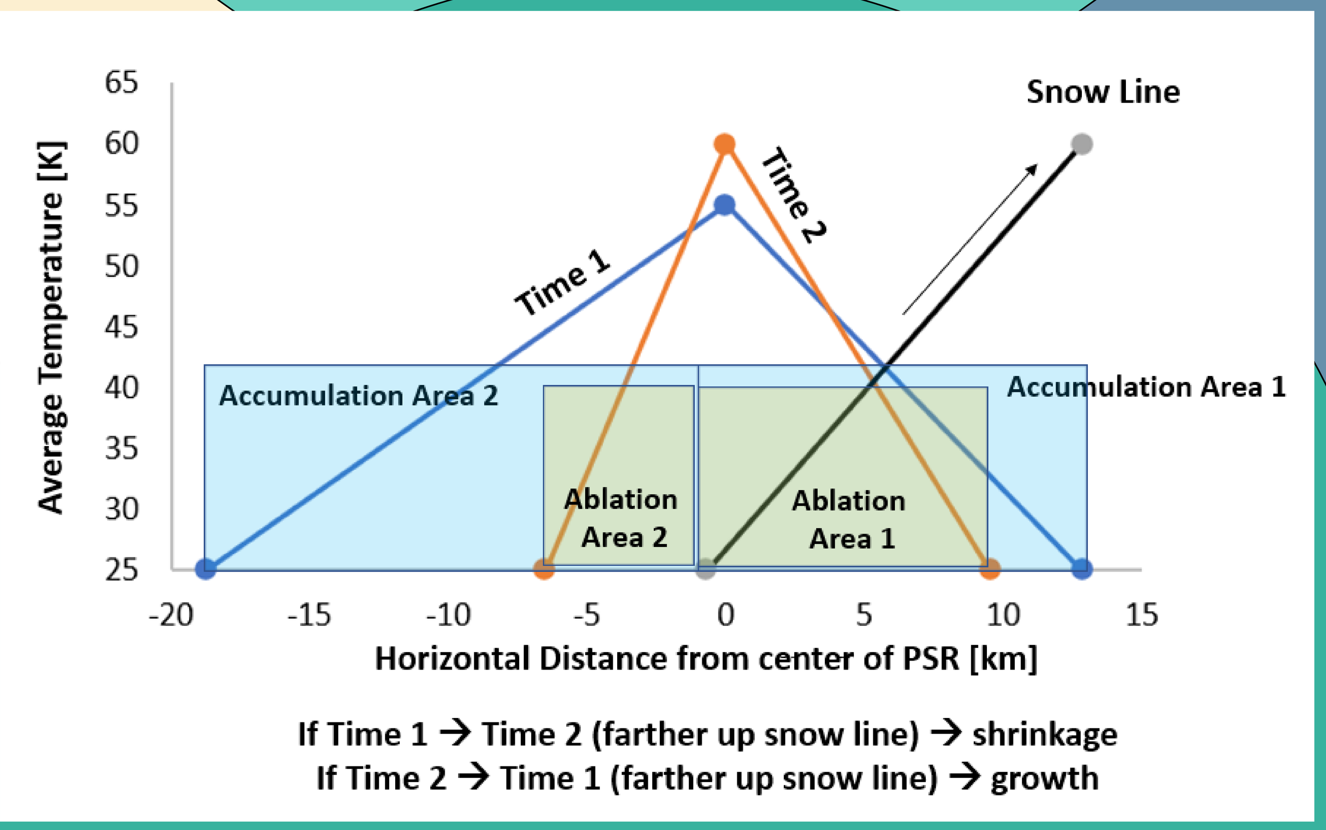


FIG 3: Example of Snowline Profile at a PSR. Time 1 (blue line) vs. Time 2 (orange line) with snowline (black line) intersecting.
This intersection determines the area in which ablation and accumulation are calculated, and how much did the PSR area rate grow or shrink

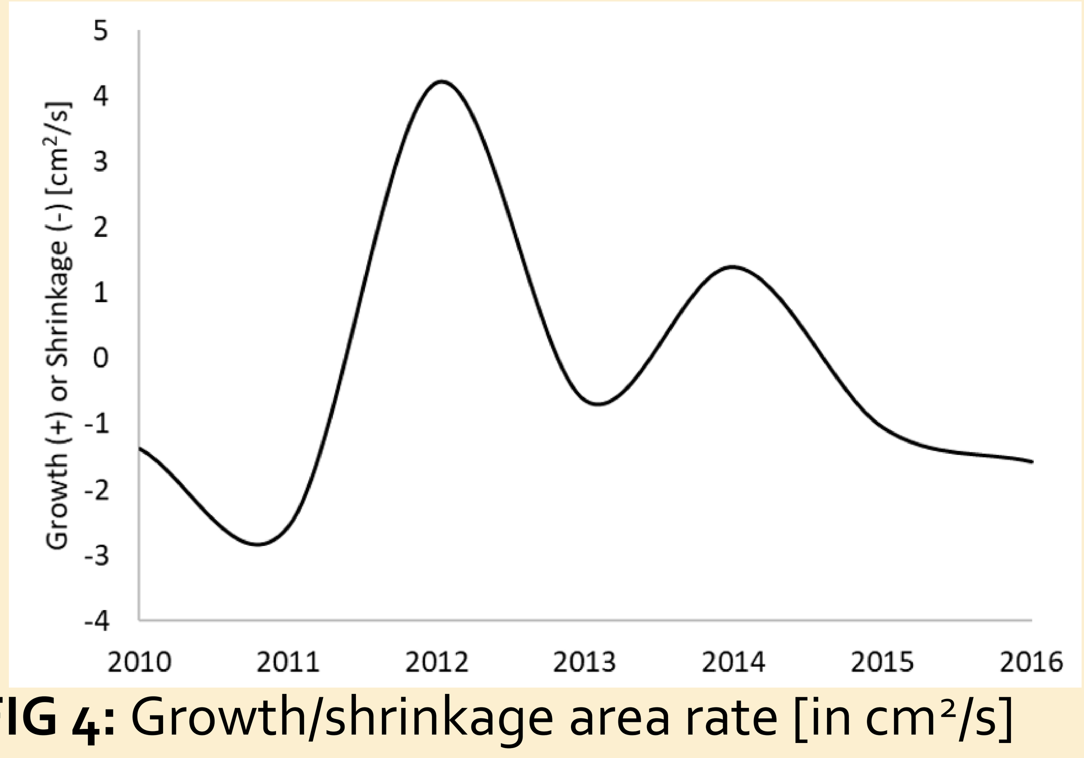
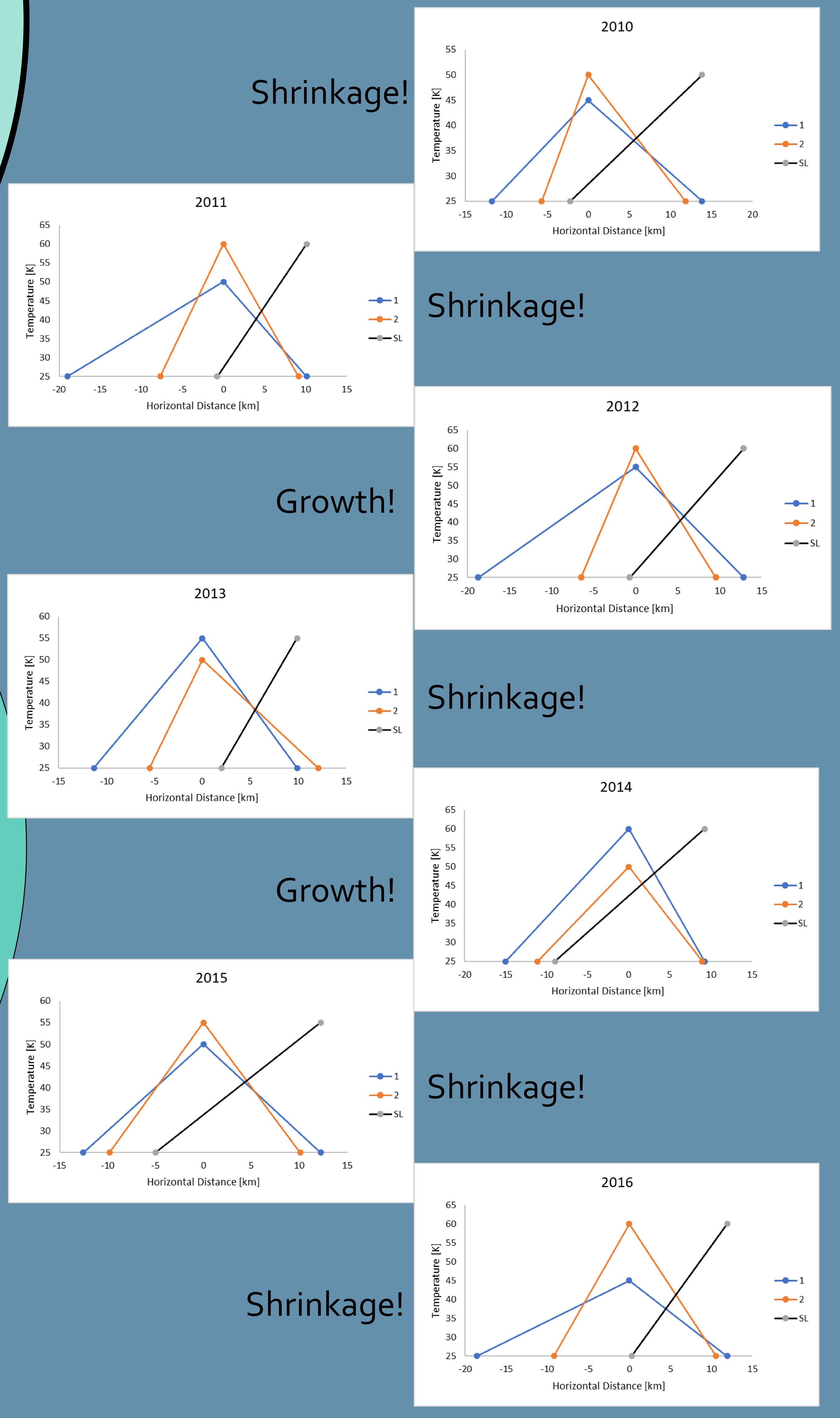


FIG 4: Growth/shrinkage area rate [in cm²/s] curve for Amundsen Crater PSR from 2010 – 2016.

RESULTS

FIG 5: Amundsen PSR snow line profiles for 2010 – 2016. Blue lines are the beginning-of-year profiles, orange lines are the end-of-year profiles. The black line is the measured snow line, where intersections higher up (top-right) on the snow line indicates more ablation (shrinking area rate).



CONCLUSIONS

We find that temperature variations are associated with the accumulation or ablation of volatiles within lunar PSRs and can be used to estimate the amount of growth or shrinkage of the PSR area on a yearly basis. Observing the differences in growth and shrinkage can give us insight to the regolith properties and the dynamics between the PSR and its respective crater (especially with transient seasonal illumination differences). These PSR craters have the potential to address key lunar exploration questions, especially the perspective on volatile distribution and regolith properties outlined in the Planetary Science Decadal Survey, Visions and Voyages [10].

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