Title: Linking climate and geology: The recent accumulation of north polar ice on Mars
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Abstract

Martian obliquity and orbital oscillations have been minor over the past few tens of thousands of years (argument of perihelion variations have dominated any climatic change). Understanding how the north polar layered deposits (NPLD) and its icy outliers have accumulated in that time period is an achievable goal as climate is unlikely to vary radically from that of today. If we can understand the recent past then we can apply this knowledge to leverage understanding of the much longer record (10^3-10^4 Kyr) of climate change recorded in the NPLD. In addition, the stability of mid-latitude ground ice is thought to have fluctuated significantly over these timescales. The polar deposits are both the source and sink of this material as mid-latitude ice waxes and wanes in extent. Determining the mass balance of the polar deposits also constrains the behavior of these mid-latitude deposits and the recent history of water on Mars in general.

Annually-averaged near-surface water vapor, and how it varies with time and location, is the most critical climatic parameter to unravel the history of water movement on Mars. Here we propose to further develop existing thermal models to investigate polar ice accumulation and ablation and utilize the following two constraints to solve for the temporal and spatial variation of this atmospheric water vapor.

1. In previous work, we have identified >100 impact craters on these deposits in CTX camera dataset (Banks et al., JGR, 2010), many of which have corresponding HiRISE stereo data available. Analysis of the population statistics of these craters indicates that it is an equilibrium population with a crater removal timescale proportional to crater diameter. HiRISE observations show craters at all geomorphologic stages of infilling by fresh ice (which leads to their eventual removal). We will use the known formation rate of craters and models of ice accumulation to model the population statistics of today's equilibrium population. With this constraint we will solve for the annually-averaged near-surface water vapor that has existed over the lifetime of this crater population (~20 Kyr) and put limits on how it may have varied.
2. Complementary information is available in the location of lower-latitude icy outliers such as Louth and Korolev craters. Any model of ice accumulation must also explain the presence of these outliers. We will use the current icy outlier distribution to constrain how the annually-averaged near-surface water vapor decreases with decreasing latitude.

The NPLD crater interiors are clearly sites of preferential ice accumulation so the crater removal rate is not a direct measure of the NPLD accumulation rate (the biggest limitation of the our previous study). As the final task in this study, we will be able to apply the same environmental conditions and models to the surrounding flat NPLD landscape and deduce the recent NPLD mass balance and by extension how mid-latitude ice extent has varied.