

PALEO-WIND MODELING USING ANCIENT TOPOGRAPHY MAPPED WITH ORBITAL RADAR: INSIGHTS TO THE EVOLUTION OF PLANUM BOREUM.

Brothers¹, T. C.; Holt¹, J.W.; Spiga², A.

¹University of Texas Institute for Geophysics, Jackson School of Geosciences, University of Texas, Austin, TX 78758 tcbrothers@utexas.edu; jack@ig.utexas.edu. ²Laboratoire de Météorologie Dynamique, Université Pierre et Marie Curie, France.

Introduction: Planum Boreum, Mars, is an approximately 1000-km-wide, stratigraphically layered ice deposit at Mars' north pole [1] (Fig. 1). The current Planum Boreum topography generates strong katabatic winds [2] that scour surface topography altering morphology, even creating spiral troughs [3]. Katabatic winds are likely responsible for many modern and ancient Planum Boreum accumulation patterns [4].

The goal of this study is to investigate the relationship between katabatic winds, paleosurfaces and modern topography. Topography generates katabatic winds, which in turn influence deposition and erosion of the icy Planum Boreum material. This work combines Shallow Radar (SHARAD) data analysis with the LMD Mesoscale Climate Model [2] to examine the evolution of Planum Boreum's evolution.

Shallow Radar (SHARAD) on Mars Reconnaissance Orbiter (MRO) has enabled the construction of ancient topography, or paleosurfaces. With this topography we can model paleo-winds potentially responsible for accumulation patterns on the mapped paleosurface. This study is a first-order look at the results of combined modeling and SHARAD mapping on Planum Boreum, Mars. This newly available technique has the potential to help decipher Planum Boreum's complex history.

Methods: Data from SHARAD were used to examine internal stratigraphy and structure of Planum Boreum. The vertical resolution of SHARAD is ~9 m in water ice [5]. To correctly position the SHARAD data, a first-return algorithm was used. This algorithm uses the time delay to calculate the location of dominant signal from Mars' surface, and hence for subsequent subsurface echoes. This provides an accurate location for the radar echo.

In this study the interface between basal unit material [6] and Planum Boreum 1 [1] material was mapped across ~400 SHARAD radargrams (see Fig. 2). The data were exported from seismic software, corrected via the first return algorithm, then plotted within GIS software to generate a continuous surface grid using the nearest neighbor algorithm. The gridded data were used as input for the LMD Mesoscale Climate Model [2]. The model was then run under current martian atmospheric conditions.

Results: Three reentrants identified in SHARAD basal unit mapping created recognizable patterns in the

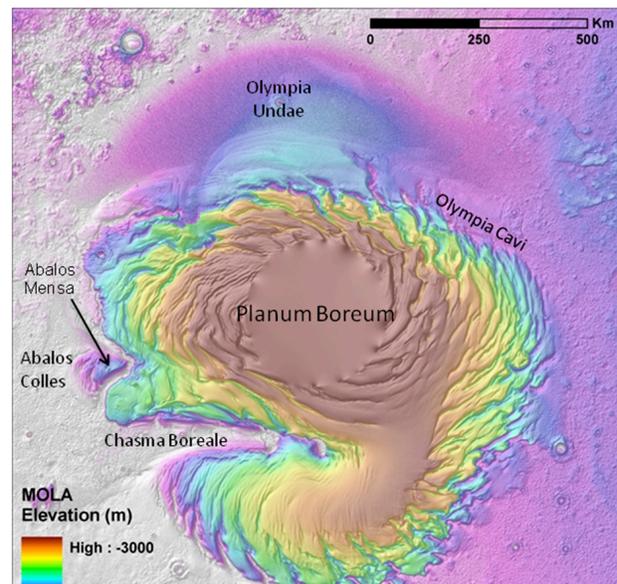


Fig. 1: Context map for Planum Boreum. Note location of Olympia Cavi and Abalos Mensa, two modern landforms very near basal unit reentrants (Fig. 3).

LMD wind simulations which show magnified wind

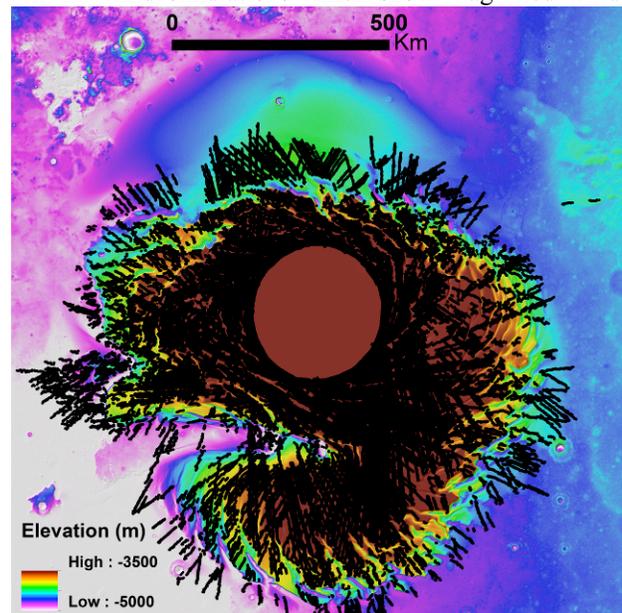


Fig. 2: Coverage map for SHARAD basal unit mapping. Each black point represents a mapped radargram with picked paleosurfaces.

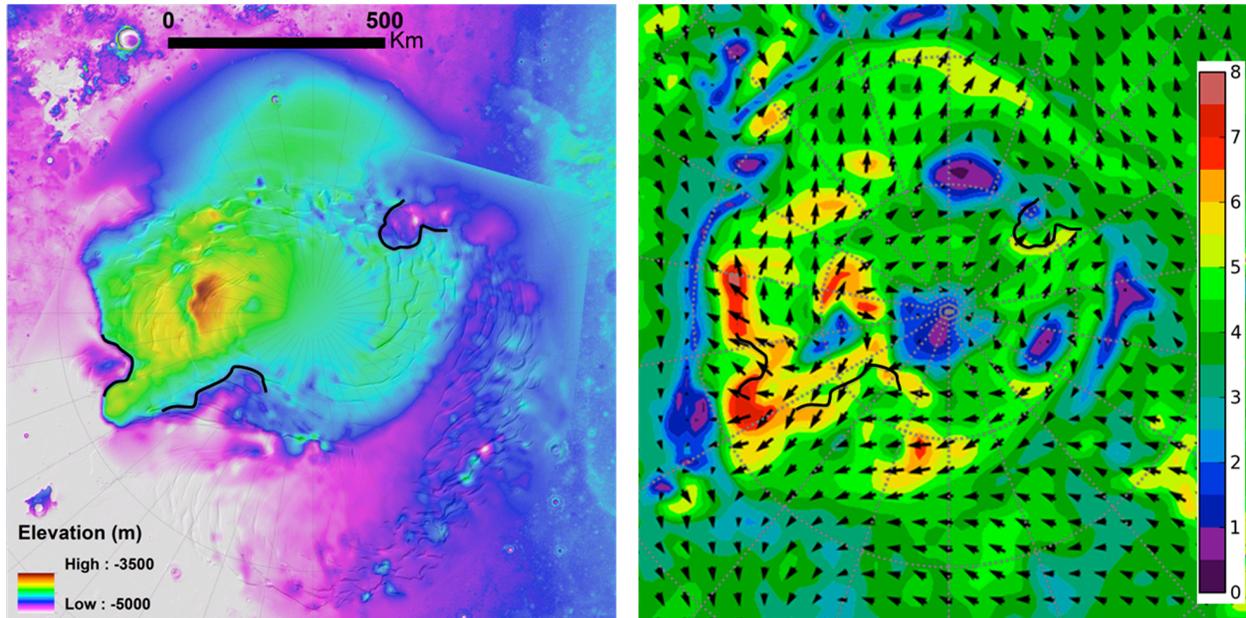


Fig. 3: (left) Gridded results from SHARAD basal unit mapping merged with MOLA at boundaries and overlain with shading from the modern surface. Black lines represent outline of prominent basal unit reentrants. (right) Modeling results from LMD mesoscale wind model with velocity as color, in m/s. Wind vectors represented by small black arrows. The basal unit reentrant outlines are repeated from figure on left.

velocity along their scarps (see Fig. 3). The location of these reentrants and their strong paleowinds are proximal to enigmatic Planum Boreum landforms such as Abalos Mensa and Hyperborea Lingula.

The strongest winds are in the region spanning 240° E to 320° E longitude. This is in close proximity to the basal unit topographic high and the modern Rupes Tenuis scarp. Southward of the basal unit's edge, katabatic winds slow down to only a few m/s.

Discussion: The modeled wind patterns based on mapped paleotopography are consistent with aeolian forces controlling erosion and subsequent deposition for features proximal to Planum Boreum. Abalos Mensa is perhaps the clearest example of this. This indicates that aeolian processes likely account for many polar landforms once attributed to more complex fluid-ice interactions [7-10]. The topography of ancient basal unit material appears to have had strong influence on early landforms and the distribution of north polar layered deposits. However, this work is only the first step in unveiling the complex history of Planum Boreum accumulation.

While this mapping/modeling effort does help explain formations such as Abalos Mensa, it does not explain how ancient basal unit reentrants were filled in, or why Gemina Lingula appears to have become a distinct depositional center after initial erosion of a proto Chasma Boreale [4]. Fortunately, the basal unit inter-

face is one of many paleosurfaces within the SHARAD dataset that can be mapped. Additional paleosurfaces will provide valuable input to the LMD Mesoscale Model regarding the long-term evolution of these deposits. Modeling the pattern of katabatic winds through time will likely provide new insights into the evolution of Planum Boreum.

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