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Assessing the Potential of Radar Inversion for Determining the Electrical Properties of the Martian North Polar Layered Deposits

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The polar caps of Mars are thought to contain a wealth of information regarding the climatic history of the planet. In particular, the North Polar Layered Deposits (NPLD) are composed of many subparallel layers of water ice with varying (but small) amounts of dust. The layers and changes in composition represent a climate signal related to the hydrologic cycle of Mars and, presumably, orbital forcing. Internal reflections in radar sounding data are thought to result from the variations in dust content. Analysis of these reflections may be able to provide estimates for the dielectric properties of the layers, which could then be used to place constraints on the absolute dust concentrations and their changes through time.

Using data from the Shallow Radar (SHARAD) instrument on the Mars Reconnaissance Orbiter (MRO) a number of scientists have already proposed models for how an inversion may be used to accomplish this task (e.g. Lauro et al. 2012, Ilyushin et al. 2005, Nunes and Phillips 2006). Using the power of the reflected energy from the interfaces between different layers, it may be possible to determine both the dielectric constant of, and the attenuation resulting from, each layer. These properties could elucidate composition. So far, the most successful techniques have used simple plane wave propagation models, though more complex radiative transfer models have been proposed as well. In practice, these techniques have only been applied to the bottom-most layer of the NPLD, known as the Basal Unit (BU) (Lauro et al. 2012). It is possible that with some adjustments, a similar approach may be effective for the more complex layering of the upper NPLD. This work describes first steps in this effort, including an analysis of vertical variations in radar properties in SHARAD data.

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