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Inversions of Multi-Layer Media of Mars Polar Region with Validation of SHARAD Data

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The physical properties of Mars polar deposits have been studied for several decades. Some studies show that the layered deposit in Mars polars might be rich in water ice. These stratified media were formed due to varying amounts of dust impurity mixed with the water ice. The varying impurity ratio is likely related to historical climate change.

HF (high frequency) radar sounder technology has been developed for several missions of Mars surface/ subsurface exploration. HF radar waves can penetrate through the regolith media several kilometers. There are mainly two missions, i.e. the MARSIS onboard the Mars Express with 4 bands centered at 1.8, 3, 4, 5 MHz, and the SHARAD onboard MRO with a 20 MHz central frequency.

This paper presents a model of rough surface and stratified sub-surfaces to describe the multi-layer structure of Mars polar deposits. Based on numerical simulation of radar echoes from rough surface/stratified interfaces, an inversion approach is developed to obtain the parameters of Polar Layered Deposits, i.e. layers thickness and dielectric constants. As validation example, the SHARAD data of the Promethei Lingula of Mars South Polar region is adopted for parameters inversion. The result of stratification is also analyzed and compared with the optical photo of the deep cliff of Chasma Australe canyon. Dielectric inversions show that the deposit media are not uniform, and the dielectric constants of the Promethei Lingula surfaces are large, and become reduced around the depth of 20 m-30m, below where most of the deposits are nearly pure ice, except a few thin layers with a lot of dust.

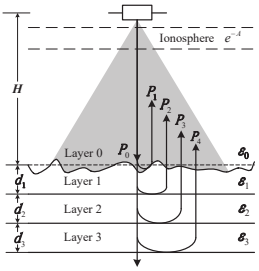

Figure 1 A model of rough surface and stratified media

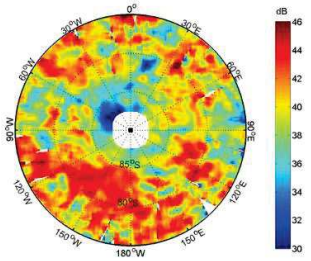

Figure 2 The SHARAD surface echoes data

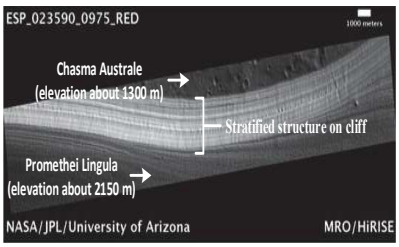

Figure 3 The stratified structure on HiRISE photo

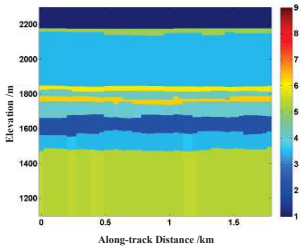

Figure 4 Inverted layered dielectric Constant of each layer