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MODELING, SIMULATION, INVERSION AND DATA VALIDATION FOR MICROWAVE REMOTE SENSING OF DEEP SPACE: MOON AND MARS

Abstract

A research profile and main progress of the Laboratory L-WASRSI for microwave remote sensing of planetary media during recent years are reported. It includes (1) To make data validation and information retrieval for the Chinese Chang'E-1 (CE-1) lunar exploration, the layering model and numerical simulation of multi-channel microwave (MW) brightness temperature TB of lunar surface media were developed. Based on the modeling, the data validation and analysis of CE-1 were studied. Further, inversions of global lunar regolith layer thickness from multi-channel CE-1 TB data were presented. Quantitative evaluation of global inventory of 3He in lunar regolith was obtained. (2) Based on inversions of physical temperatures of lunar layering media from CE-1 TB data, diurnal temperature variations of the lunar surface media were studied. Two craters, typically representing the fresh craters rich in rock abundance and an old one almost free of rocks, respectively, located at similar latitudes were chosen for comparison of the diurnal temperature changes. Correlation between the diurnal MW and IR thermal emissions and the rock abundance was presented, and abnormal phenomena of "cold spots" and "hot spots" in two craters was discussed. Temperature profile of regolith layer inverted by CE-1 TB data was also compared with IR measurements from the LRO, especially at Apollo 15 site. Dielectric constant of regolith layer is also validated by comparison of CE-1 MW and LRT IR data. These results had been further applied to analysis and comparison of lunar surface ages and gas transportation, and others. (4) Radar range echoes from Moon/Mars cratered rough surface/subsurface media, using satellite-borne high frequency radar sounder technology, can provide rich information about the internal physical structures, such as the media dielectric properties, layer thickness etc. Based on the ray tracing of geometric optics and a numerical approach of the triangulated network for rough surface scattering calculations, radar range echoes from the two-layer model of Moon/Mars surface/subsurface media were obtained. Numerical simulations analyze the functional dependence of radar range echoes at 1-50MHz center frequencies upon the surface and layering structures. This study presents a design of radar center frequencies for Chinese future Mars exploration. Finally, inversions of the dielectric constants of two-layer media and the layer thickness are developed.