Radio wave propagation in the Martian polar deposits: models and implications for radar sounding.

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In the present study, the propagation of electromagnetic waves in the northern polar ice sheet of Mars is considered. Several different scenarios of the structure of the polar deposits and composition of the ice, compatible with previously published observational data, are proposed.

Both analytical and numerical simulations of ultra wide band chirp radar pulse propagating through the cap are performed. Approximate approach, based on the non-coherent theory of the radiative transfer in layered media, has been applied to the problem of the propagation of radar pulses in the polar caps. Both 1D and 2D and 3D geometry, applicable to the orbital and landed radar instruments, are studied. The side clutter and phase distortions of the signal are also analyzed.

The possibilities of retrieval of the geological information, depending on transparency of the polar cap for radio waves, are discussed. If the polar cap is relatively transparent, the echo from the base of the sheet should be clearly distinctive and interpretable in terms of basal topography of the cap. In the case of moderate optical thickness, coherent basal echo is corrupted by strong multiple scattering in the layered structure. However, some conclusions about basal conditions could be made from the signals, for example, the subglacial lakes may be detected. Finally, optically thick polar caps prevent any sounding of the base, so only the medium itself can be characterized by GPR measurements, e.g. the impurity content in the ice can be found.

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