

Energy balance in ice layers - the solid-state greenhouse effect at the Mars polar caps

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Icy surfaces like the polar caps of Mars or the surfaces of the outer Galilean satellites behave different than rock and soil surfaces when they are irradiated by solar light. The latter ones absorb and reflect incoming solar radiation immediately at the surface. In contrast ices are partially transparent in the visible spectral range and opaque in the infrared. Due to this property it is possible for the solar radiation to reach a certain depth and raise the temperature of the ice layer below the surface. This internal temperature rise is called “solid-state greenhouse effect”. It may play an important role in the energy balance of icy surfaces in the solar system, as already suggested in previous theoretical investigations. One possible consequence of the solid-state greenhouse effect are the “Martian spiders” observed at the cryptic region on Mars by Mars Global Surveyor.

In the frame of a project performed at the Space Research Institute in Graz the solid-state greenhouse effect was investigated experimentally and theoretically. A couple of experiments were performed including diverse samples with the main focus on layered samples with a covering coat consisting of pure H₂O-ice. Different samples were irradiated under cryo-vacuum conditions by a solar simulator. The temperature distributions inside the samples were measured and compared with the results of theoretical modelling. In addition models describing the influence of the solid-state greenhouse effect on Mars, where the surface is partially covered by CO₂-ice, were developed. The results of these models will be shown and possible implications for the understanding of various observed phenomena at the Mars polar areas will be discussed.