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Glaciation of Mars from 10 million years ago until 10 million years into the future simulated with the model MAIC-2

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The Mars Atmosphere-Ice Coupler MAIC-2 is a simple, latitudinal model that consists of a set of parameterizations for the surface temperature, the atmospheric water transport and the surface mass balance (deposition minus sublimation) of water ice. It is driven directly by the orbital parameters obliquity, eccentricity and solar longitude (Ls) of perihelion. Surface temperature is described by the Local Insolation Temperature (LIT) scheme, which uses a daily and latitude-dependent radiation balance. The sublimation rate of water is calculated by an expression for free convection, driven by density differences between water vapor and ambient air, the deposition rate follows from the assumption that any water vapour which exceeds the local saturation pressure condenses instantly, and atmospheric transport of water vapour is approximated by instantaneous mixing. Glacial flow of ice deposits is neglected. Simulations from 10 million years (Ma) ago until 10 Ma into the future (with an additional spin-up from 20 to 10 Ma ago) predict a variable glaciation with two distinct stages. Stage 1, the period of high average obliquity prior to 4 Ma ago, is characterized by ice thicknesses less than 400 m and a very mobile glaciation all over the planet. During stage 2, from 4 Ma ago until today, the north and south polar ice deposits grow essentially monotonically; however, interrupted by significant sublimation events at ˜3.2, 1.9 and 0.7 Ma ago (when maximum amplitudes of the main 125-ka obliquity cycle occur). The growth of the polar deposits is predicted to continue into the future.

Keywords: Mars, Planetary ice, Ice cap, Polar layered deposits, Modelling