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Gas transport in the near-surface porous layers of a cometary nucleus

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Abstract

The gas transport through non-volatile random porous media is investigated numerically. We extend our previous research of the transport of molecules inside the uppermost layer of a cometary surface. We assess the validity of the simplified capillary model and its assumptions to simulate the gas flux trough the porous dust mantle as it has been applied in cometary physics. A new microphysical computational model for molecular transport in random porous media formed by packed spheres is presented. The main transport characteristics such as the mean free path distribution and the permeability are calculated for a wide range of model parameters and compared with those obtained by more idealized models. The focus in this comparison is on limitations inherent in the capillary model. Finally a practical way is suggested to adjust the algebraic Clausing formula taking into consideration the nonlinear dependence of permeability on layer porosity. The retrieved dependence allows us to accurately calculate the permeability of layers whose thickness and porosity vary in the range of values expected for the near-surface regions of a cometary nucleus.