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# Sublimation of water vapour through porous media in rarefied conditions

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## Résumé

Numerous observations suggest the presence of a highly porous layer of dust on the surface of comets that plays an important role in the outgassing properties and behaviour of comets. Located above the water ice sublimation front, this dust layer helps to explain a lower production rate and higher gas temperature at the comet surface (Christou et al. 2018). Unfortunately, very little is known about the constitution of the comet's surface, and the precise role of this porous structure remains difficult to understand. The idea is therefore to numerically simulate the flow of water vapour through different model porous media in order to understand which properties of the porous structure are most relevant. Ideally, we would like to be able to derive physical constraints on the properties of the dust layer on the surface of comets such as the thickness, particles size distribution and geometrical structure. As we are in a vacuum, the gas is in a rarefied form, i.e. the interactions between the gas molecules themselves are less frequent than those with the solid wall. The Navier-Stokes equations are no longer able to describe the flow. We therefore use the direct simulation Monte Carlo (DSMC) method to numerically simulate the flow through 2D cylinder arrays. After a study of role of the model parameters such as those describing the gas/gas and gas/solid interactions, we focus on the role of the porous structure. Considering a large number of configurations we show that, independently of the rest, the two most important parameters are the thickness and the mean pore size thus confirming the validity of the Clausing's formula (Skorov et al. 1998 & 2011) initially established for capillary tubes. The disadvantage of this analytical formula is that it requires knowledge of the pressure and temperature at the surface of the comet, which are unknowns in the problem. Beyond this validation, we highlight a coupling between the porous medium and the production rate which allows us to better understand the outgassing properties.

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