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A bulk averaging method to upscale non-equilibrium heat transfer in porous media with inertial flow

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Upscaling non-equilibrium heat transfer in porous systems is important for many engineering applications where thermal efficiency and temperature distribution need to be predicted. For that purpose, the Volume Averaging method allows to write averaged equations that describe macroscopic heat transfer of inertial flows in porous media.

Here, a study of the Volume Averaging model is proposed through numerical simulations of heat transfer in a straight porous channel with uniform flow conditions at the inlet. Results show that this model provides temperature profiles that differ from those obtained with Direct Numerical Simulations when the Péclet number is increased.

In order to improve the accuracy of the model, a similar methodology based on the definition of a volume-averaged bulk temperature is proposed, which is inspired from models for fully developed heat transfer in periodic structures. The performance of this new model is determined on the previous test case for multiple pore Péclet numbers. Finally, further analysis will be conducted to assess the accuracy of the model on porous channels with non-uniform temperature profiles along a cross-section of the domain.

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