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Open-FOAM simulation and analysis of non-Fickian transport in truncated pluri-Gaussian permeability fields.

Tuesday, 31 May 2022 10:45 (15 minutes)

Understanding flow and transport in porous media is of fundamental importance for the design of processes and management strategies in oil extraction, groundwater remediation, CO₂ storage, and many other applications. However, the applicability and validity of standard macroscale transport models for highly heterogeneous media is still widely debated. Our study focuses on the impact of the subsurface structure and properties on the transport of solute through heterogeneous geological domains by means of three-dimensional simulations based on an open-source C++ library, built on top of the finite-volume library OpenFOAM®.

Since it is not always possible to characterise the heterogeneities in a deterministic way, we make use of standard geostatistical techniques and pluri-gaussian truncated random fields, generated through Fourier decomposition, to construct realistic domains for flow and transport simulations. Additional challenges are posed by the numerical simulation of such highly heterogeneous and discontinuous permeability fields. We study the numerical upscaling of dispersion models from the meso- (i.e. heterogeneity) to the macro- (i.e. reservoir) scale and we analyse the onset of non-Fickian or anomalous transport. The whole simulation workflow has been implemented using our open-source library whose implementation and capabilities will be illustrated. Flow and transport simulation results will be discussed and the impact of geostatistical metrics (e.g. correlation lengths, permeability contrast and Péclet numbers) on transport results (e.g. early solute arrival, solute peak and breakthrough curve statistical moments) assessed. Preliminary conclusions from our study highlight the role of high permeable channels in triggering non-Fickian transport behaviour by creating fast flow channels on which advection prevails over dispersion but also the importance of the interpolation method in estimating the macrodispersion parameters.

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References

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

Unsure

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Presenter: PESCIMORO, Eugenio

Session Classification: MS08

Track Classification: (MS08) Mixing, dispersion and reaction processes across scales in heterogeneous and fractured media