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A systematic study of uncertainty quantification for the lattice Boltzmann method in bifurcating geometries

Jon W.S. McCullough*[1], Peter V. Coveney[2,3]

[1] Centre for Computational Science, Department of Chemistry, University College London, 20 Gordon Street, London, WC1H 0AJ, UK, j.mccullough@ucl.ac.uk

[2] Centre for Computational Science, Department of Chemistry, University College London, 20 Gordon Street, London, WC1H 0AJ, UK, p.v.coveney@ucl.ac.uk

[3] Informatics Institute, Faculty of Science, University of Amsterdam, Postbus 94323, 1090 GH Amsterdam, Netherlands, p.v.coveney@uva.nl

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The use of computational methods to study problems of scientific and engineering interest has become a significant tool for the generation of new knowledge. However, for such tools to gain widespread acceptance in day-to-day decision making a rigorous understanding of model uncertainty must be demonstrated. In the medical field, regulators globally are introducing frameworks by which *in silico* trials can be used to guide the design of a medical treatment or instrument [1]. Software tools are available and being further developed to support the increased study of validation, verification and uncertainty quantification (VVUQ) with a variety of numerical methodologies [2].

In this presentation, we demonstrate how the EasyVVUQ [3] toolkit can be deployed to assess the uncertainty characteristics of the lattice Boltzmann method within the scalable blood flow simulator HemeLB [4]. This work serves two purposes: 1) to demonstrate to the lattice Boltzmann community how VVUQ can be incorporated into computational workflow; and 2) to indicate key sources of potential errors intrinsic to the lattice Boltzmann method through a systematic VVUQ analysis. As HemeLB is focussed on the study of macroscopic blood flow through complex vascular domains, we focus our study to three configurations of a bifurcating pipe flow. Whilst these have been selected to represent junctions of vessels found throughout the human body, they can also be viewed as representative of a wider number of flow scenarios throughout science and engineering.

Our results illustrate the impact of how the choice of boundary condition parameters and intrinsic lattice Boltzmann method parameters influence the pressure and velocity fields generated within the canonical bifurcation domains. This information will provide key quantitative knowledge for users of the lattice Boltzmann method in all fields of application.

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