



NERC Centre for Doctoral Training in Oil & Gas (2017 start)

Project Title: A new sub-grid scale modelling approach for reservoir simulation

Host institution: Imperial College London

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Project description: Enhanced Oil Recovery (EOR) in the North Sea is a key current and future industry for the UK. EOR project requires detailed simulation studies of the behaviour of injected and resident fluids in geological porous media. The high cost of collecting geological and well information in deep water means that it is difficult to develop mathematical models to predict key quantities such as maximum rate at which fluids can safely be injected or produced. The computational cost of the model is intensive. In this work a fast and accurate reservoir model is developed based on a new sub-grid-scale modelling approach to address these issues. It will provide a convenient way of performing computationally intensive tasks such as detail reservoir modelling.

Thus, in this project a new approach to performing sub-grid-scale SGS or Hyper-reduction HR modelling using methods based on Proper Orthogonal Decomposition POD but performed locally is developed. There are two scales that are modelled within this approach with a mesh associated with each scale. The first coarse mesh (finite element meshes are used here) holds a number of variables (associated with the SGS modelling) at each node. Then each of these coarse finite elements is decomposed into a potentially much larger number of elements which holds the SGS information. We obtain separate optimized basis functions for each coarse grid node - optimized to represent the SGS solution and possibly geometry - in the local vicinity of that coarse grid node. This is then used to collapse down the number of equations to each coarse grid node.

This approach promises the development of a new approach for sub-grid-scale modelling with general applicability to a wide range of problems e.g. turbulent flows. However, here we will apply the method to model the fine-scale flows through individual fractures within a large-scale oil reservoir.

The objective of this research is to develop a novel domain decomposed based reduced order reservoir model that reduces the computational time and/or increases accuracy drastically.

The deliverables of the PhD research are (1) a local approach to forming SGS models; (2) demonstrate the capability of the new subgrid ROM.

Novelty: The specific technologies (representing a new research direction in forming sub-grid-scale models) that distinguish this project are the locally applied reduced order model, computation efficiency capability.

CDT Research theme(s): A. B. The project will yield improved predictions of flow in complex reservoirs, including heavy oil (viscous fingering), unconventional (natural and induced fractures), and improved predictions of remaining oil in mature (carbonate) fields and how this can be recovered.

PhD Proposal: UK Oil and Gas Collaborative Doctoral Training Centre (2014 start)

Research context: The earth science and engineering at ICL comprises a large, interdisciplinary group of researchers investigating various aspects of earth science and engineering via theoretical, numerical and experimental work. The student will join the groups (NORMS,AMCG) at ICL and work with experienced researchers.

Research costs: 1. Workstation (4K). 2. Conference travel (2K per year). IC will provide computing support (Clusters).

Career routes: Will develop generic modelling skills that can be applied to a whole host of disciplines in academia and industry. In the oil industry for example they include: specialist research (e.g. ExxonMobil URC), service provider (e.g. Schlumberger), reservoir engineer (numerous companies).