



## **Pie in the sky or models in the cloud? Unlocking cloud architectures for environmental modelling with Model Driven Engineering.**

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Environmental models have increasing complexity as we move towards integrated modelling, a need to reason about uncertainties, and the desire for finer resolution. Yet, with a few exceptions, environmental modellers have not taken full advantage of the latest advances in computer science. In our work we focus on cloud computing alongside advances in software engineering tools and techniques, examining in particular how such tools can transform the development and deployment of environmental models in the cloud.

Cloud computing has brought transformative advantages to technologies such as social media and e-commerce, through new architectures, new data stores, rich analytics capabilities and elastic computing. These services have not yet put to use in environmental modelling, but have the potential to be equally transformative.

Critically, executing complex environmental models not only requires the understanding of scientific phenomena, but also a computing skillset, including experience of operating systems, supporting software and knowledge of computer architectures. We believe that new software engineering practices, including tools that enable abstraction from underlying computing complexity, can allow environmental modellers to leverage emergent cloud architectures and services to support a paradigm shift in environmental modelling. Such a shift can allow scientists to a) spend more of their time concentrating on science rather than systems administration, b) run models more times and orchestrate new ensembles to better understand sensitivities and uncertainties, and c) allow scientists without big budgets to pay per use to run models without needing upfront infrastructure investment.

Our vision is of environmental models built as micro services, self-assembling in an elastic cloud architecture. Perhaps this can seem a little out of reach or “pie in the sky”. But we have taken concrete steps to containerize the Weather Research and Forecasting model, simplifying deployment and providing domain specific languages as part of a model driven software engineering approach.