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ADAPTIVITY AND ERROR ESTIMATION FOR PHYSICAL MODELS

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ABSTRACT

All numerical simulations are based on the combination of a physical model for the underlying system behaviour, and a numerical discretisation of this model. But while adaptive methodologies for the numerical part of the simulation, based on sophisticated error estimations, have reached a high degree of maturity, adaptive methods for physical models are not yet encountered frequently. Instead, the same physical model tends to be used throughout a simulation, the choice of model depends on the experience of the user, and uncertainties are approximated through comparisons with similar simulations that have been validated with experiments.

Potential difficulties in creating locally adaptive physical models are, first, that no suitable hierarchies of models, from cheap to accurate, may be available. A second challenge is to define consistent couplings between these models, to allow each one to be applied locally. And finally, error models for physical models (equivalent to the well-known power-law behaviour of many numerical discretisations) are not available. Nevertheless, for example the recent advances in machine learning could bring such models within reach.

The goal of this exploratory minisymposium is to gather the participants' thoughts on the feasibility of solution-adaptive physical models. Topics include, but are not limited to, model coupling and hybridisation, adaptive microscale models, data-driven models, combined numerical and physical adaptation, model selection criteria, and error indicators. Applications could include turbulence modelling, boundary and shear layers, nonhomogeneous materials, damage growth, etc. Early-stage research, incomplete work, or even conceptual discussions are very much encouraged. It is hoped that these discussions will contribute to the evolution of reliable fully automated simulation of physical phenomena.