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The use of inexact hardware to mimic subgrid-scale variability

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We study the use of inexact hardware in numerical weather and climate models. The different setups of inexact hardware promise large savings in power consumption and an increase in computational performance. However, simulations with inexact hardware show numerical errors, such as rounding errors or bit flips. The effect of these errors can be described as an additional forcing term which is added to the governing differential equations. Since hardware errors are hardly correlated in space and time, the forcing term due to inexact hardware has some similarities to a stochastic forcing. Stochastic forcings, however, are used successfully in stochastic parametrisation schemes to mimic subgrid-scale variability within a numerical model and are motivated by physical reasons.

We investigate a model of the 1D Burgers equation that is using the stochastic parametrisation scheme of Dolaptchiev et al. based on the MTV stochastic mode reduction strategy. We emulate the use of inexact hardware within the model. The forcing of the stochastic parametrisation scheme is compared to the forcing caused by hardware errors. We show that the forcing of inexact hardware can replace the stochastic forcing of the stochastic parametrisation scheme and lead to a similar quality of solutions, when only small changes are made within the numerical code. We conclude that numerical errors of inexact hardware can be beneficial for physical reasons, at least in idealised setups, while inexact hardware will provide significant savings in computational cost. We will also present results on the use of inexact hardware to setup ensemble simulations.