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A scale dependent approach to use efficient but inexact hardware in weather and climate modelling

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We study the use of emulated inexact hardware in a spectral dynamical core of an atmosphere model. Inexact hardware is promising 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. A numerical weather or climate model running on inexact hardware might allow numerical simulations with higher resolution, due to reduced computational cost, and therefore higher model accuracy.
We show that large parts of the model integration can be performed with emulated inexact hardware without adversely affecting the quality of the simulations. The parts of the model that calculate small scale dynamics can tolerate a large amount of hardware errors. However, the parts of the model that calculate large scale dynamics are very sensitive and need to be calculated with exact hardware. It seems to be a necessary but sufficient approach to increase the level of hardware errors, and therefore the savings in computational cost, with decreasing spatial scales within the model. The use of a spectral discretisation scheme allows large and small scale dynamics to be treated separately within the code. The impact of lower-accuracy arithmetic can be restricted to components close to the truncation scales and hence close to the necessarily inexact parametrised representations of unresolved processes.