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Parameter study of 2D convection and supercomputer performance analysis

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We perform hydrodynamic 2D simulations of solar convection. We aim to study the dependence of different physical parameters, the box size, and box aspect ratio on the actual convective motions we observe in the numerical model. Furthermore, we need to evaluate the performance of different Input/Output strategies on supercomputers, in order to plan and run future large-scale magneto-hydrodynamic models of the solar atmosphere. To this end, we use our convection model for a performance analysis of different numerical IO schemes. We use a large simulation domain together with a high grid resolution in order to provide high Reynolds numbers in the numerical model. This allows us to model the solar convection zone down to 20 Mm below the surface and include the solar atmosphere up to 10 Mm. We use 1024x256 grid points with initial conditions matching the gravity, temperature, and density stratification of the Sun. After the bottom of the box is heated sufficiently, the convective motions set in and transports energy towards the surface. At the top of the convection zone, material is ejected into the atmosphere, before falling down again.
We conclude that we require a minimum horizontal extent of the simulation domain and a minimum box aspect ratio, in order to obtain realistic convection cells. Also we find that HDF5 output is required for future large-scale computer models, because the traditional IO strategy of the Pencil Code puts too high demands on nowadays supercomputer file systems, both in storage space requirements and number of file operations.

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