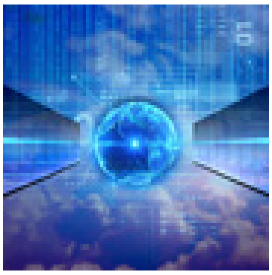

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A baseline for global weather and climate simulations at 1km resolution

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Advancing the simulation and understanding of the Earth's weather and climate by representing deep convection explicitly is demonstrated with an average grid spacing of 1.4km. Our global simulations are spanning a 4 months period (November 2018 - February 2019, NDJF season) with the state-of-the-art Integrated Forecasting System (IFS) of ECMWF. So far this has only been possible in limited-area or very short time range simulations, thus lacking the feedback of fundamental energy exchanges onto the larger scales at extended time ranges. The world's first seasonal timescale global simulation with 1.4 km average grid spacing addresses the question of how resolved deep convection feeds back on global dynamics of the atmosphere, and thus provides a reference and guidance for future simulations, albeit under the caveat of affordability of only a single realisation at this point in time. Our work makes available an unprecedented O(1 km) dataset with 137 vertical levels covering the atmosphere up to a height of 80 km. The simulation results are compared with corresponding 9 km average grid spacing simulations with and without deep convection parametrisation, respectively. The simulations were conducted as part of our INCITE20 award for computer access to Summit, the currently fastest computer in the world (Top500, Nov 2019). Thanks to its unprecedented detail, the dataset will support future satellite mission planning that relies on observing system simulation experiments (OSSEs) based on 'nature runs' for simulating yet non-existing satellite observations. This work may be seen as a prototype contributing to a future digital twin of the Earth and we will quantify and illustrate how to handle the unprecedented data flow produced by such extreme-scale simulations.

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