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A new climate modeling framework for convection-resolving simulation at continental scale

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Major uncertainties remain in our understanding of the processes that govern the water cycle in a changing climate and their representation in weather and climate models. Of particular concern are heavy precipitation events of convective origin (thunderstorms and rain showers). The aim of the crCLIM project [1] is to propose a new climate modeling framework that alleviates the I/O-bottleneck in large-scale, convection-resolving climate simulations and thus to enable new analysis techniques for climate scientists. Due to the large computational costs, convection-resolving simulations are currently restricted to small computational domains or very short time scales, unless the largest available supercomputers system such as hybrid CPU-GPU architectures are used [3]. Hence, the COSMO model has been adapted to run on these architectures for research and production purposes [2]. However, the amount of generated data also increases and storing this data becomes infeasible making the analysis of simulations results impractical. To circumvent this problem and enable high-resolution models in climate we propose a data-virtualization layer (DVL) that re-runs simulations on demand and transparently manages the data for the analysis, that means we trade off computational effort (time) for storage (space). This approach also requires a bit-reproducible version of the COSMO model that produces identical results on different architectures (CPUs and GPUs) [4] that will be coupled with a performance model in order enable optimal re-runs depending on requirements of the re-run and available resources. In this contribution, we discuss the strategy to develop the DVL, a first performance model, the challenge of bit-reproducibility and the first results of the crCLIM project.

[1] http://www.c2sm.ethz.ch/research/crCLIM.html

[2] O. Fuhrer, C. Osuna, X. Lapillonne, T. Gysi, M. Bianco, and T. Schulthess. "Towards gpu-accelerated operational weather forecasting." In The GPU Technology Conference, GTC. 2013.

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[4] A. Arteaga, O. Fuhrer, and T. Hoefler. "Designing bit-reproducible portable high-performance applications." In Parallel and Distributed Processing Symposium, 2014 IEEE 28th International, pp. 1235-1244. IEEE, 2014.