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Next-Generation Time Integration for Weather and Climate Simulations

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Running simulations on high-performance computers faces new challenges due to e.g. the stagnating or even decreasing per-core speed. This poses new restrictions and therefore challenges on solving PDEs within a particular time frame. Here, disruptive mathematical reformulations which e.g. exploit additional degrees of parallelism also in the time dimension gained increasing interest over the last two decades.

This talk will cover two examples of the current cutting edge research on parallel-in-time integration methods in the context of weather and climate simulations:

* Parallel-in-time rational approximation of exponential integrators (REXI) based on Terry's (T-REXI) and Cauchy Contour (CI-REXI).

* Multi-level time integration of spectral deferred correction (ML-SDC) & Parallel Full Approximation Scheme in Space and Time (PFASST)

These methods are realized and studied with numerics similar to the ones used by the European Centre for Medium-Range Weather Forecasts (ECMWF). Our results motivate further investigation for operational weather/climate systems in order to cope with the hardware imposed restrictions of future super computer architectures.

(I gratefully acknowledge contributions and more from Francois Hamon, Terry S. Haut, Richard Loft, Michael L. Minion, Nathanaël Schaeffer)

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