MMM SEMINAR SERIES

Cut Cells, Spherical Grids, L-Galerkin Methods and the efficient organisation of numerical Atmospheric models

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Classical Galerkin schemes have a number of advantages and are today occasionally used in the form of spectral modelling and finite elements. From the practical point of view, the classical Galerkin method has only one disadvantage: Even with local basis functions a global impact is present. For the divergent equations of NWP this non-local impact is small, but for the use of massively parallel computers this poses a serious problem. Therefore local alternatives have been explored, which are called L-Galerkin methods. The L-Galerkin method being nearest to practical applications in weather prediction and Climate is the Spectral Element (SE) method, being characterised by a Gauss Lobattho collocation grid, and the use of high (3rd degree) basis functions. Obviously, the expense of this method is that of a finite difference method plus the transformation between the function spaces.

In this lecture we consider more efficient versions of the L-Galerkin method under the names o2o3 and o3o3 which use sparse grids. Sparse grids do not use all the points of the associated full grid and it can be shown that all deviations from the sparse approximation represent noisy fields. For simple test cases the equivalence of sparse and full grid solutions can be shown. Galerkin textbooks of the 1970 tiess already describe sparse grids in connection with the the classic Galerkin method.

Galerkin and L-Galerkin methods lead to simple implementations of the cut cell grids. Except for an extremely strong filtered orography it can be shown that the terrain following orography does not fulfil the approximative equations. Cut cells were considered difficult to implement and it is shown how L-Galerkin methods can help with this. An existing cut cell model showed that forecasted vertical velocities are making sense, which they did not with terrain following coordinates.

Thursday, 13 April 2023, 2:00pm
Refreshments 1:45pm
Please also join colleagues for refreshments and informal discussion after the seminar until 3:30pm
NCAR-Foothills Laboratory, 3450 Mitchell Lane
FL2-1022, Large Auditorium

Seminar will also be live webcast
https://operations.ucar.edu/live-mmm
Participants may ask questions during the seminar via Slido