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Implementation of a Semi-Lagrangian scheme for water vapour and tracer advection in RegCM4

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A semi-Lagrangian approach is introduced in the latest version of the ICTP regional climate model (RegCM4) for water vapor and tracer advection. A 'quasi' cubic interpolation and McGregor's third order accurate trajectory calculation are used in the advection scheme. The modified scheme is evaluated on idealized as well as realistic case studies and its results are compared against those of the Eulerian scheme originally employed in RegCM4. In the idealized test cases the semi-Lagrangian scheme appears to be superior to the Eulerian scheme in terms of the dissipative and dispersive errors, especially when large gradients are present in the advected quantity. Two realistic cases of meso-scale phenomena over the European domain were also tested in a short range mode for specific humidity transport. In both cases, the semi-Lagrangian scheme has captured better the detailed structure and improved the overall pattern of the vertically integrated humidity field.
In the present preliminary implementation, the scheme is more expensive than the Eulerian one. This is because the same time step is used for tracer advection as the explicit time discretization employed by the dynamical core. However, greater computational gains are expected as the number of tracers considered increases, for instance when the gas phase chemistry is switched on.