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Implementing the HYbrid MAss flux Convection Scheme in ICON - Adaptions of the dynamical core and idealized tests

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The role of cumulus convection in the atmosphere can hardly be overemphasized. On the one hand side, convection is controlled by a wide range of processes such as dynamical, radiative and boundary layer processes. On the other hand side, the convective transports regulate the atmospheric stratification and may act as a driver for atmospheric dynamics itself. Due to these complex interactions, its representation in numerical weather prediction (NWP) models is a challenging task.
Over the recent decade, the horizontal resolution of NWP and climate models has become finer and finer. With a grid spacing in the order of $\Delta x \sim$ 1-10 km, some classical assumptions made in cumulus parametrization schemes have become questionable and hence, revised approaches have been developed for operations in the convective gray zone.
Among others, the hybrid mass flux convection scheme HYMACS is a promising framework to enhance the scale awareness of the parametrization schemes. Shortly, HYMACS abandons the assumption of local compensational subsidence within a grid column. Instead, the environmental subsidence is transferred to the grid-scale dynamics by realizing a net mass transport.

While the hybrid approach has already been implemented successfully in the regional COSMO model (*Kuell et al., 2007*) and recently revealed promising results in the IFS model (*Malardel and Bechthold, 2019*), our project aims to implement HYMACS in the multi-scale ICOsahedral Non-hydrostatic (ICON) model.
The introduction of local mass sources and sinks in the dynamical core as part of the physics-dynamics coupling evokes some problems which are related to the grid geometry of ICON. While the application of a numerical filter in the hosting model with a triangular grid is indispensable, the anisotropic fourth-order divergence damping as operationally used is incompatible with local mass sources and sinks.
Hence, after testing different techniques of mitigating small-scale noise in the divergence field, we propose to use a combined divergence damping approach. It is shown that this approach gives similar results in the Jabolonowski-Williamson benchmark test cases for the dynamical core while also inducing a physical dynamical response to the net mass transfer.
With a proper model configuration on hand, several idealized tests are performed with ICON and compared to COSMO reference simulations. The successful tests are the basis for further development of HYMACS within the modeling framework of ICON.