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A semi-implicit pseudo-incompressible flow solver for diabatic dynamics: Baroclinic-wave life cycles

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This study introduces an efficient modeling framework for investigations of diabatic flows in the atmosphere. In particular, the spontaneous emission of inertia-gravity waves is addressed in idealized simulations of baroclinic-wave life cycles. Numerical simulations are perfomed using a finite-volume solver for the pseudo-incompressible equations on the f-plane with newly implemented semi-implicit time stepping scheme, adjusted to the staggered grid, which provides high stability and efficiency for long simulation runs with large domains. Furthermore, we have modified the entropy equation to include a heat source, allowing for a development of the vertically dependent reference atmosphere. Numerical experiments of several benchmarks are compared against an explicit third-order Runge-Kutta scheme as well as numerical models from the literature, verifying the accuracy and efficiency of the scheme. The proposed framework serves as a construction basis for an efficient simulation tool for the development and validation of a parameterization scheme for gravity-waves emitted from jets and fronts.