Bedymo: a combined quasi-geostrophic and primitive equation model in sigma coordinates

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We introduce the idealised atmospheric circulation model Bedymo, which combines the quasi-geostrophic approximation and the hydrostatic primitive equations in one modelling framework. The model is designed such that the two systems of equations are solved as similarly as possible, such that differences can be unambiguously attributed to the different approximations, rather than the model formulation or the numerics. Using either approximation, Bedymo successfully simulates a mid-latitude atmospheric storm track and the stationary wave response to orographic forcing or diabatic heating.

In addition to the atmospheric core, Bedymo also includes a slab ocean model and passive tracer module that could provide the basis for an idealised parametrisation of moisture and latent heat release. Further, Bedymo has a graphical user interface, making it particularly useful in teaching.

In contrast to most other quasi-geostrophic models, Bedymo is using sigma-coordinates in the vertical. This is unique as it ensures mass continuity within the model domain and allows a more direct inclusion of orography. We point out several insights and potential pitfalls when deriving quasi-geostrophy in sigma-coordinates and show that it is possible to obtain a self-consistent set of equations.