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Introducing a non-spectral Quasi-Geostrophic model

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Mountain ranges contribute significantly to the observed asymmetry of the atmospheric general circulation between the two hemispheres. The linear effect of topography on the mean circulation is relatively well understood whereas our understanding of the non-linear impact is still incomplete. This study introduces a Quasi-Geostrophic (QG) model called BEDYMO that was designed such that the blocking mechanism can be represented explicitly within the model by prohibiting flow through blocked grid cells in the interior of the model domain. Most of the QG models the authors are aware of, solve the governing equations in spectral space, which makes it close to impossible to introduce new domain boundaries within the model domain. BEDYMO solves the equations in grid point space, using either pressure or geometric height as the vertical coordinate.

BEDYMO incorporates a hierarchy of simplifications ranging from linearised QG up to Semi-Geostrophy. The model's one-vertical-layer mode is equivalent to the set of equations used to study geostrophic turbulence, a two-layer setup corresponds to the two-layer model that is often used to derive properties of baroclinic instability. An intermediate step between the one- and two-layer setups is provided by Surface QG. Although the model is usually used with few vertical levels, there is no technical limitation in the number of levels.

We present the first results for flow over idealised mountains obtained with this model, utilising the whole hierarchy of simplifications available within BEDYMO. Those results are compared with results from the global spectral circulation model developed at the Geophysical Fluid Dynamics Laboratory and a purely linear QG model.