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An appropriate finite-element pair to simulate inertia-gravity waves

Most of atmospheric, oceanic and hydrological models typically employ gridpoint, finite and spectral-element techniques. For all these numerical methods the coupling between the momentum and continuity equations usually leads to spurious solutions in the representation of inertia-gravity waves. The spurius modes have a wide range of characteristics and may take the form of pure inertia oscillations, Coriolis modes and pressure modes. The spurius modes are small-scale artifacts which are trapped within the model grid, and can cause aliasing and an accumulation of energy in the smallest-resolvable scale, leading to noisy solutions. Their appearance is mainly due to an inappropriate placement of variables on the grid and/or a bad choice of approximation function spaces. We present a triangular finite-element pair candidate, which 'properly' models the dispersion of the inertia-gravity waves. In particular, the discrete frequency increases monotonically with wavenumbers as in the continuum case, contrarily to most of other finite-element pairs (if not all). It will also be shown that, like for most other pairs, this finite element candidate should be employed when a precise calculation of the Rossby modes is not an issue. Results of test problems to simulate the propagation of inertia-gravity waves with the proposed finite-element pair are presented and they are compared with results of other grids. They illustrate the promise of the proposed approach.