Numerical wave propagation for the triangular $P1_{DG} - P2$ finite element pair

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The $P1_{DG} - P2$ finite element pair was introduced as a discretisation for ocean and atmospheric flows which would have no pressure modes and which would preserve stationary geostrophic states exactly. In this presentation we will demonstrate some additional properties of this element pair which make it especially suitable for large scale geophysical flows. In particular, we will both prove and show through actual simulations that the discretisation is third order accurare for inertia-gravity waves and Rossby waves even though it is only second order accurate for general flow problems.

We will also show that the only spurious modes admitted by this element pair are spurious inertial oscillations which have frequency f, and which do not propagate. A restriction of the velocity space of this element will be proposed in which these modes are not present thereby resulting in a discretisation completely free of spurious modes.