Quantification of non-hydrostatic effects and the role of vertical resolution in HOMME

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Non-hydrostatic (NH) effects in protypical atmospheric flows at the synoptic scale and the mesoscale are quantified in anticipation of the use of the NH atmospheric dycore in upcoming versions of E3SM. Given that NH effects scale with the vertical to horizontal aspect ratio (the NH parameter) we conduct a range of small-earth experiments while holding the Rossby and Froude numbers fixed. We find that (a) the NH dycore better represents mesoscale processes as compared to the hydrostatic dycore, that (b) the level of mesoscale activity in the hydrostatic dycore depends on the NH parameter when naive scaling of the governing equations suggests otherwise, and that (c) the synoptic baroclinic instability growth rate decreases with increasing NH parameter. In addition, we examine and find a surprisingly strong dependence of synoptic and mesoscale dynamics on vertical resolution.