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Energy transfers between balanced and unbalanced motions

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The energy transfers between balanced and unbalanced motions is discussed in context of the ocean and its energy cycle. Balanced motions, for instance mesoscale eddies generate unbalanced motions, such as internal gravity waves by spontaneous emission, amongst other processes. The exact mechanism of this wave generation, however, is not well understood and hence not well represented in ocean models. This is hindered to an extent by the challenge of separating the flow field into balanced and unbalanced motions. We achieve this separation using the non-linear initialization procedure proposed by Machenhauer in 1977. Results show that gravity wave emission becomes increasingly stronger going towards a $Ro = O(1)$ regime. The kinetic energy tied to the unbalanced mode scales close to Ro^2 (or Ri^{-1}), with Ro and Ri being Rossby and Richardson numbers. Furthermore, internal gravity waves dissipate predominantly through small-scale dissipation, which emphasizes their role in the downscale energy transfer. We also diagnose internal gravity waves emitted from balanced flow in three different scenarios: spontaneous emission, convective instability, and lateral boundary instability. Our diagnosis show that there is much more gravity wave activity in the case of convective and lateral boundary instability than spontaneous generation.