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Contributions to Jupiter's gravity field from dynamics in the dynamo region and deep atmosphere

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The antisymmetric part of Jupiter's zonal flows is responsible for the large odd gravity harmonics measured by the Juno spacecraft. Here, we investigate the contributions to Jupiter's odd gravity harmonics (J_3, J_5, J_7, J_9) from dynamics in the dynamo region and the deep atmosphere. First, we estimate the odd gravity harmonics produced by zonal flows in the dynamo region. Using Ferraro's law of isorotation, we construct physically motivated profiles for dynamo region zonal flow. We use the vorticity equation to determine the density perturbations associated with the flows and then calculate the odd gravity harmonics. We find that dynamo zonal flows with root mean square (RMS) velocities of 10 cm/s would produce J_3 values on the same order of magnitude as the Juno measured value, but would not significantly contribute to J_5, J_7 , and J_9 . Next, we examine the gravitational contribution from zonal flows above the dynamo region. We consider a simple model where the observed surface winds are barotropic (i.e., z -invariant) until they are truncated at some depth by some dynamical process, such as stable stratification and/or MHD processes. We find that barotropic zonal flow in the strongly antisymmetric northern (13° - 26° N) and southern (14° - 21° S) jets extending to the likely depth of a rock cloud layer or deep radiative zone can account for a significant fraction of the observed gravity signal.