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On the asymmetry of cyclones and anticyclones in the cellular regime of rotating Rayleigh-Benard convection HAO FU, Stanford University, SHIWEI SUN, Nanjing University — In rotating Rayleigh-Benard convection, rotation breaks the symmetry on its rotating axis, making the cyclones and anticyclones unequal in size and magnitude. A theory of such vorticity asymmetry is proposed specifically for the rotation-dominated (called cellular or geostrophic) regime. The property that columnar updraft and downdraft plumes are densely packed is shown to make the vertical vorticity profile at the vortex center approximately linear with height via thermal wind relation. This simplification of morphology enables a linkage between the vorticity strength of a plume which is quantified by vorticity Rossby number $\mathrm{Ro_V}$, and the vorticity magnitude difference between the plumes' cyclonic and anticyclonic ends which is quantified with a nondimensional asymmetry factor δ. The relationship between δ and $\mathrm{Ro_V}$ is found to be constrained by vertical vorticity equation alone. An analytical solution is found using asymptotic expansion, which shows that the asymmetry is generated mainly by the vertical advection and stretching of vertical vorticity in fluid interior, and is modified by the Ekman layer dynamics.

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