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**Defining and Computing Vortices Objectively from the Vorticity** GEORGE HALLER, ALIREZA HADJIGHASEM, ETH Zurich, MOHAMMAD FARAZMAND, Georgia Tech, FLORIAN HUHN, German Aerospace Center — We introduce the notion of rotationally coherent Lagrangian vortices as tubular material surfaces in which fluid elements complete equal bulk material rotation relative to the mean rotation of the fluid. We find that initial positions of such tubes coincide with tubular level surfaces of the Lagrangian-Averaged Vorticity Deviation (LAVD), the trajectory integral of the normed difference of the vorticity from its spatial mean. LAVD-based vortices turn out to be objective, i.e., invariant under time-dependent rotations and translations of the reference frame. In the limit of vanishing Rossby numbers in geostrophic flows, cyclonic LAVD vortex centers can be proven to coincide with the observed attractors for light particles. A similar result holds for heavy particles in anticyclonic LAVD vortices. We also discuss a relationship between rotationally coherent Lagrangian vortices and their instantaneous Eulerian counterparts. The latter are formed by tubular surfaces of equal material rotation rate, objectively measured by the Instantaneous Vorticity Deviation (IVD). We show how the LAVD and the IVD detect rotationally coherent Lagrangian and Eulerian vortices objectively in analytic flow models and numerical flow data.

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