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Coherent vortices and tracer cascades in two-dimensional turbulence

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We discuss the properties of enstrophy and passive-tracer-variance transfers in two-dimensional turbulence, and show that these transfers display significant differences in the inertial range of the enstrophy cascade. Passive-tracer variance always cascades towards small scales, while enstrophy is characterized by the simultaneous presence of a direct cascade in hyperbolic regions and of an inverse cascade in elliptic regions. The inverse enstrophy cascade is particularly intense in small-scale elliptic regions in the turbulent background, and it is associated with gradient-decreasing processes. The inversion of the enstrophy cascade, already noticed by Ohkitani (1991), appears to be the main difference between vorticity and passive-tracer dynamics in incompressible two-dimensional turbulence.