Geophysical Research Abstracts
Vol. 21, EGU2019-3301, 2019
EGU General Assembly 2019

Non-self-similar collapse of surface quasigeostrophic point vortices

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Point-vortex models are presented for the surface quasigeostrophic (SQG) equations, which are characterized by a fractional Laplacian relation between the active scalar and the stream function and for which the existence of finite-time singularities is still a matter of debate. We focus on the collapse of solutions for the three-point-vortex model using a geometric framework. In particular, we show that for SQG the collapse can be either self-similar or non-self-similar. Self-similarity occurs only when the Hamiltonian is zero, while non-self-similarity appears for nonzero values of the same. For both cases, collapse is allowed for any choice of circulations within a permitted interval. These results differ strikingly from the classical point-vortex model, where collapse is self-similar for any value of the Hamiltonian, but the vortex circulations must satisfy a strict relationship. Results may also shed a light on the formation of singularities in the SQG partial differential equations, where the singularity is thought to be reached only in a self-similar way.

Reference:

G. Badin and A.M. Barry, 2018,"Collapse of generalized Euler and surface quasigeostrophic point vortices", Physical Review E, 98, 023110