Review of egusphere-2026-4368, FA Chishtie

GENERAL

In view of the difficulty of obtaining observations of tornadoes, theoretical approaches are justified. This paper details an approach that succeeds in describing a steady state that sheds light on the balances in an axisymmetric framework. It cannot however deal with the observational phenomena of rapid intensification and rapid dissipation that are often seen in real tornadoes.

One remark that I have is that the kinetic energy of air in general is a very low fraction of the internal and gravitational energy (Gill, 1982; Dutton, 1986). That fact makes it possible for the generation of very high wind speeds provided a relatively modest supply of Gibbs free energy is available to do the entropy-free work. Such supply is evident in supercell thunderstorms, ultimately arising from the evaporation of liquid water to a large population of free gaseous H_2O molecules.

The paper is well written and well organised, and is suitable for publication in *Non Linear Processes in Geophysics.*

COMMENTARY

Line 17: "nonlocal" implies a scale and "non-Gaussian" implies fat-tailed scale invariance. In turn that suggests that turbulence plays a key role, yet the word does not appear in the paper. Whatever the observational shortcomings of supercells and tornadoes, there can be no doubt that they are turbulent. In the spirit of vorticity being central, there is an argument that atmospheric structure can be described by a sequence of vortices interacting on all scales, from the mean free path to a great circle (Tuck, 2025).

Line 23: "Control" is a word that needs careful thought before deployment in the context of atmospheric predictability. The complexity of nonlinear interactions makes attribution of control to a single phenomenon difficult.

Lines 43-48: What does "hierarchically constrained many-body dynamics" mean? Are the many bodies air molecules? I'm thinking of Kadau et al. (2010).

Lines 54-55: This is a good justification for your approach.

Lines 57-60: Is the rotation cyclonic in the powerful vortex in the atmosphere? How large is the pressure gradient and how is it generated/ Please specify. I note that about 98% of tornadoes are cyclonic, so how is the Coriolis effect neglectable?

Line 63: "jet" - what jet? Specify.

Lines 281-299: If atmospheric structure is really a series of vortices on all scales, what value is there in "selecting" numbers like 2,3 or 4? The tornado itself is a vortex, is it not? I have not checked the mathematics in Sections 3 to 9, but it smacks of trying to deal with the analytically unsolvable Navier-Stokes equation by circumventing the problems of dissipation and closure.

Lines 315-325: I can't see a realistic solution to this problem without considering the whole system's energetics.

Lines 326-341: The limitations are well put.

REFERENCES

Dutton, J.A. (1986) Chapter 14. In: The ceaseless wind: an introduction to the theory of atmospheric motion, 2nd edition. Mineola, New York: Dover Publications.

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Tuck, A.F. (2025) The generation of wind velocity via scale invariant Gibbs free energy: turbulence drives the general circulation. Entropy, 27(7), 740. Available from: https://doi.org/10.3390/e27070740.