Review 1

PC member: Chaima Bounadra
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Review

This work is located at the interface between theoretical fluid physics and machine learning. The author proposes an innovative methodology to model turbulence intermittency by learning the distribution of velocity increments directly from the data. The study uses differentiable optimization to question and potentially surpass the classical log-normal hypothesis of Kolmogorov (K62) for the description of energy cascades.

The methodological originality is the major strong point: the use of the Gumbel-Softmax distribution to make the stochastic sampling process differentiable is good, allowing the use of gradient descent. The validation approach is also rigorous, starting with the reproduction of a reference model (Chevillard, 2012) to calibrate the parameters ((c_1, c_2)) before making the model more complex to capture the heavy tails (intermittency) via the flatness.

The description of the experimental data is too brief. The author mentions “256 samples […] at 100 scales” but specifies neither the nature of the flow (wind tunnel, jet, atmospheric?) nor the Reynolds number, which is crucial for validating physical relevance. Also, although the Gumbel-Softmax approach is cited, its concrete implementation for generating “turbulence samples” remains vague in this summary. Finally, the absence of preliminary results (natural for a V0 since they don't have real results yet) makes assessing feasibility uncertain.

The writing is of excellent quality. The plan is logical (follows the demanded template structure) and the theoretical context is clear, setting the historical bases (K41, K62) before introducing the methodological rupture. The problem statement is explicit and the methods, even if complex (stochastic neural networks), are explained in a way that is comprehensible for an expert scientific audience.

Reviewer's confidence

3: Yes, I have the necessary background to understand and review this study.

Usage of LLM

1: No, not at all.

Confidential remarks for the program committee

(None provided)