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Brief communication: A clarification of wake recovery mechanisms.

authors:
Maarten Paul van der Laan
Mads Baungaard
and Mark Kelly1

Summary:

The manuscript entitled "Brief communication: A clarification of wake recovery mechanisms" endeavors to describe the recovery mechanisms of a wind turbine wake in terms of fundamental flow quantities. The manuscript points toward several commonly accepted relationships between mean sheer gradients, turbulent stresses, and the recovery of momentum deficits, relying heavily on simplified wake models and classical hypotheses. The primary argument of the authors is that "the gradient of the shear is responsible for wake recovery, and not the shear or Reynolds stresses themselves." While this manuscript aims to clarify that is often missed in the wind turbine wake research community, the momentum recovery is more cleanly described by the flux and production terms in the mean kinetic energy transport equation. This topic has been explored to some depth going as far back as a few decades. The authors would be well served to survey the literature in more depth.

Comments:

- Viewed from the perspective of the mean and turbulent kinetic energy transport equations, the divergence of the turbulent stresses are found in a flux term of the form, $\frac{\partial \overline{u_i u_j} U_i}{\partial x_i}$. Expanding with the chain rule offers the very quantities discussed at length in the manuscript, although from a fundamental starting point, rather than a phenomenological one.
- The simplified description of wake contributions relies heavily on many assumptions and hypotheses including:
  - neglecting $\partial/\partial x$ terms
  - zero pressure gradient in the far wake
  - constant eddy viscosity in the wake
  - isotropic Boussinesq hypothesis
  - no buoyancy terms or thermally-driven turbulence
  - etc.

  Some of these assumptions are questionable in real-world scenarios, and should be addressed more clearly in the manuscript. Are there cases where the assumptions do not hold that would change the balance of wake recovery mechanisms (e.g., strongly convective atmospheric boundary layers)?
- Under what conditions would a non-uniform eddy viscosity change the balance of wake recovery mechanism?

- line 45, "... z_H is the wind turbine hub height and σ is the standard deviation..." of what, exactly? What are the units? It would help readers and researchers new to the field to explain the details of the model, and why it is a good choice.
- Lines 78–80 relate the magnitude of the momentum transport to the local extrema of the divergence of the shear stresses. This builds on a large body of work that is not cited in the manuscript (see references below, to start).
- The authors point to two cases that would ostensibly illustrate the main argument (namely, the homogeneous shear flow and the Ekman spiral), but do not actually show support for their thesis, either mathematically or graphically. If these cases support the main argument, the paper would be greatly strengthened with more complete demonstrations.

References

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