

Data assimilation from stochastic reduced order models in micro-meteorology

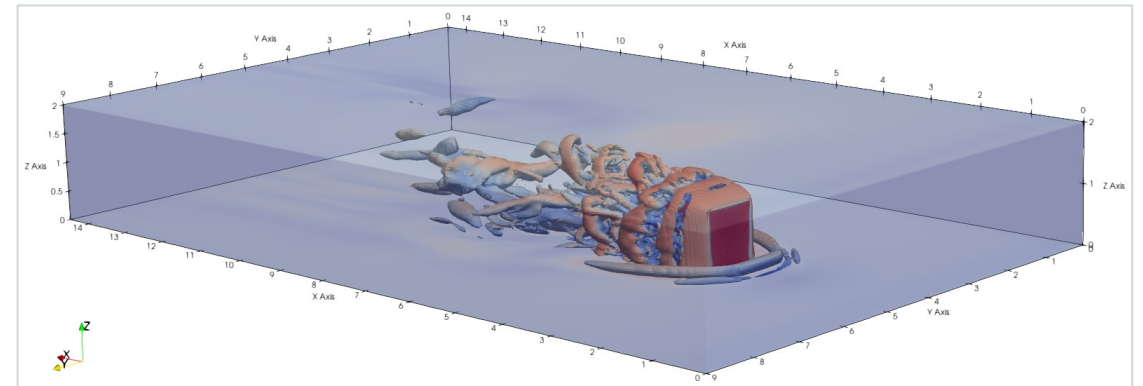
Toward real-time wind estimation at the plot scale

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Why estimate the wind at the plot scale?

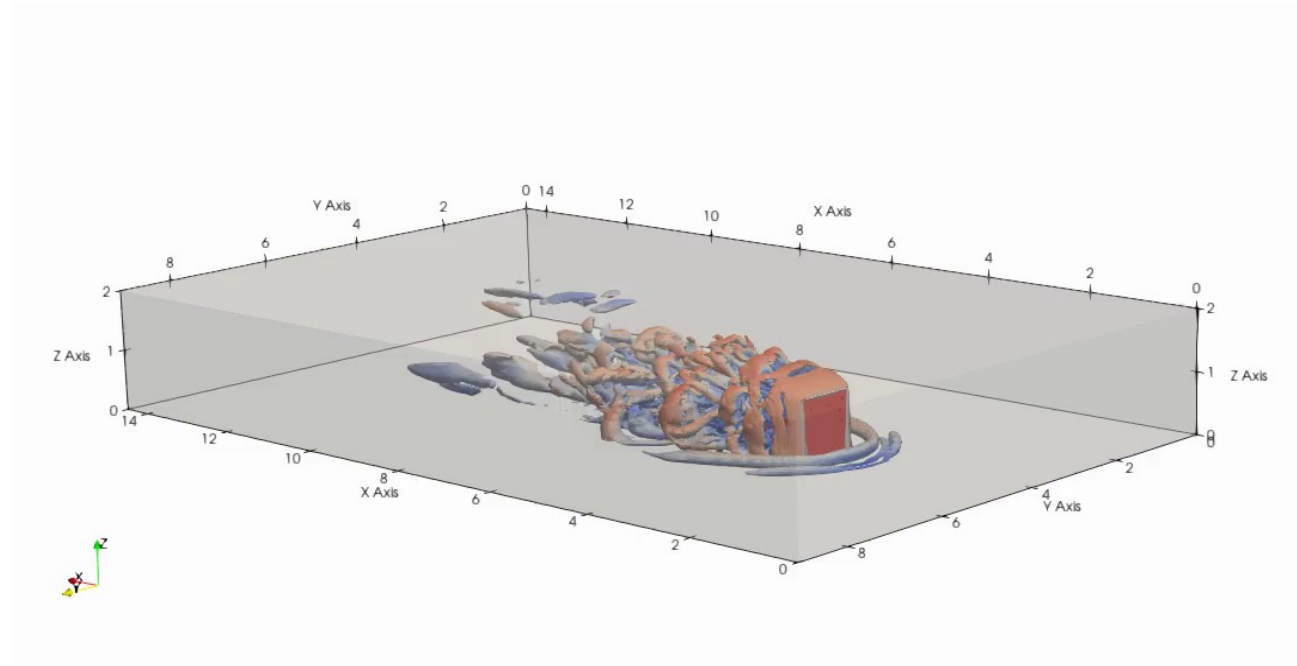
- Wind near the ground affects spraying and crops.
- Farms measure it at only a few points.
- Full 3D simulations are accurate, but take hours to days.



Fog flowing over a hill (image: Google Images)

Goal: estimate the 3D wind around a plot in real time, from a few sensors.

Benchmark: LES of a surface-mounted cube



Q-criterion iso-surfaces, OpenFOAM LES (Spalart–Allmaras IDDES)

Reference case: Martinuzzi & Tropea (1993), ERCOFTAC case 41.

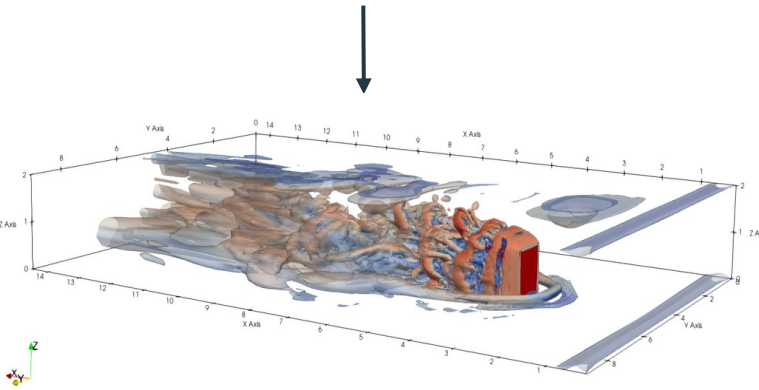
Reducing the flow to a few patterns

$$u(x,t) \approx$$

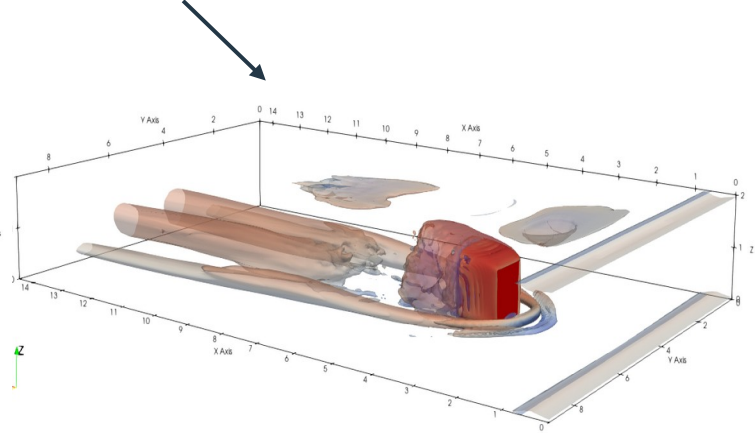
$$\bar{u}(x)$$

+

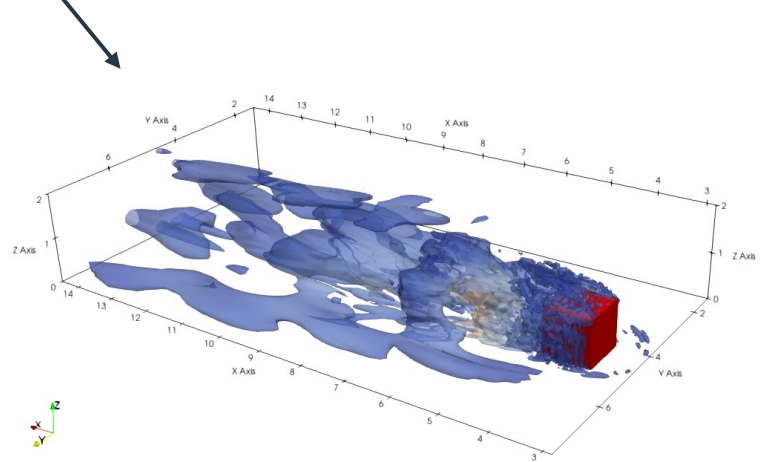
$$b_1(t) \varphi_1(x)$$



LES snapshot (OpenFOAM)

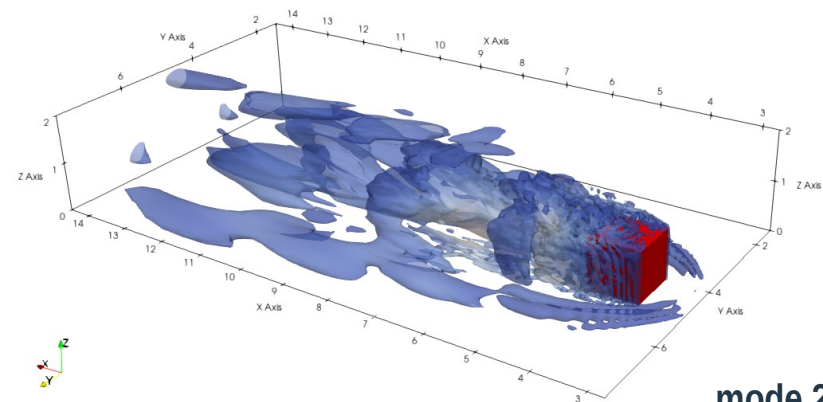


mean flow



mode 1

$$+ b_2(t) \varphi_2(x) + \dots$$



mode 2

Thank you!

References

- [1] R. Martinuzzi, C. Tropea (1993). The flow around surface-mounted, prismatic obstacles placed in a fully developed channel flow. J. Fluids Eng. 115(1), 85–92.
- [2] V. Resseguier, A. M. Picard, E. Mémin, B. Chapron (2021). Quantifying truncation-related uncertainties in unsteady fluid dynamics reduced order models. SIAM/ASA J. Uncertainty Quantification 9(3), 1152–1183.
- [3] V. Resseguier, M. Ladvig, D. Heitz (2022). Real-time estimation and prediction of unsteady flows using reduced-order models coupled with few measurements. J. Comput. Phys. 471, 111631.
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LET'S TALK AT THE POSTER!

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