Extreme gust loads for novel wind turbines

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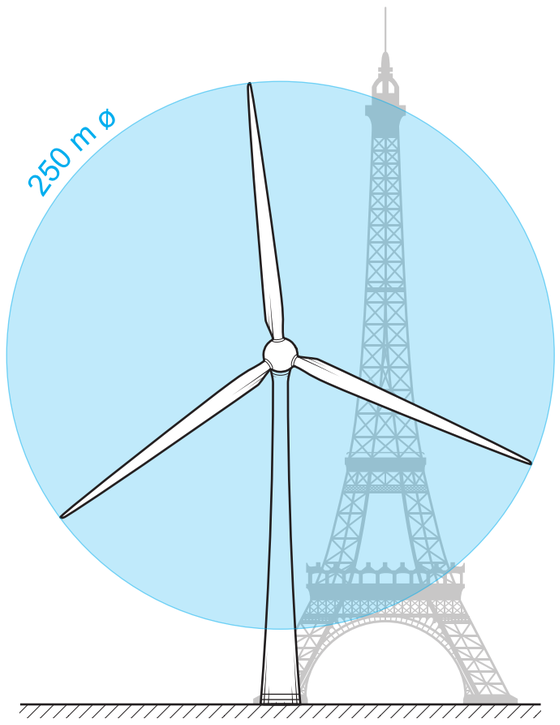
In the scope of the Innwind project, future *"beyond-state-of-the-art"* wind turbines are envisioned that approach the 20 MW scale. To accomplish this, it is important to properly cover the atmospheric conditions in the design phase of the turbine. One of the challenges is finding and modeling the extreme operating gust with a 50-year recurrence period in order to assess its effect on such large turbines. This encompasses finding a suitable model with a physical basis that is also easy to handle during the early conceptual design phases. An important aspect is to find the correct shape in space. Therefore, one has to leave the Eulerian perspective that is offered by ground-based measurement equipment, and start to view gusts as being three-dimensional structures.

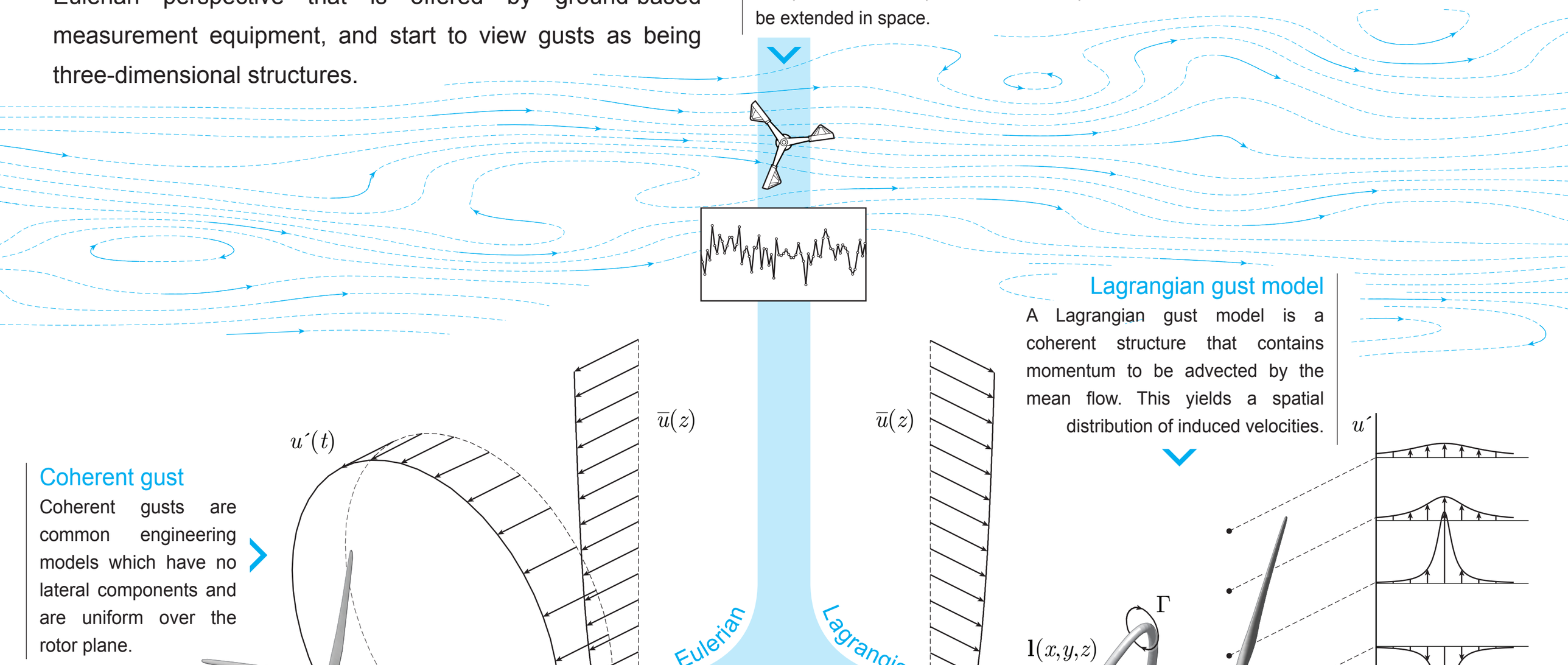
Breaking the laws of scale

Over the years, turbines have been gradually scaled up to find the optimum between capital costs, O&M costs and the energy yield. Feasibility studies in the scope of the UpWind project have shown that a big jump towards a 20 MW offshore turbine is technically feasible. This is the scope of the 5-year Innwind project – an EU initiative lead by DTU, featuring TU Delft and 25 other European partners.



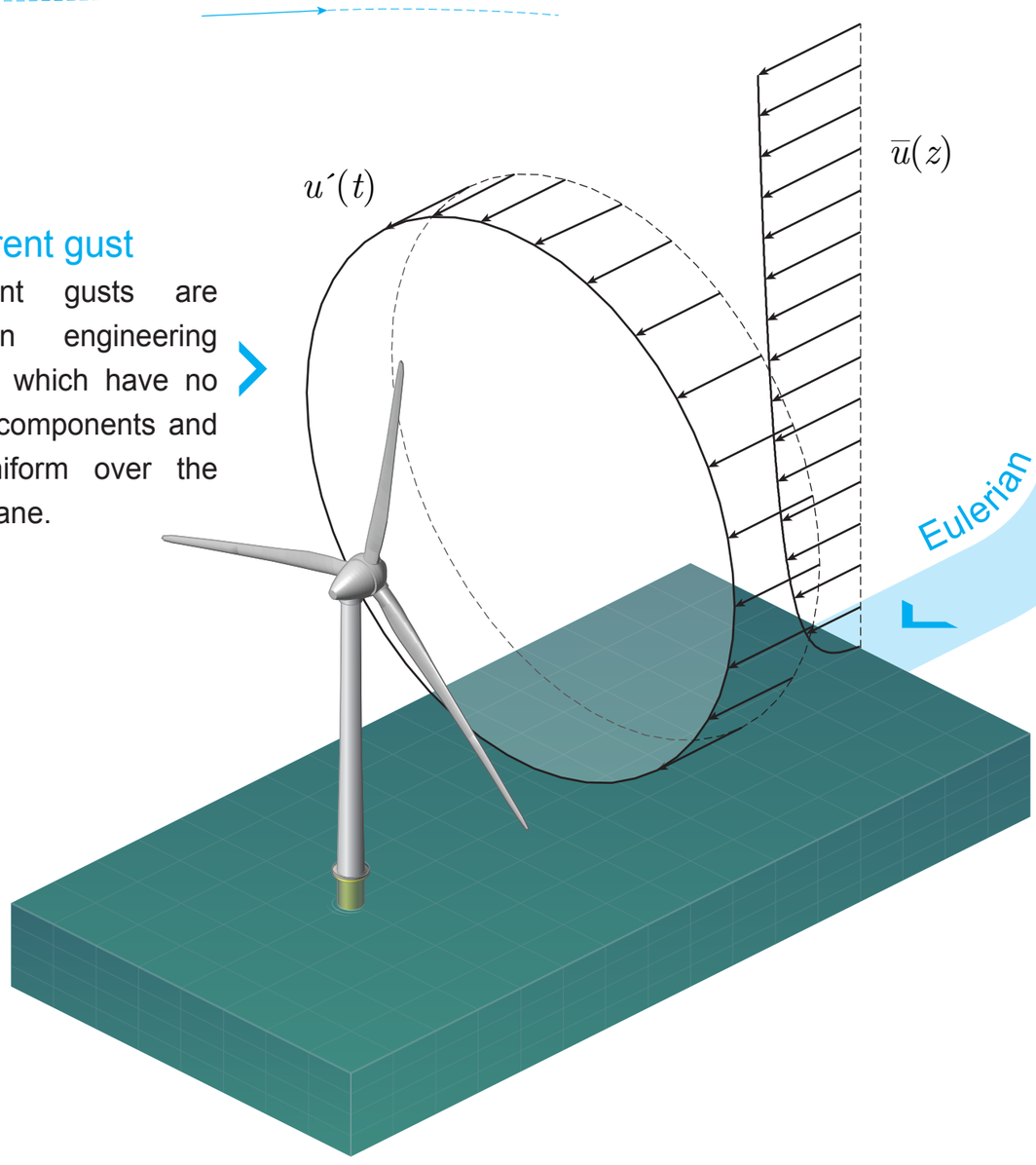
The Eulerian perspective

Anemometers can only measure the unsteady wind speed at a single point in space. However, the flow field is all but homogeneous. It is therefore the question how far predictions for this point can be extended in space.



Coherent gust

Coherent gusts are common engineering models which have no lateral components and are uniform over the rotor plane.

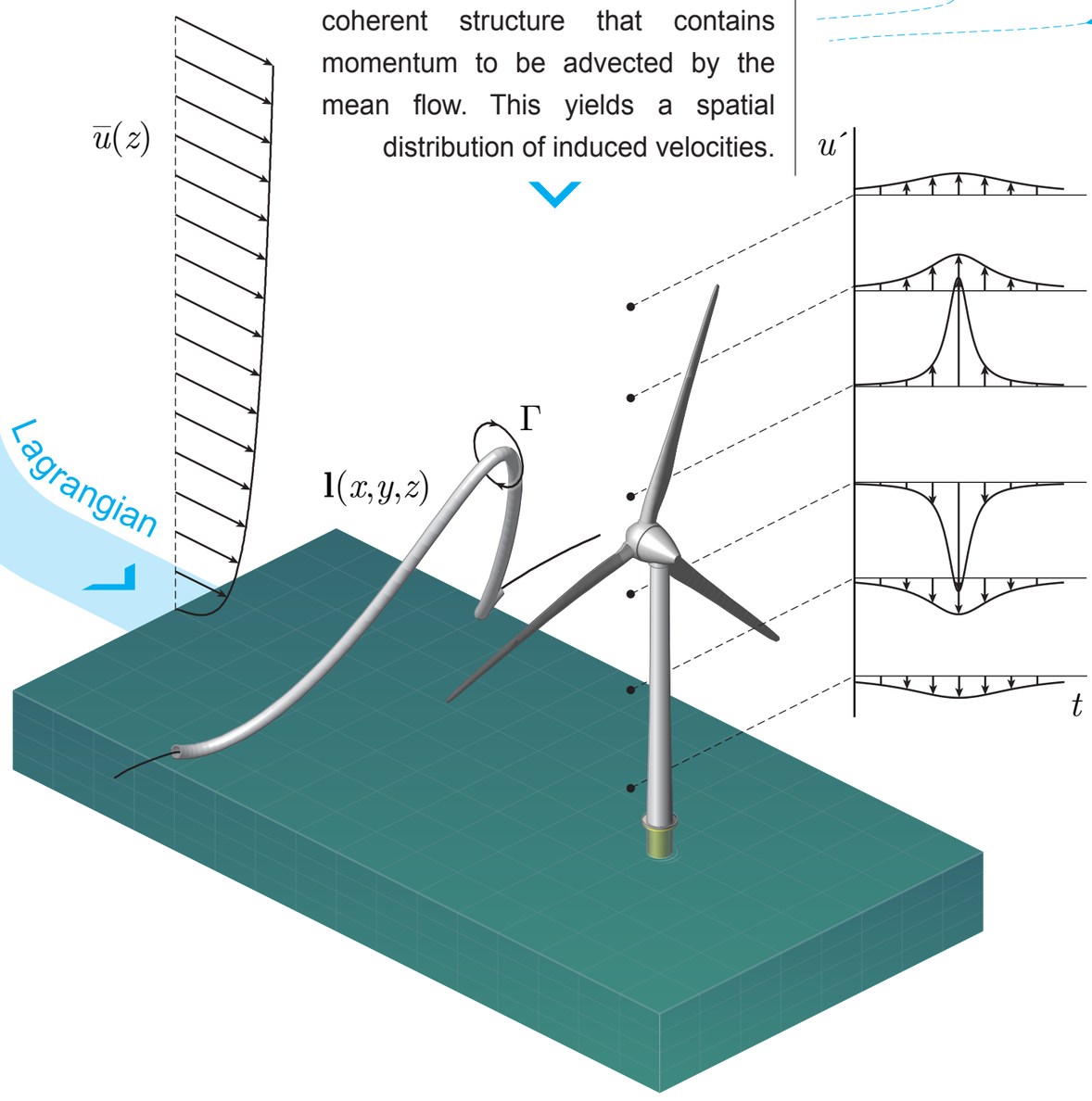


Eulerian

Lagrangian

Lagrangian gust model

A Lagrangian gust model is a coherent structure that contains momentum to be advected by the mean flow. This yields a spatial distribution of induced velocities.



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