Determining the optimal smoothing length scale for actuator line 
models of wind turbine blades¹ LUIS MARTINEZ, CHARLES MENEVEAU, 
Johns Hopkins University — The actuator line model (ALM) is a widely used tool 
for simulating wind turbines when performing Large-Eddy Simulations. The ALM 
uses a smearing kernel \( \eta_c = \frac{1}{\epsilon^3} \pi^{3/2} \exp \left( \frac{-r^2}{\epsilon^2} \right) \), where \( r \) is the distance to an 
actuator point, and \( \epsilon \) is the smoothing length scale which establishes the kernel 
width, to project the lift and drag forces onto the grid. In this work, we develop 
formulations to establish the optimum value of the smoothing length scale \( \epsilon \), based 
on physical arguments, instead of purely numerical constraints. This parameter has 
a very important role in the ALM, to provide a length scale, which may, for example, 
be related to the chord of the airfoil being studied. In the proposed approach, we 
compare features (such as vertical pressure gradient) of a potential flow solution 
for flow over a lifting surface with features of the solution of the Euler equations 
with a body force term. The potential flow solution over a lifting surface is used 
as a general representation of an airfoil. The method presented aims to minimize 
the difference between these features of the flow fields as a function of the smearing 
length scale (\( \epsilon \)), in order to obtain the optimum value.

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