

The SWiFT Benchmarks

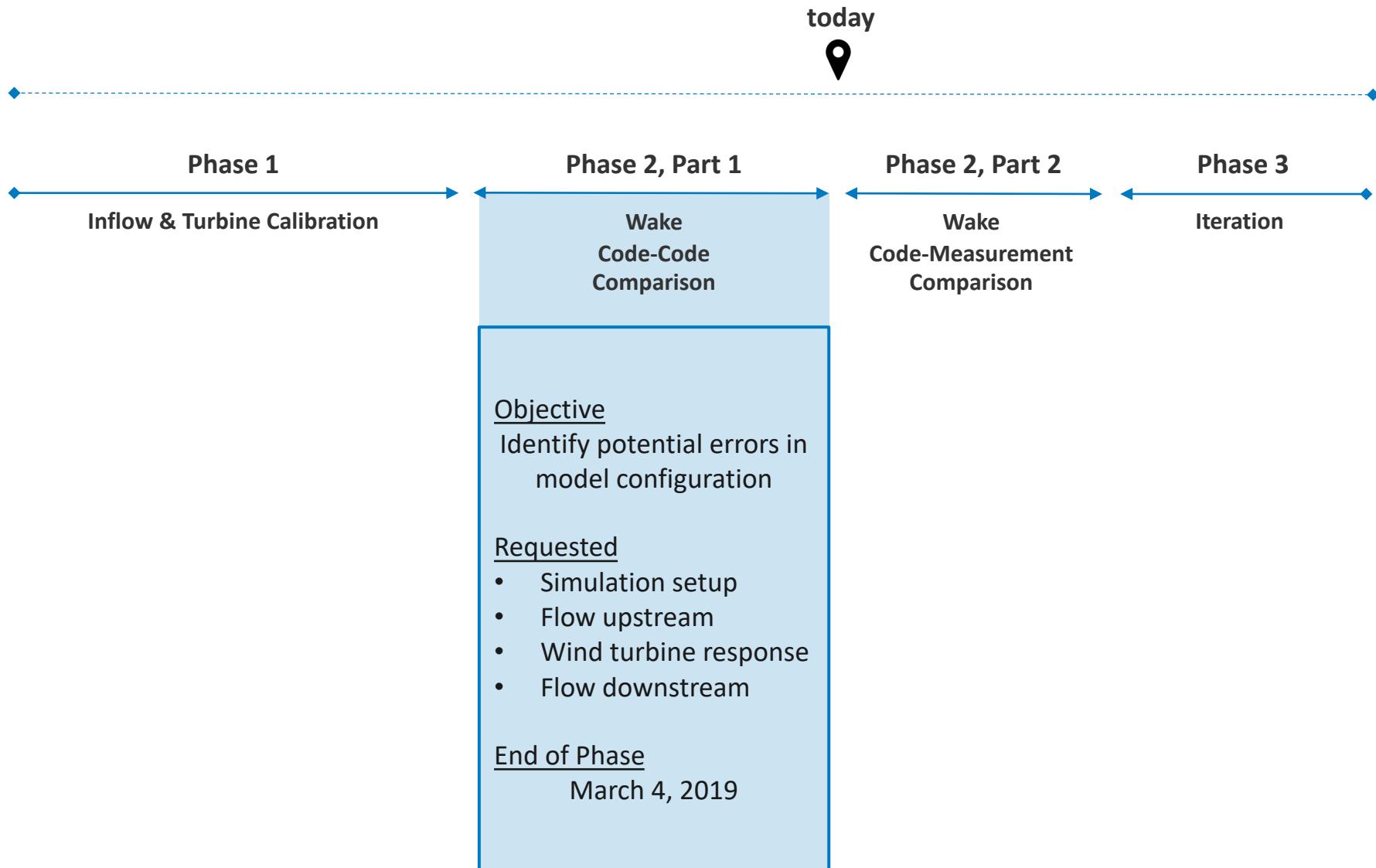
Part of IEA Wind Task 31 Phase 3 (2018-2019)
Meeting #5 – March 12, 2019 @ Boulder, CO, USA

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National Renewable Energy Laboratory

Status

More info: <https://wakebench-swift.readthedocs.io>

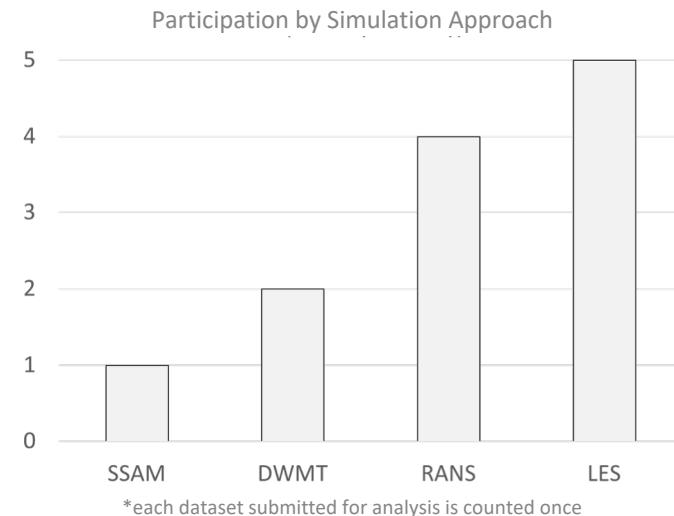


Phase 2 – Part 1*

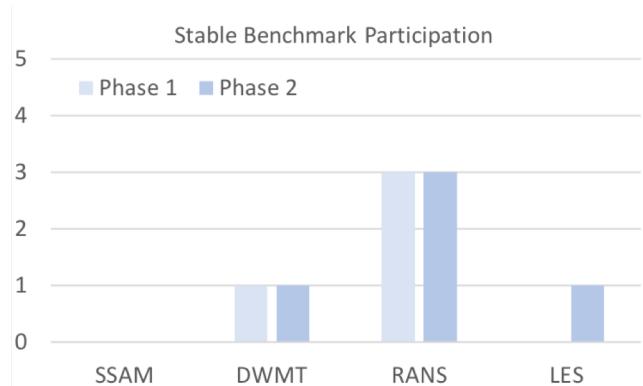
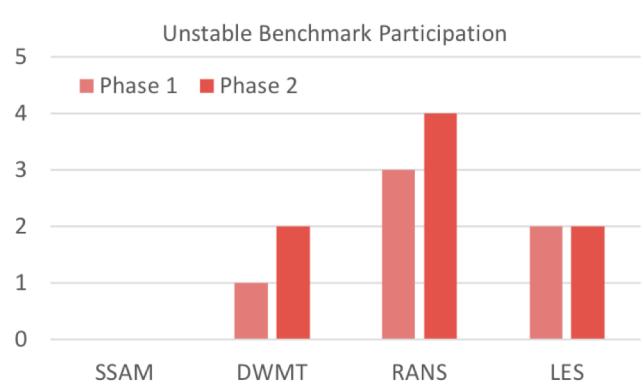
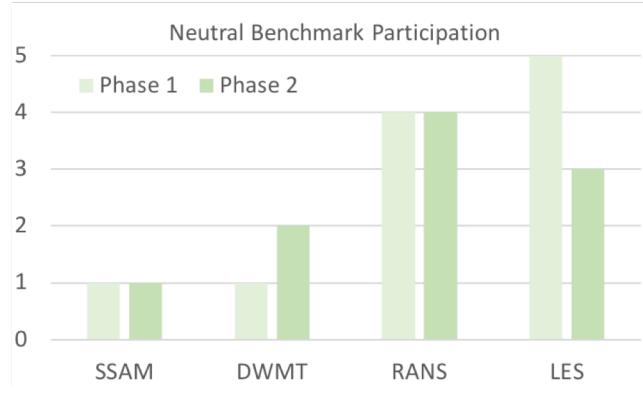
Participation

Participation

- 7 institutions
- 12 simulation approaches



Participation



Hub-height wind speed ~ 8.7 m/s
Hub-height turbulence intensity ~ 10.7 %
Power-law shear exponent ~ 0.14
Stability parameter z/L ~ 0.00

Hub-height wind speed ~ 6.7 m/s
Hub-height turbulence intensity ~ 12.6 %
Power-law shear exponent ~ 0.14
Stability parameter z/L ~ -0.09

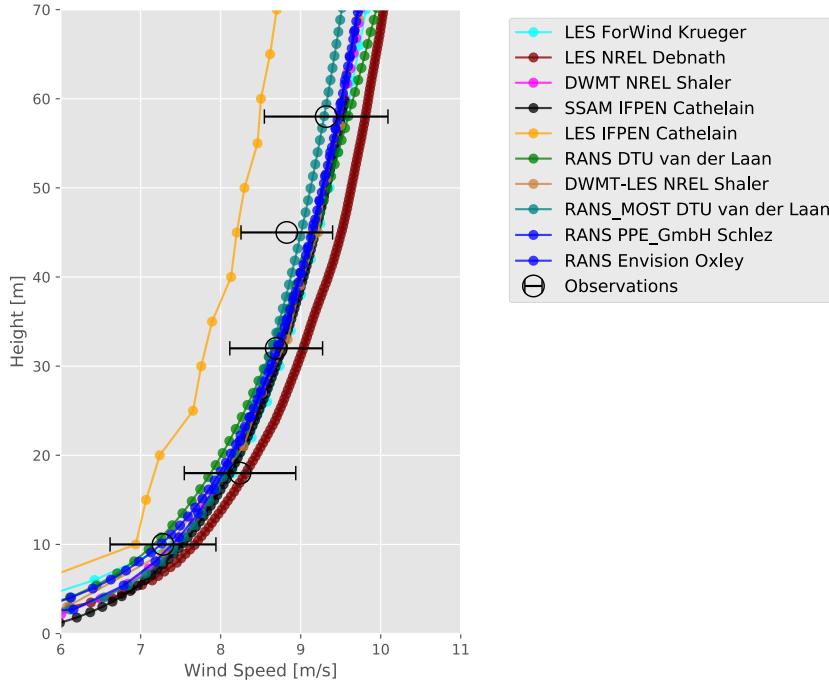
Hub-height wind speed ~ 4.8 m/s
Hub-height turbulence intensity ~ 3.4 %
Power-law shear exponent ~ 0.5
Stability parameter z/L ~ 1.15

Phase 2 – Part 1*

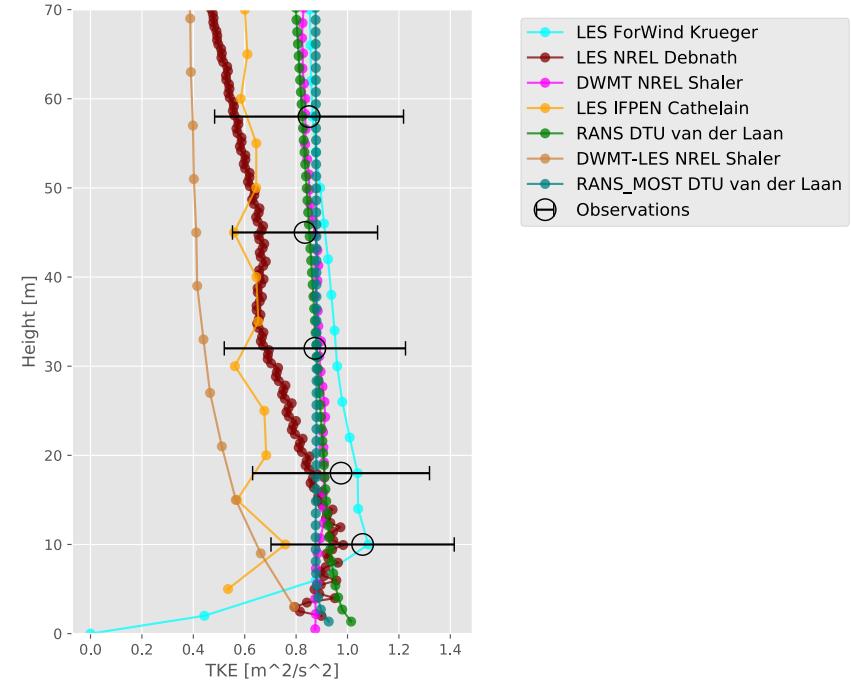
Atmospheric Inflow

Atmospheric Inflow – Neutral Benchmark

Wind Speed Profile averaged along (t, y)
Benchmark: Neutral

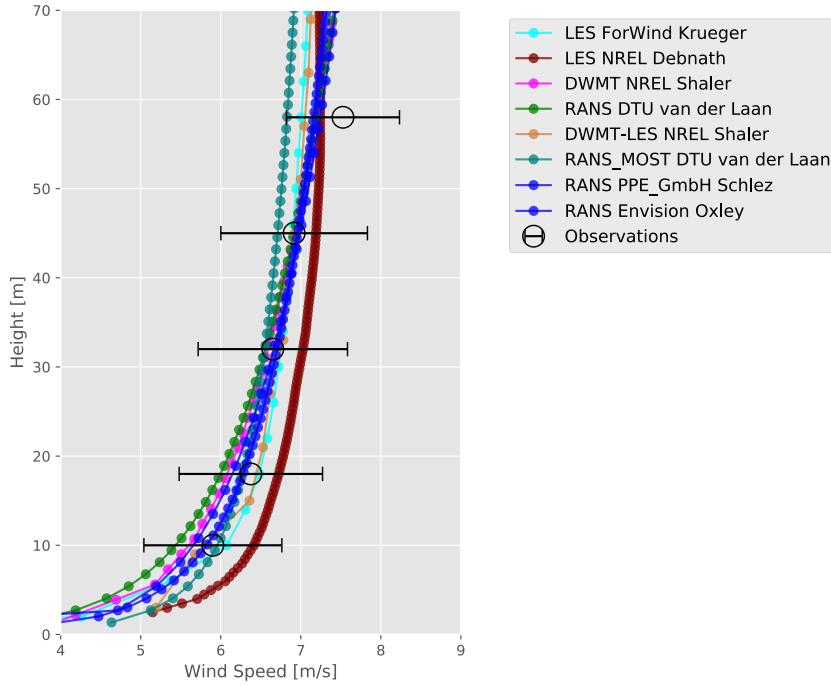


TKE averaged along (t, y)
Benchmark: Neutral

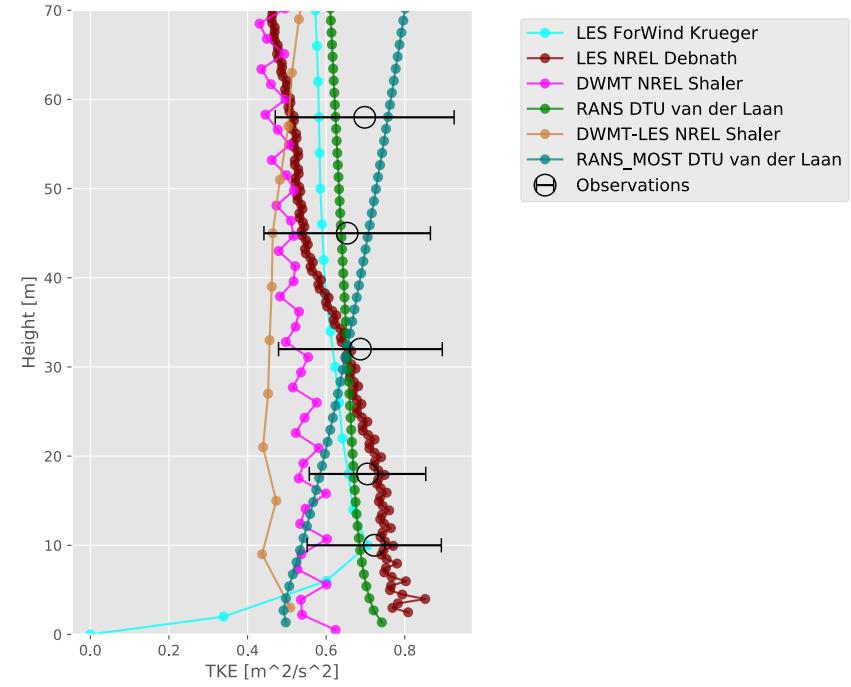


Atmospheric Inflow – Unstable Benchmark

Wind Speed Profile averaged along (t, y)
Benchmark: Unstable

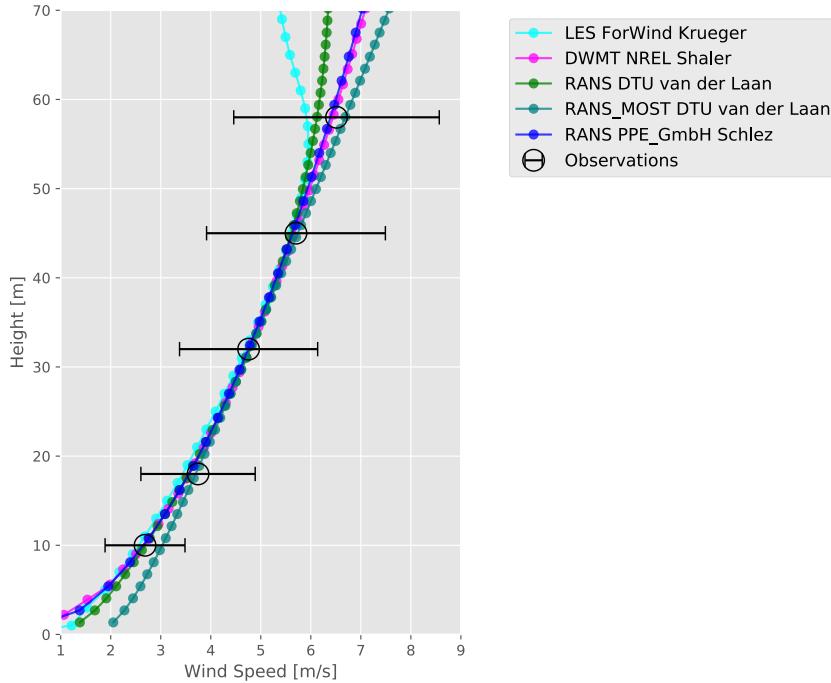


TKE averaged along (t, y)
Benchmark: Unstable

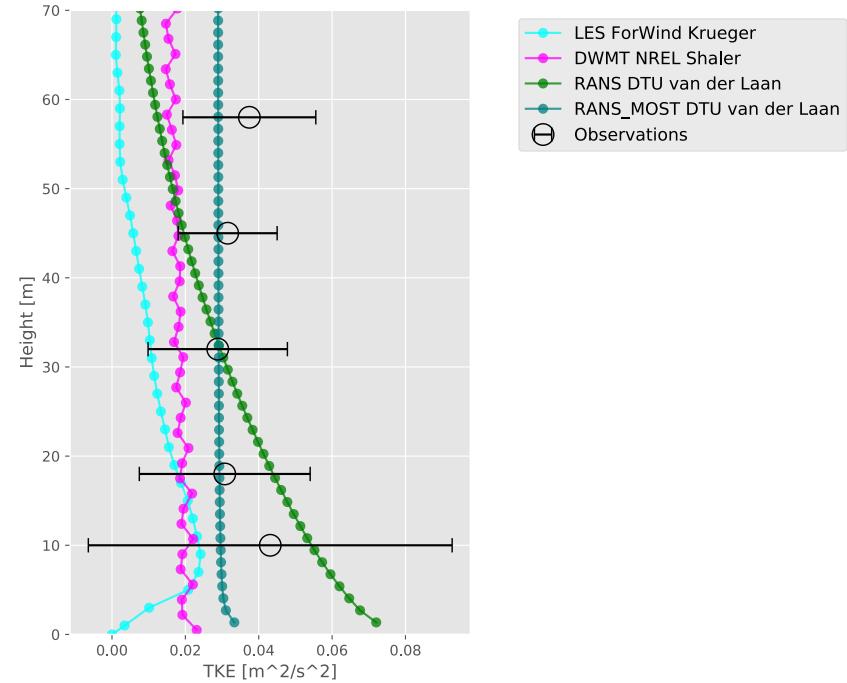


Atmospheric Inflow – Stable Benchmark

Wind Speed Profile averaged along (t, y)
Benchmark: Stable



TKE averaged along (t, y)
Benchmark: Stable

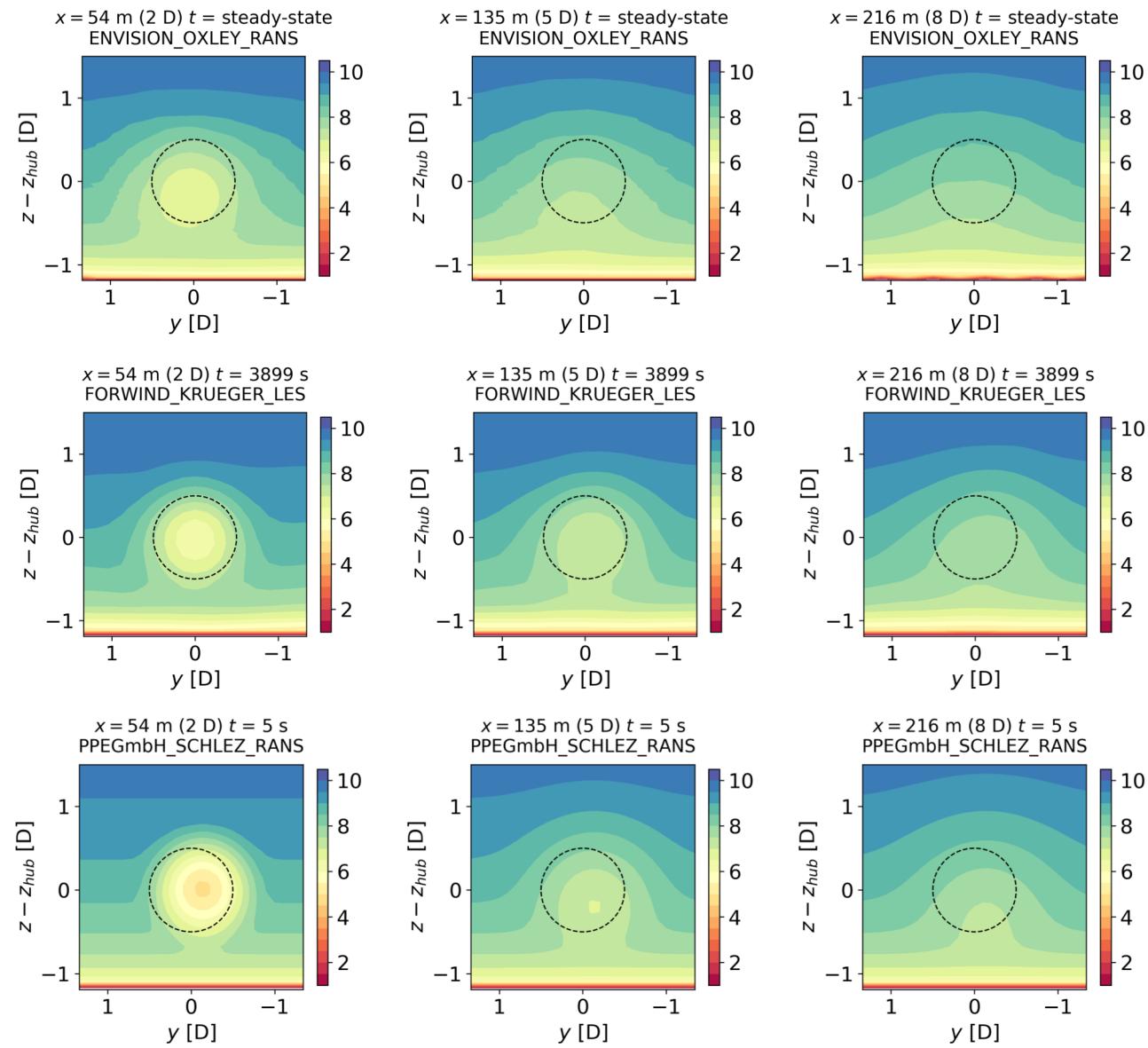


Phase 2 – Part 1*

Turbine Wake

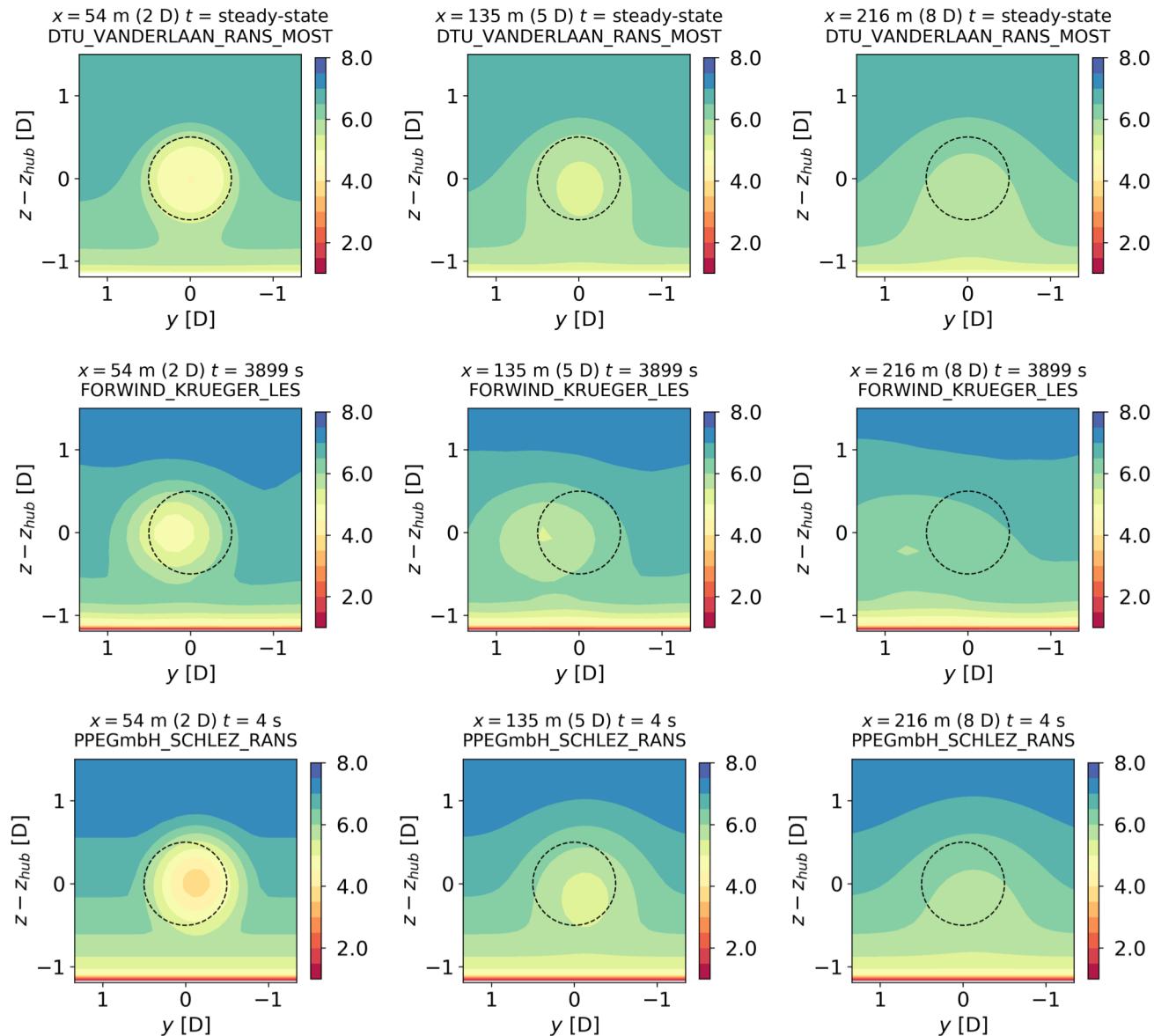
Simulated wake for neutral benchmark

- Horizontal wind speed (m/s)
- Fixed frame of reference
- Looking downstream
- Dashed line = rotor outline
- Differences seen at 2 D persist to far wake at 8 D
- Not sure yet whether coming from differences in inflow or operation



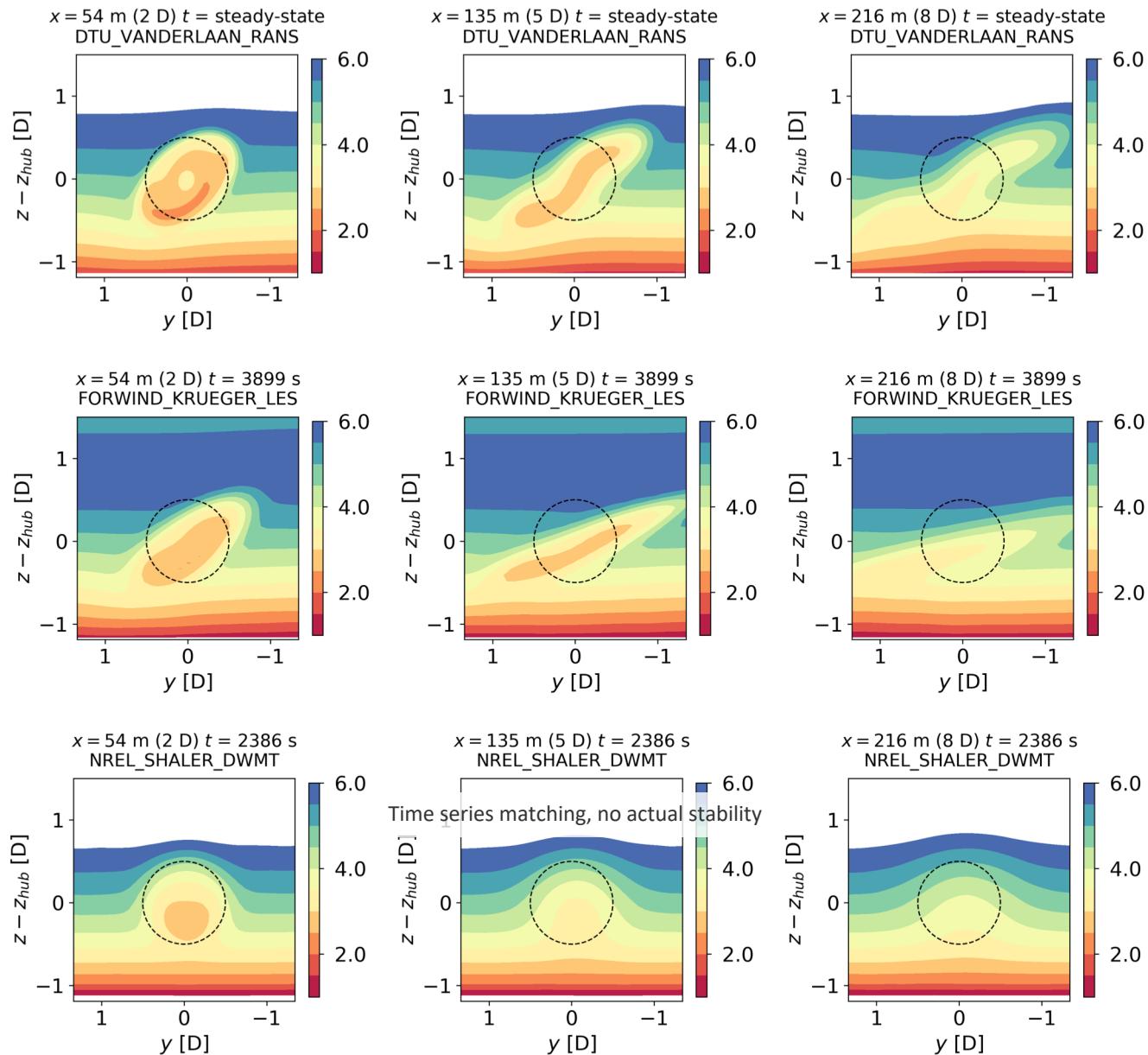
Simulated wake for unstable benchmark

- Horizontal wind speed (m/s)
- Fixed frame of reference
- Looking downstream
- Dashed line = rotor outline
- Differences across models more pronounced than for neutral case
- Not sure yet whether coming from differences in inflow or operation



Simulated wake for unstable benchmark

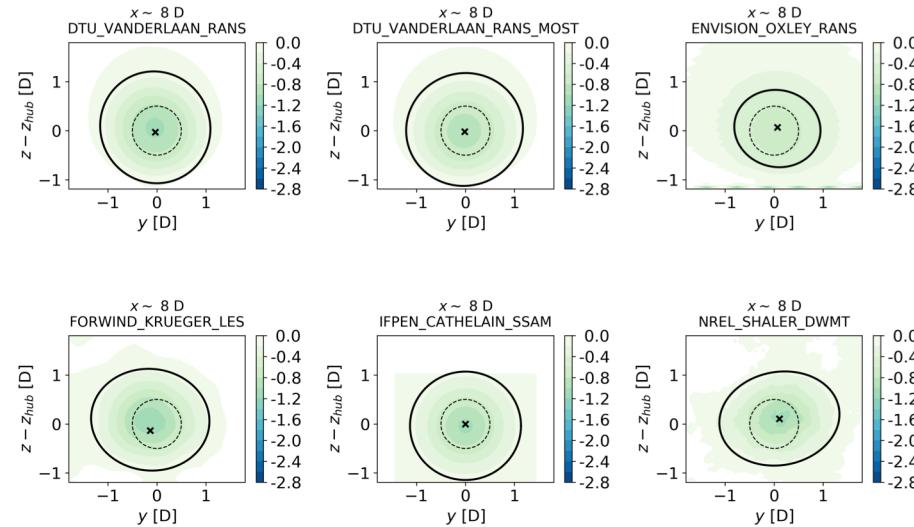
- Horizontal wind speed (m/s)
- Fixed frame of reference
- Looking downstream
- Dashed line = rotor outline
- Differences across models more pronounced than for unstable case
- Not sure yet whether coming from differences in inflow or operation



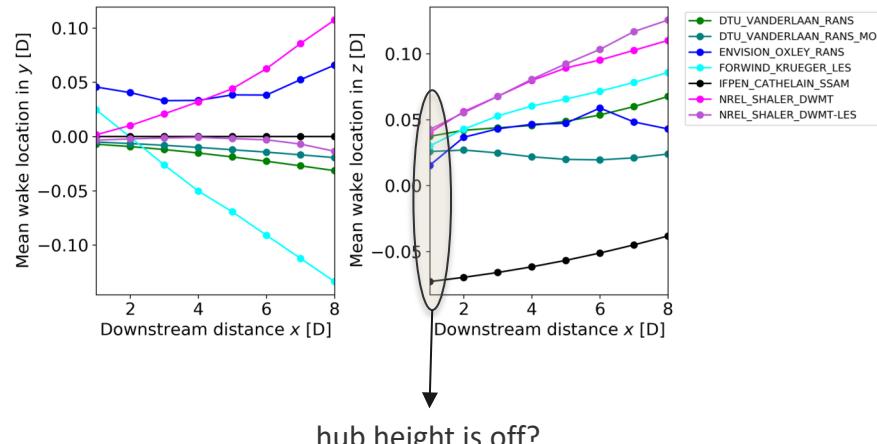
Wake identification and characterization

- We are experimenting with wake identification methods
(more from Eliot and Tommy)

- Velocity deficit contours
- $vd = u/u_{\infty} - 1$
- 2D Gaussian fit



- Spatial evolution of identified center of mean wake



These are preliminary, example figures made just for this meeting!

Lessons learned

Some lessons learned

- Before defining benchmark, gather feedback from modelers:
 - Where are their models underperforming?
 - What are they interested in validating?
 - What kind of benchmark would appeal the most? (in terms of inflow and operation)
- Provide very detailed instructions on file structure, file naming, file formats, variable names, variable units
- Provide code that participants can run on their data prior to submission to make sure it conforms to the standard

Thank you



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