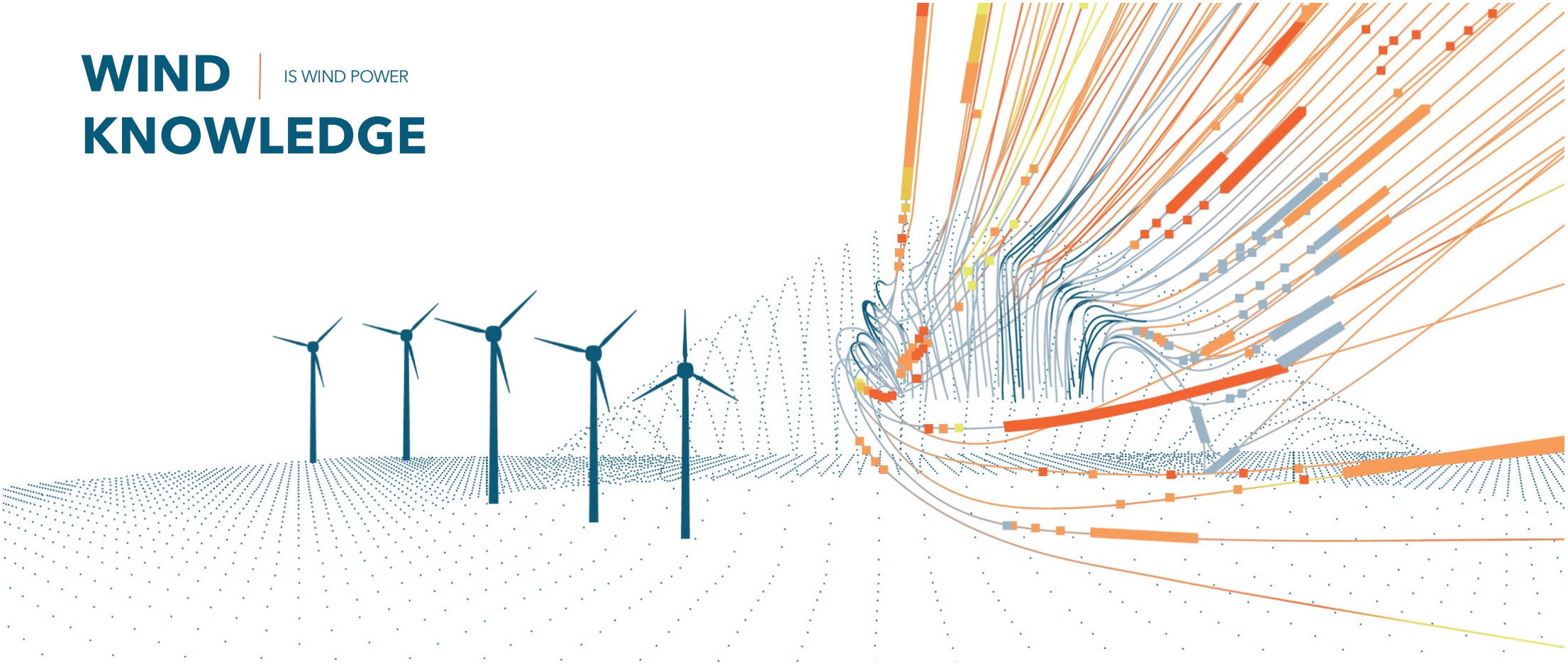
WIND IS WIND POWER
KNOWLEDGE



WindSim User Meeting 2024

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Recommended Settings

Presented by:
Mohammadreza
Mohammadpour Penchah

Overview

- Default settings? Perfect fit for all sites?
- Tweaking models
- Top boundary conditions
- Turbulence models
- Refinement Area – size of buffer?
- When to use smoothing
- Grid size
- Solvers: When to use each
- Stability: When is it useful

Default settings? Perfect fit for all sites?

- Default settings can be used for many sites
- There are several options for the users to find the best configuration for their sites:
  - Forest model
  - Top boundary conditions
  - Turbulence models
  - Etc.

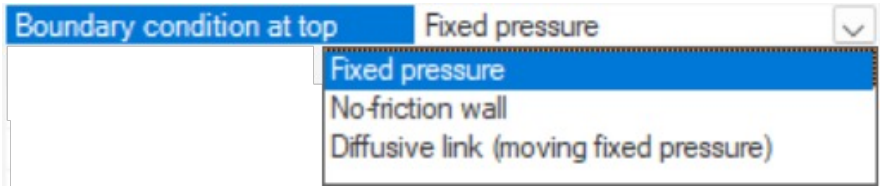
1: Boundary and initial conditions	
Do Nesting	Disregard nesting
Sector input type	Uniform distribution of the sector angl
Number of sectors	12
Sectors for next run	0;30;60;90;120;150;180;210;240;27(
Height of boundary layer	500
Speed above boundary layer he	**12**
Use previous run as input	False
Boundary condition at top	Fixed pressure
2: Physical models	
Potential temperature	Disregard temperature
Air density	1.225
Turbulence model	Standard k-epsilon
3: Calculation parameters	
Solver	GCV
Number of simultaneous sector	1

When should you start tweaking models?

- Non-convergence?
  - Many factors can contribute to the non-convergence of the model. Initial and boundary conditions, grid resolution
  - In the very complex terrain increase or even decreasing grid resolution can help to solve non-convergence issues

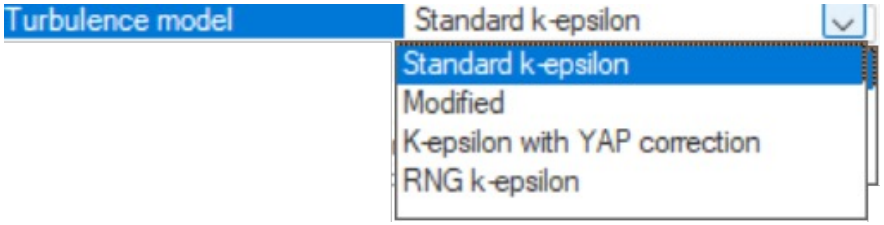
- Vertical profiles are not match with the observations
  - Try with atmospheric stability
  - If the domain includes forest, configure forest model

Top boundary conditions: what is each and when to use them?



- Fixed pressure should be used when running the Wind Fields over complex terrain
- The No-friction-wall should be used over flat terrain. This will make sure that the momentum is maintained in the flat terrain case.
- The diffusive link (moving fixed pressure) is like fixed pressure case but imposing a constant speed at the top and should be used over simple terrain.

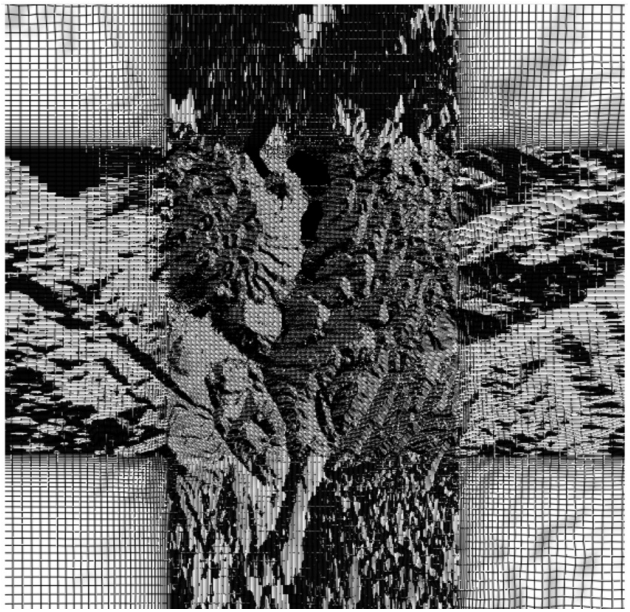
Turbulence models



- Standard k-ε model: Widely used turbulence model. But it's not appropriate for complex terrain with severe pressure gradient and flow separation. k-ε simulates very large vertical mixing.
- Modified k-ε model: modified some of the model parameters in k-ε model based on atmospheric experimental data. Less mixing length comparing standard k-ε.
- The RNG and the YAP correction usually help in cases where a recirculation has to be simulated; they behave like the standard k-ε far from the separation zones. They are therefore recommended in any case.
- RNG has best convergence behavior.

Refinement Area: size of buffer?

- Recommended buffer area is 10 km from each side of the boundaries.
  For offshore and stable atmosphere, it should be larger.
- The boundaries of the refinement area should be more than 1 km away from the climatological site positions.



When to use smoothing

- We don't recommend to use smoothing unless divergence occurs in the module Wind Fields

- When: divergence occurs in areas where the grid is highly skewed, and the speed shows much too high values.
  - first tries for the smoothing factor should be in the order of 0.1.
  - If divergence still occurs, then gradually decrease this second order derivative threshold.
  - Use the "Smoothing radius" in order not to smooth in the middle of the terrain where normally the wind farm is located but only towards to borders.

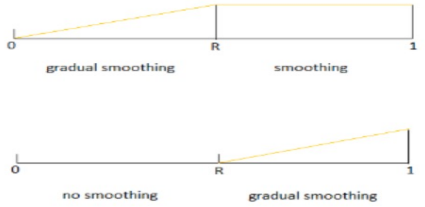


Figure 4. Definition sketch for the Gradual smoothing type equal to Inner (top) and Outer (bottom), where R is the non-dimensional Smoothing radius.

Grid size

- If you are Desktop user you have to consider hardware resources, CPUs and memory
- A typical project can have a resolution between 10 - 50 m resolution
- For complex terrain higher resolution is recommended.
- 25-30 vertical layers is almost enough for flat terrain but when you are using a higher horizontal resolution, it is recommended to use more vertical layer.
- The bottom 3 layers should have roughly the same thickness.

.	1	2	3	4	5	6	7	8	9	10
z-dist. max (m)	2.5	7.5	12.5	17.5	22.5	27.5	32.5	37.8	43.4	49.1
z-dist. min (m)	2.5	7.5	12.5	17.5	22.5	27.5	32.5	37.8	43.4	49.1

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Solvers: When to use each

- It depends on your project configurations and size.
- GCV solver is one of the best in convergence in many of the tests.
- For big projects (more than 4 M cells) Parallel GCV-AMG solver could be fastest in term of time.
- However, users should keep in mind that reaching convergence criteria depends on several factors such as terrain complexity, turbulent models, boundary conditions can be different for different projects

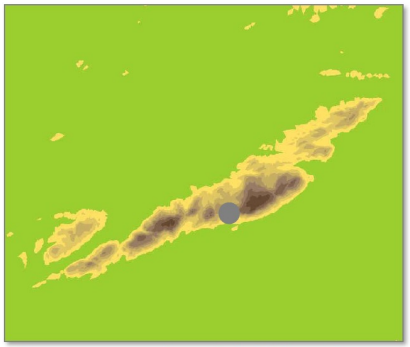
Stability: When is it useful

- Analyze your observation data, or mesoscale data, whether the stable condition is dominant
- The Monin Obukhov length should be more than 50.
- Negative Monin Obukhov length should not be run.

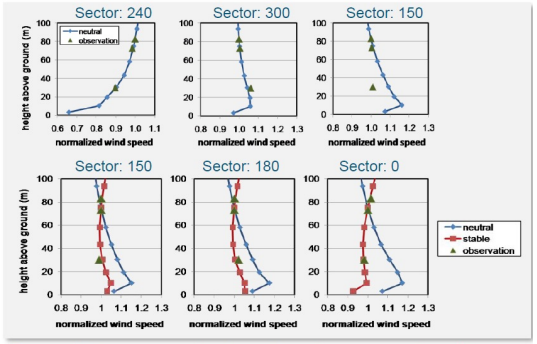
During winter stable situations are frequent for wind from the inland sector

Sector	0	30	60	90	120	150	180	210	240	270	300	330
Stability	s	s	s	s	s	s	s	n	n	n	n	s

Wind sectors with neutral (n) and stable (s) stratification.



Measurements: Speed (30, 73 and 83 m), Temperature (50 and 83 m)



Better fit between simulated and measured profiles with stable stratification in CFD simulations

Source: Meissner C., Gravdahl A. R., Steensen B., *"Including thermal effects in CFD simulations"*, EWEC 2009

Thank you!

WindSim AS
Tollbodgaten 22
3111 Tønsberg
Norway
Tel.: +47 33 38 18 00

WindSim China
No. 101 Shaoyang Beili, Chaoyang District
1000029 Beijing
China
Tel.: +86 186 1029 1570