

Best Practice Guide

How to Set Up CFD Model Parameters Correctly in WindSim

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Introduction

WindSim's Wind Fields module contains a number of settings that directly affect the accuracy of your CFD simulation. Leaving these at their default values is a common source of error — the defaults were calibrated for high-latitude, onshore conditions and may not be appropriate for your site. This guide covers the five key parameters to review and set correctly at the start of every project, along with guidance on solver selection and the nesting workflow.

The recommended starting point for any new simulation is a neutral atmospheric stability case. After verifying model quality through cross-validation and flow model inspection, stability corrections (Monin-Obukhov length) can be introduced if needed. That workflow is covered in the next webinar in this series.

1. Recommended Setup Workflow

Before running any wind field simulation, work through the following steps in order:

Step 1: Site Characterisation	Step 2: Wind Field Settings	Step 3: Solver & Run
<ul style="list-style-type: none"> Determine site latitude Identify terrain complexity (check maximum inclination angle) Estimate geostrophic wind speed from mast data if available Note whether site is onshore or offshore 	<ul style="list-style-type: none"> Set Height of Boundary Layer (HBL) for latitude and surface type Set Speed Above Boundary Layer Select Boundary Condition at Top based on inclination angle Select Turbulence Model based on terrain complexity 	<ul style="list-style-type: none"> Select Solver based on number of cells Run wind fields for all sectors Check convergence; switch solver or turbulence model if needed Validate with cross-checking before applying stability corrections

Critical: Do not keep all settings at default. The defaults in WindSim reflect Norwegian (high-latitude, onshore) conditions and will produce incorrect inlet profiles for other regions or offshore sites.

2. Key Parameters

2.1 Height of Boundary Layer (HBL)

The Height of Boundary Layer defines the inlet wind speed profile fed into the CFD model. It represents the depth of the atmospheric boundary layer, which is controlled by surface friction and the Coriolis force. This value varies significantly with latitude and surface type.

Condition	Typical HBL Range	Notes
High latitude (e.g. Norway, Scotland)	350 – 500 m	WindSim default (500 m) reflects this range. Appropriate for Scandinavian and northern European sites.
Mid latitude (e.g. central Europe, USA)	800 – 1500 m	Default significantly underestimates HBO. Adjust upward based on site latitude.
Low latitude (e.g. tropics, Southeast Asia)	1500 – 2500 m	HBO should be increased substantially. Large impact on vertical wind profile.
Offshore (sea surface)	Variable — lower surface roughness changes the profile structure	HBO over water differs from land. Adjust when running offshore simulations.

HBL varies between daytime and night-time. Use an average value representative of the site's typical conditions. This parameter can affect vertical profile shape and AEP by approximately 1–2%.

2.2 Speed Above the Boundary Layer (Geostrophic Wind Speed)

This is the wind speed at the top of the boundary layer, also known as the geostrophic wind speed. It is driven by the pressure gradient force and Coriolis effects, and varies by geographic location and surface type. Typical values range from 10 to 25 m/s.

Consideration	Guidance
Impact on AEP	Relatively low. WindSim uses speed-ups (relative wind speeds), so the absolute value at the top does not strongly influence AEP. The default of 10 m/s is acceptable for most AEP calculations.
Impact on flow structure	Influences the size of recirculation zones. If capturing recirculation is important for your analysis, estimate this value from site measurements.
How to estimate	If a 10 m mast measurement is available, use the surface wind to estimate geostrophic wind speed using the logarithmic wind profile relationship for your surface roughness.
Varies by surface type	Ocean, land, forest, and urban surfaces produce different geostrophic speeds. Offshore sites may require adjustment from the 10 m/s default.

2.3 Boundary Condition at the Top

WindSim offers three boundary conditions at the top of the simulation domain. The correct choice depends on the maximum inclination angle (MIA) of the terrain within the simulation domain. Using the wrong boundary condition for your terrain type can introduce unphysical solutions.

Boundary Condition	When to Use (MIA)	Description
Fixed Pressure	MIA > 17° (complex terrain)	Most commonly used setting. Recommended for wind farms in complex or hilly terrain. Maintains correct pressure conditions at the upper boundary.

Boundary Condition	When to Use (MIA)	Description
Diffusive Link	MIA 10° – 17° (moderate terrain)	Introduced in WindSim 12. Behaves similarly to Fixed Pressure but imposes a constant speed at the top. Appropriate for moderately complex terrain.
Non-Friction Wall	MIA < 10° (simple/flat terrain)	Prevents flow entering or leaving through the top boundary, keeping the simulation stable. Use for flat or gently rolling terrain only. Applying this to complex terrain introduces unphysical solutions.

Check the maximum inclination angle in WindSim's terrain visualisation before selecting the boundary condition. For most wind energy projects in complex terrain, Fixed Pressure is the correct choice.

2.4 Turbulence Model

WindSim offers four turbulence model variants. The choice of model affects both simulation accuracy and convergence behaviour. Based on validation across multiple wind farm projects using cross-checking against met mast data, the following guidance applies:

Model	Best For	Convergence	Recommendation
RNG k-epsilon	Complex terrain	Can struggle with >30 million cells	First choice for complex terrain. Achieves the lowest cross-checking errors in validation studies.
Standard k-epsilon	Simple / flat terrain, or as fallback	Most stable — ~98% convergence rate	Use for simple terrain, or switch to this if RNG cannot converge. Good fallback option for large models.
Modified k-epsilon	Intermediate terrain complexity	Generally stable	Intermediate option. Use when RNG is needed but convergence is borderline.

Always start with RNG k-epsilon for complex terrain. If convergence cannot be achieved — particularly for models with more than 30 million cells — switch to Modified or Standard k-epsilon. For simple terrain, Standard k-epsilon is the recommended default.

2.5 Solver Selection

WindSim 12 offers two solver types: GCV (serial) and GCV AMG (Algebraic Multigrid). The choice should be based on the number of cells in your wind field model. GCV AMG works by first converging on a coarse grid and progressively refining cell size — this approach significantly reduces computation time for large models and can achieve convergence where serial GCV cannot.

Solver	Number of Cells	Guidance
GCV (serial)	< 5 million	Most stable and reliable. Recommended for smaller models. Serial GCV achieves convergence in approximately 98% of cases. Speed advantage of parallel solvers is limited at this scale.

Solver	Number of Cells	Guidance
GCV Parallel	5 – 8 million	Use parallel GCV to reduce computation time at mid-range model sizes. Stable for most cases.
GCV AMG Parallel	> 8 million	Recommended for large models. Substantially faster than serial GCV and can converge cases where standard GCV fails. WindSim continues to improve GCV AMG performance — expect further gains in future releases.

If time is not a constraint, serial GCV remains the most reliable solver. For production work where simulation turnaround is critical, select the solver tier appropriate to your model size. If GCV Parallel cannot converge, switching to GCV AMG Parallel often resolves the issue.

3. Nesting: Mother and Daughter Projects

Nesting allows a high-resolution simulation (daughter project) to use the wind fields from a coarser simulation (mother project) as its inlet boundary condition. This improves accuracy in the turbine and mast area without requiring an excessively large, high-resolution simulation over the full domain. Nesting is recommended when site complexity or domain size would otherwise require an impractically large single model.

Note: Nesting must currently be run on the WindSim desktop application. It is not yet supported on WindSim Accelerator (cloud).

Mother Project (Background)	Daughter Project (High-Resolution)
<ul style="list-style-type: none"> Use the same GWS file (can be the same large domain) Uniform horizontal resolution only — no refinement area Adjust maximum number of cells to achieve resolution < 200 m Typical cell count: 3–5 million (converges within ~5 hours) Set HBL, geostrophic speed, and boundary condition as per the guidance above Run for all required sectors 	<ul style="list-style-type: none"> Reduce the XY domain to cover turbines + met masts + ~2 km buffer Apply refinement area or refinement file for the inner zone In Wind Fields settings, enable 'Do Nesting' and point to the mother project .ws file Use the same number of sectors as the mother project Avoid a large cell size ratio at the boundary — do not try to match mother cell sizes at the daughter boundary, as a jump from 20 m to 200 m degrades model quality Can use a different turbulence model from the mother project if needed

4. Atmospheric Stability — Starting Point

For the initial simulation of any project, run a neutral stability case: disable temperature effects and do not set a Monin-Obukhov length. This provides the cleanest baseline for cross-validation and model quality assessment.

Setting	Initial Recommendation
Atmospheric Stability	Neutral — disregard temperature for the first run

Setting	Initial Recommendation
Monin-Obukhov Length (MOL)	Not applied initially. Introduce only if the neutral model fails to capture the measured vertical profile or cross-validation results are unsatisfactory.
Sector-specific stability	Different MOL values can be applied per sector if wind direction and stability vary seasonally (e.g. stable conditions in winter from the northeast, unstable in summer from the southeast). This is an advanced setting — do not apply without measurement evidence.
Air Density	Keep at default. Air density does not affect CFD speed-ups. Density correction for AEP is applied separately at the power curve stage.

Atmospheric stability correction and the use of Monin-Obukhov length will be covered in detail in the next webinar in this series, including how to interpret cross-validation results and decide when stability adjustments are warranted.

5. Best Practice Checklist

5.1 Before Running Wind Fields

- Determine the site latitude and look up or estimate the appropriate Height of Boundary Layer
- Check the terrain's maximum inclination angle to select the correct top boundary condition
- Estimate the number of cells in your model to select the appropriate solver
- Use RNG k-epsilon as the default turbulence model for complex terrain
- Start from a neutral stability case — do not apply MOL or temperature corrections on the first run

5.2 Parameter Settings

- Height of Boundary Layer: adjust from the 500 m default for non-Norwegian latitudes and offshore sites
- Speed Above Boundary Layer: default of 10 m/s is acceptable for AEP; adjust if recirculation accuracy is required
- Top boundary condition: Fixed Pressure for MIA > 17°, Diffusive Link for 10–17°, Non-Friction Wall for MIA < 10°
- Turbulence model: RNG k-epsilon first for complex terrain; Standard k-epsilon for simple terrain or as fallback
- Solver: GCV for < 5M cells, GCV Parallel for 5–8M cells, GCV AMG Parallel for > 8M cells

5.3 What Not To Do

- ✗ Do not leave all parameters at default — the defaults are calibrated for high-latitude Norwegian conditions
- ✗ Do not apply the Non-Friction Wall boundary condition to complex terrain
- ✗ Do not start with atmospheric stability corrections before validating the neutral model
- ✗ Do not use GCV AMG Parallel for models with fewer than 5 million cells — serial GCV is more stable at that scale
- ✗ Do not match the daughter project cell size at the boundary to the mother project — allow the grid to expand gradually
- ✗ Do not adjust air density in the Wind Fields settings for AEP purposes — apply density correction at the power curve instead

Questions? Contact the WindSim team at support@windsim.com or visit www.windsim.com