Quick Start Guide

MMC

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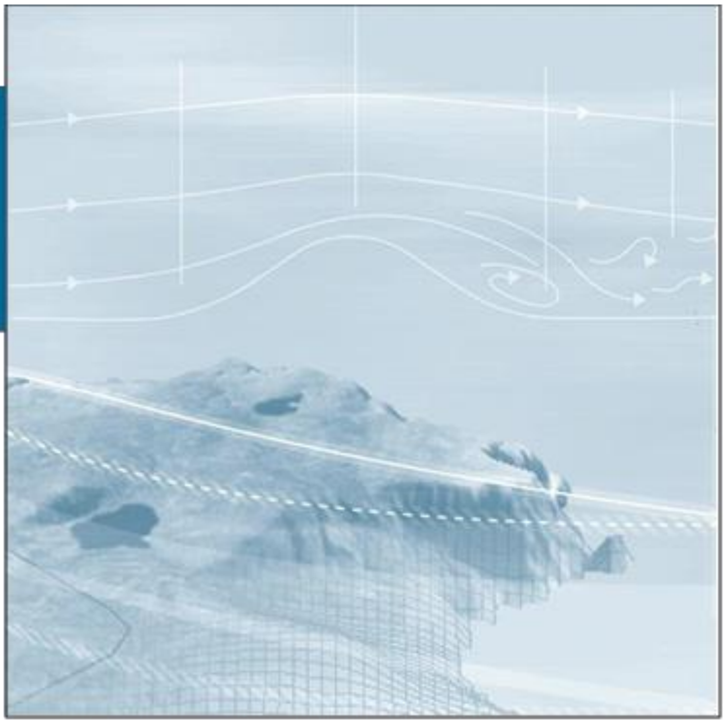

WindSim | Quick Start Guide

Meso-microscale coupling

15th Edition | July 2025

WindSim Desktop

Contents

Meso-microscale coupling console

The Meso-microscale coupling (MMC) console can be opened at Tools → Meso-Microscale Coupling Console. Five tabs: *NC to XYZ converter*, *Directional aggregation*, *SOM2L aggregation*, *XYZ* to *DWS converter* and *Visualization* are available.

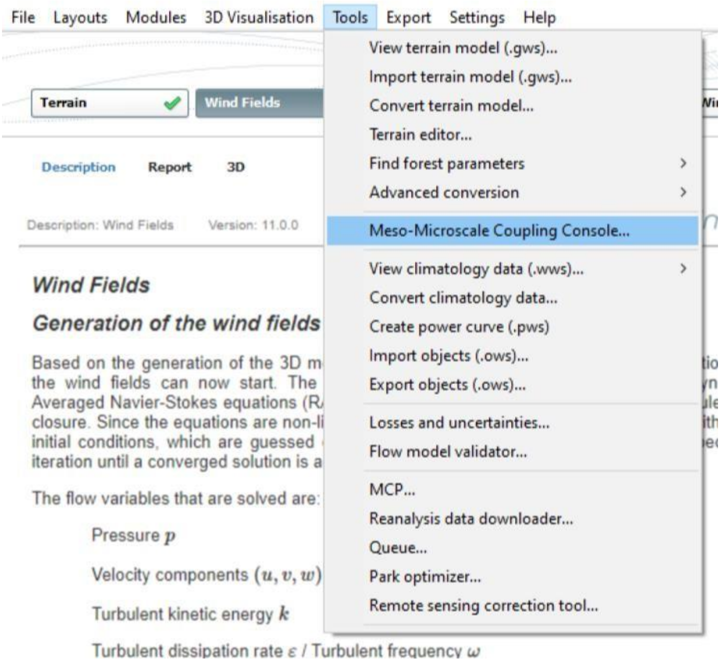

Figure 1: Opening of the MMC console.

Workflow

The complete workflow the user must follow will depend on the purpose and type of MMC the user wants to conduct. There are two possible MMC workflows in WindSim, as described in the following.

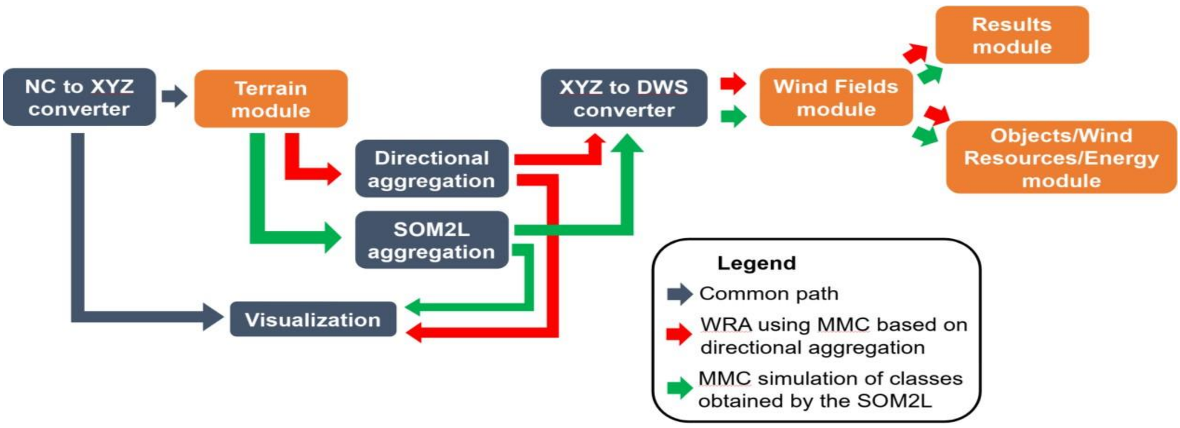

Figure 2: MMC workflows available in WindSim 12.

WRA using MMC based on directional aggregation

The mesoscale timesteps are aggregated by wind direction, producing one mesoscale field per wind direction. These mesoscale fields are used to compute the boundary conditions per direction. The Energy and Wind Resource modules can be run as normally.

MMC simulations of classes obtained by the SOM2L

The mesoscale timesteps are aggregated by the most predominant wind conditions (classes), producing one mesoscale field per class. These mesoscale fields are used to compute the boundary conditions per class. The Energy and Wind Resources modules can be run, the SOM classes are aggregated by wind direction and weighted on frequency base. The frequencies can be mesoscale based or observed based. By default the frequencies are mesoscale based, contact support@windsim.com if you want to set frequencies observed based.

Folder structure

The meso-microscale coupling console uses and creates a lot of files: input data files .nc, intermediate .xyz files and .dws output files, the hard drive usage of all those files can be quite demanding so they are not stored in the WindSim Project folder but in the "WindSim Project \Data\Mesoscale" folder. When starting a new instance of meso-microscale coupling console it creates a folder structure in that dedicated area with the same name as the WindSim Project.

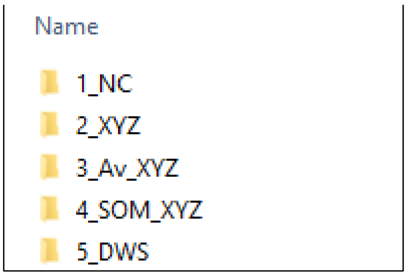

Figure 3: folder structure in …\WindSim Projects\Data\Mesoscale\"ProjectName"

All the paths if the input and output folders of each step of the MMC tool are set to this area using a defined structure, the user can still manually set the path as desired.

Some logs, images and information are written in the WindSim Project folder under "windfield\Mesoscale\".

NC to XYZ converter

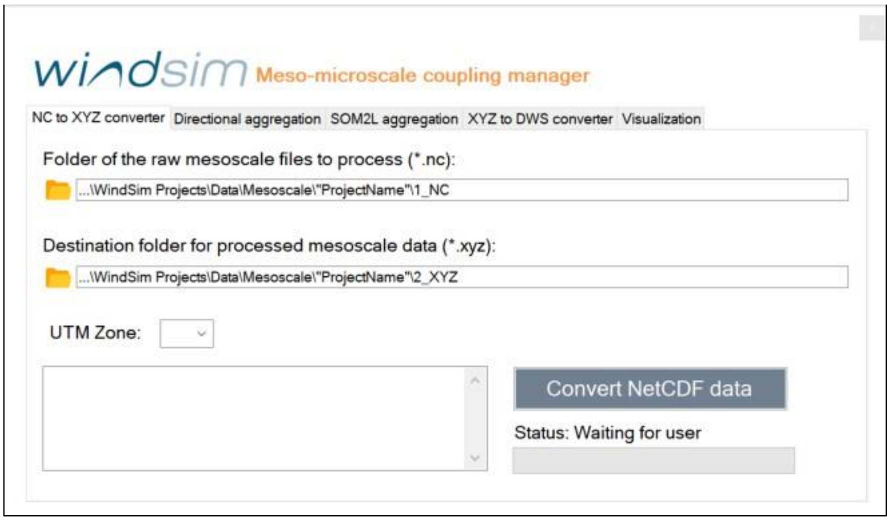

Figure 4: NC to XYZ converter tab

Typically, mesoscale data comes in NetCDF format (*.nc). This is a highly customizable format and therefore it is not possible to have a tool that can convert from any source. In general, WindSim's NC to XYZ converter can handle NETCDF data configured with the default settings of the Weather Research and Forecasting model (WRF). The variables necessary to run the MMC procedure are:

Times – Timestamp

PH – perturbation geopotential

PHB – reference geopotential

U – East component of the wind

V – North component of the wind

W – Vertical component of the wind

T – perturbation potential temperature

P – perturbation pressure

PB – reference pressure

PBLH – Planetary boundary layer height

UST – Friction velocity

TKE_MYJ – Turbulent kinetic energy

The description and configuration of the WRF model is beyond the scope of this document. Best practises can be found in e.g., Hahmann et al. (2020), but as a general guideline, the simulation period should be representative of the mesoscale flow features observed at a site. We conducted our validation study (Duran et al., 2020) with 1-km resolution and at least one year of data per site.

Some sample wrf output files for a farm in Hundhammerfjellet, Norway can be found in the installation folder: [Install path]\WindSim 12.0.0\Data\Objects\Climatology\wrf. These data can be used as input NetCDF files for the steps below, in conjunction with the "Tutorial Project" outlined in the WindSim Getting Started Guide ([Installation folder]\WindSim 12.0.0\Documentation). To create a new project with this data, simply navigate to File → New → Project, give a name to the project, leave the "GWS file" field empty and hit OK.

Prior to opening the MMC console, the user should complete the Terrain module. Every time a new calculation grid is produced by the Terrain module, the user has to rerun the "XYZ to DWS" conversion (but not the other steps). See Section 2.5 below for more information.

Folder of the raw mesoscale files to process (*.nc)

Input folder with the NetCFD files to be converted to XYZ. *This folder must only contain WRF output NetCDF files - the presence of any other files will cause the conversion to fail.*

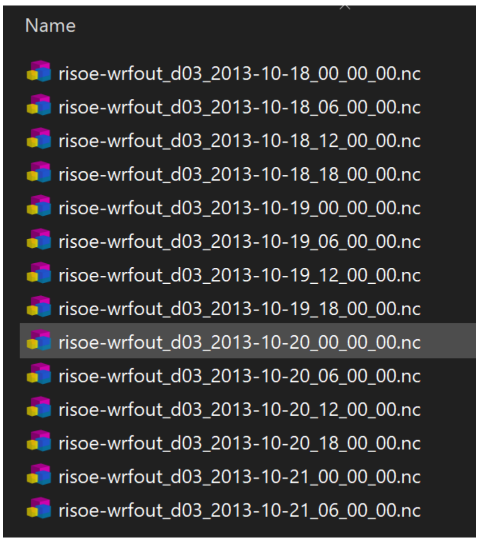

Figure 5: Example of folder containing NC files

Destination folder for processed mesoscale data (*.xyz)

Output folder for the XYZ files

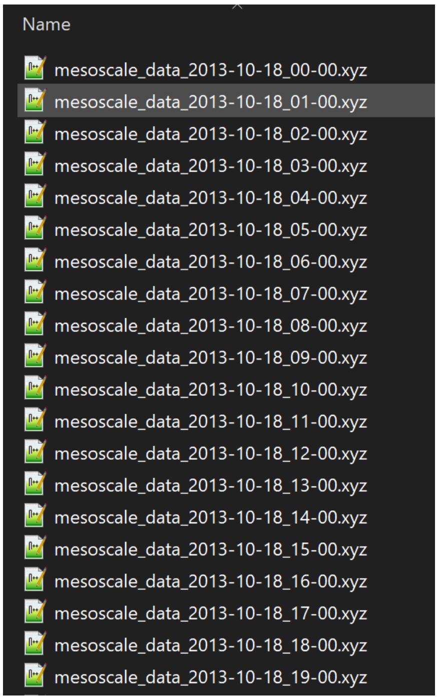

Figure 6: Example of folder containing XYZ files

UTM Zone

Mesoscale data typically comes in geographical coordinate system (latitude, longitude). The NC to XYZ converter writes the XYZ data in UTM coordinates, using the zone provided by the user. The chosen zone should match the coordinate system used to create the grid.gws file.

Directional aggregation

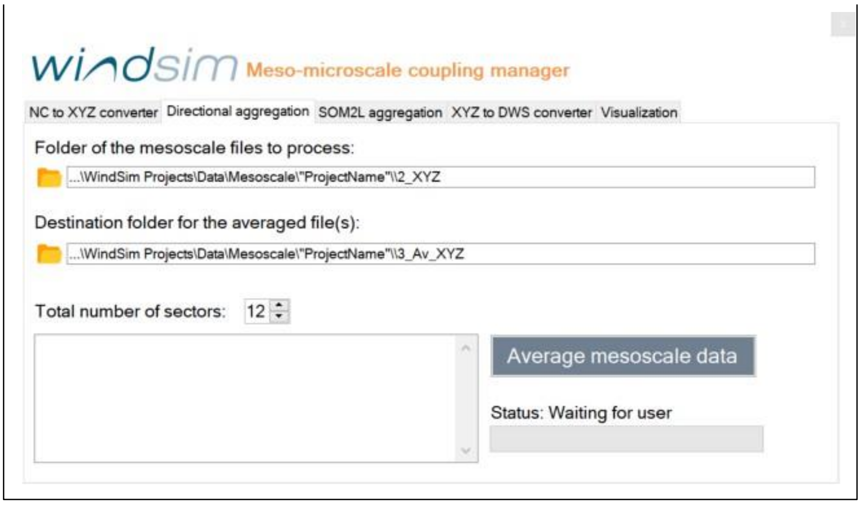

Figure 7: Directional aggregation tab

After the XYZ files per timesteps are created, it is possible to aggregate them by wind direction. The files used in the aggregation are listed in "mesoscale_av_list.log" at

[Project]\windfield\Mesoscale\. Also, the wind direction of each timestep is stored in the same folder in the file "mesoscale_av_dir.log"

Folder of the mesoscale files to process

Input folder with the timeseries of XYZ files to be aggregated.

Destination folder for the averaged file(s)

Output folder for the aggregated XYZ files (one per sector). Note that it is possible that for some directions there is no mesoscale data, the creation of the XYZ file is skipped in that case.

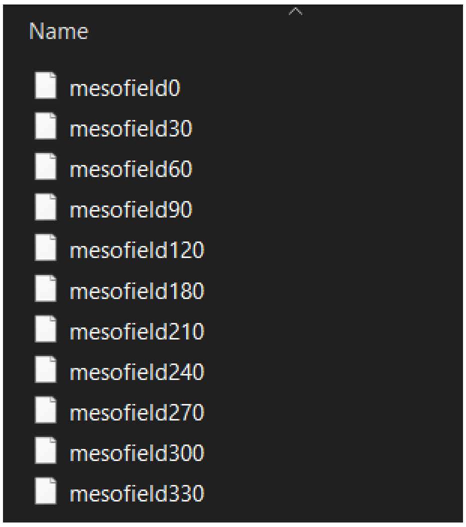

Figure 8: Example of folder containing the aggregated XYZ files by wind direction

Total number of sectors

Total number of directional sectors that the user would like to simulate. The console can handle any number. However, WindSim 12 can only simulate up to 36 sectors.

SOM2L aggregation

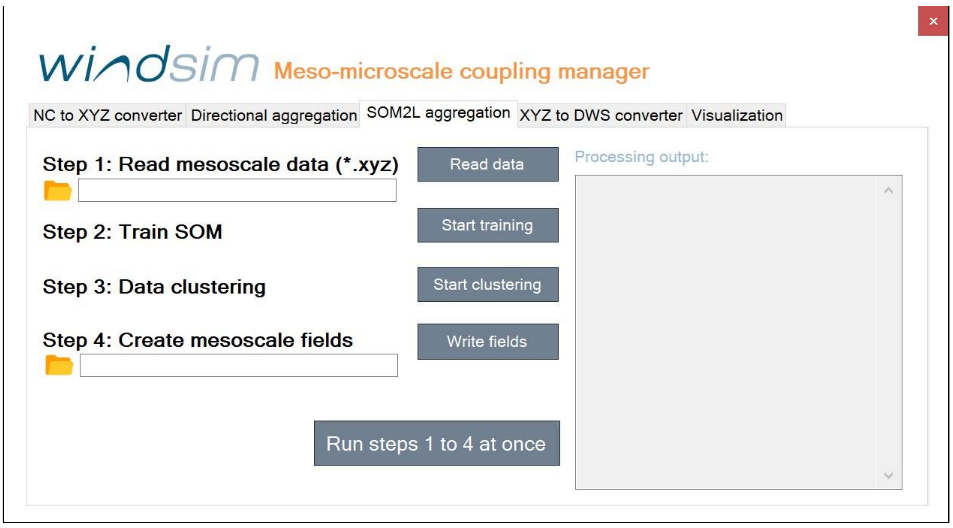

Figure 9: SOM2L aggregation tab

Alternatively, to the aggregation by wind direction, the XYZ files per timesteps can be aggregated by class. These classes represent a given set of local wind conditions. The classes are automatically obtained from a two-level self-organizing map clustering (SOM2L) method.

The SOM2L aggregation tab provides the class identification (consisting of steps 1 to 3) and the aggregation of the XYZ files by class (step 4). The steps must be run sequentially. The user can start each step manually or continuously run the 4 steps, by pressing “Run steps 1 to 4 at once”.

Step 1: Read mesoscale data (*.xyz)

Here the user must provide the input folder with the timeseries of XYZ files to be aggregated. The user can start the process by clicking “Read data”. The console will prepare the mesoscale data for the machine learning training. As intermediate outputs, the files “Input.npz” and “metadata.npz” are written at [Project]\windfield\Mesoscale\.

Step 2: Train SOM

In this step, the training of the self-organizing map (SOM) training is started. The user can start this stage by clicking “Start training”. As intermediate output, the file “sMap_t.obj” is written at [Project]\windfield\Mesoscale\.

Step 3: Data clustering

In this step, the SOM is partitioned to obtain the classes. Each mesoscale timesteps is classified into one class. In this file the classes are in the same order as in the input data. The user can start this stage by clicking “Start clustering”. The classification of each timestep is written in the file “SOM_classification” at [Project]\windfield\Mesoscale\. Timesteps that are not used in the classification (because of low winds) are classified as class 0.

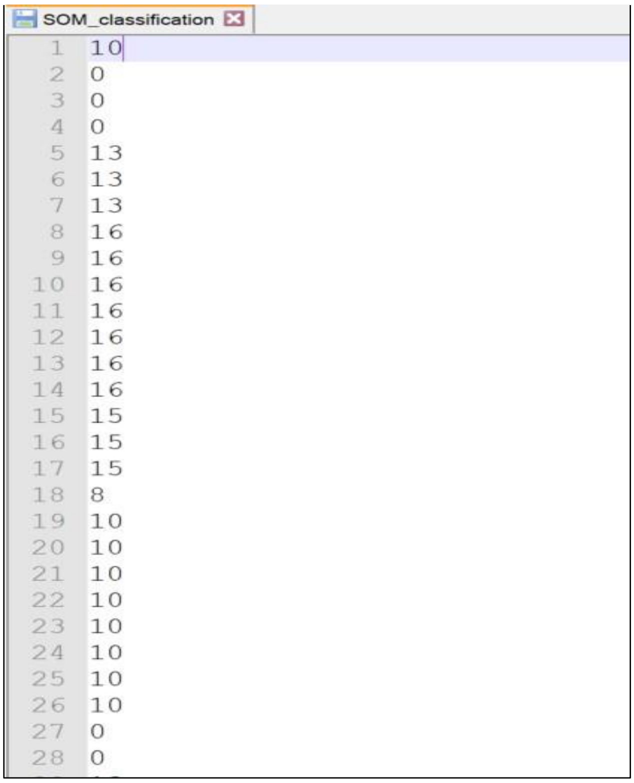

Figure 10: Example of SOM_classification file

Step 4: Create mesoscale fields

In this step, the aggregation of the XYZ files by class is conducted. Here the user must provide the input folder with the timeseries of XYZ files (in step 1) and the output folder for the aggregated XYZ files (one per class).

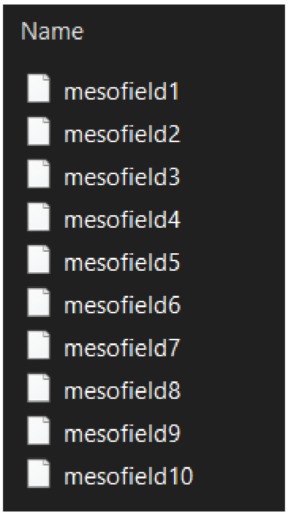

Figure 11: Example of folder containing the aggregated XYZ files by class

XYZ to DWS converter

This tool computes the boundary conditions for the WindSim simulation (Wind Fields module). It produces one *.dws file per XYZ file that is provided. *Remember to rerun the conversion after any changes you've made in the Terrain module!* To start the procedure the user must click on "Convert *.xyz to *.dws". In addition to the DWS files, the tool will produce table with information about the wind conditions at the middle of the CFD domain in "Wind_Conditions_per_DWS.log" at [Project]\windfield\Mesoscale\. The created DWS files can be used in the Wind Fields module to run coupled simulations.

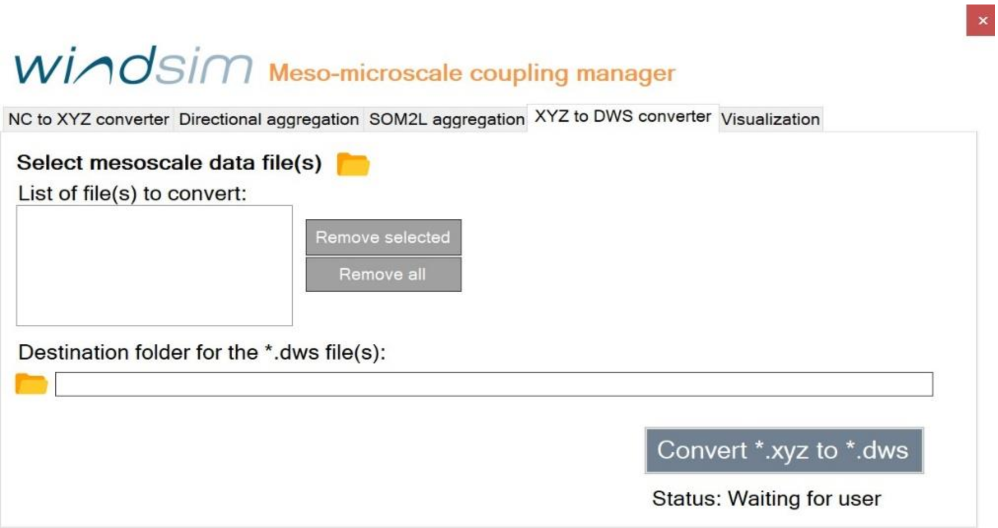

Figure 12: XYZ to DWS converter tab

Select mesoscale data file(s)

With the console, the user can select the input folder with the XYZ files. All XYZ files found in the folder will be listed and the user can remove selected files or all files from the list.

Destination folder for the *.dws file(s)

Output folder for the DWS files.

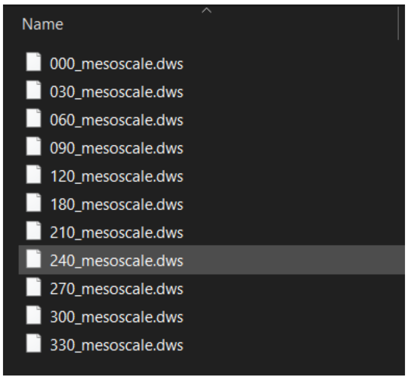

Figure 13: Example of folder containing the DWS files

Visualization

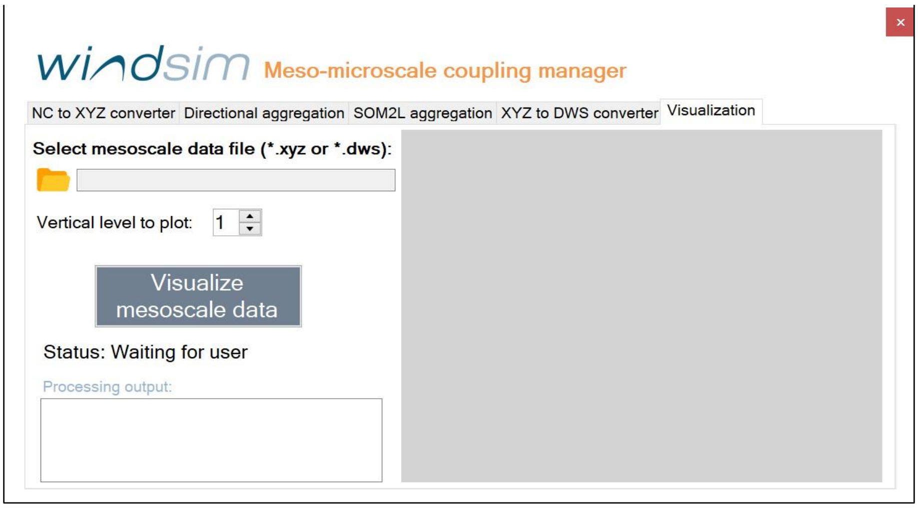

Figure 14: Visualization tab

With this tab it is possible to plot horizontal planes of wind speed of the data contained in XYZ files (either before or after aggregation) or DWS files. In the case of XYZ files, also the wind vectors are plotted as dark arrows.

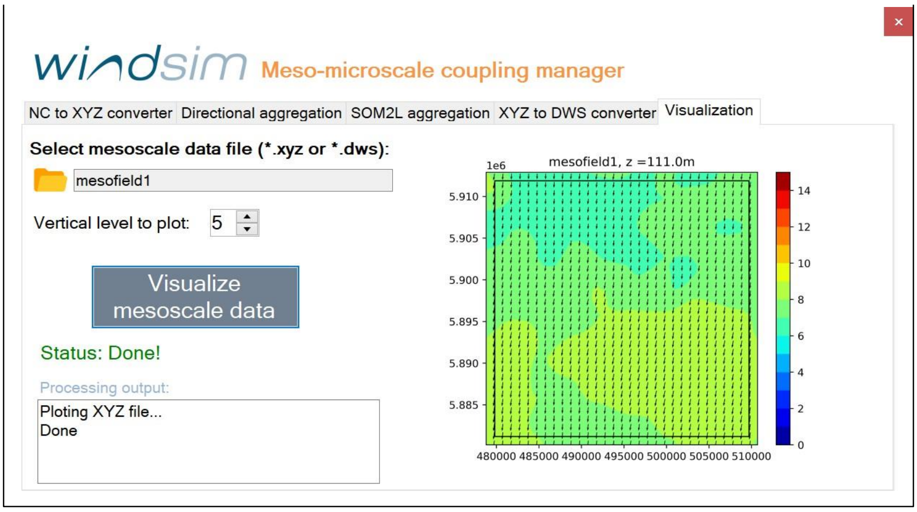

Figure 15: Plotting of XYZ file

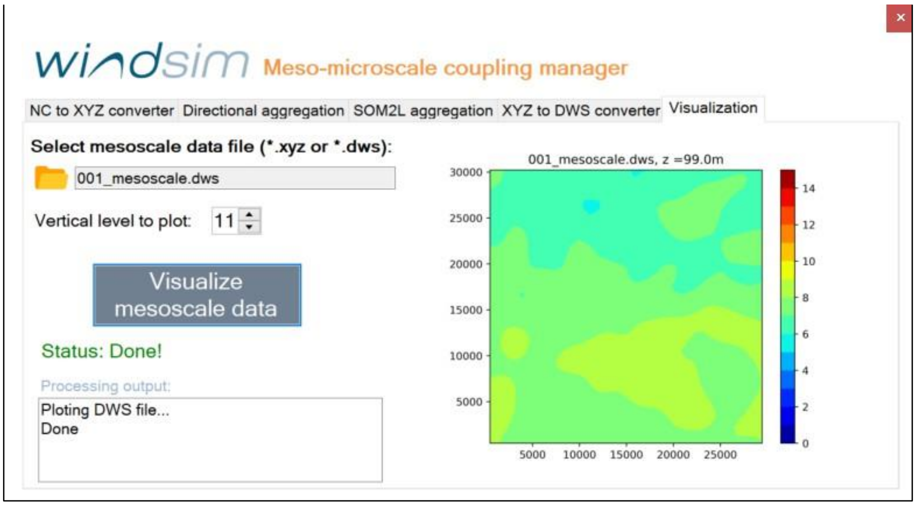

Figure 16: Plotting of DWS file

Select mesoscale data file (*.xyz or *.dws)

Select the file to plot. The program automatically detect if it is a XYZ or DWS file. It is also possible to plot XYZ timesteps (before aggregation).

Vertical level to plot

Vertical level selected to plot the horizontal plane. If the value provided is higher than the total number of vertical nodes, an error message will be written in the “Processing output” field. The lowest possible level is 1.

To start plotting click “Visualize mesoscale data”. The plot will be displayed in the console. Additionally, a PNG file will be created at [Project]\windfield\Mesocale\ with the same name as the original file plus the info about the vertical level "_nz_**". The plotted height is provided on top of the image. For DWS plotting, consider that the CFD model might not have the cells of a given vertical level at the same height. In that case the shown value corresponds to the average height of the cells at that level.

Postprocess (beta)

The directional aggregation option has a straightforward postprocess as the sectors are uniformly distributed at the WindSim wind rose. The SOM2L aggregation instead produces non-uniformly distributed sectors, and the postprocessing needs to be adapted accordingly. In WindSim 12, the results of the WindFields calculation are averaged back to the equally-spaced sectors by weighing each class by their frequency in a given sector. The frequencies are set to be detected from the Mesoscale model data, whose classification is stored in the [Project]\windfield\Mesocale\SOM_classification file (the existence of this file is necessary in order run the postprocessing scheme). Please note the following when using the WindSim 12 postprocessing models with the mesoscale results:

- Object module: if .tws observed time series are present the Object modules creates the "SOM_classification.sws" in climatology folder. This associates each time step in the time series with the windfield case that is more similar to it. To avoid bugs if there is more than one time series they need to be consistent with each other. *They have to be of the same length, with the same time step and provide the same time period.*

- Wind Resources and Energy module (beta): the sector interpolation is skipped, the SOM classification postprocess is not yet enabling it, the windfield results are merged into directional windfield by weighted average based on the frequencies of the cases referring to Mesoscale data, reading the file SOM_classification.

In WindSim 12 the Energy module is run in simplified mode in SOM classification case.

Here is the list of inactive features:

- Rotor equivalent wind speed
- Weighted power history
- Export rotor profiles

- Export vertical profiles (use "Export/Export vertical profiles..")
- IEC calculation and following exports (Loads Analysis are not yet supported)

Troubleshooting

Distorted console/icons or other visual defects

This is most likely a DPI scaling issue. To solve this, go to [WindSim installation folder]\bin\MMC. Do secondary click at “MMC_GUI.exe”, Properties → Compatibility tab → Change High DPI settings → Check “Override high DPI scaling behavior” and select “Application”.

If this does not work, try another configuration in the same window.

SOM aggregation failing

Check that the intermediate outputs are written (check sections above to know where and which ones). If you do not find them then make sure the inputs are correct.