# 9th WindSim User Meeting

**26-27 June 2014, Tønsberg**

## WindSim 6.3

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windsim

# Content

- Developments in the last months
- WindSim 6.3 - New Features
- Research activities in WindSim
- Outlook

# Developments in the last months

Release of WindSim 6.1 and 6.2 in December 2013

- Improvement of the GCV => much faster
- Word report
- Improvement of the new features from 6.0
- Coupled solver not longer available from 6.2 on

Validation GCV

New features for WindSim 6.3

Patch for Version 6.2 – Release first week of July

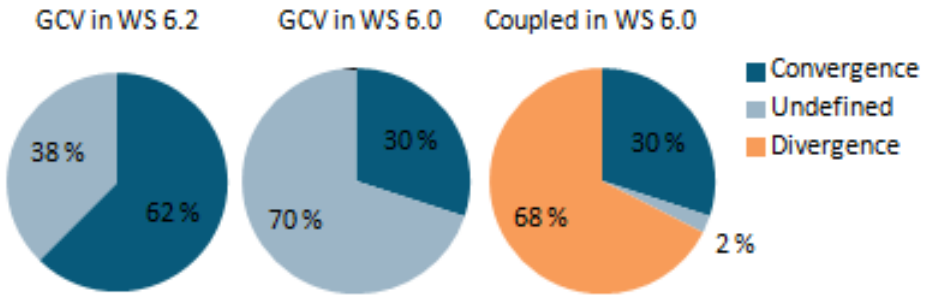
- Improved forest implementation for the GCV
- Pictures of the ambient turbulence in the wind resource module
- New wall functions to improve behaviour of residuals when using GCV

Improved/New tools:

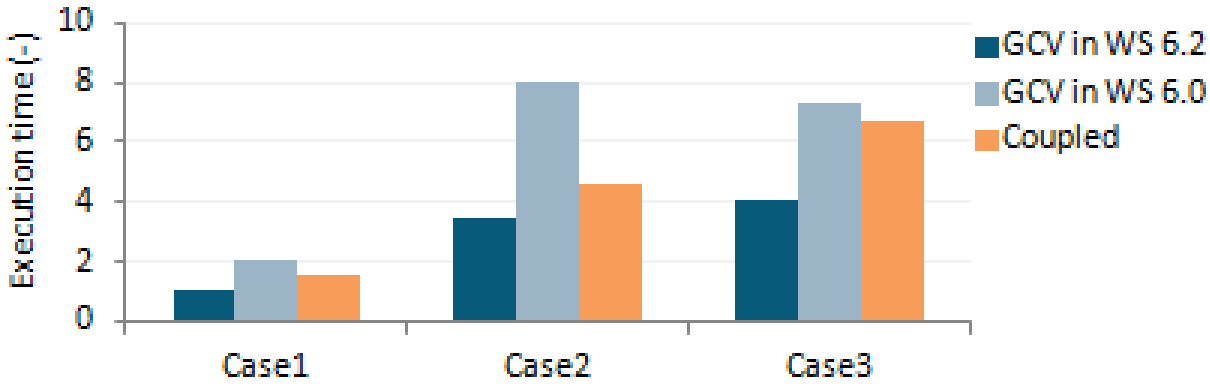
- WindSim Express, WindSim Cloud, WindSim Forecasting
- WindSim Power Line

# Validation GCV

- Robustness

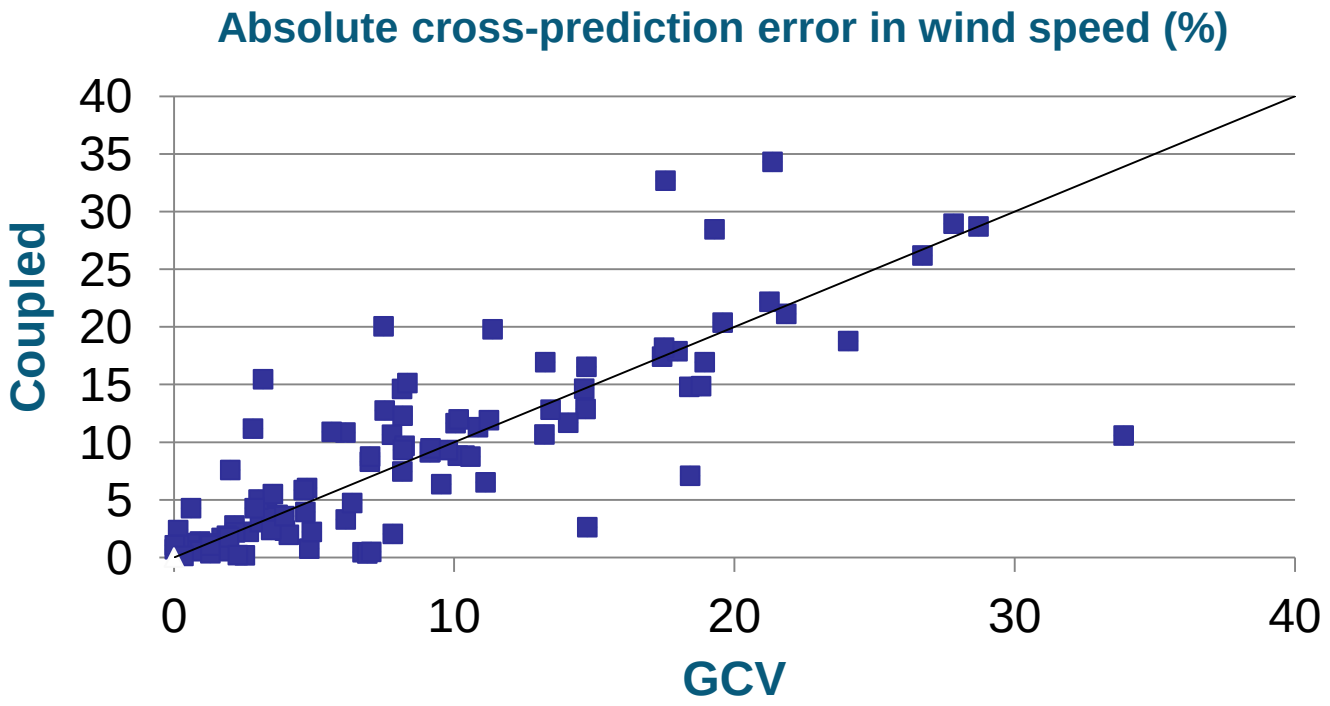



- Speed



# Validation GCV

- Quality

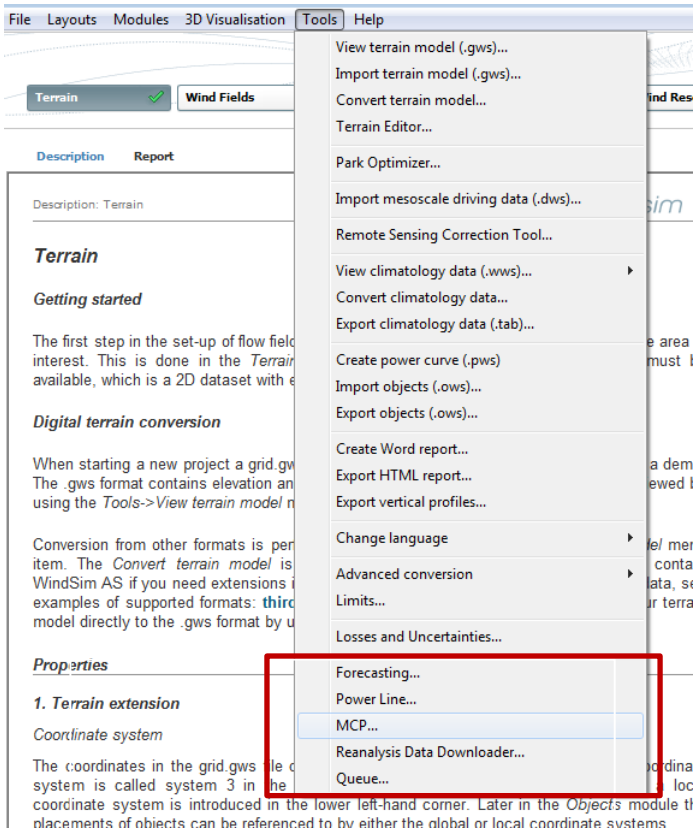



In the average GCV performes better

# WindSim 6.3

## New Features:

- WindSim Terrain complexity
- WindSim Queuing
- WindSim  MCP
- WindSim Reanalysis Data Downloader
- Bigger models
- Break a run properly
- New wall functions
- Improved post processing



# WindSim 6.3

## Terrain complexity

- In the standard there is a complexity index which tells if you need to add turbulence to the calculated values of linear models
- This doesn’t tell you if the site is complex in the eyes of CFD modeling
- Therefore we defined 4 WindSim indexes which can help to get a relation between cross prediction errors and site complexity such that we can on the long term give an estimate for the losses & uncertainty calculation regarding the uncertainty of the WindSim modeling

# WindSim 6.3

## Terrain complexity

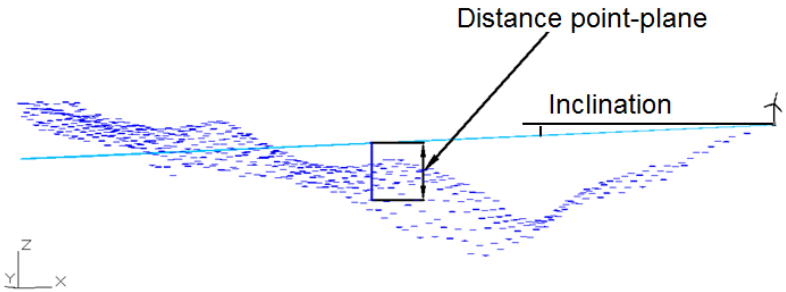
Available Indexes:

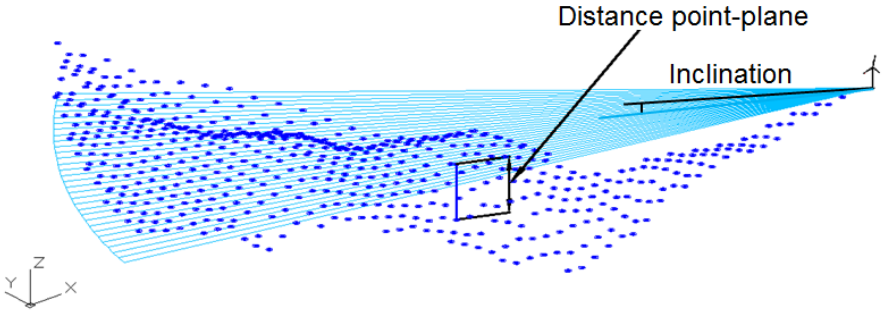
a. Inclination

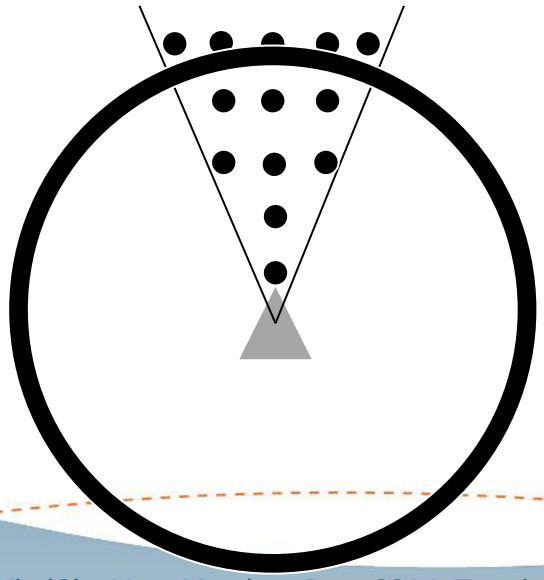
b. Mean absolute distances point-plane

c. Standard deviation of distances point-plane

d. Roughness



# WindSim 6.3

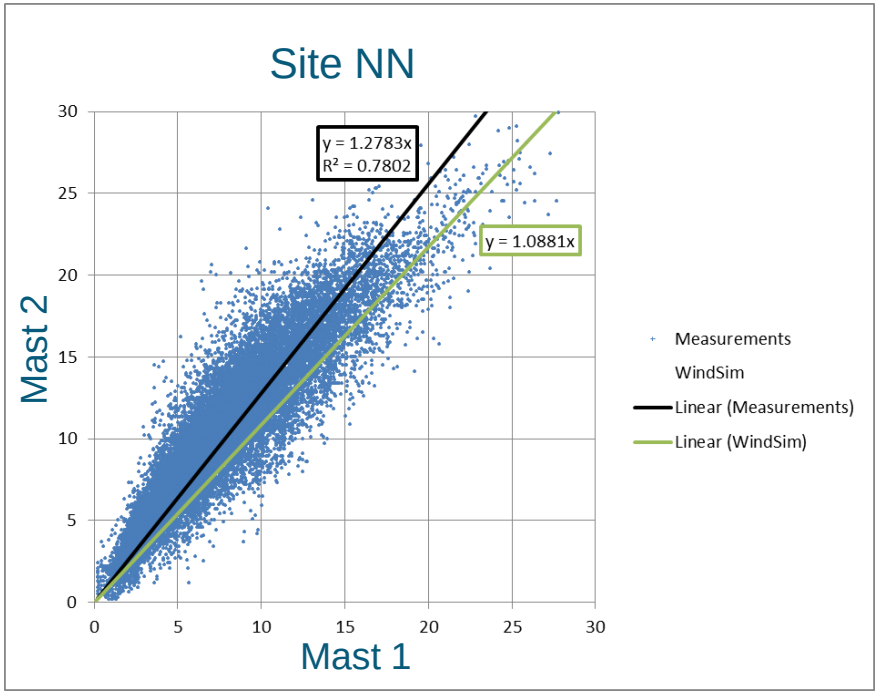
## Terrain complexity

•Idea: Share your cross-correlation and terrain complexity values with WindSim

• Anonymous: No geo-referencing of the site,

• Outcome: Statistics on modeling accuracy according to terrain complexity indicators

- Input for losses&uncertainty calculation
- Improved understanding of the wind conditions
- Improved modeling



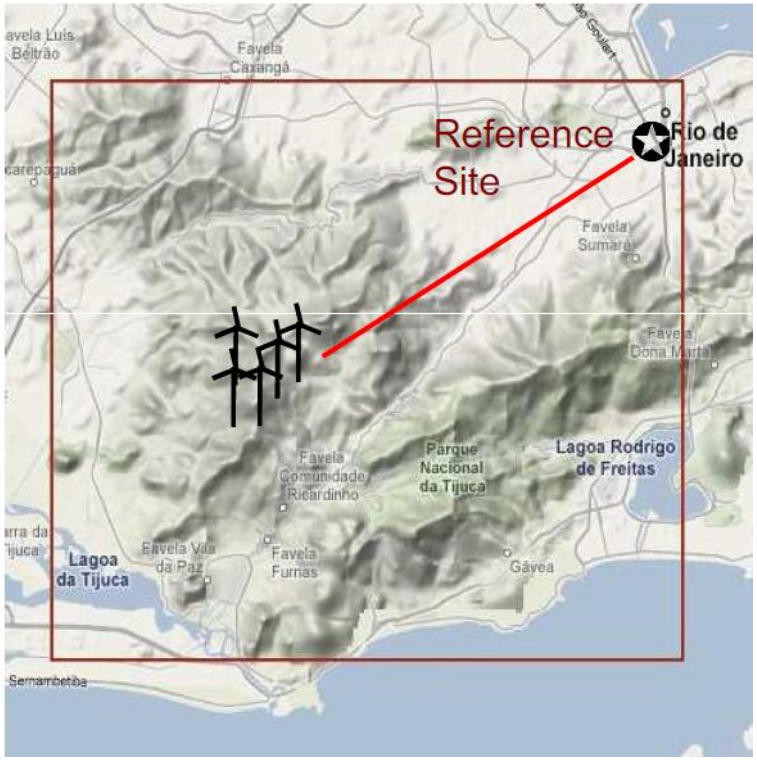
# WindSim 6.3

## Queuing

- Possibility to run several projects in a consecutive order
- Able to start, stop and pause runs as you would like

# WindSim 6.3

## MCP (Measure-Correlate-Predict)




MCP is a statistical technique used for predicting the long term wind resource at a proposed wind farm site by relating measurements from a short-term measurement campaign to the long term data sets of a reference

Find **statistical relationship between a reference observation** (usually long term time series) **and a on site observations** (at least one year)

Traditional reference:

- Meteorological observation stations

Synthetic reference:

- Forecast models (Merra etc..)

# WindSim 6.3

## WindSim Reanalysis Data Downloader based on MERRA

- Data for virtual measurement masts
- Data for MCP
- Data for stability classification

# WindSim 6.3

## Bigger models

- So far 1000*1000*60 cells
- We aim to have much more
- More layouts and more climatologies
- More cells in terrain conversion

# WindSim 6.3

## Break a run

- So far all results are lost when you press the stop button in the wind fields module
- Now you can stop and it will stop at the iteration you are at when you stop

# WindSim 6.3

## New wall functions

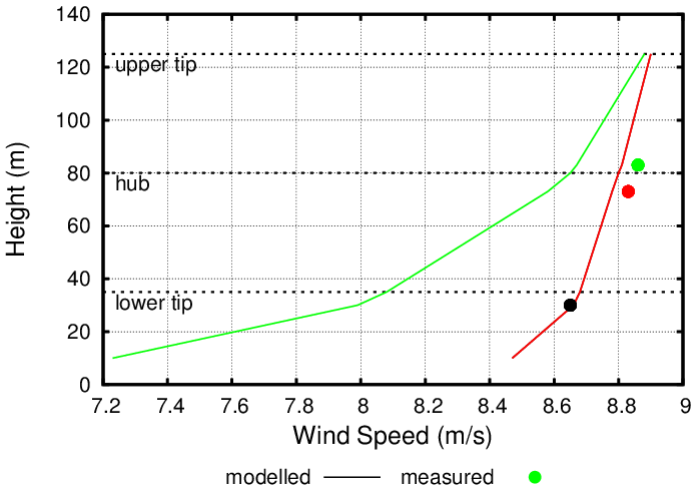
- Deliver the same results as the old functions
- Prevents strong oscillations in residuals in GCV

# WindSim 6.3

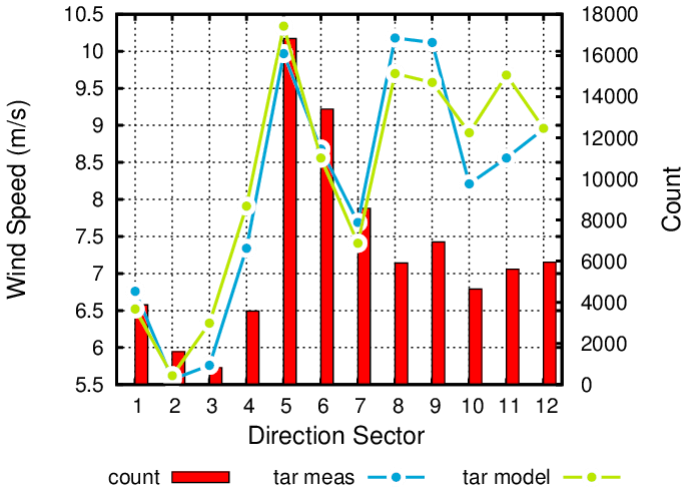
## Improved post-processing

- Cross-checking plots

### Scaled profiles for mean wind speed



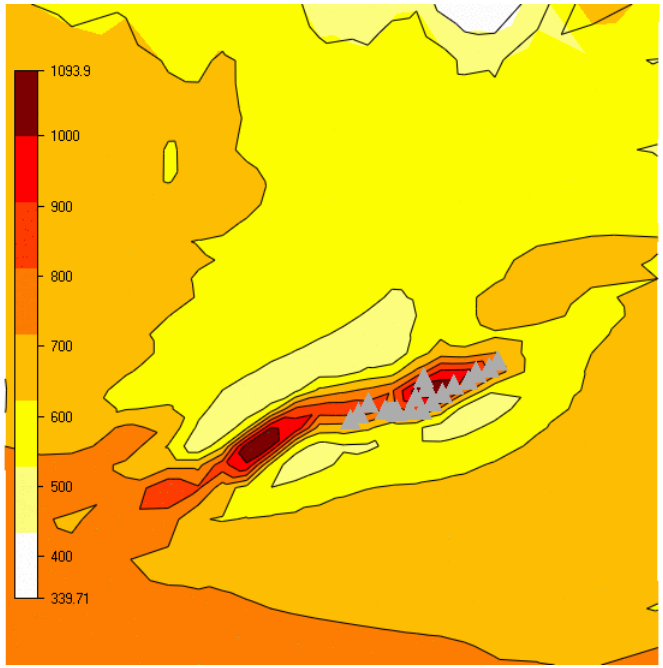

### Sectorwise speed-up comparison



# WindSim 6.3

## Improved post-processing

- Power density plots in the wind resources



# WindSim 6.3

## Improved post-processing

- Restructuring of the energy module

| Climatology | Distribution | Gross AEP | Wake loss % |
|---|---|---|---|
| **Climatology1** | Frequency table | **130.7819** | 4.90 |
| **Climatology1** | Weibull distribution | **128.3603** | 5.06 |
| **Climatology2** | Frequency table | **145.2548** | 4.61 |
| **Climatology2** | Weibull distribution | **142.6373** | 4.68 |
| All | Frequency table | **138.0109** | 4.75 |
| All | Weibull distribution | **135.4915** | 4.86 |

*Table 1. Energy production in GWh/y based on climatology represented by the frequency table and by the Weibull distribution.*

| Air density ($kg/m^3$) | Wake model | Multi-wakes model | Roughness (m) | Amb. Turb. Int. (%) | Sub-sectors | Influence range (Rotor diameter) |
|---|---|---|---|---|---|---|
| Individual 1 | 1 | 2 | Variable | - | 5 | 1.0 - 50.0 |

*Table 2. Site and wake characteristics.*

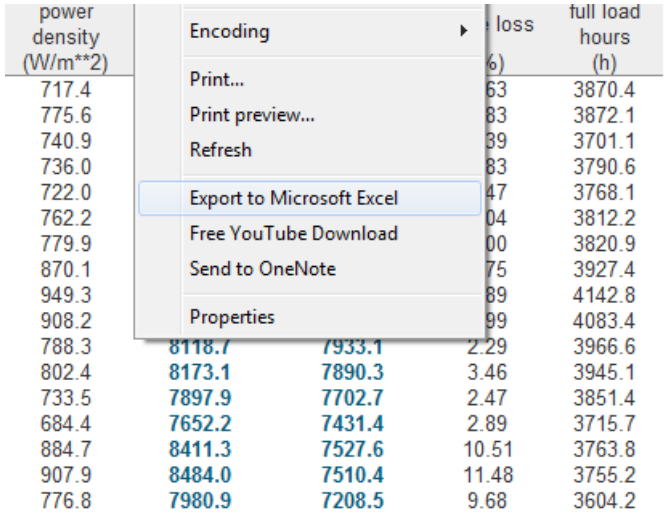
# WindSim 6.3

## Improved post-processing

- Restructuring of the energy module

| name | power (kW) | hub height (m) | density (kg/m**3) | wind speed (m/s) | power density (W/m**2) | gross AEP (MWh/y) | AEP with wake losses (MWh/y) | wake loss (%) | full load hours (h) |
|---|---|---|---|---|---|---|---|---|---|
| **wecs1** | 2000 | 80.0 | 1.204 | 8.18 | 717.4 | **7789.5** | **7740.7** | 0.63 | 3870.4 |
| **wecs2** | 2000 | 80.0 | 1.202 | 8.41 | 775.6 | **8052.9** | **7744.1** | 3.83 | 3872.1 |
| **wecs3** | 2000 | 80.0 | 1.203 | 8.28 | 740.9 | **7907.1** | **7402.1** | 6.39 | 3701.1 |
| **wecs4** | 2000 | 80.0 | 1.203 | 8.26 | 736.0 | **7882.8** | **7581.2** | 3.83 | 3790.6 |
| **wecs5** | 2000 | 80.0 | 1.203 | 8.20 | 722.0 | **7806.9** | **7536.2** | 3.47 | 3768.1 |
| **wecs6** | 2000 | 80.0 | 1.201 | 8.33 | 762.2 | **7945.2** | **7624.4** | 4.04 | 3812.2 |
| **wecs7** | 2000 | 80.0 | 1.201 | 8.38 | 779.9 | **7960.5** | **7641.9** | 4.00 | 3820.9 |
| **wecs8** | 2000 | 80.0 | 1.198 | 8.72 | 870.1 | **8334.5** | **7854.9** | 5.75 | 3927.4 |
| **wecs9** | 2000 | 80.0 | 1.195 | 9.00 | 949.3 | **8620.8** | **8285.6** | 3.89 | 4142.8 |
| **wecs10** | 2000 | 80.0 | 1.197 | 8.87 | 908.2 | **8506.0** | **8166.8** | 3.99 | 4083.4 |
| **wecs11** | 2000 | 80.0 | 1.200 | 8.47 | 788.3 | **8118.7** | **7933.1** | 2.29 | 3966.6 |
| **wecs12** | 2000 | 80.0 | 1.201 | 8.51 | 802.4 | **8173.1** | **7890.3** | 3.46 | 3945.1 |
| **wecs13** | 2000 | 80.0 | 1.205 | 8.25 | 733.5 | **7897.9** | **7702.7** | 2.47 | 3851.4 |
| **wecs14** | 2000 | 80.0 | 1.207 | 8.04 | 684.4 | **7652.2** | **7431.4** | 2.89 | 3715.7 |
| **wecs15** | 2000 | 80.0 | 1.197 | 8.79 | 884.7 | **8411.3** | **7527.6** | 10.51 | 3763.8 |
| **wecs16** | 2000 | 80.0 | 1.196 | 8.87 | 907.9 | **8484.0** | **7510.4** | 11.48 | 3755.2 |
| **wecs17** | 2000 | 80.0 | 1.199 | 8.39 | 776.8 | **7980.9** | **7208.5** | 9.68 | 3604.2 |
| All | 34000 | - | - | - | - | 137524.3 | 130781.9 | 4.90 | 3846.5 |
| Mean | - | - | 1.201 | 8.47 | 796.4 | - | - | - | - |
| Reference production at climatology position | | | | | | | | | |
| **ref..** | 2000 | 20.0 | 1.211 | 6.82 | 418.8 | **6021.1** | - | - | 3010.6 |
| **ref..** | 2000 | 30.0 | 1.209 | 7.26 | 504.8 | **6651.0** | - | - | 3325.5 |
| **ref..** | 2000 | 40.0 | 1.208 | 7.50 | 555.2 | **6980.7** | - | - | 3490.4 |
| **ref..** | 2000 | 50.0 | 1.207 | 7.71 | 603.1 | **7256.9** | - | - | 3628.4 |
| **ref..** | 2000 | 60.0 | 1.206 | 7.86 | 638.0 | **7441.2** | - | - | 3720.6 |
| **ref..** | 2000 | 70.0 | 1.205 | 8.01 | 673.7 | **7599.2** | - | - | 3799.6 |
| **ref..** | 2000 | 80.0 | 1.204 | 8.11 | 700.4 | **7724.9** | - | - | 3862.4 |
| **ref..** | 2000 | 90.0 | 1.202 | 8.22 | 727.7 | **7835.9** | - | - | 3917.9 |
| **ref..** | 2000 | 73.0 | 1.209 | 8.04 | 681.7 | **7637.5** | - | - | 3818.8 |

*Table 1. Energy production based on the frequency table.*



# WindSim 6.3

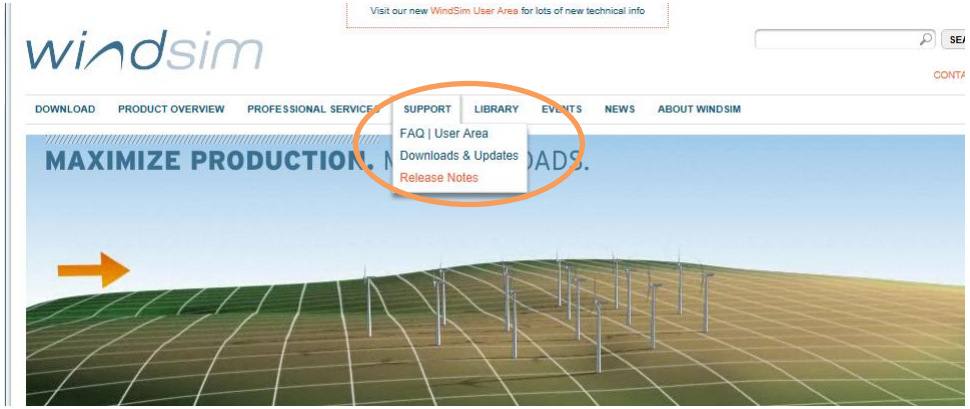
## Release Dates

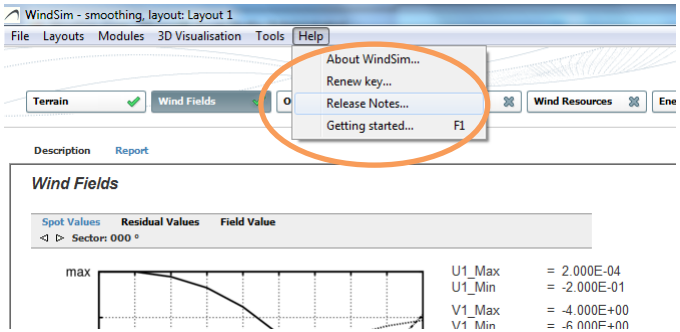
Beta version end of July; Ongoing updates

Final version: Mid of September

## Release Notes

Noted on the web and in the software



# Research activities in WindSim

## Forest

Master thesis by Karsten Busch beginning summer 2014

## Actuator disc

Phd thesis by Nikolaos Simisiroglou started in 2013

## Mesoscale coupling

ENERGIX Research project with the UniComputing in Bergen

## Forecasting

ENERGIX Research project with the UniComputing in Bergen

# Outlook

- Turbine assessment file weighted
- Power history export weighted
- Correct things reported at bugs@windsim.com
- Revise analytical wake models
- Stability classification and its use to weight WindSim results
- Choose WRG dimension
- New GUI platform

# Remember.....

***....to download the patch for 6.2!***

# Validation GCV

- Quality