



9st WindSim User Meeting

26-27 June 2014, Tønsberg

Forecasting tools and developments

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windsim

Coupling Mesoscale and CFD

Global Models
100 - 16 km
e.g. ECMWF, GFS

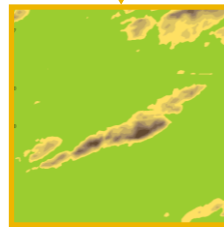


Regional Models
9 - 1 km
e.g. WRF



Description of the
atmospheric
conditions

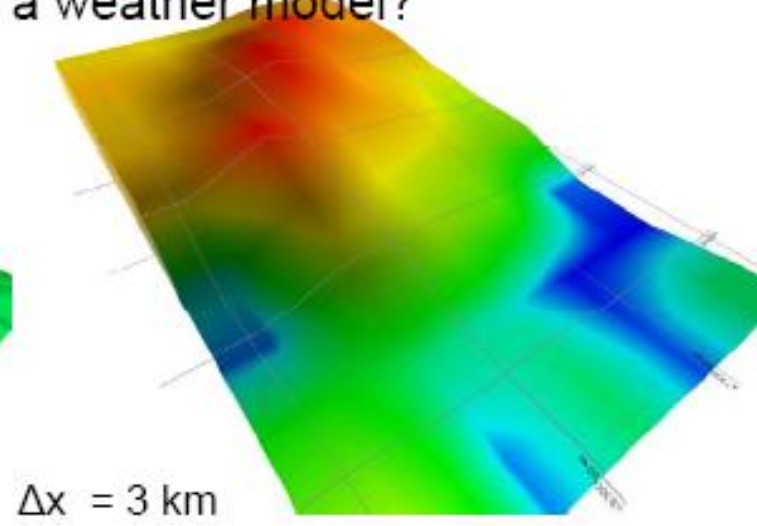
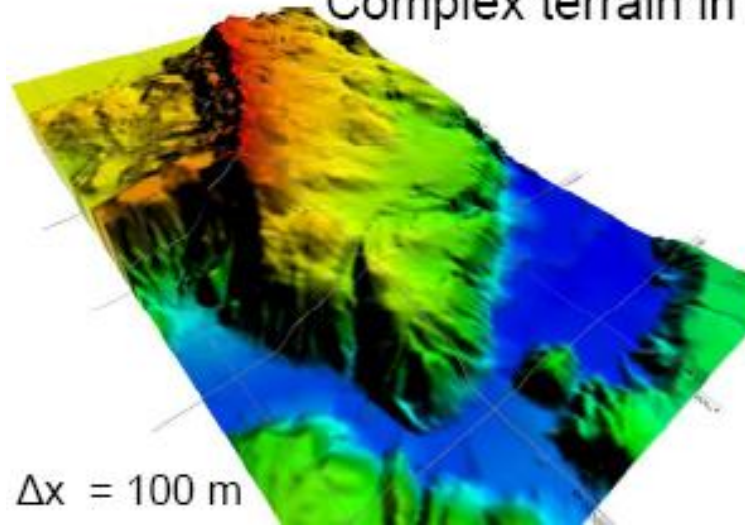
Micro Model
100 - 10 m
WindSim



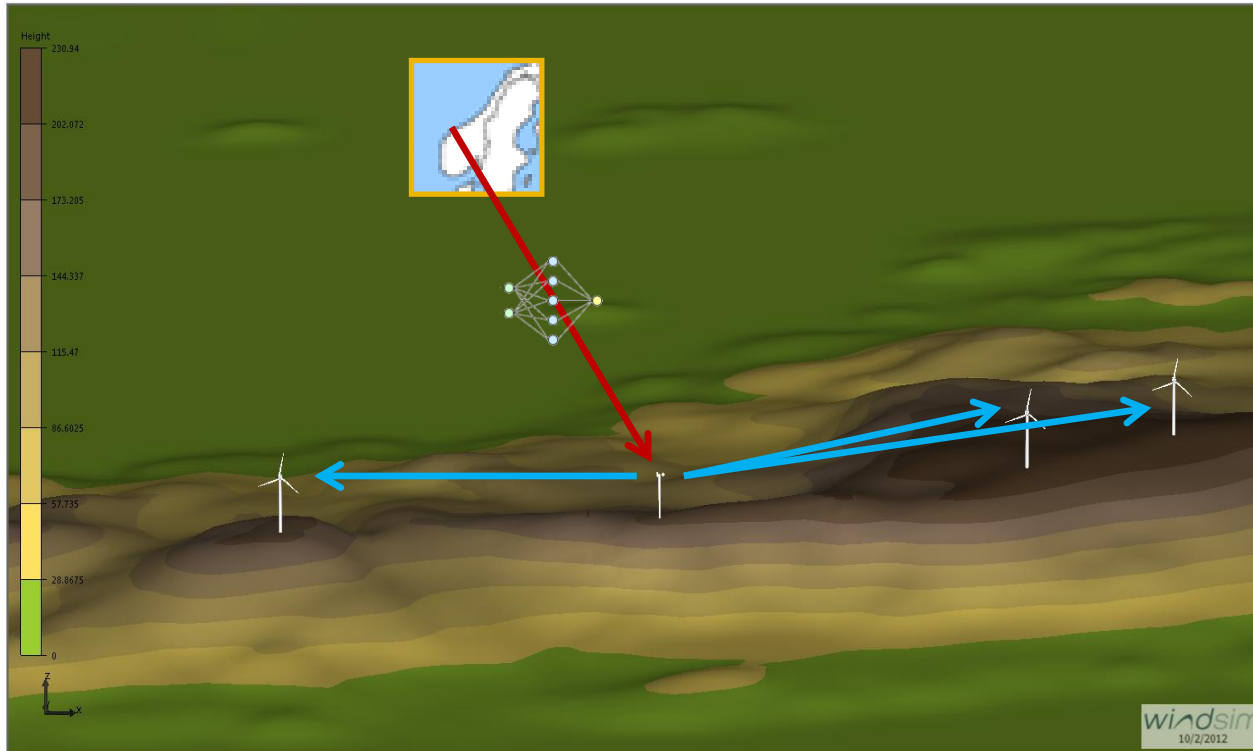
Accurate description
of the local flow field
and the wake effects

Mesoscale Models

Complex terrain in a weather model?

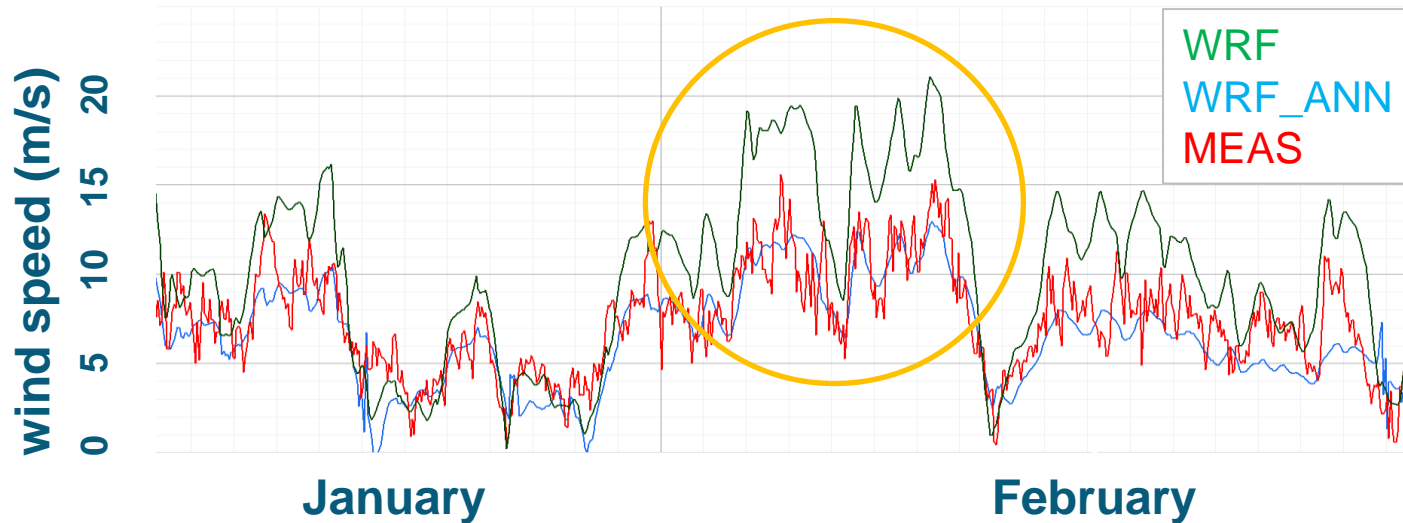


Coupling Mesoscale and CFD using ANN



Virtual met-mast technique

Why use Artificial Neural Networks?



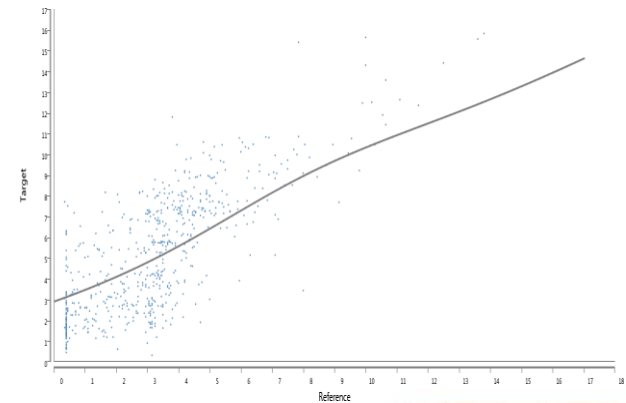
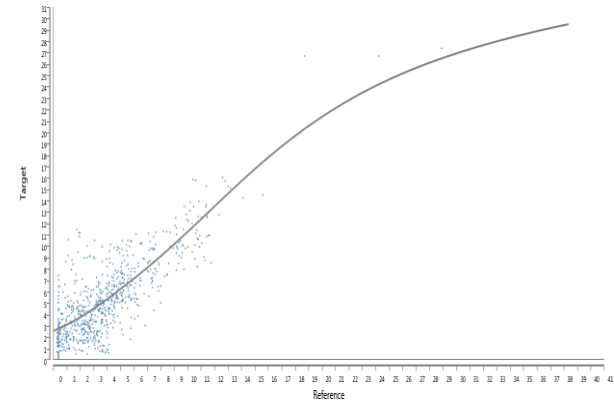
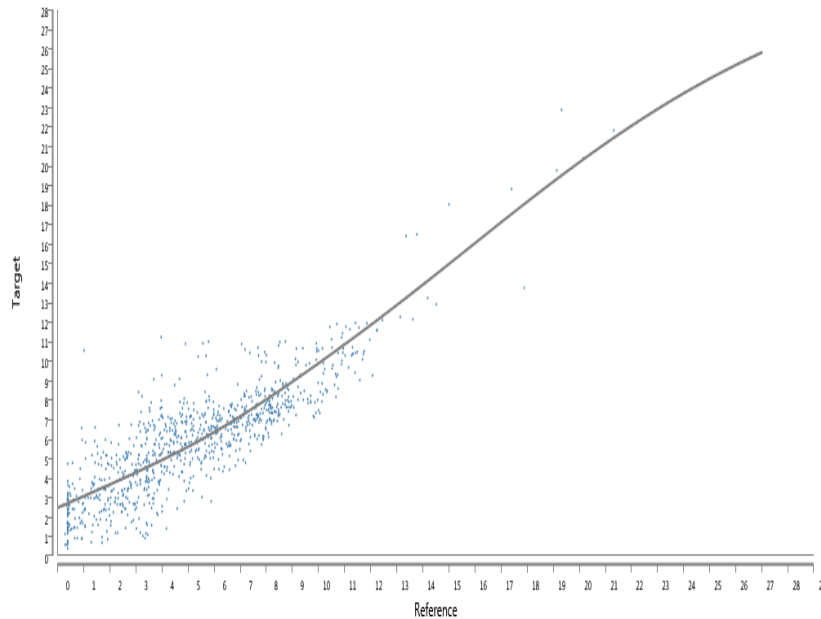
WRF data has phase and model bias errors in wind speed and direction

Trained networks can be used to correct each forecasted time series from the mesoscale model before it is used in the CFD simulation

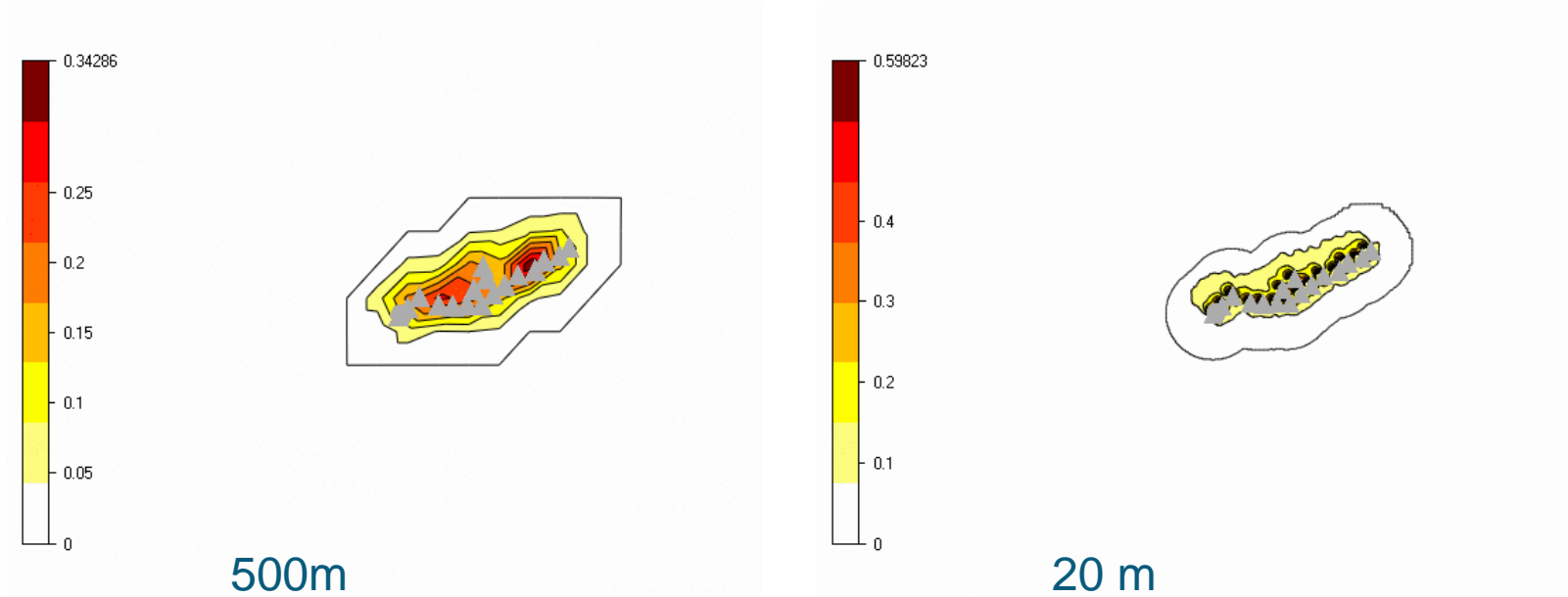
Why use Artificial Neural Networks?

ANN solve a non linear problem

Using ANN in MCP the curved lines fit better than straight lines the sectors points



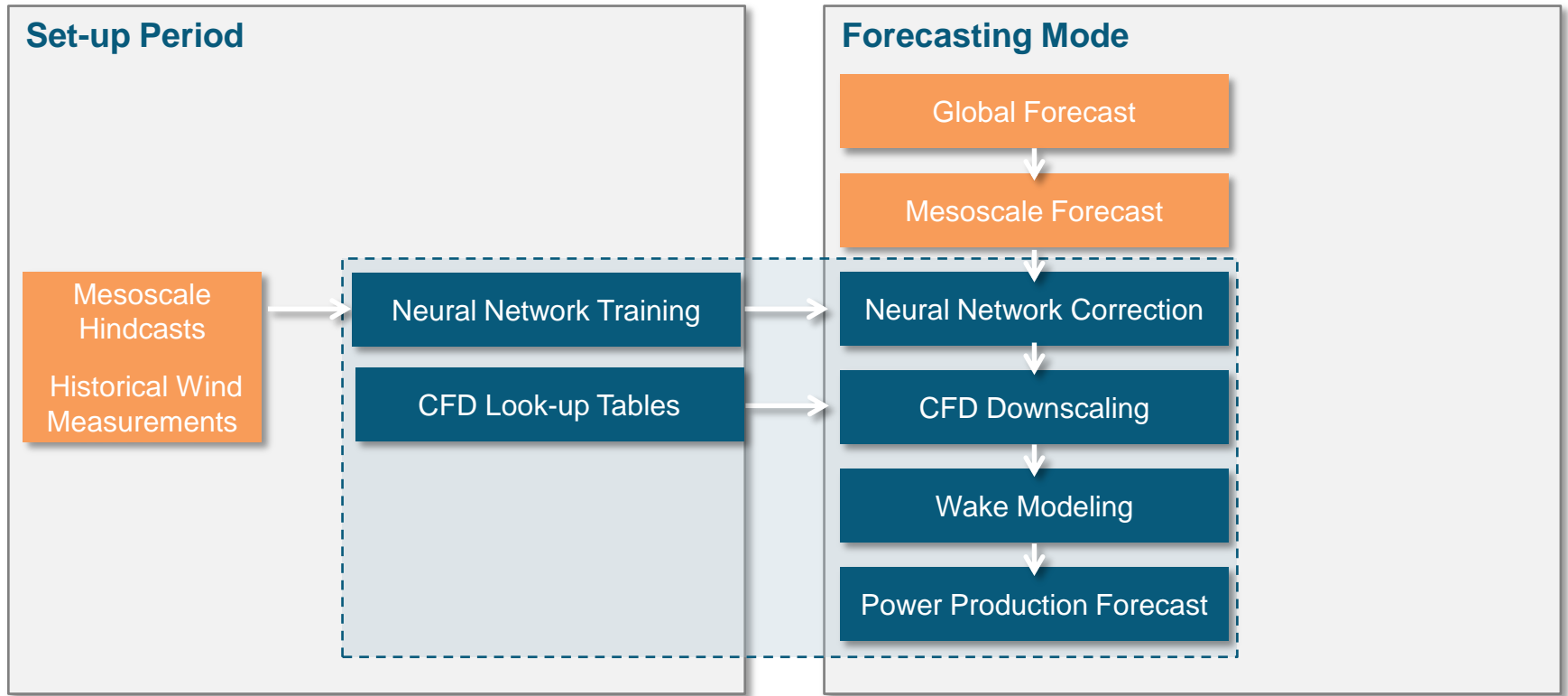
The added value of using CFD



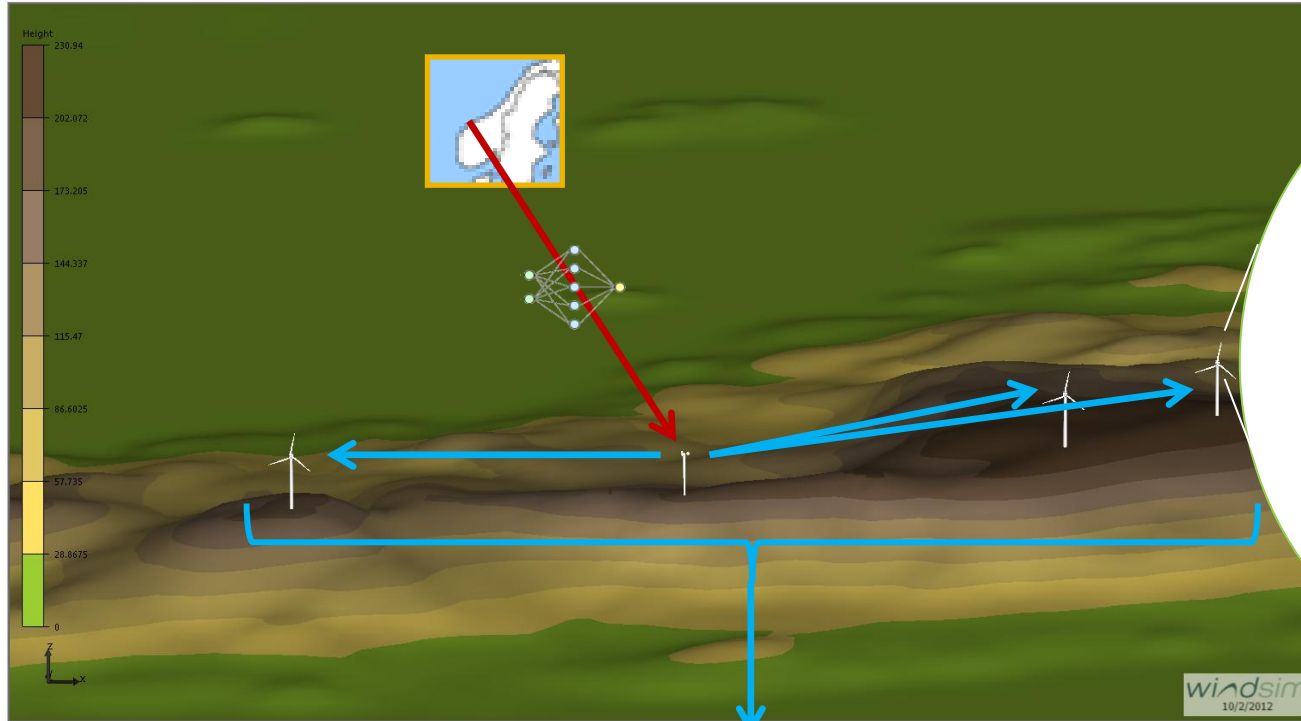
The CFD describes more accurately the local flow field around the turbines and can therefore downscale the mesoscale model results

The CFD is able to calculate the wake corrected energy production and take in account more accurate information about roughness, forest etc..

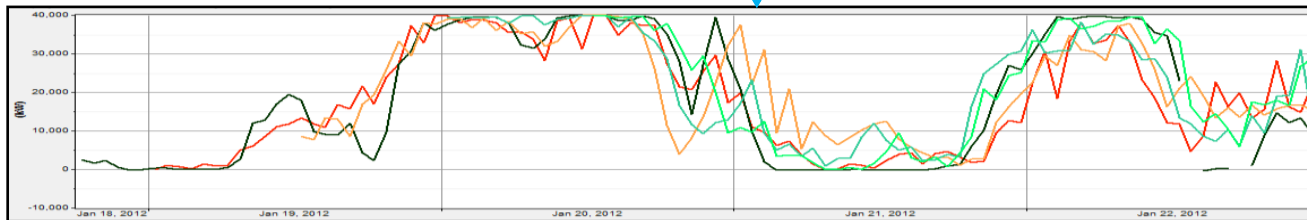
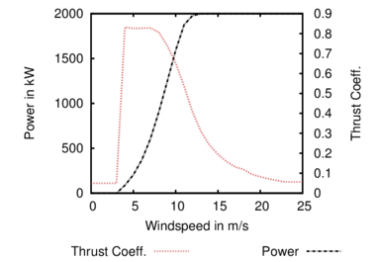
Forecast Application Basics



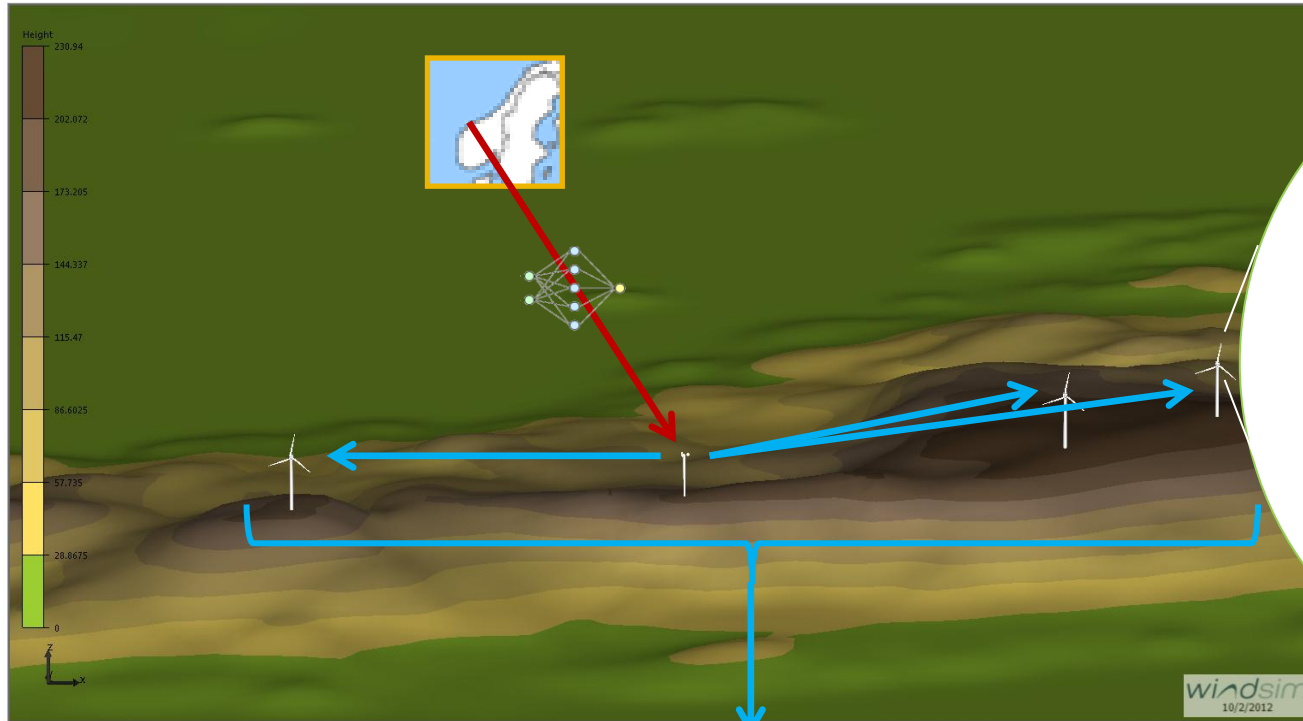
WindSim Forecasting



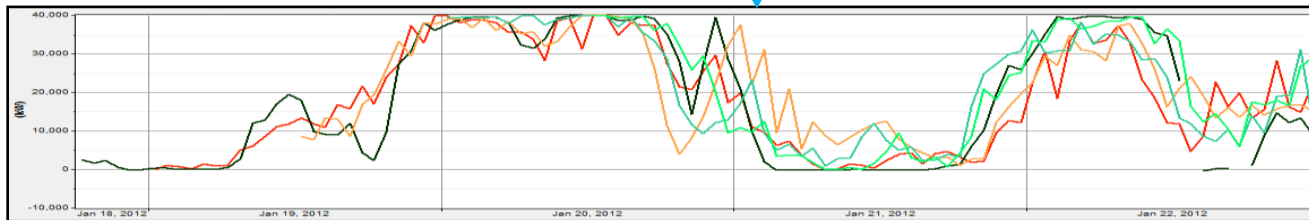
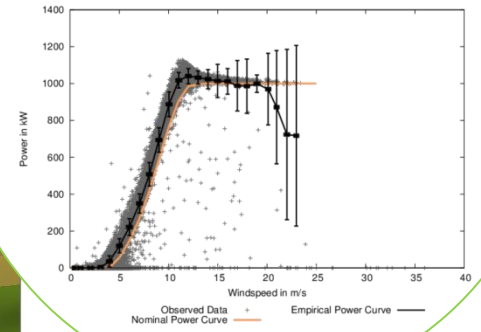
Nominal Power Curve



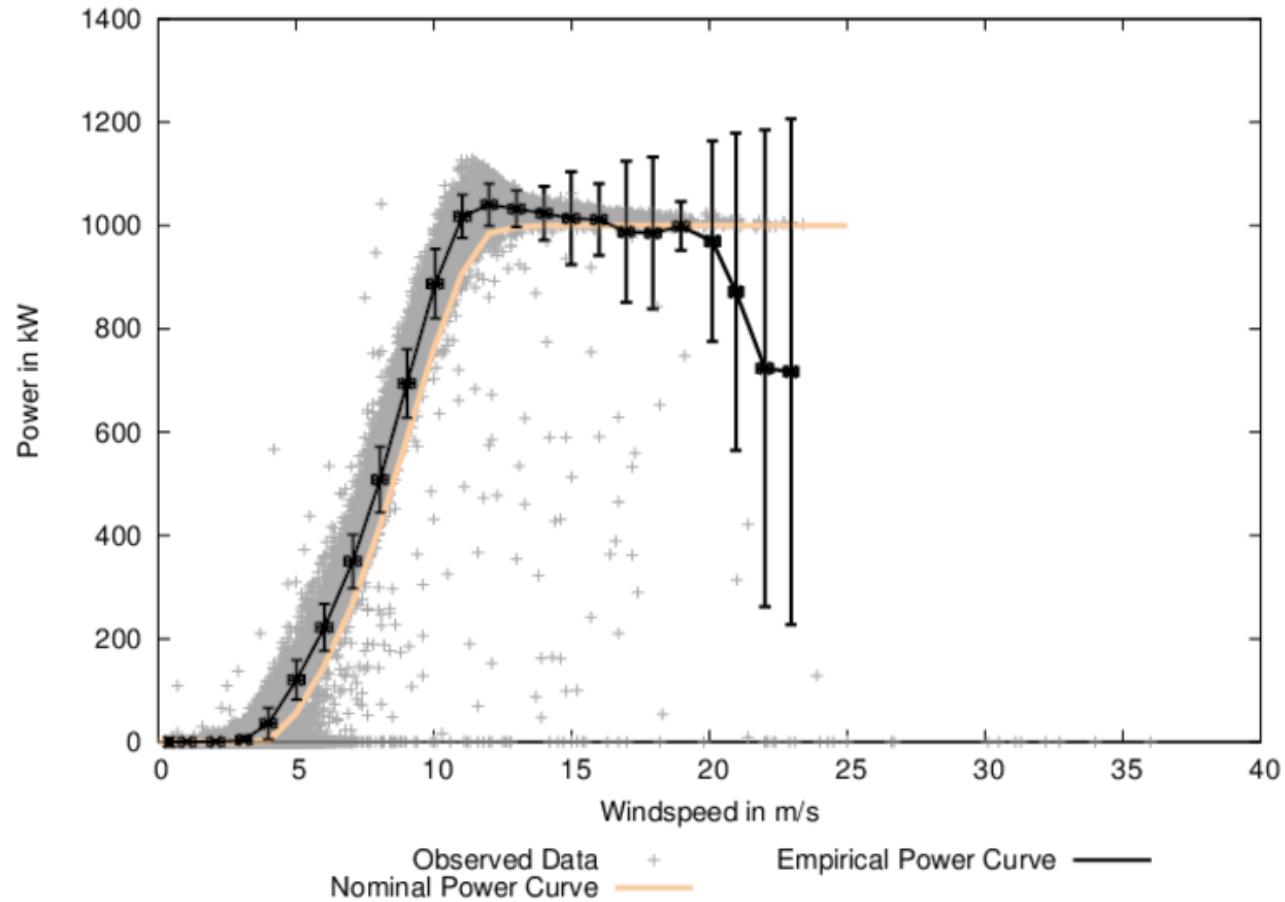
WindSim Forecasting



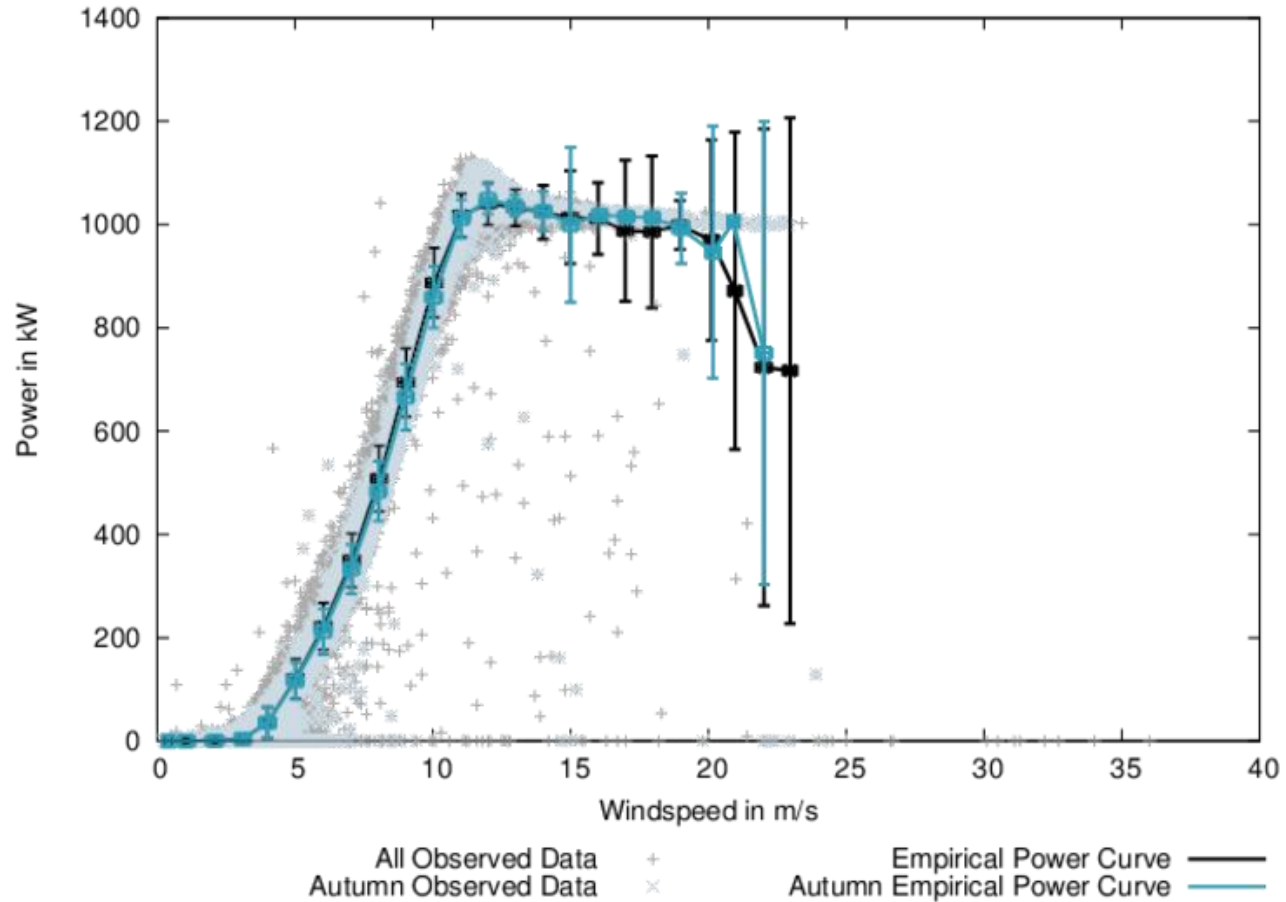
Empirical Power Curve



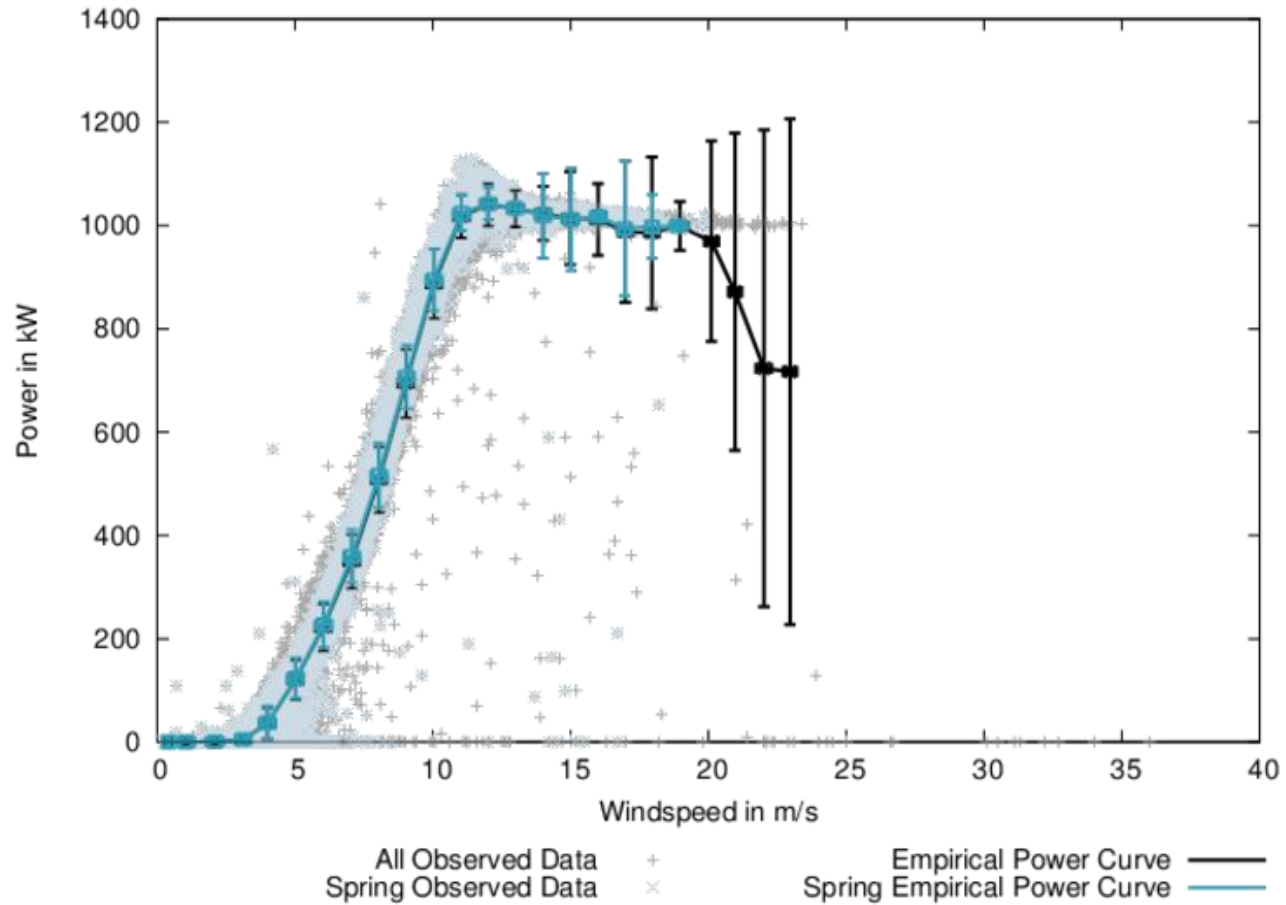
Empirical Power Curve vs Nominal



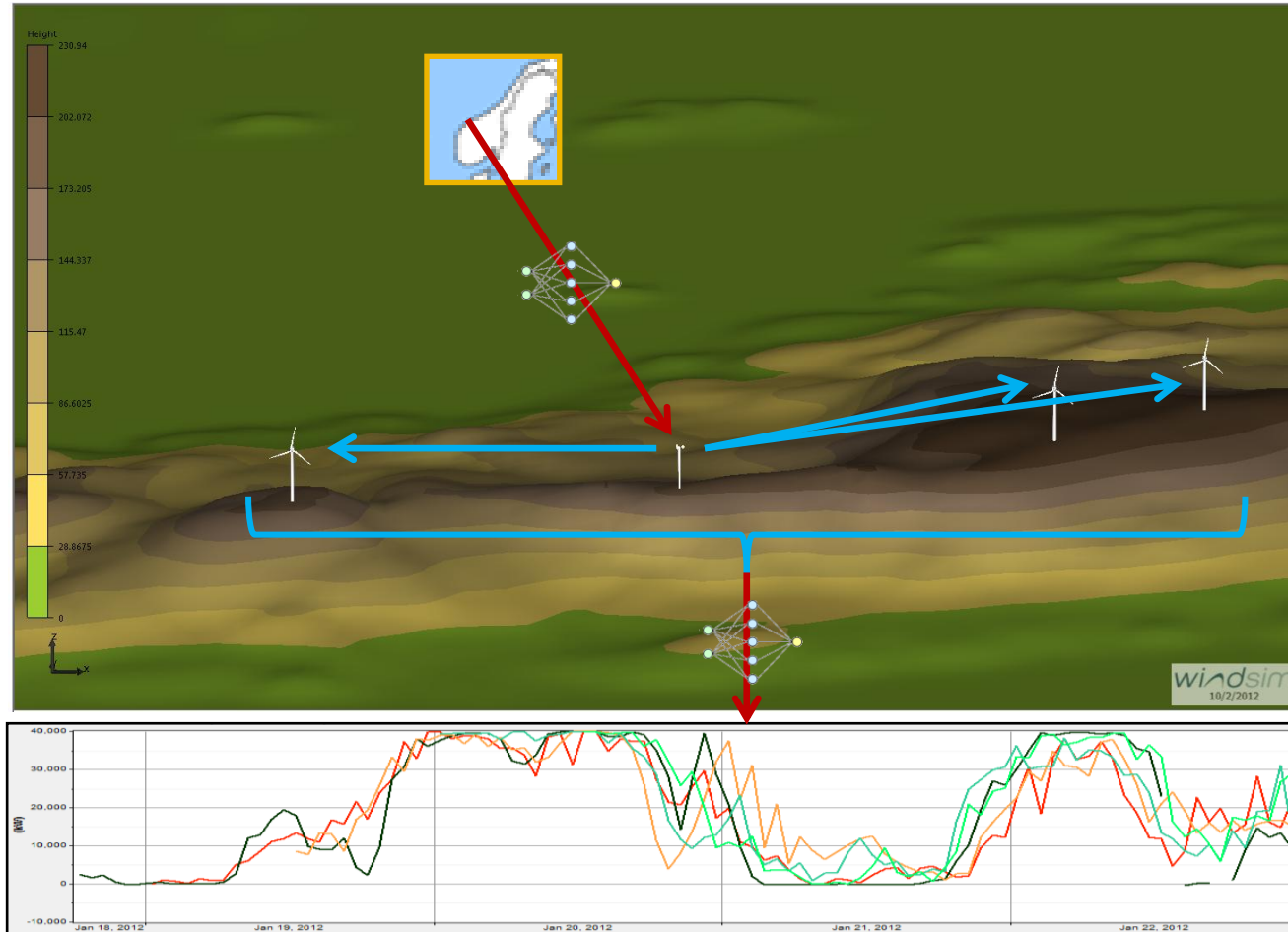
Empirical Power Curve per Season



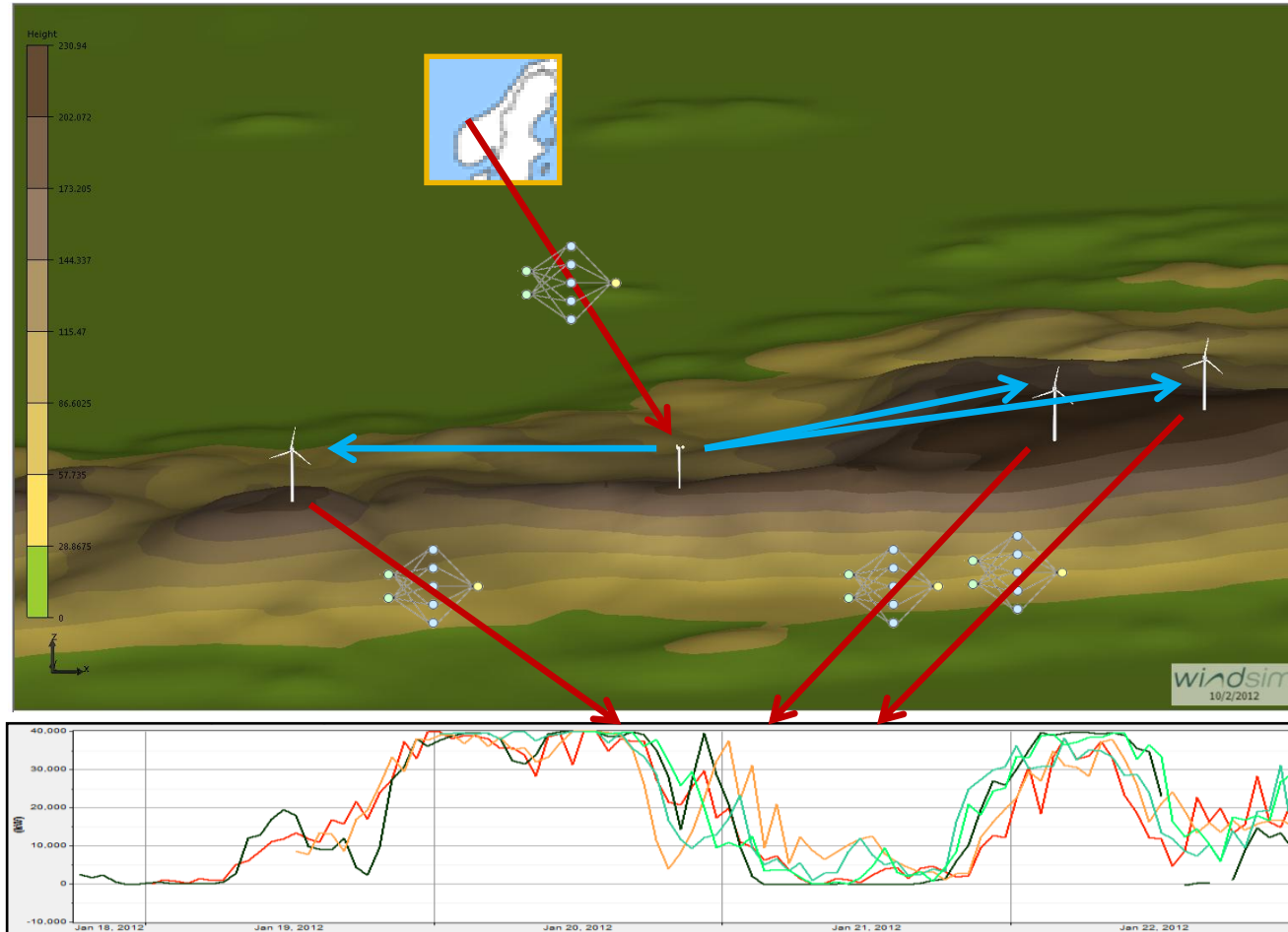
Empirical Power Curve per Season



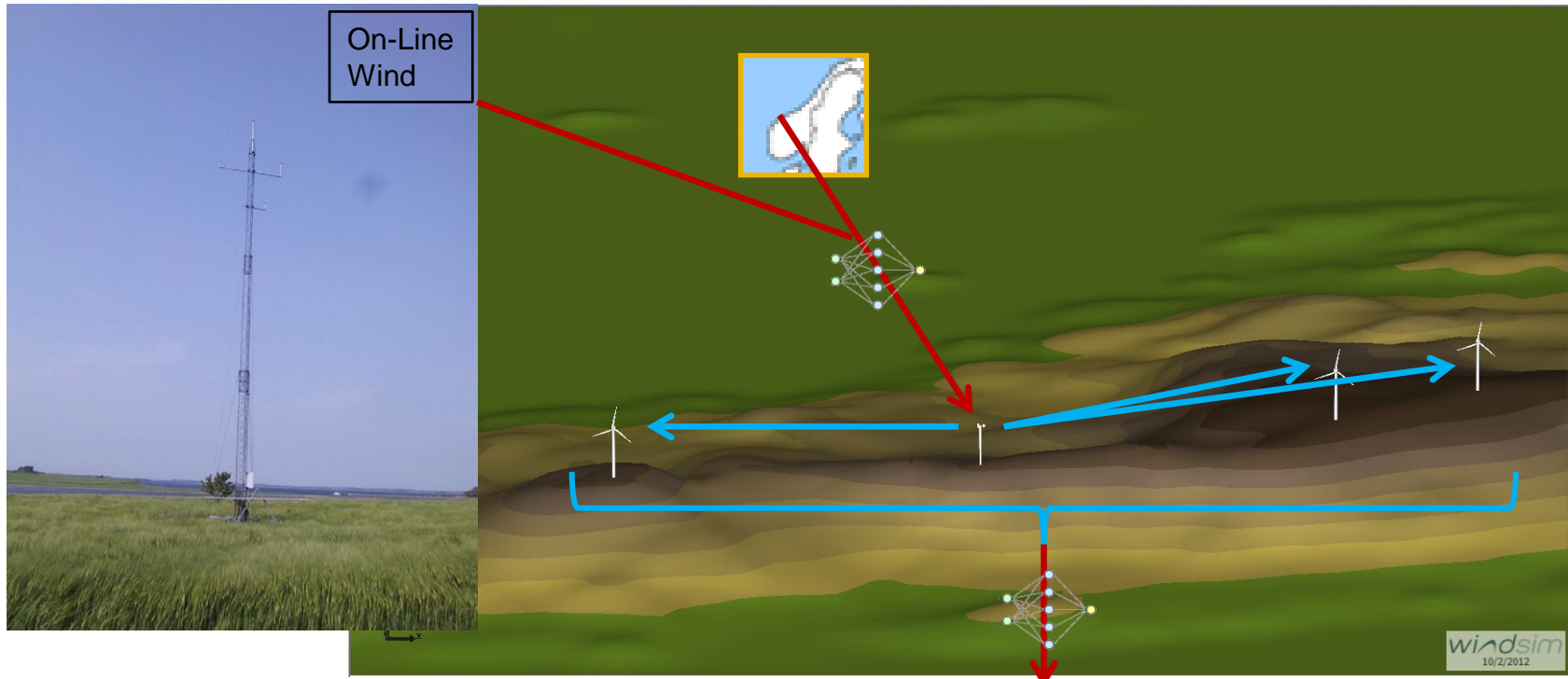
WindSim Forecasting



WindSim Forecasting

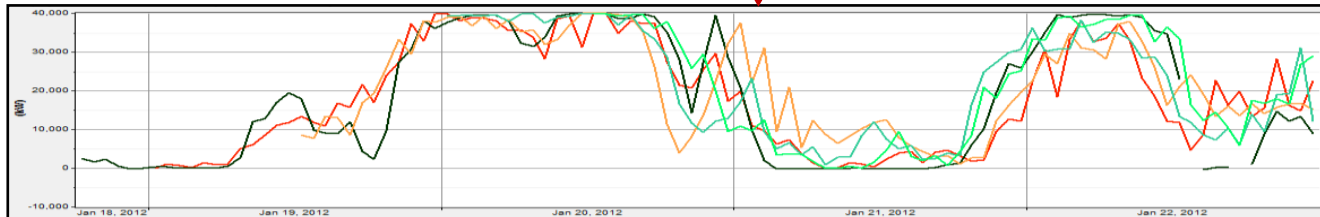


WindSim Forecasting



NMAE decrease:
~2.5% in the first
hours

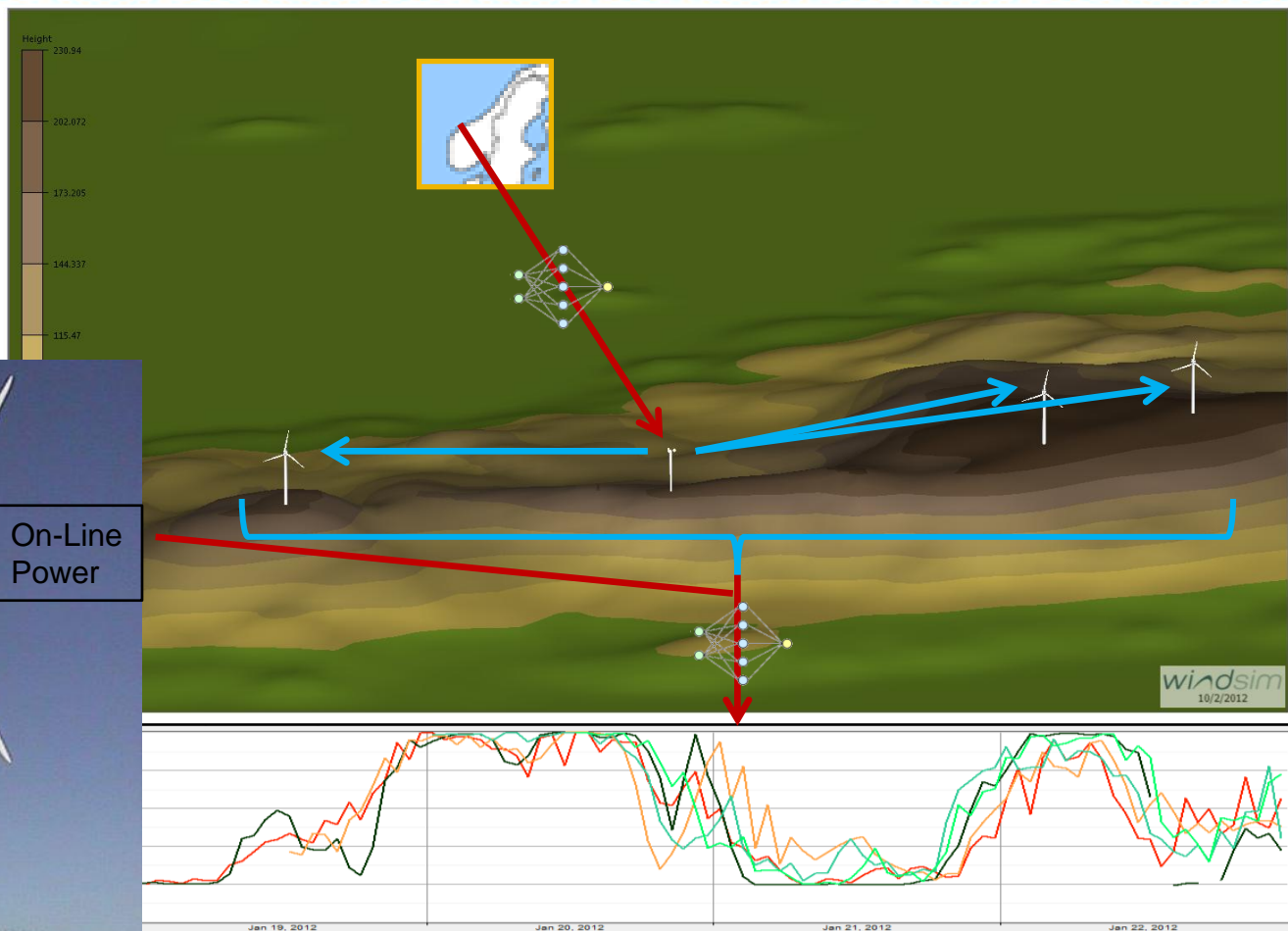
Suitable for short
term forecast



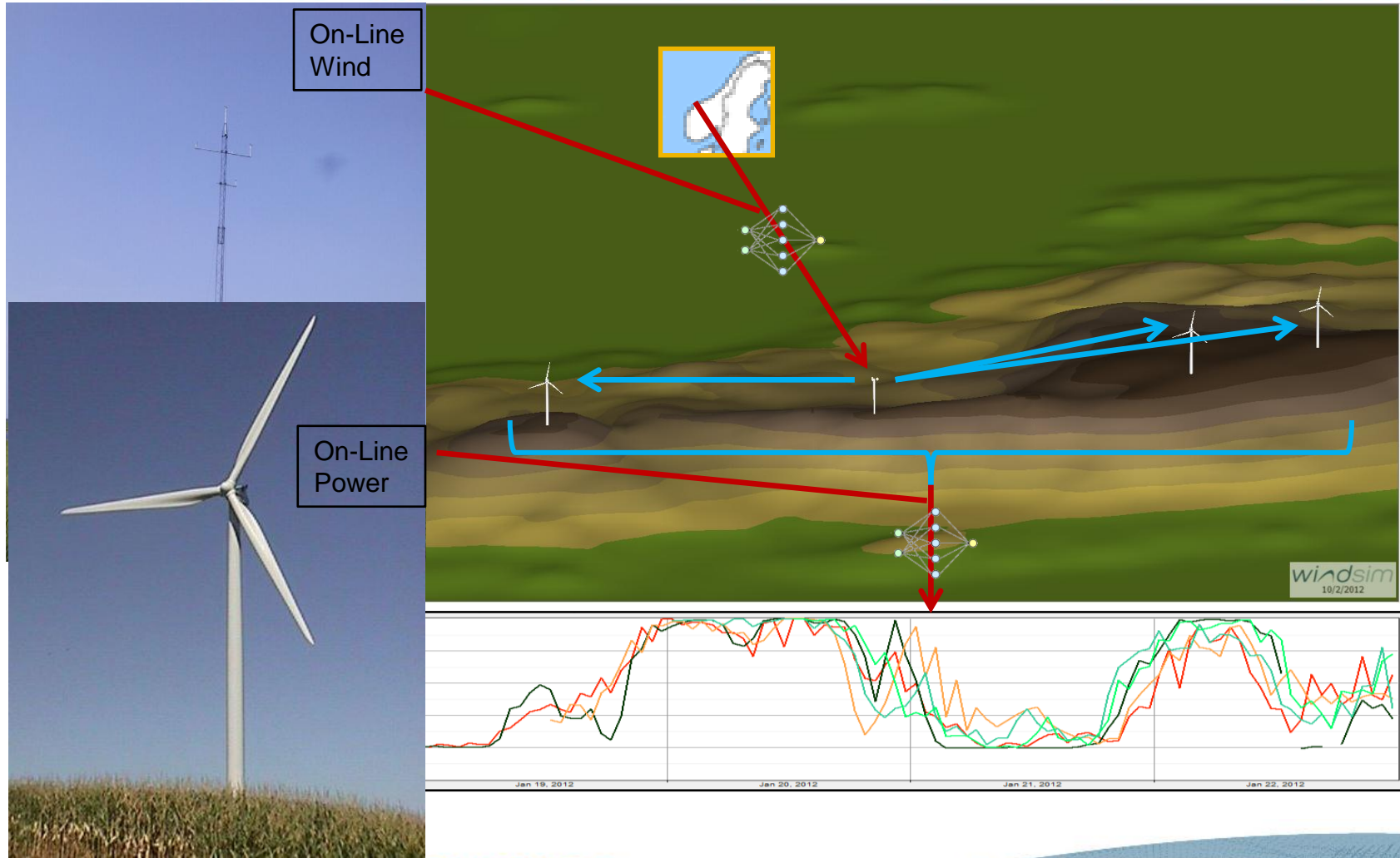
WindSim Forecasting

NMAE decrease:
~2.5% in the first
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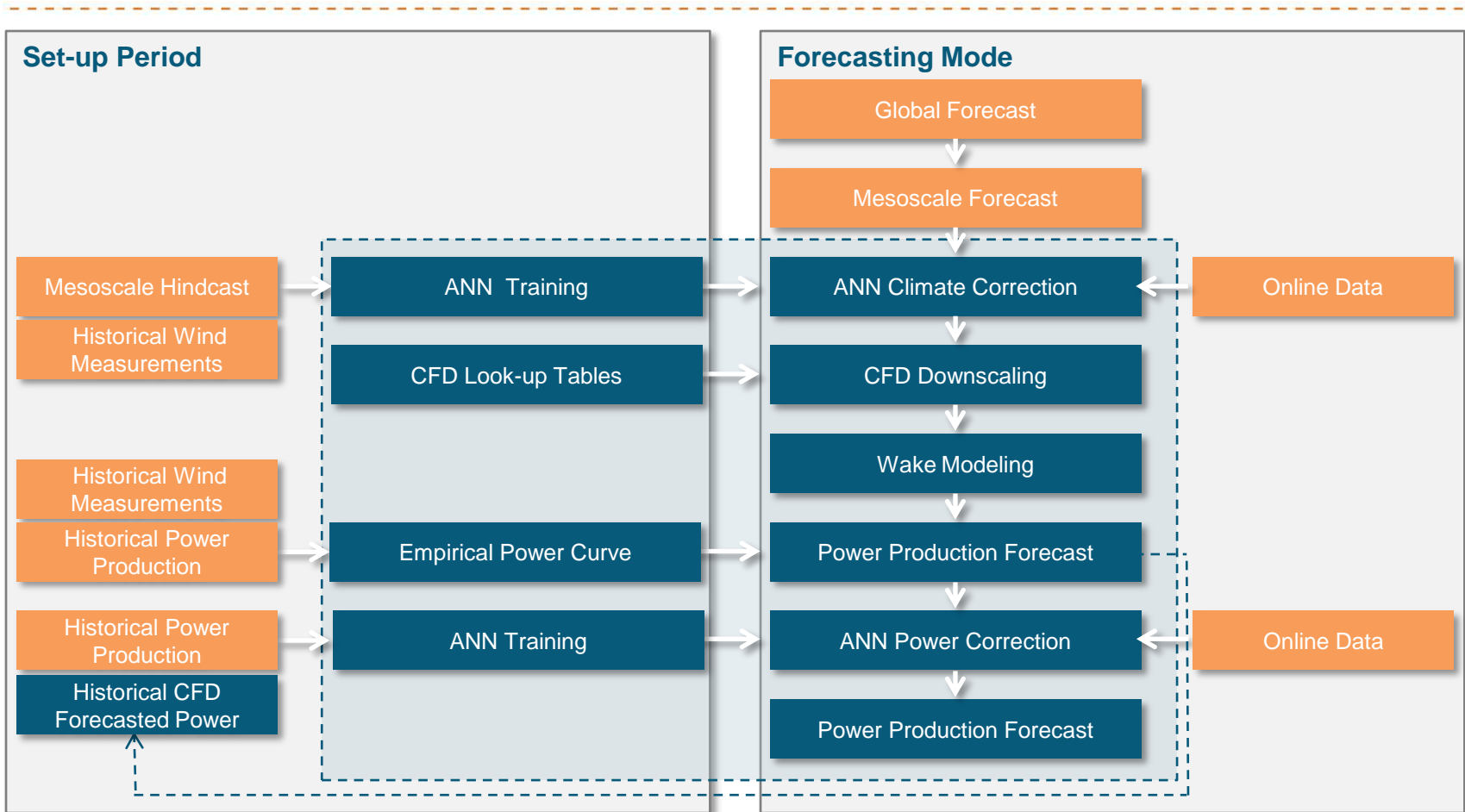
Suitable for short
term forecast



WindSim Forecasting



Short-term Power Production Forecast

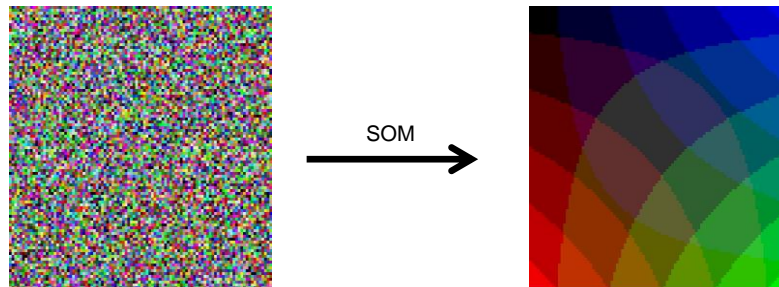


Short-term Forecasting using Mesoscale Simulations, Artificial Neural Networks (ANN) and Computational Fluid Dynamics (CFD): ■ Input; ■ WindSim software or data

Developments in WindSim Forecasting

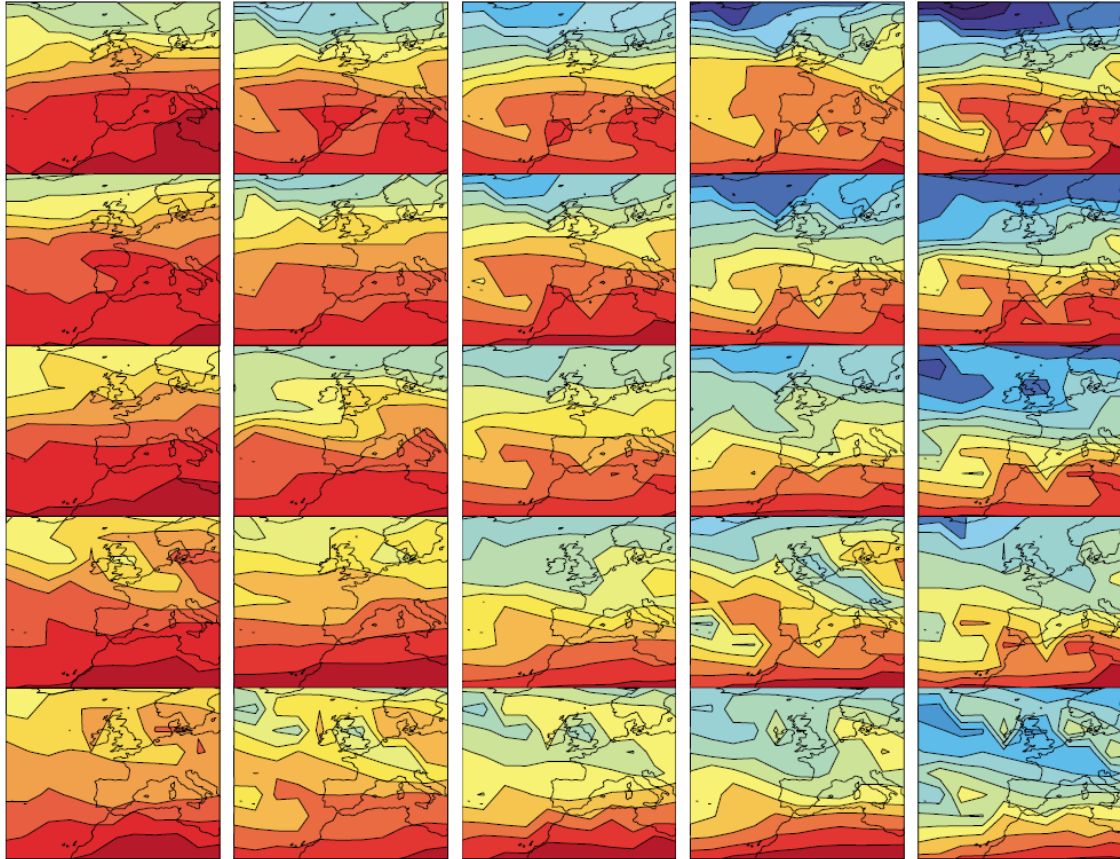
Recognize pattern in Forecasts:

- High dependency of the forecast on the NWP model
- Getting input from more than one NWP point
- Divide the forecast into subgroup (season - daytime - atmospheric pattern)



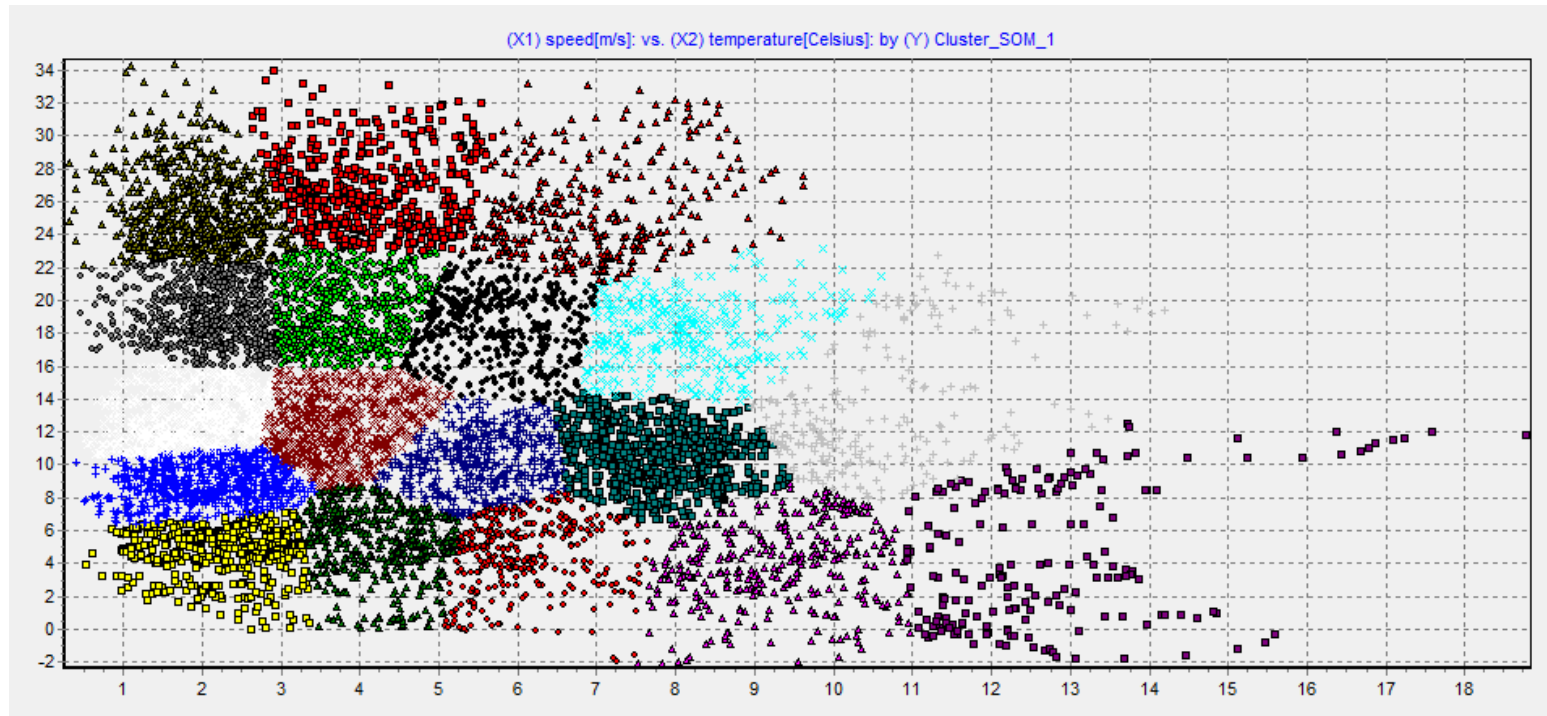
Self Organizing Map (SOM) is a type of ANN that can cluster data sets

Developments in WindSim Forecasting



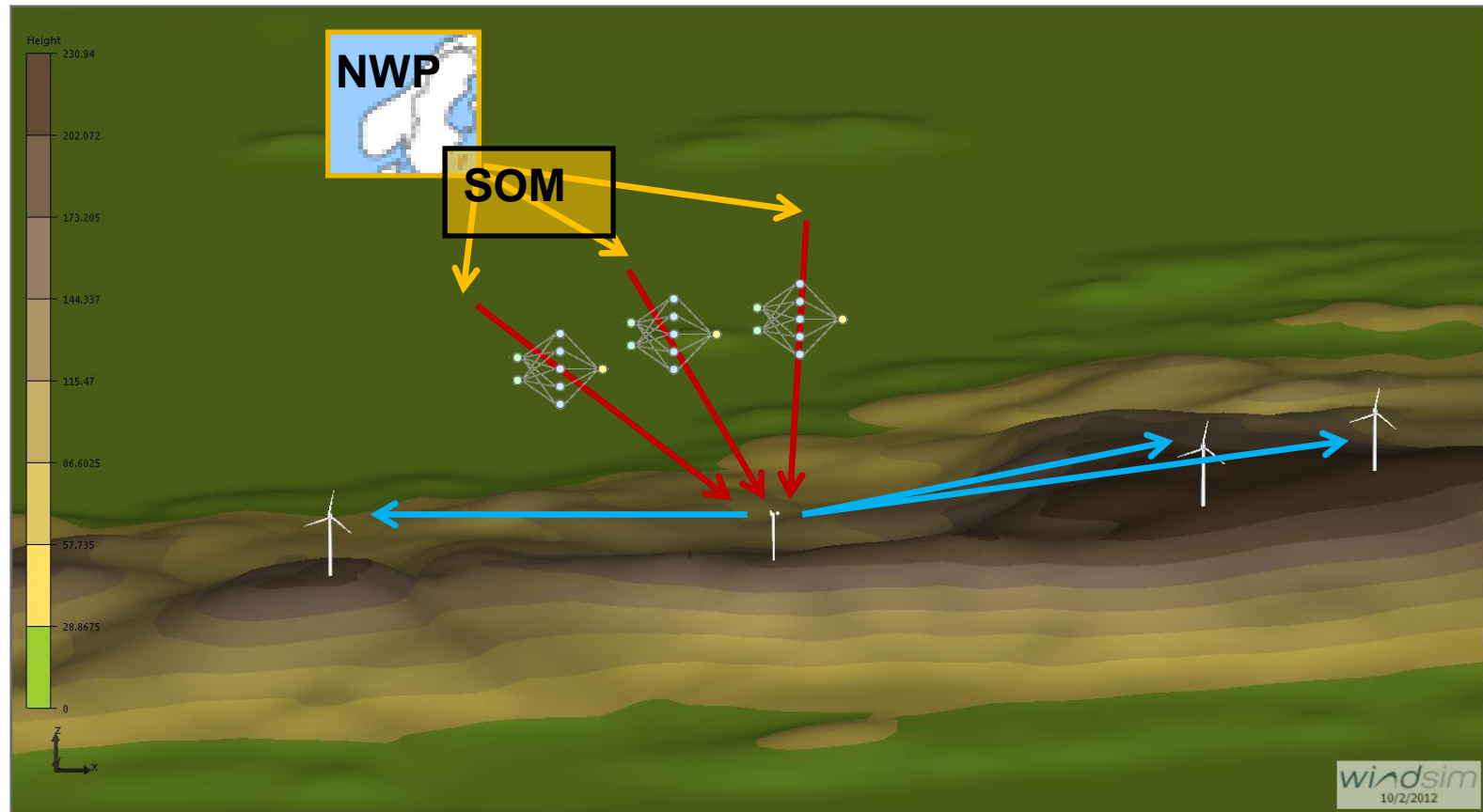
SOM can cluster forecasts periods

Developments in WindSim Forecasting



Clusters of time series points plotted depending on wind speed vs. temperature

Developments in WindSim Forecasting



Developments in WindSim Forecasting

Better tuning needed

- SOM provides good results in some cases but we need a better set-up and more testing (cluster number and inputs used)
- Increasing performance with number of cluster vs decrease of number of samples for each ANN training. Needs longer time series

Questions...

Thanks for your attention!