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EMD webinar:

WAsP-CFD in WindPRO 22/10-2013

Questions submitted during the webinar

Questions		Answers
If profile fit is not a good performance indicator, which indicator is better?		The best indicator is the cross-prediction error between top-level anemometers between two or more masts measuring close to hub height. This is a good indicator of the error you will get when modelling the turbine positions if the masts are at representative positions.
From what I understand, the user doesn't send the wind data. How can the model calibration be assured for the site?		Firstly, you would typically setup everything as usually when using WAsP and run your standard WAsP calculations. This will serve as some degree of calibration as you call it, and at least catch any problems with the terrain and roughness models. But it is important to stress that before submitting the CFD calculation to the cluster please go through your roughness and terrain models meticulously. The stability is a post-processing, and can be used in the final site specific calibration of the model after the CFD flow results are downloaded from the cluster.
Do you need to perform a new simulation when changing the atmospheric stability?		No there is no need to rerun the CFD model, the stability model is a post-processing performed via WAsP 11 on your local PC after the CFD result has been downloaded.
The meteo object for CFD will be always inside the calculation target area? And one more: the CFD site data must be in the same position of a mast or it is independent from the position of mast?		To do a STATGEN, yes - the mast must be within a 2x2km CFD tile. The position of the site data object itself is not important, only where you add/position the CFD-tiles is important for the calculation.
This problem that profile fit has not improved - does that mean that it is even more important now, than before, to measure at hub height?		No - because all our results are for default stability settings. You can always adjust the stability parameters to better match the site conditions. However, it is always a good idea to measure as close to hub height as possible.
How do you include effect of skew inflow on the rotor area near a ridge?		The effect of skew inflow is not handled by the CFD model, which will only predict if and how much the inflow conditions are inclined/skewed. If you want to account for inclined inflow on the power performance you need to apply a correction to the power curve. We are actually working on power curve corrections that also account for flow inclination. This will be introduced in a later version of WindPRO.

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Is it possible to make the calculation on my computer or do I need to calculate through the cluster?		So far only the cluster solution is available. One tile would take approximately 1 week to calculate on a standard PC due to the very fine grid, many sectors and large domain.
Did you use 4 credits 200 Euro each for the demo calculation? Was it possible to arrange the tiles in a different way and use just 3 and get the same results?		We are committed to giving you a good experience with the webinar ☺…. For the demo site three tiles would have been sufficient. As results are practically independent of tile configuration as shown in our validation study, the tiles could be placed in any odd way, overlapping or far from each other.
How does the accuracy of WAsP CFD compare with other CFD programs - WIndSIm, Meteodyn etc - has EMD carried out a comparison - simple and complex terrain.		Our focus has been on WAsP-CFD and not the competitor's solutions. However, most of the other models are meant to run on a PC which means that they have limited computational power available and hence tend to compromise on the grid resolution in particular vertically and on domain size or number of directions to limit the PC calculation time. This is the main reason that WAsP-CFD runs on a dedicated HPC cluster. A single WAsP-CFD tile calculation would take around a week on a standard PC!
How much is a simulation time? Is it few hours?		A tile takes around 45 minutes calculation time on the cluster. The 1 hour calculation time seen in the demo is a conservative estimate.
The mesh parameters can be set by the user? And the target area can be smaller than the 2x2km?		No, these are all fixed parameters, which are well tested and optimized, there is no need to adjust these parameters.
Is it possible to export the ambient turbulence? What is the turbulence model?		Turbulence will be available in next version. The turbulence model is a k-ε model.
How is the thermal stability class handled?		The stability model is the same as for WAsP and is a post-processing done via WAsP 11 on your local PC after the CFD calculation has been downloaded. All the CFD flow corrections calculated on the cluster assume neutral stability. You can read more about this stability model in the European Wind Atlas chp. 8.
I don't know how the CFD resource looks like, but a normal wrg is composed by weibull parameters per grid point of the area. If this is the same for CFD resource calculations, shouldn't be some error on describing non-weibull distribution sites? (specially in complex terrain, it is often to find non-weibull wind distribution) What is the workaround?		Typically, you would see that the individual sectors better match a Weibull, and with WAsP-CFD you can calculate for up to 36 sectors where probably all bi-modality is gone within all sectors. It is currently not possible to circumvent the use of Weibull distributions. However, keep in mind that an observed frequency table based on 1y of measurements is not the "truth". Add another year and that measured table would be slightly different. With more years the table tends to converge towards the Weibull within each sector.

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		So the Weibull fit is also a good thing as it reduces the statistical sampling error from using limited time series because it smoothes the frequency table.
The PARK calculation with CFD results uses a wind resource grid + a generated wind statistic generated with CFD results. Why do you neeed both of them? (you could for example perform a PARK calculation with only a .rsf file)		The WAsP-CFD based PARK calculation does not need a resource grid, it needs the grids with the CFD flow corrections computed on the cluster, which has not yet been combined the wind data. That is why you need to select the CFD calculations (grid files with flow corrections) and the wind statistics in a PARK calculation.
What is the convergence criteria used?		Each CFD simulation is solved in an iterative manner. This means that the final solution is found by making small steps or iterations that each improves the solution slightly. When a sufficient number of iterations have been made the simulation is finished. In order to decide if enough iterations have been made, the CFD solution at one iteration is compared with the one from the previous iteration. The difference between two iterations is called the “residual” and should be small. Our requirements for each of the 36 sectorial CFD simulations is a residual below res < 0.00005 (log(res)<-4.3) for all variables. This is a high quality level.
The speed-up factors are referenced to which wind speed? Some constant wind speed used as input to the boundary of the domain?		The speedup factors are referenced to the logarithmic velocity profile used at the inlet of the computational domain. The logarithmic profile is defined by the reference roughness / mesoscale roughness defined in the European Wind Atlas chp. 8.3.
When simulating the CFD without the wind data, in which velocity the calculations are based?		The simulations are done with a logarithmic profile that is set to 10 m/s in 10m height but it is not important. The speedup factors are independent on wind speed (friction velocity). We could simulate at 1, 10 or 20m/s and get the same speedup factors. this is because temperature and coriolis forces are neglected in the CFD; they are "added" afterwards as a post-processing by WAsP
Are the obstacles taken into account in the CFD model? If so, how is it implemented? (does WAsP CFD gets the height and dimensions of the obstacle and model it?)		The obstacles are not taken into account by CFD. Their effect is "added" afterwards using the standard obstacle model, in the same way as it is added to the standard linearized WAsP-IBZ model.
Will CFD wasp result in a lower uncertainty and higher P90 value compared to a normal wasp and how large will the average difference be?		In complex terrain using WAsP-CFD will reduce the uncertainty, if it will reduce or increase P90 compared to WAsP depends also on how the mast is positioned relative to the WTGs. It is not possible to give typical values for these figures as it will be very site dependent.

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Will this model mean that lesser number of met masts and remote wind measurements are needed in one complex site or is this not affected?		In principle it means fewer masts ... but you have to be careful. You are using the flow models to extrapolate your measured wind resource. Better models should allow greater extrapolation distances, but you should be careful. We have not changed recommendations on mast distances
Andreas, how complex the site should be (in RIX value) for the CFD calculation to give better results than standard WAsP model? How close are the CFD results to standard WAsP model if RIX=0?		There is no lower limit to WAsP-CFD in regards to terrain complexity. We have tested it in many places with flat terrain where it performs comparable to WAsP, not identically but close. The results will never be identical because the two models treat roughness in quite different ways.
The domain is set by the 2x2km areas we define in the beginning of the simulation?		Yes. You define 2x2 km areas in the beginning. They can be separated or overlapping it is up to you. The centre of the CFD domain will be at the tile position. The CFD domain will have an extend of about 34 km (diameter)
How is the effect on wake added turbulence for complex terrain?		Wind turbine wakes are not included in the CFD calculation; they are calculated afterwards by WAsP using traditional means. The work on improving the wake models is ongoing but will likely be separated from the CFD model for some time. If you include them in the CFD simulations the number of CFD calculation will increase by a factor 10, since you would also need to do CFD simulations at different wind speeds.