IEA Wind Task 36 Workshop:

Experiences in using Wind Power Predictions and Gaps in Forecasting Research

Barcelona, 9th June 2016

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Collected views from the audience

Issues from some remote access participants

Previous research agendae (SRA 2015, …)

EU TP Wind SRA 2015

3.4.1.2 Research priorities

Research priorities are:

- Better information about the current state of the atmosphere and power production through **new or improved measurement techniques** and strategies;
- Development of **integrated forecasting models** including all available online data, NWP models and wind power forecasting models;
- Development of **specific wind power forecast systems for** the **different needs** in the operation of the power system, e.g. for short term prediction of extreme high frequency wind gusts, ramp forecasts for warning systems, forecasts with grid node resolution, forecast scenarios, forecasts and maps of predictability, etc;
- Improving **probabilistic wind power forecasts** and transforming the information into a forecasting system suitable for daily operation.

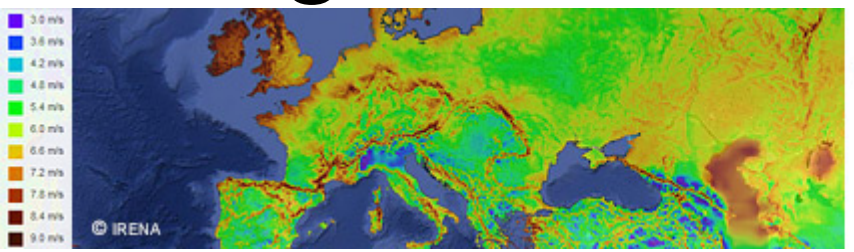
EU TP Wind SRA 2015

5.3.2 Research priorities

Development of **improved probabilistic tools** for power system, portfolio and asset management, intended for high penetration of renewables and taking new business models for generators into account;

- Improved probabilistic **generation, demand and price forecasting** and use of such forecasts for power system management and market integration;

Crowdsourcing the future



EWEA Technology Workshop:
Wind Power Forecasting 2015
Meeting end-users needs

1-2 October 2015
Leuven, Belgium

47 inputs

Ranking	Votes	Category
1	31	probabilistic forecasting
2	19	data availability
3	18	NWP development
4	18	users' needs
5	14	short-term forecasts
6	11	real-time
7	7	mid-range
8	6	installation, O&M
9	6	storage
10	5	cut-out
11	5	icing
12	4	best practice
13	2	standardisation
14	1	portfolios
15	0	computational power
16	0	errors, use of

Introduction to Meteorology gone wrong – really ?

What does that actually mean if the NWP model does not develop certain phenomena ?

Could it also be a different view upon things ?

Meteorologists view:

- Phenomena was not resolved in the model
- Phase Errors
- Deterministic View on things can be misleading

(Power) Engineers View:

- Met model gives totally wrong signal
- Conversion from wind to power fails
- Leads to “bad decisions” (over/under estimation of risk and/or cost)

Collected Issues

- Nowcast (especially for difficult situations, thunderstorms, small lows, …)
- Sub 1 hour temporal resolution
- Meteorology below 1km spatial resolution
- Stability issues, especially with daily pattern
- (Nightly) Low level jets
- Farm-Farm interaction / quality of direction forecast
- Short-term ensembles
- Rapid Update Models (hourly, with hourly data assimilation)
- Use of probabilistic forecasts and quality of the extreme quantiles
- Do DSOs need different forecasts than TSOs?
- Penalties for bad performance? Incentives for improved perf.?
- Seasonal forecasting? What's the business case?

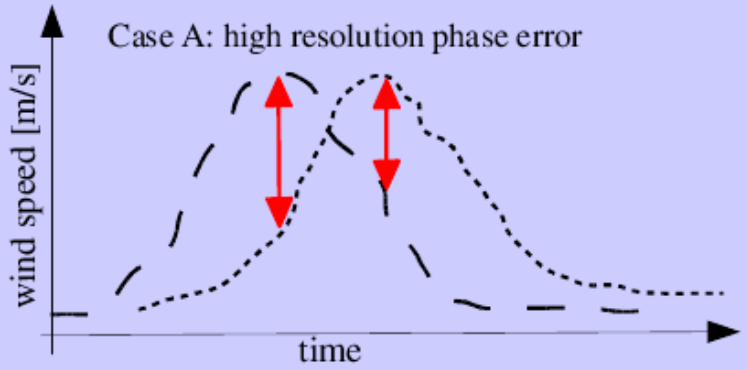
Forecasting sub hour/km phenomena

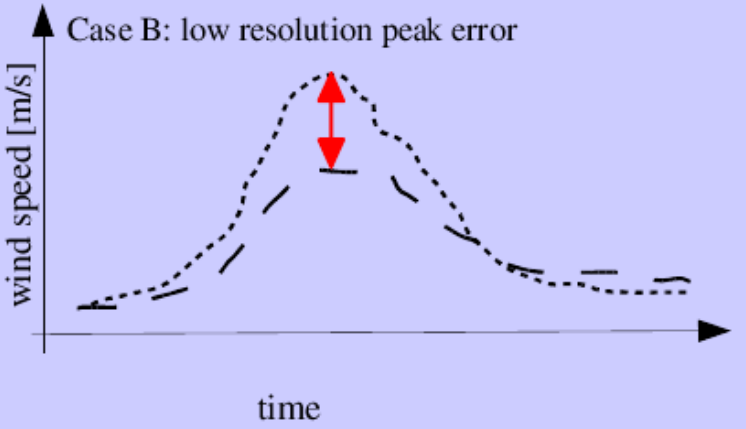
The general "believe" is that :

increased resolution → better forecasts

Subjectively, high resolution models simulate the weather better,
BUT the modelling study revealed:

-- phase errors are still present in the high resolution
-- high resolution model is punished twice on peaks with phase errors
-- statistically there is no difference between high and low resolution

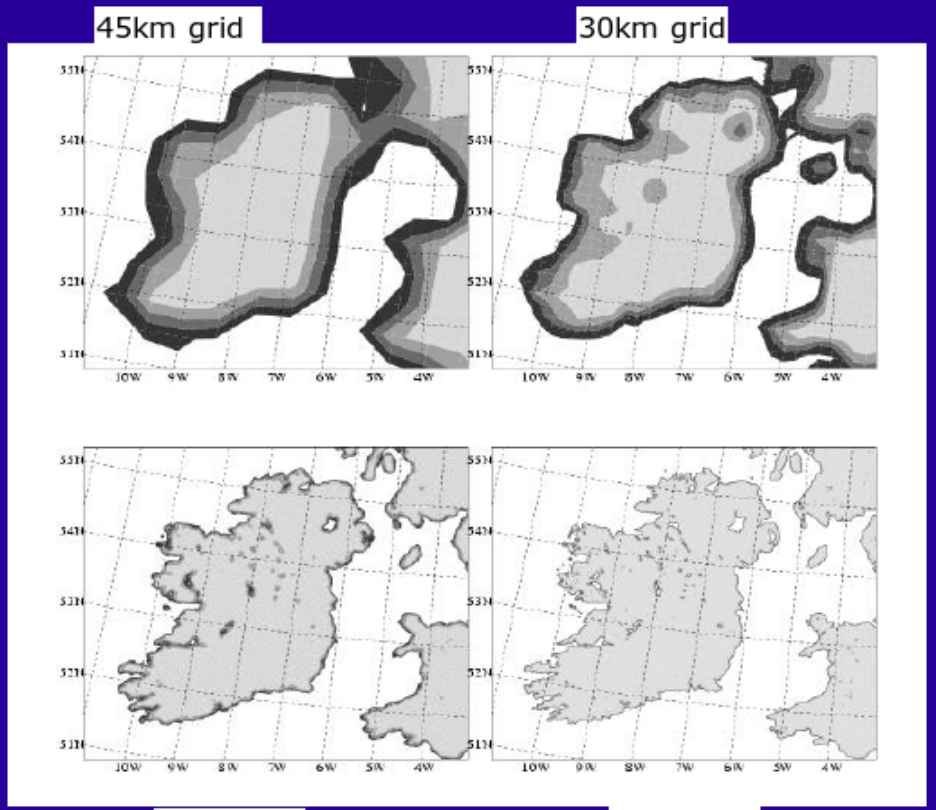




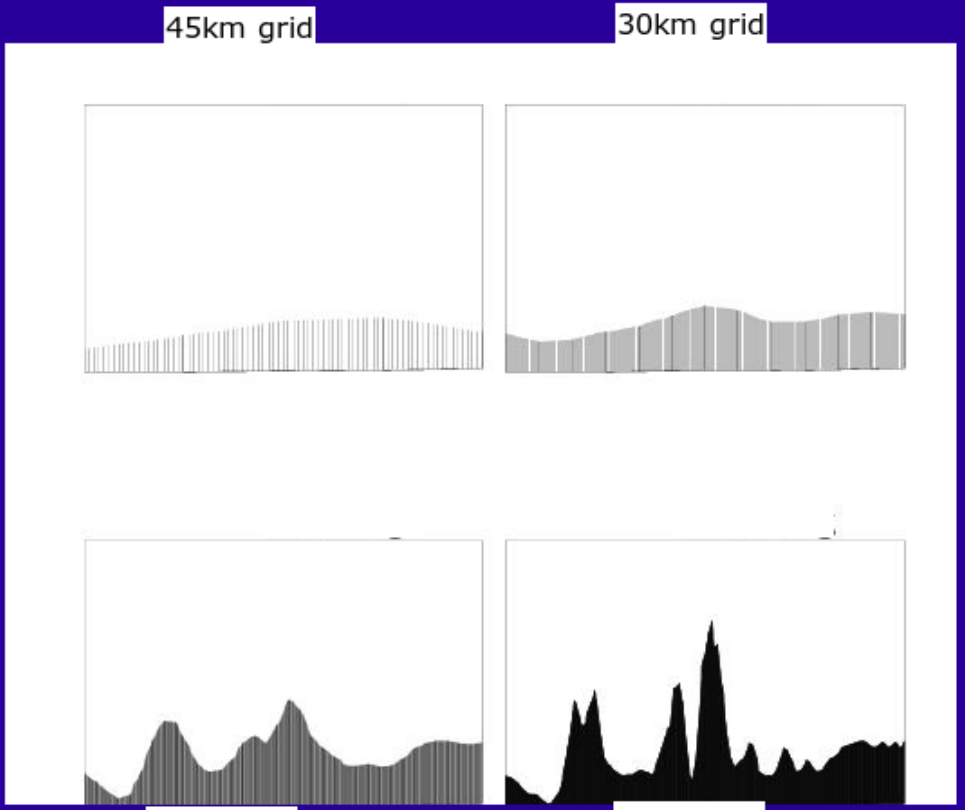
Forecasting sub hour/km phenomena

How does a NWP model discretise the world in different model resolutions ?

Land Sea Mask of the numerical Model



Vertical Profile of the numerical Model



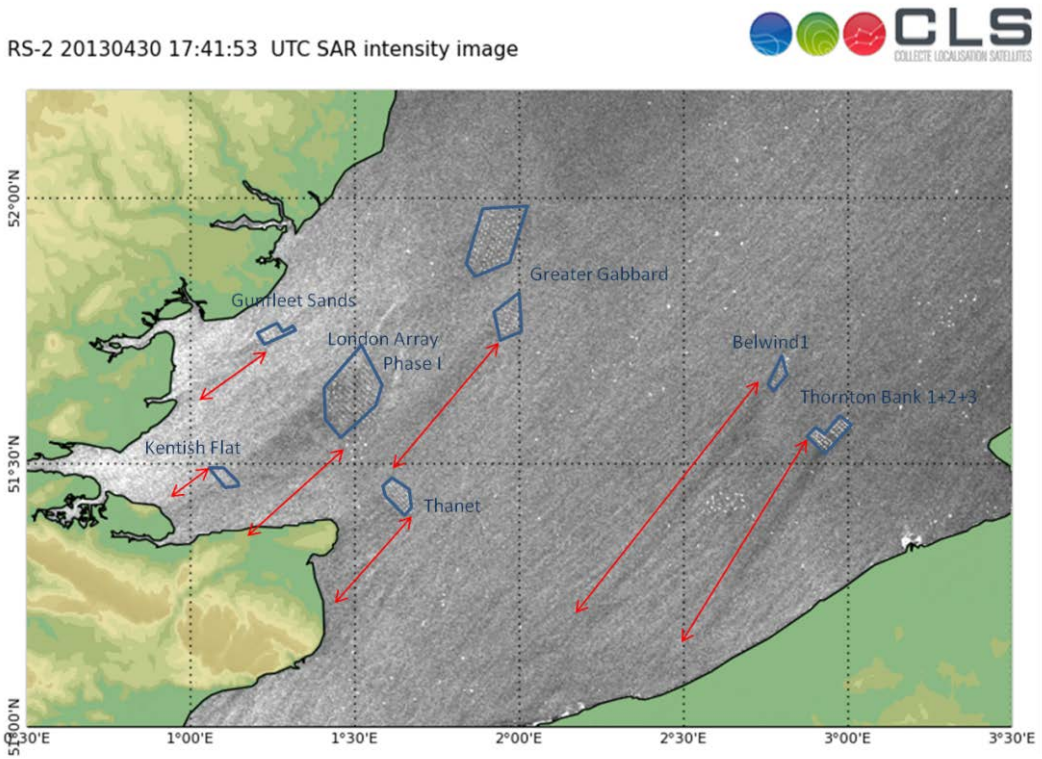
Forecasting the interaction between turbines (and between wind farms on a larger scale) due to the wake effect

Relevant for which end-user? Time resolution?

This might be relevant to primary frequency control, however in interconnected systems the impact seems marginal…

Better direction signal needed!

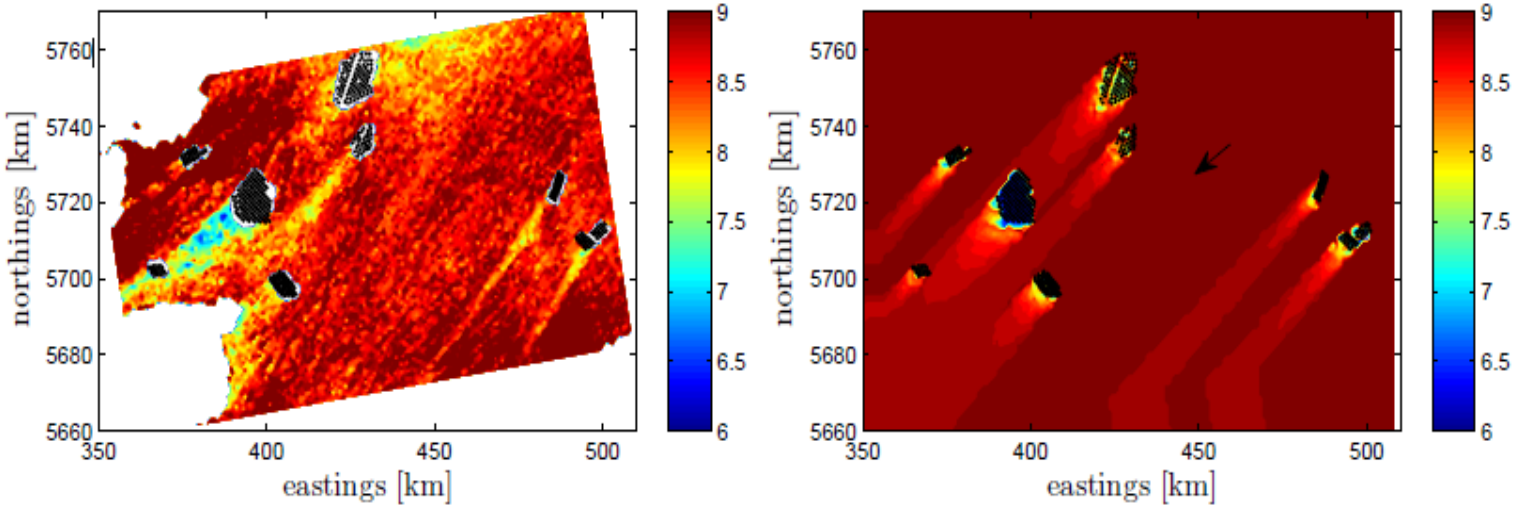
Farm-farm interaction from satellite



Wake models:

- PARK
- WRF DTU
- WRF CENER
- WRF CIEMAT

Source:
EERA-DTOC



Forecasting Cut-out during high wind conditions (and the return from cut-out when the wind subsequently drops)

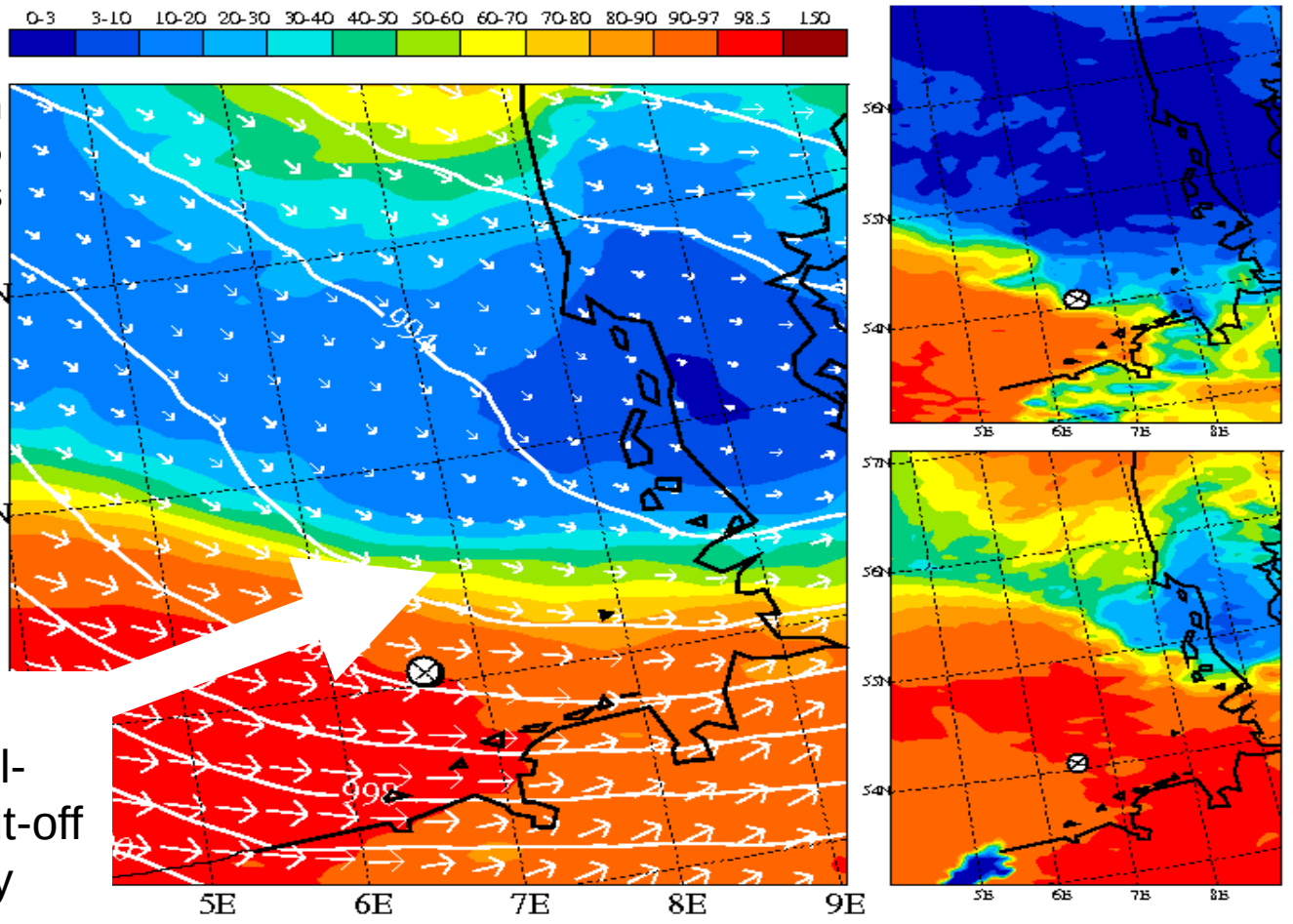
Useful at individual wind farm or aggregated scale?

How to forecast the maximum wind speed module inside an interval (e.g. 30 min)? How to estimate its impact in wind power output?

Remains relevant considering that several wind farms has anti-storm control? How to model the power output with anti-storm control functionality?

Forecasting Cut-out during high wind conditions (and the return from cut-out when the wind subsequently drops)

Mean, Maximum and Minimum of 75 forecasts as wind power potential

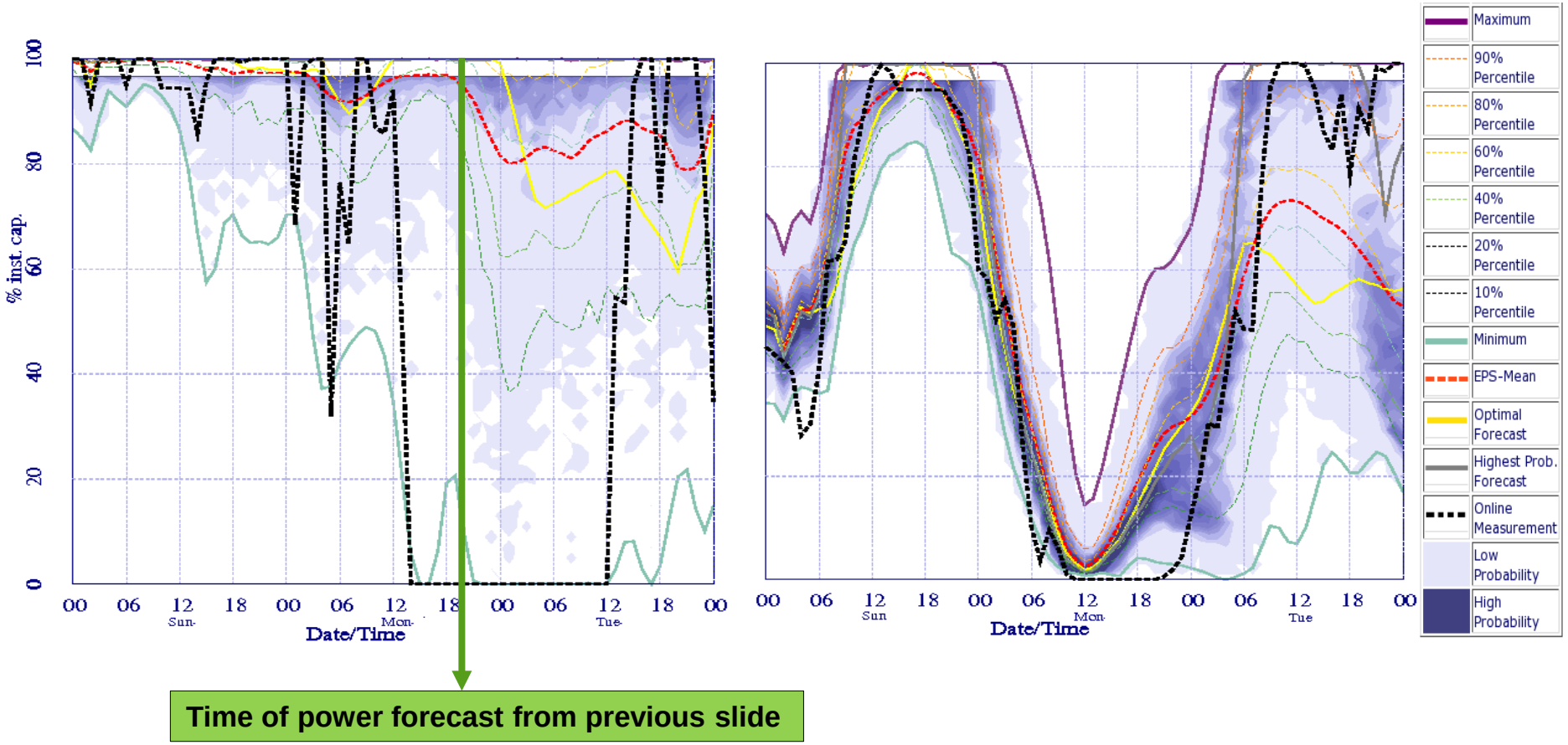


The areas between full-load and cut-off is often very small

Forecasting Cut-out during high wind conditions (and the return from cut-out when the wind subsequently drops)

Uncertainty “explodes“ in such cases

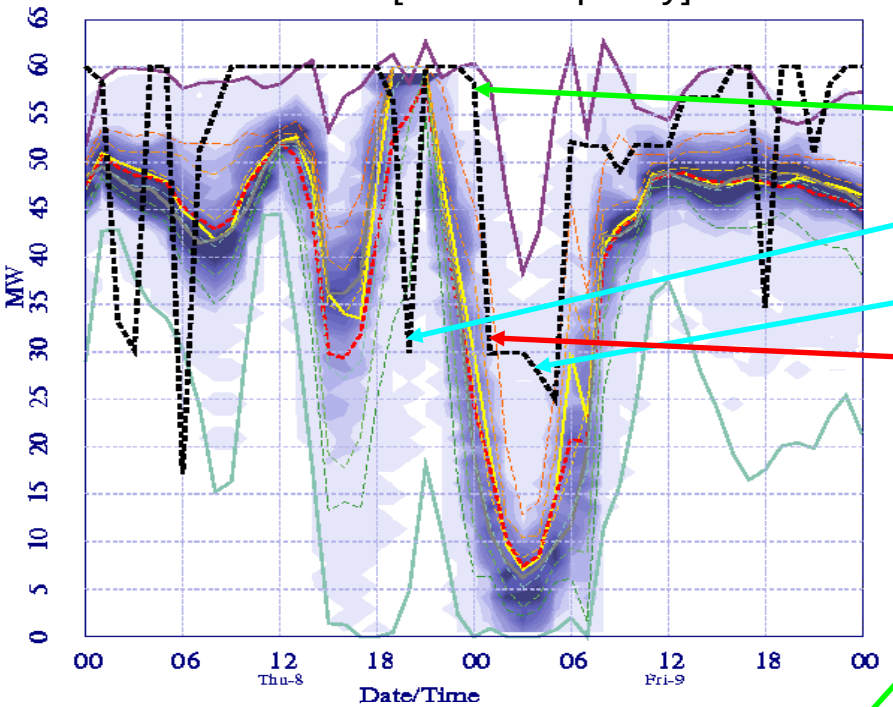
Offshore Wind Park Alpha Ventus, Northsea



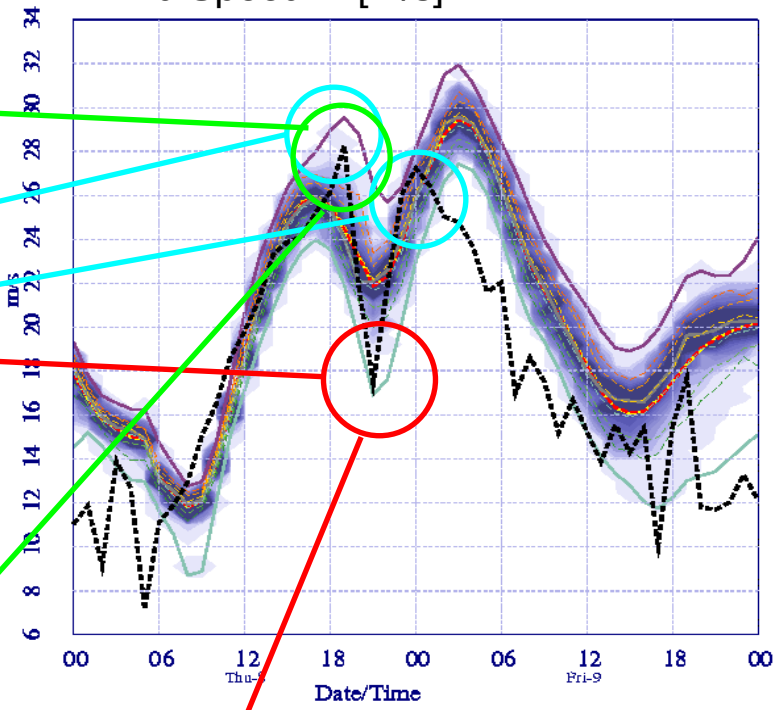
Time of power forecast from previous slide

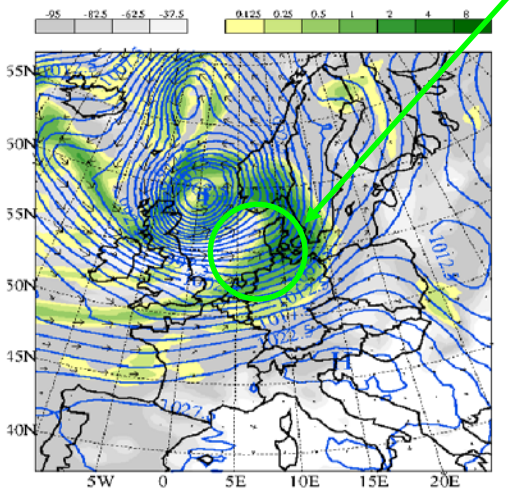
Forecasting Cut-out during high wind conditions (and the return from cut-out when the wind subsequently drops)

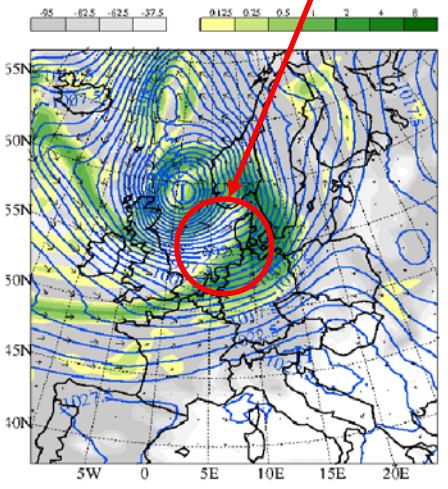
Wind Power in [% inst. capacity]



Wind Speed in [m/s]



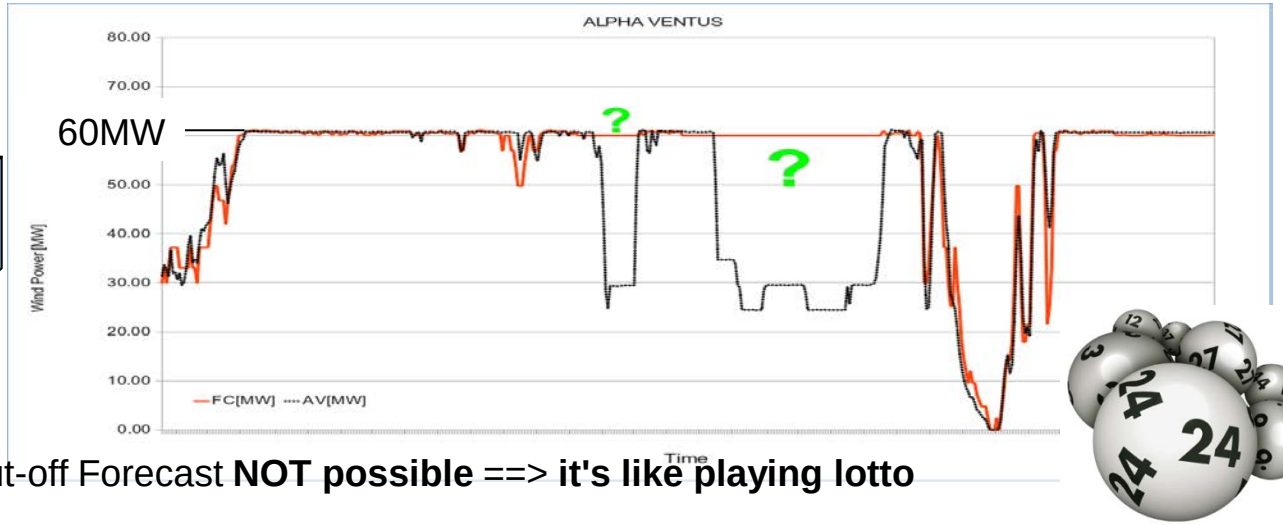




Offshore Wind Park Alpha Vetus, Northsea

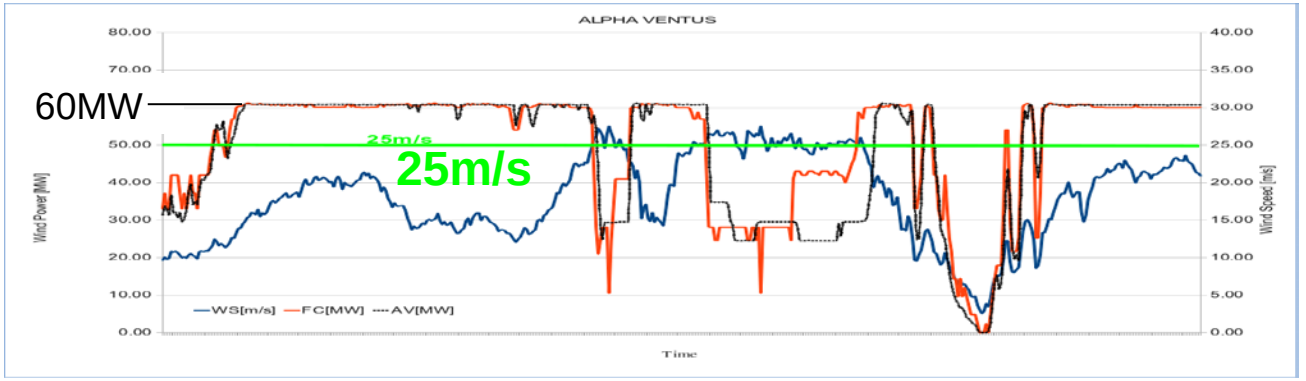
Forecasting Cut-out during high wind conditions (and the return from cut-out when the wind subsequently drops)

Predicting Cut-off with and without wind forecasts



Power Data + **Power Forecast**

Cut-off Forecast **NOT possible** ==> **it's like playing lotto**



Power + Wind Data + **short-term Forecast**

Forecasts with windspeed influence (machine adaptation)

Cut-offs prediction **possible** ==> **no gambling required:**
wind speed measurement clearly indicates risk of cutoff

Making the best use of probability forecasting within the control room

Where can probability forecasts be used ?

Operational planning of the power system/transmission network
- setting operating reserve requirements
- setting net transfer capacity (NTC) values between control areas
- detect/solve technical constraints violation (overcurrent, over/under-voltage)

Distribution network operation
- detect/solve technical constraints violation (overcurrent, over/under-voltage)
- state estimation
- grid optimization (topology reconfiguration, reactive power

Isolated systems (islands)
- situational awareness under extreme weather events (ramps, cut-out wind speed)
- level of primary reserve and inertia in the system

Making the best use of probability forecasting on the Trading Floor

Where can probability forecasts be used ?

Probabilistic decision making in the trading of electricity from wind and solar
- finding the best forecasts
- creating step-wise prices
- using experience to adjust forecast within uncertainty bands

Short-term forecasting with measurement influence
- find the forecast that fits best to the current measurement

Power plant monitoring
- identify hardware issues with uncertainty bands
- identify where power output does not reflect weather conditions

Reserve Forecasting
- predict the forecasting error

Summary and Conclusion

Let’s discuss!

Collected Issues

Nowcast (especially for difficult situations, thunderstorms, small lows, …)

Sub 1 hour temporal resolution

Meteorology below 1km spatial resolution

Stability issues, especially with daily pattern / (Nightly) Low level jets

Icing

Farm-Farm interaction / quality of direction forecast

Short-term ensembles

Ramps and other extremes

Spatio-temporal forecasting

Rapid Update Models (hourly, with hourly data assimilation)

Use of probabilistic forecasts and quality of the extreme quantiles

Do DSOs need different forecasts than TSOs?

Penalties for bad performance? Incentives for improved perf.?

Seasonal forecasting? What's the business case?

Data assimilation (with non-linear Kalman filters, 4D Var, …)

Red: Important research, but (to be) done elsewhere
Green: We work on at least some aspects