A few months of floating LiDAR data. What's next? GTS

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VORTEX

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BACKGROUND

Once a floating LiDAR is deployed in an offshore site and a few months of measurements available, wind farm developers need to estimate the Energy Yield of the future wind farm. However, at least two problems arise:

1- Data is obtained at a single point whereas the extension of the area is much larger.

2 - A few months of data is not representative of the long-term (seasonality).

Unless developers can invest in deploying several floating LiDAR (and wait for one or two years of data collecting) **Gridded Time Series (GTS)** in high resolution (100m) maps (WRB/WRG files) in a large area, can help to tackle those two problems.

OBJECTIVE

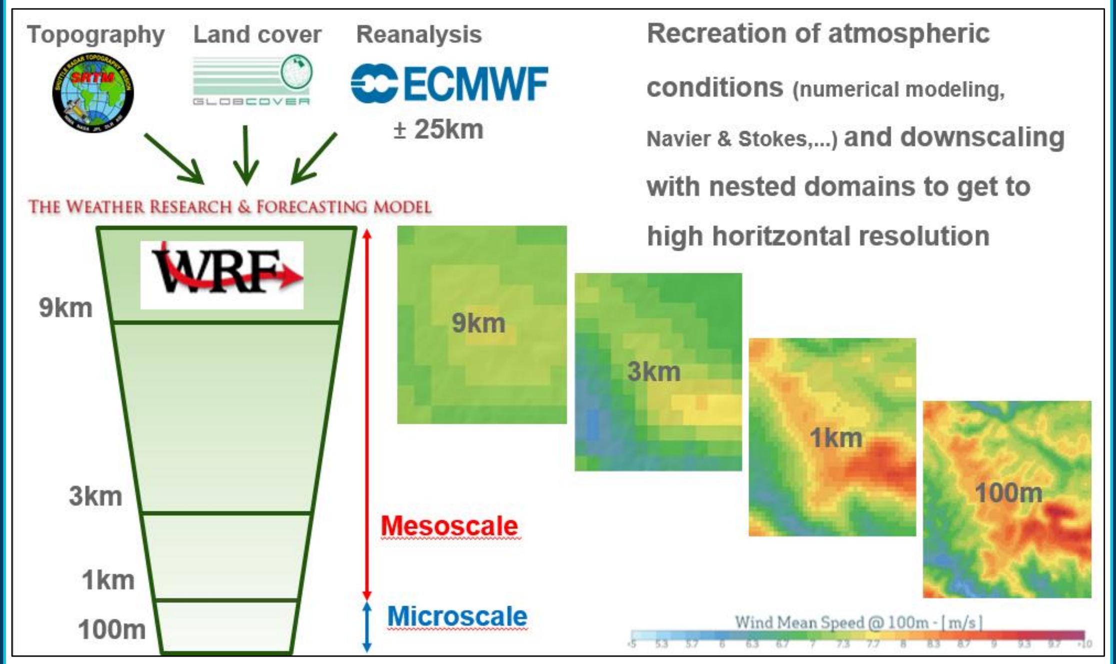
The goal is to obtain GTS the closest possible to each turbine position in the wind farm layout, as complement of LiDAR measurements, to estimate the Energy Yield.

METHODS

A key limitation of the current horizontal extrapolation methods is that the spatial variation is not easy to predict. Assuming that wind conditions at LiDAR will be the same in the whole area is far from reality although this is not as critical in offshore sites as in onshore.

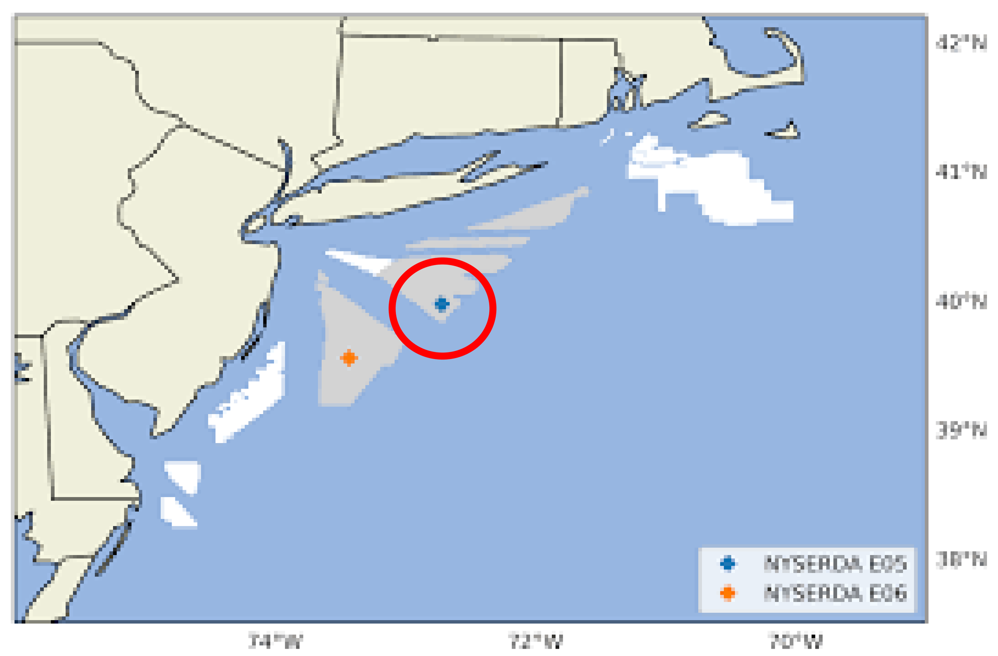
Downscaling climate wind conditions up to 100 m horizontal resolution through a nesting down procedure. Data available at all heights from 50m to 300m for a wind shear profile analysis.

The atmospheric model includes a complete physics package to describe mechanical and thermal drivers of wind regime turbulence and speed-up effects affecting flow



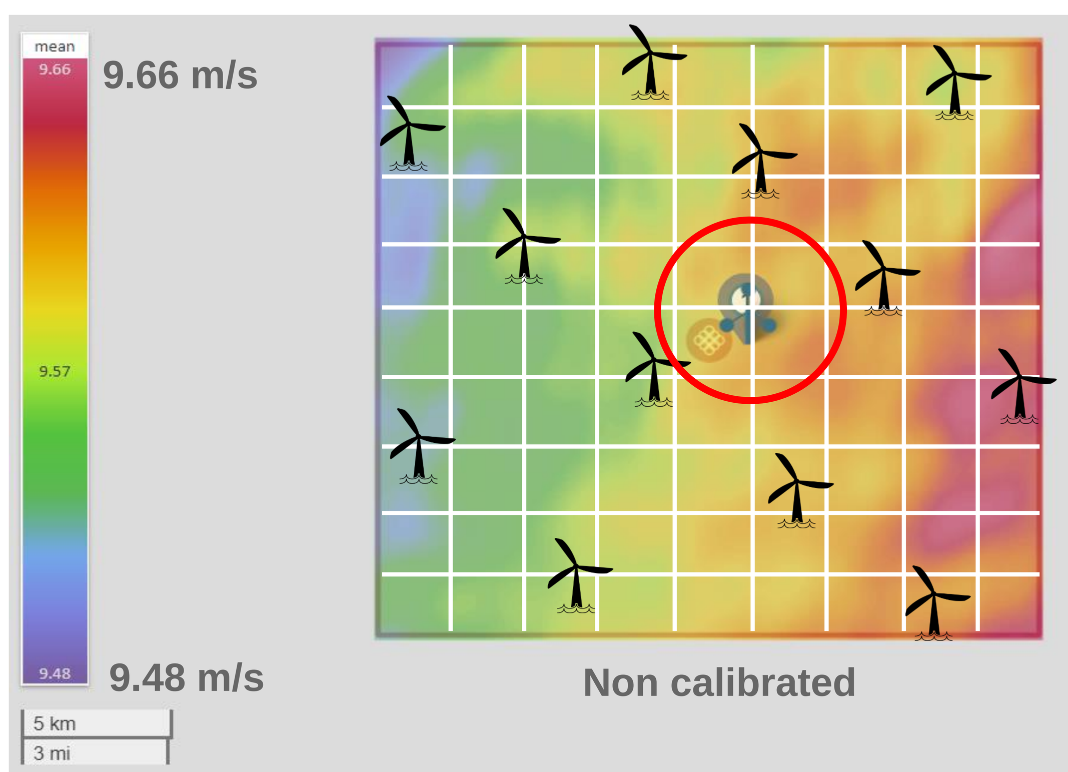
RESULTS

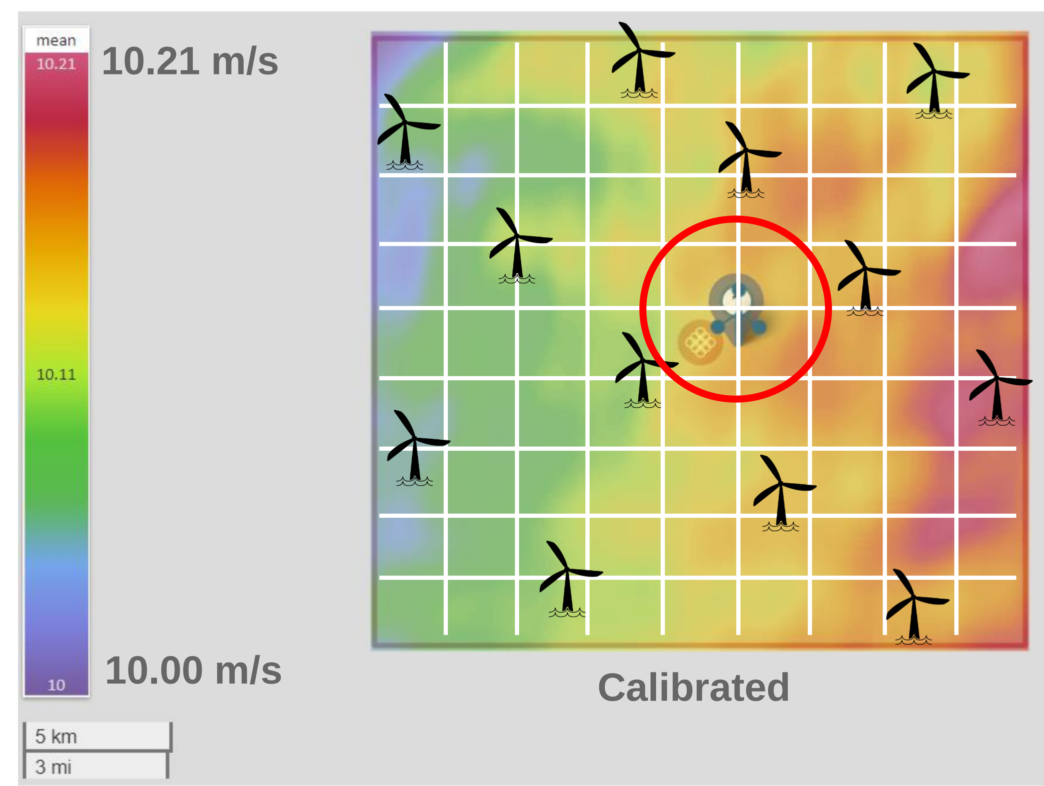
Public data available at **NYSERDA E05 buoy** (39.97◦N, 72.72◦W and 114km distance from coast) was used for 4D remodeling (time & spatial) to improve wind resource grid at all time steps. **One year of data (2020) at 140m height** was considered as potential hub height for future wind turbines



The 500km2 area where the simulation was done. The E05 buoys is in the central spot of the area

These turbines are a possible layout to illustrate that **30-min GTS can be obtained at each turbine position**





These are Mean Wind Speed maps. However,…

- *Wind Direction*
- *Temperature*
- *Density*
- *Pressure*
- *Richardson Number*
- *RMOL*
- *Inverse Monin-Obukhov Length*
- *TI(15m/s)*
- *Mean TI*

…can also be obtained

Some plots…

```
#VORTEX FDC(www.vortexfdc.com)
#Lat=40.0128908  Lon=-72.7597046  Hub-Height=140  Ti
wind is calibrated in the computation . Other variab

YYYYMMDD HHMM   M   Dir  T    P        RMOL      RI

20191231 2000 12.59 277 07.1 987.7 -0.00973  -1.117
20191231 2030 12.16 272 07.2 987.7 -0.00870  -1.021
20191231 2100 12.18 267 07.3 987.6 -0.00748  -0.725
20191231 2130 11.83 261 07.5 987.5 -0.00671  -0.439
20191231 2200 11.73 257 07.7 987.3 -0.00549  -0.343
20191231 2230 11.94 256 08.0 987.1 -0.00458  -0.192
20191231 2300 12.35 258 08.2 987.1 -0.00380  -0.156
20191231 2330 13.25 263 08.3 987.1 -0.00305  -0.170
20200101 0000 14.87 275 08.1 987.1 -0.00290  -0.217
20200101 0030 15.84 290 07.4 987.2 -0.00408  -0.982
20200101 0100 15.10 298 06.6 987.2 -0.00641  -1.943
20200101 0130 14.76 302 06.1 987.2 -0.00824  -2.107
20200101 0200 14.98 304 05.7 987.2 -0.00870  -2.059
20200101 0230 15.38 304 05.3 987.2 -0.00885  -1.960
20200101 0300 15.70 305 05.0 987.5 -0.00885  -2.525
20200101 0330 15.77 304 04.6 987.7 -0.00900  -2.567
20200101 0400 15.78 304 04.4 988.0 -0.00916  -2.607
20200101 0430 15.70 303 04.1 988.0 -0.00946  -2.662
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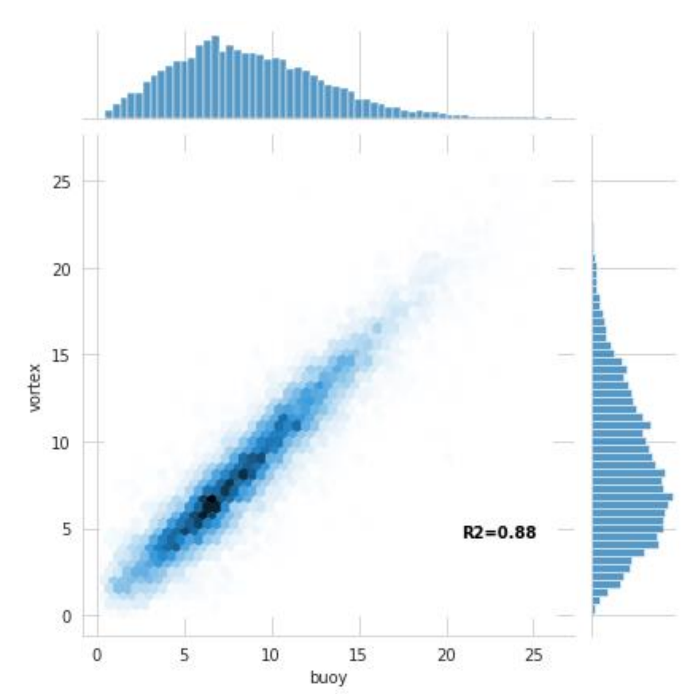

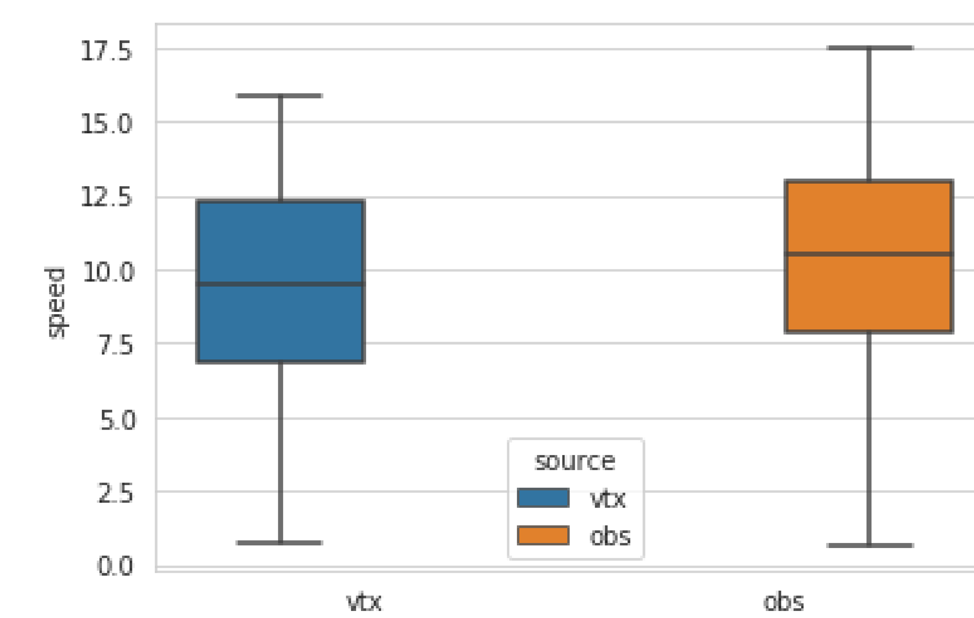

CONCLUSIONS

One-year of 30-min GTS at 100m resolution allow a full time-evolving representation of the wind conditions in a site since wind blows different all through the year.

GTS allow a very accurate seasonality analysis (e.g., wrg/wrb files for day/night or winter/summer) that also can be useful for curtailment strategies.

GTS can be calibrated (remodeled) in the time domain (not a bias correction) with LiDAR measurements which makes this tool ever more powerful. This 4D (time & space) remodeling improves the modeling and it benefits of using multiple LiDAR (or met masts) if available.

The one-year of data can be either selected by user (e.g., 2020, as in this poster) or, when no measurements available, it can be representative of the long-term using the 'One-year rolling method' where a 20y Time Series (3km horizontal resolution) is calculated at the same site. Several statistics are then derived, such as the global and seasonal wind speed and the windspeed and direction distributions for the full period (climatic values). The same statistics are calculated for a one-year subset, moving this period in one-day steps. A final optimization process is done to select the one-year period that minimizes the differences.

ACKNOWLEDGEMENTS

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