A comparison of short-term weather forecast with the measured conditions at the Hywind Demo site

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Abstract

Operations at the floating wind turbine Hywind Demo site have been challenging due to weather forcast that fails, especially for strength and direction of the ocean current. This work is comparing short-term weather forecast with measured data from a Seawatch buoy. It is found a low correlation for currents. For wind and waves the correlations are relatively good. It is shown that one year of weather forecast data give a reasonable estimate of which loads an object will experience at the site. Exceptions are that stronger surface currents will most likely occur and lower waves are to be expected.

Forecast methods

The weather forecast are provided by the Norwegian Meteorological Institute (MET Norway). The predicted data are result of short-term forecast models that have been run once a day for currents, and twice a day for wind and waves. All the models predict the weather +1, +2, +3 etc. hours ahead.

- *The atmospheric model* is called UM1 and covers the Hywind area on a 1 km scale.
- *The wave model* Simulating Waves Nearshore (SWAN) is used at this site. The model has a mesh size of 500 m x 500 m.
- *The ocean model* MET Norway used was a version of The Princeton Ocean Model (POM), called MI-POM, having a mesh size of 1.5 km.

The Seawatch buoy

In 2009, the Seawatch buoy was installed 200 m west of Hywind Demo, positioned south-west of Karmøy. The following metocean parameters are measured by the sensors printed in italics.

- Wind speed, direction and gust at 3.5 m above the sea level. *Yound, 85106-19 Ultrasonic*
- Wave height, period and direction relative to mean sea level. *Seatex, MRU-4*
- Current speed and direction, from 3 to 180 m depth. *RDI, ADCP 150 kHz - Sentinel*

Offshore operation

To perform an operation at the Hywind Demo site, a significant wave height of 1.5 m is the upper, permissible limit. A common practise is an upper limit of wind speed at 12 m/s. For comparison has current speed below 0.7 m/s been plotted.

Result

Parameter	r_{+3}	r_{+24}
Wind speed 10 m	0.88	0.82
Significant wave height	0.94	0.92
Current speed 10 m	0.34	0.34

Table 1: ***The correlation coefficients between the weather forecast +3/+24 and the measured values.***

Wind

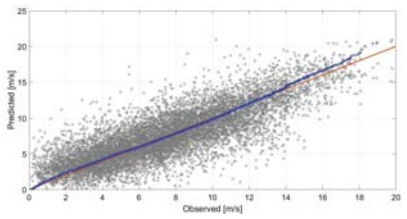

Figure 1 : ***A comparison of wind speed data at 10 m height, forecast +24 (UM1). Grey dots - scatter plot, blue dots - q-q plot and red line - observation equal to forecast.***

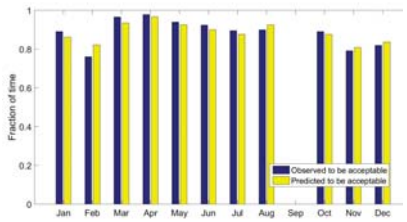

Figure 2 : ***The fraction of time the wind speed at 10 m height is less than 12 m/s, forecast +24 (UM1).***

Wave

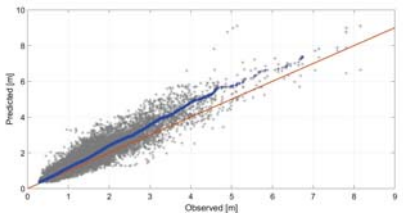

Figure 3 : ***A comparison of significant wave height data, forecast +24 (SWAN). Grey dots - scatter plot, blue dots - q-q plot and red line - observation equal to forecast.***

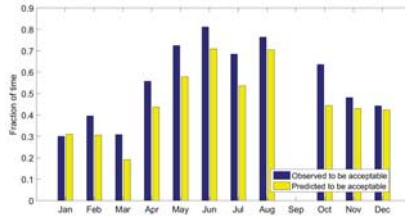

Figure 4 : ***The fraction of time the significant wave height is less than 1.5 m, forecast +24 (SWAN).***

Ocean current

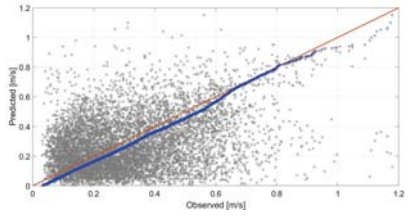

Figure 5 : ***A comparison of current speed data at 10 m depth, forecast +24 (POM). Grey dots - scatter plot, blue dots - q-q plot and red line - observation equal to forecast.***

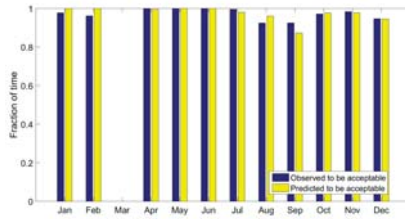

Figure 6 : ***The fraction of time the current speed at 10 m depth is less than 0.7 m/s, forecast +24 (POM).***

Conclusions

- The forecast of wind is relatively good.
- The forecast of waves is relatively good, but lower waves are to be expected.
- The ocean model POM is unreliable and struggles with estimating strong currents.

References

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