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Wind Forecasting in a marine environment (WRF and GFS)

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Here we investigate, based on 3 months of observations carried out with a wind lidar from 126 to 626-m height at the $FINO_3$ research platform in the North Sea, the ability of the Advanced Research version of the Weather Research and Forecasting model (WRF) to simulate the changes in the observations ahead of time (lead time). WRF simulations performed in both analysis as well as forecasting mode will be presented.
In the analysis mode, the model was nudged towards ERA-Interim Reanalysis Data (ERA) boundary conditions available every 6 hours. The simulations were initialized every 10 days. When the model is run in forecast mode, it was nudged towards the Global Forecast System (GFS), a weather forecast model developed by the National Centers for Environmental prediction (NCEP). Forecasts are available every 6 hours. Forecasts with 10 min output were performed every 6 hours up to a forecast horizon of 8 days.
It is common knowledge that the atmosphere is inherently chaotic at both small and larger time scales with some intermediate regime where predictability can be demonstrated. The chaotic nature at the smaller time scales is predominantly caused by turbulence and the larger scales by the limit in predictability caused by the non-linearity of the Navier-Stokes equations.
Taking a correlation coefficient of 0.6 as a lower limit for skills in the simulations corresponds to a turbulence limited lead time of about 4 hours for both wind speed and direction in both types of model simulations. This value is larger than typically found over land - being about 2 hours. The difference is likely related to the marine conditions of the measurement site, with minor daily variation of the atmospheric conditions but the variability is to a larger degree controlled by the prevailing synoptic conditions.
For the simulations in the forecast model (GFS) when the predictability is limited by the non-linearity of the Navier-Stokes equations, a correlation coefficient of 0,6 was found at about 6 days for the wind speed and somewhat smaller – about 4 days for the wind direction. Thus the window of predictability of the WRF/GFS forecasts is found to be in the interval 4 hours up to 6 days (wind speed) and 4 days (wind direction). The predictive skills are found to be a function of height; at a height of 626m it is better than at 126m.
It is often argued that for some parts of the time series the agreement between observations and simulations could be improved by shifting the time series of the model simulations. This has been investigated ad will be discussed.