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Rapid Wind - Rapidly updated forecasts for wind energy production

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Abstract

For the wind power industry it is essential to have a highly accurate wind forecast to reduce uncertainty when making wind energy production plans. In order to give precise weather forecasts, it is crucial to have an initial state of the weather model that is as close as possible to the corresponding true atmospheric state. This is done by data assimilation utilizing various observation types at given intervals, typically every six hours in operational models.

As the model resolution increases, and the model updates (cycling) are performed more frequently, observations of high temporal frequency and high spatial resolution are important. The project focuses on the use of these novel observation types. Further, these observations are assimilated in the model with a rapid update cycling, aiming at more precise timing of predicted weather events.

Additionally to the conventional observation types, radial wind measurements from weather radars, which are available at high temporal frequency (~ 15 minutes) and spatial resolution (500 meter), scatterometer data from satellites, and the 10 m wind observation network are used for the preparation of the next generation weather model for rapid update cycling.

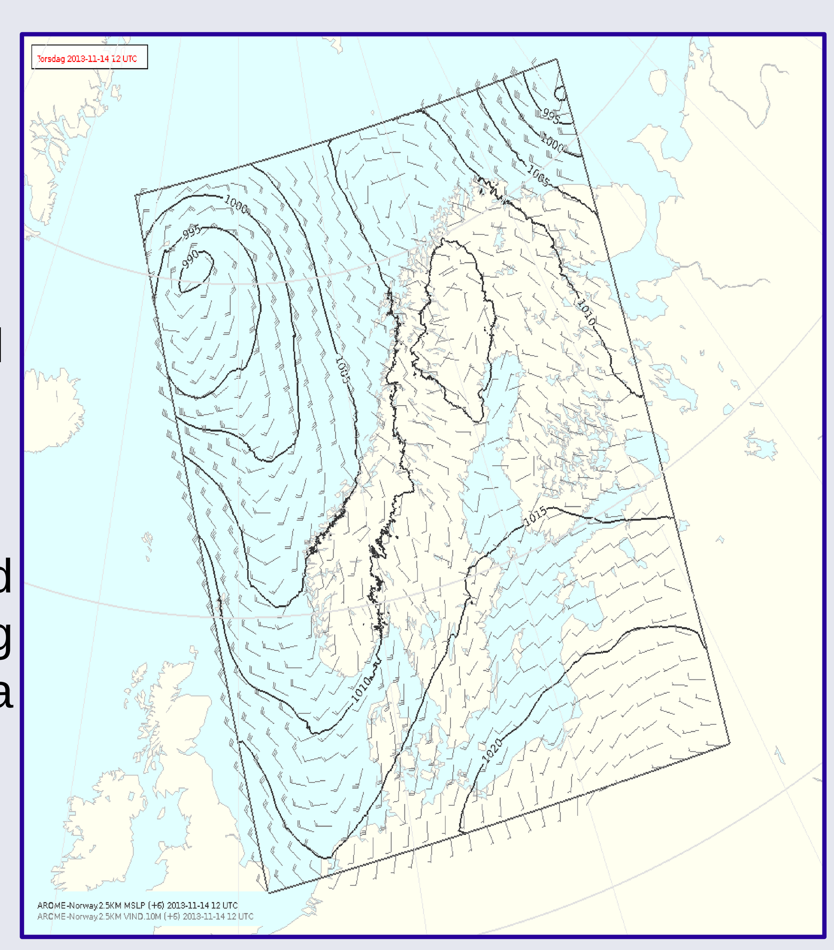
Objectives

The main objective of RapidWind is to improve wind forecasting by preparing an operational weather forecast model for Rapid Update Cycling (RUC) with 3 hour cycling, but even more frequent updates will be considered. Utilization of novel observation types will be developed, along with optimizations of the data assimilation system. The new NWP system is planned for operational use within the project period.

Weather prediction model

AROME-Norway

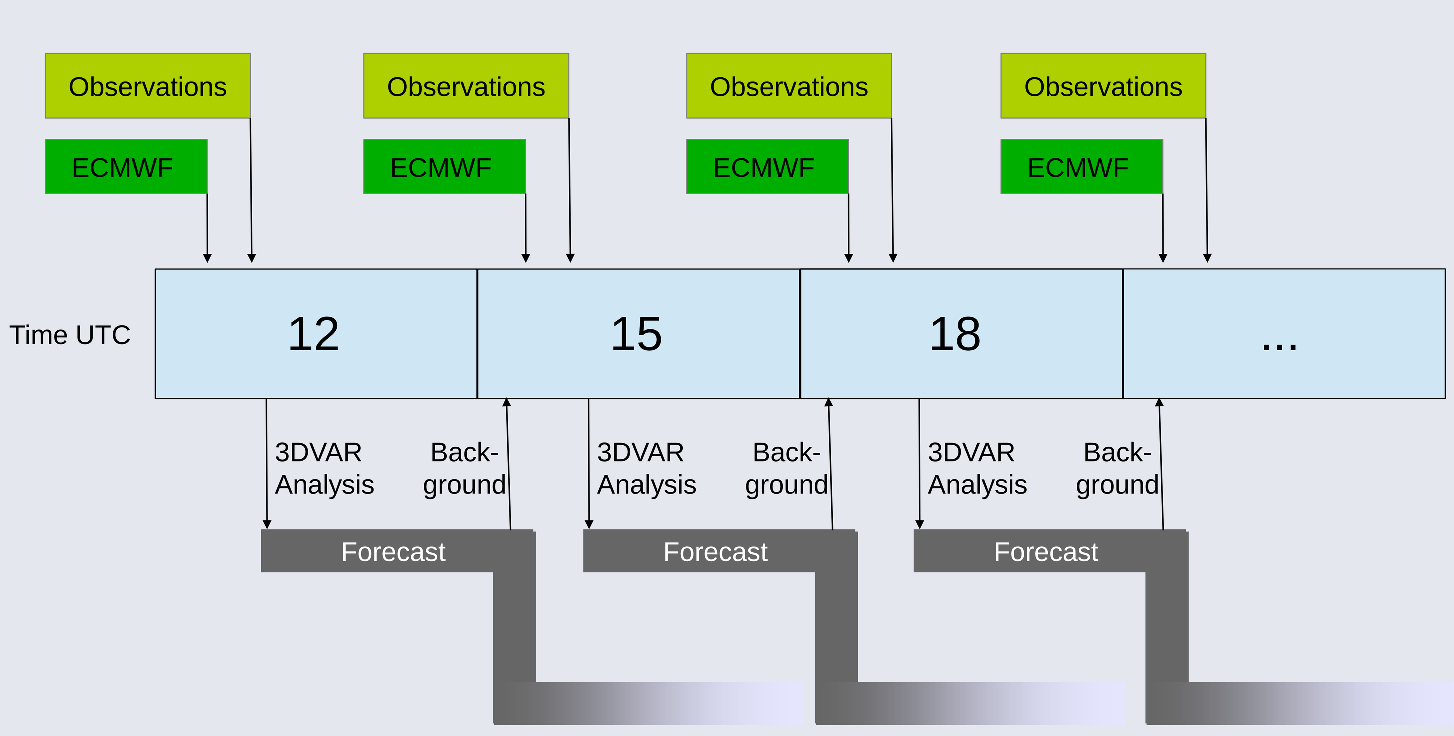
- operational since October 2013
- non-hydrostatic model
- 2.5 km horizontal resolution
- 65 vertical levels
- surface data assimilation
- analysis obtained by blending host model
- from April 2014 planned 3DVAR data assimilation with 3 hour RUC



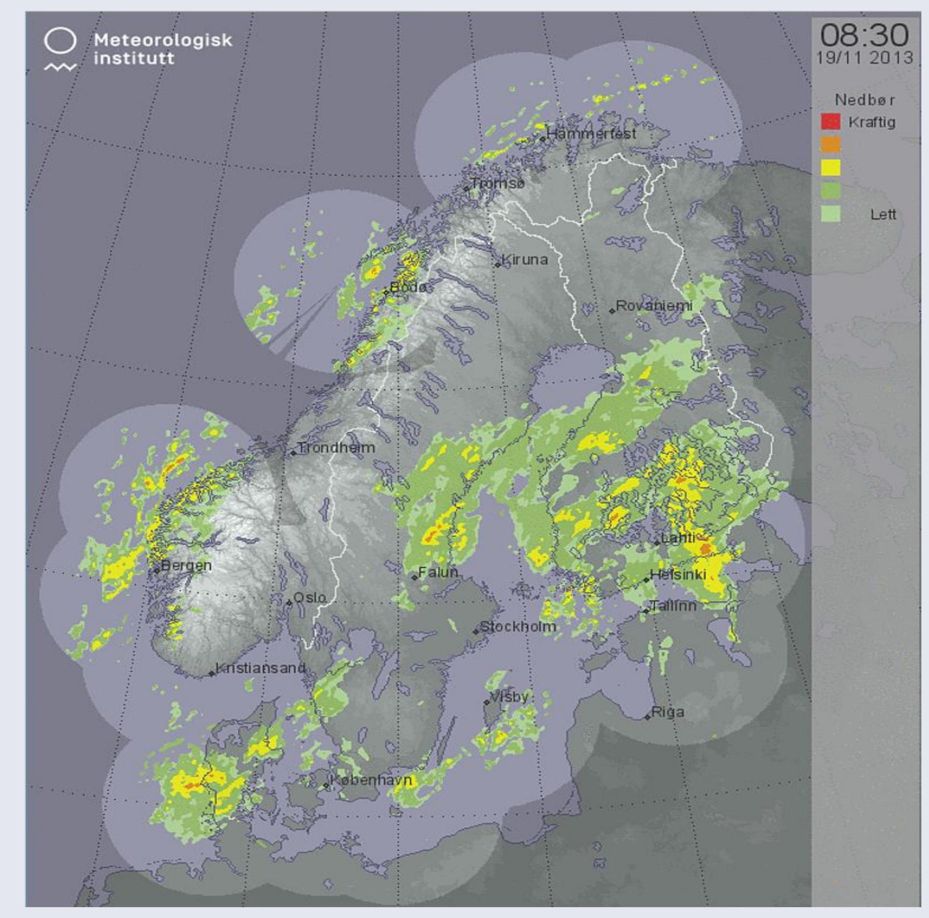
In order to improve the forecast timing and intensity of the wind events, the following observation types will be included with a RUC:

- radar radial wind observations
- ASCAT scatterometer observations
- SYNOP 10m winds

Rapid Update Cycling



High-resolution observation types



Weather radars

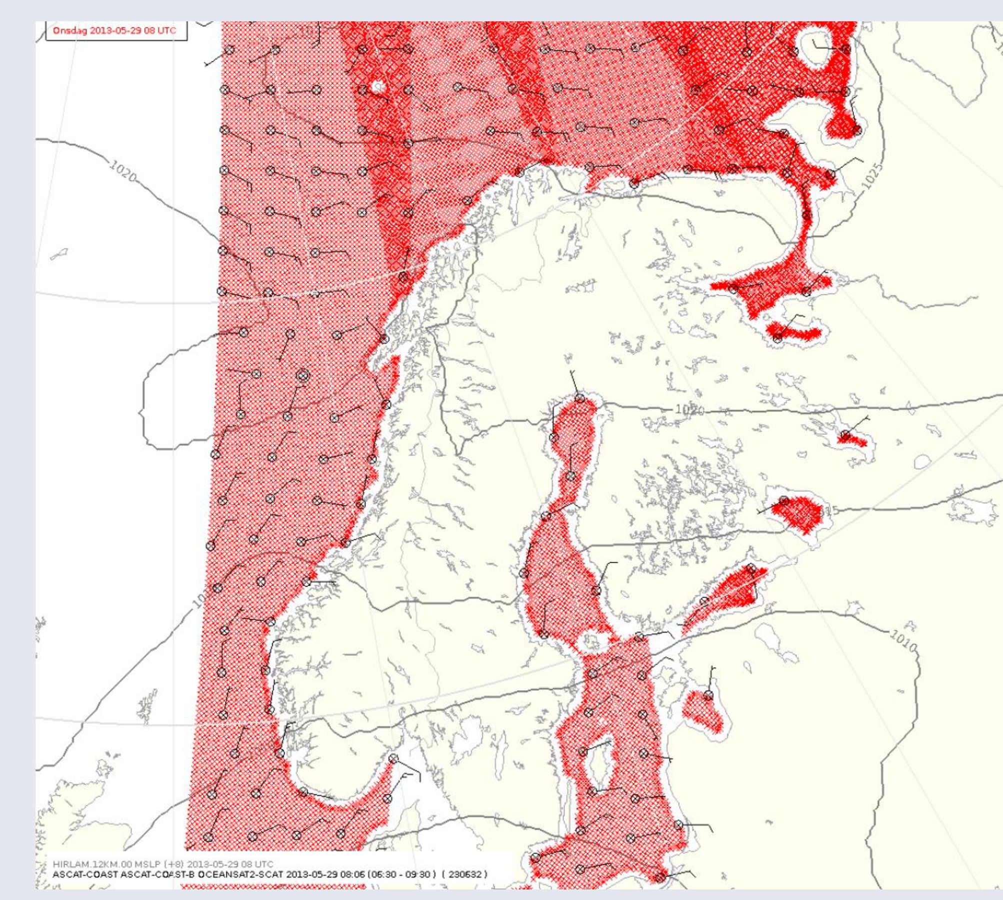
Weather radars do observe the radial wind component within precipitating systems and provide 3D information about the air circulation.
- Data from 9 Norwegian and 11 Swedish radars are available
- Observation of radial Doppler wind in a range of ~100 km
- spatial resolution of ~500 m and about 10 scan elevations
- time resolution 15 min. to 1 hour

Scatterometer winds

Satellite based scatterometers observe the roughness of the sea surface, which is used for surface wind retrievals.

- 3 satellite scatterometers are presently available; Metop-A, Metop-B, and Oceansat

- spatial resolution of 12.5 km
- improved coastal products



Summary & Outlook

Norway will face a period with rapid expansion in the wind power industry and more accurate forecasting will become increasingly important as we approach 2020. In the RapidWind project a limited area numerical weather prediction model is improved by decreasing the update cycling and including novel observation types which are available with a high temporal frequency, Previous studies showed that assimilation of radar data (Montmerle and Faccani 2009) give more realistic winds in the vicinity of radars and that radial wind assimilation shows noticeable improvements measured against near-surface observations of wind and humidity.

The current 3DVAR data assimilation system does not allow for a flow-dependent description of the error covariances. However, having appropriate error covariances is of great importance in order to allow for a proper conditioning of the upper air model state variables. Some successful attempts have been made to introduce weather regime dependent assimilation structure functions (Montmerle and Berre, 2010, Brousseau et al. 2012). It is planed to include such development in our current data assimilation system.

References

1. Montmerle, T. and Faccani, C. (2009) Mesoscale assimilation of radial velocities from Doppler radars in a preoperational framework. *Monthly Weather Review*, 137, 1939-1953.
2. Montmerle, T. and Berre, L. (2010) Diagnosis and formulation of heterogeneous background-error covariances at the mesoscale. *Quarterly Journal of the Royal Meteorological Society,* 136, 1408-1420.
3. Brousseau, P., Berre, L., Bouttier, F., and Desroziers, G. (2012) Flow-dependent background-error covariances for a convective-scale data assimilation system. *Quarterly Journal of the Royal Meteorological Society,*138, 310-322.

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