Towards the Assimilation of Near-Surface Winds from Tall Anemometric Wind Farm Towers

Joël Bédard[a], Stéphane Laroche[b], and Pierre Gauthier[c]

[a] *Department of Earth and Atmospheric Sciences, UQAM, Canada, bedard.joel@gmail.com,*
[b] *Data Assimilation and Satellite Meteorology Section, Environment Canada, Canada,*
[c] *Department of Earth and Atmospheric Sciences, UQAM, Canada.*

Hourly wind power prediction plays a key role in the integration of wind power in an energy production network comprising different energy sources. The ability to predict hourly wind power up to 48h lead time relies on accurate Numerical Weather Predictions (NWP) of near-surface winds. Although increasing the resolution of NWP model helps to improve the forecast skill in the lower troposphere, the main sources of forecast errors are still the analysis inaccuracy due to the limited number of near-surface wind observations assimilated, the atmospheric boundary layer modeling, and the growth of large-scale phase and amplitude errors in the analyses.

The main objective of this project is to improve lower tropospheric analyses by assimilating near-surface wind observations from 80m anemometric wind farm towers, as well as 10m wind observations from operational surface stations in the hybrid ensemble variational data assimilation system (EnVar) developed at Environment Canada. To achieve this, it is necessary to complete: 1) an evaluation of near-surface flow correlation with the upper air atmosphere; 2) the estimation of the background error covariances prescribed for use in the assimilation system; 3) the development of an observation operator including a statistical representativeness error correction; and 4) a validation of the method where observation system experiments are performed using near-surface wind observations and verified against non-assimilated collocated radiosondes to assess if the vertical corrections concur with observations.

The background error statistics used in EnVar comprises a stationary homogenous component, as in a 3D-Var, and a flow dependent component from the Ensemble Kalman Filter (EnKF). Preliminary results show that the vertical structures of variances from the stationary homogenous and EnKF components are quite similar, except near the surface where the EnKF background error statistics underestimates the wind, temperature and surface pressure variances. This can be attributed to the fact that the surface analyses are currently not perturbed in the EnKF. However, the cross-correlations are more pronounced in the flow-dependent component and thus, its multivariate impact for single near-surface observation is significantly higher in the vertical for all prognostic variables. This investigation also reveals that the vertical structure of error correlations in the EnKF depends on the local atmospheric stability. However, these results are sensitive to the ensemble size. Even when using 192 members, localization is still needed as spurious long-distance error correlations appear in the original covariances due to poor sampling (especially over complex terrain). Nevertheless, the EnKF tends to capture dynamical features (e.g. coherent tilted increments associated with baroclinic structures) and the temporal correlations enable the analysis increments to evolve with the meteorological system.