

SPECIAL PROJECT FINAL REPORT

All the following mandatory information needs to be provided.

Project Title:	Development in HARMONIE model framework - adoption of new observational network (NetAtmo) in data-assimilation
Computer Project Account:	spnolabo
Start Year - End Year :	2020 - 2021
Principal Investigator(s)	Anette Lauen Borg
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The following should cover the entire project duration.

Summary of project objectives

(10 lines max)

The objective of the iOBS (improved observation usage in NWP) project is to investigate the potential impact of high resolution crowd sourced observations on numerical weather prediction. In iOBS the focus has been on surface pressure from Netatmo stations in the Nordic countries. A large part of the project has been to develop quality control for which several methods, including machine learning methods, were tested. The quality controlled observations were then introduced to the NWP model. Several experiments were run to compare the different datasets, trying different observation errors, different bias correction methods among a few other things.

Summary of problems encountered

(If you encountered any problems of a more technical nature, please describe them here.)

In general the experiments run under the special project have been progressing fine. The only problem has been that the progress has been very slow. At times it has taken one day, or even more, to produce one day of forecasts. This is mostly related to access to MARS but also long times for jobs in the queue.

Experience with the Special Project framework

(Please let us know about your experience with administrative aspects like the application procedure, progress reporting etc.)

Nothing to report

Summary of results

(This section should comprise up to 10 pages, reflecting the complexity and duration of the project, and can be replaced by a short summary plus an existing scientific report on the project.)

In the iOBS project the potential of using crowdsourced observations to determine the initial state of a NWP model has been demonstrated. In order to do so, a new observation type for Netatmo surface pressure has been introduced to the NWP data-assimilation system Harmonie-Arome. The large amount of observations in a crowdsource data set of observation, like Netatmo data, puts new demands on the quality control. Especially since there is no possibility for users, like national weather centers, to control how and where the sensors are placed; the insight into the calibration, maintenance of the instruments and their exploitation is also limited. During this project three different methods of quality control were tested, one basic method and two involving machine learning. The results show that the machine learning approaches were rather similar but produced better results than the basic method.

The results show that for all parameters but mean sea level pressure there is a neutral impact. For MSLP a rather large bias is introduced by the Netatmos observations. To account for this in the analysis two ways of on-line estimation of biases for the Netatmo observations were studied. One “traditional” starting from zero bias coefficients (CSTART_ZERO) spinning up for a long time and one new method that starts with bias coefficients equal to the first guess departure at the first assimilation cycle (CSTART_MODE). Unfortunately the experiment with a long spin up time (CSTART_ZERO) was not ready at the time of this report so all results that are presented concern estimation of the bias based on the CSTART_MODE method. The results indicate that even if this method starts with rather reasonable values of the bias coefficients some spin up is still needed. One possibility to refine the methodology further is to apply passive assimilation in combination with CSTART_MODE for some period when a new Netatmo station appears. The passive assimilation experiment using CSTART_ZERO option indicates that two-three weeks of passive assimilation are enough to stabilise the estimates of the bias correction coefficients. As one could see from the passive assimilation experiment the quicker convergence of the bias estimate can be achieved by adjusting the parameter controlling the memory of the bias coefficient.

In an attempt to increase the impact of Netatmo observations the observation error, σ_o , was decreased compared to the original settings. This leads to an even larger bias in the resulting scores. The reason for this is that with a smaller observation error the analysis adjusts more to the observations. In this case the observations are equipped with a bias so the resulting bias will be larger. A smaller observation error in combination with a longer spinup of the VARBC coefficients may produce better scores. This will be tested in future experiments.

An increased resolution/density of Netatmo observations (from 20km to 10km) was also tested to increase the impact of the Netatmo stations. The results do not show any improvement or degradation of the results. One reason for this, which also is a general difficulty when trying to extract information from high density observations, is that the 3Dvar assimilation system as used here is not really designed to handle such observations. It is difficult to utilise the full potential of such a high resolution dataset with 2.5 km grid distance and 3 hour cycling. Another “problem” is the structure functions used. The structure functions determine, among a few other things, how the information from observations are spread in space around the observations. In a 3Dvar system the structure functions are fairly coarse, homogeneous and isotropic, meaning that the information is spread equally in all directions around the observation, regardless of the orography or large scale flow pattern. A way forward would be to use advanced flow-dependent data assimilation methods with non-homogeneous error structures. As a first step Netatmo observations will be introduced in the 4Dvar assimilation system developed for HARMONIE. Later various ensemble based methods should be evaluated with Netatmo observations included.

A full report describing the experiments, quality control and results in more detail can be found in:
https://drive.google.com/file/d/1y2F6uFmdvWQ_eVKPIXb_roinS-Dt4XJ5/view?usp=sharing

List of publications/reports from the project with complete references

Future plans

(Please let us know of any imminent plans regarding a continuation of this research activity, in particular if they are linked to another/new Special Project.)

Several additional experiments will be performed in order to try to improve the impact of the observations from the Netatmo stations. This will not be linked to any new special project.