OPTIMISING THE EXPLOITATION OF AEOLUS WINDS IN REGIONAL NWP

Susanna Hagelin[1], Gert-Jan Marseille[2], Roohollah Azad[3], Martin Ridal[1], Ad Stoffelen[2], Harald Schyberg[3], Isabel Monteiro[2]
[1]SMHI, [2]KNMI, [3]Met Norway

INTRODUCTION

The aim of this project is to find the optimal settings for assimilating Aeolus L2B HLOS winds in regional models. We will use the regional model Harmonie-Arome, using 4DVar data assimilation. We will test the impact of Aeolus observations over two domains, Arome-Arctic and UWC-West (see Fig.1). The more Northern domain is chosen to have many Aeolus overpasses, whereas the UWC-West domain is chosen to be more representative of a typical mid-latitude domain. In order to maximise the impact of Aeolus, we will focus on periods of strong winds, which means that the experiments for Arome-Arctic will run over a period with many polar lows (Nov-Dec 2019) and the experiments over UWC-West will be run for February 2020 to coincide with winter storms Ciara and Dennis.

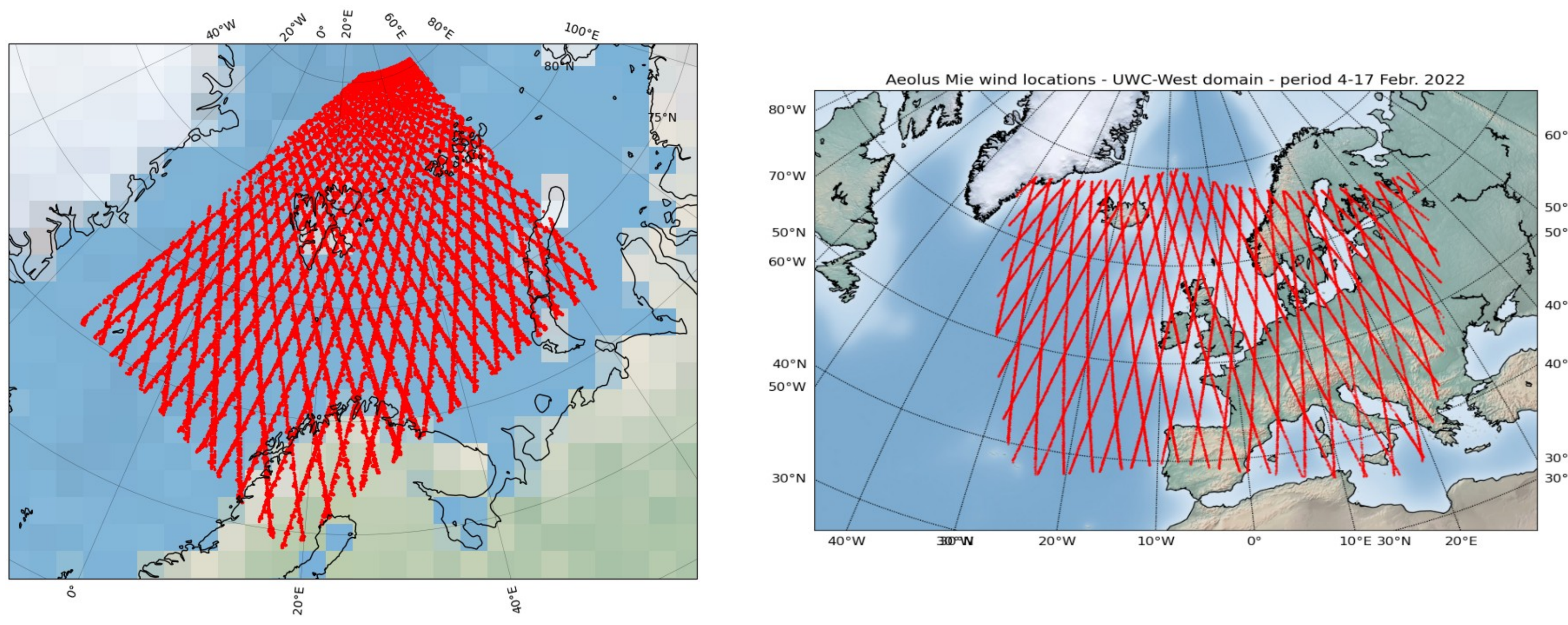

Fig.1: Domains used in this study, Arome-Arctic (left) and UWC-West (right) and the available Aeolus overpasses during the study periods.

IMPACT OF LATERAL BOUNDARY CONDITIONS

The Aeolus Observation System Experiment (OSE) performed at ECMWF for the second reprocessed dataset consists of two experiments, one with and another without Aeolus assimilation in the ECMWF DA system. Arome-Arctic uses the ECMWF forecasts as boundary conditions, and we decided to use this dataset to study the impact of assimilating Aeolus winds in the host model on the analyses in the Arome-Arctic. We also ran two experiments for Arome-Arctic, one with and the other one without Aeolus assimilation in the global ECMWF model used as boundary and initial conditions. We decided to run these experiments using 3DVar because the OSE forecasts were archived only for specific lead times in MARS and we could only use the 3h forecasts from the global model.

Fig. 2 (left) shows that the O-B and O-A slightly decrease with the Aeolus assimilated in the global model and fig 2 (right) shows the normalised differences and confirms that the region with the most positive impact is between 400-800 hPa.

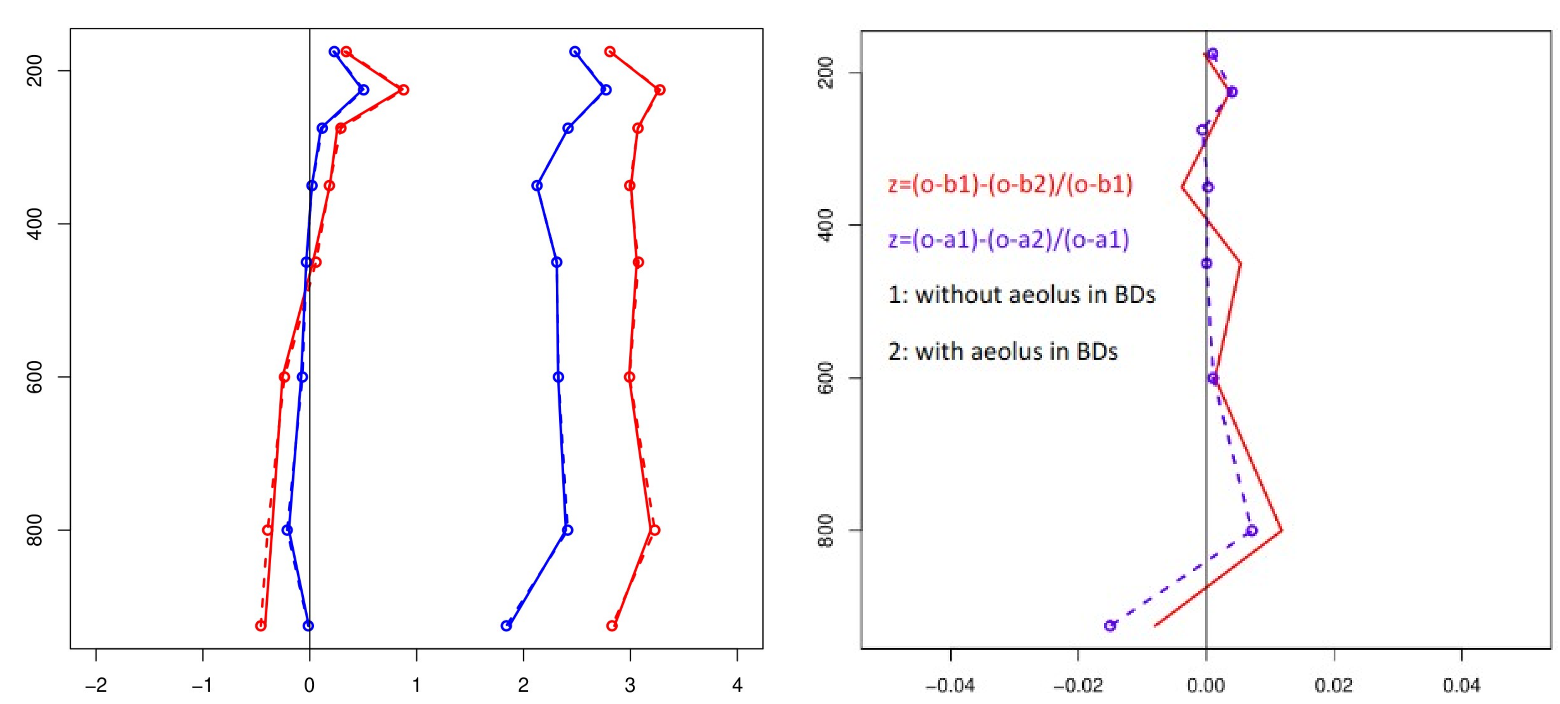

Fig 2: left – the bias and standard deviation of O-A (blue) and O-B (red) for Arome-Arctic with (dashed lines) and without (solid lines) in the driving model. Right – relative O-A (dashed blue) and O-B (solid red) standard deviation for the same experiments

ONGOING WORK AND FUTURE PLANS

During the rest of the project we aim to continue to run further experiments over Arome-Arctic to find the optimal strategy of Aeolus data usage, mainly the amount of error inflation needed to avoid the need of data thinning. Once these settings are found, we want to evaluate them on the larger and more computationally heavy UWC-West domain.

INITIAL EXPERIMENTS

Since the Arome-Arctic domain is smaller and there are more Aeolus overpasses over this domain, we decided to do our first investigations using this domain. First we ran a series of four experiments, one control experiment (which also provided the warm start files for the other three experiments), one using all Aeolus data and two using only either Mie or Rayleigh data. The experiments were evaluated for the period 25 Nov to 15 Dec 2019. From these we could see that assimilating Aeolus observations decreases the O-B and O-A. The top row of figure 3 below shows the relative O-B where O is either radiosonde (left) or aircraft (right) for these experiments. The bottom row shows the vertical distribution of the available observations from radiosondes, aircraft and Aeolus.

Above 600 hPa there is a positive impact using when adding the Aeolus observations, but at lower altitudes the impact is less good, in particular for the Mie data.

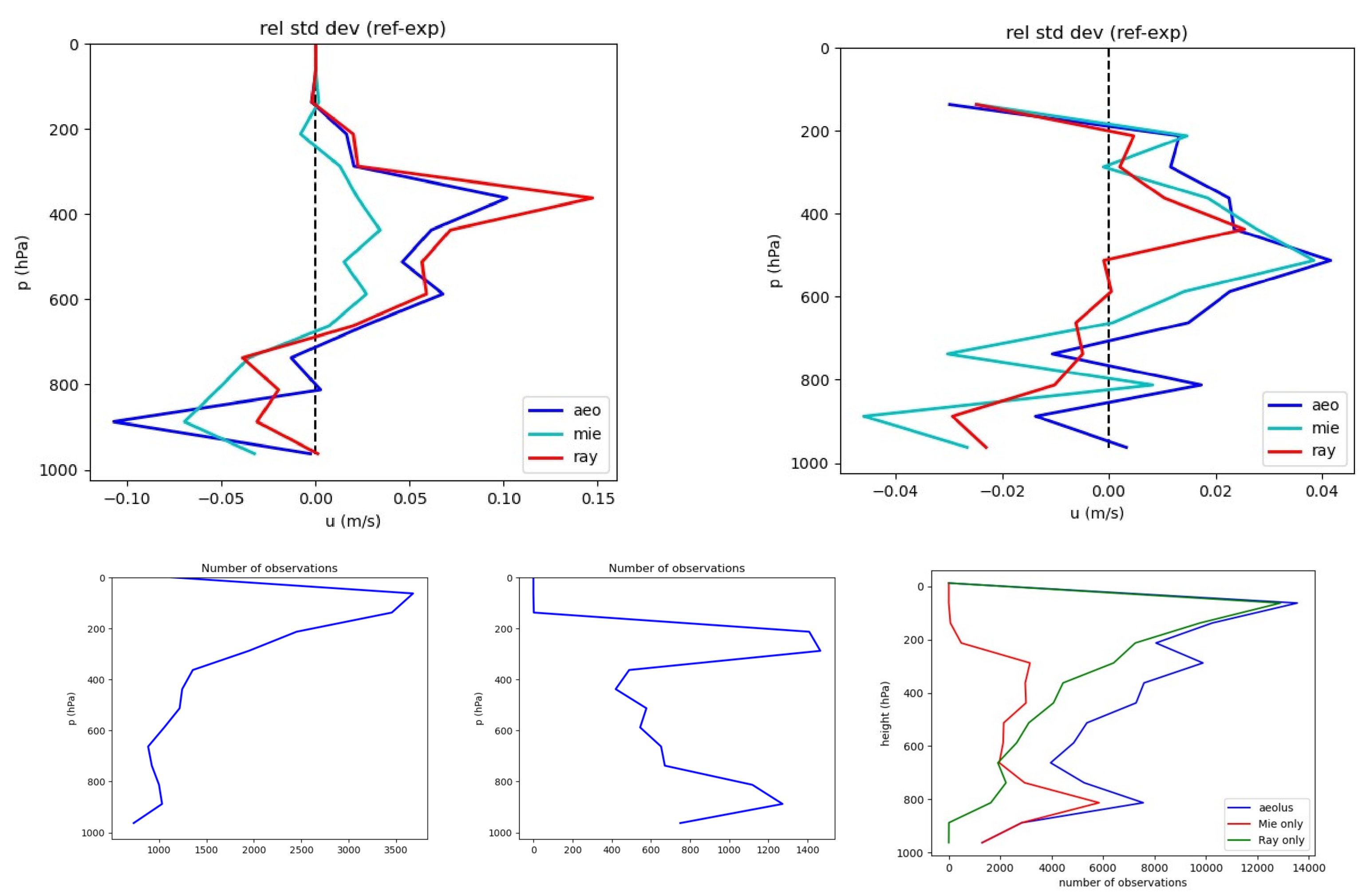

Fig.3: top – relative O-B of radiosonde (left) and aircraft data (right) for the three Aeolus experiments. Bottom – vertical distribution of all radiosonde, aircraft and Aeolus observations used in the experiments.

OBSERVATION ERROR INFLATION

A first set of experiments inflating the observation error to give the Aeolus observations less impact showed that we could decrease the negative impact near the ground, but at the same time we also reduced the positive impact at higher altitudes. Experiments with further revised observation error settings are currently running.

VERIFICATION

The Arome-Arctic domain is rather data sparse which makes verifying the forecasts a bit more challenging than for a more typical mid-latitude domain like UWC-West. Fig. 4 shows the verification of wind speed and temperature against the seven available radiosondes in the Arome-Arctic domain. For the sake of clarity we only show the bias and standard deviation for the reference experiment and the experiment assimilating all Aeolus observations. The verification is for the 6h forecast and we see a positive impact for both parameters in the standard deviation.

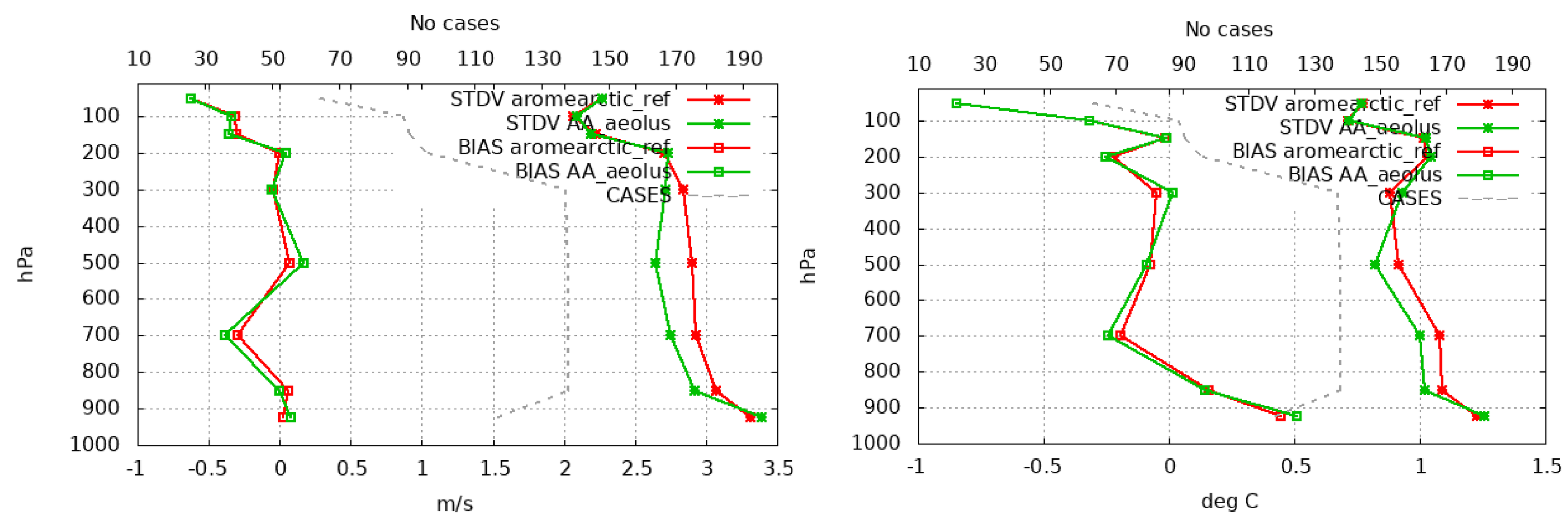

Fig.4: bias and standard deviation for wind speed (left) and temperature (right) for the reference experiment (red) and the experiment assimilating all Aeolus observations (green).

ACKNOWLEDGEMENT

This work is funded by the ESA contract: 4000137365/22/NL/IA