Hirlam Radar Working Week

9-13 may 2022

Report from the working visit by **Mats Dahlbom** and **Jana Sanchez-Arriola** to SMHI from where **Martin Ridal** and **Magnus Lindskog** participated. The working days were from 9-13 May 2022. Topics related to radar assimilation were discussed and worked with. The main topics, results and conclusions are summarised below.

1. A common quality control/monitoring/status update

A suggestion to have a common area,e.g. on the accord wiki, to report known issues with radar observations was discussed. It was agreed that it should be called “known issues” or similar not to confuse it with routine monitoring and quality control.

Magnus will set up a skeleton that can be filled with known problems. The list can then be gone through during, for example, the RT13/ST5 meetings to keep it up to date.

Similar information, wiki pages, will also be set up for other observations.

Action: Magnus to set up a skeleton wiki page - Done

https://opensource.umr-cnrm.fr/projects/accord/wiki/Radar_issues

2. Doppler winds Data Assimilation status

After the “radar revolution” which means to have a different size for super observations (SO) for reflectivity (refl) and wind (dow), good impact has been obtained for the MetCoop domain but not for the Aemet domain.

The cause of this was investigated by inspecting the quality and statistics of the French and Spanish radars separately.

It has been found by Aemet that higher elevation angles (french radars) are detrimental for Doppler wind assimilation for some cases. This will be more investigated.

Apart of this, two issues were detected with Spanish radars wind:

1) The obsvalues of the wind close to zero are missing for several spanish radars. Not all the time but it looks strange. The reason for this is not clear and will be investigated. It could be present already in the raw observations or introduced somewhere in the processing chain. (see Fig 1)

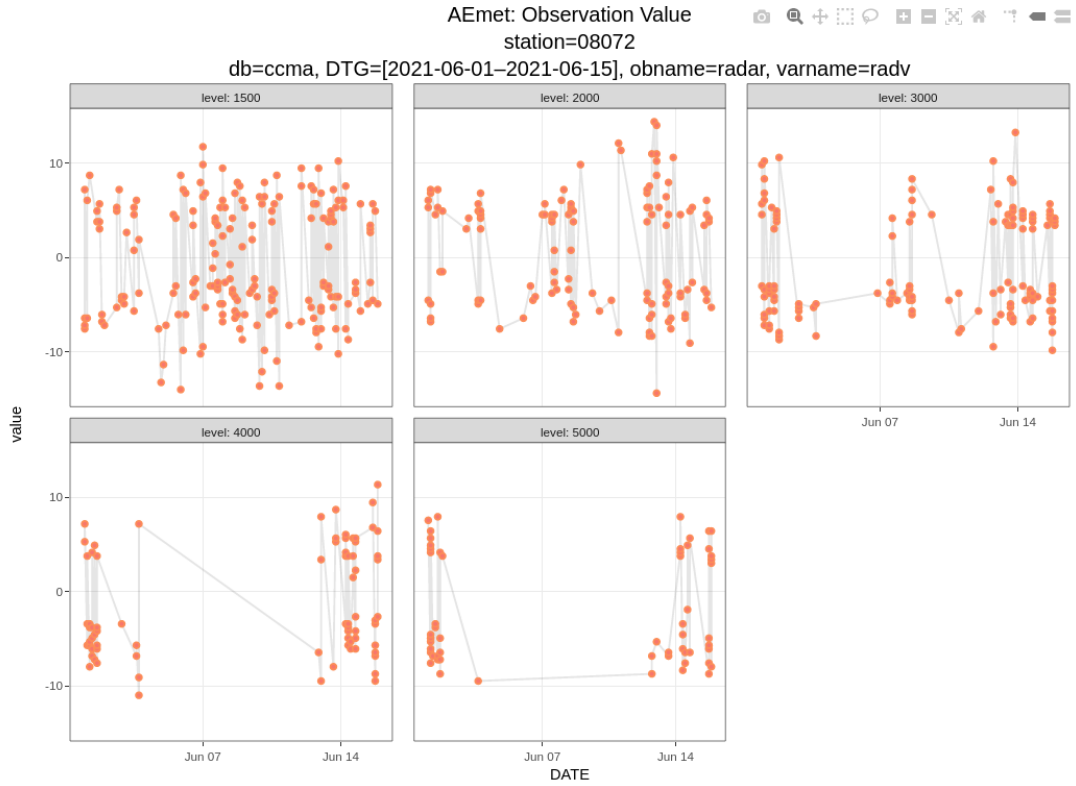

Figure 1. Time series of a Spanish radar from 1-15 June 2021.

2) When investigating the first guess departures for individual radars it was found that the Spanish radars do not present Gaussian histograms like expected. The number of observations is also much less compared to the French radars which also make the histogram difficult to believe but anyhow there is an indication that the data is not healthy and probably should not be used in the data assimilation. (see Fig 2)

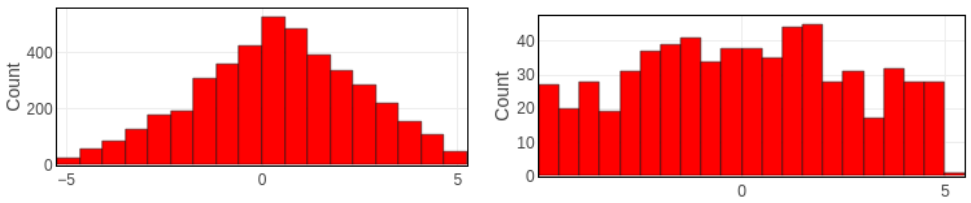

Figure 2. Histograms of observation minus first guess for a French radar (left) and a Spanish radar (right). The Spanish radar and the time span is the same as in Figure 1.

The number of wind observations has been compared to the number of relative humidity (rh) observations from radar for the Iberian domain and the number of dow observations is one order of magnitude lower than for rh. This does not happen for the MetCoOp domain. There the number of observations are more similar. Also the number of dow obs for Iberia is one order of magnitude lower than for MetCoOp when comparing the same period length.

Action: Jana will contact the radar responsible person at AEmet to see if this is a known problem and/or if the data sent to OPERA can be improved by sending to opera wind scan optimised winds together with reflectivity scans to include the quality index . And why are there so few wind observations?

Action: A new experiment will be run by Jana removing Spanish radar and using just French radars for winds and both for reflectivity. If the results show good impact the radar revolution settings will be tested again - done

Action: Jana will find a date/time with a lot of reflectivity observations from a radar in Spain. This will be investigated and run through the assimilation to get statistics. The reason is to check if the bad statistics is due to very few observations in this case or if it is a general problem - done

3. The future of preprocessing radar data, prepopera or HOOF

The future use of the two different preprocessing softwares within the HIRLAM countries (more or less) was discussed. Should we keep using prepopera, should we use HOOF or should we try to merge the two?

It was decided during this week to keep using and developing prepopera.

There are a few arguments to support this decision:

1. prepopera can handle files from the ODE (OPERA Development Environment, also called Baltrd) server as well as OIFS files (see below).
2. This is important considering the timeliness of the observations. OIFS is not useful for nowcasting (20 min after nominal time) while ODE is.
3. It is also important since lots of wind data that can be extracted from ODE ,cannot be extracted from the OIFS data files
4. Many Hirlam countries already use prepopera operationally. A switch would take time, manpower, and lots of testing would be needed to switch to a new preprocessing.
5. It is very likely that COPE/OOPS will change the framework for this part of the code in the foreseeable future.
6. We believe that cooperation can be equally efficient using two systems, exchanging ideas and methods. In fact this option could be more beneficial for everyone.

4. Preprocessing: prepopera.py preprocessing script

Part of the “radar revolution” is also an overhaul of the preprocessing script prepopera.py. The script is used to build super observations, check the sanity and filter radar files before entering the data assimilation. Examples of what was changed:

1. The code was cleaned
2. The use of wmoid numbers were removed.
3. All user settings were moved to the top of the script and will probably be moved to a namelist.

4. A few additional checks were introduced to make the script more stable and handle bad observation files.

These changes, especially nr. 2, were introduced since new radars are not given any wmoid number. At the same time it makes the scripts more easy to use, and leaves less possibilities for mismatch between other scripts used in the radar handling.

During the working days, the preprocessing code has been adapted to also be able to process OPERA data fetched from the OIFS server. The two data sources (ODE/OIFS) are different in the sense that the OIFS files contain all observations within 15 minutes in one file. At the ODE (OPERA Development Environment) server (previously known as the baltrad server) the files are divided into separate scans.

The script prepopera3.py reads OIFS data and the check for overlapping elevations makes sure that just one elevation is kept in case there are several elevations with the same, or a very close, elevation angle. This can lead to some elevations being observed at different times depending on the scan strategy. Maximum difference will be between 10-15 minutes so we assume that this is ok to use.

Depending on the scan strategy and how the data is sent to OPERA some wind data in the OIFS files cannot be used. The reason is that the wind scans do not contain any reflectivity information. This information is used for the quality control of the wind observations.

During the working week several attempts to solve this by building new volumes using winds and reflectivity from the same elevation angle and time were tried. It turns out however that this is not possible due to different resolutions and, in most cases, different scan angles.

In consequence, some countries like Spain, Poland, Norway etc won't find any wind data on the OIFS files.

Currently, there are limitations with the use of radar observations from OIFS. The main reasons, and reasons we should point out to OPERA (again) are:

- The best option would to disseminate one file per radar volume
- Any wind optimised scan should contain reflectivity with corresponding quality information
- Data should be made available with a timeliness of maximum 20 minutes.

Action: Martin will write a piece of code that removes data sets that are not quality controlled - Done

Action: Martin will investigate the possibility to use namelists.

Action: Mats will add the functionality in prepopera that, in case of several data sets, the dataset that contains both reflectivity and radial wind is selected. -Done

Action: Mats will improve prepopera by using file exception handling for detecting corrupt radar files (reported issue). This can cause problems for the NWP runs. - Done

Action: Martin will investigate the possibility to use the median instead of the mean to build the super observations for case studies with high winds.

5. Evaluation of OIFS/ODE

The two data sources for receiving OPERA radar data for use in NWP provide the same data but it is treated and presented slightly differently. As mentioned earlier the content is slightly different as well as the quality control. There will also be much less wind observations from the OIFS files. The ODE server, on the other hand, is not an operational service.

One of the goals of this working week is to have prepopera + Bator that can assimilate both options, ODE or OIFS, and have the option to switch between them.

It was discussed if one data source would be preferred as the primary source and, if so, if the other source is good enough to be a backup solution?

In order to answer this we will run a number of experiments. (Martin, Jana, Mats)

Some experiments will be performed:

1. Reference run without radar observations
2. Reflectivity from ODE files included
3. Reflectivity from OIFS files included
4. Reflectivity and winds from ODE files
5. Reflectivity and winds from OIFS files

This will be run for three domains, MetCoOp, AEMet, the Danish NEA domain.

Possibly also to run the same period using the HOOF software to preprocess the observations.

Possibly try to use the median of the super observations instead of the mean.

To do these experiments and to build in the choice of data source for NWP users the NWP code needs some updates.

Action: Add the variable “radar source” in scr/include.ass, scr/Bator and scr/Prepradar (Martin) - Done
Action: Test these changes in both 3Dvar and 4Dvar If technically works (Jana and Mats) - Partly Done

Action: Test to assimilate VRAD only data (i.e. not using qc information from reflectivity) if NI sufficiently high (as suggested by Gunther) (Martin)

6. Summary

All the goals set up for the working week were fulfilled. We identified a potential reason for the poor, or not so good, results from using radar winds in the AEMet domain. We improved the functionality of the pre-processing to read OPERA data from two different dissemination points. We also improved the functionality and stability of the preprocessing.

A possible publication about the radar radial wind usage was also discussed.

In general it was a very productive working week. It is so much more efficient and fun to sit together and work concentrated on one topic during a few days. Much work still remains but we all came to agreement on many points and we know what to do. Anyway if it were necessary we could meet again in a few months.

Special thanks also to Günther Haase, radar expert at SMHI, who spent a day answering all our questions with great patience.