OPERA – HARMONIZING THE EUROPEAN WEATHER RADAR NETWORK

M. Peura*, M. Martet, A. Huuskonen, L. Delobbe, B. Lipovscak, H. Leijnse, M. Lukach, and E. Saltikoff
FMI Helsinki, Finland, Meteo France, RMI Brussels Belgium, KNMI de Bilt The Netherlands

1. INTRODUCTION

The operational weather radar network in Europe covers more than 30 countries and contains close to 200 weather radars. The radar network is heterogeneous both in hardware, signal processing, and scanning strategy, thus making it fundamentally different from the NEXRAD network (Huuskonen et al, 2014). Within EUMETNET, the grouping of European Meteorological Services, the operational program for weather radar networking (OPERA) has been working since the 1990s on improving the harmonization of radars and their measurements. In addition, OPERA has facilitated and stimulated the exchange of radar data between its members, amongst others by the development of a radar data information model and jointly agreed data formats. Since 2011 a radar data center has been in operation producing network-wide radar mosaics from volumetric data. An essential part of the OPERA work is the documentation of the members' best practices in radar operation and data production, and the making of joint recommendations. The current programme phase, OPERA 4, covers years 2013-2018

2. QUALITY MONITORING AND IMPROVEMENTS

An important section of joint development in OPERA 4 has been development and assessment of tools for quality monitoring. Separate work packages concentrate on using the Sun for pointing accuracy monitoring, on using long-time accumulations for homogeneity monitoring, and on comparing radar data to gauges. For beam blocking, detection of residual clutter and vertical reflectivity profiles, the members have provided their national algorithms to be compared in a central environment. The idea is to test each of these algorithms on different radars across Europe, each with its own characteristics and settings (wavelength, scan schedule, etc.) and physical environment (climate, terrain, proximity to sea, etc.). This will yield information about the robustness and applicability of the different algorithms for such a diverse radar network, and it may ultimately lead to new algorithms being developed that incorporate the best parts of the different algorithms that were tested.

The compositing data hub has been running since 2012. In December 2015, the following algorithms were implemented: beam blocking correction, removal of non-meteorological echoes based on data analysis, and removal of residual clutter with help of satellite data.

The increasing harmonization can be illustrated with sums of annual precipitation. Difference between years 2012 and 2015 (Fig 1) shows changes implemented nationally, leading to more uniform datasets sent to the data hub. This harmonization, which has happened in the incoming data, not as post processing at the data hub, is of great importance for NWP assimilation.

The effect of correction algorithms is illustrated with frequency of “”dry pixels” (figure 2). In 2015, before implementation of the above mentioned algorithms, there were a remarkable amount of pixels (shown in blue in the figure), which were dry less than 20% of time. Such frequent rain is not realistic in Europe and, especially when located near the radars, reveals residual clutter. In 2016, the number of those suspicious pixels has decreased remarkably. There are still some in the northern part of the area, which may be telling of less than optimal quality of the geostationary satellite data at high latitudes.

* *Corresponding author address:* Markus Peura
Finnish Meteorological Institute P.O.Box 503
FI 00101 HELSINKI, FINLAND
email first.lastname@fmi.fi

Before the present data hub, the first "Pilot hub" was created as a composite of national composites. It produced strong artificial boundaries collocated with national borders, related to different processing algorithms in different countries. Hence, the first principle of OPERA data centre was to send the data "as raw as possible", and implement all cleaning centrally. However, with radar upgrades and implementation of dual polarization technology, many more quality management procedures are available locally, and majority of them are implemented on signal processor level. Hence, in end of 2016, OPERA made a new recommendation to send clean data to the hub – and to document the used cleaning processes

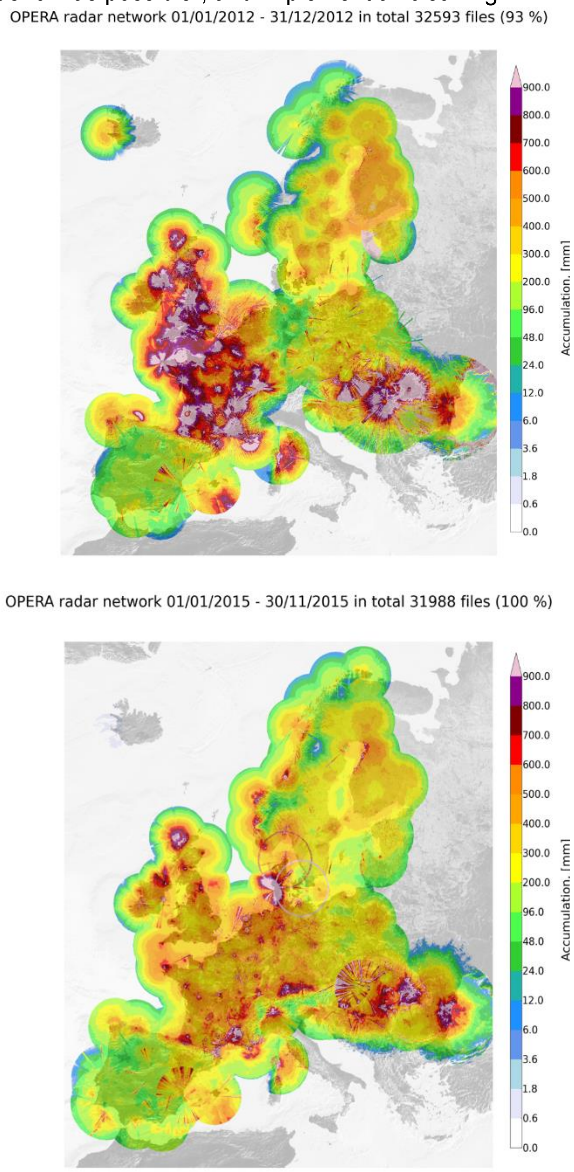

Fig 1. 1-year rainfall accumulation in 2012 (above) and 2015 (below).

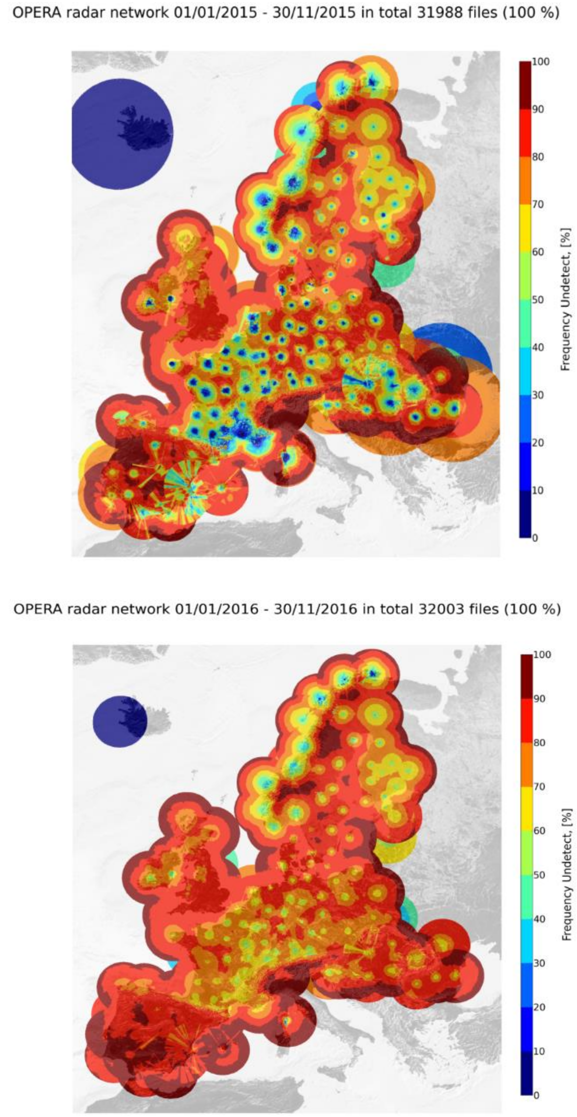

Fig 2. Frequency of "undetect" pixels in 2015 (before the central quality control algorithms, above) and in 2016 (after implementation of the quality control).

carefully. Implementation of such change of paradigm is still pending.

2.1 Solar monitoring

Solar monitoring is a method based on the analysis of sun signals in the polar volume data produced during operational scanning of weather radars (Huuskonen and Holleman, 2007; Holleman et al, 2010). A continuous reflectivity signal is searched along radials in the operational scan data and, depending on the hardware of the radar, the volume coverage pattern, the season, and the latitude of the radar, several tens of sun hits are found per day. Least squares fitting will give information on the antenna pointing bias and on the stability and calibration of the receiver. The system runs now operationally on OPERA data server. It has been observed, that the national QC system remove the Sun signals before the data arrives to the OPERA hub, but by encouraging members to send also the uncorrected data, we aim to provide valuable feedback of antenna pointing to all of our members. It is expected that this monitoring tool will greatly help in harmonizing radar data quality across Europe

3. EXCHANGING EXPERIENCES

After 2012, almost 20 of 30 OPERA members have upgraded their national radar network partially or fully to dual polarization. The dual-pol parameters are not yet exchanged, but several surveys have been executed (some still ongoing) about the best settings and of the use of the data by various stakeholders.

The survey about maintenance practices revealed that it is not the radars that cause the most unavailability of radar data, but power failure and data communication failure. If there are problems with a radar, the most common cause can be found in the transmitter or the antenna controller. The most important reason for longest periods of unavailability is waiting for spare parts to arrive. For keeping a radar network operational, maintaining and monitoring the infrastructure (power supply and data connection) is at least as important as the radars themselves (Saltikoff et al., 2017)

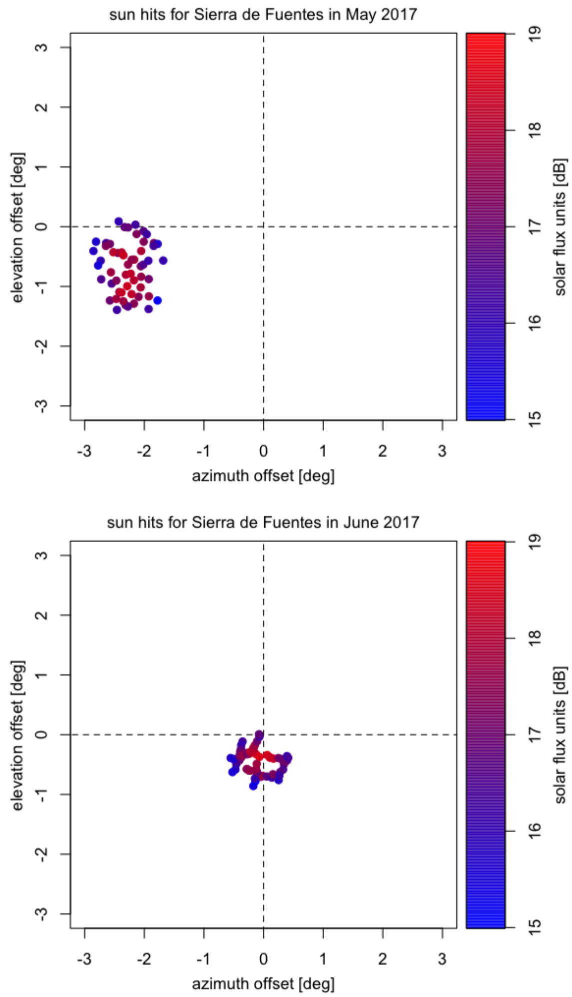

Figure 3. Example of benefits of OPERA solar monitoring service. Upper panel, before correction shows azimuth bias of almost 2 degrees; lower panel after adjustment of the hardware.

4. THE COMPOSITES

By creating composite radar image of the European forecasters are enabled tracking synoptic system cold and warm fronts.

The composite of the European area is founded on the very dense network of radars. The mean distance between radars is 126 km (80 miles). Hence, measurements often overlap and measure the same rain element with different radar which allows improving the quality of the composite for example in case of strong attenuation affecting one of the radars..

OPERA combines radars of various wavelengths, various scanning strategies and introduces comparability between measurements, standardization, and quality control. Quality-based compositing (or mosaicking) is under development, and is expected to yield European rainfall products with improved quality, with information about the local quality.

In addition to quality monitoring of radar data, the composites are used for official duties within the member countries. External users can get a license according to ECOMET rules. The nature of the license depends on the nature of the client and intended use of the composites. (More at http://www.ecomet.eu/ecomet-catalogue/ecomet-licenses/ecomet-licenses)

Example of OPERA composite is in figure 4. We would like to draw your attention not only to how well it shows where it rains. Much more effort has been used recently to show accurately, where it does not rain ! There are areas in Europe not covered in this composite. OPERA is providing technical guidance to the areas where radars exist but data is not sent to OPERA center. For the two big areas without radar data North sea and South east part of Mediterranean sea. Recommendations were made for the selection of radar sites for construction of new radar installations. (Dombai 2010.).

5. JOINT RECOMMENDATIONS

Two big challenges for modern weather radars are the co-existence with wind farms and with the radio communication devices such as wi-fi and R-LAN. During earlier phases, OPERA has given its statements in both issues. In 2016, an article was published in Bull.Am-Met.Soc jointly with EUMETFREQ and international colleagues, to explain the frequency issue even for stakeholders and decision makers who have less deep education in radio technology (Saltikoff et al, 2016). For wind turbines, the first statement was published in 2006, which was updated in 2010, and the team is working on a new one.

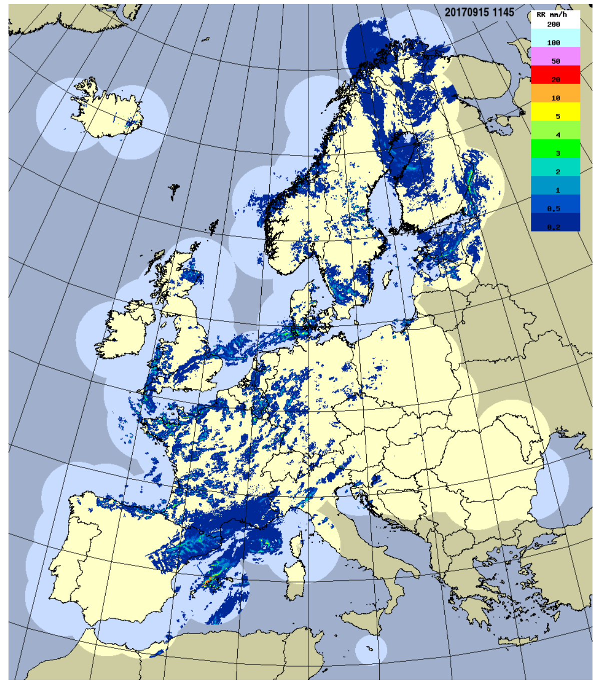

Fig 4. OPERA composite of rainrates 15 September 2017 at 11:45 UTC.

REFERENCES

Dombai F. 2010: Weather radar site selection and protection, OPERA deliverable OPERA_2010_04

Holleman I., A. Huuskonen, M. Kurri, and H. Beekhuis, 2010: Operational Monitoring of Weather Radar Receiving Chain Using the Sun. J Atm. Oc. Tech., 27, 159-166.

Huuskonen, A, and I. Holleman, 2007: Determining weather radar antenna pointing using signals detected from the sun at low antenna elevations, 24, 476-483.

Huuskonen, A., E. Saltikoff, I. Holleman, 2014: The Operational Weather Radar Network in Europe. Bull. Amer. Meteor. Soc., 95, 897 – 907.

Saltikoff, E., J. Y. N. Cho, P. Tristant, A. Huuskonen, L. Allmon, R. Cook, E. Becker, and P. Joe, 2016: The threat to weather radars by wireless technology. Bull. Amer. Meteor. Soc., 97, 1159–1167, doi:https://doi.org/10.1175/BAMS-D-15-00048.1.

Saltikoff E., M. Kurri, H. Leijnse, S. Barbosa, K. Stiansen, 2017: Maintenance keeps radars running. Bull. Am. Met. Soc, (in print) https://doi.org/10.1175/BAMS-D-16-0095.1