

EUMETNET OPERA: Achievements of OPERA-3 and challenges ahead

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(Dated: 30 May 2012)



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1. Abstract

The OPERA programme (Operational Programme for the Exchange of weather Radar information) is the Weather Radar programme of EIG EUMETNET, the Network of the European Meteorological Services. The programme is a joint effort of 30 European countries and is coordinated by Koninklijk Nederlands Meteorologisch Instituut (KNMI). The scope of OPERA covers weather radar matters at large including studies on merits of radar hardware and software solutions, radar data information models with associated data format and software, creation of European wide radar composites, and distribution of data and composites, both for operational applications and research. Another important role of OPERA is that it provides a forum to exchange information and experience on operational weather radars, on radar data and products and on their uses. In June 2011, OPERA entered into a new stage when the OPERA Data Center, Odyssey, started operations. Odyssey collects radar polar volume data of more than 100 radars and produces 2-D composites of maximum reflectivity, rain intensity and accumulation. The time resolution is 15 minutes, and products are made at 2 km x 2 km horizontal resolution. Odyssey thus replaces the OPERA pilot hub, which had operated since 2005, and provides a better resolution, and significantly more homogeneous processing of the data than its predecessor. In the presentation we will give a summary on the outcome of the third phase of OPERA (2007-2012) and on the challenges ahead for the coming years, with emphasis on the development of the OPERA data center.

2. OPERA programme

OPERA (Operational Programme for the Exchange of weather Radar information) is the Weather Radar programme of GIE/EIG (Economic Interest Group) EUMETNET, the Network of the European Meteorological Services. The third phase of the OPERA programme is a joint effort of 30 European meteorological services, runs from 2007 till 2012, and is coordinated by KNMI.

The objective of OPERA is to harmonize and improve the operational exchange of weather radar information between national meteorological services. The work towards this goal is carried out by projects work and during project meetings. Two meetings are arranged per year, hosted by different National Meteorological Services (NMSs). Typically around 35 national delegates and project members from more than 20 countries attend these meetings. The OPERA meetings consist of a plenary session and working group session. Two working groups have been established during this phase of OPERA: Working Group 1 is dedicated to "Radar Technology and Algorithms" and Working Group 2 is dedicated to "Formats, Software, and Data Hub". The working groups monitor the progress and quality of the OPERA projects. The major goal of the third phase of OPERA is the establishment of Odyssey, the OPERA data centre. The work builds on the experience gained during the project to build the pilot Data Hub, which was established in 2005 to demonstrate the full potential in the European Weather Radar Network (Huuskonen 2006). Holleman et al. (2008) and Huuskonen et al. (2010) contain further information on the roots of the OPERA programme, and on its relation to radar associated research programmes.

OPERA works in co-operation with many other EUMETNET programmes, most notably with EUCOS, WINPROF, EUMETFREQ and SRNWP. EUCOS (European Composite Observing System) coordinates EUMETNET observation programmes and hosts the Quality Monitoring Portal, which provides statistics for OPERA on radar data collection and composite production. WINPROF runs a data hub which collects, displays and monitors the quality of radar wind profiles, including those from weather radars. EUMETFREQ is an essential counterpart to OPERA on all matters related to frequency protection. SRNWP coordinates EUMETNET numerical modelling activities, which are becoming more and more important to OPERA in the future. OPERA also works closely with EU projects, such as BALTRAD, and has also been in a close co-operation with COST actions related to weather radars.

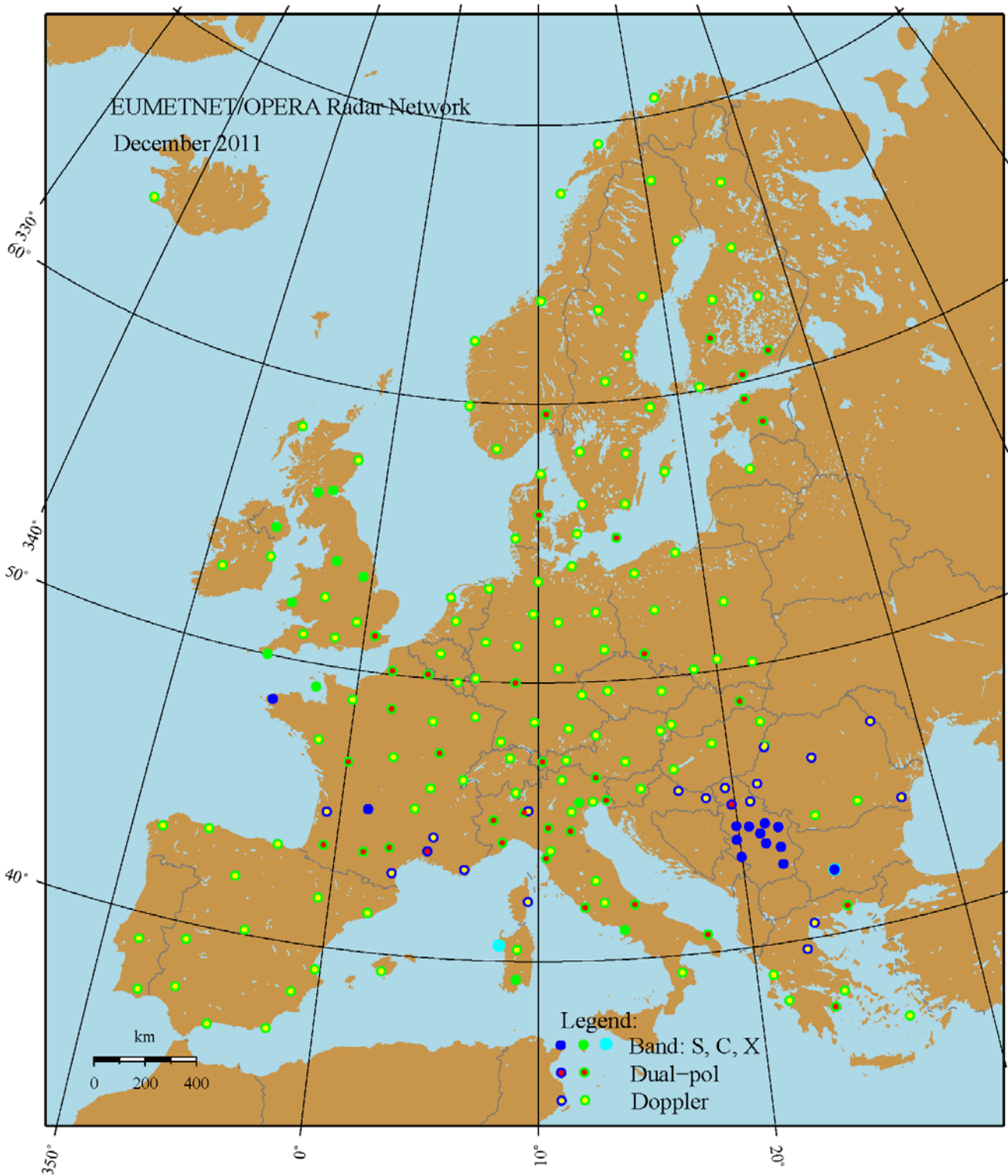


Figure 1: A map of weather radars based on entries in the OPERA radar database

3. OPERA projects and their results

The development work within OPERA is arranged in a number of projects. Most of the project results are publicly available. In the following we summarize the main results of the OPERA work.

Weather radars in Europe: This activity is designed for the NMSs to maintain and update their entries to the OPERA radar database and update the OPERA plenary on the status of their national radar networks. The database is available in public at the OPERA web site. Several user interfaces exist to access the data. A map of the radar network based on the entries in the OPERA database is shown in Figure 1.

Application of quality information for radars and radar data: The number of users of weather radar data is increasing and it is becoming increasingly important to incorporate quality information in radar products. The goal is to characterize the quality of products which will add value to their application (Norman et al., 2010; Sandford and Gaussiat, 2012)

Evaluation of new technologies: This is a forum wherein radar experts collect information on and evaluate new and expected radar technology. A study on the experiences gained on dual-polarization systems has been completed (Tabary et al. 2009). The work discusses items such as the hydrometeor classification, quantitative precipitation estimation and on data quality assessment and evaluations, especially on using the differential reflectivity signal of rain. A further study has been completed to further summarize the experiences on polarimetric applications in C- and S-bands (Tabary et al, 2012) and to evaluate dual-polarization X-band systems (Cremonini et al, 2012).

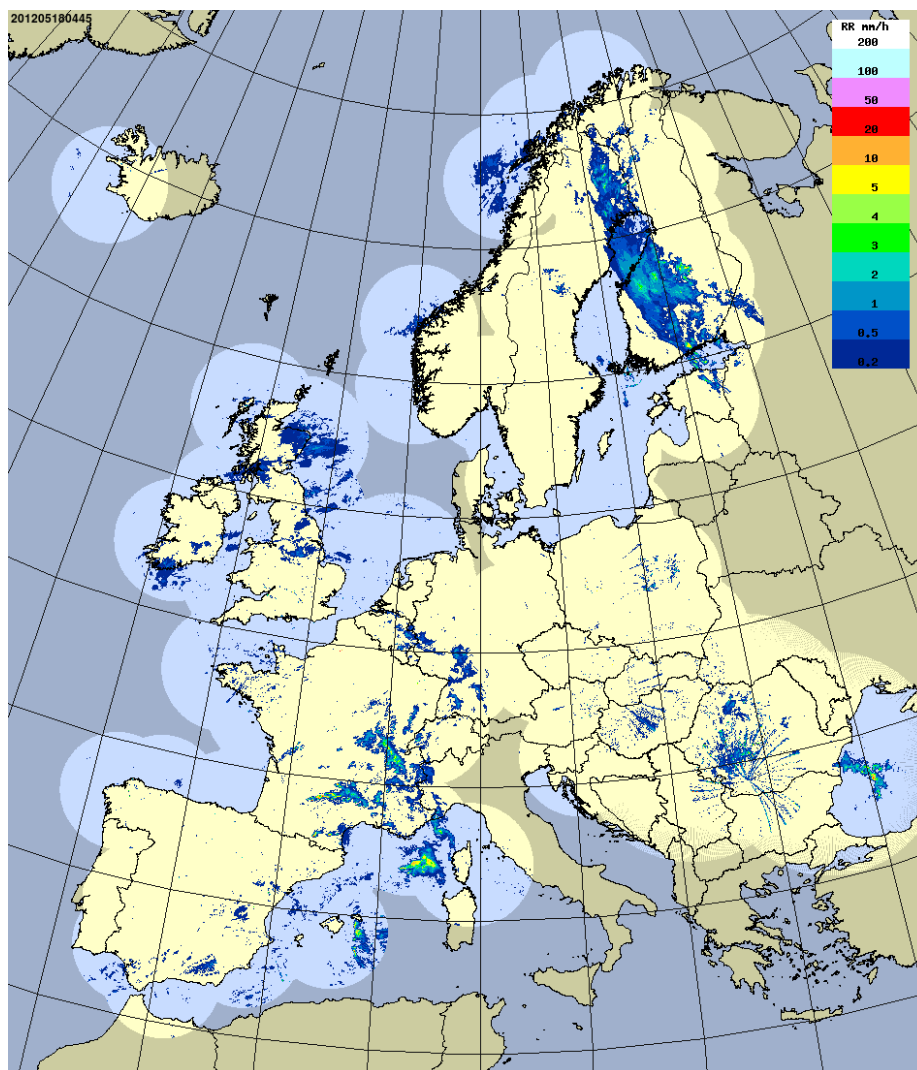


Figure 2: A rain intensity composite produced by the OPERA Data Center Odyssey

Site and frequency protection: This activity serves to collect European expertise on how weather radar is adversely affected by various disturbances such as wind turbines, jamming transmitters, buildings and other structures, and how such disturbances can be constructively minimized, either through pre-emptive administrative management and policy, or through signal/data analysis techniques (Dombai, 2010; OPERA 2010).

Harmonized production practices: In order to harmonize the application and exchange of weather radar data throughout Europe, either through bilateral agreements or through the use of data at the OPERA Data Hub, an agreed-upon set of guidelines must be available. A recommendation has been produced, which addresses the best practices for the production of the radar volume data, as well as for the weather radar wind profiles and for the low level reflectivity (Huuskonen et al. 2009).

OPERA Data Information model (ODIM): The OPERA data information model (ODIM) is a common specification for radar volume data and products (Michelson et al., 2009). The specification exists in UML, and implementations exist in BUFR and HDF5. The data model can be seen as a major achievement, because it provides a means of exchanging radar data in formats other than those by radar software manufacturers.

Data exchange and compositing software: OPERA has been active in providing software to encode and decode radar data in BUFR and HDF5 format. For the OPERA BUFR software user support is provided to the OPERA group and other users of the OPERA BUFR software, including commercial radar software suppliers. BUFR descriptors, sequences, and tables are being defined if needed to allow the coding of new radar data and products in BUFR. Software and tables are available on line at the OPERA web site for all users. OPERA also supports compositing software to produce composites from 2D products. This software is freely available for non-commercial applications.

Pilot Data Hub operations: Maintenance and operation of the pilot Data Hub was established during the second phase of OPERA. The pilot hub ran successfully from 2005 until February 2012, collected data of more than 140 OPERA radars, either as single site or composite products, and produced European wide composites at every 15 minutes. The pilot hub was an important step which indicated that producing radar composites covering nearly all OPERA members is doable.

Development and operation of the OPERA Data Center Odyssey: In June 2011, the OPERA programme reached the major goal set to it, namely the start of operations of the OPERA Data Center, named as Odyssey. The work was started in 2007 by first collecting the user requirements and drafting the functional specifications (Chèze et al, 2009). For this, the project team evaluated the pilot data hub and other operational radar data hubs, e.g. CWINDE, NORDRAD, and US National Radar Mosaic. In addition the user requirements for main user groups have been collected. Odyssey ingests volume reflectivity data from single radars and produces two-dimensional European reflectivity, rain intensity and rain accumulation composites. Matthews et al. (2012) give a more detailed description of Odyssey. In April 2012, a total number of 119 radars from 17 OPERA members contributed to the Odyssey composites. Figure 2 contains an example of a rain intensity composite. Work is ongoing to reduce the amount of non-meteorological echoes seen in the composite.

4. Summary and challenges ahead

The third phase of the OPERA programme has focused on the operational generation of a European weather radar composite, exchange of 3D radar reflectivity data, and availability of radar data for official duty of NMSs as well as for research and education. A Radar Data Center has been completed, and taken in operational use. This operational data hub is crucial for reaching the main objective of OPERA-3, i.e. establishing the weather radar networking as a solid element of the European infrastructure. The renewal of the observational programmes of EUMETNET is ongoing, and OPERA is now established for a new phase for 2013-2017. The work to increase the coverage of the Odyssey composites will then continue, as well as efforts to increase the quality of the composites, and to provide quality information with them. Work packages to monitor the quality of the data and the products are also on the list, as well as studies on various other radar issues. The scope of OPERA is also widened so that OPERA will start distributing quality controlled volume data (reflectivity and radial velocity) for use in numerical weather prediction.

More information on OPERA and its projects is found on the programme internet site (<http://www.knmi.nl/opera>; <http://www.eumetnet.eu/opera>) from where deliverables of the present and previous phases of the OPERA programme, both software and project documents, can be downloaded.

Acknowledgments

All national delegates and project members of OPERA are gratefully acknowledged for their efforts and the pleasant collaboration during the course of the work.

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