

# The European Weather Radar Network (OPERA): An opportunity for hydrology!

Iwan Holleman<sup>1</sup>, Laurent Delobbe<sup>2</sup>, and Anton Zgonc<sup>3</sup>

<sup>1</sup> Royal Netherlands Meteorological Institute (KNMI), De Bilt (Netherlands).

<sup>2</sup> Royal Meteorological Institute of Belgium (RMI), Brussels (Belgium).

<sup>3</sup> Environmental Agency of Slovenia (EARS), Ljubljana (Slovenia).

## 1 Introduction

The tradition of weather radar collaboration at the European level dates back to COST 72 (Measurement of precipitation by radar) which started in 1979 and which presented its final report in 1985. The results from COST 72 led to the launching of COST 73 (Weather Radar Networking, Newsome, 1992) which ended in 1991. At that point, operationally-oriented activities continued in GORN (Liaison Group on Radar Networking) which, eight years later, led to the establishment of OPERA (Operational Program on the Exchange of Weather Radar Information) within the framework of EUMETNET (the Network of European Meteorological Services, [www.eumetnet.eu.org](http://www.eumetnet.eu.org)). At that time, the clear objective was “*To harmonize and improve the operational exchange of weather radar information between National Meteorological Services*”. The second phase of OPERA, 2004-2006, has involved a significant renewal of the Program's terms of reference, priorities, activities, and working methods (Huuskonen, 2006).

More research-oriented activities continued after COST 73 within COST 75 (Advanced Weather Radar Systems, Collier, 2001), while COST 76 (Development of VHF/UHF wind profiler radars and other vertical sounders for use in European observing systems) concentrated on related technology dedicated to wind profiling, and COST 78 (Nowcasting) focused on integrating data from several observational systems, among them radar, for nowcasting purposes. Following these COST actions, the operational and research communities have again converged and

transformed successful research results into operational real-time systems. The successful collaboration between OPERA and COST 717 (Use of radar observations in hydrological and NWP models, Rossa *et al*, 2005) exemplifies this convergence. This collaboration now continues with the COST 731 Action (Propagation of uncertainty in advanced meteo-hydrological forecast systems).

Relevant user communities for weather radar data and products are aviation meteorologists, air traffic control, nowcasting, duty forecasters, NWP modelers, public safety authorities, hydrologists, and hydrological modelers. It is with these diverse and important user groups in mind that OPERA II established its pilot Data Hub with the goal to demonstrate the full potential in the European Weather Radar Network. The third phase of the OPERA program is a joint effort of 28 European countries, runs from 2007 till 2011, and is managed by KNMI. OPERA III is designed to firmly establish the Program as the host of the European Weather Radar Network.

## 2 Layout of the Program

Since 1 January 2007 Iwan Holleman (KNMI) is program manager of the third phase of OPERA. An overview of the 28 participating countries is given in Table 1. Two OPERA meetings are arranged per year by the program manager and they are hosted by different National Meteorological Services (NMSes). 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 parallel working group discussions. Two working groups have been established during this phase of OPERA: Working Group 1, chaired by Laurent Delobbe (RMI), is dedicated to “Radar Technology and Algorithms” and Working Group 2, chaired by Anton Zgonc (EARS), is dedicated to “Formats, Software, and Data Hub”. The

---

Corresponding author: Iwan Holleman (KNMI)

[holleman@knmi.nl](mailto:holleman@knmi.nl) and [www.knmi.nl/opera](http://www.knmi.nl/opera)

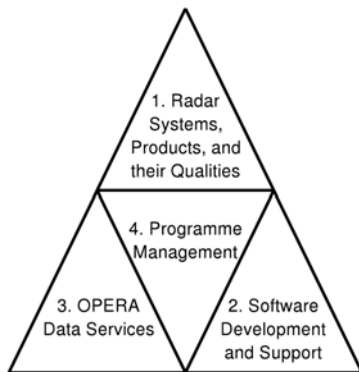
**Table 1.** An overview of the 28 European countries that are participating in the third phase of OPERA.

Austria	Belgium	Bulgaria
Croatia	Cyprus	Czech Republic
Denmark	Finland	France
Germany	Greece	Hungary
Iceland	Ireland	Italy
Latvia	Luxembourg	Netherlands
Norway	Poland	Portugal
Romania	Slovak Republic	Slovenia
Spain	Sweden	Switzerland
United Kingdom		

working groups monitor the progress and quality of the OPERA projects. A schematic overview of the program elements of OPERA III and their interaction is presented in Figure 1. Currently OPERA’s operational network consists of more than 150 weather radars, of which roughly 100 systems have Doppler processing and about 10 systems have dual-polarization capability. In the coming years the number of dual-polarization systems will increase dramatically, thus offering new opportunities for quantitative precipitation estimation. The European weather radar network of OPERA is displayed in Figure 2. The OPERA program also interacts with several other EUMETNET programs, like EUCOS (European Composite Observing System), EUMETFREQ (Protection of radiofrequencies), WINPROF (Wind profiles), and SRNWP (Short Range Numerical Weather Prediction).

### 3 Operational exchange of radar data

OPERA maintains and develops the agreed-upon mechanisms for exchanging radar data and products in Europe. The number of bilateral links between NMSes where radar data are exchanged operationally using OPERA



**Fig. 1.** Overview and interaction of program elements of OPERA III.



**Fig. 2.** Map showing the weather radar network of OPERA

tools and standards is now around 50. In addition weather radar data from roughly 100 sites are being sent to the pilot data hub. Finally the operational availability of weather radar wind profile (WRWP) products has increased dramatically since 2004 and currently data from 84 sites are exchanged in real-time.

### 4 Projects of OPERA program

Within the framework of the OPERA program a number of projects are conducted in the field of radar technology and algorithms and for development of exchange software and the data hub. **Working group 1** is dealing with the following projects:

#### 4.1 Weather radars in Europe

This activity is designed for the NMSes to maintain and update their entries to the OPERA radar database, and update the OPERA plenary on the status of their national radar networks.

#### 4.2 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. In this project, work on quality which has been started in OPERA will be focussed, and recommendations will be formulated on how each NMS can create quality information for their radar data. The goal is to characterize the quality of products which will add value to their application. Close cooperation with the NWP

and hydrological modelling communities, along with other data user communities, is required.

#### 4.3 Promotion and evaluation of operational radar data use

This is a forum for radar data user communities to be able to meet the radar data providers on a regular basis, in conformance with the WMO recommendations on performing rolling reviews. Examples of such communities are aviation meteorologists, duty forecasters, NWP modellers, hydrologists, and hydrological modellers, and developers of nowcasting models, depending on which of these are nominated from a given country. The emphasis is on operational requirements from these user communities and how data providers can support them in using radar data and products to their greatest potential, as a part of an integrated observing system. Topics include the selection of appropriate radar technology for a given application, radar configuration issues, product definitions, and quality indicators.

#### 4.4 Evaluation of new technologies

This is a forum wherein radar experts collect information on and evaluate new and expected radar technology. Examples of such technology are: dual-polarization (started in OPERA II), multi-parameter systems, rapid-scanning systems, use of phased-array antennas, sensor synergy, physical parameter retrievals, phase-coding algorithms, accuracy of such retrieval algorithms, choice of frequency, gap-filling systems, dual-Doppler, radome issues, sources of error, etc. The results of such evaluations are useful when procuring new radar systems.

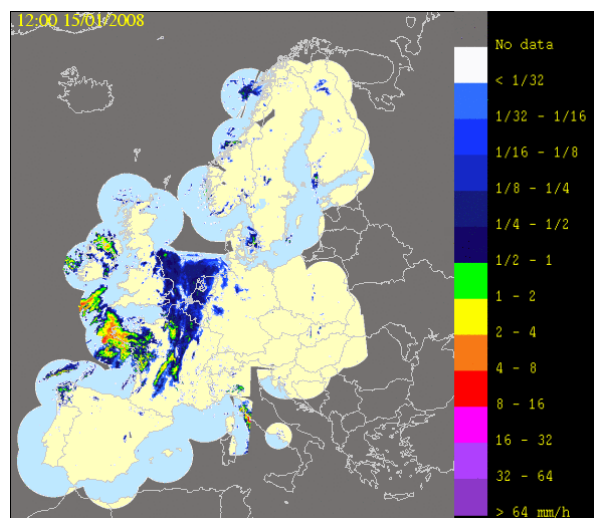
#### 4.5 Site and frequency protection

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. OPERA works closely together with EUMETFREQ in this project.

#### 4.6 Harmonized production practices

In order to harmonize the application and exchange of weather radar data throughout Europe, either through bilateral agreements or through the data's use at the OPERA Data Hub, an agreed-upon set of guidelines must be available. Such guidelines should address best-practises for radar configuration, and production algorithms for internationally-exchanged data and products. This work is an important part of the efforts of increasing the quality of the radar data and products.

And **Working group 2** is dealing with the following projects:



**Fig. 3.** Example of European radar composite from pilot data hub of 15 January 2008 at 1200 UTC.

#### 4.7 Data exchange software development

Based on the results of OPERA II, the issue of selecting appropriate technology which will enable and facilitate foreseen needs for the exchange of data and products are carefully analyzed. Once this has been achieved, appropriate tools will be developed, made available, and supported for all OPERA members. Furthermore this project includes a limited development of the OPERA BUFR software.

#### 4.8 BUFR software maintenance

This activity concerns the maintenance of OPERA BUFR software. User support is provided to the OPERA group and other users of the OPERA BUFR software, including commercial radar software suppliers.

#### 4.9 BUFR table maintenance

This activity includes defining new descriptors, sequences, and tables for use with OPERA BUFR exchange software, where relevant and applicable, based on results achieved in other projects.

#### 4.10 Compositing software support

Within the first OPERA Program, compositing software has been developed that is available to all OPERA members. It is portable software that runs on all commonly available computer platforms. For the continuation, this work package covers the support of the software.

#### 4.11 Pilot Data Hub operations

Maintenance and operation of the pilot Data Hub was established during OPERA II. The pilot hub is expected to run for an initial two years (2007-2008) and also in 2009 during the development of the operational hub. The pilot hub

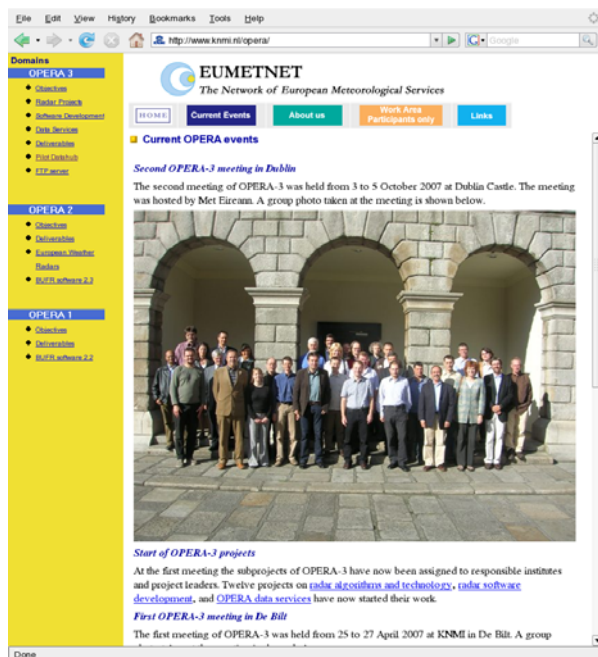


Fig. 4. Snapshot of the internet site of OPERA

gives data services for quality control purposes and non-commercial use within NMSes only. A recent example of a European radar composite produced by the pilot data hub is shown in Figure 3.

## 5 Development of operational data hub

A project team within OPERA is currently collecting the user requirements for the operational data hub and drafting its functional specifications. For this, the project team has evaluated the pilot data hub and other operational radar data hubs, e.g. CWINDE, NORDRAD, and US National Radar Mosaic. In addition four priority user groups have been selected and the user requirements for these groups have been drafted:

- Core services forecasting and nowcasting
- NWP (Assimilation and verification)
- Hydrology
- Civil and military aviation

Since June 2007 visits to Eurocontrol and ECMWF have been paid and valuable feedback on the draft user requirements has been collected. In addition the project team

has discussed the user requirements within their institutes. Contacts with COST 731, SRNWP, and JRC Ispra (Flood forecasting) have been established and feedback was received. In February 2008 the project team will finalize the user requirements and extract the functional specifications. In June 2008 the functional specifications for the operational data hub will be submitted to the Program Board on Observations (PB-OBS) of EUMETNET for approval, and it is expected that the development will start early 2009.

## 6 Summary and outlook

The new OPERA program will focus on the operational generation and quality control of a European weather radar composite, exchange of 3D radar reflectivity and wind data, exchange of quality information, and availability of radar data for official duties of NMSes and research. An operational Weather Radar Data Hub will be specified, developed, and operated during this phase of OPERA. This operational Data Hub is crucial for reaching the main objective of OPERA III, i.e., establishing the weather radar networking as a solid element of the European infrastructure. In this paper, the OPERA program and its objectives have been discussed, and opportunities for use of European weather radar data in hydrological research and applications have been highlighted. More information on the OPERA program and the projects can be found on the internet site ([www.knmi.nl/opera](http://www.knmi.nl/opera)) and deliverables of the previous programs, both software and project documents, can be downloaded.

*Acknowledgements:* All national delegates and project members of OPERA are gratefully acknowledged for their efforts and the pleasant collaboration. Especially the contribution of the other authors of the OPERA III proposal (on which a part of this paper is based), i.e., Asko Huuskonen (FMI), Jean-Luc Chèze (Météo France), Stuart Matthews (UK Met Office), and Daniel Michelson (SMHI), is recognized.

## References

- Collier, C.G., 2001: Advanced Weather Radar Systems 1993-97. *Final Report of COST 75, EUR 19546, Brussels, 362 pages.*
- Huuskonen, A., 2006: EUMETNET OPERA: Operational Programme for the Exchange of Weather Radar Information. *Proceedings of ERAD 2006, 3, 371-373.*
- Newsome, D.H., 1992: Weather Radar Networking. *Final Report COST 73, Kluwer Academic Publishers, 254 pages.*
- Rossa, A., M. Bruen, D. Frühwald, B. Macpherson, I. Holleman, D. Michelson, and S. Michaelides, 2005: Use of Radar Observations in Hydrological and NWP Models. *Final Report of COST 717, EUR 21954, Brussels, 286 pages.*