



## EUMETNET OPERA: Operational Programme for the Exchange of Weather Radar Information

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### 1 Introduction

The OPERA programme (Operational Programme for the Exchange of weather RADar information) is the Weather Radar programme of EUMETNET, the Network of the European Meteorological Services. The objective of OPERA is to harmonize and improve the operational exchange of weather radar information between national meteorological services. To this aim OPERA has worked on the specification of the radar products to be exchanged, on their exchange format, as well as on the software to enable the data exchange. Moreover, recommendations on the radar systems as well as on the procedures to enhance the quality of the data have been produced. During the present phase of OPERA, special emphasis has been laid on the quality information, on the user needs, and on a study of the file format for the future data exchange. Work is also ongoing on an assessment of the dual polarization technique, and on the effect on wind turbines on the weather radar measurement. OPERA is also building a pilot radar data hub for European radar data. This paper summarizes results of the present phase of OPERA, which covers years 2004-2006.

OPERA is a joint effort of 27 European national meteorological services and is managed by the Finnish Meteorological Institute. The OPERA members are the national meteorological services of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Norway, Poland, Portugal, Rumania, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, and United Kingdom

### 2 EUMETNET

EUMETNET is a network grouping 21 European National Meteorological Services. It provides a framework to organize co-operative programmes between the Members in the various fields of basic meteorological activities such as observing systems, data processing, basic forecasting products, research and development as well as in training. Co-operative programmes with close link to weather radars are:

- EUCOS (EUMETNET Composite Observing System) with the aim to design and coordinate the evolution of the ground based observing system at European scale with a view to improve short range forecast over Europe.
- OPERA (Operational Programme for the Exchange of weather RADar information)
- WINPROF (wind profilers)
- EUMETFREQ, which coordinates the work to protect the radio-frequencies.

A full list on the co-operative programmes and other further information on EUMETNET is available at the EUMETNET web site <http://www.EUMETNET.eu.org>

### 3 OPERA

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) which ended in 1991. At that point, operationally-oriented activities continued in GORN (Liaison Group on Radar Networking) which, eight years later in 1999, led to the establishment of OPERA (Operational Programme on the Exchange of Weather Radar Information) within the framework of EUMETNET, which had been established in 1995. 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 the OPERA programme started in 2004 for a three year period.

OPERA is the largest of all EUMETNET programmes in terms of participation. The number of member services is 27. The responsible member of OPERA is the Finnish Meteorological Institute and the programme manager is Dr. Asko Huuskonen. The OPERA group meets twice a year at programme plenary meetings, during which the working groups also meet.

A most important task of the meetings is to act as a venue where people working on operational radar issues meet regularly and can discuss on the problems and advances within their radar networks. These meetings have created a network of radar specialists within the OPERA members. One of the tasks of OPERA is to give recommendations on the radar technology. During the present phase this work has focused on the assessment of the benefits of the dual-polarization technique for operational weather radar networks.

The weather radar network within the OPERA members consists of close to 150 weather radars, of which some 100 are Doppler radars, i.e. able to measure both rain and wind. A list of radars as well as a map of radar of OPERA members is found at the OPERA web site.

The OPERA budget is about 120 000 € per year, which is used to finance the programme management, the project work within the programme and the programme electronic services to members.

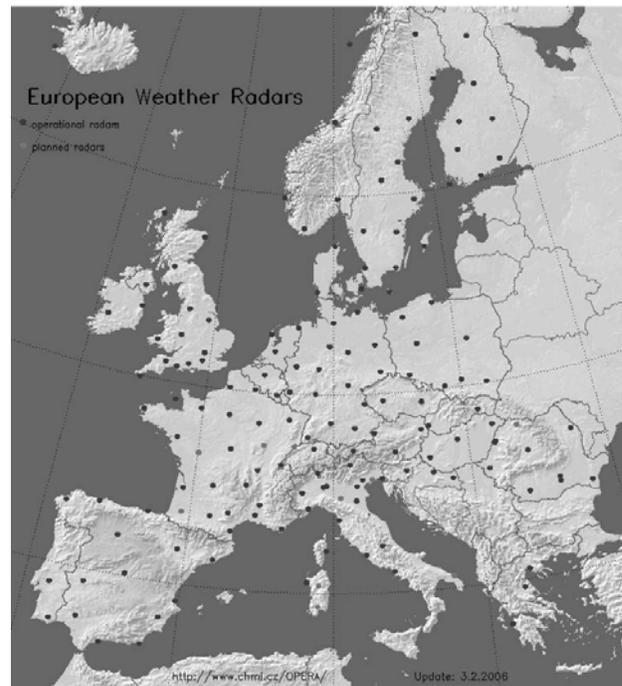
#### 4 Data

The main aim of OPERA is to harmonize and improve the operational exchange of weather radar data. OPERA has specified the data formats for the data to be exchanged and prepared a list of radar products which are used in the exchange. The data exchange itself is not a task of OPERA, but is handled by the OPERA members themselves. Weather radar data is available as single site unprocessed data, or in various processed forms. A list of the available data is found in the Ecomet catalogue.

During the present phase OPERA has created a pilot radar data hub which collects, controls the quality of, and processes weather radar rain data, to be used for quality control within the OPERA members. The hub is operated by the UK MetOffice for OPERA. The hub receives national composites from eight members and single site data from altogether 76 radars. In total this corresponds to more than 110 weather radars.

The work with the BUFR encoder/decoder programs is one of the tasks of OPERA. The OPERA BUFR software is now a stable and mature product which serves the radar community when data are exchanged between members, or data are sent from members to their customer. Updates of the BUFR tables are released regularly, and templates are

presented to facilitate harmonization of the data transfer. WMO approval is being sought for some set of descriptors. The BUFR software is available free of charge for non-commercial applications, and the radar software companies are encouraged to include the software as part of their radar software releases. The software is now a general-purpose tool which can be used to facilitate the encoding/decoding of data from observation systems other than just radar. The BUFR technology is getting close to its limits when used with radar data. New data representation formats have been tested within OPERA, and two formats (HDF5, GRIB2) have undergone practical tests to see how and to what extent they can complement BUFR in the future.



**Fig. 1.** Weather radars in OPERA and EUMETNET member countries. The map is based on entries stored at the OPERA public radar data base in February 2006.

Another type of weather radar data is the wind profile. Wind profiles from more than 70 radars are available in the GTS network. They are also shown on the web site of the EUMETNET WINPROF programme, which is the EUMETNET programme dedicated to wind profiling radars. During the present phase of OPERA a significant amount of resources has been put to harmonization of the WRWP product. The agreed sequence of BUFR descriptors is now used by most data providers, and GTS header following the WMO guidelines. This work has been carried out in close co-operation with the EUMETNET WINPROF Programme and its WINPROF/CWINDE hub, which is operated by the UK MetOffice. The hub provides monthly statistics on the quality of the WRWP. The statistics are based on the NWP

model runs by the UK Met Office, and are used as a tool in the quality work on WRWP.

## 5 Work to protect radar environment

Most important issues for the radar environment are the frequency matters and the constructions near radar installations, wind turbines and farms in particular.

Within the frequency allocation we have seen several attempts to propose new uses for the weather radar frequency bands. Within the European radar networks the most important radar band is the so-called C-band, which in most countries extends from 5600 Mhz to 5650 MHz. Some new uses of this band have been accepted. The radio LANs are allowed, as long as equipped with a DFS (Dynamic Frequency Selection) feature which should protect the weather radars adequately. Some opposing examples have emerged, but the full implication of these is still not known.

The Ultra Wide Band (UWB) devices are also being taken into use. They operate at very low power levels, but use extremely wide band widths. The weather radar receivers are very sensitive, and therefore special notice has to be taken to protect the weather radar bands. Within EUMETNET, the frequency matters are coordinated by the EUMETFREQ programme, lead by Météo France.

The wind turbines and wind farms disturb weather radars in two different ways. A construction close to a radar facility will produce a blocking sector in which measurements are not obtained. In this respect a wind turbine is just like any other construction which is erected to a radars field-of-view. The moving blades of a wind turbine have two-fold effect. Radar is capable of removing fixed ground objects from the data by filtering, but moving objects, such as cars, ships, birds or moving blades, escape this process. The blades are affecting the velocity data produced by radar, lowering the quality of the wind profiles. OPERA is working on a recommendation which could be used when objecting to wind farm projects.

## 6 User needs

Direct and active participation with OPERA by data user communities is a strategy designed to increase the contact area between provider and user communities, thereby optimizing dataflow with the most appropriate characteristics for a given application. Different user communities have diverse, and partly opposing, needs on the frequency and type of the radar data. Some important user communities are aviation meteorologists, air traffic control, nowcasting, duty forecasters, NWP modellers, public safety authorities, hydrologists, and hydrological modellers.

OPERA has carried out a user survey within these important user groups. The survey consisted of a material which contained selected products and various ways of presenting the data. These data were presented to users who were then interviewed by professional radar people. The aim was to present the full potential of the modern weather radar to users and to learn more on the user needs and wishes.

The traditional use of weather radar information is in the form of visual qualitative products viewed by forecast meteorologists and hydrologists. However, over the last decade, the quantitative use of radar information has increased drastically, in the forms of quantitative precipitation estimation techniques, nowcasting applications, and use in modelling systems, both in numerical weather prediction and in hydrological applications. These developments have led to increased knowledge of radar data's strengths and weaknesses, which in most cases are application-dependent. The quantitative use of the data makes it increasingly important to incorporate quality information to the radar products. A work is ongoing to specify which kind of quality information is needed, and how it is presented and incorporated with the data. A close co-operation with the users is most important, and the quality information must be such the users find useful and are able to use.

## 7 More information on OPERA

More information on the EUMETNET is found at its website <http://www.EUMETNET.eu.org>, through which the OPERA web site is also easily found. The OPERA web site contains general information on the programme, contact information and

- Deliverables of the first and second phase of OPERA
- List of all weather radars within OPERA, with some basic information on each radar
- Map of weather radars within OPERA and EUMETNET countries.

Other useful links are:

- The WINPROF/CWINDE web site is <http://www.meto.gov.uk/research/interproj/cwinde/index.html>
- The Ecomet web site is <http://www.meteo.oma.be/ECOMET/>

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