OPERA – the operational weather radars in Europe

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EIG EUMETNET

is a grouping of 31 European National Meteorological Services that provides a framework to organise co-operative programmes between its Members in the various fields of basic meteorological activities. These activities include

- observing systems,
- data processing,
- basic forecasting products,
- research and development
- training.

- Observations
  - Programme Management
  - Radiosonde Stations
  - Surface Land Stations
  - E-ASAP
  - E-AMDAR
  - E-GVAP
  - E-SURFMAR
  - E-PROFILE
  - OPERA

Opera The Club

- 30-40 European experts
- 2 x year since 1999
- Open discussion of local and common challenges, experience, outlooks
- Joint projects producing reports and software

Opera in brief

- Radar project of European NMS's within EUMETNET
- Objectives:
  - to provide a European platform wherein expertise on operationally-oriented weather radar issues is exchanged.
  - to develop, generate and distribute high-quality pan-European weather radar composite products on an operational basis

OPERA aims

To operate and develop ODYSSEY, which collects radar volume data, distributes quality flagged volume data to modelers and other **radar data users**, and produces quality controlled radar products, such as (but not limited to) composites of radar reflectivity, rain intensity and accumulation for uses such as NWP, nowcasting, aviation, hydrology, and climatology.

To develop the OPERA Data Information Model (ODIM). To develop and keep available radar encoding/decoding **software to produce radar data** and products in formats such as HDF5 and BUFR.

OPERA aims

To carry out studies to collect**, share and increase expertise** in the field of weather radar (hardware, software, processing algorithms, radar products, quality monitoring and control techniques, network design, user requirements etc) within EUMETNET and the whole weather radar community.

To provide **support to its members** in environmental and societal issues related to weather radars, such as radar siting, radio-frequency interference and the impact of wind farms.

To offer a forum for **exchange of experience** and for capacity building in the field of weather radars within EUMETNET.

To inform the wider **operational and research community** of its activities.

OPERA composite fact sheet

The EUMETNET OPERA composite is a radar image mosaic generated by using single-site radar data provided by members of OPERA and ECOMET. The composite is an estimate of instantaneous surface rain rate, using the unit of mm/h. The composite covers most of Europe in Lambert Equal Area projection. It is updated every 15 minutes, and issued ca. 15 minutes after data time.

Composites are delivered to users by FTP via GTS/RMDCN or Internet. They are available in a single format, HDF5. Format descriptions are available at the EUMETNET OPERA web site.

Visualization of the data is to be performed by the user. Some national meteorological services may be able to provide visualization as an added service.

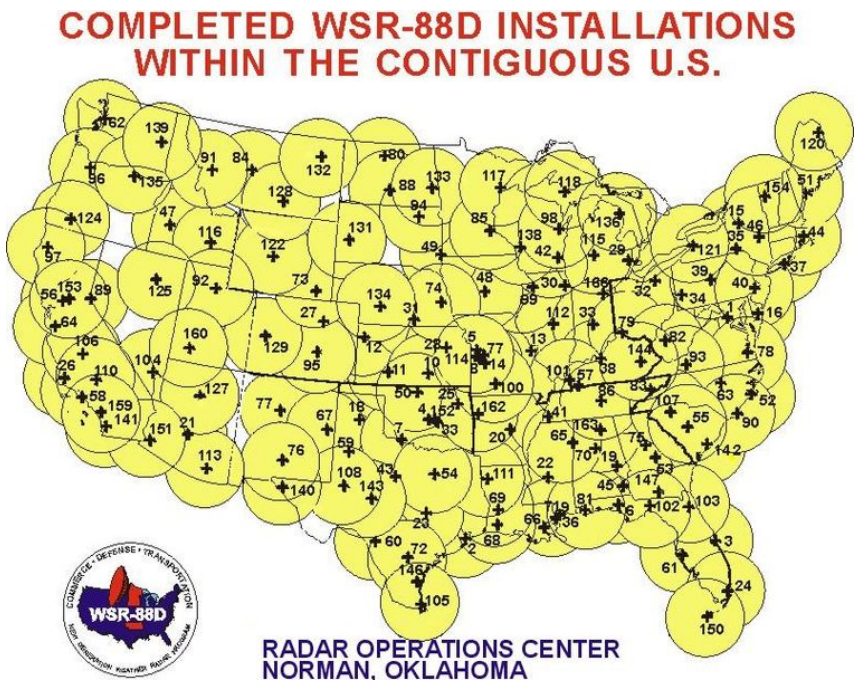
Odyssey system produces a set of 3 European composites (Reflectivity, Rain Rate and Hourly accumulations)

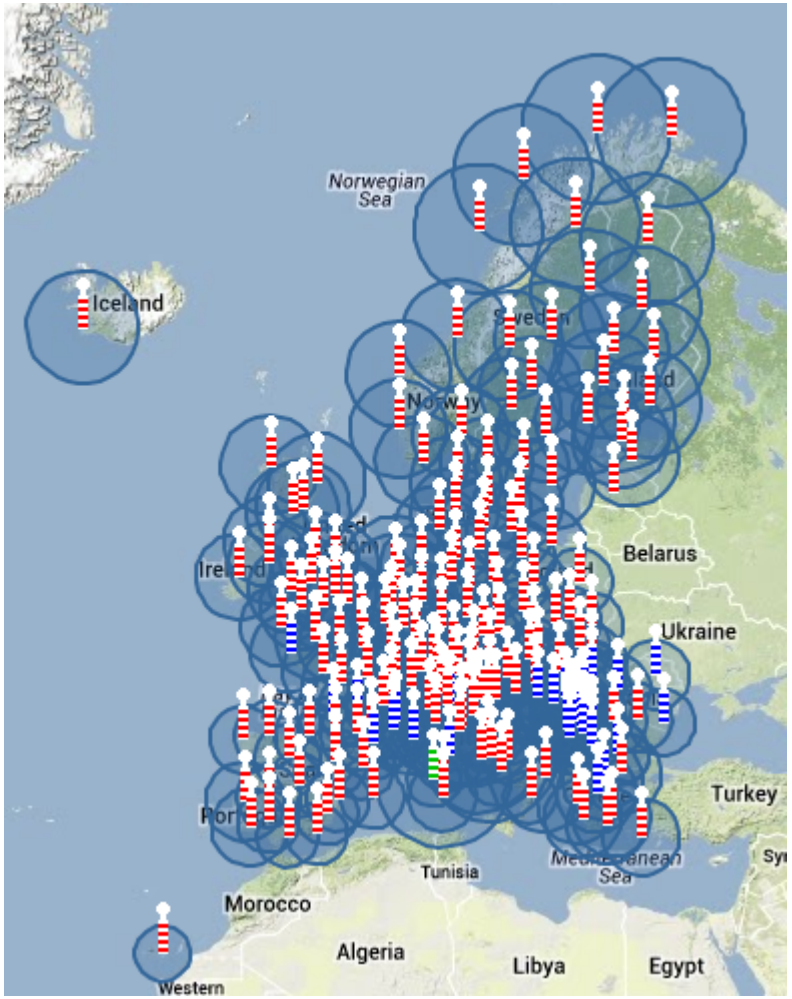
Parameter	instantaneous surface rain rate
Unit	mm/h
Frequency	every 15 minutes
Issued at	Data time + 15
Projection	Lambert Equal Area
Area	Parts of Europe covered by available
Corner coordinates, approximately	70 N 30 W, 70N 50E, 32N 15W, 32 N 30E
Data formats	HDF5

Opera in Europe = Nexrad in USA

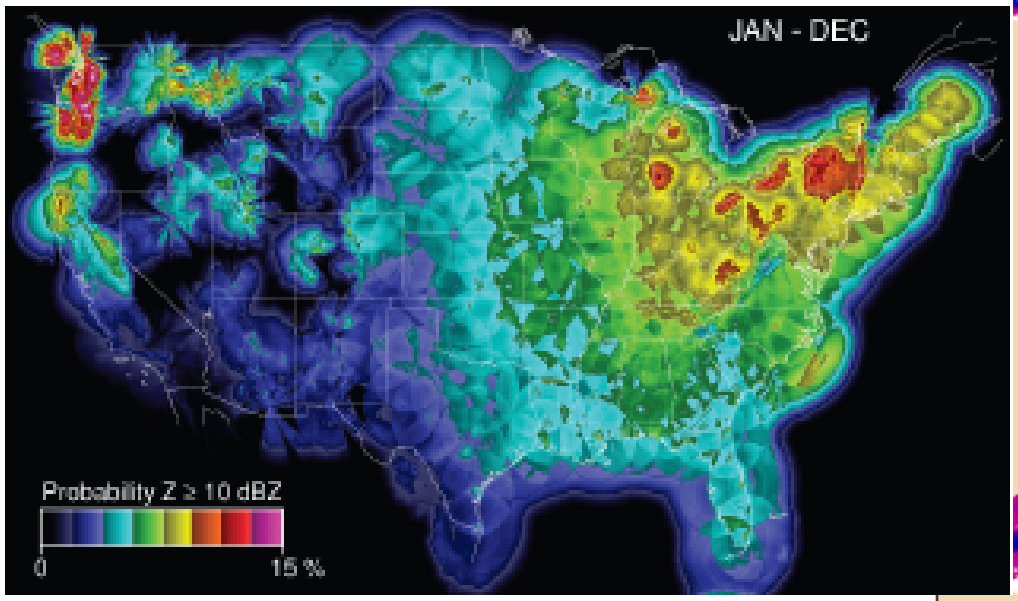
- Opera is sometimes referred as "Nexrad of Europe”
- the big difference:
- Opera network is extremely heterogeneous
  - installation date,
  - manufacturers, wavelenghts (S,C,X)
  - scanning strategy
  - signal processing
  - product generation.
- Opera radar density is about twice that of Nexrad.

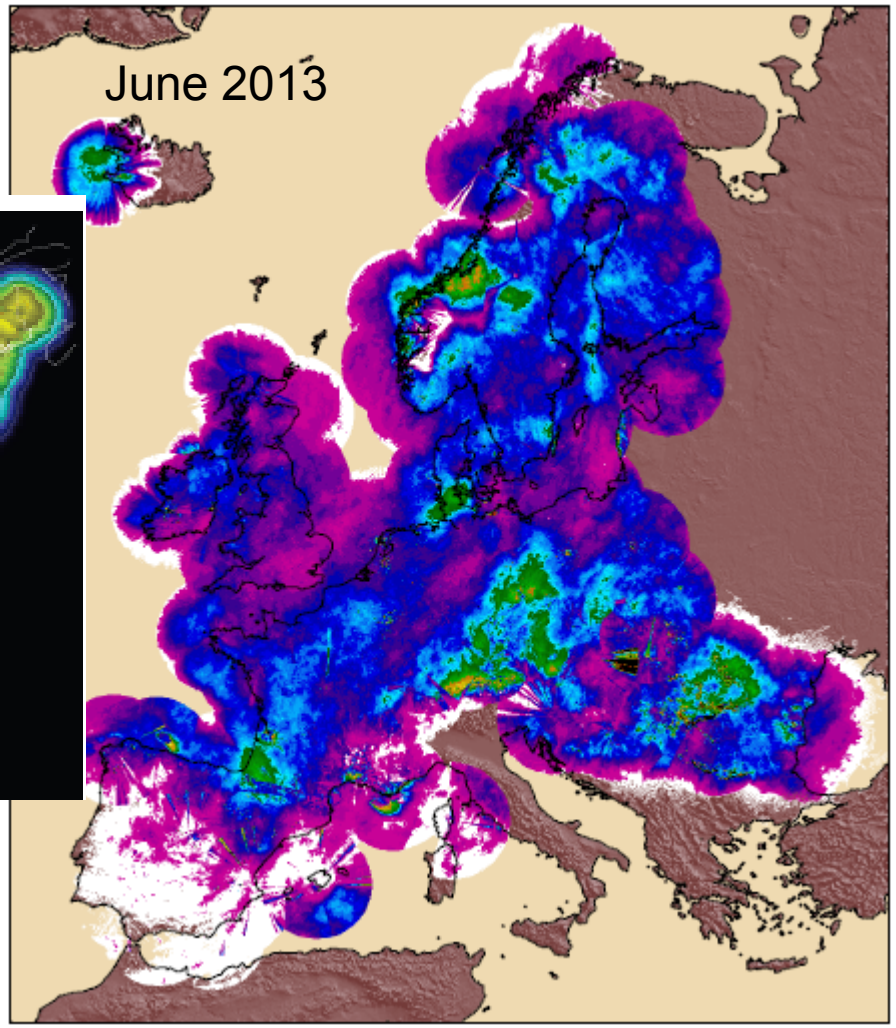
Networks


COMPLETED WSR-88D INSTALLATIONS
WITHIN THE CONTIGUOUS U.S.
WSR-88D
RADAR OPERATIONS CENTER
NORMAN, OKLAHOMA


Norwegian Sea
Iceland
Belarus
Ukraine
Turkey
Tunisia
Morocco
Algeria
Libya
Egypt

Statistics

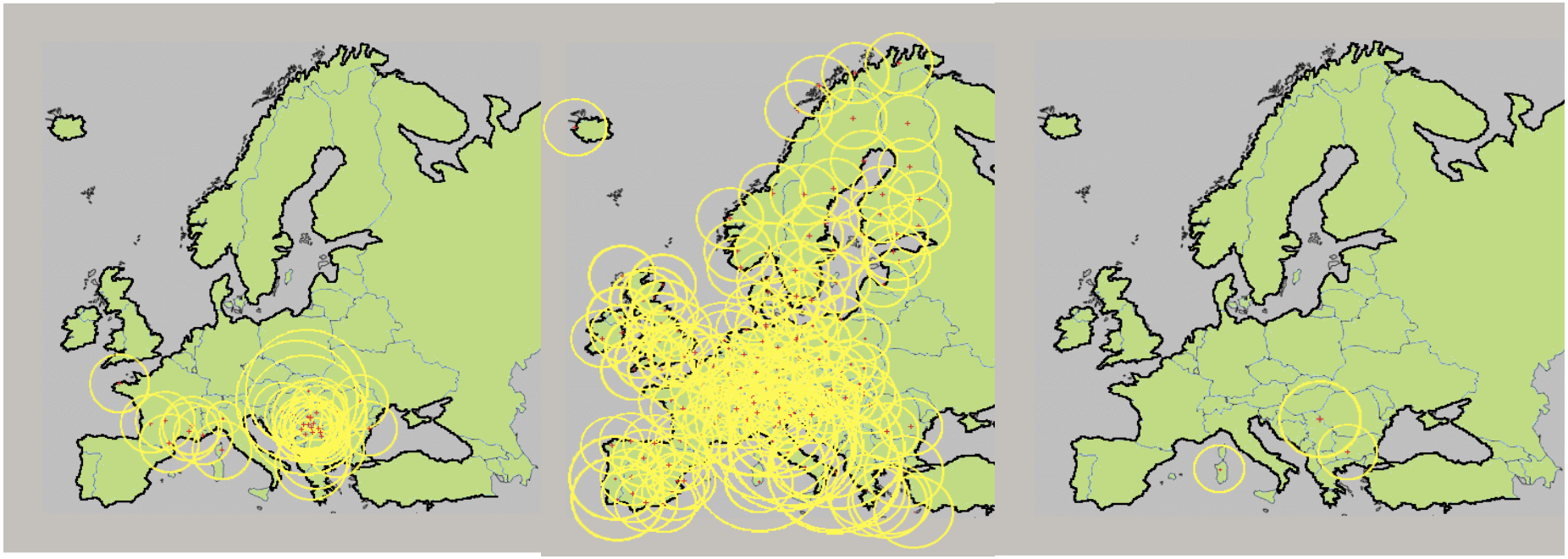




- Frequency of 10 dBZ

F. Fabry & M. Berenguer, AMS 2013

OPERA radar network S,C,x band

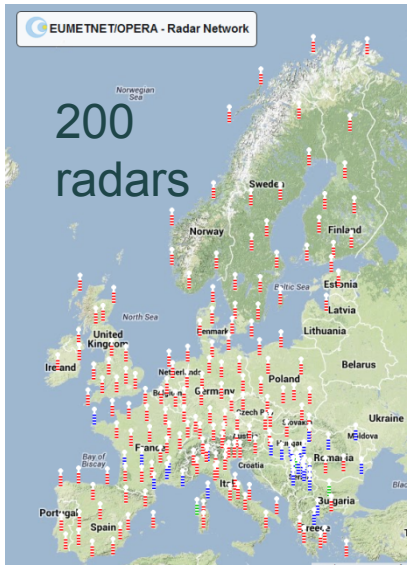


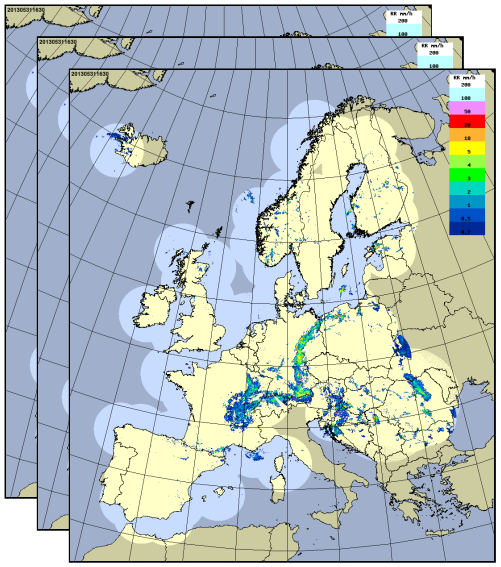
OPERA has credibility

- OPERA has prepared statements of wind farms and radio interference
- OPERA is encouraging manufacturers to support OPERA's requested data formats (BUFR and HDF5)
- OPERA is preparing reviews of new technologies
  - Opera 1 : "How to buy a Doppler radar"
  - Opera 3: "Dual polarization"

Opera Data Centre ODC = ODySsey

- Opera operates and develops the ODYSSEY data hub, which collects radar volume data, distributes quality flagged volume data to modellers and other radar data users, and produces quality controlled radar products;





Data policy

- Composite distributed to members of OPERA and EUMETNET for official duties
- Licences given for Research and education
- Commercial licencing to external users via ECOMET* catalogue
- * The Economic Interest Grouping of the National Meteorological Services of the European Economic Area

Odyssey Output: 3 composites

1. **Surface rain rate composite (every 15 minutes):**

Each composite pixel is a weighted average of the lowest valid pixels of the contributing radars, weighted by the inverse of the beam altitude. Polar cells within a search radius of 2.5 km of the composite pixel are considered. Data measured below 200 m altitude are not used.

2. **Rainfall accumulation (every hour),**
   sum of the previous four 15-minute surface rain rate products.

Maximum reflectivity composite (every 15 minutes)

See next page

Odyssey Output: 3 composites

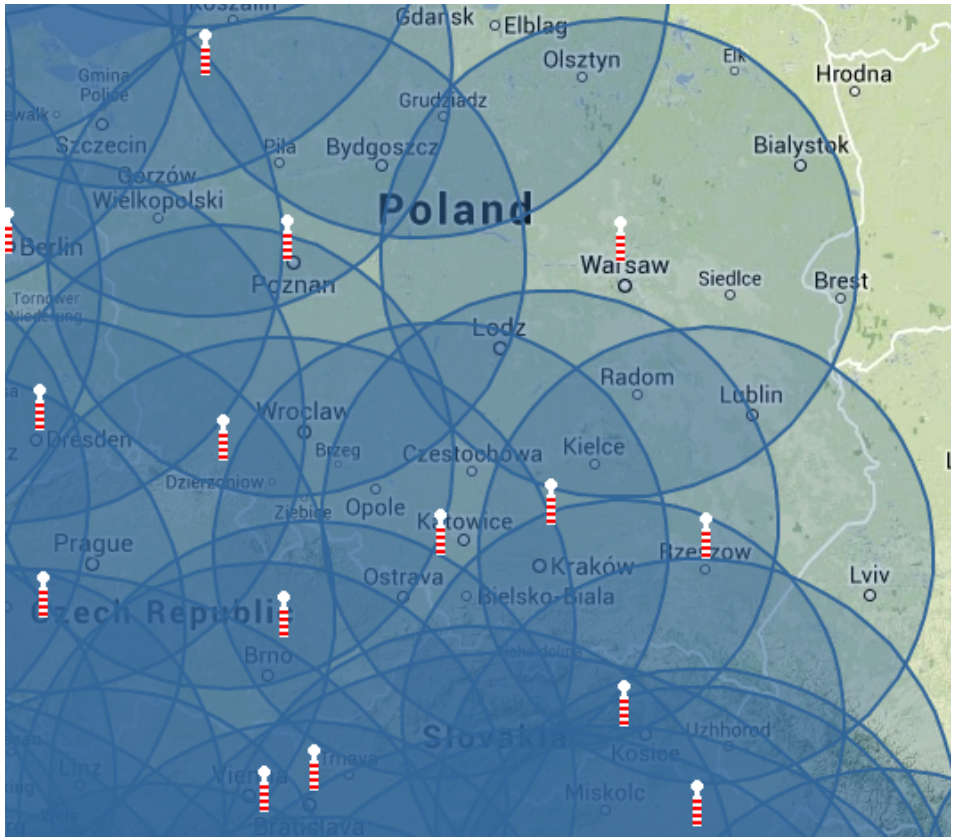
3. **Maximum reflectivity composite (every 15 minutes):** Each composite pixel contains the maximum of all polar cell values of the contributing radars at that location.

Rainrate for end users

Reflectivity for radar professionals

Reflectivity and wind in polar volumes for NWP

Why composites ?

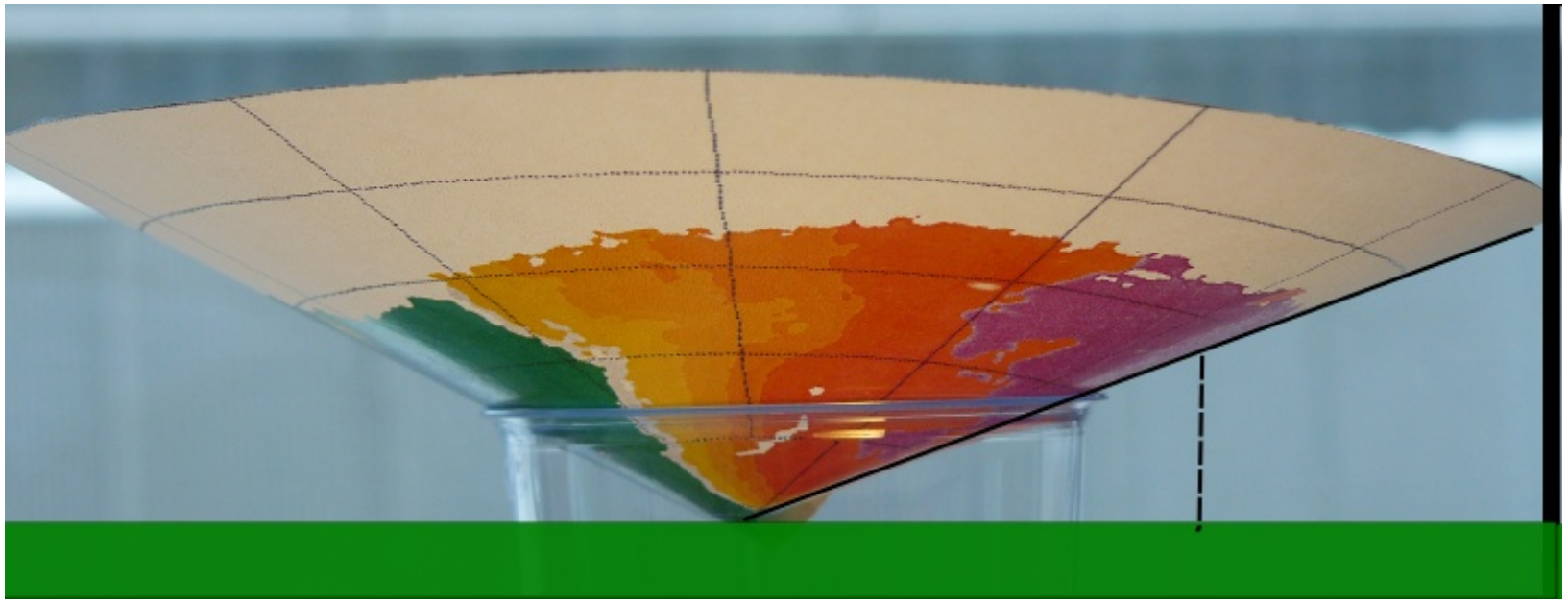


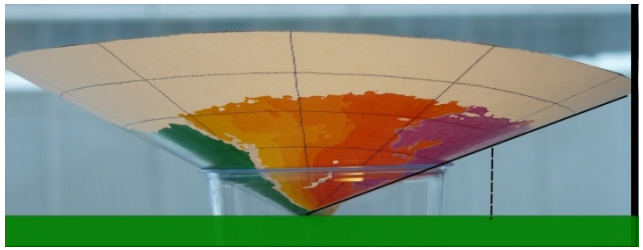
- Average radar measurement range (226 km) is usually larger than the distance between radars (median distance within Opera is 128 km)
- In overlapping areas we can select the best data.

Example from Poland - Czech Rep - Slovakia

Why composites ?

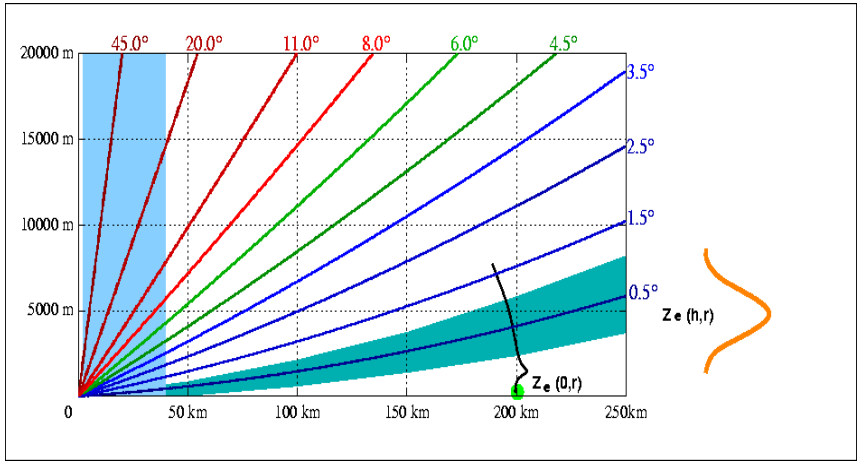
- Radar measurements are made on conical surface: edges are rather high (because Earth is a ball)





Why single site volumes ?

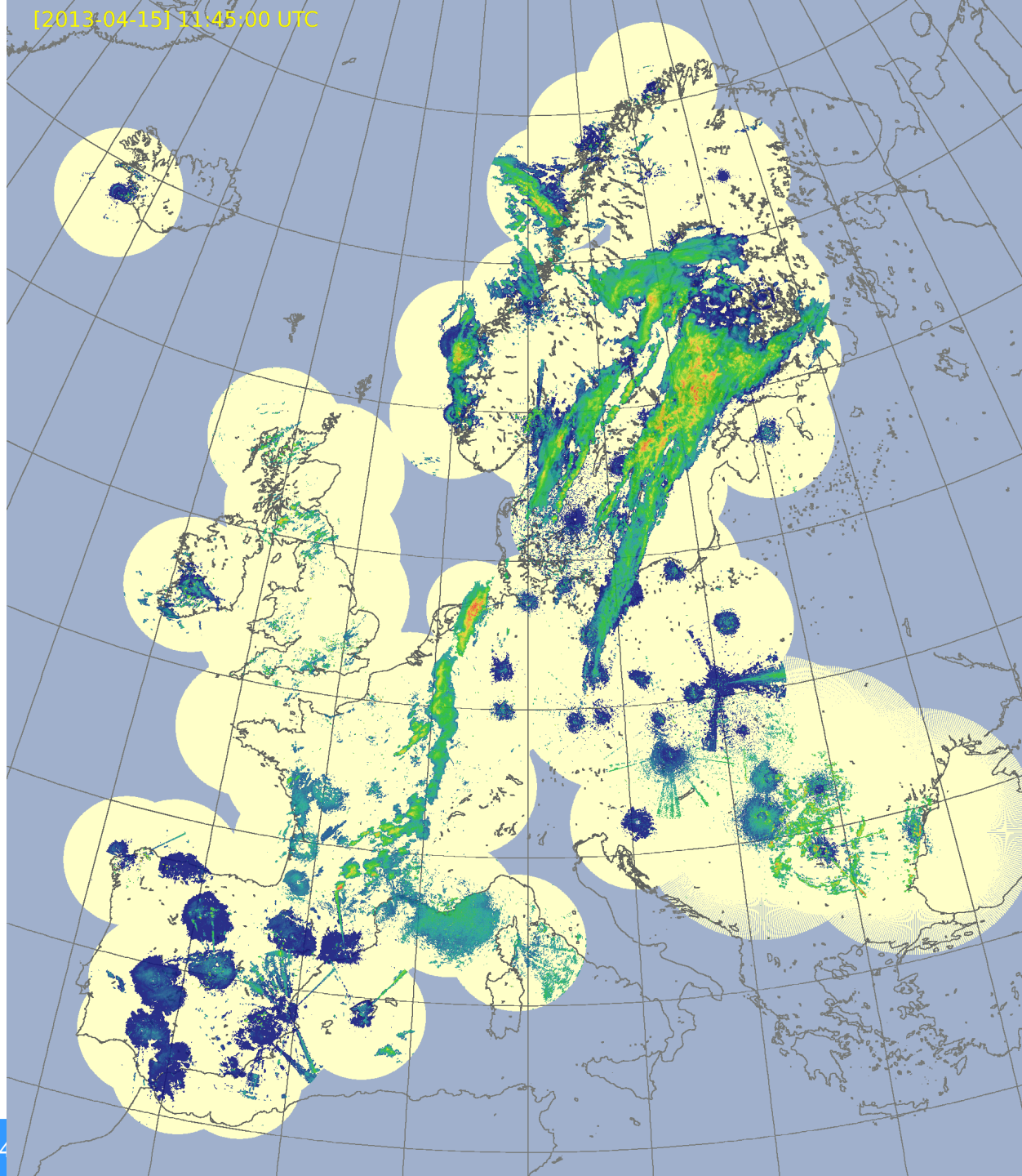
- Radar beam does not only get higher when it travels, it also gets wider. Clever assimilation schemas can understand this, but then they need to know for each pixel which radar measured it.
- Especially the velocity related properties vary often by elevation angle.



EUMETNET
European Meteorological Services Network

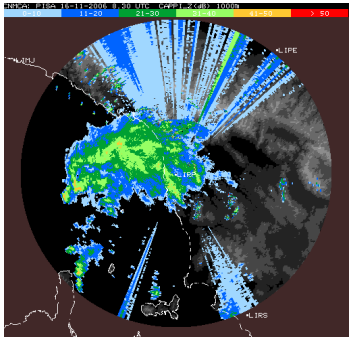
15 Apr 10z

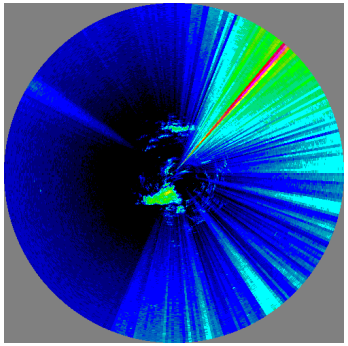
- Max reflectivity
- ”dirty”
- = data as it came to Odyssey



Interference is serious problem

hence EUMETNET has Frequency Manager



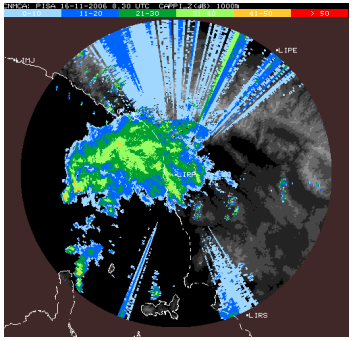


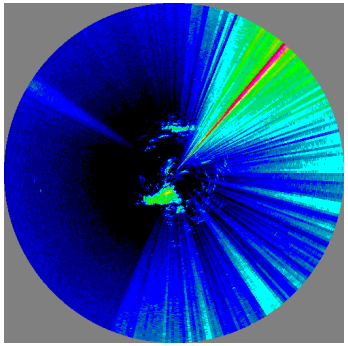
- RLAN 5 GHz decisions were made 2003-2004, with the **requirement for DFS** (Dynamic Frequency Selection) to protect radars
- Interference cases since 2006
- Huge number of non-compliant equipment (**more than 50% equipment on the market)**
- large number of interference cases are not lasting long enough to be investigated
- no radio Administration has the ability to withdraw large number of equipment from use (e.g. more than 275 000 in Czech Republic)
- If the trend is maintained = **Big risk of loosing the band** (e.g. South Africa)

Courtesy of Philippe Tristant
EUMETNET Frequency Manager

Windmils is serious problem

hence EUMETNET has Frequency Manager





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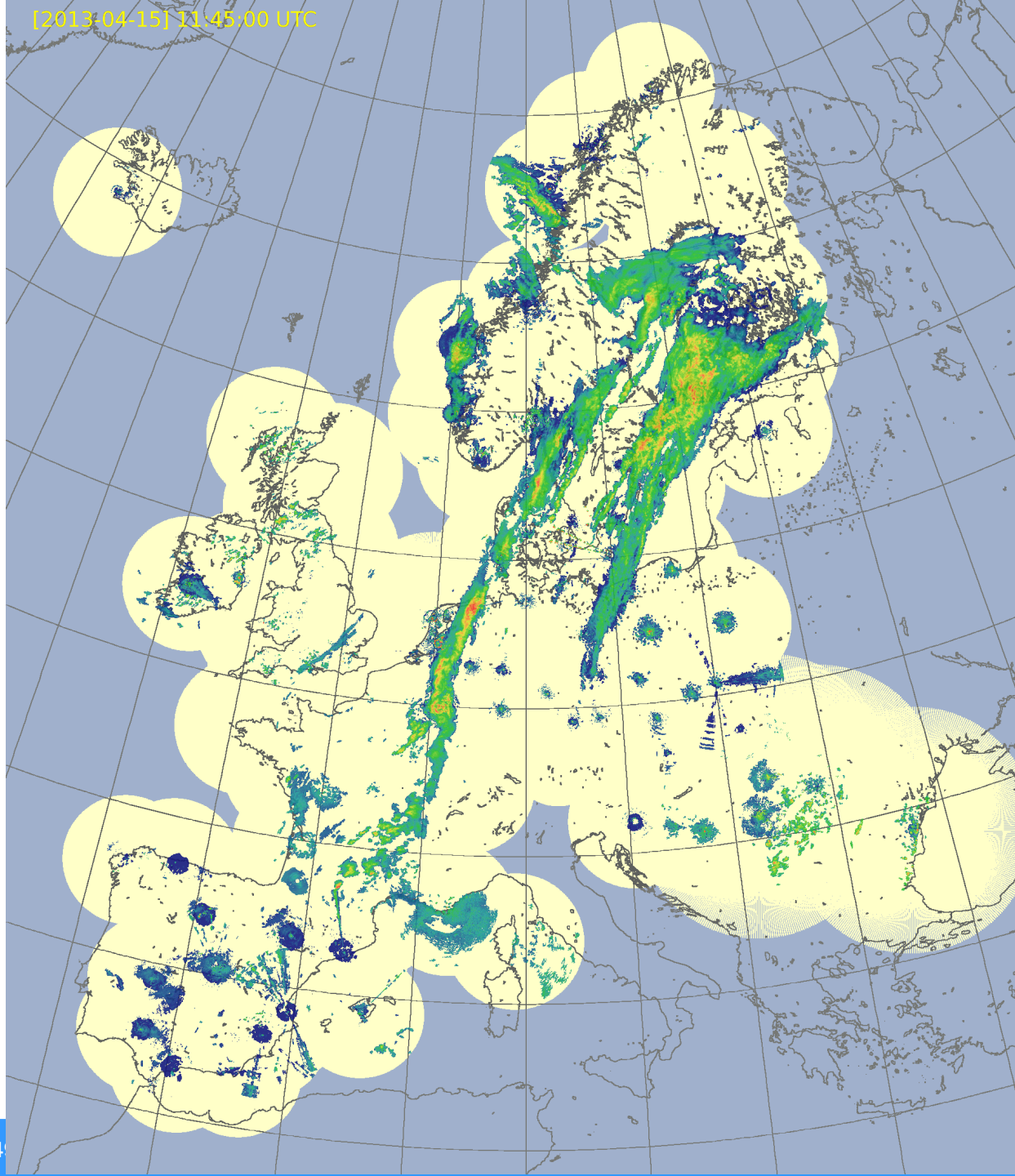
EUMETNET
European Meteorological Services Network

15 Apr 10z

- Max reflectivity
- Central ”cleaning” applied



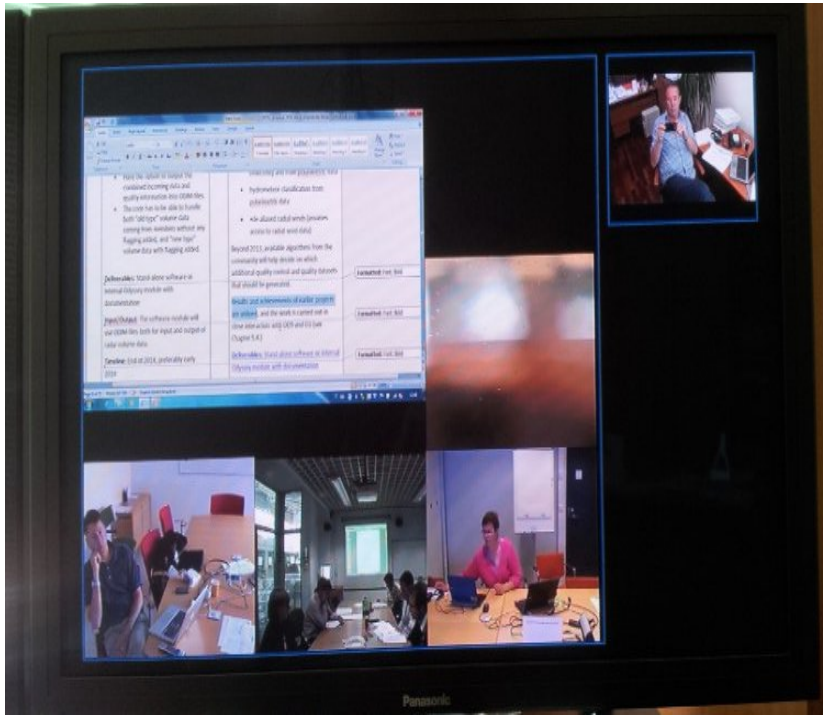
Success factors

Lessons learned 1/3: The differences

- You can not unify everything
  - There are still inches and millimeters
  - Ferrari owners will not drive Trabant speed
- Plan carefully to tolerate the differences
- A radar is a mesoscale tool, a network is synoptic scale tool. Needs careful consideration which applications should use which data

Lessons learned 2/3: Traveling is expensive

- Do not waste meeting time
- Act online whenever you can
- Seeing people is important to learn to know them



Lessons learned 3/3: Talk to each other

- The largest benefit to Opera members comes from free and honest exchange of experiences.

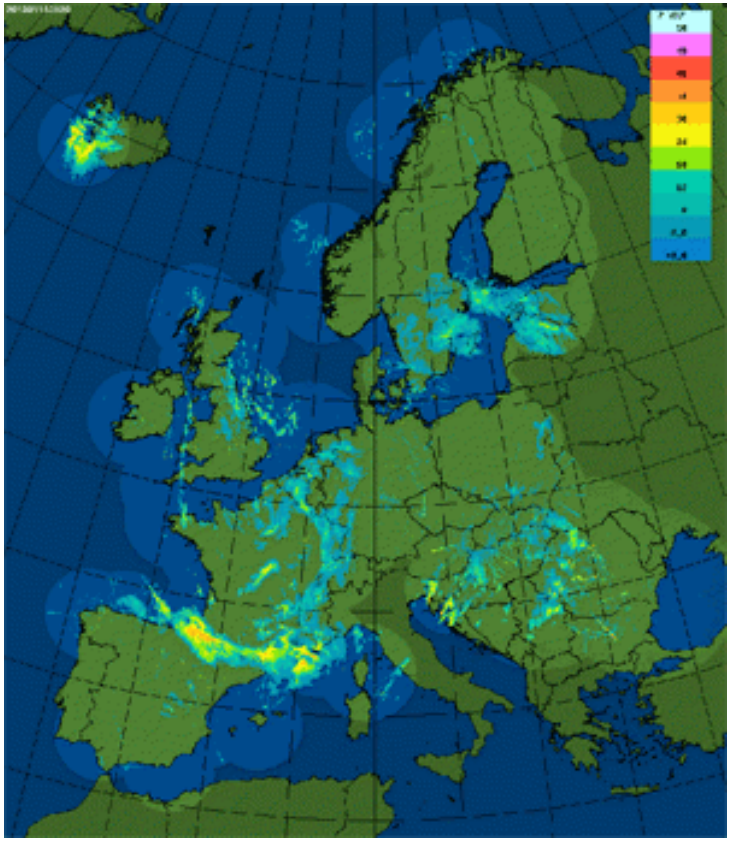
Milestones and deliverables

Work package	2013a	2013b	2014a	2014b	2015a	2015b	2016a	2016b	2017a	2017b
O-tasks										
Program management (+O5+O6)	1	report in every meeting								
O1 Odyssey operations	report in every meeting									
O4 Software support	report in every meeting									
O2 Radar database	report in every meeting									
O3 Radar studies		7,8	11	14,15,16						
O7 Portability					(23 ongoing)					21
O8 Inspire		4		13						
O9 More radar studies										
OD tasks										
OD1 Quality information in polar data	2	9	12							
OD2 Compositing improvements		5,6	10		17					
OD3 Distribution of flagged volume data		3			18					
OD5 Solar monitoring					19	20	25		25	
OD6 Vertical profile correction							21			
OD9 Integration	report in every meeting (24)									
Desirable requirements (OD4,7,8.10-16)										

	T	Description	When
1	O6	Succession plans	ET2013a
2	OD1	Updated ODIM supporting the inclusion of additional metadata & QI layers in the data sent to Odyssey by OPERA members	ET2013a
3	OD3	Report on the scenarii of bandwith use; each scenario will have associated technical solutions to implement the redistribution, with their cost	ET2013b
4	O8	Report of INSPIRE related practices among Opera members	ET2013b
5	OD2	Quality-based compositing formulation.	ET2013b
6	OD2	ODIM quality-based composite representation	ET2013b
7	O3	Selection of algorithms to be tested by OD1 and OD2	ET2013b
8	O3	Specification of evaluation methodology to be used by OD1 & OD2	ET2013b
9	OD1	New version of Odyssey software capable of ingesting both old and updated ODIM Synthesis of consultation of NWP community & OD2 List of metadata & QI layers to be output by Odyssey	ET2013b
10	OD2	Quality-based compositing methods implementation	ET2014a

T		Description	When
12	OD1	Evaluation report of algorithms generating the additional metadata & QI layers defined in OD1b New version of Odyssey software generating the additional metadata & QI layers	ET2014a
13	O8	Recommendation of work towards INSPIRE compliancy	ET2014b
14	O3	Final report on quality information	ET2014b
15	O3	Final report on use of quality information	ET2014b
16	OD1	Evaluation report of algorithms generating more / improved metadata & QI layers defined in OD1b	ET2014b
17	OD2	Implementation of verification metrics. Trialling of the methods. Selection of the all-rounder method.	ET2015a
18	OD3	A working system to redistribute the flagged volume data to the NWP consortia	ET2015a
19	OD5	Implement sun hit detection	ET2015a
20	OD5	Implement analysis software	ET2015b
21	OD6	Standalone Code for each VPR correction methods compatible with Odyssey standards. Inter comparison analysis report. Operational module on Odyssey infrastructure.	ET2016a

Opera composite



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