baltrad

Report on final implementation and validation of tailored end-user products into BALTRAD system

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Contents

1. Motivation

The report has been prepared in the frame of BALTRAD+ Project as part of work carried out in Work Package 4 “Pilot investment and real-world use”.

The tailored end-user products which are considered in this report were defined and described in the following earlier reports:

1. BALTRAD+ W4-2: Draft of catalogue of radar-based products which end-users are interested in
2. BALTRAD+ W4-31: Final version of catalogue of radar-based products which end-users are interested in

The aim of this report is to indicate how and where the products have been implemented and validated.

2. BALTRAD+ data processing

The BALTRAD+ processing algorithms are divided into packages that are related to groups of data corrections/processing and the algorithm providers. The following algorithm are implemented up to end of the Project:

bRopo		Anomaly (non-precipitation echo) detection and removal
	speck	Speckle removal
	speckNormOld	Speckle removal
	emitter	External antenna signal removal
	emitter2	External antenna signal removal
	clutter	Clutter removal
	clutter2	Clutter removal
	sofcut	
	biomet	Biological echo removal
	ship	Ship echo removal
	sun	Sun spike removal
	sun2	Sun spike removal
beamb		Determination of, and correction for, beam blockage caused by topography
	analyze	
	correct	
radvol-qc		Corrections and QI determination
	speck	Speckle removal
	spike	External antenna signal removal
	att	Attenuation correction
	broad	QI related to beam broadening
QI_total		Total QI determination based on all quality algorithms
Product2D		Generation of quality-based radar products
	ppi	PPI
	max	MAX

	vil	VIL
	et	ET (echo top)
	convection	Convection detection
compositing		Radar data compositing
	ppi	PPI
	cappi	CAPPI
	pcappi	PseudoCAPPI
	max	MAX
	pmax	PseudoMAX
	nearest radar	Nearest radar based compositing
	lowest bin	Lowest bin based compositing
qpe		Quantitative precipitation estimation (QPE)
	acrr	Accumulation QPE
	vpr	VPR corrections
	gauge adjust	Gauge adjustment
other		Other
	scansun	
	dealias	Wind field de-aliasing
	vp	
	wrwp	Baltrad weather radar wind products
	etop	Echo Top product generation
	poo	
	hac	
dual-pol algorithms		Algorithms for dual-pol radars
	attenuation	Attenuation correction
	class	Echo classification

The following algorithms have been delivered as software to GIT repository (http://git.baltrad.eu/git/) during the Project

–	BaltradDex	Distribution and Exchange subsystem
–	GoogleMapsPlugin	Creates PNG images for use with Google Maps
–	OdimH5	Data injector using ODIM_H5 and Rainbow file formats
–	baltrad-db	Database manager subsystem
–	baltrad-wms	Baltrad WMS package
–	baltrad-wrwp	Baltrad weather radar wind products
–	bbufr	BALTRAD interface to EUMETNET OPERA's BUFR software
–	beamb	Determination of, and correction for, beam blockage caused by topography
–	beast	Task manager/scheduler subsystem
–	brack	Anomaly detection and removal, product generation including injective compositing
–	bropo	Anomaly (non-precipitation echo) detection and removal
–	hlhdf	MHI's high-level C and Python APIs to HDF5
–	jrat	java tools
–	node-installer	Installation wizard
–	rave	Product generation framework and toolbox. Injector using ODIM_H5 files

3. BALTRAD+ products classification

In general, weather radar data can be divided into two groups:

1. Three-dimensional (3D) data written in spherical coordinates as set of two-dimensional scans. They are often called “volumes” (data volumes) or “raw data”.
2. Two-dimensional (2D) Cartesian data as cross-section or more complicated information written in 2D form, called “products”.

The 3D volumes are not highly useful for weather radar users because they are difficult to interpret. For this reason numerous 2D products can be generated from volumes. There is set of a few tens of standard products, but many products dedicated to specific users can be defined and generated. In this report the 2D products developed in the frame of the BALTRAD+ project are described.

The products may include different meteorological quantities like the standard ones: radar reflectivity (Z, in $mm^6\ m^{-3}$ or dBZ), precipitation rate (R, in $mm\ h^{-1}$), and wind speed (V, in $m\ s^{-1}$), or their derivates, like Echo Top (ET, in m) or Vertically Integrated Liquid Water (VIL, in dBA or mm).

All the products generated by BALTRAD system may be quality controlled (post-processed), i.e. corrected and quality characterized, by means of set of quality algorithm that are developed for the system needs.

In Table 1 general classification of reflectivity-based radar products is presented whatever they are available in BALTRAD system at present or not.

Table 1. Classification of base BALTRAD products (based on BALTRAD+ W4-42 report).

Basic meteorological quantity	Class of product	ODIM (standard) denotations	BALTRAD implementations	State of works (end of 2013)
Radar reflectivity, Z (in dBZ)	Plan position indicator	PPI	Product2D: PPI (IMGW)	Completed
Radar reflectivity, Z (in dBZ)	Constant altitude PPI	CAPPI, PCAPPI	RAVE	Completed
Radar reflectivity, Z (in dBZ)	Range height indicator	RHI, XSEC	RAVE	Completed
Height of echo top, h (in km)	Echo top	ETOP	Product2D: ETOP (IMGW)	Completed
Radar reflectivity, Z (in dBZ)	Echo maximum	MAX	Product2D: MAX (IMGW)	Completed
Liquid water content, VIL (in mm)	Vertically integrated liquid water	VIL	Product2D: VIL (IMGW)	Completed
Precipitation rate, R (in $mm\ h^{-1}$)	Ground-related precipitation, QPE	--	Networked VPR (FMI)	Completed
Precipitation rate, R (in $mm\ h^{-1}$)	Ground-related precipitation, QPE	--	COMBINATION (IMGW)	Research ongoing
Precipitation accumulation, R (in $mm\ h^{-1}$)	Ground-related precipitation, QPE	--	ACRR (SMHI, FMI)	Completed
Wind speed, V (in $m\ s^{-1}$)	Vertical profile	VP	WRWP (SMHI)	Completed

Classes of echoes	Hydrometeor classification	CLASS	BALTRAD-HMC (DMI)	Completed
Classes of echoes	Convection detection	CLASS	CONVECTION (IMGW)	Research ongoing

4. Applications for visualization of BALTRAD data

4.1. STUK application BALTRAD WMS

STUK has developed a visualization software for BALTRAD data. The visualization package is called BALTRAD WMS and it uses WMS protocol to serve radar images. The radar image viewing functionality is part of STUK's collaborative emergency management system TIUKU and dose-rate monitoring network Web site USVA (see Fig. 1).

WMS package version 2.0 with many improvements has been released can be obtained from GIT repository (via command line: git clone git://git.baltrad.eu/baltrad-wms.git).

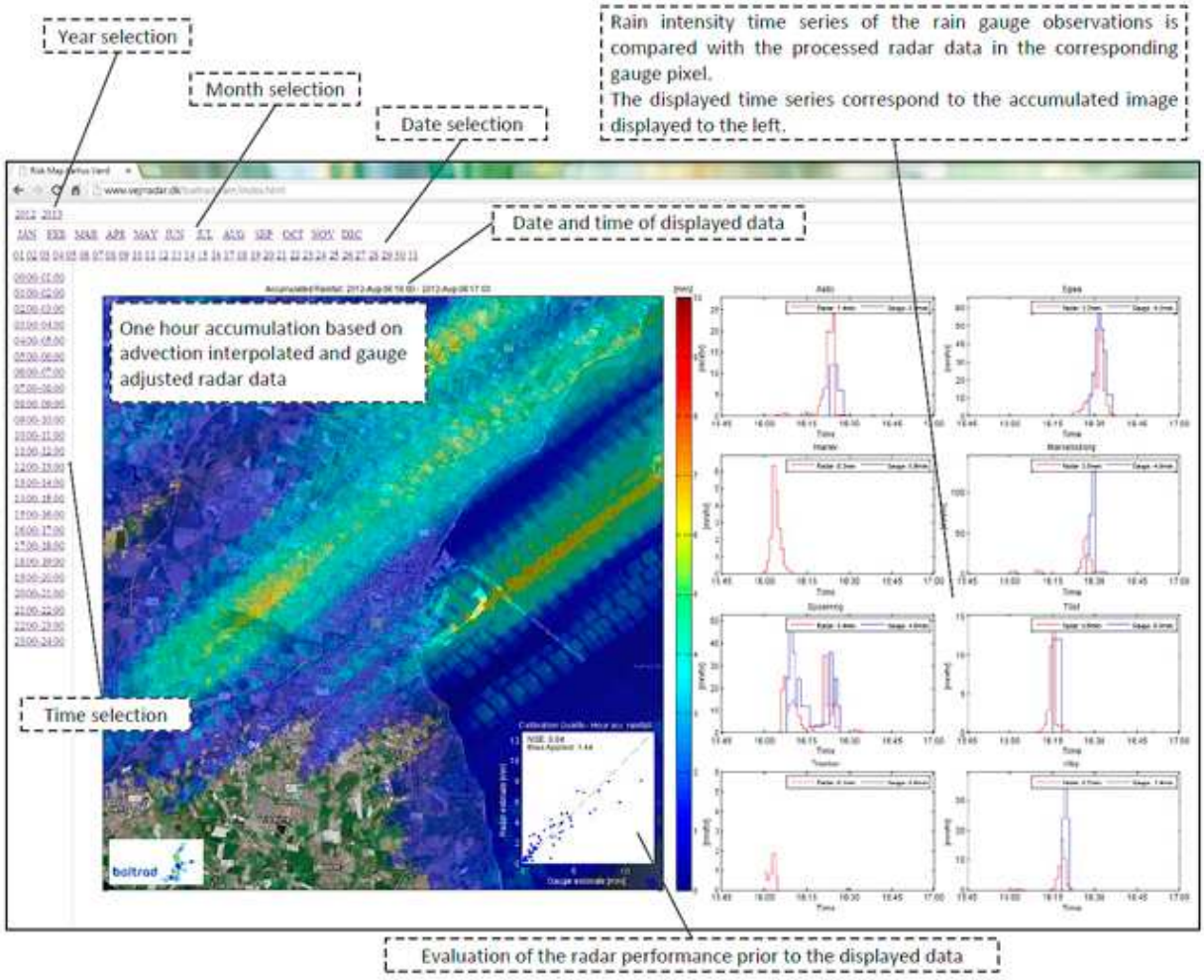

Fig. 1. View of BALTRAD WMS application

STUK will provide e-mail support if necessary for installation until the end of January. The installation is step-by-step guided for Ubuntu 12.04 and it probably works on other Ubuntu distros too. In other systems you have to install the dependencies yourself. The installation requires some knowledge on

package management and Web server configuration and it is explained in INSTALL file. A demo with BALTRAD and FMI Open data: https://ketaletest.stuk.fi/go/195.148.240.180/baltrad_demo/demo.html.

The host computer where demo is running is a virtual machine with low resources allocated and that's why it can be quite slow. The demo page can also ask some security related confirmations due to http requests in https page. If you don't get this working you may have to tweak some security settings of your browser. The demo will be online until the end of January.

4.2. Radar-based Risk Assessment Map (RAM) for urban flooding

A radar-based Risk Assessment Map (RAM) for urban flooding was developed in Aalborg University as tailored BALTRAD end-user product. The idea behind the application is that the RAM should support the daily routines in urban drainage management by facilitating an easy access to radar based observations. The properties and functionally of the Risk Assessment Map product was determined in a dialogue with the BALTRAD partner Aarhus Water Utility. The RAM is based on a combination of radar and rain gauge data. The radar data is received from DMI's BALTRAD node via BALTRAD data exchange to the Aarhus Water BALTRAD UD node, which is the first BALTRAD sub-node. The rain gauge data source is sent from Aarhus Water (in Aarhus) to the Aarhus Water BALTRAD UD node (in Aalborg).

BALTRAD partner STUK (Radiation and Nuclear Safety Authority) has developed a Web Map Service (WMS) -package as interface to visualise BALTRAD data in STUK's emergency systems KETALE (Centralised data system for the management of dispersion and dose calculation results) and USVA (Web interface to display results from the online dose-rate-monitoring network). STUK receives real-time radar data from FMI's BALTRAD-node.

Local Area Weather Radar (LAWR) integration

The integration of LAWR data into the BALTRAD network is an important step towards user-orientation in the urban context. LAWR have the potential to fill the gaps in the coverage of conventional radars. The BALTRAD system is designed to handle radar data in a general way it is possible to use LAWR data just like data from the conventional systems. This integration was demonstrated successfully. The BALTRAD sub-node in Aalborg University is online and exchanging data with two other nodes. The development of first and second generation radar data integration models have been completed and tested in off-line mode.

Under the hood

External support function was established, including regular software updates and commits to GIT server (git.baltrad.eu) and testing, integration and deployment on Jenkins continuous integration server (git.baltrad.eu/jenkins).

Data exchange component (BaltradDex) went through major modifications, aiming at improving exchange reliability and stability. These include modified and improved the data exchange format and communication scheme, database normalization, transactions in the object-relational mapping, error detection and more.

System documentation, such as user manual including data exchange format documentation was elaborated in parallel with development activities, and source code documentation was generated both with Javadoc and Doxygen tool.

Several Quality Assurance algorithms are implemented, validated, documented and added to the BALTRAD toolbox.

A flow of surface observations from the DWD's GISC (Global Information System Center) to SMHI's BALTRAD node has been established. It offers other BALTRAD partners access to such observations in the same way once we have finalize such methodology.

5. Abbreviations

2D – two-dimensional
3D – three-dimensional
CAPPI – constant altitude plan position indicator (standard radar product)
PCAPPI – Pseudo CAPPI (standard radar product)
CLASS – radar product which classifies certain phenomena
ETOP – echo top (standard radar product)
IMAGE – 2D Cartesian image (file object)
MAX – maximum of reflectivity (standard radar product)
ODIM – OPERA digital information model
PPI – plan position indicator (standard radar product)
R – precipitation rate/accumulation
RHI – range-height indicator (standard radar product)
SRI – surface rainfall intensity (standard radar product)
V – wind data (velocity and direction)
VIL – vertically integrated liquid water (standard radar product)
VP – vertical profile
Z – radar reflectivity

6. References

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