Conference Paper, Published Version

Petersen, Leif; Gomez, Roberto; Helzel, Thomas; Thomas, Nicolas

New Data Management System for Coastal Radar WERA to Support Decision Making

ICHE 2014, Hamburg - Lehfeldt & Kopmann (eds) - © 2014 Bundesanstalt für Wasserbau ISBN 978-3-939230-32-8

New Data Management System for Coastal Radar WERA to Support Decision Making

L. Petersen, R. Gomez & T. Helzel
Helzel Messtechnik GmbH, Kaltenkirchen, Germany

N. Thomas
Actimar S.A., Brest, France

ABSTRACT: The HF-Coastal Radar "WERA" is a shore based remote sensing system to monitor ocean surface currents, waves and wind direction. This very reliable long range (up to >200 km) monitoring system provides reliable data maps of the coastal zone with high spatial and temporal resolution. These data can be used for decision makers to optimize coastal zone management and planning and in case of emergencies it can be used to support hazard management.
The new data management system provides easy and fast access to all archived current, wave and wind data. The data are stored in an archive and can be accessed as time series plots for individual grid cells or as animated maps for the entire measured area. For each grid cell all data are marked with quality flags which can be used to exclude suspicious data from the analysis. Various output formats are available to compare the ocean radar data with data acquired from other sensors or numerical models.
In addition to use the measured data for planning and real-time monitoring, a special forecasting mode can be used to improve predictions of ocean currents and waves in case of risk management. Due to the outstanding accuracy of the radar the acquired data can be assimilated into numerical oceanographic models. In case of accidents in a distance of up to 200 km off the coast the real-time ocean surface current data can help Search and Rescue (SAR) operators. Presently, SAR tools are based on hydro-dynamical and atmospheric models to provide hindcast and forecast situations. Even if these oceanic numerical models are efficient to produce instantaneous maps of currents, the accuracy of derived Lagrangian trajectories is not sufficient for search and rescue purposes.
Results of various experiments with drifters to simulate a drifting persons or containers show the significant improvement of the drift simulation, when using real-time current data provided by radar systems instead of using results from numerical models only. This improved quality of the drift prediction can be very useful for various applications.
The same tool can be used for backtracking a monitored oil spill and estimate the origin to identify the polluter. Furthermore the improved numerical models can be used to provide more reliable metocean forecasts (sea states and currents) to be used by ferry operators. Data and experimental results from the French coast demonstrate the efficiency of these instruments.

Keywords: Data management system, Ocean radar, WERA, Decision-making

1 INTRODUCTION

1.1 *Coastal Radar WERA*

The array type HF-Coastal Radar WERA (Gurgel, et al., August 1999) is a shore based remote sensing system to monitor ocean surface currents, waves and wind direction. The measurement range of these systems can reach out to more than 200 km for current mapping or more than 100 km for wave measurements, depending on the operating frequency.

Publications about the results from systems installed all over the world have proved the accuracy of these systems (Liu et al., 2014; Cochin et al., 2006). The accuracy of the current mapping was tested by means of comparisons between the measured data of ADCPs or drifters with the ocean radar system. The results from various studies typically shows an excellent correlation factor of >0.9 (Cochin et al., 2006).

These data can be used for decision makers to optimize coastal zone management and planning and in case of emergencies it can be used to support hazard management.

2 DATA MANAGEMENT SYSTEM

2.1 *Standard Data Management System Structure*

The standard WERA data management system used to store the measurement data in individual files, with part of the file name being composed of the unique time stamp of the measurement start time.

Raw measurement data was stored in binary format to save space, post-processed data in ASCII format.

Generating e.g. a time series of data for an individual grid cell was slow, because for each time stamp the corresponding data file had to be opened and the required data point read out using customized scripts. 3rd party software had to be used to plot results.

2.2 *New Data Management System Structure*

The new WERA data management system uses a MySQL database to store measured data. MySQL is a very powerful open-source relational database management system (RDMS) and allows subsequent tools in the WERA system to have a structured base from which data can be retrieved and stored. Using a database, in comparison with having data stored in text files, brings several benefits, some of them:

- Data can be stored in binary form, not in ASCII characters, optimizing space requirements.
- RDMS allows setting indexes, foreign keys, queries from simultaneous users and other benefits which allow a faster, ordered and secure way of storing and retrieving data.
- RDMS use the standard and widely known SQL code. This allows users of WERA systems to develop their own routines or modify the existing structure of the database to satisfy particular needs.
- Usage of other open-source software (e.g. phpMyAdmin for MySQL databases).

The database was designed to both minimize storage requirement and, at the same time, to take advantage of indexes and foreign keys for fast retrieval of required data.

The new WERA data management system includes several software tools which processes and store the oceanographic data measured by reading the data files provided by WERA and storing the information to the database in an organized manner using SQL commands. In standard configuration, these tools are executed automatically without any human intervention.

Additionally, the data management system includes a user-friendly web application that allows accessing all the data stored in the database (Figure 1), as well as creating time-series and exporting the data to different formats (Figure 2).

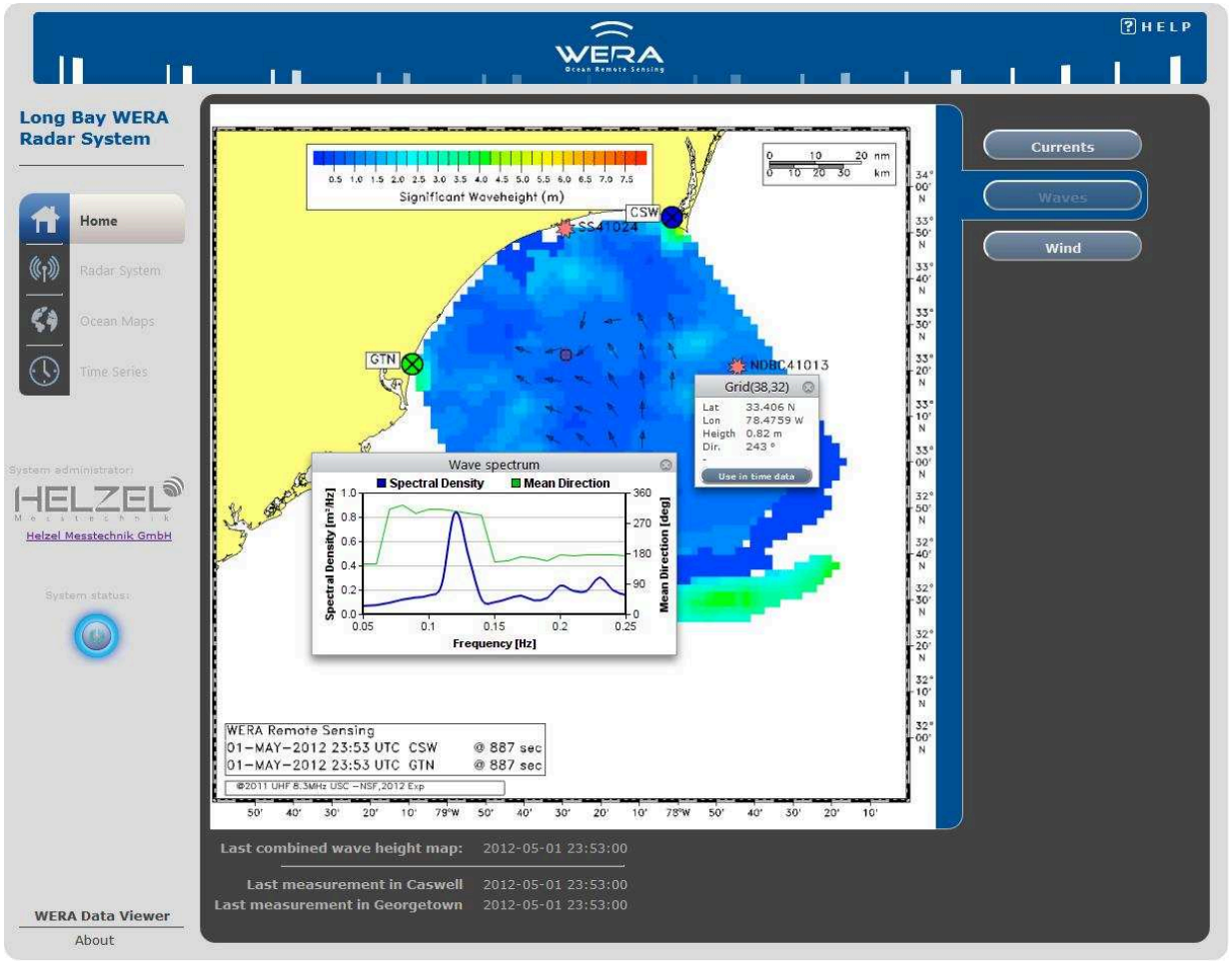

Figure 1. Web application to access data stored in the database.

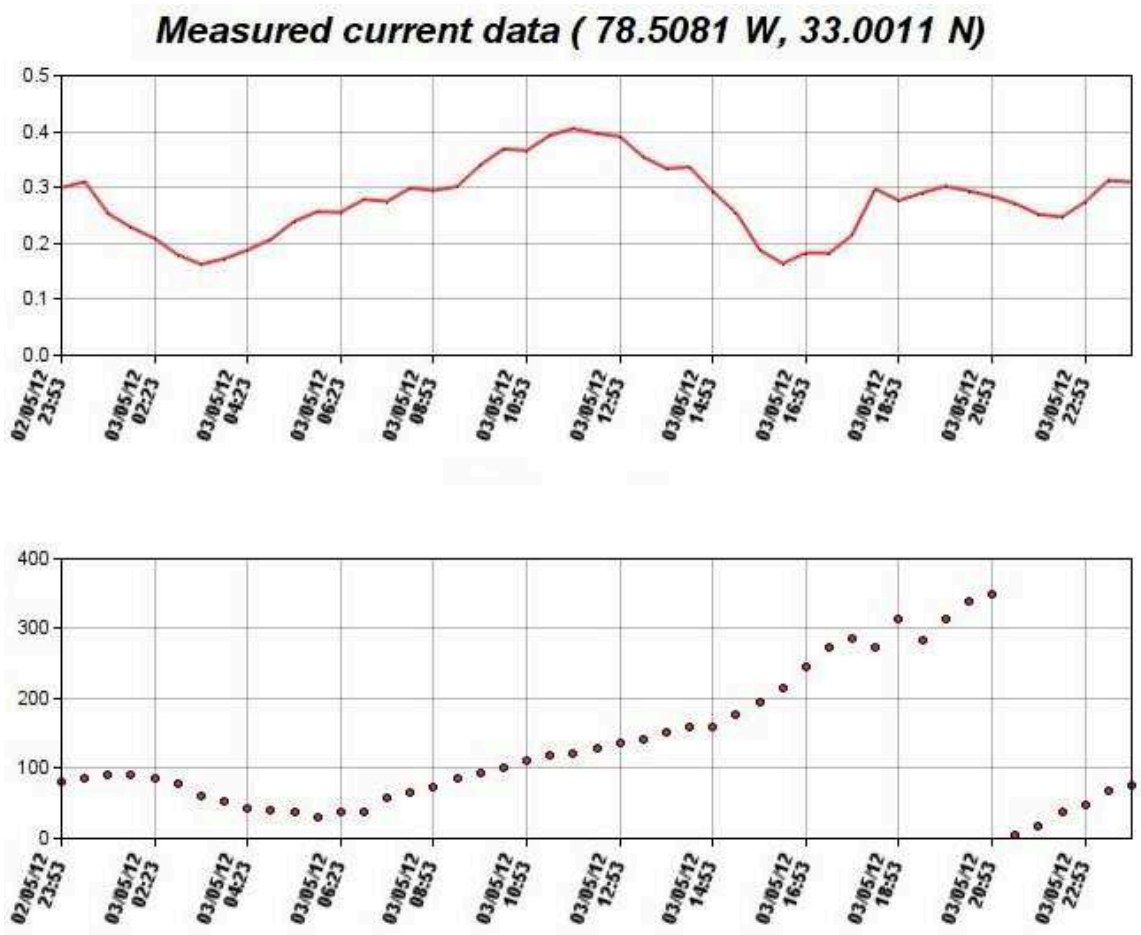

Figure 2. Example of time series created from data stored in the new database.

Having the possibility to access the past data from the database in an organized and fast manner facilitates the development of Quality Control routines that, in addition to the usual quality control tests on the data, also evaluate the consistency of the data in the time axis, rendering quality values that are more reliable and robust. After quality control is performed, corrupted data and artifacts can be easily identified and neglected. (Clifford R. Merz et al., 2014)

On the other hand, data with excellent quality standards can be selected and used for sensitive applications such as data assimilation. The tests and evaluations performed on the data during the Quality Control routines may be configured according to local conditions and to optimize the results obtained.

The standard data processing chain of the new WERA data management system already includes Quality Control routines. In the same way, the web application for viewing the data also allows visualization of different levels of quality.

The relatively easy access to the data provided by the database can also be exploited to make forecasts in coastal zones.

3 USING THE NEW DATA MANAGEMENT SYSTEM

3.1 *Integration of the WERA data into external data servers*

The New Data Management System of WERA enables browsing, viewing and applying quality controls to the data of several WERA station of a WERA network. The next step in the life of the WERA data flow is to be integrated in end-user applications.

In order to do this the WERA data must be usable by standard external metocean data servers, this is made possible by activating the Netcdf export of the New Data Management System. The data are exported to the Netcdf data format using the CF (Climat and Forecast) convention. The data can then easily be integrated for instance in a THREDDS (Thematic Real-Time Environmental Distributed Data Services) Data Server also named TDS, which is a web server that provides meta-data and data access for scientific datasets, using OPeN-DAP, OGC WMS and WCS, HTTP, and other remote data access protocols. This technology is already used by national agencies such as NOAA or IFREMER. This enables joining into a same data server the numerical modeling outputs with the data of various sensors included the WERA measurements.

Based on the TDS architecture, derived applications such as web data viewers based on the WMS protocol can be implemented and made available to a large panel of users (Figure 3).

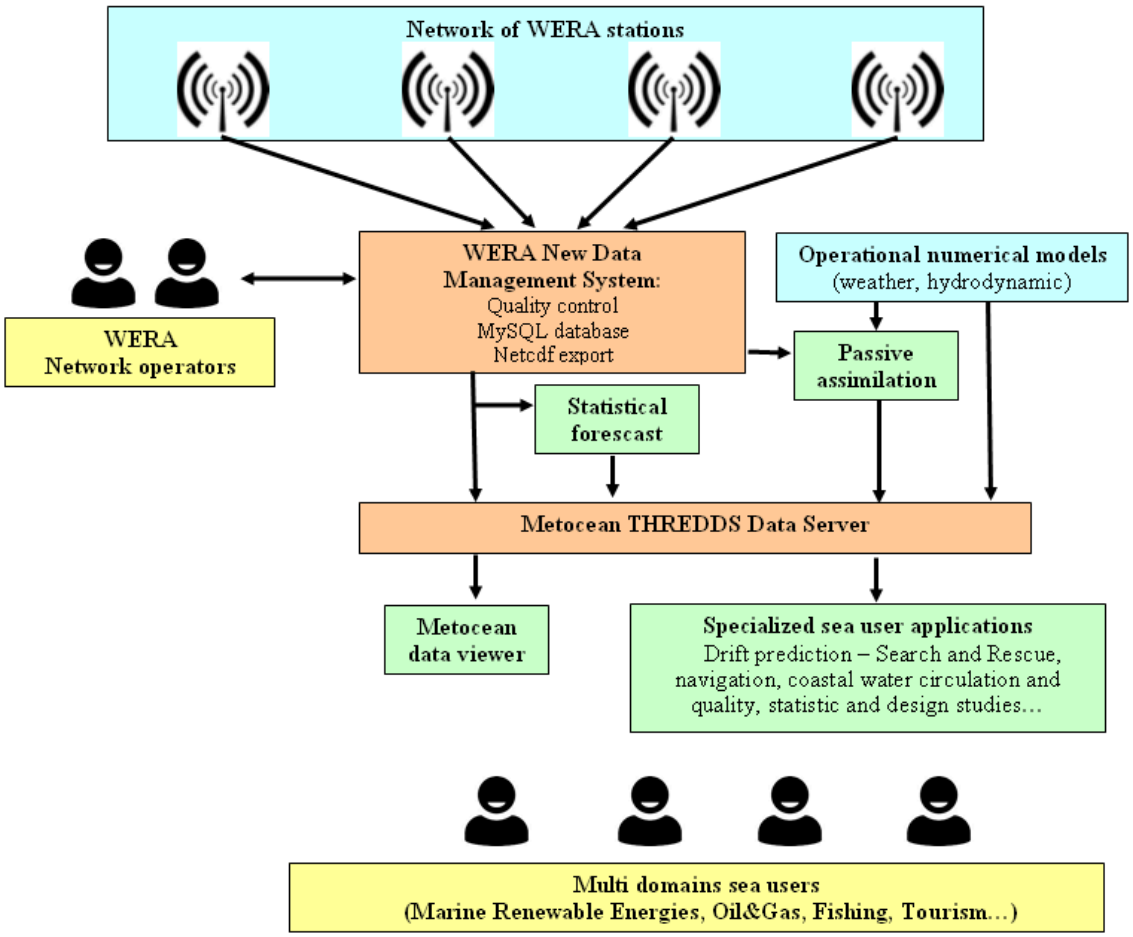

Figure 3. Example of data flow from the WERA stations to the end users using as center elements the WERA New Data Management System and a Metocean TDS system.

3.2 *Drift Prediction using the new Data Management System*

The accuracy of the WERA measurement, combined with the quality controls and the data exports allowed by the New Data Management System offers an ideal dataflow usable by surface drift computation systems. CURDRIFT© is one of those systems, it was developed by Actimar and allows to setup and run forward and backward drift computations for objects and oil slicks at sea, through a Web interface. The system needs a flow of surface currents and surface wind fields in the interest area, it can use any source of gridded surface currents and wind (WERA measurements, statistical forecast based on WERA measurements, numerical modelling, numerical modelling after assimilating WERA measurements…).

The outputs of CURDRIFT© are statistical results which are shown as contours delimiting several areas, depending on the spatial presence probability of the objects at sea, at the end of the drift scenario.

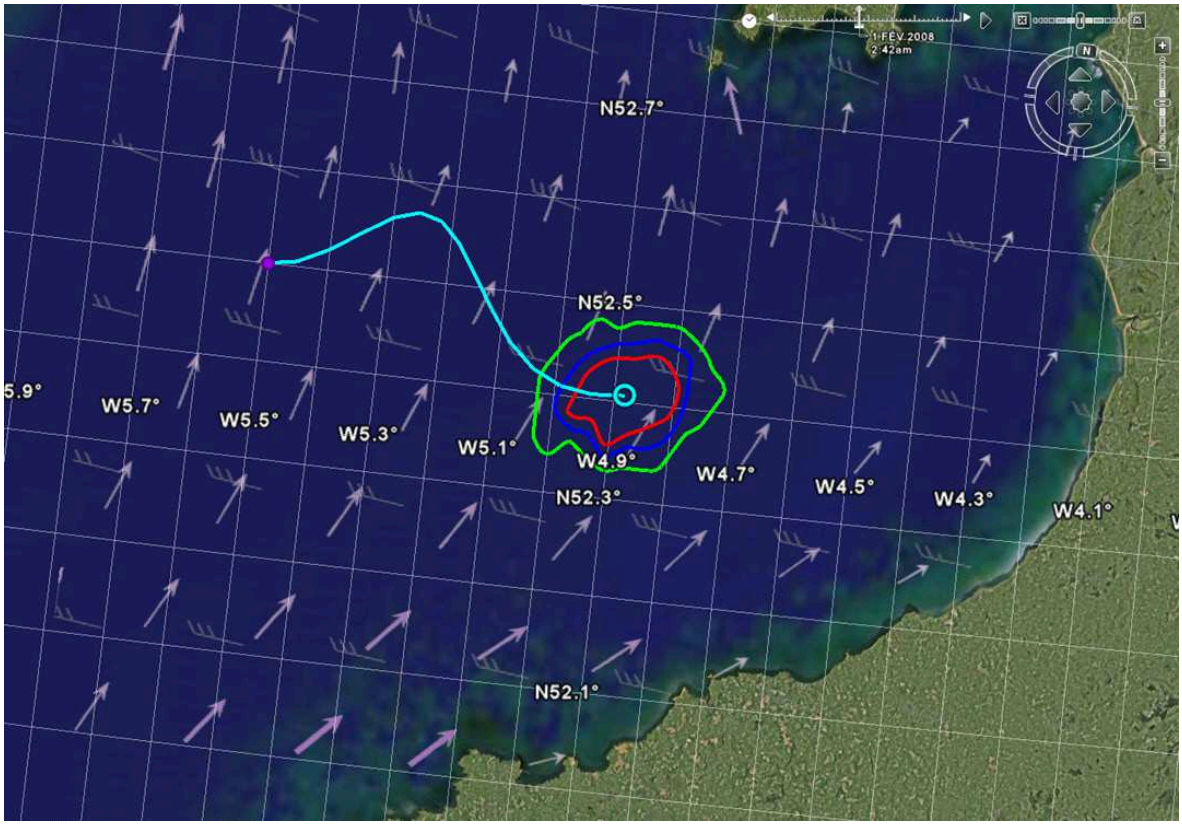

Figure 4. Simulated scenario of CurDrift©, container drift. Cyan : mean trajectory. From red to green : decreasing probability to find the object.

4 CONCLUSION

The new Data Management System for the ocean radar WERA provides easy and fast access to all archived current, wave and wind data. Due to its improved quality flagging for each grid cell and for each measurement, suspicious data can easily be excluded from further use and analysis of the data.

The new MYSQL data base structure and the option to export the quality flagged data into various output formats make it easy to import and use the data in all kinds of end-user applications or numerical models.

The data can e.g. be used for planning, real-time monitoring and drift prediction. A special forecasting mode can be used to improve predictions of ocean currents and waves in case of risk management.

This way it will support the user in decision making.

REFERENCES

Clifford R. Merz, Yonggang Liu, Robert H. Weisberg, Roberto Gomez, Thomas Helzel, Leif Petersen, Matthias Kniephoff, (2014). Real-Time Quality Control of Current Velocity Data on Individual Grid Cells in WERA HF Radar

Cochin, Thomas, Mariette, and Gurgel, (May 2006). SURLITOP experiment in West Brittany (France): Results and validation. 6th intern. Radiowave Oceanography Workshop (ROW-6), Hamburg, Germany

Gurgel, et al., (August 1999). Wellen Radar(WERA), a new ground-wave based HF radar for ocean remote sensing, Coastal Engineering Vol. 37, NOS. 3-4, ISSN 0378-3839, pp. 219...234.

Liu,Y.,Weisberg, R.H., Merz, C.R., (2014). Assessment of CODAR SeaSonde and WERA HF radars in mapping surface currents on the West Florida Shelf", Journal of Atmospheric and Oceanic Technology (resubmitted with minor revision)