Some quality aspects related with Punta Galea wind profiler and Kapildui weather radar.
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ABSTRACT

Operational radar systems must be monitored in real time. In general, this task is hard work, but it is a lot worse if we are talking of remote sensing systems. The amount of data that is generated by these systems, makes it necessary that technicians develop monitoring tools and indicators of quality to validate data. Visual inspections of data are essential but, it is important to take into account, manual work reduces the number of verifications in real time. Furthermore it is an expensive solution and it is very easy to lose the global aspects of the situation, looking at the details.

Our work is focused on keeping working, the polarimetric weather radar and the wind profiler that belong to the Basque Meteorology Agency, with a minimum level of quality. To achieve this objective, it was necessary to detect the weakness of the systems independently. Later, the procedures of the manufacturer were analysed and fixed to the site. Finally the integration, between them and with other observations was a challenge. The last task was more difficult to get because the integration is limited by non redundant observation systems.

This is not a finished work but it can offer a new perspective of the advantages of integration systems and involve groups of different disciplines to gather experiences that they could be potential operational solutions.

1. INTRODUCTION

In the last decade, the need of the Meteorology and Climatology Department of the Basque Government (Basque Meteorology Agency-EUSKALMET) to improve the meteorological observations in real time (high resolution time-space) and to supply data to heterogeneous groups of users (forecasters, civil protection, etc.), have led to increase its observation systems with a boundary layer wind profiler LAP-3000 (from Vaisala, in 1996) and a polarimetric weather radar (from Selex-Gematronik in 2005) between others.

These systems are useful if data have a minimum level of quality. if the users cannot trust in the meteorological products it isn't possible to make decisions. The definition of quality associated with meteorological data is complex itself, and in many scientific applications descriptions or metadata are necessary to reach good conclusions.

The European weather radar scientific community has been working during a long time to identify; sources of errors in data and deficits in weather radar technology, OPERA program [1] and its results is a good example of the goals achieved. An equivalent program that can be associated for wind profiles is WINPROF project. These two different programs have common objectives and their experience can enrich the work of the other.

Nowadays, to reach a complete definition of quality of radar, data must take into account many different factors that involve different disciplines and people (engineer, mathematician, computer scientist and experts in different applications).

In an operational point of view the Basque meteorological service needs to have their systems working and registering representative meteorological data.

2. OBJETIVES

The main goal of this article is to build good methods to monitor these operational systems and assure a minimum level of quality in the historical database. For this purpose we are going to take into account all the information above. Step by step, the met service will incorporate improvements and will identify the weakness in use of operation.

3. INSTRUMENTATION AND DATA QUALITY

A description of our systems and their sites is necessary to understand the complexity of the problem and the methodology applied. The complex topography, system features, applications and the meteorology of the Basque country and how they interact with quality aspects, are some of the points we are going to analyze.

1. Complex topography. The Basque country is located in northern Iberia, on the Bay of Biscay between two mountain ranges, Cantabrian and Pyrenees. It is a region of complex topography. In detail, the wind profiler is placed at the coast -43.37 N 3.04W, on top of a cliff at the entrance of an estuary [2]. The weather radar is placed inland, on top of a mountain [3]. Both sites have been considered due to the high impact in the quality of data.
2. System features.
   -The LAP-3000® wind profiler/RASS was installed in January 1996 at Punta Galea site. It has generated approximately a 12 year database. In general, the quality of the wind profiles is controlled by visual inspection of the

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data together with Weber and Wuertz automatic quality control algorithm. These are suitable controls under homogeneous conditions but not enough under certain meteorological situations in as complex a site as Punta Galea is. [4]. Wind and virtual temperature profiles are provided every 30 minutes. During wind operation two modes are alternated, after that, RASS mode is operated. -The Meteor 1500C polarimetric weather radar was installed in November 2005 at Kapildui site [5], [6], [7]. The system gives information of reflectivity, differential reflectivity and wind field every 10 minutes. For that purpose the system operates with two volumetric and two elevation scans [8]. The elevation scans are defined in two directions, trying to avoid the complex topography. The system has implemented pre-processing options and processing tools to filter data and improve the quality. But these tools aren't being used in operation. To reduce ground clutter impact Doppler filter is used in the lower elevations.

3. Applications of data. The main application of data is for real-time analysis, nowcasting and forecasting tasks. Depending on the meteorological event more attention is given to one system or another or both. Besides, not all the applications have the same quality requirements. Some particular requests of historical data require a high level of quality. In those cases post-processing studies are made by EUSKALMET.

4. Meteorology. It is well known to everybody that the systems need favourable conditions to work. Otherwise it can be meteorological conditions or seasons that are correlated with different clutter situations. This signifies that it is possible to know in advance the quality of the data associated with a meteorology event. This implies a deep study of the data registered in different meteorological patterns. Besides our country has a variety of meteorological phenomena that vary from the coast to inland and from west to east. Situations of floods, thunderstorms and strong winds are some of them.

To summarize, the error sources can be classified in three groups: the measurement errors of system (technical instrumentation, data processing, maintenance, calibration), errors of operation (poor definition of the operational parameters) and finally errors caused by varying meteorological conditions (site impact). If it is possible to quantify all of them, we can assure high data quality [9].

4. METHODOLOGY

The methodology is based on managing these three groups with one purpose that is: "be familiar with the system and its performance in a particular environment in order to make the best of it" [9].

We studied and analyzed:

1. The system information. It is important to know how it works, and what are the tools to test, to calibrate and control the quality of the data that the manufacture provides. To establish a feedback with the manufacture and to gather experiences with other people that work with the same technology are two of the actions most recommended and enriched by this communication.

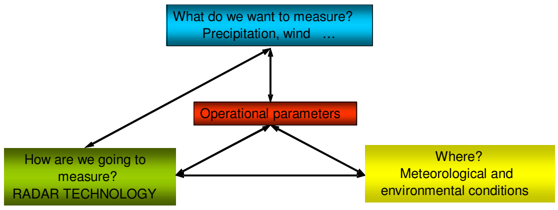

Figure 1. *The three groups interact with each other. The origins started with the necessity to measure and control a meteorological variable. The operational parameters should be defined to satisfy the original premise using the best of the system.*

2. The Basque country meteorology and the site. The performance of the system for a particular meteorology should be analyzed and studied in depth. There are many sources of contamination that are associated with a meteorological event and the performance and quality of the signal is meteorological dependent. Besides, the site of the system has a dynamic behaviour that must be evaluated from time to time. Some examples can be: bird migration, ground and sea clutter, anomalous propagation, blocking effects … .

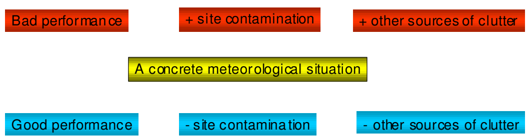

Figure 2. *Assuming that the system is functioning correctly, the capacity for the system to measure and the impact of the site and the clutter of a meteorological event should be evaluated. More emphasis is taken with severe meteorological events.*

3. Operational parameters. The optimization of the operational parameters has dynamical behaviour that is very difficult to apply in an operational point of view. Besides, the settings of the system along the years vary due to: advances in the technology (new versions), and basically because we acquire a better knowledge of the abilities of our sys-

tem. During the time it is necessary to work in the two groups above to achieve good settings. One approach is to use a standard, an non compromised operation sufficiently reliable for all meteorological conditions.

The basic tools used to undertake this are, explore the data with visual tools that provide the manufacture in different levels of processing and make statistics to emphasize features in the data. Remember that this methodology is applied to two different radar technologies, this has an advantage, improvements of one system are considered as potential solutions to the other.

5. RESULTS

In spite of the systems that are sold to work unattended, the truth shows that it too many controls are necessary to assure that the system is working properly.

In June the wind profiler was submitted to a complete maintenance. This was made by engineers of Deutscher Wetterdienst Meteorologisches DWD. This work was economically supported by the WINPROF project and Basque met service. The goals: were test the system; review the operational parameters and server as training for the maintenance group and the technical support of the Basque Met Service. During the maintenance an intermittent failure was found in the relays. After the maintenance some statistics of the data was made to achieve reference values and to re-examine data looking for definitions of ranges of values in meteorological, a non meteorological pattern. Visual inspection of the data is made everyday. In case suspicious behaviour or an interesting meteorological event was detected, deeper inspection is made. The day shown was June 17 of this year.

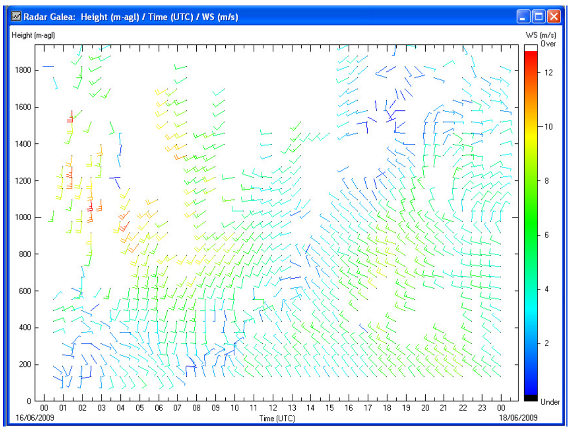

Figure 3. *June 17 2009 (first day after maintenance). Low mode 60 m). The first hours of day the profiles are contaminated by birds. The first gates are biased by the cliff effect. Image made from Graphxm.*

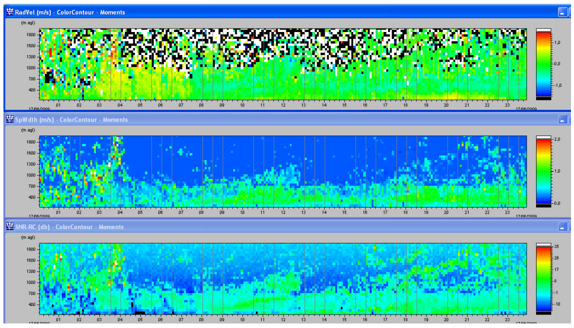

Figure 4. *June 17, 2009.The image showed the contour plot of the three moments of the vertical beam in the low mode. Correlation of meteorological patterns along the three moments has been found. The different layers are identified by correlated discontinuities in the three moments. Bird contamination and downward vertical motions in the first layers are found (features of the site) Image made from Lapmon.*

More detail is found with statistics. Scatter plots of the three moments of this day (from 8 AM to 3 PM) is shown below.

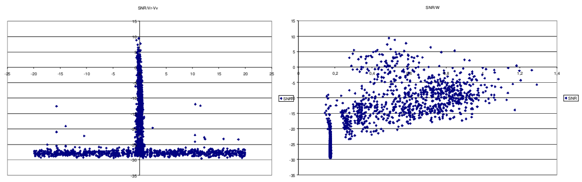

Figure 5. *June 17, 2009. It is possible to improve the quality of the data defining a range for the three moments.*

During May and June several improvements in the operational parameters were made according to the suggestions of Winprof project and requirements of the Basque met service.

Similar work was made with Kapildui weather radar. In July the manufacturer performed maintenance and calibration of the system. This helped to improve our knowledge of the system and to update the nominal values.

After this, the data was monitored using two rainbow tools Raindart and 3D Rave. Special emphasis is taking in the dynamical impact of the clutter along different meteorological conditions.

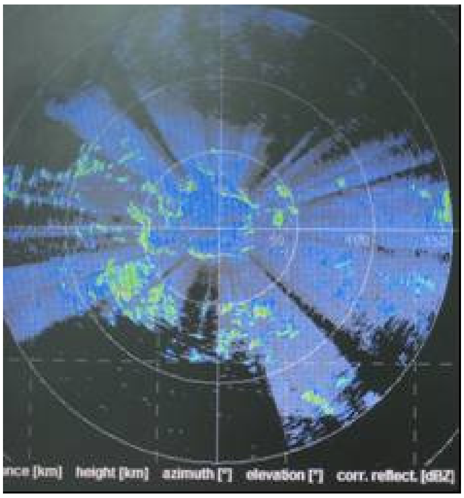

Figure 6. *This is the reflectivity data registered by the radar of Kapildui, without clutter filters. Elevation 0º, (Short pulse) in clear air conditions.*

Differential reflectivity is the only polarimetric variable registered by the radar at this moment. The calibration and adjustment of this is very complex. A complete meteorological database should be analyzed trying to characterize the range of values registered under different meteorological conditions. Although this variable has a potential value to distinguish between different hydrometeorological targets, more experience and more knowledge is necessary.

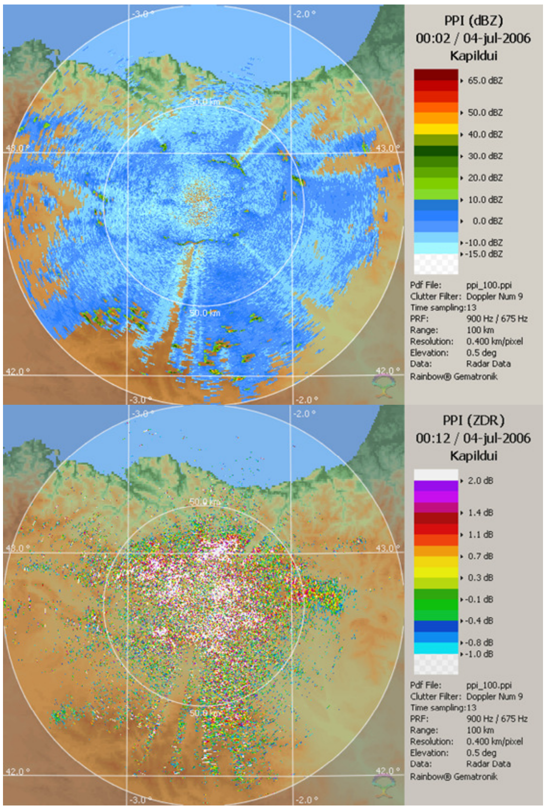

Figure 7.*July 4, 2006. The figures above are the reflectivity and differential reflectivity as registered by Kapildui weather radar. Elevation 0.5º (Operation elevation-Short pulse).*

The Kapildui weather radar has some thresholds to reject poor quality data. One of them is the SQI (Signal Quality Index). The SQI is the normalized magnitude of the autocorrelation al lag 1 and varies between 0 to 1 [10]. In a practical point of view this index is sensible to weak SNR and large width, situations where the quality of the velocity could be degraded. One of the works that we are working on, if the possibility of applying this index for the wind profiler data.

This work isn't finished but much progress has been made in the last year. The integration of both systems is crucial. Our knowledge with management of wind profiler radar should be used to weather radar. The weather radar studies and experience should be evaluated to apply to wind profilers.

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