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Inclusion of Radar information in the surveillance panel of the Basque Meteorology Agency

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1 Introduction

Basque Meteorology Agency (Euskalmet), among others functions, is in charge of weather surveillance and monitorization in a full time non-stop basis (24h 365d).

One of the most effective techniques for operational surveillance is the human visualization of radar images as an early warning of a forthcoming large precipitation event. We adopt this strategy, and radar information in different formats is presented in combination with other products in the so-called "surveillance panel" in the Basque Meteorology Agency. The system implemented is giving us, in a real time basis, graphical information generated from different data sources. Few months ago a new acquisition data source was incorporated, the recently installed Kapildui Weather Radar (more details in Aranda, Morais 2006). Information from this radar becomes the most effective data source for weather surveillance and monitoring of heavy precipitation events.

In this paper we focus on those aspects related with the implementation of systems for the radar data used in the surveillance panel. First we introduce the Kapildui Radar operative configuration. Second we focus on the surveillance panel and software developed for slides view. Third we present the automatic products generation system. Fourth we deal with the products selection and the integration of radar information in different slides. Finally we present some conclusions and future work.

2 Kapildui Radar system overview

Kapildui Radar is a METEOR 1500 Doppler Weather Radar with Dual polarization capabilities from Gematronik. This Radar is based in a Klystron transmitter system, operates in C-band frequency and uses the advanced signal processing environment Aspen DRX as digital receiver and signal processor. The radar control processor RCP interfaces to the signal processor and buffers the preprocessed raw data, establishing an efficient control structure for all components in the system and interfaces the radar with the two software packages used: Ravis and Rainbow.

At Kapildui site a Linux PC is used as Rainbow server, controlled from Lakua site where a similar Linux PC is used as Rainbow client workstation. The radar data acquisition is completely managed by the Rainbow server workstation; raw data is acquired and stored and the product generation is automatically scheduled according to the installed scheduler job on the server.

At present time we are using a configuration based in four different scans providing meteorological data every 10 min. First volumetric scan takes 120 seconds and is configured for a maximum range of 300 km with 5 elevations from 0º to 2.5º, a range step of 1km, an angle step of 0.8º, a pulse length of 2µs and 495Hz PRF. Second volumetric scan takes 363 seconds and is configured for a maximum range of 100 km with 14 elevations from –1.5º to 35º, a range step of 250m, a angle step of 1º, a pulse length of 0.8µs and 900Hz PRF. Third and Fourth scans are elevation scan for selected direction (339º and 241º) with an angle step of 0.3º, a maximum range of 100km from –1º to 50º elevation, taking 16 seconds each one (see Gaztelumendi et al 2006 for more details about kapildui radar system).

3 The surveillance panel

In Euskalmet offices we have a lot of information available for Basque country area coming from our systems (AWS, Wind Profiler, Radar, Meteosat) and from other external sources (internet). The most interesting part of this information is the base for many different products that we generate in real time basis for surveillance purposes.

3.1 Hardware description.

One of the most relevant monitoring tool available in Euskalmet offices is the so-called "visualization panel" (or "surveillance panel"). This panel is a Display Wall of 10 meters broad by 3 meters high, conformed with 8 DLP

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Display Wall Cubes (Mitsubishi VS-50XL20U 50" Projector). This Display Wall is connected to a dual PC that supports visualization hardware with Windows XP as operative system. In this panel we are monitoring different graphical outputs with real time information relevant for different purposes related with continuous surveillance, that is, the system is running 24 hours per day the hole year (see fig. 1). The monitoring capabilities are driven with a specific control system software we have developed with that purpose.

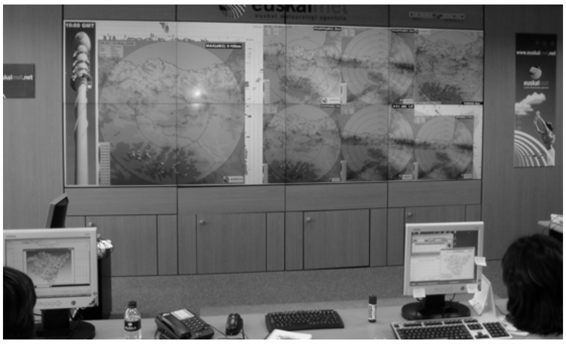

Fig. 1.. The "surveillance panel" in Euskalmet Office.

3.2 Software description

Surveillance Panel Control System has been developed using Visual Basic 6.0, and is running under Windows XP operative system. The surveillance panel control system is based on a general module (see fig. 2) controlling a group of N different slides control applications (see fig. 3) corresponding to N independent surveillance slides.

The General Control Module controls each particular slide configuration, managing all common aspects, assessing continuous execution of the corresponding surveillance slide.

The Slides Control Applications take advantage of the main characteristics of the Activex Image control technology, the low use of system resources and rapidity of update, in order to show simultaneous and synchronous the images sequences. The change of each frame in all the surveillance slides that conform the system is made every second. As the components of each frame (images) are stored in a remote particular directory structure, we are using Activex control FileListBox for navigation and selection of different components. It is worth mentioning the role of DoEvents() function, this function allows the operating system to take control and facilitates interactions panel-user necessaries to change from a slide configuration to another one, to stop a particular frame, or to navigate step by step showing particular information for each 10 minutes period chosen.

The kernel of each slide application is based on a recursive procedure, allowing visualization of all the images in a synchronous way, checking the different frame components once a temporal slide shows cycle finalizes. Information is included in the system as soon as it is generated. The synchronization process considers different possible timings for the images updates, as different products have different update times rate (radar and Basque Country AWS mesonet data are available each 10 minutes,, profiler data each 20 minutes, etc.) Inter-frame time delay and the last frame stop time are also configurable. At any time it is possible to change between different slides and to stop and advance each time, step by step into a given slide. This actions are controlled with mouse button clicks. Changing each slide scenario is done under selected control- key from the keyboard.

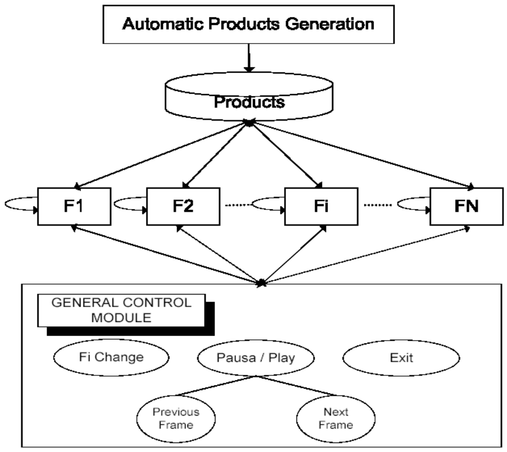

Fig. 2. Surveillance panel control system, general scheme.

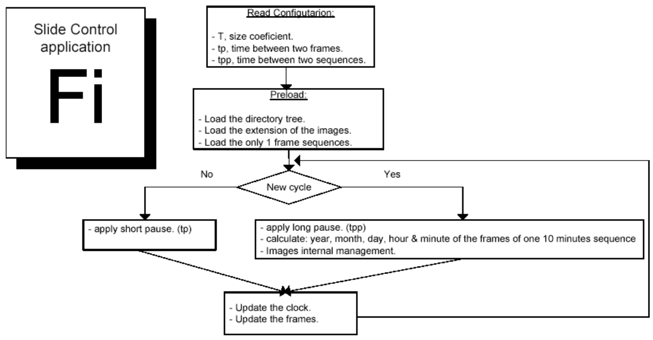

Fig. 3. Slide control application scheme.

4 Automatic radar product generation system

The Surveillance Panel Control System needs, in a specific location with a specific directories structure, the different products used. We have developed automatic product generation applications to feed the system with graphical outputs from different sources. Here we introduce the Automatic Radar Product Generation System used today and mention other non-radar product generation systems that also feed the surveillance panel.

Once a particular scan (azi, vol, ele) is done, a raw data file (dBZ, V, W, ZDR) is generated and a set of products (ppi, cappi, max, etc.) are automatically generated. At this moment, the main tool used for radar data display and generation of products is RainDART, the display analysis and research tool from Rainbow application group. DART offers the possibility to convert displayed products automatically to .png through "Image Generator", so we are using this capability to generate automatically images. Image

Generator opens views, displays and grabs images automatically, stores these as .png and closes the product view again, so two sessions of DART are continuously working in the background of Lakua Rainbow client workstation, one generating files for internet use and the other one as the basis for intranet products. Images are generated from products views, so we have specified for each product the visual appearance desired, including the colour palette, the legend, the corporative logo, the topographic and political boundaries depending on each product. Further treatment of those images are done (outside DART) based on Linux shell scripts and ImageMagick functions for preparing selected images for its panel visualization (see fig 4). Other Linux shell scripts are implemented to manage the file structure, rename files and distribute final images.

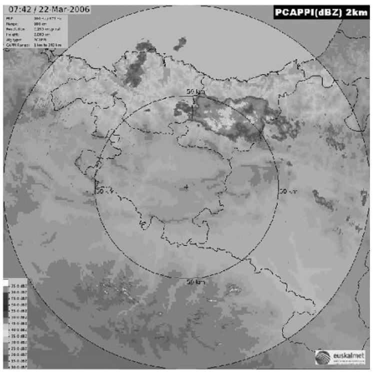

Figure 4. An example of surveillance panel image.

As we have mentioned earlier, other products generation systems are implemented for graphical outputs generation. Using AWS data as input, we have two main systems to generate images in real time, for their use in the surveillance panel. The first one is developed using IDL, and is mainly used for spatial interpolation of meteorological data, as the base for a continuous representation of meteorological magnitudes in the territory. The second one is based in a couple of FORTRAN and C routines in combination with GrADS, and is used to generate different maps and graphics for warnings and temporal evolution of different meteorological variables (Gaztelumendi et al 2006). A similar system is used for image generation from other available sources (SYNOP, METAR, etc..). We are also generating different images with software available from the Pta Galea Wind profiler and the Meteosat system.

All these graphical generation systems are running under linux shell scripts control and run automatically when information coming from the different data sources are available. As a result all maps and graphical resources, including radar products are generated as soon as possible for its visualization in the surveillance panel.

5 Radar data in the surveillance panel.

All the information coming from the Kapildui radar each 10 minutes is complemented with the data originated from other sources. A Wind Profiler located in Punta Galea (near Bilbao harbour) registers with a temporary resolution of 30 minutes, profiles of wind and virtual temperature. A Meteosat Data system is also available in Euskalmet offices. A combined automatic high density measuring network for meteorology, hydrology, oceanography and water quality, provides each 10 minutes some type of meteorological measure in 85 different locations in the country. More details about AWS mesonet in Gaztelumendi et al 2003.

A selection of information available is grouped in thematic visualization slides, each slide is a special combination of different graphical products giving information about one particular surveillance subject. Since now we have configured several slides, containing relevant information for general vigilance, flash floods situations, Storms surveillance, Coastal Trapped Disturbance situations, AWS warning detection. And monothematic slides for Meteosat and Radar.

5.1 Radar product selection.

We have selected a group of products for operational use, considering potential surveillance interest. Operational radar scheduler configuration gives us measured scan data sets of Z type (log reflectivity in [dBZ]), V type (mean velocity in [m/s]), W type (spectral width estimate in [m/s]) and D type (differential reflectivity ZDR in [dB]). For the moment the most part of products selected are produced from reflectivity data type sets. In order to avoid misinterpretation problems, most part of products selected for routine use are first levels products selected from the standard products group and few from extended hydrological, phenomena detection or nowcasting products groups.

From the standard group, we have selected for its potential inclusion in the surveillance panel: - Plan position indicator product (PPI) for DBZ data type and the two volume scan available the first three elevations (for 100km 0.5º, 1.5º, 2.7º and for 300km 0º, 0.5º and 1º). - Range height indicator product (RHI) for the two elevation scan for DBZ and ZDR data type. - Pseudo constant altitude PPI product (PCAPPI) for the first volume scan 2km, 3km, 4km, 5km level DBZ type for the 100km range 1km, 2km, 3km, 4km, 5km, 6km, 8km, 10km, 12km level DBZ and ZDR type. - Maximum products (MAX) for the two volume scan from 2 to 10 km DBZ data type. - Echo height products (EHT), in particular echo top, echo base, layer thickness and maximum reflectivity height for 100 and 300 range and 15, 45 and 55 dBZ as thresholds.

The rest of products are generated from the 100 km volume scan. From the extended group, we have: - Volume velocity processing products (VVP) for a column from 1km to 8 km above the radar site. - Horizontal wind (HWIND) for 2 km and 3 km with a range of –35 m/s to 35 m/s. - Layer mean reflectivity (LMR) products from 2 km to 10 km.

From the phenomena detection group we have the storm structure analysis product (SSA) and the hail detection (ZHAIL). From the hydro group we have surface rainfall intensity (SIR), precipitation accumulation (PAC) and the vertical integrated liquid water content (VIL).

5.2 Slides configuration.

Radar data are introduced in the surveillance panel through a particular slide configuration containing a group of specific radar product. We are using some Radar products in nearby every slide. Slides for flash floods, storms and general surveillance contains very basically Z type products like 2km PCAPPI maps for 300km and 100km range and PPI 0.5º 300km range in combination with data from other sources (see fig 6).

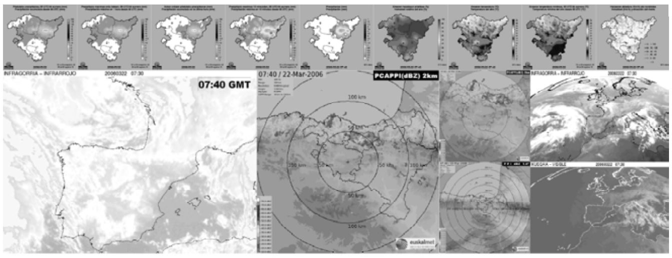

Fig. 6. Surveillance slide for general monitoring, containing Radar images combined with Meteosat and AWS data maps.

We have defined four radar monothematic slides containing selected radar products, KAP00, KAP01 and KAP02.

For a general situation overview slide KAP00 contains seven combined maps from 300km range and from 100km range. We have for 300km range MAX from 2 km to 10 km, PCAPPI 2km, PPI 0.5º and a 1km PCAPPI zoomed for 150km. For 100 km range we have MAX from 2 km to 10 km, PCAPPI 2 km, and HWIND for 2 km. (see fig 7)

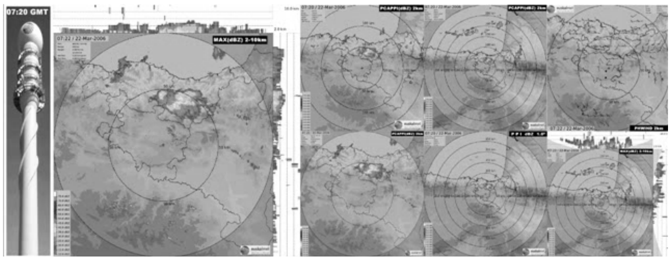

Fig. 7. The KAP00 monothematic radar slide.

KAP01 slide is used for analysis of such situations when precipitation structures far away from our territory can arrive to Basque Country in a given time. In this slide all products correspond to 300 range and are Z type. Products shown in real time are MAX from 2 km to 10 km, PPI 0.5 º, PPI 1 º, CAPPI 2 km, CAPPI 3 km, echo top 15 dBz, and height maximum reflectivity. With this seven standard products we can estimate precipitation type, convection, reflectivity fields in low levels based in the constant altitude products and at high altitudes from the plan position product.

KAP02 slide is used for analysis of such situations when precipitation structures are affecting Basque Country. In this slide all products correspond to 100 range and are Z type. Products are MAX from 2 km to 10 km, PPI 0.5 º, CAPPI 2 km, CAPPI 4 km, CAPPI 6 km, CAPPI 8 km, CAPPI 10 km, CAPPI 12 km. RHI for NW and SW direction. Based on those products we can have a clear perception of localized potential problems into Basque Country, Max product together with the CAPPI different levels maps give a rapid and interesting three-dimensional view of the 3D reflectivity fields.

We are testing more monothematic radar slides configurations. For instance, we are checking a slide with specific products for evaluation and nowcasting in convective situations, with severe storms and hail presence. Using standard products in combination with selected phenomena detection group products, configuration will probably contain echo top for 15 dBz, 45 dBz and 55 dBz, Z and ZDR 2 km CAPPI, and some ZHAIL, SSA, RTR and CTR products. We are evaluating utility of such products combination for different thunderstorm episodes.

6 Conclusions and future work

The system developed has improved our monitoring capabilities allowing a clear perception of propagation and evolution of precipitation fields.

Through visual inspection of the different radar slides surveillance and forecaster personnel have a clear perception of when and where something is happening.

Radar reflectivity patterns can be associated with observed precipitation patterns very quickly in a qualitative way and also in a quantitative way (with some precautions) using combined slides with kriging rain maps and reflectivity products.

System implemented is fully re-configurable and scalable in such a way that other display options and map distributions can be established very effectively.

This system is complementary with other analysis and visualization systems like the generation under demand from RainDART or our intranet radar products pages.

Further analyses must be done to define slides with more sophisticated products or more useful combination of actual products.

We are developing new applications fro graphical products generation to have more control and flexibility that provided by DART.

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