

Study about the nowcasting techniques and their implementation in the meteorological radar of Kapildui

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1 Introduction and motivation

Today's weather forecasts are increasingly demanded by users: hydrology, agriculture, emergency and early warning method, etc. Because of this special interest, since 2006 the Basque Government through the Department of Emergency Attention and Meteorology (DAEM) and Euskalmet [1], has the polarimetric radar Kapildui that helps to the observation and prediction of different weather events.

The radar, which is located on the top of Kapildui Mountain (1176m), in the south of the Basque Country, **it** is a dual polarization Doppler radar METEOR 1500 developed by Selex-Gematronik [2].

Due to the process of continuous improvement of products, especially in stormy situations, DAEM through Euskalmet and in collaboration with the Faculty of Engineering of Bilbao and Adasa Systems, decided to make a study of the nowcasting techniques and their possible implementation in Kapildui's weather radar.

In a special interest, it's the improvement of the predictions in the short term due to convective situations that takes place between the months of May and September, although these kind of situations are given during all year, accompanied in some cases by hail and thunderstorms, as we have seen in the latest images, reaching recording significant damage in the affected area by hail. That is why we are optimizing the predictions to prevent such damage.



REGISTRO HISTÓRICO

La lluvia y el granizo dejan 118 litros en Sarria, Murgia y zonas del Gorbea

La granizada sorprendió a decenas de conductores en la autovía de Altube

31.05.11 - 02:38 - EL CORREO | VITORIA.



La granizada sorprendió a decenas de conductores en la autovía de Altube. -EL CORREO



Images. Top left: Bilbao, 4/7/2006. Top right: Vitoria-Gasteiz, 1/7/2009.
Bottom left: Press release of 31/5/2011. Bottom right: Agurain, 23/6/2014.

2 Objective and methodology

Firstly, it was decided to study the nowcasting products created by Rainbow and its improvement capacity by varying its calculation parameters.

In a next step the possible software alternatives were considered, as TITAN, but for different reasons, such as size, complexity and implementation capacity, we finally opted for the creation of an alternative system.

In that document will be discussed the results of the above tasks, divided into two sections:

On one hand, we will be reviewed the parameters used in the creation of products for Rainbow and it will be detailed the changes made to the configuration of the default values.

On the other hand it is briefly explained, the development of a software in Matlab [4] which serves to provide supplement information to the system actually used.

3 Evaluation and improvement of rainbows's ctr product

Until the completion of that study, only the Rainbow software was used for performing short-term predictions. This CTR (Cell Centroid Tracking) [5] product, which identifies and monitors storm cells, are generated, providing as a result, a number of screenshots of the progress of the cells across the territory, and its possible future location.

It was observed that the products created by a default setting were generally satisfactory, however, with quick forming character convective storms, the prediction was wrong. It is concluded, that in some of these cases the detection of the cells was poor and therefore displacement prediction ability was impaired.

That is why using a testing process with the meteorological database provided by Euskalmet, analyzing some of the most severe cases which have occurred in recent years, they were modifying the parameters of configuration of CTR products seeing how they affected to the results, trying to find the most interesting configuration to the regional meteorological service.

For the testing method, we started to use PPI for the creation of the CTR, but we realize that CAPPI it is more stable and the forecasts were better. For our study, according to our geographical situation, we use a CAPPI located at 2km height.

Four parameters of the configuration are mainly analyzed:

- **dBZ Threshold:** The reflectivity threshold default value was 30dBZ, however it was noted that it was set too high, resulting in many small cells instead of getting larger mass fronts. This produced calculation problems during the process of displacement predicting, considering unrelated results together. That is why it was decided to reduce it and switch to a lower value as 20dBZ and it were obtained broadest masses and it was achieved an improvement in the displacement prediction.
- **Diameter:** The diameter value, marking the minimum size for the designation of a cell, it was considered to keep it stable at 3km. It was considered a sufficiently broad to start considering possible cell value.
- **Minimum Fill Factor:** The minimum amount of reflectivity values above the threshold that must contain a cell. As it was happened with the threshold reflectivity, it was considered that the default percentage markup of 70% was too high and it was decided to reduce it to 50%. Therefore smaller masses were detected, but due to their speed establishment it suited to have previously identified.
- **Offset Change Factor:** this value was increased to get more stylized masses, as it is not considered that such definition is needed, which also increase the calculation speed. It was decided to increase the value to 0.5.

We concluded that the CTR has to adjust according to the cell size: small cells, medium-cells and super-cells. In most of the CTR with a considerable cell size, it occurs an aberration due to a shield situation.

The next images in Table 1, show us some cases of detection of the cells after the configuration change.

4 Complementary software development

After the improvement of the results by Rainbow it was decided to analyze different software to use as a complement for situations where there are variations which Rainbow's CTR can't detect. We try to implement TITAN, but for different reasons it was dismissed and it was decided to develop a software with Matlab.

To do this, we draw on the ideas presented by Rinehart and Garvey [6], about TREC and reflectivity matrices correlation at two temporarily followed points to get an array of displacement vectors. Also it took into account the ideas described by Li, Schmid and Joss [7] on improving the results obtained by TREC implementing additional processes and correcting erroneous vectors, implementing COTREC system.

First it is selected the prediction type:

- Ten - minutes predictions, give us only the third window.
- Performing a time series from two captures.

Either we select the HDF5 files that we get from the processing of the raw data provided by the radar. And then trying to follow a similar process that carried out in the studies, it is decided to take advantage of the qualities that offer particle image velocimetry (PIV) systems. In this case it is decided to use a toolbox for Matlab developed by Nobuhito Mori and Kuang-An Chang [8].

Thus, we obtain a matrix of displacement vectors, so that information may be used to calculate the future position of the values of the capture, and therefore the most interesting cells in a short period of time that does not produce large changes.

The results, shown in Table 2, that it is obtained by the software it is used as a complement for Rainbow, especially in situations of convective nature, where the detection of cells in some cases is poor, offering sufficiently adequate results to predict the future position of convective cells.

5 Conclusions

It is considered that Rainbow is a very useful tool that offers many products, both nowcasting and interpretation support. Furthermore, in general, the quality of convective cells detection is successful. However, it sometimes shows some instability in the detection of certain elements, either by the shielding effect produced by other cells, or by the configuration used for the production of CTR products.

It has been observed that Rainbow does not work properly in situations with some small cells or with large masses across a territory. In a future projection it tends to accelerate the movement of the cells that makes wrong the localization of elements.

We appreciate the importance of a correct configurations of the CTR parameters according to the cells sizes and the geographical location, near the sea and with a complex orography. Therefore, for the use of this study in other location, it will be necessary the change of the parameters values.

Moreover, the software developed during the study has brought positive results, although sometimes it does not detect all the elements presented in radar captures, mainly because the reflectivity threshold level set for the detection of cells.

Visually the software does not represent the cells as a uniform single mass, so it does not have the facility to show only the outlines of the cells as Rainbow offers.

However, in many cases in which the program offered by the manufacturer of the radar failed to detect or forecast the movement, especially for exceeding in it, the software has been able to show a positive result.

As a final conclusion of this study is extracted the idea that complementary work between Rainbow and self-developed software for creating nowcasting products, can be an aid in the interpretation of meteorological phenomena, especially of convective character.

6 Acknowledgements

We would like to acknowledge the assistance of the Office of Emergency Management and Meteorology and Euskalmet for offering us their data for conducting this study as well as the support received from Adasa Systems to the technical questions which arose us. We would also like to thank for their collaboration to the Faculty of Engineering of Bilbao, University of the Basque Country, for giving personnel, equipment and workspace.

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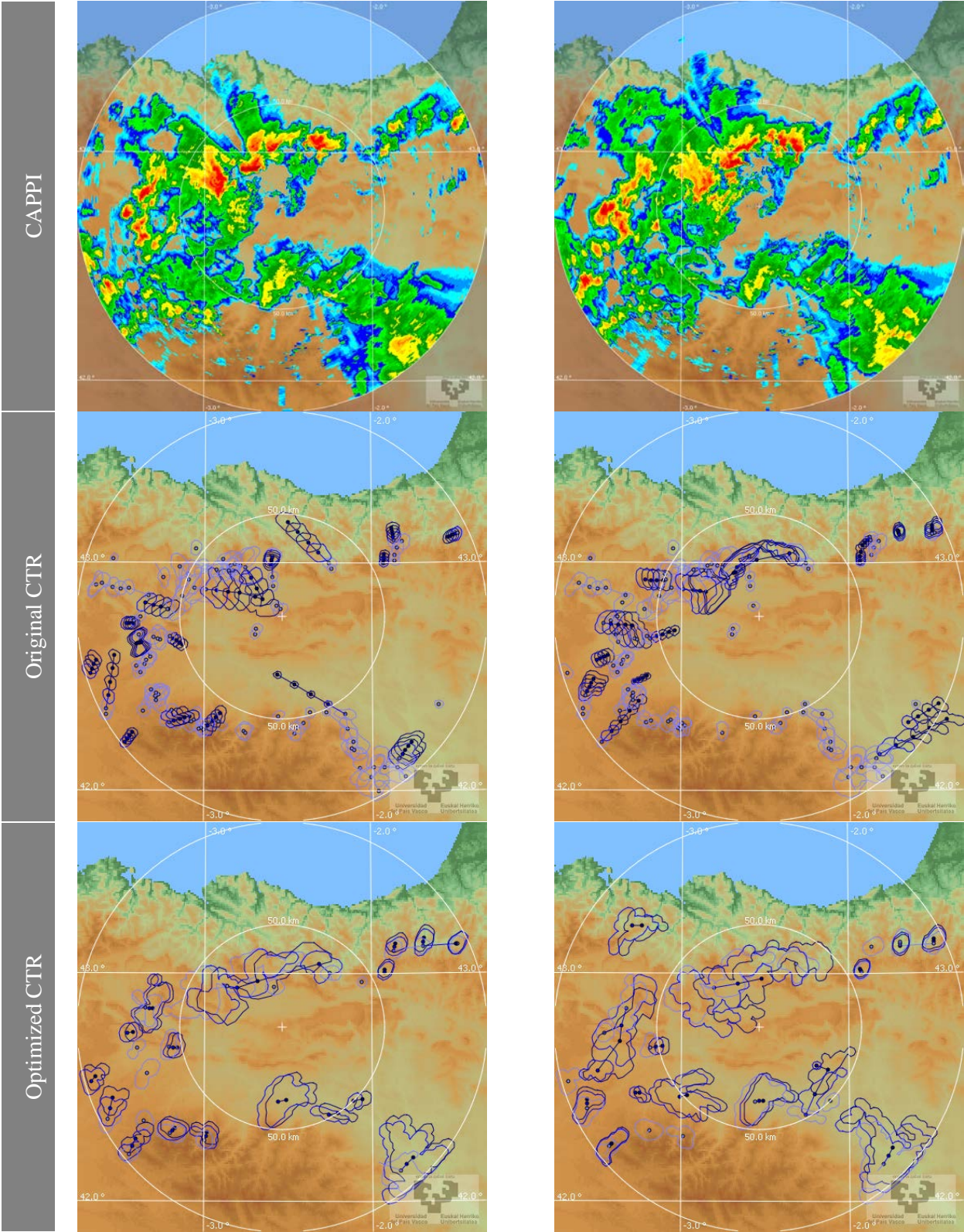


Table 1. Comparison between CTR configurations

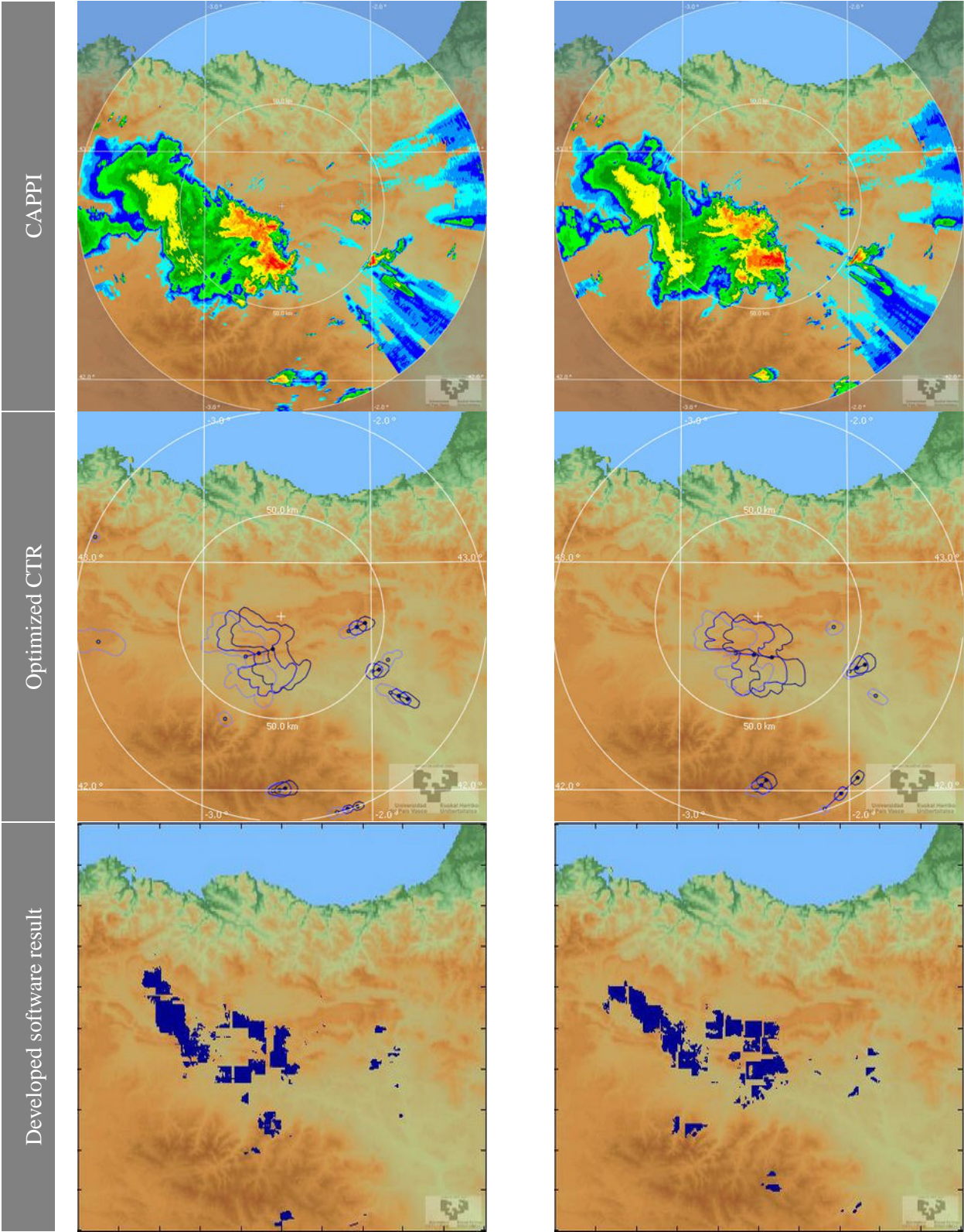


Table 2. Results of the developed software