210 IMPROVING INTERACTIVE VISUALIZATION OF POLARIMETRIC WEATHER RADARS - FROM OPEN SOURCES TO GAMES

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1. INTRODUCTION

This work presents our experience with radar data analysis for single and dual polarimetric systems, using scientific visualization techniques to explore complex data and obtain an overview and better understanding the observed phenomena.

In less than 5 years, in Brazil we increased our radar coverage, from 23 single polarization weather radars to 15 more new dual polarization radars, mainly S-Band, with a concentration in the southern region, an area prone to severe weather, mostly related to Mesoscale Convective Systems.

Weather radars in the south of Brazil play an important role in quantitative precipitation estimation (Calheiros et al 2014, Calvetti et al 2015) and severe weather monitoring and forecasting (Beneti et al 2013). The major economical activity in this region is agro-industry and energy production, responsible for more than 35% of hydro-power energy generation used in the country, directly dependent on precipitation distribution, water availability and severe storms impacts.

2. DATA AND METHODOLOGY

A hydrometeorological system comprising two S-band radars, one single and one dual polarization, a network of lightning detection and location sensors and a network of automatic hydrological and meteorological stations is used for this objective (Figure 1).

The weather radar network in Parana State is operated remotely from Curitiba, in an Operational Center responsible for operation, supervision, data archive and product dissemination (Figure 2)

Since the radar network is formed of different brands, a Radar Server (Figure 3) for data storage, conversion, processing and dissemination in real-time was developed.

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A radar conversion library in C and Python, mainly, was developed in order to read and/or convert data from several formats, such as: SIGMET/IRIS, EEC/EDGE 4 and 5, NetCDF CF/Radial, HDF5 ODIM and GAMIC, Universal Format, and MDV.

The Python ARM Radar Toolkit (Py-ART) library (Helmus et al 2013) is used for data input and processing, and Unidata's Thematic Real-time Environmental Distributed Data Services (THREDDS) is used for data dissemination.

Analysis of storm properties and nowcasting is performed using the Thunderstorm Identification, Tracking, Analysis, and Nowcasting (TITAN) algorithms (Dixon and Wiener 1993).

3. RESULTS

Traditionally, data visualization systems in meteorology maintained some standard user interfaces and features that have persisted for many years. Designers and developers of such systems have given little attention to issues relating to the interface, specially with regard to usability and also exploring new tools to interact and explore data visually.

This project has a focus on User Experience, on the analysis and understanding of the object rather than how to use the system. The user should not be distracted, with less mental effort (simpler and intuitive) and less physical effort.

A more efficient User Interface minimizes the cognitive effort demanded by the interface and gives the user the capacity to make decisions and conclusions quickly and effectively (Figure 3).

Python language and PyGame libraries were used because of the balance between productivity in the development and performance in the application, with several modules for numerical processing, visualization and user interfaces.

We expect to develop and explore different features and tools to offer the user a more pleasant and efficient experience, using techniques for navigation and interaction inspired by systems with highly interactive nature, such as games and mobile devices applications. PyGame (http://pygame.org) libraries and modules provide an easier way to develop interactive visual system, such as computer gams, with libraries providing low-level access to the keyboard, mouse, joystick, 3D hardware via OpenGL, and 2D image buffer. Using these packages it is possible to develop and test new ways to navigate and interact with weather radar data. The characteristic of the system developed, Radar Data Explorer (RADEX) is the following:

- Desktop application for interactive visualization and analysis of single and dual polarization weather radar;
- Provides an interface to visualize and control algorithms for product generation, visual exploration and data analysis;
- Basic functionalities include: navigate spatially and temporally using a graphical interface, zoom in/out, alternate between radar moments (e.g. Z, ZDR, KDP, V, etc), vertical cross-sections and access data ray-by-ray;
- Products are on-demand and stored in memory buffers for fast access and interaction in real-time;
- Next steps include implementation of more graphics options (PCA, dispersion, …), data processing and correction algorithms (echo and hydrometeor classification, clutter identification and correction, attenuation correction), and perform tests and evaluation with users involvement.

Figure 4 presents some examples of the RADEX display output.

4. CONCLUSIONS

The main idea of this application is to obtain several radar products from a set of data available locally, interacting directly on a visual representation that serves as a basis for the interaction. In this way, the user can focus on the analysis of the data much faster and naturally, without the need to convert in advance the data through several processes before being able to view a specific variable or product. This work presents our experience in polarimetric weather radar data visualization and usage within and operational environment for nowcasting severe weather

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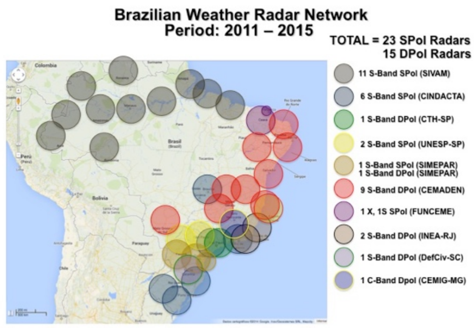
(a)



(b)

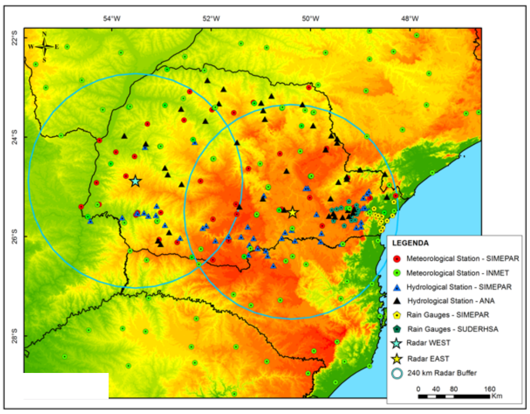


Figure 1: (a) Brazilian weather radar network; and (b) Hydrometeorological Monitoring System in Parana State, with 2 S-Band weather radars, 1 Single Pol and 1 Dual Pol.

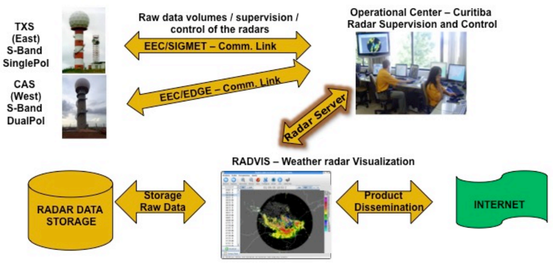


Figure 2: Weather operacion center and Radar Server.

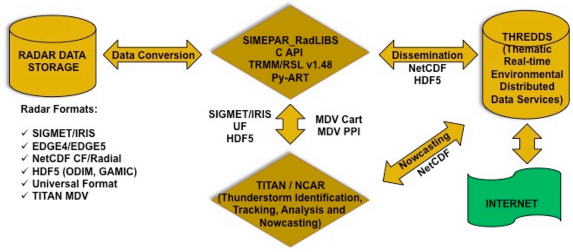


Figure 3: Weather radar server diagram.

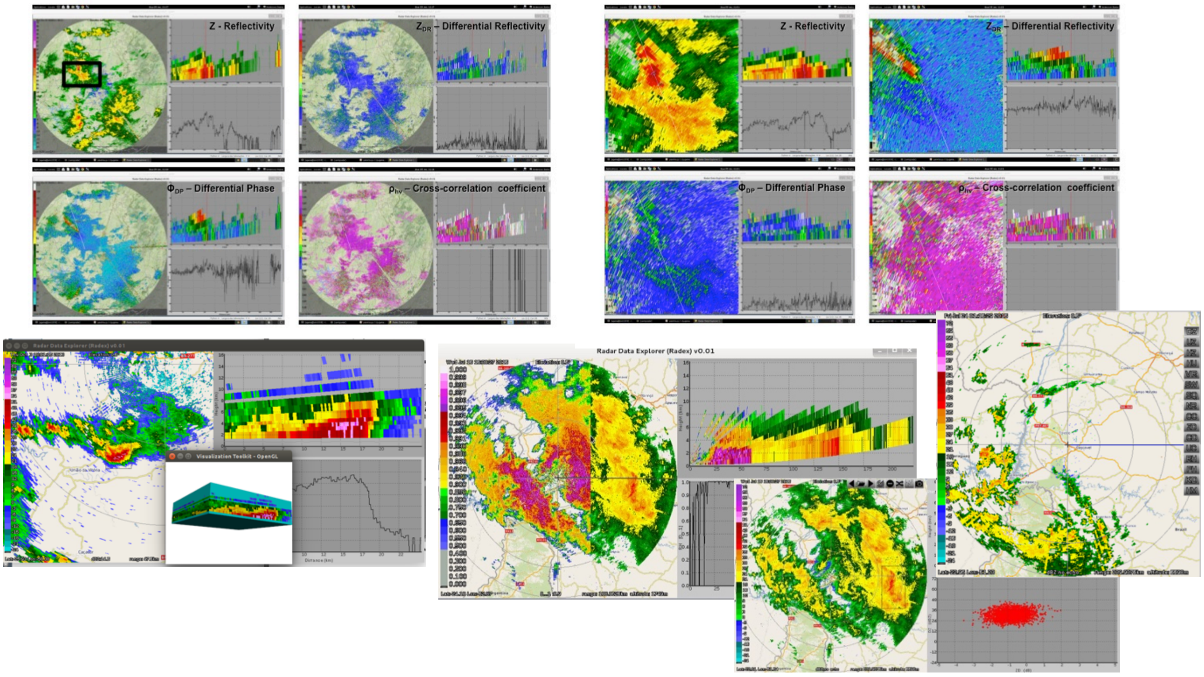


Figure 4: Radar Data Explorer (RADEX) display examples.