P1.9 IMPACT OF IMPROVED RADAR DETECTION CAPABILITY ON CLEAR AIR OBSERVATIONS

Maria Andrea Lima [1 *] and Roberto Vicente Calheiros[1]
(1) Meteorological Research Institute, Bauru, SP, Brazil, UNESP

1. Introduction

This study presents clear air signatures, such as bores and smoke plumes, as detected by the Bauru and Presidente Prudente radars after the recent upgrade. The importance of detection and identification of meteorological targets in the non-precipitating atmosphere lies in the potential of such radar observations to provide, in many cases, a morphological picture of the PBL. Several meteorological mechanisms (e.g. storm initiation) begin in the lower atmospheric layers. Similarly, some clear air phenomena may represent meteorological noise, as is the case of smoke returns (e.g. from sugar cane processing plant) that when simultaneously with precipitation echoes should be discarded.

The DWSR-88S meteorological radars of Bauru and Presidente Prudente were planned for multiple purposes, such as operation and research. Operation includes monitoring, severe weather forecasting and precipitation quantification. Radars must also provide an appropriate database for research and development of new techniques. Volumetric data are regularly collected up to 240km and 45 degrees of elevation to accomplish these objectives.

The radars have been upgraded to achieve these demands. Receiver and antenna control systems have been upgraded. However, because a technical problem with the pulse transformer, the radar operated in long pulse (2μ) for 24 months. This contributed to improved observations of non-precipitating echoes. Results from a previous field experiment have shown that operation in long pulse gives the best match between the vertical wind profile derived from radar and the radiosonde wind in an atmosphere void of precipitation (Calheiros et al., 1997).

* *Corresponding author address:* Maria Andrea Lima, Instituto de Pesquisas Meteorológicas, UNESP, Bauru SP, 3103-6030; e-mail: andrea@ipmet.unesp.br

This study describes a bore and smoke plume detection during Bauru radar operation in long pulse. Bore identification is supported by similarities with independent observations made in other regions. These similarities may be essential to non-ambiguous identification of the phenomena in many cases.

2. Analysis

2.1. Bore

A well defined bore was observed by the Bauru radar on 4 March 2006. Bores are a type of gravity wave and are more common and more important than imagined, given their impact in severe weather, such as tornado intensification or storm initiation. These waves cause instability and may initiate and sustain severe storms, which on the other hand, may generate another bore. They usually occur during the night when a temperature inversion creates a stable layer near the surface (Knupp, 2006).

A bore is defined in this study by the existence of a wave train of fine lines of reflectivity moving in the same direction. Figure 1 shows the evolution of a gust front into a bore on 4 March 2006. The wave structure is best observed at 2:46 local time. At least four distinct waves were registered by the radar. The bore passage was detected by the surface ground station located at the radar site, as is shown in Figure 2.

The bore moved faster than the surface wind. The wind direction shifted to the direction of the bore propagation, returning to pre-bore direction one hour later. No perturbation in temperature was registered while pressure presented a slight rise associated with the bore passage.

2.2. Smoke plumes case

Smoke plumes are frequently identified by radars. On 22 July 2009, several plumes associated to the activity of sugar cane processing plant were outlined by the Bauru radar. Sugar cane fire returns were mixed with these plumes. Emission source location was registered by its latitude and longitude in the radar images and placed over Google Earth images in order to identify the plants. Intense northwest flow produced by a strong pressure gradient between the center of high pressure in Argentina and a low pressure area in SE Brazil advected plumes a long distance (Figure 3). Plumes are shifted a number of kilometers from the source by the wind advection effect.

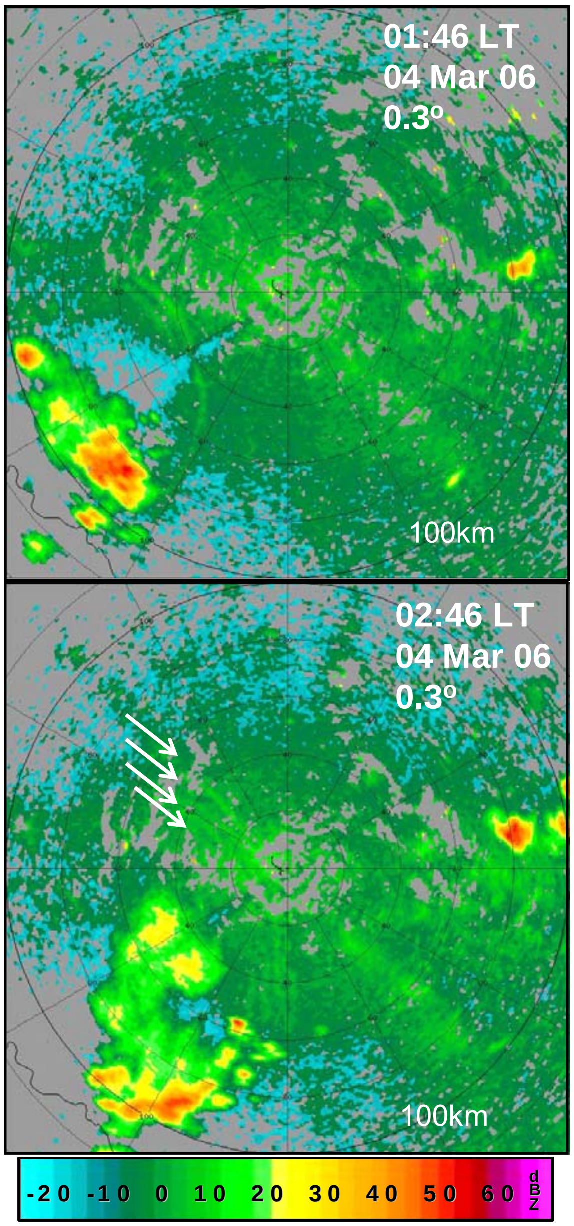

Figure 1. Temporal sequence of reflectivity associated with a bore on 4 March 2006.

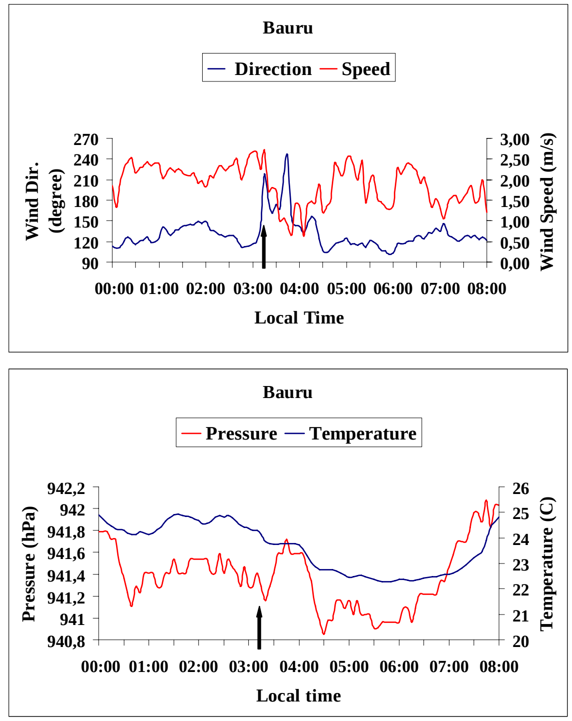

Figure 2. Temporal series, with a five-minute resolution, of the automatic meteorological station of Bauru on 4 March 2006. The arrow indicates the time the bore was detected.

3. Considerations

The identification and monitoring of clear air phenomena by radars is a well known process, implicitly connected to the radar sensitivity and regional factors related to the local weather. Thus, the knowledge of the conditions leading to the occurrence of those phenomena for climatologically different regions is required.

The study focuses on bores, a phenomenon which has had its detection significantly increased. The motivation was the fact that in some cases, the radar observations indicates that bores seem to induce convection, indicating the importance of this phenomenon for nowcasting. Smoke plumes detected by radar associated with sugar cane processing plant activities that are common in the radar range are also part of the study.

Upgrade/update results were surprising considering the limitations of the radars, especially the moderate sensitivity and two-degree beam width. With the new detection capability resulting from the recent upgrade/update that these radars have undergone, it was already possible to verify a significant increase in the number of cases of clear air phenomena occurring throughout the year under different atmospheric conditions.

Acknowledgments. The authors thank M.A. Antonio for prepare the display in Google Earth and A.C.A. for the job with the figures.

References

Calheiros, R. V.et al. Clear-air wind profiling in the planetary layer with microwave radar: Conference on Southern Hemisphere Meteorology and Oceanography, Pretoria, South Africa, 1997, p.124-125.

Knupp, K., 2006: Observational Analysis of a Gust Front to Bore to Solitary Wave Transition within an Evolving Nocturnal Boundary Layer. *J. Atmos. Sci.*, **63**, 2016–2035.

Koch, S.E., C. Flamant, J.W. Wilson, B.M. Gentry, and B.D. Jamison, 2008: An Atmospheric Soliton Observed with Doppler Radar, Differential Absorption Lidar, and a Molecular Doppler Lidar. *J. Atmos. Oceanic Technol.*, **25**, 1267–1287.

Melkinov, V. et al. Radar polarimetric signatures of fire plumes. 25th Conference on International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, January 2009, Phoenix, Arizona.

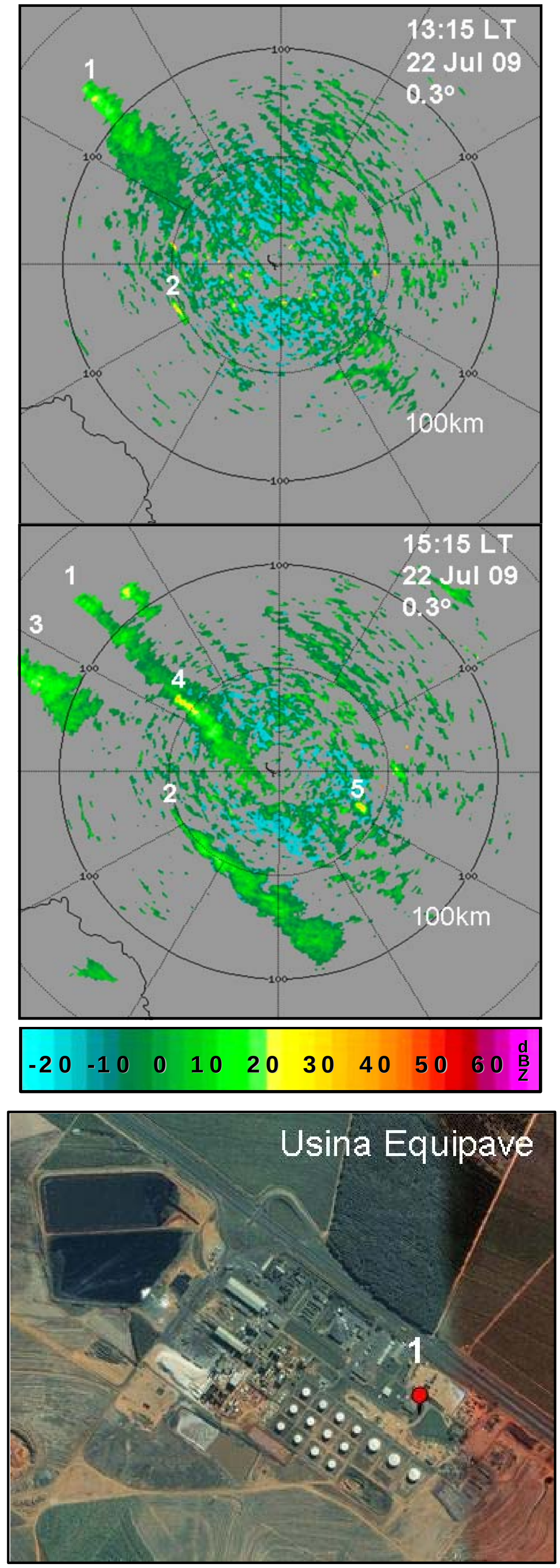

Figure 3. Main emission sources registered on 22 July 2009. The source labeled 1 is detailed above.