O9D.1 AN INITIALIZATION TECHNIQUE USING AIRBORNE DOPPLER RADAR OBSERVATIONS FOR NUMERICAL SIMULATIONS OF HURRICANE BRET (21−23 AUGUST 1999)

O. Nuissier[1*], R. Rogers[2] and F. Roux[1]

[1]Laboratoire d'Aérologie, Observatoire Midi−Pyrénées, UPS−CNRS, Toulouse, France

[2]Cooperative Institute for Marine and Atmospheric Studies, NOAA/AOML/HRD, Miami, Florida

1. INTRODUCTION

Since 1977, Doppler radar observations have permitted researchers to deduce the internal kinematic, thermodynamic, and microphysical structure of tropical cyclones. Such information can be obtained from the National Oceanic and Atmospheric Administration (NOAA) WP−3D research aircraft or by operational ground−based Doppler radars. Numerous numerical studies have shown the importance of introducing an initialization procedure that provides a more realistic initial vortex from what is obtained from conventional large−scale analyses. In this study, we intend to show that it is possible to simulate realistic characteristics of Hurricane Bret over the Gulf of Mexico using an original initialization technique based on the introduction of information derived from Doppler radar at the beginning of the simulation.

2. HURRICANE BRET (21−23 AUGUST 1999)

a. Hurricane Bret

Bret formed on 18 August 1999 over the Bay of Campeche and moved northward and became a 125−kt and 944−hPa category 4 hurricane on the Saffir/Simpson scale on the morning of the 22nd , while approaching the southern Texas coast near Brownsville (Fig 1). It made landfall over the Texas coast between Brownsville and Corpus Christi at 0000 UTC on 23 August and finally dissipated on the 25th over the high terrain of north central Mexico.

b. The airborne Doppler observation

During the hurricane season, the NOAA's annual hurricane field program aims at improving the understanting of the structure and behavior of hurricanes. Different airborne experiments are conducted within tropical cyclones, among which the objective of the Hurricane Synoptic−Flow Experiment is to gather vertical profiles of wind, temperature, and humidity typically within 1,000 km from hurricanes centers over the data−sparse oceanic regions of the western Atlantic or Gulf of Mexico. Such an experiment was conducted with the NOAA G−IV and WP−3D aircraft in Hurricane Bret on 21−22 August 1999 from 1751 to 0143 UTC (Fig 1). The Extended Velocity Track Display analysis (EVTD), (Roux and Marks 1996), permitted to retrieve the main thermodynamical structure of Hurricane Bret from the airborne−Doppler data with the help of thermal wind balance. We show in this study that it is possible to initialize a mesoscale numerical model with small−scale fields derived from these data.

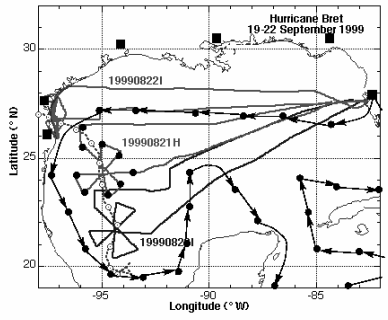

Figure 1. The successive NOAA aircraft missions within Hurricane Bret (20−21−22 August 1999). Storm track is shown by the dashed line. The points and the squares indicate locations of G−IV dropwinsondes and operational rawinsondes at 00 UTC on 22 August, respectively.

3. A FILTERING REMOVAL TECHNIQUE

Numerous studies have shown that initial vortices provided by conventional large−scale analyses are often ill−defined, too weak and sometimes misplaced. In order to remove the crudely analyzed tropical

cyclone, we applied the scheme proposed by Kurihara et al. (1993, hereafter referred to as K93) which consists of using appropriate filters to extract the vortex from the large−scale analyses, and adding a specified vortex. The scheme is simplified as:

(initial field) = (global analysis) − (analyzed vortex)
+ (specified vortex).

In this present study, we propose to use the radar−derived vortex as the specified vortex.

a. The model

A three−dimensionnal, two−way interactive, nested−grid version of the French « Meso−NH » nonhydrostatic mesoscale numerical model was used for the present study (Lafore et al. 1998). A « quadruple » nested−grid version of Meso−NH is initialized with the ECMWF analyses at 00 UTC on 22 August, the horizontal resolution being 45, 15, 5, and 1.6 km, respectively.

b. The different filters

A low−pass filter is first applied over the outermost domain (45 km resolution) to remove small−wavelength features about 1000 km (i.e, vortex). Using the terminology of Fig. 1 in K93 article, this produces the basic field. We can subtract the basic field from the total field (« large−scale » analyses) to get the disturbance field. This includes the hurricane, in addition to any other disturbance that is small in wavelength but is not hurricane−related. The next step is to separate the hurricane from the non−hurricane component of the disturbance field. This is done with a second filter based on a smoothing function also described in K93. The different filters are applied successively to remove the analyzed vortex, and the new specified vortex (or the radar vortex) is included with respect to the observations. Figure 2 illustrates the different steps of the specification of the radar vortex.

The impact of such an initialization method on the evolution and propagation of Hurricane Bret will be presented at the conference, especially when the simulation is performed without any modification of the large−scale analyses.

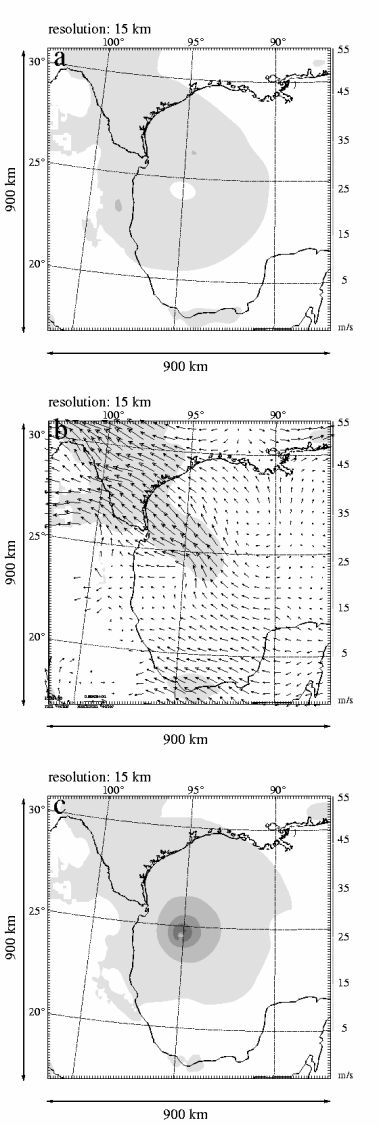

Fig. 2: Design of a « zoom » of the outermost domain and horizontal winds at 850 hPa at 00 UTC on 22 August from **a**) ECMWF analyses, **b**) filtered ECMWF analyses, and **c**) filtered ECMWF analyses + radar vortex

4. REFERENCES

Kurihara, Y., et al. 1993A: An initialization scheme of hurricane models by vortex specification. *Mon*. *Wea*. *Rev*., **121**, 2030−2045.

Lafore, J. P., et al. 1998: The Meso−NH Atmospheric Simulation System. Part I: Adiabatic formulation and control simulations. *Ann*. *Geophys*., **16**, 90−109.

Roux, F. and F. D. Marks, 1996: Extended Velocity Track Display (EVTD): An improved processing method for Doppler radar observations ot tropical cyclones. *J*. *Atmos*. *Oceanic*. *Technol*., **13**, 875−899.

* Corresponding author address: Olivier Nuissier, Laboratoire d'Aérologie, Observatoire Midi−Pyrénées, 14 Avenue Edouard Belin, 31400 Toulouse, France; e−mail: nuio@aero.obs−mip.fr