A high resolution, real time experimental forecast for the Río de la Plata: A "Sea-Breeze" case study.

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1. Introduction:

The Río de la Plata is one of the largest estuaries in the world and is located at the opening of the Paraná river between Argentina and Uruguay. Due to its large extent, the differential diurnal cicle of heating between the estuary and the shores forces local circulations (Berri and Nuñez 1993, Berri and Straibman, 2005) wich affect both sides of the shores. This kind of effect is important to sport navigation, transport of pollutant agents while it can also produce significant changes in temperature and moisture over the shores, with circulations penetrating more than 70 km inland. Sometimes under unstable conditions, convergence associated with these local circulations can trigger thunderstorms.

The Advanced Research WRF (Weather Research and Forecasting) (Skamrok, 2005) has been used in idealized studies to simulate local circulations like mountain-valley breezes (Rampanelli et. al. 2004). It has also been tested for real time experimental forecasts with resolutions as high as 4 km over the United States with a focus on the forecast of convection (http://rain.mmm.ucar.edu/wrf/). In this work the WRF-ARW is used in an experimental real time forecast of the "Sea Breeze" effect over the Rio de la Plata. The 9th December 2006 case has been selected to preliminary assess model performance.

2. Methodology:

In order to simulate the local circulations associated with temperature gradients along the shore, the WRF-ARW model has been run covering the entire estuary (Fig. 1 a) with a horizontal resolution of 5 km and 36 vertical levels between the surface and 500 hPa., given that the focus of the experiments is in the low level circulation. The model has been run with moisture treated as a passive tracer to avoid the generation of other local circulations associated with lateng heating or cold pools development, and to reduce computational cost. Future experiments will include the effects of rain and clouds which are very important for an operational implementation.

The initial conditions for the model are taken from the GFS-NCEP (Global Forecasting System- National Centre for Enviromental Prediction) analysis. The boundary conditions are provided at 3 hour intervals by the WRF-ARW real time forecast performed twice a day at CIMA (Centro de Investigaciones del Mar y de la Atmósfera) with a horizontal resolution of 20 km.

The 9th December 2006 "sea breeze" event selected for this case is particularly suitable due to the small amount of cloud cover over the domain, what reduces the potential impact of running the model in a no-precipitation mode. Doppler radar data and surface observations provided by the National Weather Service of Argentina are used to compare the observed local circulation with that forecasted by the model.

3. Results:

During the early morning, on December 9 2006, a weak trough associated with low level convergence crossed over the model domain and after that, the circulation in the Argentinian shore was dominated by weak winds from the southwest (less than 10 km/h) (Fig 1 b). During the daytime a local circulation due to differential heating established along the Argentinian shore, as denoted by the wind rotation at Aeroparque station (see fig. 1 b for station location) that goes from the SW to the E at noon (15 UTC) and then to the NE.

Around 18 UTC a well developed land-sea breeze front is indicated by a narrow band of weak reflectivity in the RADAR located at Ezeiza (Figure 2 a). The doppler velocity also indicates a wind shift associated with this sea-breeze front (not shown). Figure 2 b, shows the WRF-ARW experimental forecast verifying at the same hour, with a well developed and correctly positioned wind shift line. Strong low level convergence also develops along the shore (Figure 2 b) co-located with the upward branch of the sea-breeze circulation (not shown). Areas of low level divergence developed over the estuary associated with broad subsidence over the area. Figure 3 shows the wind direction for Aeroparque (Figure 3 a) and Ezeiza (Figure 3 b). The wind shift associated with the breeze circulation is well reproduced by the model at both stations although the change in direction takes place earlier in the model than in the observations.

These results are encouraging and suggest that an operational forecast of local circulations over the Rio de la Plata is possible provided a good regional forecast is available. Cloud and precipitation effects as well as an increased vertical coverage should be included in future experiments to better represent events where convection could have a prominent role.

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5. References:

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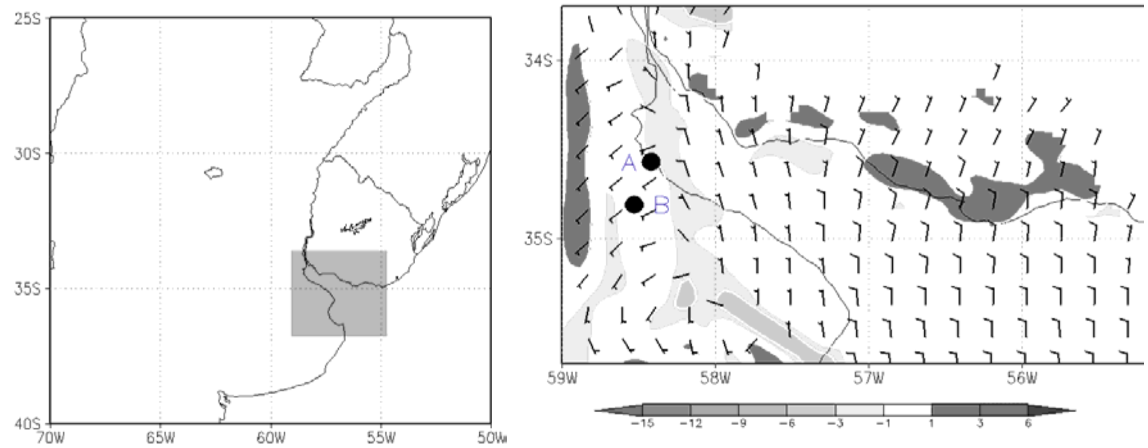
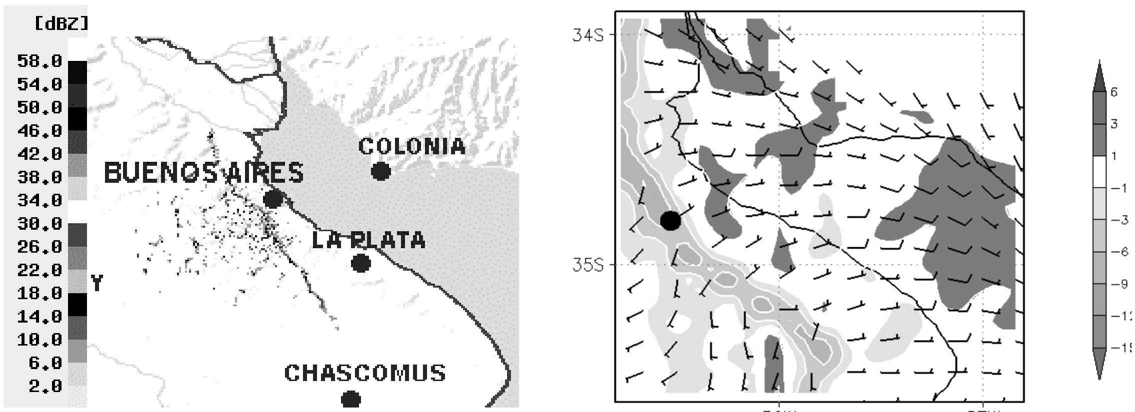


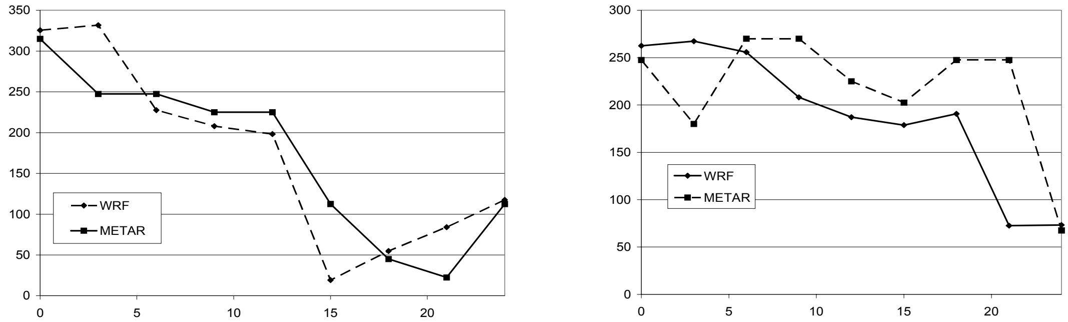
(a) **(b)**

Figure 1: (a) Domain location (gray rectangle) and (b) 30 hour forecast verifying at 06 UTC 9th December 2006. Wind barbs at 100 meters (m s^{-1}) and convergence (shaded) (1e 4 s^{-1}). The black circles in the Argentinan shore indicate the position of Aeroparque (A) and Ezeiza (B) stations.



(a) **(b)**

Figure 2: (a) Radar reflectivity (shaded) (dBz). (b) as in Figure 1 but for a smaller region. The black circle represents the location of the Radar. Both at 21 UTC 9th December 2006.



(a) **(b)**

Figure 3: Wind direction (degrees) forecasted by the WRF model (dashed) and observed (solid line) between 00 UTC 9th and 00 UTC 10th December 2006. For (a) Aeroparque and (b) Ezeiza.