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Some results from assimilation on Kapildui radar wind information in the Basque Country.

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1 Introduction

In the Basque Meteorology Agency (Euskalmet), numerical weather prediction (NWP) models are executed daily for many different purposes. In order to improve results for first hours, we have implemented a system to include wind information from the new Kapildui Dual Doppler radar. For the moment, the assimilation scheme considers just wind vertical profiles for different resolutions.

In this paper we present such assimilation system and some preliminary results. The system has been executed for different scenarios to check its behavior.

2 Radar Characteristics and configuration

Euskalmet Radar is sited in Kapildui mountain (1174 m), a location near the capital of Basque Country (Vitoria-Gasteiz). Kapildui Radar is a METEOR 1500 Doppler Weather Radar with Dual polarization capabilities. This Radar is based in a Klystron transmitter system, operates in C-band frequency and uses the advanced signal processing environment Aspen DRX as digital receiver and signal processor. The radar control processor RCP interfaces to the signal processor and buffers the preprocessed raw data, establishing an efficient control structure for all components in the system and interfaces the radar with the two software packages used: Ravis and Rainbow.

At present time we are using a configuration based in four different scans providing meteorological data every 10 min. First volumetric scan takes 120 seconds and is configured for a maximum range of 300 km with 5 elevations from 0º to 2.5º, a range step of 1km and a angle step of 0.8º. Second volumetric scan takes 363 seconds and is configured for a maximum range of 100 km with 14 elevations from –1.5º to 35º, a range step of 250m and a angle step of 1º. Third and Fourth scans are elevation scan for two selected direction.

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See Gaztelumendi et al (2006) for more details about Kapildui radar system configuration and planned developments and applications.

In Aranda and Morais (2006) some details about Radar installation, construction and site selection are shown.

3 System description

The system consists on two components. The first member of the system is responsible for the data handling, and the second one is the responsible for the assimilation process (Euskalmet, 2005a).

3.1 Data Handling

A set of FORTRAN programs and Shell scripts achieve, decode and write the data in the proper format. The assimilation scheme implemented is able to work with several datasets from different sources, surface measurements such as SYNOP, Buoy, METAR and automatic weather stations; and upper air measurements: RAOB soundings, and wind profiles from our Dual Doppler radar and our wind profiler.

Some used datasets come from the Basque Country datasets (AWS network, radar and wind profilers), this data must be rewritten in the adequate format. Available datasets with whole world data are downloaded and stored continuously. METAR and SYNOP files are written with its own code, those data are decoded and data necessary is selected. Information of cloud type heights and cloud cover included in METAR files are used in the assimilation system.

3.2 Assimilation process.

The second member of the assimilation system is a numerical mesoscale prediction model: Advanced Regional Prediction System (ARPS), (Xue et al, 2003). The ARPS system was developed by the Center for Analysis and Prediction of Storms (CAPS) in the University of Oklahoma.

The characteristics of the ARPS system: no-hydrostatic dynamics, generalized terrain-following coordinate, and nesting capabilities are well suited for areas with complex topography, such as the Basque Country.

The application of a regional weather forecast model with varying local influences requires an accurate meteorological analysis that should include all meteorological measurements available in the area of interest.

The ARPS Data Assimilation System, (ADAS) (Brewster 1996, Xue et al. 2003), is a three-dimensional analysis program module that interpolates observations onto the ARPS grid, combining the observed information with a background field. The analysis method used in ADAS is based on the successive corrective scheme of Bratseth (1986), which asymptotically approaches the result of a statistical (optimal) interpolation, but at lower computational cost. As in the optimal interpolation scheme, the Bratseth interpolation method can take into account the relative error between background and observational data; therefore they are relatively insensitive to large variations in data density and can integrate data of mixed accuracy. This method can be applied with a low computational cost in an operational setting, providing significant improvement over the background model forecast as well as any analysis without high-resolution local observations.

Currently in ADAS, a set of five meteorological variables are considered during the analysis: horizontal grid-relative wind components, pressure, potential temperature and specific humidity.

Observed data are classified into four types,

1) single-level observations,

2) multiple-level observations or upper-air (ua) observations (such as rawinsondes and wind profilers),

3) raw Doppler radar (rad) observations, and

4) radar-retrievals (ret), consisting of pseudo-observations obtained from retrieval algorithms which use a time sequence of Doppler radar data to deduce Cartesian wind components, temperature and pressure.

Each observation type has its own data arrays and input control variables.

Once the data is processed by the ADAS, it is included in the ARPS as initial conditions and executed to obtain the weather forecast (Euskalmet, 2005b).

4 Radar wind data

The radar wind profiles included in the assimilation system are obtained using the Gematronik implementation of the Velocity Volume Processing (VVP) algorithm, which has been developed by Waldteufel and Corbin (Waldteufel and Corbin, 1979).

The VVP algorithm supplies horizontal wind velocity, direction and divergence in a vertical column centered above the radar site. These quantities are derived from a volume raw data set with velocity data. To derive the additional information from the measured radial velocity data, it assumes linear wind field variations across the analysis domain. The algorithm calculates wind velocity, wind direction and divergence for a set of equidistant layers. The VVP technique is applied to thin layers of data at successive altitudes to obtain a high quality wind vertical profile of the horizontal wind data. VVP is sensitive to analysis errors in regions of large gaps in radar echo coverage. An extensive quality control is performed where the inner and outer range of the analysis volume, the minimum radial velocity, and the minimum number of points in a 45-degree azimuthal sector can be adjusted by the user.

Even in the situation that no hydrometeors are present (i.e. no rain) the algorithm is able to determine the vertical profiles up to a height of a few kilometres. This is because of the high sensitivity of the velocity channel of radar, and the air pollution (e.g. dust, salt particles) all over the world. Because of the theory behind and the, therefore, necessary quality checks, the algorithm needs velocity data of good quality as input. In general, a separate volume scan, optimized for velocity raw data, is required. Vertical profiles can be derived even in the case of "good weather".

The VVP datasets used in the assimilation system are generated from the 100 km range volume scan. This scan consists on 14 elevations, with 35 º as highest elevation. The parameters in the product definition are: range from 0 to 25 km, the minimum height 1.2 km and maximum 8 km. The “complete” regression type is applied (in the regression analysis are used all the derivatives terms). For data quality checks minimum velocity of 1.0 m/s and 5 m/s as minimum regression points are set, the option second regression is chosen and 5 m/s is used in both parameters (maximum velocity difference and maximum standard deviation).

5 Preliminary results and conclusions.

A module to integrate the wind radar data has been designed and implemented into the data assimilation system. This module generates a file with the radar geographical characteristics and with the wind speed and wind direction data at equidistant levels.

Preliminary test experiments have been defined: ARPS without assimilation, ARPS with Radar data, ARPS with all the data available without radar data and ARPS with all the data available (including radar data). The assimilation system has been used to generate initial conditions to use in the ARPS execution. These experiments have been executed for different scenarios to study the influence of the radar data on the wind and temperature forecast.

An improvement in the temperature forecast for the first hours of the execution has been observed, the inclusion of the wind radar data in the dataset to be assimilated obtain better results than without it. In the following hours of execution the forecasted data does not fit so well with the observed data. Executions including only radar data do not give good results.

With the wind data, at the moment, the results are not good enough. More tests must be made to tune the system to obtain better results in its application.

Regarding the radar products, the next steps to give are including the reflectivity and the radial wind data, in the assimilation system. The reflectivity data gives information about the humidity and cloud presence. The initialization of moisture and cloud fields is very important in the precipitation processes. The inclusion of horizontal wind fields for the whole domain should improve the wind forecast and consequently the other variables of the weather forecast.

References

Gaztelumendi, S., Egaña, J., Gelpi, I.R., Otxoa de Alda, K., Maruri, M., Hernandez, R. 2006: The new Radar of Basque Meteorology Agency : configuration and some considerations for its operative use. On this volume.

Aranda, J.A, Morais, A, 2006: The new Radar of Basque Meteorology Agency: site selection, construction and installation. On this volume.

Bratseth, A.M., 1986: Statistical interpolation by means of successive corrections. *Tellus*, **38A**, 439-447.

Brewster, K., 1996: Implementation of a Bratseth analysis scheme including Doppler radar. Preprints, 15th Conf. on Weather Analysis and Forecasting, Norfolk, VA, Amer. Meteor. Soc., 92–95.

Euskalmet 2005 a. Informe Técnico de Desarrollo A014. Asimilación de datos.

Euskalmet 2005 b. Informe Técnico de Desarrollo C004. Implementación del ADAS.

Waldteufel, P. and H. Corbin, 1979. On the analysis of single Doppler data. *J.Appl. Meteorol*. **18**, 532-542**.**

Xue, M., D.-H. Wang, J.-D. Gao, K. Brewster, and K. K. Droegemeier, 2003: The Advanced Regional Prediction System (ARPS), storm scale numerical weather prediction and data assimilation. *Meteor. Atmos. Physics*, **82**, 139-170.