For the second annual progress report.

Steluta ALEXANDRU: ”Scientific strategy for the implementation of a 3D-VAR data assimilation scheme for a double nested limited area model”

Progress

The purpose of the work is to find the best scientific strategy for the implementation of the 3D-VAR data assimilation scheme for a double nested limited area model. ALADIN/HU is a double nested limited area model, which is coupled with ALADIN/LACE (which is coupled with ARPEGE). The boundary conditions are obtained from ALADIN/LACE integration, at 12 km resolution. The resolution of the ALADIN/HU model is about 8 km.

To produce a good forecast, a good description of the initial conditions is necessary. The objective of data assimilation is to define the best initial state of the model taking into account all the possible information. 3D-VAR consists in minimizing of a cost function, in order to get the best fit to the available information sources. The cost function is the sum of three terms:

$$J(x) = J_b(x) + J_o(x) + J_c(x)$$

where $J_b(x)$ represents the departures from the first-guess, $J_o(x)$ represents the departures from the observations, and $J_c(x)$ controls the amplitude of gravity waves in the analysis. At the moment for ALADIN model only the first two terms are defined.

In 2000, the 3D-VAR data assimilation scheme was ported to Budapest for the Origin 2000 machine of the Hungarian Meteorological Service. The AL13 version of ALADIN model is used for 3D-VAR, taking into account classical NMC statistics for the background term (Parrish and Derber, 1992), and only SYNOP and TEMP observations for the observational term of the cost function. The first-guess is the 6h forecast from an earlier model run. It contains information on the small scales (the scales of the model), but being a forecast it is not fully precise. The 3D-VAR scheme is running four times per day (to have the first-guess), but the 48h integration is made twice per day.

The steps performed in the 3D-VAR scheme are: first, the preparation of the observational data, then the distribution of the observational data across the available processors, followed by a screening procedure, which calculates the high resolution departures and makes the quality control of the observations, then the incremental variational analysis is performed, using the first-guess (6h forecast from the previous model run), the observation file prepared by screening, and the classical background error statistics file. Because 3D-VAR data assimilation scheme is acting for the upper-air meteorological fields, after the variational analysis step, the optimal interpolation analysis is applied for the surface variables, and finally the model integration is realized to obtain the first-guess. (Široká and Horányi, 1999).

The verification is made to evaluate the model performance. The statistical measures (RMSE, bias) are used as indicators of the extent at which model prediction match observations. These objective scores are calculated for the forecast of the model using 3D-VAR scheme, and also for the operational forecast (in dynamical adaptation). The compared fields are the temperature, geopotential, zonal and meridional wind, relative humidity, direction and intensity of the wind, at different pressure levels. The first results indicate that the scores are better for wind, temperature and geopotential, using 3D-VAR scheme. The worst scores are for relative humidity (Alexandru, 2002).

Trying to understand the behavior of the humidity field, we made many experiments, using the operational coupling files, and some coupling files prepared in Prague (from the ARPEGE and ALADIN/LACE assimilation cycles). As a reference for all the experiments, we were running the model in dynamical adaptation. For the experiments with 3D-VAR scheme we decided to use different coupling techniques, with and without incremental digital filter initialization in cycling and to obtain the first-guess from the ALADIN/LACE files prepared in Prague.

The problem with the humidity appeared again. So we chose a case when the scores of the humidity using 3D-VAR scheme were bad compared to the forecast of the model in dynamical adaptation. For this case, we rerun all the experiments for 6h integration without DFI in production. Then we used the humidity treated as univariate variable. Another idea was that maybe the analysis coming from ALADIN/LACE model is so close to first-guess, that even if 3D-VAR scheme realizes some features of the small scales, there are too small. So we tried to have the first-guess using ARPEGE files, as coupling files. But the results of the humidity didn't show an improvement.

In all these experiments, the humidity field seems to be better represented in dynamical adaptation than with 3D-VAR scheme, which is quite an unexpected result. Now we concentrate to see if all the procedures are working properly, and to understand the results of the humidity field.

Perspectives

After we'll resolve the humidity problem, we decided to focus our attention on the next aspects:

- ◇ Case studies. For the beginning we chose two cases. One case is from the period that G. Bölöni made the tests with blendvar and varblend in Prague (Bölöni, 2001), and the idea was to see the results for a double nested limited area model. Both cases were chosen because we considered them as interesting meteorological situations, with a front passing through the domain. On these cases we will make the experiments with different background error statistics (standard, lagged statistics), first-guesses (the 6h forecast of the previous run, blending of the ALADIN forecast with ARPEGE analysis (Giard, 2001)), initialization methods, together with their posteriori evaluation, etc.

- ◇ We want to establish which one of the coupling techniques is better.

- ◇ Then we plan to run four times per day the spectral blending procedure for the first-guess. The necessary files, which contain the large scales are provided from Prague.

⋄ Other experiments will be performed using the blendvar and varblend combinations, with lagged statistics.

Future work

The next months will be devoted to the experiments with different background error statistics, first-guesses, initialization methods and posteriori evaluation. So at the end of this first stay, we would like to get an idea about the best possible version of 3D-VAR data assimilation scheme for a double nested limited area model.

Future training activities

In May 2002 I will participate to a seminar on "Data Assimilation for the Earth System", organized by the NATO Advanced Study Institute (ASI). In autumn 2002 I shall attend for the EWGLAM (European Working Group on Limited Area Modelling) meeting, to be held in Netherlands.

References:

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