# POTENTIALS

***Minutes from the second Project Meeting***

***Bologna, 1-4 June, 1999***

*Prepared by Annette Guldberg, DMI*

### *Participants*

- Cineca: Susanna Corti, Franco Molteni
- Meteo-France: Michel Déqué
- LMD: Fabio D'Andrea
- MPI: Bennert Machenhauer, Ingo Kirchner
- DMI: Eigil Kaas, Sannie Vester Thorsen, Annette Guldberg

### *Opening*

This second meeting within the POTENTIALS project was planned to be a longer meeting with the purpose of exchanging information about obtained results and starting off writing a common paper comparing the different techniques used in the project.

Eigil Kaas opened the meeting by describing the status of the project :

- So far two papers related to the projects have been accepted for publication in Tellus - one by D'Andrea and Vautard and one by Kaas, Guldberg, May and Déqué. The project has been presented at the European Climate Science Conference in Vienna in 1998 (E. Kaas) and at the EGS meeting in The Hague in 1999 (E. Kaas, I. Kirchner, M. Déqué)
- The project has been prolonged by 6 months, meaning that it will end 2000-06-30.
- The next meeting will take place in Toulouse in the beginning of December 1999.

### *Presentations and obtained results*

#### E. Kaas : Preliminary results from ensemble hindcasts in flux-corrected mode.

Using a two-step assimilation procedure where the ARPEGE model (climate version 2) has been nudged towards ERA data for all the winter seasons covered by the ERA data an estimate of the model tendency errors has been obtained. Monthly averages of these tendency errors are then used as correction terms in the prognostic equations of the model. Ensemble predictions have been made for the winters 1980-1993 (2 members in each ensemble) with the original version of the model (control run) and with the forced (flux-corrected) version (forced run). The systematic errors in the forced run are much reduced compared to the systematic errors in the control run - and are indeed small. Furthermore it has been investigated how the time series of anomalies in MSLP (and 500 hPa geopotential height) correlates with the similar time series of ERA anomalies. A very encouraging result is that these correlation's are improved in large areas using the flux-corrected model, meaning that this new model is probably better for making seasonal predictions. In order to check whether the results are statistically significant larger ensembles have to be made.

F. D'Andrea : Preliminary results from an extremely simplified model of the low frequency variability of the model.

In a spectral model the operators are normally developed and truncated on a base consisting of spherical harmonics. In the simplified quasi-geostrophic model considered here the base is taken to be EOF's of the full model (a T21 QGM) and the operators are developed on the EOF basis and then truncated. The complete model (based on 1449 EOF's) is taken as the reference and the systematic error of the model is determined as a function of the truncation (N). For the complete model the systematic error is zero (as this is the reference) and also for N=1 the systematic error is zero since EOF number 1 represents climatology. When N increases from 1 the systematic error increases, reaches a maximum and decreases again as N reaches 1449. A similar behaviour is seen for the variance, except that the variance in the complete model is not zero. Choosing the truncation (in this case N=26) that gives the same variance as the complete model, the low frequency variability is very well represented compared to the complete model. The high frequency variability is not so well represented. Choosing N=10 the model has less systematic error but there is also too little variance in the model then. But as shown earlier the variance can be improved by adding a flow-dependent forcing term and also reasonable weather regimes can be obtained then.

Michel Déqué : Forcing ARPEGE v3 with the results of the ERA nudging.

An assimilation run covering the whole ERA period has been made in which the nudging time constant was set to 6 hours for all atmospheric variables (except humidity) and surface temperature. This assimilation run shows that the initial drift and the mean error of the model does not necessarily correspond. Based on this assimilation 12 correction terms have been obtained - one for each month. The correction terms are determined as monthly averages of the forcing errors. But using these correction terms as additional terms in the prognostic equations of the model brings the model to explode because of too strong winds in the stratosphere. In order to avoid this the horizontal diffusion in the stratosphere is enhanced. The model does not explode anymore but the winds in the stratosphere are still too strong, the winter stratosphere is too cold and the Icelandic low is moved towards north-east. A new assimilation run was then made in which the horizontal diffusion is turned off. New correction terms are determined and used in a new run without horizontal diffusion. This new run does not explode and furthermore the winter stratosphere is not too cold anymore and the problem with the Icelandic low has disappeared, i.e. the problem seems solved. Another kind of experiment has been made in which the model is nudged towards the model itself with the time constant equal to two times the time step of the model. First a dummy nudging is made in order to judge the noise of the method. Secondly the model is nudged towards itself but with the radiation scheme turned off in order to investigate the effect of the radiation.

Bennert Machenhauer : Standard Nudging versus Slow Normal Mode Insertion (SNMI).

In standard nudging the residual is not the real tendency error, but the residual should be multiplied by the nudging time constant and divided by 2 times the time step of the model in order to obtain the tendency error. Using standard nudging problems with spin-up, imbalances in the assimilated data and gravity noise may occur and in order to minimise these problems the new technique Slow Normal Mode Insertion (SNMI) is applied. Using this method the slow modes of the model are replaced by the slow modes of the ERA data, while the fast modes of the model are let free to adjust. Experiments with the limit between fast and slow modes being a period of 12h and 24h have been made. For surface pressure the large tendency errors especially in mountain regions are much reduced using the SNMI method. Also for divergence and temperature the tendency errors are reduced compared to those obtained by standard nudging. For vorticity the difference between the two methods is not big. For all fields except divergence at the top of the atmosphere the difference between the tendency errors obtained using 12h and 24h cut-off period are not very big.

Ingo Kirchner : Preliminary Results of Slow Normal Mode Insertion (SNMI) Using ERA Data and ECHAM4.

In order to use the ERA data for nudging it is necessary to interpolate the data from the resolution of the ERA data to the resolution of the model. It has turned out that there were some problems using the interpolation scheme originating from ECMWF. In the interpolated data the SST's and the atmospheric data did not fit, the orography was not the same as in the ECHAM model and there was a bug in the interpolation scheme for the lowest levels. The interpolation scheme has therefore been replaced by a scheme based on the interpolation scheme in the HIRLAM model. This solves the problems with the old scheme. The extreme differences between MPI and DMI observed data were in the order of +3 and -3 Kelvin independent of the level. The structure was very diffuse with concentration of clusters in the tropics. This can be an effect of changes in the cloud or precipitation parameterisation used in the reanalysis scheme. Nevertheless (using the corrected interpolated data) the truncation from T106 to T42 generates imbalances in the data, later used for assimilation. Therefore a new technique, the so called Slow Normal Mode Insertion (SNMI), was used instead of the standard nudging.

Susanna Corti : Tendency errors in a Primitive equation simplified model: preliminary results.

Nudging experiments have been performed using a primitive equation model. The model has the dynamical core from GFDL and the parameterisation is made by Molteni. The model is a spectral model run in T30 resolution with 5 vertical levels. Assimilation runs are made for the months January and July 1984. The time constant for nudging is set to 6h for the variables wind, temperature and humidity. The nudging is performed in grid point space. For temperature and wind there is very good agreement between the assimilated run and the ERA data. But the 500 hPa geopotential height is approximately 60 m too high almost all over the northern hemisphere. This might be due to the fact that the surface pressure is not nudged. Inserting the obtained nudging term as a constant flux correction in the model causes the model to explode within 20-25 days. Again this can have to do with the surface pressure not being nudged.

### *Common Paper*

The writing of a common paper comparing different methods for obtaining tendency errors was initiated and this work will be continued in the near future. The title of the paper is : "Methods to Estimate Tendency  Errors In Atmospheric Models".