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"How to Run a Regional Forecast on a Workstation at a Remote Location Based on Analysis & Forecast Data from DWD (Offenbach/Main, Germany)"

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HOW TO RUN A REGIONAL FORECAST ON A WORKSTATION AT A REMOTE LOCATION BASED ON ANALYSIS AND FORECAST DATA FROM DWD, OFFENBACH/MAIN, GERMANY

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1. Introduction

Initial and lateral boundary data for the EM/DM are provided on the ftp-server of the DWD (ftp.dwd.de). The data consist of

- forecasts of DWD's Global-Modell (GM) with a spectral resolution of T106 (approximately 190 km mesh size) and 19 layers. The data reside in several directories on the ftp-server and are based on 00 and 12 UTC forecasts for the steps +0 h, i.e. the initialized analysis, up to +84 h at 6-hourly intervals. To keep the file size small, not all variables corresponding to one forecast step are in one file, but are distributed into six different files with sizes ranging from 23 kBytes to 513 kBytes. The total amount to be transfered is about 35 MBytes for all 15 GM forecast steps (+0h, +6h, .., +78h, +84h) for one run, e.g. for 00 UTC.

- EM-analysis for those users who's model domain form part of the EM domain (i.e. 0.5 degree mesh size).

The EM analysis for 00 UTC is ready for distribution by 2.45 UTC and for 12 UTC by 14.45 UTC.
The GM analysis for 00 UTC is ready for distribution by 4.13 UTC and for 12 UTC by 16.13 UTC.
The GM forecasts up to 84 hours started at 00 UTC are ready for distribution by 06.21 UTC and at 12 UTC by 18.21 UTC.

A program, called gmpp_ws is available for workstations which transforms the GM data to the Gaussian grid (approximately 1.125 degree resolution), either globally, i.e. to 320*160 gridpoints, or some latitude belt covering the regional domain of interest, e.g. 320*40 gridpoints.

The program gmtoem_ws interpolates these data from the Gaussian grid to the grid of the regional model(s) and adapts the fields to the higher resolution topography. These data serve as initial and lateral boundary data for the regional NWP model. For operational applications, the lateral boundary data are usually taken from the GM forecast started 12 hours earlier, i.e. from the 00 UTC GM run for the 12 UTC run of the regional model. Thus a 72-h forecast of the regional model can be performed using the GM forecast steps +12h up to +84h at the lateral boundaries. Therefore only the transmission of the GM analysis which can start as early as 04.13 UTC (or the EM analysis at 02.45 UTC) is time-critical, whereas the time period for transfering the lateral boundary data is almost 10 hours, i.e. from 06.21 UTC until 16.13 UTC.

Thus an Internet connection with a speed of 8 kBit/s should permit the transmission of the complete 35 MBytes of GM data in time.

Only other National Meteorological Services (NMS) are granted access to the actual data directories, universities and research institutions are only allowed to use the data in a delayed mode (24 hours). Thus TWO modes of running the regional version of EM/DM are possible

a) Operational application

Here the actual EM or GM analysis (e.g. for 00 UTC) is combined with lateral boundary values from the previous GM forecast (i.e. started at 12 UTC of the previous day for the 00 UTC run of the regional model).

b) Research application

Here the actual EM or GM analysis (e.g. for 00 UTC) is combined with lateral boundary values from the GM forecast starting from the same date and time. These data are available in a delayed mode to universities (by 24 hours). Or a sequence of GM analyses may be used as "true" lateral boundary values for past cases.

On average, the regional forecast driven by lateral boundary data from the GM run with the same initial date and time (application b) should be of a better quality than the one using boundary data from a GM run started 12 hours earlier (application a). But the verification at the DWD between the "early" EM forecast with lateral boundary data from the previous GM run and the "main" EM run with lateral boundary data from the actual GM run shows that the root-mean-square errors are only by 5% higher for the early run in the inner portion of the EM domain and about 10% for the total EM domain.

For the following short user guide we assume that you have already installed the EM/DM system on the your computer. Thus the following programs should work successfully

- gmtoem_ws which interpolates the GM data from the Gaussian grid to the grid of your regional model version of EM/DM
- emdm_ws which runs the regional forecast
- emdmpp_ws which does the postprocessing, e.g. interpolation from the model layers to pressure levels.

2. How to get the GM data from the ftp-server of the DWD

2.1 Preparations

To be allowed to ftp data from the DWD please do the following:
- Apply for GM data to the President of DWD.
- Send an e-mail to Mr. M. Gertz specifying the Internet address of the workstation you are using to "ftp" the GM data since this number is put into the list of workstations connected to DWD. Also add a secret key-word used in the creation of your password to the ftp-server.

You will receive an e-mail with the login name and password to the ftp-server. The password will be changed from time to time, just as a security check. The program 'codax' will be used to de-code the encrypted password at the user location. 'codax' is one of the files in the the tar-file 'dwdmail.tar'.

2.2 Directory structure

On your workstation where you store the GM data create the following sub-directories

- gm_data with the sub-directories

  - const constant GM data (e.g. topography) and climatological GM data (monthly mean fields of deep soil temperature and moisture)

  - data00 GM forecast started at 00 UTC

  - data12 GM forecast started at 12 UTC.

You may create sub-directories containing information about the date since the GM data file names do not contain any information about the initial date of the GM forecast.

2.3 Get the GM data via ftp from the DWD, Germany

You have to FTP to the ftp-server workstation at DWD Offenbach/Main, Germany, to get the GM data.

TYPE: ftp -i ftp.dwd.de.

You will be prompted for your login name.
TYPE: nwvact

You will be prompted for a password. Enter the decode password given to you via e-mail (e.g xyzabc).
TYPE: xyzabc

You will now be connected to the ftp-server at DWD,Germany.

On this ftp-server there are three sub-directories containing the GM data, namely "const", "data00", "data12". Thus these directories are the same as the ones on your workstation.

2.3.1 The sub-directory "const"

The first directory, "const", contains files with constant data.
To move into this directory
TYPE: cd const

The constant files are:

Orography, land/sea mask, etc.	gconG00
Month to month climatological fields from January (01) to December (12)	gcmmG01 gcmmG02 gcmmG03 gcmmG04 gcmmG05 gcmmG06 gcmmG07 gcmmG08 gcmmG09 gcmmG10 gcmmG11 gcmmG12

All the fields correspond to the Gaussian Grid (320*160 gridpoints) of the GM.
In the file gconG00 are the following fields:

Orography	: FIB
Land/Sea Mask	: BLA
Geog. Lat. of the grid points	: PHI
Geog. Lon. of the grid points	: RLA

The 12 files gcmmG01,gcmmG02,.....,gcmmG12 contain climatological soil fields which are held constant for one whole month and only change from one month to the next. These fields are:

Climatological temperature of the deep soil layer	: TCL
Climatological water content of the deep soil layer	: WCL

These 13 files you have to get only once from the DWD, of course!!
They are stored in the sub-directory "const" on your workstation.

2.3.2 The sub-directories "data00" and "data12"

The second "data00" (third "data12") directory contains data initialized at 00 UTC and 12 UTC, respectively. Both times have forecast files from 0hr to 84hrs, written at 6-hourly intervals.

Move to the 'data00' directory
TYPE: cd data00

NOTE:
There are two additional files

info.gm	: informs user when the 84 hours FORECAST DATA, initialized at either 00UTC or 12UTC, are ready for distribution.
info.gm00	: informs user when ANALYSIS DATA, for either 00UTC or 12UTC, are ready for distribution.

The content of the info-files is the actual date of the data; it should be checked before the data transmission.

NOTE: You can write a small script to check the presence of these data files before you start the data transmission.

The following files are to be found in this directory:
---

(1) Spectral data: vorticity (vor), divergence (div), temperature (tem), specific humidity (hum), and logarithm of surface pressure (pre).
The spectral data are given for all 19 model layers, except for the logarithm of surface pressure (pre).

Initialized Analysis Data	gvorS00	gdivS00	gtemS00	ghumS00
	gvorS06	gdivS06	gtemS06	ghumS06

Forecast Data	gvorS12 gvorS18 gvorS24 . . . . gvorS84	gdivS12 gdivS18 gdivS24 . . . . gdivS84	gtemS12 gtemS18 gtemS24 . . . . gtemS84	ghumS12 ghumS18 ghumS24 . . . . ghumS84

Each file is about 4.45 MByte in size.
For a 48-h operational (i.e. with "old" boundary data) forecast, you have to access boundary data from the 12-h up to the 60-h forecast of the previous GM run.

(2) The logarithm of the surface pressure is only one layer.

Initialized Analysis Data	gpreG00
Forecast Data	gpreG06 gpreG12 gpreG18 gpreG24 . . . . gpreG84

(3) Surface fields on the Gaussian grid (320*160 gridpoints).
These fields are:

Surface temperature	:	TB
Temperature of the second soil layer	:	TD
Snow amount	:	SN
Soil water content of the first layer	:	WB
Soil water content of the second layer	:	WD

NOTE: All surface fields are lumped together into one file called, 'gsurG'.

Initialized Analysis Data	gsurG00
Forecast Data	gsurG06 gsurG12 gsurG18 gsurG24 . . .

	gsurG84

2.3.3 Moving the GM data to your workstation

For operational application at e.g. 00 UTC, you have to combine the GM analysis from 00 UTC (sub-directory "data00") with GM forecasts from the previous GM run (sub-directory "data12").

Get the GM forecast of the previous GM run

```
TYPE: cd data 12
TYPE: mget *12
TYPE: mget *18
TYPE: mget *24
        .
        .
        .
        .
TYPE: mget *84
```

You can start to "ftp" these data at about 18.21 UTC, i.e. about 6 hours past the initial time of the GM forecast. The transmission should be completed by 04.13 the next day; thus about 10 hours transmission time are available.

NOTE:
How many forecast files you move to your remote workstation location depends upon:
(i) The storage capacity of your workstation
    (the disk and tape space) and
(ii) On how many days ahead you want to perform your forecast.

Get the GM analysis

```
TYPE: cd data00
TYPE: mget *00
```

You can start to "ftp" these data at about 04.13 UTC, i.e. about 4 hours past the analysis time. The transmission of the analysis files is time-critical, of course, since you cannot start your forecast without the analysis.

To disconnect from the ftp-server at DWD
TYPE: quit (or bye)

To see if all the FTPed Data is in your 'gm_data' directory
TYPE: ls -al

If all the GM data files have been FTPed to your workstation, you can proceed to the next step.

3. Using the program gmpp_ws to transform all GM data to the Gaussian grid and extract the latitude belt for the domain of interest

The program 'gmpp_ws' takes the GM data which are in GRIB code, de-GRIBs the data, cuts out the sub-area of interest from the global Gaussian grid, downloads the unpacked (de-GRIBed) data on this sub-area, packs the data of the sub-area in GRIB code and writes these packed data into a file.

3.1 Get and install gmpp_ws

The program gmpp_ws is on the ftp-server of the DWD as tar-file.

The program consists of several Fortran (.f) files and header files (.h); a simple makefile and a README file is provided, too. A sample input file to gmpp_ws, called GM_PP_IN, is also there.

To get the files send an e-mail to M. Gertz (gertz@ecmwf.int) to ask for the login name and password of the source directory on the ftp-server. To install gmpp_ws ftp the tar-file gmpp_ws.tar to your workstation. Create the sub-directory gmpp_ws and de-tar (TYPE: tar -xvf gmpp_ws.tar) the tar-file. Modify the makefile with respect to compiler/loader and the pathnames to the libraries libsupp.a and libemdm_ws.a. To generate the binary gmpp_run, TYPE: make.

Of course, this installation of gmpp_ws has to be done only once!!

3.2 To run 'gmpp_ws', please follow these instructions

Edit the Namelist file called 'GM_PP_IN'.
Modify the date and forecast hour in the Namelist &GMCONTL.
Also, modify the domain bounds to describe the sub-area of your interest (JFIRST, JLAST).
Lastly, you have to specify the sub-directories containing the GM data files for input ("const", "data00", "data12") and output.

```
&GMCONTL
 YDATUM=DDMMMYYTT,
 IVV   =0,
 JFIRST=60,
 JLAST =101,
 YCCAT ='.../const/'
 YICAT ='.../data00/'
 YOCAT ='.../data00/'
 /
```

3.3 Transform the initial analysis to the Gaussian grid

To get the initial analysed data of the GM at 00UTC for your latitude belt
TYPE: gmpp_run

For the very first run, 'gmpp_run' will create a Legendre file called

'legfile'.

This file is used in the transformation of the spectral coefficients from

spectral to grid space. Do not remove this file!

After successful completion of gmpp_run you will find the result GRIB file in the directory you specified in the Namelist variable YOCAT. The initial analysed data file has the general file name

"gaJLN00"

where JLN is the : Julian Date
(i.e 1 to 365 days/year calendar).

3.4 Transform the lateral boundary data (GM forecasts) to the Gaussian grid

It depends on your mode of application, which GM forecast data you use as lateral boundary condition.

3.4.1 Operational application

Here you will use GM forecast data from the previous GM run, i.e. you combine the 00 UTC analysis with the GM forecast started at 12 UTC of the previous day. Thus you have to modify the pathname of the GM input data (YICAT) in GM_PP_IN to 'data12' assuming that this directory contains the 12 UTC GM forecast files of the previous day. You have to run gmpp_run separately for each forecast step you need, e.g. 12-h, 18-h, ..., 78-h, 84-h. Thus you have to reset the Namelist variable IVV to 12, 18, ..., 78, 84, and run gmpp_run for each step.

The output data files generated by 'gmpp_run' for your domain of interest (sub-area) will be the following:

	gaJLN00
Initialized Analysis Data	For Example ----------
	ga28800 for 14th Oct,1996
Forecast Data	gm12G12 gm12G18 gm12G24 . . . . gm12G84

These data allow a 72-h forecast of your regional model.

NOTE: In an operational environment you won't type all the commands manually but prepare small scripts which do the job for you. These scripts may be started using the UNIX command 'crontab'.

3.4.2 Research application

Here you use the GM forecast data from the same date and time as the GM

analysis, i.e. you combine the 00 UTC analysis with the GM forecast started at 00 UTC. You can even use a sequence of analyses as lateral boundary conditions if you want to drive your regional model with "true" lateral boundary data.

The output data files generated by 'gmpp_run' for the your domain of interest (sub-area) will be the following:

	gaJLN00
Initialized Analysis Data	For Example ---------- ga28800 for 14th Oct,1996
Forecast Data	gm00G00 gm00G06 gm00G12 gm00G18 gm00G24 . . . . gm00G84

These data allow a 84-h forecast of your regional model in research mode.

NOTE: You can convert the Initalysed Analysis Data File, ga28800, into the first forecast file by copying.
TYPE: cp ga28800 gm00G00

4. RUNNING 'GMTOEM_WS'

The 'gmtoem_ws' program takes the GM Data generated by 'gmpp_run' for your domain of interest (sub-area) and interpolates the data to the grid of your regional-scale version of EM.

The topographical data in the domain of your regional model have to be provided to gmtoem_ws by yourself, but for coarser resolution (like 0.5°) we can offer some help in creating the proper GRIB file.

4.1 Modify gmtoem_ws for your model domain

Set up a directory for 'gmtoem_ws', and move to this directory
TYPE: mkdir gmtoem_ws
TYPE: cd gmtoem_ws

Set up a workbench for the 'gmtoem_ws' program
TYPE: $ADM/projgen gmtoem_ws
Here the Korn shell variable ADM should contain the full pathname where the scripts of the source code administrator reside.

Edid two header decks which will be placed in the sub-directory 'work'

namely,

resgm.h
resem.h

and modify the grid points to define your sub-area.
For resgm.h, the variable JEGM has to be set to the result of JLAST-JFIRST+1 (see gmpp_ws).
For resem.h, the variables IEEM and JEEM are the number of gridpoints of your regional version of EM in West-East, South-North direction.

Prepare a new executable binary (TYPE: make exe). This new binary gets the name 'tstbin'. Use this binary in the script 'gmtoem_run'.

4.2 Prepare the initial data of your regional model, based on the GM analysis

Get the job script file, 'gmtoem_run' and modify the set-up to create the analysis file

```
YANDAT='14109600', <--- Day, month, year, time   'DDMMYYTT'
HANF=0,
HENDE=0,
YTYPGM='ANA',      <--- This means the GM analysis is taken
LRANDD=.FALSE,     <--- This means that initial data are derived,
                        not lateral boundary data
  .
  .
  .
YGMEXPN='   '        :   leave the 3 spaces blank.
```

Now: TYPE: gmtoem_run

This run will generate an EM GRIB data file called
ea28800

using the above defined Julian Date as an example.

4.3 Prepare the lateral boundary data of your regional model

4.3.1 Operational application, i.e. lateral boudaries from previous GM forecasts

Get the job script file, 'gmtoem_run' and modify the set-up to create the lateral boudary data files

```
YANDAT='13109612', <--- Day, month, year, time   'DDMMYYTT'
                        Note that the date is 12 hour earlier than
                        the initial date of your regional run!
HANF=12,
HENDE=84,
DH=6,
YTYPGM='PROG',     <--- This means the GM forecasts are taken
LRANDD=.TRUE.,     <--- This means that lateral boundary data are
                        derived
  .
  .
YGMEXPN='12G'        :   Name of GM run providing the data
```

Now: TYPE: gmtoem_run

|---|---|

Initialized Analysis Data	ea28800 for 14th Oct,1996
Boundary Data	er12G12 er12G18 er12G24 . . . er12G84

These data allow a 72-h forecast of your regional model with lateral boundary data taken from the previous GM forecast.

4.3.2 Research application, i.e. lateral boudaries from the GM run based on the same initial date and time

Get the job script file, 'gmtoem_run' and modify the set-up to create the lateral boudary data files

```
YANDAT='14109600', <--- Day, month, year, time   'DDMMYYTT'

                        Note that the date is the same as the
                        one of your regional run!
HANF=00,
HENDE=84,
DH=6,
YTYPGM='PROG',      <--- This means the GM forecasts are taken
LRANDD=.TRUE.,      <--- This means that lateral boundary data are
                         derived
  .
  .
YGMEXPN='00G'         :  Name of GM run providing the data
```

Now: TYPE: gmtoem_run

Initialized Analysis Data	ea28800 for 14th Oct,1996
Boundary Data	er00G00 er00G06 er00G12 er00G18 er00G24 . . . er00G84

|---------------|--------------------------|

These data allow a 84-h forecast of your regional model with lateral boundary data taken from the GM forecast started at the same initial date and time.

5. RUN THE EUROPA MODEL 'EMDM_WS' USING GM DATA FOR INITIAL AND LATERAL BOUNDARY CONDITIONS

Now, you have initialized analysis data plus the boundary data required to run your regional-scale version of EM.

5.1 Modify emdm_ws for your regional model domain

Create a directory called, 'emdm_ws' for the EM and move to the directory

```
TYPE: mkdir emdm_ws
TYPE: cd emdm_ws
```

Create a workbench for the 'emdm_ws'

```
TYPE: $ADM/projgen emdm_ws
```

Edid the header file 'param.h' which will be placed in the sub directory 'work' and alter the number of gridpoints (IE, JE) to your specification

```
TYPE: edid param.h
```

Generate an executable, named 'tstbin'

```
TYPE: make exe
```

Of course, it is only neccessary o n c e to set up your regional version of the EM.

5.2 Run the forecast of your regional model

The data files created in Sections 4.2 and 4.3 are sufficient to run your regional version of EM.

5.2.1 Operational application

Here you combine initial data with lateral boundary data derived from the previous GM run.

Get the job script file 'emdm_run' for running the 'emdm_ws' and modify the Namelists' variables accordingly

```
YADAT='14109600',       <--- initial date of regional forecast
YRDAT='13109612',       <--- initial date of GM forecast
NHANF=0,
NHENDE=72,              <--- 72-h forecast
NHERGA=0,               <--- First GRIB result file at +0 hour
NHDERG=6,               <--- GRIB result files written every 6h
YEDEN='XYZ'             <--- Experiment-Name (3 Characters)
YADEN='   ',
YRDEN='12G',            <--- Name (3 characters of GM run providing
                             the lateral boundary data)
```

5.2.2 Research application

Here you combine initial data with lateral boundary data derived from the GM run with the same initial date and time.

Get the job script file 'emdm_run' for running the 'emdm_ws' and modify the Namelists' variables accordingly

```
YADAT='14109600',       <--- initial date of regional forecast
                             If YRDAT is omitted, it will be
                             set to YADAT automatically.
NHANF=0,
NHENDE=84,              <--- 84-h forecast
NHERGA=0,               <--- First GRIB result file at +0 hour
NHDERG=6,               <--- GRIB result files written every 6h
YEDEN='XYZ'             <--- Experiment-Name (3 Characters)
YADEN='   ',
YRDEN='00G',            <--- Name (3 characters of GM run providing
                             the lateral boundary data)
```

To run your regional-scale model
TYPE: emdm_run

The GRIB result files of the regional model are named

emXYZ00, emXYZ06, ..., emXYZ72

for a 72-h forecast with GRIB result files written at 6-hourly intervals.

6. INTERPOLATION FROM MODEL TO PRESSURE LEVELS

The post-processing program 'emdmpp_ws' interpolates data from the hybrid model layers to pressure levels.

6.1 Modify emdmpp_ws for your model domain

Create a directory for post-processing of the EM output and move there.
TYPE: mkdir emdmpp_ws
TYPE: cd emdmpp_ws

Create a workbench for post processing.
TYPE: $ADM/projgen emdmpp_ws

Edid the header file 'kon.h' which will be placed into the 'work' sub-directory and modify the number of grid points (IE, JE).
TYPE: edid kon.h

Compile the program to generate the executable called 'tstpint'
A second executable for the vertical sections called 'tstvers' will also be created.
TYPE: make exe

6.2 Run the interpolation job

Get the job script 'pintem_run' , modify the Namelist variables and set the time interval for the interpolation.

To run the script file

This run will generate files that are interpolated to pressure levels; these files get the suffix 'p', e.g.

emXYZ00p, emXYZ06p, ..., emXYZ72p

for a 72-h forecast with GRIB result files written at 6-hourly intervals.

7. GRAPHICAL VISUALIZATION OF THE EM OUTPUT DATA

At present, graphical interfaces are provided to the public domain packages 'GRADS' (by V. Pescaru, Romania) and 'VIS5D' (by P. Gross, University of Bonn, Germany). A program which de-GRIBs EM/DM data and writes them out as ASCII data is provided by F. Hamelbeck (University of Austria). Please contact these persons (see the mailing list if you are interested in the software).