OpenIFS convection experiments

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Date:	09-Jun-2014 10:55
URL:	https://software.ecmwf.int/wiki/display/OIFS/OpenIFS+convection+experiments

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1 About this tutorial

This tutorial goes through the steps required to complete the runs of OpenIFS for the convection case studies.

There are two case studies, one looking at tornado formation over the USA, the other looking at formation of deep convection over Africa. In each case study, a control run is carried out together with other runs which disable a part of the convection parametrization in the model to compare with the control and understand the role of convection. For more details of the case studies, please see the handout by Peter Bechtold.

It is assumed the reader is familiar with Linux/Unix commands.

2 Setting up

Before running OpenIFS, it is important to make sure that the environment is correctly set. This means setting some Unix environment variables to locate various files that OpenIFS needs to run.

From the home directory:

Perform these steps..

```
cd openifs
source ./oifs.setup
```

Take a look at the contents of the oifs.setup file. Environment variables beginning OIFS are used by the scripts that run the model to locate files and set the configuration.

3 Experiments

The convection experiments can be found in the directory: openifs/expts, which contains the following:

```
t255l91/ t255l62/ t159l62/
```

There are 3 experiments directories. They are:

t255l91 : T255 horizontal resolution and 91 levels.

t255l62 : T255 horizontal resolution and 62 levels.

t159l62 : T159 horizontal resolution and 62 levels.

T255 spectral resolution is approximately 80km with T159 spectral truncation 125km.

The files `fort.4` and `job` will be described later. They are used for running the model.

In these examples the model will be run for a 30hr forecast.

3.1 Memory requirements

Unfortunately OpenIFS requires significant amount of memory to run. The memory setting on the virtual machine, or the computer you plan to use, should be high enough to accommodate the model. It is also important not to set the memory used by the virtual machine itself to not more than half of the total memory on your computer.

For t255l91 allow at least 12Gb memory, t255l62 10Gb memory, t159l62 5Gb memory on the virtual machine (plus some extra for the virtual machine itself).

3.2 Runs

For each experiment there are 3 runs that are performed.

oper: The first is a control run which is referred to as 'oper' simulating the way the model would be run to produce the operational forecasts at ECMWF.

nodeep: The second run is called 'nodeep' and this involves turning off the parametrization of deep, penetrative convection in the model. The aim of this experiment is to see what difference it makes to the convection when compared with the 'oper' or control run. This run is only useful for the US Tornado exercise.

nodcyc: The third run is the 'nodcyc' run. This is where the diurnal cycle improvement of parametrized convection is disabled. This improvement was introduced in the most recent version of the operational model. It is not available in OpenIFS but the necessary code has been added for the purpose of this tutuorial. This run is only useful for the Africa exercise.

4 Running OpenIFS experiments

First, choose a model resolution. You can do as many as you want. For the purpose of this tutorial, it's assumed the model will be run for the t255l91 case (the highest resolution). If you choose another resolution, change the directory and experiment id as appropriate.

4.1 Preparing the files

Each OpenIFS run or experiment is identified using a four character *experiment id* e.g 'g455'. This experiment id was created at ECMWF when the initial files were created. This identifier is part of the filename of the initial files and must be set in the namelist read by the model. This is described below.

Taking the t255l91 resolution as an example, to prepare the model run, first copy the initial data into each case study directory and unpack the data:

```
cd openifs/expts/t255l91
tar -x -f t255l91_g455.tar -C oper
tar -x -f t255l91_g455.tar -C nodeep
tar -x -f t255l91_g455.tar -C nodcyc
```

In this case 'g455' is the ECMWF experiment id for the T255L91 (91 levels) experiment. Inside each directory there should now be these files:

```
ICMCLg455INIT  ICMGGg455INIT  ICMGGg455INIUA  ICMSHg455INIT
```

These are the initial files for the model in GRIB format. If you want to inspect the contents of the file, use the grib_ls command .e.g.

```
grib_ls ICMg455INIT
```

The files that begin ICMGG are files with data in grid-point representation. The files beginning ICMSH have data in spectral representation.

Next copy the script to run the model 'job' and the file containing the list of variables ('switches') given in Fortran NAMELIST style 'fort.4'. Both these files need editing before the model can be run.

For the 'oper' run:

Copy files into the 'oper' directory:

```
cp job fort.4 oper
```

repeat this for the other runs 'nodeep' and 'nodcyc'.

4.2 Control run 'oper'

Edit the run script 'job'

In the 'oper' directory, the file 'job' contains a Unix script to run the model. Edit this file in your favourite editor and look for these lines:

```
#  Exptid
EXPID=
```

This is the experiment id given in the initial files. Make sure it matches. i.e. if the initial file is ICMGGg455INIT, set: EXPID=g455.

Also look for this line:

```
# Model spectral resolution
RES=255
```

This sets the model horizontal resolution. Make sure it is correct. If you are doing the t159l62 experiment, it will need changing.

Edit the 'fort.4' file to change namelist variables...

The file 'fort.4' contains a list of variables that control what the model does. Most of these do not need altering and should not be changed unless you are aware of what they do (see OpenIFS website documentation for more details).

In this tutorial, a few of these variables need altering for the model runs. Edit fort.4 in your favourite editor and look for these variables:

```
NPROC=<editme>,              ! number of parallel MPI tasks
CNMEXP="<editme>",           ! experiment id
NFP3DFP=<editme>,            ! number of variables to output on pressure levels
MFP3DFP(:)=<editme>,         ! GRIB codes of variables to output on pressure levels
```

For NPROC, make sure it is set the same as the value in the 'job' script. Likewise CNMEXP.

NFP3DFP and MFP3DFP control the model output on pressure levels. For more information about what these variables do and how to change them, go to the OpenIFS website (http://software.ecmwf.int/oifs/) and find the page entitled 'How to control OpenIFS output'.

Change the namelist to output these fields...

geopotential, temperature, vertical velocity, relative vorticity, divergence, relative humidity, specific humidity

In order for the model to output these variables, they must be given as GRIB codes. More information is on the OpenIFS web page.

Remember: some of these variables will be output by the model in spectral form, not gridpoint form.

- Which output file do they go in?
- What output frequency is set?

4.2.1 Running the model

Before executing the script to run the model first ensure you have set the correct environment variables (as described at the top of this document).

Then run the model by:

```
./job
```

If you want to capture the model output, then use:

```
./job &> log
```

4.3 Runs 'nodeep' and 'nodcyc'

Follow the same procedure for the model runs in the 'nodeep' and 'nodcyc' directories as above, except for:

> ⓘ **nodeep run: turn off deep convection**
>
> In the nodeep case, turn off deep, penetrative convection. Do this by editing 'fort.4', find the namelist NAMCUMF and add a line:
>
> ```
> LMFPEN=false, ! disable deep convection
> ```

> ⓘ **nodcyc run: turn off the diurnal cycle for convection**
>
> In the nodcyc case, disable the diurnal cycle modification to the deep convection. Do this by editing 'fort.4', find the namelist NAMCUMF add add a line:
>
> ```
> RCAPDCYCL=0.0, ! disable diurnal cycle correction
> ```
>
> The default value, with the diurnal cycle correction on, is 2.0.

5 Analysing output

As OpenIFS runs, the GRIB output files (beginning with ICMGG and ICMSH) and the model log (the NODE.001_01) are written to the same directory as the job script and model initial files. At the end of the run, the job script will move these files into a new directory called 'run1'. Remember, OpenIFS does not delete its output files. If the GRIB output files exist from a previous run, OpenIFS will just append to them and you could have the same fields several times.

5.1 Metview

To use the output from OpenIFS in the workshop tutorial, the files first need to be processed by Metview.

Locate the openifs_to_area.mv macro file :

openifs_to_area.mv

Make a copy of this macro and edit the lines near the top to change file locations. Select 'Execute' on the macro menu to run it and generate the GRIB file for use with the exercises.

See separate handout for more details of the exercises.