OpenIFS practical exercises with Metview (Stockholm)

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1 Preface

These practicals feature two case studies (deep convection and diurnal cycle) based on fields derived from runs with **IFS CY40r1** (the current operational version at ECMWF). There are also additional **OpenIFS** experiments available. If time permits, you can compare these simulations to one another or to the IFS runs used in the case studies.

Please see **Annex I** for the full list of fields/experiments.

1.1 Starting up Metview

First, start Metview as described below:

- Start virtual machine (see separate handout)
- Open a terminal window by clicking on the 'terminal' icon in the system tray
- Type the command:

```
metview -desktop
```

Once Metview is up and running open folder 'openifs'. You will work in subfolders 'deep_conv', 'dcycle' and 'openifs_runs'

2 Case study: deep convection

On 27 April 7pm local time (00UTC 28 April), tornadoes hit towns north and west of Little Rock, Arkansas.

Key questions/tasks

1. Understand the **weather situation** resulting in tornadoes
2. Evaluate the **control forecast** and compare it to the analysis and observations
3. What is the **area of threat** according to the control forecast?
4. How does the **convective adjustment** process takes place and and what is the role of large scale forcing (why and where it happens)?
5. What difference does deep convection parametrization make? Compare **control** vs. **nodeep** case and give physical reasons for the differences.

Please enter folder 'deep_conv' to start working.

2.1 Understand the weather situation over North America

Overlay GOES infra red (10.0 m) satellite images with MSLP analysis

1. Visualise map_usa_sat
2. Drop goes_ir.grib and sat_shade into the plot together
3. To overlay with mslp also drop mslp_for_sat and mslp_green into the plot together

Plot *analysis* in various layouts

Plot *analysis* in various layouts

Macro an_ls_1x1.mv plots *analysis* fields over North-America.

Change plot contents

The plot contents can be changed by editing the **plot1** variable in the macro. By default an overlay of 500 hPa temperature and geopotential is generated:

```
plot1=["t500","z500"]
```

To plot other parameters e.g. 500 hPa wind just change **plot1**:

```
plot1=["wind500"]
```

You will find the list of available parameters in the macro.

Change plot layout

The number of maps appearing in the plot layout can be 1, 2, 3 or 4. Macro an_ls_2x2.mv demonstrates how to plot a four-map layout in a similar fashion to the one-map layout. The only difference here is that you need to define four plots instead of one, like this:

```
#Define plots (min 1- max 4)
plot1="mslp"
plot2=["speed200","z200"]
plot3="wind10"
plot4="t850"

plots=[plot1,plot2,plot3,plot4]
```

2.2 Evaluate the control forecast

Plot *control* forecast

Use the ctl_1x1.mv and ctl_2x2.mv macros to visualise the *control* forecast. You can change the fields to plot exactly in the same way as it was shown above for the analysis.

Plot ENS fields to estimate the uncertainty in the forecast

There is a set of macros with the name of en_*,mv to plot ENS forecast field. Each plots a map with the ensemble mean and spread (shaded) of the corresponding parameter. You should not edit these macros just use them 'as is'.

2.3 Compare control forecast to observations

Compare precipitation forecast to radar

Macro fc_to_radar.mv generates a two-map plot showing the 1h total precipitation forecast together with the precipitation measurements derived from NEXRAD.

Compare *control* to *analysis* fields

Use macro ctl_to_an_1r.mv to compare *control* to *analysis* . This macro generates a plot with two maps next to each other, the first showing the *control* forecast while the second one the *analysis*.

Change plot contents and layout

The plot contents can be changed by editing the **row1** variable in the macro. By default two map of 2m temperature is generated:

```
row1=["t2"]
```

To compare other parameters e.g. 500 hPa wind just change **row1**:

```
row1=["wind500"]
```

You will find the list of available parameters in the macro. There is a two-row version of this macro to comparing two parameters at the same time: ctl_to_an_r2.mv . You can edit it in a similar manner.

Compare *control* to *synop* observations

Use macros ctl_to_synop_*_.mv to compare *control* to *synop* observations at a given time for a given parameter. These macros generates plots featuring 3 maps: one for the forecast, one for the analysis and one for the difference between them.

You will find the list of available dates in the macros

2.4 Identify the area of threat

Plot *control* forecast

Use macro ctl_threat_2x2.mv to generate a four-map plot with the parameters most useful for identifying the area where tornadoes could possibly occur. (Naturally, you can edit this macro to define your own choice of parameters).

If you wish to mark your area (as a rectangle) in the plot just edit the cre_area.mv macro and drop it into the plot.

2.5 Describe the convective adjustment process and forcing

Create tephigrams for observations at Little Rock

The tephi_obs.mv macro generates a tephigram from the radiosonde observations taken at **Little Rock** at two different times.

Edit the macro to

- set the times to compare
- change the colour of the profiles

Create tephigrams for the *control* forecast

Use the tephi_ctl.mv macro to plot tephigrams from the *control* forecast at two different time steps for your selected location.

Edit the macro to

- define the location
- set the times to compare
- change the colour of the profiles

Please note that the GRIB data for tephigram rendering is only available over this domain: S: 28, N: 42, W: -100, E: -88

If you wish to mark your tephigram location on a map (rendered as a filled circle) just edit the cre_point.mv macro and drop it into any of the plots.

2.6 Compare experiments and give physical reasons for differences

Plot *nodeep* forecast

Use macros nodeep_1x1.mv and nodeep_2x2.mv to generate similar plots as for the control forecast.

Compare *control* and *nodeep* forecast

Use macro ctl_to_nodeep_1x2.mv to compare one parameter from *control* to *nodeep* in a very similar way to how you compared *control* to the *analysis*. There is another version of this macro to compare two parameters at the same time: ctl_to_nodeep_2x2.mv .

Create tephigrams for the *nodeep* forecast
Use macro tephi_nodeep.mv and customise the location and times in it to plot the tephigrams.

3 Case study: diurnal variation of convection

Key questions/tasks

1. What difference and why does diurnal variation of convection make?
2. Describe the phase and amplitude of (scaling) of the precipitation with the different experiments with respect to surface heat fluxes.
3. What is it that scales precipitation flux?
   Compare buoyancy flux with enthalpy. Think about the effect of local heating combined with atmospheric moisture.
   What is the role of large scale in this case?
4. How important is the correct diurnal cycle of precipitation and radiation for 2m temperature and dewpoint forecast?
5. Compare differences between Central Africa and other areas (e.g. Amazonia)

Please enter folder 'dcycle' to start working.

3.1 Understand the weather situation over Central Africa

Plot gridded 24-hour precipitation observations

1. Visualise icon map_caf
2. Drop rain24h_obs.grib into the plot
3. Drop tp_24h_shade into the plot

Plot METOSAT water vapour (6.2 m) images

1. Visualise icon map_caf_sat
2. Drop meteosat_wv.grib into the plot
3. Drop wv_shade into the plot

3.2 Evaluate diurnal cycle over Central Africa

Compare area-averaged total precipitation for *control* and *nodcycle*

Use macro cmp_prec.mv to compare the temporal evolution of total precipitation averaged over Central Africa.

If you want to mark the area selection on a map just edit the cre_area.mv macro and drag it into the map/plot.

Plot area-averagred surface fluxes for *control* and *nodcycle*

Use macros ctl_flux.mv and nodcycle_flux.mv to plot the temporal evolution of averaged fluxes over Central Africa.

Plot t2 and td2 forecasts and observation for selected locations

Macro cmp_to_synop.mv plots the temporal evolution of the 2m temperature and dewpoint forecasts (*contol* and *nodycycle*) and synop observations at a selected WMO station.

Please edit the macro to change the station. To have an idea about the available stations either visualise plot_stations.mv or drop cre_stations.mv into an existing map/plot.

3.3 Evaluate diurnal cycle over other areas (e.g. Amazonia)

Find other areas of interest

Macro oper_prec_6h.mv plots a global 6h precipitation forecast to help you find an area (you can use t p_shade to customise the plot).

Compare precipitation and surface fluxes for *control* and *nodcycle*

Just set the area in cmp_prec_other.mv , ctl_flux_other.mv and nodcycle_flux_other.mv to create similar plots like you did for Central Africa.

4 OpenIFS Runs

The **OpenIFS** model was modified to include the diurnal correction for convection, present in the above IFS experiments. A number of experiments were also run with OpenIFS for these cases (see **Annex I** for details). As OpenIFS is based on an older cycle of IFS, the forecasts will be different from the IFS experiments, largely because of changes to the physical parametrizations.

If time permits, try comparing one of these experiment to the IFS simulations.

Please enter folder 'openifs_runs' to start working.

You will find a number of template macros here. You can guess what the macros are for from their name (using your experience from the case studies). They are to plot individual experiments or compare any two experiments (OpenIFS or IFS). You just need to set the input file name and experiment label in the macros accordingly. Please see **Annex I** for the file path of each experiment.

Run your own simulation

The above experiments can be run with OpenIFS on your own installation. Please refer to the separate handout. All the initial files are provided on the virtual machine.

5 Annex I

The table below gives you an overview about the **IFS CY40R**1 datasets used for the case studies.

Experiment	Config	Resolution*	Steps/times available	File
analysis	oper	T1279/L137	6h	data/an.grib
ENS	oper		3h	data/en*.grib
control	oper	T255/L137	1h	data/ctl_t255.grib
nodeep	deep convection switched off	T255/L137	1h	data/nodeep_t255.gib
nodcycle	no diurnal correction for convection	T255/L137	1h	data/nodcyc_t255.grib

* For the practicals the original fields were post-processed and interpolated onto a 0.8°x0.8º grid with Metview.

The table below gives you an overview about the **OpenIFS** datasets available with a **1h** temporal resolution.

Experiment	Config	Resolution*	File
t255l91_oper	oper	T255/L91	data/t255l91_oper.grib
t255l62_oper	oper	T255/L62	data/t255l62_oper.grib
t159l62_oper	oper	T159/L62	data/t159l62_oper.grib
t255l91_nodeep	deep convection switched off	T255/L91	data/t255l91_nodeep.grib
t255l62_nodeep	deep convection switched off	T255/L62	data/t255l62_nodeep.grib
t255l62_nodeep	deep convection switched off	T159/L62	data/t159l62_nodeep.grib
t255l91_nodcycle	no diurnal correction for convection	T255/L91	data/t255l91_nodcyc.grib
t255l91_nodcycle	no diurnal correction for convection	T255/L62	data/t255l62_nodcyc.grib
t255l91_nodcycle	no diurnal correction for convection	T159/L62	data/t159l62_nodcyc.grib

* For the practicals the original fields were post-processed and interpolated onto a 0.8°x0.8º grid with Metview.