Introduction of warning index in coupling files

Rachida El Ouaraini
GMAP Supervisor : Ryad El Khatib
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1. Introduction

This document does not describe the scientific background of monitoring the Coupling-Update Frequency (CUF). In fact, the reader will find information in Termonia (2003) and Termonia (2004), in few words, the use of lateral-boundary data of much poorer temporal resolution than the time step of the coupled model is considered as one of the limitations of the limited-area models (LAMs). Thus, efforts have been made to monitor the data transfer between the coupling and the coupled model.

This work could not have been born without the considerable efforts of Piet Termonia related to monitoring the coupling-upadte frequency. Indeed, during his stay in spetember 2004 at GMAP, he has computed new fields allowing the mentionned monitoring and has written them in historical files ARPEGE/ALADIN. He has written a technical documentation for his implementation [3].

These fields are lnPs (logarithm of surface pressure) filtred by 1, 2, 3, 4 or 5 filters. In opeartionnal mode, one filter seems to be sufficient if the update interval of coupling is equal to 3h.

I will call these fields in this paper CUF fields.

My work during this stay consisted in reading these new fields and then on post-proccessing them, with the view to run the configuration 927 for the objective of coupling. Thus, if the forcaster notices an important signal of CUF field with a depression which circulates too quickly, one should increase the coupling interval frequency to better supervise this «extreme meteorological phenomena».

2. Code modifications to cy29t3

The modifications done by Piet consisted on :

1. Compute $[\ln Ps]^{\mathbf{filt}}$ and time shifting.
2. Write this (these) field(s) to the historical files. The number of fields depends on the number of filters applied.

The aim of my training consisted on :

1. Read these new fields from historical files.
2. Post-process them.
3. Run the configuration e927 for the objective of coupling.

For reading the CUF field(s) from the historical files, modifications were made in :

- arp/setup/suspeca.F90 : reads the new field(s) (CUF1PRESSURE, CUF2PRESSURE, CUF3PRESSURE, CUF4PRESSURE, CUF5PRESSURE).
- arp/namelist/nammcuf.h : contains the logical key LREACUF to read CUF field(s).
- arp/module/yommcuf.F90 : module.
- arp/setup/sumcuf.F90 : Setup the default value of LREACUF.

For the post-processing and configuration e927, modifications are made in :

- arp/setup/suafn1.F90
- arp/setup/suafn2.F90
- arp/setup/suafn3.F90
- arp/namelist/namafn.f
- arp/module/yomafn.F90

in order to set up all the characteristics which allow us to monitor CUF fields. New «fullpos-descriptor» types were then added.

5 arrays were introduced : RMCUFGP1, RMCUFGP2, RMCUFGP3, RMCUFGP4 and RMCUFGP5. These are CUF fields in grid-point space :

- arp/module/yommcuf.F90 : module.
- arp/pp_obs/allocuf.F90 (New) : allocates the CUF field(s) in grid-point space (RMCUFGPi, i=1,5).
- arp/pp_obs/deallocuf.F90 (New) : deallocates these arrays.
- arp/pp_obs/fpinvtrcuf.F90 (New) : inverse transforms CUF fields from spectral space to grid-point space (RMCUFFP --> RMCUGPi).
- arp/setup/sumcuf.F90 : calls sufpcuf.F90.
- arp/setup/sufpcuf.F90 (New) : setup of the item %ILMOD of CUF fields for e927 monitoring.
- arp/control/scan2mdm.F90 : calls allocuf.F90, fpinvtrcuf.F90 and deallocuf.F90.
- arp/pp_obs/pos.F90 : CUF fields are post-processed. CUF fields are added in the routine's arguments.
- arp/pp_obs/vpos.F90 : calls pos.F90.
- arp/pp_obs/specfitadm.F90 : reads interpolated CUF fields.

These routines can be found in tora *:* /u/gp/mrpa/mrpa667/pack/CUF/src/local.

They also have been written in clearcase.

3. Results

3.1.First expérience : with ALADIN

This test was realised in three steps :

1. ALADIN was run with 2 cpus, and one filter (NCUFNR=1). The logical key LMCUF was switched to . TRUE. to enable filtering.

Field CUF1PRESSURE was written in the historical files (checked with frodo).

2. ALADIN was run with 2 cpus, and with LREACUF=.TRUE. to read CUF1PRESSURE written in the historical files created in step 1.
3. Finally, I run fullpos (output domain is lalon) with 2 cpus.

The new field CUF1PRESSURE was then visualized with CHAGAL. Figure 1.

One can compare these graphs with those of Piet Termonia, ploted without post-processing [3] from historical files with chagal.

The storm is detected, in similar way as in Piet's documentation. We note also the presence of noise at 3h-forcast time, in fact, the digital filter needs few hours to become stable (adaptation of the filter).

3.2.Second experience : with ARPEGE

I runned ARPEGE with LMCUF=.TRUE. and LREACUF=.TRUE., and then run configuration e927 to get ALADIN files for coupling reasons.

The new field CUF1PRESSURE was then visualized. Figure 2.

As for the first experiment, there is some noise present at 03h forcast time. Later, the storm is detected in an obvious way. One can even note, in this figure, at 12h forcast, the presence of two storms. The first is leaving France (extreme north east) and the second is about to cross France from Brittany.

3.3.Usage

The namelist NAMMCUF.h contains the CUF keys :

- LMCUF (logical) : switch on the filtering (default value is FALSE).
- LREACUF (logical) : read the CUF field(s) from historical files (default is FALSE).
- NCUFNR (integer) : number of filters applied to ln*Ps* (default is 1).
- NCUFOR (integer) *:* order of the filter(s) (default is 2).
- RMCUFI (1:NCUFNR) : the coupling interval(default is 10800.).
- RMCUFA(0:NCUFOR,1:NCUFNR) et RMCUFB(:NCUFOR,1:NCUFNR) : coefficients of the filter(s). They can be specified in the namelist nammcuf.h, if not, they are computed during the setup.

An example that can be used for ALADIN as well as for ARPEGE :

```
&NAMMCUF
        LMCUF=.TRUE.,
        LREACUF=.TRUE.,
```

NCUFNR=3,

NCUFOR=2,

RMCUFI=43200.,

In this namelist, we use 3 filters of order 2, and a coupling update interval of 12h. Coefficients of the filters are computed during the setup. This namelist can be used with Aladin NORAF which uses a coupling update frequency of 12h !

3.4.Profiling

Configuration e927 was runned with 1, 2 and 3 processors in 2 cases :

- We don't ask for CUF1PRESSURE (reference).
- We ask for CUF1PRESSURE.

I noted that, in both cases :

- CPU time and memory are very close. Making a profiling is then useless.
- using one processor uses less CPU time than using 2 or 3 processors (this is due to communications between processors),

4. TO BE DONE

- Write a document for the Aladin community to explain why this new field was coded, how to get it in coupling files, ...

We agreed that Piet Termonia will do this.

- Do more tests with differents cases (storms, no storms).
- Do more tests with NCUFNR=2, 3, 4 and 5. I have done all my experiments with NCUFNR=1, I will validate results with NCUFNR different from 1 in september.

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References

[1] Termonia, P., 2003: Monitoring and Improving the Temporal Interpolation of Lateral-Boundary Coupling Data for Limited-Area Models. Mon. Wea. Rev., 131, 2450-2463.

[2] Termonia, P., 2004: Monitoring the Coupling-Update Frequency of a Limited-Area Model by Means of a Recursive Digital Filter. Mon. Wea. Rev., 132, 2130-2141.

[3] Termonia, P., 2004: Monitoring the Coupling Update Frequency (MCUF) : Implementation in cy28t2, ARPEGE/ALADIN, Technical documentation.