AROME : USE/TEST IMPACT OF HIGHER RESOLUTION OROGRAPHY FROM PGD

Stay Report By

ALPER GUSER
(TSMS)

Supervisor Yann SEITY
(Meteo-France CNRM/GMAP)
14 November - 14 December 2011

1. Introduction

Currently, we are using 5km. resolution orography in AROME model. When we use new orography with spin up mode, model blow up and crashed for some experiments. Then model runs without escale system. Tests show that model doesn't blow up in spin up mode without escale. For this aim, we are especially focused on use of ESCALE system in 'Apache' vertical interpolator routine, compare the results for different experiments output and checked the posibility of using LESCALE=F.

2. APACHE Routine and ESCALE System

Apache is a interface routine for some interpolations, called if post-processing on only height or η-levels and change of horizontal geometry (second part of 927-type FULL-POS applications only). The organigramme of APACHE :

- Several adiab/GP... routines.
- PPINIT
- FPVIEW
- Several adiab/GP... routines.
- PPFLEV
- PPSTA
- PPUV → PPINTP and PPITPQ
- PPT →
  - PPT_OLD → PPINTP
  - PPSTA
  - PPINTP
- PPQ → PPINTP
- PP2DINT
- PPGEOP → PPSTA, adiab/GPGEO, PPITPQ and PPINTP.

In the apache vertical interpolator routine, parameters prepare and interpolate for system 1 and then transfer to escale levels and calculate for escale system and finally make profile with the combination of two sytem using their weightiness. Currently we are using ESCALE sytem operationally.

3. Case Description

All the test performed with AROME France domain with 2.5 km resolution and 60 levels. Olive swapp enviroment was used for all experiments. Also we use dd2met for 2-D plotting and ddh for vertical profiles. Key study date is on 3 January 2011 at 00.00 GMT. But we run for 12.00 GMT to see the effects of global radiation for 2 experiments.

Table 1. Experiment names and descriptions

Exp. Name	Description
66I5	Cy37t1.bf3 coupling with **LESCALE=F**, cy36t1.op2.19 binary for forecast (6 Minutes), 00GMT
66ID	Cy37t1.bf3 coupling with **LESCALE=T**, cy36t1.op2.19 binary for forecast (6 Minutes), 00GMT
66IF	Same as 66I5 (**LESCALE=F)** but different namelist for forecasts and dfhd for grid points, 00GMT
66IG	Same as 66I5 (**LESCALE=T)** but different namelist for forecasts and dhfg for grid points, 00GMT
66IY	Same as 66IF but 12.00 GMT coupling and forecasts
66IZ	Same as 66IG but 12.00 GMT coupling and forecasts
66J0	Same as 66IG but different calculation in LESCALE (without weightiness direct ESCALE outputs)
66JB	Same as 66IF but cy37t1.bf3 binary for forecasts and NAMPARAR for AROME physics results
66JQ	Same as 66IG but cy37t1.bf3 binary for forecasts and NAMPARAR for AROME physics results
66JP	Same as 66JB (**LESCALE=F)** but hydrostatic version (LNHDYN=F)
66JF	Same as 66JQ (**LESCALE=T)** but hydrostatic version (LNHDYN=F)
66KF	Same as 66IG(LESCALE=T) but during the ver.velocity calculation (LESCALE=F)
OPER	Operational AROME outputs for relevant date
ARPE	Operational ARPEGE outputs for relevant date

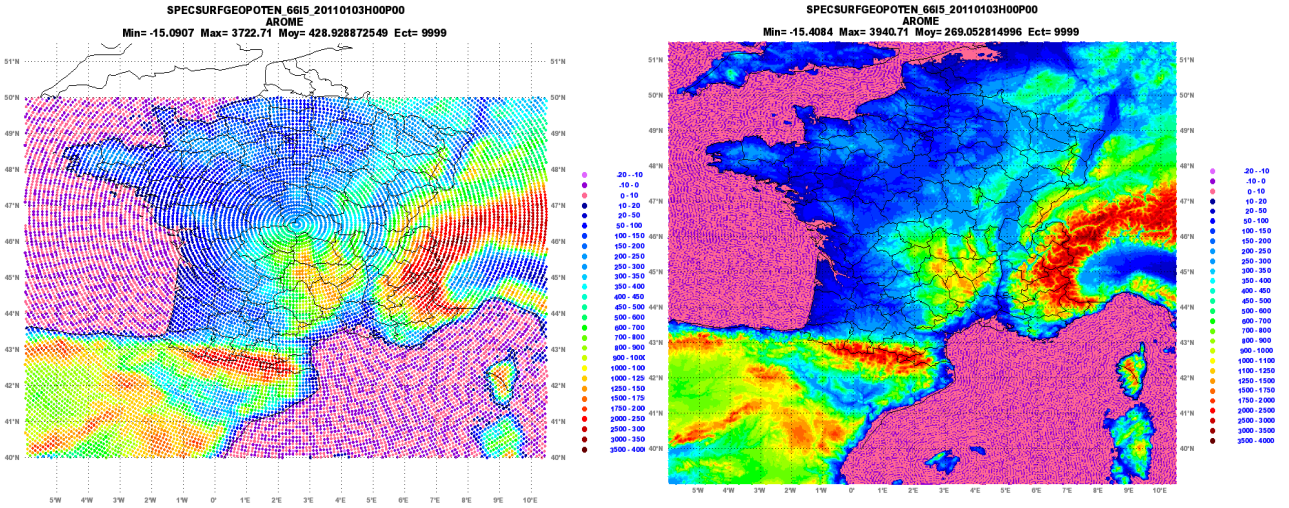


Figure 1. Arpege and Arome Orography

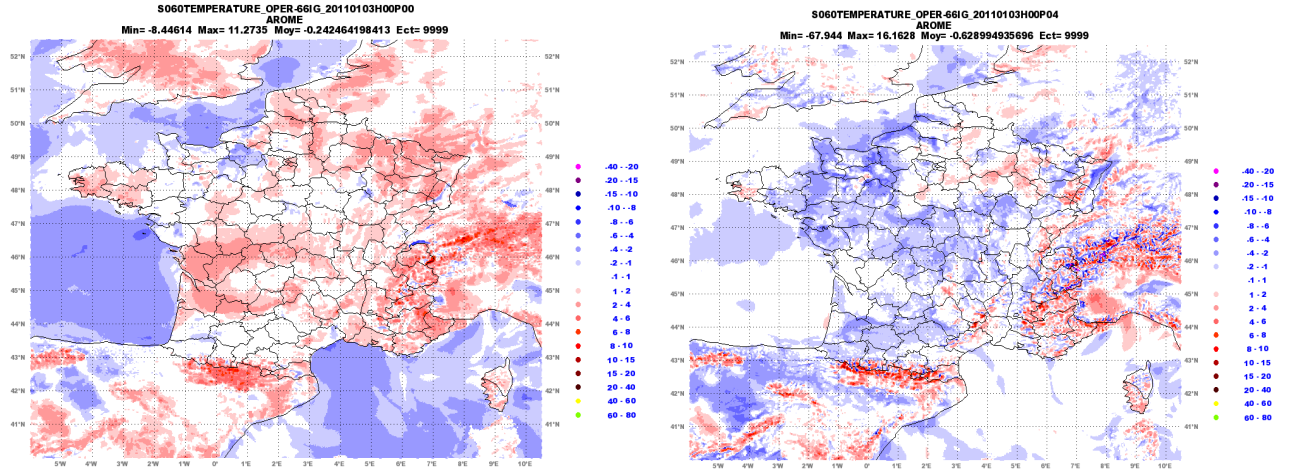


Figure 2. S060 Temperature differences between operational suite of AROME and case of 'LESCALE=.T.' for coupling (left) and T+4 forecast(right)

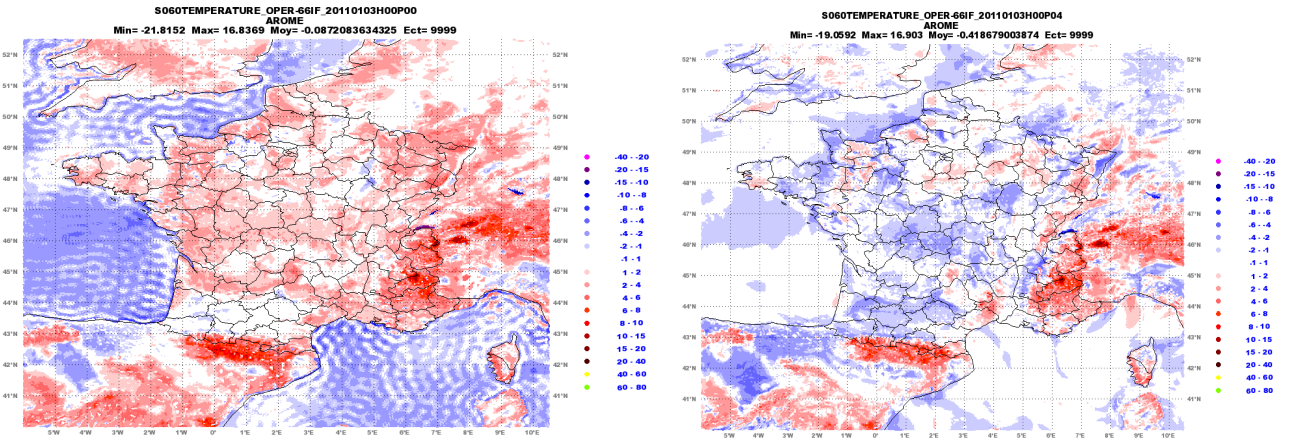


Figure 3. S060 Temperature differences between operational suite of AROME and case of 'LESCALE=.F.' for coupling (left) and T+4 forecast(right)

Figure 2 and Figure 3 are comparison of using new and old orography in case of lescale is equal true and false respectively. Notice that coupling files with using lescale system is generally better than not using lescale. Also there are some waves on seas on Figure 3. But if we consider the forecast outputs, there are very strong gradients on Figure2 especially over the Alps and Pyrenees. The temperature differences between operational suite and lescale=T is over 60 °C at some grid points. For the humidity, wind, 2m. and layer temperatures except surface temperature, we can see the same conditions. Also there are strong gradients between neighbour grid points.

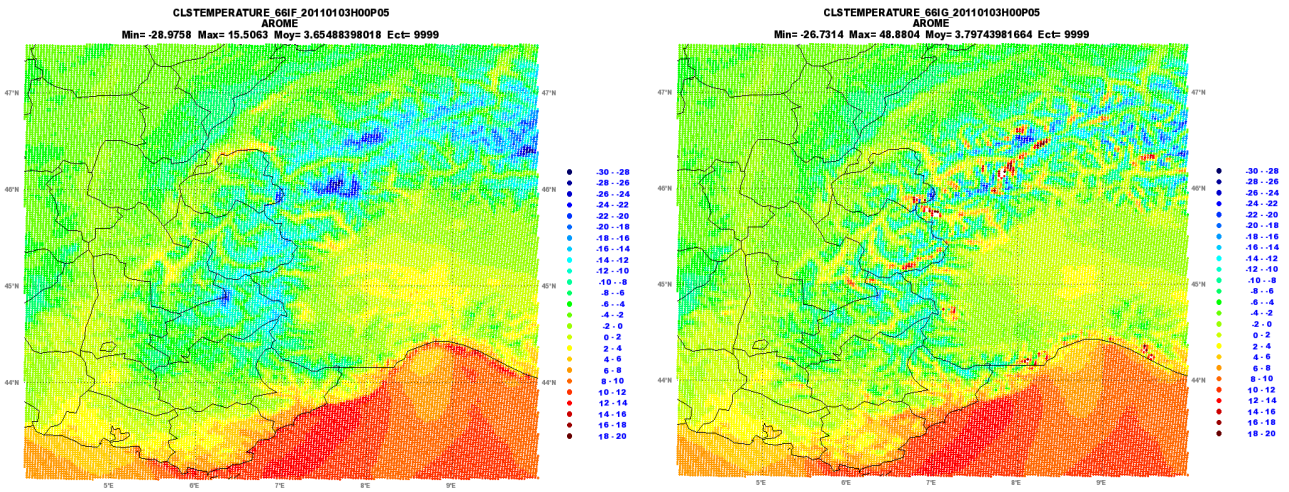


Figure 4. 2 meter Temperature for T+5 forecast using 'LESCALE=.F.' (left) and LESCALE=T (right) over Alps for non-hydrostatic AROME.

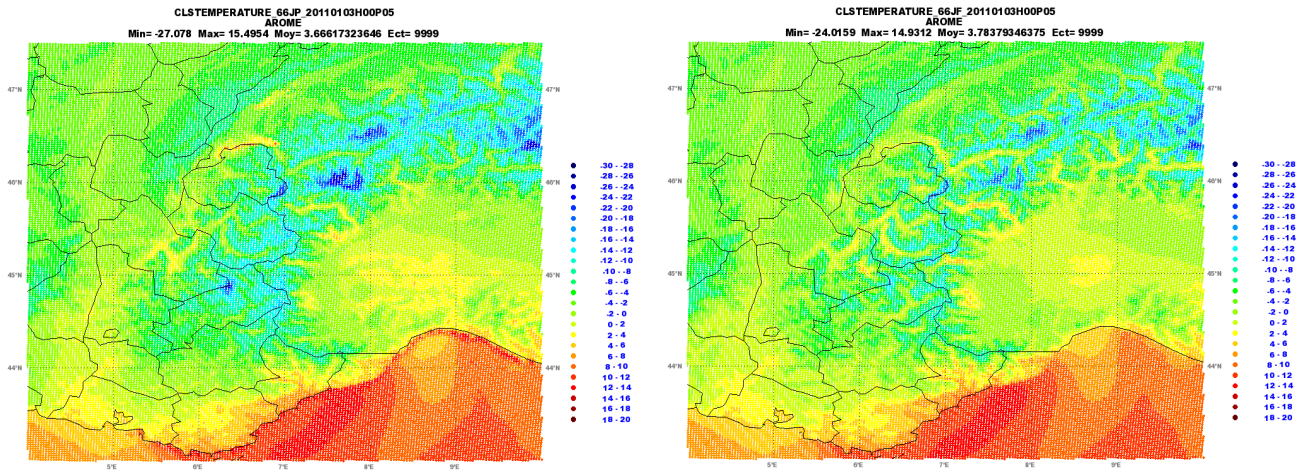


Figure 5. 2 meter Temperature for T+5 forecast using 'LESCALE=.F.' (left) and LESCALE=T (right) over Alps for hydrostatic AROME.

If we compare the Figure 4 and 5 maps for using lescale system, we couldn't see the strong gradients on hydrostatic version. For the testing of turbilance at coupling we plot the following CAPE for both lescale=T and lescale=F. Especially over lakes we can see higher CAPE values for lescale=F option. Also over the sea, there are cape waves and too.

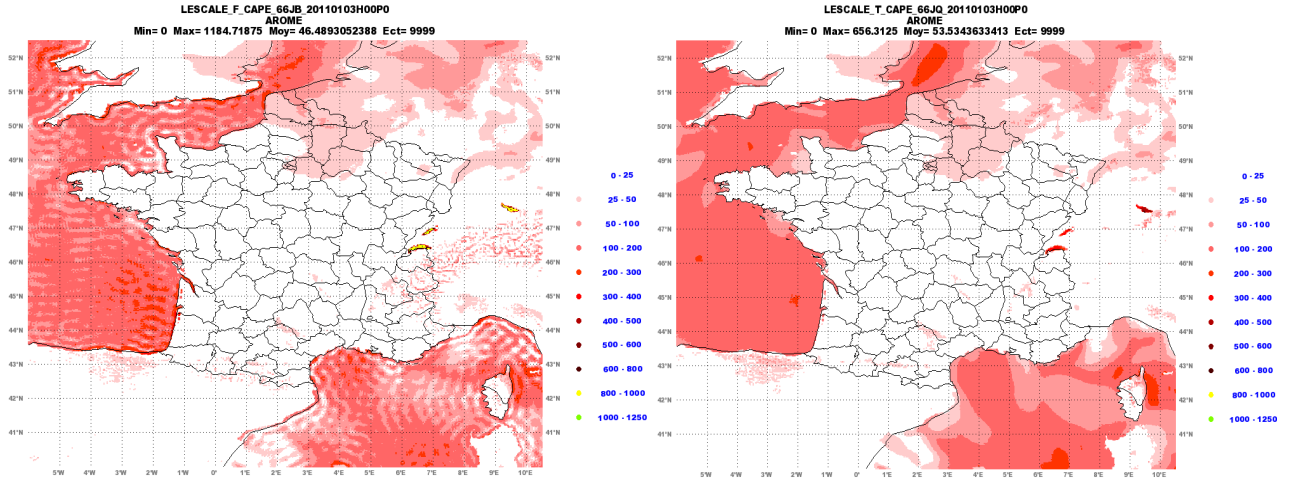
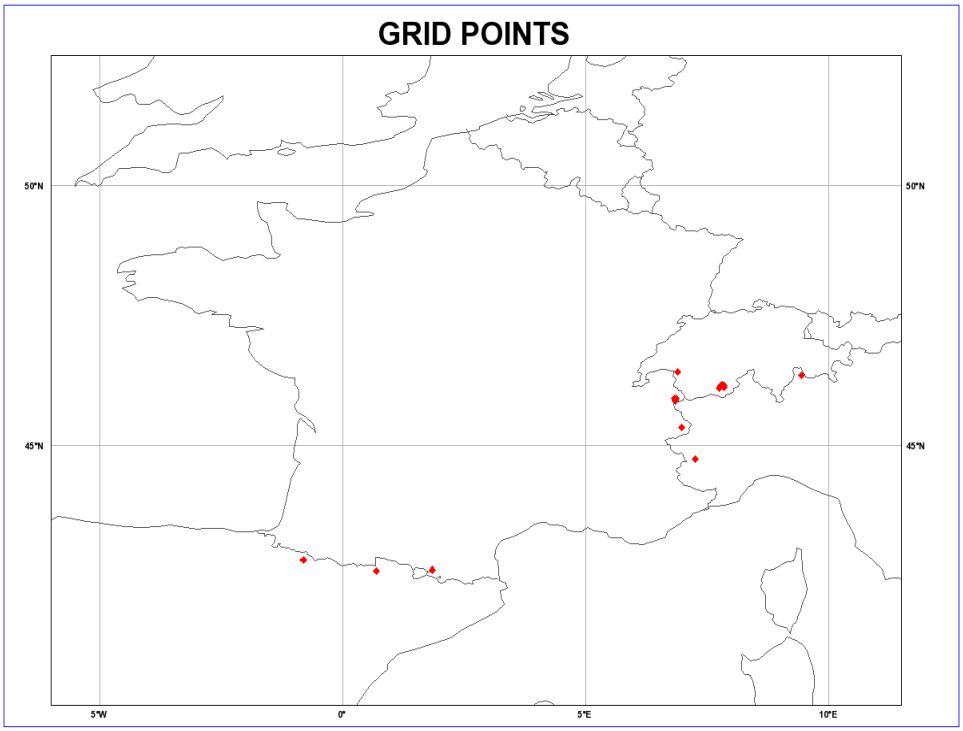


Figure 6. CAPE for coupling file using 'LESCALE=.F.' (left) and LESCALE=T (right)

Considering with the problem over mountains, we define the following 16 grid points to illustrate the vertical profile of the relevant parameters. Some of the points are over Mount Blanc(1,4,8,11), Mount Rose(2,6,9,12,13), Pyrenees(14,15,16), and Geneva Lake(10).

Table 2. Coordinates of points used for vertical profiles and place of points



Point	Longitude	Latitude
1	6.8489	45.9000
2	7.7815	46.1498
3	6.9738	45.8496
4	6.8450	45.8551
5	9.4364	46.3482
6	7.7444	46.1066
7	7.2564	44.7330
8	6.8166	45.9014
9	7.8438	46.1241
10	6.8944	46.4161
11	6.8469	45.8776
12	7.8138	46.1482
13	7.8462	46.1465
14	0.6891	42.5788
15	1.8475	42.6090
16	-0.8156	42.7973

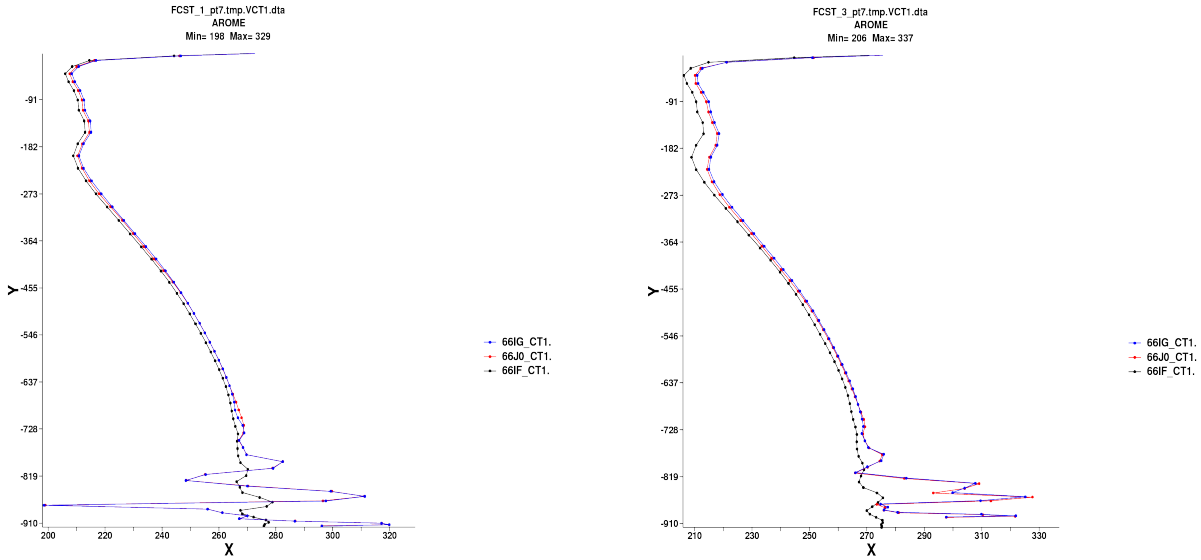


Figure 7. Vertical temperature profiles of 7th point for T+1(left) and T+3 (right) forecast in case of lescale=F (black) , lescale=T (blue) and lescale=T but direct lescale system output without merging with system 1(red).

As shown in Figure 6, vertical profile of LESCALE=T option in case of both merging with/without system 1 has strong gradient on lower level than LESCALE=F. When we merge two system we use ;

$$P = W * Pes + (1-W) * Ps$$

which, P is the final value of parameter, Pes is the calculated value from Escale system, Ps

is calculated value from System1 and *W* is the weightiness parameter. If we accept that 60th level is the lowest level, between 1 an 30 level, W is almost equal 0, between 30-35 level W parameter increase 0 to 1 and 35-60th level W is equal to 1. For the lower level, merging values is equal to escale system values.

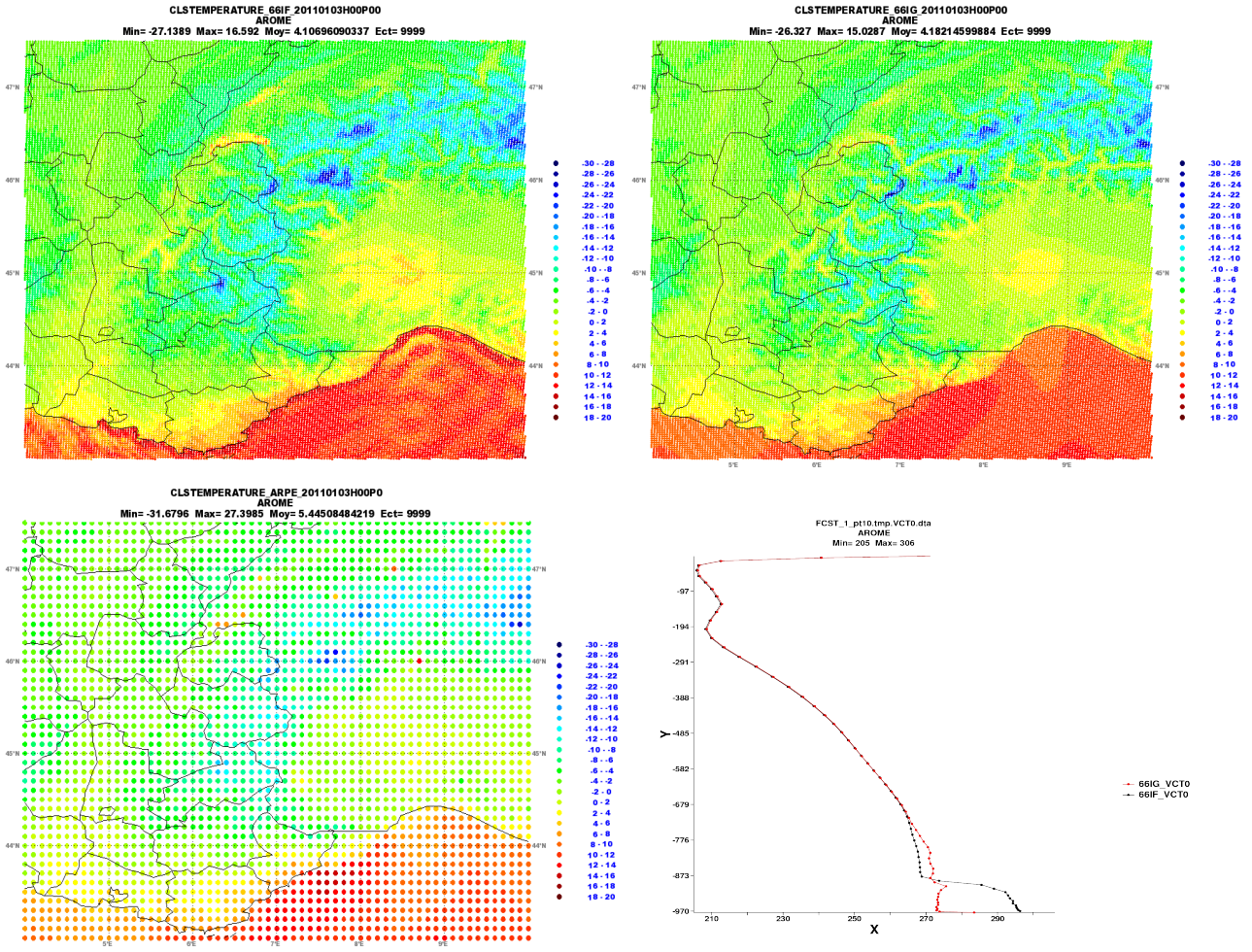


Figure 8. CLS temperature of coupling files for lescale=F (upper left), lescale=T (upper right), ARPEGE file (bottom-left) and vertical profile of temperature (bottom-right) for both lescale=F(black) and lescale=T (red)

For the coupling file if we compare Figure 8 maps, ARPEGE coupling 2m temperatures are higher than AROME over Geneva Lake. Also Lescale=F option temperatures are close to ARPEGE. We can see this condition on the vertical profile. For lescale=T, there are strong gradient at the first layer. Lescale=F temperatures ar close to escale profile between 49 and 50th level.

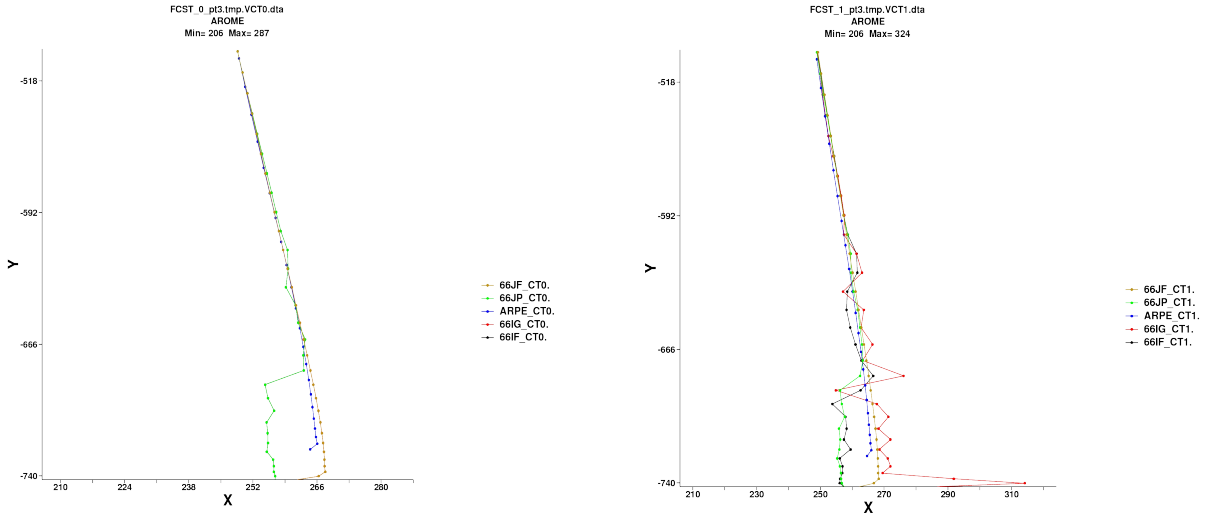


Figure 9. Vertical temperature profiles of 3th point for T+0 coupling (left) and T+1 (right) forecast in case of hydrotatic+lescale=T (gold), hydrostatic+lescale=F (green), non-hydro+lescale=T (black), non-hydro+lescale=F (red) and ARPEGE

For the coupling files, lescale=T options of both hydrostatic and nonhydrostatic versions overlaped like lescale =F option experiments. For this grid point, lescale=T option experiments close to Arpege. Between 48 and 49th level there are almost 6 °C gradient for lescale=F. Above this level, all of the experiments close to Arpege profile. For the first time step, non-hydrostatic experiment with lescale=T has strong gradient at lower levels especilally at 59th. Hydrostatic version with lescale=T is similar to Arpege forecast.

In order to see the effects of escale system on neighbour grid points, we choose a grid point (Point 3), define the neighbour grid points and produced the vertical profile for temperature. Table3 shows the places of grid points and orography.

G1 **G2** G3 G4 G5

which G2 is our referance grid point (Point 3)

Table3. Coordinates of Neighbour Grid Points, Orography and Colour

Points	Longitude	Latitude	Orography (m)	Colour
G1	7.0383	45.8468	2167	Black
G2	6.9738	45.8496	2522	Red
G3	6.9416	45.8510	2831	Blue
G4	6.9094	45.8524	3409	Green
G5	6.8722	45.8538	3899	Gold

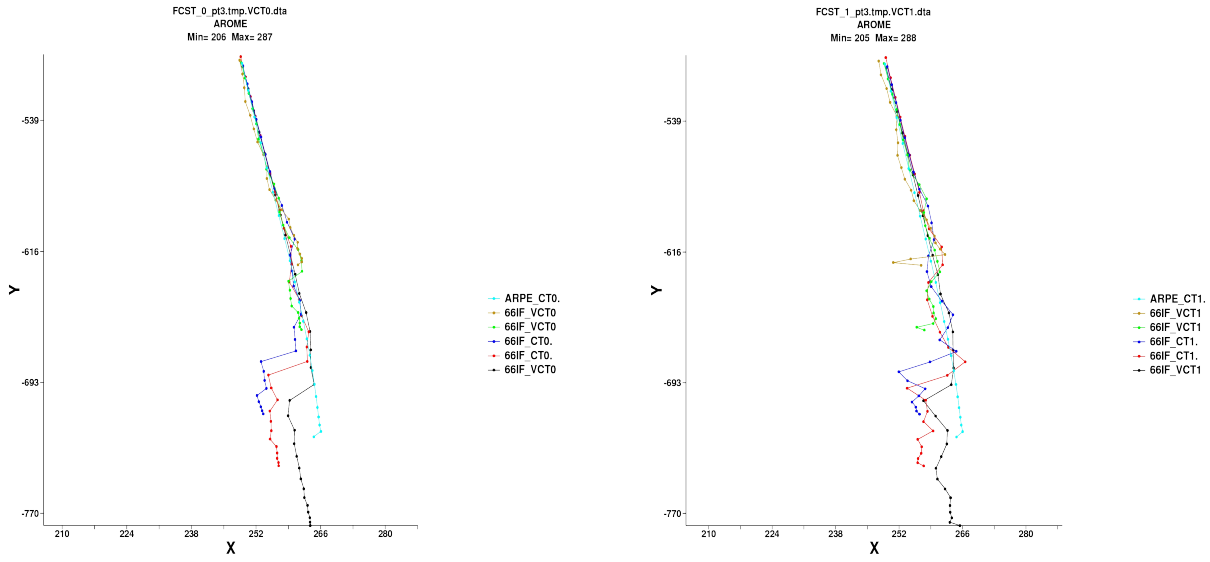


Figure 10. Vertical temperature profiles of neighbour grid points and arpege(cyan) for coupling (left) and T+1 forecast(right) using lescale=F (non-hydro.)

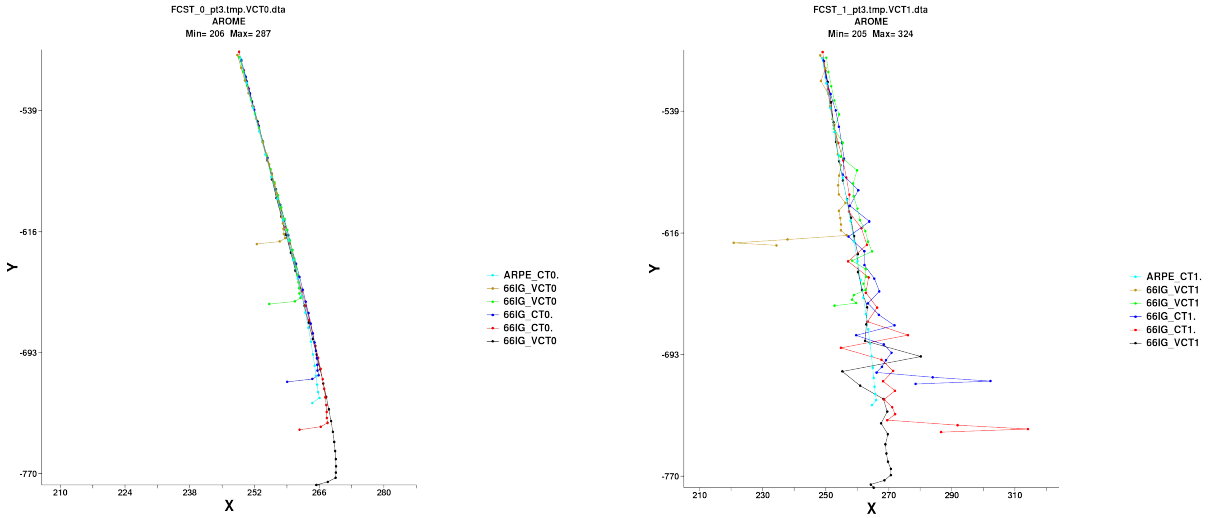


Figure 11. Vertical temperature profiles of neighbour grid points and arpege(cyan) for coupling (left) and T+1 forecast(right) using lescale=T (non-hydro.)

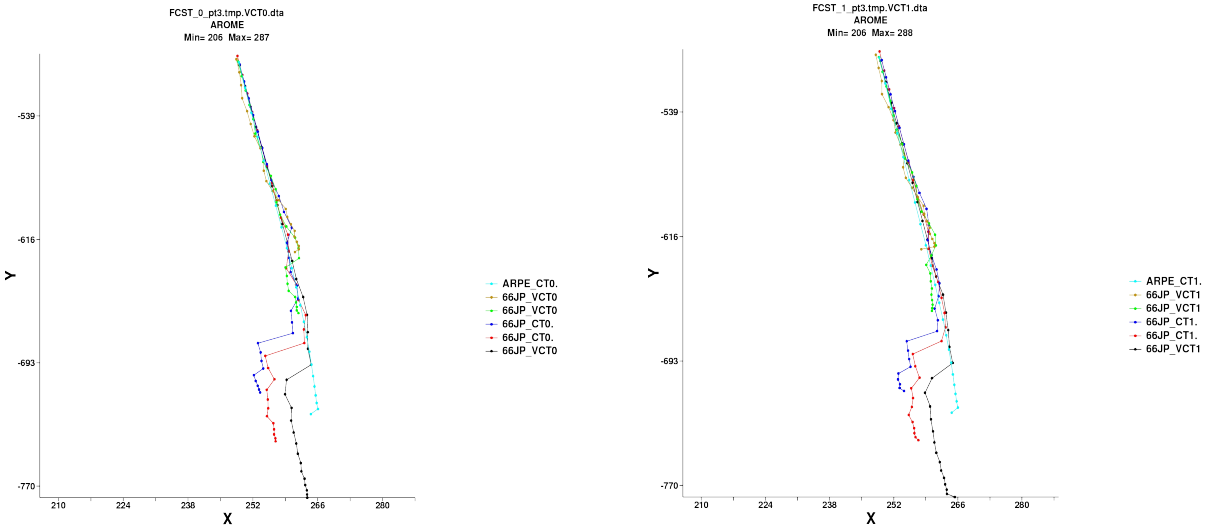


Figure 12. Vertical temperature profiles of neighbour grid points and arpege(cyan) for coupling (left) and T+1 forecast(right) using lescale=F (Hydro.)

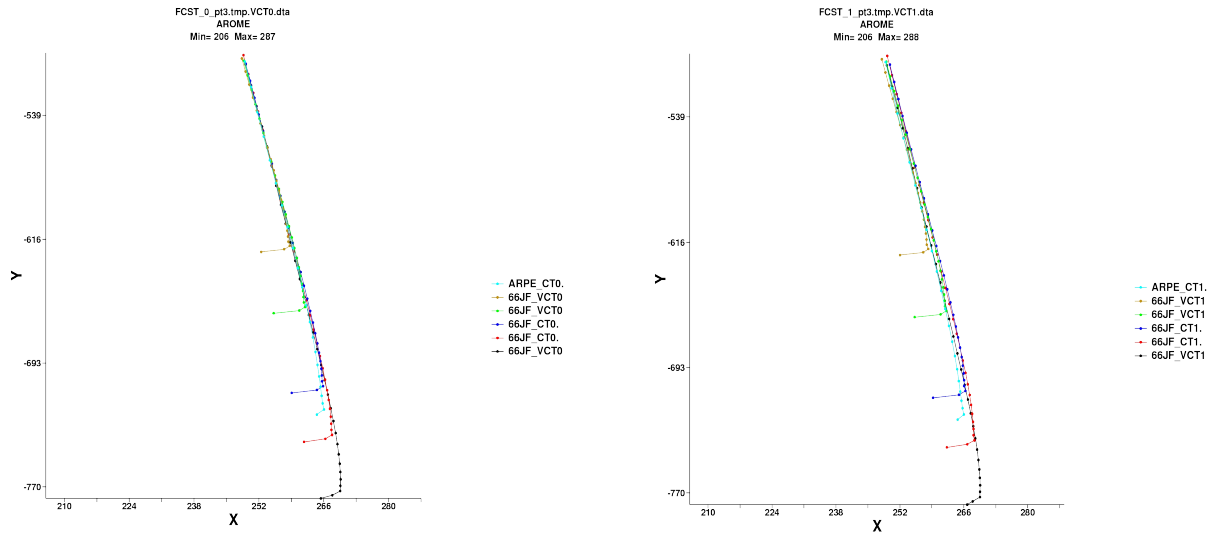


Figure 13. Vertical temperature profiles of neighbour grid points and arpege(cyan) for coupling (left) and T+1 forecast(right) using lescale=T (Hydro.)

As we see on Figure 10, 11 12 and 13 there are 2 °C gradient between lowest level and previous level. Also during the calculation of first levels of AROME versions we can see the effects of this gradient. Expect Lescale=T for nonhydrostatic experiment (66IG), points have the same forecast profile as coupling.

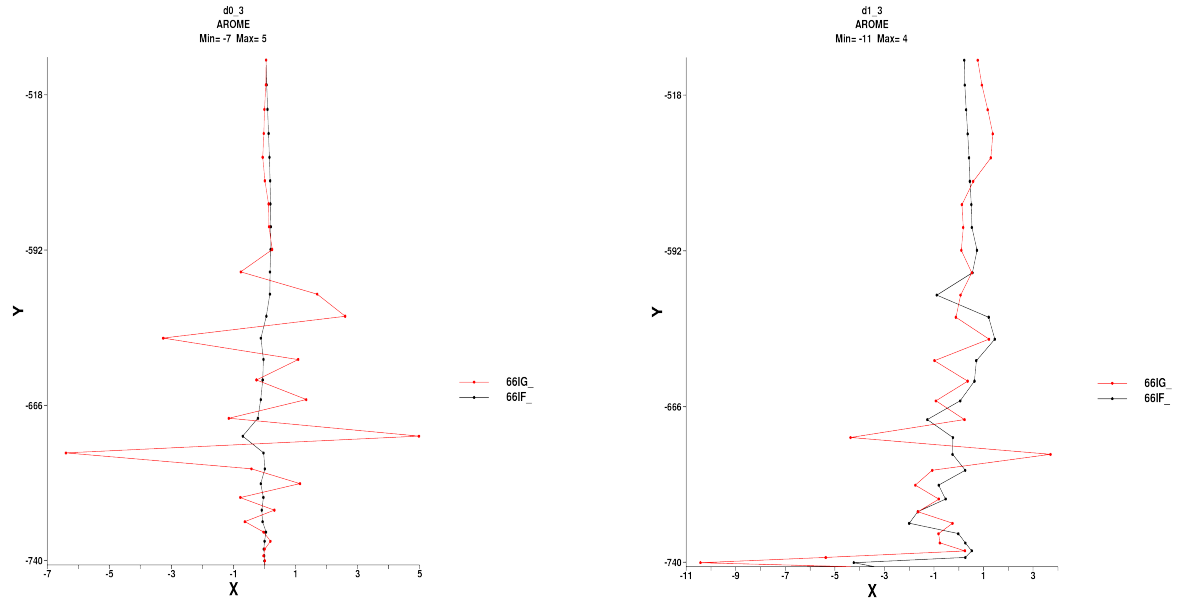


Figure 14. 'VERTIC.DIVER' profiles of Point 3 for coupling(left) and T+1 forecast (right) for LESCALE=F(black) and LESCALE=T (red) options.

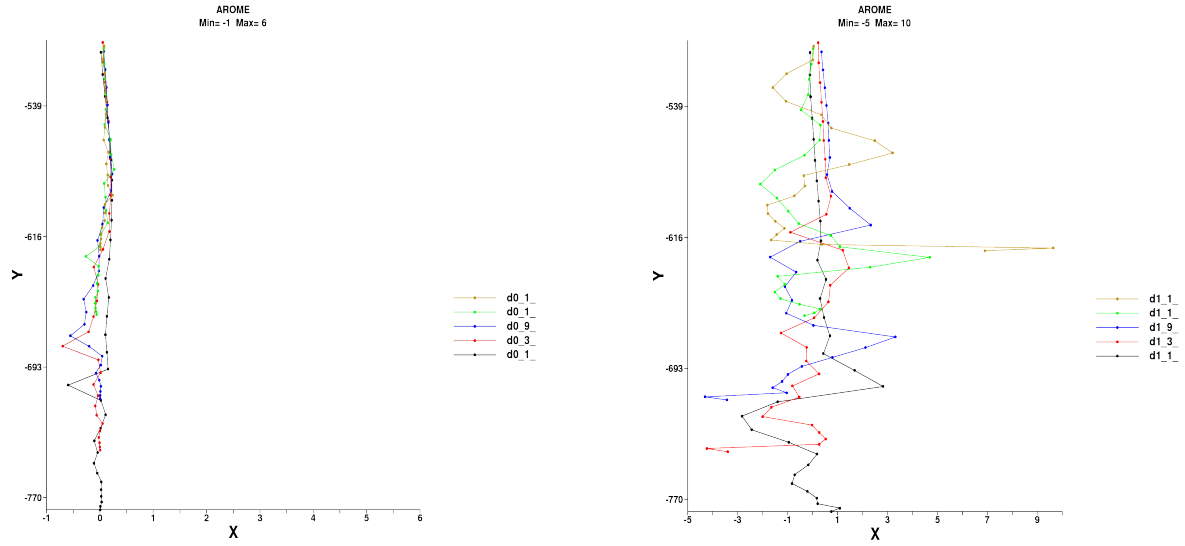


Figure 15. 'VERTIC.DIVER' profiles of neighbour grid points for coupling(left) and T+1 forecast (right) for LESCALE=F

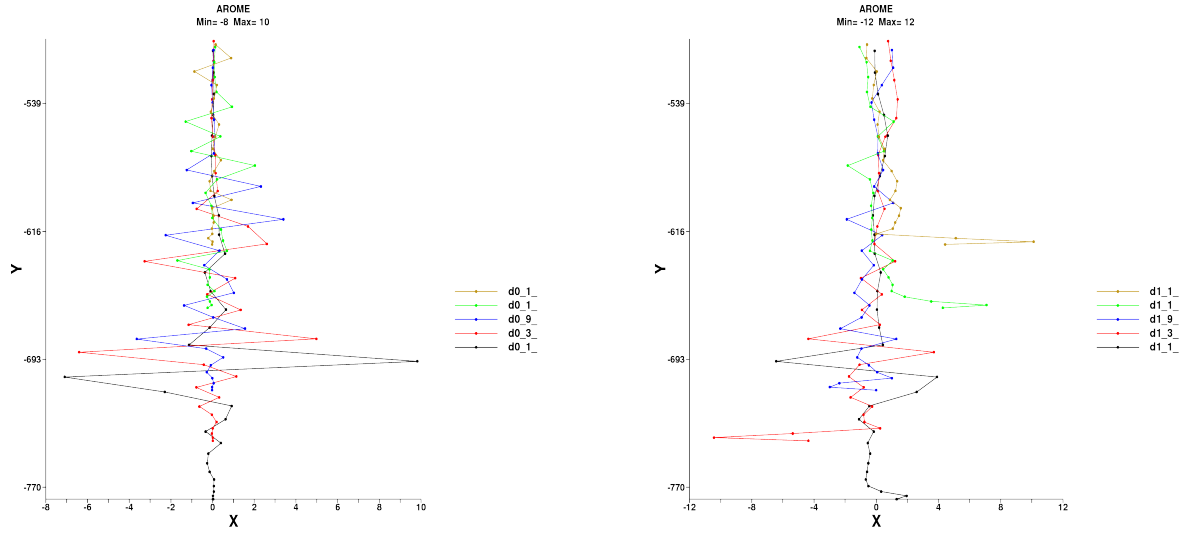


Figure 16. 'VERTIC.DIVER' profiles of neighbour grid points for coupling(left) and T+1 forecast (right) for LESCALE=T

4. Conclusion

During this stay, we try to test the effects of using high orography for different methods and calculations. For escale system, the weightiness value is 1 for the lower levels during the merging with system 1. Using the direct outputs of escale level values couldn't solve this problem.

We have strong gradients for lower levels when we use escale system. After defining strong tandencies for one grid, we test the AROME physic values. But there was no any problem with Arome physic outputs. So this tandencies problem doesn't cause of Arome physics. On the other hand if we consider divergence tendencies for coupling files for both lescale option, we use escale sytem but not for vertical velocity in apache. But there was little bit changes in outputs. Also working on apache for this problem will continue.

5. Reference

Yessad, K.(2011). Full-pos in the cycle38 of ARPEGE/IFS, 35.
'http://cnrm.meteo.fr/gmapdoc/IMG/pdf/ykio38.pdf