Status of LBC’s and initialization

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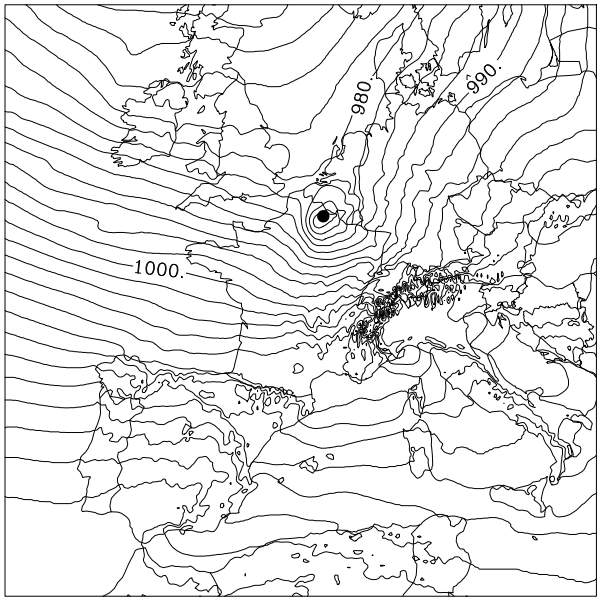
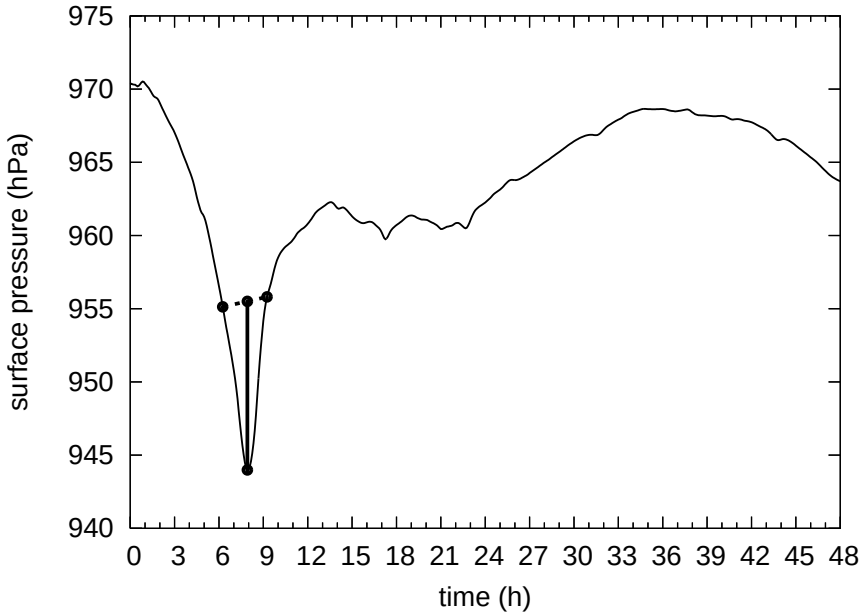
Content

- The lateral-boundary temporal resolution problem: gridpoint nudging
- Periodic fields by Boyd's windowing

The LBC Temporal problem

p_s in the ALADIN-Fr Lothar stom run in the indicated point for a field provide with 3-h temporal resolution:



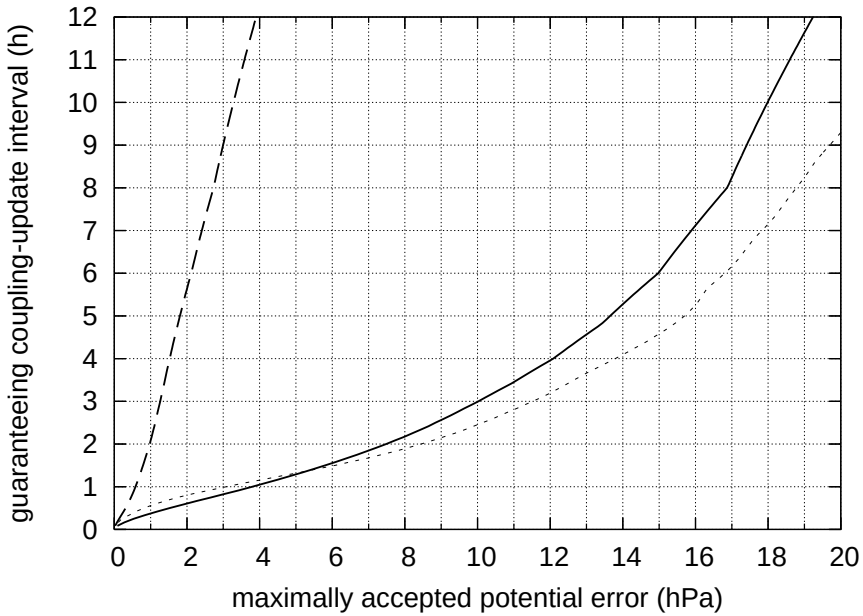


The error between interpolation and real field is 11.5 hPa!!!!

The interpolated low is always LESS deep!

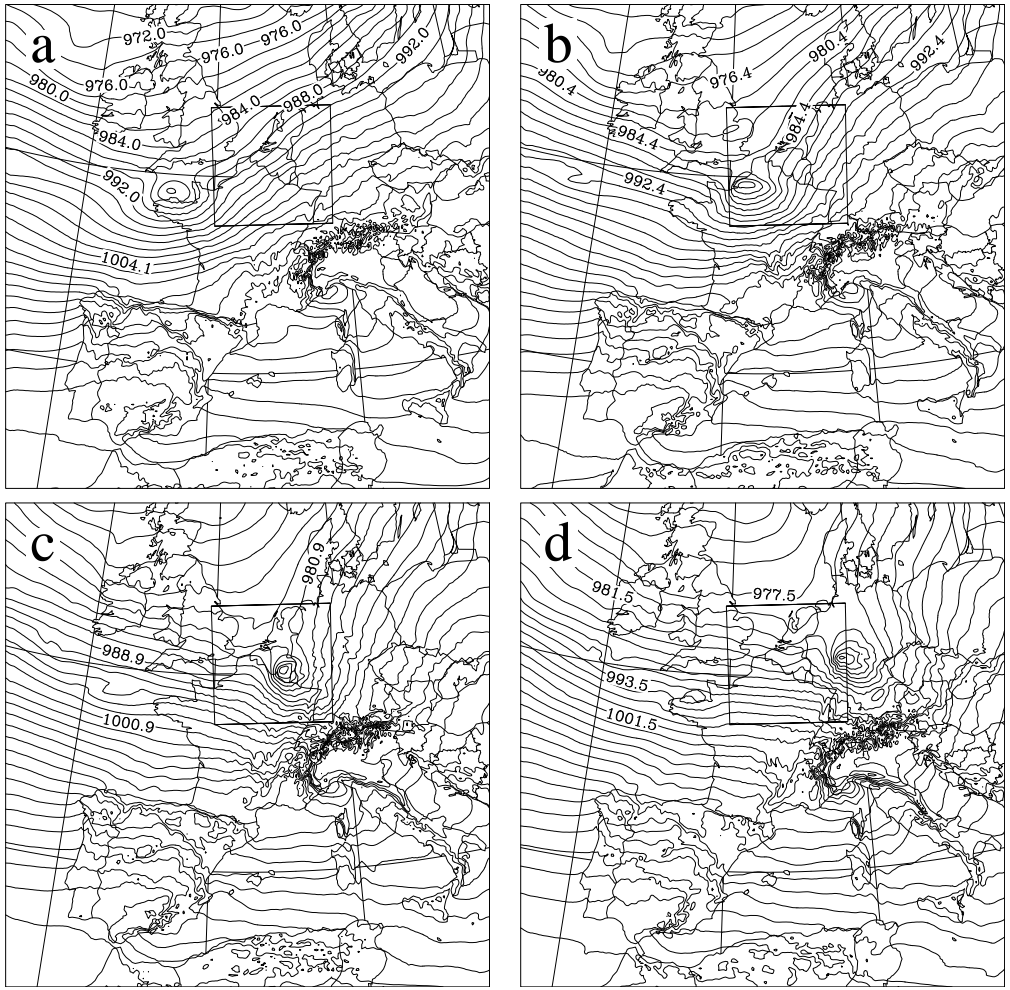
What coupling interval should we use?

Termonia, Deckmyn, Hamdi, 2009, MWR:



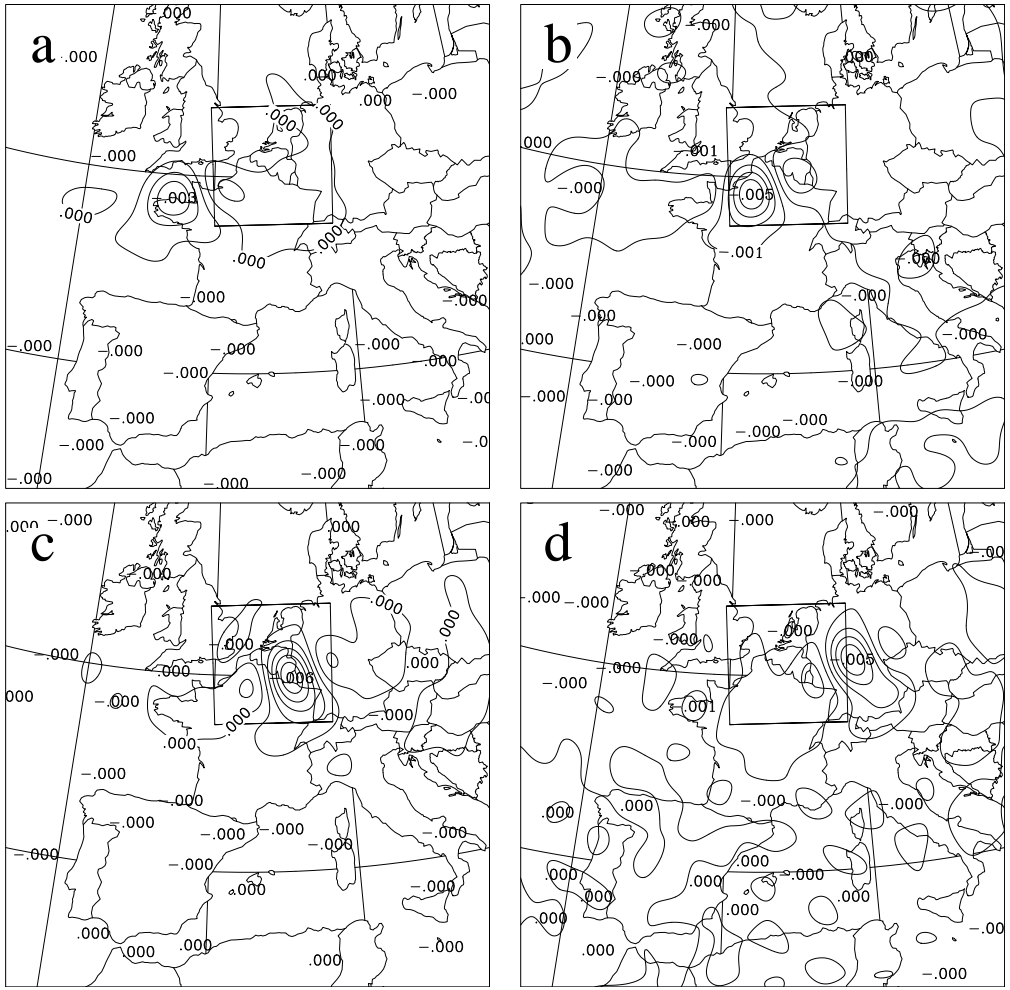
So to have a guarantee that we never make an interpolation error of more than 1 hPa we would need to coupled with about 15-20 min intervals! This is about the time step of ARPEGE. But in normal cases 3h is OK.

Termonia, MWR, 2004, ’99 storm



Think of the rectangle as the coupling domain of a two-nested model. In fact it is the old small ALADIN-Belgium domain.

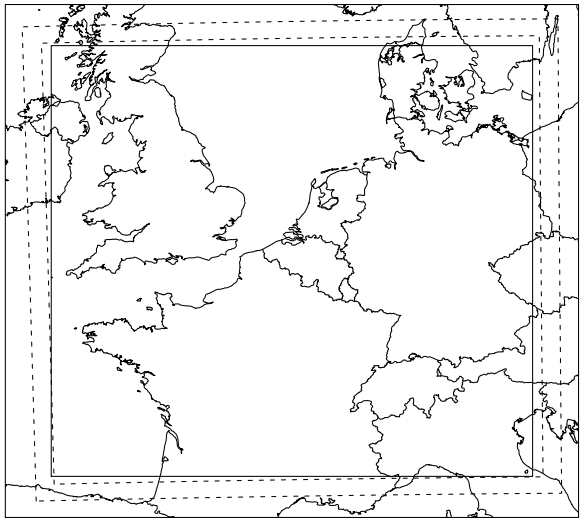
MCUF



The monitoring by the MCUF field is done in ALADIN-France, i.e. the coupling model.

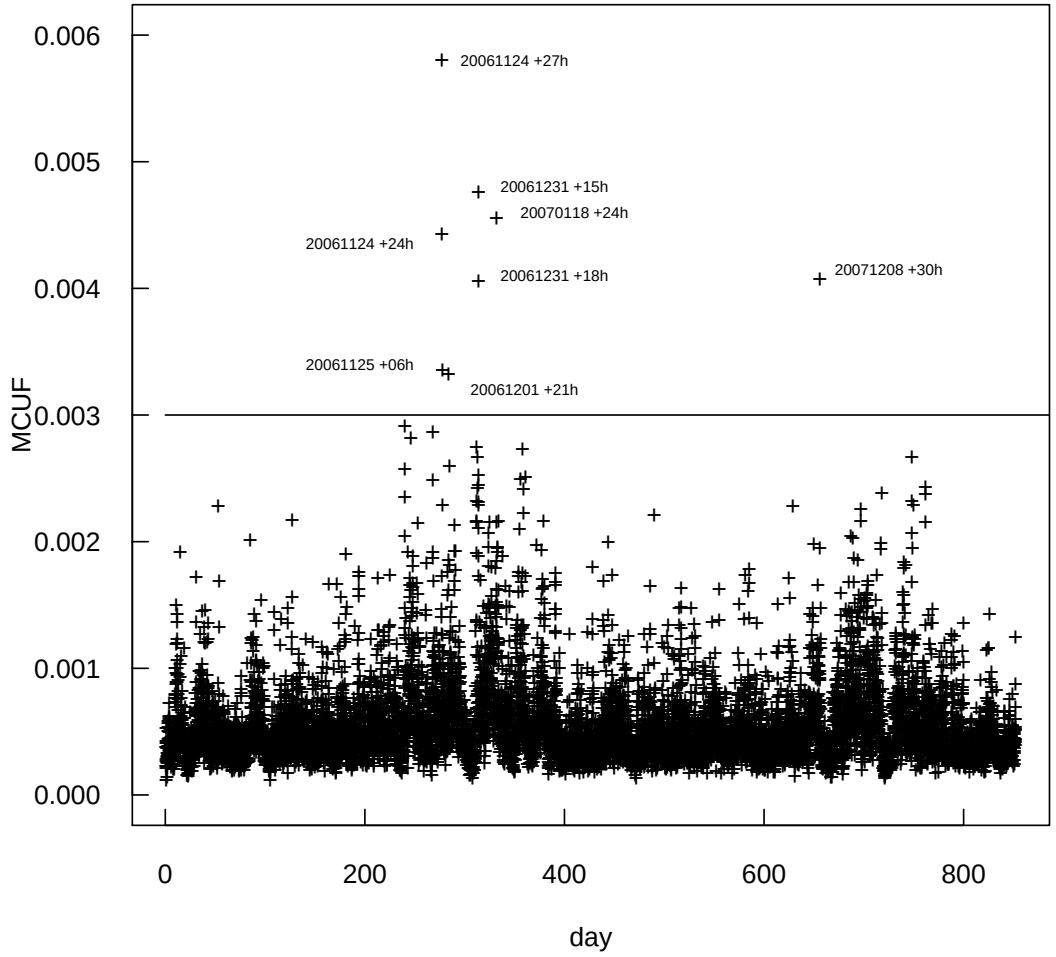
MCUF

This MCUF field is operationally computed in ARPEGE and written to the coupling files of the ALADIN models. We considered it in the frame (solid line) covering the Davies zone (dashed),



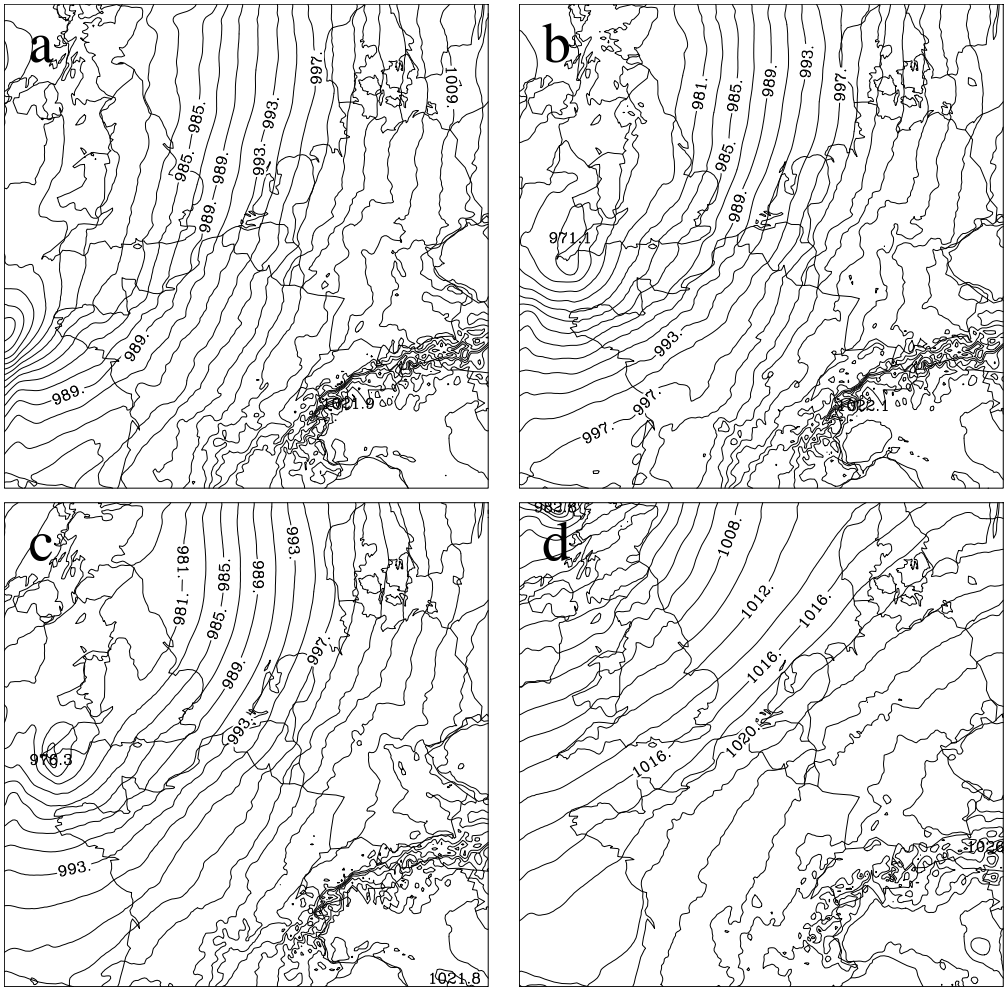
The maximum MCUF in the frame

in the period 21 February 2006 – 30 June 2008

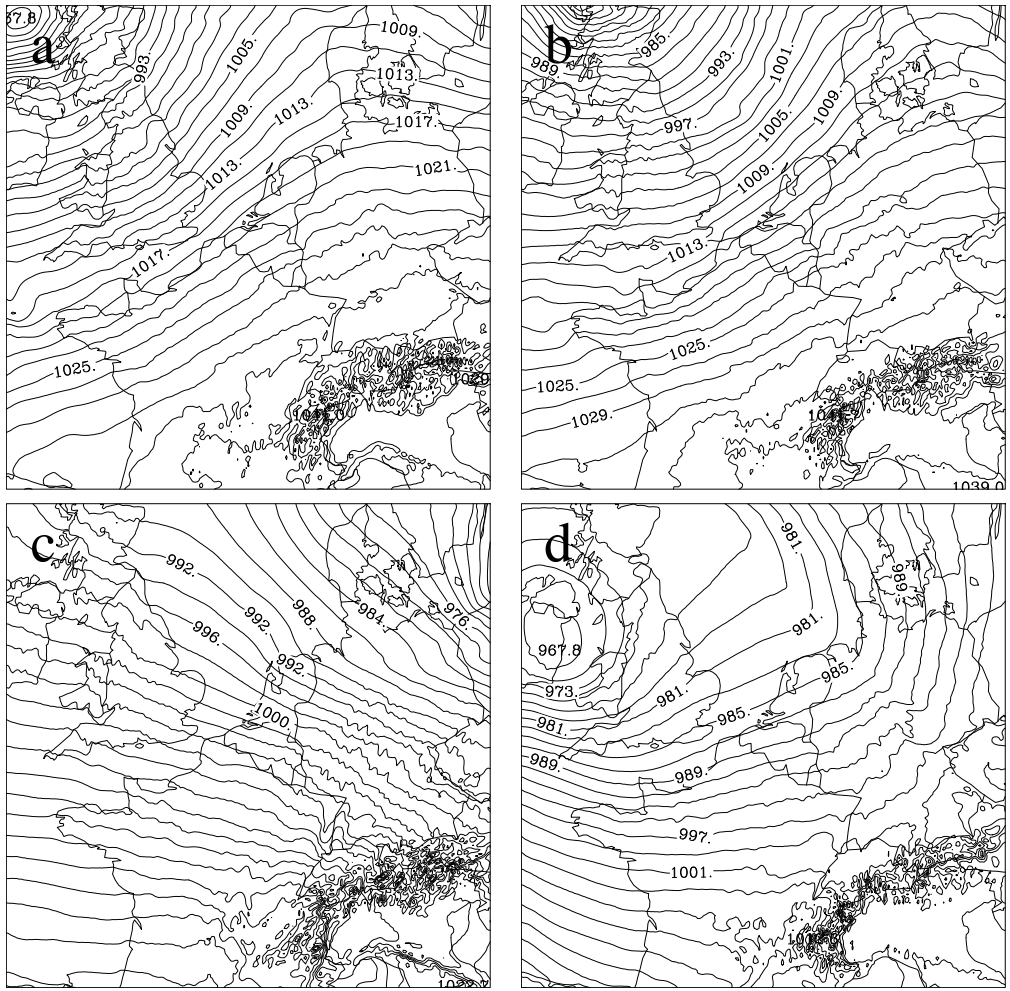


Let us consider a threshold value of 0.003. Then we had 8 alerts.

The cases


a
985.
989.
993.
997.
1009.
989.
1021.9
b
981.
985.
989.
993.
997.
971.1
993.
997.
1022.1
c
981.
985.
989.
993.
997.
976.3
993.
1021.8
d
1008.
1012.
1016.
1016.
1020.
1016.
1026

The cases continued



What to do?

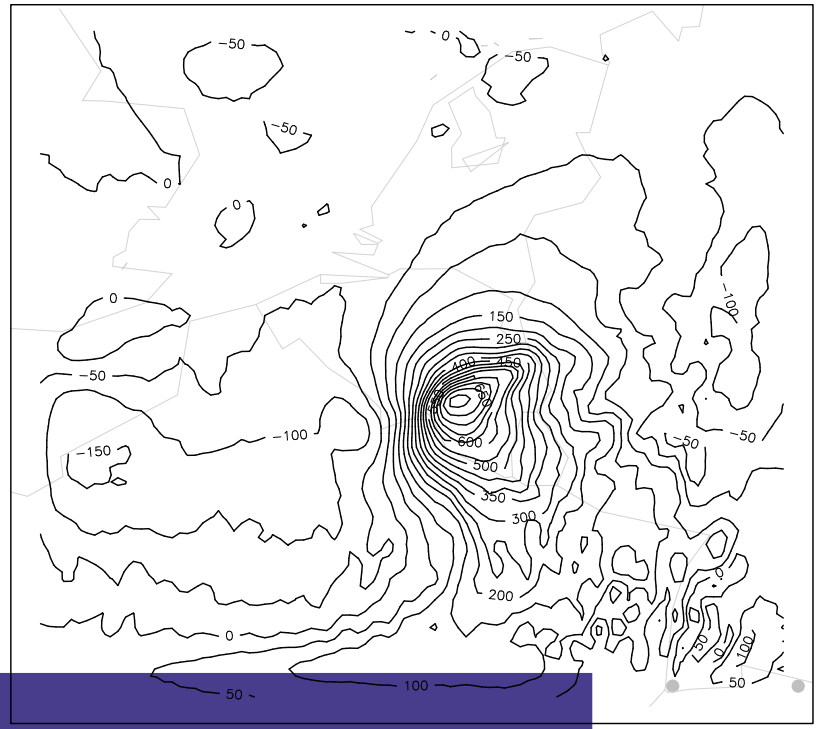
We could now

- couple with roughly 20 min. But this will be pratically be the time step of the global models. So they will be forced to do IO all the time, or
- invent something new:
- Utrecht: we studied boundary-errror restarts (BER). Termonia, Deckmyn, Hamdi (2009)
- New since Utrecht: gridpoint nudging.

DFI

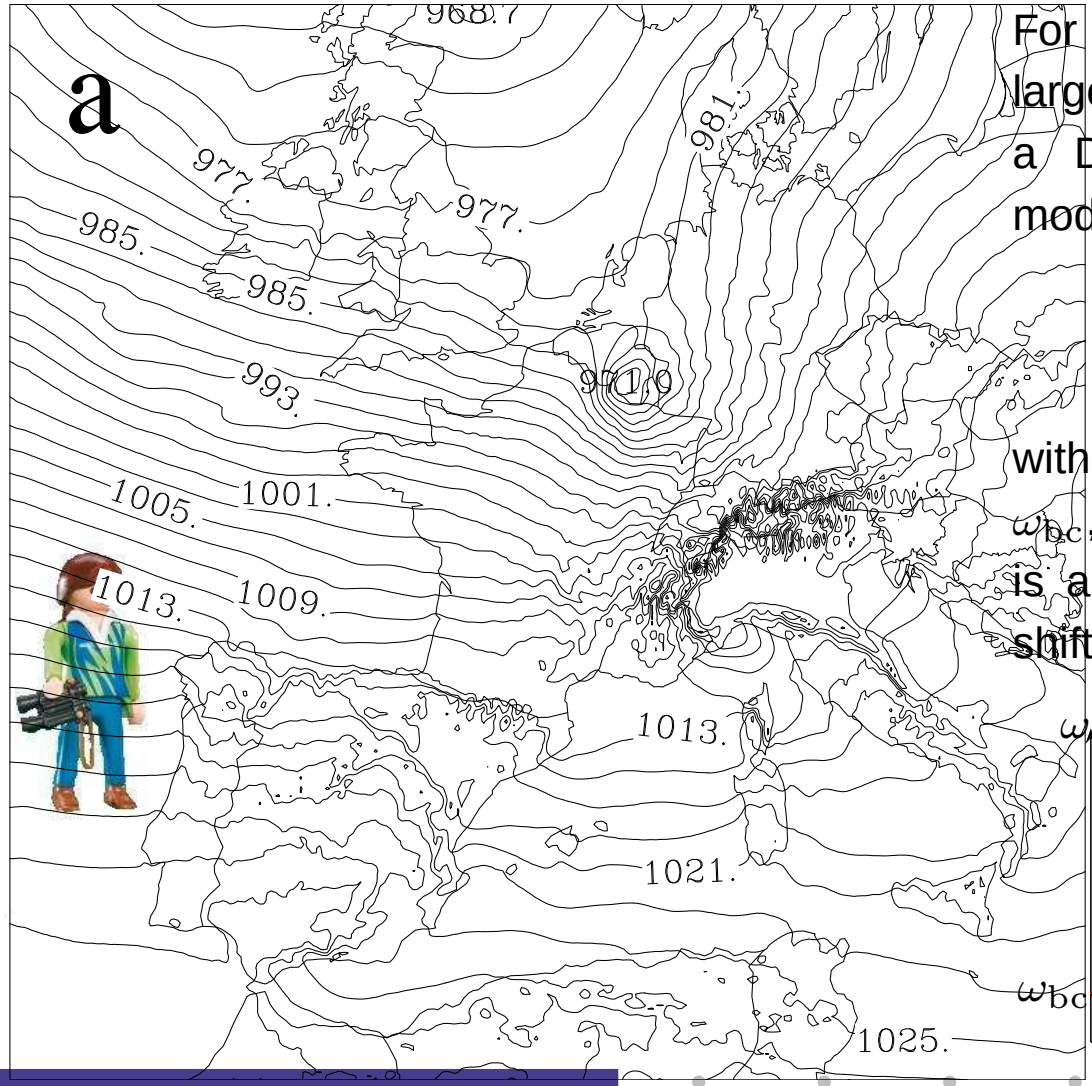
However these restarts should be initialized by a DFI!!!

MSLP 26/12/1999 +9h
DFI(3h) − no DFI



max difference of about 8.5 hPa!

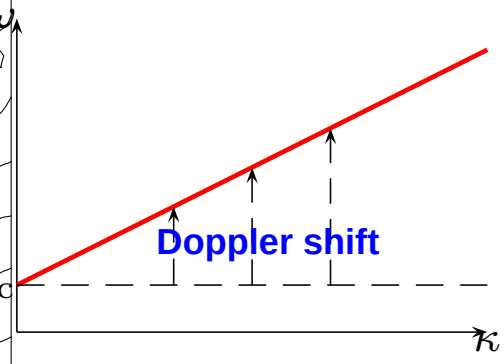
... in a French Storm (Lothar):



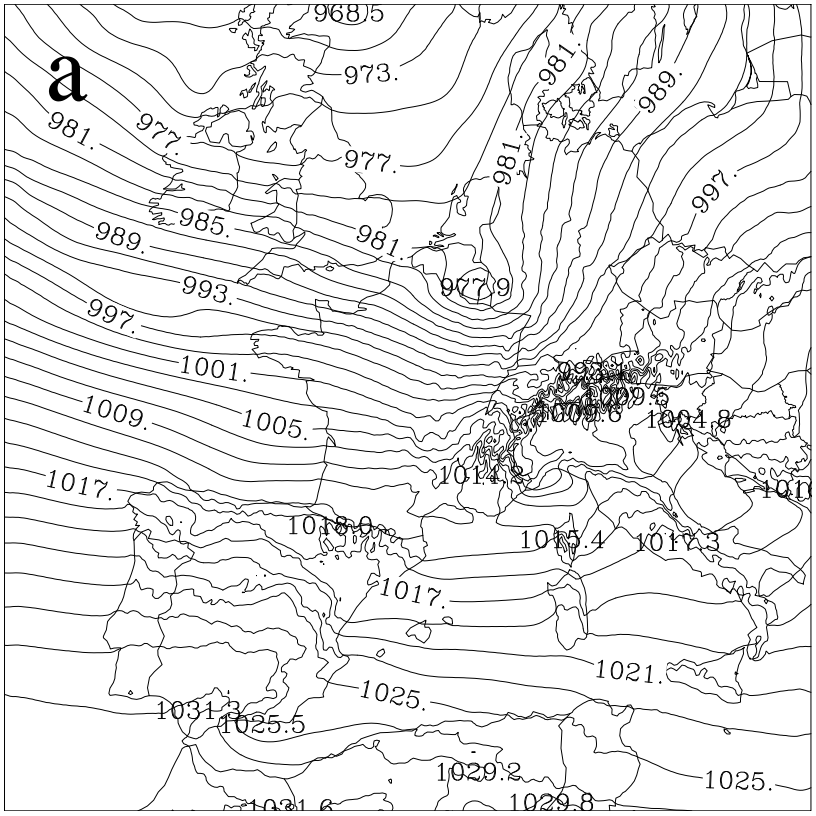
For waves superposed on a large-scale flow, we also have a Doppler effect for each mode

$$\omega = \omega_{\mathrm{bc}} + c\,\kappa$$

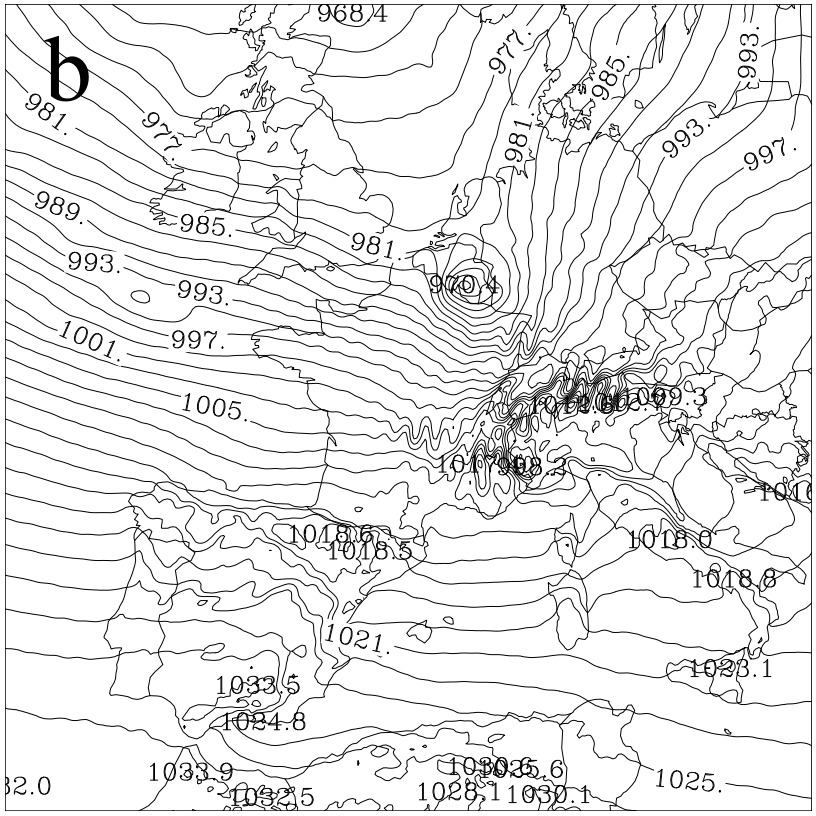
with (baroclinic) frequency ω_{bc}, the deeping of the storm is a time evolution that gets shifted.



The effect of a DFI

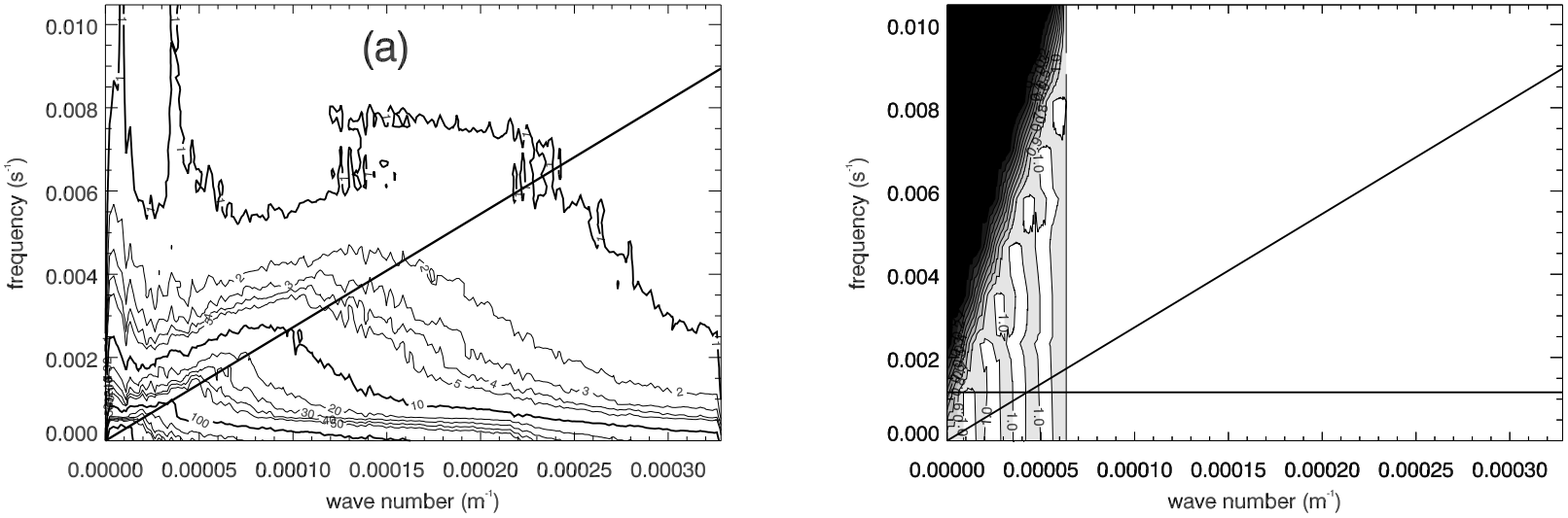


The result of a standard (operationally) used DFI (**977.9 hPa**).



ALADIN forecast after developping for 9 h (**970.4 hPa**).

Scale-selective low-pass windows

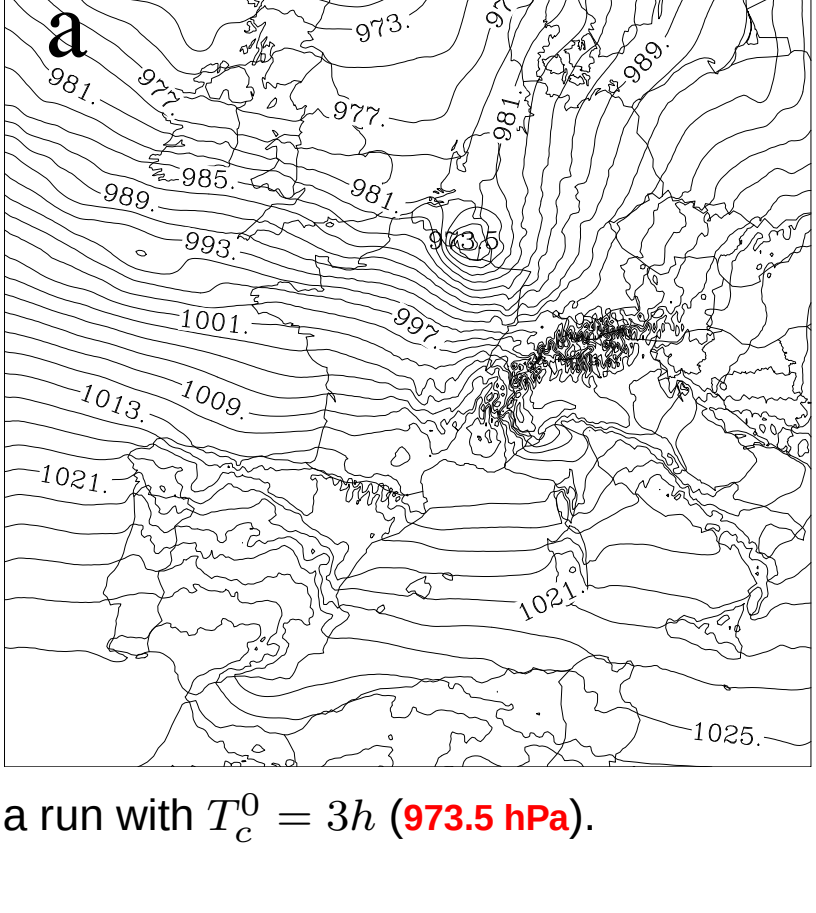


The *scale-selective* cut-off frequency of a low-pass Lancsoz filter:

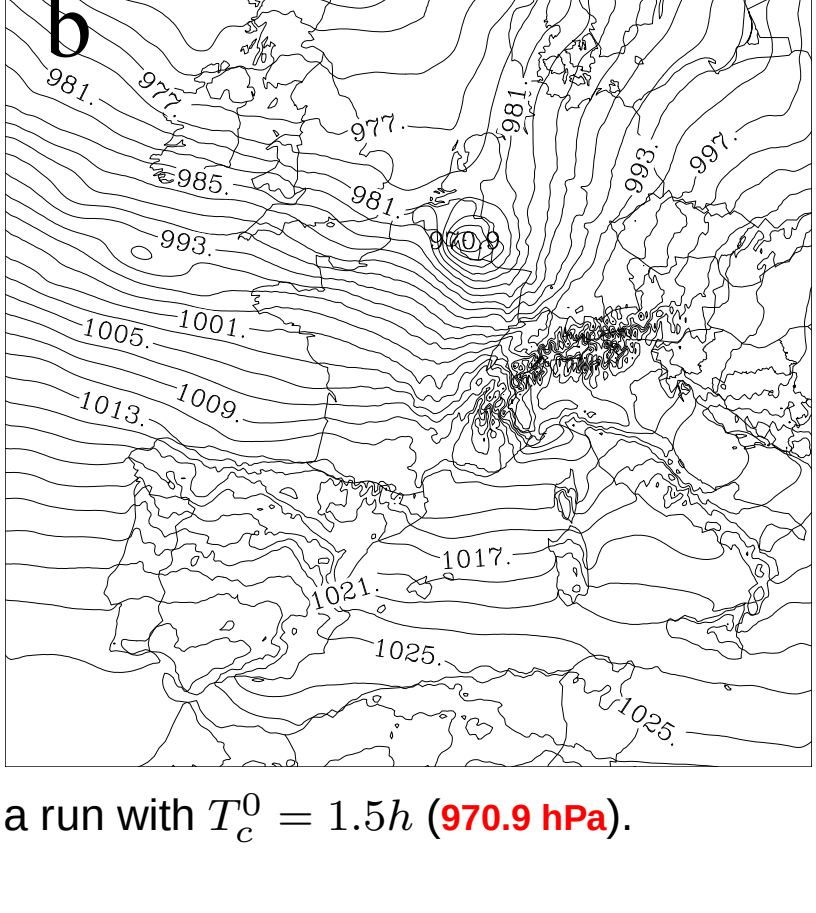
$$\omega_c(\kappa) = \begin{cases} \omega_c^0 + \frac{\kappa}{\kappa_c}\left(\frac{\pi}{\Delta t} - \omega_c^0\right) & \text{if} \quad \kappa \leq \kappa_c \\ \frac{\pi}{\Delta t} & \text{if} \quad \kappa > \kappa_c \end{cases}$$

The cut-ott period is $T_c^0 = 2\pi/\omega_c^0$ while the *slope* of the cut-off frequencies is $c = \pi/(\kappa_c \Delta t)$.

Results:

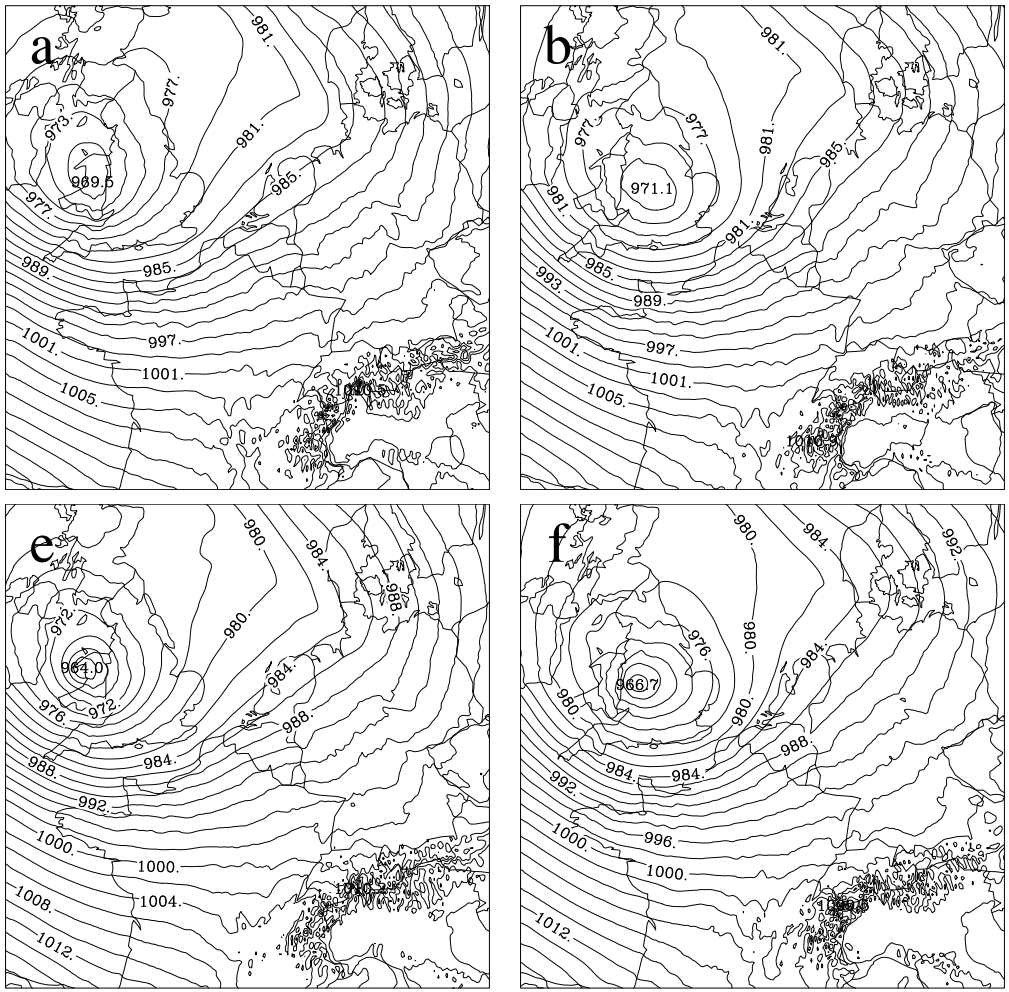


a run with $T_c^0 = 3h$ (**973.5 hPa**).



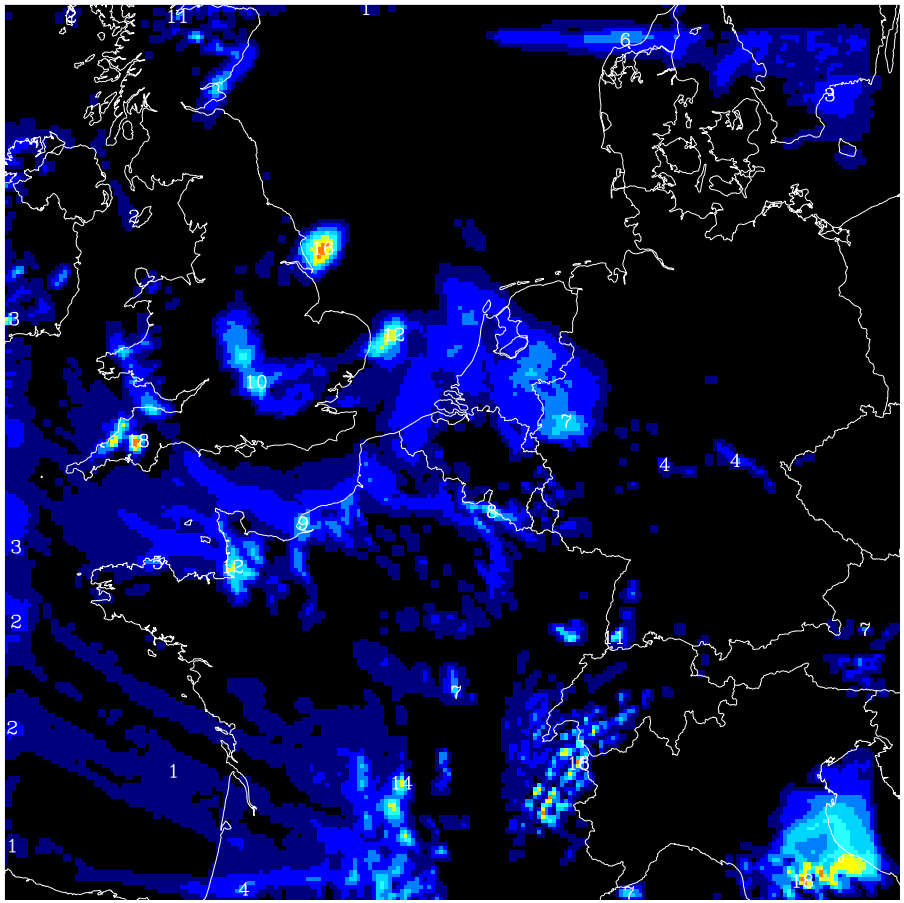
a run with $T_c^0 = 1.5h$ (**970.9 hPa**).

Improvements by a restart with SSDF

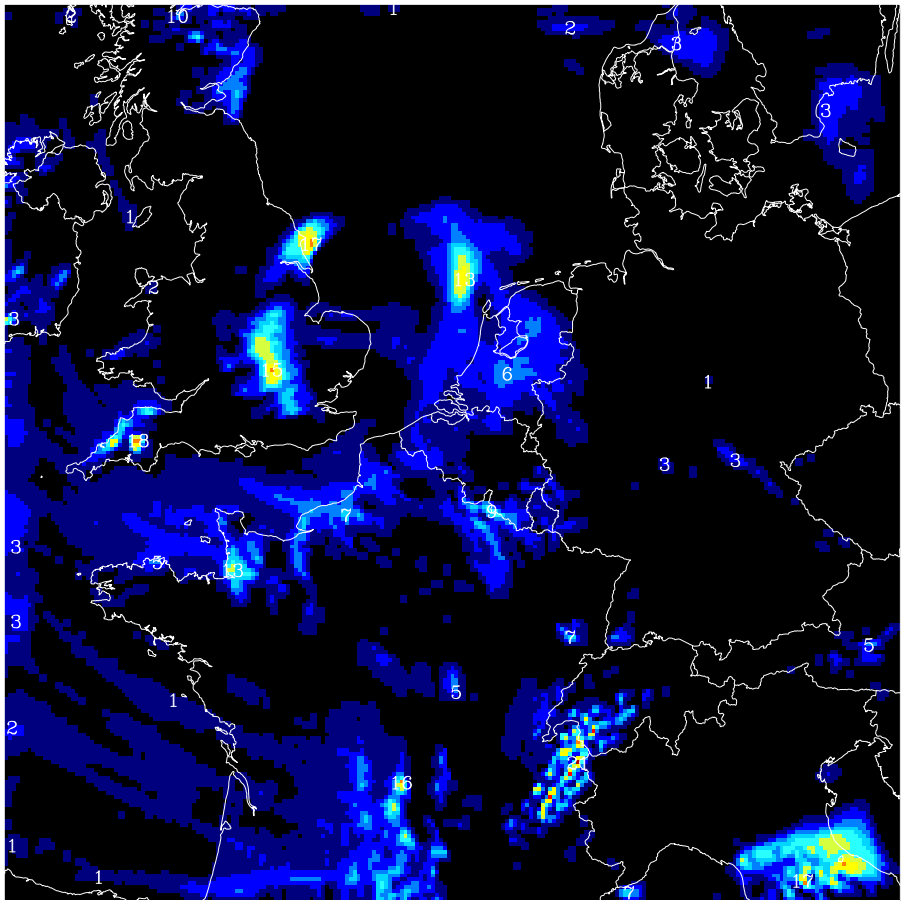


- (a) 33-h forecast range (low 969.5 hPa), the
- (b) 36-h forecast range (971.1 hPa) of the 0000-UTC forecast on 24 November 2006;
- (e) BER run performed at 33-h forecast range at 0900 UTC (964.0 hPa) and
- (f) restart at 1200 UTC 09 December 2007 (966.7 hPa).

BER: Small scale features are lost

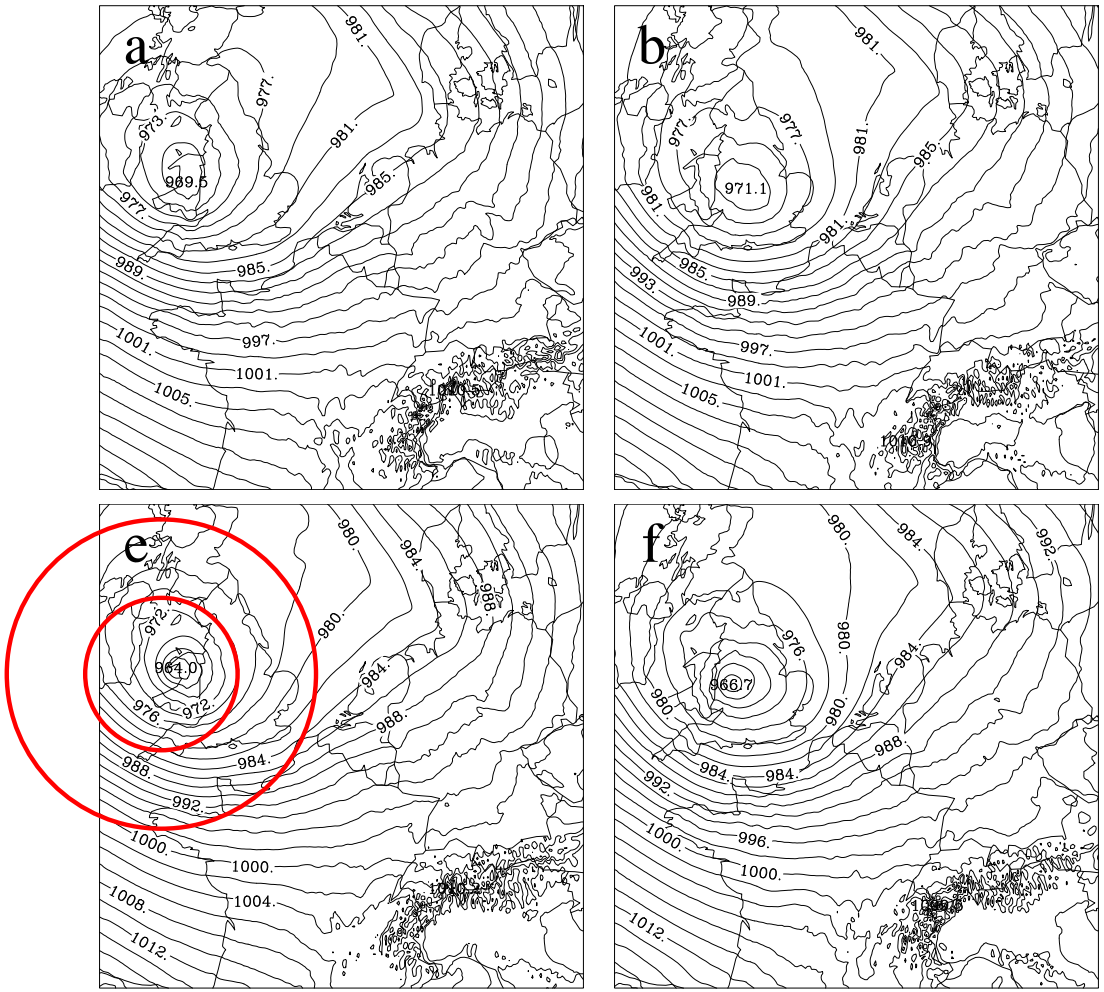


RUN



Boundary-error restart

Improvements by a gridpoint nudging



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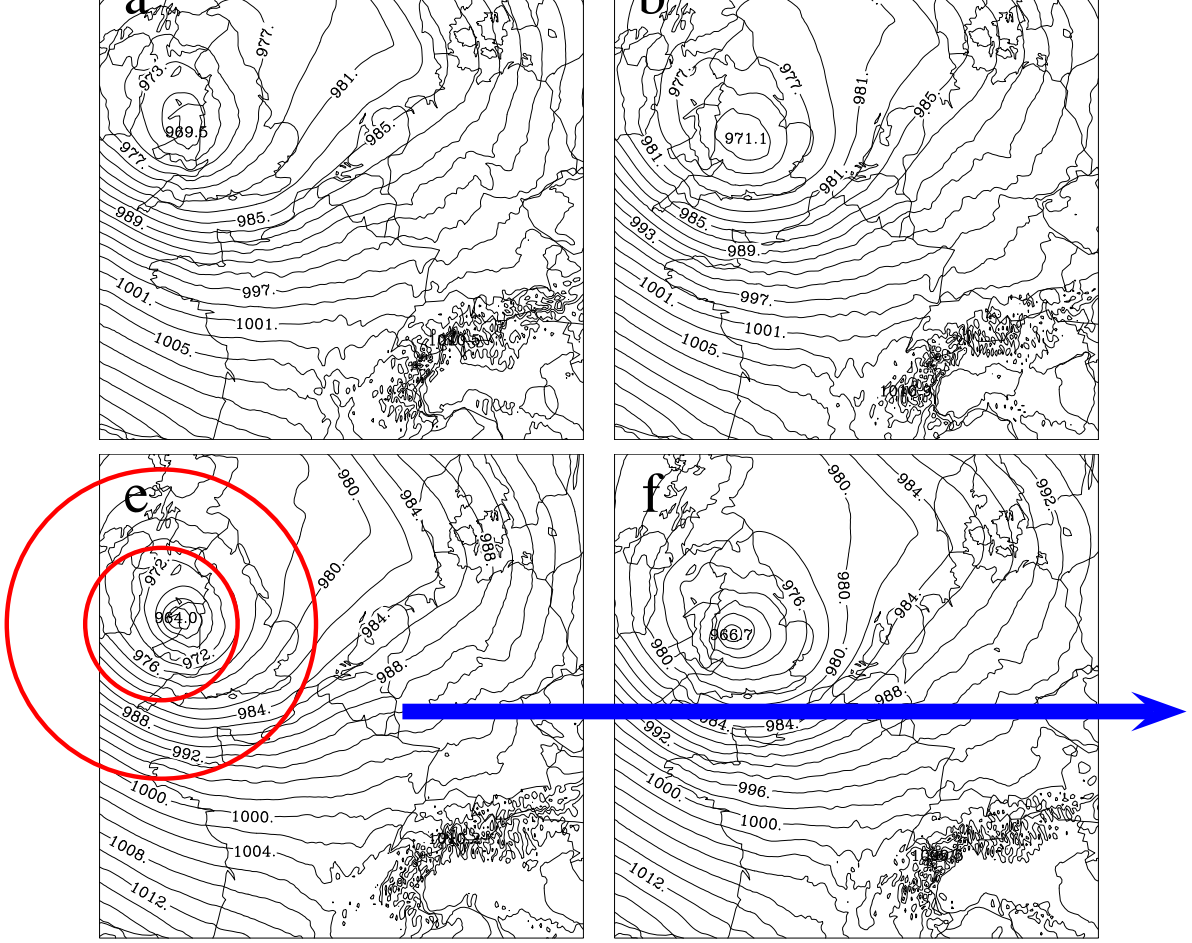

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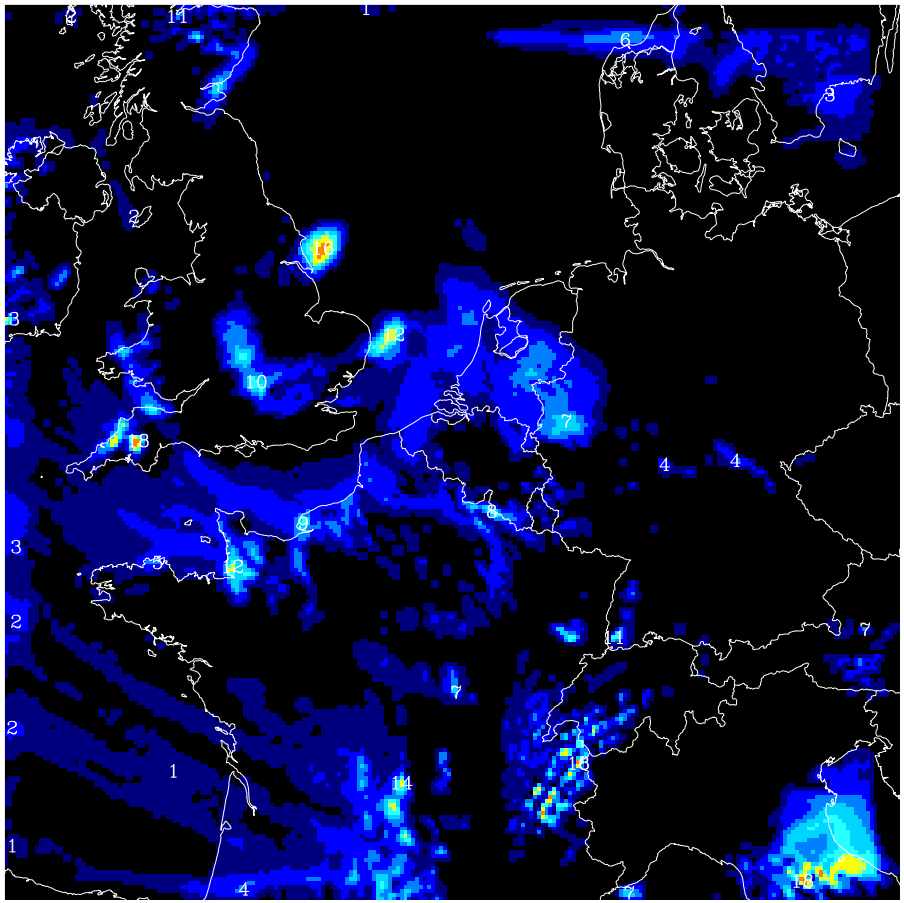
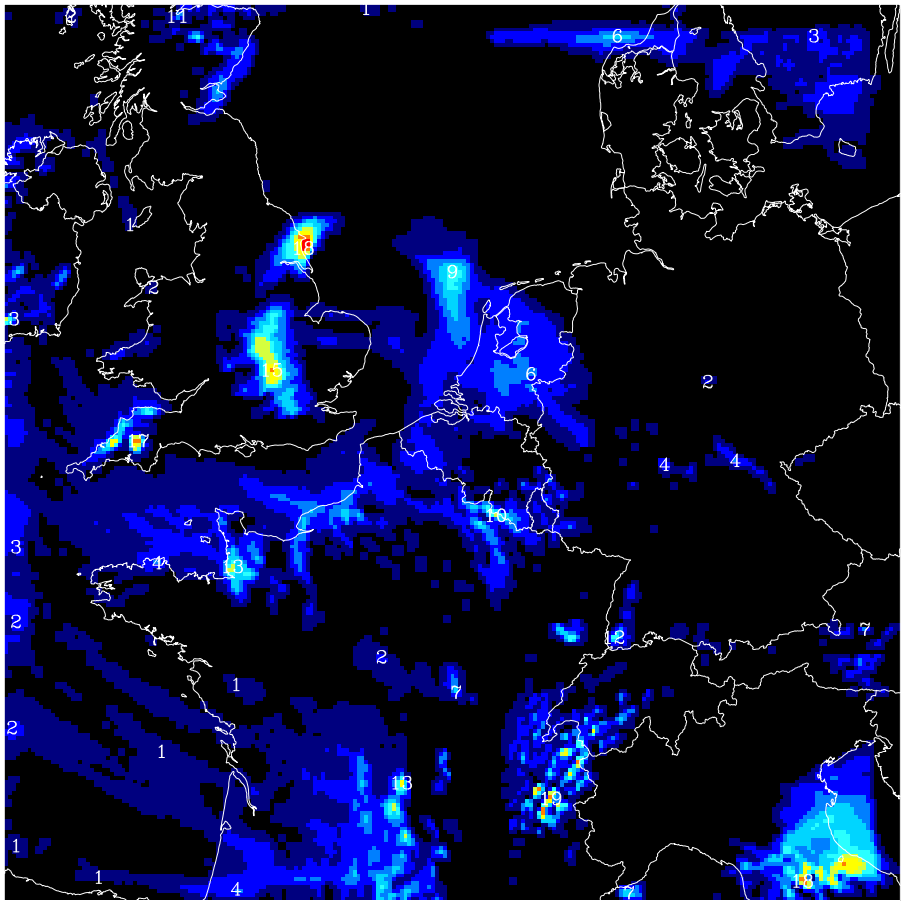
Gridpoint nudging

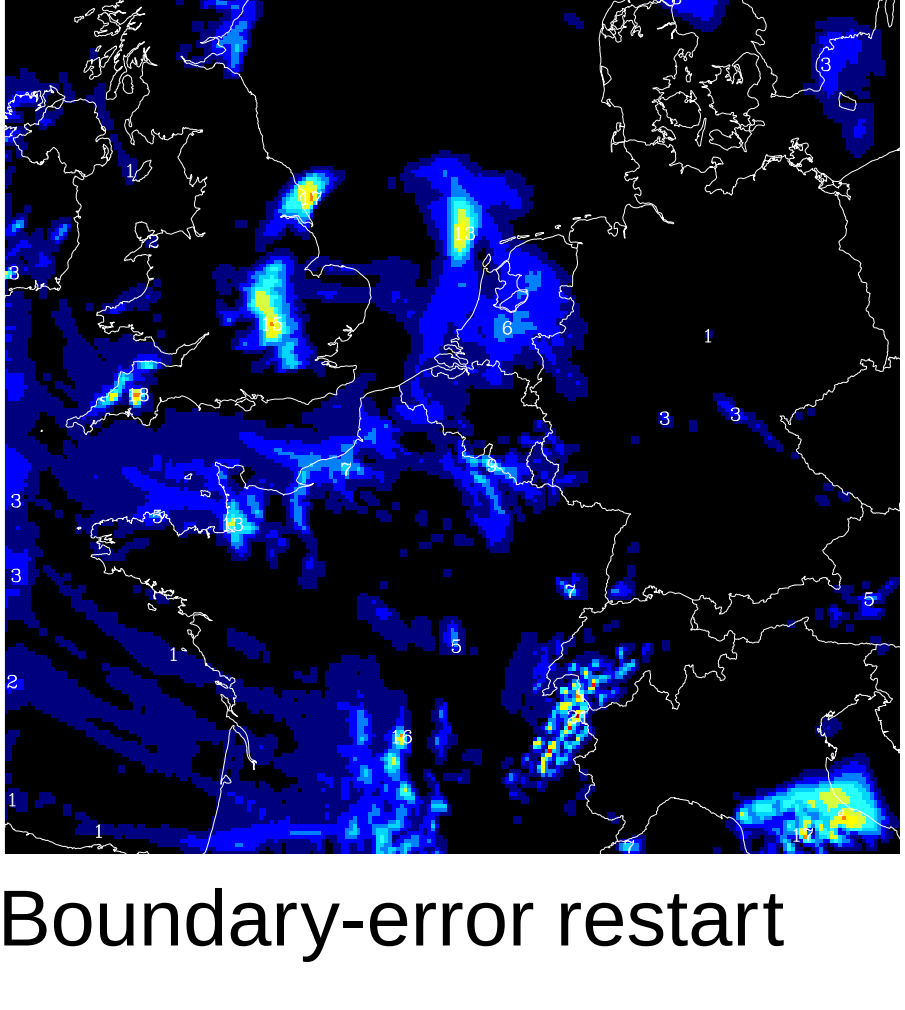


RUN

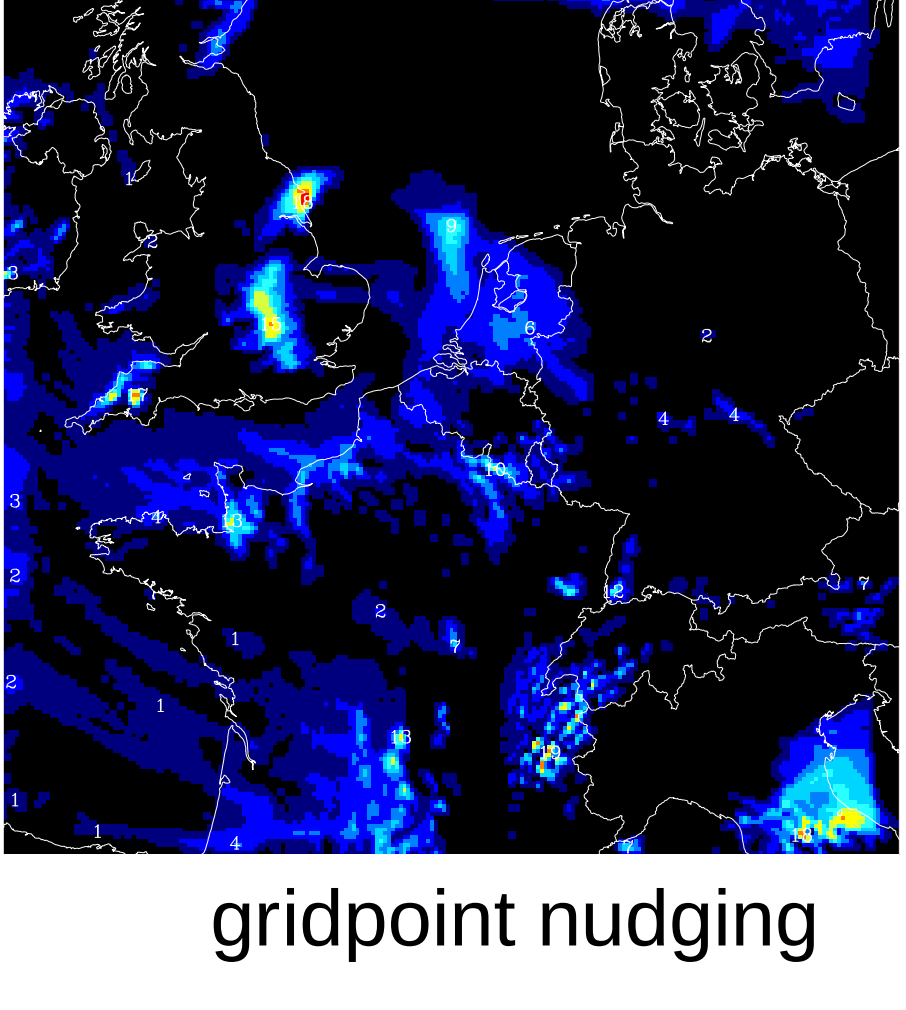


gridpoint nudging

Gridpoint nudging



Boundary-error restart



gridpoint nudging

Extra work

These are preliminary results.
We are setting up perfect model tests (PT, D. Degrauwe, R. Hamdi, M. Tudor)

Practically

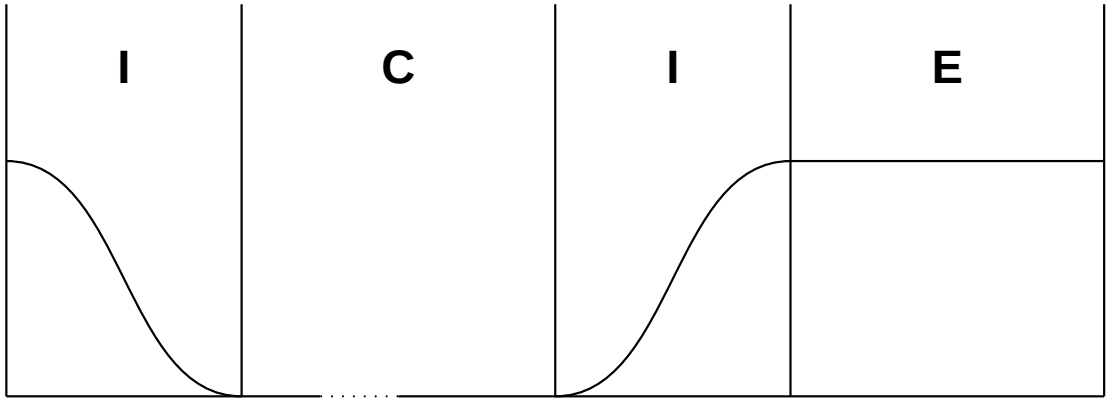
- We are close to a solution, which will be a combination of MCUF, SSDFI and gridpoint nudging.
- the MCUF fields are available in the ALADIN coupling files
- SSDFI is phased in the beginning of this year in cy53t1
- There you only have to choose a propagation velocity: only 1 namelist variable (`RDFIS`).
- I will write a brief manual later

Implementation of Boyd's solution

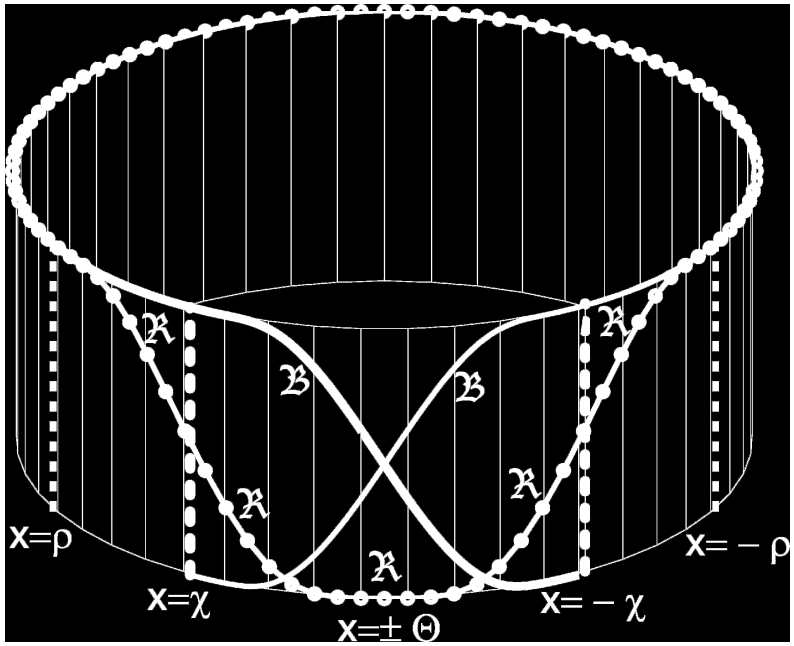
This is actually LACE work of F. Voitus and myself in Prague:

- Main goal: taste all Czech beers. Good progress but still lot's of work left to do ... (see Alena's beer minutes).
- Secondary goal: implement Boyd's solution in ALADIN, AROME, HARMONIE. Status: idem dito.

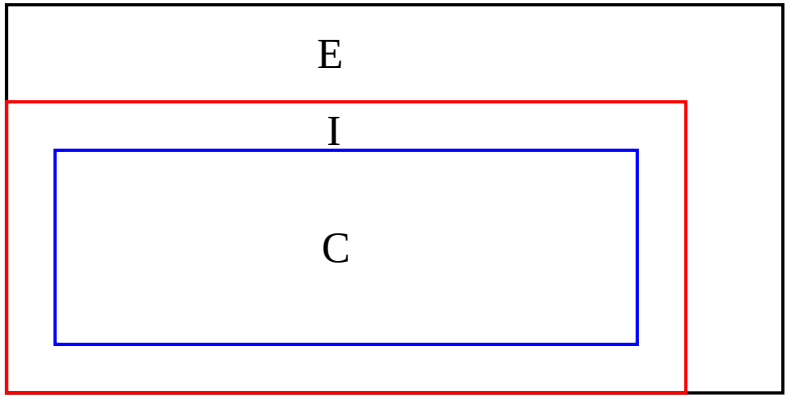
Haugen, Machenhauer



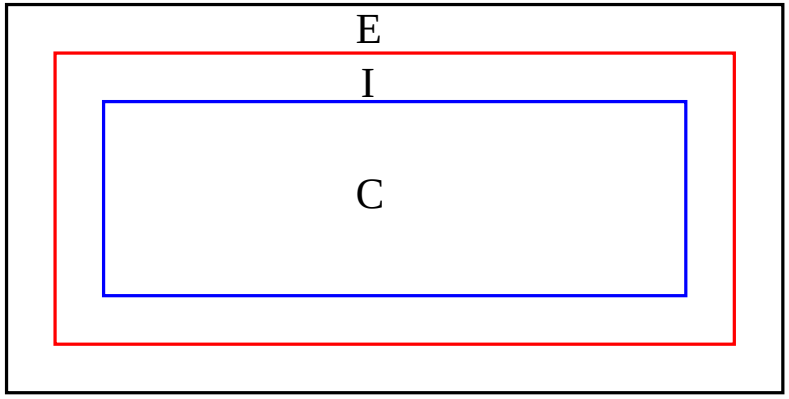
Boyd's Solution



In fact we could use the C,I, and E zone in the code



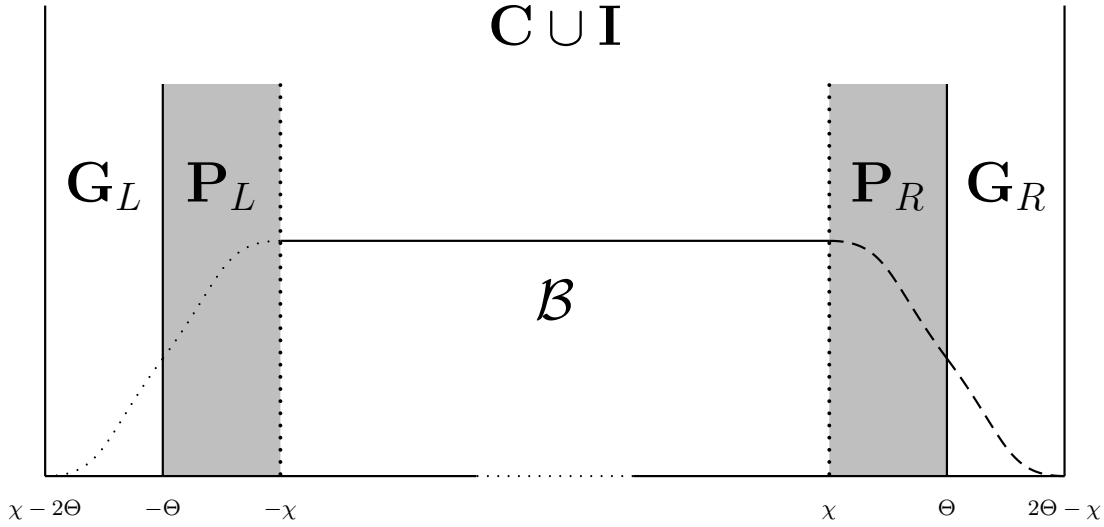
if we make it symmetric:



Feasibility studied by Benedikt Strajnar.

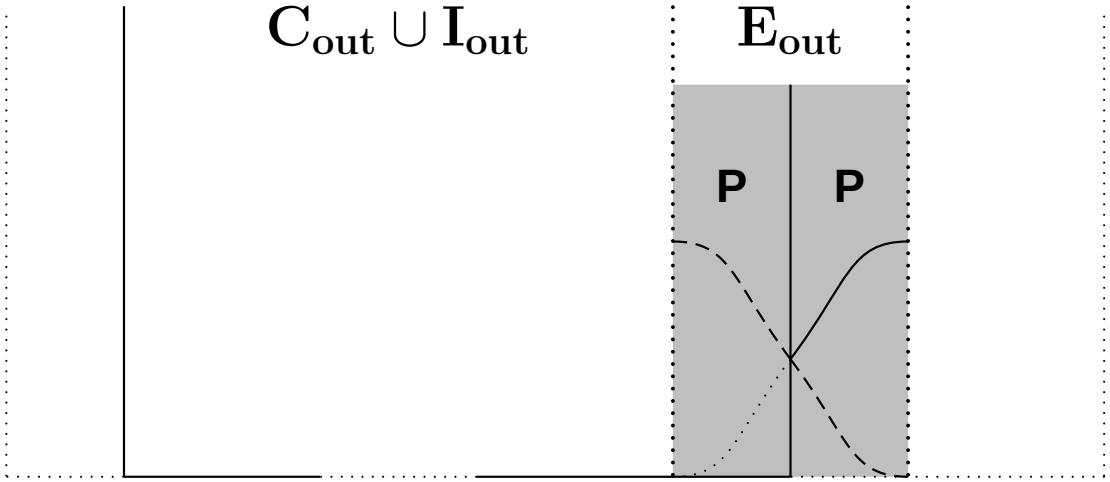
Boyd's solution

Do everything during the creation of the coupling files. Ryad's idea: avoid parallellization issues by doing it when the fields are made periodic.



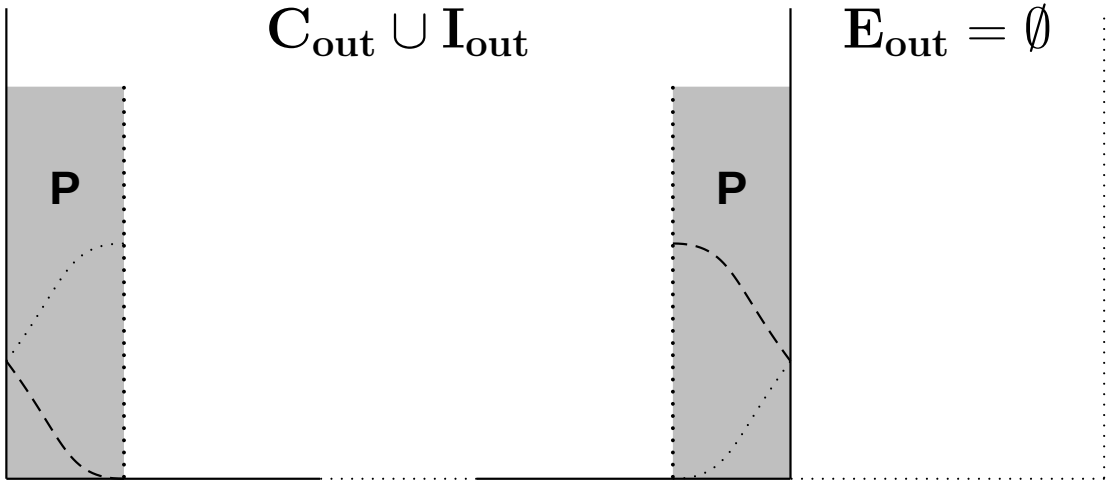
$$\begin{aligned} \mathbf{P}_L: &\quad \mathcal{B}(\mathbf{P}_L)\,\phi(\mathbf{P}_L) + [1 - \mathcal{B}(\mathbf{P}_L)]\;\phi(\mathbf{G}_R)\,, \\ \mathbf{P}_R: &\quad \mathcal{B}(\mathbf{P}_R)\,\phi(\mathbf{P}_R) + [1 - \mathcal{B}(\mathbf{P}_R)]\;\phi(\mathbf{G}_L)\,, \end{aligned} \tag{1}$$

Option 1



- temporary advantage: can run with the existing non-symmetric code, only has to adapt the Davies relaxation function
- disdavantage: On can not benefit from the fact of chosing the SL trajectories outside the physical domain.

Option 2



- advantage: optimally use SL trajectories leaving the "physical" domain.
- disadvantage: change of practice for the model user

Problems with the numbers EE927

Domain sizes should satisfy the constraints,

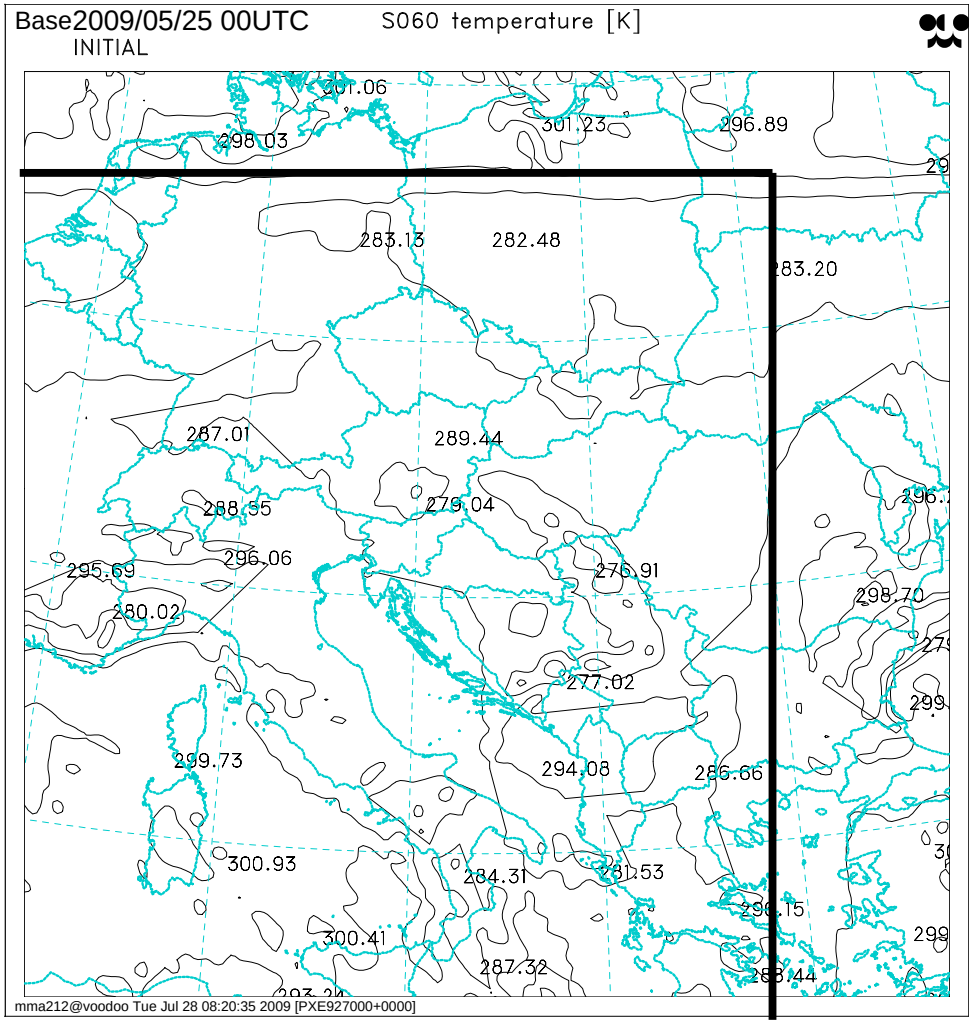
$$2^p\, 3^q\, 5^r \tag{2}$$

with p, q, r integer. For the present construction, we need to remove the $\mathbf{E}$ zone which in practice is 11 points wide. So

$$2^p\, 3^q\, 5^r - 11 - 2 \times width(\mathbf{G}) = 2^{p'}\, 3^{q'}\, 5^{r'}? \tag{3}$$

Also there is currently a constraint in the code that it should run with $p \neq 0$?

Option 1: the E zone



A first run

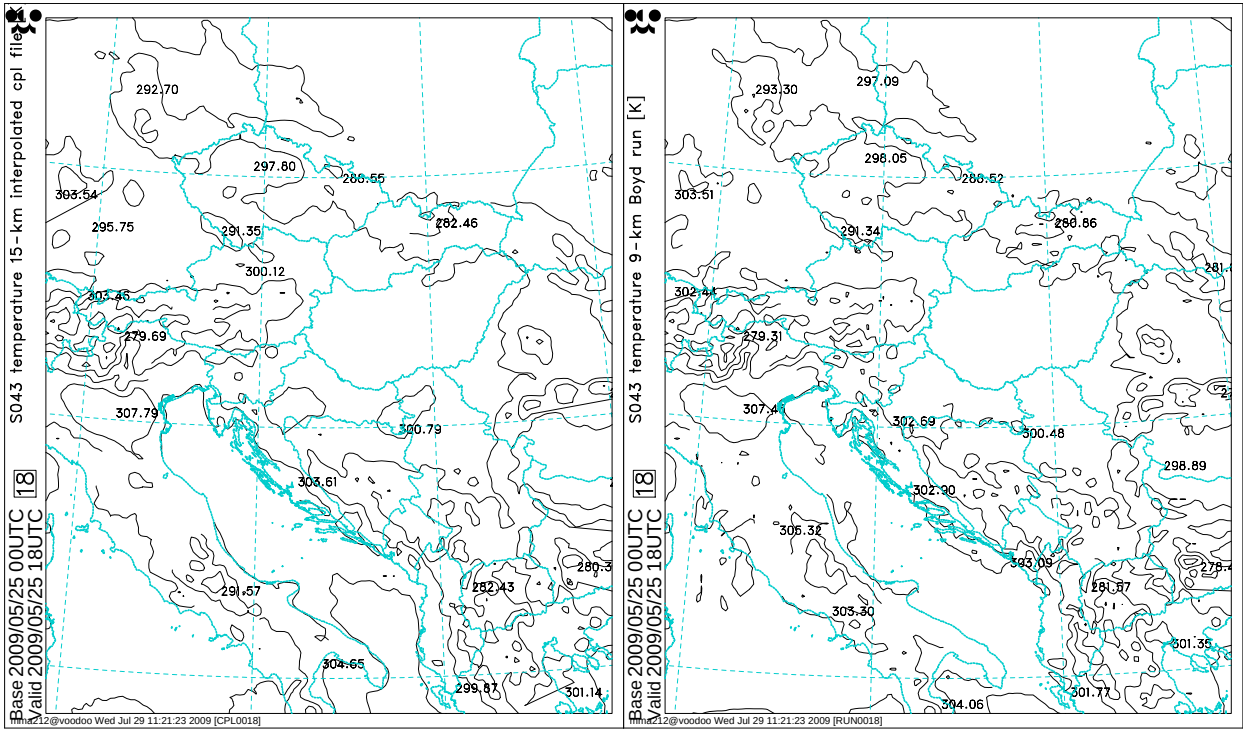
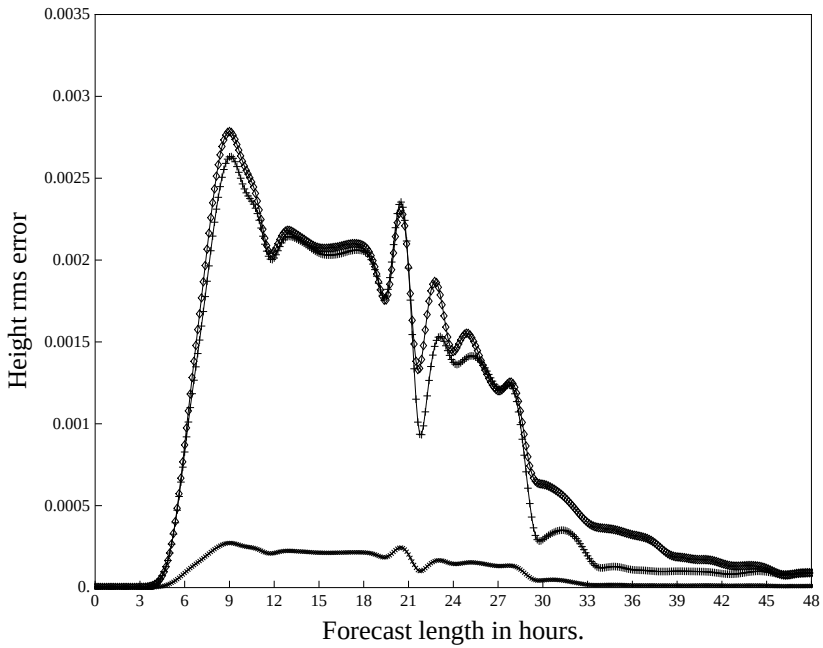


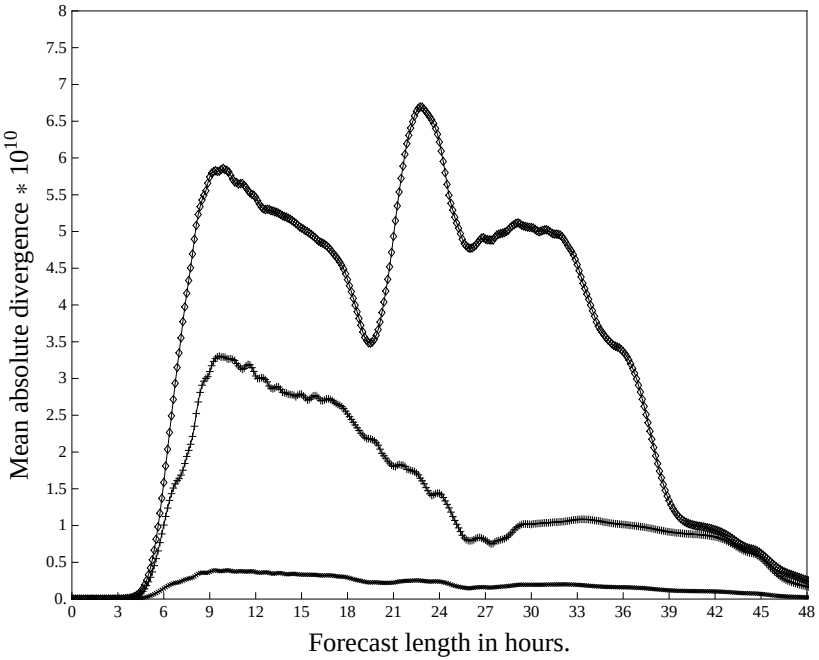
Figure 1: A preliminary run: the content of the original domain (resolution 15 km) after being interpolated to 9 km (left), and the run (resolution 9 km), at 18-h forecast range (right).

Gains from SL trajectories

- Tests with 1D spectral shallow water Eq. with a 2TL SI SL scheme.
- a bell-shaped field propagates through the domain.
- 3 solutions:
  - classic splines as known
  - Boyd's solution but with SL truncation
  - Boyd's solution but SL trajectories extending into the E zone

Gains from SL trajectories





Boyd's solution: priorities

- Cleaning
- Phasing!
- Phasing of Benedikt's work to allow a symmetric $\mathbf{E}$ zone.
- Lot's of science: perfect-model tests, SL trajectories, data assimilation, see our technical LACE report.