Regional Cooperation for Limited Area Modeling in Central Europe

LACE
nwp central europe

ACCORD
A Consortium for COnvection-scale modelling Research and Development

Dynamics & Coupling in LACE

Petra Smolíková (CHMI) and Gabriel Stachura (IMGW)

ZAMG DHMZ Czech Hydrometeorological Institute OMSZ IMGW METEO ROMANIA SHMU ARSO METEO Slovenia

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Coupling in LACE

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Outline

- Motivation
- Frame approach in the LBC files
  - The method
  - The results
  - The file size reduction estimate
- The impact of higher truncation in LBC files
  - The results
  - The file size reduction

Outline

- Motivation

Motivation

- With increasing horizontal resolution, the LBC file size increases.
- It may be challenging to get LBC files in time for operations.
- Can we reduce the LBC file size without decreasing the quality of the obtained results?

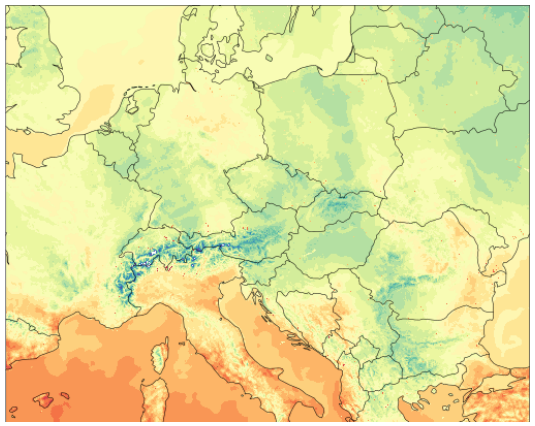
Outline

- Motivation
- Frame approach in the LBC files

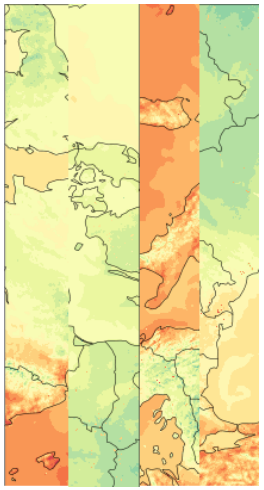
Frame approach in the LBC files

- For coupling, LBCs are used only in an outside frame of the domain.
- In the central zone, LBCs are not used.
- It is true for grid point representation of model variables in LBCs.
- But currently, the representation of the model variables in LBCs is spectral, and a transformation to grid-point representation is applied before coupling.
- Can we prepare LBC files with grid-point represented model variables only in the frame of the domain and decrease the size of the transferred files?
- When going to spectral space, all values (including central zone) matter.
- Can we reconstruct the files afterwards to get coupling files in the comparable quality as the original files?

Frame approach in the LBC files



remove inner part

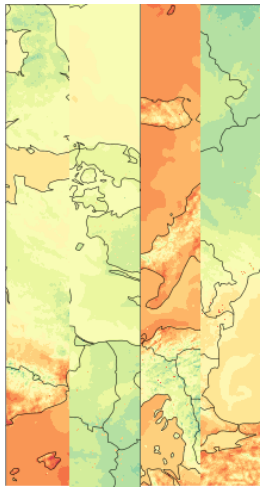


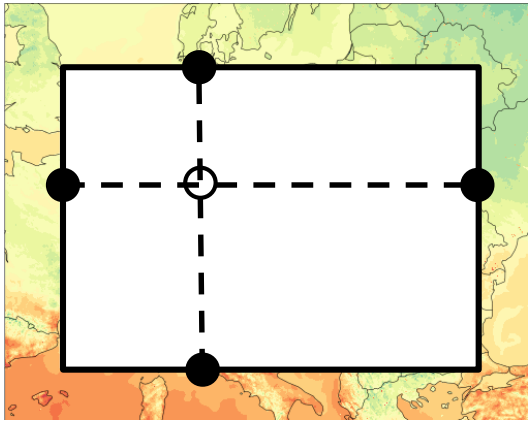
compress:
compressed file size estimate

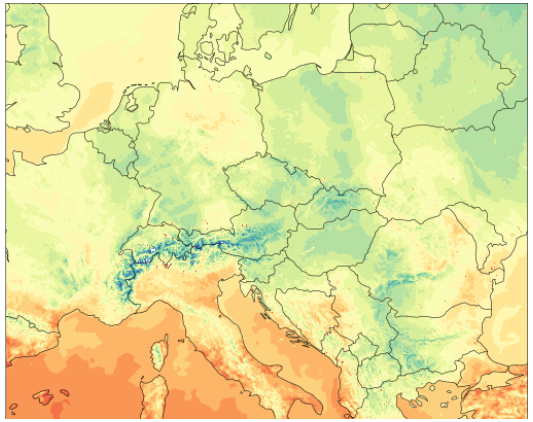
transfer

Frame approach in the LBC files

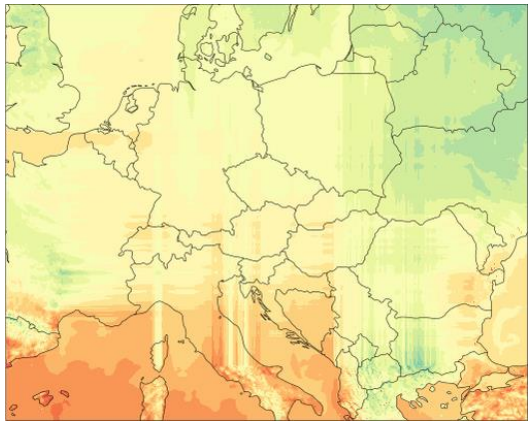
Resonstruction: decompress







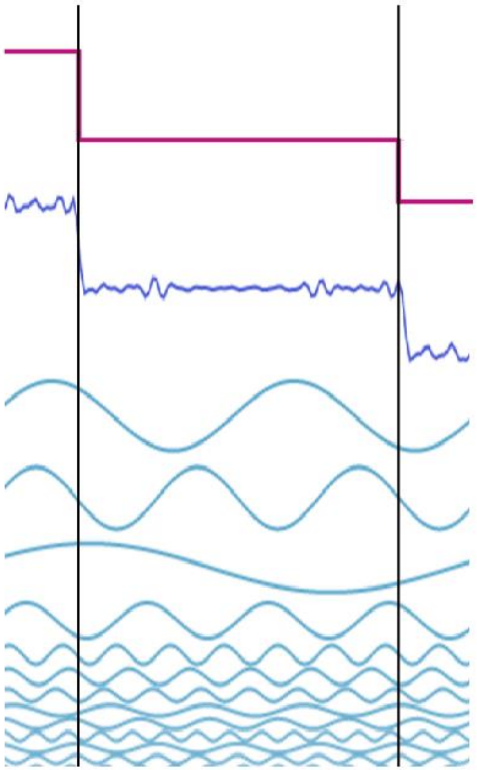
fill with artificial values: reverse-distance 2d-linear interpolation



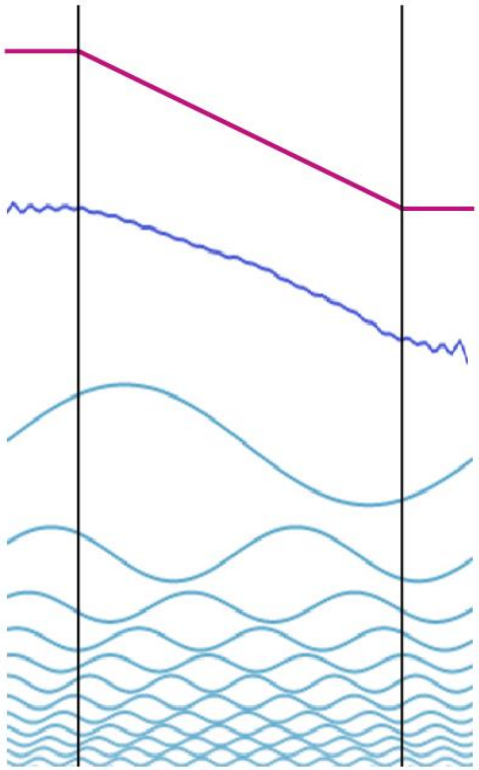
compare with the original field

Frame approach in the LBC files

How to fill artificially the inner part ? In 1D:



fill with an average (artefacts)

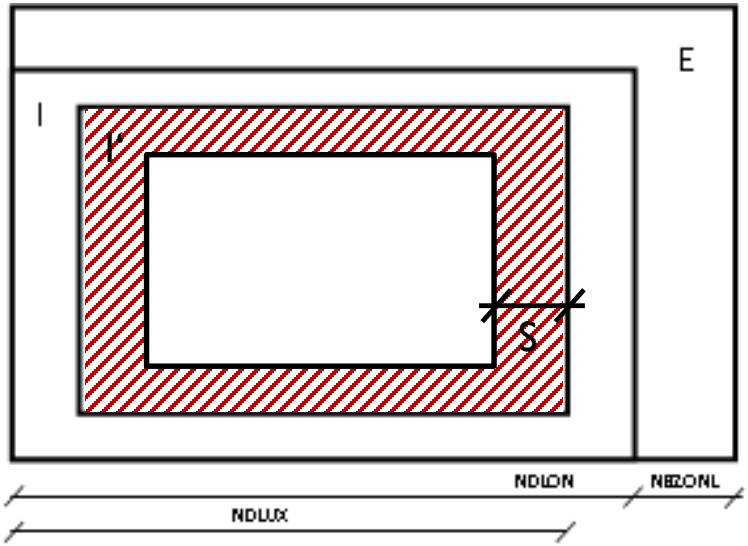


fill with linear interpolaton (better)

and transform to the spectral space

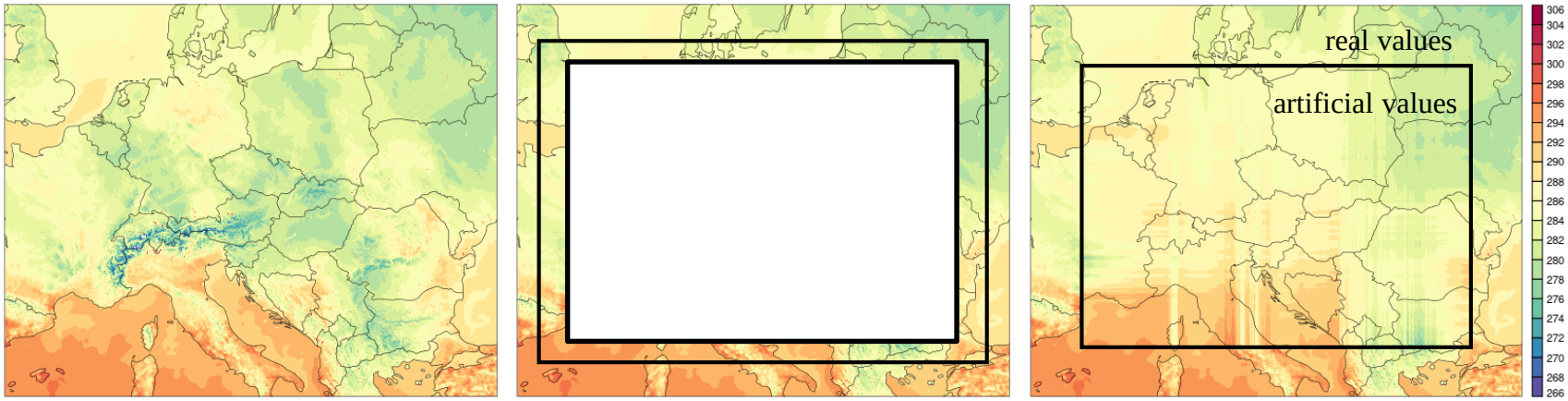
Frame approach in the LBC files

- A code modification enabling the usage of LBC files with model variables in GP representation was prepared in MF.
- Several fortran-based tools were used to prepare grid-point represented LBC files and framed LBC files.
- Some modifications of the size of the frame were tested by changing a parameter S (S=0 means the smallest frame possible).



- Only upper air fields were framed since they are the subject of coupling. The other fields which are needed for physics, surface scheme or other purposes as orography, roughness etc. are kept unchanged.

Frame approach in the LBC files



Original spectral field:
quadratic truncation,
8km x L105

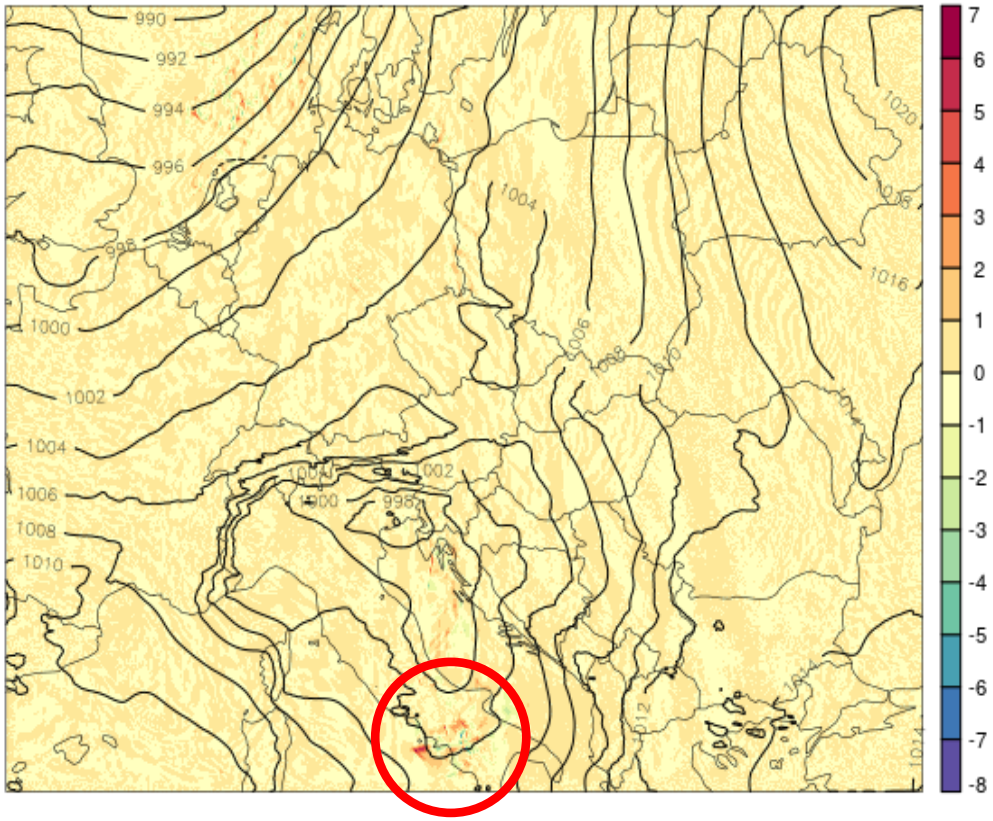
Final gp field: 2.3km x L87

Framed gp field

Reconstructed gp field:
2.3km x L87

Frame approach in the LBC files

Objective scores (RMSE, STDEV, BIAS) show that the quality of the forecast made from framed LBC files is good.

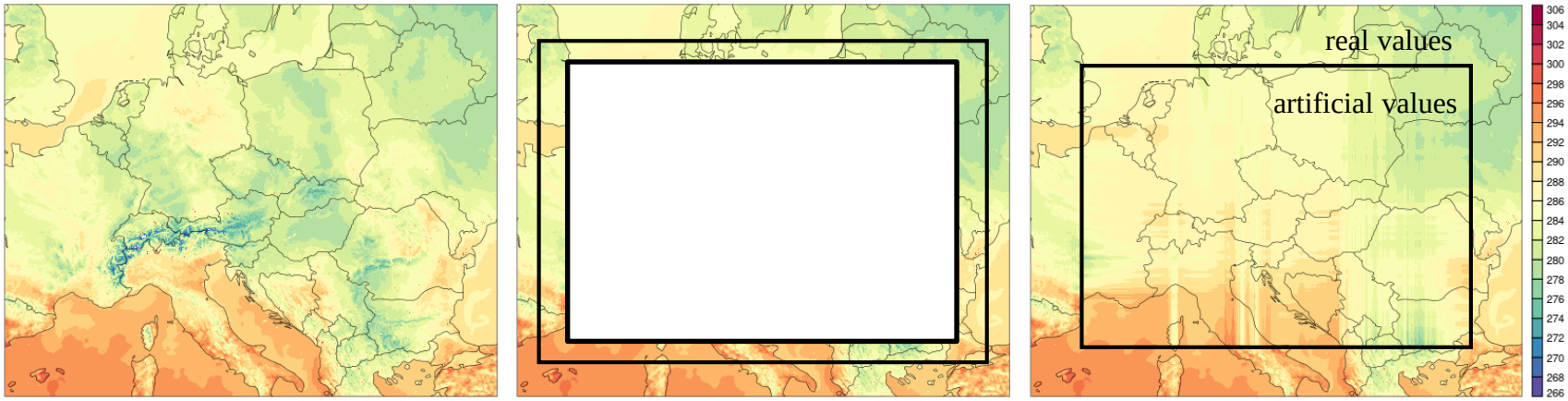


Difference of the meridional wind component between the forecast made from framed LBCs and the reference;

local differences, mainly in the centres of lows.

Frame approach in the LBC files

File size estimate: for one field



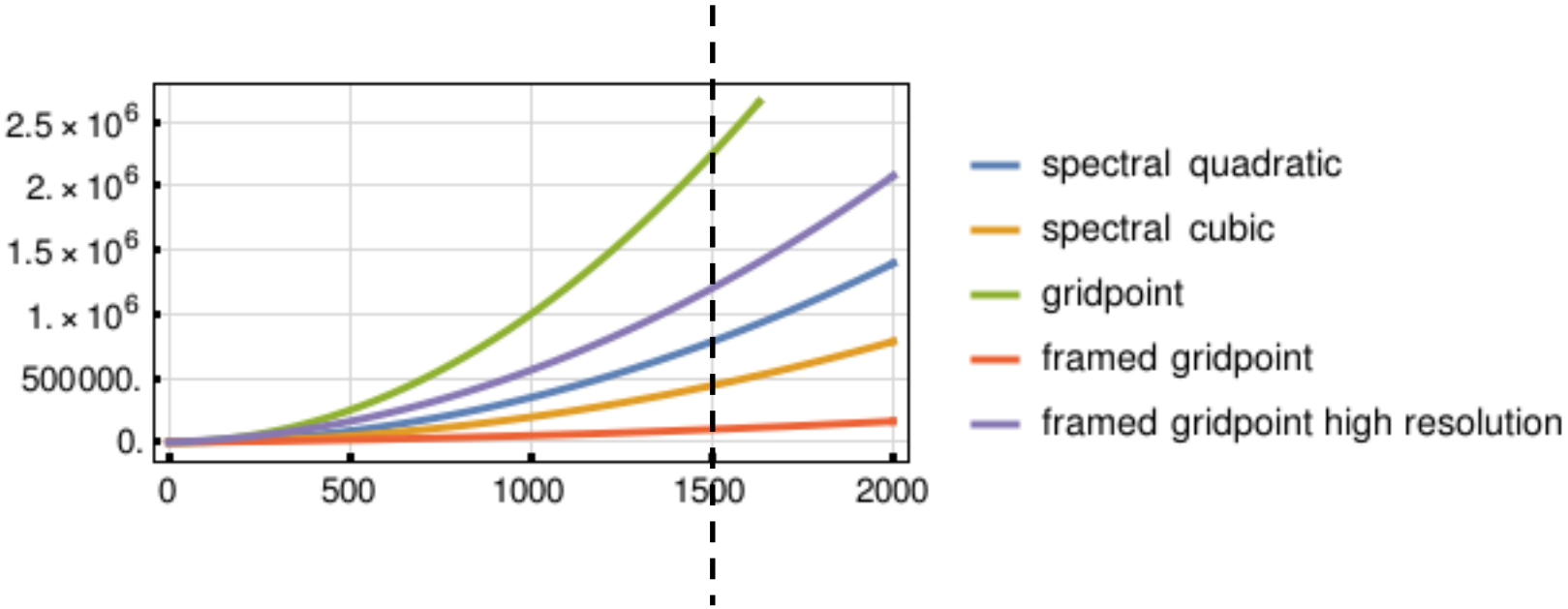
Original spectral field:
quadratic truncation,
8km x L105: 48k
gp field: 138k

Final gp field: 2.3km x L87
933k

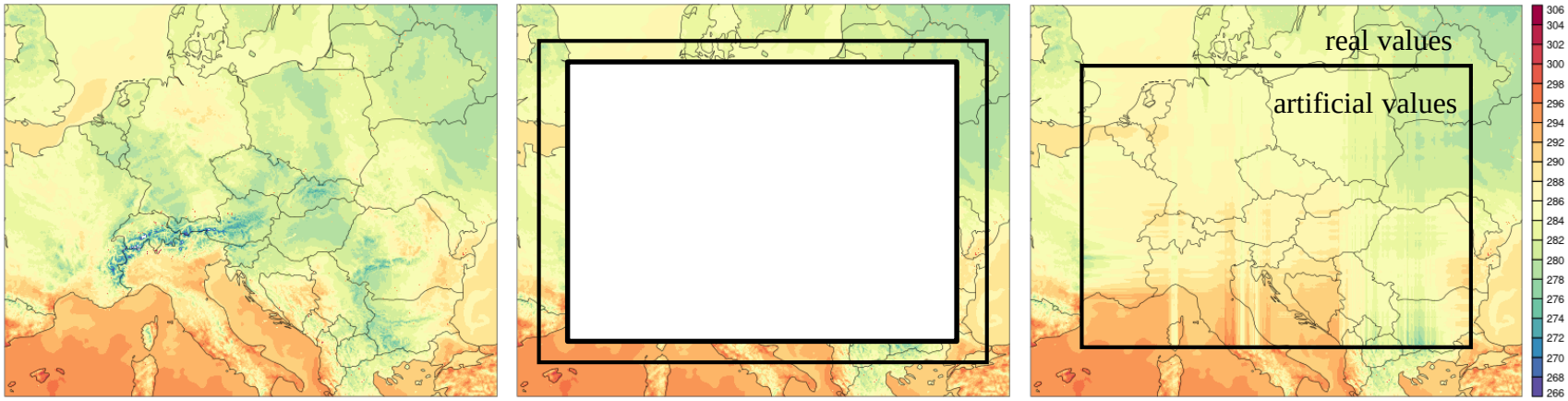
Framed gp field
85k

Reconstructed gp field:
2.3km x L87

Frame approach in the LBC files



Frame approach in the LBC files



Original spectral field:
quadratic truncation,
8km x L137: 48k
gp field: 138k

Final gp field: 2.3km x L87
933k

Framed gp field
26k

Reconstructed gp field:
2.3km x L87

Frame approach in the LBC files

Conclusions:

- The quality of results is good when framed LBCs are used.
- The file size reduction is not satisfactory in case of framing final resolution LBC files.
- The possibility of framing the low resolution LBC file and make the reconstruction and interpolation to final resolution afterwards will be tested.
- The framing has to be before file transfer (in MF).
- The LBC are prepared for a given domain, may not be used for all domains being contained in (as it is the case of the Telecom domain for LACE).

Outline

- Motivation
- Frame approach in the LBC files
  - The method
  - The results
  - The file reduction estimate
- The impact of higher truncation in LBC files

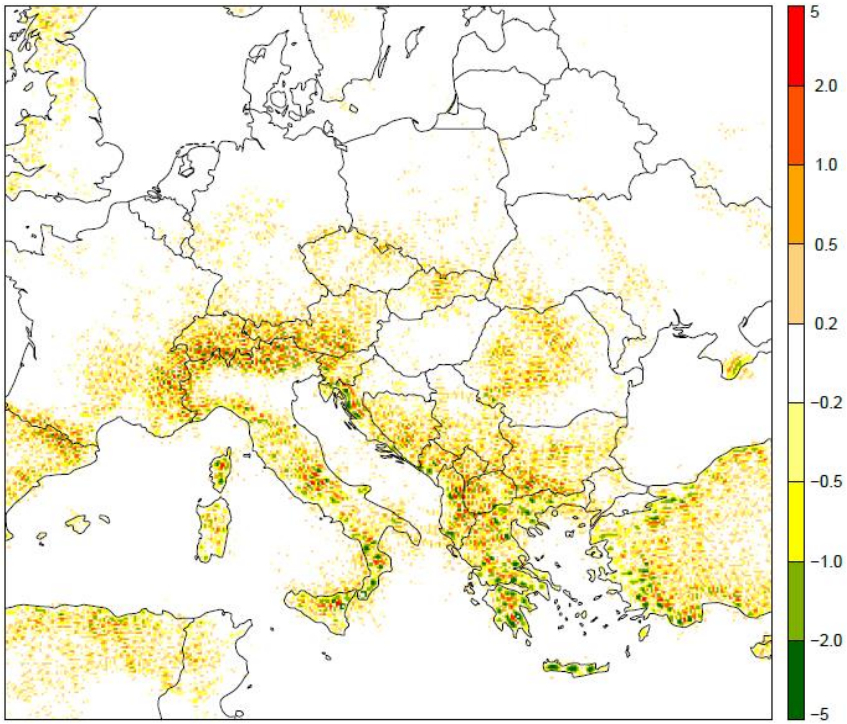
The impact of higher truncation in LBC files

- Global model ARPEGE uses linear truncation and variable horizontal resolution (stretched geometry) with approx. 5km over Europe, 105L.
- LBC files on the Telecom domain for LACE have quadratic truncation and uniform 8km horizontal resolution, 105L.
- May even higher truncation be reasonable in the LBC files? May it allow a forecast with the similar quality as with the original LBCs?

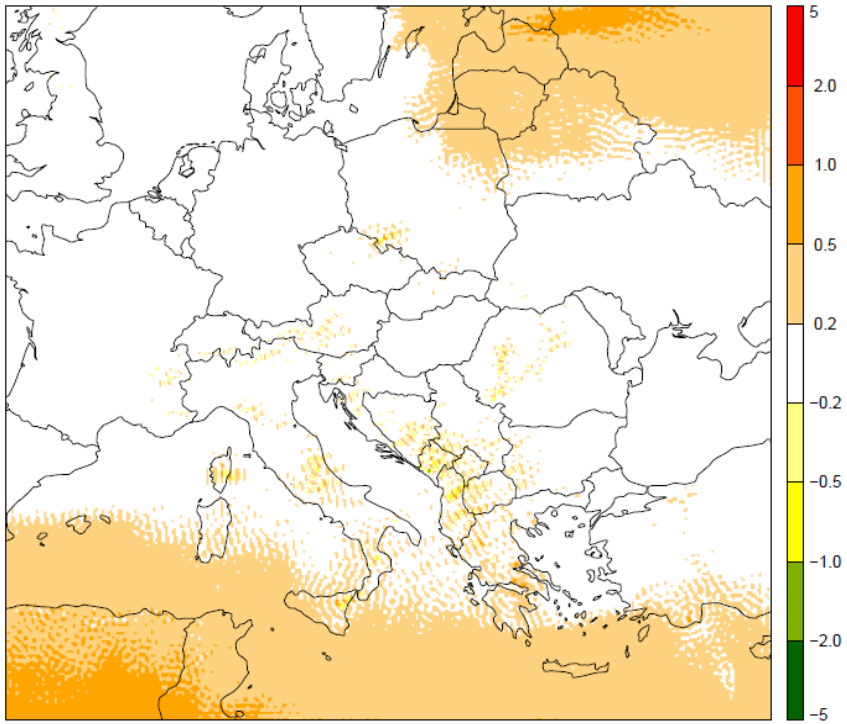
The impact of higher truncation in LBC files

We have tested only cubic truncation used in the LBC files.

Difference in the LBC files (8km, 105L): quadratic - cubic truncation



Temperature at the lowest level

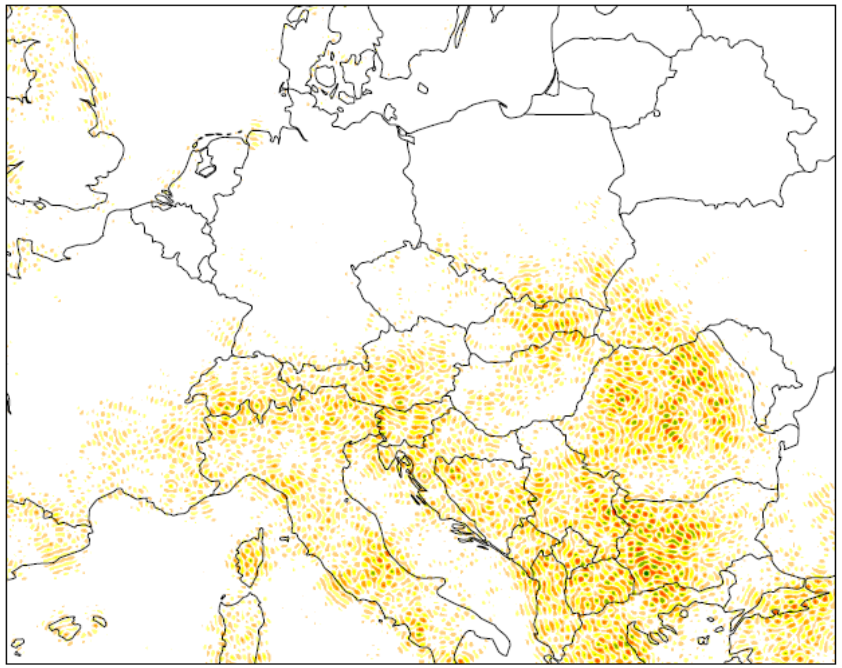


Zonal component of wind at 40th vertical level

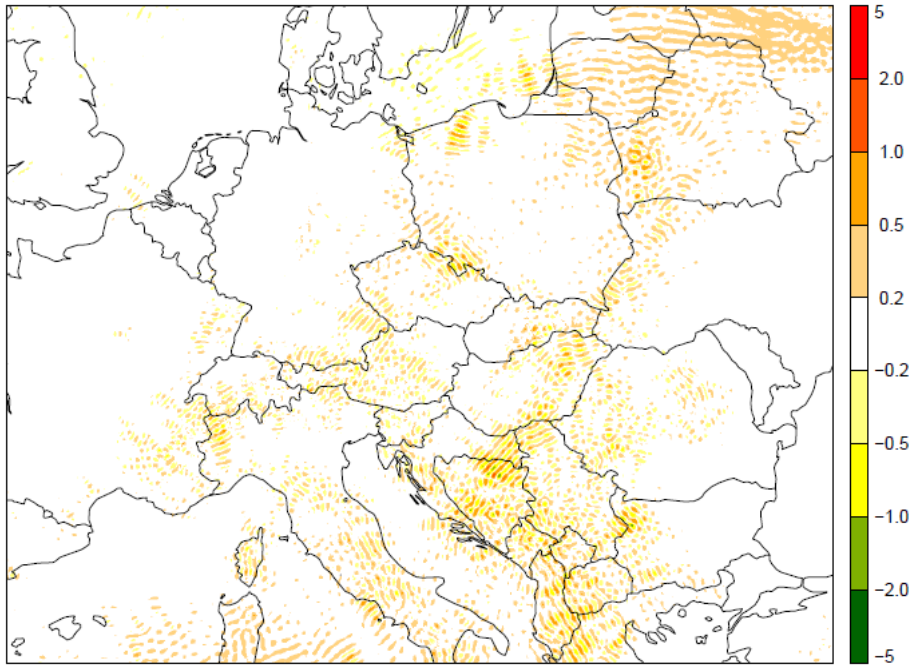
The impact of higher truncation in LBC files

We have tested only cubic truncation used in the LBC files.

Difference in coupling files used for integration (after interpolation to 2.3km hor.res. and vertical interpolation to 87L, domain cut): quadratic - cubic truncation



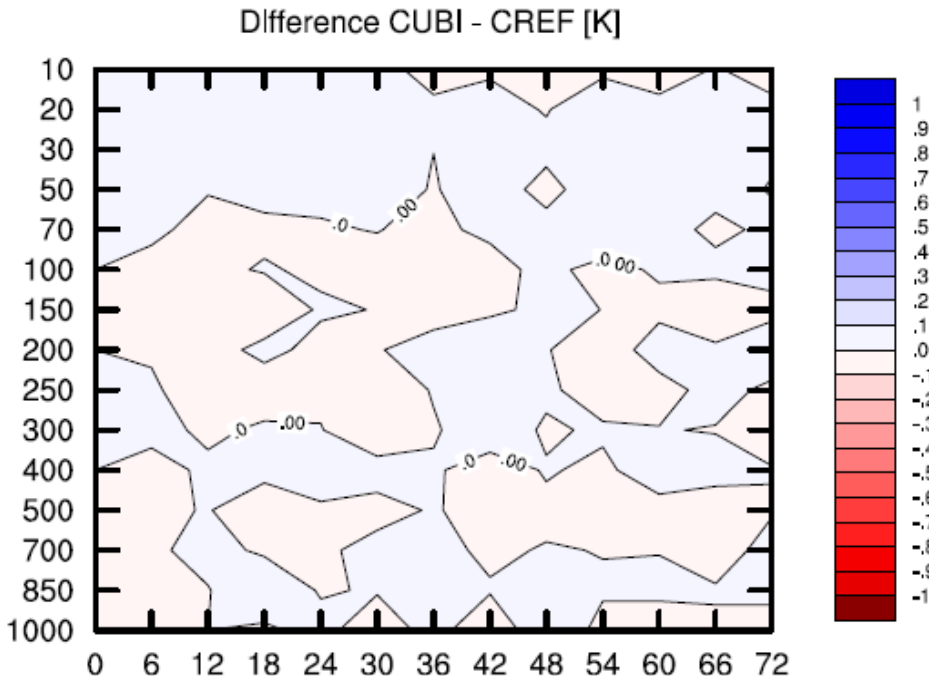
Temperature at the lowest level



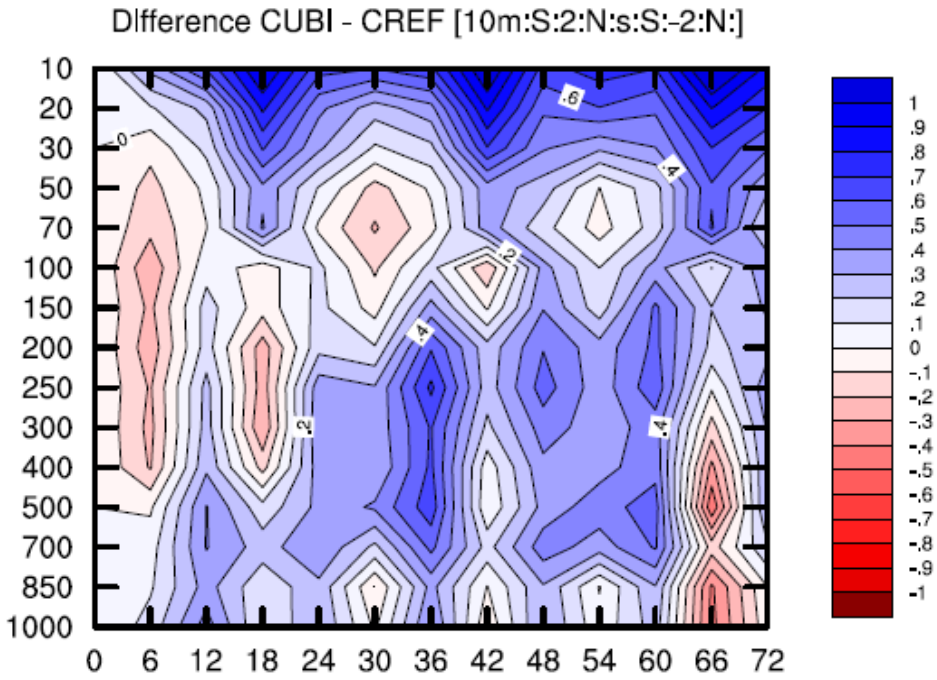
Zonal component of wind at 40th vertical level

The impact of higher truncation in LBC files

The effect in the forecast: 14 days of the forecast from 0 UTC for 72 hours



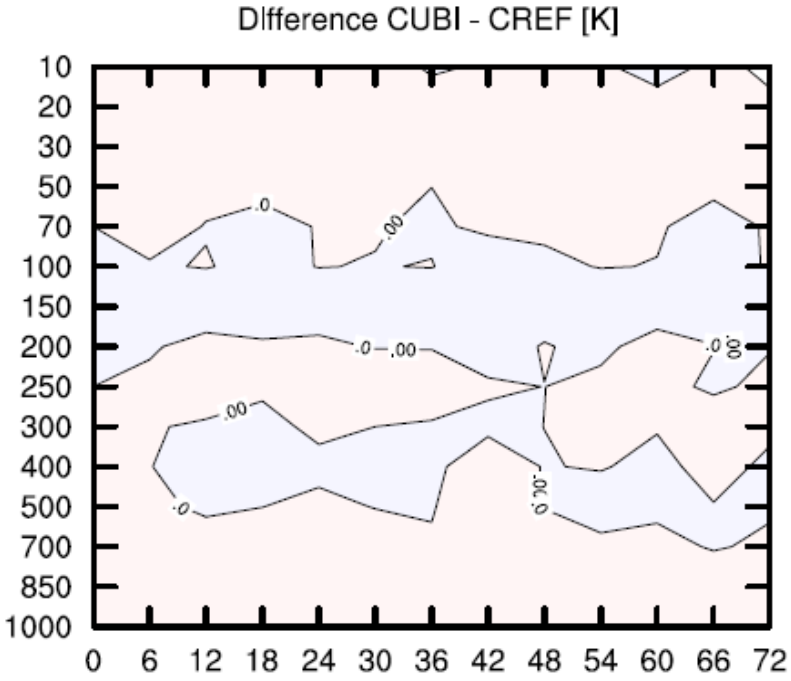
RMSE of temperature

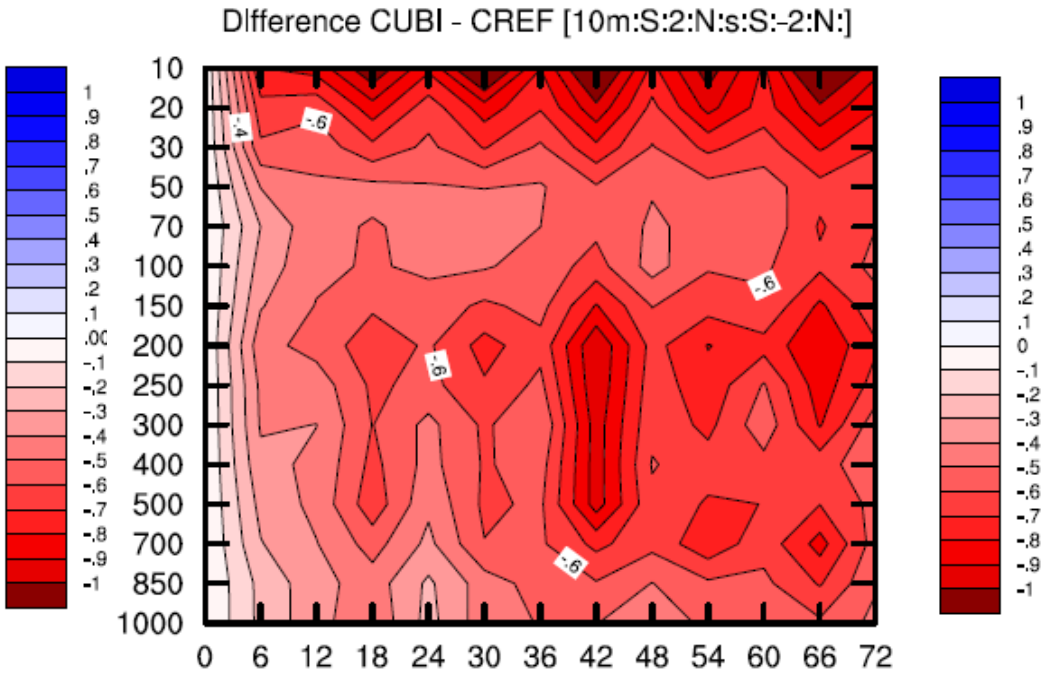


RMSE of geopotential

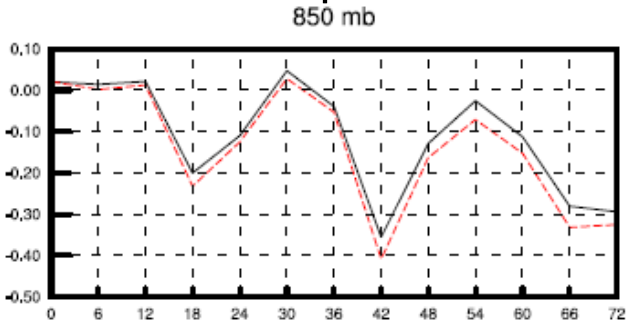
The impact of higher truncation in LBC files

The effect in the forecast: 14 days of the forecast from 0 UTC for 72 hours

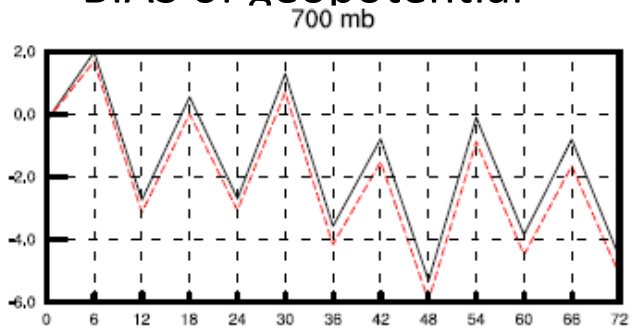




BIAS of temperature



BIAS of geopotential



The impact of higher truncation in LBC files

The reduction of the size of the LBC file is proportional to the ratio of the truncation order with a quadratic and cubic grid (in 2 dimensions):

9/16 = 56% for one spectral field.

For the whole file with many (35) GP represented fields which are not changed, we get

the size of cubic LBC file = 70% of the size of quadratic LBC file.

The quality of results is reduced, mainly in the geopotential field.

Thank you for your attention …!
Greetings from Prague!