Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

ACC RD

A Consortium for COnvection-scale modelling
Research and Development

Dynamics & Coupling in LACE

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GeoSphere Austria   DHMZ   Czech Hydrometeorological Institute   OMSZ   IMGW   METEO ROMANIA   SHMU   ARSO METEO Slovenia

Outline

❑ On demand time scheme

❑ Stability analysis with constant slope in SI

❑ 3D features of the turbulence scheme TOUCANS
(EWGLAM 2022 talk)

❑ Frame approach in the LBC files

3nd ACCORD ASW

On demand time scheme

Motivation

In current resolutions, in most of the cases SETTLS time scheme is stable enough, less frequently more expensive PC scheme is needed.

In high horizontal resolutions with steep slopes even more iterations of the PC scheme are necessary.

Could we switch the corrector steps on demand only when needed?

Which condition to use for the decision making?

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On demand time scheme

Previous work

- we tried to find a balance between less accurate/more stable non extrapolating scheme NESC and second order accurate/less stable scheme SETTLS for each grid point

- a **COMBINED** scheme allowing to use a transition between these two approaches for each grid point was proposed and implemented

- stability criterion was proposed based on the time derivative of the non-linear residual of the pressure departure variable

- alternative is the usage of SETTLS everywhere but in points where the threshold is exceeded, where NESC is used
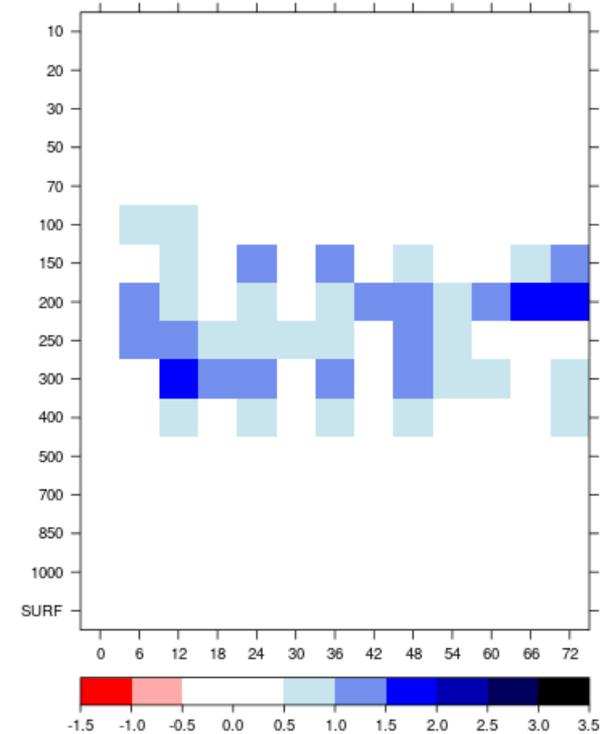
On demand time scheme

**Reference PC** **NESC if needed** **COMBINED**
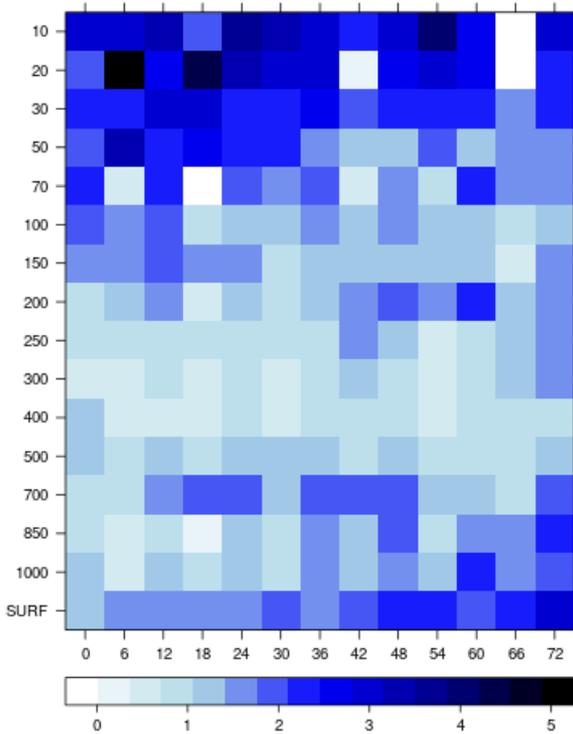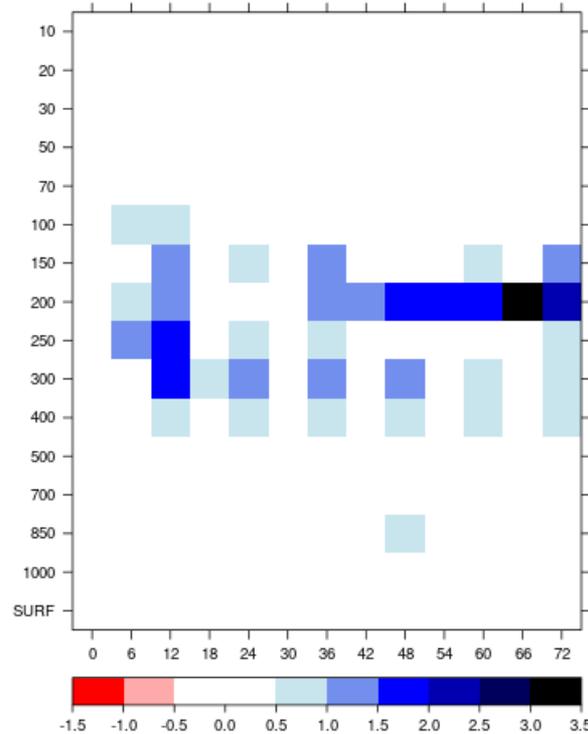
TEMPERATURE RMSE
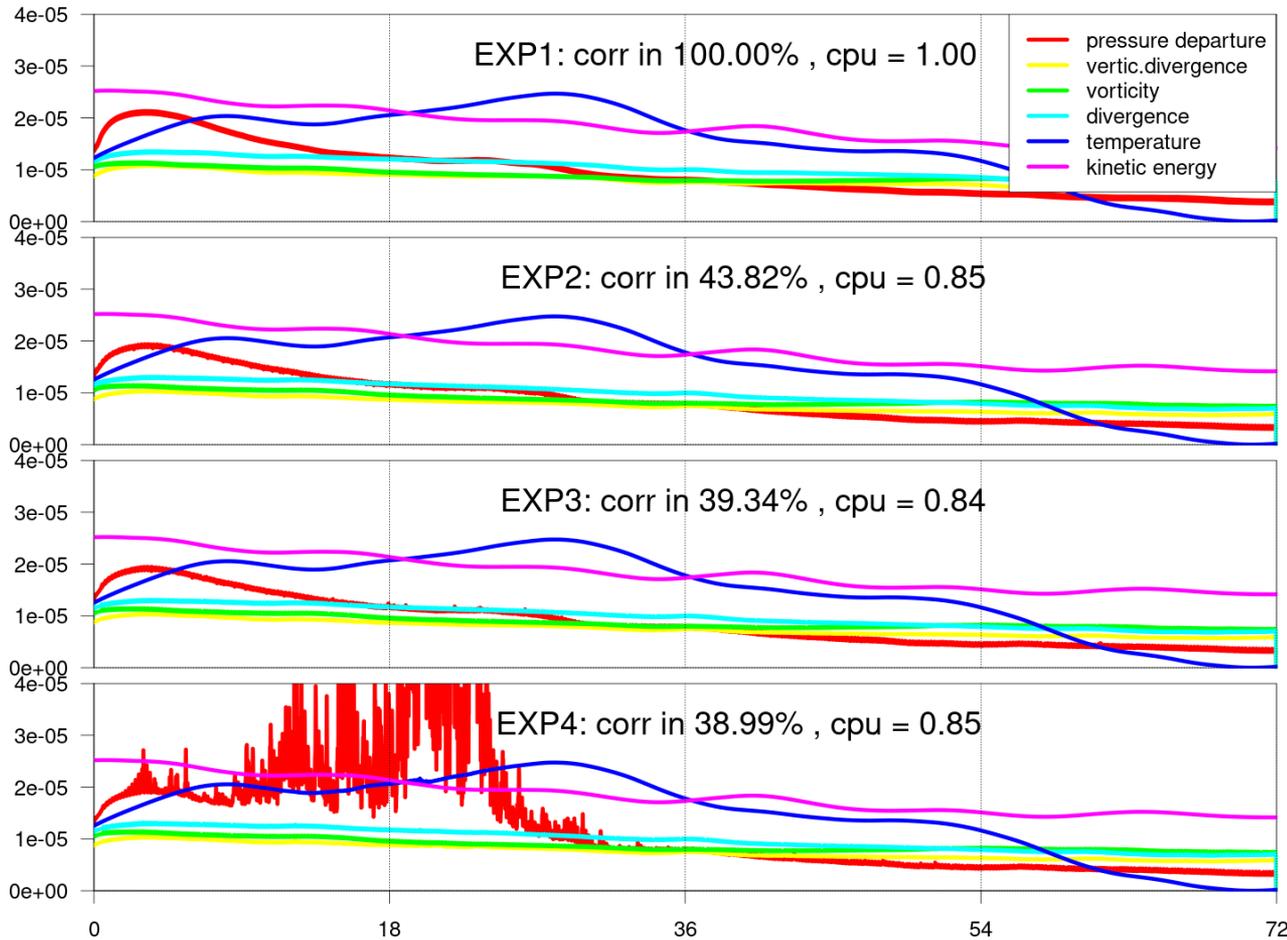
On demand time scheme

- a global stability criterion based on the time derivative of the vertical divergence non-linear residual in every grid point was formulated

- the percentage of grid points for which this characteristic exceeds a given threshold is evaluated

- a choice between non-iterative SI scheme with SETTLS evaluation of the non-linear terms and iterative centred implicit scheme with one iteration and NESC evaluation of the non-linear terms is made at the beginning of every time step

- implemented in the ACCORD codes based on cy46t1 and then tested on two real cases, known to be dynamically unstable when SI + SETTLS for non-linear terms is used

On demand time scheme

Stability criterion : stability characteristics > τ for more than 50% gp
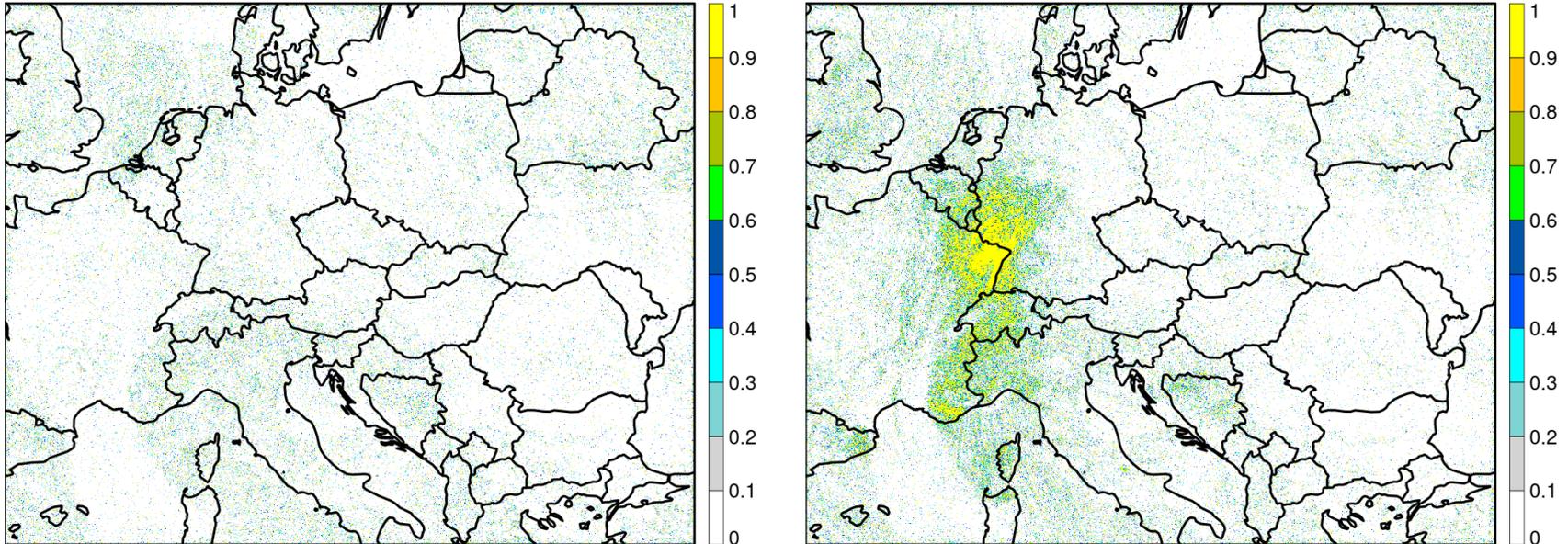
The stability characteristic at the lowest model level for a time step which will need only SI scheme and one which needs one PC iteration to stabilize the integration.

(courtesy of Alexandra Craciun)

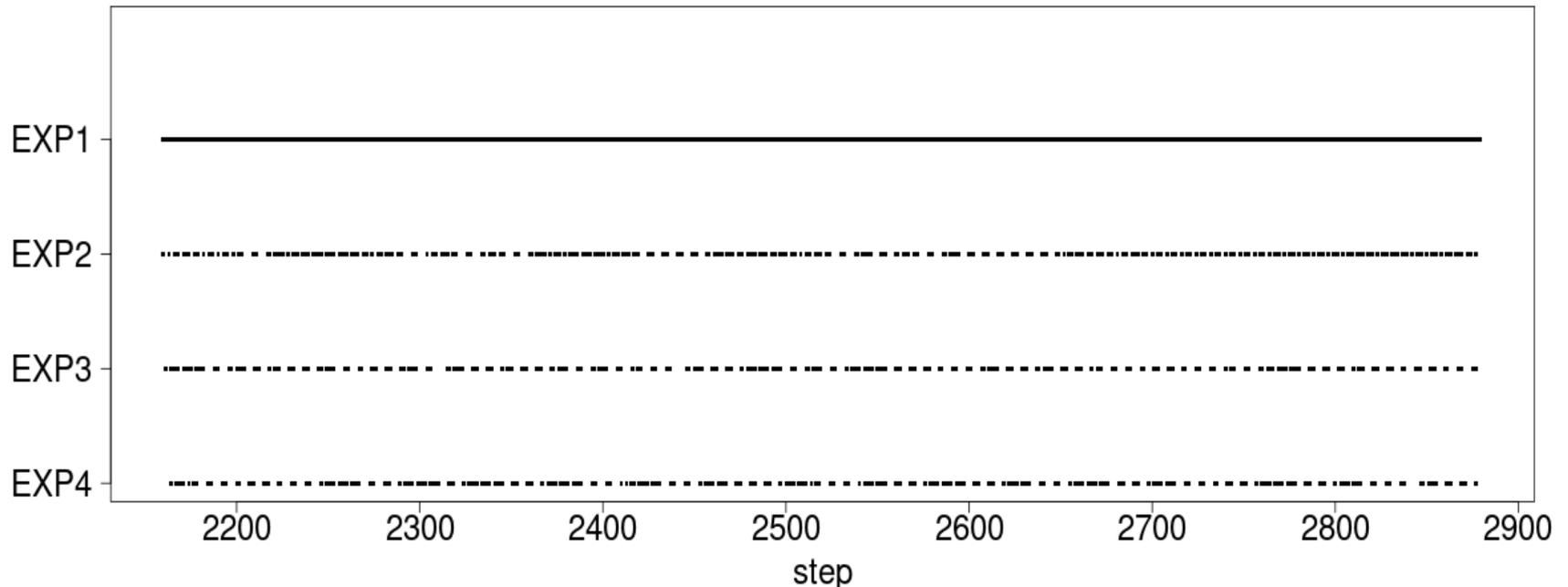# On demand time scheme

The time evolution of domain averaged spectral norms.

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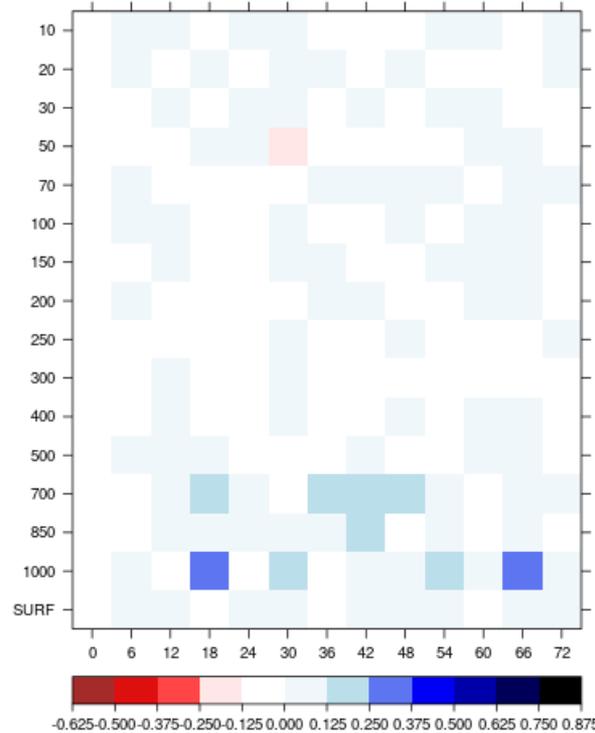
On demand time scheme

Czech operational domain and setting @ 2.325km

Scenarios of the usage of the SI scheme (white) and PC scheme (black) - more white means earlier delivery
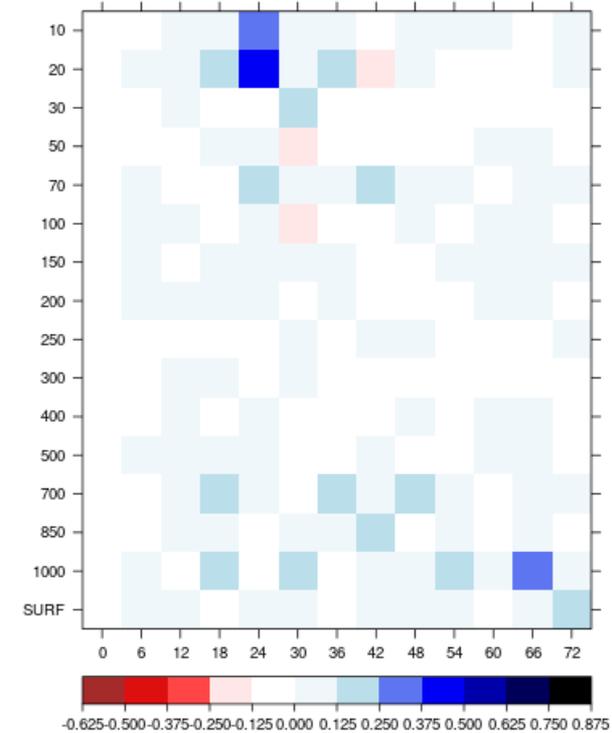
On demand time scheme

Reference PC   **NESC if needed**   **COMBINED**
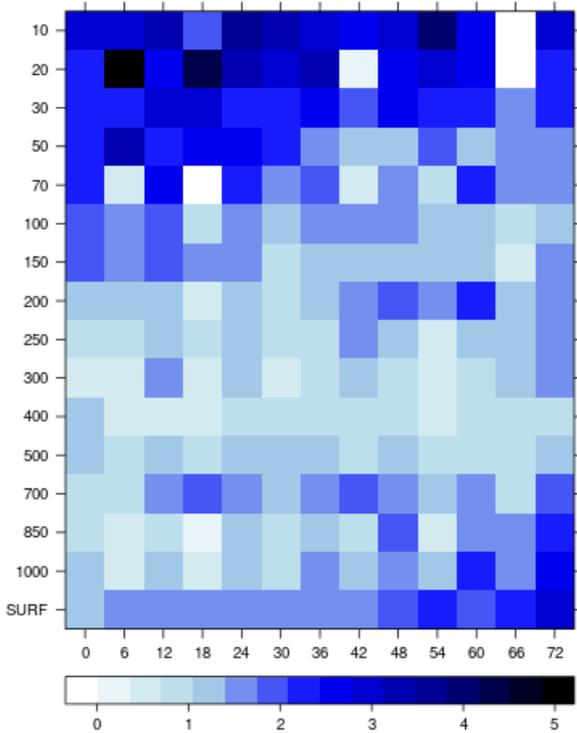
TEMPERATURE RMSE

# On demand time scheme

Conclusions

- A global stability criterion and the decision made at the beginning of each time step may lead to a stable run.

- A CPU time needed may be decreased with the dynamic choice of the time scheme with results of the comparable quality as the reference experiment (NESC+PC at each time step).

- The dynamic setting experiments cost is about 115% of the SI + SETTLS scheme experiment CPU time cost.

On demand time scheme

Future work

- longer period testing to decide weather the stability is really flow dependent (or meteorological situation dependent), or the parameters of the domain, discretization and dynamics setting are dominant

- assessing behaviour in high resolutions

Stability analysis for constant orography slope and the SI and ICI schemes.
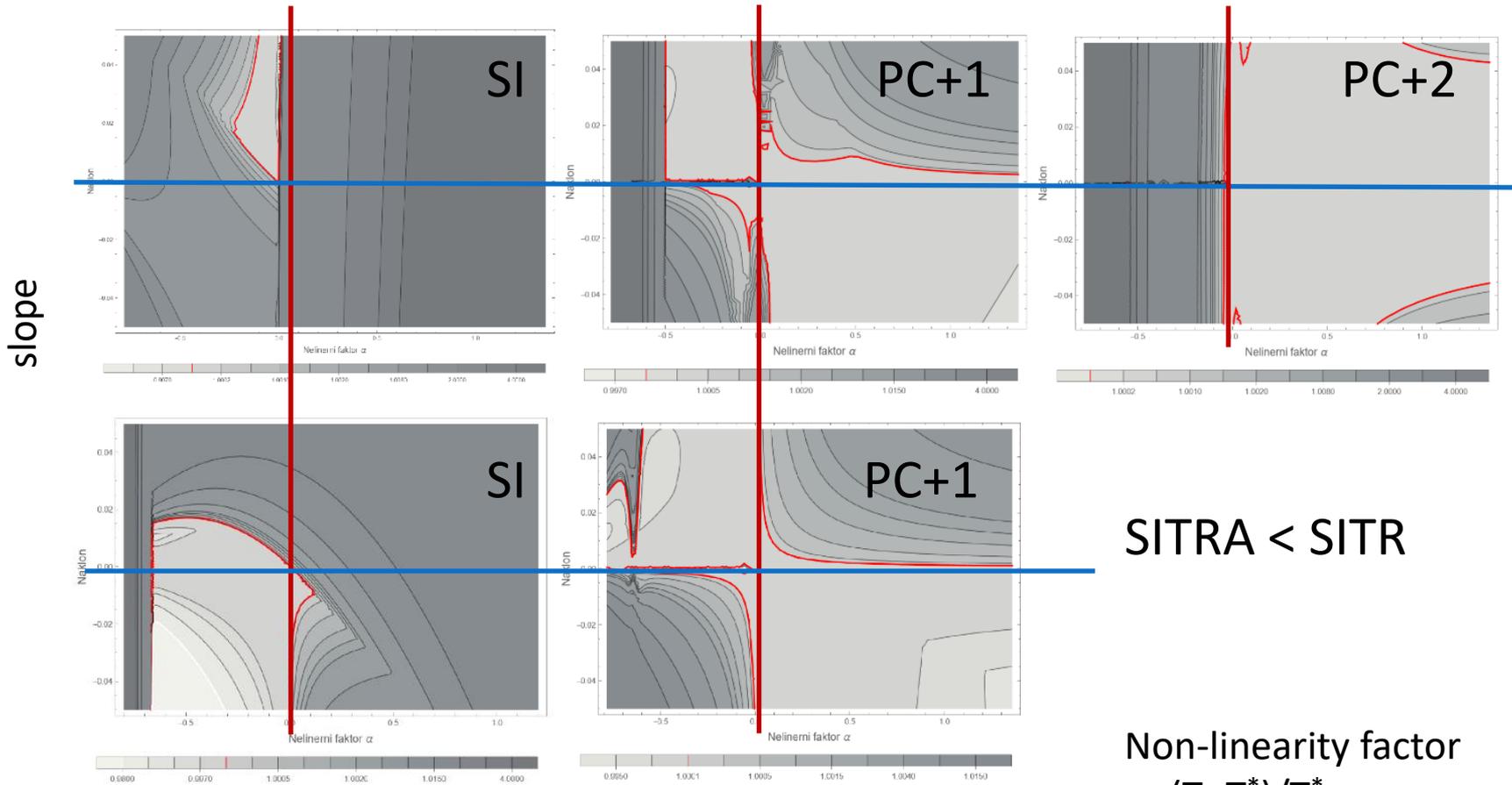
slope

SITRA < SITR

Non-linearity factor
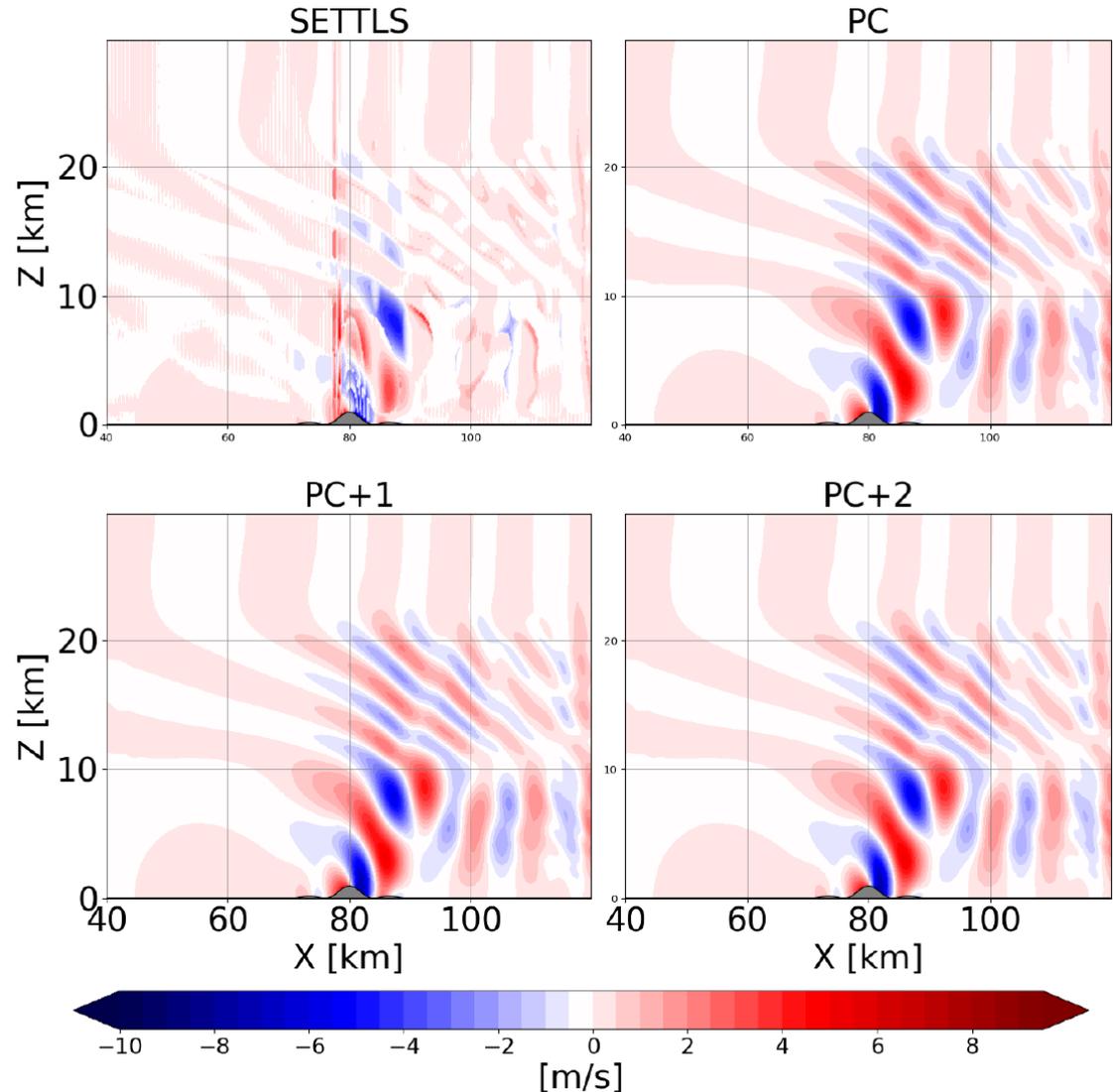$\alpha = (T - T^*)/T^*$

(courtesy of Nika Kastelec)

Stability analysis with constant slope in SI

2D Schär tests with ICI showing enhanced stability with PC and good convergence of the method.

Can be used to test the proposed hybrid scheme H-NH with controlled parameters.

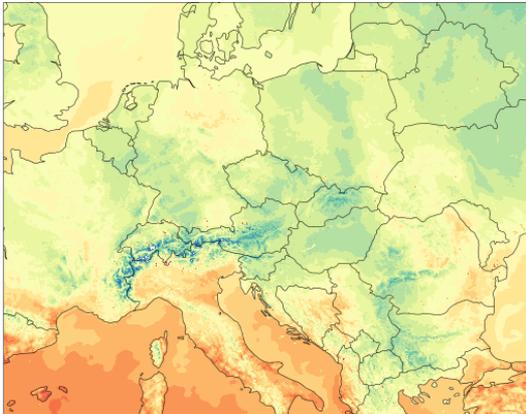(courtesy of Nika Kastelec)

Frame approach in LBCs

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?
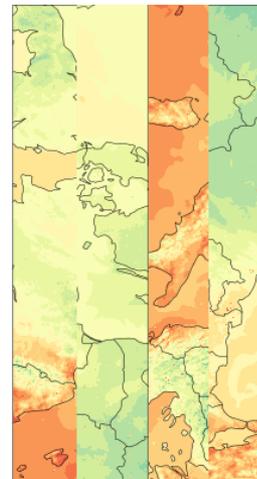
Frame approach in LBCs

- 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.

- When going to spectral space, all values (including central zone) matter.

- 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?

- Can we reconstruct the files afterwards to get coupling files in the comparable quality as the original files?
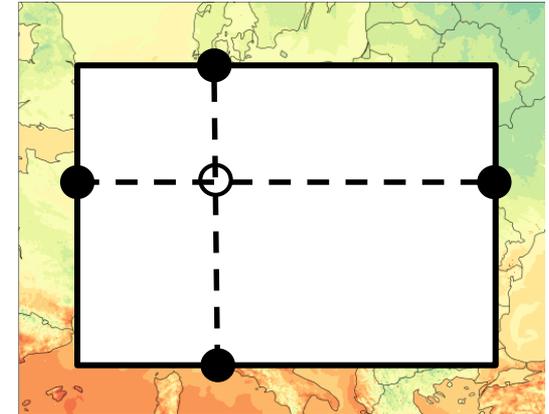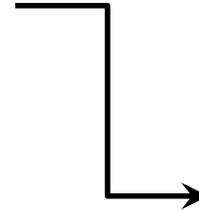
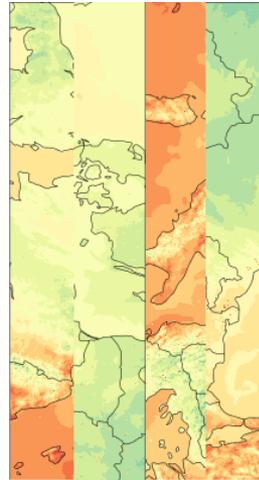# Frame approach in LBCs
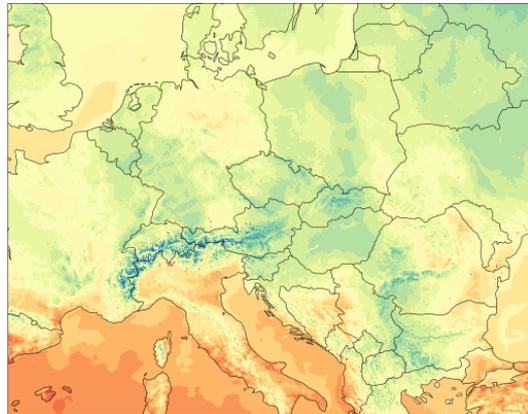
remove inner part

transform to grid
point space

compress and
transfer

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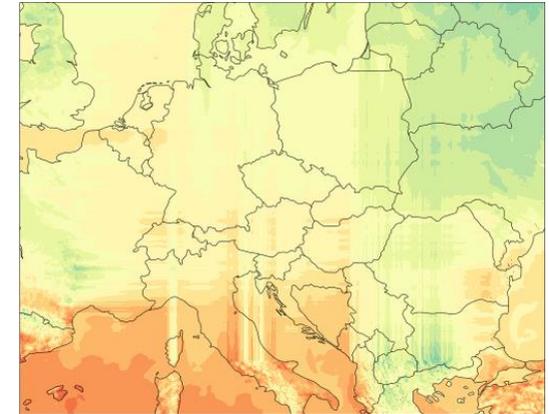
Frame approach in LBCs

Resonstruction:
decompress

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

transform to spectral
space and
compare with the
original field

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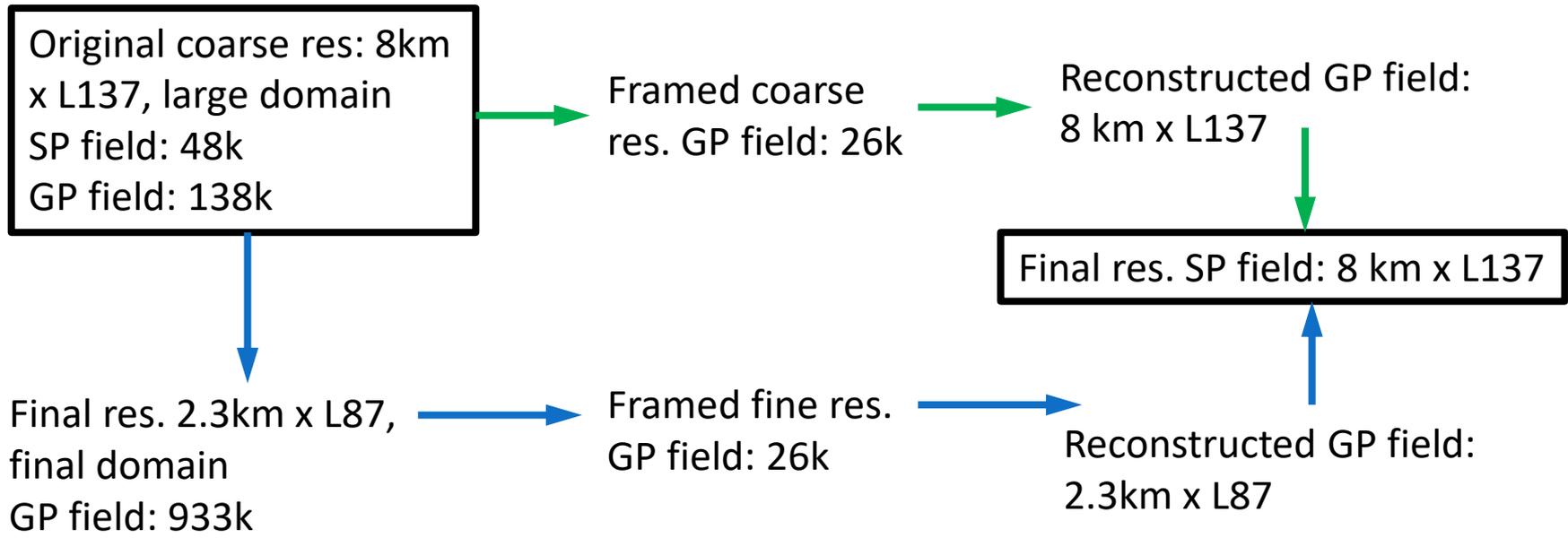
Frame approach in LBCs

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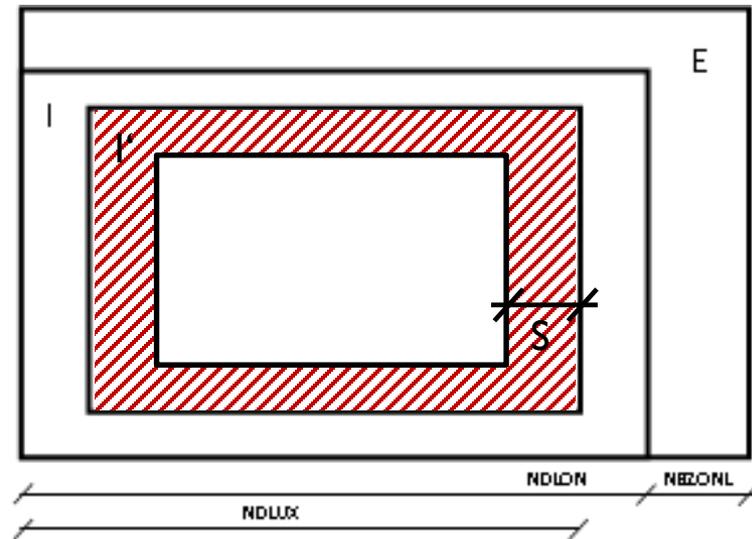
- Only upper air fields were framed since they are the subject of coupling. The other fields which are needed for physics, surface scheme or other purposes as orography, roughness etc. are kept unchanged.

Frame approach in LBCs

Original coarse res: 8km x L137, large domain
SP field: 48k
GP field: 138k

→ Framed coarse res. GP field: 26k

→ Reconstructed GP field: 8 km x L137

→ Final res. SP field: 8 km x L137

Final res. 2.3km x L87, final domain
GP field: 933k

→ Framed fine res. GP field: 26k

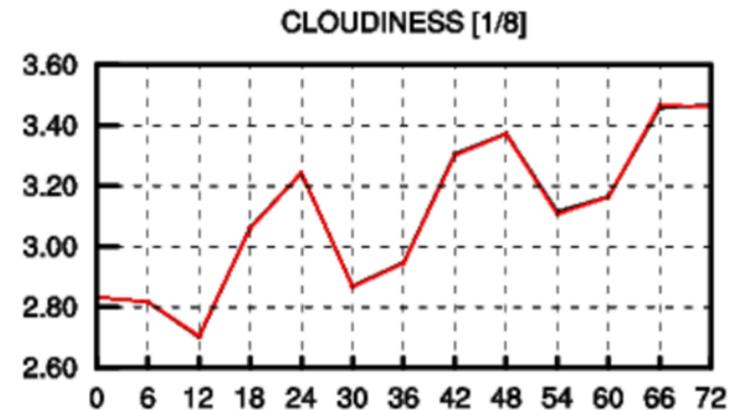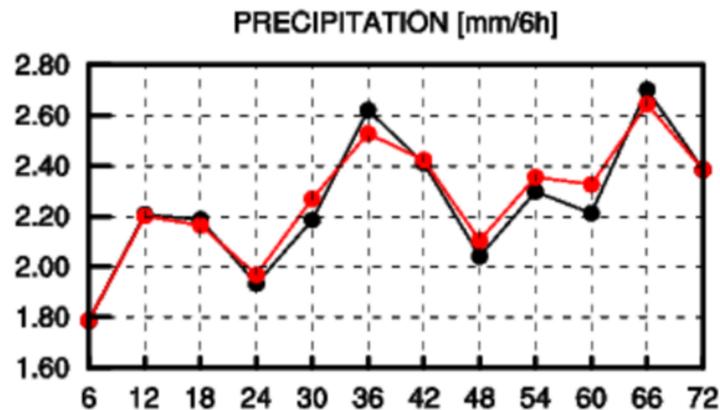→ Reconstructed GP field: 2.3km x L87

Frame approach in LBCs

Verification – both ways

A testing period (1-14 November 2021) with a low-pressure system passing through the domain, once a day 00 UTC forecasts for +72h, Czech operational basic setting and the initial files

- forecasts were evaluated point-wise against observations using objective scores (e.g. BIAS, RMSE, STDE)

- no systematic degradation of results was observed
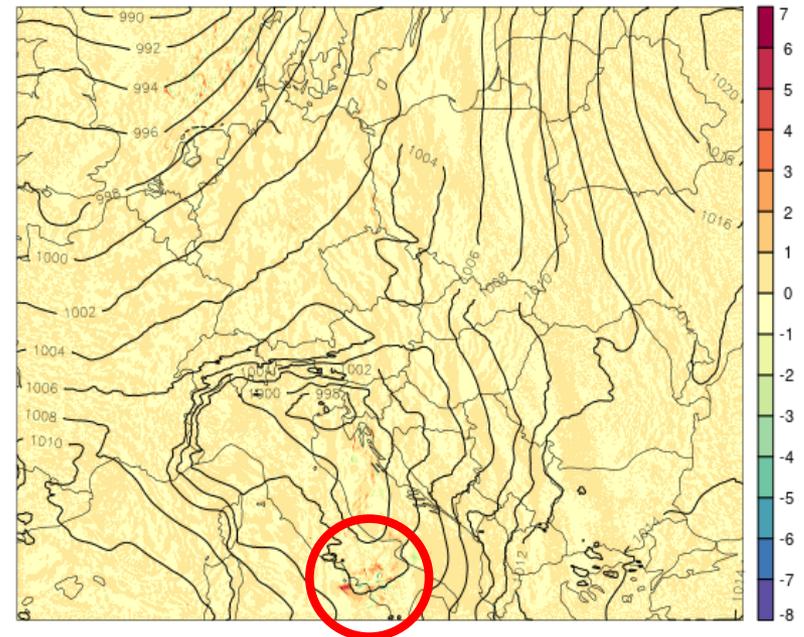

(courtesy of Gabriel Stachura)

Frame approach in LBCs

Verification

A testing period (1-14 November 2021) with a low-pressure system passing through the domain, once a day 00 UTC forecasts for +72h, Czech operational basic setting and the initial files

- locally, there were differences detected in the individual fields which were not significant, mainly in the centres of lows

(meridional wind component)

(courtesy of Gabriel Stachura)

Frame approach in LBCs

File size reduction

BLUE WAY conclusion

The file size reduction is not satisfactory.

(GP size > SP size, fine res. size > coarse res. size)

GREEN WAY conclusion

- with the packing method available in the fullpos in recent cycles (NFPGRIB=140)

- the standard gzip software (default compression level)

The file size reduction is substantial.

	input size	output size	compression [%]
NFPGRIB=140	270 336 B	122 880 B	54,5%
gzip	270 336 B	35 612 B	86,8%

But

- process of framing carried out on the side of the partner who prepares the global forecast and produces the LBC input (MF and ECMWF)

- LBCs for each domain are prepared separately

Thank you for your attention …!
Täname tähelepanu eest …!