Regional Cooperation for Limited Area Modeling in Central Europe

LACE
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Physics parametrizations developments and plans in RC LACE

Bogdan Bochenek

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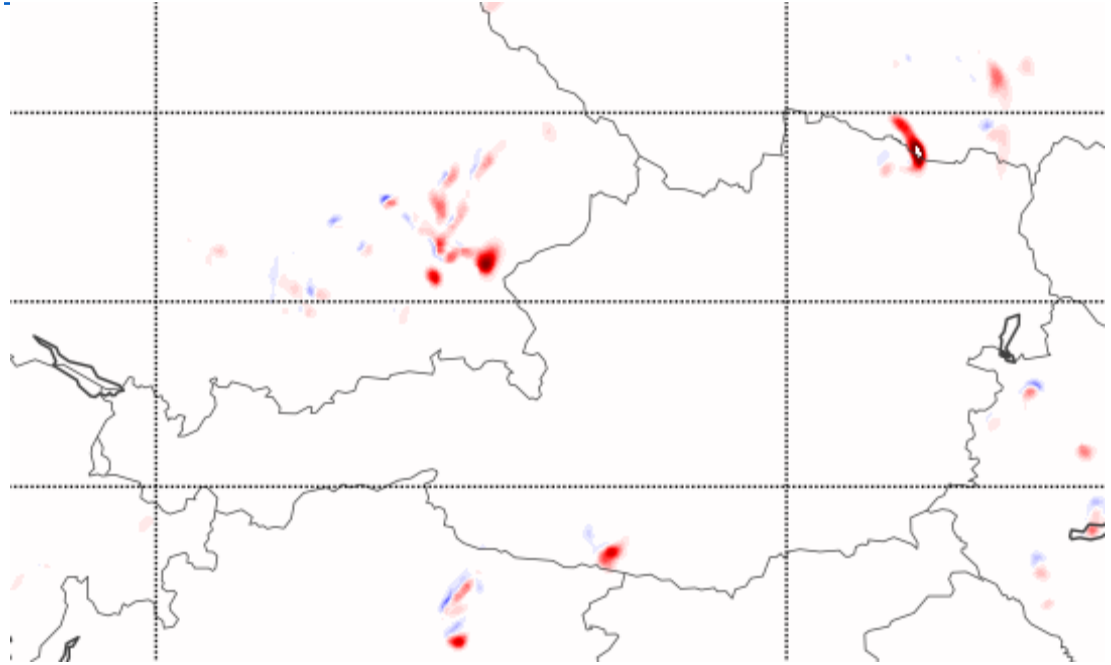
1. New fields/products
2. Interactions with Surface
3. Meetings
4. Mixing length
5. Microphysics
6. Climate modeling

Extension / Improvement of Model-Diagnostics / FPOS ZAMG

- Upraft Helicty code as new fullpos parameter
- **Prepared and (finally) accepted as contribution to CY48T2** (wittmannc_CY48T1_updraft_helicity)

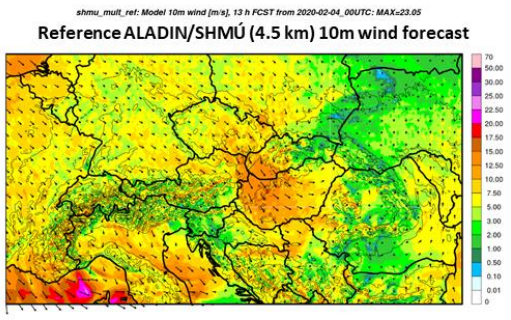


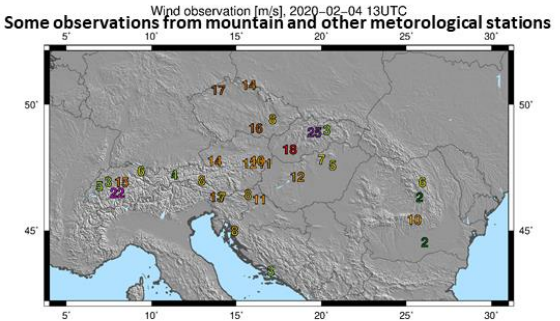
example: Updraft Helicity for superecell-case in NE Austria

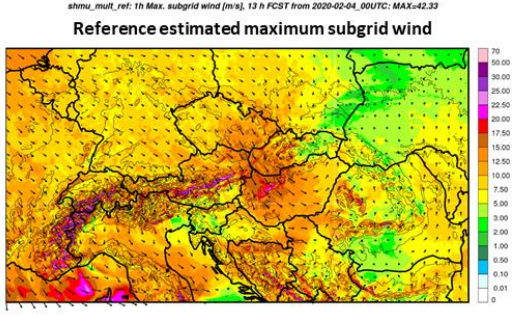
Maximum subgrid wind speed parameterization
A. Simon

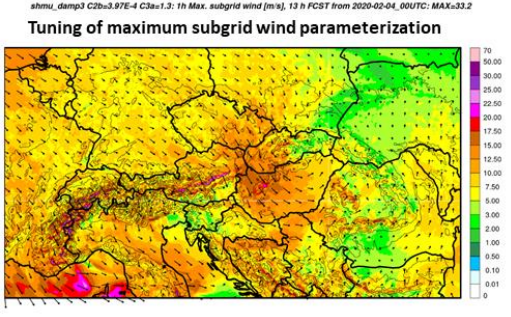
- Coded within the ALARO (ALADIN/SHMÚ) model physics, cycle cy43t2
- Preliminary tests on the ALADIN/SHMÚ domain, validation of respective parts of the code
- Plans: validation with available observations, adjustment

Parameterisation of maximum subgrid wind (Simon, Vivoda, SHMÚ):









Testing different SURFEX setups (DIFF vs. FR, nr patches, etc.) ZAMG

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- Various setups (ECOCLIMAP version, LAI, patches, …) for SURFEX tested for ½ year period

Experiment	Land cover data	LAI	Patches	Canopy	comment
CO12	ECOCLIMAP 1	Climate	1	T	=reference
CO11	ECOCLIMAP 2	Climate	1	T	
CO02	ECOCLIMAP 1	Copernicus	1	T	
CO14	LISA + UrbanAtlas	Climate	1	T	
CO33	ECOCLIMAP 2	Copernicus	1	T	
CO17	ECOCLIMAP 1	Climate	12	T	
CO08	ECOCLIMAP 1	Prognostic	12	T	
CO03	ECOCLIMAP 2	Climate	12	T	ZSFILTER=1
CO06	ECOCLIMAP 2	Climate	12	T	
CO15	ECOCLIMAP 2	Prognostic	12	T	
CO34	ECOCLIMAP 2	Prognostic	12	F	

Testing different SURFEX setups (DIFF vs. FR, nr patches, etc.) ZAMG

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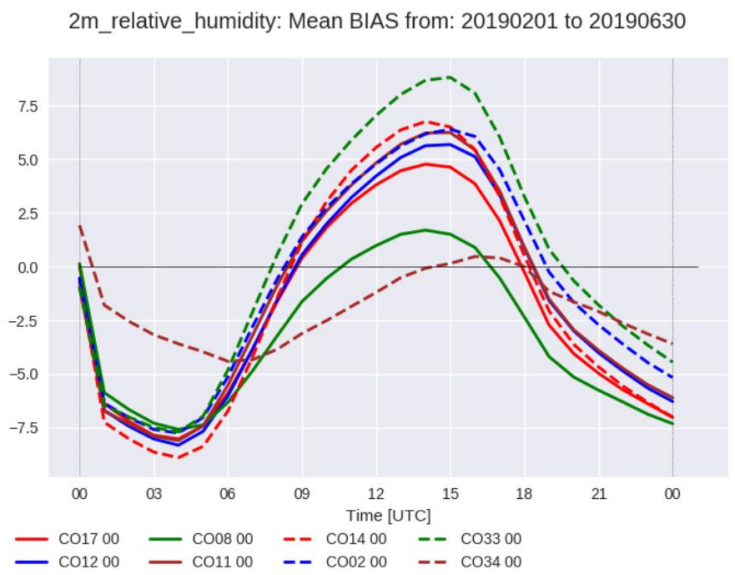
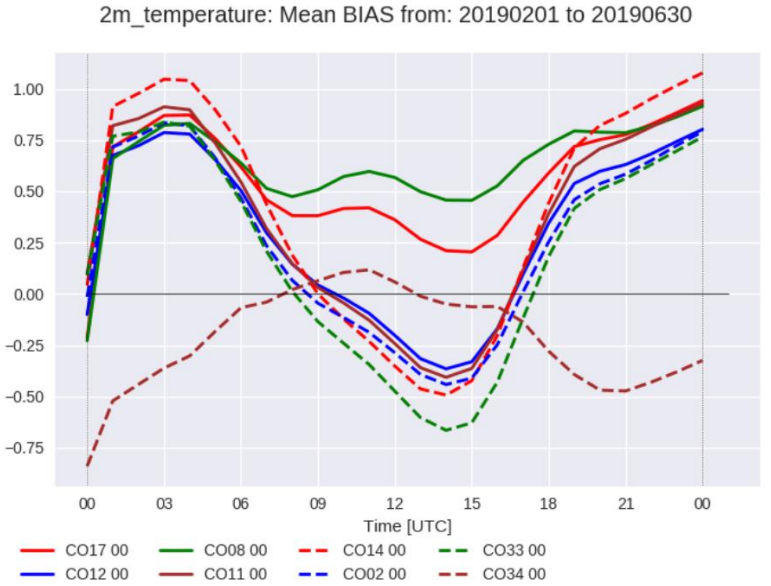
- "C012" corresponds to current operational setting in AT
- No operational change yet, but setup "C034" (= ECOLIMAP2, 12 patches, prognostic LAI, CANOPY=F) with promising results (in particular with respect to the diurnal cycle of errors)
- will be tested in one of next e-suites at ZAMG





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ALARO with SURFEX

J. Masek, R. Brozkova

- The work on ALARO with SURFEX started back in 2015–2016 by **technical preparations.**
- Since 2017, study of roughness length problem and other issues blocking **scientifically smooth transition** from ISBA to SURFEX is ongoing.
- In 2021, **SURFEX modset** with all available developments and fixes was prepared, but it is **not yet fully validated. (Modest with other developements)**
- In 2022, **additional bugs** were **found and fixed,** but the new issues arose.

- A **smooth transition** from directly called ISBA to ISBA called via SURFEX.
- Having ALARO with SURFEX, we will **benefit from better physiography.**
- **Activate and validate more advanced options** (3L ISBA, ISBA-ES, TEB, FLAKE, ORORAD, . . .). Once the target SURFEX configuration is set, **retuning of ALARO with SURFEX** can start.

ALARO with SURFEX

J. Masek, R. Brozkova

- Problem of 10m wind oscillations was caused by antifibrillation treatment applied only in atmospheric model
- TOUCANS stability functions on SURFEX side were fixed (added missing factor C3TKEFREE, removed USURIC correction)
- Inclusion of orographic roughness length as in configuration E923
- Scaling of the tree height and orographic roughness via namelist
- Printing of all &NAM SURF ATM variables into the output listing
- Some **new SURFEX namelist variables** were introduced (**&NAM SURF ATM**)
- Added treatment of undefined roughness values in flooded areas with zero fraction, blowing up D95 snow scheme
- Added missing allocations, blowing up FULLPOS-PREP
- Added missing wind shear protection
- Safe evolution of canyon temperature and humidity
- Added moist gustiness correction

ALARO with SURFEX

J. Masek, R. Brozkova

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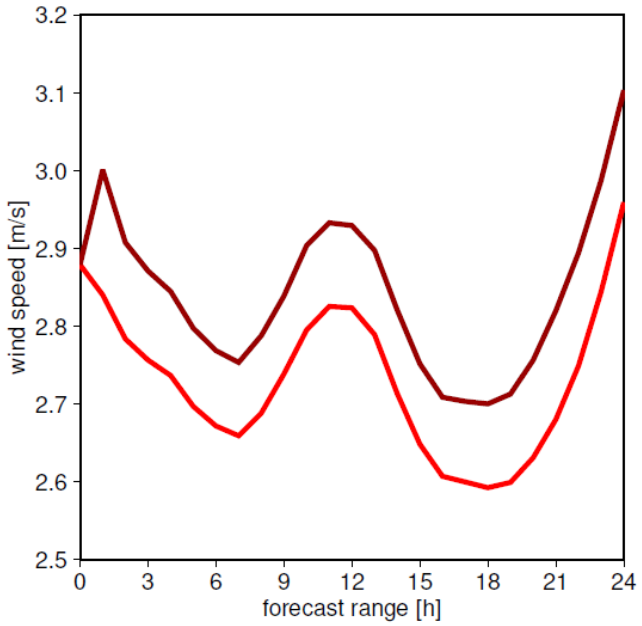
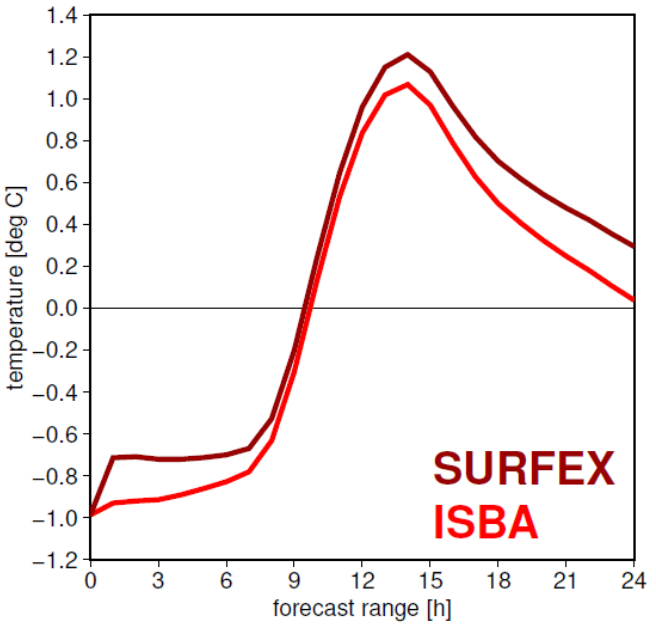
Unresolved Issues & SURFEX training

Lowest model level wind speed



Lowest model level temperature



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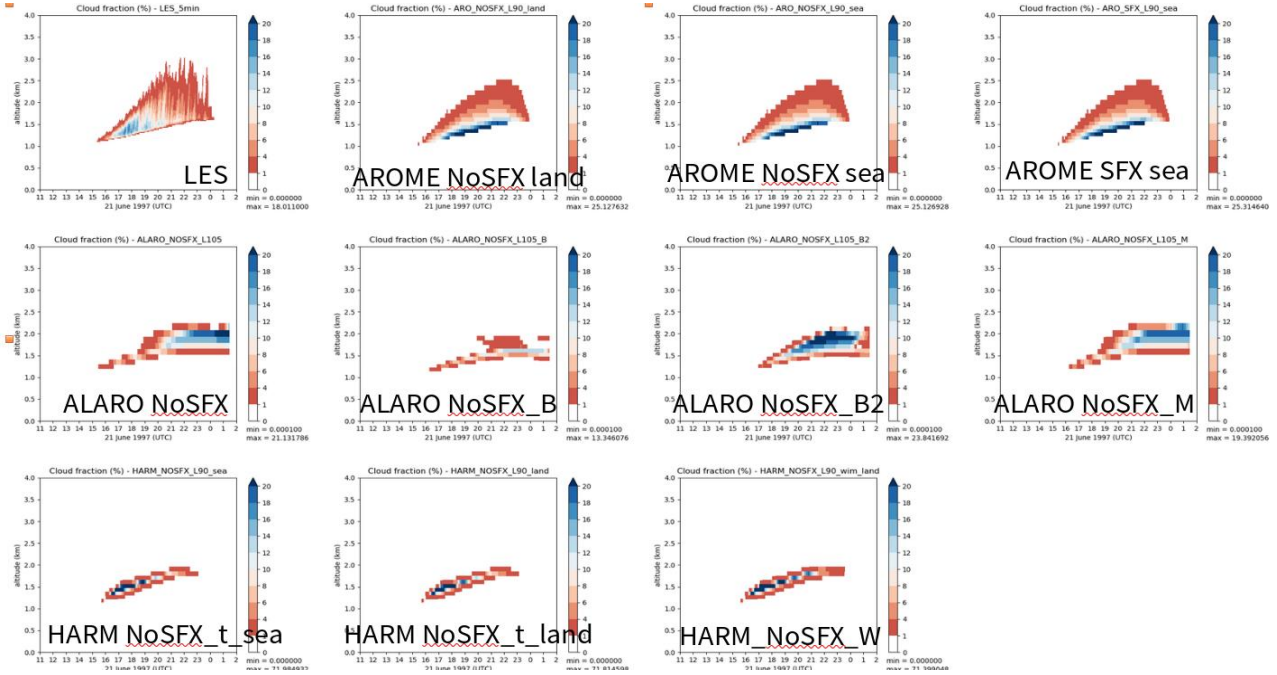
MUSC

- A working week on MUSC, the single-column ACCORD model, was arranged in **Helsinki 15-19 November 2021**.
- The aim of the workshop was to build a common platform for MUSC (Modèle Unifié, Simple Colonne) use across the consortium.
- This means, in addition to the common source code, ready-made test experiments with namelists, initial and forcing data as well as tools for preparing input and analyzing the output.
- Experiences of MUSC use for model-observation intercomparison experiments, code development and testbed applications were shared.
- The meeting was held in hybrid form, built on the agenda and materials on the wiki page https://hirlam.org/trac/wiki/Meetings/Physics/MUSCWW21. Presentations and results of the working week are available via this wiki page.
- The starting point of the working week was the ARMCu experiment without SURFEX (à la mitraillette) using prescribed surface fluxes.
- The task was to merge the modifications done in Toulouse on cy46t1_op1_MUSC and the CY46T1_bf.06++, used by Harmonie for CY46H1
- Proposed common environment/directory on belenos to share results and working experiments (at least for ALARO)

MUSC

- The graphic tool Atlas, developed by Romain Roehrig for automatic comparison with LES



TOUCANS Brainstorming

Ivan Bastak Duran, Mario Hrastinski, Peter Smerkol, Jan Masek, 6-10 June 2022, Prague

Review developments done so far and exchange information about them, and identify and discuss problems that arose during development

A plan was made to correct and finish current developments, and merge the separate developments into an improved TOUCANS scheme.

Additionally, technical aspects of TOUCANS development such as code cleaning and organization and optimal evaluation tools usage were discussed.

ALARO WD

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13-15 June 2022, Prague

Country	Participants
Belgium	Daan Degrauwe Michiel Van Ginderachter Luc Gerard
Croatia	Martina Tudor Ana Šljivić Mario Hrastinski
Czech Republic	Radmila Brožková Petra Smolíková Alena Trojáková Antonín Bučánek David Němec Ján Mašek
Germany	Ivan Bašták Ďurán
Poland	Bogdan Bochenek Piotr Sekula
Slovakia	Mária Derková Martin Dian
Slovenia	Neva Pristov Peter Smerkol
Spain	Pau Escribà

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ALARO WD

ALARO operational experiences

R&D (TOUCANS, ML, SURFEX)

ALARO 1km

ALARO in EPS

Tools (clim files, MUSC)

Code refractoring and GPU adaptation

Mixing length computation

M. Hrastinski

- Continuation of work by adopting new scaling of L_{up} and L_{down}.
- During the analysis of the autumn case with a lack of low-level cloudiness (8.11.2020.), a problem with numerical stability appeared at several points within the coupling zone.
- Reducing the VUAL value or switching-off CP helps to stabilize the model, but deteriorates its performance within the central zone and for other types of cases.
- After some attempts, the APACHE treatment within E927 was identified as an “offender”, i.e., it had to be switched-off for all variables (LESCALE=.F; not only wind).

Mixing length computation

M. Hrastinski

- When LESCALE=.T., the profile of temperature and specific humidity had sharp jump above the level 70, which caused huge buoyancy production of TKE and TKE itself.
- Ultimately, this led to increase of mixing, huge tendency due to turbulent diffusion and finally to instability.

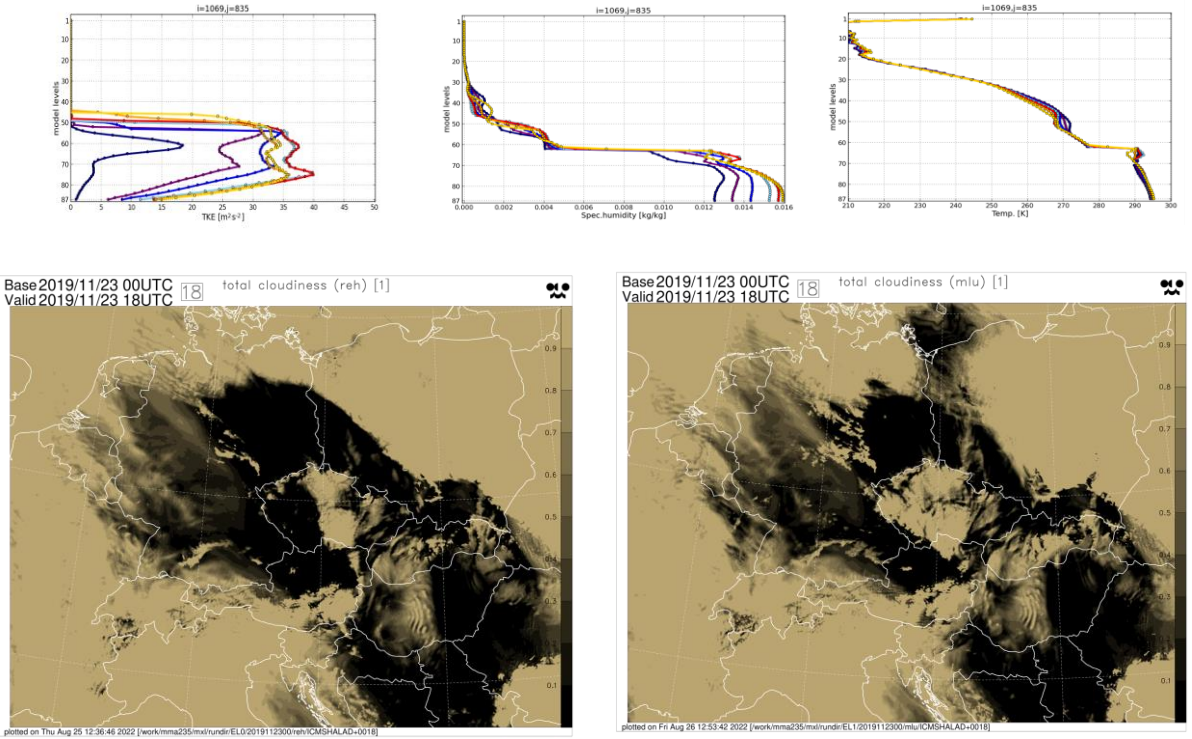


Figure 1. TKE (upper left), temperature (upper right) and specific humidity (central) in a "problematic" single point within the coupling zone (i=1069, j=835) on 8.11.2020. Outputs are produced each hour during first 6 hours of integration (legend), while "mtc" (legend) is name of the stable experiment which was stabilized by modifying VUAL value

Microphysics
D. Nemec

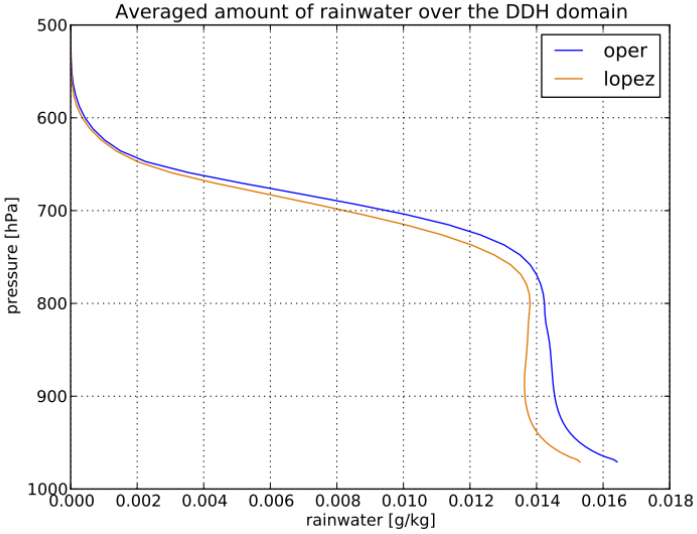
A non-linear version of autoconversion, (following proposal of Khairoutdinov and Kogan (2000) using formula dqr/dt ~ (ql)), was tested. The main aim was to reduce the overestimation of the area of light precipitation from stratocumulus in autumn. However, tests of this type of autoconversion revealed unrealistically high cloud water content in stratocumuli as a consequence of this proposal. Moreover, forecasts and scores were not improved. **Consequently, tests were stopped**.

A new method for the computation of the threshold value of cloud ice for ice-to-snow autoconversion (RQICR) following the approach from Meso-NH has been implemented. This change, together with halving the value of RAUTEFS (from 2E-03 to 1E-03), leads to better representation of cloud anvils.

Microphysics

D. Nemec

Graupel and rain using the Abel-Boutle size distribution has been implemented in the Lopez-type of evaporation, which is considered to be superior compared to the currently used Kessler-type of evaporation, since it is based on more realistic physical assumptions.



Also, too low evaporation rates of the Kessler evaporation has been reported in literature. This change leads to cooling of the lower troposphere due to higher evaporation rates. Also, it partially compensates for the positive bias of precipitation and it slightly reduces the area of light precipitation from stratocumulus, especially if the cloud base is higher. Finally, it often reduces too high maxima of accumulated precipitation in showers, which appears when prognostic graupel is used.

Prognostic graupel

D. Nemec, R. Brozkova

CHMI launched an e-suite containing the prognostic treatment of graupel, the fall speed of graupel follows the choice of the ICE3 microphysics, and finally there is a new product of flash density. The suite was launched mid February and put in operations on 10th May 2022.

Regarding the upper air scores (EU domain):

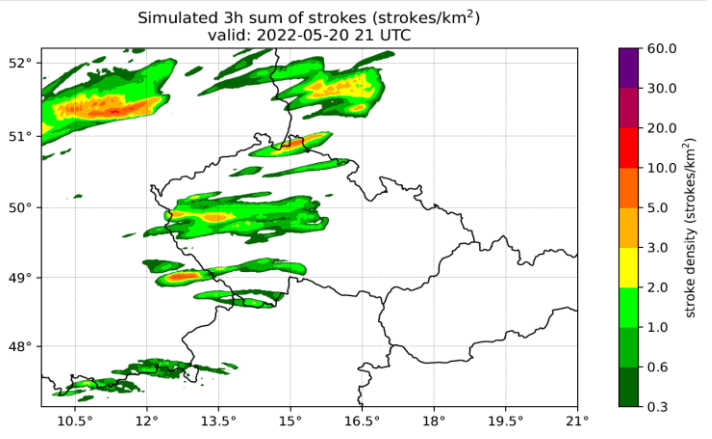
- weak signal in geopotential bias, with a bit more mass below 700 hPa and a bit less above this level
- in temperature there is a slight cooling in the troposphere with respect to the reference, which goes to the right direction
- temperature RMSE and SDEV is better in the PBL
- wind scores are neutral
- there is more moisture in the layer between 500 and 850 hPa, due to a bit higher sublimation of graupel, which goes to the right direction.

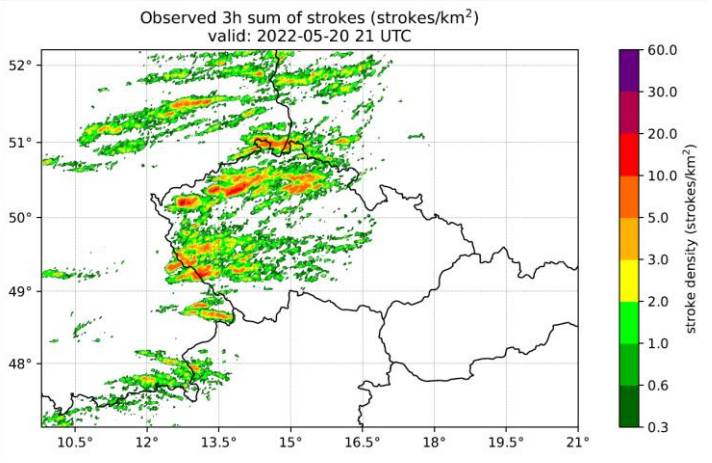
Prognostic graupel

D. Nemec, R. Brozkova

A bit higher sublimation causes a bit decreased precipitation bias (less precipitation, which is better) and the amount of cloudiness is increased a bit (also better). There is a tiny improvement in T2m and RH2m SDEV. Under winter conditions, T2m is a bit warmer, this effect is not so pronounced in spring.

There is also an impact on simulated ZMAX reflectivity. Since amount of snow gets reduced in favor of graupel, we get rid of exaggerated maxima. This is a clear improvement. On the other hand, since there is no prognostic hail, the ZMAX maxima do not reach the hail level.





Climate modeling
R. Brozkova, A. Trojakova, J. Masek

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Activities with ALARO-Climate continued at CHMI. From historical runs, moved to CMIP6 scenario SSP5-8.5 (years 2015-2100). LBC files from global model ESM2-1 were prepared for LACE telecom domain and they are available on hendrix with 6-hour frequency. SST is interpolated directly from NEMO ocean model (to avoid contamination due to SURFEX tiling in ESM2-1).

ALARO-Climate is run on CHMI operational domain with **2.3km resolution**. Time critical factor for integration turned to be hourly output of PF files. For this reason **I/O server was activated**, after ensuring that it provides bit identical results. Design of climate suite had to be adapted accordingly, performing all file manipulations outside of the integration chain.

Strengths & weaknesses of ALARO climate simulations:

+ RCM provides detailed, physically consistent description of local climate.
+ Convection permitting resolution allows for more realistic climatology of extreme precipitation events.
+ Orographic drag is well resolved by model dynamics.
+ Hourly high resolution outputs are available in-house.
– Most of physiography comes from coarse e923 datasets.
– Present day ozone/aerosols not consistent with ESM2-1.

ESM2-1 global atmospheric file:	**493 MB**
Telecom LBC file:	**12.4 MB**
High resolution LBC file:	**897 MB**
1 year of telecom LBC files:	**17.7 GB**
1 year of high resolution LBC files:	**1.20 TB**
1 year of fullpos and GRIB files:	**3.79 TB**

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Thank you for your attention.

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