LACE STAY REPORT

ZAMG, Vienna

10.07.2017 - 04.08.2017

Revision of ALADIN-LAEF multiphysics and its combination with SPPT

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Acknowledgements

I want to mention that I am a newcomer in this topic. This was my first research stay and it was an honor for me being for four weeks at ZAMG. For this I would like to express my gratitude to Mr. Yong Wang and Mr. Martin Bellus because they made possible my stay at ZAMG. I want to thank to Christoph Wittman for the patience with which he listened to me each time, for all his help and suggestions. Also, I want to thank to all the persons from ZAMG because they made my stay more comfortable. Last but not least, I want to thank to Simona Tascu for all the constructive discussions, all the support and the patience with which she helped me.

Taking into account the new findings regarding stochastic physics and the cy40t1_bf07 version, the main objective of the stay was to test this new modifications in order to analyze the impact on system's solution. This stay can be considered a continuation of Simona Tascu's last year experiments with the purpose to improve ALADIN-LAEF ensemble, with respect to multiphysics by optimizing the physics settings package. The goal is to have less number of namelists (currently, 16 namelists are used) and also to be able to combine stochastatic physics with multiphysics to obtain better results.

In the last year experiments, five versions were built by combining several physical packages. Due to the fact that ALADIN-LAEF ensemble consists of 16 members, in order to reduce the number of physics packages, a single namelist was used for four members.

The evaluation of the five versions was done for a period of two weeks, starting with 18th May 2016 to 1st of June 2016 by calculating different verification scores. For surface, the following parameters were analyzed: air temperature at 2m, mean sea level pressure, wind speed at 10m, relative humidity at 2m and cumulative precipitation in 6 hours. For the upper levels (500 and 850 hPa), the temperature, geopotential and wind speed were evaluated. Thereby, it was observed that the first version of set of multiphysics namelists (4), using only ALARO-1, has a better distribution of the members for the temperature at 500 hPa. Similar results have been obtained also for others parameters, for surface and upper levels. This version consists of combining the following settings:

		Changes
EX01	ALARO-1	-
EX55	ALARO-1	in microphysics and deep convection: LAB12=F, LCVGQM=F, LCVGQD=F, LENTCH=F, LSCMF=F, LSMGCDEV=T, LXRCDEV=F
EX57	ALARO-1	in turbulence mixing length: EL3, CGTUR=QNSE+retune, LPRGML=F
EX58	ALARO-1	in microphysics and deep convection: LAB12=F, LCVGQM=F, LCVGQD=F, LENTCH=F, LSCMF=F, LSMGCDEV=T, LXRCDEV=F, in turbulence mixing length: EL3, CGTUR=QNSE+retune, LPRGML=F

Starting with this version, during this stay, a series of experiments was performed on ECMWF's HPCE and on ZAMG computer, for the same period (18.05-01.06.2016). The boundary conditions for ALADIN-LAEF ensemble used for this experiments were obtained from ECMWF/EPS system (91 vertical levels), using GL tool (instead of 901 and e927 configurations).

EX57	members:	01	05	09	13
EX01	members:	02	06	10	14
EX55	members:	03	07	11	15
EX58	members:	04	08	12	16

Therefore, the following steps were done:

- cy40t1: bf_05 vs. bf_07
- activation of SPPT scheme
- modification of supersaturation adjustment
- case study
- technical notes regarding jobs optimization on ECMWF's HPCE

1 cy40t1: bf_05 vs. bf_07

The first step was to compare the solutions of the ALADIN-LAEF ensemble using two different MASTERODB executables (bf_05 and bf_07). For cy40t1_bf05, the experiment is called old_pureMPHYSICS and for cy40t1_bf07 is called pureMPHYSICS. The verification was performed for surface and upper levels parameters (presented above), for two weeks period.

In the next figures (Figure 1-3), different scores (eq. BIAS, RMSE and SPREAD) are presented. Some slight improvements are observed for geopotential at 850 hPa only for BIAS and RMSE score. In terms of SPREAD, the curves are the same for both experiments. For other parameters, it can be noticed that the results are the same for BIAS, RMSE and SPREAD scores. Similar results are obtained for 500 hPa level when slight improvements are obtained for geopotential (Figure 2) and for surface for MSLP parameter (Figure 3).

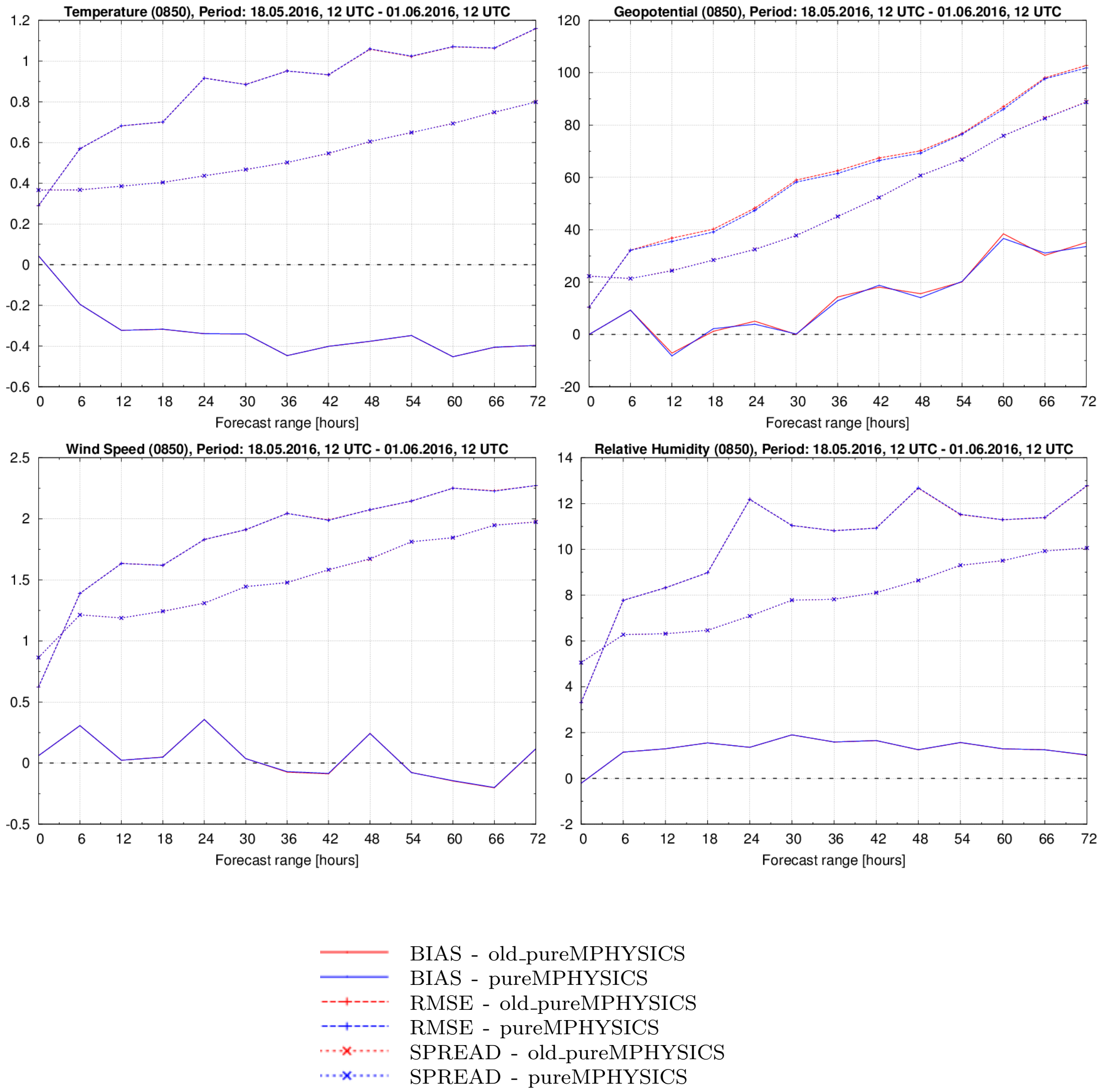

Figure 1: BIAS, RMSE and SPREAD for temperature, relative humidity, geopotential and wind speed at 850 hPa for pureMPHYSICS version and old_pureMPHYSICS version (obtained using the old binary), for 18.05-01.06.2016 period

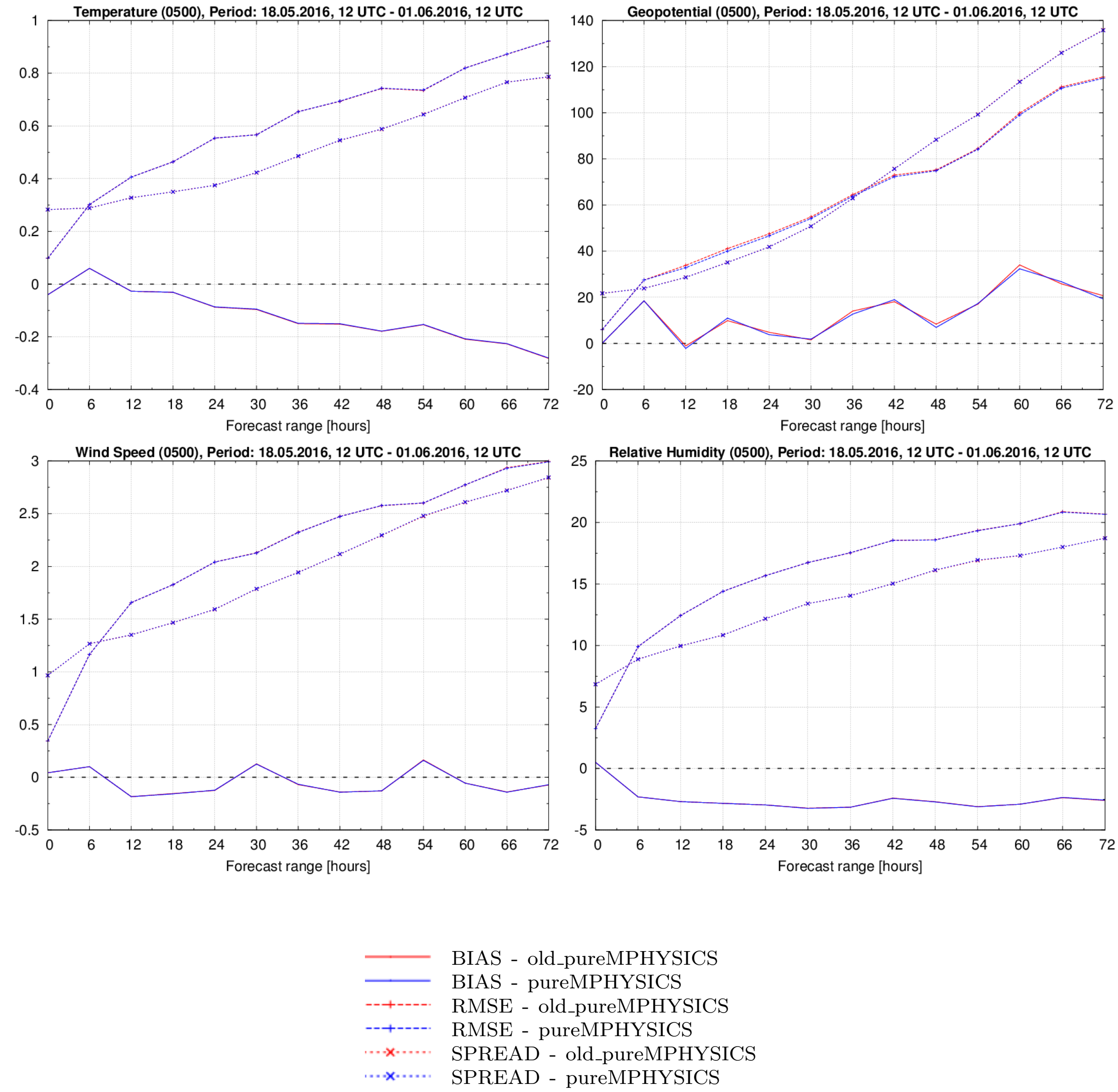

Figure 2: BIAS, RMSE and SPREAD for temperature, relative humidity, geopotential and wind speed at 500 hPa for pureMPHYSICS version and old_pureMPHYSICS version (obtained using the old binary), for 18.05-01.06.2016 period

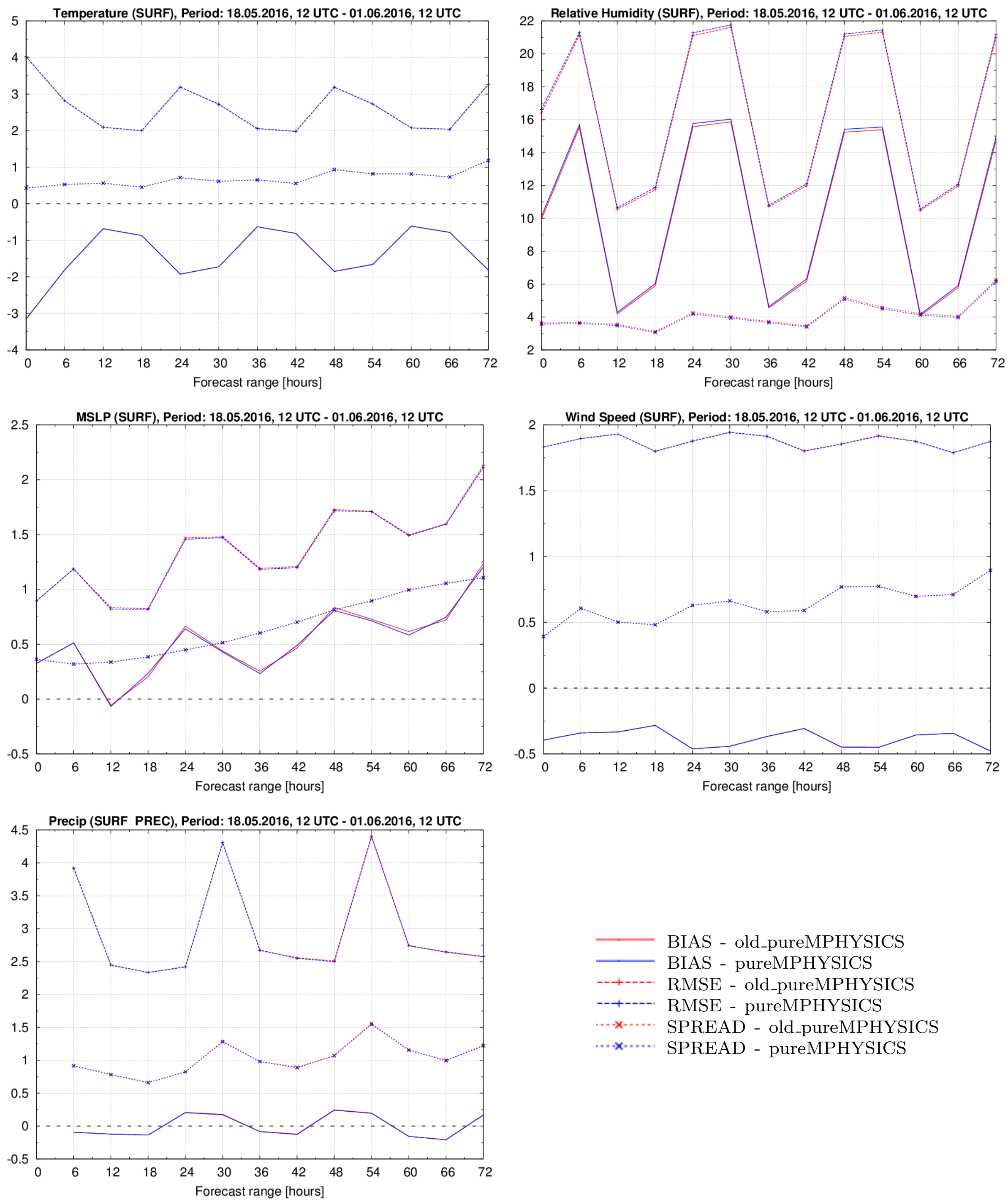

Figure 3: BIAS, RMSE and SPREAD for temperature at 2m, relative humidity at 2m, mean sea level pressure, wind speed at 10m and cumulated precipitation in 6 hours for pureMPHYSICS version and old_pureMPHYSICS version (obtained using the old binary), for 18.05-01.06.2016 period

2 Activation of SPPT scheme

The second step was to activate SPPT scheme.

The SPPT settings used for this experiments were the following:

SPPT settings
LSPSDT=.TRUE.,
TAU_SDT(1)=7200.,
XLCOR_SDT(1)=60000.,
SDEV_SDT(1)=0.5,
NSEED_SDT=RANDOM_SEED,
XCLIP_RATIO_SDT=2.0,
NQSAT_SDT=0,
LTAPER_BL0=.TRUE.,
LTAPER_ST0=.TRUE.,

In the next figures the scores BIAS, RMSE, SPREAD are presented for upper level (500 and 850 hPa) and surface, for pureMPHYSICS (red) and pureMPHYSICS+SPPT (blue) versions. For upper levels, it can be observed that for relative humidity at 850 hPa (Figure 4) and temperature at 500 hPa (Figure 5), the SPPT scheme provides some slight improvements. On the other hand, for geopotential and relative humidity at 500 hPa (Figure 5), it can be noticed a slight degradation when this scheme configuration is used.

For surface parameters, the verification results show a slight improvement for pureMPHYSICS+SPPT experiment for relative humidity at 2m and wind speed at 10m parameters (Figure 6).

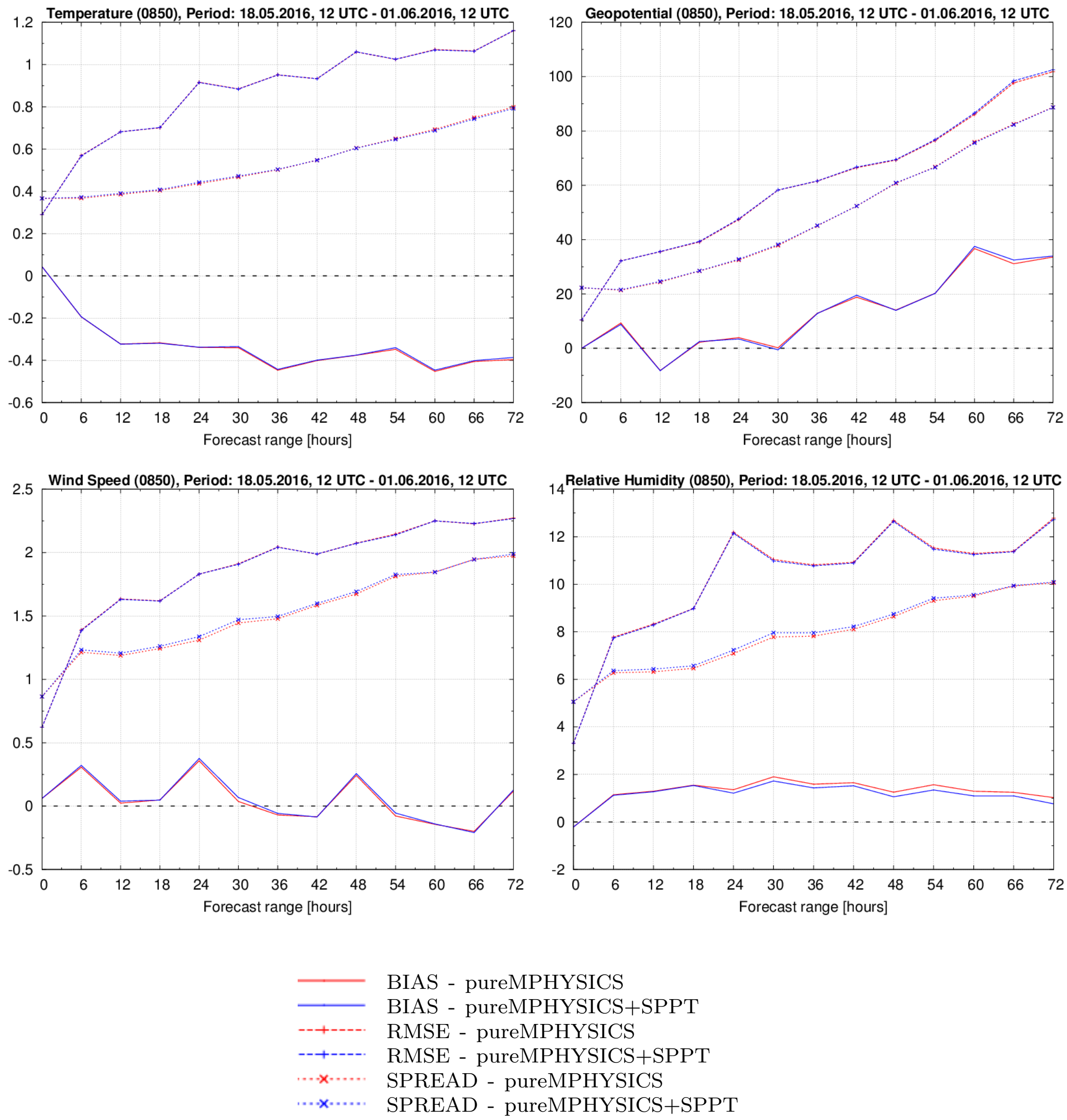

Figure 4: BIAS, RMSE and SPREAD for temperature, relative humidity, geopotential and wind speed at 850 hPa for pureMPHYSICS version and pureMPHYSICS+SPPT version, for 18.05-01.06.2016 period

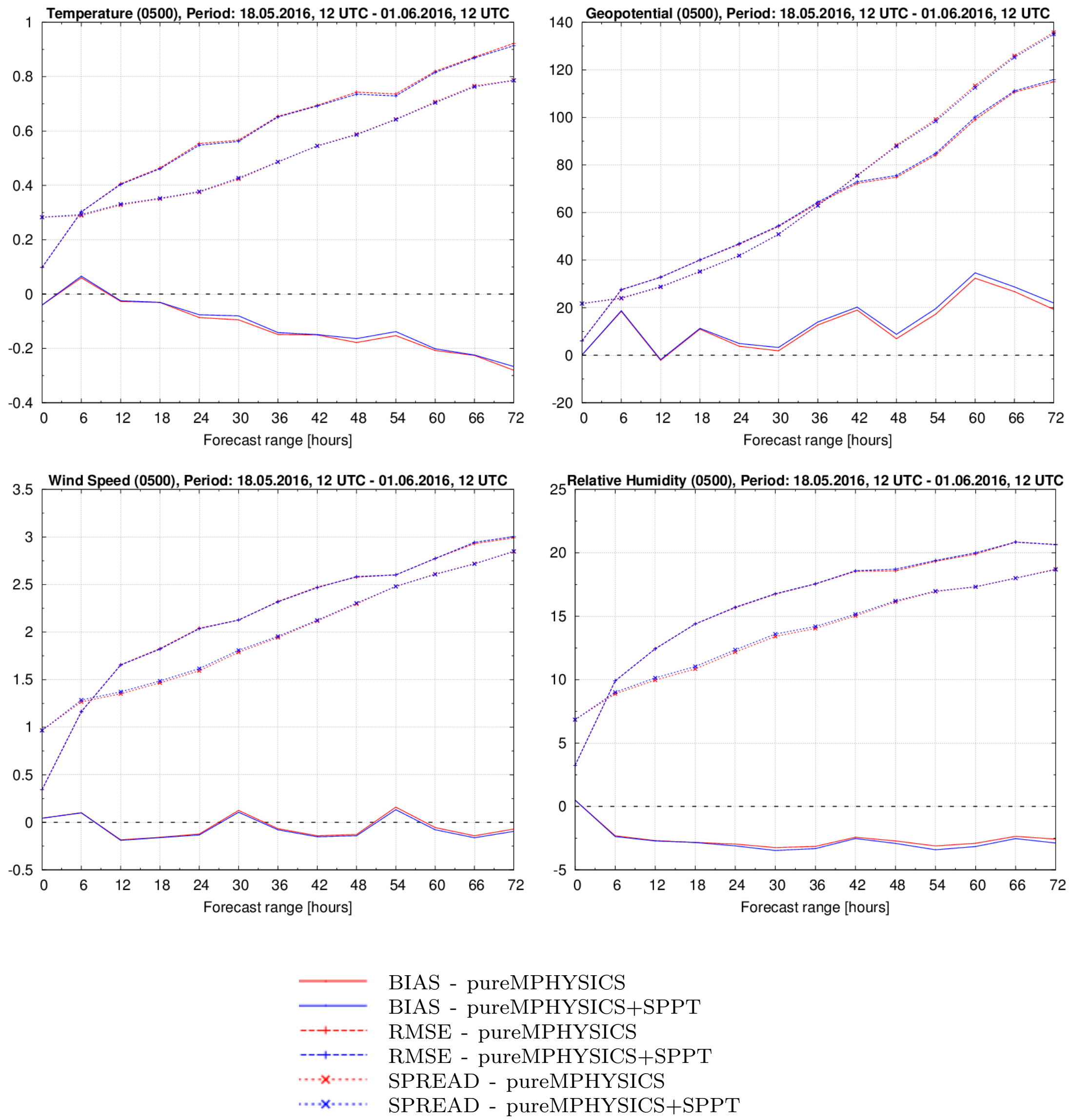

Figure 5: BIAS, RMSE and SPREAD for temperature, relative humidity, geopotential and wind speed at 500 hPa for pureMPHYSICS version and pureMPHYSICS+SPPT version, for 18.05-01.06.2016 period

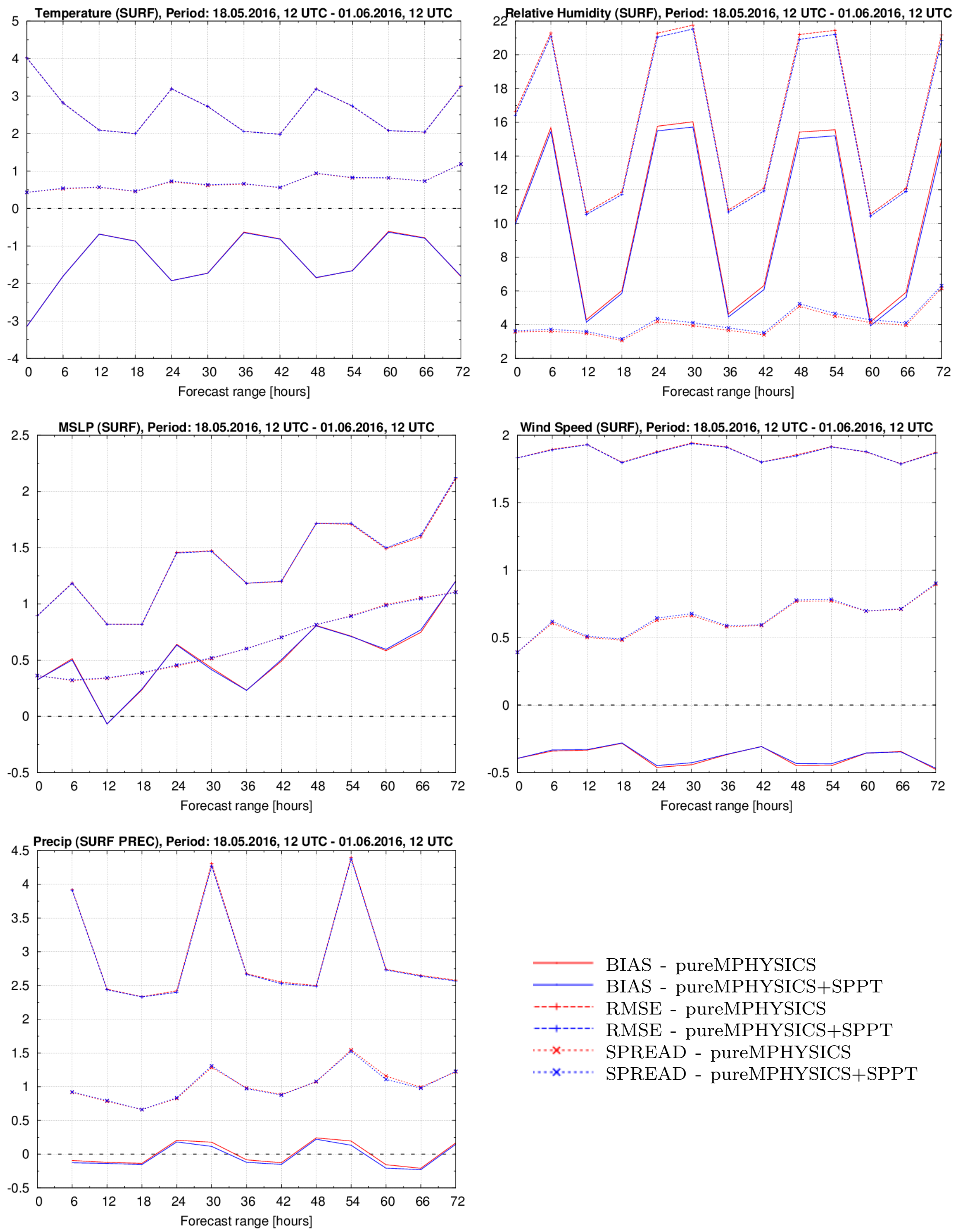

Figure 6: BIAS, RMSE and SPREAD for temperature at 2m, relative humidity at 2m, mean sea level pressure, wind speed at 10m and cumulated precipitation in 6 hours for pureMPHYSICS version and pureMPHYSICS+SPPT version, for 18.05-01.06.2016 period

3 Modification of supersaturation adjustment

Another step regarding the two weeks period analyzed, the supersaturation adjustment was changed, $NQSAT\_SDT = 3$. Theoreticaly, this additional check should affect humidity and precipitation BIAS.
In order to analyze the impact of supersaturation adjustment on the system's solution, in the next figures (Figures 7 - 9) the scores BIAS, RMSE and SPREAD are presented, for pureMPHYSICS+SPPT and pureMPHYSICS+SPPT+SuperSaturation versions. It can be observed that in this case, using this configuration, the changes are not significant.

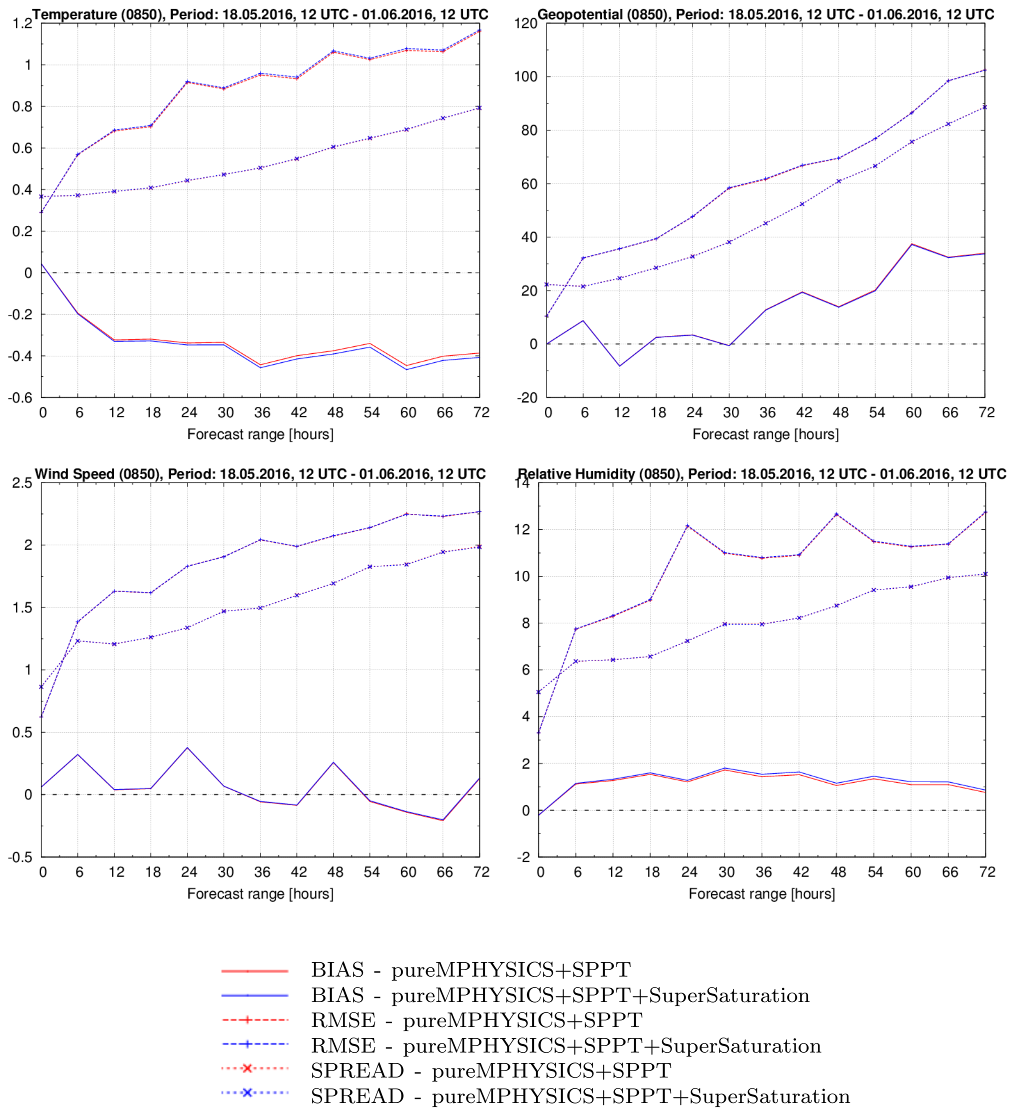

Figure 7: BIAS, RMSE and SPREAD for temperature, relative humidity, geopotential and wind speed at 850 hPa mean se for pureMPHYSICS+SPPT version and pureMPHYSICS+SPPT+SuperSaturation version, for 18.05-01.06.2016 period

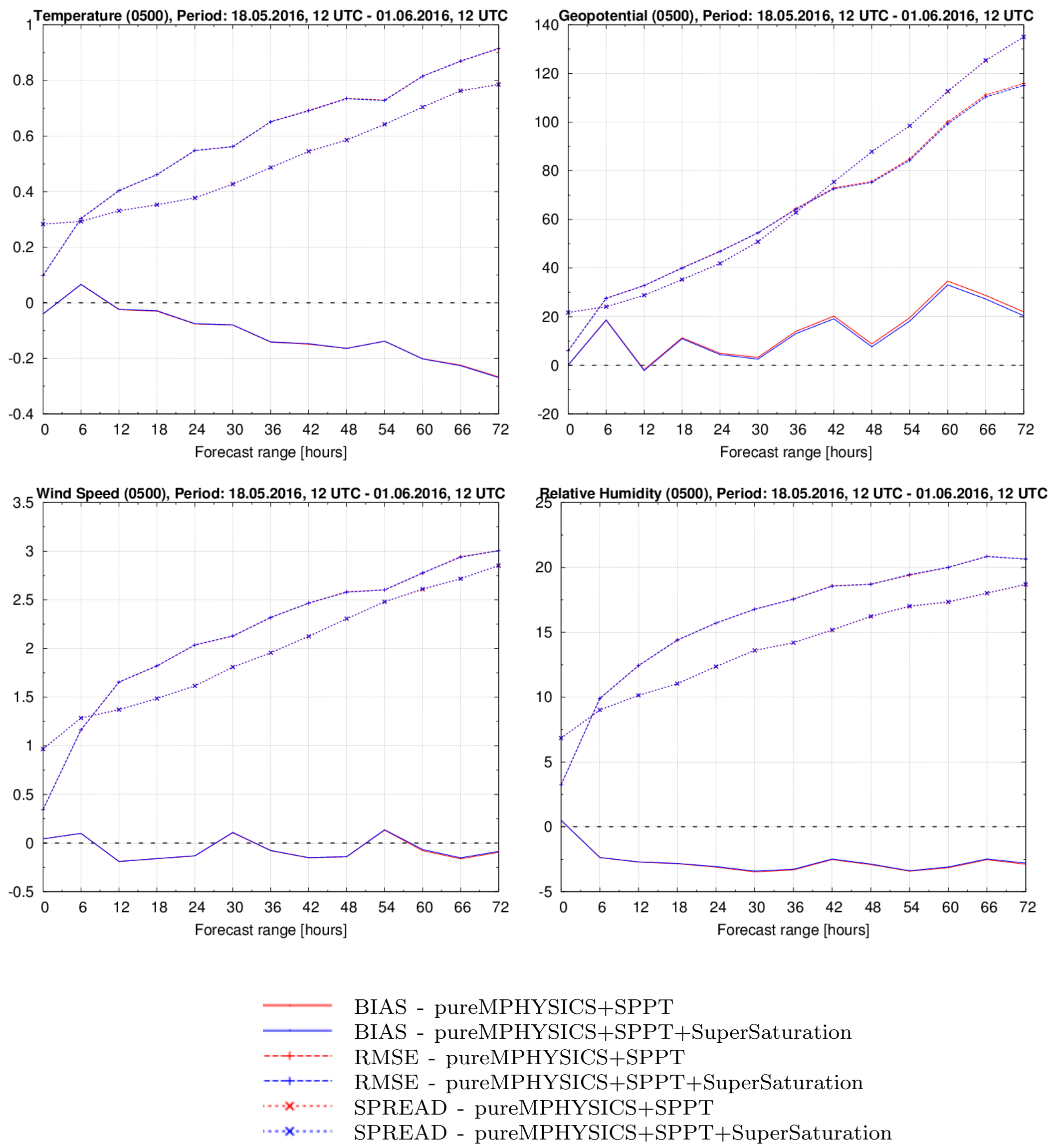

Figure 8: BIAS, RMSE and SPREAD for temperature, relative humidity, geopotential and wind speed at 500 hPa for pureMPHYSICS+SPPT version and pureMPHYSICS+SPPT+SuperSaturation version, for 18.05-01.06.2016 period

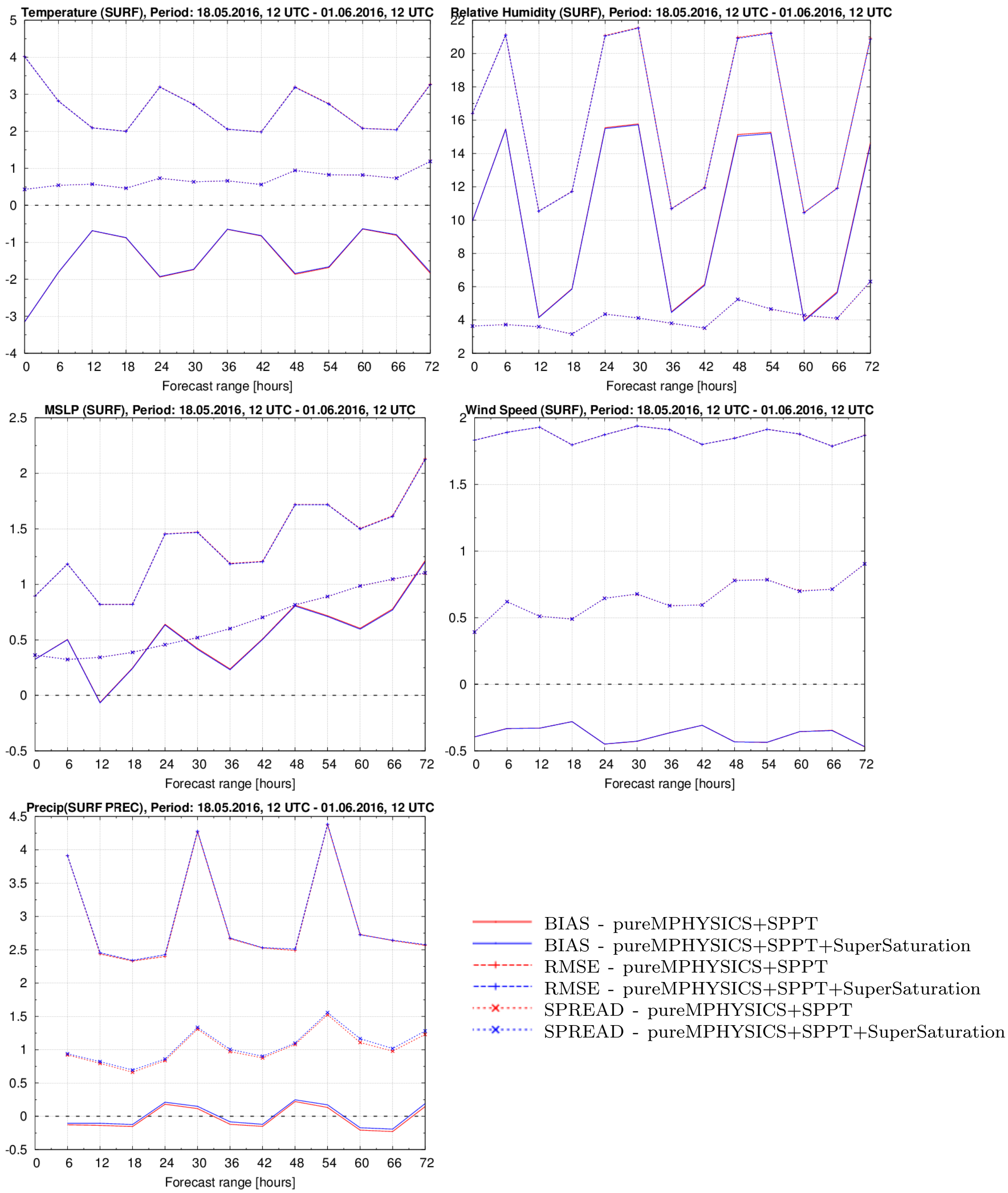

Figure 9: BIAS, RMSE and SPREAD for temperature at 2m, relative humidity at 2m, mean sea level pressure, wind speed at 10m and cumulated precipitation in 6 hours for pureMPHYSICS+SPPT version and pureMPHYSICS+SPPT+SuperSaturation version, for 18.05-01.06.2016 period

4 Case study (31th of May 2016)

In the second part of the stay, in order to investigate the impact of each configuration on the system's solution, a local flash flood event was analyzed, when the amount of precipitation exceeded 100 mm in 24 hours in specific area over Austria (Figure 10).

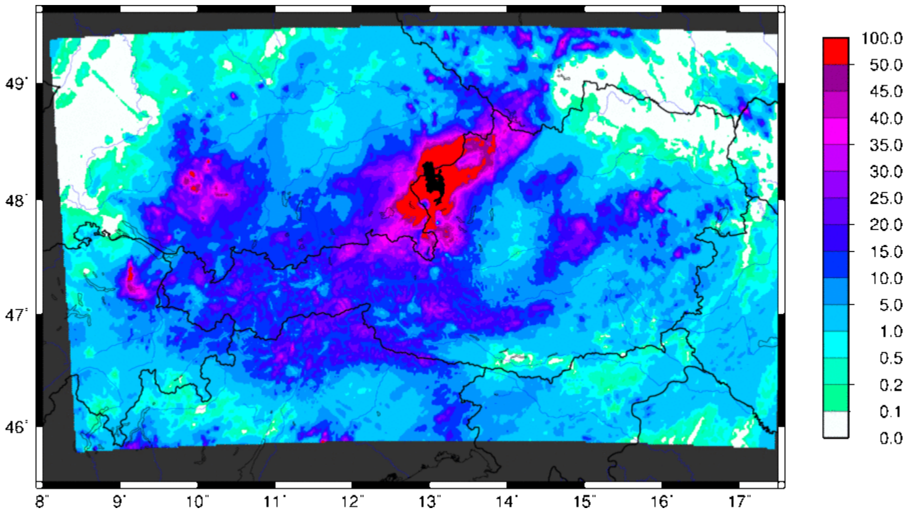

Figure 10: INCA analysis, 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

For this case, four experiments using only the 16th member solution were built, each experiment consisting of four members. The same boundary conditions were used for all of them. The next four tables contain a schematic description of these experiments:

pureMPHYSICS
Member 16 Boundery conditions: member 01
1. namelist 57 2. namelist 01 3. namelist 55 4. namelist 58

pureSPPT
Member 16 Boundery conditions: member 01
1. namelist 01 - NSEED_SDT=10 2. namelist 01 - NSEED_SDT=100 3. namelist 01 - NSEED_SDT=1000 4. namelist 01 - NSEED_SDT=10000

pureMPHYSICS+SPPT
Member 16
Boundery conditions: member 01
1. namelist 57 with activated SPPT
NSEED_SDT=100
2. namelist 01 with activated SPPT
NSEED_SDT=100000
3. namelist 55 with activated SPPT
NSEED_SDT=1000
4. namelist 58 with activated SPPT
NSEED_SDT=10000

pureMPHYSICS+SPPT+SuperSaturation
Member 16
Boundery conditions: member 01
1. namelist 57 with activated SPPT
NSEED_SDT=100, NQSAT_SDT=3
2. namelist 01 with activated SPPT
NSEED_SDT=100000, NQSAT_SDT=3
3. namelist 55 with activated SPPT
NSEED_SDT=1000, NQSAT_SDT=3
4. namelist 58 with activated SPPT
NSEED_SDT=10000, NQSAT_SDT=3

The following figures show the forecasts of the four versions (pureMPHYSICS, pure-SPPT, pureMPHYSICS+SPPT, pureMPHYSICS+SPPT+SuperSaturation) for precipitation cumulated in 24h, 31.05 12 UTC - 01.06.2016 12 UTC.

In Figure 11, it can be observed that the changes in turbulence mixing length (namelist 57) generate a local increase (NW of Austria) of rainfall quantities, comparing with the reference (namelist 01, left-up).

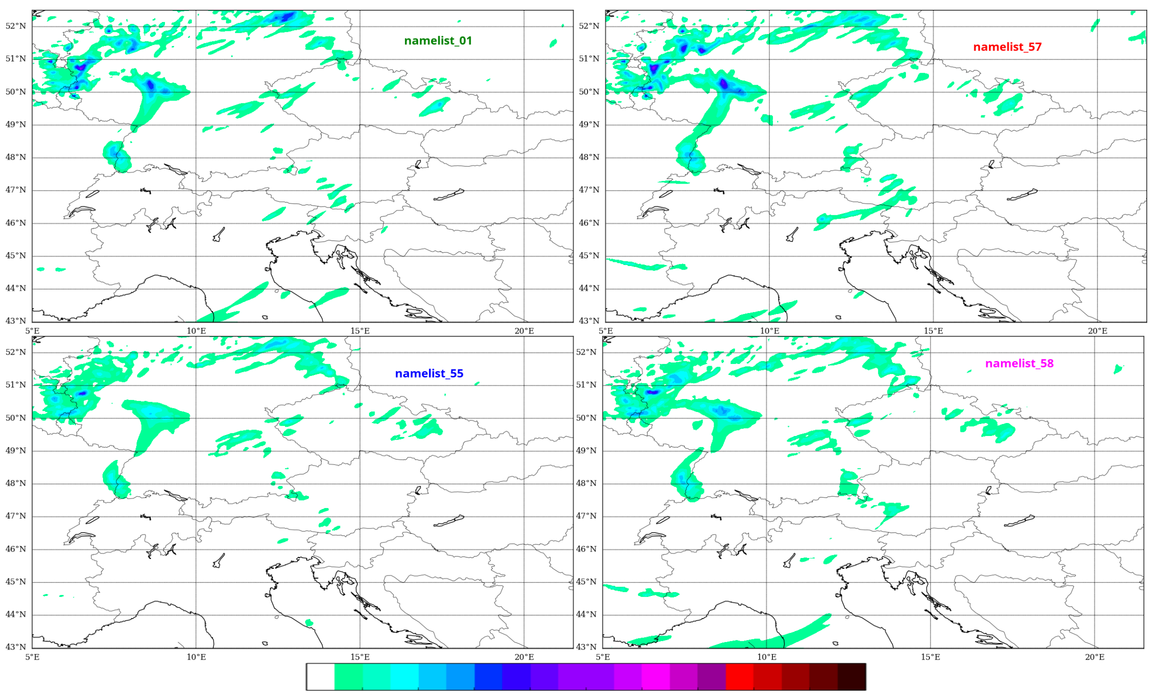

Figure 11: ALADIN-LAEF ensemble forecast, pureMPHYSICS version, 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

Figure 12 shows the impact of NSEED_SDT value on system's solution. When NSEED_SDT=1000 option is used, the rainfall quantities for some local areas.

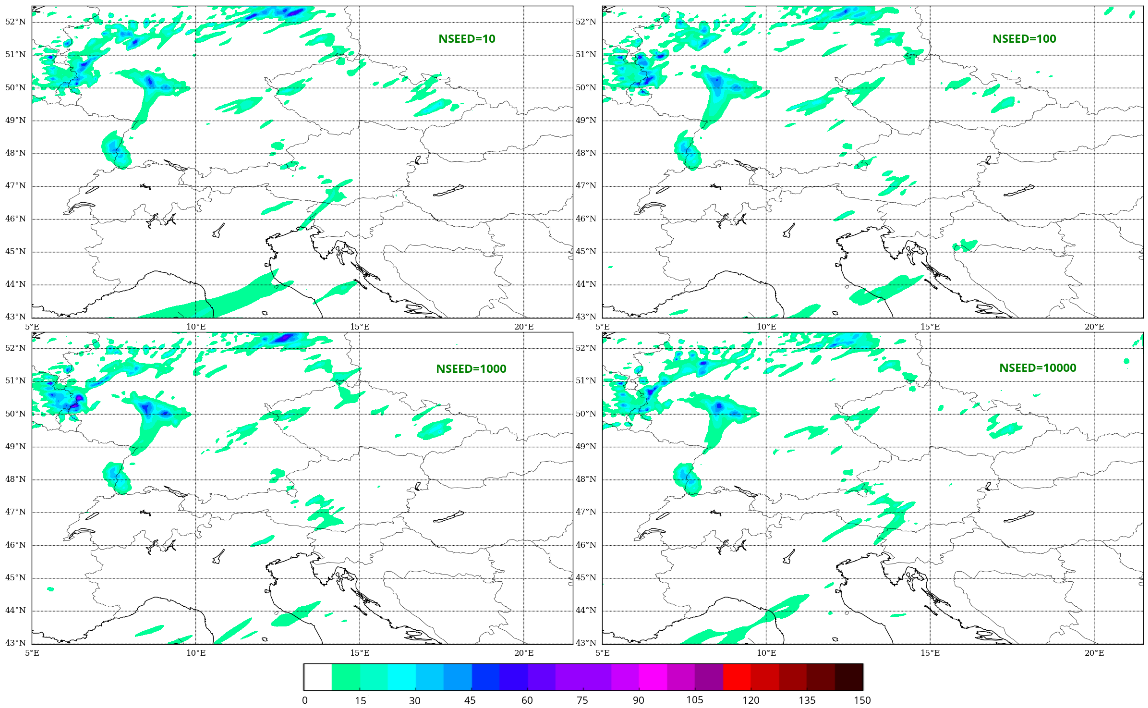

Figure 12: ALADIN-LAEF ensemble forecast, pureSPPT version, 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

The next two figures (Figure 13 and Figure 14) present the ALADIN-LAEF system's solution with activated SPPT scheme and 'supersaturation check'. Theoreticaly, this additional check affects the humidity and precipitation fields. Comparing this figures, it can be observed there are no significant changes in the precipitation field. More results can be found in Appendix.

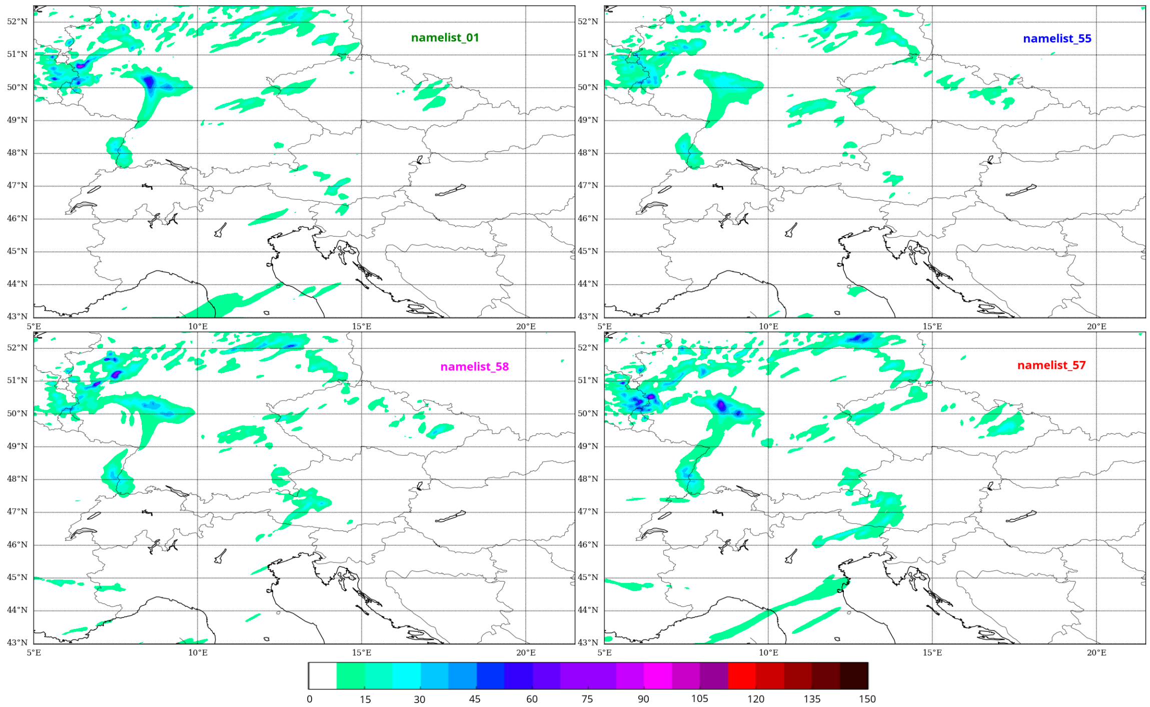

Figure 13: ALADIN-LAEF ensemble forecast, pureMPHYSICS+SPPT version, 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

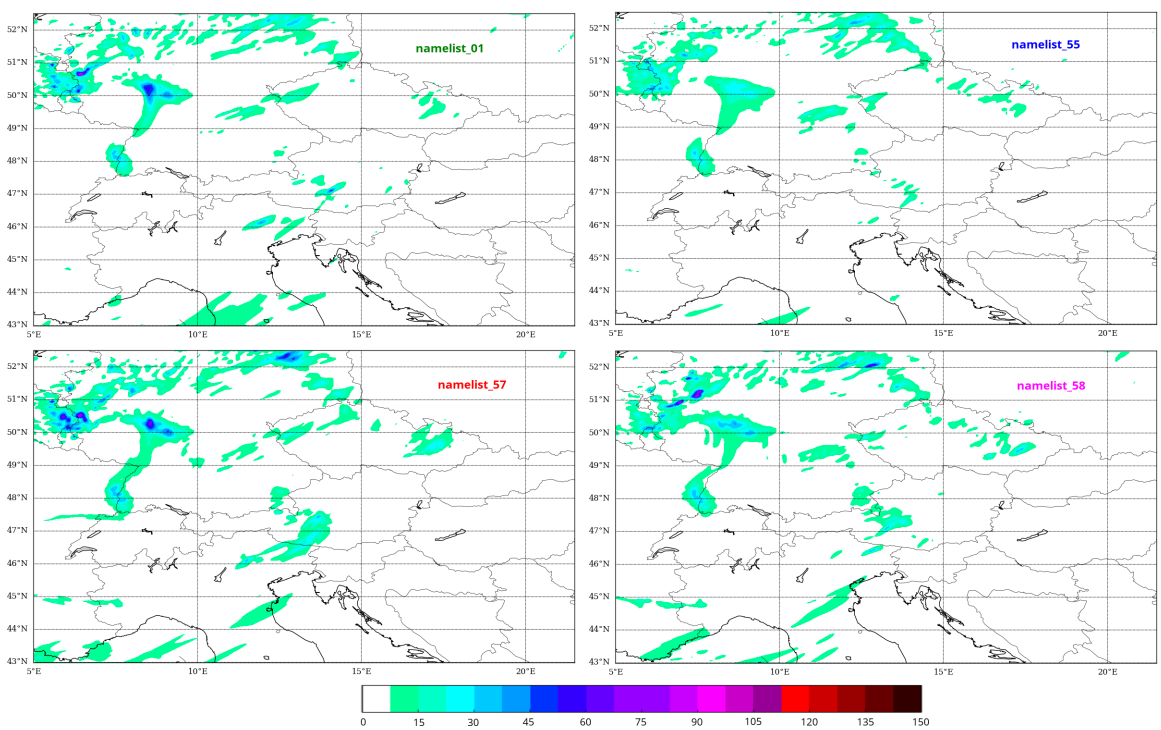

Figure 14: ALADIN-LAEF ensemble forecast, pureMPHYSICS+SPPT+SuperSaturation version, 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

5 Technical notes regarding jobs optimization on ECMWF's HPCE

Regarding the technical part, I would like to thank to Simona Tascu and to Christoph Wittman for all their help.

During offline FULLPOS procedure, some problems appeared regarding job class on ECMWF's HPC. In order to optimize the running time and the used SBU units, some configurations which define the geometry of the jobs were tested. The first configuration was the following:

The geometry of the jobs
#PBS -S /bin/bash
#PBS -q ns
#PBS -V
#PBS -m a
#PBS -l EC_total_tasks=1
#PBS -l EC_hyperthreads=1
#PBS -l EC_threads_per_task=1
#PBS -l EC_ecfs=1
#PBS -l walltime=02:30:00
#PBS -j oe

Using this configuration for more experiments for short time, this job started to be temporarily suspended. The problem appeared because by default memory is set to 1 GB and the fullpos job running in sequential queue (ns) was using much more memory, 26 GB.

To solve this problem the sequential queue (ns) was changed with fractional queue (nf) and the total number of tasks requested was set to 9. Also, the memory required by every task was defined by using PBS directive:

#PBS -l EC_memory_per_task = 8GB

Also, there is one thing that I must to mention. For the case study, the precipitation field was plotted using EPYGRAM tool. It was observed that this tool is not compatible with the new format of FA frames. Therefore, NCADFORM value was changed to 0 (NCADFORM=0).

Conclusions

- cy40t1bf_07 has not a significant impact on the ensemble forecasts;
- the SPPT scheme provides a slight improvement only for some parameters (relative humidity at 850 hPa, temperature at 500 hPa, relative humidity at 2m and wind speed at 10m);
- the 'supersaturation check' does not lead to a better forecasts for the precipitation and relative humidity at 2m fields.

A Appendix

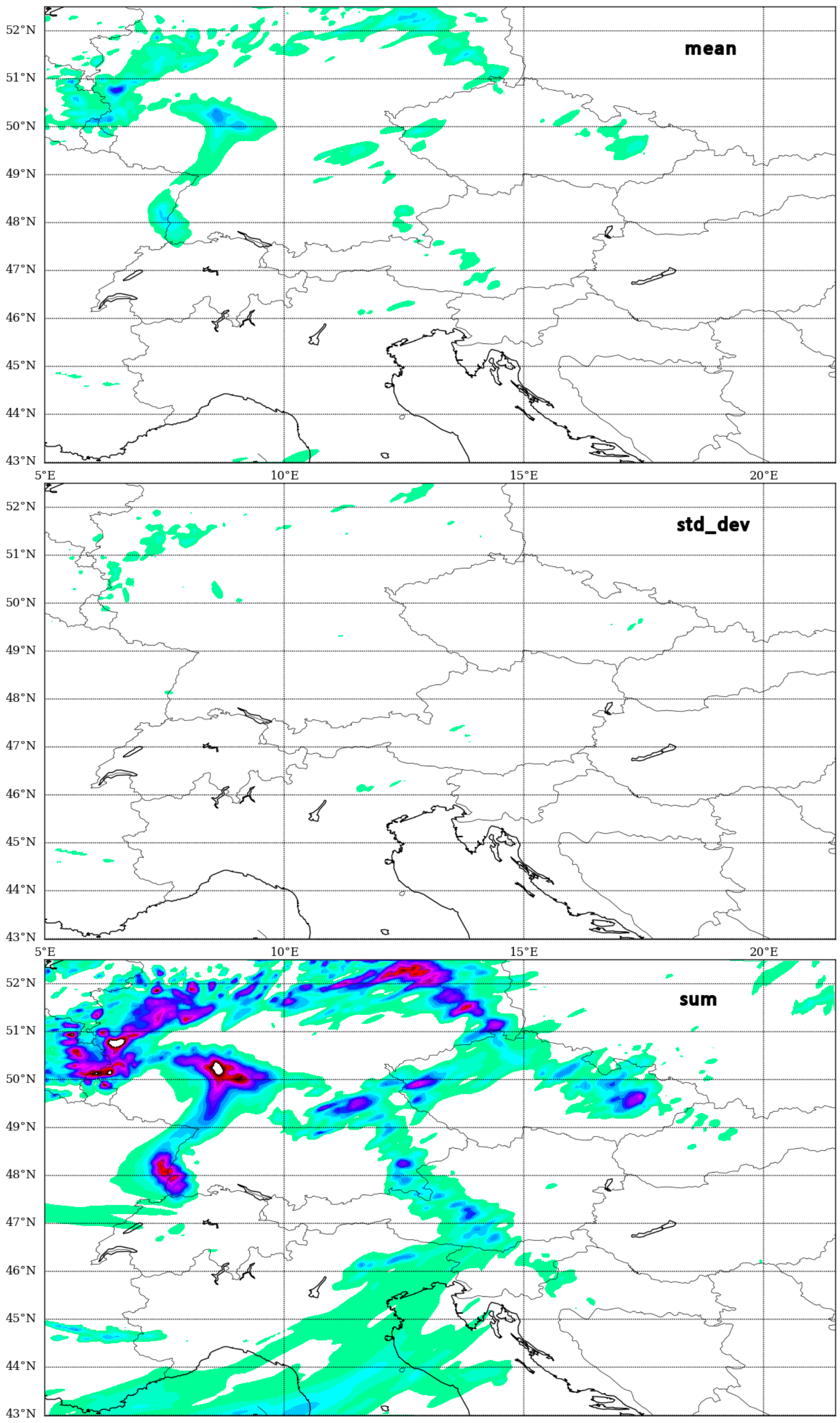

Figure 15: Mean, standard deviation and sum for pureMPHYSICS version forecasts for 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

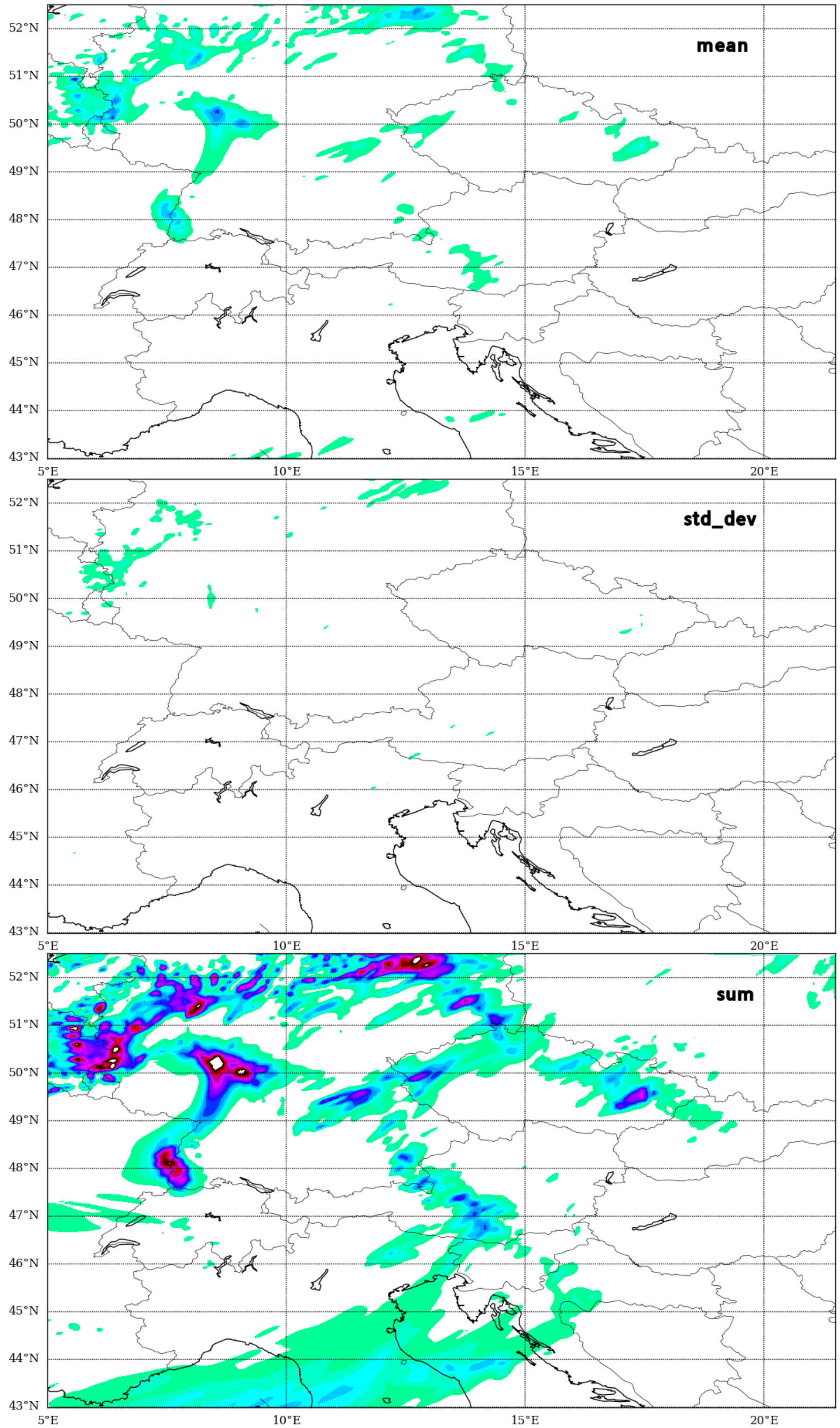

Figure 16: Mean, standard deviation and sum for pureSPPT version forecasts for 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

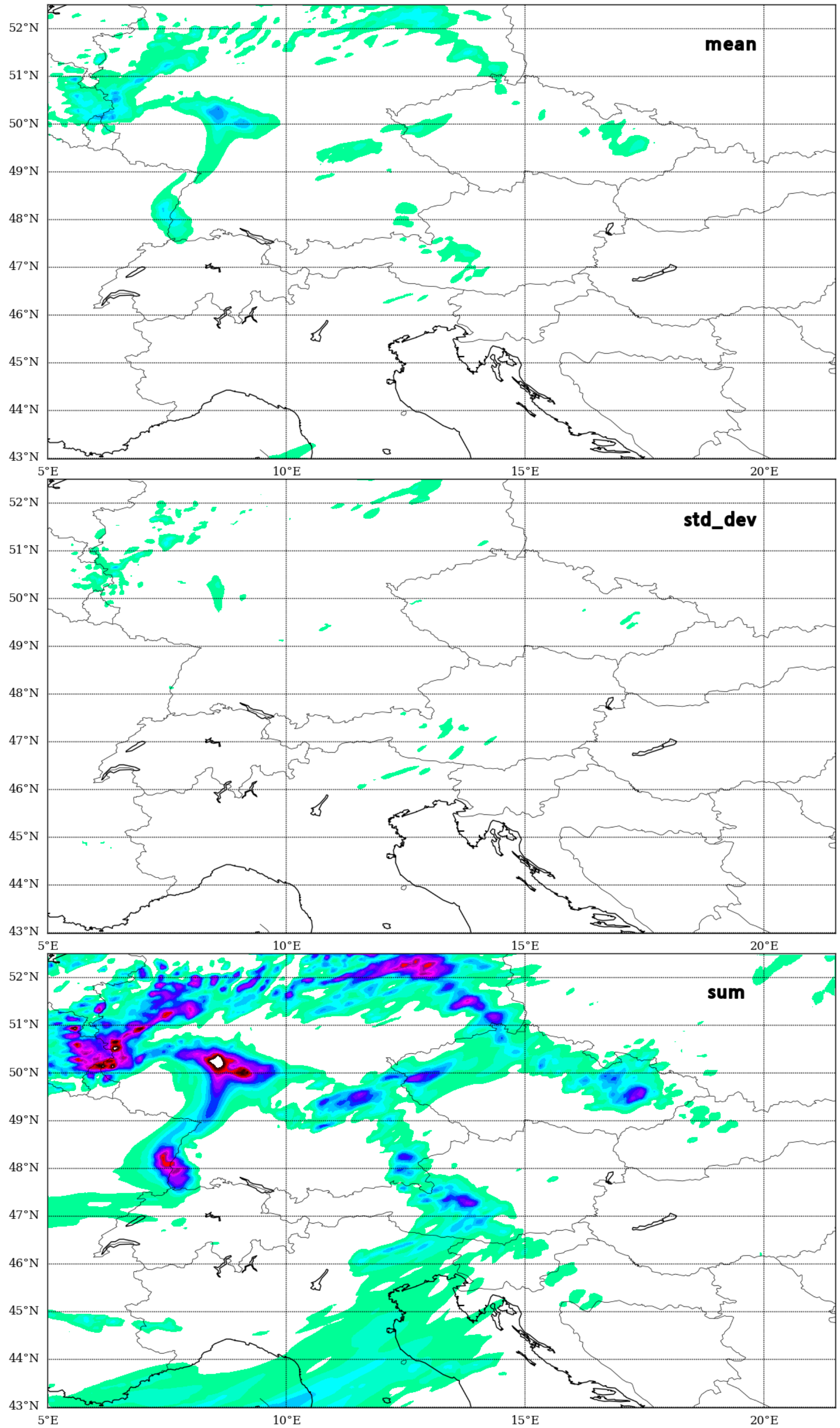

Figure 17: Mean, standard deviation and sum for pureMPHYSICS+SPPT version forecasts for 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

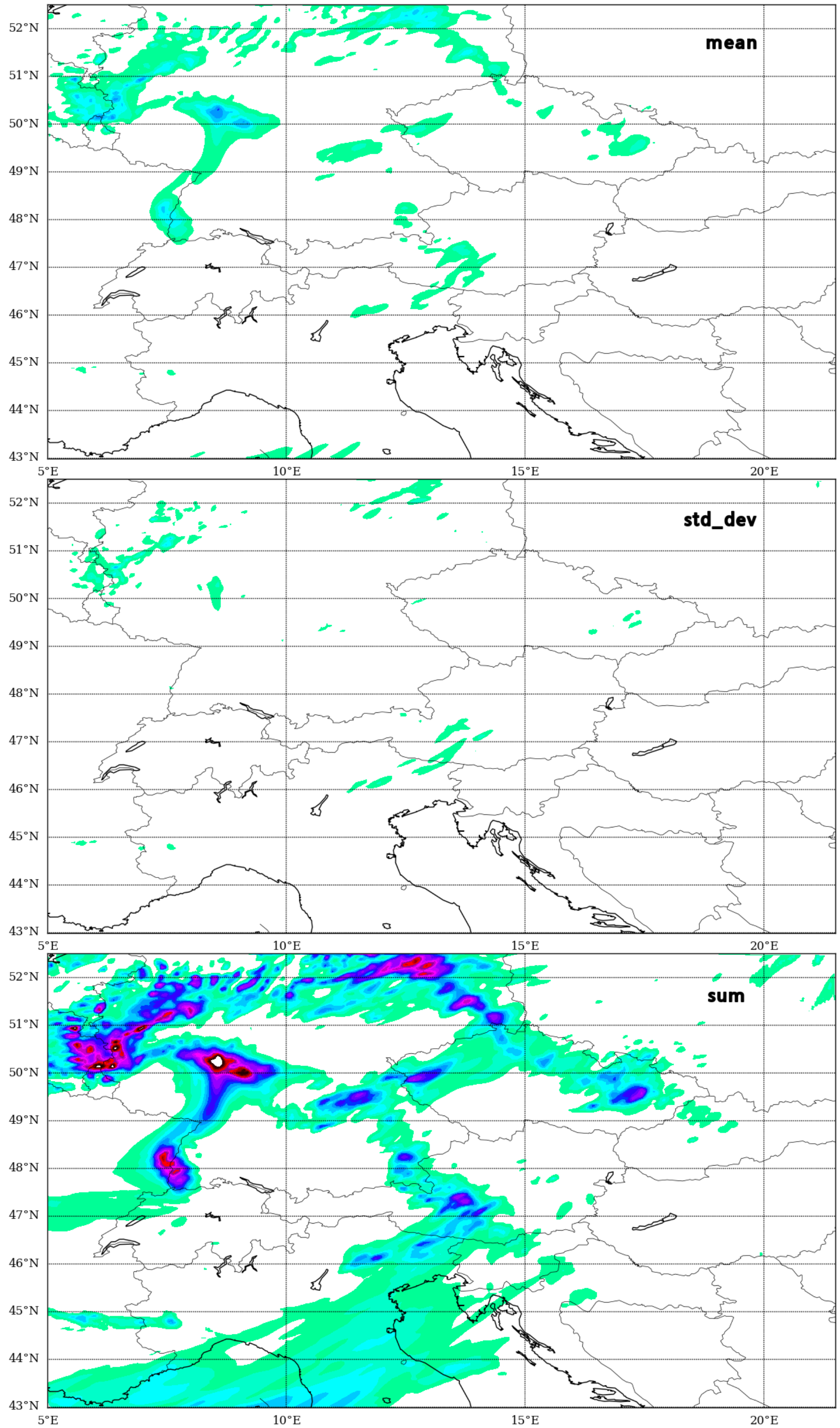

Figure 18: Mean, standard deviation and sum for pureMPHYSICS+SPPT+SuperSaturation version forecasts for 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

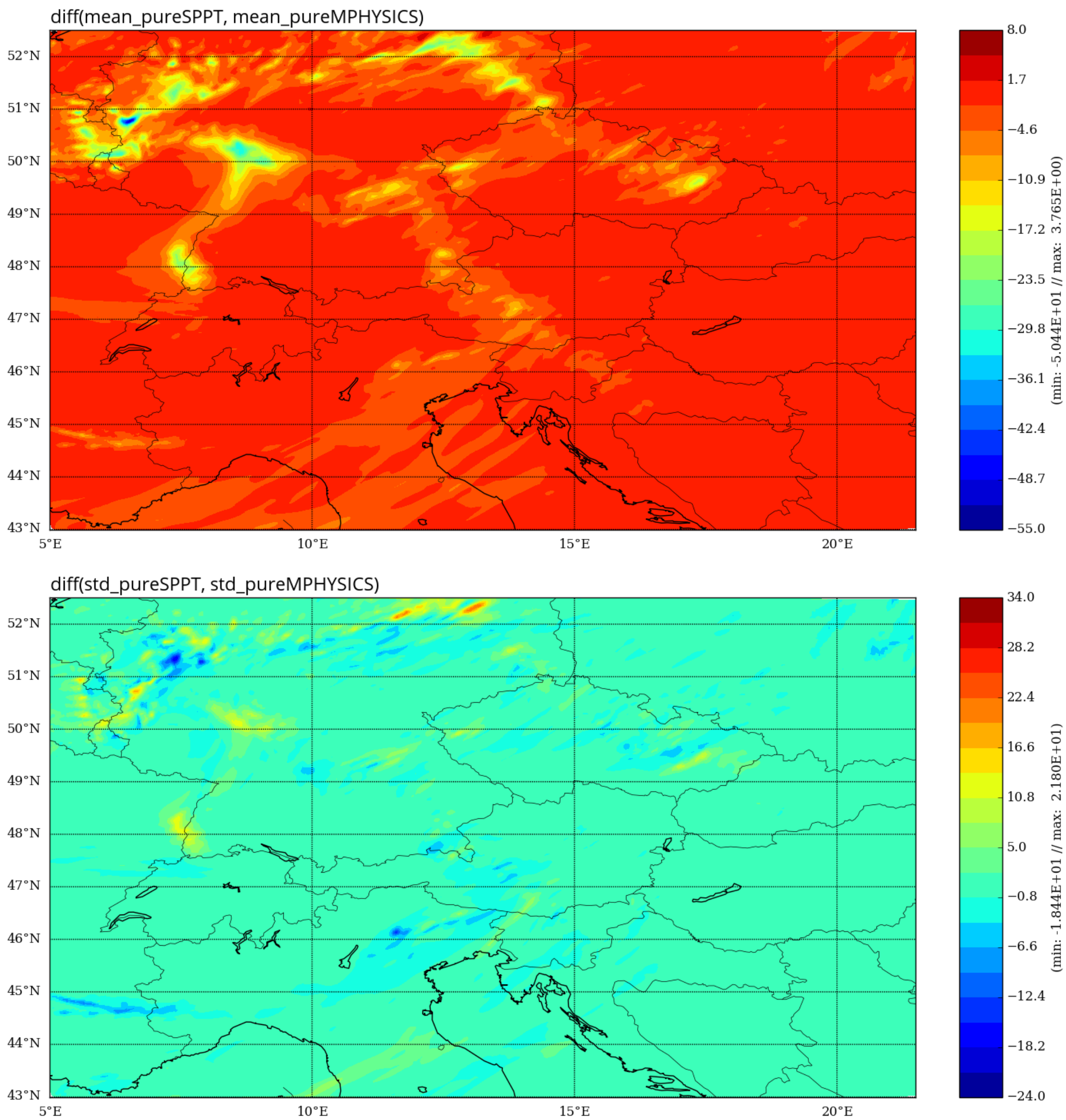

Figure 19: Mean difference (up) and standard deviation difference (down) between pureSPPT version and pureMPHYSICS version forecasts for 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

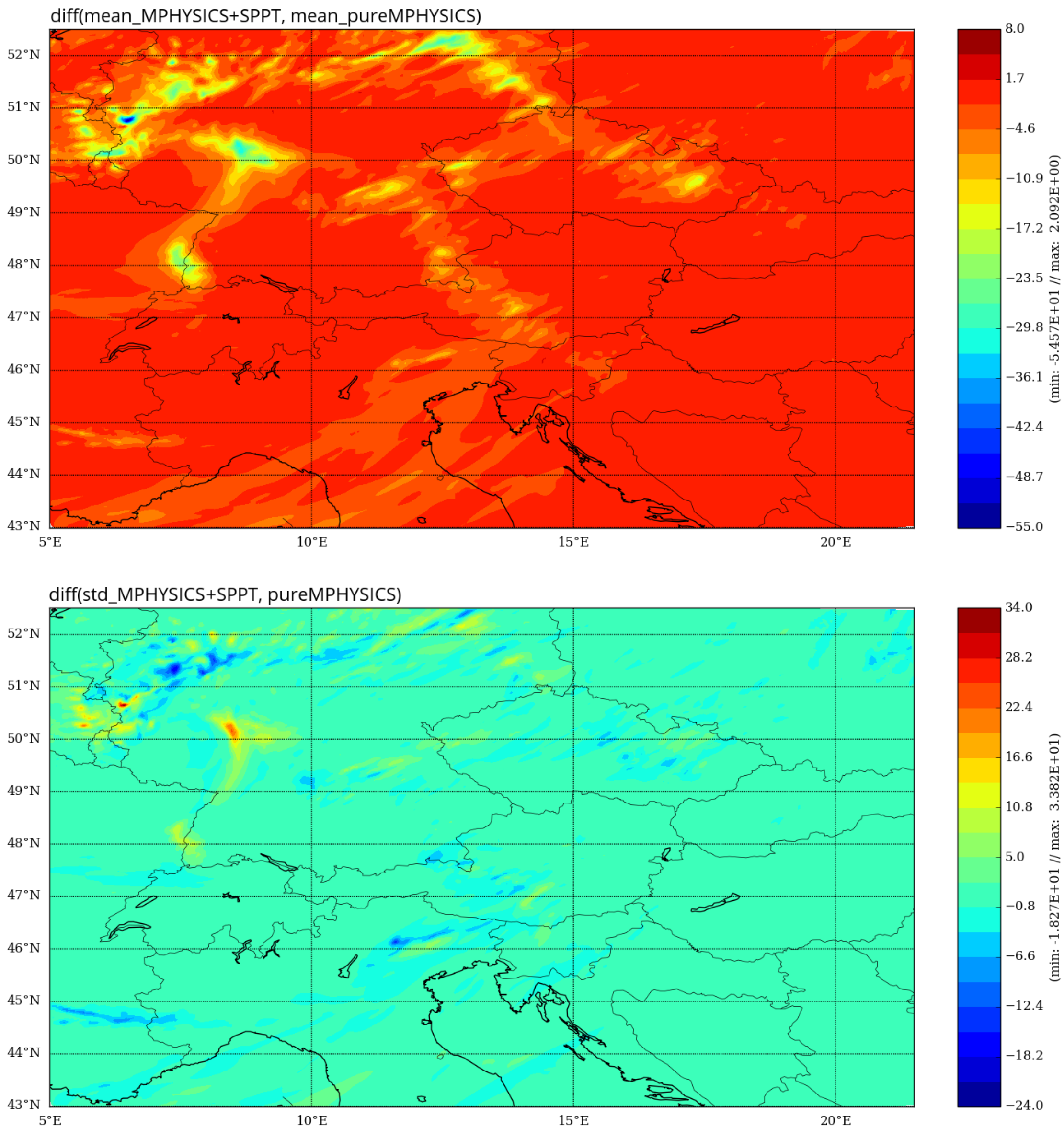

Figure 20: Mean difference (up) and standard deviation difference (down) between pureMPHYSICS+SPPT version and pureMPHYSICS version forecasts for 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC

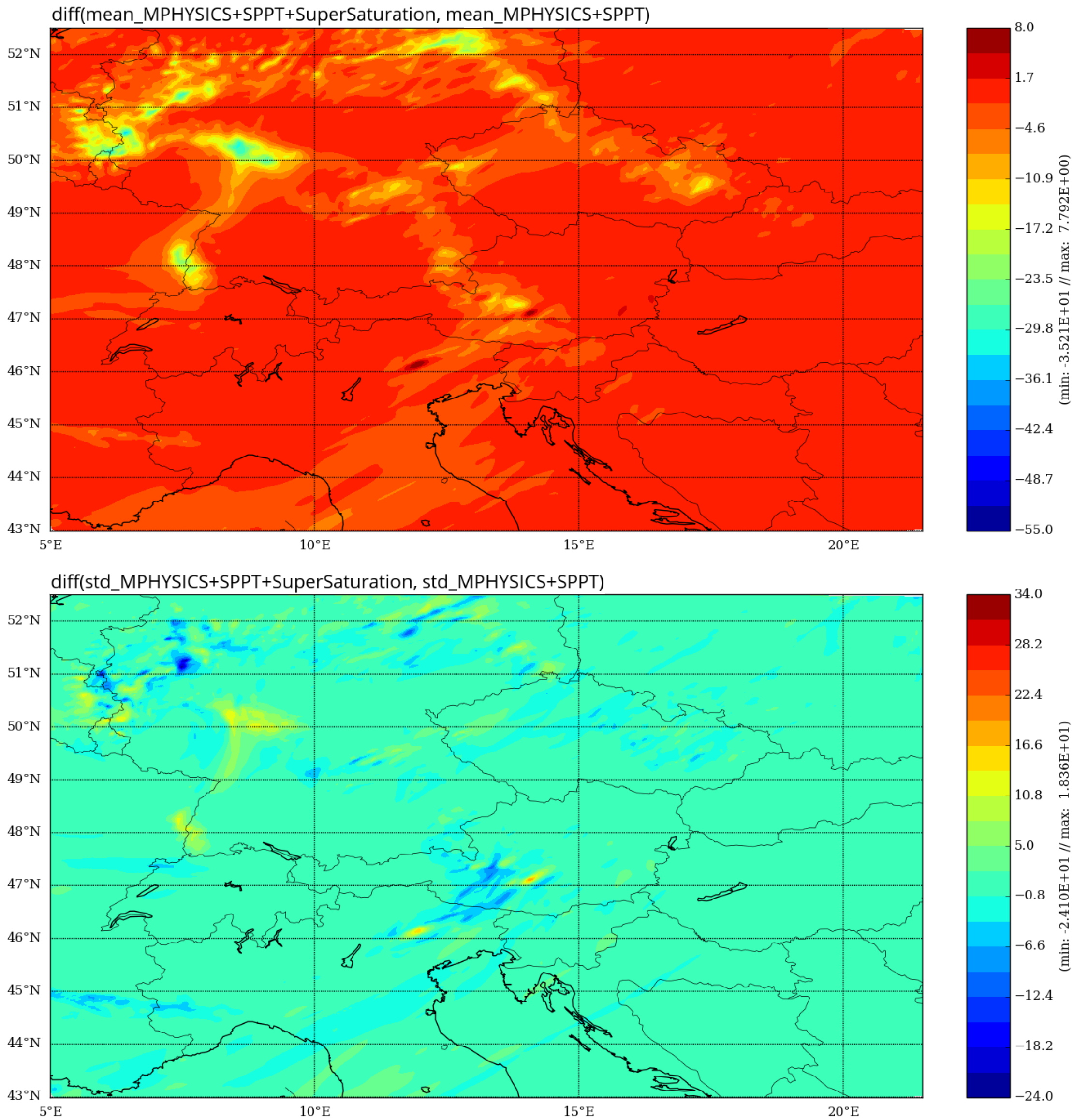

Figure 21: Mean difference (up) and standard deviation difference (down) between pureMPHYSICS+SPPT+SuperSaturation version and pureMPHYSICS+SPPT version forecasts for 24h cumulated precipitation, 31.05.2016, 12 UTC - 01.06.2016, 12 UTC