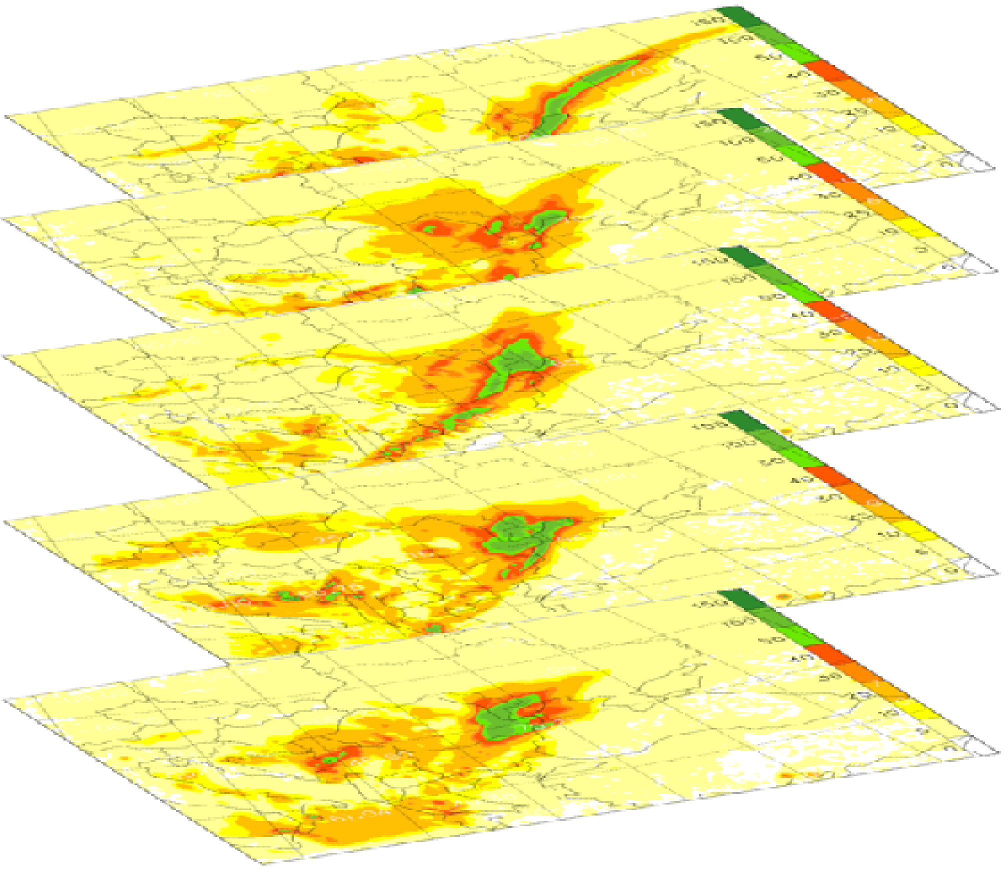
Report on stay at ZAMG

Vienna, Austria

04.07.2016 - 26.08.2016

Revision of LAEF Multiphysics



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Taking into account the upgrade of ALADIN-LAEF system towards finer resolution (approximately 5 km horizontal resolution and 60 vertical levels), the main purpose of this stay was the revision of ALADIN-LAEF multiphysics for this new system. At the moment, for the current operational version (11 km horizontal resolution and 45 vertical levels) 16 namelists are used (Annex 1, provided by the colleagues from ZAMG).

Following the ideas and work of Christoph Wittmann (Austria) and Canberk Karadavut (Turkey), the goal of this stay was to increase the maintenance of the ALADIN-LAEF system by reducing with respect to multiphysics, the number of namelists from 16 to 4. Thereby, different namelist were created (by Christoph Wittmann) from ALARO-0 and ALARO-1 cy40 using different options which can be seen in figure 1, with target on convection, microphysics and turbulence schemes.

Sensitivity tests: Experiment list	
EX00	ALARO-0
EX01	ALARO-1
EX02	ALARO-1 TOUCANS
EX03	ALARO-1 MIXLEN="EL1"
EX04	ALARO-1 MIXLEN="EL2"
EX05	ALARO-1 MIXLEN="EL3"
EX06	ALARO-1 MIXLEN="EL4"
EX07	ALARO-1 MIXLEN="EL5"
EX08	ALARO-1 ACRANEB2
EX09	LAB12=.F.
EX10	ALARO-0 gravity wave drag computation LGWD=.F.
EX11	ALARO-0 Smith Gerard option in condensation/evap
EX12	ALARO-1 Smith Gerard option in condensation/evap
EX13	ALARO-0 FMR/RRTM radiation scheme
EX14	ALARO-1 FMR/RRTM radiation scheme
EX15	ALARO-0 no LENTCH
EX16	ALARO-0 LSCMF=.FALSE.
EX17	ALARO-0 LCVGQM=F
EX18	ALARO-0 LCVGQM=F,LGVGQD=F
EX19	ALARO-0 prognostic updraft LCVPRO downdraftLCDDPRO → FALSE
EX20	ALARO-0-MIXLEN="Z"
EX21	ALARO-0-MIXLEN="EL1"
EX22	ALARO-0-MIXLEN="EL2"
EX23	ALARO-0-MIXLEN="EL3"
EX24	ALARO-0-MIXLEN="EL4"
EX25	ALARO-0-MIXLEN="EL5"
EX26	ALARO-0-MIXLEN="AYC"
EX27	ALARO-0-MIXLEN="EL0"
EX28	ALARO-0 no LENCHT, LSCMF=.FALSE., LCVGQM=F, LCVQGD=T
EX29	ALARO-0 no LENCHT, LSCMF=.FALSE., LCVGQM=F, LCVQGD=T, Smith Gerard, MIXLEN="Z"
EX30	ALARO-0 LVFULL=T
EX31	ALARO-0 LRNUMX=.FALSE.
EX32	ALARO-0 LPRGML=F
EX33	ALARO-0 no LENTCH, LSCMF=.FALSE., LCVGQM=F, LCVGQD=T, Smith Gerard, MIXLEN="Z"
EX34	ALARO-0 no LENTCH, LSCMF=.FALSE., LCVGQM=F, LCVGQD=T, Smith, Gerard, MIXLEN="Z", LGWD=.FALSE., LNEWD=.FALSE.
EX35	ALARO-0 no LENTCH, LSCMF=.FALSE., LCVGQM=F, LCVGQD=T, Smith/Gerard=.TRUE., MIXLEN="Z", LPRGML=F, LGWD=.FALSE., LNEWD=.FALSE.
EX36	ALARO-0 no LENTCH, LSCMF=.FALSE., LCVGQM=F, LCVGQD=T, Smith/Gerard=.TRUE., MIXLEN="EL5", LPRGML=F, LGWD=.FALSE., LNEWD=.FALSE.
EX37	ALARO-0 no LENTCH, LSCMF=.FALSE., LCVGQM=F, LCVGQD=T, Smith/Gerard=.TRUE., MIXLEN="EL5", LPRGML=F
EX38	ALARO-1 LCVGQM=F, LCVGQD=F
EX39	ALARO-1 LENTCH=.F.
EX40	ALARO-1 LENTCH=.F., LSCMF=.FALSE.
EX41	ALARO-1 LCVGQM=T, LCVGQD=T
EX42	ALARO-1 LGWD=.FALSE., LNEWD=.FALSE.
EX43	ALARO-1 LPRGML=F → NOT STABLE
EX44	ALARO-1 CGTURS=MD1+retune pf parameters → NOT STABLE
EX45	ALARO-1 CGTURS=RMC01+retune pf parameters → NOT STABLE
EX46	ALARO-1 CGTURS=QNSE+retune pf parameters → NOT STABLE
EX47	ALARO-1 CGTURS=EFB+retune pf parameters → NOT STABLE
EX50	ALARO-1 LCOEFKTKE=.F. (→ LPTKE)
EX51	ALARO-1 XDAMP=0 (turn off moist antifibrillation)
EX53	ALARO-1 CGTURS=MD1=default+retune → not stable
EX54	ALARO-1 modif turbulence: mixing length:EL5, CGTURS=MD2+retune, LPRGML=F
EX55	ALARO-1 modif micro+conv: LAB12=F, LCVGQM=F, LCVGQD=F, LENTCH=F, LSCMF=F,LSMGCDEV=T,LXRCDEV=F
EX56	ALARO-1 modif turbulence: mixing length: EL5, CGTURS=MD2+retune, LPRGML=F, modif micro+conv: LAB12=F, LCVGQM=F, LCVGQD=F, LENGTH=F, LSCMF=F, LSMGCDEV=T, LXRCDEV=F
EX57	ALARO-1 modif turbulence: mixing length: EL3, CGTUR=QNSE+retune, LPRGML=F
EX58	ALARO-1 modif micro+conv: LAB12=F, LCVGQM=F, LCVGQD=F, LENTCH=F, LSCMF=F, LSMGCDEV=T, LXR-CDEV=F, modif turbulence mixing length:EL3, CGTUR=QNSE+retune, LPRGML=F

Figure 1: Experiment list for the sensitivity tests.

The control impact of namelist changes (related to deep convection, microphysics and turbulence) was done by using MTEN tool (Moits Total Energy Norm - Storto, A. and Randriamampianina, R. (2010)) in order to evaluate the relative impact with respect to reference (ALARO-1 or ALARO-0).

A series of experiments for two weeks period starting with 18th May 2016 to 1st June 2016 were performed on HPCE in ECMWF and on ZAMG computer. The boundary conditions for ALADIN-LAEF ensemble were interpolated from ECMWF/EPS system (91 vertical levels) using GL tool (instead of 901 and e927 configurations) even if some scores show degradation. GL tool was used, in these experiments, to evaluate multiphysics impact.

In order to evaluate the ability of multiphysics and/or SPPT choices, the members of ALADIN-LAEF system were coupled in a dynamical mode with the first 16th members of ECMWF/EPS.

It is well known that a higher resolution, deterministic or ensemble systems, demands considerable power resources. In order to take into account the advanges of the finer resolution of ALADIN-LAEF at 5 km horizontal resolution, the new integration domain (Figure 2 - from Martin Bellus's report stay from 2016 at ZAMG, Vienna) was diminished.

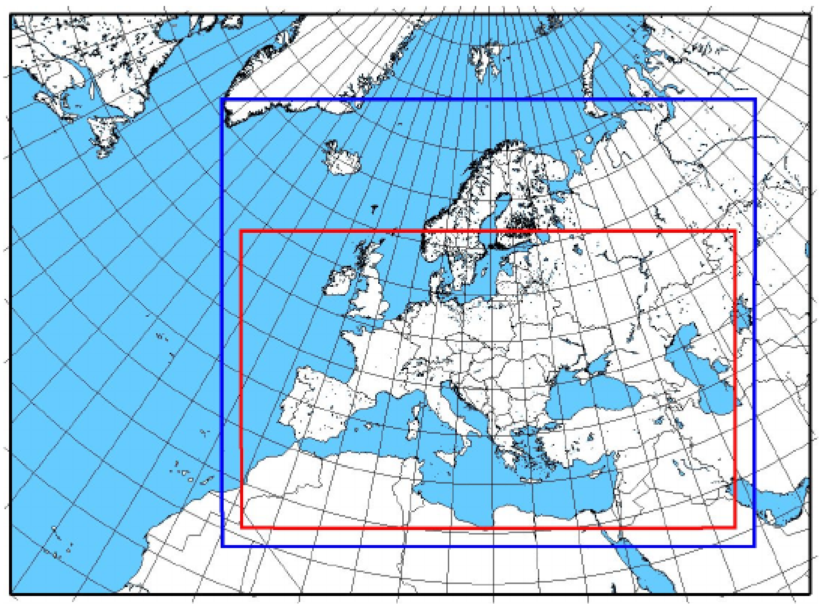


Figure 2: ALADIN-LAEF integration domains: the current one at 11 km horizontal resolution (blue) and the new one at 5 km horizontal resolution (red).

Taking into account the sensitivity tests results, five versions namelist settings (four namelists) were used to create different settups of ALADIN-LAEF system (Table 1). The performance of each version was evaluated computing different verification scores (probabilistic and deterministic evaluation). For surface verification, analysed parameters were temperature at 2m, mean sea level pressure, wind speed at 10 m, relative humidity at 2m and total precipitation cumulated in 6 hours. For upper levels (500 and 850 hPa), the parameters were temperature, geopotential and wind direction. The surface verification was done against 1355 synop stations over Europe and upper levels verification was done using ECMWF analyses for 508x446 grid points.

The verification results of two weeks period showed similar behaviour for many verification scores and it was a little bit complicated to choose one version. The main purpose is to avoid clusters or a spread too large between members which belong to the same version. In figure 4, for BIAS score for temperature at 500 hPa, it can be noticed that for bias values (black lines) of the ensemble mean, VERSION 5 outperforms VERSION 4. Looking separately at each member, at the same forecast time, it can be seen that members which are run with ALARO-0 (EXP 00) are distant from the others. Thereby, VERSION 4 has a the better distribution of the members for temperature at 500 hPa. Similar results for other parameters for upper levels

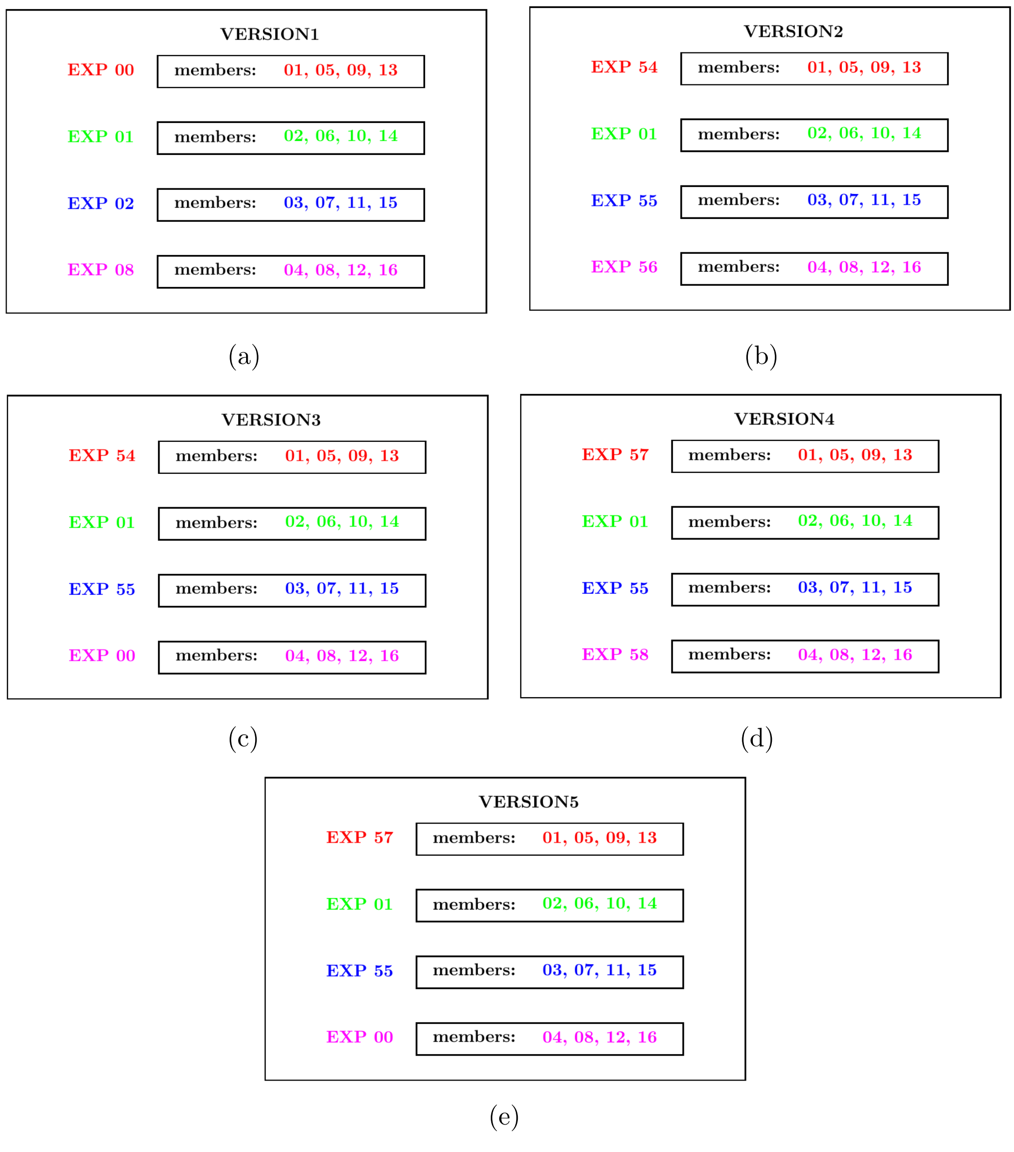


Figure 3: Namelist settings versions.

and for surface, led to the choice that version 4 should be further investigated (to be combined with SPPT scheme).

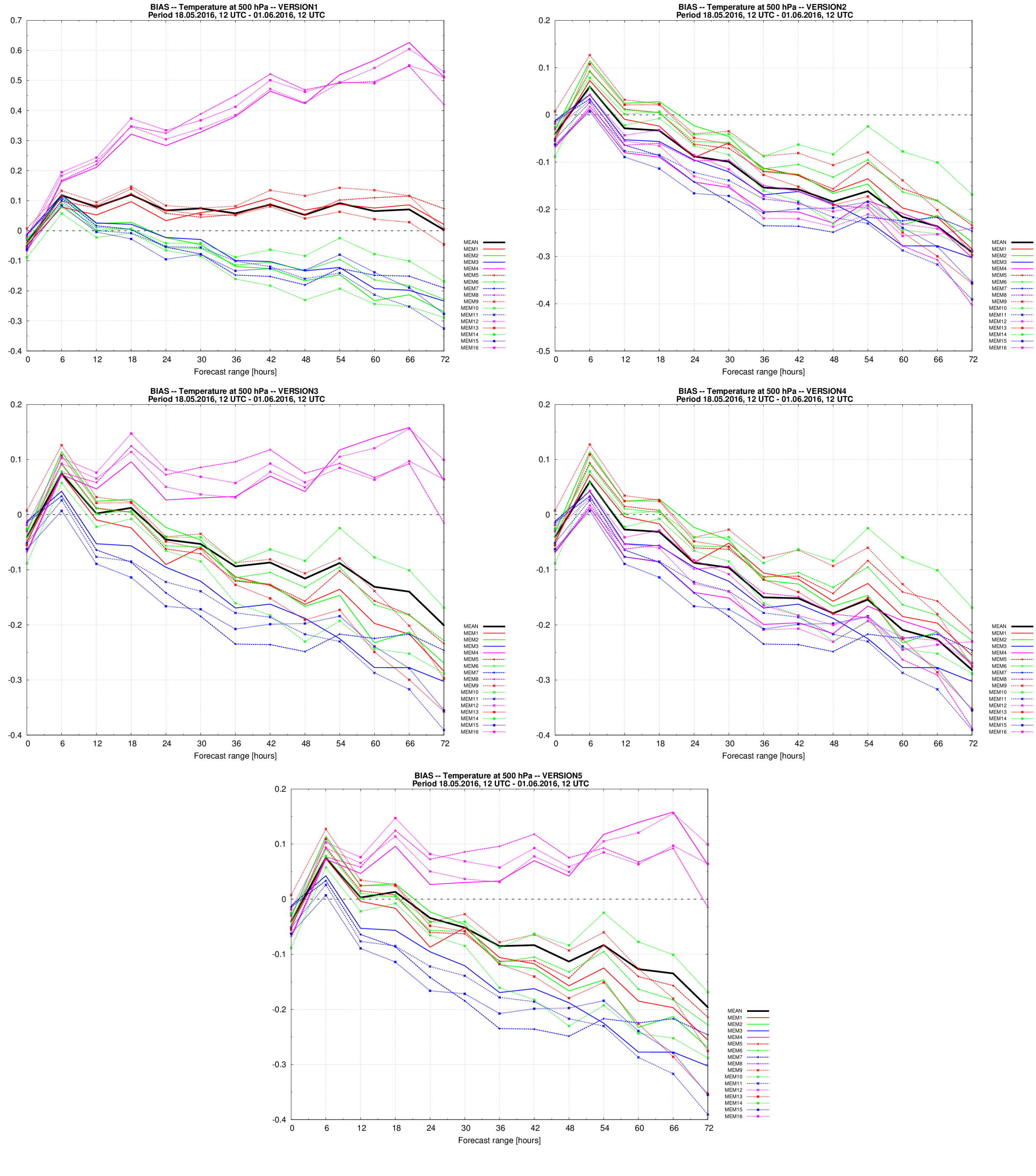


Figure 4: BIAS for temperature at 500 hPa for all five versions.

The next step was to introduce SPPT scheme for VERSION4 and to reference ALARO-1, the SPPT used settings were the following (default settings):

- standard deviation = 0.5
- horizontal correlation length scale = 80000
- correlation time scale = 7200
- clippig ratio = 2.0

In figure 5 it can be seen the spectral pattern of the perturbation with the default setup of SPPT. More details can be found on Mihály Szũcs's reports from www.rclace.eu. The resulting histogram of this spectral patterns can be observed in figure 6 which shows a strange distribution of random numbers (not gaussian). More experiments were made using different SPPT setups (if needed they are available upon request).

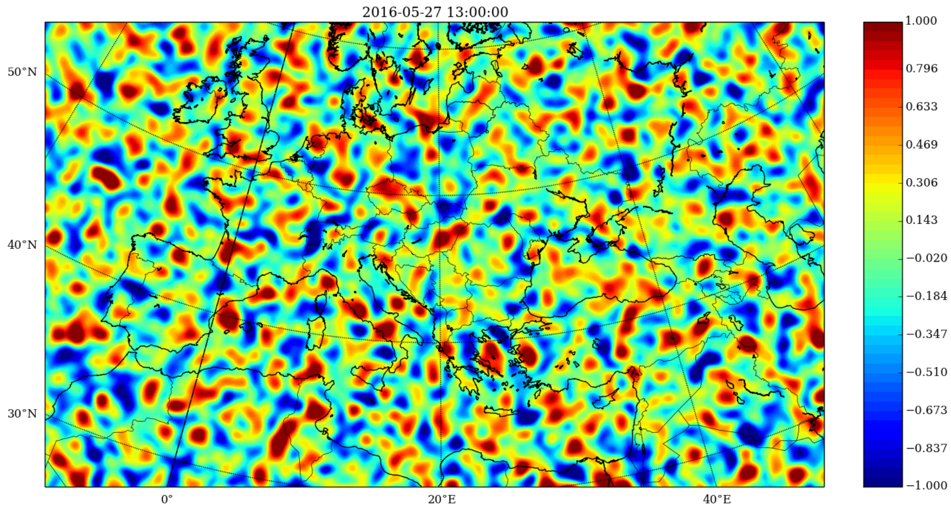


Figure 5: Spectral pattern at + 1 hour for: $TAU\_SDT = 7200., XLCOR\_SDT = 80000., SDEV\_SDT = 0.5, NSEED_SDT = 1, XCLIP\_RATIO_SDT = 2.0.$

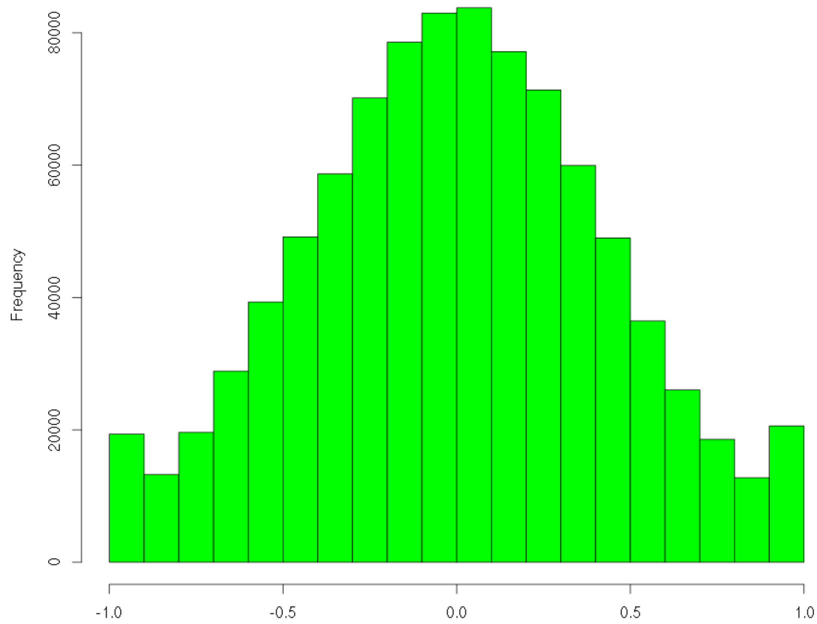
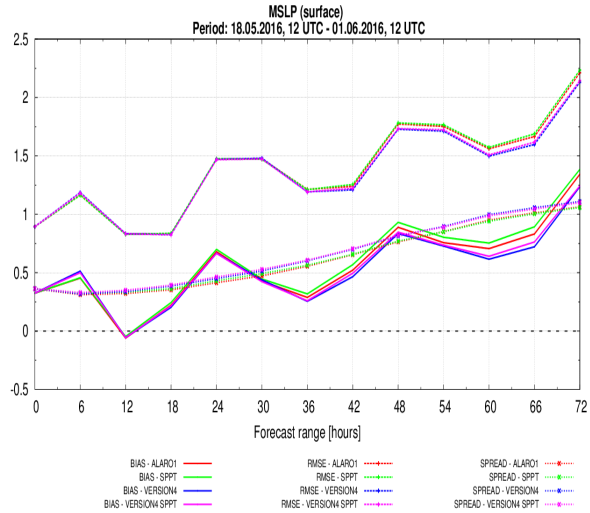
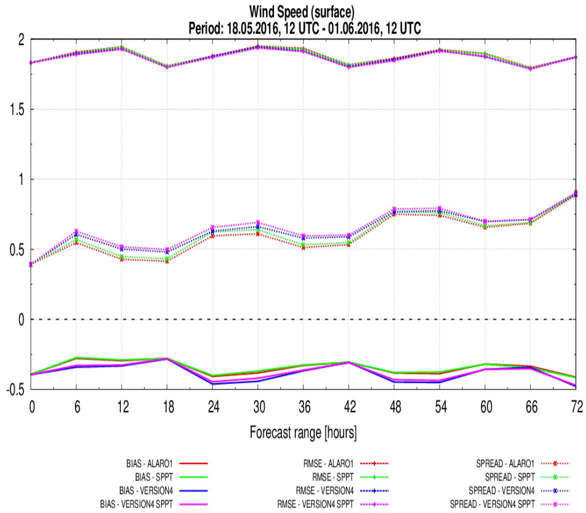


Figure 6: Histogram for: $TAU\_SDT = 7200., XLCOR\_SDT = 80000., SDEV\_SDT = 0.5, NSEED\_SDT = 1, XCLIP\_RATIO\_SDT = 2.0.$

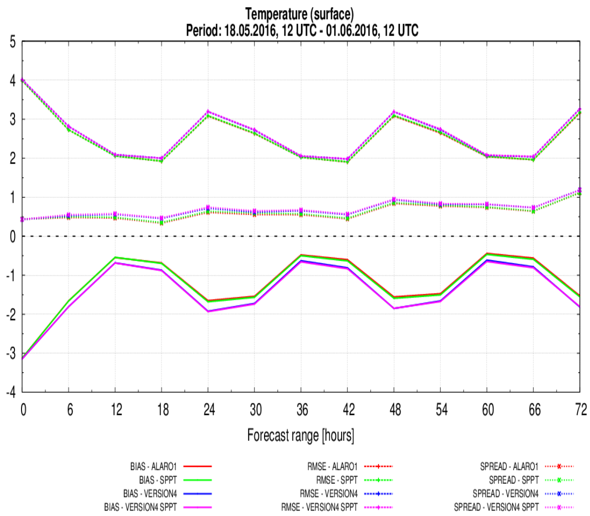
In figures 7, 8, 9 are presented the BIAS, RMSE and SPREAD scores for surface and upper levels (500 and 850 hPa) experiments with ALARO-1 (red), only ALARO-1 plus SPPT (green), VERSION4 (blue) and VERSION4 plus SPPT (magenta). Comparing all the experiments, it can be noticed some differences between the first two experiments (ALARO-1 and ALARO-1 plus SPPT) and the last two experiments (VERSION4 and VERSION4 plus SPPT). ALARO-1 with SPPT is more similar to the ALARO-1 and VERSION4 with SPPT is more similar to VERSION4. Similar results are obtained for other scores. For example, for percentage of outliers (Figure 10), it can be observed that VERSION4 and VERSION4 with SPPT have less outliers than ALARO-1 and ALARO-1 with SPPT. It is also obviously for figure 11 (BIAS for temperature of 2 m for each individual member) that the impact of SPPT with the default setup is rather small.



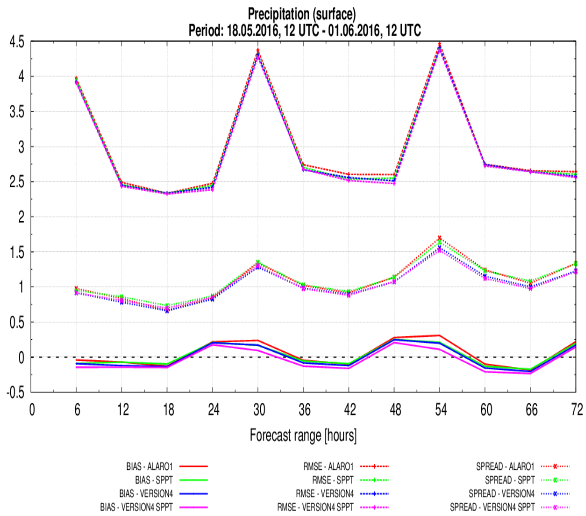
(a)



(b)



(c)



(d)

Figure 7: BIAS, RMSE and SPREAD for MSLP (a), wind speed (b), temperature at 2m (c), precipitation cumulated in 6 hours (d) for experiments with ALARO-1 (red), only ALARO-1 plus SPPT (green), VERSION4 (blue) and VERSION4 plus SPPT (magenta) for 18.05 - 01.06.2016 period.

In conclusion, in order to avoid too strong members clustering, ALARO-0 was excluded and a preliminary setup with new multiphysics was finally chosen (four namelist options for ALARO-1). Also, the introduction of SPPT scheme has just a small impact.

As a final conclusion of multiphysics, as Christoph said: *Multiphysics is 'endless' story . . . too many possibilities.* :)

Acknowledgements

Many thanks to ZAMG team for their hospitality, especially to Christoph Wittmann, Yong Wang and Florian Weidle for their guidance and constructive suggestions during my stay. I would like to express my appreciation to Martin Bellus (SMHU) for his constant help.

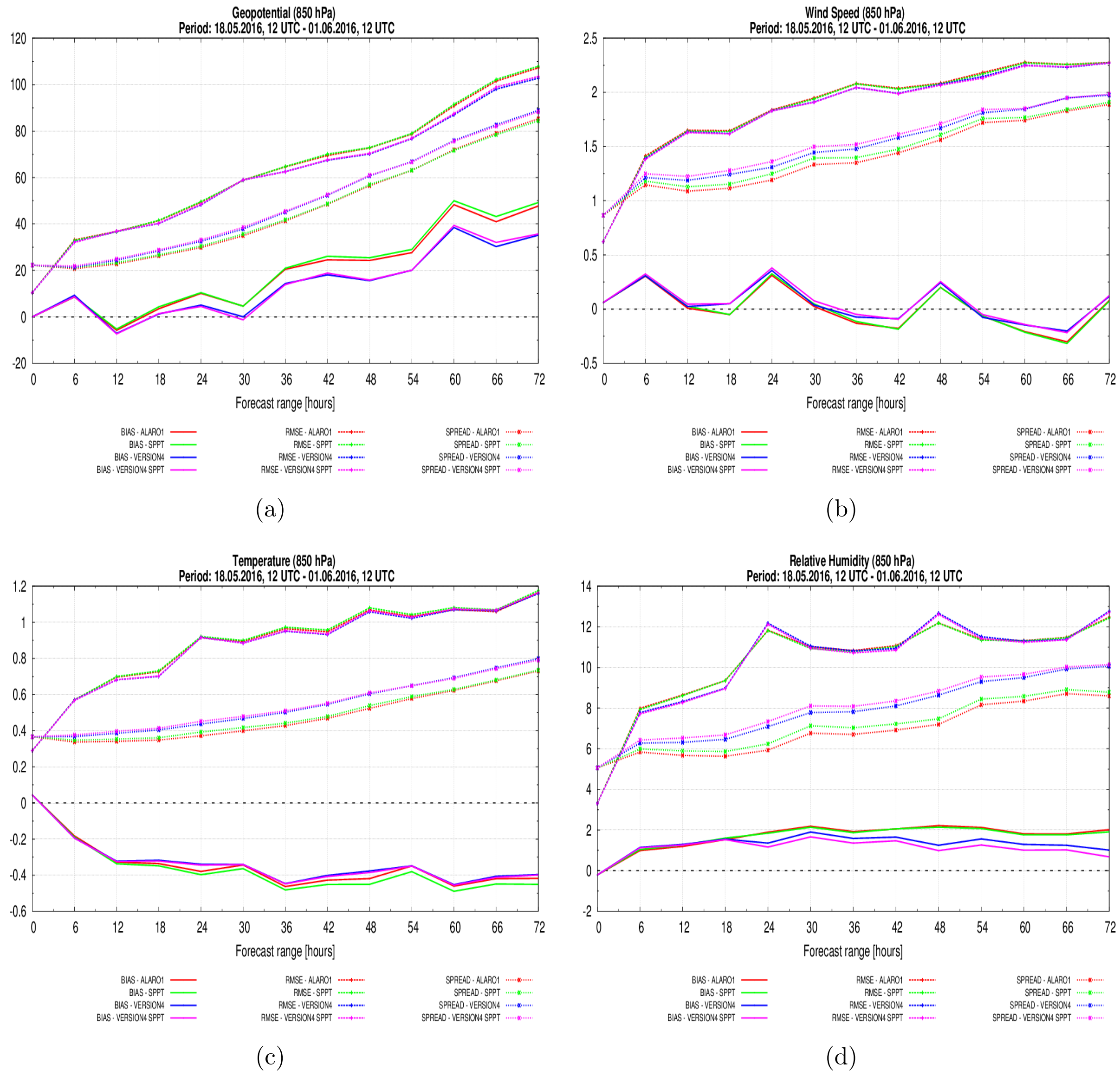


Figure 8: BIAS, RMSE and SPREAD for geopotential (a), wind speed (b), temperature at 2m (c), relative humidity (d) at 850 hPa for experiments with ALARO-1 (red), only ALARO-1 plus SPPT (green), VERSION4 (blue) and VERSION4 plus SPPT (magenta) for 18.05 - 01.06.2016 period.

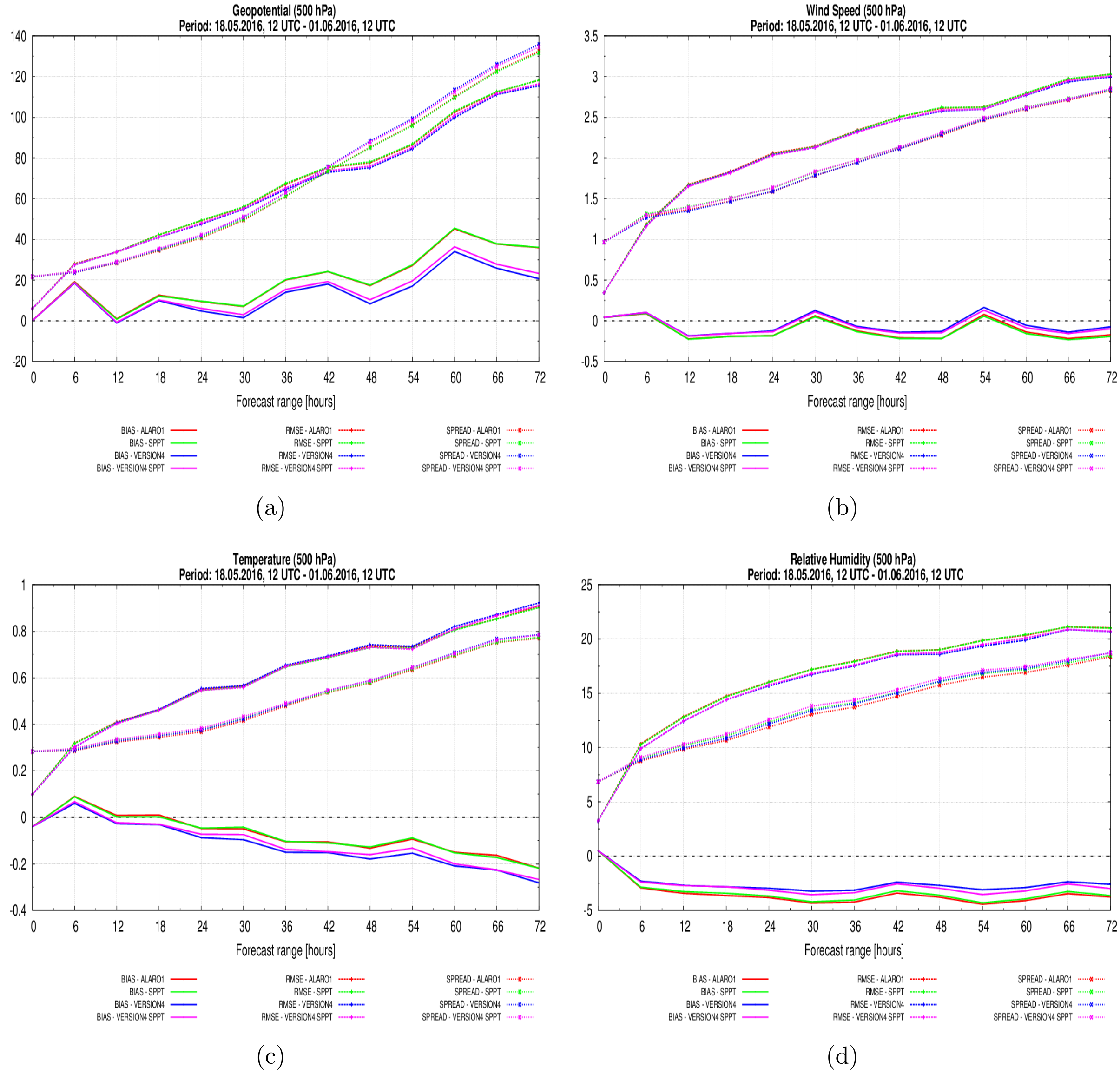


Figure 9: BIAS, RMSE and SPREAD for geopotential (a), wind speed (b), temperature at 2m (c), relative humidity (d) at 500 hPa for experiments with ALARO-1 (red), only ALARO-1 plus SPPT (green), VERSION4 (blue) and VERSION4 plus SPPT (magenta) for 18.05 - 01.06.2016 period.

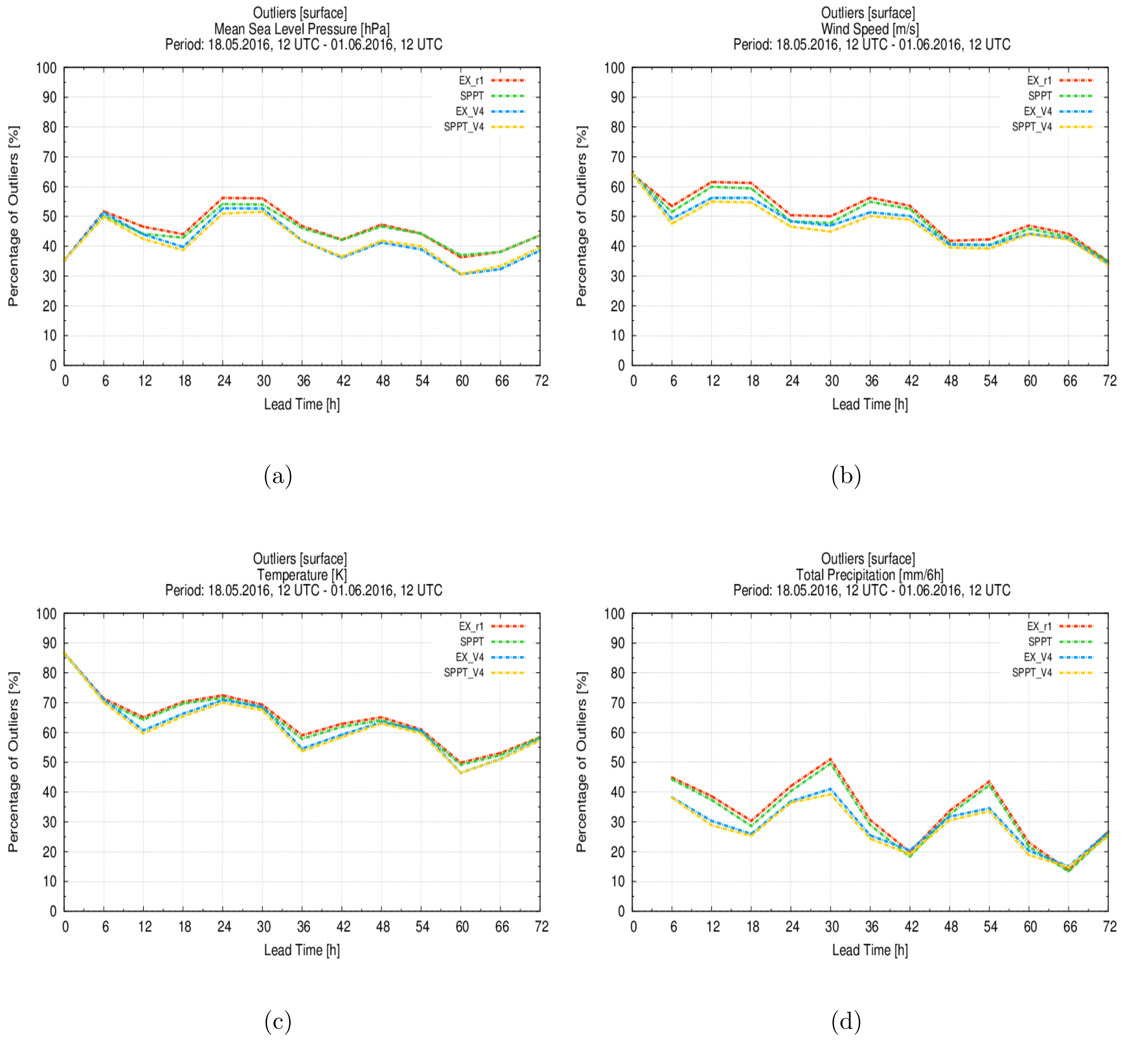
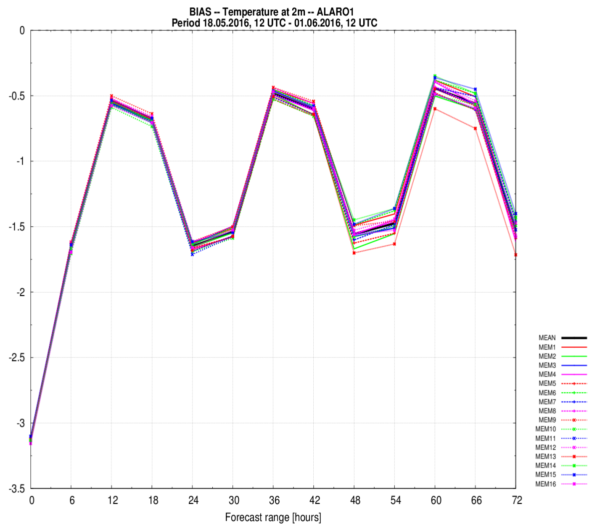
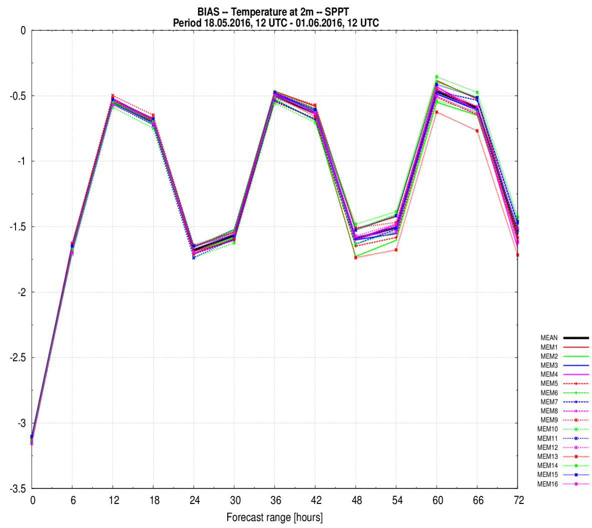


Figure 10: Outliers for MSLP (a), wind speed (b), temperature at 2m (c), precipitation cumulated in 6 hours (d) for experiments with ALARO-1 (red), only ALARO-1 plus SPPT (green), VERSION4 (blue) and VERSION4 plus SPPT (magenta) for 18.05 - 01.06.2016 period.



(a)



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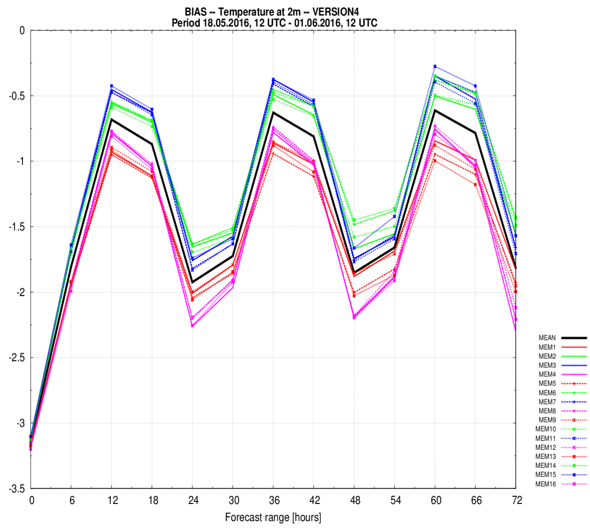
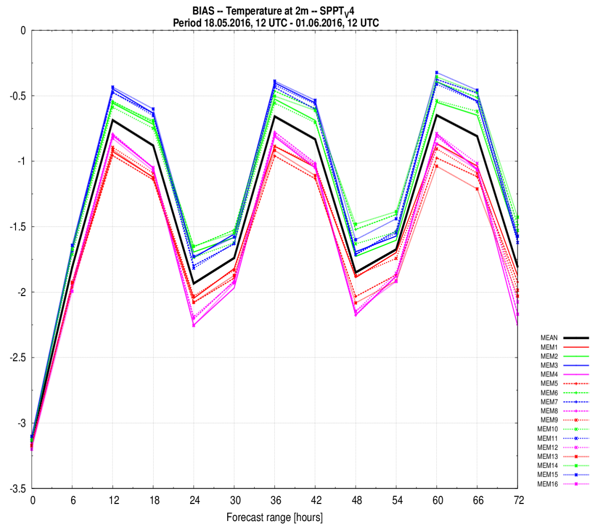


(c)



(d)

Figure 11: BIAS for temperature at 2m for ALARO-1 (a), ALARO-1 with SPPT (b), VERSION4 (c) and VERSION4+SPPT (d) for 18.05 - 01.06.2016 period.

Annex 1

Microphysics setup for ALADIN-LAEF system at 11 km horizontal resolution

NAMELIST	MICROPHYSICS	TUNING	DEEP CONV.	TUNING	SHALLOW CONV.	TUNING	RADIATION	TUNING	TURBULENCE	TUNING	GUST DIAG.	TUNING	SCREENING LEVEL DIAG.	TUNING
MP01	**ALARO-XR**		**3MT**		**JFG87**		**JFG05**		**JFG06**		**RAFTUR**		**NSCRE0**	
MP02	ALARO-XR	*M3H*	3MT	*D2L, D3H*	JFG87		JFG05	*R1H, R3H, R4T*	JFG06		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP03	ALARO-XR	*M1L, M2L, MBL*	3MT	*D2H, D3L*	JFG87		JFG05	*R1L, R3L, R4T*	JFG06		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP04	ALARO-XR	*MBL*	3MT	*D2H, D3L*	JFG87		JFG05	*R1L, R3L, R4T*	JFG06		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP05	ALARO-XR	*M1H, M2H, MBL*	3MT	*D2H, D3L*	JFG87		JFG05	*R1L, R3L, R4T*	JFG06		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP06	ALARO-SM		3MT		JFG87		JFG05	*R4F*	JFG06	*T2H, T3L*	RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP07	ALARO-SM		3MT	*D5T*	JFG87		JFG05	*R4T*	JFG06	*T2L, T3H*	RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP08	**LOPEZ**		**BG**		**KFB**		**ECMWF**		**CBR**		**RAFTKE**		**NSCRE0**	
MP09	LOPEZ		BG	*D1T*	KFB		ECMWF		CBR		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP10	LOPEZ		BG		KFB		ECMWF		CBR		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP11	LOPEZ		BG	*D1T*	KFB	*S1*	ECMWF		CBR		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP12	ALARO-XR	*M1L, M2L, MBL*	3MT/CA	*D2H, D3L*	JFG87		JFG05	*R1L, R3L, R4T*	JFG06		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP13	ALARO-XR	*M1H, M2H, MBL*	3MT/CA	*D2H, D3L*	JFG87		JFG05	*R1L, R3L, R4T*	JFG06		RAFTUR/RAFTKE/RAFBRA		NSCRE0/NSCRE1/NSCRE2	
MP14	ALARO-XR		3MT		JFG87		JFG05		JFG06		RAFTUR/RAFTKE/RAFBRA		LSCRSTOCH	*NTSGN=10*
MP15	LOPEZ		BG		KFB		ECMWF		CBR		RAFTKE		NSCRE0/NSCRE1/NSCRE2	
MP16	LOPEZ		BG		KFB		ECMWF		CBR		RAFTKE		NSCRE0	*NTSGN=-10*