

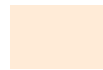


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Regional and Local Climate Modeling and Analysis Research Group



R e L o C l i m

Parameterization induced error-characteristics in Regional Climate Models: An ensemble based analysis

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- Brief Overview
- Experiment Design
- Results
- Summary of key findings

WRF (Skamarock et.al. 2005)

MM5 (Dudhia 1993)

**Initial and boundary
conditions: ECMWF's ERA-40
re-analysis ~ 1.125° grid
spacing (Uppal et. al. 2005)**

D1, grid-spacing 30 km

D2, grid-spacing 10 km

Simulation start, 1st Oct, 1998

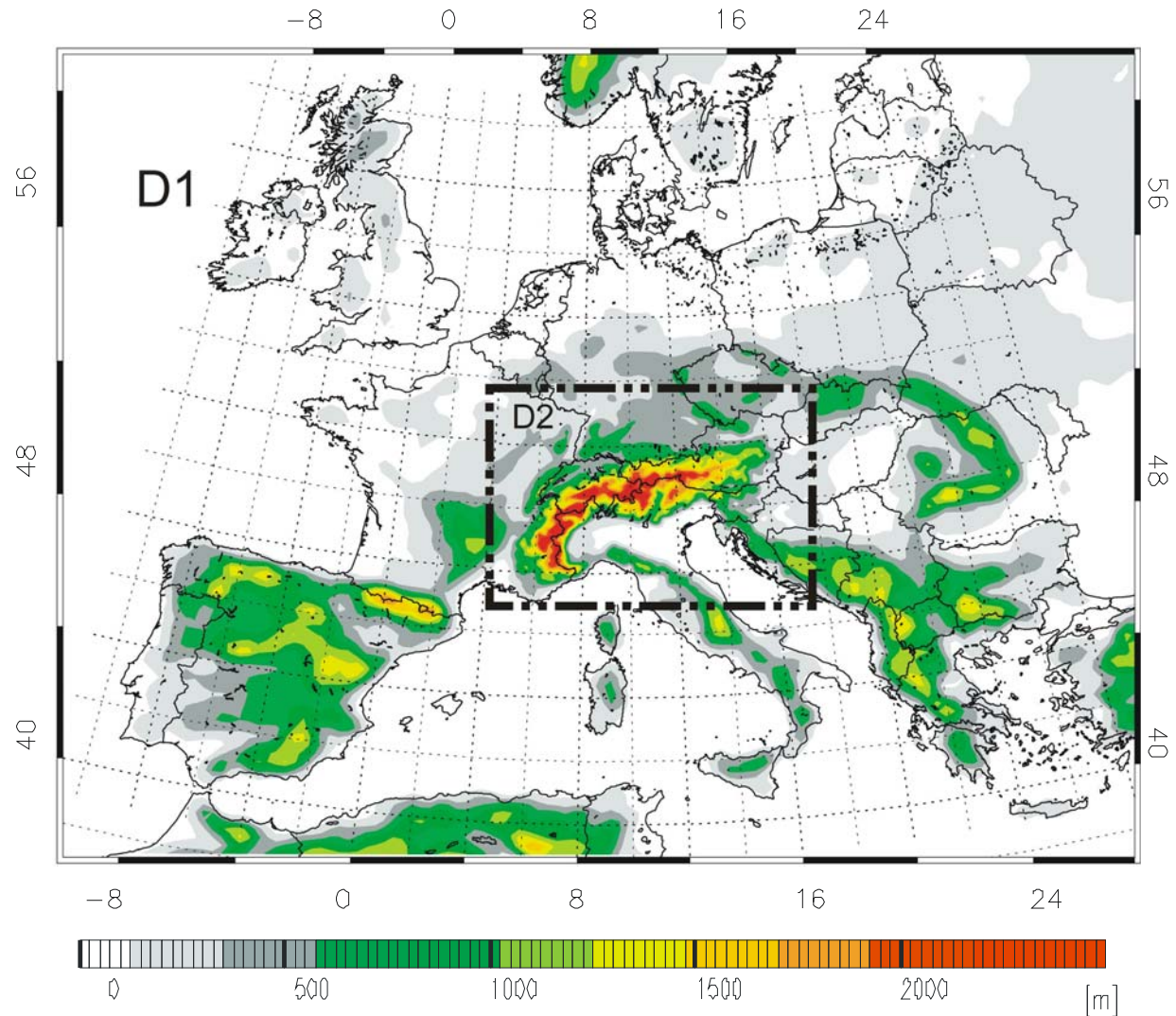
Simulation end, 1st Jan, 2000

Spin-up: 3 months

Evaluation year, 1999

**ECA&D dataset (Haylock et.
al. 2008)**

ETH (Frei and Schär, 1998)

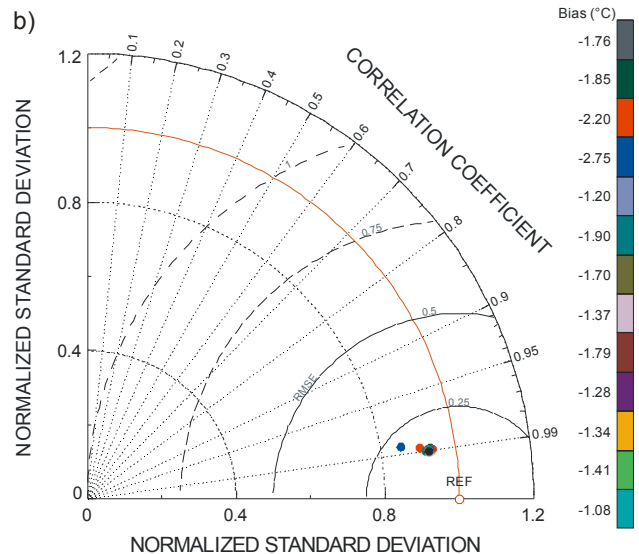
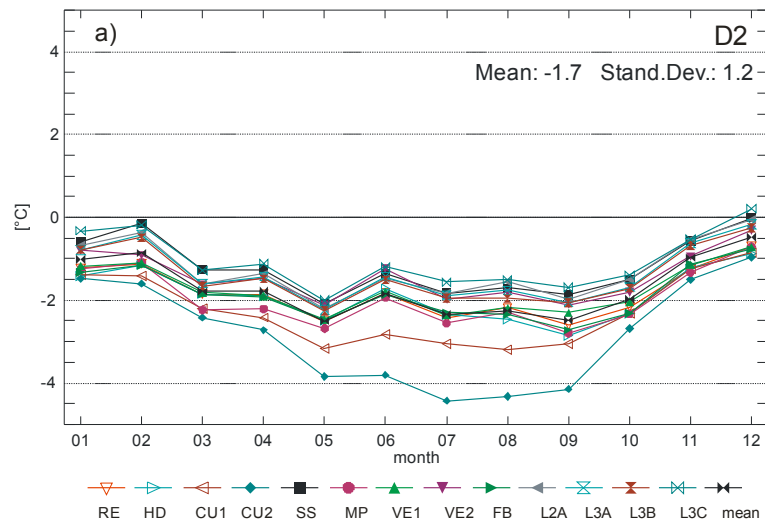


The MM5 and WRF ensemble members with key parameterization settings

Physical Parameterization Settings (MM5)		Physical Parameterization Settings (WRF)	
Exp		Exp	
RE	KF, REISNER 1, RRTM, ETA PBL, NOAH LSM, shallow convection, Vertical levels: 30, SST & Feedback Off, Pressure at model top: 100 mb	RE	GD, FERRIER, GODDARD, RRTM, MOJ, NOAH, MYJ, Vertical levels: 30, SST & feedback On, Pressure at model top: 50 mb
HD	Zängel z-diffusion	PT	Pressure at model top: 100 mb
CU1	BM	CU1	KF
CU2	GR (no shallow convection)	CU2	BMJ
SS	MRF PBL	MP	WSM6
MP	REISNER 2	DA	Model filter: Damping on
VE1	Vertical Levels: 40	SW1	DUDHIA
VE2	Vertical Levels: 20	SW2	GFDL
FB	Feedback On	SS	MOS, YSU
		VE	Vertical Levels: 20
L2A	REISNER 2, MRF PBL	L2A	BMJ, WSM6
L3A	REISNER 2, MRF PBL, Feedback On	L2B	KF, MOS, YSU
L3B	REISNER 2, MRF PBL, Feedback On, Vertical Levels: 40	L2C	KF, DUDHIA
L3C	REISNER 2, MRF PBL, Feedback On, Vertical Levels: 20	L3A	KF, MOS, YSU, DUDHIA
		L3B	KF, MOS, YSU, DUDHIA, WSM6
		L3C	KF, MOS, YSU, DUDHIA, THOMSON

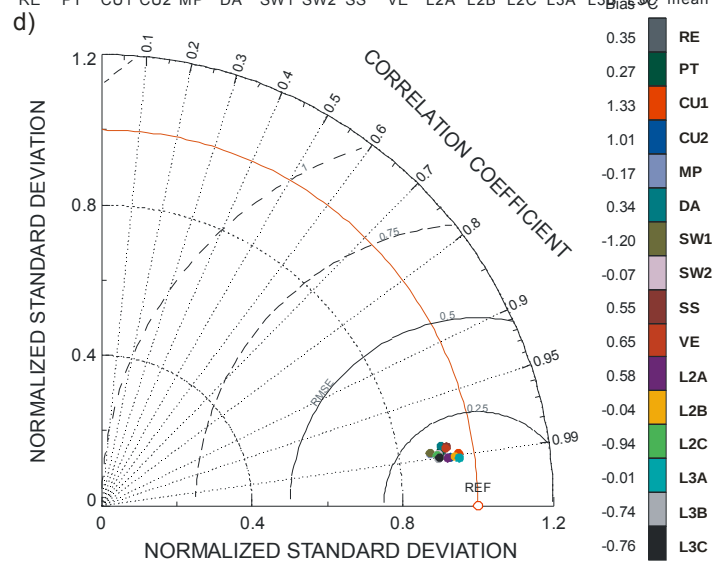
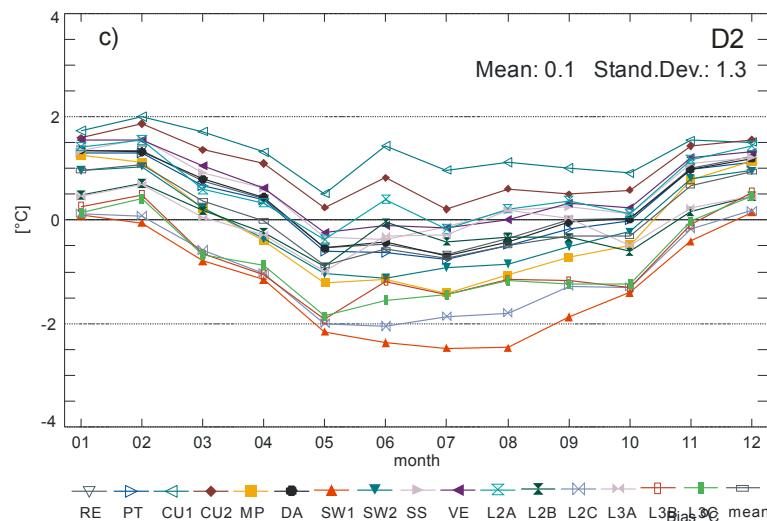
Results: Ensemble results (T_{2m})

Monthly mean biases MM5



Taylor-Plot MM5

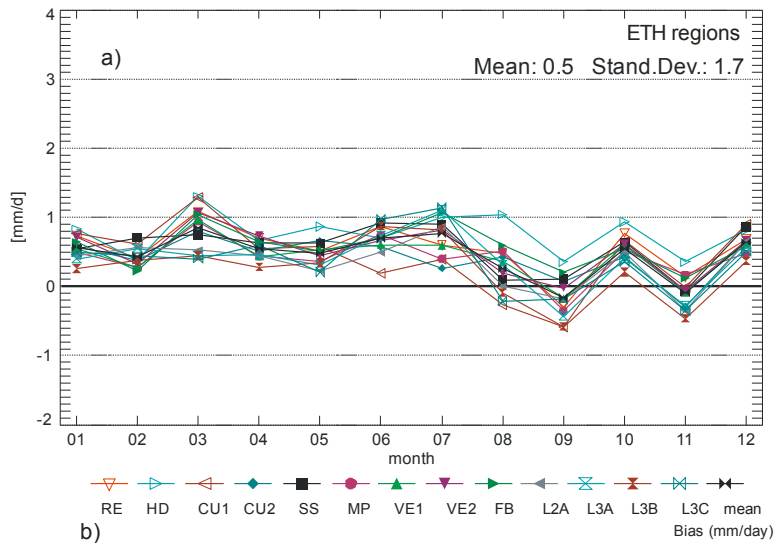
Monthly mean biases WRF



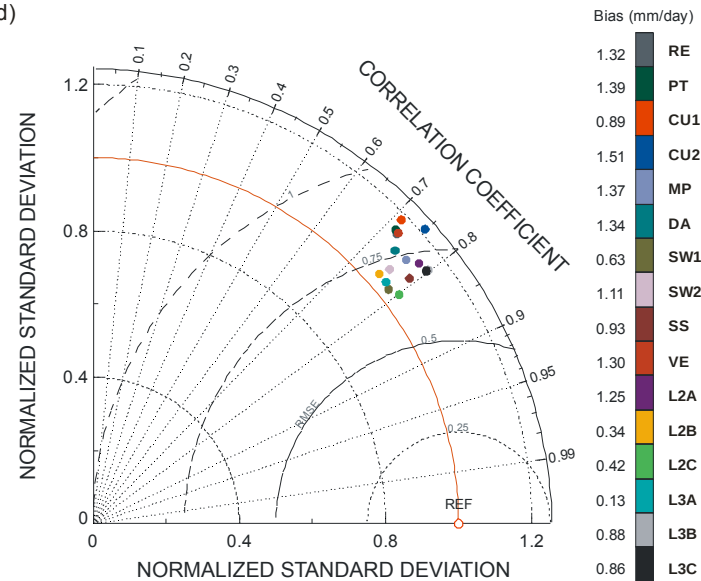
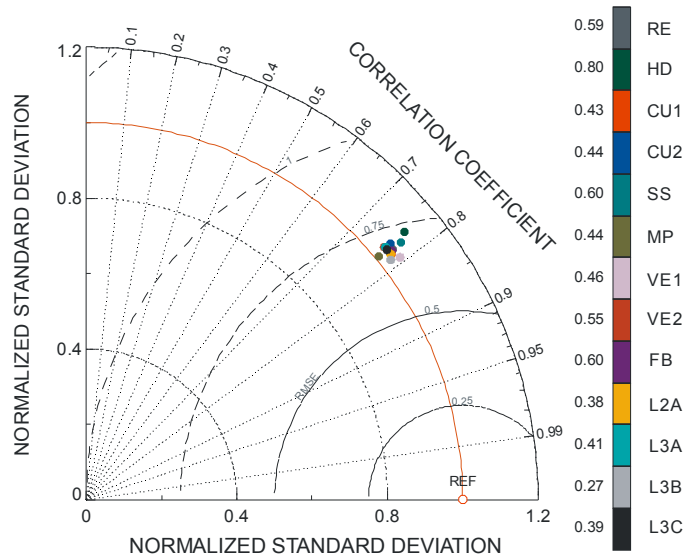
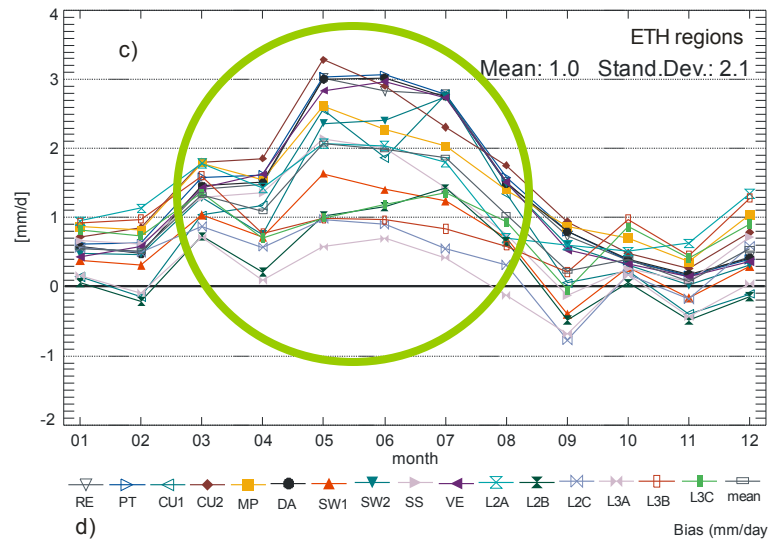
Taylor-Plot WRF

Results: Ensemble results (Precipitation)

Monthly mean biases MM5



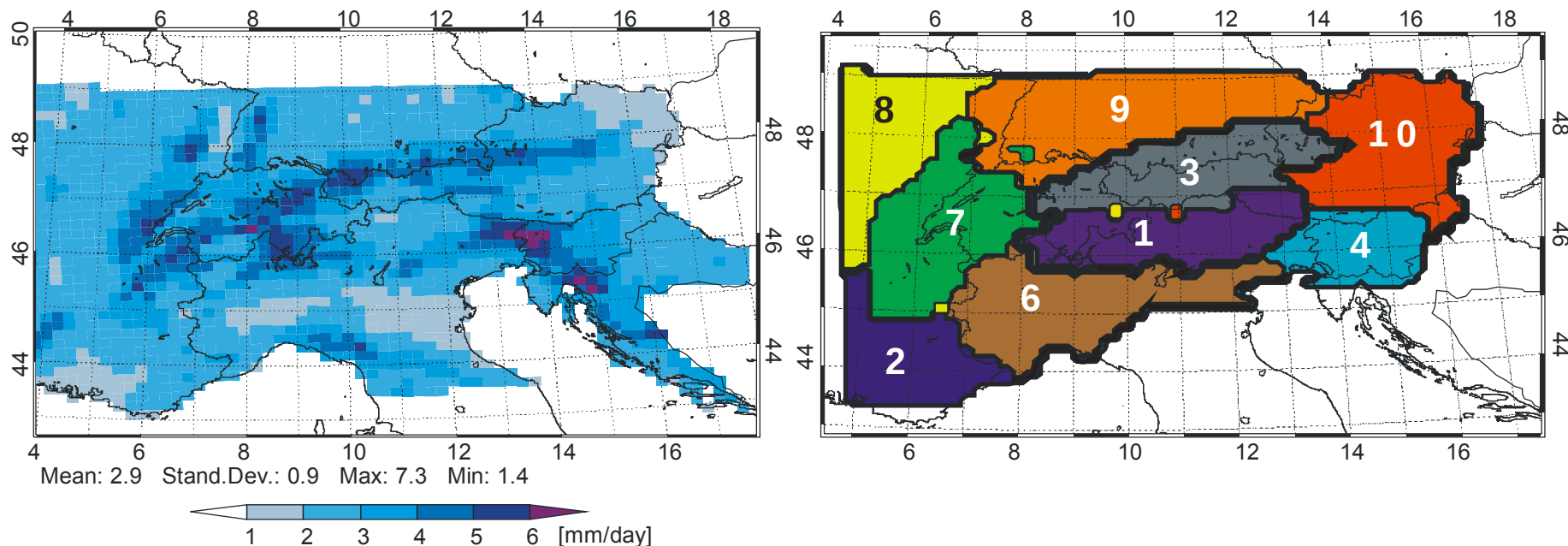
Monthly mean biases WRF



Taylor-Plot MM5

Taylor-Plot WRF

Results: Sub-regional analysis



On left observed annual mean precipitation (1979–1999). The plot on right showing the ten climatological sub-regions (no of grid-points shown in brackets) found by applying a clustering method. 1. “Alps South” [133] 2. “Provence” [163]. 3. “Alps North” [143]. 4. “Slovenia” [82]. 5. “Not in D2 therefore, it is excluded”. 6. “Padan Plain” [172]. 7. “Western Prealps” [160]. 8. “Bourgogne” [380]. 9. “Southern Germany” [208]. 10. “Alps East” [267]

Please refer to Suklitsch et. al. (2009) for details about clustering and regridding methods applied in this study

Results: Sub-regional Analysis, T_{2m}

L1

RE	-2.07	2.41	-1.56	-1.30	-1.48	-2.65	-2.23	-1.98	-2.29	-2.73
HD	-2.10	2.53	-1.75	-1.35	-1.48	-2.71	-2.21	-2.05	-2.22	-2.63
CU1	-2.82	3.25	-2.98	-2.15	-1.95	-2.95	-2.60	-3.08	-2.88	-3.55
CU2	-3.96	4.82	-4.09	-2.98	-3.09	-4.59	-4.13	-3.95	-3.78	-4.22
SS	-1.55	1.84	-1.12	-0.93	-0.84	-1.76	-1.42	-1.72	-1.92	-2.43
MP	-2.18	2.50	-1.69	-1.43	-1.59	-2.76	-2.42	-2.09	-2.40	-2.76
VE1	-2.03	2.28	-1.65	-1.30	-1.41	-2.47	-2.20	-2.02	-2.22	-2.71
VE2	-1.61	1.85	-1.20	-0.89	-1.02	-2.01	-1.84	-1.53	-1.86	-2.25
FB	-2.07	2.44	-1.59	-1.23	-1.42	-2.69	-2.30	-1.98	-2.22	-2.73
L2										
L2A	-1.57	1.83	-1.16	-0.98	-0.95	-1.82	-1.46	-1.62	-1.93	-2.34
L3										
L3A	-1.61	1.94	-1.20	-0.93	-0.99	-2.12	-1.56	-1.57	-1.89	-2.31
L3B	-1.72	2.12	-1.37	-1.08	-1.13	-2.15	-1.59	-1.69	-1.98	-2.37
L3C	-1.40	1.75	-0.95	-0.92	-0.82	-1.72	-1.32	-1.38	-1.80	-1.97
mean	-2.05	2.43	-1.72	-1.34	-1.40	-2.49	-2.10	-2.05	-2.26	-2.69

JJA

MM5

mean
Slovenia (4)
Alps East (10)
Alps North (3)
Alps South (1)
Padan Plain (6)
Provence (2)
South Germany (9)
Western Prealps (7)
Bourgogne (8)

L1

RE	-0.41	-0.47	0.04	0.33	0.36	-0.35	-0.52	-0.65	-0.75	-1.69
PT	-0.55	-0.53	-0.01	0.22	0.21	-0.51	-0.78	-0.82	-0.94	-1.83
CU1	1.12	1.02	1.80	1.71	1.51	0.97	0.66	1.28	0.59	0.58
CU2	0.59	0.63	1.08	1.12	1.14	0.87	0.51	0.43	0.03	-0.48
MP	-1.14	-1.15	-0.80	-0.41	-0.31	-1.21	-1.17	-1.47	-1.41	-2.30
DA	-0.43	-0.47	-0.01	0.29	0.35	-0.31	-0.59	-0.69	-0.80	-1.68
SW1	-2.21	-2.54	-2.04	-1.30	-1.26	-2.29	-2.17	-2.66	-2.23	-3.42
SW2	-0.85	-1.05	-0.44	-0.07	0.08	-0.86	-0.99	-1.19	-1.12	-1.99
SS	-0.12	-0.11	0.21	0.14	0.33	0.50	-0.00	-0.32	-0.73	-1.06
VE	-0.02	0.08	0.50	0.67	0.77	0.31	-0.23	-0.35	-0.47	-1.42
L2										
L2A	0.16	0.12	0.71	0.70	0.62	0.23	0.24	0.01	-0.30	-0.87
L2B	-0.22	-0.50	0.30	0.49	0.26	-0.52	-0.50	-0.15	-0.50	-0.85
L2C	-1.81	-2.07	-1.66	-1.34	-1.27	-1.62	-1.62	-2.07	-2.05	-2.62
L3										
L3A	-0.24	-0.47	0.21	-0.06	-0.11	-0.10	-0.22	-0.18	-0.72	-0.52
L3B	-1.32	-1.50	-0.92	-0.91	-1.04	-1.30	-1.29	-1.40	-1.68	-1.88
L3C	-1.42	-1.63	-1.01	-0.99	-1.09	-1.39	-1.42	-1.44	-1.78	-2.01
mean	-0.55	-0.67	-0.13	0.04	0.03	-0.47	-0.63	-0.73	-0.93	-1.50

WRF

mean
Slovenia (4)
Alps East (10)
Alps North (3)
Alps South (1)
Padan Plain (6)
Provence (2)
South Germany (9)
Western Prealps (7)
Bourgogne (8)

Results: Precipitation, Summer

JJA

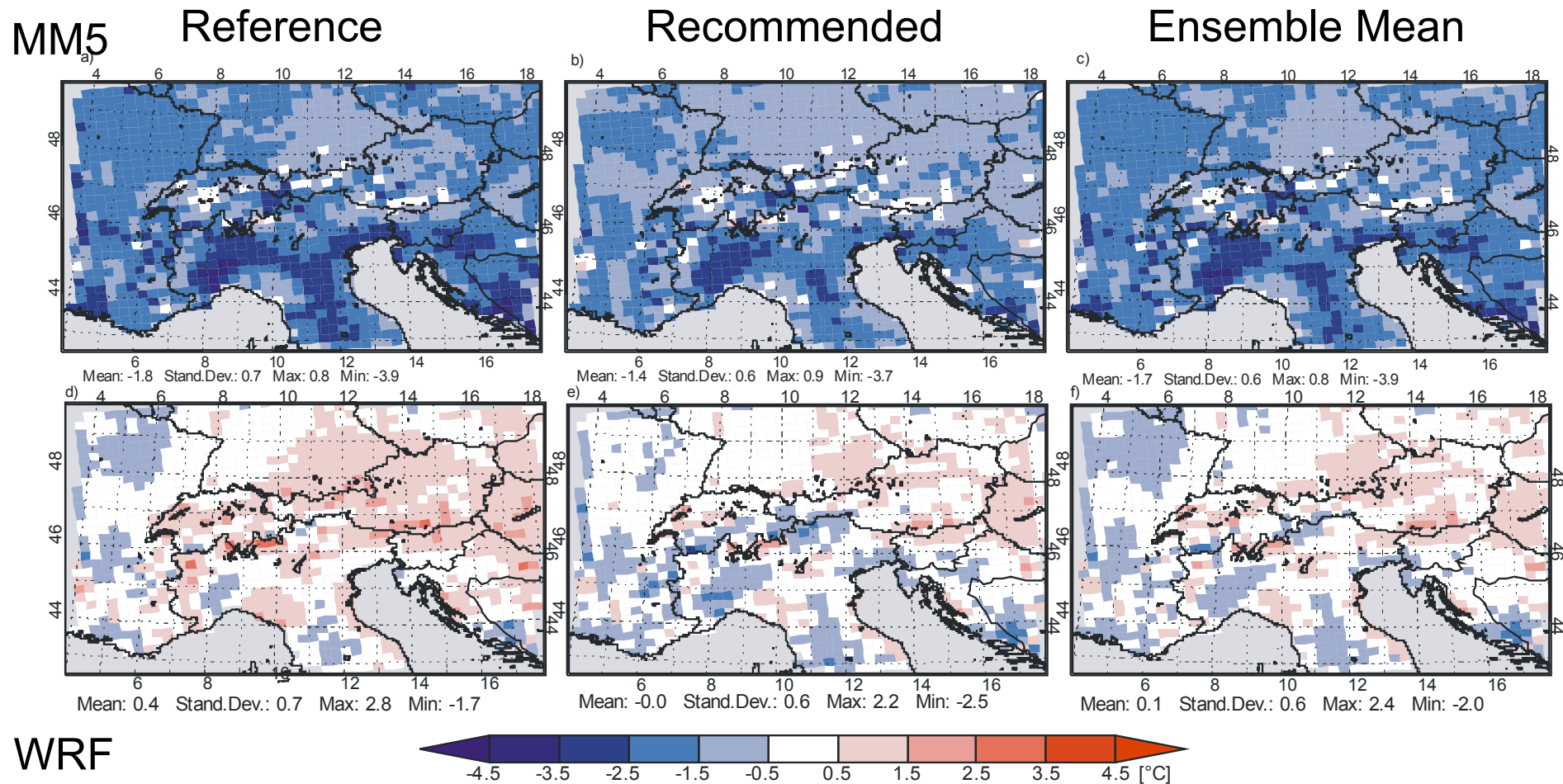
L1	RE	HD	CU1	CU2	SS	MP	VE1	VE2	FB	L2	L2A	L3	L3A	L3B	L3C	mean	
	0.69	1.11	0.98	0.61	0.57	0.28	0.93	0.29	0.60	0.87							
	1.00	1.83	1.69	1.16	1.03	0.29	1.06	0.38	0.78	0.80							
	0.06	-0.65	-0.07	-0.00	0.35	0.02	0.36	-0.40	0.03	0.87							
	0.36	-0.49	-0.50	-0.38	-0.10	0.70	1.53	0.23	0.72	1.50							
	0.67	0.38	0.35	1.37	1.29	0.47	0.74	-0.10	0.90	0.63							
	0.62	1.75	1.10	0.51	-0.14	0.12	1.13	0.23	0.27	0.63							
	0.50	0.12	1.03	0.34	0.16	0.40	1.23	0.19	0.39	0.67							
	0.57	0.62	0.85	0.72	0.12	0.27	1.03	0.30	0.50	0.70							
	0.84	1.45	1.02	0.81	0.39	0.76	1.36	0.30	0.73	0.67							
L2																	
L2A	0.47	0.27	0.28	0.37	0.98	0.53	0.72	-0.05	0.62	0.49							
L3																	
L3A	0.74	0.50	0.44	0.67	1.51	1.08	1.05	0.03	0.90	0.44							
L3B	0.54	0.02	-0.32	0.46	1.35	0.76	1.03	0.05	1.05	0.48							
L3C	0.70	1.38	0.71	0.40	0.89	0.69	1.02	0.04	0.86	0.30							
mean	0.60	0.64	0.58	0.54	0.65	0.49	1.01	0.12	0.64	0.70							
	mean	(4) Slovenia	(10) Alps East	(3) Alps North	(1) Alps South	(6) Padan Plain	(2) Provence	(9) South Germany	(7) Western Prealps	(8) Bourgogne							

MM5

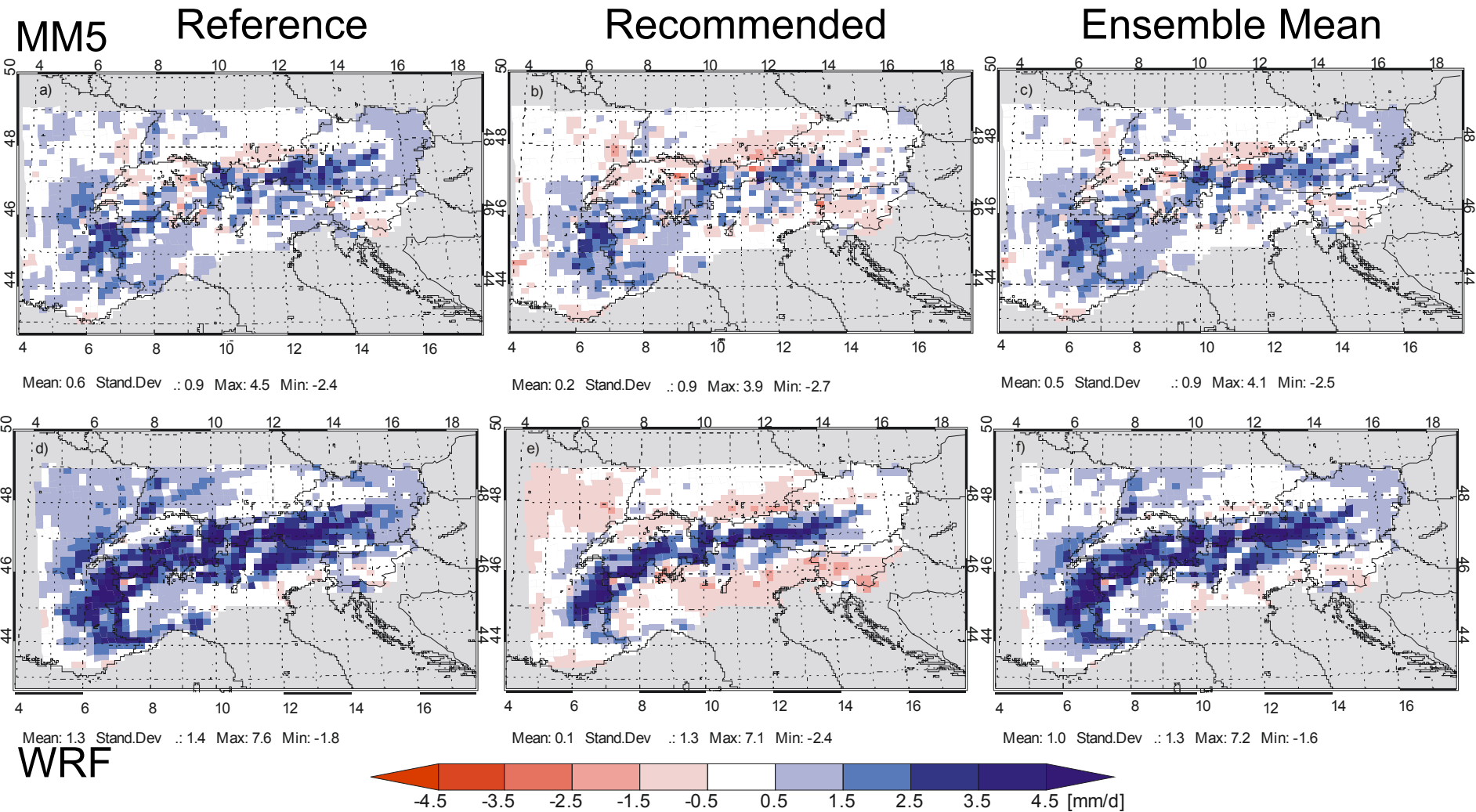
L1	RE	PT	CU1	CU2	MP	DA	SW	SS	VE	L2	L2A	L2B	L2C	L3	L3A	L3B	L3C	mean	
	2.37	1.06	1.61	3.50	4.35	2.11	1.81	1.4	3.08	2.43									
	2.43	0.77	1.58	3.70	4.14	2.34	1.83	1.8	3.03	2.63									
	1.95	0.12	1.98	3.99	2.66	1.62	2.02	1.4	2.43	1.21									
	2.31	0.93	3.27	4.95	3.90	0.92	1.21	1.2	2.81	1.43									
	1.91	0.9	0.81	2.08	4.00	2.37	1.81	1.3	1.93	1.95									
	2.41	0.94	1.89	3.76	4.32	2.01	2.01	1.5	3.12	2.15									
	1.21	1.63	0.44	1.03	2.29	1.67	1.46	-0.0	1.38	0.99									
	1.32	-0.4	1.21	3.70	2.08	0.42	0.66	1.2	2.10	0.89									
	2.36	0.37	1.84	3.84	4.10	1.50	2.00	1.9	3.23	2.42									
L2																			
L2A	1.47	0.0	1.21	3.37	2.35	0.86	1.04	1.0	2.10	1.18									
L2B	1.07	0.37	1.81	2.32	1.42	0.77	0.98	0.5	0.93	0.42									
L2C	0.60	-0.1	0.52	1.61	1.29	0.04	0.67	-0.0	1.11	0.34									
L3																			
L3A	0.27	-0.8	0.73	2.00	0.03	0.64	-0.10	0.2	0.79	0.19									
L3B	0.73	-0.6	0.63	2.84	0.61	0.10	0.59	0.9	1.40	0.41									
L3C	1.11	-0.2	1.30	3.29	1.37	0.24	0.85	1.0	1.58	0.53									
mean	1.57	0.32	1.39	3.07	2.59	1.08	1.26	1.0	2.07	1.28									
	mean	(4) Slovenia	(10) Alps East	(3) Alps North	(1) Alps South	(6) Padan Plain	(2) Provence	(9) South Germany	(7) Western Prealps	(8) Bourgogne									

WRF

Results: Annual mean T_{2m}



Results: Annual mean precipitation



Summary of key findings

- The results clearly indicate that significant improvements can be achieved by choosing a suitable parameterization settings.
- All parameterizations (not only cumulus) significantly effect the climate simulations.
- There is less effect of parameterization in winter and autumn than in spring and summer seasons.
- MM5 results have less spread within the ensemble members, i.e. error range is smaller for MM5
- Both models show a strong convective response to orography, resulting in an intensification of summer precipitation in the Alpine region. This is more prominent in WRF results than MM5.
- The annual D2 mean error range is between -2.75°C and -1.08°C (-1.12°C and 1.33°C) and 0.80 mm/day and 0.27 mm/day (1.51 mm/day and 0.13 mm/day) for MM5 (WRF) T_{2m} and precipitation respectively.
- The annual D2 mean error for recommended setting is -1.4°C (0°C) and 0.2 mm/day (0.1 mm/day) for MM5 (WRF) (however seasonal and sub-regional errors are larger).

Thanks for your attention!

For details please have a look at poster P3A.15



FWF

