wege entstehen, indem wir sie gehen
ways emerge in that we go them

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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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Outline of today's talk

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

Brief Overview

WRF (Skamarock et.al. 2005)

MM5 (Dudhia 1993)

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

D1, grid-spacing 30 km

D2, grid-spacing 10 km

Simulation start, 1st Oct, 1998

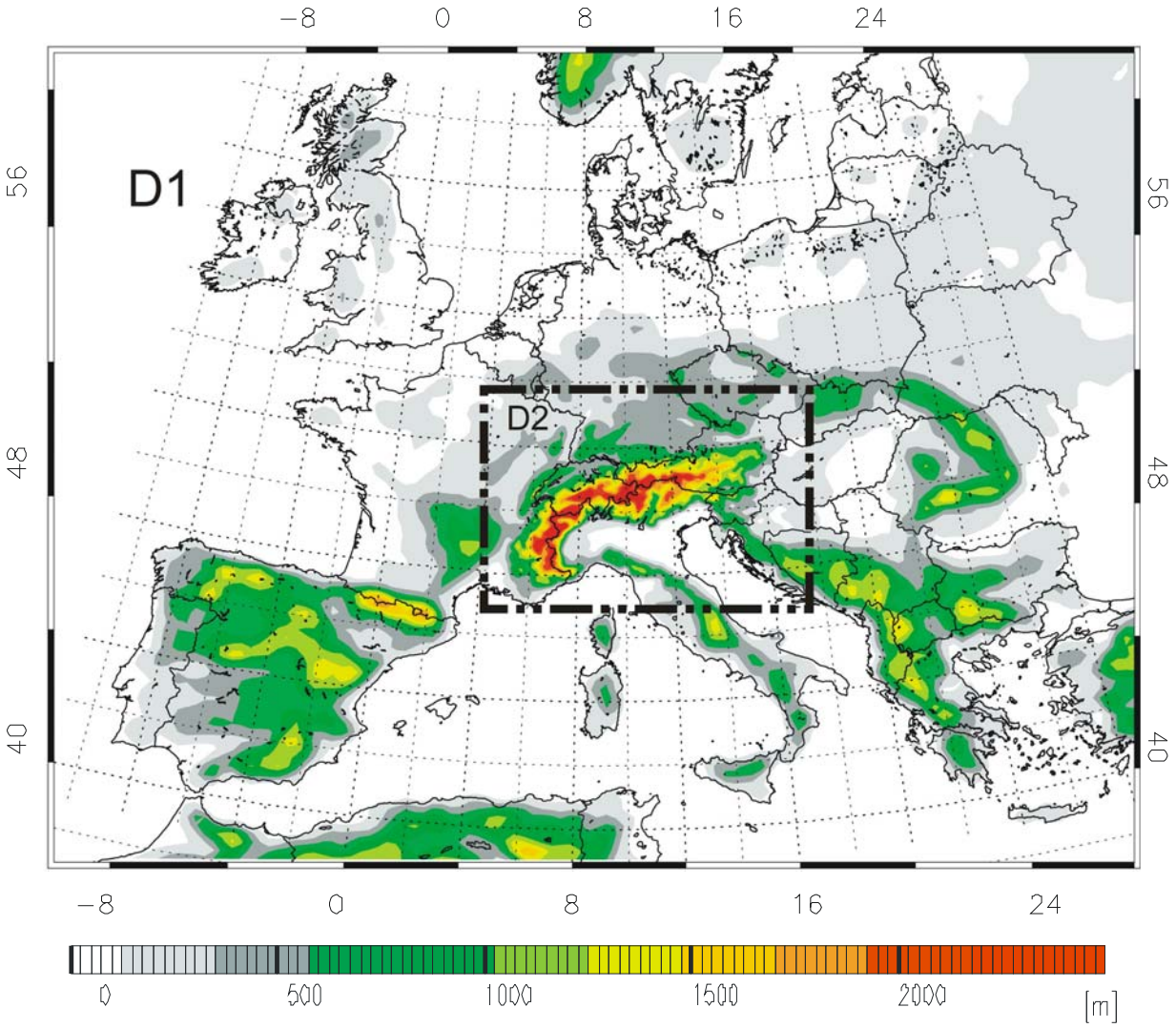
Simulation end, 1st Jan, 2000

Spin-up: 3 months

Evaluation year, 1999

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

ETH (Frei and Schär, 1998)



Experiment Design

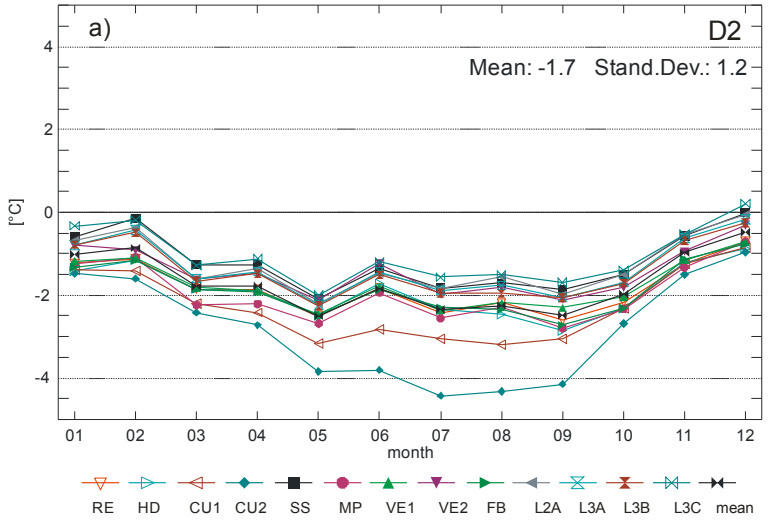
The MM5 and WRF ensemble members with key parameterization settings

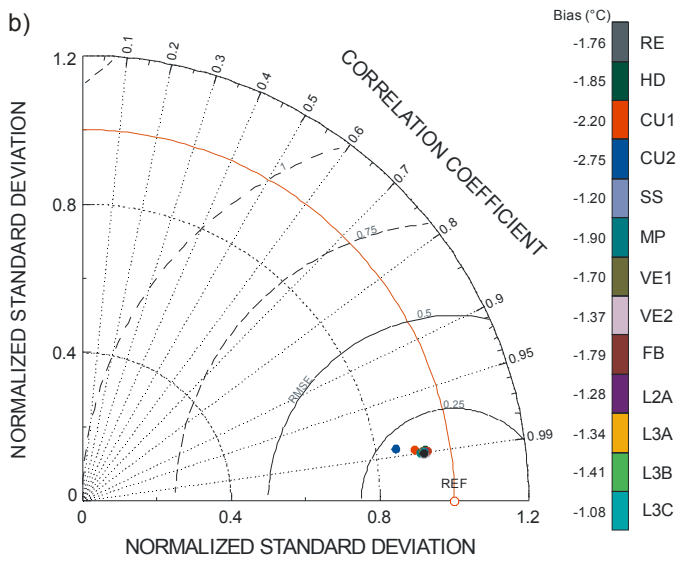
Exp	Physical Parameterization Settings (MM5)
RE	KF, REISNER 1, RRTM, ETA PBL, NOAH LSM, shallow convection, Vertical levels: 30, SST & Feedback Off, Pressure at model top: 100 mb
HD	Zängel z–diffusion
CU1	BM
CU2	GR (no shallow convection)
SS	MRF PBL
MP	REISNER 2
VE1	Vertical Levels: 40
VE2	Vertical Levels: 20
FB	Feedback On
L2A	REISNER 2, MRF PBL
L3A	REISNER 2, MRF PBL, Feedback On
L3B	REISNER 2, MRF PBL, Feedback On, Vertical Levels: 40
L3C	REISNER 2, MRF PBL, Feedback On, Vertical Levels: 20

Exp	Physical Parameterization Settings (WRF)
RE	GD, FERRIER, GODDARD, RRTM, MOJ, NOAH, MYJ, Vertical levels: 30, SST & feedback On, Pressure at model top: 50 mb
PT	Pressure at model top: 100 mb
CU1	KF
CU2	BMJ
MP	WSM6
DA	Model filter: Damping on
SW1	DUDHIA
SW2	GFDL
SS	MOS, YSU
VE	Vertical Levels: 20
L2A	BMJ, WSM6
L2B	KF, MOS, YSU
L2C	KF, DUDHIA
L3A	KF, MOS, YSU, DUDHIA
L3B	KF, MOS, YSU, DUDHIA, WSM6
L3C	KF, MOS, YSU, DUDHIA, THOMSON

Results: Ensemble results (T_{2m})

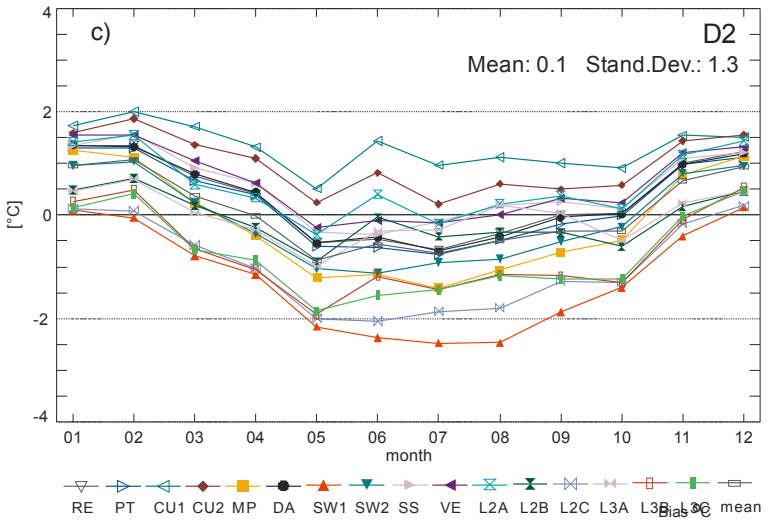
Monthly mean biases MM5

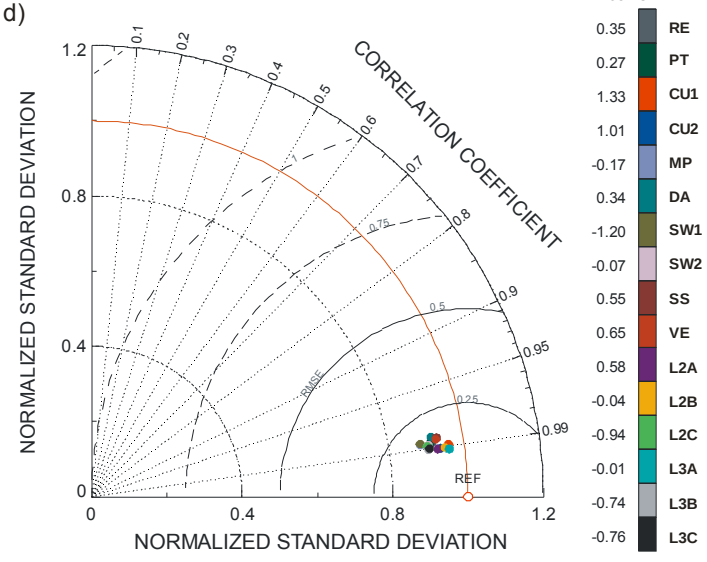




Taylor-Plot MM5

Monthly mean biases WRF

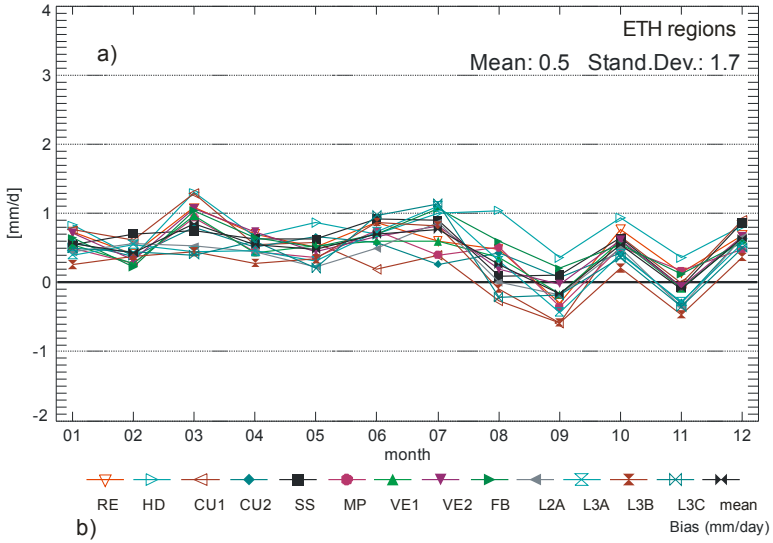




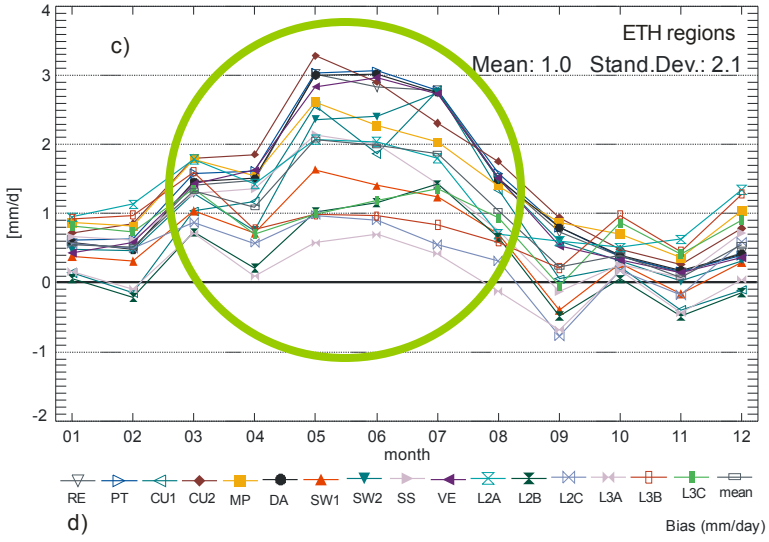
Taylor-Plot WRF

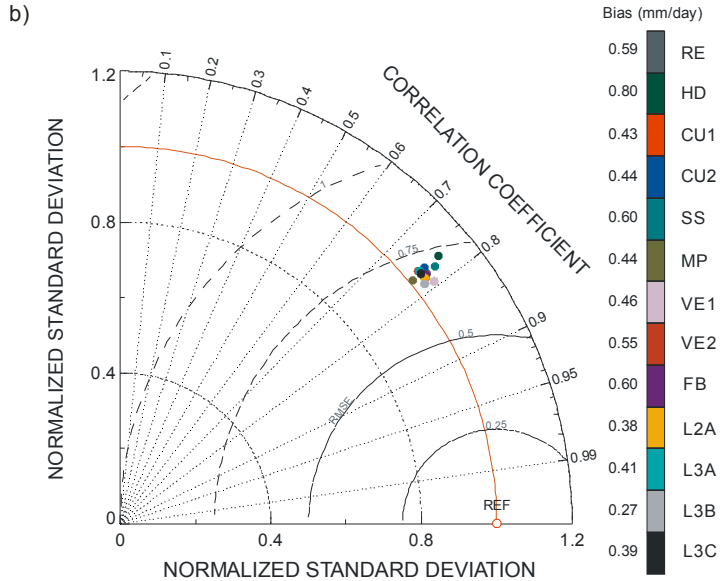
Results: Ensemble results (Precipitation)

Monthly mean biases MM5

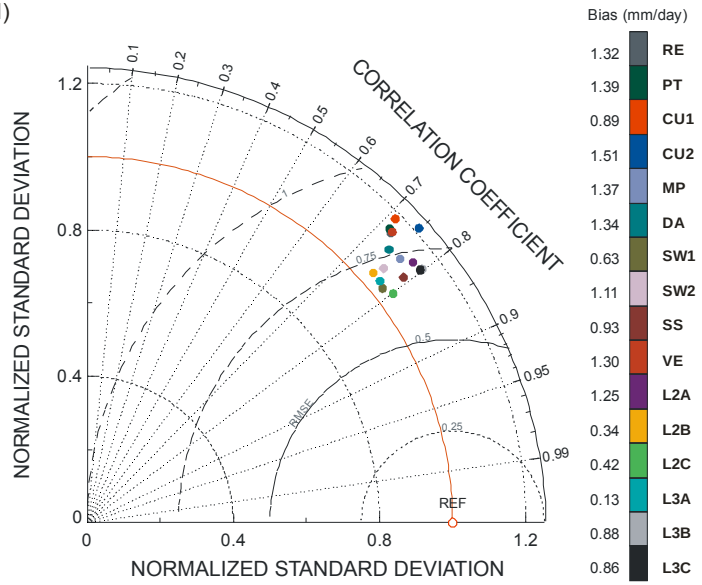


Monthly mean biases WRF



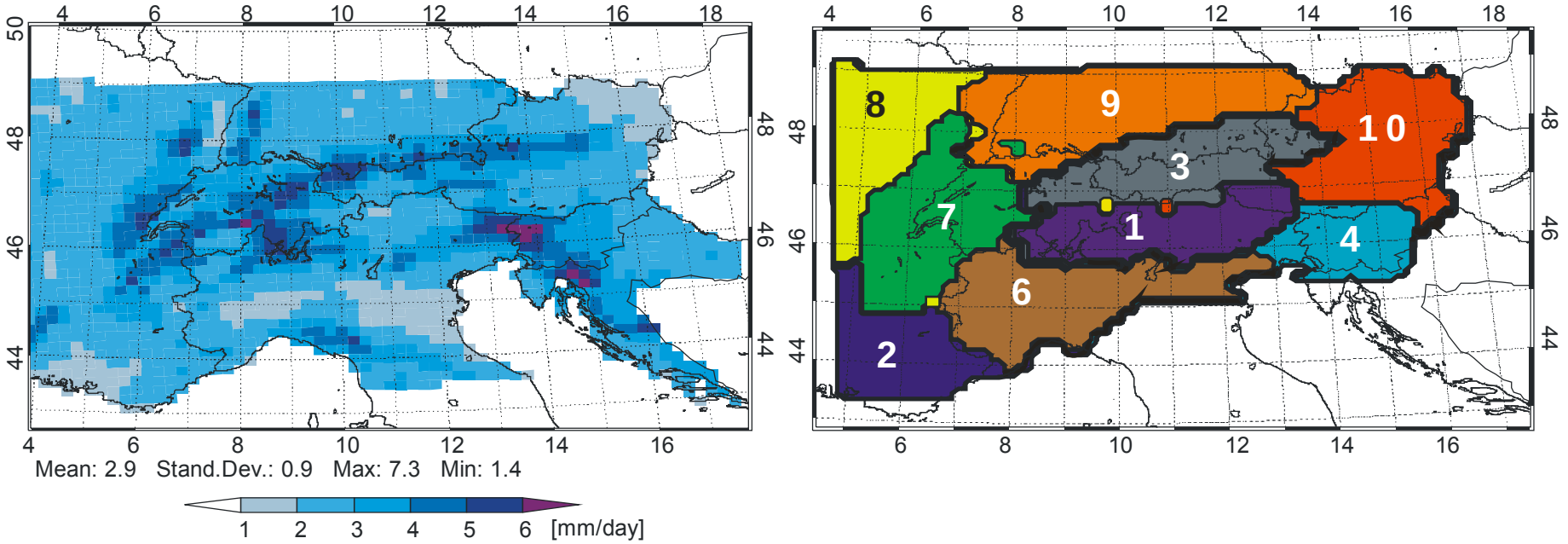


Taylor-Plot MM5



Taylor-Plot WRF

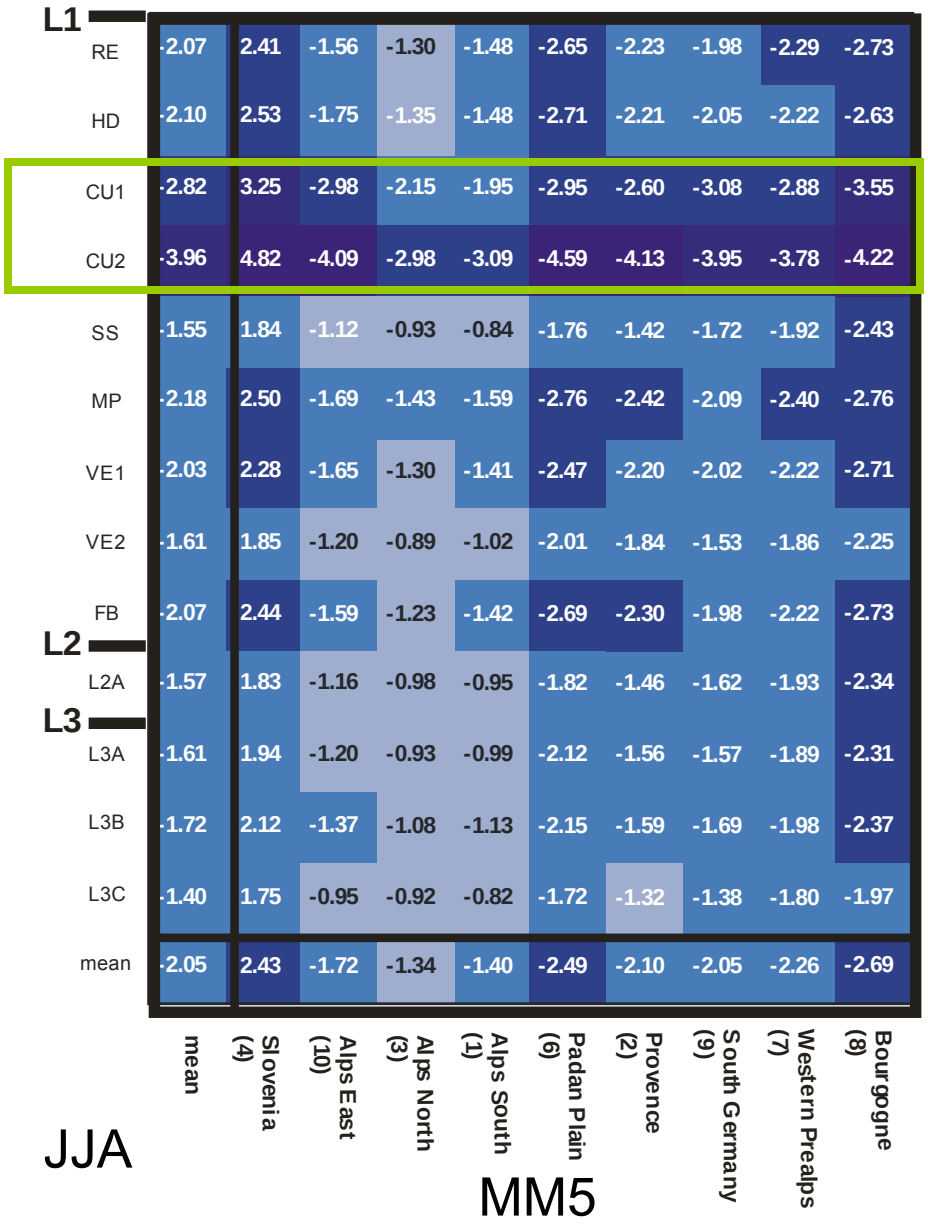
Results: Sub-regional analysis

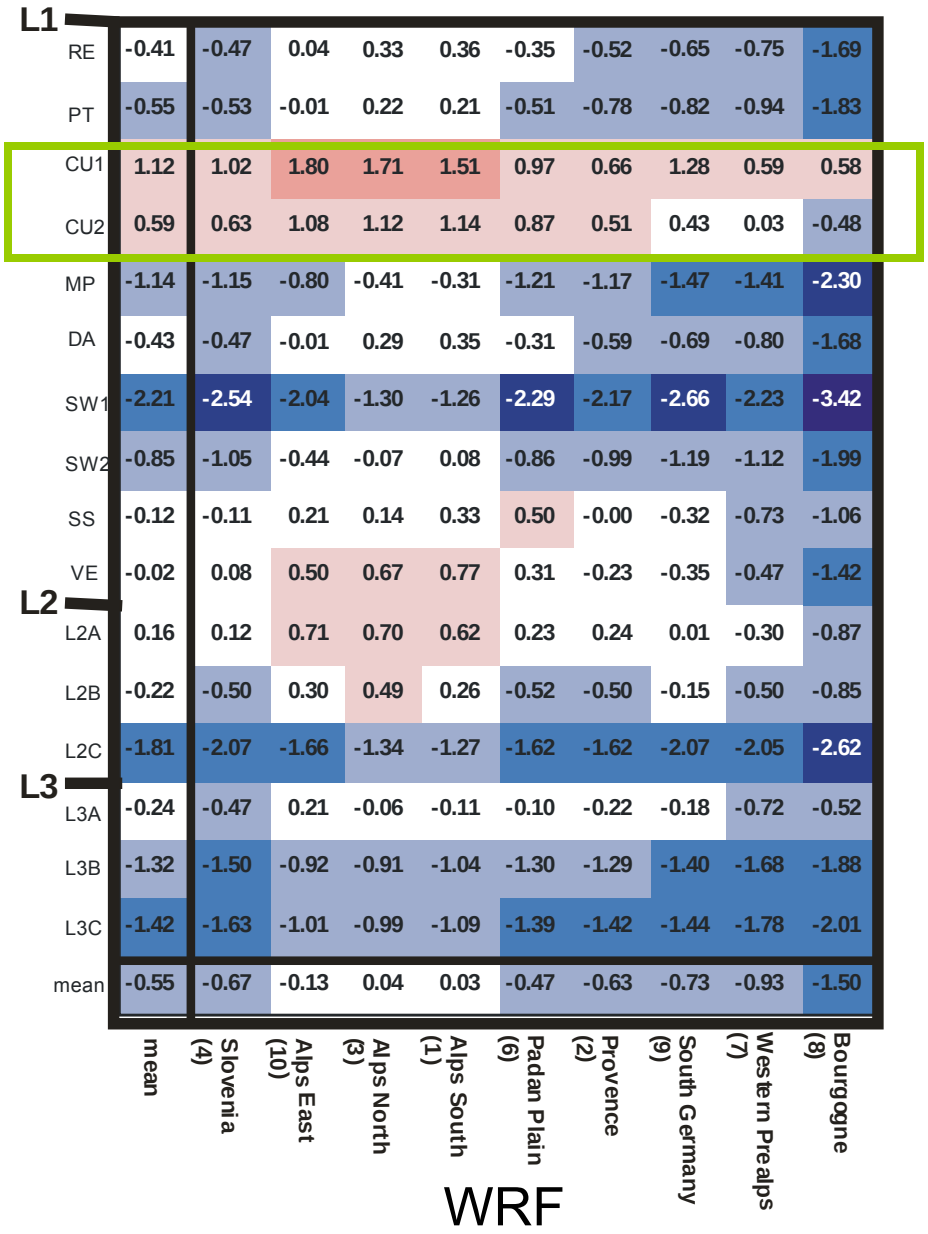


On left observed annual mean precipitation (1979–1999). The plot on right showing the ten climatological sub-regions (no of grid-points shown in brackets) found by applying a clustering method. 1. “Alps South” [133] 2. “Provence” [163]. 3. “Alps North” [143]. 4. “Slovenia” [82]. 5. “Not in D2 therefore,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

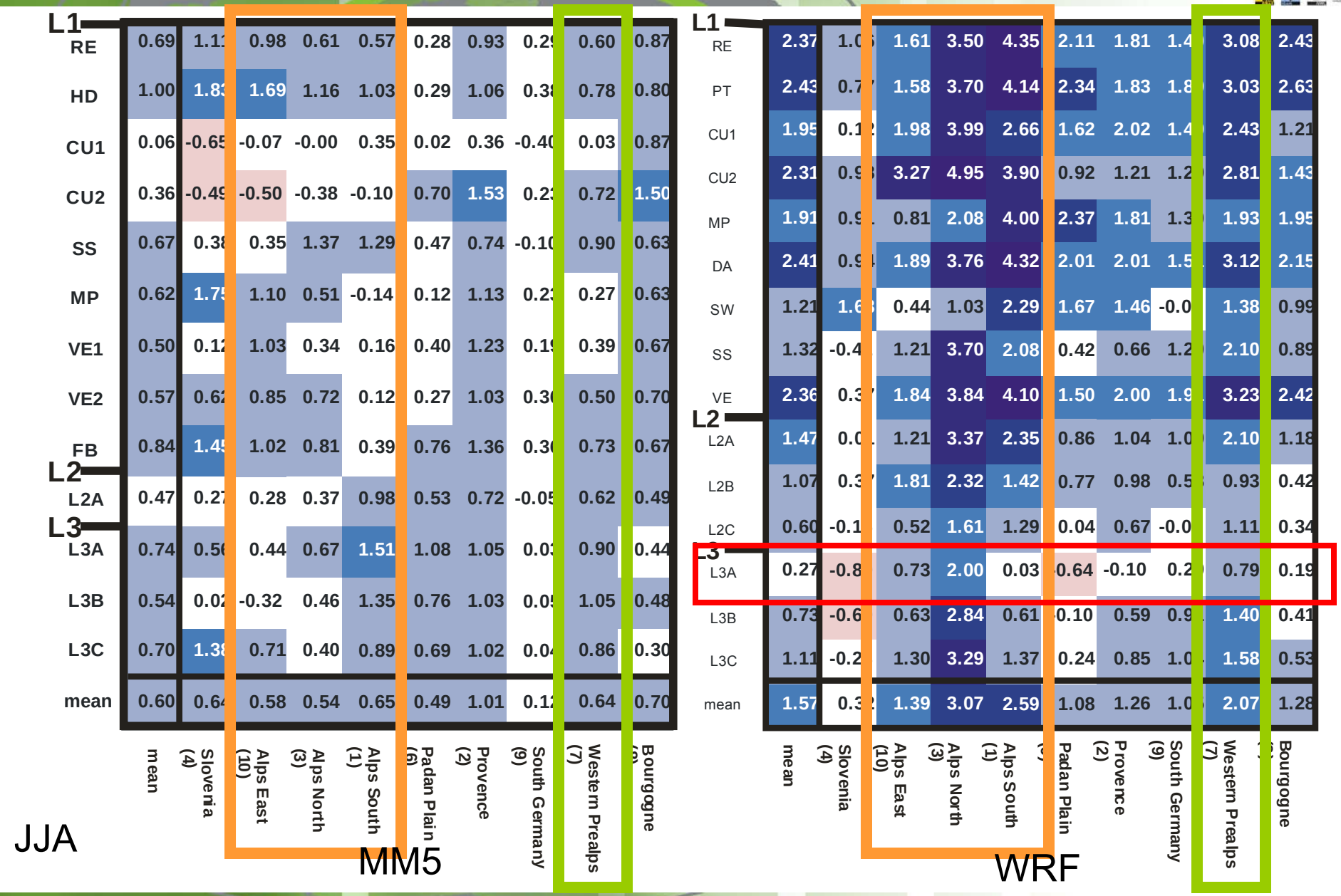
Please refer to Suklitsch et. al. (2009) for details about clustering and regridding methods applied in this study

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





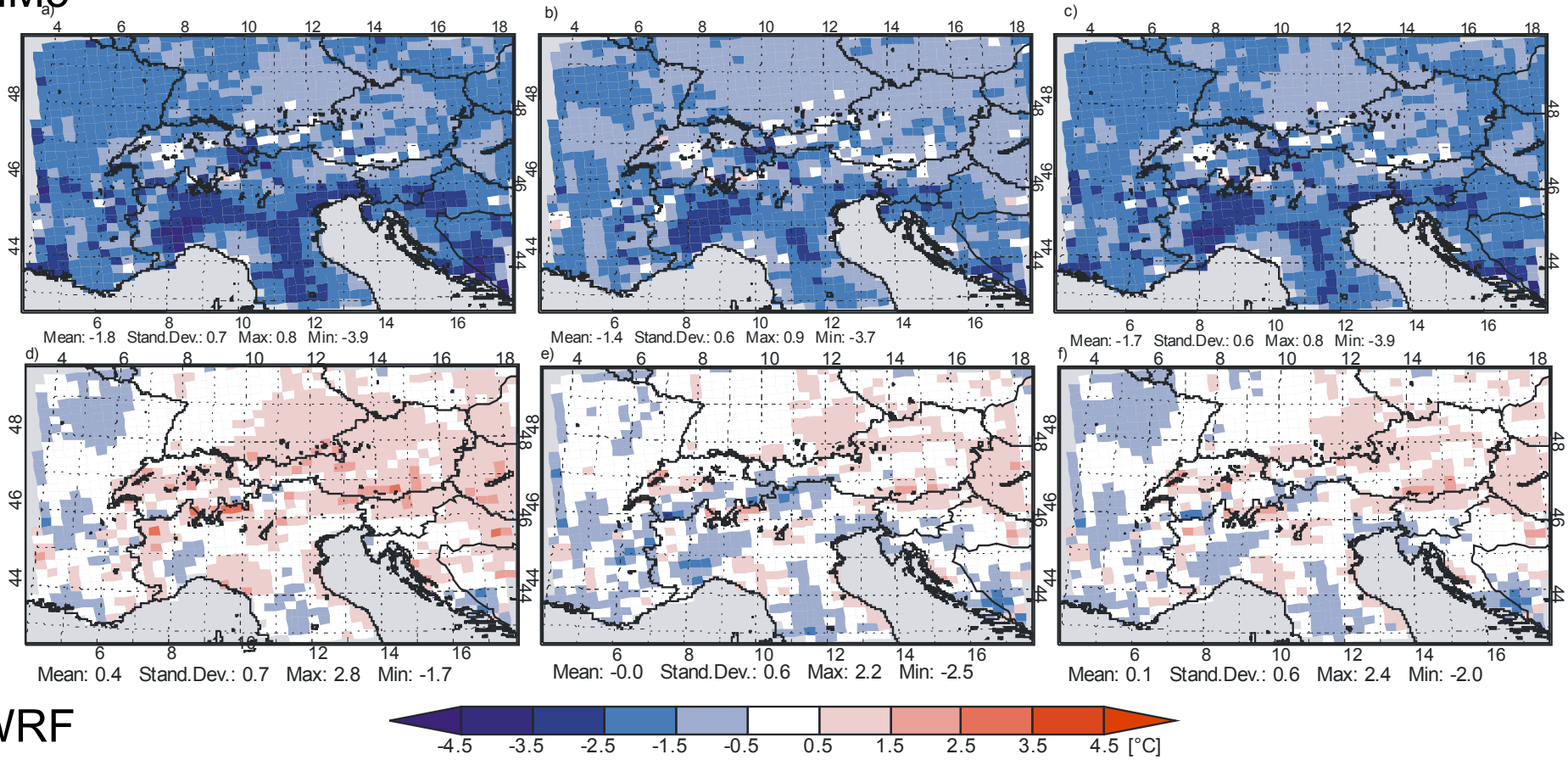
Results: Preicpitation, Summer



Results: Annual mean T_{2m}

MM5

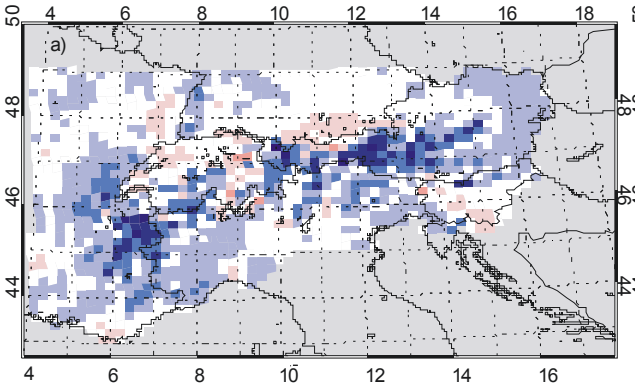
WRF



Results: Annual mean precipitation

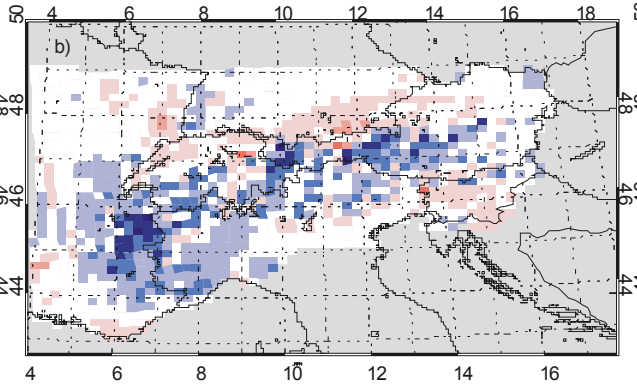
MM5

Reference



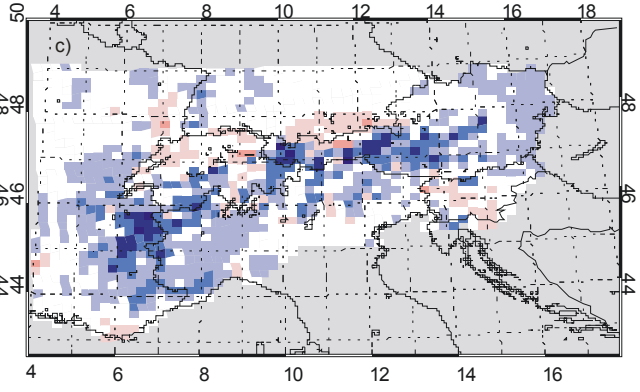
Mean: 0.6 Stand.Dev .: 0.9 Max: 4.5 Min: -2.4

Recommended



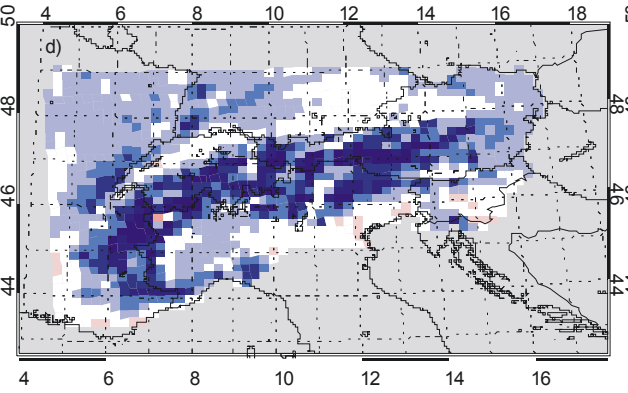
Mean: 0.2 Stand.Dev .: 0.9 Max: 3.9 Min: -2.7

Ensemble Mean

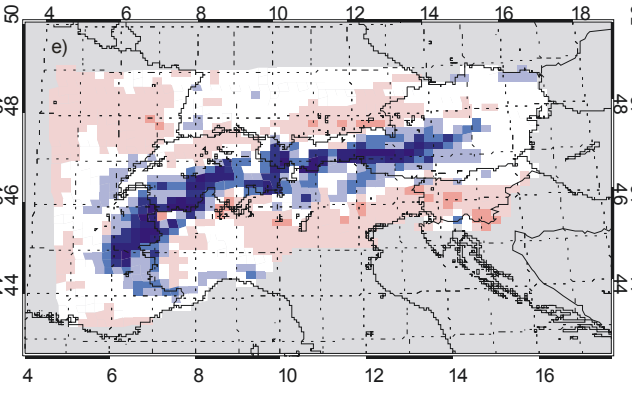


Mean: 0.5 Stand.Dev .: 0.9 Max: 4.1 Min: -2.5

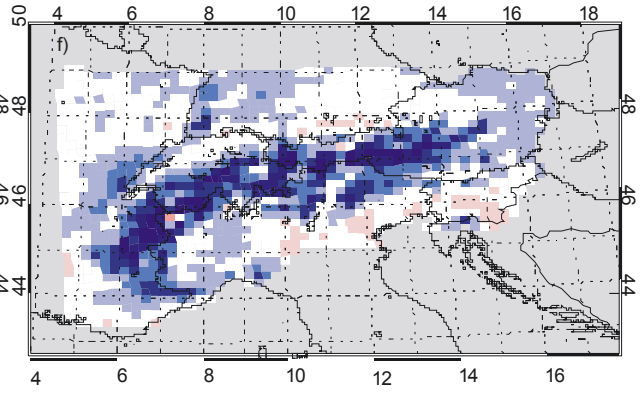
WRF



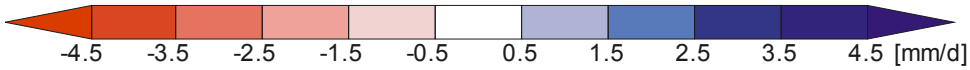
Mean: 1.3 Stand.Dev .: 1.4 Max: 7.6 Min: -1.8



Mean: 0.1 Stand.Dev .: 1.3 Max: 7.1 Min: -2.4



Mean: 1.0 Stand.Dev .: 1.3 Max: 7.2 Min: -1.6



Summary of key findings

- The results clearly indicate that significant improvements can be achieved by choosing a suitable parameterization settings.
- All paramterizations (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 ^{o}C and -1.08 ^{o}C (−1.12 ^{o}C and 1.33 ^{o}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 ^{o}C (0 ^{o}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

ÖAD