Climate Limited-area Modelling Community

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

The comparison of the COSMO-CLM and COSMO-EU

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- overview of the project
- simulation design
- results:
  - climatological evaluation with gridded datasets
  - standard NWP verification with SYNOP data
  - special site validation in Lindenberg
  - convergence
- summary and outlook

overview of the project

Project PCCEVAL

- the model COSMO-CLM is used in both weather forecast and regional climate modelling
- idea to compare the same model in both modes and learn from each other

Aims of this study

investigation of the **predictive quality** of the COSMO-CLM simulations in climate configuration compared to routine forecasts

analysis of the **error growth** with increasing lead time in comparison of COSMO-CLM and COSMO-EU

investigation of the **convergence** of the NWP to the climate mode

simulation design

3 types of simulations

CCLM-NWP

weather forecast mode

daily forecasts for 2009, starting 00UTC

configuration of IPCC-AR5 simulations

COSMO-EU

operational weather forecast version

daily forecasts for 2009, starting 00UTC

standard NWP configuration

CCLM-Climate

climate version

continuous simulation for 2009

configuration of IPCC-AR5 simulations

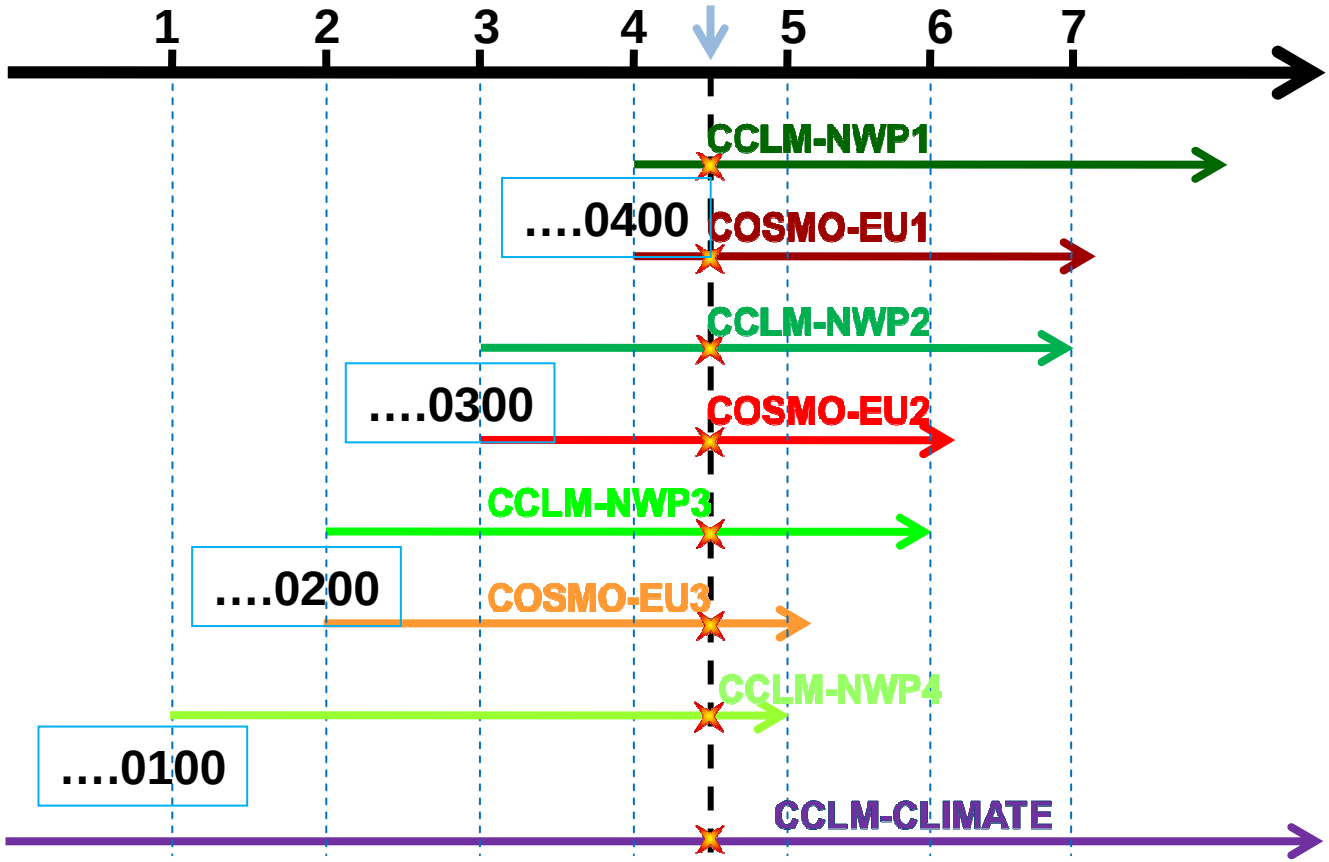
	CCLM-NWP	COSMO-EU	CCLM-Climate
INT2LMsource code	INT2LM1.10 CLM6 gme-ml	—	INT2LM1.10 CLM6 gme-ml
COSMO source code	COSMO4.8 CLM17	COSMO4.6 – 4.10	COSMO4.8 CLM17
simulation period	01.01.2009 –31.12.2009	01.01.2009 –31.12.2009	01.10.2008 –31.12.2009
analysis period	——— 01.01.2009 —— 31.12.2009 ———		
forcing	GME forecast	GME forecast	GME analysis
domain	IPCC-AR5-EU	COSMO-EU	IPCC-AR5-EU
grid spacing	0.11◦ (12 km)	0.0625◦ (7 km)	0.11◦ (12 km)
forecasting period	96 h (4 Days)	78 h (~ 3Days)	—
configuration (namelist settings)	IPCC-AR5-EU	COSMO-EU	IPCC-AR5-EU
Data assimilation	☑	☑	☒
soil moisture analysis	☑	☑	☒

3 simulations → 8 model realizations

COSMO-EU:
3 different
forecast ages

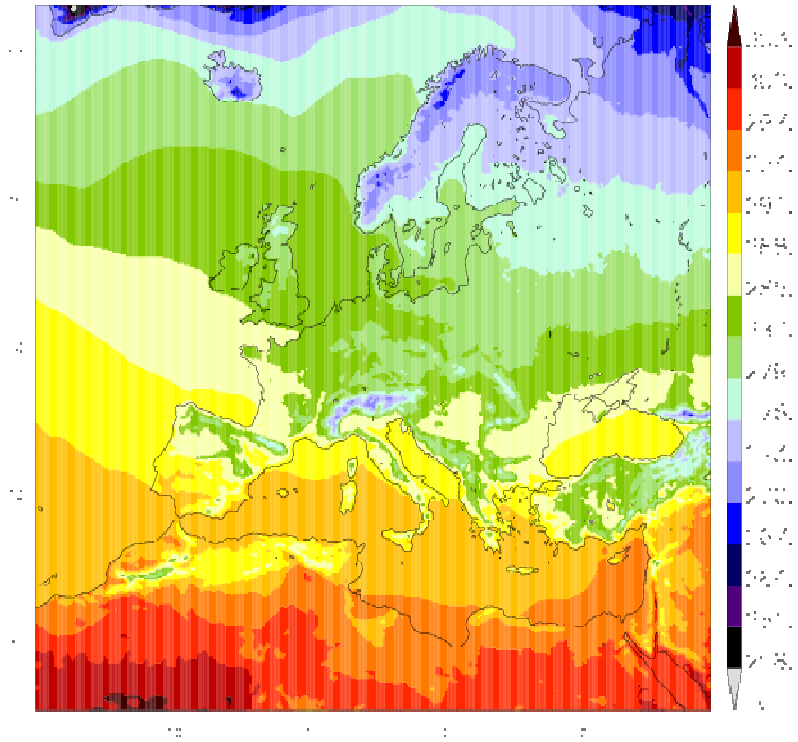
CCLM-NWP:
4 different
forecast ages

CCLM-Climate:
1 simulation

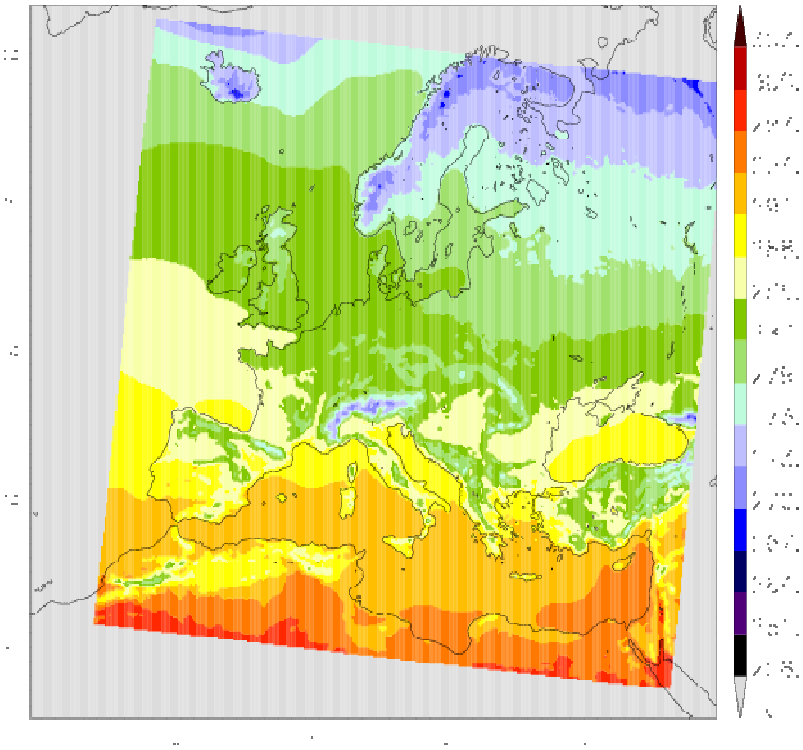


2 model domains

EURO-CORDEX domain



COSMO-EU domain



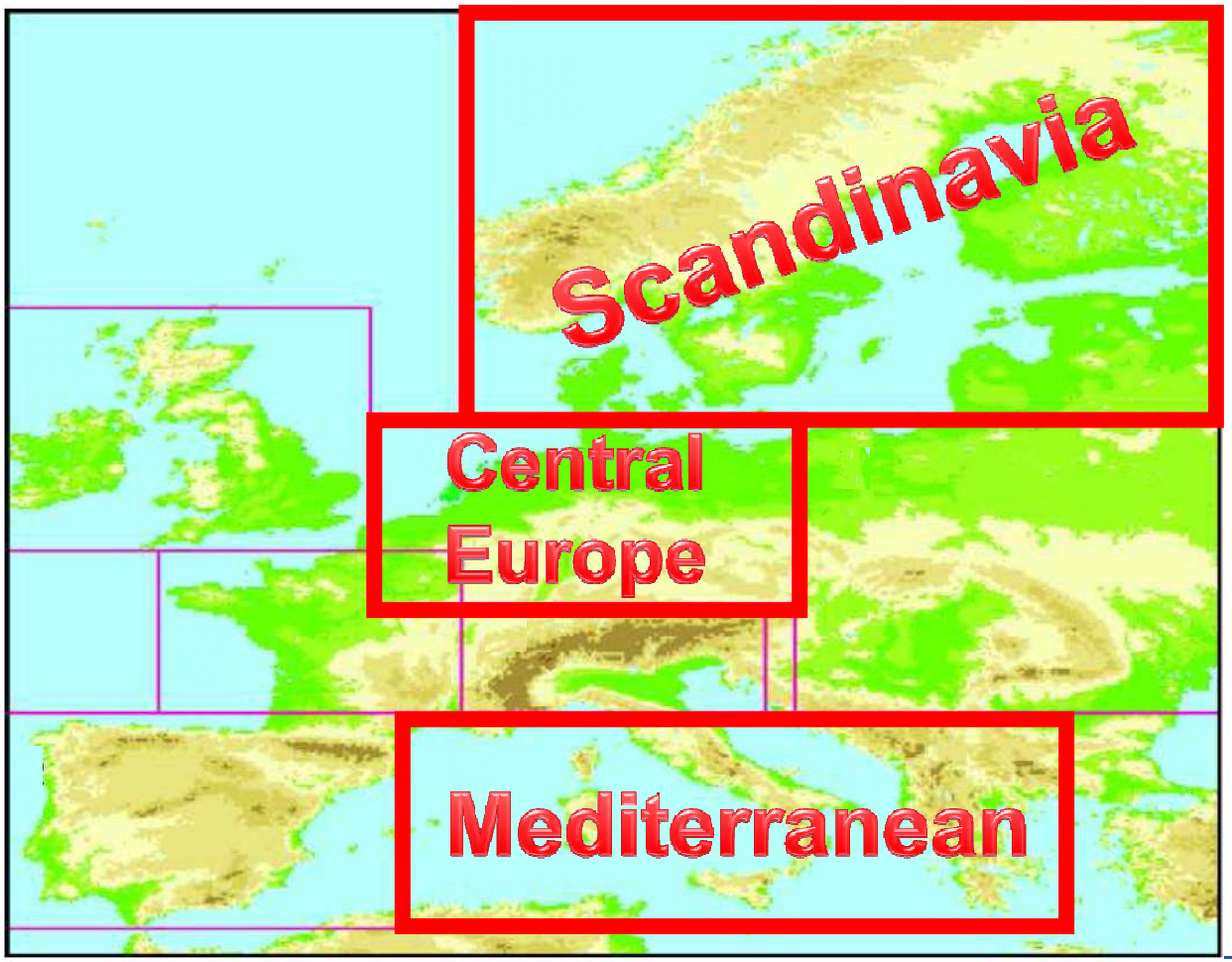
results: climatological evaluation with gridded datasets

where: Europe and 3 selected subregions

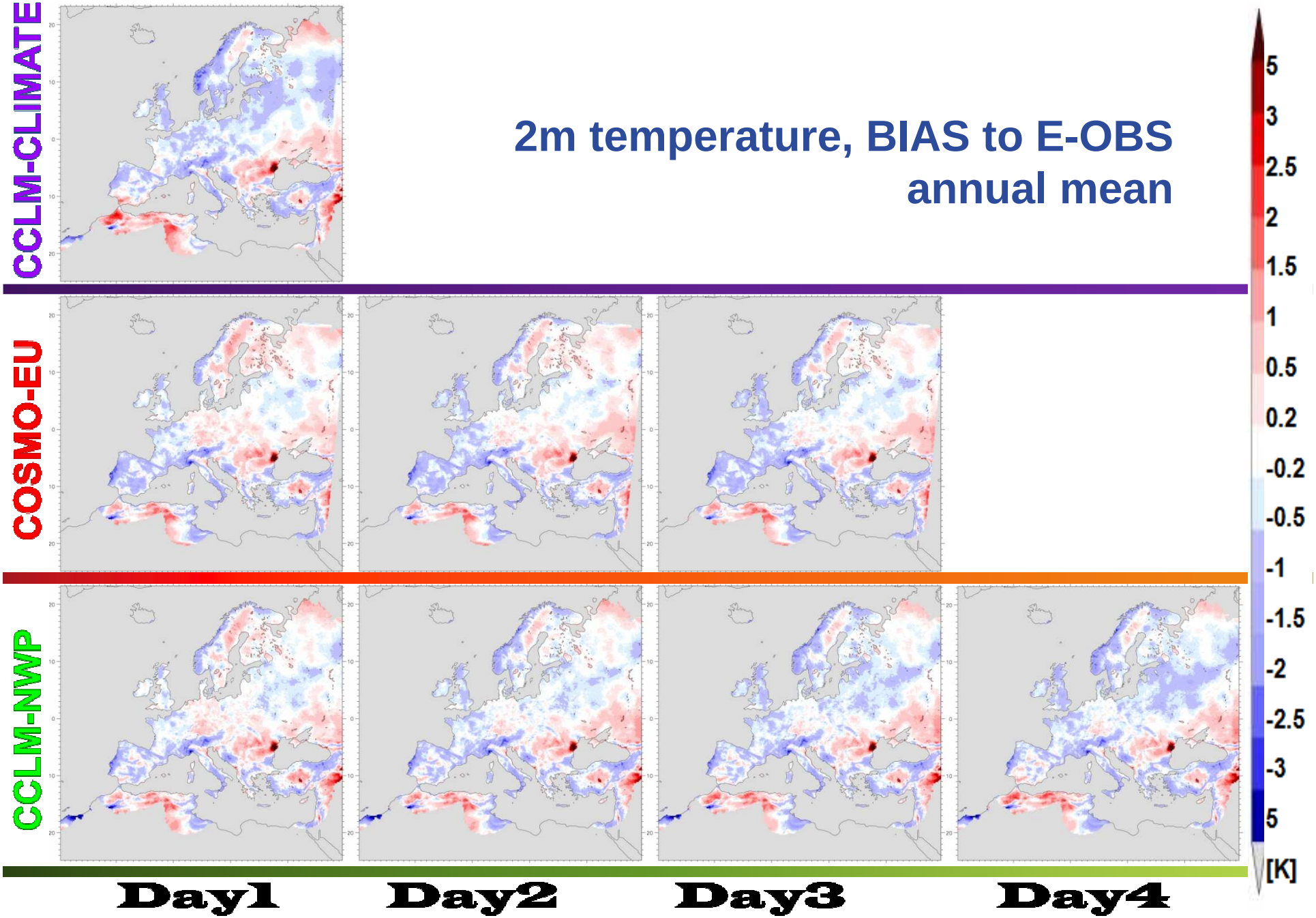
what: T_2M, TOT_PREC, MSLP, CLCT

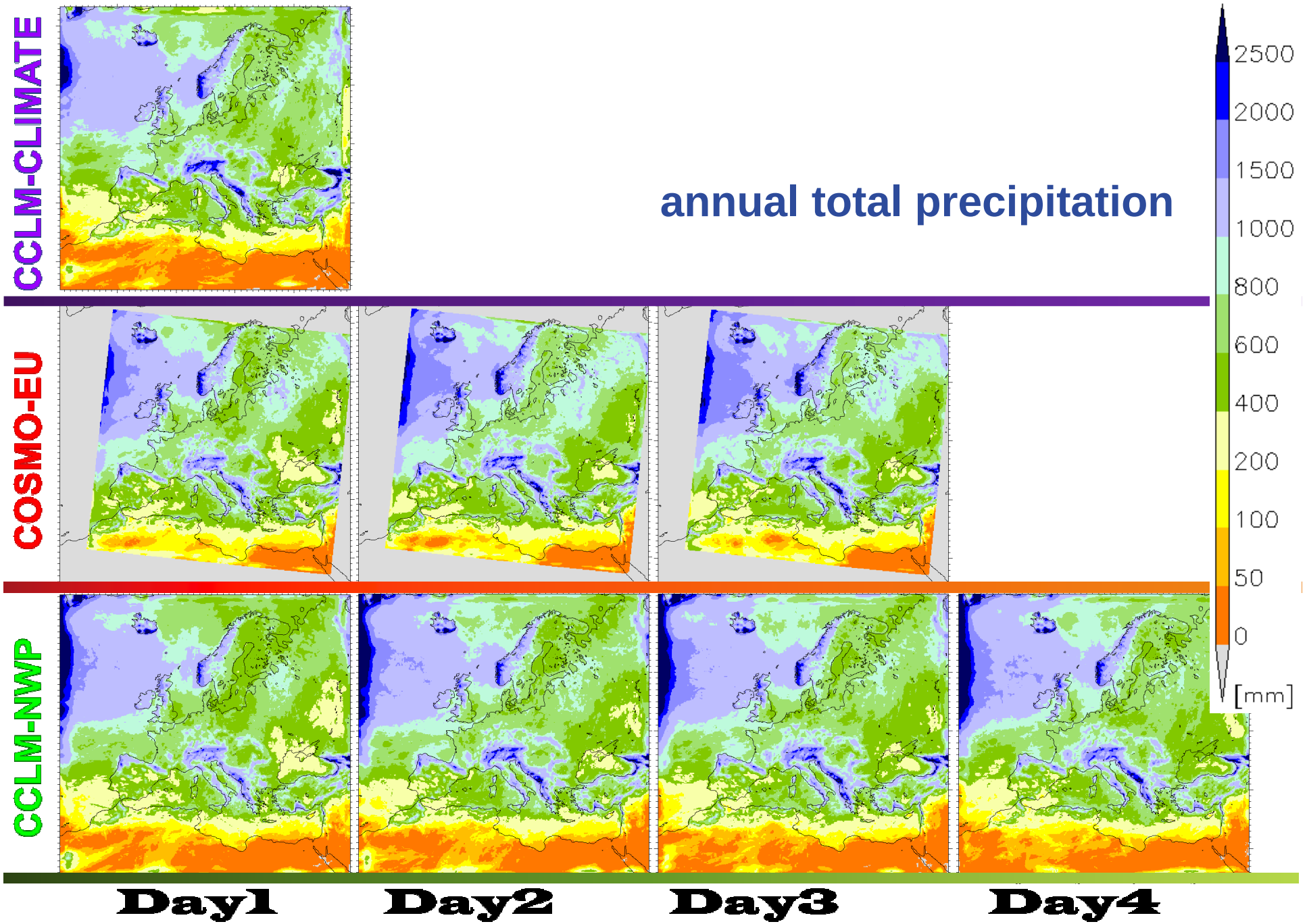
data: gridded datasets with daily resolution:
E-OBS (v.6, 0.25°), CRU (0.5°)

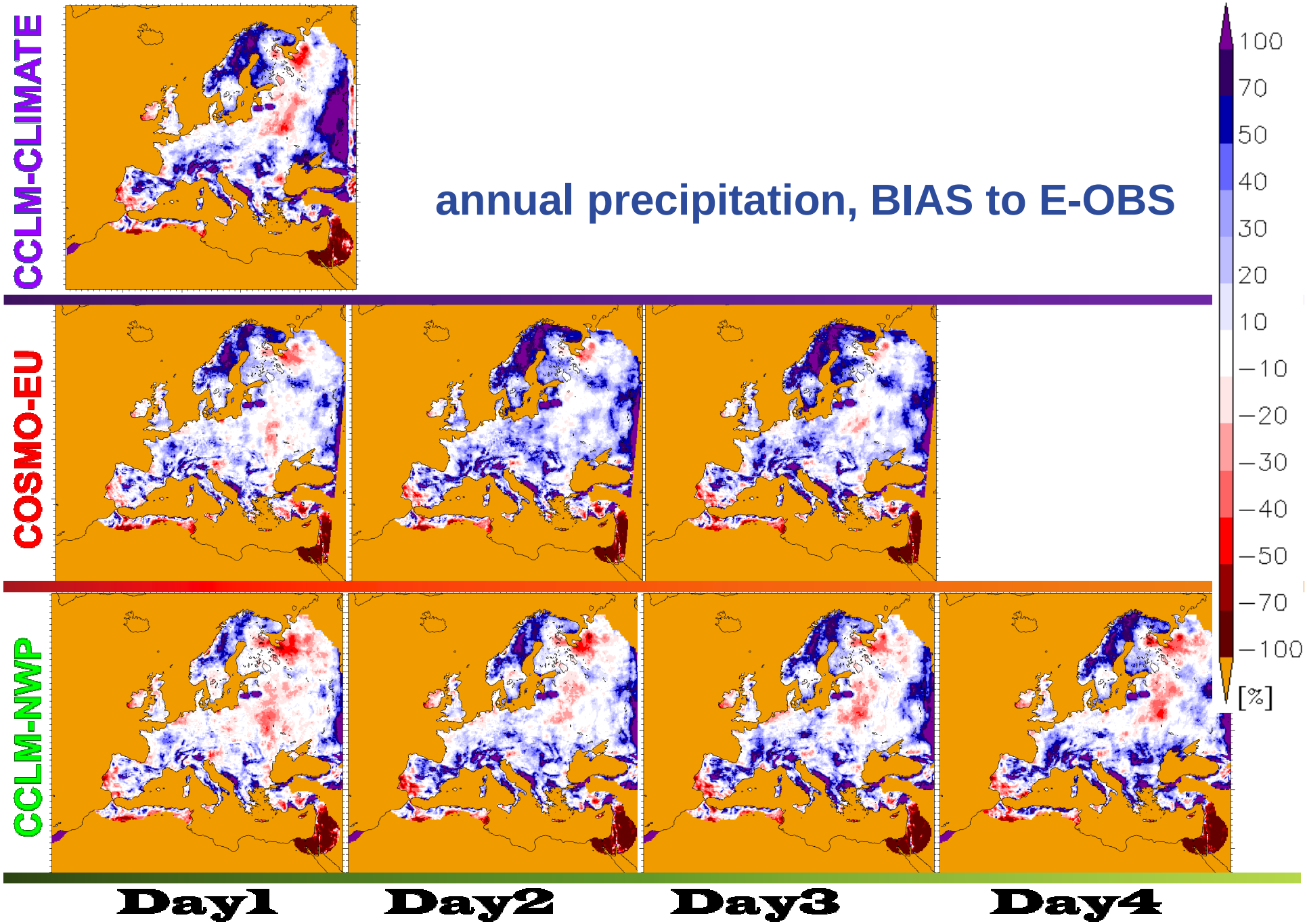
Regions for evaluation



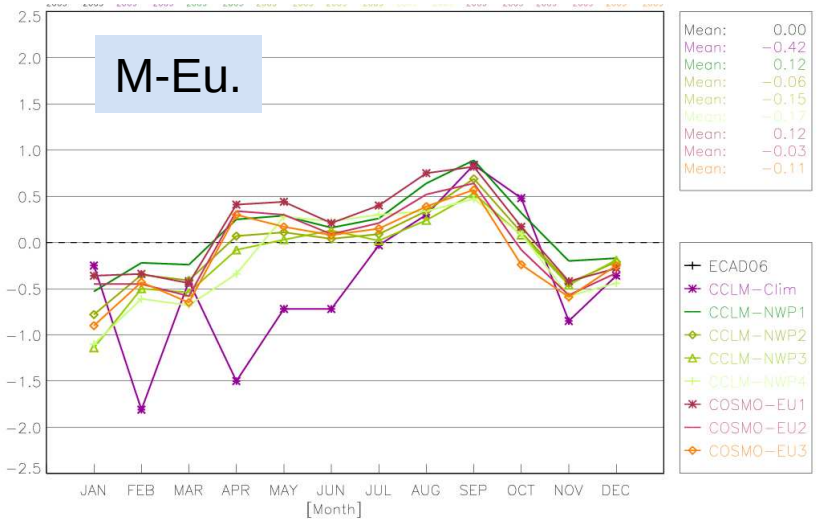
2m temperature, BIAS to E-OBS
annual mean

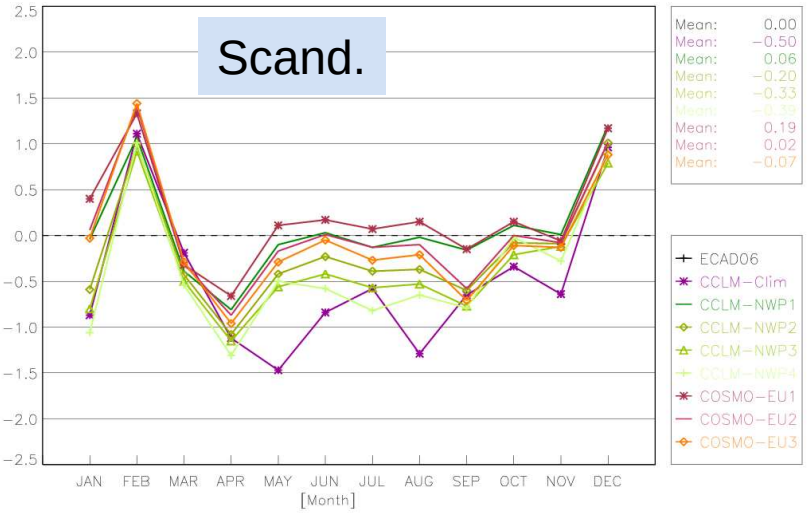


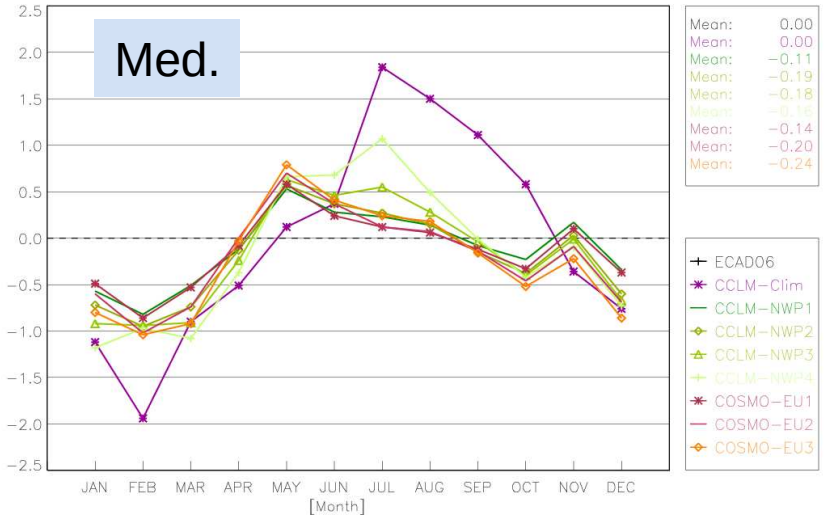

CCLM-CLIMATE
COSMO-EU
CCLM-NWP
annual total precipitation
2500
2000
1500
1000
800
600
400
200
100
50
0
[mm]
Day1
Day2
Day3
Day4


CCLM-CLIMATE
COSMO-EU
CCLM-NWP
annual precipitation, BIAS to E-OBS
100
70
50
40
30
20
10
−10
−20
−30
−40
−50
−70
−100
[%]
Day1
Day2
Day3
Day4

annual cycle, T_2M
BIAS to E-OBS,
all realizations

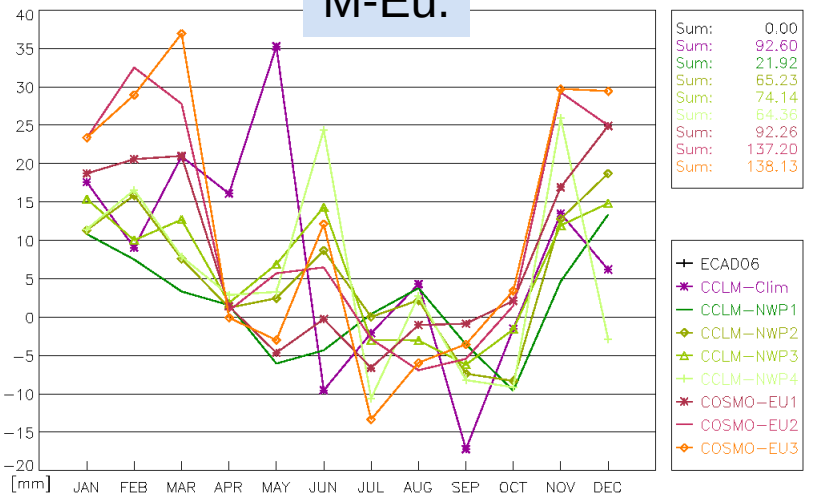




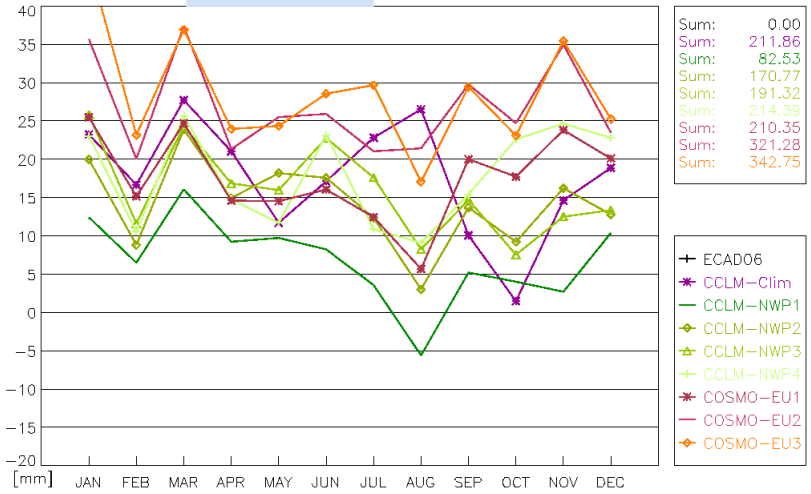


annual cycle, TOT_PREC BIAS to E-OBS, all realizations

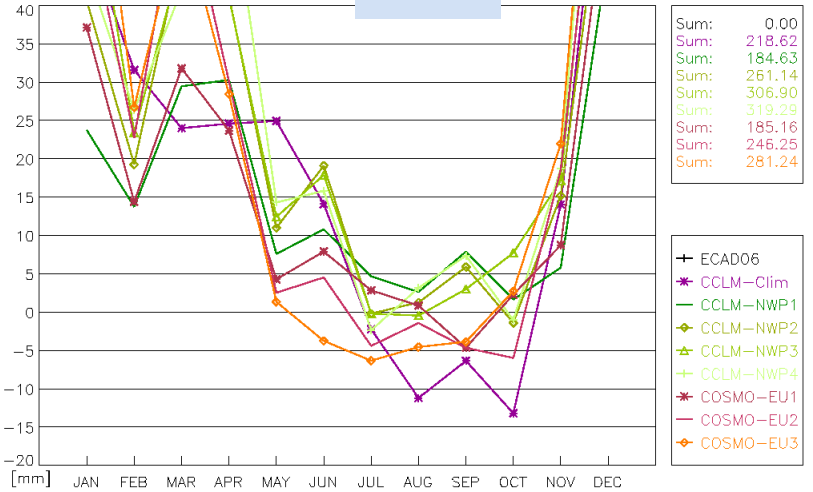
M-Eu.



Scand.



Med.



Summary

- mostly larger error with increasing forecast time (some cooling of warm biases over Central Europe and Scandinavia)
- clear boundary effect for precipitation (larger extent in COSMO-EU)
- NWP runs closer together than CCLM-Climate (less for TOT_PREC)

results: standard NWP verification with SYNOP data

where: SYNOP stations averaged over same subregions

what: verification scores (RMSE, BIAS, POD, FAR, ETS, HSS) for same parameters, as function of forecast time
(only COSMO-EU vs. CCLM-NWP)

2m temp., January, RMSE + BIAS, 3 subregions

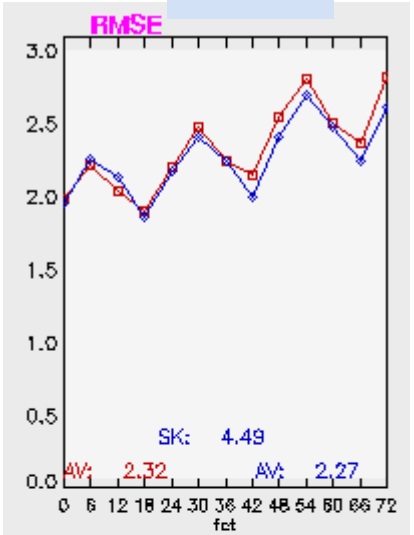
RMSE

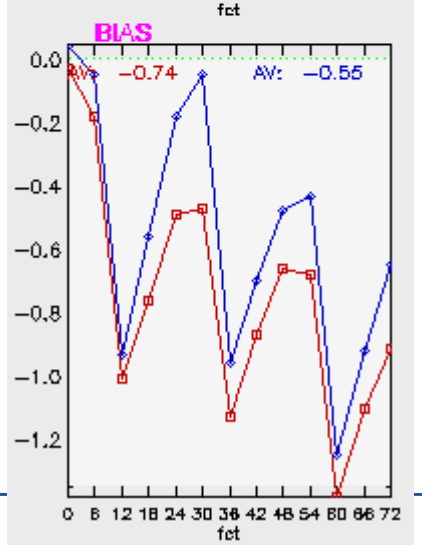
BIAS

CCLM-NWP

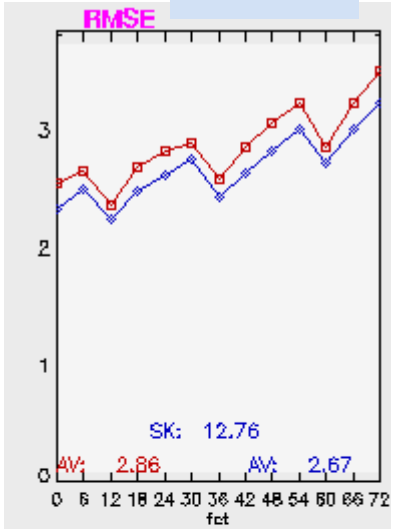
COSMO-EU

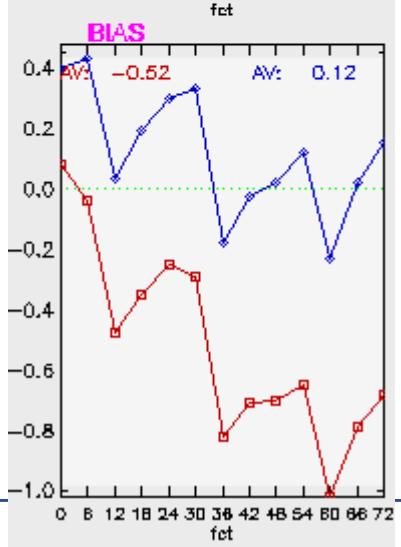
M-Eu.



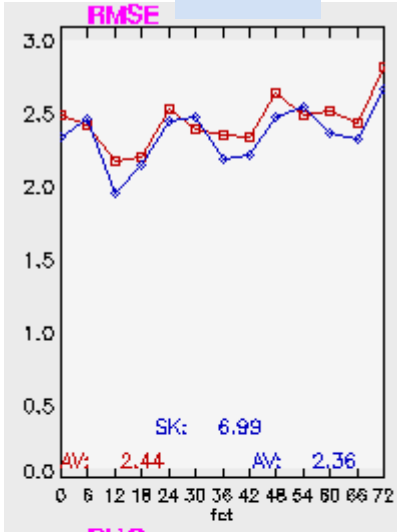


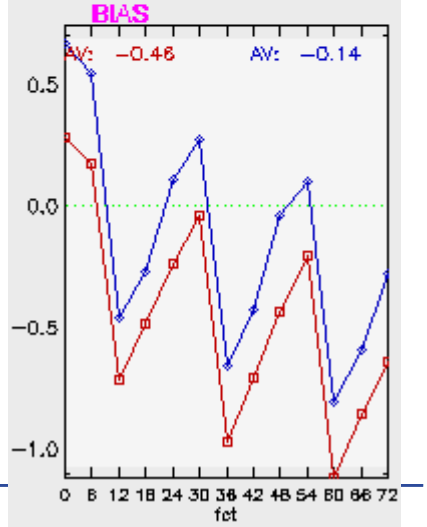
Scand.





Med.





2m temp., July, RMSE + BIAS, 3 sub-regions

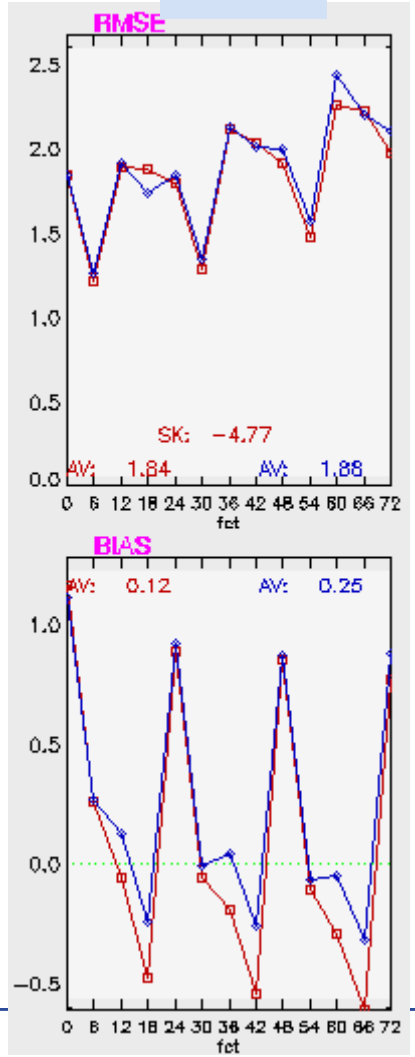
M-Eu. | Scand. | Med.

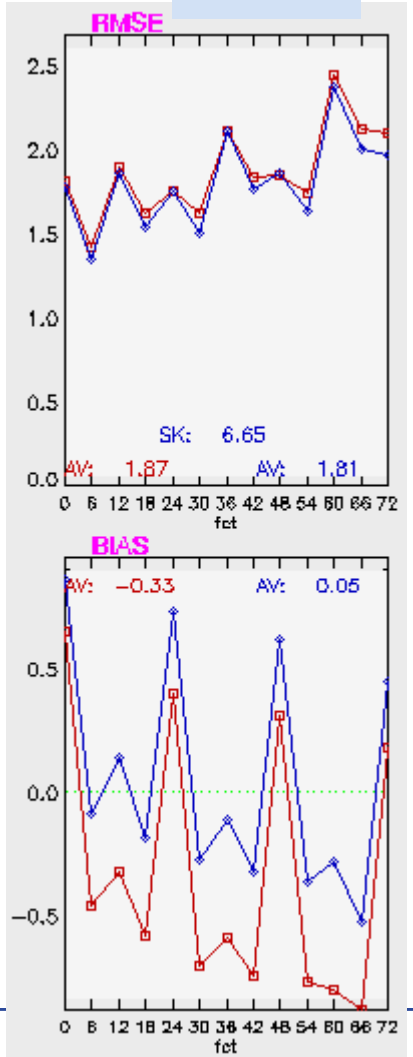
RMSE

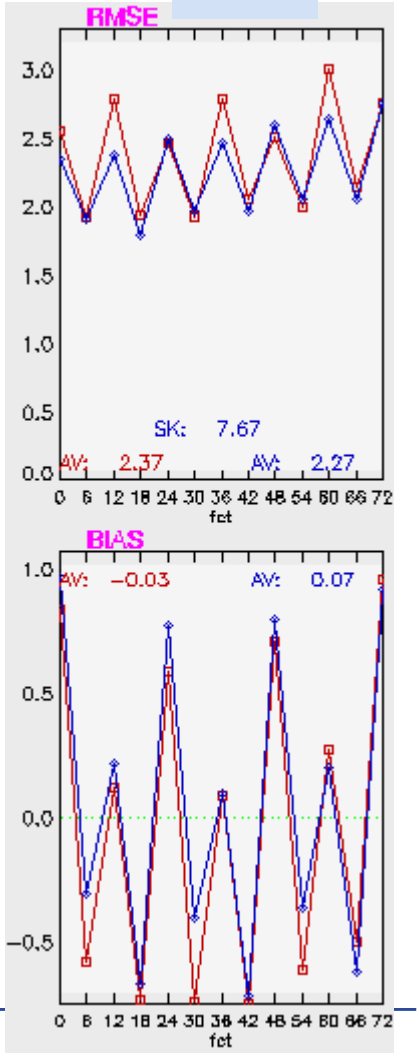
BIAS

CCLM-NWP

COSMO-EU





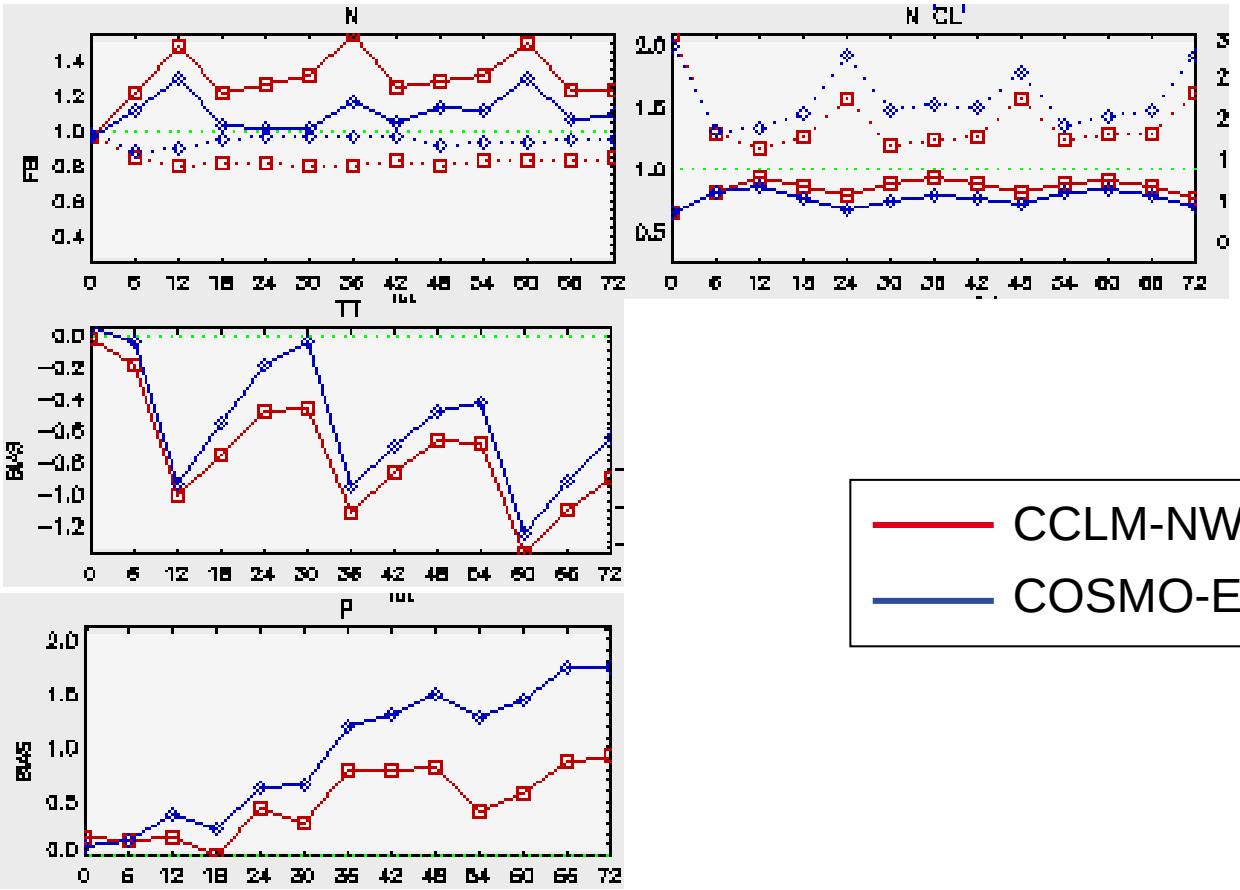


BIAS, January, Middle Europe

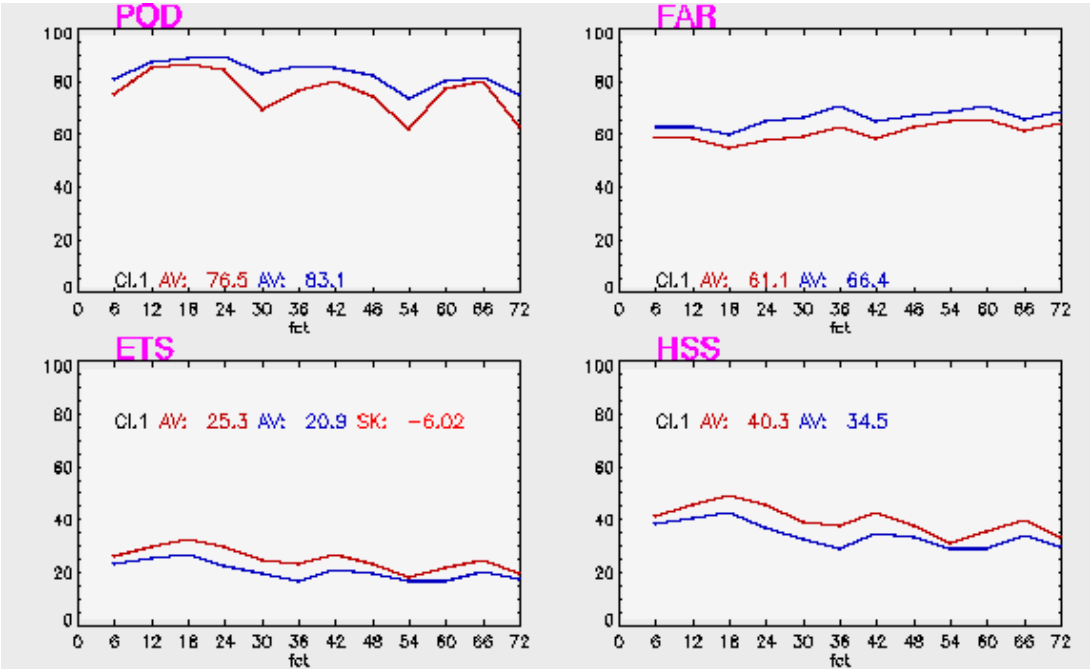
cloud cover
(*total / low clouds;*
dottet: <3 octa,
solid: >6 octa)

2m temperature

mean sea level pressure



precipiation > 0.1mm, January, Middle Europe



July and other regions:

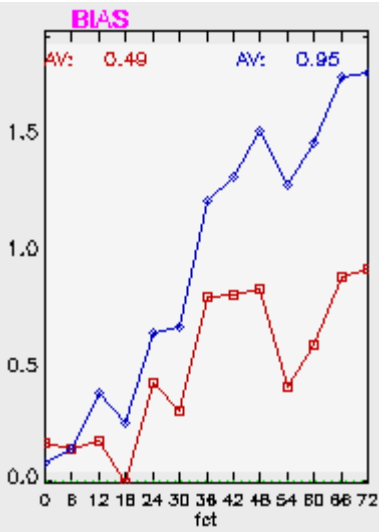
no remarkable differences

CCLM-NWP
COSMO-EU

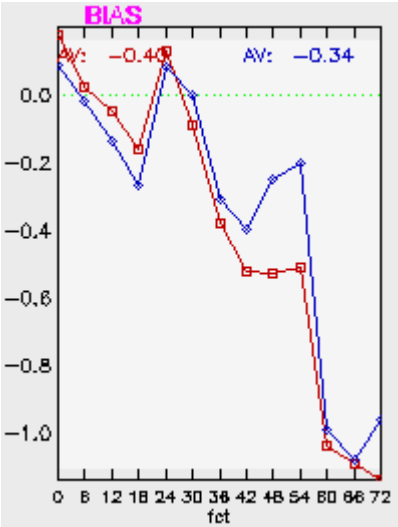
MSLP, BIAS, Middle Europe

CCLM-NWP
COSMO-EU

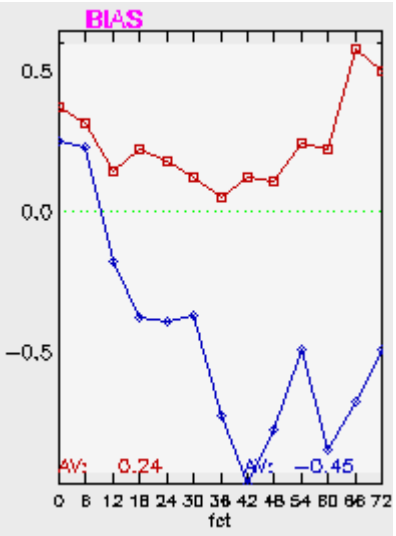
Jan.



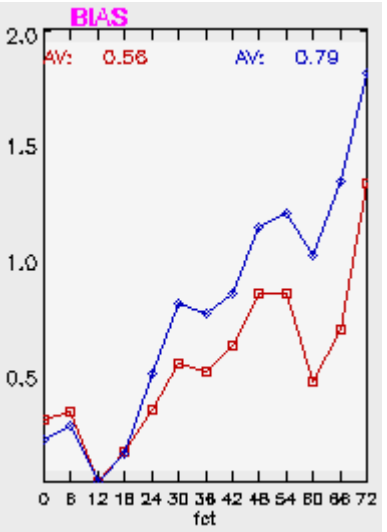
Apr.



Oct.



Dec.



Summary

- mostly non-remarkable differences for precipitation and cloud cover
- MSL pressure: deviations in the BIAS (due to different domains?)
- 2m temp: COSMO-EU distinctly better in Scandinavia; large diurnal cycle of scores

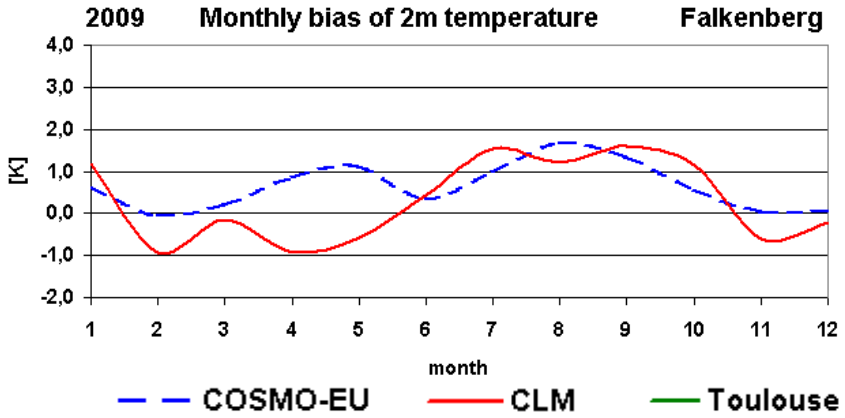
results: special site validation in Lindenberg

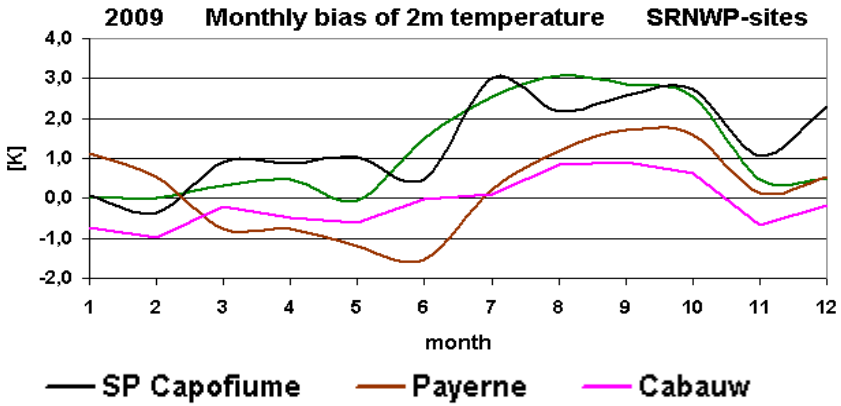
where: Lindenberg/Falkenberg: measurement site of DWD in Eastern Germany

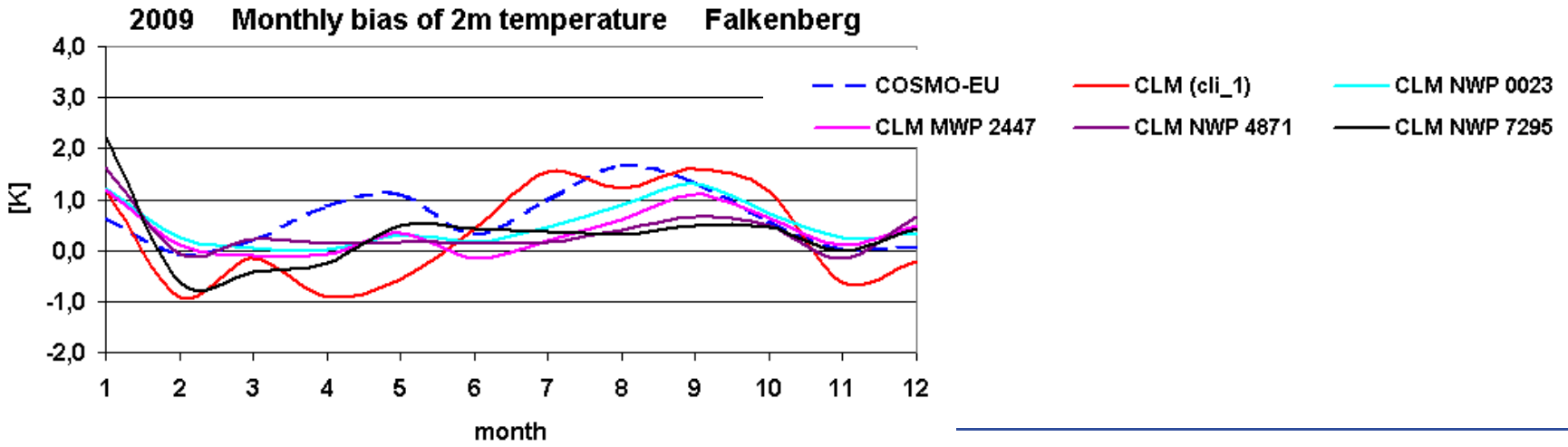
+ some SRNWP sites: Toulouse, San Pietro Capofiume, Payerne, Cabauw

what: annual cycle of 2m temperature, precipitation, soil moisture

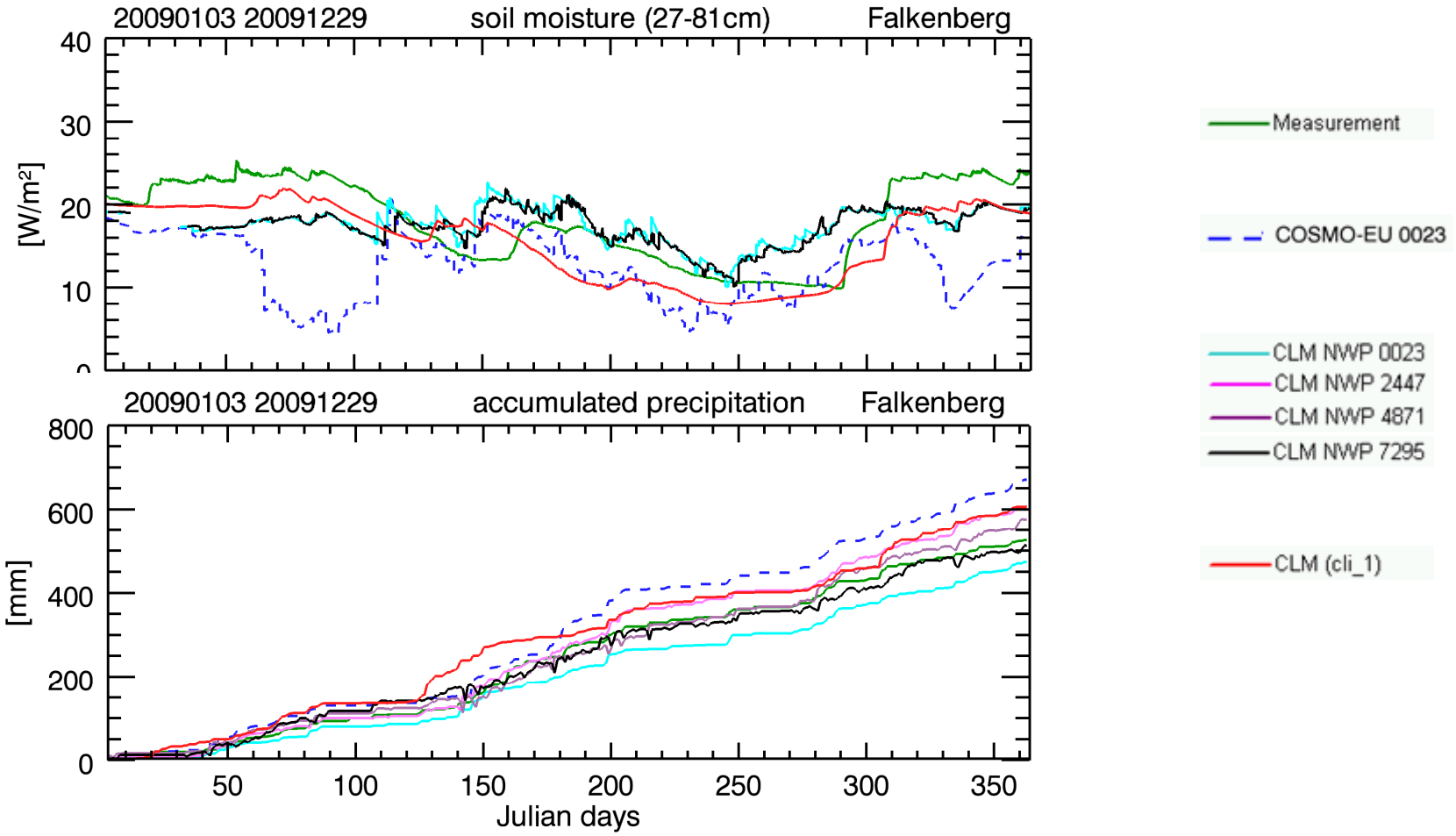
annual cycle of 2m temperature BIAS to observations







Soil moisture and precipitation



Summary

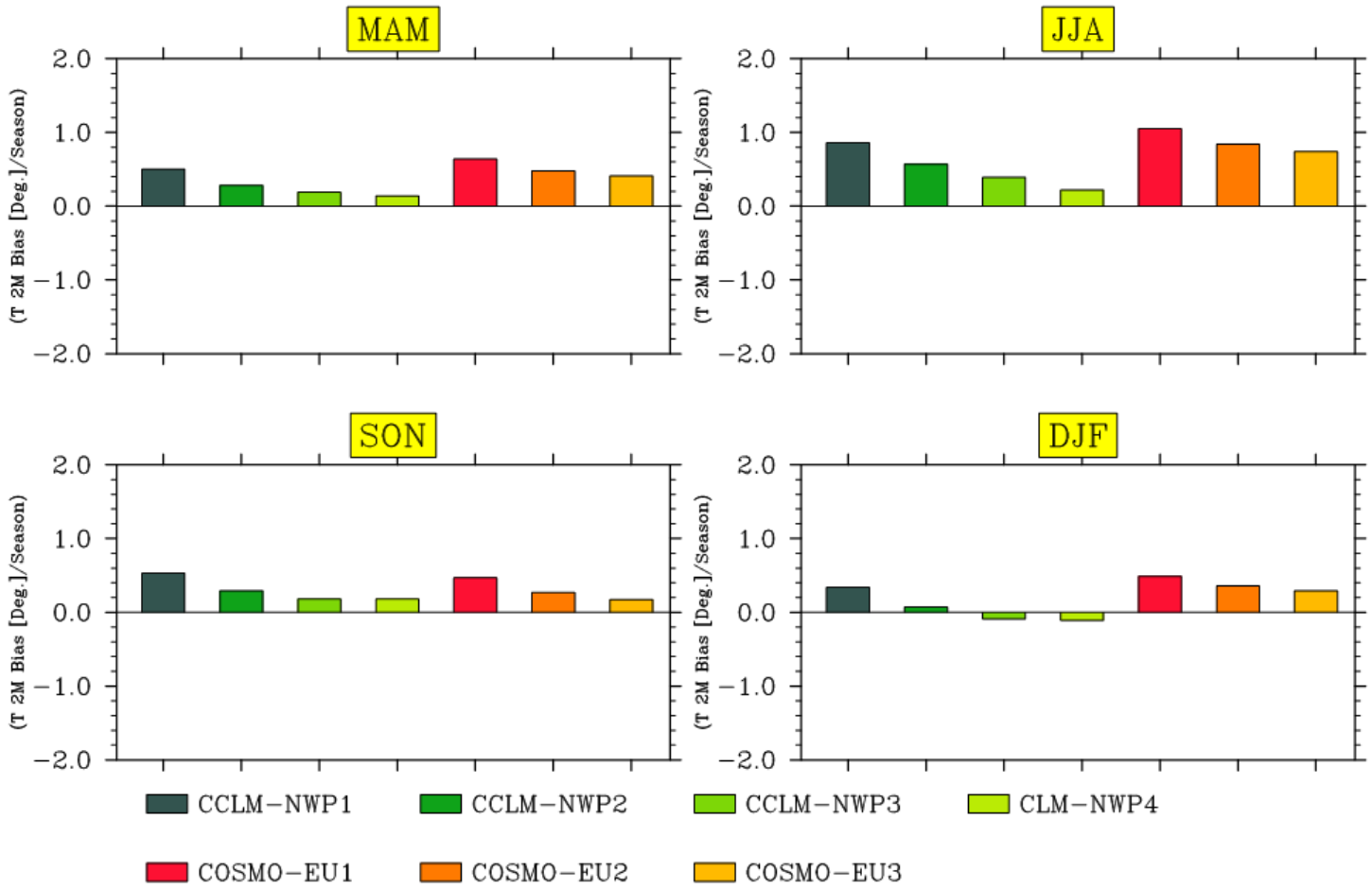
- 2m temp: similar behaviour at SRNWP stations and ME region
- soil moisture: winter too dry, winter/spring: CCLM-Climate closest to obs, summer/autumn: CCLM-NWP; problems with COSMO-EU
- precipitation: CCLM-NWP4 closest

results: convergence

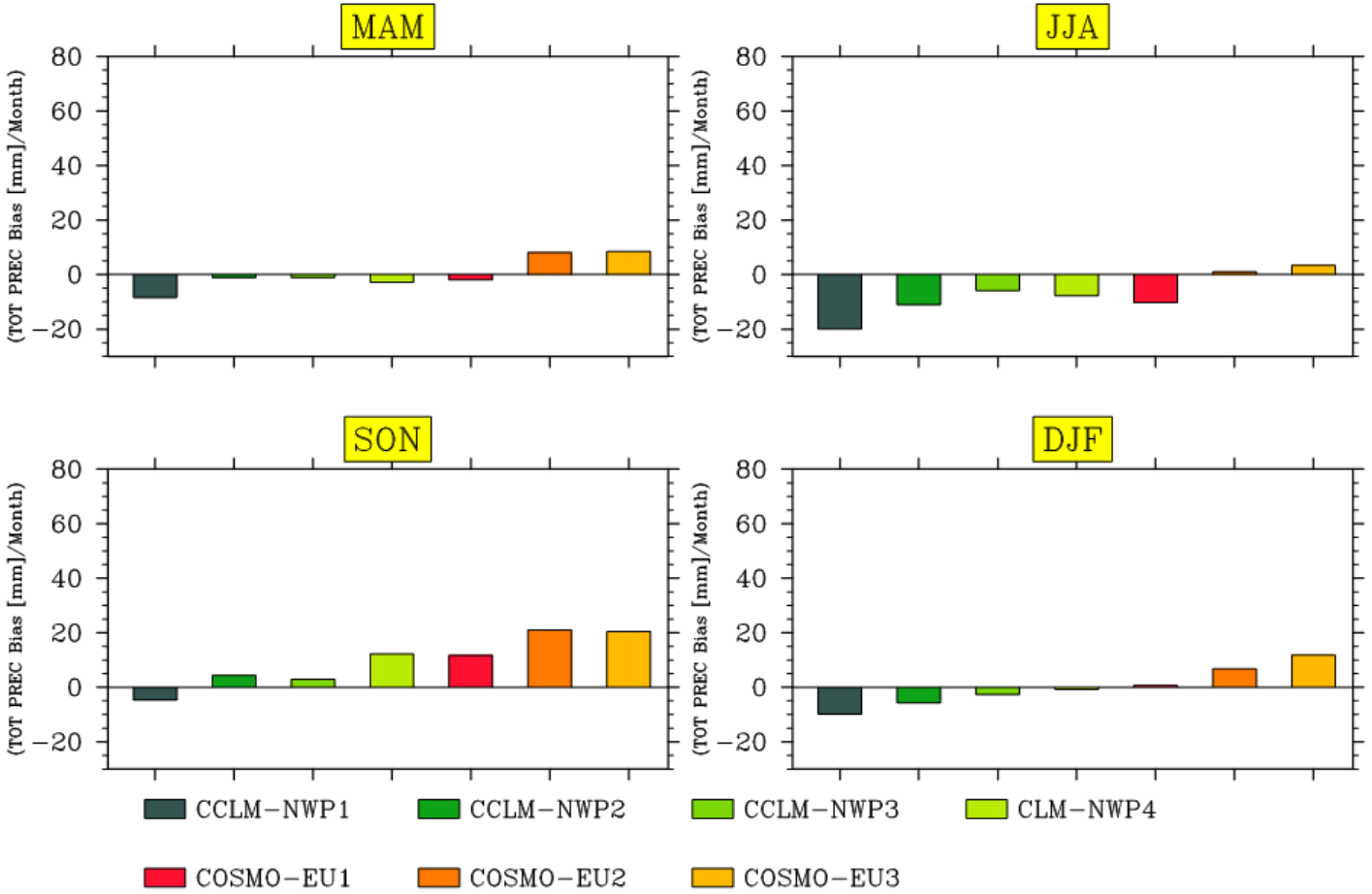
where: all land/water points; European sub-regions (Scandinavia)

what: deviations from CCLM-Climate, differences between forecast ages

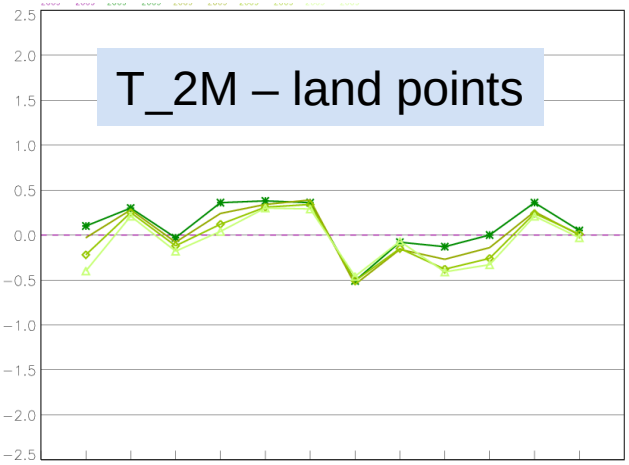
T_2M, Scandinavia, difference to CCLM-Climate

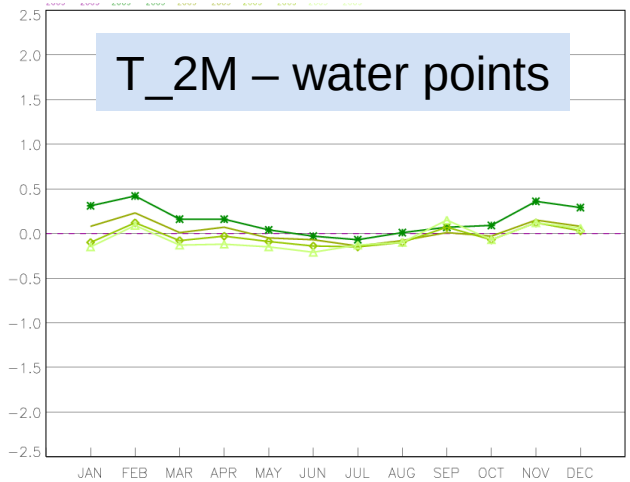


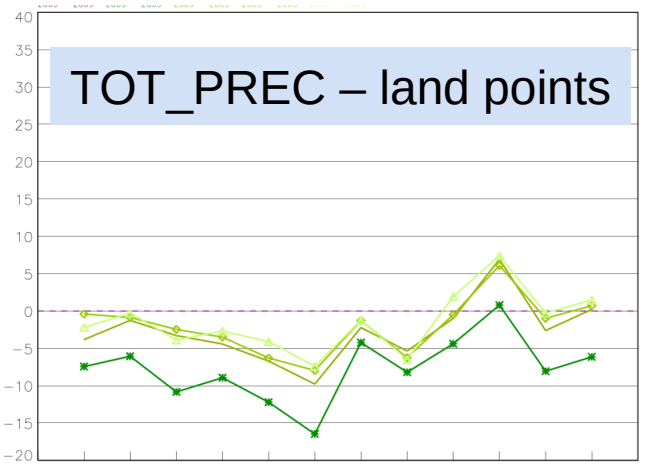
TOT_PREC, Scandinavia, difference to CCLM-Climate

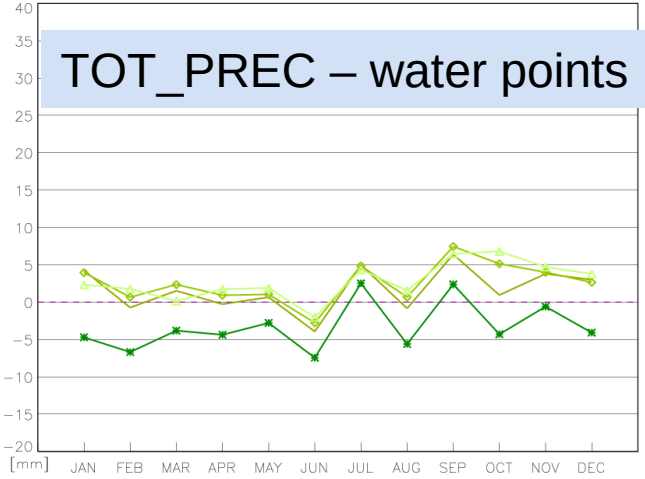


annual cycle, CCLM-NWP realizations – CCLM-Climate



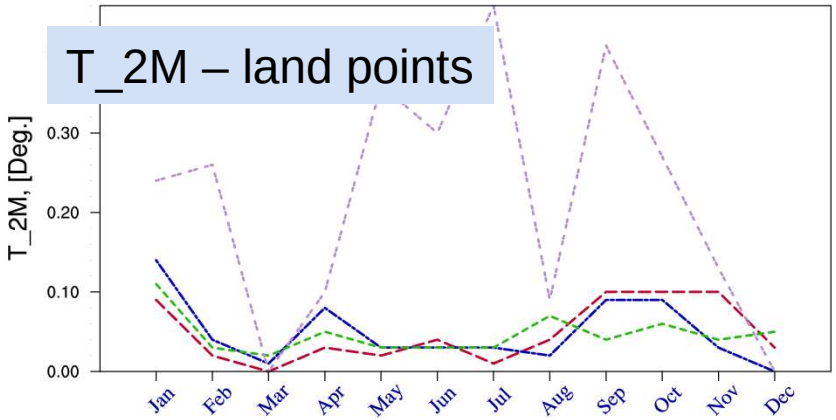




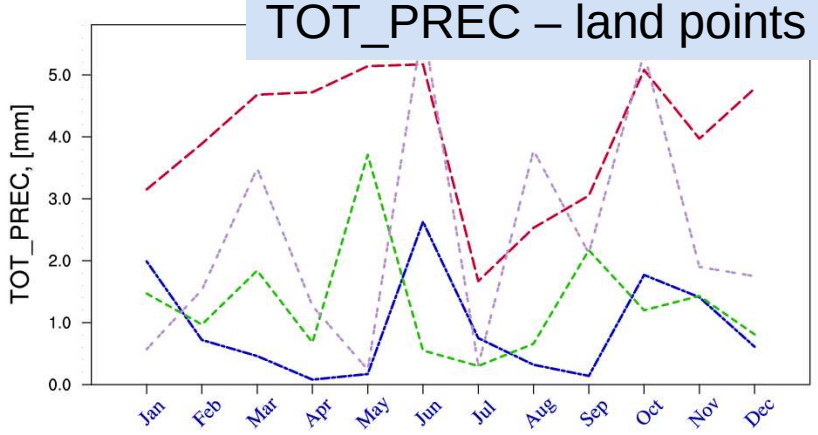


difference between subsequent realizations

T_2M – land points

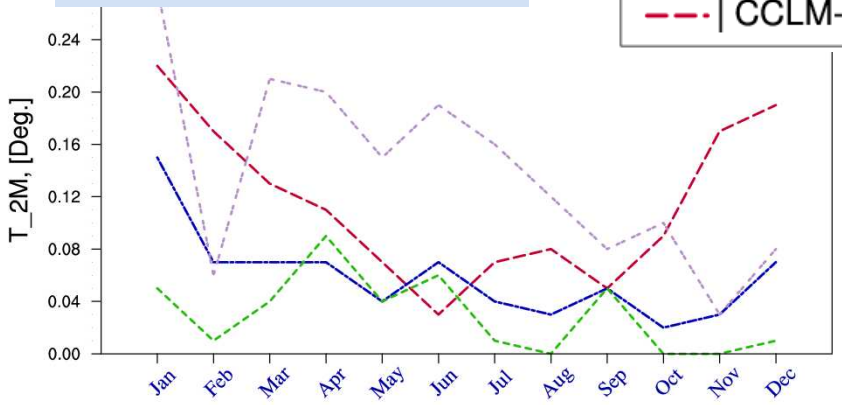


TOT_PREC – land points

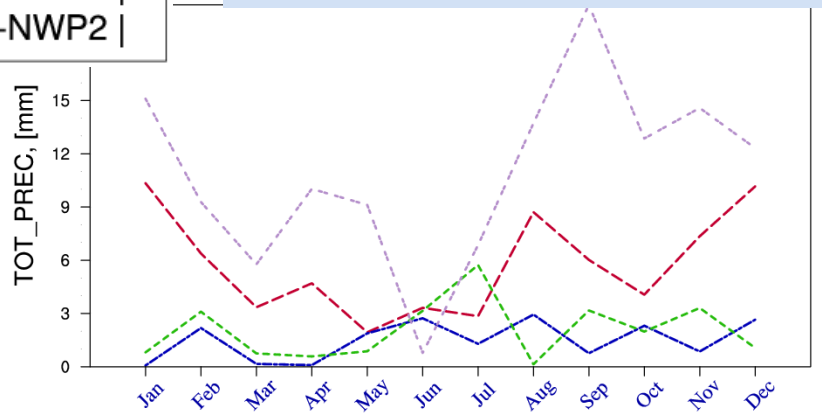


| CCLM-NWP4 - CCLM-Climate |
| CCLM-NWP3 - CCLM-NWP4 |
| CCLM-NWP2 - CCLM-NWP3 |
| CCLM-NWP1 - CCLM-NWP2 |

T_2M – water points

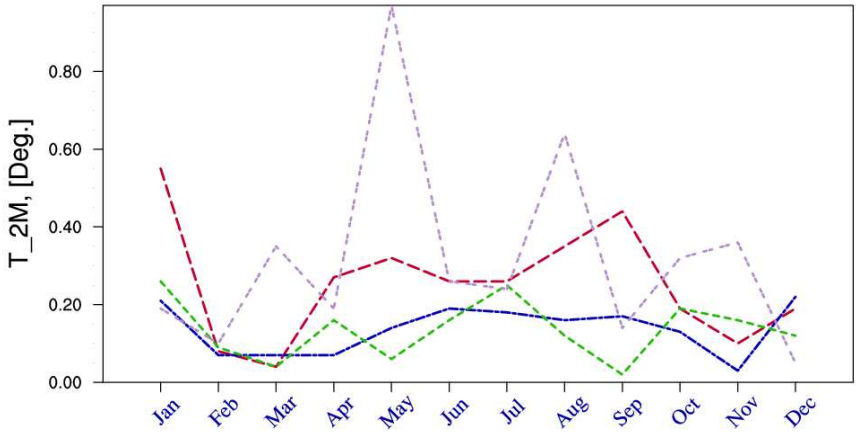


TOT_PREC – water points

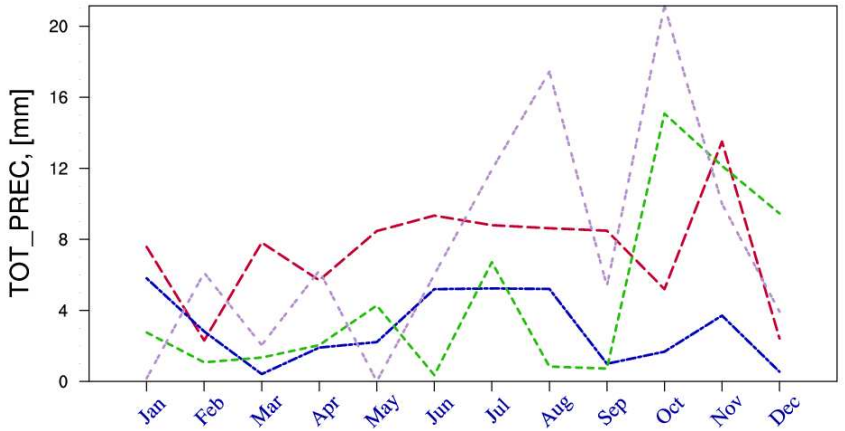


difference between subsequent realizations: Scandinavia

T_2M – Scandinavia



TOT_PREC – Scandinavia



| CCLM-NWP4 - CCLM-Climate |
| CCLM-NWP3 - CCLM-NWP4 |
| CCLM-NWP2 - CCLM-NWP3 |
| CCLM-NWP1 - CCLM-NWP2 |

Summary

- convergence only clearly visible in few cases (due to high variability?)
- e.g. temperature/precipitation over water and in Scandinavia in some months
- nothing to be seen for PMSL and CLCT

conclusions and outlook

what have we learned so far?

predictive quality: CCLM-NWP with data assimilation has similar predictive quality as COSMO-EU (different boundary effects)

error growth: errors generally growing with increasing forecast time (esp. T_2M and PMSL Bias), not quantified in detail yet

convergence: difficult to see because of high variability/uncertainty; most pronounced over water and for precipitation

Outlook

- analyze diurnal cycle
- uncertainty not quantified yet (analyze perturbation run)
- causes for deviations from theory have still to be investigated more closely
- not yet accounted for inter-annual variability: 2010/11 in preparation