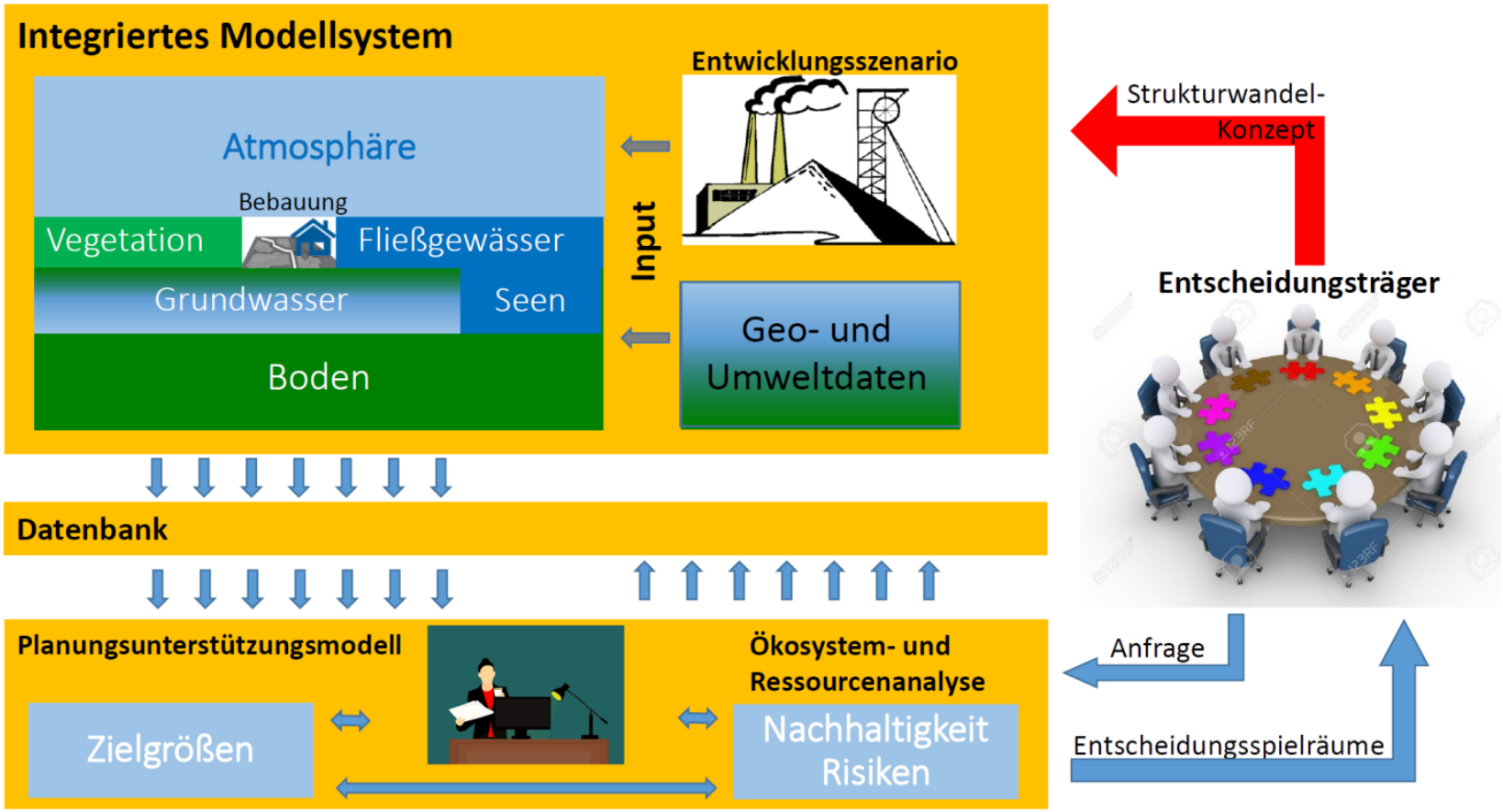
Brandenburg-Berlin Model
Status of Development

Andreas Will (BTU)



3.1 Simulation results: resolution, physics and numerics

List of simulations

EXPID	IBC	HR	DOM	CONF
S4p4d0.25Ct-dynamics				
TEU006	ERAINT	50 km	EUL	CCLM
CEU011	TEU006	7 km	EU	COSMO-EU
CDE011	CEU011	2.8km	DE	COSMO-DE
C3p2d0.0Cs-dynamics				
TEU007	ERAINT	50 km	EUL	CCLM
CEU012	TEU007	7 km	EU	COSMO-EU
CDE014	CEU012	4.5km	DE	COSMO-DE
CDE012	CEU012	2.8km	DE	COSMO-DE

IBC: Initial and Boundary Conditions
HR: Horizontal model resolutions: 2.8km, 7km
DOM: Domain simulated
CONF Model configuration used

3.1 Simulation results: Simulation configuration

Simulations in COSMO-EU or COSMO-DE domain using the recommended configuration of CLM-Community or DWD for the domain and horizontal resolution

Convergence X convergence order of the numerical error

Advection CX upwind discretisation of order X (reference)

SX symmetric discretisation of order X

Pressure pX pressure gradient term discretisation of order X

Diffusion dY horizontal numerical diffusion of strength Y

Convection CT Convection parameterisation

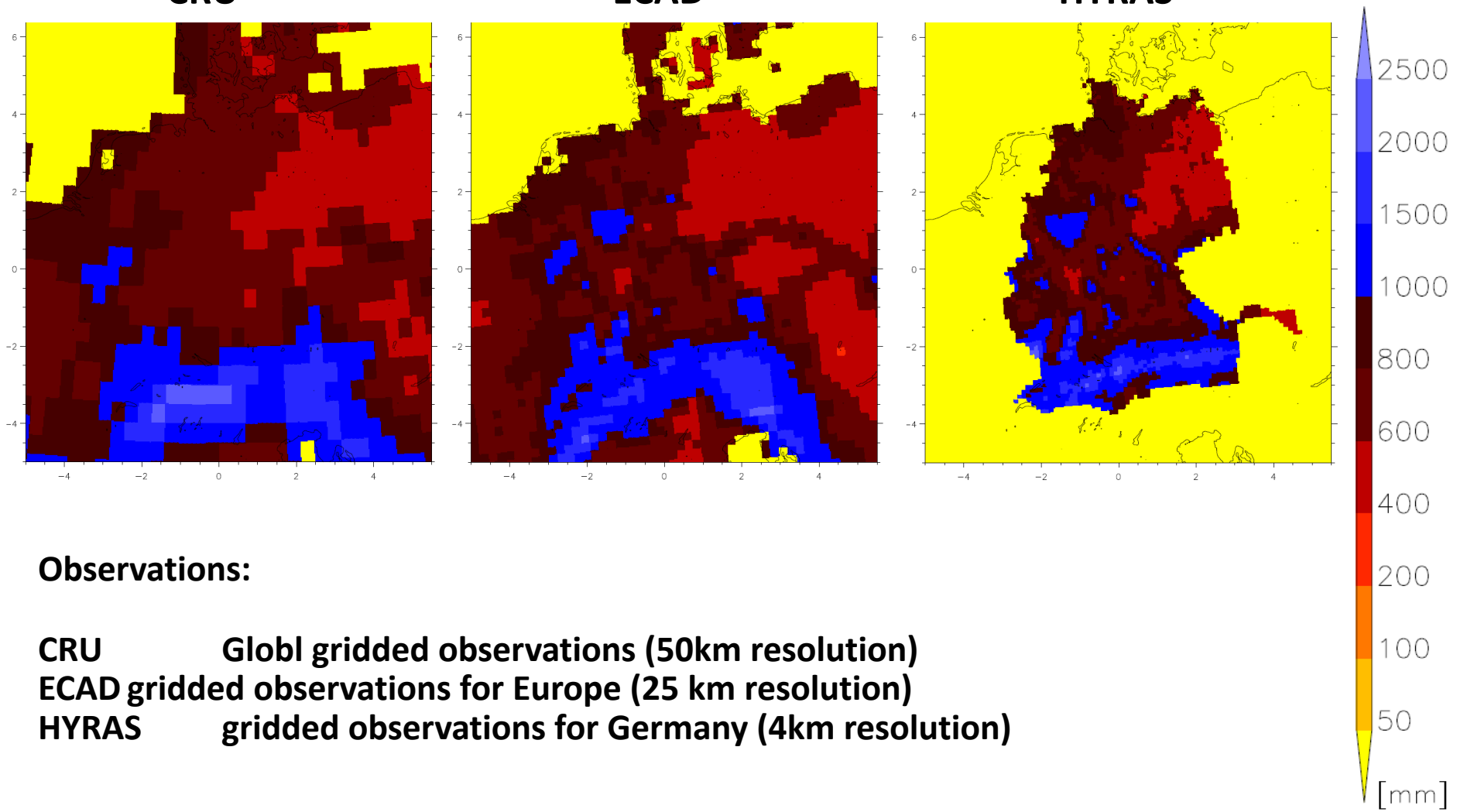
T=t Tiedtke deep convection parameterization

T=0 No deep convection parameterization,

T=s shallow convection parameterisation only

3.1 TOT_PREC
mean annual sum 2000-2010

CRU **ECAD** **HYRAS**

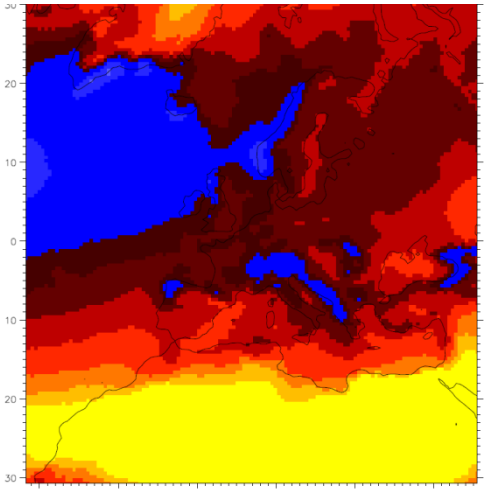


Observations:

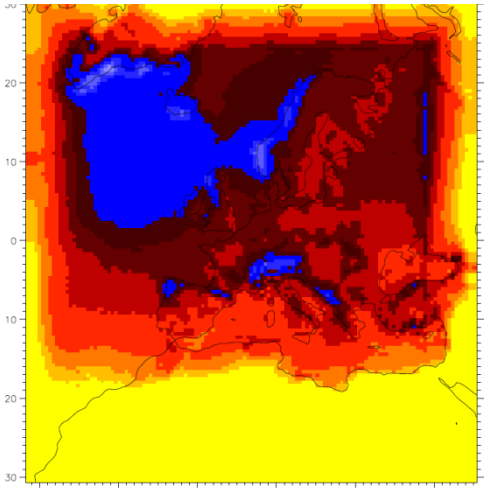
CRU Globl gridded observations (50km resolution)
ECAD gridded observations for Europe (25 km resolution)
HYRAS gridded observations for Germany (4km resolution)

3.1 TOT_PREC
mean annual sum 2000-2010

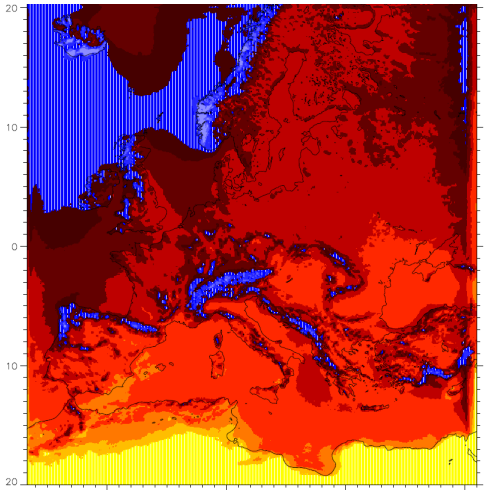
ERAINT



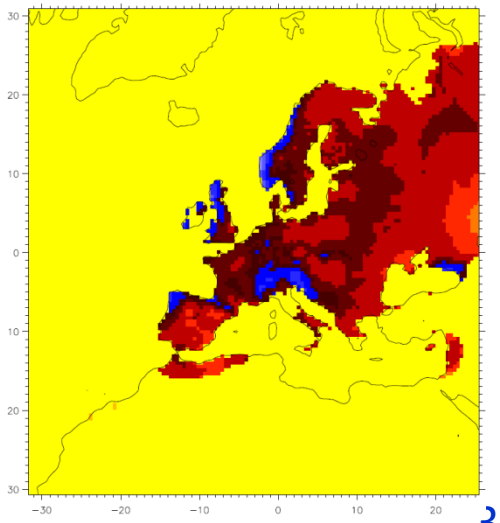
TEU007



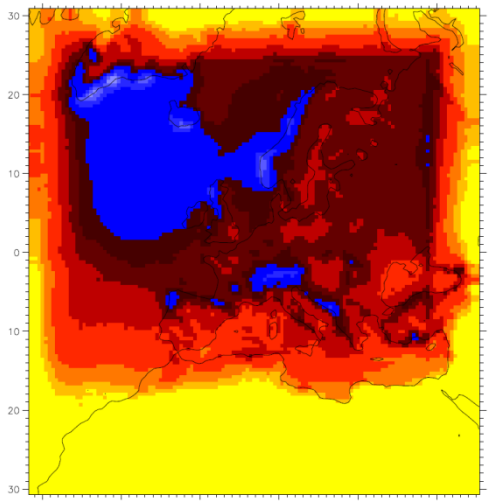
CEU012



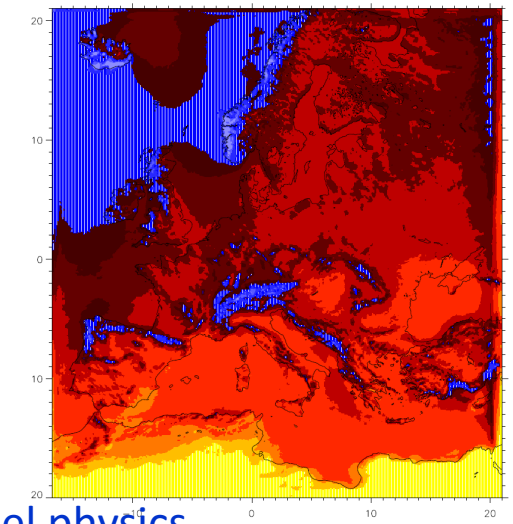
ECAD

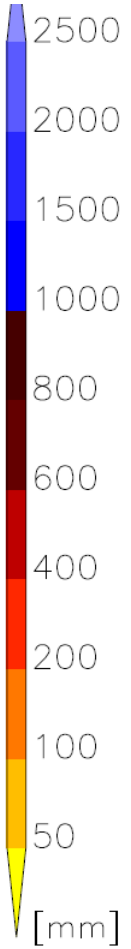


TEU006



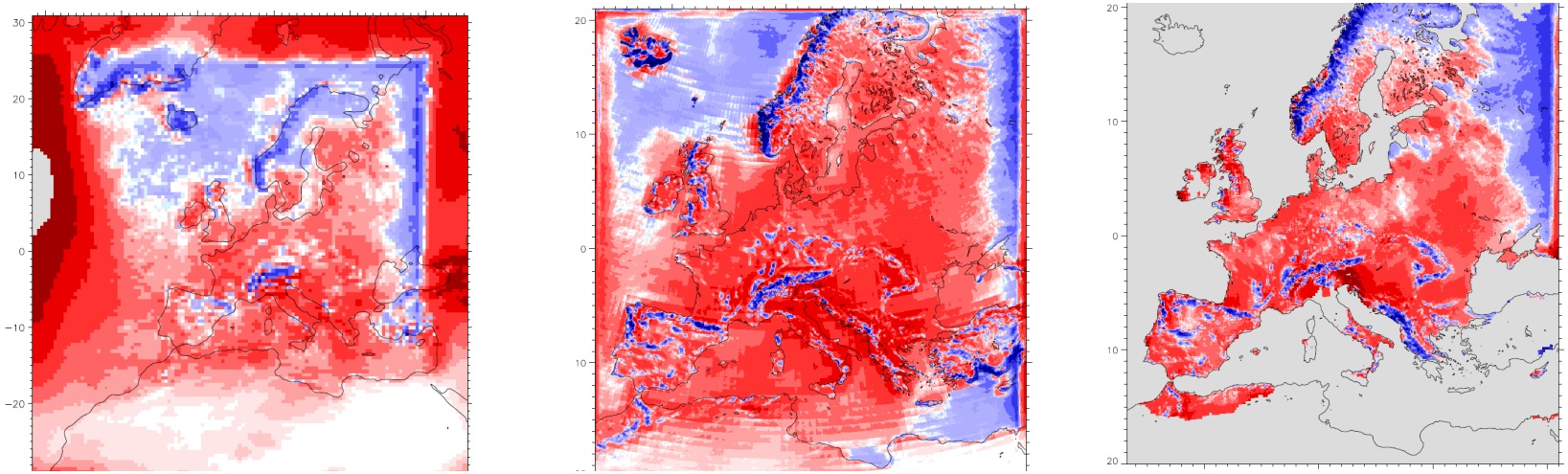
CEU011



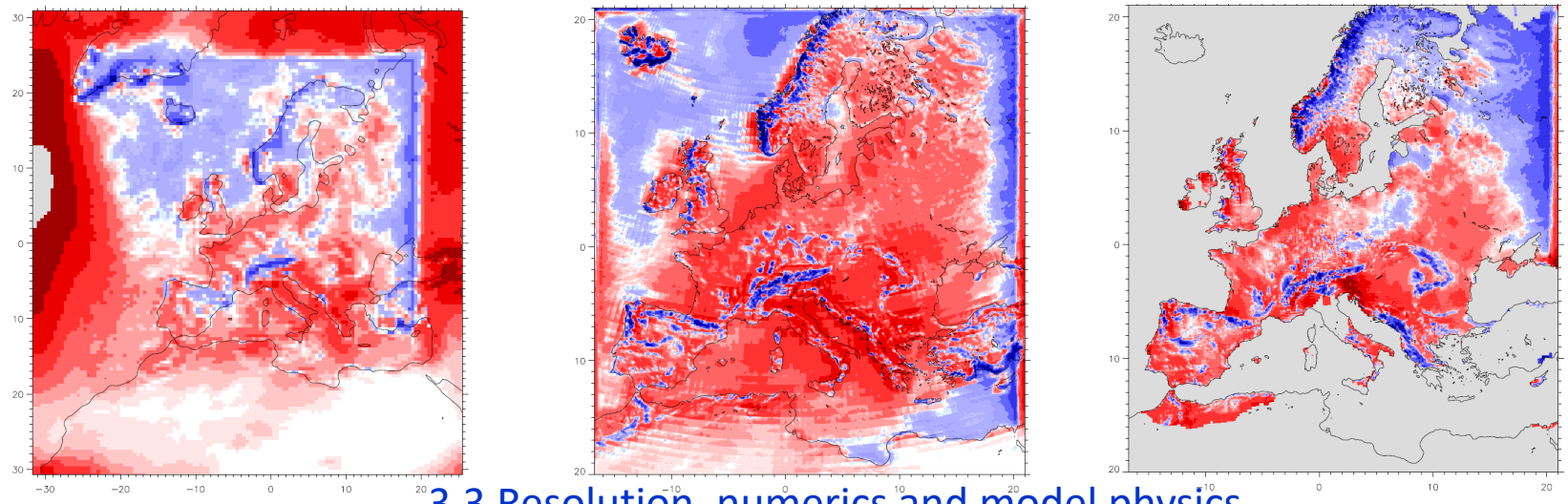


3.1 TOT_PREC
mean annual sum 2000-2010

TEU007- ERAINT CEU012-ERAINT CEU012-ECAD

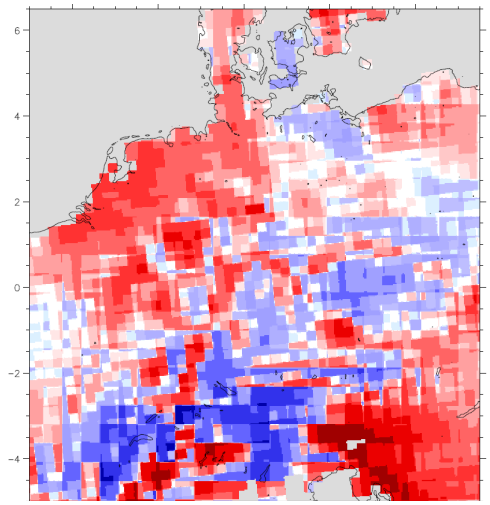


TEU006- ERAINT CEU011-ERAINT CEU011-ECAD

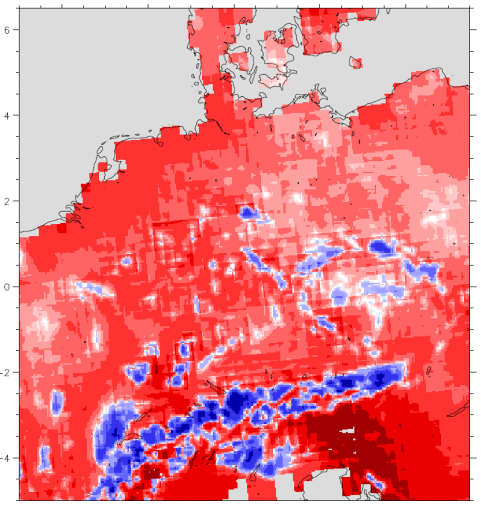


3.1 TOT_PREC
mean annual sum 2000-2010

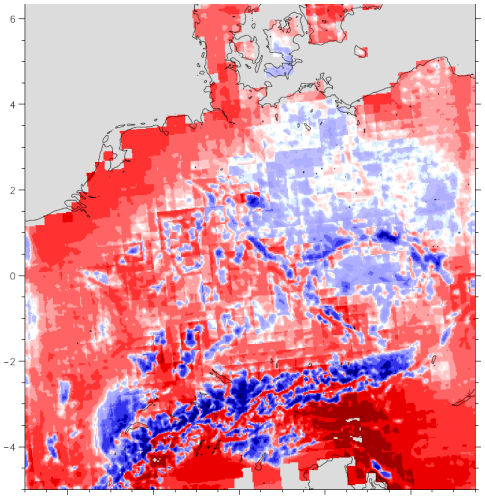
TEU007-ECAD



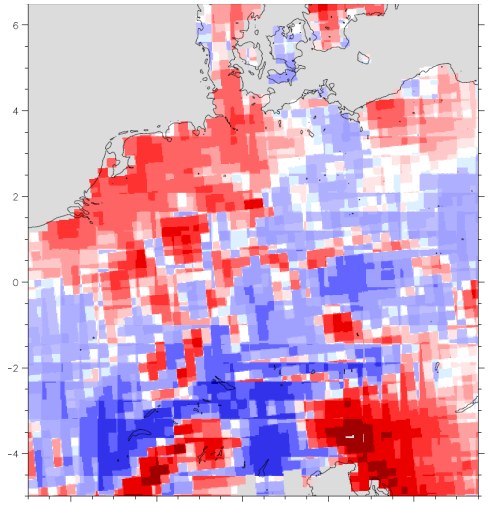
CEU012-ECAD



CDE012-ECAD



TEU006-ECAD



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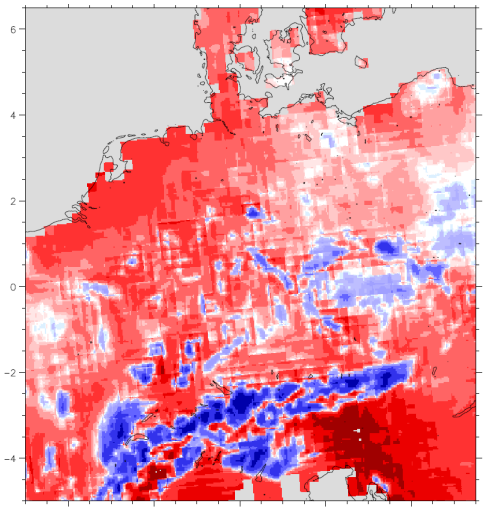
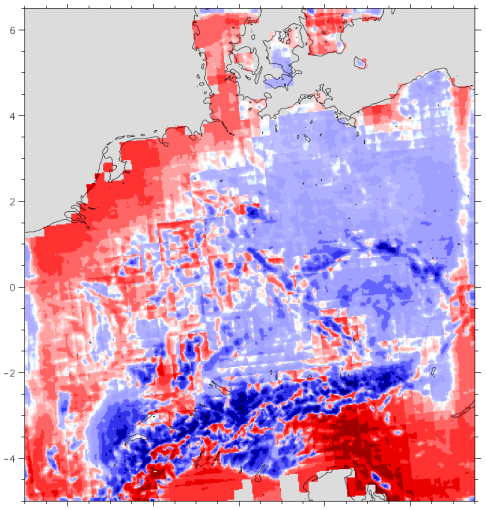
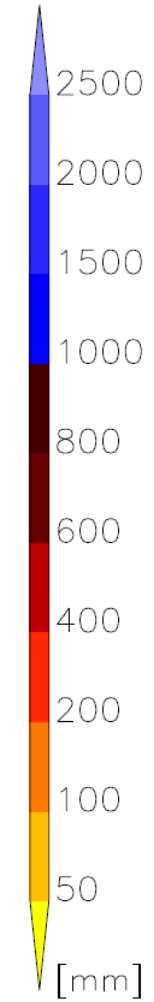
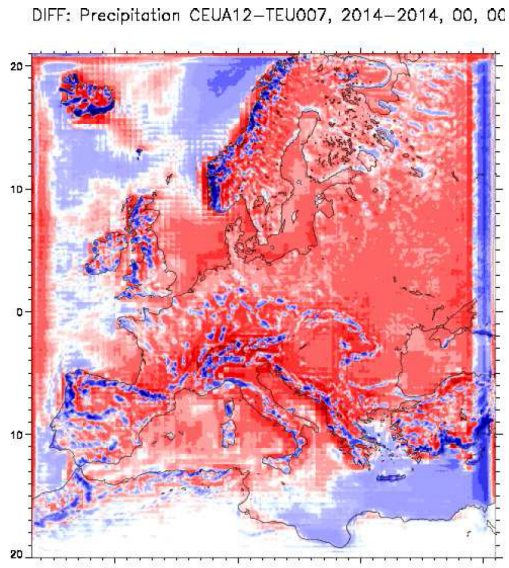


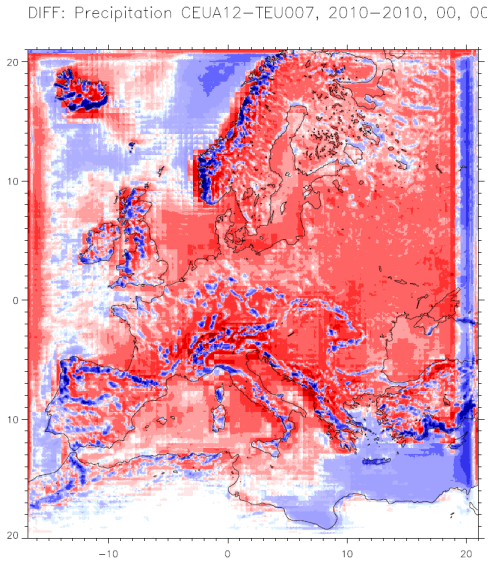
CDE011-ECAD





3.1 TOT_PREC
mean annual sum 2000-2010



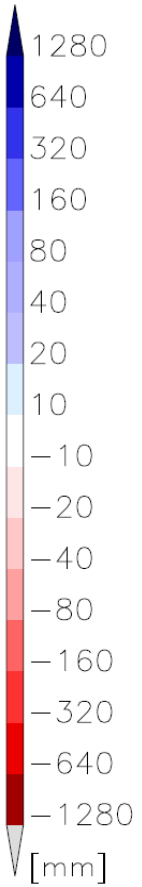


Impact of resolution+BC

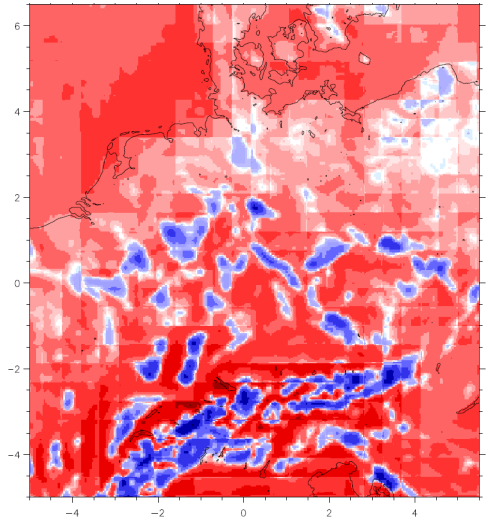
CEU011-TEU006:, f=7,C3p2D0.25

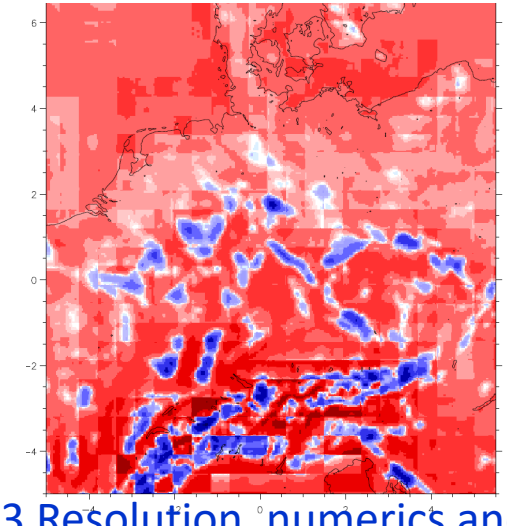
CEU012-TEU007:, f=7, S4p4D0

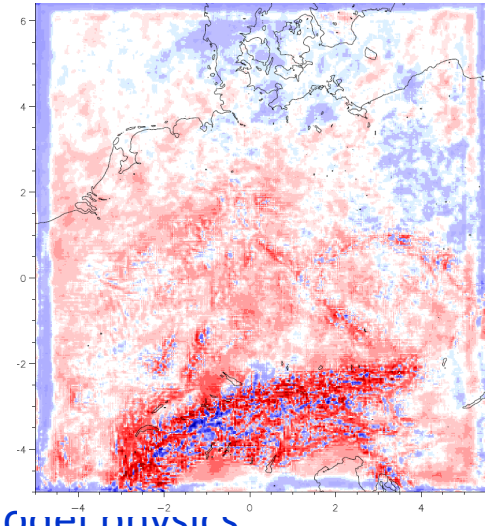
CDE012-CDE014: f=1.5, S4p4D0



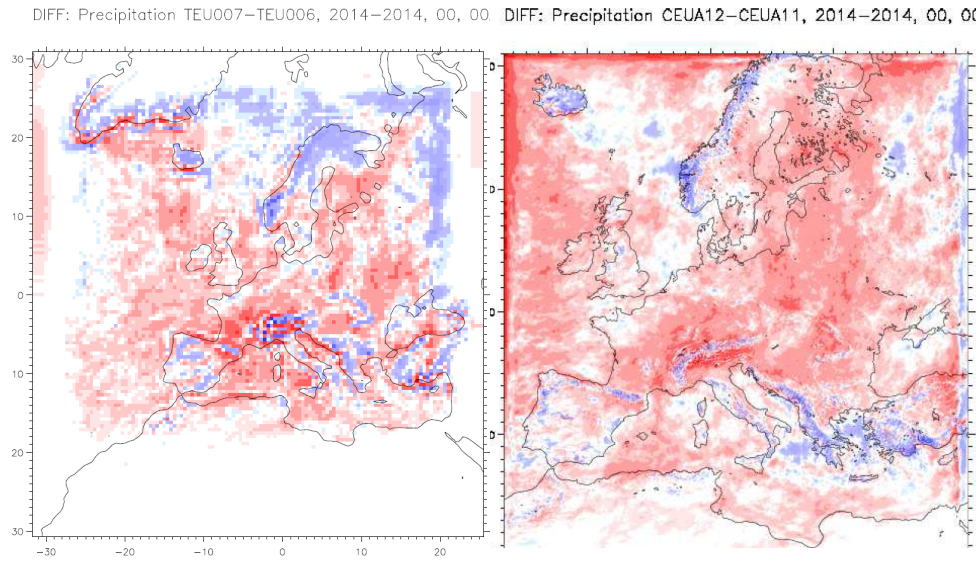
CEU011-TEU006 CEU012- TEU007 CDE012-CDE014







3.1 TOT_PREC, 2000-2010

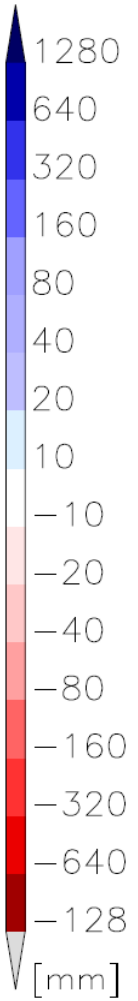


Impact of numerics + hor. diffusion:
(S4p4D0.0 – C3p2D0.25)

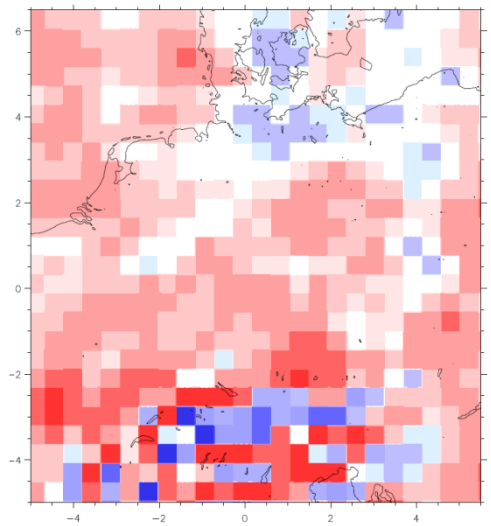
TEU007-TEU006: 50km, Ct

CEU012-CEU011: 7km, Ct.

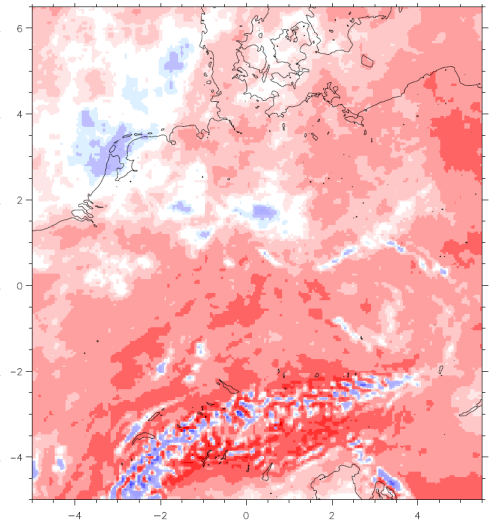
CDE012-CDE011: 2.8km, D0C0



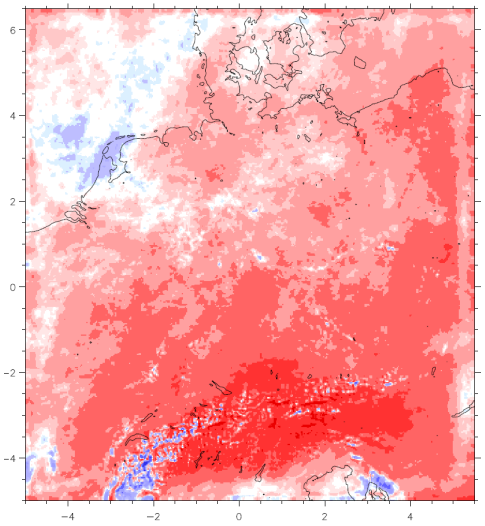
TEU007-TEU006



CEU012-CEU011



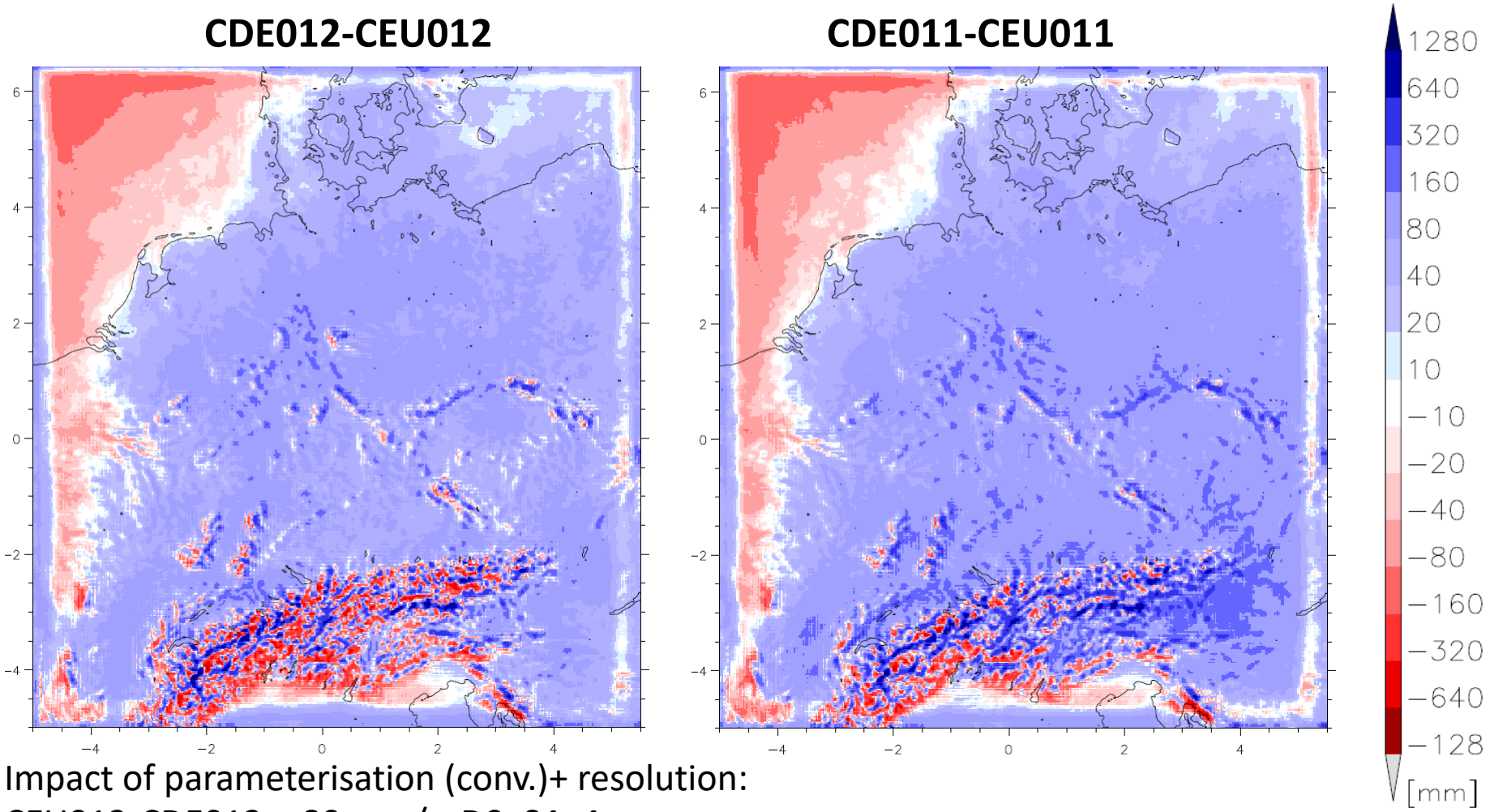
CDE012-CDE011



3.1 TOT_PREC, 2000-2014

CDE012-CEU012

CDE011-CEU011

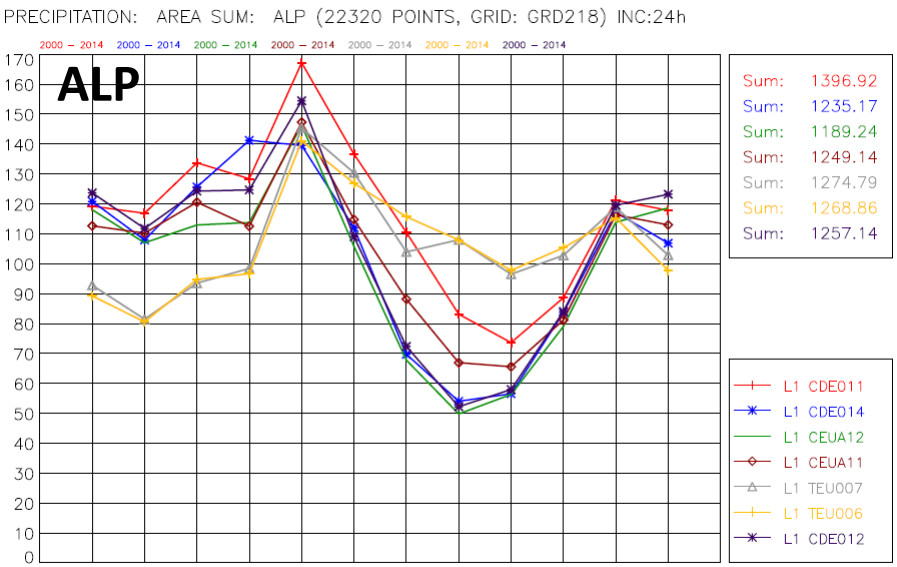


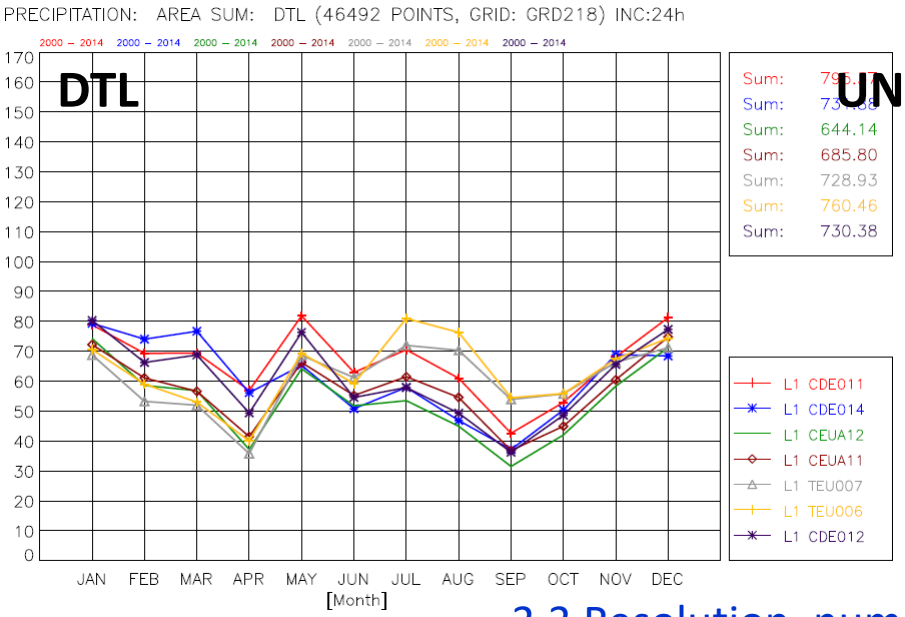
Impact of parameterisation (conv.)+ resolution:

CEU012-CDE012: +80 mm/y, D0, S4p4

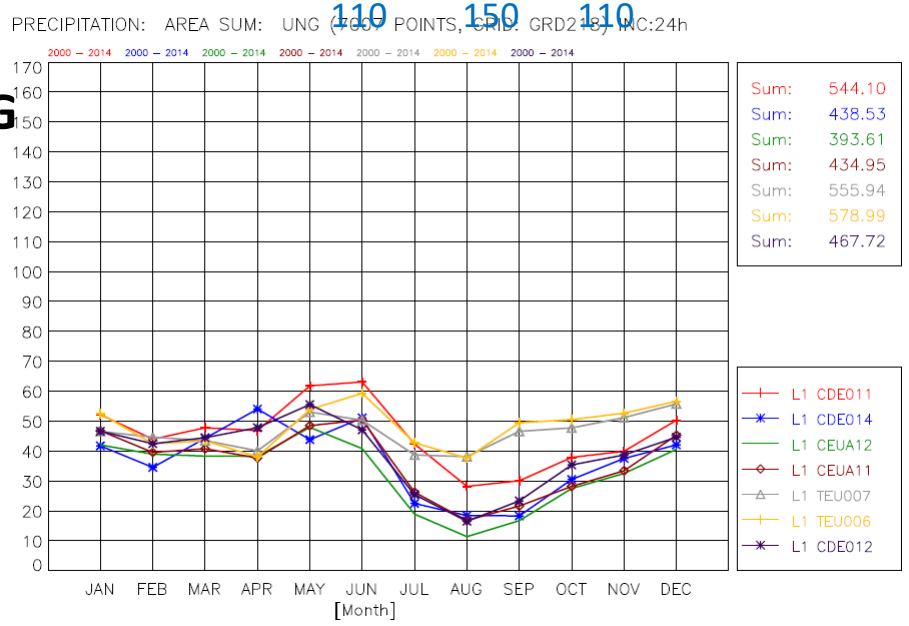
CEU011-CDE011: +40 mm/y, D0.25, C3p2

3.1 TOT_PREC, 2000-2014





	DTL	ALP	UNG	
Impact of resolution+BC				
CEU011-TEU006:	-75	- 40	-145	f=7,C3p2D0.25
CEU012-TEU007:	-85	- 85	-160	f=7, S4p4D0
CDE012-CDE014:	- 2	20	30	f=1.5, S4p4D0
Impact of numerics + hor. diffusion: (S4p4D0.0 – C3p2D0.25)				
TEU007-TEU006:				50km, Ct
CEU012-CEU011:	-30	- 15´	- 25	7km, Ct.
CDE012-CDE011:	-40	- 60	- 40	2.8km, C0
Impact of parameterisation (conv)+ resolution:				
CDE012-CEU012:				D0, S4p4
CDE011-CEU011:	85	70	70	D0.25, C3p2
	110	150	110	



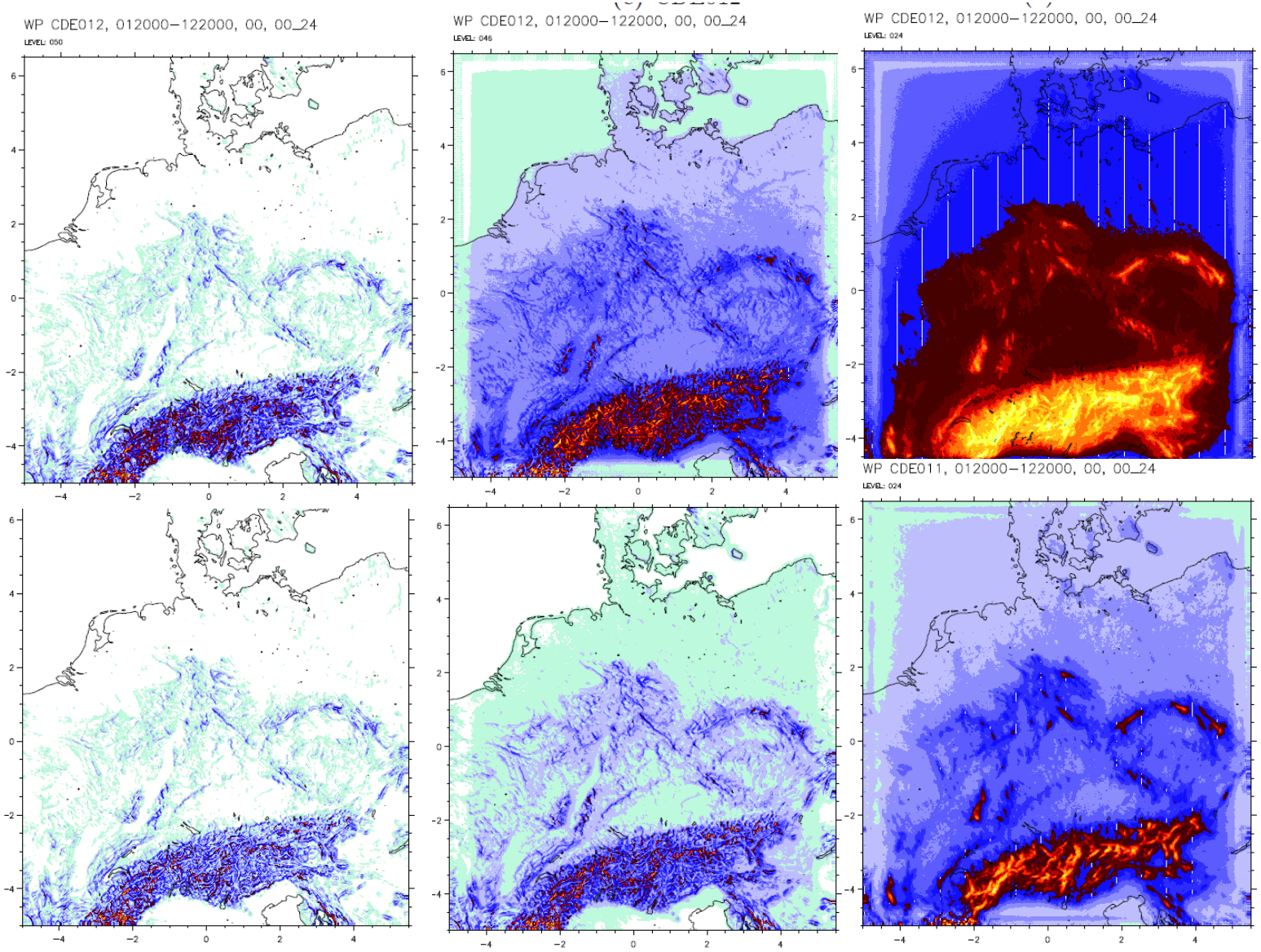
3.1 RESULTS for WP (W>0)

mean 2000

P= 998 hPa 975 hPa 500 hPa

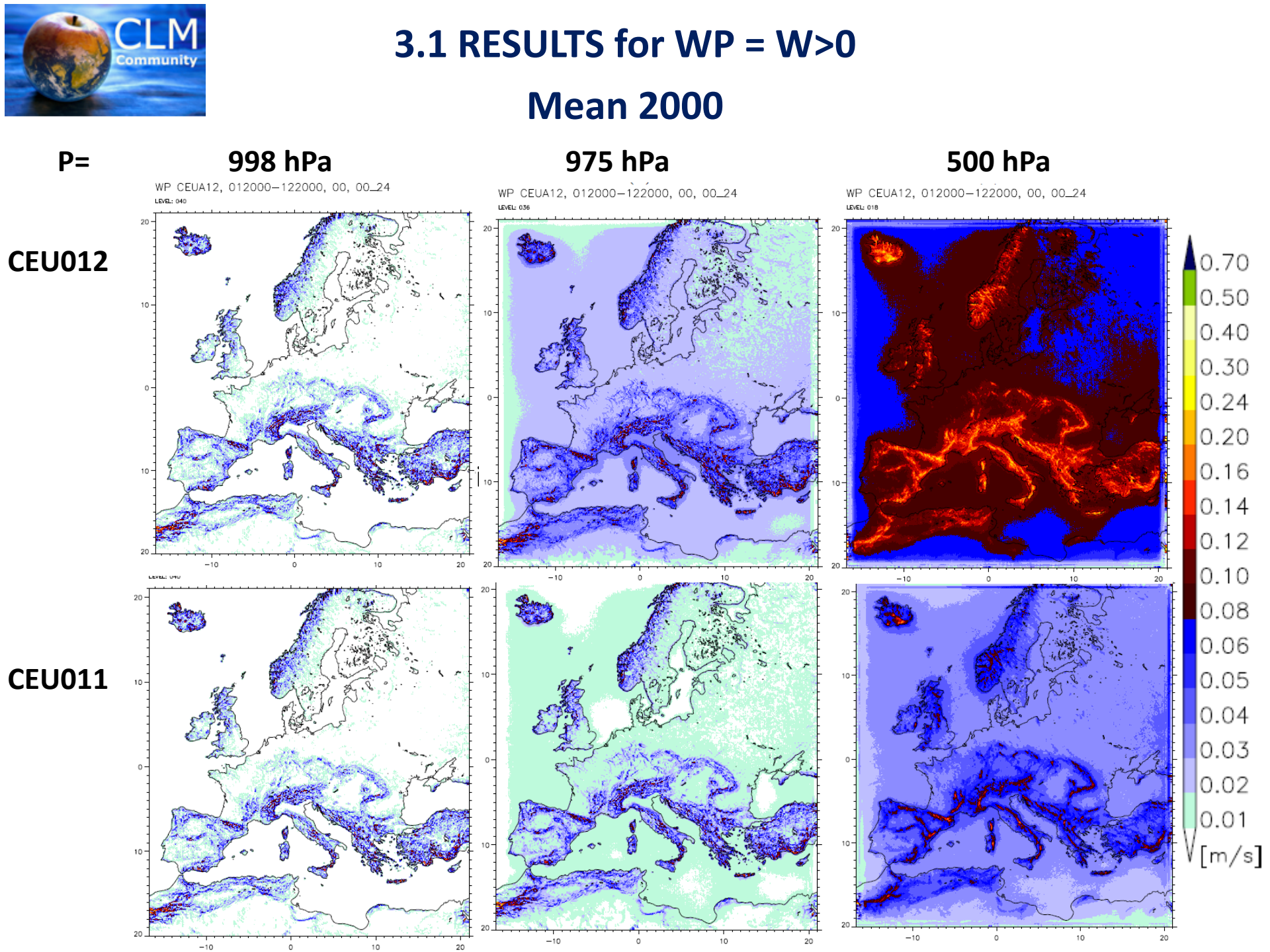
CDE012

CDE011

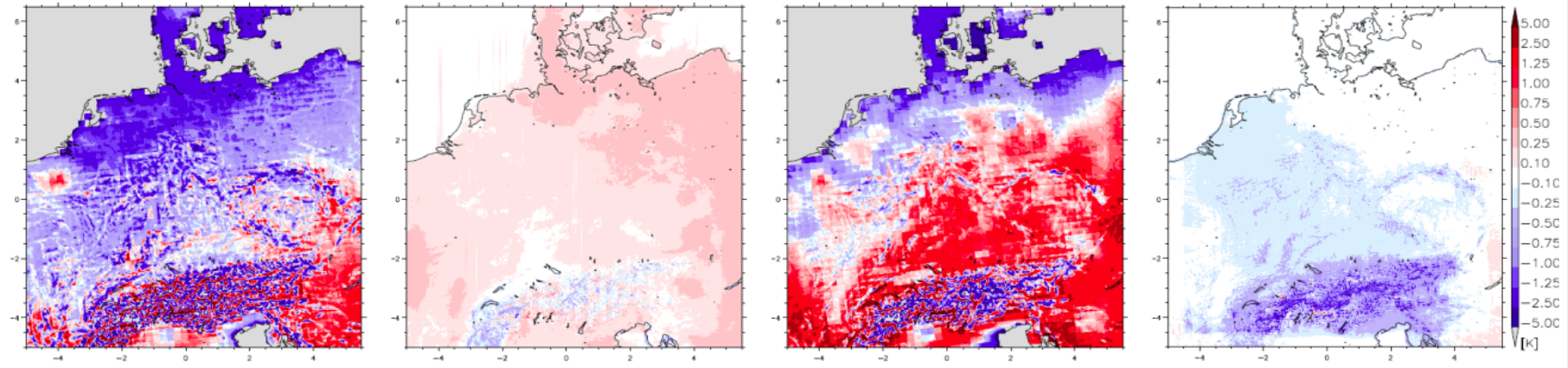


3.1 RESULTS for WP = W>0

Mean 2000



Mean daily MIN/MAX 2m Temperature, 2000-2010



TMAX_2M, CDE012-ECAD **TMAX_2M, CDE012-CDE011** **TMIN_2M, CDE012-ECAD** **TMIN_2M, CDE012-CDE011**

Fig.3: Mean Min/Max 2m Temperature differences, 2000-2010, S4p4d0.00-C3p2d0.00 at 2.8km resolution:. The results exhibit an overall improvement of daily temperature range at convection permitting scales. The mean temperature is nearly unchanged.

Local circulation in Rhone Valley

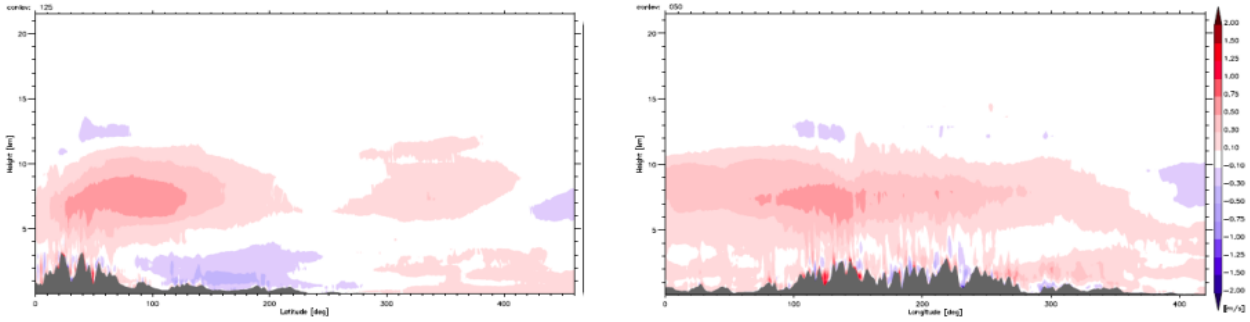


Fig.4: Mean December zonal wind 2000-2014 at $d\lambda = 0.25°$, S4p4d0.00-C3p2d0.00: Vertical-latitudinal at $ny = 50$ (left) and Vertical-longitudinal at $nx = 125$ (right) cross sections.

At 2.8km resoltuion an increase of winter zonal velocity in the troposphere is found of up to 1m/s over the Alpine region. An increase of mean winter velocity of up to 2 m/s is found in Sitten in Rhone valley (grid points (nx=125, ny=50). This valley wind is known to be significantly underestimated by COSMO, even at 1km resolution.

3.1 Impact of resolution, numerics and model physics

- **orographic forcing, land-sea and earths rotation dominate the pattern**
- **higher model resolution by factor 2 reduces the precipitation by 5%**
- **Numerical Diffusion is increasing and**
- **Deep Convection is decreasing the precipitation by 10 to 20 % with different spatial structures.**
- **Long simulation times (>5 years) are necessary to investigate the impact on the annual cycle, even more for the diurnal cycle.**

•INTERPRETATION:

- Convection parameterisation has an infinite speed. The potential energy is transported vertically immediately when buoyancy is positive. The physical convection has a finite speed. The convective motion is suppressed as long as the convection parameterisation is used.

- Parameterised convection is tuned to produce the correct amount with numerical diffusion.

- Numerical Diffusion is a disturbance of dynamics. This increases the precipitation since the atmosphere has to balance this disturbance

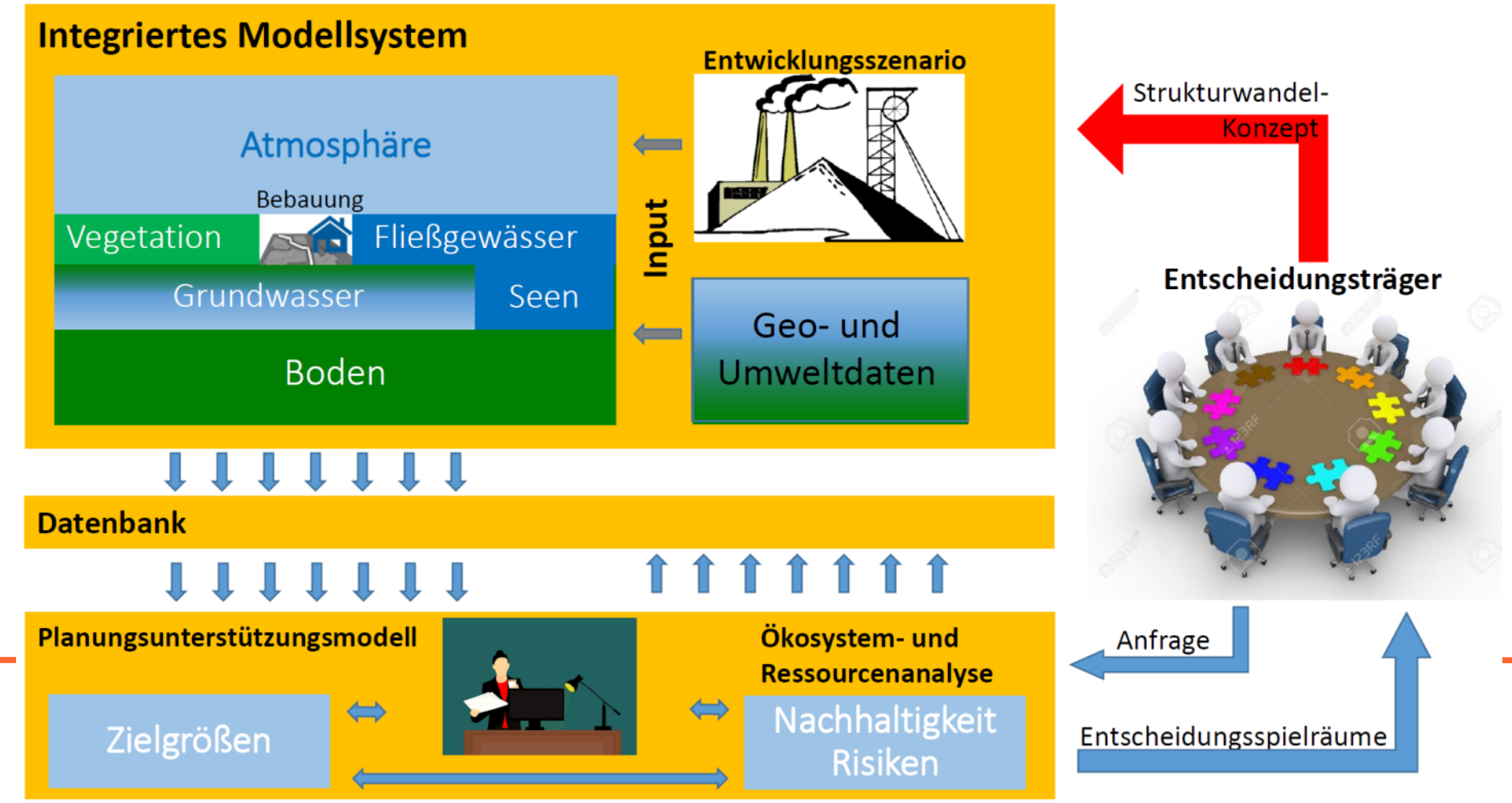
- An Increase of horizontal resolution is reducing the size of the air parcels. Smaller air parcels have higher vertical velocity and thus the system is faster in aequilibrium. This is reducing the precipitation because precipitation occurs if the system is out of aequilibrium.

- Retuning of precipitation is necessary without numerical diffusion.

Further Model development concept

Brandenburg-Berlin Model

**Andreas Will (BTU) , Ingo Kirchner (FU Berlin), Sebastian Schubert (HU Berlin),
Instituete of Environmental Sciences (BTU Cottbus)**



Model Concept

Target Model versions:

COSMO-CLM_5.6_hos_twc_

Two-Way Coupled model system: COSMO-COSMO

2WC_CC: **COSMO-COSMO (Reduce boundary effect)**

TERRA-INH **TERRA for vertically inhomogeneous soil (w_so -> p_so + BUEK200)**

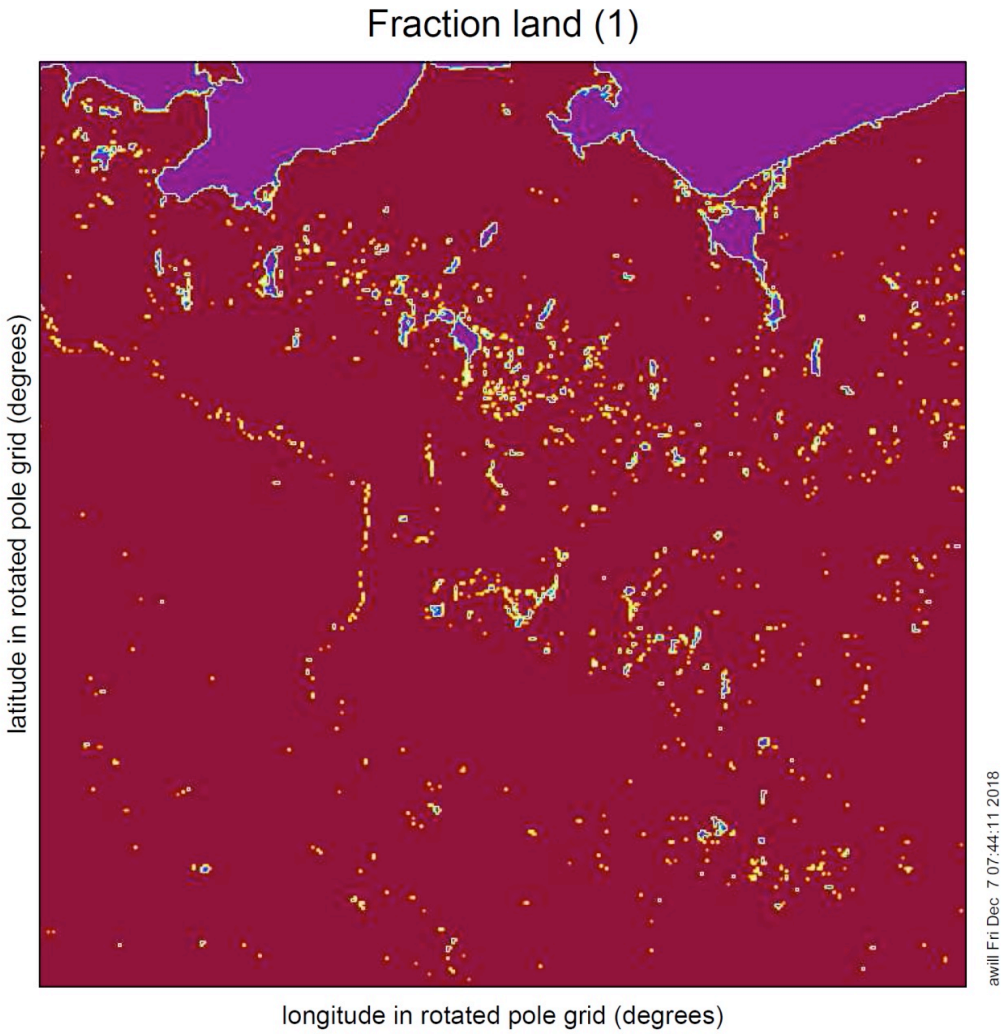
Reference Configurations:

Coupled Regions:	CORDEX-EU	COSMO-BRB
horiz. Res.	$\Delta\lambda=0.0625°$	$\lambda=0.01°$

OASIS3-MCT2: Reference configurations for sequential coupling:

Rgion BRB

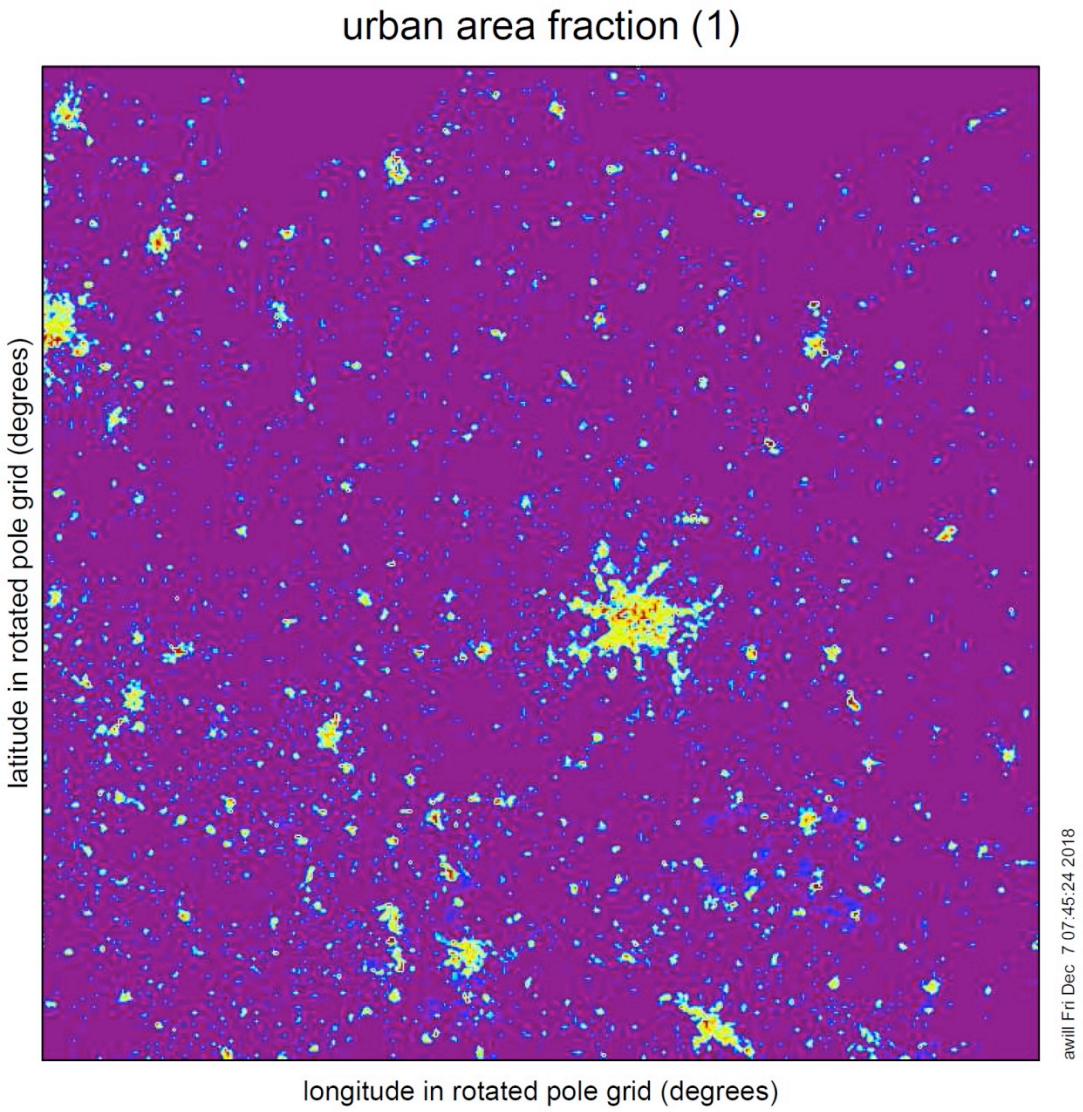
Fraction Land



Rgion BRB

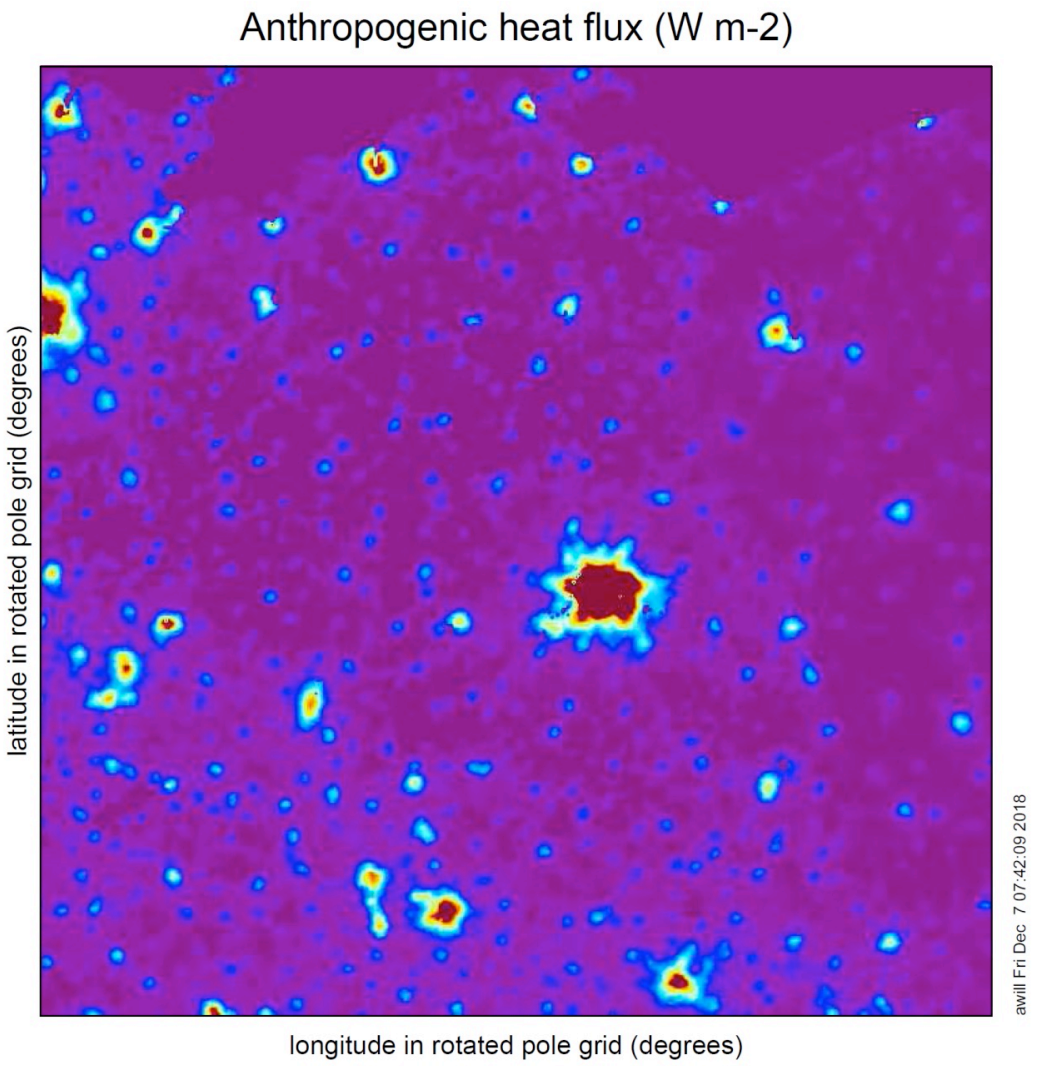
Urban fraction

- **One City: Berlin**



Rgion BRB

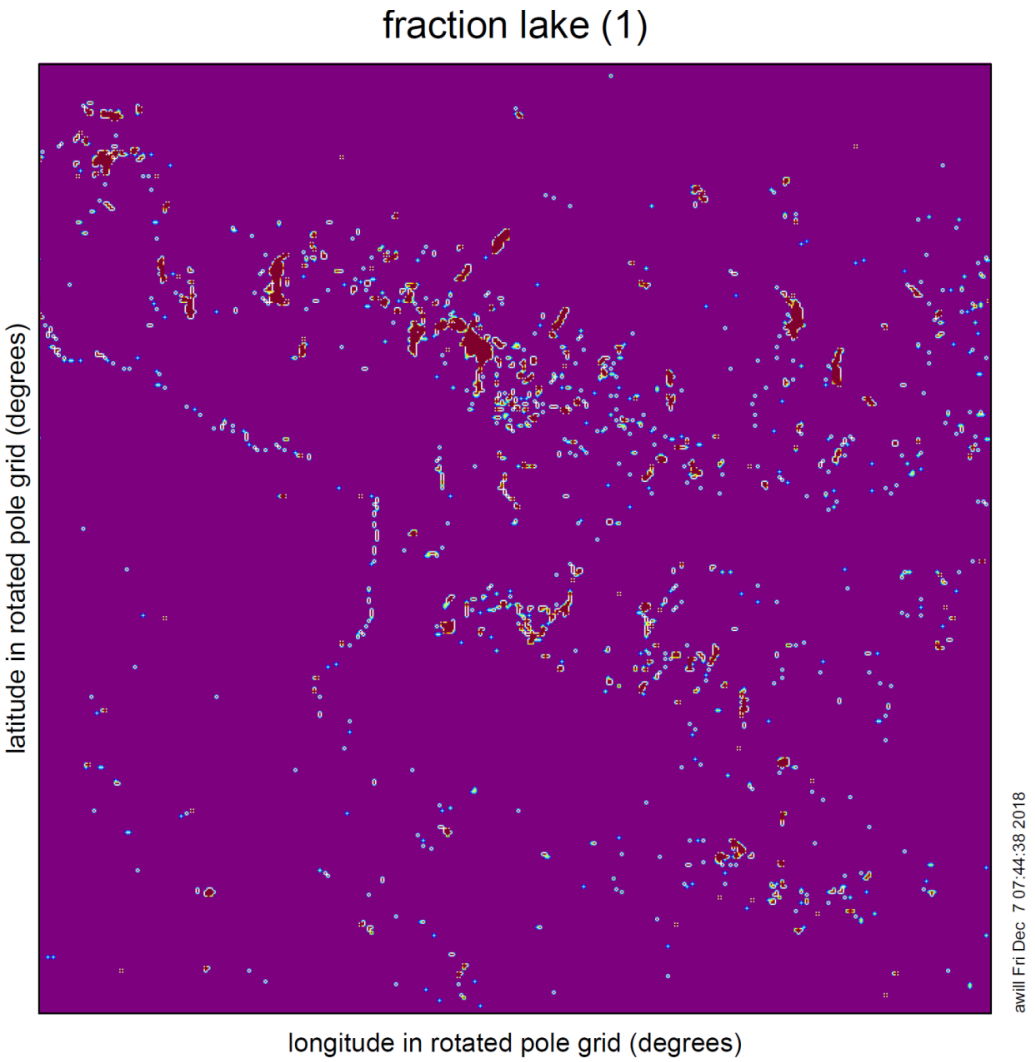
Anthropogenic Heat Flux



Rgion BRB

Fraction Lake

- Many small lakes
- 20 New Lakes after coal mining



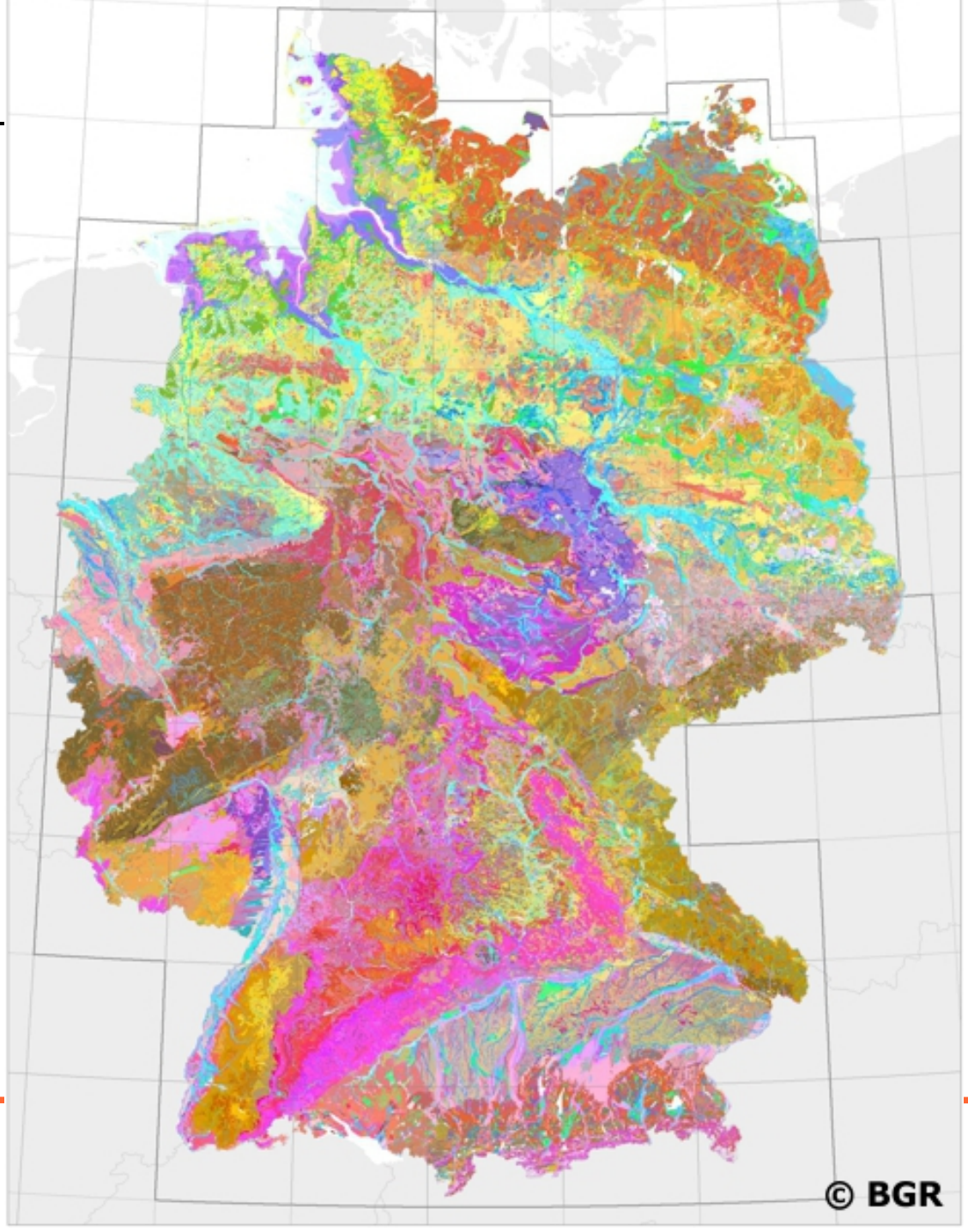
Rgion Germany

BUEK 200 has a resolution of 1km

includes information about depth of the deep soil layers

The depth of ground water is resulting from this information

Richards equation is unstable if w_so is used due to strong changes of soil water content, if the soil type changes
- > replace w_so by p_so
NEW VARIABLE:
water pressure p_so



Development of

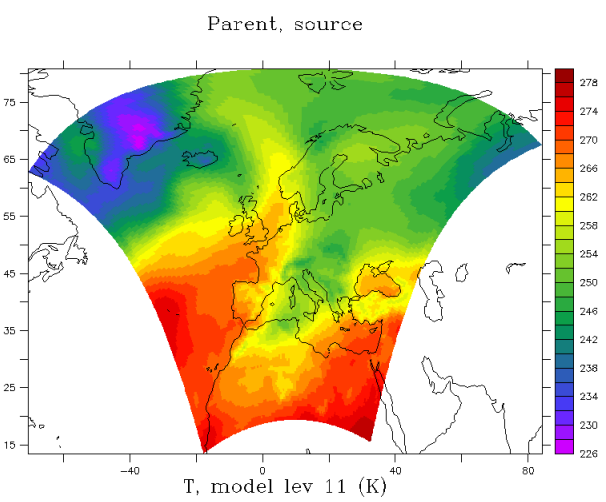
COSMO-COSMO

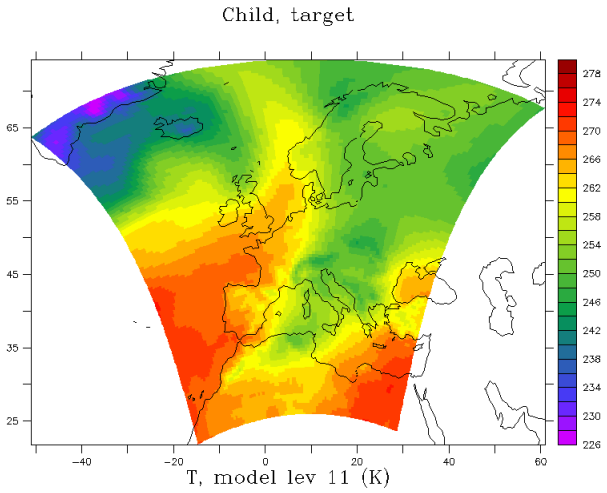
Two –way Coupling

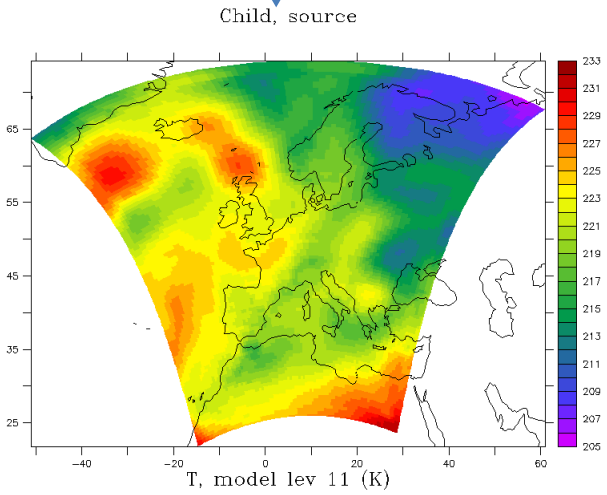
TWC COSMO-COSMO : Field Exchange

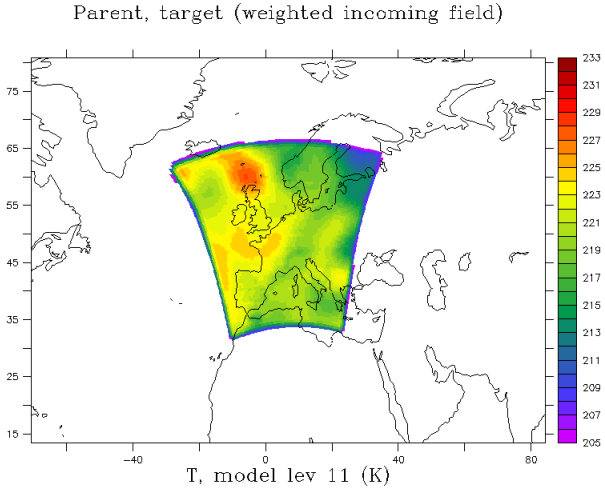
Parent

Child









Summary

- No obvious unphysical behavior of the two-way coupled system
  - The lack of precipitation was solved by considering different saturation adjustments in COSMO and MPIESM

Mean pressure interpolation accuracy of 1 Pa +/- 3 Pa achieved

Substantial noise reduction by

- iteration of the hydrostatic pressure adaption of vertical interpolation
- extrapolation instead of interpolation at the lower boundary

Open Issue:

- Adjustment to COSMO 300 hPa level