Current status and developments of COSMO-CLM

Barbara Früh

Deutscher Wetterdienst

COSMO General Meeting

September 10, 2014

Eretria, Greece

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Overview

Implementation of new IFS convection scheme –

Panitz & Rockel

Impact of land use and soil data specifications –

Smiatek, Helmert & Gerstner

URBMIP –

Wouters, Trusilova & Schubert

COSMO-CLM/NEMO-MED12 over the Mediterranean Sea –

Akhtar, Ahrens, Brauch

Higher order spatial discretization, EXTPAR developments, OASIS unified interface, …

CLM-Community issues

Hans-Jürgen Panitz   KIT/IMK-TRO

Implementation of new IFS convection scheme

Hans-Jürgen Panitz, KIT

Burkhardt Rockel, HZG

diurnal cycle **precipitation** 1989 – 1996 JJA

Daily Cycle TOT_PREC impact convection scheme: CCLM_4.8_clm19 JJA 1989–1996 Africa Sahel (10E–30E, 5N–20N)
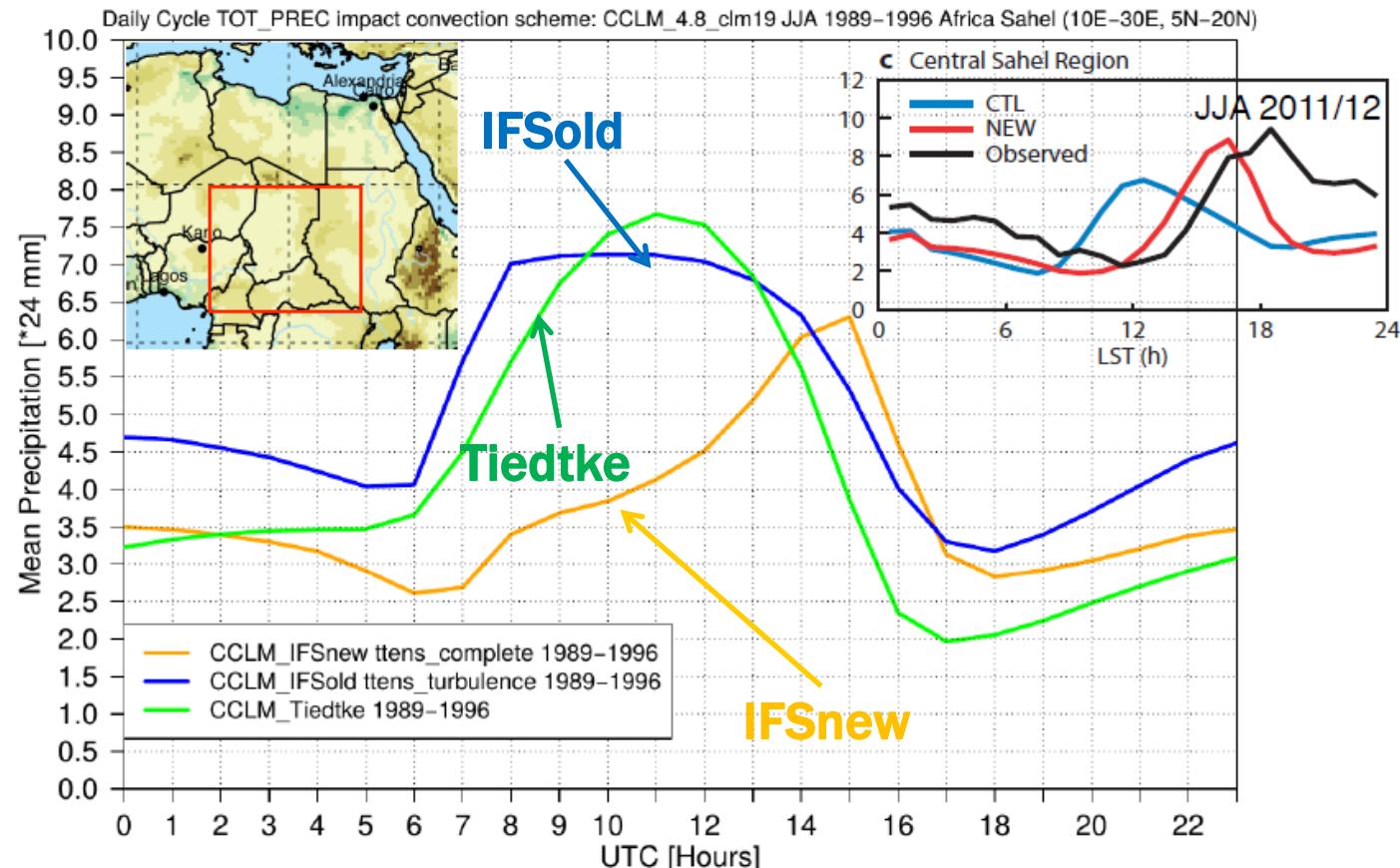
Bechtold, P, N.Semane, P.Lopez, J.-P.Chaboureau, A. Beljaars, N. Bormann, 2014: Representing equilibrium and nonequilibrium convection in large-scale models. *J. Atmos. Sci.* **71**, 734–753.

Hans-Jürgen Panitz   KIT/IMK-TRO

Implementation of new IFS convection scheme Cy40r1

annual cycle **precipitation** 1989 – 1996 JJA

worse
no improvement
better

PIKCRU
Tiedtke
IFSold
IFSnew

CCLM_IFSnew
CCLM_IFSold
CCLM_Tiedtke
PIKCRU
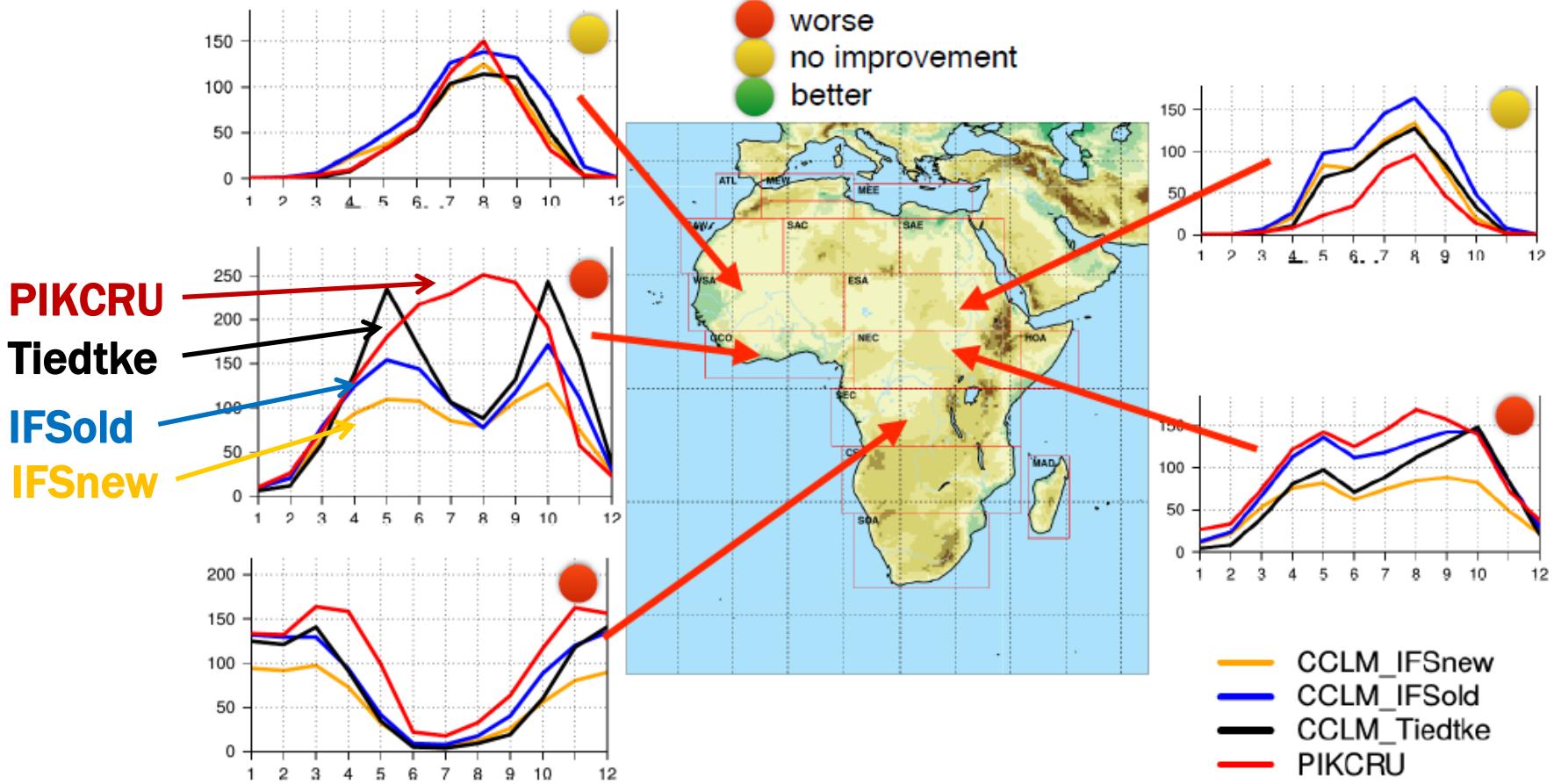
Hans-Jürgen Panitz   KIT/IMK-TRO

Implementation of new IFS convection scheme

Difference in
precipitation

IFSnew – IFSold

1989 – 1996

➔ new IFS generally
drier over land
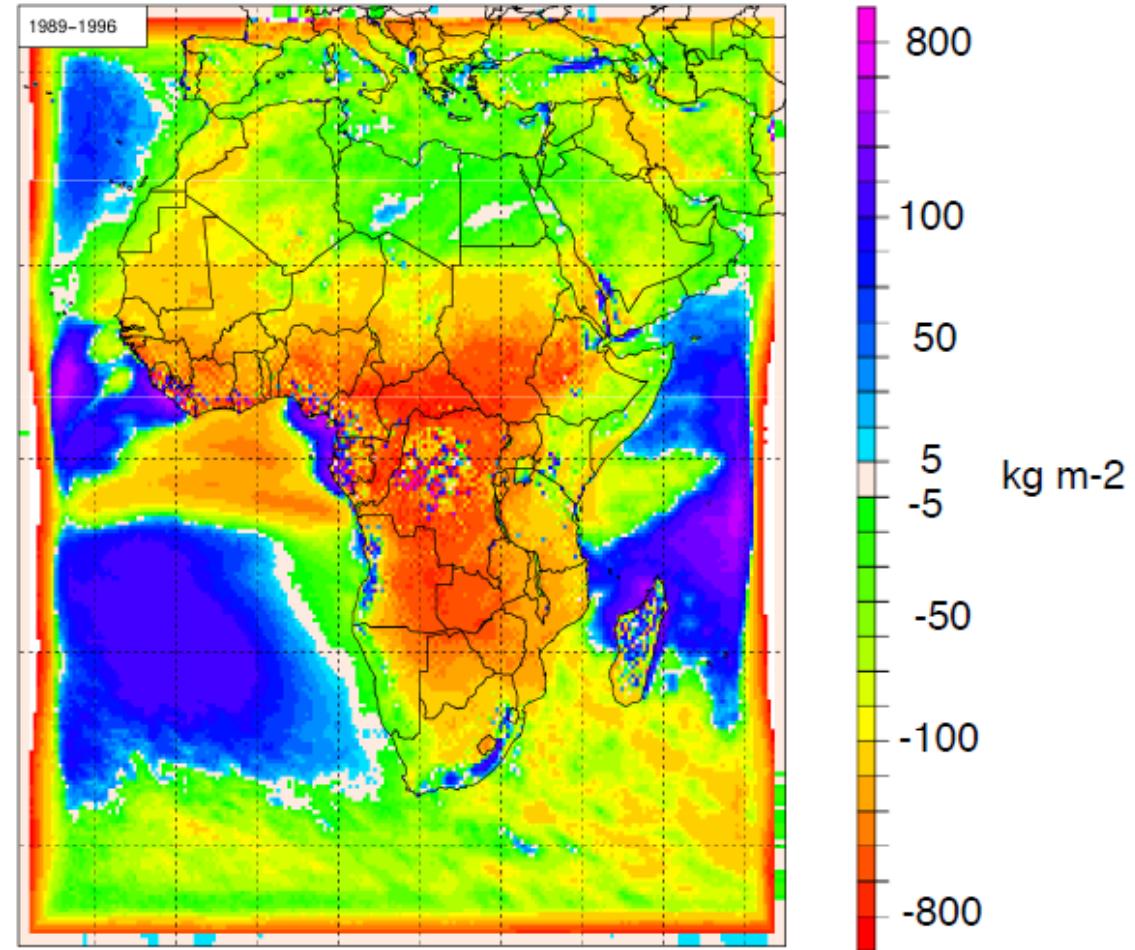
Hans-Jürgen Panitz   KIT/IMK-TRO

Implementation of new IFS convection scheme

Conclusions

- improved diurnal cycle
- precipitation climatology not improved

Outlook

- tests over Europe and other domains
- analyze influence on other quantities
- implementation in COSMO-CLM 5.0

Impact of land use and soil data specifications

Gerd Smiatek, KIT

Jürgen Helmert, DWD

Eva-Maria Gerstner, Uni Frankfurt

Vegetation characteristics
- **GLC200** – min/max for each land use category
- **ECOCLIMAP** – monthly for each land use category and climatic zone

Soil characteristic
- **DSMW/FAO** – soil texture categories
- **HWSD** – proportions of sand, silt and clay

Gerd Smiatek, KIT/IMK-IFU

Impact of land use and soil data specifications

Comparison for ERA40 driven run
on **CORDEX-MED** domain
1986 - 2000
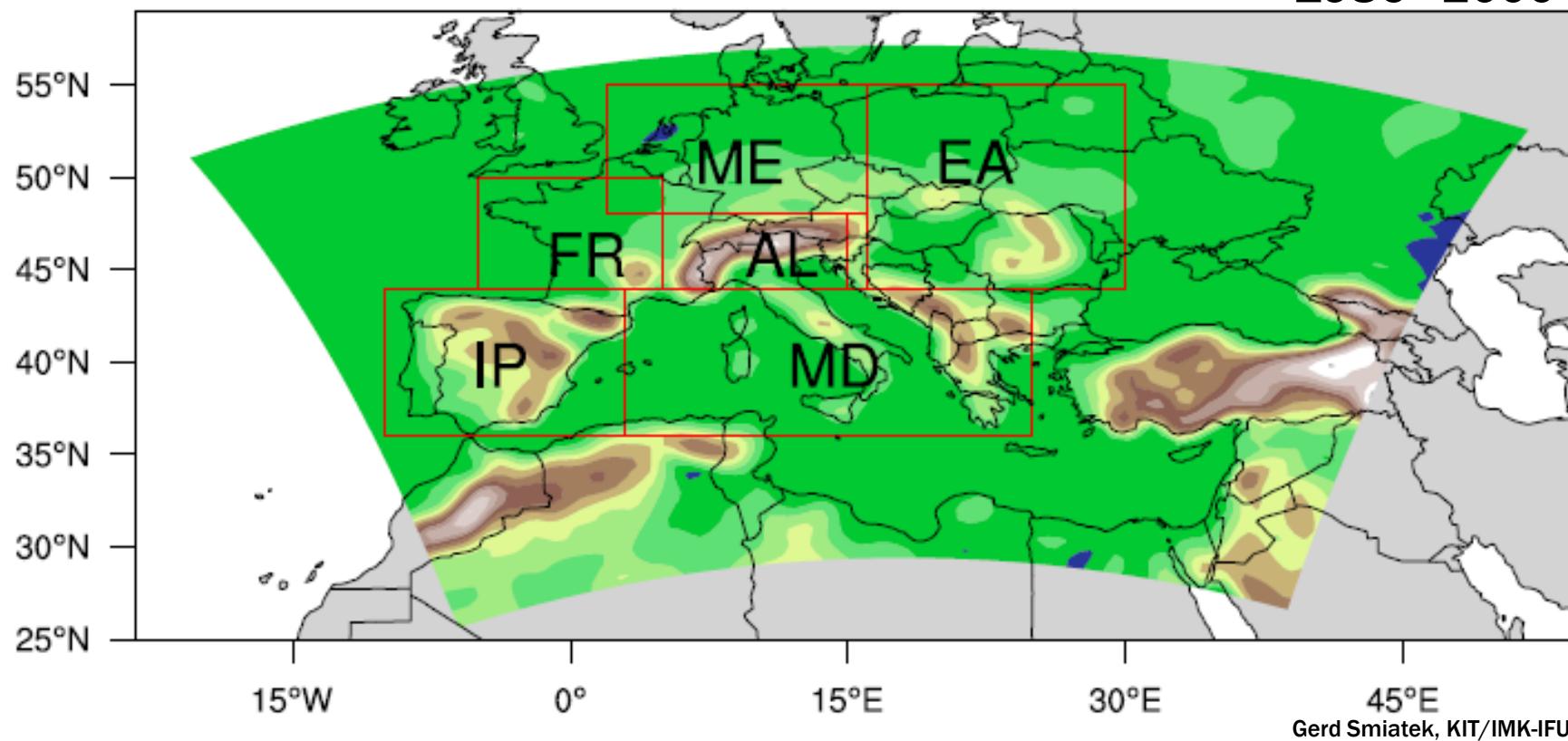
Gerd Smiatek, KIT/IMK-IFU

Impact of land use and soil data specifications

ECO-FAO GLC-FAO   **GLC-HWSD   ECO-HWSD**

**Difference to
E-OBS V9.0**

2m temperature
(area mean)

1991 - 2000
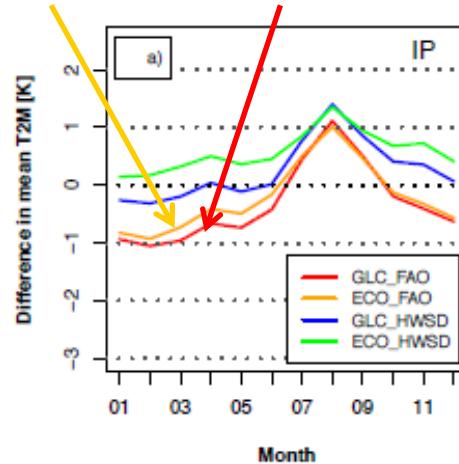
**Vegetation
GLC200 - ECOCLIMAP
Soil
DSMW/FAO - HWSD**
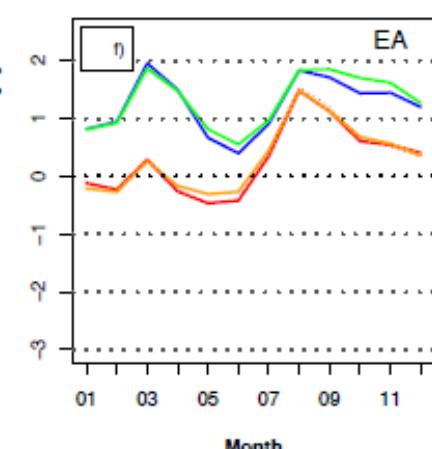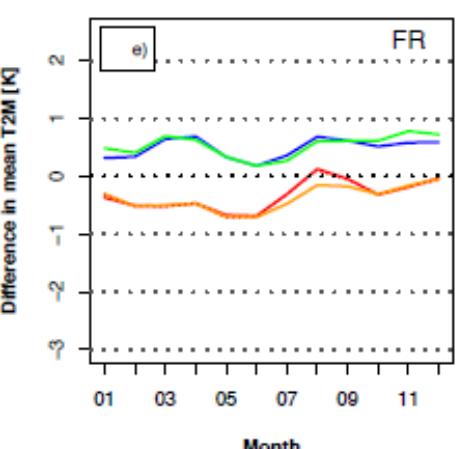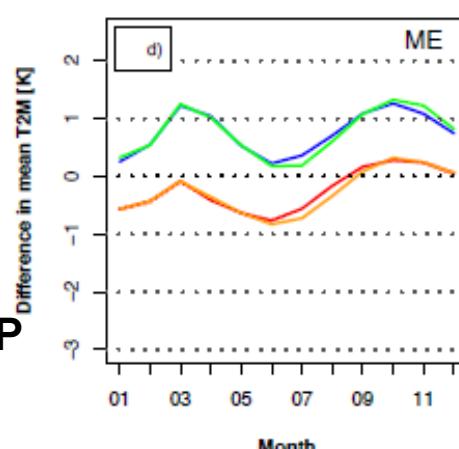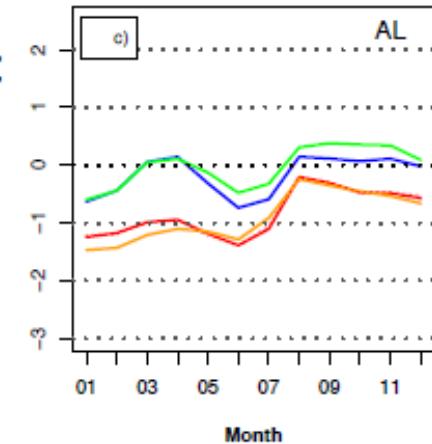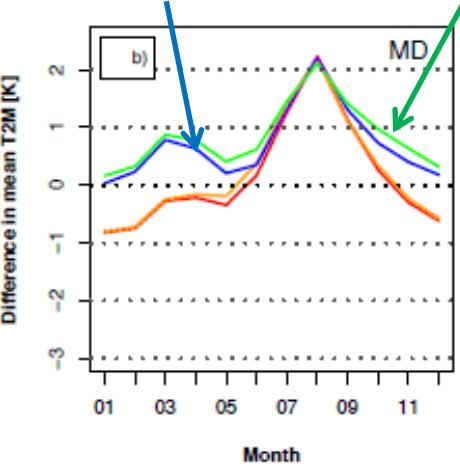
Gerd Smiatek, KIT/IMK-IFU

Impact of land use and soil data specifications

ECO-FAO GLC-FAO   GLC-HWSD   ECO-HWSD

Difference to
E-OBS V9.0

precipiation
(area mean)

1991 - 2000

Vegetation
GLC200 - ECOCLIMAP
Soil
DSMW/FAO - HWSD
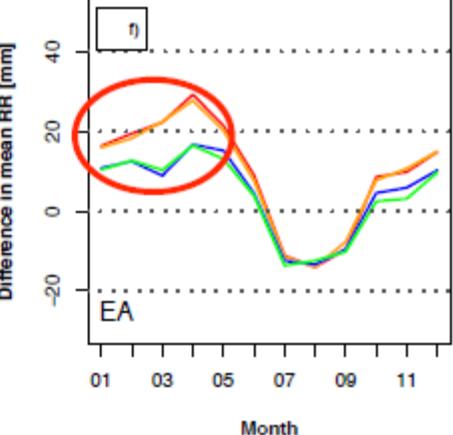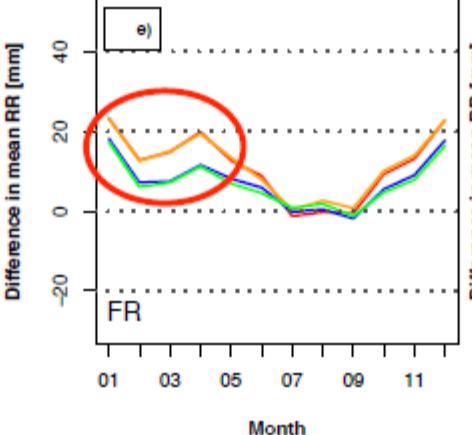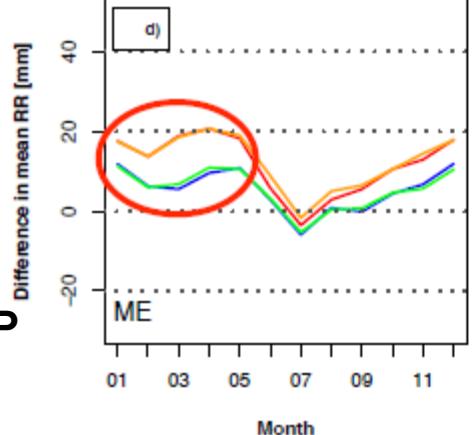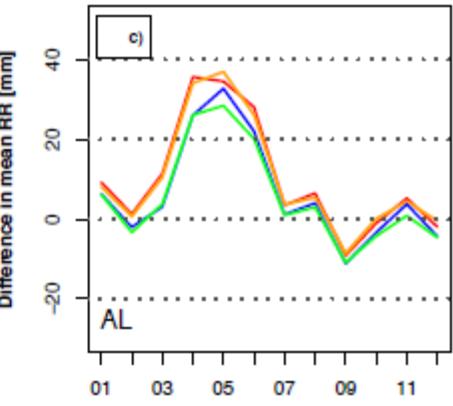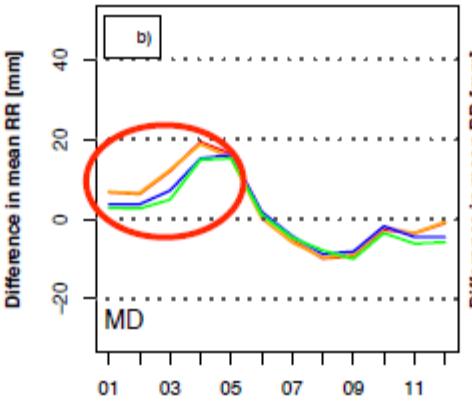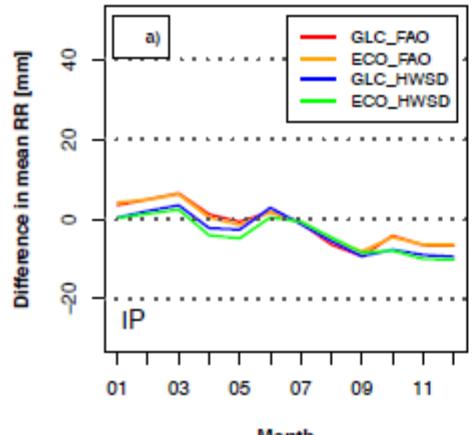
Gerd Smiatek, KIT/IMK-IFU

Impact of land use and soil data specifications on COSMO-CLM simulations

Conclusions

- Evaluation of GLC/ECOCLIMAP and DSMW/FAO HWSD (newly implemented)

- Internal model variability approx. 0.3 K and 0.3 mm/day (seasonal mean values)

- Differences related to land use in range of the internal model variability

- Differences related to soil data: up to 1.8 K in temperature and 21% in precipitation (monthly mean)

- Closer look to the soil data, implementation, higher resolution needed

Gerd Smiatek, KIT/IMK-IFU

URBMIP

Hendrik Wouters, KU Leuven

Kristina Trusilova, DWD

Sebastian Schubert, PIK

Objectives

- **Compare** the existing **urban parameterizations** in COSMO-CLM on a real site application

- Chosen site: **Berlin** urban area

- Chosen variable: **temperature**

URBMIP
Differences in parameterization for urban land
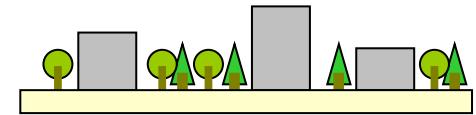
	DCEP/BEP multi-layer urban canopy model	**TEB** single-layer urban canopy model	**TERRA-URB** bulk urban canopy model
Geometry of buildings	n layers	1 layer	no
Evaporation	no	yes	no
Snow cover	no	yes	no
Anthropogenic heat flux	modelled	modelled	prescribed
Input	full 3D city GML	standard	urban soil sealing (EEA), anthr.heat emiss. (NCAR)

Kristina Trusilova/ DWD

URBMIP

Model domains and simulations

4 model domains - 6 model simulations
Simulated time: 2002
Forcing: ERA interim

**Simulation 1 (domain 1, $\triangle x$= 24 km)**

Simulation 2 (domain 2, $\triangle x$= 7 km)

Simulation 3 (domain 3, $\triangle x$= 3 km)

Simulation 4a (domain 4, $\triangle x$= 1 km) + urb.param. 1

Simulation 4b (domain 4, $\triangle x$= 1 km) + urb.param. 2

Simulation 4c (domain 4, $\triangle x$= 1 km) + urb.param. 3
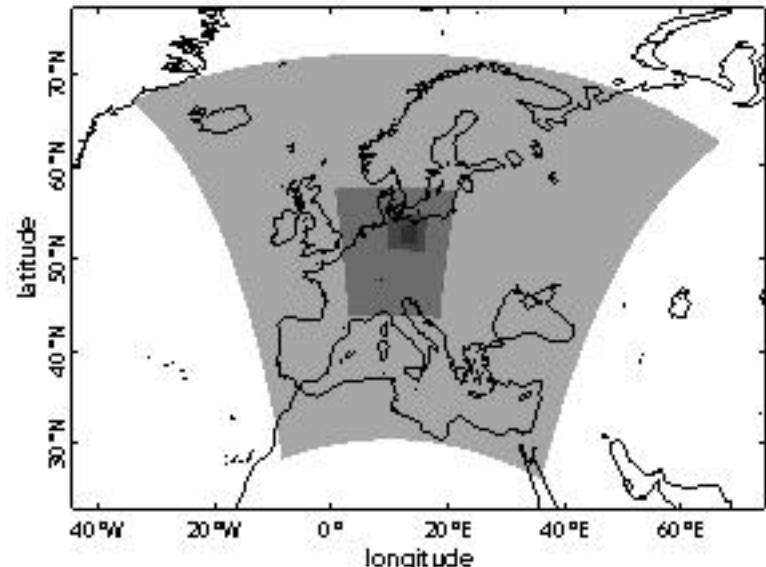
Kristina Trusilova/ DWD

URBMIP

annual cycle mean daily UHI = $T_{Alexanderplatz}$ − $T_{Lindenberg}$ at 2m

Mean UHI

Obs   **0.99 °C**

DCEP/BEP   **1.53 °C**

TEB   **1.33 °C**

T-URB   **1.95 °C**

Legend:
**— *observations***
— BEP
— TEB
— TERRA-URB
— TERRA-URB$_{0-flux}$

Kristina Trusilova/ DWD
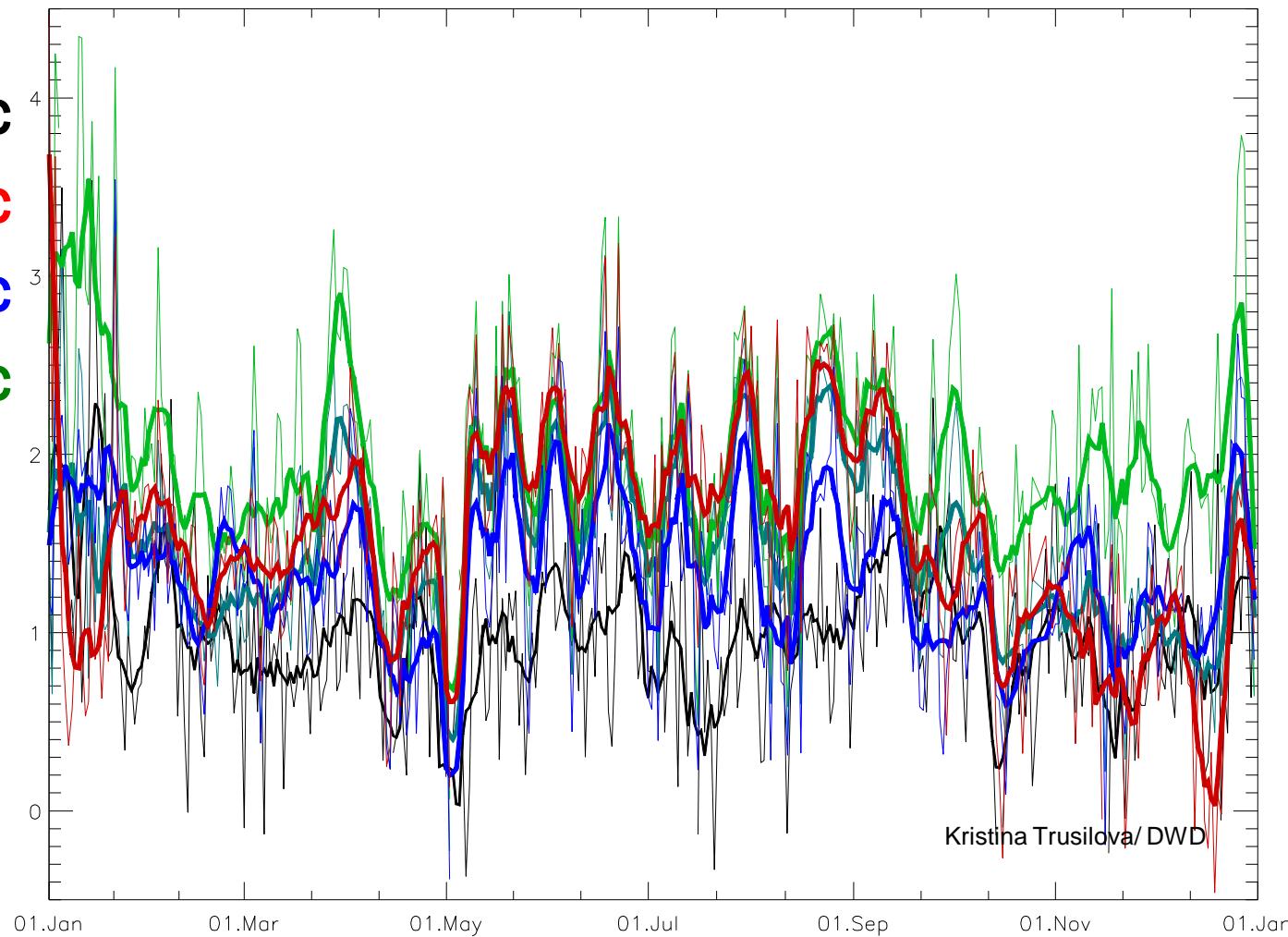
URBMIP

diurnal cycle of average UHI in different seasons
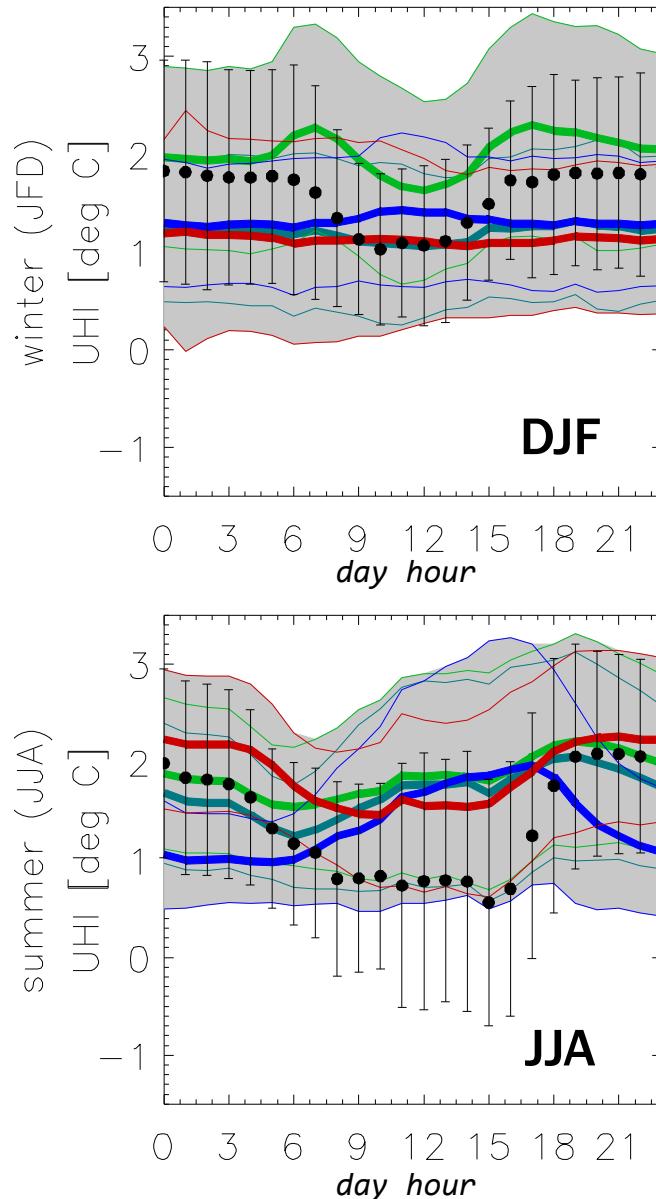
Legend:
--- observations
--- MLUCM
--- SLUCM
--- BULK
--- BULK$_{0-flux}$

Kristina Trusilova/ DWD
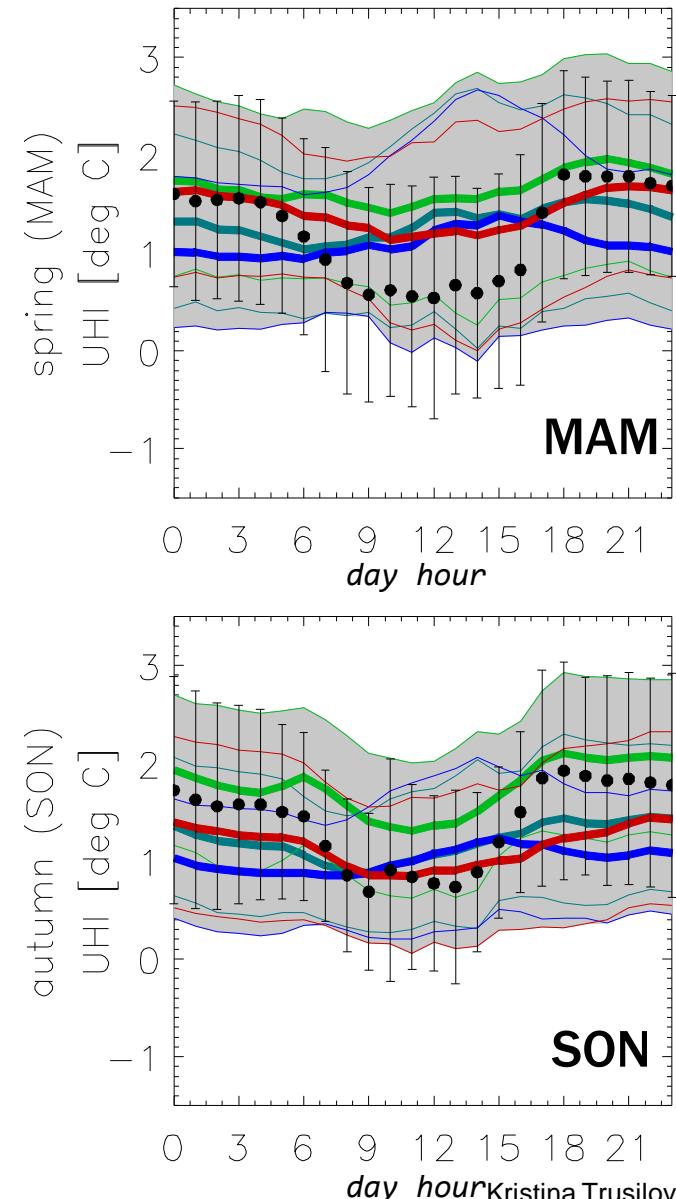
URBMIP

- no model performs best for all seasons

- choice of the model should be guided by goal of the study

- current planning for implementation in standard COSMO code
  - TERRA-URB
  - Interface for BEP-DCEP
  - Interface for TEB – implementation

- more details on the **Berlin study**:
  K. Trusilova et al: The urban land use in the COSMO-CLM model: a comparison of three parameterizations for Berlin, submitted to Met.Z.

- to come: **Basel study** using BUBBLE urban boundary layer observations

Kristina Trusilova/ DWD

COSMO-CLM/NEMO-MED12 over the Mediterranean Sea

Naveed Akhtar, Uni Frankfurt

Bodo Ahrens, Uni Frankfurt

Jennifer Brauch, DWD

atmosphere
COSMO-CLM   (0.44°)

ocean
NEMO-MED12 (1/12°)

coupler
OASIS3-MCT2

atmospheric forcing
ERAinterim (1979-2012)

river climatology
Ludwig et al. (2009)

Atmospheric Model

Evaporation - Precipitation
Wind Stress
Solar Energy Flux
Non-Solar Heat Flux

Coupler:OASIS 3
Ocean grid ⇔ Atmospheric grid

Time Step = 1h

SST

Ocean Model
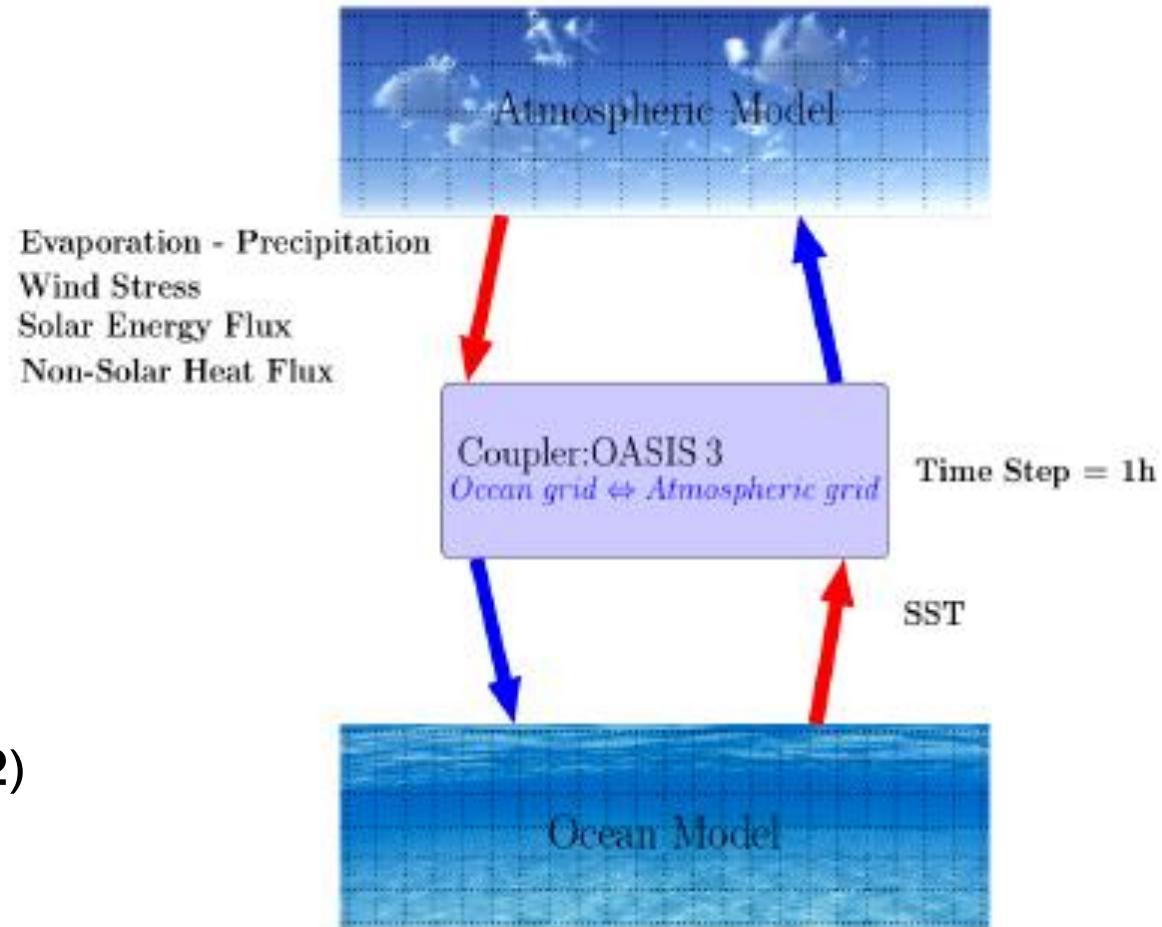
Naveed Akhtar / Uni Frankfurt

# COSMO-CLM/NEMO-MED12 over the Mediterranean Sea

1980 - 2011

surface temperature
SST / T_S

coupled *CPL*
- uncoupled *CCLM*

SST...
- in CPL **warmer** than CCLM in **DJF**
- in CPL **colder** than CCLM in **JJA**

T_S: CPL – CCLM

Naveed Akhtar / Uni Frankfurt
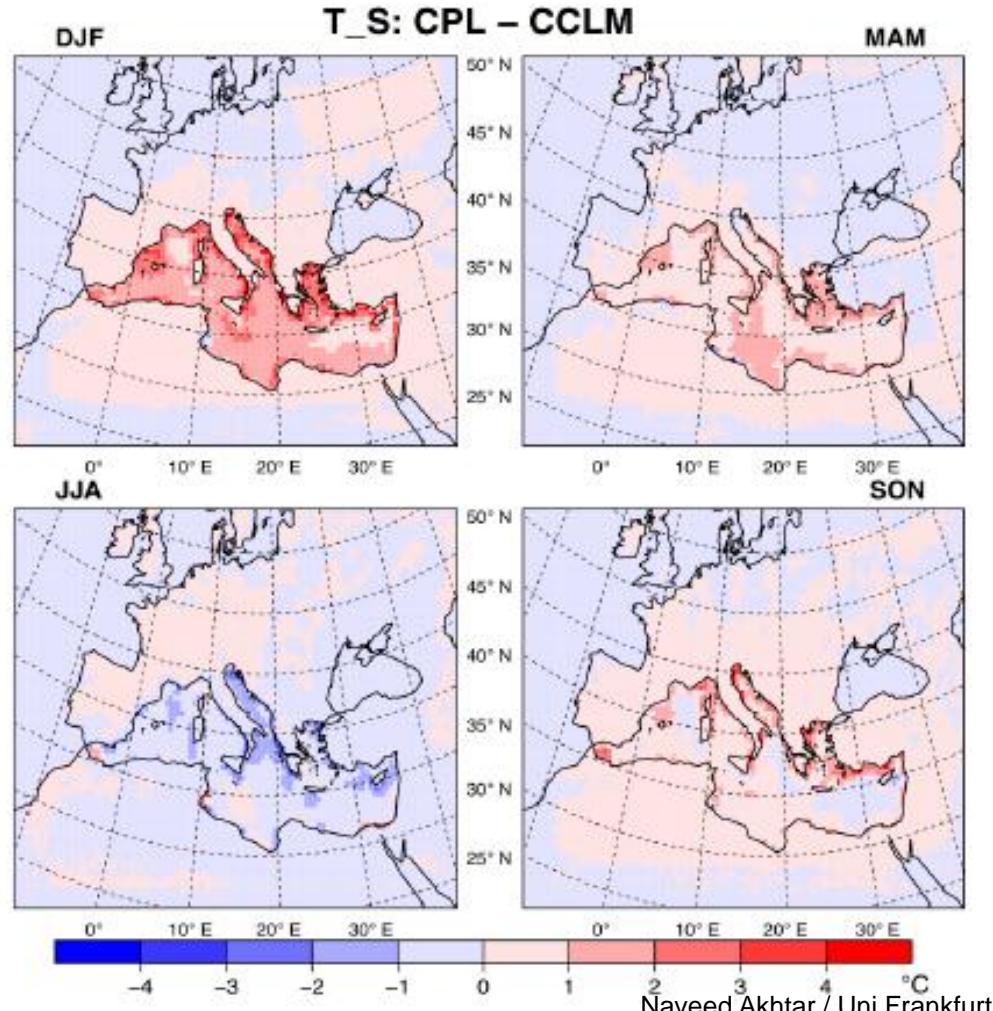
COSMO-CLM/NEMO-MED12 over the Mediterranean Sea

Interannual variability hindcast using Regional Climate System Models (RCSM)
Models: ERA-Int driven run, ENEA, CNRM, GUF, LMD, INSTM, IPSL
Obs (Flux): NOCS, SRB-QC, SRB-GEWEX, ISCCP-FD, OAFLUX, GEBA, BRSN

ERA-Int CNRM ENEA
LMD GUF INSTM IPSL
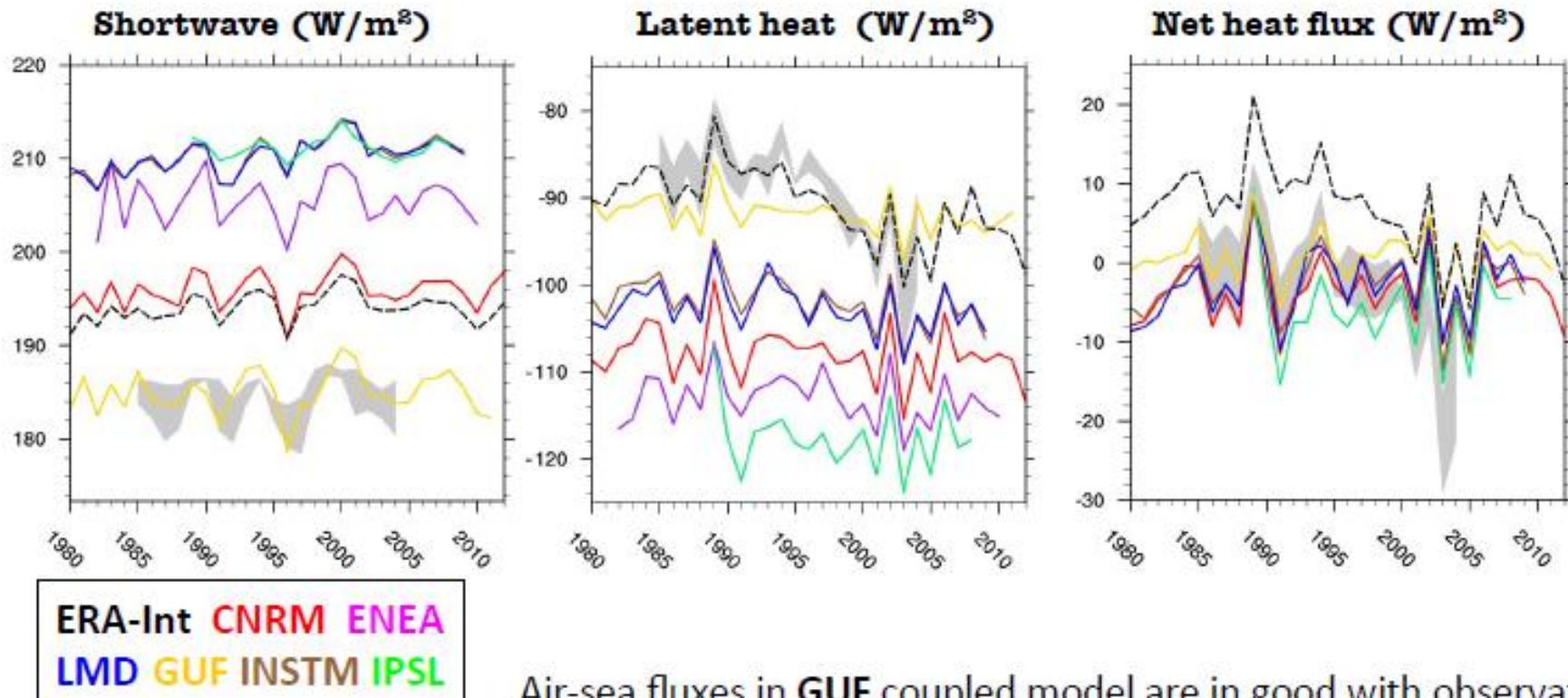
Air-sea fluxes in **GUF** coupled model are in good with observations

C. Dubois & S. Somot / CNRM

COSMO-CLM/NEMO-MED12 over the Mediterranean Sea

- **Coupled system for the Mediterranean Sea is running with good first results**

- **MACC climatology increased solar radiation (up to 30 Wm-2) during spring and summer which reduced SST bias (2-3°C)**

- **Air-sea fluxes are better represented in the coupled model compared to ERA-Interim and the uncoupled COSMO-CLM**

C. Dubois & S. Somot / CNRM

CLM-Community development

Update of CLM-Community Flyer

THE MODEL

The COSMO model in Climate Mode (COSMO-CLM) is a non-hydrostatic regional climate model developed by the CLM-Community on the basis of the Local Model (LM) for weather forecasting of DWD (now COSMO model). The developments related to the COSMO model are coordinated by COSMO (COnsortium for Small scale MOdeling).

Thus, the model system serves for Numerical Weather Prediction and Regional Climate Modeling. Recently, a new unified model version COSMO 5 for weather, climate, and environmental research has been released.

COSMO-CLM is an atmosphere model with the soil-vege-

MEETINGS

General Assembly:
Here, all CLM-Community members meet every year in late summer. Recent developments are presented, further cooperations discussed and community decisions taken.

User Seminar:
Common meeting of COSMO-, CLM- and ART- communities in springtime. Emphasis is here on the scientific presentations and the exchange of information between the communities.

Training Course:
... of COSMO, ART and CLM-Community ... the training course in Spring to get a practi- ... on of the model system.

CLM Community

INFORMATION

Climate Limited-area Modelling Community

International network of scientists

THE CLM-COMMUNITY

The Climate Limited-area Modelling Community (CLM-Community) is an open, international network of scientists, who investigate the regional climate by developing and applying the COSMO model in Climate Mode (COSMO-CLM). All members accepted the CLM-Community agreement as a basis of joint efforts in COSMO-CLM development and application.

In summer 2014, the CLM-Community has 239 scientific members from 59 climate research institutions all over the world. It is the largest obliging cooperation in the field of regional climate modelling aiming to address the challenges of model development, to efficiently use the computing resources, and to make substantial contributions to answer the key questions of regional climate research.

For more information, please visit our website!

▶ www.clm-community.eu

WORLD		EUROP	
Brazil	1	Austria	3
China	2	Belgium	3
Iran	1	Cyprus	1
Israel	2	Finnland	1
Mexico	1	Germany	21
Nigeria	1	Greece	2
Saudi Arabia	1	Ireland	1
Senegal	2	Italy	2
Tanzania	1	Luxembourg	1
USA	2	Russia	1
Venezuela	1	Switzerland	3
Vietnam	1	Turkey	1
		UK	2
		Ukraine	1

COMMUNICATION

The most important tool of the CLM-Community is communication on the level of coordinated model development, on cooperations, and community issues themselves. There are several ways to exchange information at the moment:

- Regular meetings
- COSMO-CLM Website
- Newsletter (bi-annual)
- working and project group meetings and their mailing lists
- the RedC (Redmine for model development and dissemination in the CLM-Community) forum to post and answer questions and the RedC wiki for information
- publications by the members

ORGANISATION

The CLM-Community follows the bottom-up approach to allow the members to take part in community decisions, which happen at the CLM-Community Assembly.

Working/Project Groups:
The common tasks and interests around the usage and further development of the model system are coordinated and conducted here. Generally, they serve as a forum for collaborations and work distribution.

- WG EVAL: evaluation
- WG DYNNUM: dynamics and numerics
- WG SOILVEG relates to the land surface components of COSMO-CLM,
- WG SUPTECH: support and technical issues
- WG AIO: atmosphere, ocean and ice interaction
- WG CCAR: chemistry, clouds, aerosol and radiation
- WG CRCS: Convection resolving climate simulations

QR-Code to ▶
www.clm-community.eu

...erdienst
...tion
...h and Dr. Susanne Brienen
...Se 135
...a@dwd.de

Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD
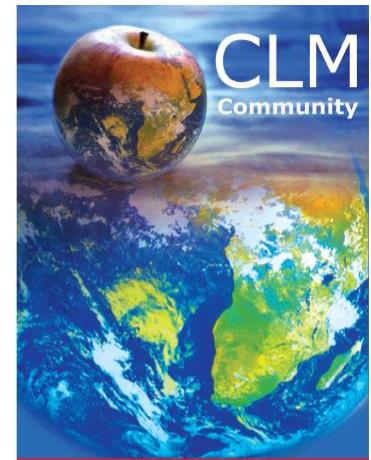
CLM-Community Newsletter

To improve the communication within the growing community:
CLM-Community Newsletter

- 3rd issue published in July

If you are interested in receiving, please, send an email to:
clm.coordination@dwd.de

CLM-Community science plan

Completely rewritten very dense document with 12 pages only! Reviewed by CLM-SAB

COSMO agreement Annex D equal to Appendix G of CLM-Community agreement

outlines relation COSMO and CLM-Community (special development partner)

COSMO

CLM-Community

provides new version of COSMO software

invites to COSMO GM

CLM coordinator invited to SMC meetings

"unified" model version

provides regularly development to COSMO

invites to CLM Assembly

COSMO SPM invited to CLM-CO
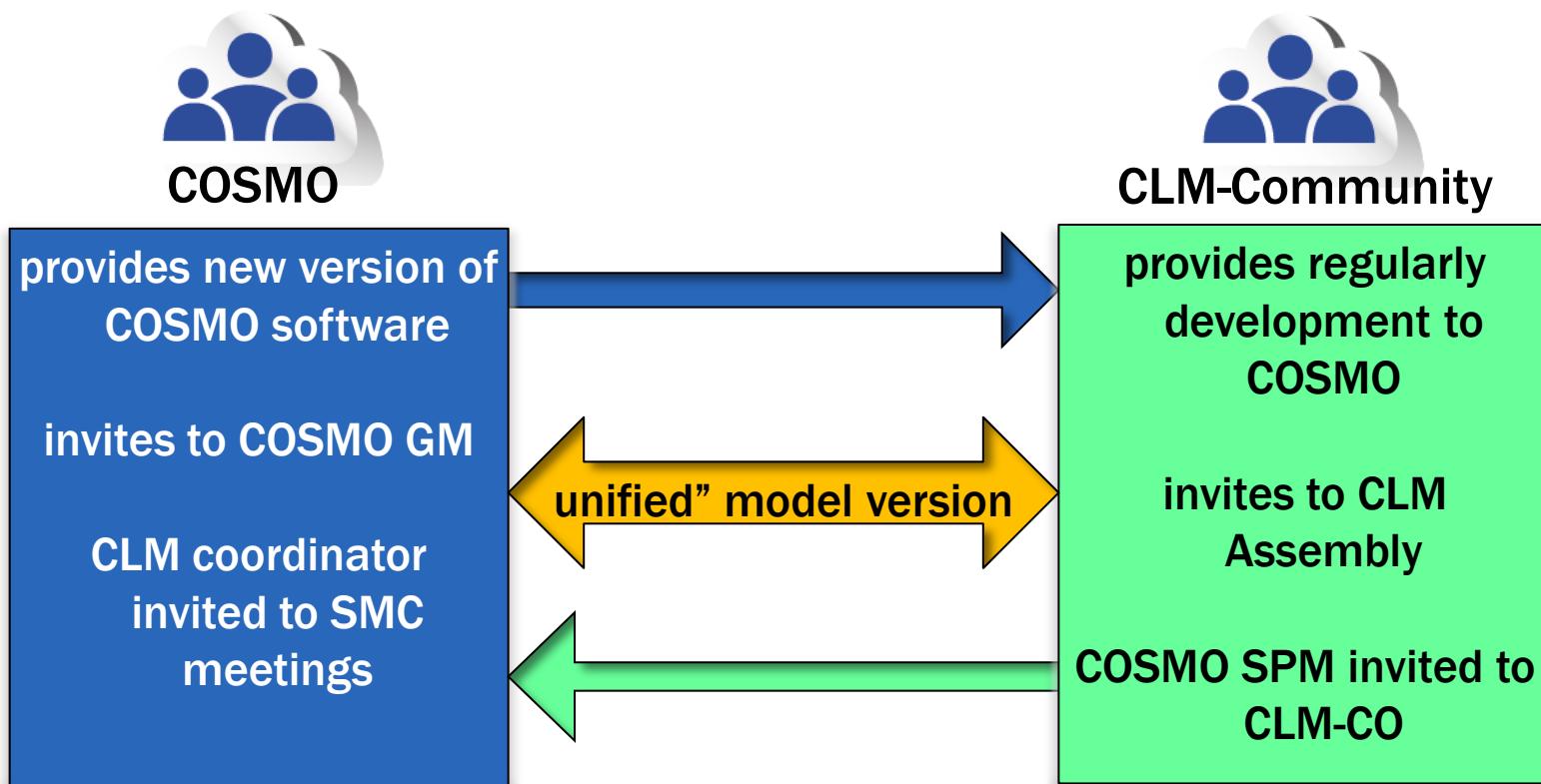
CLM-Community Assembly 2015

September 22 – 25, 2015
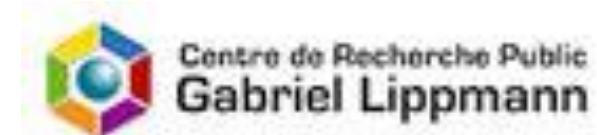
CRP - Gabriel Lippmann
41, rue du Brill
4422 Belvaux

Luxembourg

http://www.crpgl.lu/index.php?id=27&L=2

Thank you very much for your attention!!!

Towards a regional climate system model (RCSM)
Unified oasis interface

cosmo_4.21	Oasis3_MCT	Veg3D	KIT	Running
cosmo_4.8_clm19	Oasis3_MCT (UOI)	CLM	ETH	Testing
cosmo_4.18	Oasis3_MCT (UOI)	ROMS	ETH	Testing
cosmo_4.8_clm19	Oasis3_MCT (UOI)	TRIM+CICE	HZG	Testing
cosmo_4.8_clm19	Oasis3_MCT (UOI)	Nemo_Med12	GUF/BIK_F/DWD	Running
cosmo_4.8_clm19	Oasis3	Nemo_Baltix	GUF/BIK_F/DWD	Running
cosmo_4.8_clm19	Oasis3_parallel	Nemo+MFS	CMCC	Running
cosmo_4.8_clm19	Oasis3_MCT (UOI)	Echam6	BTU	Running
cosmo_4.8_clm19	Oasis3_MCT	Fesom	Uni Trier	Planned

- unified oasis interface (UOI) not mature for implementing into COSMO-CLM yet
- Workshop on UOI & UOImulti (multi component coupling) in SEPTEMBER!

Jennifer Brauch / DWD

Atmosphere – Sea ice – Ocean Coupling:
Status of projects

Models: Ocean/Ice/ Runoff	Region	Scientists	Institution	Status
NEMO / (LIM) /	Mediterranean, North, Baltic Sea	J. Brauch, B. Ahrens, T.V. Pham, N. Akhtar	GUF, BiK-F, DWD	running
TRIM / CICE /	North, Baltic Sea	H. Hagemann, B. Rockel	HZG	running
FESOM / FESOM | CCLM /	Arctic, Laptev Sea, Svalbard	O. Gutjahr	University Trier	in progress
NEMO?/ (LIM) /	(Western) Mediterr., Northeast Atlantic	H. Feldmann, G. Schädler, H.-J. Panitz	IMK-TRO (KIT)	planned
NEMO / (LIM) /	Mediterranean Sea	A. Will	BTU Cottbus	planned
NEMO / (LIM) /	Mediterranean Sea	L. Cavicchia, A. Sanna, S. Gualdi, P. Oddo	CMCC	running
ROMS / /	Southern Atlantic	D. Byrne, L. Papritz	ETHZ	running

Burkhardt Rockel / HZG