TERRA-ML Developments 2014

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STATUS CLM-TERRA 2013

2	Model development (CLM-Community, TERRA)			
2.1	COSMO	N/A	Vertically dependent soil structure, HWSD data set	[CLM] B. Ahrens (Uni Frankfurt
2.2	COSMO	N/A	Soil thermal conductivity dependent on soil moisture	[CLM] JP. Schulz (Uni Frankfur
2.3	COSMO	N/A	Carbon cycle	[CLM] B. Ahrens (Uni Frankfurt
2.4	COSMO	N/A	Dynamic vegetation	[CLM] B. Ahrens (Uni Frankfurt
2.5	COSMO	N/A	Urban scheme BEP	[CLM] S. Schubert (PIK)
2.6	COSMO	N/A	Urban scheme TEB	[CLM] K. Trusilova (DWD)
2.7	COSMO	N/A	Parameterization of urban effects	[CLM] H. Wouters (KU Leuven)
2.8	COSMO	N/A	River routing model	[CLM] J. Volkholz (PIK)

CURRENT STATUS CLM-TERRA

Start date	Task status	Expected delivery	Task subject	Responsible person
				all description all status all
WG3b				
2013-07-01	work	N/A	Soil temperature - lower boundary condition	[CLM] J. Tödter (Uni Frankfur
2013-01-01	work	2013-12-31	Revision of transpiration and root parameterization	G.Vogel (DWD)
2012-12-01	work	2014-09-30	Revision of TERRA to support HWSD data	J.Helmert (DWD)
2012-10-01	work	N/A	Veg3D Coupled with OASIS	[CLM] M. Breil (KIT)
2012-09-10	work	2013-12-31	Revision of rainfall interception	J.Helmert (DWD)
2012-03-01	test	N/A	Tile approach to support partial snow cover	E.Machulskaya (DWD)
2012-01-01	work	N/A	Parameterization of urban effects	[CLM] H. Wouters (KU Leuven)
2012-01-01	stop	N/A	Revision of TERRA configuration	J.Helmert (DWD)
2012-01-01	test	N/A	Soil thermal conductivity dependent on soil moisture	[CLM] JP. Schulz (Uni Frankfur
2011-10-01	test	2013-12-31	Community Land Model coupled with OASIS	[CLM] E. Davin (ETHZ)
2011-09-30	finish	2014-03-31	Multi-layers snow model	E.Machulskaya (DWD)
2011-09-30	test	N/A	Comprehensive tiles approach	E.Machulskaya (DWD)
2011-09-01	test	2014-03-31	COSMO PT Mire parametrization	A.Yurova (RHM)
2011-01-01	test	N/A	Urban scheme BEP	[CLM] S. Schubert (PIK)
2011-01-01	finish	N/A	Urban scheme TEB	[CLM] K. Trusilova (DWD)
2009-01-01	finish	N/A	Community Land Model coupled as subroutine	[CLM] E. Davin (ETHZ)

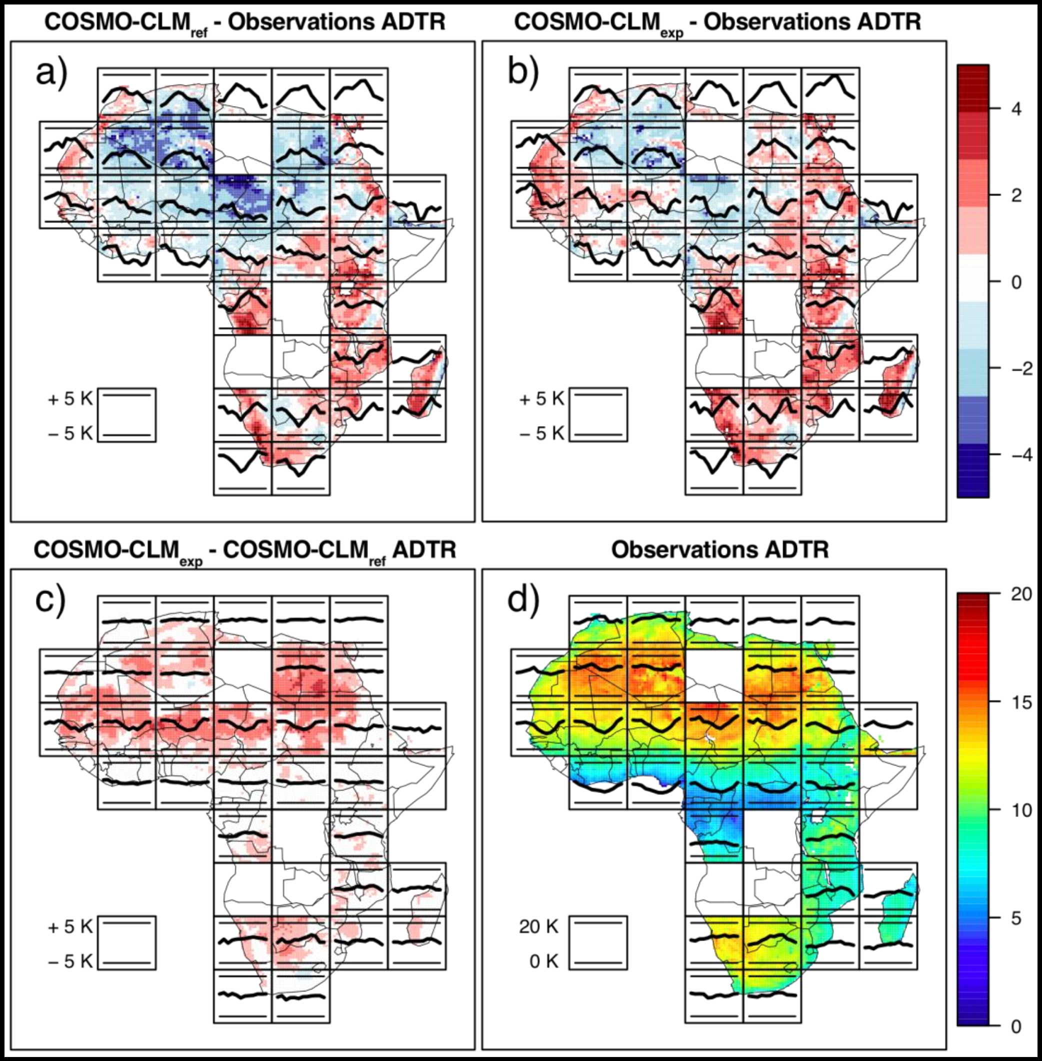
SOIL THERMAL CONDUCTIVITY

- Introduction of dependency of soil thermal conductivity on soil water content (currently a constant conductivity representing a medium soil wetness is assumed)
- As a consequence the ground heat flux is reduced in dry regions, and enhanced in wet regions
- Work done by Jan-Peter Schulz (Uni Frankfurt)
- Tests for COSMO-DE, COSMO-EU, and COSMO-CLM in Africa

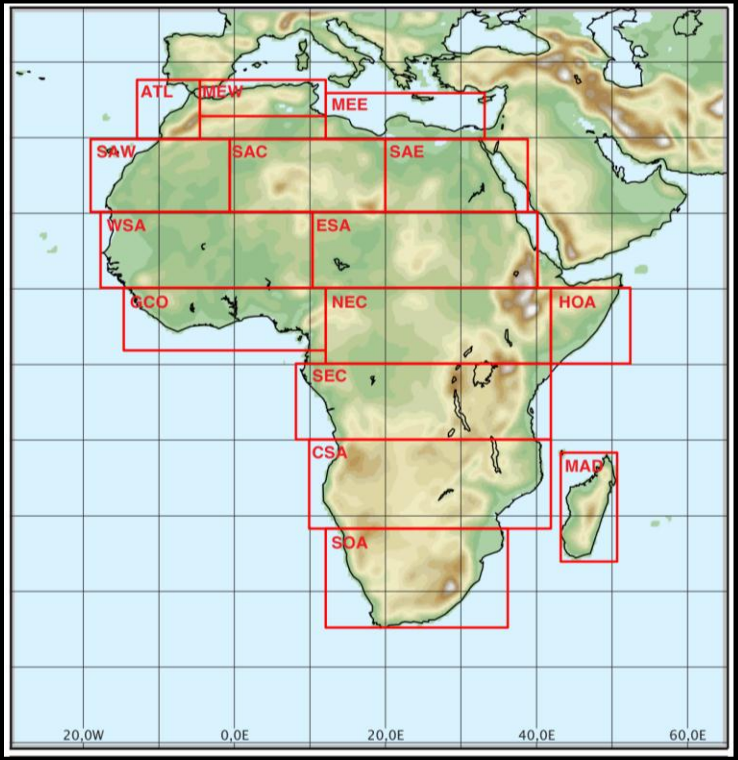
  ⇒ Project status: work

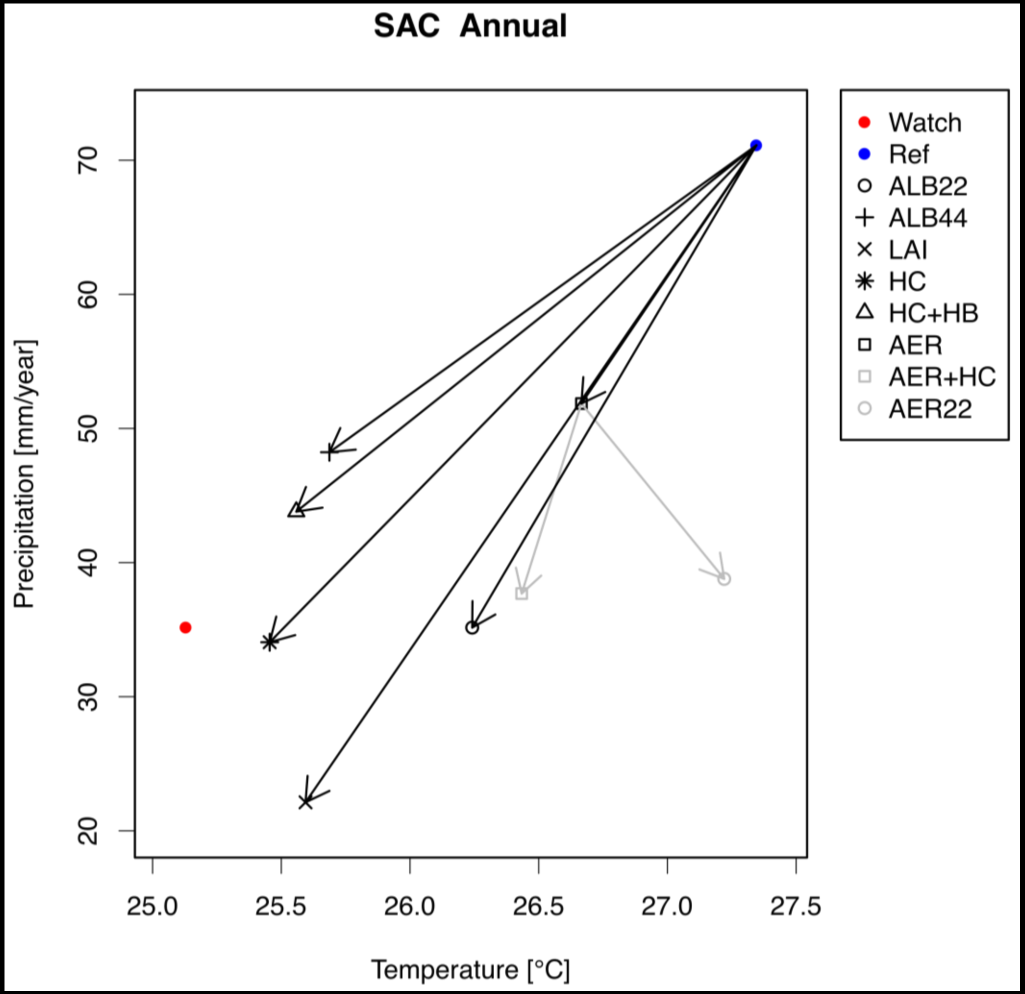
  ⇒ Successful implemented into COSMO-CLM

Soil thermal conductivity



Soil thermal conductivity





SOIL CARBON CYCLE

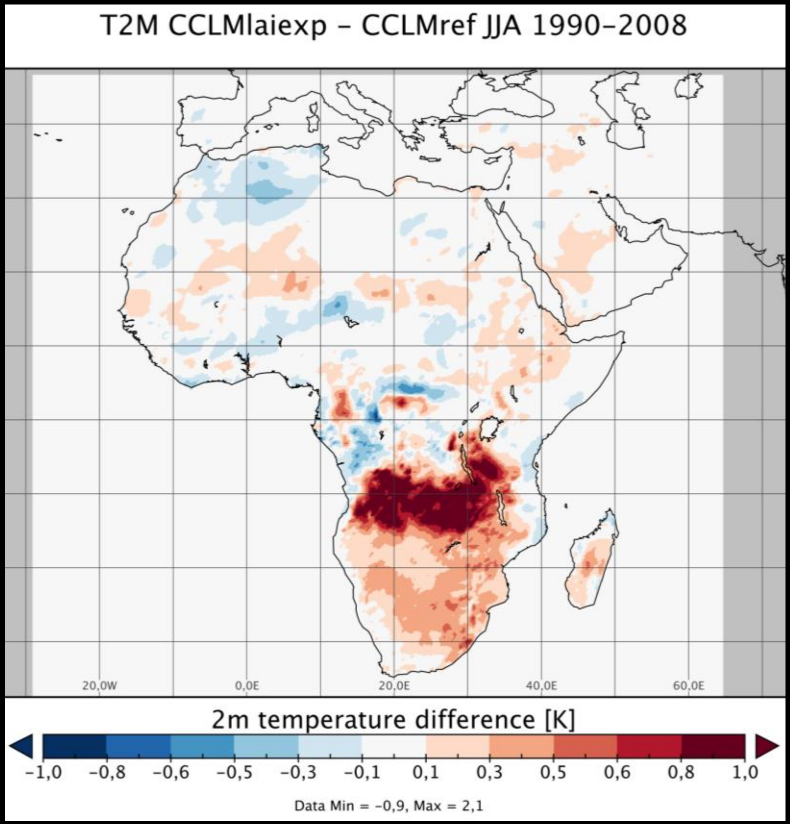
- Stand-alone-version of soil carbon model basing on ECOSSE
- TERRA output of soil temperature and soil water content used as boundary condition
- Adaption of individual terms to reach consistency with TERRA
- Work done by Jana Schröder (Uni Frankfurt)
- First version implemented in offline TERRA
- First tests are done

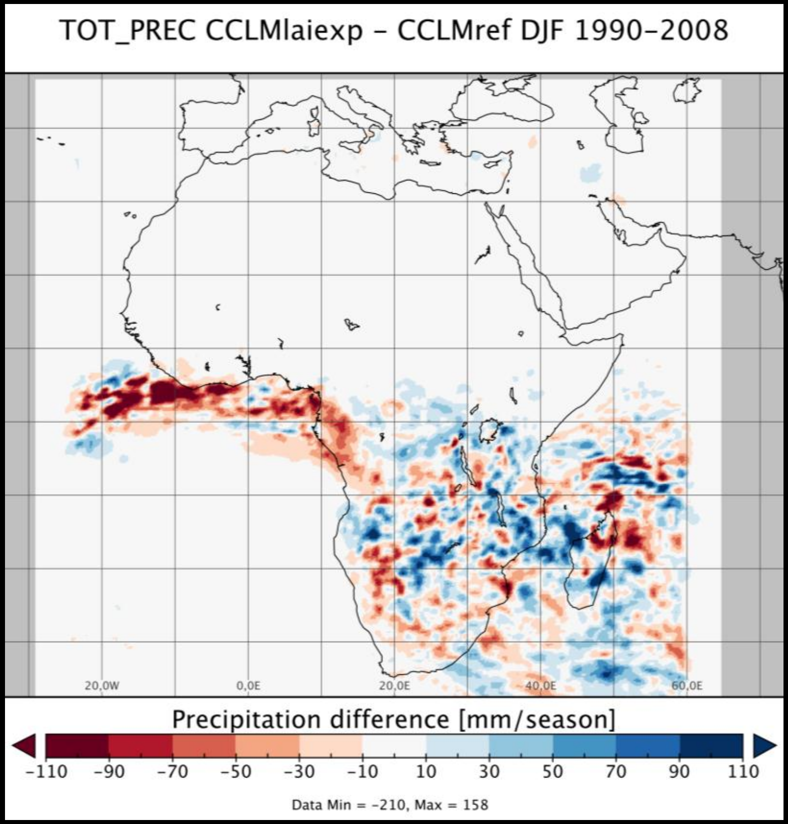
  ⇒ Project status: work (project ends in June 2014)

DYNAMIC VEGETATION

- It is intended that Jan-Peter Schulz (Uni Frankfurt) will work on this topic in the near future

  ⇒ Project status: planning / pre-testing phase





VEGETATION PHENOLOGY

- Implementation of phenology parameterization to improve LAI
- Work done by Jan-Peter Schulz (Uni Frankfurt)

  ⇒ Project status: work

  ⇒ Presentation: “A new leaf phenology for the land surface scheme TERRA of the COSMO atmospheric model“

URBAN PARAMTERIZATION

- Parametrization of urban effects
  - Work done by Hendrik Wouters (KU Leuven)

    ⇒ Project status: work
- Urban scheme BEP
  - Work done by Sebastian Schubert (PIK)

    ⇒ Project status: test
- Urban scheme TEB
  - Work done by Kristina Trusilova (DWD)

    ⇒ Project status: finished

⇒ Presentation: “The urban land use in the COSMO-CLM model: a comparison of three parameterizations for Berlin“

SOIL TEMPERATURE – LOWER BOUNDARY CONDITION

Modelling of T_SO in COSMO(-CLM)

- Prognostic variable: determines SH flux
  ⇒ strong influence on near surface temperatures
- Solution of the discretized 1D heat conduction equation
- Upper Boundary: Flux exchange with atmosphere (SH, LH, radiation)

$$c_v \frac{\partial T}{\partial t} = \frac{\partial}{\partial z}\left(\lambda \frac{\partial T}{\partial z}\right)$$

Lower BC in CCLM: „Fixed Temperature“ at Bottom

- Standard: 30yr mean of T2M from CRU (in EXTPAR)
- Only valid on this scale **if** model has same T2M mean
- Otherwise represents artificial source or sink of energy
- Particularly questionable for short & medium range climate

$$T(z_{max}, t) = \overline{T_{2m}^{CRU}}$$

SOIL TEMPERATURE – LOWER BOUNDARY CONDITION

Update: „No Heat Flux“ at Bottom

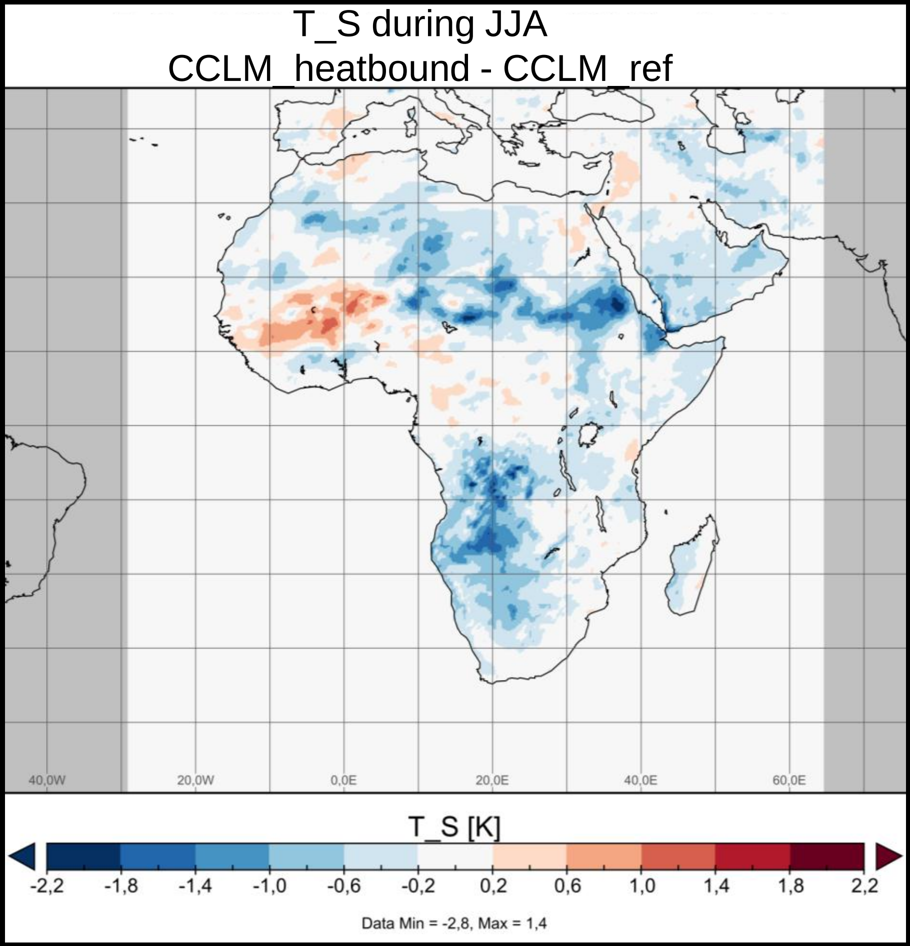
- No energy gain/loss in deep soil
- Deep soil is able to adjust to atmospheric forcing
  ⇒ Soil temperature profile gets more adequate

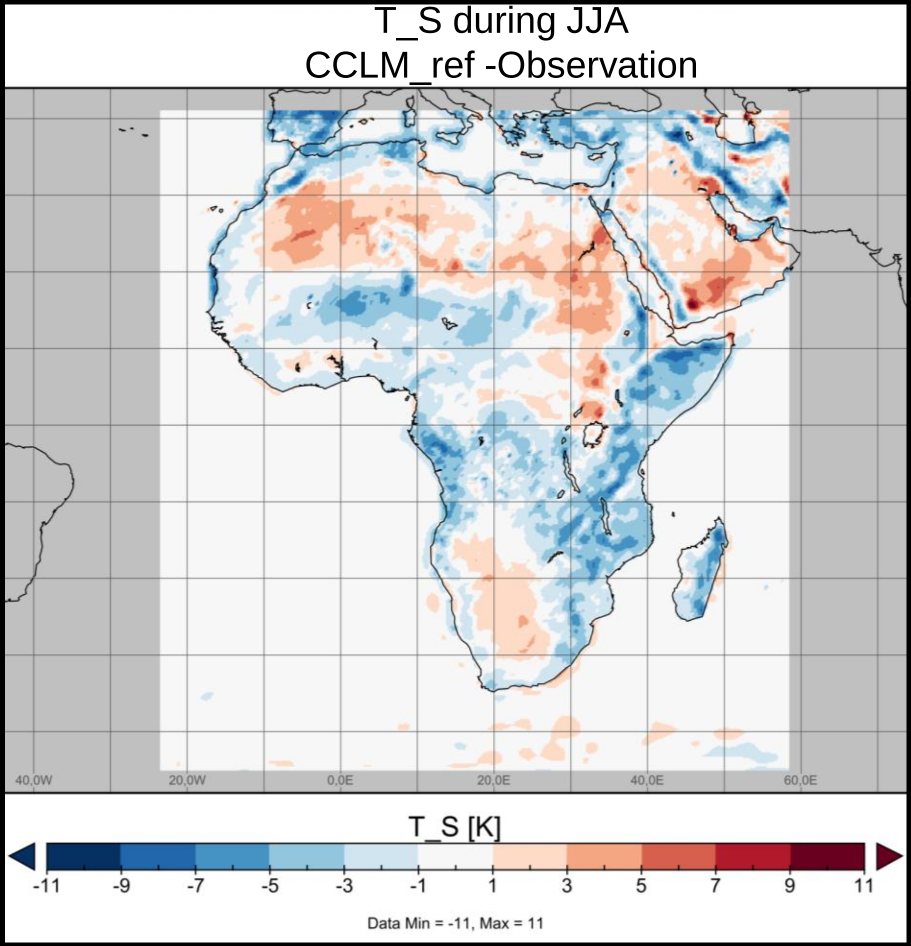
$$-\lambda \frac{\partial T}{\partial z}\bigg|_{z_{max}} = 0$$

- Work done by Julian Tödter (Uni Frankfurt)
- First tests are done
- Documentation is available

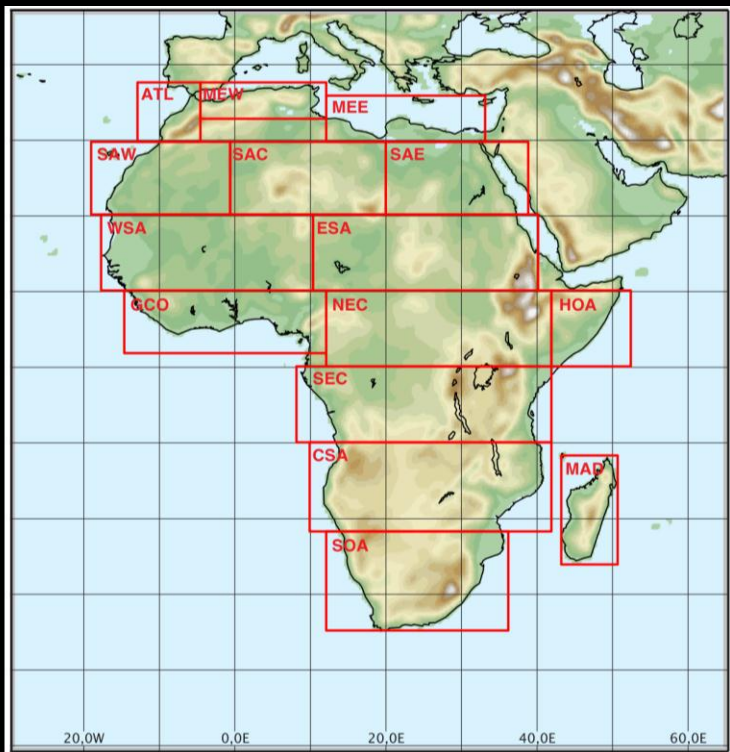
⇒ Project status: work

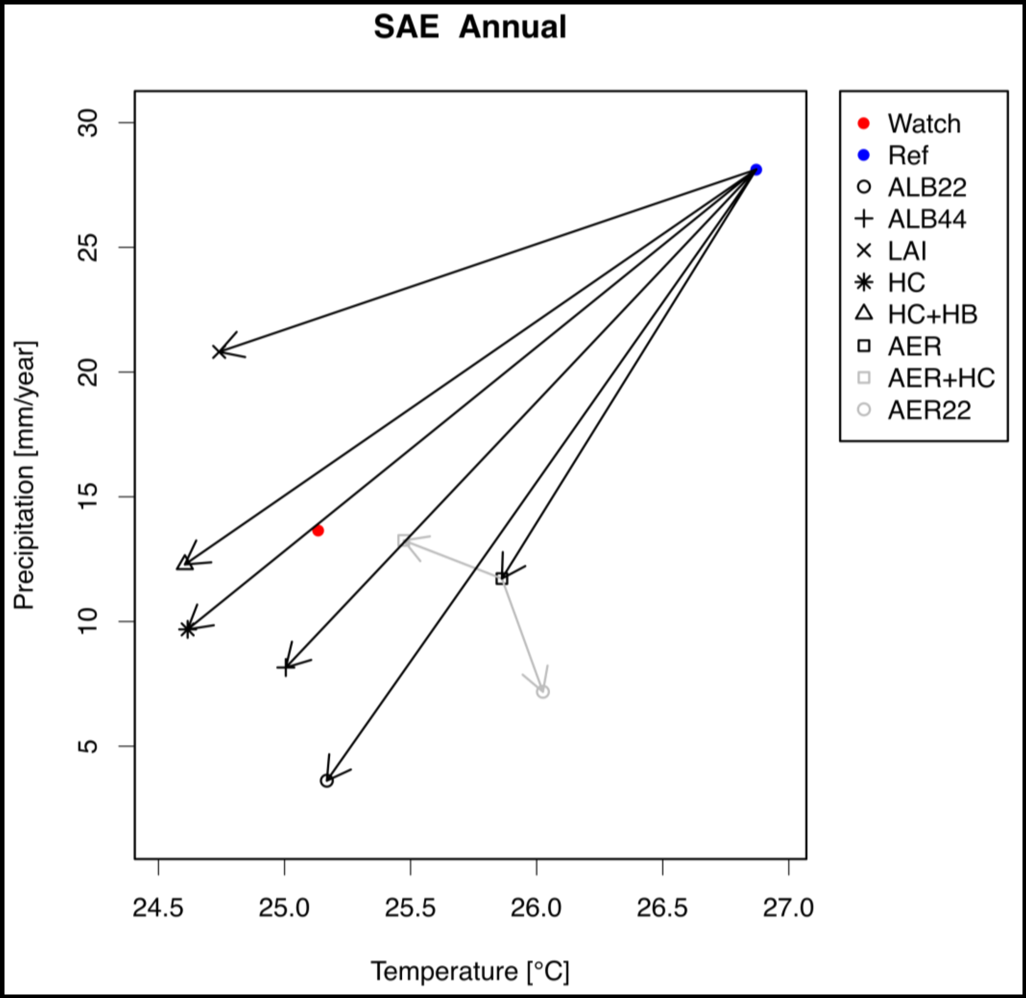
SOIL TEMPERATURE – LOWER BOUNDARY CONDITION





SOIL TEMPERATURE – LOWER BOUNDARY CONDITION





TERRA – GENERAL NOTES

- BATS bare soil evaporation
  - If itype_evsl=2, default
  - If computed evaporation flux would lead to soil moisture content in the first layer below ADP (air dryness point, minimum value), the evaporation flux is set to 0

    ⇒ would be more consistent to limit it according to the maximum flux possible

TERRA – GENERAL NOTES

- Prognosis of snow temperature
  - Implicit prognosis of T_SNOW is done by predictor-corrector algorithm, where the prediction step is a forward integration step

```
ztsnown(i,j) = ztsnow(i,j) + zdt*2._ireals*(zfor_snow - zgsb(i,j))  /zrocs(i,j)!
- ( ztsn(i,j) - zts(i,j) )
```

  - Forward step is done with time step 2dt , which probably is originated in old leapfrog time scheme
  - With two time level scheme, is has to be dt only
  - Last term (red) is strange (e.g. if new sfc temp is 0.5K larger than old sfc temp, the snow temp prediction is reduced by 0.5K ???)

TERRA – GENERAL NOTES

- Snow temperature meaning
  - Documentation shows difference between:
  - „Snow sfc temperature" = temperature at top of snow deck, important for coupling to atmosphere etc
  - „Snow temperature" = temperature in middle of snow deck, important for heat flux through snow
  - However, in the code there is no distinction, only T_SNOW is used

  ⇒ Should be clarified

TERRA-ML STAND-ALONE

- All I/O routines have been revised, rewritten in convinient NetCDF form
- Parallelization
  - TERRA_offline has no internal parallelization (MPI)
  - Development of external parallelization scheme
  - TERRA can now conventienly be run in parallel (with domain decompistion), which strongly enhances speed for large-scale applications

TERRA-ML STAND-ALONE

- Transfer scheme
  - „Old" Loius scheme used in TERRA_offline
  - Leads to problems as the first-layer height was adapted to the height of forcing data (2m/10m)
  - Enhanced "wind adaption” leads to zero wind in case the roughness length was between 2 and 10m
  - In general results with higher roughness lengths were ambiguous as the transfer coefficients got unrealistically large

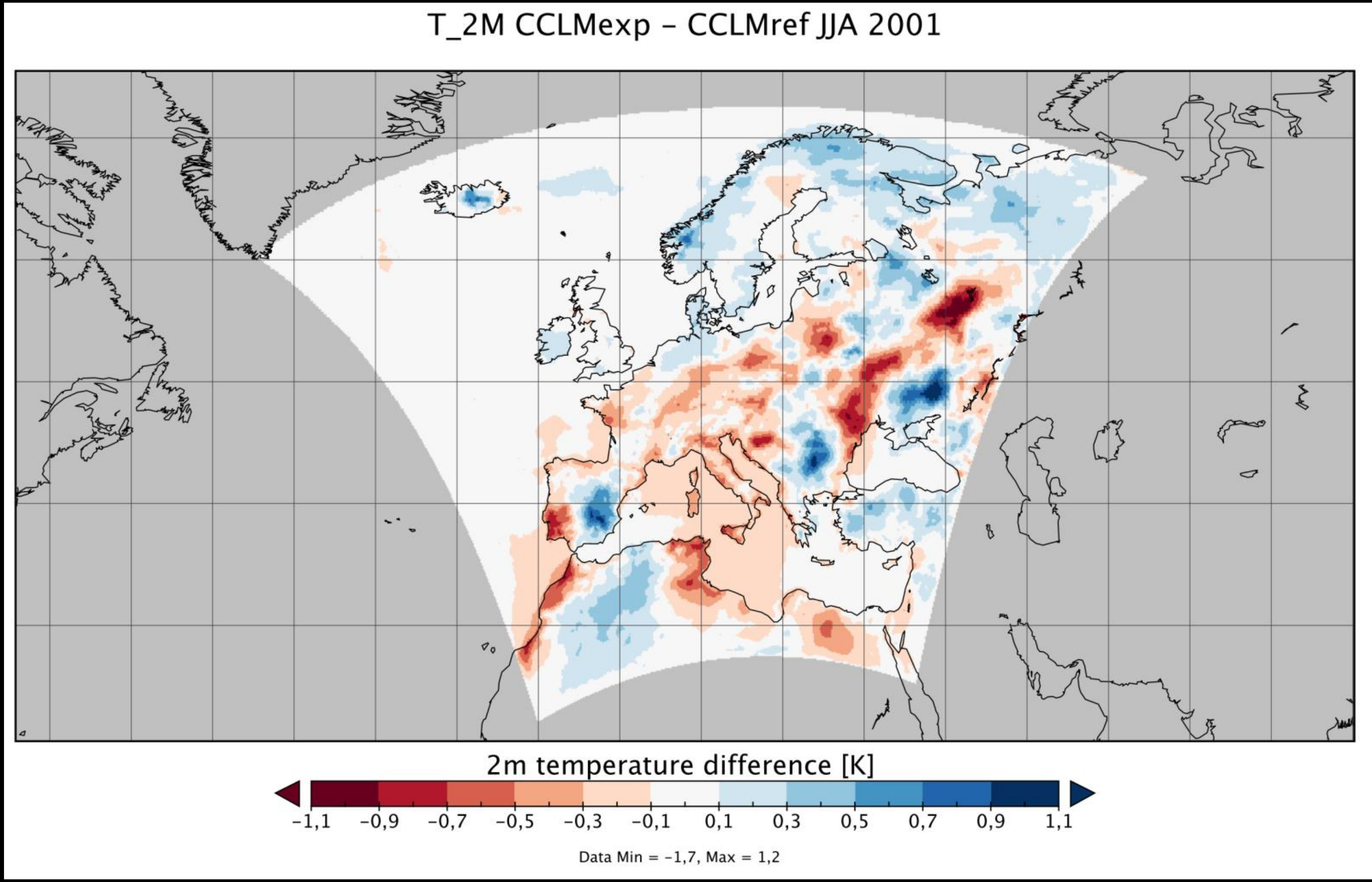
  ⇒ led to numerical instabilities in combination with flat first soil layer

TERRA-ML STAND-ALONE

- WATCH+TERRA to generate initial conditions
  - Environment has been prepared, which allows to spin-up soil with WATCH forcing data ("measurement driven soil analysis“)
  - Aim of generating “improved” land surface initial conditions for COSMO-CLM simulations
  - Model balancy is ensured as same soil model is used
  - See also poster: „Land surface data assimilation with TERRA in a climate context“ (Tödter, Ahrens)

TERRA-ML STAND-ALONE

- WATCH+TERRA to generate initial conditions

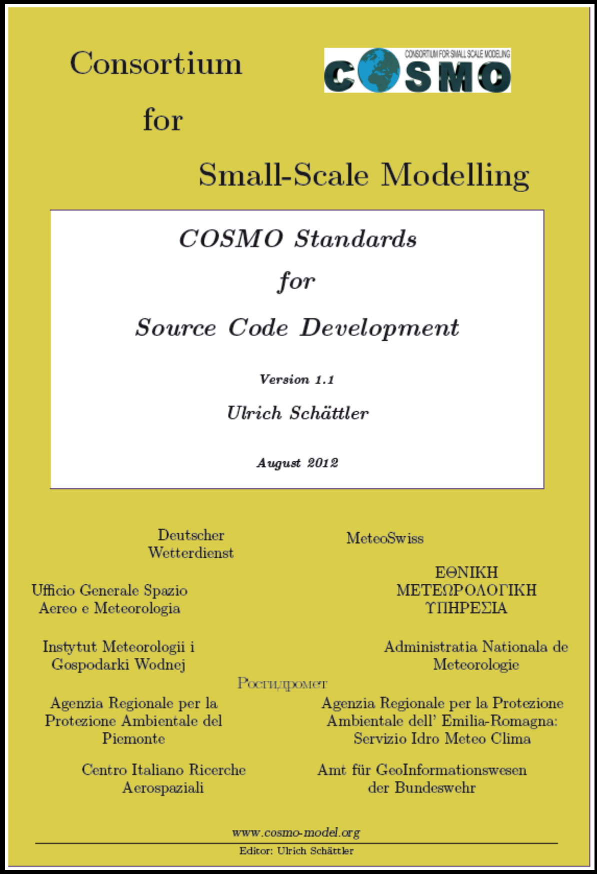


TERRA-ML STAND-ALONE

- New version?
  - Extraction of new terra offline version from the ICON-TERRA with tile approach and transfer functions etc.
  - Would be useful for many offline investigations
  - Has to be combined with appropriate I/O routines (for extpar, initial fields, forcing fields) and transfer scheme and dealing with external parameters (interpolations etc.)

Source code development

- Basis for successful implementation of new developments should be the official "COSMO standard for source code development"



Consortium for Small-Scale Modelling

COSMO

COSMO Standards for Source Code Development

Version 1.1

Ulrich Schättler

August 2012

Deutscher Wetterdienst

MeteoSwiss

Ufficio Generale Spazio Aereo e Meteorologia

ΕΘΝΙΚΗ ΜΕΤΕΩΡΟΛΟΓΙΚΗ ΥΠΗΡΕΣΙΑ

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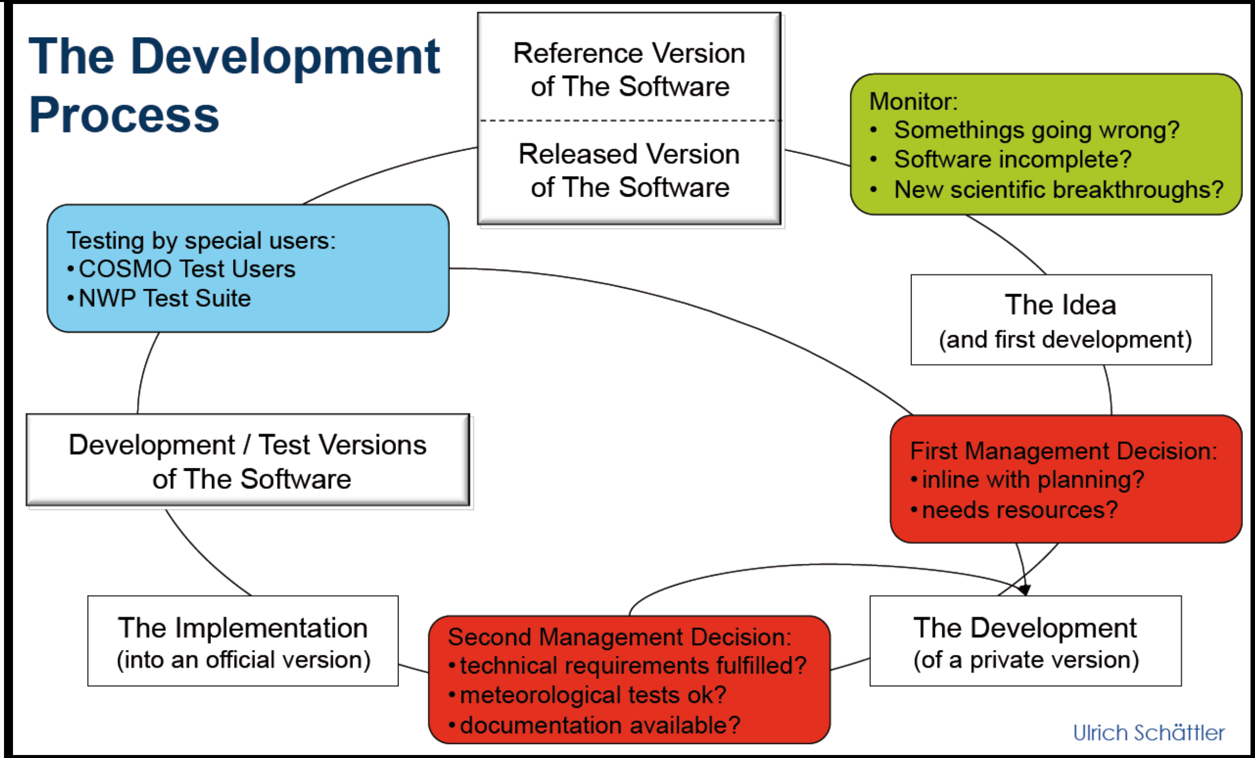
Editor: Ulrich Schättler

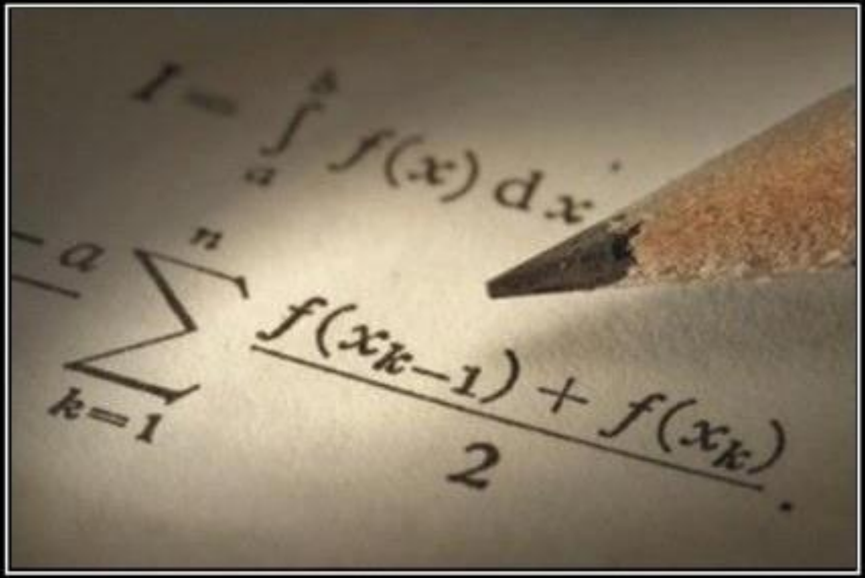


Source code development

Questions concerning implementation procedure?

Are there new TERRA developments?

Please contact me: kothe@iau.uni-frankfurt.de



LIFE IS LIKE MATH

IF IT GOES TOO EASY SOMETHING IS WRONG