GOETHE UNIVERSITÄT FRANKFURT AM MAIN

TERRA-ML Developments 2013

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with contributions by

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Goethe University Frankfurt, Institute for Atmospheric and Environmental Sciences

Sebastian Schubert
Potsdam Institute for Climate Impact Research

Kristina Trusilova
German Meteorological Service

Hendrik Wouters
KU Leuven

CURRENT STATUS

Name	Mainly relates to	Target version	Task subject	Responsible person	Task status	Started	Expected delivery	Secondary association
2	**Model development (CLM-Community, TERRA)**							
2.1	COSMO	N/A	Vertically dependent soil structure, HWSD data set	[CLM] B. Ahrens (Uni Frankfurt	work	N/A	2012-12-31	N/A
							notes	status
2.2	COSMO	N/A	Soil thermal conductivity dependent on soil moisture	[CLM] JP. Schulz (Uni Frankfur	test	N/A	N/A	N/A
							notes	status
2.3	CO							
2.4	CO						otes	status
2.5	CO						otes	status
2.6	CO						otes	status
2.7	CO						otes	status
2.8	CO						otes	status

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 2.1

2.1	COSMO	N/A	Vertically dependent soil structure, HWSD data set	[CLM] B. Ahrens (Uni Frankfurt

- Adaption of water budget equation to inhomogeneous soil texture
- Implementation of inhomogeneous soil textures from Harmonized World Soil Database
- Some tests were made, but substantial evaluation is still missing
- Main work by Frank Kalinka (GU Frankfurt)
- Frank left the group

  ⇒ Project 2.1 stopped

CURRENT STATUS 2.2

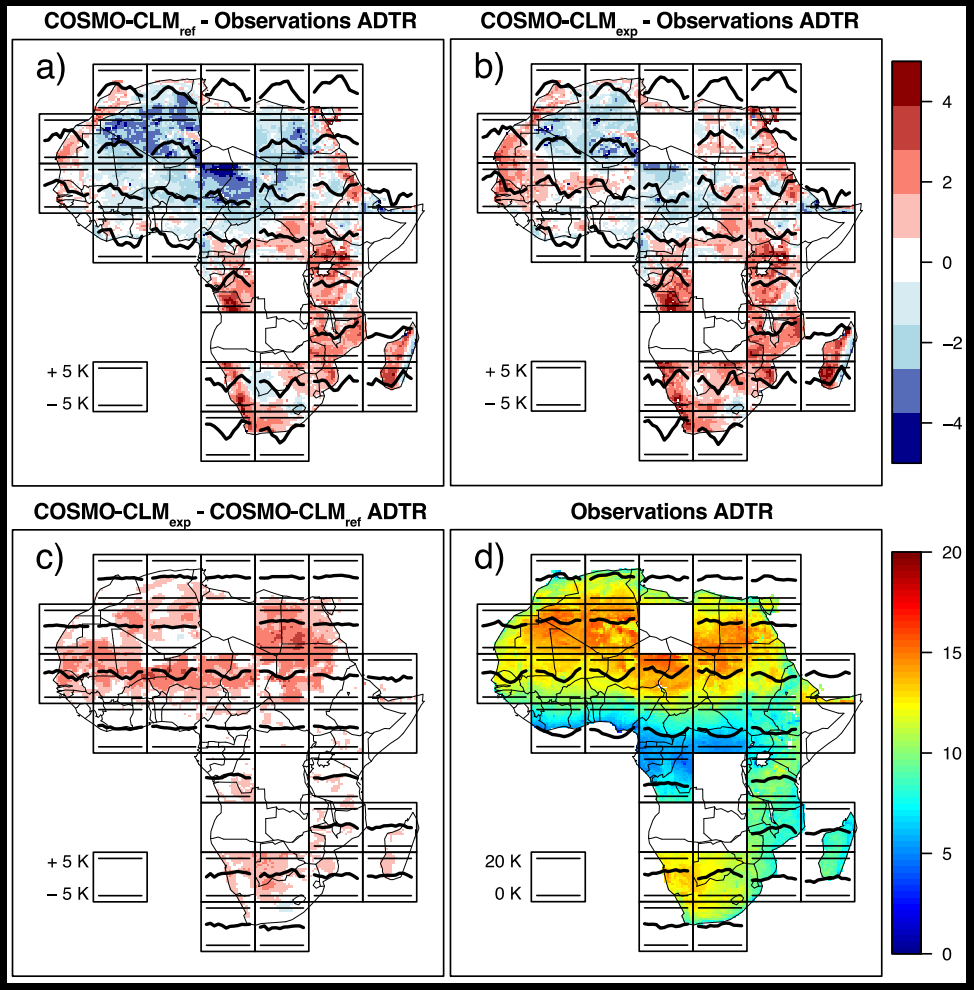
2.2	COSMO	N/A	Soil thermal conductivity dependent on soil moisture	[CLM] JP. Schulz (Uni Frankfur

- Introduction of dependence 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 (GU Frankfurt)
- Will be implemented in COSMO 5.0
- Tests for COSMO-EU, COSMO-DE, and COSMO-CLM in Africa

  ⇒ Project 2.2 ongoing; successful implementation expected

CURRENT STATUS 2.2

2.2	COSMO	N/A	Soil thermal conductivity dependent on soil moisture	[CLM] JP. Schulz (Uni Frankfur



CURRENT STATUS 2.3

2.3	COSMO	N/A	Carbon cycle	[CLM] B. Ahrens (Uni Frankfurt

- Soil carbon cycle
- Work done by Jana Schröder (GU Frankfurt)
- First version implemented in offline TERRA
- Some tests were made, but no evaluation
- Jana left the group for maternity leave

  ⇒ Project 2.3 stopped

CURRENT STATUS 2.4

2.4	COSMO	N/A	Dynamic vegetation	[CLM] B. Ahrens (Uni Frankfurt

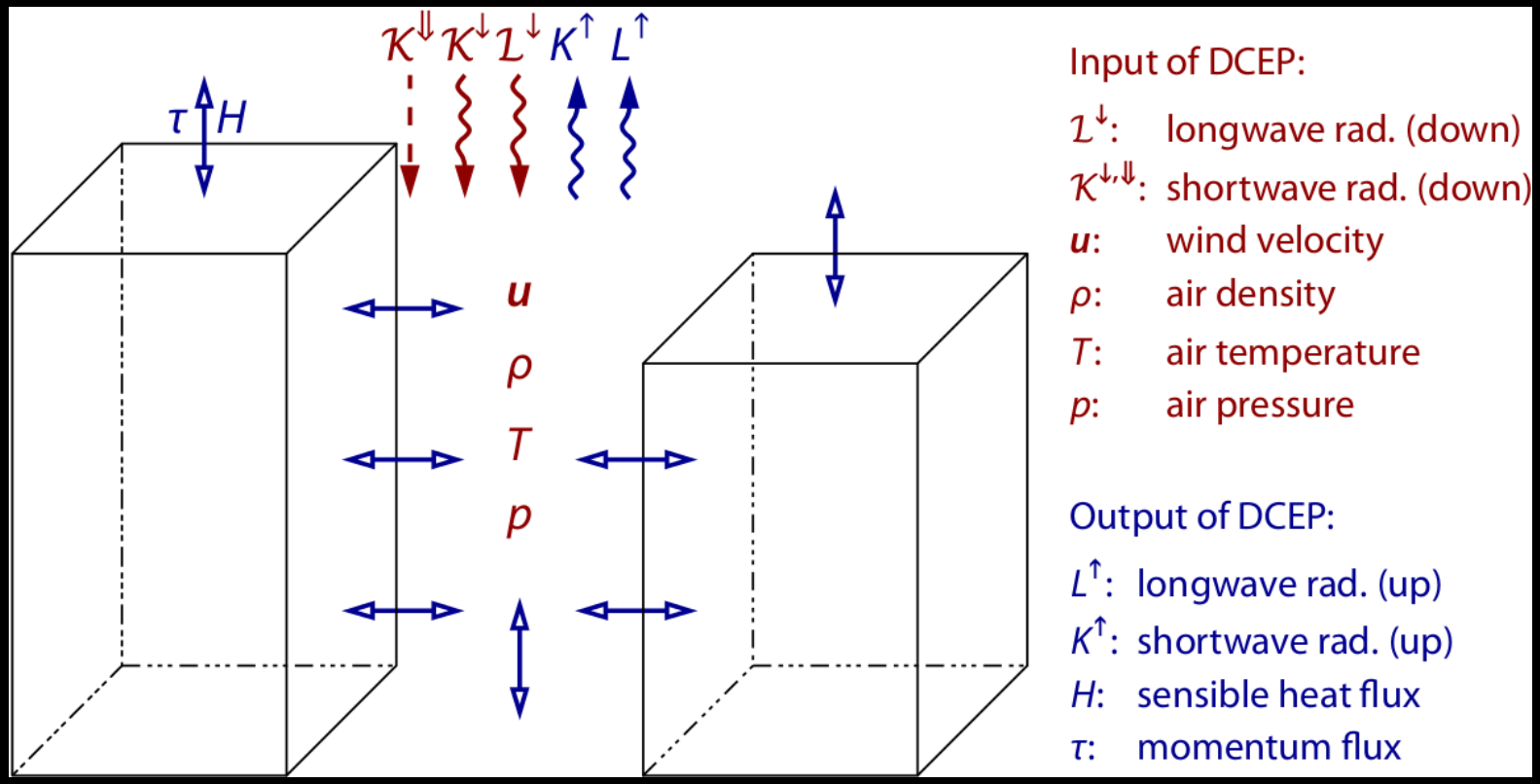
- Currently, nobody is working on this topic
- It is intended that Jan-Peter Schulz (GU Frankfurt) will work on this topic in the near future

  ⇒ Project 2.4 in planning phase

CURRENT STATUS 2.5

2.5	COSMO	N/A	Urban scheme BEP	[CLM] S. Schubert (PIK)

- Urban parametrization scheme DCEP (Schubert et al. 2012, PIK)
- Multi-layer street canyon model:



CURRENT STATUS 2.5

2.5	COSMO	N/A	Urban scheme BEP	[CLM] S. Schubert (PIK)

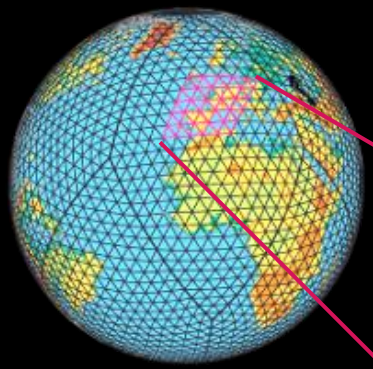
- DCEP successfully evaluated with flux measurements (poster, submitted paper)
- Applied to analyse urban heat island mitigation measures (Paper in Meteorologische Zeitschrift)
- Code will be made available
- Currently, precipitation effects being implemented into DCEP

  ⇒ Project 2.5 in testing phase

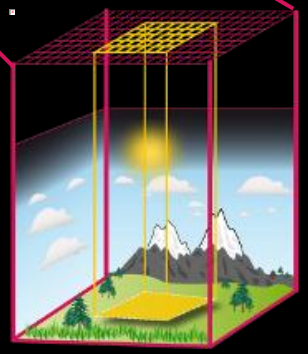
CURRENT STATUS 2.6

2.6	COSMO	N/A	Urban scheme TEB	[CLM] K. Trusilova (DWD)

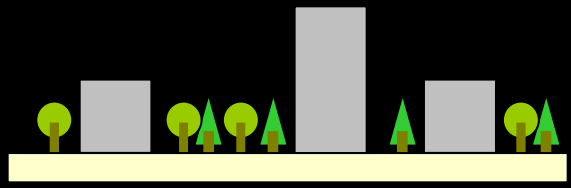
- New model for downscaling global climate projections to city-scale
- Work done by Kristina Trusilova (DWD)



Global climate model



Regional climate model COSMO-CLM

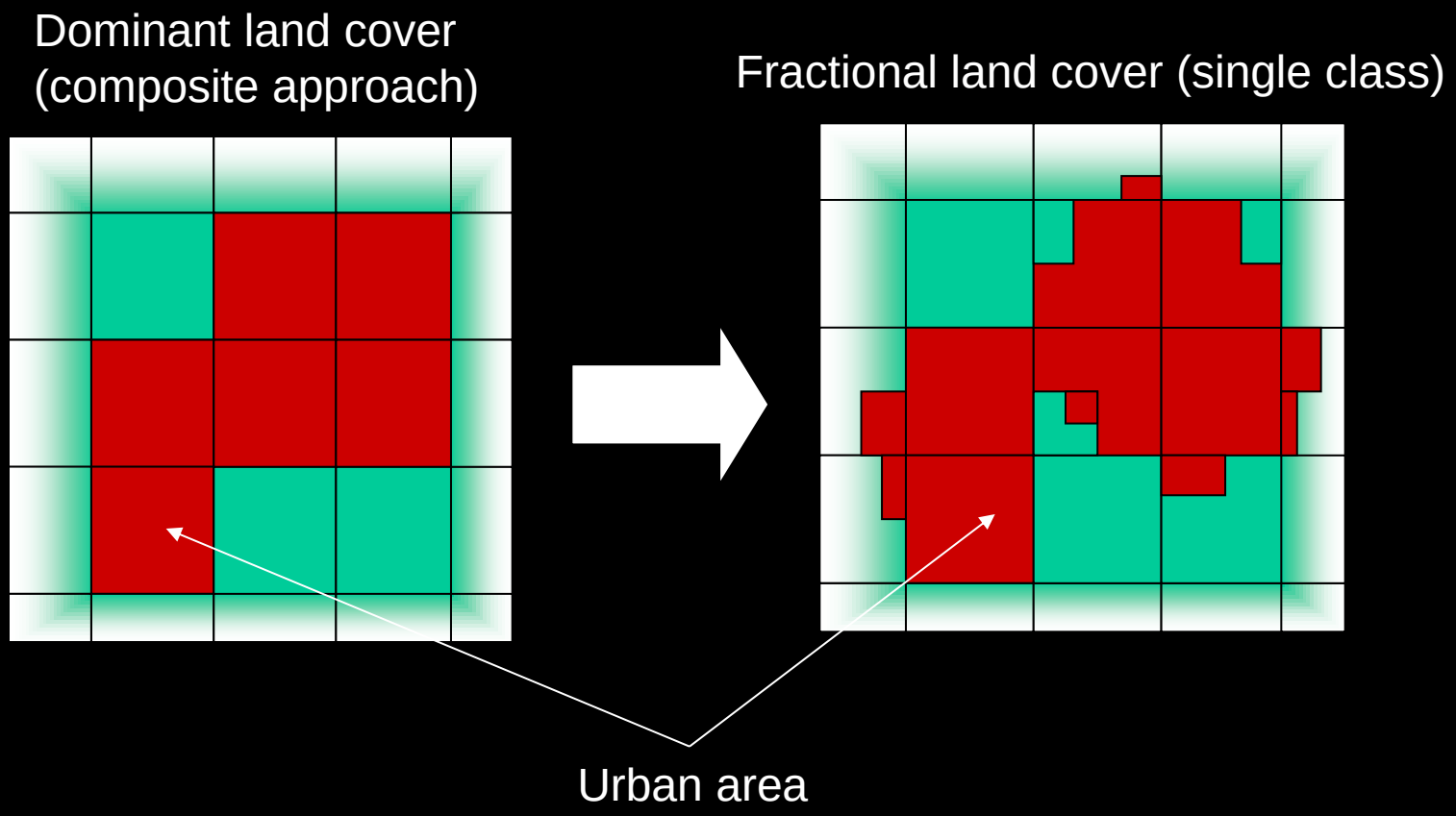


parameterization for urban land

CURRENT STATUS 2.6

2.6	COSMO	N/A	Urban scheme TEB	[CLM] K. Trusilova (DWD)

- Implementation of tile-approach for fractional land cover

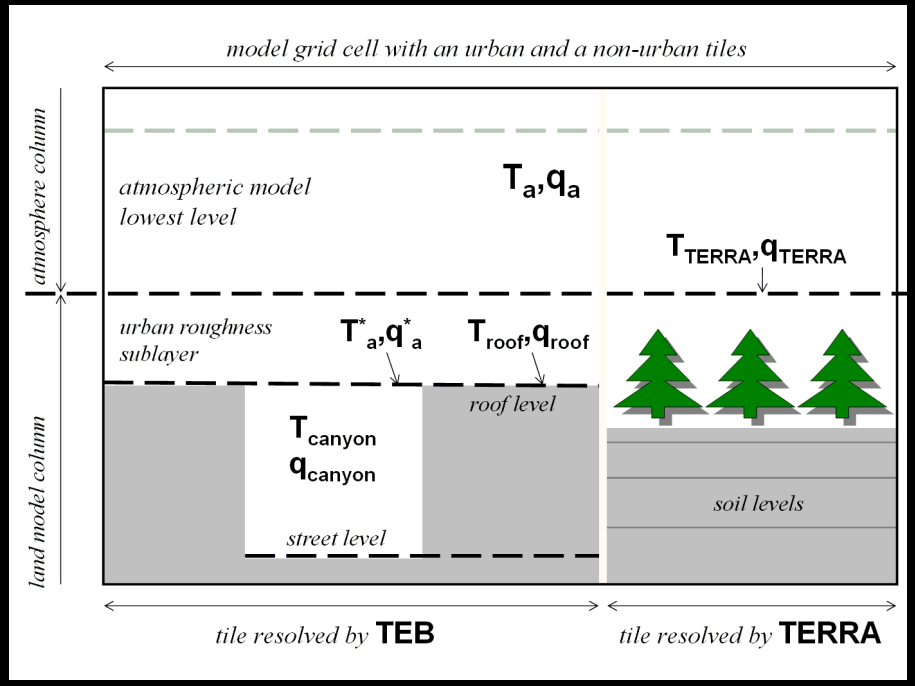


CURRENT STATUS 2.6

2.6	COSMO	N/A	Urban scheme TEB	[CLM] K. Trusilova (DWD)

- Implementation into standard version due to too high computational costs not intended

  ⇒ Project 2.6 stopped



CURRENT STATUS 2.7

2.7	COSMO	N/A	Parameterization of urban effects	[CLM] H. Wouters (KU Leuven)

- Urban parameterization in TERRA-ML, including an impervious water storage
- Work done by Hendrik Wouters (KU Leuven)
- 'Offline' evaluations were performed for urban sites of Marseille, Toulouse and Basel
- COSMO-CLM/TERRA 'Online' evaluation for Flanders, Belgium

CURRENT STATUS 2.7

2.7	COSMO	N/A	Parameterization of urban effects	[CLM] H. Wouters (KU Leuven)

Outlook

- Urban land-use scenarios for Belgium
- Urban Air quality modelling
- It is intended to implement it into standard TERRA-ML, but this still needs extra efforts in close cooperation with the main developers of TERRA-ML

  ⇒ Project 2.7 ongoing

CURRENT STATUS 2.8

2.8	COSMO	N/A	River routing model	[CLM] J. Volkholz (PIK)

- Implementation of wetlands
- Work done by Jan Volkholz (PIK)
- Currently project suspended, but tests in South American region are planned

  ⇒ Project 2.8 stopped

2.9 Soil temperature: lower boundary condition

Modelling of T_SO in COSMO(-CLM)

- Prognostic variable: determines GH 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

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

2.9 Soil temperature: lower boundary condition

Update: „No Heat Flux“ at Bottom

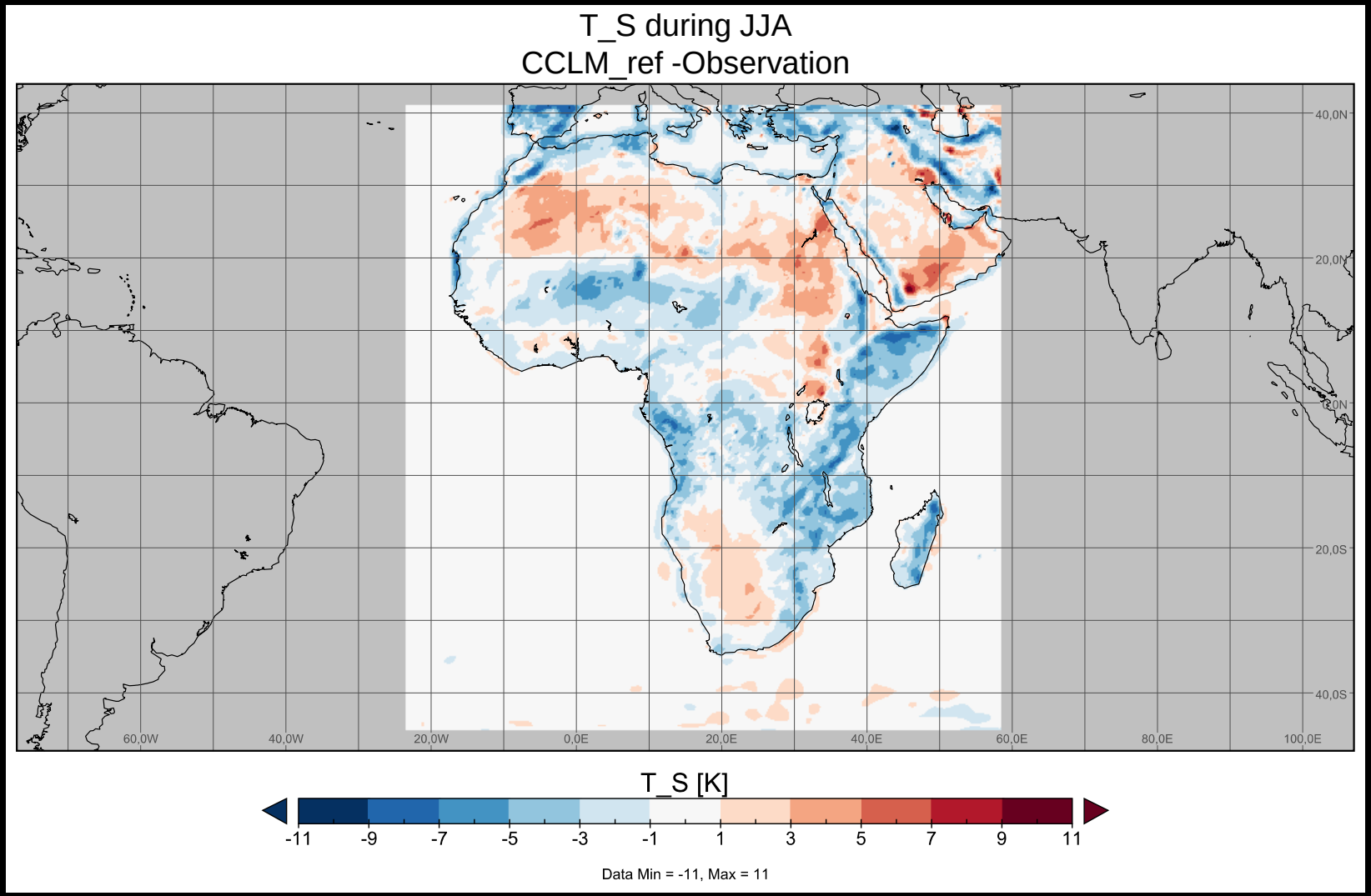
- No energy gain/loss in deep soil
- Deep soil is able to adjust to atmospheric forcing
- → Soil temperature profile gets more adequate

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

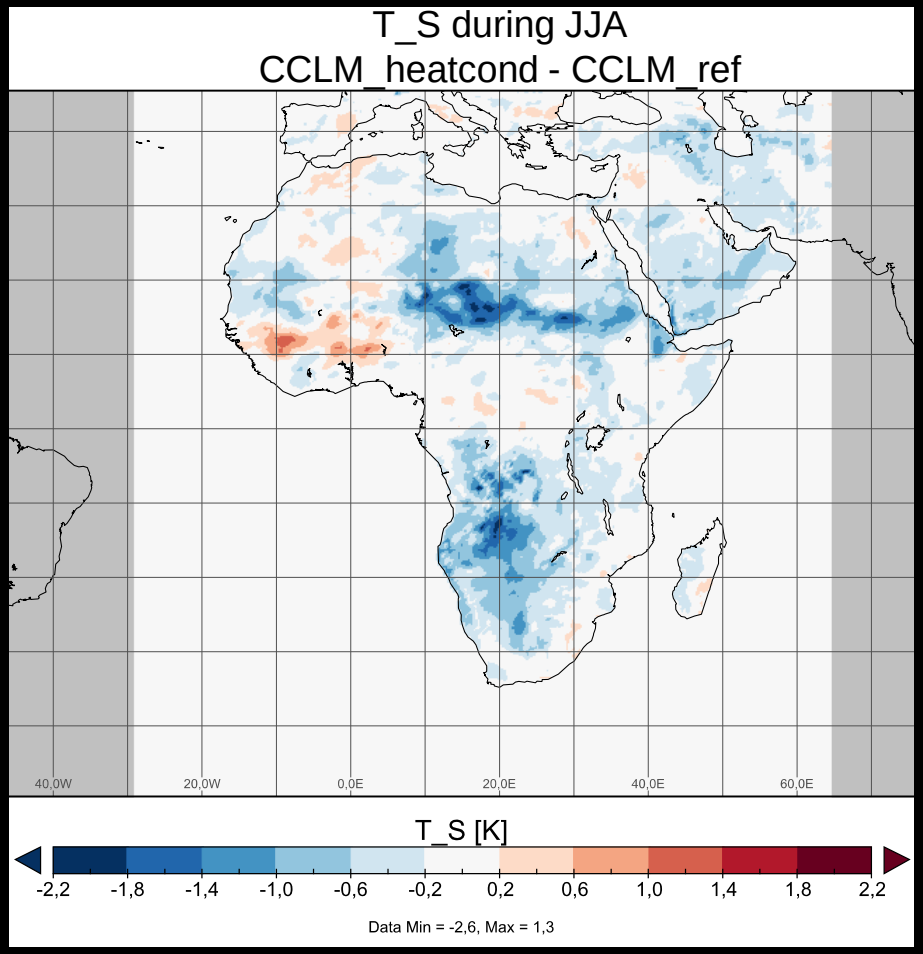
- Work done by Julian Tödter (GU Frankfurt)
- First tests are done
- Documentation is available

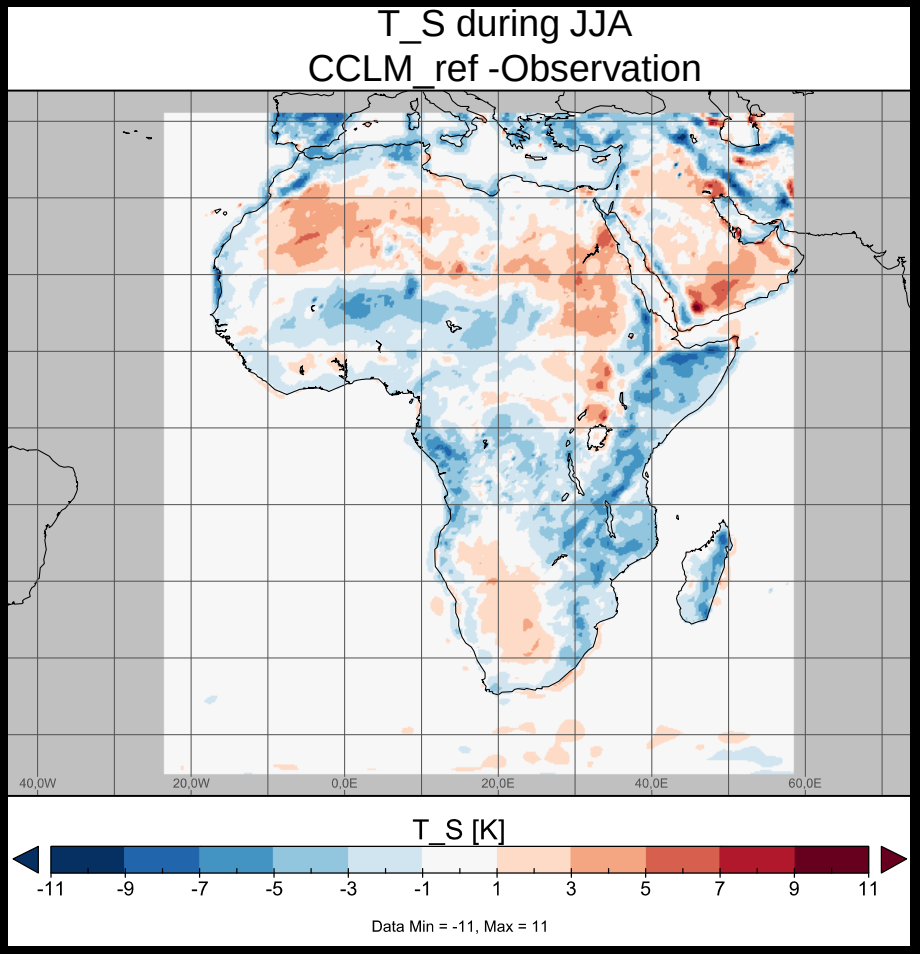
⇒ Project 2.9 ongoing; successful implementation expected

RESULTS OF SOIL MODIFICATIONS

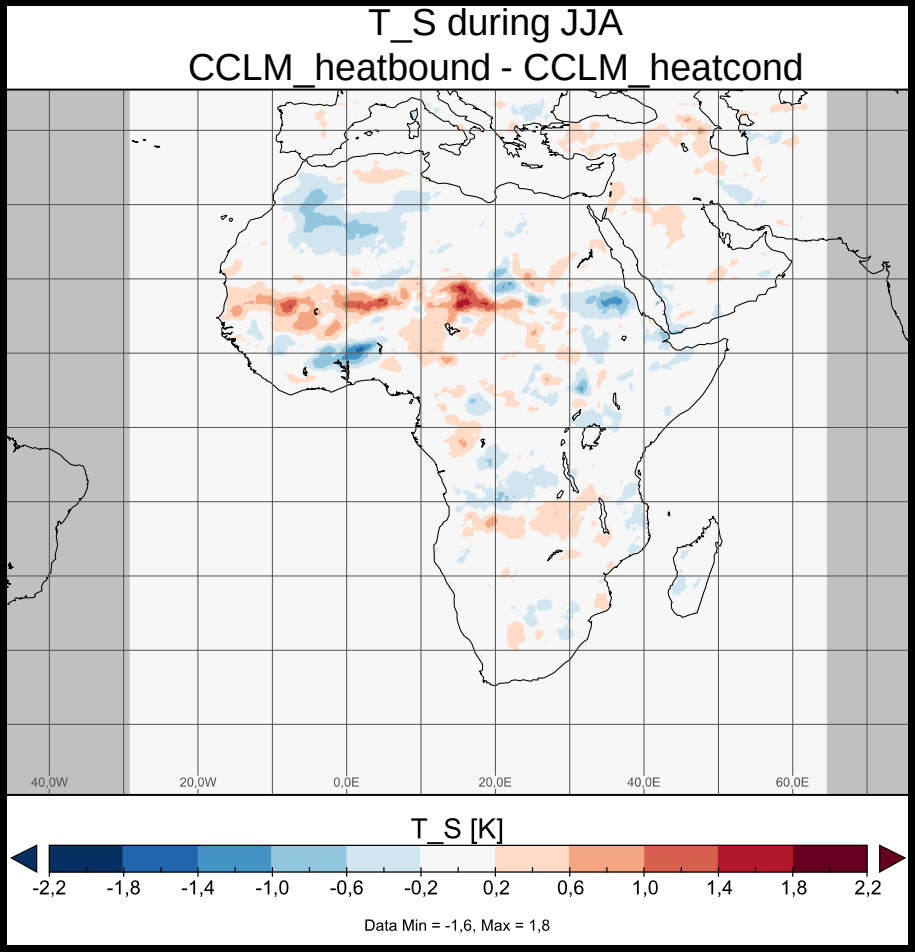


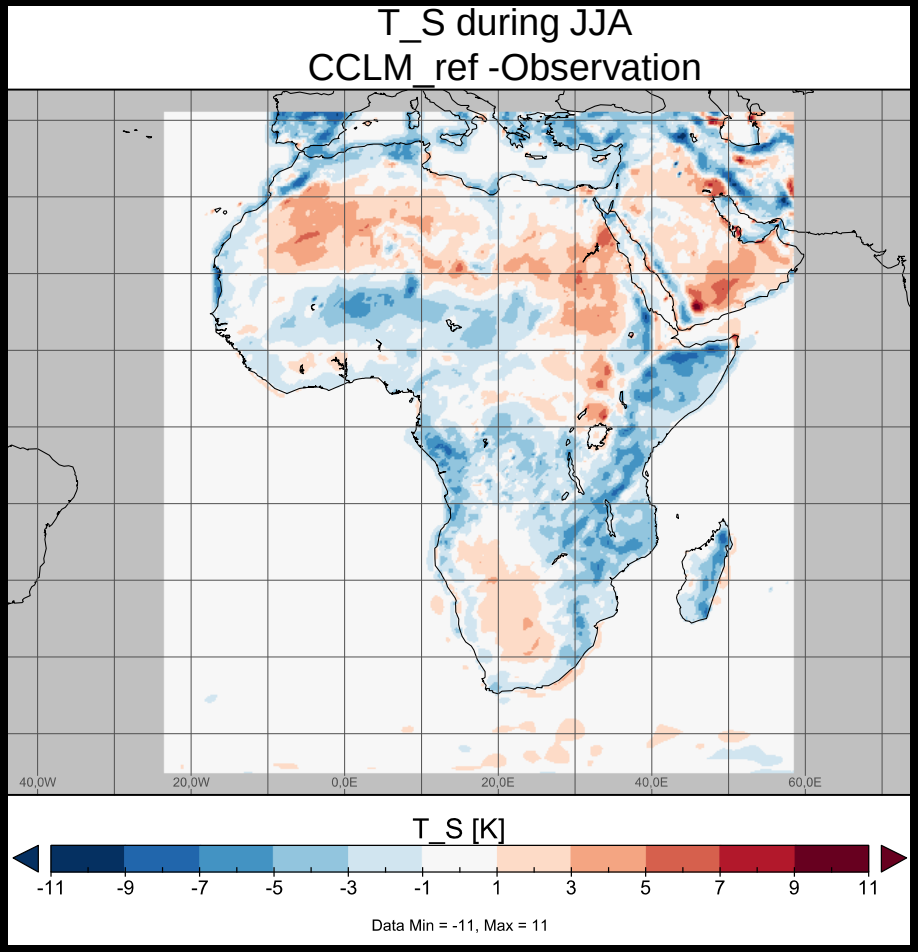
RESULTS OF SOIL MODIFICATIONS





RESULTS OF SOIL MODIFICATIONS





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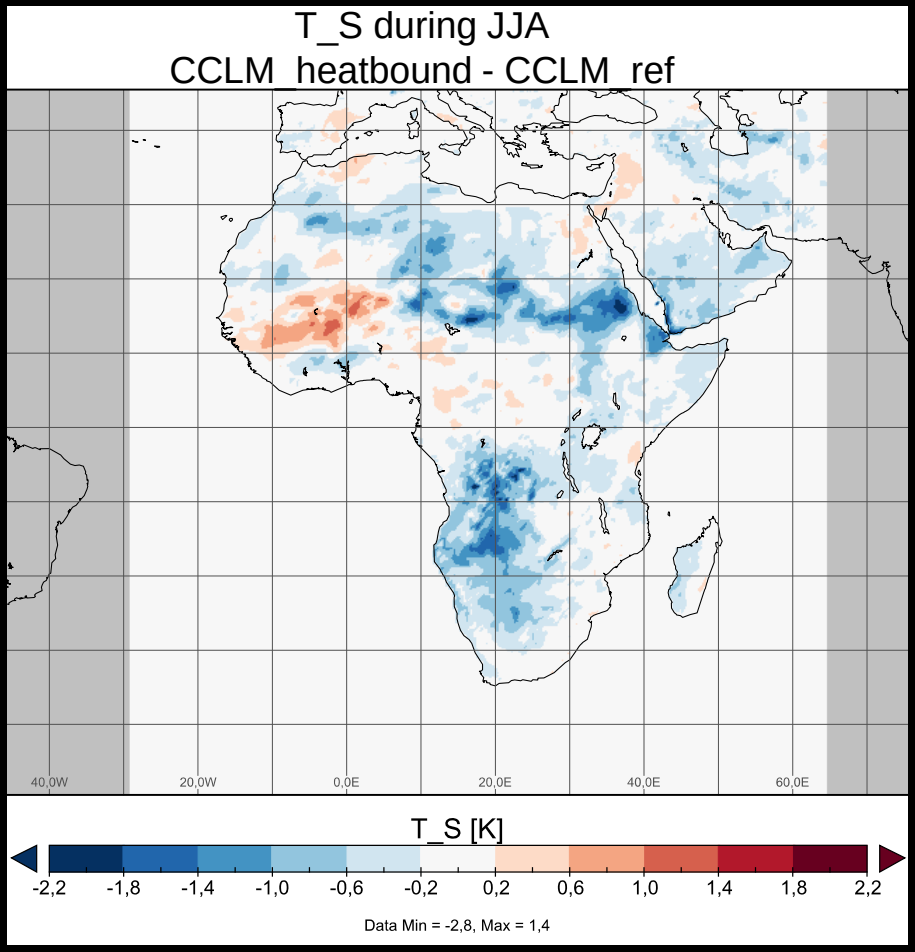
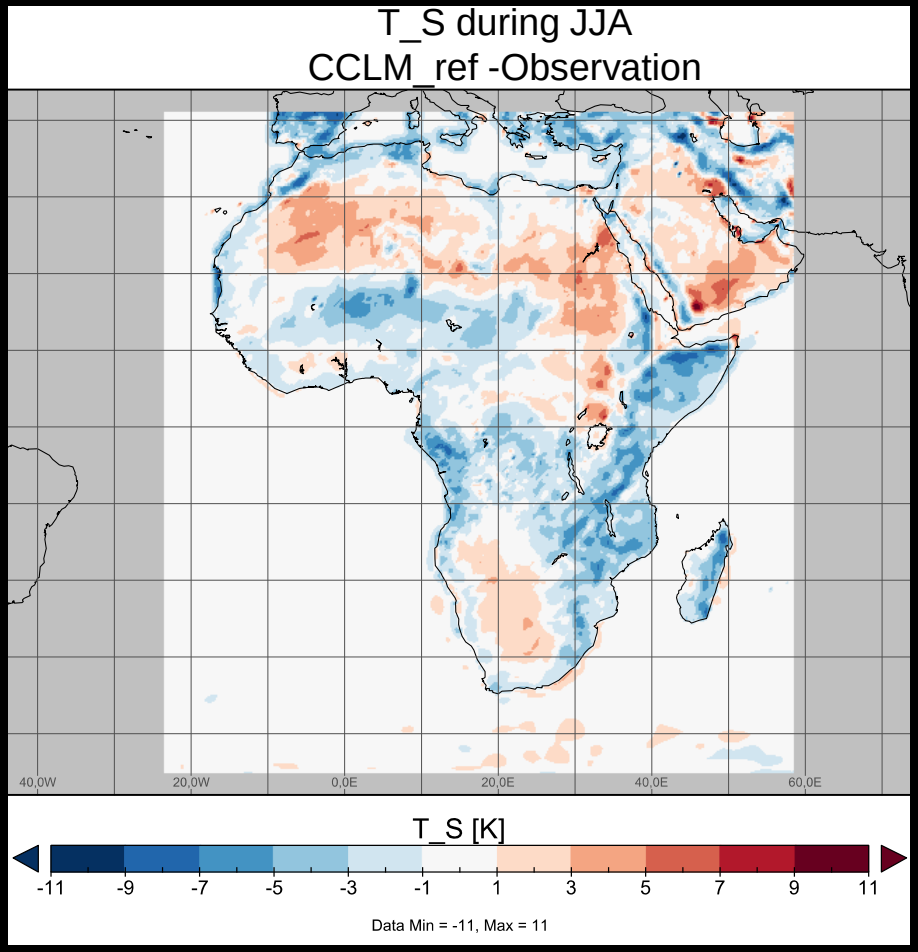


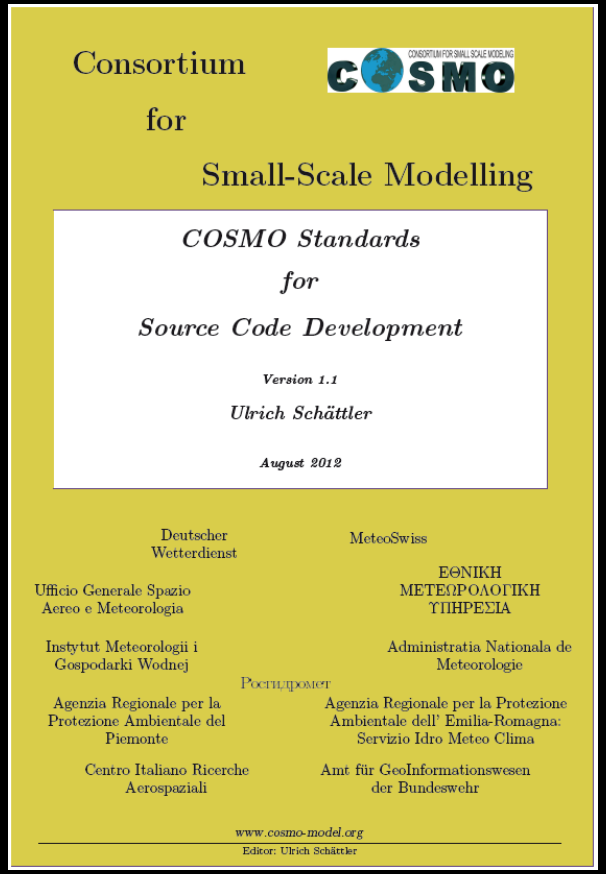


TERRA-ML OFFLINE

- Netcdf input for external parameters, forcing, and initial fields
- Netcdf output
- Bug fixes, which have to be documented
- New type of lower boundary condition for thermal part of TERRA-ML [J. Tödter, 2.9]
- Implementation of data assimilation scheme for TERRA-ML

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 Standards for Source Code Development

Version 1.1

Ulrich Schättler

August 2012

Deutscher Wetterdienst
MeteoSwiss
Ufficio Generale Spazio Aereo e Meteorologia
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Instytut Meteorologii i Gospodarki Wodnej
Administratia Nationala de Meteorologie
Росгидромет
Agenzia Regionale per la Protezione Ambientale del Piemonte
Agenzia Regionale per la Protezione Ambientale dell' Emilia-Romagna: Servizio Idro Meteo Clima
Centro Italiano Ricerche Aerospaziali
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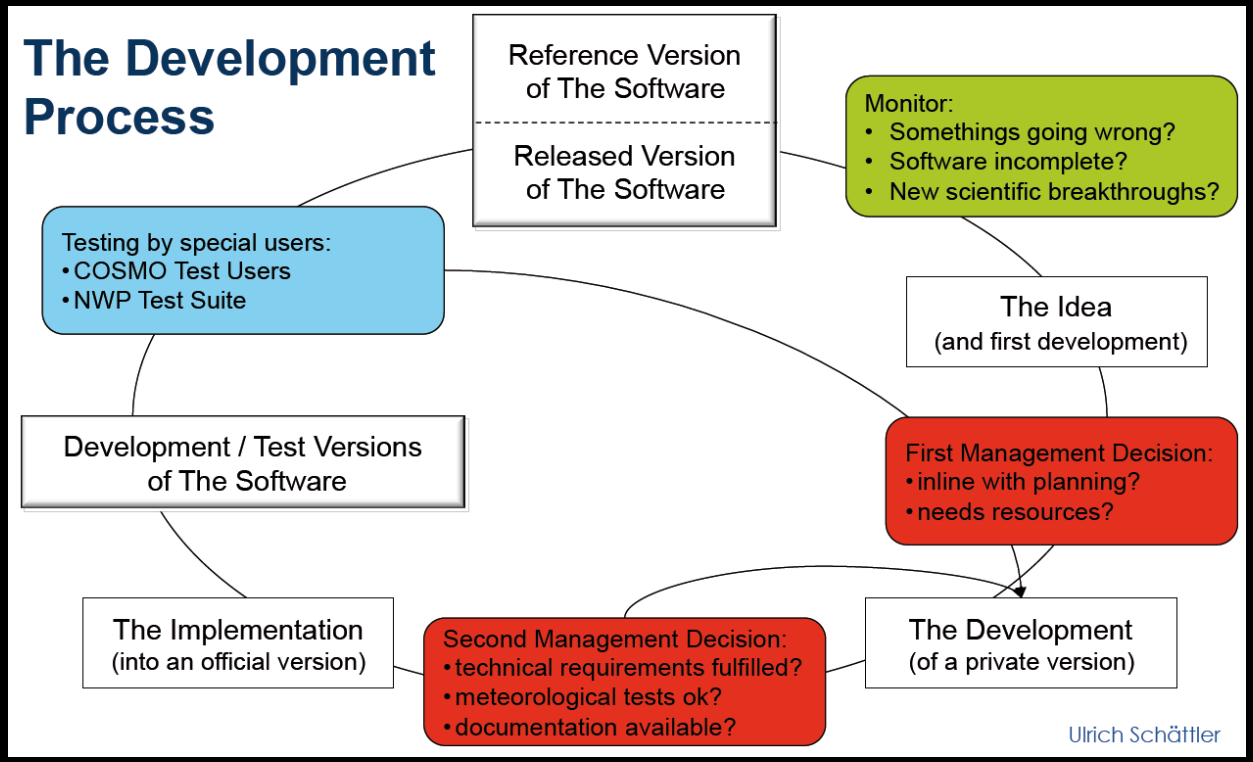
www.cosmo-model.org

Editor: Ulrich Schättler



Source code development

Questions concerning implementation procedure?

Are there new TERRA developments?

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