COLOBOC project : ‘Final’ Report

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Jean-Marie Bettems / MeteoSwiss
Jürgen Helmert / DWD

COLOBOC (Consolidation of Lower Boundary Conditions)

Main goal of this COSMO Priority Project:

- incorporate all activities related to the lower boundary conditions which have already reached an advanced state,
- and to consolidate these developments into well tested and documented software packages readily usable by the COSMO community.

COLOBOC : Overview

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

COLOBOC : Sept. 2008 – Sept. 2010 , extended to Sept. 2011

Task 0: Document **observation sets** available for SVAT model validation

Task 1: Tools – Consolidation of TERRA standalone code (SVAT model of COSMO)

Task 2. Tools – Consolidation of software to generate external parameters

Task 3: Revision of **external parameter** sets
(raw data sources for generation of external param. for COSMO & GME)

Task 4: Revision of **SVAT** module TERRA and the associated look-up tables

Task 5: Revision of **snow** representation:
- multi-layer snow model
- snow analysis

Task 6: **Urban** module (Fuhrer, CH)

Task 7: Parameterisation of land surface heterogeneity by the **tile** / mosaic approach

Task 0: Observation data sets for SVAT model validation

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Documentation: available

Data pool: collect soil / surface / BL observations at selected sites, on behalf of the C-SRNWP Programme

- operational data with time lag from: Lindenberg (D), Payerne (CH), Toulouse (F), San Pietro (I), Cabauw (Netherland), Sodankylaa (Finland), .
- data (in common .xls format) of 6 participating sites for 2006 – 2008 soon available **on-line** on the **COSMO web site** (www.cosmo-model.org , for access: request to Andras Horanyi or Jean-Francois Mahfouf)

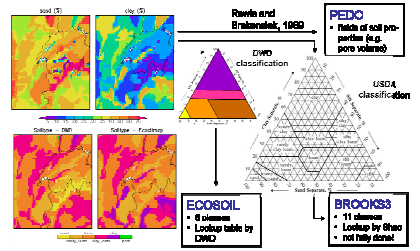
Extension:

- extend on-line documentation (e.g. effective data availability, site characteristics)
- collect 2009 data, collect 2006 & 2008 from Toulouse (by end of 2010)
- include additional observatories (Cardington (UK); more ? (Russia, Hungary))

Important: **use data pool for validation and diagnostics** (for operational suite & for model development)

Tasks 2 + 3: External Parameters

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



- consolidated software for generating external parameters;
  reference system at DWD, accessible through a Web interface
- consolidated raw data sets (GLOBE, GLC2000, DSMW),
  13 new external parameters available for any domain (aerosol, TERRA module, urban module, lake module)
- external parameters for orographic radiation correction will soon be available

Aims for 2011:

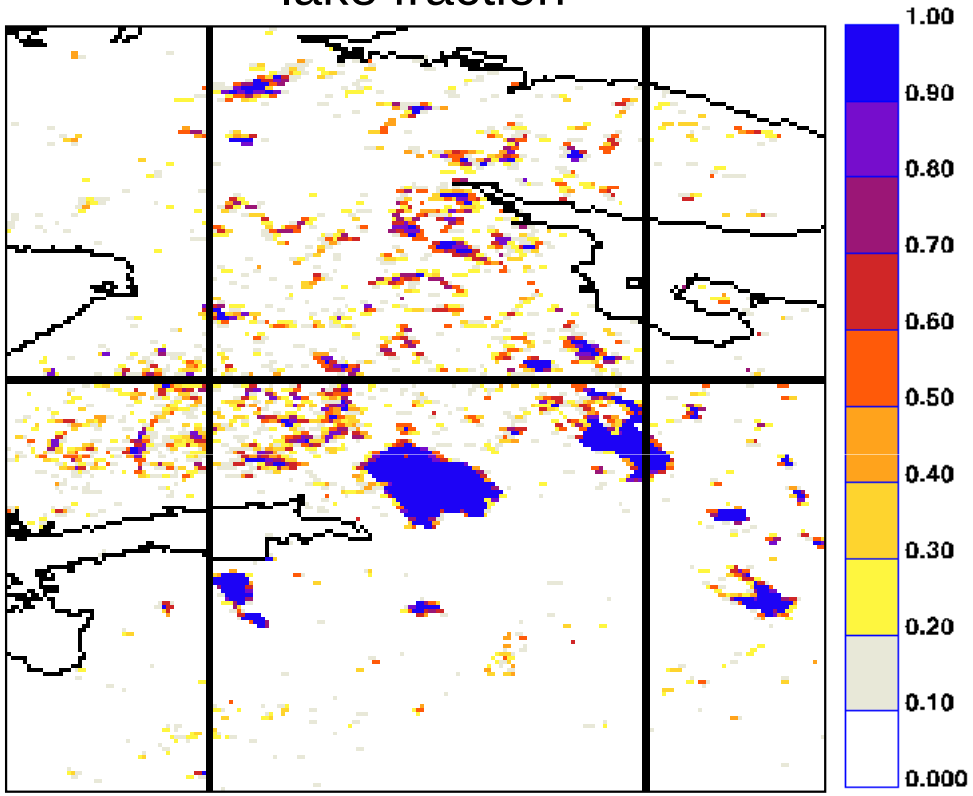
- alternative data sets (MODIS solar albedo, Harmonized World Soil Database, GLOBCOVER land use, SRTM or ASTER GDEM topo)
- add support for vertically dependent soil information
  (e.g. depth of water reservoir or inactive layer, texture), root depth clima. consistent w. NDVI
- alternative vegetation characteristics using MODIS calibrated phenology model
  (R.Stöckli), evaluate use of information on crop life cycle
- allow correct representation of scale separation for z0 / SSO / resolved scales
  (filter, option for topo smoothing in EXTPAR instead of INT2LM)

Tasks 2 + 3: External Parameters

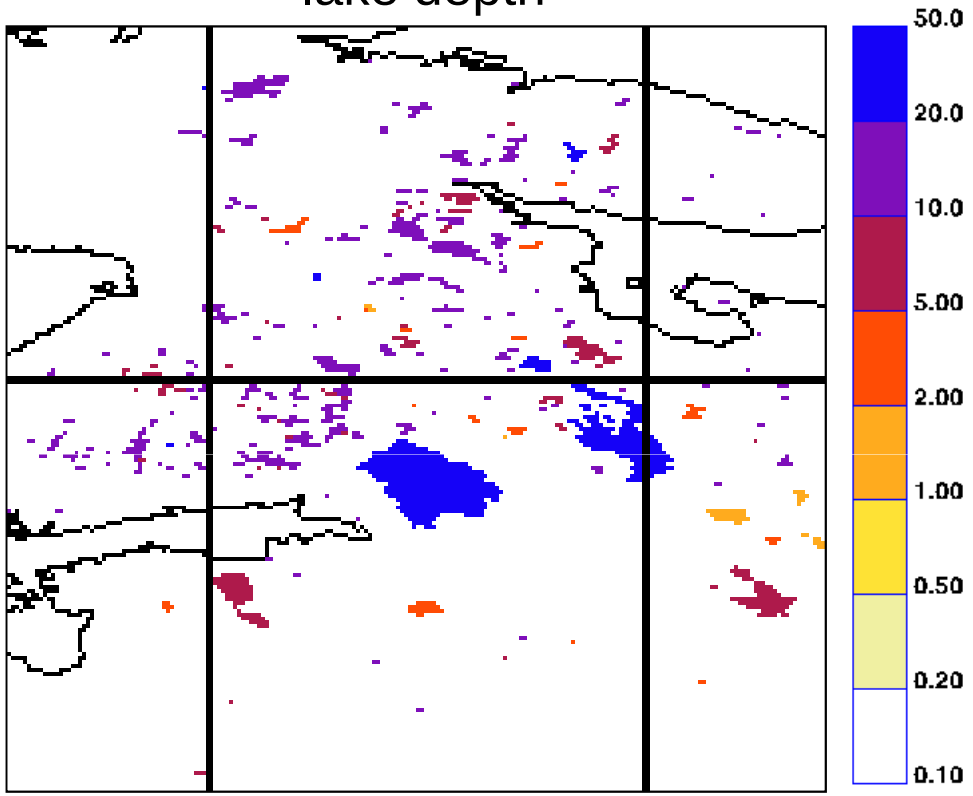
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

example for new external parameters
(H. Asensio, DWD)

lake fraction

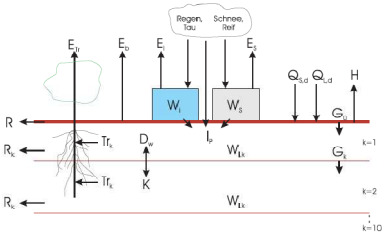


lake depth



Tasks 1 + 4: SVAT model ‘TERRA’

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

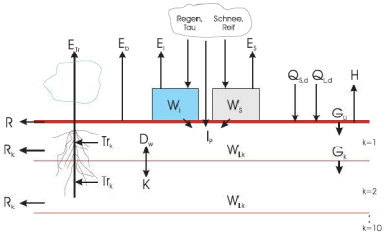


Revision of TERRA and the associated look-up tables:

- developments of TERRA are integrated in official COSMO code
- experiments are running to calibrate the land-surface scheme (parameterisations, external parameters, look-up tables)
- a consolidated and recommended configuration is expected at end of 2010

Tasks 1 + 4: SVAT model 'TERRA'

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



test with adaptations:

- external parameters:
  - vegetation climatology (LAI, PLCOV) ; aerosol climatology
  - space-dependent emissivity, minimum stomatal resistance
- soil model parameterisation:
  - non-uniform root distribution
  - ground water with upward diffusion
  - soil moisture dependent heat conductivity

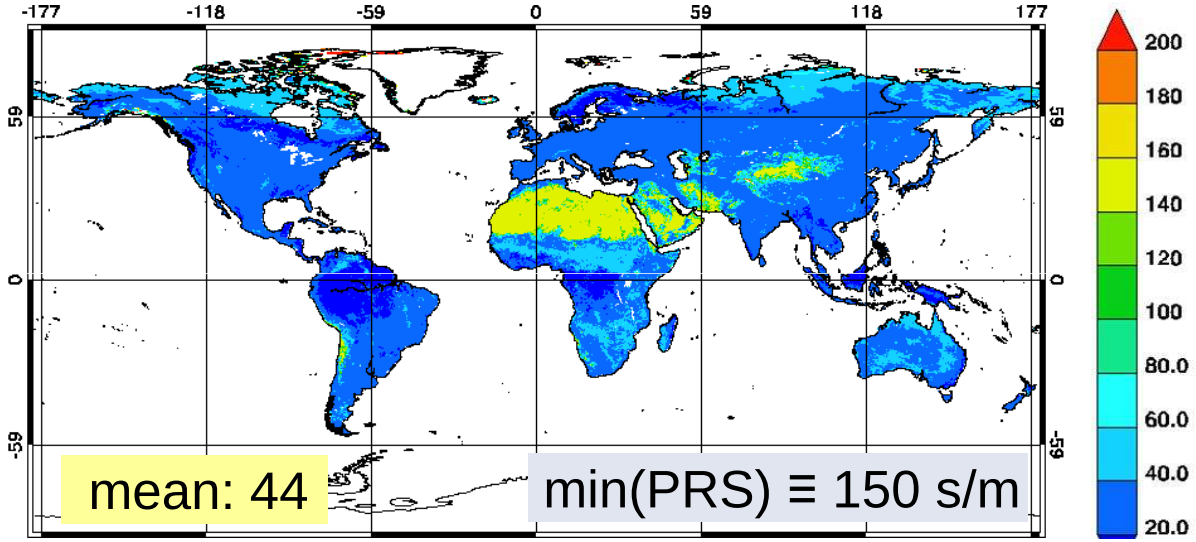
result: tested combination of external parameters and TERRA adaptations leads to increased **PRS/LAI ratio** (plant stomatal resistance / leaf area index)

→ less evapotranspiration, **dry and warm PBL**

→ variational soil moisture initialisation tries to compensate T2M-bias, leads to wet soil

Tasks 1 + 4: SVAT model 'TERRA'

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

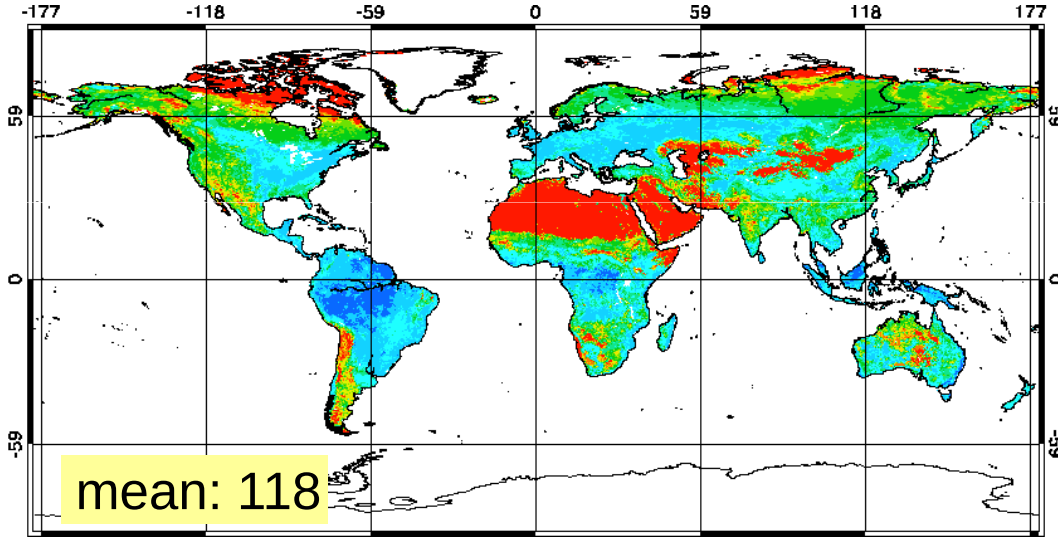


mean: 44

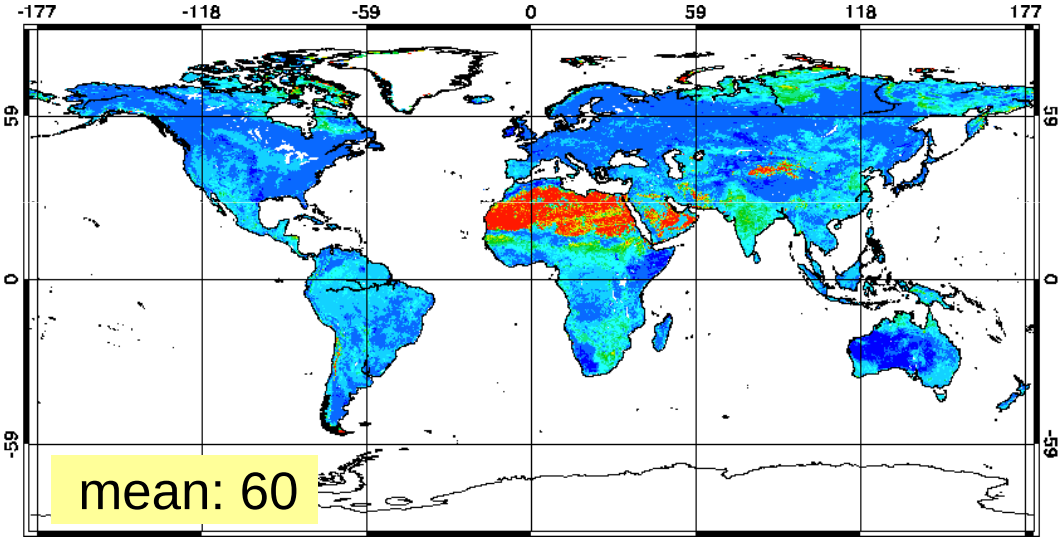
min(PRS) ≡ 150 s/m

min(PRS) / max(LAI)

used operationally for GME 1999 – 2007



mean: 118



mean: 60

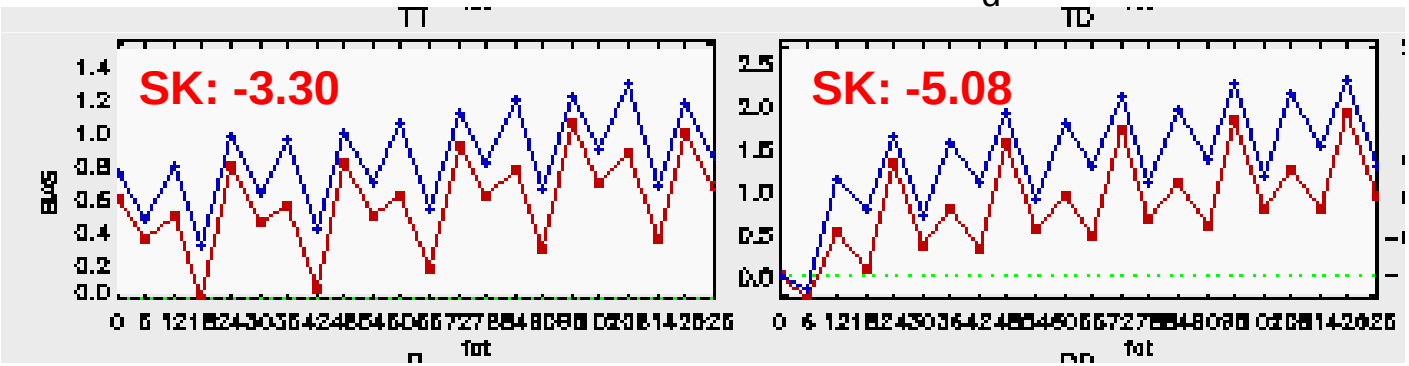
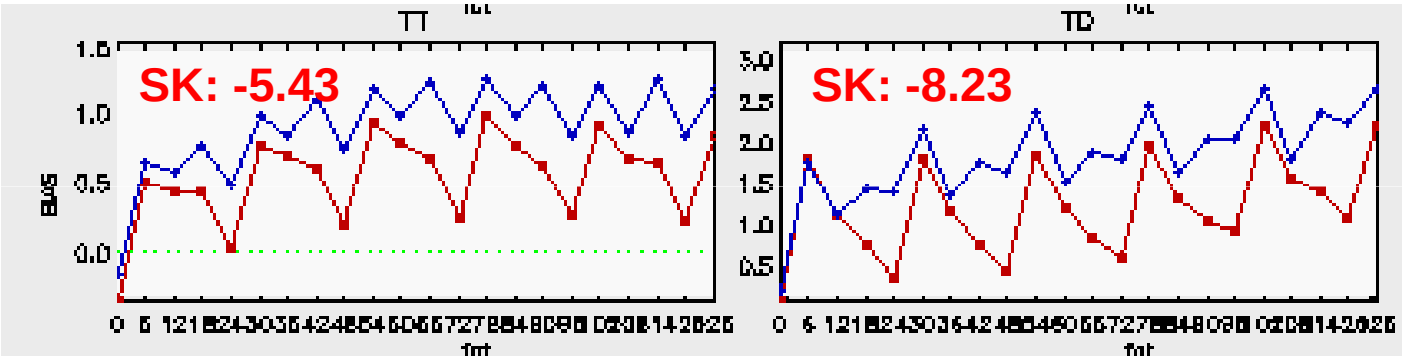
used operationally for GME since 2007
used in test for COSMO

ECOCLIMAP (Masson, 2003)

Tasks 1 + 4: SVAT model 'TERRA'

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

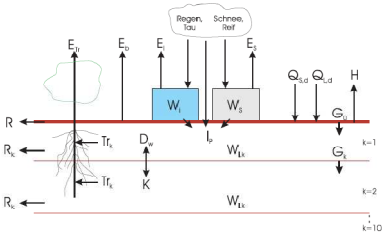
GME experiment, June 2009, 0 UTC : ECOCLIMAP
vs. GME-Opr. (= COSMO-Test)

	T-2m bias	T_d-2m bias
Europe		
North America		

without modifying model physics, but
only using improved external parameters can reduce model bias (here in extra-tropics)
→ test ECOCLIMAP–PRS/LAI also for COSMO

Tasks 1 + 4: SVAT model ‘TERRA’

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

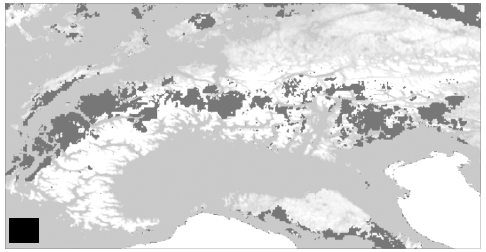


Aims for 2011:

- test **ECOCLIMAP–PRS/LAI** also for COSMO
- revision of TERRA **rainfall interception** and surface water treatment
- implementation of an **orography dependent surface runoff**
- detailed comparison of COSMO/TERRA with **COSMO/CLM** in weather mode
- tests in **climate mode**

Task 5.1: Consolidate / validate multi-layer snow model

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



New multi-layer snow model, includes

- snow compaction by metamorphism and gravity
- explicit description of radiation effects
- phase transition of liquid water within snow pack
- water percolation

Status:

- code is available in latest COSMO release, ongoing tests at DWD / MeteoCH
- tests: some improvements of snow depth,
  especially during melting phase and in complex topography

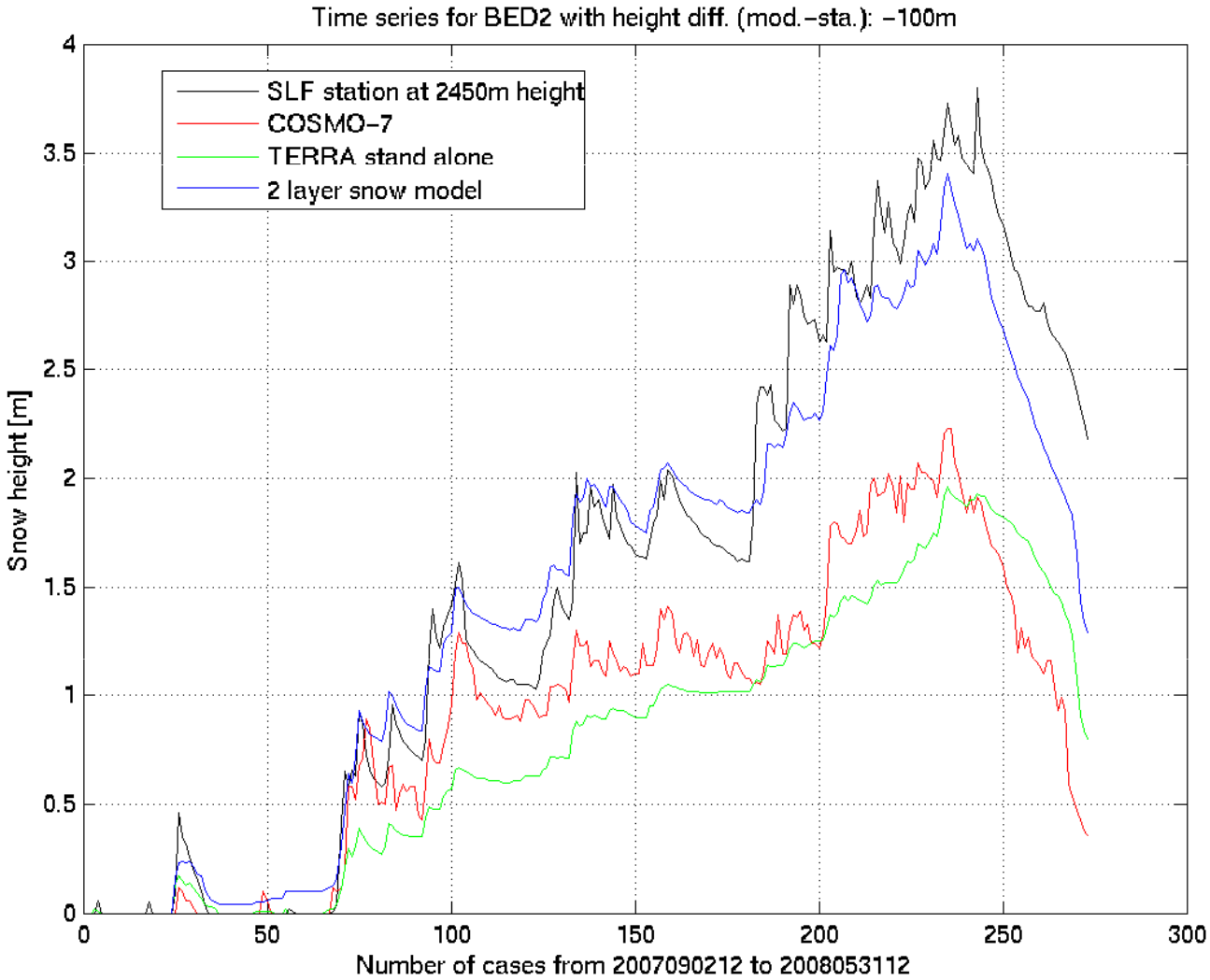
Aims for 2011:

- correct fresh **snow density** (too high), snow density aging, heat conductivity
- improve albedo in situations with **snow in forest** covered areas
  (dynamic evolution of snow over forest canopy)
- improve **partial snow cover** representation (use tile / mosaic approach)
- tests in **climate mode**

Task 5.1: Consolidate / validate multi-layer snow model

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Validation experiments



station at **2450 m**
on southern slope of Alps

model at **2350 m**

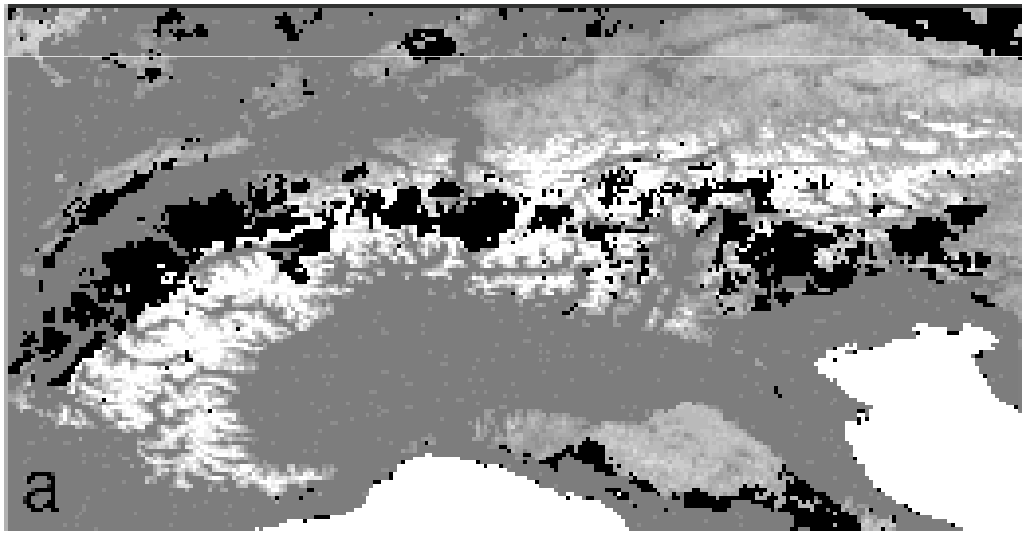
Δh = -100 m

SLF Obs
COSMO-7 (fully 3-D, with snow analysis)
TERRA stand-alone REF
TERRA stand-alone 2LSM (no snow ana.)

Task 5.2: Refined snow analysis

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

snow analysis extended by introducing a **MSG-derived snow mask**
and by tuning the Cressman analysis of snow height observations

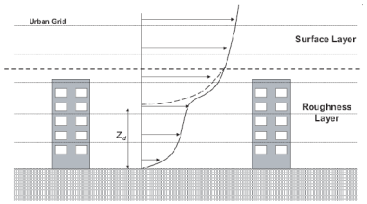


Aims for 2011:

- **altitudinal interpolation** (regression) has still to be integrated
  (→ should increase **temporal stability** of analysis)
- adapt analysis for new **multi-layer snow model**

Task 6: Urban module

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



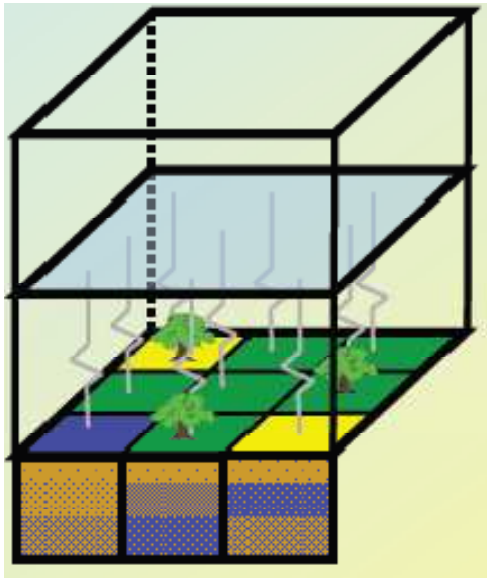
- complex module, code & documentation ready
- code has already been used (S.Schubert PIK/Potsdam, B.Sändig IfT/Leipzig)

Task 7: land surface heterogeneity by tile / mosaic approach

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

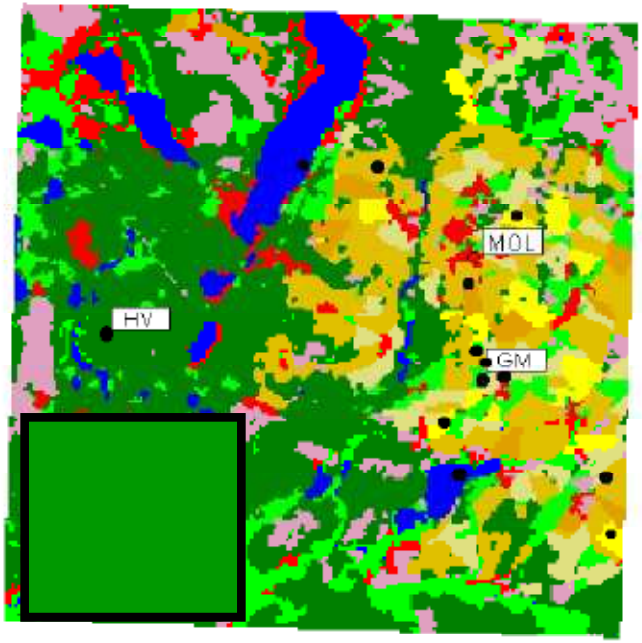
objective: account for non-linear effects of sub-grid surface inhomogeneities on surface fluxes of energy and moisture

mosaic approach:
surface divided
in **N subgrid cells**

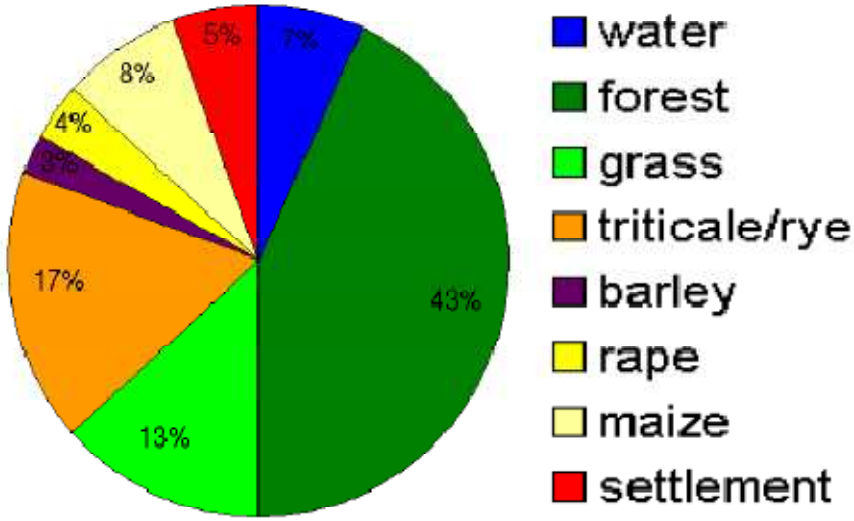


(Figure from
Ament & Simmer, 2006)

map of land-use
within LITFASS domain
(surroundings of Lindenberg)



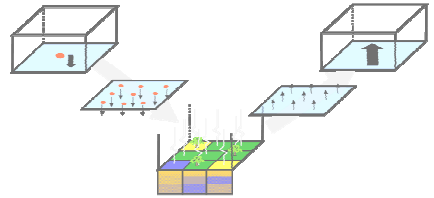
tile approach:
N dominant classes
(e.g. water, snow, grass)



(Figure from C. Heret, DWD Lindenberg)

Task 7: land surface heterogeneity by tile / mosaic approach

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Status:

- MOSAIC implemented in an old COSMO version, still buggy, true flux aggregation is missing
- documentation has been adapted

Aims for 2011:

- implement tile approach
- full support of tiles and mosaic in official COSMO code
- impact studies (e.g. tiles with nature / urban / lake / sea, mosaic for partial snow in complex topo)

Implementation of tile approach requires:

- extensions in external parameter software (i.e. land-use dependent parameters for a number of dominant classes within each atmospheric grid cell)
- code structure to support multiple 'soil columns' within each grid cell (in Terra)
- suitable diagnostics, validation, computational efficiency and flexibility

COLOBOC : Overview

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

COLOBOC : Sept. 2008 – Sept. 2010 , extended to Sept. 2011

Task 0: Document **observation sets** available for SVAT model validation
→ consolidate data exchange action (SRNWP)

Task 1: Tools – Consolidation of TERRA standalone code (SVAT model of COSMO)

Task 2. Tools – Consolidation of software to generate external parameters

Task 3: Revision of **external parameter** sets (extended)
(raw data sources for generation of external param. for COSMO & GME)

Task 4: Revision of **SVAT** module TERRA and associated look-up tables (extended)

Task 5: Revision of **snow** representation
- multi-layer snow model → fresh snow density, snow in forest, partial snow cover
- snow analysis → adapt for multi-layer snow model

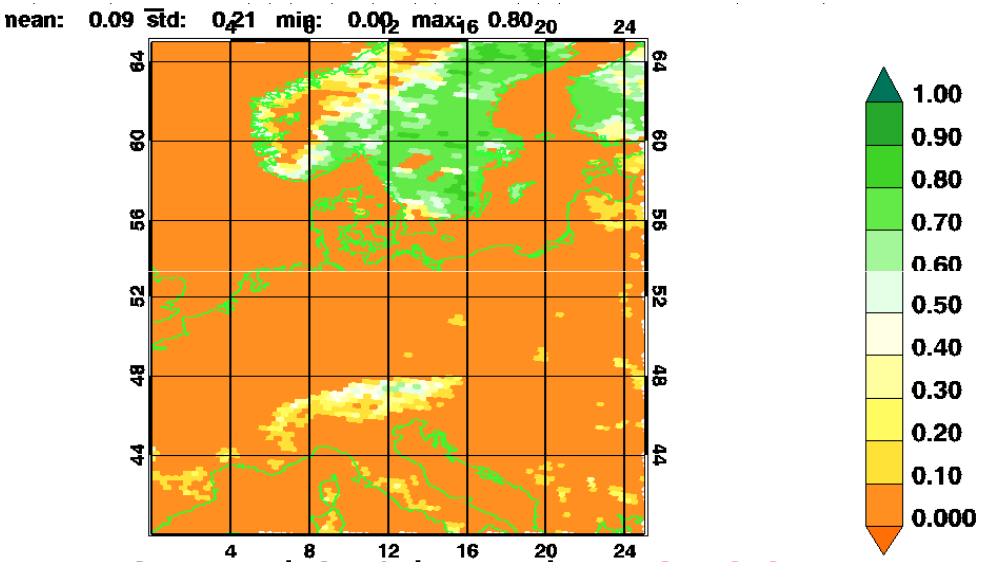
Task 6: **Urban** module (Fuhrer, CH)

Task 7: Param. land surface heterogeneity by **tile** / mosaic approach (extended)

thank you for your attention

Tasks 2 + 3: External Parameters

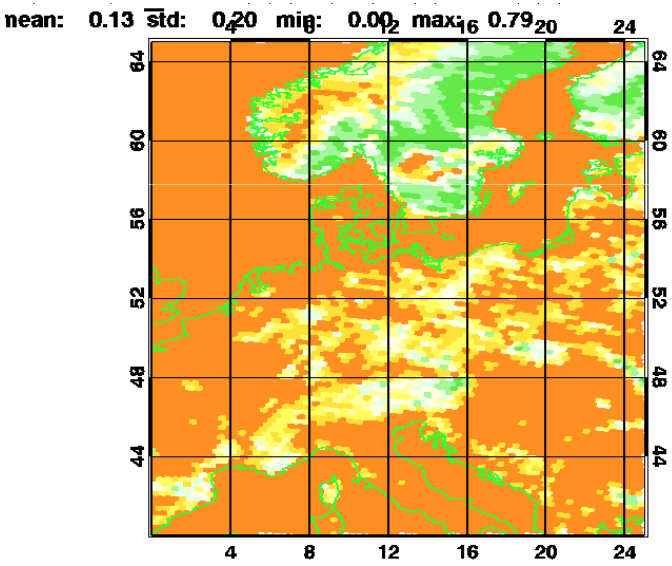
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



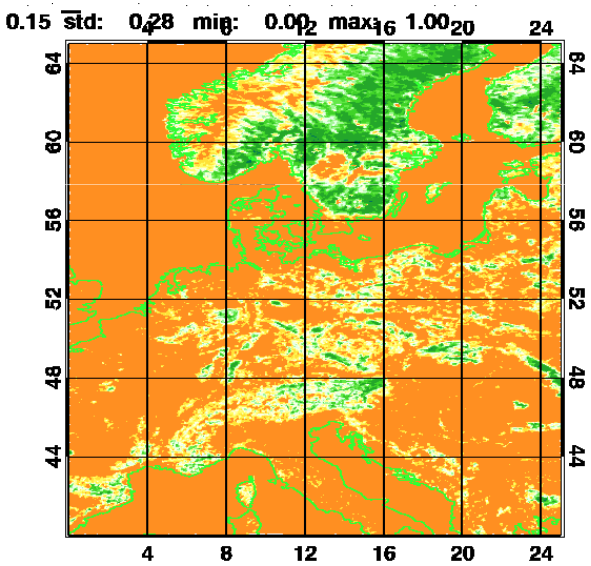
GME ni 256 based on GLCC

example for uncertainties of external parameters:
(H. Asensio, DWD)

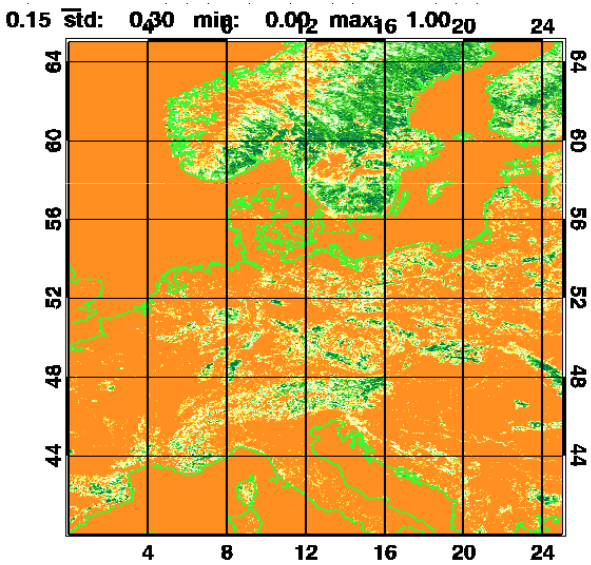
evergreen forest:
GLC2000 vs. GLCC



GME ni 256 (GLC2000)



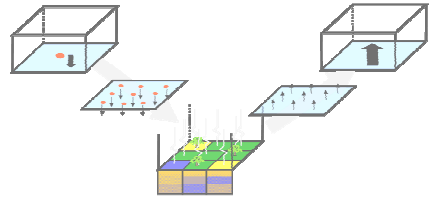
COSMO-EU



COSMO-DE based on GLC2000

Task 7: land surface heterogeneity by tile / mosaic approach

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Examples for tiles:

- AROME (SURFEX) : 4 tiles: nature , town, sea, inland water
  nature: ISBA 3L (Boone et al. 1999) , 1L snow scheme (Douville, 1995)

- UM (Jules) : 9 tiles, 5 veg + 4 non-veg
  veg: broadleaf and coniferous forest, temperate and tropical grasses, shrubs
  non-veg: urban, inland water, bare soil, land ice

- IFS (HTESSEL) : 6 land-surface tiles:
  high vegetation, low vegetation, interception reservoir, bare ground,
  snow on ground and low vegetation, snow under high vegetation