SRNWP COSMO CONSORTIUM FOR SMALL SCALE MODELING

Deutscher Wetterdienst

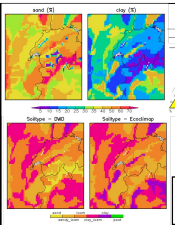
Wetter und Klima aus einer Hand

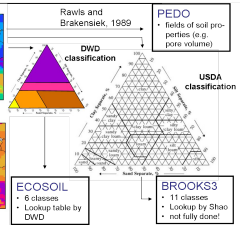
COSMO Activities

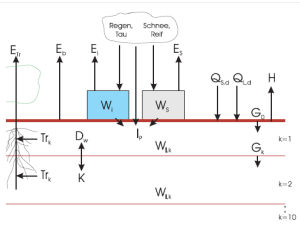
Status Report

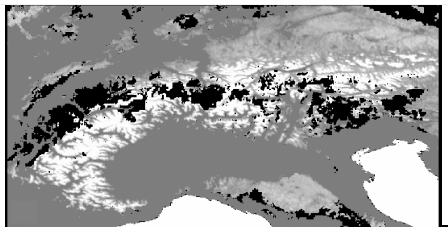
Jürgen Helmert / DWD, Jean-Marie Bettems / MeteoSwiss

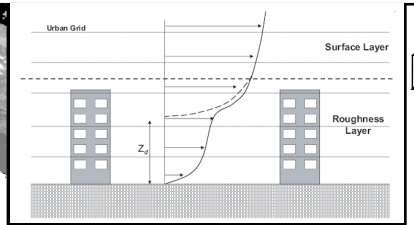
SRNWP ET Surface Processes, Zurich, September 15th, 2010

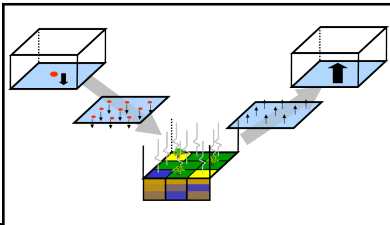






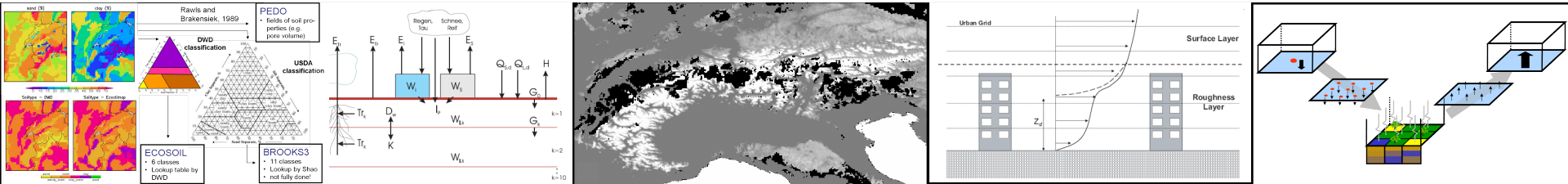






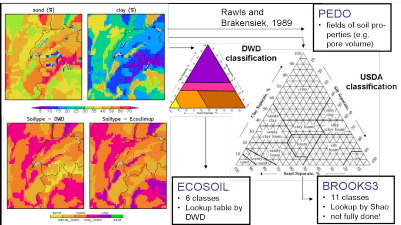
COLOBOC – Consolidation of Lower Boundary Conditions

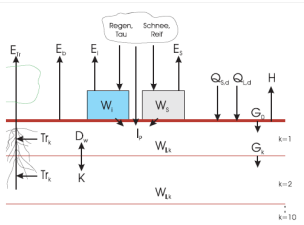
- COSMO-Priority Project: Sept. 2008 – Sept. 2010 – Extension to Sept. 2011
- Focus:
  - incorporate all activities related to the lower boundary conditions which have already reached an advanced state
  - consolidate these developments into well tested and documented software packages readily usable by the COSMO community
- Project leader: J.-M. Bettems (MeteoSwiss), Coproject leader: J. Helmert
- Project structure: Tasks with specific elapsed time

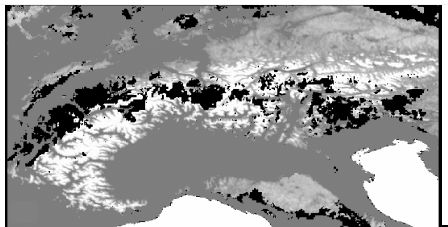


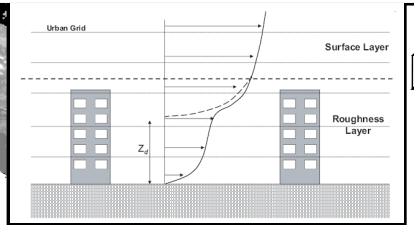
COLOBOC – Tasks

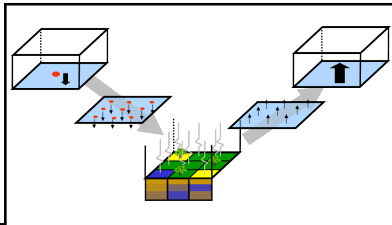
- Observation data sets available for SVAT model validation
- TERRA standalone
- External Parameters (Software)
- Consolidation/Documentation of external parameter data sets
- Update of TERRA in the COSMO model
- Snow model / Snow analysis
- Urban module, Tile/Mosaic approach











Review – COLOBOC Obs data

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Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

Observation sets for SVAT model validation.

- **Documentation**
- **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), Sodankylaa (Finland), Cabauw (Netherland).
  - Data of 6 participating sites for 2006-2008 soon available on-line on the COSMO web site. Year 2009 will follow afterwards. Common xls format.
  - Special side meeting on this topic at the EMS conference in Zurich

    (Wed. Sept. 15th, 14h00 - 15h30).
  - Aim: Use data pool for validation and diagnostics

Demo

Review – COLOBOC EXTPAR

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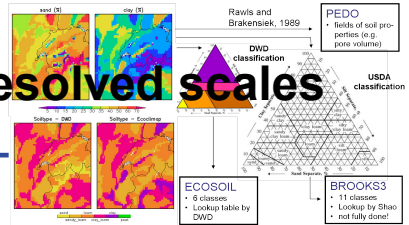
Consolidate software for generating external parameters, data

- **Reference system** at DWD, accessible through a Web interface ➡ Demo
- 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 2010/11:** 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), Consolidate **root depth**
- Alternative vegetation characteristics using MODIS calibrated **phenology model** (work by R.Stöckli), crop life cycle
- Allow correct representation of **scale separation for z_0 / SSO / resolved scales** (filter, option for topo smoothing in EXPAR instead of INT2LM)



Example for new ext. parameters
Fraction lake and lake depth

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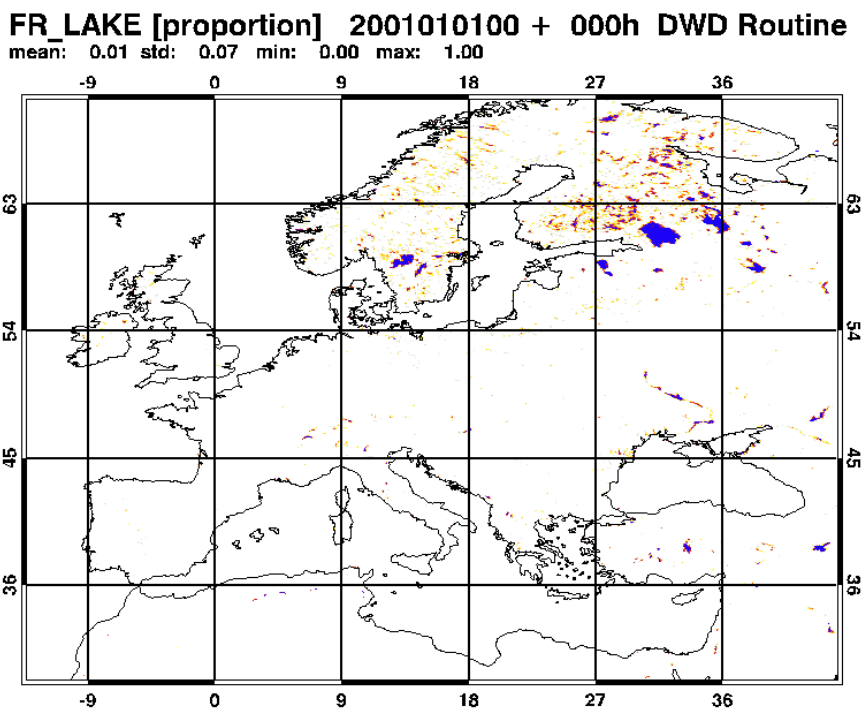

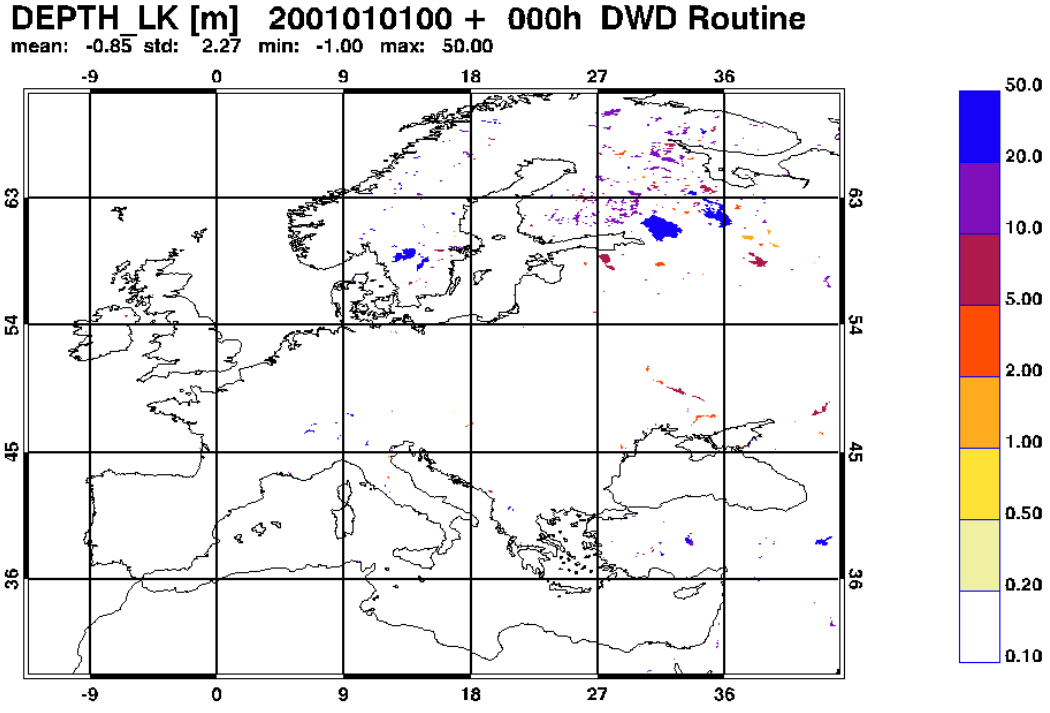

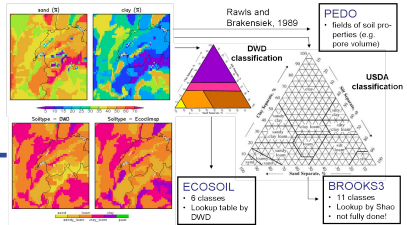

Example for uncertainties of ext. parameters

Evergreen Forest: GLC2000 vs. GLCC

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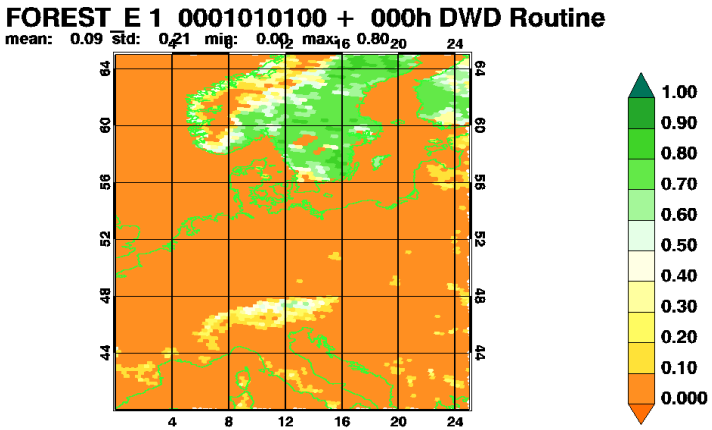
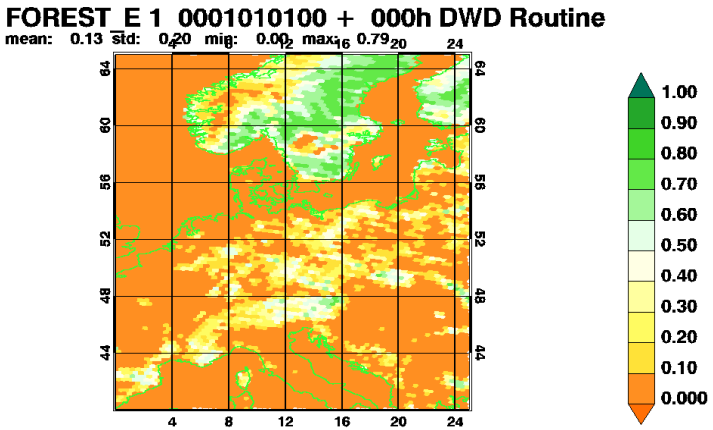
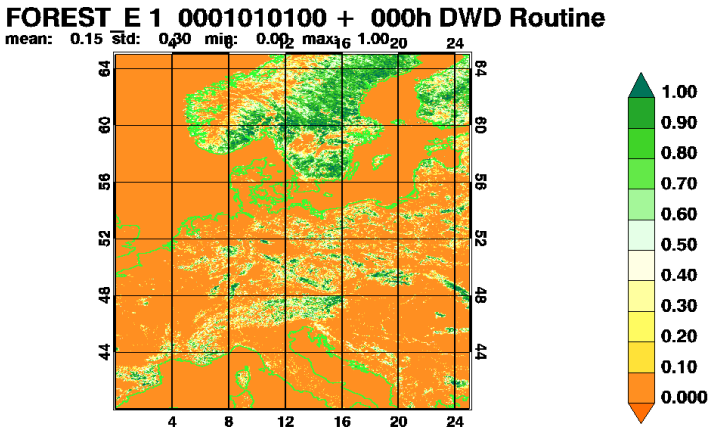


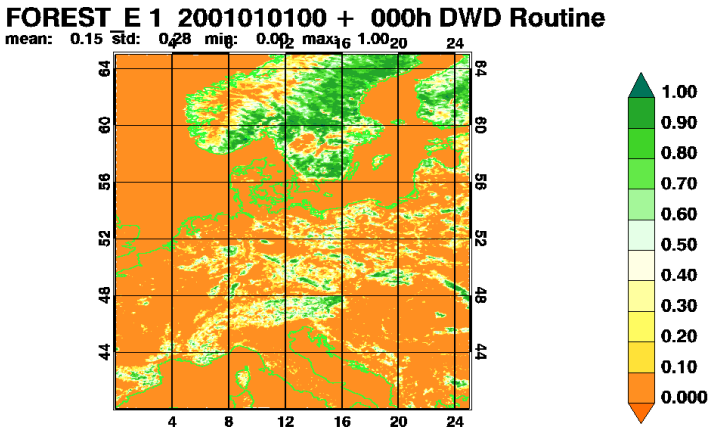
GME ni 256 based on GLCC



GME ni 256 based on GLC2000



COSMO-DE based on GLC2000



COSMO-EU based on GLC2000

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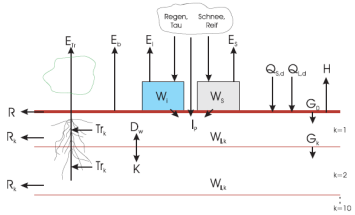
Revision of TERRA and the associated look-up tables.

- Developments of TERRA have been integrated in official COSMO code
- Experiments are running to calibrate the land-surface scheme (parametrizations, external parameters, look-up tables).
- A consolidated and recommended configuration is expected till the end of 2010.

• Adaptions:

- Aerosol climatology, Emissivity
- Vegetation climatology (LAI, PLCOV)
- Minimum stomatal resistance

- Non-uniform root distribution
- Ground water with upward diffusion
- Soil moisture dependent heat conductivity



Review – COLOBOC SVAT model

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- Adaptions:

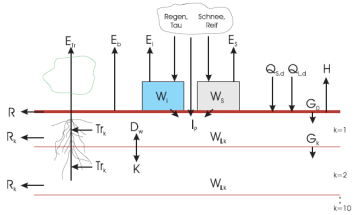
- Aerosol climatology, Emissivity
- Vegetation climatology (LAI, PLCOV)
- Minimum stomatal resistance

- Non-uniform root distribution
- Ground water with upward diffusion
- Soil moisture dependent heat conductivity

- Result: less evapotranspiration, **dry and warm PBL**

- Reason : Tested combination of external parameters and TERRA adaptions could lead to increase in P**RS/LAI ratio ?**

- **SMA** tries to compensate T2M-Bias, wet soil



BATS Plant transpiration (Dickinson, 1984)

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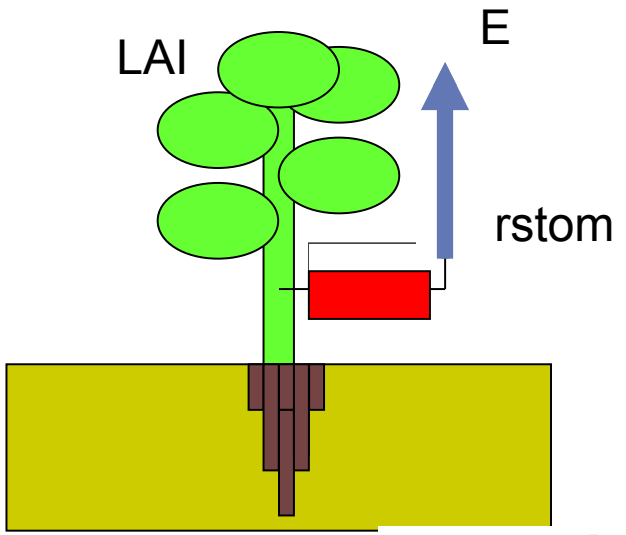
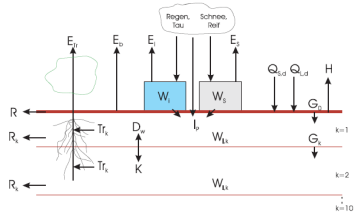
$$E_{trans}^{dick} = -\rho \left(q_{atm} - q^*(T_s)\right) \left(\frac{1}{r_{ca} + \frac{1}{f_{LAI}} (r_{lc} + r_{stom})} \right)$$

rstom stomatal resistance
rlc res. btw. leaves and canopy air
rca res. btw. canopy air and atm. level





PRS_MIN/LAI_MX ROUTI 1999-2007

PRS_MIN = 150 s/m

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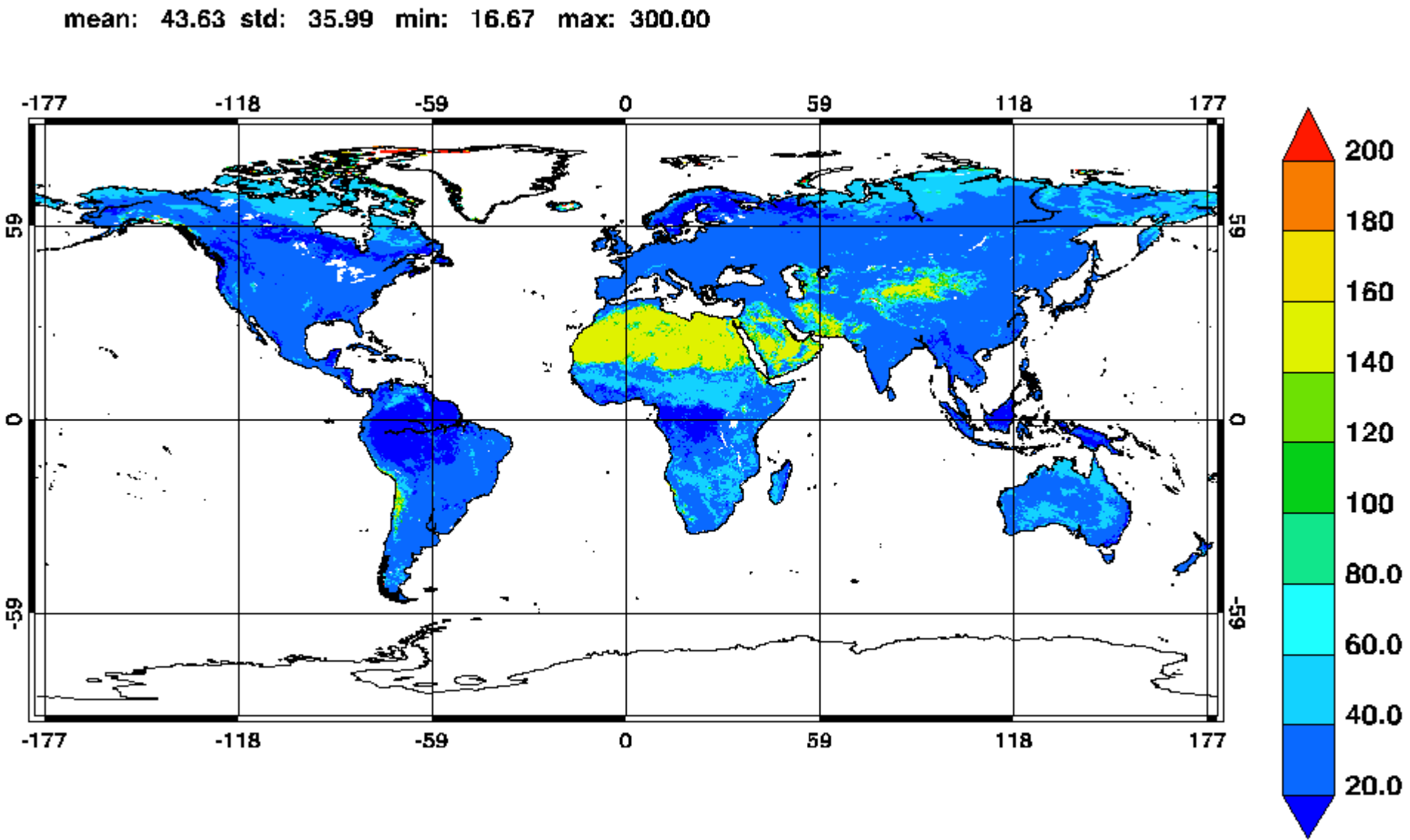
Wetter und Klima aus einer Hand



PRS_MIN/LAI *June* ROUTI 2007- Now

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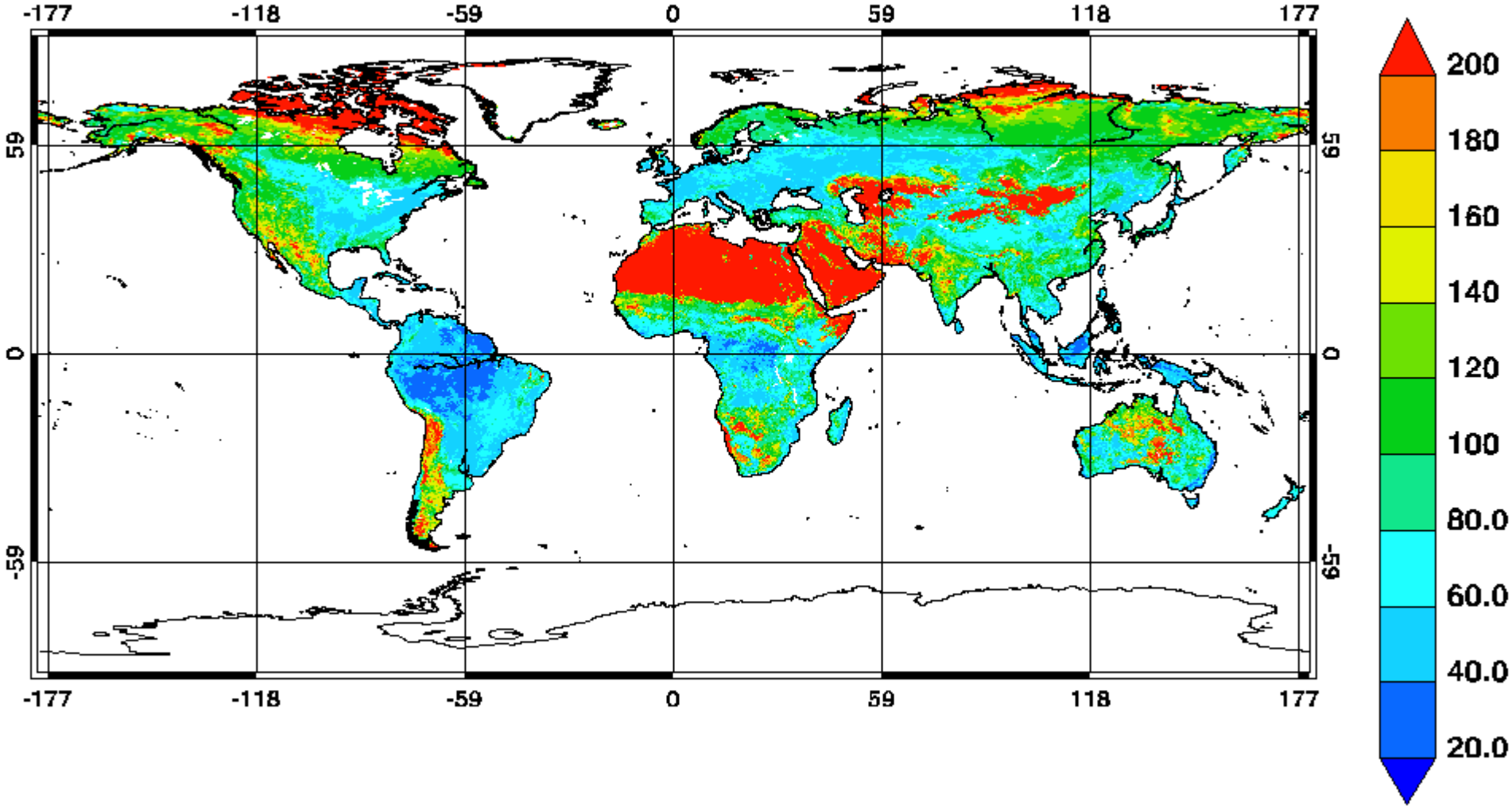
mean: 117.84 std: 86.13 min: 35.00 max: 3277.53



PRS_MIN/LAI *June* EXP

Masson (2003) - Ecoclimap

Deutscher Wetterdienst
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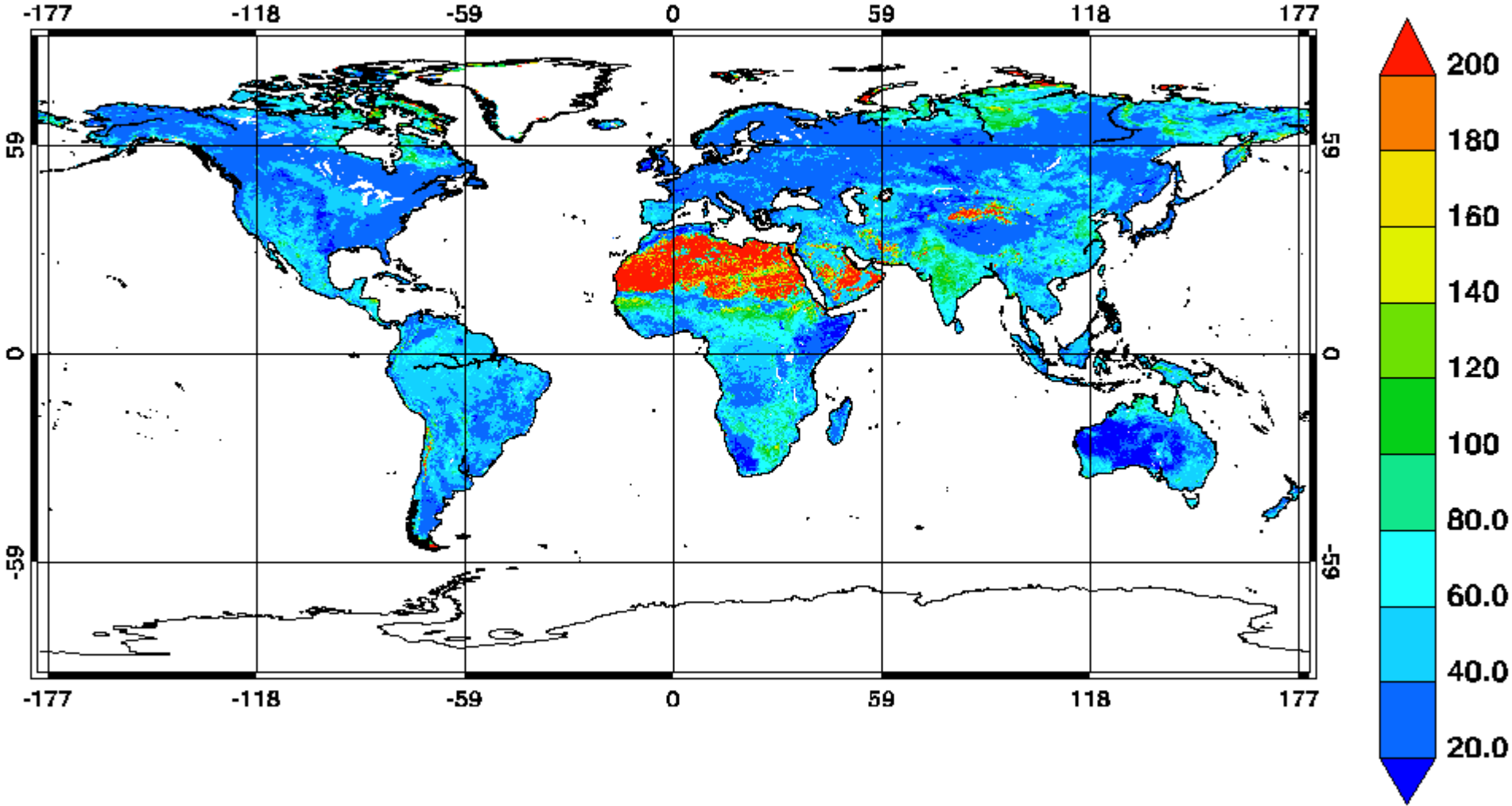
mean: 59.67 std: 47.84 min: 7.46 max: 3006.84



PRS_MIN/LAI *June* EXP
Dorman and Sellers (1989)

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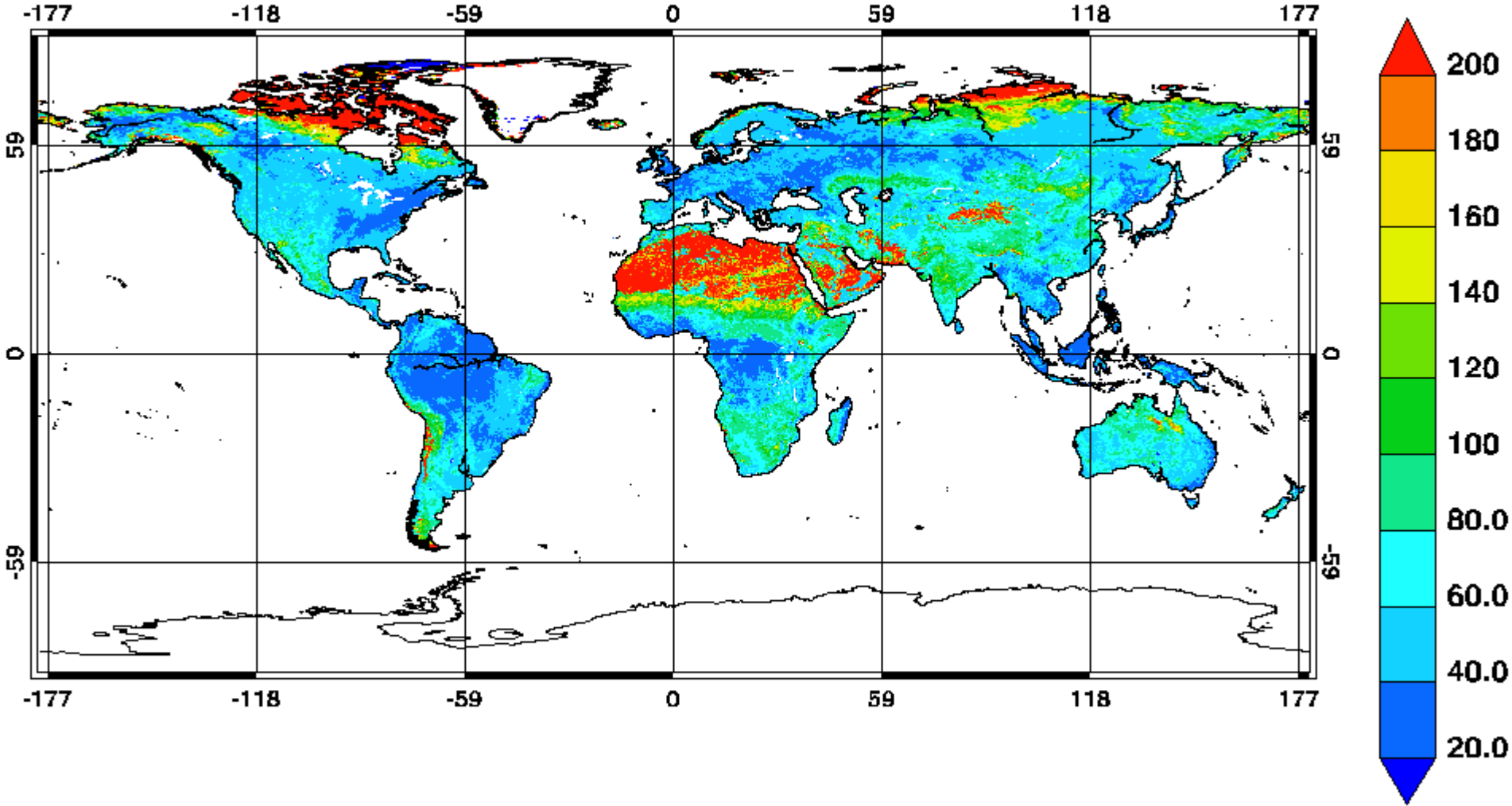
mean: 82.48 std: 77.62 min: 0.00 max: 7335.87

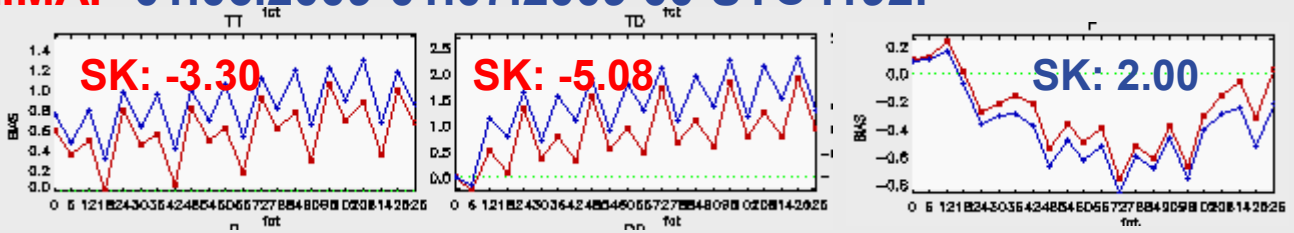


Latest TERRA developments
Global Verification

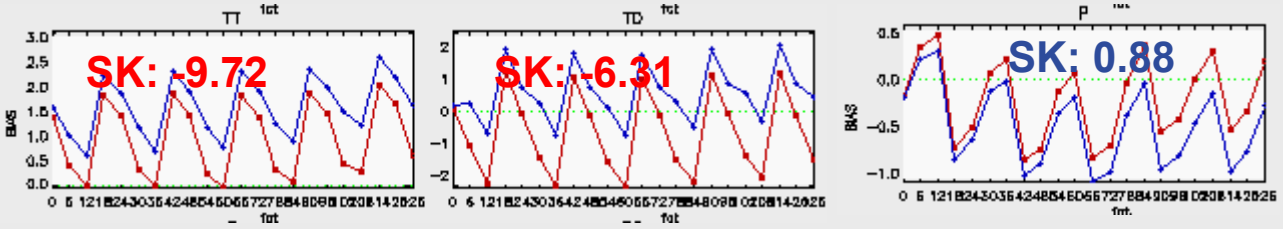
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

EXP 7601 ECOCLIMAP 01.06.2009-01.07.2009 00 UTC i192f

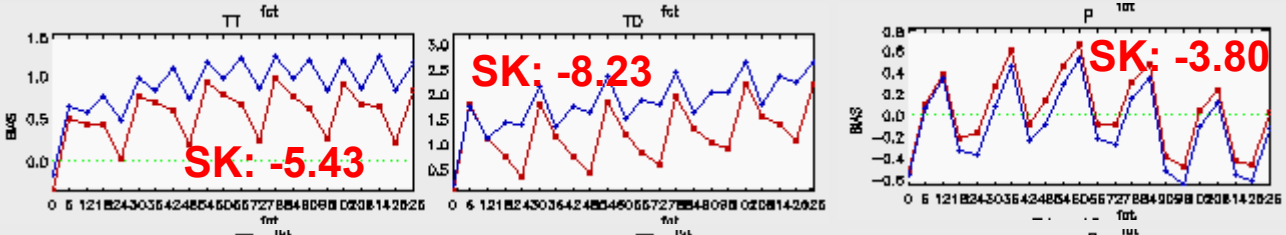
Europe



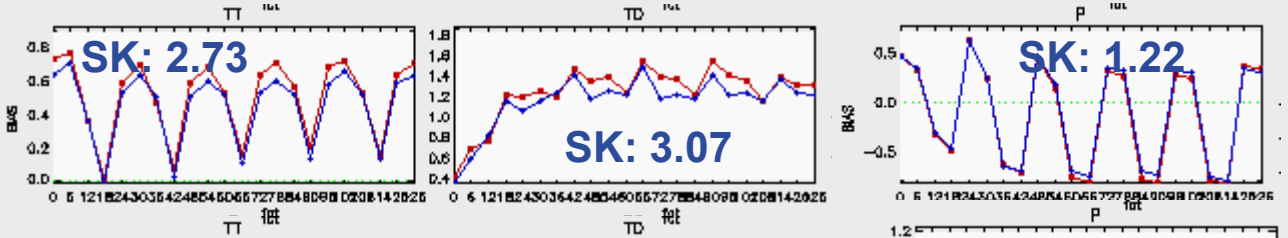
East Sibiria



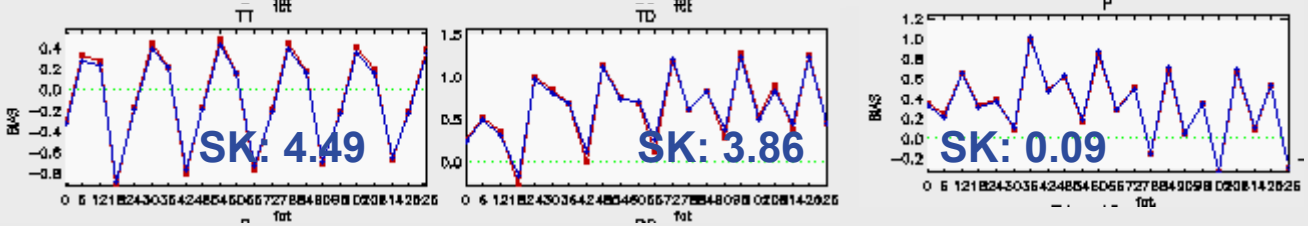
North America



Tropics Africa



Tropics America



Latest TERRA developments
Global Verification

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

EXP 7602 D&S89 01.06.2009-01.07.2009 00 UTC i192f

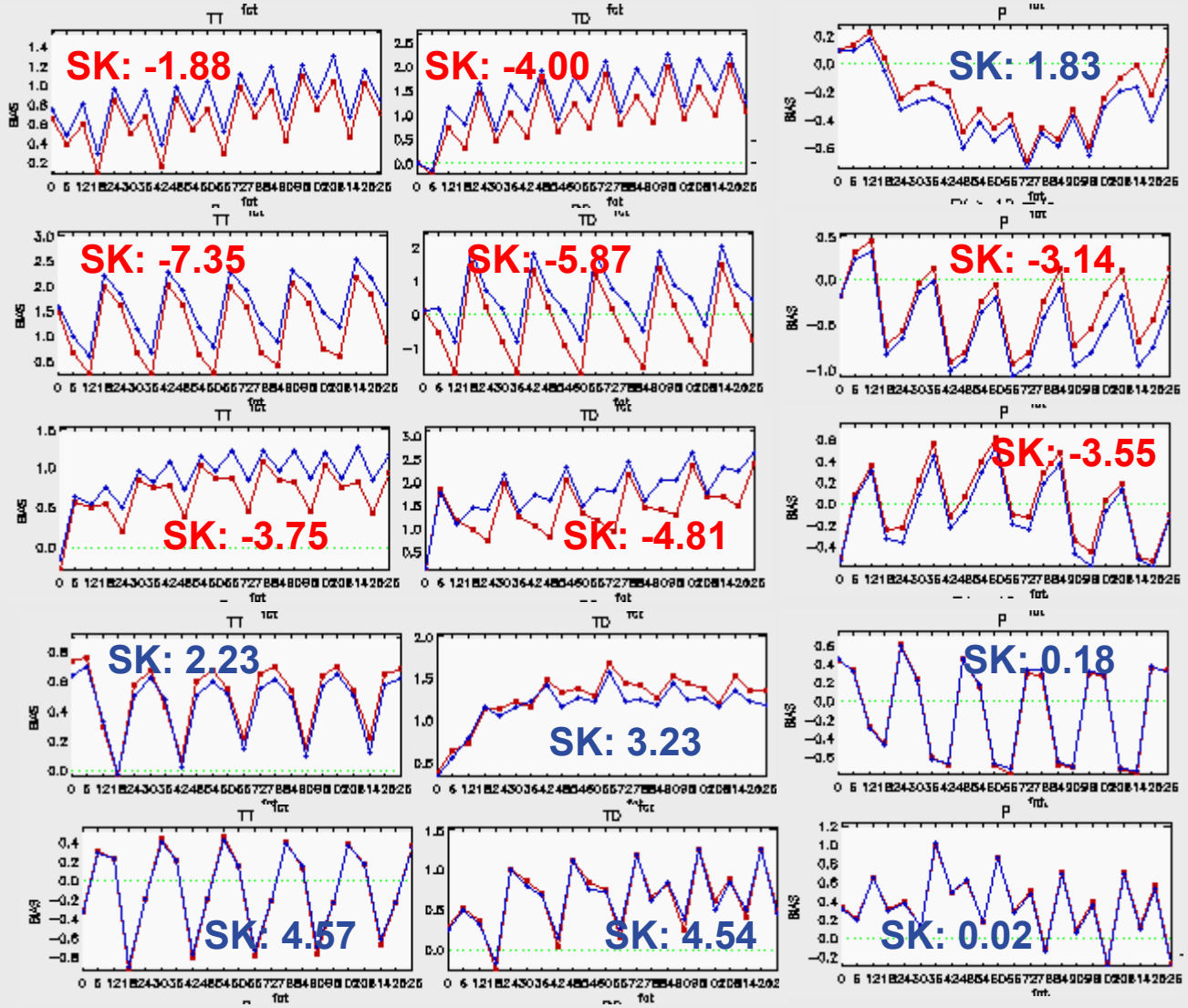
Europe

East Sibiria

North America

Tropics Africa

Tropics America



Review – COLOBOC SVAT model
Conclusions and Outlook

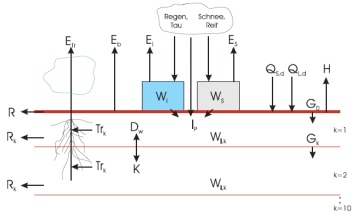
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- Global numerical experiments showed the impact of PRS/LAI ratio on evapotranspiration and screen level temperature

- Results from global experiments will be used in COSMO experiments

Aim for 2010/11:

- Revision of TERRA **rainfall interception** and surface water treatment
- Implementation of an **orography dependent surface runoff**
- (Considering of mires)
- Detailed comparison of COSMO/TERRA with **COSMO/CLM** in weather mode (Master student at ETHZ, in group of S.Seneviratne)
- Tests in **climate** mode



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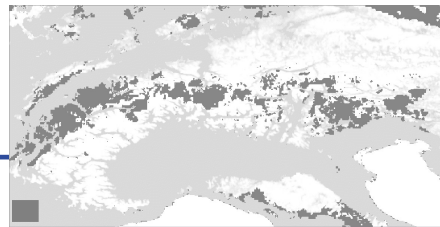
Verify and consolidate the new multi-layer snow model

New multi-layers snow model, including

- Snow compaction by metamorphism and gravity
- Explicit description of radiation effects
- Phase transition of liquid water within snow pack
- Water percolation

- **Code is available** in latest COSMO release
- Tests have shown some improvements of snow depth with the new multi-layers snow model, specially during melting phase and in complex topography.
- Some issues remain with the density of the (fresh) snow and with the representation of partial snow cover
- Ongoing tests at DWD and MeteoSwiss



Review – COLOBOC, task 5.1

SRNWP COSMO CONSORTIUM FOR SMALL SCALE MODELING DWD
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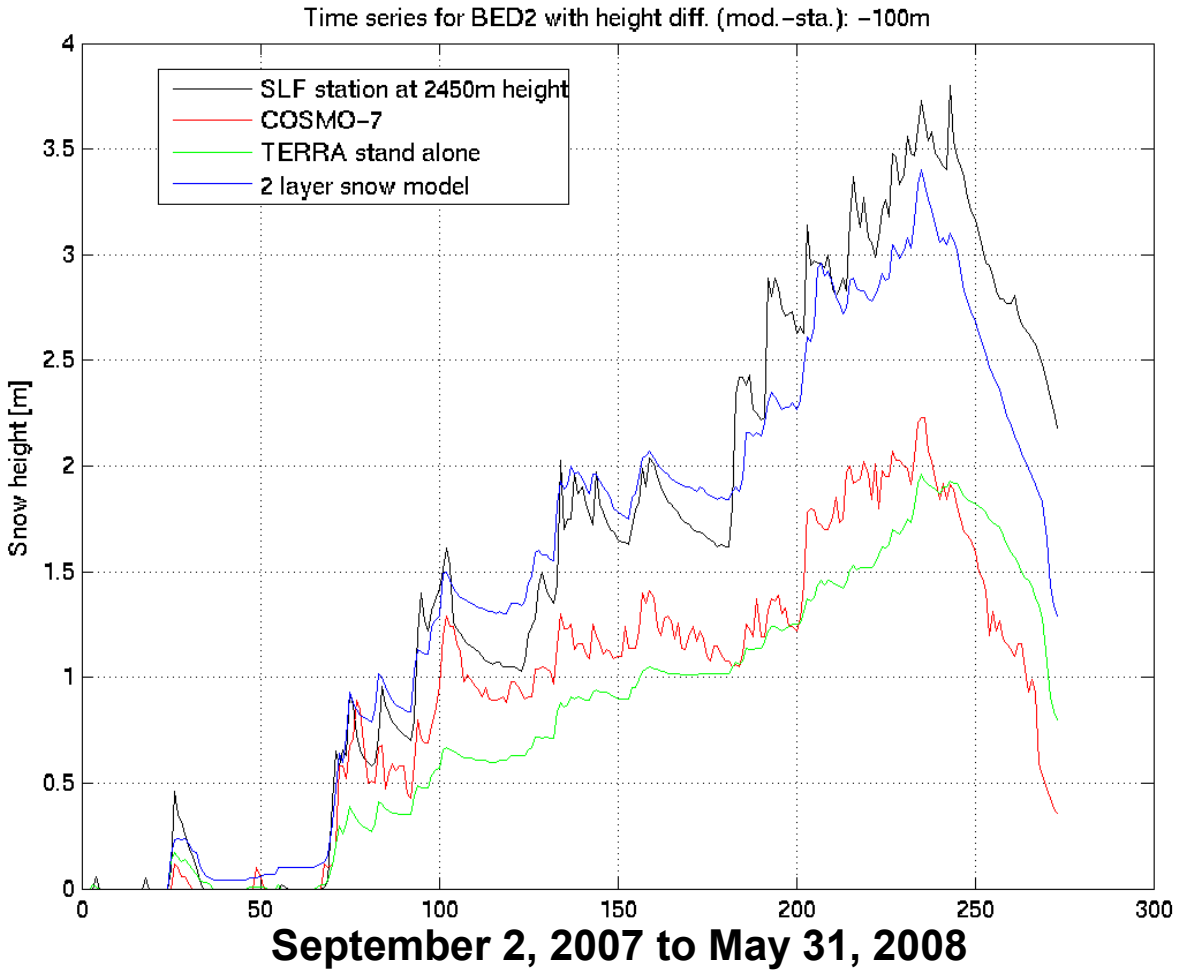
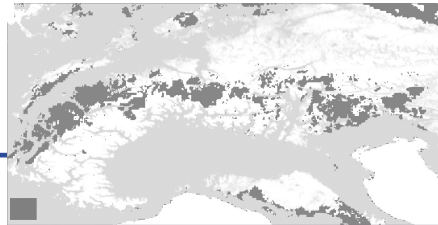


Station at **2450m** on the southern slope of the Alps

Model at **2350m**

Dh = -100m



Review – COLOBOC, task 5.1

SRNWP

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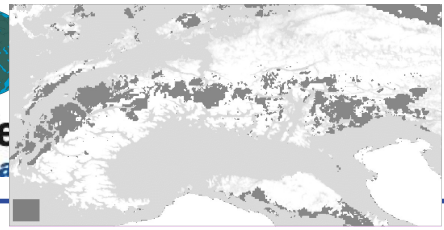
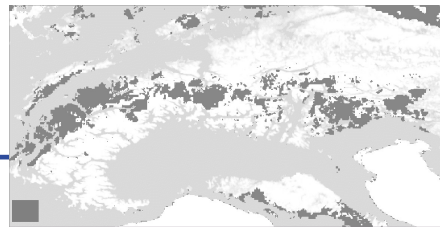
Wetter und Klima a



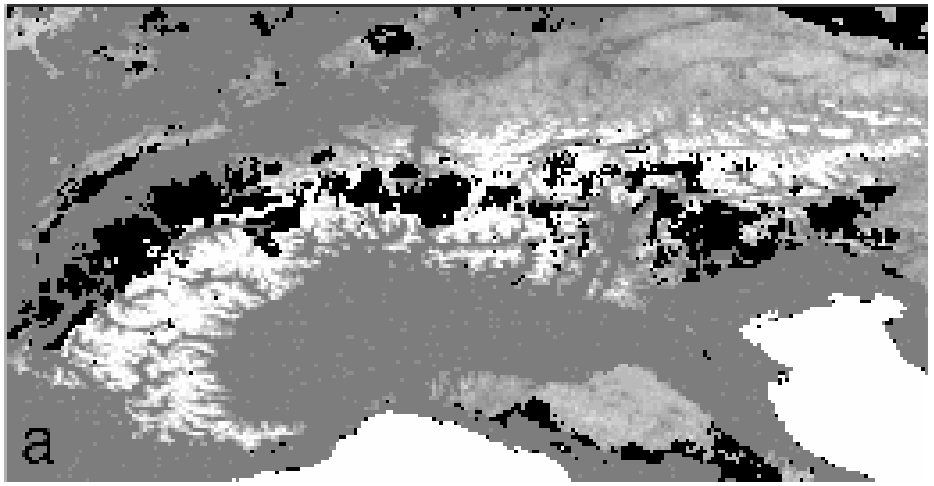
Aims for 2010/11

- Correct fresh **snow density** and feedback effects on soil temperature
- Improve representation of **snow in forest** covered area (albedo …)
- Improve **partial snow cover** representation, in particular by using the tile/mosaic approach
- Tests in **climate** mode



Improved snow analysis

MeteoSwiss has extended the DWD snow analysis by introducing a **MSG derived snow mask** and by tuning the Cressman analysis of snow height observations.



- DWD and MeteoSwiss codes have been merged (sfcana 3.0), test are on-going
- **Aims 2010/11: Altitudinal interpolation** has still to be integrated
- **Temporal stability** of analysis has to be improved

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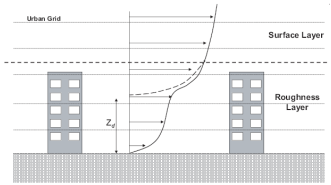
Urban module.

- ➔ Code and documentation are ready.
- ➔ Code has already been used
  (S.Schubert PIK/Potsdam and B.Sändig IfT/Leipzig)



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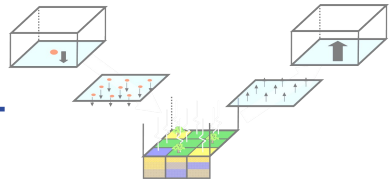
Parameterization of land surface heterogeneity

- ➔ Modifications implemented in former COSMO version (MOSAIC)
- ➔ Documentation has been adapted

Aims 2010/11

- ➔ Implement tile approach (%)
- ➔ Full support of tile and mosaic in official COSMO code
- ➔ Impact studies
  (e.g. tile with nature/urban/lake/sea,
  mosaic for partial snow in complex topo)



Objective

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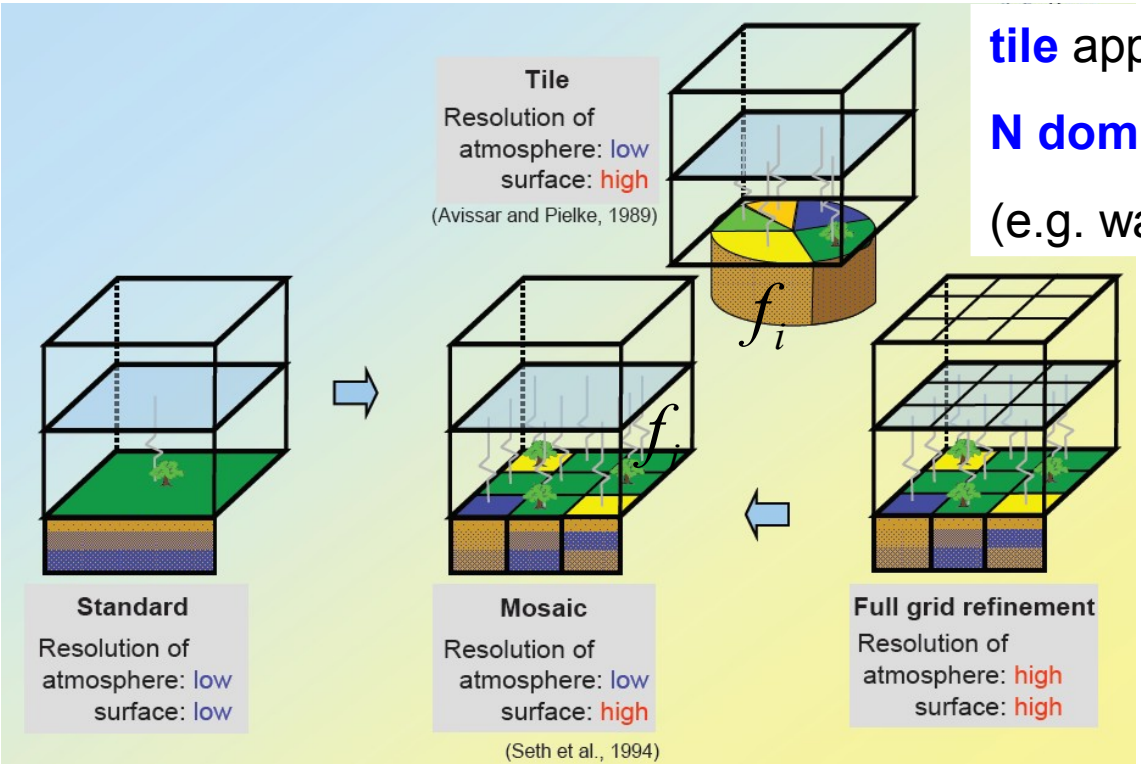
Account for non-linear effects of sub-grid inhomegeneities at surface on the exchange of energy and moisture between atmosphere and surface (cf. Ament&Simmer, 2006)



tile approach

N dominant classes

(e.g. water, snow, grass)

$$\sum_{i=1}^{N} f_i = 1$$

(Figure taken from Ament&Simmer, 2006)

mosaic approach

surface divided in **N subgrid cells**

$$f_i = \frac{1}{N}$$

Objective

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Coupling of coarse atmosphere and high resolution surface

E.g. Latent Heat Flux for one patch :

$$E_{0,i} = -\rho K_{h,i} |\vec{v_h}| \left(q_{atm} - q_{s,i}\right)$$

$$E_0 = \sum_{i=1}^{N} f_i E_{0,i}$$

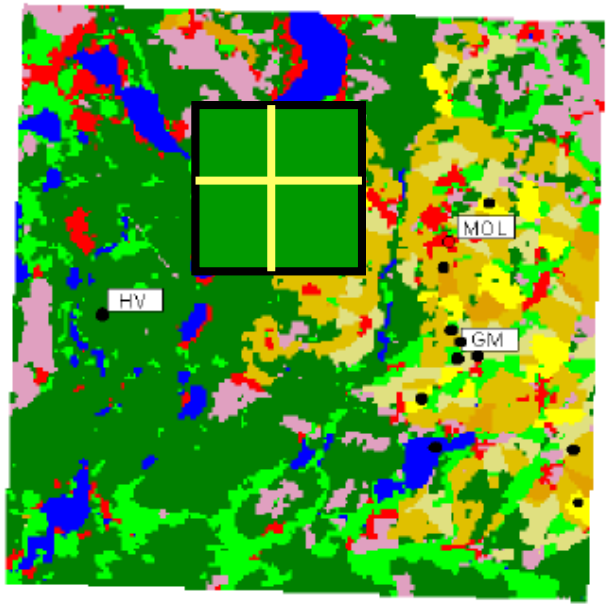
Grid box average

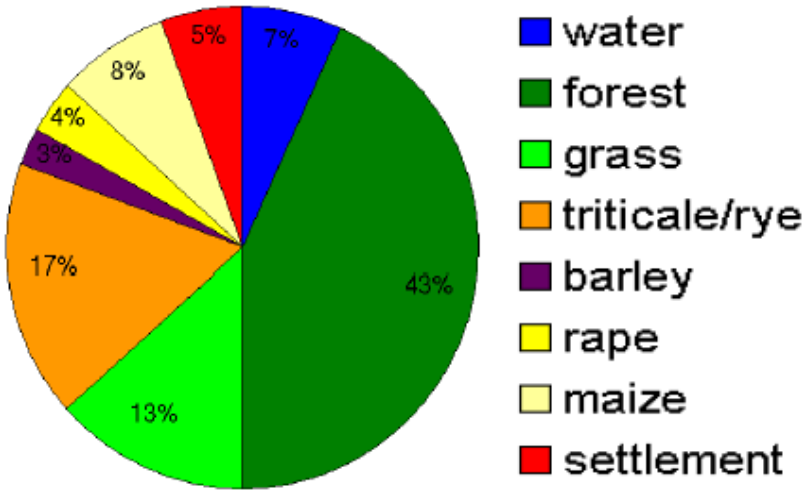
atmospheric variables

surface variables

Options of TILE & MOSAIC

MOSAIC versus TILE approach





(Figure taken from Ament, 2006)

Map of the land-use within the LITFASS domain. Indicated are the measuring sites at the observatory Lindenberg (MOL), the boundary layer measuring site GM Falkenberg (GM) and the forest site (HV). (Plots by the courtesy of C. Heret, DWD Lindenberg.)

Implications for NWP

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Implemention of tile approach requires:

- development and implementation of corresponding extensions in external parameter software (i.e. landuse dependend parameters for a no. of dominant classes within each atmospheric grid cell)

- code structure to support multiple ‚soil columns' within each grid cell (TERRA adaptions in COLOBOC)

- physics interface routine or multi-layer soil model, which controls the computation over (flexible) number of classes within each cell and performs necessary aggregation (&disaggregation)

- suitable diagnostics (within soil model) to allow proper validation of tile scheme

- a computationally efficient and flexible implementation (vectorisation?)

Implications for NWP

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AROME (SURFEX)

4 tiles: nature , town, sea, inland water

Nature: ISBA 3L (*Boone et al 1999*)

1L snow scheme (*Douville, 1995*)

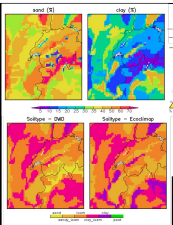
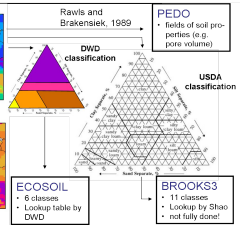
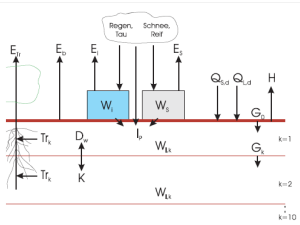
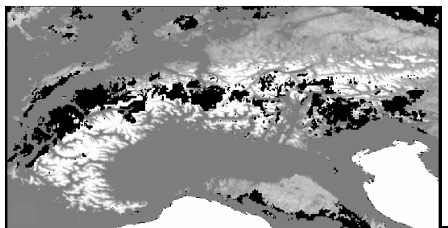
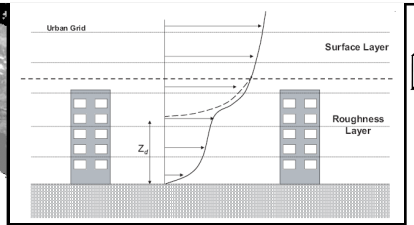
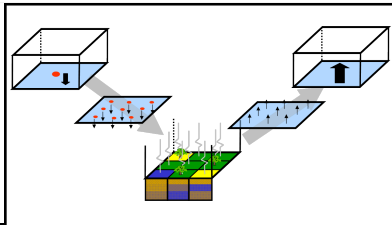
Town

Sea, inland water: constant T_s, Charnock formula

UM (Jules) 9 tiles, 5 veg + 4 non-veg

Broadleaf and needleleaf trees, temperate and tropical grasses, Shrubs, 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

Thank you for your attention!