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CONSORTIUM FOR SMALL SCALE MODELING
COSMO

Soil & Surface activities

WG3b Status Report

Jean-Marie Bettems, MeteoSwiss

COSMO GM, September 15, 2021

Ongoing/Future WG3b Activities at DWD

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- **ICON seamless**; JSBACH + VDIFF in icon-nwp.
  - Roland Wirth started July 1st, is working on the *implementation*
  - *NWP-performance* of JSBACH+VDIFF will be evaluated (in addition to seasonal and decadal scales)
  - Integration of JSBACH *external parameters* into Extpar – work in progress at MPIM
  - Further work on the *interface atmosphere – land* is foreseen (ICON consolidated); keep stand-alone capability in mind

- **ICON-LAND** will be the land component of ICON
  - ICON-LAND as software architecture, currently holds JSBACH
  - Inclusion of modular code parts into ICON-LAND

- **BMBF Proposal WarmWorld** (https://warmworld.de/): pre-proposal submitted
  - Integration of the *hydrological model* ParFlow (https://parflow.org/) into ICON-LAND
  - *Redesign interface* between land and atmosphere
  - Provide interfaces to the larger community (biogeochemical cycles, …). *Separation of concerns.*

Other on going WG3b activities

- Introduce *dynamic* vegetation : PT VAINT
- Modelisation of *urban effects* : PT AEVUS 2 , PP CITTA'
- Modelisation of *snow pack* : PT SAINT
- *Snow pack analysis*

- Tools : *calibration* of model free parameters (PP CALMO & CALMO-MAX)
- Tools : production of *external parameters* (EXTPAR)
- Tools : *offline* soil & surface module (TERRA standalone)

- Tools (WG4) : model *pre- & post-processing* (fieldextra)

PT VAINT (09.2020 – 08.2022)

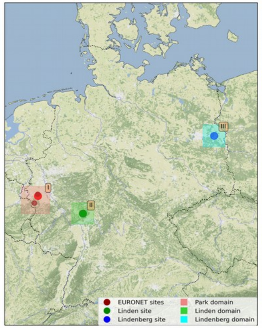
- Preliminary work towards a *dynamic vegetation growth module* has been successfully done, new parameterization is delivering meaningful results.
  - New code is implemented in COSMO-CLM v5.0_clm16 (TERRA)
- Next steps:
  - Implement carbon allocation and plant growth module
  - Implement heterotrophic respiration and litter/soil carbon module

PT VAINT (09.2020 – 08.2022)

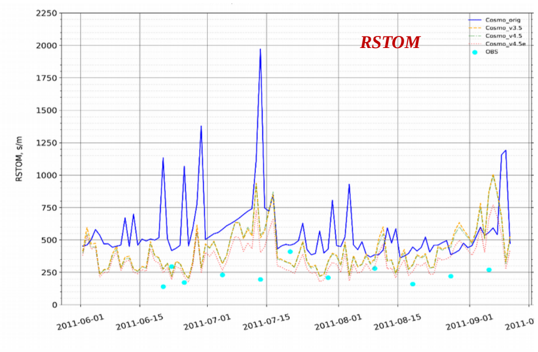
Implemented in COSMO-CLM v5.0_16

- Ball-Berry **stomatal resistance approach** (Ball and Berry, 1991) instead of Jarvis approach (Jarvis, 1976);
- Farquhar (1980) and Collatz (1992) algorithms for **leaf photosynthesis**
- "**Two-big leaf**" approach (Thornton and Zimmermann, 2007) instead of "one-big leaf" (Doms et al, 2018)

Research domains



Result examples



Verification strategy and parameters

Time

2009 | 2010 | 2015

Control (***COSMO-CLM v5.16***)

Experiments (***CCLM_v3.5, v4.5, v4.5e***)

- AEVAP, $ALHFL_{PL}$, $ALHFL_S$, $ASHFL_S$, QV_{2M}
- QV_S, T_{2m}, T_S, T_{max}, T_{min}, PS, $RELHUM_{2M}$
- ZTRALEAV, ZVERBO, RSTOM

CALibration of the COSMO **MO**del
CALMO -MAX

Project participants*

Antigoni Voudouri, Euripides Avgoustoglou, Yoav Levi, Izthak Carmona, Eduardo Bucchignani and Jean-Marie Bettems

*with the contribution of Pirmin Kaufmann, Silje Soerland (ETHZ) and Andreas Will (BTU)

- Domain choice: Wider Eastern Mediterranean Area

❑ Parameter list

PARAMETER	INTERPRETATION	RANGE	TEST VALUES (default)
rat_sea	ratio of laminar scaling factors for heat over sea	1-100	1, **10**, 50
rlam_heat	scaling factor of the laminar boundary layer for heat	0.1 – 10.0	0.1, **1.0**, 2.0
tkhmin tkmmin	minimal value of diffusion coefficient for heat and momentum (kept equal)	0.0-2.0	0.1, **0.40**, 2.0
tur_len	asymptotic maximal turbulent length scale (m)	10 – 10000	100, **150**, 1000
c_soil	surface area index of evaporative soil surfaces (dependent on surface area density of the roughness elements over land , c_lnd)	0-c_lnd(2.0)	0, **1**, 2

cosmo_userguide_5.06.pdf

Also in the namelist group /TUNING/ there are some variables that are chosen differently in the ICON setup. At least compared to the settings that were used at DWD for COSMO-DE or for the former COSMO-EU. Of course the choice of these variables depend on special configurations and domains. The following table lists the variables that are now chosen at DWD for COSMO-D2 ("OLD") and for ICON ("NEW").

/TUNING/	OLD	NEW	Explanation	Default
tkhmin	0.4	0.75	Minimal diffusion coefficients [in m^2/s] for vertical scalar (heat) transport.	1
tkmmin	0.4	0.75	Minimal diffusion coefficients [in m^2/s] for vertical momentum transport.	1
rat_sea	20.0	7.0	Ratio of laminar scaling factors for heat over sea and land.	10.0
pat_len	500.0	750.0	Effective length scale of subscale surface patterns over land [in m].	100.0
tur_len	150.0	500.0	Asymptotic maximal turbulent distance [in m].	500.0
a_hshr	1.0	2.0	Length scale factor for separate horizontal shear production.	1.0
c_soil	1.0	1.75	Surface area density of the (evaporative) soil surface.	1.0

❑ Optimization and Evaluation strategy

Selection of cases, parameters and meteorological fields

↓

Station observations from Greece and Israel
(Daily Tdry max, Tdry min, Tdew max, Tdew min and Precipitation)

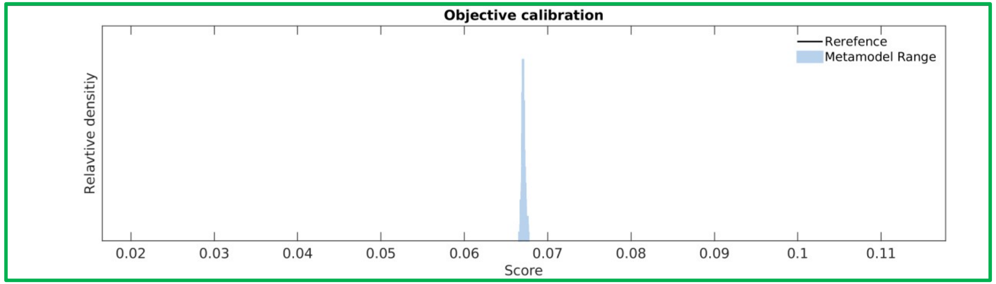
→ COSMO Model runs

↓

Metamodel calibration

↓

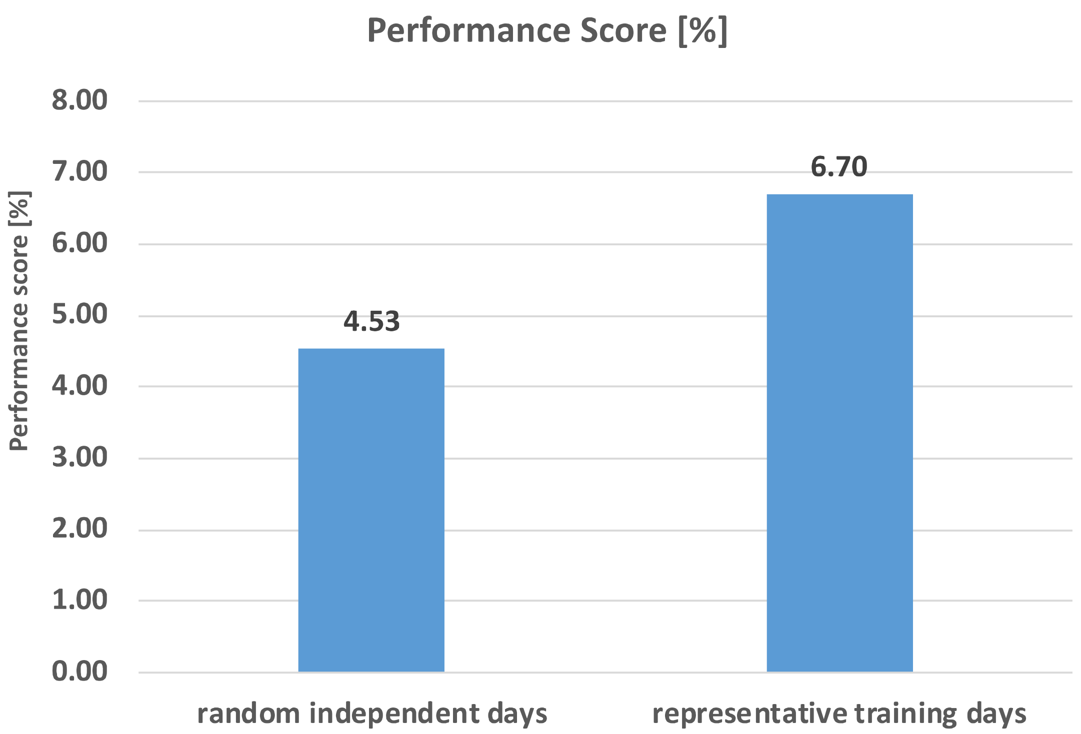
Derivation of optimum parameter values in reference to the default runs



Verification with independent days

- 60 randomly days which were not included in training days
- Year 2019
- 5 days for each month

- The random days' skill is only slightly lower compared to the skill of the days the MM was built on.



Optimal parameter values (iteration number 100)
Performance Score for all 5 surface fields.

4 seasons, 15 representative days for every season in 2019

C_soil	Rat_sea	Tur_len	rlam	tkhmin	parameter
0.7346	1.3873	274.658	1.1796	1.0551	winter (DJF, 15 days)
1.0004	5.3174	688.76	1.0677	1.8574	spring (MAM, 15 days)
0.9184	8.9973	711.41	0.9510	1.8626	summer (JJA, 15 days)
1.3921	10.7768	508.81	0.7681	0.8552	autumn (SON, 15 days)
0.8252	5.2889	524.66	1.0489	1.3564	**all 60 representative days**
1	*10*	*150*	*1*	*0.4*	***Default***
0-2.0	*1-50*	*100-1000*	*0.1-2*	*0.1-2*	*range*

WG1 / WG3b : snow analysis

MCH developments

- Use *snowpolino (snow model) driven by atmospheric analysis*. Validation has shown that the quality of the snow mask so obtained is similar to the current MSG derived snow mask.

DWD developments

- *Cressman-based snow analysis* currently remains operational without new developments (only bugfixes and additional checks for data quality)
- *New variational snow analysis using DACE* is under development
    - Development of a generic tool for variational analysis (3DVAR, EnVAR, 4D-EnVAR)
    - Transfer of pre-processing of observations (eg. fall back to precip. + temperature if snow depth is missing) remains to be done
    - First tests with a complete implementation are planned for Q4/2021, with further testing and tuning in 2022