Karlsruhe Institute of Technology

FONA Decadal Climate Prediction BMBF

MiKlip

Institute for Meteorology and Climate Research (IMK-TRO)
Working Group: Regional Climate and Water Cycle

# Comparison of CCLM climate predictions and projections using TERRA_ML and VEG3D

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## Motivation

The joint project DecReg (within MIKLIP) studies the feasibility and potential added value of regional climate predictions. The assessment is based on hindcast ensembles which are produced by downscaling global decadal predictions with the regional model COSMO-CLM. One focus is to evaluate the role of soil as a slow component of the climate system on the predictability by analyzing simulations with different soil-vegetation transfer schemes (SVATs) in different configurations.

A high resesolution soil moisture and temperature data set for Europe shall be provided to initialize COSMO CLM with a settled soil. An accurate soil moisture is critical in representing surface processes in climate models (Enthekabi and Eagleson, 1989).

## VEG3D

The SVAT was developed 1990 at the KIT(Meißner et al., 2008). It includes a multilayer soil module, a snow layer and an explicit vegetation layer (a “big leaf approach“) where separate energy and water balances are calculated, regulating the sensible and latent heat fluxes as well as radiation fluxes etween the surface and the atmosphere.

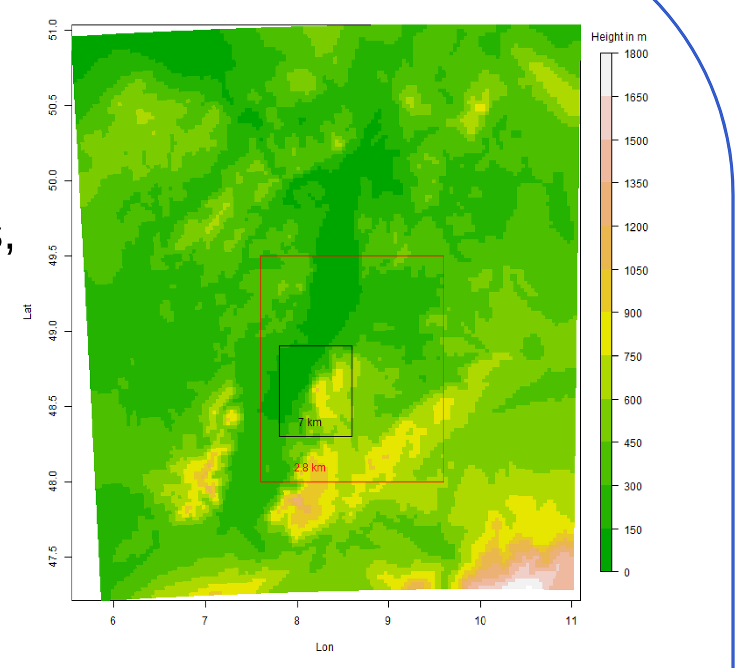
- the number of soil types ,soil layers, layer thickness and land use classes is user defined (including soil horizons)
- Several soil parametrizations (Cosby, van Genuchten) are available

VEG3D was updated repeatedly, the last modification were the implementation of melting and freezing processes (C. Meißner, 2008).

- Newest VEG3D Stand alone
  - effects of terrain slope included
  - NETCDF support
  - Cycle option
- Parallelization (by M. Breil): The parallelized Version is able to reproduce exactly the simulation results of the non-parallelized one.
- Coupling with OASIS - 3MCT (by M. Breil): Tested in the DEPARTURE project
- Sensitivity studies were performed concerning LAI, macroporosity, radiation on slopes, time steps, start years of the forcing and location/size of the simulated area
- Stand alone simulations with high resolution evaluated with interest in soil water content W_SO and soil temperature T_SO:
  - 0.0625°, with CCLM – ECHAM6 simulations as input
  - 0.025°, driven by CCLM – ERA40

## Results of sensitivity studies and evaluation runs

Rhinevalley (Baden Württemberg)
Model domain for 2.8km:
5.55°E – 11°E
47.2°N – 51°N → 140 x 150 grid points,
test site marked in red 55 x 60 grid points




Second test site for performance tests, domain for 7km:
7.8°E – 8.6°E
48.3°N – 48.9°N → 15 x 16 grid points

Both: 10 Soil layer from 0.005 m till 15.34 m

Shown on the right is the result of the performance test concerning the time step. No significant difference between the time steps of 60s, 120s and 240s was found. Even the largest difference remained < 3 % for all variables of interest.

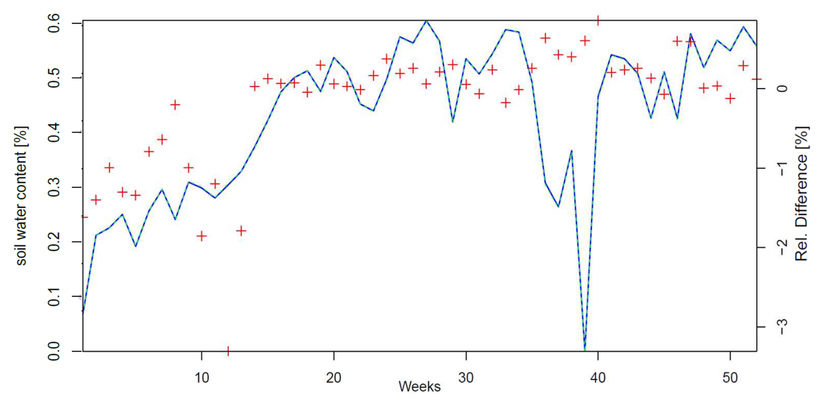



Fig 1.:Weekly field averaged W_SO and the relative difference 240-120s

The cycle option was tested for both areas, including 5 year and 10 year cycles. The results expressed a clear time ↔ soil depth dependency.
In depths > 0.5 m, the spin up for the soil component need to be at least 3 – 5 years.

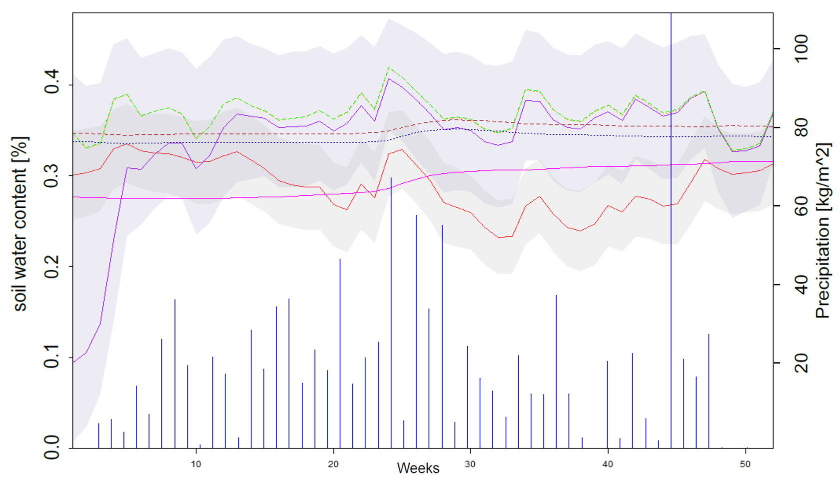



Fig.2: Weekly field avg. W_SO for k = 0.34m (VEG3D: purple, orange, green, TERRA_ML: red) and k = 1.41m (VEG3D: magenta,blue,brown) for the odd years of a 5 year cycle run

## Results from the 2.8 km Stand alone run, year 1971, spin up 5 years

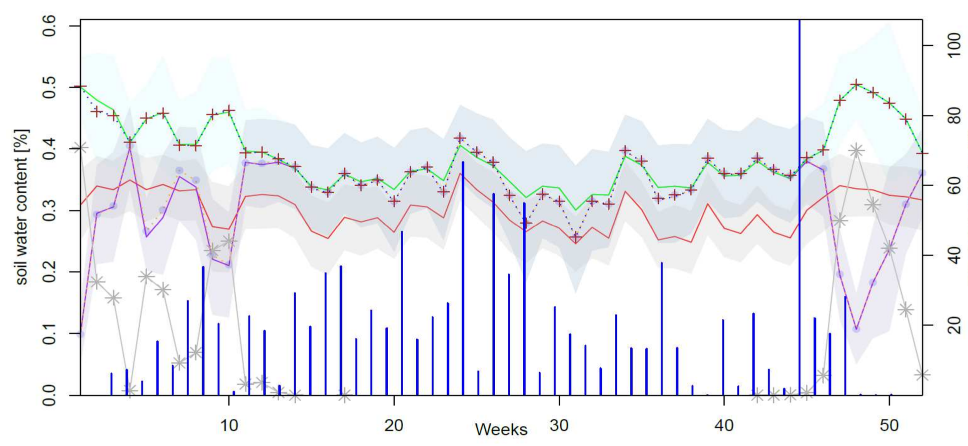



Fig.3: 1971 Weekly field averaged W_SO for the first soil layer (VEG3D purple, orange), TERRA_ML red) and W_SO + EISG (VEG3D, green, blue) of the odd years of a 5 year cycle run and VEG3D EISG in grey

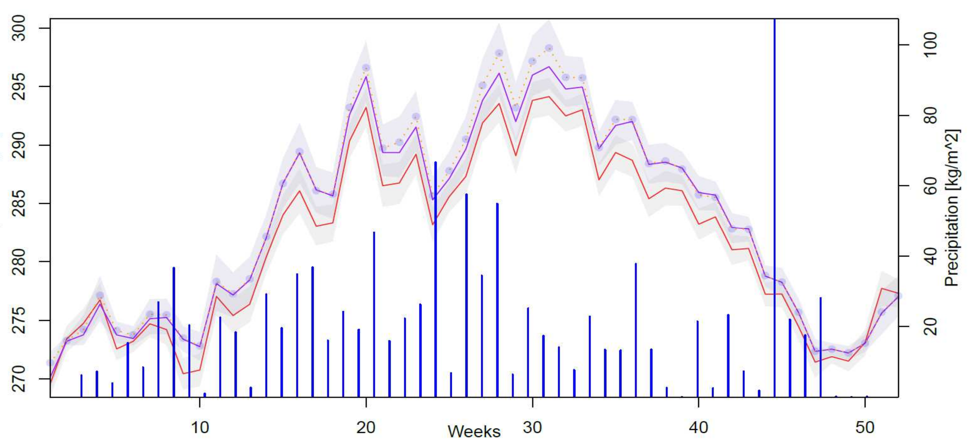



Fig.4: 1971 Weekly field averaged T_SO for the first soil layer (VEG3D purple, orange), same as Fig. 3

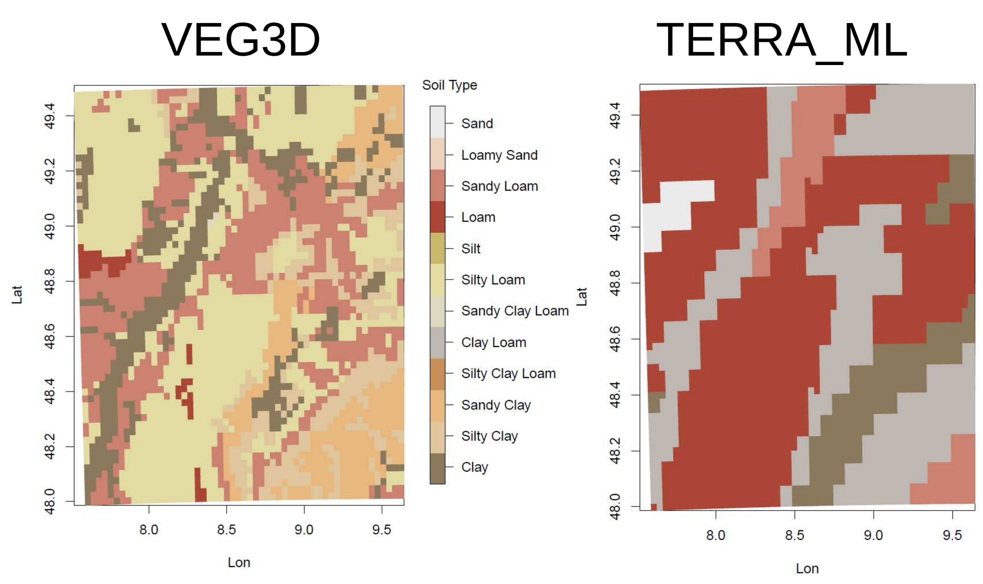



Fig. 5 + 6: The field plots show the soil types occurring in the second test site for VEG3D and TERRA_ML (translated into VEG3D types)

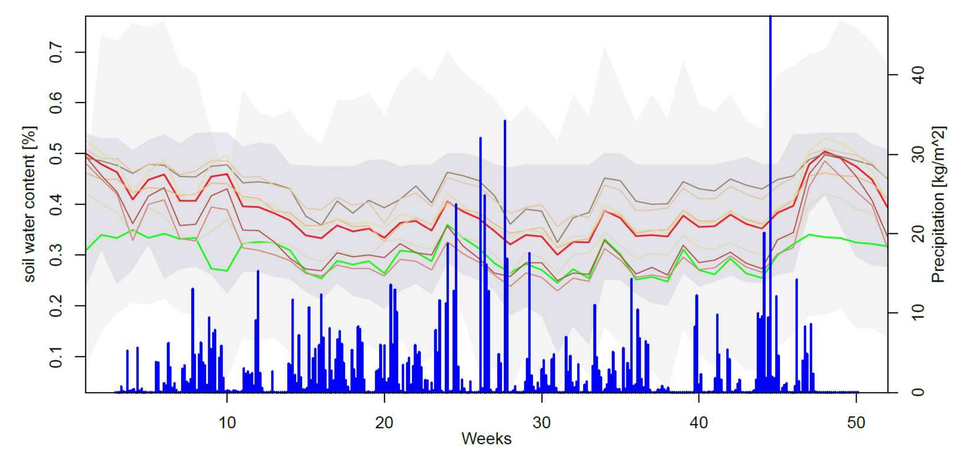



Fig. 7: Weekly field avg. W_SO+EISG for VEG3D separated for the occurring soil types and TERRA_ML (green)

- VEG3D performs well for the soil temperature in comparison with TERRA_ML, reducing the cold bias known from CCLM over Europe.
- Land use classes and soil types play an important role in the behaviour of the model.
- It turns out, that VEG3D is highly sensitive towards the freezing option as can be seen in the soil water content.
  - The soil water content is higher than in TERRA_ML, especially when freezing occurs.

## Outlook

Decadal runs are planned with VEG3D coupled to COSMO-CLM with OASIS-3MCT over Europe with a resolution of 7 and 2.8 km for the period of 1971-2010 as well as similar runs with VEG3D stand alone (currently in process).

**Literature:**

**Entekhabi, D.** a. Eagleson, P.S., 1989: Land surface hydrology parameterization for atmospheric General Circulation models including sub grid scale spatial variability. – J. Climate **2**, 816 – 831

**Meißner, C. ,** Schädler, G., Panitz, H.-J., Feldmann H. and Kottmeier, C., 2009: High-resolution sensitivity studies with the regional climate model COSMO-CLM. – Meteorol. Z., **18**, 543–557