IMPETUS Westafrikaprojekt

IMPETUS Benin

Impact of land use change on local precipitation for 2025

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Conclusions

- integration of land use change information for the year 2025 into the meteorological models
- the fully dynamical downscaling of two mesoscale convective systems for the scenario year 2025 is shown
- case study reveals a potential risk of high local rainfall variability for the regarded scenario runs

land use change

Lokal-Modell (LM)

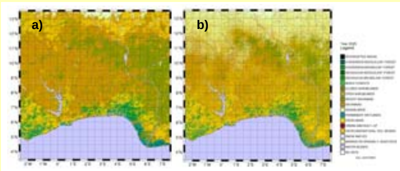


Fig. 1: Approximation of land use for LM modelling. The years 2000 a) and 2025 b) are regarded. The classification of land use is based on the "International Geosphere-Biosphere Program 2". Only characterising parameters for vegetation are used within the LM realisation (e. g. LAI, albedo, etc.). Information, e. g. on roads etc., are not considered.

The projection for the year 2025 (Fig. 1b) is based on the assumption of an increase of population of about 100 % starting with the year 2000 (Fig. 1a). Furthermore, a 30 % reduction of the 2000 forested areas is assumed.

processing of land use data

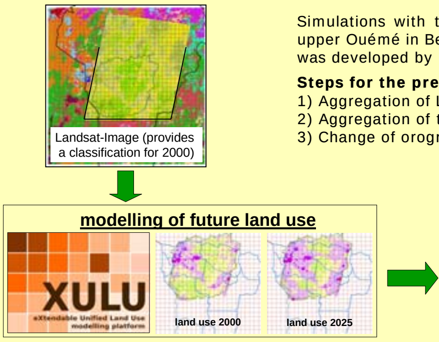


Fig. 2: Preparation of future land use scenarios on basis of Landsat satellite data, and according to the Xulu model platform.

FOOT3DK

Simulations with the mesoscale model FOOT3DK are conducted for the catchment of the upper Ouémé in Benin. Therefore a land register for the years 2002 and 2025 is used, which was developed by means of the cooperation of several (cf. Fig.3) IMPETUS working groups.

Steps for the preparation of the FOOT3DK land register (Landsat and Xulu):

1) Aggregation of Landsat/Xulu information on a 1 km grid (orig. resolution 30 m)
2) Aggregation of the 1 km grid data to 3 km resolution (GIS interpolation)
3) Change of orography on basis of the SRTM30 data

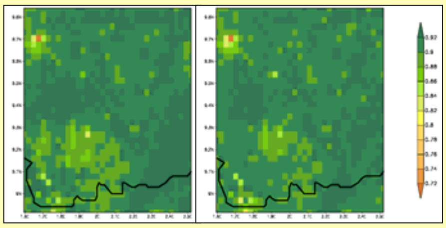
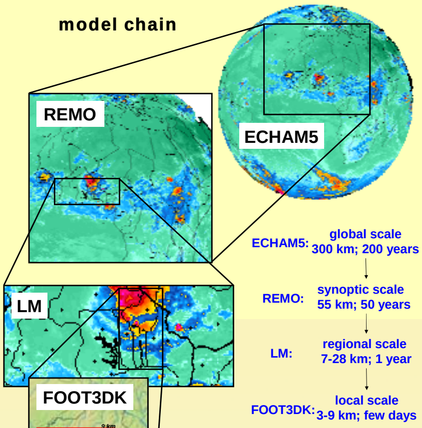
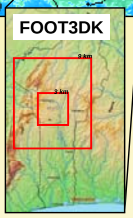


Fig. 3: FOOT3DK vegetation cover of the year 2002 (left) and the projection for 2025 (right), according to the land use scenario results on basis of the Xulu model platform. Units are percent.

dynamical downscaling

model chain





IPCC scenarios are calculated with the entire IMPETUS model chain. Due to the limited computer capacity it is not possible to compute several rainy seasons fully dynamically on the regional, and, in particular, on the local scale. Therefore episode simulations are utilised within a statistical-dynamical approach.

Fig. 4: IMPETUS model chain: The results of the high resolution models LM and FOOT3DK are presented on this poster.

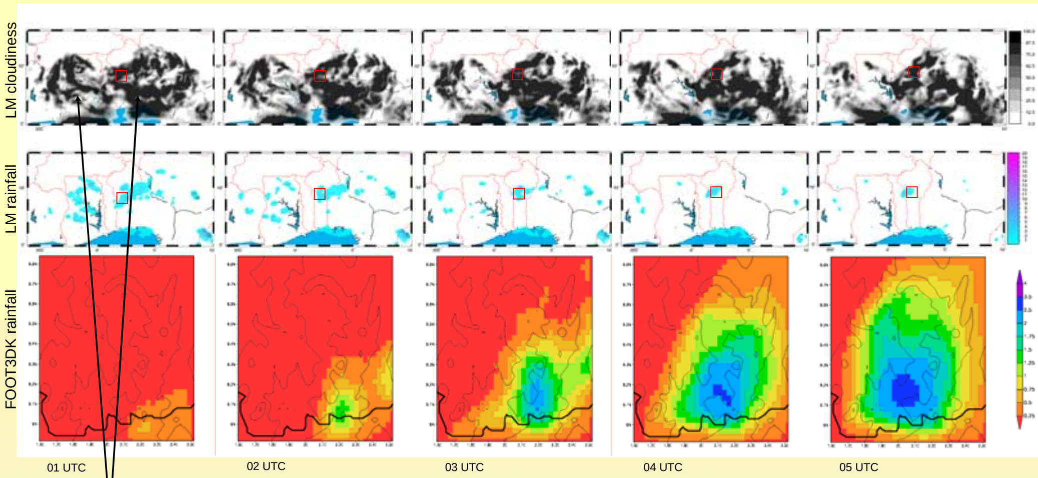


Fig. 5: Development of a precipitation system on the regional to local scale. As an example the situation of the second of April 2025 is shown. Units for cloudiness are 1/8 and for precipitation mm/h.

In the upper panel the sequence of typical MCS (OCS resp.) cloud structures are depicted as simulated by the LM. The time step is one hour. The structures are linked with two westward propagating clusters. The associated rainfall systems are shown in the middle panel. In the lower panel the hourly simulated precipitation of FOOT3DK is presented. The red box in the two upper rows indicates the margin of the HVO simulation domain. It is well indicated that the precipitation system of the given case study, which is simulated with the LM, passes earlier than in the rainfall area in the FOOT3DK calculations. This process is accompanied by a local shift of the rainfall maximum, which is partly caused by the slightly different FOOT3DK convection scheme.

results

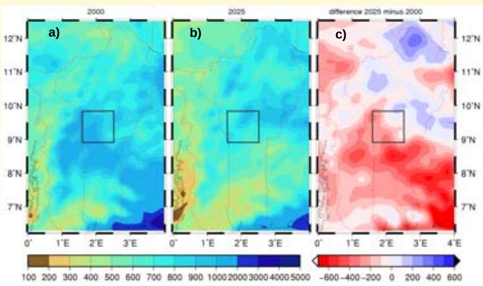
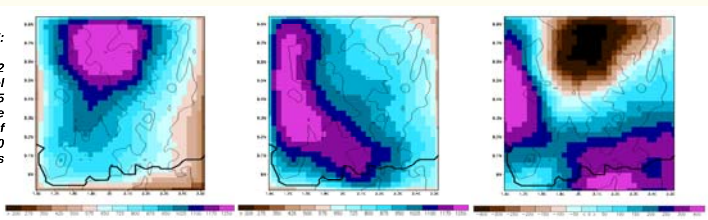


Fig. 6: Yearly LM precipitation for the area around Benin in mm for the years 2000 a), 2025 b), and the difference between 2025 and 2000 c). The black box indicates the FOOT3DK simulation domain (cf. Fig.7).

A comparison of LM precipitation amounts of the rainy seasons 2000 and 2025 (Fig.6) reveals a high rainfall variability in the margins of the investigated area, while the basic structure of the rainfall distribution is prevailed. In particular in the North and Northwest of the regarded domain an increase of precipitation is visible, whereas in the South and Southeast a decrease is indicated. Further simulations of future rainy seasons forced with other driving scenarios are planned.

On basis of the identification of precipitation systems for the year 2025 and with the assumption of a prevailing frequency distribution of the observed rainfall systems associated with MCS, OCS resp. instability thunderstorms the 40 episodes of the rainy season 2025 are recombined as a "first guess" precipitation climatology (Fig. 7 - centre). Therefore the scenario B2 of the IPCC was used to force the entire model chain (cf. Fig. 4). The result shows a shift of rainfall to the western margin of the simulation domain (Atakora-Mountains), whereas particularly the North experiences a remarkable reduction. The currently used subjective classification of rainfall episodes for the year 2025 in FOOT3DK was replaced by an objective scheme, which is based on an objective assignment by means of REMO data. The results can be obtained in the computer presentation of the Problem Complex PK Be.L3.

Fig. 7: Precipitation sum of 2002 (left), model year 2025 (centre) and the difference of 2025 and 2000 (right). Units are mm.



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