Sensitivity of the regional climate model ALARO-0 to land surface changes: a conceptual framework

Julie Berckmans[1,2] (julie.berckmans@meteo.be), Alexandra-Jane Henrot[3], Ingrid Jacquemin[3], Rafiq Hamdi[1]

[1]Royal Meteorological Institute, Research Department, Brussels, Belgium, [2]Centre of Excellence PLECO (Plant and Vegetation Ecology), University of Antwerp, Belgium, [3]Unit for Modelling of Climate and Biogeochemical Cycles, University of Liège, Belgium

Motivation

Current status on coupled models

- No full coupling of the climate, land surface and socio-economic system
- Low resolution models

What we will deliver

- A full coupling of the climate, land surface and socio-economic system
- High resolution models

Approach

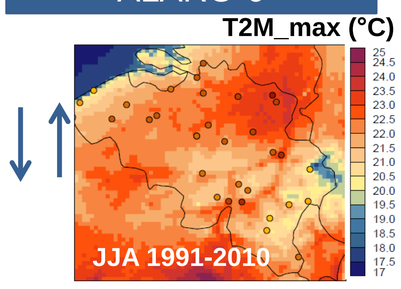
- **3 models**: regional climate model, dynamic vegetation model, agent-based land use model
- Country-scale assessment tool for **Belgium**
- Coupling done at **4 km** horizontal resolution, but case studies will be performed at **1 km** horizontal resolution
- Future period of **2015-2035**

Initial setup of the models

Global reanalysis ERA-Interim

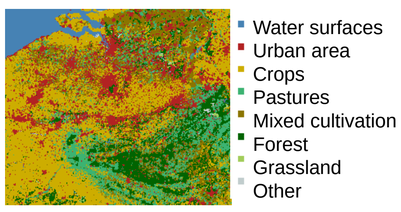
↓ Dynamical downscaling

Atmospheric model ALARO-0

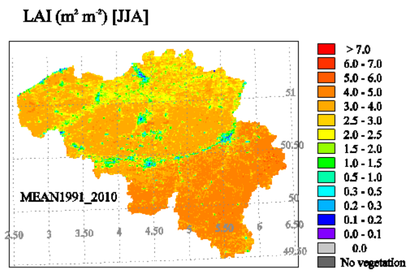


Land surface model SURFEX

Static land use: ECOCLIMAP II



The regional climate model ALARO-0 [1] is forced with lateral boundary conditions from ERA-Interim and coupled to the land surface model SURFEX [2]. The land covers in SURFEX are described by the ECOCLIMAP-II database [3].



Dynamic vegetation model CARAIB

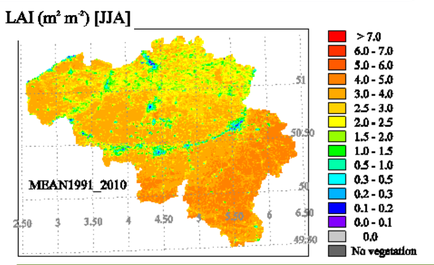
CRU Global Climate Dataset

The dynamic vegetation model CARAIB [4] is forced monthly with climate data from the CRU [5] database (at 0.5° resolution) combined with WorldClim [6] data (at 30''~1 km).

- Belgium is highly urbanised.
- The T2M_max shows the orographic cooling in the southeastern part. This region is covered by large forests, which is also indicated by the LAI.
- A region in the northeast (de Kempen) has higher maximum temperatures, due to the presence of sandy soils. Also, this region shows lower LAI.

Coupling to dynamic vegetation model

Atmospheric model ALARO-0 ⇅ Land surface model SURFEX ⇄ Dynamic vegetation model CARAIB



The atmospheric parameters, wind speed, relative humidity, temperature, precipitation and incoming downward solar radiation, are exchanged at the lowest model level at 4 km horizontal resolution. The vegetation parameters, leaf area index, albedo, emissivity and roughness length are exchanged at 1 km horizontal resolution.

- Lower LAI when using ALARO-SURFEX vs CRU
- Possible relation with higher temperature in ALARO-SURFEX vs CRU

Coupling to dynamic vegetation model + agent-based model

Atmospheric model ALARO-0 ⇅ Land surface model SURFEX ⇄ Dynamic vegetation model CARAIB ⇅ Agent-based land use model

The dynamic vegetation model is coupled to the agent-based land use model and together, they provide the **land surface dynamics**. The agent-based model consists of land dynamics, agent dynamics and crop dynamics.

Full coupling in a future climate

ARPEGE CM5 RCP2.6, RCP4.5, RCP8.5

↓

Atmospheric model ALARO-0 ⇅ Land surface model SURFEX ⇄ Dynamic vegetation model CARAIB ⇅ Agent-based land use model

Discussion and future outlook

- Most likely **scenarios** will be chosen for Belgium:
  - Urban land type increases, at the expense of agriculture & forest if:
    - high urban pressure
    - allowed by spatial plans
  - Forest is a relatively stable land type
- Case studies selected in collaboration with follow-up committee members within project
- **Assessment** of the impact of the land use changes on the climate at a local scale, by performing 1 km SURFEX simulations in offline mode (no feedback to atmosphere)
- **Recommendations** to policy makers in relation to climate change mitigation

References

[1] De Troch, R. et al.: Multiscale performance of the ALARO-0 Model for simulating extreme summer precipitation climatology in Belgium, J. Climate, 26, 8895–8915, 2013
[2] Hamdi, R. et al.: Evaluating the performance of SURFEXv5 as a new land surface scheme for the ALADINcy36 and ALARO-0 models, Geosc. Mod. Dev. 7, 23–39, 2014
[3] Faroux, S. et al.: ECOCLIMAP-II/Europe: a twofold database of ecosystems and surface parameters at 1 km resolution based on satellite information for use in land surface, meteorological and climate models, Geosc. Mod. Dev., 6, 563–582, 2013
[4] Warnant, P. et al.: CARAIB: a global model of terrestrial biological productivity, Global Biogeochemical cycles, 8, 3, 255-270, 1994
[5] Harris, I. et al.: Updated high-resolution grids of monthly climatic observations – the CRU TS3.10 Dataset, Int. J. Clim., 34, 3, 623-642, 2014
[6] Hijmans R.J., et al.: Very high resolution interpolated climate surfaces for global land areas, Int. J. Clim., 25, 1965-1978, 2005

Funded by belspo

In collaboration with Université de Liège, Universiteit Antwerpen, Universiteit Gent, Météo France, Université de Namur