Spatial aggregation for crop modelling at regional scales: the effects of soil variability

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More info on the soil-plant-atmosphere model www.coupmodel.com

We studied the effect of aggregating soil mapping units by area majority (resolutions from 1km to 100 km) for regional crop model simulations

Results.

I. Key soils coverage

II. DAE as explained by key soils distribution

Table 1: extreme values of model outputs data

<table>
<thead>
<tr>
<th></th>
<th>Topsoil 30-60 cm</th>
<th>Root Zone 0-120 cm</th>
<th>Subsoil 160-600 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (t ha⁻¹)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Water drainage</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>C mineralization</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>-25%</td>
<td>-25%</td>
<td>-25%</td>
</tr>
<tr>
<td>SOC (%)</td>
<td>8% SOC</td>
<td>33% SOC</td>
<td>33% SOC</td>
</tr>
</tbody>
</table>

Reference [1] Ten clusters defined by k-means clustering analysis grouped soil mapping units with similar properties (texture, thickness and organic C content of three soil horizons)

Method I

A case study with the CoupModel

- North-Rhine Westphalia Region (NRW) ~34000 km²
- 2648 soil mapping units at resolution 1 km
- 30 years climate data time-series, regional average
- Monoculture of winter wheat, rain fed and fertilized (208 kg N ha⁻¹yr⁻¹)

Simulated variables: yield, water drainage, C mineralization and N-leaching

Method II

Sensitivity analysis & key soils

1. Ten clusters defined by k-means clustering analysis grouped soil mapping units with similar properties (texture, thickness and organic C content of three soil horizons)

2. Three clusters were identified that were associated with extreme values of model outputs, hereafter denoted as key soils (Fig. 1)

3. Spatial coverage of soil clusters (Fig. 2 & 3)

Method III

Data Aggregation Error (DAE)

The simulated variables at the four coarser resolutions (10, 25, 50 and 100 km) were compared with those of the finest resolution (1 km, Δ).

DAE was quantified in terms of rRMSE (%)

Figure 5: The DAE was approximated using the relative spatial coverage of key soils and the mean relative difference in simulated variables shown in Table 1 (Fig. 1)

A-B) Gridded error depends on A1, A2 or A3 in As

C-D) Regional error (DAE) additionally depends on N0 and N6

Conclusion & perspectives

- The spatial distribution of key soils explained a large part of the DAE observed for the different variables, resolutions and sub-areas of NRW (Fig. 4)

- A spatial analysis of the pattern of these key soils (i.e. presence / absence, coverage and aggregation) can help in defining the appropriate grid-resolution that would minimize the error caused by aggregated soil input data in regional model simulations

- The method will be applied and evaluated with respect to another European region (Tuscany) which is characterized by a warmer and drier climate

References: