Impact of forests on climate change

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1. Motivation and scientific questions

Projected climate change 2071-2100 vs. 1971-2000

yearly precipitation sum

yearly temperature mean

(IPCC AR5, Jacob et al. 2013)
1. Motivation and scientific questions

Can forest cover increase influence the projected climate change signal?

A) Enhance or mitigate?  
B) In which magnitude?

- Climate change
  - due to emission change
  - due to forest cover increase
  - due to emission change forest cover increase

only biogeophysical aspects!

EC-FP7 project CC-TAME (Climate Change – Terrestrial Adaptation and Mitigation in Europe)
### 2.1 Experiment set-up

Regional climate model REMO  
(*Jacob et al. 2007*)

Horizontal resolution: 0.22°

Analyzed months: June-July-August

#### Simulation domain

<table>
<thead>
<tr>
<th>1961-1990</th>
<th>2071-2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control simulation without land cover change</td>
<td>Emission scenario simulations - greenhouse gas forcings A1B, A2 -</td>
</tr>
</tbody>
</table>

- without land cover change  
- with potential afforestation

**Climate change due to emission**

**Climate change due to forest cover increase**

Climate change due to emission and forest cover change
2.2 Changes of the land surface characteristics due to maximal afforestation for summer

<table>
<thead>
<tr>
<th>Reference forest cover</th>
<th>Maximal afforestation</th>
<th>Forest cover change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 %</td>
<td>0 - 10</td>
<td>0 %</td>
</tr>
<tr>
<td>10 - 20</td>
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<td>90 - 100</td>
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</tbody>
</table>
Parameterisation of vegetation in the applied climate model

- AVHRR data (1 km)
- Olson classification
- Global distribution of ecosystem types
- Satellite data
- Land surface parameters for each type
- Aggregation to the model grid cell

Fractions in a gridbox:
- 0%
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%

Categories:
- Sea ice
- Water
- Land
### 2.3 Changes of the land surface characteristics due to maximal afforestation for summer

<table>
<thead>
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<th>Reference forest cover</th>
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</tr>
</thead>
</table>

- **Roughness length**: increase
- **Leaf area index**: increase
- **Albedo**: decrease
3.1 Climate changes due to maximal afforestation

Simulation results for 2071-2100

- with- vs. without forest cover change
- summer

(Gálos et al. 2012)
3.2 Changes of the summer precipitation

![Graph showing changes in precipitation percentages for different regions in Hungary, SWH, SEH, and NEH.](Gálos et al. 2011)
The potential afforestation map is based on the

- net primary production map (derived from MODIS products),
- precipitation and temperature conditions (Wordclim database)
- soil conditions (International Institute for Applied Systems Analysis; Kindermann 2011)
4.1 Effect of afforestation on the summer temperature and precipitation conditions in Europe

Effect of GHG concentration change 2071-2090 vs. 1971-1990

Effect of afforestation 2071-2090

(Gálos et al. 2013)
4.2 Change of summer temperature mean due to GHG concentration change 2071-2090 vs. 1971-1990

due to potential afforestation 2071-2090

due to GHG emission + potential afforestation 2071-2090 vs. 1971-1990

(Gálos et al. 2012)
4.3 Change of summer precipitation sum

due to GHG concentration change 2071-2090 vs. 1961-1990

due to potential afforestation 2071-2090

due to GHG emission + potential afforestation 2071-2090 vs. 1961-1990

(Gálos et al. 2012)
5. Conclusions, application of the results

- Afforestation in small forest fragments: slight effects; large continuous forest blocks: regional-scale effects

- **Possible climate change mitigating potential:**
  - cooler and moister conditions in summer
  - reduce the projected tendency of drying, the drought frequency
  - **Both** biogeophysical + biogeochemical feedbacks have to be considered! & **appropriate land surface description**

**Practical application**

- Assessment of the climatic role of forests
- Identification of areas, where forest cover increase is the most favourable (from climatic point of view)
- With appropriate land use strategy the mitigation costs can be reduced
Thank You for your attention!