Uncertainty in simulating biomass yield and carbon-water fluxes from Euro-Mediterranean grasslands under climate changes

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Uncertainty in simulating biomass yield and carbon-water fluxes from Euro-Mediterranean grasslands under climate changes

Renáta Sándor, S Ma, M Acutis, Z Barcza, H Ben Touhami, L Doro, D Hidy, M Köchy, J Minet, E Lellei-Kovács, A Perego, S Rolinski, F Ruget, G Seddaiu, L Wu, G Bellocchi
Grassland model inter-comparison in MACSUR

- Questionnaires to modelling teams
- Guidelines and minimum dataset requirement for model evaluation
- Common protocol for model inter-comparison
- Model inter-comparison at selected sites in Europe (plot-scale simulations)

Aims:

- To quantify uncertainties on yield and carbon-flux outputs
- To explore the sensitivity of grassland models to climate change factors

Coordinator

- Data segregation
- Output evaluation
- Uncertainty analysis
Systemic approach

- Inputs
- Parameters
- Input variables
- Initial values
- Outputs

PaSim
SPACSYS
AnnuGrow
STICS
EPIC
ARMOSA
Biome-BGC
MuSo
LPJmL
CARAIB

Grassland-specific
Crop models (adapted to grasslands)
Biome models

(HAB, GPP, NEE ...)

Investigated sites

- **Flux-tower observational sites**
  (GPP, NEE, RECO, ET, ST, SWC, HAB)
  Data: hourly resolution

- **Grassland experimental sites**
  (HAB)
  Data: cutting events

**Management:**
- Kemp-1: intensive (4 cuts/year)
- Kemp-2: extensive (2 cuts/year)
- Roth-1: NH4 – fertilization
- Roth-2: NO3 – fertilization
- Lq-1: intensive (N fertilized)
- Lq-2: extensive (non fertilized)
UNCALIBRATED vs CALIBRATED runs
(HAB, g DM m$^{-2}$)

Uncalibrated vs Calibrated runs (HAB, g DM m$^{-2}$)

Uncertainty of the simulated yield from all models at Sassari site

- envelope of simulated HAB
- observed data
- median of all models
Actual Evapotranspiration with monthly resolution at Grillenburg (Germany)
SENSITIVITY TEST
(Yearly Gross Primary Production vs CO₂)

Baseline: 380 ppm

<table>
<thead>
<tr>
<th>CO₂ Change</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>+100% CO₂ (760 ppm)</td>
<td>+25%</td>
</tr>
<tr>
<td>+50% CO₂ (570 ppm)</td>
<td>+17%</td>
</tr>
<tr>
<td>+25% CO₂ (475 ppm)</td>
<td>+11%</td>
</tr>
<tr>
<td>+15% CO₂ (437 ppm)</td>
<td>+8%</td>
</tr>
<tr>
<td>+10% CO₂ (418 ppm)</td>
<td>+6%</td>
</tr>
<tr>
<td>+5% CO₂ (399 ppm)</td>
<td>+4%</td>
</tr>
</tbody>
</table>

y = 1732.9e^{0.0354x}
R² = 0.921
SENSITIVITY TEST
(Yearly Gross Primary Production vs Temperature and Precipitation)

Change of GPP at Oensingen, Mean

Temperature

-25% T → -7%
-10% T → -3%
-5% T → +0.2%
+5% T → +3%
+10% T → +4.5%
+25% T → +6%

Precipitation

-25% P → -1.4%
-10% P → +0.5%
-5% P → +1.5%
+5% P → +2.5%
+10% P → +3%
+25% P → +3.3%
SENSITIVITY TEST
(Yearly Gross Primary Production vs Temperature and Precipitation)
Conclusions

◆ Overall, model calibration improves accuracy and reduces uncertainty in biomass and carbon-water cycle estimations

◆ Alternative models show different sensitivity to climate change factors

◆ Estimated Gross Primary Productivity is roughly exponentially increasing with the atmospheric CO$_2$ level (by up to ~25% when doubling [CO$_2$])

◆ The effect of temperature on the GPP changes is higher than the effect of precipitation
Action plan and perspectives

MACSUR
◆ To analyze the envelope of model outputs of sensitivity tests on the yield biomass production

◆ To estimate the interactions between different scenarios and model simulations related with the sensitivity of the applied model

Perspectives
◆ To expand the collaboration with new sites, models on different treatments and/or grazing animals

Thank you for your attention!