Modeling local response of vegetation from regional climate scenarios

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Structure

• Question
• Results
• Method
• Detailed Result
• Discussion - Conclusions
Question!

• If we know how a species physiology/growth depend on:
  – Temperature (air temperature, T(t))
  – Humidity (air relative humidity, RH(t))
  – Light (irradiance, I(t))

Can we predict the response to climate change?
Lichen: Platismatia GlaucanäverlavVaried Rag Lichen

Widely spread in conifer forest

Epiphytic

Fungus + Green algal

Green algal direct response to humidity

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Humidity</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td>Humid or Dry Light or Dark</td>
<td></td>
</tr>
<tr>
<td>Varm</td>
<td>Humid Light</td>
<td></td>
</tr>
<tr>
<td>Varm</td>
<td>Humid Dark</td>
<td></td>
</tr>
<tr>
<td>Varm</td>
<td>Dry Dark or Light</td>
<td></td>
</tr>
</tbody>
</table>

Energy

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>+</th>
<th>-</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>photosynthesis</td>
<td>respiration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Vegetationszoner i Fennoskandien
(efter Moen 1996)
Study:
Two yearly growth patterns of lichens:

- 2070-2100 scenario SRES A2
- 2070-2100 scenario SRES B2
  relatively
- 1971-2000 reference climate
- local timeseries 1993/94

Results:

- Interior lichens:
  - reduced to unchanged yearly growth

- Exposed lichens:
  - increased growth
More details

• Functions:
  – Net Photosynthesis: $NP(I(t), T(t), RH(t))$
  – Respiration: $R(I(t), T(t), RH(t))$
  – Water content $WC(T(t), RH(t))$

• Parameterized by data on $I(t), T(t), RH(t)$ and $NP, R, WC$
  – Laboratory $CO_2$ exchange data
  – Field micro-climate data 1993/94
  – Growth of lichens
More details

- Functions: photosynthesis and respiration
- Regional climate change:
  - Transforming the time series of Micro–climates

\[ Measured\ Interior\ 93/94: I(t) \ T(t) \ RH(t) \]
\[ \rightarrow SRES\ A2,\ 2070-2100 \]
\[ \rightarrow I(t) \ T(t) \ RH(t) \]
\[ \rightarrow SRES\ B2,\ 2070-2100 \]
\[ \rightarrow I(t) \ T(t) \ RH(t) \]

\[ Measured\ Exposed\ 93/94: I(t) \ T(t) \ RH(t) \]
\[ \rightarrow SRES\ A2,\ 2070-2100 \]
\[ \rightarrow I(t) \ T(t) \ RH(t) \]
\[ \rightarrow SRES\ B2,\ 2070-2100 \]
\[ \rightarrow I(t) \ T(t) \ RH(t) \]

Six yearly growth pattern from different micro climates
More details

- Functions: photosynthesis and respiration
- Regional climate change to 6 Micro – climates:
  - Combining micro- regional- climate data
More details

• Functions: photosynthesis and respiration

• Regional climate change to 6 Micro – climates:
  – Combining micro- regional- climate data

Regional data (Västerbotten):
  Monthly mean and variances:
  \( I(t), RH(t), T(t) \)
  1971-2000 reference
  2070-2100 SRES A2
  2070-2010 SRES B2

Difference in mean and variance between Reference and SRES
Applied to measured timeseries

Preserving local pattern

Changing mean and variances
absolute change temperature
relative change humidity and light
More details

- Functions: photosynthesis and respiration
- Regional climate change to 6 Micro – climates:

![Graphs showing cumulative growth over months for Interior and Exposed regions with temperature, humidity, and light June exposed data.](image)
Conclusions:
Vegetation – climate change – tilted earth axis

Expect a larger local than regional redistribution of species.
Lichens and vascular plants and...