

Modeling local response of vegetation from regional climate scenarios

Uno Wennergren Linköping University

Anna Cabraijic Umeå University

Kristina Palmqvist Umeå University

Part of PhD Thesis of Anna C, June 2009

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?

Temperature
Humidity
Light



Lichen:
Platismatia Glauca
Näverlav
Varied Rag Lichen

Widely spread in
conifer forest

Epiphytic

Fungus + Green algal

Green algal direct respons
to humidity

Cold
Humid or Dry
Light or Dark

Varm
Humid
Light

Varm
Humid
Dark

Varm
Dry
Dark or Light

Energy

0

+

photosynthesis

-

respiration

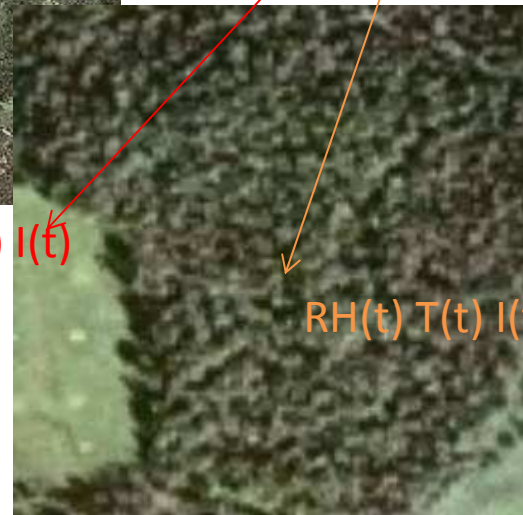
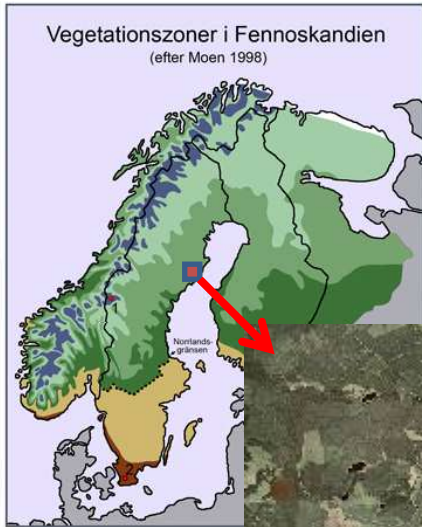
0



•1. Alpin tundra, mitten av juni (Helags-Sylarna)



•2. Nemoral skog, slutet av maj (Dalby Söderskog)



RH(t) T(t) I(t)

RH(t) T(t) I(t)

Study:

Two yearly growth patterns of lichens:

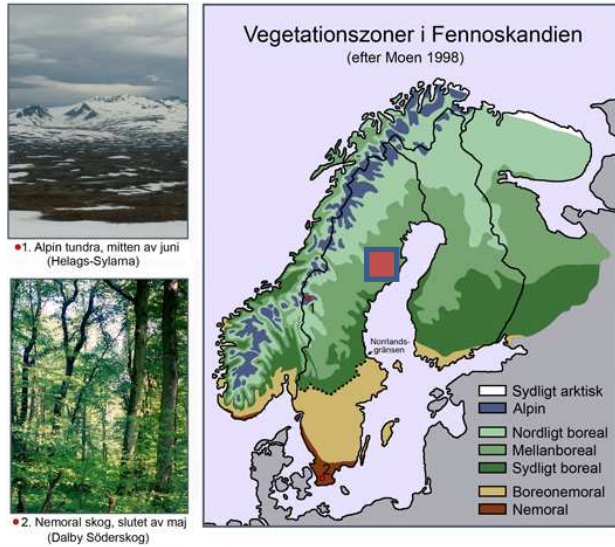
2070-2100 scenario SRES A2

2070-2100 scenario SRES B2

relatively

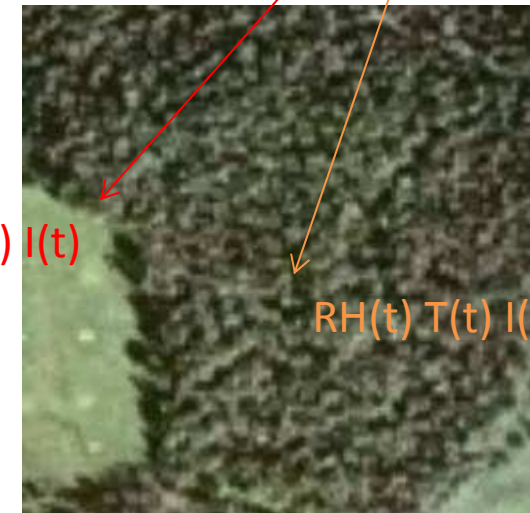
1971-2000 reference climate

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

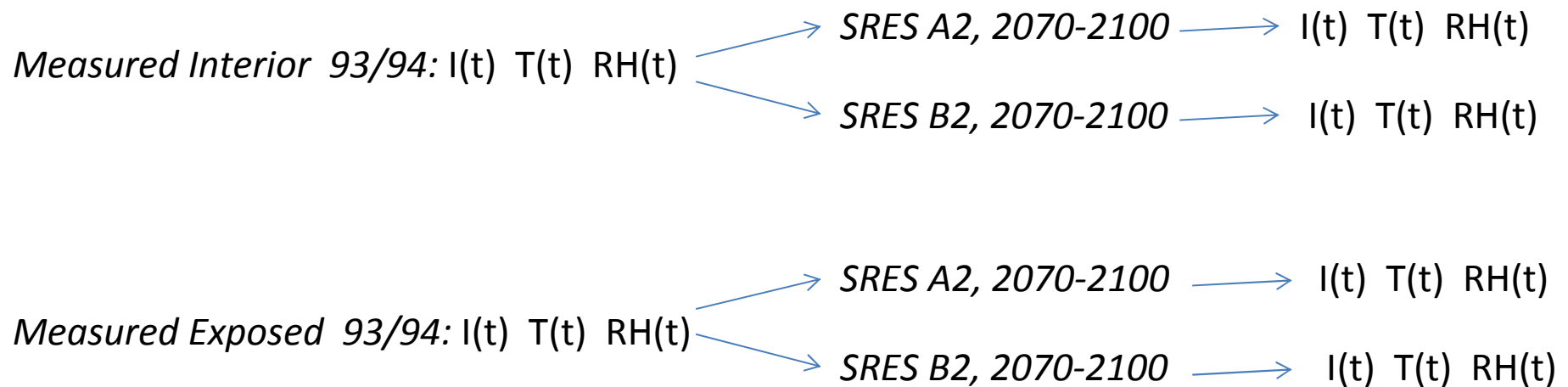
- Laboratory CO_2 exchange data

- 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

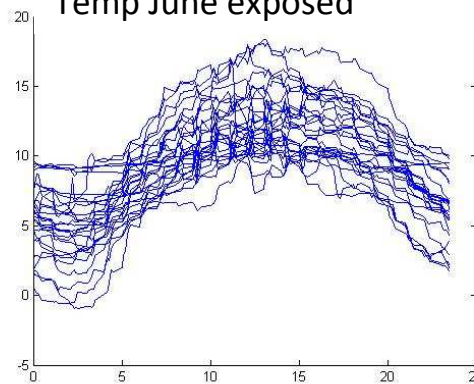


Six yearly growth pattern from different micro climates

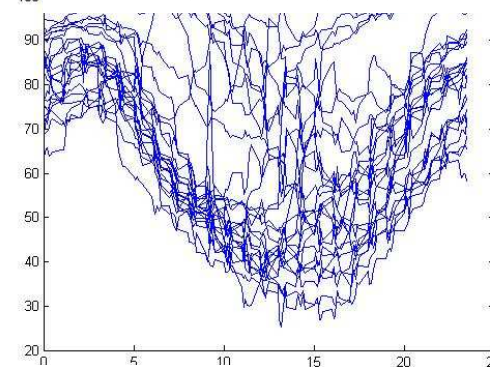
More details

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

Temp June exposed

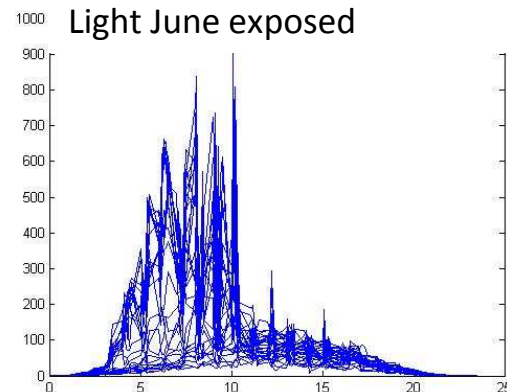


Humidity June exposed

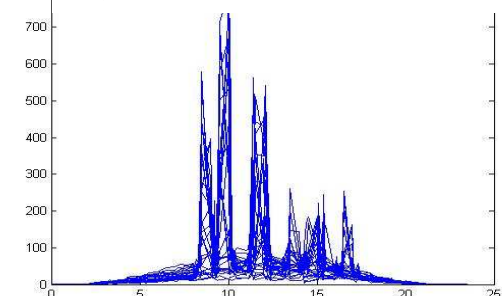


Measured
Micro-climate 24h

Light June exposed



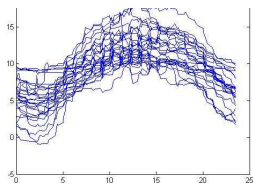
Light June interior



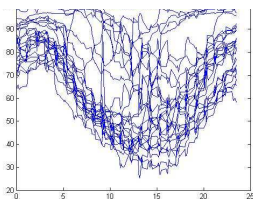
More details

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

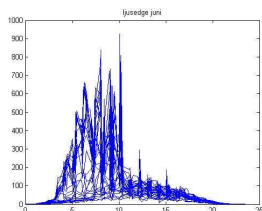
Temp June exposed



Humidity June exposed



Light June exposed



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

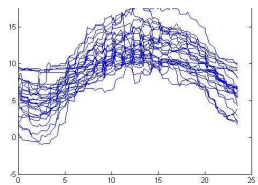
Preserving local pattern

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

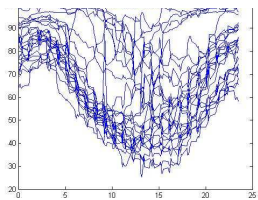
More details

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

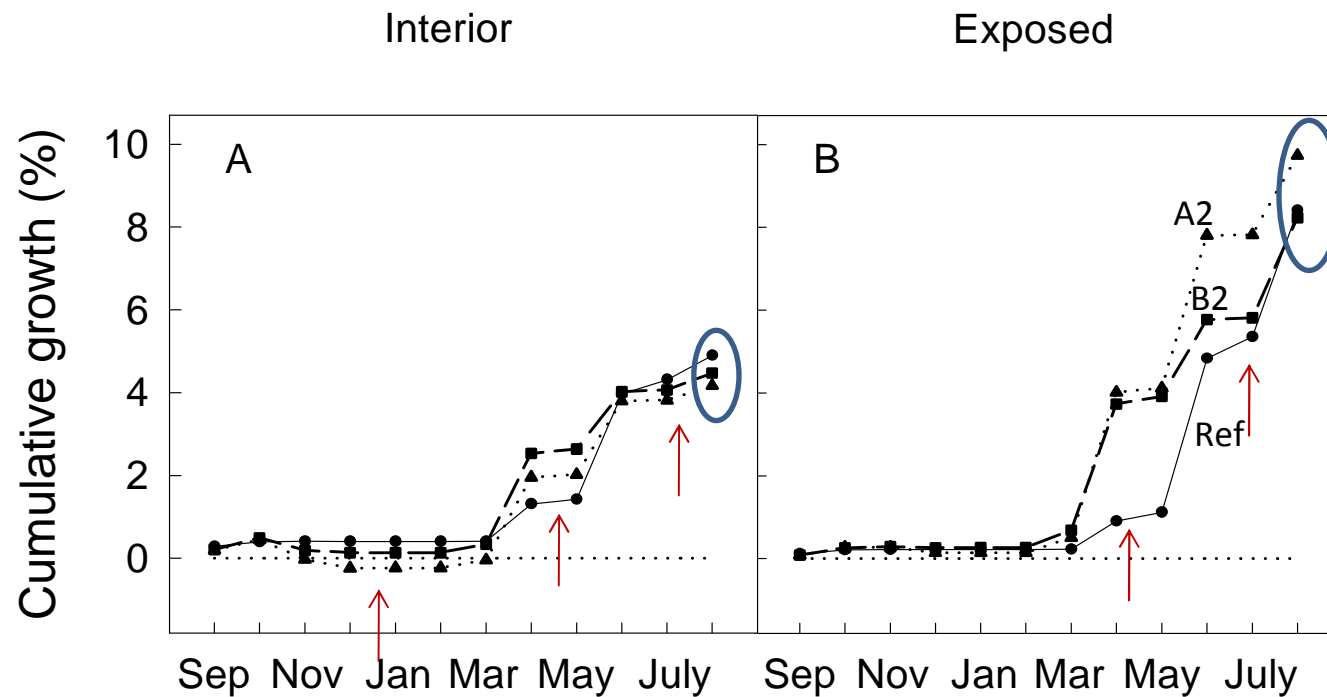
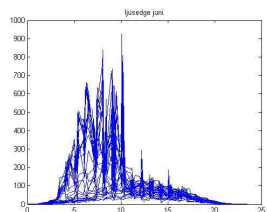
Temp June exposed

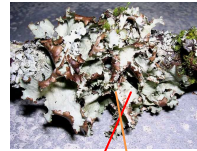
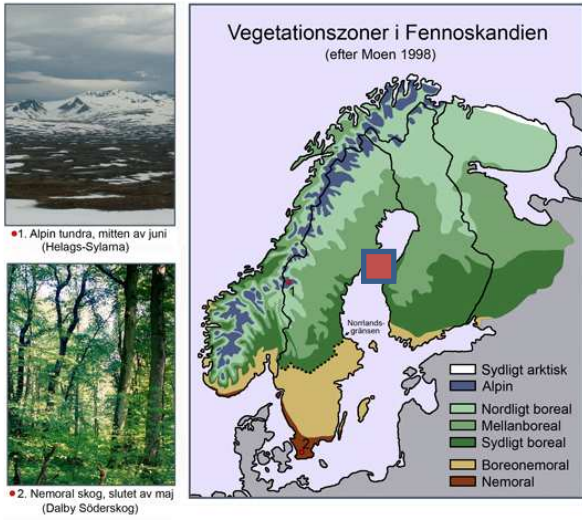


Humidity June exposed



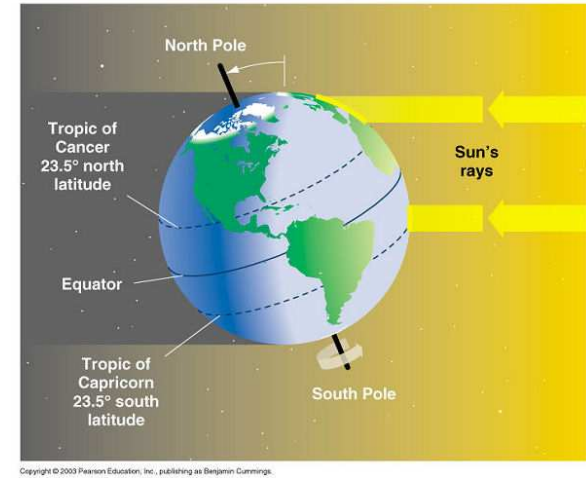
Light June exposed





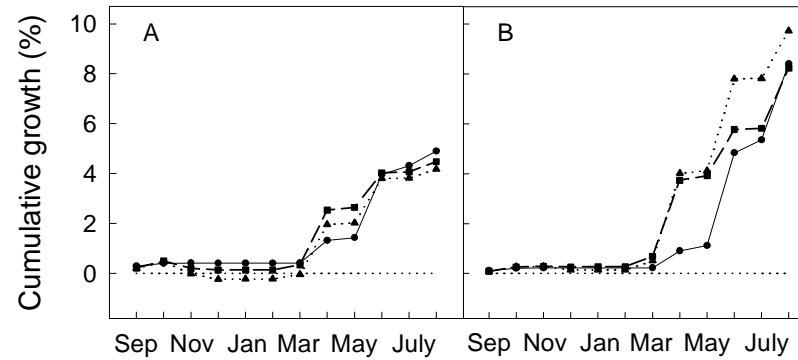
$RH(t)$ $T(t)$ $I(t)$

$RH(t)$ $T(t)$ $I(t)$



Interior

Exposed



Conclusions:

Vegetation – climate change – tilted earth axis

Expect a larger local than regional redistribution of species.

Lichens and vascular plants and...