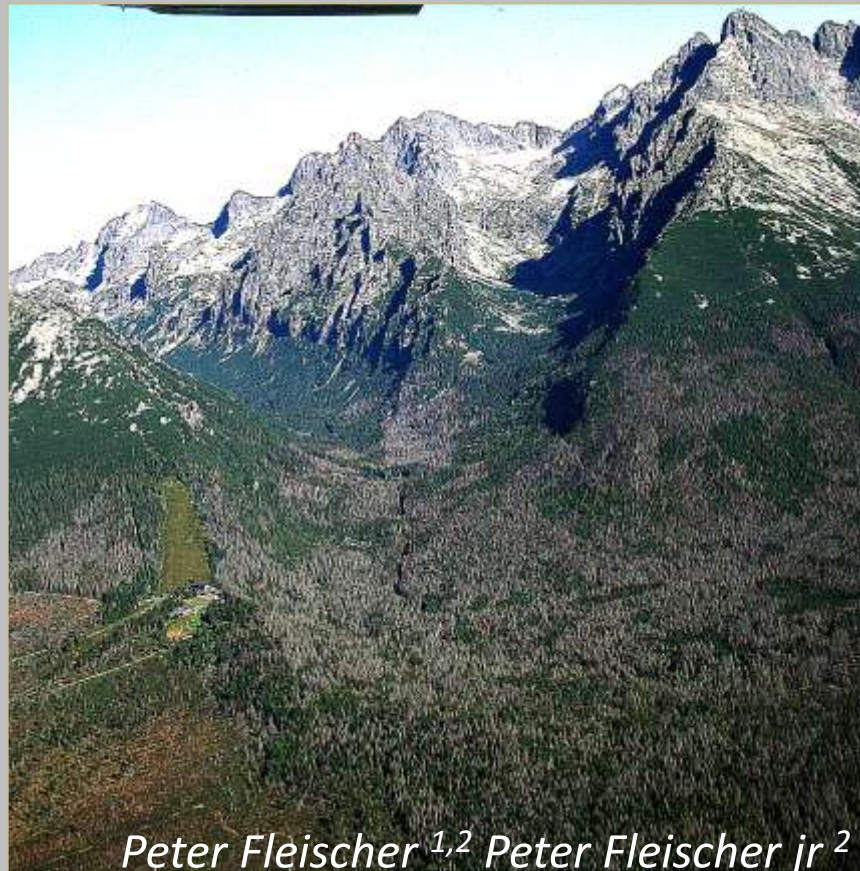


# The impact of ecological pressures and pulses on the forest ecosystems in Tatra National Park (SK)



*Peter Fleischer<sup>1,2</sup> Peter Fleischer jr<sup>2</sup>*

<sup>1</sup> Research station and Museum of Tatra National Park, SF TANAP, Tatranska Lomnica, Slovakia

<sup>2</sup> Technical University Zvolen, Forestry Faculty, Zvolen, Slovakia

# Disturbing factors

according to temporal, spatial scale and magnitude

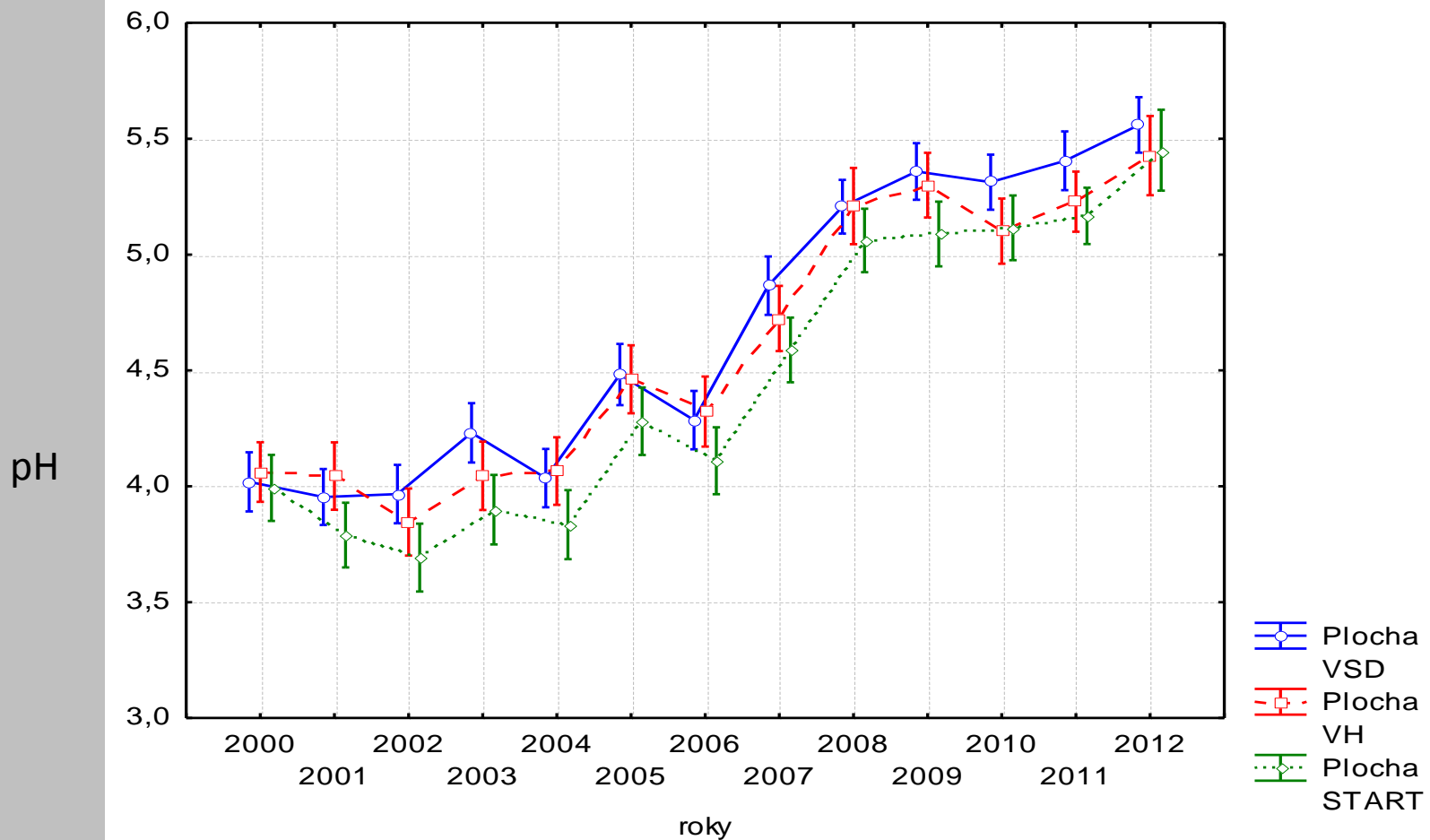
## **PRESURES**

- Pollution (acid rain )
- Ground level ozone
- Elevated temperature
- Bark beetle infestation

## **PULSES**

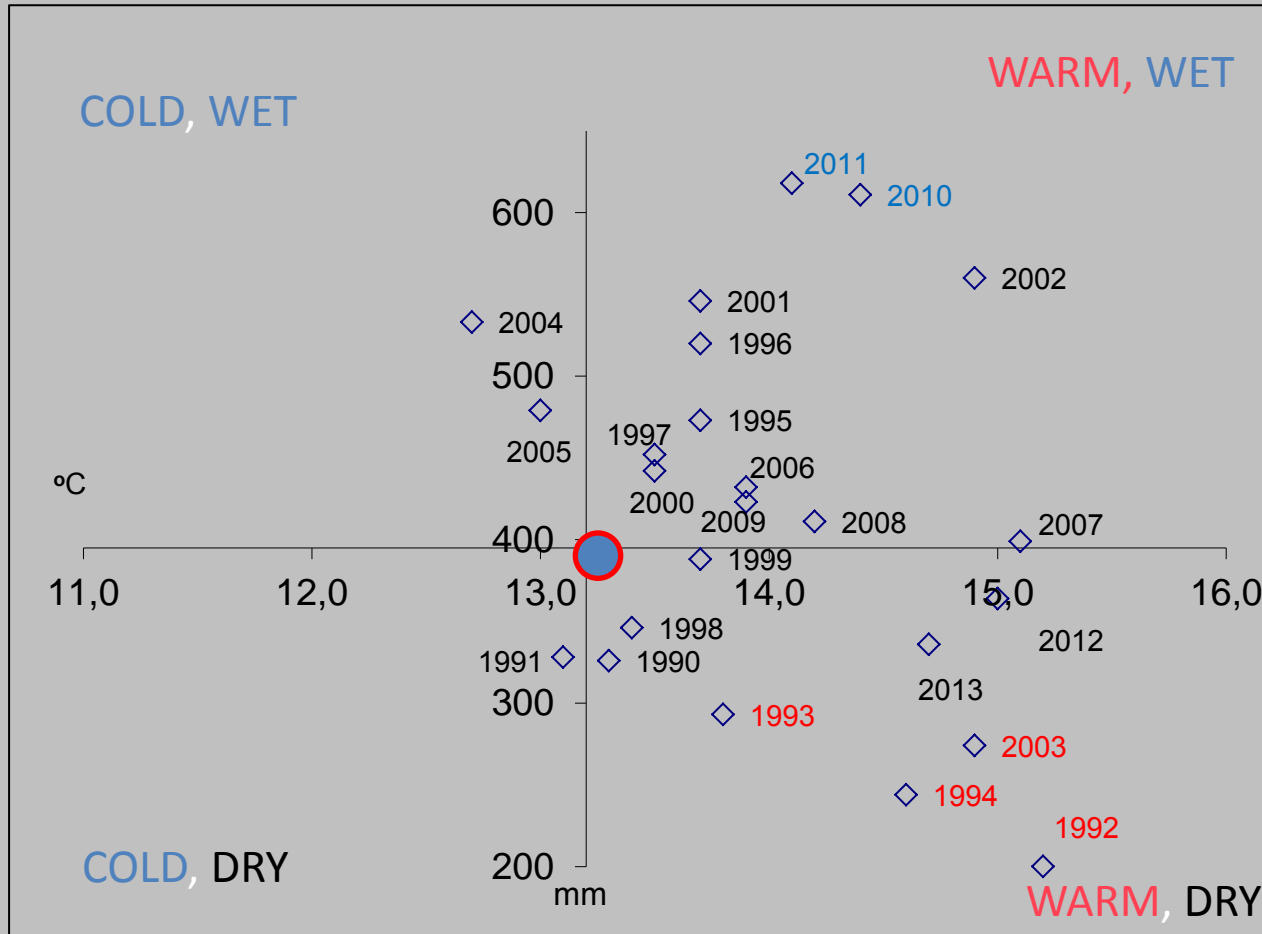
Windthrows  
(downslope wind – bora)

# Pressure: Pollution (acid rain 1998-2012)



# Pressure: Weather

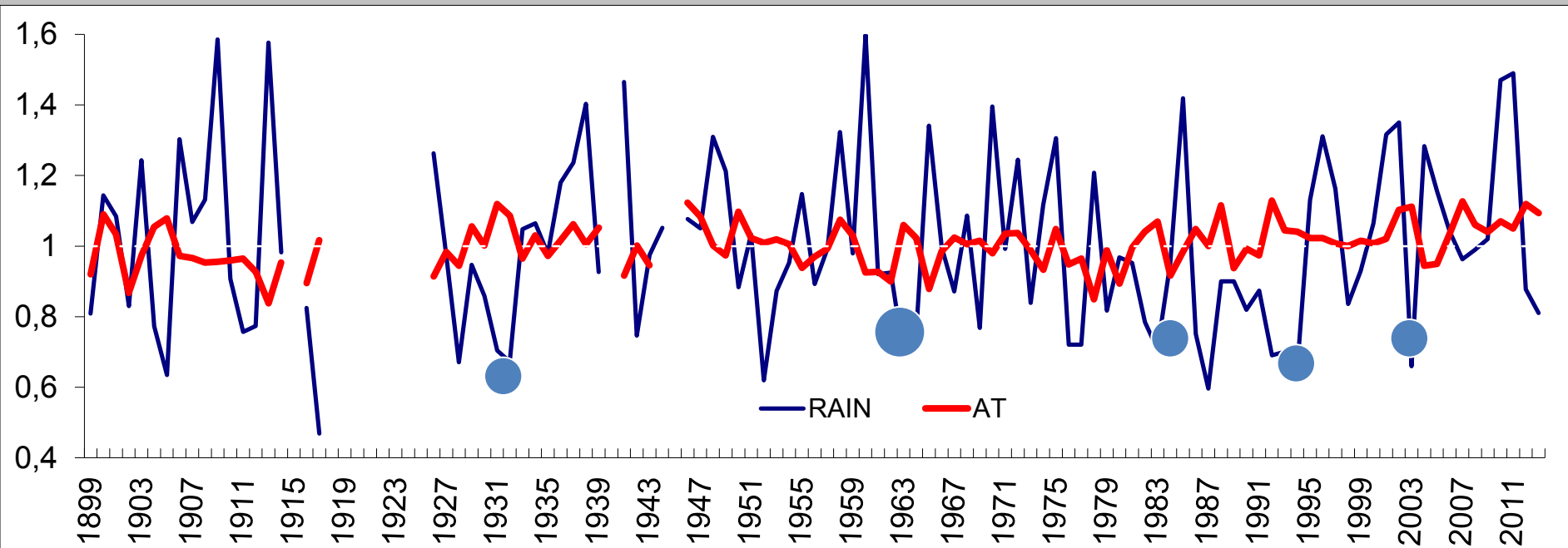
AT and R in during growing seasons 1990-2013



1930-1960: AT 13.2 °C

R 385 mm

# Pressure: weather and BB outbreak



# Pulses – Windstorm 2004



Area: 12 000 ha  
Volume: 2.5 mil m<sup>3</sup>,  
Wind max: 230 km/h

New research concept:

- temporal and spatial data extrapolation
- processes and ecosystem services
- experiments, modelling and application



# EXT – managed, wood extracted



Higher species diversity  
Lower spatial heterogeneity

# NEX – unmanaged, natural processes only



Lower species diversity  
Higher spatial heterogeneity (clusters)



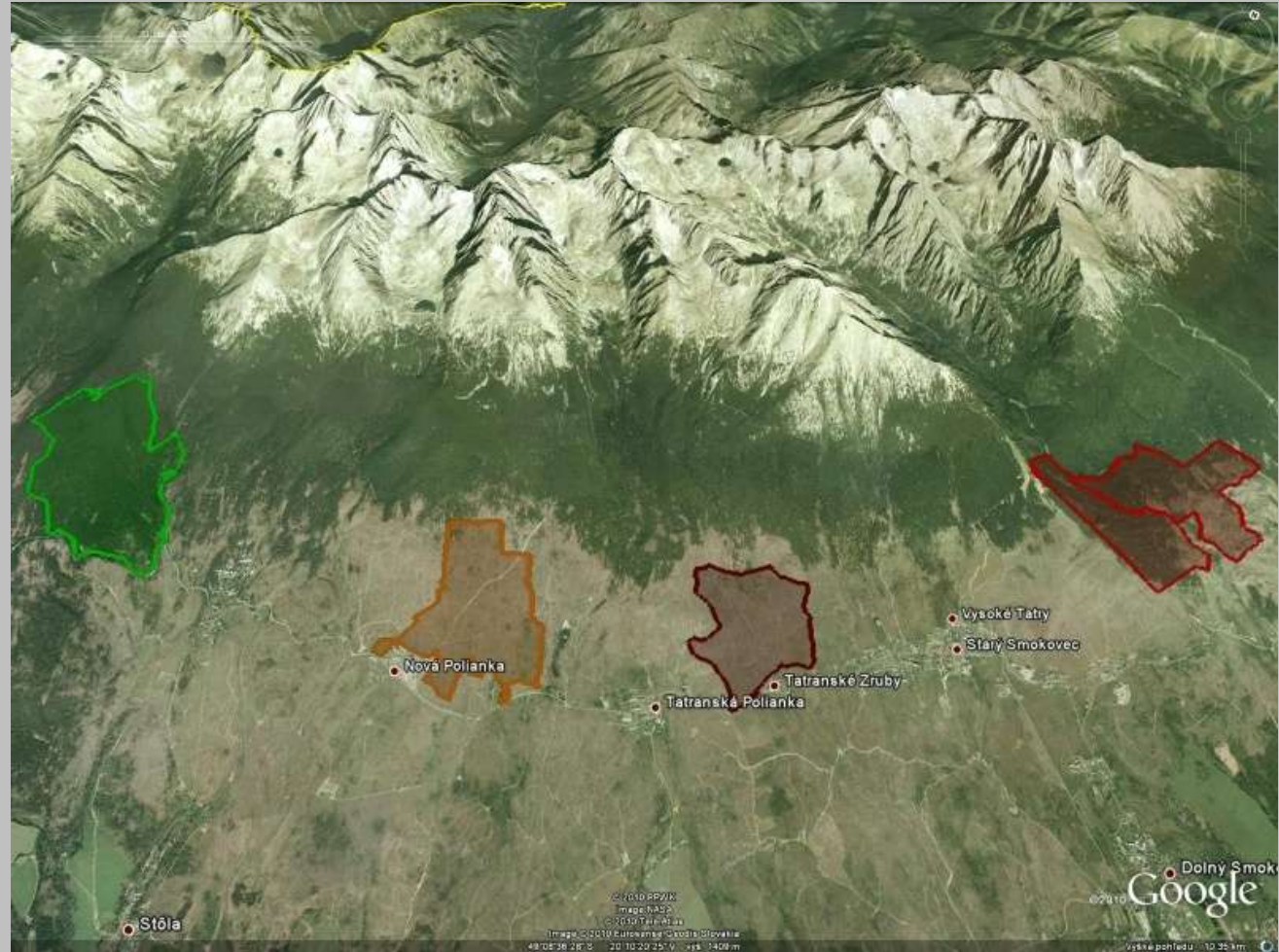


# REF – undisturbed, reference site



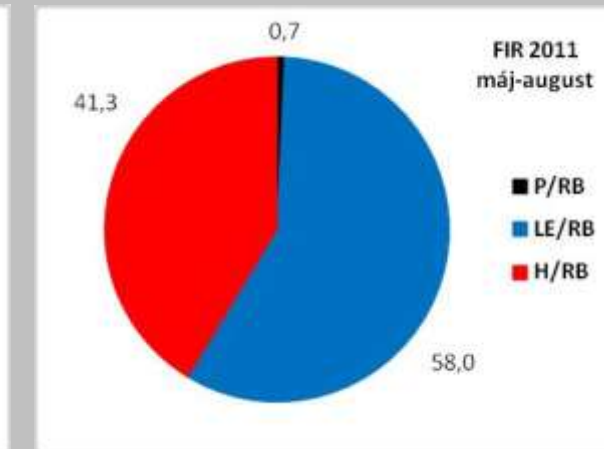
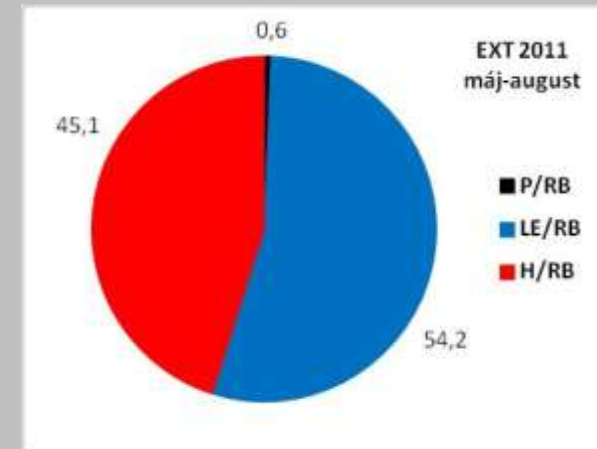
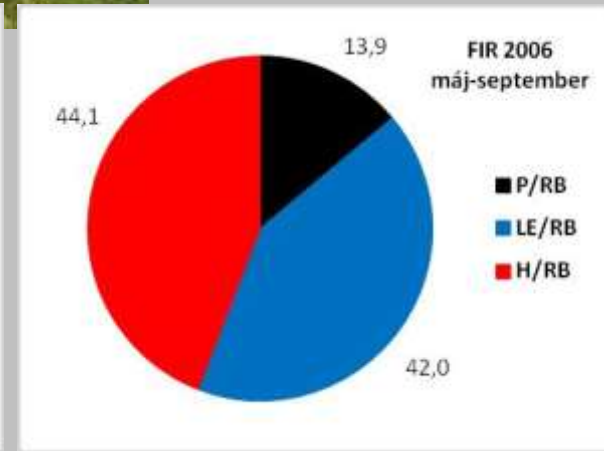
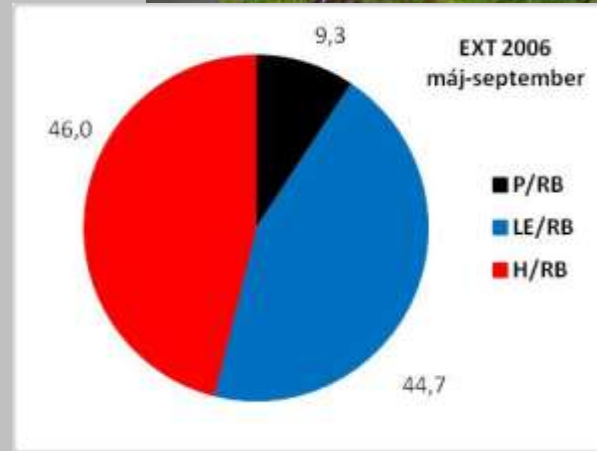
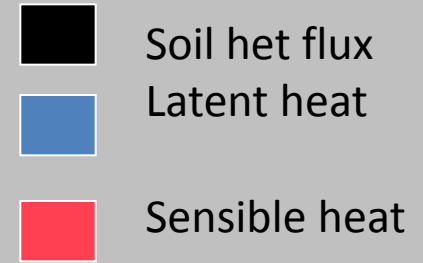
# Post-windstorm research

- Climate
- Hydric conditions
- Energy balance
- Bioproduction
- Biogeochemical cycles
- Soil, humus, erosion
- Regeneration
- Succession
- Plant, animal communities
- Forest management



# Energy balance

Rn FIR 73%, EXT 47% of GR



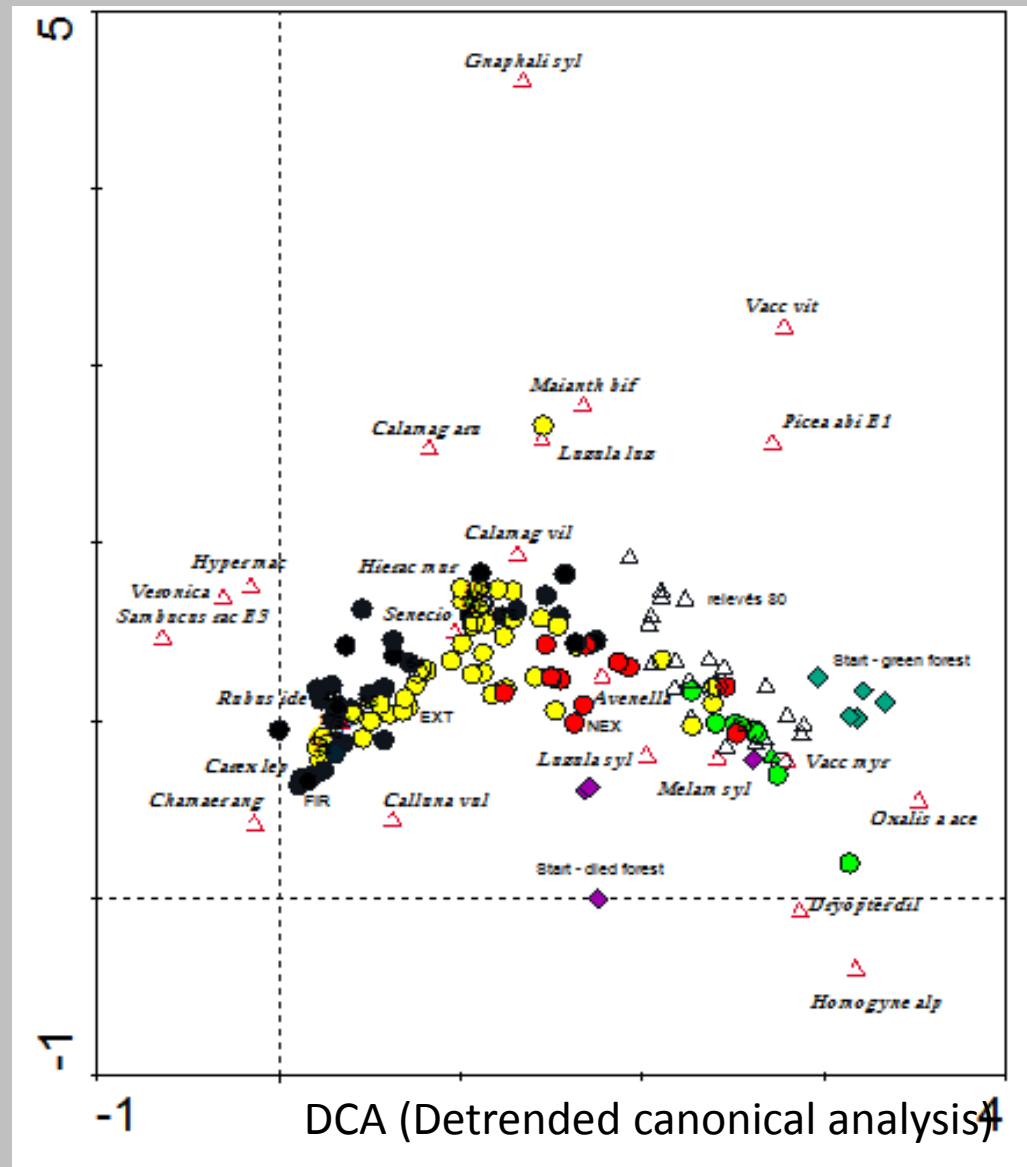
# Succession and biomass



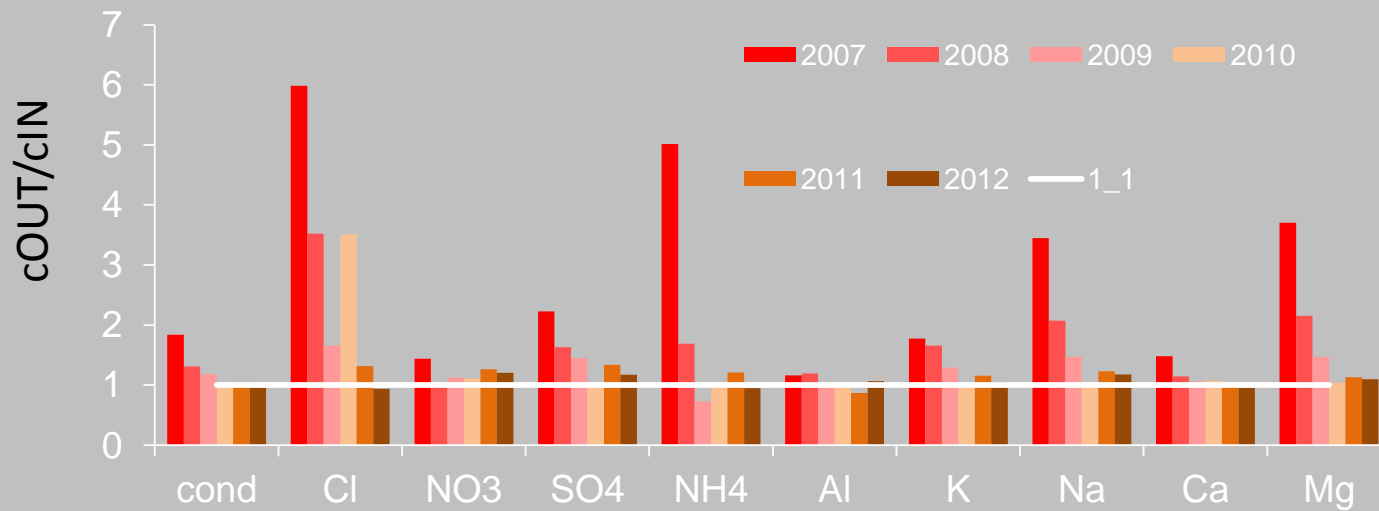
2012-  
Spruce  
forest  
species:  
*Vaccinium  
myrtillus*  
*Pleurozium  
schreberi*



# Vegetation tendency – increasing similarity

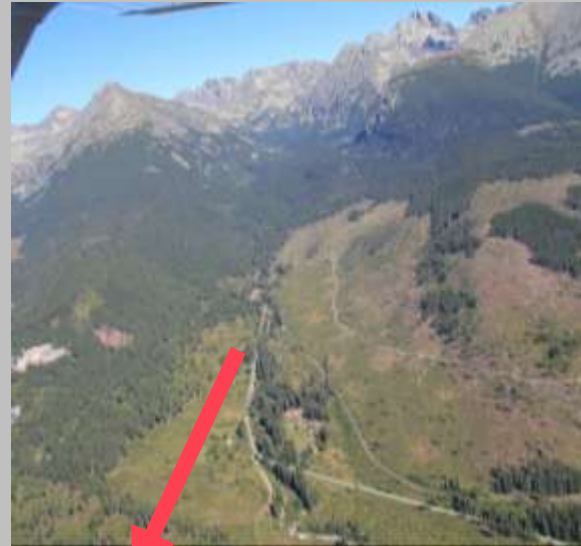


# Leaching and ion transport



# Ions transport by surface streams

Ions Index of enrichment:  $I_{en} = C_{out}/C_{in}$



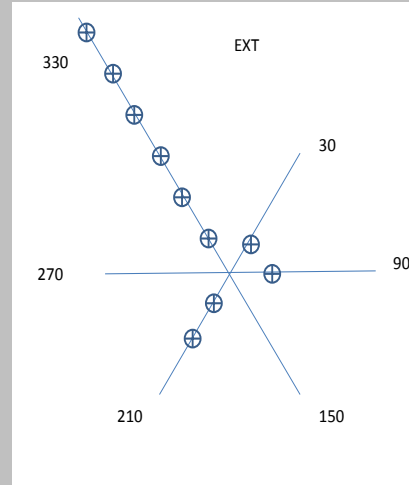
*I<sub>en</sub>* confirmed good sensitivity in a watershed suddenly affected by BB attack in 2010-11

# Soil and ecosystem respiration on a windtrow



$$SR = (a \cdot s_m) e^{bT}$$

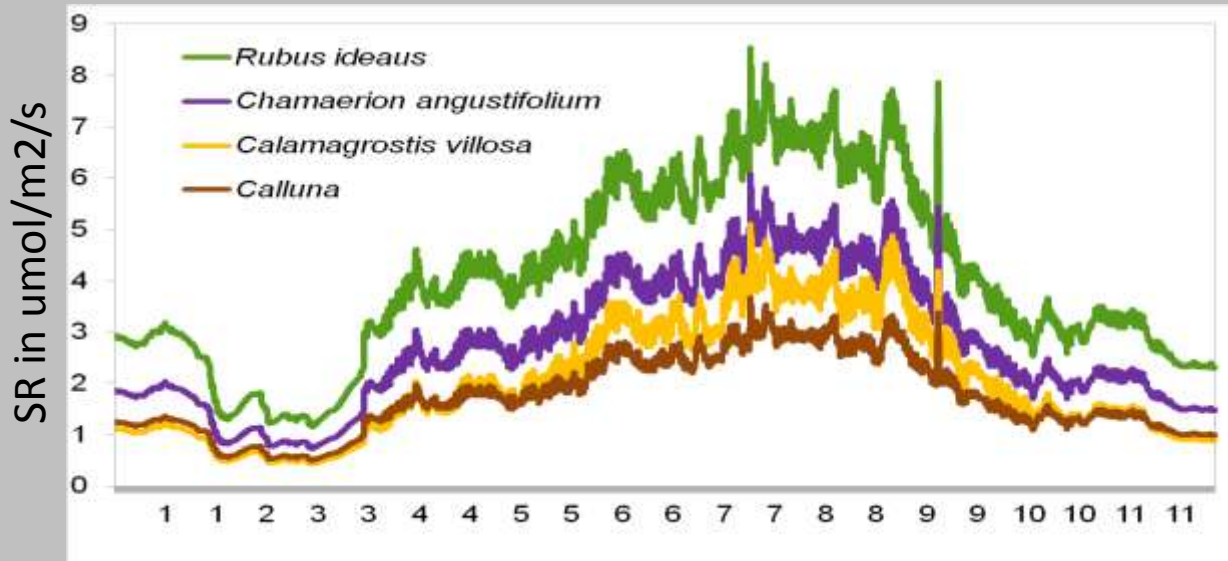
(Temporal extrapolation)



Vegetation map  
(Spatial extrapolation)

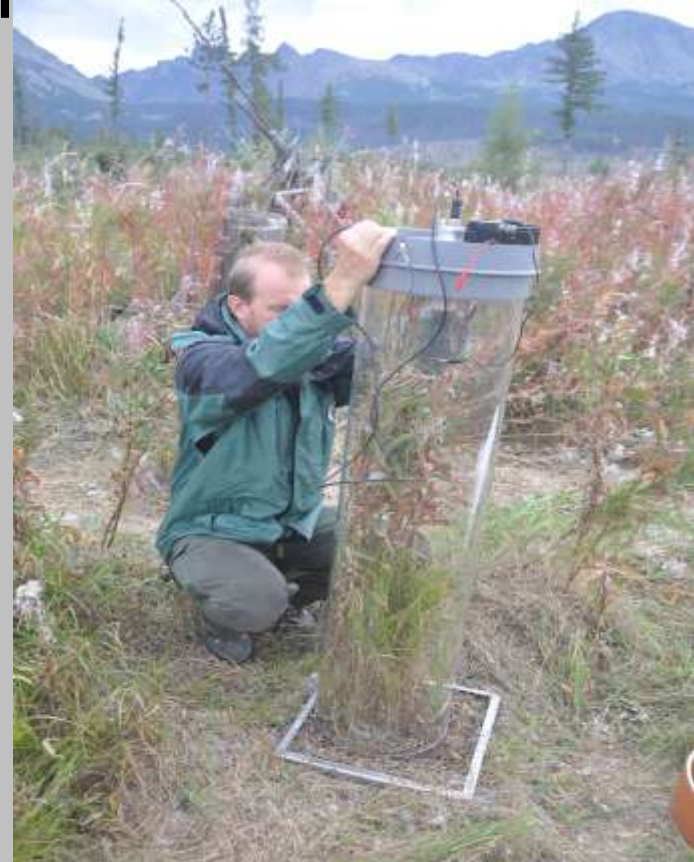


Microsites with specific vegetation

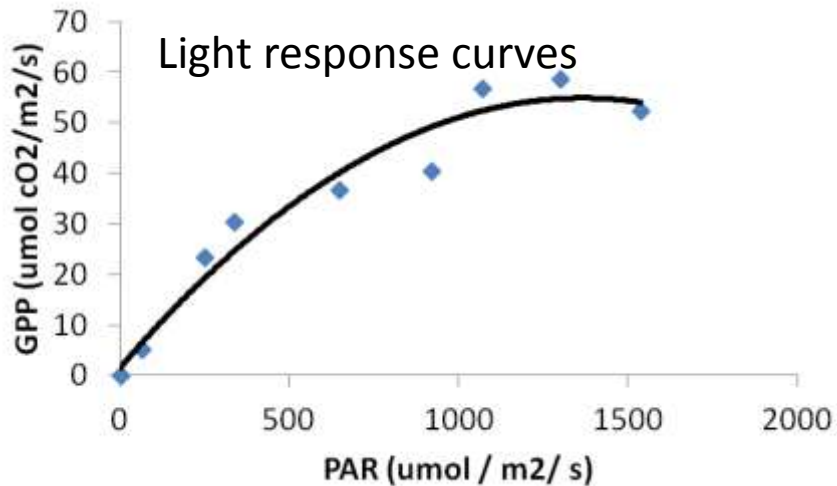




# Photosynthesis - GPP



(Michaelis-Menten)  
$$GPP = \alpha PAR \frac{GPP_{max}}{GPP_{max} + \alpha PAR}$$



*Calamagrostis vilosa*  
*Chamerion angustifolium*  
*Rubus ideaus*  
*Vaccinium myrtillus*  
*Calluna vulgaris*  
*Deschampsia flexuosa*  
*Pleurozium schreb.*

# C balance

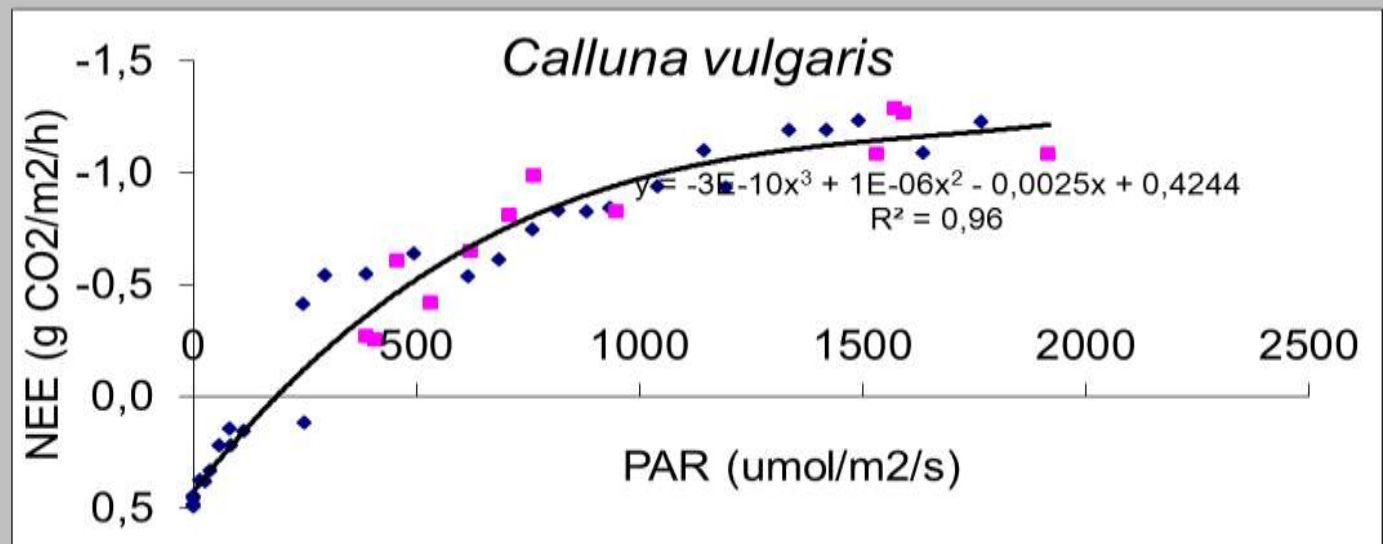
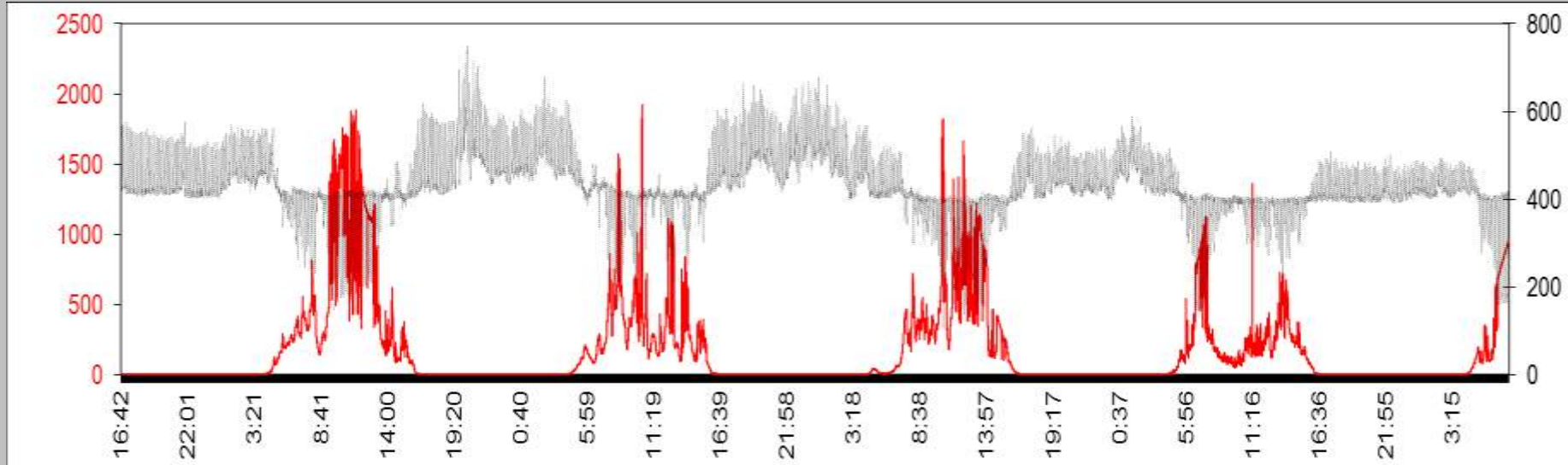
$(NEE) = GPP - Re$

WINDTHROW 2013

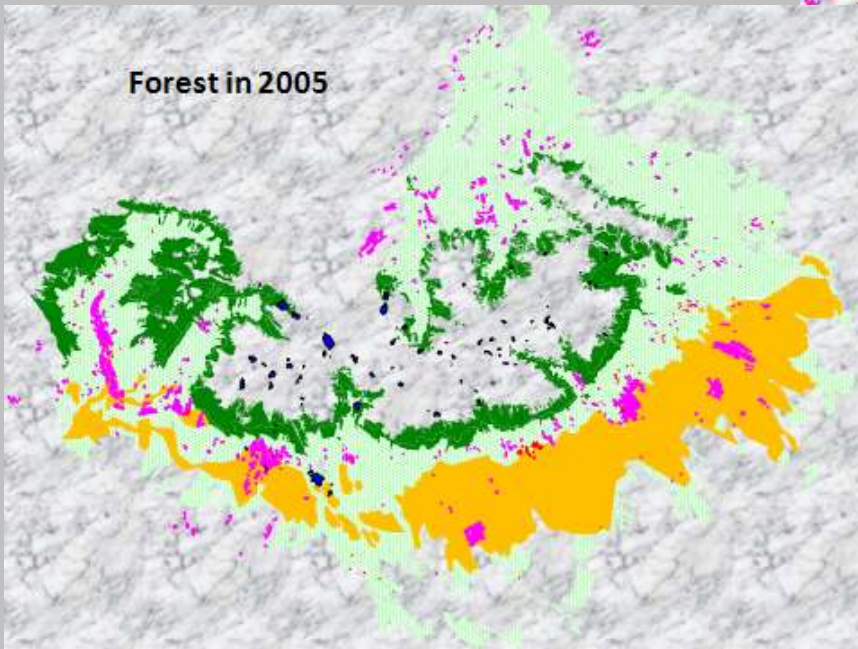
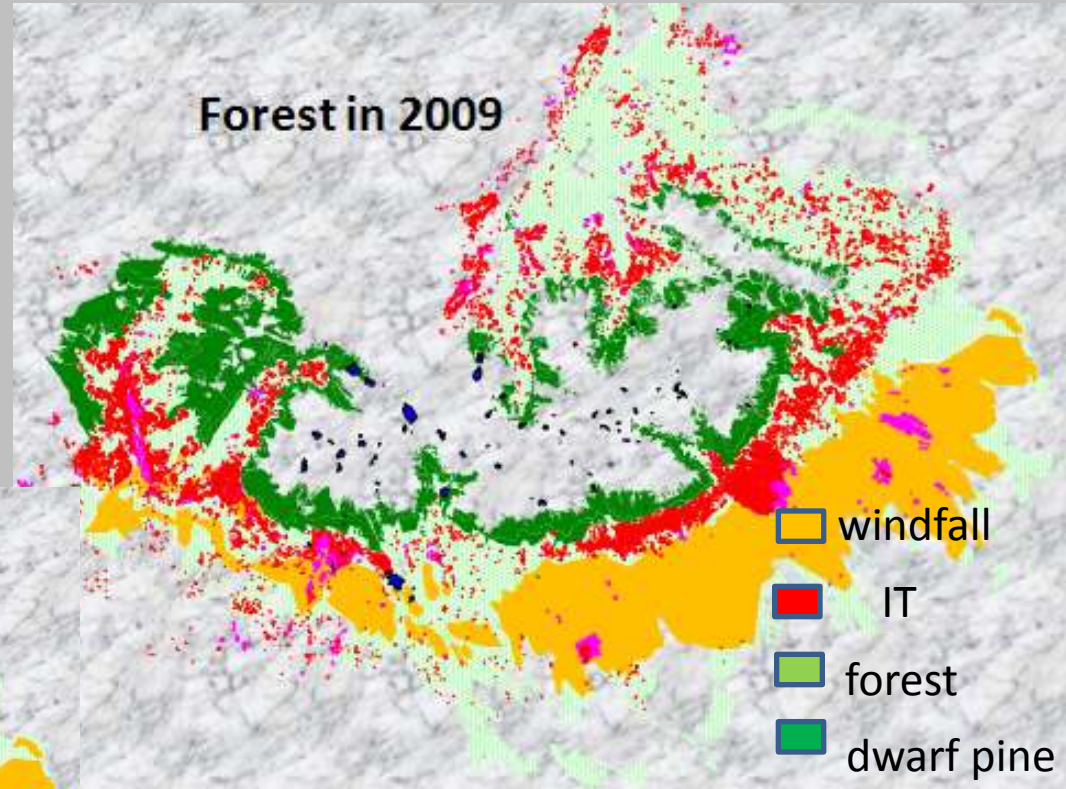
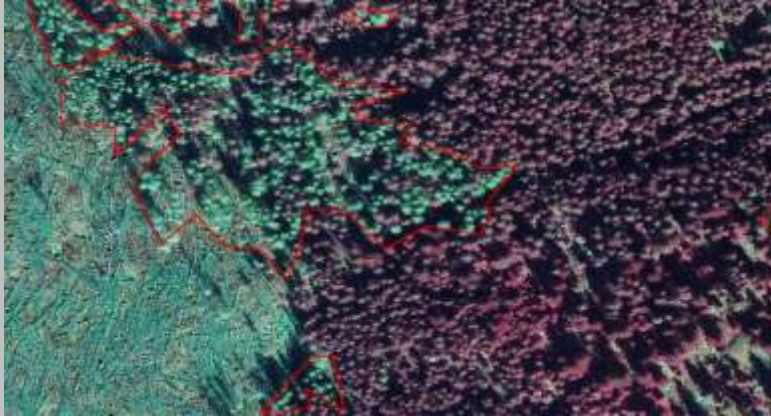


C sink 5,1 tC/ha/y

# Continuous CO2 flux measurement



# Bark beetle outbreak



2005-2013: 7 000 ha killed by BB  
(25% remained from 2004)

# IT life cycle in „normal“ and warm year in 830 m a. s. l.

DD

2005 (2006)

2007 (2012, 2013)

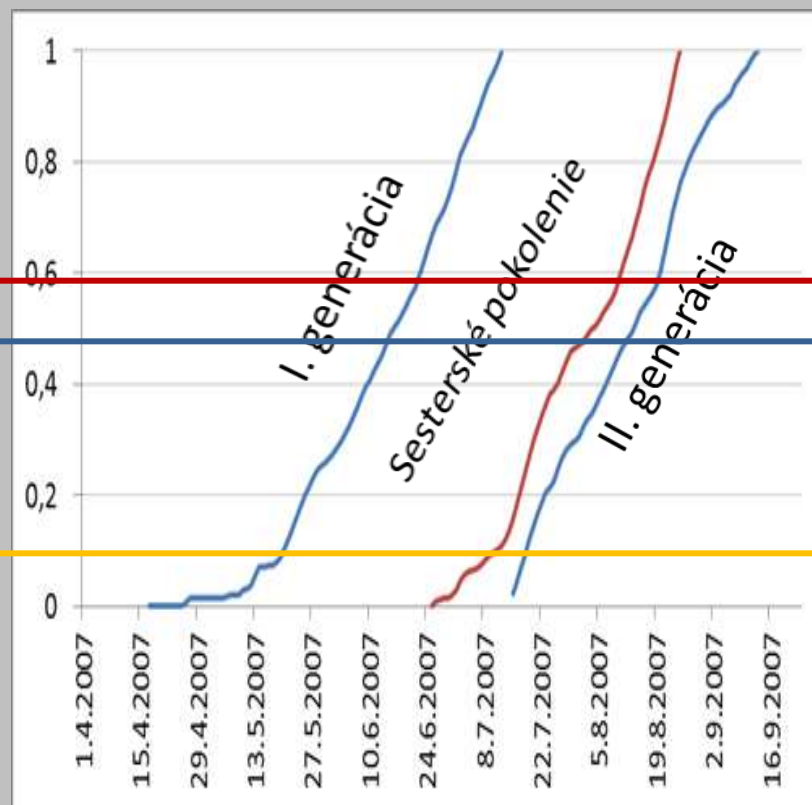
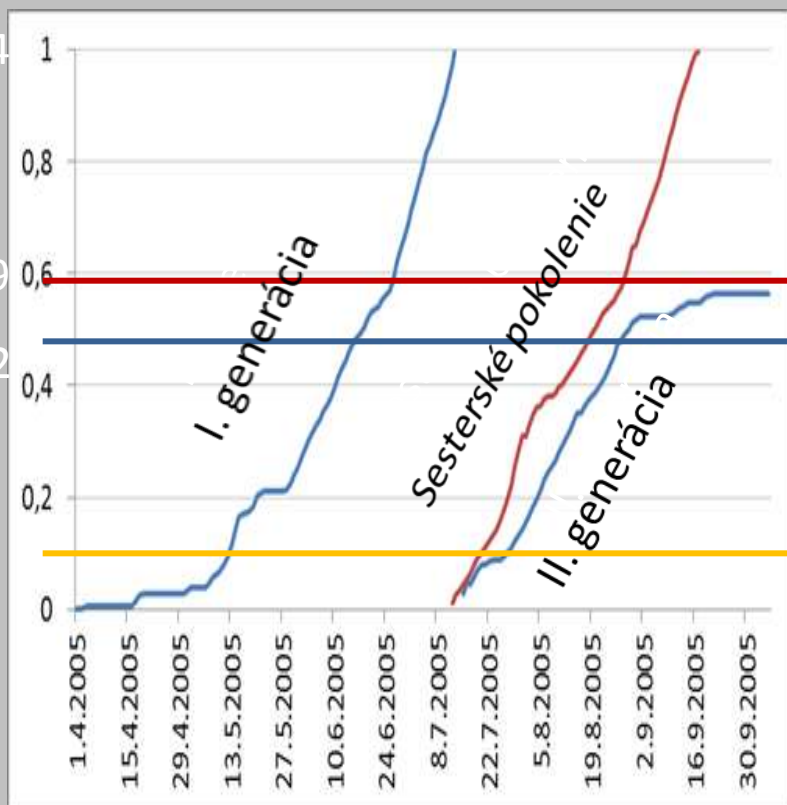
phase

557,4

313,9

256,2

51,8



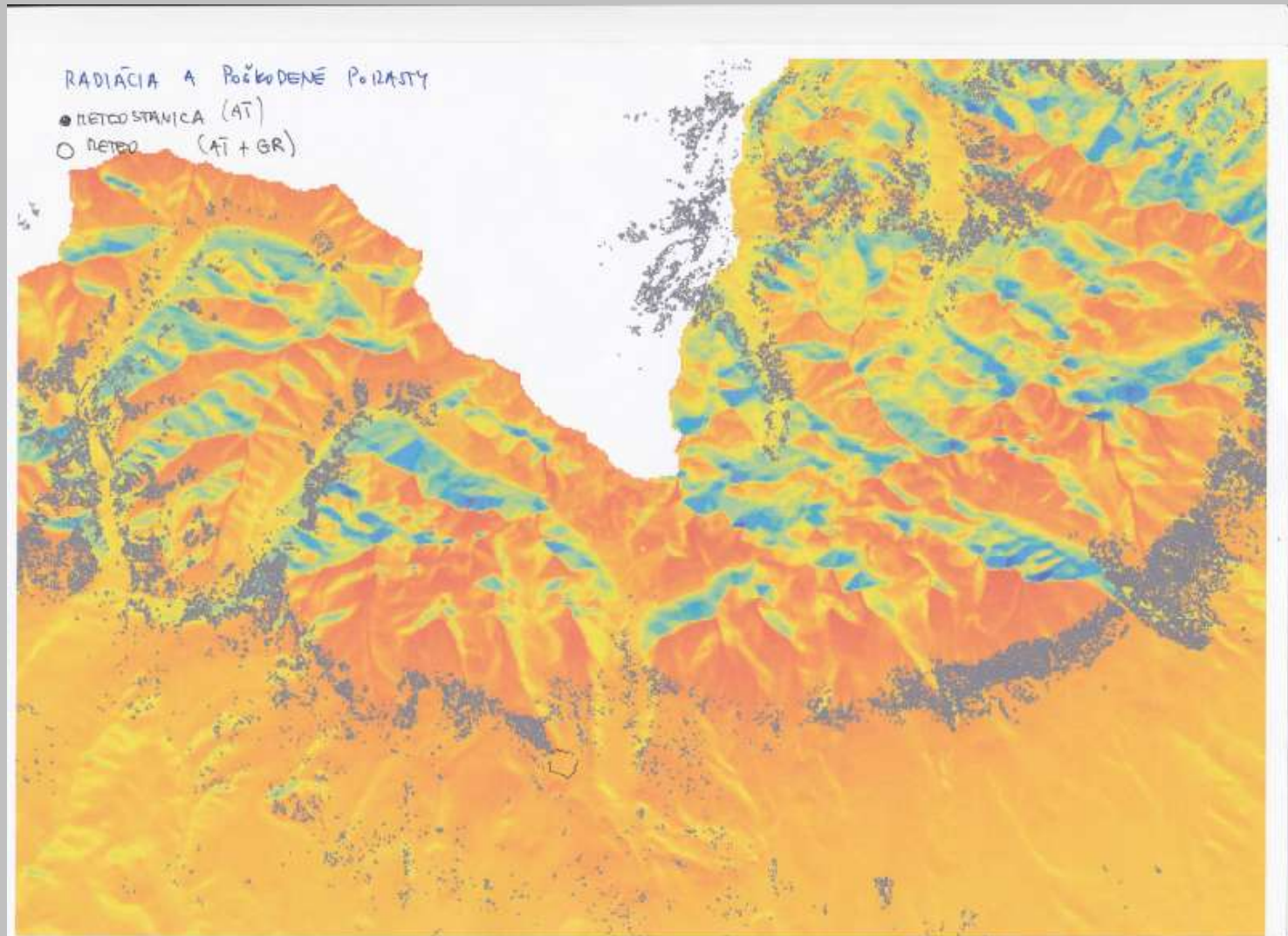
adult

larvae

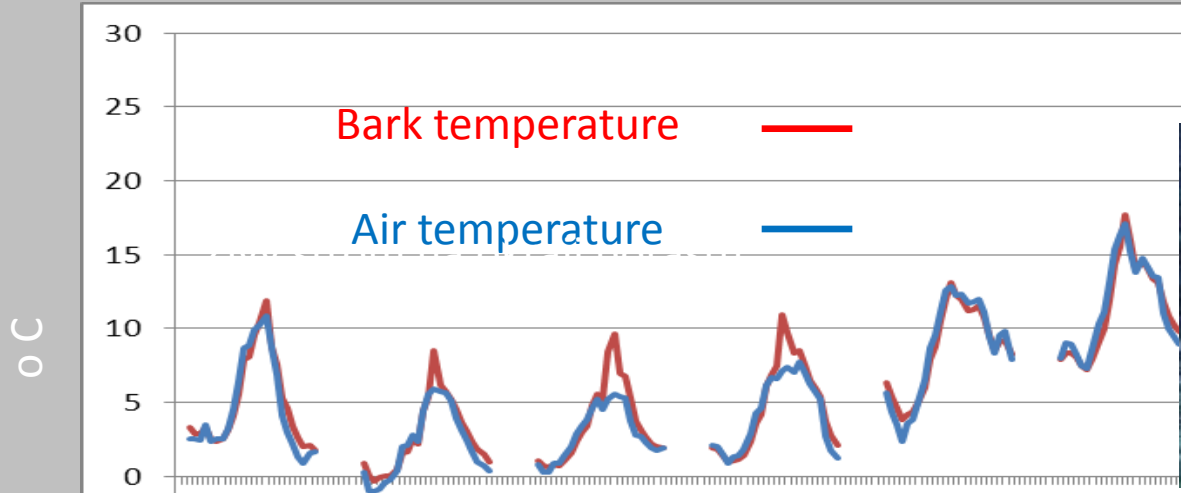
egg

Pupae

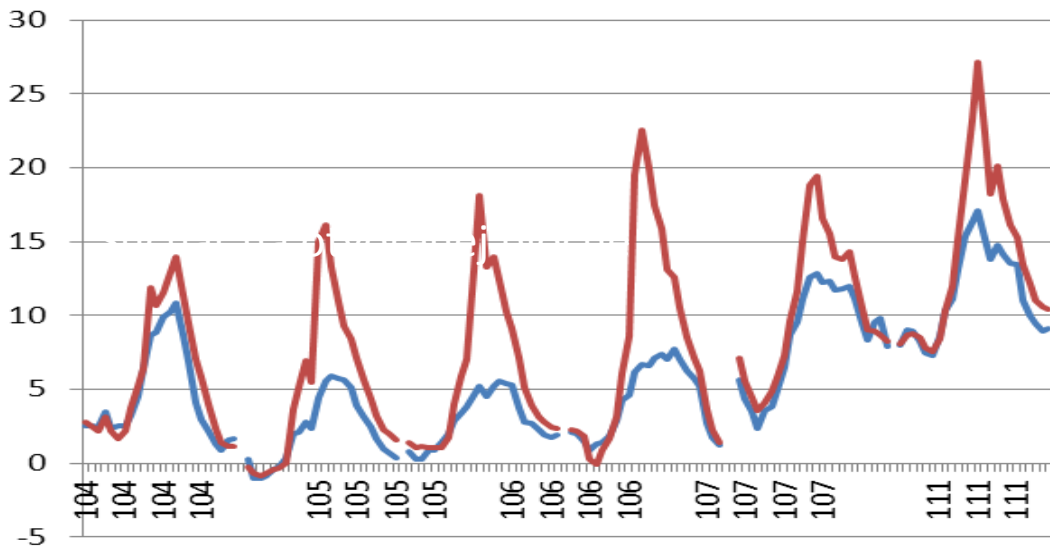
# DTM, Solar radiation, heat sum and BB voltinism



# Ambient temperature – driving factor for ectothermal insect

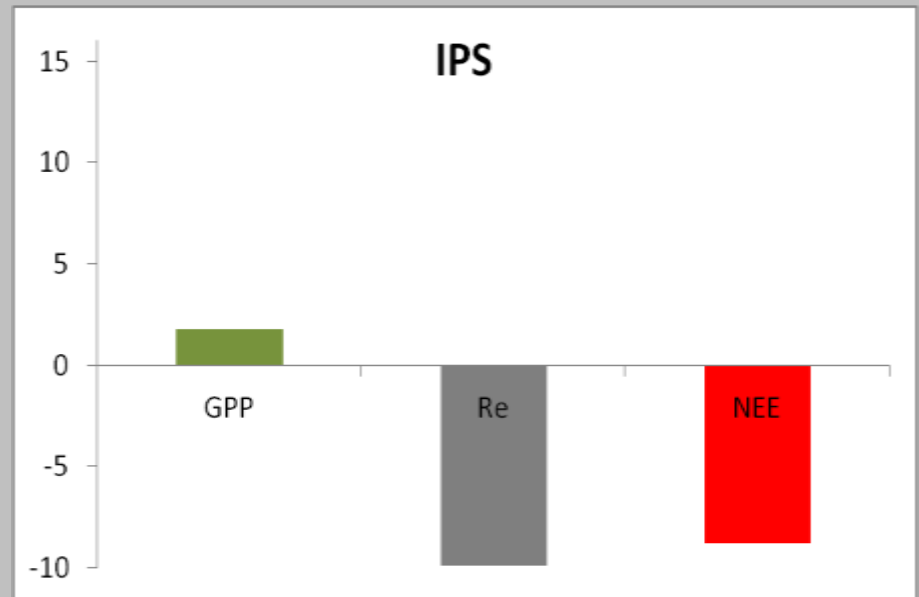


Avg BT 6,6 °C



Avg BT 9,2 °C

# GPP, Re and NEE on „bark beetle“ site



GPP only sparse ground vegetation

SR high due to elevated decomposition of large soil C content (>110t/ha)

Bark beetle site – source 8,7 tC/ha/y



# Ecosystem services

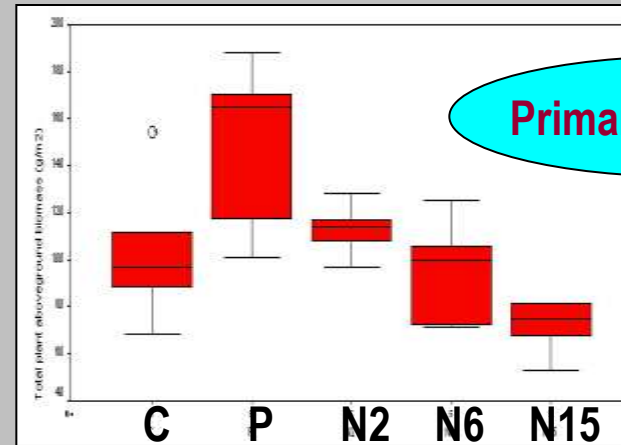
C sequestration  
Rock fall  
Tree fall  
Recreation  
Habitat



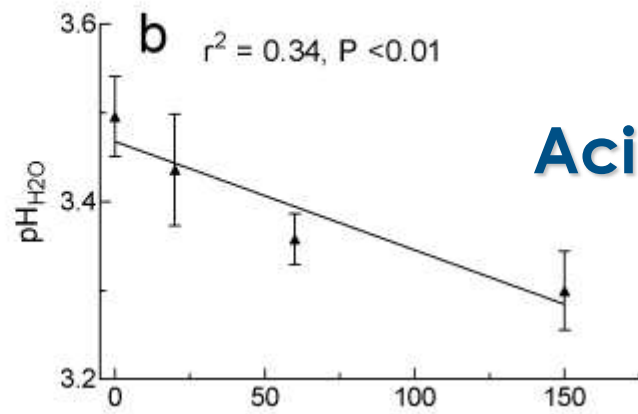
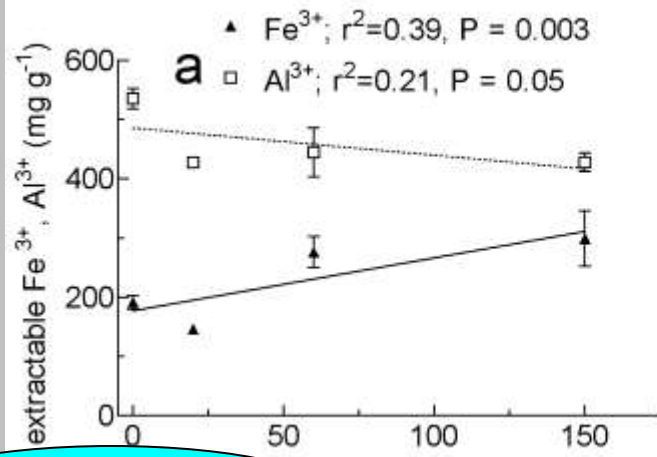
# Need for Experiments

- Current environmental conditions – more frequent extremes but still in natural variability
- Severe changes predicted in next 30-50 years
- Ecosystem reaction – uncertain
- Experiments

# Experiment with elevated N deposition



Primary production



Acidification

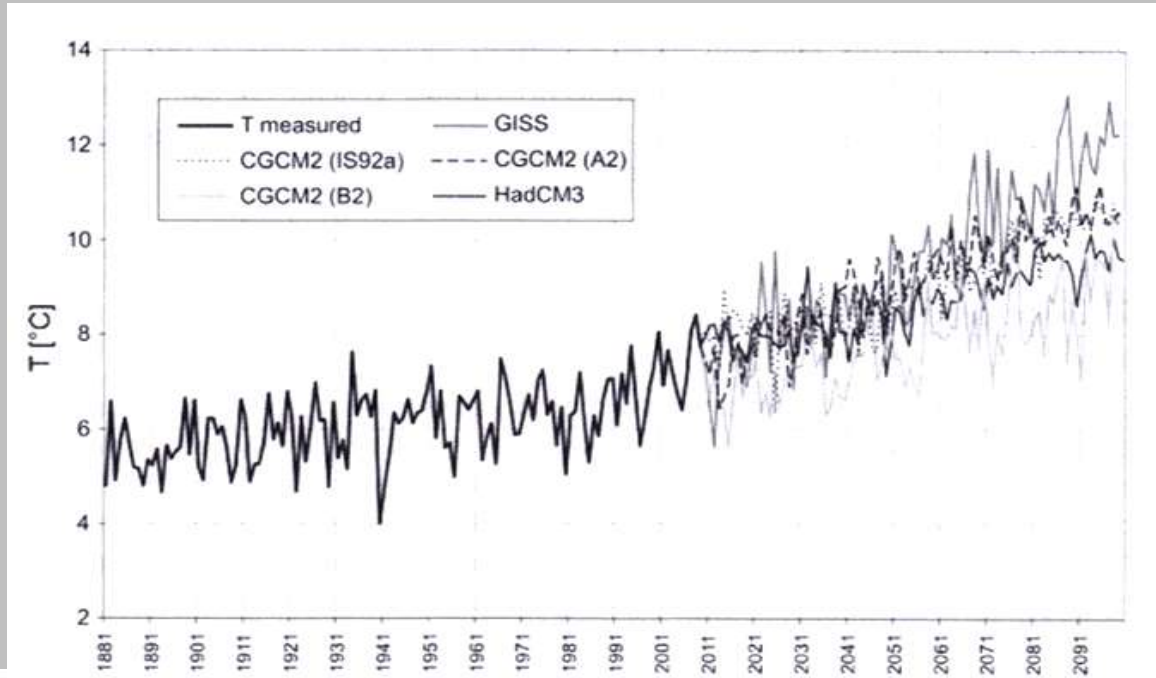
Soil buffer capacity

# Experiment with elevated AT



Both SR and GPP controlled by water availability

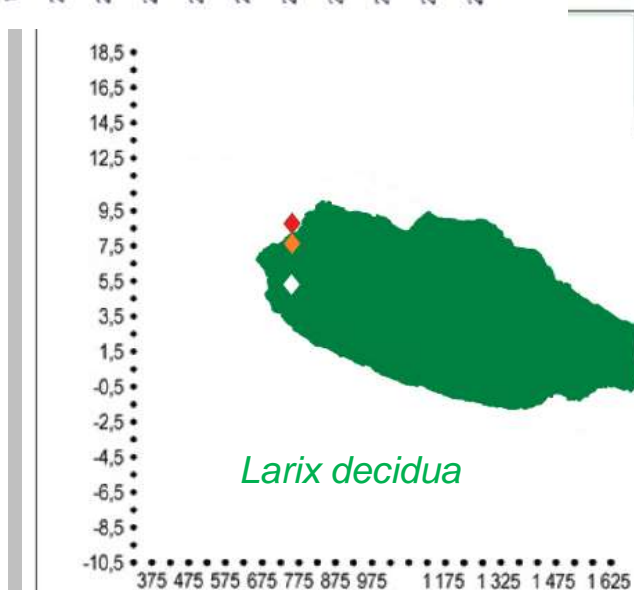
# Projected AT (GCMs)



*Melo et al., 2013*



*Picea abies*



*Larix decidua*

*Kölling 2007*

# Summary

- Fast vegetation recovery after stand replacing events to pre-windstorm conditions
- Current vegetation in risk under CC
- Fast recovery of carbon sequestration
- Bark beetle site – large C source
- After 10 years only minimal difference between managed and unmanaged disturbed sites
- No impact of stand replacing event on catchment hydrology
- Ecosystem limits probably not exceeded
- Experiments with elevated temperature – GPP decline (drought)
- Info for NP management, sci. community