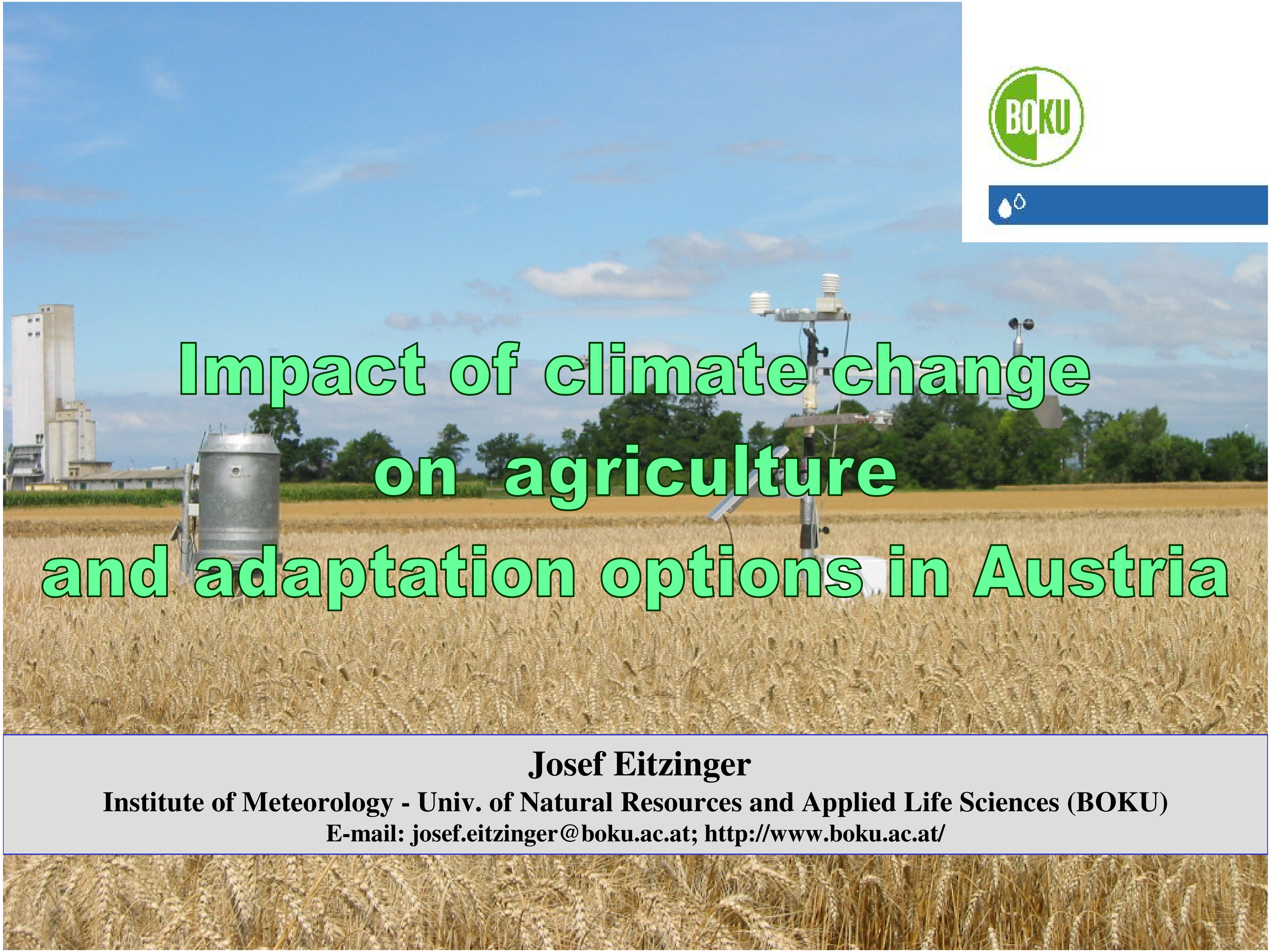

Impact of climate change on agriculture and adaptation options in Austria

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Agriculture in Austria

Land use :

Grassland: ~ 1.9 Mio ha (22%)

Arable land: ~ 1.4 Mio ha (17%)

Forests: ~ 3.8 Mio ha (46%)

Others: ~ 1.2 Mio ha (15%)

Agricultural land use mostly limited by:

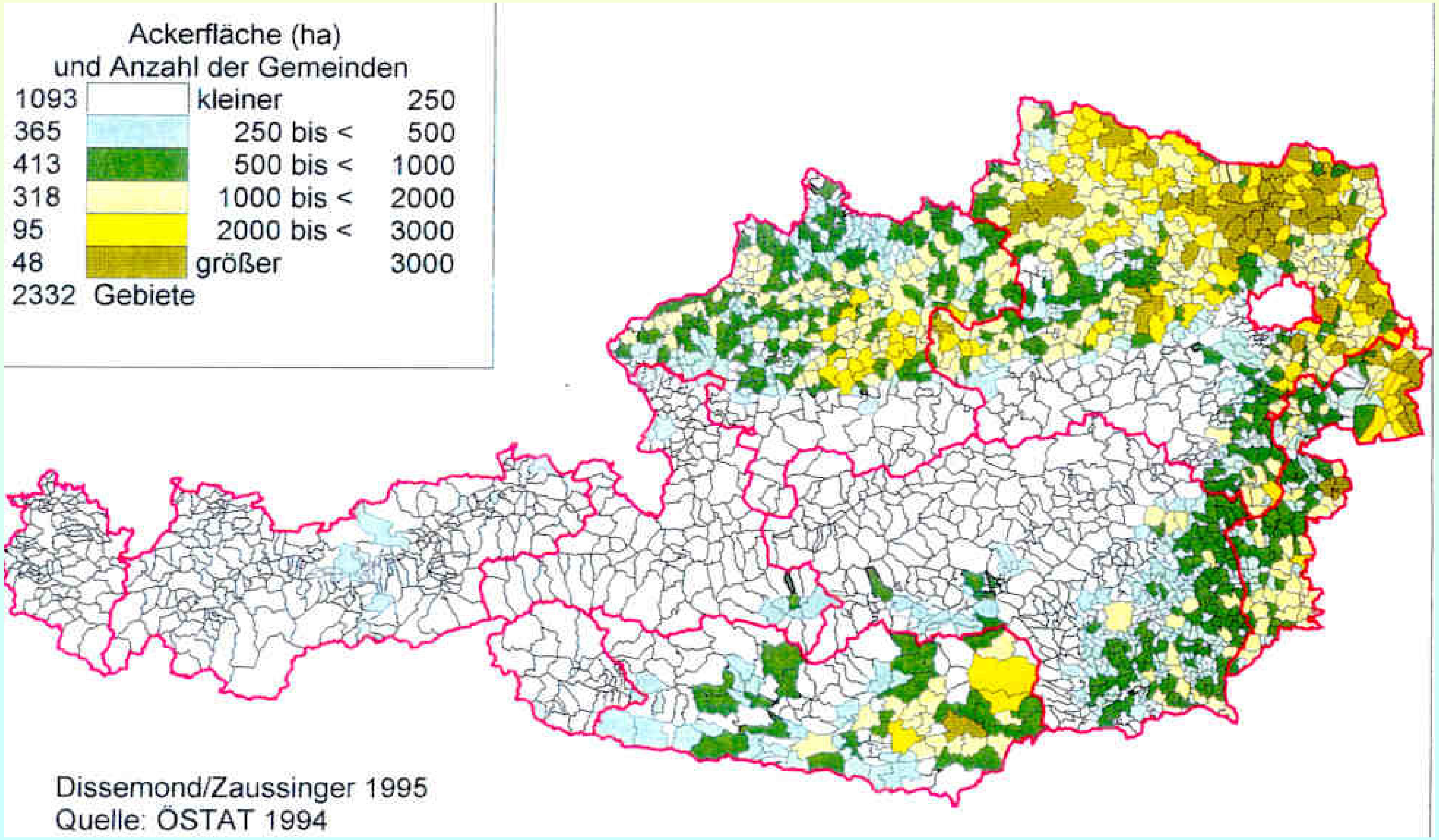
topography,

temperature

soil conditions

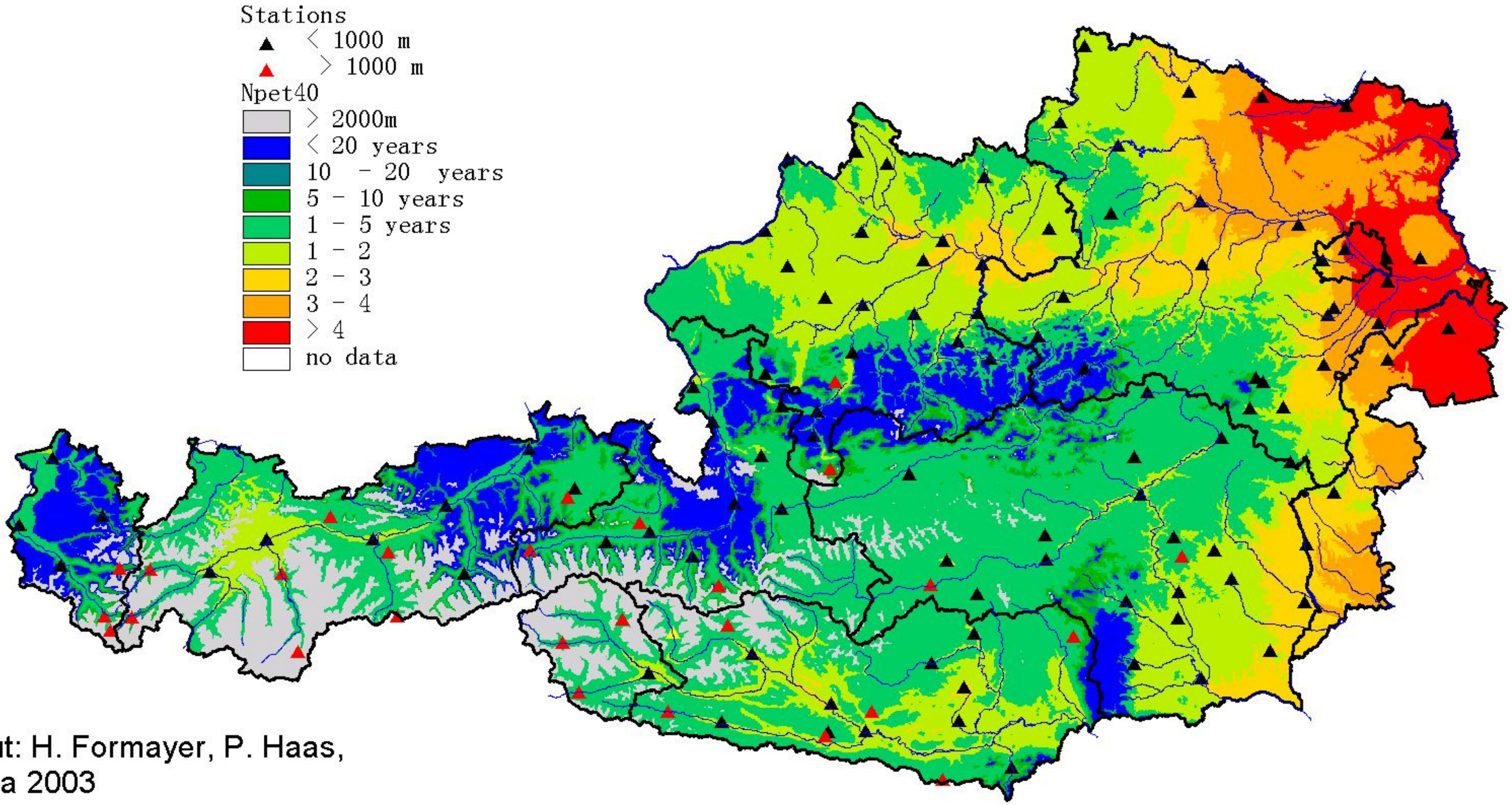
Precipitation

Arable land use



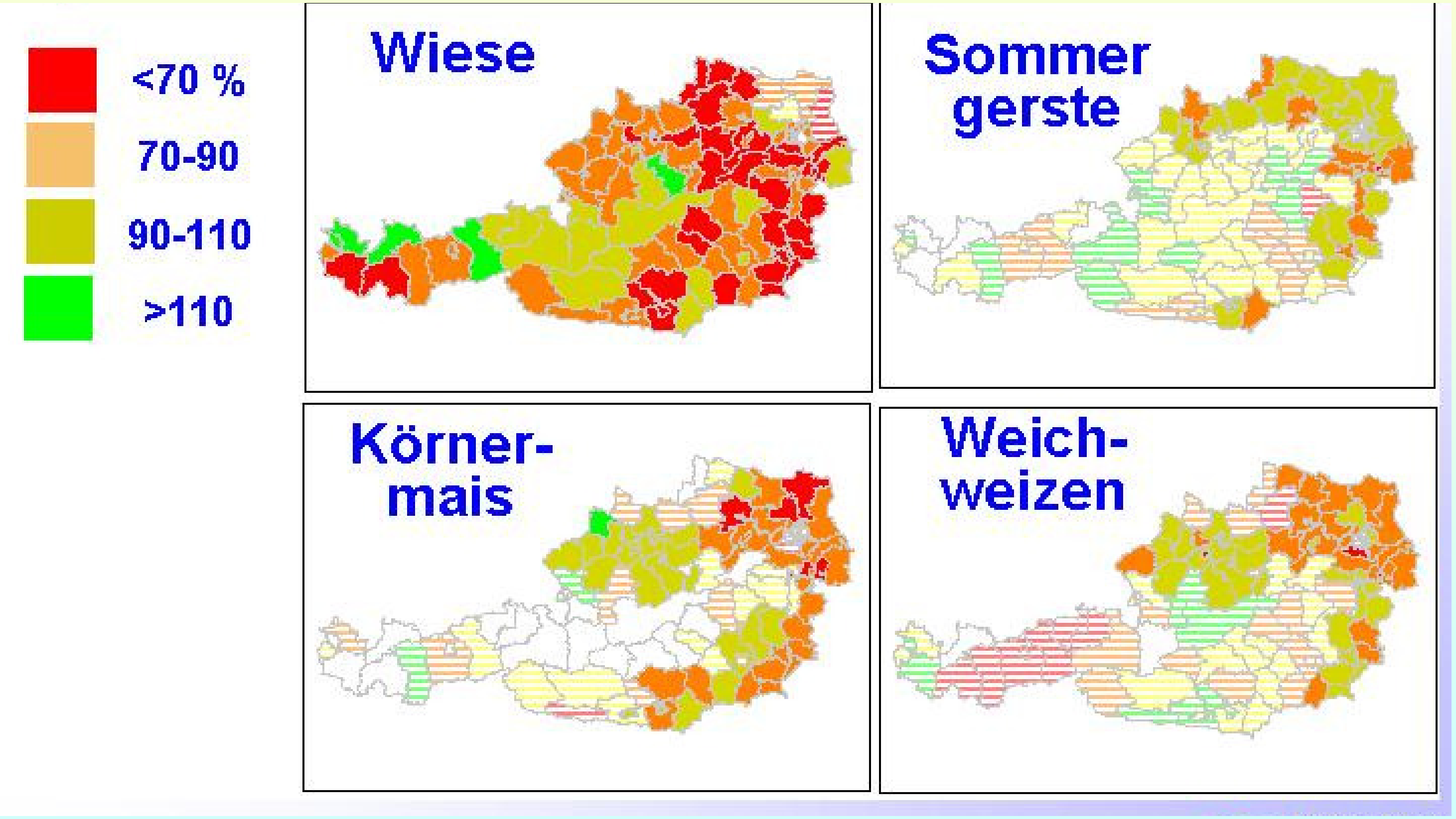
Average frequency of dry spells exeeding accumulated NPET- sums of 40 mm.

Long term drought frequency in Austria

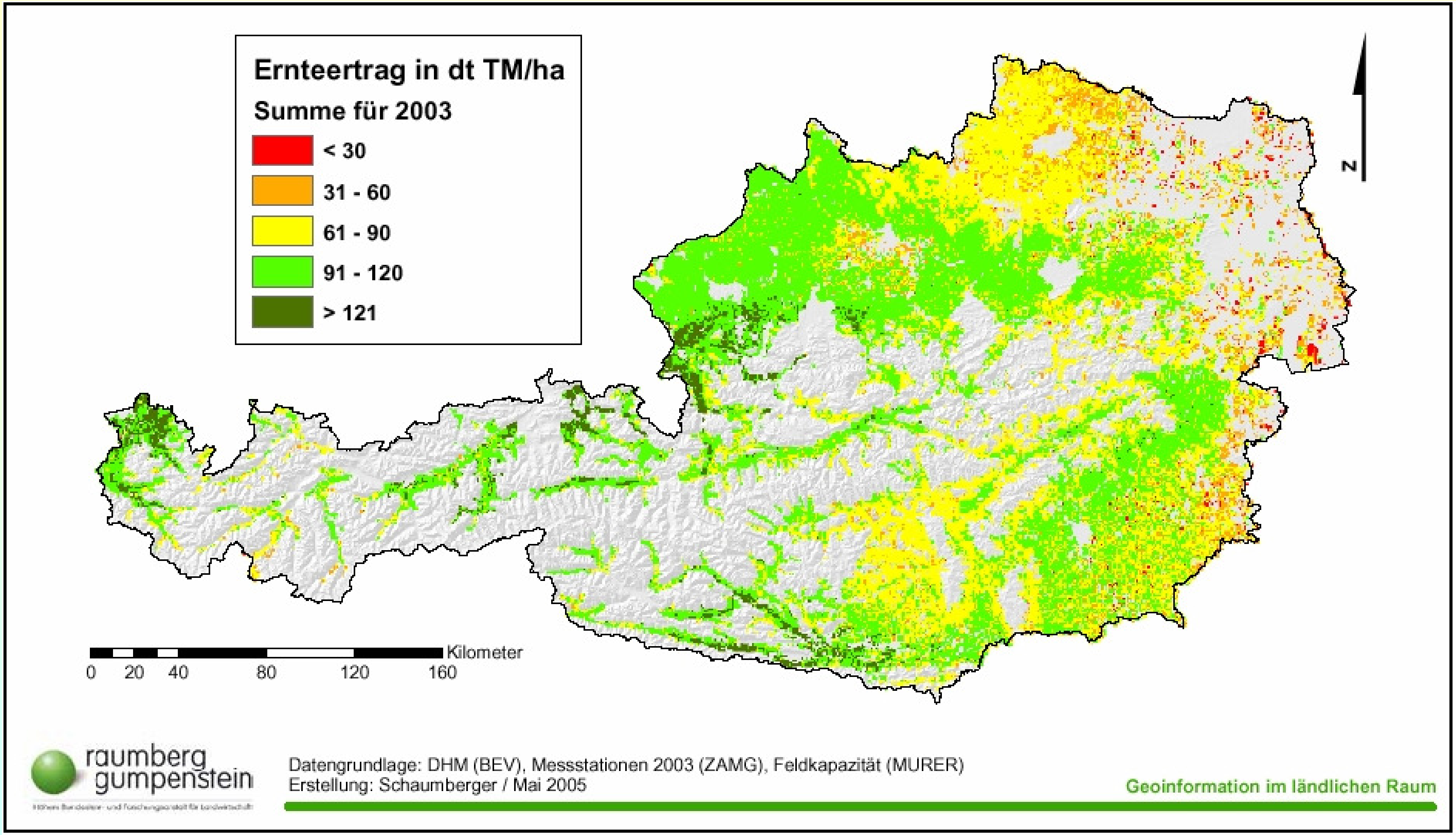


Layout: H. Formayer, P. Haas,
Vienna 2003

Yield depression by drought and heat in 2003



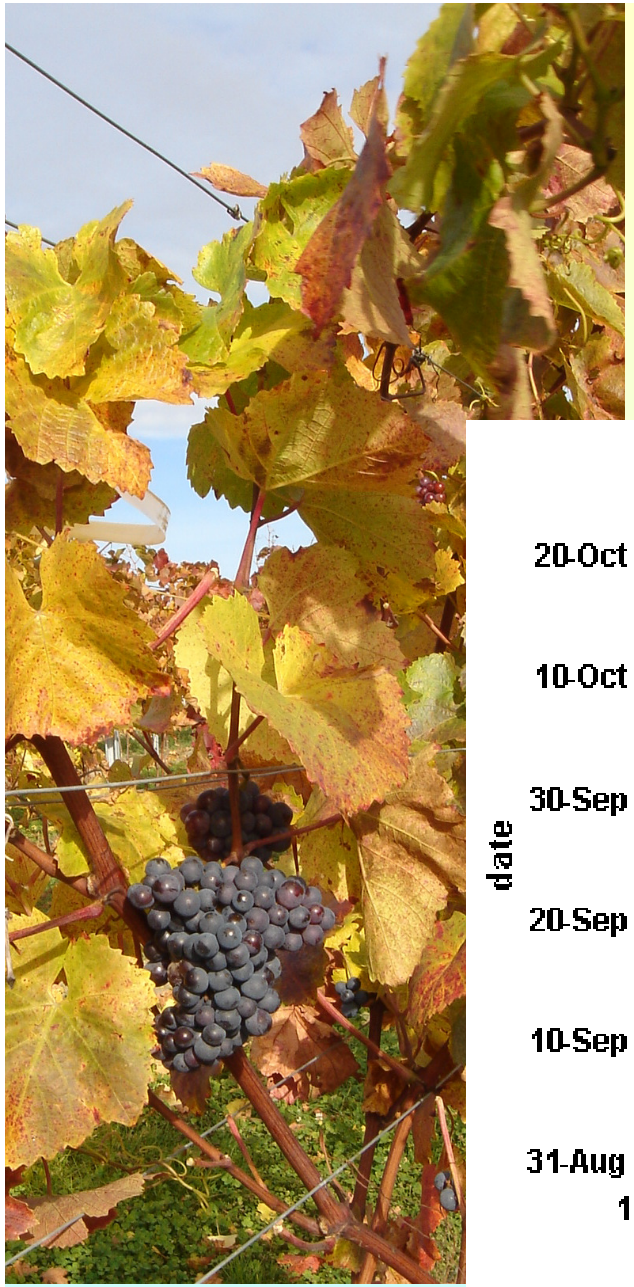
Soja et al., StartClim 2004 / ARCS

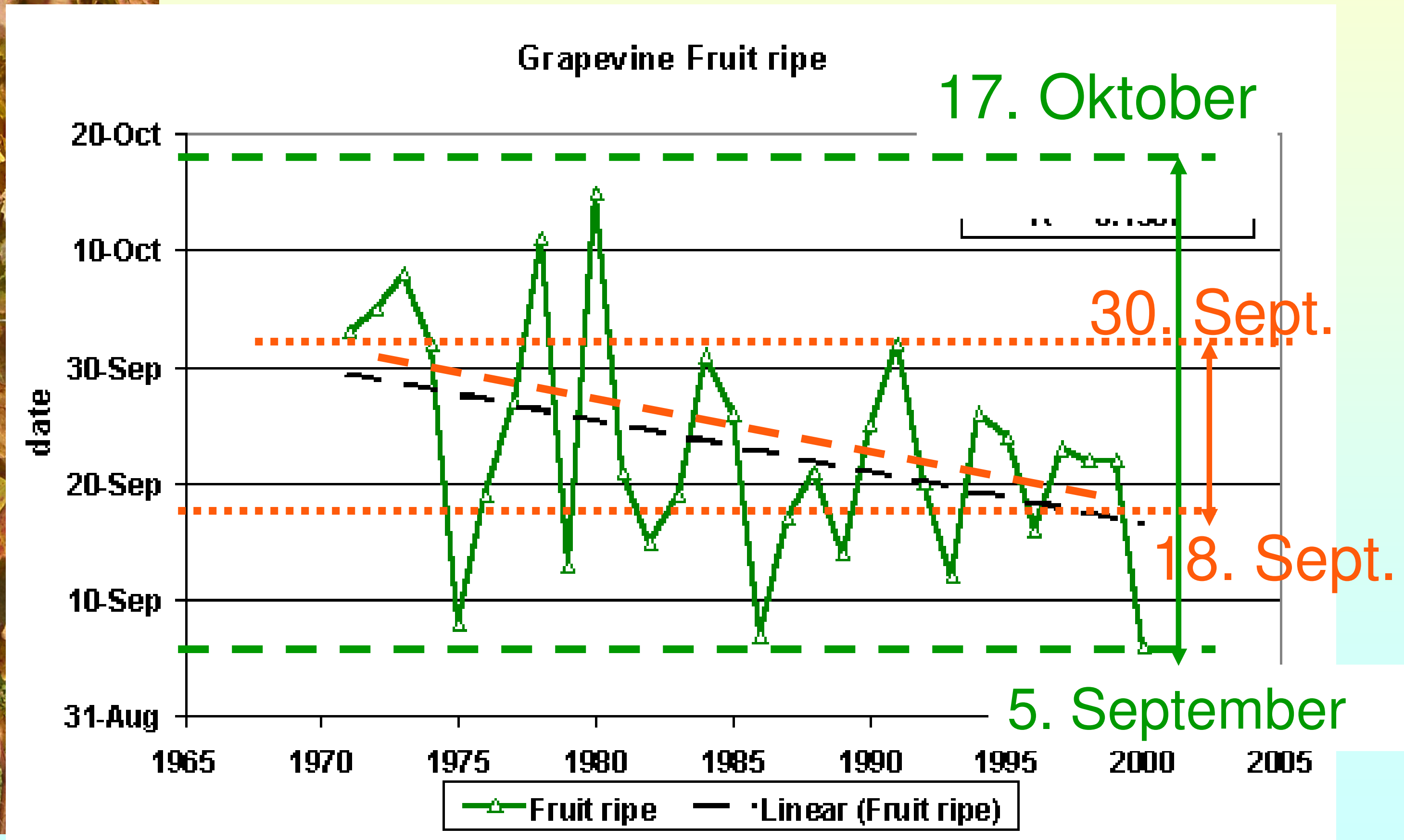


Simulated grassland dry matter yield, total, 2003

Grapevine Fruit ripe

Slovakia, 1970-2000





Results of impact studies on Austrian agriculture

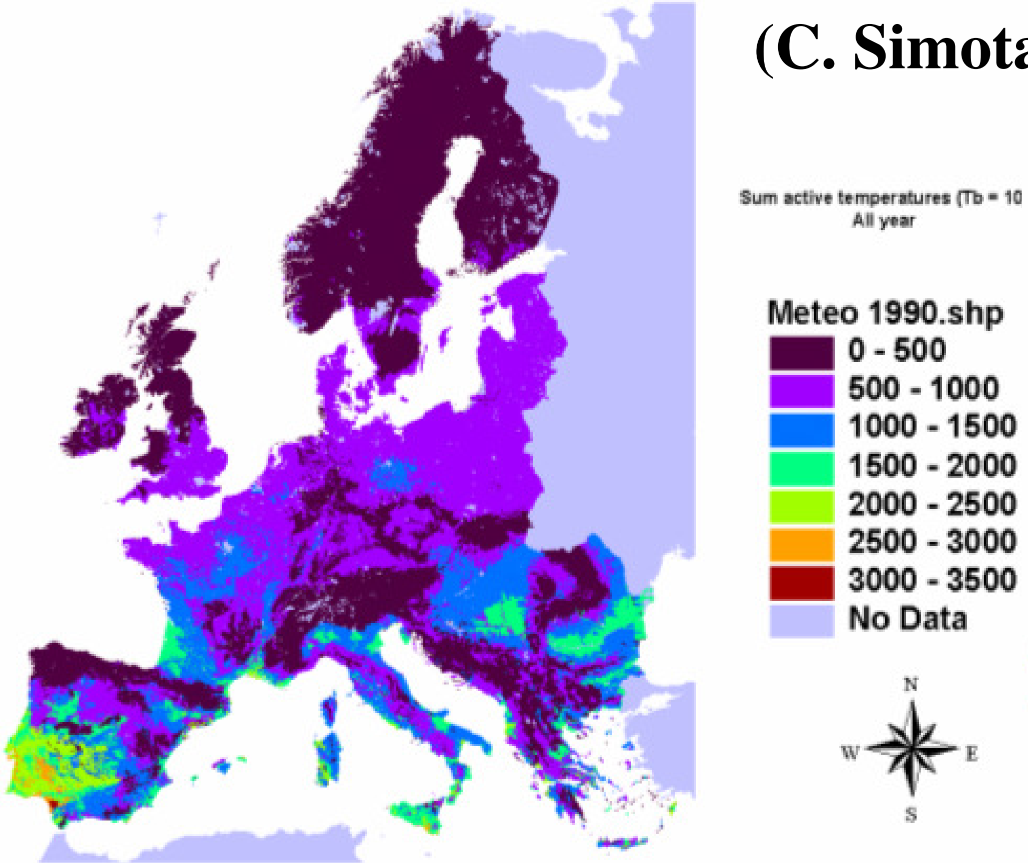
Key factors for crop production

- Global warming
  - + Removal of cold temperature limitations
  - – Exceedance of temperature thresholds
  - – Increased crop water requirements
  - – Changed occurence of pests and diseases
- Changes in composition of atmosphere
  - + Yield increases due to CO2 fertilization
  - + Increased water-use-efficiency
  - – Pollution (e.g. troposheric ozone)
- Alterations in precipitation patterns, soil moisture conditions, surface runoff

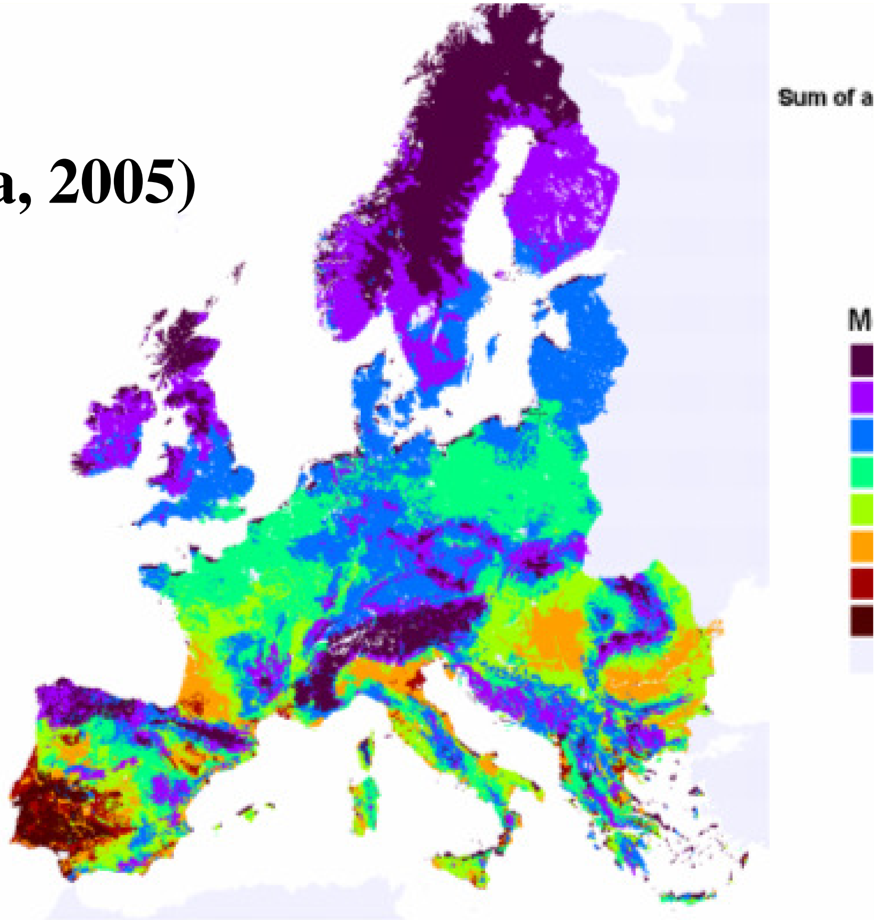
– Increased occurrence of extreme weather events

– Increased climate variability

(C. Simota, 2005)



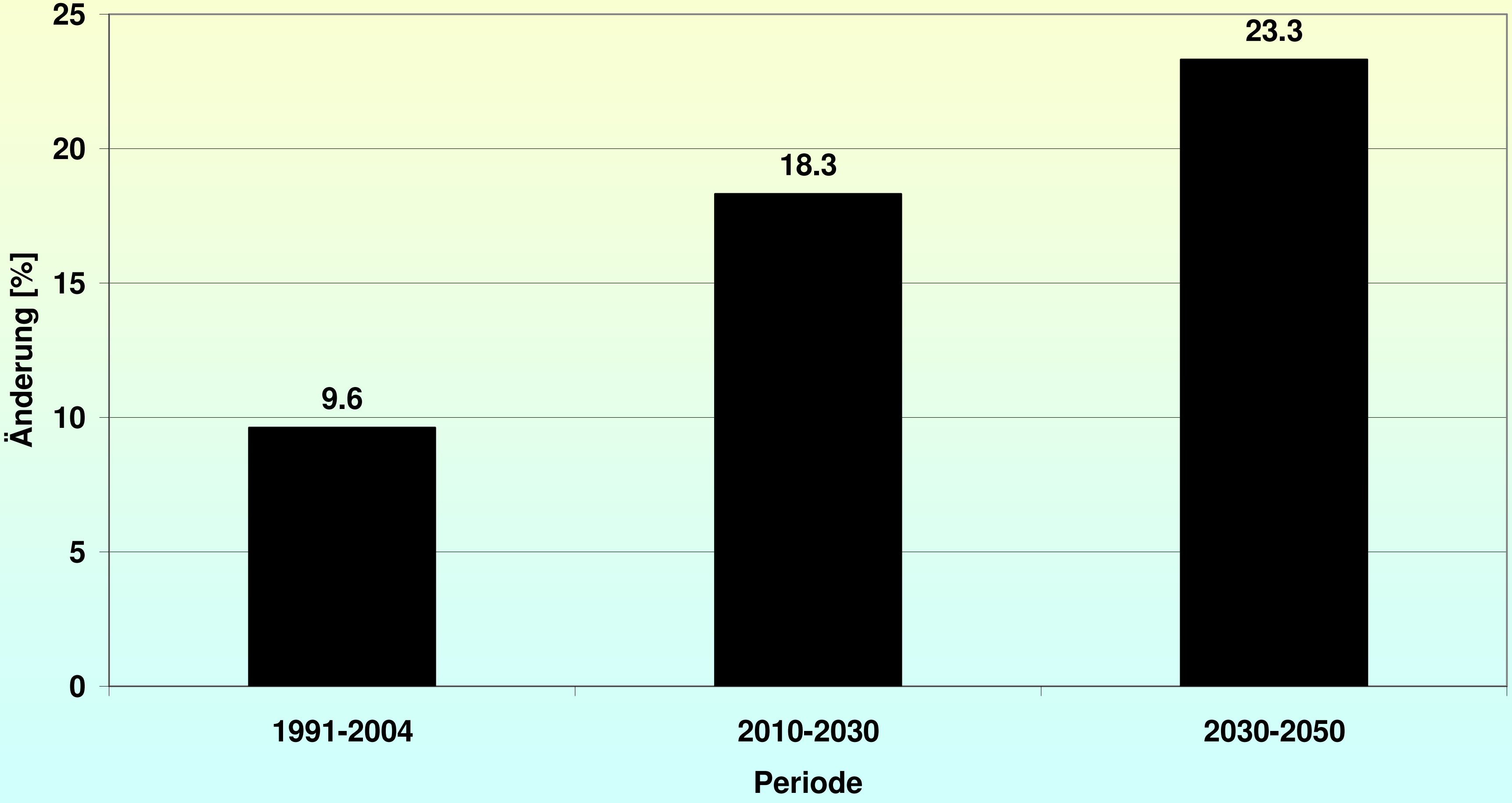
1990-2000



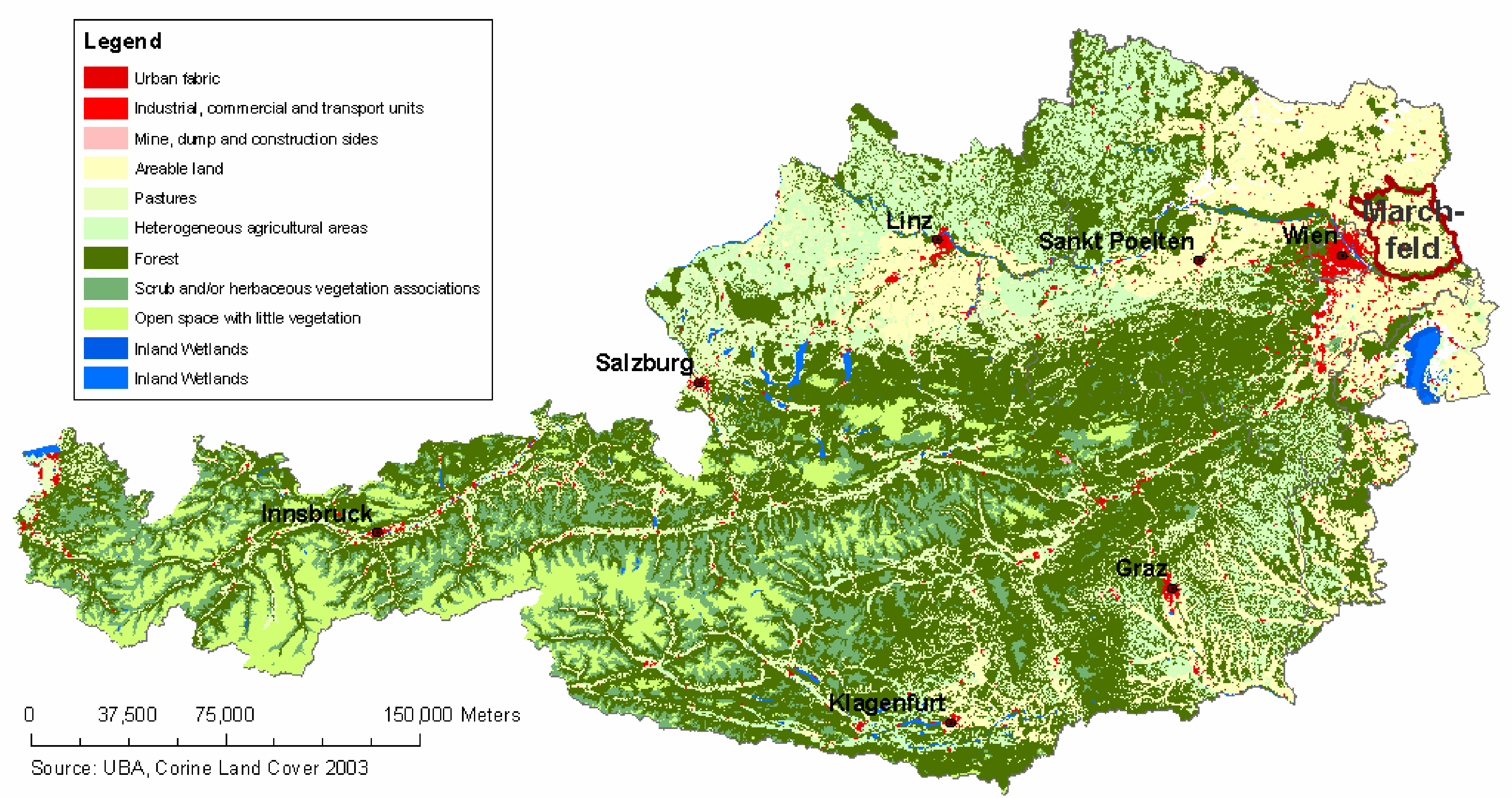
SRES-A2 2085-2095

Increase of temperature sums (base > 10^{o}C)

Increase of potential evapotranspiration in Eastern Austria compared to 1961-1990 period



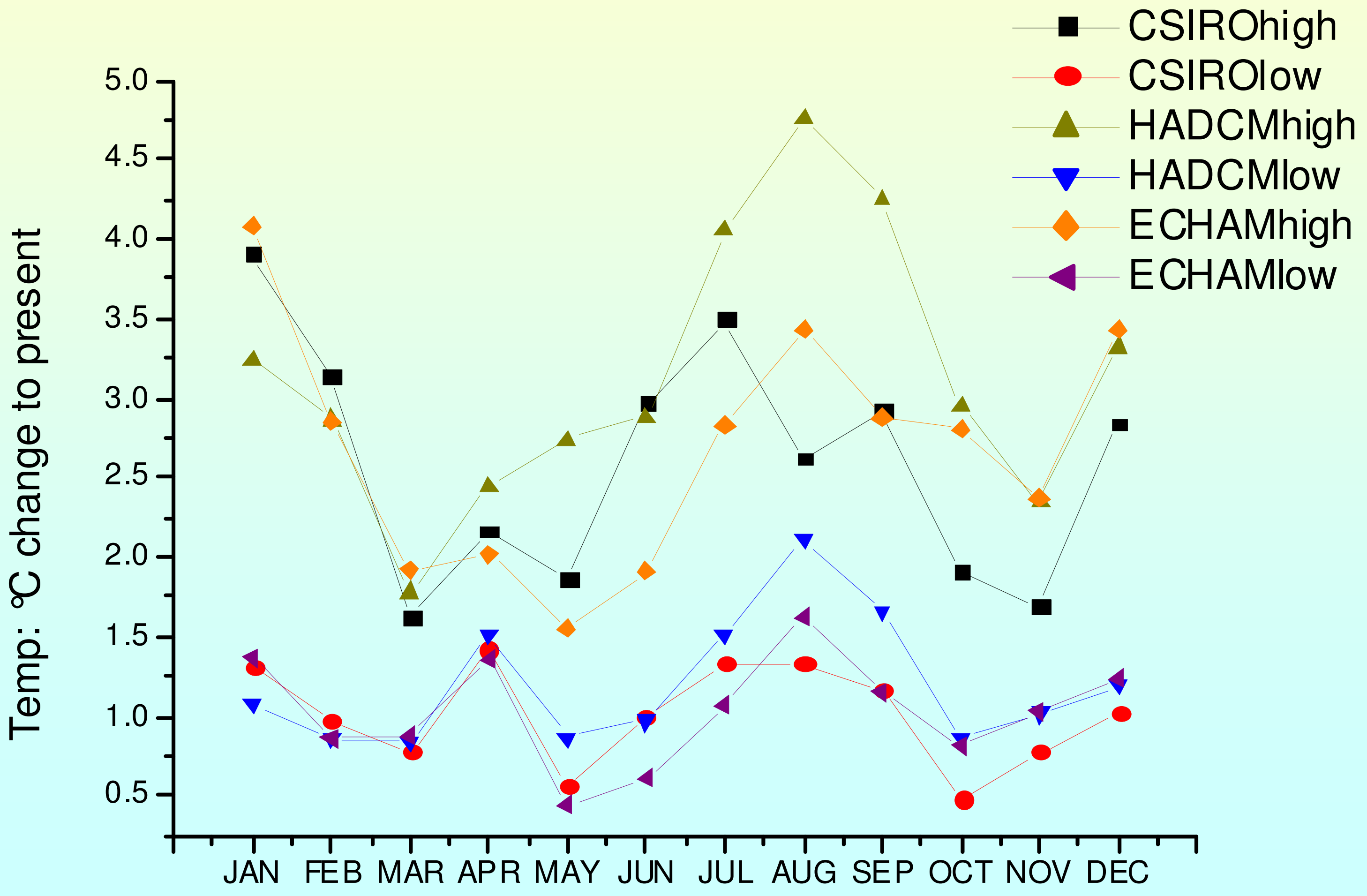
Investigation area: Marchfeld



- one of the major field agricultural production areas of Austria
- geologically part of the Vienna Basin, soils contain of bedrock Loess based on diluvial gravel, no access to groundwater
- semi-arid climate (Fuchsenbigl): annual mean temperature=9.8°C
annual precipitation sum=550mm

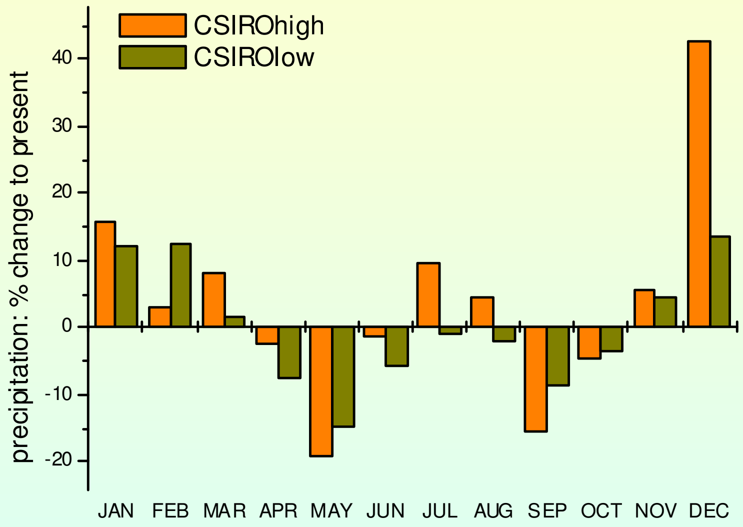
A2 SRES scenario 2050: CSIRO, HadCM, ECHAM - Maximum temperature

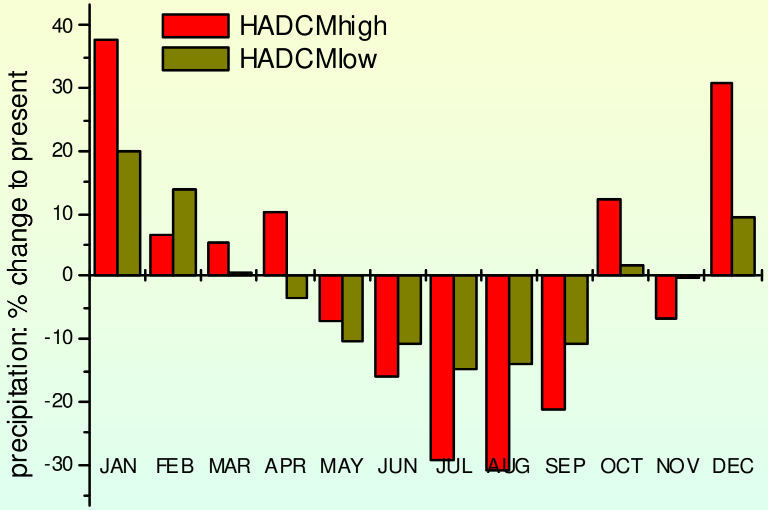
[°C change in respect to the present conditions]

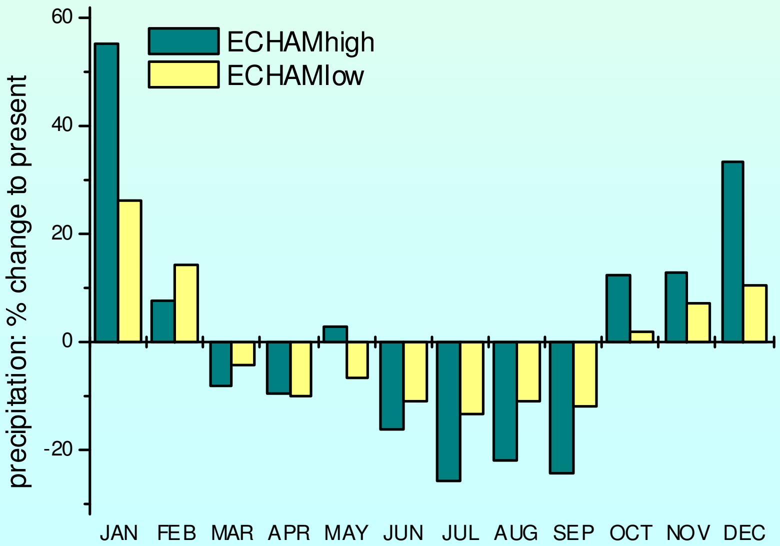


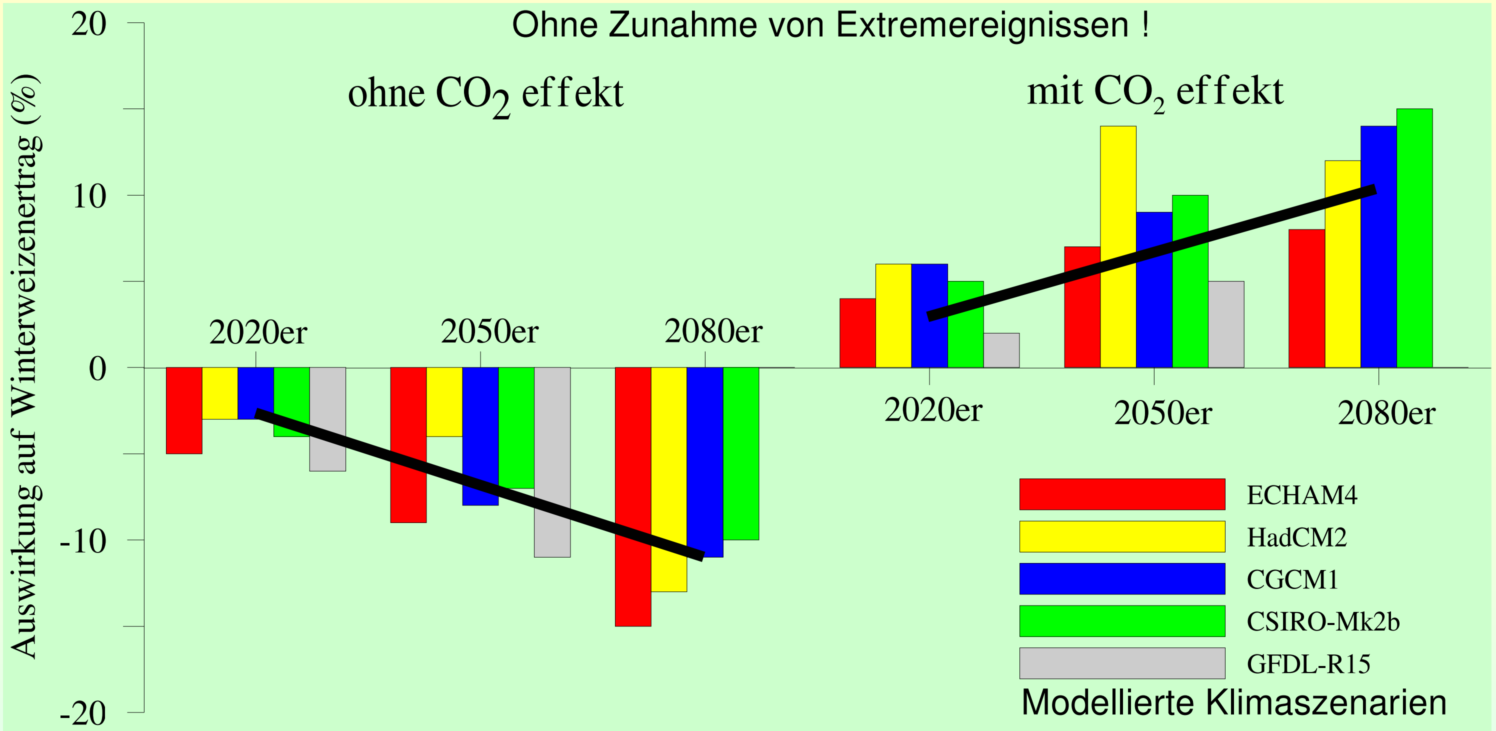
A2 SRES scenario 2050: CSIRO, HadCM, ECHAM – Precipitation

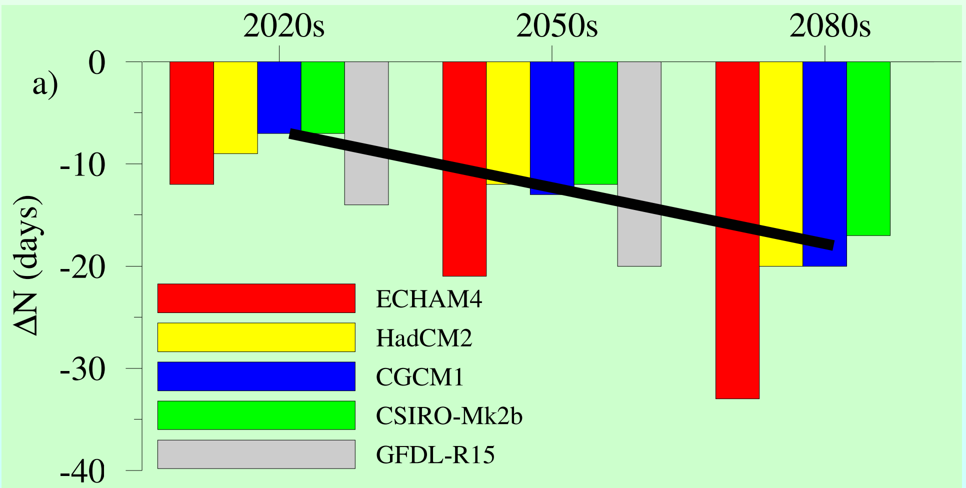
[% change in respect to the present conditions]







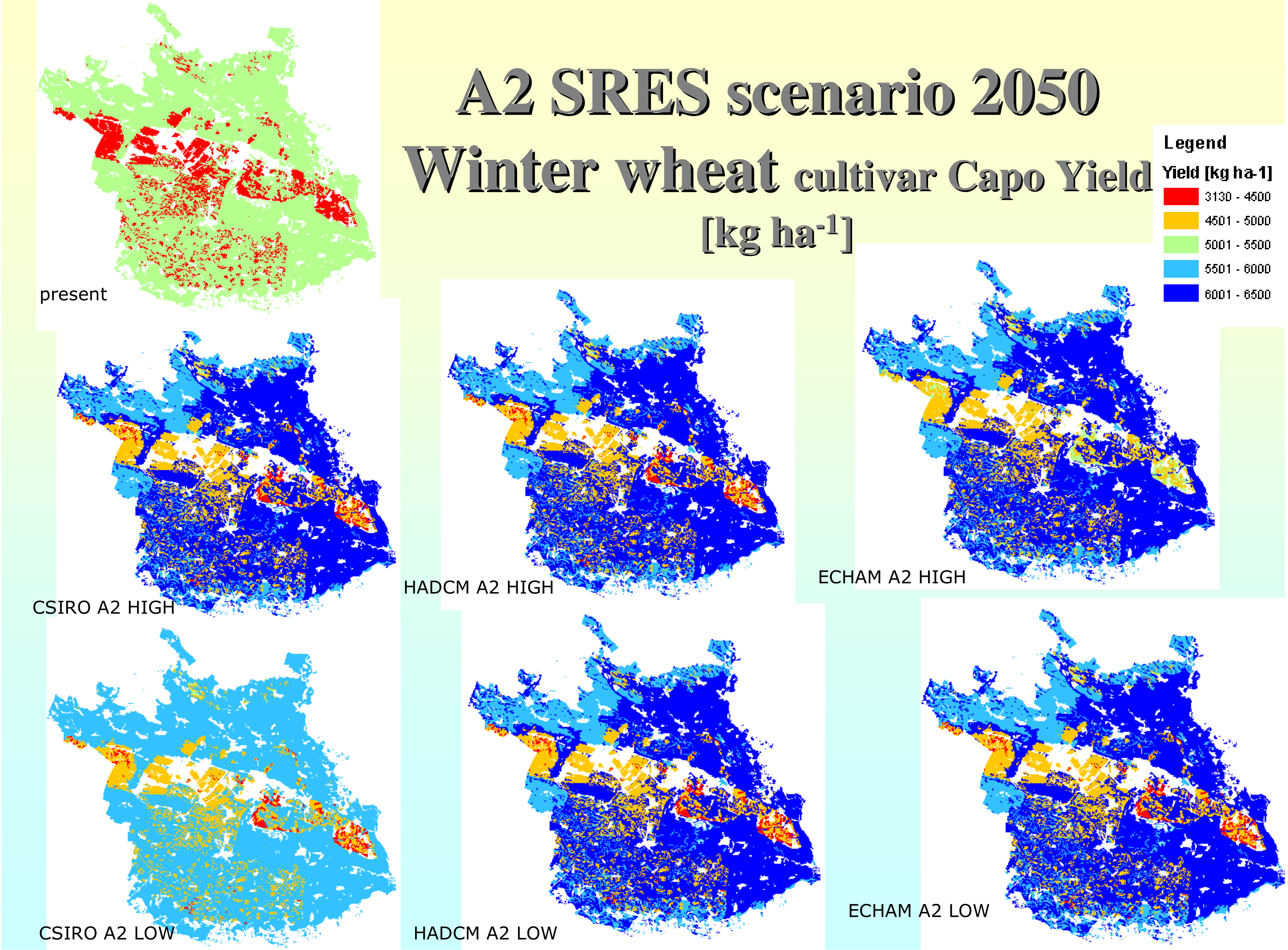




Crop model simulations
(CERES Wheat)

Sensitivity of winter wheat yield and phenology to climate change
(Alexandrov and Eitzinger, 2001)

A2 SRES scenario 2050
Winter wheat cultivar Capo Yield [kg ha^{-1}]



A2 SRES scenario 2050 (CO_2 = 535ppm)
Winter wheat cultivar Capo Yield [kg ha^{-1}]
% change in respect to the present conditions

	CSIRO HIGH	CSIRO LOW	HADCM HIGH	HADCM LOW	ECHAM HIGH	ECHAM LOW
Fuchsen-bigl	+ 8.7	+ 5.3	+ 8.7	+ 6.1	+ 8.5	+ 6.4
soil 1	- 2.1	+ 5.1	- 0.5	+ 6.8	+ 0.6	+ 8.3
soil 2	+ 11.3	+ 6.8	+ 11.9	+ 8.5	+ 11.8	+ 9.0
soil 3	+ 17.7	+ 11.7	+ 15.4	+ 12.2	+ 16.2	+ 12.6
soil 4	+ 16.6	+ 12.7	+ 13.8	+ 13.0	+ 14.2	+ 13.4
soil 5	+ 5.7	+ 7.4	+ 6.3	+ 8.4	+ 3.5	+ 7.7

Main impacts on Austrian agriculture

Crops

- **Due to increasing temperature sums, and related change in water balance a shift in the potential production areas of different crops is expected (e.g. maize, potatoe, soybean, sugar beet,..). New crop varieties and crops could be introduced.**
- **Summer crops will suffer more than winter crops**
- **Mean yields will slightly increase till the 2040´s for winter cereals, slightly decrease for summer cereals.**
- **But : Significant increase of interannual yield variability due to increasing extremes (especially drought and heat)**
- **In dry/warm regions negative effects due to increasing drought and heat stress will be significant (especially for summer crops and on sandy soils)**
- **The variation of production potentials between regions will increase, as water becomes a more limiting factor!**

- Crop production can show strong yield decrease under drier climate, especially in regions which are currently already close to the precipitation limits.
- Effects combined with heat and drought can trigger additional damages (e.g. ozone, UV radiation)
- New weeds will spread (e.g. invasion from the warmer southern and eastern countries)
- An increasing vegetation period and climate will affect workable days and has implications on production technology and costs.
- Pest and diseases will change their occorence, development rate, geographical distribution

Permanent grassland

- In regions of up to 700mm annual precipitation increasing drought periods will lead to higher production risk and deacreasing production potential.
- In the more humid regions (alpine) the increase of the vegetation period due to warming will lead to higher production potential. However, increasing drought frequency can lead to higher variability in annual yields.
- A change in composition of grassland varieties will occur, with consequences to fooder quality.
- Heat damage of grassland will increase, even without drought.
- Damages by pests (insects e.g. white grub) will probably increase.
- In alpine regions grasslands could increasingly be damaged by extreme precipitation and water erosion.

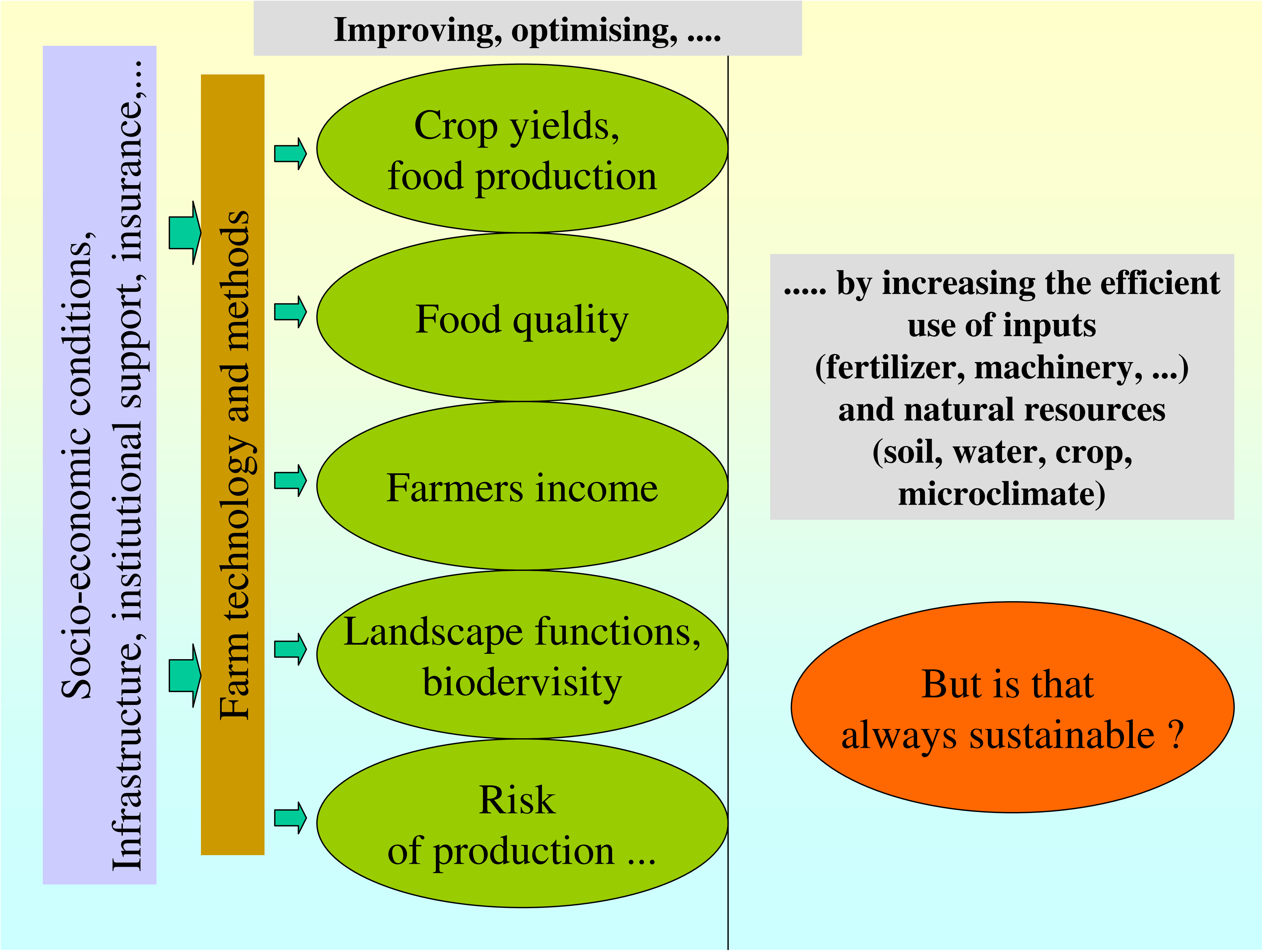
Orchards

- Wine production will be affected especially by higher temperatures (shift of phenological calendar and related management; change in wine quality; shift of potential production areas; new pests (especially insects),...)
- Soil water erosion problems will increase in hilly regions.
- In some regions increasing hail damage is possible (e.g. Styria)
- Drought could be an increasing problem in apple orchards in Austria.
- Late frost damages will increase due to earlier phenology (all orchards are affected)
- Increasing pressure from pests (especially insects - new ones, more generations)

Animal farming

- Increasing number of heat days will have consequences for air conditioning of stables (higher costs for cooling); potential losses will increase under current condtions
- In cool regions heating costs and cost for stables regarding isolation could be reduced.
- Shading of animals in free land will be important
- Decreasing performance of animals by heat stress
- Increasing need for storage potential of fodder due to increase of yield variablity of fodder.
- ...

Adaptation options in agriculture – some aspects



Improving, optimising, ...
Socio-economic conditions,
Infrastructure, institutional support, insurance,...
Farm technology and methods
Crop yields,
food production
Food quality
Farmers income
Landscape functions,
biodervisity
Risk
of production ...
..... by increasing the efficient use of inputs (fertilizer, machinery, ...) and natural resources (soil, water, crop, microclimate)
But is that always sustainable ?

Potential adaptation measures in Austria

- **Protection against evapotranspiration (reducing wind speed : hedge rows etc.; increasing conductance : mulching etc.; reducing available energy : shading etc.)**
- **Adaptation of crop rotation; reducing summer crops, increasing winter crops (better use of soil water)**
- **Reducing soil cultivation and improving soil structure (increasing soil water storage capacity)**
- **Adaptation of crop growing period (seeding date etc.)**
- **Change of crops and cultivars (e.g. for a better drought tolerance or water use efficiency)**
- **Invest in irrigation systems**
- **Increasing number of crop varieties - decreasing yield risk through weather extremes**
- **Protection measures for soil erosion (hilly regions)**
- **Establishing monitoring systems (e.g. by using GIS)**

Fields for further investigation in Austria

- Investigate feedbacks from economic and socioeconomic conditions on adaptation measures
- Multiple effects of adaptation measures often unknown (e.g. earlier seeding time vs. frost damage; increasing mulching vs. deseases, insect damage etc.)
- Yield risk under climate scenarios of local production conditions and current production systems (e.g. meadows vs. arable land)
- Water demand of biomass production under climate scenarios
- The potential of ecological farming for adaptation
- Adaptation options against soil erosion in various regions
- Changing potential of pests and diseases on main crops
- In which regions / for which crops irrigation could be an alternative
- Adaptation options for orchards / grapes
- ...?


Thank you !