MMM Conference
Graz, Jan. 29-31, 2007

Scenarios of Climate Change in Southern and Eastern Styria
and
Potential Impacts on Agriculture and Water Availability

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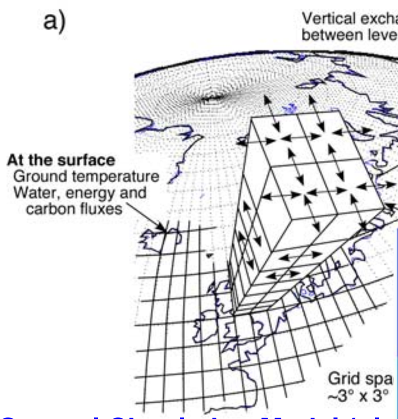
Outline

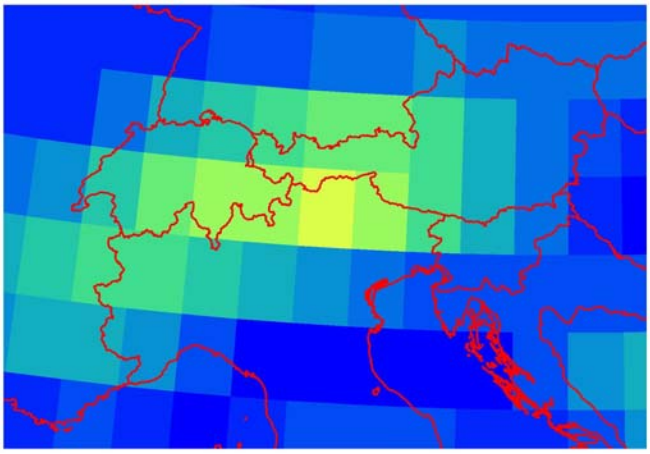
- **Introduction – Regional Climate Modelling**
- **Model Evaluation**
- **Regional Climate Change 2040s**
- **Examples for Climate Impacts in Styria**
- **Conclusions and Outlook**

Globale Modelle ...



General Circulation Model (glo
Quelle: McGuffiie, Henderson-Sellers, 2005

The Alps as seen by a global Model

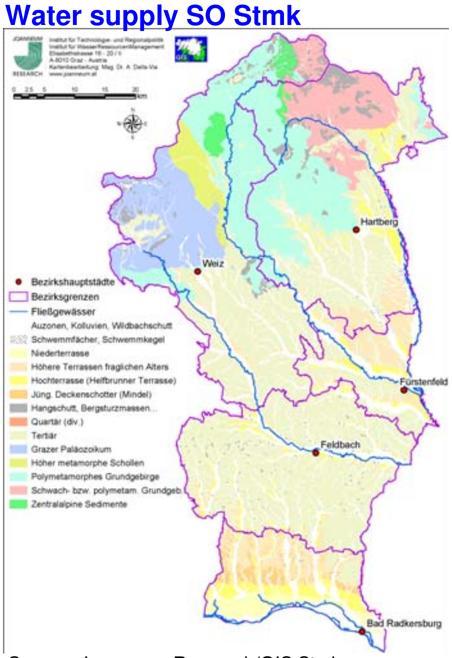


... regional/local challenges

Flash floods

Kappl/Paznauntal, Sommer 2005 (Source: ASI Tirol)

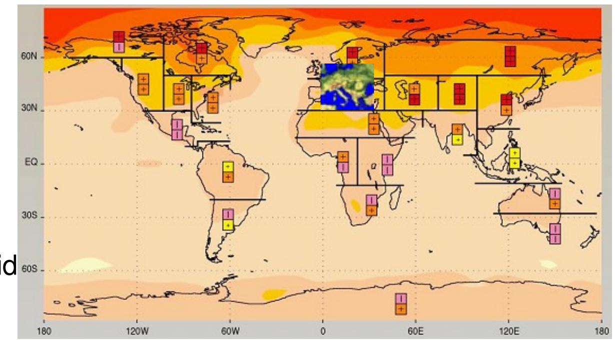
Water supply SO Stmk



Source: Joanneum Research/GIS Stmk

“Dynamical Downscaling”

- Regional Climate Model (RCM) “nested” within a global general circulation model (GCM) to increase resolution
- Initial and boundary conditions from GCM, insid RCM dynamics



Source: IPCC, 2001

- GCM simulates the response of general circulation to large scale forcings, RCM simulates regional responses to general circulation and regional-scale forcings

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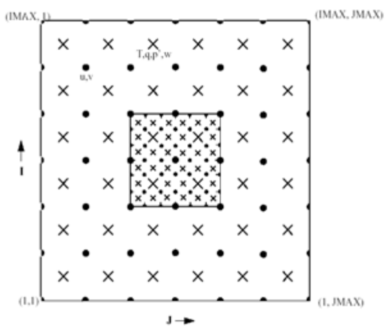
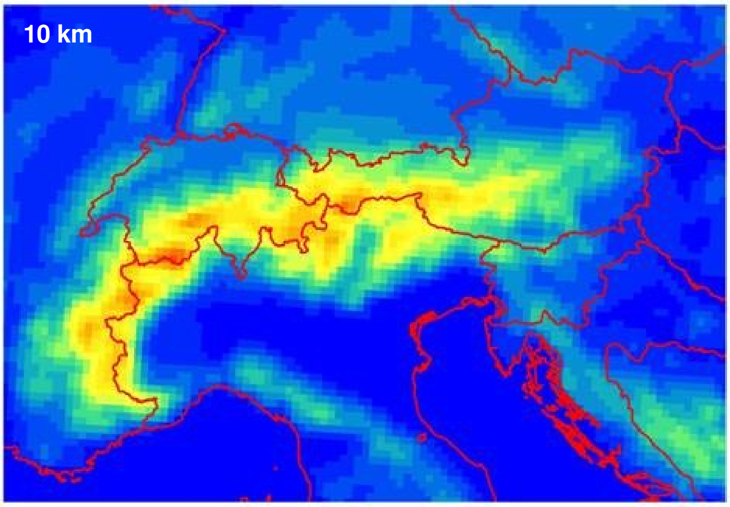


- GCM simulates the response of general circulation to large scale forcings, RCM simulates regional responses to general circulation and regional-scale forcings

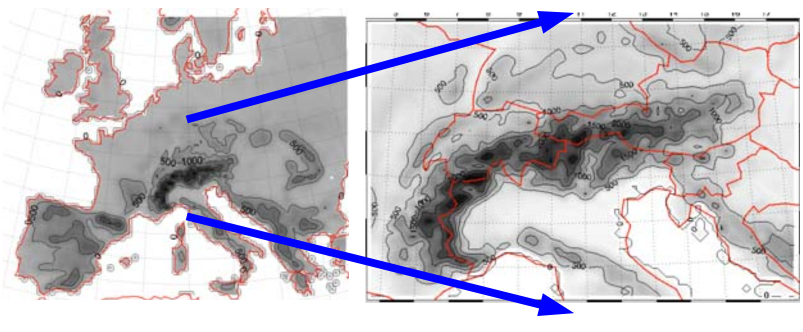
Alps as seen by a high res. RCM



Model Setup

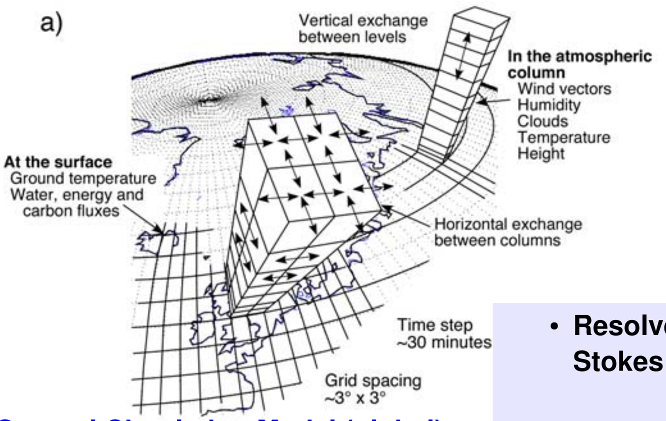
MM5

- Climate mode
  (no re-initialization)
- Double nesting
  (T106 --> 30 km -> 10 km)



- **Introduction - Regional Climate Modelling**

Global Models ...



General Circulation Model (global)
Source: McGuffiie, Henderson-Sellers, 2005

- **Resolved processes: Navier-Stokes Equations**
- **Sub-grid processes: Parameterizations**

--> Results: Physical state of the atmosphere (temp., pres., wind, humid., radiation, precip., ...)

Regional Climate Simulations

1) Hindcast/Evaluation Run (1981 – 1990)
Boundary conditions: ERA-40 ("perfect boundary conditions")
→ RCM evaluation
→ Reference for quality assessment RCM+ECHAM5
→ High res. climate analysis

2) Control Run (1981 – 1990)
Boundary conditions: ECHAM5 T106* (observed GHG)
→ Control simulation for:

3) Scenario Simulation (2041 – 2050)
Boundary conditions: ECHAM5 T106* (IS92a)
→ Climate change analysis
→ High res. climate scenario for further downscaling and impact studies

*ECHAM5 simulation by M. Wild and P. Tschuck, ETH Zurich

reclip:more

Research for **Cli**mate **P**rotection: **Mo**del **R**un **E**valuation (**reclip:more**)

- **Team:** ARC-sys, BOKU-Met, IMG/UniVienna, WegCenter/UniGraz, ZAMG

- **Objectives:**
  - Evaluate the capability of dynamical and statistical downscaling methods in the **Alpine region** to create **high resolution climate scenarios**
  - Create of climate **scenarios suitable for climate impact research**.

- **Challenges:** various **climatic regimes**, extremely complex **topography**, **high target resolution** (**10km**/1km) → simulation and evaluation challenges

- **Periods:** **1981-1990** (control), **2041-2050** (scenario), shorter periods

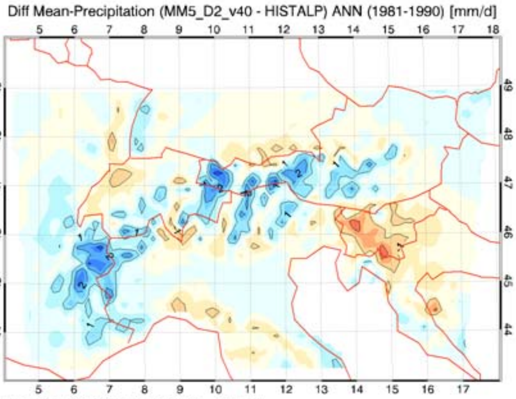
- **Methods:** **Dynamical** (**MM5**, **ALADIN**), statistical, diagnostic downscaling

- **Model Evaluation**

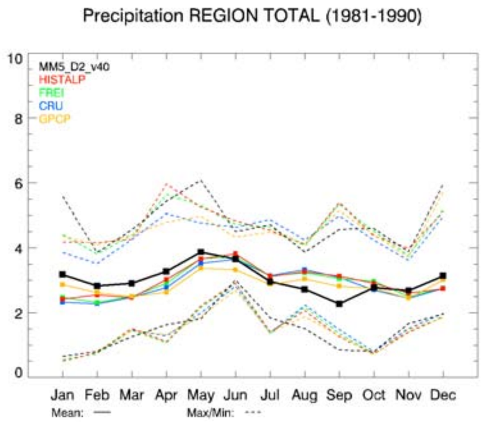
MM5 Precipitation Difference to Observations

Precipitation
MM5 – Obs. (HISTALP) annual mean

Bias: 0.1 mm/d

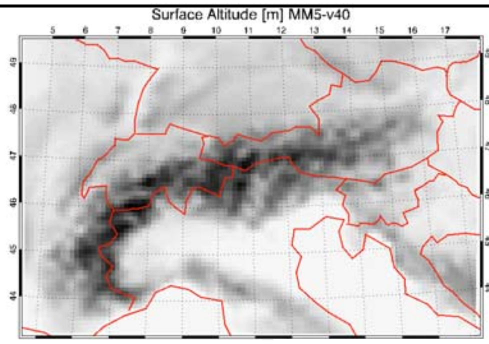


Precipitation
MM5 – Observation annual cycle

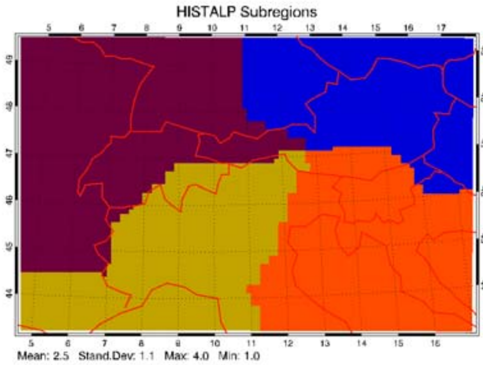


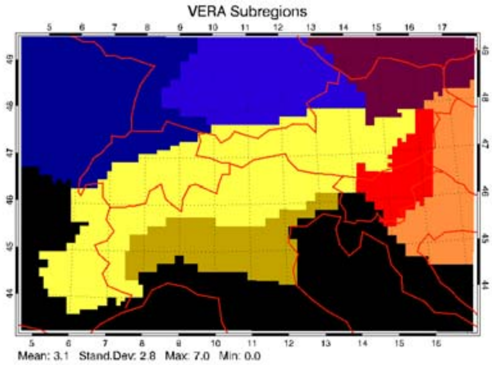
Sub-Regions

HISTALP
Source:
ZAMG Austria

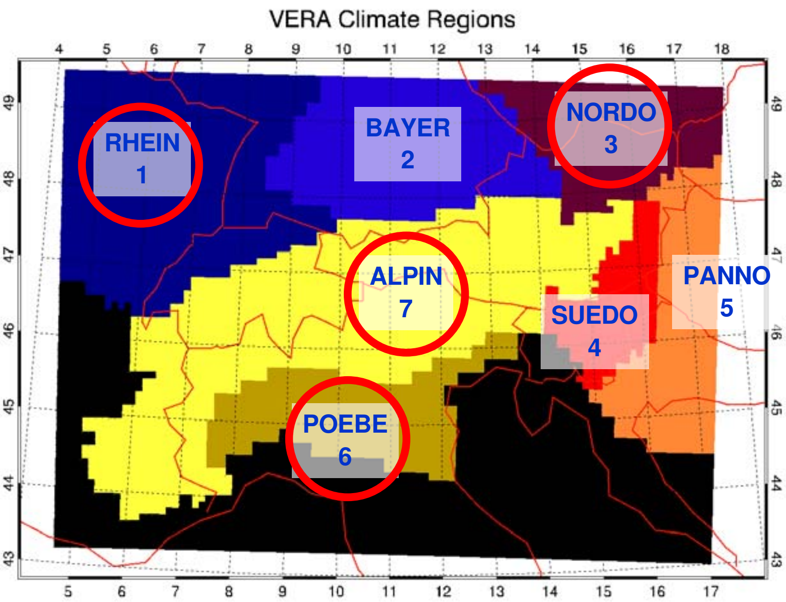


VERA
Source:
IMG/ Uni Vienna

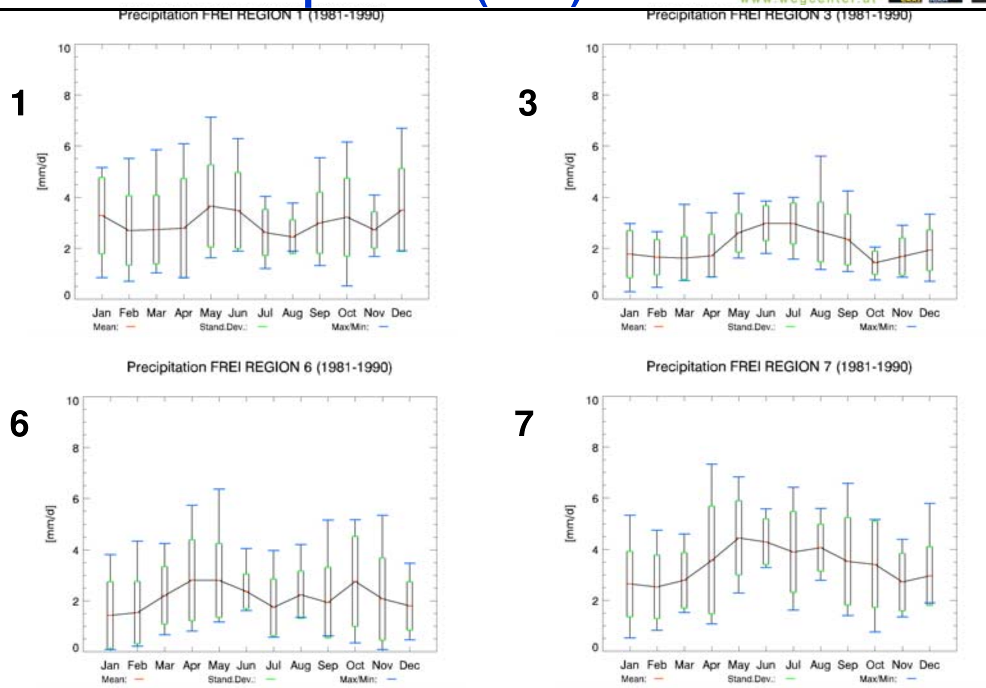




Evaluation Summary
MM5 Precip. vs. HISTALP

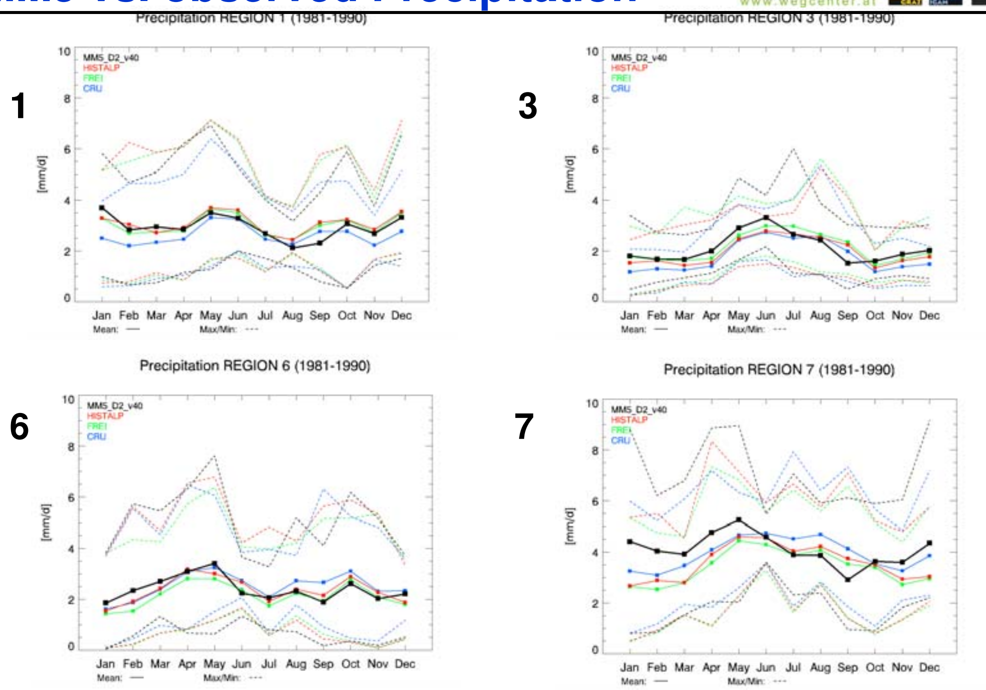


Evaluation Summary
Observed Precipitation (Frei)



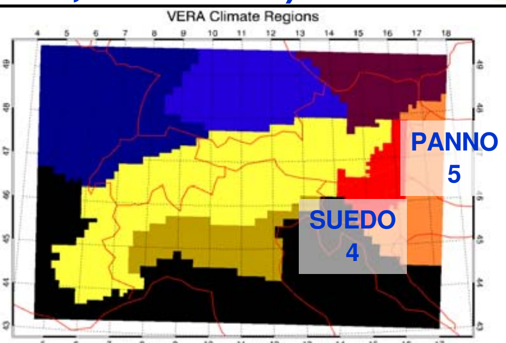
Source: Frei, MeteoSwiss

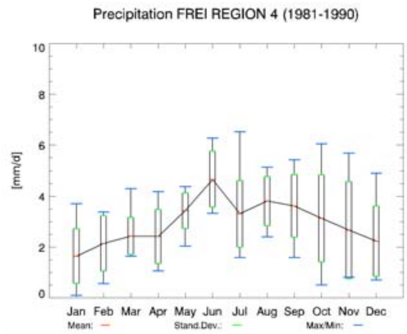
Evaluation Summary
MM5 vs. observed Precipitation

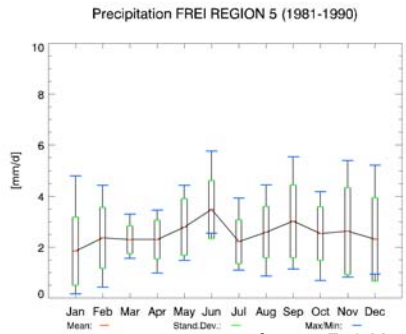


Source of obs. data: ZAMG, CRU, MeteoSwiss

Evaluation Summary
South East (Frei, HISTALP)







Source: Frei, MeteoSwiss

Evaluation Summary
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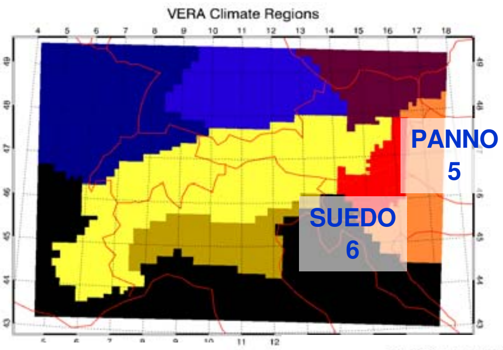
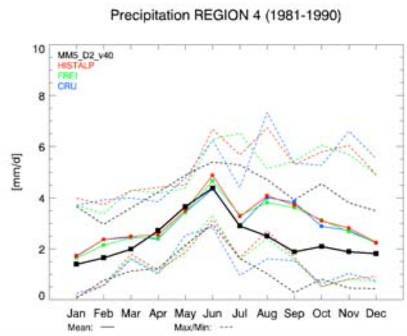
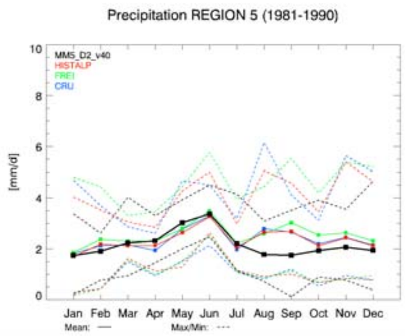


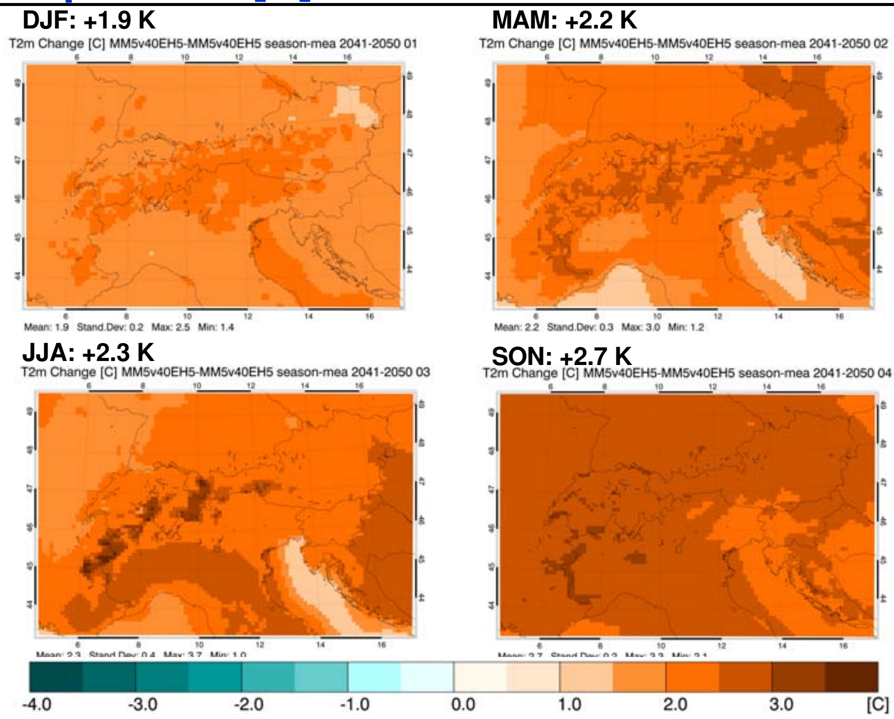




Source of obs. data: ZAMG, CRU, MeteoSwiss

- **Regional Climate Change 2040s**

Mean Climate Change 1980s vs. 2040s
2m Temperature [K]

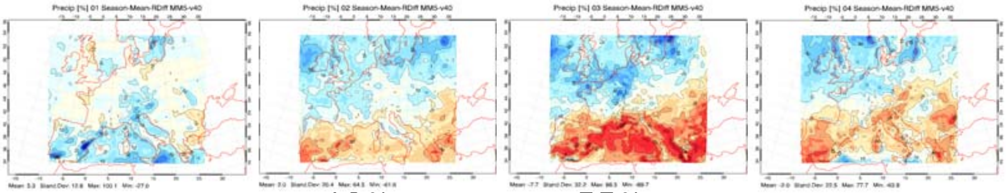


Year:
+2.3 K

Mean Climate Change 1980s vs. 2040s
Precipitation [%]

MM5 D1

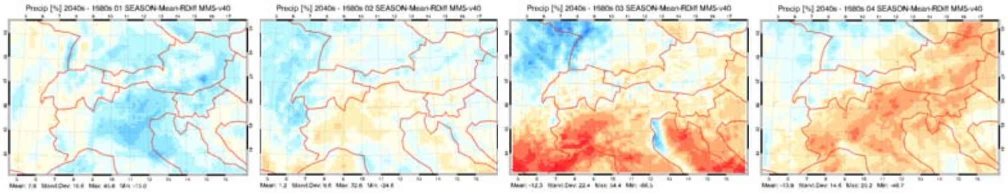
Year DJF MAM JJA SON



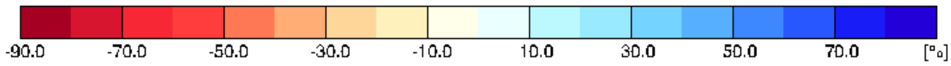
5.3 % 1.2 % -7.7 % -2.0 %

MM5 D2

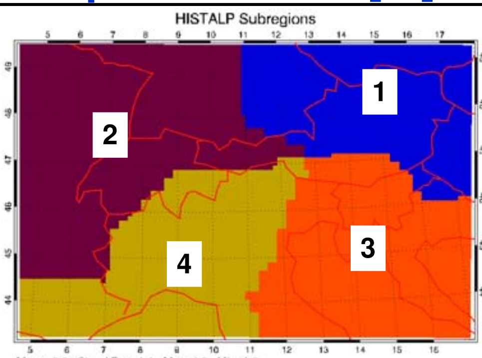
Year DJF MAM JJA SON

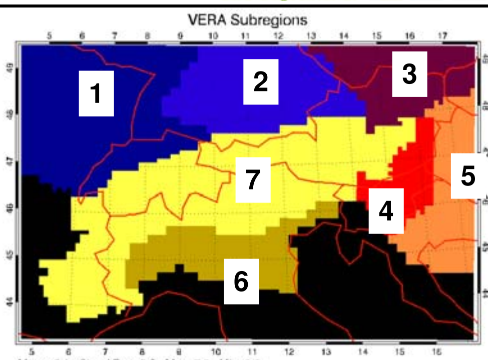


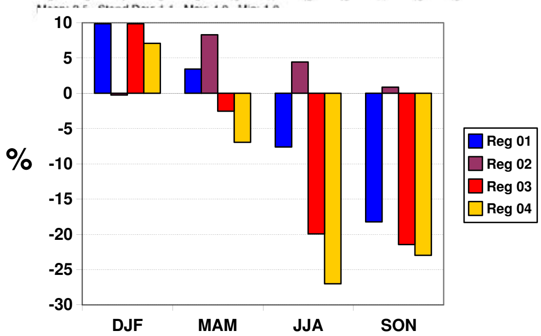
-4.0 % 7.9 % 1.2 % -12.3 % -13.9 %

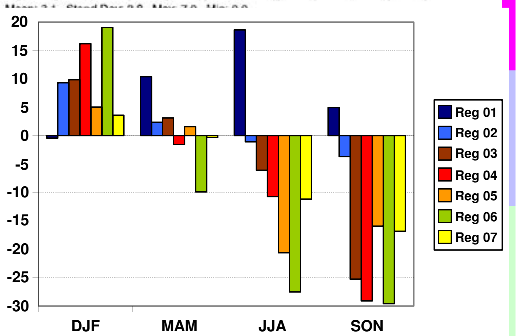


Mean Climate Change
Precipitation MM5 [%]





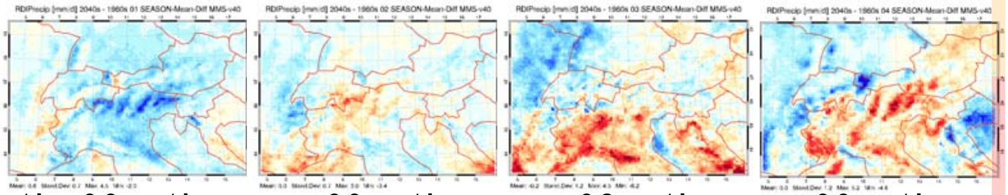




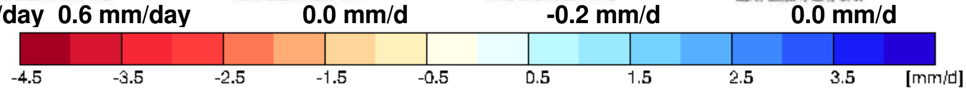
Precipitation Intensity / Frequency

MM5 Precip. Intensity

Year | DJF | MAM | JJA | SON

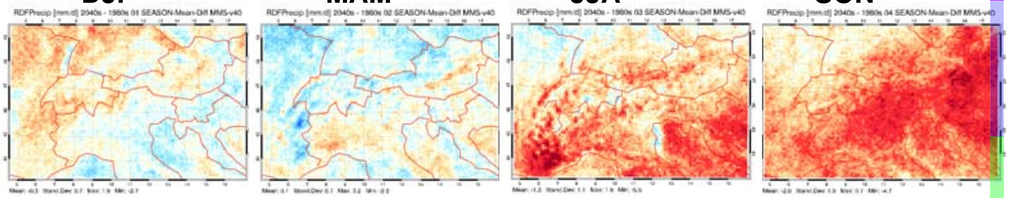


0.1 mm/day | 0.6 mm/day | 0.0 mm/d | -0.2 mm/d | 0.0 mm/d

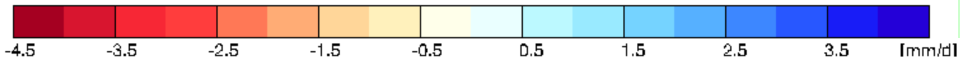


MM5 Precip. Day Frequency [days per month]

DJF | MAM | JJA | SON



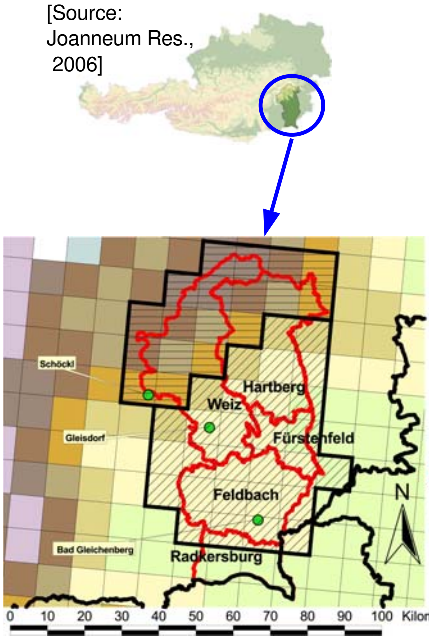
-0.9 | -0.3 | 0.1 | -1.3 | -2.0

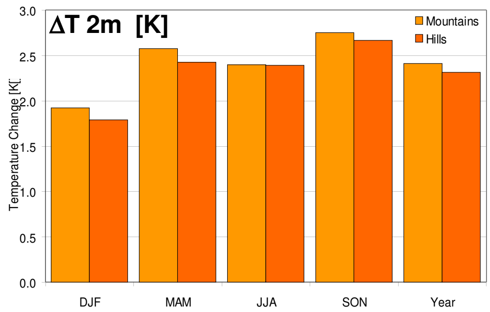


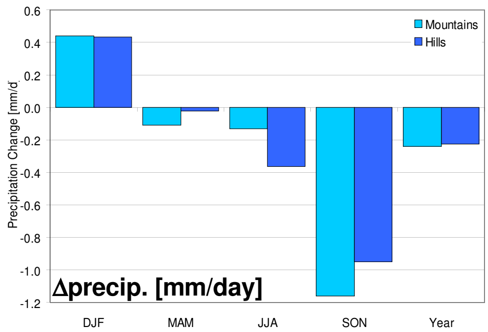
- **Examples for Climate Impacts in Styria**

Climate Change in SE Styria

[Source:
Joanneum Res.,
2006]







Impacts
EHGC Water

Adaptation in the Water Supply Sector of Eastern Styria
(Joanneum Research, WegCenter)

EHGC Water Conclusions:

- **Groundwater Recharge may decrease ~30% until 2040s** [JR, Dalla Via]
- **Comparing with supply-side adaptive strategies, demand-side options reveal to be insufficient** [JR, Oberauner, Prettenthaler]
- **Rough predictions of hydrologists about additional future water demand in times of peak load is about 200 l/s** [JR, Oberauner, Prettenthaler]
  - **Demand-side options are a good contribution, but can not cover expected demands**
  - **Realization of supply-side adaptive strategies necessary**

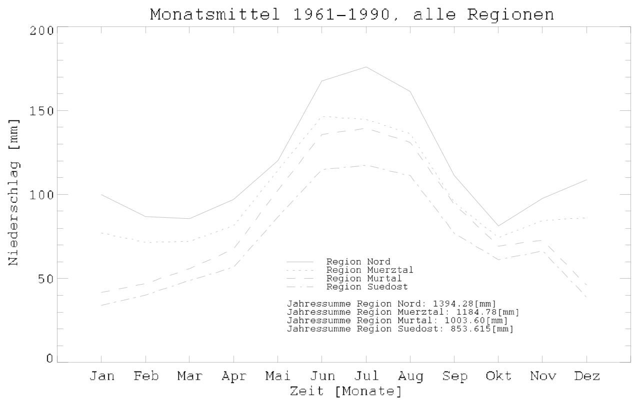
Impacts
AgroClim

Climate Change Impacts on Drought Agricultural Risk in Austria
(WegCenter, HBLFA)

- **Analysis of various drought indices for Styria**
- **Offline coupling of reclip:more results with drought stress + grassland yield model**

→ **Drought stress scenarios**

→ **Grassland yield scenarios**



[prepared by G. Heinrich]

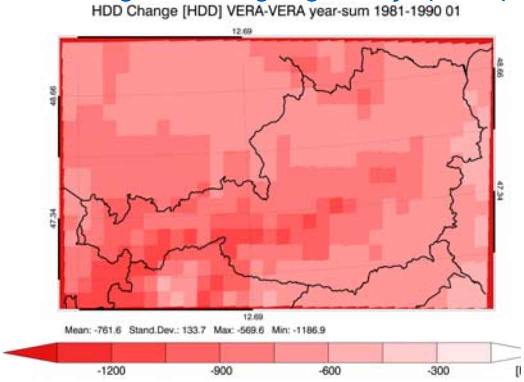
Impacts
StartClim: Heating/Cooling Energy

Climate Change Impacts on Heating and Cooling Energy demand In Austria (WegCenter, Uni. Vienna, Joanneum Res.)

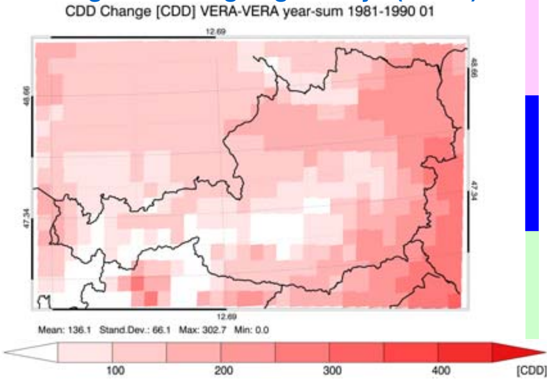
- **Observational data + reclip:more scenario → heating/cooling degree days**
- **Demographic + technical data**

→ **Changes in heating/cooling energy demand**

Change in heating degree days (2040s)



Change in cooling degree days (2040s)



- **Conclusions and Outlook**

Summary

Mean Climate Change

- 60-year temperature change in the Alpine region: **+2.2 K** (1.9 in spring, 2.7 in autumn)
- 60-year precipitation change in sub-regions: up to **+20 %** (winter), up to **-30 %** (SE, summer + autumn).

Change in Variability (day-to-day)

- Precipitation: Large regions with intensity (or even mean) increase and frequency decrease (e.g., NW winter) → more extreme conditions.

Conclusions & Outlook

Climate

- Alps: sharp transition zone for precipitation change, various sub-regions with different change-characteristics → more analysis in sub-regions necessary
- Closer analysis of variability (extremes) and their relation to model resolution

Climate Impact Research

- Results (10 km grid resolution) **available for climate impact research**.
- Further downscaling (~ 1km scale) and creation of "user tailored" datasets is currently going on...

more information:

http://www.wegcenter.at

http://systemsresearch.ac.at/LUC/reclip/