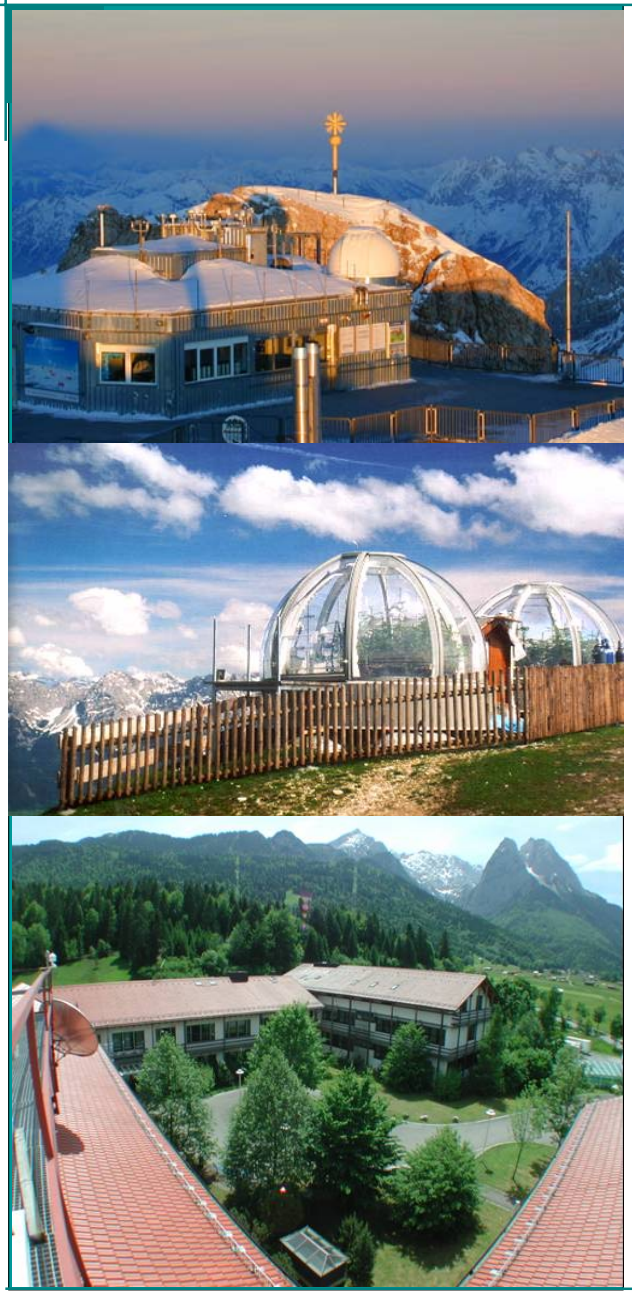

Climate Change in Mountainous Regions
Impacts, Responses, Research Needs

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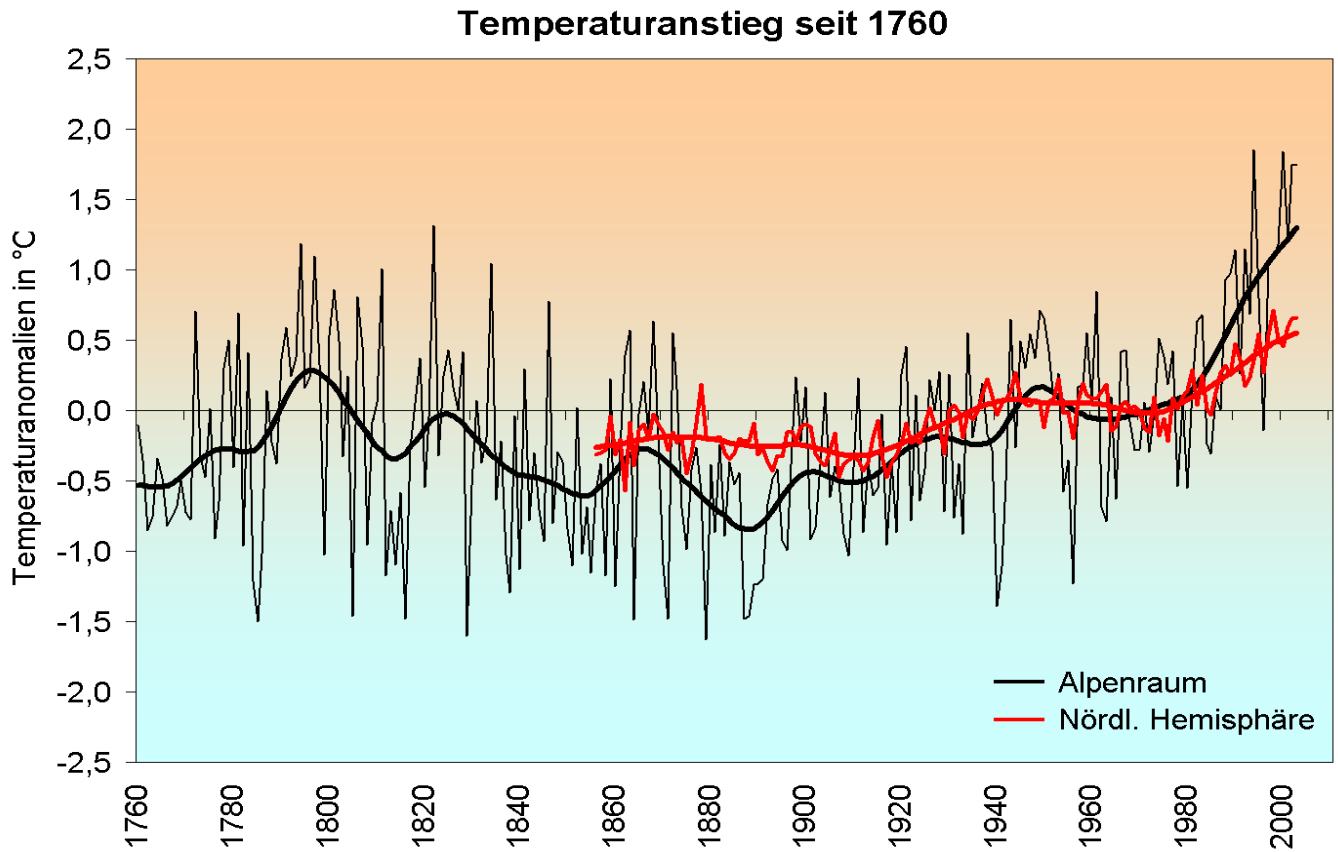
Observed Climate Change

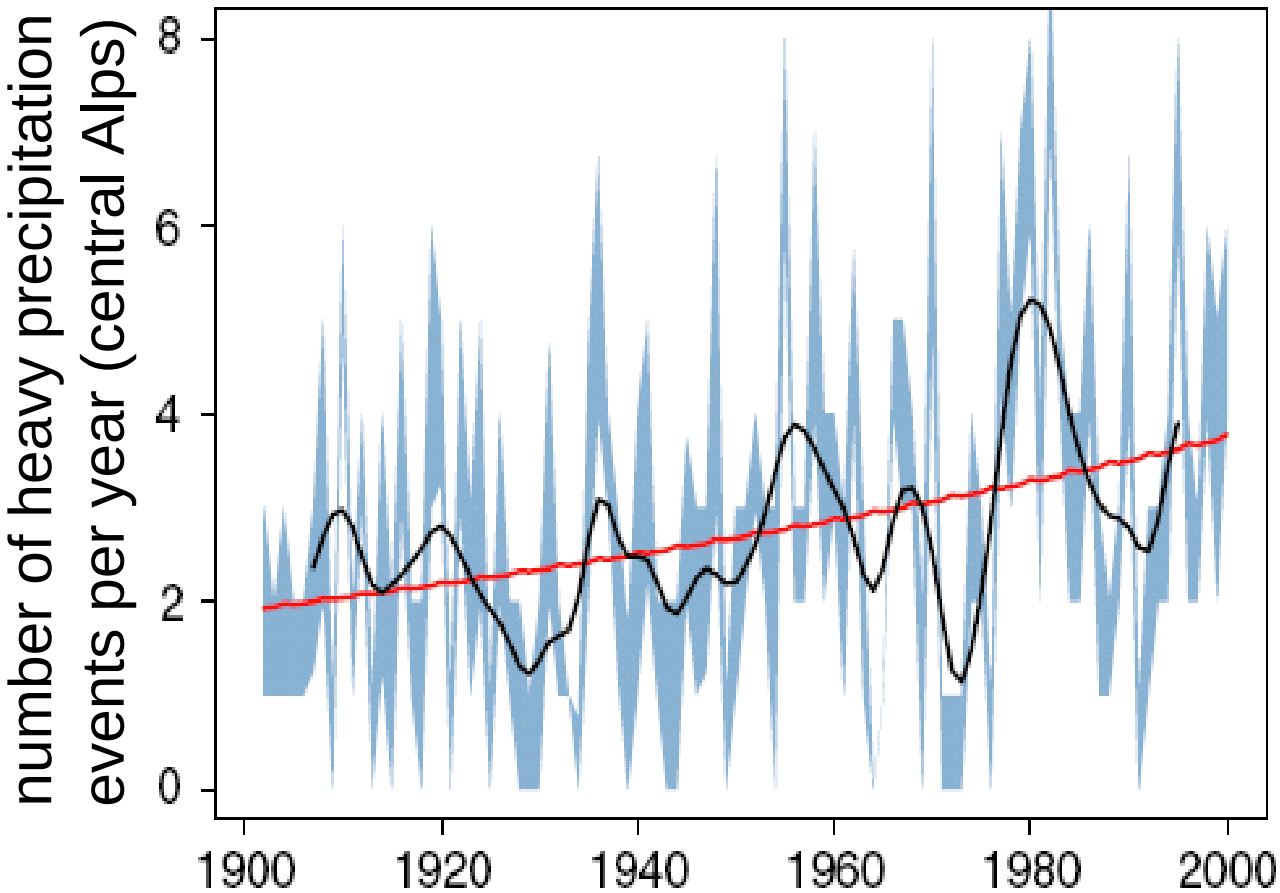
- Temperature
- Precipitation



References:
1) Auer et al. 2007 (HISTALP)
2) ProClim Report 2007 (CH2050)

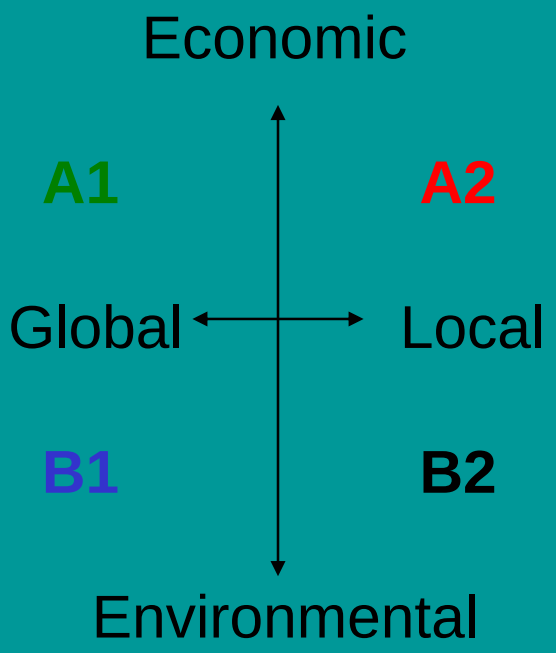
Observed Climate Change

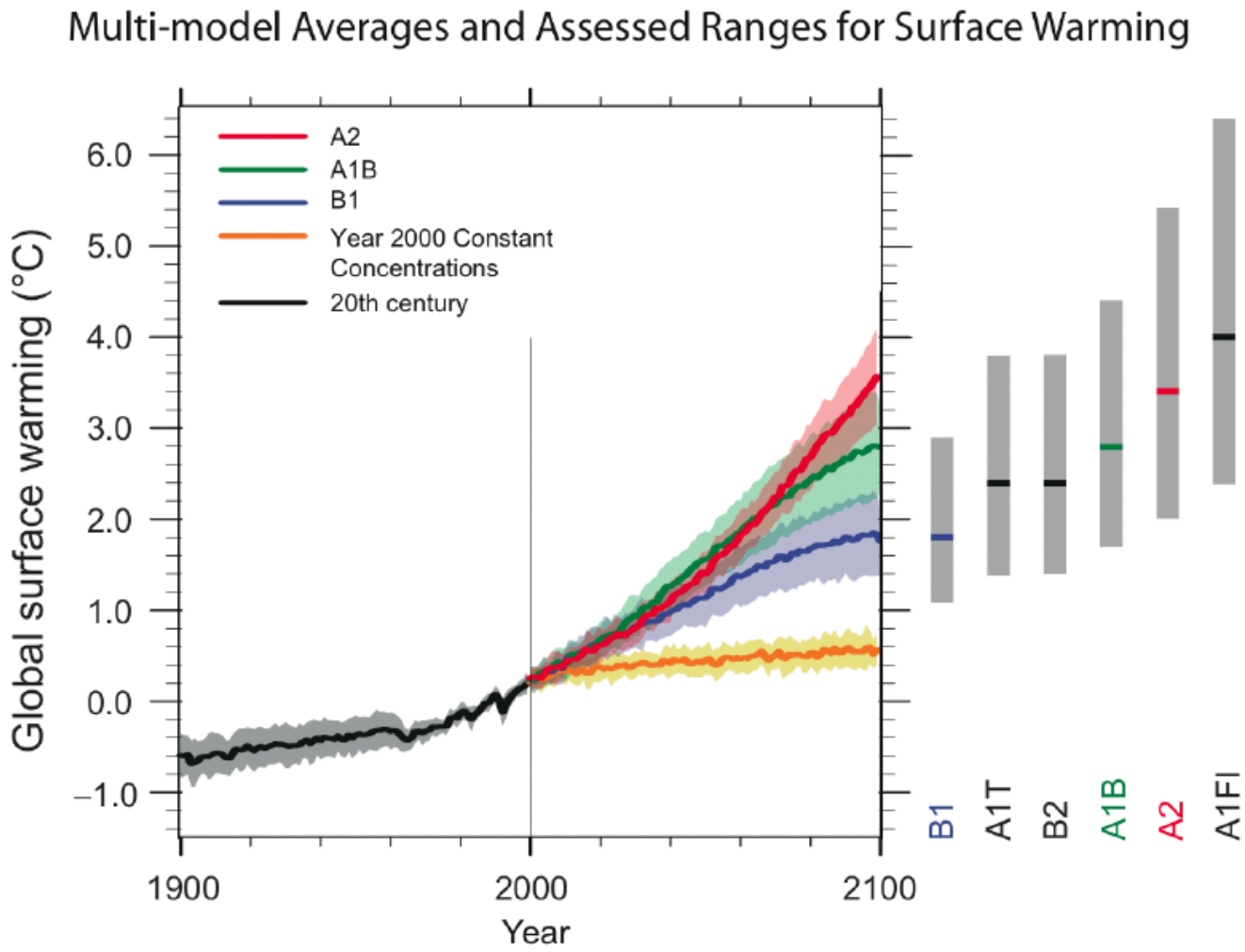
- Temperature
- Precipitation



References:
1) Raible et al. 2006 (CH, Winter)
2) Schmidli & Frei 2005
cit. In Fuhrer et al. 2006

Projected Climate Change





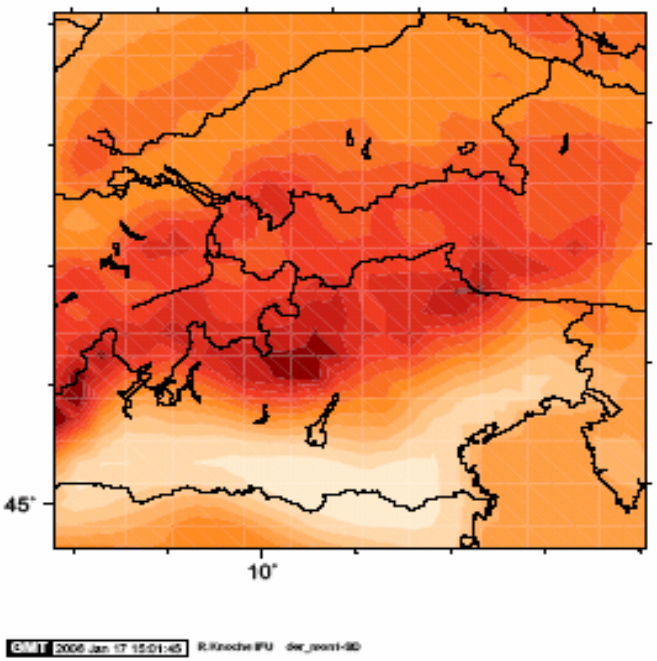
References:
1) IPCC 2007

Projected Climate Change

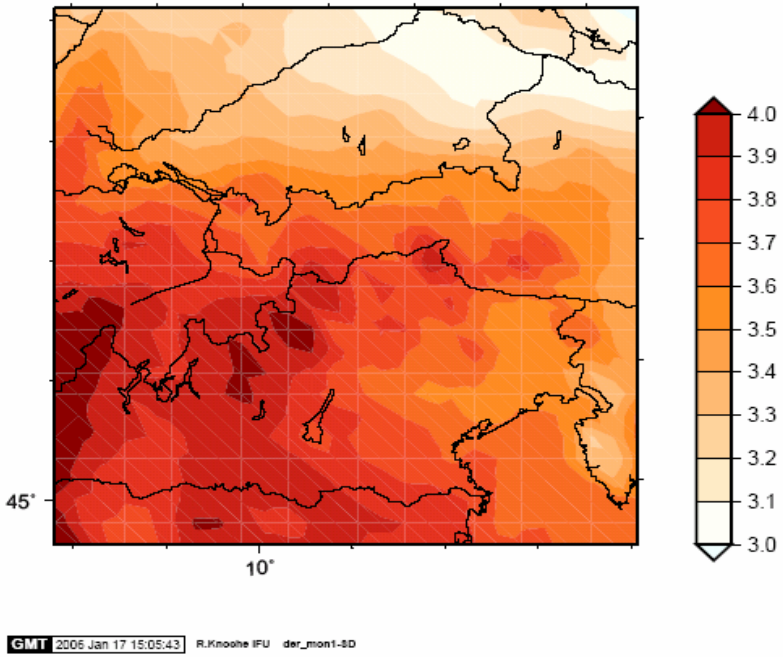
Up to 2040 (business as usual)

- Temperature
- Precipitation

Winter (DJF)



Summer (JJA)

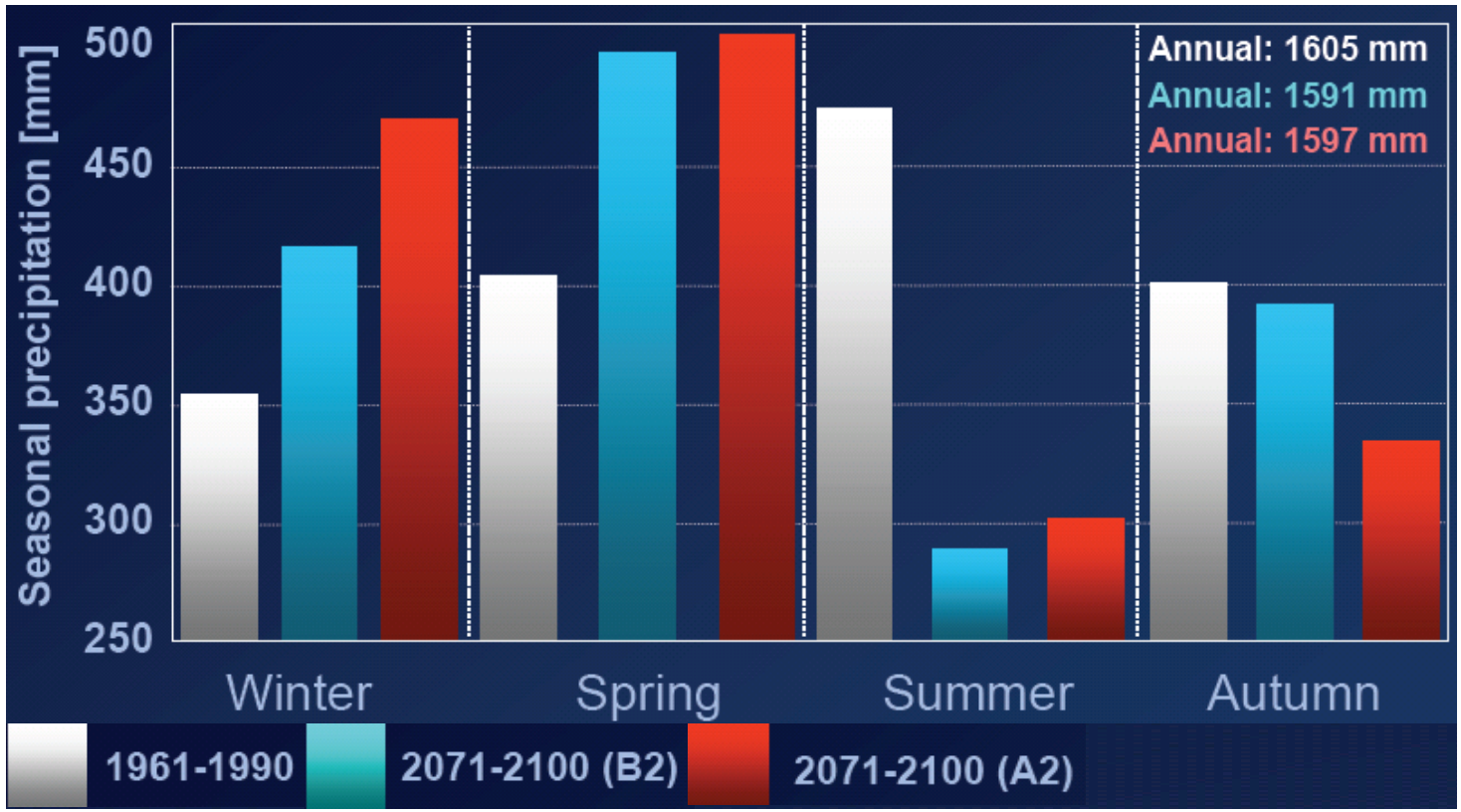


Higher locations → Higher temperature increase !

References:
1) Knoche and Forkel (IMK-IFU), in press

Projected Climate Change

- Temperature
- Precipitation



Shift from summer into winter and spring!

References:

1) Beniston, 2006 (Results from the PRUDENCE project, cit. from Workshop presentation, Wengen 2006)

Expected Climate **Impacts**

Climate Change:
Temperature, Precipitation,
Wind speed,…

Physical/Chemical Impact:
Glacier Extension, Drought, Runoff,
Permafrost, Mass flows, Fire,…

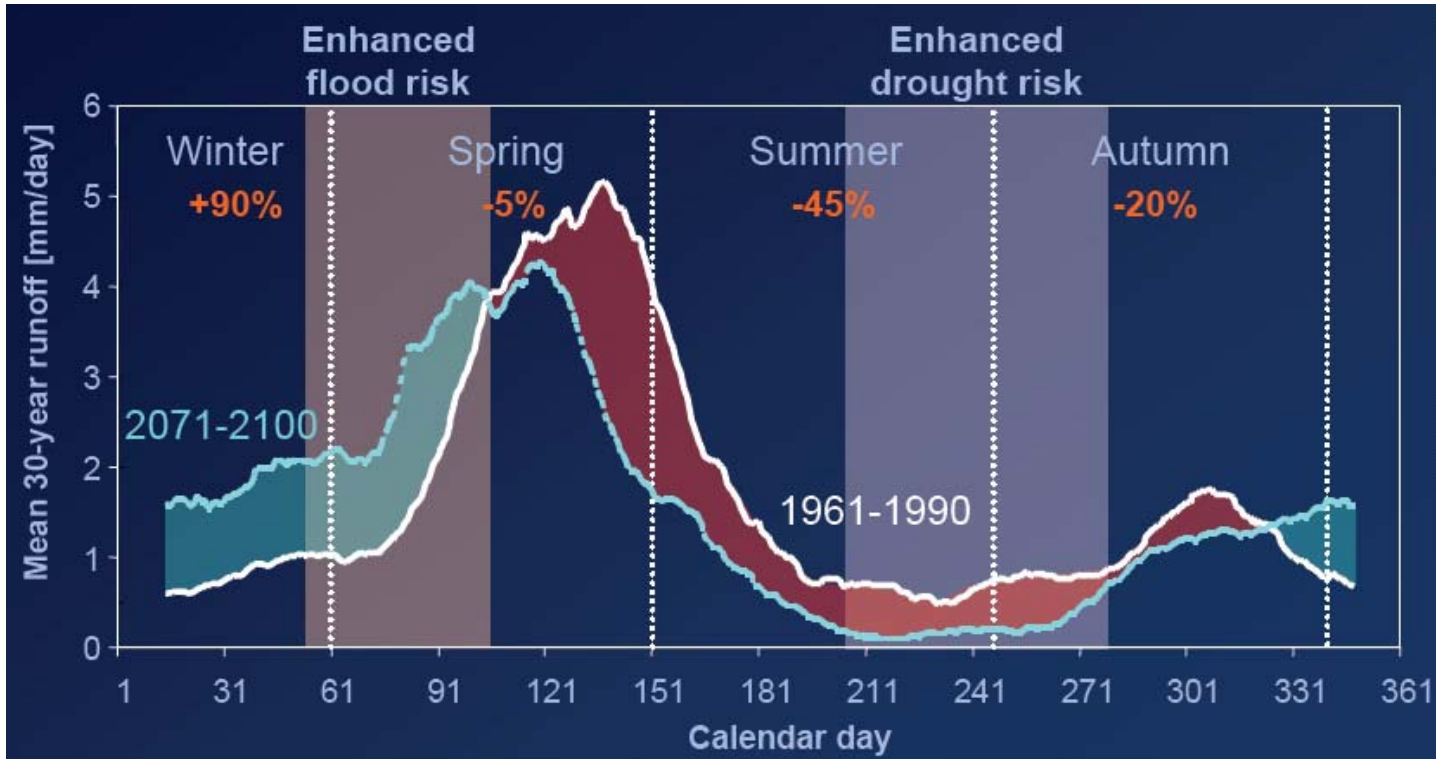
Feedback:
Water Use,
Stability,
Susceptibility,…

Biological/Ecological Impact
Growth, Emission, Diseases,
Competition, Biodiversity,…

Socio-economic Impact:
Yield, Energy production, Tourism,
Health, Land use, Safety,…

Expected Climate **Impacts**:
Physical

- Increasing winter & spring flooding
- Increased summer drought
- Glacier retreat
- More earth mass movements
- Probable increase of other hazards



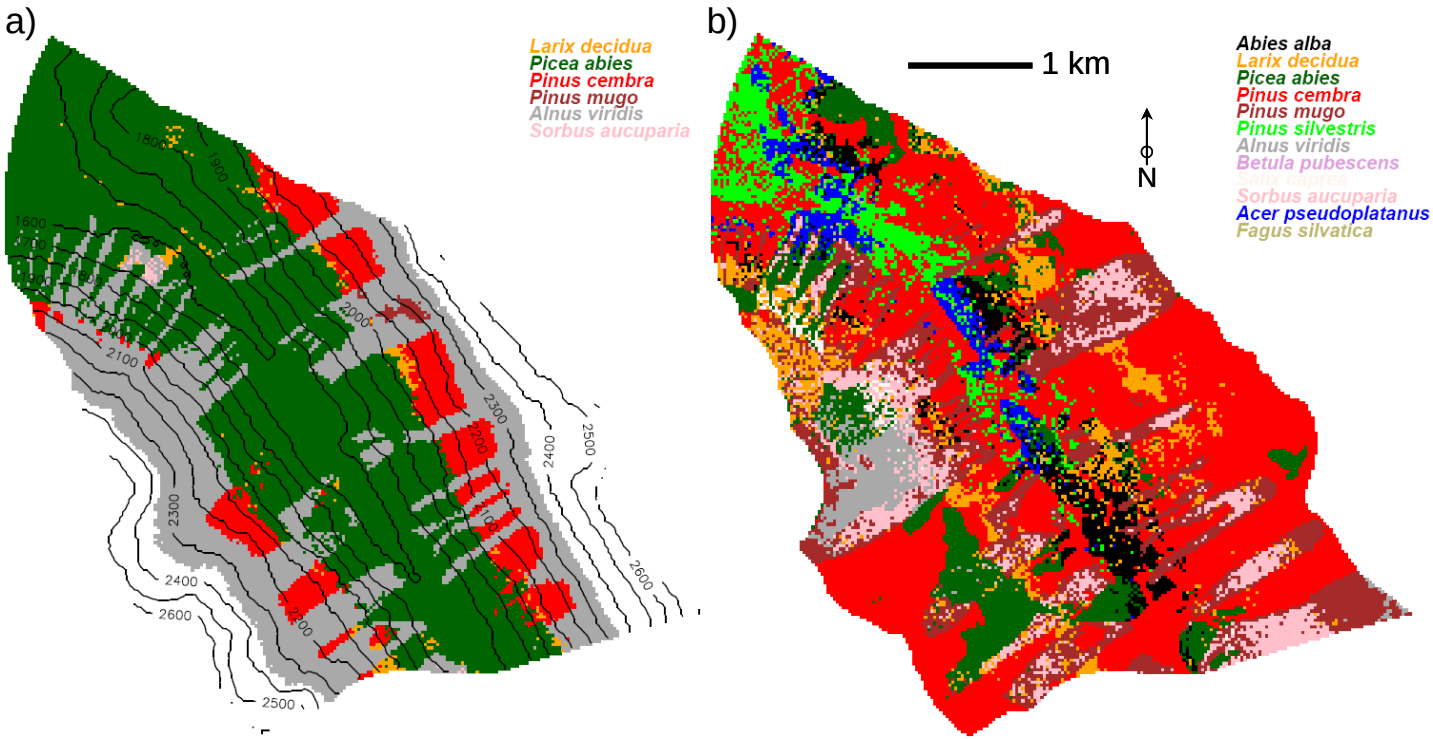
HIRHAM RCM scenario for the central European Alps

References:

1) Beniston, 2006 (Results from the PRUDENCE project, cit. from Workshop presentation, Wengen 2006)

- Changed growth (increased temperatures and CO_2 but more frequent drought)
- Changed competition
- Disturbed host - parasite interaction
- Increased invasion rate (plants, insects, …)
- Dynamically changing biodiversity

Expected Climate **Impacts**: Ecological



Current climate

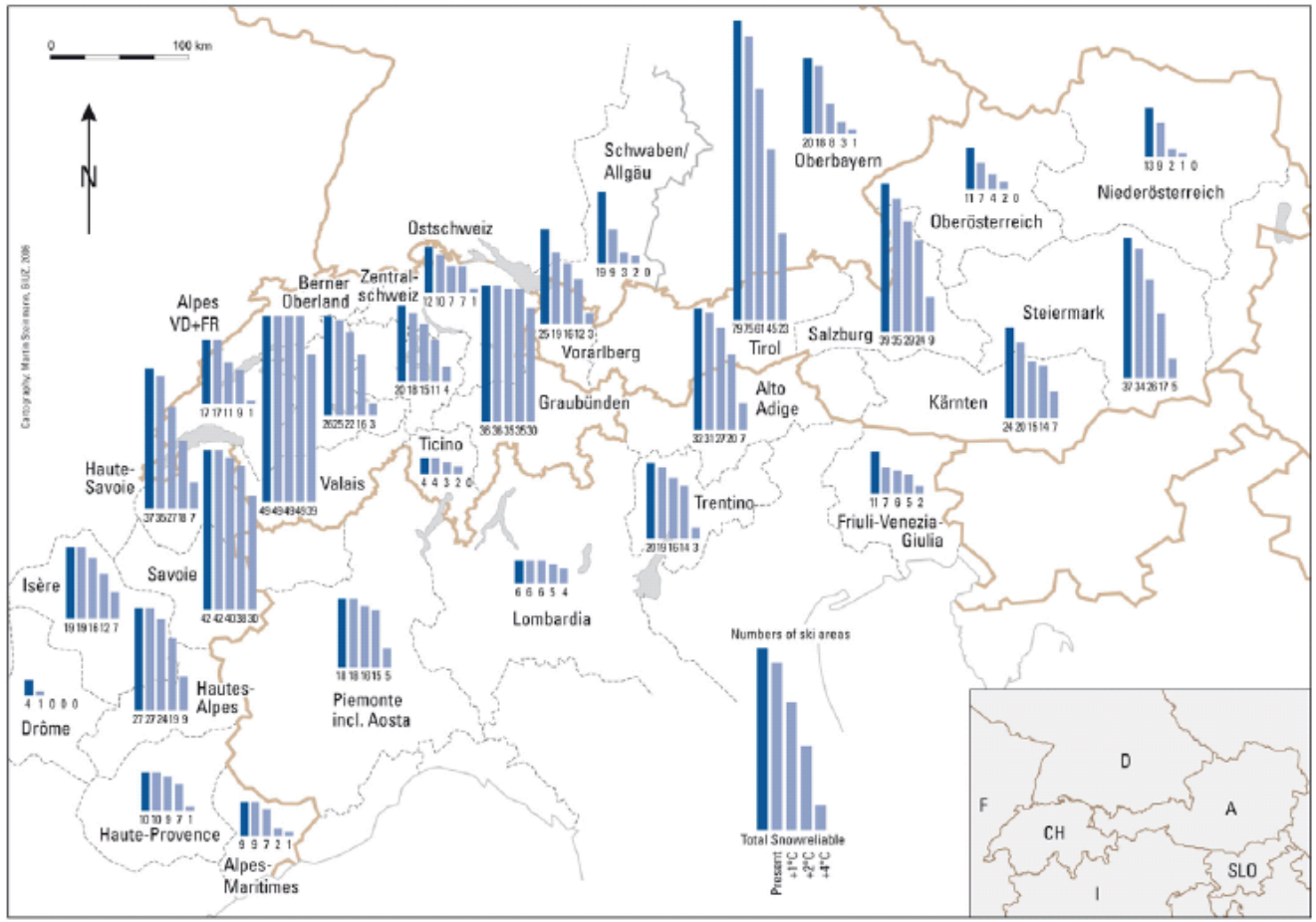
Climate scenario

References:
1) Pretzsch, Grote et al. (in press)

- Shorter skiing season
- Less water and hydropower in summer but increased water & energy demand
- Increased damage related costs and management risk
- Changing yield and production (+/-)
- New health risks pattern (ozone, insect related,..)
- Better accessibility

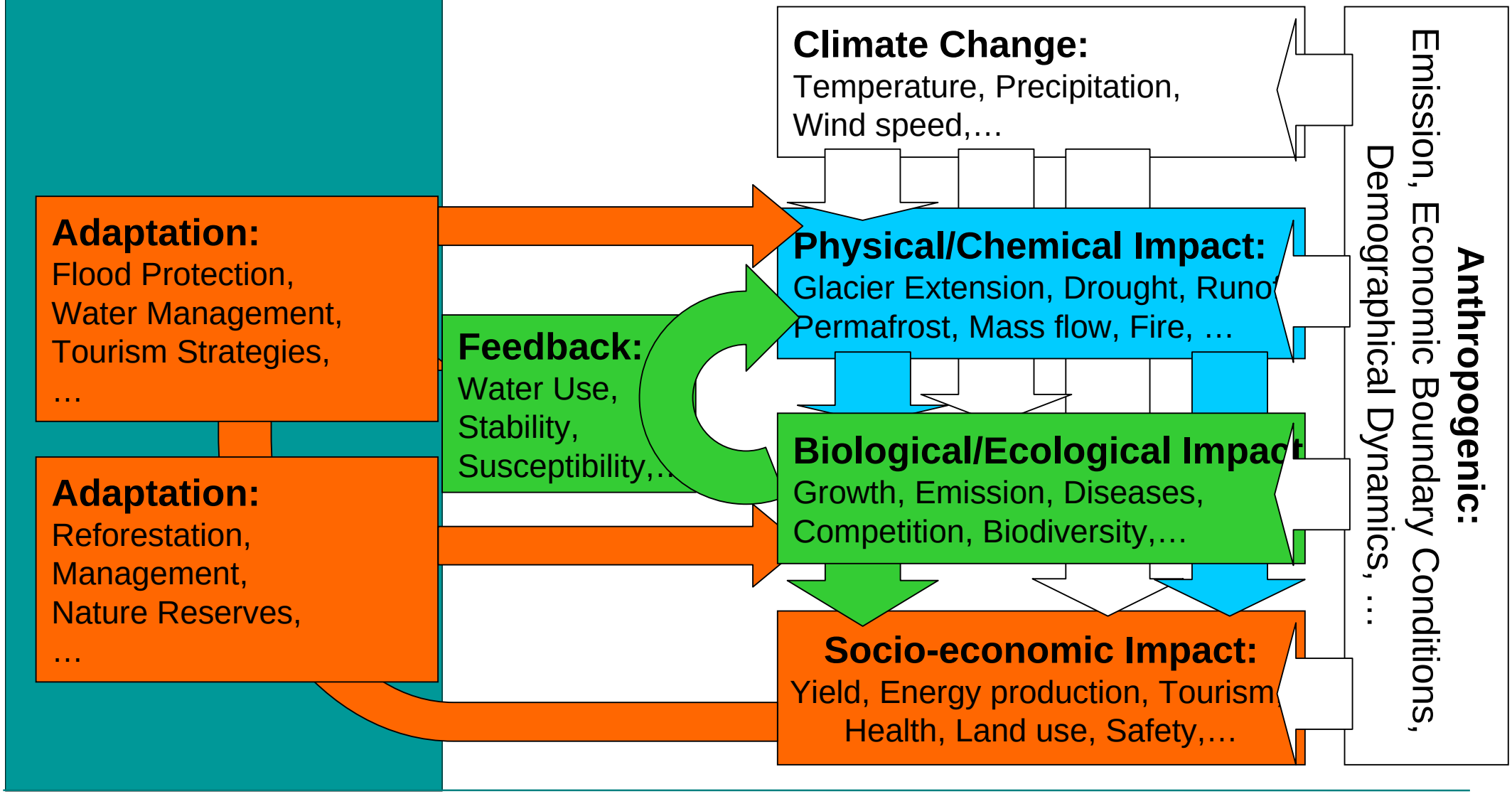
Expected Climate **Impacts**:

Socio-Economic



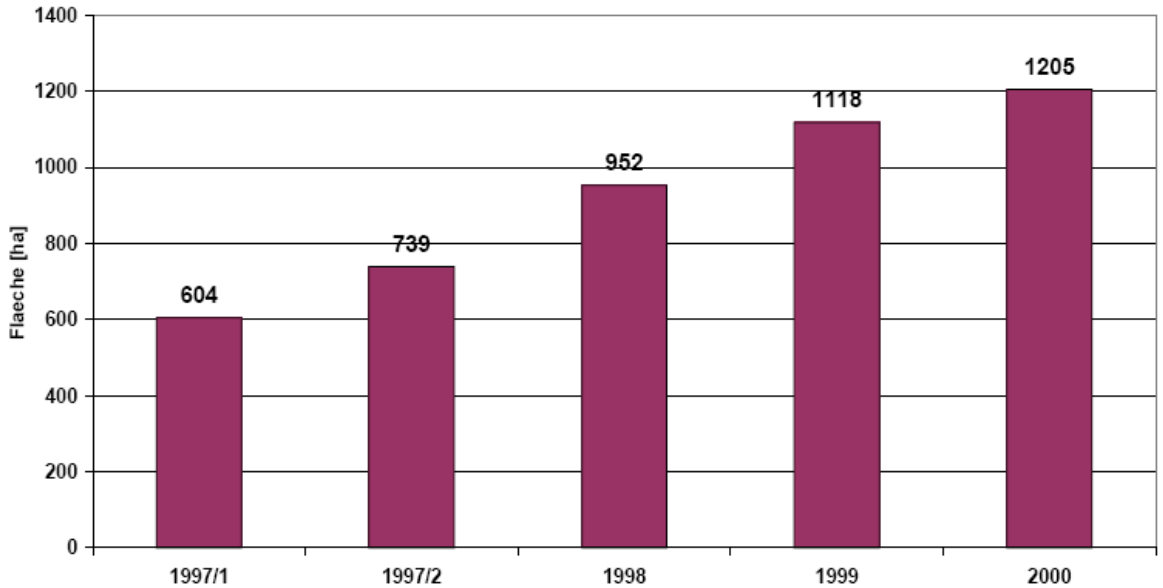
References:
1) OECD 2006

Impacts and Adaptation Responses



Responses - Tourism

- Expand snowmaking capabilities
- Explore the use of higher ski terrain
- Market the middle of the season.
- Expand non-snow winter recreation and cultural activities.
- Expand summer tourism activities



Artificially snowed area in the county of Salzburg, Austria (1997-2000)

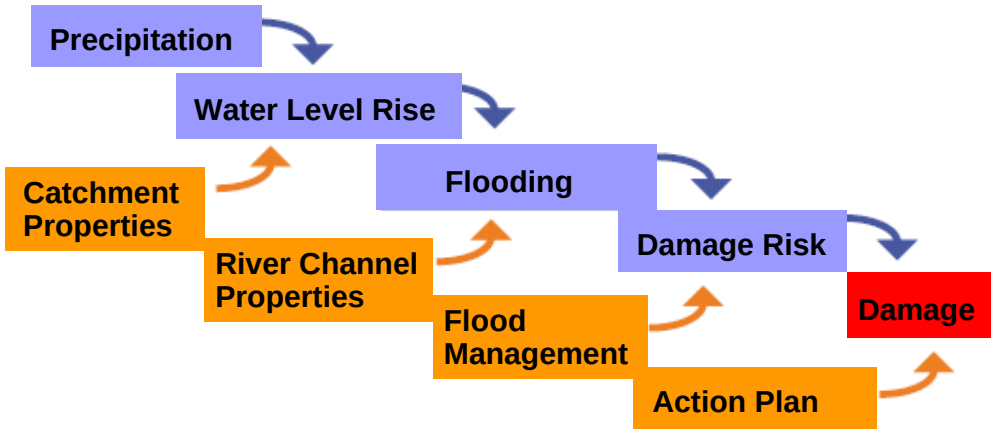
References:
1) "Klimaänderung un mögliche Auswirkungen auf den Wintertourismus in Salzburg", BOKU, 2001

Abbildung 3: Im August 2005 wurde das Hochwasser der Engelberger Aa um das Schadenempfindliche Siedlungsgebiet geleitet. (Quelle: Schweizer Luftwaffe 2005)

- Flood risk prevention
- Controlled flooding
- Flood prediction
- Evacuation plans

- Water saving measures
- Less reliance on hydro power production and cooling capacity for industrial use

Responses – Water management



Rückhalt im Einzugsgebiet
Aufforstung. Rückhalt in Speicherbecken und Seen, Erhöhung der Infiltration, ...

Bauliche Massnahmen
Vergrösserung des Abfluss-querschnitts. Dämmer, Ufer-schutz, ...

Angepasste Raumnutzung
Ausscheiden von Überflutungs-flächen, Objekt-schutz, ...

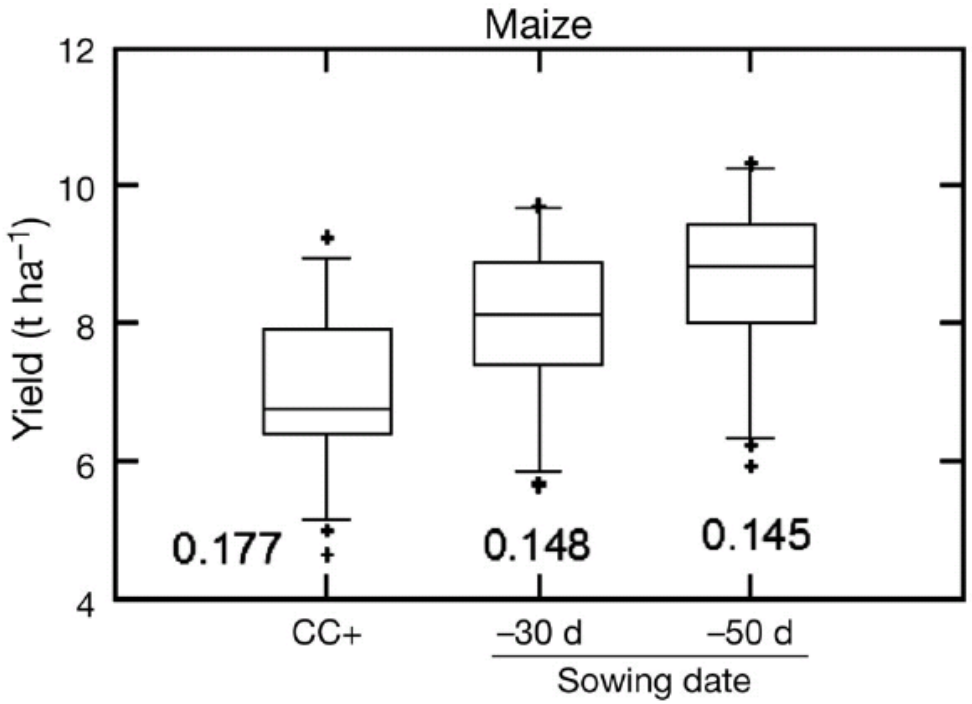
Notfallplanung
Vorhersagen, Alarmierung, Evakuationspläne, mobile Schutz-massnahmen, ...

References:
1) OcCC report (Klimaänderung in der Schweiz 2050) 2007

Abbildung 5: Bei der Ernte von Rundballensilage ergeben sich aufgrund der Klimaerwärmung zusätzliche Erntemöglichkeiten im Früh- und Spätsommer. Teure Spezialmaschinen können so besser ausgelastet werden.
(Quelle: Agroscope ART Reckenholz-Tänikon)

Responses – Agriculture and Forestry

- Simple measures (e.g. early sowing)
- Intensification
- Increased irrigation where appropriate
- Consideration of new species (bioenergy?)
- Fire protection measures
- Pest control

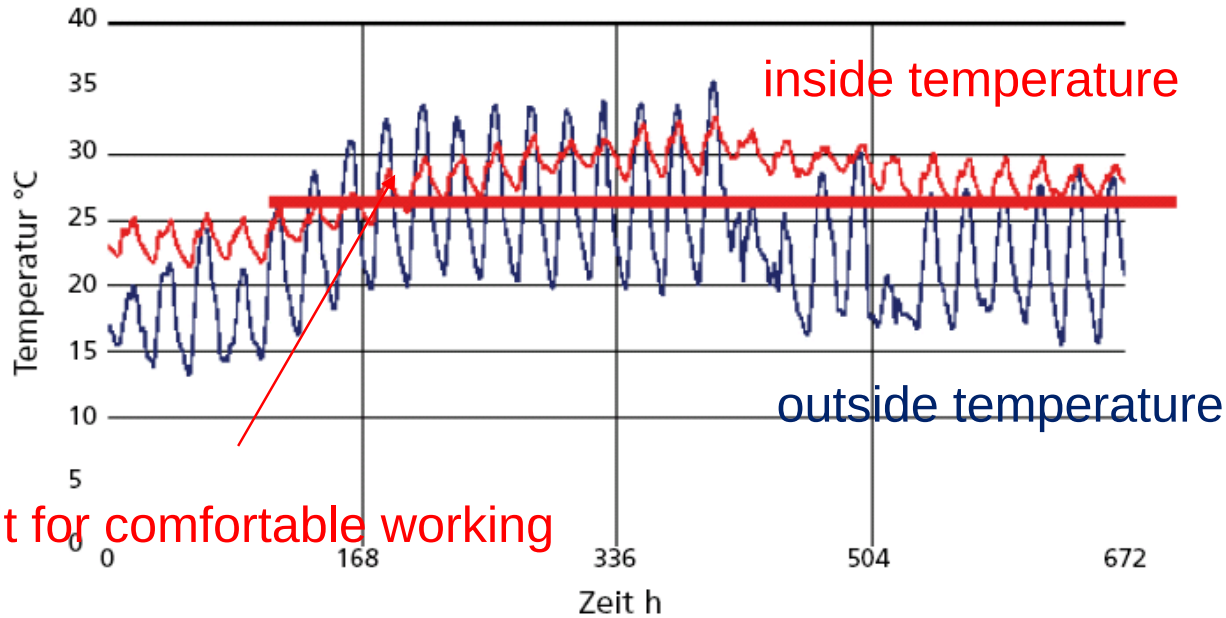


References:
1) Torriani et al. 2007

Abbildung 4: Schneedruck verursacht Hallendacheinsturz, Waldstatt 2006. (Quelle: Thomas Egli)

- Health control (heat wave related, allergy, insect triggered)
- New building regulations (heat isolation, damage resistance, …)
- …

Responses – Health and others

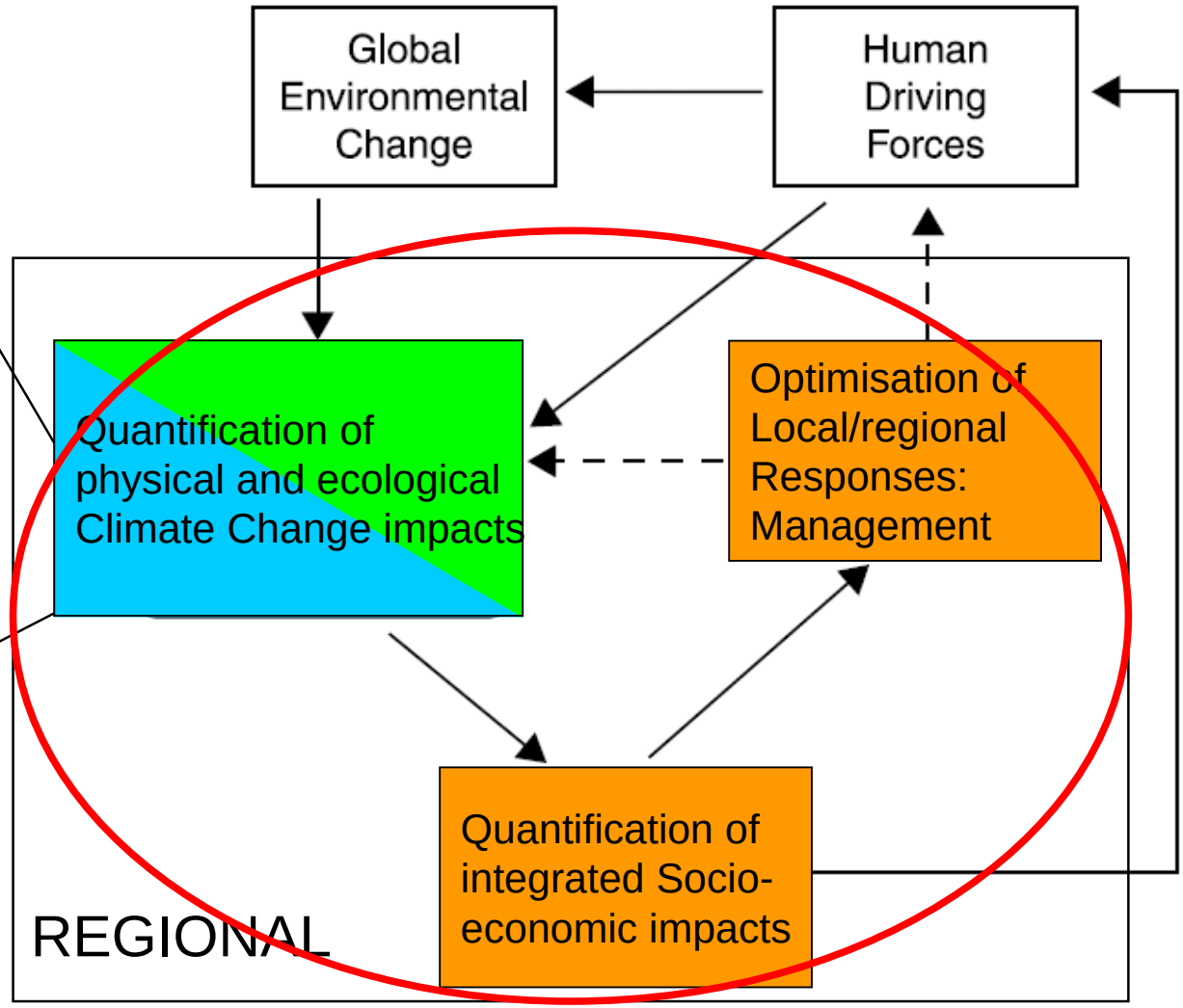


Temperature development inside and outside an office block with high fraction of glass coverage.

References:
1) Frank 2006 (from OcCC report (Klimaänderung in der Schweiz 2050) 2007

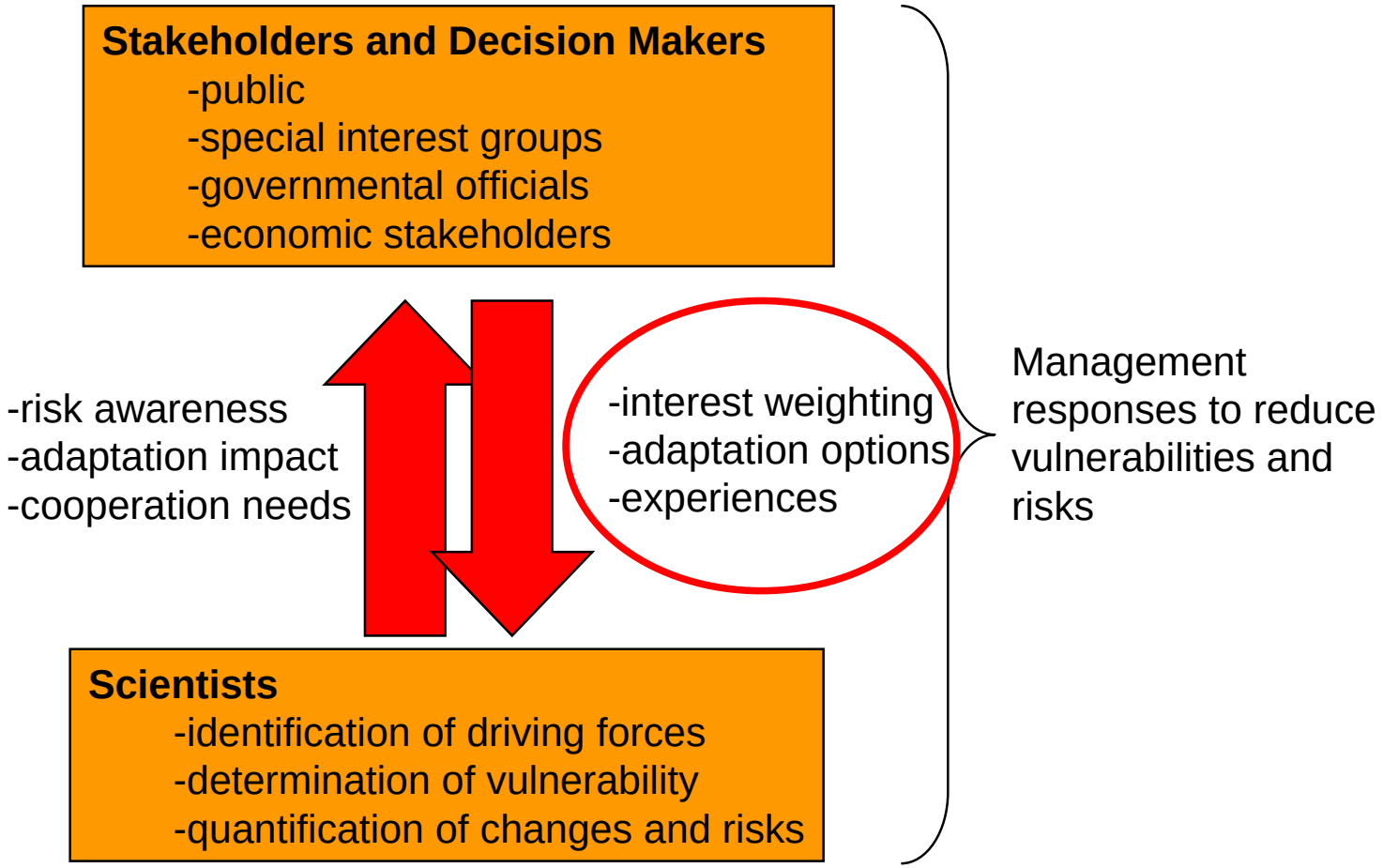
Research Strategies: Integrated Studies

- Observation and indicator analysis
- Process studies along altitudinal gradients
- Integrated, Model-based studies



References:
1) modified after Becker & Bugmann 2001 (MRI report)

Research Strategies: Participatory Assessments



Research Strategies: Participatory *Assessments*

Dangers of insufficient participation

Wrong estimation of adaptation potentials

Missing ongoing management trends

Overlooking major interests

Final Remarks: Assets

- There are loads of regional climate change studies, the most recent large projects being PRUDENCE and ENSEMBLES
- A number of regional ‘integrated’ assessments had already been carried out or are going to be installed
- The reality of Climate Change is recognized by stakeholders and decision makers and the demand for advice is growing.

Final Remarks: Deficits

- Regional Climate Change projections still need higher resolution for coupling with regional hydrology and ecological models, particularly in mountainous regions.
- Regional integrated assessments generally miss major linkages and feedbacks between physical and ecological impacts. Adaptation measures are seldom included.
- Cooperation with stakeholders and decision makers on the regional scale is still difficult.

Final Remarks: EU Opportunities

- 7th EU Framework Program (**FP7**): Suggestions for third call topics welcome (e.g. integrated assessments with focus on agriculture, hydrology or tourism?)
- ESF Research Networks (**RTN Network**) (e.g. linkages between integrated assessment studies)
- **COST** Actions (e.g. bringing together modelling communities)
- **INTERREG** programms (e.g. IVb, Alpine Space)

The End