



The CH2011 Initiative

Matteo Buzzi

Federal Office of Meteorology and Climatology MeteoSwiss

C. Appenzeller, I. Bey, T. Bosshard, T. Corti, M. Croci-Maspoli, A. Fischer, E. Fischer, J. Fuhrer, S. Kotlarski, R. Knutti, A. Kress, C. Kull, M. Liniger, A. Lustenberger, P. Pall, C. Schär, S. Scherrer, A. Weigel

Climate matters....

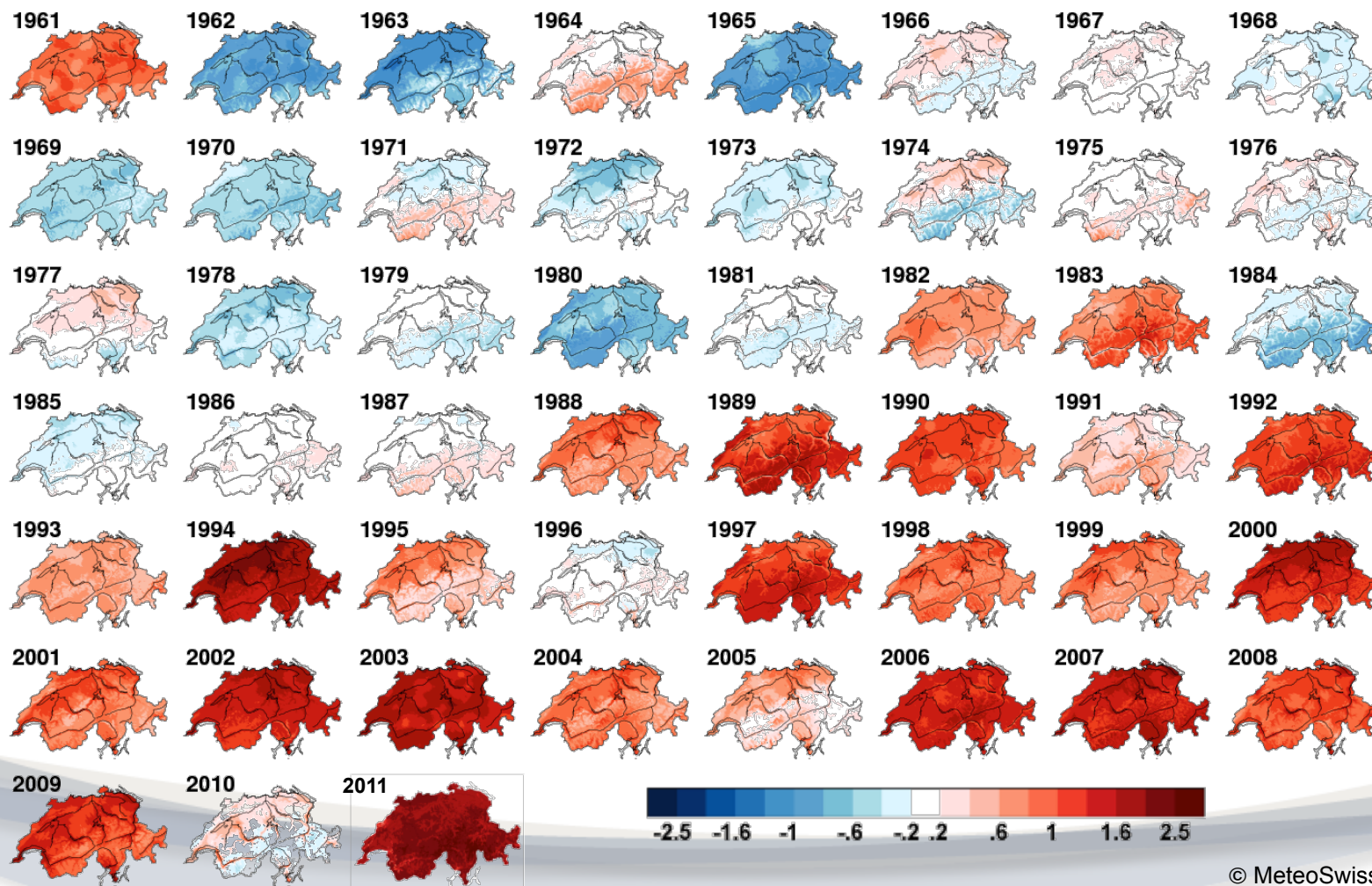


Future climate?

Climate evolution



Temperature increase ~ 1.8 °C from 1961



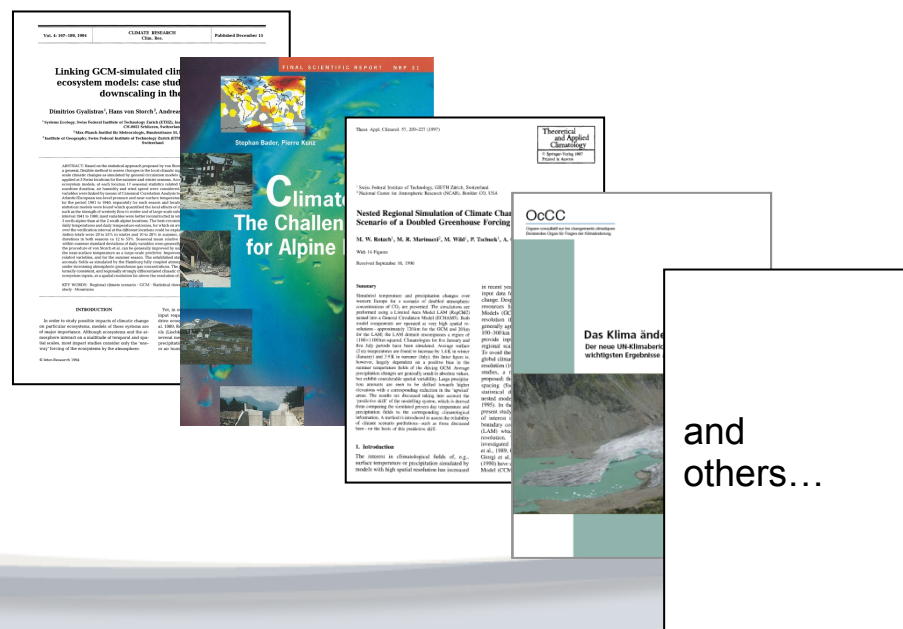
Historical aspects



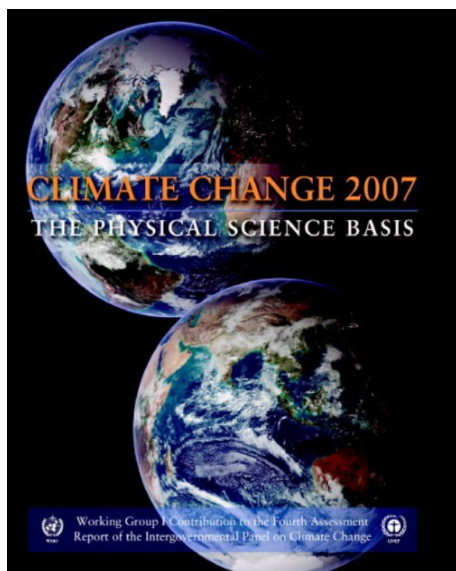
CH2007 climate scenarios

Report: Climate Change and Switzerland 2050
OcCC & ProClim (2007)

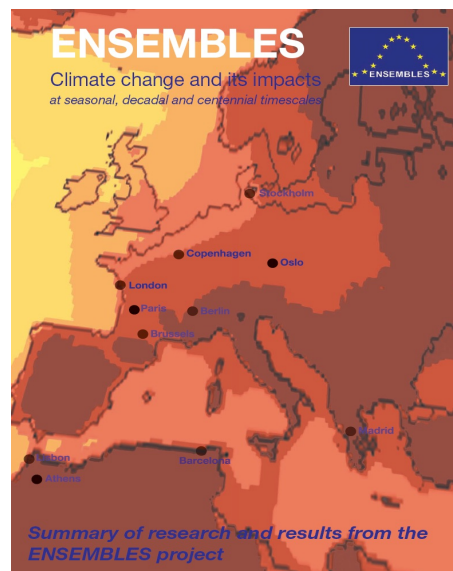
→ Climate scenarios cover ~10 pages



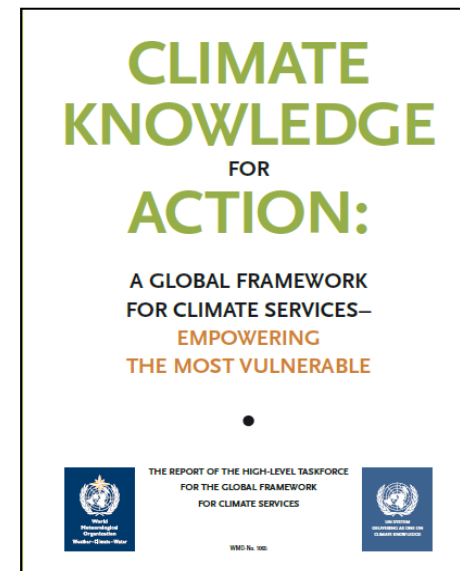
International activities



Intergovernmental Panel
on Climate Change AR4
(2007)



EU 6. Framework
Programme ENSEMBLES
(2009)



Global Framework for
Climate Services (GFCS)
(2009)

The CH2011 scientists!



The CH2011 Initiative
28 September 2011

info@ch2011.ch

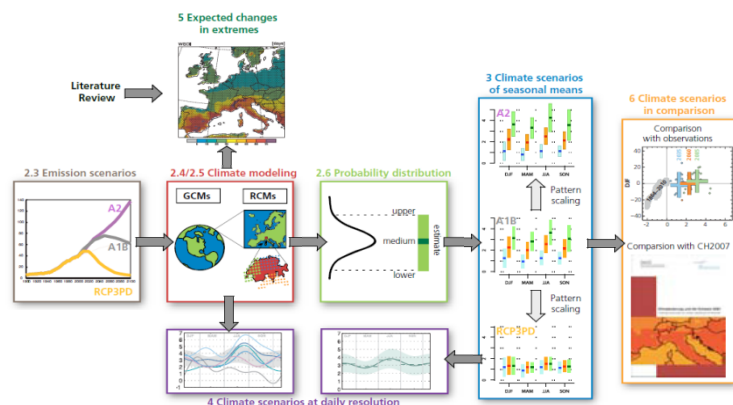


Climate Scenarios: Large-scale perspective

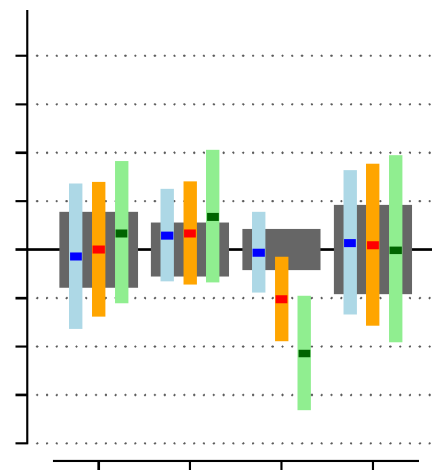
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The recipe for CH2011

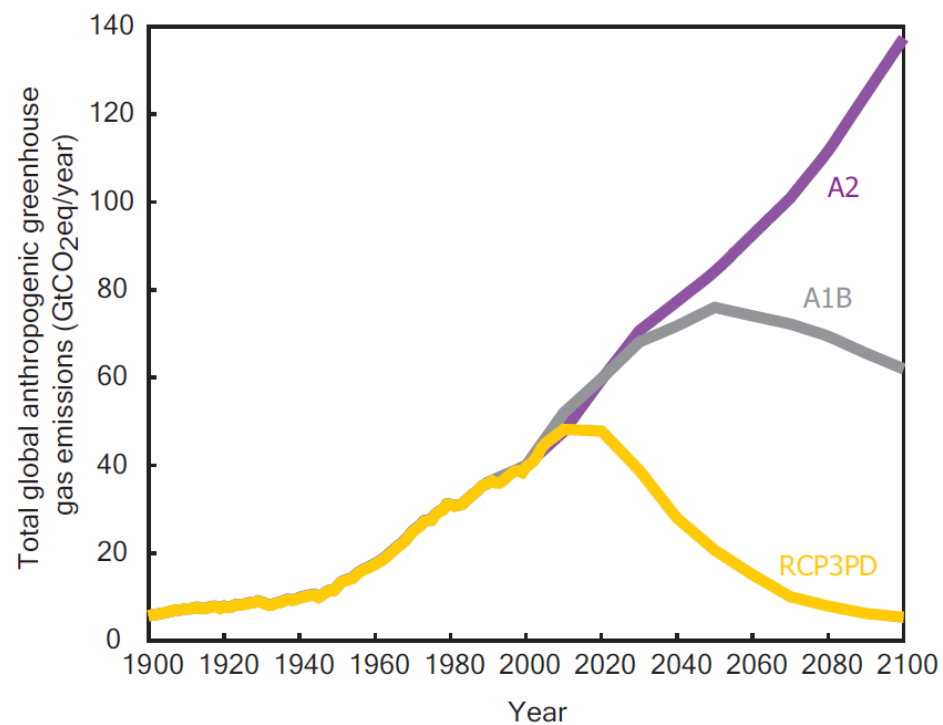


- Emission scenarios
- Climate models
- Pattern scaling
- Uncertainties



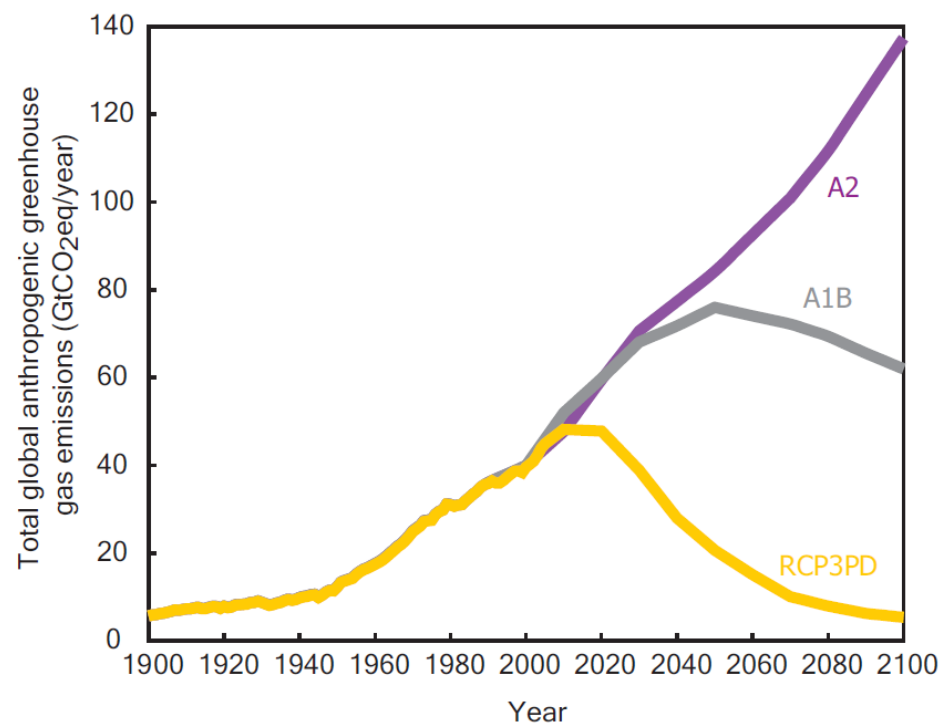
Emission scenarios

Global greenhouse gas emissions

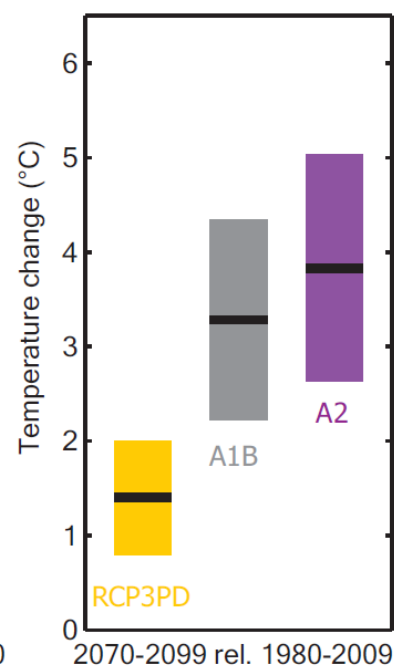


Emission scenarios

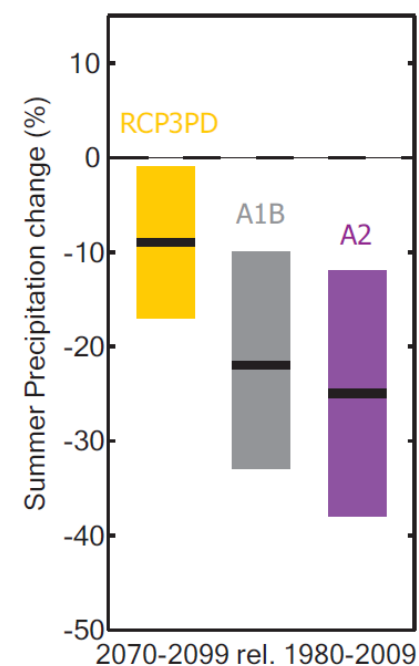
Global greenhouse gas emissions



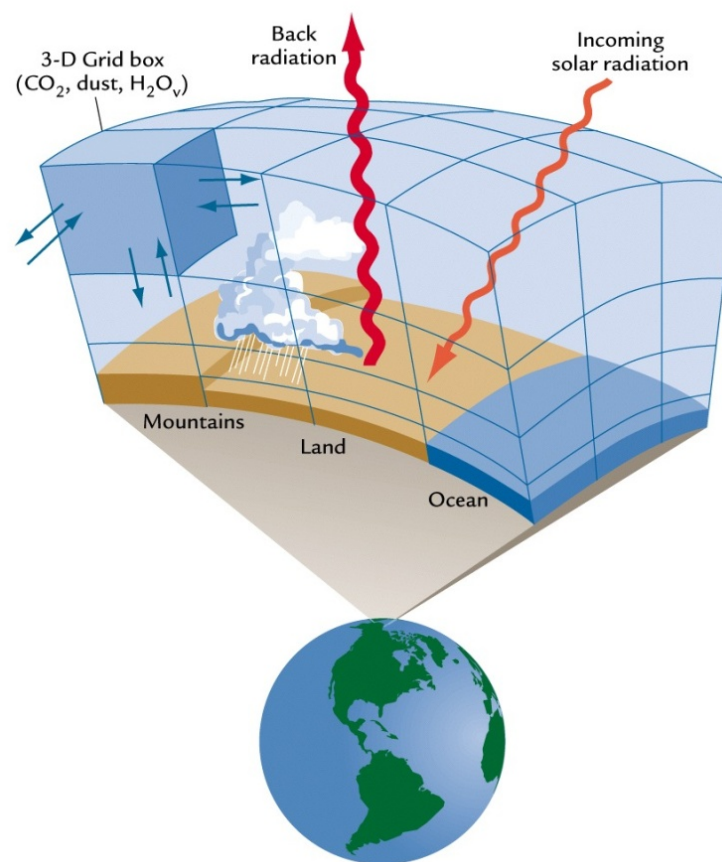
Temperature change (°C)
Switzerland

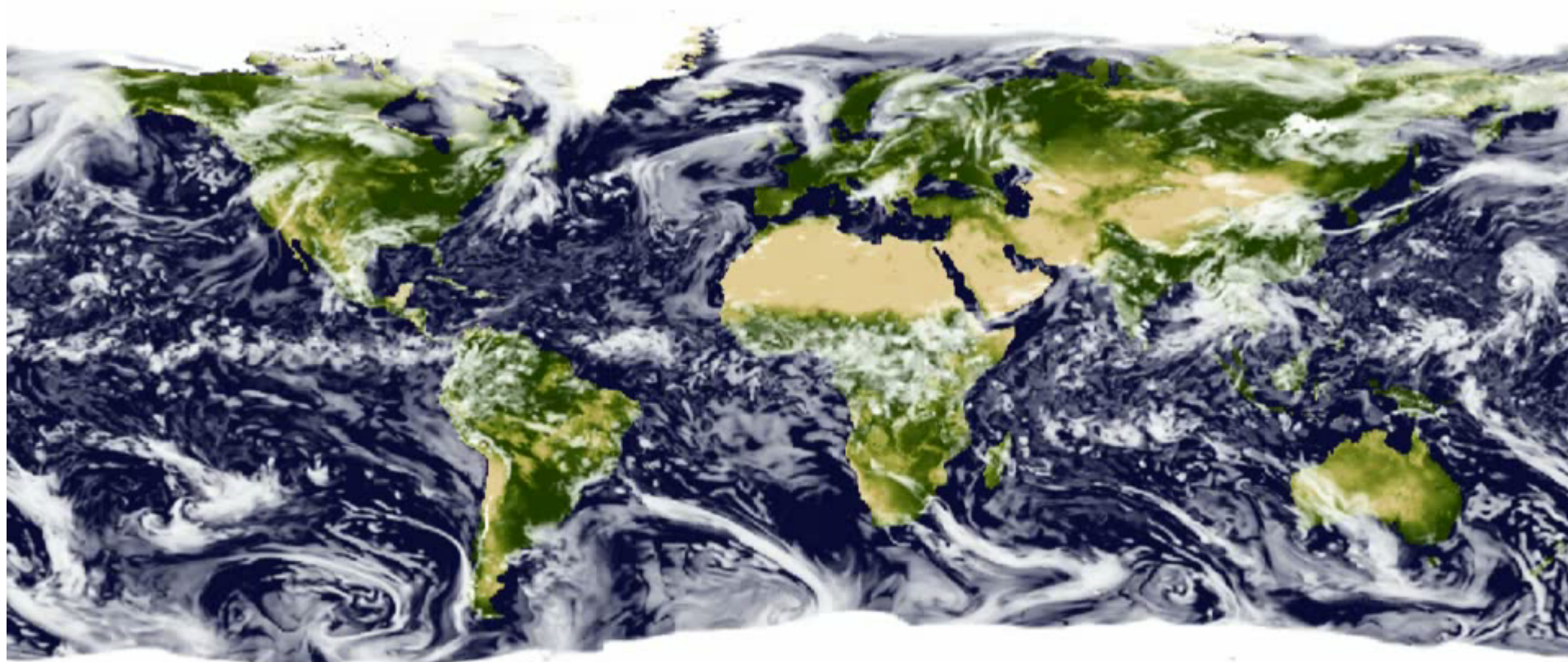


Summer precipitation change (%)
Switzerland

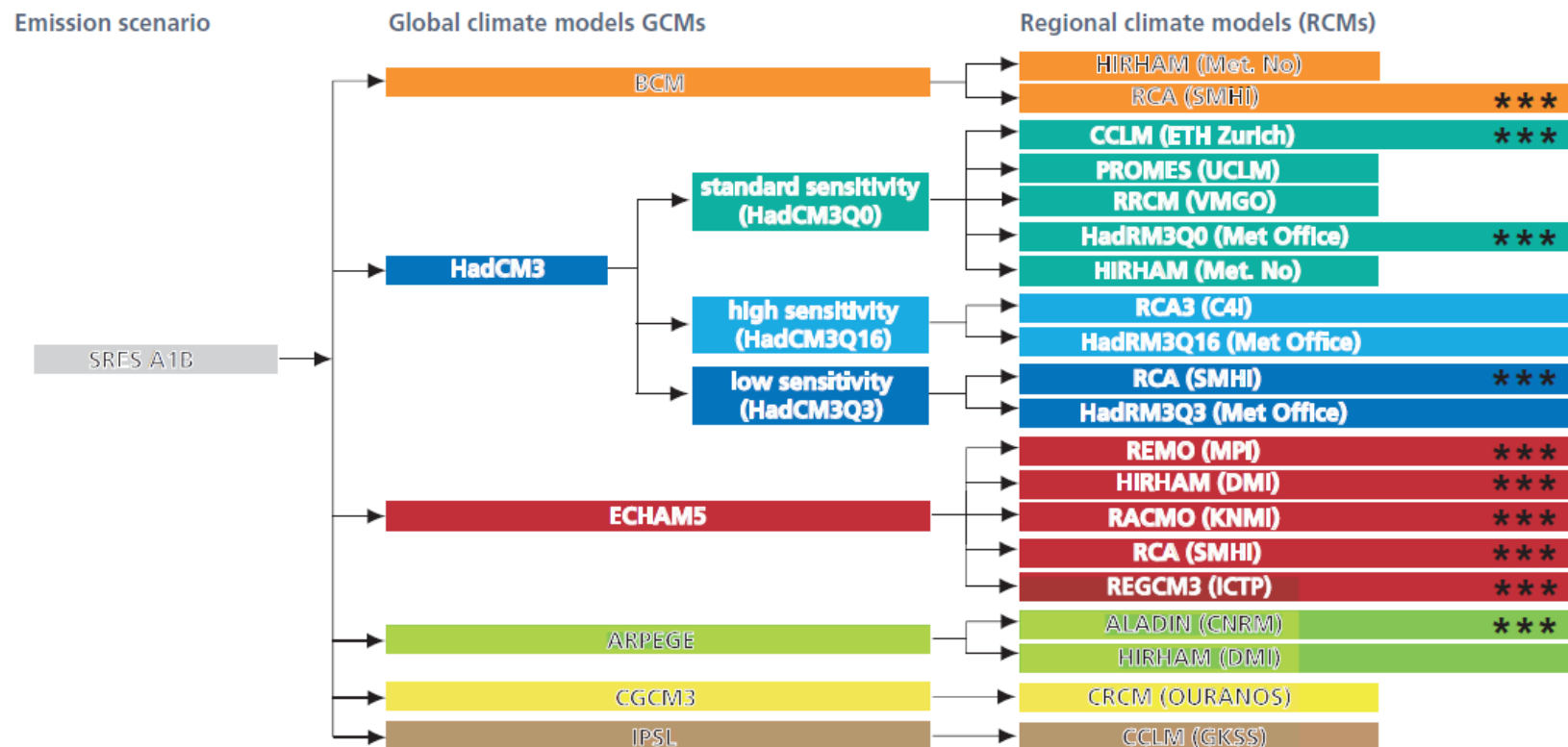


Climate models

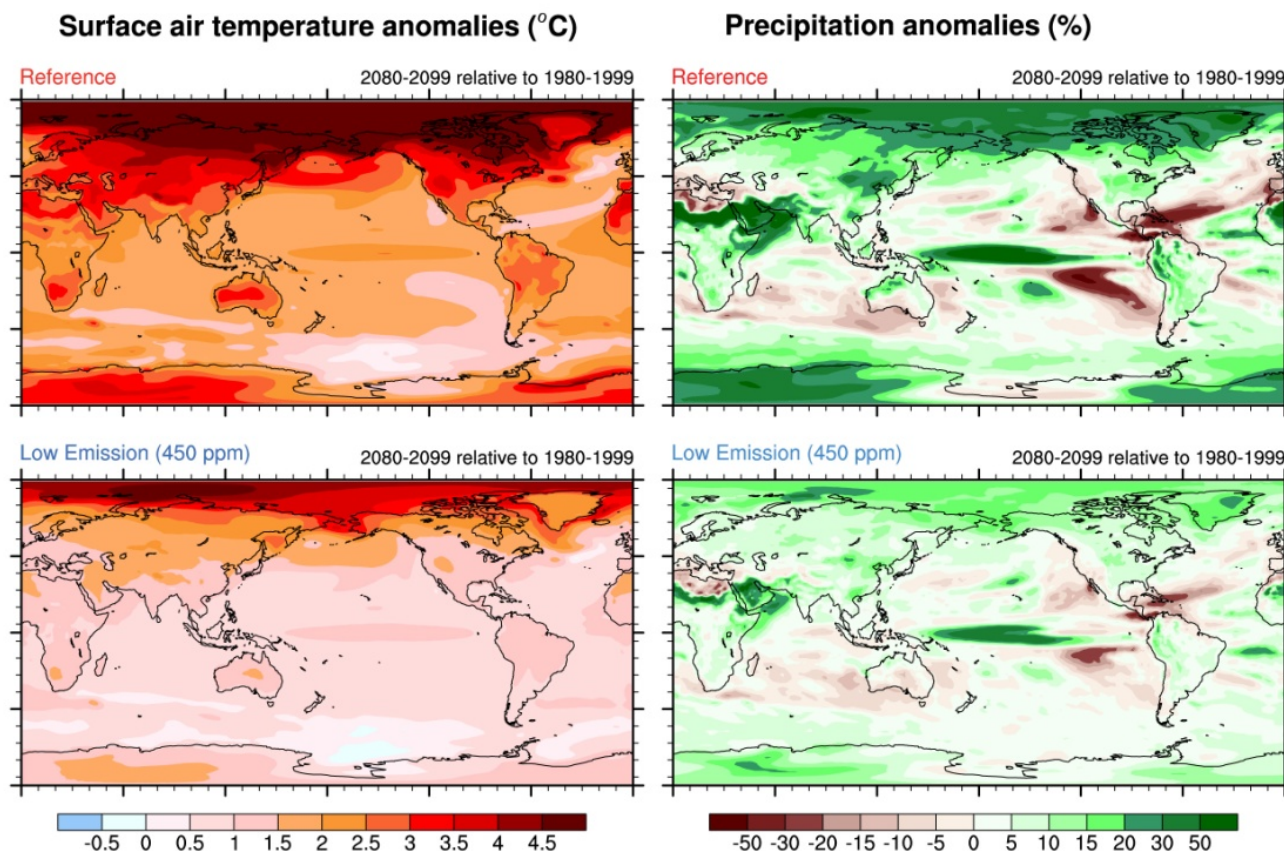




ENSEMBLES models

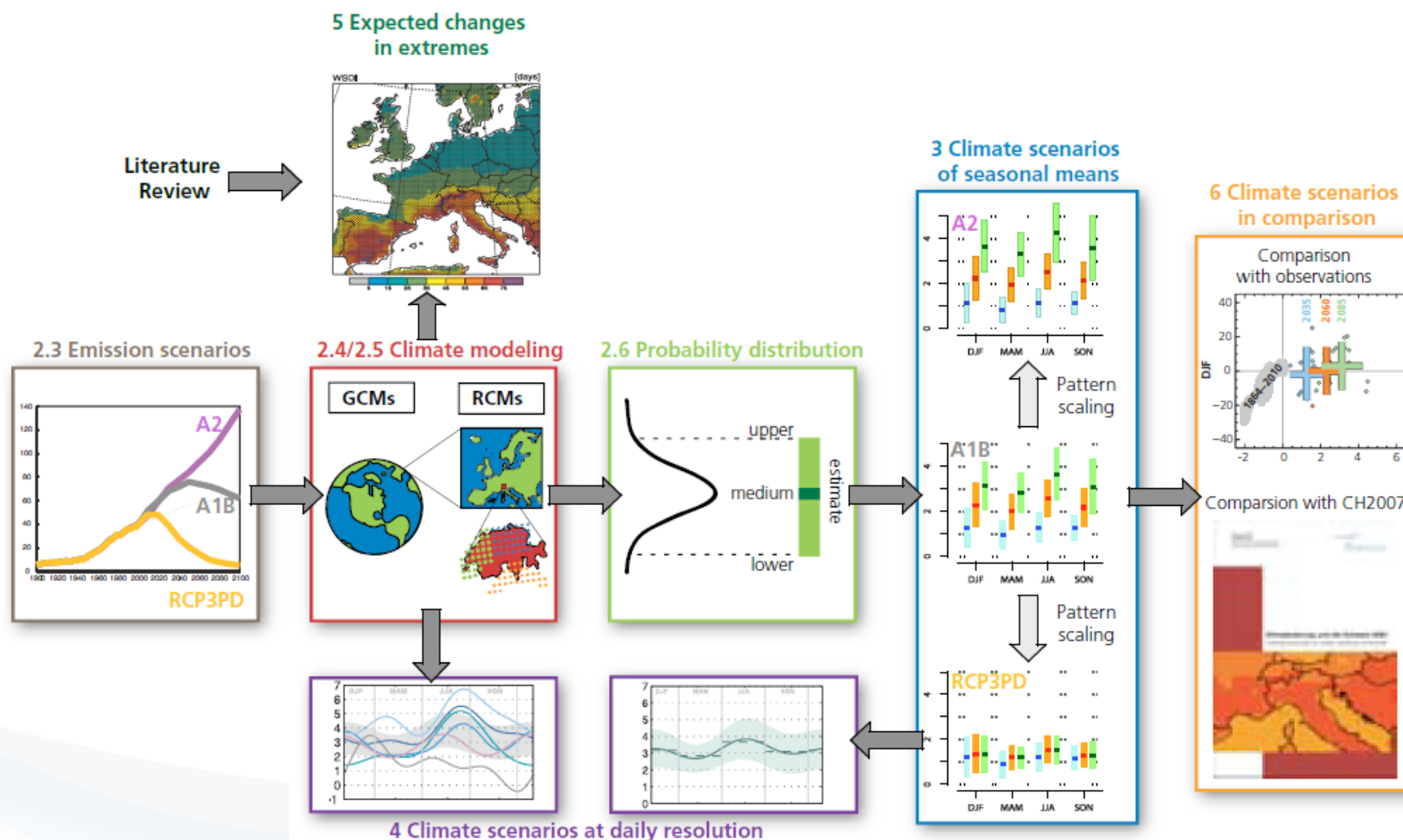


Pattern scaling

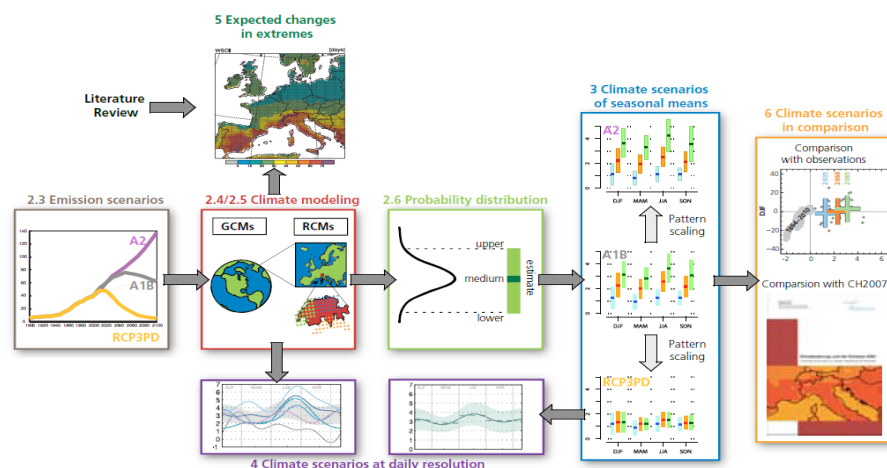


(Washington et al. 2009)

Method overview



What is new?



- Three emission scenarios considered
- New and better global and regional climate models with higher resolution
- Transient simulations to 2100
- Comprehensive uncertainty assessment
- Information on climate extremes
- Daily data at station level
- Data portal

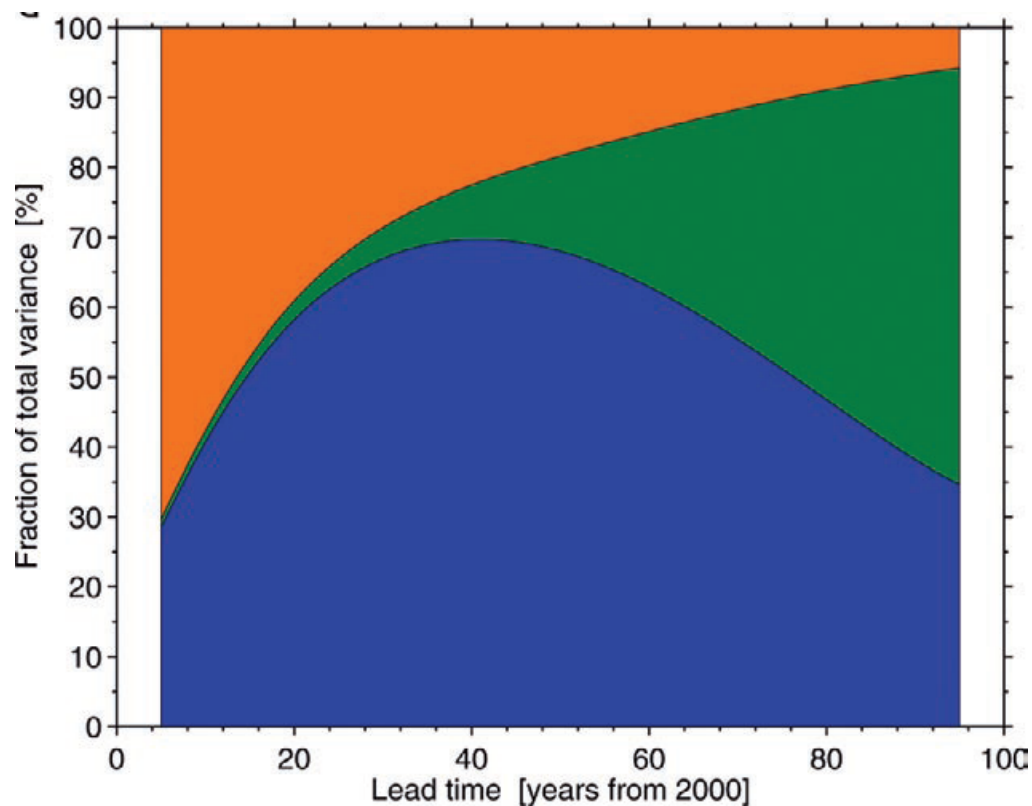
Uncertainty



- «All models are wrong, but some are useful», but only for certain variables and scales
- Multiple model chains
- Statistical methods to combine models and observations
- Assess results, process understanding, observed trends, and literature

Uncertainty

British Isles, decadal temperature



Natural internal variability

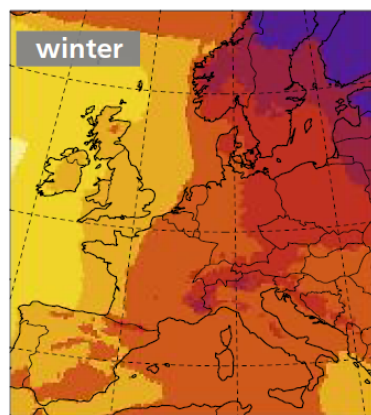
Scenario uncertainty

Model uncertainty

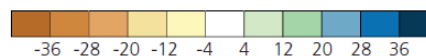
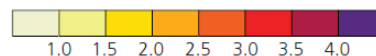
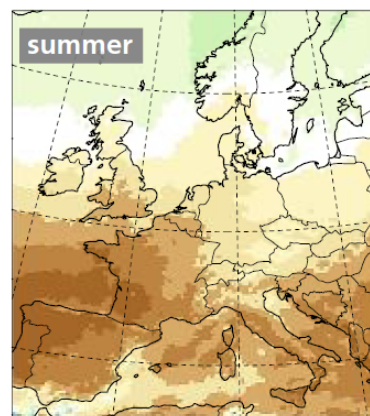
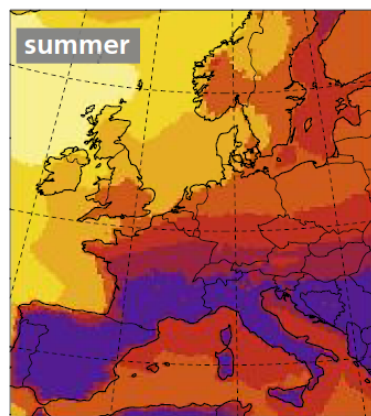
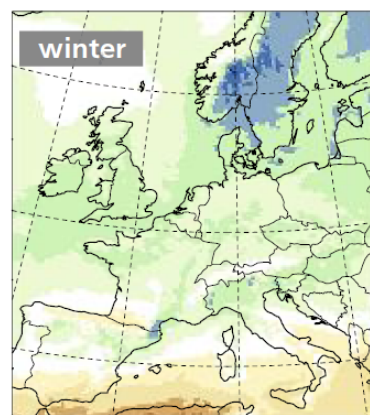
(Hawkins and Sutton, 2009)

Large scale changes

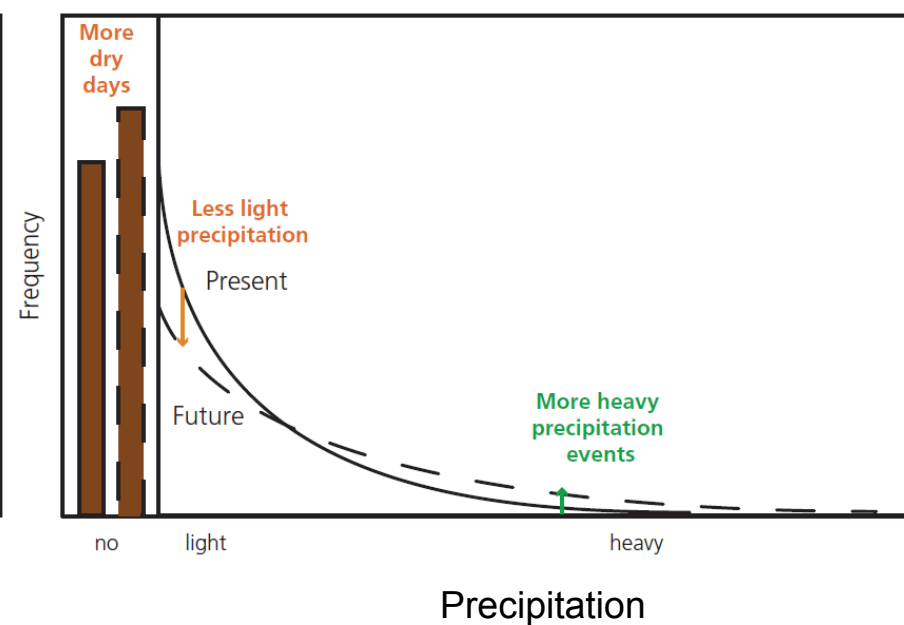
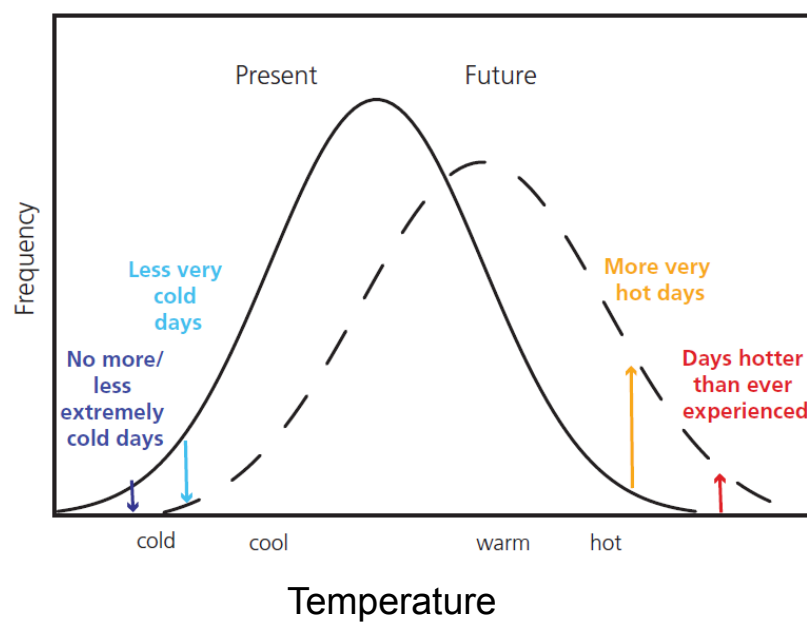
Temperature Change (°C)



Precipitation Change (%)

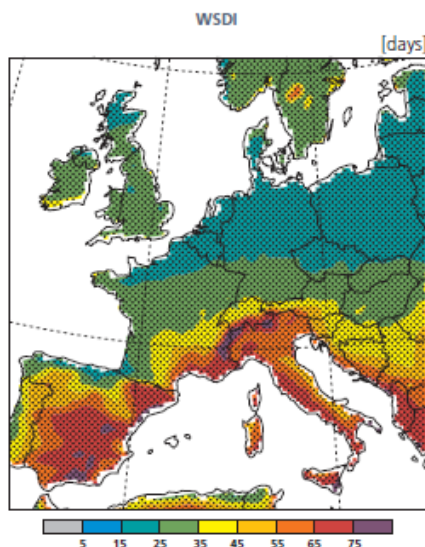


Extreme events

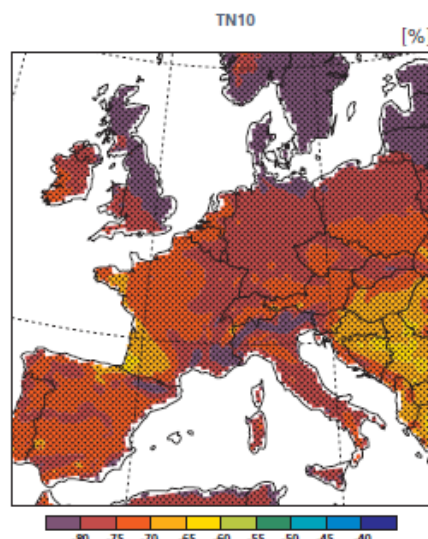


Extreme events: 2080

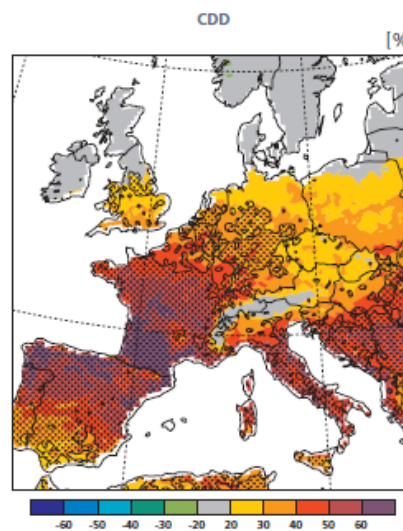
Longer warm spells



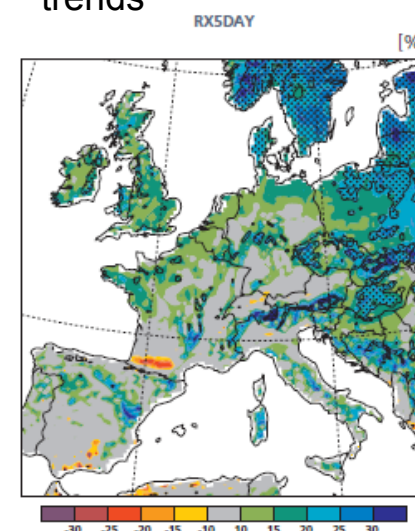
Fewer cold nights



Longer dry periods



Large uncertainty in
heavy precipitation
trends



High confidence



Low confidence



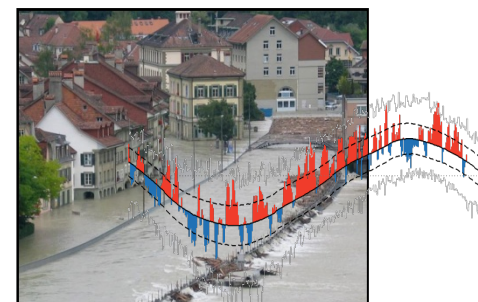
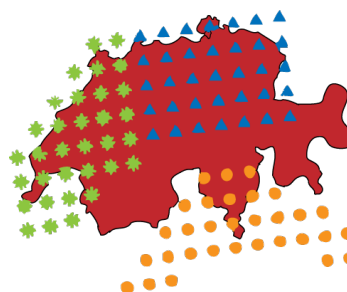
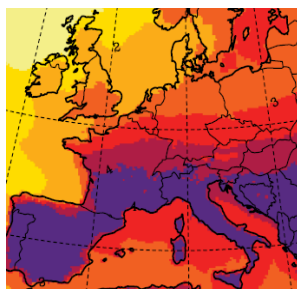
Climate Scenarios: Swiss perspective

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Scales and uncertainties



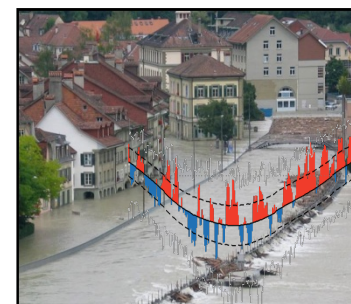
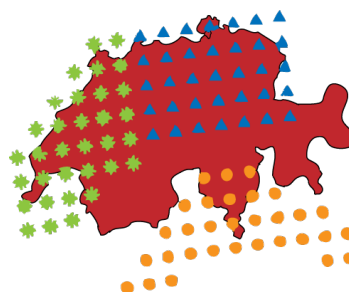
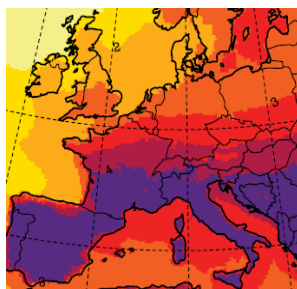
global

continental

**regional
seasonal**

**local
daily**

Scales and uncertainties



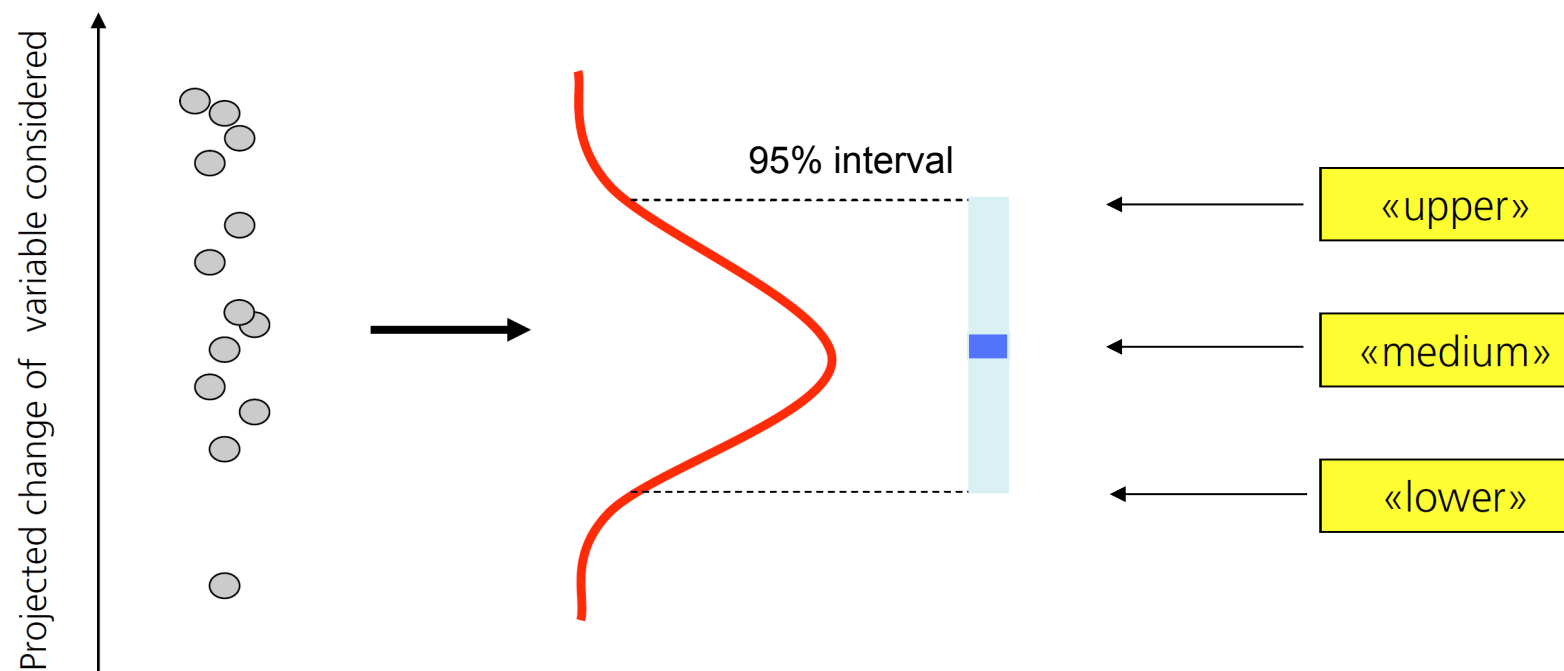
global

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UNCERTAINTIES



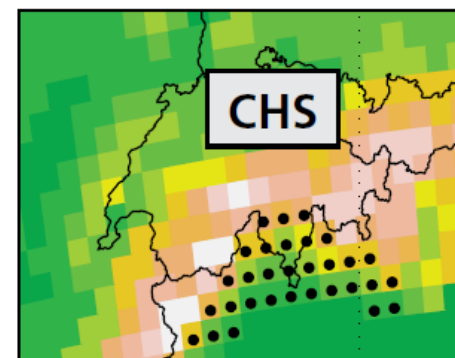
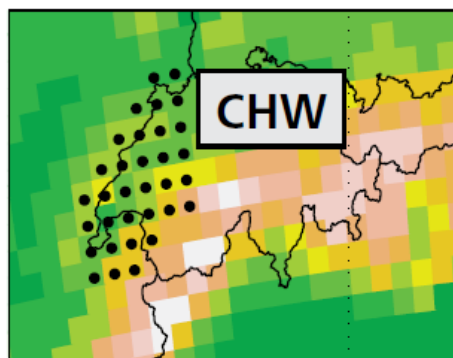
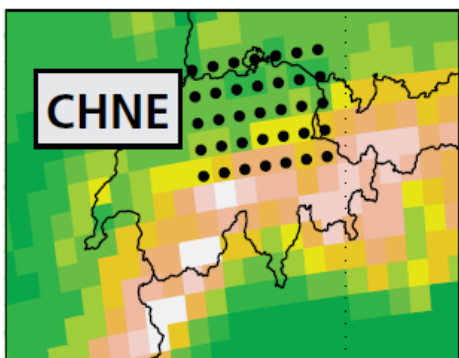
Statistical framework which combines
measurement data with model simulations
of past and future climate

Buser et al. (2009), A. Fischer et al. (2011)

Expert judgment suggests
considerably larger uncertainties than
statistical framework

Four seasons (DJF, MAM, JJA, SON)

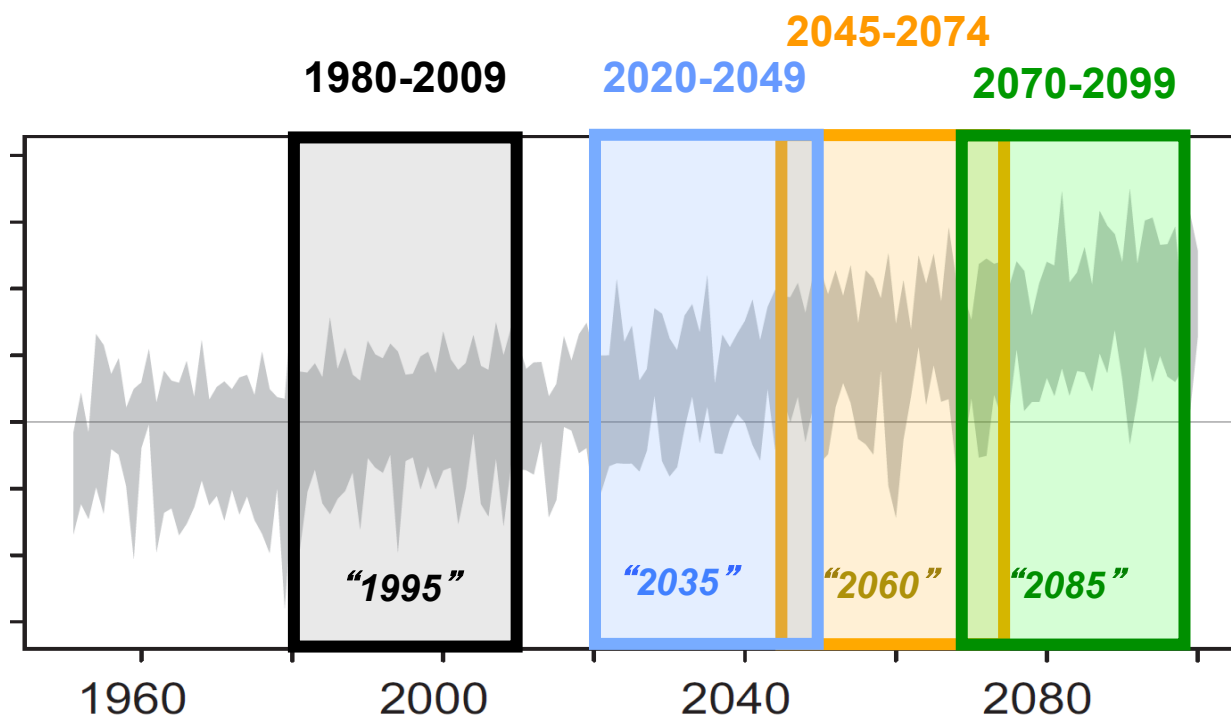
Three climatologically representative regions



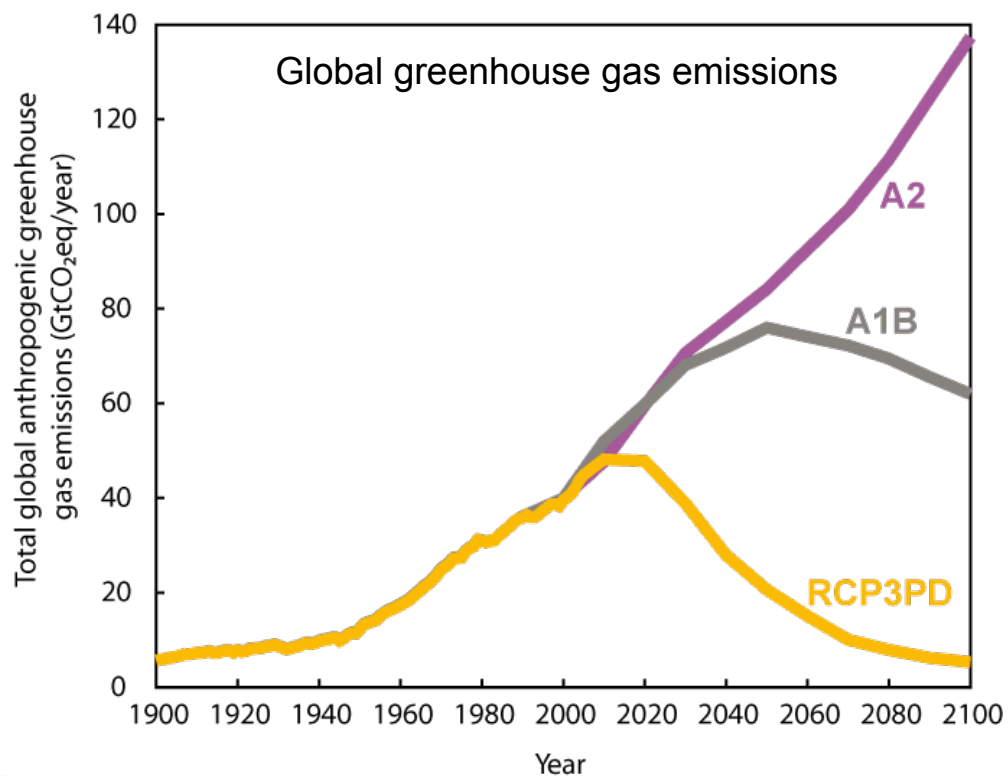
- Central Alps excluded for conceptual reasons
- For impact assessment in Alps the *local scenarios* should be used

Projection context

Three scenario periods with respect to reference 1980-2009



Three emission scenarios



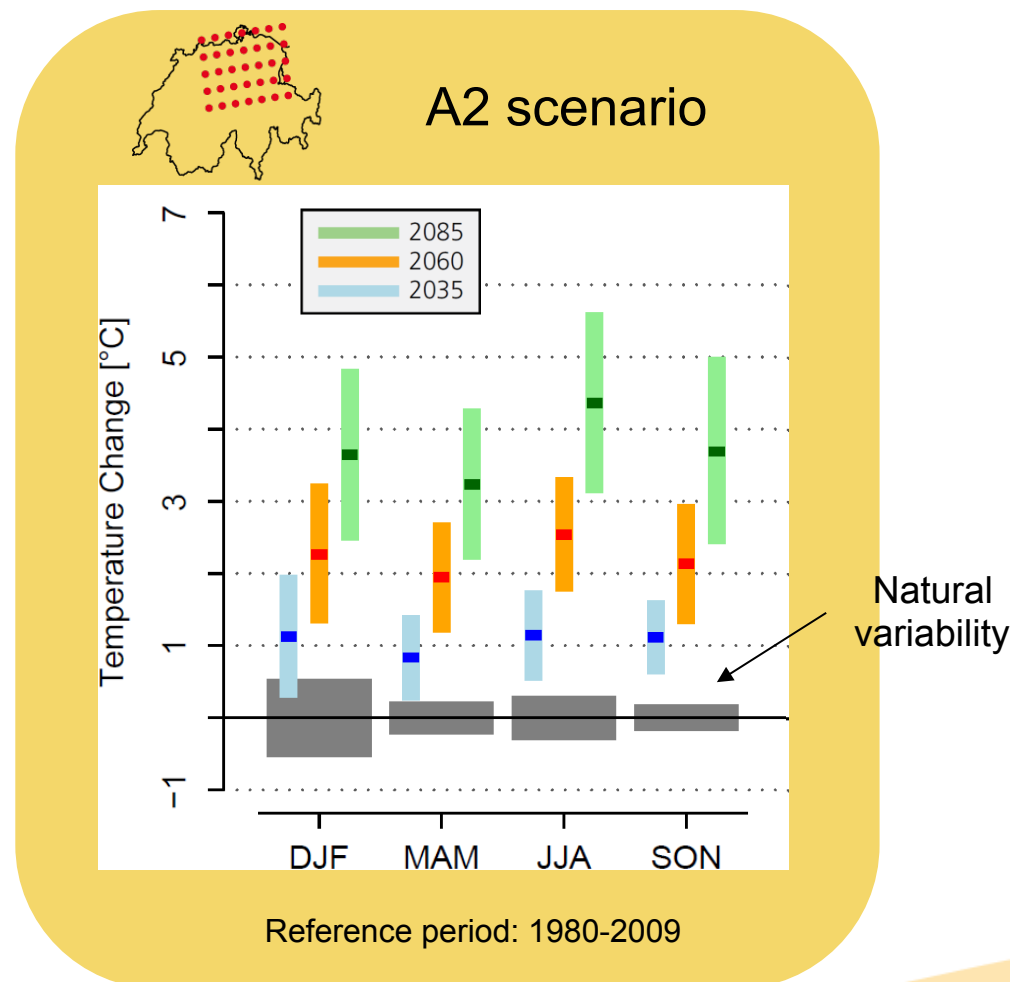
Significant warming in all seasons and regions already by 2035

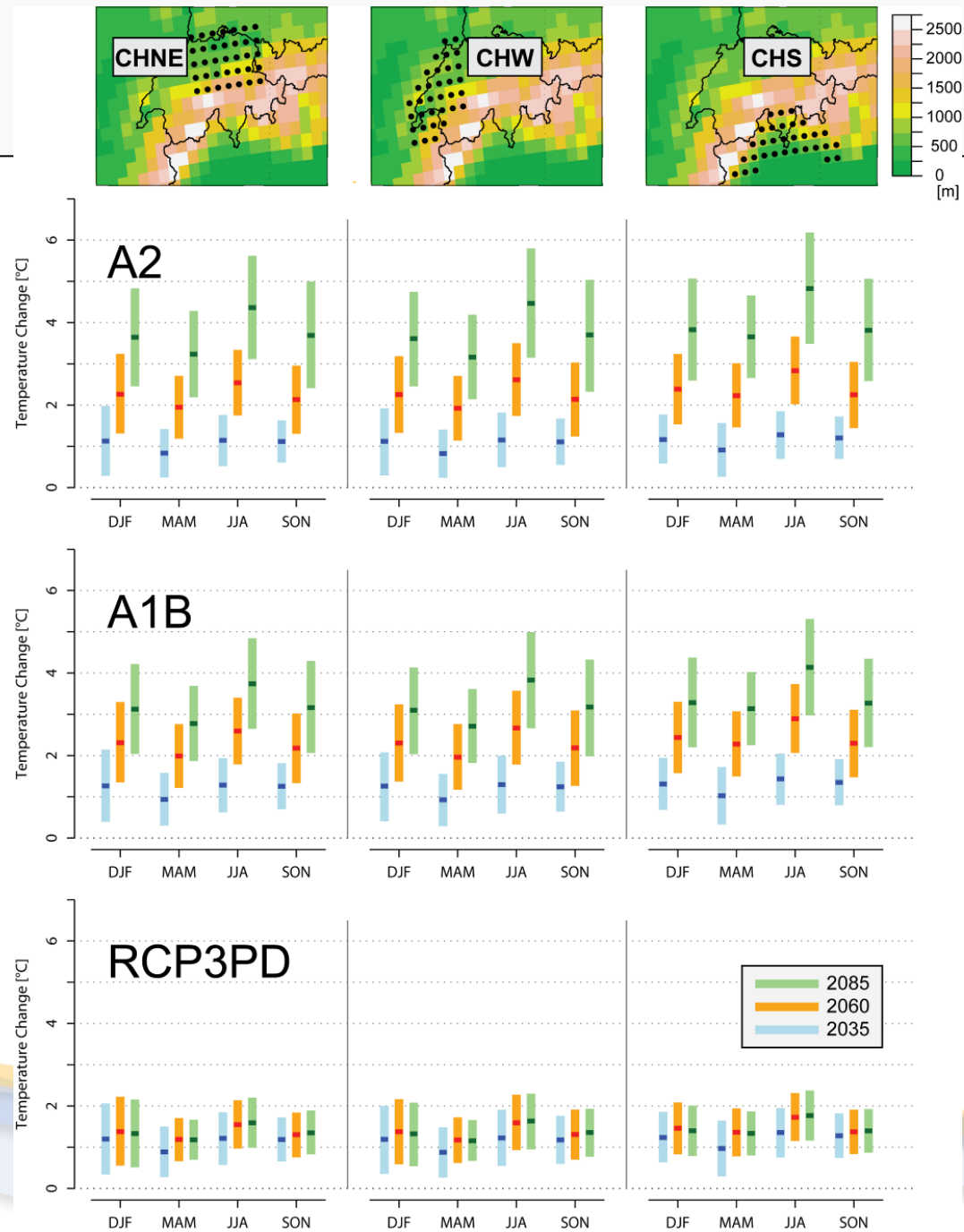
Differences between seasons and regions comparatively small.

In tendency more warming in summer than in winter, and more warming south of the Alps than in northern Switzerland

Medium estimates for A2 scenario by 2085:

3.2 - 4.8°C warming by 2085
(depending on region and season)



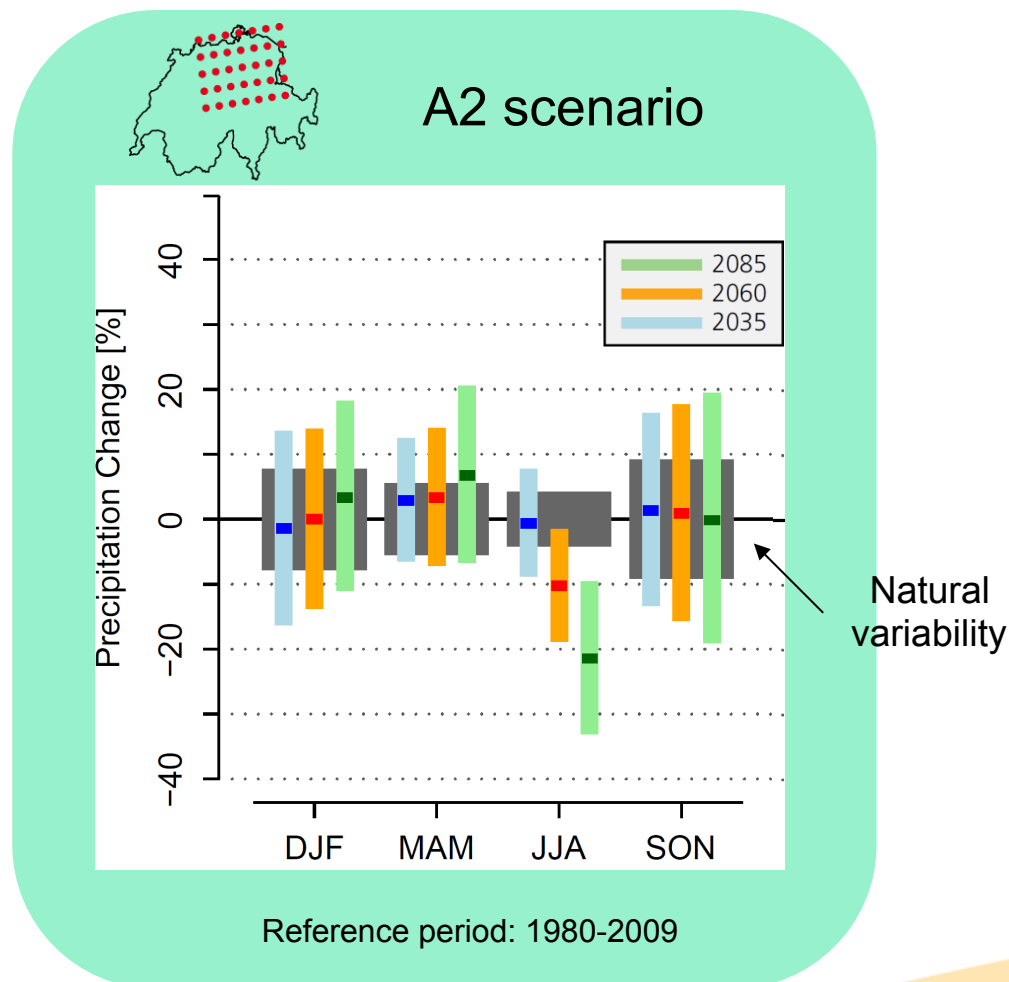
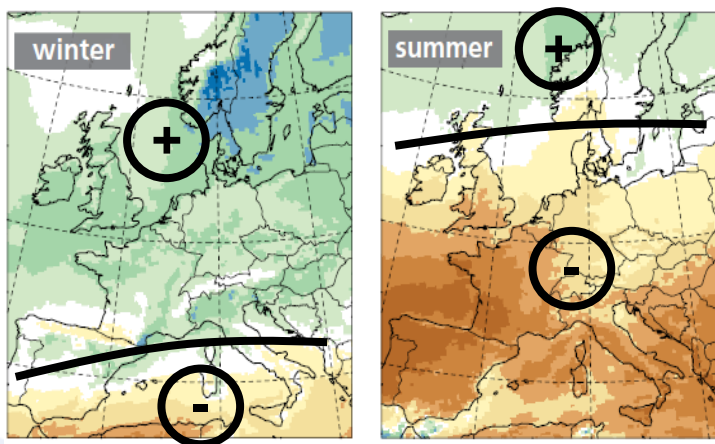


Precipitation



Significant summer drying in all regions during second half of century.

In all other seasons precipitation could either increase or decrease.



Precipitation



Significant summer drying in all regions during second half of century.

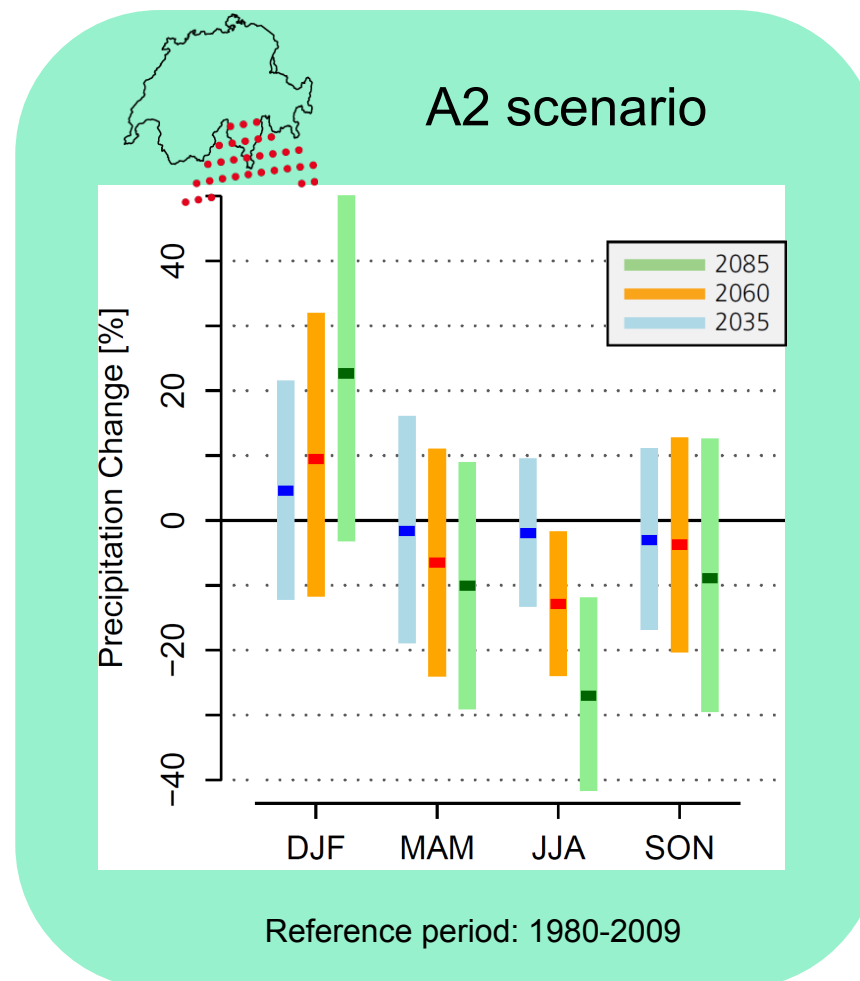
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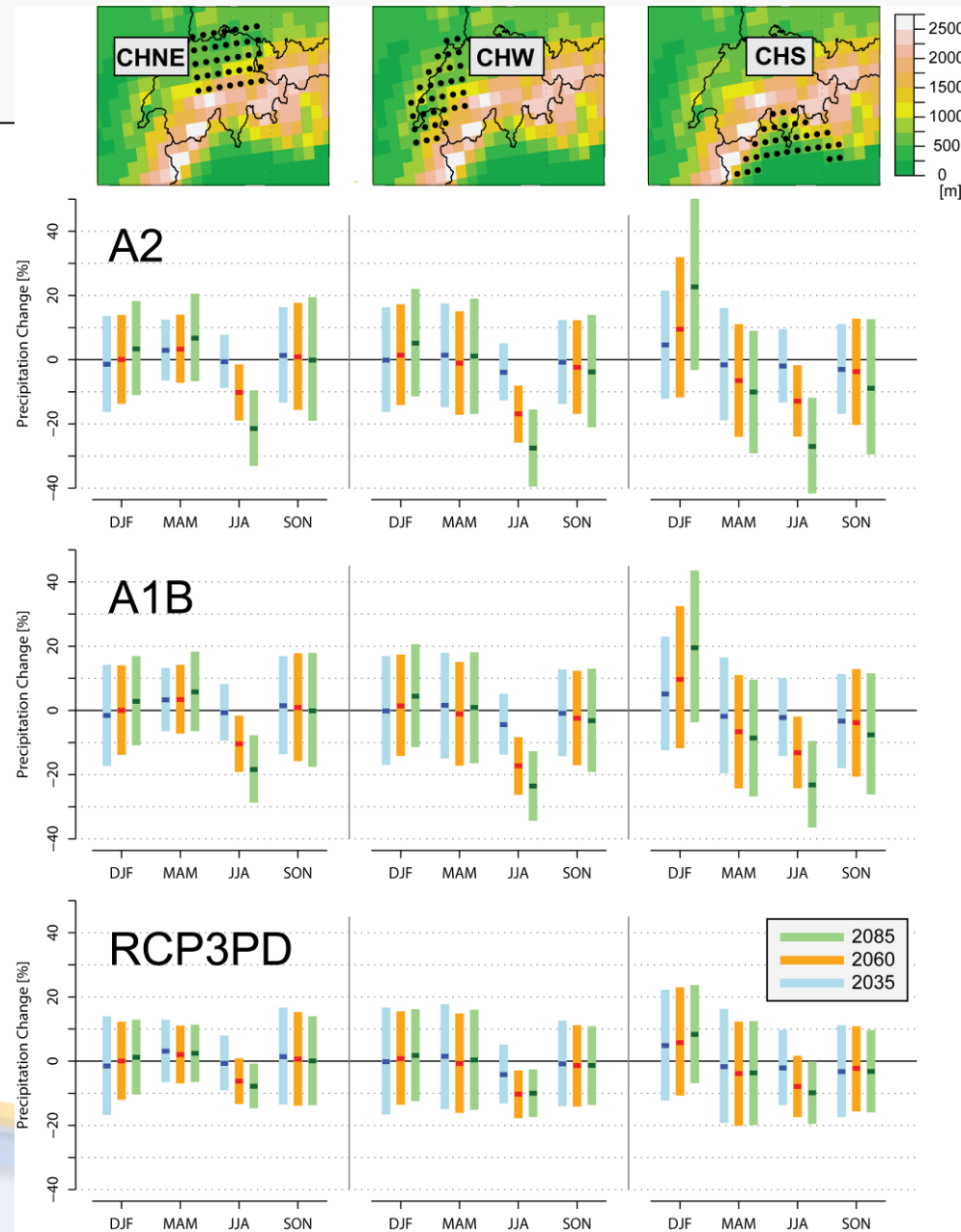
In southern Switzerland, uncertainty ranges are larger and winter precipitation will likely increase

Medium estimates for A2-scenario by 2085:

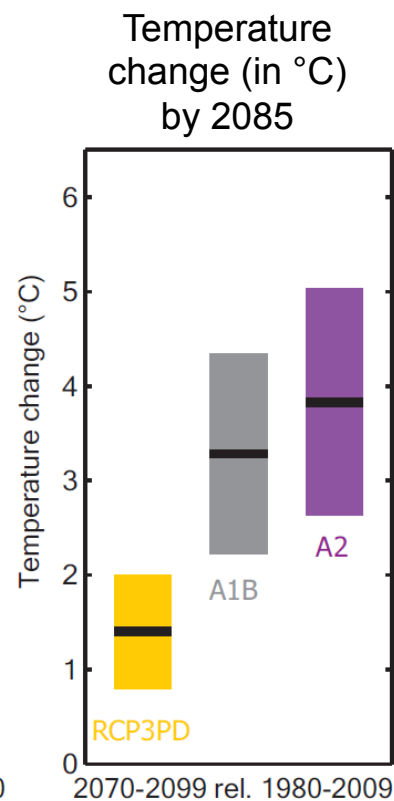
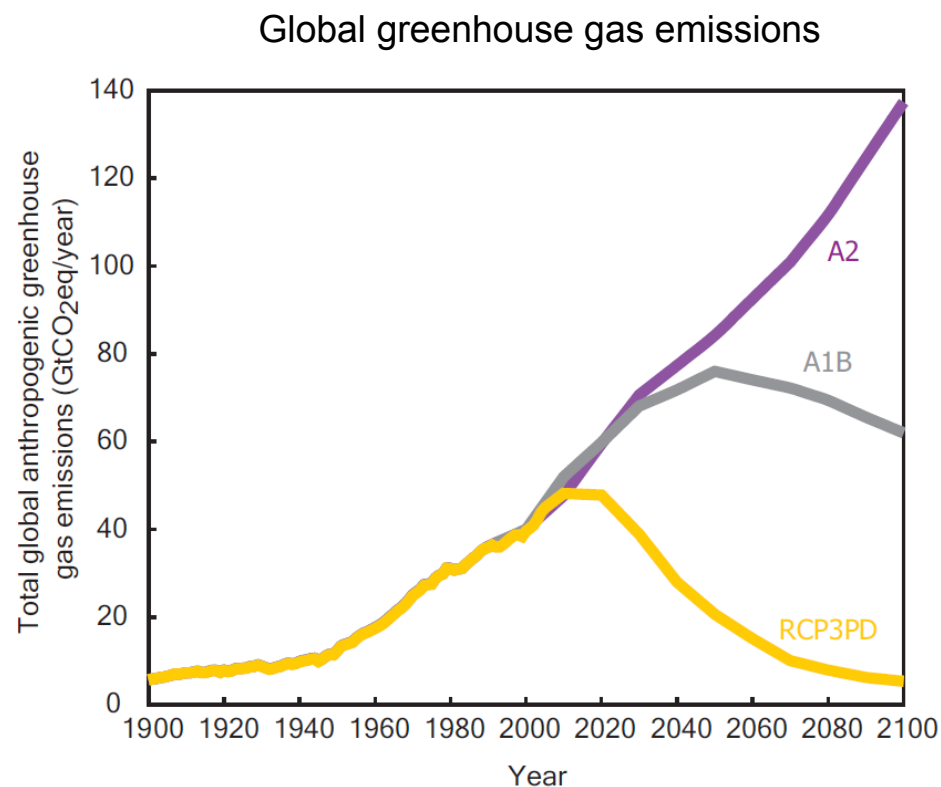
Decrease of summer mean precipitation: 21-28% (depending on region).

Increase of winter mean precipitation in southern Switzerland: 23%

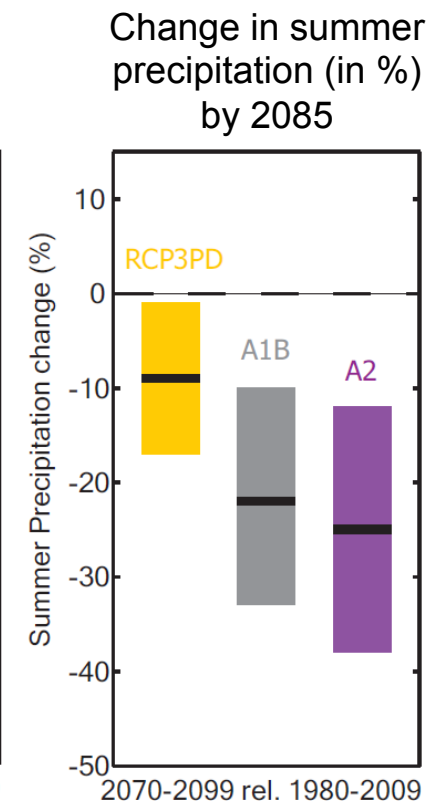




Impact of emission scenarios

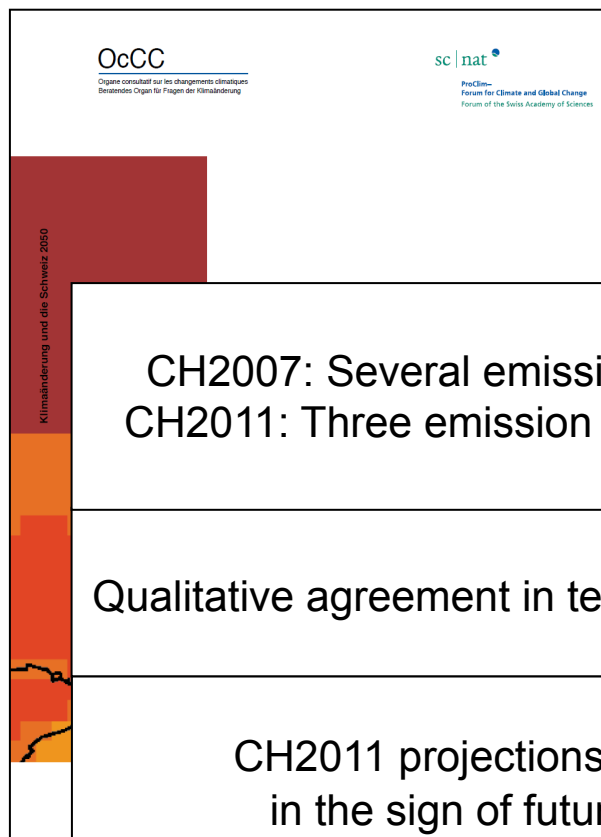


Average over all
seasons and regions

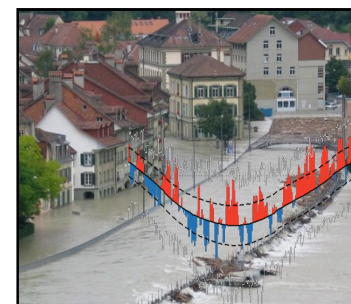
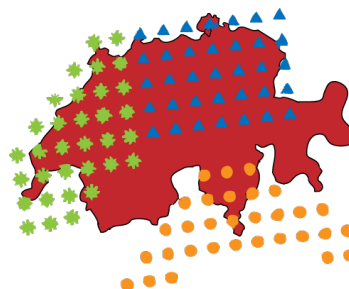
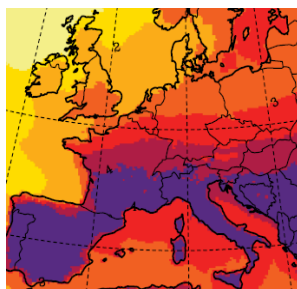


Average over all
regions

Comparison with CH2007



Scales and uncertainties



global

continental

**regional
seasonal
& daily**

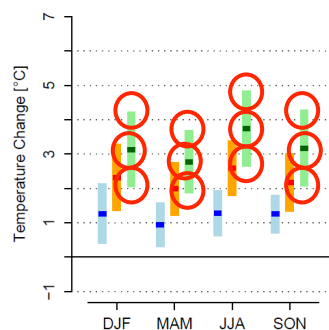
**local
daily**

UNCERTAINTIES

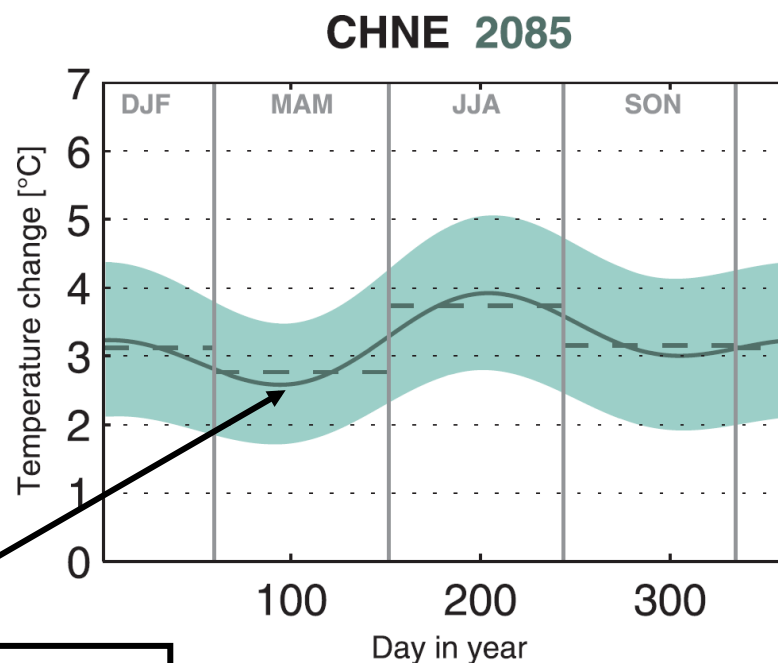
Daily scenarios - regional



Derived from probabilistic seasonal projections



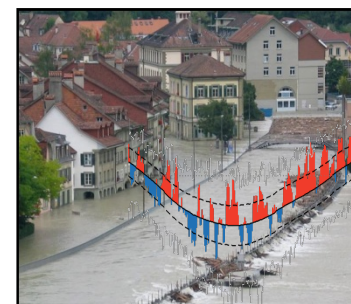
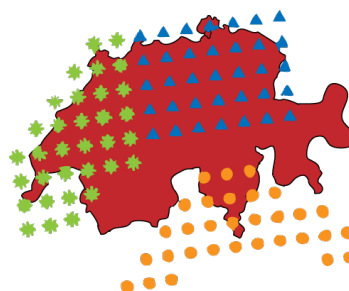
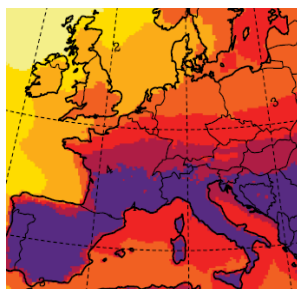
A1B



Set of daily scenarios that are fully consistent with probabilistic seasonal projections, but do not contain more independent information

Heuristic fit of a possible annual cycle preserving seasonal means

Scales and uncertainties



global

continental

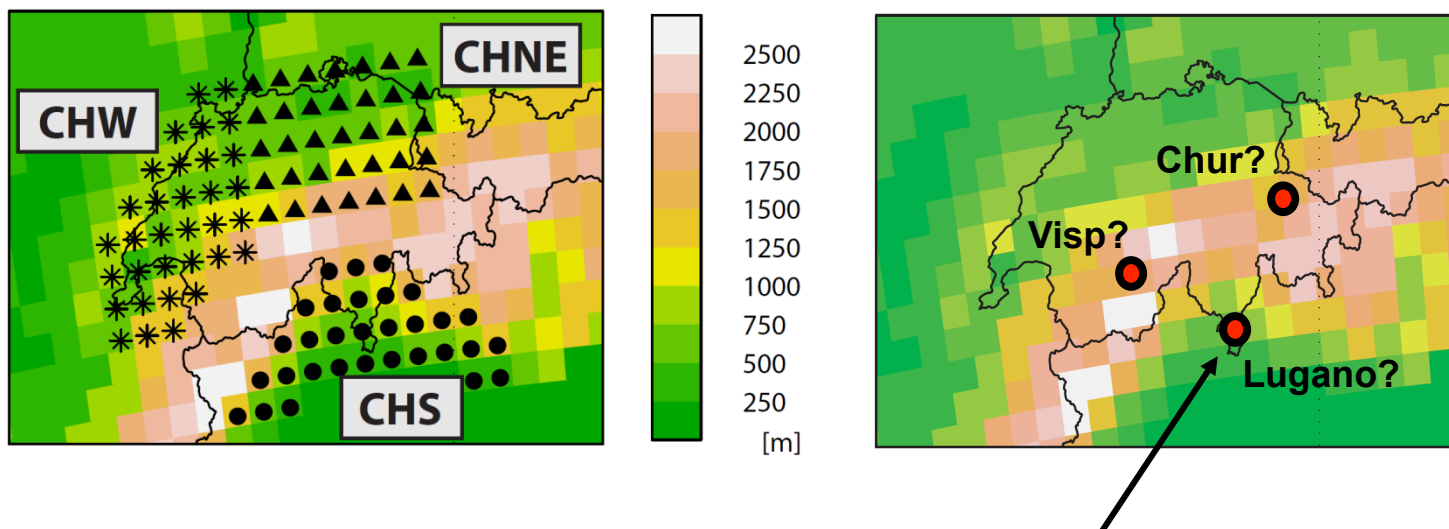
**regional
seasonal
& daily**

**local
daily**

UNCERTAINTIES



Daily scenarios - local

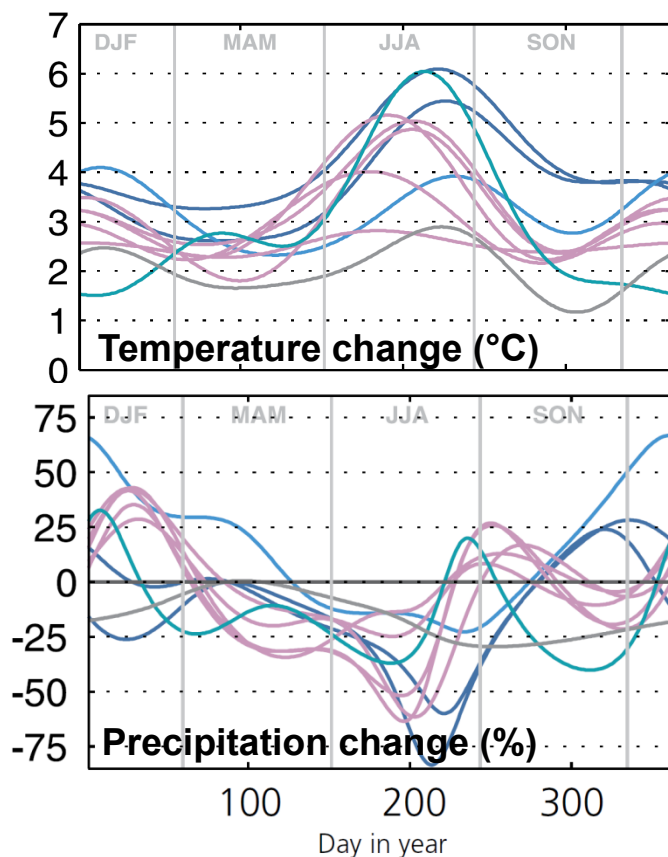


Statistical downscaling of
local daily output of individual model chains
(Bosshard et al. 2011)

Daily scenarios - local

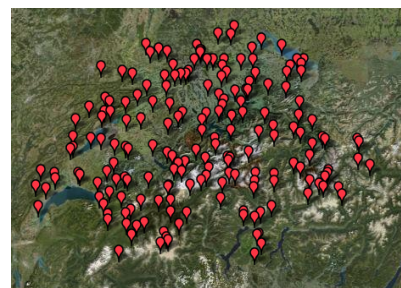


Annual cycles of climate change signal from individual model chains

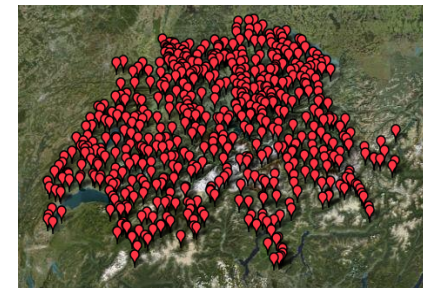


Example Lugano (A1B scenario for 2070-2099)

- Only individual model chains
- No multi-model uncertainty assessment
- Only A1B scenario

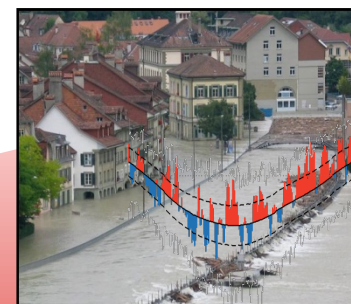
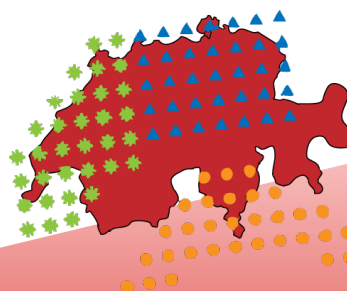
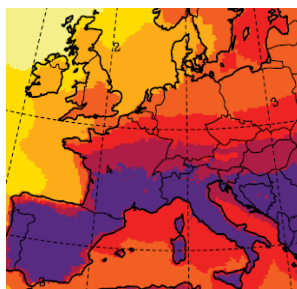


188 sites for
temperature



565 sites for
precipitation

EXTREMES?



global

continental

**regional
seasonal
& daily**

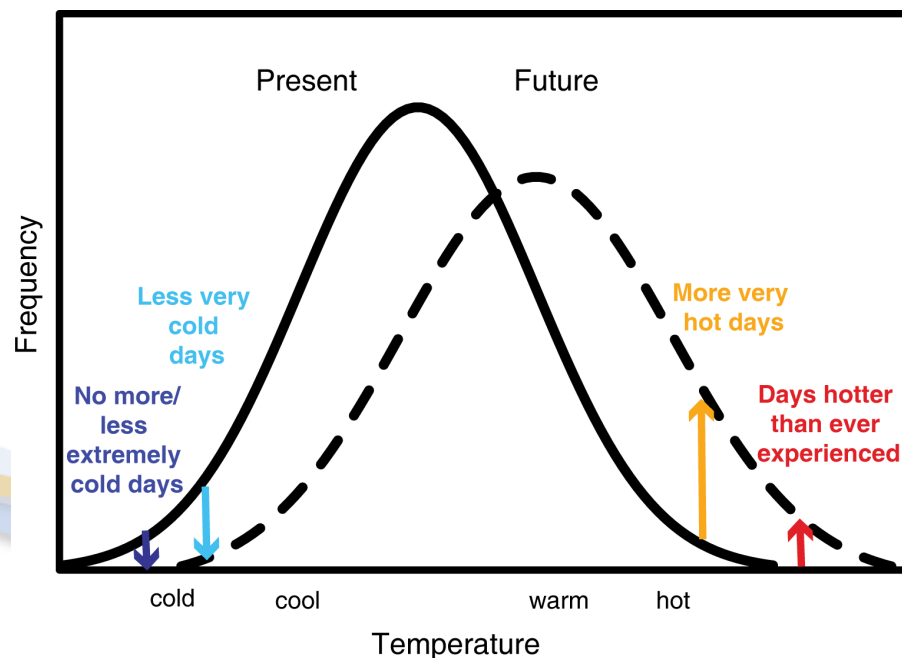
**local
daily**

UNCERTAINTIES

Temperature extremes

Expected changes based on literature review and supplemented by analysis of model chains:

- **Increasing** frequency, duration and intensity of **summer heat waves**
- **Decreasing** frequency of **cold nights and days**



Precipitation extremes



Substantial changes in precipitation extremes are expected based on **understanding** of physical processes

Tendency toward increasing **risk of droughts** and **longer dry spells**

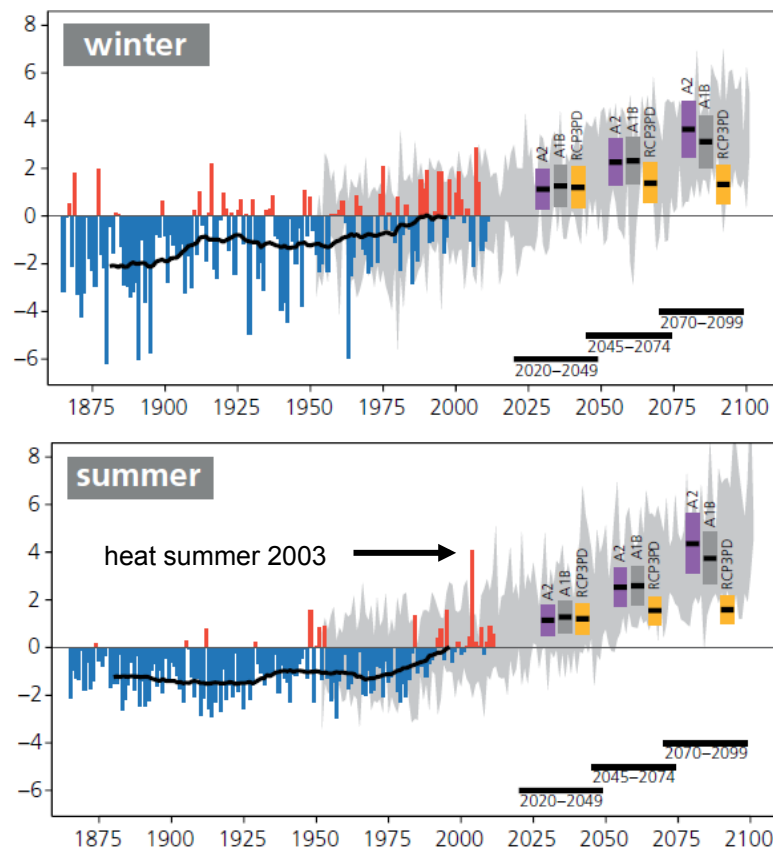
Changes in heavy rainfall events are **more uncertain** due to large natural variations but major increases **cannot be ruled out**

Shift from solid (snow) to liquid (rain) precipitation is expected, which would **increase flood risk** primarily in the lowlands

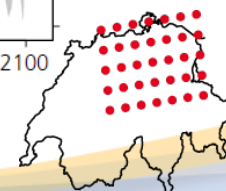
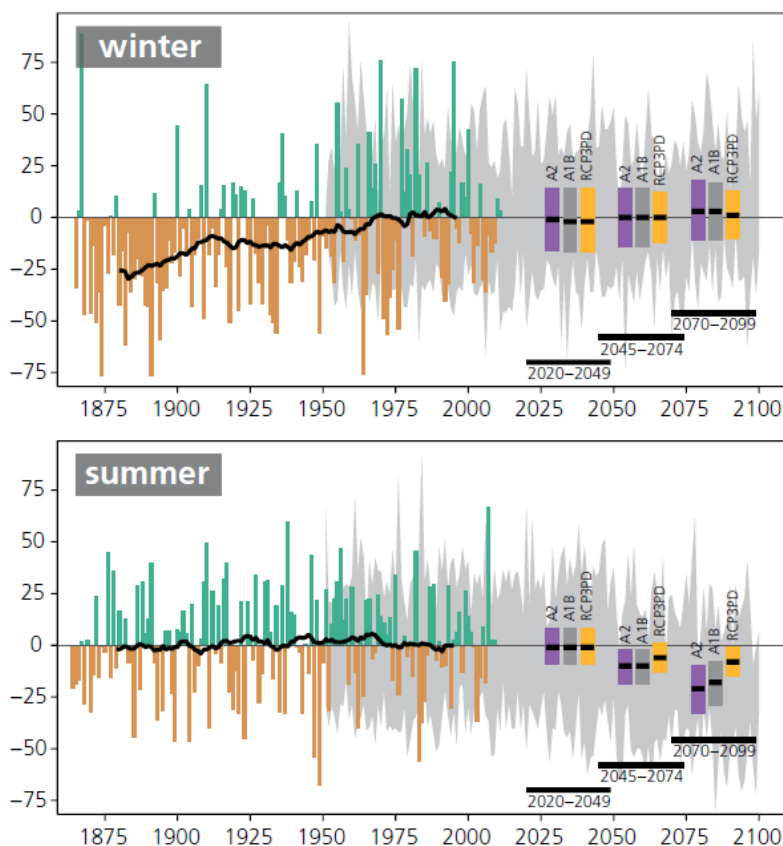
Summary



Temperature Change (°C)



Precipitation Change (%)





Beyond CH2011

Matteo Buzzi

C. Appenzeller, I. Bey, T. Bosshard, T. Corti, M. Croci-Maspoli, A. Fischer, E. Fischer, J. Fuhrer, S. Kotlarski, R. Knutti, A. Kress, C. Kull, M. Liniger, A. Lustenberger, P. Pall, C. Schär, S. Scherrer, A. Weigel

CH2011 data dissemination

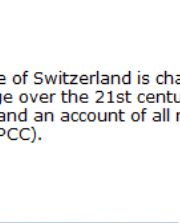
**Report, summaries,
and scenario data in
digital form available
at:**

www.ch2011.ch

Swiss Climate Change Scenarios CH2011

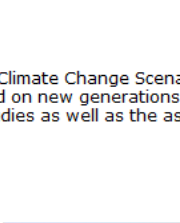
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The climate of Switzerland is changing. The Swiss Climate Change Scenarios CH2011 provide a new assessment of how this climate may change over the 21st century. They are based on new generations of climate models with higher resolution, improved statistical methods, and an account of all recent relevant studies as well as the assessments by the Intergovernmental Panel on Climate Change (IPCC).



Full report

[Medium resolution](#) (pdf, 17M)
[High resolution](#) (pdf, 55M)



Summary (pdf, 8.4M)

[Zusammenfassung](#) (pdf, 8.4M)
[Résumé](#) (pdf, 8.4M)
[Riassunto](#) (pdf, 8.3M)

[Data download](#)

Day in year	ETHZ_HI_HR_2006C	SWM1_20	SWM1_10	SWM1_5	SWM1_2	SWM1_1	SWM1_0	SWM1_0	SWM1_0
1	2.62	2.45	2.49	2.47	2.54	2.45	2.28		
2	2.61	2.46	2.48	2.41	2.54	2.44	2.29		
3	2.59	2.47	2.49	2.41	2.53	2.44	2.29		
4	2.59	2.47	2.51	2.46	2.53	2.44	2.29		
5	2.54	2.48	2.53	2.39	2.53	2.44	2.29		
6	2.52	2.49	2.53	2.39	2.52	2.44	2.28		
7	2.50	2.49	2.54	2.38	2.52	2.44	2.28		
8	2.48	2.50	2.58	2.37	2.51	2.45	2.28		
9	2.48	2.50	2.59	2.36	2.51	2.45	2.27		
10	2.44	2.51	2.60	2.35	2.50	2.43	2.27		
11	2.41	2.51	2.62	2.34	2.49	2.42	2.26		
12	2.39	2.52	2.63	2.32	2.49	2.41	2.26		
13	2.37	2.52	2.64	2.31	2.48	2.41	2.25		
14	2.35	2.53	2.65	2.30	2.47	2.40	2.24		
15	2.33	2.53	2.64	2.28	2.46	2.39	2.23		
16	2.31	2.54	2.66	2.26	2.45	2.38	2.22		
17	2.29	2.54	2.67	2.25	2.44	2.38	2.21		
18	2.27	2.54	2.67	2.23	2.43	2.37	2.19		
19	2.26	2.55	2.68	2.22	2.42	2.36	2.18		
20	2.24	2.55	2.68	2.19	2.40	2.34	2.17		
21	2.22	2.56	2.68	2.17	2.39	2.33	2.15		
22	2.20	2.56	2.68	2.15	2.38	2.32	2.14		
23	2.19	2.56	2.68	2.13	2.37	2.31	2.12		
24	2.17	2.56	2.68	2.11	2.36	2.29	2.11		
25	2.16	2.57	2.68	2.09	2.34	2.28	2.09		
26	2.14	2.57	2.67	2.07	2.32	2.26	2.07		
27	2.13	2.57	2.67	2.04	2.31	2.25	2.06		
28	2.12	2.58	2.68	2.02	2.29	2.23	2.04		
29	2.11	2.58	2.67	2.00	2.28	2.22	2.02		
30	2.10	2.58	2.64	1.97	2.26	2.20	2.00		
31	2.09	2.58	2.63	1.95	2.25	2.19	1.98		
32	2.08	2.59	2.62	1.93	2.23	2.17	1.96		
33	2.07	2.59	2.61	1.90	2.22	2.15	1.94		
34	2.06	2.59	2.59	1.88	2.20	2.14	1.92		
35	2.05	2.59	2.58	1.85	2.19	2.12	1.90		
36	2.05	2.59	2.58	1.83	2.17	2.10	1.88		
37	2.04	2.60	2.54	1.81	2.15	2.08	1.86		
38	2.04	2.60	2.53	1.78	2.14	2.07	1.84		

The CH2011 Initiative

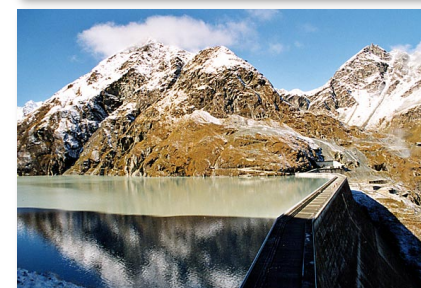
28 September 2011

info@ch2011.ch

Applying the CH2011 data

Examples of projects applying earlier versions of the CH2011 climate change scenarios

- CCHydro – “Climate Change and Hydrology” (BAFU)
 - Klimaänderung und Wasserkraftnutzung (Swisselectric research / BFE)
 - Klimaänderung und Wasserkraftnutzung - Sektorielle Studie Wallis (Canton du Valais / FMV)
 - Agriculture and future climate (MeteoSwiss / Agroscope)
-
- National Research Program 61 – Sustainable Water Management (SNF)



Sustainable water management
National Research Programme NRP 61

Applying the CH2011 data

- **Evolution of the Gorner glacier**

Laboratory of Hydraulics,
Hydrology and Glaciology
(VAW), ETH Zurich

Gorner glacier

Monte Rosa



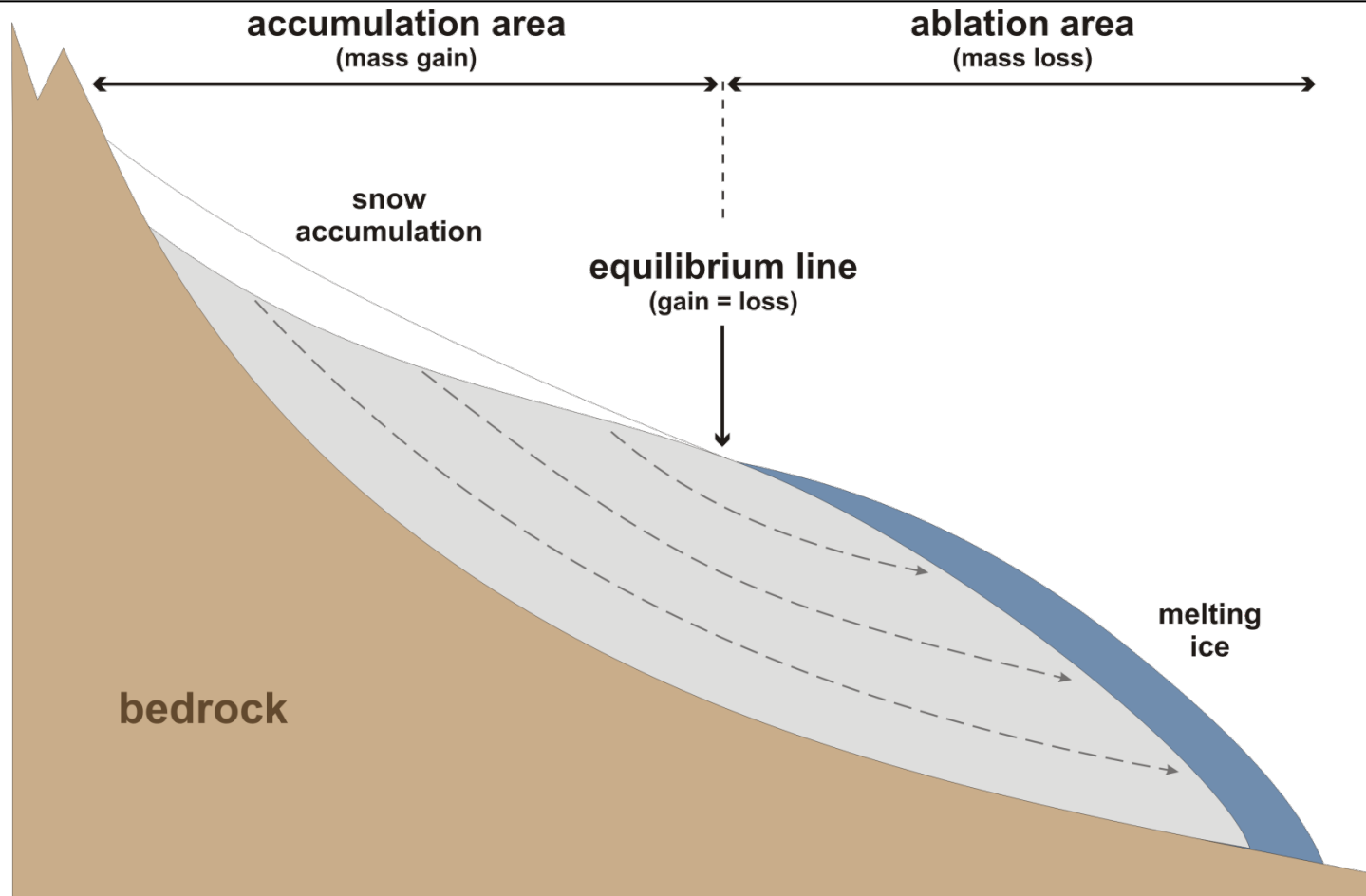
- **Predicting agricultural pests under future climate**

MeteoSwiss / Agroscope

Colding moth in apple orchading



Glacier mass balance and dynamics



Courtesy: Sven Kotlarski, ETH Zurich

- Since 1985, Swiss glaciers are losing mass at an increasing rate.
- What is the predicted evolution of Swiss glaciers and the associated impact on hydrology?

Evolution of the Gorner glacier

Approach:

- Combine 10 local scenarios based on individual model chains with 10 past observed interannual variability of T and P
- Generate 100 realizations of future T and P
- Use those data to drive a glacier model

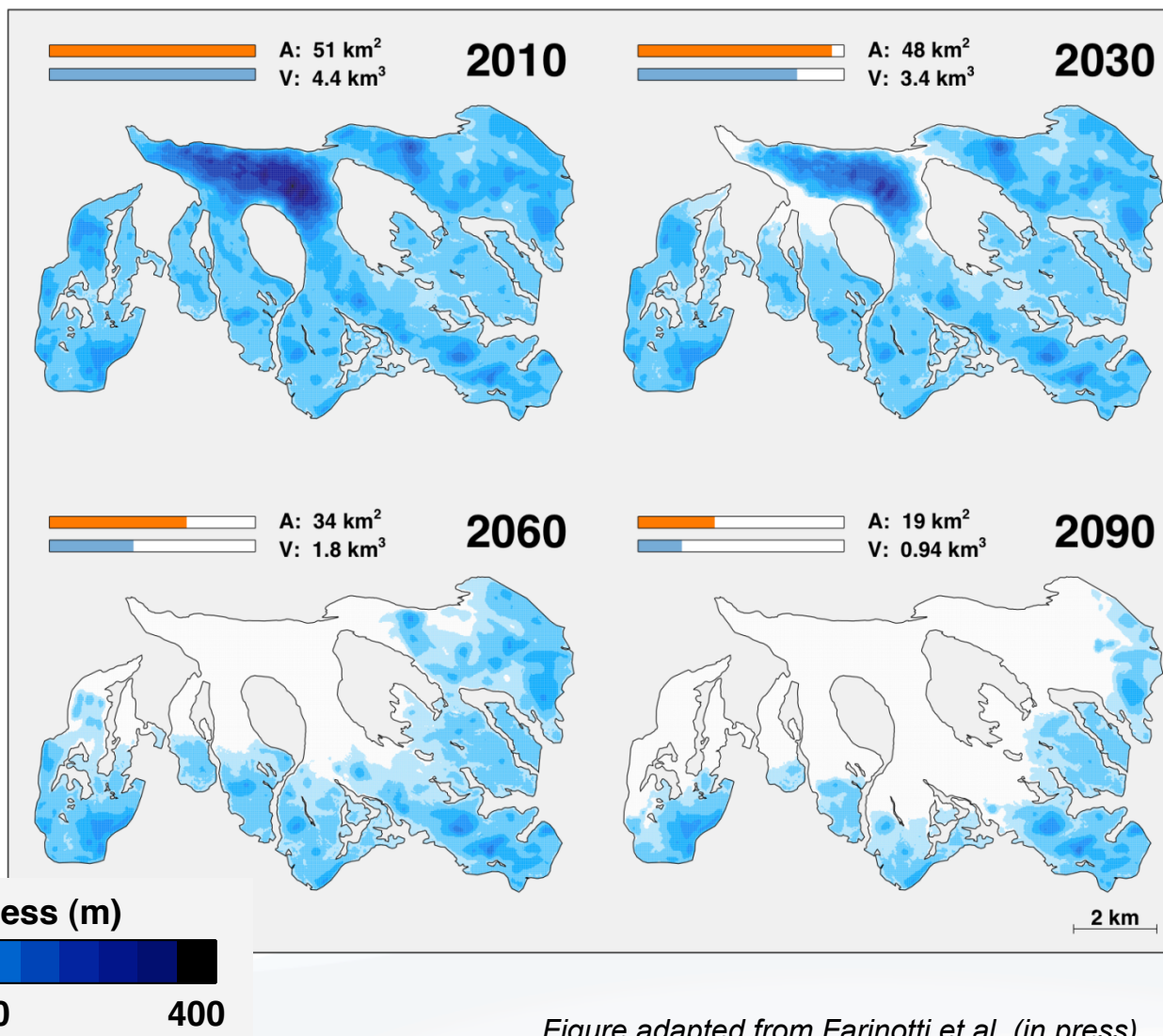
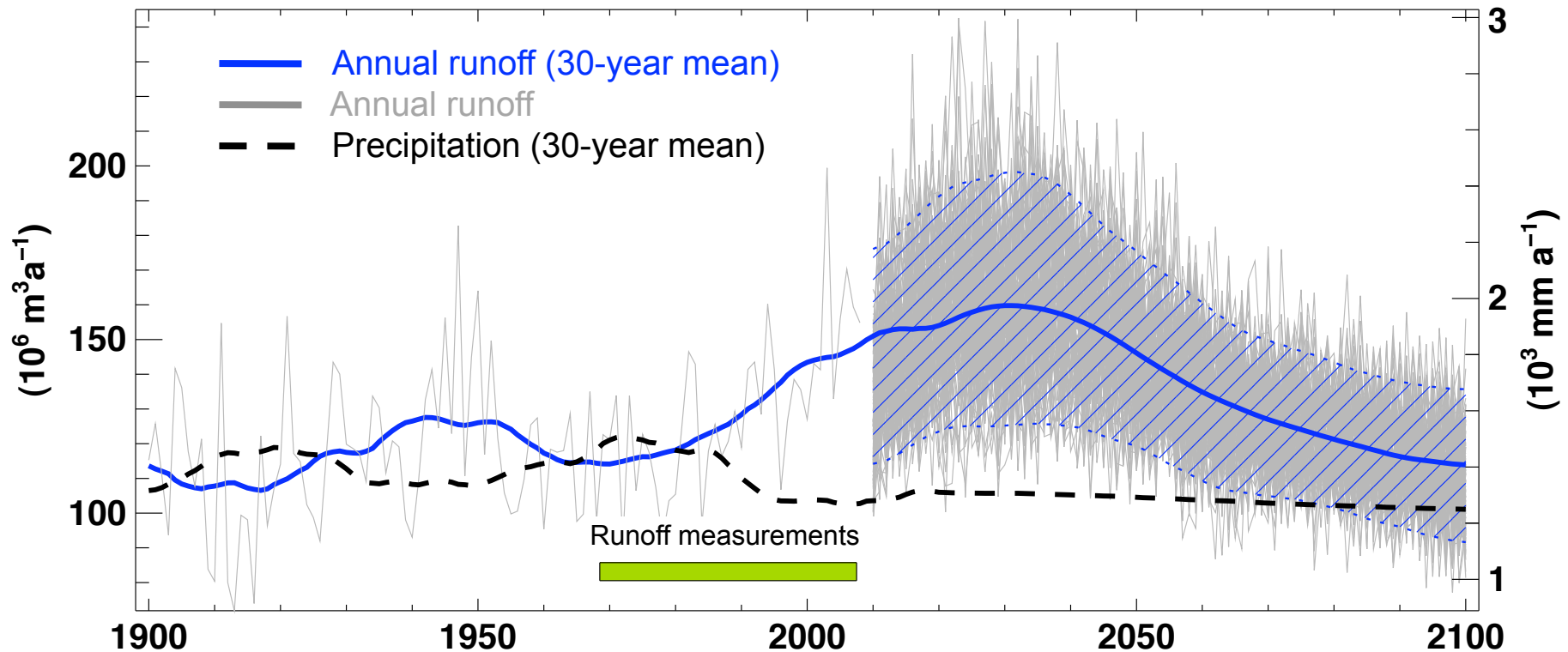


Figure adapted from Farinotti et al. (in press), VAW, ETH Zurich

Implication for the Gorner glacier runoff



- Short-term increase in runoff until 2040
- Long-term decrease back to levels of the beginning of the century (but strong changes in runoff seasonality)
- Glacier retreat will result in a change in water availability and natural risk potentials

Figure adapted from Farinotti et al. (in press),
VAW, ETH Zurich



Grazie per la vostra attenzione!