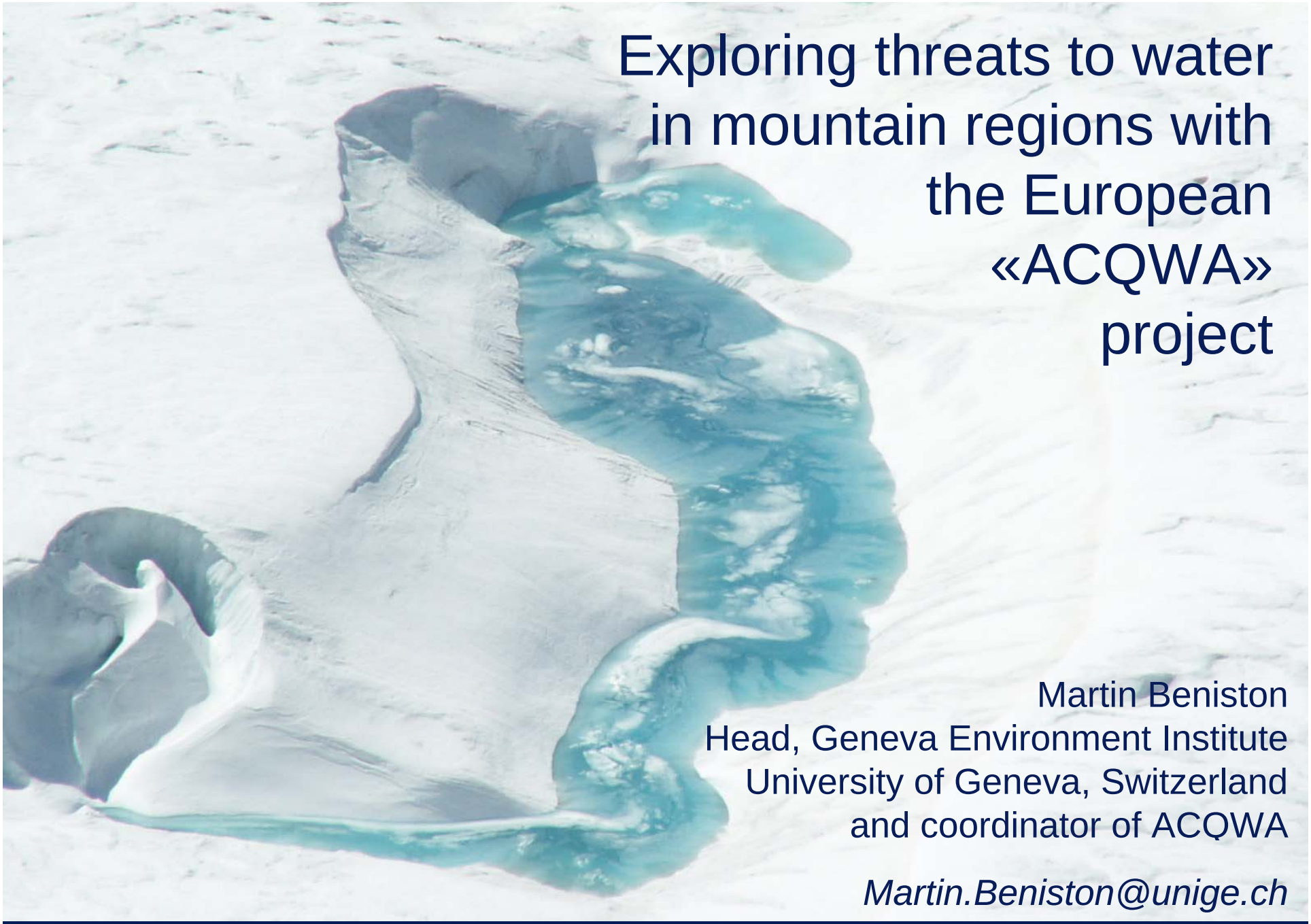


Exploring threats to water in mountain regions with the European «ACQWA» project

Martin Beniston
Head, Geneva Environment Institute
University of Geneva, Switzerland
and coordinator of ACQWA

Martin.Beniston@unige.ch

UNIVERSITÉ DE GENÈVE

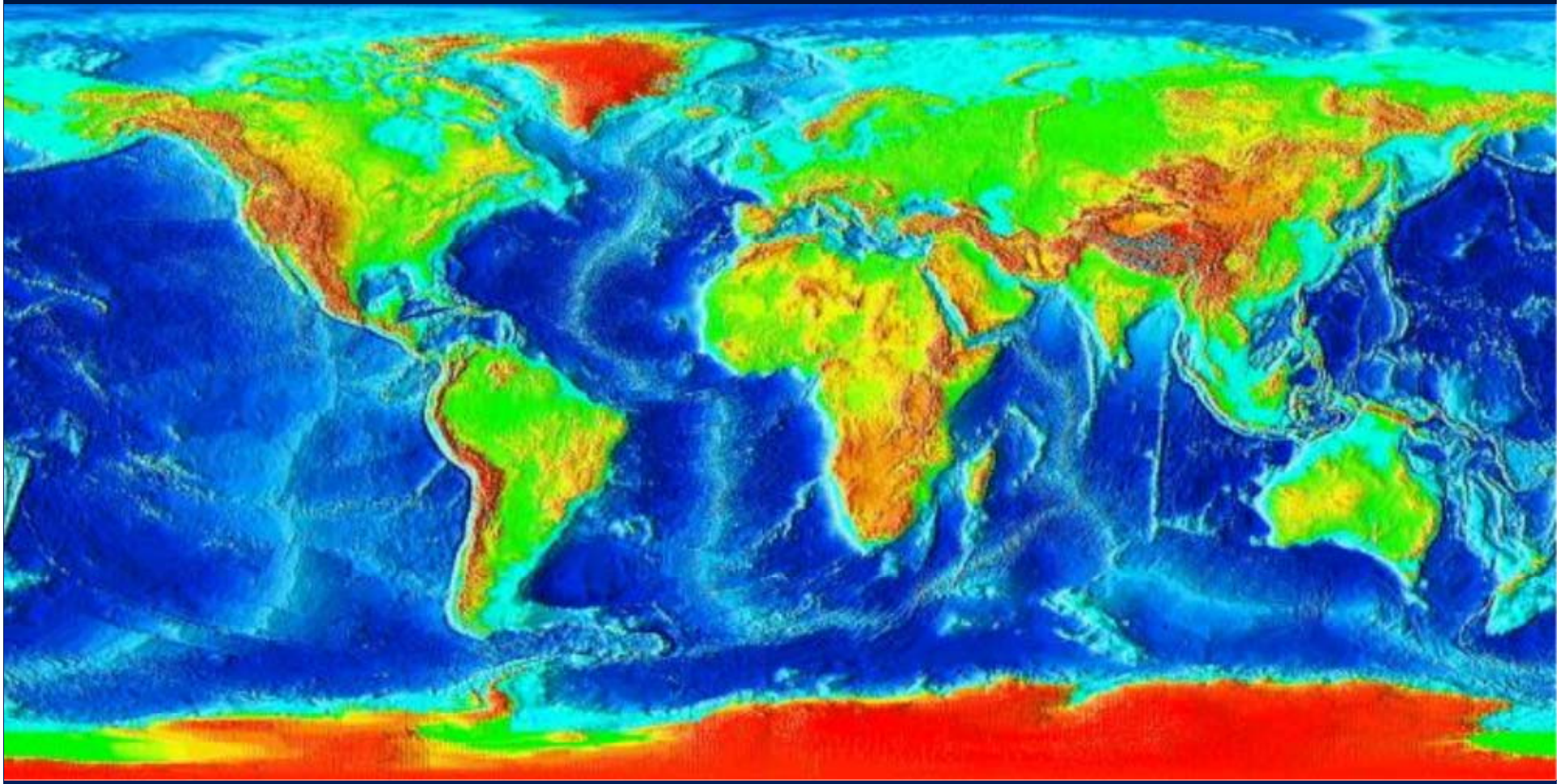
Overview

- Mountains and water
- Current and future climate (Alps)
- Potential impacts
- The EU « ACQWA » Project
- Concluding remarks

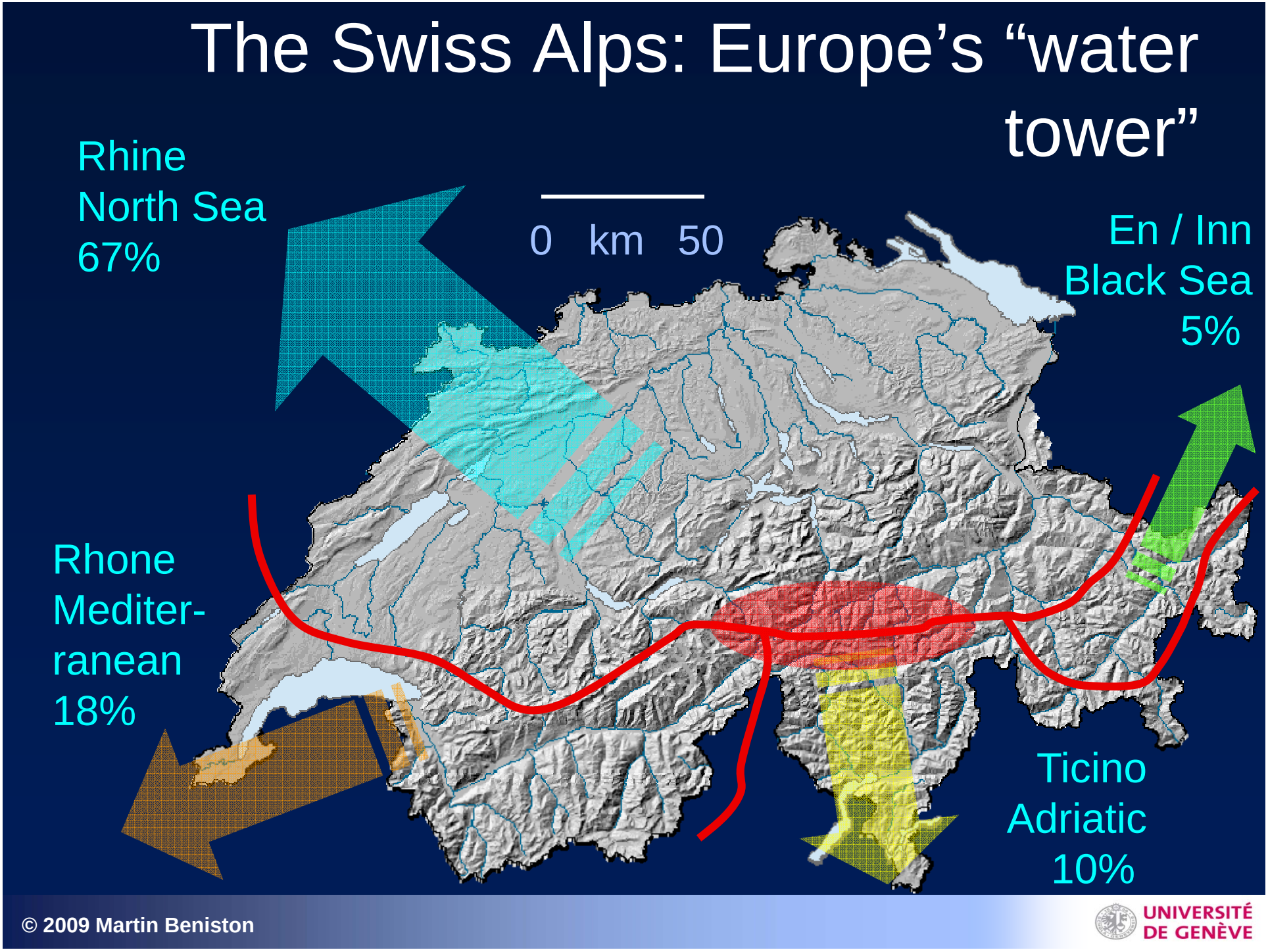
1

- Mountains and water
- Current and future climate (Alps)
- Potential impacts
- What ACQWA aims to achieve
- ACQWA partners

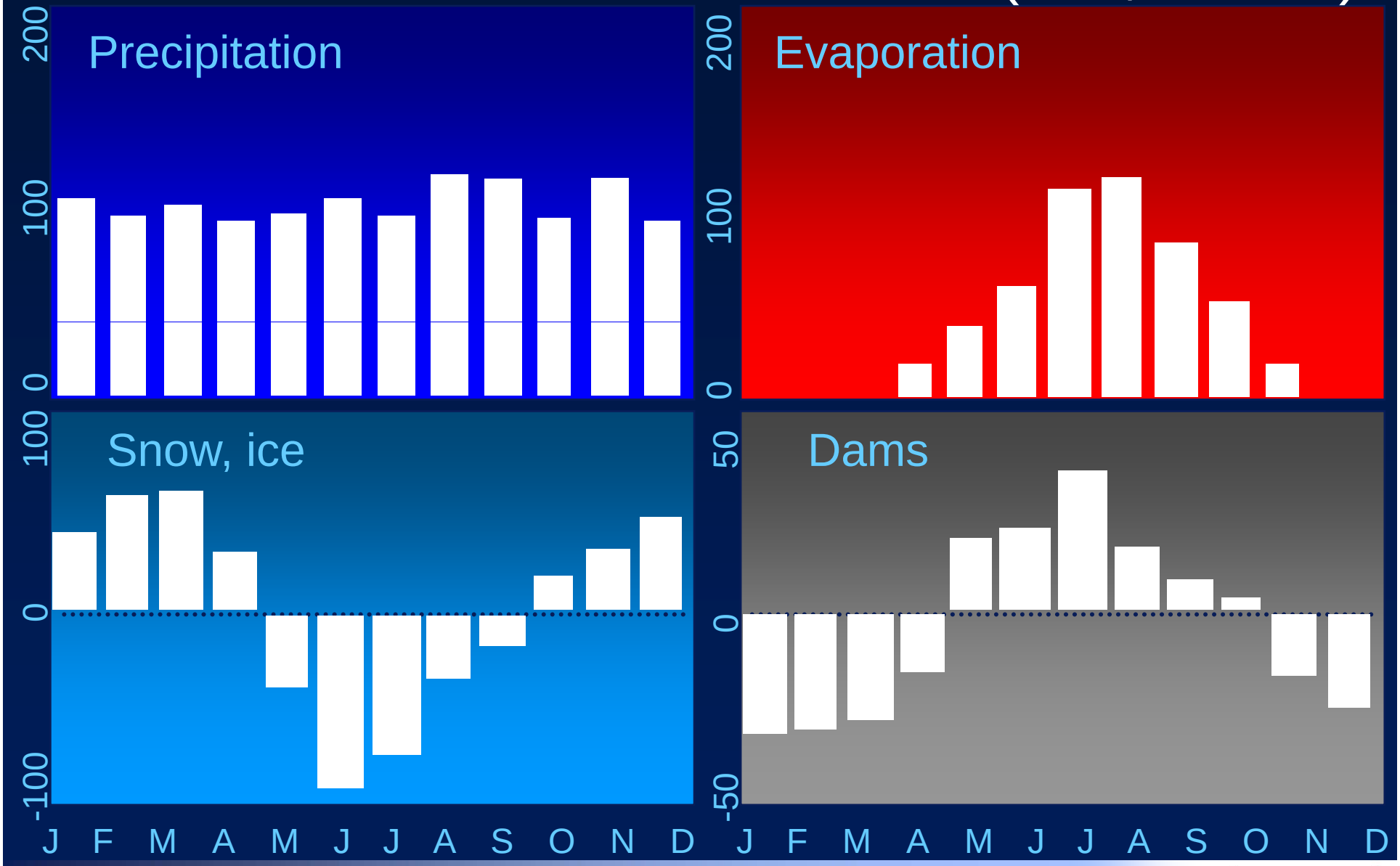
Mountains as a source of more than half the world's rivers



The Swiss Alps: Europe's "water tower"



Components of the hydrological cycle under current climate (mm, Rhone)



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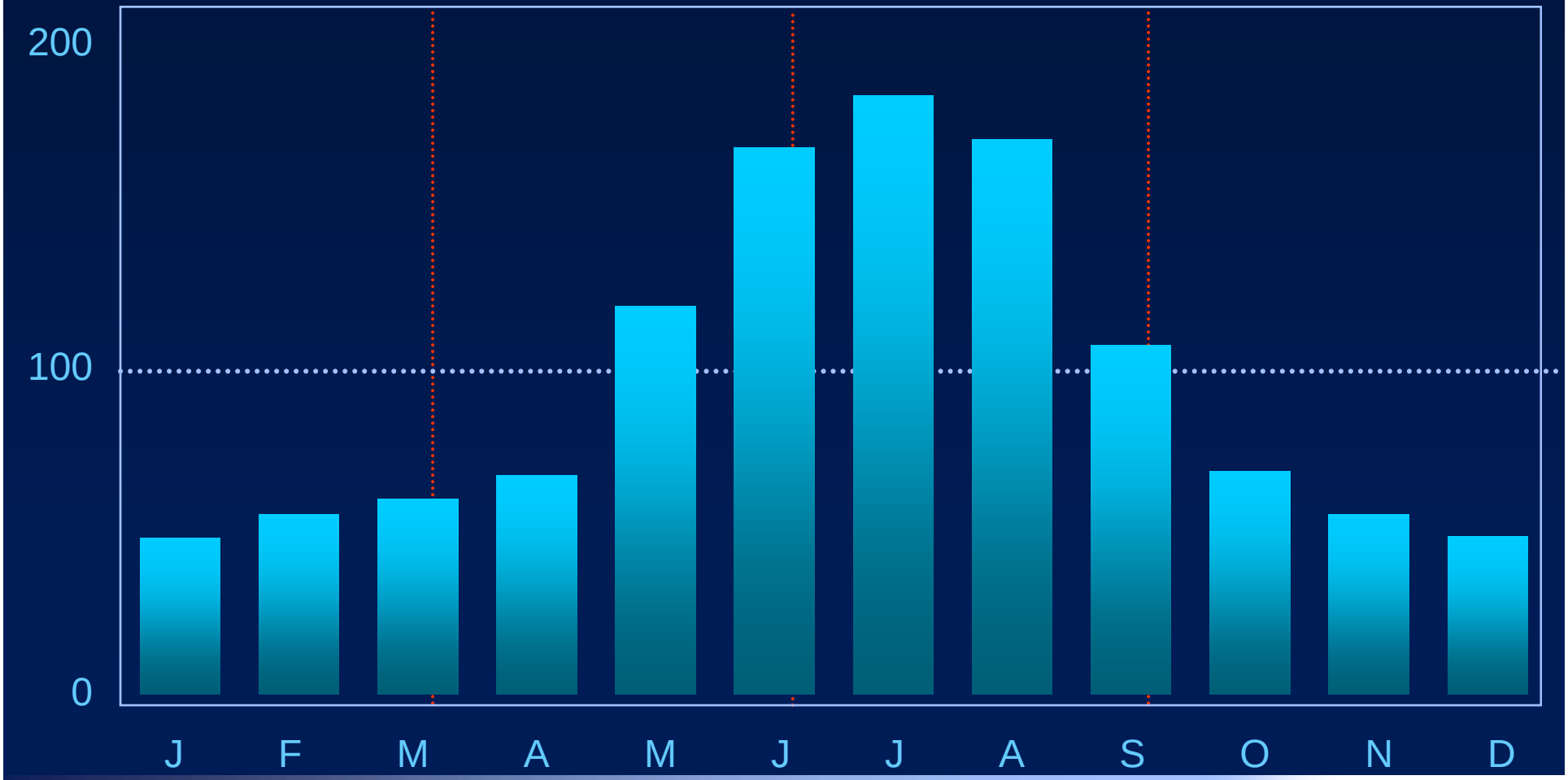
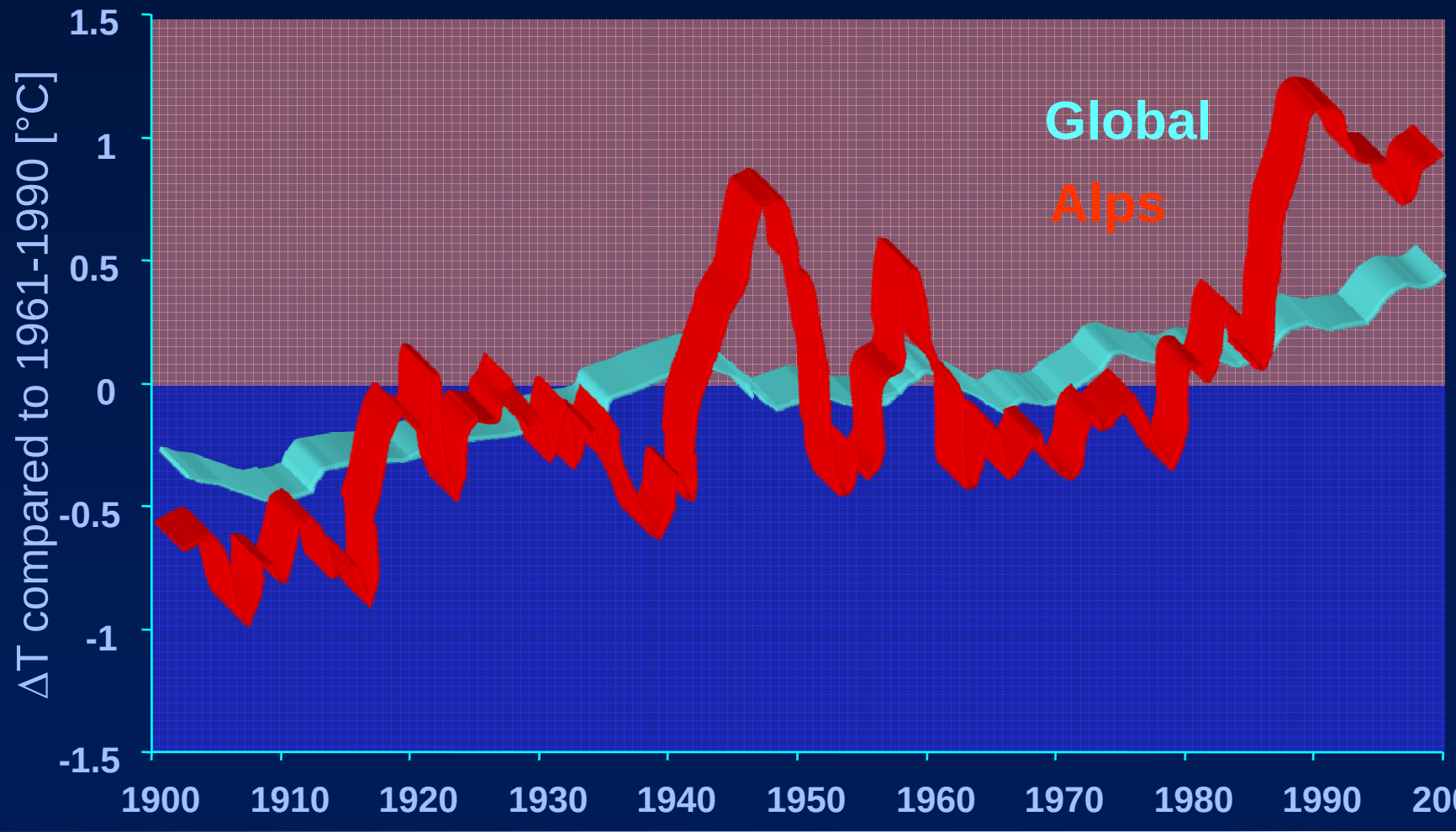
Average monthly discharge (mm, Rhone)



2

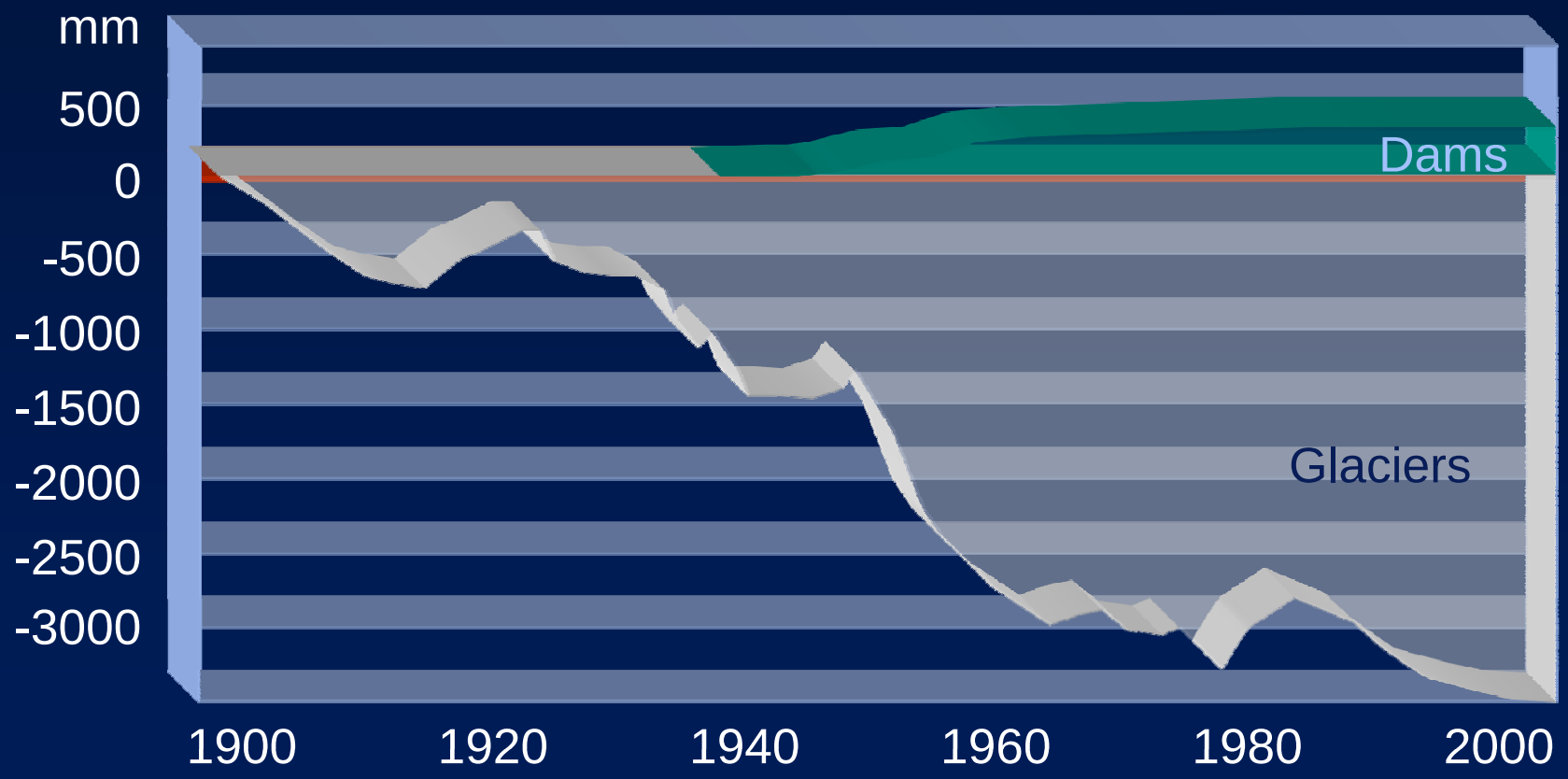
- Mountains and water
- Current and future climate (Alps)
- Impacts
- The EU « ACQWA » project
- Concluding remarks

Evolution of global and alpine temperatures, 1901-2000

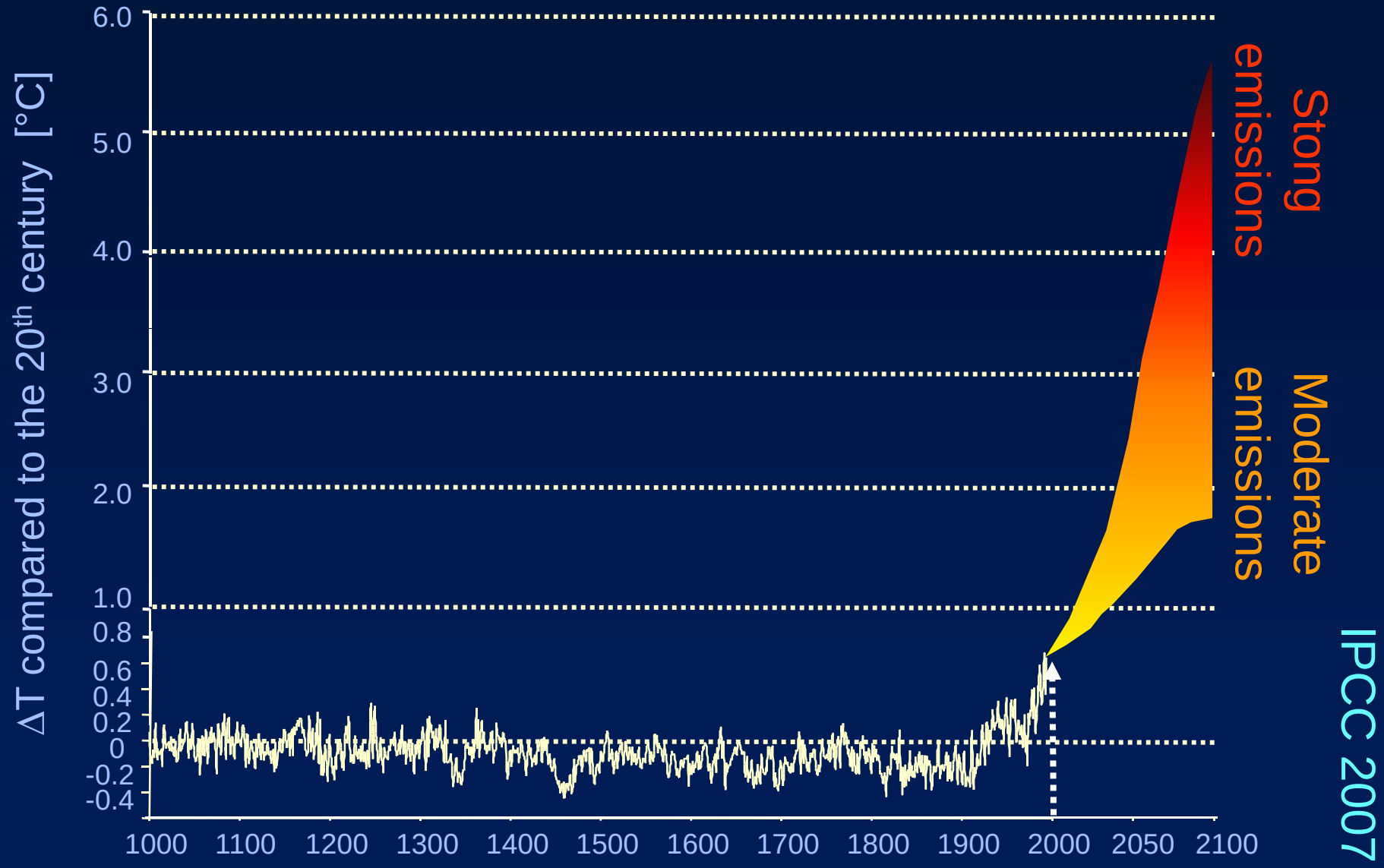


Beniston, 2000: Environmental Change in Mountains, Arnold, London

Changes in water availability for the Rhône River

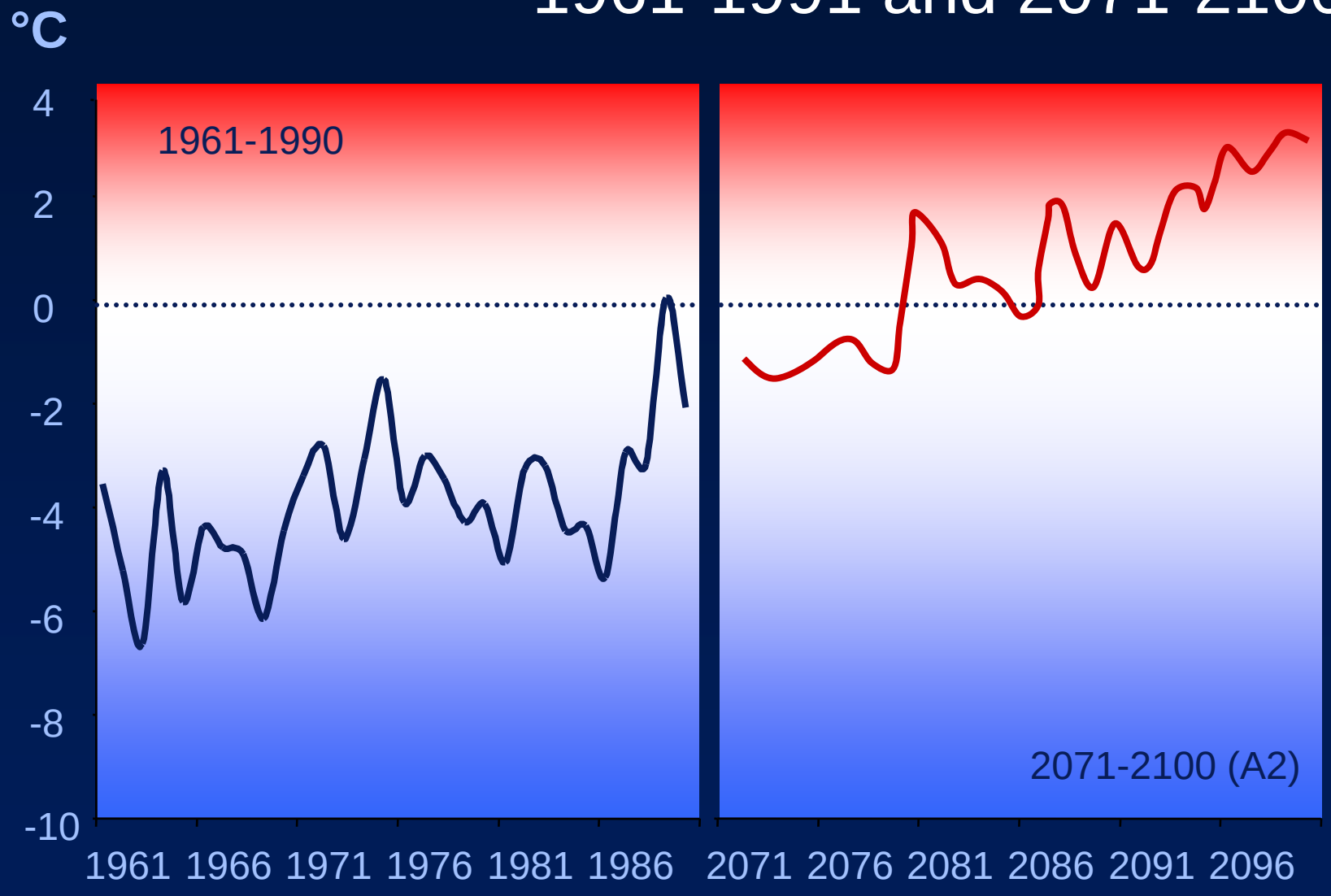


Climate futures



Changes in temperature by 2100

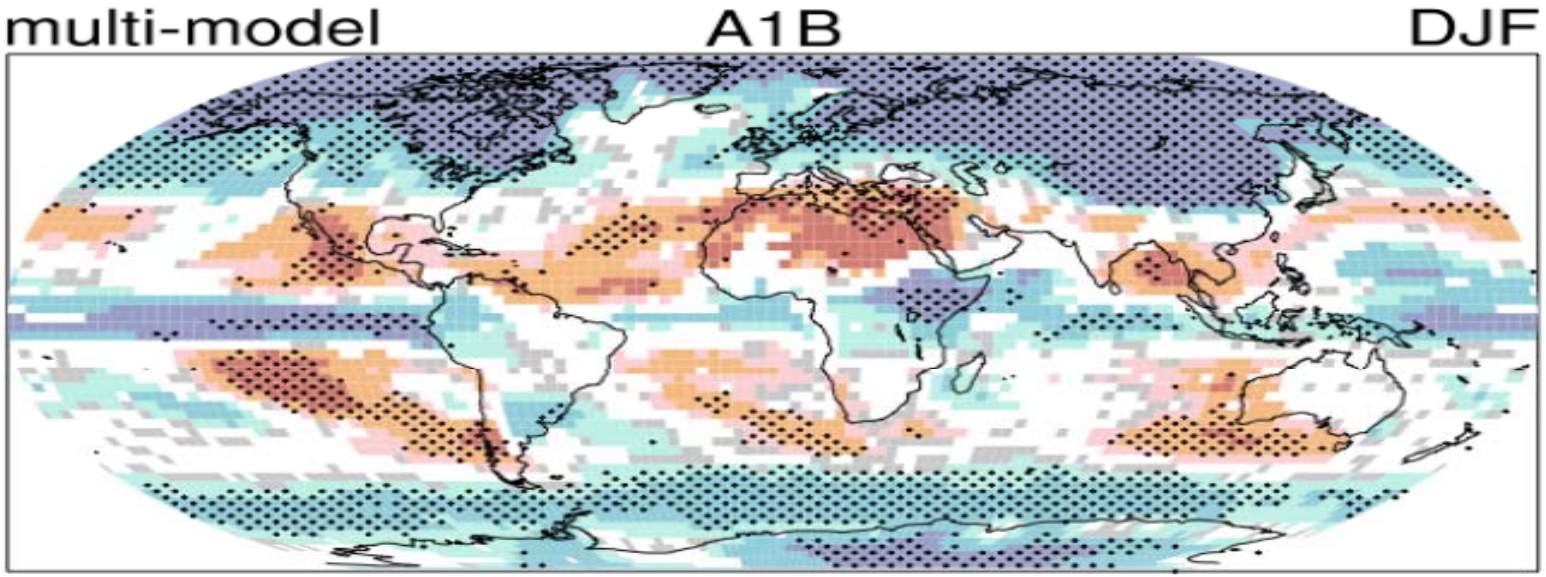
Winter temperatures at Säntis (2,500 m): 1961-1991 and 2071-2100

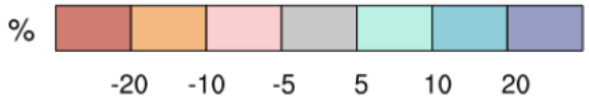


Beniston, 2004: Climatic Change and Impacts, Springer Publishers

Evolution globale des pluies

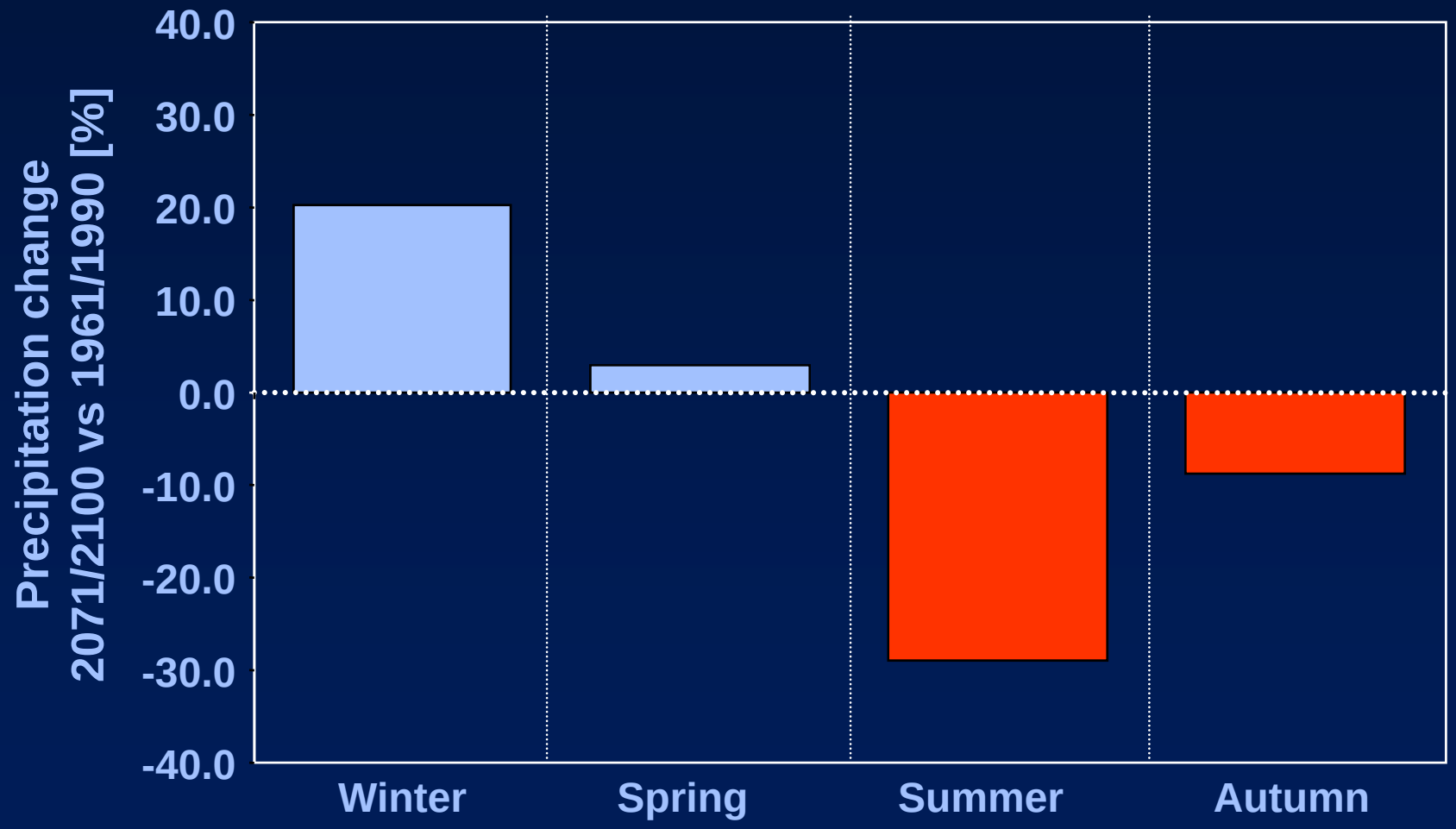
(IPCC AR4, 2007)





Beniston, 2006:
Geophysical Research Letters

Changes in seasonal precipitation



3

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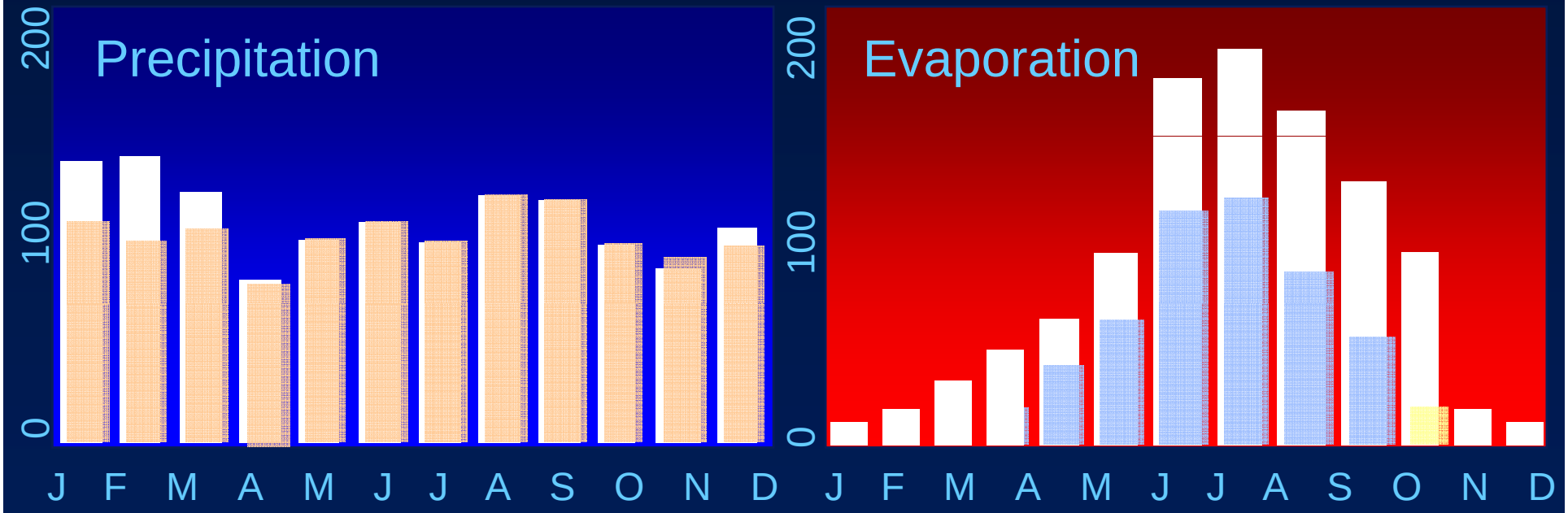
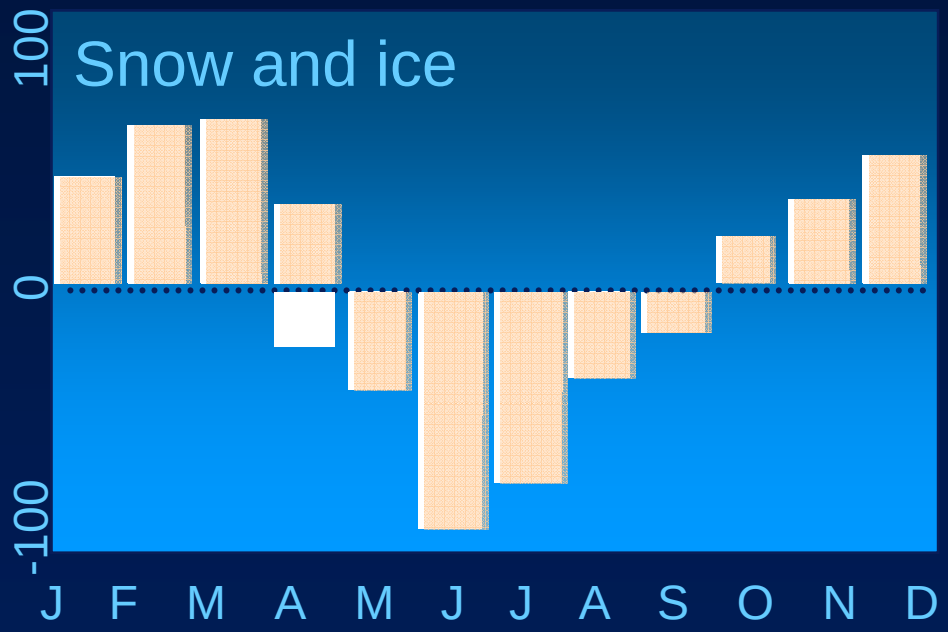
Components of the hydrological cycle by 2100 (mm, Rhone)



Glacier retreat: Tschierva Glacier, Engadine

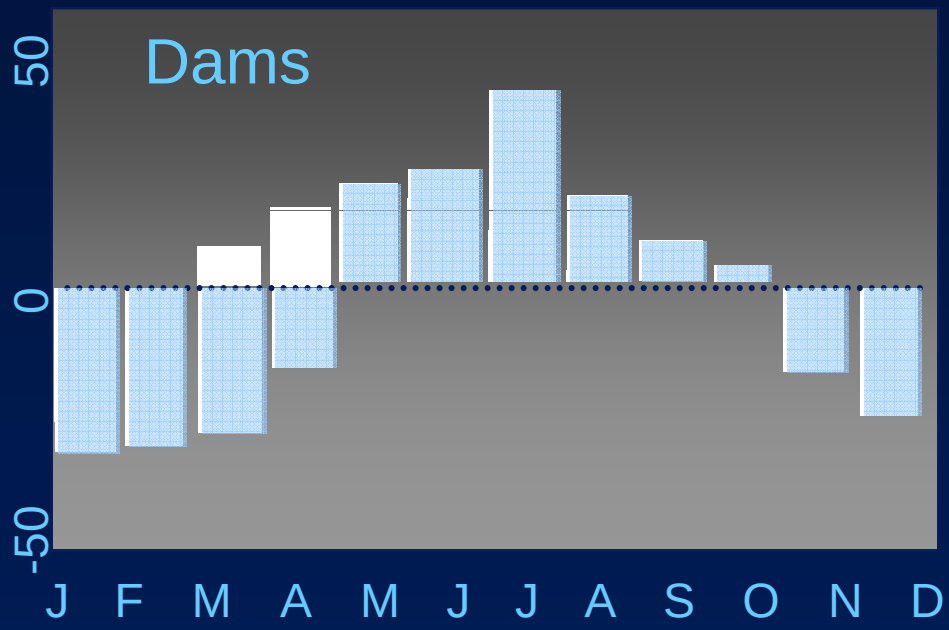
Courtesy: Max Maisch
University of Zurich, Switzerland

Components of the hydrological cycle by 2100 (mm, Rhone)



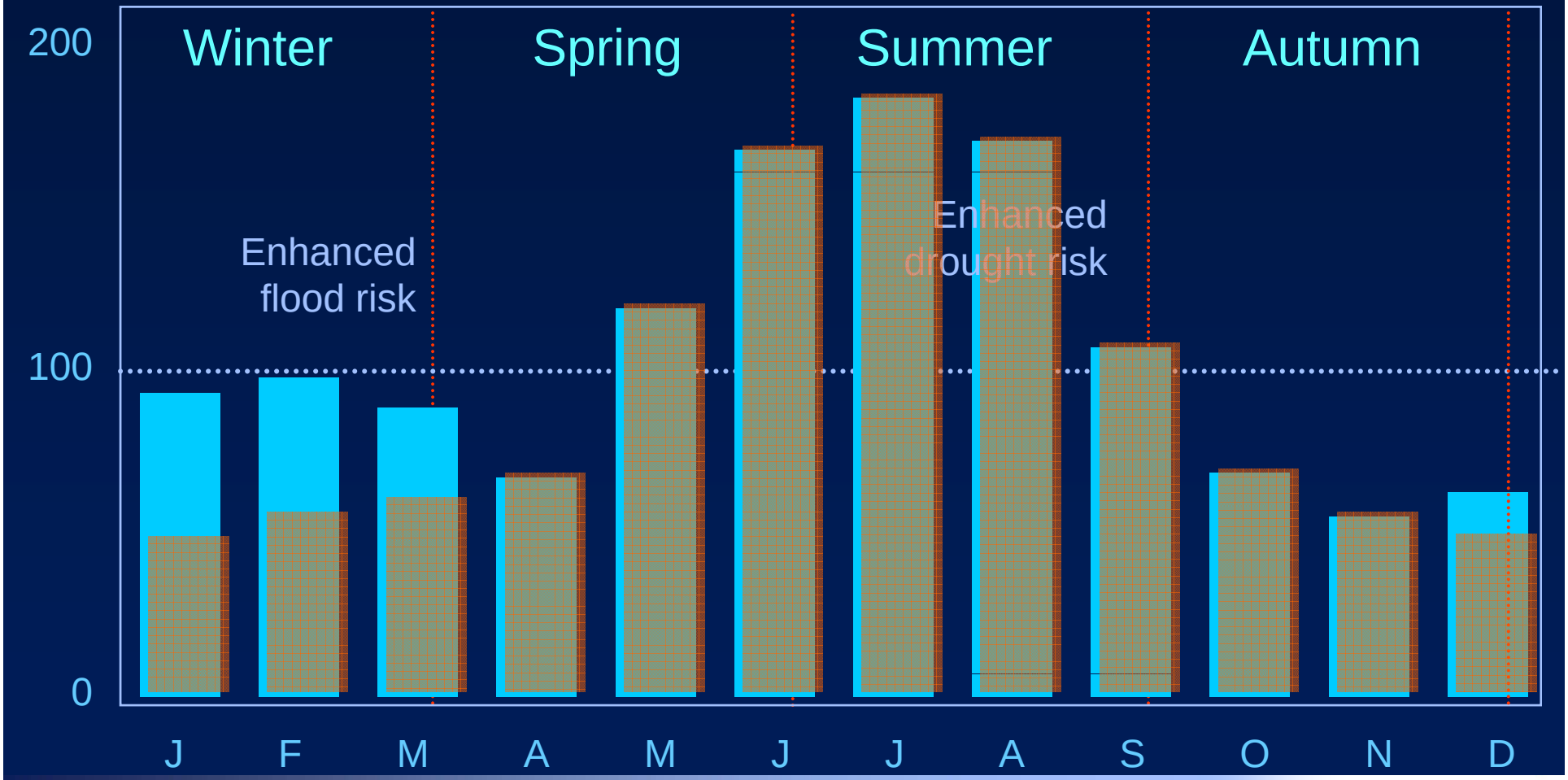
Grande Dixence, Switzerland

Components of the hydrological cycle by 2100 (mm, Rhone)



Average discharge by 2100 (mm, Rhone)

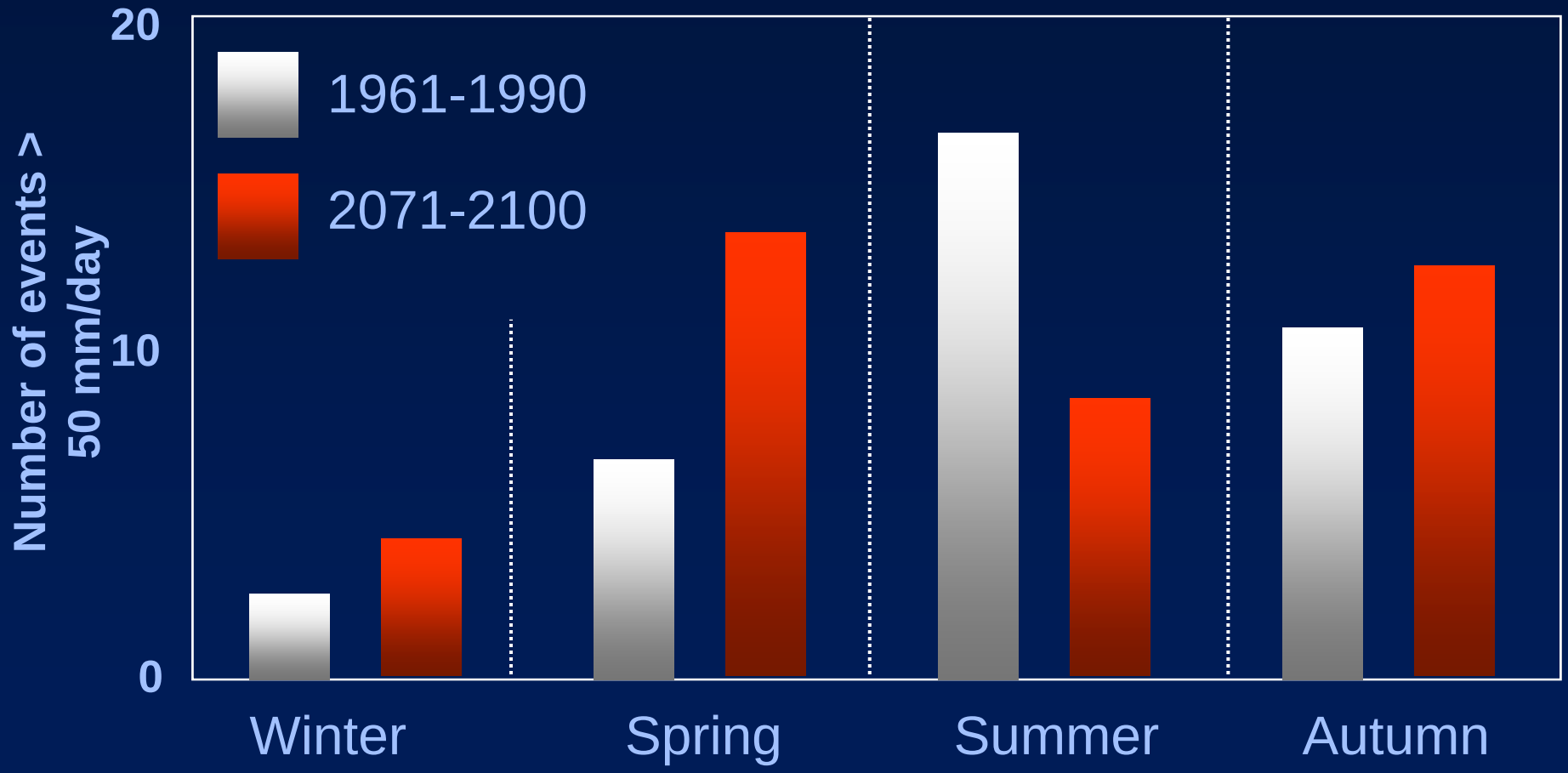
Beniston, 2004:
Climatic Change and Impacts,
Springer Publishers



Beniston, 2006:
Geophysical Research Letters

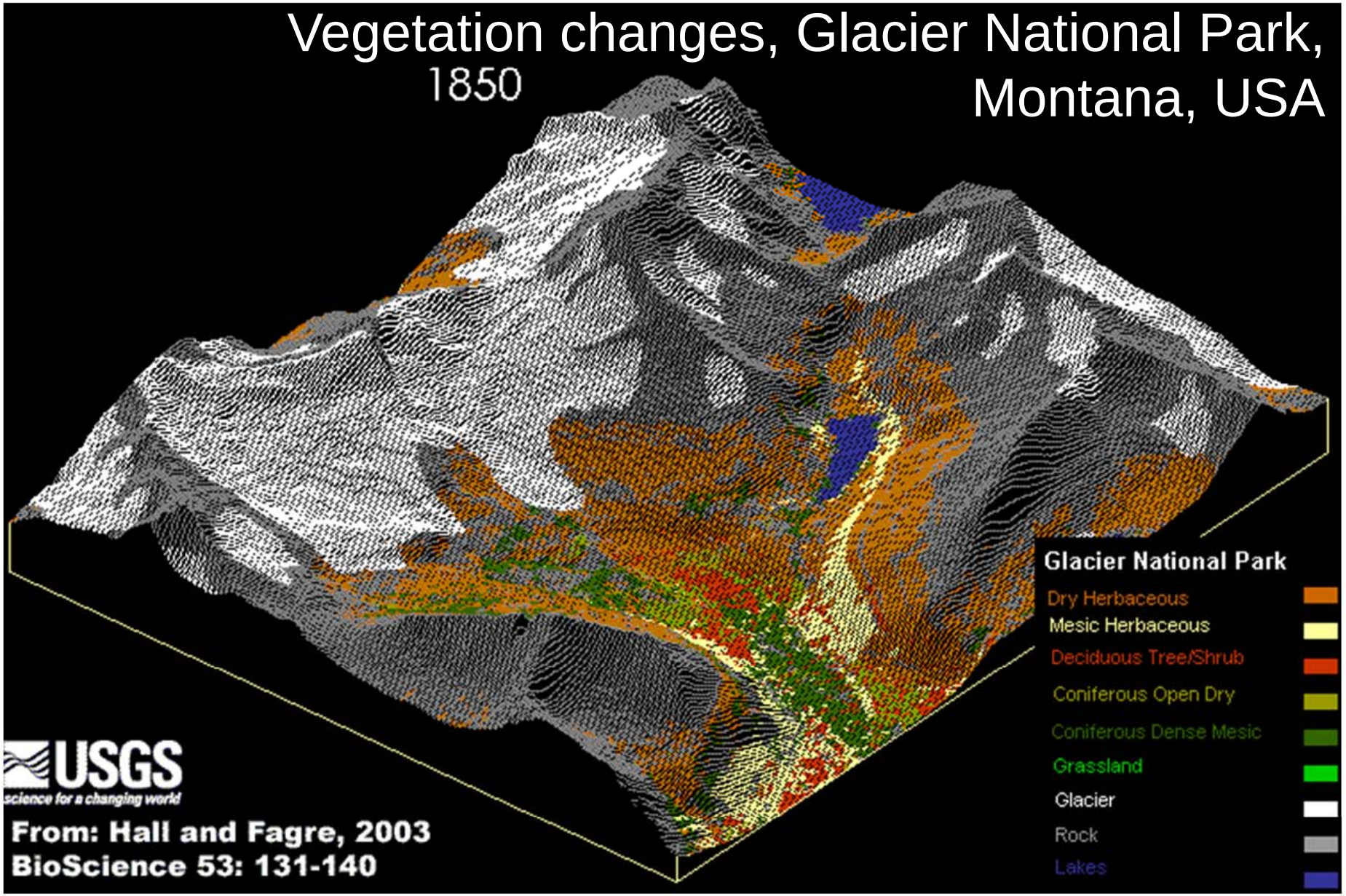
Changes in extreme precipitation in the Alps

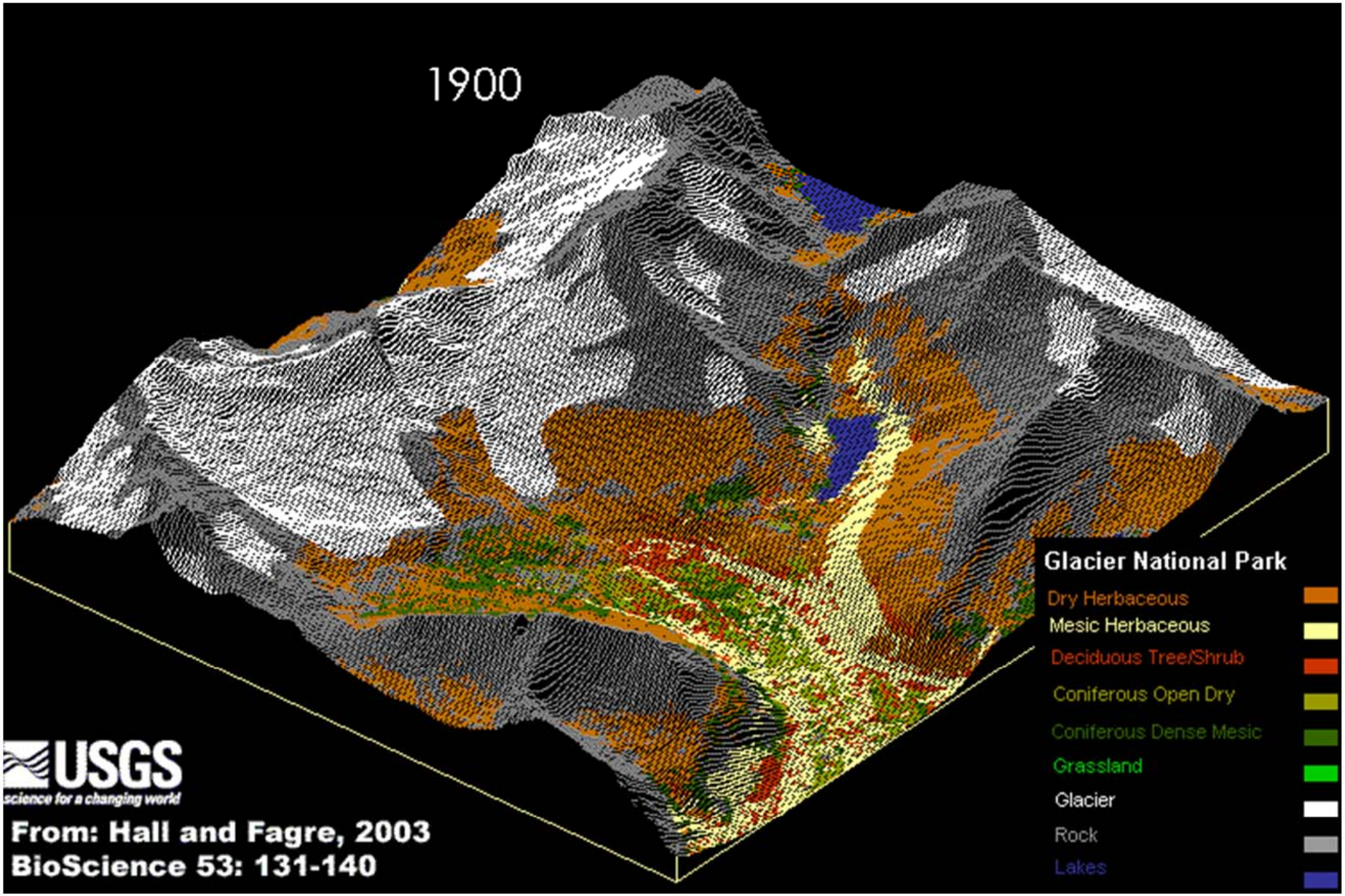
(HIRHAM Regional Climate Model)



Types of floods in the Alps

Courtesy: Markus Stoffel
Universities of Geneva and Berne


Vegetation changes, Glacier National Park, Montana, USA
1850
Glacier National Park
Dry Herbaceous
Mesic Herbaceous
Deciduous Tree/Shrub
Coniferous Open Dry
Coniferous Dense Mesic
Grassland
Glacier
Rock
Lakes
USGS
science for a changing world
From: Hall and Fagre, 2003
BioScience 53: 131-140


1900
Glacier National Park
Dry Herbaceous
Mesic Herbaceous
Deciduous Tree/Shrub
Coniferous Open Dry
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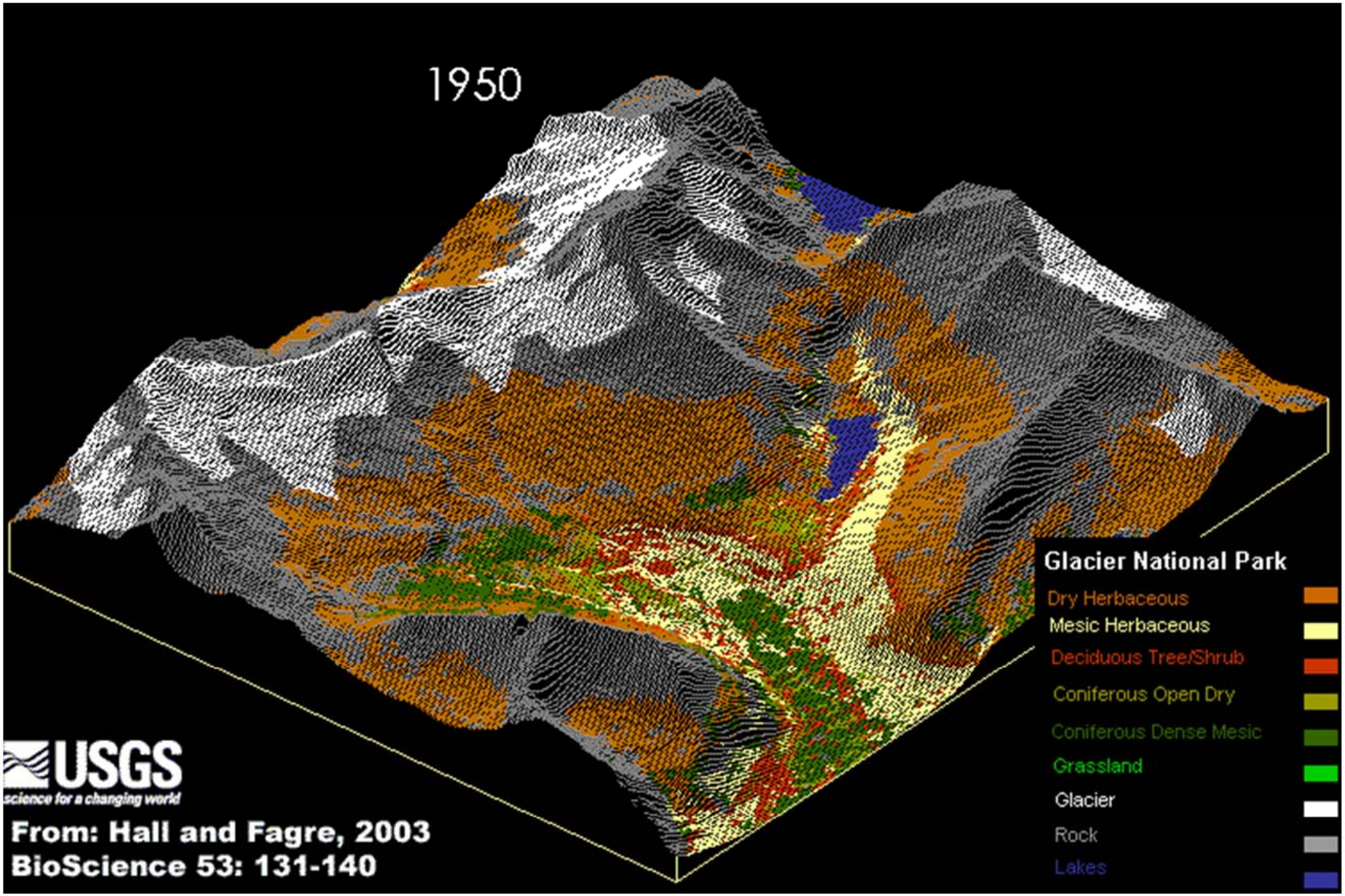
1950
Glacier National Park
Dry Herbaceous
Mesic Herbaceous
Deciduous Tree/Shrub
Coniferous Open Dry
Coniferous Dense Mesic
Grassland
Glacier
Rock
Lakes
USGS
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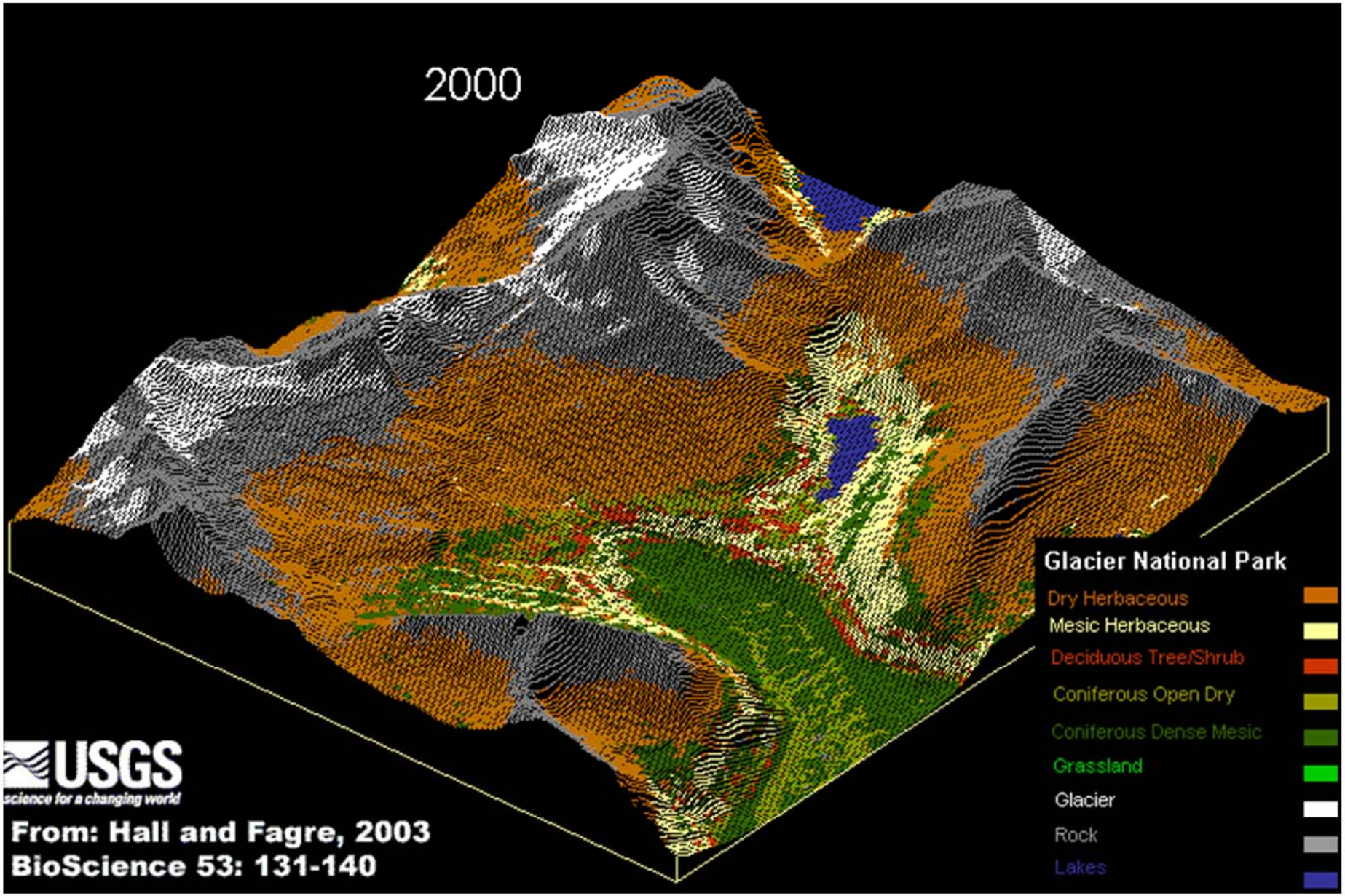
2000
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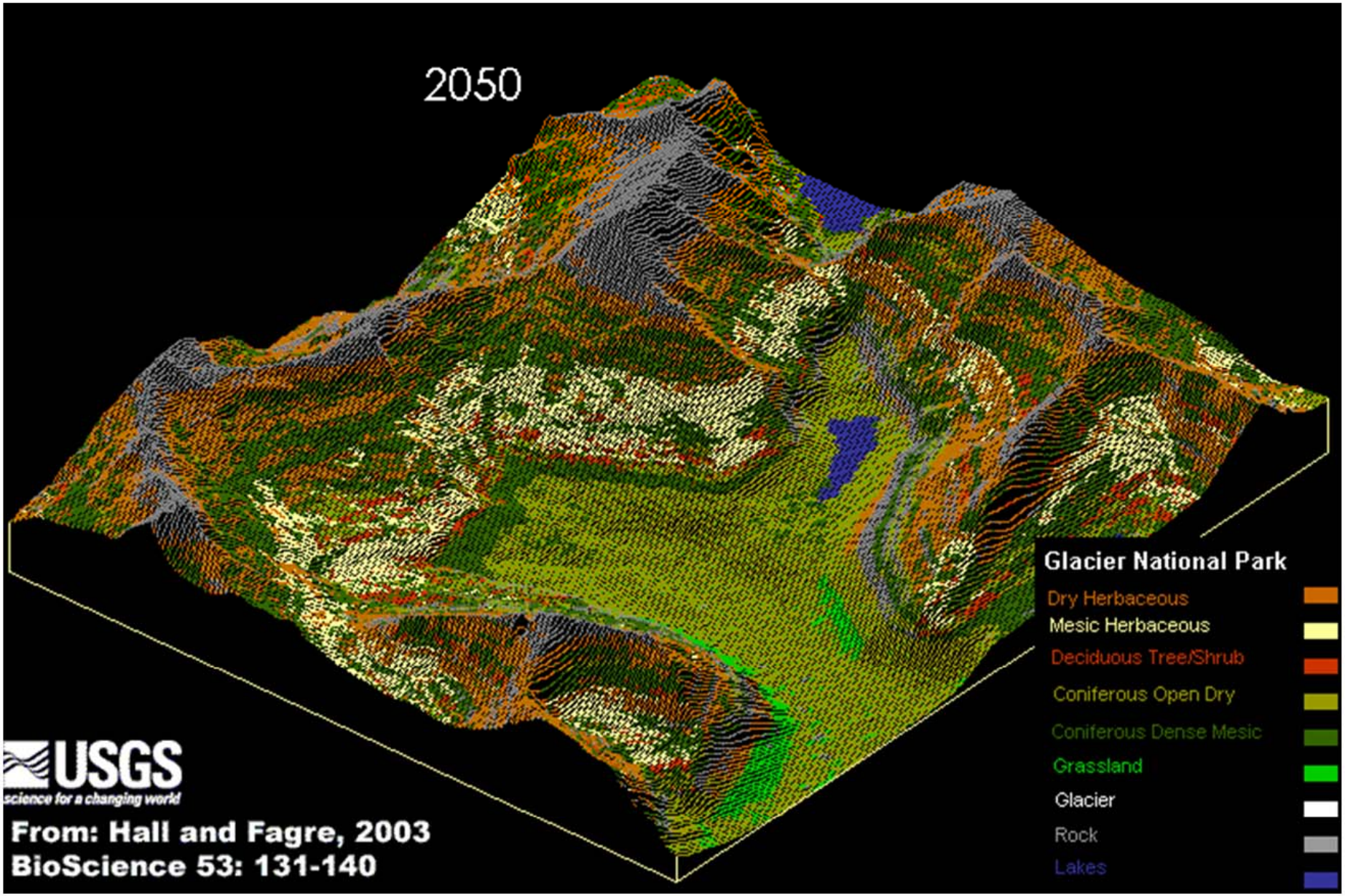
2050
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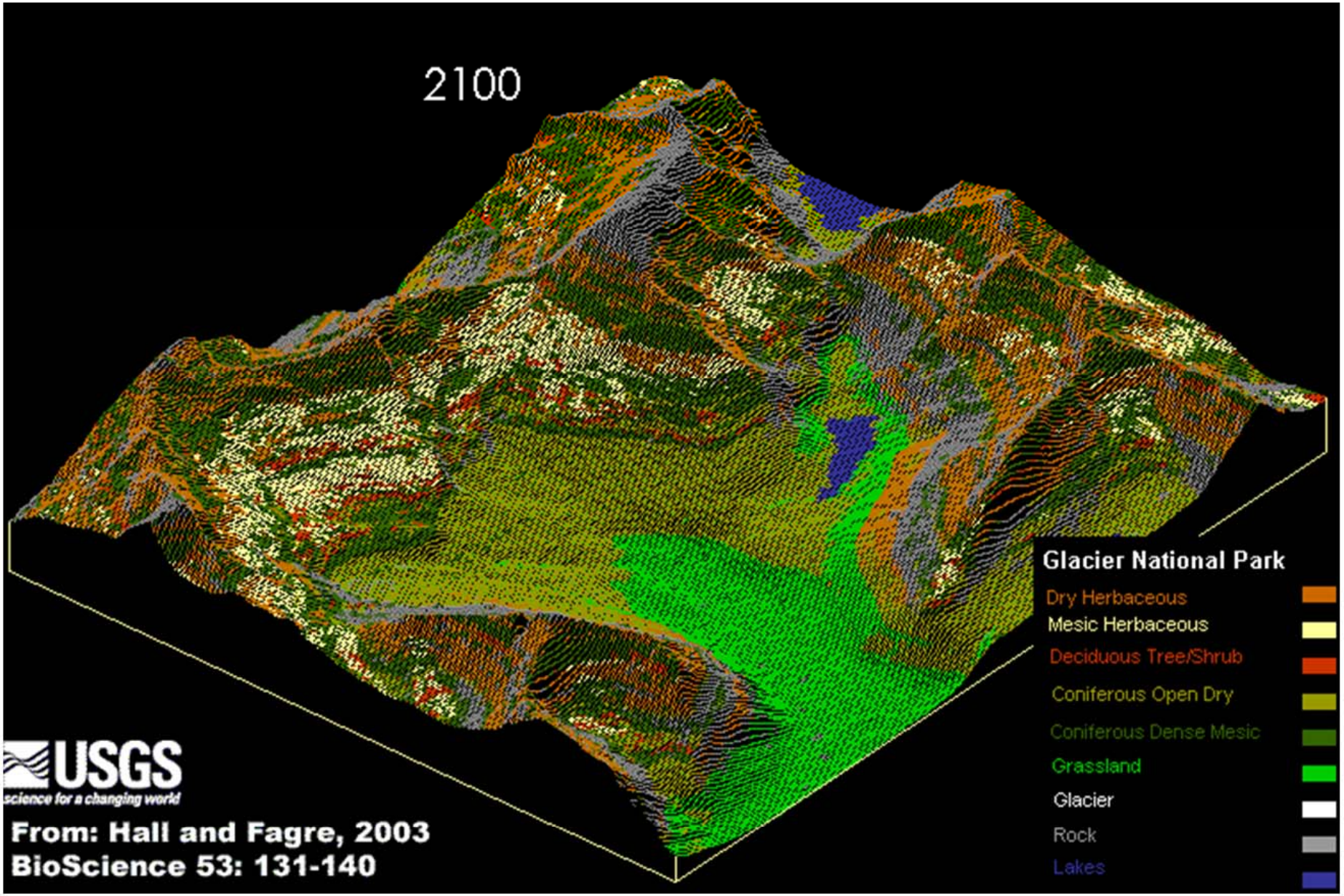
2100
Glacier National Park
Dry Herbaceous
Mesic Herbaceous
Deciduous Tree/Shrub
Coniferous Open Dry
Coniferous Dense Mesic
Grassland
Glacier
Rock
Lakes
USGS
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BioScience 53: 131-140

4

- Mountains and water
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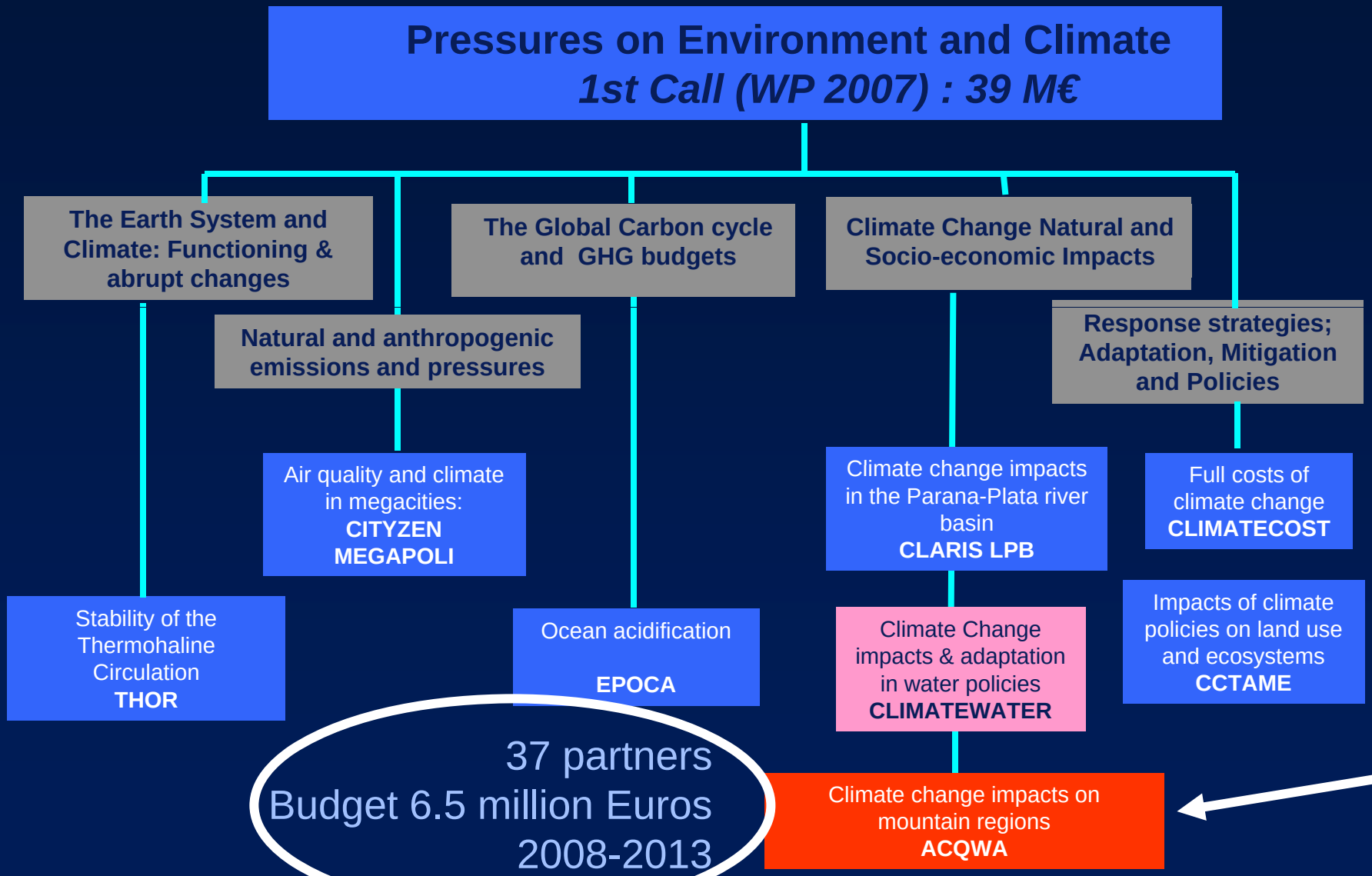
- The EU « ACQWA » project
- Concluding remarks

Assessing **C**limate change impacts on the **Q**uantity and quality of **WA**ter

www.acqwa.ch

EU FP7 1st call (2007)



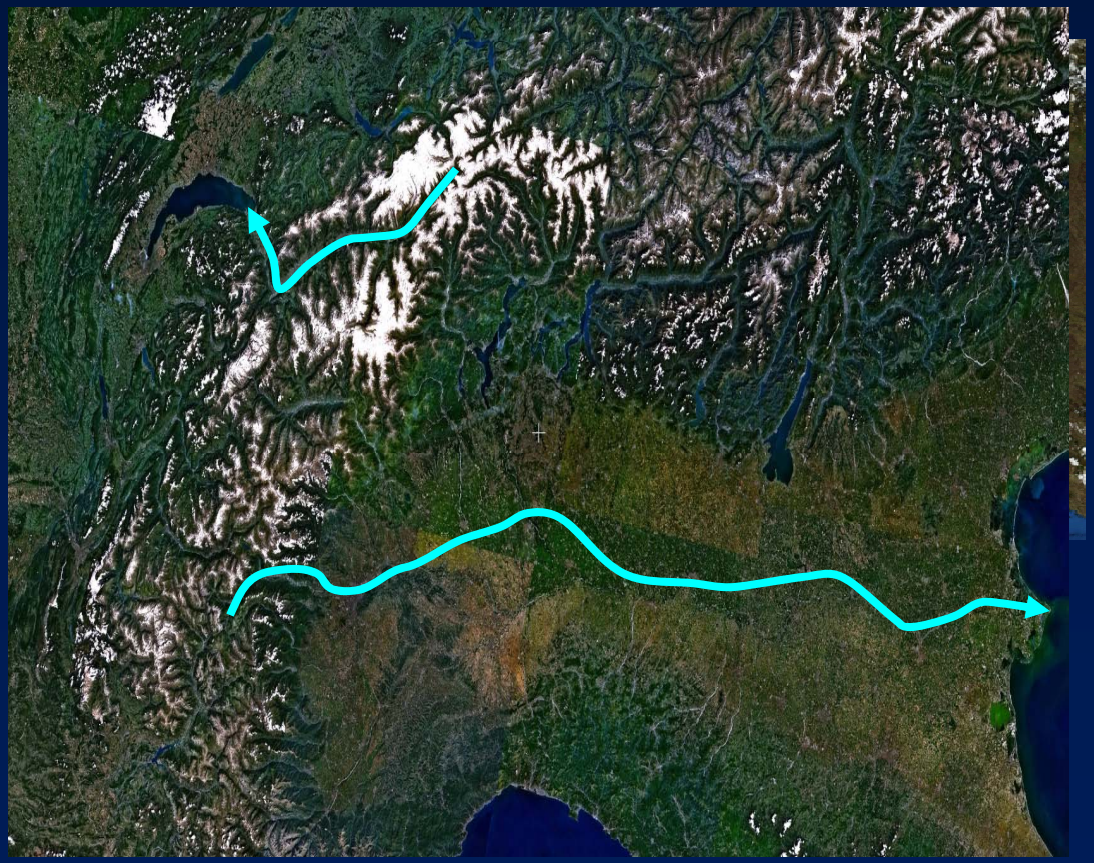
ACQWA Project objectives

- To assess the vulnerability of water resources in mountain regions where snow and ice is a major component of the hydrological cycle
  - Water in these regions will be vulnerable in a warmer climate because of reduced volumes of snow and ice
- The primary objective will be to use, refine, and develop numerical models to help understand interlinks between climate system components:
  - climate, hydrology, cryosphere
- To predict the evolution of these systems over the next 50 years
  - more useful target date than 2100 for water policies

ACQWA Project objectives

- To assess the potential impacts on:
  - Extreme events
  - Energy
  - Agriculture
  - Tourism
- To identify possible conflicts of interest among economic actors, in the context of a resource that may become rarer in a warmer climate
- To assess how such conflicts could be resolved through improved governance

Case-study regions

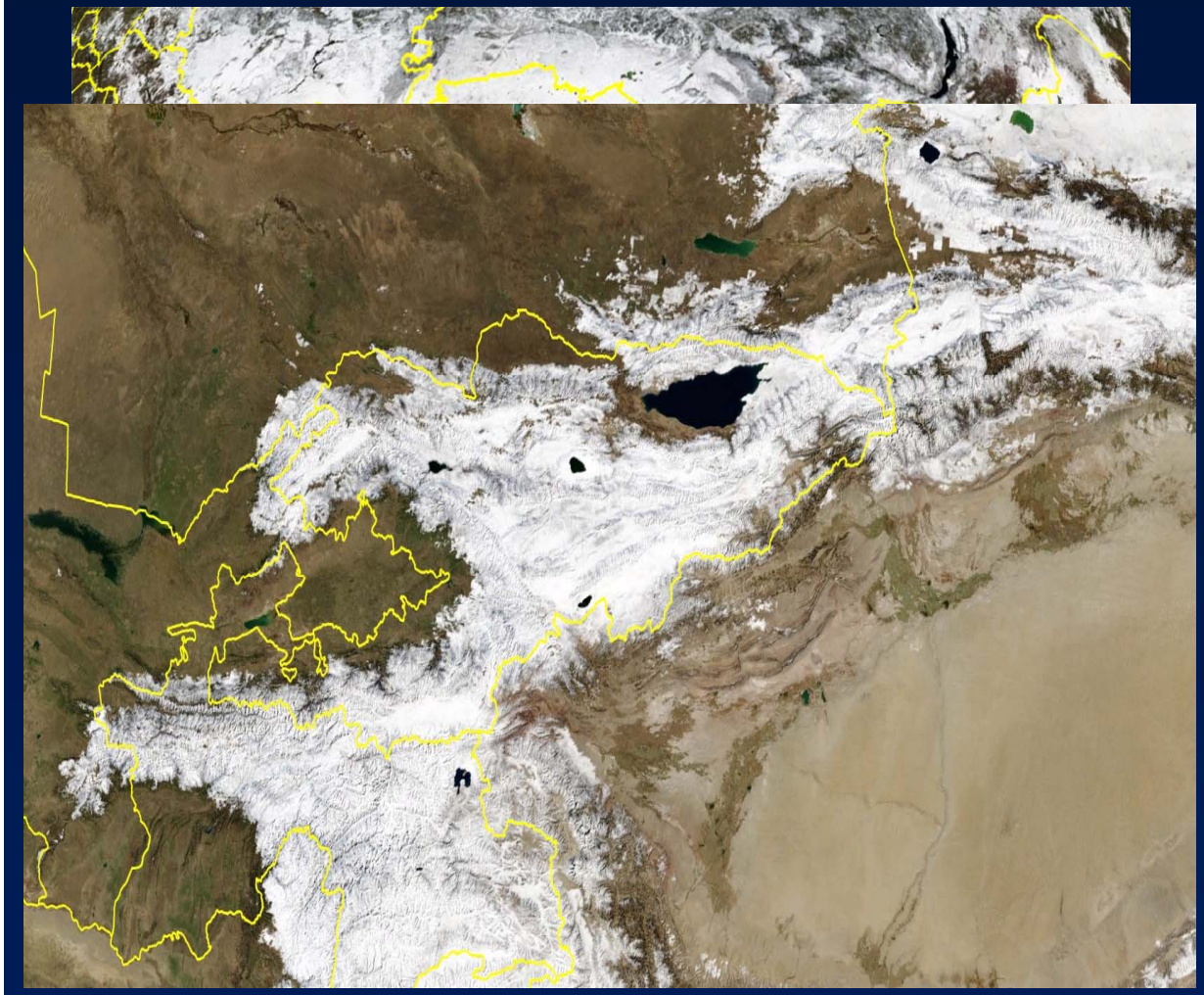


- Data rich regions
- Opportunities to test modeling strategies and integration of results
- Possibilities of investigating socio-economic issues
  - Energy, tourism, agriculture
- Access to information for assessing governance and forward planning

Aconcagua basin (Chile)

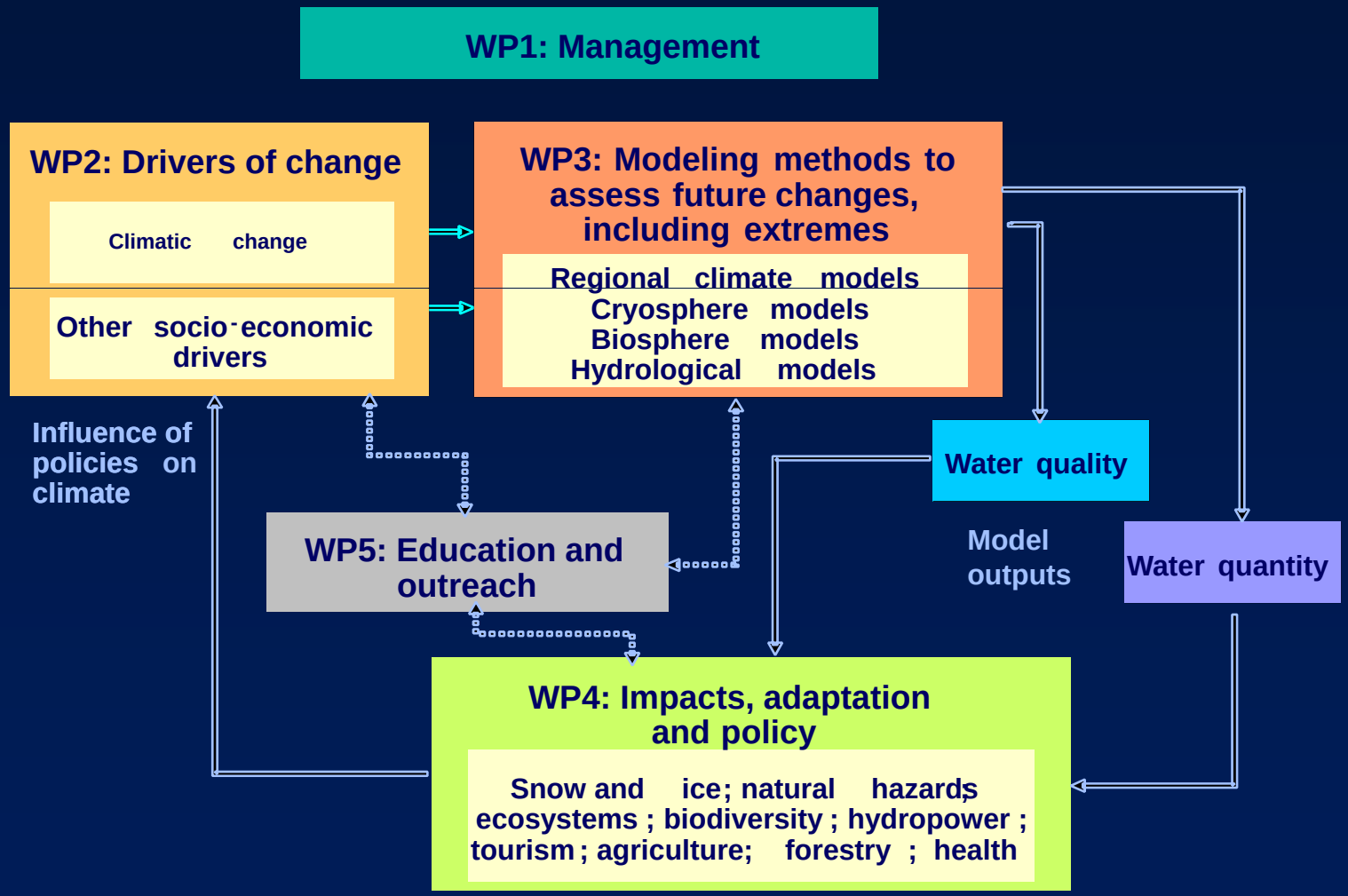
- Major supply problems in a matter of decades:
  - The essential source of water comes from rapidly dwindling ice-caps on the Andes
- Exacerbation of an already competitive situation for water between sectors:
  - Agriculture
  - Energy
  - Mining

Kyrgyzstan

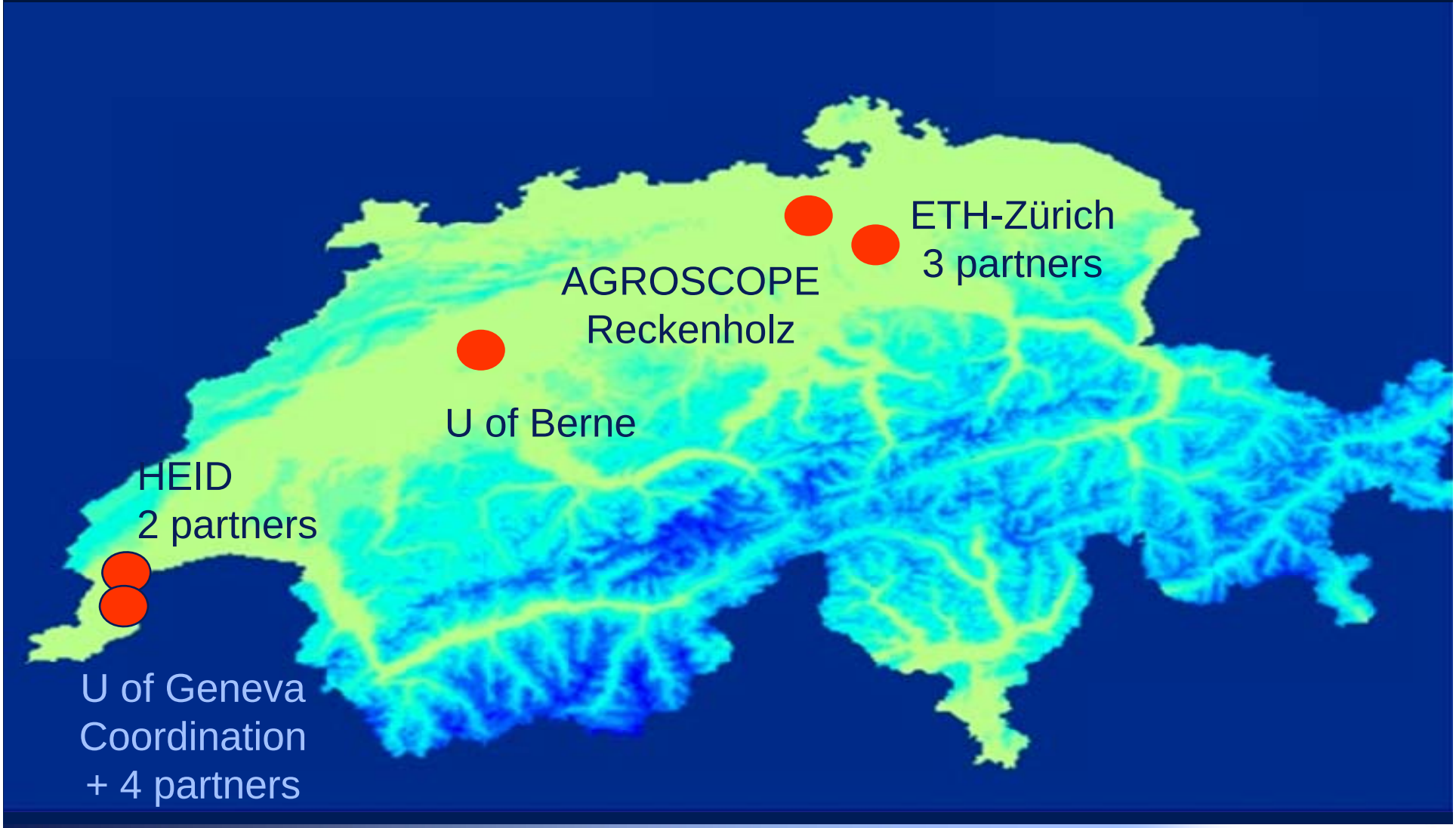


- New opportunities over the next century and beyond because of the large volume of ice remaining
  - Development of hydro-power
  - Foreign income from sales of energy to neighbors (e.g., to Russia)
  - Possible development of agriculture for export

ACQWA Project Flowchart



Swiss partners
11 groups, 5 institutions



European partners
22 institutions, 6 countries

Partners outside of Europe
Chile-2, Argentina-1, Central Asia-1

5

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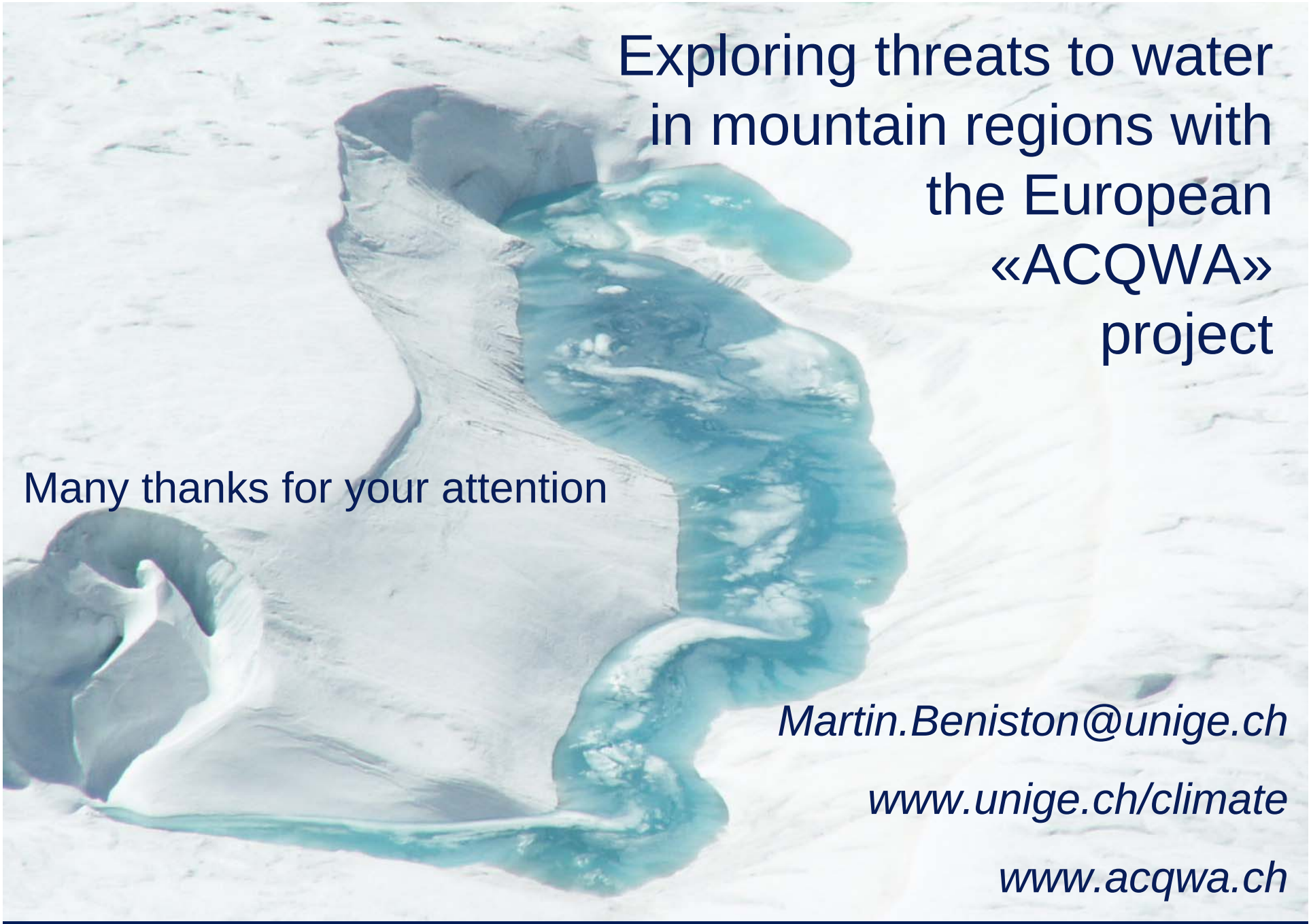
Snow and ice in mountains:
expect major hydrology impacts in a warmer climate!

- Snow and ice in many mountain regions are dominant factors that control runoff characteristics for numerous river catchments
- Shifts in temperature and precipitation regimes could significantly modify the behavior of the mountain snow pack, thus changing:
  - the seasonal character of runoff
  - the timing of the peak flow
- Changing water amount will have numerous impacts:
  - Tourism
  - Energy
  - Agriculture
  - Mining
  - Natural hazards
    - Insurance sector

Originalities of the ACQWA Project

- Water as a measure of vulnerability of regions to climatic change
- Truly integrated model simulations rather than a juxtaposition of sector-by-sector simulations
  - Building better bridges across the disciplines
- Enhanced knowledge on extreme events
- Understanding the mechanisms underlying conflicting uses of water
- How to improve policy approaches through more efficient governance



Exploring threats to water in mountain regions with the European «ACQWA» project

Many thanks for your attention

Martin.Beniston@unige.ch

www.unige.ch/climate

www.acqwa.ch

ACQWA Partners

- Switzerland
  - U of Geneva, Coordination
    - Energy, Aquatic Biology, UNEP-GRID, Climate Research
  - U of Bern
    - Baseline climates of the past
  - ETH-Zurich
    - Hydrology, Glaciology, Forest Science
  - Agroscope Federal Agricultural Research
  - HEID Graduate Institute for International Research and Development (2 entities)
- Italy
  - ICTP, Trieste
  - U of L'Aquila
  - ARPA Piemonte + Val d'Aosta
  - Fondazione Montana Sicura
  - ENEL
  - CVA
  - Parco Nazionale Gran Paradiso
  - Monterosastar
  - ISAC-CNR
- France
  - CNRS (3 entities)
  - U Joseph Fourier, Grenoble
- Germany
  - Max-Planck Institute, Hamburg
- Austria
  - U of Graz
- UK
  - U of Birminham
  - U of Dundee
- Spain
  - CSIC Zaragoza
- Chile
  - CEAZA, La Serena
  - CECS
- Argentina
  - IITD
- Kyrgyzstan
  - Academy of Sciences, Bishkek