Setting the scene on climate change impacts in the Alps

Prof. Lučka Kajfež Bogataj
WG II review editor for the 5th
IPCC assessment report

Energy Platform Workshop 2

Energy vs. Environment
- interest conflicts and the acceptance for energy production in the Alps

24 - 25 October 2013
Lucerne, Switzerland

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

IPCC Working Group I Reports Since 1990

Principles of IPCC (1998, 2003, 2006, 2011)

[…]

2. The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies.

3. Review is an essential part of the IPCC process. Since the IPCC is an intergovernmental body, review of IPCC documents should involve both peer review by experts and review by governments.

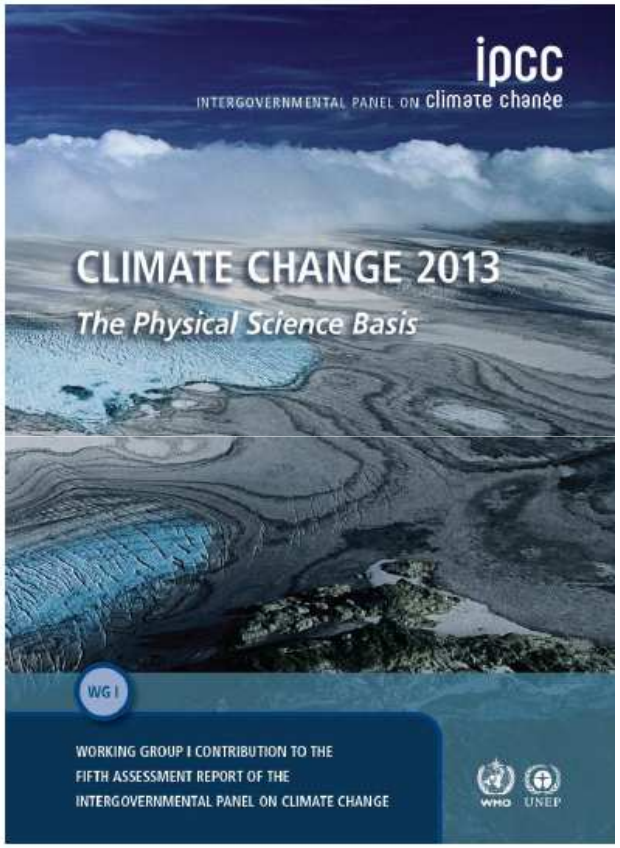
The four Elements of the WGI Fifth Assessment Report

- **14 Chapters**
  1'140'000 Words, ca. 2000 Pages
  1250 Figures und Diagrams

- **Atlas: Regional Projections**
  Timeseries und Maps for 35 Regions of the World, 2 Mio G Bytes, Atlas Team

- **Technical Summary**
  55'000 Words, ca. 90 Pages

- **Summary for Policymakers**
  14'000 Words, 22 Pages, 10 Figures



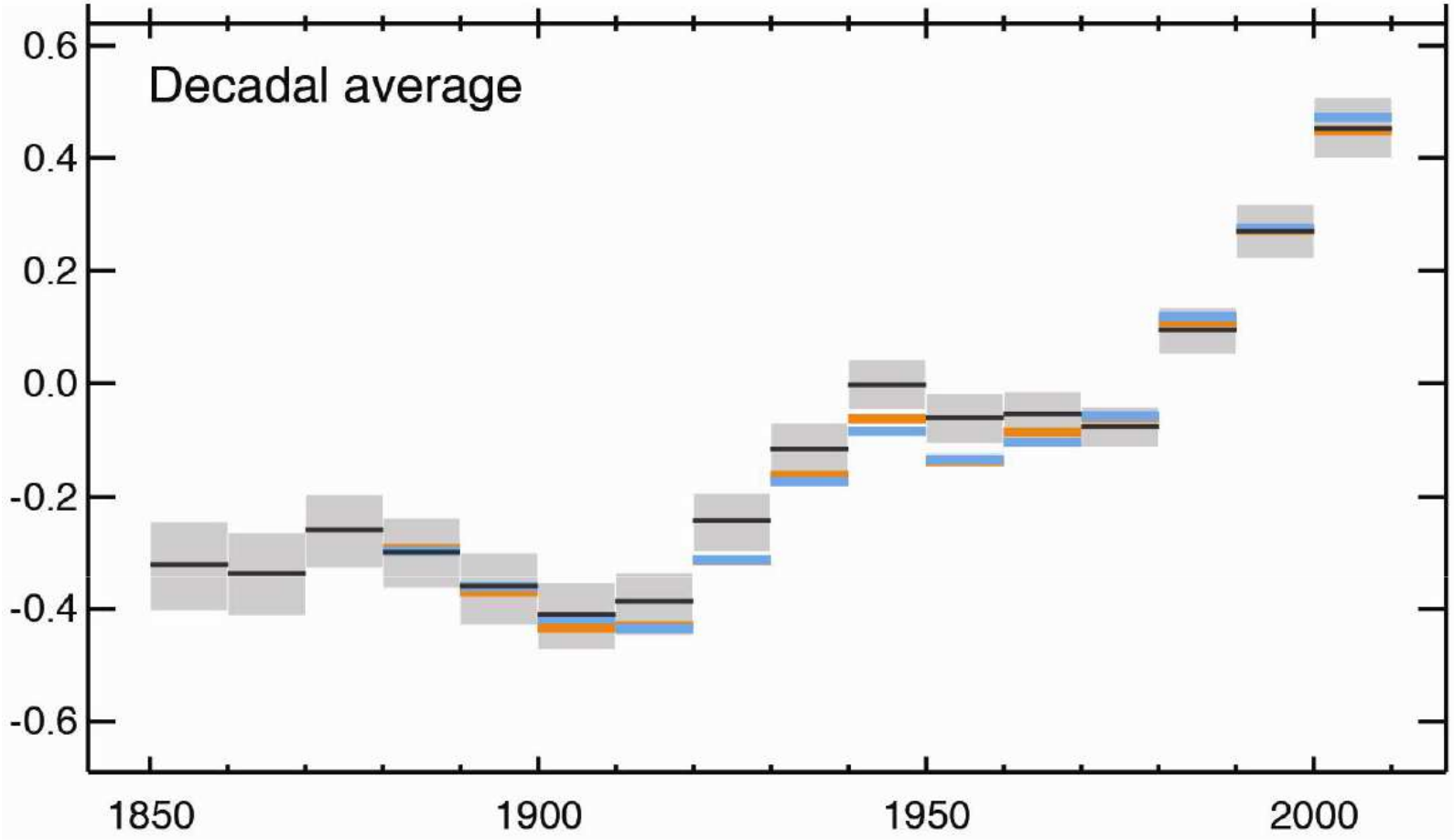
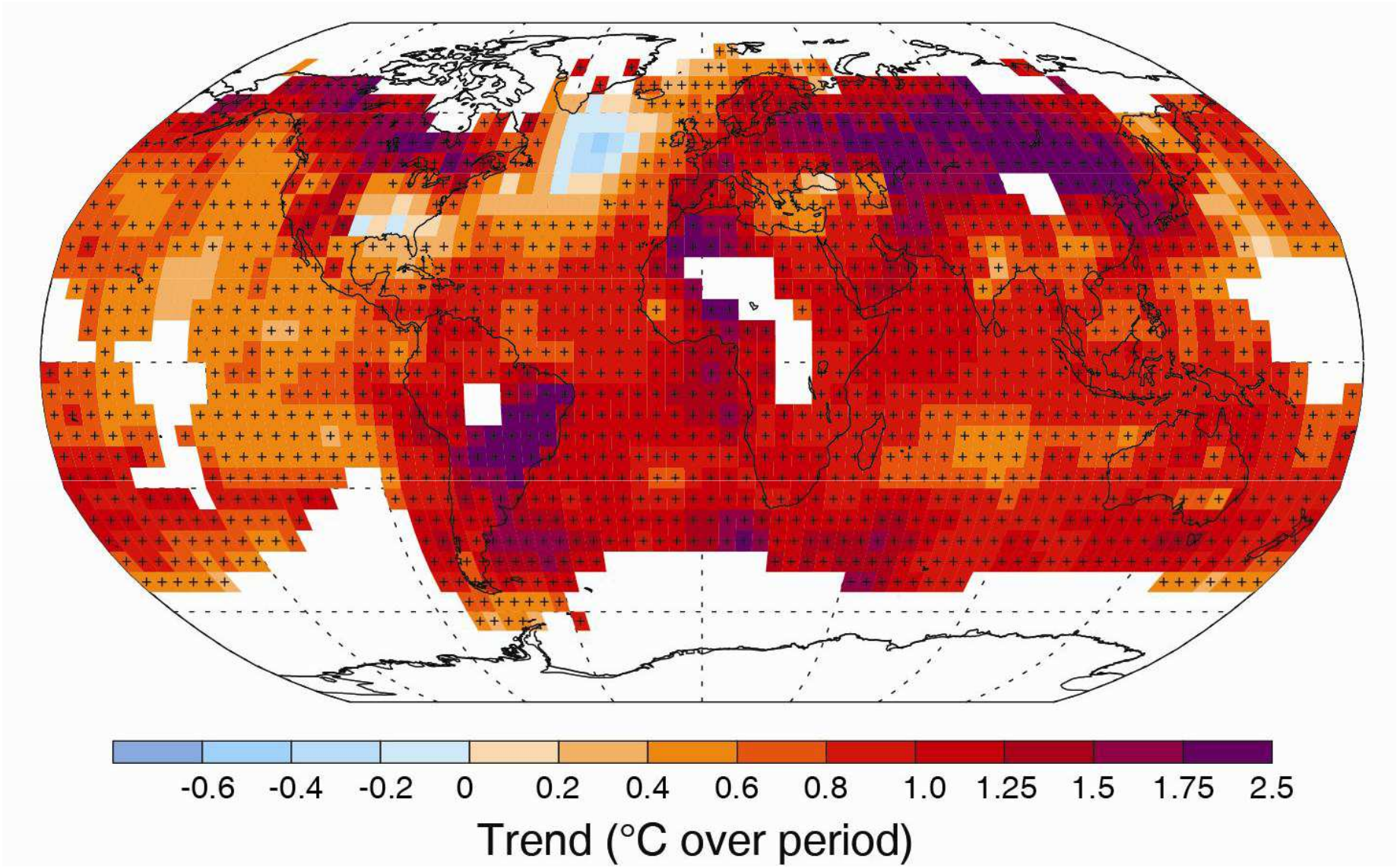


Fig. SPM.1a

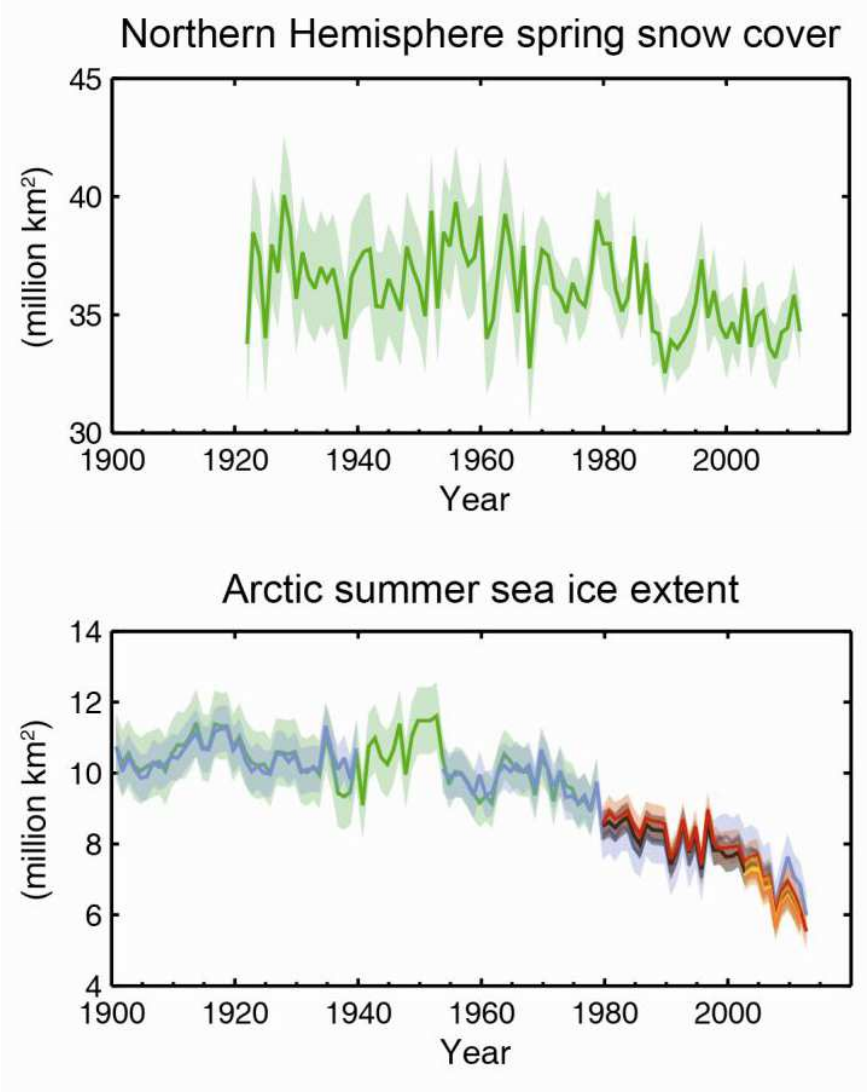
Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

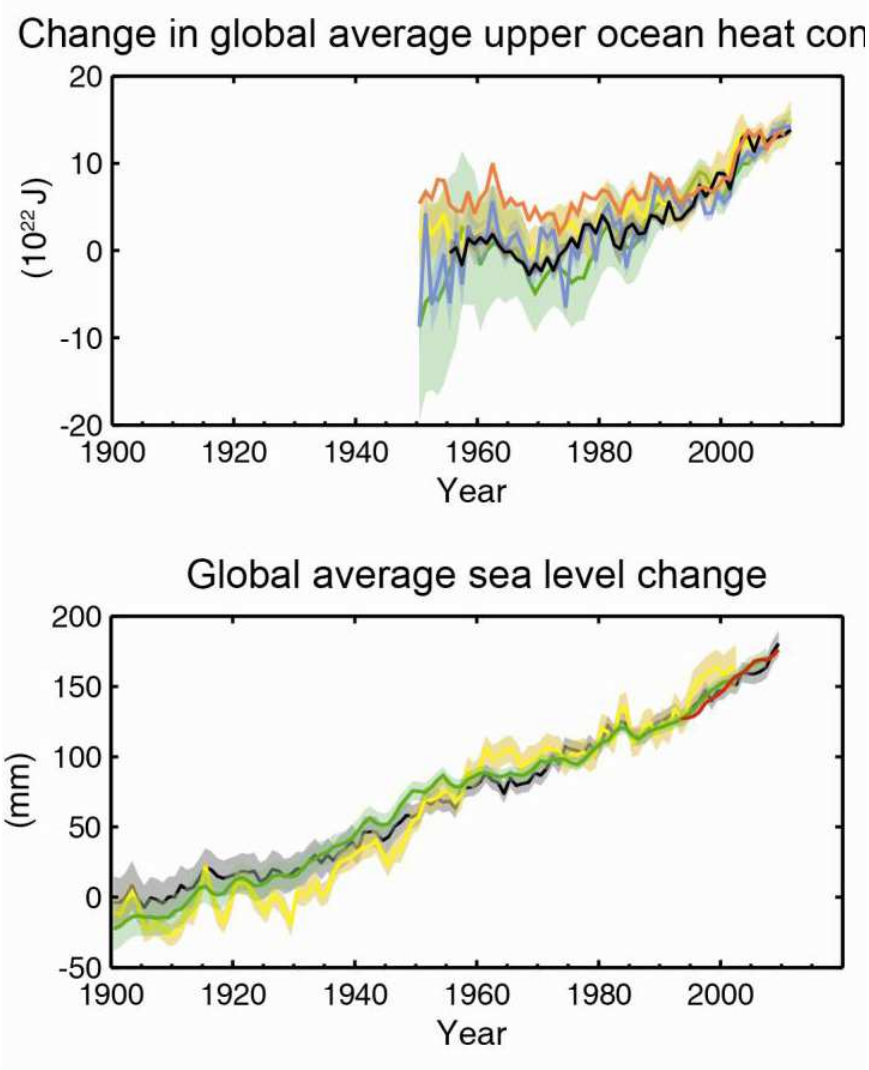
In the Northern Hemisphere, 1983–2012 was *likely the warmest 30-year period of the last 1400 years (medium confidence).*



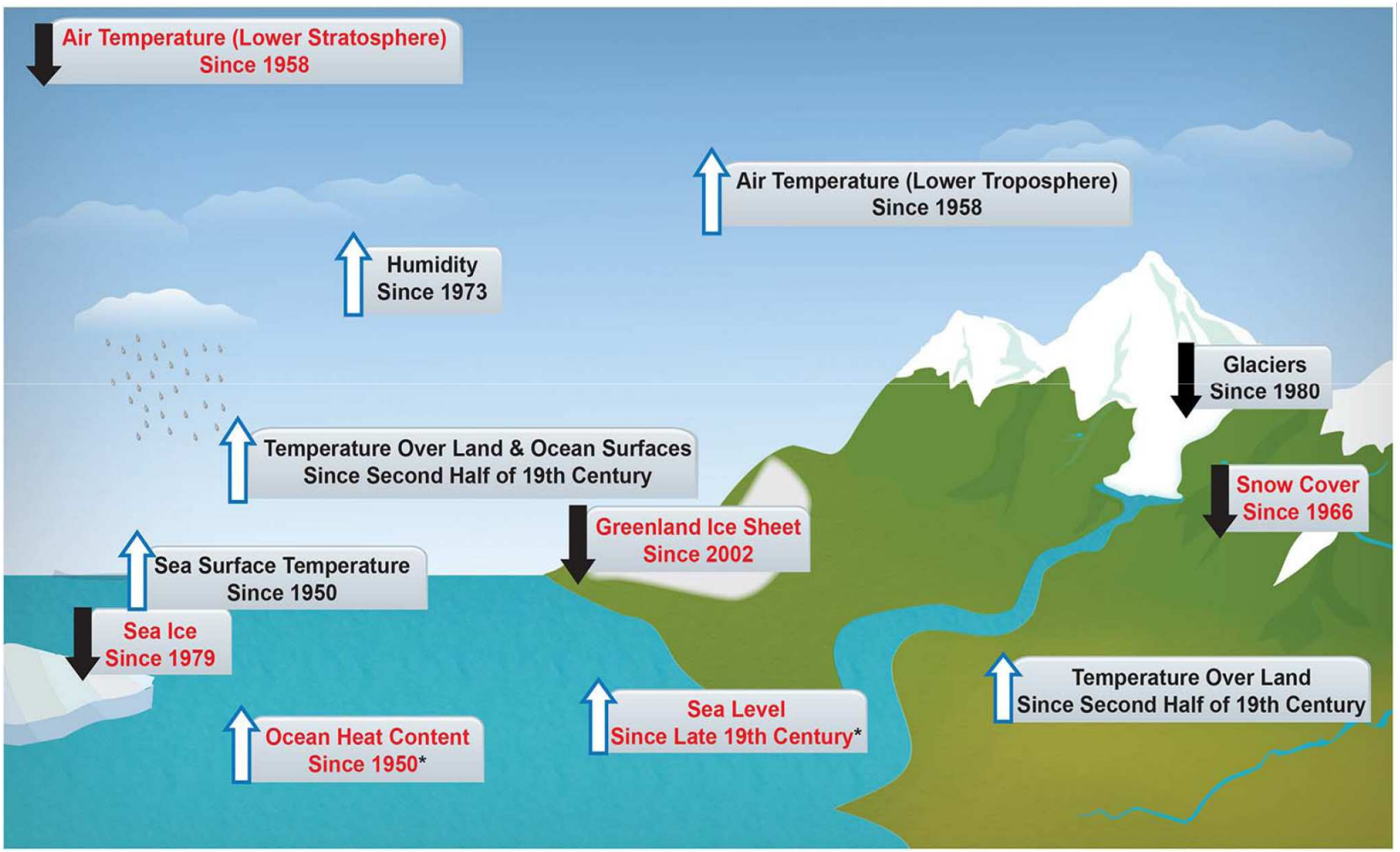
Warming in the climate system is unequivocal

Monitoring of climate system

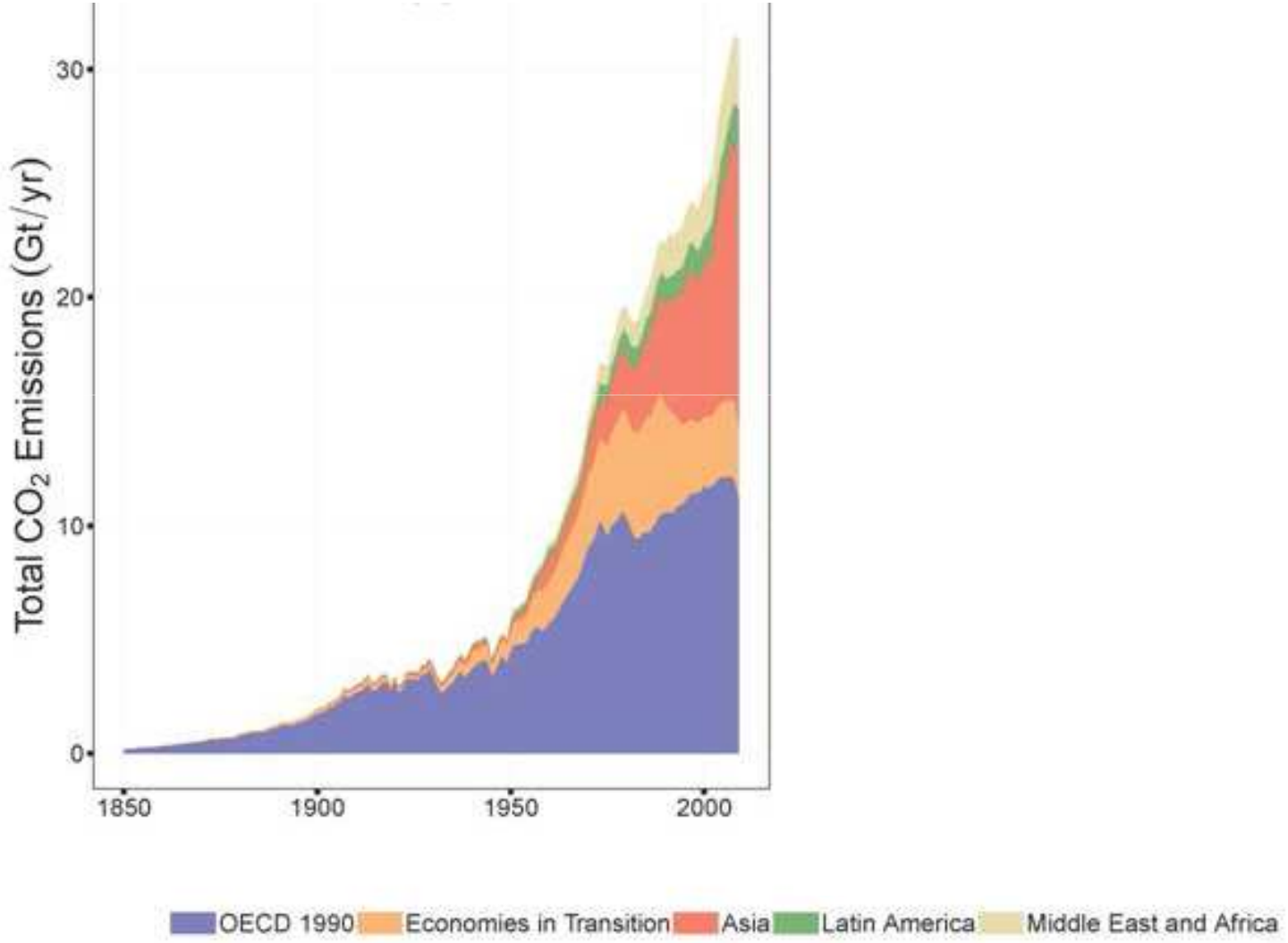


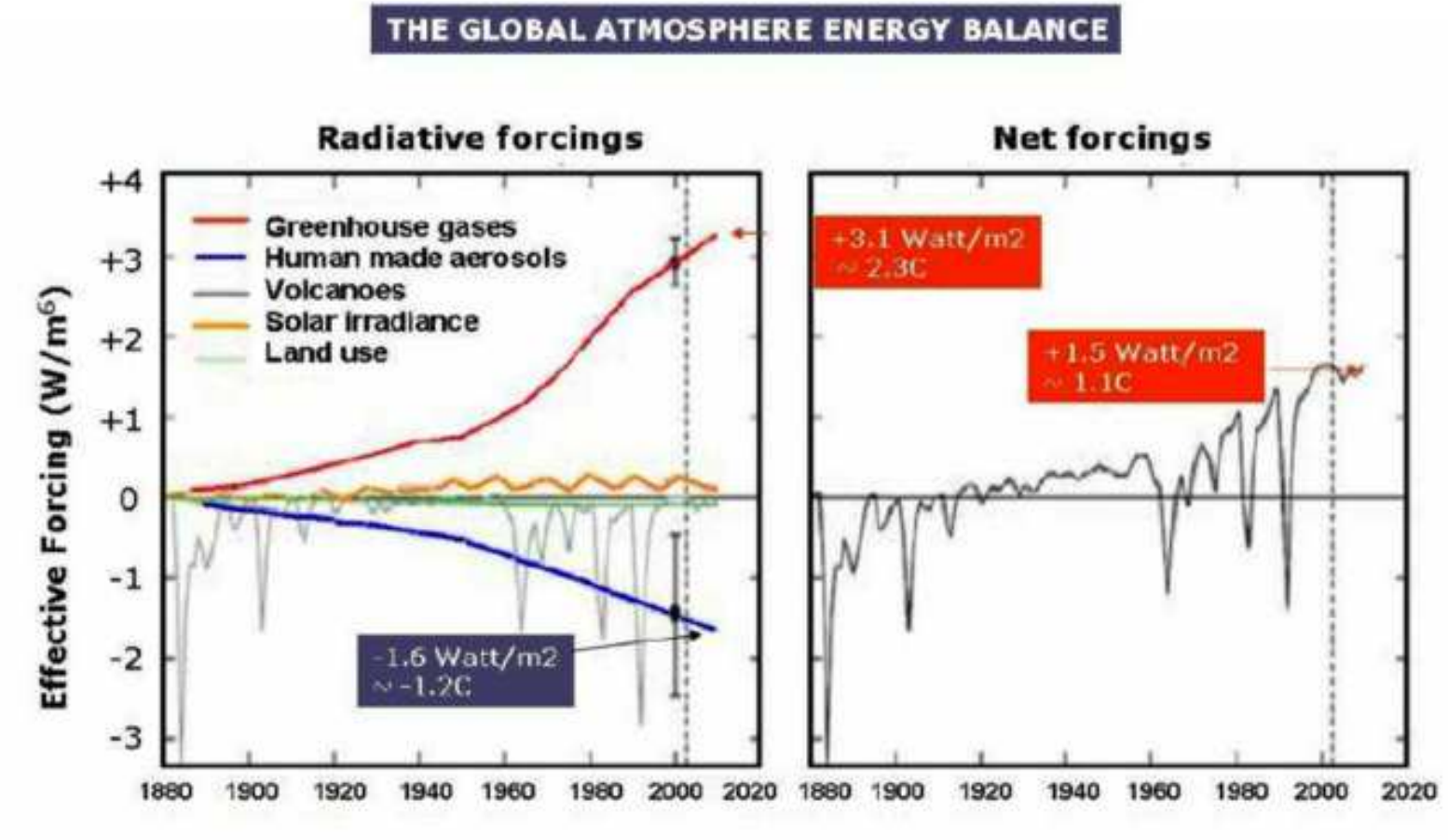


Monitoring of climate system

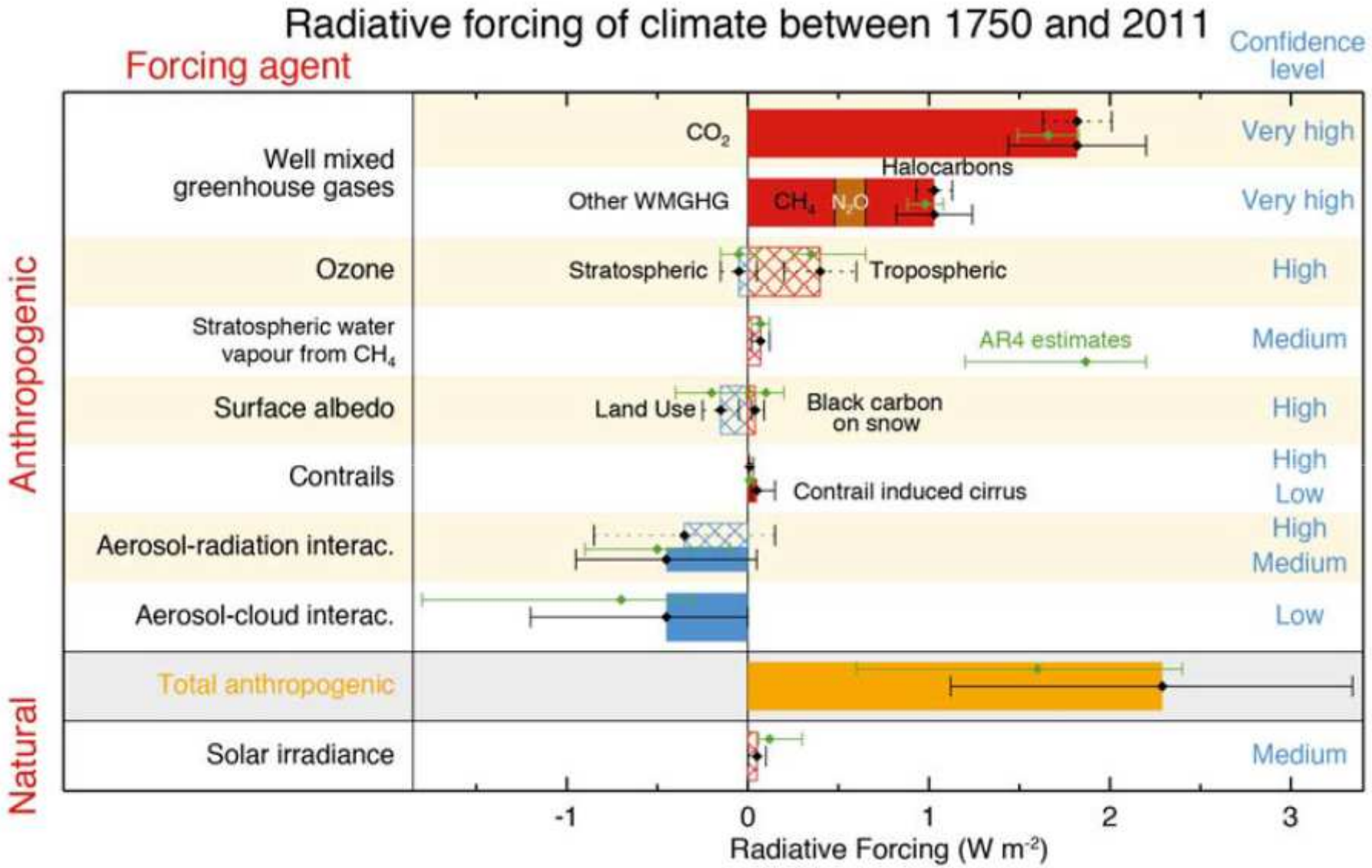


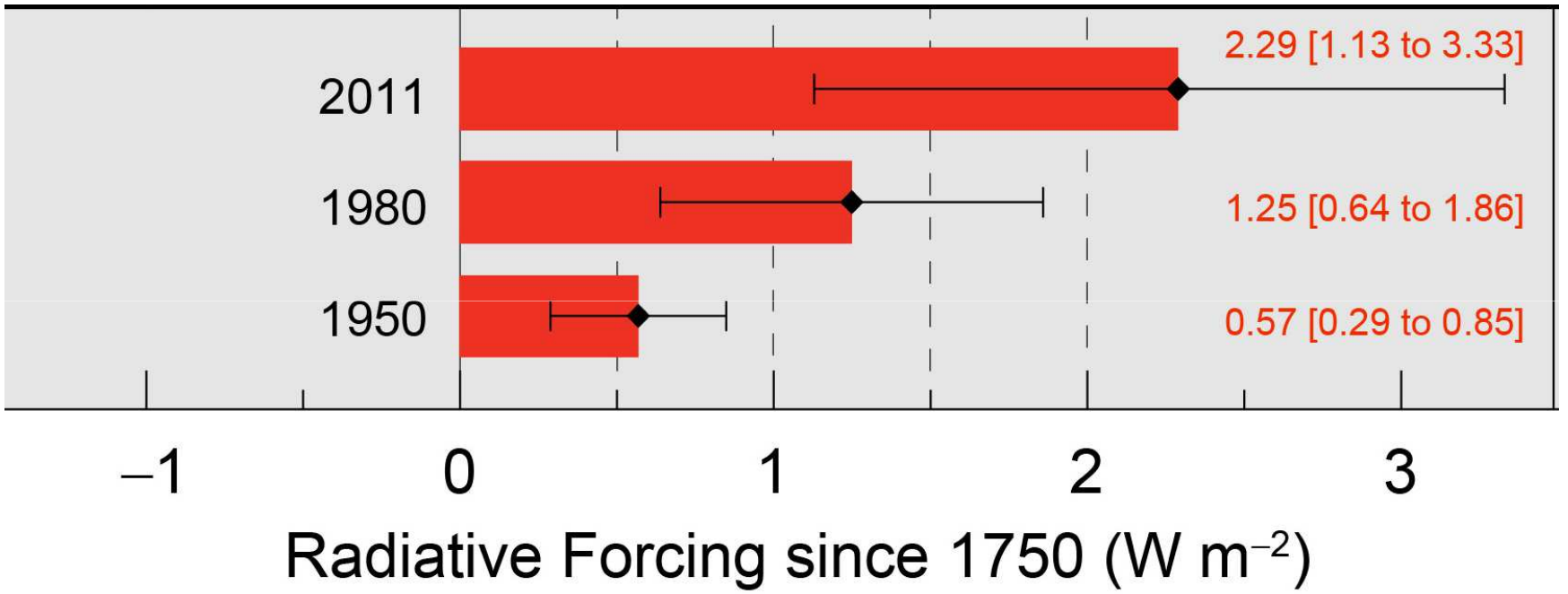
Current and historical anthropogenic CO_2 emissions from fossil fuel combustion in 5 major world regions



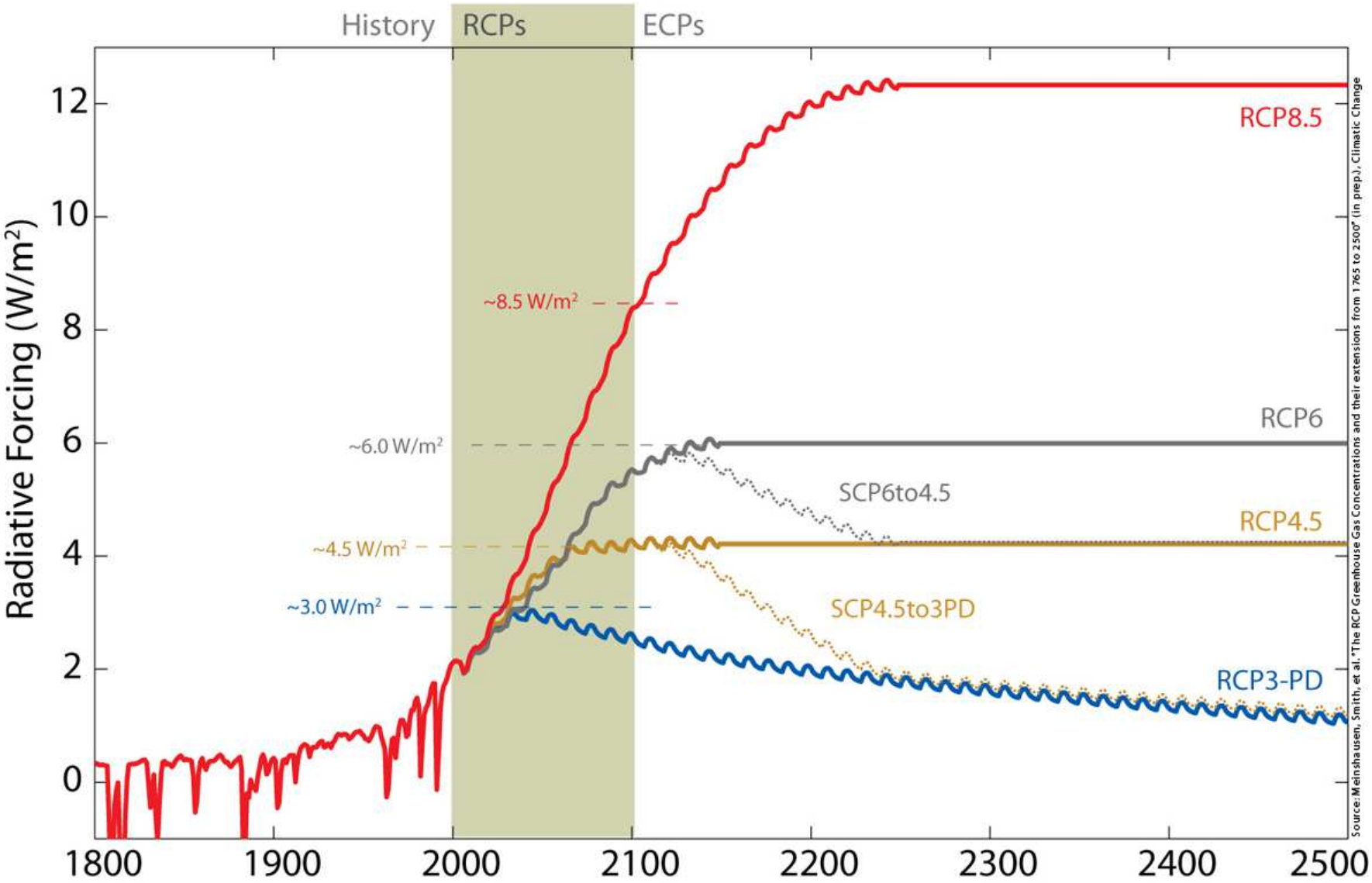


It is extremely likely that more than 50% of the warming since 1951 is due to the increase in greenhouse gases and other anthropogenic forcings together

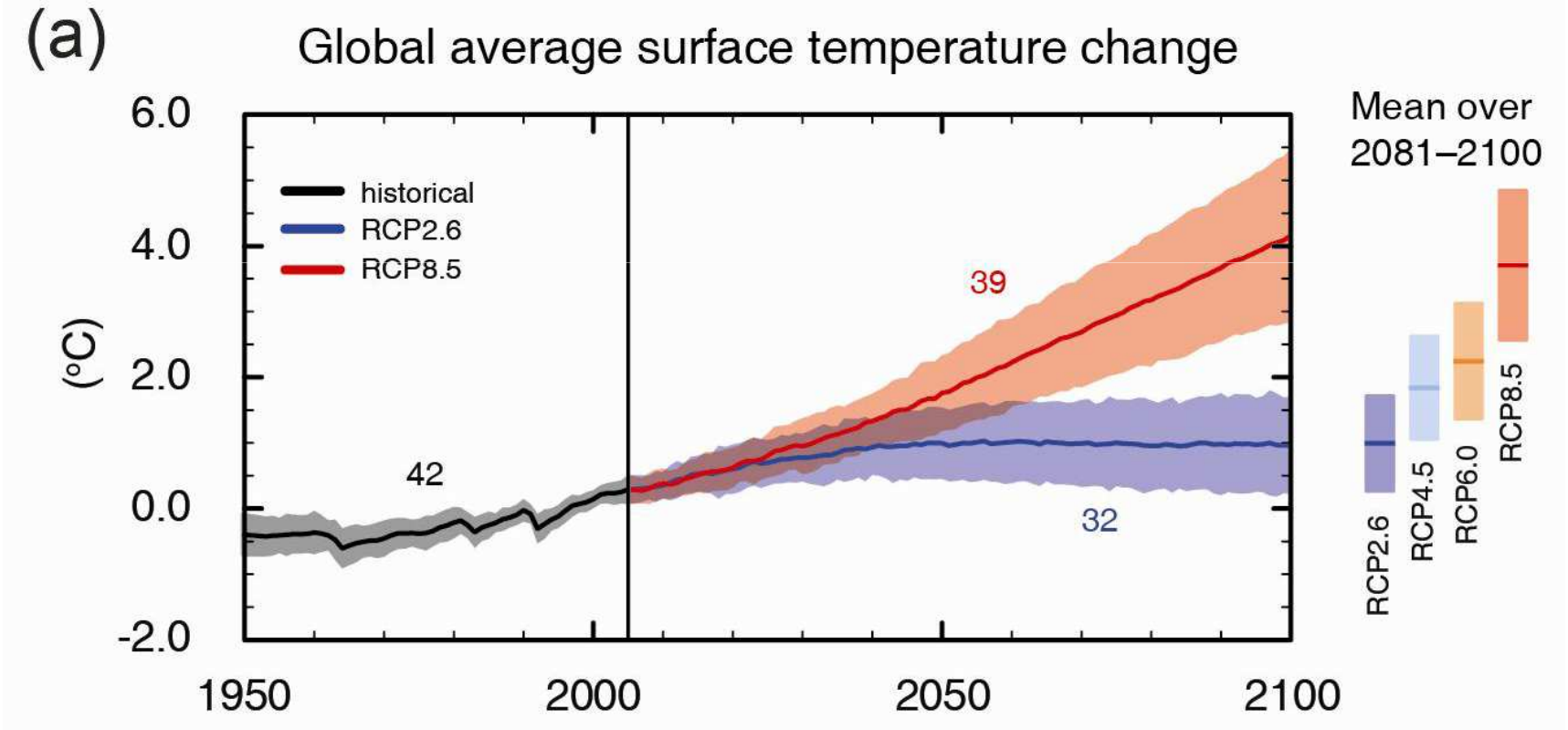

Radiative forcing of climate between 1750 and 2011
Forcing agent
Confidence level
Anthropogenic
Natural
Well mixed greenhouse gases
Other WMGHG
Ozone
Stratospheric water vapour from CH4
Surface albedo
Contrails
Aerosol-radiation interac.
Aerosol-cloud interac.
Total anthropogenic
Solar irradiance
CO2
Halocarbons
CH4
N2O
Stratospheric
Tropospheric
AR4 estimates
Land Use
Black carbon on snow
Contrail induced cirrus
Very high
Very high
High
Medium
High
High
Low
High
Medium
Low
Medium
-1
0
1
2
3
Radiative Forcing (W m-2)


2011
1980
1950
2.29 [1.13 to 3.33]
1.25 [0.64 to 1.86]
0.57 [0.29 to 0.85]
−1
0
1
2
3
Radiative Forcing since 1750 (W m−2)

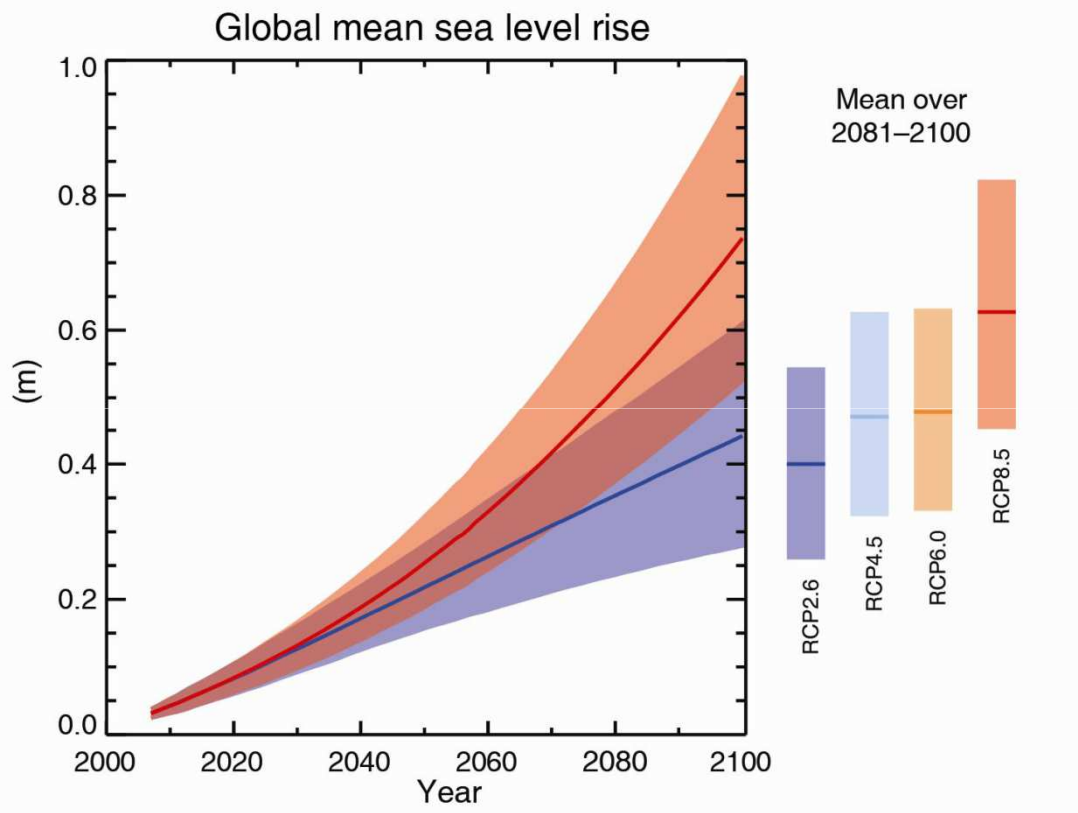
SCENARIOS: Global Anthropogenic Radiative Forcing in the future



Global surface temperature change for the end of the 21st century is *likely to exceed 1.5°C relative to 1850 for all scenarios*



Global mean sea level will continue to rise during the 21st century

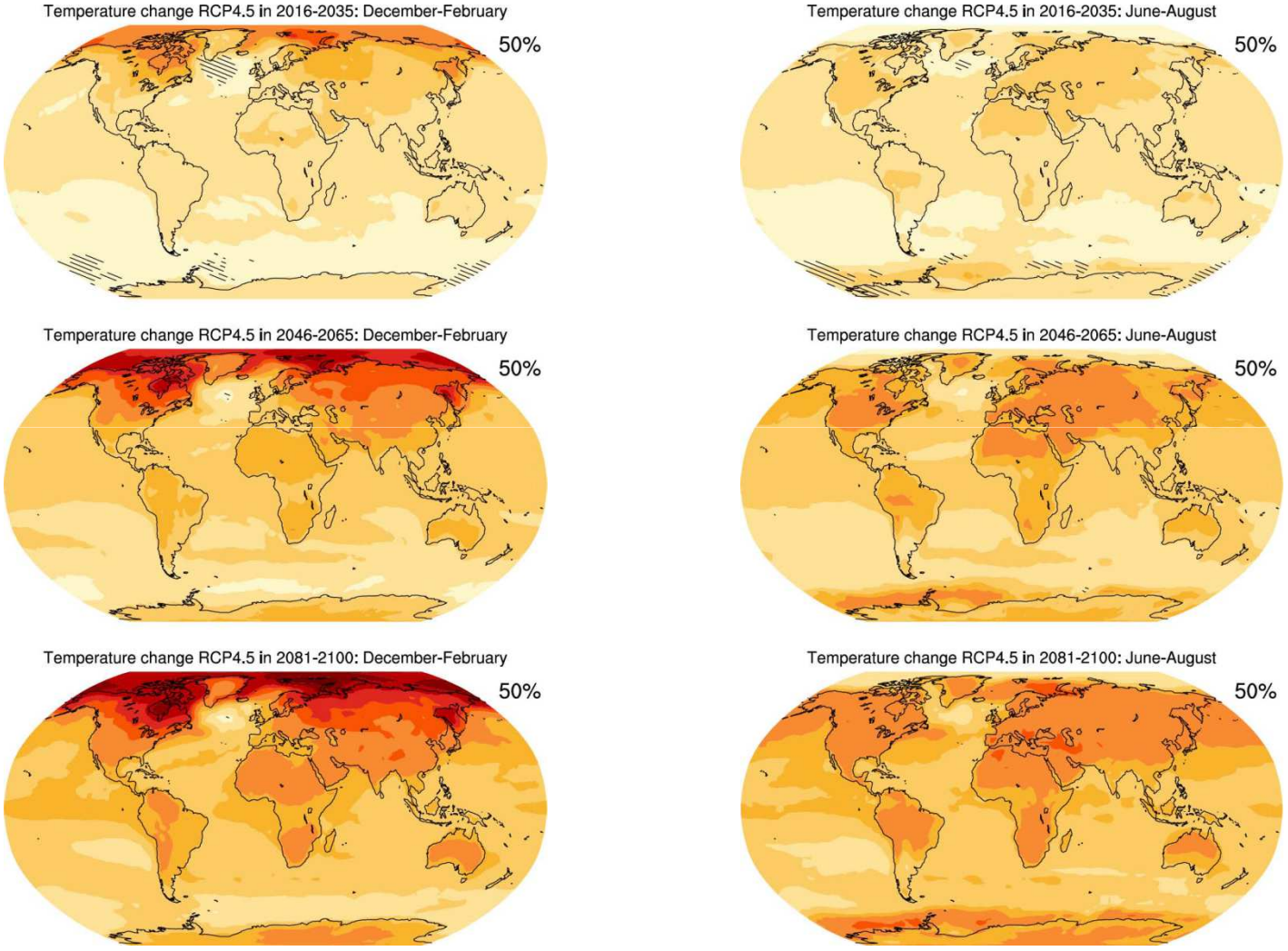


RCP2.6 (2081-2100): 0.26 to 0.55 m

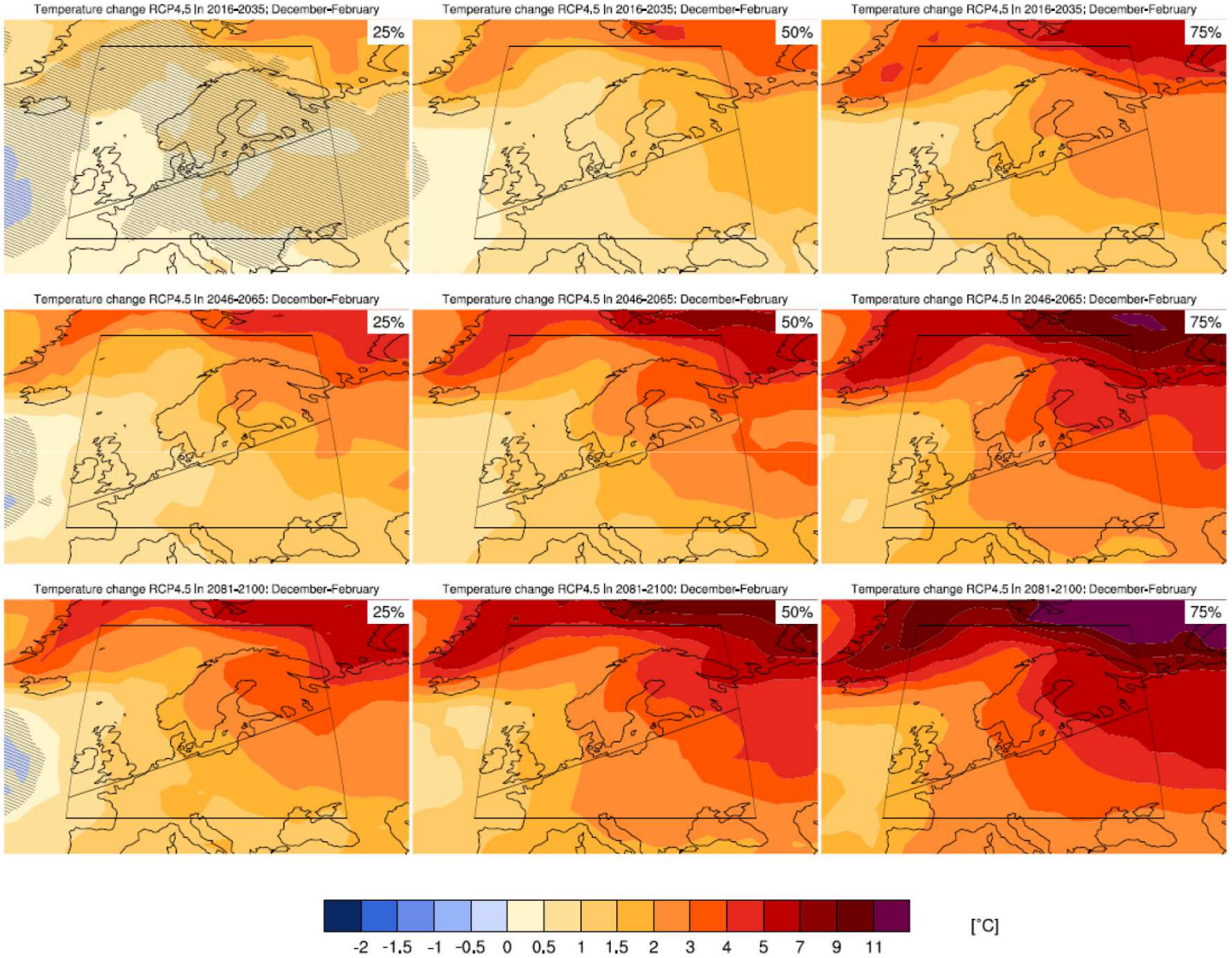
RCP8.5 (2081-2100): 0.45 to 0.82 m

Projections (RCP4.5)

versus 1986-2005

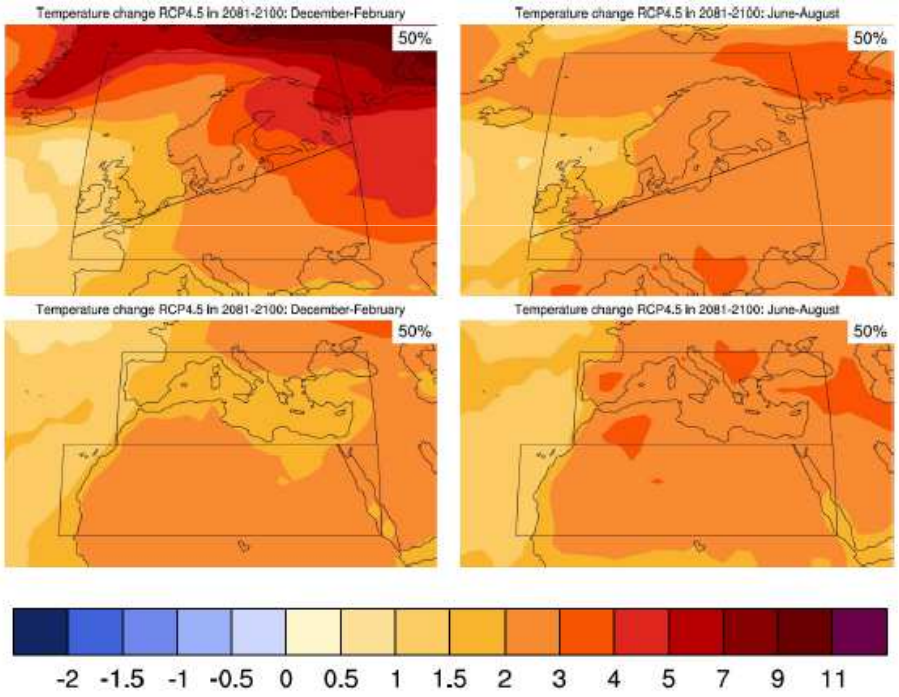


Atlas Data electronically available at the time of publication of the Full Report (January 2014)



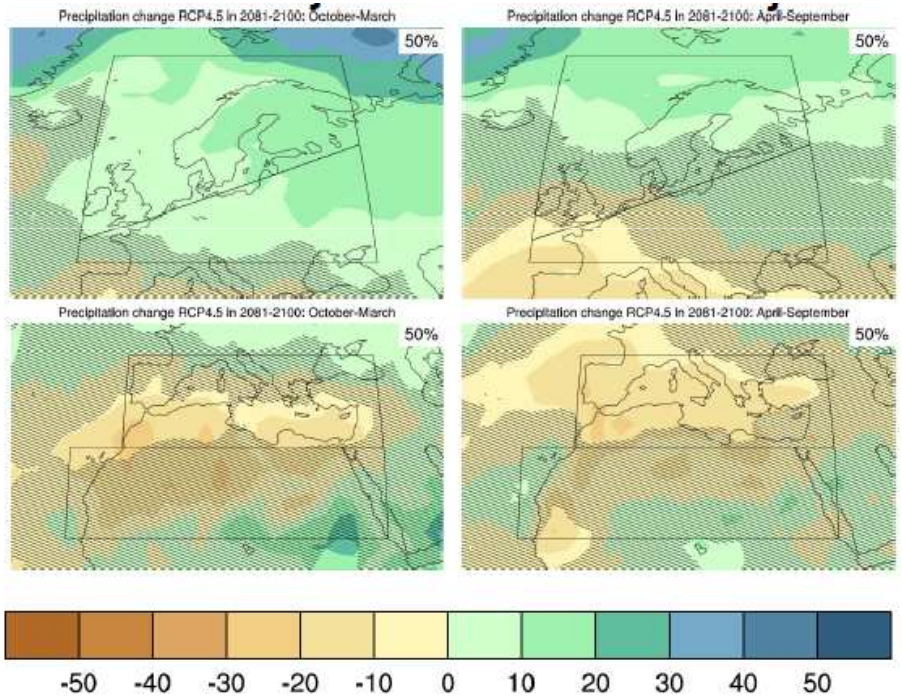
Projections Europe (RCP4.5)
2081-2100 versus 1986-2005

Temperature (°C)



winter summer

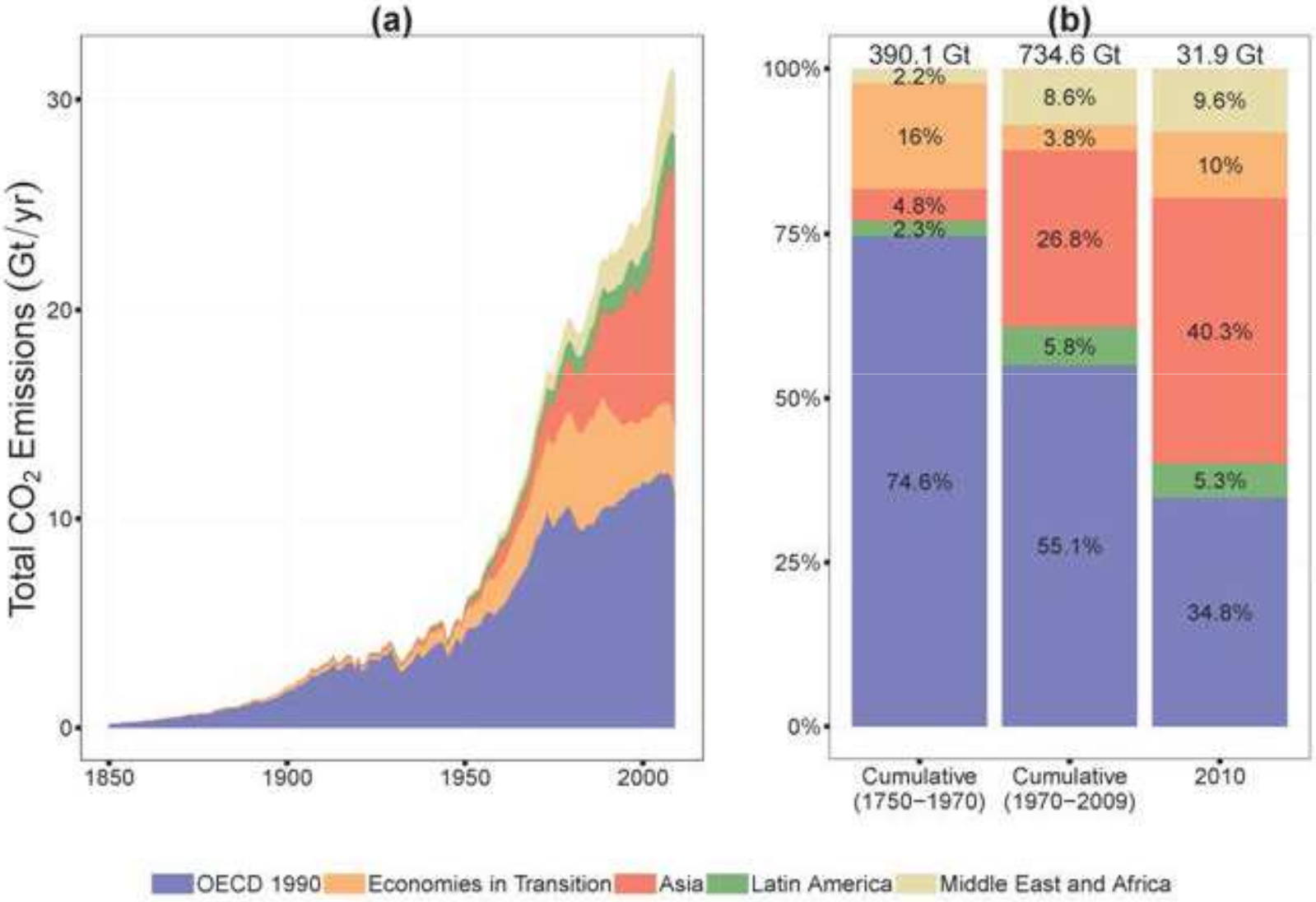
Precipitation (%)



winter half summer half


Climate Change 2013: The Physical Science Basis
Working Group I contribution to the IPCC Fifth Assessment Report
Further Information
www.climatechange2013.org
© Yann Arthus-Bertrand / Altitude

Current and historical anthropogenic CO_2 emissions from fossil fuel combustion in 5 major world regions



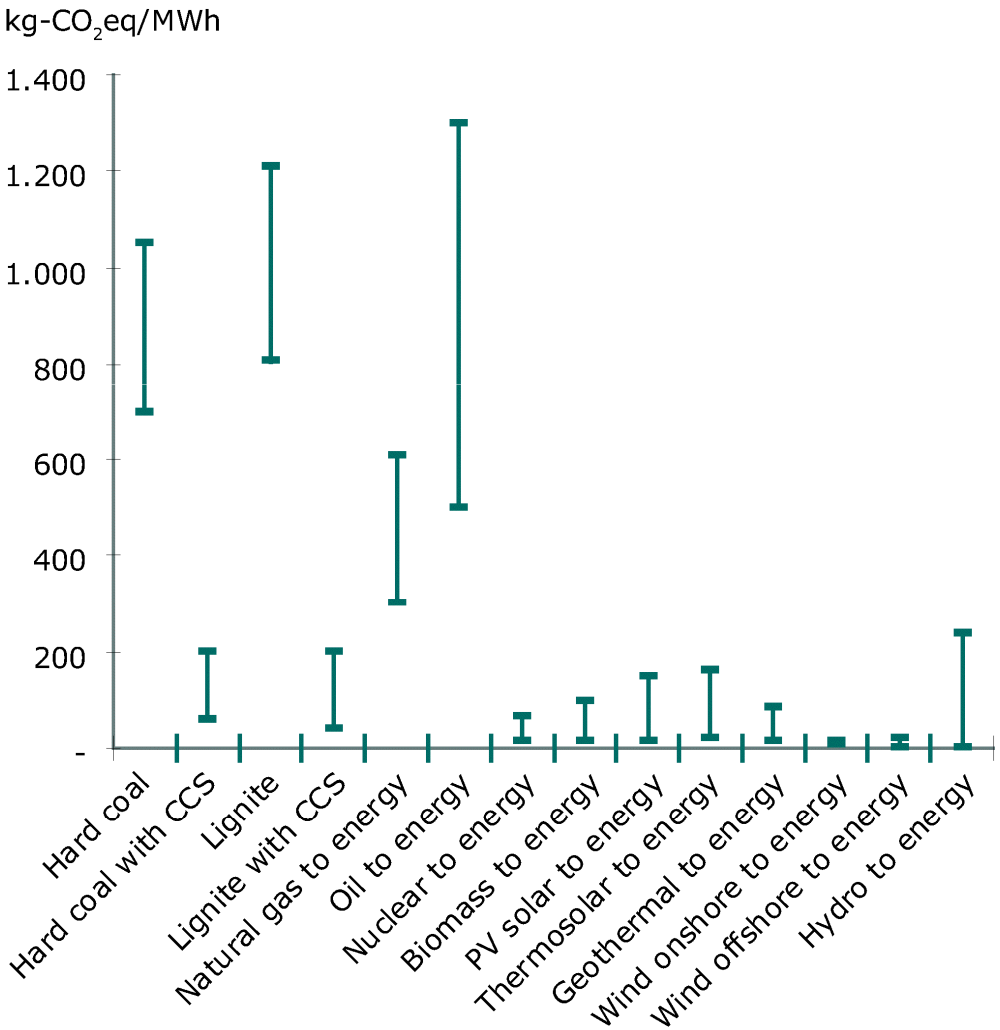
Realities of reducing CO_2 emissions

- Stabilizing at 450 ppmv CO_2-e means 2050 global CO_2 emissions must be reduced by ~**7-9** GtC/yr
- To understand the size of this challenge, consider some examples of what avoiding **1** GtC/yr in 2050 requires…

- energy use in buildings cut 20-25% below BAU in 2050, or
- fuel economy of 2 billion cars ~4 l/100 km instead of 8 l/100 km, or
-1 million 2-MWe wind turbines replacing coal power plants or
- 2,000 1-GWe(peak) photovoltaic power plants replacing coal power plants
- cutting 2005 tropical deforestation rate in half worldwide

Socolow & Pacala, 2004

LCA (Life Cycle Analysis) emissions of energy technologies for electricity production



So far,

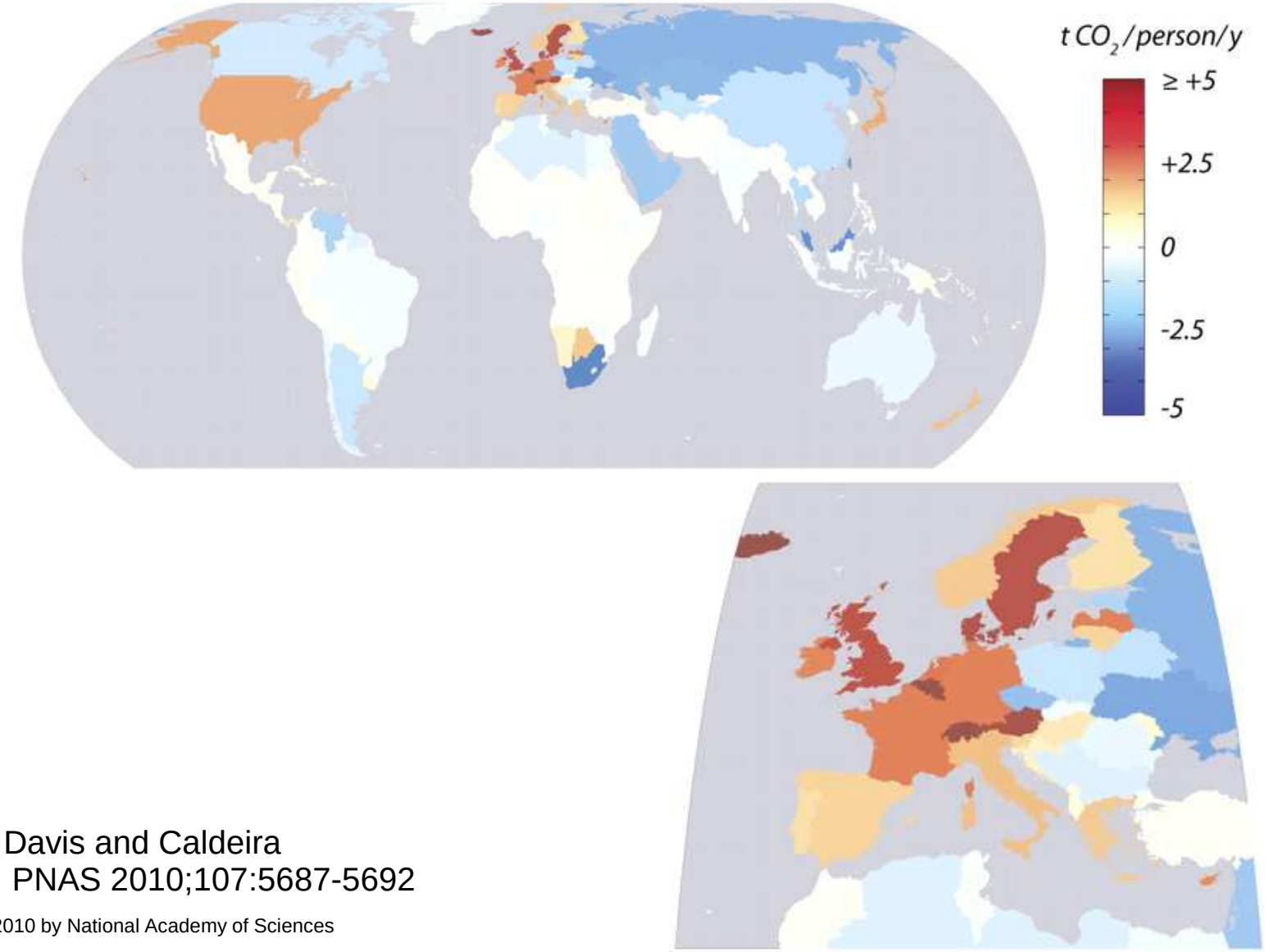
zero carbon technology

does not exist

The significance of imported stuff

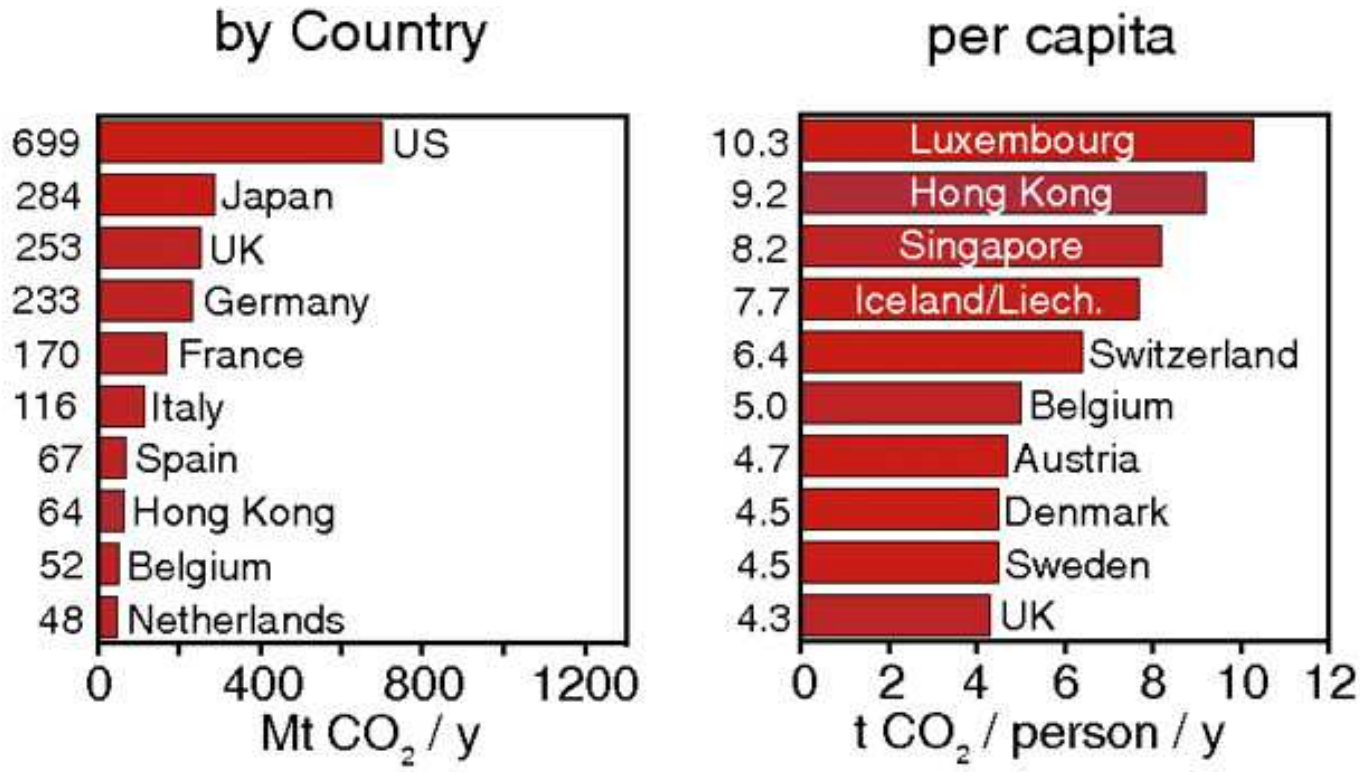
- In standard accounting of “energy consumption”, imported goods are *not* counted..
- Now Alpine region doesn’t manufacture so much (so energy consumption and CO_2 emissions have dropped a bit), but we still love cars, computers.... and we get them made for us by other countries.
- Allowing for imports and exports, carbon footprint of some countries is nearly *doubled* from the official “9 tons CO2e per person” to about 18 tons.
- It is possible that the biggest item in the average Alpine person’s energy footprint is the energy cost of making imported stuff.

Global differences between consumption and production emissions (i.e., the net effect of emissions embodied in trade) in 2004 per capita



Davis and Caldeira
PNAS 2010;107:5687-5692

Top 10
Net Import
of Emissions



Davis and Caldeira
PNAS 2010;107:5687-5692

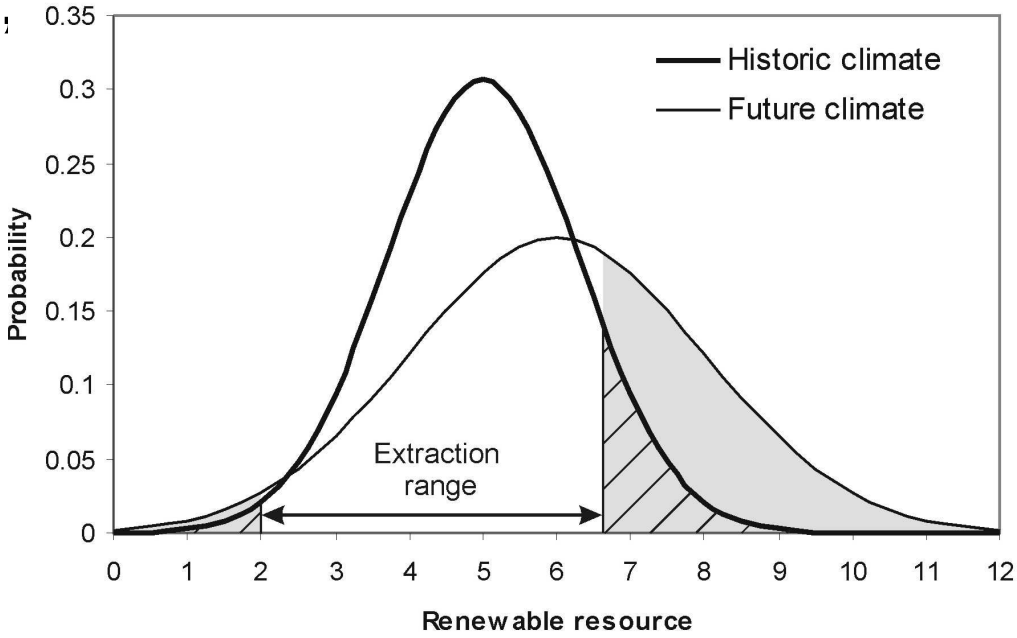
Can Alpine countries live on their own renewables?

Country	Total production of primary energy [TWh/a]	Total final energy consumption [TWh/a]	Primary production of RES [TWh/a]	RES production as % of total primary production	RES production as % of total final consumption
Austria	134	318	97	73%	31%
France	1'569	1'722	208	13%	12%
Germany	1'447	2'408	364	25%	15%
Italy	371	1'422	208	56%	15%
Liechtenstein	0.13	1.31	0.13	100%	10%
Slovenia	44	58	11	24%	18%
Switzerland	146	255	58	40%	23%

Table 1 Total renewable energy production in TWh/a per country in comparison to primary energy production and final energy consumption. Data basis: 2011 (Switzerland 2010). Data sources: eurostat and Energiestatistik 2011 Liechtenstein.

The impact of climate change on renewable energy sources

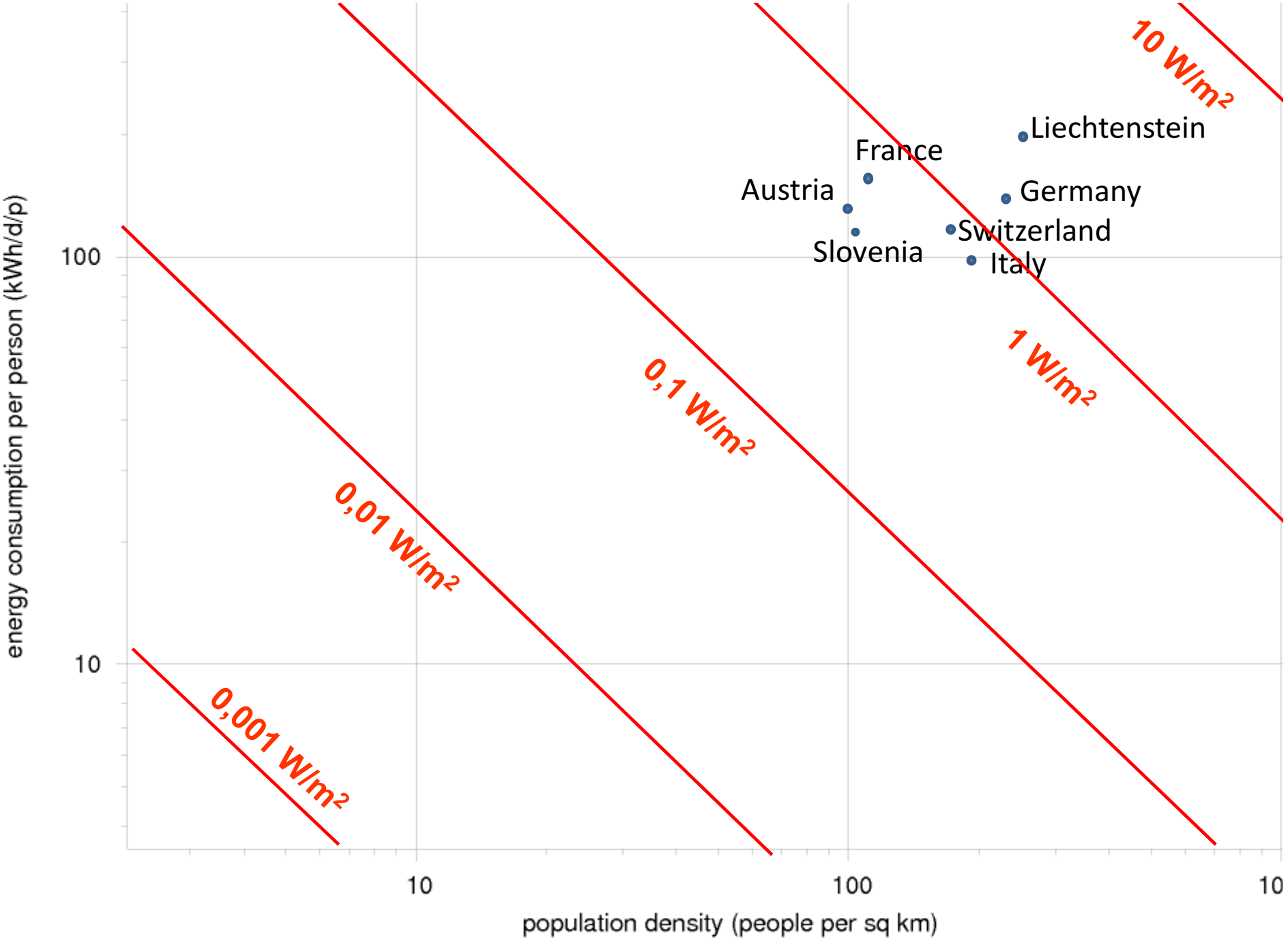
- changes in the quantity and timing of the renewable resource
- changes in operational performance and energy production
- impacts on the 'willingness to develop' resources



The impact of climate change on renewable energy sources

- Studies on hydropower indicate future production losses due to decreasing river flows,
- Too few studies on power plants that consider climate changes as well as variations in demand.
- No studies on impact of water scarcity on other energy sources such as biomass.
- Problems with extreme weather events (wind energy?)

There is a need for further research into the impact of climate change on the energy sector.


10 W/m²
1 W/m²
0,1 W/m²
0,01 W/m²
0,001 W/m²
Liechtenstein
France
Austria
Germany
Switzerland
Slovenia
Italy
100
10
10
100
10
energy consumption per person (kWh/d/p)
population density (people per sq km)

Mac Kay, 2011

Andasol, Spain

10 W/m^2

Bavaria,
Germany

$5\,W/m^2$

www.powerlight.com

Most renewables offer 0.5 to 5 W/m^2

.

POWER PER UNIT LAND OR WATER AREA	
Wind	2 W/m^2
Offshore wind	3 W/m^2
Solar PV panels	5 – 20 W/m^2
Plants	0.5 W/m^2
Hydroelectric facility	11 W/m^2

Renewable facilities have to be country-sized
because all renewables are so diffuse

Most renewables offer 0.5 to 5 W/m^2

.

- Countries whose power consumption per unit area is bigger than **0.1 W/m²** are countries who should expect renewable facilities to occupy a significant *intrusive* fraction of their country, if they ever want to live on their own renewables.

- Countries with a power consumption per unit area bigger than **1 W/m²** (eg Germany) would have to industrialize most of their countryside, if they want to live on their own renewables.

Use of RE is unfortunately limited

Great potential for renewable energy sources

In regions that have 3 things:

a) low population density
b) large area
c) a renewable power supply with high power density

Alternatively, options are

- to radically reduce consumption,
- use nuclear power,
- and/or to buy renewable power in from other countries
- ?

Final remarks

- Energy self-sufficiency, autonomy etc.: these declarations should be used much more in a scientific sense; not just as result of a political decision-making process.
- The drastic reduction of energy use and general consumption in the Alpine area is a first step towards energy self-sufficiency
- Conversion to renewable energies next step, but only if this change is connected with a fundamental restructuring of energy supply.
- Significantly greater efforts in the field of research and development
- Some vision hold great fascination – but we have to be realistic and honest!