

Klimatförändringar i ett globalt perspektiv

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Tack till IPCC, Erik Kjellström



Regionalklimatgruppen på Geovetarcentrum

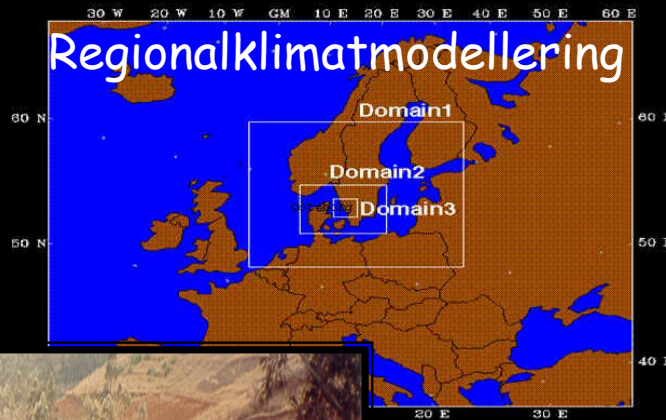
etablerades 1995 av Prof. Deliang Chen,
idag: 4 disputerade, 8 doktorander

www.gvc2.gu.se/rcg

Regionalklimatstudier



Regionalklimatmodellering



Klimat o. klimatförändringarnas
betydelse i Kina



Rekonstruktion
av gångna tiders
klimat



photo © H.D. Grissino-Mayer

Regional Climate Group

www.gvc2.gu.se/rcg

Group leader: Prof. Deliang Chen

Current members: Dr. Christine Achberger, Dr. Madelene Ostwald, Dr. Lijun Fan, Dr. Hans Linderholm, Eskil Mattsson, Staffan Rosell, Elisabeth Simelton, Lin Tang, Matilda Palm, Alexander Walther

Associate PhD students: Lars Zetterberg (IVL), Markus Åhman (IVL), Cecilia Bennet (SMHI), Ge Gao (CMA), Jiandong Liu (CMA).

Visitors: 3-5 persons



Brief Introduction

- Climate and climate change at **regional and local scales** and its impact on ecosystems, environment and society are studied by observations and numerical modeling.
- Sweden and China have been the focus of these studies.



The causal links between observed changes in Earth's climate system and human activities

- IPCC 1995 “Global warming has occurred, and it **may** be due to anthropogenic greenhouse gas emissions”
- IPCC 1998 “ The balance of evidence **suggests** a discernable human influence on global climate.”
- IPCC 2001 “ **Most** of the observed warming over the last 50 years is **likely** to have been due to the increase in greenhouse gas concentrations.”
- IPCC 2007 “?????????”



CLIMATE CHANGE 2007

**Fourth Assessment Report of
Intergovernmental Panel on Climate
Change
February 2007**



- The complete report, which will have taken more than six years to complete, draws on research by 2,500 climate scientists.
- It has involved more than 800 contributing authors from over 130 countries.



Broad conclusions

1. Numerous long-term changes in climate have been observed at continental, regional, and ocean basin scales.
2. Warming of the climate system is unequivocal.
3. Average air and sea temperatures are increasing globally.

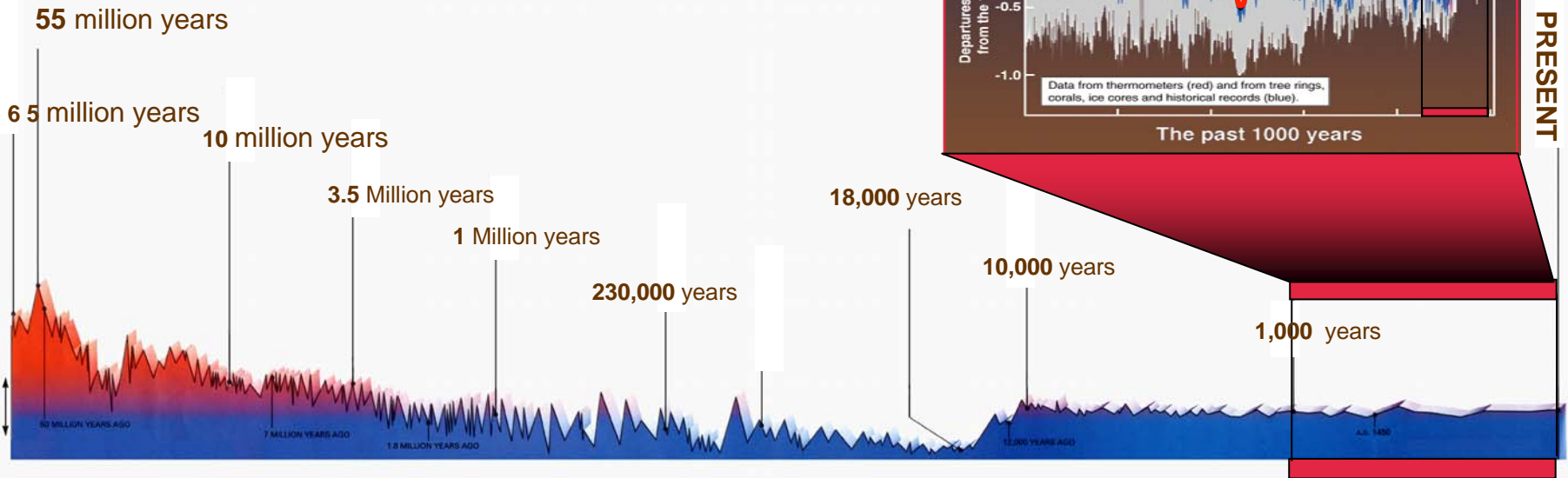
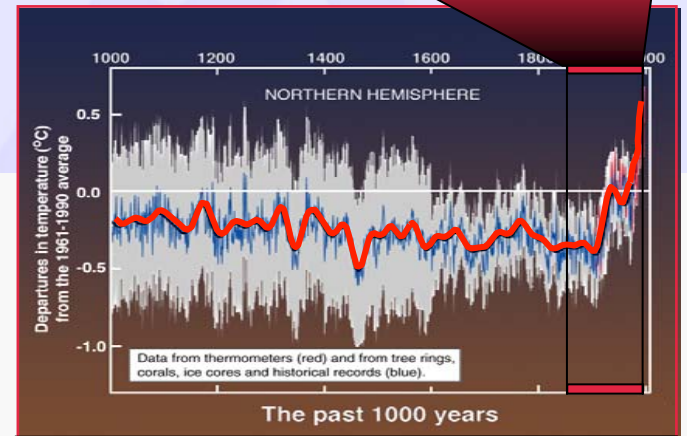
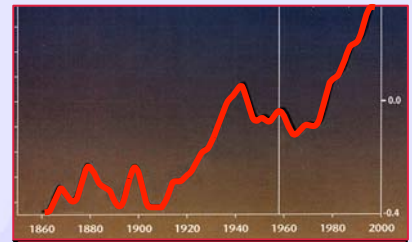


Observed changes in Earth's climate since 1860

- All are statistically significant changes
- All have been causally linked to human activities (primarily burning of oil, coal & gas). This is called “attribution”
 - Increased global mean temperature, and more heat waves
 - Sea level has risen by several inches
 - Increased global cloudiness
 - Warming mainly at night and during winter
 - Increased global rain and snowfall, and more very heavy rain and snow days (floods and winter storms)
 - More frequent and more intense El Niño years
 - More severe hurricanes in the Atlantic
 - Large declines in most temperate and tropical glaciers (30% - 60% volume loss)
 - Large decline in Arctic sea ice, freshening of Arctic & N Atlantic oceans, slowing of North Atlantic conveyor belt

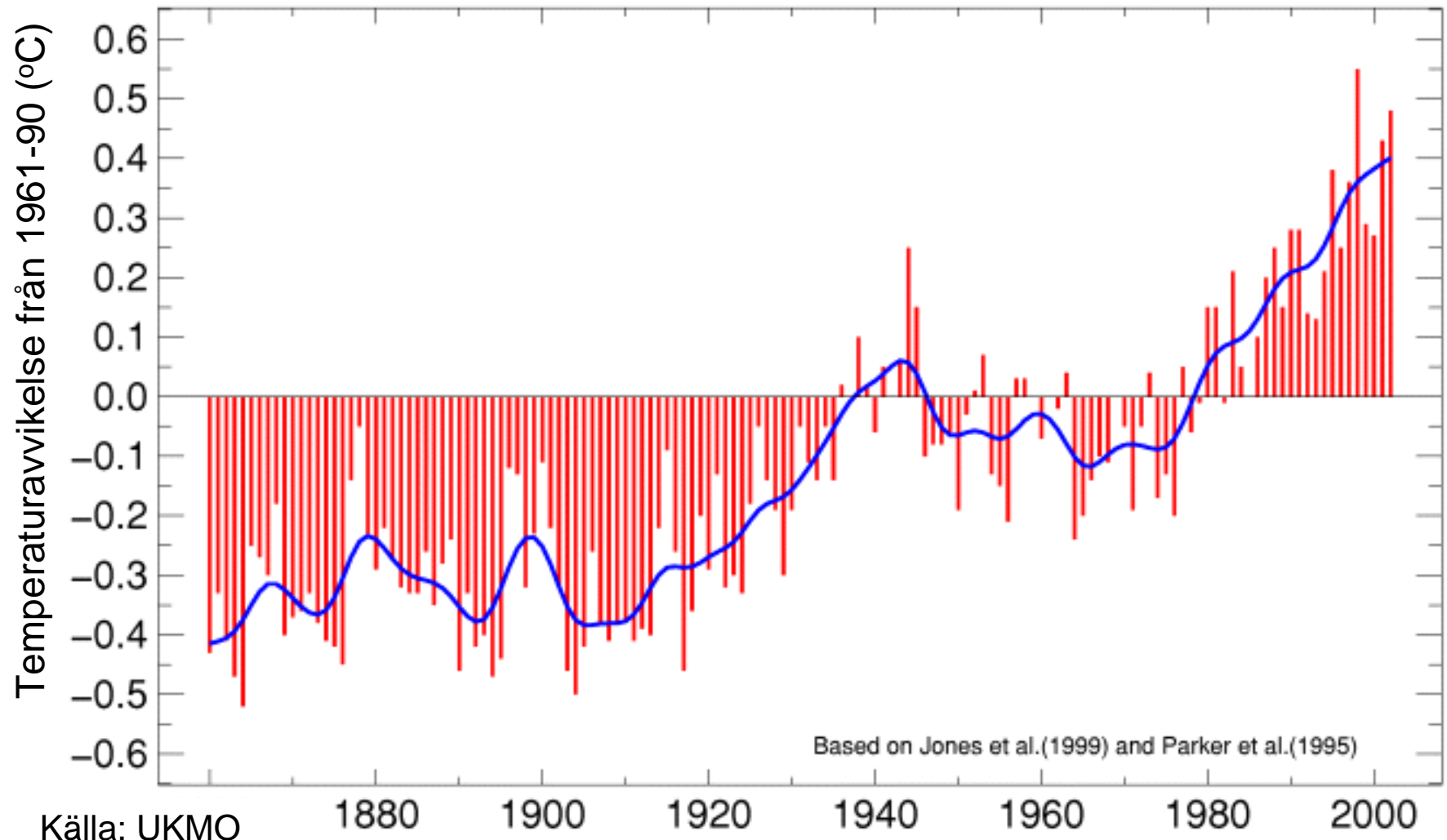


Global temperature over the past 65 million years.

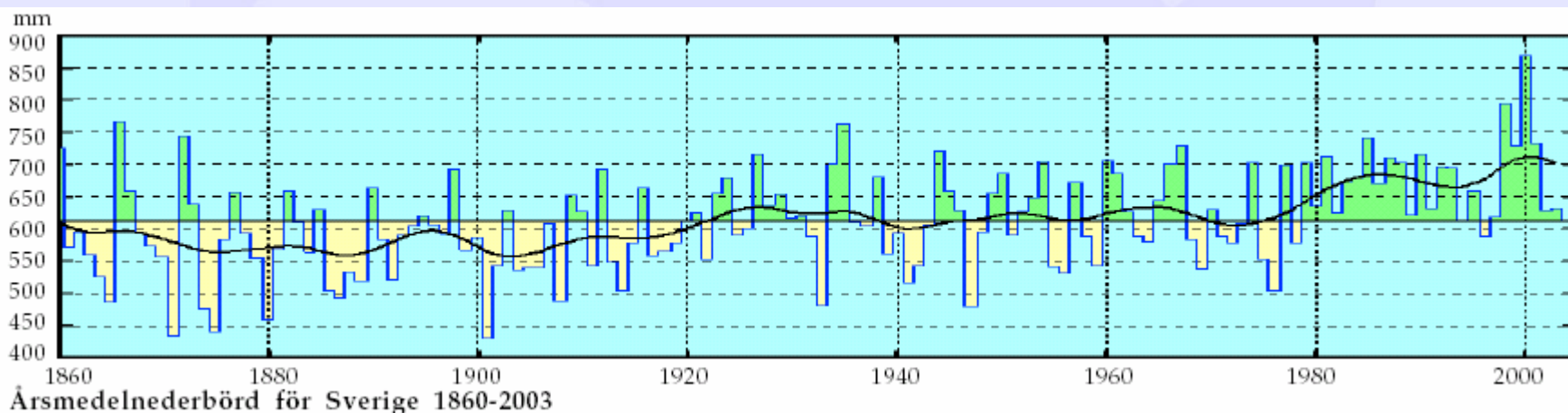
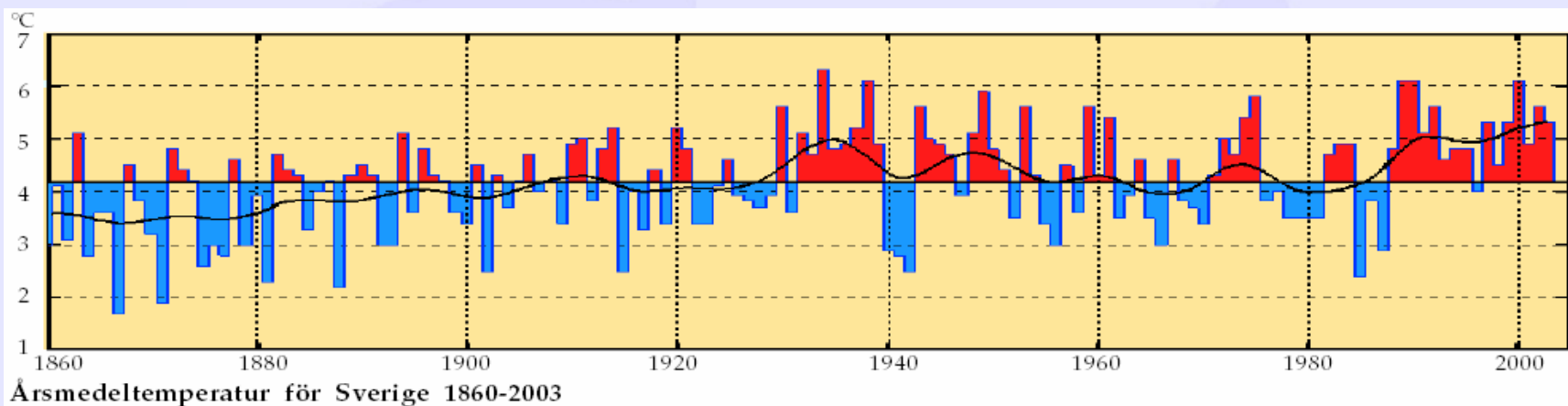


Jorden har blivit varmare

Global Average Near-Surface Temperatures
Annual anomalies, 1860 – 2002

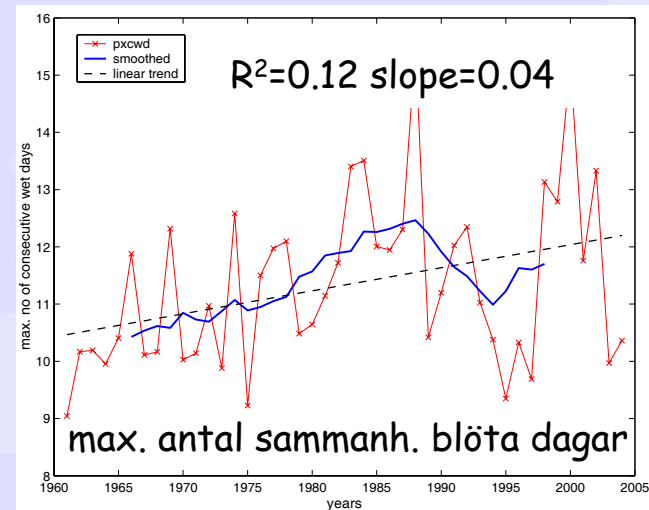
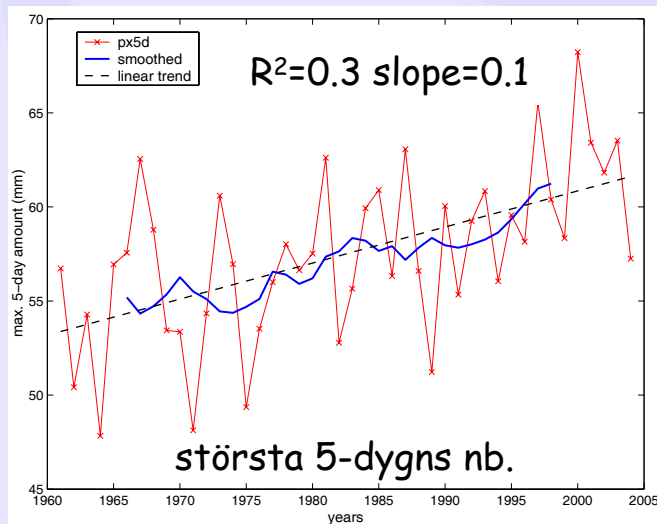
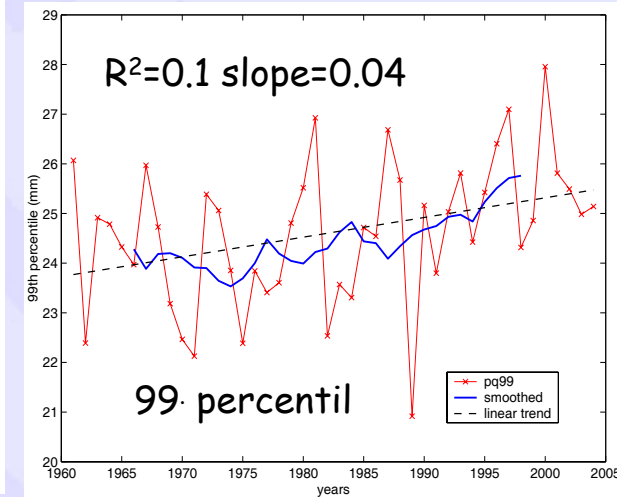
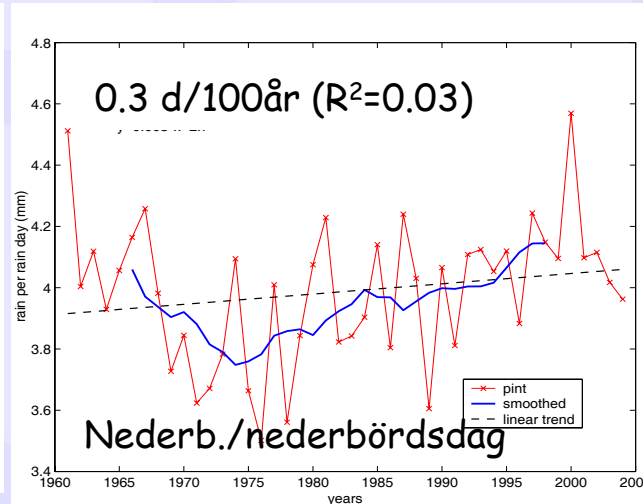
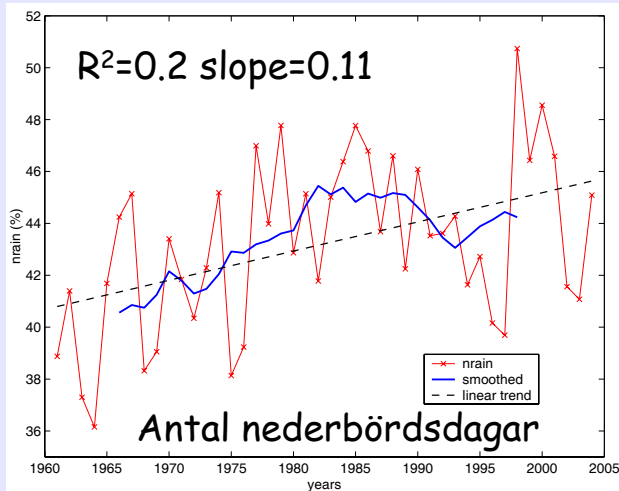


Temperatur och nederbörd i Sverige sedan 1860



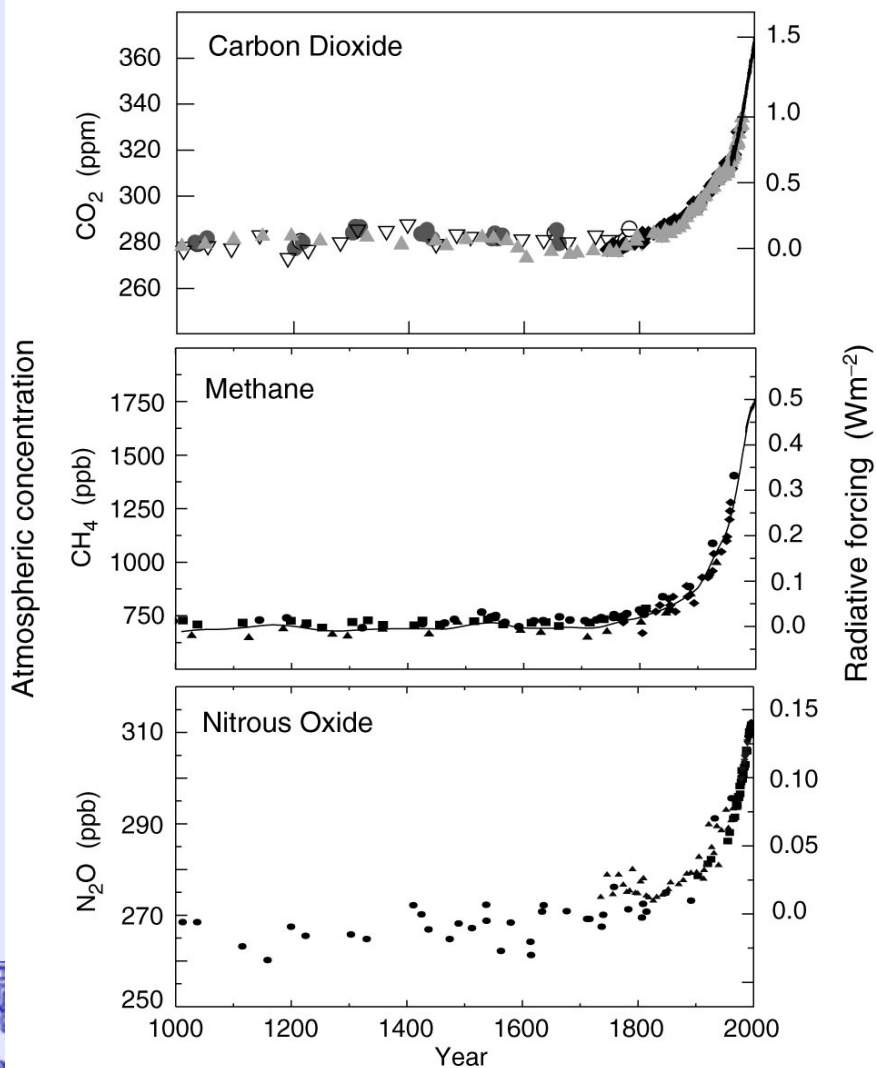
Källa: SMHI's faktablad: "Variationer och trender i temperaturen och nederbörden"

Medelvärde i trenden över alla stationer

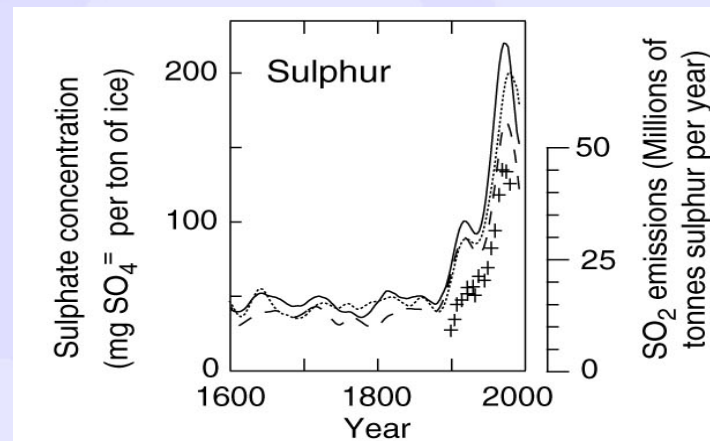


Indicators of the Human Influence on the Atmosphere during the Industrial Era

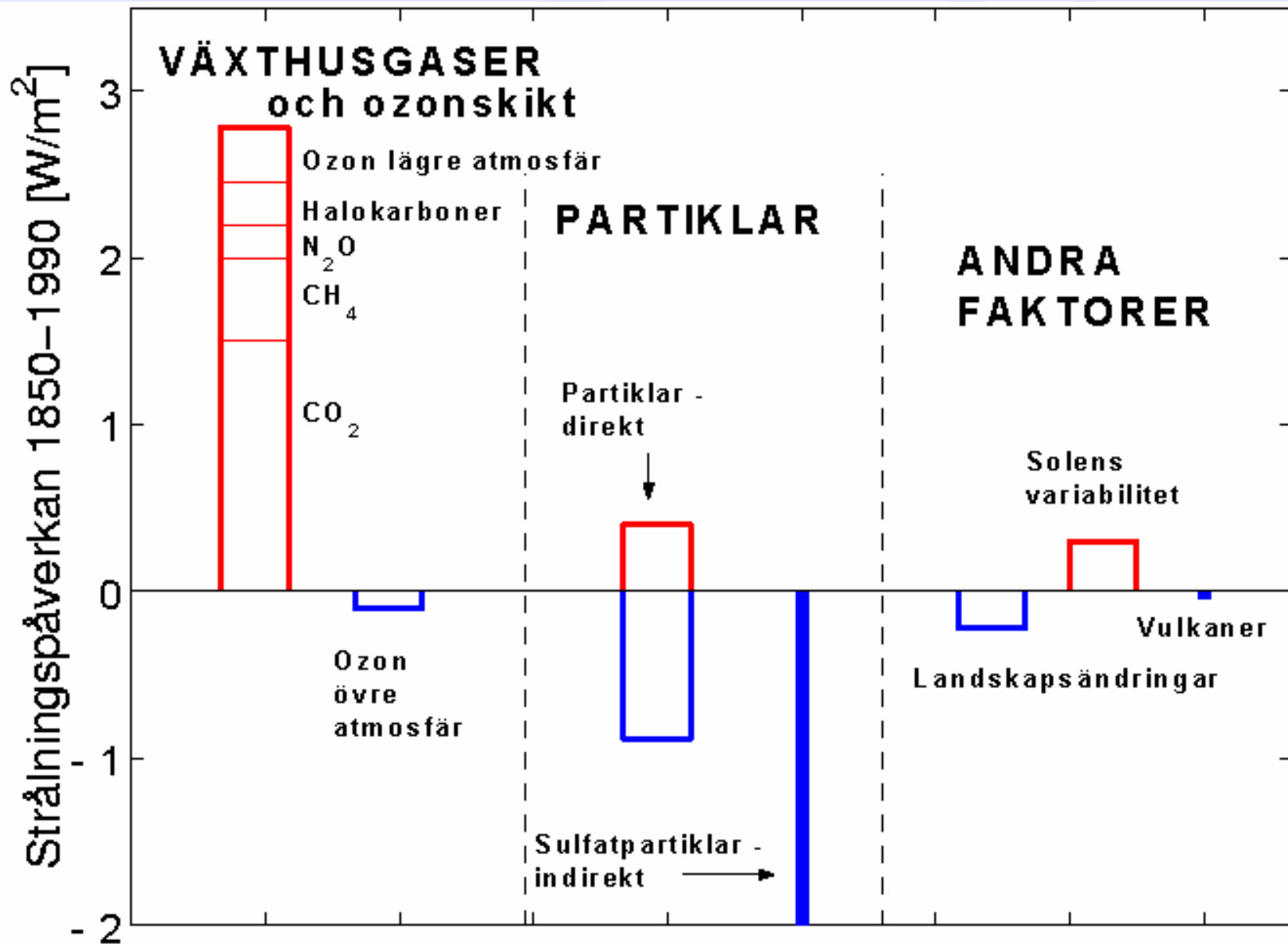
(a) Global atmospheric concentrations of three well mixed greenhouse gases



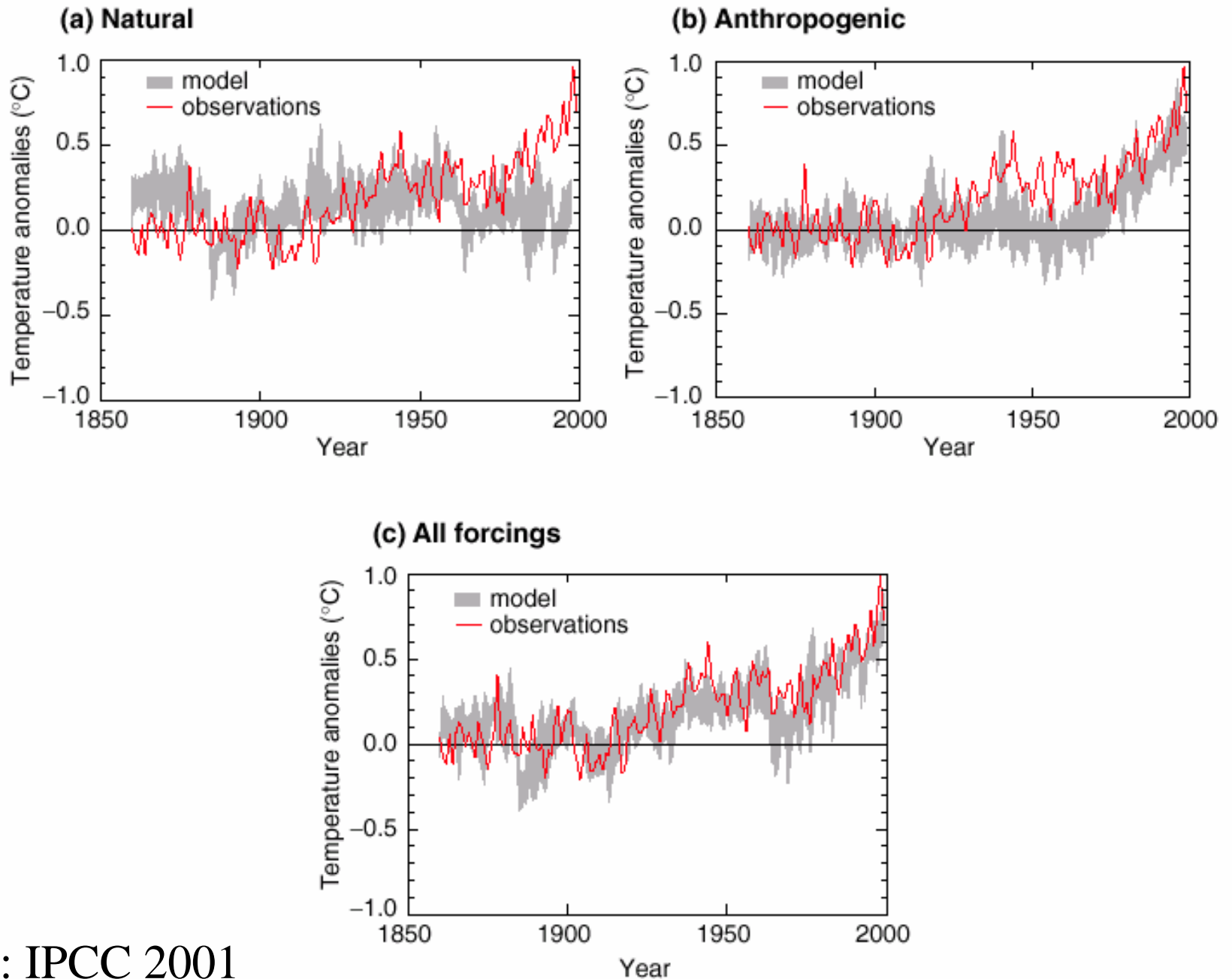
(b) Sulphate aerosols deposited in Greenland ice



Faktorer som kan ha påverkat klimatet under 1900-talet



Simulated annual global mean surface temperatures

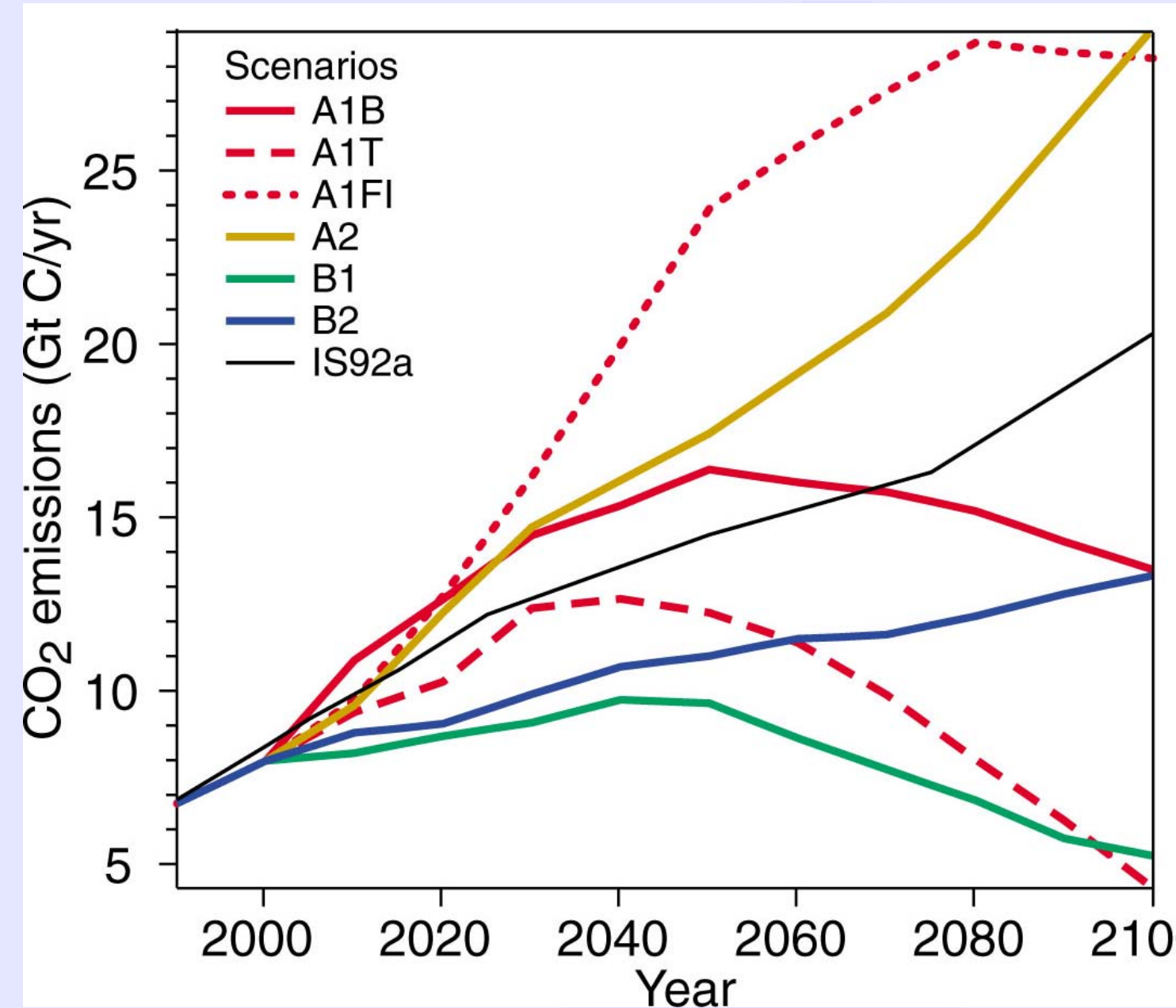


Vad kan hända i framtiden?

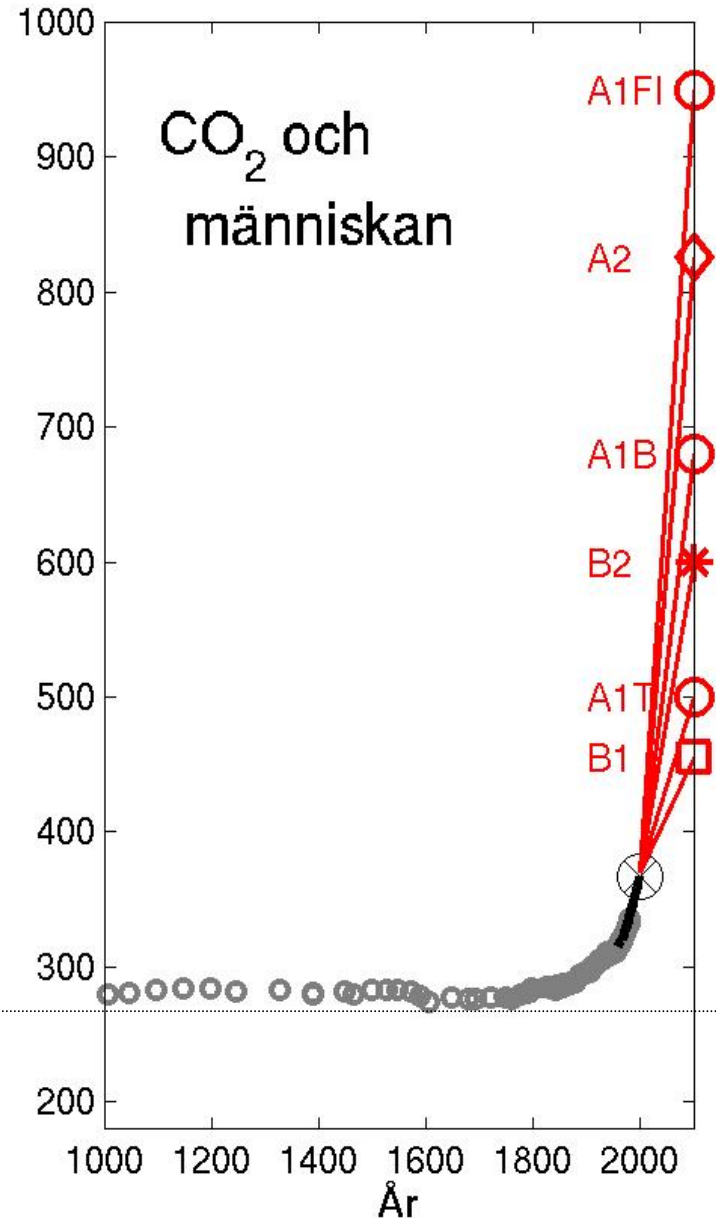
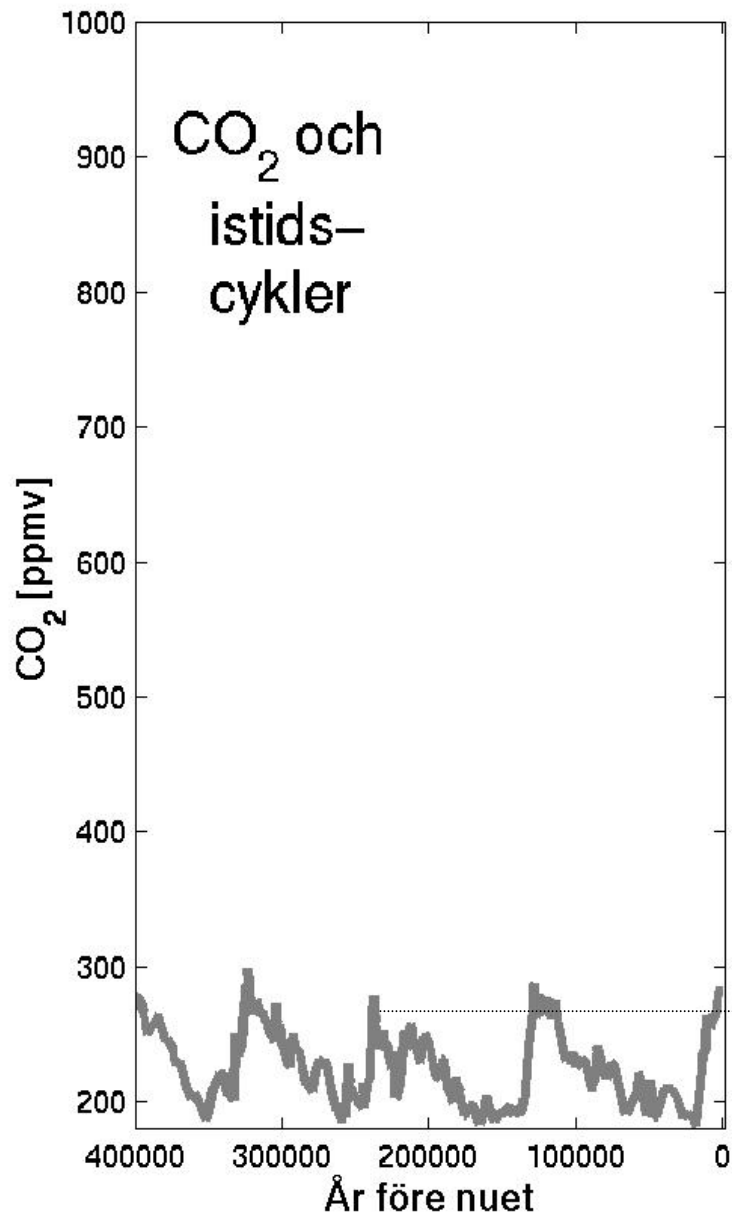


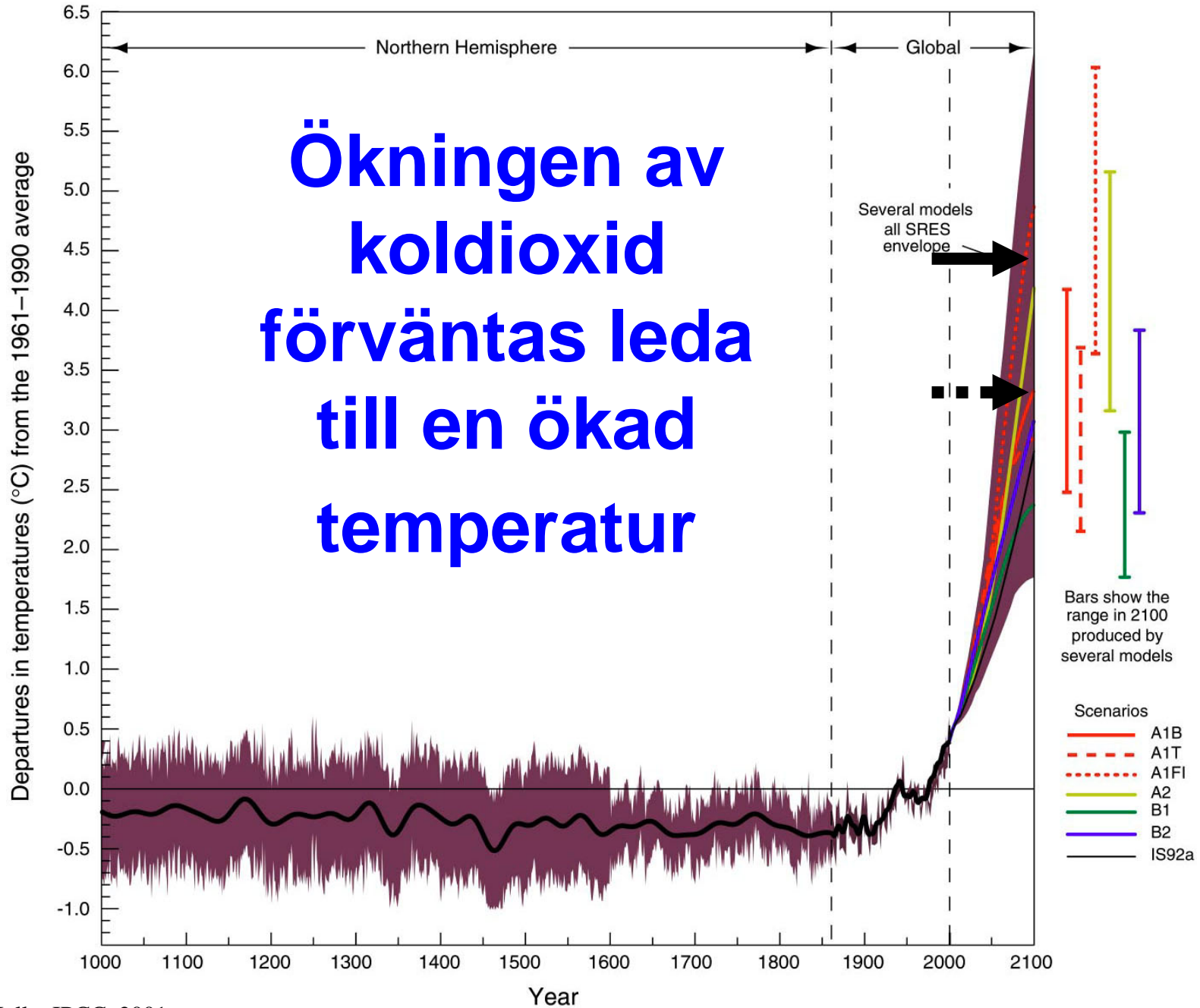
Koldioxid- utsläpp under olika emissions- scenarier

Källa:
IPCC



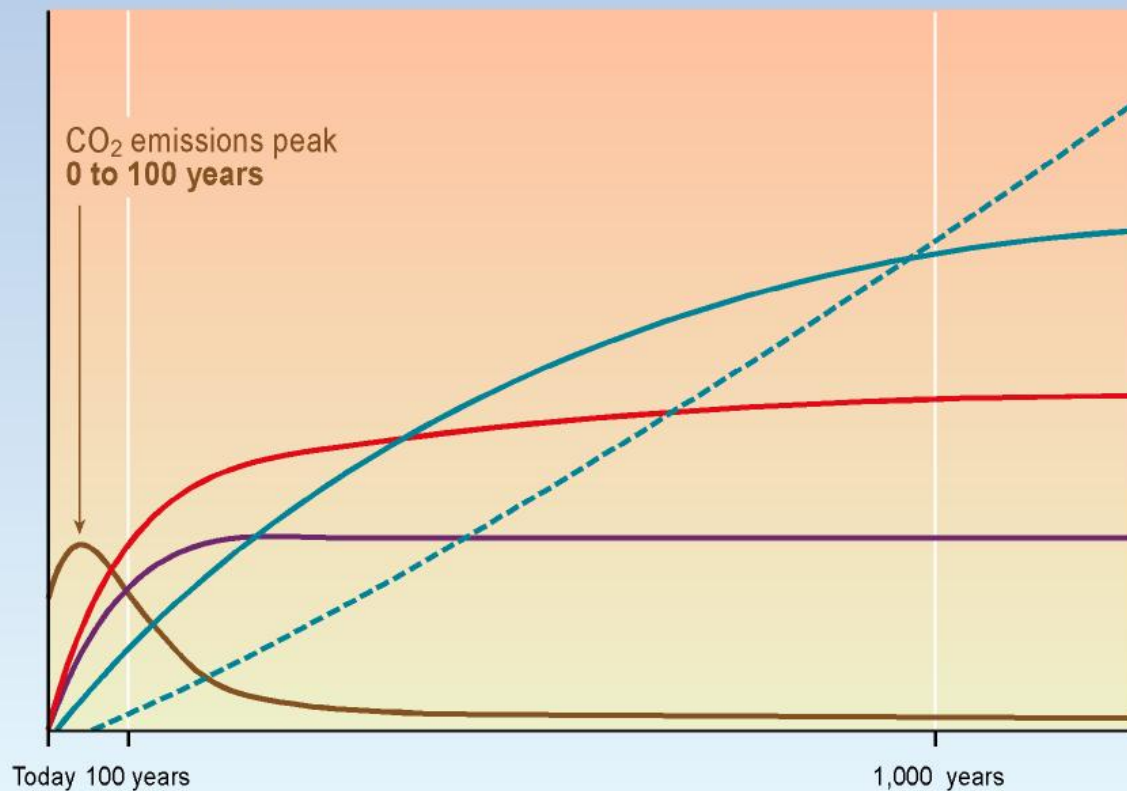
Halten koldioxid förväntas fortsätta öka i atmosfären





CO₂ concentration, temperature, and sea level continue to rise long after emissions are reduced

Magnitude of response



Time taken to reach equilibrium

Sea-level rise due to ice melting:
several millennia

Sea-level rise due to thermal expansion:
centuries to millennia

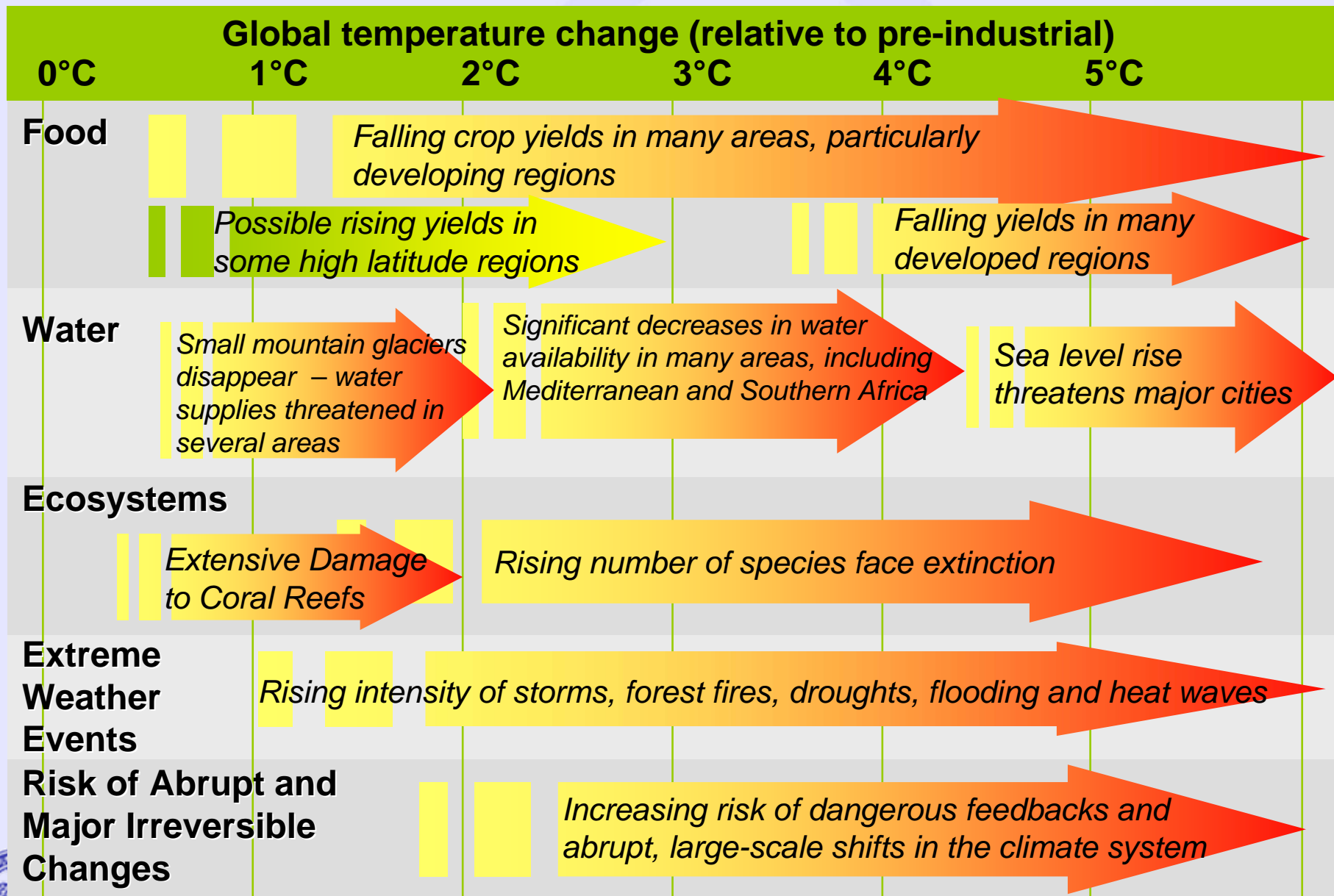
Temperature stabilization:
a few centuries

CO₂ stabilization:
100 to 300 years

CO₂ emissions

SYR - FIGURE 5-2

Projected impacts of climate change



Effekter

- Ekosystemen
- Vattentillgång
- Jordbruket, skogsbruket
- Kusteffekter/havsnivåer
- Människor och djurs hälsa
- Extrema väderhändelser



WEGGERISSEN

Die Wucht des Wassers hat zwischen Eilenburg und Bitterfeld eine Straße in Stücke zerlegt. Die Infrastruktur in den Hochwassergebieten ist weitgehend zerstört. Auch Bahngleise versanken



1.2 to 3.2 billion facing water shortages
and drought



Malaria and dengue fever and diseases will increase



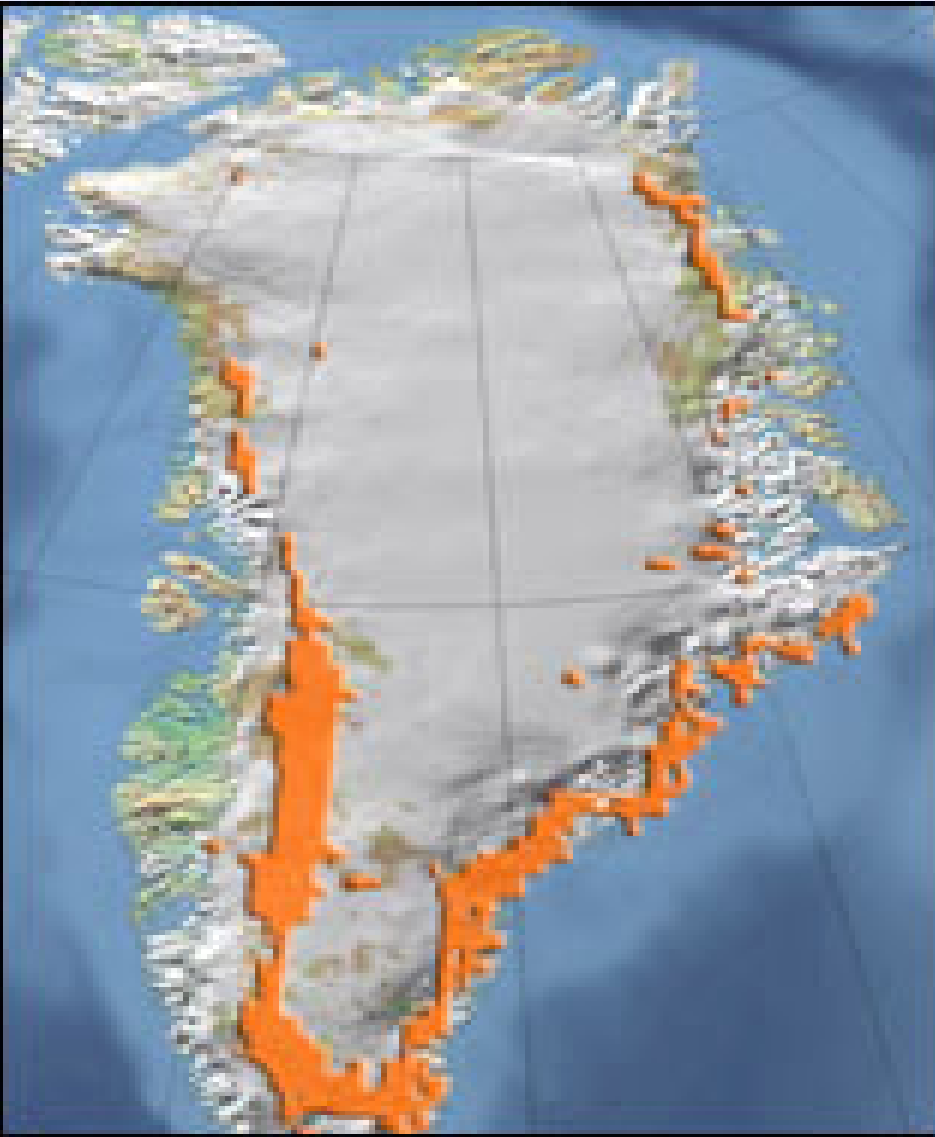
Europe's small glaciers will disappear



Large glaciers will shrink dramatically



Greenland's ice mass will
continue decreasing



By 2080, 200 to 500 million people
chronically hungry



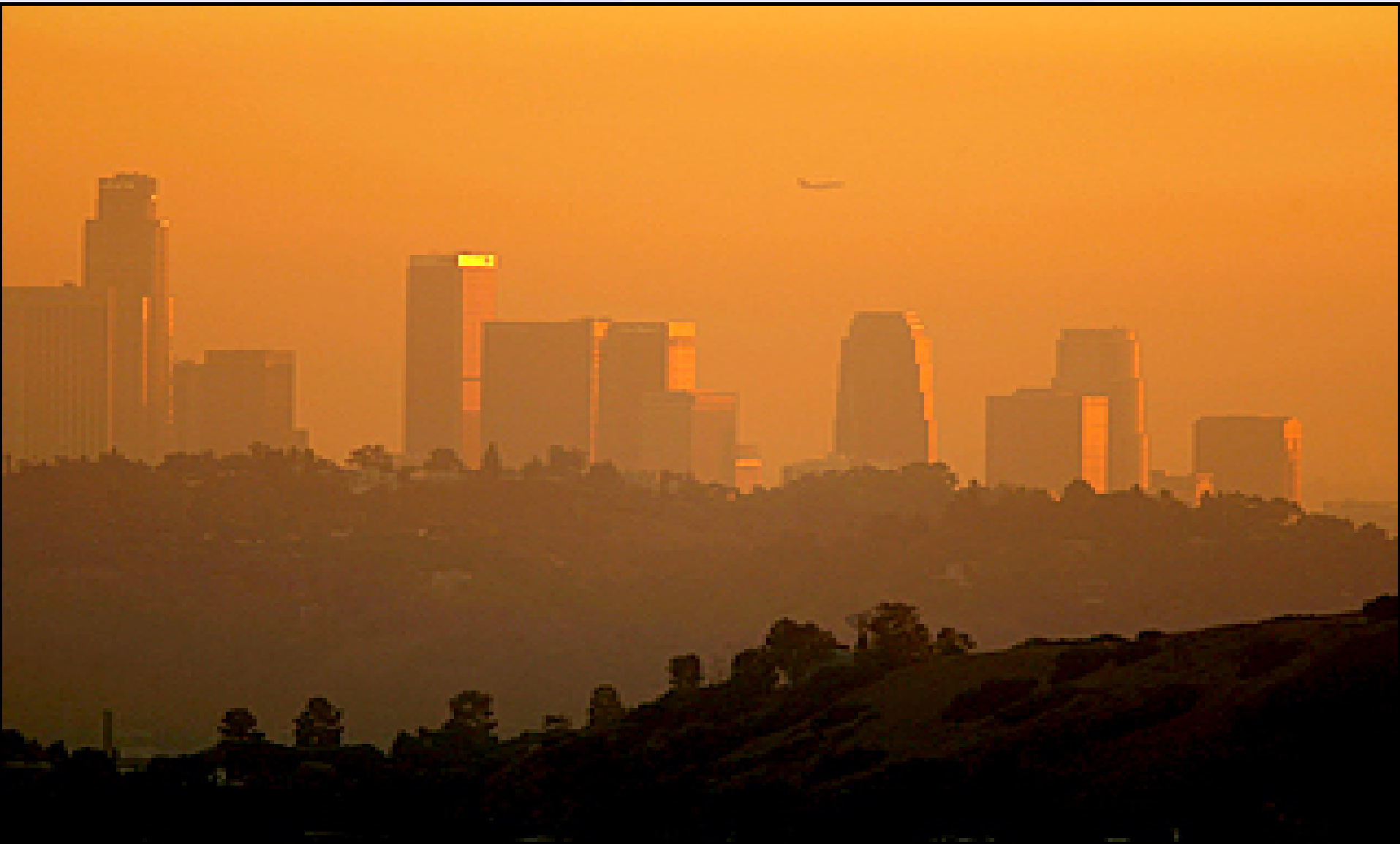
Sea levels will rise



By 2080, 100 million people flooded



Smog will worsen in USA cities



Animals and plants facing extinction



Increased migration of people seeking food & protection



Inte bara klimatförändringar i sig....

- Vem bär det största ansvaret för klimatförändringar?
- Vem utsätts för de största riskerna?
- Vem har störst möjlighet att agera?
- Vilket ansvar har vi för kommande generationer?
- Vilken rätt har vi att använda atmosfären?

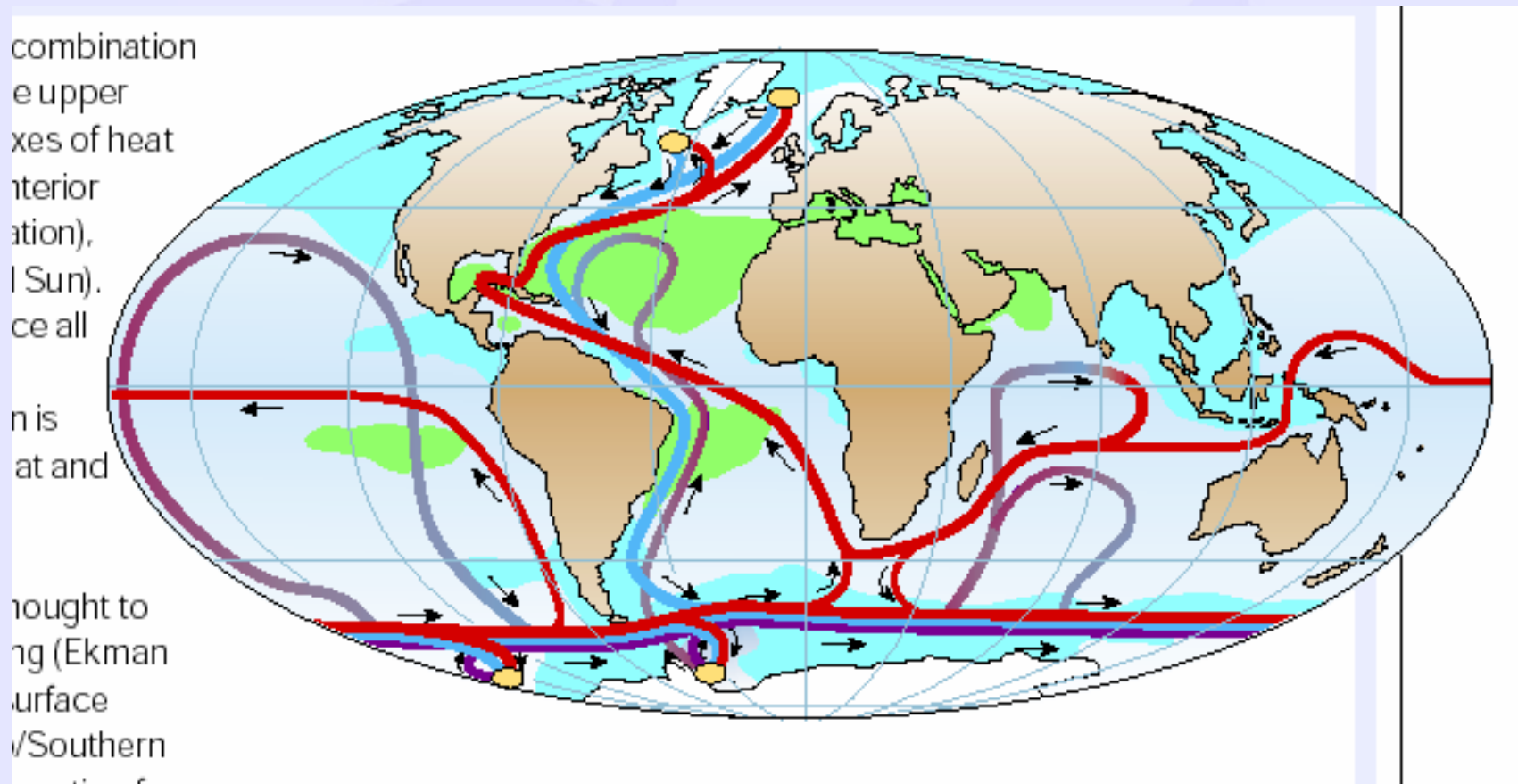


Hantering av osäkerheter i klimatfrågan

- Det finns naturliga variationer i klimatet.
... Gör många klimatsimuleringar.
- Emissionsscenarierna bygger på en rad antaganden.
... Använder flera scenarier. Förbättrar scenarierna.
- Klimatmodellerna innehåller svagheter.
... Använder flera olika modeller. Förbättrar modellerna.
- Det kan finnas överraskningar i klimatsystemet.
... Försöker förstå systemet bättre.

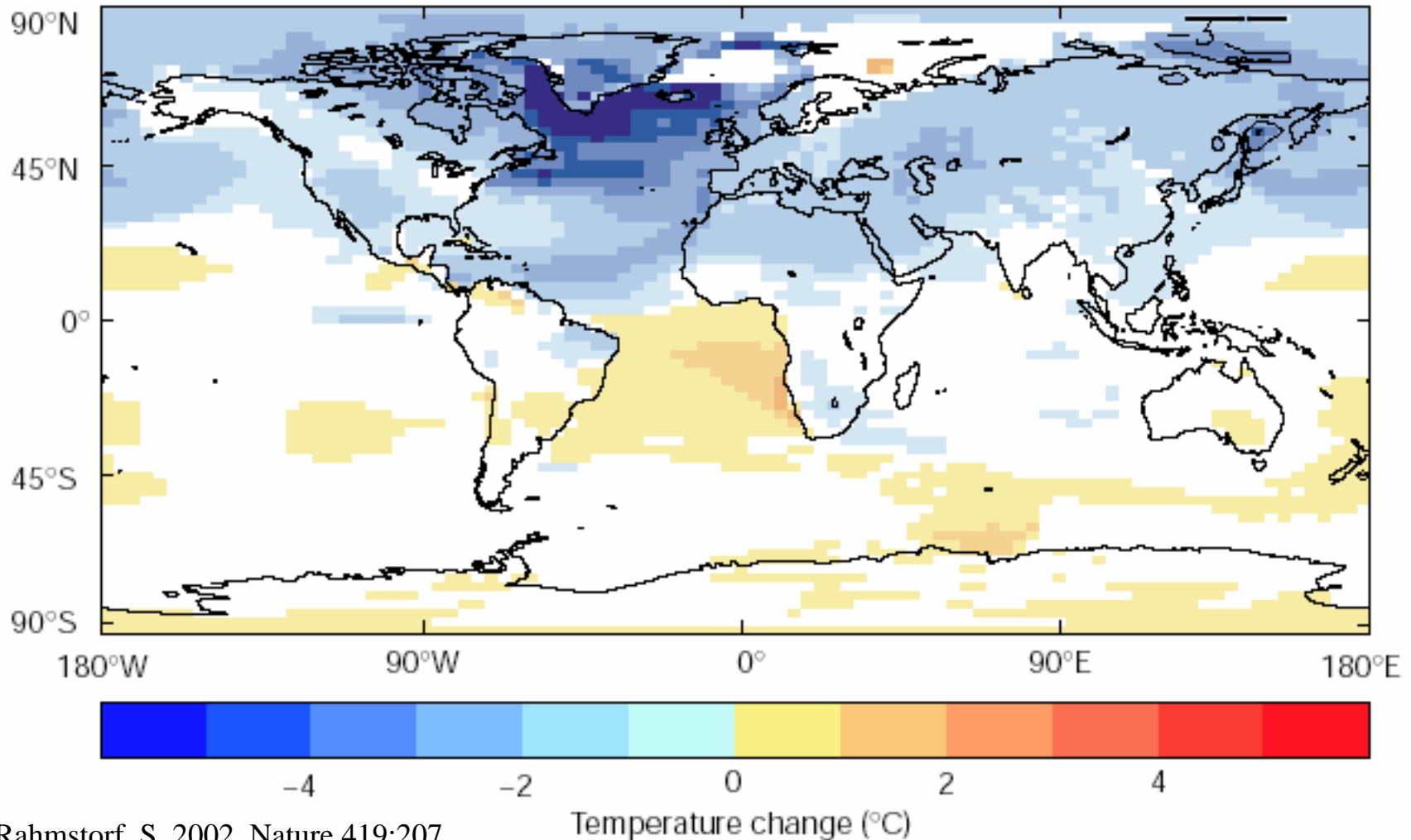
Ocean currents also distribute heat around globe

Ocean Circulation Systems. Driven by winds, thermohaline circulation (salty cold water drops down, fresh warm water floats up), and tides



Low probability, high impact extreme event: The “Day After Tomorrow” scenario

Shutdown of North Atlantic Deep Water Circulation - figure shows changes in surface air temperature if conveyor belt in Atlantic shuts down



Rahmstorf, S. 2002. Nature 419:207