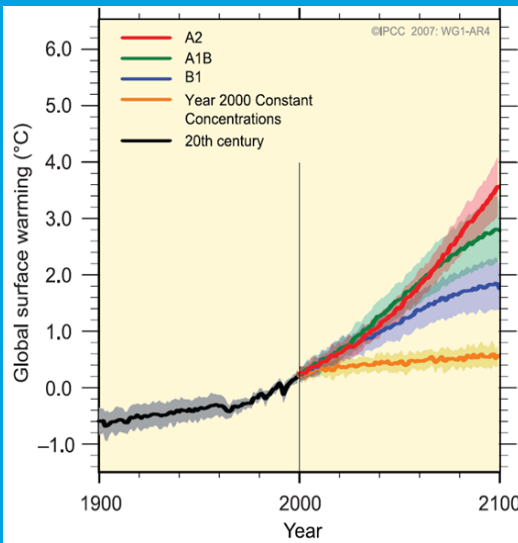




能源及環境學院
SCHOOL OF ENERGY
AND ENVIRONMENT



香港城市大學
City University
of Hong Kong



Energy, Environment and Climate Change

Johnny Chan

Guy Carpenter Asia-Pacific Climate Impact Centre

School of Energy and Environment

City University of Hong Kong

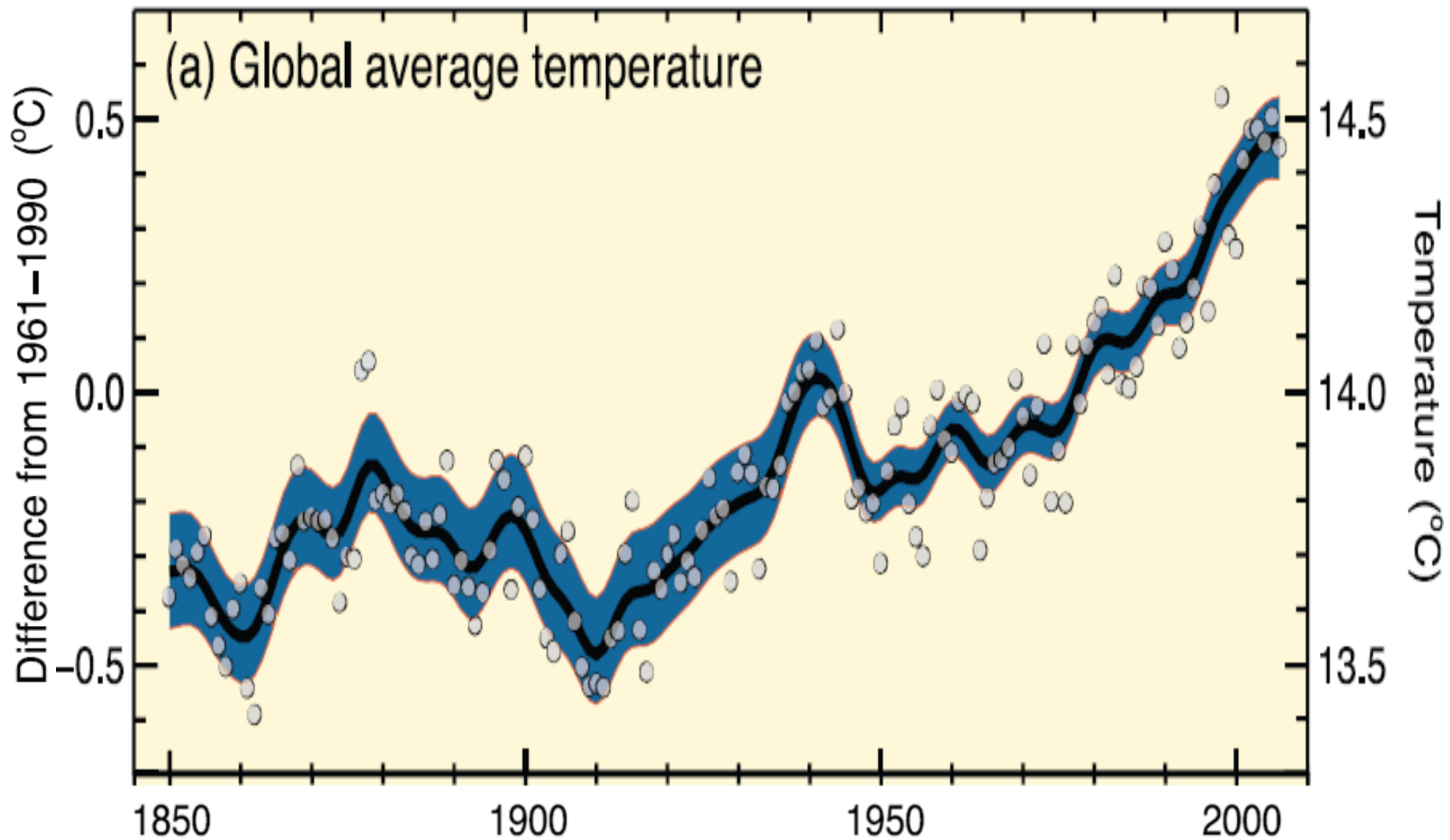
Why do we want to reduce carbon?

- **Global warming**
- **Air Pollution**
- **Energy security**

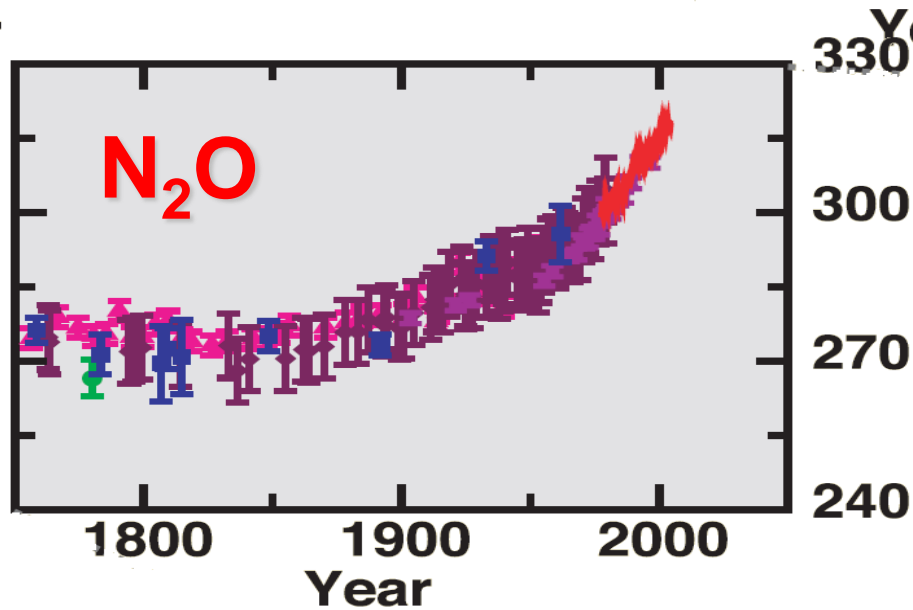
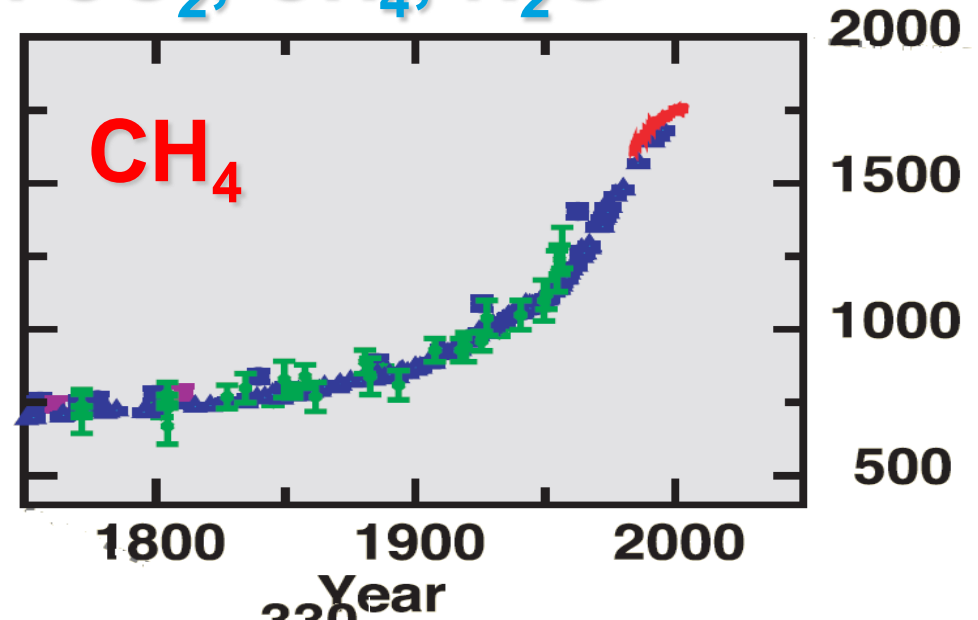
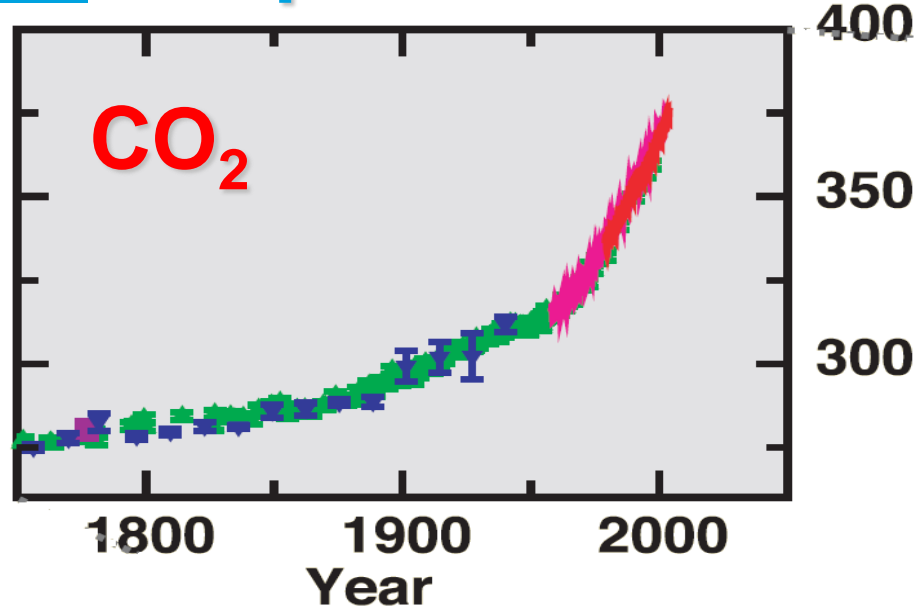
Outline

- **Science of climate change**
- **Energy demand and supply**
- **How can carbon be reduced?**
- **How do we estimate the effect of carbon?**
- **Summary**

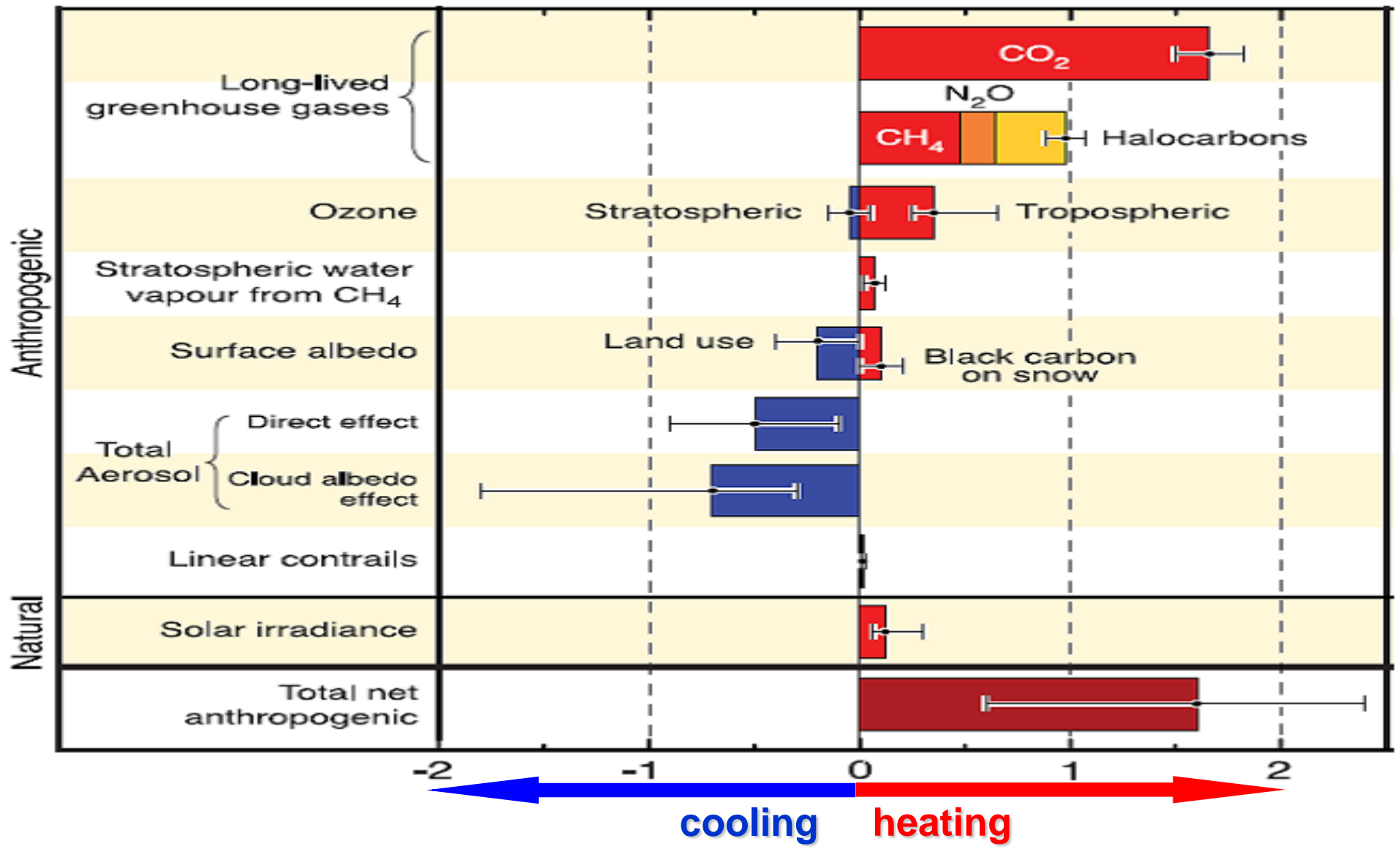
Temporal variations in global temperature



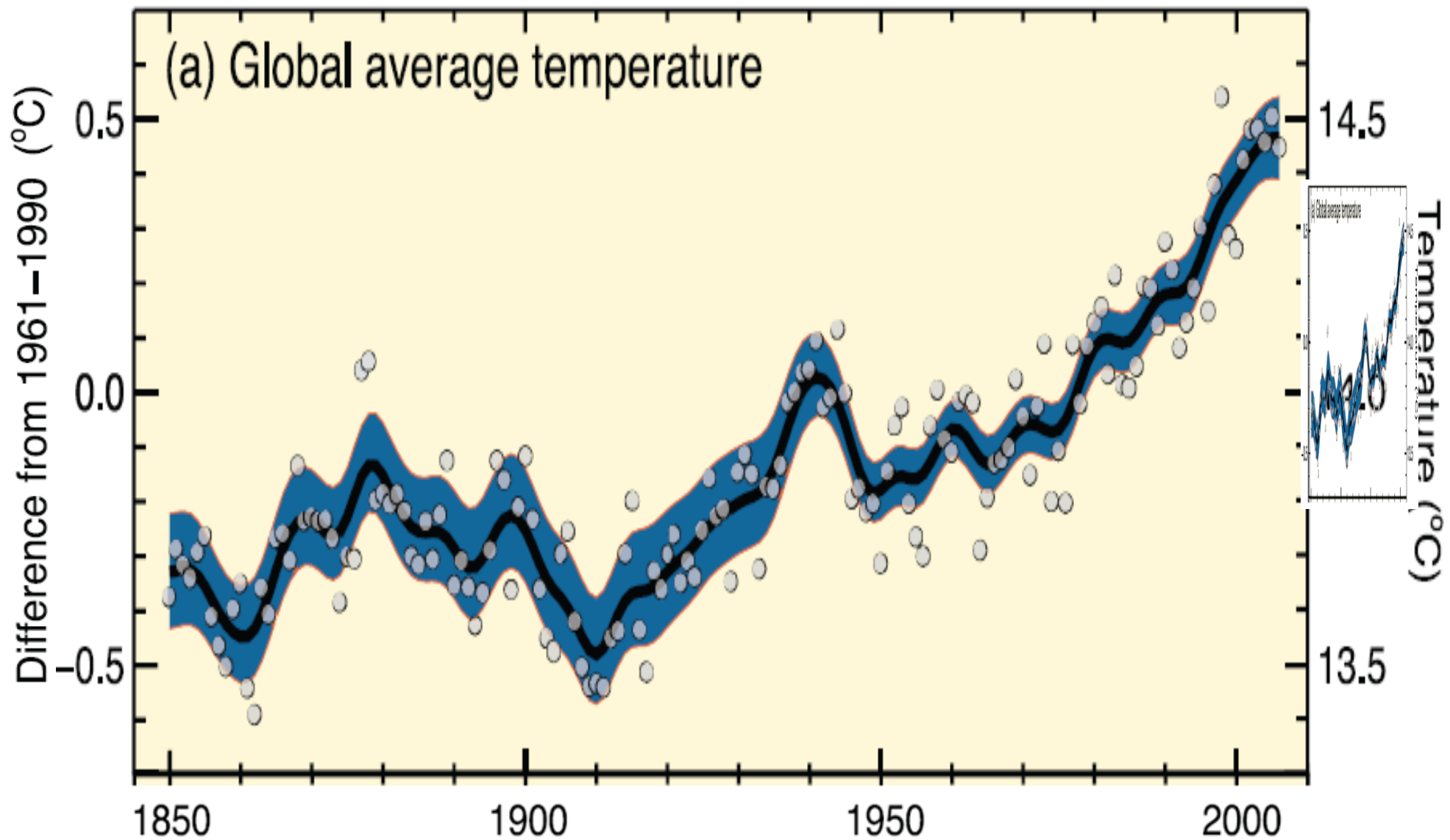
Temporal variations in CO₂, CH₄, N₂O



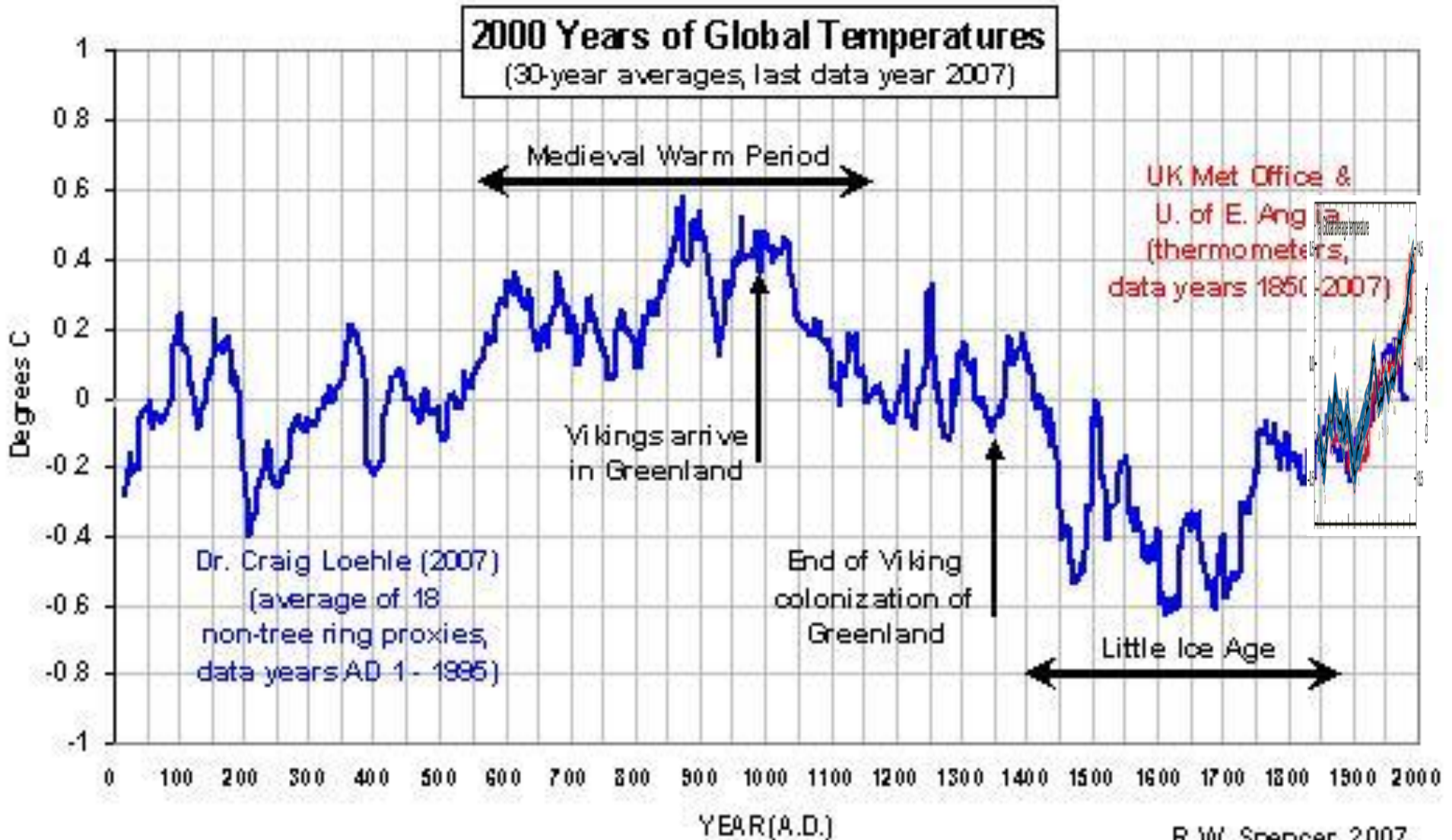
Components that cause heating/cooling of the atmosphere



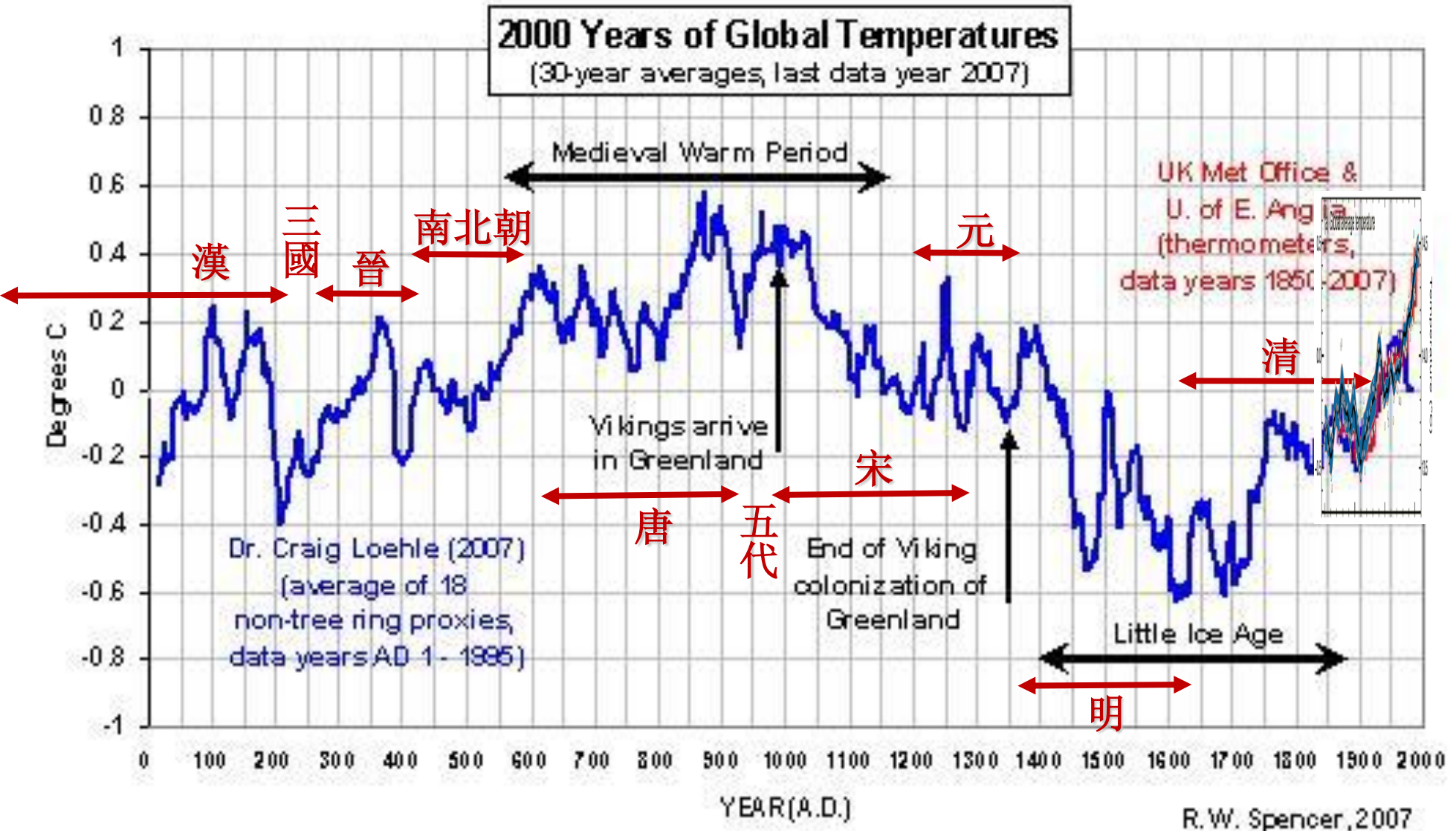
Temporal variations in global temperature



Temporal variations in global temperature

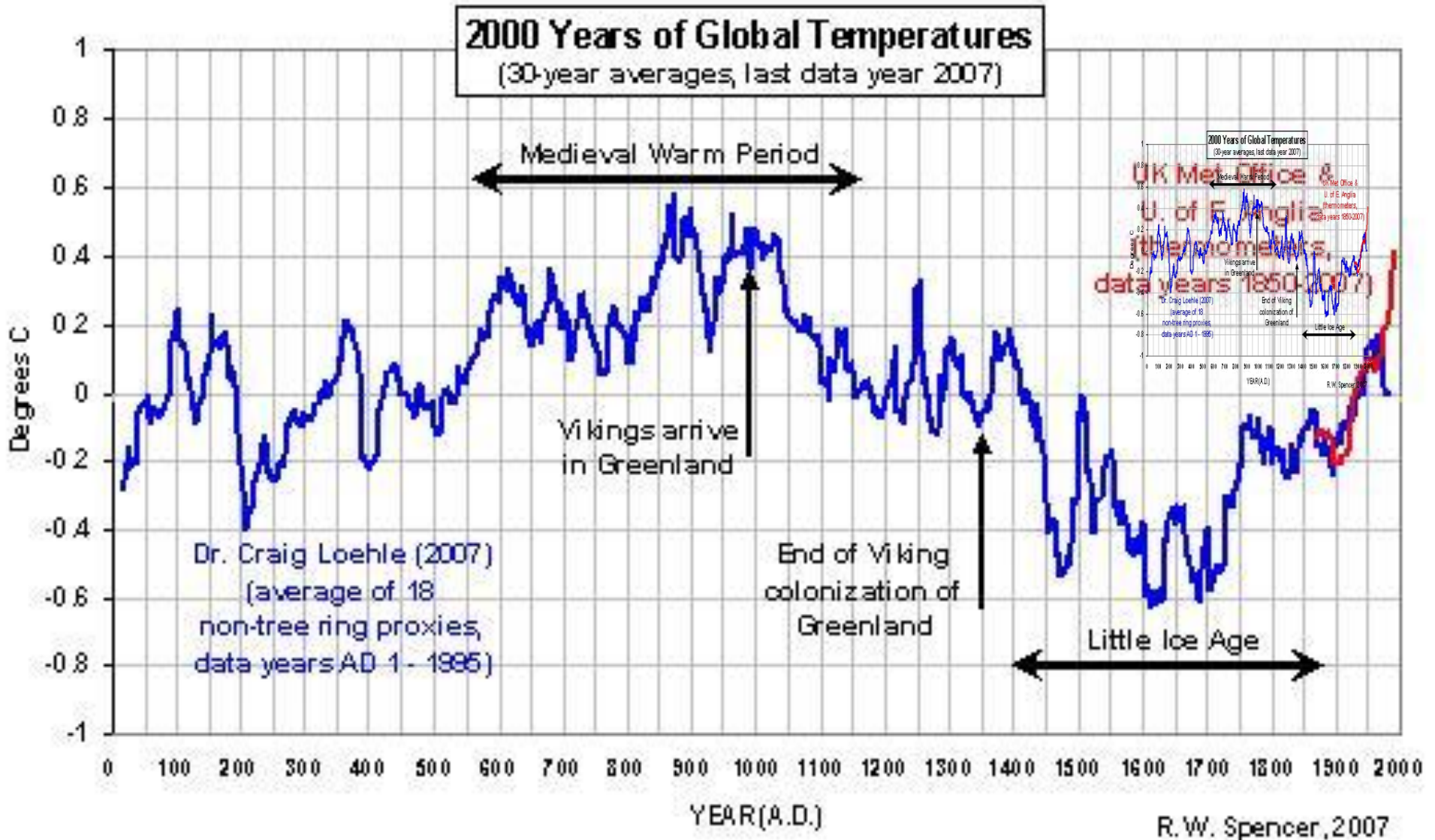


Temporal variations in global temperature

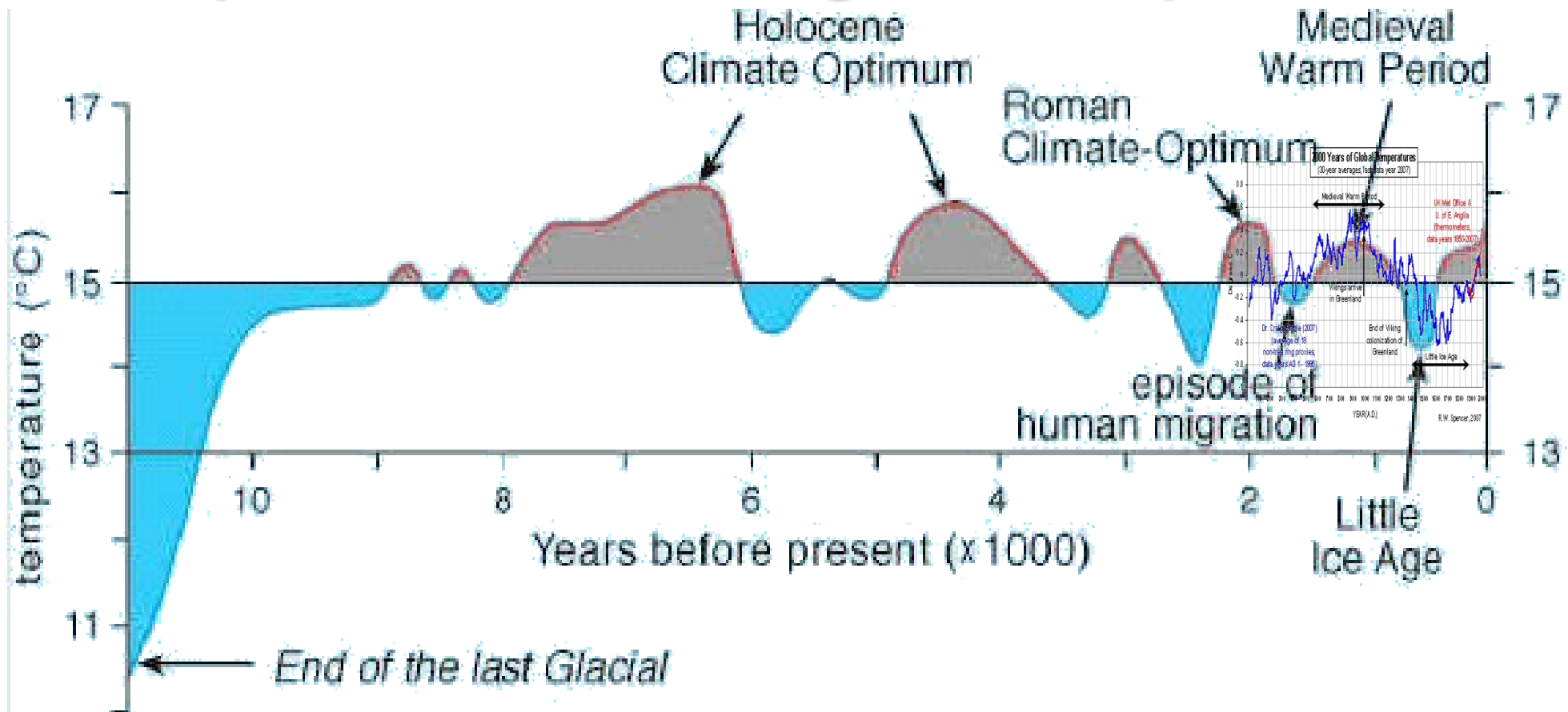


R.W. Spencer, 2007

Temporal variations in global temperature

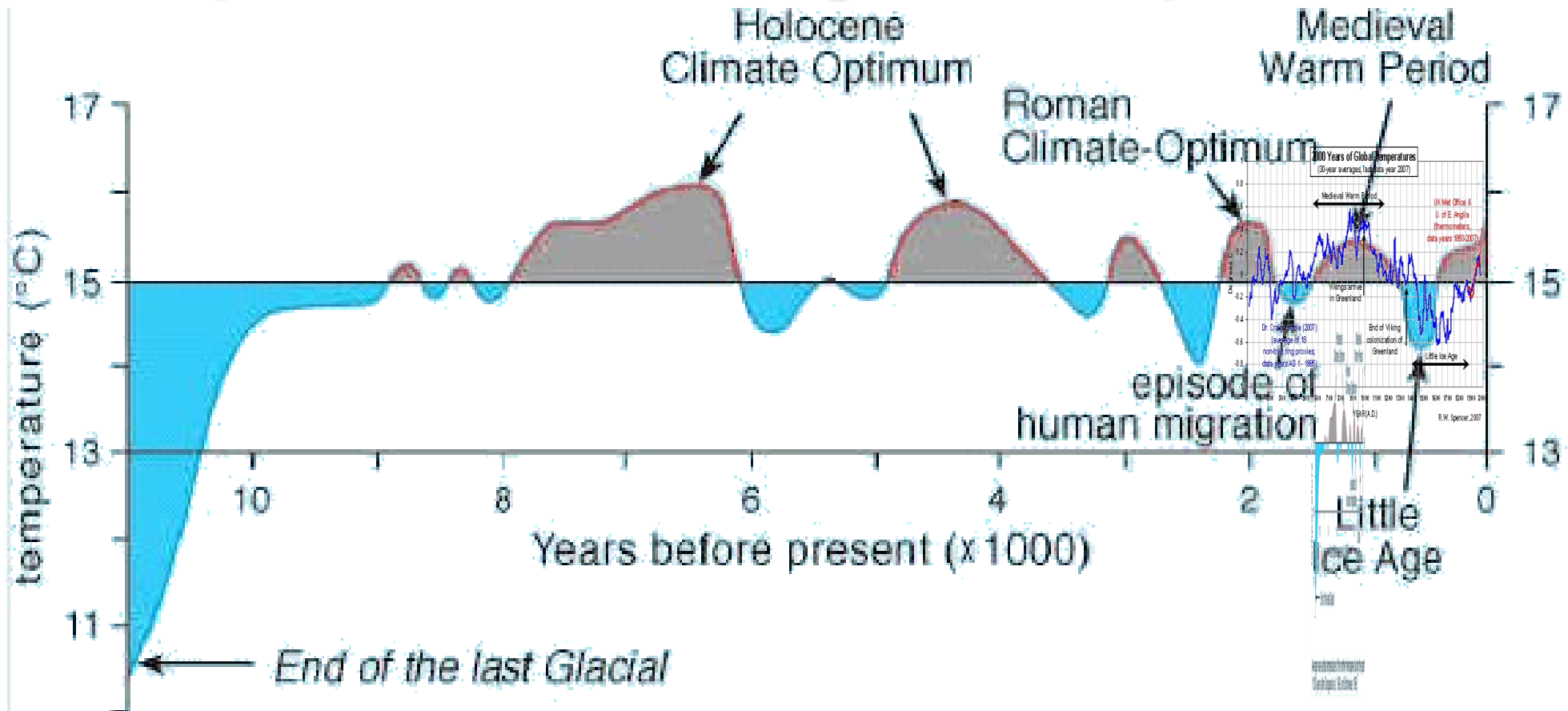


Temporal variations in global temperature



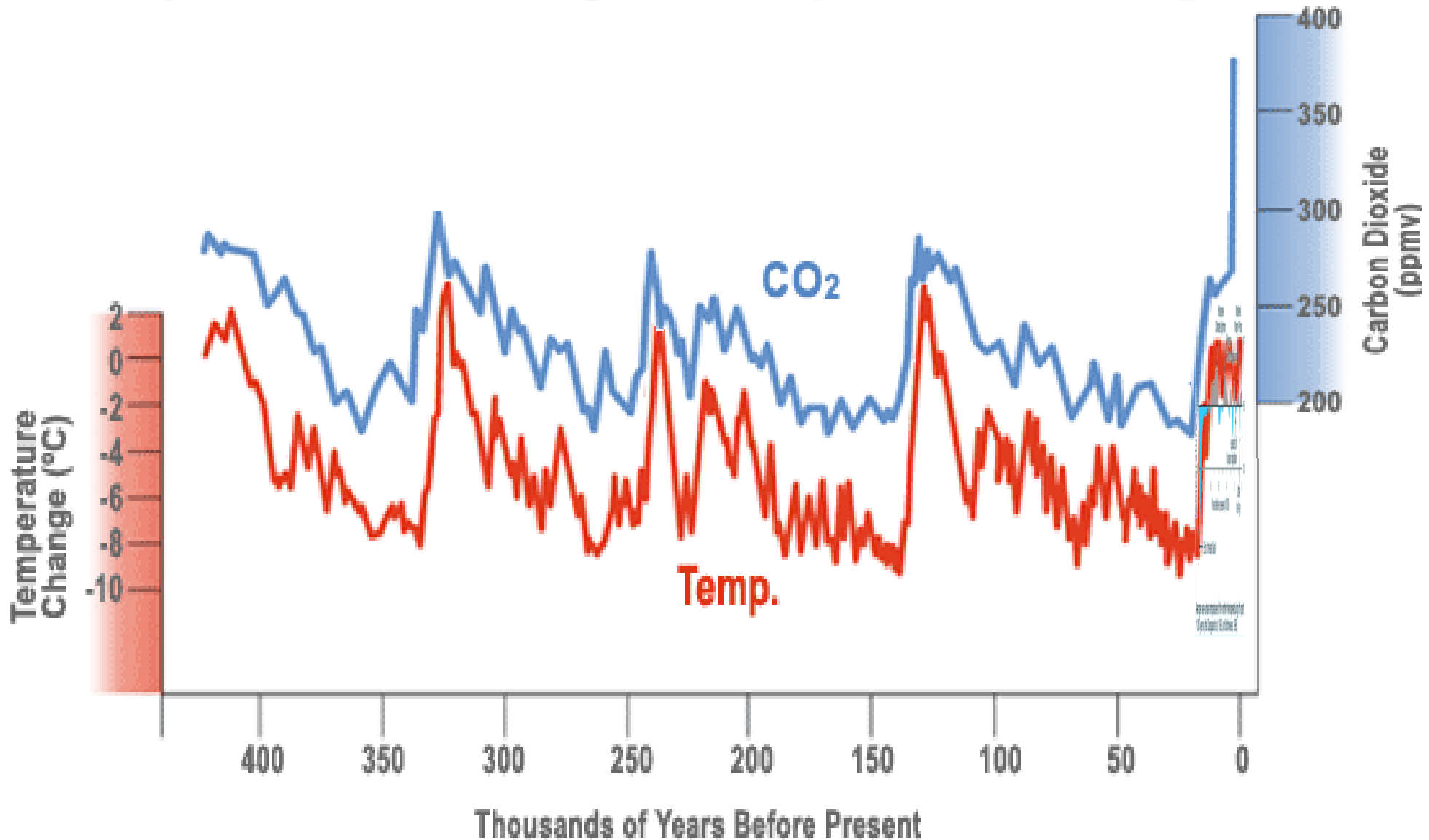
Average near-surface temperatures of the northern hemisphere during the past 11,000 years (after Dansgaard et al., 1969, and Schönwiese, 1995)

Temporal variations in global temperature



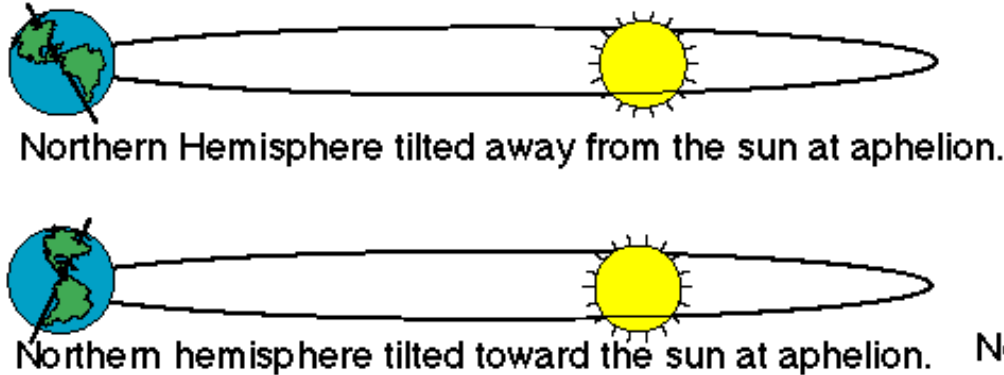
Average near-surface temperatures of the northern hemisphere during the past 11,000 years (after Dansgaard et al., 1969, and Schönwiese, 1995)

Temporal variations in global temperature and CO₂

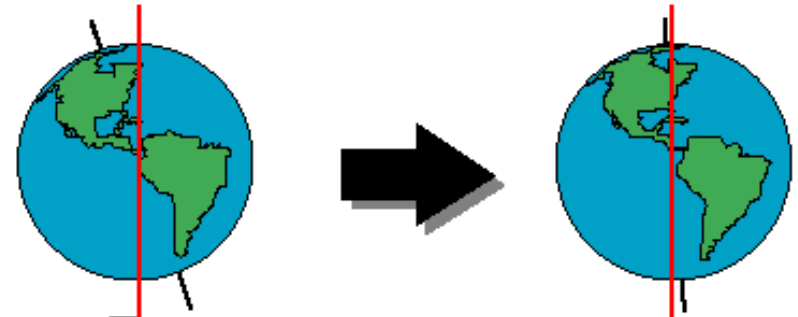


Milankovich cycles – variations of the orbital parameters

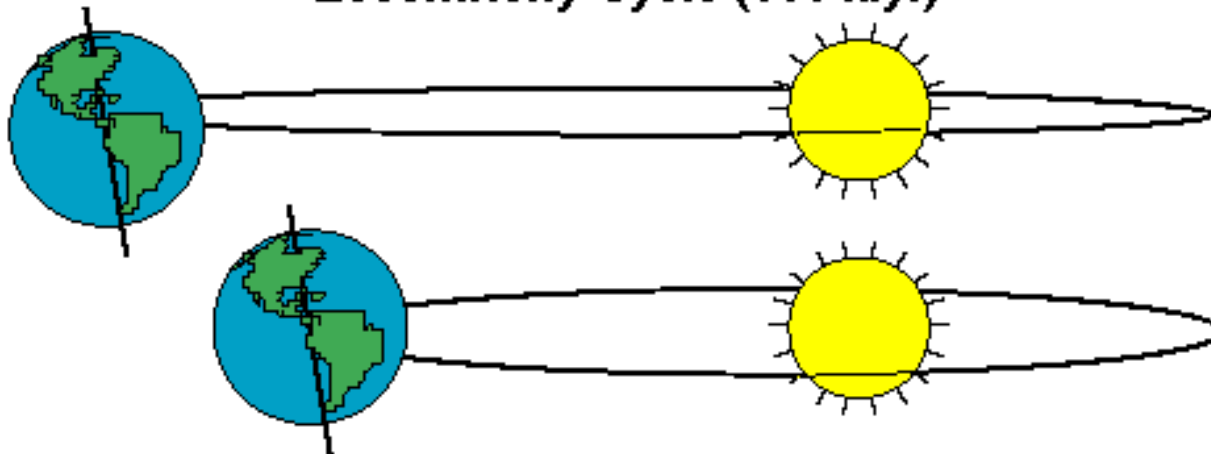
Precession of the Equinoxes (19 and 23 k.y.)



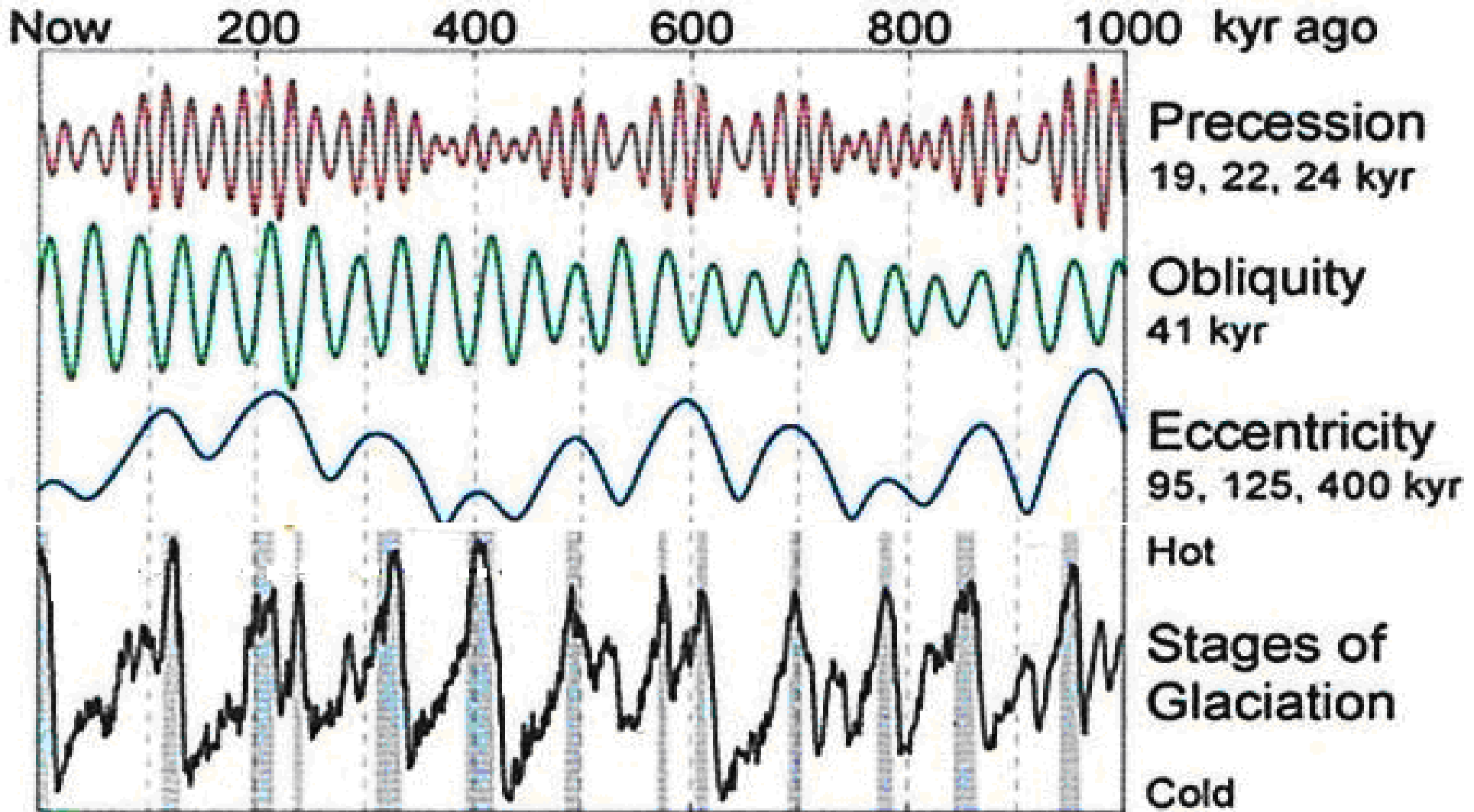
Obliquity Cycle (41 k.y.)



Eccentricity Cycle (100 k.y.)



Milankovitch cycles and glaciation



Hong Kong



Guangzhou



Urban Area vs. Farmland

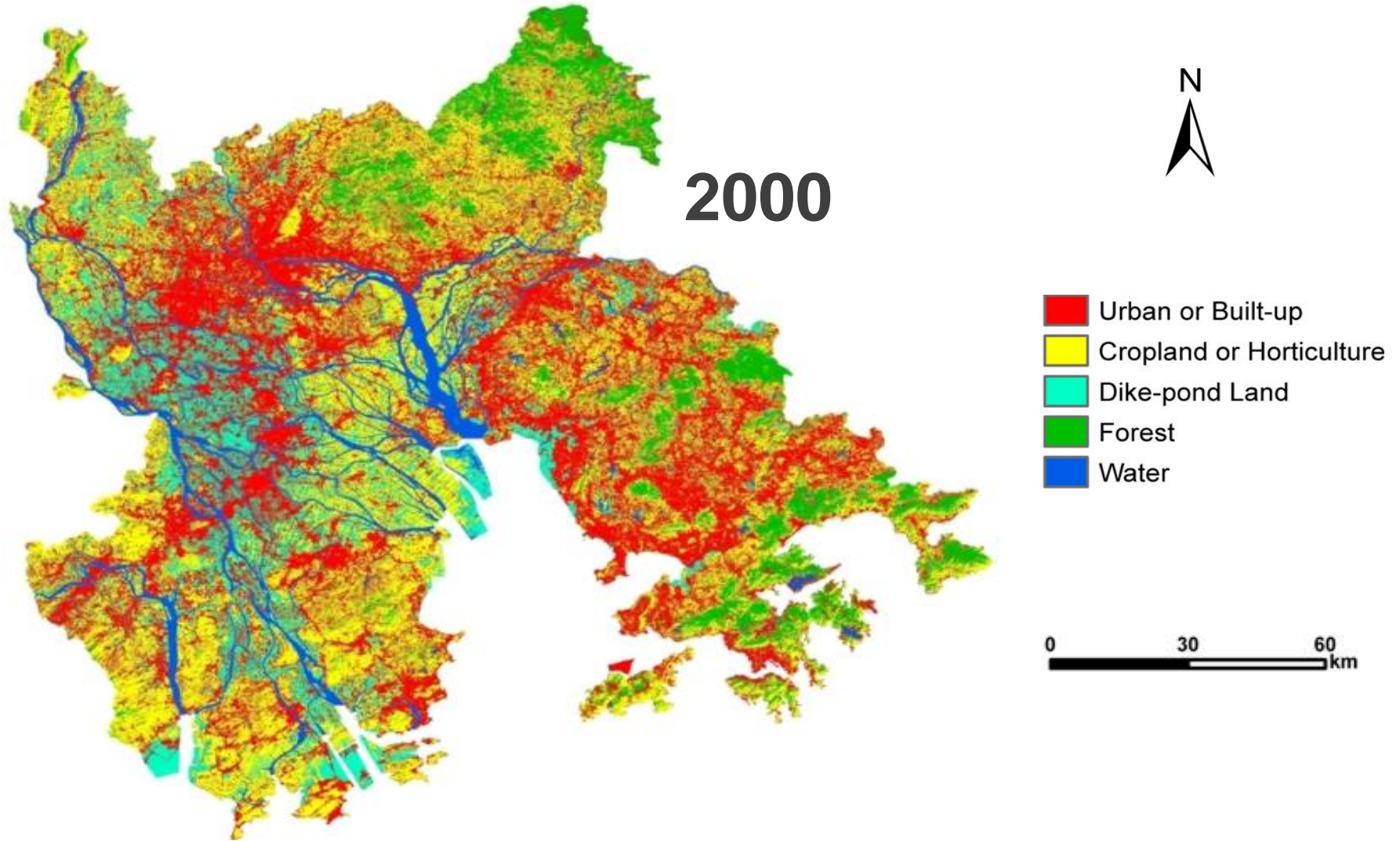
Shenzhen



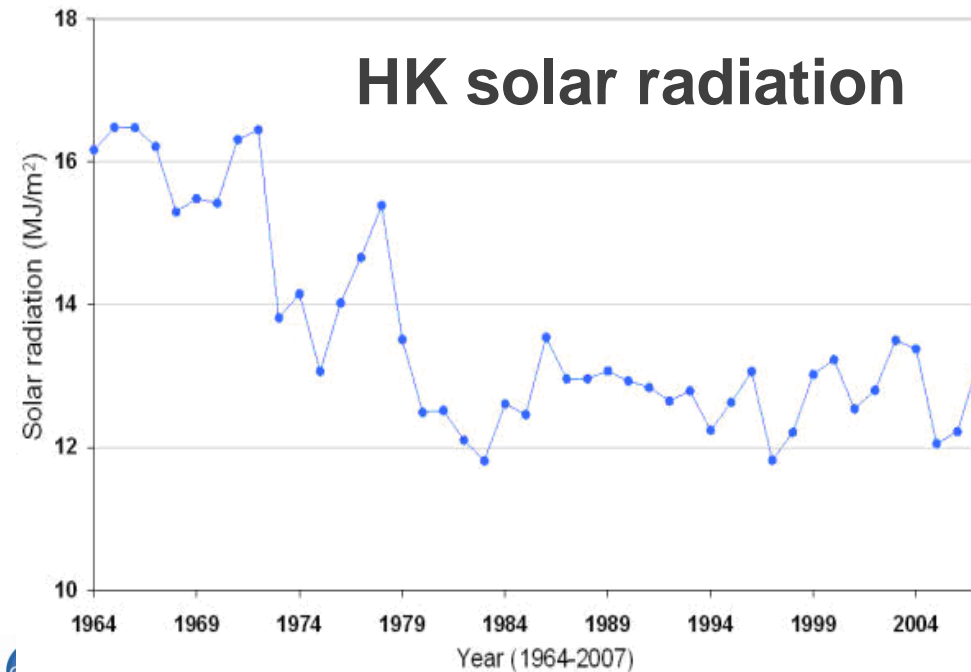
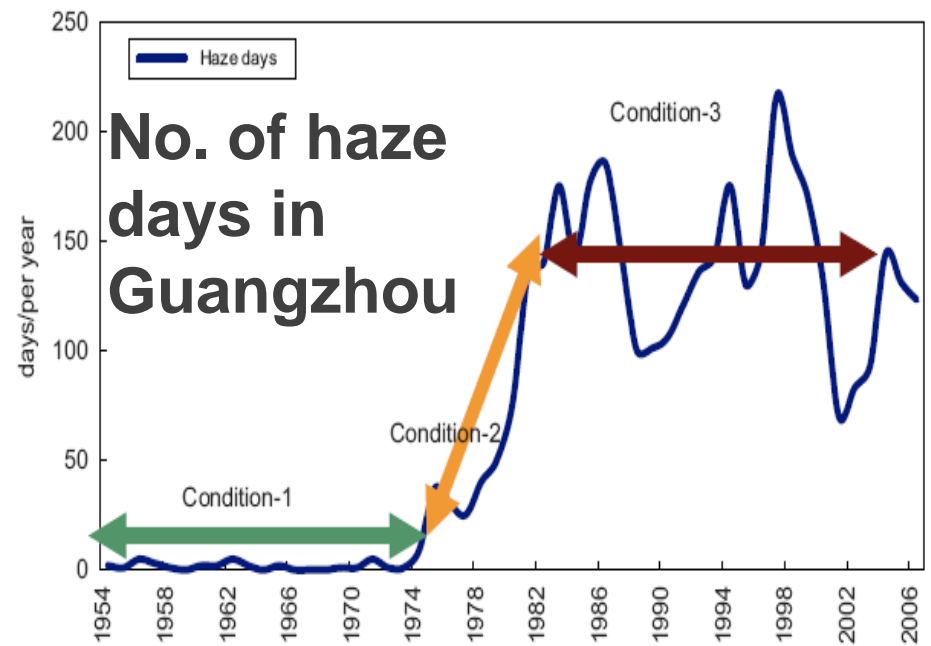
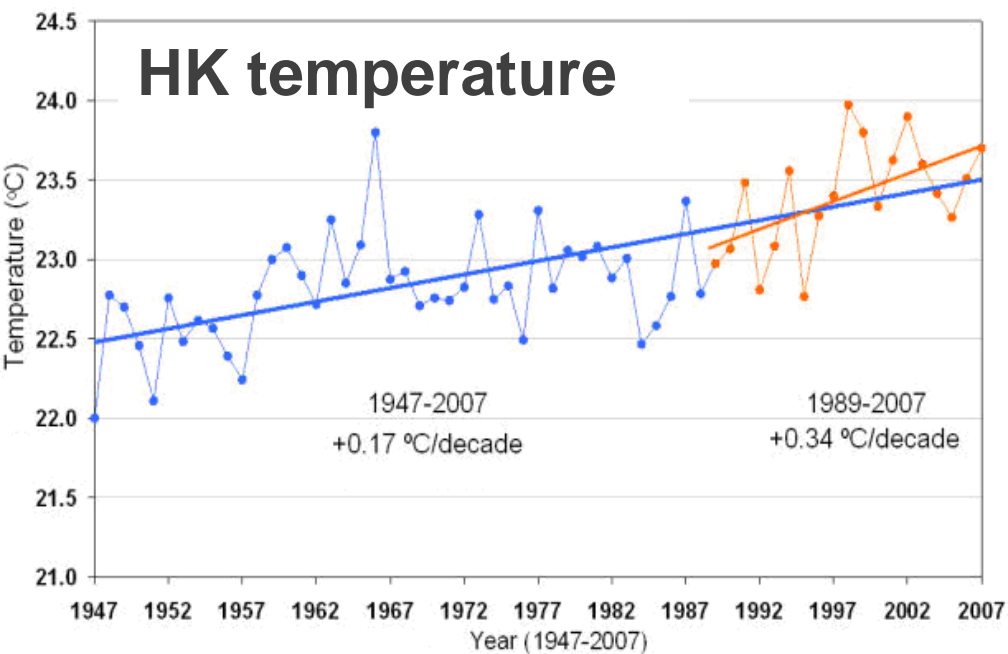
Farmland in Guangdong



Urban or Built-up Area in the Pearl River Delta

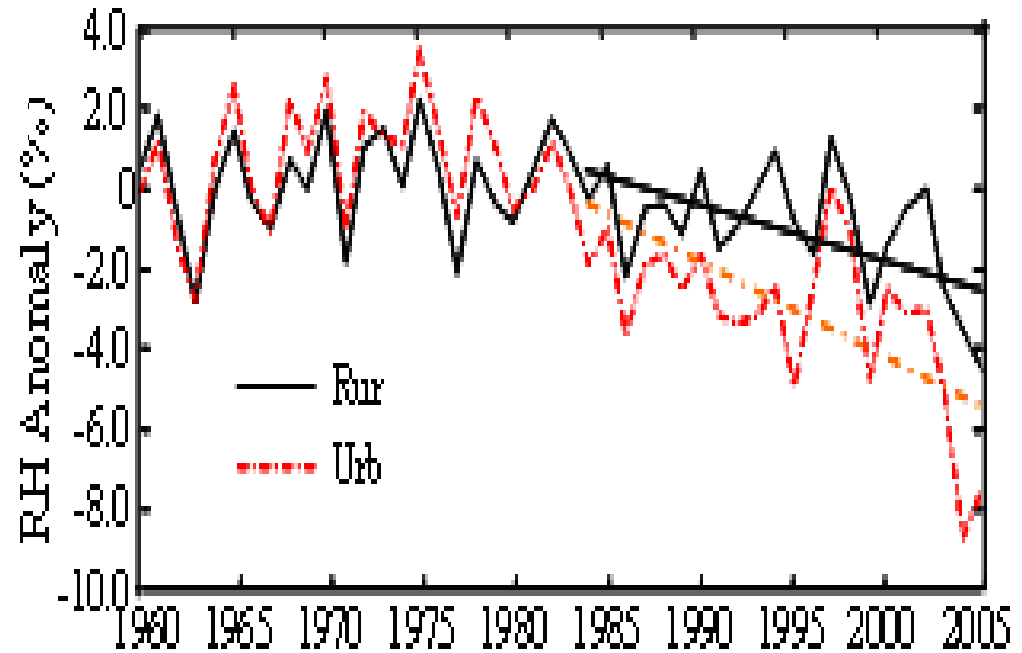


Year :	1980	→	1990	→	2000
Urban or Built-up (km ²) :	2230	→	3950	→	6570

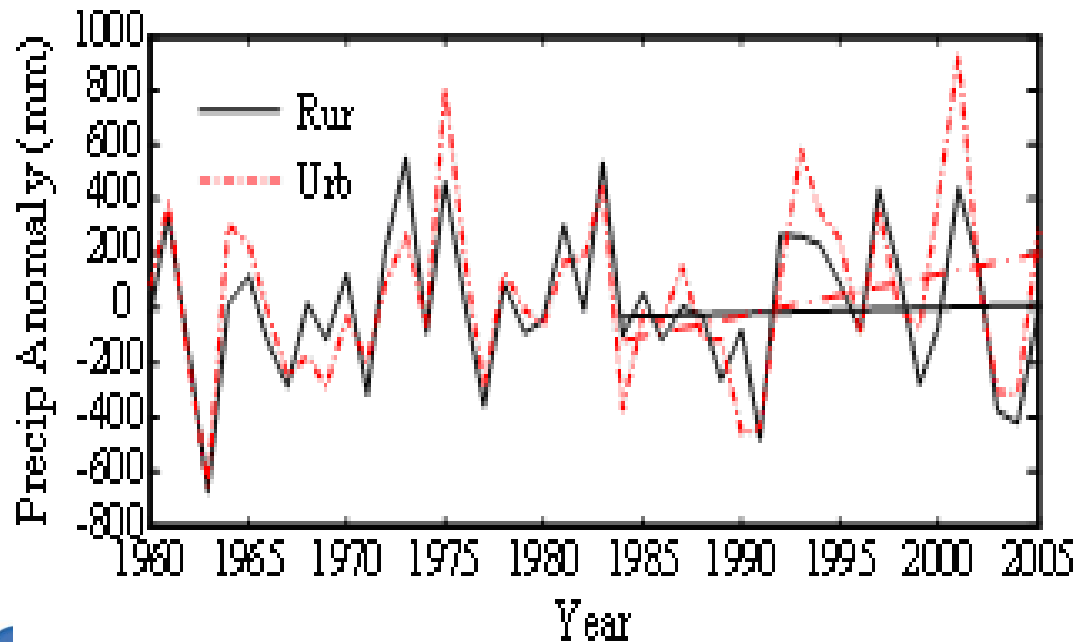


**Climate Change
in the PRD
(related to
radiation)**

PRD relative humidity

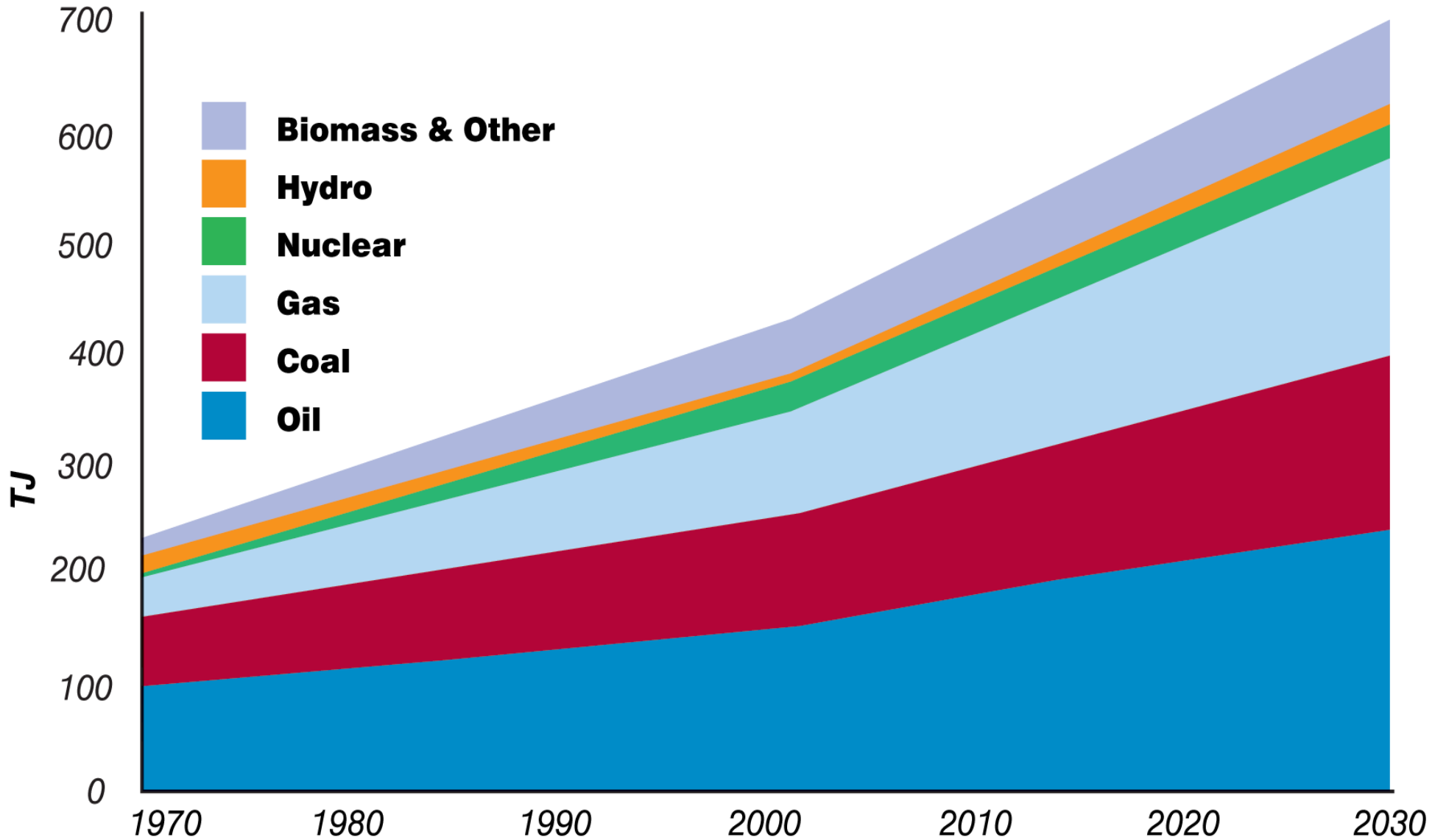


PRD rainfall

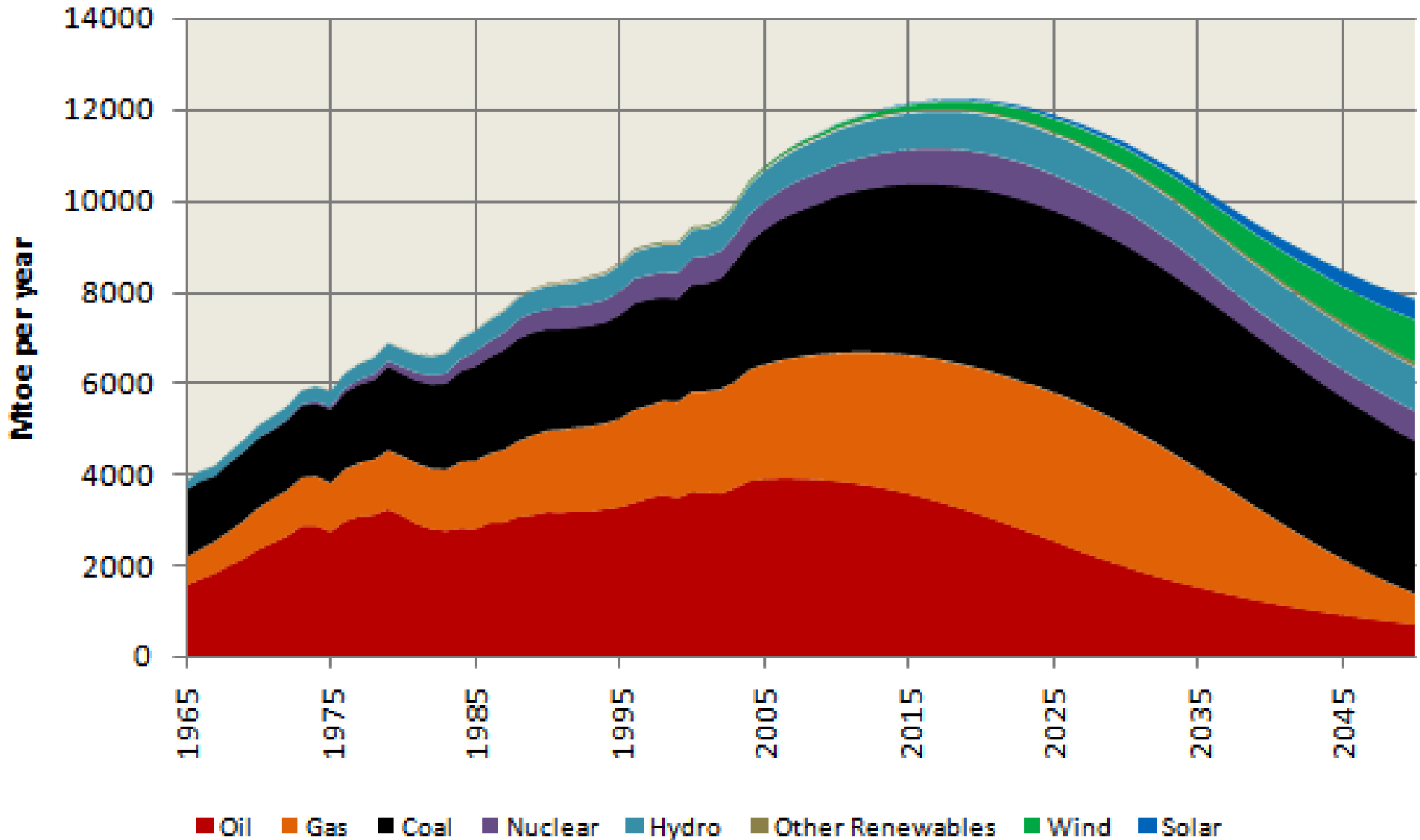


**Climate Change
and Urbanization
in the PRD
(related to water)**

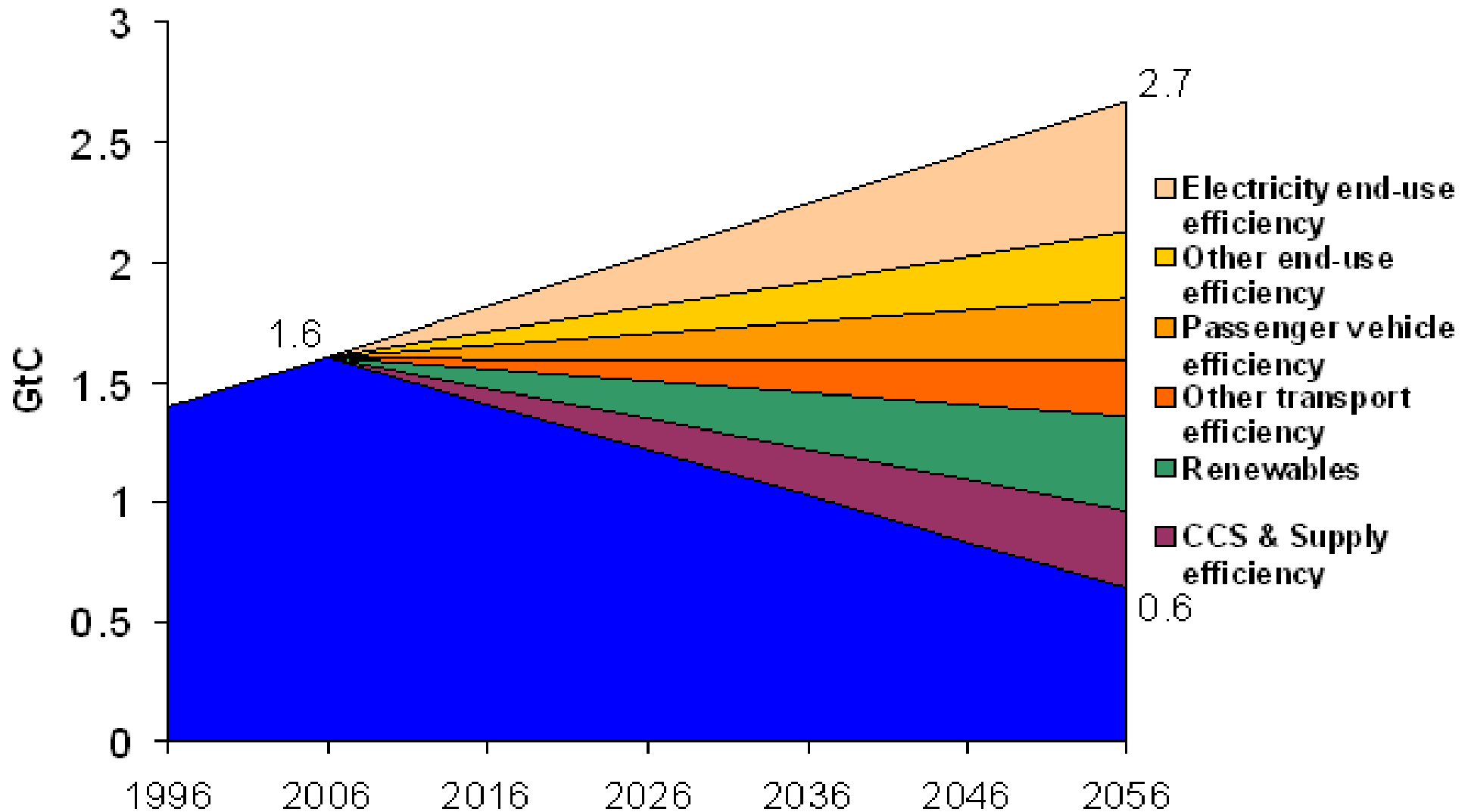
World energy demand



World energy supply

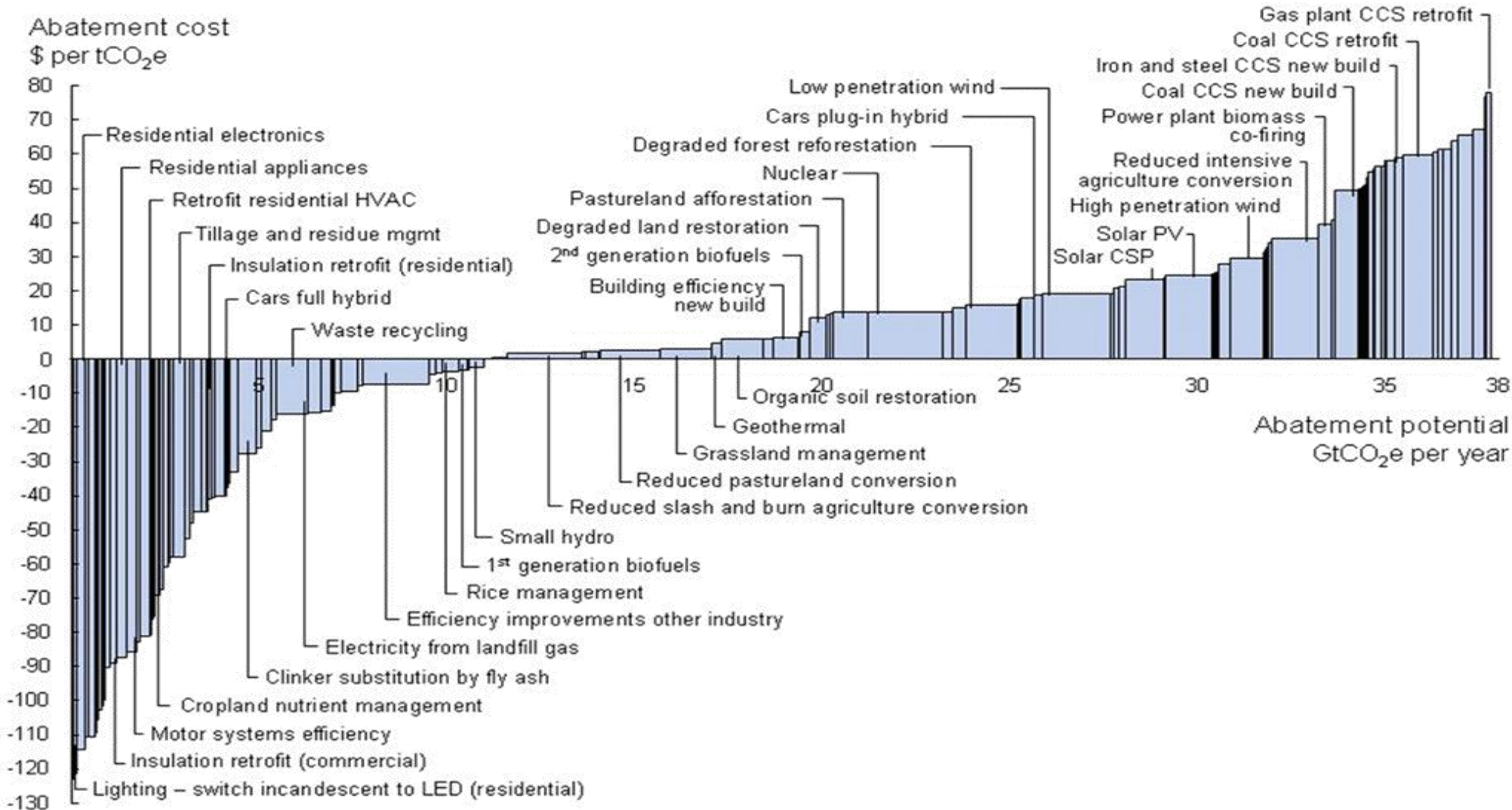


Stabilisation wedges



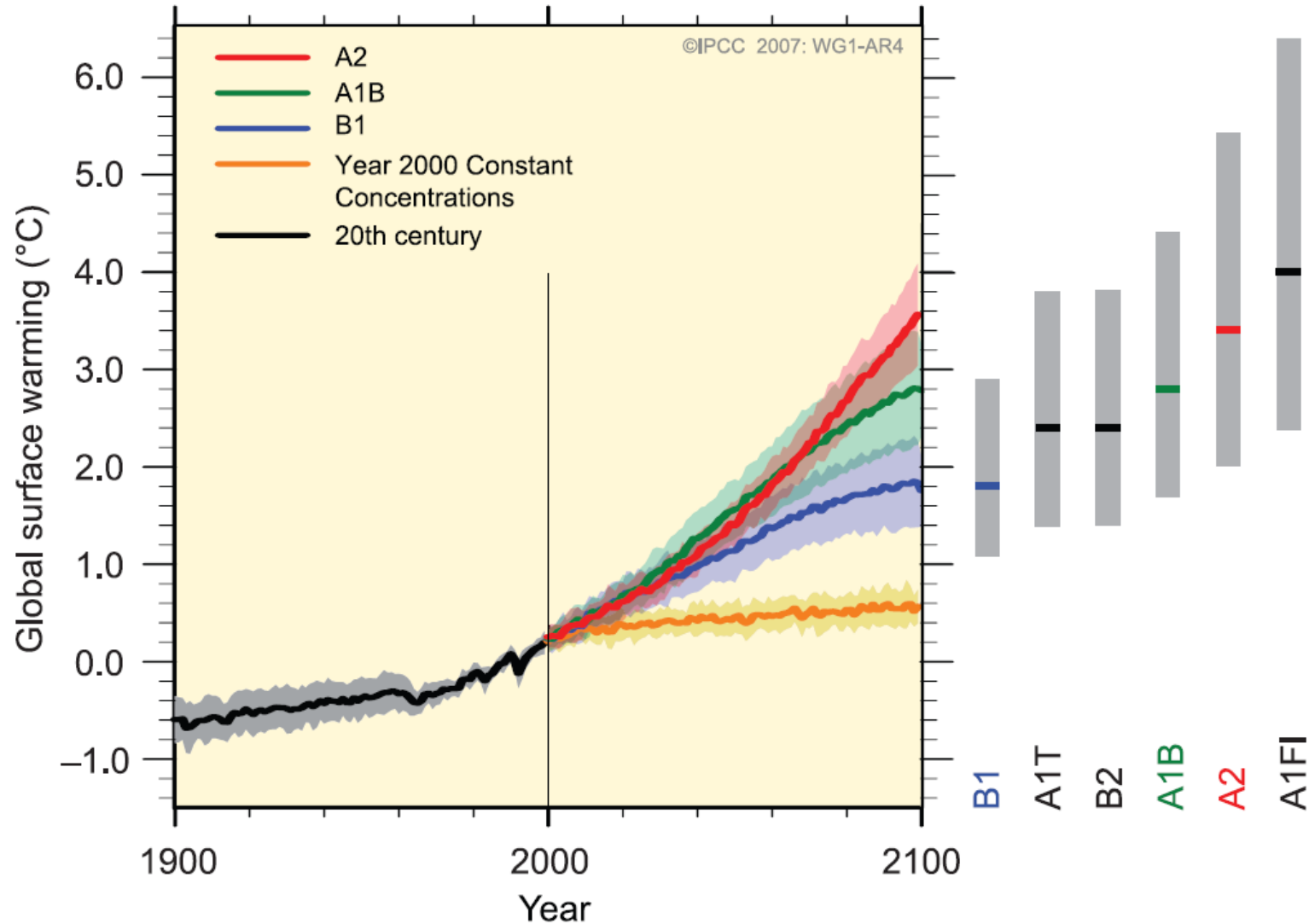
Abatement cost curve

Global GHG abatement cost curve beyond business-as-usual, 2030

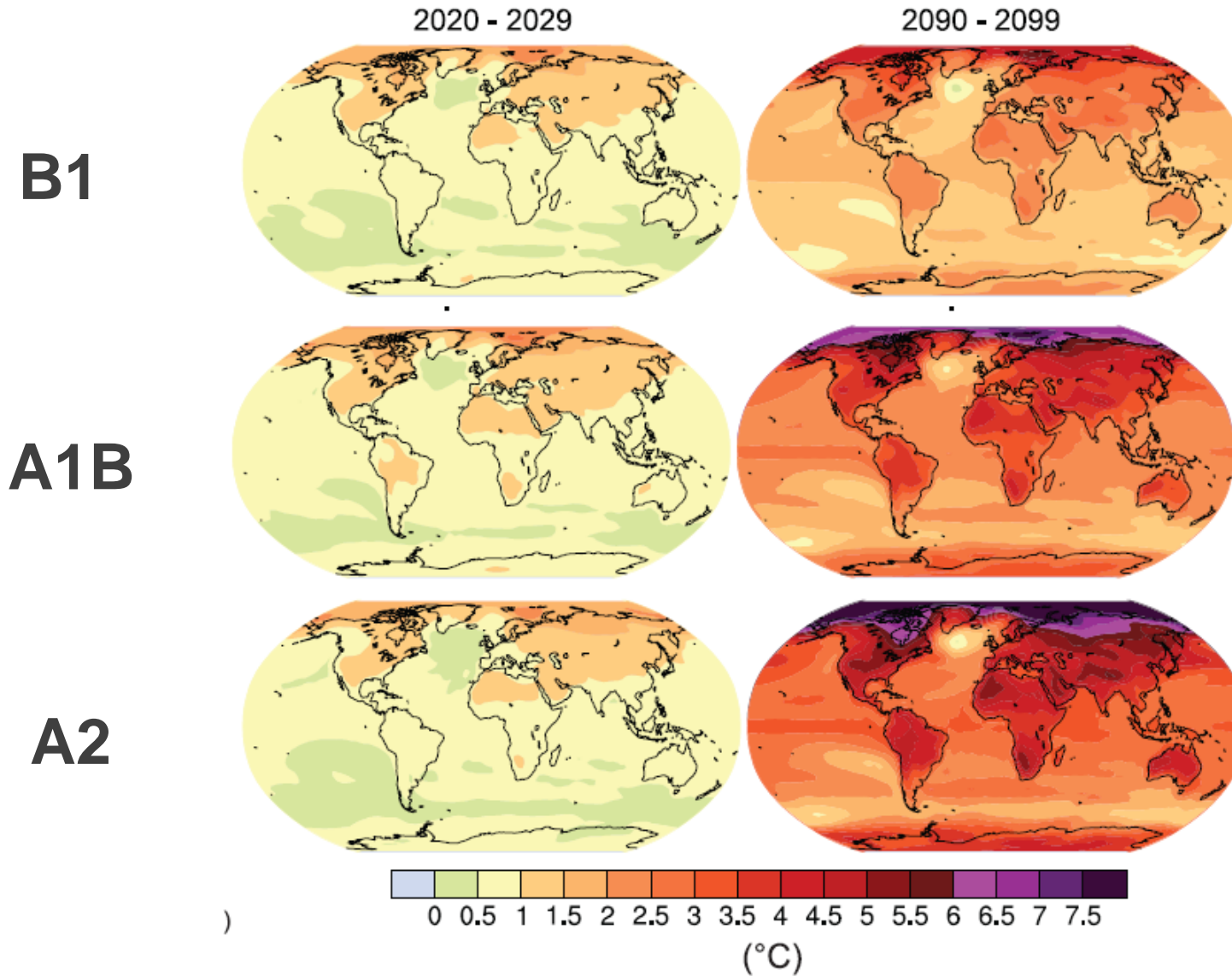


Temperature projection for the 21st century

MULTI-MODEL AVERAGES AND ASSESSED RANGES FOR SURFACE WARMING



Temperature projection for the 21st century

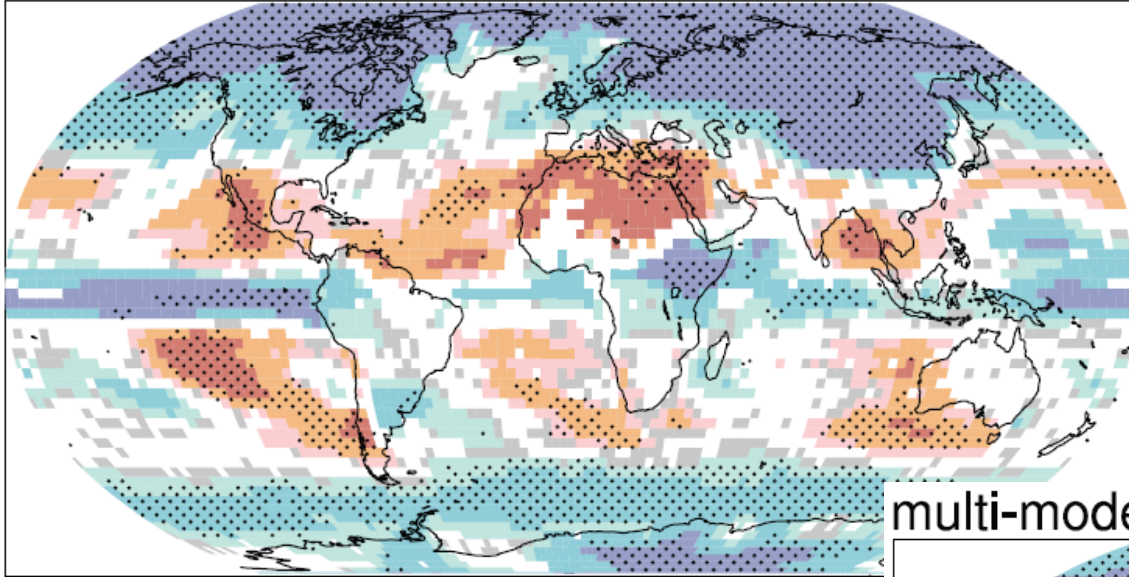


Precipitation projection for the 21st century

multi-model

A1B

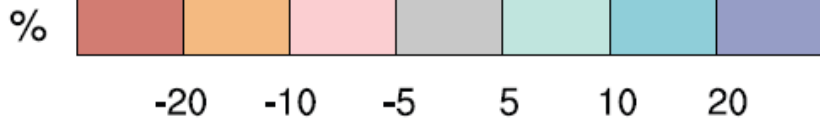
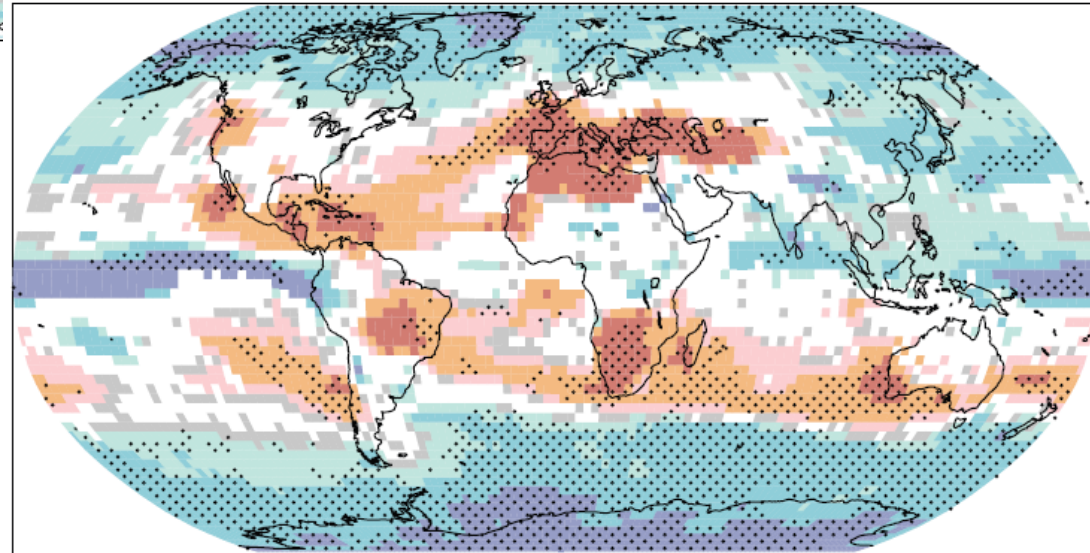
DJF



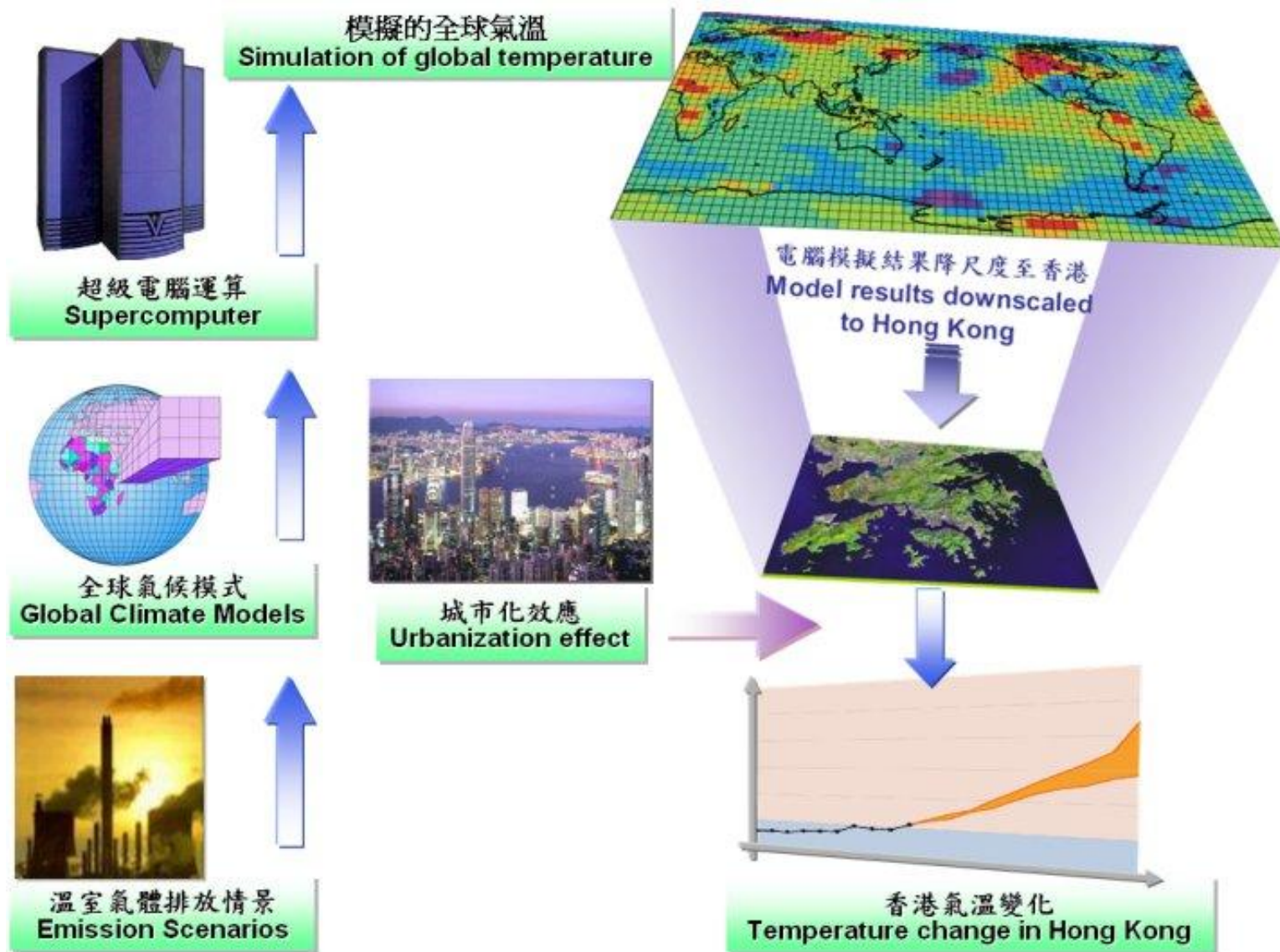
multi-model

A1B

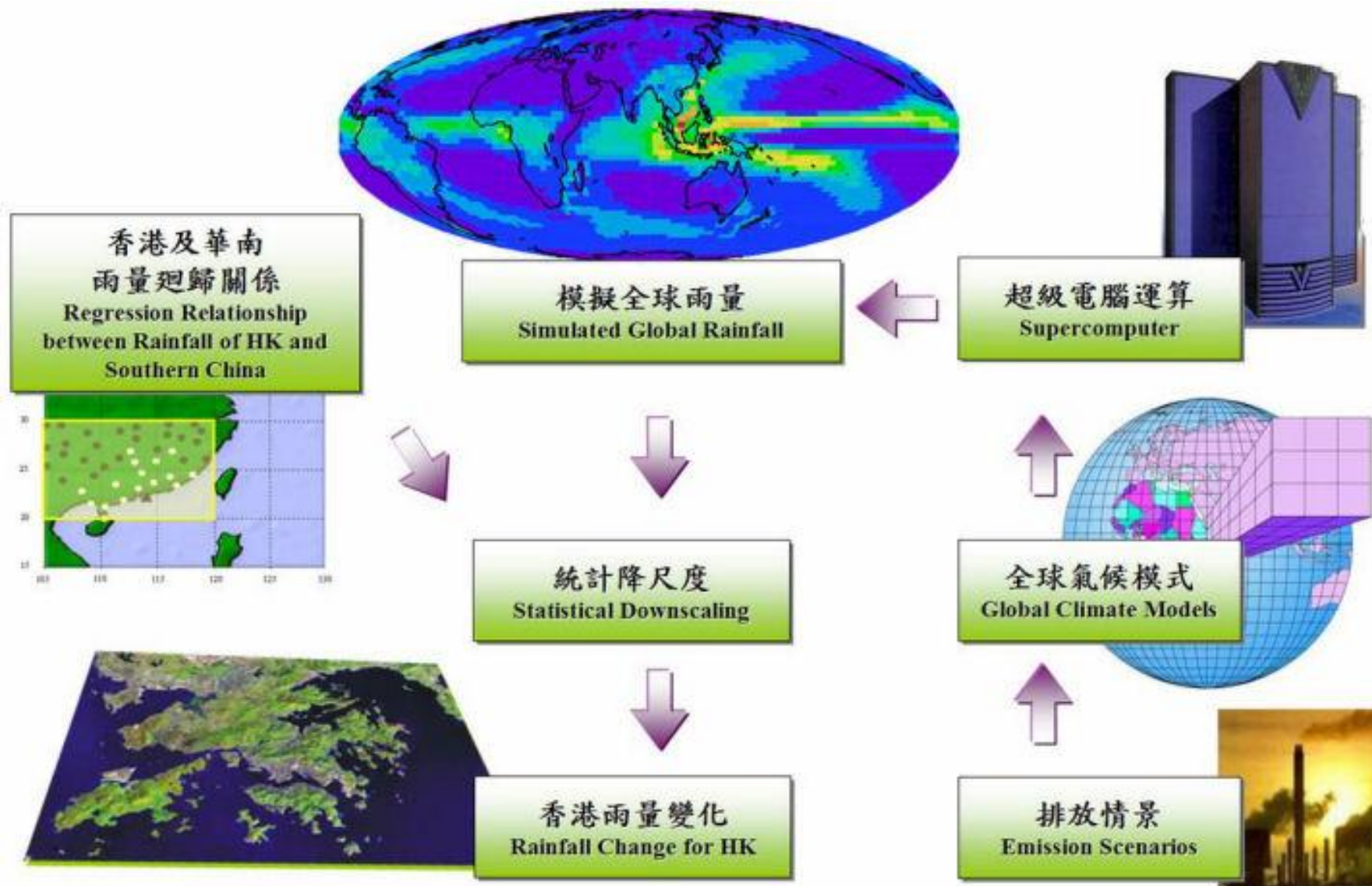
JJA



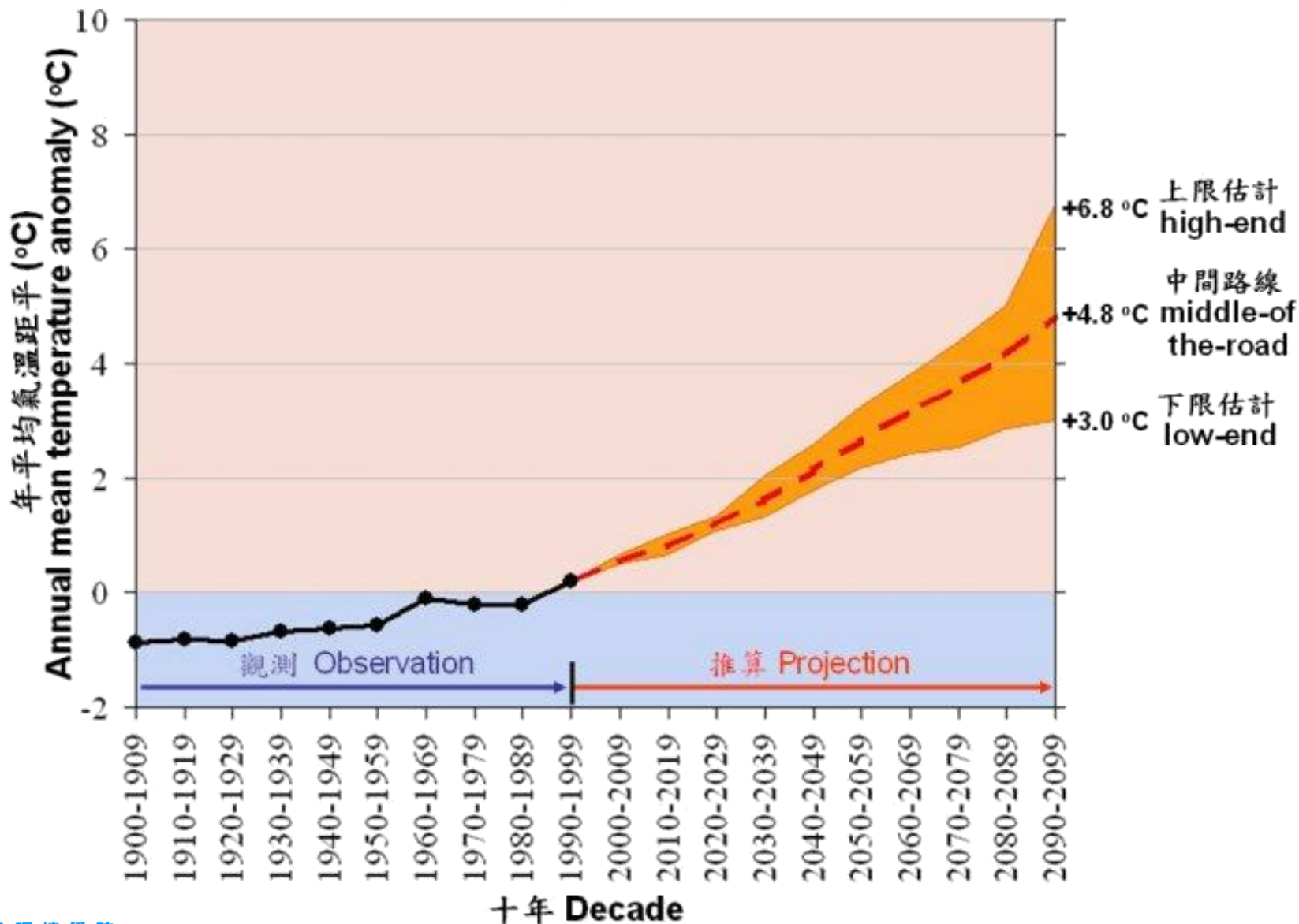
Statistical downscaling



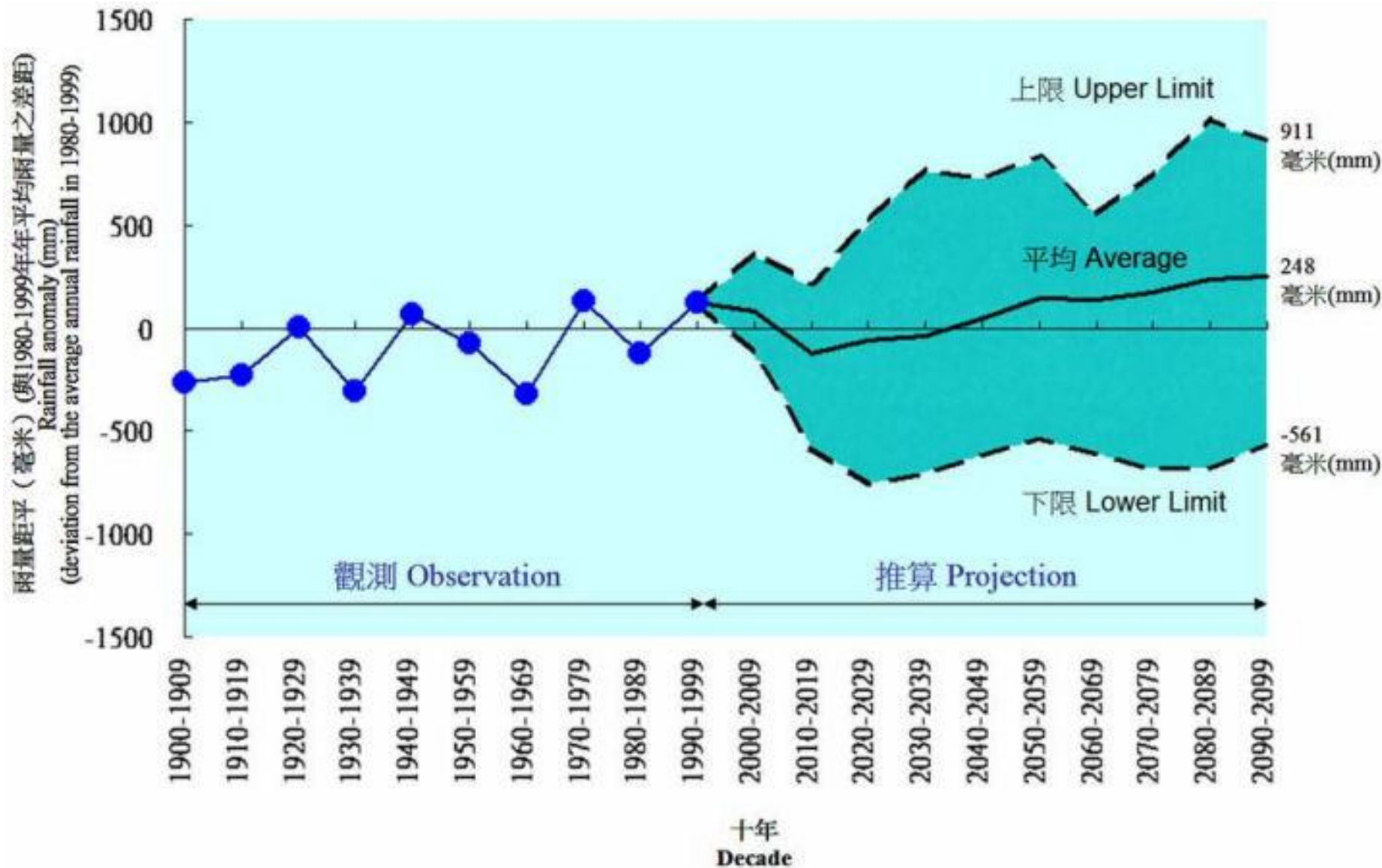
Statistical downscaling



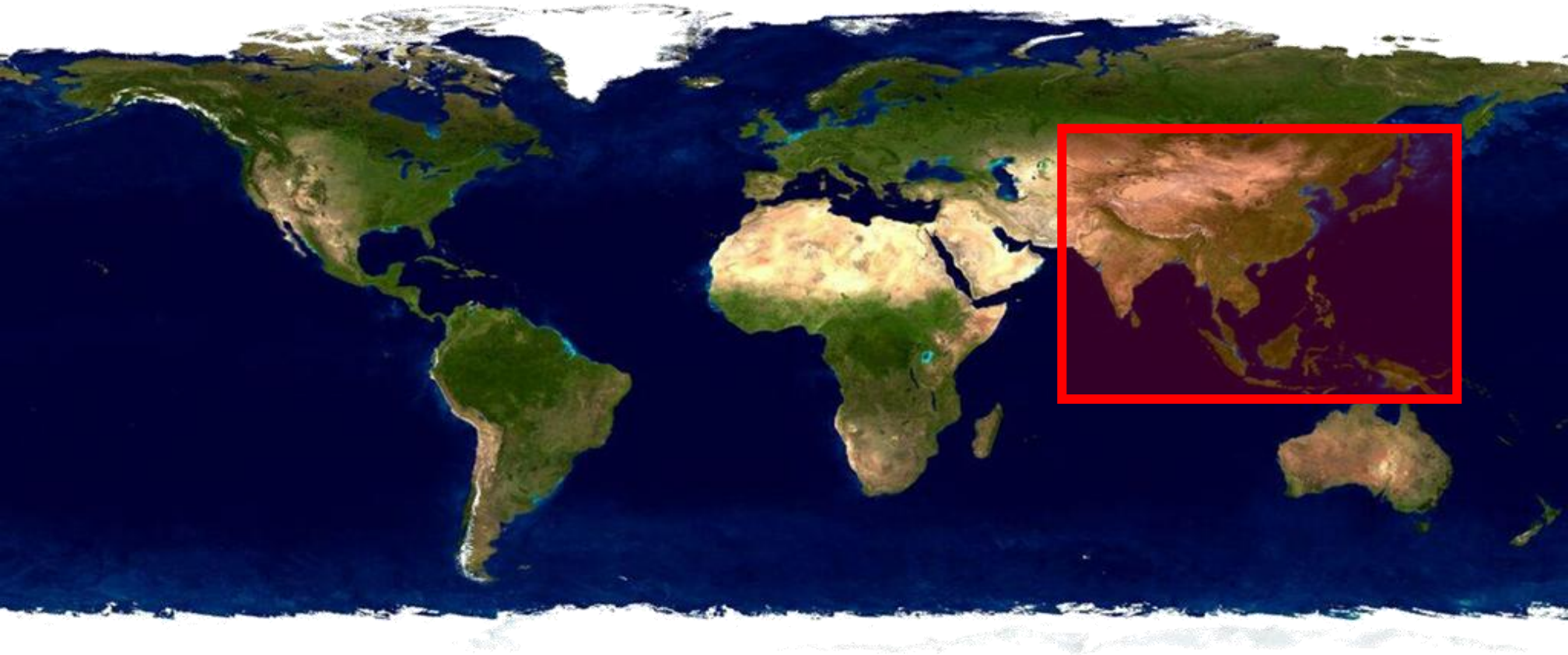
Statistical downscaling – Hong Kong temperature



Statistical downscaling – Hong Kong Rainfall

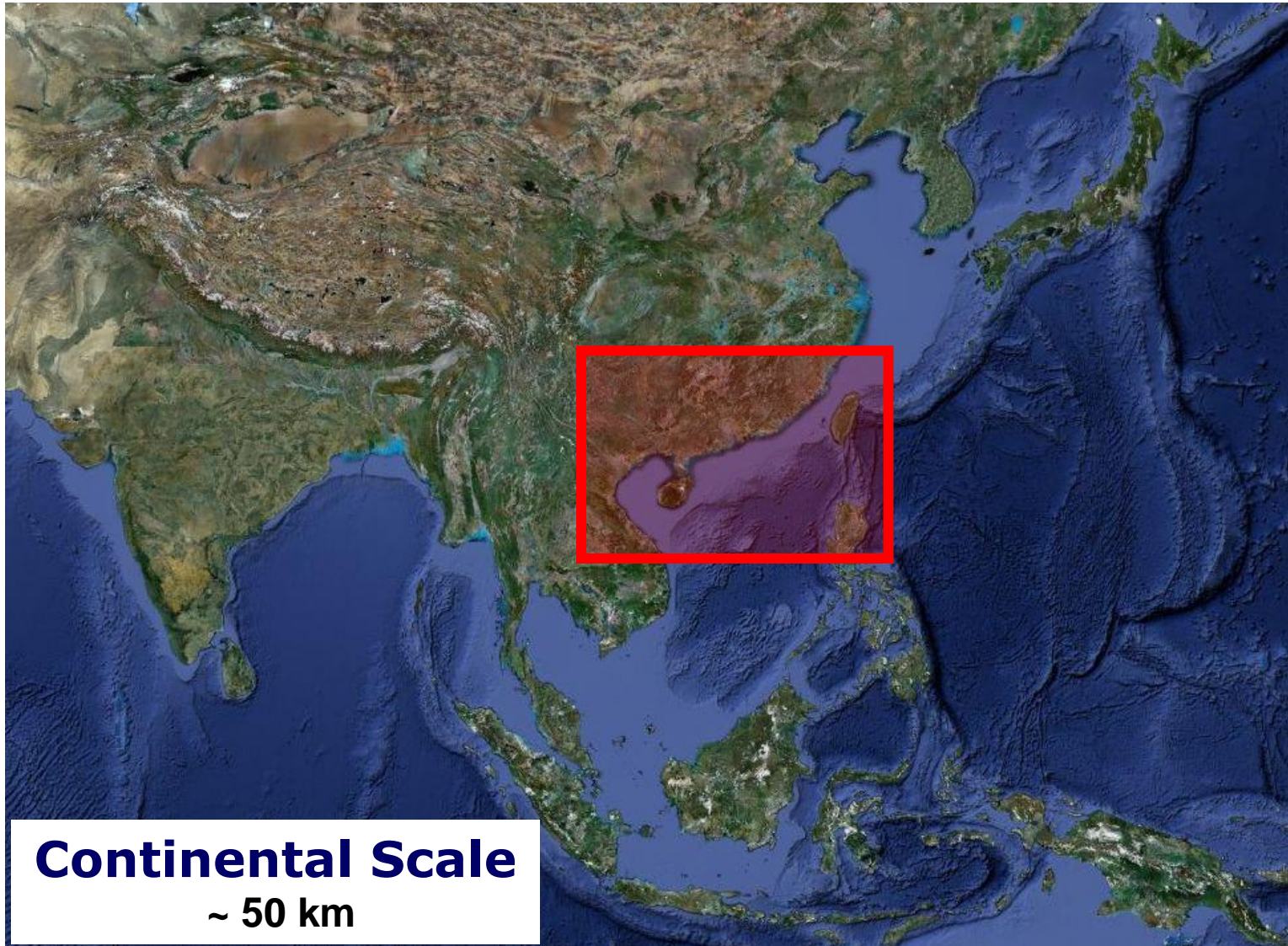


Dynamical downscaling



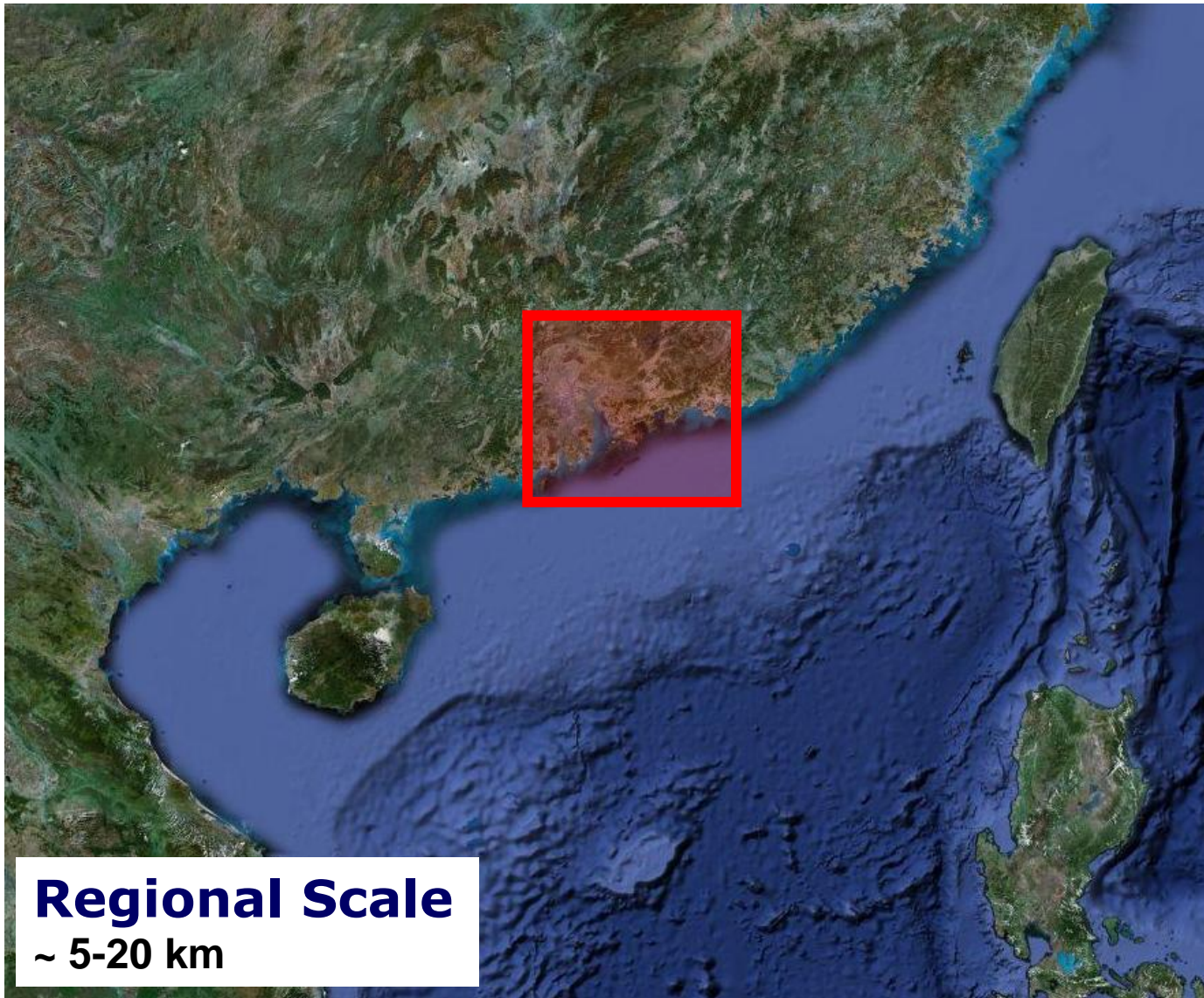
Global Scale, ~ 200 km

Dynamical downscaling



Continental Scale
~ 50 km

Dynamical downscaling



Dynamical downscaling



Local Scale
~ 1-3 km

Dynamical downscaling

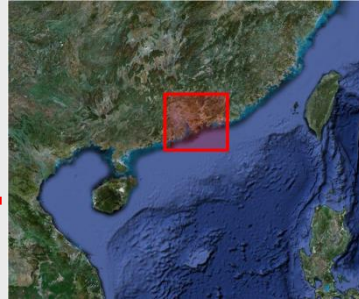
➤ **Global Scale, ~ 200 km**



➤ **Continental Scale, ~ 50 km**



➤ **Regional Scale, ~5-20 km**



➤ **Local Scale, ~ 1-3 km**



Forcings

greenhouse forcing

vegetation loss

urbanization

local climate change projections

Summary

- **Global temperatures have been on the rise during the last 100 years or so, at a rate which is faster than the natural cycle and therefore suggests that non-natural (i.e. anthropogenic) contributions are significant.**
- **Anthropogenic contributions are mainly in the form of a significant increase in greenhouse gases.**
- **Emission of aerosols in urbanized areas will modify the local climate.**

Summary

- **Because energy demand will continue to rise while fossil supplies decrease, the only way to ensure energy security as well as to mitigate the direct and indirect effects of global warming is to use alternate energy sources.**
- **Estimations of the effects of climate change at a specific location with different carbon reduction levels requires the use of statistical or numerical downscaling methods.**