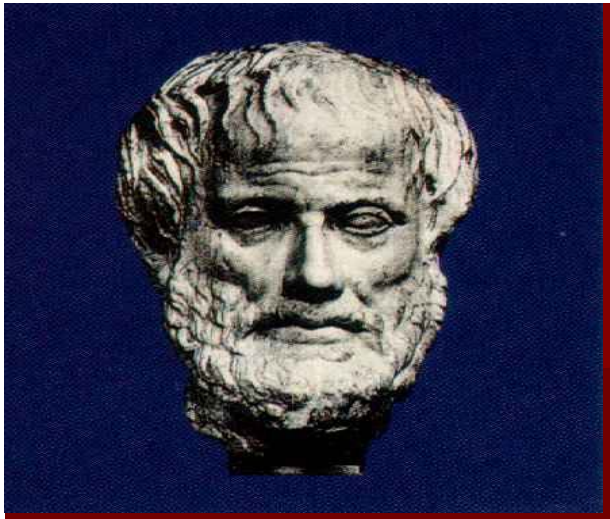
Climatic Changes Impacts on the Built Environment of the Mediterranean Region

Demosthenes N. Asimakopoulos
Professor of Environmental Physics
Former Rector of the University of Athens

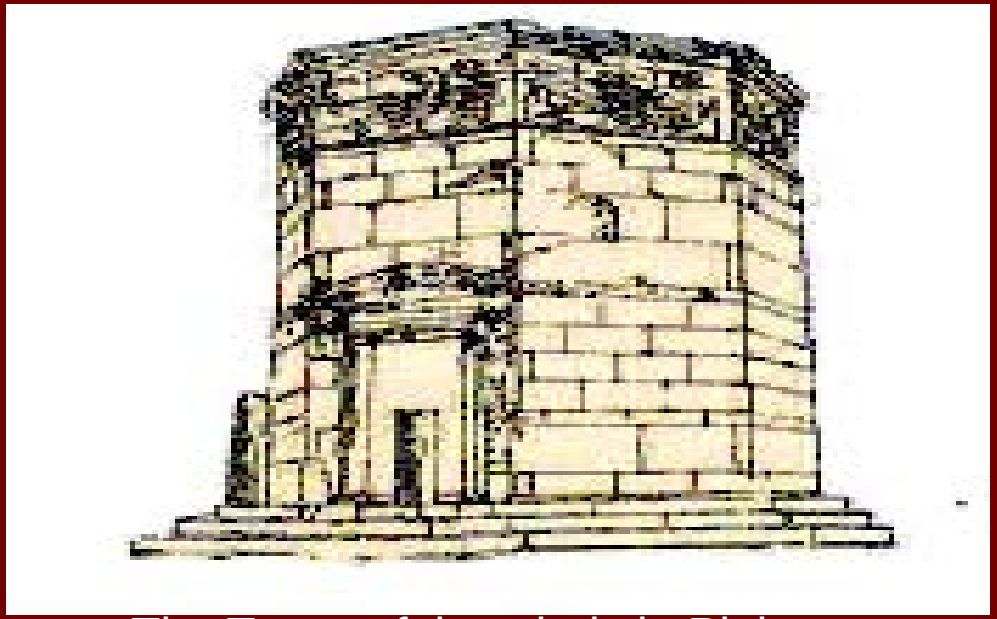
The Earth Atmosphere as Seen from the Space



Ancient Greece and Climatology

Aristotle's : Father of Meteorology

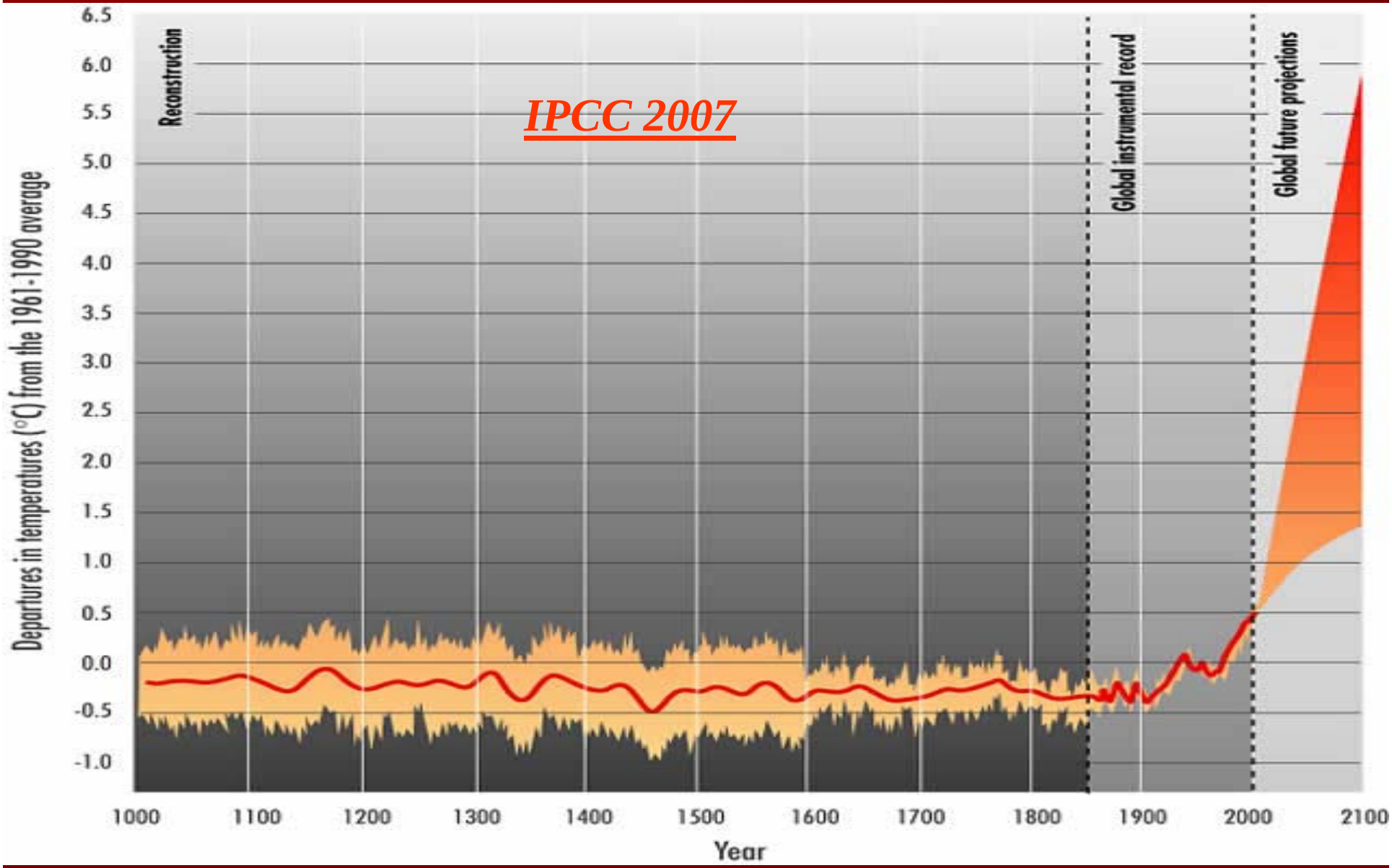
Hippocrates : Father of Climatology



The Tower of the winds in Plaka

Climate Change

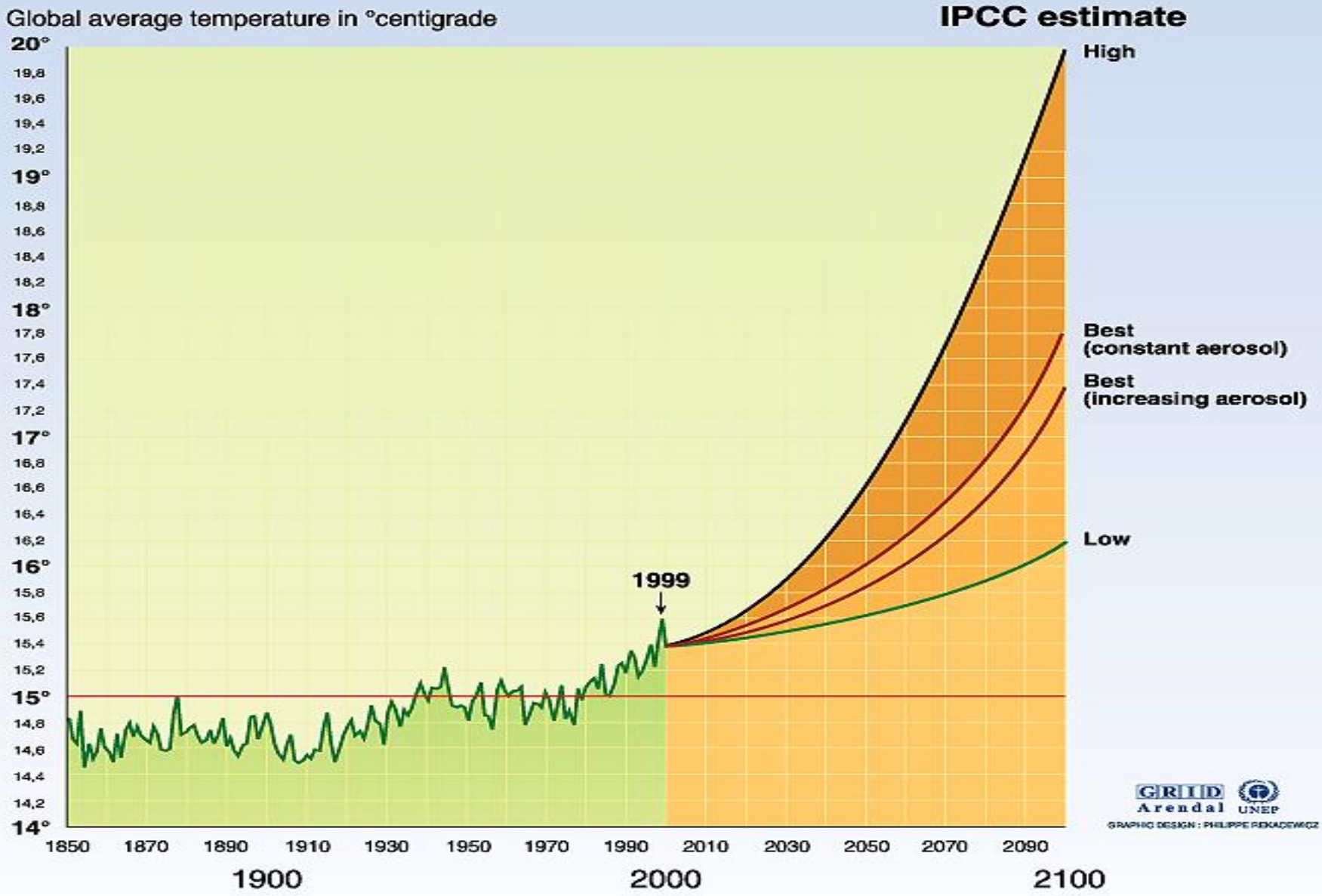
- Weather: Is the state of the Environment at a specific moment
- Climate: Is the mean weather conditions during a long time period (e.g. 30 years) and over a large region (al least 100 Km)
- Climate change forecasting does not show the weather state at a specific time and place but an indication on how the weather will be
- The indices that affect the climate are
  - The solar radiation
  - The chemical composition of the atmosphere
  - The see temperature and the ocean waves and currents
  - The ice cover of the poles
  - The biosphere (woods, cultivated areas)



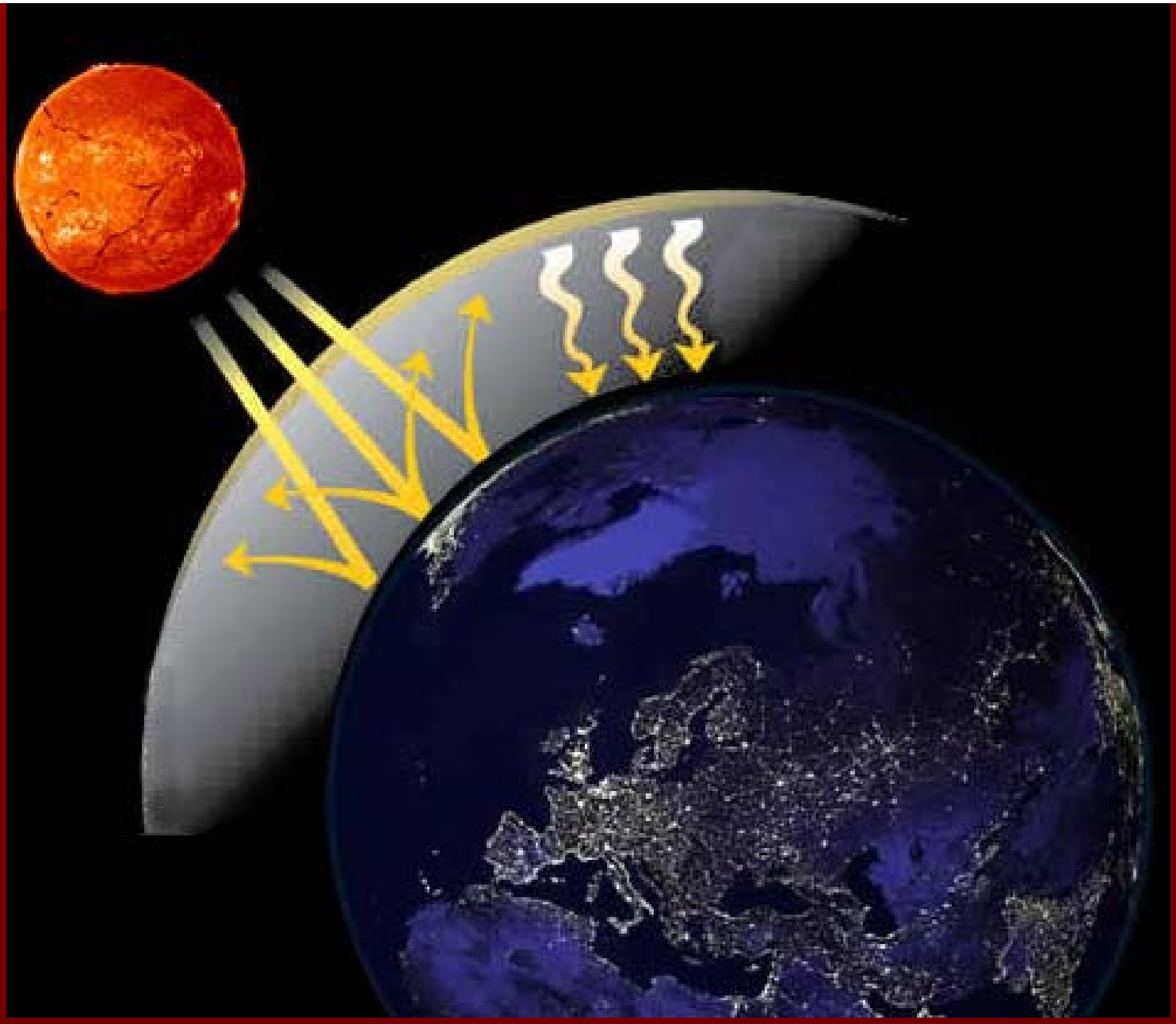
The actual and the forecasted mean surface temperature change

Projected changes in global temperature:

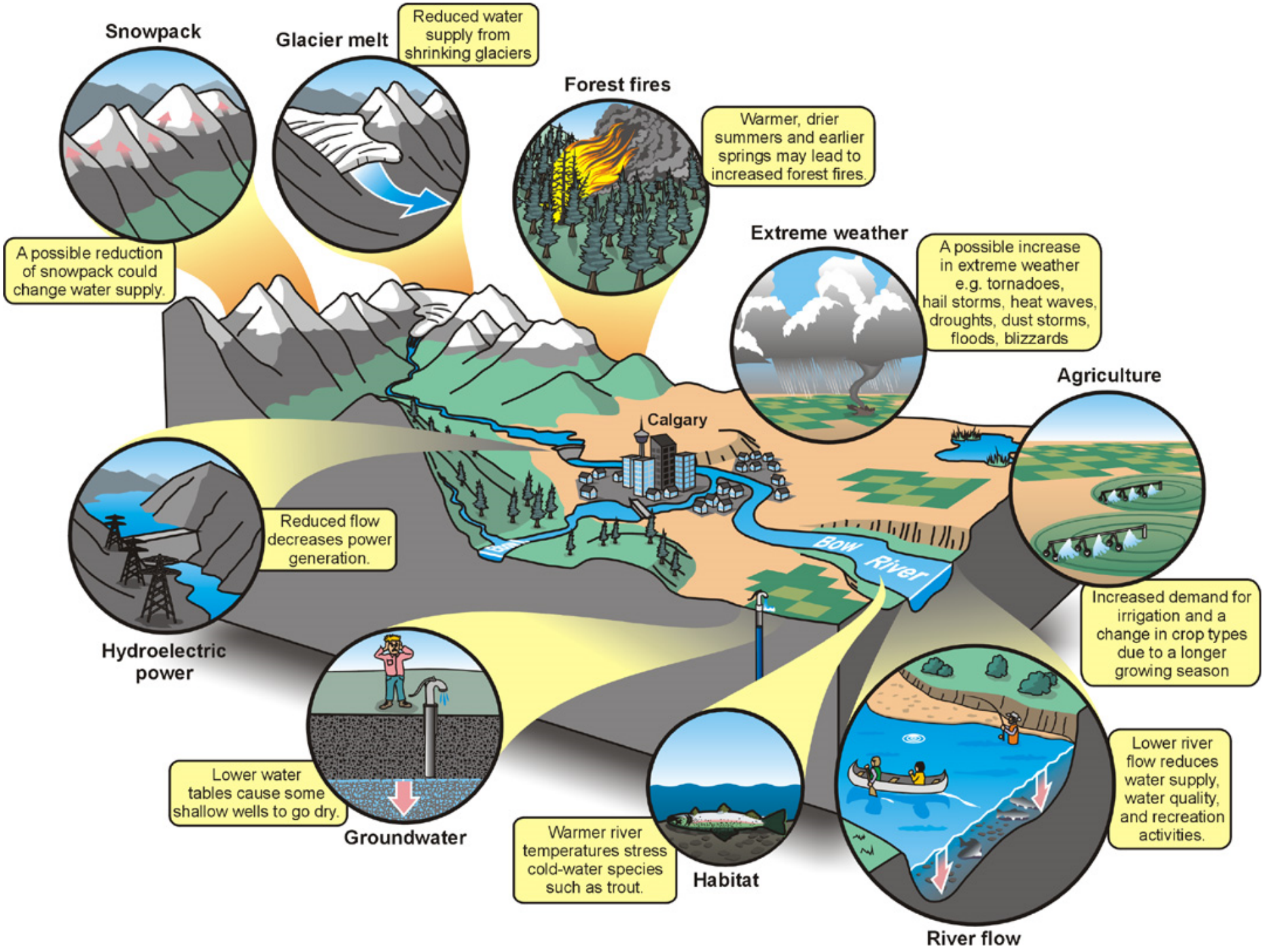
global average 1856-1999 and projection estimates to 2100



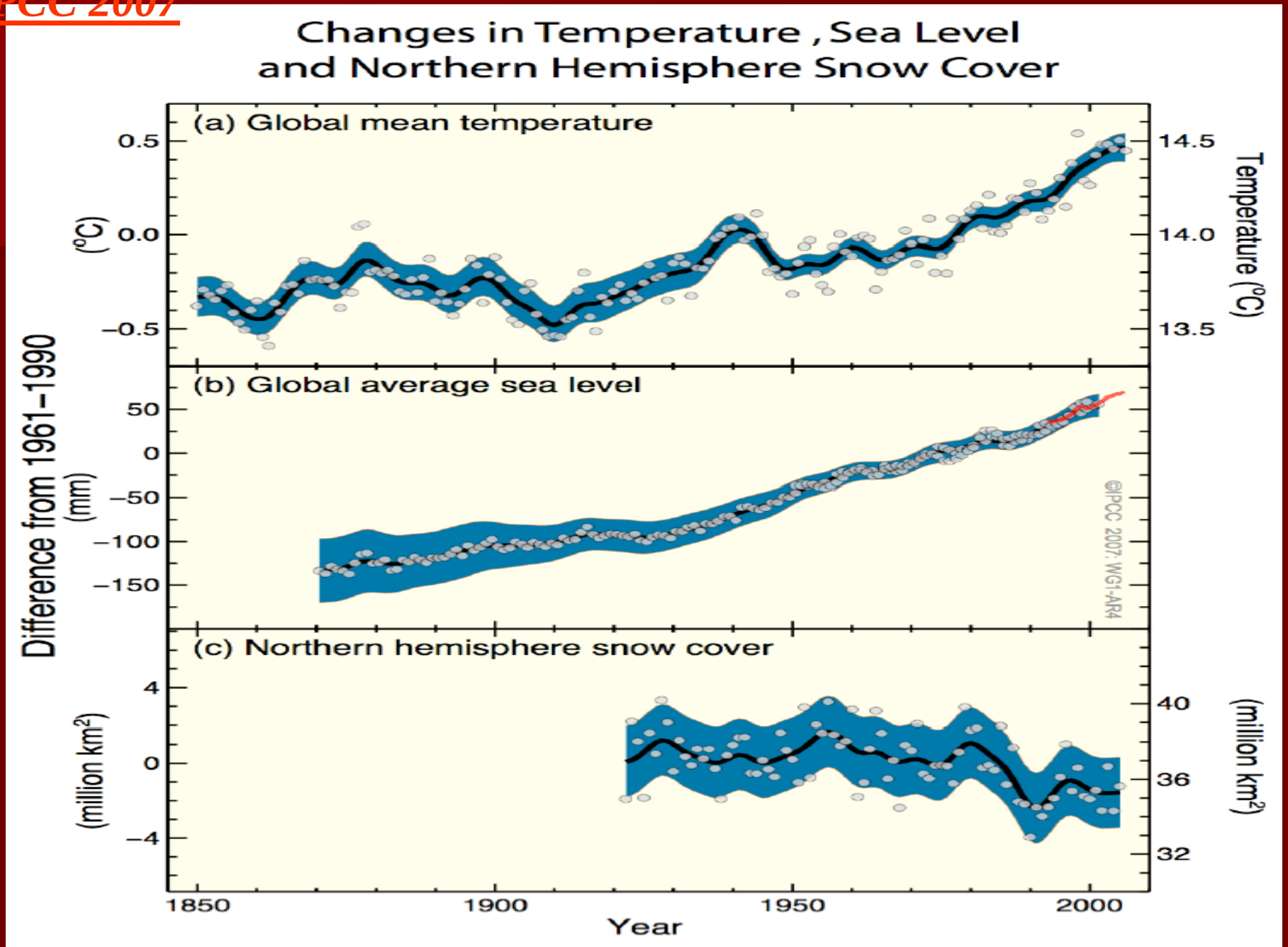
Source : Temperatures 1856 - 1999: Climatic Research Unit, University at East Anglia, Norwich UK. Projections: IPCC report 95.



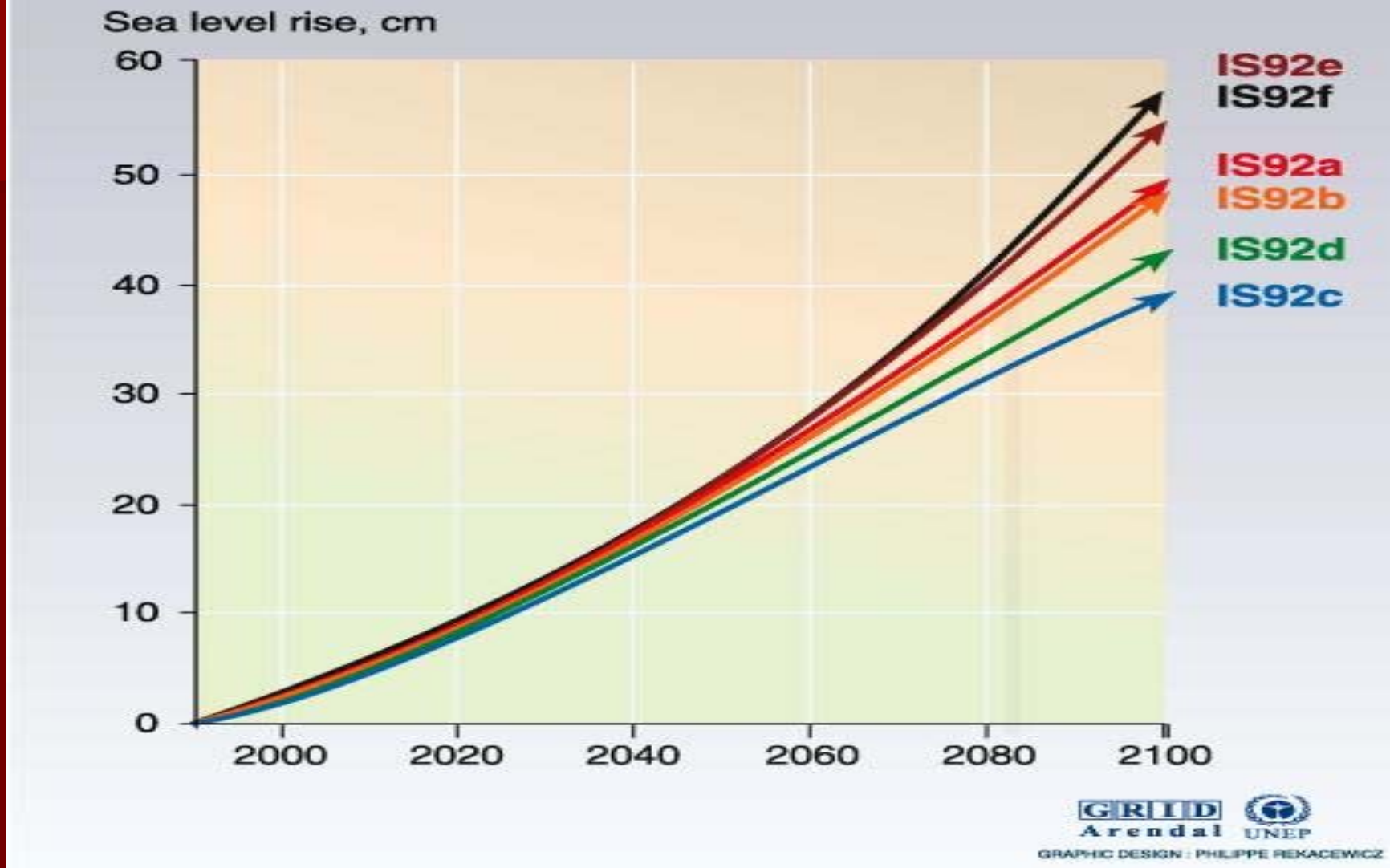
Without the greenhouse gasses the Earth temperature would have been about -19 ºC while today is +14.5 ºC


Snowpack
A possible reduction of snowpack could change water supply.
Glacier melt
Reduced water supply from shrinking glaciers
Forest fires
Warmer, drier summers and earlier springs may lead to increased forest fires.
Extreme weather
A possible increase in extreme weather e.g. tornadoes, hail storms, heat waves, droughts, dust storms, floods, blizzards
Agriculture
Increased demand for irrigation and a change in crop types due to a longer growing season
Calgary
Bow River
Hydroelectric power
Reduced flow decreases power generation.
Groundwater
Lower water tables cause some shallow wells to go dry.
Habitat
Warmer river temperatures stress cold-water species such as trout.
River flow
Lower river flow reduces water supply, water quality, and recreation activities.

IPCC 2007

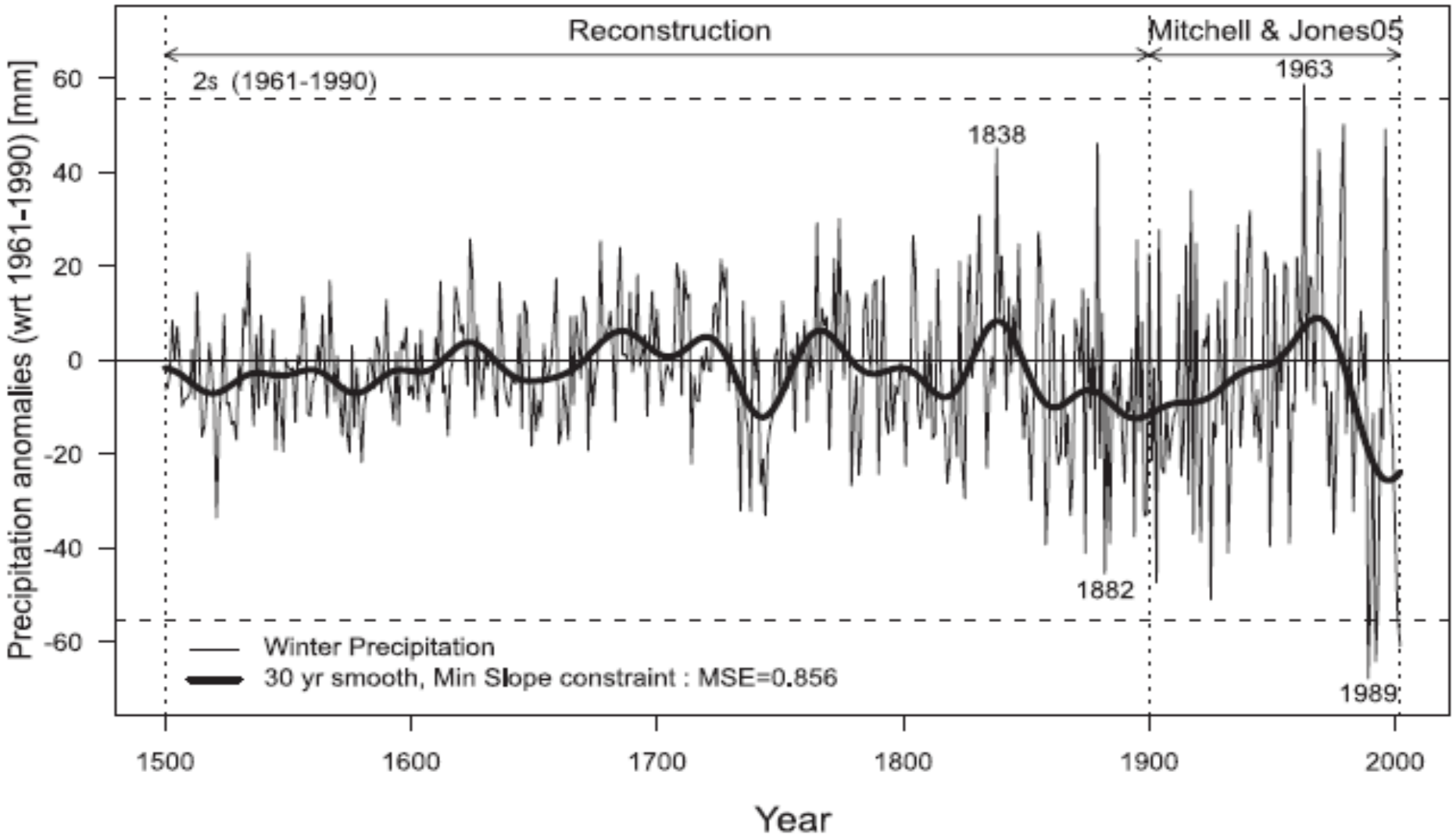

Changes in Temperature , Sea Level
and Northern Hemisphere Snow Cover
(a) Global mean temperature
(b) Global average sea level
(c) Northern hemisphere snow cover
Difference from 1961–1990
(°C)
(mm)
(million km²)
Temperature (°C)
(million km²)
0.5
0.0
−0.5
14.5
14.0
13.5
50
0
−50
−100
−150
4
0
−4
40
36
32
1850
1900
1950
2000
Year
©IPCC 2007: WG1-AR4

Scenarios of sea level rise



Source: Climate change 1995, Impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996; IPCC, Climate change 1994: radiative forcing of climate change and an evaluation of the IPCC IS92 emission scenarios, 1995.

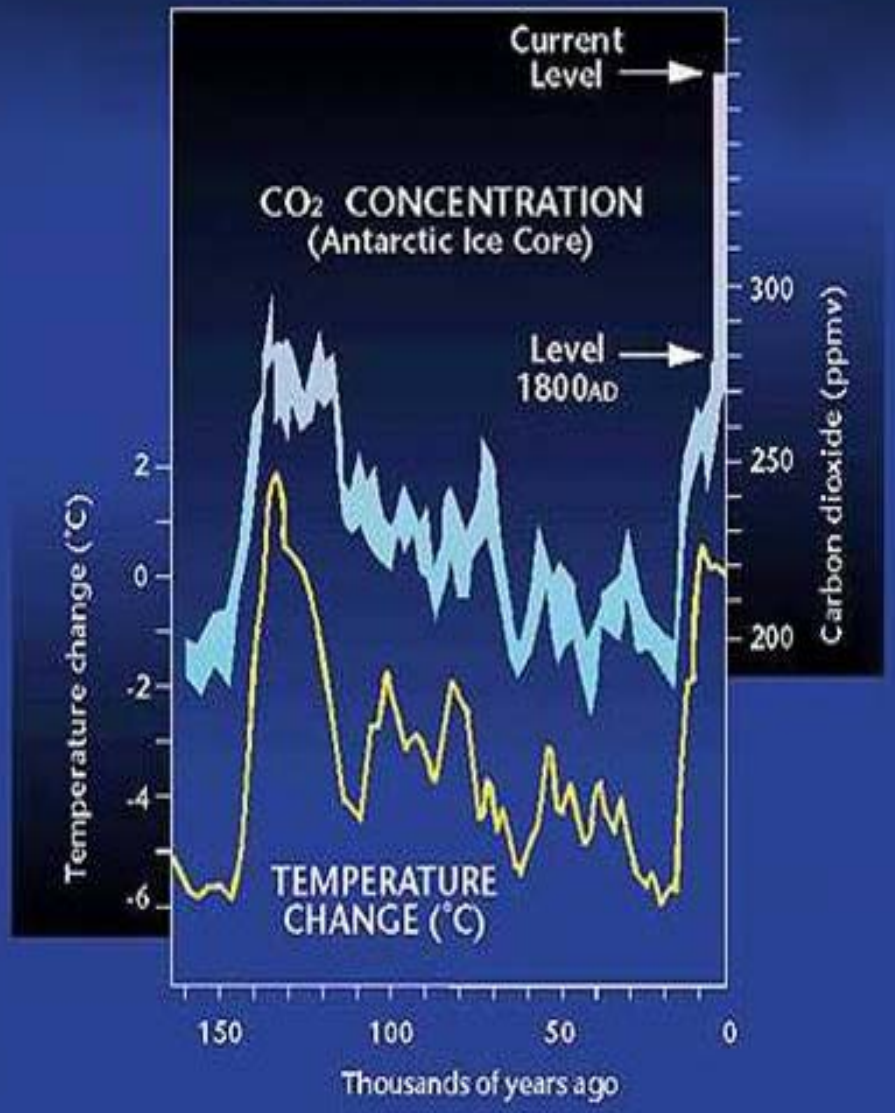
The Nelometer on the island of Elephantine (Upper Egypt)



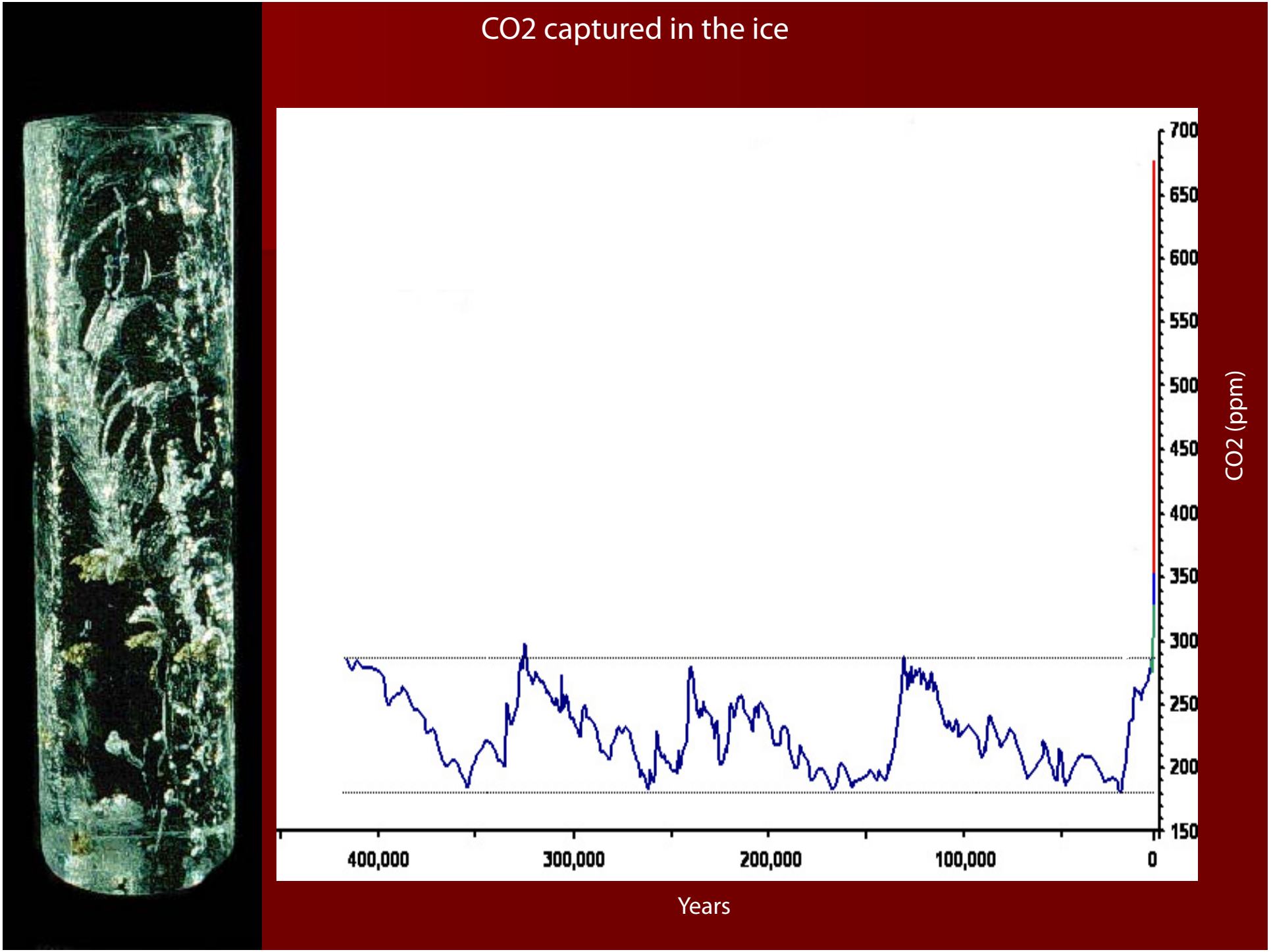
The mean rainfall in the Mediterranean region during winter from historical and other sources from 1500 to 2002, (Luterbacher et al., 2006).

The frozen Thames in 1677. The same happened in 1683, 1814 and 1953

Atmospheric Carbon Dioxide Concentration and Temperature Change



CO_2 captured in the ice

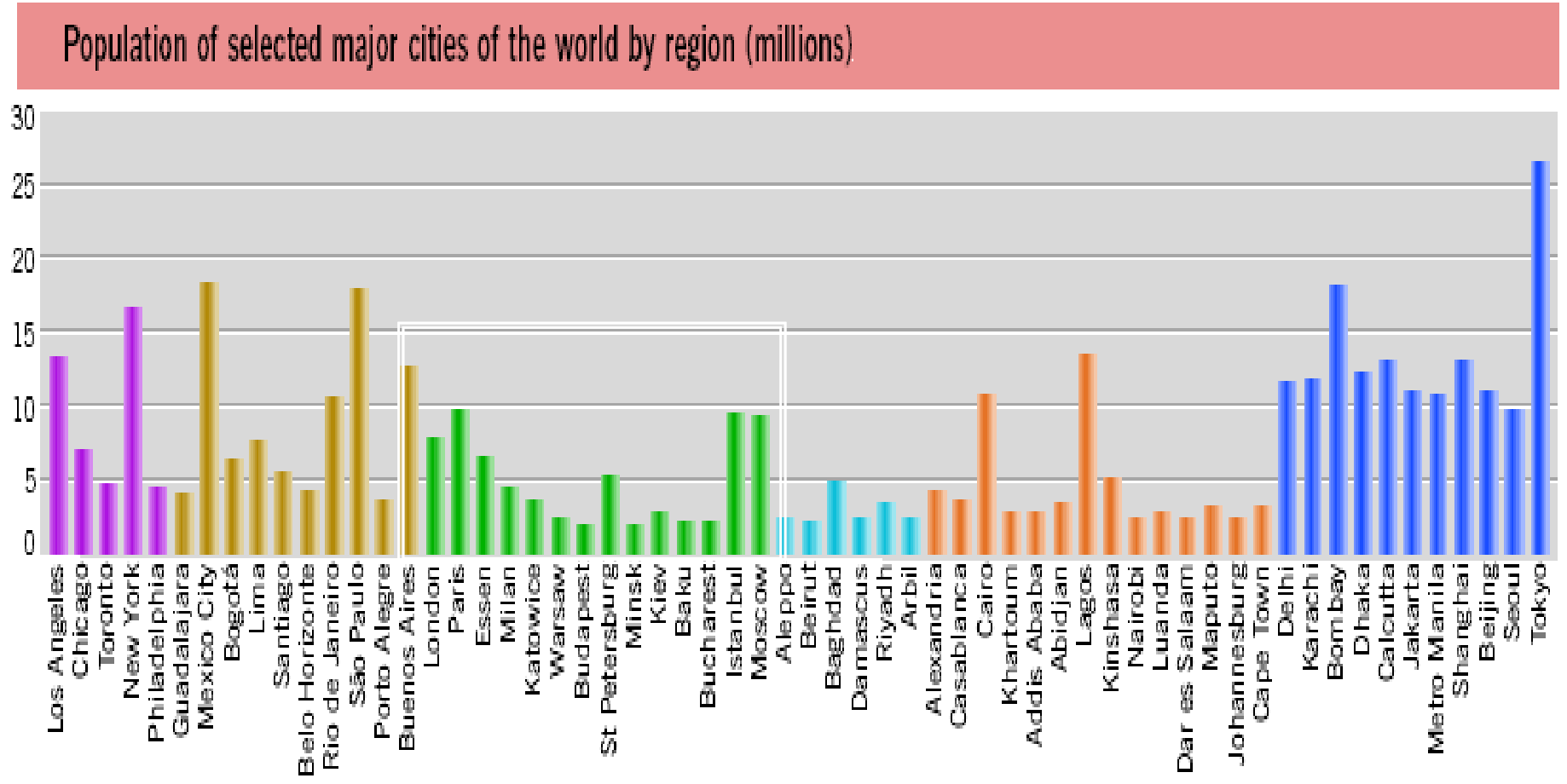


The number of urban dwellers has risen from 600 million in 1950 to 2 billion in 1986 and if this growth continues, more than one - half of the world's population will live in cities by the end of this century, where 100 years ago, only 14 percent lived in cities and in 1950, less than 30 per cent of the world population was urban. Estimations show that urban populations will occupy 80 % of the total world population in 2100. Today, at least 170 cities support more than one million inhabitants each.

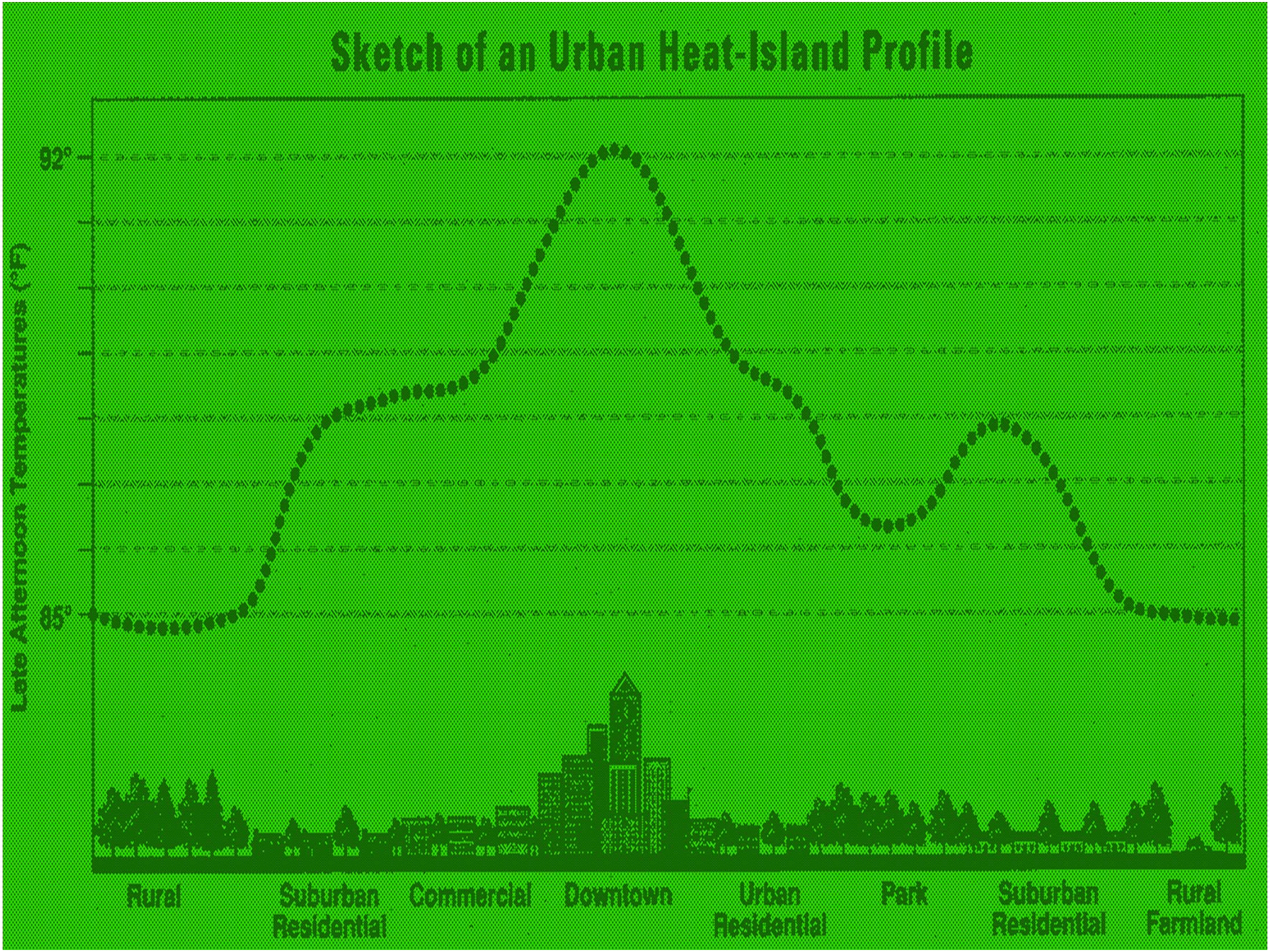
As estimated, in the United States, 90 percent of the population is expected to be living in, or around, urban areas by the year 2000.

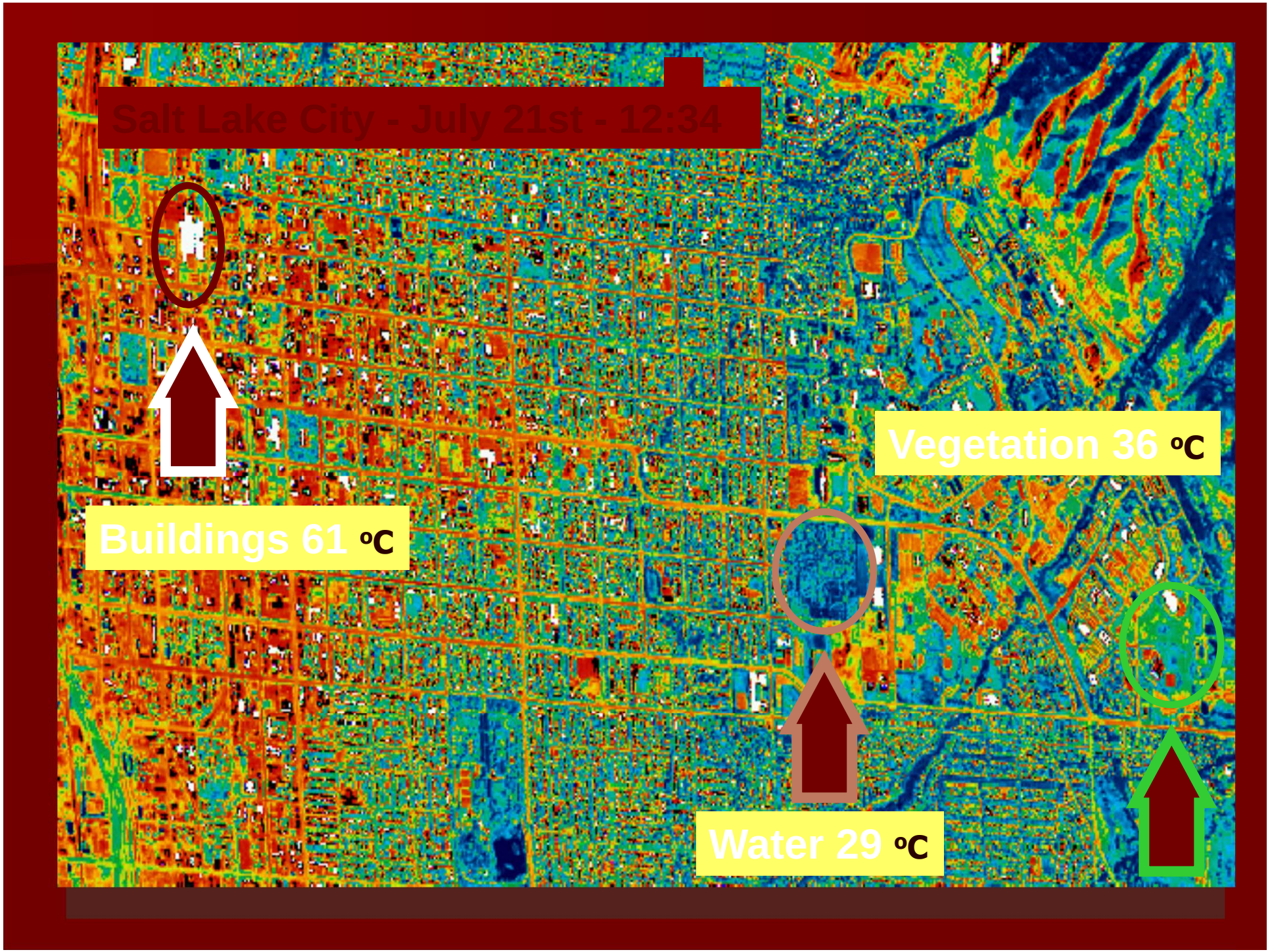
urbanisation

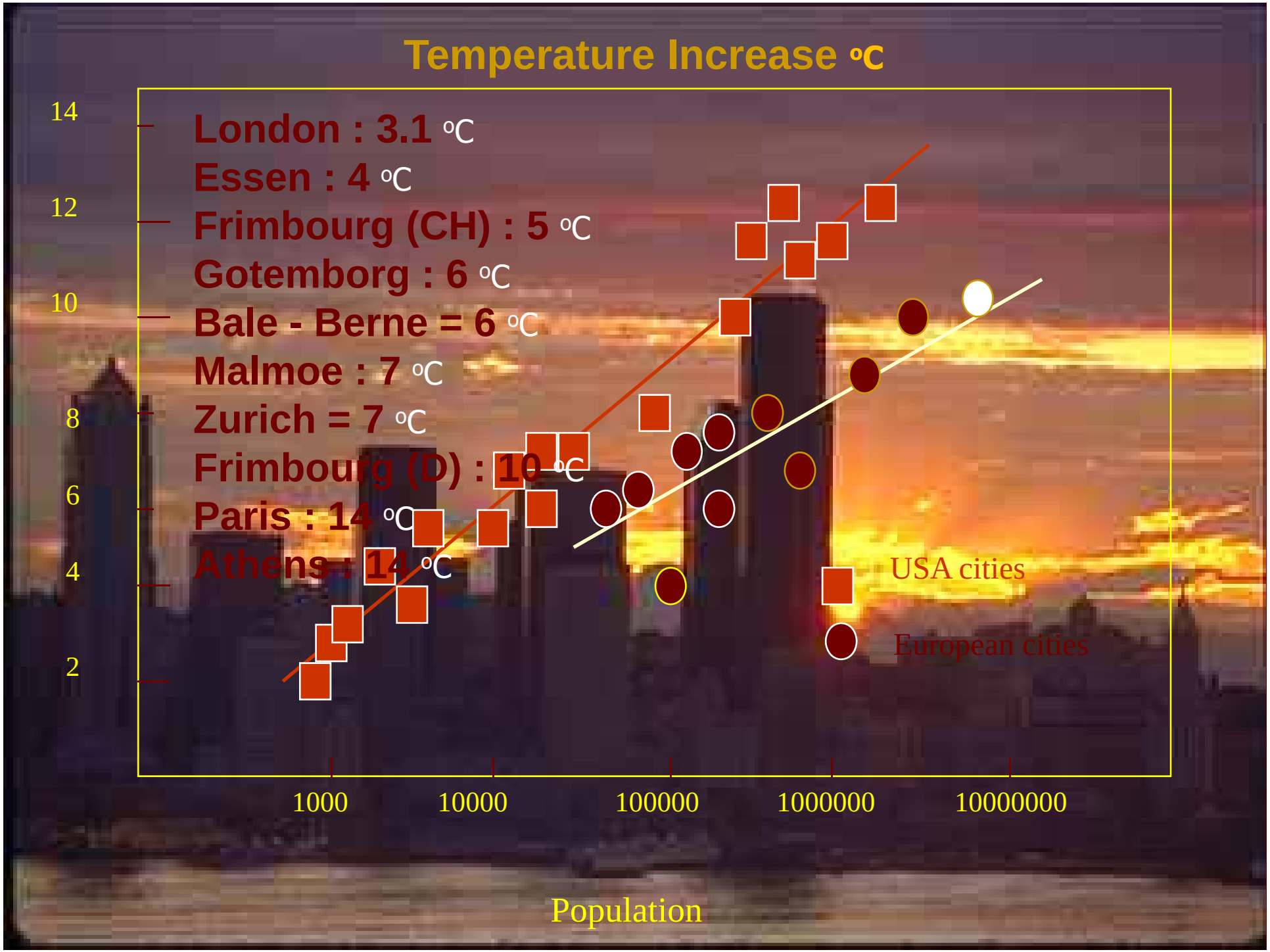
Today, at least 170 cities support more than one million inhabitants each

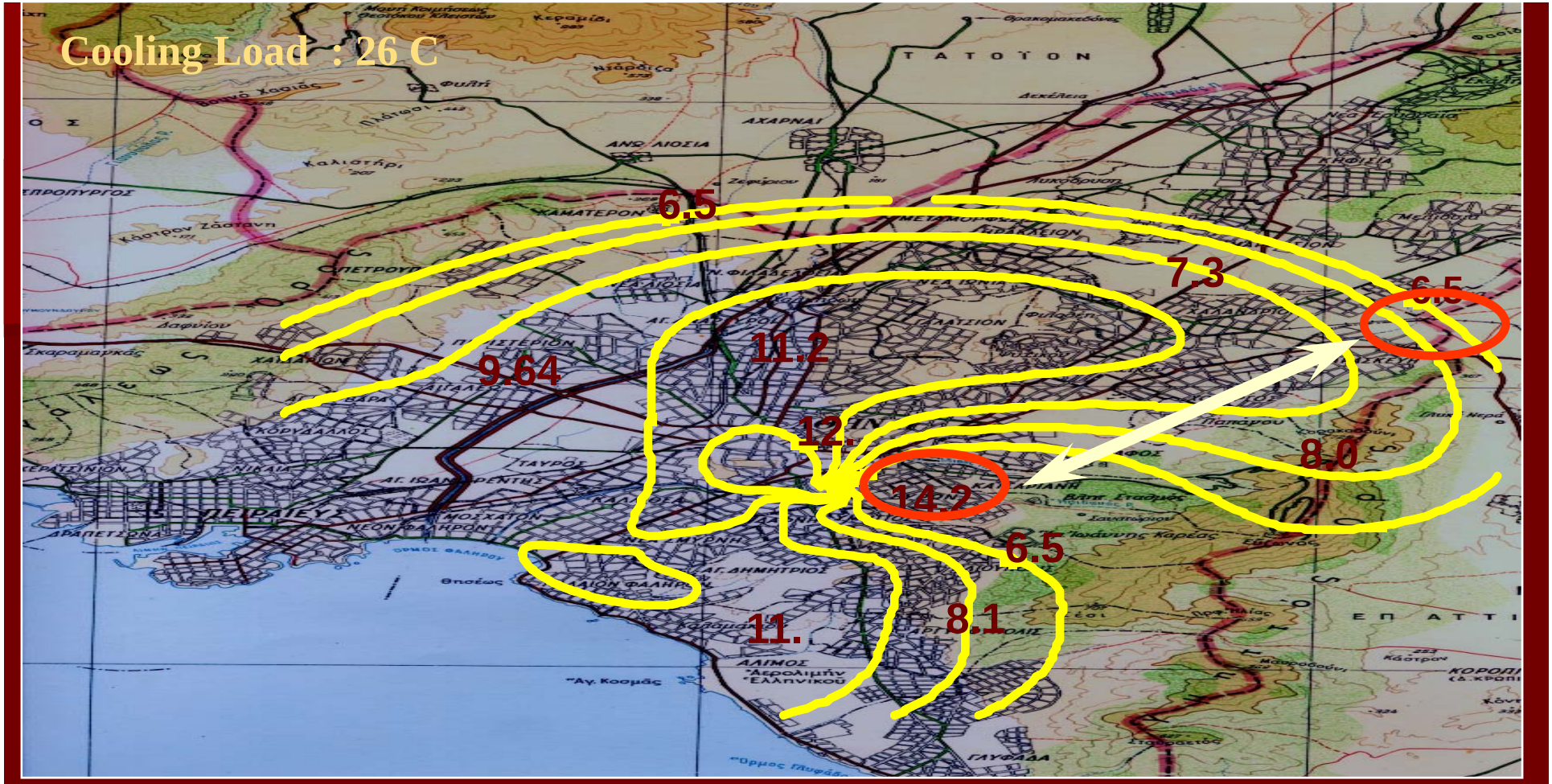


Sketch of an Urban Heat-Island Profile



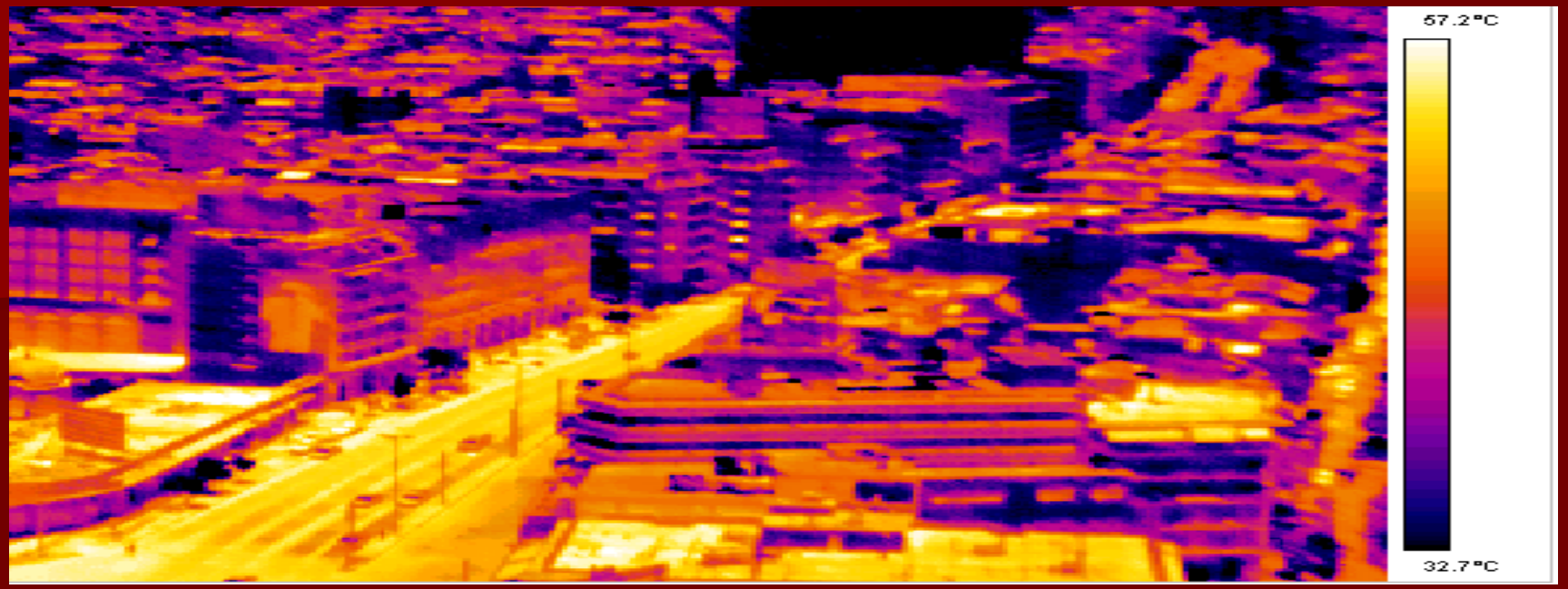

Salt Lake City - July 21st - 12:34
Buildings 61 ºC
Vegetation 36 ºC
Water 29 ºC

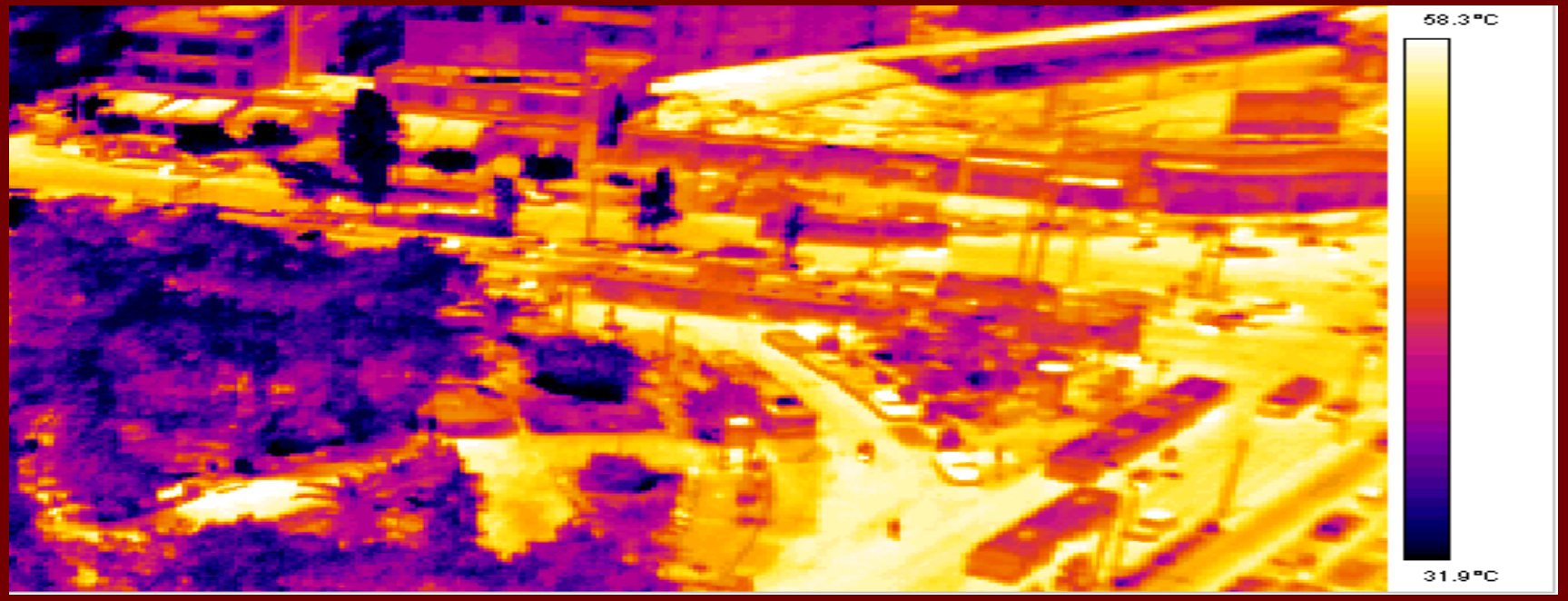

Temperature Increase °C
14
12
10
8
6
4
2
London : 3.1 °C
Essen : 4 °C
Frimbourg (CH) : 5 °C
Gotemborg : 6 °C
Bale - Berne = 6 °C
Malmoe : 7 °C
Zurich = 7 °C
Frimbourg (D) : 10 °C
Paris : 14 °C
Athens : 14 °C
USA cities
European cities
1000
10000
100000
1000000
10000000
Population



Urbanization leads to a very high increase of energy use. An 1 % increase in the per capita GNP leads to an equal (1.03), increase in energy consumption. However, an increase of the urban population by 1 % increases the energy consumption by 2.2 %, i.e., the rate of change in energy use is twice the rate of change in urbanization.

Comparison of the energy consumption per capita for the inner and outer parts of selected cities shows that the consumption in the inner part is considerably higher. Inner London presents to 30 % higher energy consumption per capita than the outer part of the city.


57.2°C
32.7°C


58.3°C
31.9°C

Techniques to Improve Urban Microclimate

- the use of more appropriate materials,

- increased use of green areas,

- use of cool sinks for heat dissipation,

- appropriate layout of urban canopies, etc.,

to counterbalance the effects of temperature increase.

Future Priorities

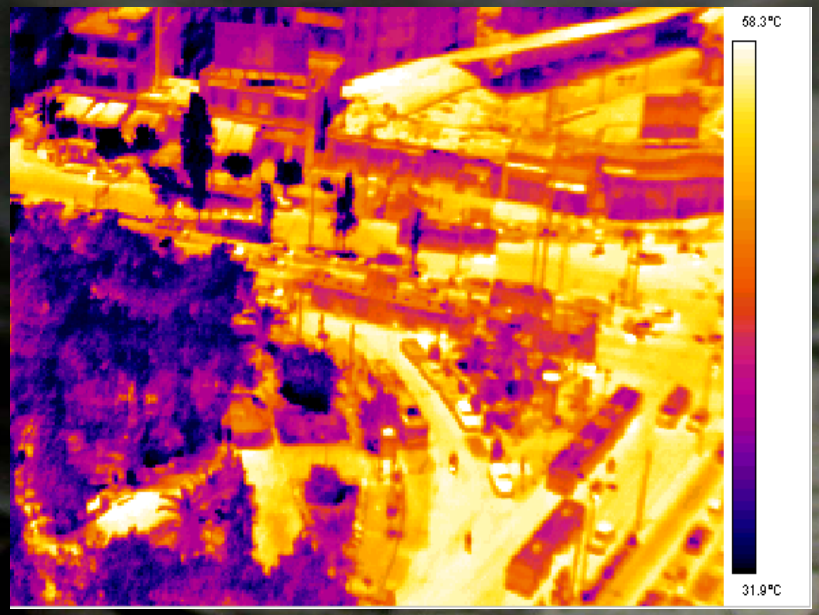
Improve the quality of the urban environments

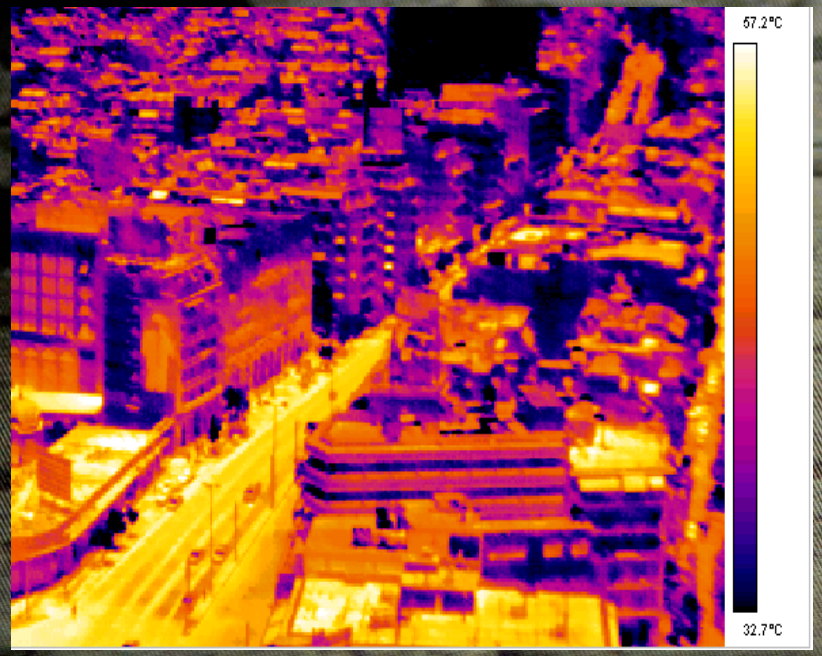
Development of efficient codes and legislation

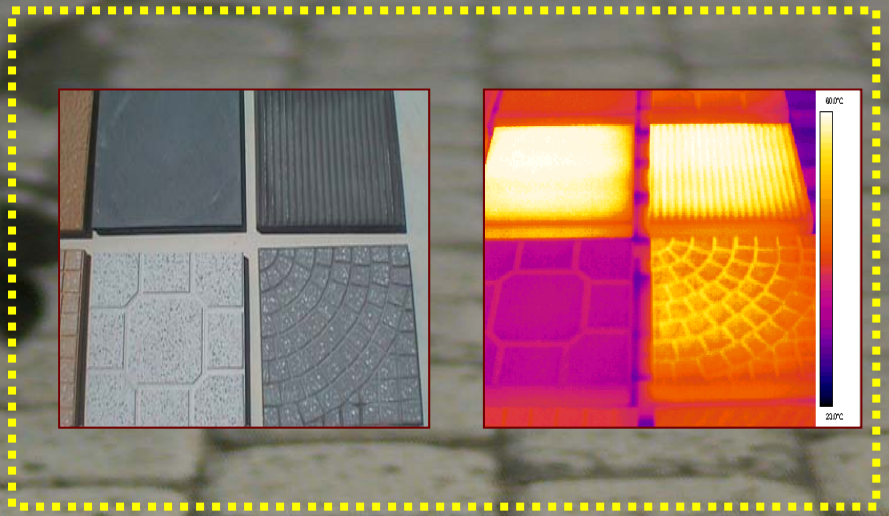
Introduction of energy efficiency technologies in retrofitting of buildings

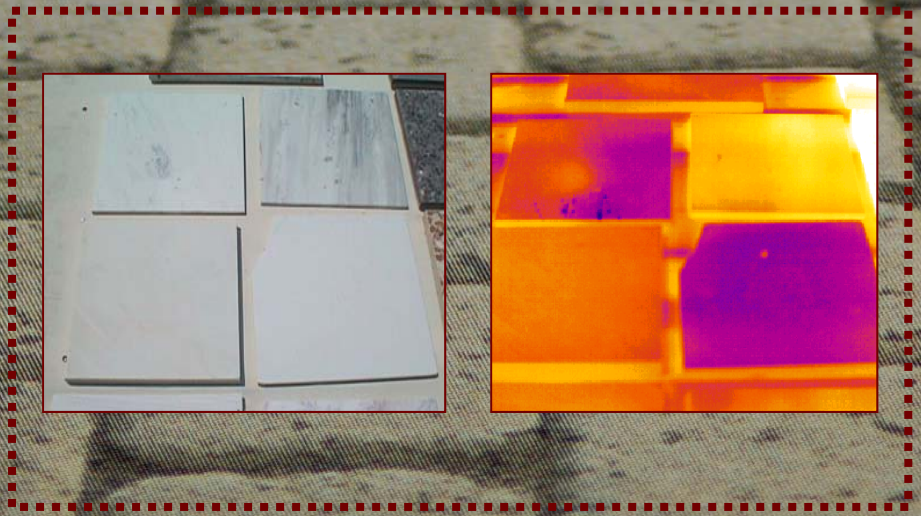
Appropriate solutions to decrease the penetration of air conditioning

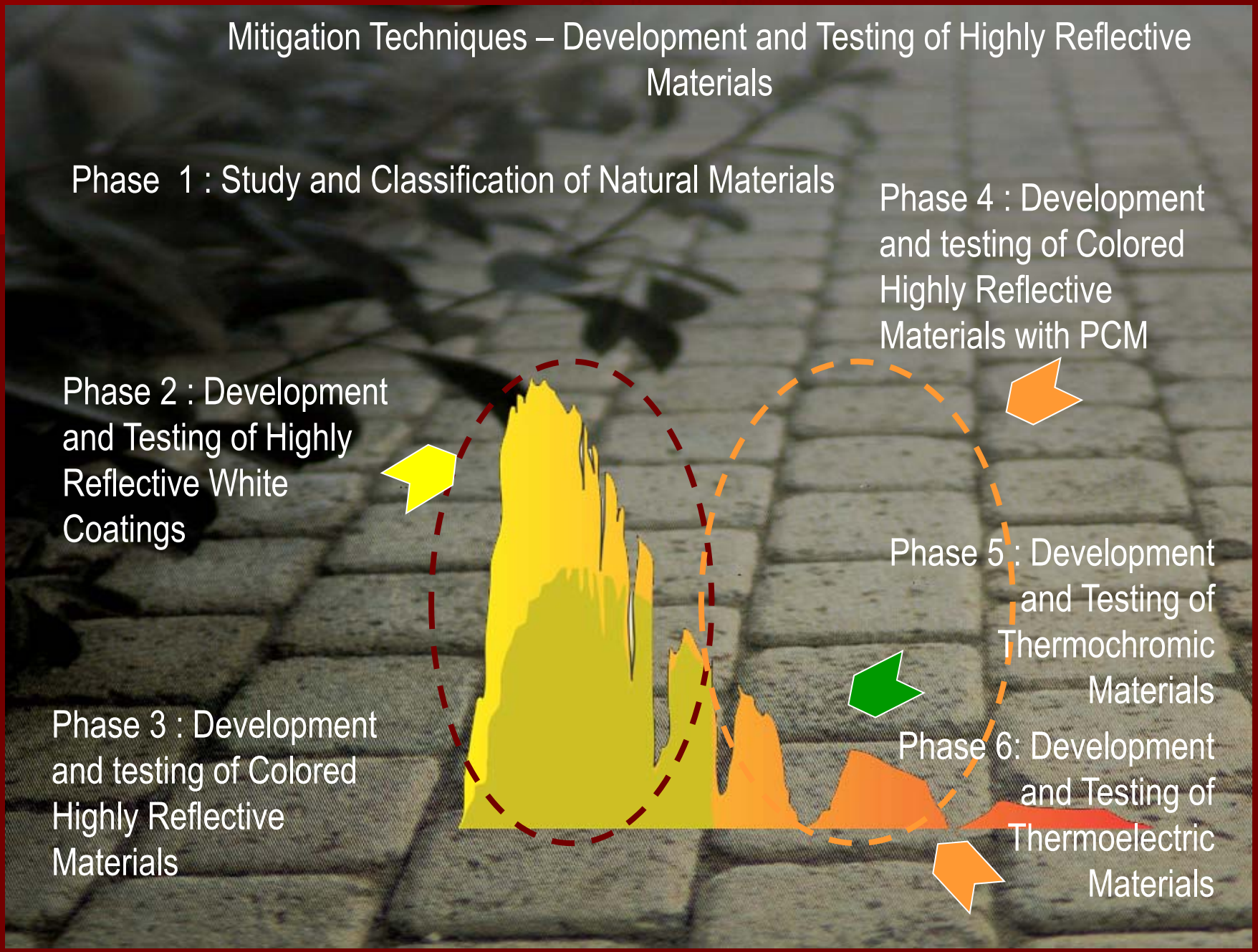
The Role of Materials

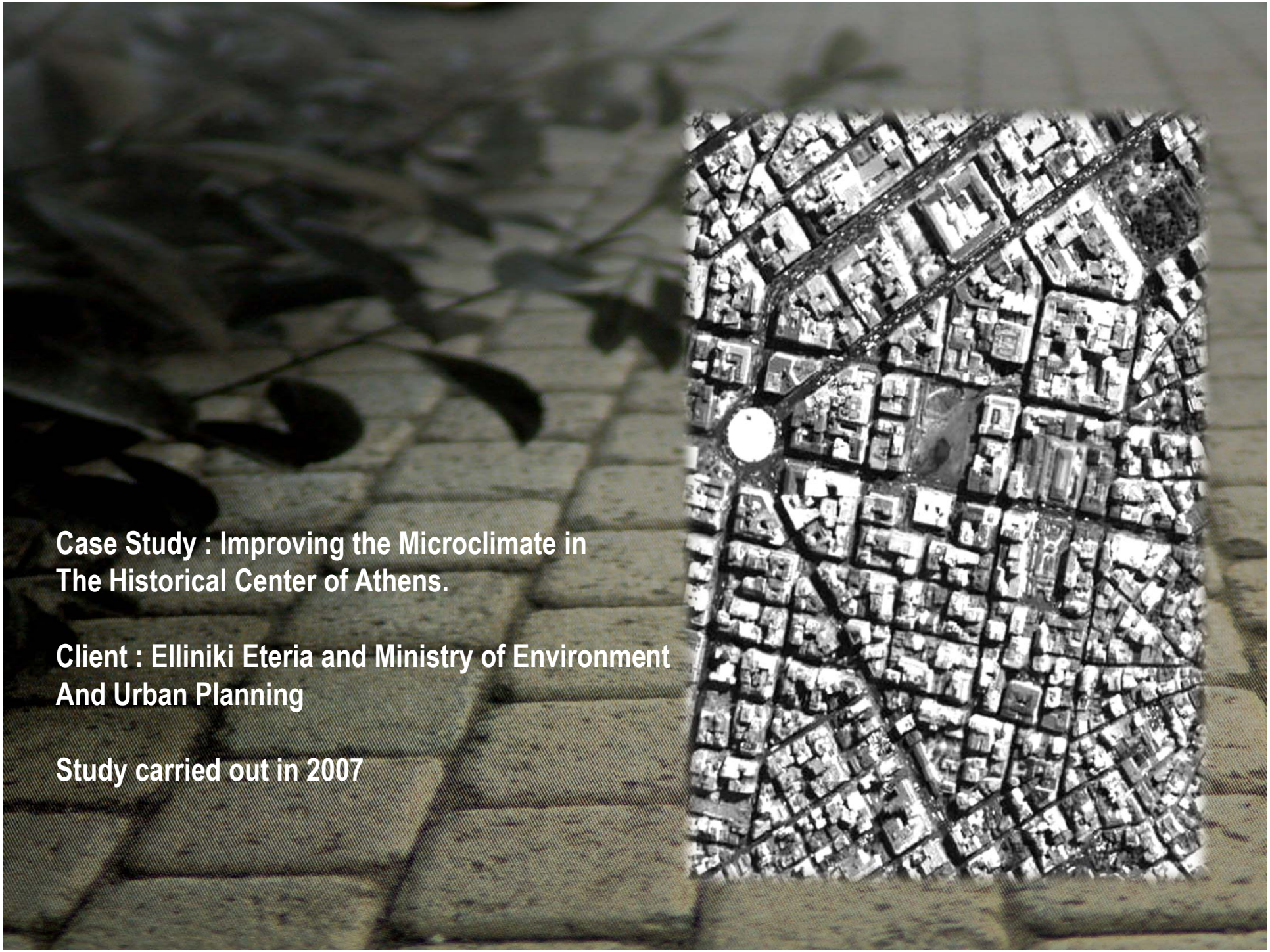









Mitigation Techniques – Development and Testing of Highly Reflective Materials
Phase 1 : Study and Classification of Natural Materials
Phase 4 : Development and testing of Colored Highly Reflective Materials with PCM
Phase 2 : Development and Testing of Highly Reflective White Coatings
Phase 5 : Development and Testing of Thermochromic Materials
Phase 3 : Development and testing of Colored Highly Reflective Materials
Phase 6: Development and Testing of Thermoelectric Materials

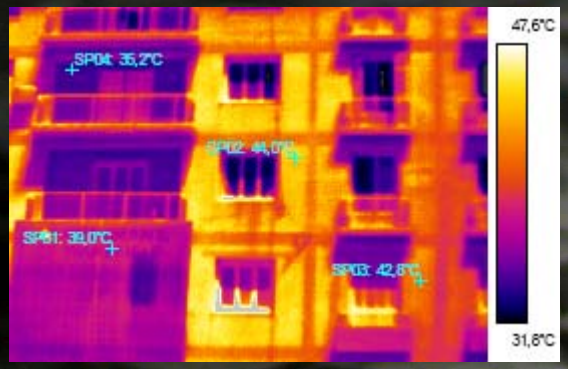

Case Study : Improving the Microclimate in
The Historical Center of Athens.
Client : Elliniki Eteria and Ministry of Environment
And Urban Planning
Study carried out in 2007

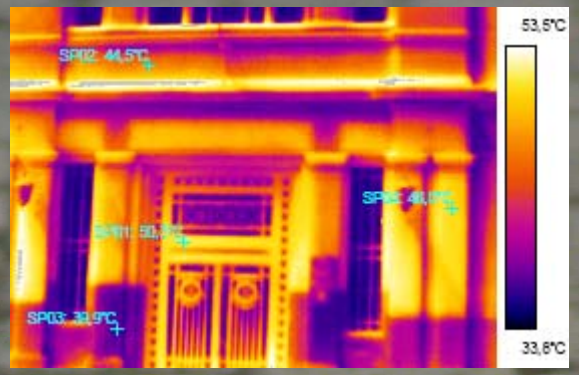
Improving the Microclimate in The Historical Center of Athens

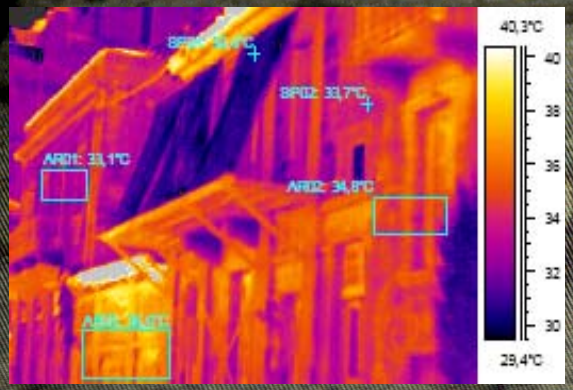
The specific strategy to improve the microclimate in the area involved actions like : :

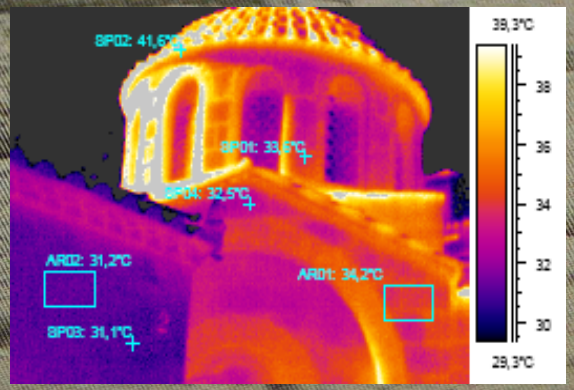
- Increase of the green spaces
- Use of Cool Materials
- Reduction of the anthropogenic heat
- Use of Cool sinks
- Proper Shading of Open spaces.

Improving the Microclimate in The Historical Center of Athens



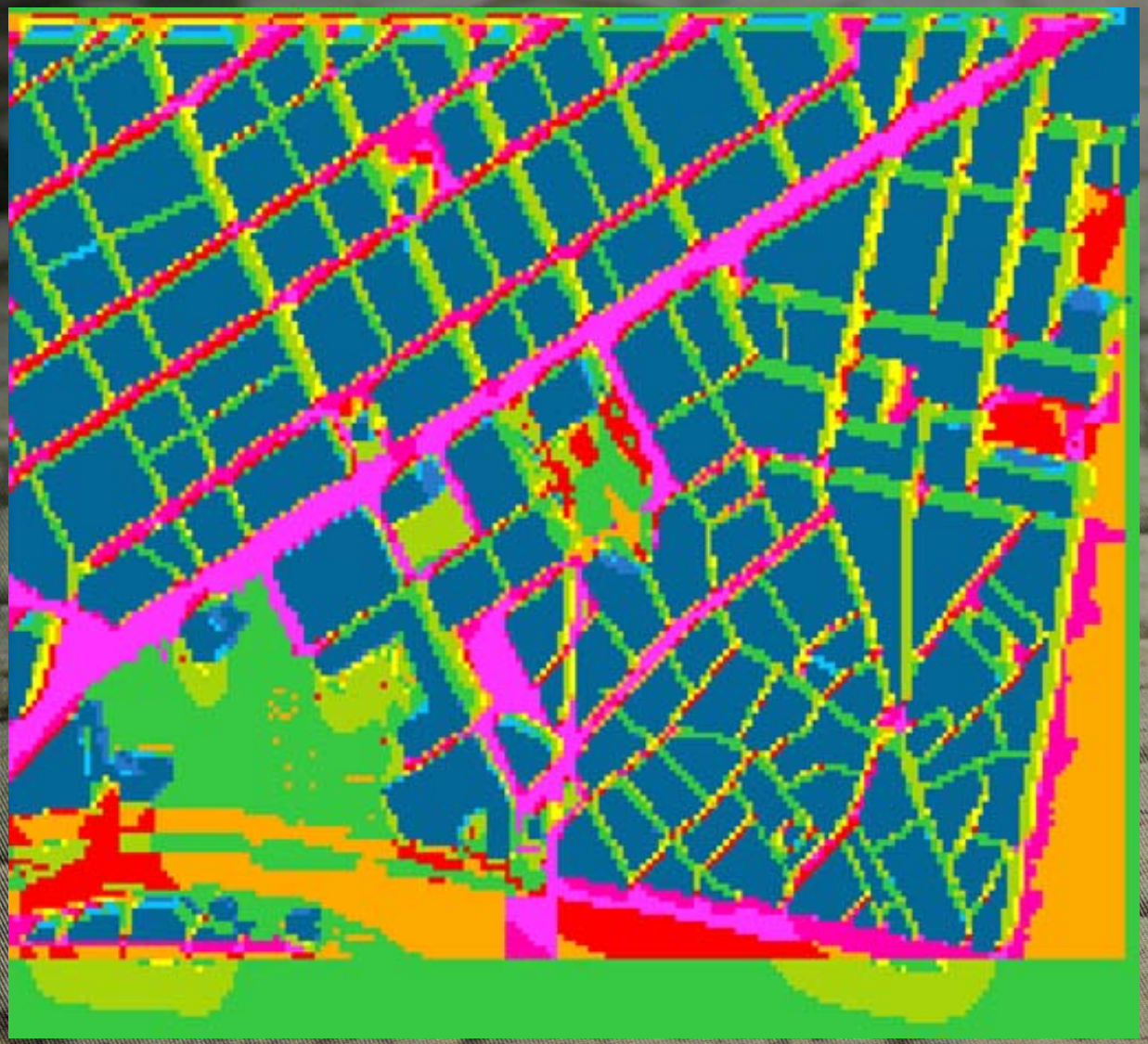






Improving the Microclimate in The Historical Center of Athens

Existing Situation – Surface Temperature



Improving the Microclimate in The Historical Center of Athens

Air Temperature – Proposed Layout

FUTURE RESEARCH

Better understanding of urban climatology in conjunction with the global climate change

Further improvement of new materials so that the energy spending in large cities will be reduced

Integration techniques for urban buildings incorporating bioclimatic design cool facades better isolation and energy production with PV elements.

The real zero CO2 emitting building is needed

Climate Change is an important and complex issue


Thanks for your
attendance