

Climate Change



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The Cyprus Institute



- Founded in 2005
- Nonprofit organization
- Research and educational center
- Funded mainly by competitive research funds
- Collaboration with world class institutions and universities (MIT, Max Planck, Jülich Supercomputing Centre, Tel Aviv University and more)

Presentation outline

- Introduction to climate change
- Causes
- Projections
- Impacts
- Discussion

Weather - Climate

- **Weather** is the state of the meteorological parameters and phenomena over a specific location and a specific time
- **Climate** is the average weather over a period longer than 30 years over a location

What causes changes in climate?

- Solar radiation/activity
- Earth's orbit around the sun
- Continents' movement
- Volcanic eruptions
- Greenhouse gases!



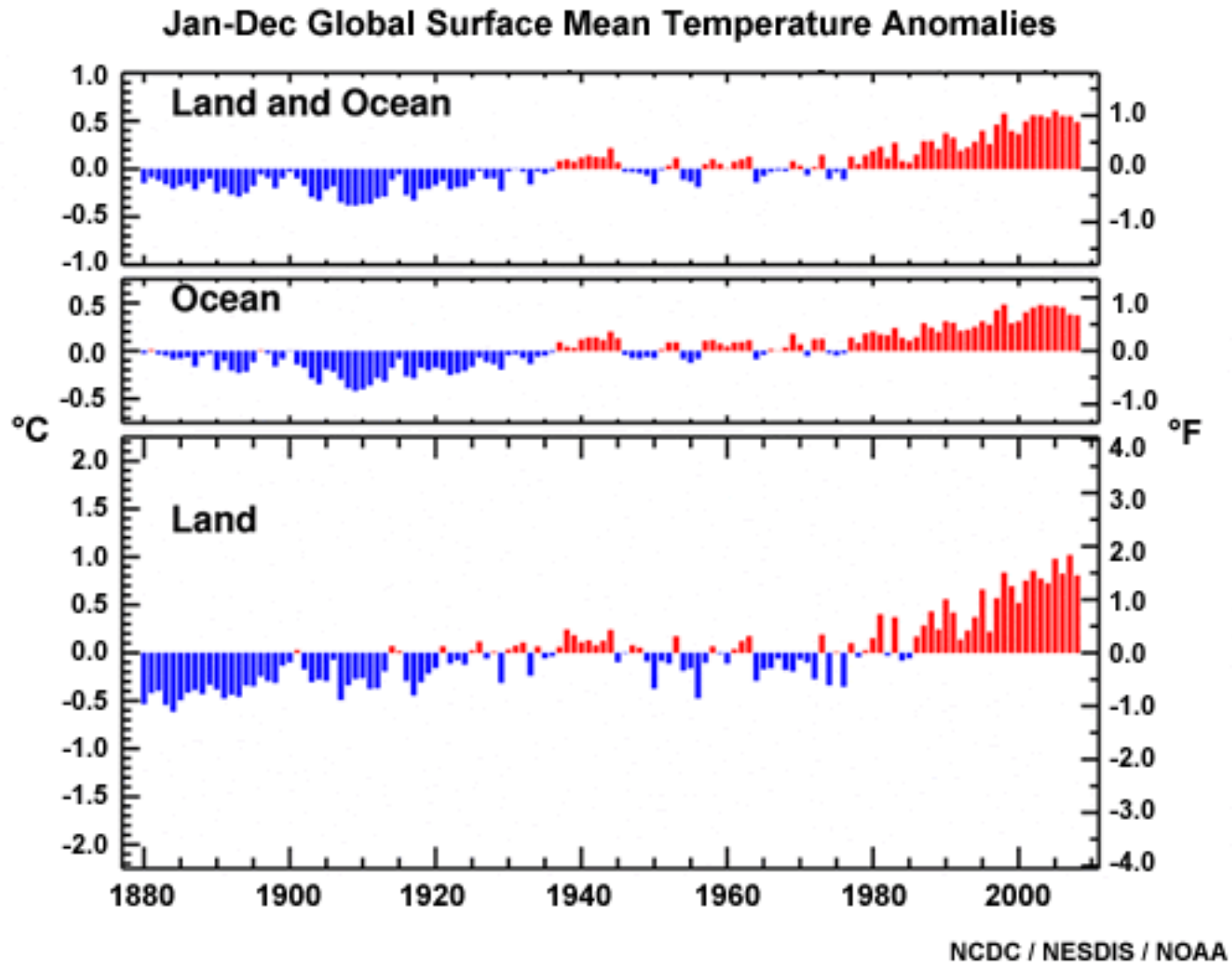
Climate change - What is it?

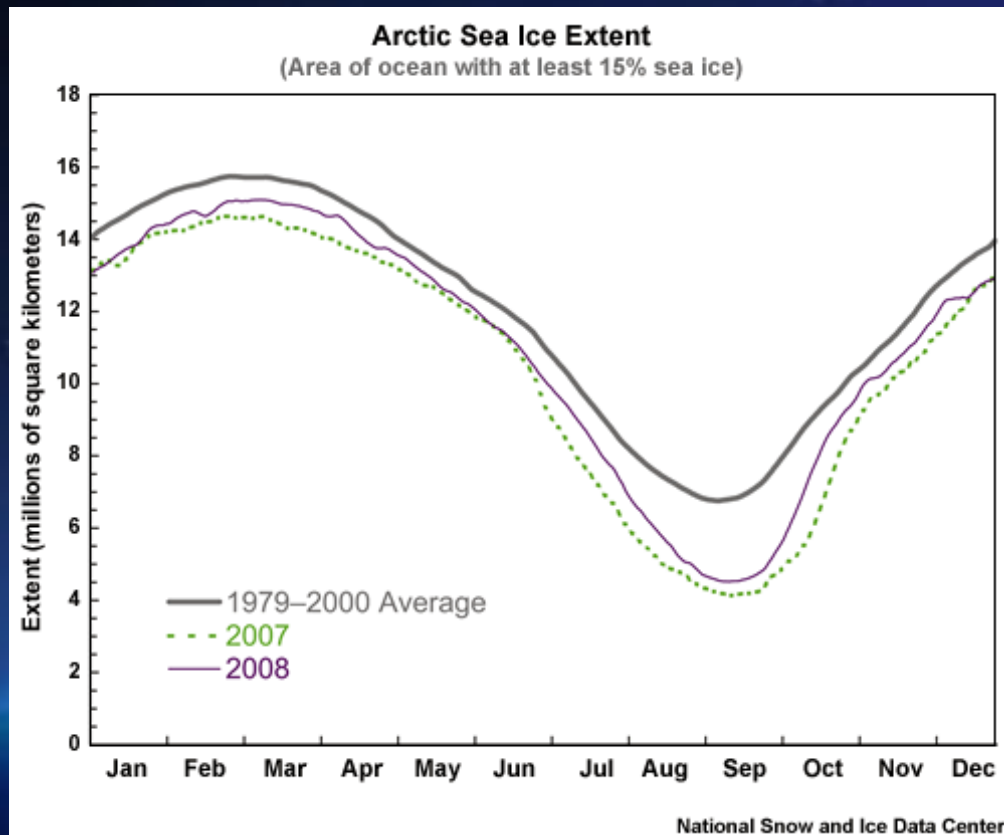
- **Climate Change** is the variation of global climate and specifically variations of meteorological conditions that refer on long time scales (decades to millennia)





Is global warming real?





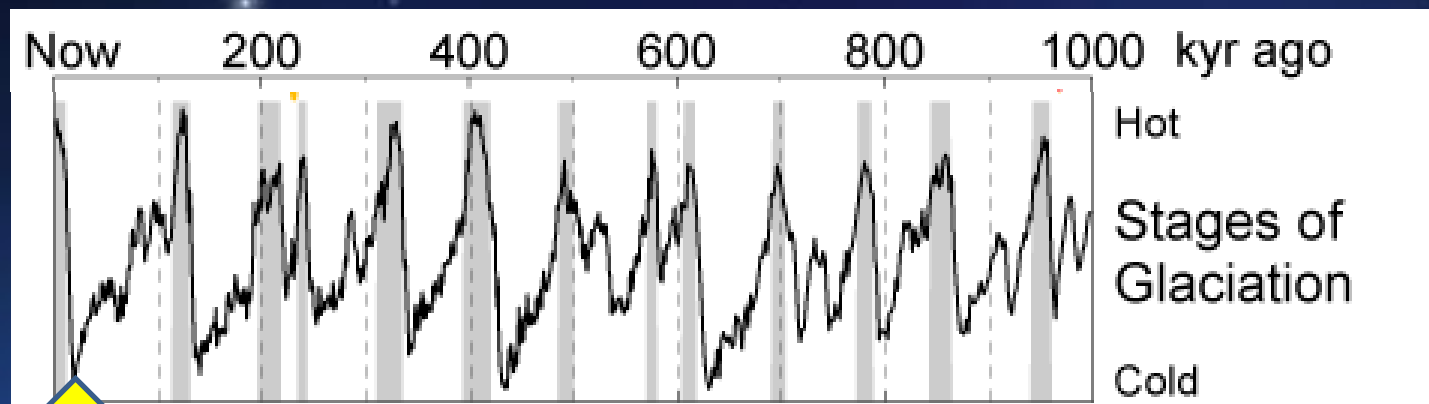
Arctic sea ice cover



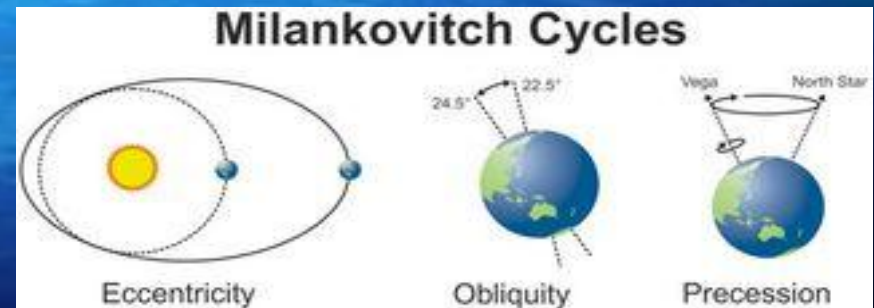
Vernagtferner glacier, Austria
United Nations Environment Program

Is it the first time?

$\approx -150.000.000$ years
 $+6^\circ\text{C}$



-30.000 years
 -6°C



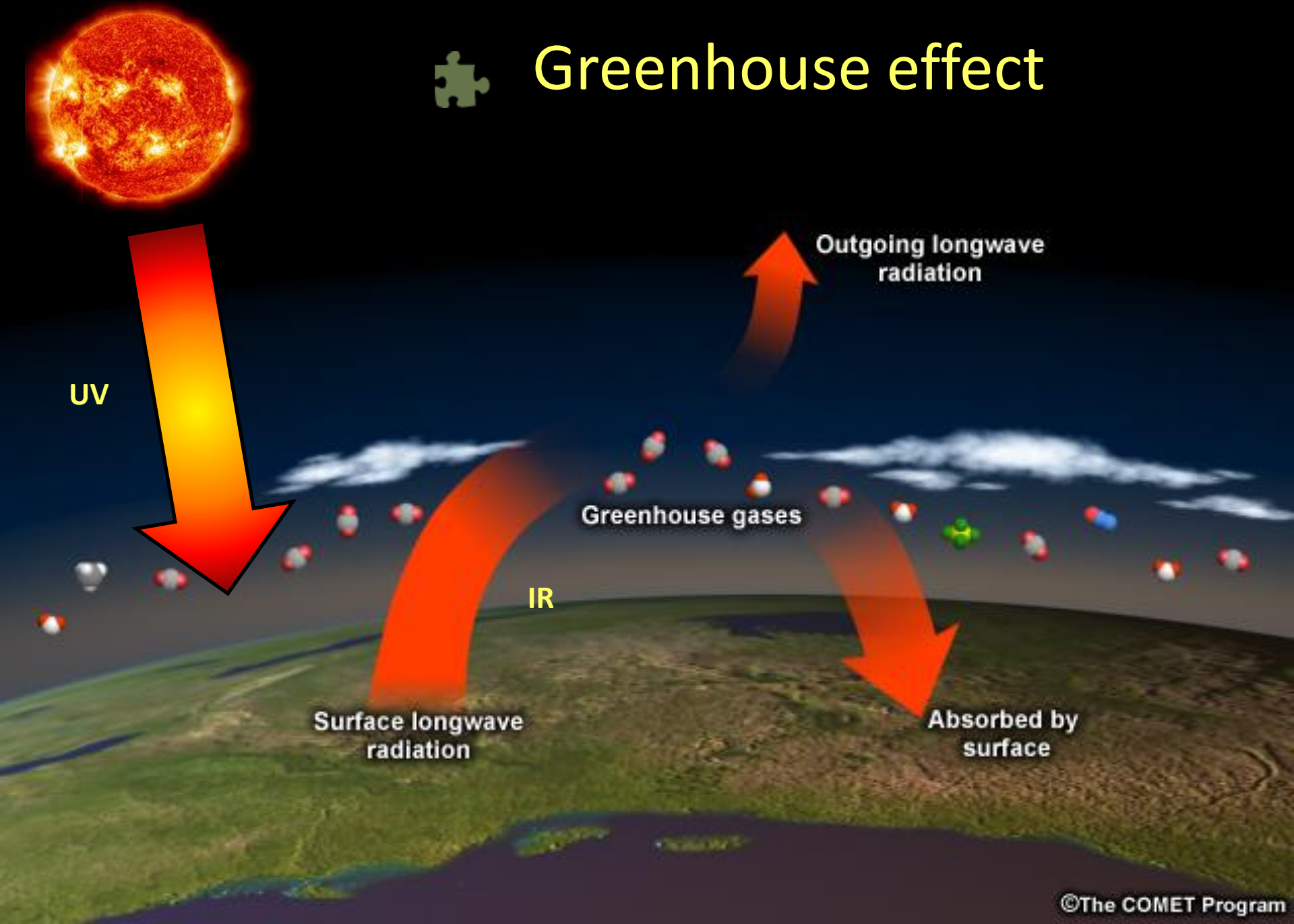
Anthropogenic contribution to climate change

- Greenhouse effect
- Air pollution
- Land use changes



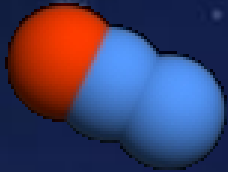


Greenhouse effect

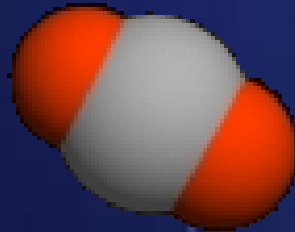




Greenhouse gases



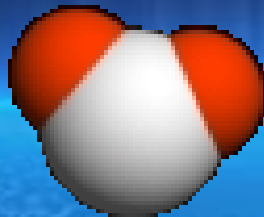
Nitrous oxide - N_2O



Carbon dioxide - CO_2



Methane - CH_4

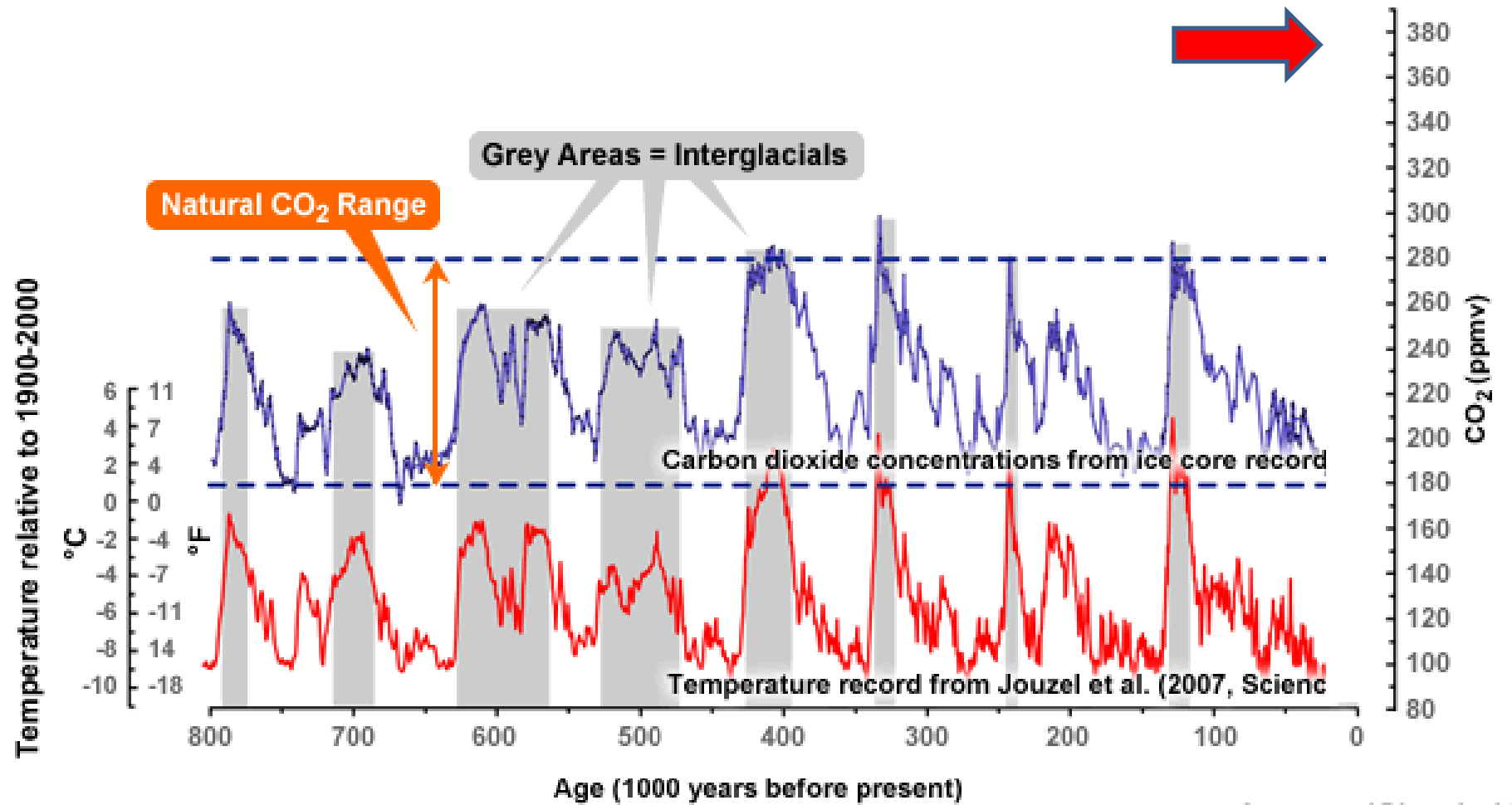


Water - H_2O



Sulfur hexafluoride - CFCs

Natural or anthropogenic sources?



Courtesy of Dieter Luthi



Land use changes

- Deforestation (1/3 of worldwide in South America – mainly in the Amazon region)
- To create agricultural land and pastures
- 1.6 billion tones /year of greenhouse gases are released in the atmosphere
- Change of the Earth's reflectivity

Biodiversity loss!!!

50.000 plant and animal species are approximately lost every year because of deforestation



Land use changes



In the next 24 hours, deforestation will release as much CO₂ into the atmosphere as 8 million people flying from London to New York!!!

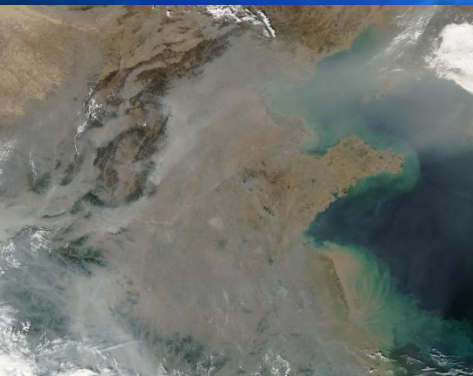


Air pollution

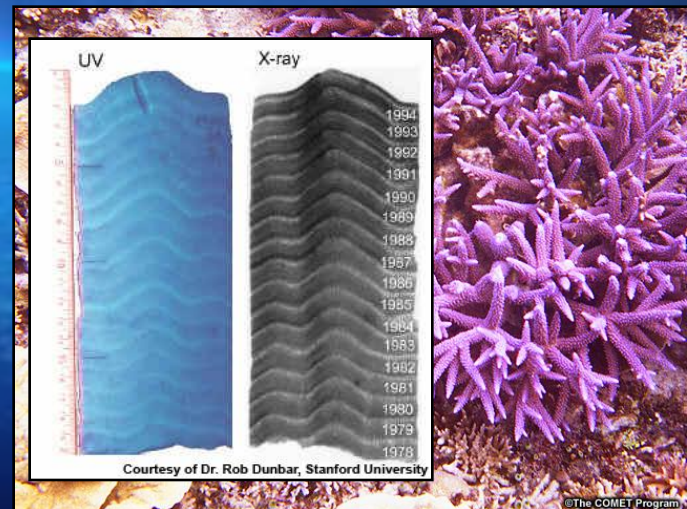
Anthropogenic:

- Biomass burning
- Industrial activities
- Transportation means

Aerosols production

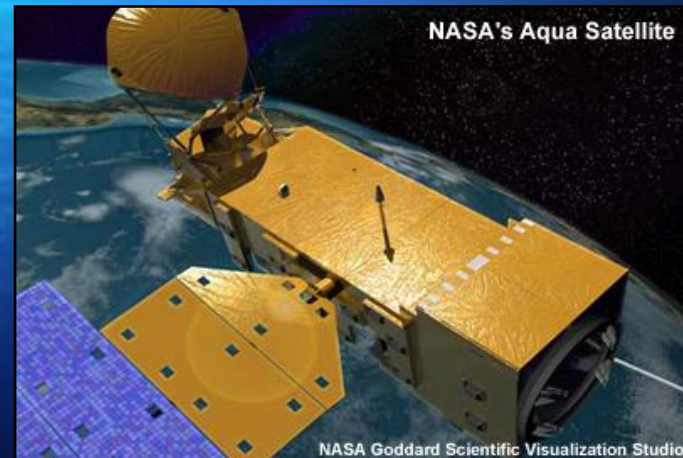


How we observe the changes?





Modern observations



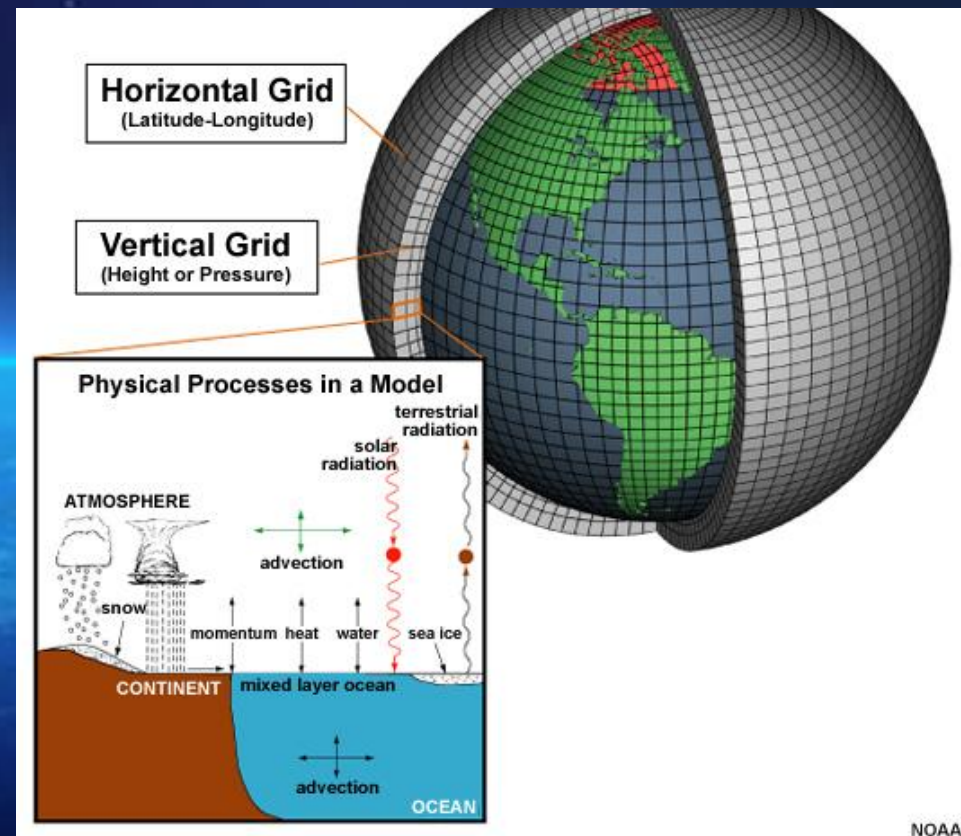


Climate models - Projections

- **Climate models:** are complex models that “run” on large computers and use meteorological observations, greenhouse gases and solar radiation as input data in order to simulate the evolution of climate by numerically resolving fundamental laws of physics

Three fundamental principles:
(i) conservation of momentum
(ii) energy conservation
(iii) conservation of mass

UNCERTAINTIES??



Climate models - Projections



$$\frac{\partial u}{\partial t} = \eta v - \frac{\partial \Phi}{\partial x} - c_p \theta \frac{\partial \pi}{\partial x} - z \frac{\partial u}{\partial \sigma} - \frac{\partial \left(\frac{u^2 + v^2}{2} \right)}{\partial x}$$

$$\frac{\partial v}{\partial t} = -\eta \frac{u}{v} - \frac{\partial \Phi}{\partial y} - c_p \theta \frac{\partial \pi}{\partial y} - z \frac{\partial v}{\partial \sigma} - \frac{\partial \left(\frac{u^2 + v^2}{2} \right)}{\partial y}$$

$$\frac{\partial T}{\partial t} = \frac{\partial T}{\partial t} + u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y} + w \frac{\partial T}{\partial z}$$

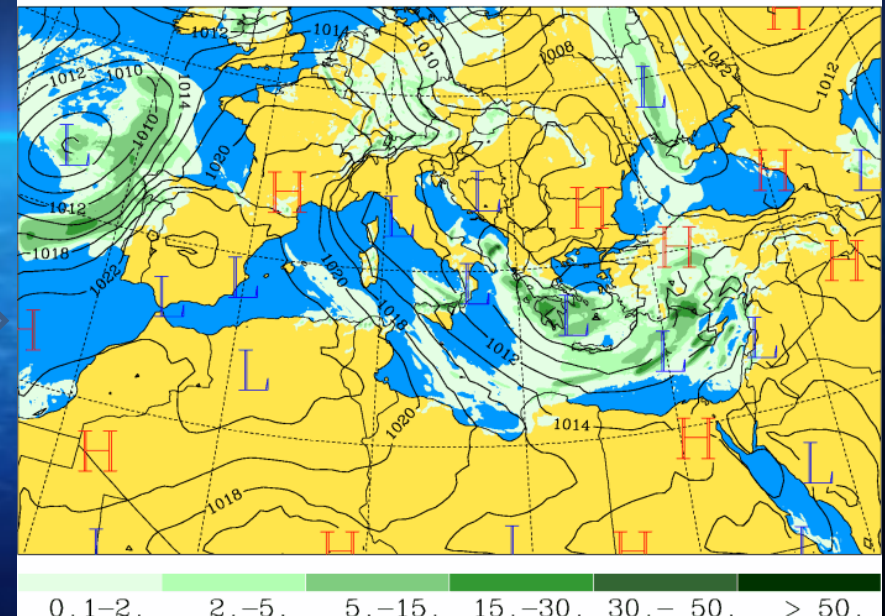
$$\frac{\partial W}{\partial t} = u \frac{\partial W}{\partial x} + v \frac{\partial W}{\partial y} + w \frac{\partial W}{\partial z}$$

$$\frac{\partial \partial p}{\partial \sigma} = u \frac{\partial \partial p}{\partial x} \frac{\partial p}{\partial \sigma} + v \frac{\partial \partial p}{\partial y} \frac{\partial p}{\partial \sigma} + w \frac{\partial \partial p}{\partial z} \frac{\partial p}{\partial \sigma}$$



University of Athens (AM&WFG)
6-h accum. precipitation (mm)

SKIRON NonHydrostatic
Thu 06.12.12 at 12 UTC

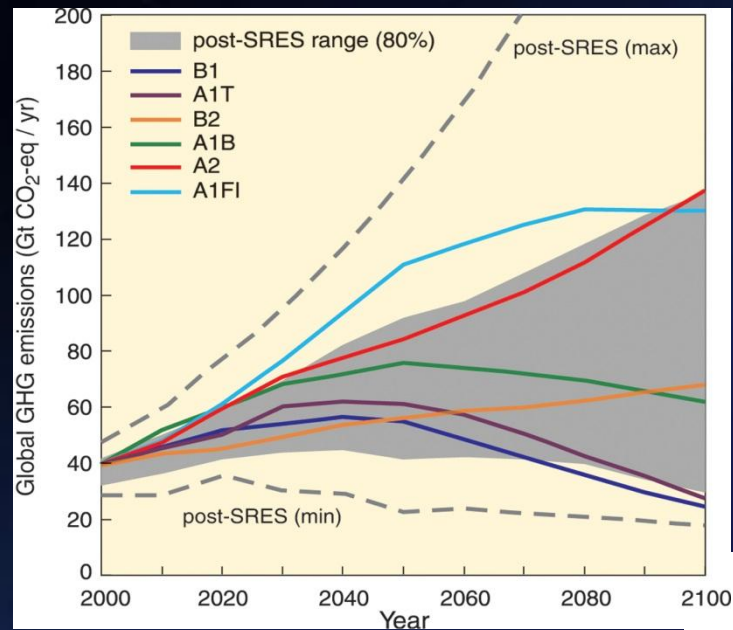




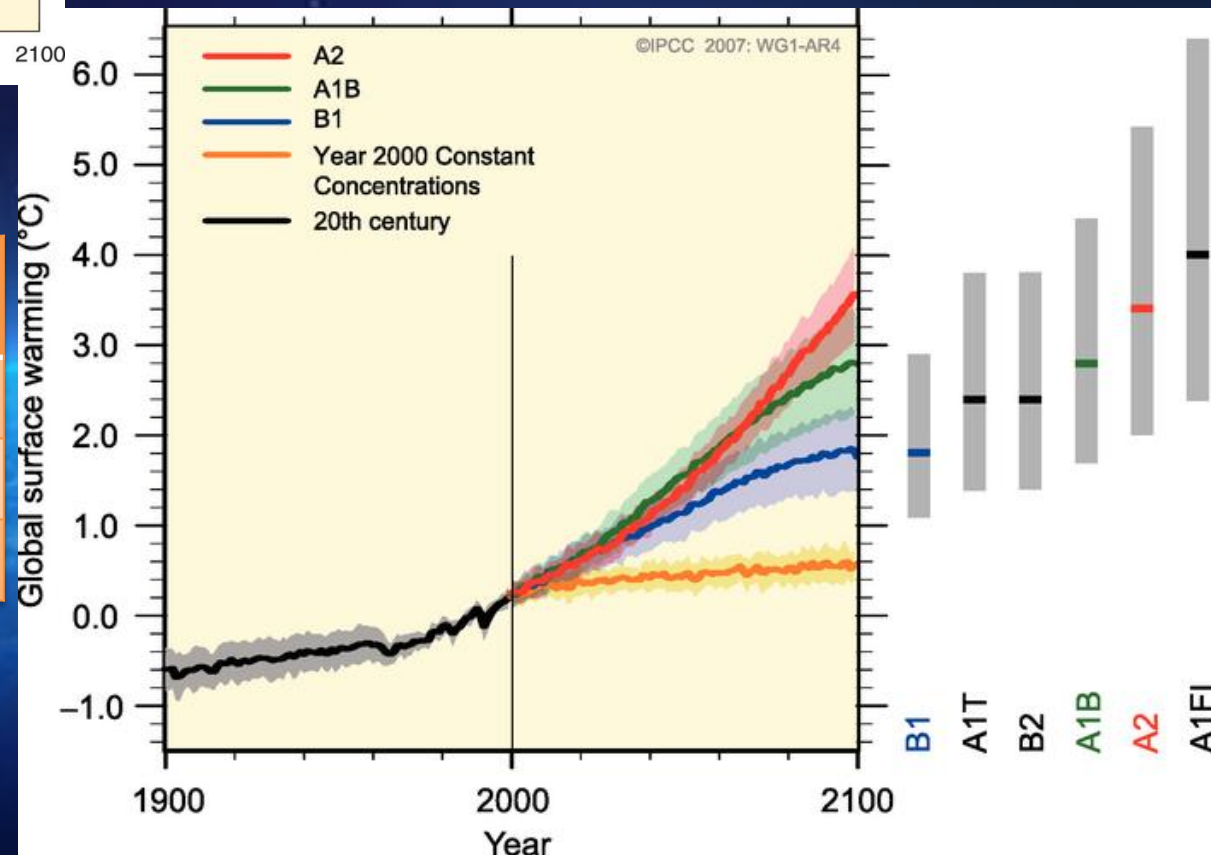
Projections

Different scenarios depending on:

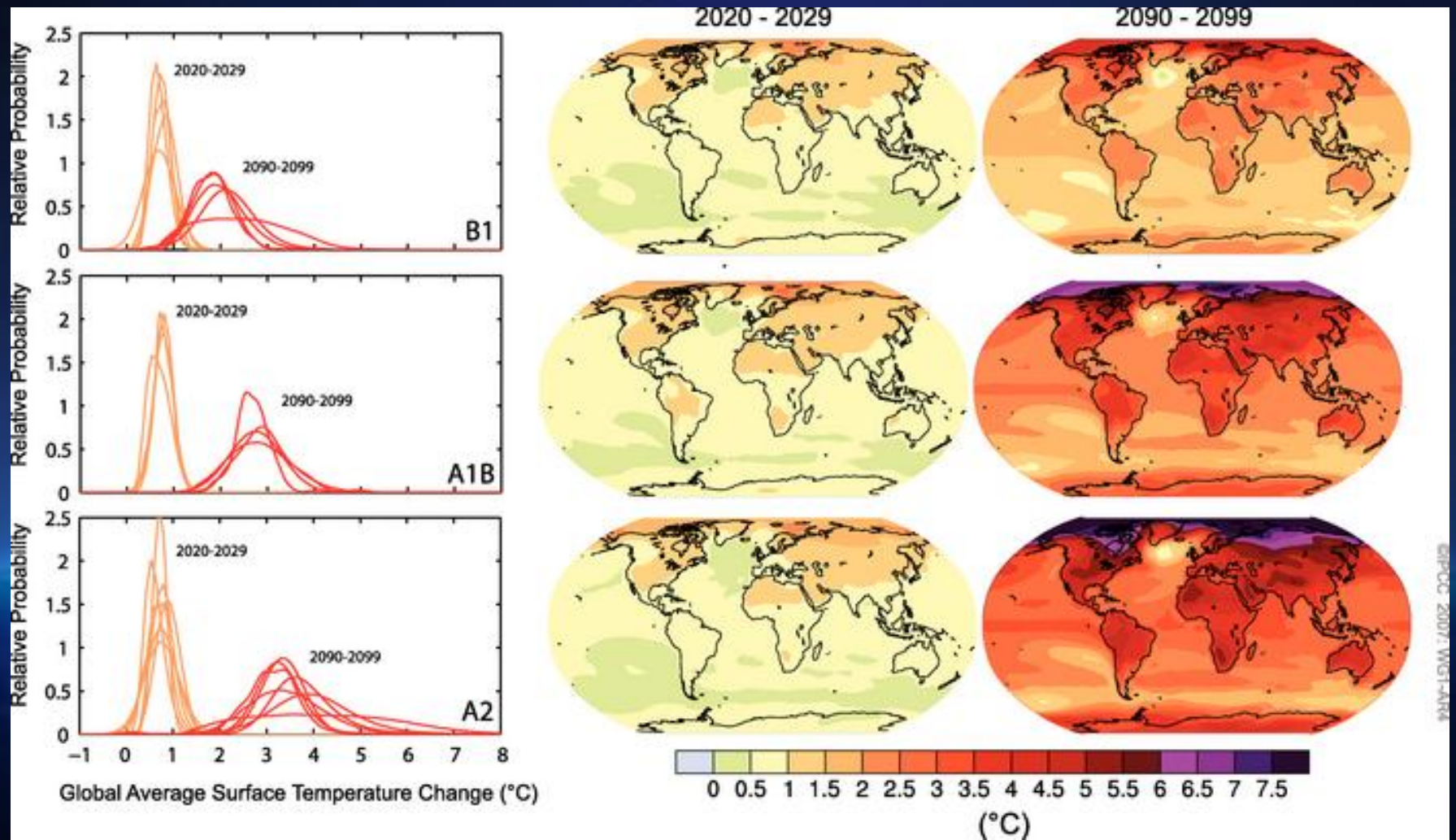
- (a) population
- (b) use of fossil fuels
- (c) introduction of new technologies
- (d) socio-political aspects



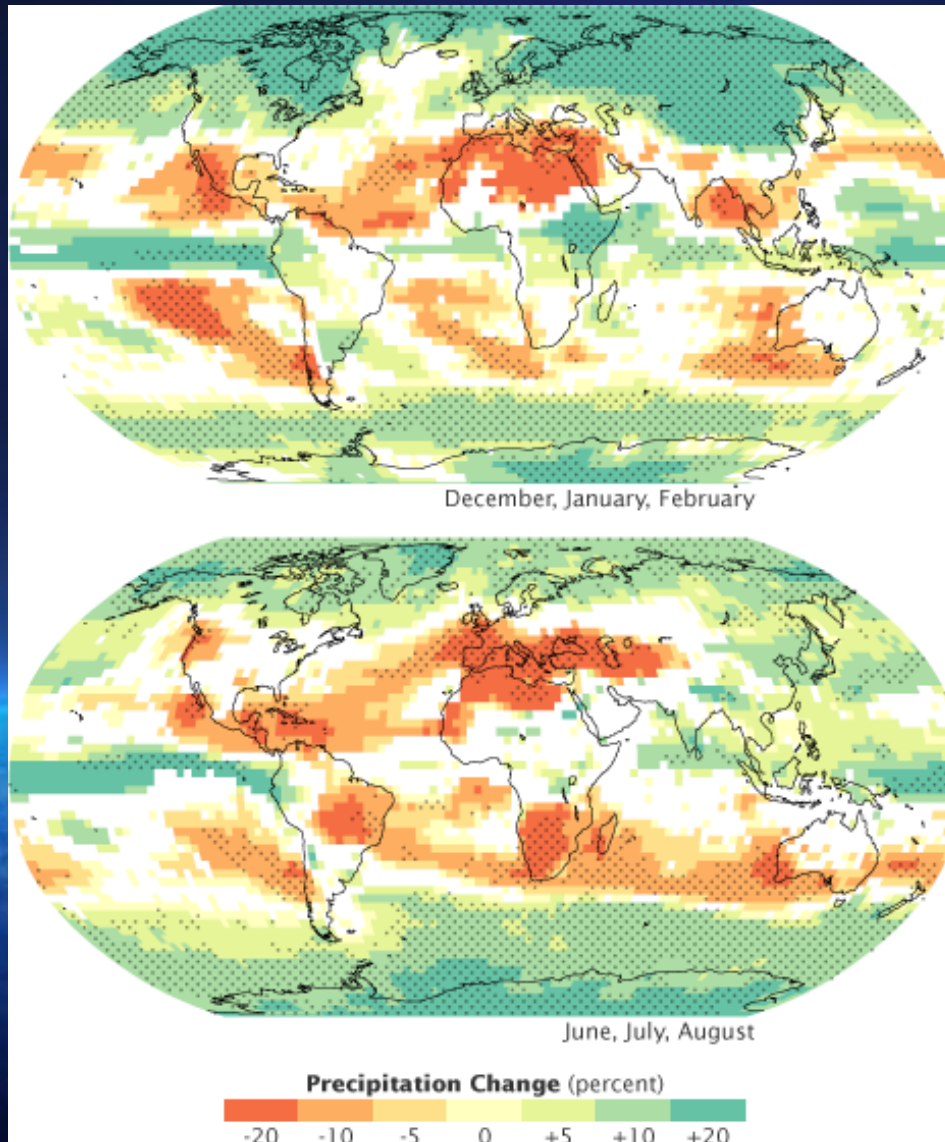
Scenario	Emissions	T Increase
A2	High	3.5°C
A1B	Medium	2.9°C
B1	Low	1.9°C



Temperature increase



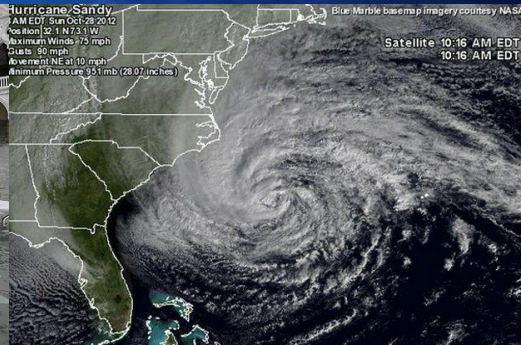
Changes in precipitation



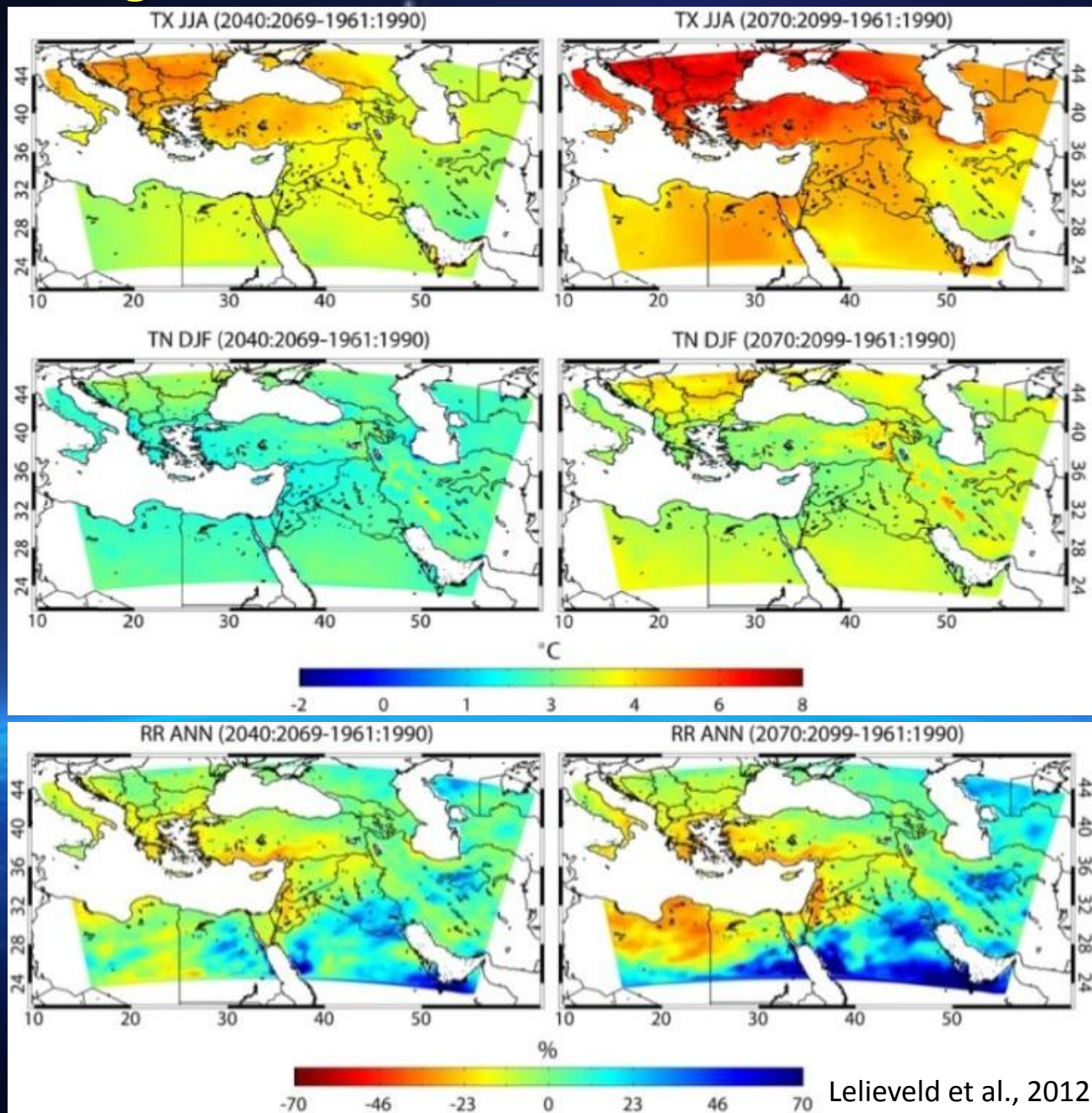


Impacts of Climate Change

- Temperature increase
- Ice melting – Sea level rise
- Change in precipitation regimes
- Changes in extreme events (floods, heat waves, droughts)



Climate change - Eastern Mediterranean

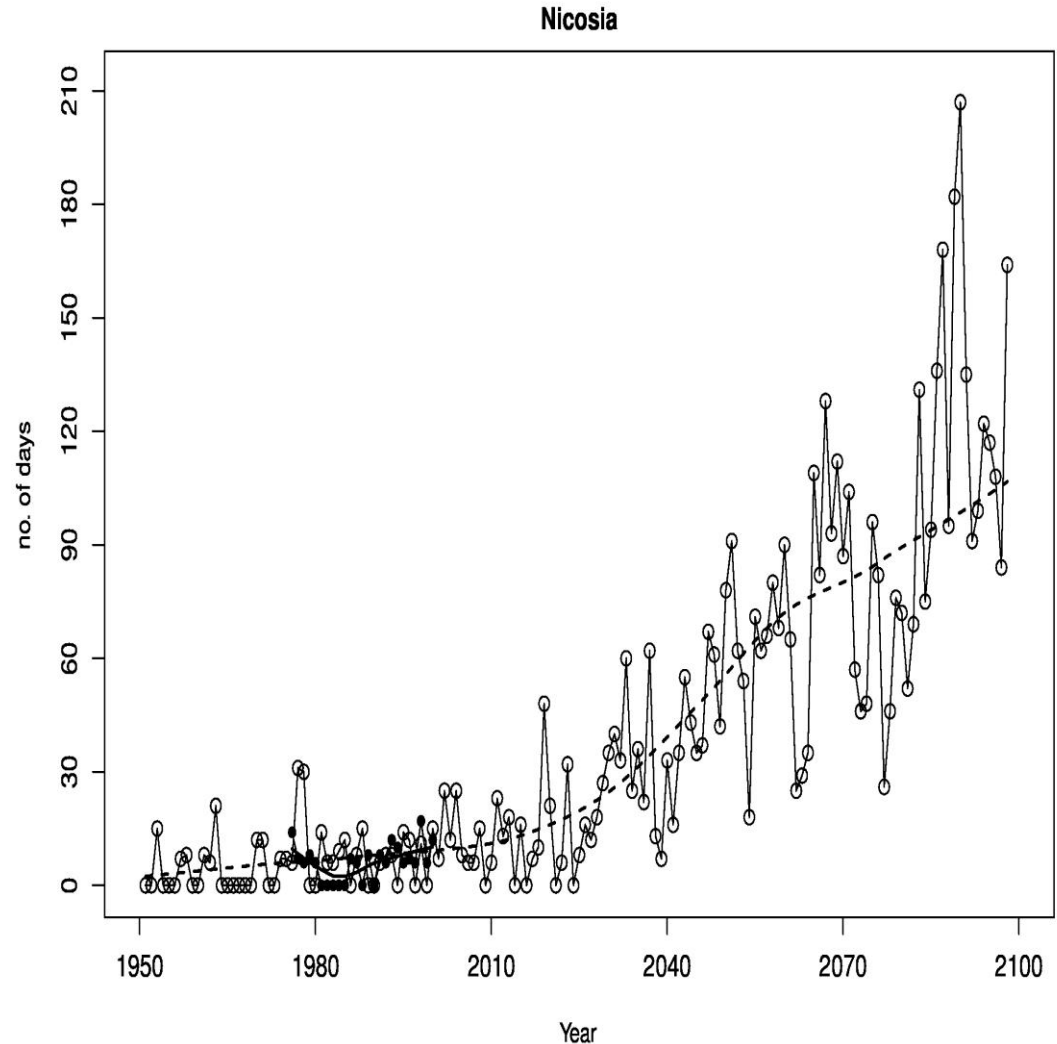


Climate projections: Heat waves

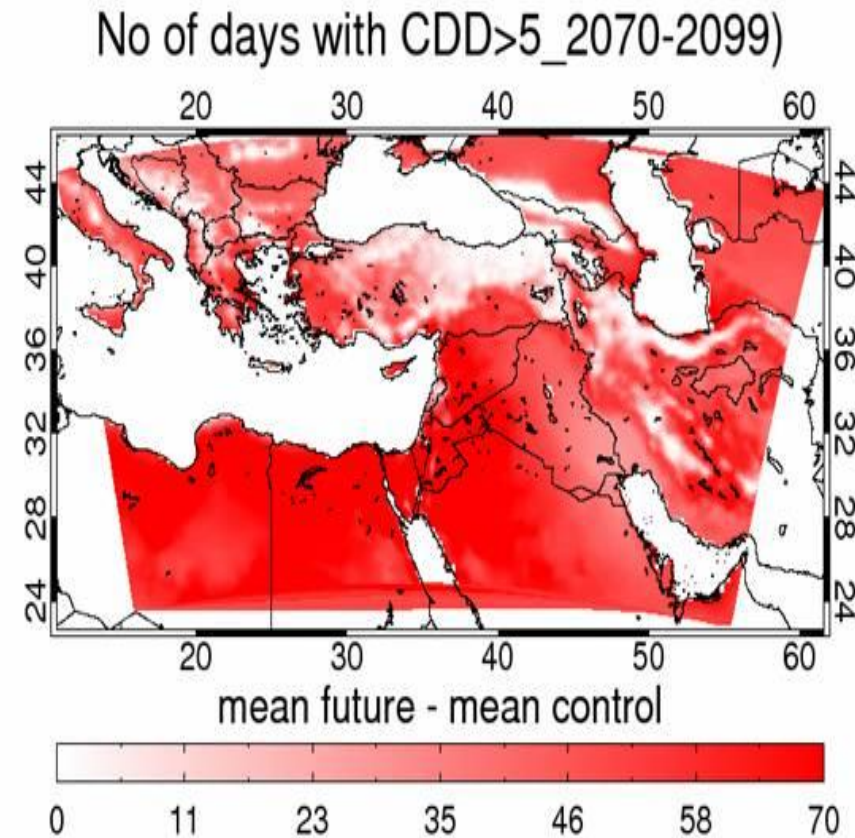
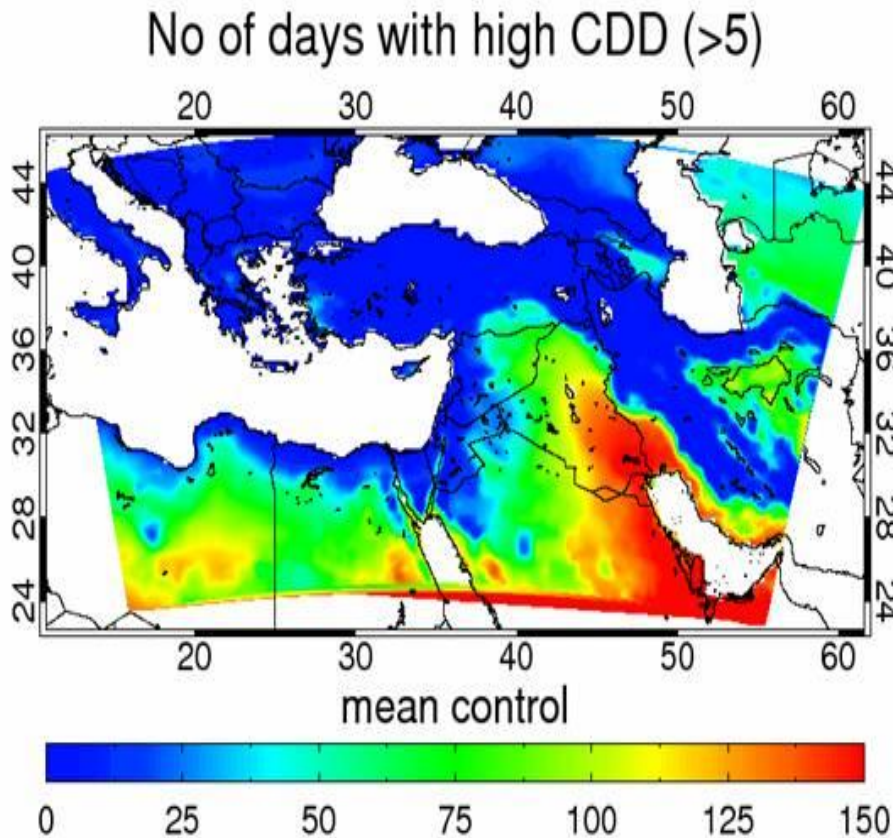
PRECIS model projections

Increased number of heat wave
days per year

Time series of HWD90 based on observations (solid circles) and model calculations (open circles).



Energy demand increase



Cooling Degree Days:
 $CDD_i = \max (T_i - 25^{\circ}\text{C}, 0)$

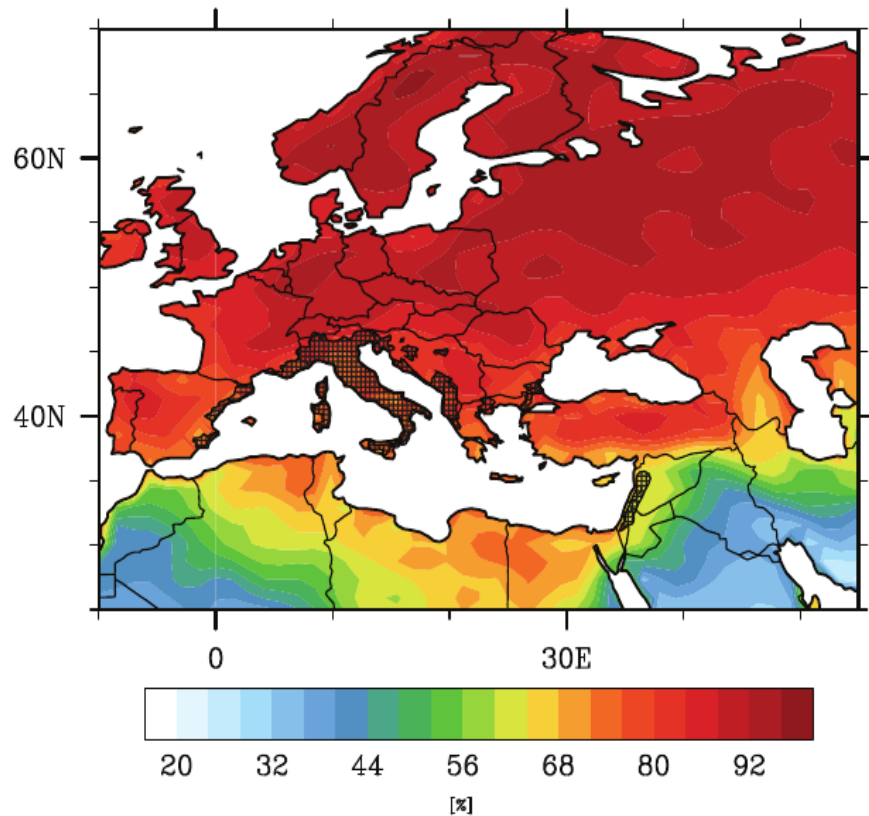
Severity of summer conditions ->
Energy demand for buildings

CDD(>5):
Heavy cooling demand

Impacts on health (examples)

- Spread of vector borne diseases due to climate change

Winter RH



Waldock et al., *Pathogens Global Health*, 2013

- Air pollution (O_3 , aerosols) and mortality

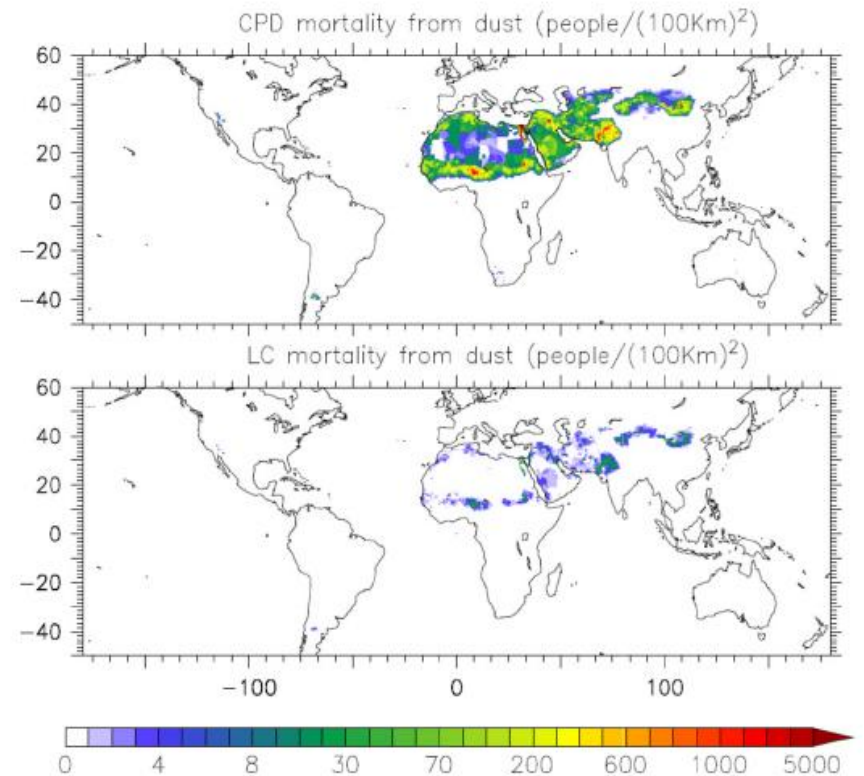
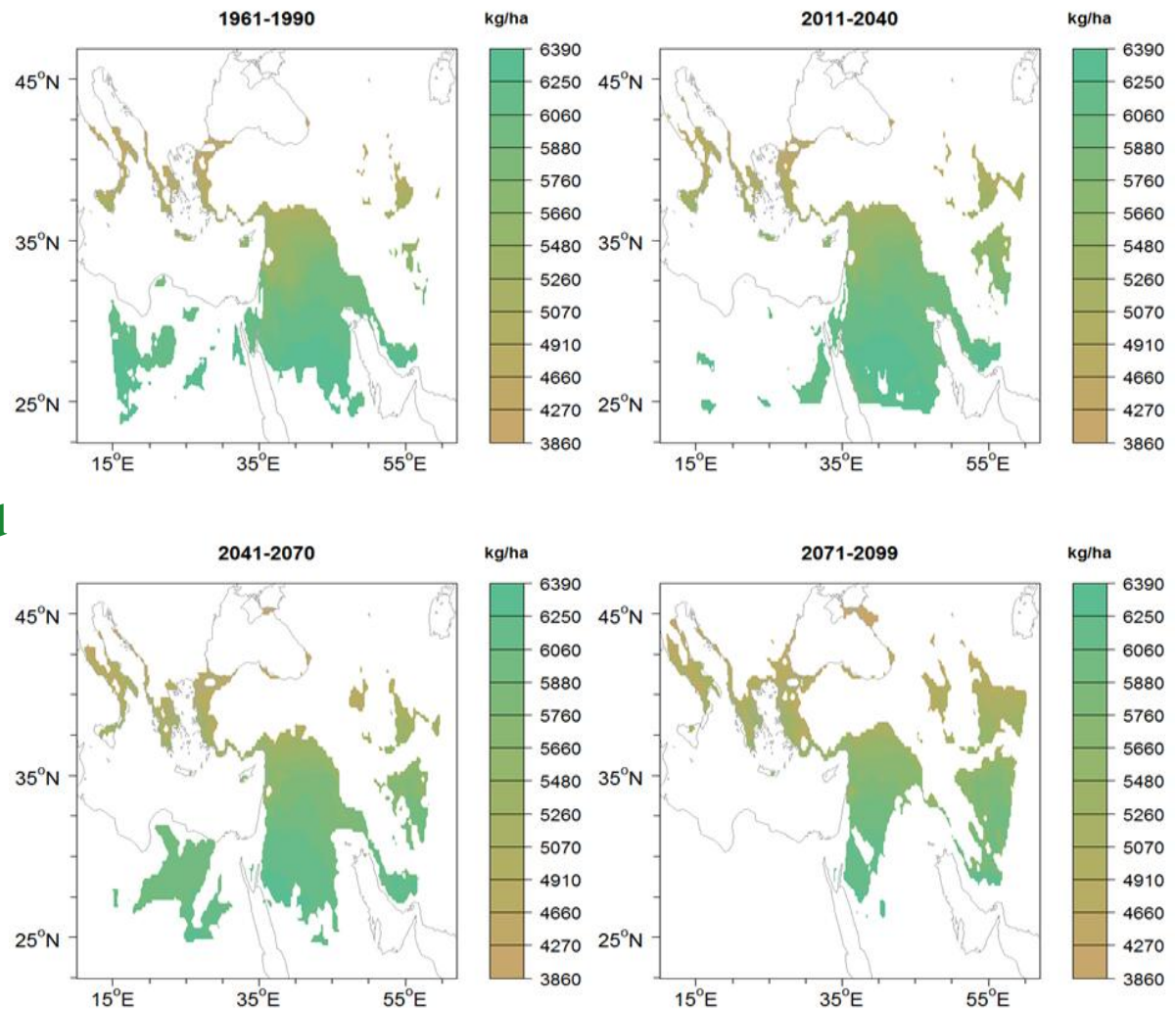


Fig. 2. Global premature mortality by cardiopulmonary disease (top) and lung cancer (bottom) (in individuals per $100 \times 100 \text{ km}^2$) due to dust ($DU_{2.5}$) for the population ≥ 30 yr in 2005.

Giannadaki et al., *Atm.Chem. Phys.*, 2014

Impacts on agriculture

Example: Thermal effect on potential yields of wheat (durum wheat) using the agro-ecological zones method (GAEZ) and results from PRECIS regional climate model.



Change in Yield potentials of durum wheat in the EMME region in throughout the 21st century



Possible impacts for Cyprus

- Energy
- Tourism
- Health
- Water resources
- Agriculture
- Plants/
Animals



Actions on individual level



Use of public
transportation
and bicycles



Energy
efficiency
control in
buildings/
insulation



Recycling /
reduce waste



Reforestation,
limitation of wildfires



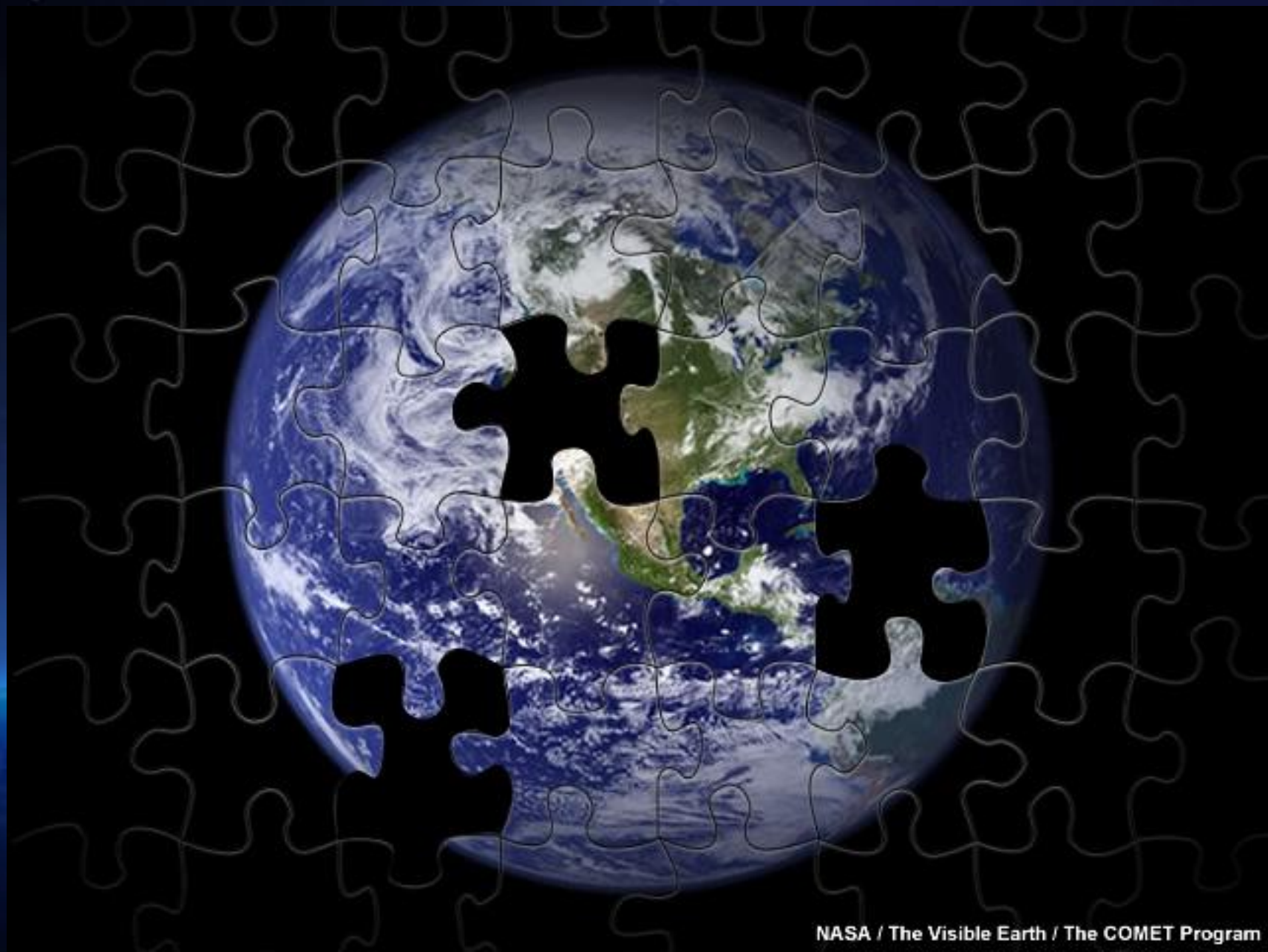
Proper use of
water resources



Wise use of
electricity
(disconnect
devices)

Renewable
energy sources





NASA / The Visible Earth / The COMET Program

Thank you for your attention

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