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CitizensHip cOmpetences to tackle clImate ChangEs

Introduction to Climate Change

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Outline

1. Climate: what it is and what it is not
2. Climate Change: observations, evidences, and projections
3. Climate change mitigation and adaptation strategies

Why it is important to understand Climate Change?

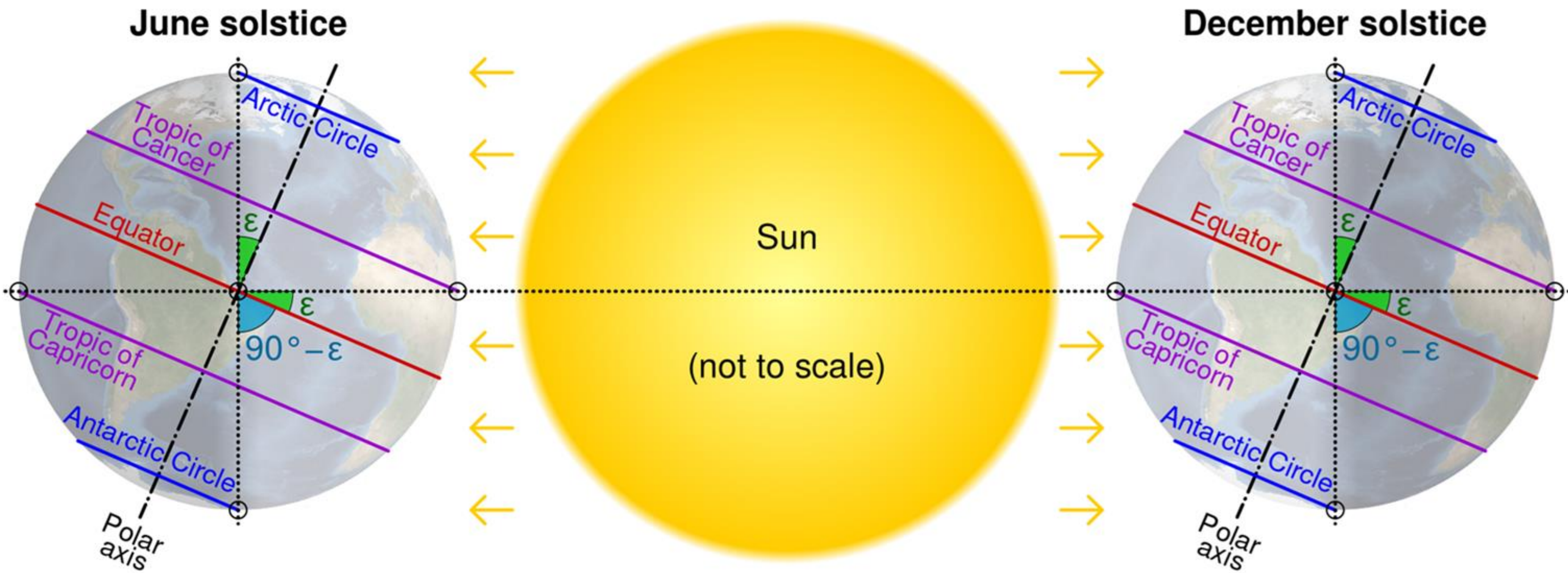
- Knowing the **difference between *weather* and *climate*** is the first step to pinpoint the two phenomenons and their differences
- **Understanding climate processes** is essential to recognise the limits and the uncertainties related to mitigation strategies
- Models, observations and measurements are the ingredients of understanding **climate change evident and subtle effects**

Section 1
Climate

What it is and what it is not

What does «climate» mean?

From the Ancient Greek Κλίμα, meaning «*slope*», «*inclination*»



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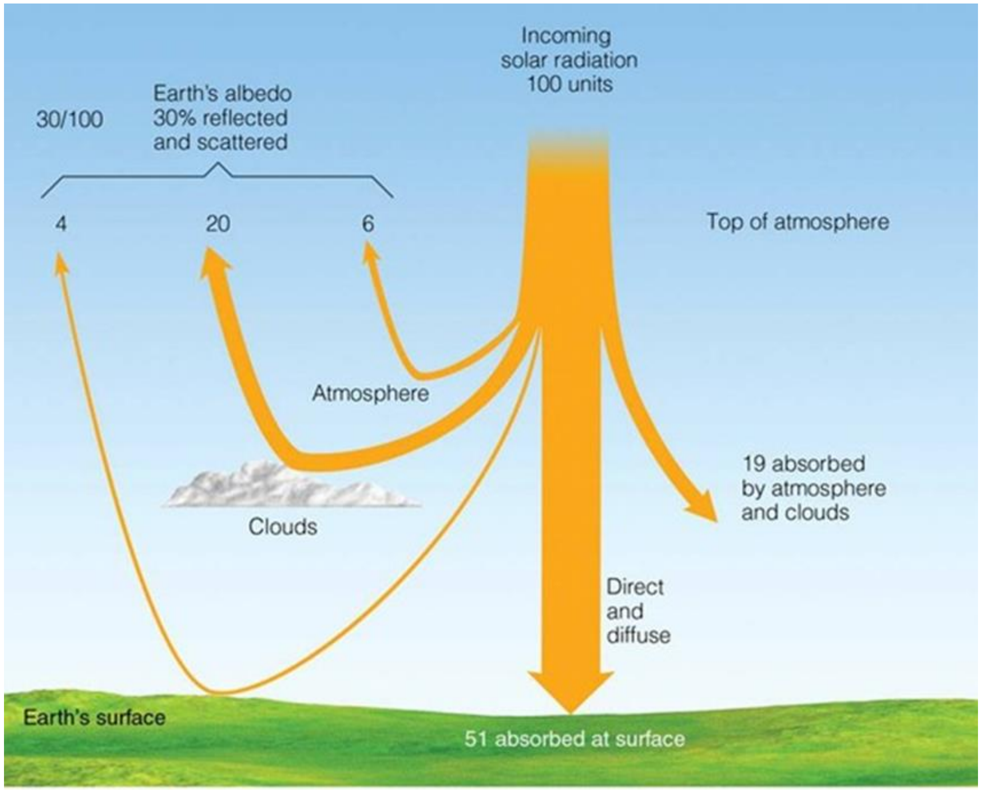
How does radiation work?



The Earth's climate system depends entirely on the Sun for its energy. Solar radiation **warms the atmosphere and is fundamental to atmospheric composition**, while the distribution of solar heating across the planet produces global wind patterns and contributes to the formation of **clouds, storms, and rainfall.**

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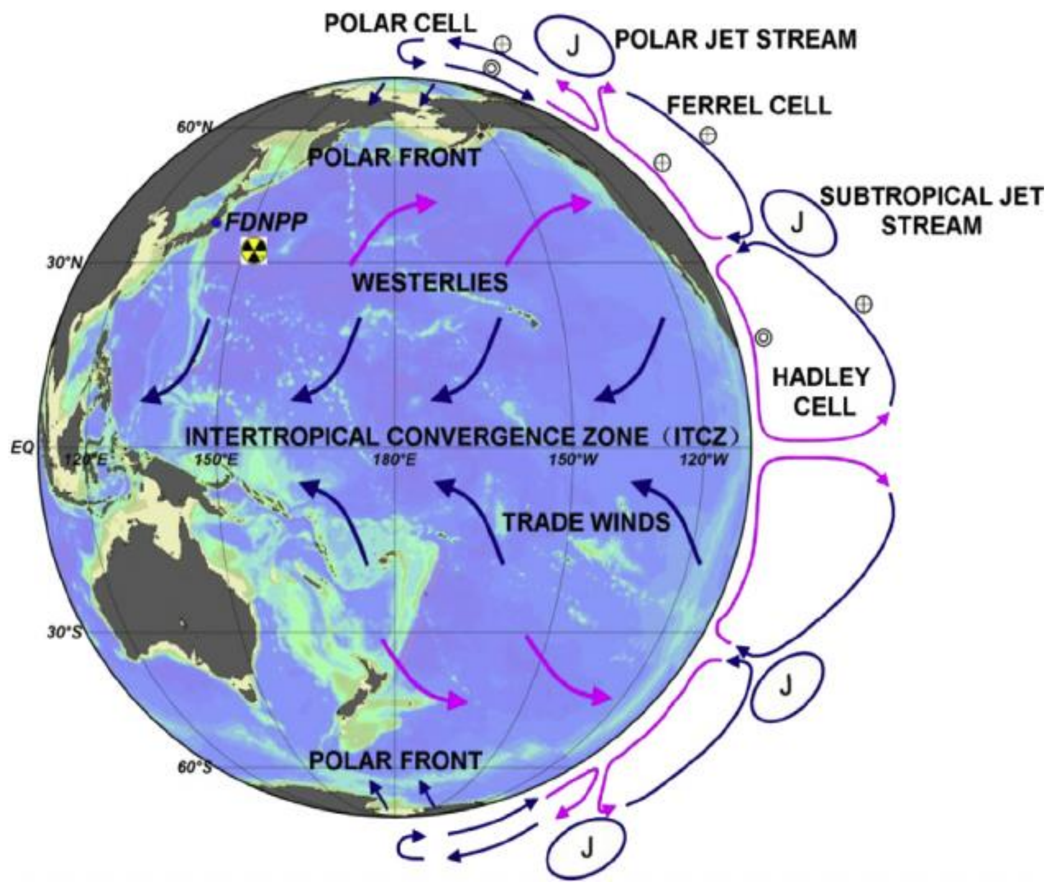
Atmospheric Symmetric Circulation



Atmospheric circulation **transports heat over the surface of the Earth that affects the water cycle, including the formation of clouds and precipitation events**. The movement of air masses brings us our daily weather, and long-term patterns in circulation determine **regional climate** and ecosystems.

Meteorology and Climatology

μετέωρος *meteōros*

μετα- *meta-* "above"

ἀείρω *aeiro* "I lift up"

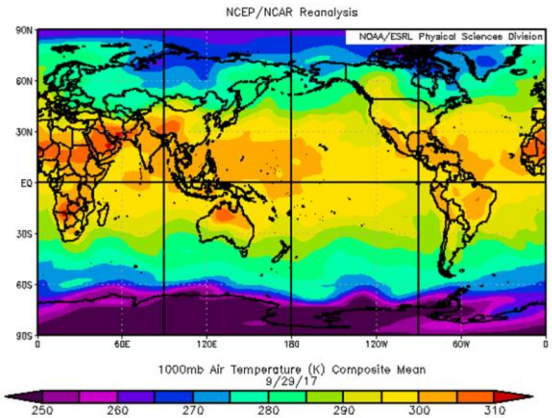
-λογία *-logia* "-(o)logy",

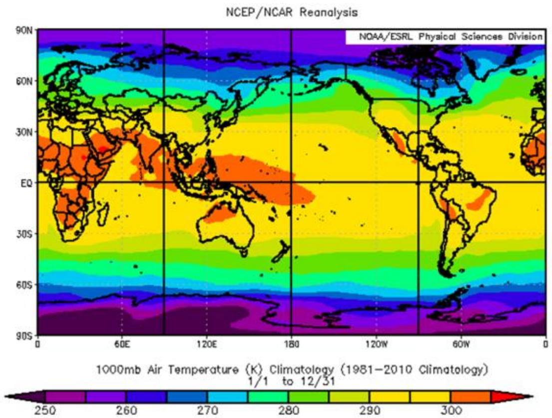
"the study of things which are in the air, in the sky or above us "

It specifies that there is **a location (above us)** and **an observation**

Meteorology and Climatology

Meteorology focuses on *short-term weather events* lasting up to a few weeks, whereas **climatology** studies the *frequency and trends* of those events *over years*.





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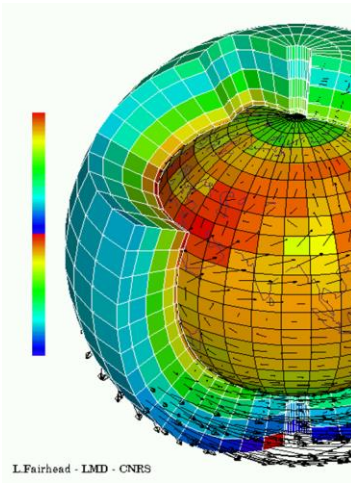
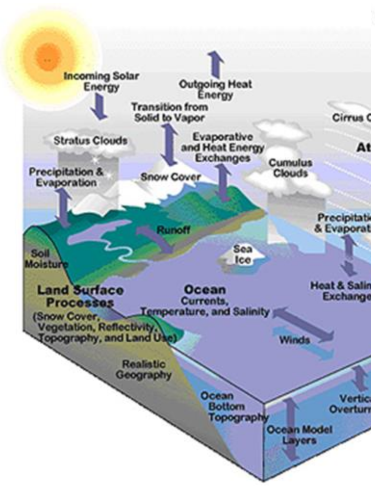
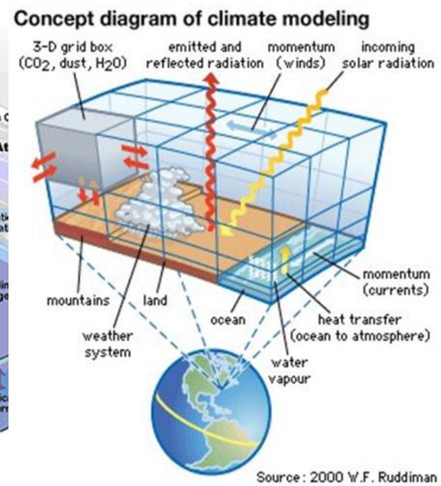
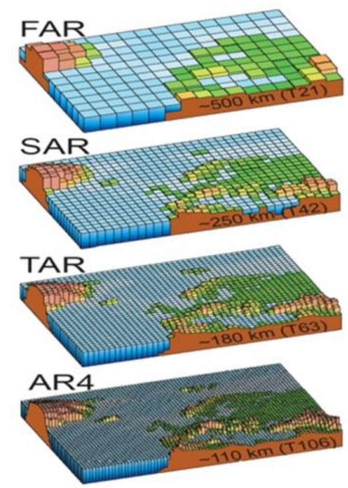
Climate Model

Do we have any instruments to assess the future?









Unlike weather forecasts, which describe a detailed picture of the expected daily sequence of conditions starting from the present, climate models are **probabilistic**, indicating areas with higher chances to be warmer or cooler and wetter or drier than usual. Climate models are **based on global patterns in the ocean and atmosphere**, and records **of the types of weather that occurred under similar patterns in the past**.

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Section 2
Climate Change

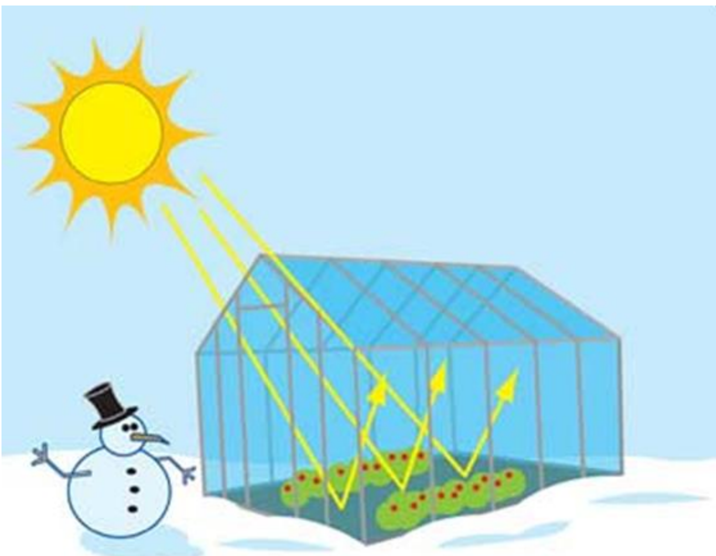
Observations, evidences and projections

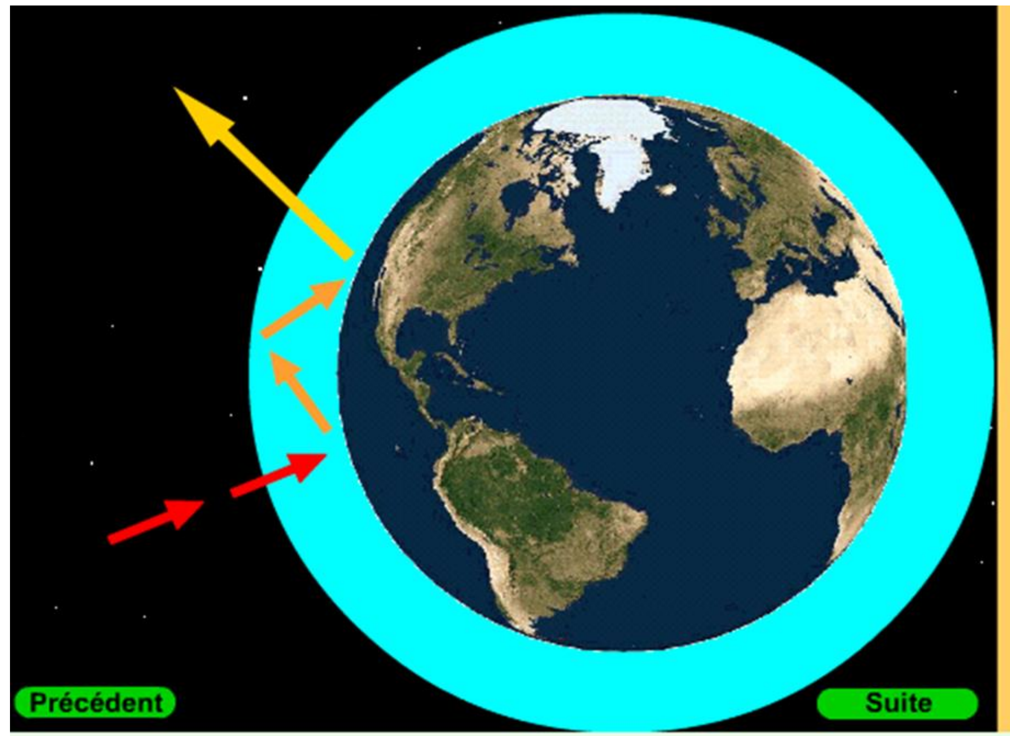
Greenhouse Effect

A greenhouse stays warm inside, even during the winter. In the daytime, sunlight shines into the greenhouse and warms the plants and air inside.

The greenhouse effect is a **process** that occurs when **gases in Earth's atmosphere trap the Sun's heat.** This process makes **Earth much warmer** than it would be without an atmosphere. The greenhouse effect is one of the things that **makes Earth a comfortable place to live**.
(Climate Kids – NASA)

Greenhouse Effect





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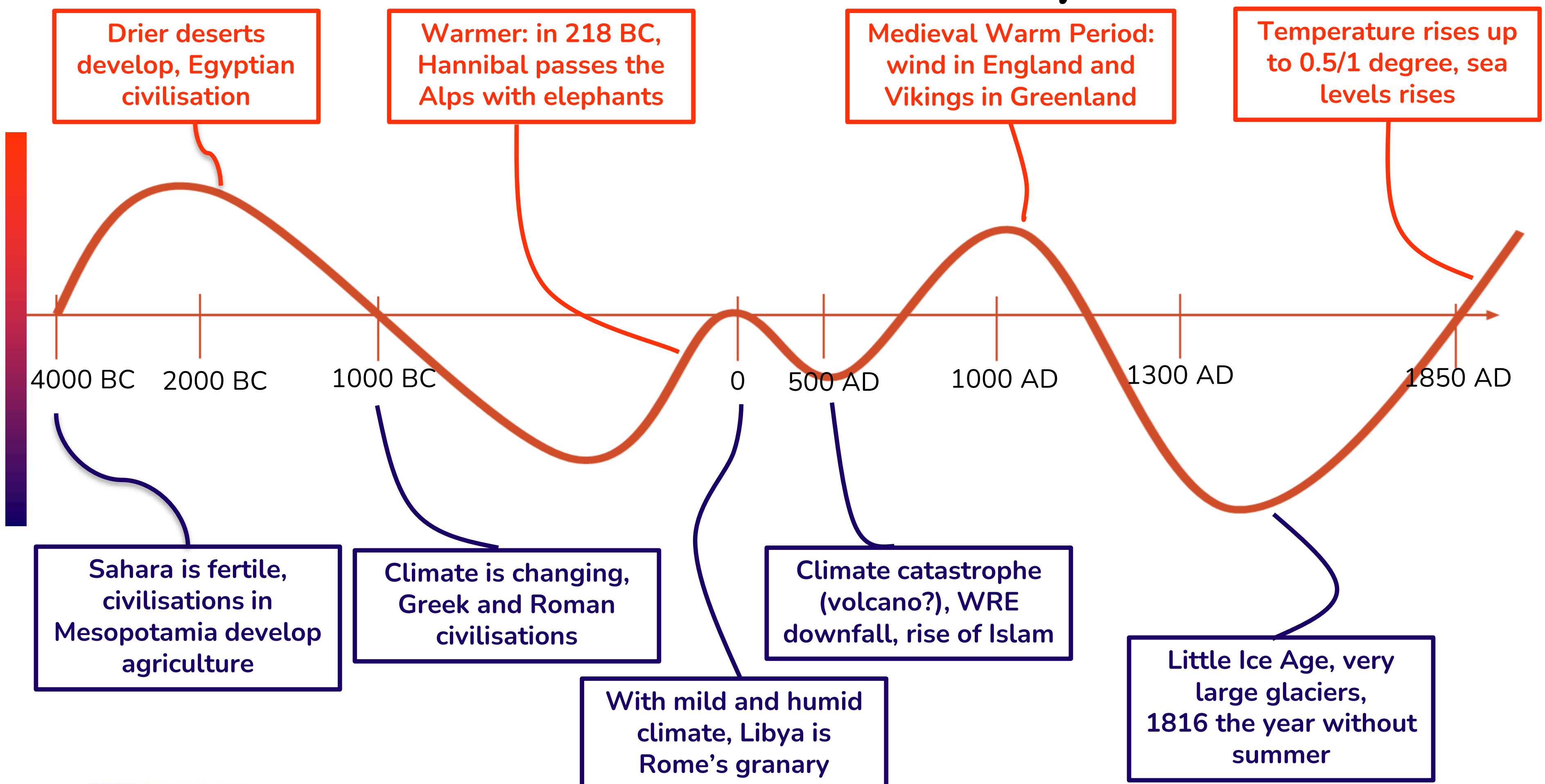
Climate and History



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Ice Ages

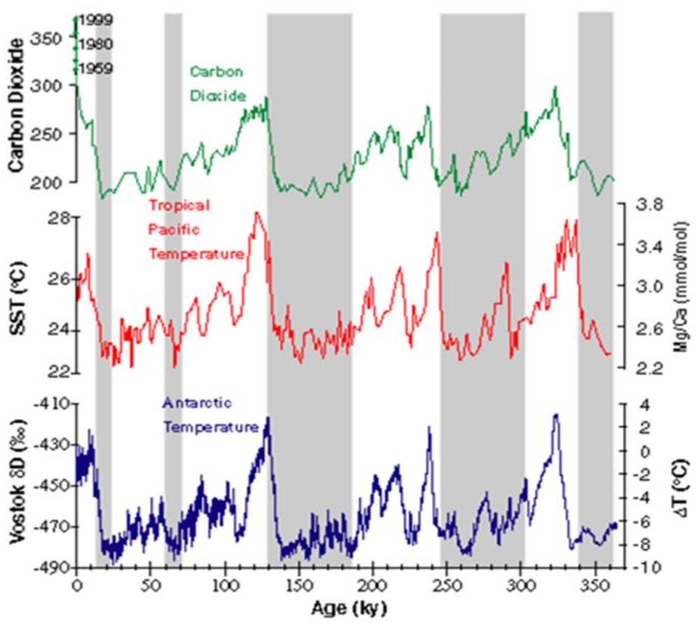
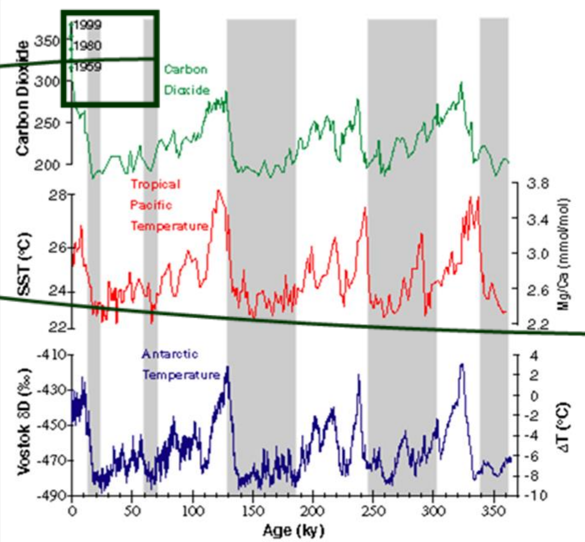


Figure by David Lea, UCSB, 2001. Data from Petit et al., 1999, Nature **399**, Lea et al., 2000, Science **289** and Keeling et al., 2000, NGDC database.

- CO_2 (Green)
- Surface Temperature on tropical pacific ocean (red)
- Antartic Temperature (Blue)

Ice cycle is about 100.000 years

We have a problem



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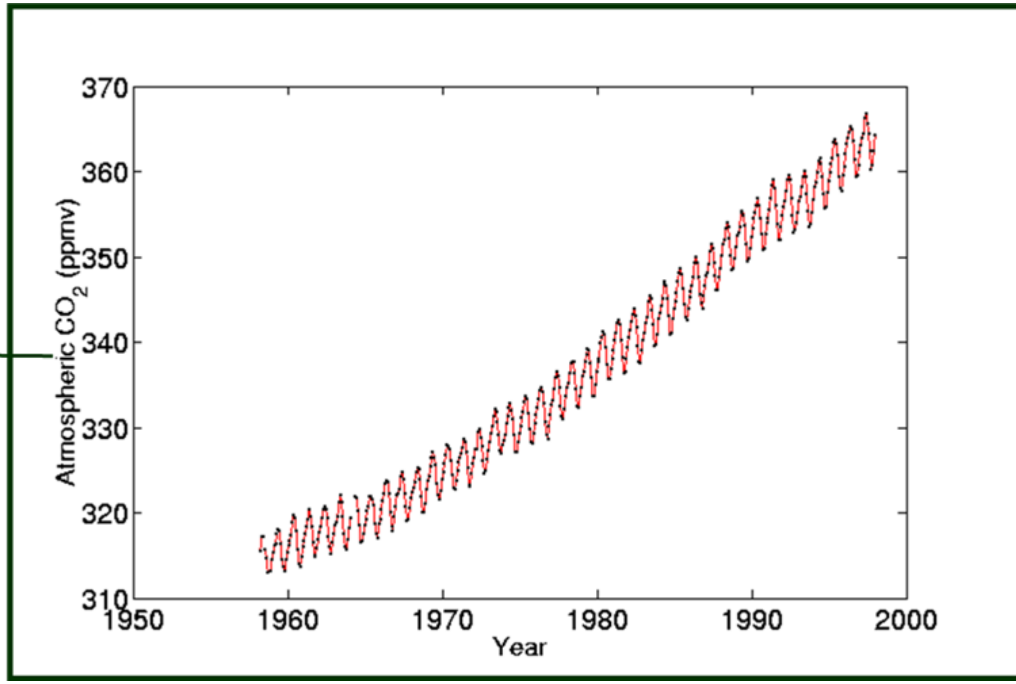
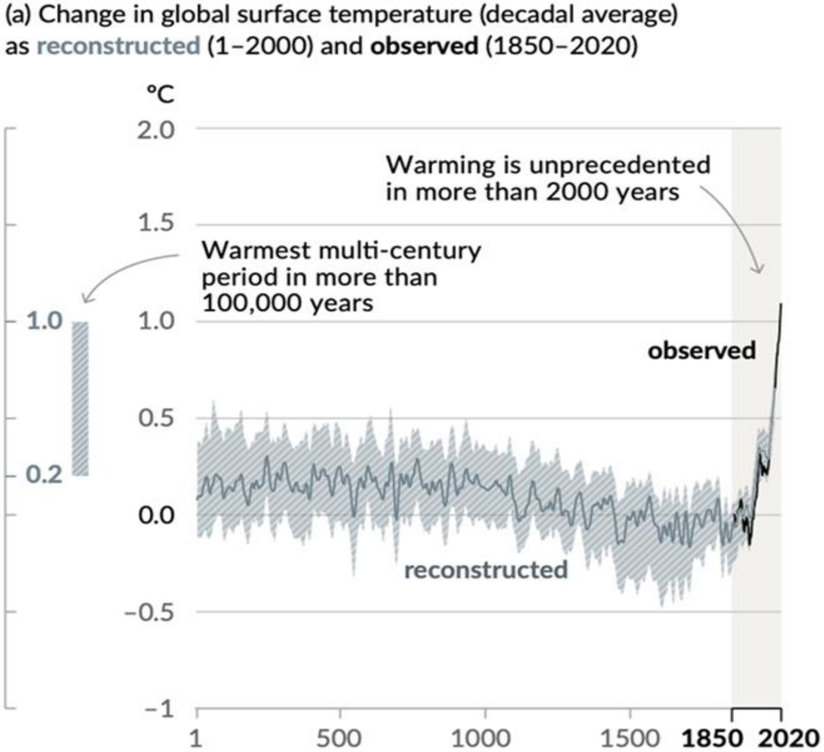
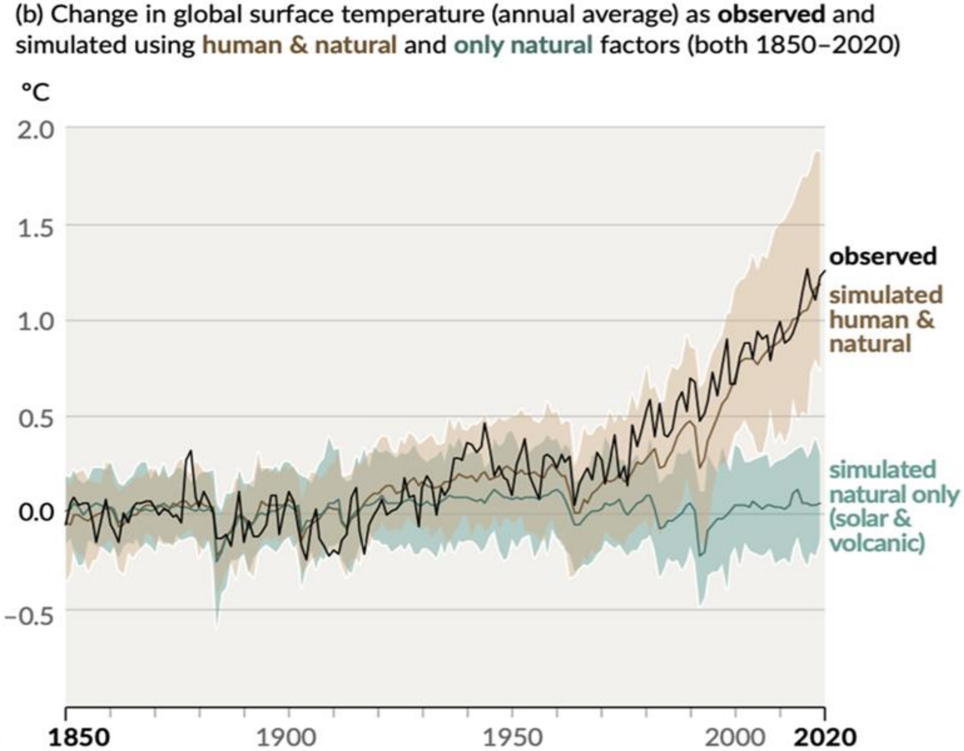


Carbon Dioxide concentration is increasing at a rate never recorded before.

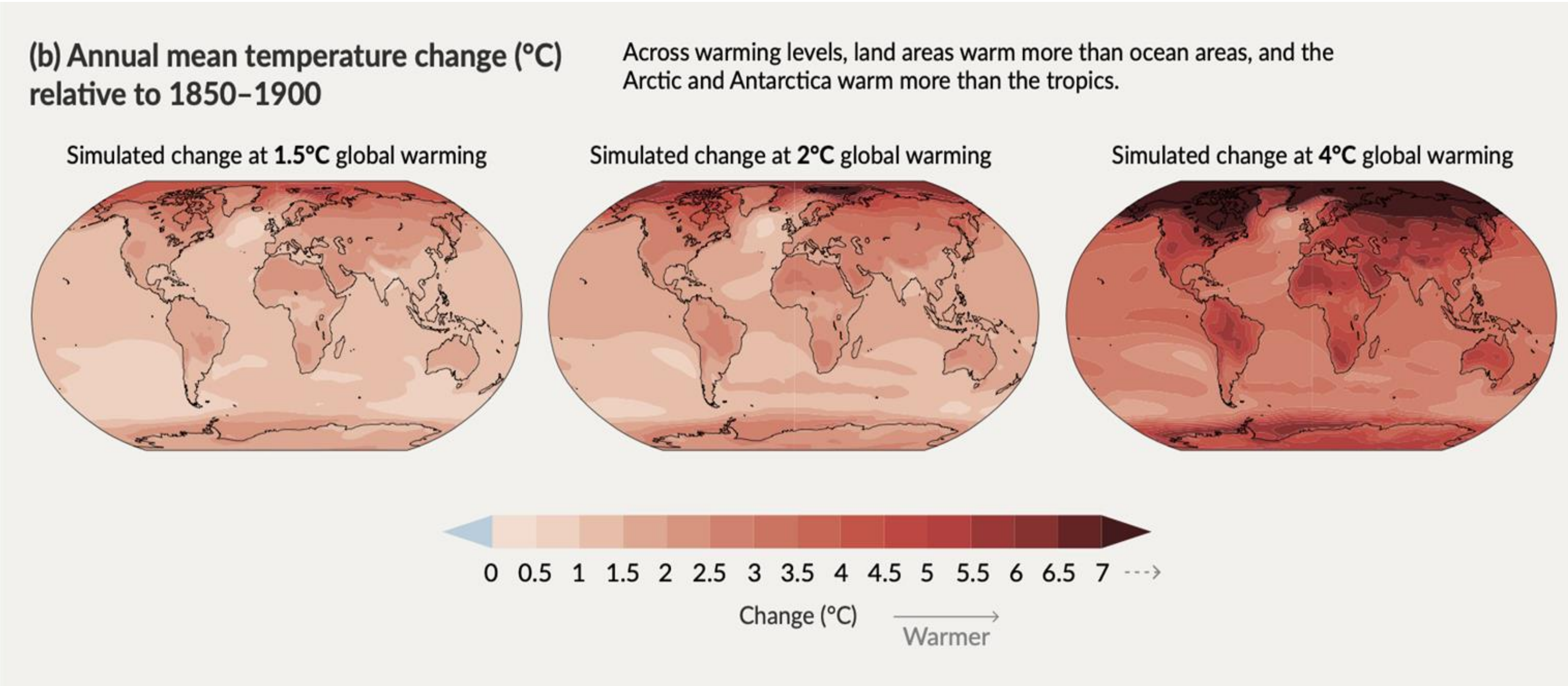
Current Climate Change

Changes in global surface temperature relative to 1850–1900

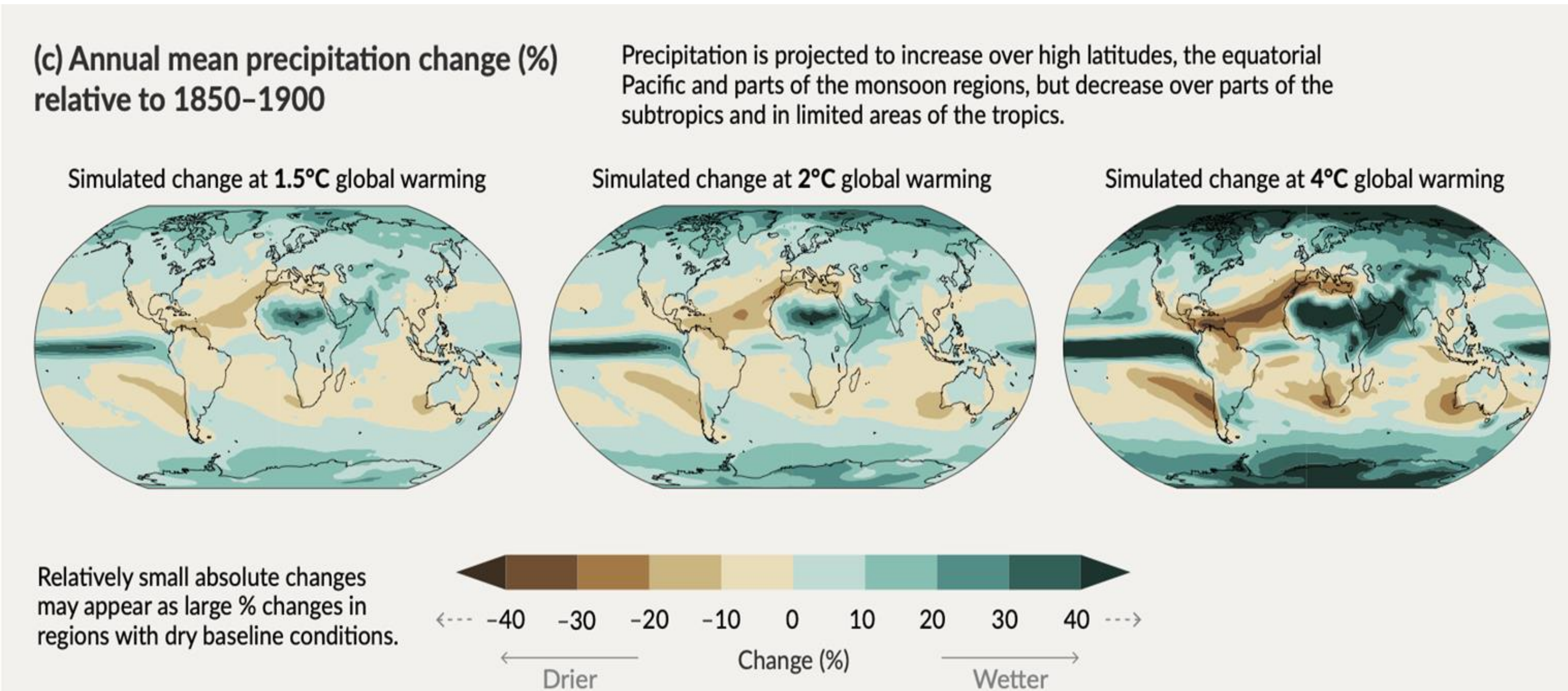




Temperature



Precipitations



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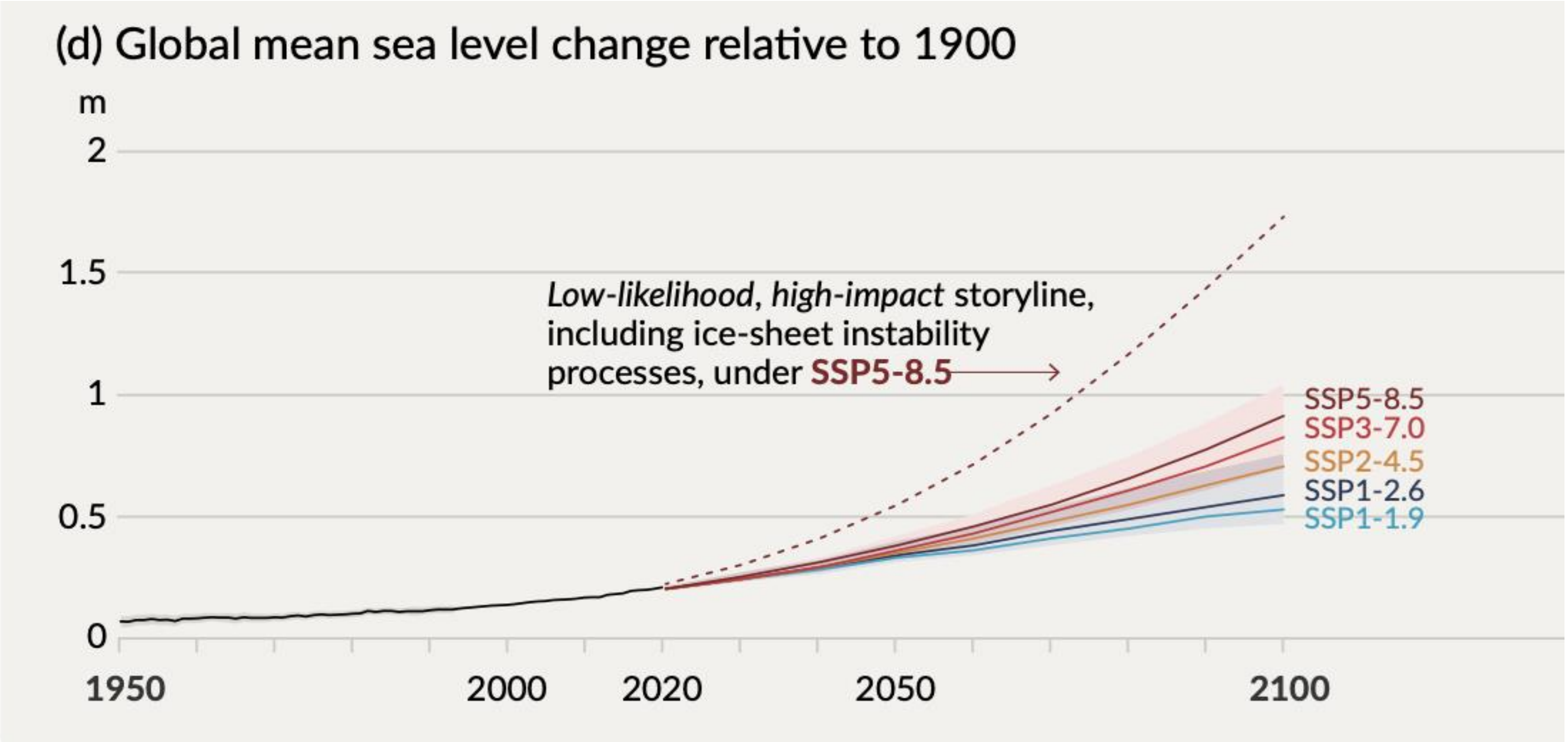
Sea Levels



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Section 3
Climate Change
Mitigation & Adaptation

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Mitigation VS Adaptation

Mitigation – *reducing Climate Change*
Involves **reducing** the flow of heat-trapping greenhouse gases into the atmosphere

Adaptation – *adapting to life in a changing climate*
Involves **adjusting** to actual or expected future climate

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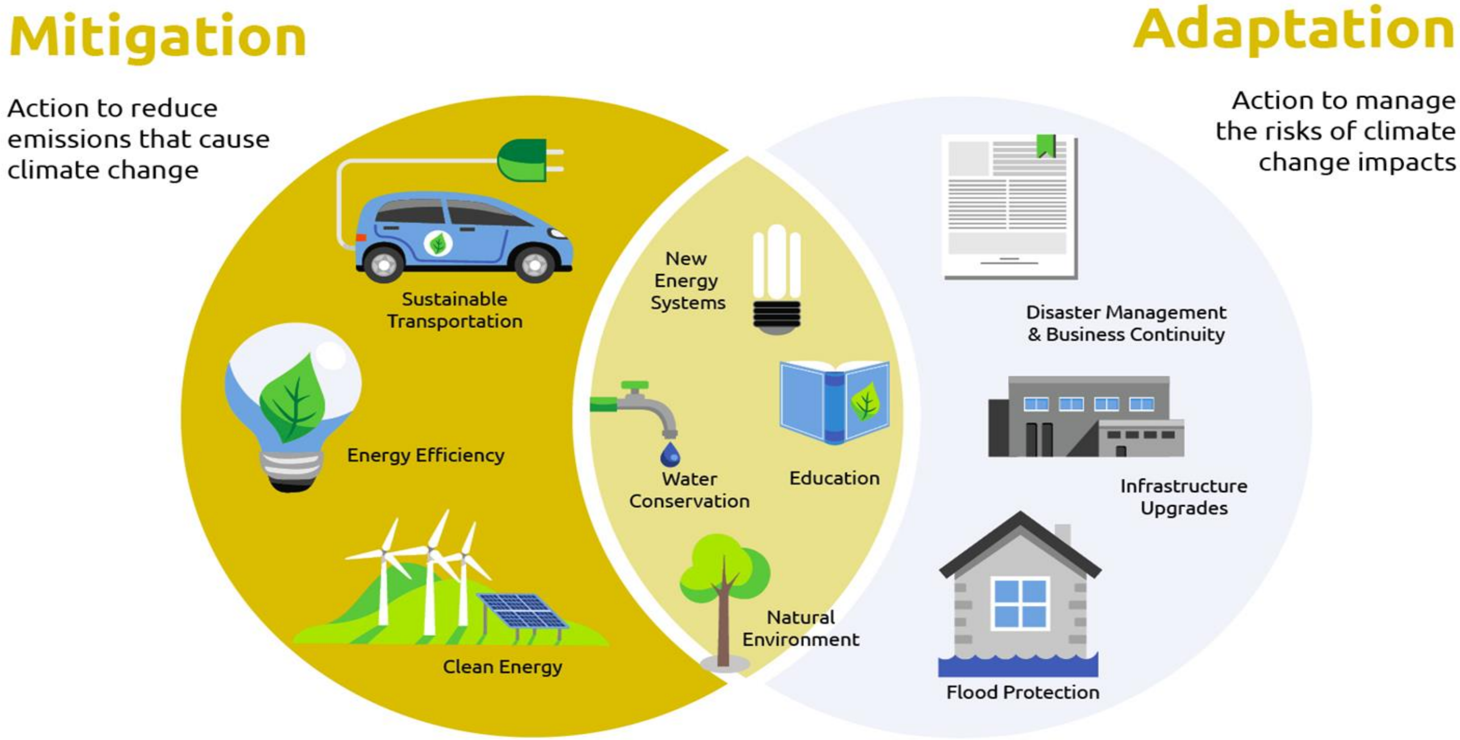
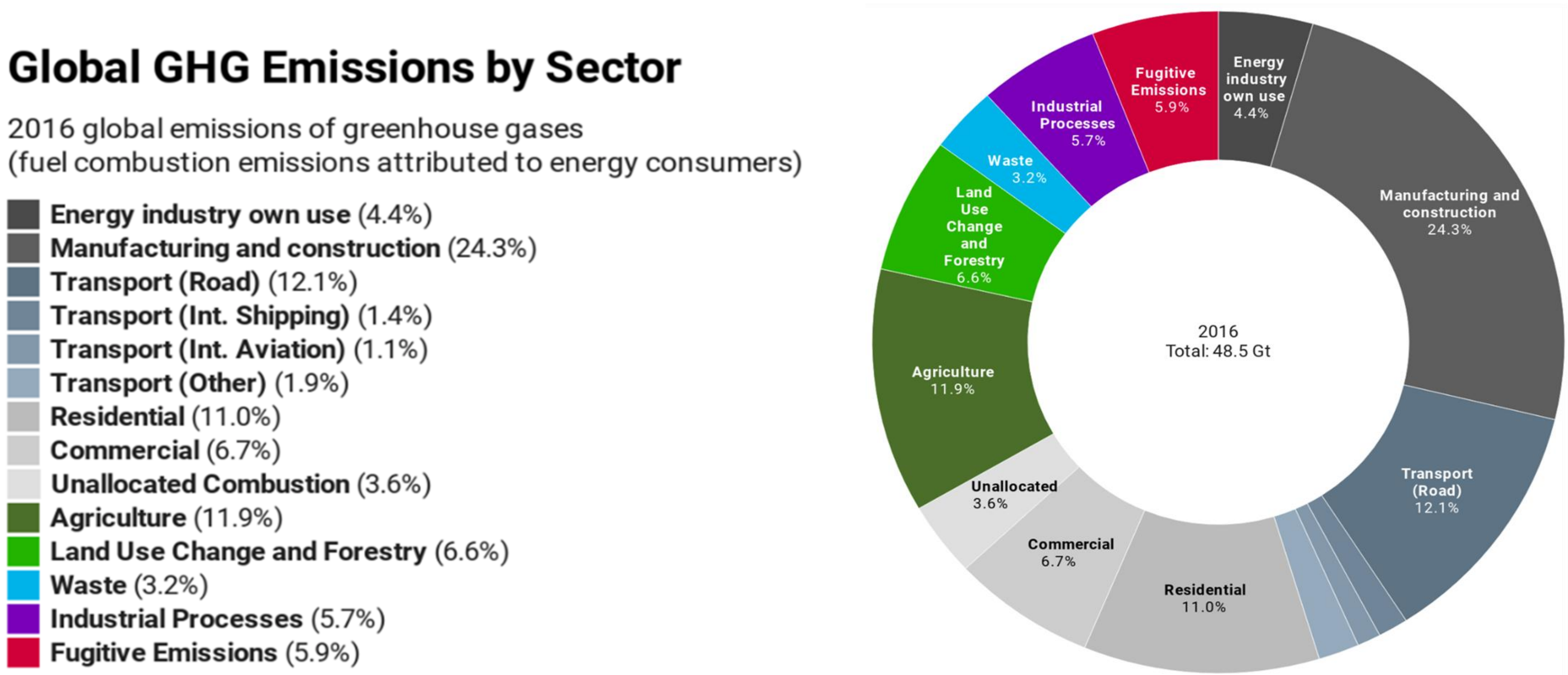
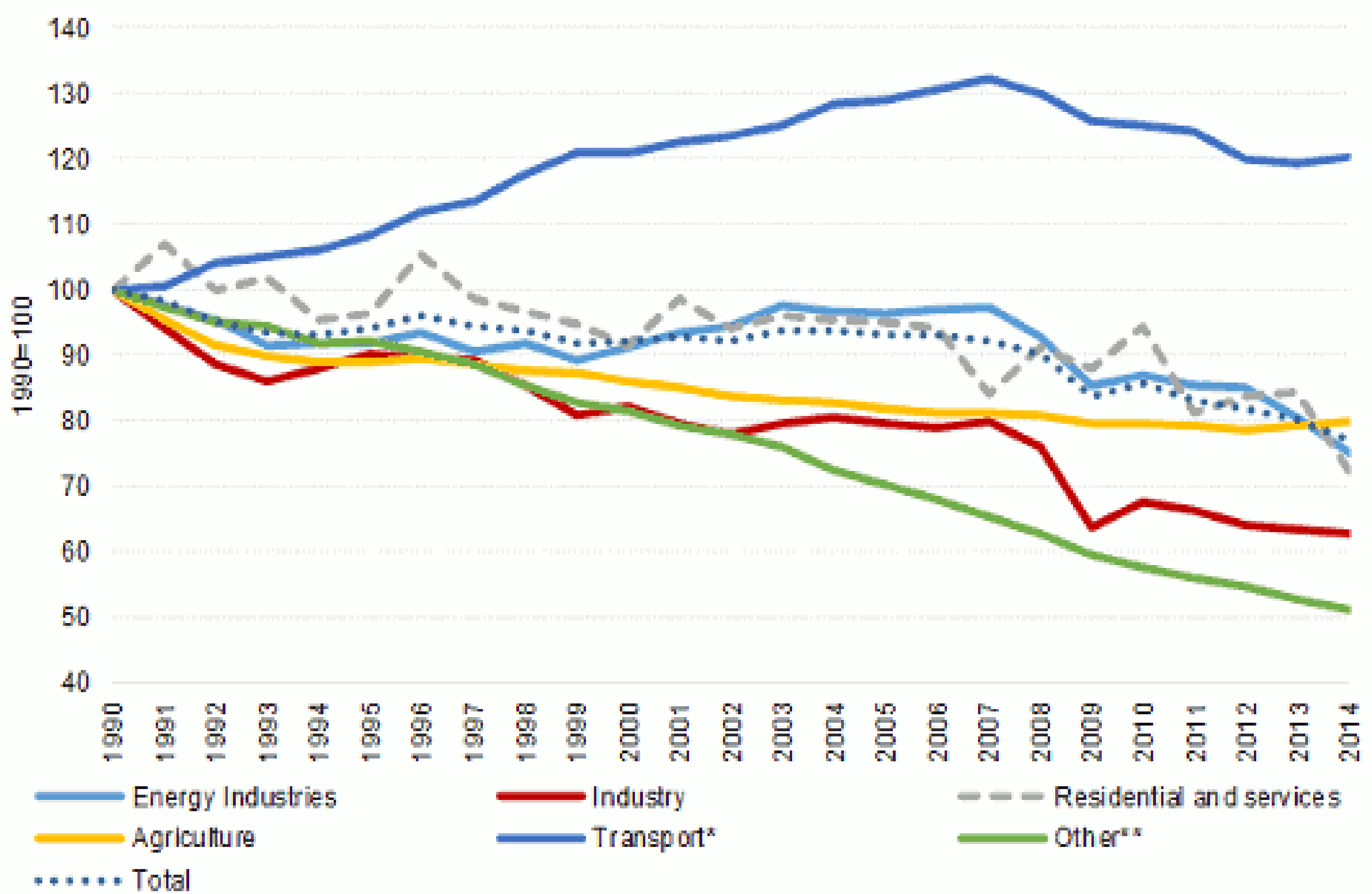
Climate Change Mitigation & Adaptation actions



Contribution to global emissions by sector



Trends in emissions



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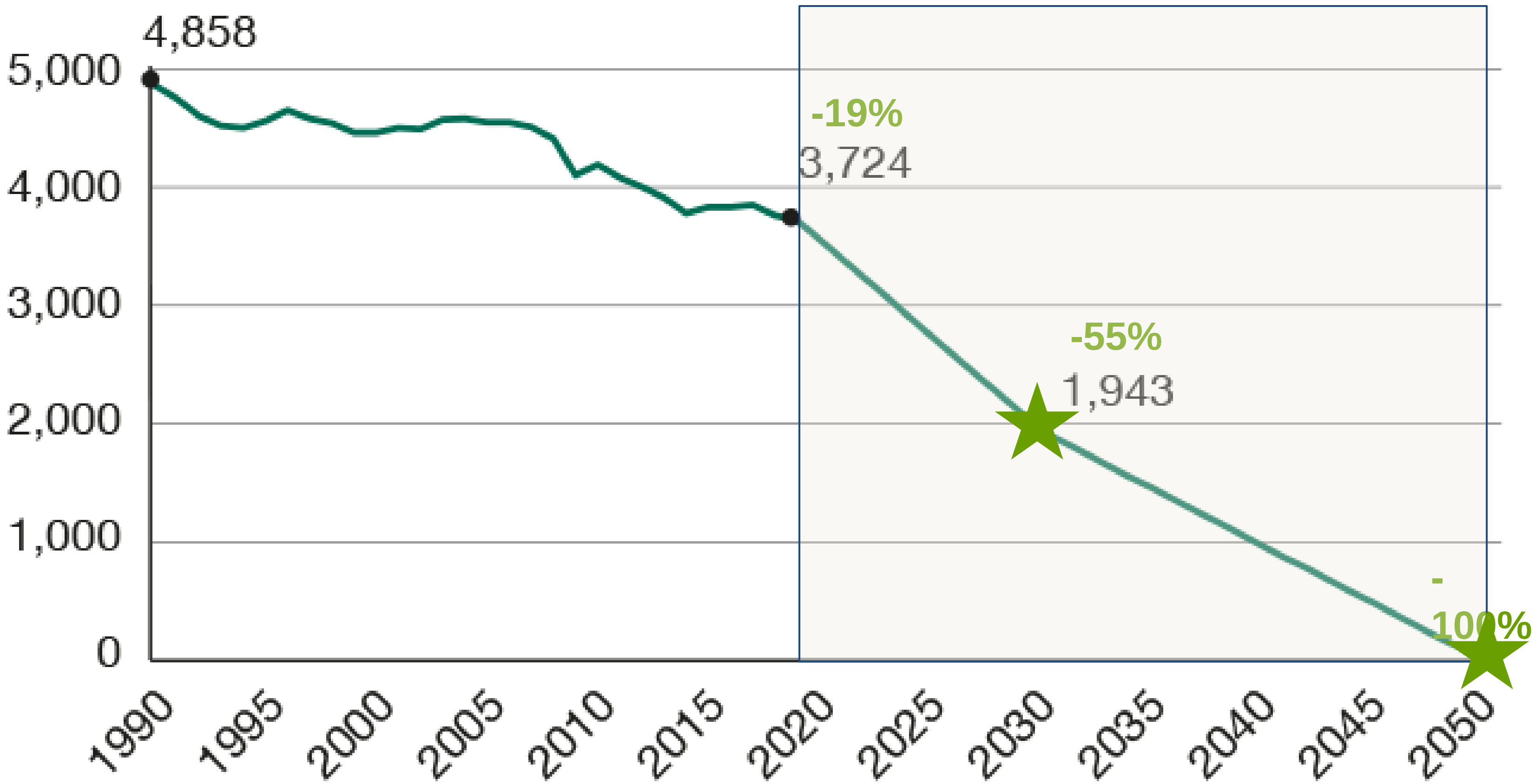
Trends in emissions



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What can we do to mitigate climate change? Reducing sources

Share (rounded)	billion euro	Field	Mt CO_2e	Societal benefits
		Emission reduction trend preceding the EGD	39	
10%	25	Frontloading a 100% renewables grid	30	
8%	20	Transforming the car-based mobility system	18	Health
8%	20	European Silk Road	20	Growth, cohesion
27%	70	Energy renovation of buildings	24	Employment
12%	30	R&D for energy-saving digitalisation	30	
12%	30	Advanced green vocational education	catalyst	Convergence, employment
12%	30	European breakthrough innovation system	catalyst	Employment
4%	10	Subcontracting management tasks for EGD	catalyst	Employment
8%	20	European planetary health policy	catalyst	Health, employment
100%	255	Total public investment per year		
		Total emissionreductions per year	161	

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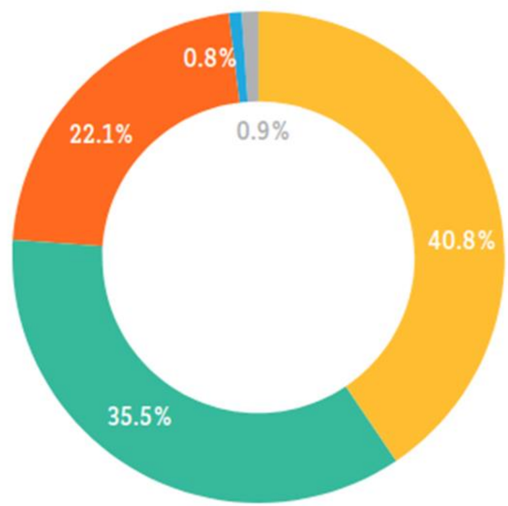
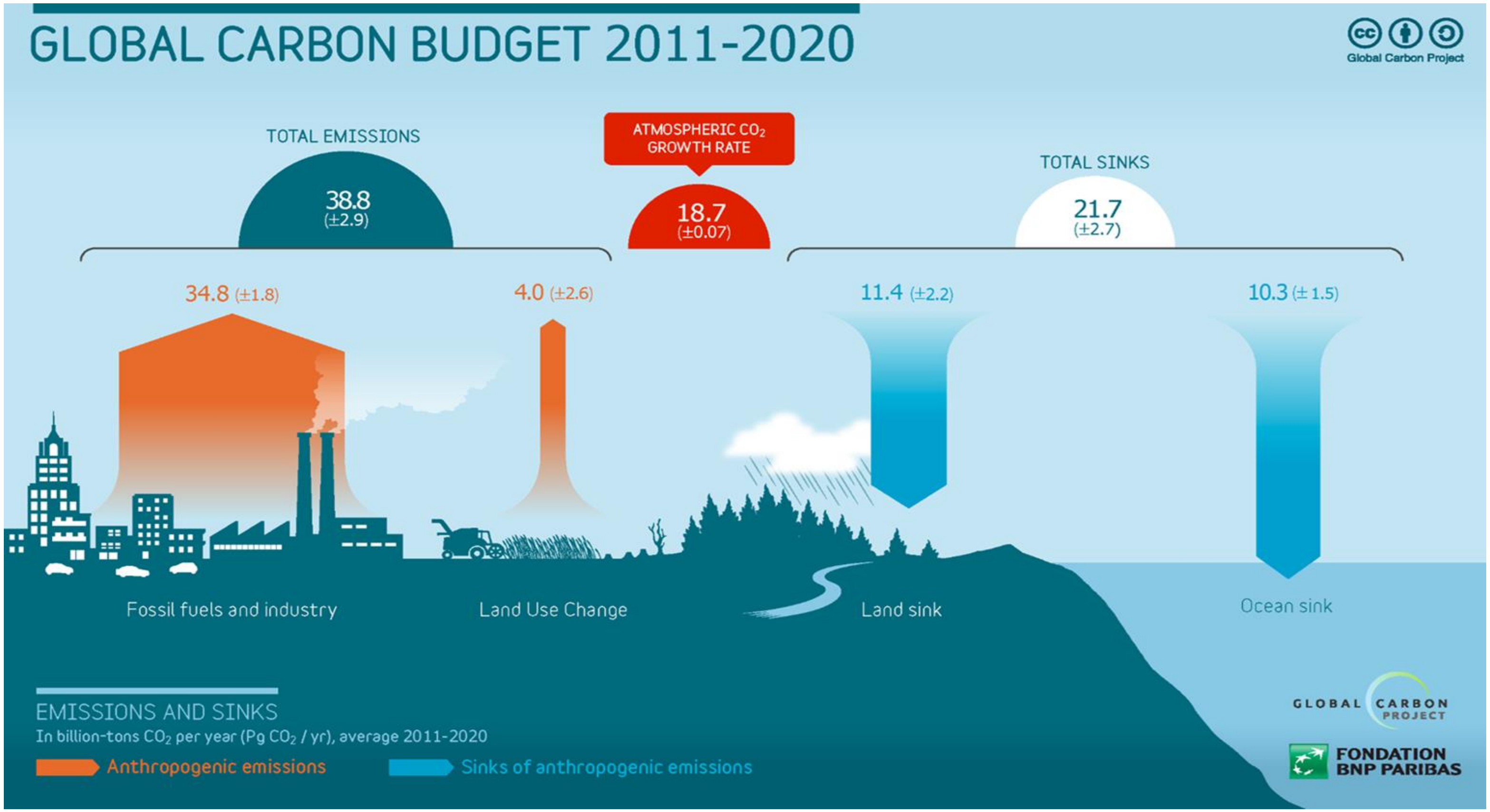
100%	255	Total public investment per year		
		Total emissionreductions per year		

Energy industry accounts for 27% of EU emissions (European Environment Agency, 2020b).

	TWh
Fossil fuels net generation (lignite and hard coal, gas, oil, mixed fuels, peat)	1 497.2
Renewable net generation (renewable hydro, wind, solar, biomass, geothermal)	1 300.6
Thermal nuclear net generation	808.8
Hydro net generation (except renewable part)	29.2
Net generation not identified	32.0



Why are human-induced emission important?



What can we do to mitigate climate change?
Safeguard the carbon sinks

Ocean

The oceans have collectively absorbed about **25% of the carbon dioxide** released into the atmosphere since the Industrial Revolution (mostly phytoplankton)

→reduce plastic pollution

What can we do to mitigate climate change? Safeguard the carbon sinks

Forests

The forests absorb around 2.6 billion tons of CO_2 every year

→ protect forests

What can we do to mitigate climate change?
Safeguard the carbon sinks

Soil

The soil absorbs roughly 25% of all human emissions each year (mostly in peatland and permafrost).

→ reform land use models

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Yet, the climate is changing

Table 1 **Projections of climate change impacts**

Averages in 2081-2100 relative to 1986-2005

	RCP 2.6	RCP 8.5
Temperature	0.3 - 1.7 C	2.6 - 4.8deg C
Sea levels	0.26 - 0.55 m	0.45 - 0.82 m
Precipitation	Increase in average precipitation in high latitudes, decrease in subtropical and mid-latitude dry regions	
Ice cover	Arctic sea ice cover will be reduced, as will the extent of permafrost in high northern latitudes	
Extreme weather events	Risks associated with some types of extreme weather events, including heatwaves and heavy precipitation, are projected to increase with climate change	

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Railway

Phenomenon	Associated weather hazard	Secondary associated hazard(s)/impact(s)	Possible adverse effect on railway infrastructure
Temperature	High temperatures	Heatwaves; wildfire	Buckling of rails; thermal expansion in structures
	Large seasonal temperature range	Permafrost thaw	Differential thaw settlement of track bed in permafrost regions
	Low temperatures	Snow; ice; frost; freeze–thaw action	Damage to overhead lines and signaling equipment; rock falls; freezing of points[a]; tunnel icing; cracking/breakage of rails
Precipitation	Excess precipitation	Flooding (surface water, fluvial, groundwater); infiltration; landslide	Infrastructure slope failure; bridge scour; flooding of track, depots, buildings; water damage to electronic equipment
	Precipitation deficit	Drought; drying of soil; shrinkage cracking; landslide	Infrastructure slope failure; track misalignment; misalignment of poles supporting overhead lines
Wind	Windstorms/gales	Tree fall; wind-blown objects	Downed power lines; structural damage and/or track misalignment by fallen trees/wind-blown objects

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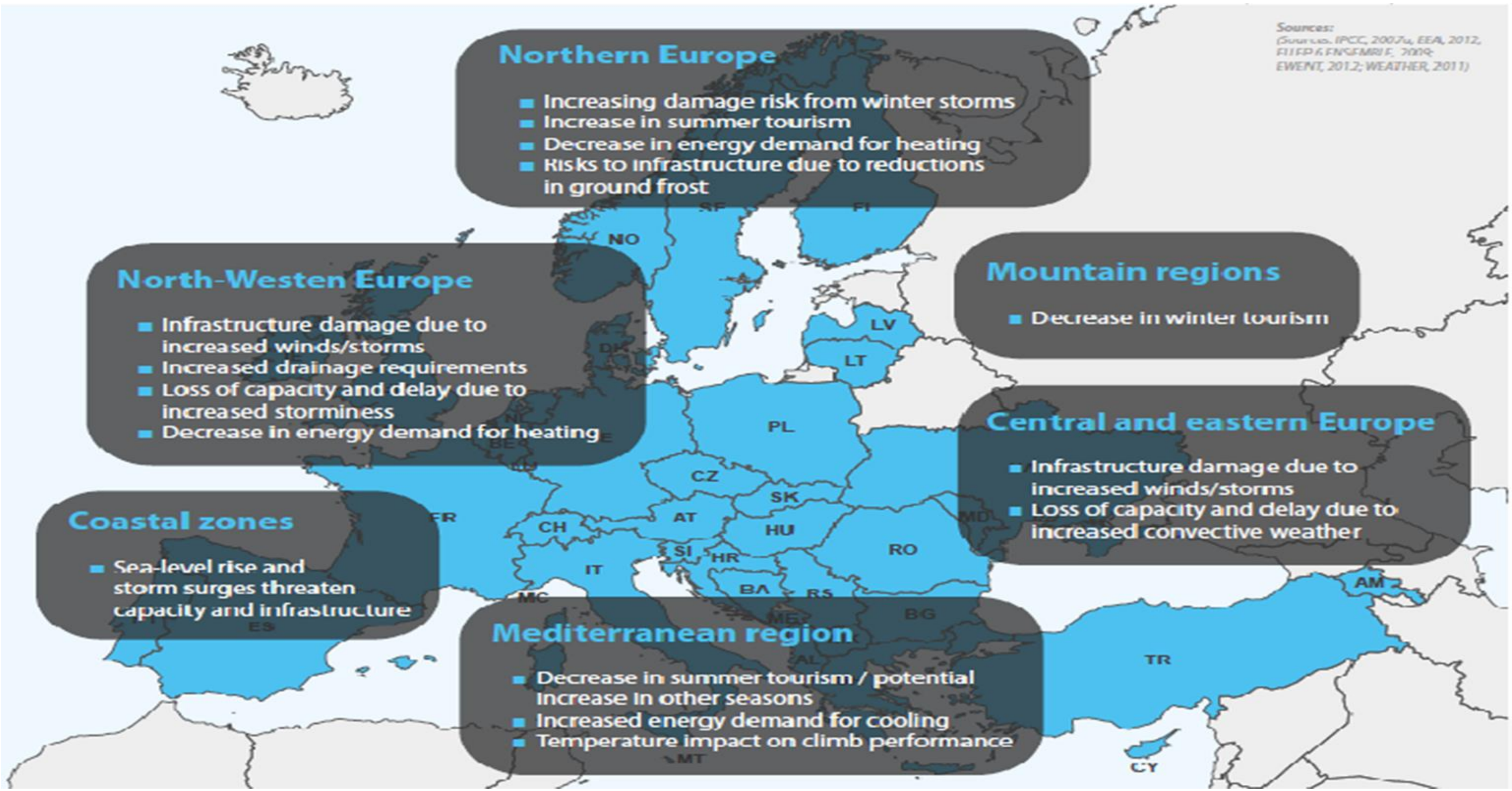
Aviation


Sources:
EWENT, 2012; WEATHER, 2011)
Northern Europe
Increasing damage risk from winter storms
Increase in summer tourism
Decrease in energy demand for heating
Risks to infrastructure due to reductions in ground frost
North-Westen Europe
Infrastructure damage due to increased winds/storms
Increased drainage requirements
Loss of capacity and delay due to increased storminess
Decrease in energy demand for heating
Mountain regions
Decrease in winter tourism
Central and eastern Europe
Infrastructure damage due to increased winds/storms
Loss of capacity and delay due to increased convective weather
Coastal zones
Sea-level rise and storm surges threaten capacity and infrastructure
Mediterranean region
Decrease in summer tourism / potential increase in other seasons
Increased energy demand for cooling
Temperature impact on climb performance
NO
FI
LV
LT
PL
CZ
SK
AT
HU
CH
FR
IT
SI
HR
RO
BA
RS
BG
AL
TR
AM
CY
MT
MC
ES

Roads and Urban Transport

- **Heat stress**: enhanced pavement degradation, especially relevant for asphalt road pavement.
- **Freezing days**: road pavement degradation, in combination with frost cracking and pothole effects, depending on asphalt binder.

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Roads and Urban Transport

- **Severe precipitation**: insufficient drainage, risk of inundation along the coasts, risks for bridges due to scouring
- **Storms**: trees or branches falling and obstructing the road system

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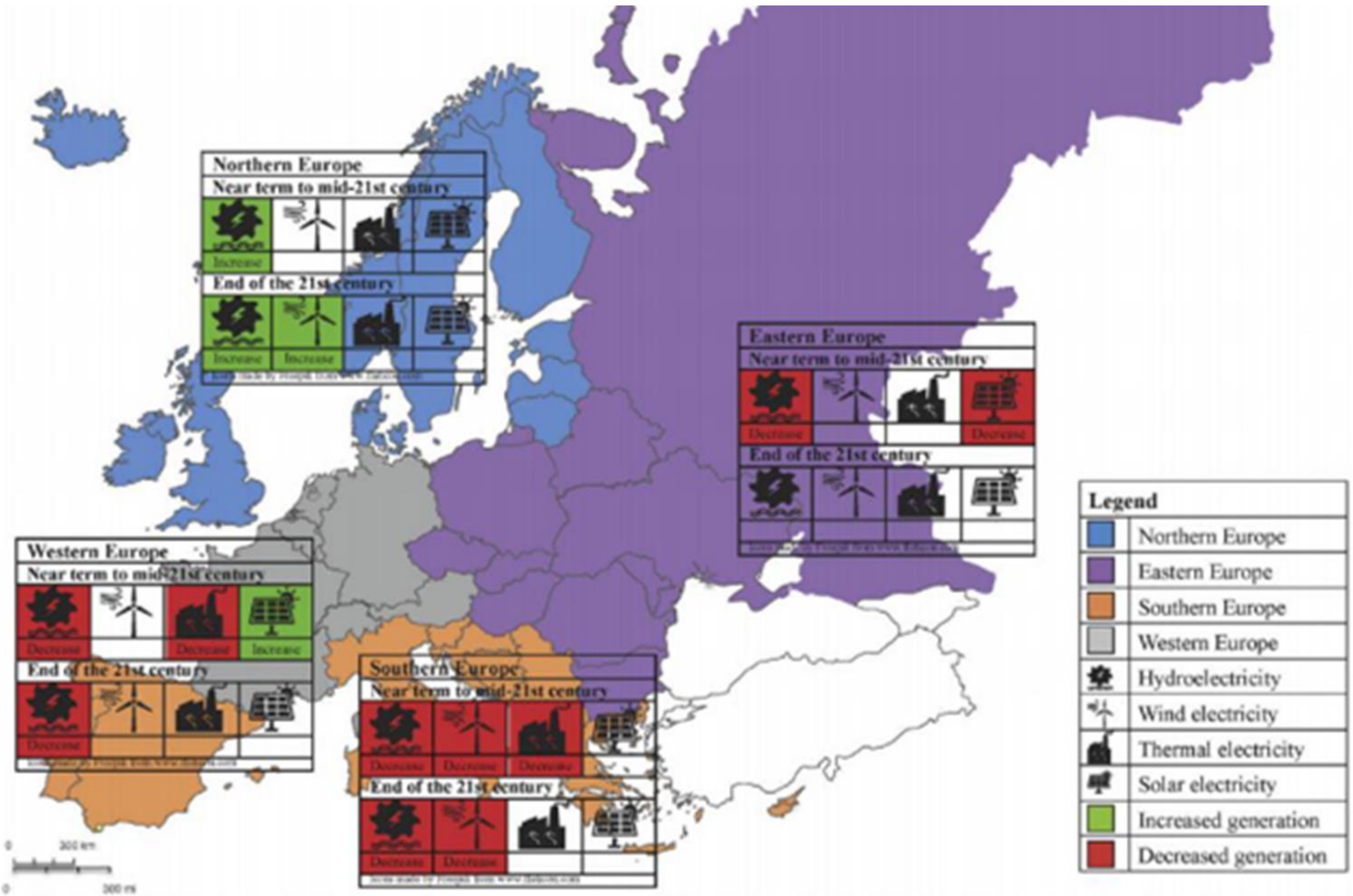
Energy sourcing, distribution and demand

Climate impact	Generation	Transmission and distribution	Demand
Rising global temperatures	• Efficiency • Cooling efficiency • Generation potential • Need for additional generation	• Efficiency	• Cooling and heating
Changing precipitation patterns	• Output and potential • Peak and variability • Technology application	• Physical risks	• Cooling • Water supply
Sea-level rise	• Output • Physical risks • New asset development	• Physical risks • New asset development	• Water supply
Extreme weather events	• Physical risks • Efficiency	• Physical risks • Efficiency	• Cooling

Renewable resources



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Thank you for your time!

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