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Science and Planetary Health Check Update

ICEF - Innovation for Cool Earth Forum
Tokyo, 09 October 2024

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Human Wellbeing within stable Planet

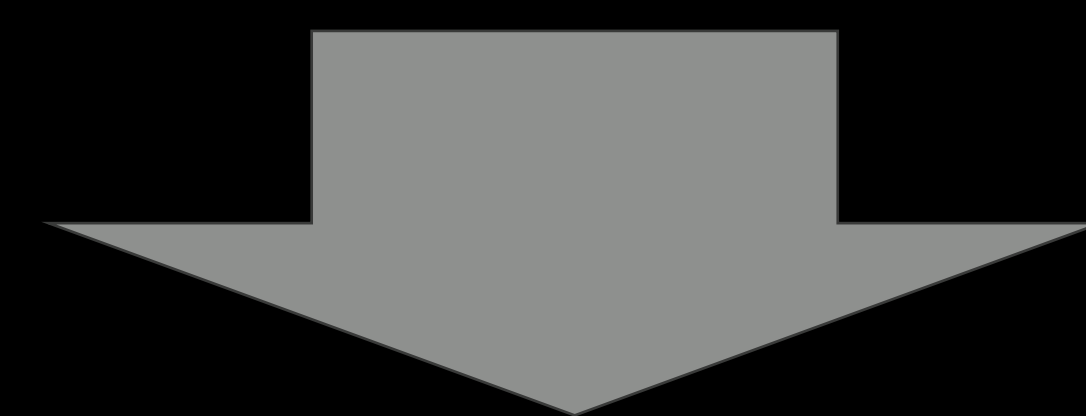
Anthropocene - Humans dominating force of change on Earth

Holocene – The only state of the Planet we know for certain can support our world

Tipping Points & Resilience – Earth as a self-regulating system



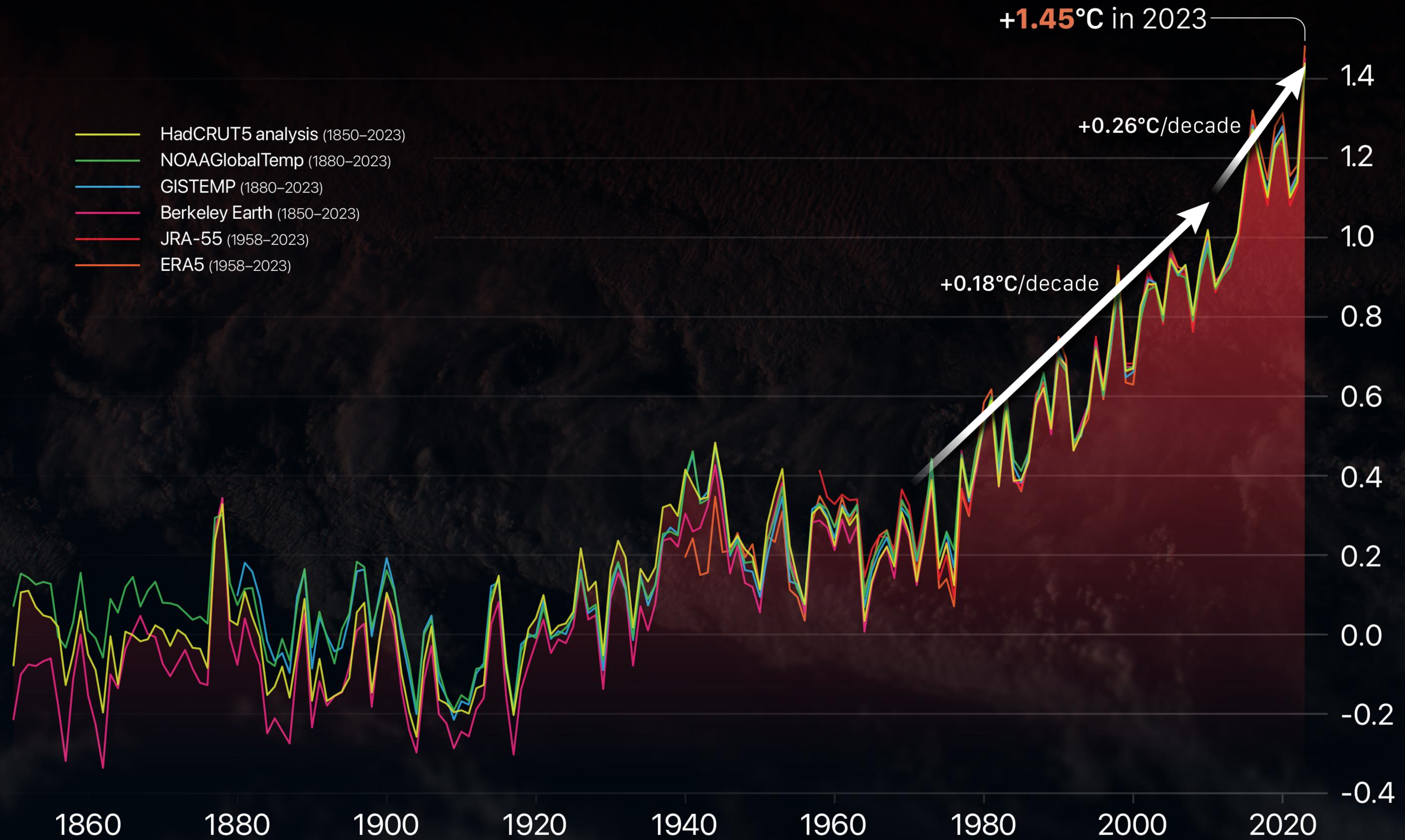
World Development within Planetary Boundaries



Transformations to prosperity and equity

Anthropocene

Annual global mean temperature anomalies (°C) relative to 1850-1900 average

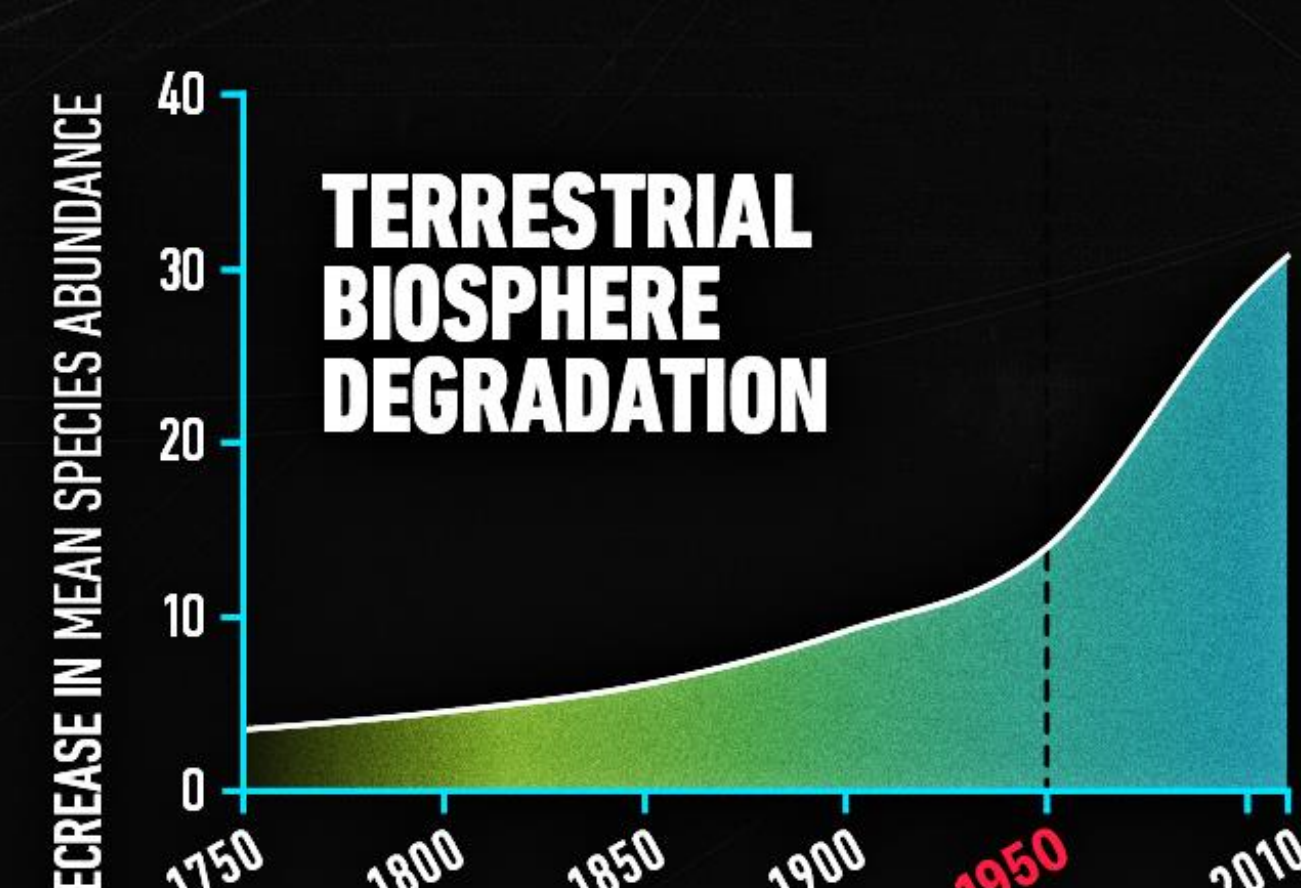
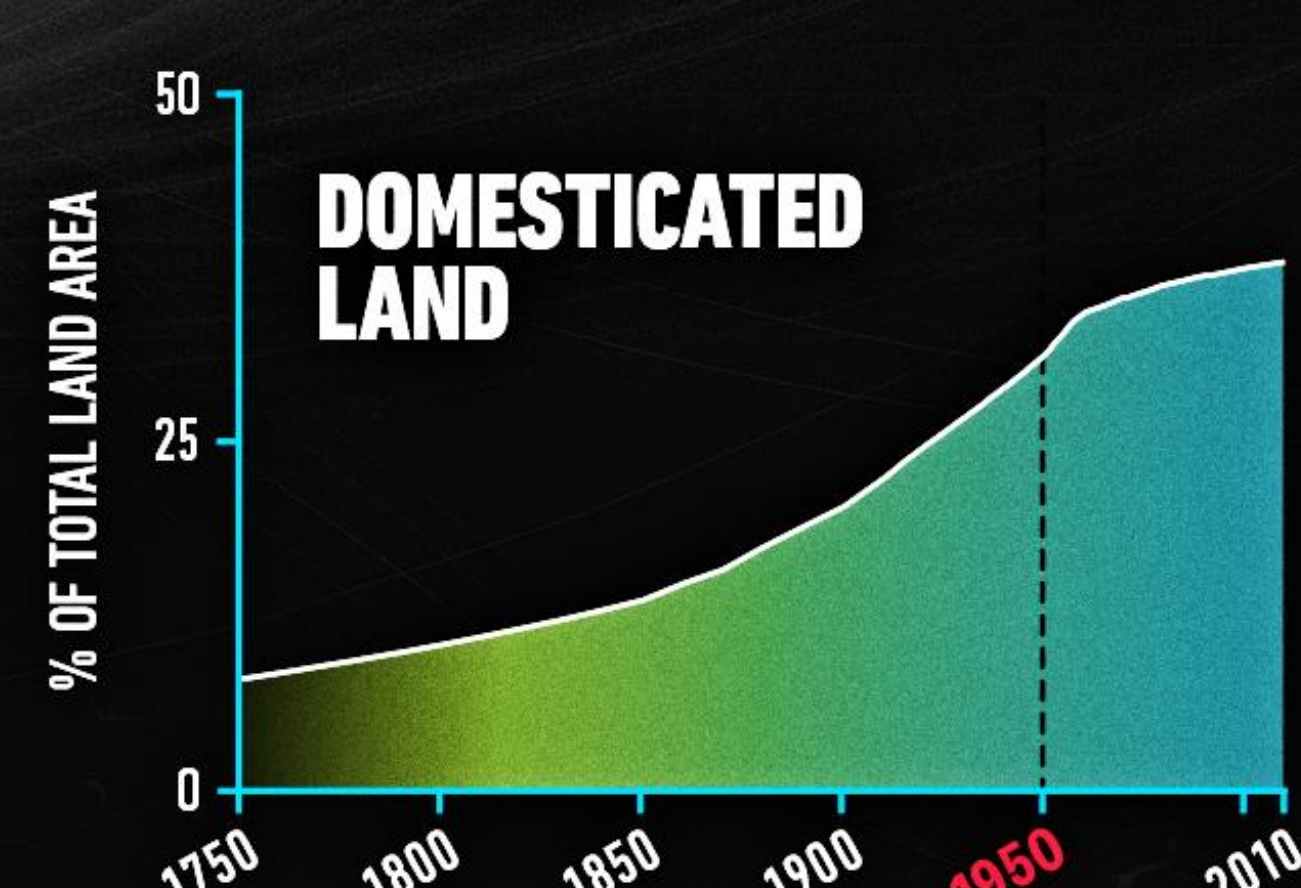
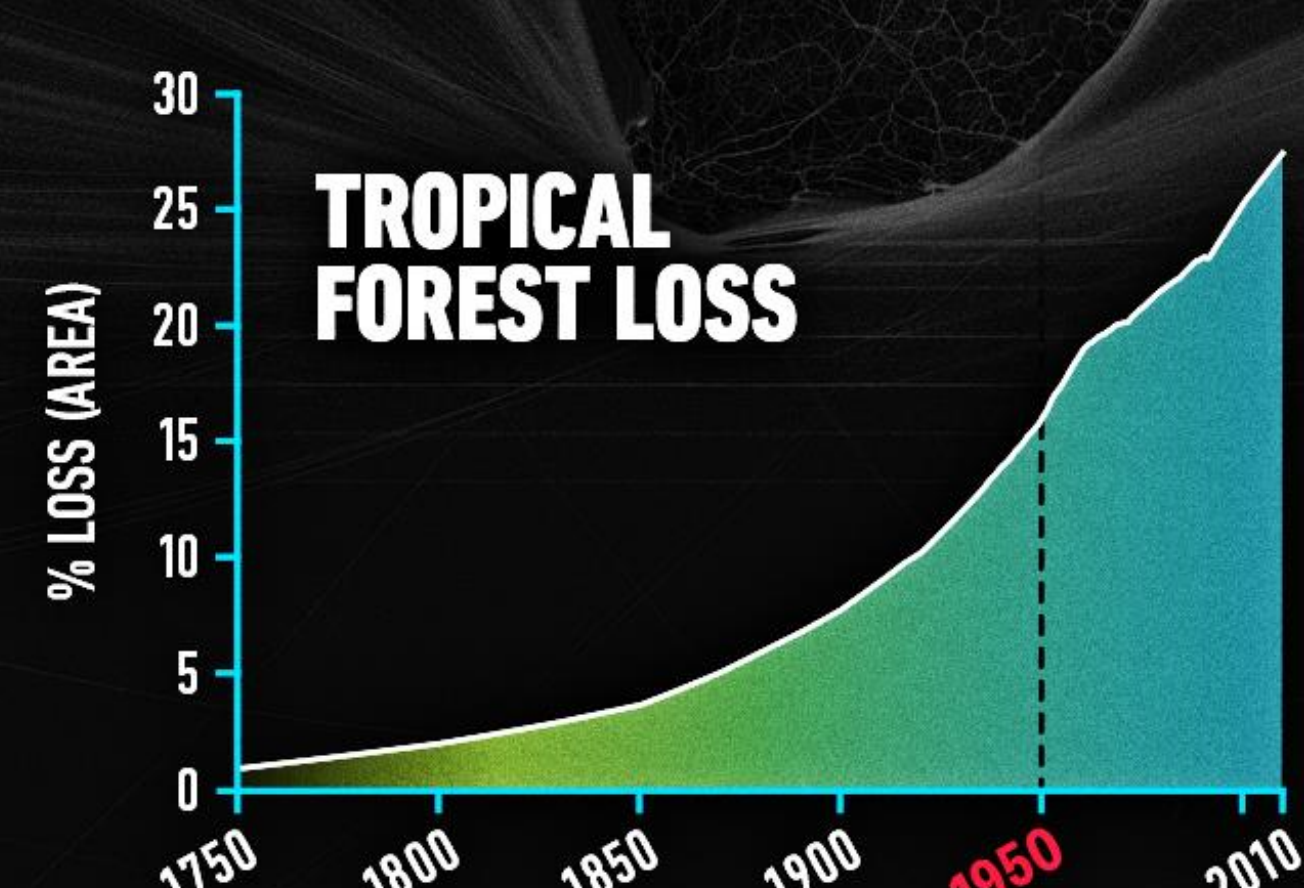
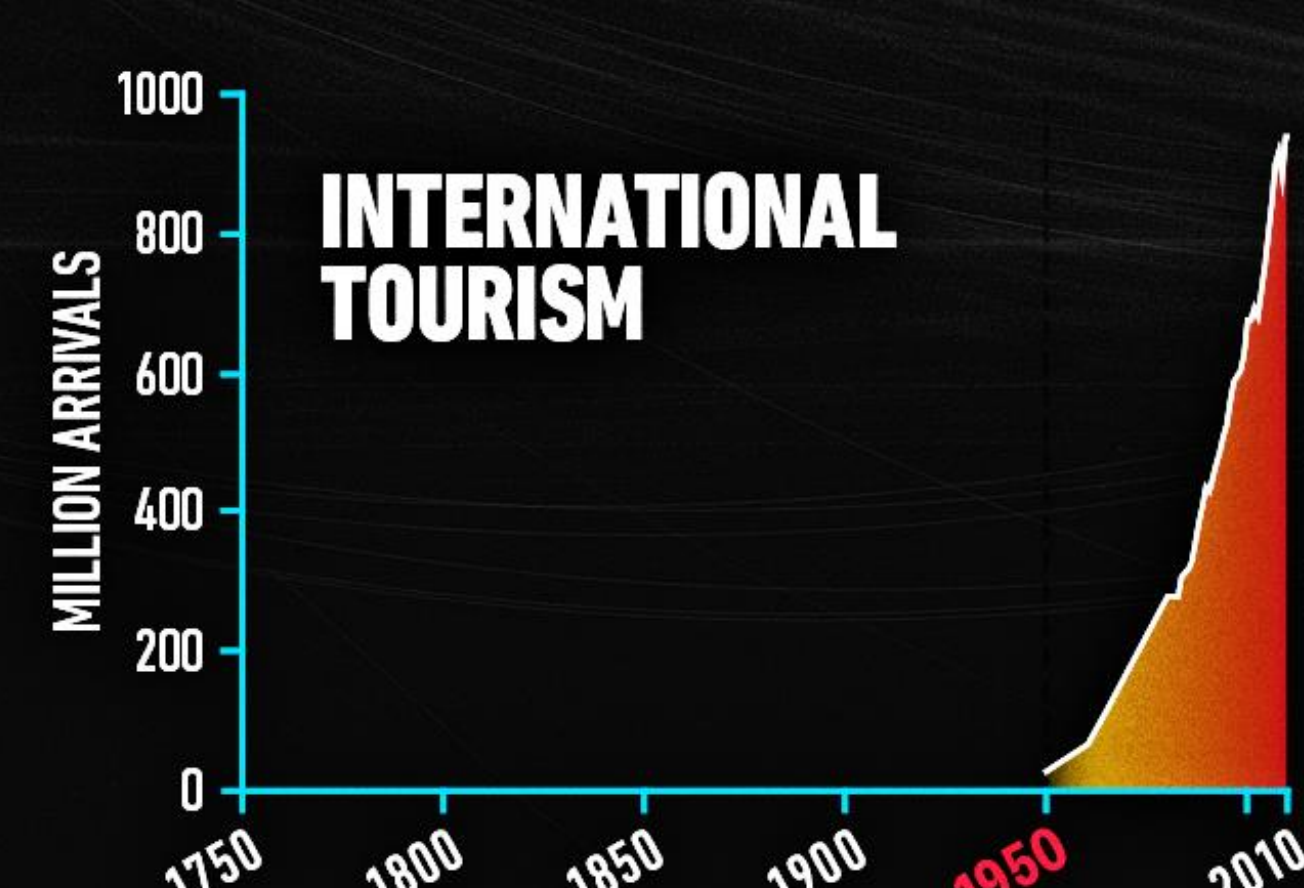
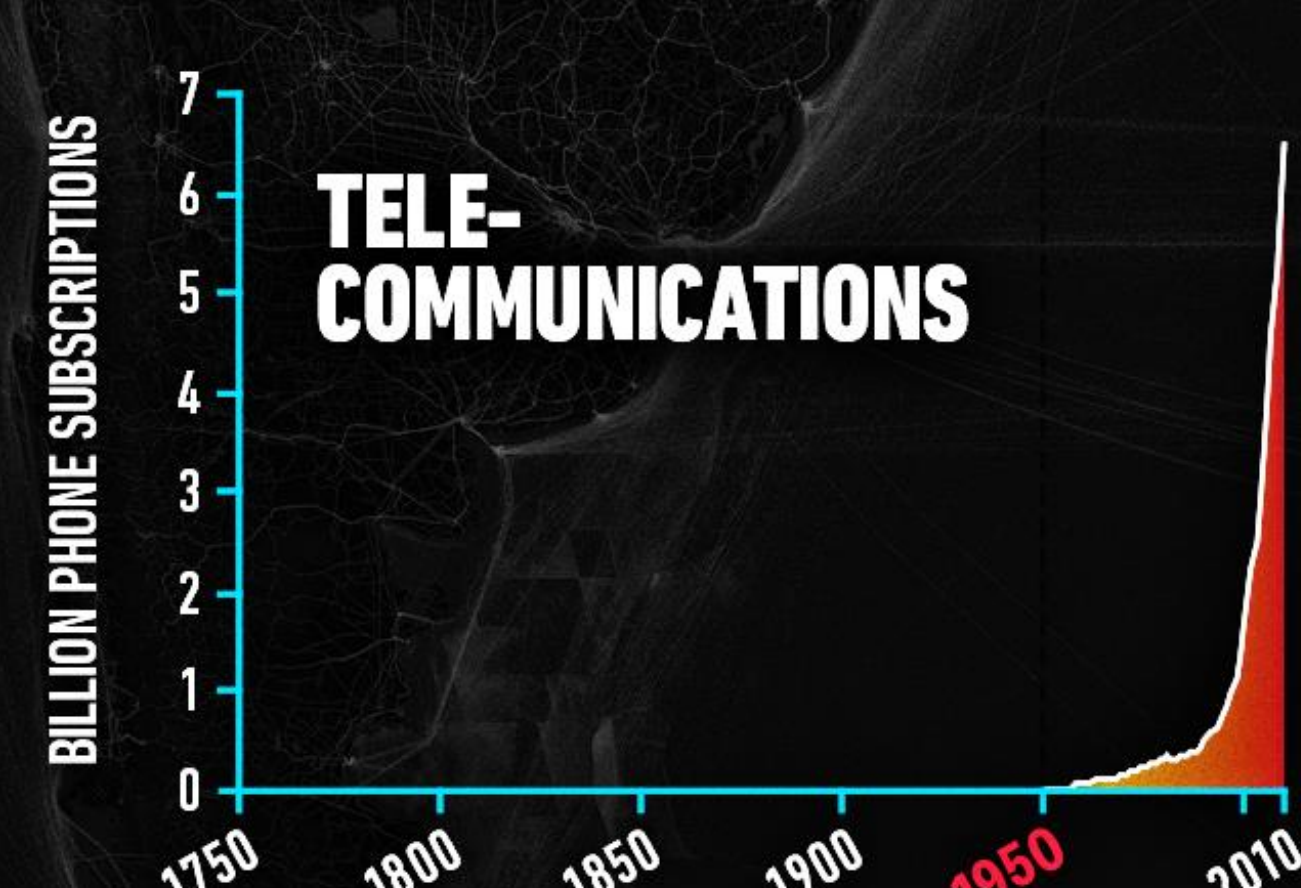
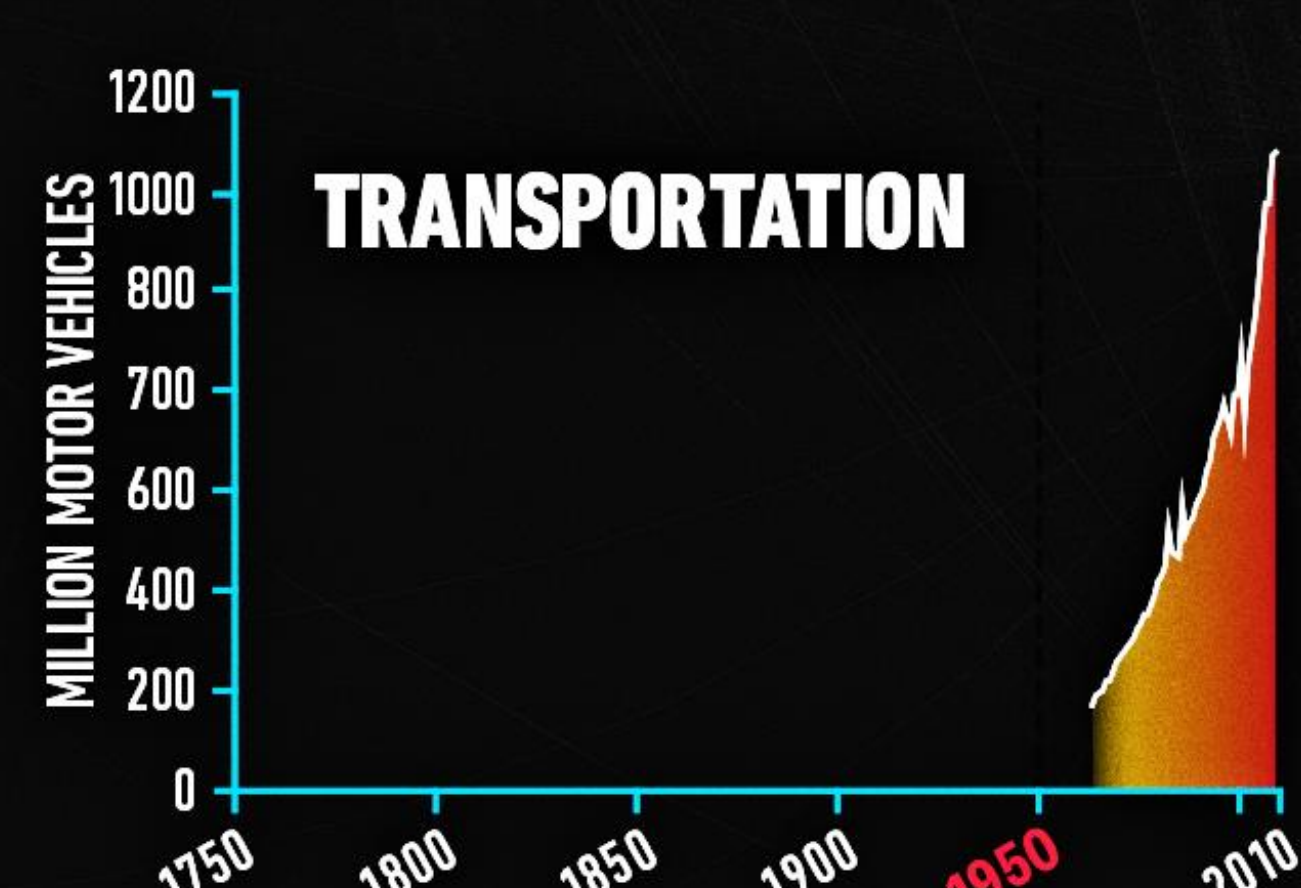
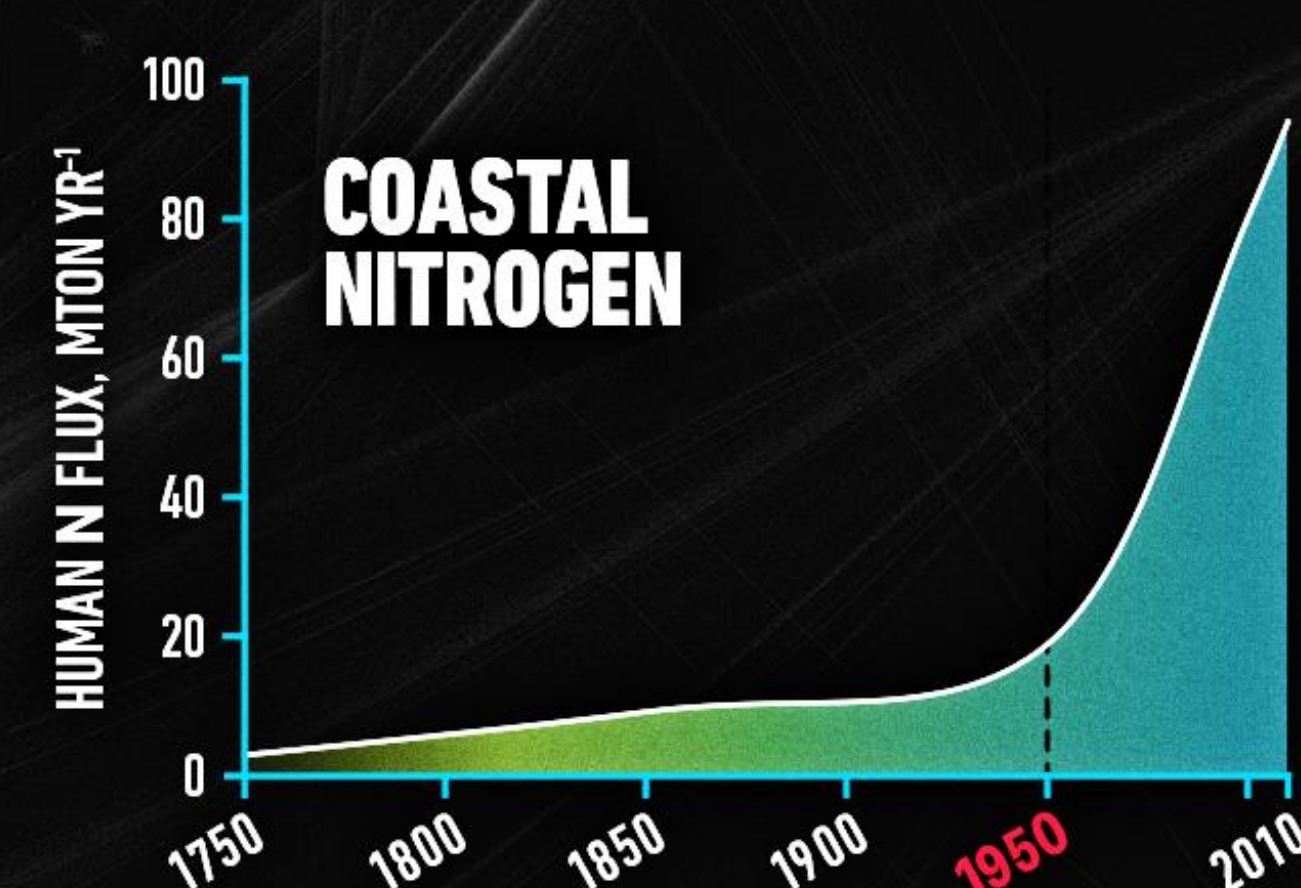
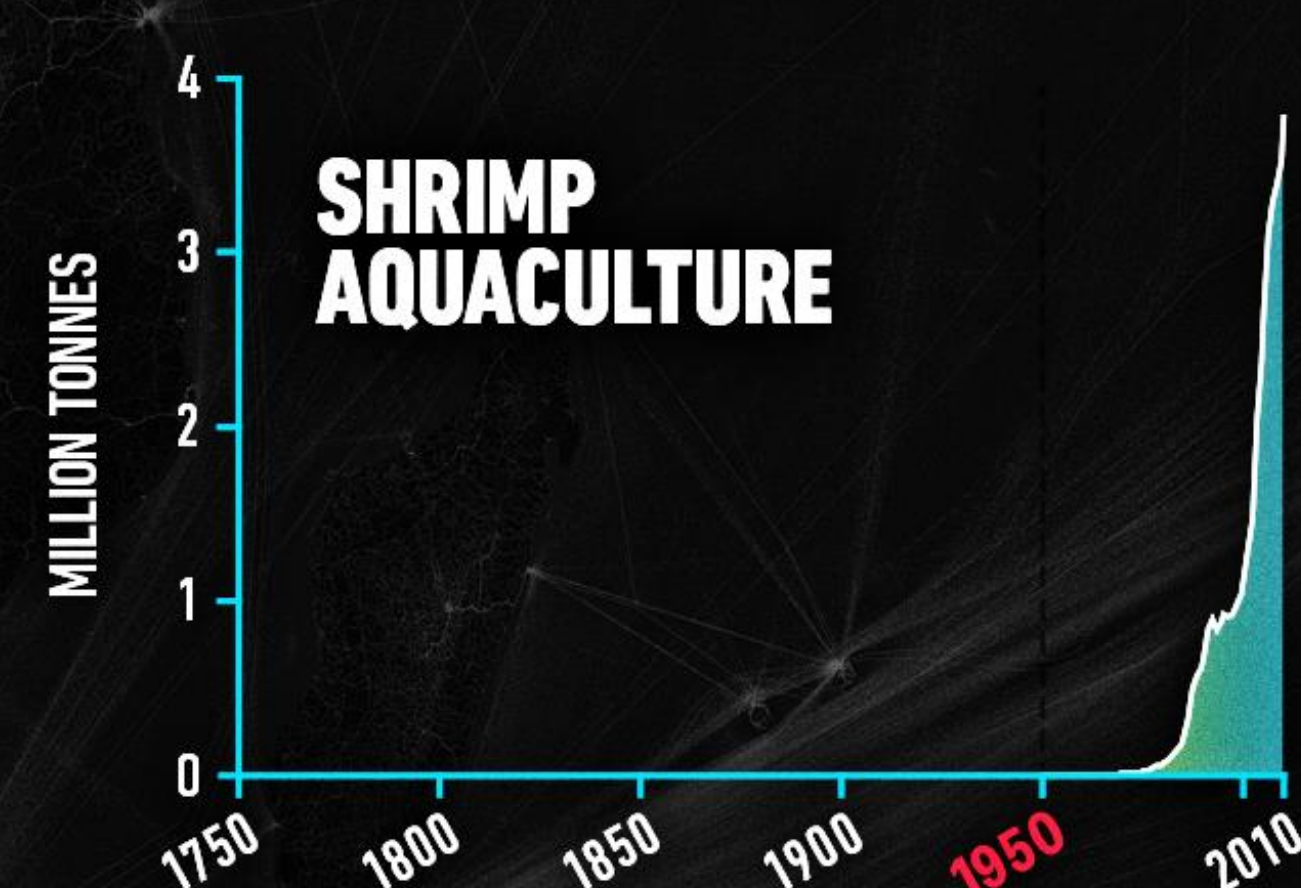
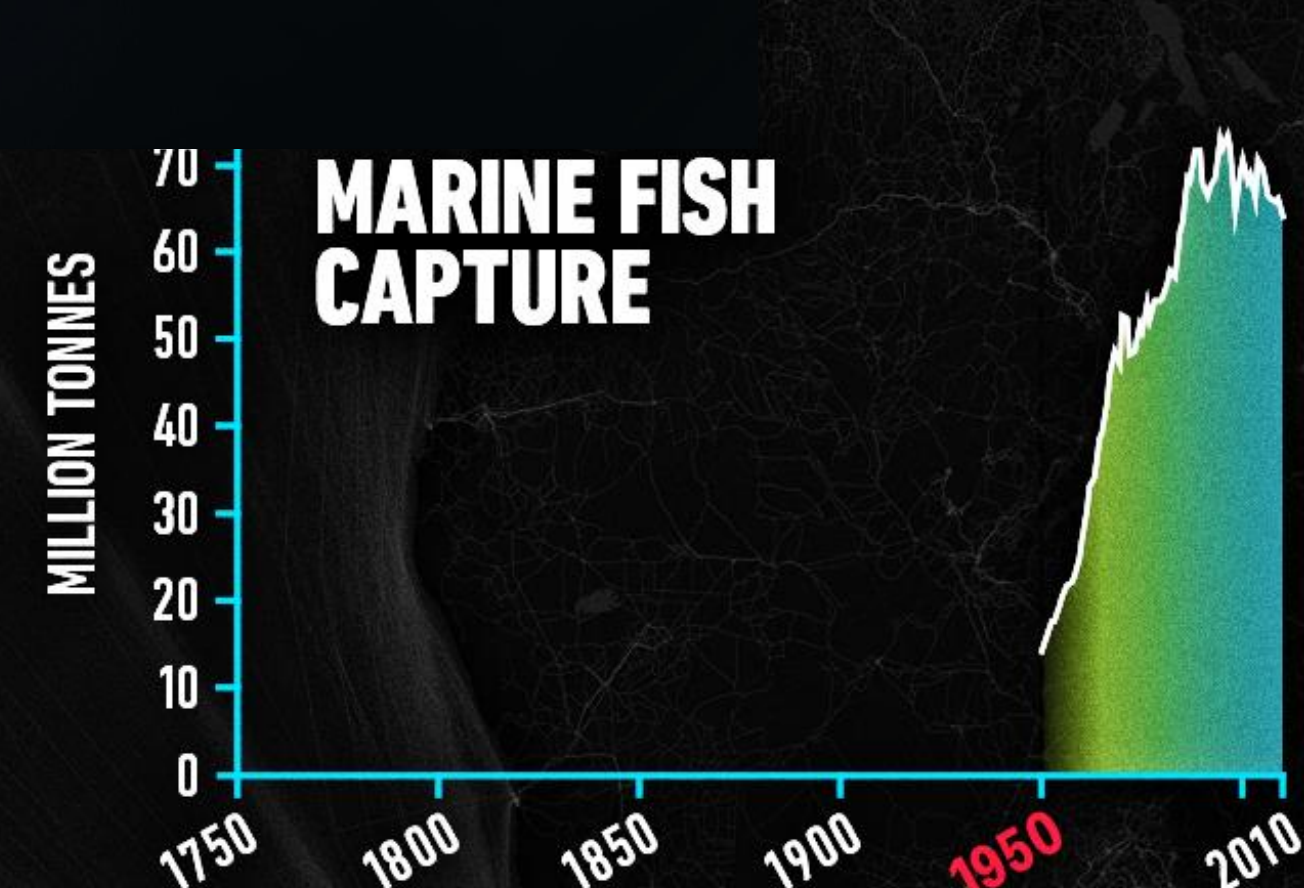
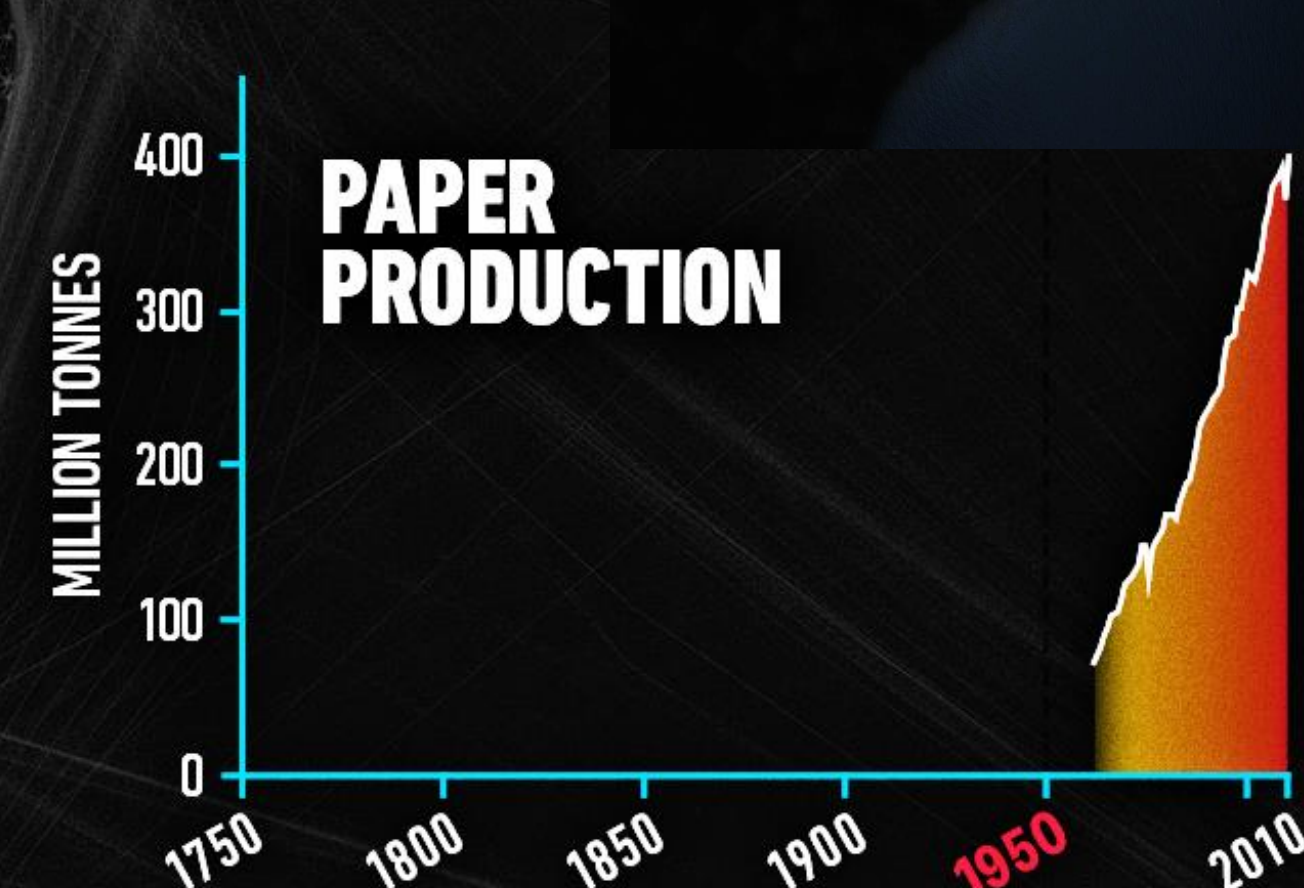
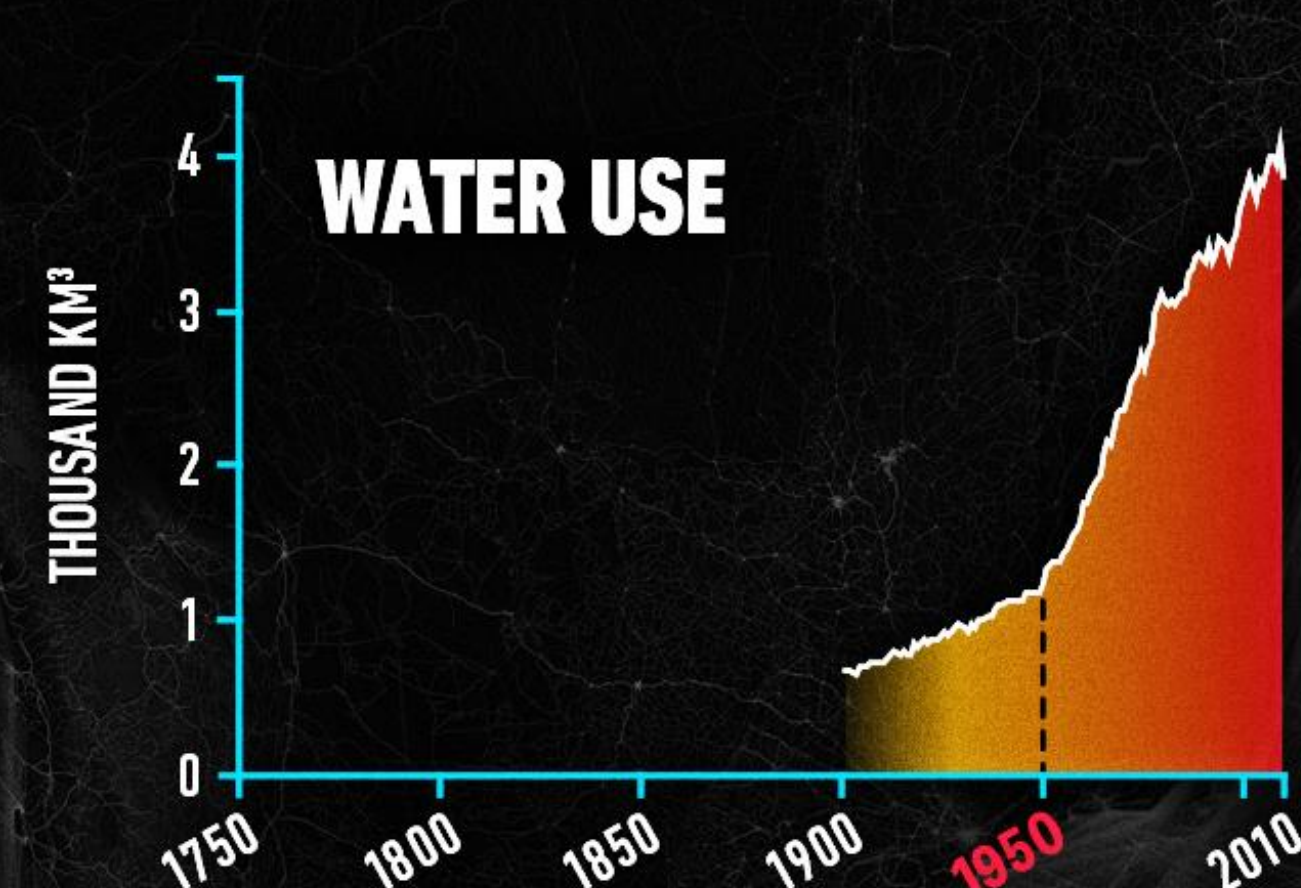
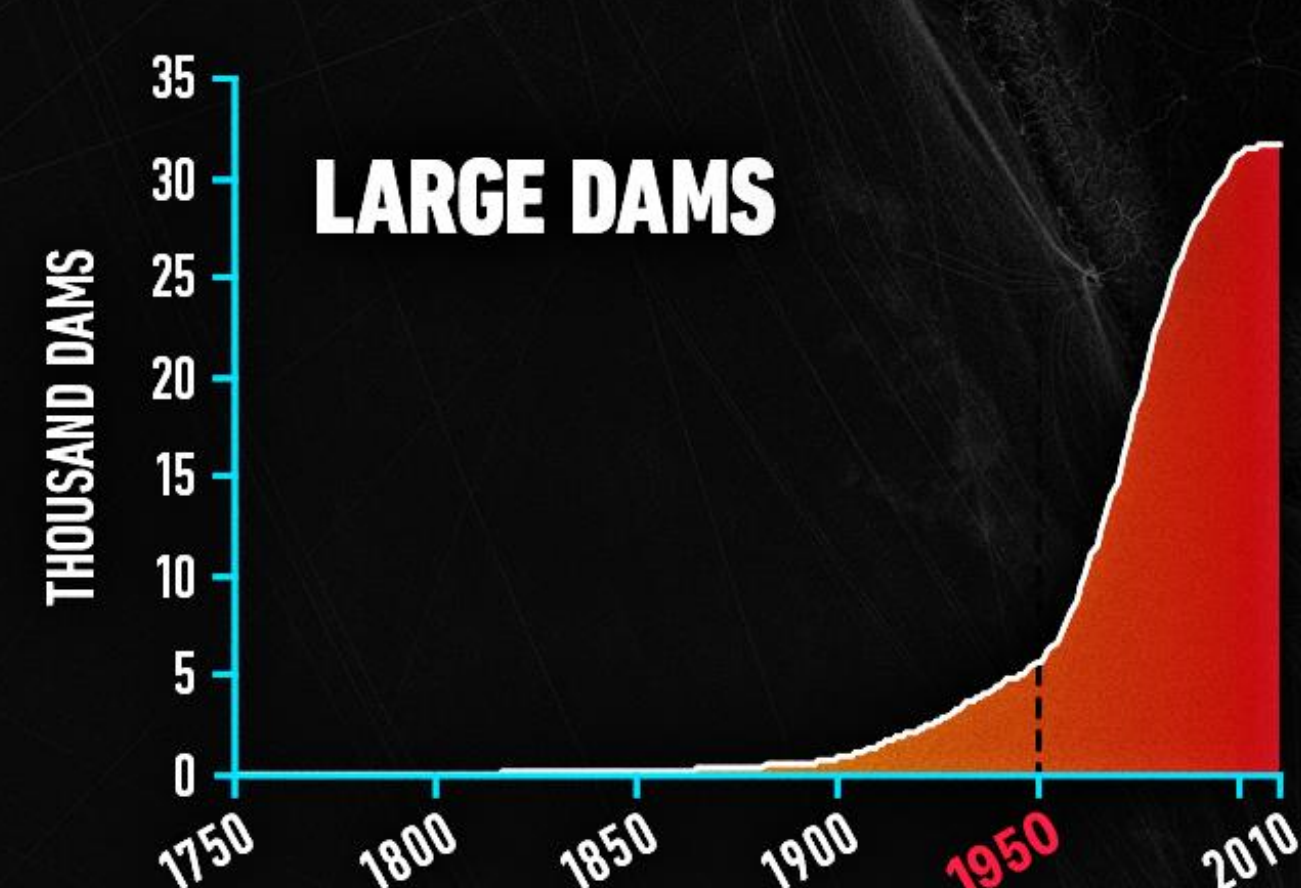
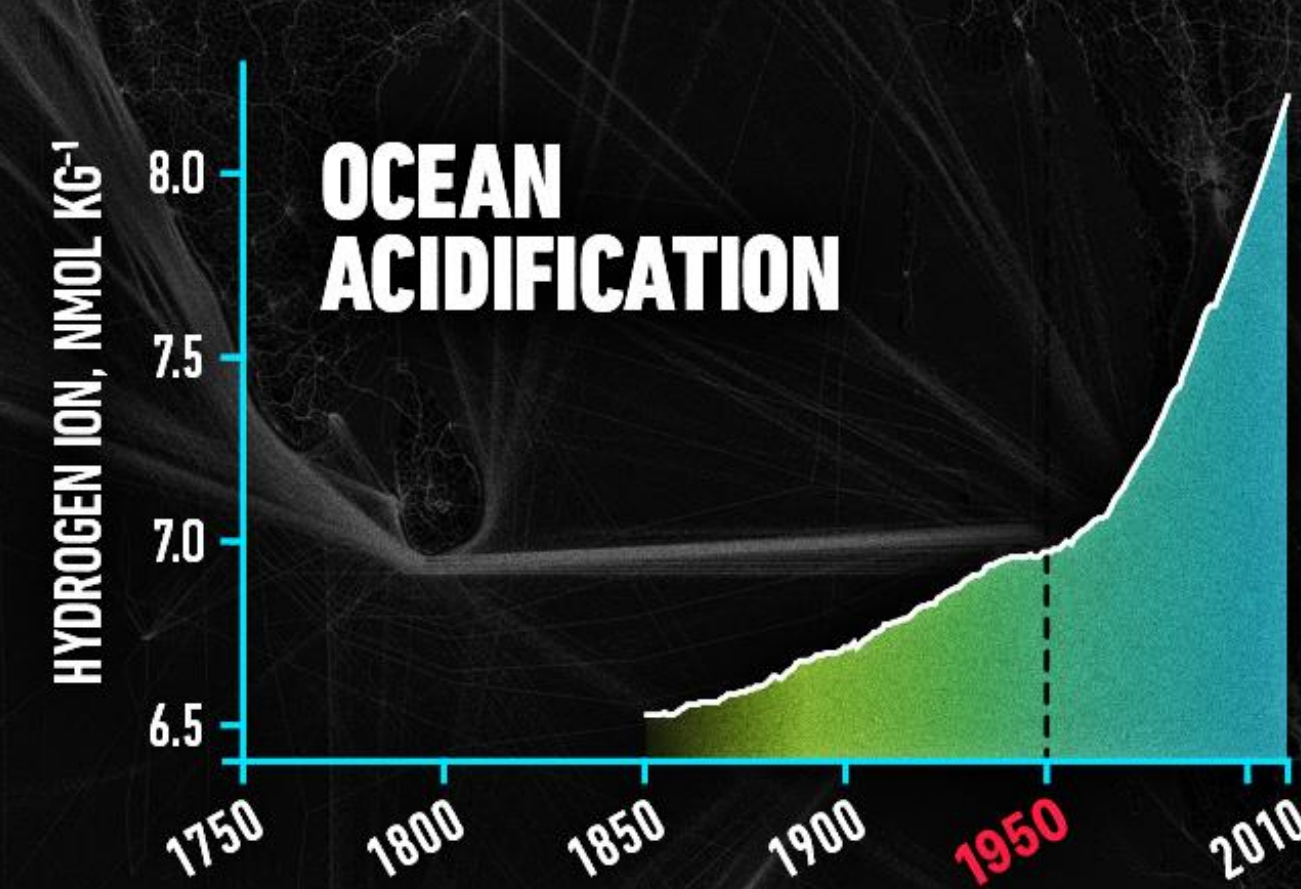
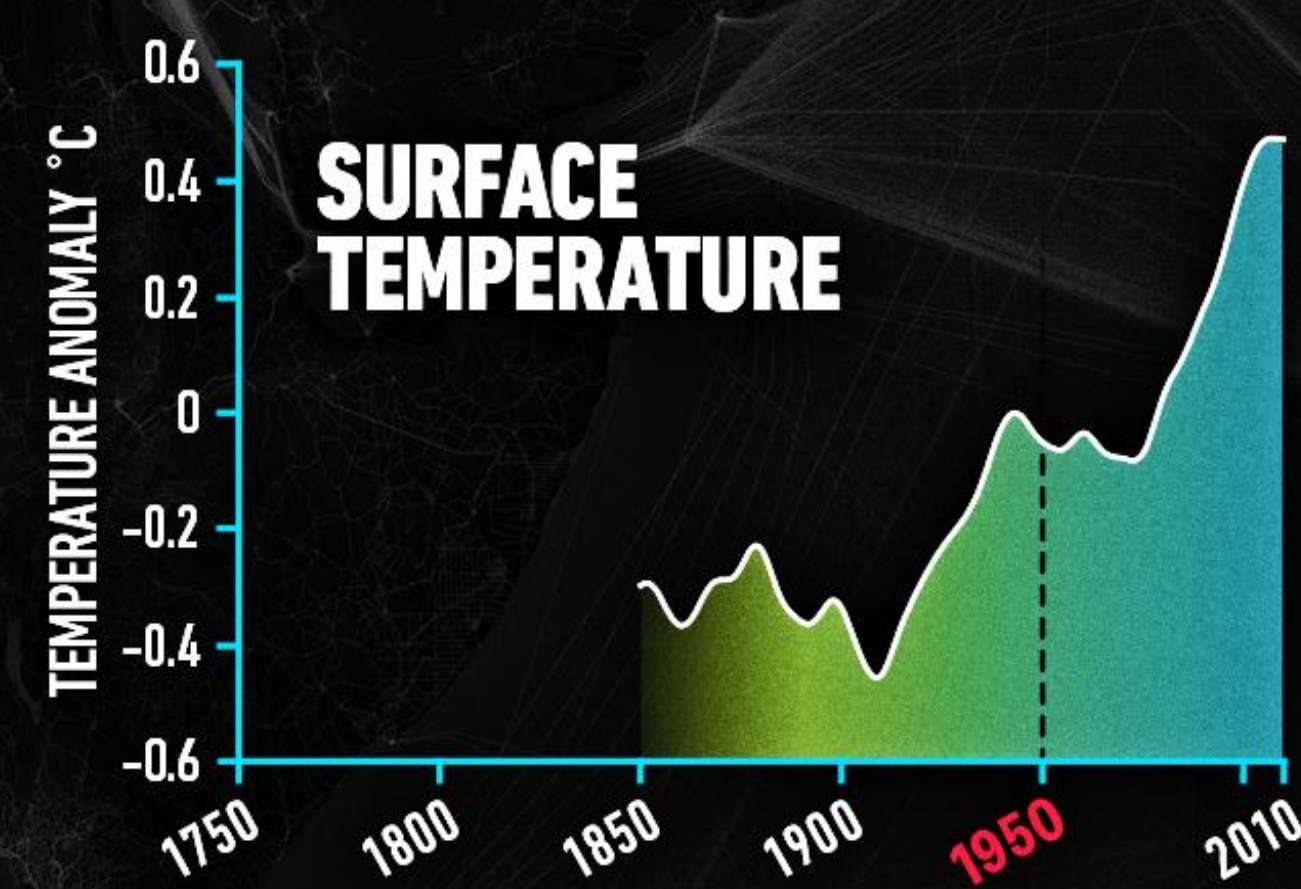
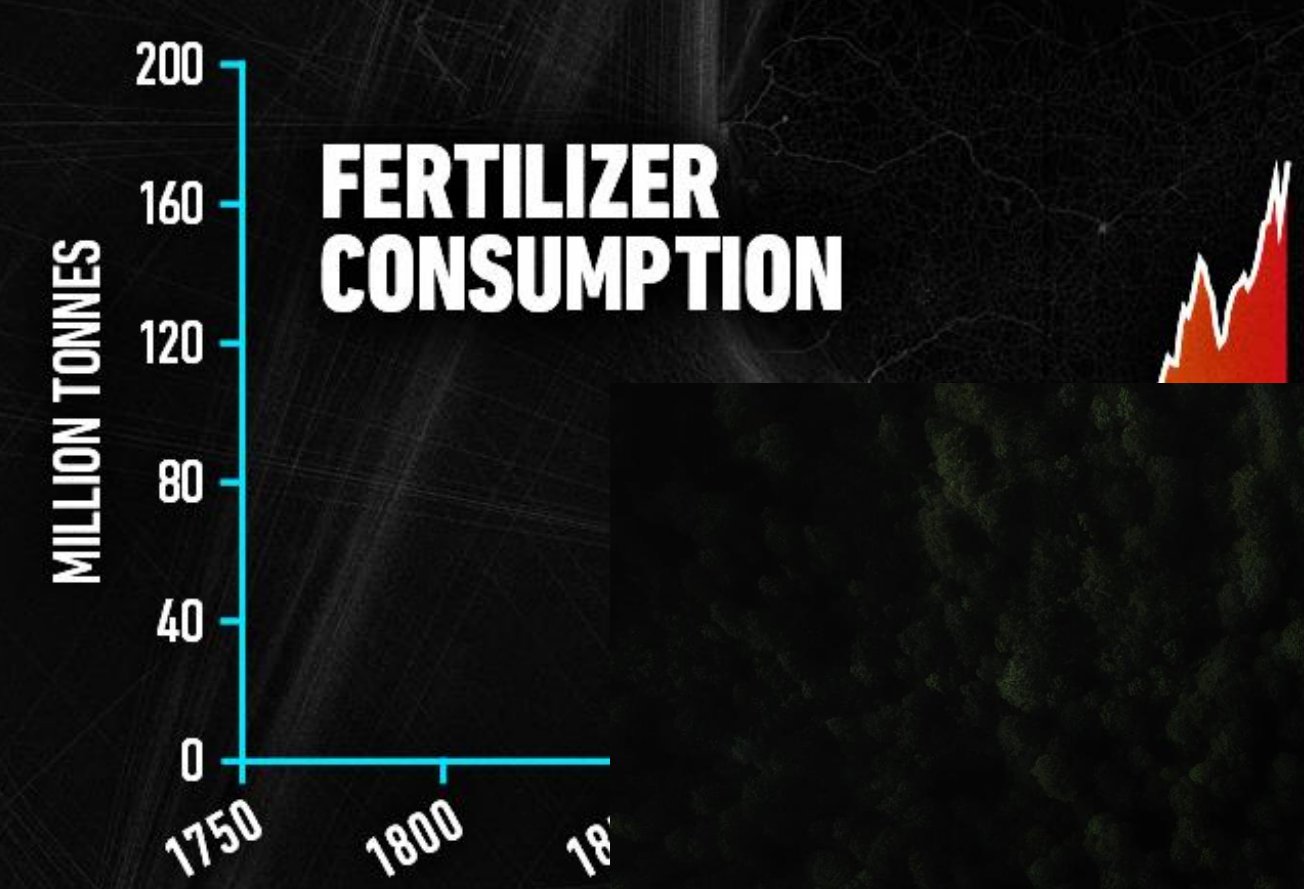
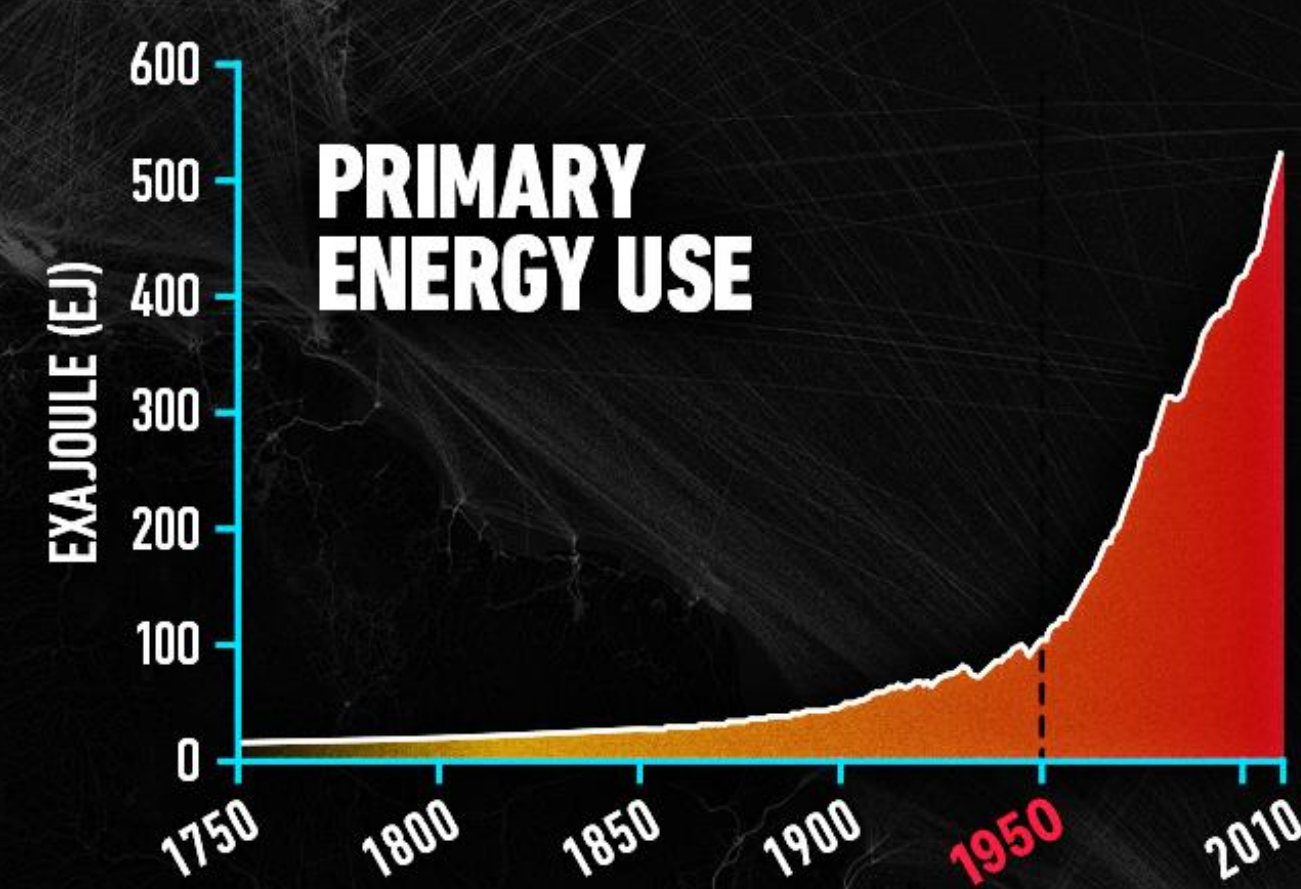
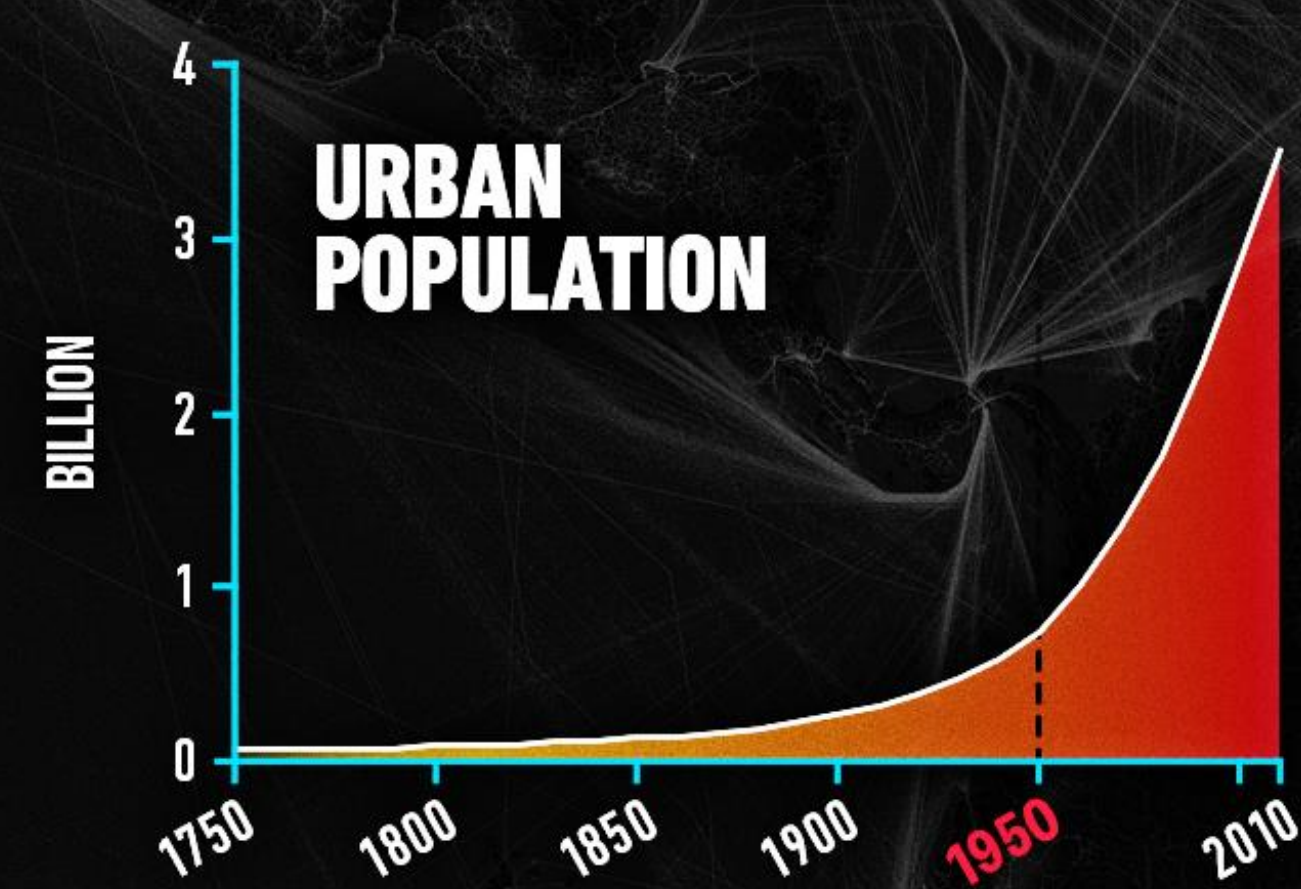
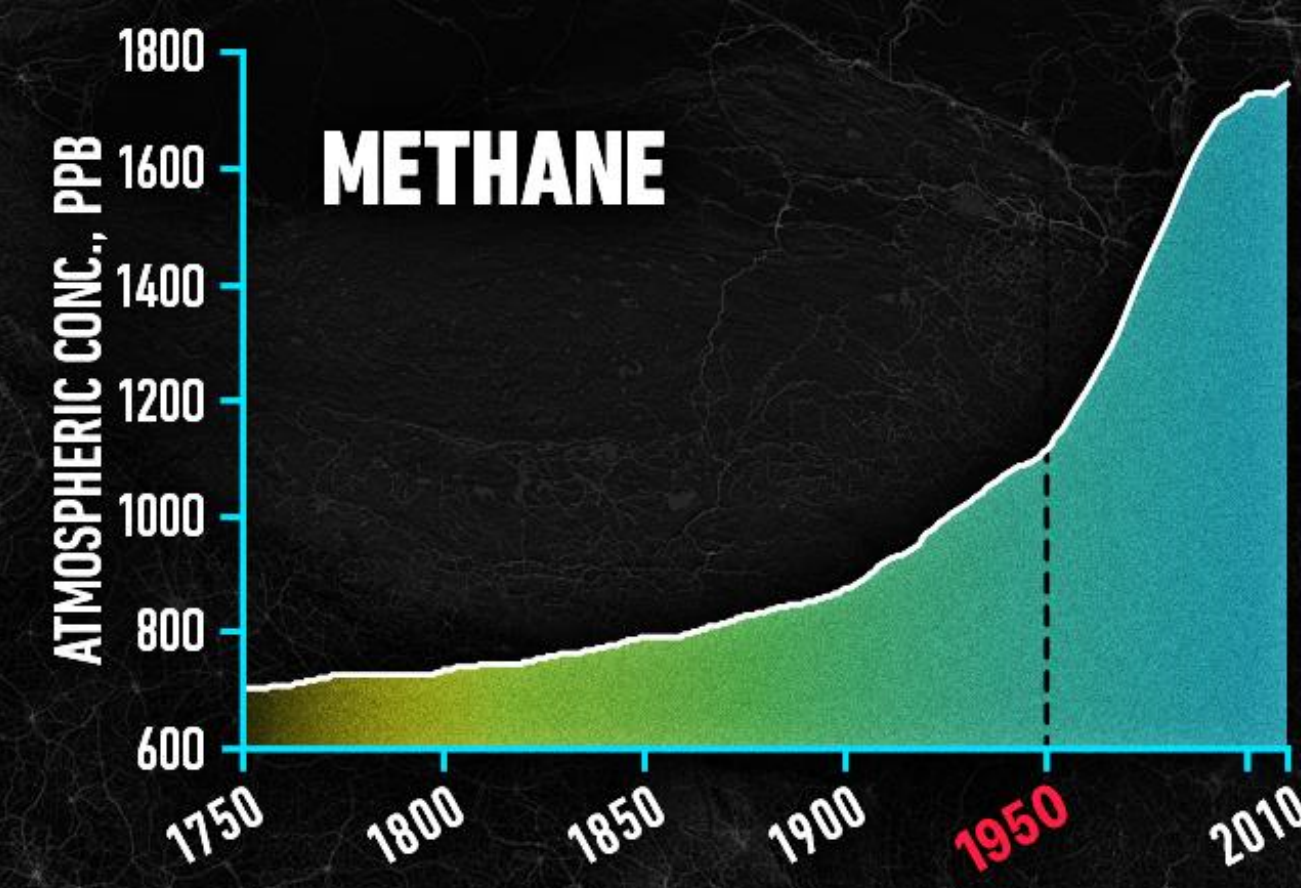
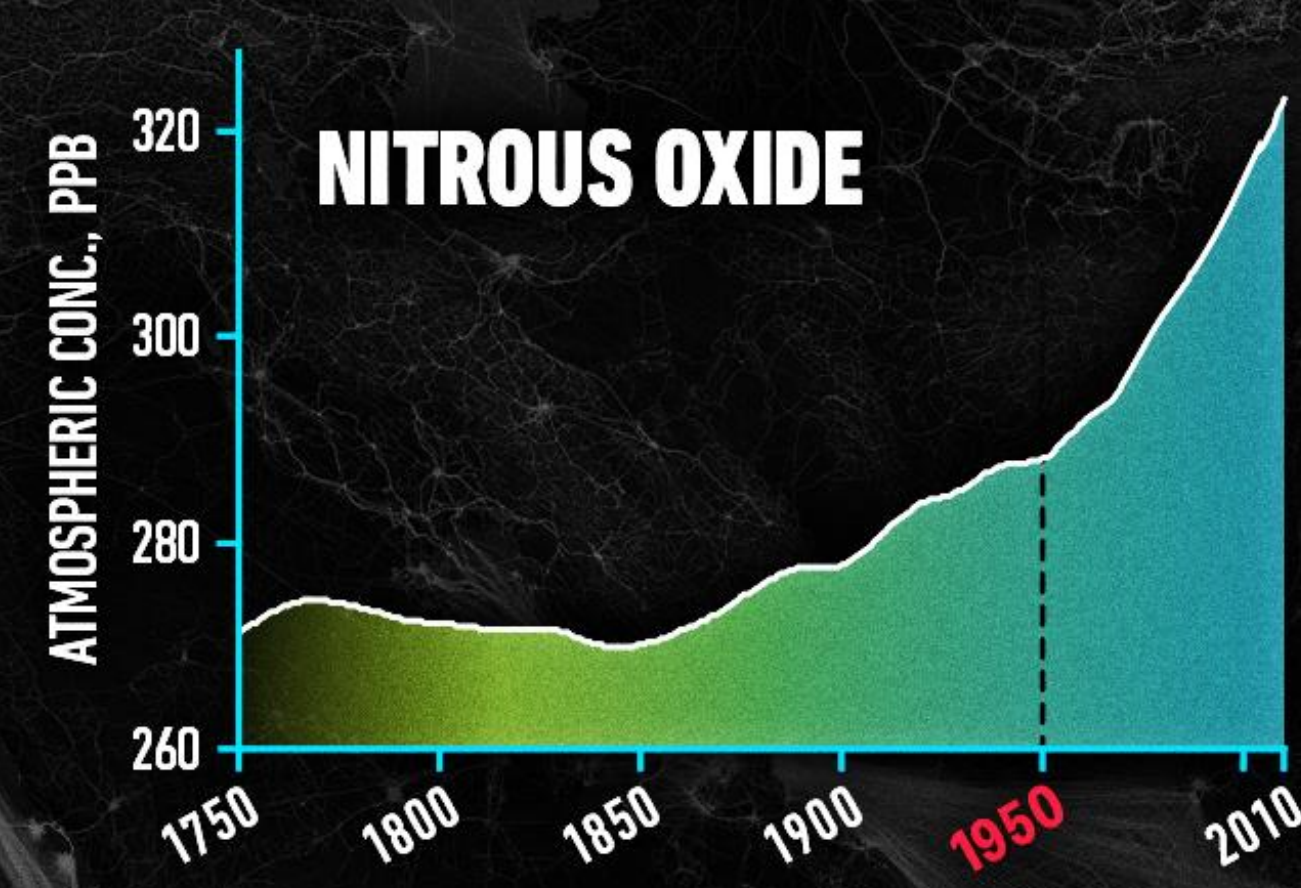
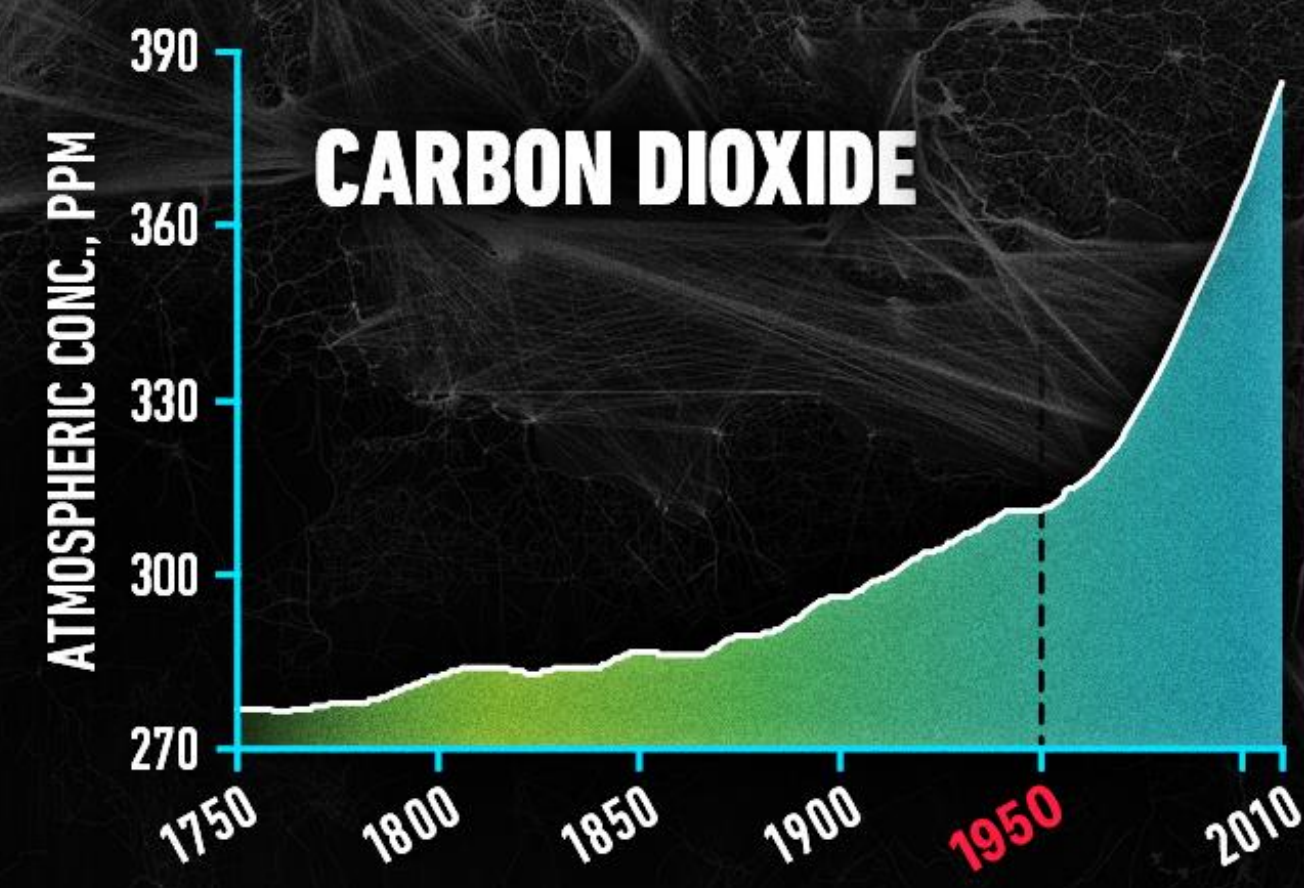
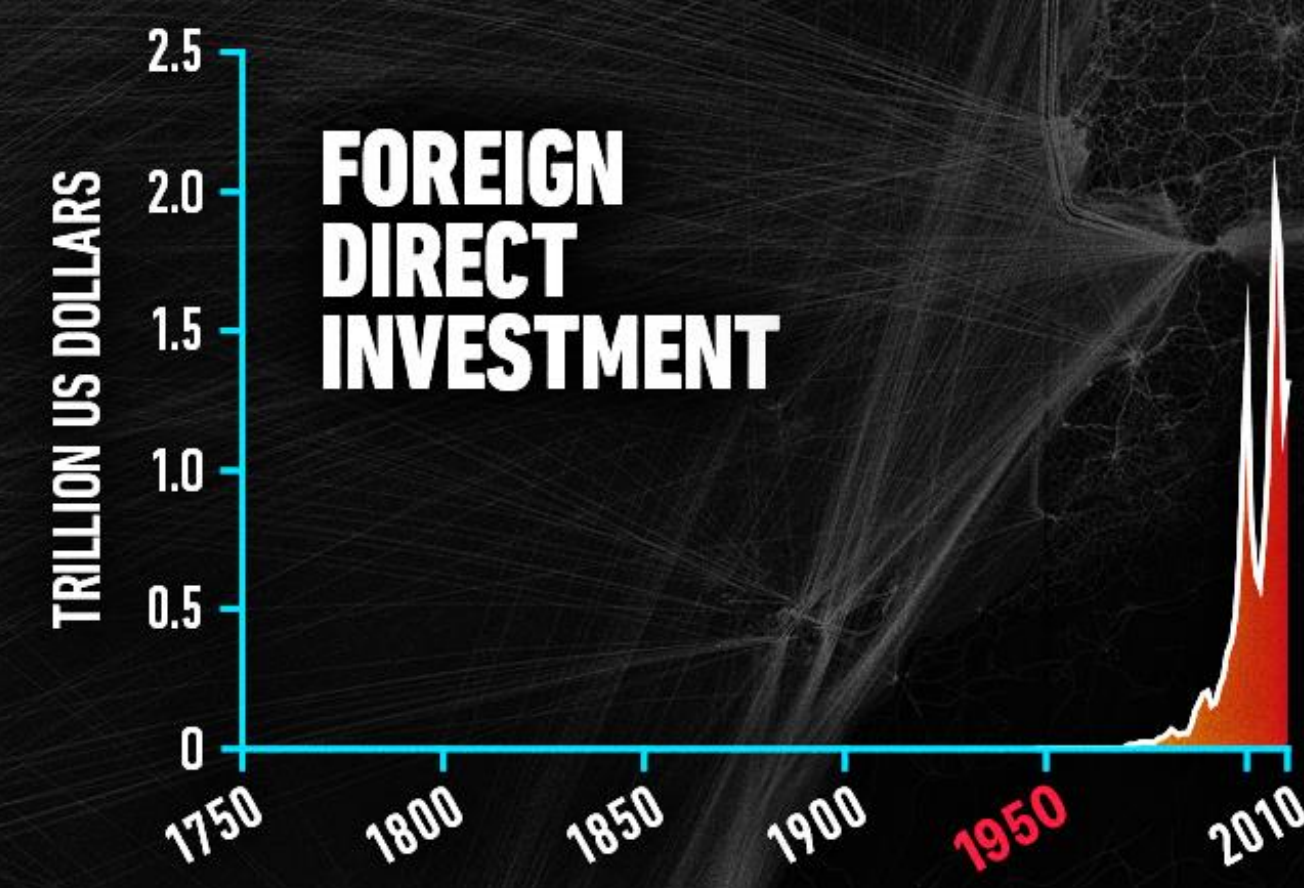
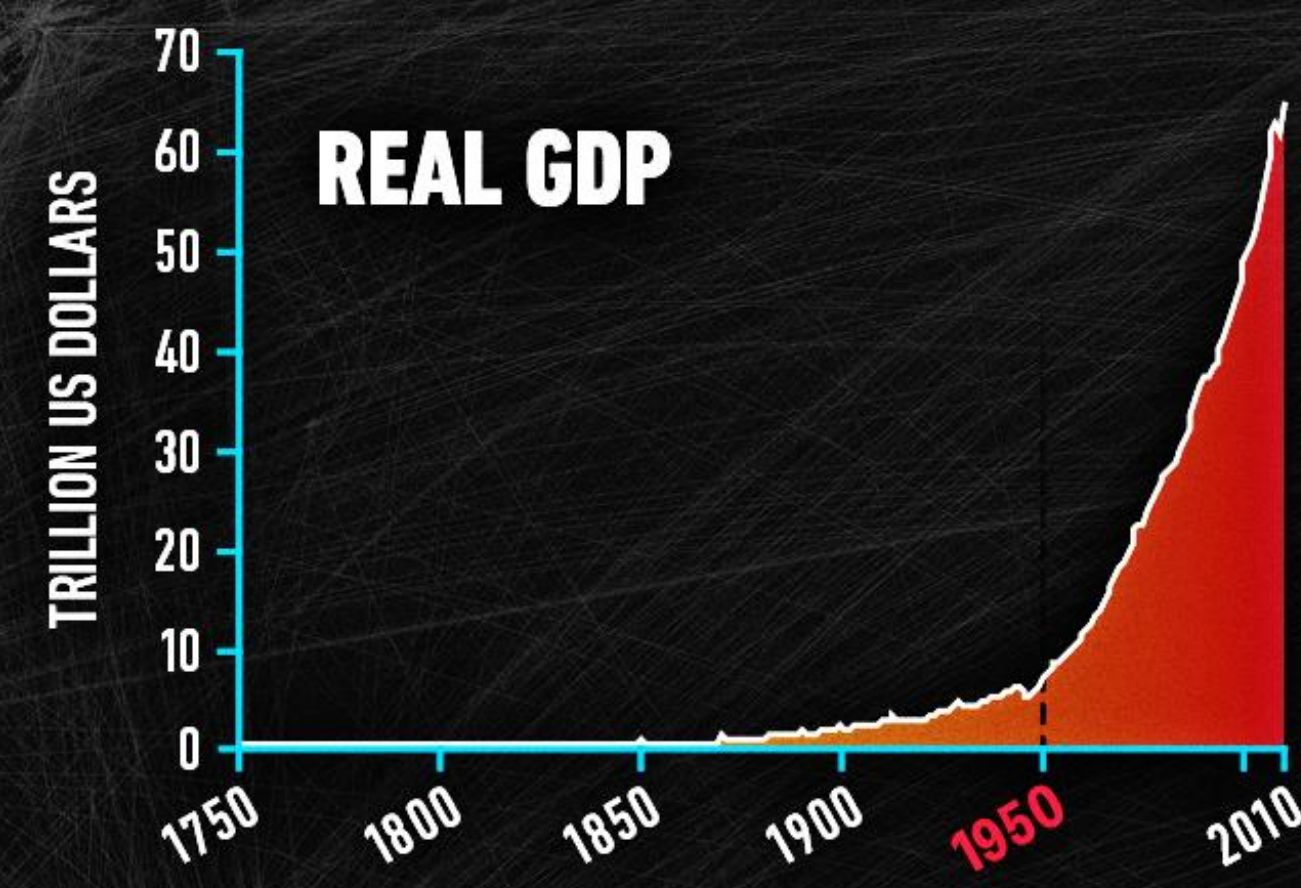
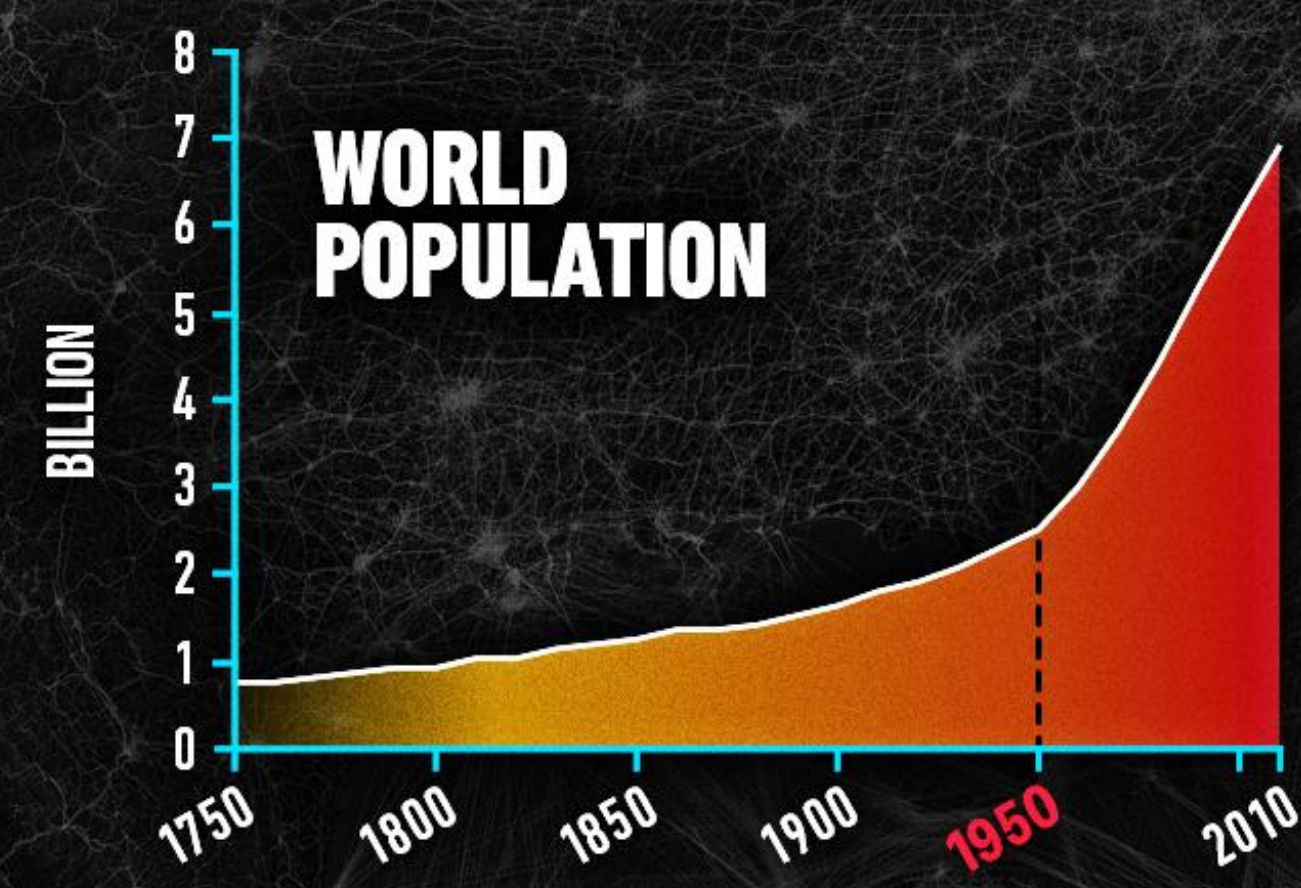


State of the Global Climate 2023. World Meteorological Organization, WMO #1347, 2024.

Forster et al., *Indicators of Global Climate Change 2023: annual update of key indicators of the state of the climate system and human influence*. Earth System Science Data, 16, 2625-2658, 2024.

SOCIO-ECONOMIC TRENDS

EARTH SYSTEM TRENDS



Holocene and the Corridor of Life

Figure pending revision

Humanity's Journey on Earth

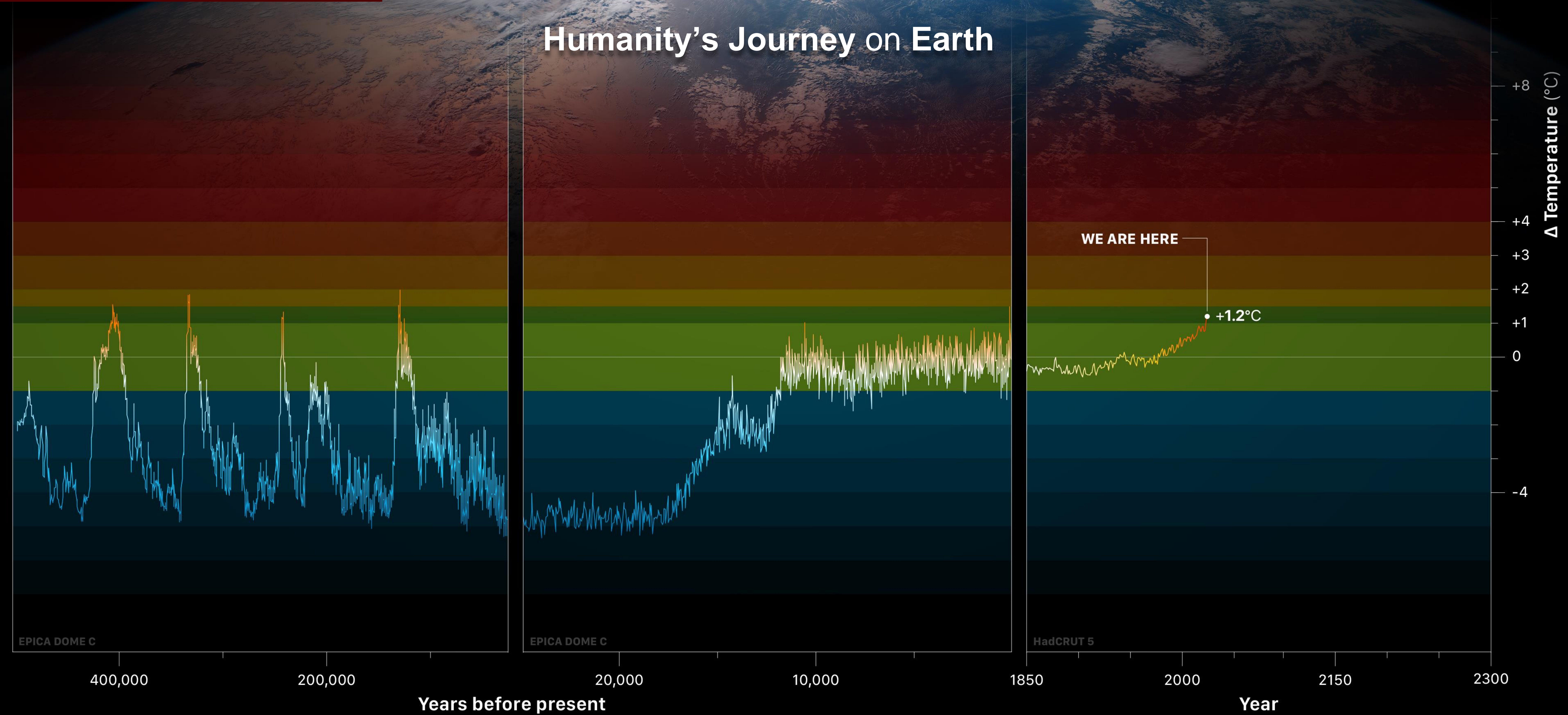


Figure pending revision

Humanity's Journey on Earth

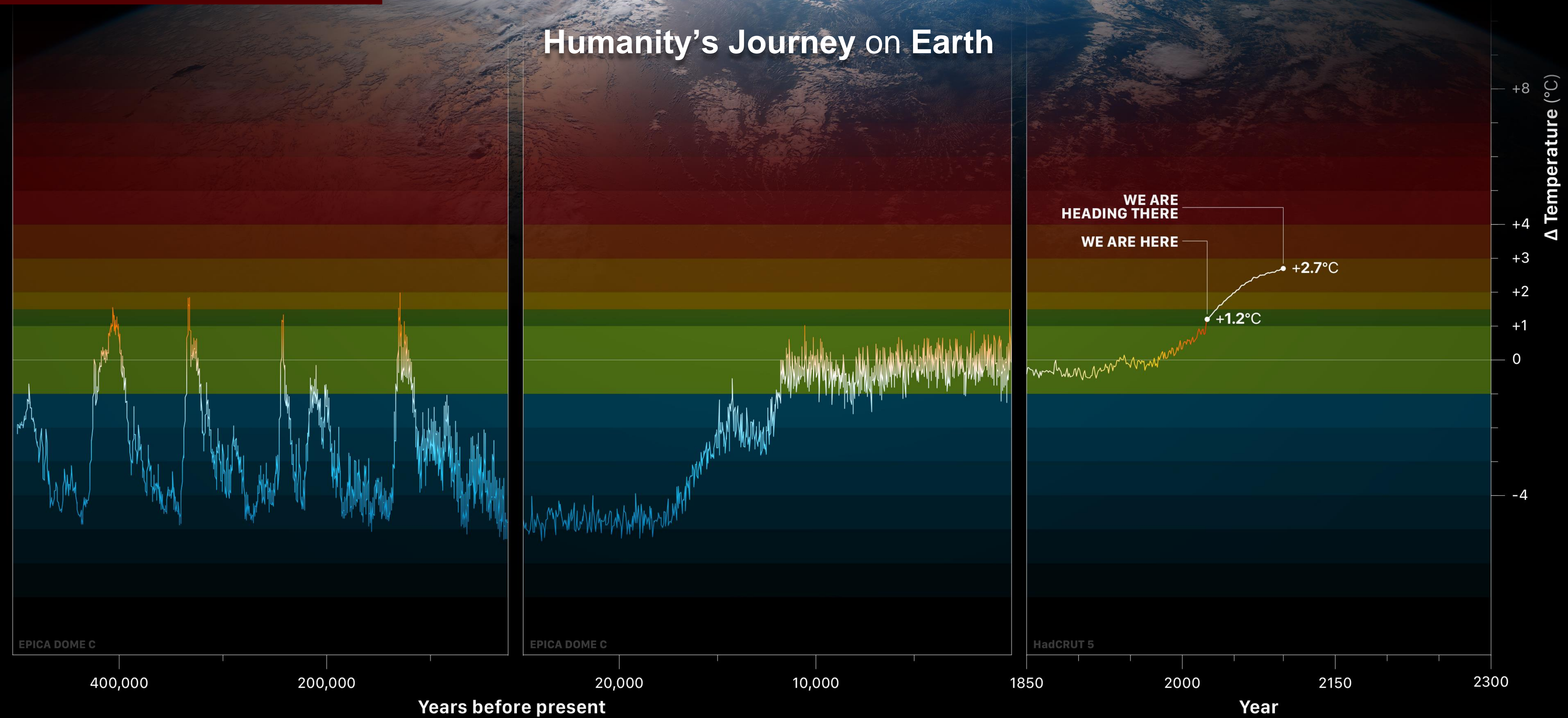


Figure pending revision

Humanity's Journey on Earth

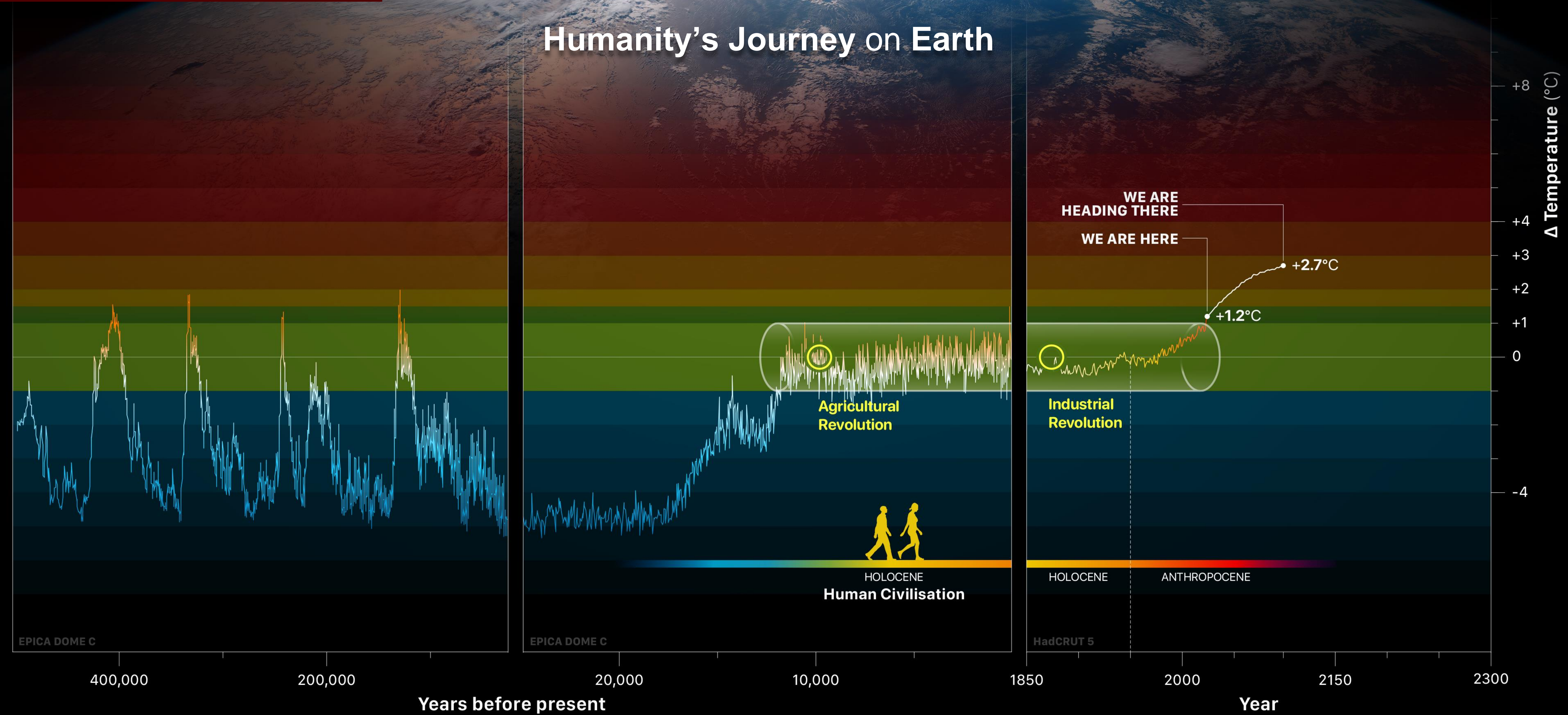
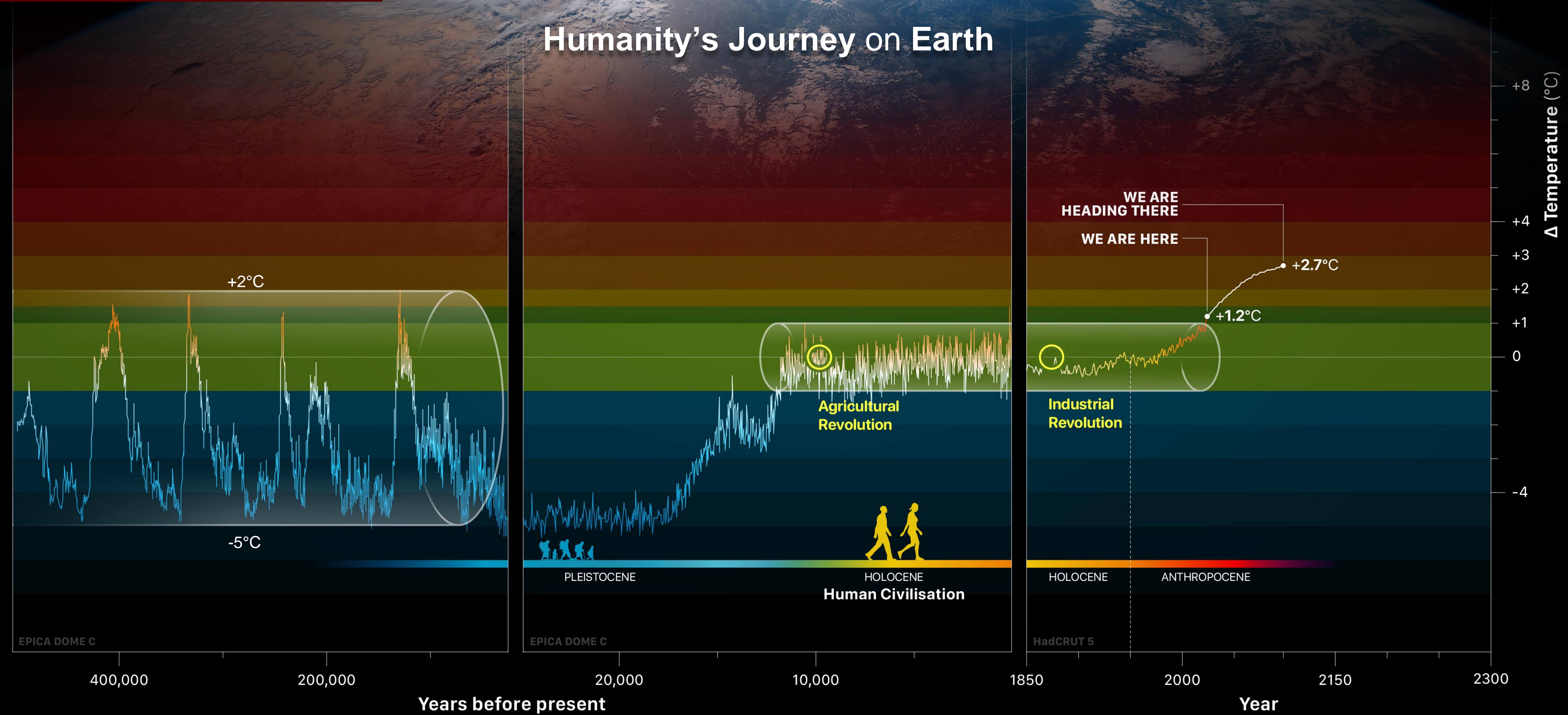


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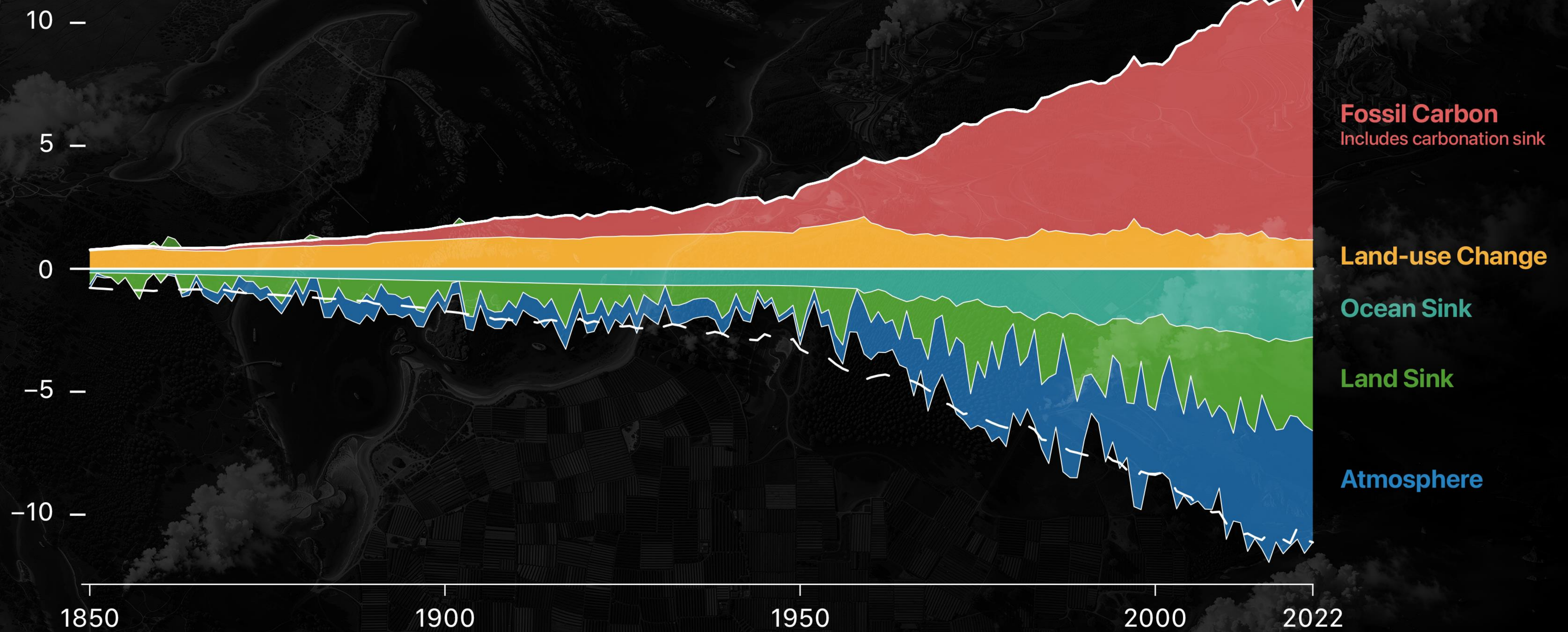
Humanity's Journey on Earth



Earth Resilience

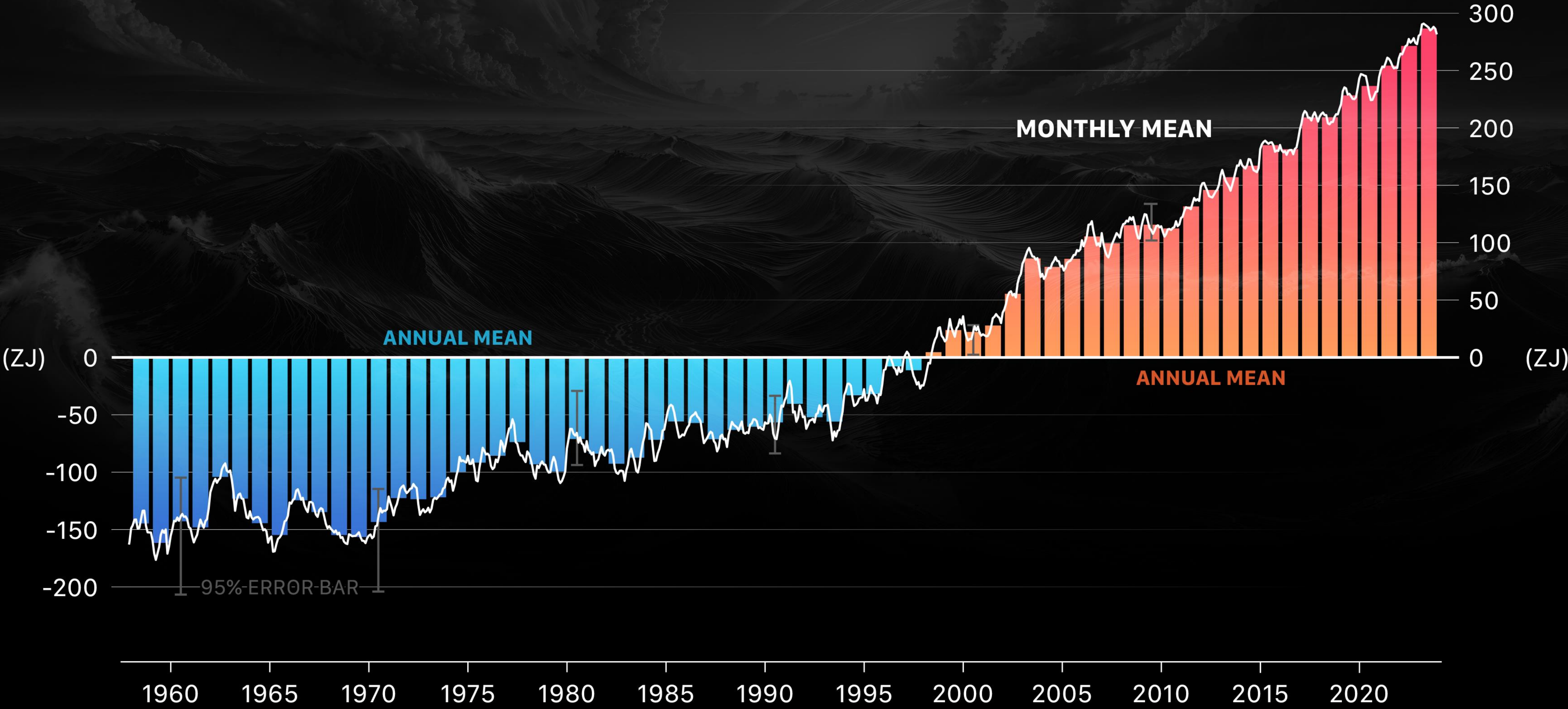
Balance of Sources and Sinks, 1850-2022

CO₂ Flux (GtC yr⁻¹)



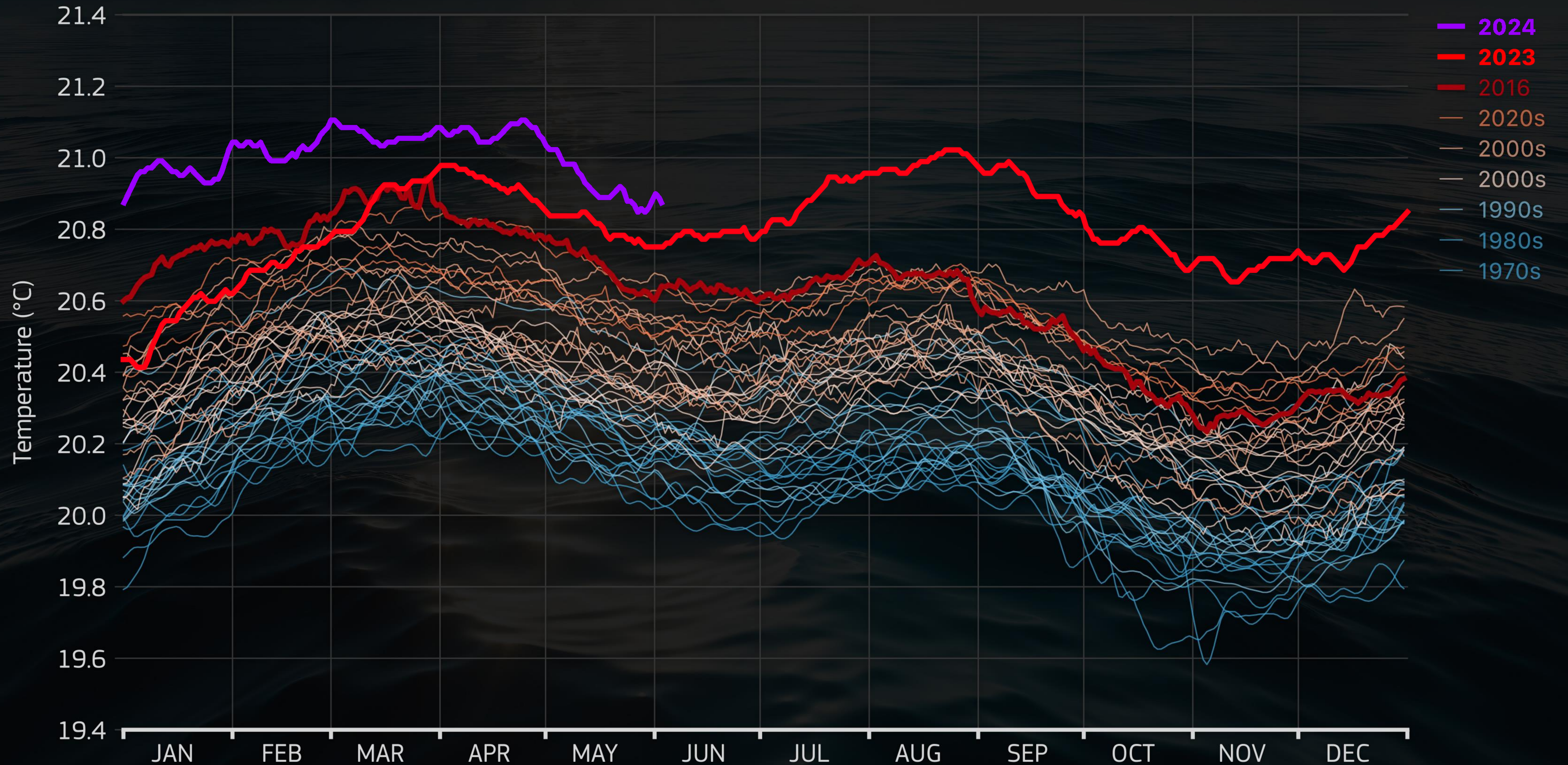
Global Ocean Heat Content Anomaly in the upper 2,000 meters, 1958-2023

1 Zetta Joule (ZJ) = 10^{21} Joules · 1981-2010 Baseline



Daily Sea Surface Temperature · 60°S–60°N

Data: ERA5 1979-2024



Tipping Points

OUR FUTURE

Present
EVENT HORIZON

Earth

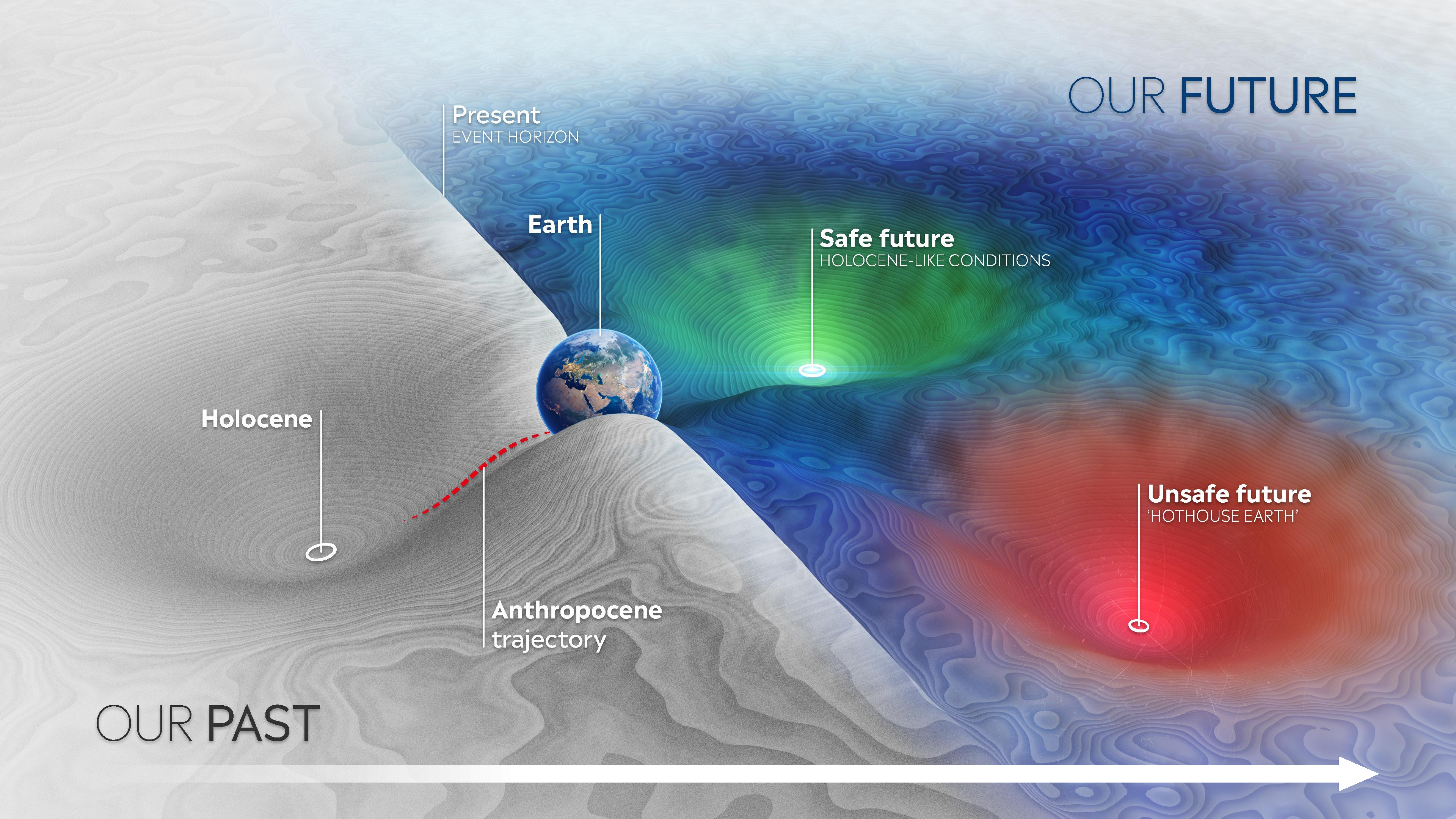
Safe future
HOLOCENE-LIKE CONDITIONS

Holocene

Unsafe future
'HOTHOUSE EARTH'

Anthropocene
trajectory

OUR PAST





**Atlantic Meridional
Overturning Circulation**
COLLAPSE

Amazon Rainforest
DIEBACK

**Extrapolar
Mountain Glaciers**
LOSS

The risk of climate tipping points is rising rapidly as the world heats up

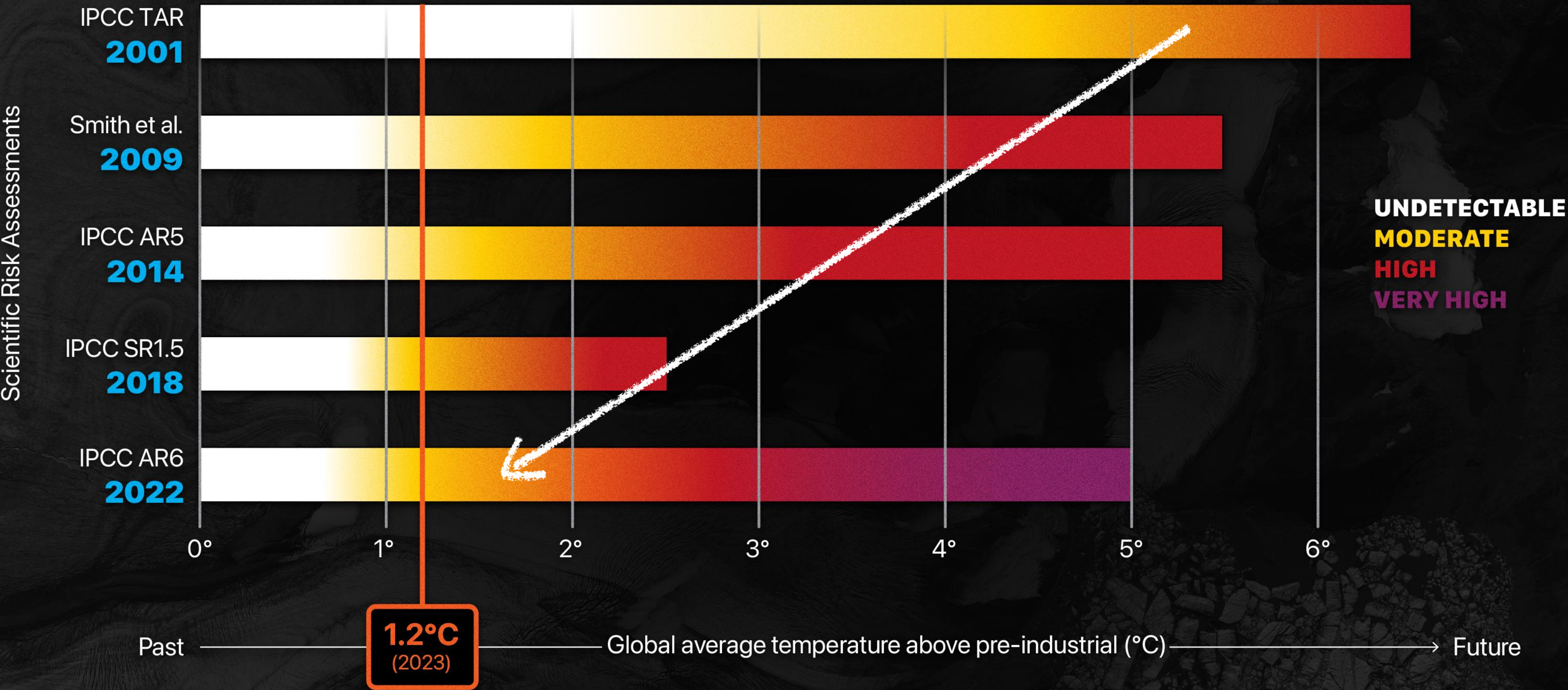
Estimated range of global heating needed to pass tipping point temperature

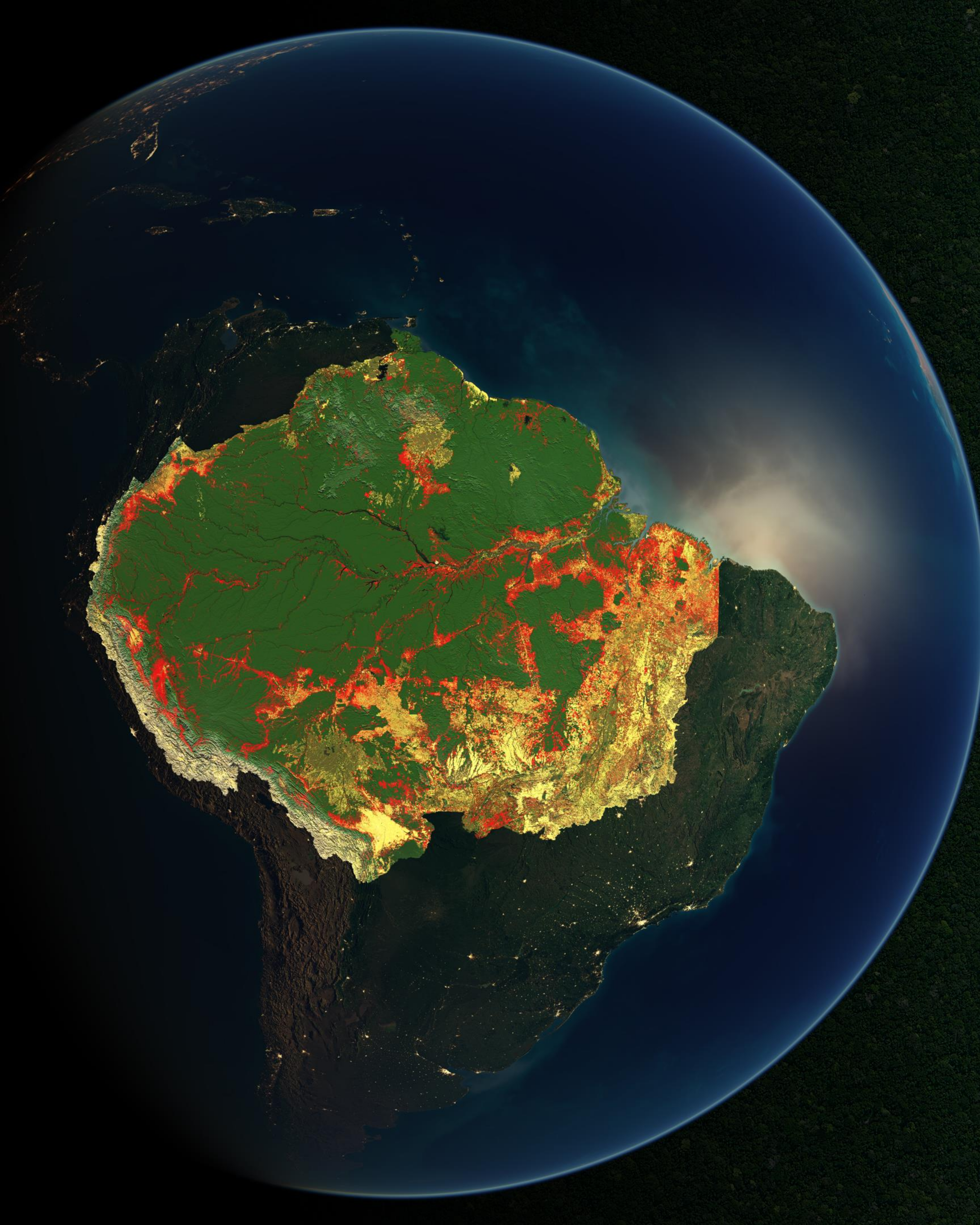


Source: Armstrong McKay et al, *Science*, 2022.

Large scale singular events (tipping elements)

Level of additional risk due to climate change





Risk of Amazon Tipping Point

Closer than we thought?

CLIMATE RISK

3-5°C

CLIMATE & ECOLOGICAL RISKS

1.5-2°C

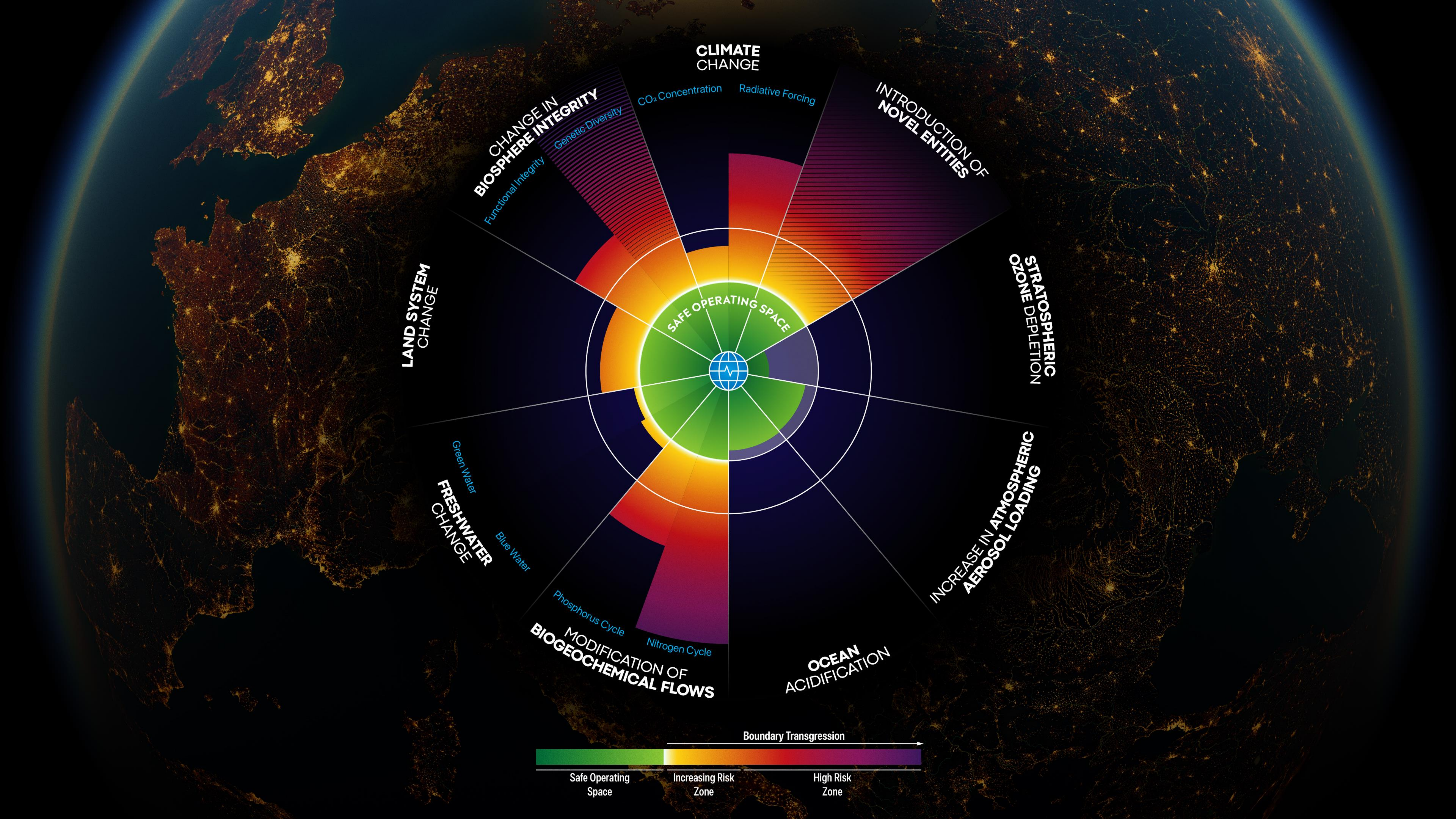
+ 20-25%

deforestation

TODAY

1.2°C + 17%

Path to a Safe Landing for Humanity on Earth



CLIMATE CHANGE

CO₂ Concentration Radiative Forcing

CHANGE IN BIOSPHERE INTEGRITY

Genetic Diversity
Functional Integrity

INTRODUCTION OF NOVEL ENTITIES

STRATOSPHERIC OZONE DEPLETION

INCREASE IN ATMOSPHERIC AEROSOL LOADING

OCEAN ACIDIFICATION

MODIFICATION OF BIOGEOCHEMICAL FLOWS

Phosphorus Cycle
Nitrogen Cycle

FRESHWATER CHANGE

Green Water
Blue Water

LAND SYSTEM CHANGE

SAFE OPERATING SPACE

Boundary Transgression

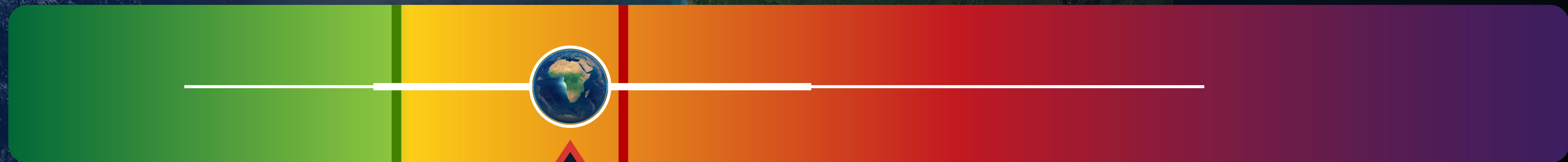


Safe Operating Space

Increasing Risk Zone

High Risk Zone

Planetary Health Check 2024

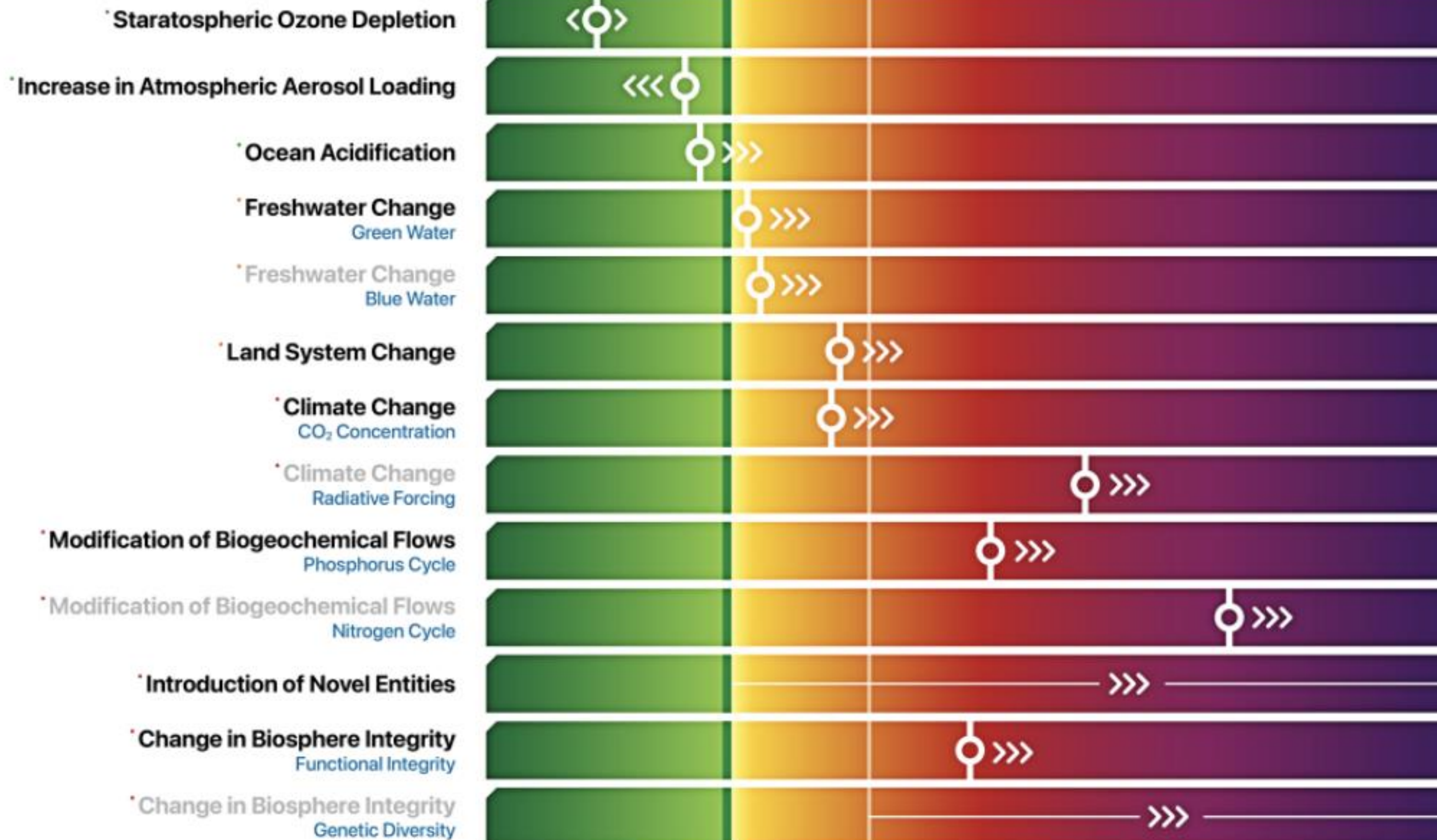




Planetary Health Check



Planetary Boundary Process



Transformative Moment

