MUNI
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03 Environmental history: past environmental changes

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Content

1. Landscape changes in the Pleistocene
2. Landscape changes in the Early–Middle Holocene
3. Neolithic revolution
4. Landscape changes in the Late Middle Holocene

"He will not understand the present who does not know the causes of the past"

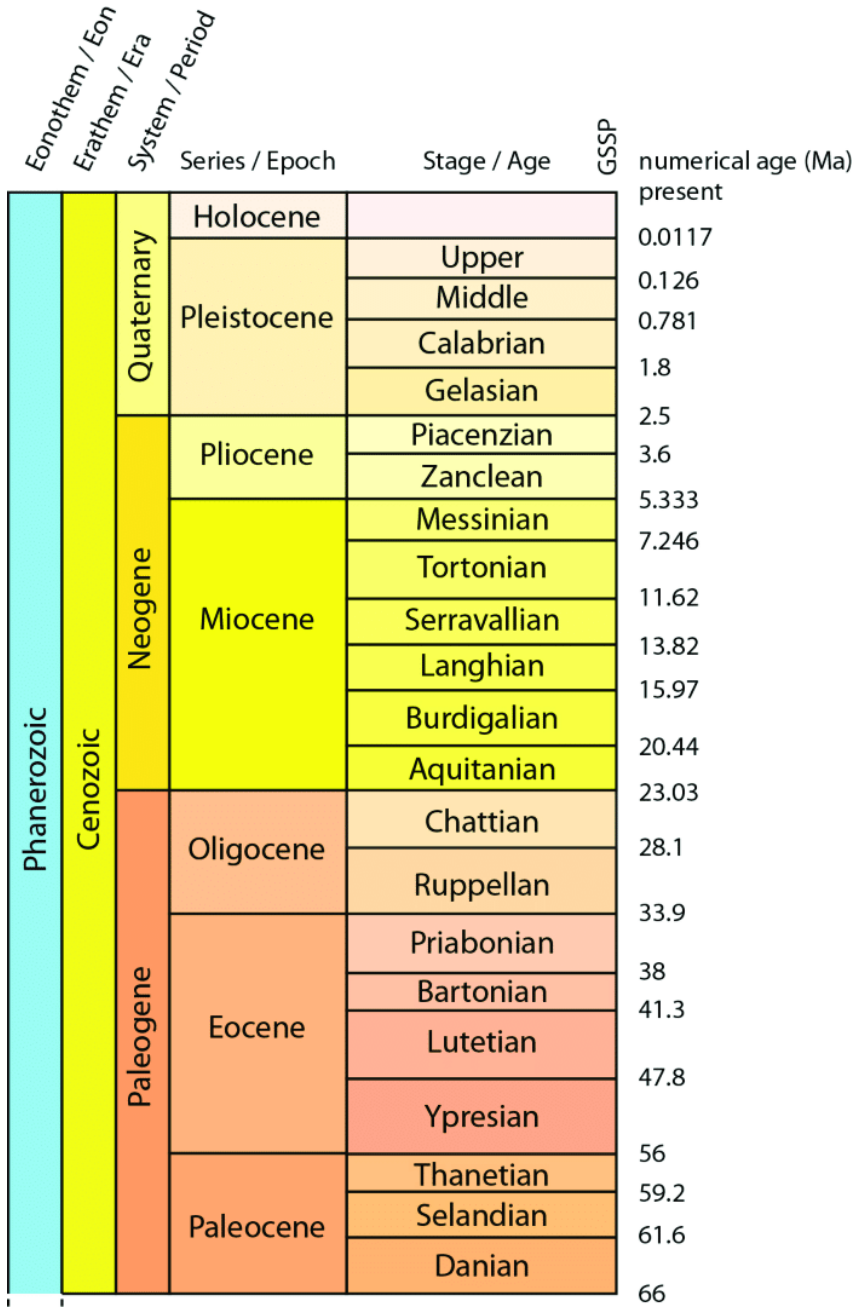
Vojen Ložek

https://dinosaurpictures.org/ancient-earth#35

Landscape in geological eras

- The **current landscape** as an **intermediate stage** of long-term development
- **Paleogene-Neogene/Tertiary (66–2.6 Myr)**: the formation of the world as we know it today
  - forming of recent continents, seas and oceans
  - Alpine-Himalayan orogeny and volcanic activity
  - formation of river systems
  - climate changes

Chronostratigraphic chart



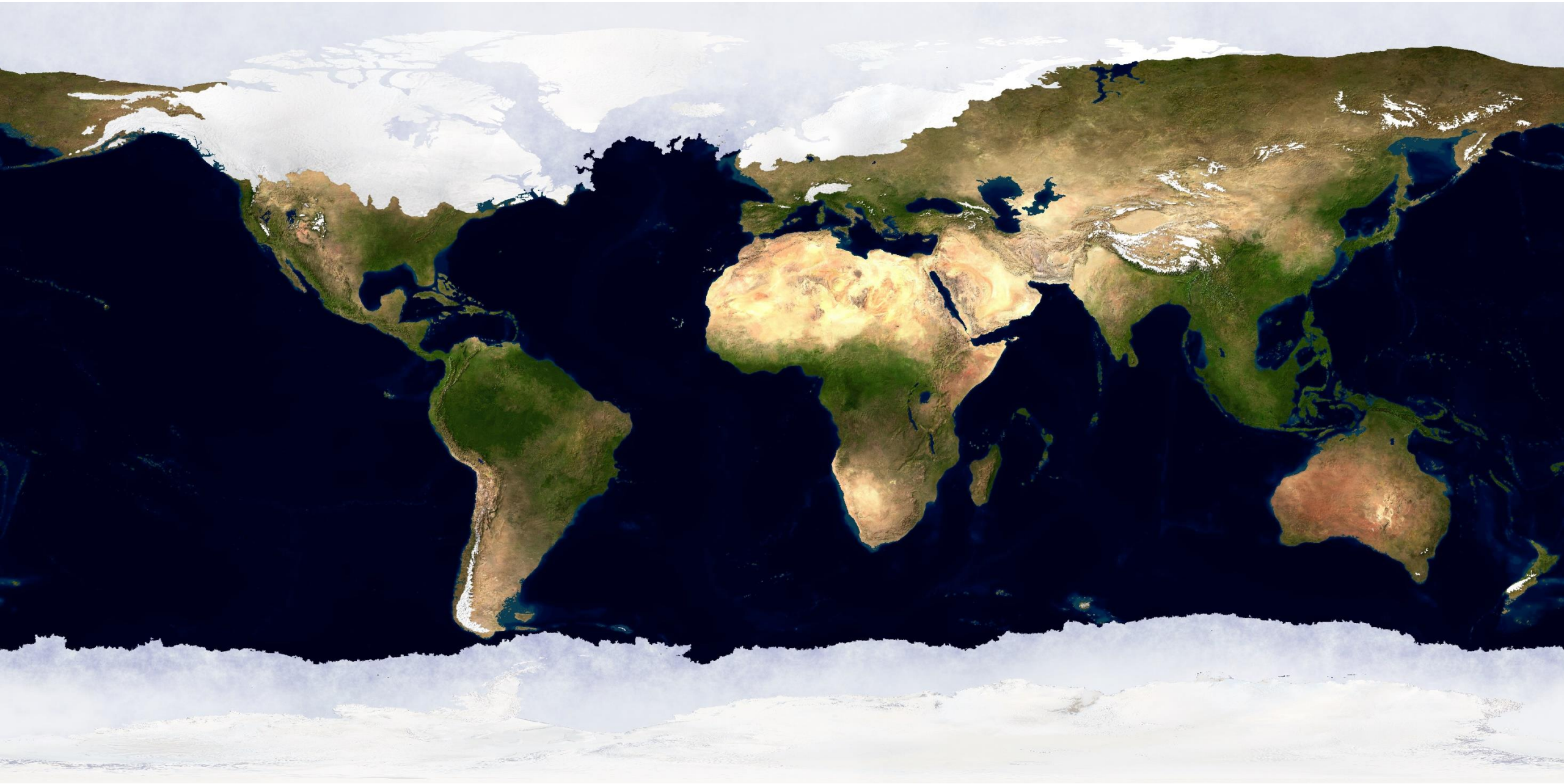
Cohen et al. 2017

Alpine himalayan orogeny

Marko et al. 2020

Quaternary (2.6 Myr–present day)

- **Pleistocene** (2.6 Myr–11 700 BP) and **Holocene** (11 700 BP–present day)
  - youngest and shortest geological period
- The beginning of the evolution of modern ecosystems (<2 Myr)
- Significant landscape changes due to **exogenous forces** (glaciations)
- **Period of human development**
  - integral part of ecosystems x origin of cultural landscapes



Reddit.com, 2021

North America,
12 600 BP

Reddit.com, 2021

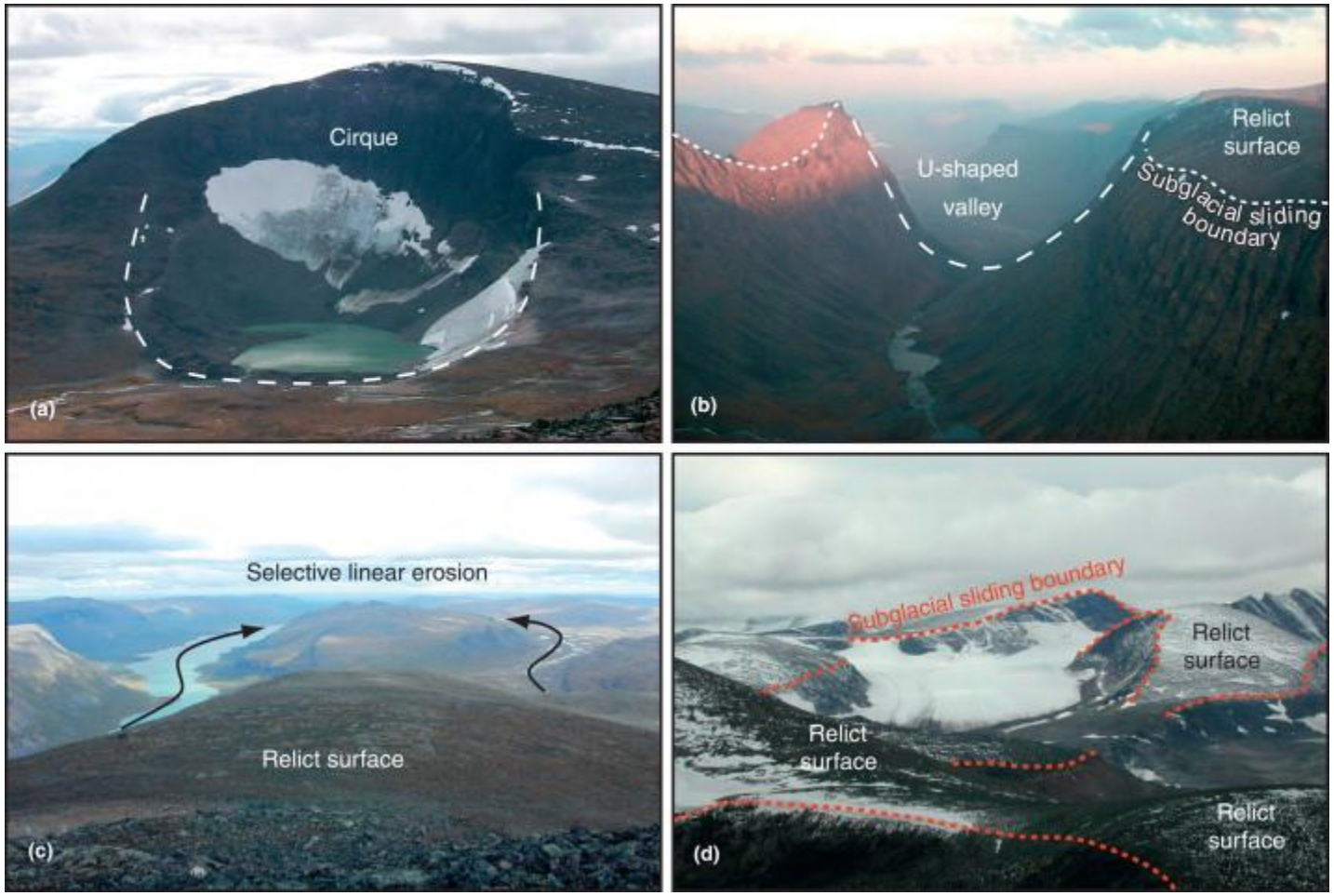
Landscape changes in the Pleistocene

Pleistocene (2.6 Myr–11 700 BP)

- **Cyclic and rapid climate fluctuations** (glacials and interglacials)
- Periodic changes in the **extent of continents and seas**
- Influence of **continental** and **mountain glaciers** to form the landscape

Pixabay, 2023

Glacial landscapes (northern Scandinavian)



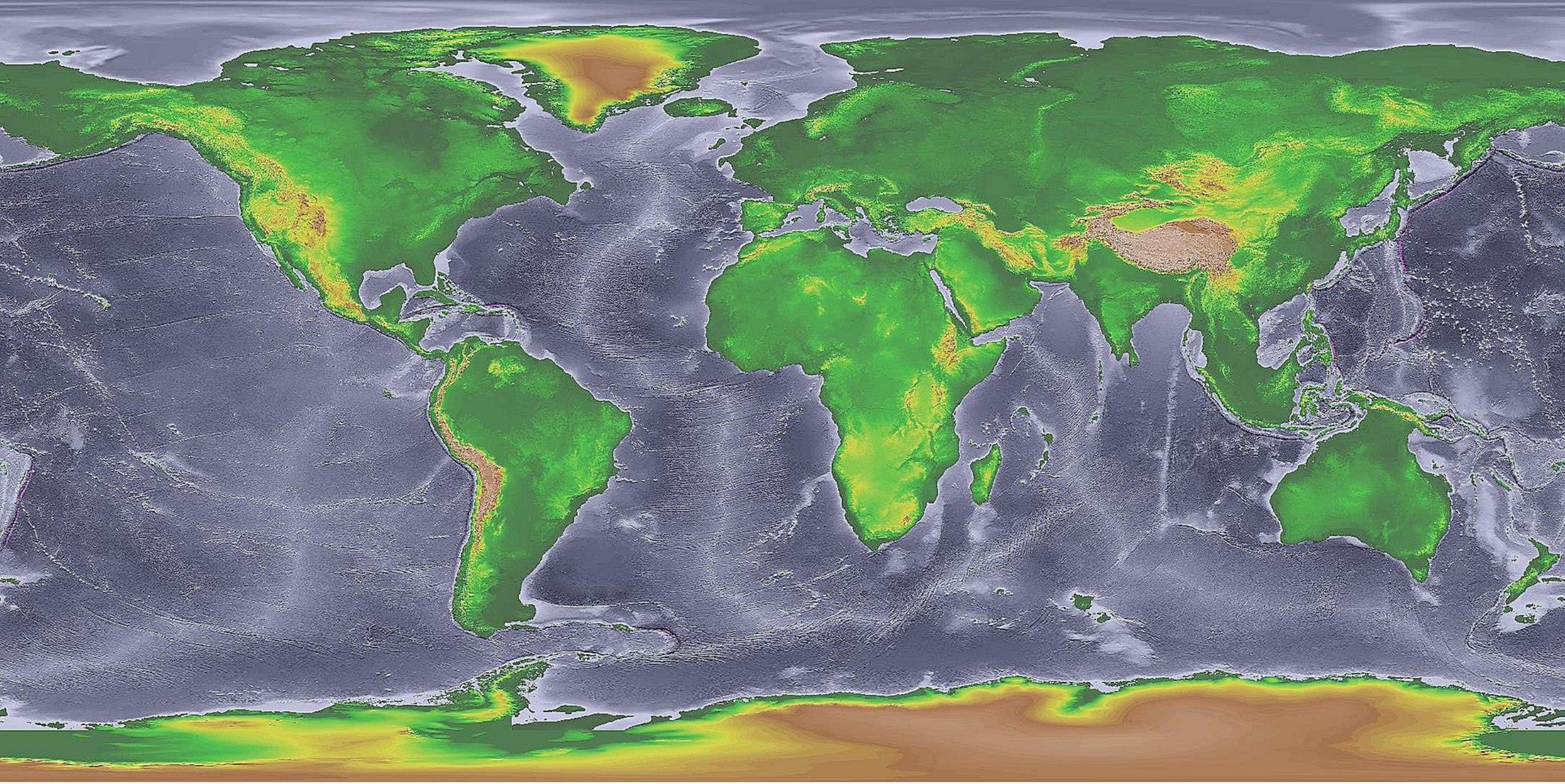
Stroeven et al. 2013

Pleistocene (2.6 Myr–11 700 BP)

- **Changes in living spaces for fauna and flora**
  - migration corridors
  - extinction events (mammoths, mastodons, cave lions and bears…)
    - North Africa and North America (native horses and camels)
- **Evolution of anatomically modern humans**
  - minimal influence of mankind on the landscape, mankind as a part of natural ecosystems

Glacial periods (*ice ages*)

- Periods of **colder temperatures**, **lower humidity** and **glaciers advance** lasting 40–100 000 years
  - formation of 3–4 km thick continental ice sheets
  - significant sea level drop (up to 120 m)
- **Effects**
  - erosion and deposition of material, modified river systems, formation of new lakes and loess deposits, changes in environment and ecosystems



Global sea levels during the last Ice Age

NOAA, 2023

Interglacial periods

- Periods between glacials with **higher temperatures**, **higher humidity** and **glaciers´retreat** lasting thousands of years
  - sea level increase (up to 9.5 m)
  - higher sea temperature (North Sea: 2°C)
- **Effects**
  - expansion of fauna and flora, increase in biodiversity, migration of humans, stabilised river systems etc.
- **State of the landscape in previous interglacials** = similar state of the landscape in the Holocene without human intervention

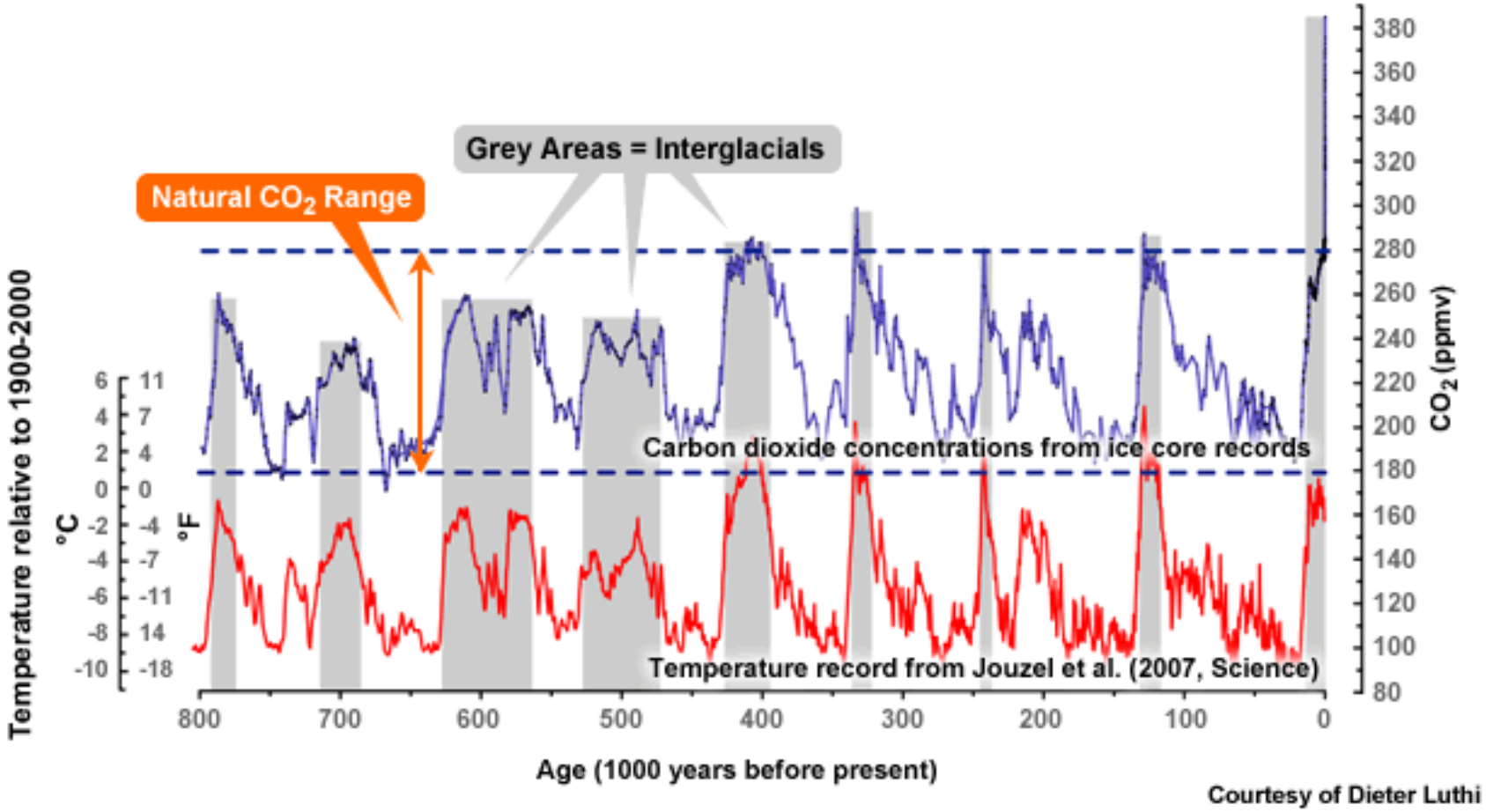
Specifics of the recent interglacial (Holocene) versus the last interglacial (Eemian, 126–115 000 years BP)

- The **evolution of human civilisation** and its direct impact on climate and landscape
- **Lower global temperature** (1–2°C, before 1750), **humidity** and **oceanicity** (lower sea level)
- Absence of some warm-temperate species (holly, boxwood)

Specifics of the recent interglacial (Holocene) versus the last interglacial (Eemian, 126–115 000 years BP)

- **Lower (tropical rain) forest cover**
  - retreat of brown soil at the expense of black soil
- **Probably longer duration**
  - expected start of the new glacial period (without human influence): ca. 3 500 AD

Specifics of the recent interglacial (Holocene) versus the last interglacial (Eemian, 126–115 000 years BP)

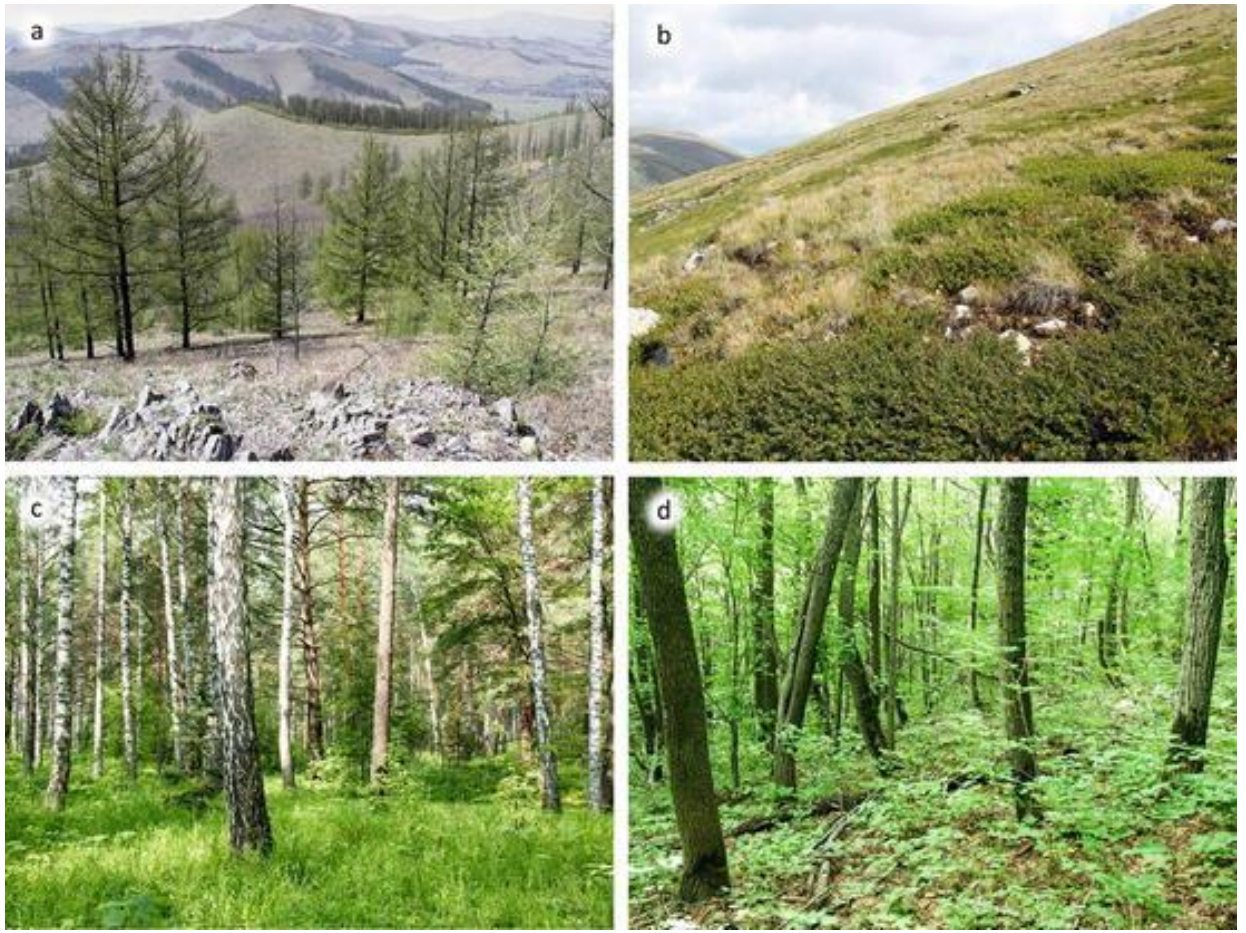


Changes in Europe at the end of last glacial

dry and cold steppes, peak glacial (today S Mongolia)

Impacts on hunters´ behaviour

lowland boreal forests-taiga, late glacial/early Holocene (today around Novosibirsk)

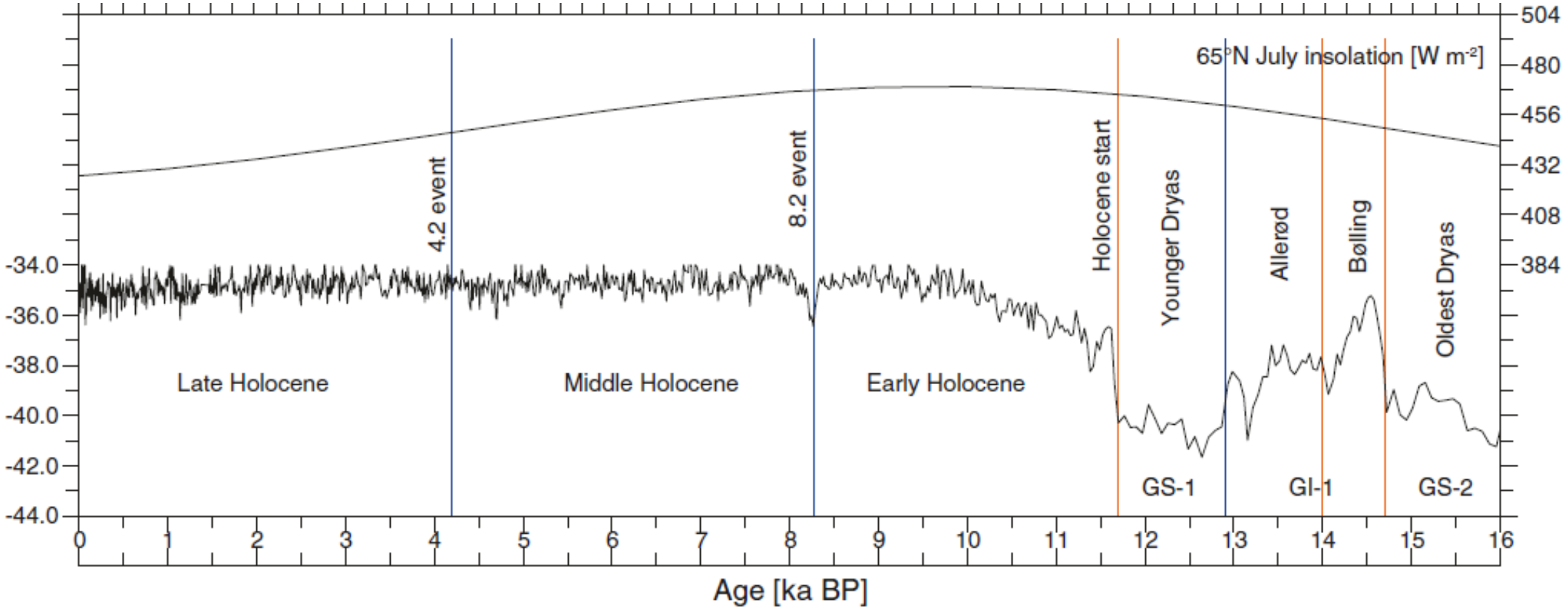


continental steppe tundra, late glacial, (today Altai)

deciduous forest, middle Holocene (nowadays south Ural)

V. Abraham (a) and M. Chytrý (b–d), 2021

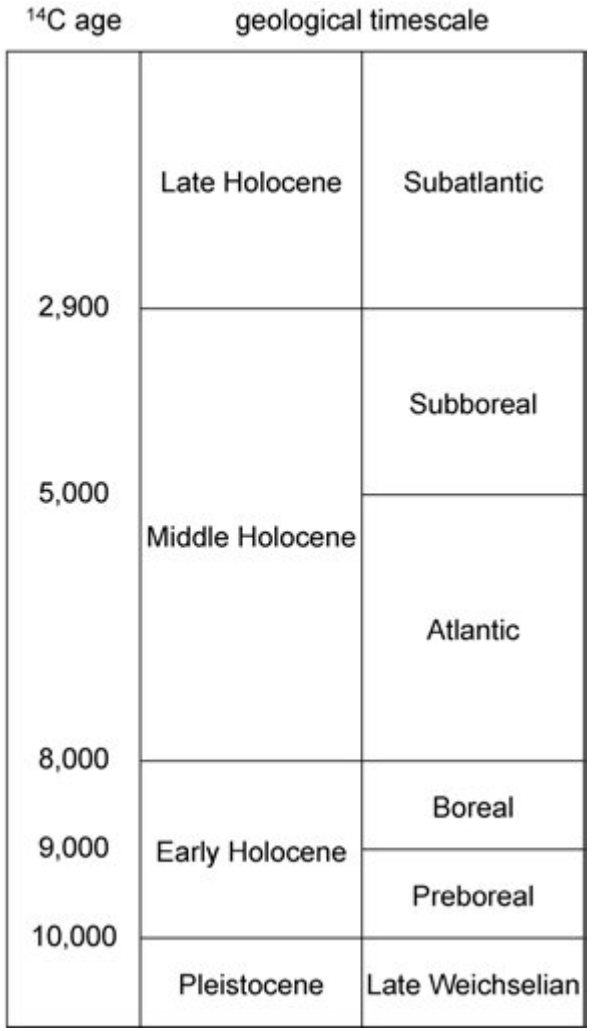
Temperature variability over the last 16 000 years

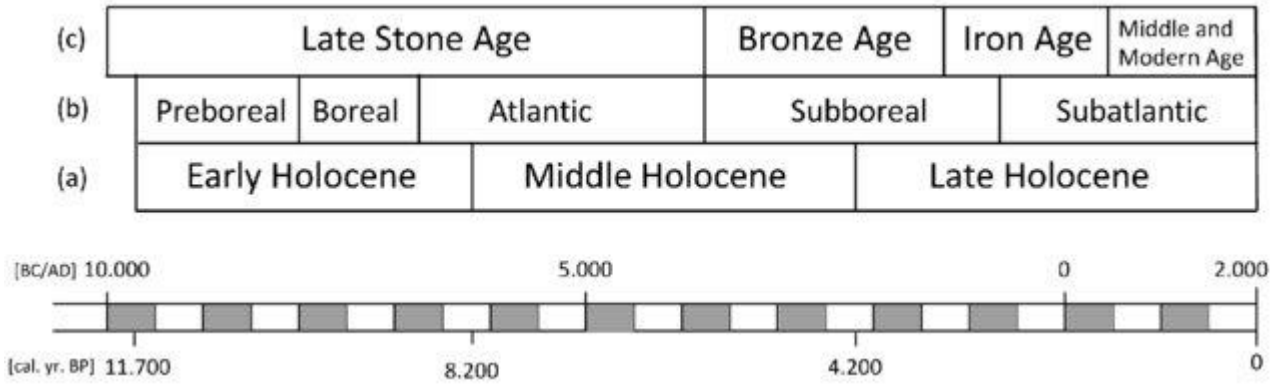


Chytrý at al. 2017

Landscape changes in the Early–Middle Holocene

Holocene sratigraphy





Heteren et al. 2002

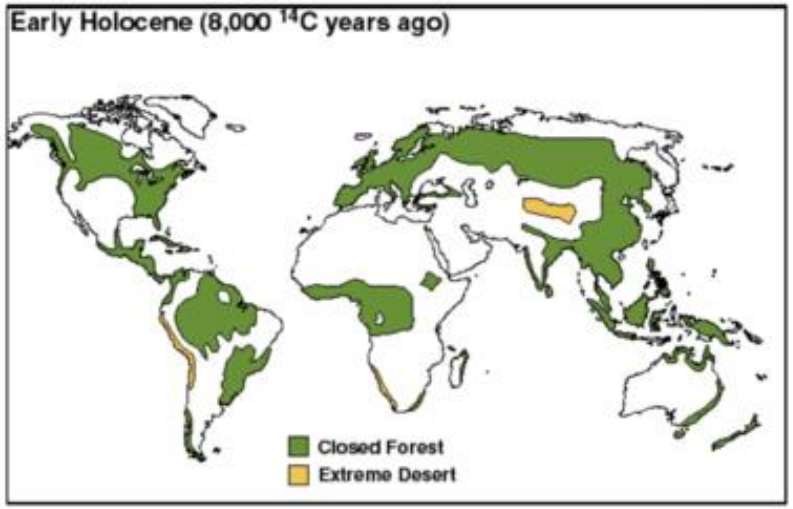
Preboreal–Boreal (11 700–8 000 BP)

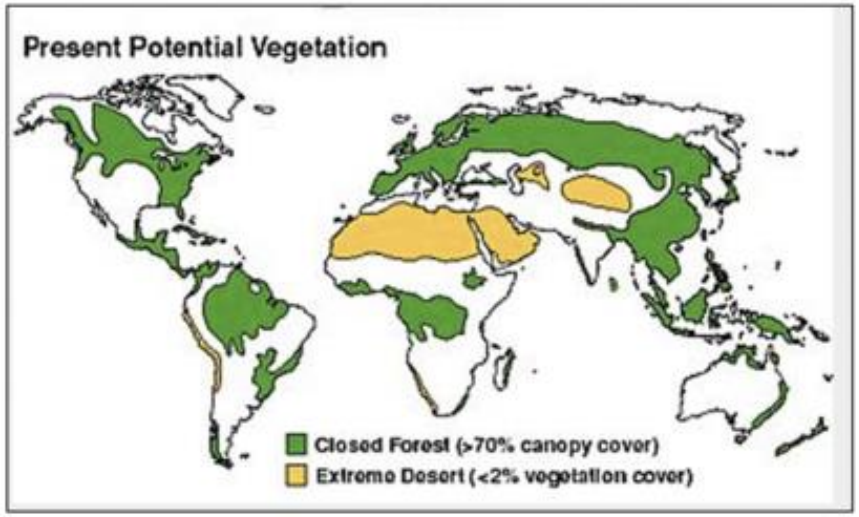
- Sudden **temperature increrase**
- **Simultaneous** evolution of old and new ecosystems
- **Forest expansion** (retreat of the "open“ landscape)

Kirsch 2010

Atlantic (8 000–5 000 BP)

- Also known as **Holocene Climatic Optimum**
- **Warm humid climate** with a stable climate conditions
- **Higher temperature** (>3°C) and **precipitation** (>650 mm) (central Europe)

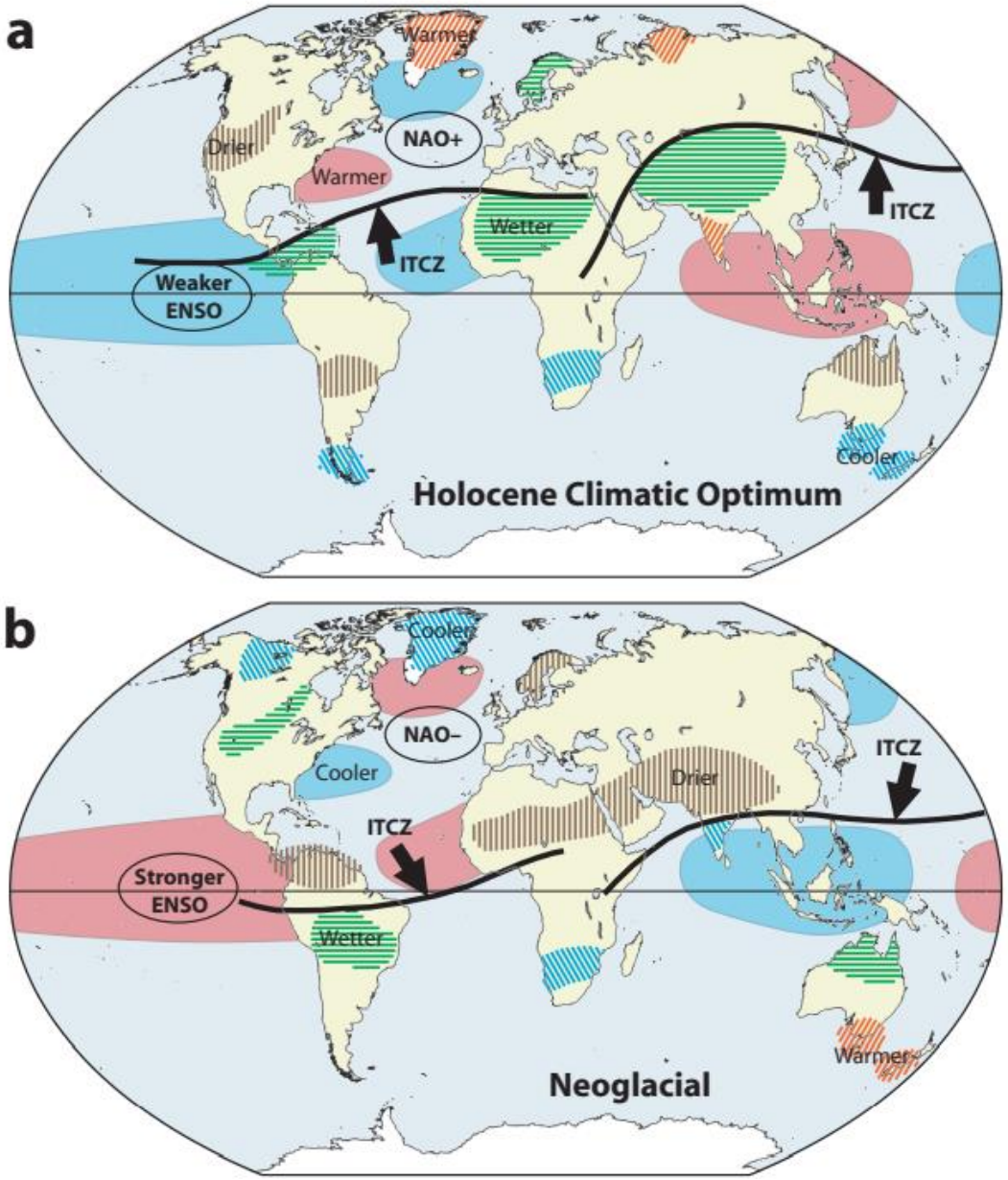




Vinós, 2022

Atlantic (8 000–5 000 BP)

- **Warmest Holocene period**
  - sea level rise (ca. 3 m above present level)
- **Migration** of "heat-loving" species northward



Vinós, 2022

Atlantic (8 000–5 000 BP)

Deciduous temperate forest

defenders.org, 2023

Atlantic (8 000–5 000 BP)

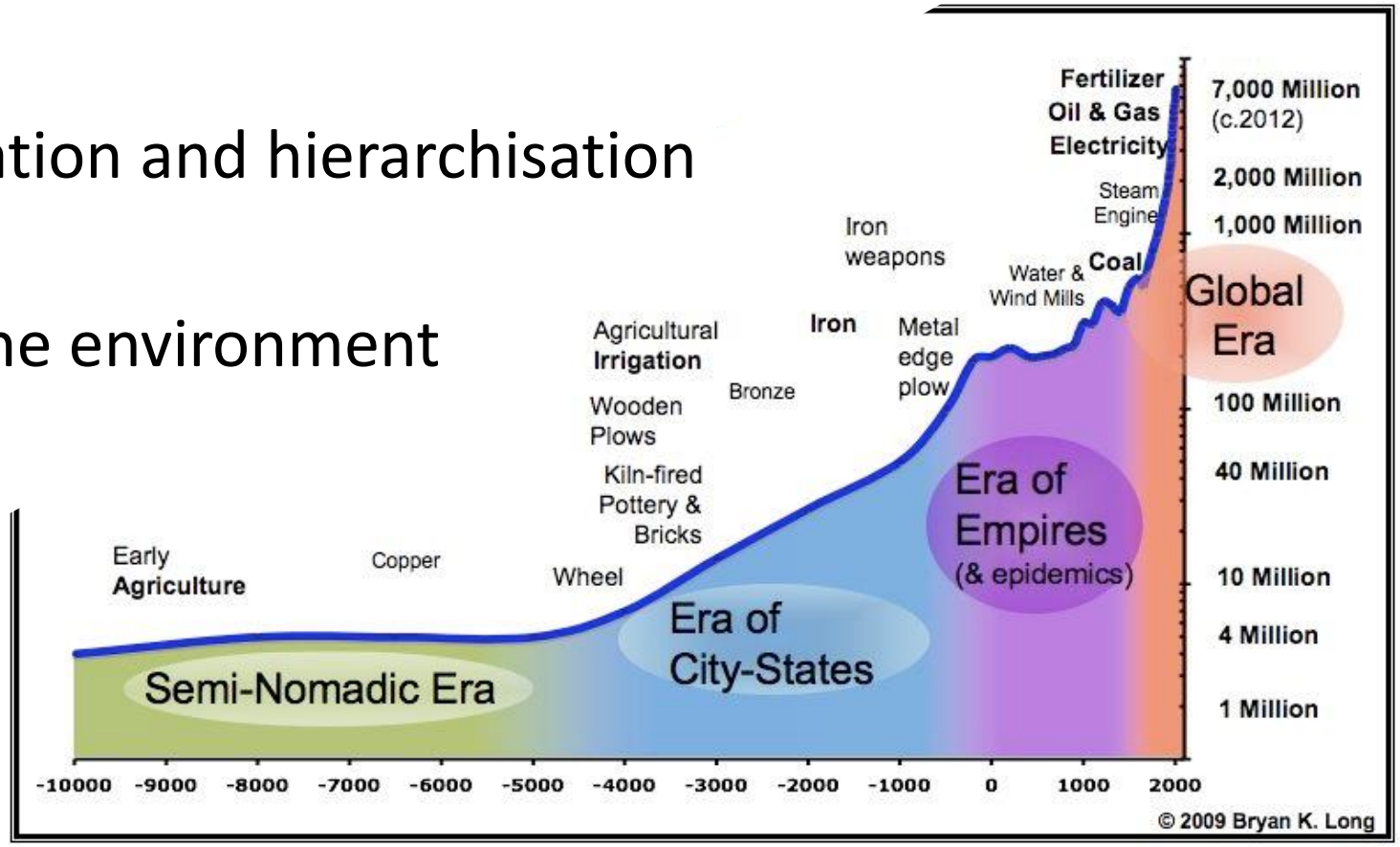
- **Linear Pottery Culture** (Europe, 7 500–6 500 BP)
  - clearing the arable land by slash and burn methods
- **Neolithic Revolution**
  - extension of agricultural and pasture land
  - beginning of a two-track landscape evolution

Inha, 2023

Neolithic Revolution

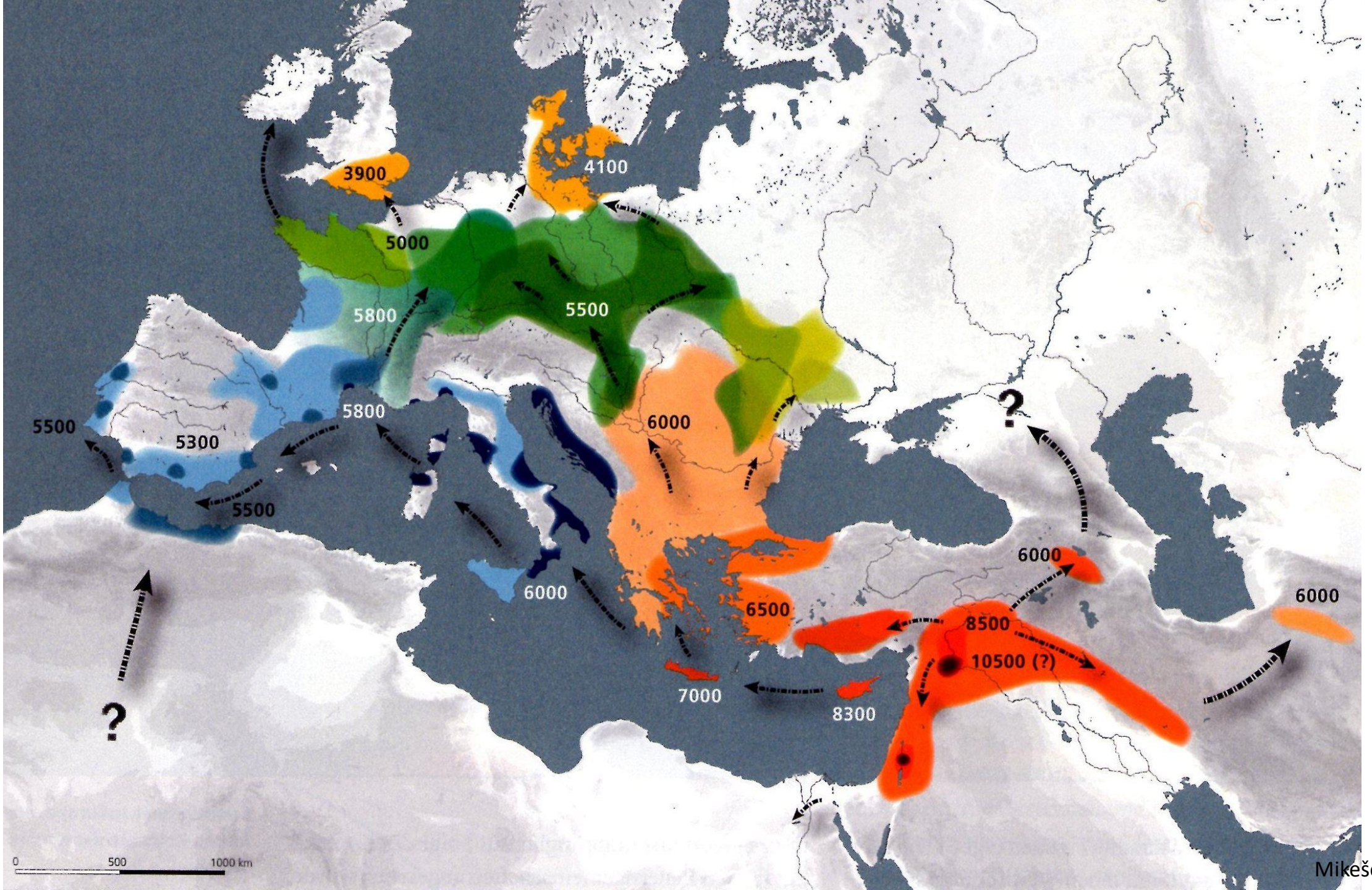
Human impact on the landscape

- **Historical context**
  - society of hunters and gatherers
  - advent of agriculture
  - growth of human population and hierarchisation of society
  - increasing pressure on the environment
  - recent global environmental crisis



Neolithic Revolution – causes

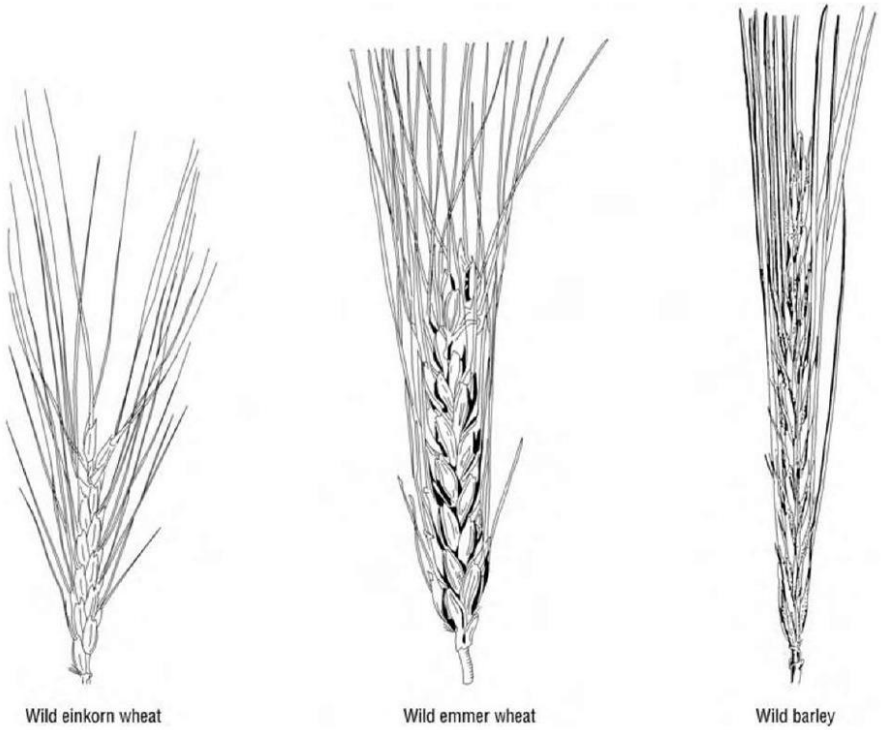
- **Increase** in **population** and its density
- **Insufficient sources** of food (hunting and gathering)
  - necessary transition to (probably involuntary) cultivation
- **Beginings of cultivation**
  - 11 700 BP: Near East
  - 11 000–6 000 BP: China, SE Asia and Central America



Mikešová 2023

Neolithic Revolution

- **Cultivated crops**
  - first cultivation of wild cereals: Palestine, Mesopotamia
  - wheat and barley (Mesopotamia, Egypt, Europe)
    - cultivated steppe grasses, need for dry soils
  - wheat, barley, millet and rice (China, SE Asia, later India)
  - grapevines (Georgia, 8 300 BP)



Neolithic Revolution

- **Domestication of animals** (dog, sheep, goats, cattle, pigs, poultry)
  - China: the origins of pig and poultry farming
- Spread of **agro-pastoral subsistence**
  - 1 man able to harvest cereals in 14 days for 4 people for 1 year
- Despite the spread of agriculture in the Neolithic, **continued nomadism**
  - coast: first permanent settlements (sufficient sources of food)

Impacts of agricultural expansion

- **Humans as a new active factor in landscape development**
- Period of significant **ecological** and **socio-economic** transformation
  - **ecological revolution**: end of human dependence on „nature's gifts“ creation of ecosystems conditioned by economic activity (agriculture, grazing, logging)
  - **social revolution**: building of permanent settlements and cities (5 000 BP), organisation of labour, social diversification, formation of the first states)

Impacts of agricultural expansion

- **Increase** of **biodiversity** in the next 3 000 years after the neolithic revolution beginning
- **Change** in the age of **first child birth** for farmers rather than hunters and gatherers (27 years)
  - opportunity for grandparents to care for children (old enough)
- **Growth of violence?**
  - 1 in 10 people had a head wound with a dull object in the Neolithic (fighting over resources?)

Impacts of agricultural expansion

- Development of **agriculture** – the **hierarchization** of **society** (Mesopotamia, Egypt, China, India, Central America)
  - the beginnings of the development of the first civilizations in **fertile landscapes** with **high biodiversity** and **abundant water** (predominance of wheat)
  - gradual **deforestation** and increasing **soil erosion**
  - **drying** of the **landscape** and development of **irrigated agriculture** (Mesopotamia, Egypt), replacement of wheat by barley

Impacts of agricultural expansion

- Development of **agriculture** – the **hierarchization** of **society** (Mesopotamia, Egypt, China, India, Central America)
  - **salinisation** of river floodplains and decline in fertility
  - mutual **rivalry** between early societies and the **fall of civilisations** (dynasties)
  - **conquest** of affected territories by new civilisations

Impacts of agricultural expansion

Babylon, 2003

The Nil Valley

wikipedia.org, 2019

Agriculture in Europe

- The **beginnings of agriculture** in the Neolithic (8 000–6 000 BP)
- First records of agriculture in **Greece**
- Small-scale **clearing** and **harvesting** of climax forests
- Spread of agricultural practices to the rest of Europe

Cedar forests, Lebanon

irozhlas.cz, 2014

Agriculture in Europe

- **The Mediterranean landscape**
  - oak, beech, cedar and pine forests before the advent of agriculture
  - deforestation for fuelwood and building materials
  - grassland grazing, soil erosion, accelerated water runoff, drying up of springs
  - today a landscape of olives, vineyards, macchia and pastures (Greece, Lebanon, Syria)

Zdroj: kalimera-recko.c, 2019

Landscape changes in the late Holocene

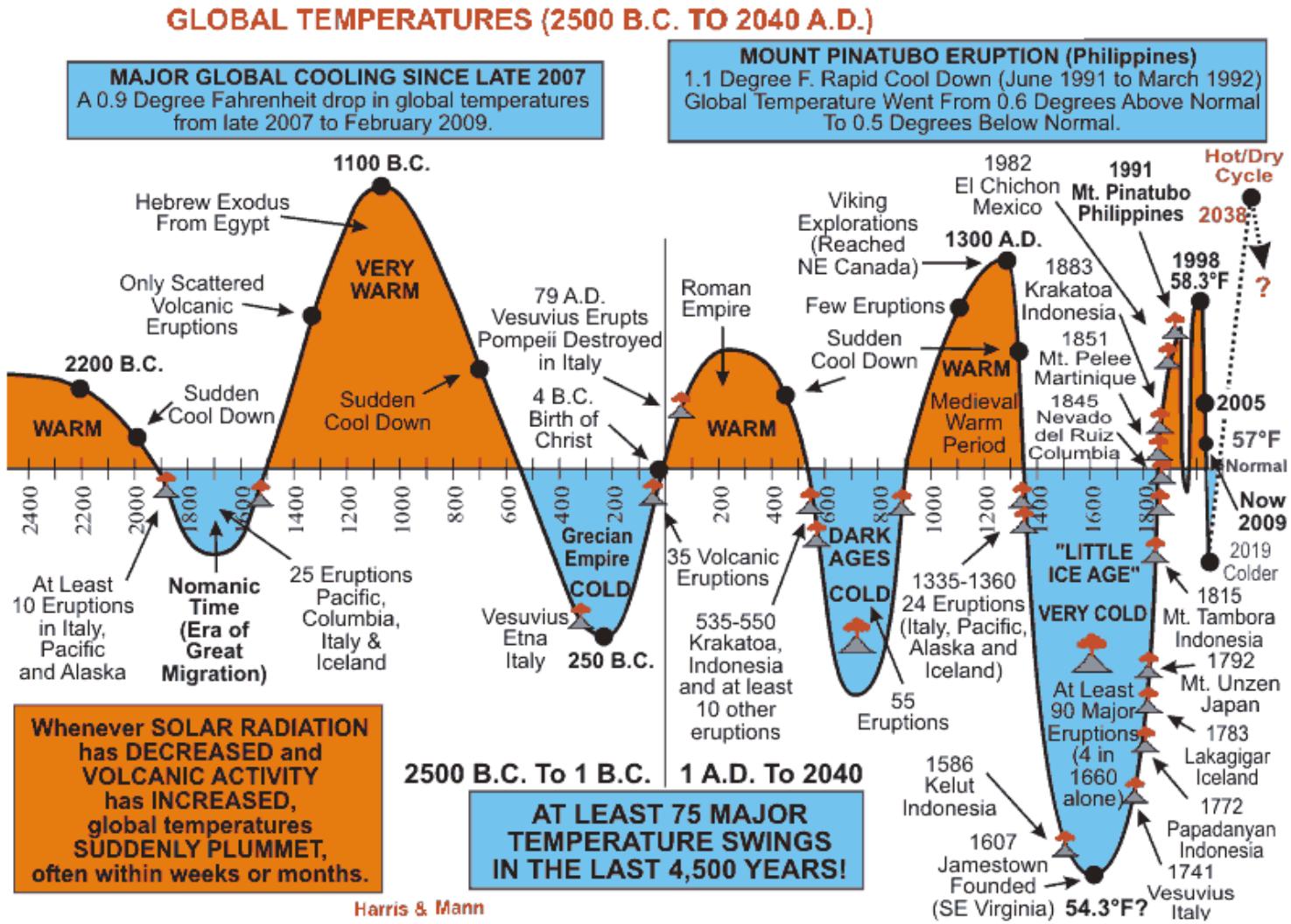
Subboreal (5 000–2 900 BP)

- **Drier** and **slightly cooler** climate than in the Atlantic
- Beginning of **constant decline of the upper forest tree line**
  - climate variability, grazing?
- **Late subboreal**
  - significant dry periods and erosion (east Mediterranean, North Africa, Near East)
  - end of the African Humid Period
- Ongoing sea level rise

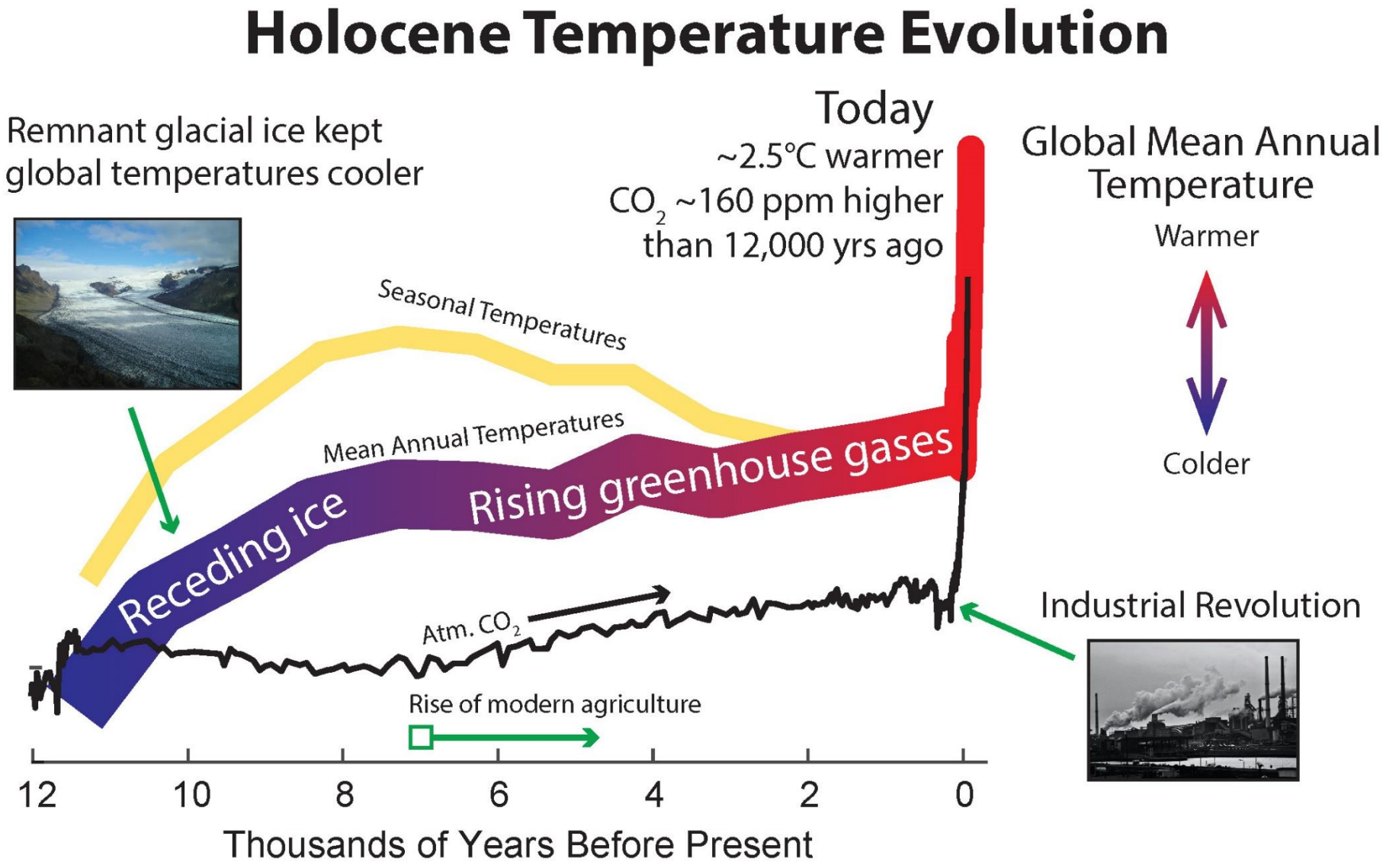
Subatlantic (2 900 BP–present day)

- **Cooler** (-0.7°C) and **wetter** (+50%) climate conditions than in Subboreal
- **Several climate oscillations**
  - Roman Warm Period (2 500 BP–350 AD, classical antiquity)
  - Migration Period (350–700 AD, cooler and drier)
  - Medieval Climate Anomaly (800–1 310 AD)
  - Little Ice Age (1 310–1850, decrease of NH snow line ca. 100–200 m)

Subatlantic (2 900 BP–present day)



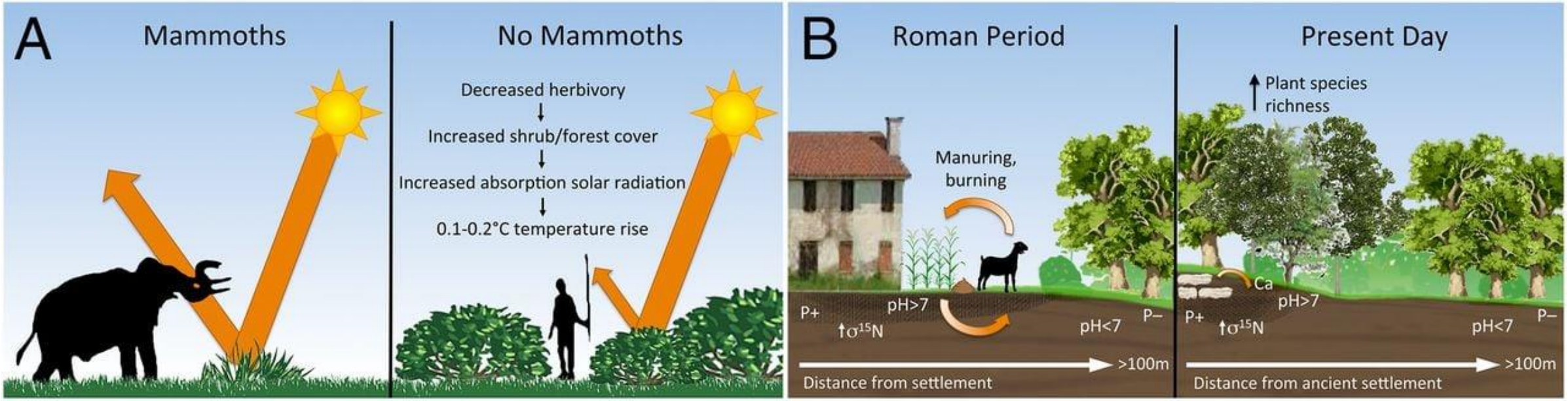
Recent annual global temperature as the warmest period of the past 10,000 years?
(Bova et al. 2023)



Bova et al. 2023

Subatlantic (2 900 BP–present day)

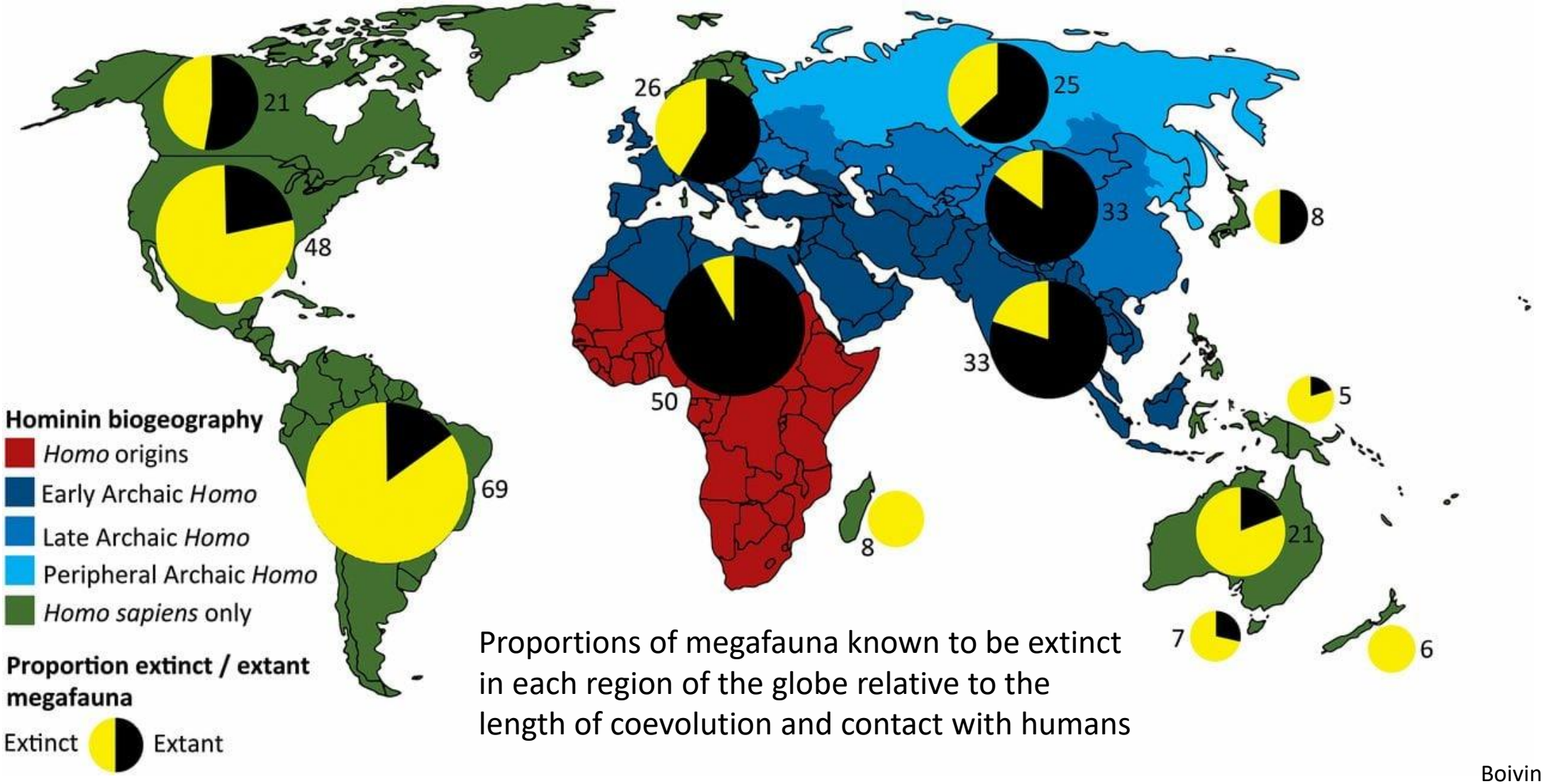
- Ongoing **sea level rise** with sudden increase in the last 30 years
- **Dominant anthropogenic influences** (i.e. agricultural land uses, grazing and forestry) since the Bronze Age (5 500 BP)



Cascade effects of changes to species: eliminating of large herbivors

Boivin et al. 2016

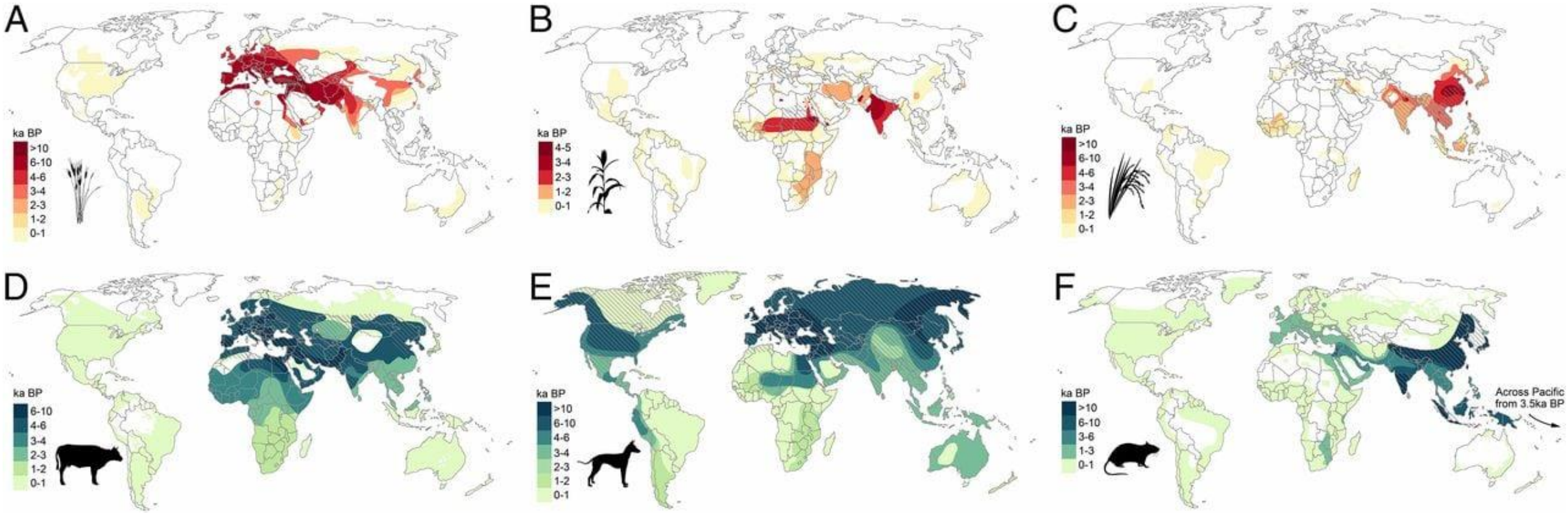
Long-term anthropogenic influence



Proportions of megafauna known to be extinct in each region of the globe relative to the length of coevolution and contact with humans

Boivin et al. 2016

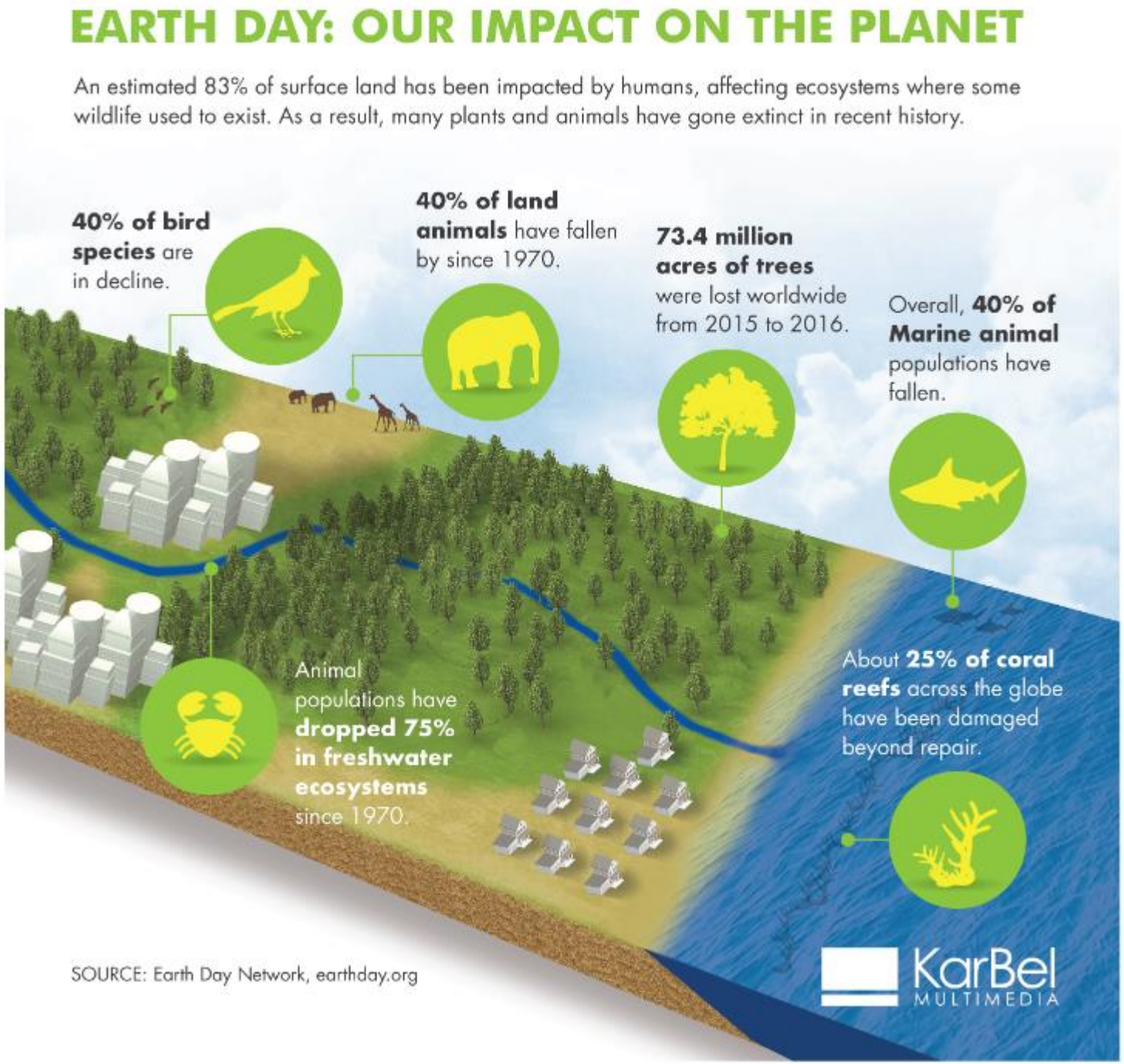
Long-term anthropogenic influence



Global spread of selected food crops (red) and domesticated and commensal animals (blue) through time
a – wheat, b – sorghum, c – rice, d- cattle, e – dog, f - rat

Boivin et al. 2016

Long-term anthropogenic influence



References

- MCNEILL, J. R. and ROE, A. ed. (2013): Global environmental history: an introductory reader. London: Routledge, Taylor & Francis Group, 449. ISBN 9780415520539.
- Boivin et al. 2016: Ecological consequences of human niche construction - Examining long-term anthropogenic shaping of global species distributions. Proceedings of the National Academy of Sciences, 113, 23, 6388-6396.

Thank you for your attention