

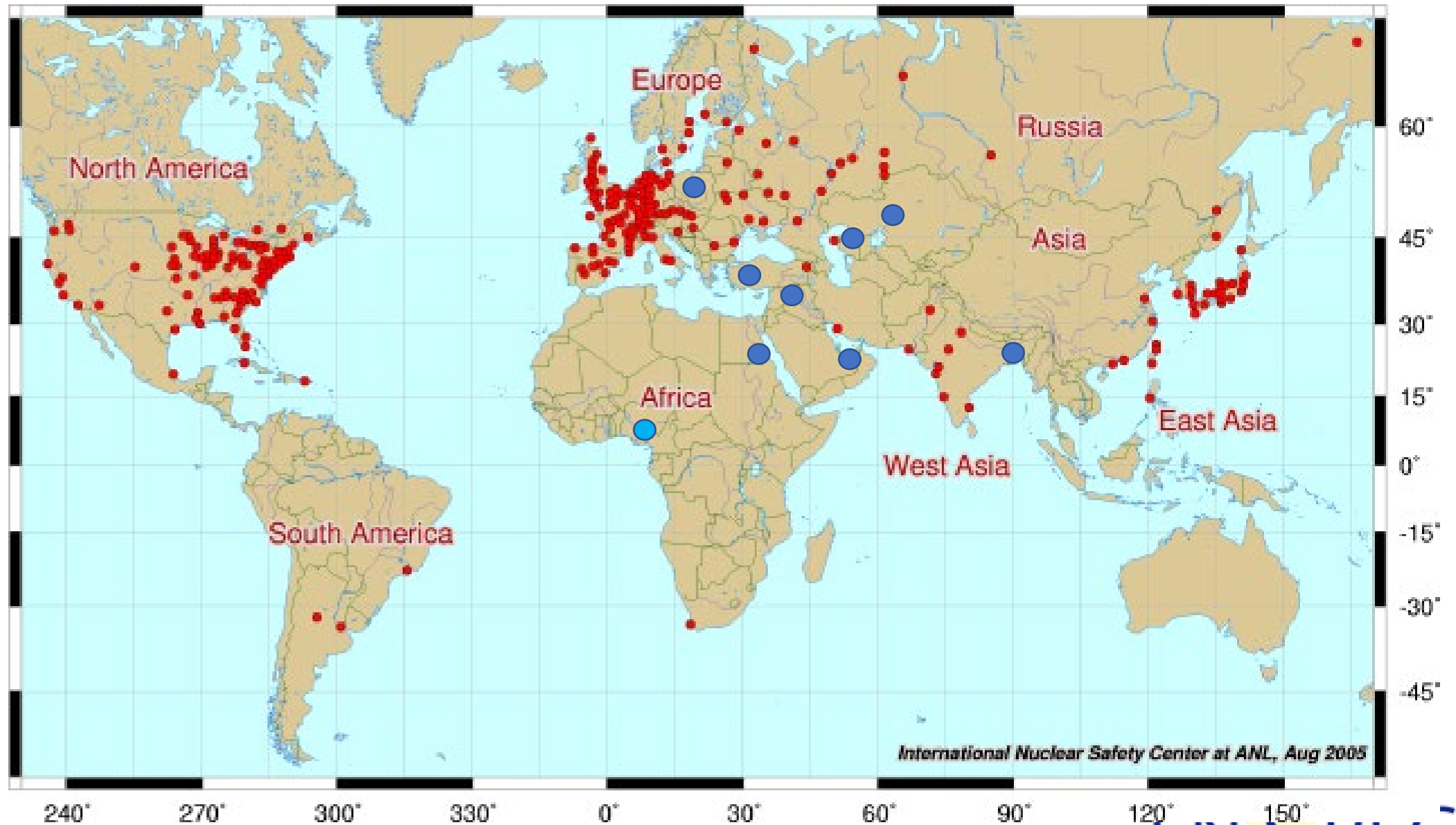
Addressing the Challenge of Climate Change

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1. Nuclear Power Plants can be built to operate under almost any kind of climate and weather.
2. With Climate change average conditions and extremes change – exceeding design bases.
3. Uncertainties of climate science must be considered.
4. Climate change will disrupt the economic, societal and political environment in which NPPs operate.
5. Conclusions

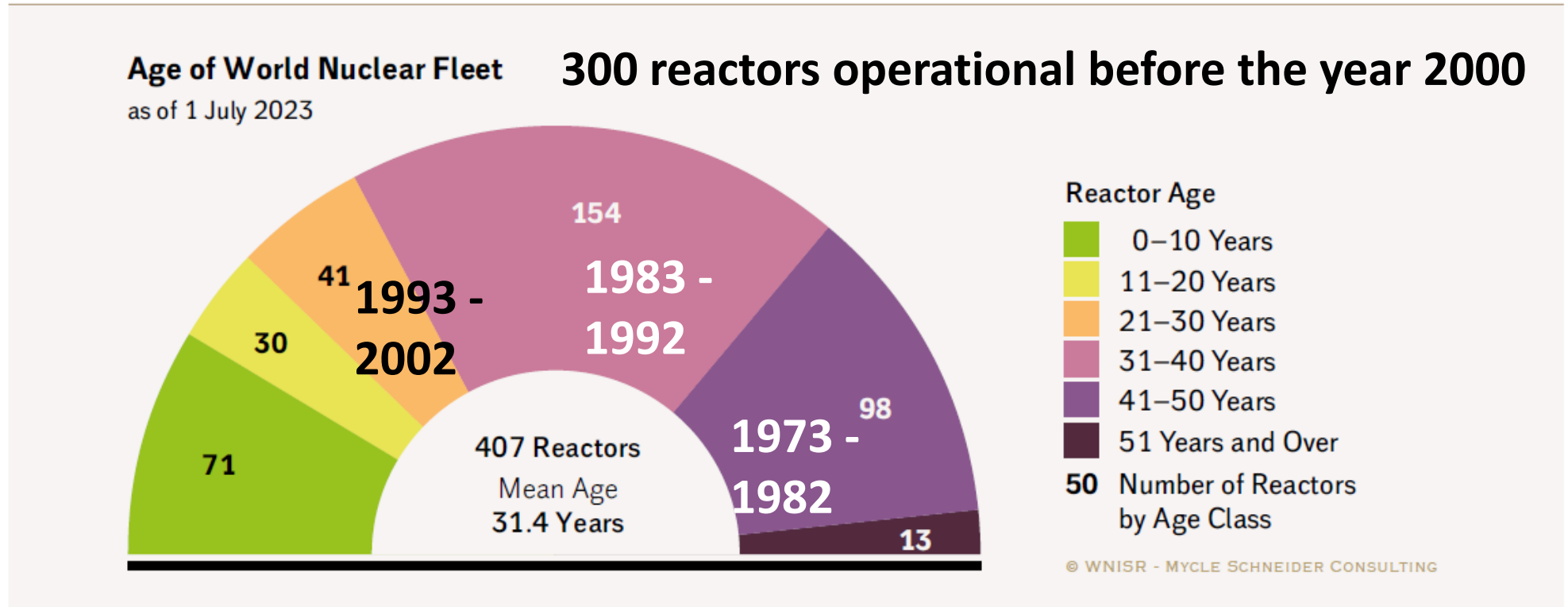
NPPs

- Existing sites
- Potential newcomers



Age distribution of operating reactors in the world

Licensing of
 $\frac{3}{4}$ of all
reactors
based on
climate data
from
previous
century



Sources: WNISR, with IAEA-PRIS, 2023

Global temperature rise 1880 - 2023

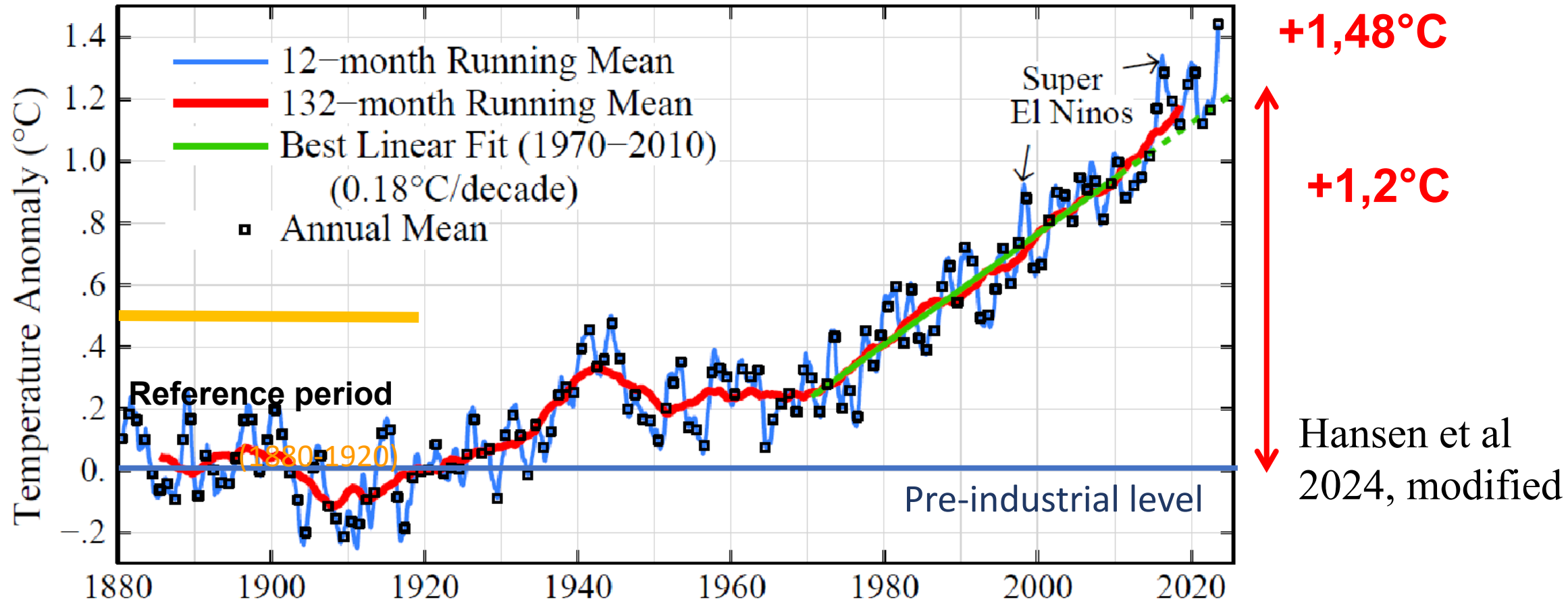


Fig. 1. Global temperature relative to 1880-1920 based on the GISS analysis.^{1,2}

Changes are not linear

Extremes change faster than means

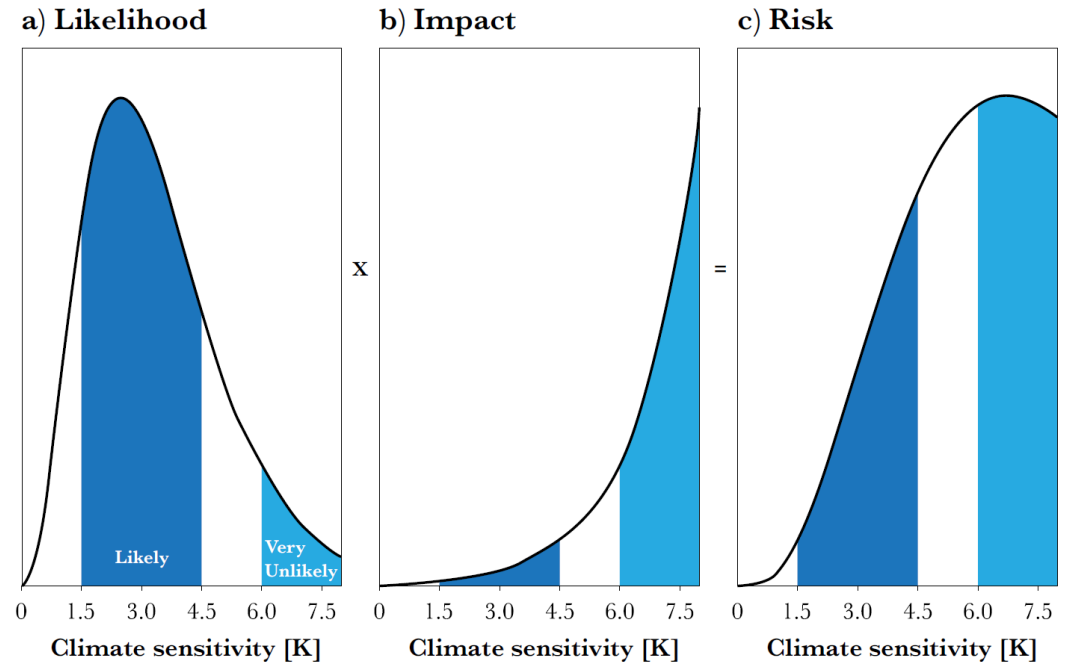
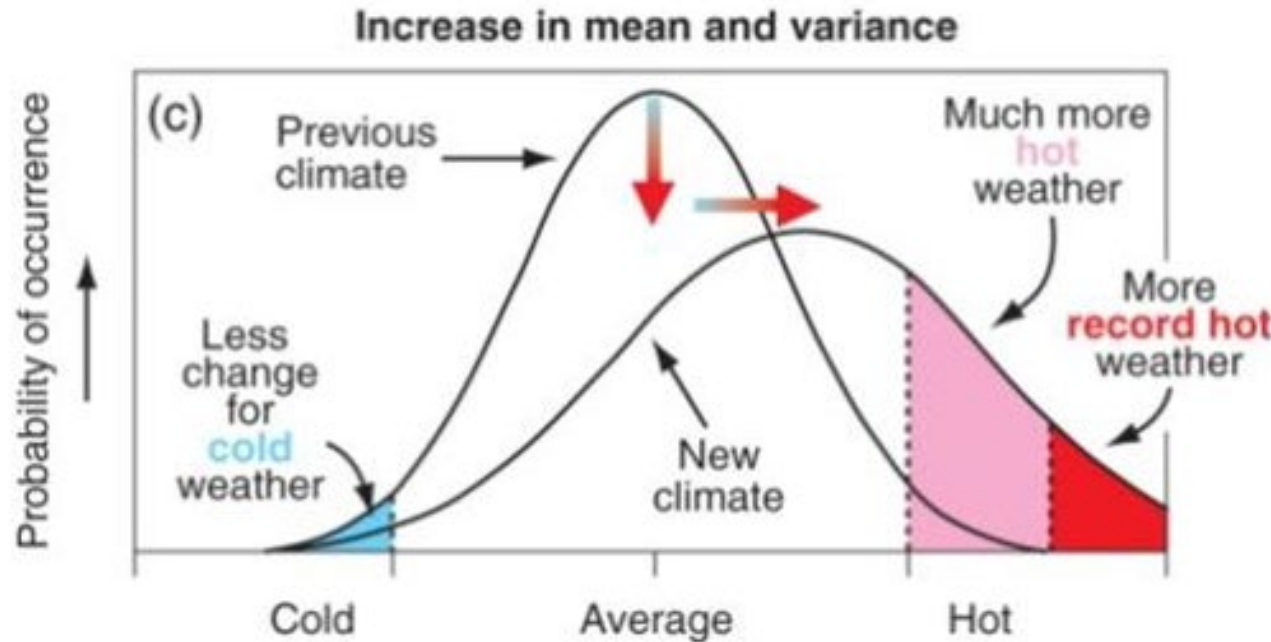
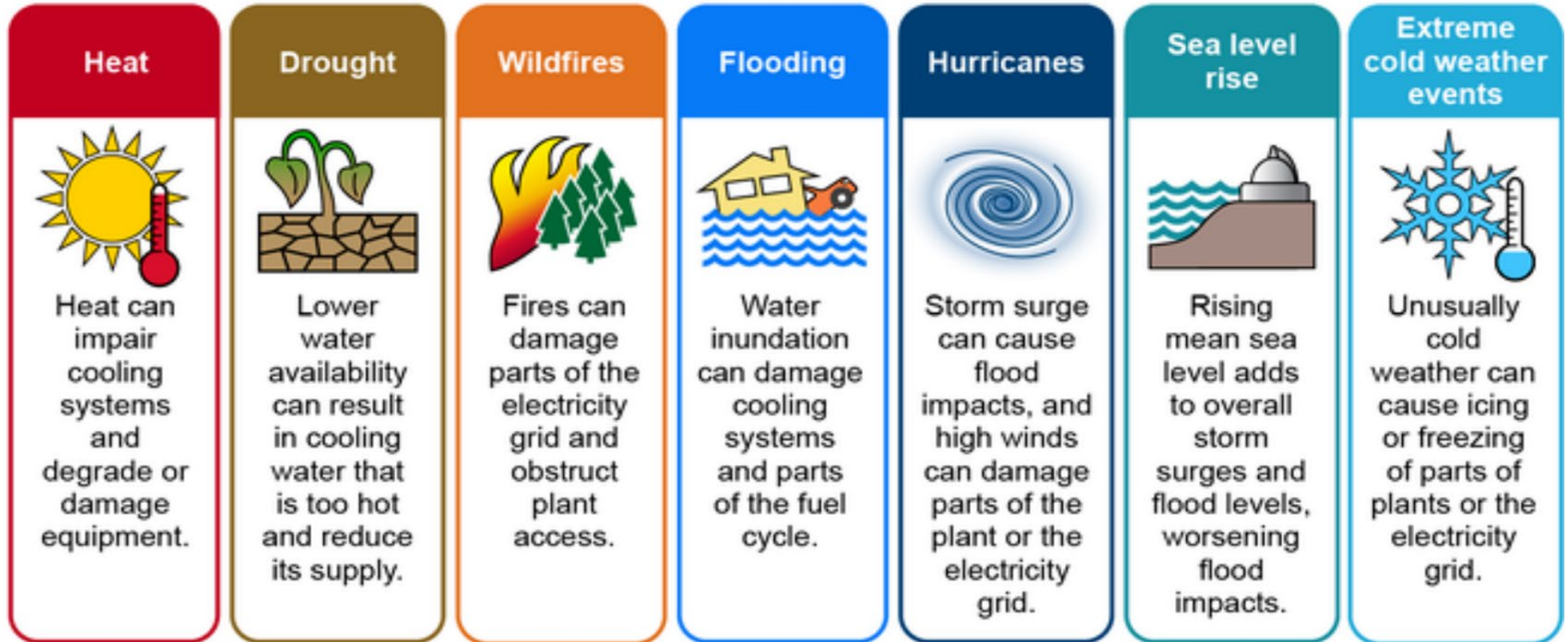


Figure 2: Schema of climate-related risk. (a) Event likelihood and (b) Impacts produce (c) Risk. Lower likelihood events at the high end of the probability distribution have the highest risk (Credit: RT Sutton/E Hawkins).

Unlikely changes imply extreme damage and therefore much higher risk than likely changes
(Grantham, 2018)

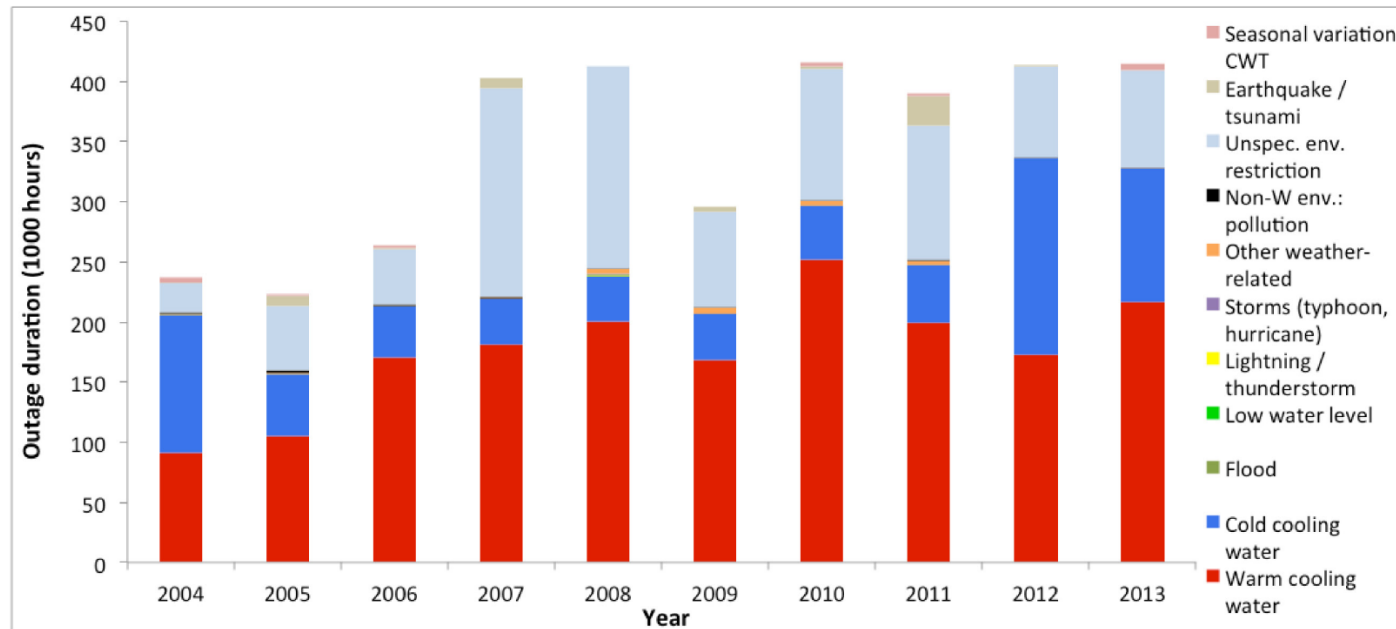
How will Climate Change affect NPPs?

Examples of Natural Hazards that May Pose Risks to Nuclear Power Plants



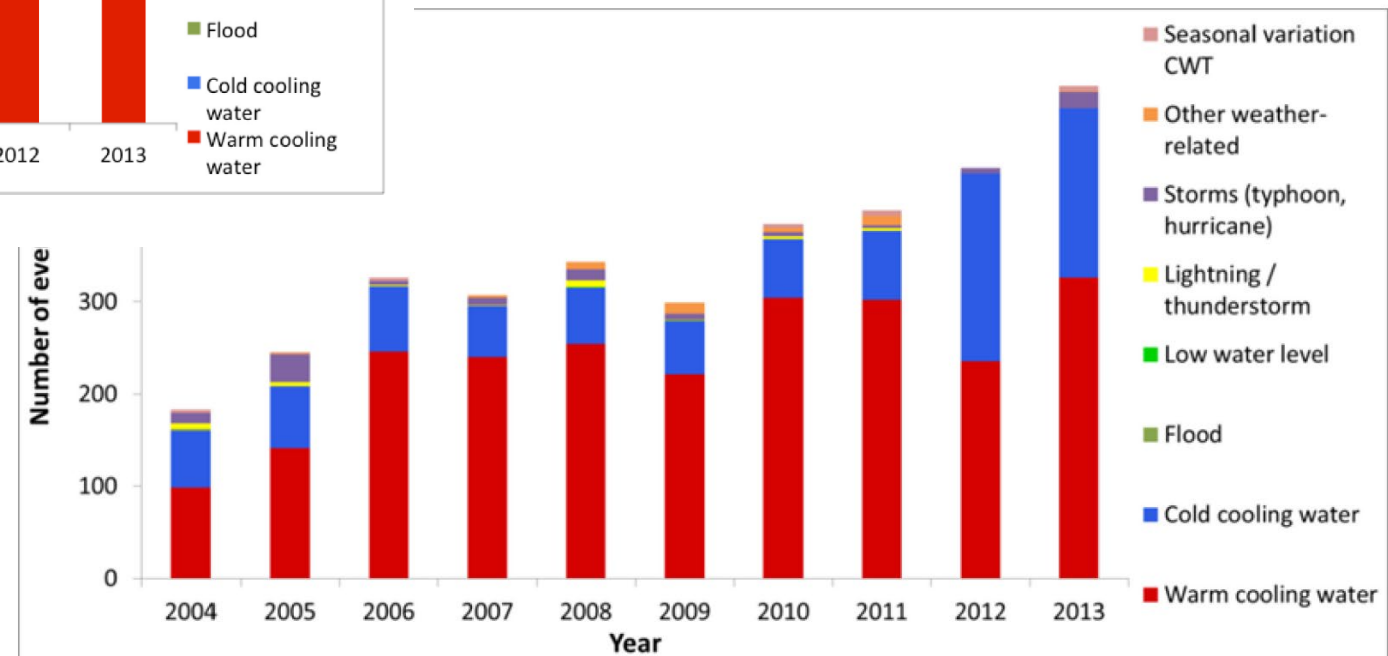
Outages due to environmental and weather-related causes (NEA, 2021)

Figure 3.3. Outage durations during 2004-2013 due to all environmental causes (1 000 hours)



Source: Based on the IAEA PRIS database.

10. Number of outage events in 2004-2013 due to weather-related causes



Source: Based on the IAEA PRIS database.

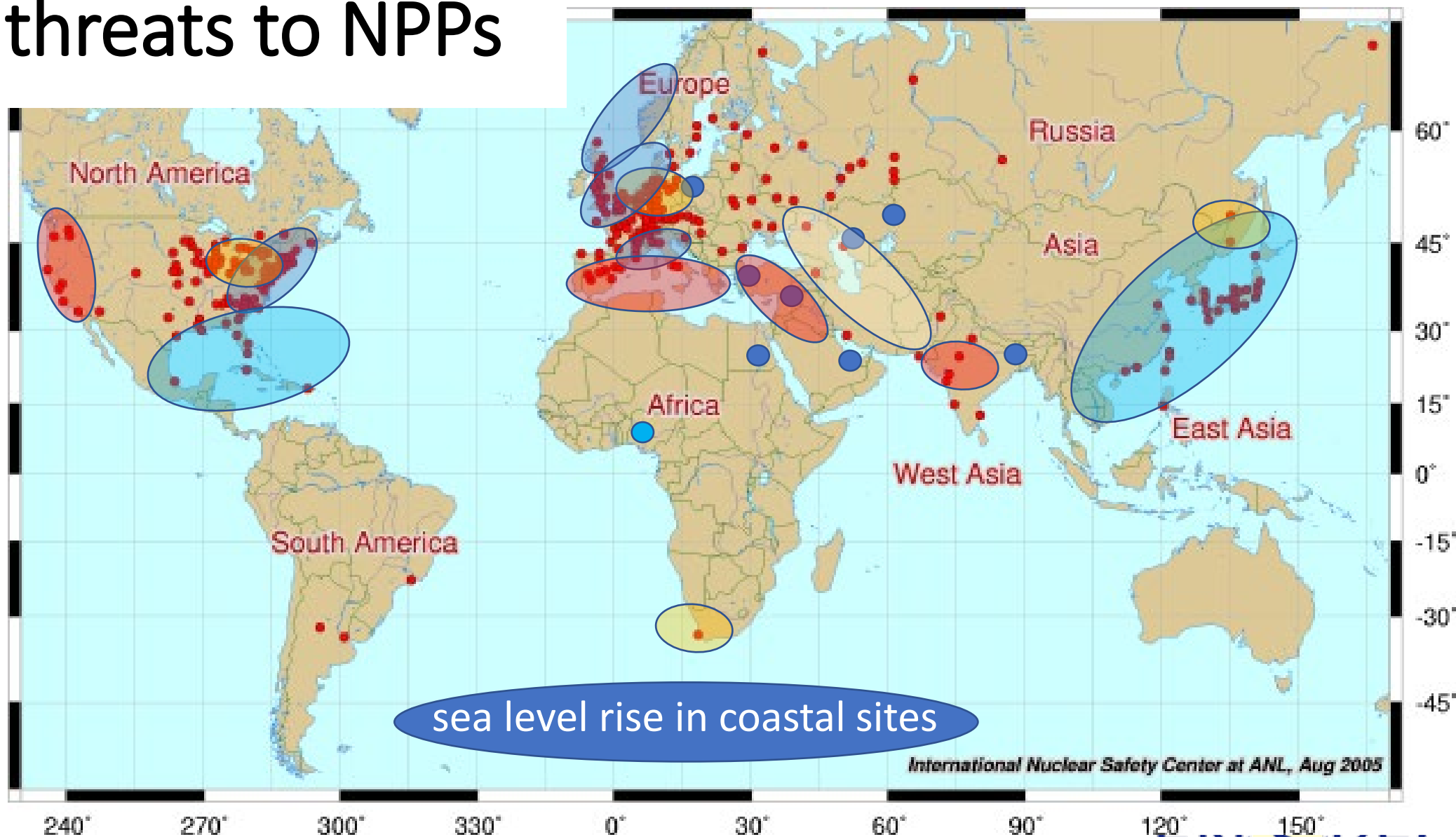
GAO Report includes maps of risks to individual plants

“NRC’s actions to address risks from natural hazards do not fully consider potential climate change effects. For example, NRC primarily uses historical data in its licensing and oversight processes rather than climate projections data. NRC officials GAO interviewed said they believe their current processes provide an adequate margin of safety to address climate risks. However, NRC has not conducted an assessment to demonstrate that this is the case.”

GAO 2024

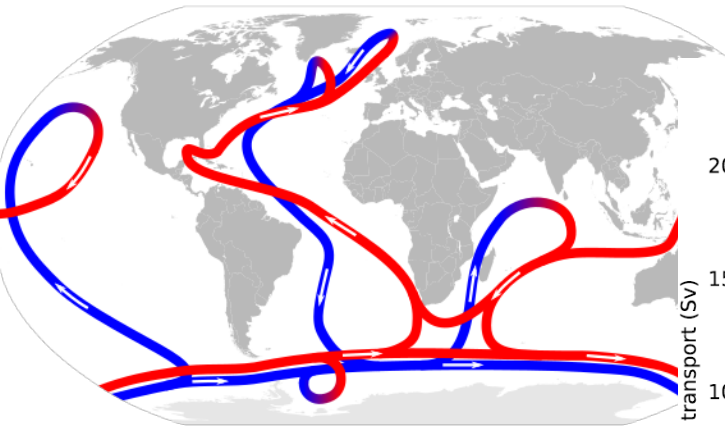
Climate threats to NPPs

- Existing sites
- Potential newcomers
- Storms
- Tropical Storms
- Heat
- (Heat)
- Desertification

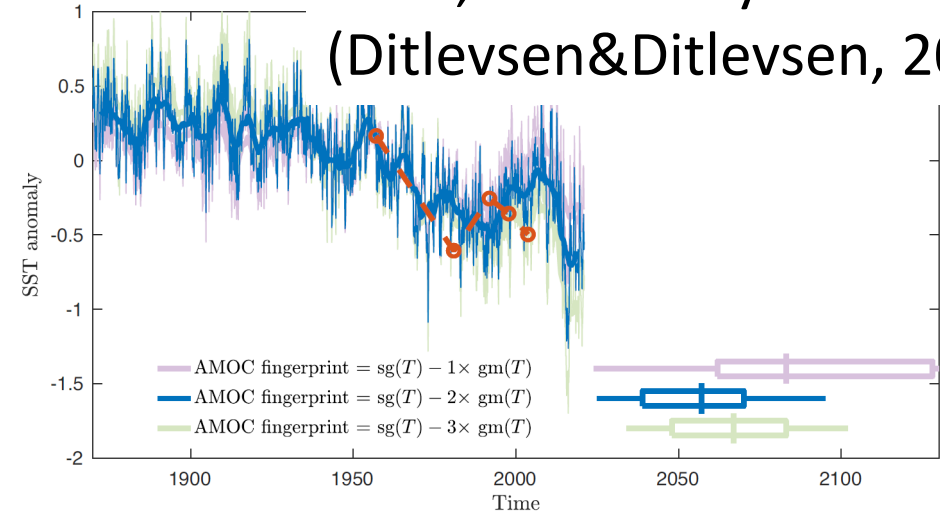
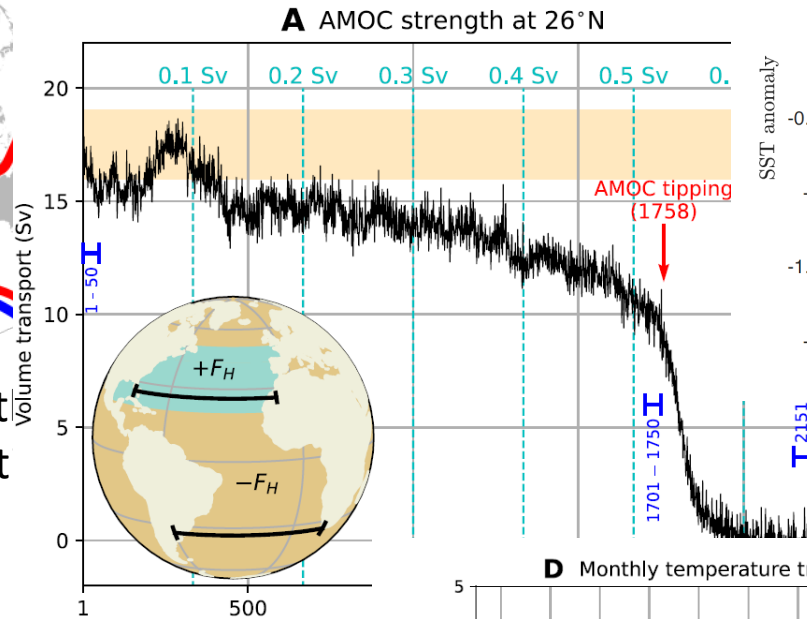


Scientific uncertainties

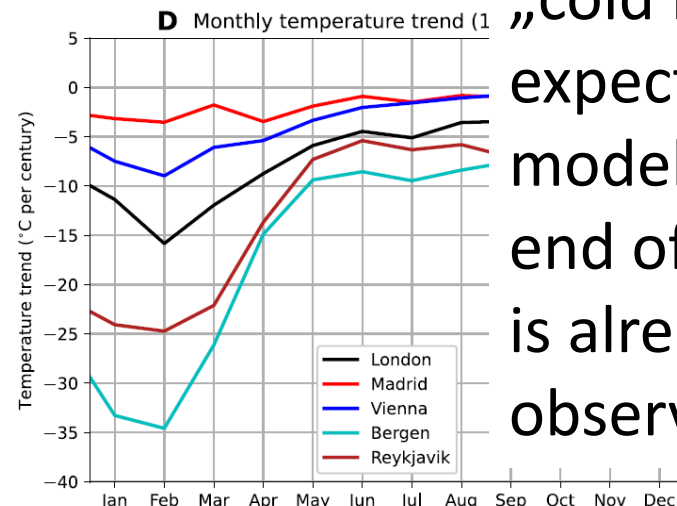
Chaos theory puts tipping point as early as 2025 or as late as 2095, most likely 2050-2060 (Ditlevsen&Ditlevsen, 2023)



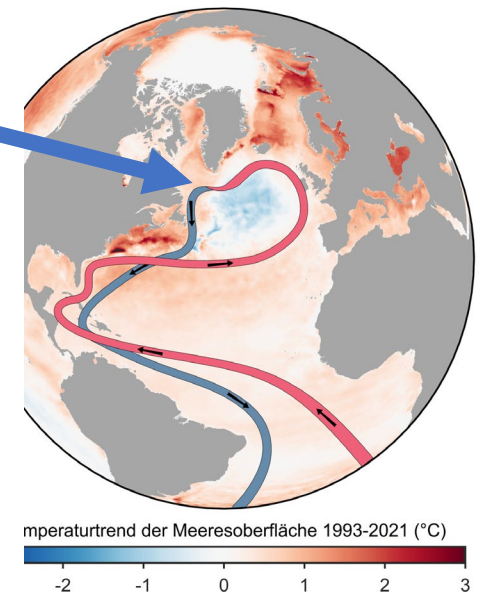
https://en.wikipedia.org/wiki/Atlantic_meridional_overturning_circulation



Input of arctic m
can cause break
(van Westen et a

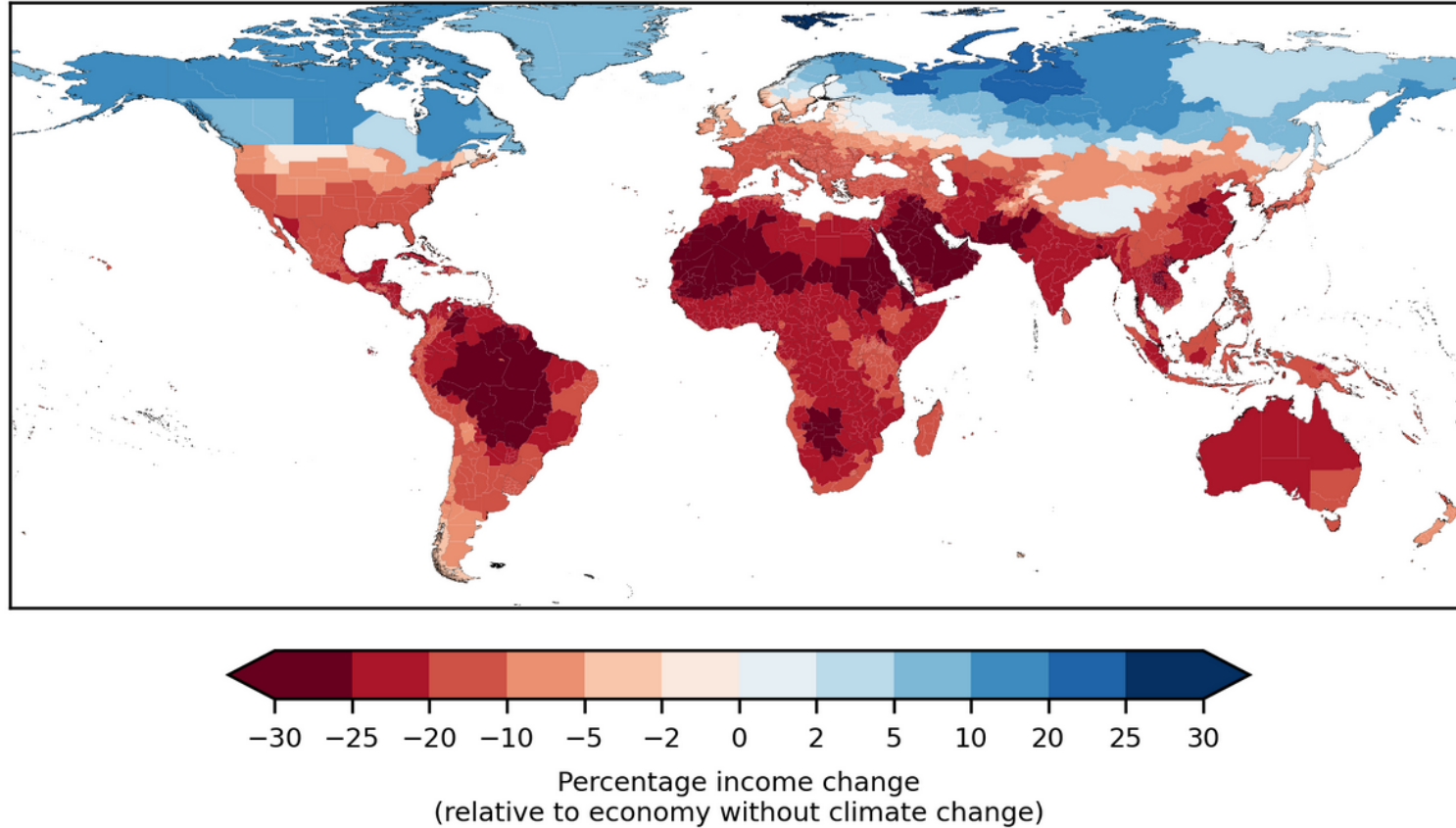


„cold blob“
expected by
models near
end of century
is already
observed now



Threats Beyond Climate:

Cascading climate and economic failure



Projected income changes in 2049 compared to an economy without climate change. Income changes are committed in the sense that they are caused by historical emissions. (Image: Kotz et al., Nature)

Center for Global
Change and
Sustainability

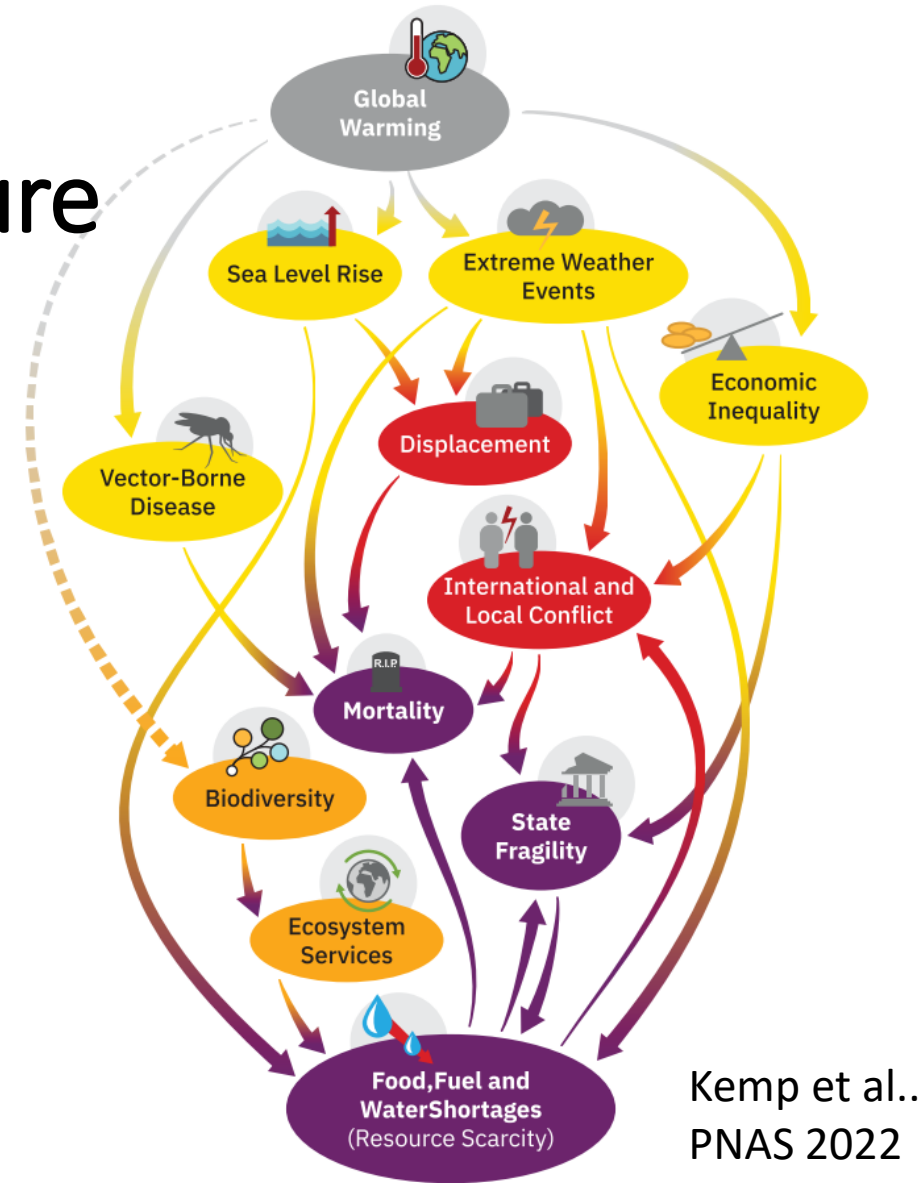
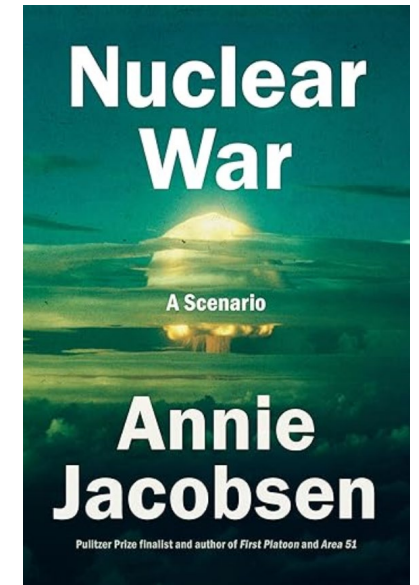


Fig. 3. Cascading global climate failure. This is a causal loop diagram, in which a complete line represents a positive polarity (e.g., amplifying feedback; not necessarily positive in a normative sense) and a dotted line denotes a negative polarity (meaning a dampening feedback). See [SI Appendix](#) for further information.

A final aspect

- Nuclear Power was considered a safeguard against war. Now war is being waged in and around the largest NPP of Europe.
- With climate disruptions, war risk increases.
- In the nuclear war scenario by Jacobsen, the first nuclear bomb is destined for the Pentagon, the second for the NPP Diablo Canyon – that makes sense in war logic.
- Nuclear winter as consequence of a nuclear exchange is aggravated by failing nuclear power plants.
 - In discussing the nuclear-climate nexus this aspect should not be forgotten.



Conclusions

1. Existing NPPs need to be subjected to stress tests based on
 - a. future very high resolution climate scenarios that should be developed or at least approved by teams of meteorologists
 - b. unlikely, but high risk climate changes
 - c. risk analyses of societal changes and their safety and security implications
2. Plans to adapt to climate change including costing are needed.
3. Efforts to combat climate change must take a big leap forward.
4. Every effort must be made to achieve and ensure peace.

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