

#showyourstripes

Climate Change

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ipcc
INTERGOVERNMENTAL PANEL ON climate change



- **Climate is changing everywhere, with visible impacts**
- **This is due to global greenhouse gas emissions**
- **On the near-term (horizon 2050), future changes are inevitable and we must be prepared to reduce risks**
- **Long-term changes (beyond 2050) depend drastically on greenhouse gas emissions in the next years and decades**
- **There are many options to act**

A major scientific endeavour

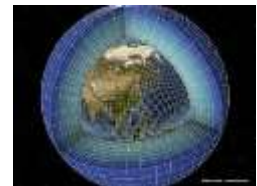
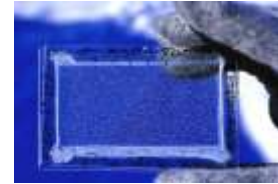
Fluid physics
Thermodynamics
Radiative transfers

Chronology, proxies
Super computers
Satellites

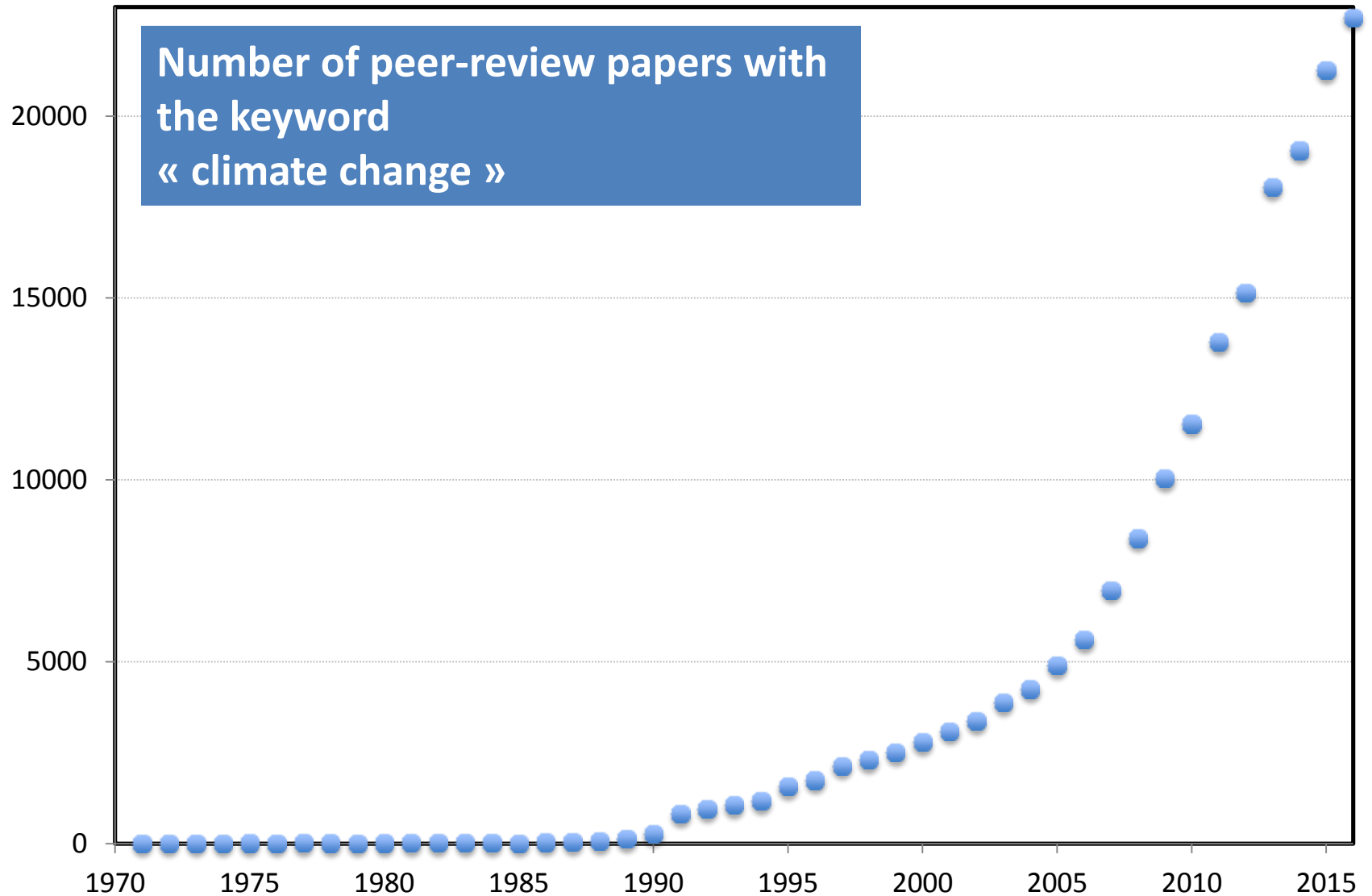
17th C
Weather
instruments

19th C
Networks
Ice ages
Greenhouse
effect

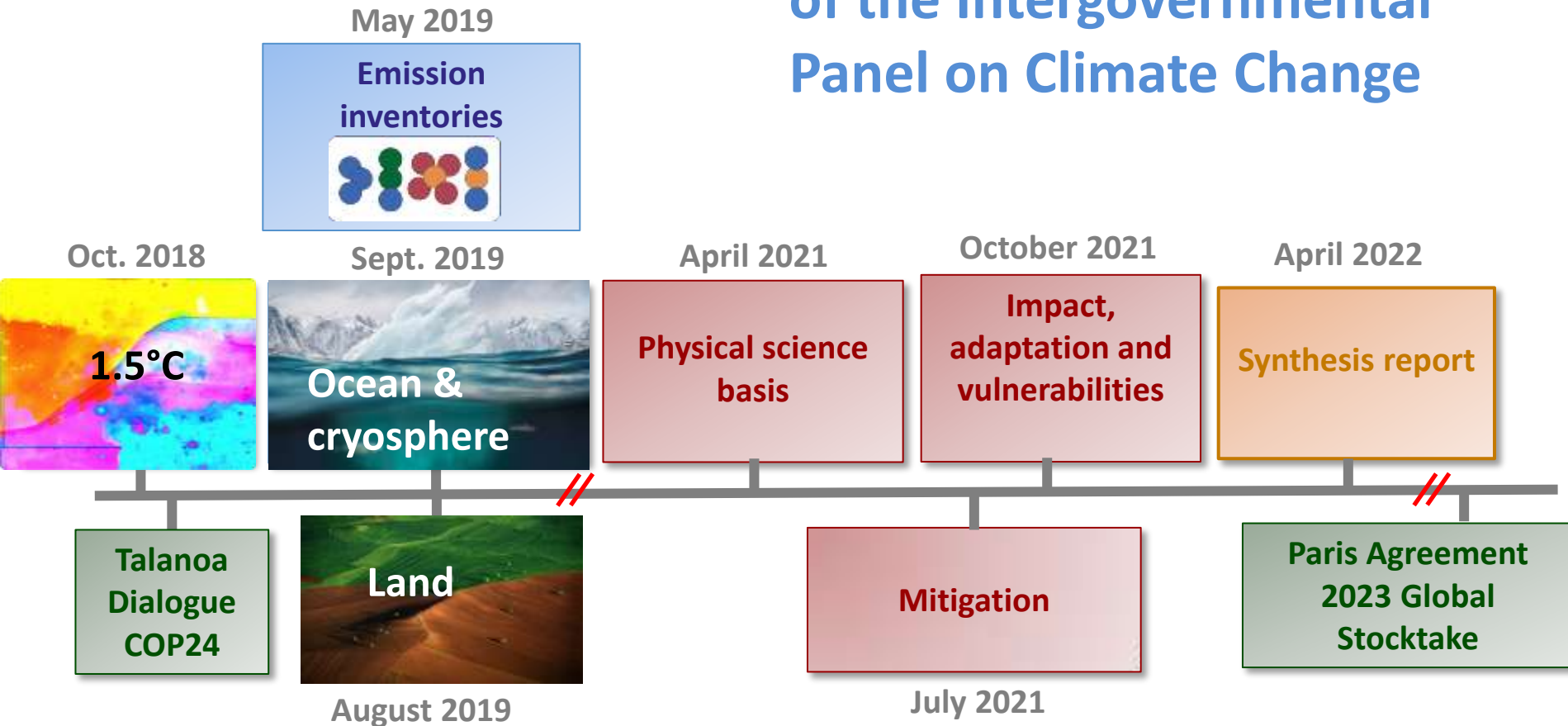
20th C
Past climate
Climate modelling



Number of peer-review papers with
the keyword
« climate change »



The 6th Assessment cycle of the Intergovernmental Panel on Climate Change

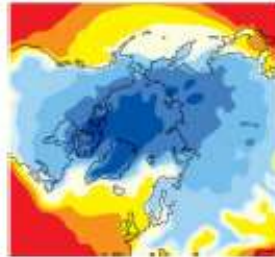


www.ipcc.ch
[@IPCC_CH](https://twitter.com/IPCC_CH)

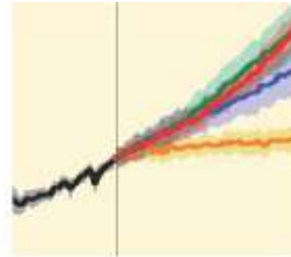
Climate modelling

$$\begin{aligned}\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} &= 0 \\ \frac{\partial(\rho u)}{\partial t} + \frac{\partial(\rho u^2)}{\partial x} + \frac{\partial(\rho uv)}{\partial y} + \frac{\partial(\rho uw)}{\partial z} &= -\rho \frac{\partial \phi}{\partial x} + \frac{\partial}{\partial x} \left(\frac{\rho \tau_{xx}}{\rho} \right) + \frac{\partial}{\partial y} \left(\frac{\rho \tau_{xy}}{\rho} \right) + \frac{\partial}{\partial z} \left(\frac{\rho \tau_{xz}}{\rho} \right) \\ \frac{\partial(\rho v)}{\partial t} + \frac{\partial(\rho uv)}{\partial x} + \frac{\partial(\rho v^2)}{\partial y} + \frac{\partial(\rho vw)}{\partial z} &= -\rho \frac{\partial \phi}{\partial y} + \frac{\partial}{\partial x} \left(\frac{\rho \tau_{xy}}{\rho} \right) + \frac{\partial}{\partial y} \left(\frac{\rho \tau_{yy}}{\rho} \right) + \frac{\partial}{\partial z} \left(\frac{\rho \tau_{yz}}{\rho} \right) \\ \frac{\partial(\rho w)}{\partial t} + \frac{\partial(\rho uw)}{\partial x} + \frac{\partial(\rho vw)}{\partial y} + \frac{\partial(\rho w^2)}{\partial z} &= -\rho \frac{\partial \phi}{\partial z} + \frac{\partial}{\partial x} \left(\frac{\rho \tau_{xz}}{\rho} \right) + \frac{\partial}{\partial y} \left(\frac{\rho \tau_{yz}}{\rho} \right) + \frac{\partial}{\partial z} \left(\frac{\rho \tau_{zz}}{\rho} \right) + \rho \frac{\partial q}{\partial t} + \rho \frac{\partial q}{\partial x} + \rho \frac{\partial q}{\partial y} + \rho \frac{\partial q}{\partial z}\end{aligned}$$

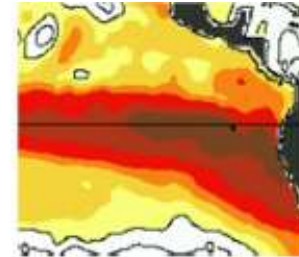
Physical principles



Today's climate



Trends



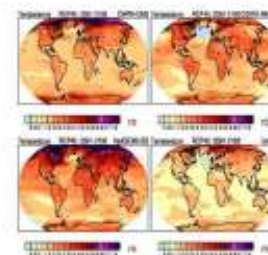
Process



Weather forecast



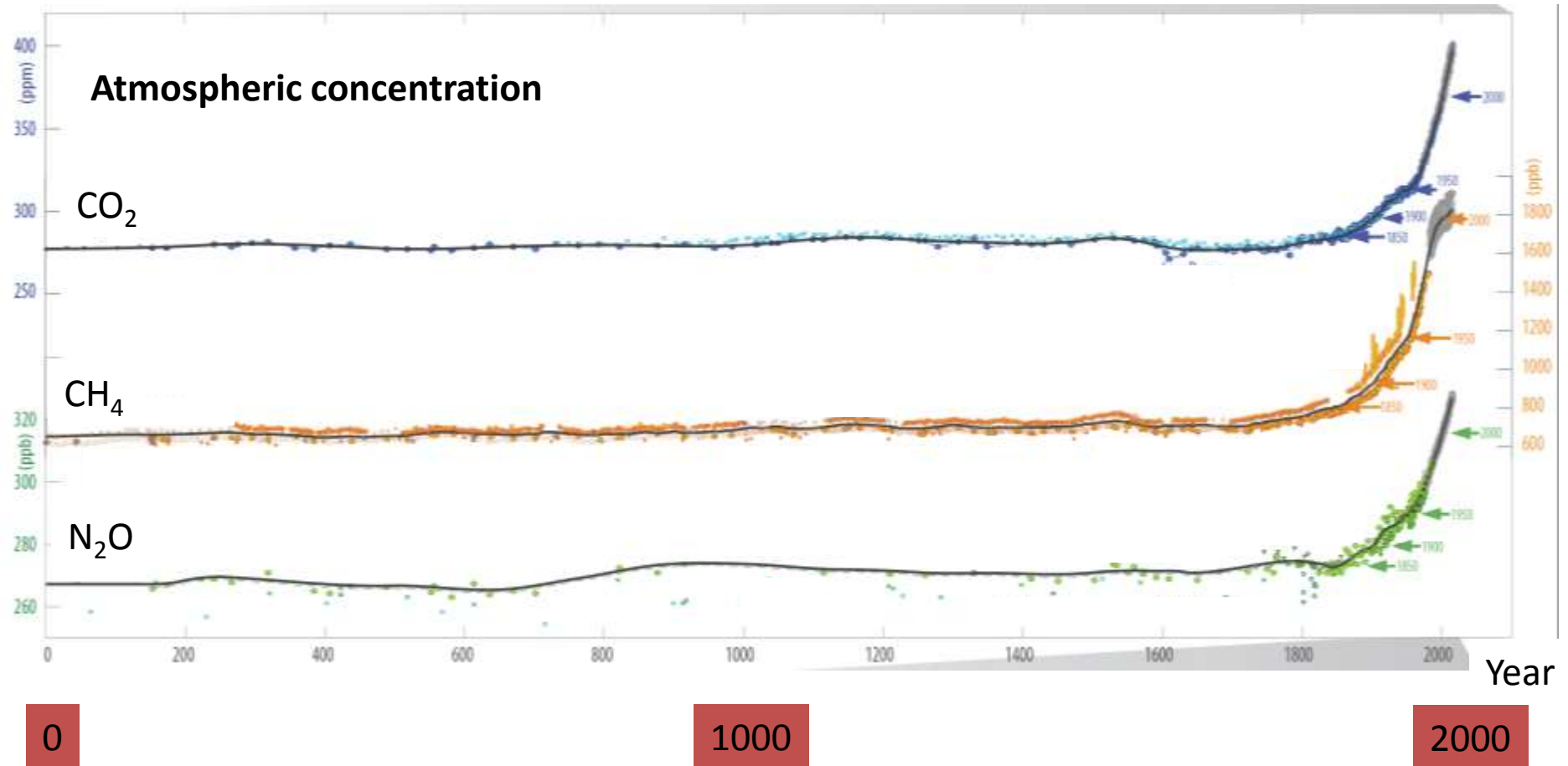
Past climate



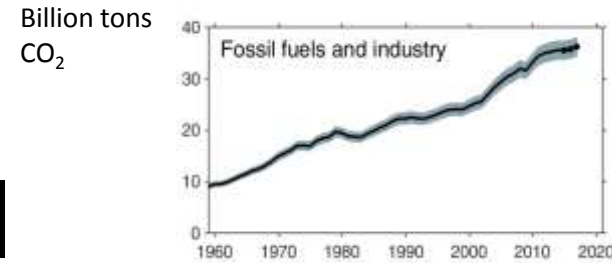
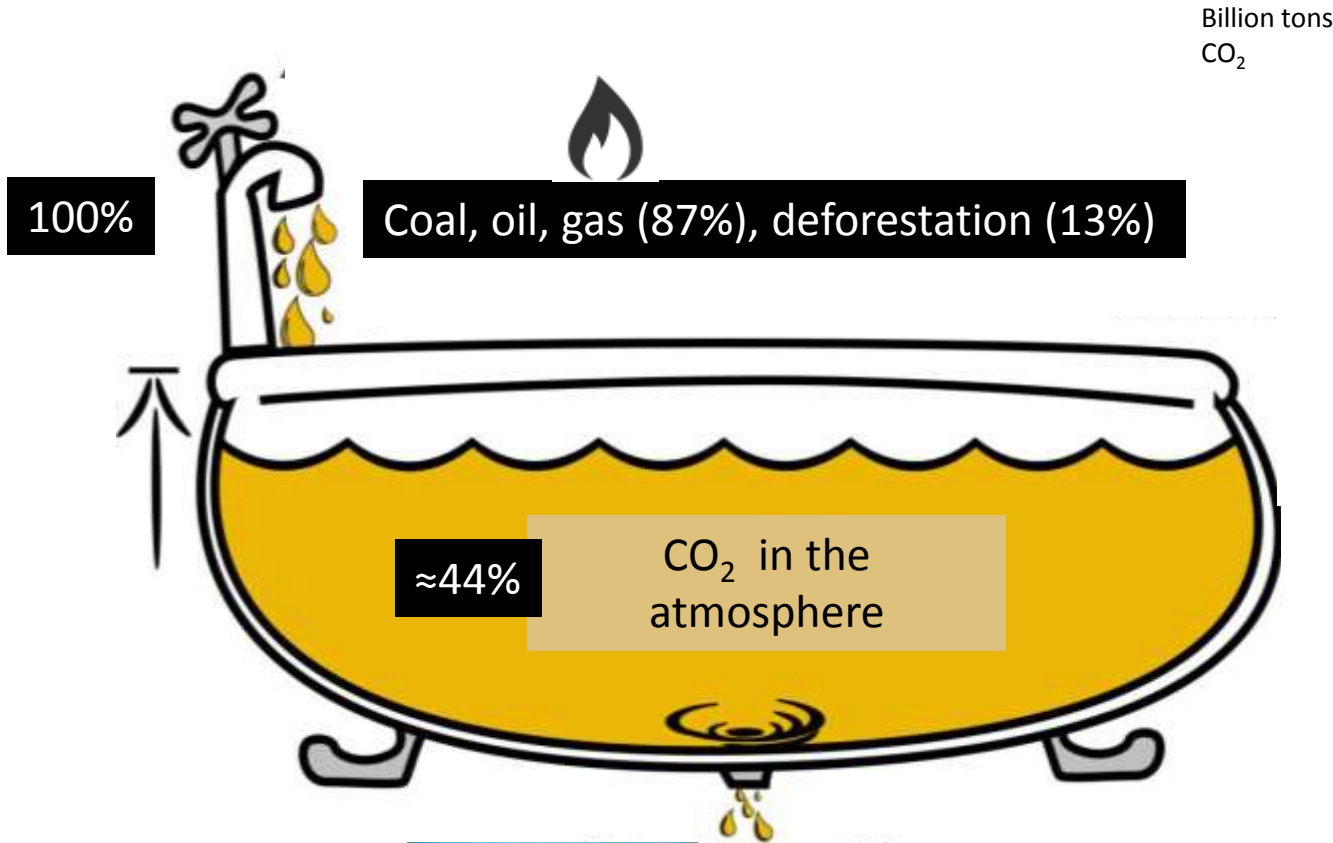
Robustness

What is climate change?

Human influence on atmospheric composition



Human influence on the global carbon cycle



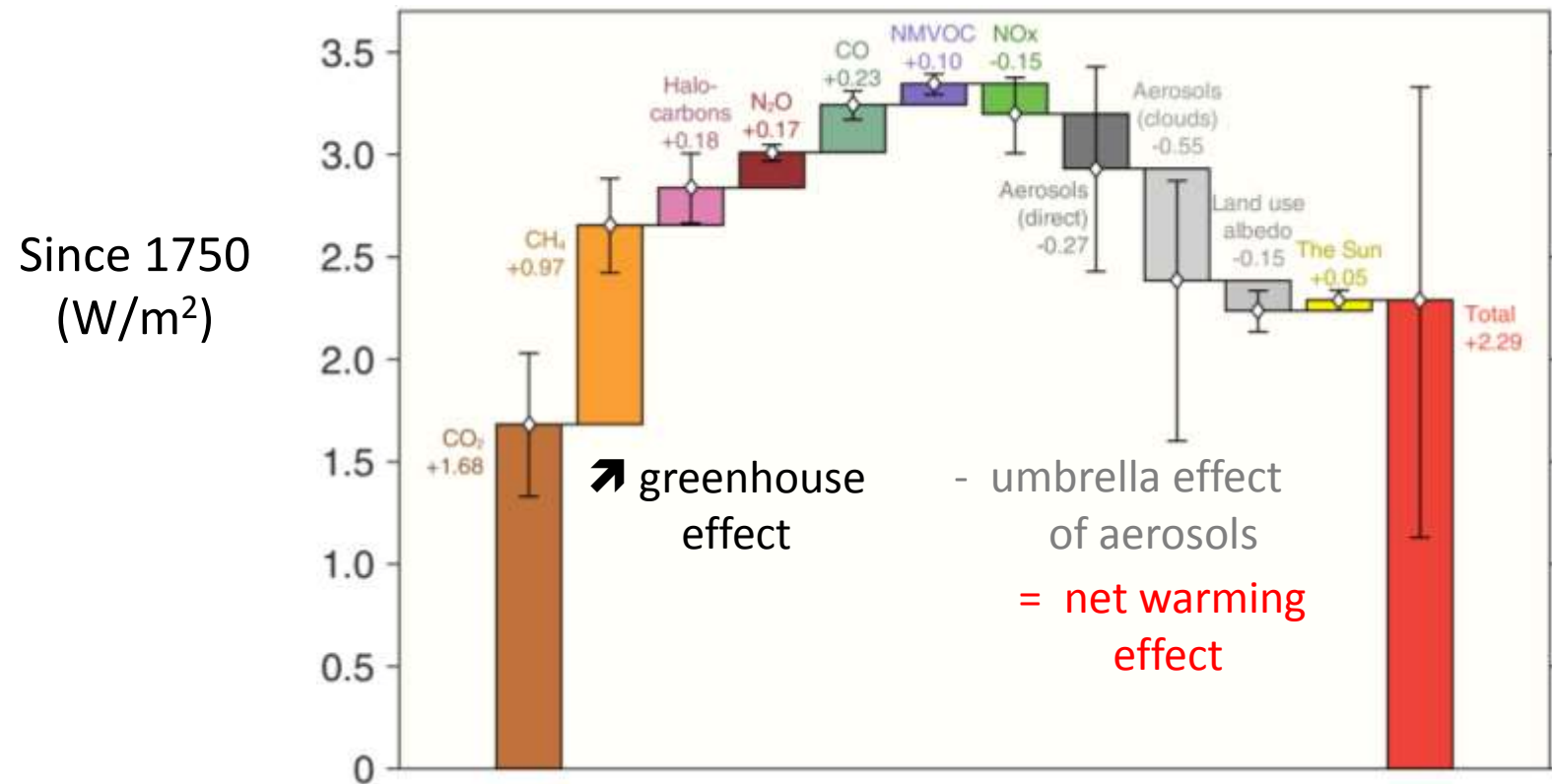
Uncertainty
 $\approx 5\%$

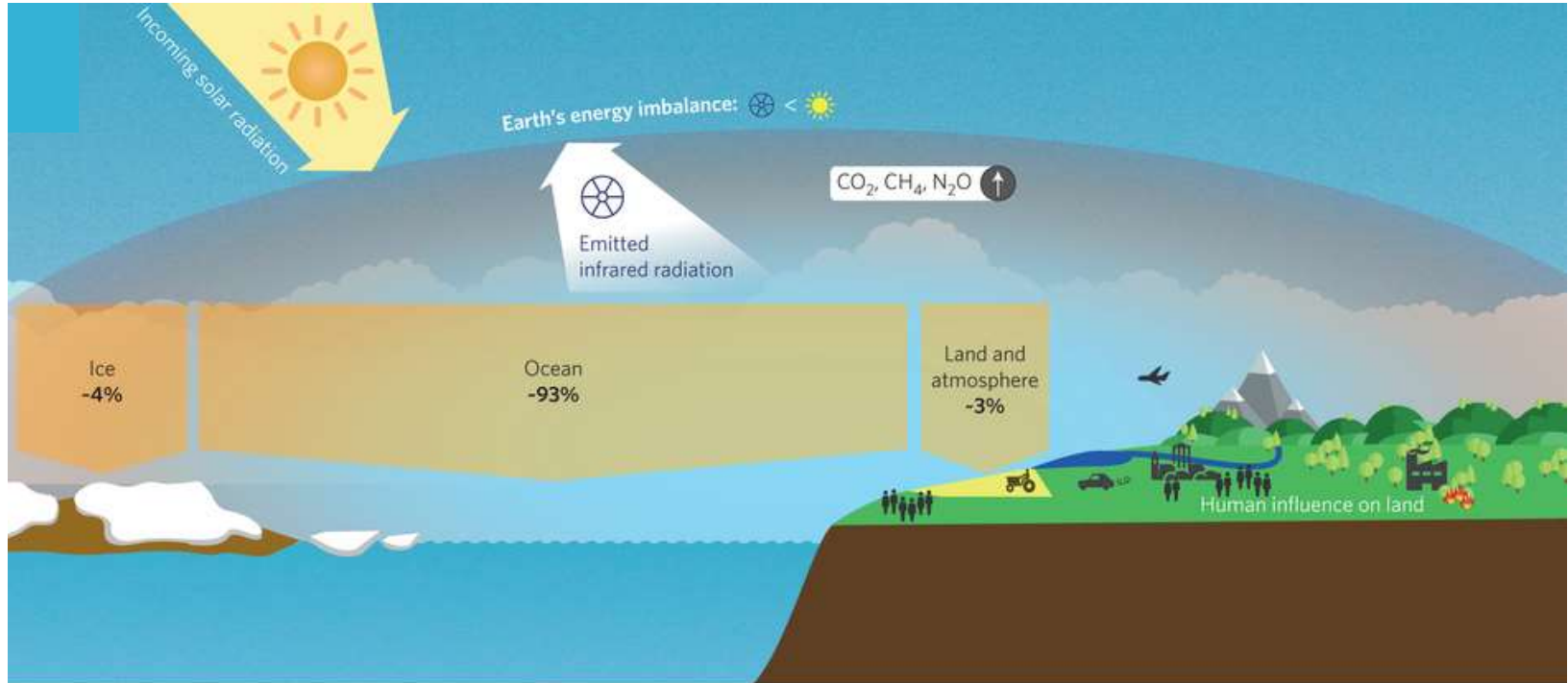
≈22%

≈29%

2008-2017
www.globalcarbonproject.org

Human influence on the Earth's energy budget



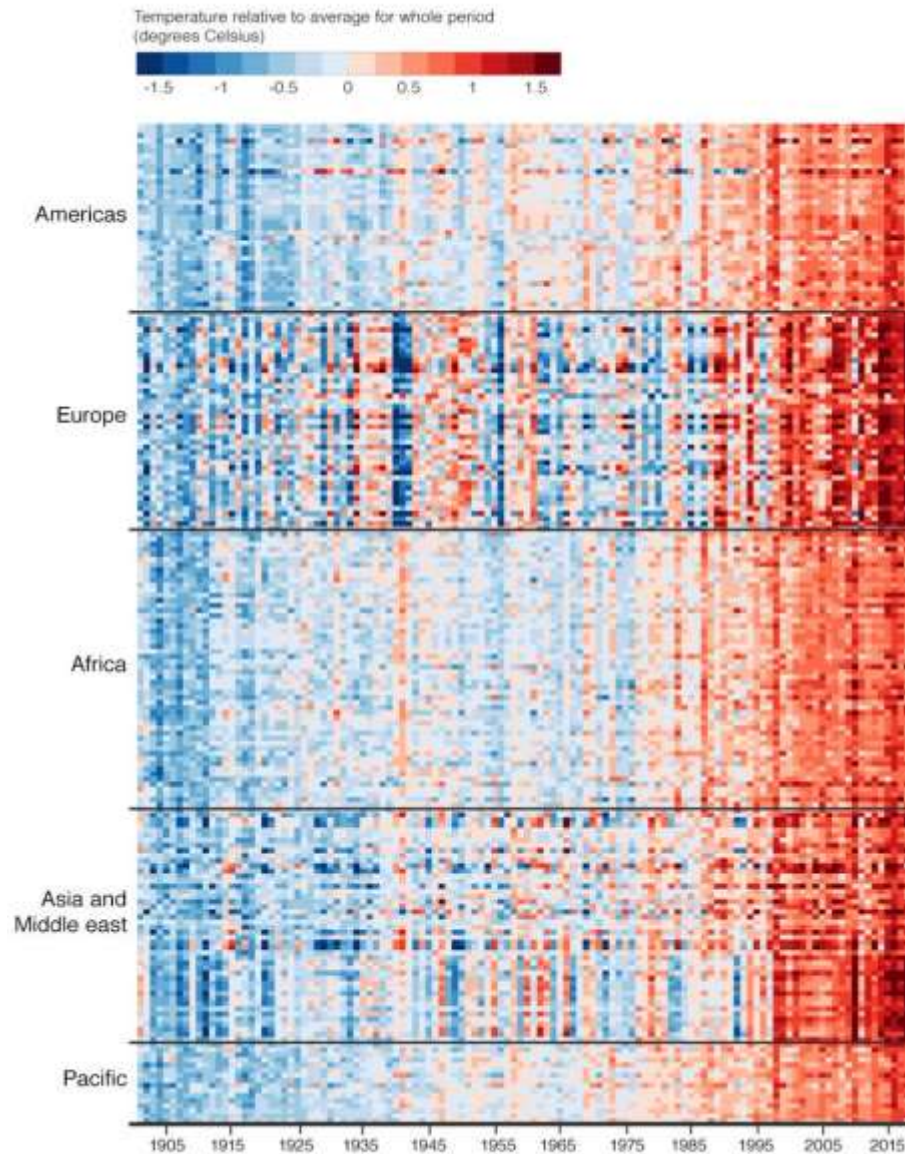


Climate is changing
due to the Earth's energy imbalance



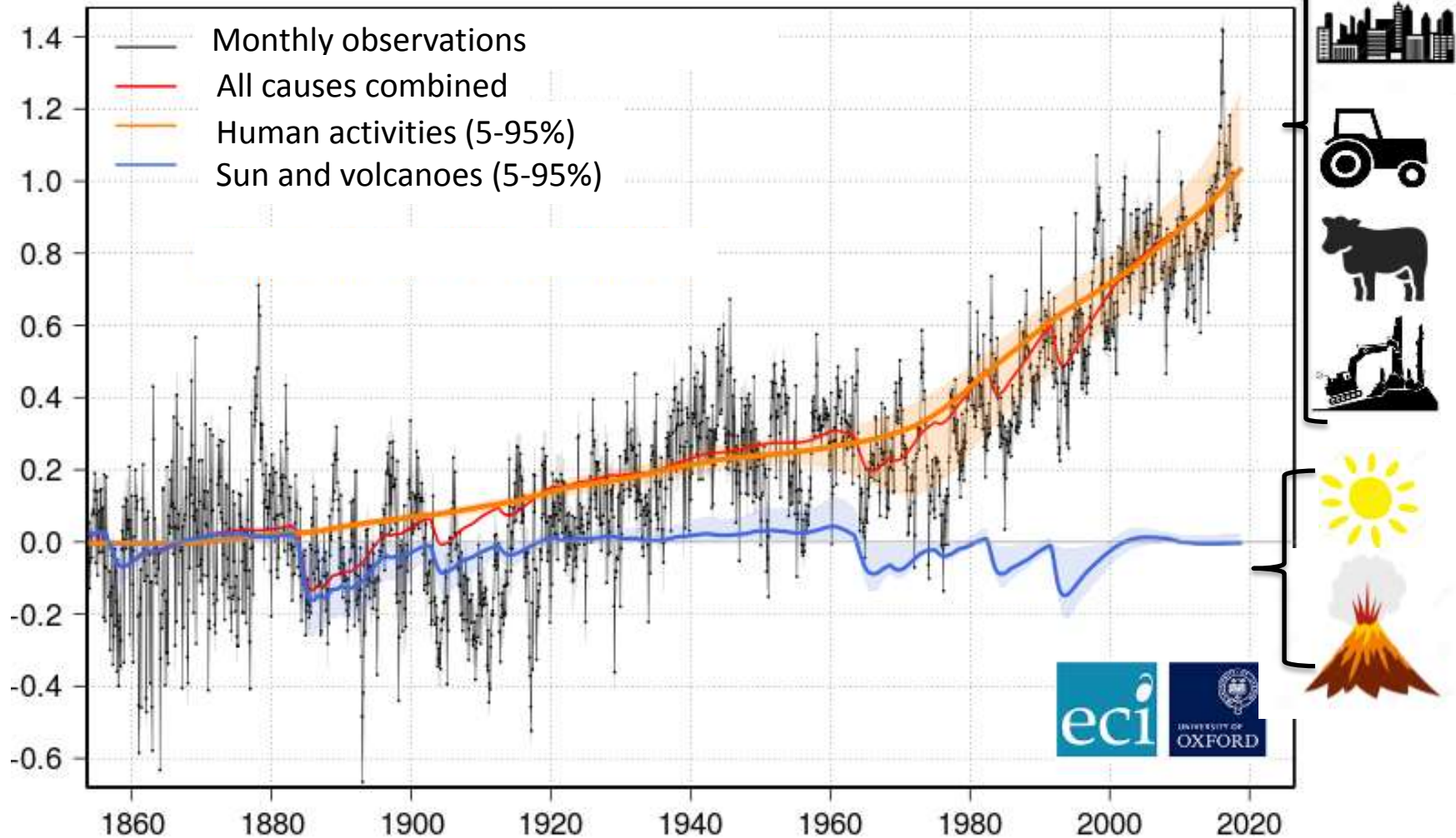
Global warming

Temperature changes around the world (1901-2018)

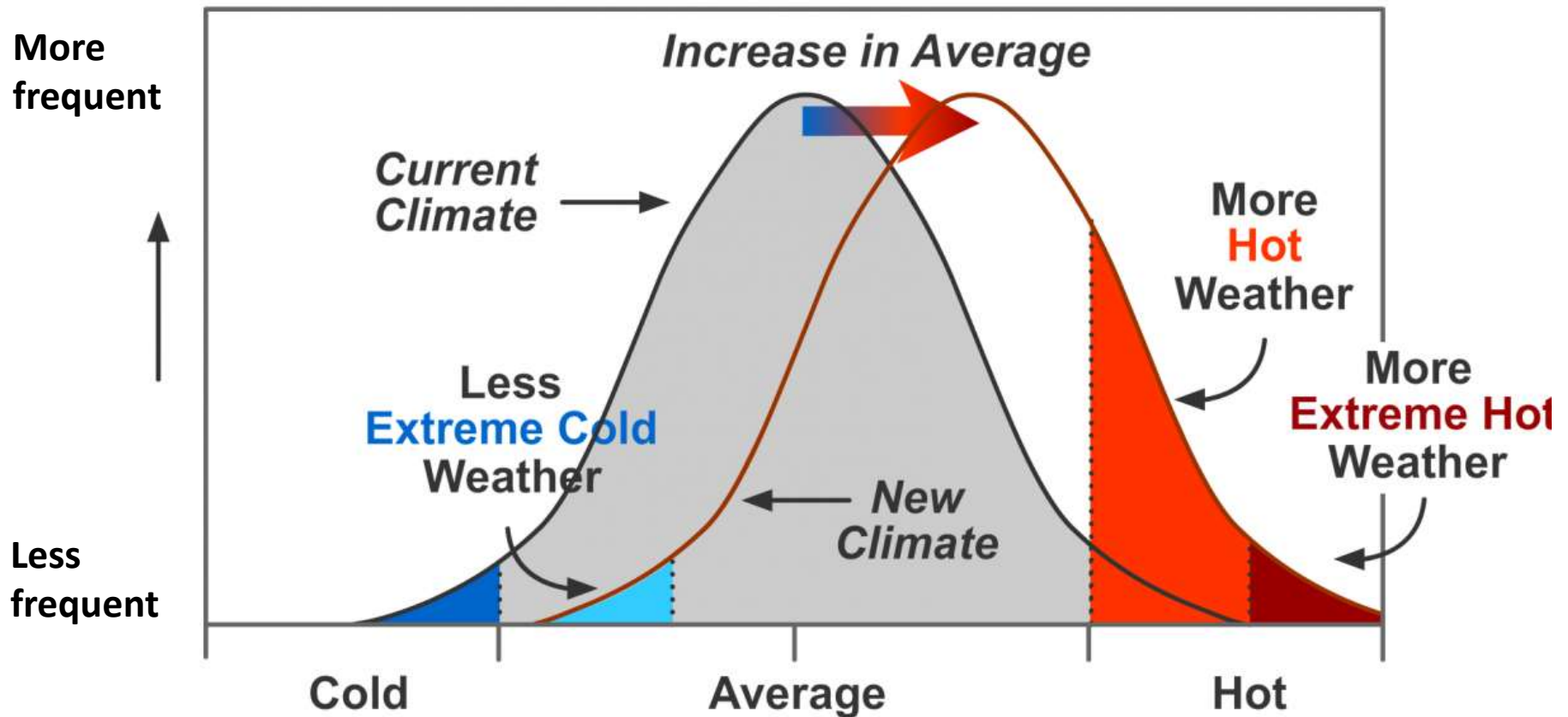


Human influence on global climate

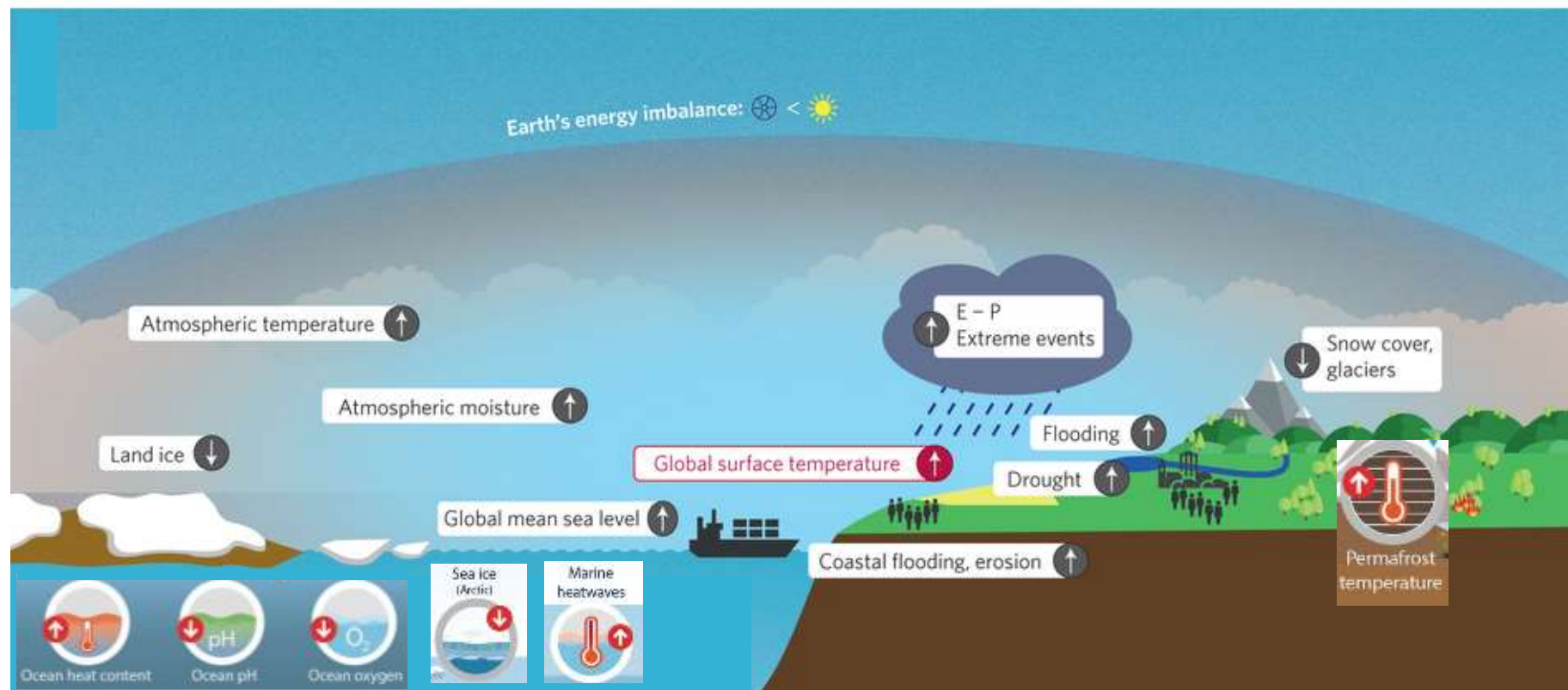
Global mean surface temperature change since 1850-1879 (°C)



Global warming is affecting extreme events



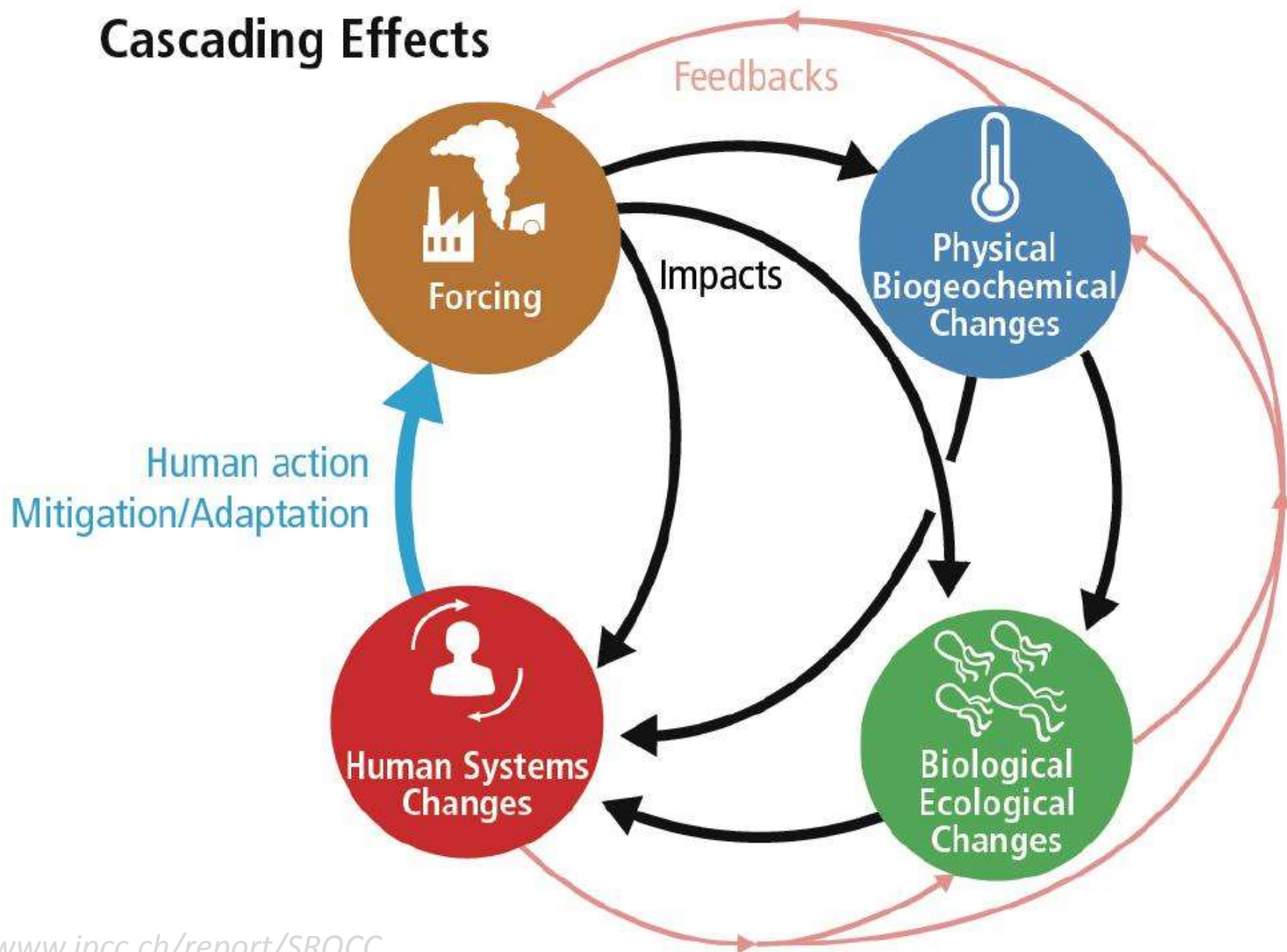
Climate change hazards



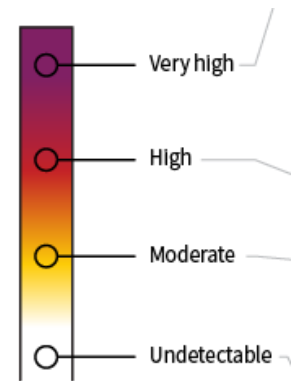
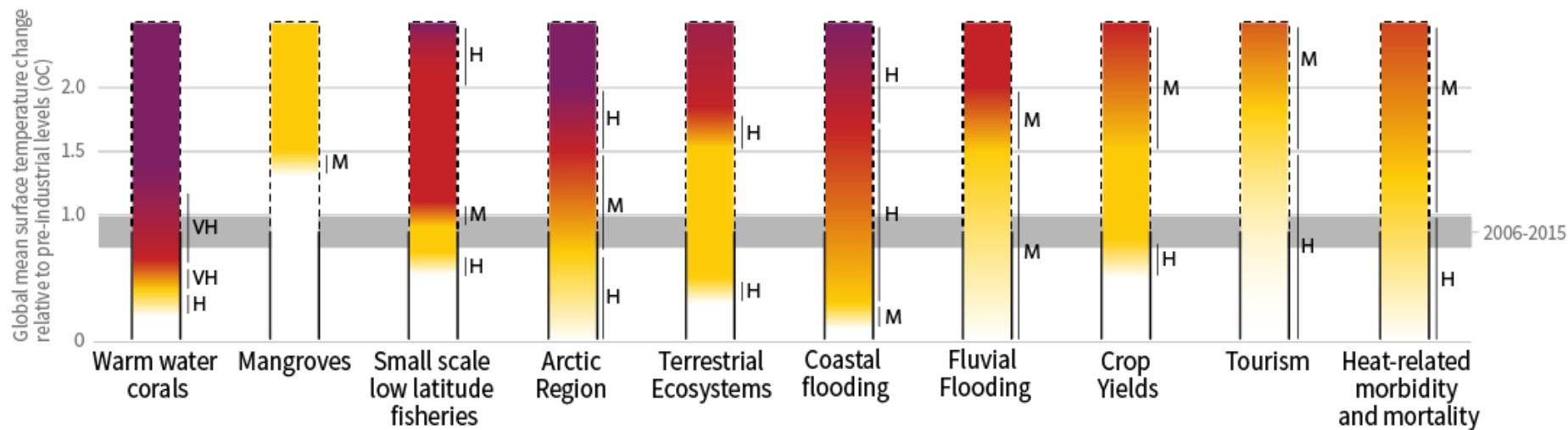
www.nature.com/articles/nclimate2876

www.ipcc.ch/report/SROCC

Cascading Effects

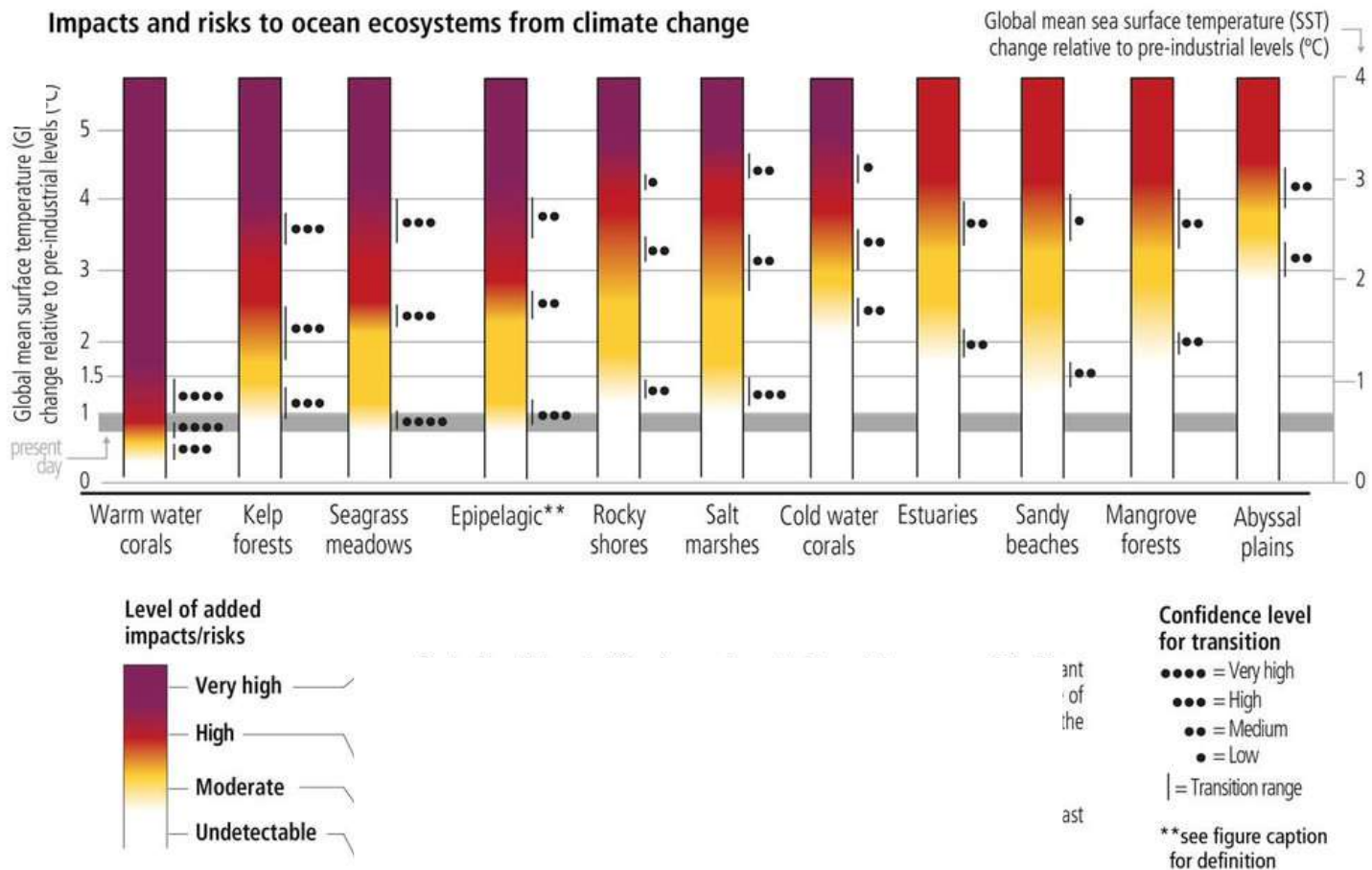


Impacts and risks for selected natural, managed and human systems

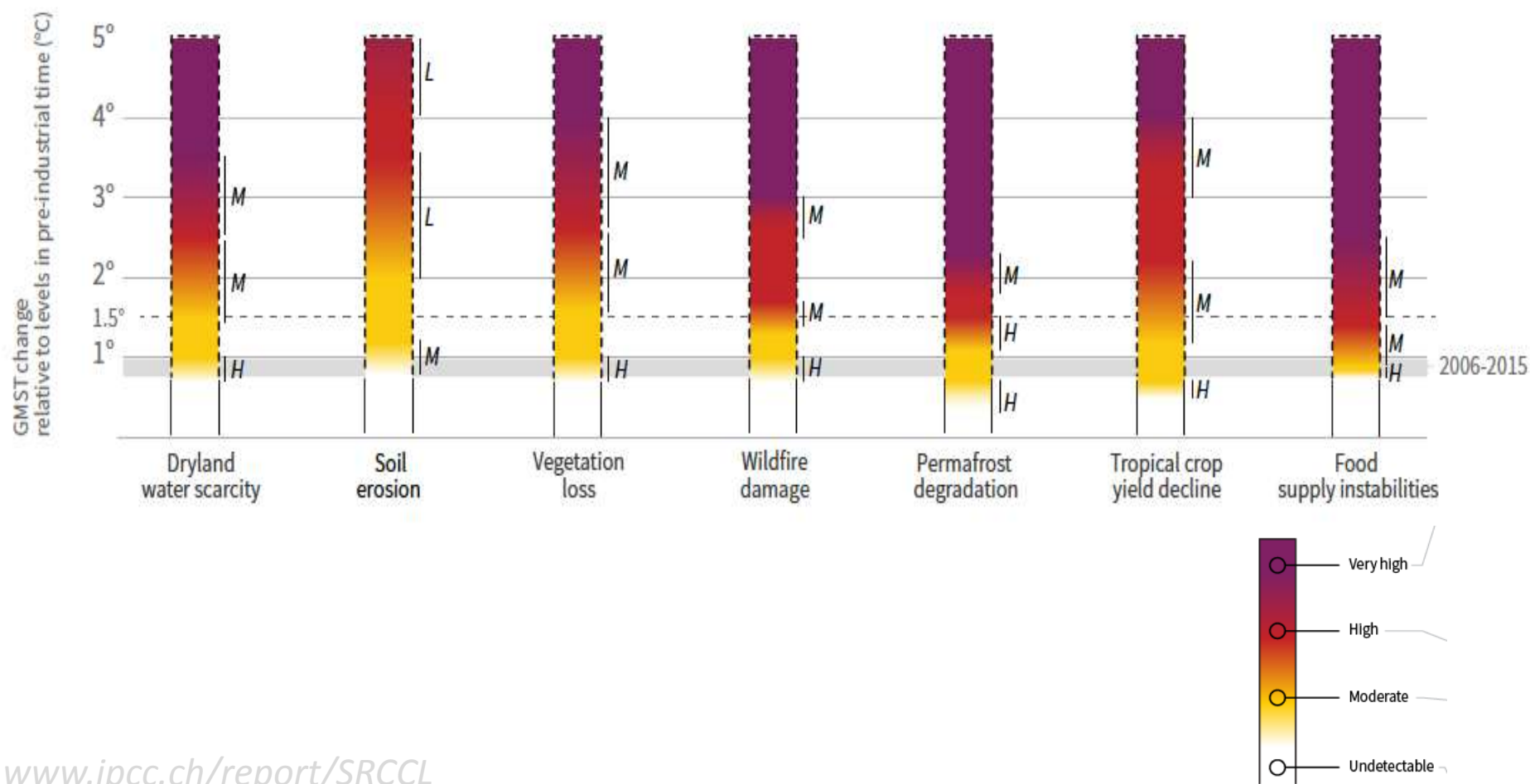




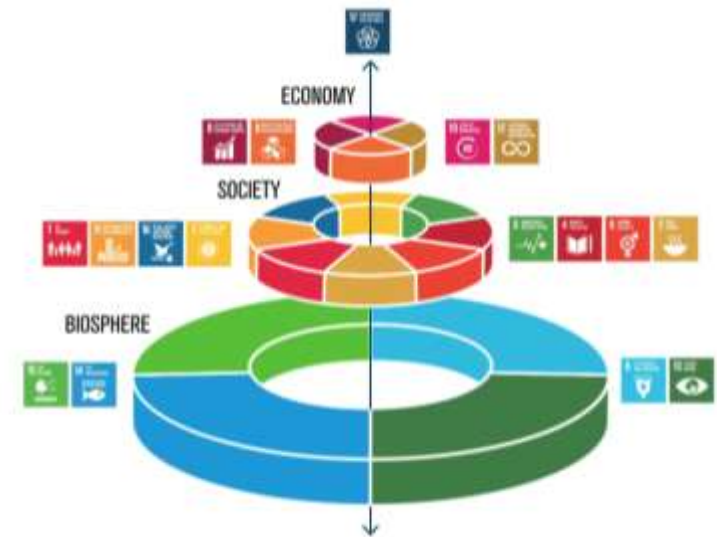
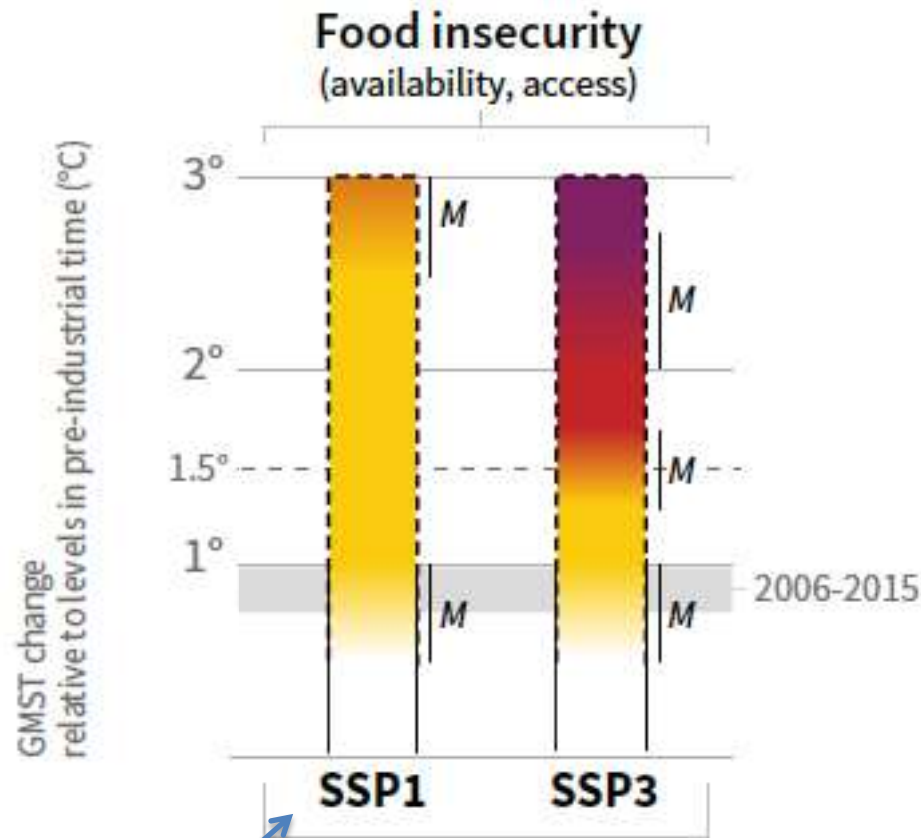
Impacts and risks to marine life from climate change



Risks from changes in land-based processes as a result of climate change



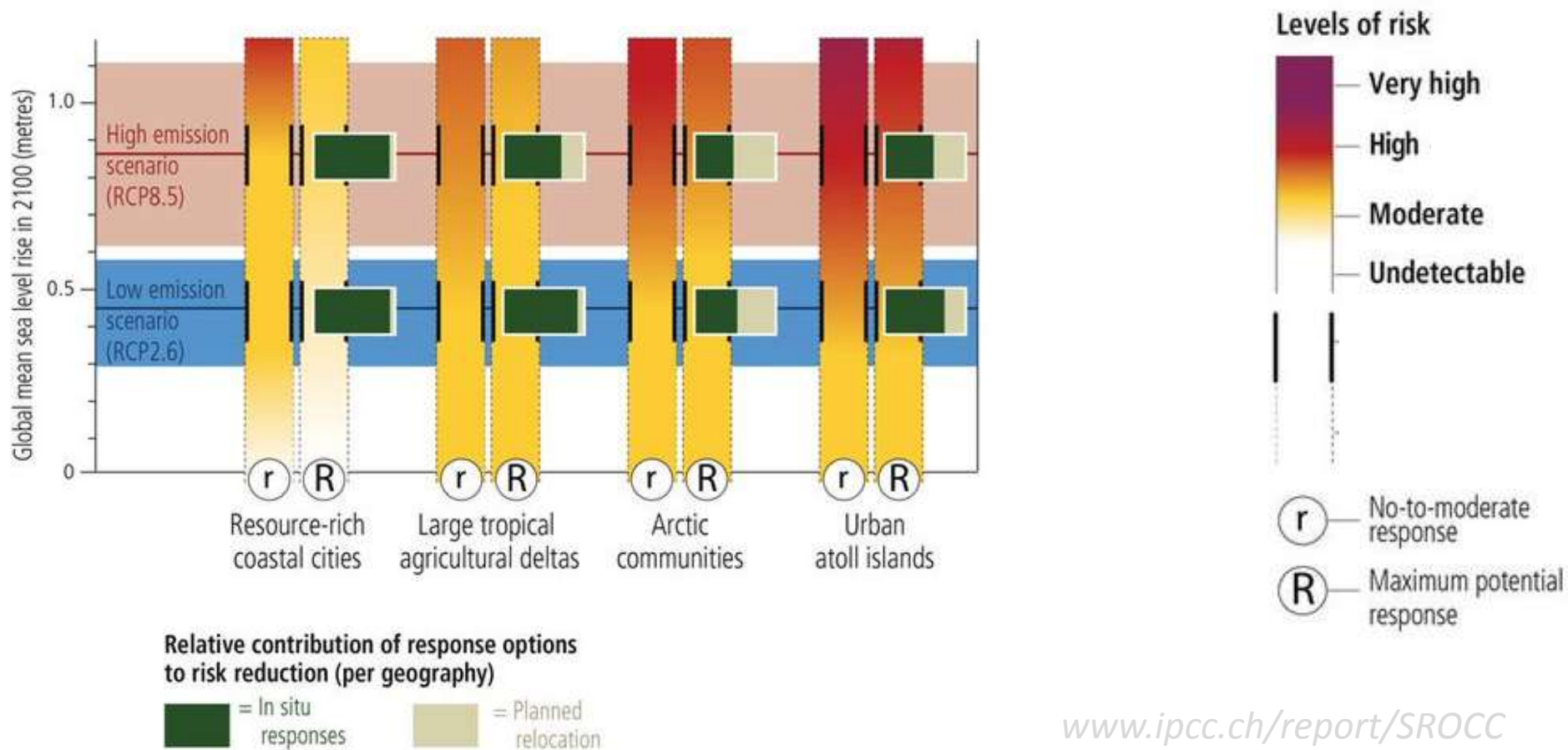
Different socio-economic pathways affect levels of climate-related risks



Low population growth, reduced inequalities, food production in low emission systems, effective land use regulation, high adaptive capacity

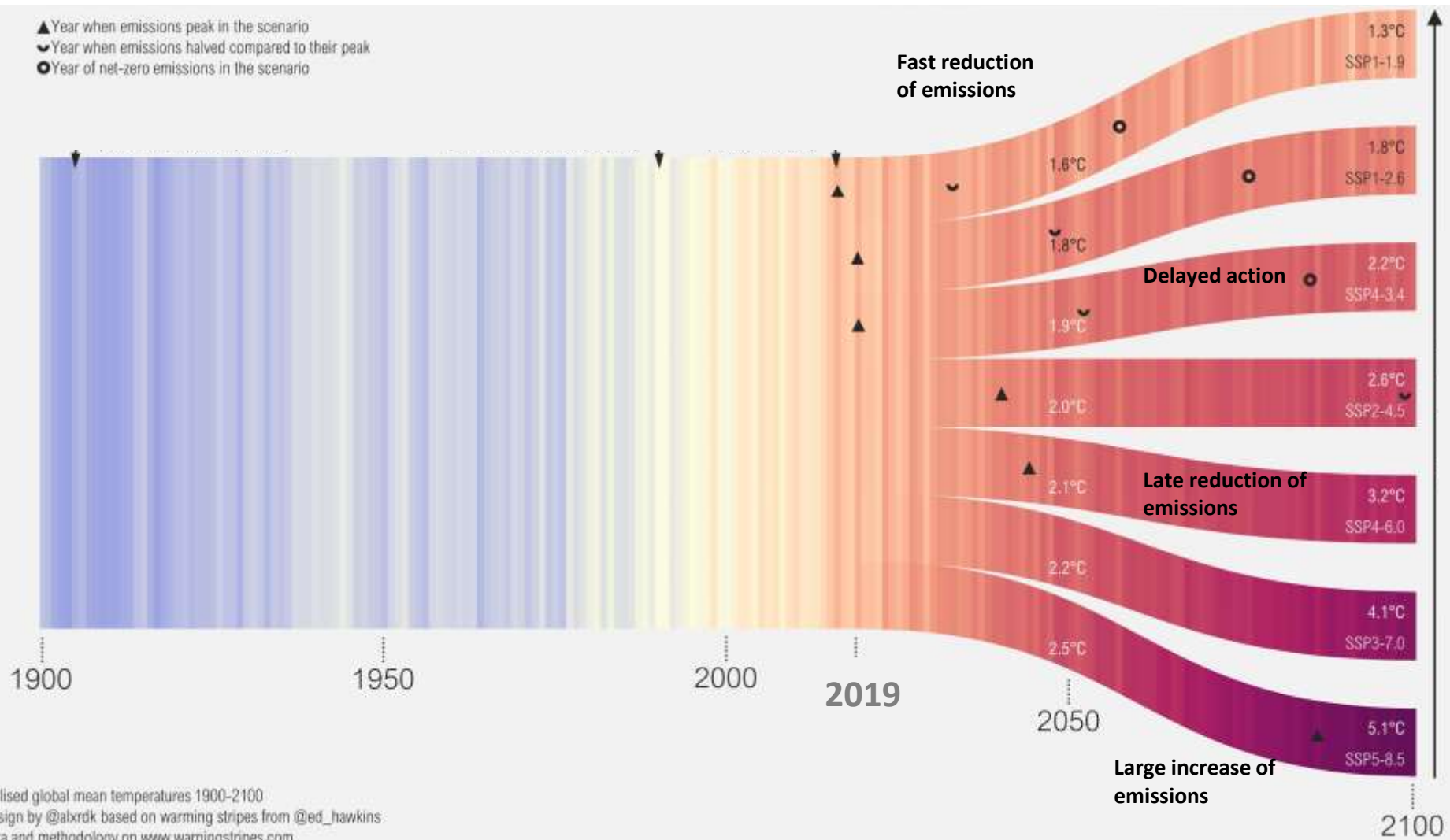


Sea level rise risks depend on emissions and on response options



What are plausible futures?

Today's choices determine future risks



If not us, who? If not now, when?

If not us, who? If not now, when?

- **There are many options for action, and this requires new mindsets and new skills (« climate literacy »)**
 - not just awareness raising, but skills
 - systemic vision (*beyond usual silos*)
 - understanding science (*Earth system*)
 - understanding societal implications
 - systems transitions (*energy, land use, urban, industry, finance*)
 - societal transformation (*law, best practices, demand side*)
 - potential and limits, co-benefits and trade-offs, enabling conditions
 - building resilient, carbon neutral development pathways
- **Training teachers** www.oce.global
- **Monitor, assess, benchmark « climate literacy »**



If not us, who? If not now, when?



futureearth.org/2019/09/20/global-research-and-action-agenda-on-cities-and-climate-change-science-published/



climateheritage.org

www.icomos.org

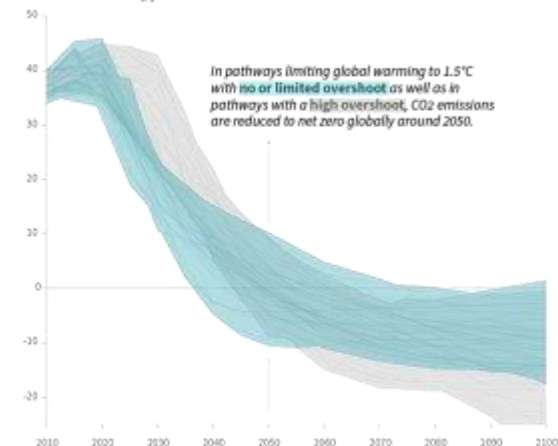
Transforming universities, living labs of transitions :

- Environmental & carbon footprints
- Open data and student projects
- Researchers engaged with society
- Vision, targets, pathways, implementation
- Net zero emissions and resilience
- International benchmarking
- Creativity

labos1point5.org

Global total net CO₂ emissions

Billion tonnes of CO₂/yr



Pathways limiting global warming to 1.5°C with no or low overshoot

Pathways with high overshoot

Pathways limiting global warming below 2°C (Not shown above)

www.ipcc.ch/report/SR15 and data.ene.iiasa.ac.at/iamc-1.5c-explorer

THANK YOU FOR YOUR ATTENTION!

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