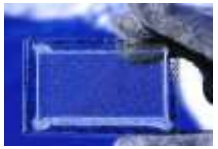
The physical science basis of climate change

Valérie Masson-Delmotte

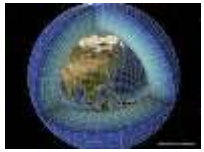
ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

A tremendous scientific endeavour



Fluid physics
Thermodynamics
Radiative transfers

Quantitative paleoclimate
Supercomputers
Satellites



Antiquity

Middle Age

17th Century
Meteorological instruments

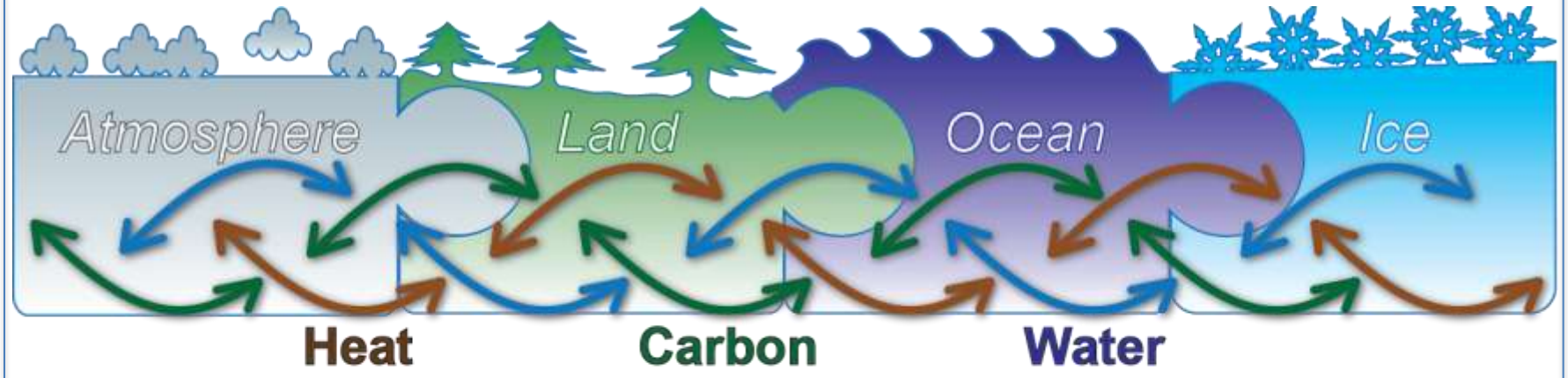
19th Century
Networks
Ice ages
Greenhouse effect

Late 20th Century
Key concepts
Climate modelling
Statistical analyses

- a vast scientific community
- thousands of scientific peer-review publications each year

What is the climate system?

external perturbations



interactions and feedbacks

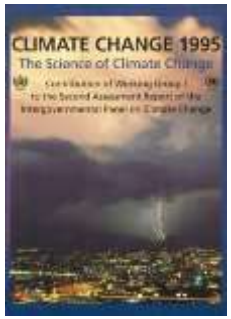
spontaneous variability
response to perturbations

Examples of key questions addressed by the IPCC Working Group I reports

- How does the climate system operate?
- What do we know of past and current climate variability and climate change?
- What are the causes of observed changes?
- What are the processes involved in the response of the climate system to perturbations?
- Which climate change may occur in the future?

5 IPCC reports

1990
Gave a broad overview of climate change science, discussion of uncertainties and evidence of warming



1995
"The balance of evidence suggests a **discernible** human influence on global climate"

2001
"There is new and **stronger evidence** that most of the warming observed over the last 50 years is attributable to human activities"

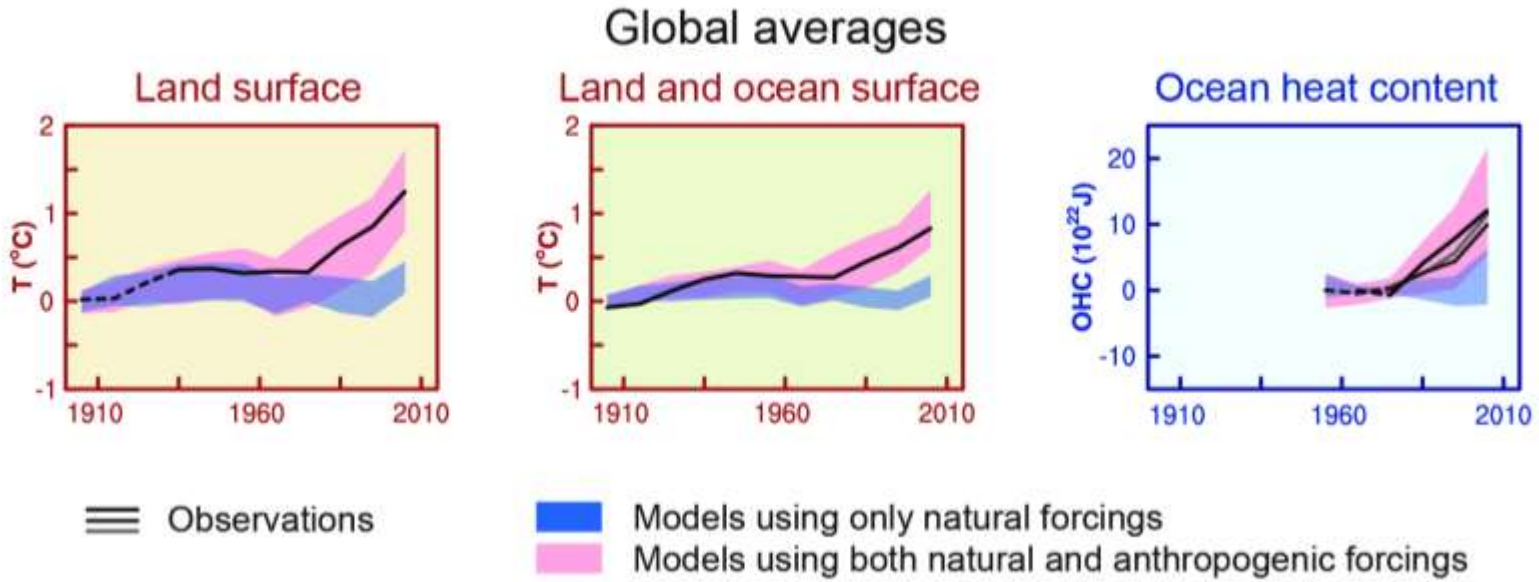
2007
"Warming of the climate system is **unequivocal**…"

2013
"Human influence on the climate system is **clear**."

Observations | Confidence in models | Process based understanding | More sophisticated models | Multiple lines of evidence

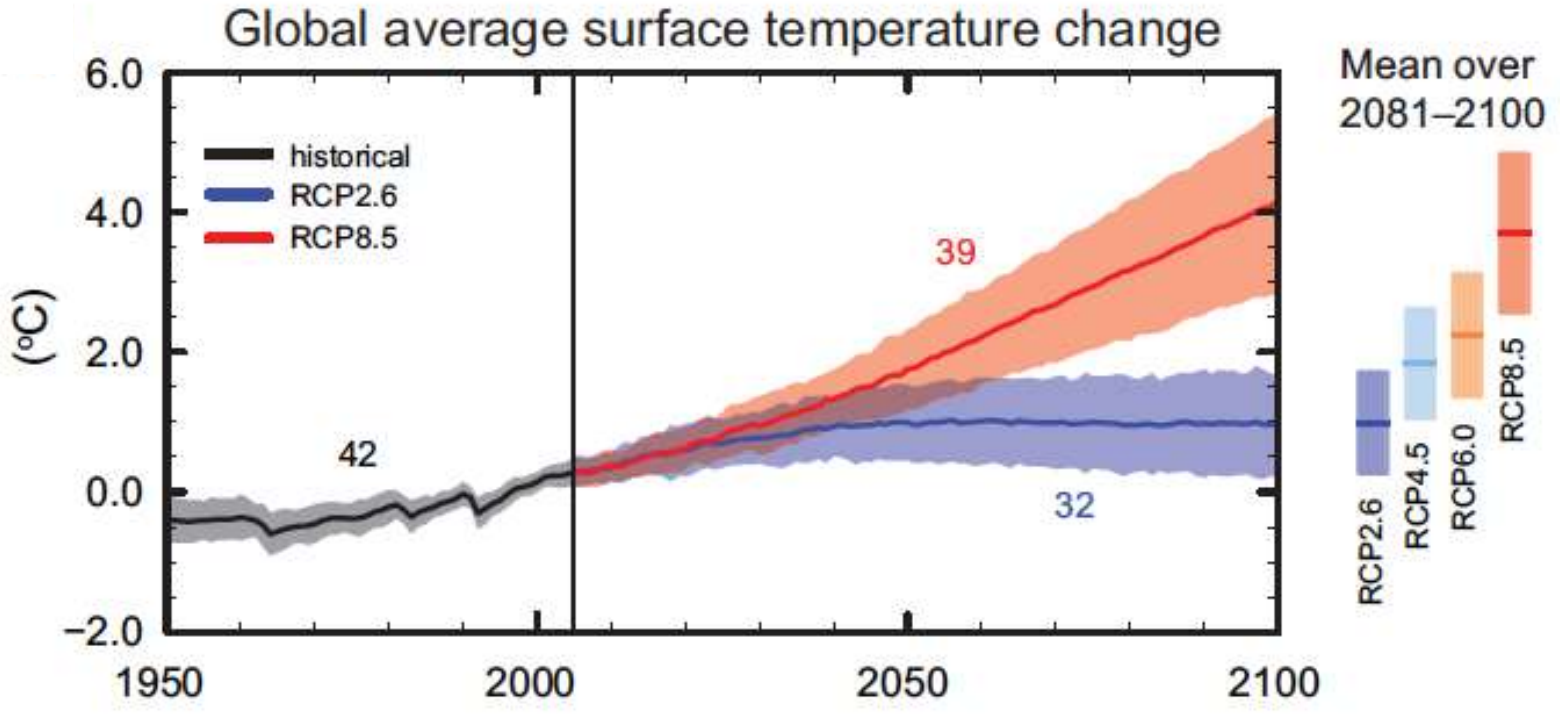
Example of key finding from the last IPCC report (2013)

It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century

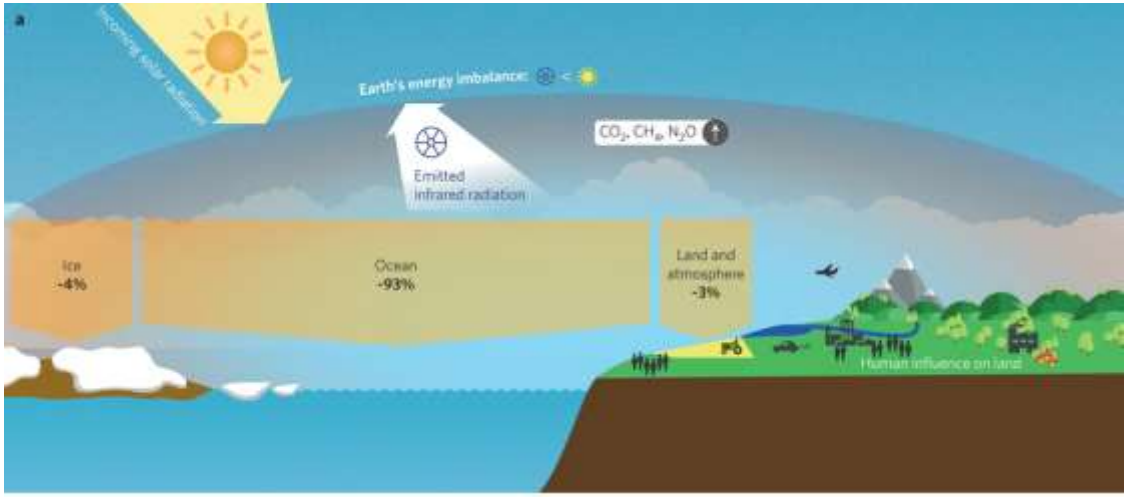


Example of key finding from the last IPCC report (2013)

Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.



The Earth’s energy imbalance



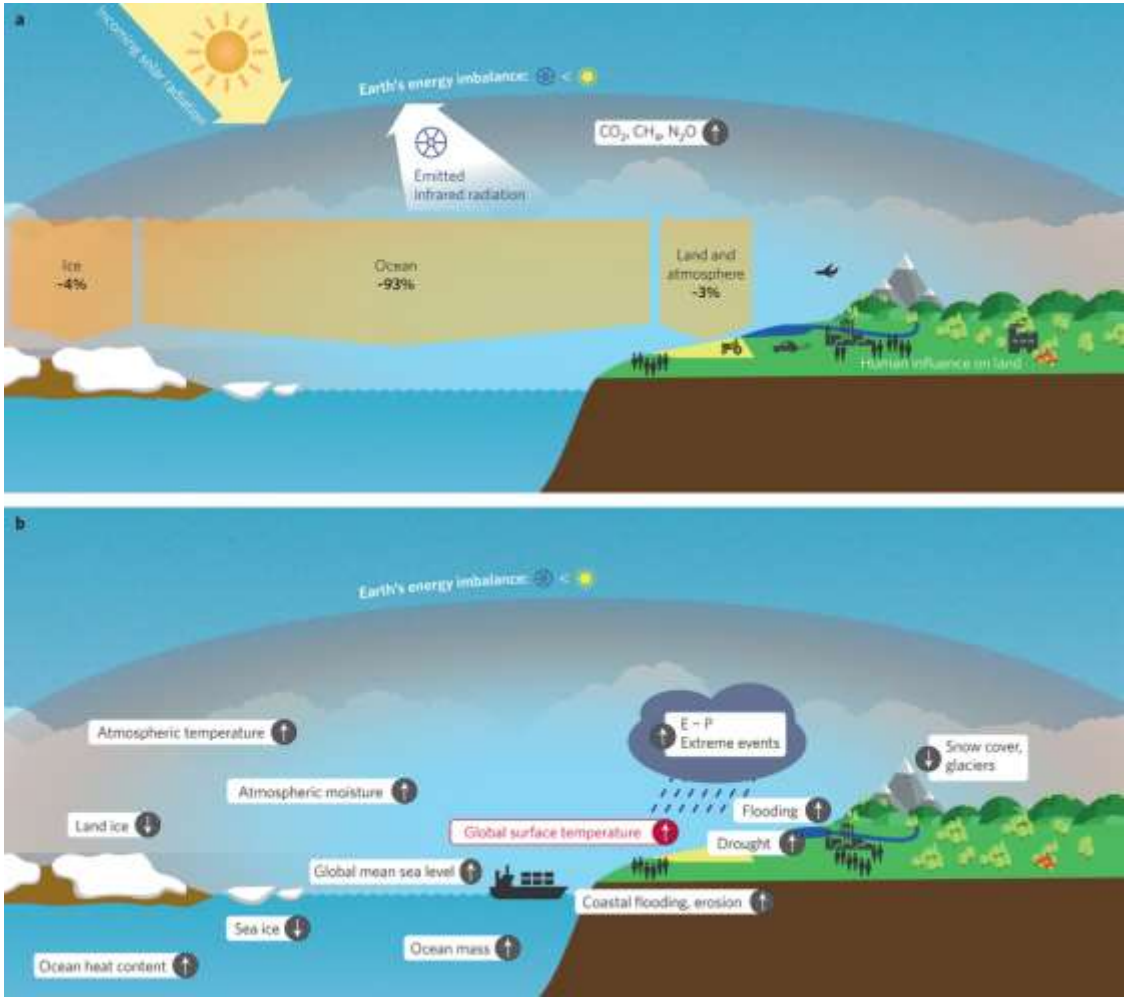
Earth’s radiation budget

Surface warming and ice melt

Heat storage in oceans

Von Schuckmann et al, NCC, 2016

The Earth's energy imbalance



Earth's radiation budget

Surface warming and ice melt

Heat storage in oceans

Consequences of accumulated energy in the climate system

Von Schuckmann et al, NCC, 2016

IPCC assessments

- Rigorous
- Robust
- Transparent
- Comprehensive

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WGI Outline

Summary for Policy Makers
Technical Summary

Chapter 1: Framing, context, methods
Chapter 2: Changing state of the climate system
Chapter 3: Human influence on the climate system
Chapter 4: Future global climate: scenario-based projections and near-term information
Chapter 5: Global carbon and other biogeochemical cycles and feedbacks
Chapter 6: Short-lived climate forcers
Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity
Chapter 8: Water cycle changes
Chapter 9: Ocean, cryosphere, and sea level change
Chapter 10: Linking global to regional climate change
Chapter 11: Weather and climate extreme events in a changing climate
Chapter 12: Climate change information for regional impact and for risk assessment

Large-scale climate change

Annexes incl. options for a Regional Atlas and Technical Annexes
Glossary
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Climate processes

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Regional climate information

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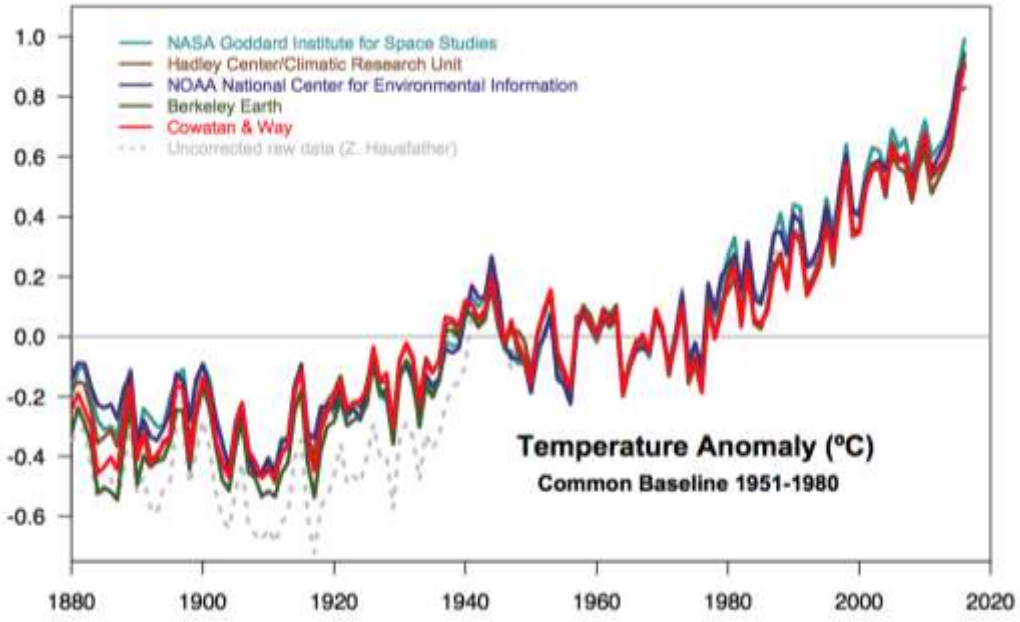
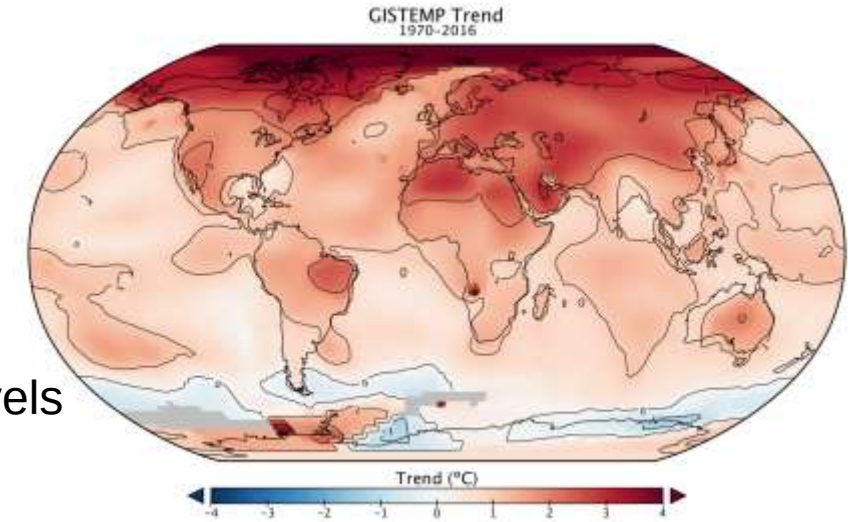
How has temperature changed at the Earth's surface?





Ongoing trend : 0.18°C per decade

2015 and 2016 : >1°C above pre-industrial levels

NASA GISS; Hawkins et al, BAMS, 2017

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Global warming of 1.5°C

Chapter 1: Framing and context

Chapter 2: Mitigation pathways compatible with 1.5°C in the context of sustainable development

Chapter 3: Impacts of 1.5°C global warming on natural and human systems

Chapter 4: Strengthening and implementing the global response to the threat of climate change

Chapter 5: Sustainable development, poverty eradication and reducing inequalities

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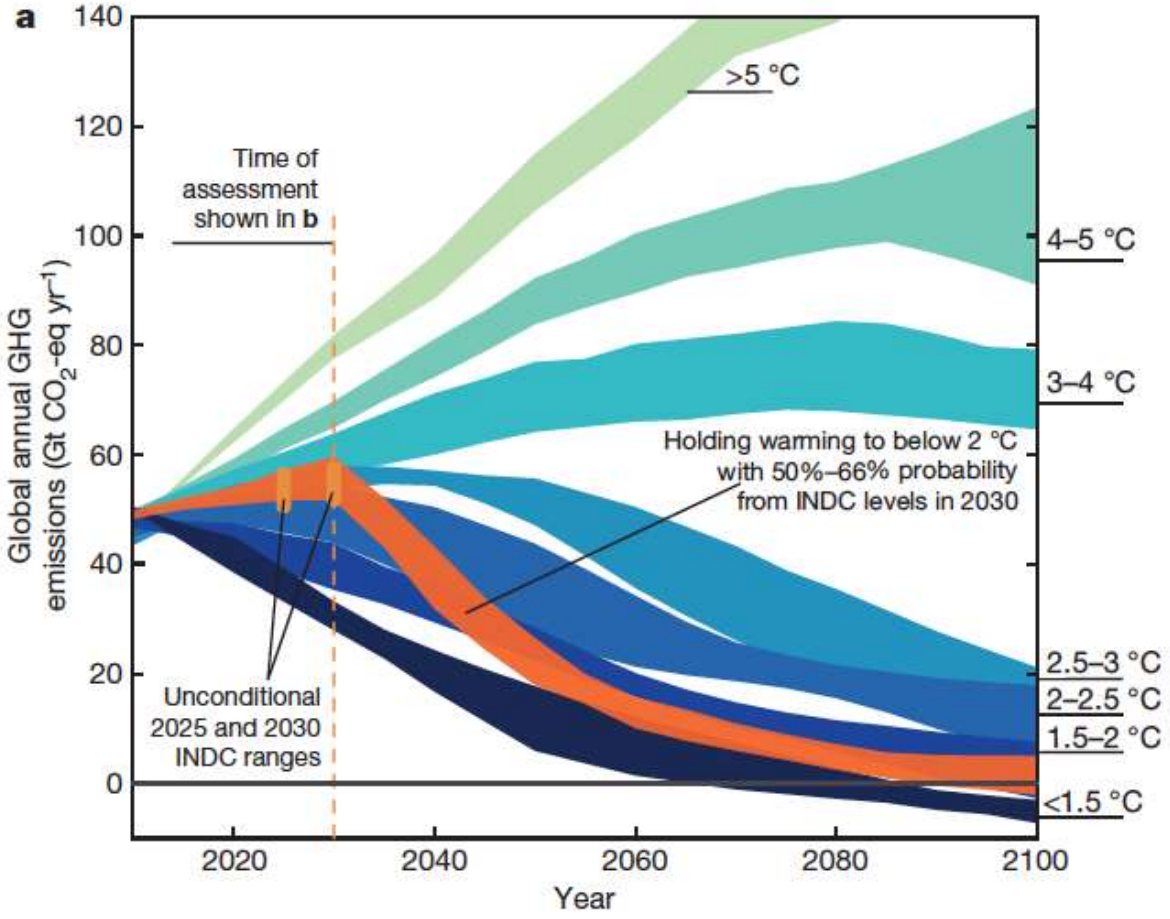
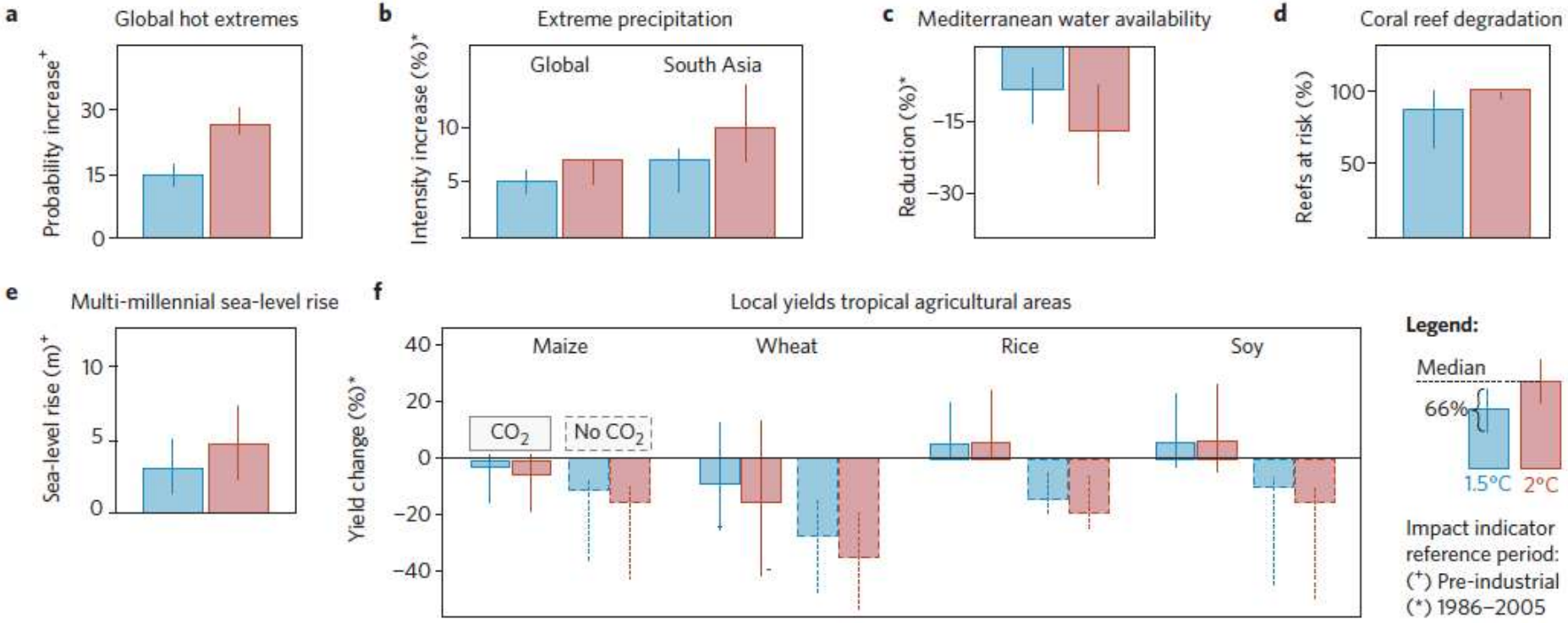
One study of greenhouse gas emission pathways compatible with climate targets



Rogelj et al, Nature, 2016

One study exploring impacts of 1.5-2°C global warming



Schleussner et al, Nature Climate Change, 2016

IPCC assessments

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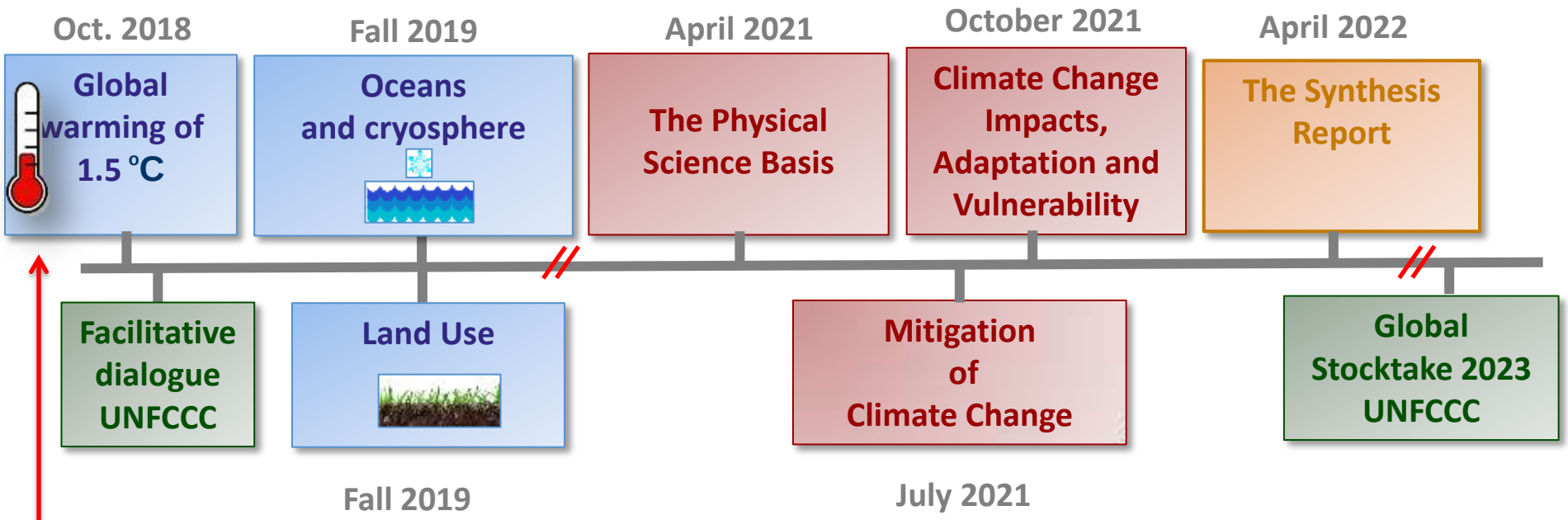
Timeline



Articles : submitted before Nov. 1st, 2017 ; accepted before May 15, 2018

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