

machine learning in climate science

Climate Change 2021 The Physical Science Basis

Sixth Assessment Report of the
Intergovernmental Panel on Climate Change
WG I

11 October 2021 Journal Club

Felix Strnad



The IPCC Report

1

- Introduction
- Basic concepts

Global Monsoon

3

- Chapter 3, 4 & 8
- Different scenarios

Global Changes

2

- Temperature
- Precipitation

Summary

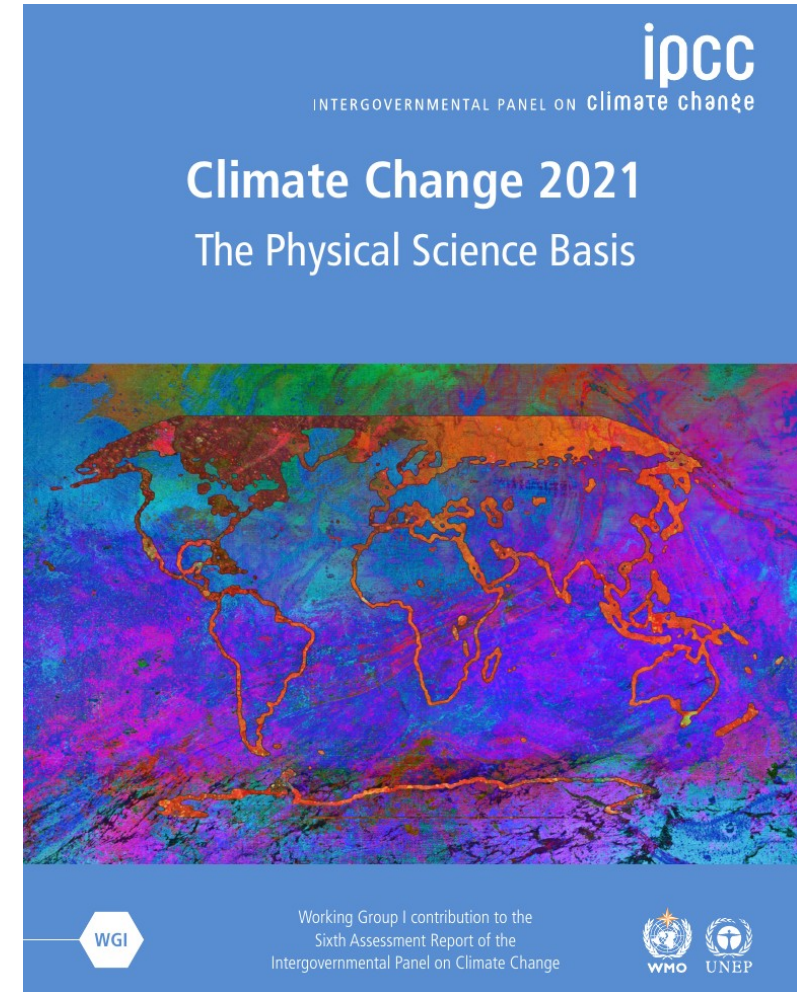
4

- Summary
- Outlook on Future Projections



The IPCC report

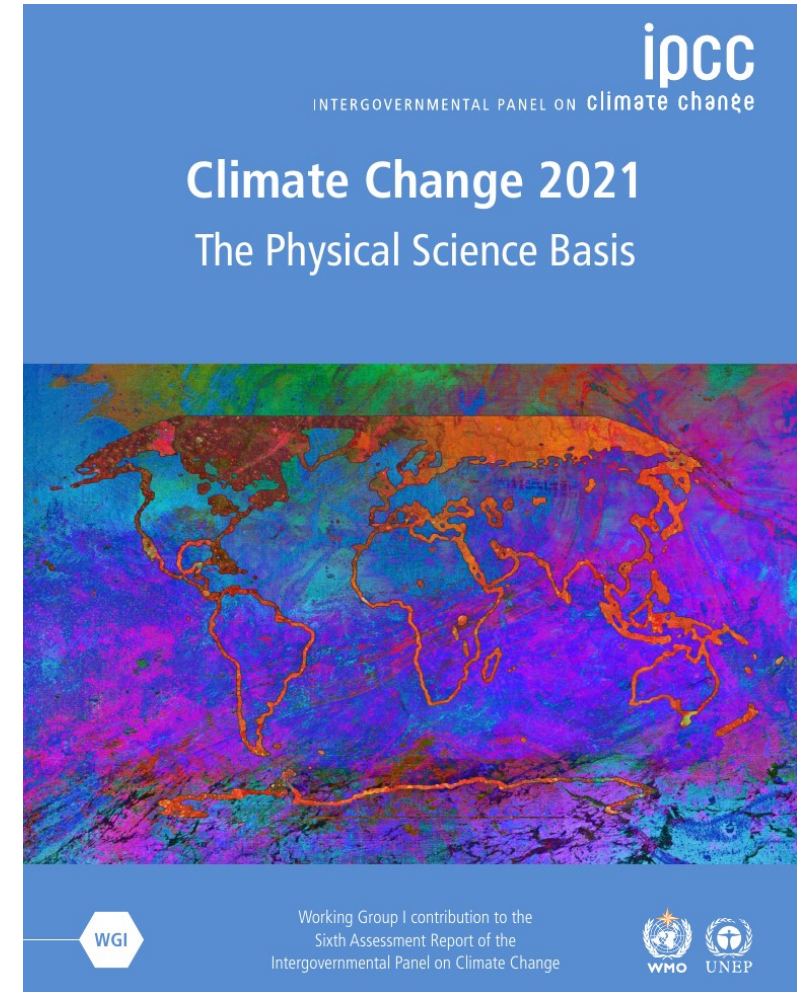
- Different Working groups
- Working Group I (WGI)
aims at assessing **the physical scientific basis** of the climate system and climate change.
- Working Group II (WGII)
assesses **the vulnerability** of socio-economic and natural systems to climate change, negative and positive
- Working Group III (WG III) assesses **options for mitigating climate change** through limiting or preventing greenhouse gas emissions



The IPCC report

The report consists of 3 parts:

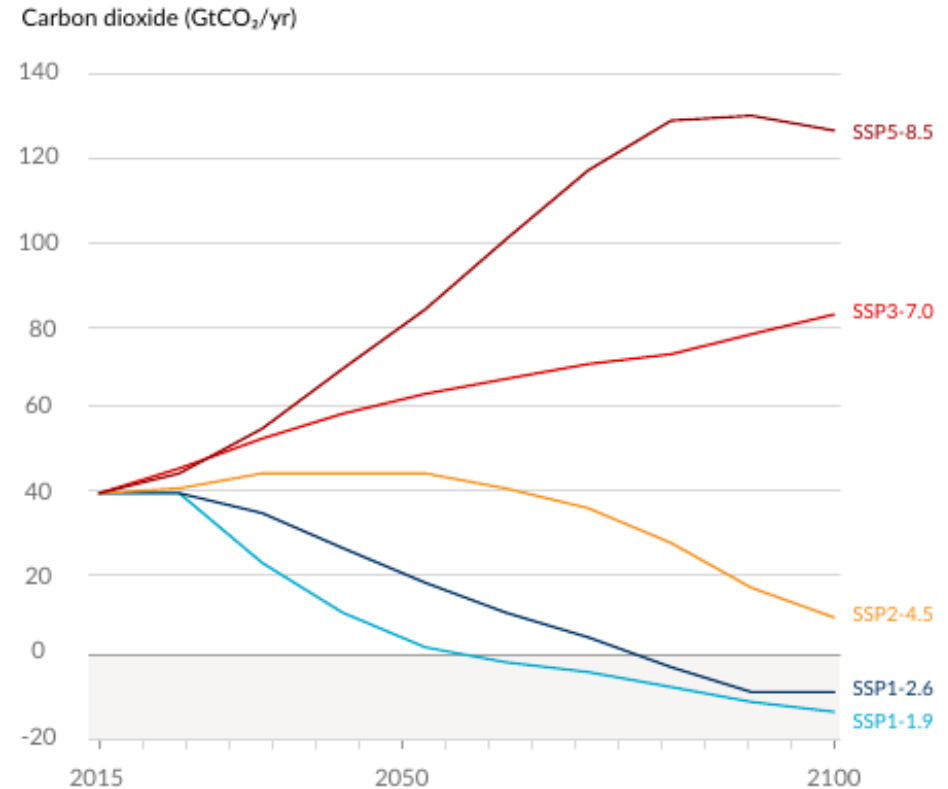
- Summary for policy makers:
High-level overview for understanding current climate change ~39 pages
- Technical Summary
Summarizes the key findings of the different chapters ~150 pages
- Full report
Detailed overview in different chapter, large-scale information (Ch 2,3,4), process understanding (Ch 5-9), regional information (10-12) ~3500 pages



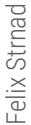
WG I Climate Change – The Physical Basis

5 different emission scenarios:

- high and very high GHG emissions, that **roughly double from current levels** by 2100 and 2050 (SSP3-7.0 and SSP5-8.5)
- CO₂ emissions remaining **around current levels** (ssp2-4.5)
- very low and low GHG emissions and CO₂ emissions declining to net zero ~after 2050, followed by varying levels of **net negative CO₂ emissions** (ssp 1-2.6, ssp 1-1.9)



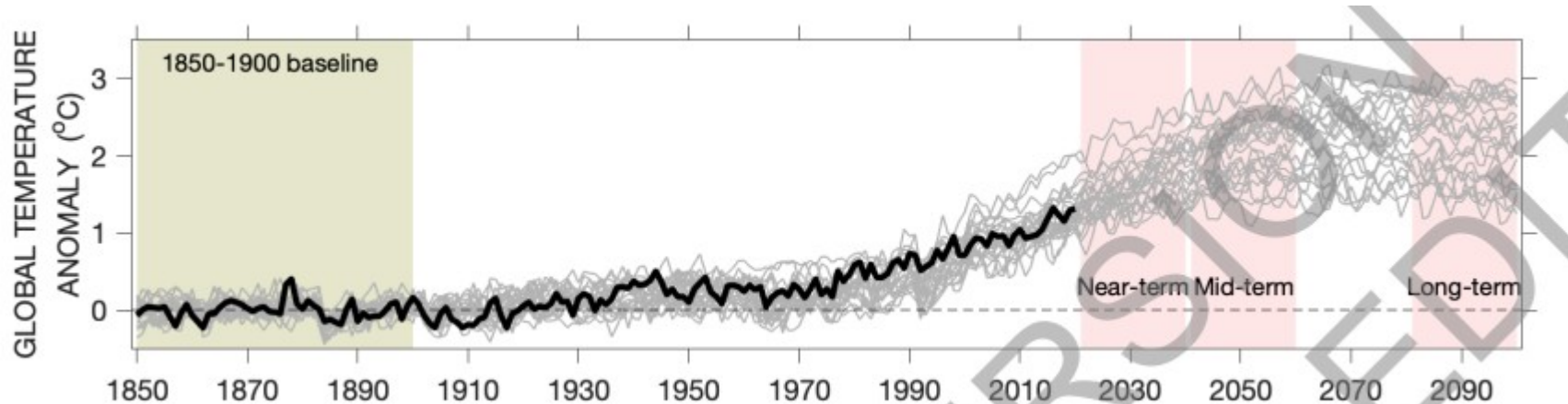
Summary on IPCC report 2021



Coupled Model Intercomparison Project Phase 6 (CMIP6)

Climate Models

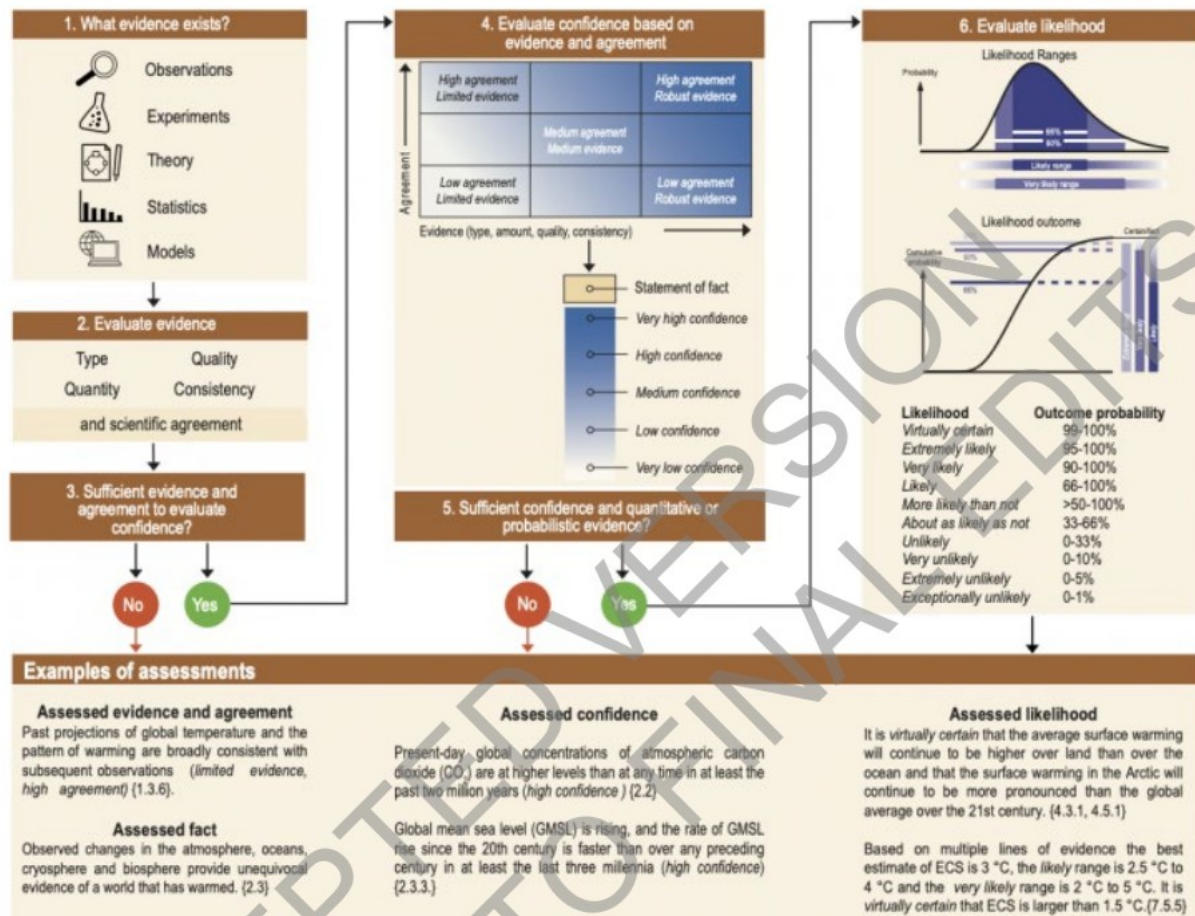
- Global Earth System Models of high complexity consisting of a General Circulation Model (GCM), representing the dynamics of the atmosphere and ocean
- Consisting of ~30 models, ensembles of climate simulations can be used to explore different sources of uncertainty and their magnitude



Coupled Model Intercomparison Project Phase 6 (CMIP6)

Likelihood statements

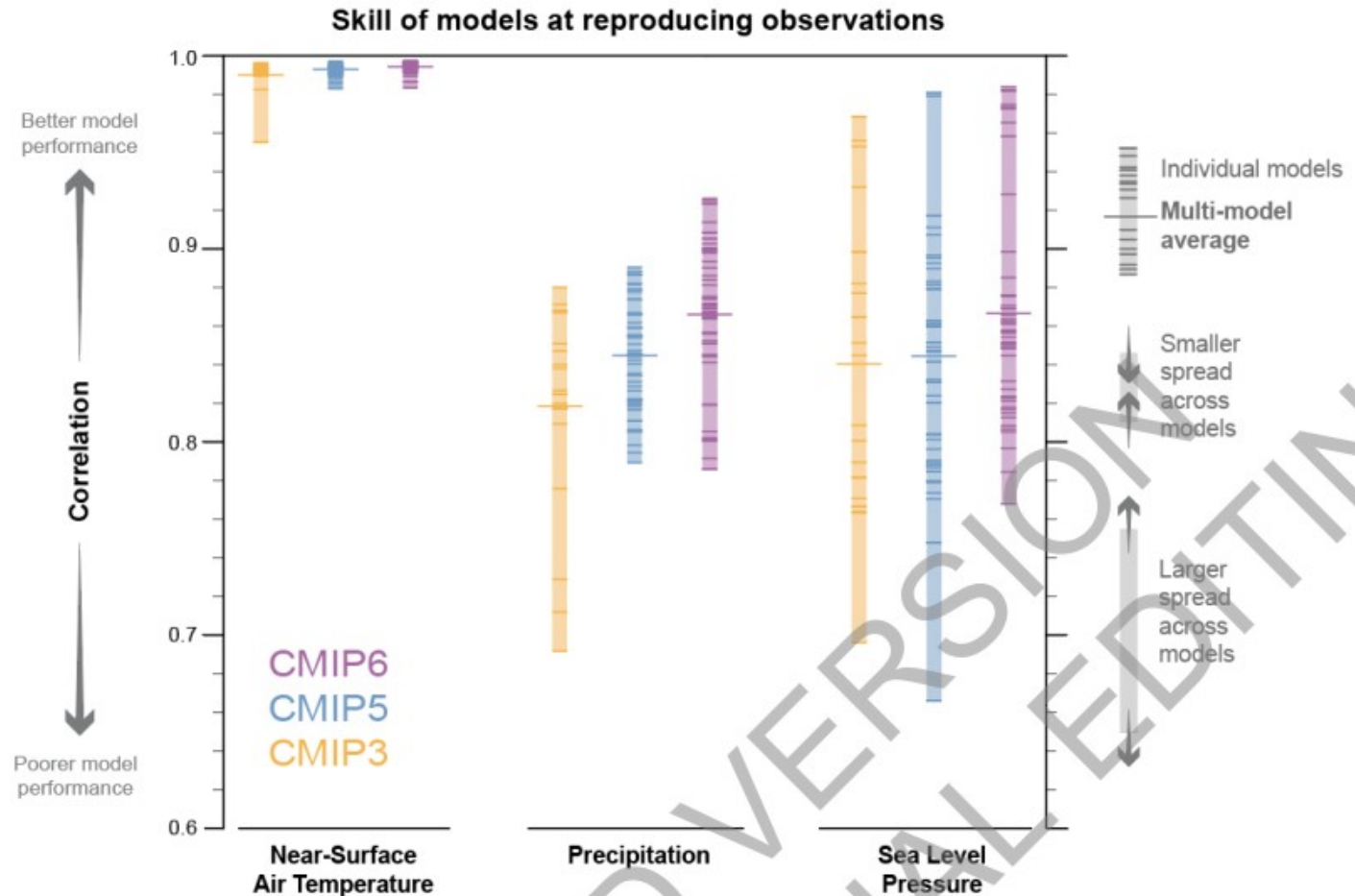
- Uncertainty interval: 90 % as *very likely range*, 66% as *likely range*
- virtually certain: 99–100%, very likely: 90–100%, likely: 66–100%, about as likely as not: 33–66%, unlikely: 0–33%, very unlikely: 0–10%, exceptionally unlikely: 0–1%
- Likelihood can indicate probabilities for single events or broader outcomes



1. Basics

Coupled Model Intercomparison Project Phase 6 (CMIP6)

Climate Models improved!



1. South Asian Monsoon



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4

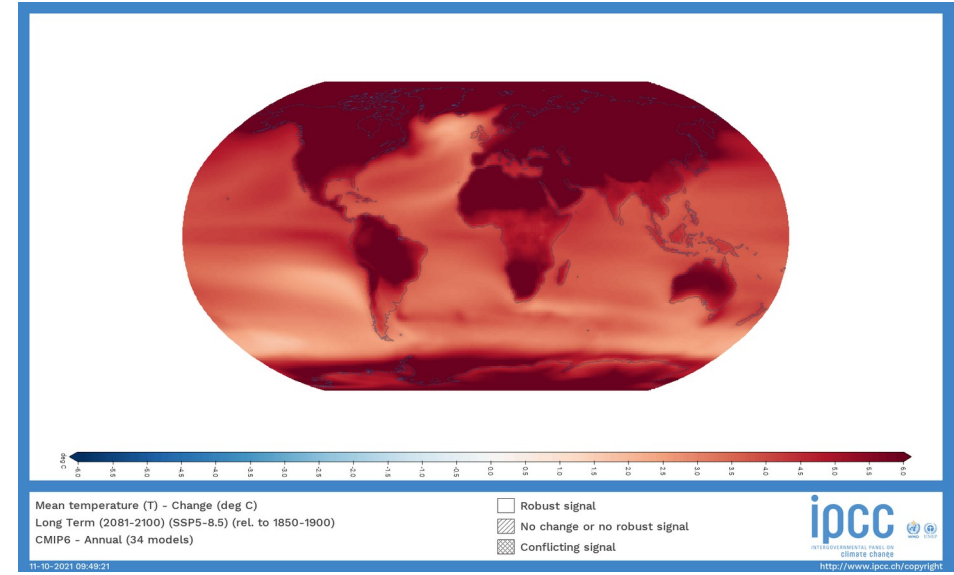
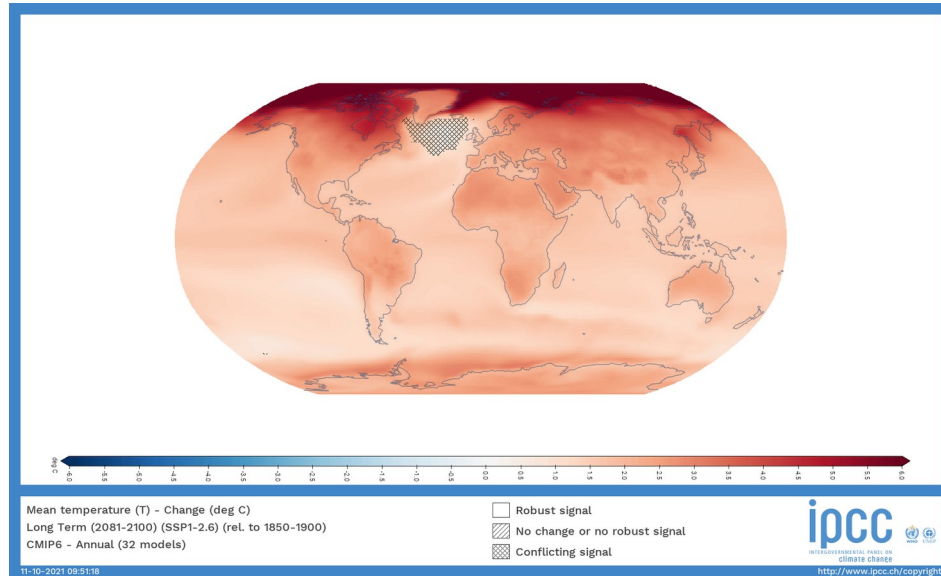
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Global Climate Change

- Interactively accessed at

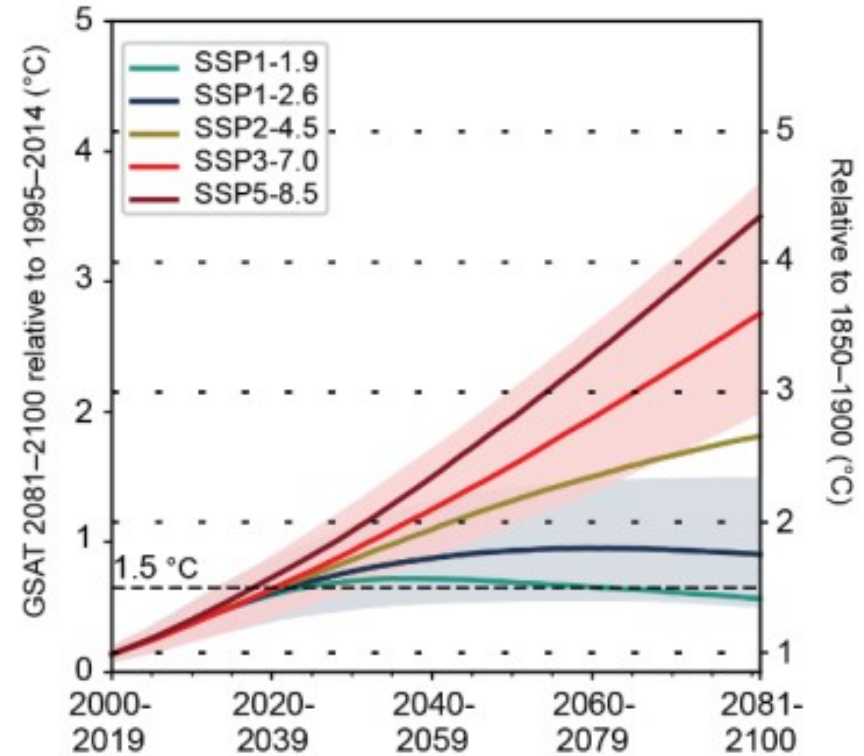
<https://interactive-atlas.ipcc.ch/>



2. Global Changes

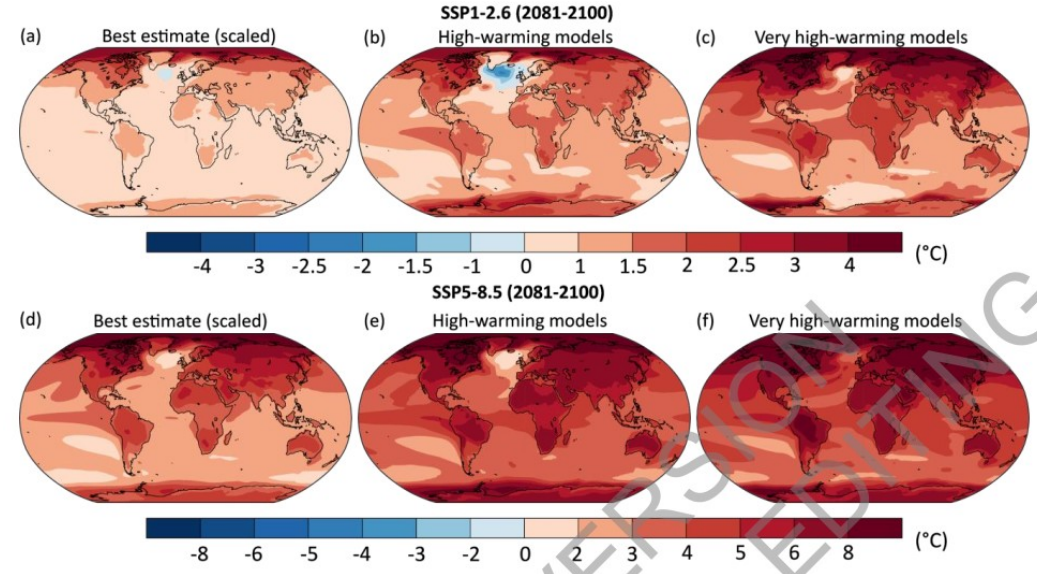
Global Warming

- Warming depends on the scenario, but **very high confidence** that the CMIP6 model ensemble reproduces observed global surface temperature trends
- It is more likely than not that under SSP1-1.9, GMT relative to 1850–1900 will remain below 1.5°C throughout the 21st century, implying a potential temporary overshoot of 1.5°C global warming



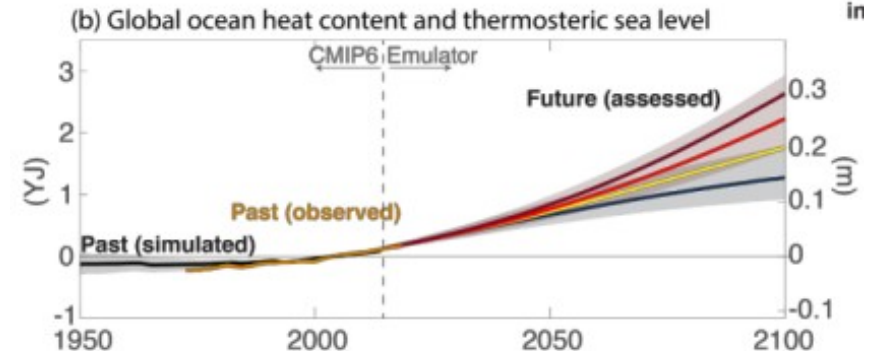
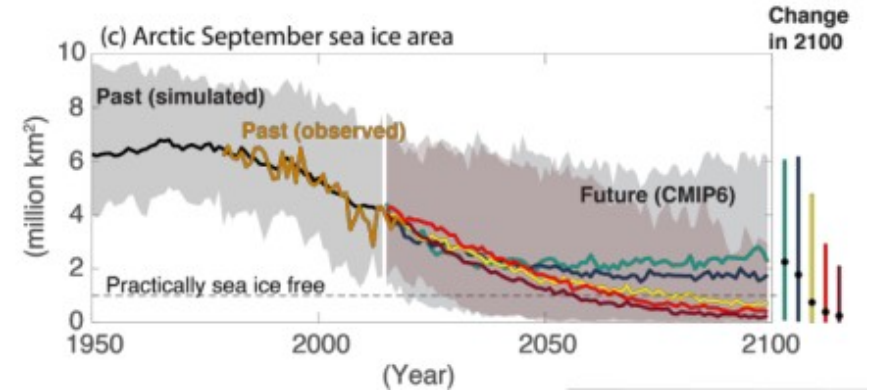
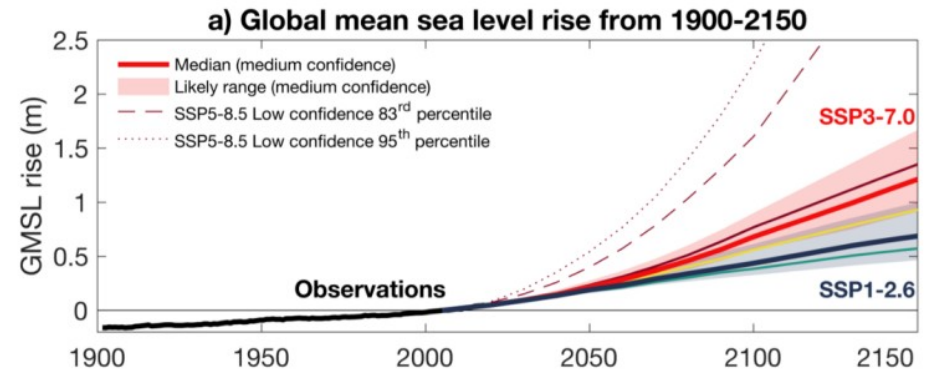
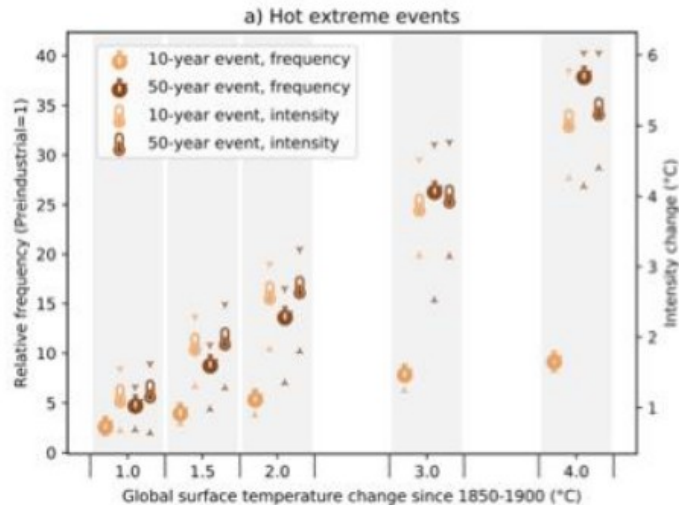
Global Warming

- Climate Models show a wide variety of warmings
- Ensemble mean does not mean a simple mean over all models, but a weighted ensemble mean to these models that do best fit in the historical runs with observation data

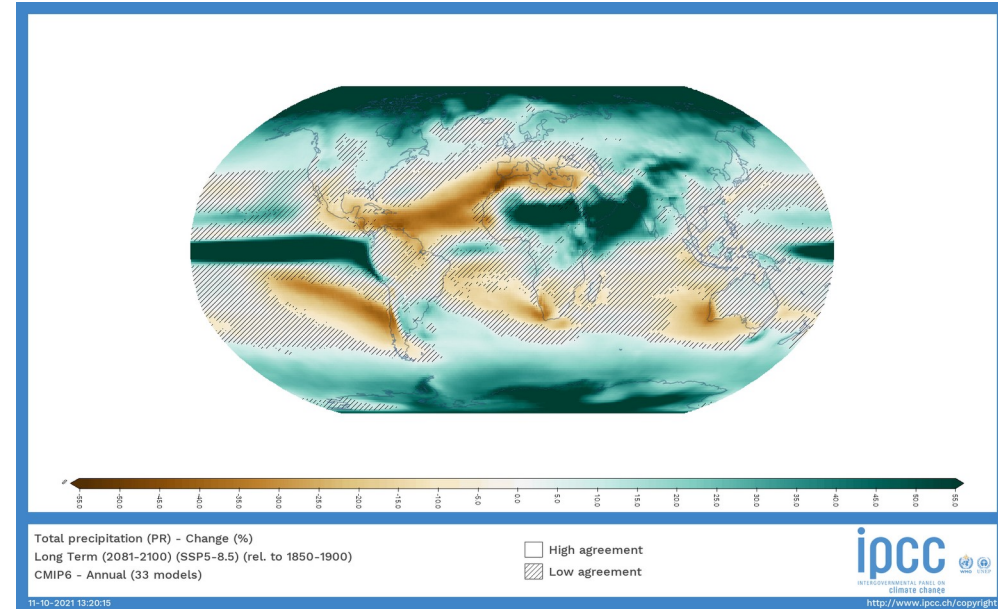
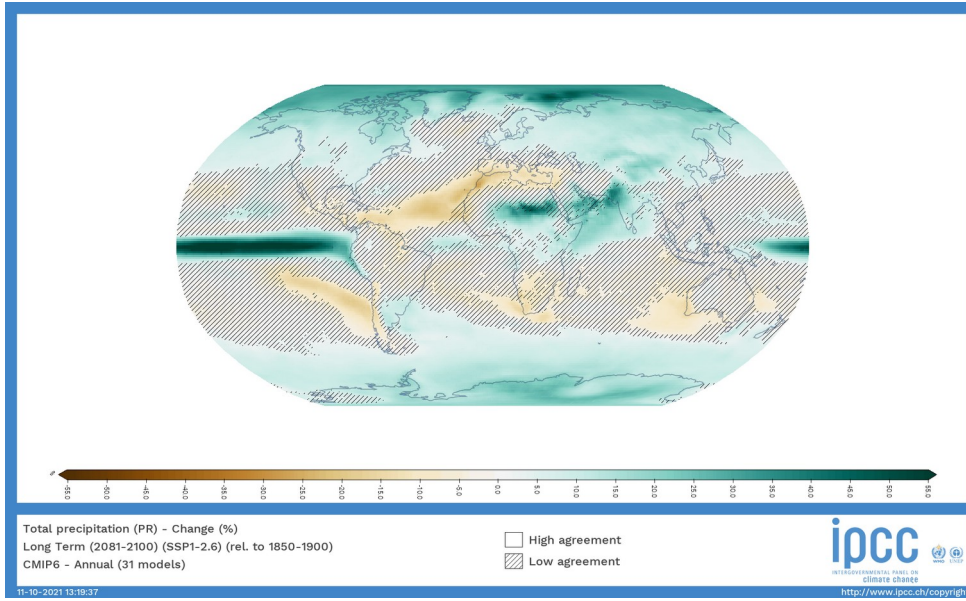


Impacts of Global Warming

- Impacts delayed by slow response of deep ocean and ice sheets, but with impacts for millennia.
- Low emission scenario show the potential to reduce the increase in ocean heat content and sea level rise but that some increase is unavoidable.

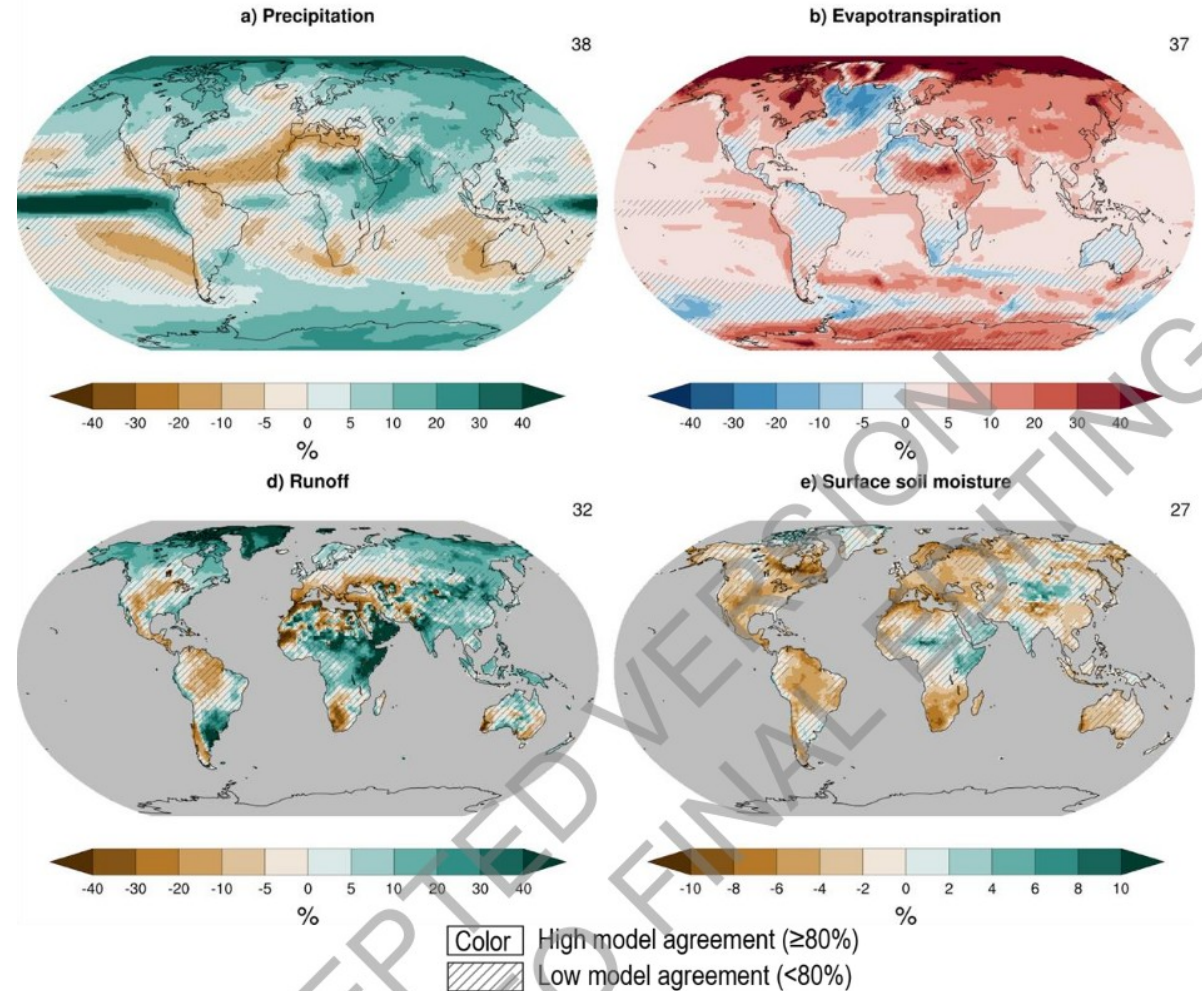


Changes in Precipitation



Changes in Precipitation

- Substantial further changes at global and regional scale
- Still: High Uncertainty in modelling changes in the hydrological cycle under future warming!
- Overall global increase in precipitation, but simple 'wet gets wetter, dry gets drier' is not true, especially in the subtropics
- Enhanced evapotranspiration will decrease soil moisture, followed by aridification

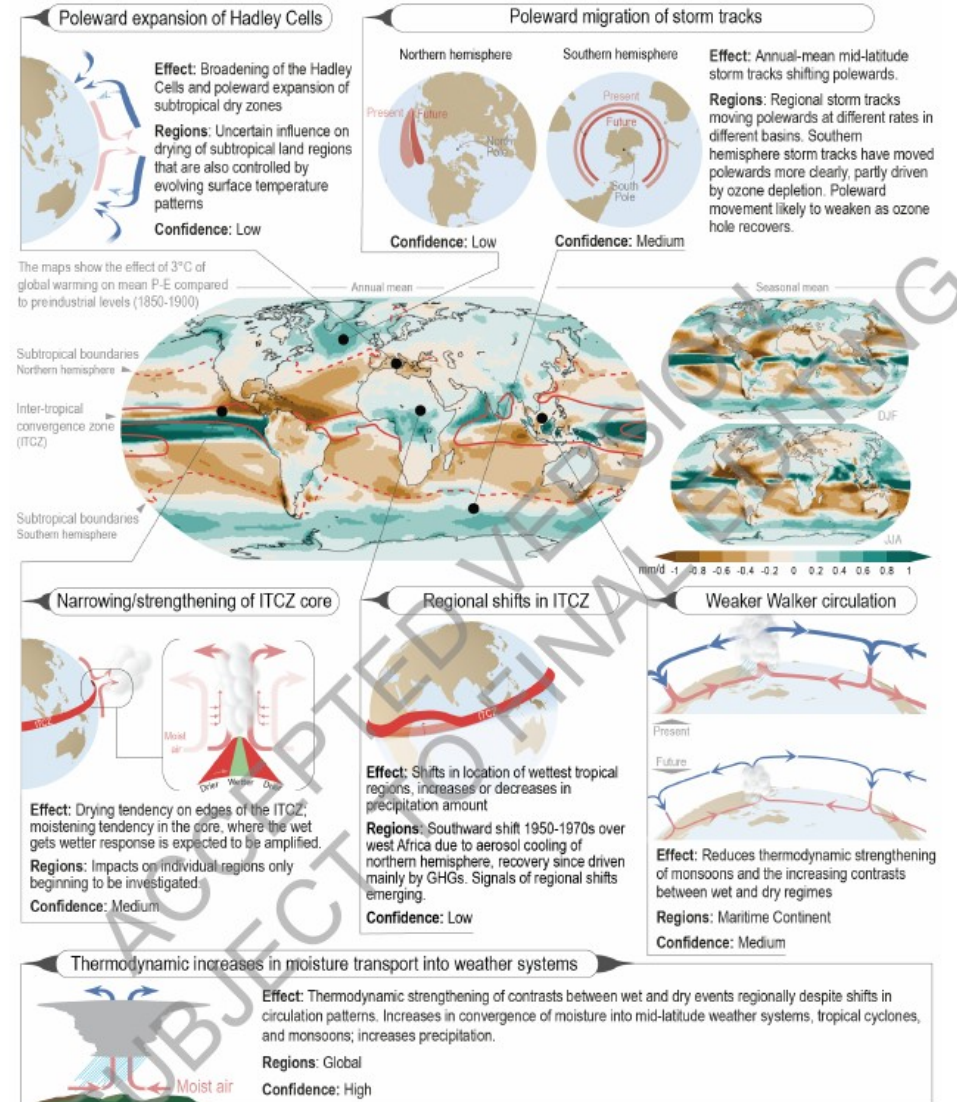


2. Global Changes

Changes in Precipitation

- Enhanced evapotranspiration will decrease soil moisture, followed by aridification
- Precipitation changes impacts global water cycle world wide

Large Scale Circulation projected changes and their effect on the water cycle



2. Global Changes

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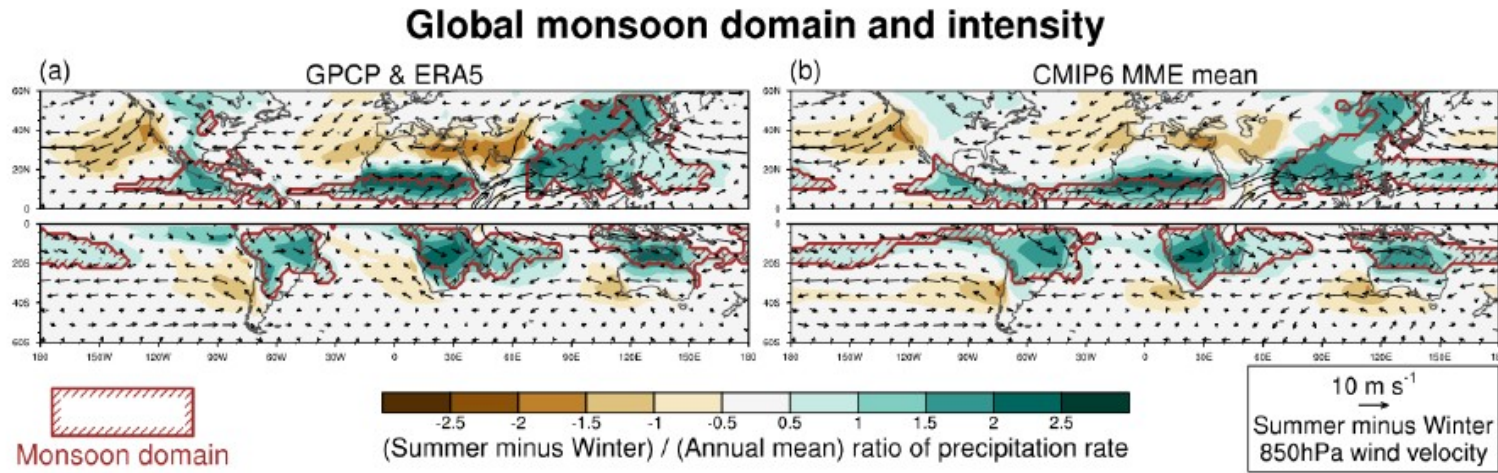
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Global Monsoon

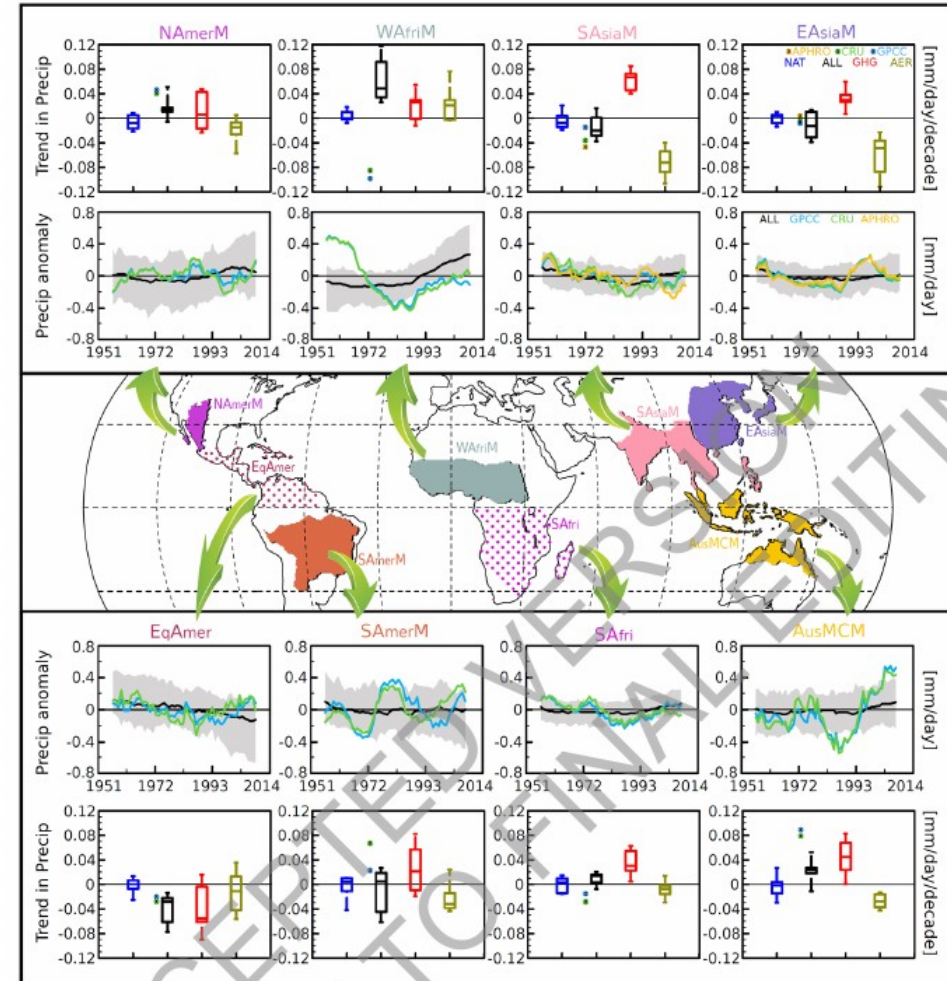
- The global monsoon (GM) is defined as the area with local summer-minus-winter precipitation rate exceeding 2.5 mm/day
- CMIP6 models simulate the global monsoon domain and precipitation better than CMIP 5
-



Global Monsoon

- The global monsoon (GM) is defined as the area with local summer-minus-winter precipitation rate exceeding 2.5 mm/day
- Regional monsoon systems react very differently on external forcing, which might help explaining model uncertainties

Trend and change in precipitation (1951-2014) over monsoon regions

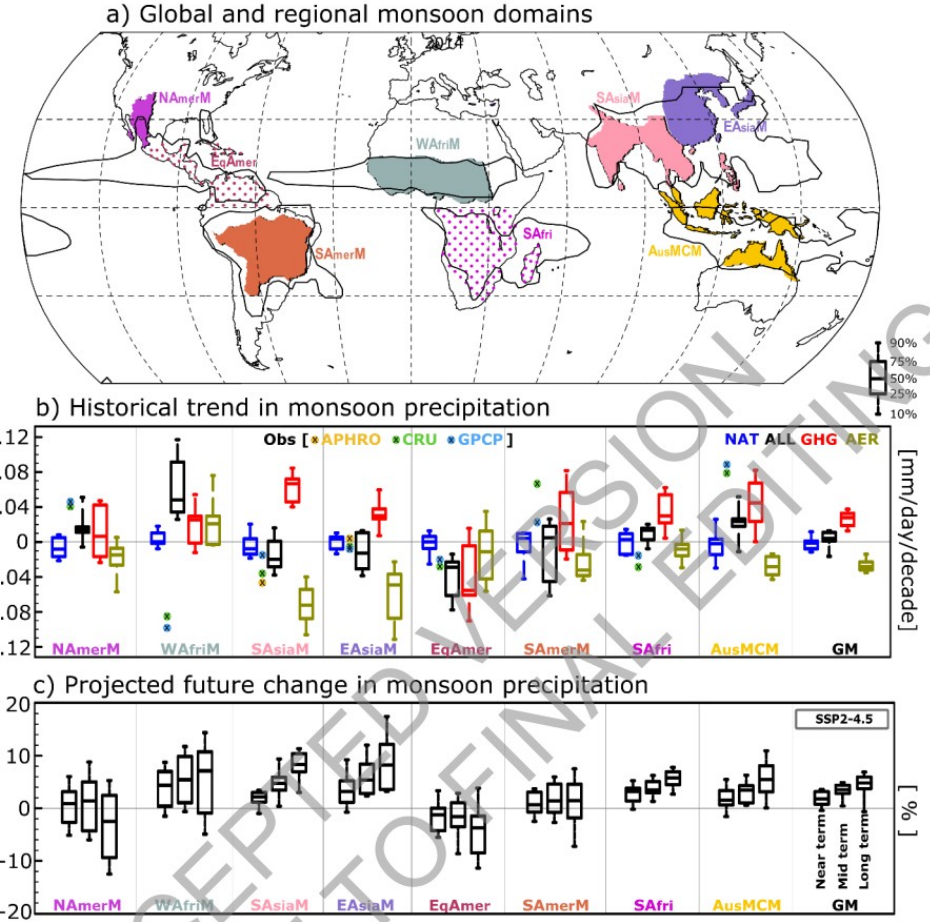


3. Monsoon



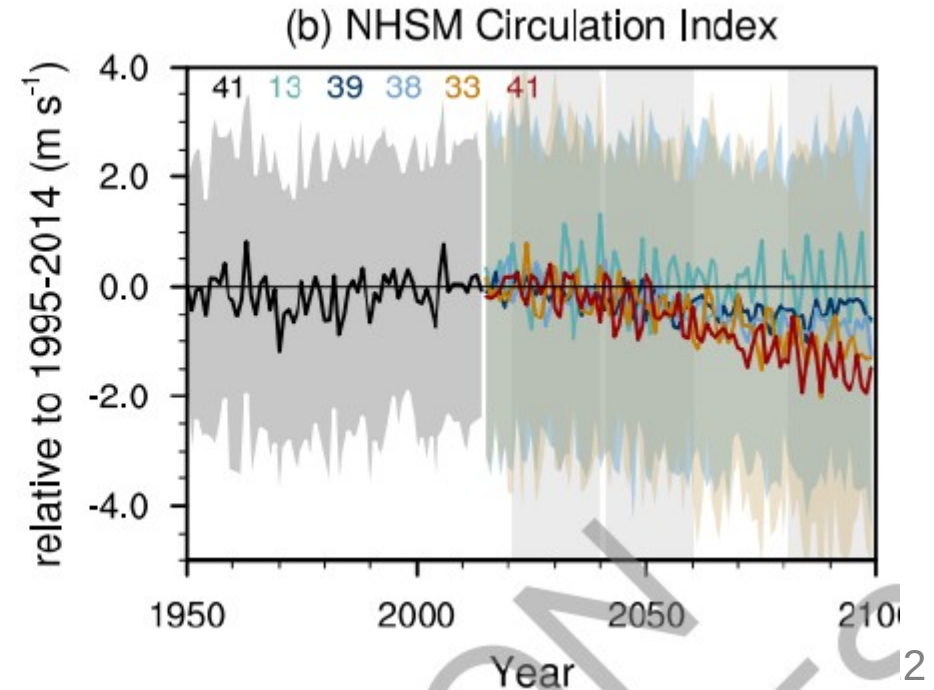
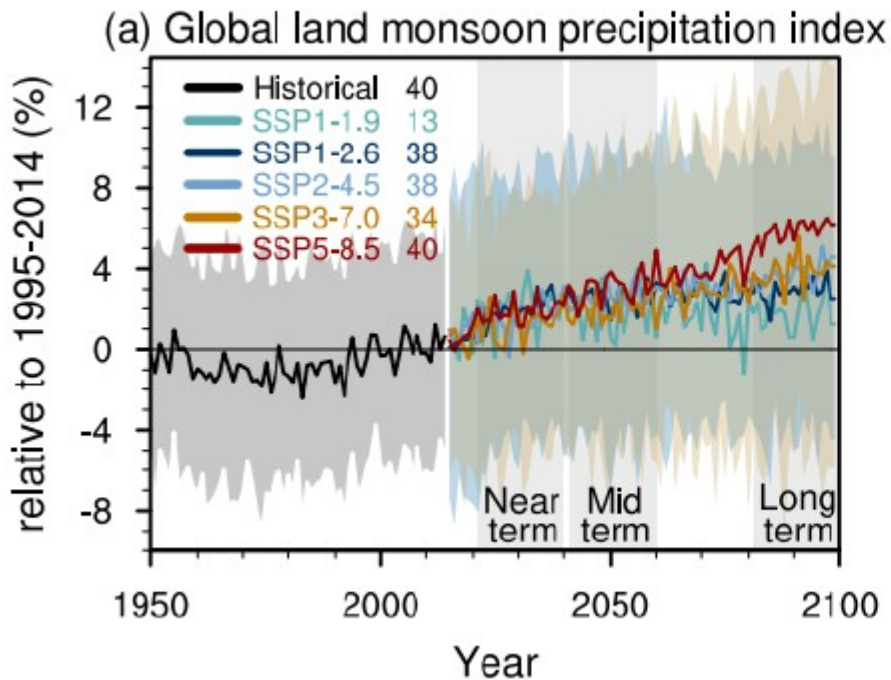
Global Monsoon Projected Changes

- Regional monsoon systems react very differently on external forcing, which might help explaining model uncertainties
- In the long term: North-South asymmetry, greater increase in NH than on SH, and similar East-West asymmetry



Global Monsoon

- Likely that GM land precipitation will increase, although monsoon circulation weakens
- But changes are small compared to inter model-spread



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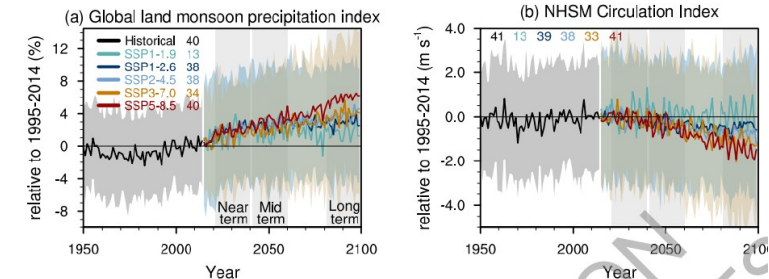
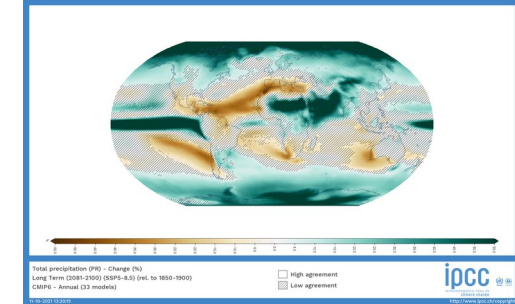
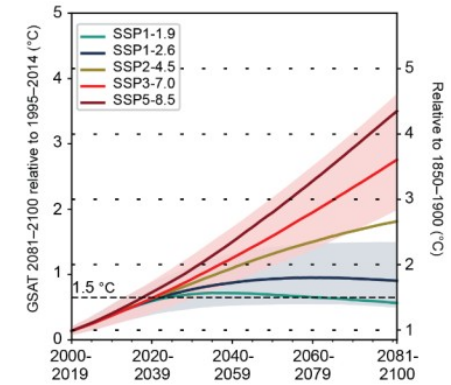
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Summary

- 1) High certainty of future warming of at least 1,5°C, even in the best case scenario.
- 2) Global precipitation is likely to increase with high regional differences and uncertainties.
- 3) Global Monsoon likely to become stronger on the NH than SH, model variability larger than projected increase.



4. Summary

Thank you for your attention!

Questions?

