Climate Impacts at 1.5° and 2° Where half a degree makes a difference

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Outline

- Context: temperature goal in the Paris Agreement
- The difference of 0.5°: impacts across sectors and regions
- Research perspectives

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Context of the long-term global temperature goal

Article 2 (a) of the Paris Agreement:

"*Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels,* ***recognizing that this would significantly reduce the risks and impacts of climate change***"

Context of the long-term global temperature goal

- **1996:** 2°C was first established in established on EU level based on IPCC Second Assessment Report
- **2005:** 2°C Reaffirmed by EU Environment council based on Third Assessment report
- **2009:** Adoption by G8 and inclusion in the Copenhagen accord – establishment of SED to review adequacy of temperature goal
- **2010:** "holding below 2°C" included in Cancun outcome (Para 4, 1/CP.16)

Since 2009: The most vulnerable countries including Small island developing states and Least Developed Countries have called for a 1.5°C limit

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Review of the below 2°C goal and the Structured Expert Dialogue (SED) under the UNFCCC

- Periodic review of its adequacy was agreed as part of the inclusion of the hold below 2°C goal in 2010
- A scientific structured expert dialogue was established (2013-2015 Review)

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Key Outcomes:

- The view that a warming of 2°C can be considered safe "***is inadequate***".
- *"Limiting global warming to below **1.5°C would come with several advantages** in terms of coming closer to a safer 'guardrail'"*
- *"The **science on the 1.5 °C warming limit is less robust** than for the 2°C warming limit or warming beyond this limit."*

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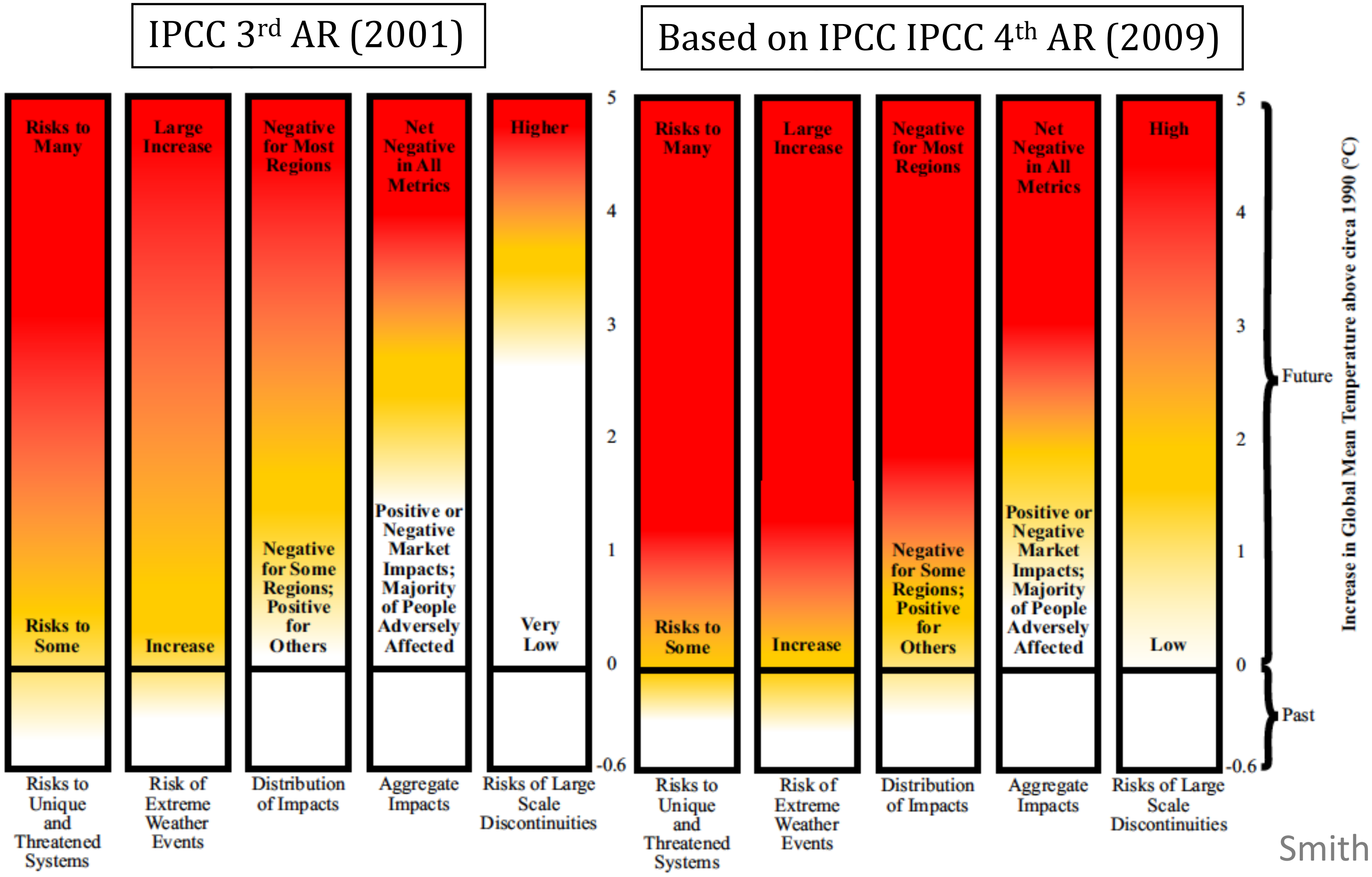
The scientific basis – IPCC's Reasons for Concern



Smith et al. (2009)

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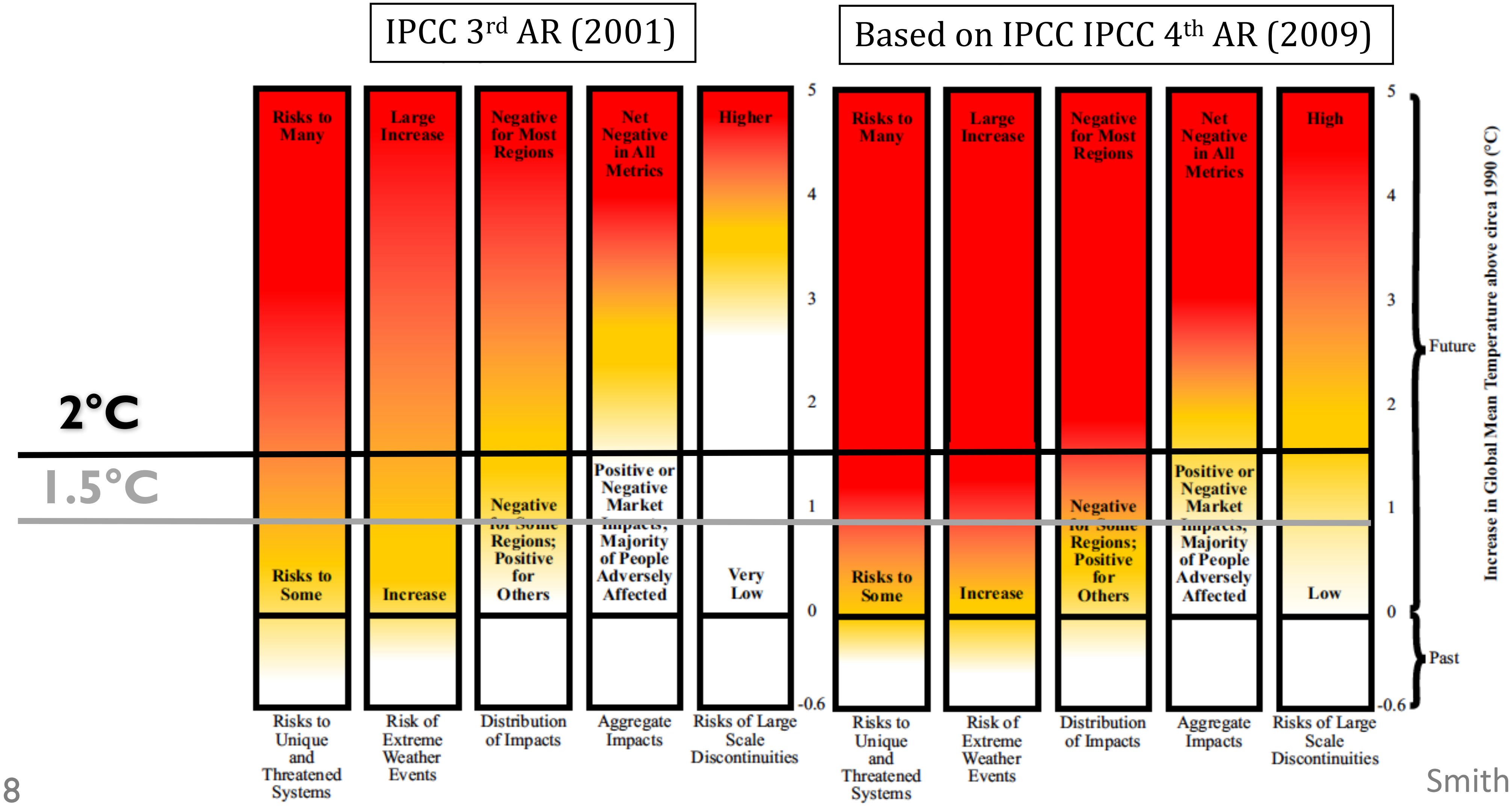
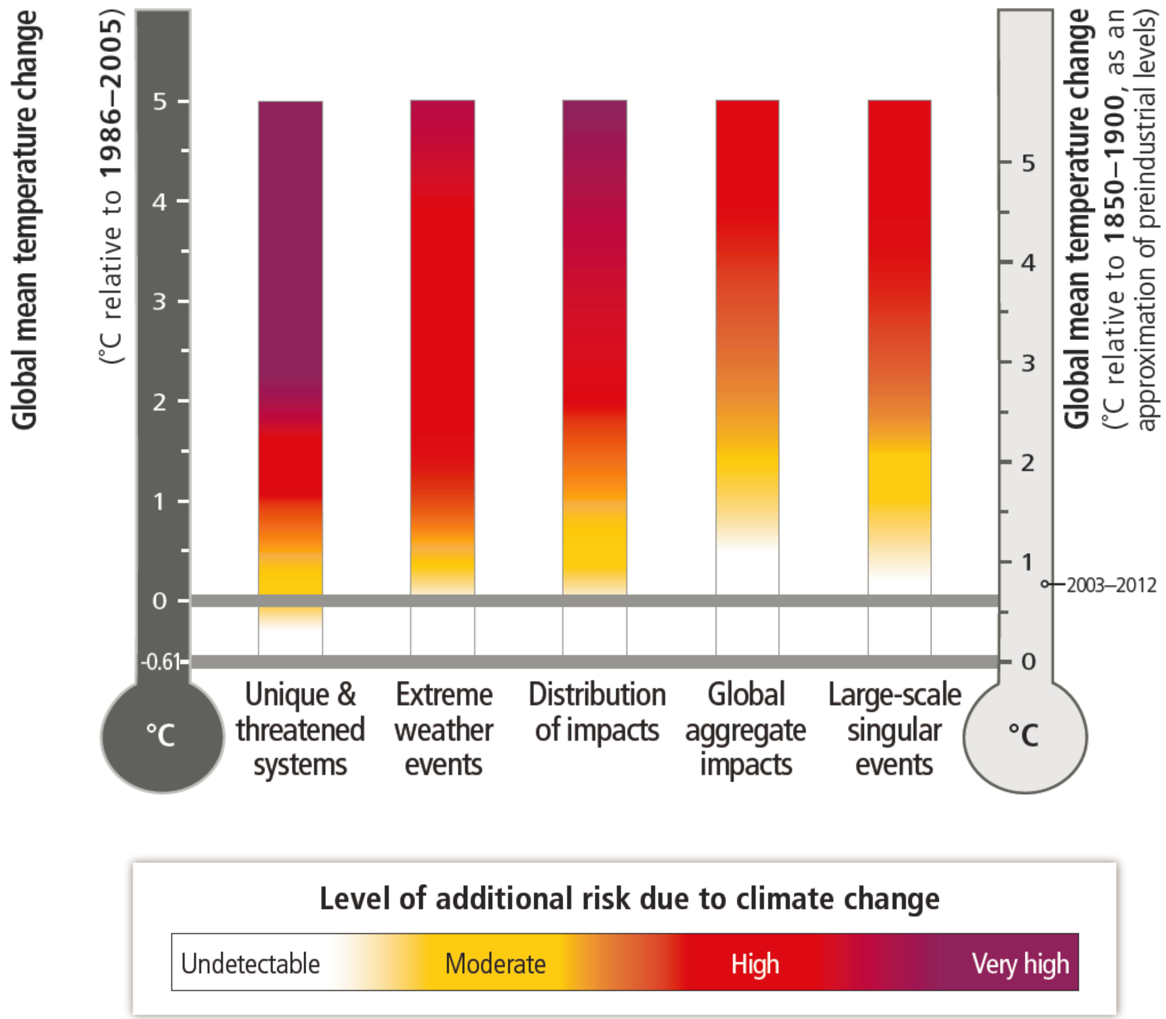


Smith et al. (2009)

The scientific basis in the 5th Assessment Report



IPCC AR5 WG2 SPM

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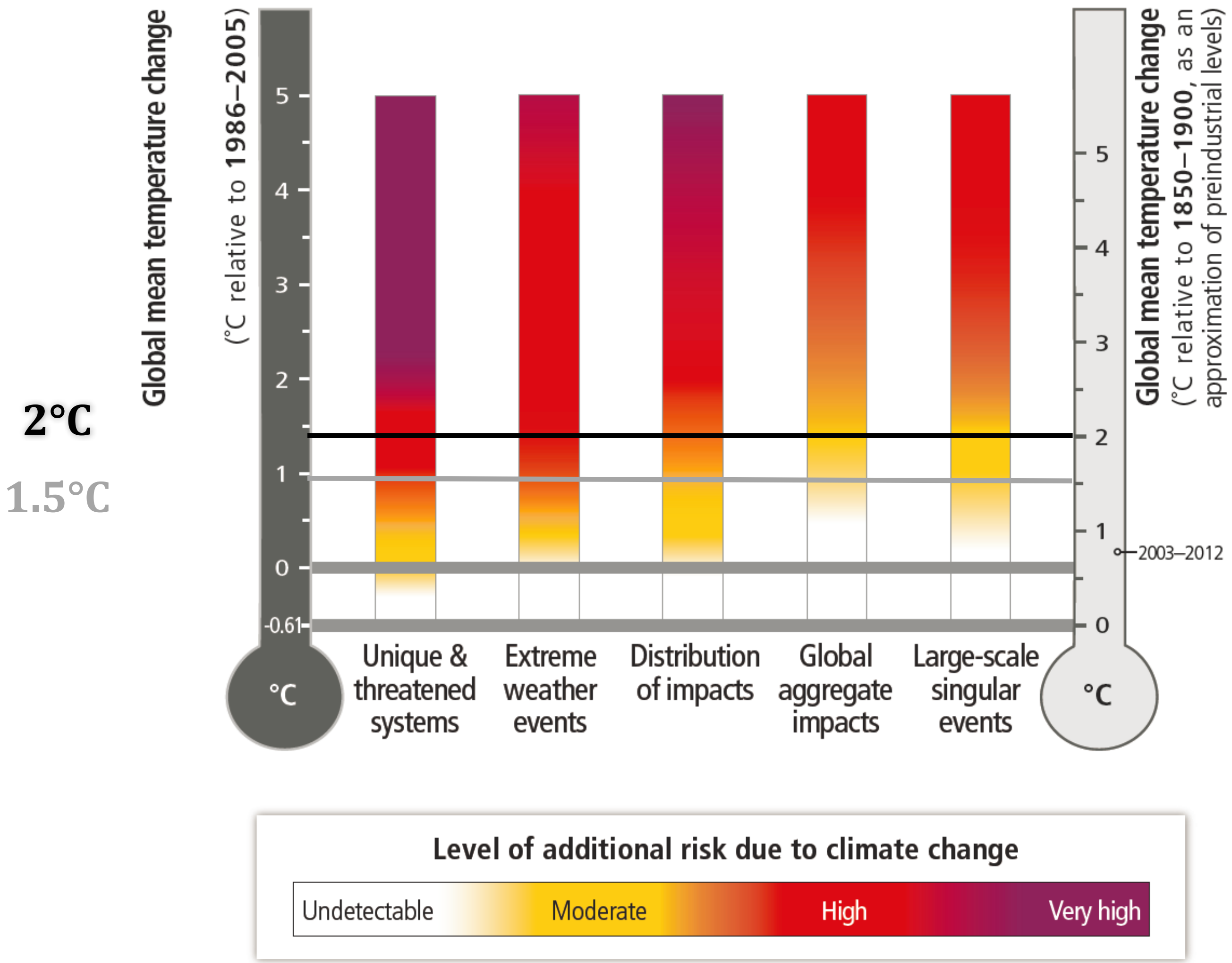

IPCC AR5 WG2 SPM

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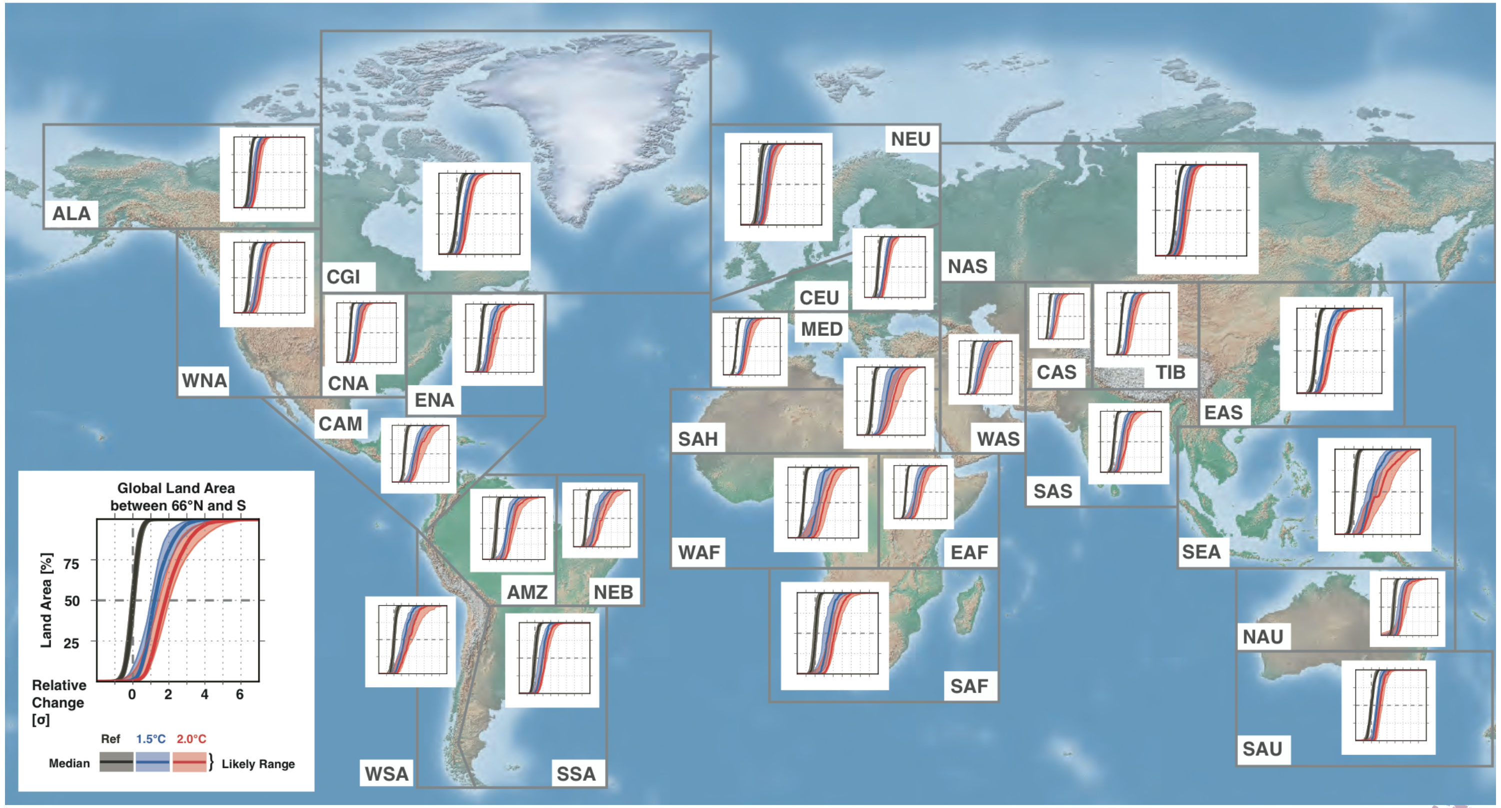
Recent science on climate impacts at 1.5°C and 2°C

- Recent study for the first time analyses the differences in impacts the world would face at 1.5°C and 2°C in a comprehensive and comparable way.
- Analysis of 11 relevant biophysical impacts, highlighting key differences both globally and in hot-spot regions.



Schleussner, Lissner et al.: Differential climate impacts for policy-relevant limits to global warming: the case of 1.5°C and 2 °C Earth Syst. Dynam., 7, 1–25, 2016 doi:10.5194/esd-7-1-2016

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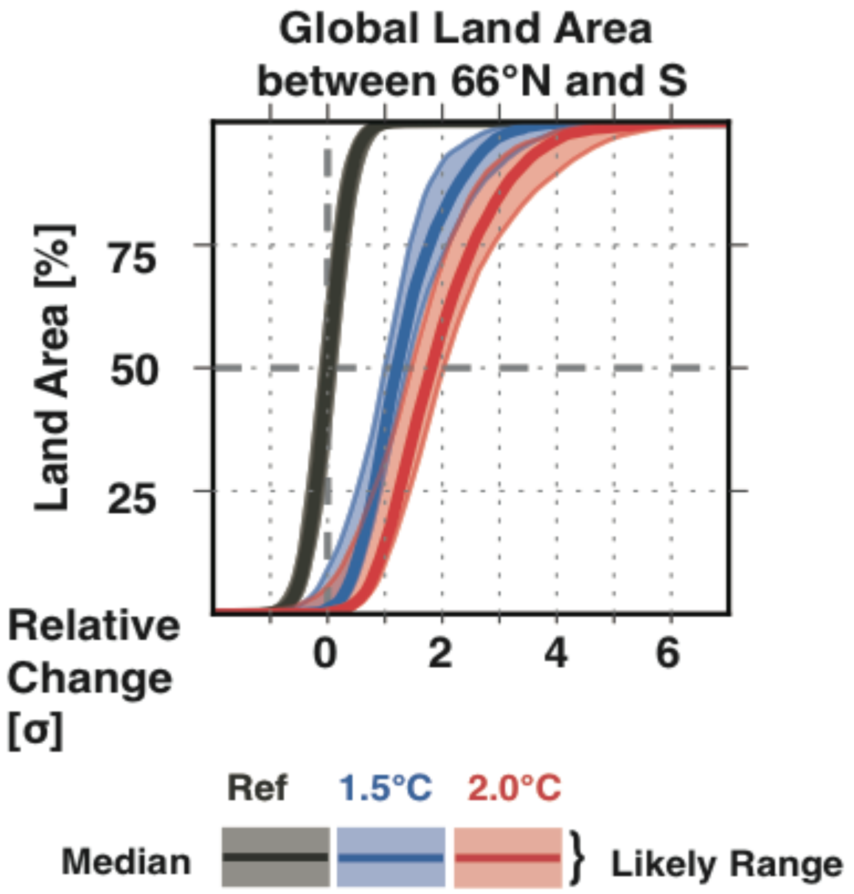
Methodological background

- Assessment of impacts for global land-mass (between 66° N and S) as well as for 26 world regions
- Based on model inter-comparison data (CMIP5 and ISI-MIP)
- 20-year time slices centered around respective warming level for each model separately
- Regional cumulative density functions for each ensemble member: allows assessing changes over smaller areas within a region



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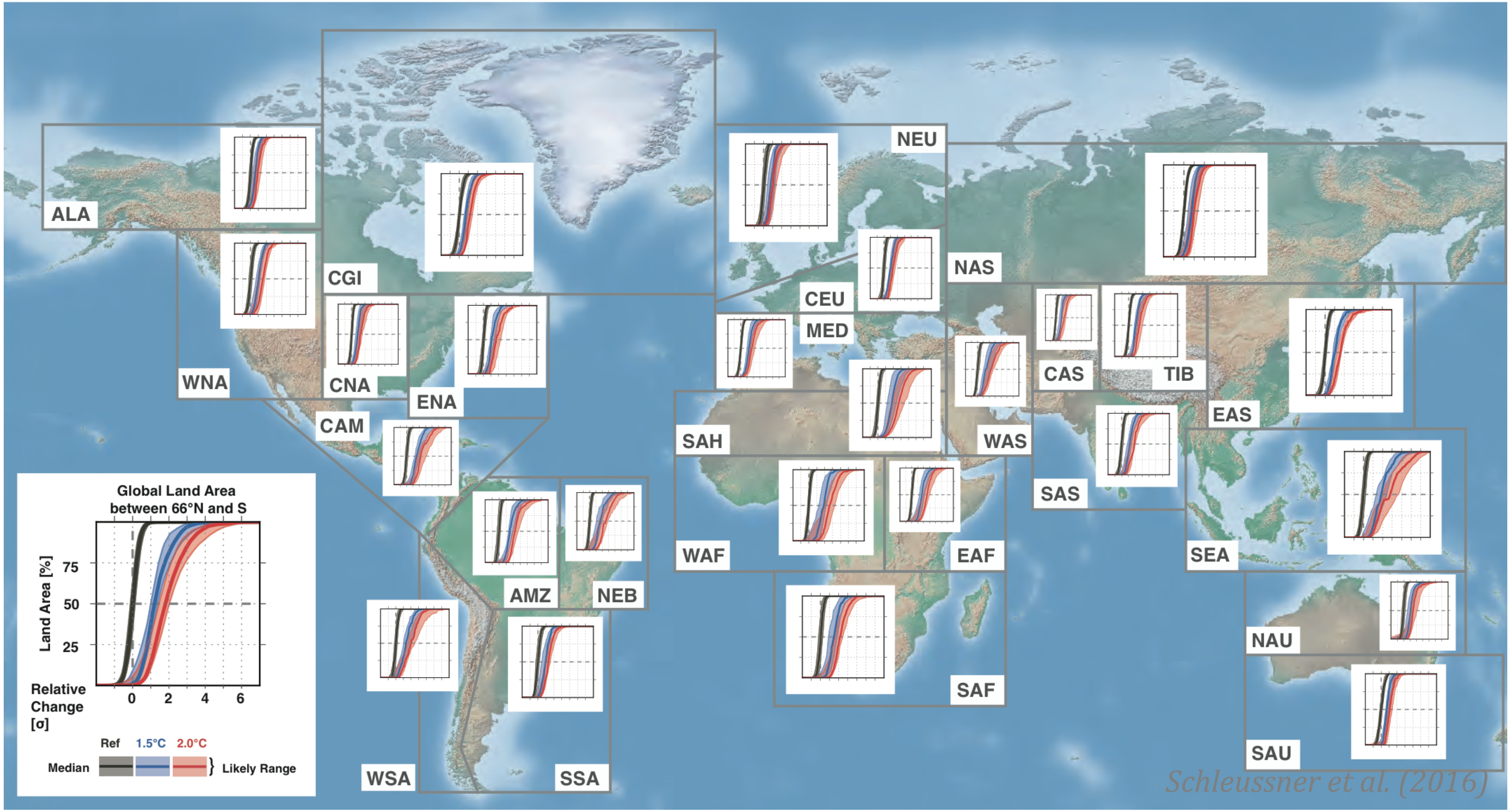
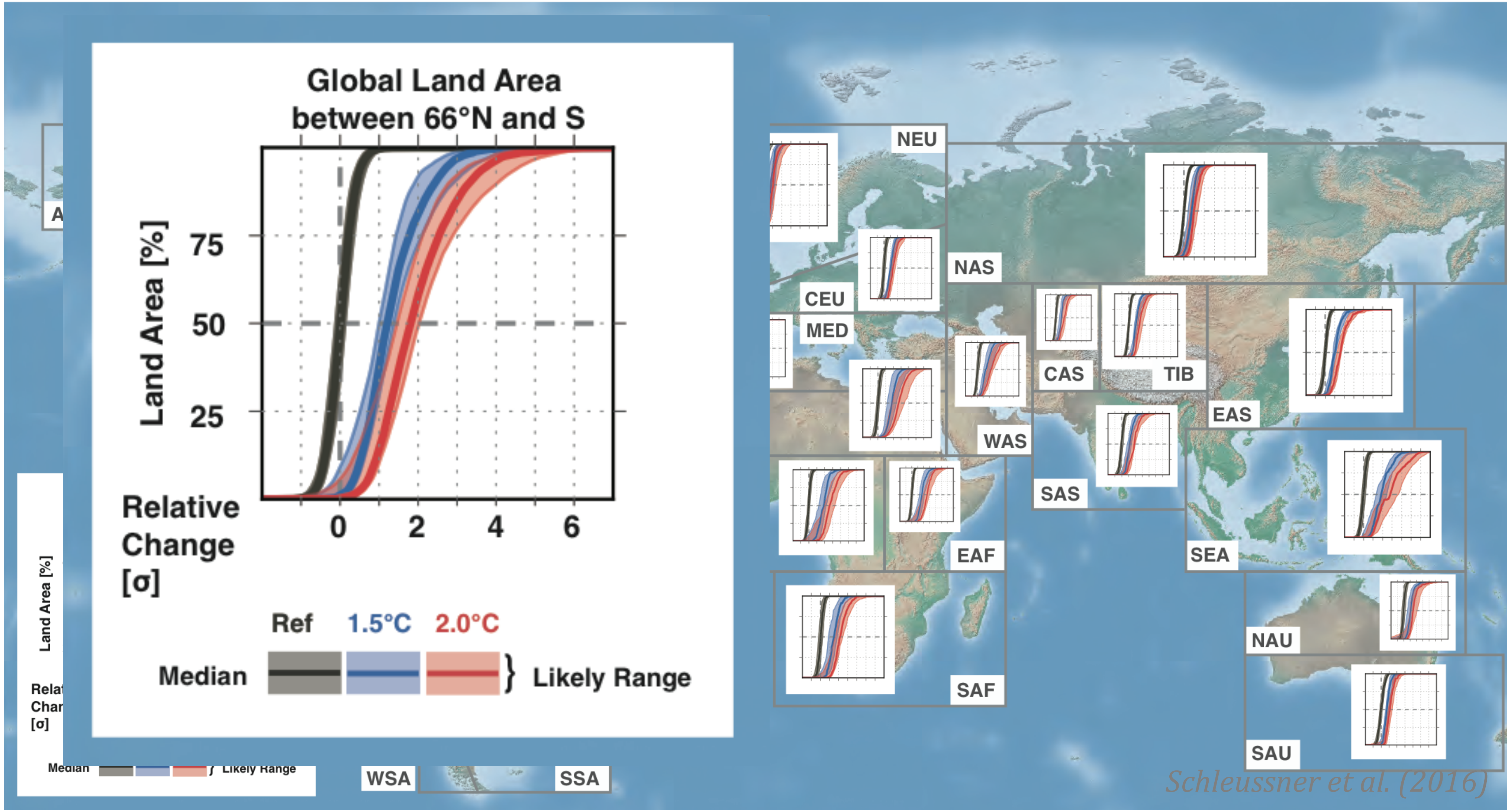
Temperature Extremes



Schleussner et al. (2016)

Temperature Extremes



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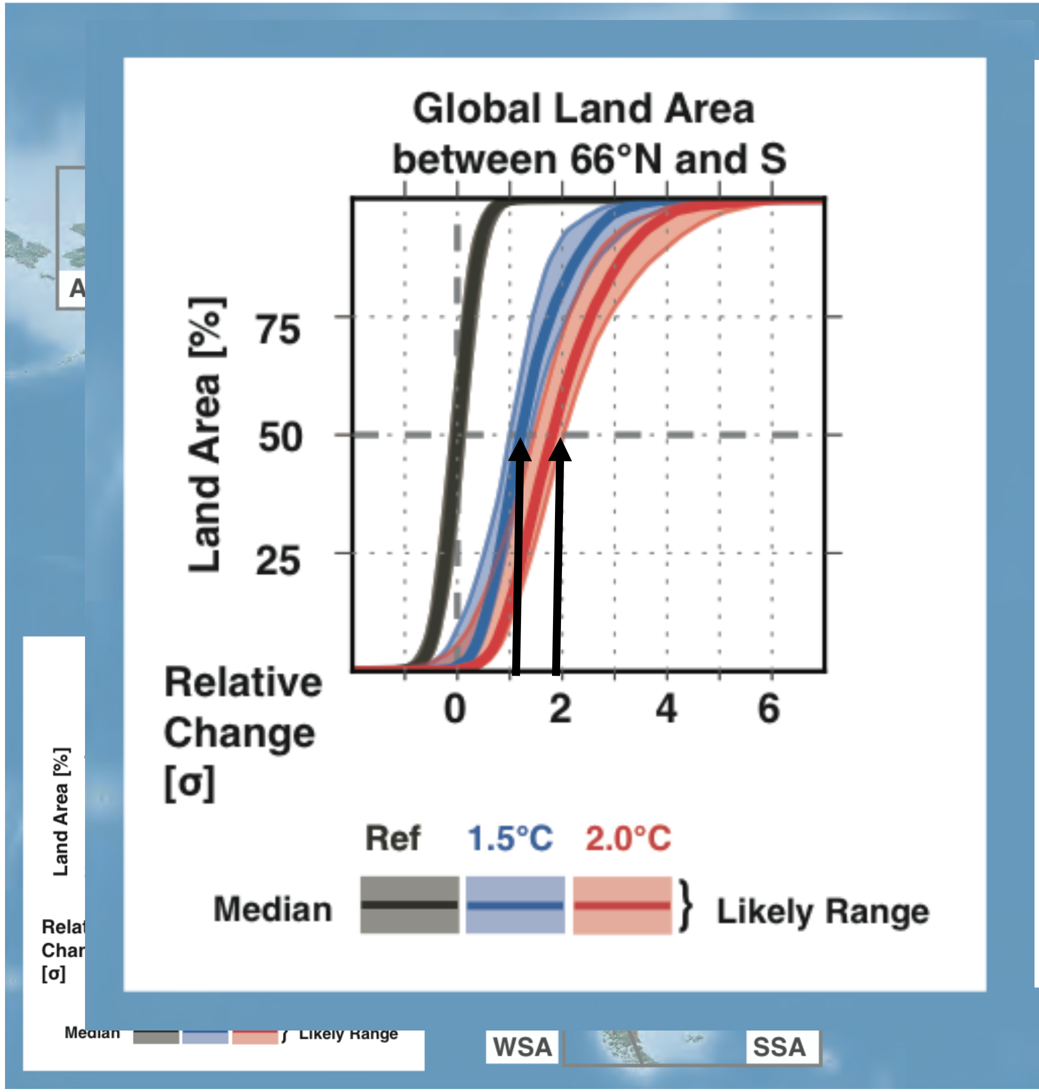
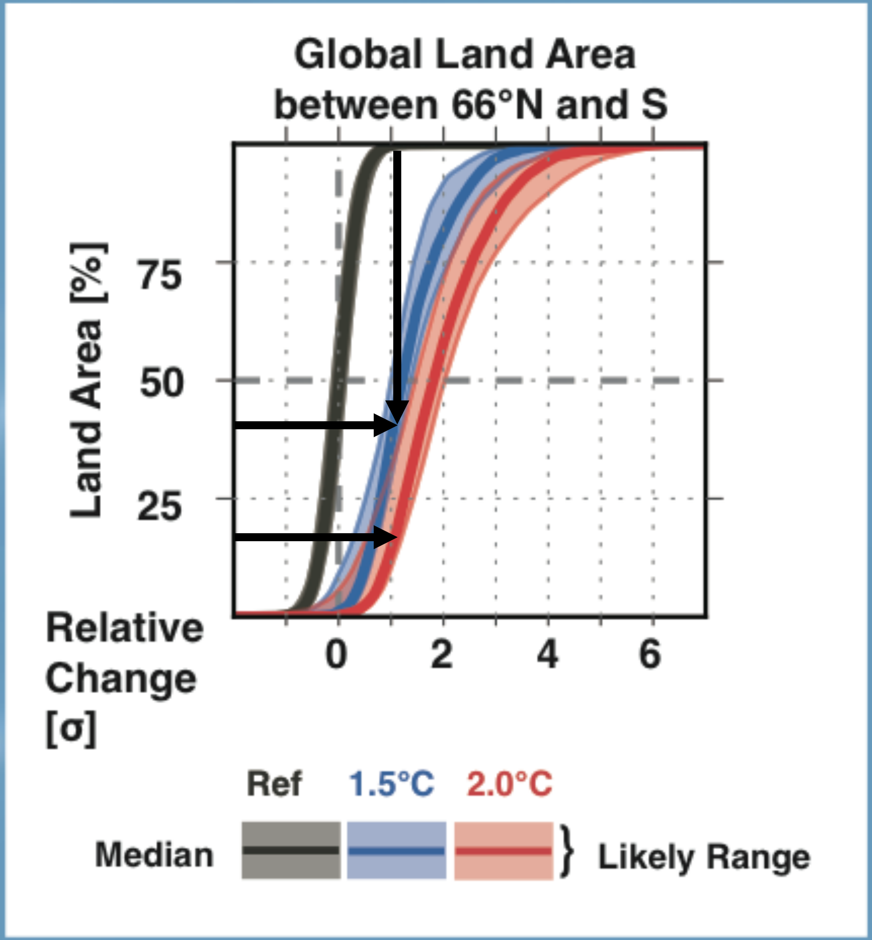


- At 2°C, (1.5°) 50% of the global land-mass experience a significant shift in heat extremes of 1.8 Std (1.2 Std)

Schleussner et al. (2016)

Temperature Extremes

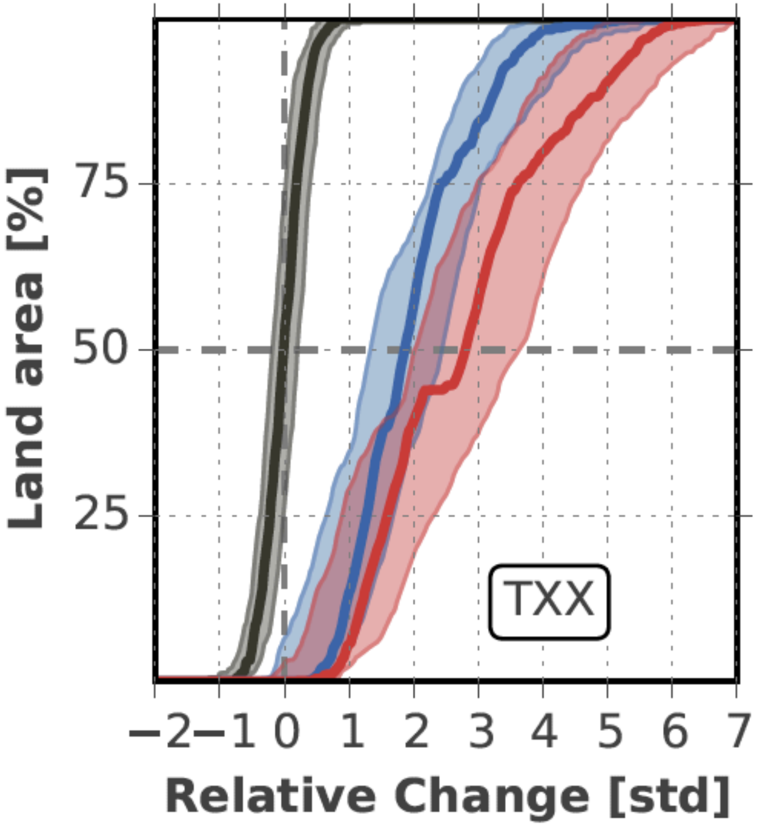


- At 2°C, (1.5°) 50% of the global land-mass experience a significant shift in heat extremes of 1.8 Std (1.2 Std)
- For 80% (60%) of the global land mass, former 'unusual events' become the new normal

Schleussner et al. (2016)

Temperature Extremes in Tropical Regions

Regional changes: South East Asia



- Most extreme increases for the tropics
- For South East Asia, '3-Sigma events' become the 'new normal' at 2°C

Schleussner et al. (2016)

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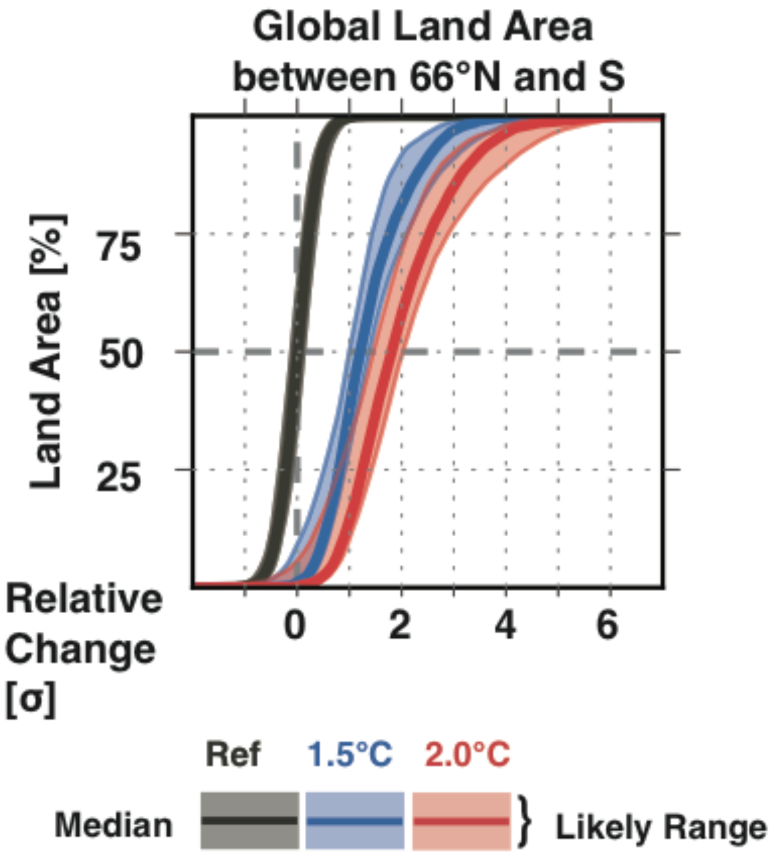
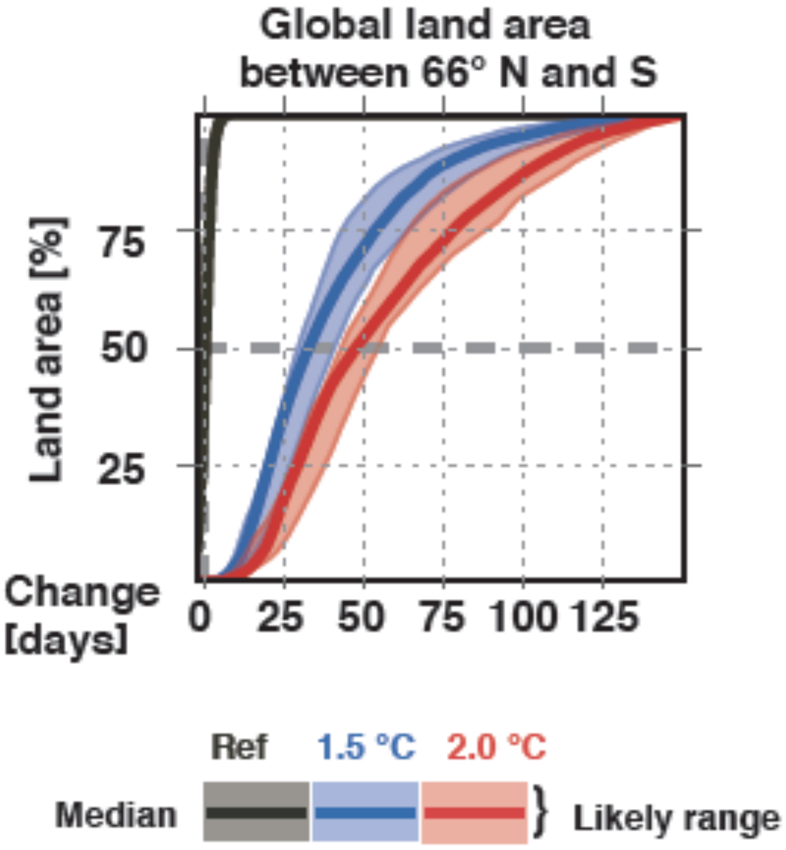
Temperature Extremes and Heat Waves

Intensity of hot extremes (annual maximum temp)



Duration of hot extremes (number of days)



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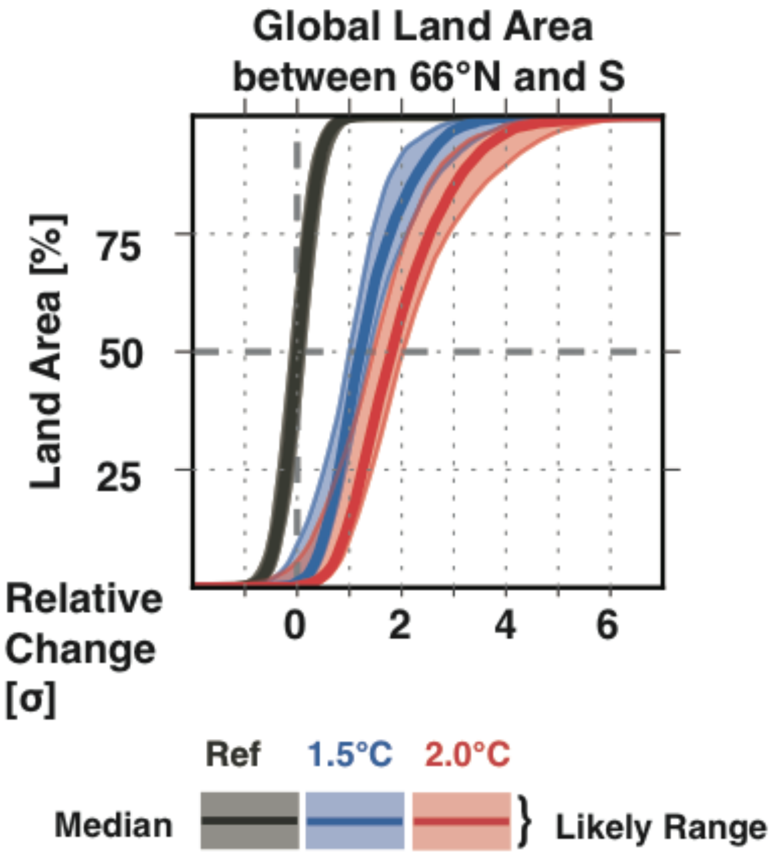

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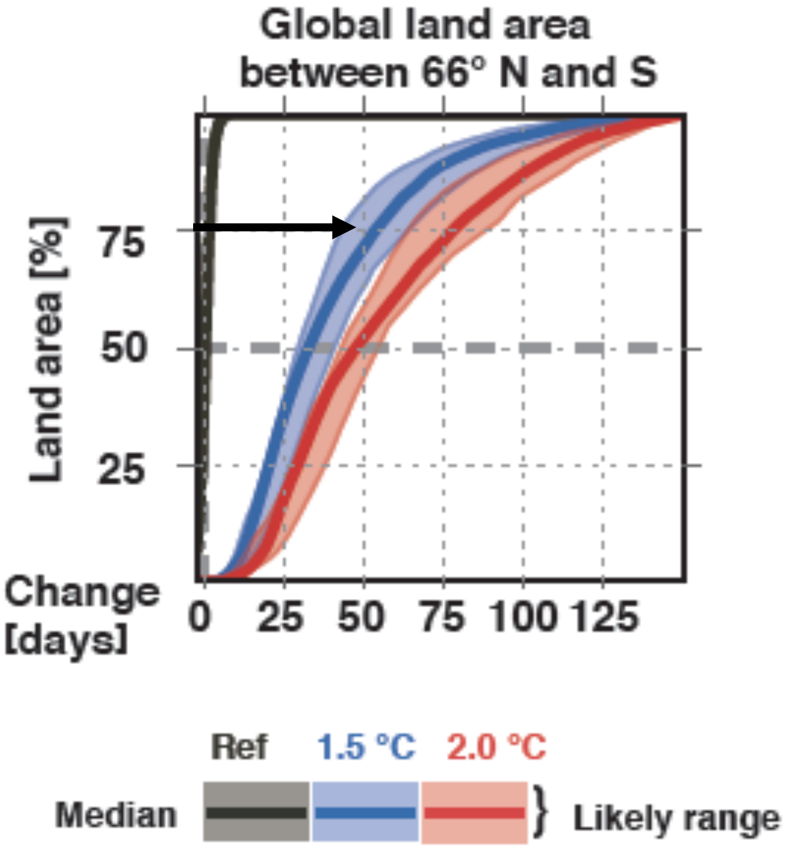

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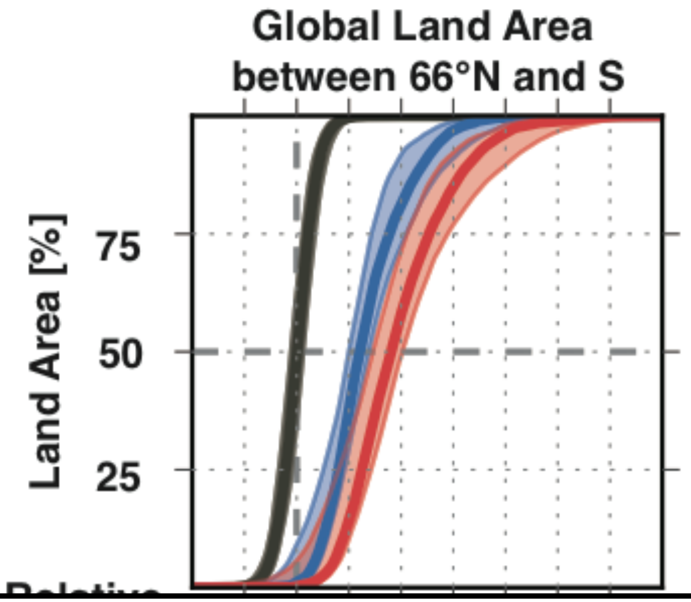

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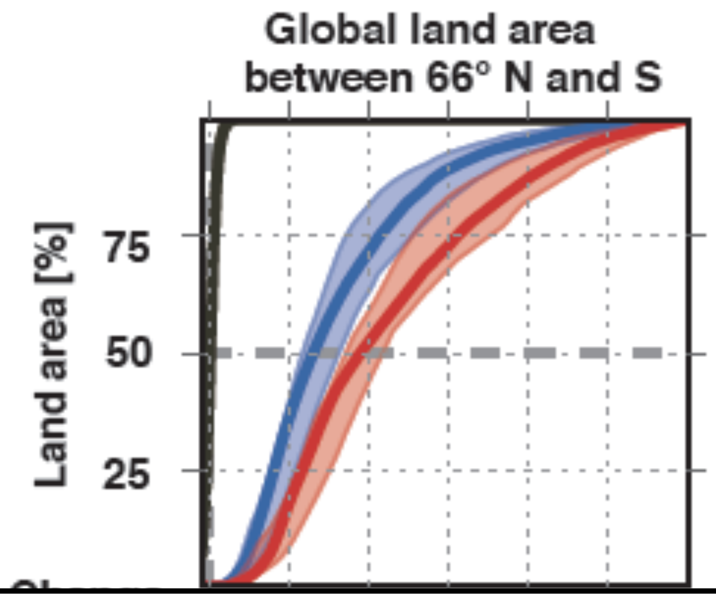
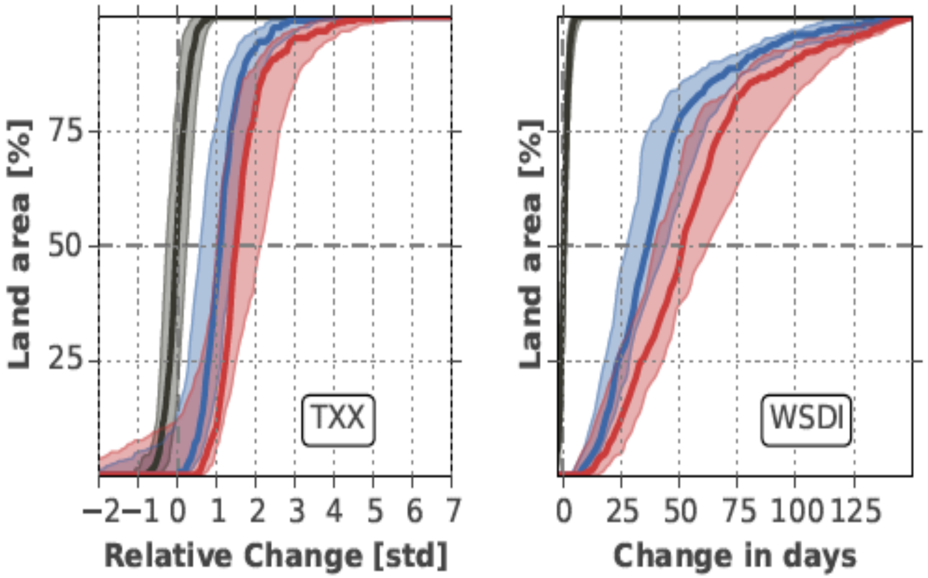


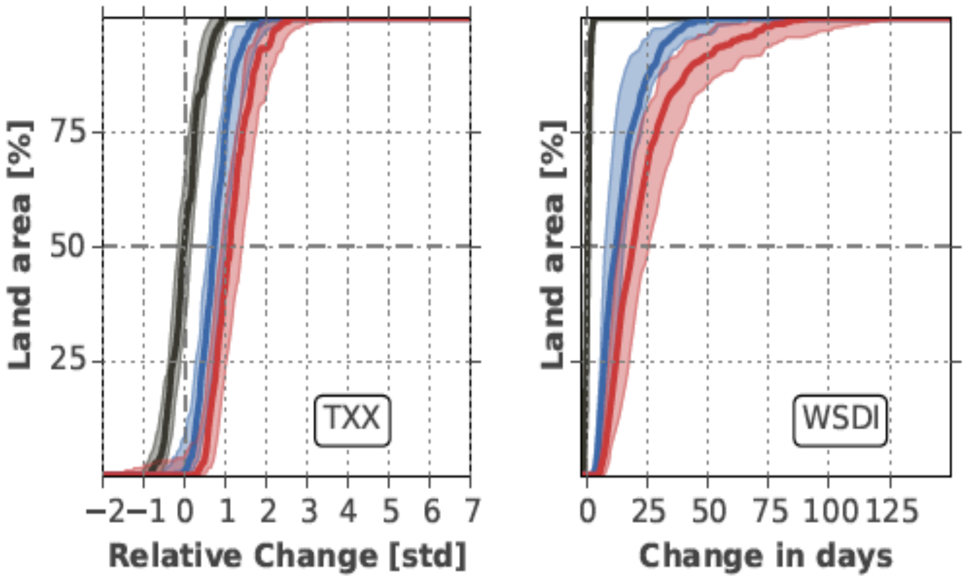
General increase in heat wave duration globally with strong increases over 25% of the global land-mass:
heat-wave duration increases of over 80 (50) days at 2°C (1.5°)

Temperature extremes over Asutralia

Northern Australia



Southern/Central Australia



Schleussner et al. (2016)

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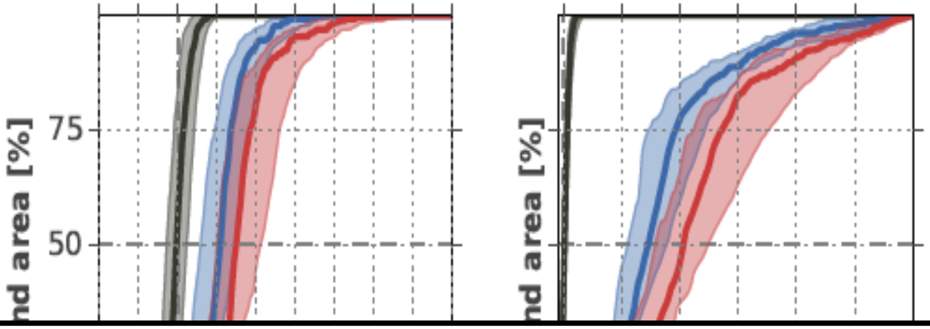
Temperature extremes over Australia

Northern Australia



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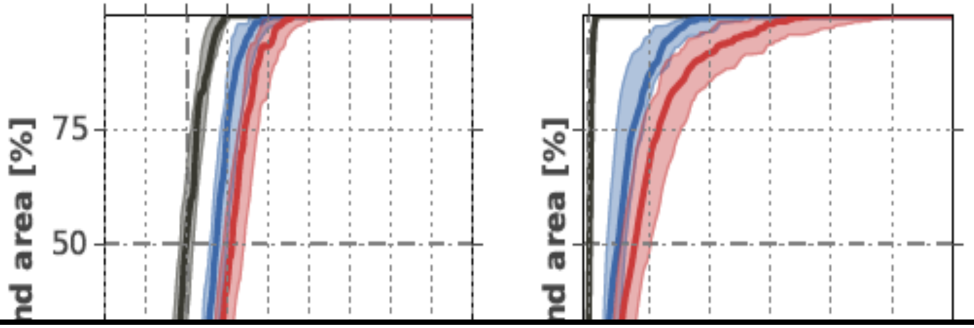

At 2°C (1.5°):

- **Extreme temperatures to exceed 3°C (2°)** above recent past (1986-2005)
- Increase in annual mean length of **warm spells** around 20 (15) days in South/Central Australia and **up to 60 (30-40) days in northern Australia**

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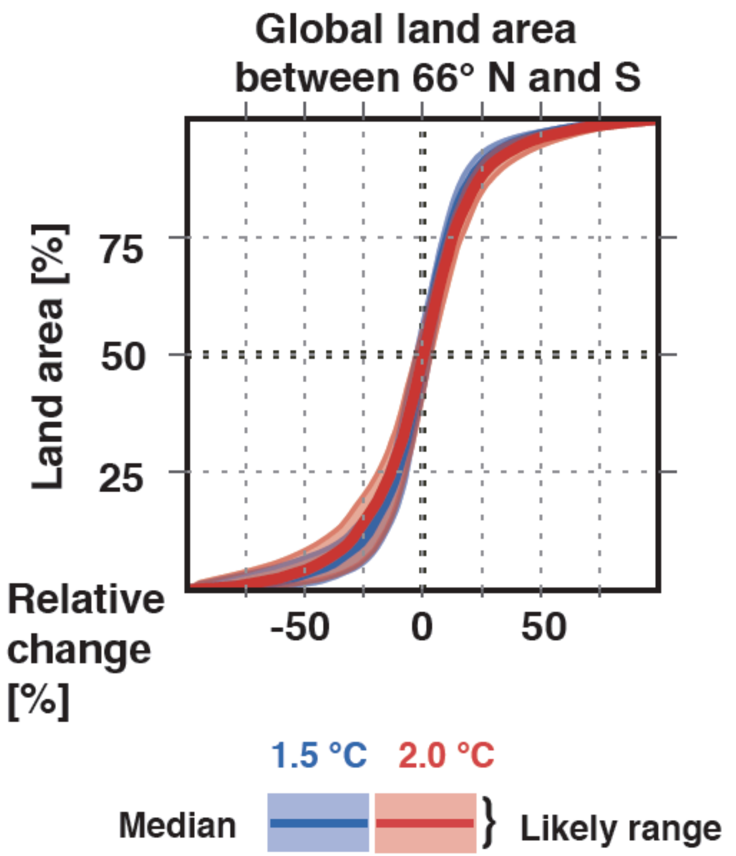
Water availability and precipitation

Annual water availability



- More uncertain than temperature-based impacts: regional hot-spots rather than global signal
- Globally, no significant trends, but regional changes
- Dry regions getting dryer, wet regions getting wetter
- E.g. Mediterranean: 9% reduction at 1.5°C, 17% at 2°C

Schleussner et al. (2016)

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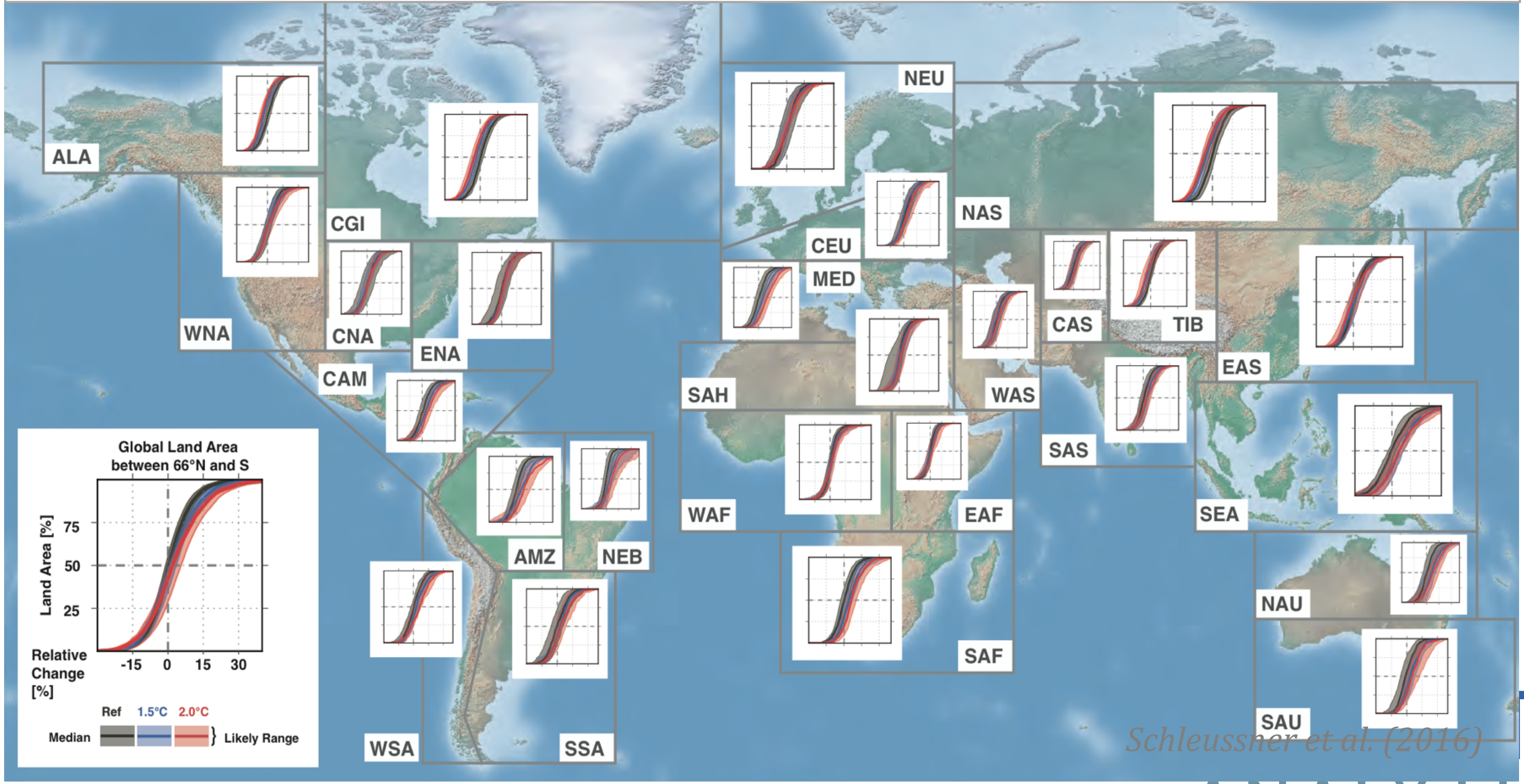
Regional Hot-Spots of Change: Drying

Change in Consecutive Dry Days (CDD) relative to 1986-2005



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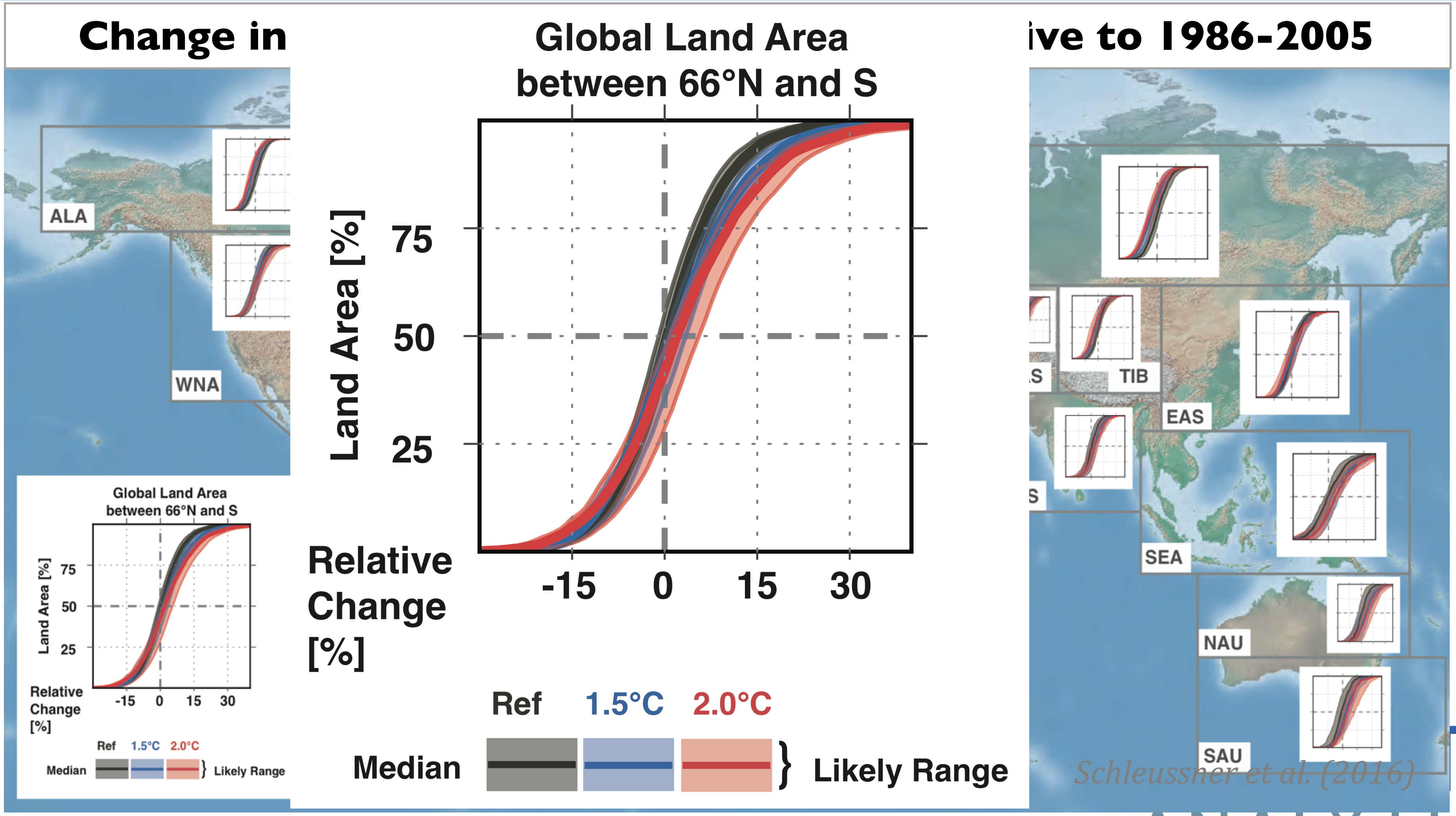

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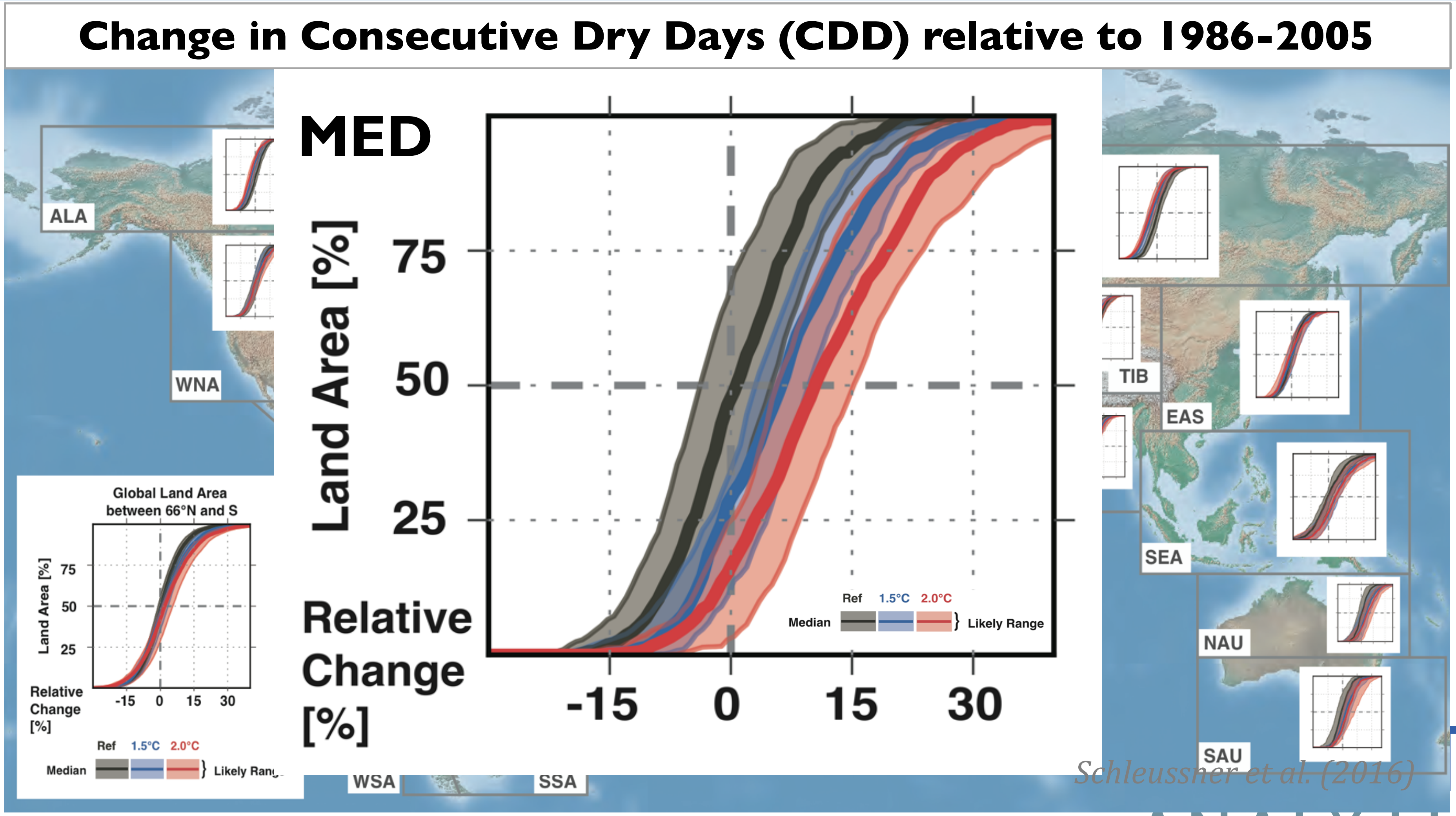

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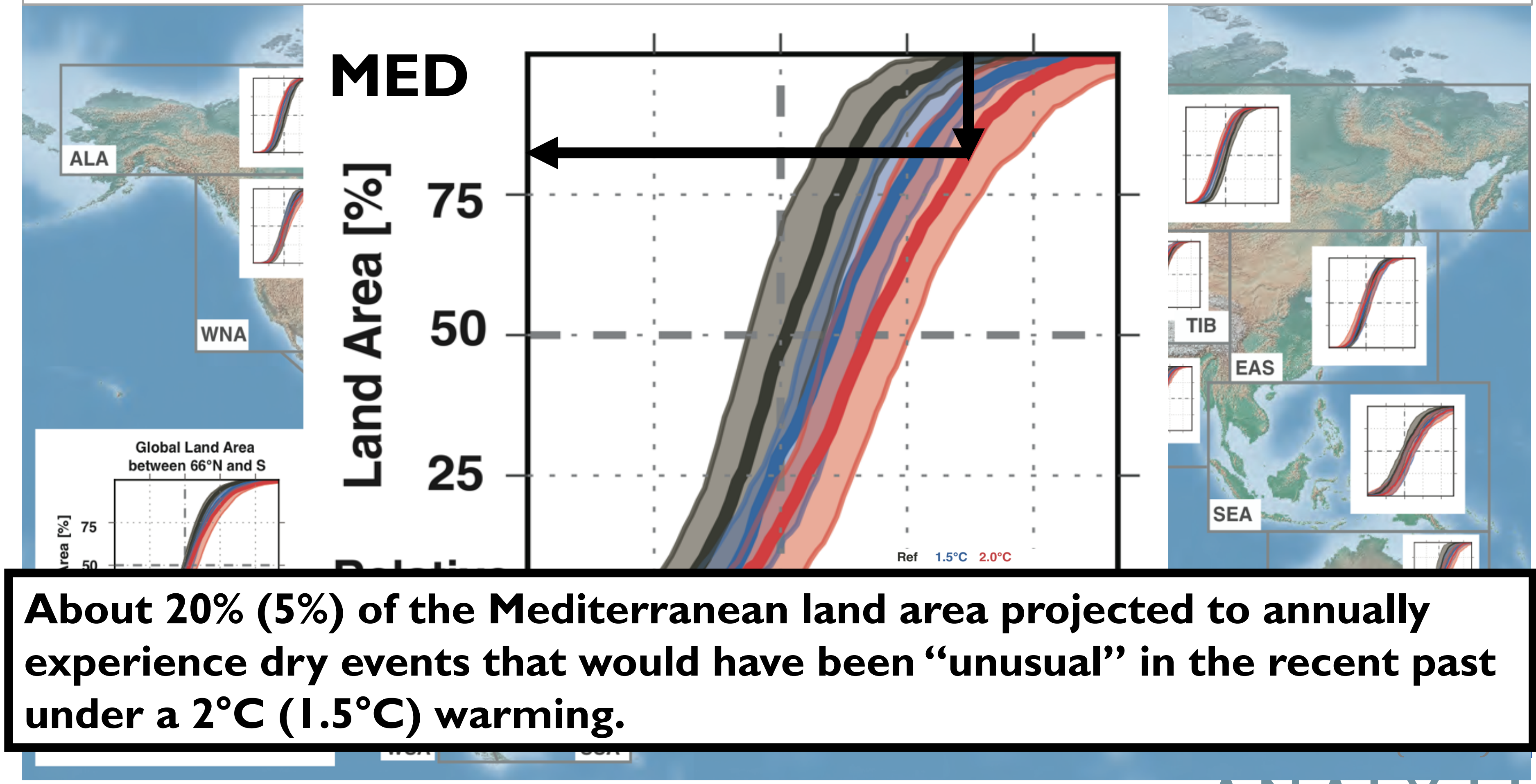
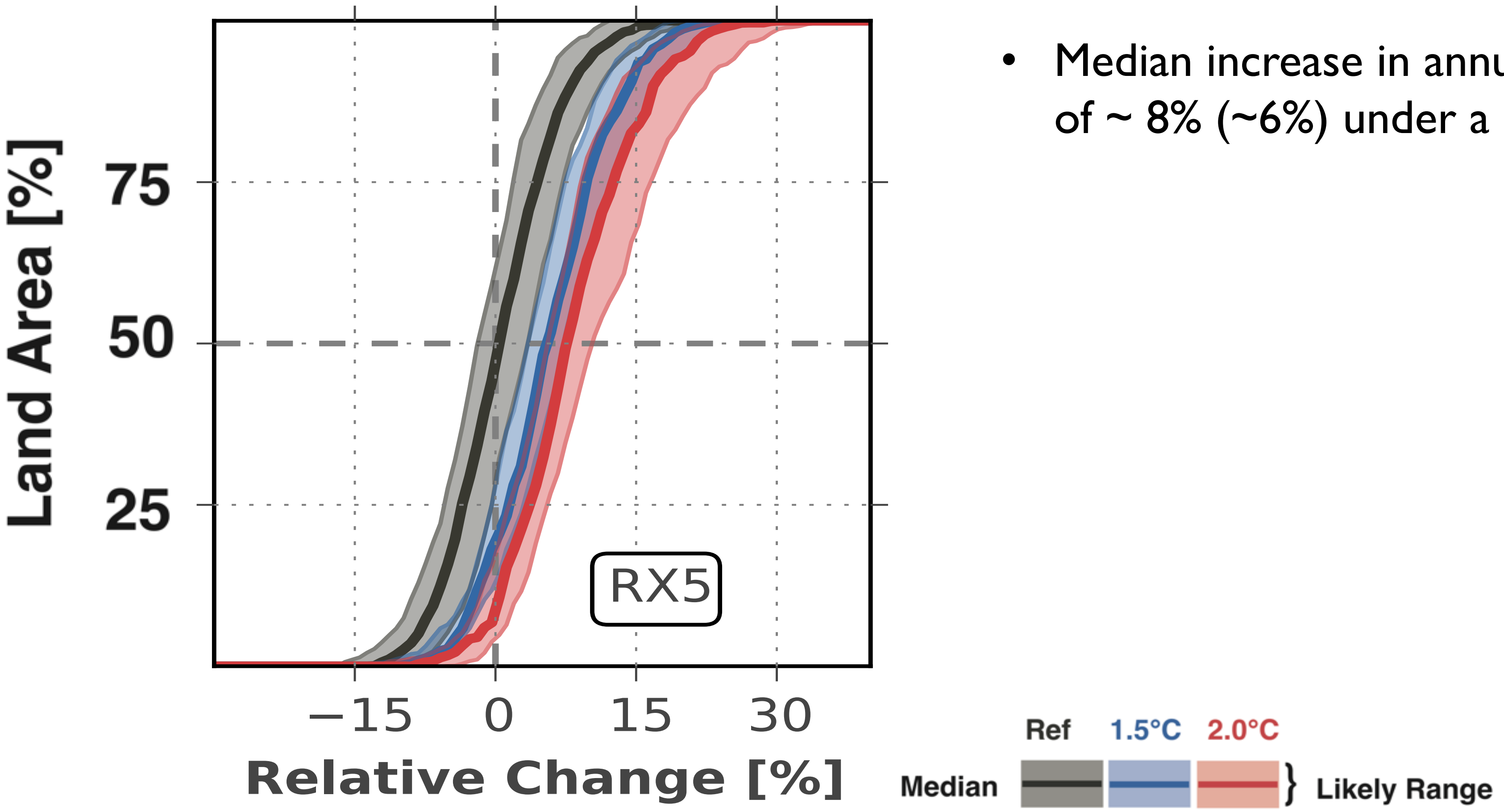


About 20% (5%) of the Mediterranean land area projected to annually experience dry events that would have been "unusual" in the recent past under a 2°C (1.5°C) warming.

Extreme precipitation over Northern Europe



- Median increase in annual maximum 5 days precipitation of ~ 8% (~6%) under a 2°C (1.5°C) warming

Schleussner et al. (2016)

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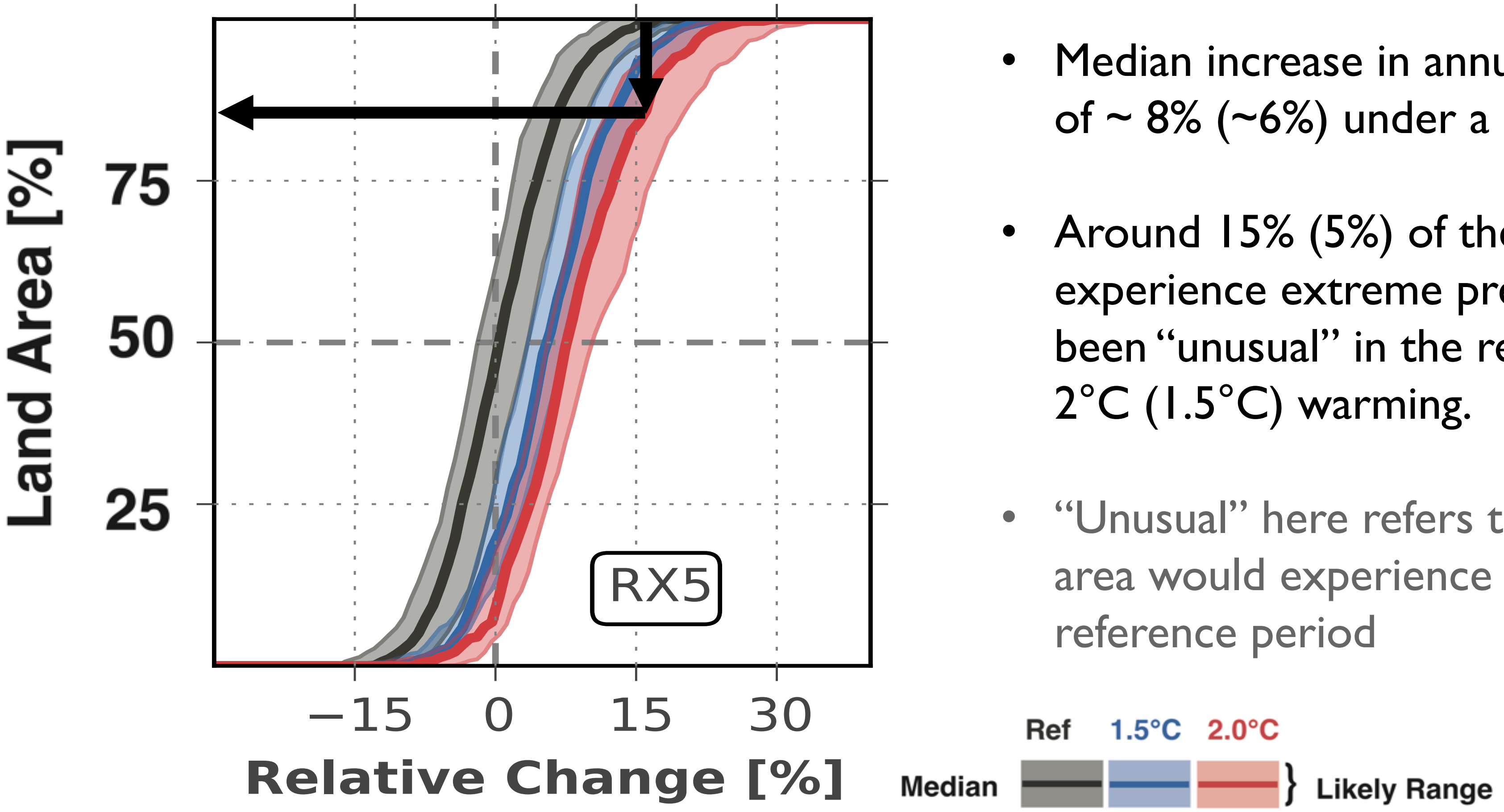
Extreme precipitation over Northern Europe



- Median increase in annual maximum 5 days precipitation of ~ 8% (~6%) under a 2°C (1.5°C) warming
- Around 15% (5%) of the land area projected to annually experience extreme precipitation events that would have been "unusual" in the recent past (1986-2005) under a 2°C (1.5°C) warming.
- "Unusual" here refers to about 1% or less of the land-area would experience such events over the 1986-2005 reference period

Schleussner et al. (2016)

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Impacts on global crop yields

		1.5°C	2°C
Changes in local crop yields over global and tropical present day agricultural areas including the effects of CO_2-fertilization [%]			
Wheat	Global	**2** [-6;17]	**0** [-8;21]
	Tropics	**-9** [-25;12]	**-16** [-42;14]
Maize	Global	**-1** [-26;8]	**-6** [-38;2]
	Tropics	**-3** [-16;2]	**-6** [-19;2]
Soy	Global	**7** [-3;28]	**1** [-12;34]
	Tropics	**6** [-3;23]	**7** [-5;27]
Rice	Global	**7** [-17;24]	**7** [-14;27]
	Tropics	**6** [0;20]	**6** [0;24]

Projected yield reductions are largest for tropical regions, while high-latitude regions may see an increase. Projections not including highly uncertain positive effects of CO_2-fertilization project reductions for all crop types of about 10% globally already at 1.5°C and further reductions at 2°C.

Schleussner et al. (2016)

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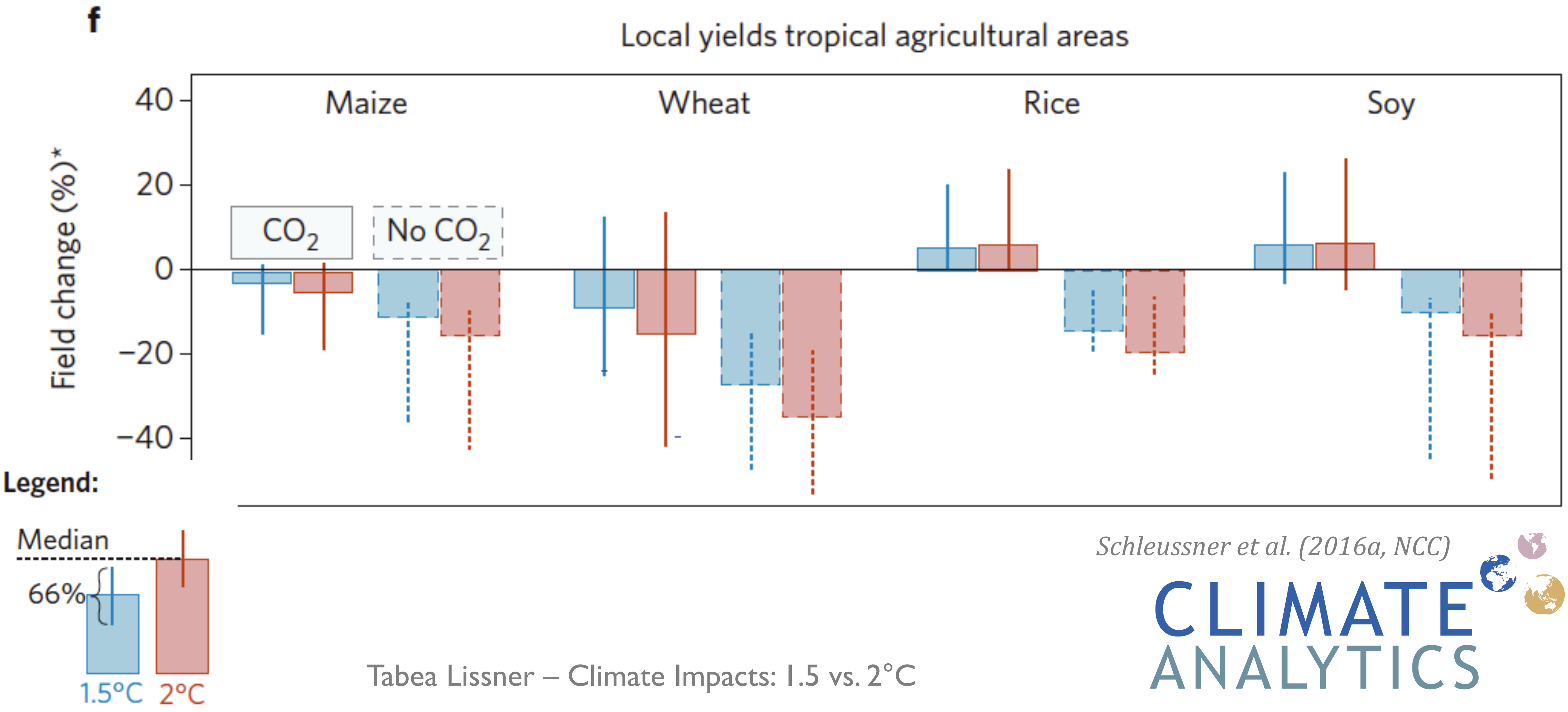
Impacts on crop yields in tropical regions



Schleussner et al. (2016a, NCC)

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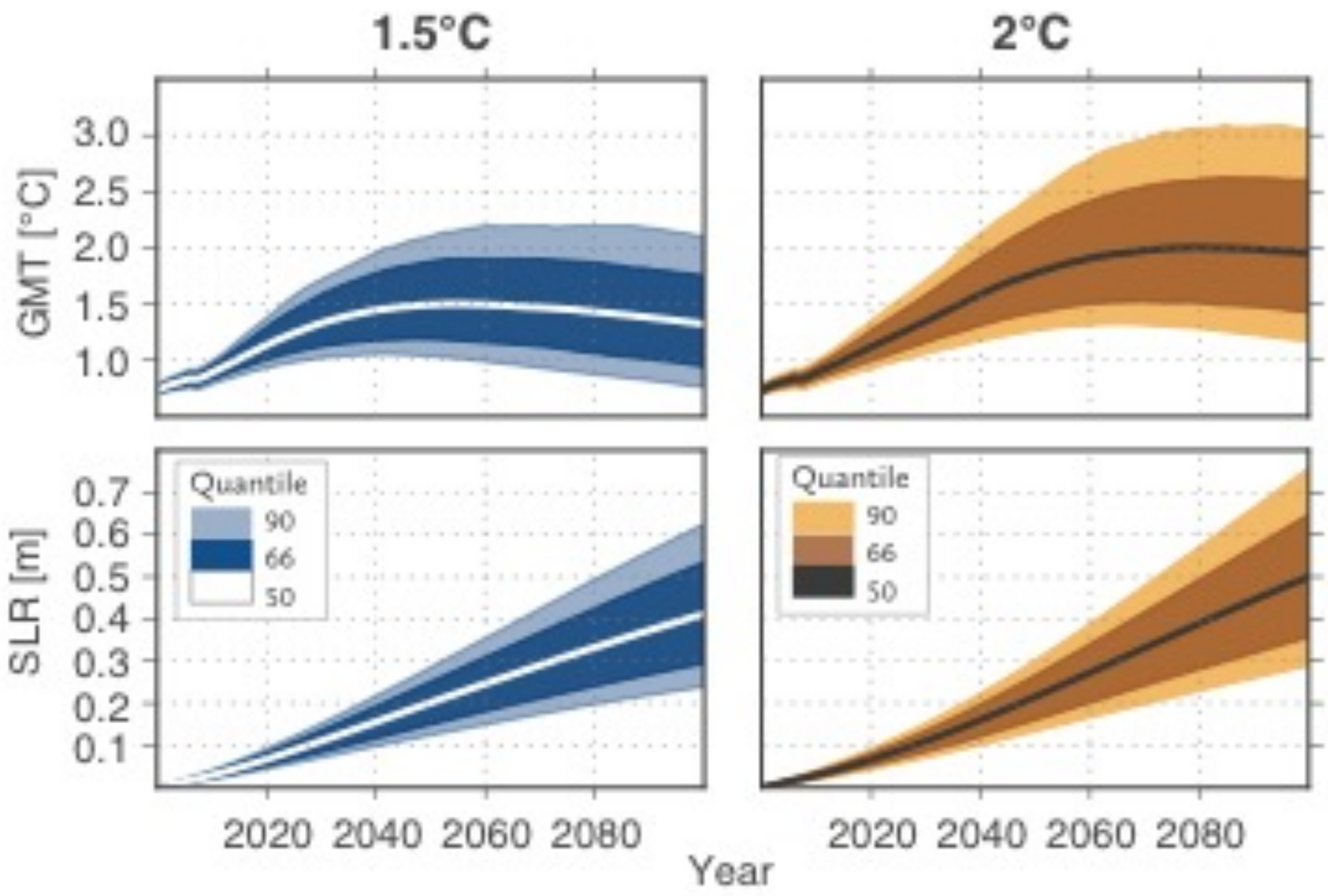
Sea-level rise



Schleussner et al. (2016)

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Sea-level rise and long-term commitment

Global Sea-level Rise	1.5°C	2°C	
in 2100	about 40 cm	about 50 cm	1.5°C end-of-century rate 30% lower than for 2°C greatly reducing long-term SLR commitment. Steep rise in long-term risks between 1.5°C and 2°C
2081-2100 rate	about 4 mm/yr	about 5.5 mm/yr	

Schleussner et al. (2016)

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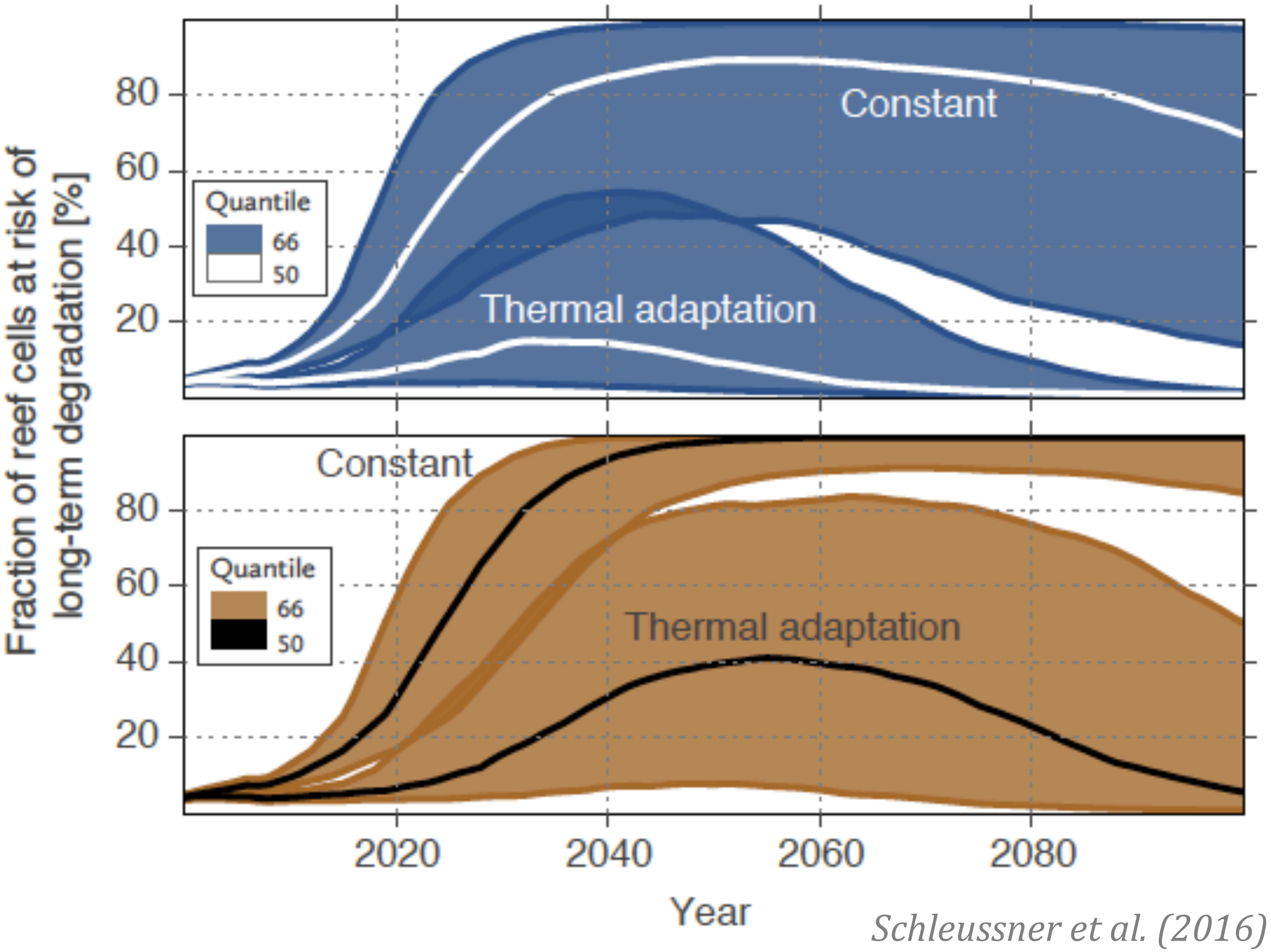
Coral reefs at risk of severe degradation

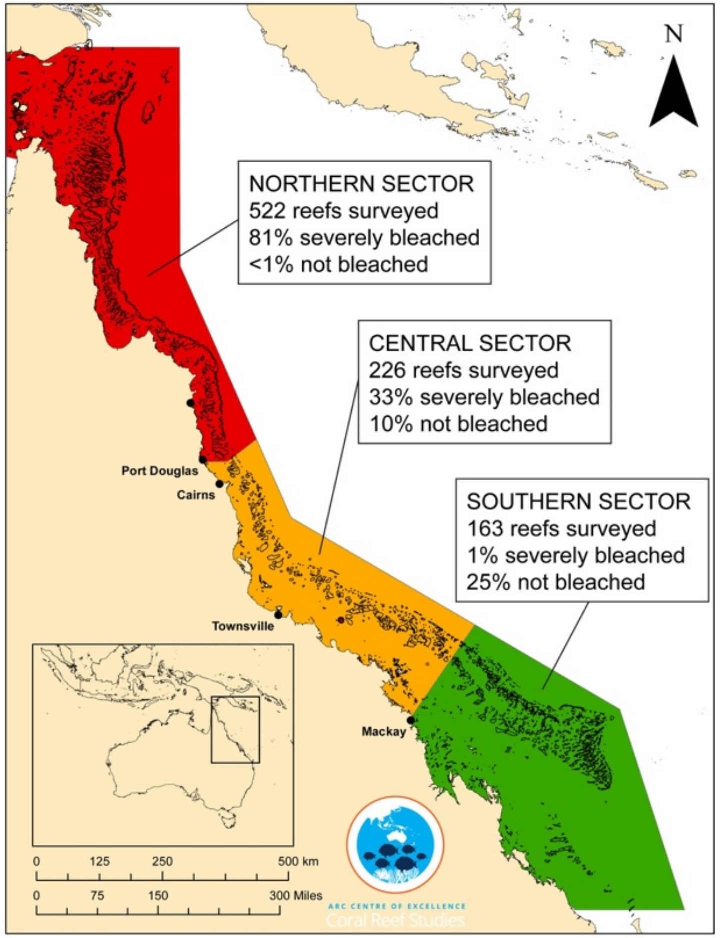


1.5°

2°

Schleussner et al. (2016)

Unprecedented global mass coral bleaching event



https://www.coralcoe.org.au/media-releases/only-7-of-the-great-barrier-reef-has-avoided-coral-bleaching

- Amplification of high water temperatures through strong El nino
- April 20, 2016: 93% of Australian Great Barrier Reef bleached


THE STRAITS TIMES

Half of Australia's Great Barrier Reef coral 'dead or dying': Scientists

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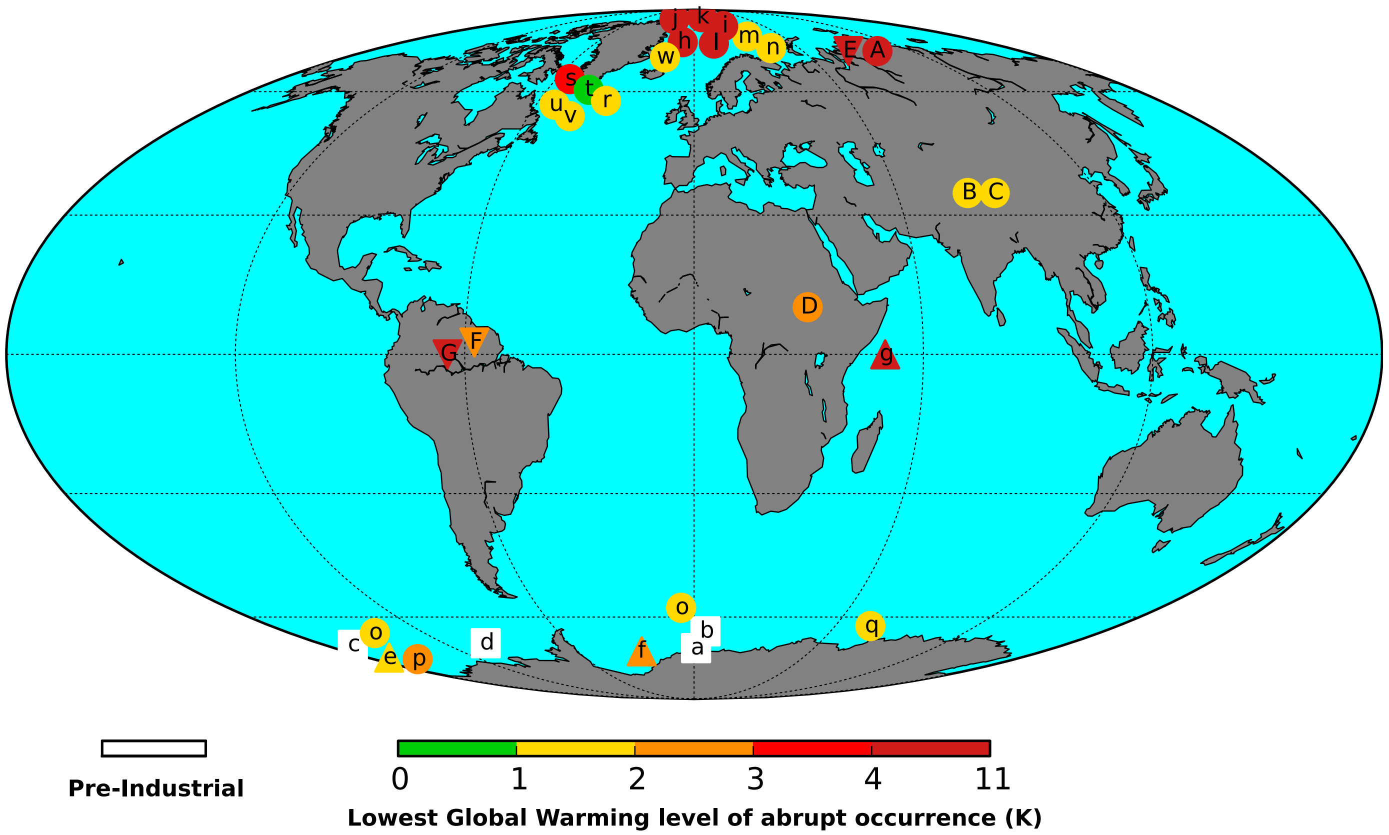
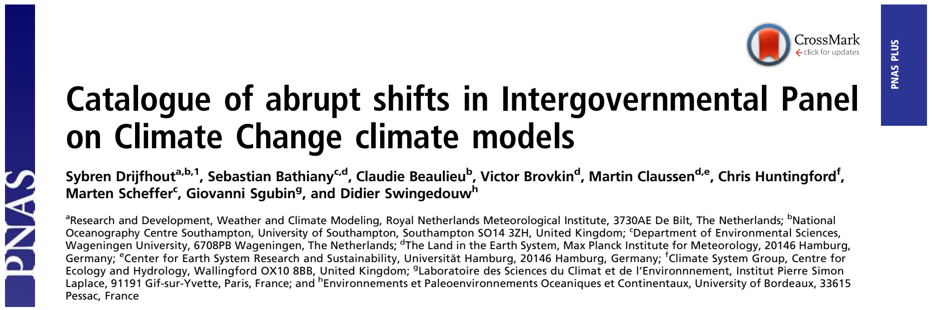
1.5°C, 2°C and tipping points in the Earth System





PNAS

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Catalogue of abrupt shifts in Intergovernmental Panel on Climate Change climate models

Sybren Drijfhout[a,b,1], Sebastian Bathiany[c,d], Claudie Beaulieu[b], Victor Brovkin[d], Martin Claussen[d,e], Chris Huntingford[f], Marten Scheffer[c], Giovanni Sgubin[g], and Didier Swingedouw[h]

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- 37 abrupt shifts in climate system identified in CMIP5 models for a warming exceeding 10°C
- Including biome changes, permafrost loss, ocean circulation changes, sea-ice snow and glacier loss

Drijfhout et al. (2015)

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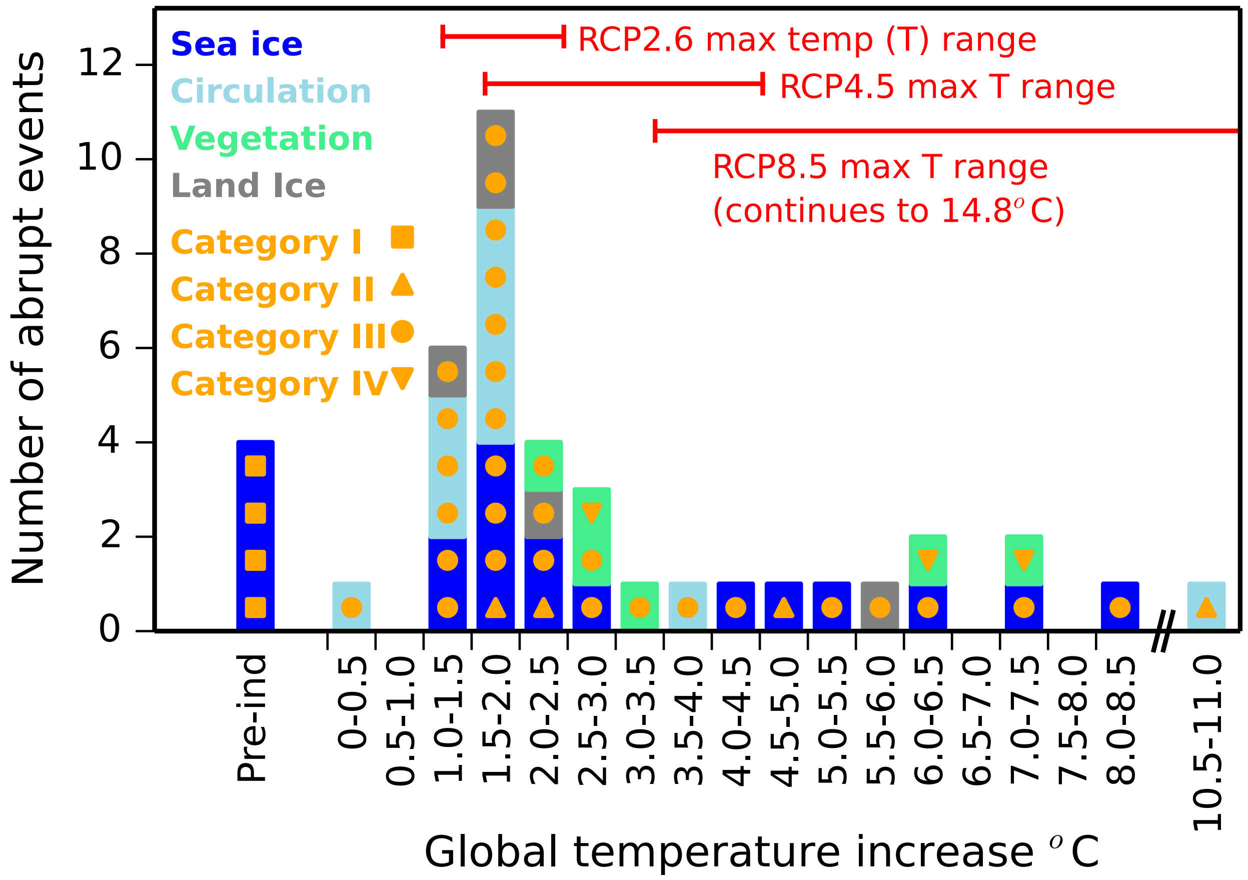
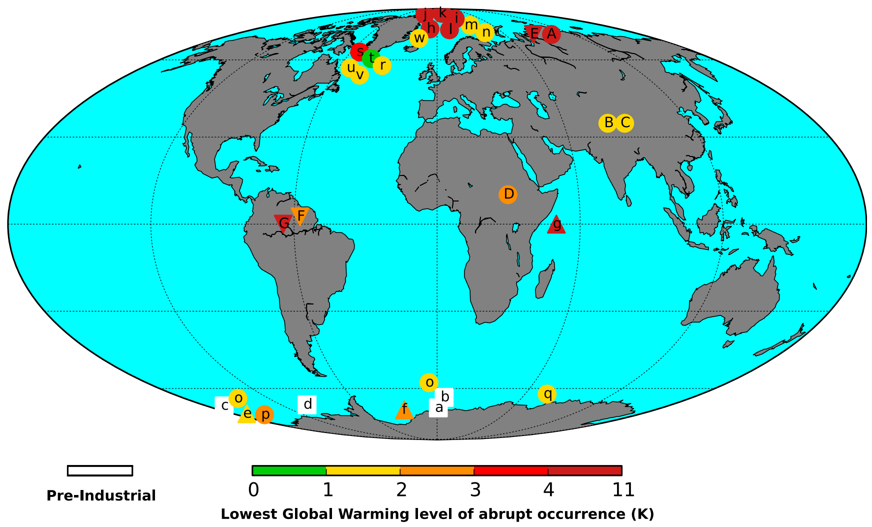
1.5°C, 2°C and tipping points in the Earth System





Drijfhout et al. (2015)

50% of thresholds of abrupt shifts crossed for 2°C compared to 20% under 1.5°C

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Research perspectives

- Pathway dependent impacts not represented in current scenario set-up for 1.5° and 2°pathways
- Important implications for time-lagged impacts and reversibility

➢ Comprehensive integrated and scenario-based analysis of 1.5°C and 2°C impacts and mitigation pathways to better understand trade-offs

Research perspectives

- Studies show large differences in impacts between regions and between warming levels: major implications for adaptation requirements and potentials

➢ better resolved impact analyses to inform pathway-dependent adaptation planning

Research perspectives

- IPCC special report on 1.5° (Decision 1/CP.21): "*Invites the Intergovernmental Panel on Climate Change to provide a special report in 2018 in the impacts of global warming of 1.5°C above pre-industrial levels and related global GHG emission pathways*"

➢ analyses to assess our existing knowledge on near-term impacts and lower warming pathways

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Thank you for your attention!

Contact: Tabea Lissner

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Key References

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