EXTREME HEAT HOTSPOTS UNDER GLOBAL WARMING

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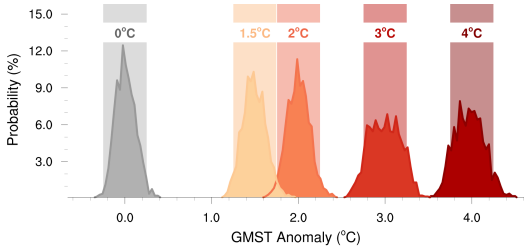
HOW AND WHERE WILL EXTREME HEAT WORSEN IN A WARMER WORLD?

What we want:

⇒ To distinguish which extremes could be avoided by limiting global warming from those extremes within the irreducible range of possibilities

What we need:

⇒ Large samples of low-probability simulated extremes and well-defined probability distributions for different levels of warming



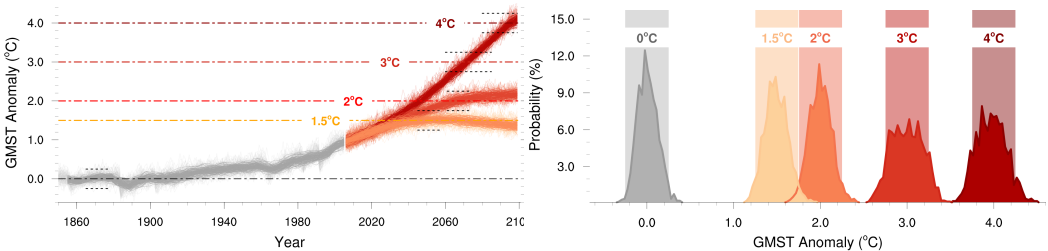
GMST: Global mean surface temperature

MPI-GE[1]

⇒ Largest ensemble from a comprehensive coupled climate model

⇒ Three future emission scenarios and 100 realizations

⇒ Range of possibilities at each warming level defined by 1000 simulated years



[1] Maher et al., 2019

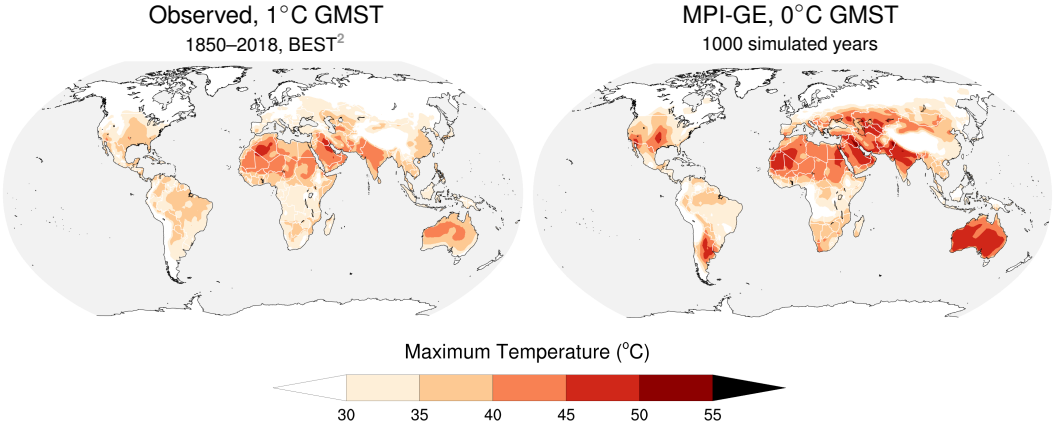
Absolute Temperature Metrics

1. Maximum absolute temperatures ⇒ Most extreme daytime temperatures
2. Return periods of extreme temperatures ⇒ Frequency of extremes
3. Maximum temperature variability ⇒ Range of all possible temperatures

Heat Stress Metrics

4. Sustained tropical night temperatures ⇒ Lack of nighttime cooling
5. Extreme wet bulb temperatures ⇒ Extreme heat + humidity

MPI-GE IS ABLE TO CAPTURE OBSERVED EXTREME MAXIMUM TEMPERATURES



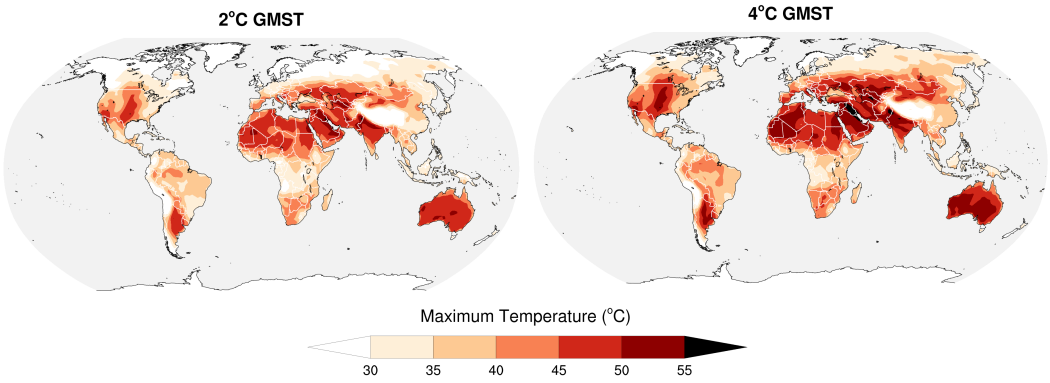
Absolute maximum observed summer temp. vs 99.5th percentile maximum summer temp. in MPI-GE

[2] **Berkeley Earth Surface Temperatures dataset; Rohde et al., 2012**

1. MAXIMUM ABSOLUTE TEMPERATURES

⇒ Mostly below 50°C in 2°C world, but 50°C exceeded over large areas in 4°C world

⇒ Hotspots: South East Asia, North Africa, Australia



Maximum absolute summer temperature; 99.5th percentile

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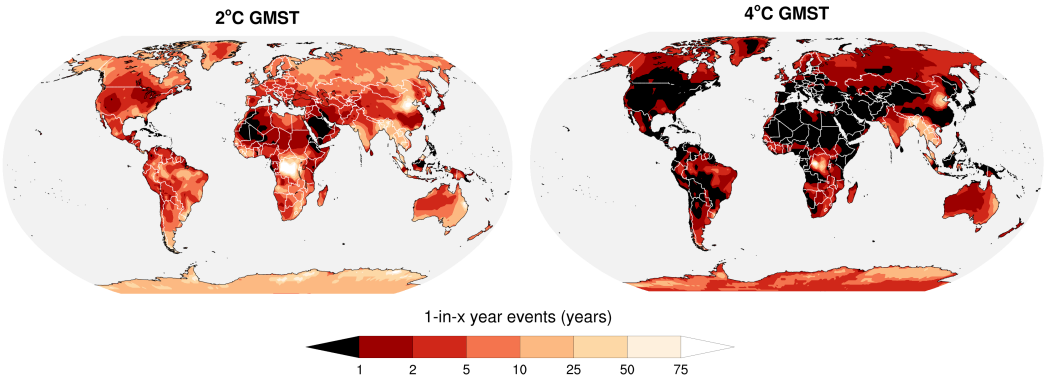
2. RETURN PERIODS OF EXTREME MAXIMUM TEMPERATURES

⇒ 1-in-100-years temperatures occur every 5-10 years at 2°C, and every 1-2 years at 4°C

⇒ Hotspots: North Africa, South Europe, South Asia, America



Frequency of preindustrial 99th percentile maximum summer temperatures

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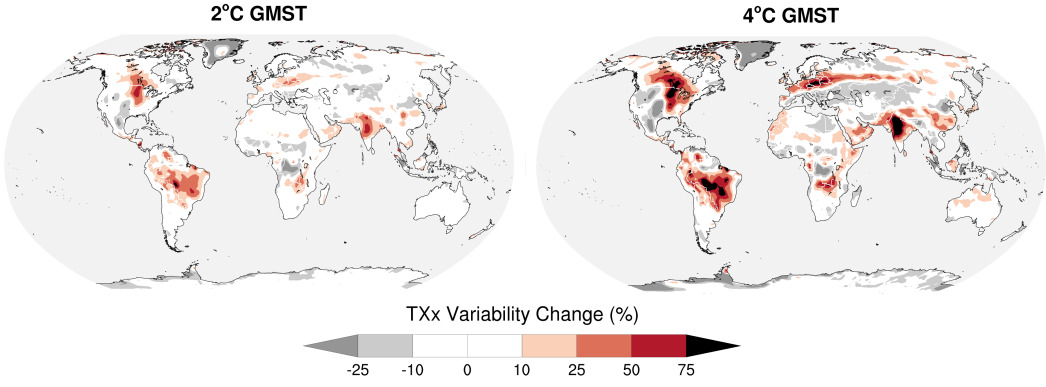
3. MAXIMUM TEMPERATURE VARIABILITY

⇒ 10-50% increase in range of maximum temp. at 2°C, 50-100% increase at 4°C

⇒ Hotspots: North America, Central South America, Central Europe, India

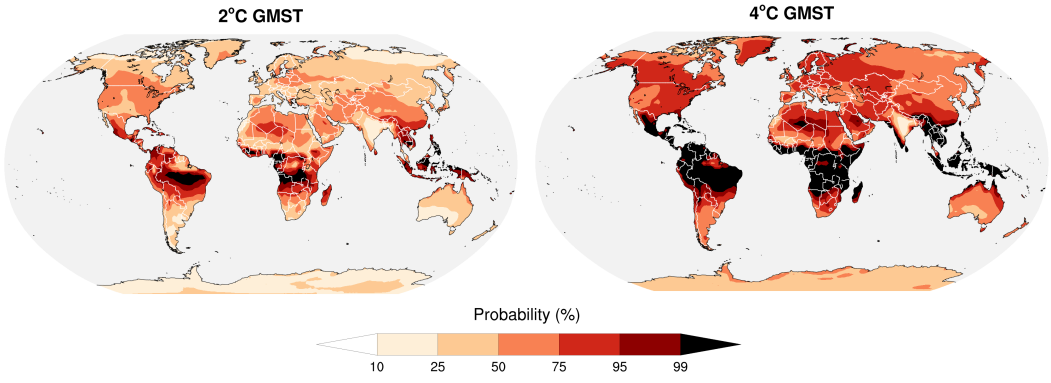


Relative change in ensemble spread in maximum summer temperatures, 2.5th to 97.5th percentiles

4. SUSTAINED TROPICAL NIGHT TEMPERATURES

⇒ Likely at 2°C, surpassed during 100% of summer months in large areas at 4°C

⇒ Hotspots: Tropics, North Hemisphere Mid-Latitudes

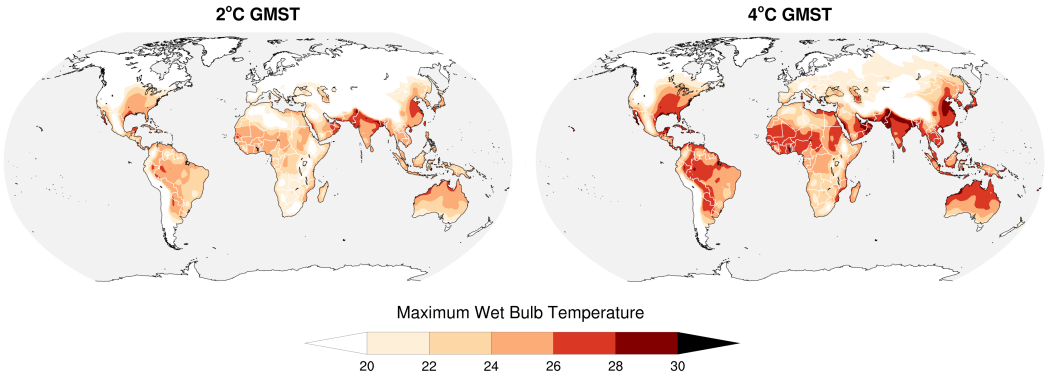


Probability of summer months with minimum temperatures higher than preindustrial 95th percentile

5. EXTREME WET BULB TEMPERATURES (W; HEAT + HUMIDITY)

⇒ W>26°C, rare in preindustrial and 2°C worlds, occur widely in 4°C world

⇒ Hotspots: South Asia, America, North Africa, Australia



Maximum monthly mean W (as in Stull, 2011); 99.5th percentile

SUMMARY

⇒ We identify summer heat hotspots using **large samples of low-probability extremes** simulated with largest ensemble from comprehensive climate model

⇒ For each metric of extreme heat, **major hotspots occur over different regions**, highlighting the different adaptation measures necessary over different areas.

⇒ **Limiting global warming increase to below 2°C is vital** to minimize our exposure to extreme heat measured by all metrics.

⇒ **But 2°C of global warming is sufficient to extremely aggravate the risk** of extreme heat and heat stress over large areas.

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References

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