Risks from climate extremes change differently from 1.5°C to 2.0°C depending on rarity

Photo credit

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Outline

- Introduction (1)
- Data and Methods (3)
- Results (7)
- Conclusion (1)

Differential risks under different warming levels

- Comparison of the costs and benefits for different warming limits requires an understanding of how risks vary between warming limits
- Risk results from the combined effect of the likelihood of an event, and vulnerability
- A simple framework only to compare the probabilities of temperature and precipitation extremes associated with a 2°C warming limit versus a 1.5°C
- Providing an important point of comparison for more complex approaches


Data and methods

Data and methods

- TXx, TNn and Rx1D from CMIP5 models
  - 26 models, 1 run each
    - historical (26), RCP2.6 (18), RCP4.5 (26), RCP8.5 (26)
    - Preindustrial take as 1861-1880
- Fit local GEV distributions, parameterized as follows

$$\mu_{\Delta T} = \mu_0 + \mu_1 \Delta T$$
$$\log \sigma_{\Delta T} = \log \sigma_0 + \sigma_1 \Delta T$$
$$\xi_{\Delta T} = \xi$$

- Global mean temperature anomaly ΔT is expressed relative to 1861-1880, low-pass filtered with a 21-year moving average
- 5 parameters estimated at each grid point, fitted to each model separately via maximum likelihood, pooling all scenarios
- 401 year pooled sample (306 years for models w/o RCP 2.6)

Data and methods

- Allowing the shape parameter to be linearly dependent on temperature did not improve fit
- Use of a parameterization with quadratic dependence on global mean temperature in location and scale parameters also did not improve fit
- Results are independent of RCP scenarios
  - Tested by fitting models using historical + one RCP scenario and comparing inferences with those from the model fitted to all data
- Uncertainty quantified via multi-model interquartile range

Data and methods

Risk Ratio (RR) $$RR_{2.0} = \frac{p_{2.0}}{p_{1.0}}$$

p_1: probability of the event in current climate
$p_{1.5}$: probability of the event at 1.5°C warming level
$p_{2.0}$: probability of the event at 2.0°C warming level

$$\frac{RR_{2.0}}{RR_{1.5}} = \frac{p_{2.0}/p_{1.0}}{p_{1.5}/p_{1.0}} = \frac{p_{2.0}}{p_{1.5}}$$

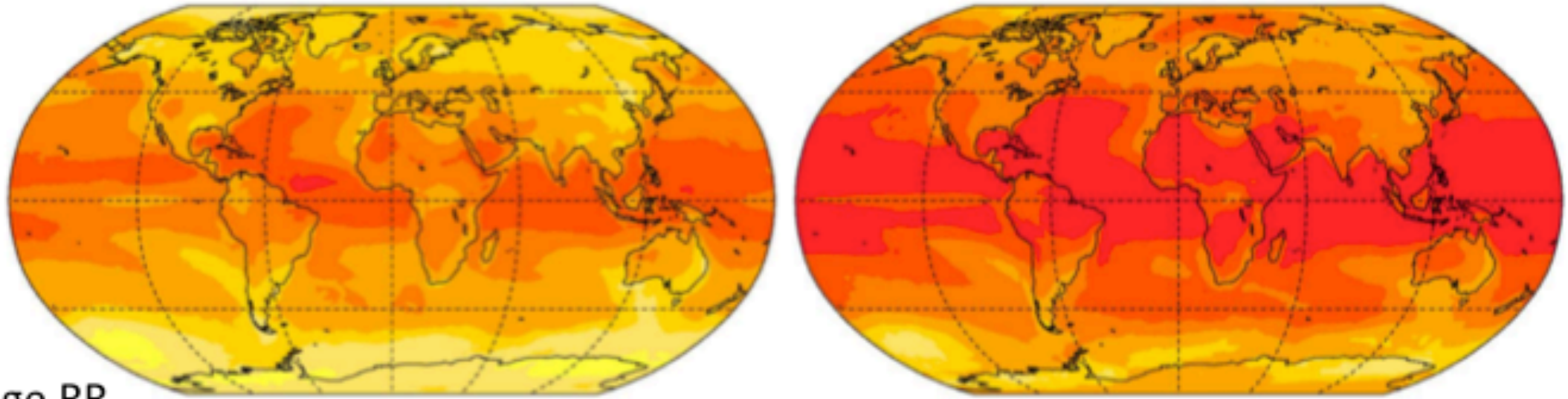
Results

TXx

1.5°C

2.0°C

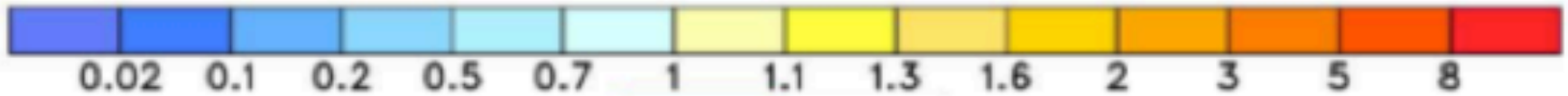
p_0=0.05 (ΔT=1°C 20-year events)



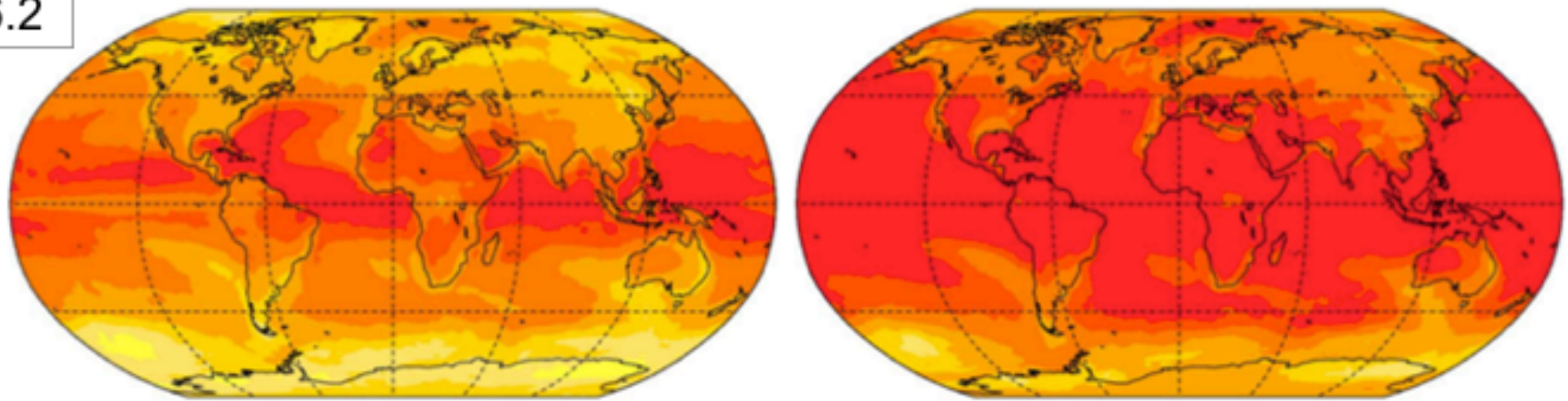
Land Average RR

2.3	4.4
2.8	6.2

RR



p_0=0.02 (ΔT=1°C 50-year events)

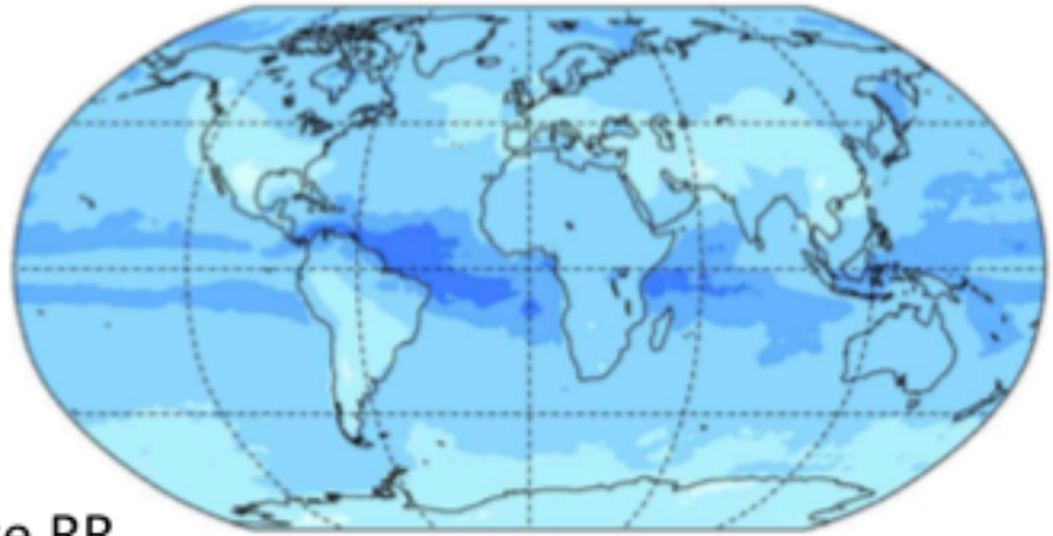


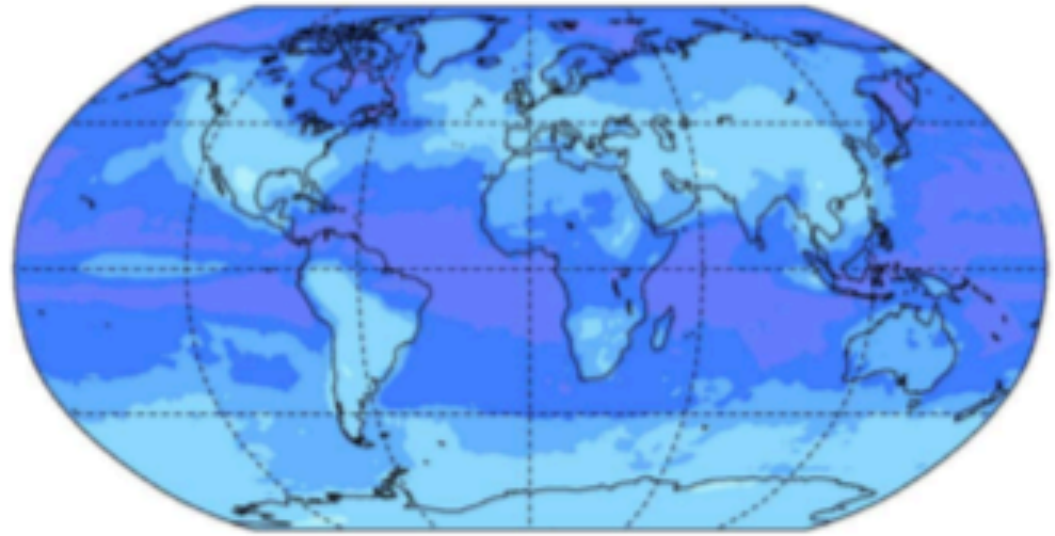
TNn

1.5°C

2.0°C

p_0=0.05 (ΔT=1°C 20-year events)

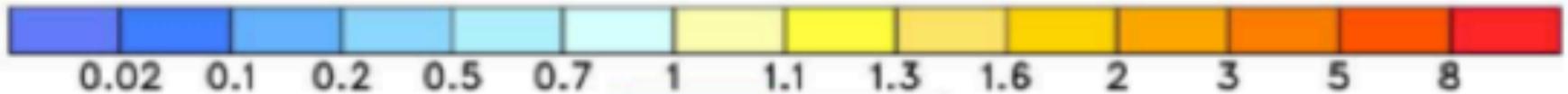




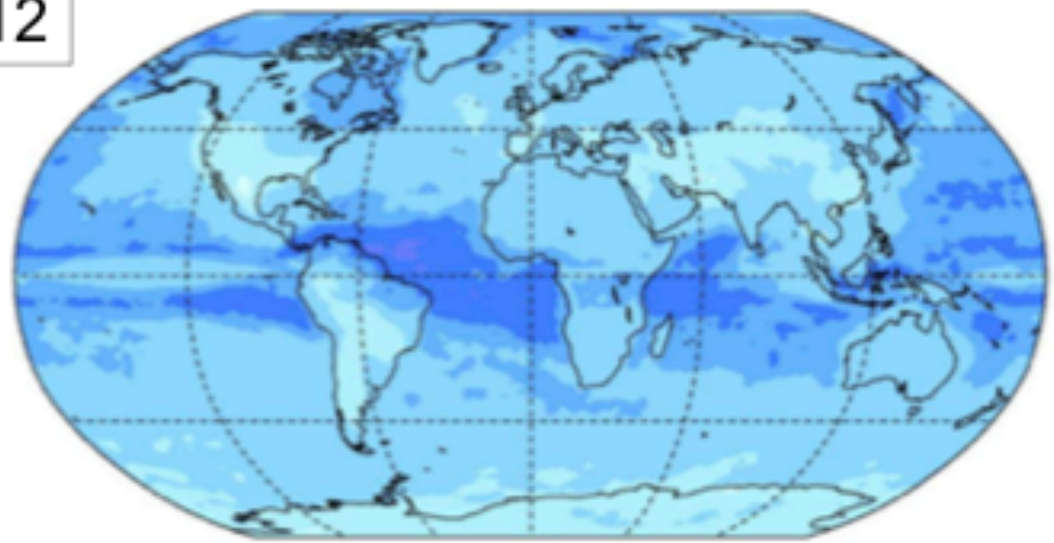
Land Average RR

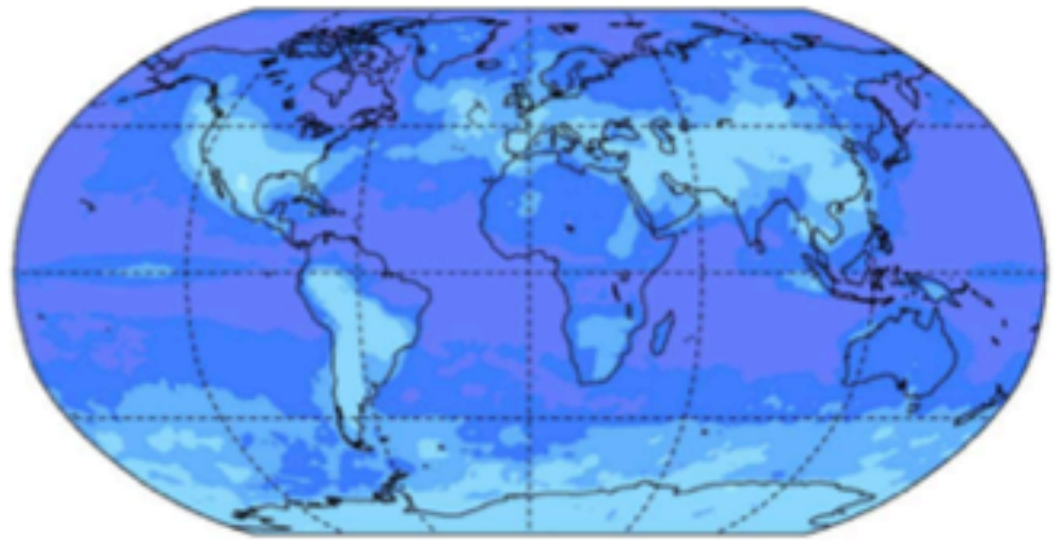
0.46	0.18
0.38	0.12

RR



p_0=0.02 (ΔT=1°C 50-year events)



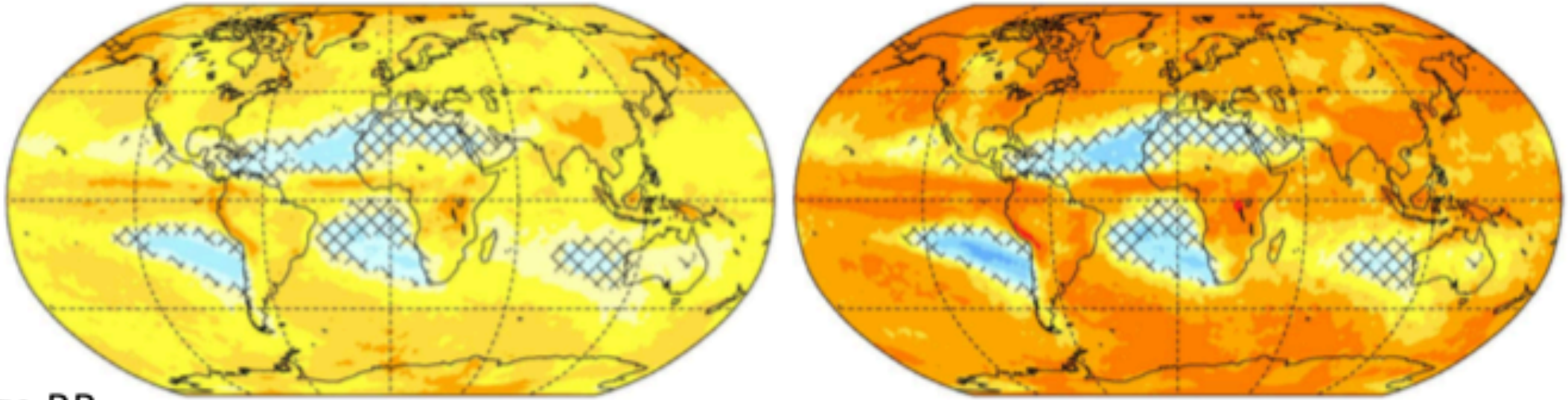


Rx1D

1.5°C

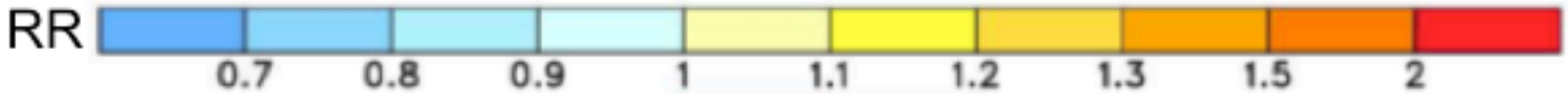
2.0°C

p_0=0.05 (ΔT=1°C 20-year events)

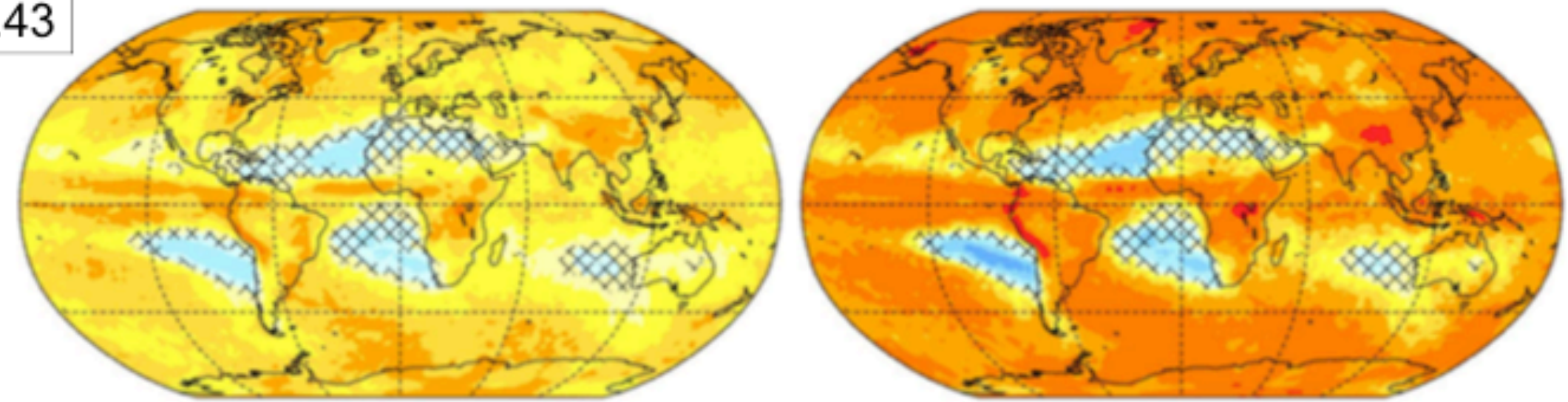


Land Average RR

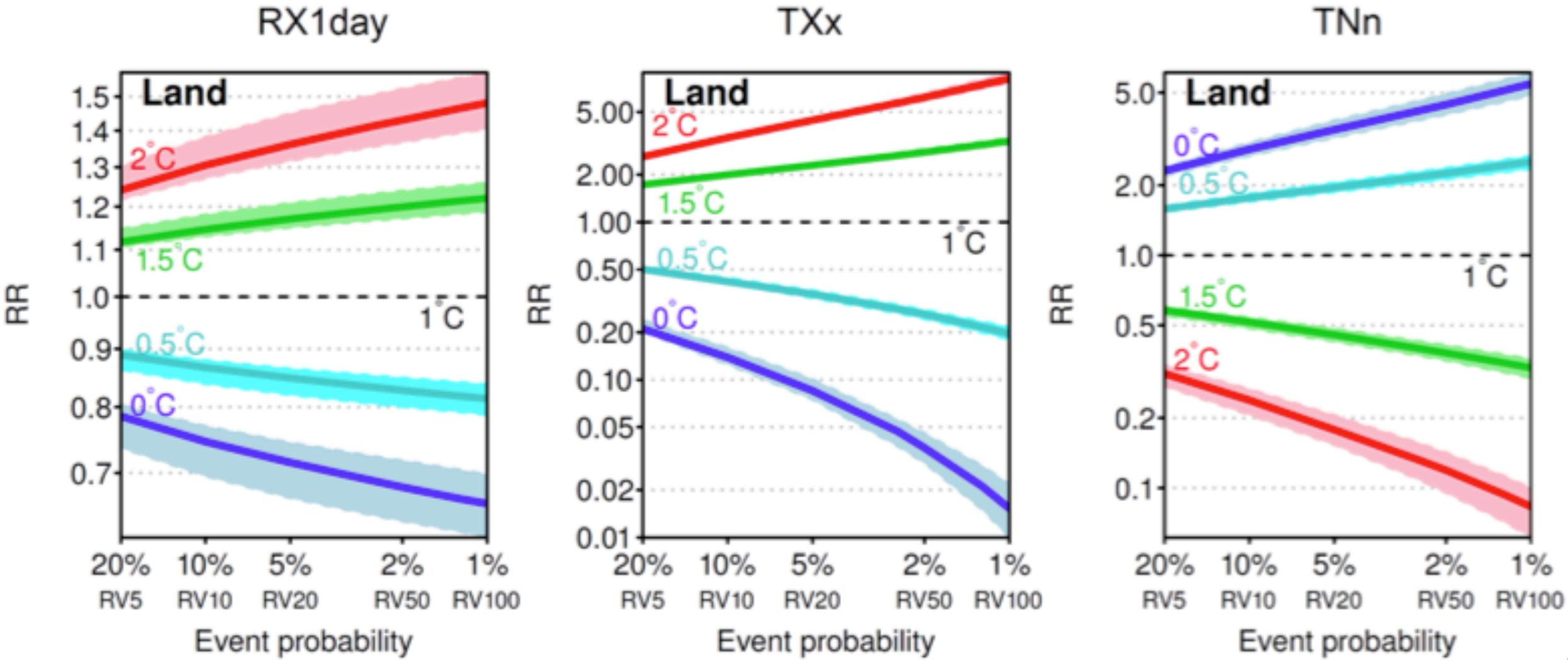
1.17	1.36
1.20	1.43



p_0=0.02 (ΔT=1°C 50-year events)

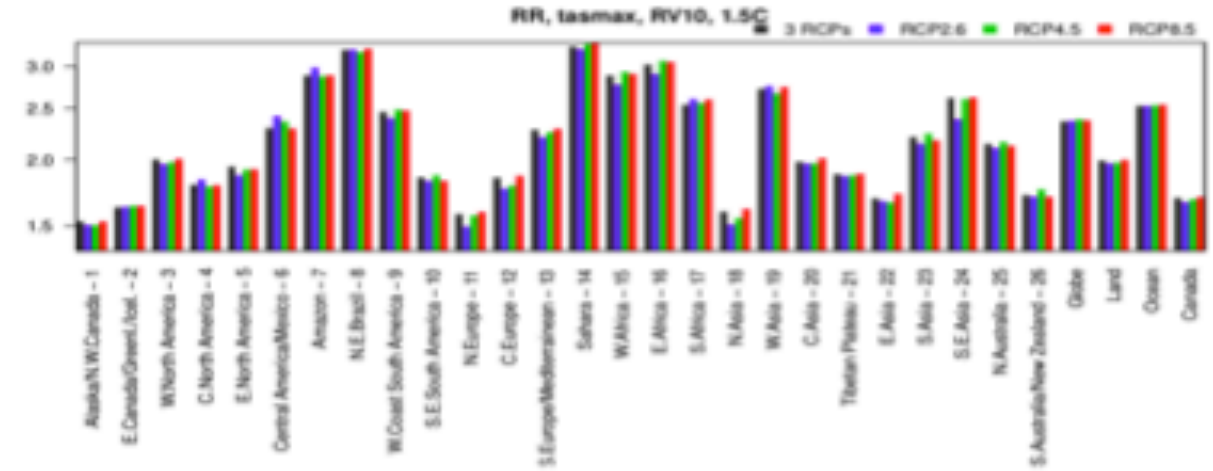


RR vs p_0 for different warming levels relative to today's climate (note different vertical scales)

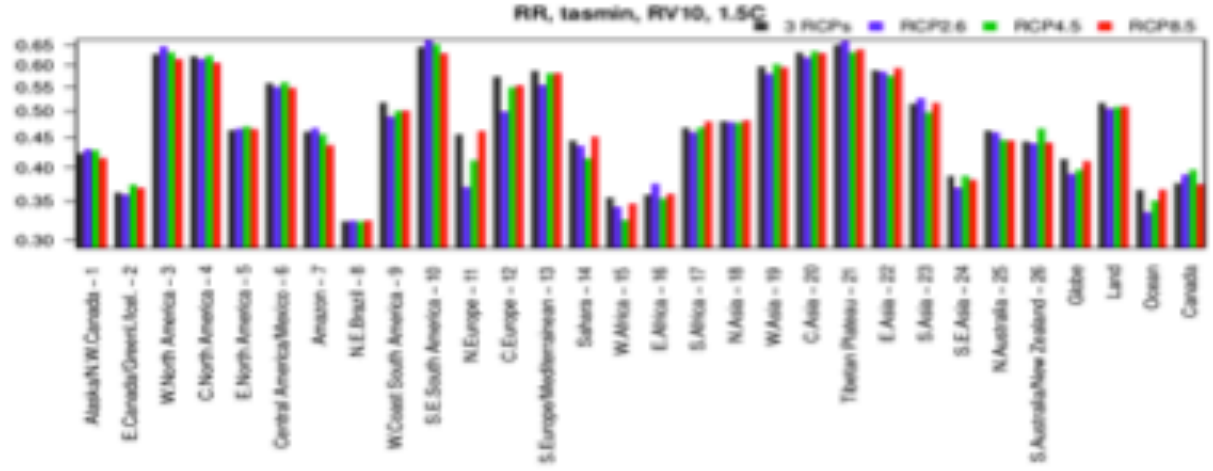


Regional and scenario variations in $RR = p_{1.5}/p_{1.0}$ for 10-year current climate event

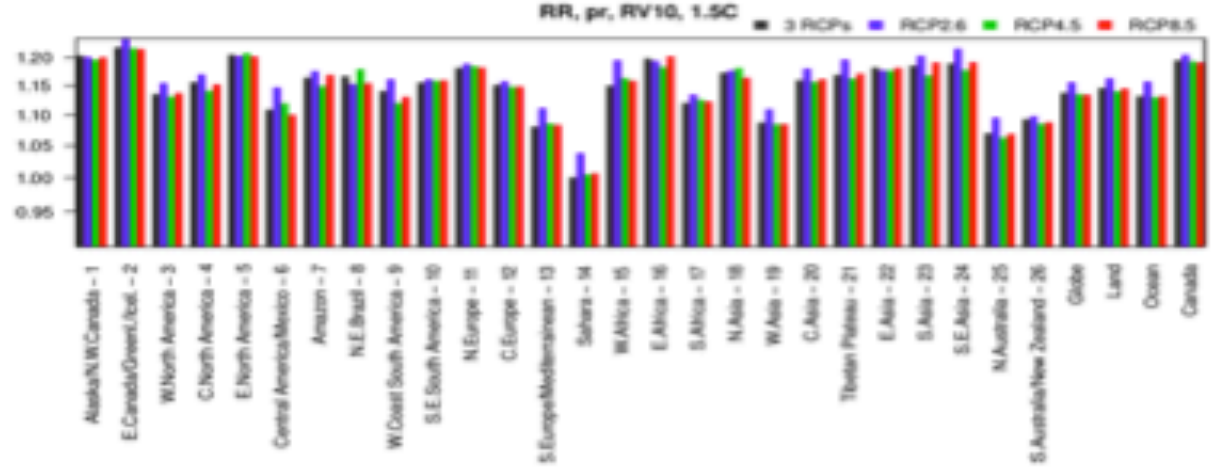
TXx



TNn

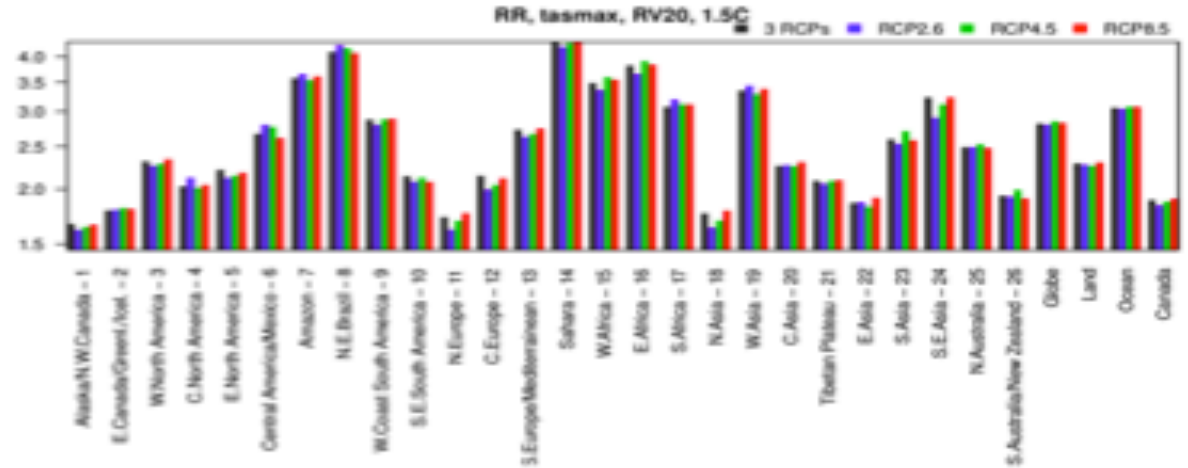


Rx1D

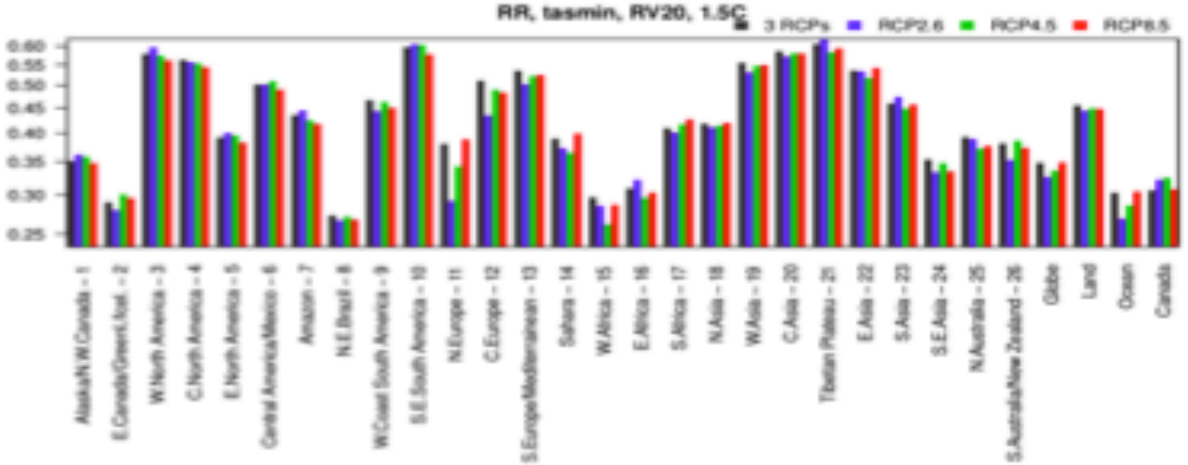


Regional and scenario variations in $RR = p_{1.5}/p_{1.0}$ for 20-year current climate event

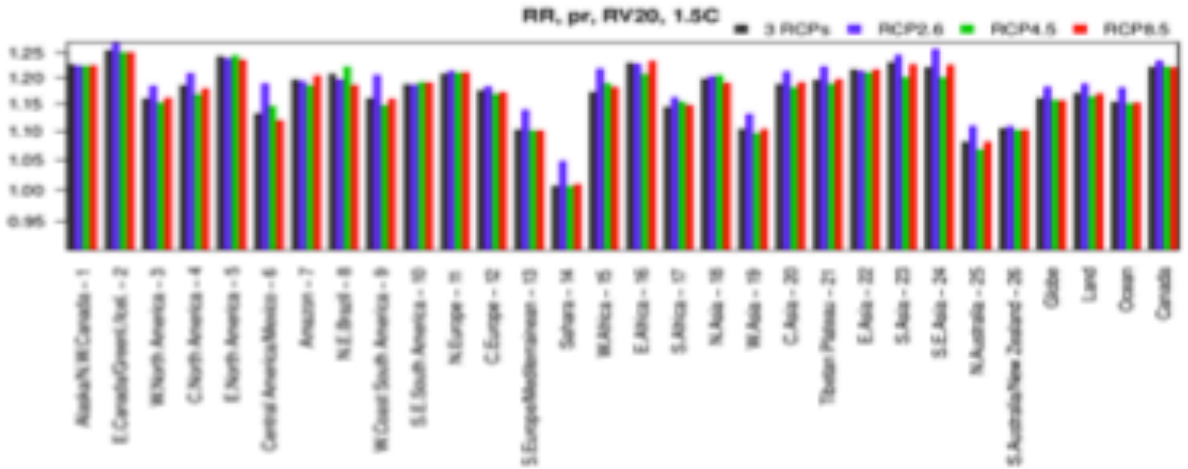
TXx



TNn

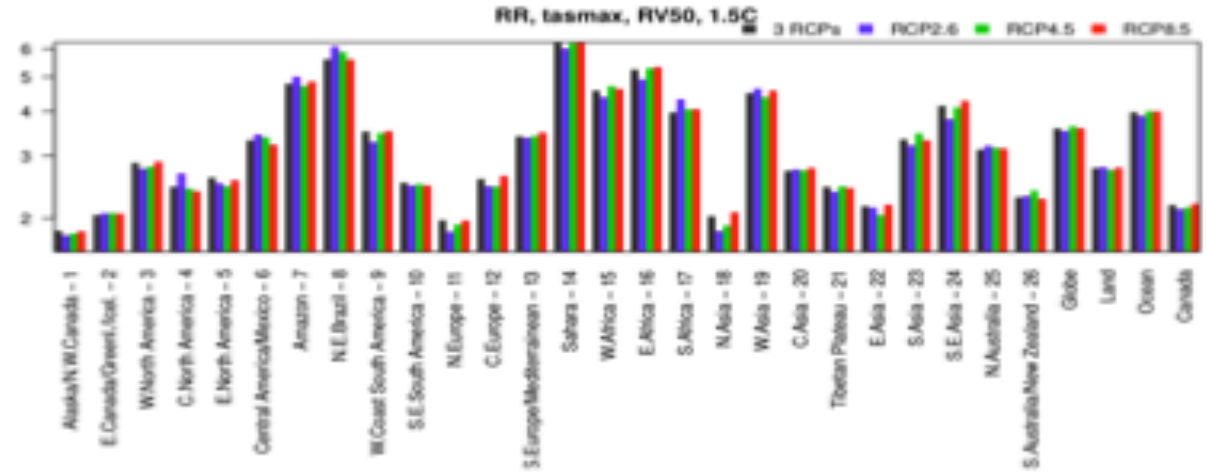


Rx1D

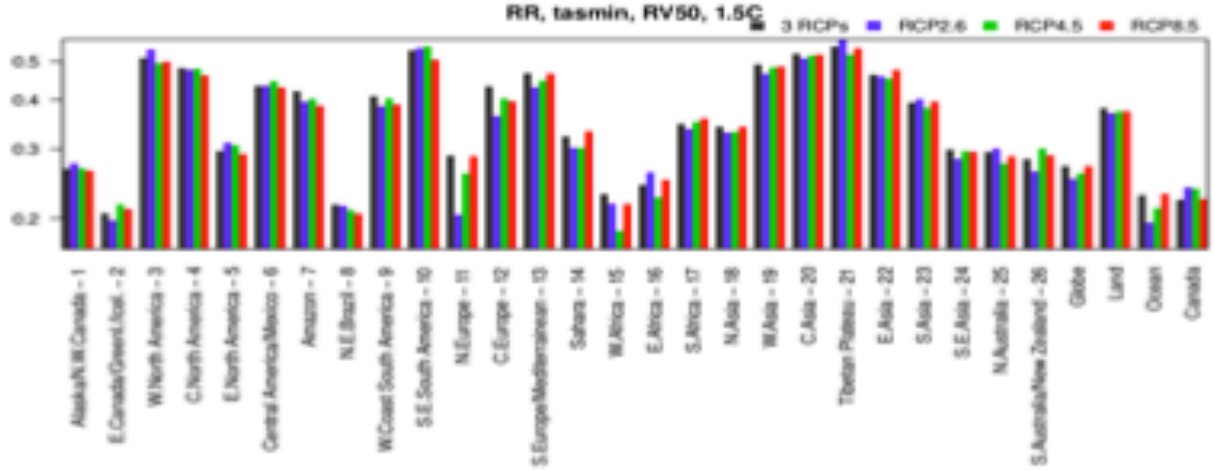


Regional and scenario variations in $RR = p_{1.5}/p_{1.0}$ for 50-year current climate event

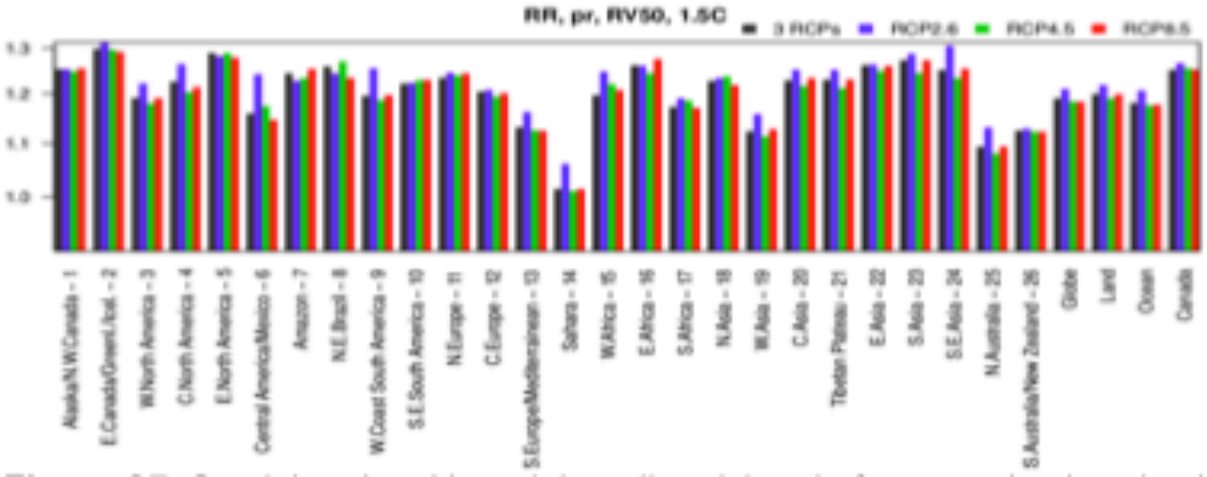
TXx



TNn



Rx1D



Discussion

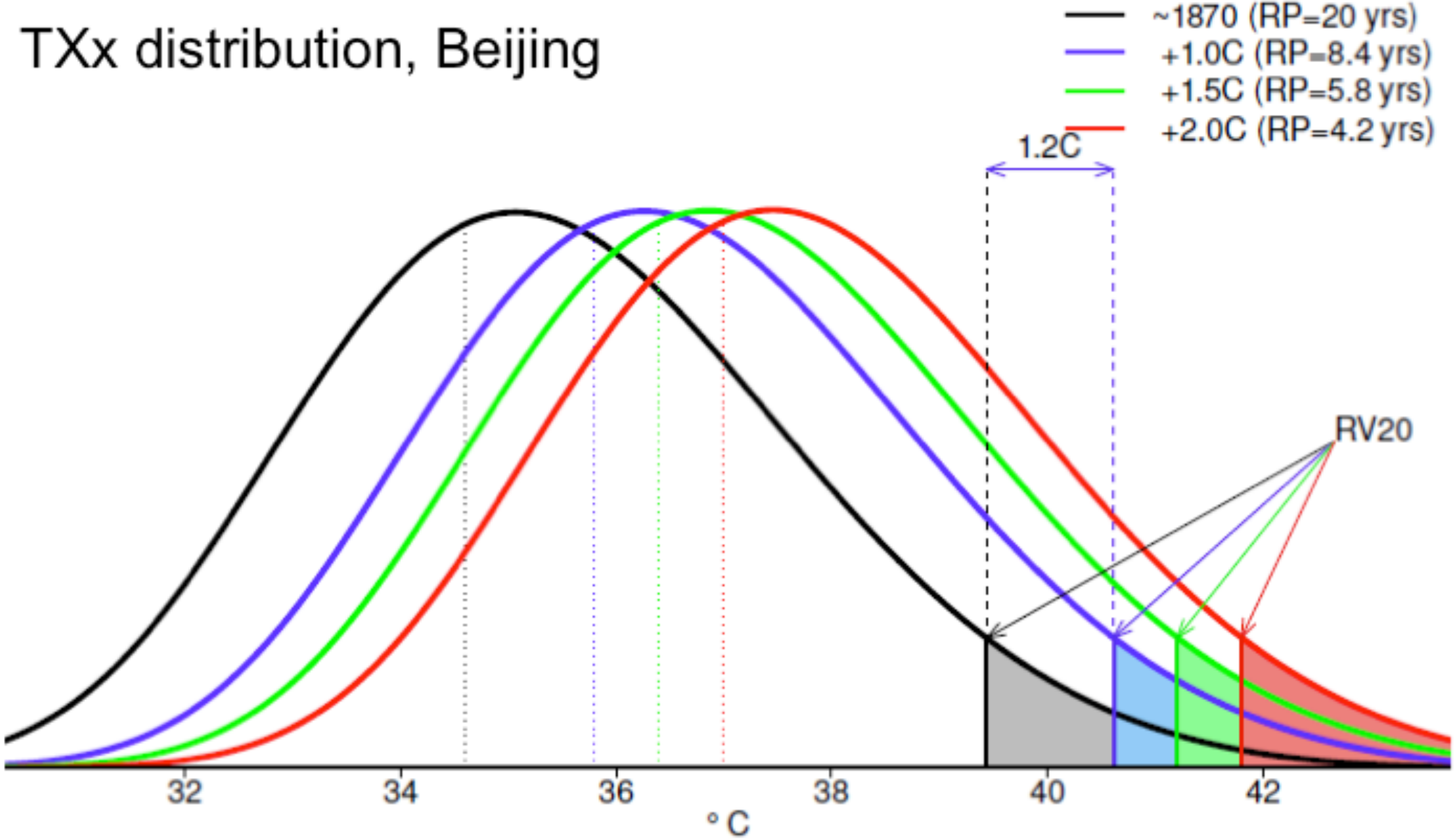
Conclusions and discussion

- Substantially larger changes in the probabilities of extreme events under 2°C global warming than under 1.5°C global warming.
- Relative changes in probability in a warmer world are larger for rarer, more extreme events.
- Risk assessments need to carefully consider the extreme event thresholds at which vulnerabilities occur.

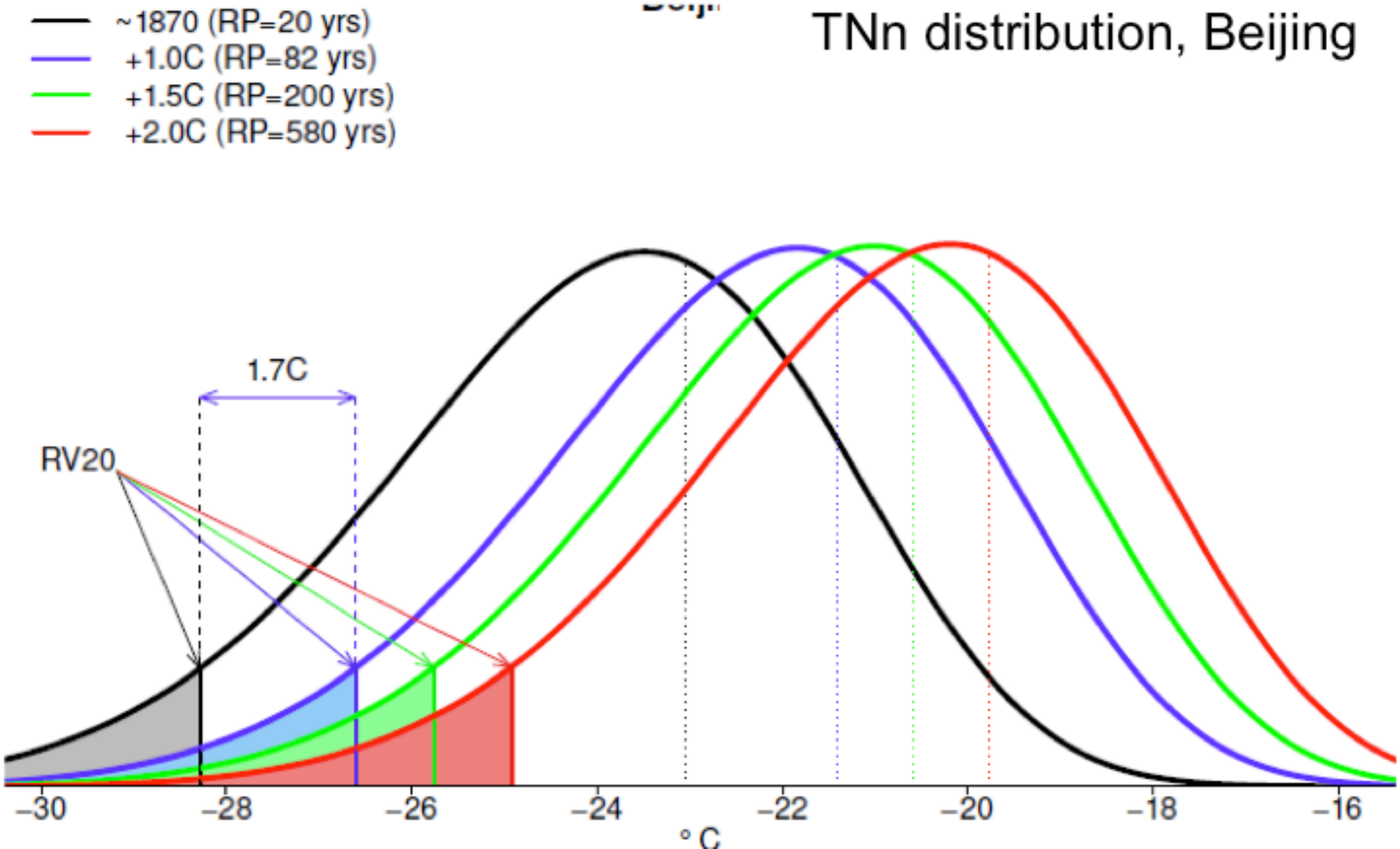
Questions

Extra Slides

TXx distribution, Beijing



TNn distribution, Beijing



Rx1D distribution, Beijing