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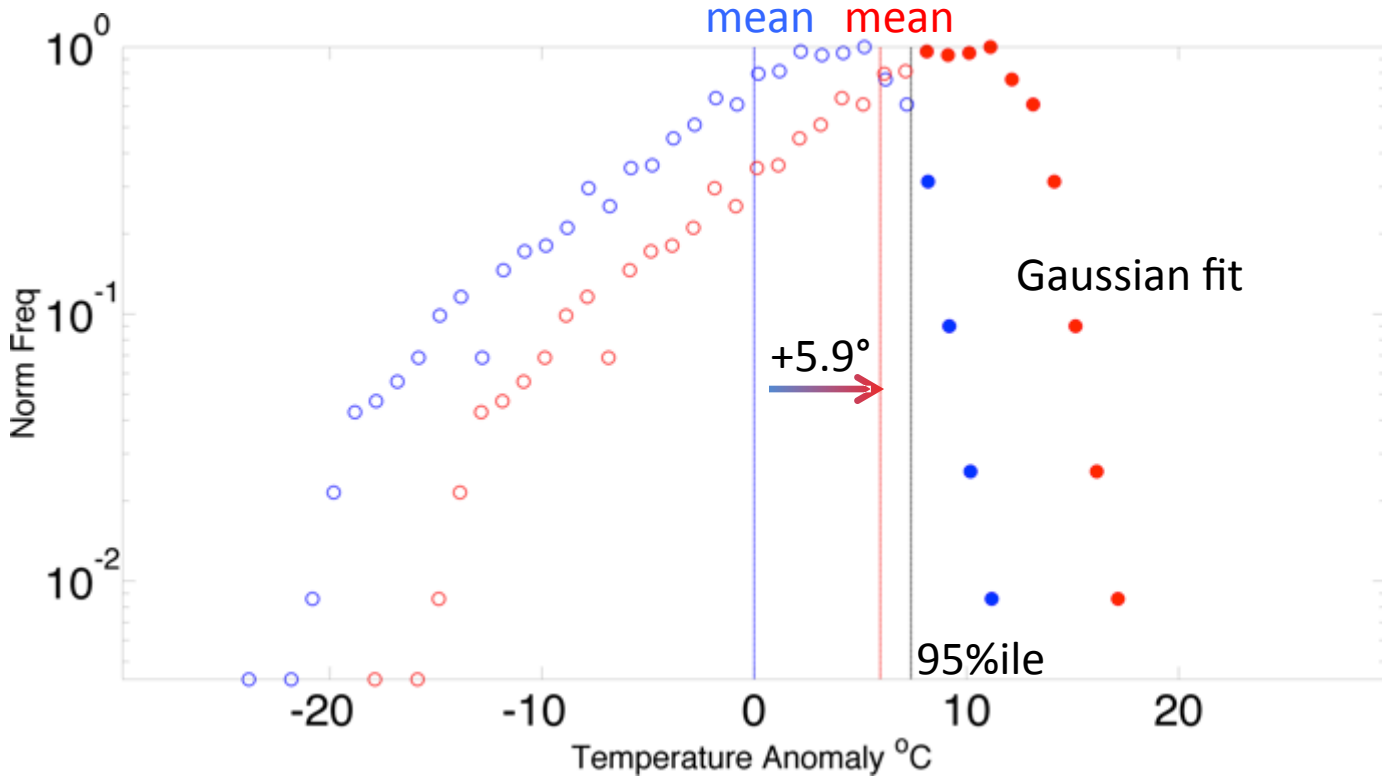
Investigating the Influence of Non-Gaussian Short Cold Tails on Future Model Projections of Cold Extremes

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Motivation

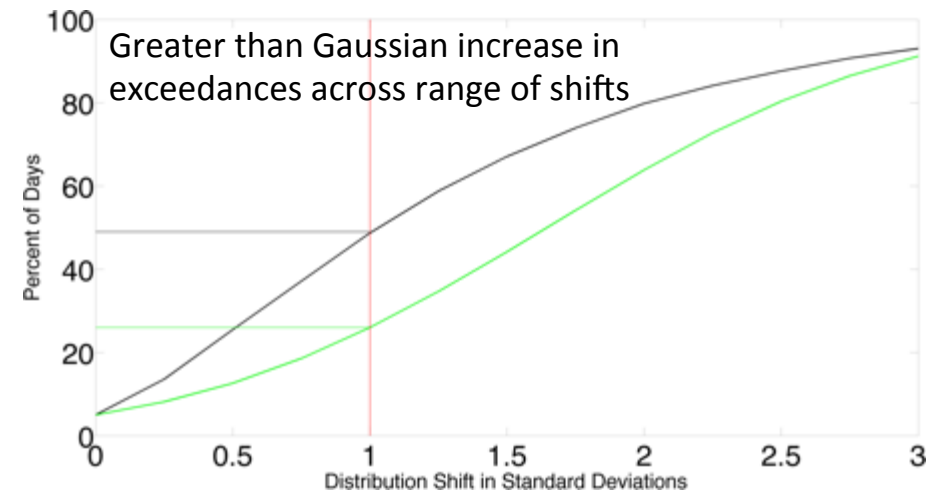
- Under global warming, changes in extreme temperature threshold exceedances will be manifested in more complex ways for locations exhibiting deviations from Gaussianity in the tails compared with normal distributions
- Shorter-than-Gaussian tails are a special case



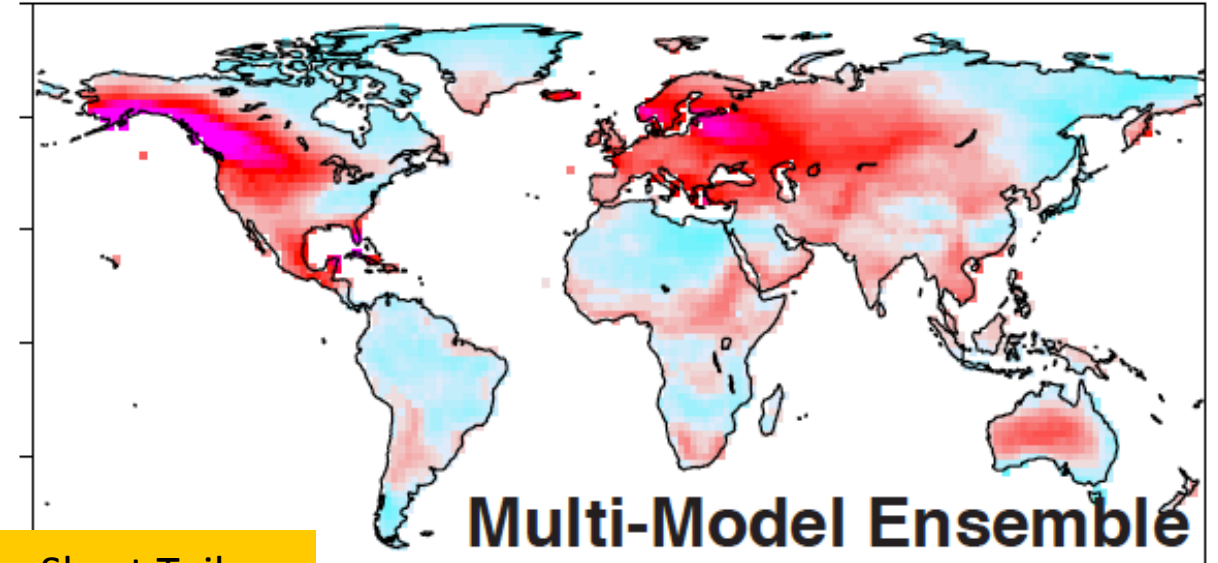
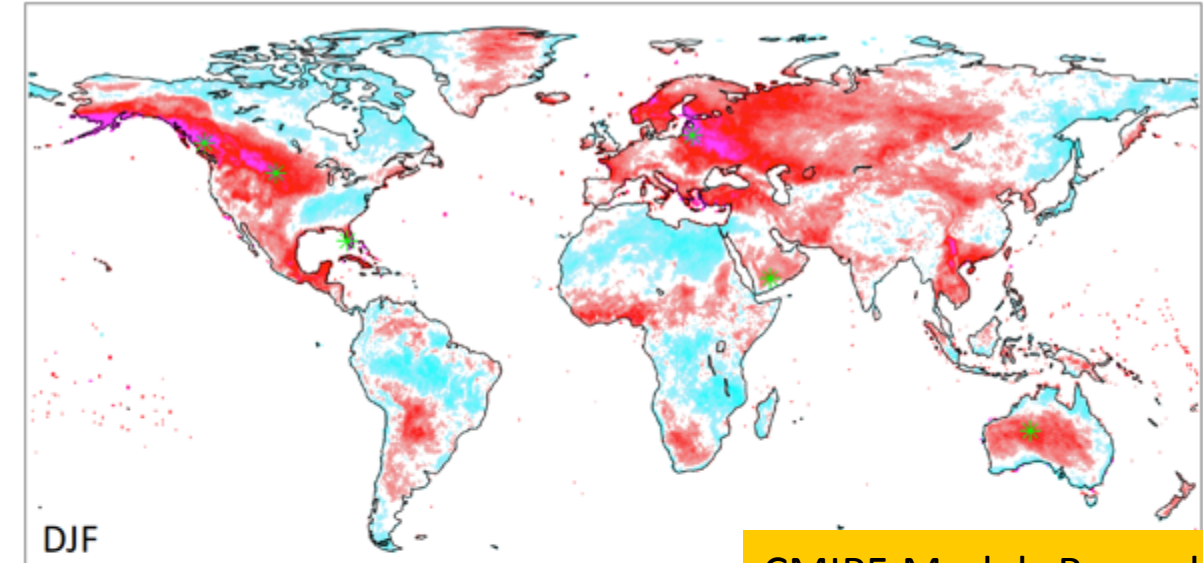
Example of shorter-than-Gaussian warm tail

After uniform 1 sigma shift, pre-shifted 95th percentile is exceeded 49% of the time

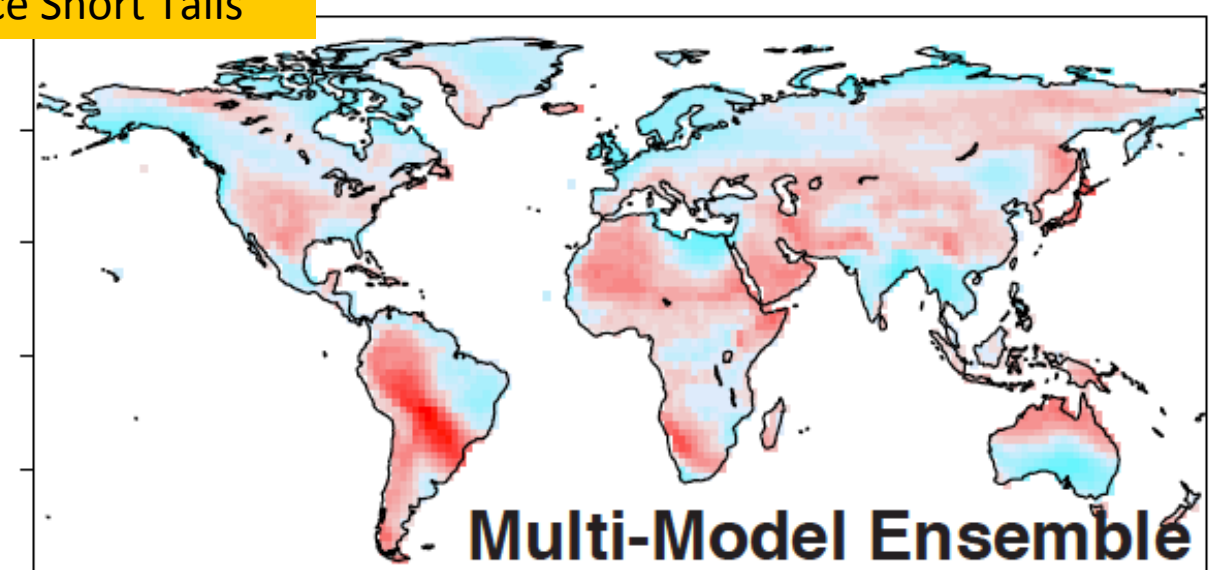
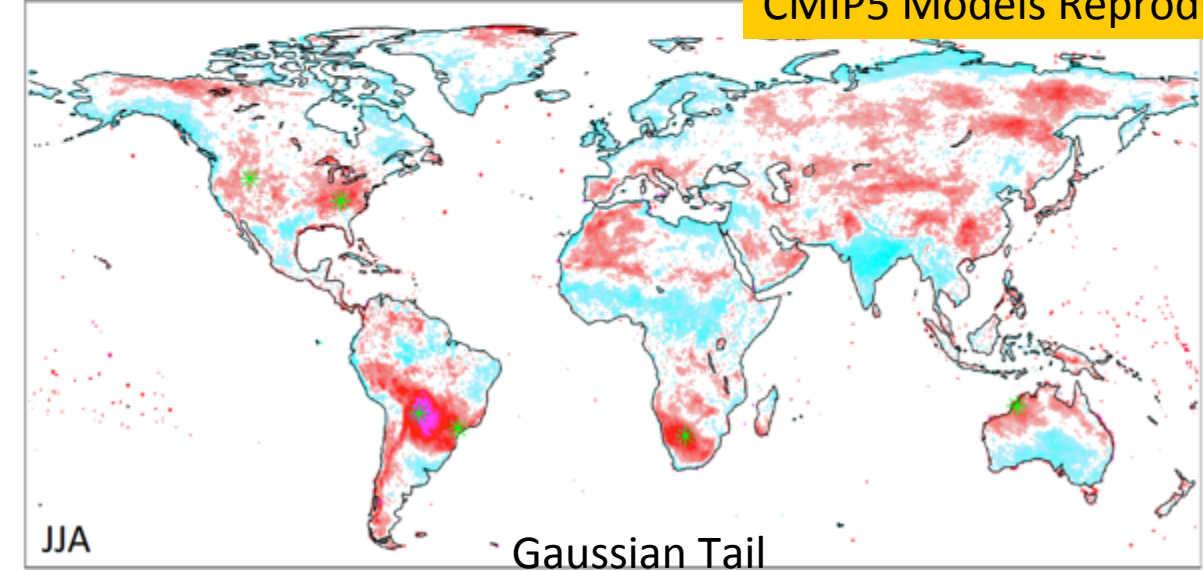
If distribution were Gaussian, a 1 sigma shift would result in an exceedance rate of ~26%



Background



CMIP5 Models Reproduce Short Tails

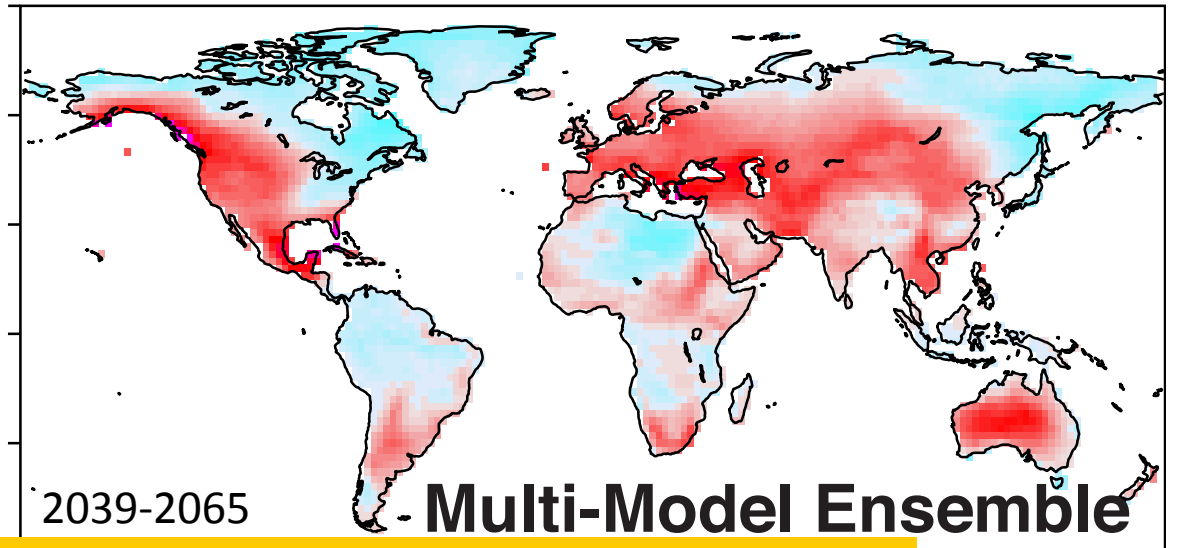
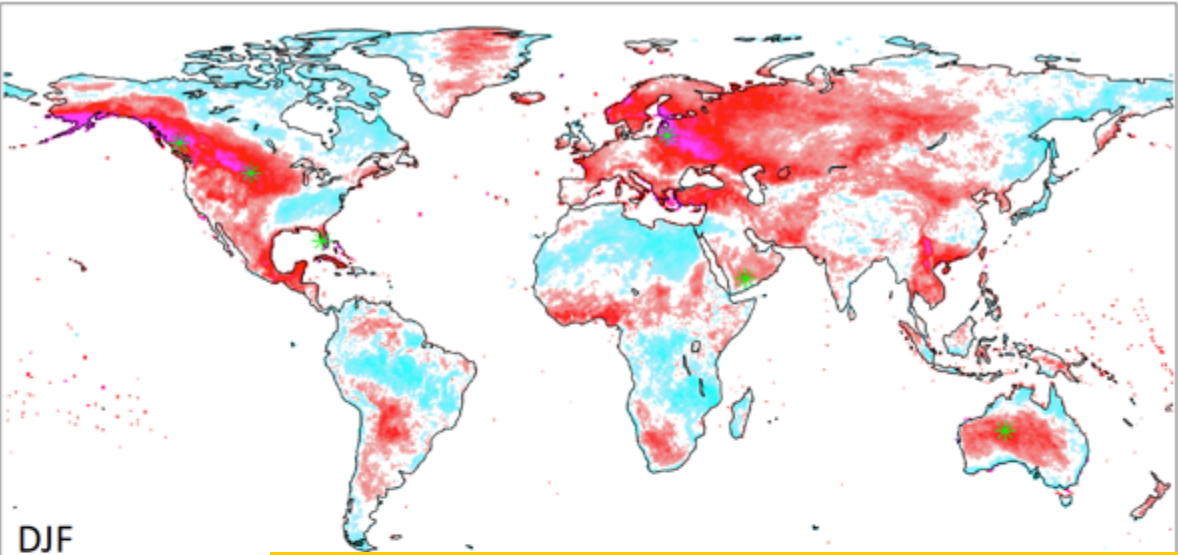


Long tail 0.5 1 1.5 Short Tail

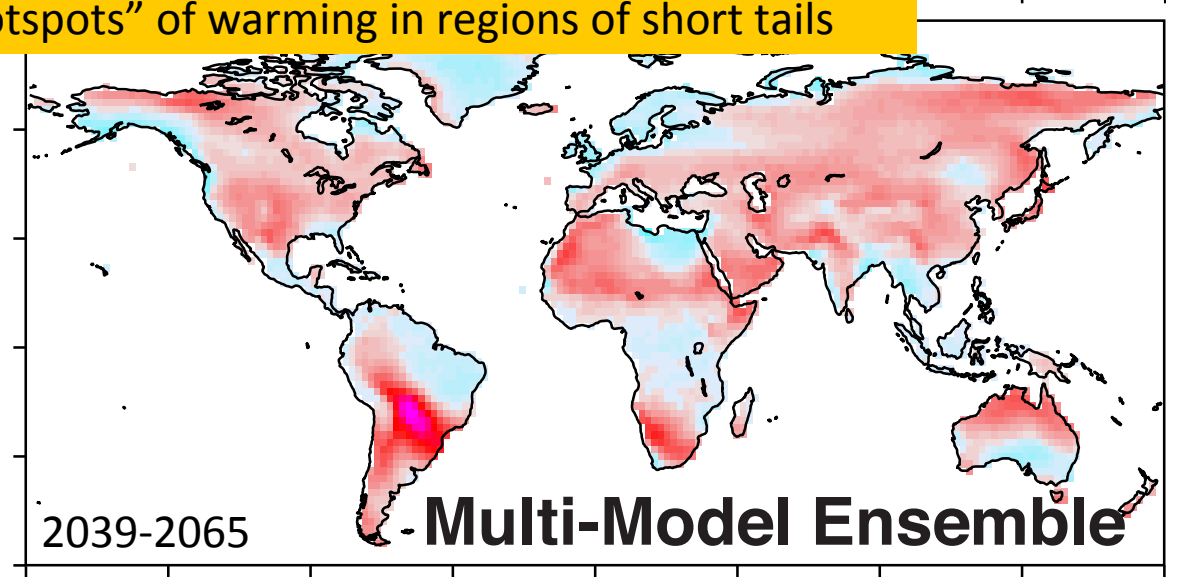
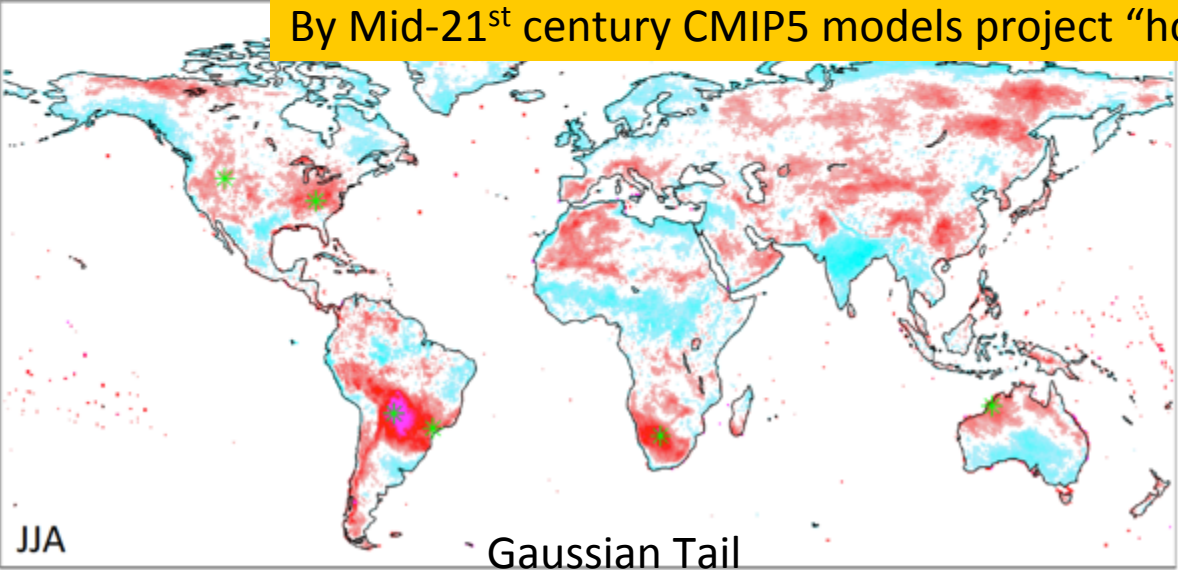
95th percentile exceedances from 0.5 sigma shift/
that expected from shifting a Gaussian

Loikith et al. in revision *J. Climate*

Background



By Mid-21st century CMIP5 models project “hotspots” of warming in regions of short tails



Long tail 0.5 1 1.5 Short Tail

95th percentile exceedances from 0.5 sigma shift/
that expected from shifting a Gaussian

Projected rcp8.5 95th percentile exceedances/
that expected from shifting a Gaussian

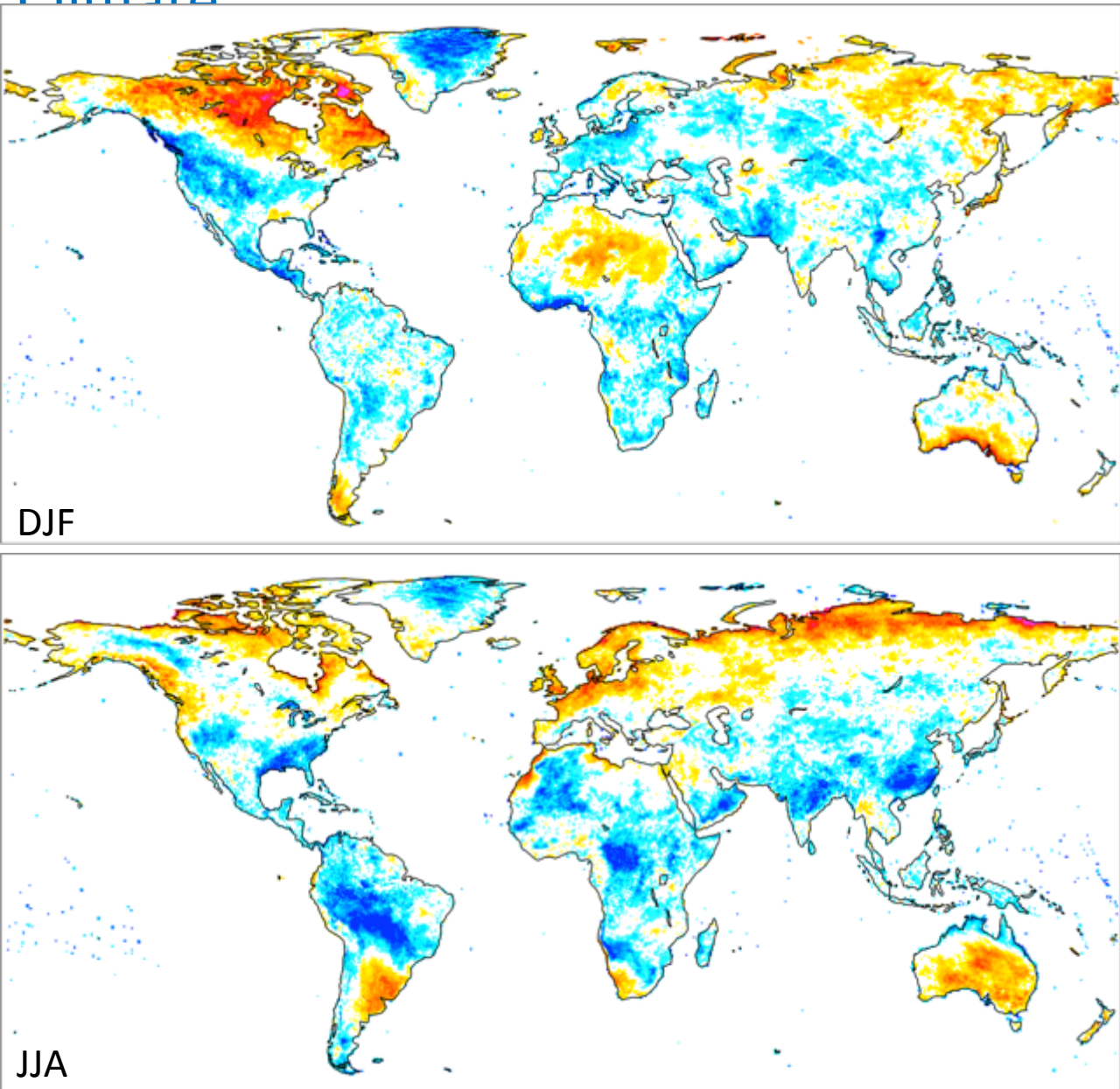
Research objective and questions

Objective: Investigate the effect shorter-than-Gaussian cold side tails have future changes in extreme cold exceedances

Research questions:

- 1) Where do short cold tails exist in the current climate?
- 2) Do CMIP5 global climate models realistically reproduce the spatial geography and magnitude of short tails?
- 3) Under simulated greenhouse warming, do CMIP5 models show more rapid than Gaussian decreases in extreme cold in areas of short cold tails?

Results: Short Cold Tails in the Current Climate



Long cold tail

2

1

1/2

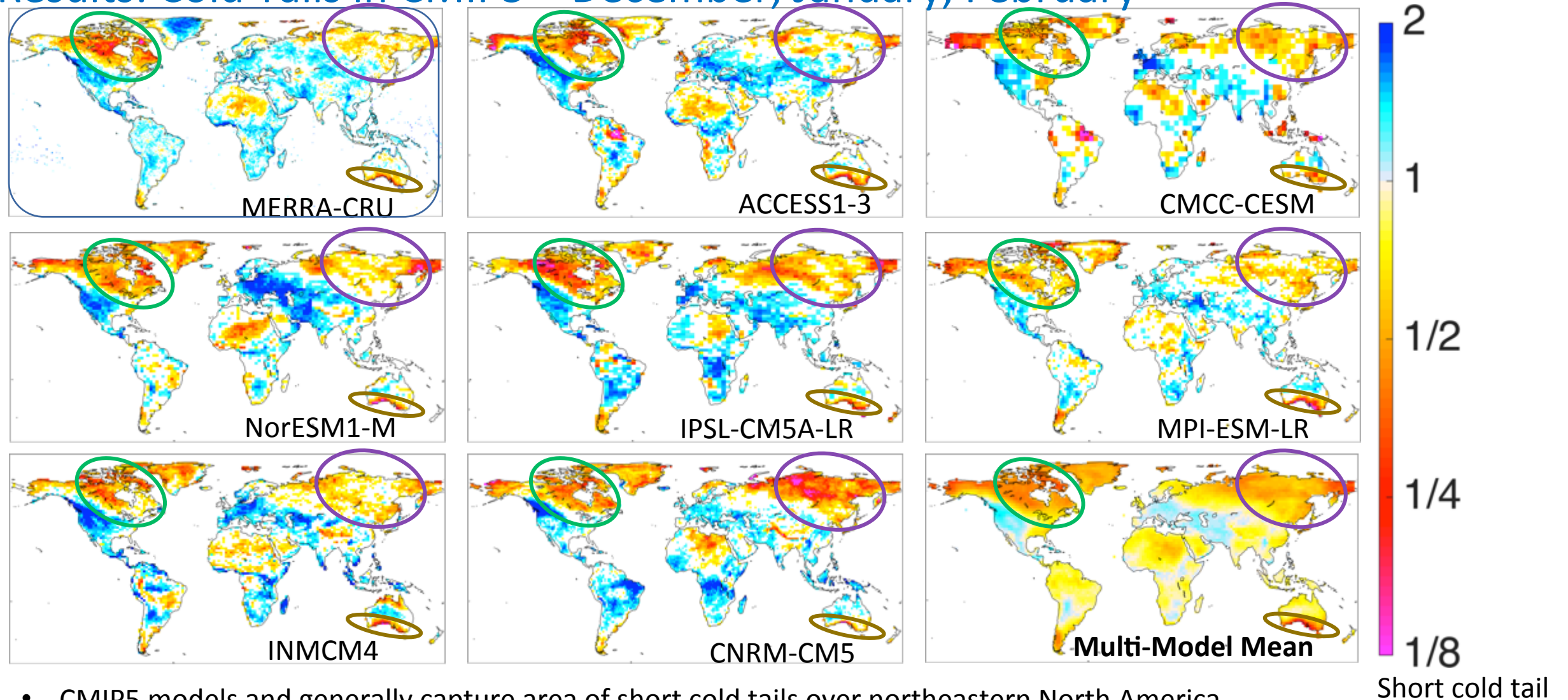
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1/8

Short cold tail

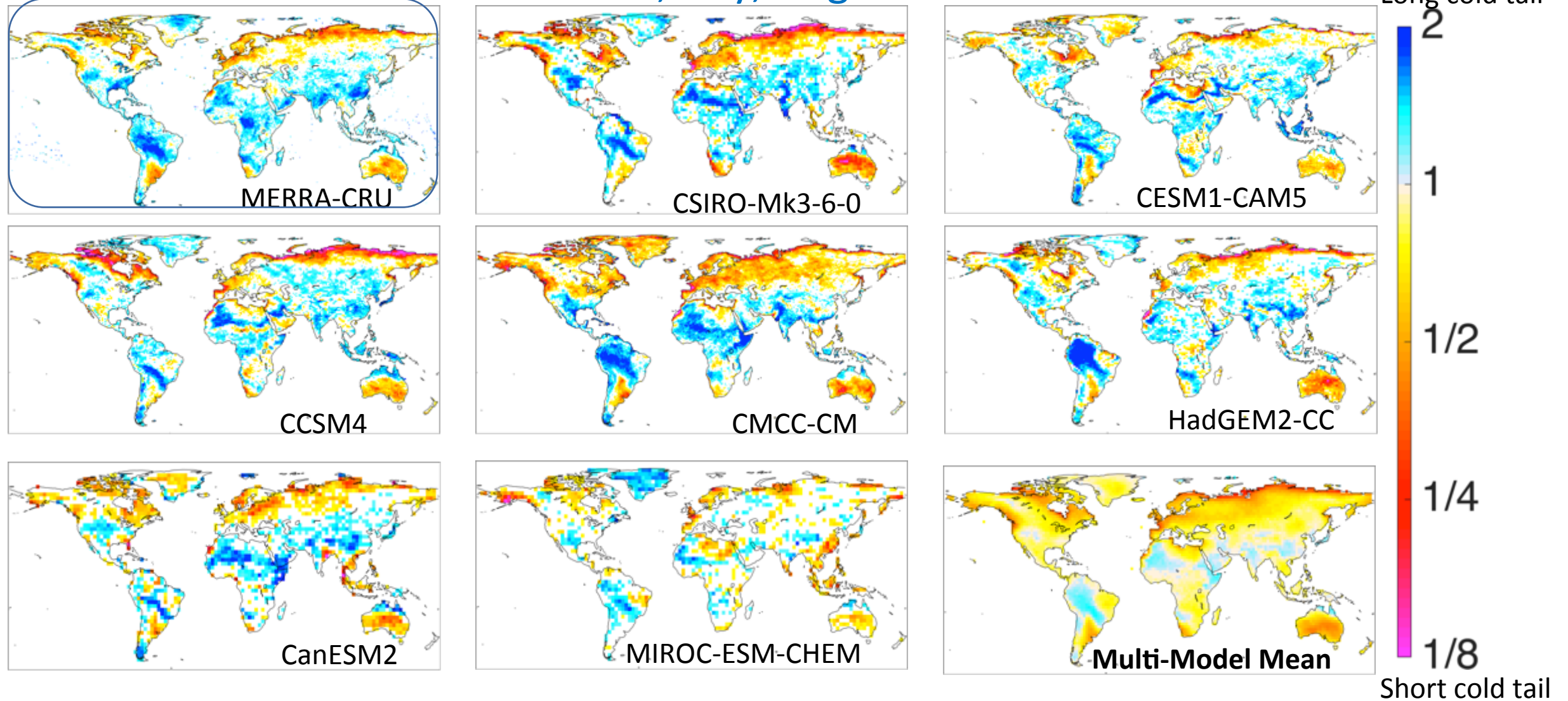
- Ratio of exceedances of the 5th percentile under uniform 0.5 sigma warm shift to that expected from a Gaussian
- Like short warm tails, short cold tails occur in spatially coherent regions

Results: Cold Tails in CMIP5 – December, January, February



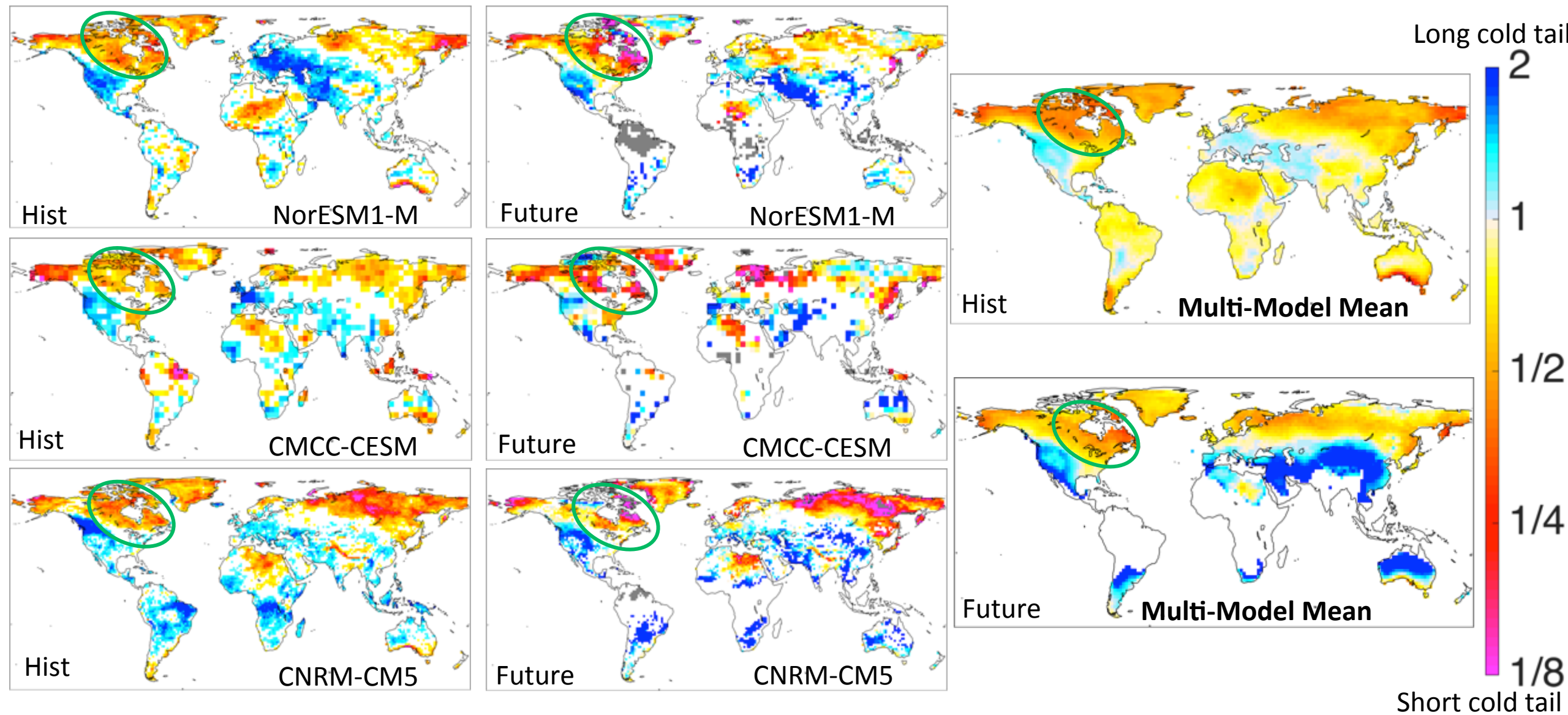
- CMIP5 models and generally capture area of short cold tails over northeastern North America
- Agreement is good, but weaker for northeast Asia
- Good agreement in relatively small region of south coast of Australia

Results: Cold Tails in CMIP5 – June, July, August



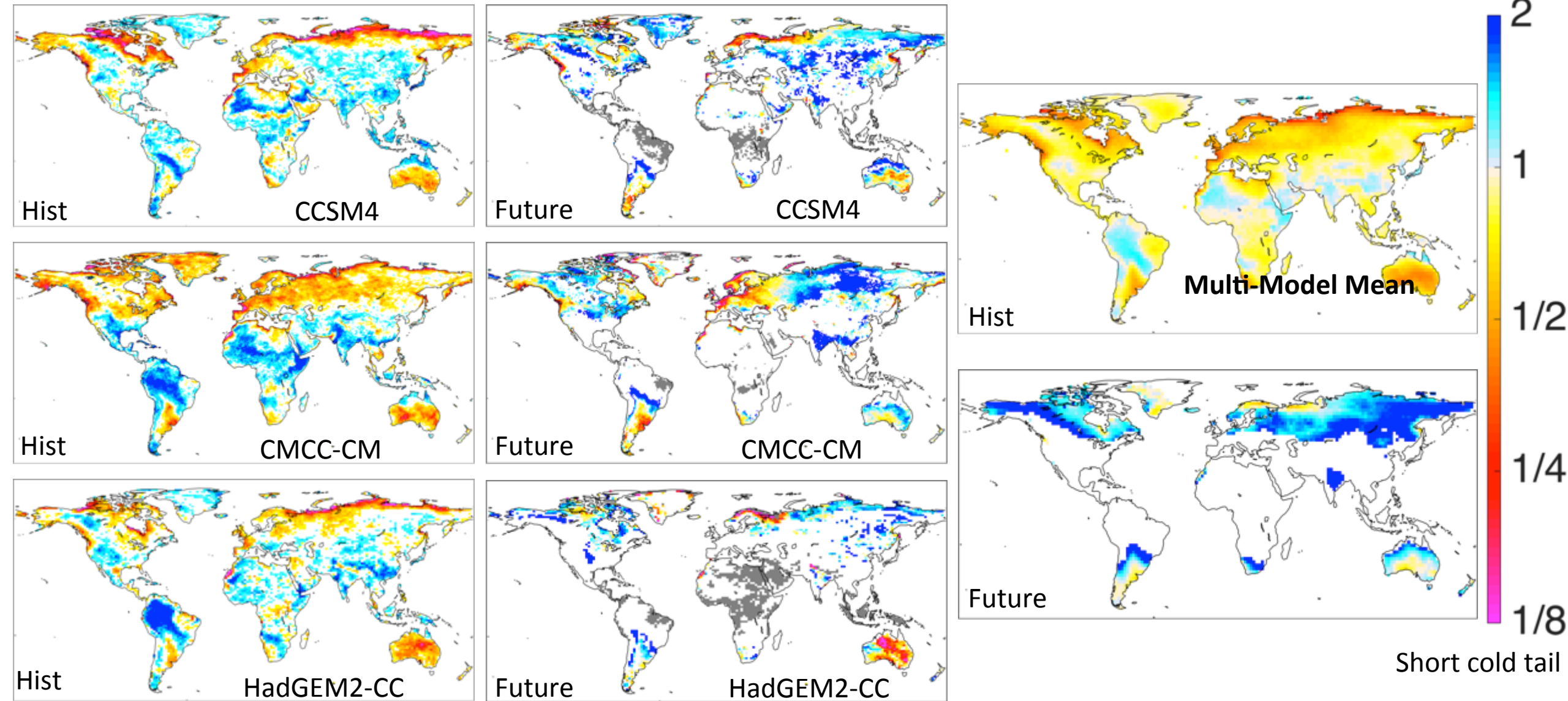
- CMIP5 models and generally capture areas of short tails, even some that are relatively small in scale

Results: Projections of Future Exceedances– December, January, February (2039-2065)



- Future simulated ratio of exceedances to that expected from shifting a Gaussian by the projected mean warming
- Areas of short cold tails show a more rapid-than-Gaussian decrease in extreme cold exceedances in most cases and in the multi model ensemble mean

Results: Cold Tails in CMIP5 – June, July, August



- Results are less clear for northern hemisphere summer, short tails in Australia show some influence on future change
- By mid 21st century most places have warmed by 1 sigma or are projected to no longer exceed 5th percentile
- Short tails are not projected to result in more rapid than Gaussian warming along Arctic Coast in multi model mean

Summary and Conclusions

- Short cold side tails occur in many regions throughout the world
- CMIP5 models generally capture short cold tails in historical simulations
- **Under simulated future warming, regions of short cold tails are projected to see a rapid decrease in the probability of extreme cold events**
- Future work to focus on mechanisms associated with short tails and with future change in short tailed regions

Thank You!

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