Assessing internal variability of climate variables as a driving force for ice sheet model simulations

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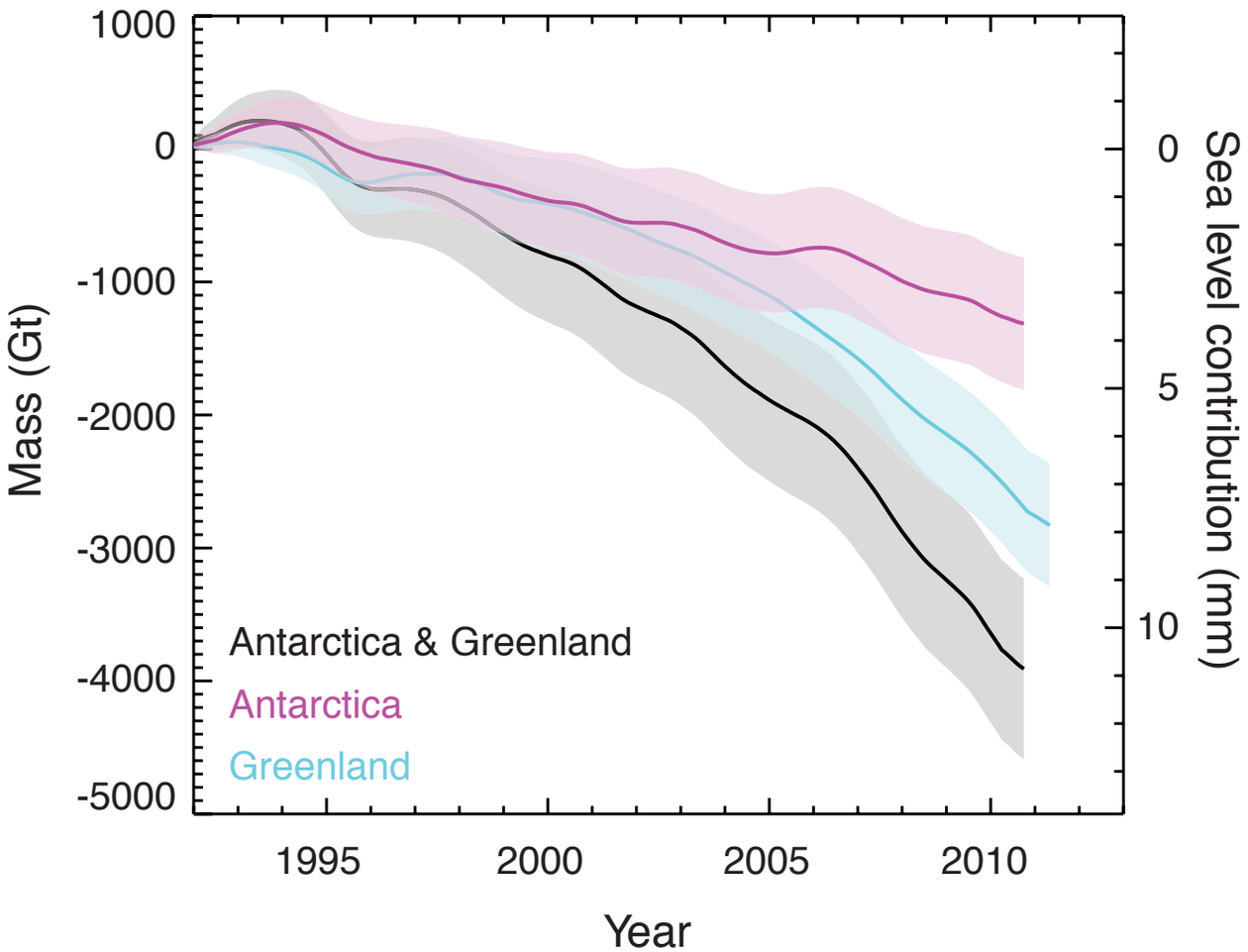
2. *Department of Geosciences, The Pennsylvania State University*
3. *Earth and Environmental Systems Institute, The Pennsylvania State University*

16th EMS Annual Meeting
& 11th European Conference on Applied Climatology
Session: UC4 The Cryosphere and its interactions with the climate system
Abstract ID: EMS2016-608

Photo credit: Ralph Lee Hopkins,
National Geographic Creative

How do ice sheets affect climate?

-Recent ice sheet changes



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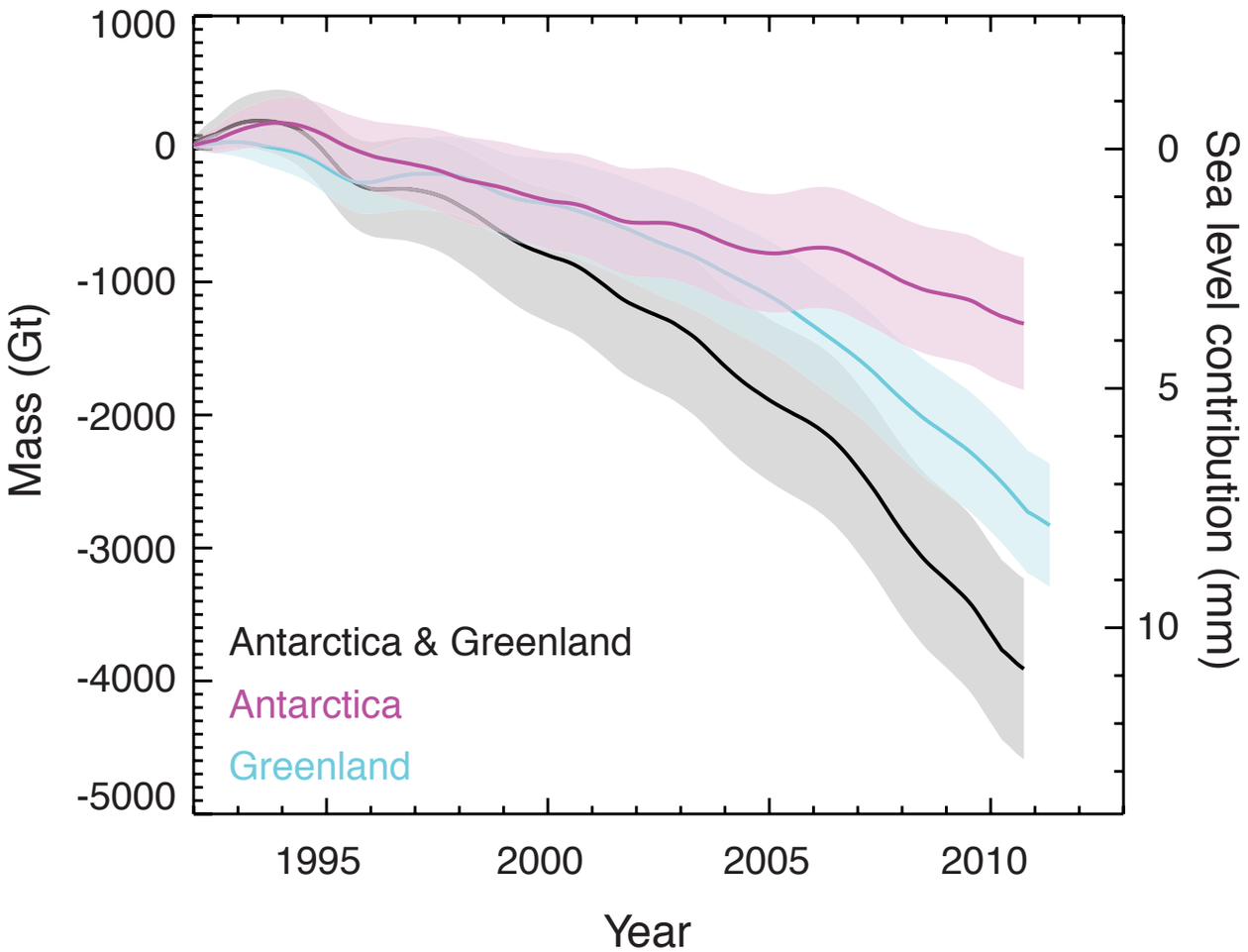

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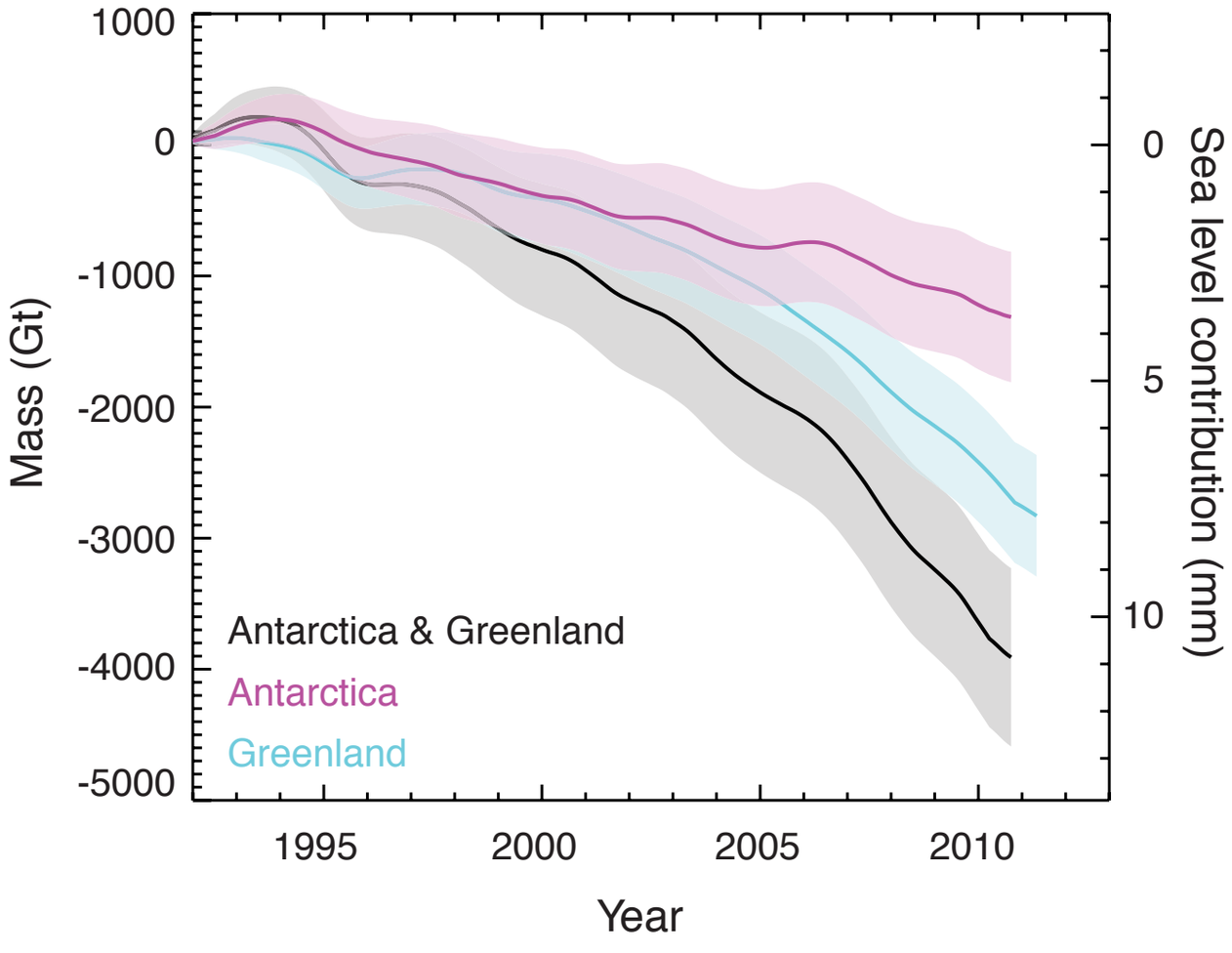

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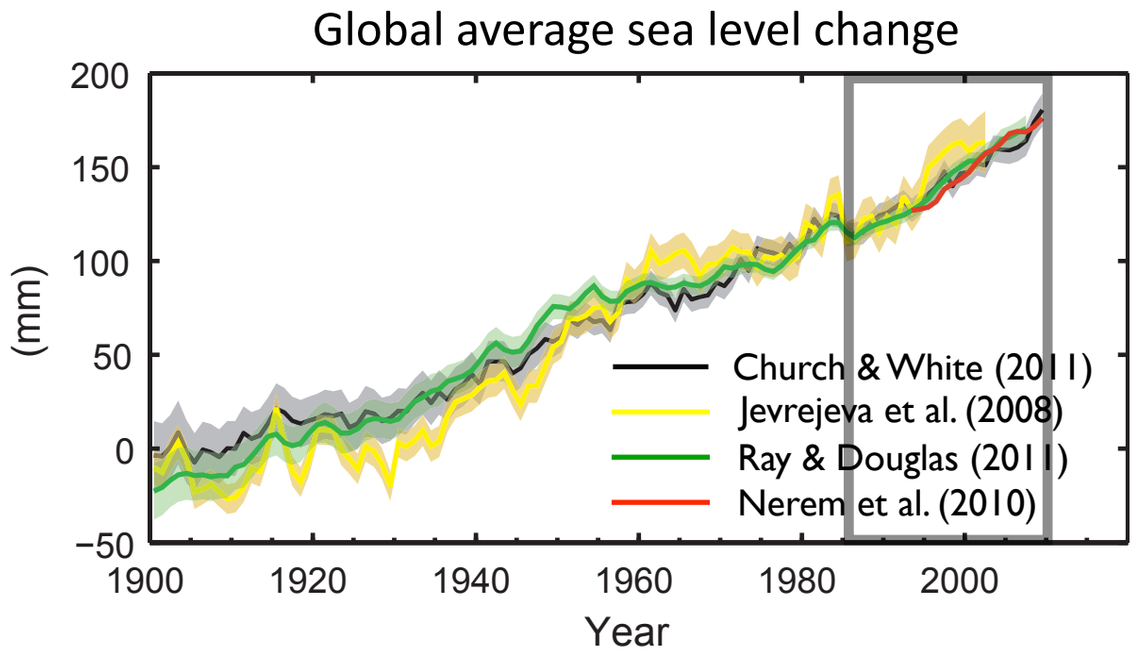
Global sea level is rising!



IPCC Climate Change 2013: The Physical Science Basis Summary for Policymakers

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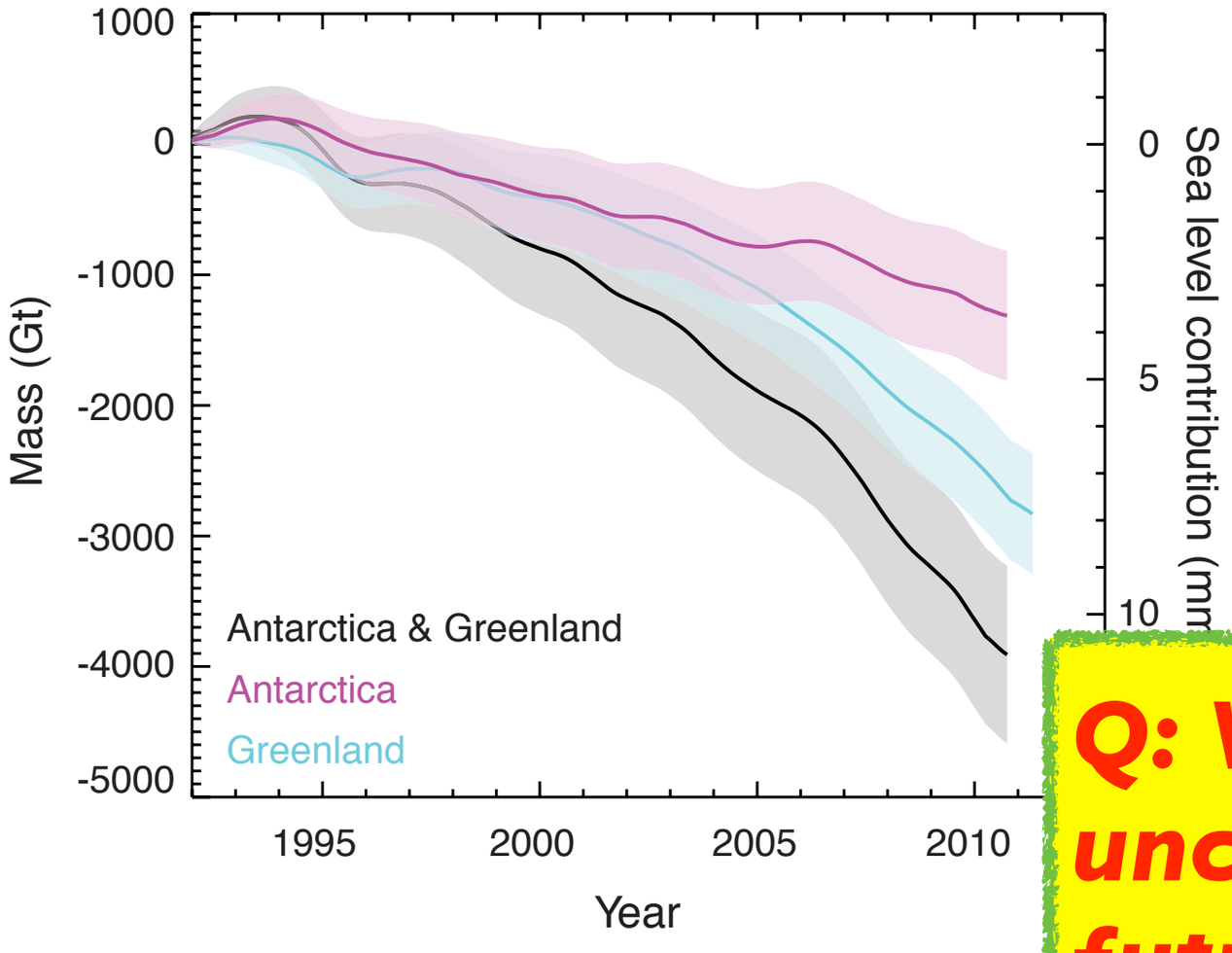

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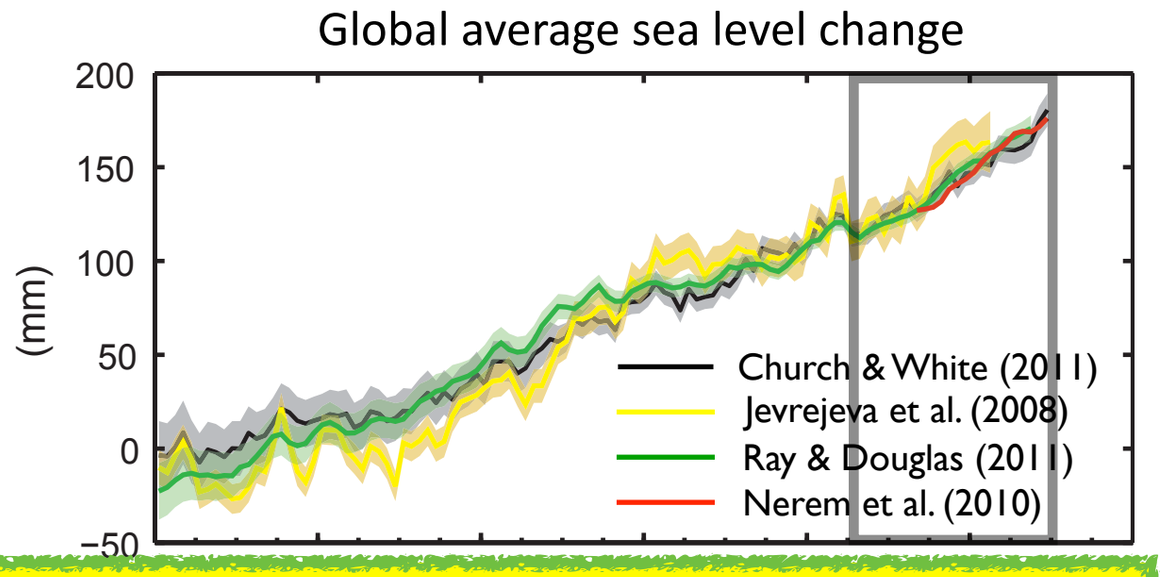

Q: What are the sources of uncertainties for projecting future SLR (sea level rise)?

IPCC: Intergovernmental Panel on Climate Change

Uncertainty in projecting future SLR (ice sheet)

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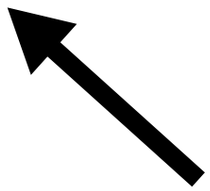

Ice sheet response to future climate change

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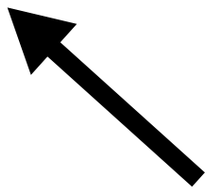

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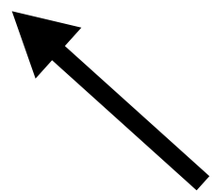

Uncertainty in projecting future climate

Sources of uncertainty in future climate projections

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Forcing

(e.g. different RCPs…)

RCP: Representative Concentration Pathways

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(model physics, resolutions, parameterizations…)

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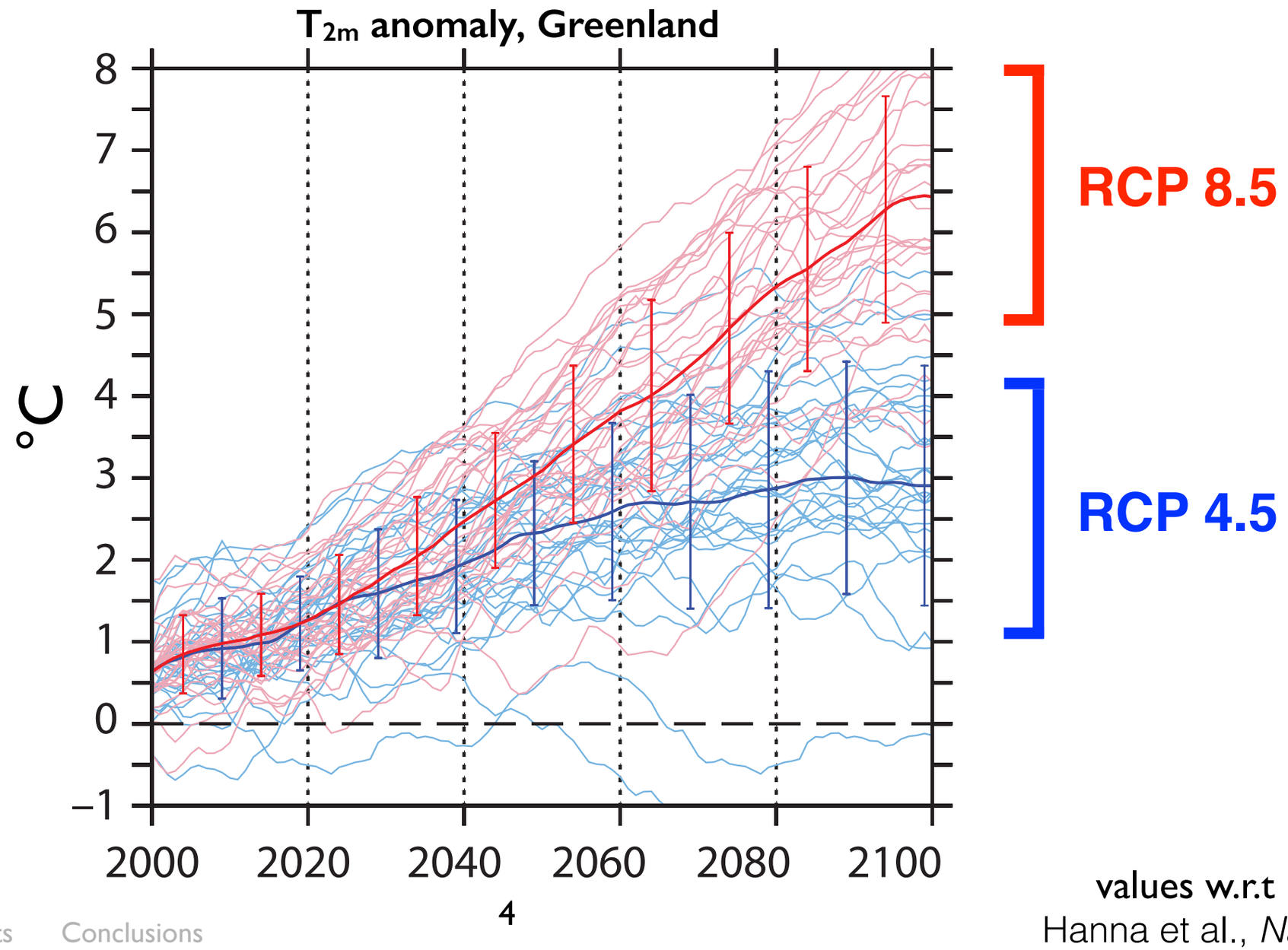

values w.r.t 1970–99

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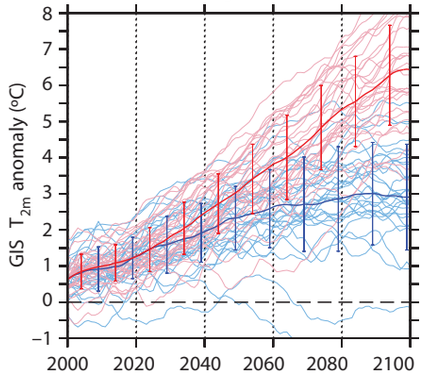

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Internal variability

(feedbacks in climate system; different initial conditions)

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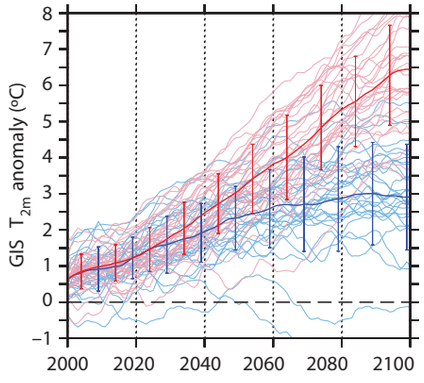

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← Not robustly assessed in IPCC, CMIP5

Experiments for studying internal variability effects on ice sheet

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climate model

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[*Sriver et al., GRL (2015)*]

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climate model → *extract*

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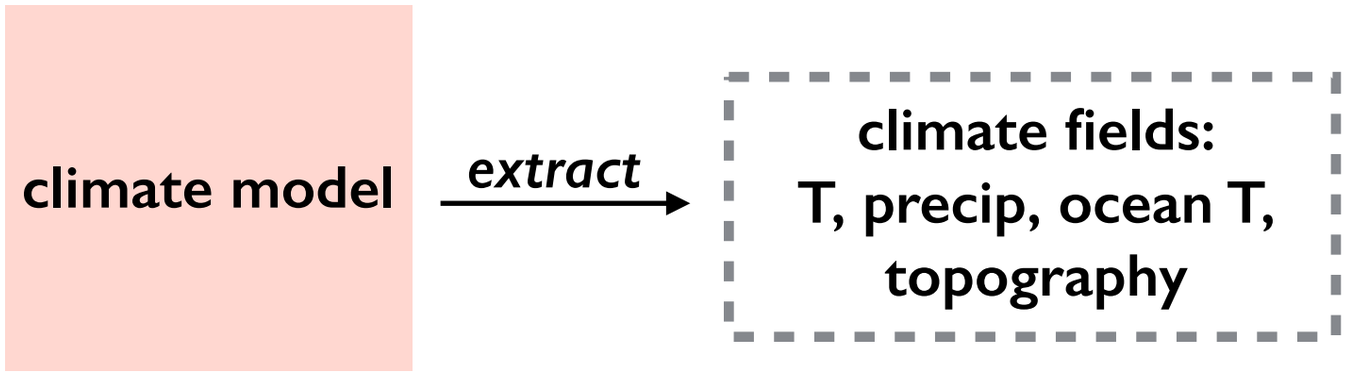

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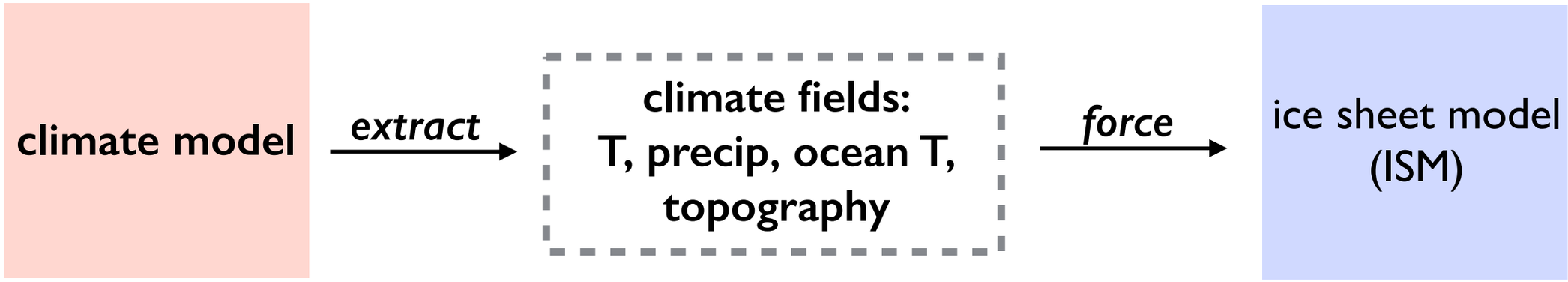

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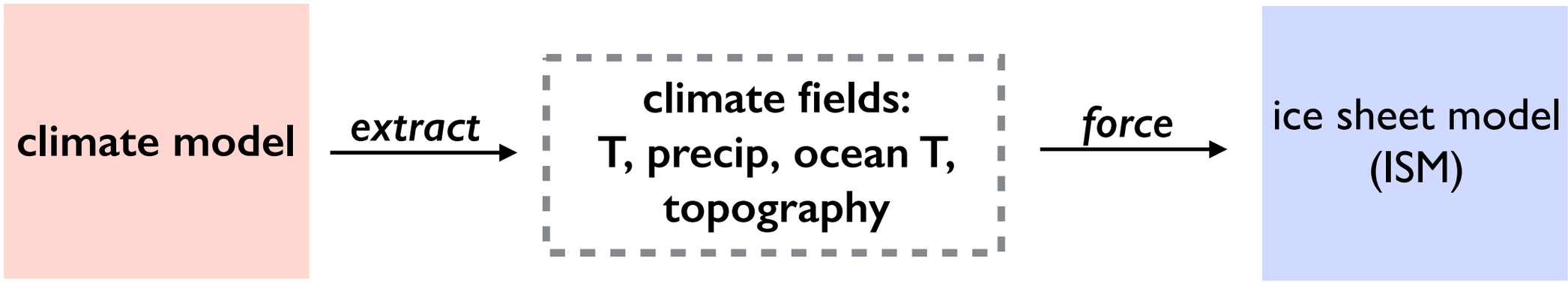

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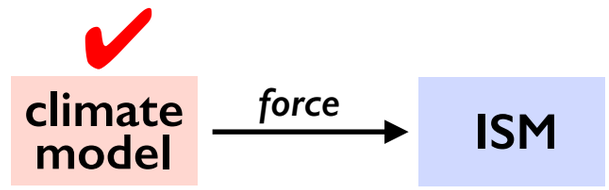
- 3D ice sheet model (PSU 3D ISM)

  [*Pollard and DeConto, 2012*]

Modelling internal variability

[*Sriver et al., GRL* (2015)]

- CESM v1.0, resolution ~ 3.75°



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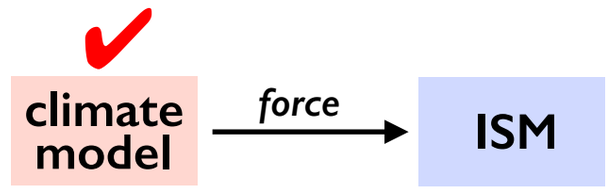

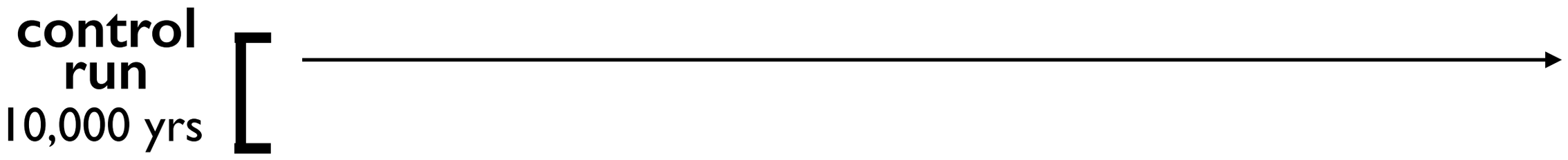

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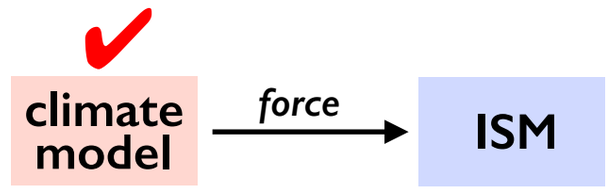

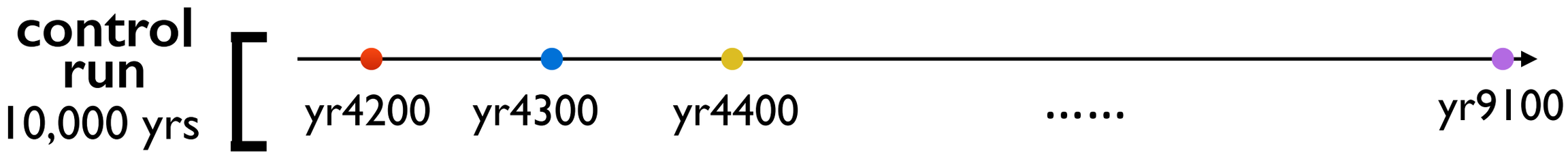

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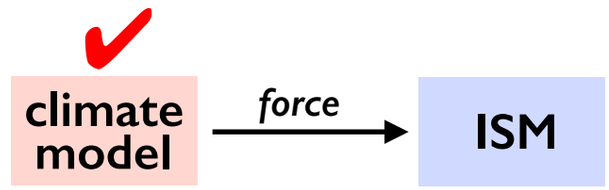

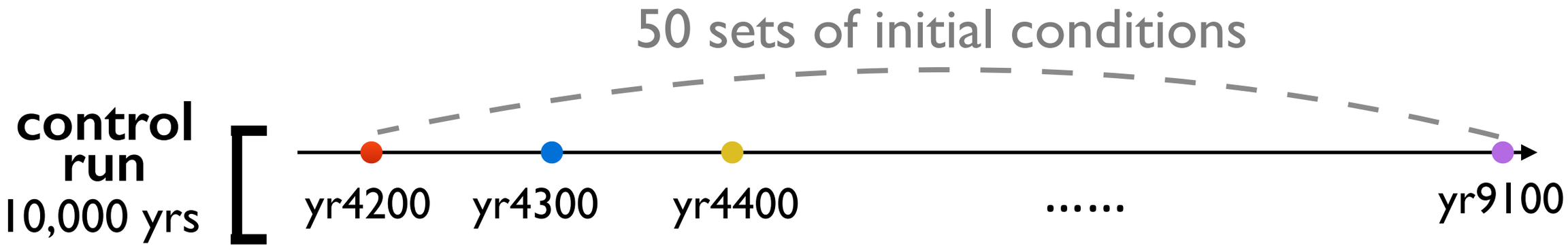

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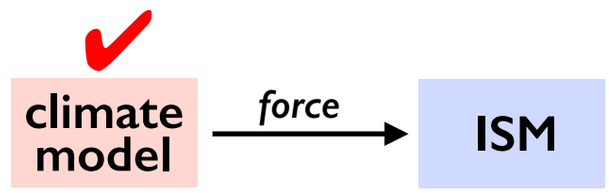

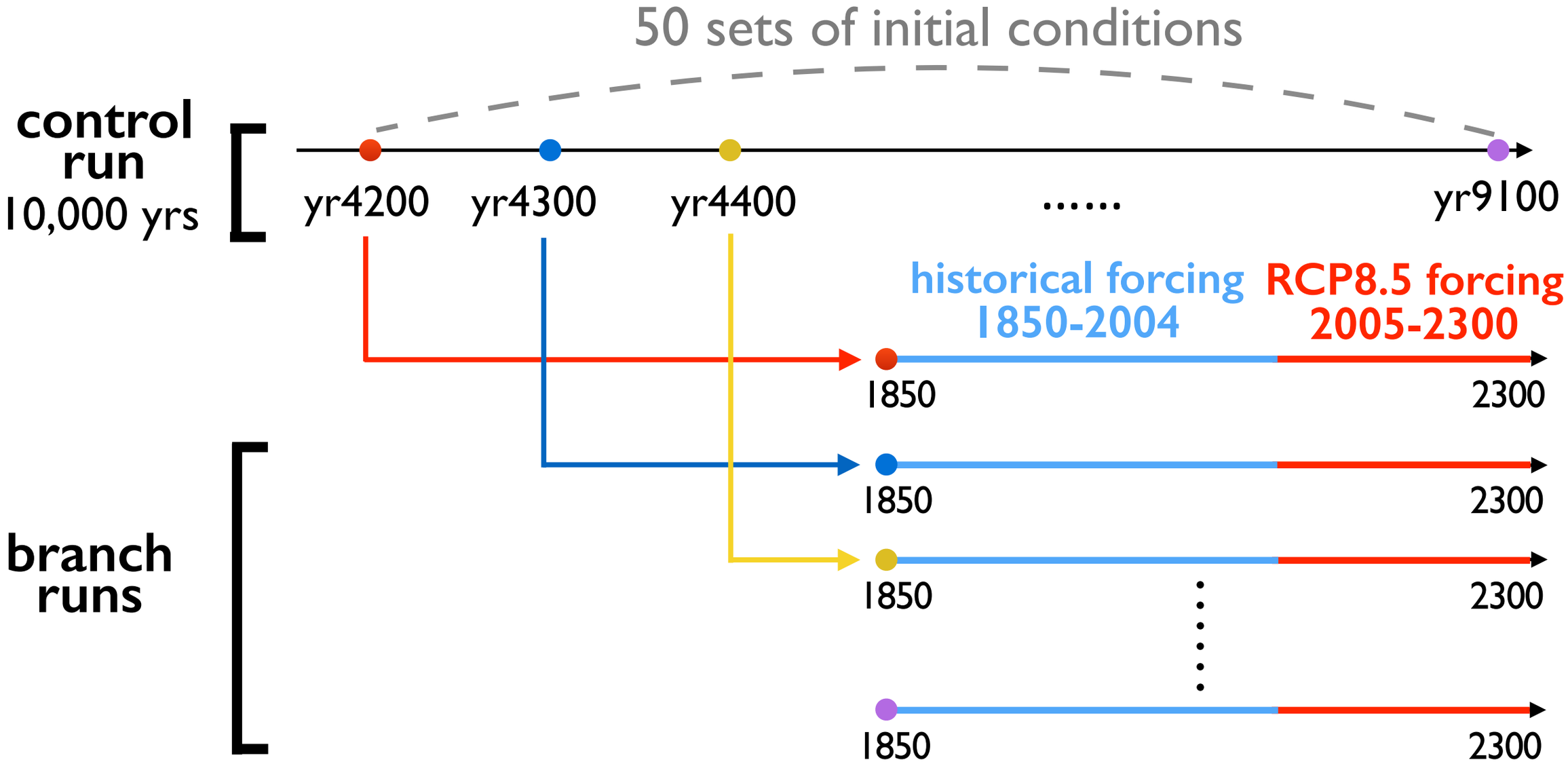

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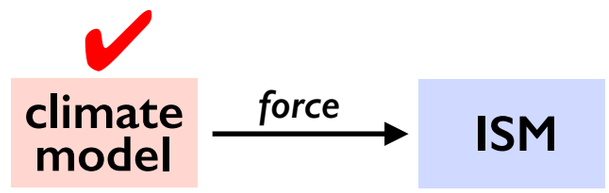

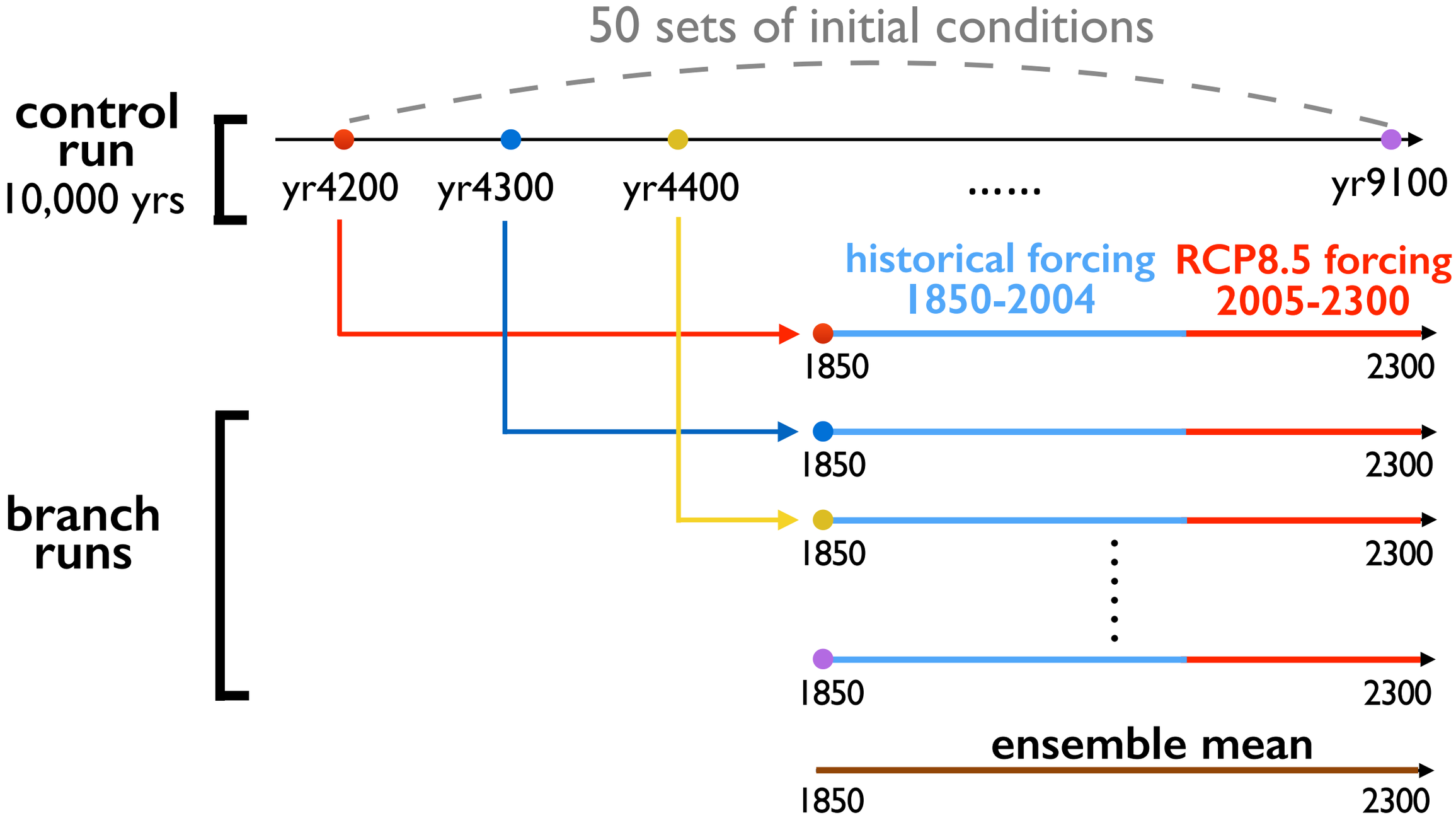

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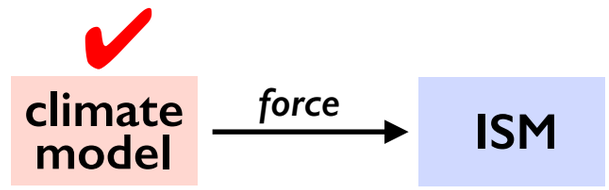
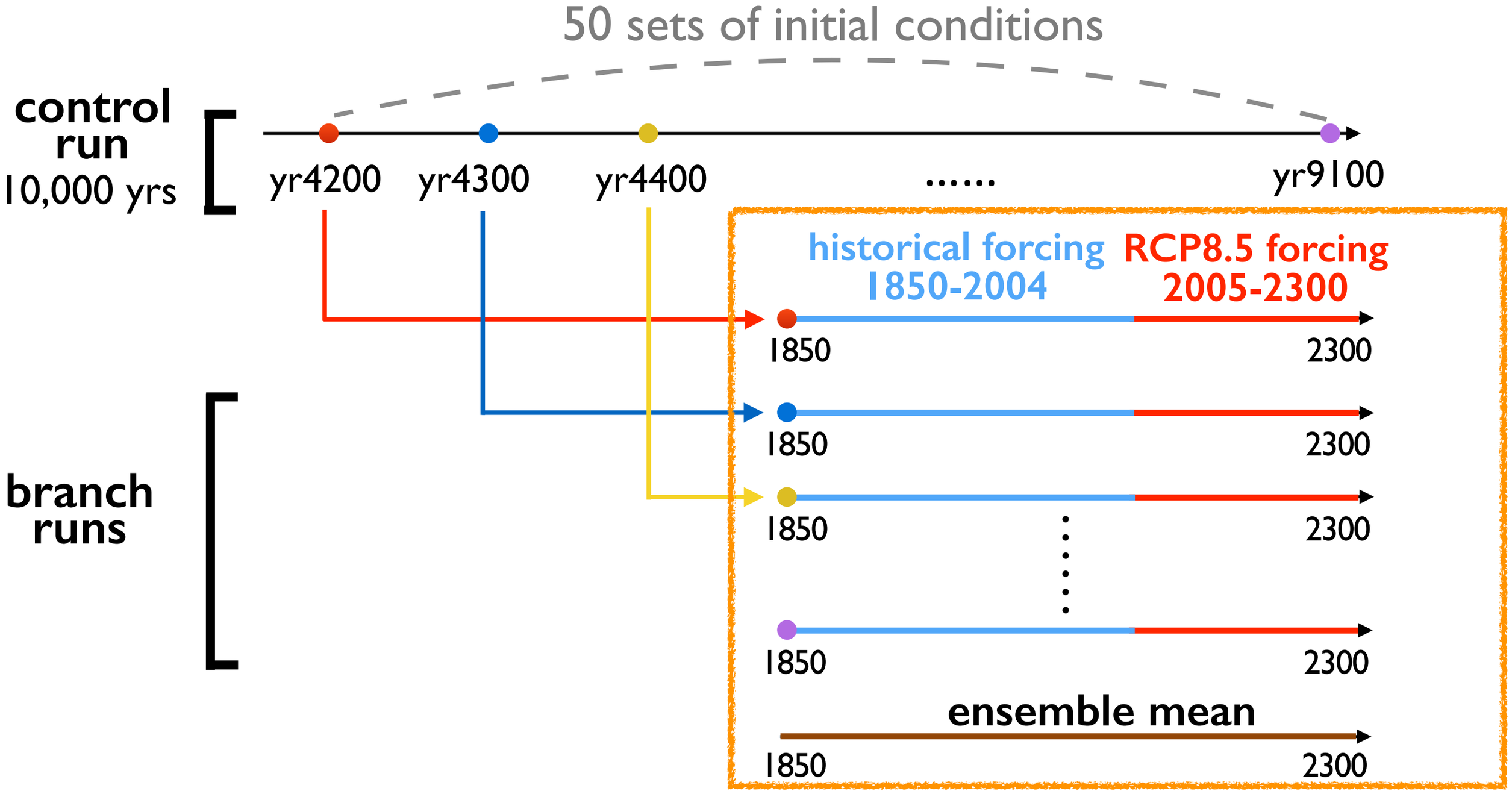
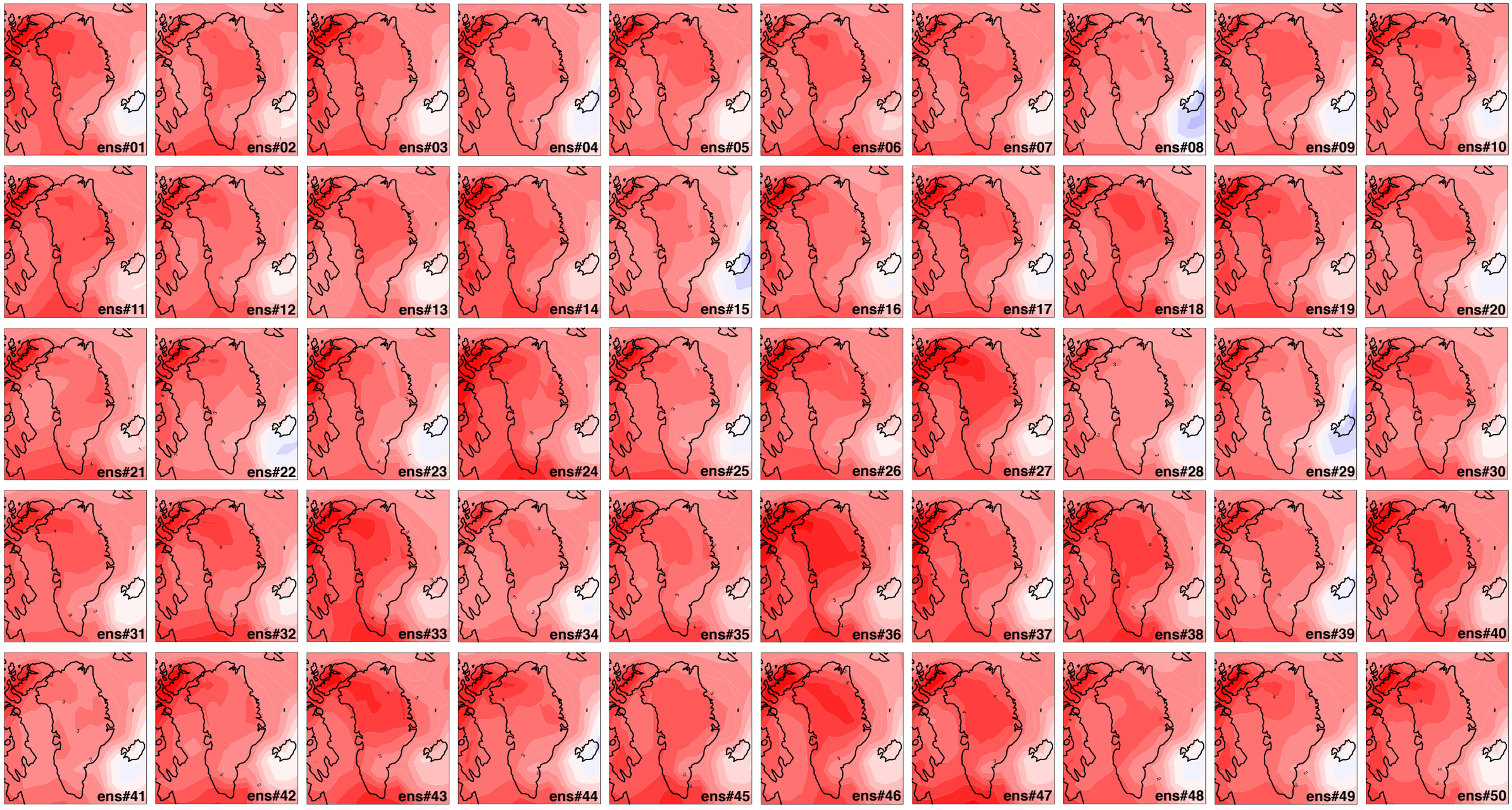




Impact of internal variability on Greenland

T_{2m} trend of SFK ensemble, JJA, 2005-2099



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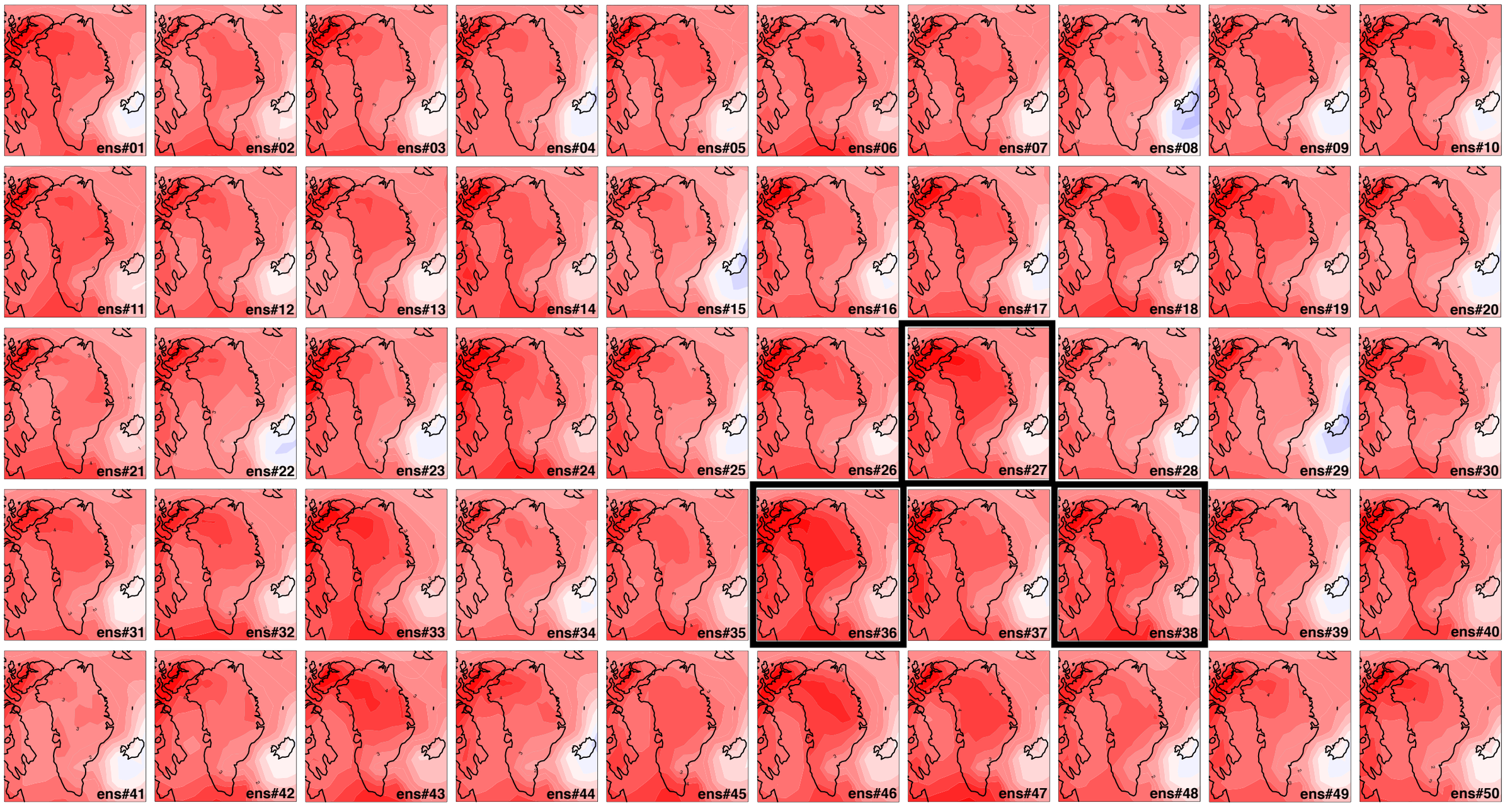

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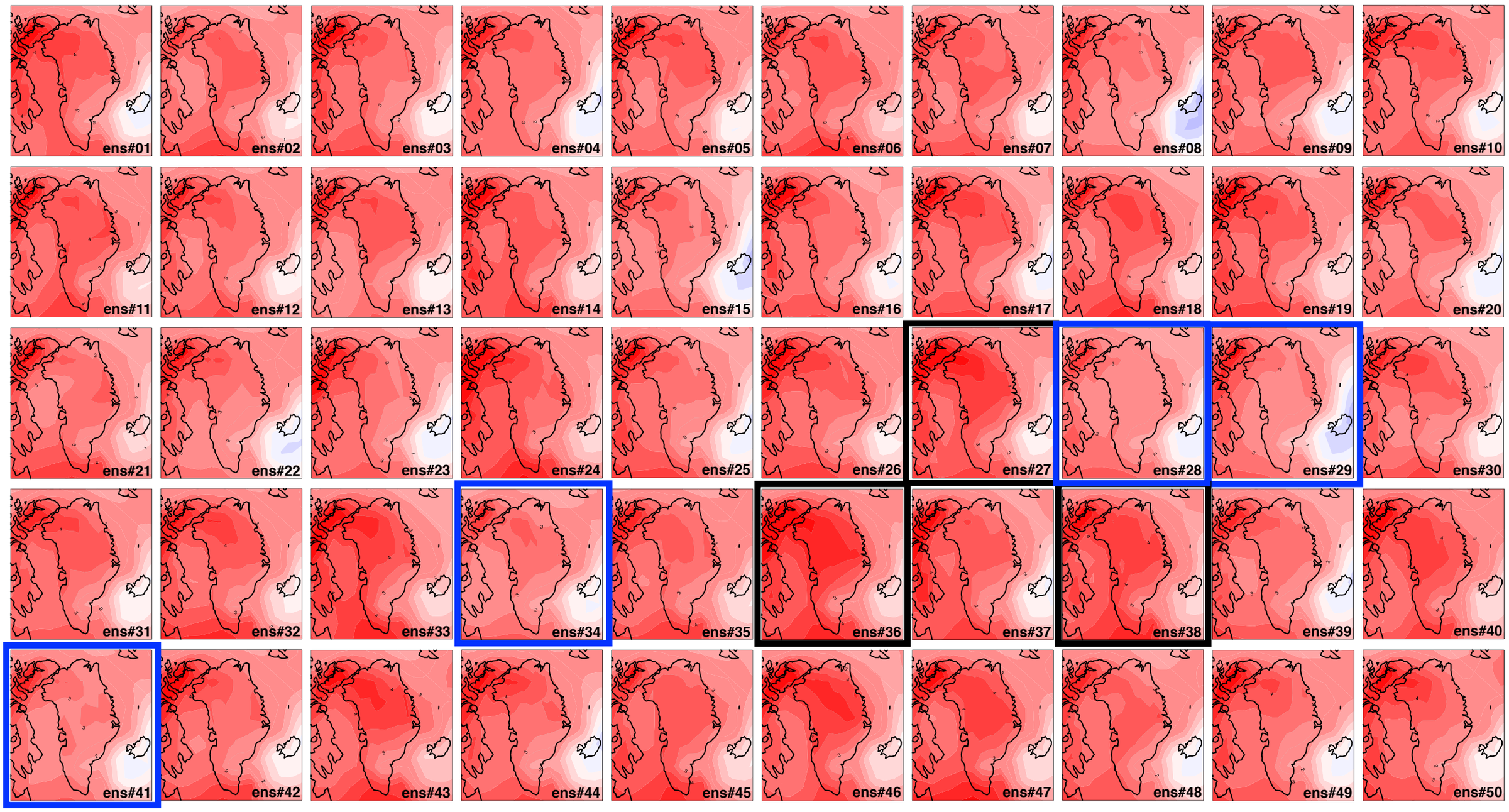

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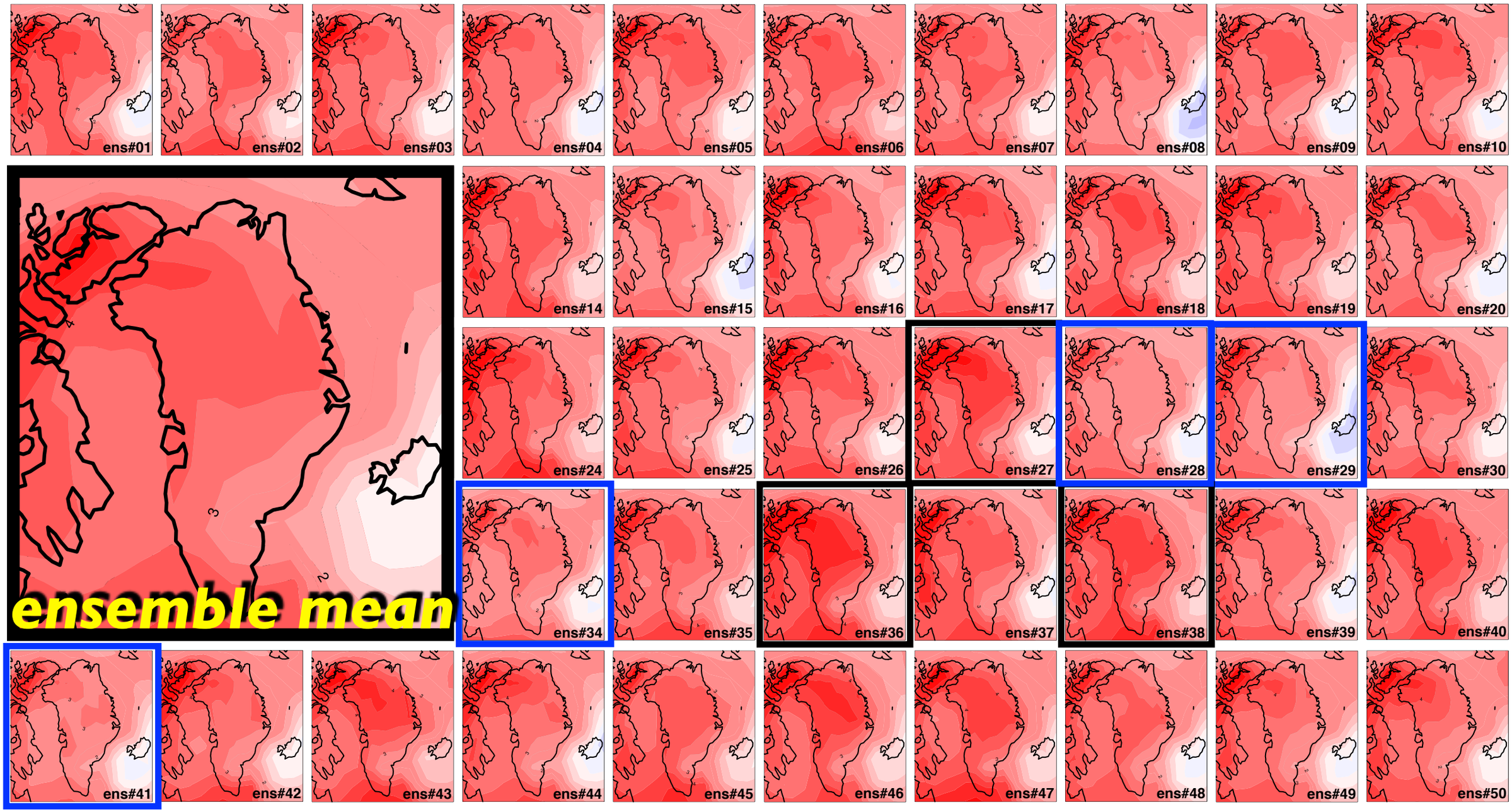

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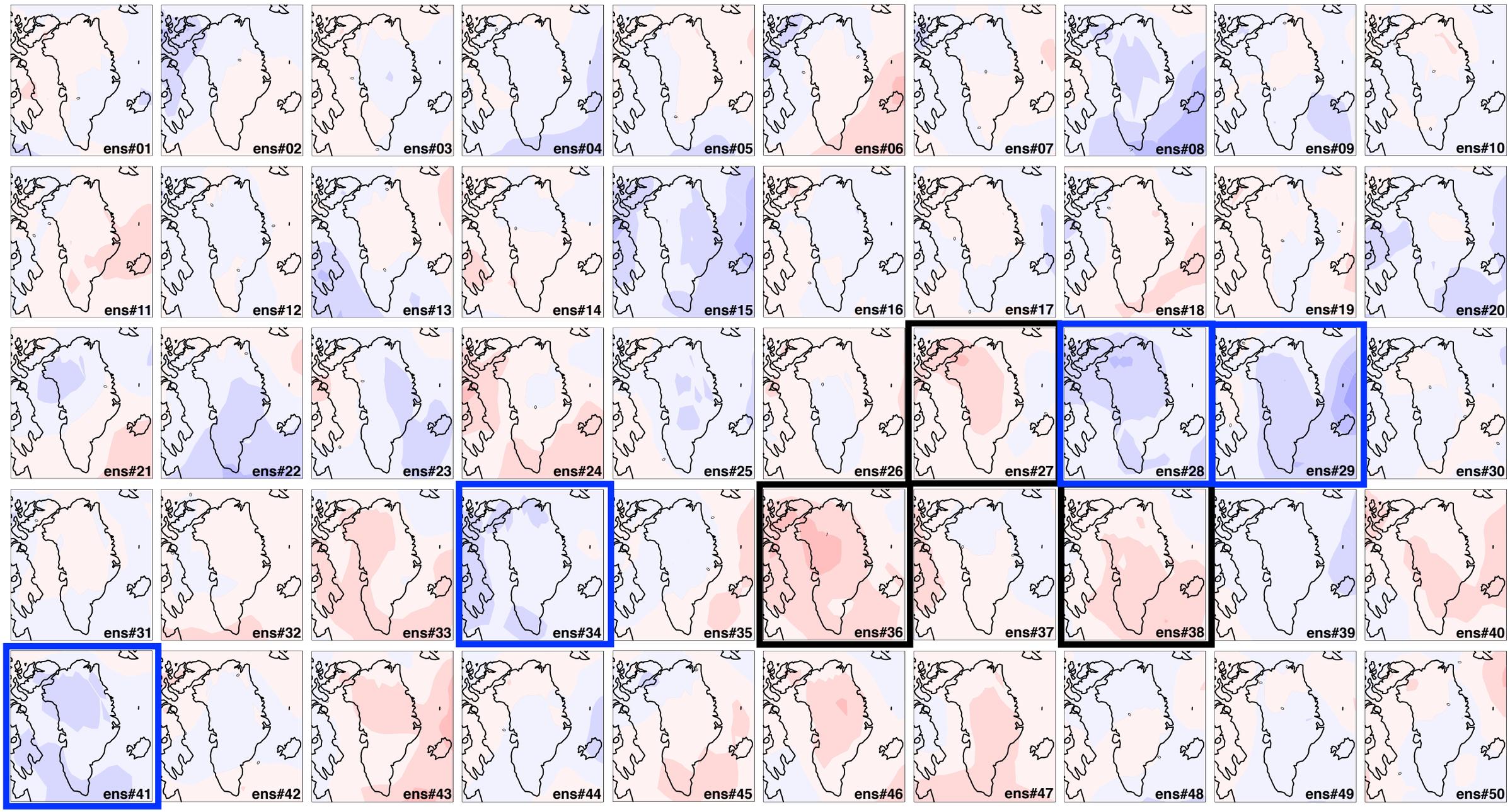

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Opposite trends of internal variability can result in different responses in ensemble members

ens#09 ens#10
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ens#21 ens#22 ens#23 ens#24 ens#25 ens#26 ens#27 ens#28 ens#29 ens#30
ens#31 ens#32 ens#33 ens#34 ens#35 ens#36 ens#37 ens#38 ens#39 ens#40
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-5 -4 -3 -2 -1 0 1 2 3 4 5 °C

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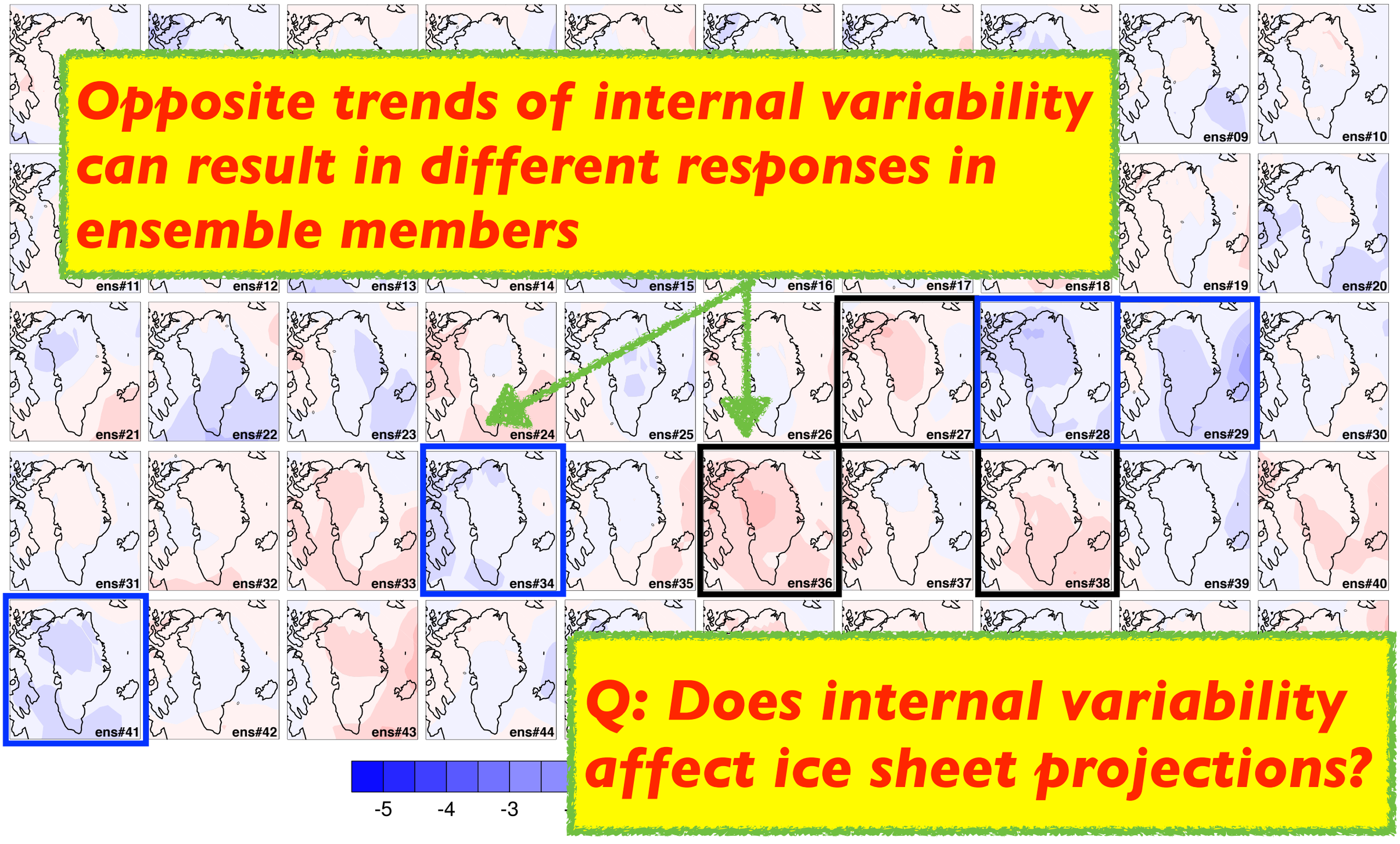

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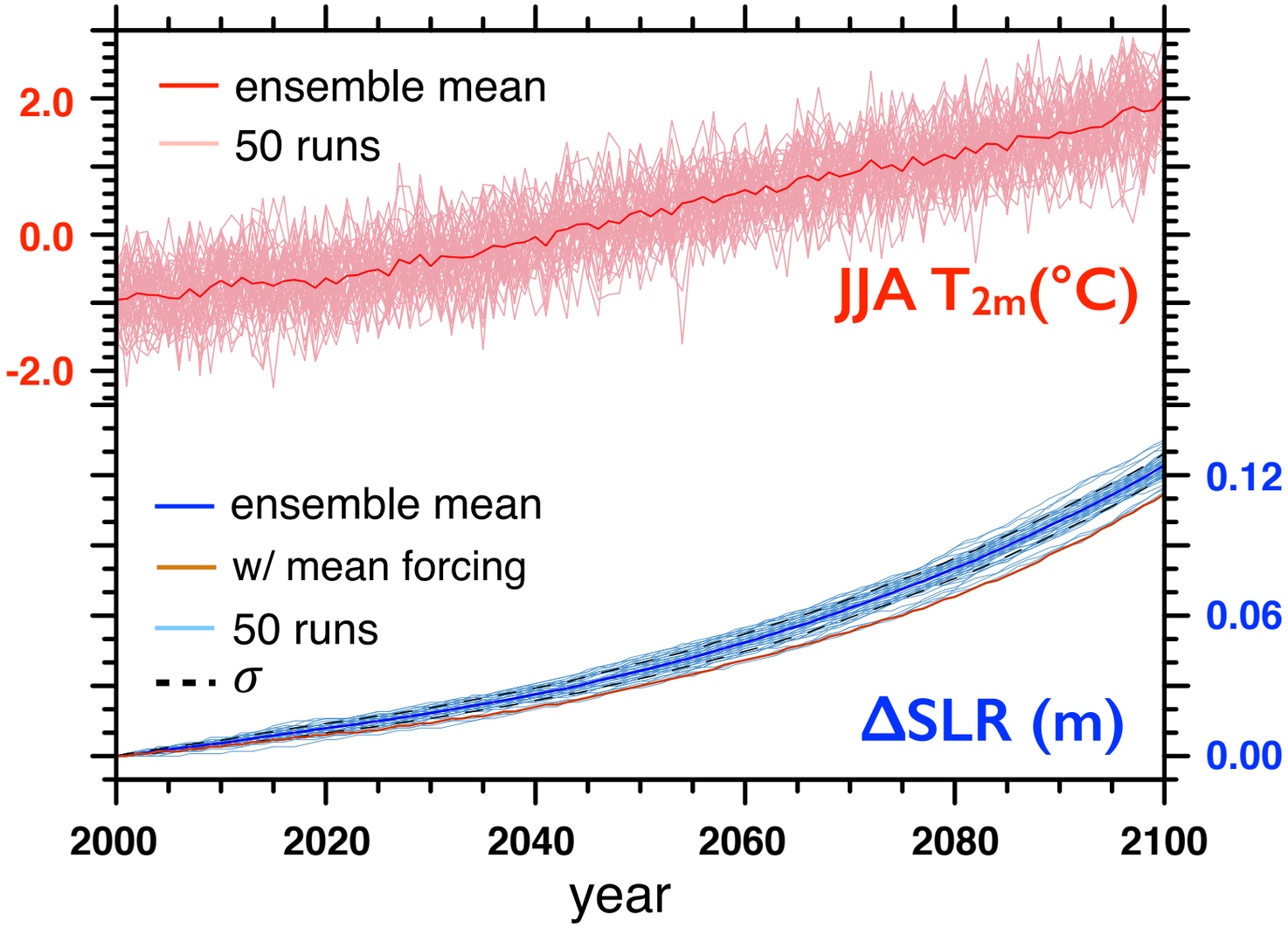
Q: Does internal variability affect ice sheet projections?

Response of sea level contribution to internal variability



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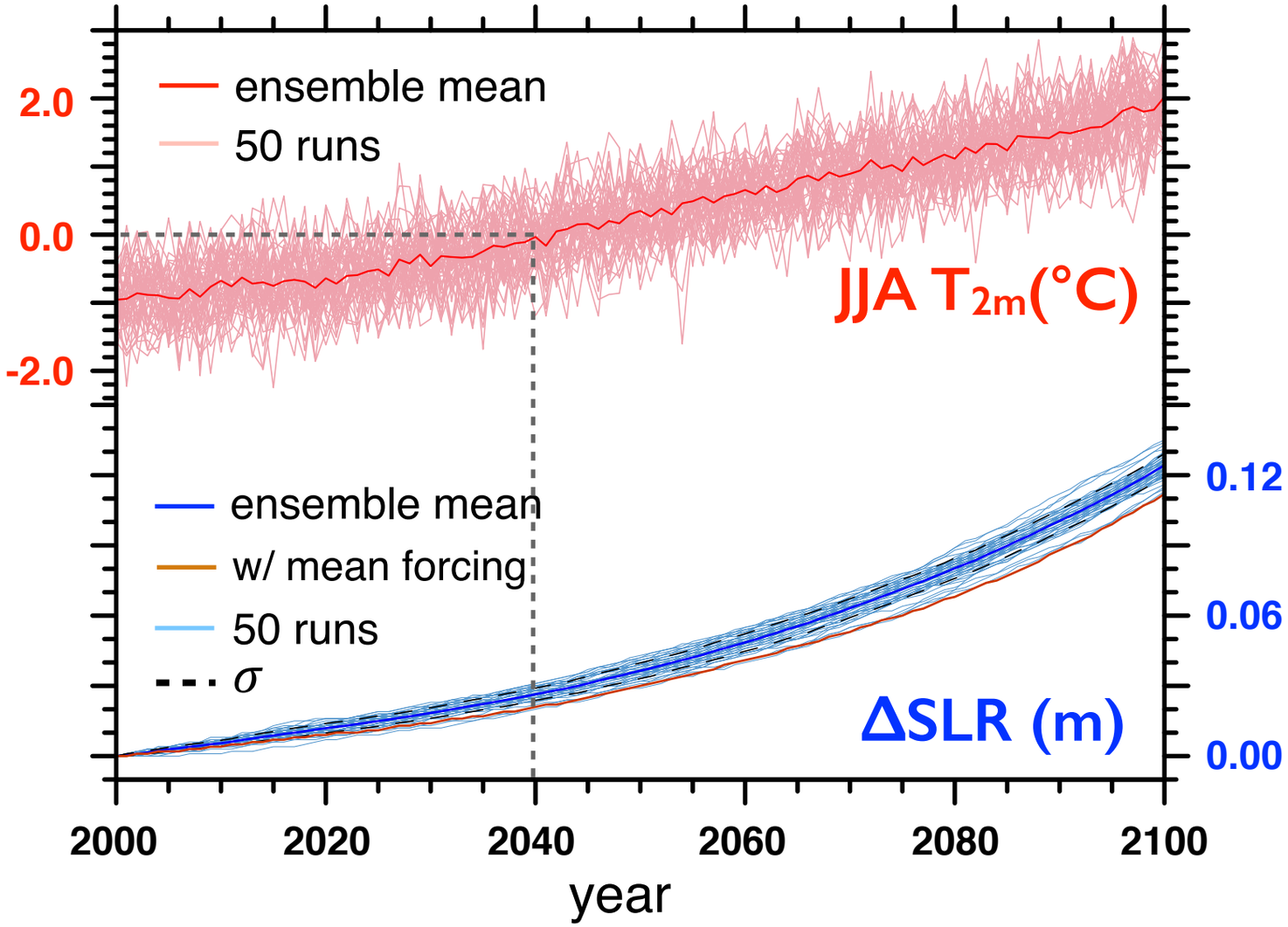

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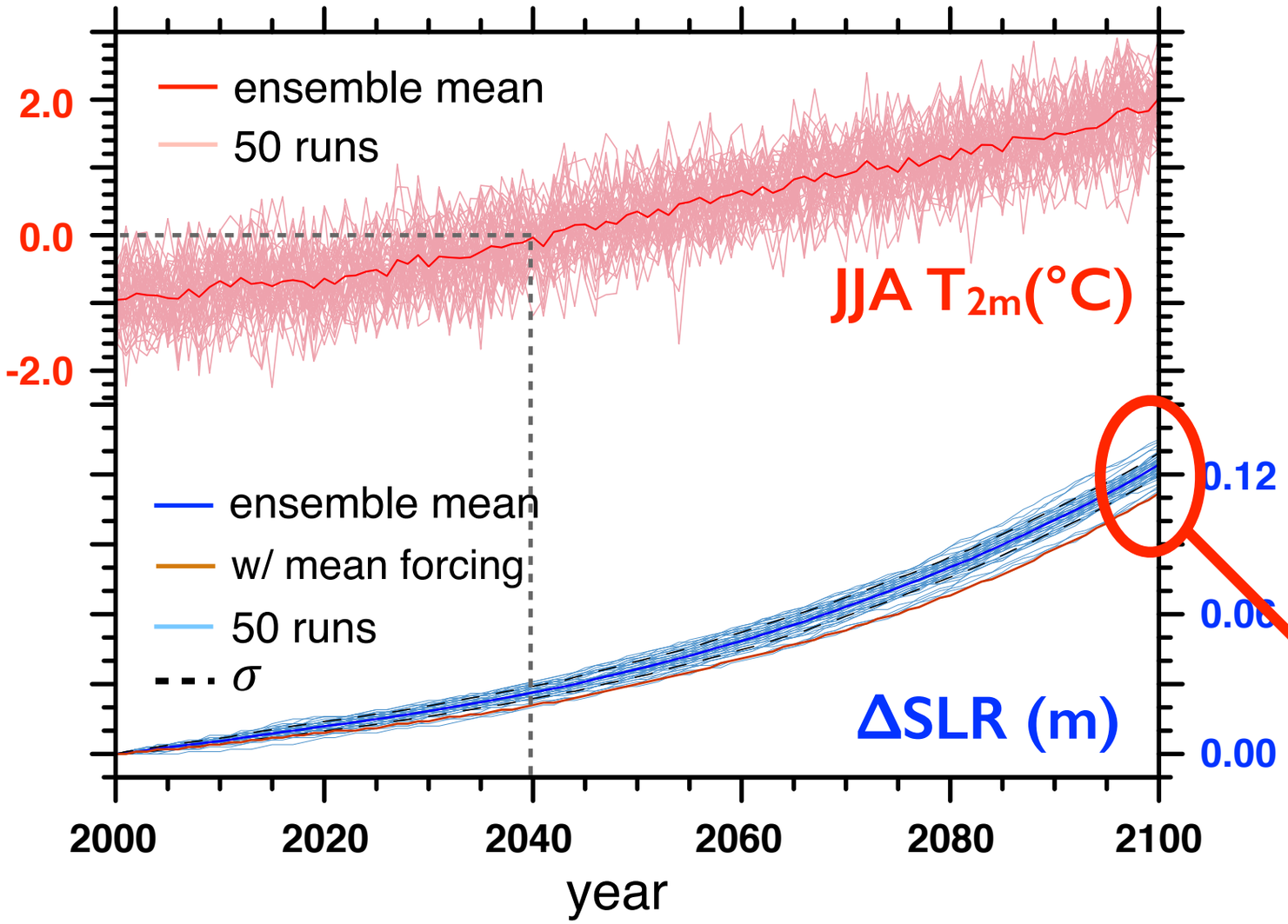

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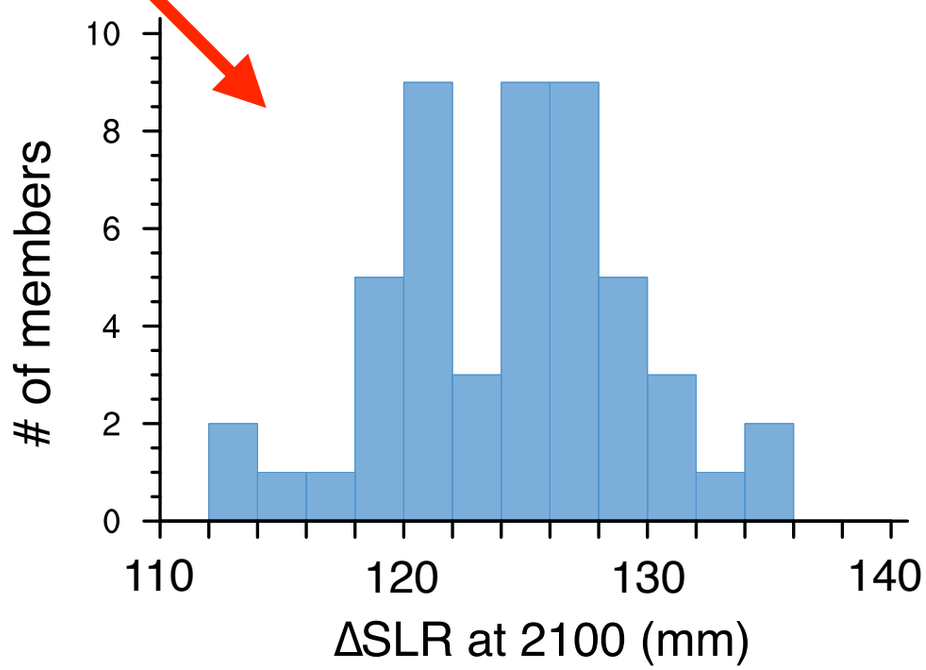
- ~20% of total change



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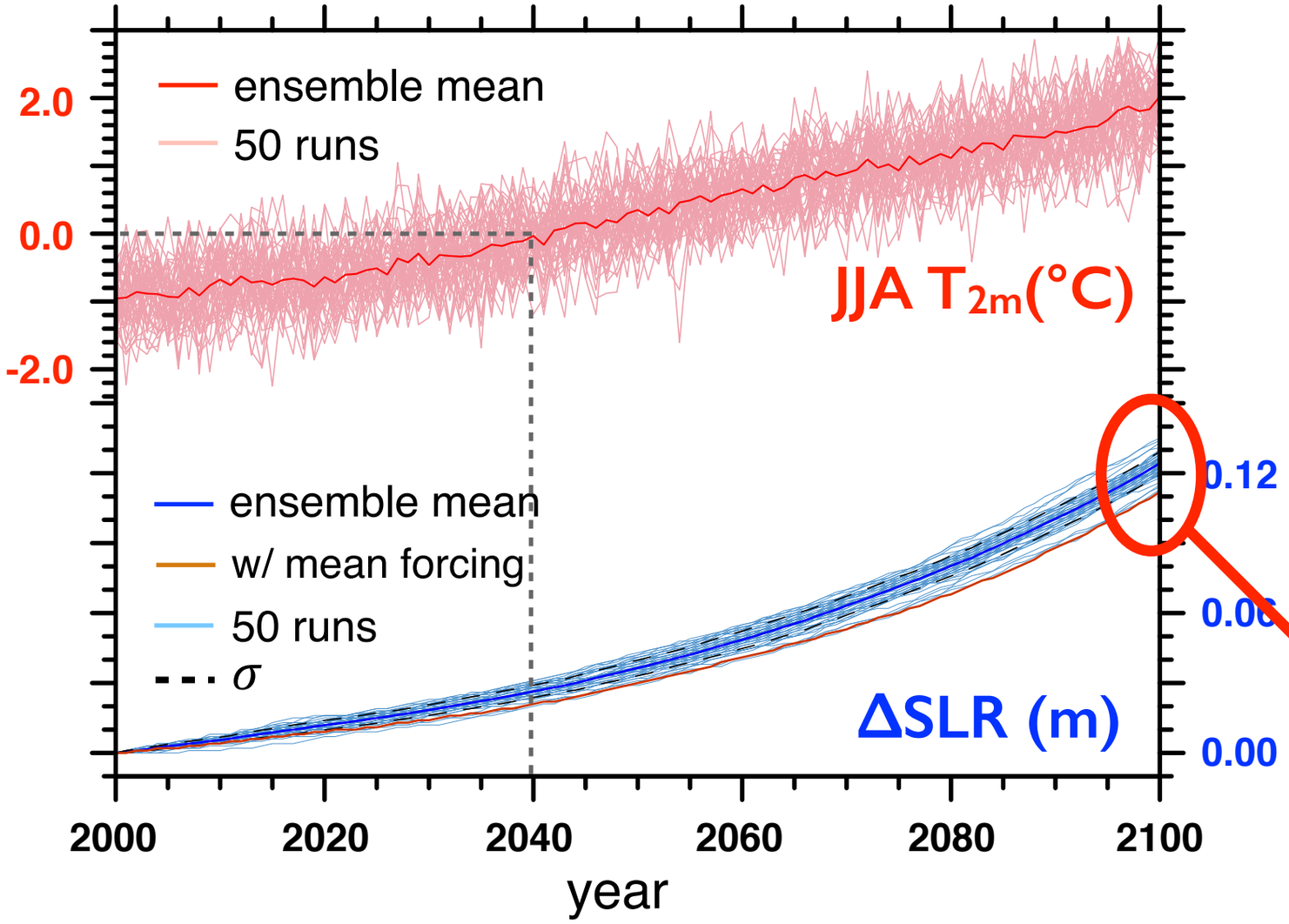

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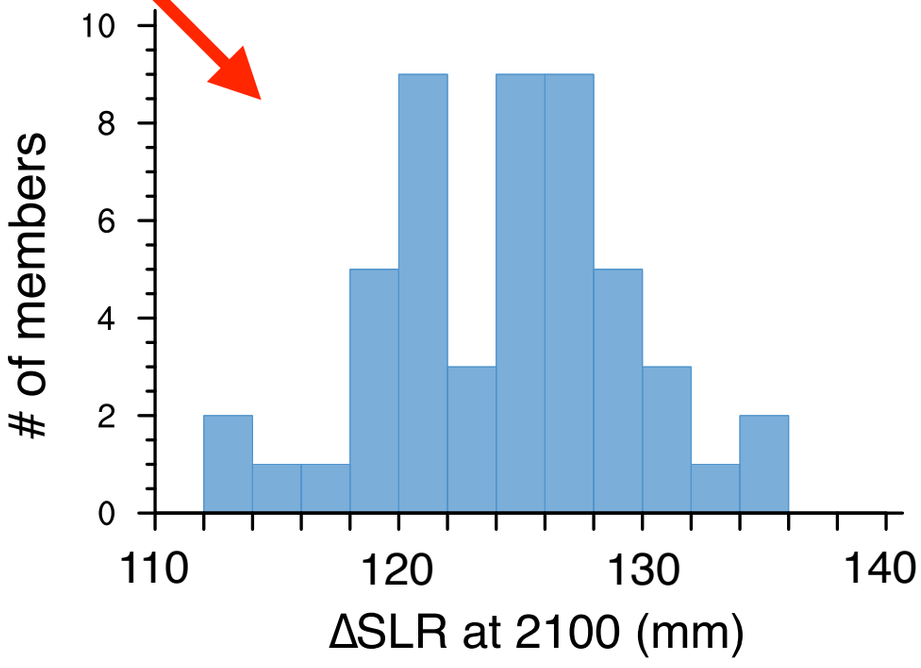

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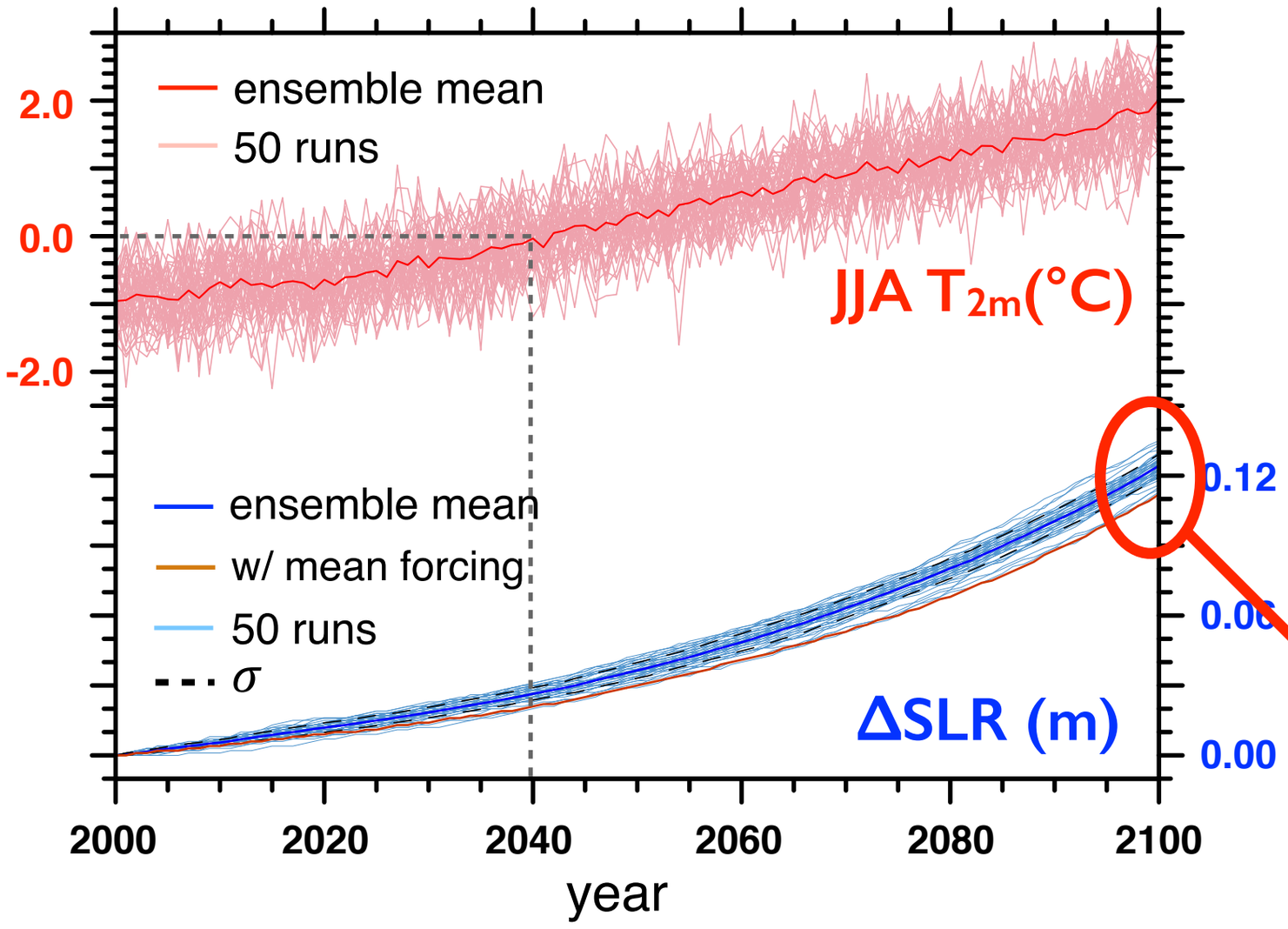

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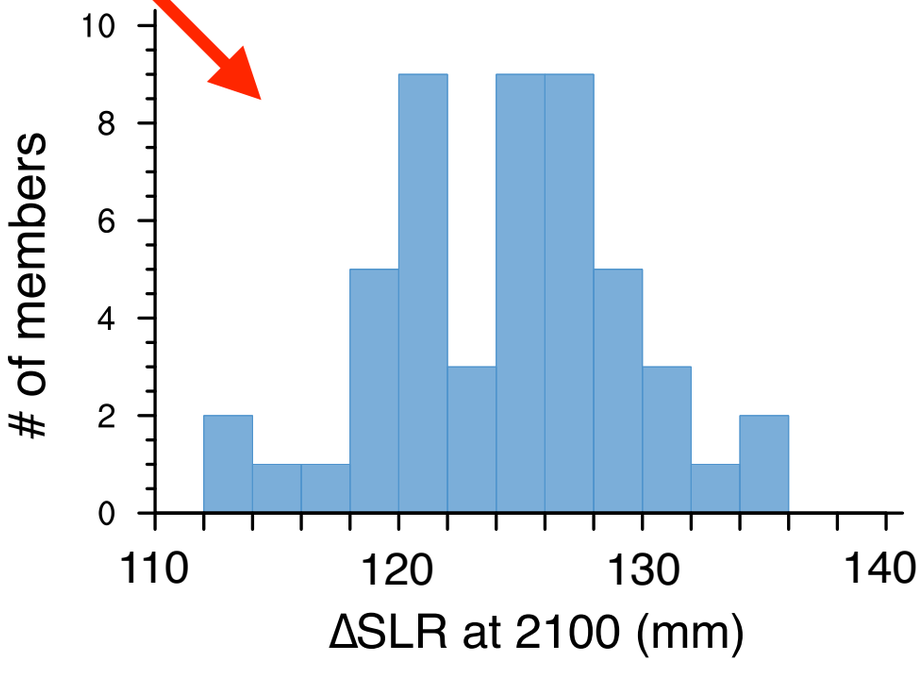
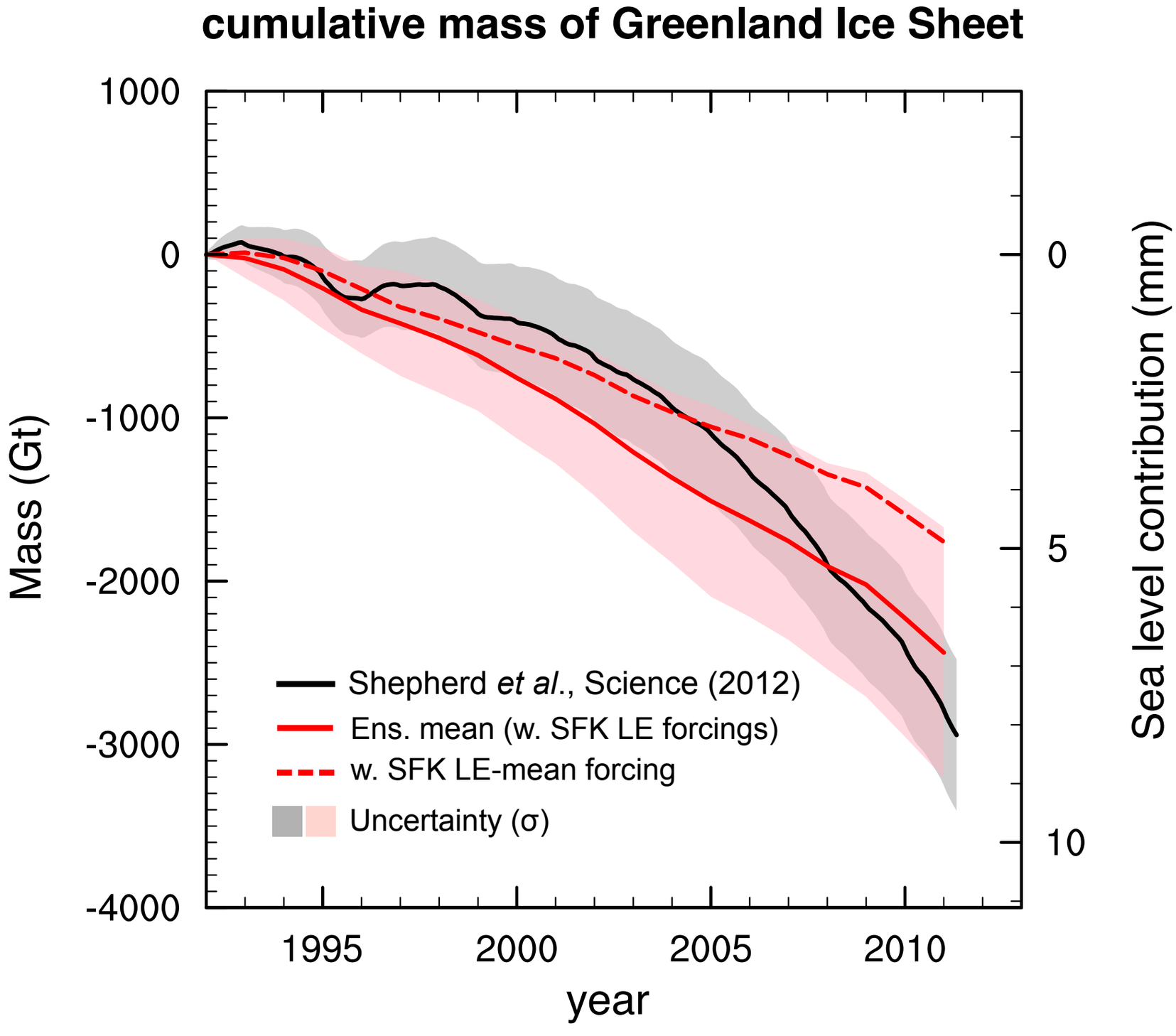


- Internal variability from climate models affects ice sheet contributions to sea level rise.

Impact of internal variability on ice sheet mass changes



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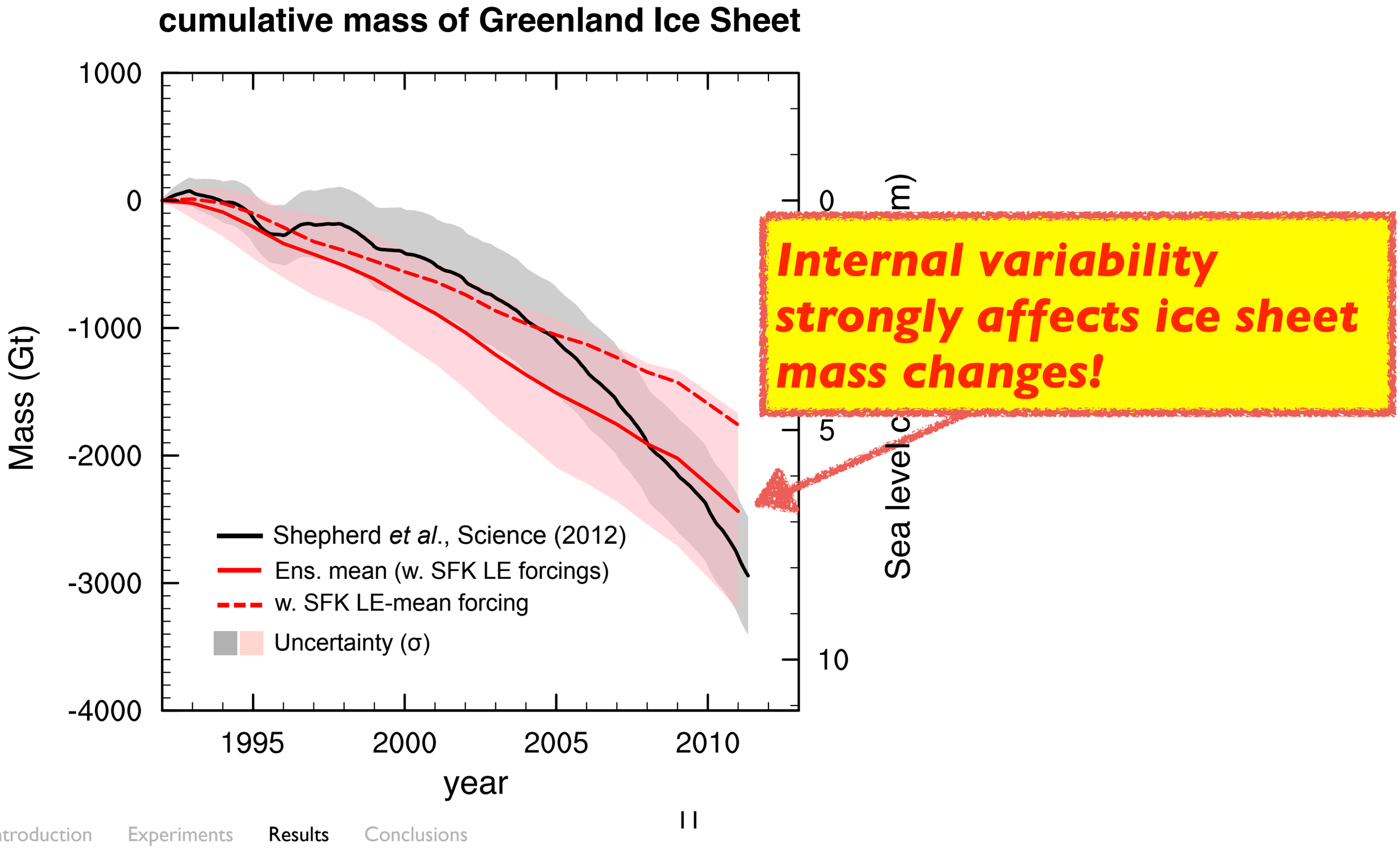
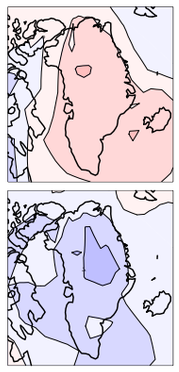
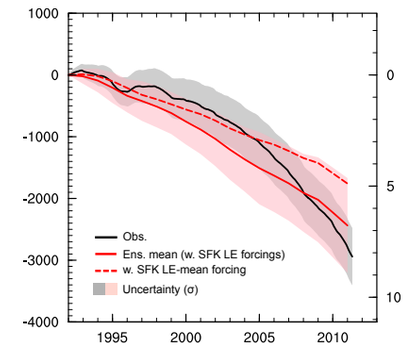


Conclusions

climate model

internal variability



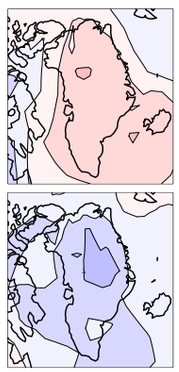


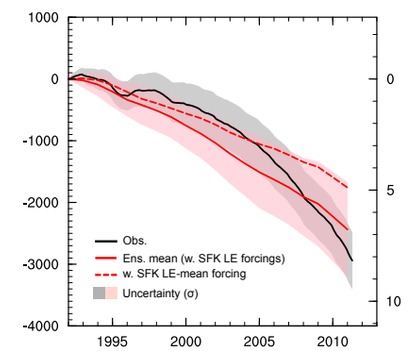
ISM

Conclusions

climate model

internal variability





ISM

- Opposite trends of internal variability can result in different climate responses in ensemble members

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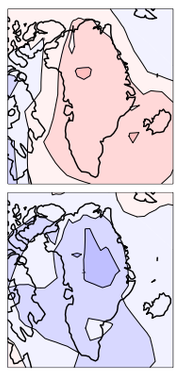
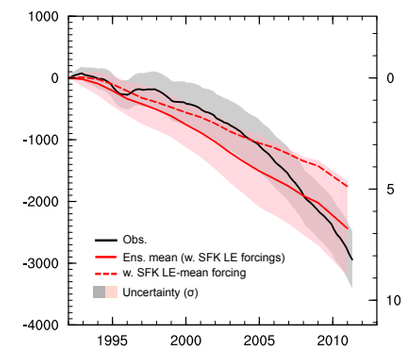




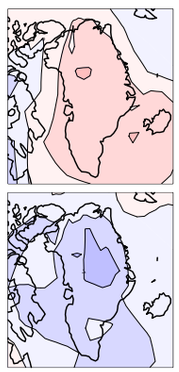
ISM

- **Opposite trends of internal variability can result in different climate responses in ensemble members**
- ***Internal variability strongly affects ice sheet evolution!***

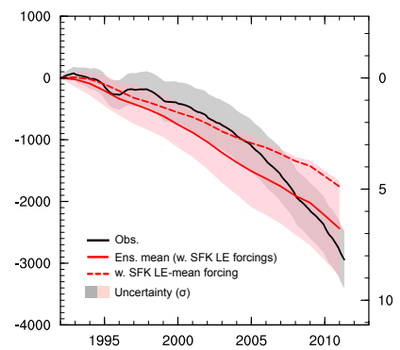
Conclusions

climate model

internal variability



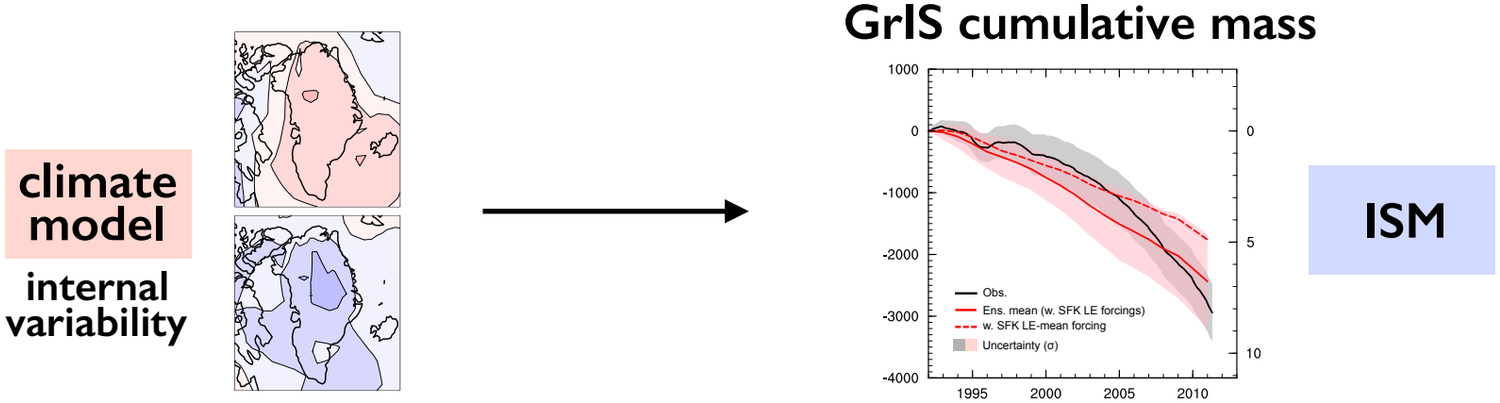
GrIS cumulative mass



ISM

- **Opposite trends of internal variability can result in different climate responses in ensemble members**
- ***Internal variability strongly affects ice sheet evolution!***
- **The impact of internal variability on ice sheet becomes larger when summer T_{2m} > 0°C**

Conclusions



- **Opposite trends of internal variability can result in different climate responses in ensemble members**
- ***Internal variability strongly affects ice sheet evolution!***
- **The impact of internal variability on ice sheet becomes larger when summer T_{2m} > 0°C**
- **Using ensemble-mean climate as climate forcings can underestimate ice loss and sea level contribution**

Thanks for your attention!!

- Sponsors for computing resources:

http://www.dw.com/en/climate-change-endangers-antarcticas-iconic-species/a-18863746