Are weather and climate extremes in mid-latitudes caused by the rapid warming of the Arctic?

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Recent extreme events

Weather, News

Meteorologists believe yesterday was Montreal's coldest snowstorm in nearly a century

Tyler Jadah
Jan 21, 2019 6:54 am 🔥 139

khatkassam/Instagram

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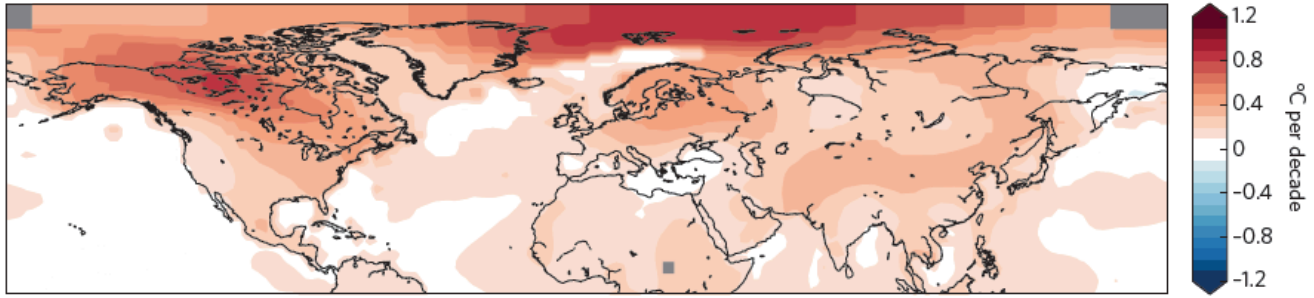
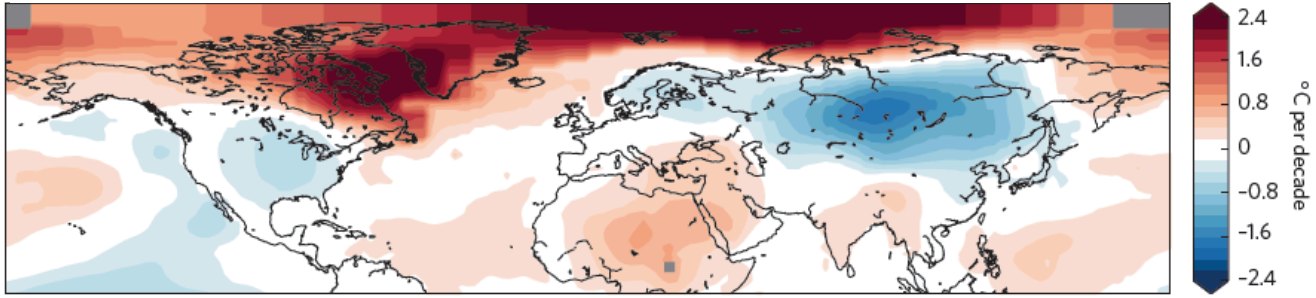
Northern Hemisphere temperature change

Winters 1960–2013



Winters 1990–2013



Cohen et al., Nature Geoscience (2014)

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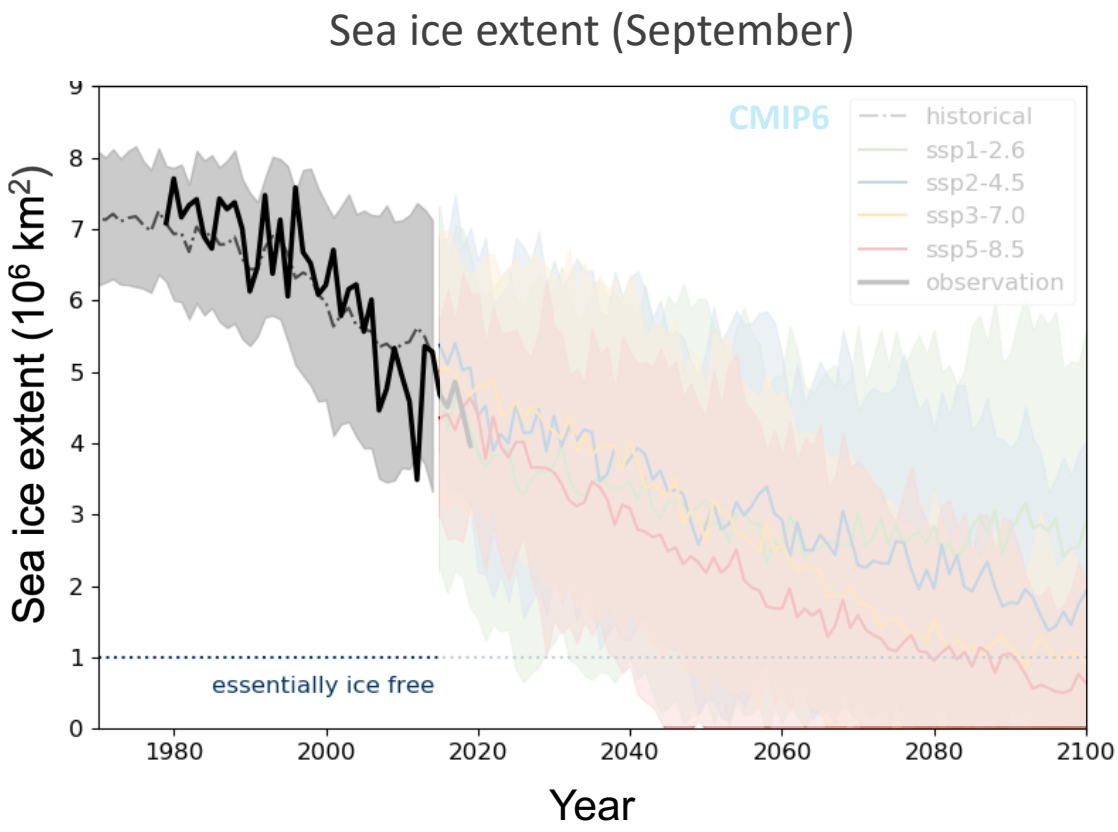
Arctic sea ice decline



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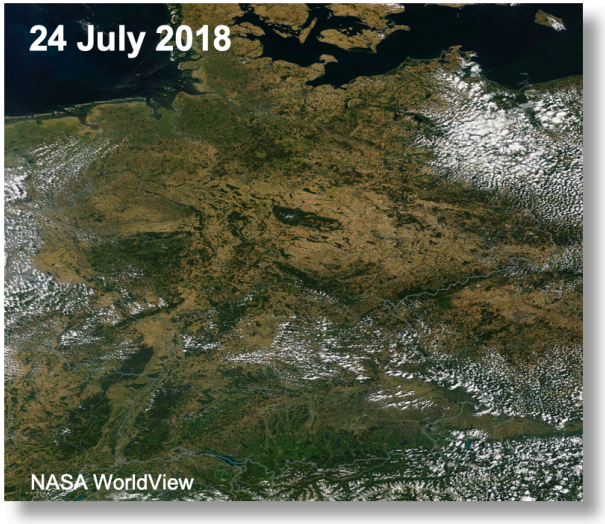
Recent extreme events

European heat waves

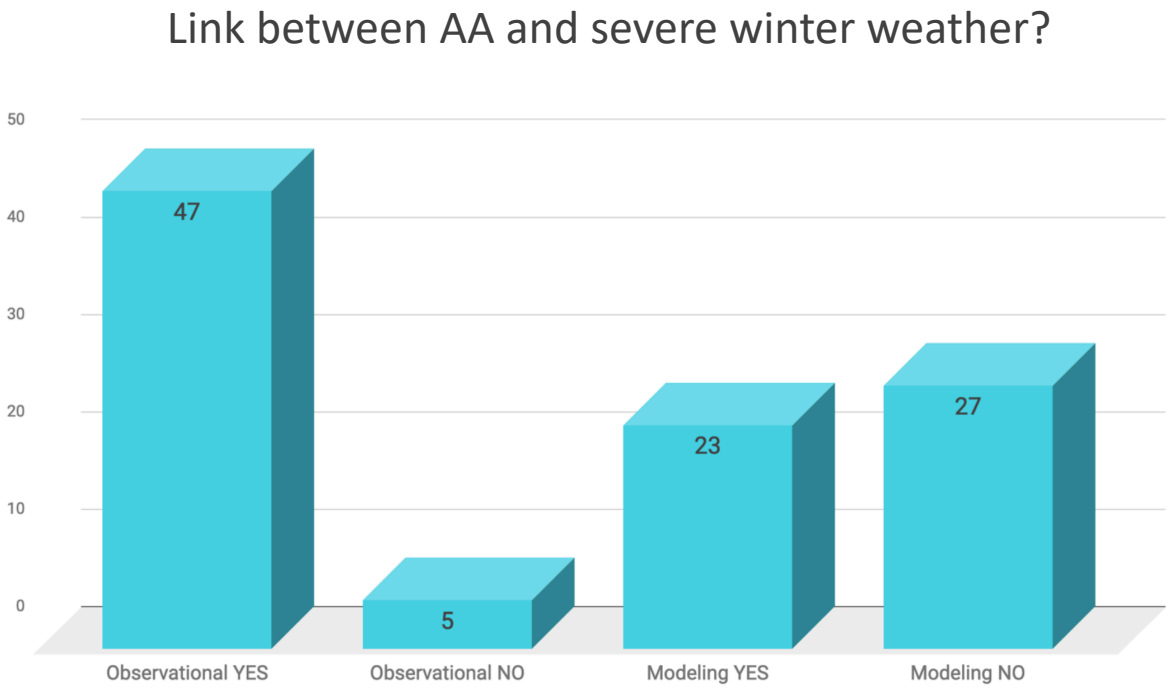


What does the IPCC have to say?

"Changes in Arctic sea ice have the potential to influence mid-latitude weather" (*medium confidence*), but "there is *low confidence* in the detection of this influence for specific weather types."

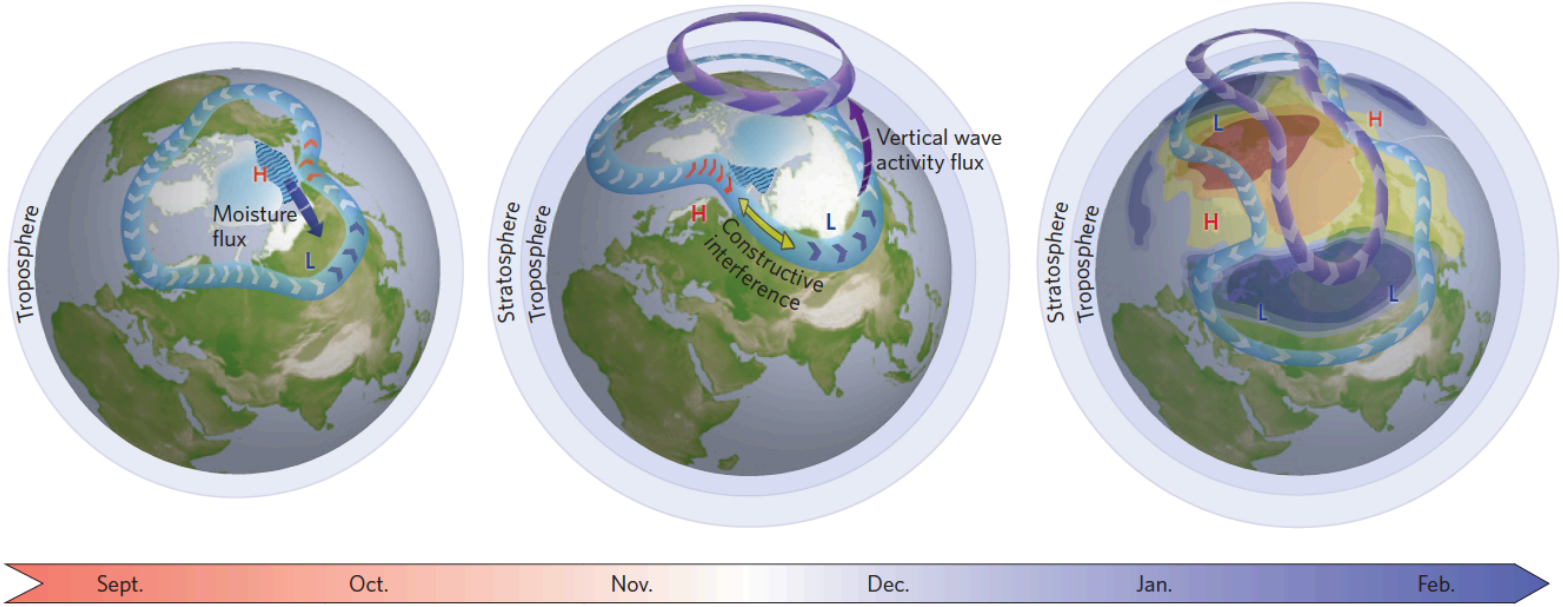
Summary for policy makers: IPPC Special Report on the Ocean and Cryosphere in a Changing Climate (2019)

Divergent consensuses...



Cohen et al., *Nature Climate Change* (2020)

A possible mechanisms



Cohen et al., Nature Geoscience (2014)

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“Uncertainty” in modelling studies

Results from different modelling groups differ:

- Different experimental protocols
- Response to reduced sea ice in models is weak

PAMIP – A coordinated modelling approach

Geosci. Model Dev., 12, 1139-1164, 2019
https://doi.org/10.5194/gmd-12-1139-2019

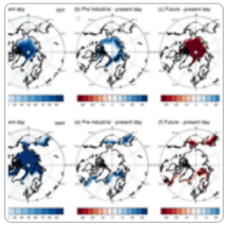
GMD | Articles | Volume 12, issue 3

Article | Assets | Peer review | Metrics | Related articles

Model experiment description paper

25 Mar 2019

The Polar Amplification Model Intercomparison Project (PAMIP) contribution to CMIP6: investigating the causes and consequences of polar amplification



Doug M. Smith[1], James A. Screen[2], Clara Deser[3], Judah Cohen[4], John C. Fyfe[5], Javier García-Serrano[6,7], Thomas Jung[8,9], Vladimir Kattsov[10], Daniela Matei[11], Rym Msadek[12], Yannick Peings[13], Michael Sigmond[5], Jinro Ukita[14], Jin-Ho Yoon[15], and Xiangdong Zhang[16]

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[4]Atmospheric and Environmental Research, Lexington, MA, USA
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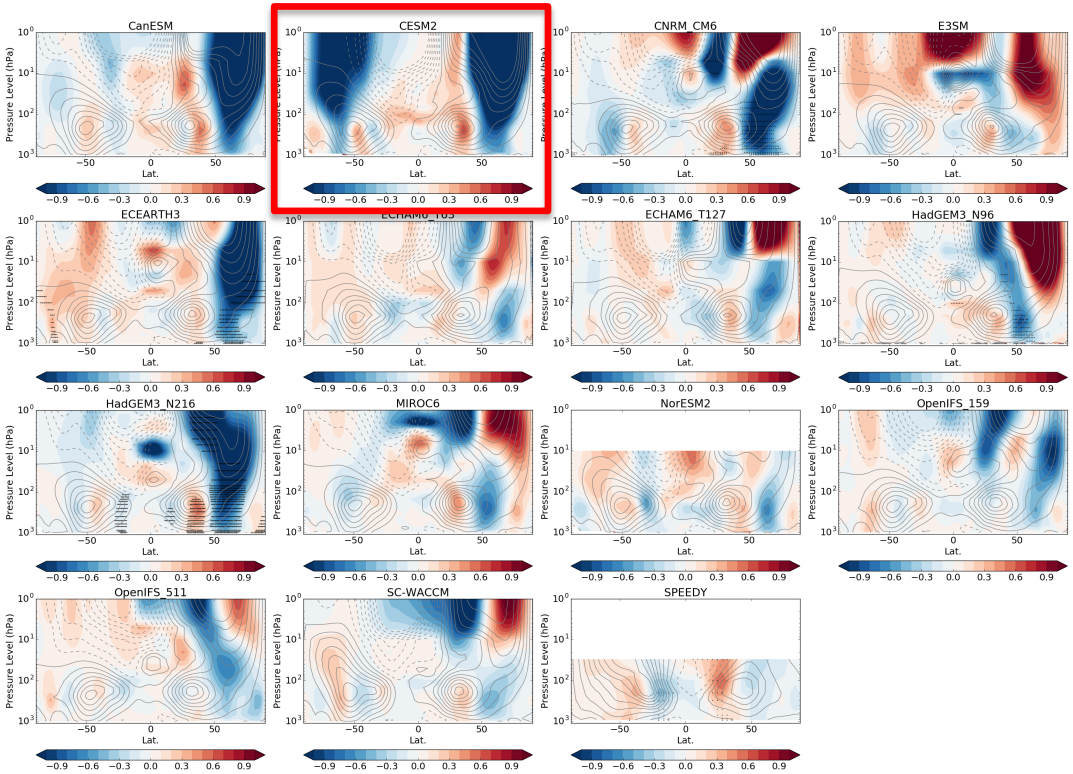
Response to future sea ice loss



- Atmosphere simulations completed by 15 models from APPLICATE and international community

Doug Smith and Rosie Eade (pers. comm.)

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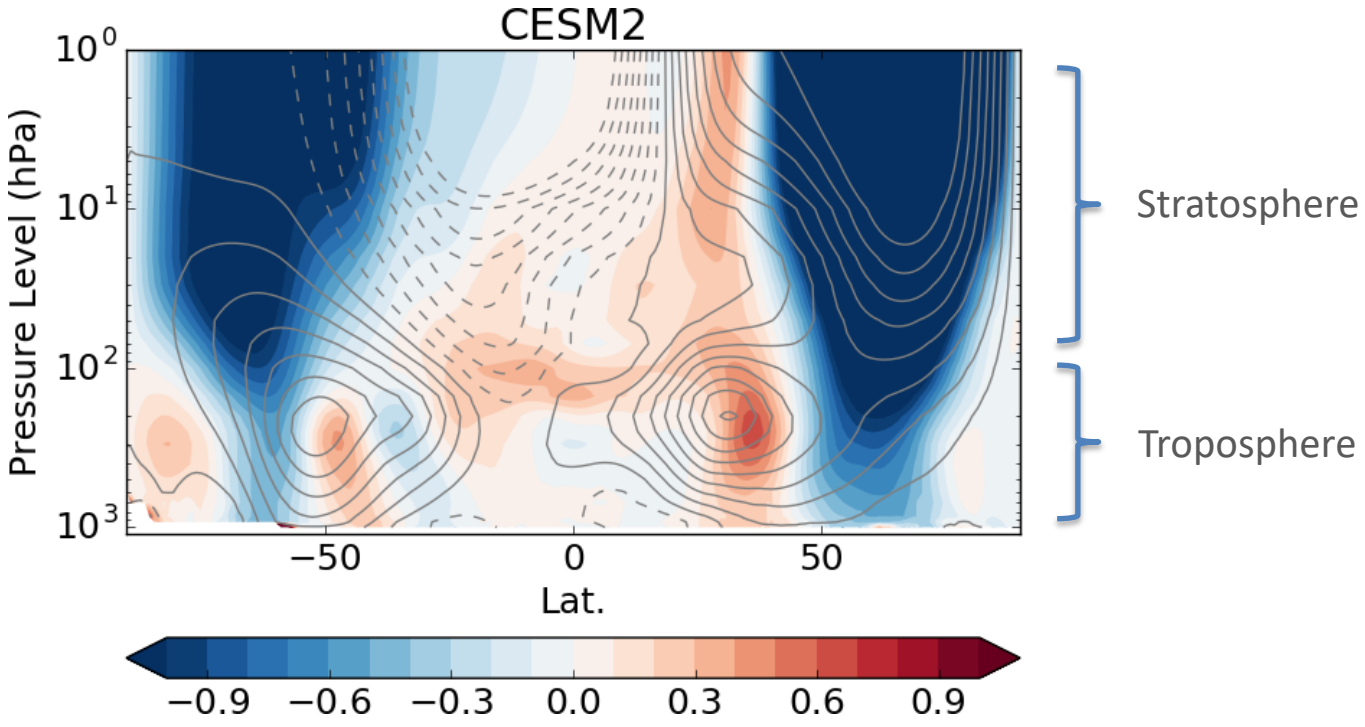
Response to future sea ice loss in models



Doug Smith and Rosie Eade (pers. comm.)

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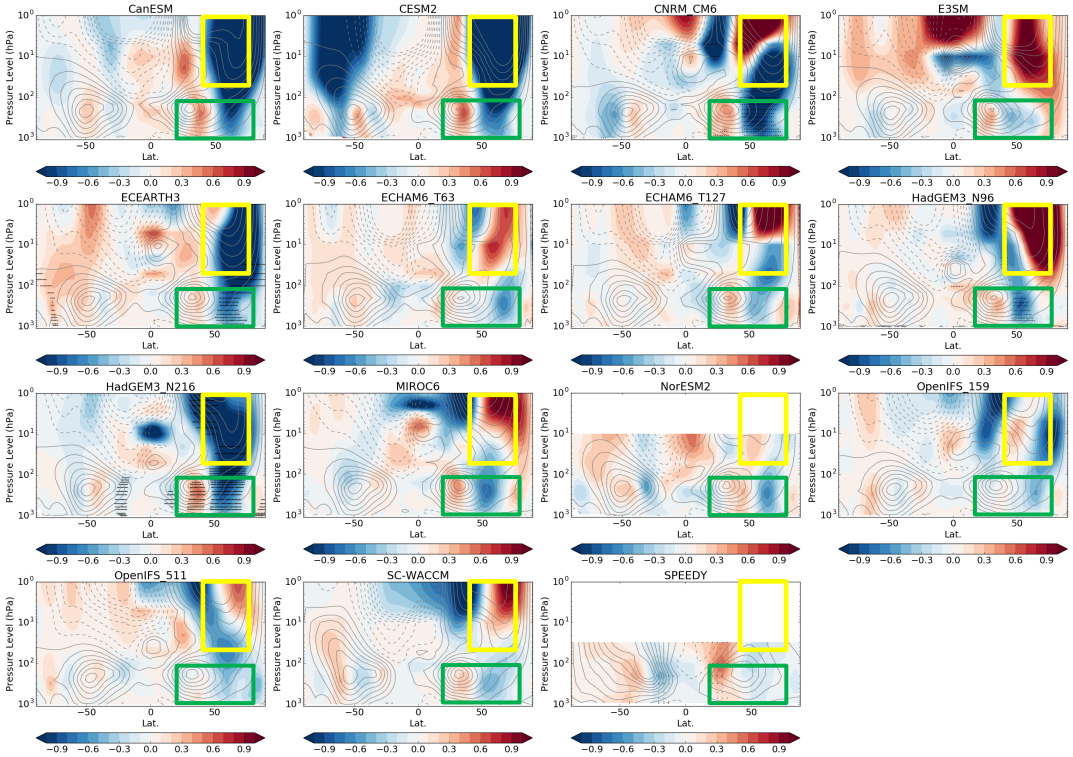
Response to future sea ice loss



- Atmosphere simulations completed by 15 models from APPLICATE and international community
- Robust weakening and equatorward shift of the tropospheric jet
- Stratosphere response not robust
- Model response not overly strong

Doug Smith and Rosie Eade (pers. comm.)

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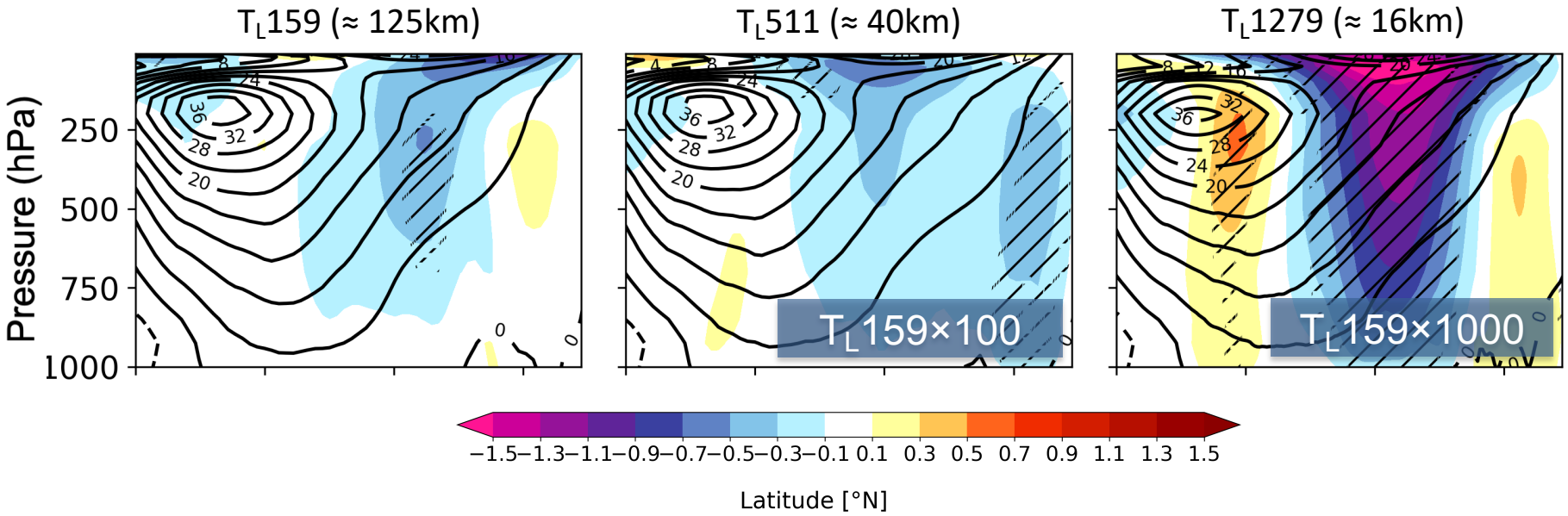
Response to future sea ice loss

The role of spatial resolution



Streffing et al., J. Climate (submitted)

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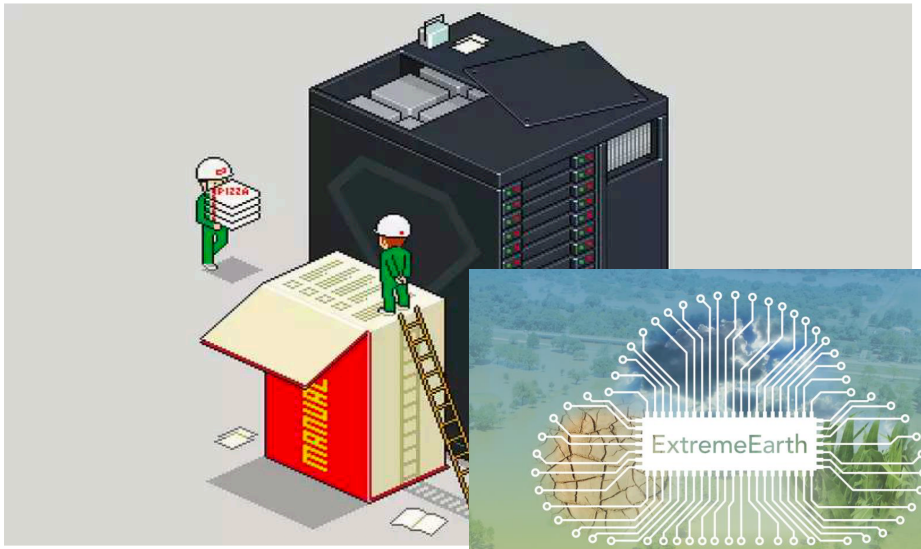
Exascale computing

Opportunity and challenge

FEATURE 10 October 2018

Could the world's mightiest computers be too complicated to use?

China, Japan and the US are racing to build the first exascale computer – but devising programmes clever enough to run on them is a different story



Totto Renna

- ➔ End of Moore's law
- ➔ End of Dennard scaling
- ➔ New and heterogeneous architectures
- ➔ Truly "big data"

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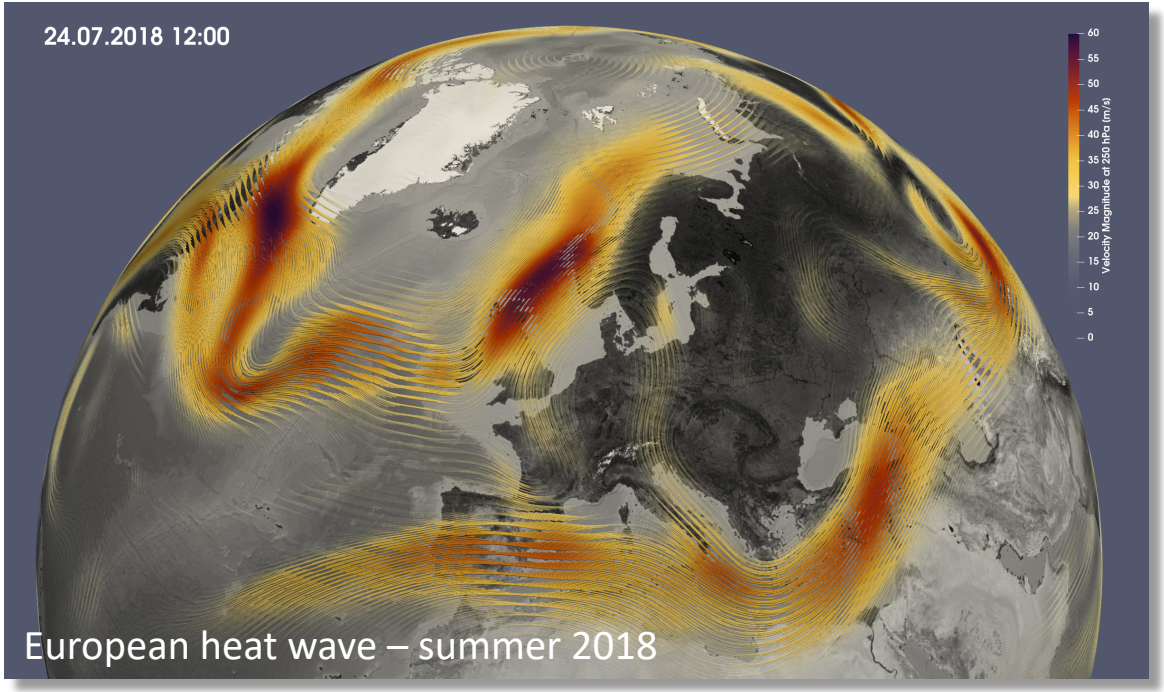
Disentangling uncertainty

Dynamic vs **thermodynamic** changes

Dynamic vs thermodynamic changes

The jet stream – Dynamical driver of extreme events



European heat wave – summer 2018

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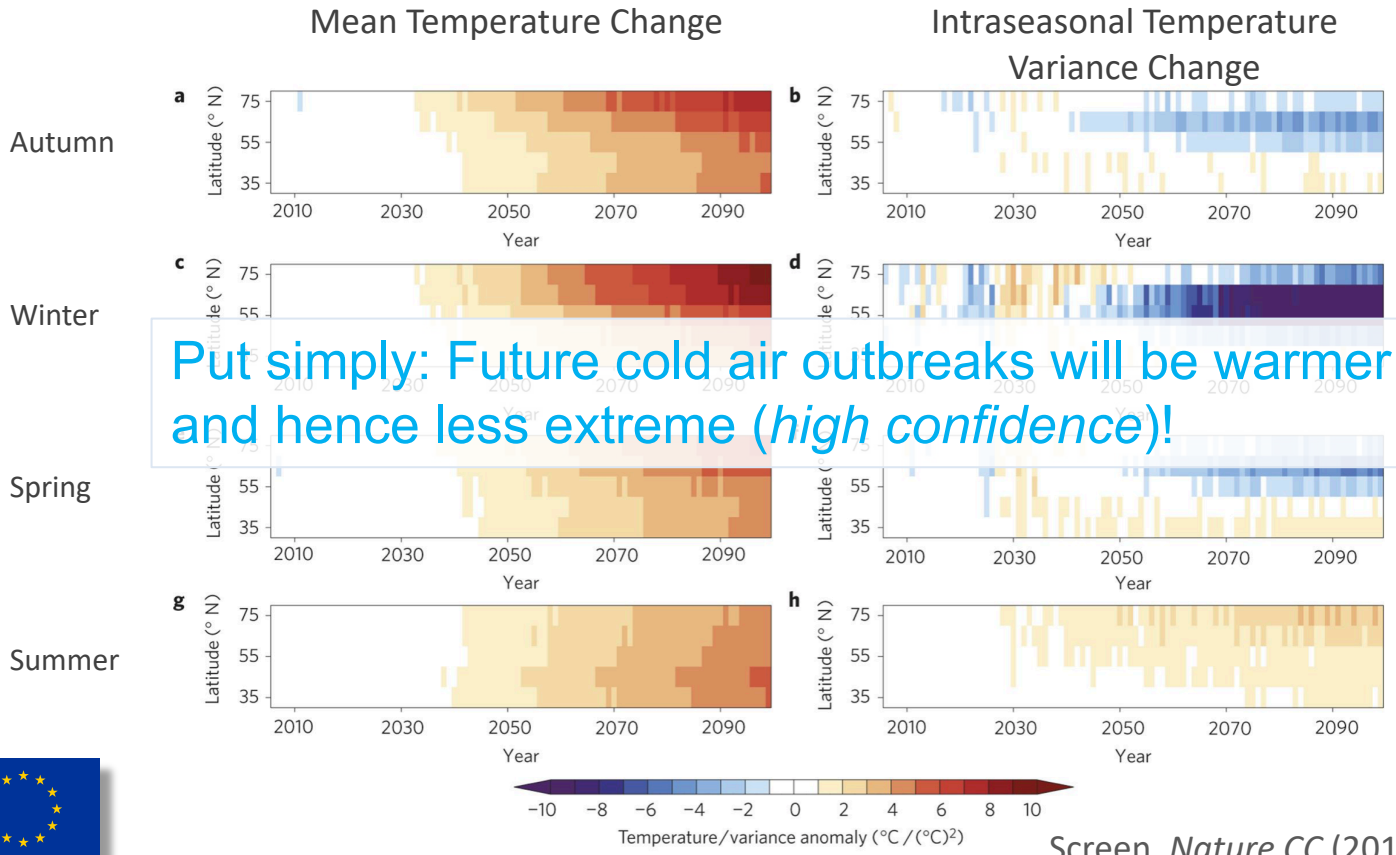
Dynamic vs **thermodynamic** changes



Put simply: Future cold air outbreaks will be warmer and hence less extreme (*high confidence*)!

Screen, *Nature CC* (2014)

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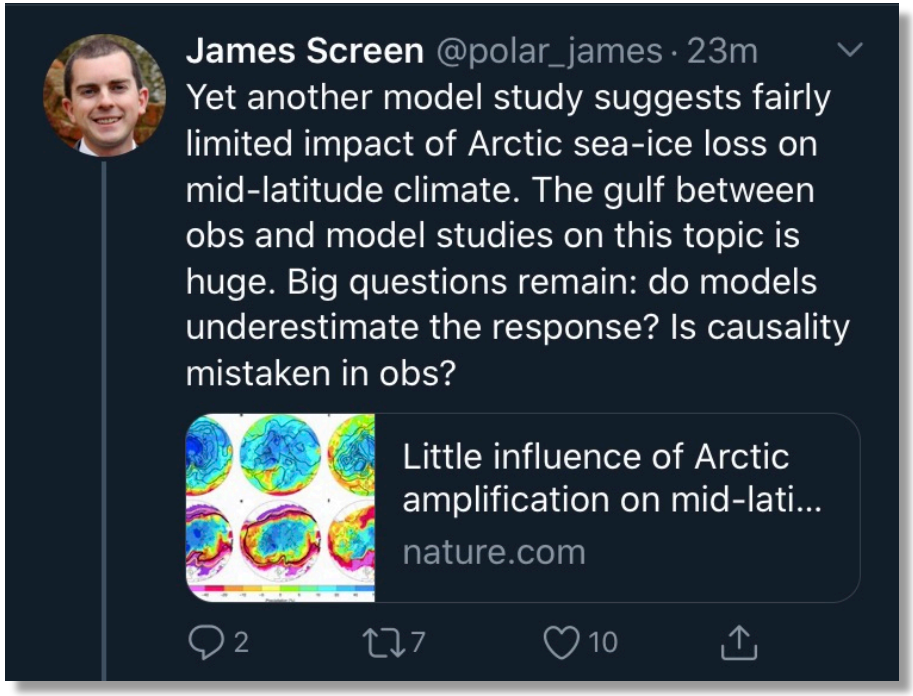
Conclusions



Tweet from 13 February 2020

Conclusions

"Big questions remain"

- True for the **dynamic** response (jet stream)
- Not quite so true for **thermodynamic** response (we know more than some are aware of!) → Translates to mid-latitude extreme events more generally!
- Conjecture:
  - The response from observations is overestimated
  - Models underestimate the response (model shortcomings)
  - New class of high-resolution models could make all the difference (computational challenge)
- Quantitative knowledge within reach