Met Office
Hadley Centre

When might we begin to reach 1.5°C?

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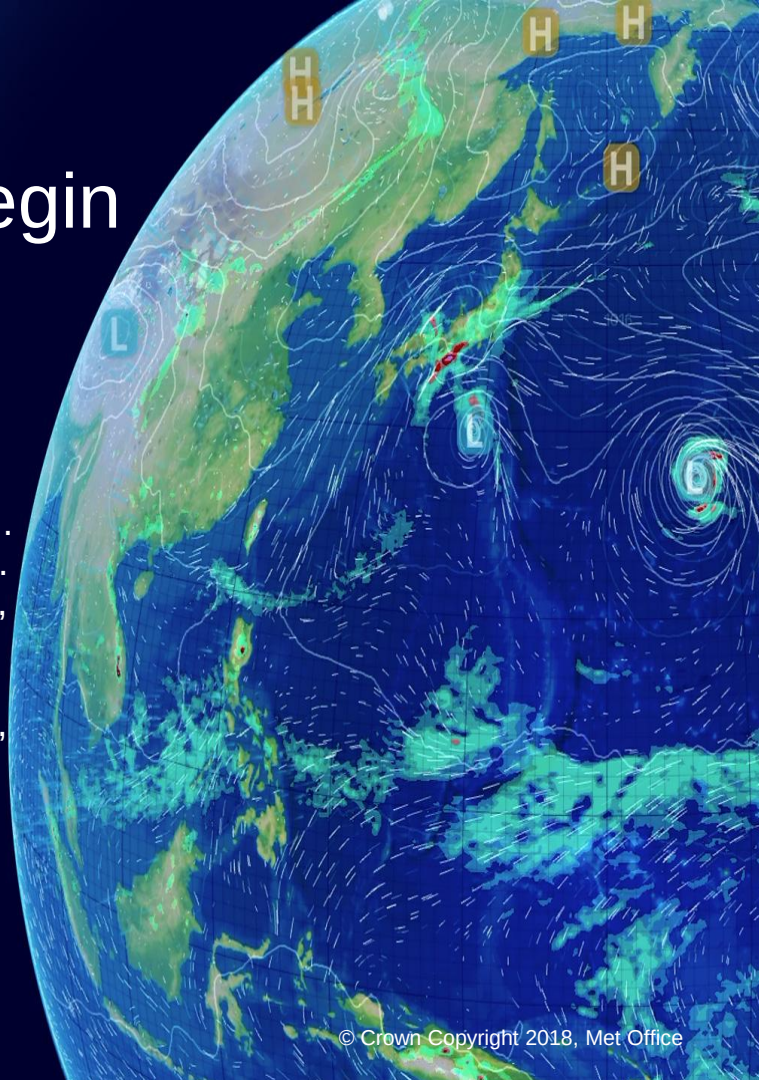
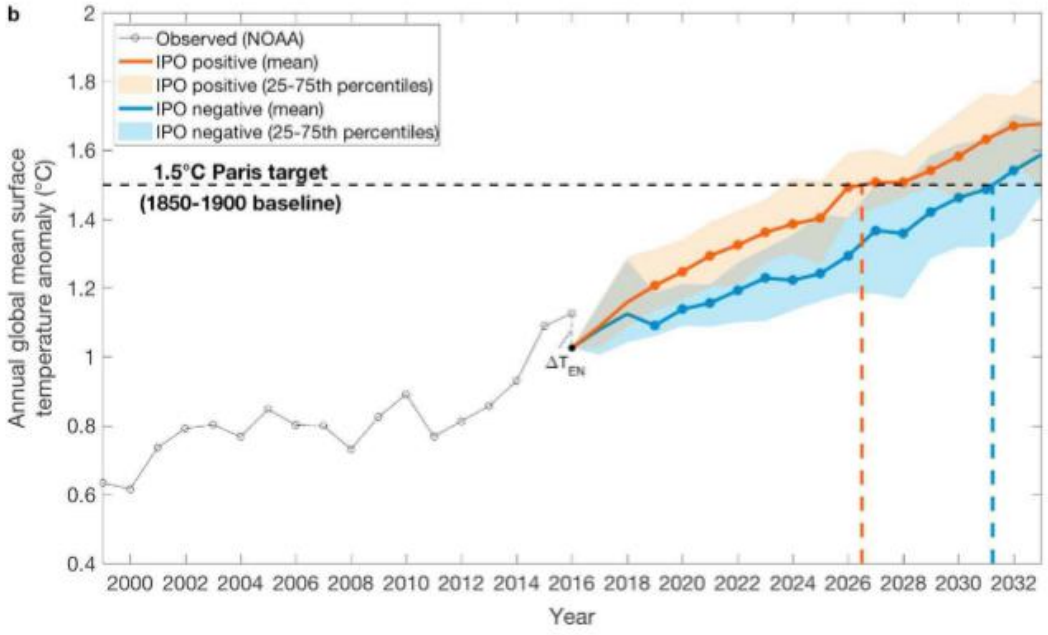


Forcing and variability

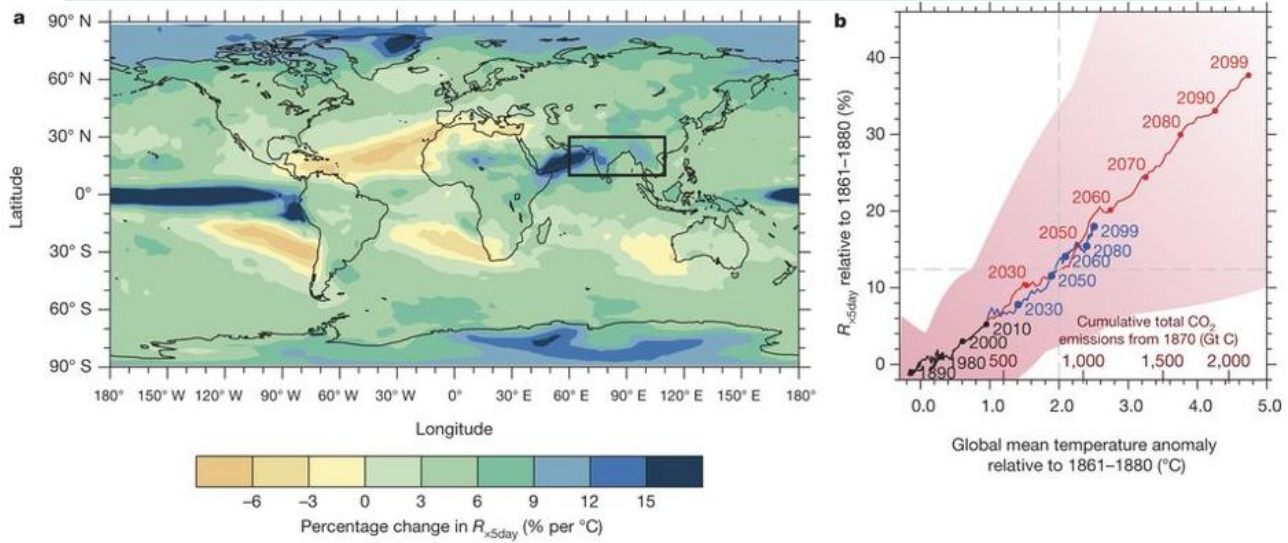


- Natural variability may temporarily add to the underlying human-induced warming
- Temporary excursions above 1.5°C would be a sign that we are getting close
- Policy makers will require guidance regarding how long temperatures will remain above the threshold

Henley and King 2017

Extremes

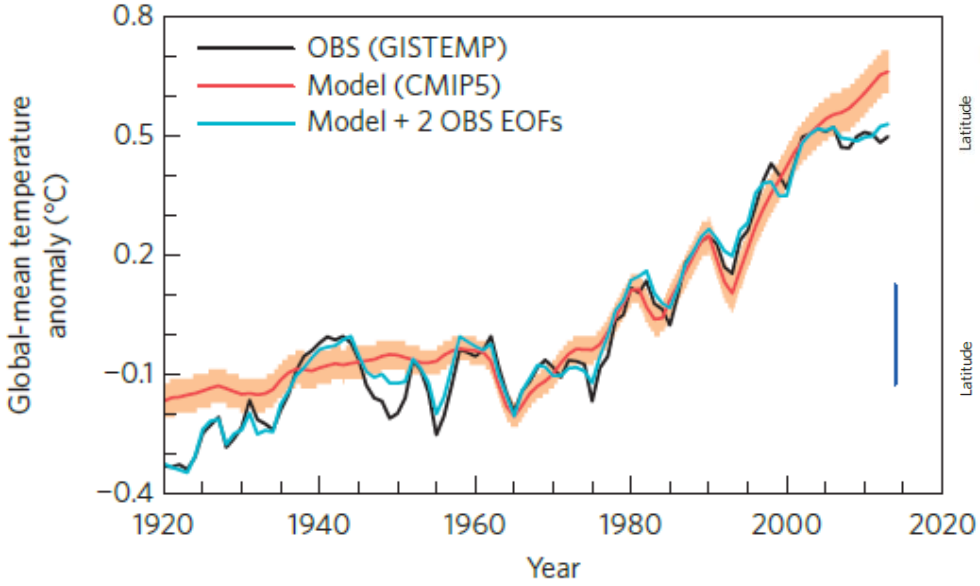
Scaling of 5-day heavy precipitation events with global mean temperature changes

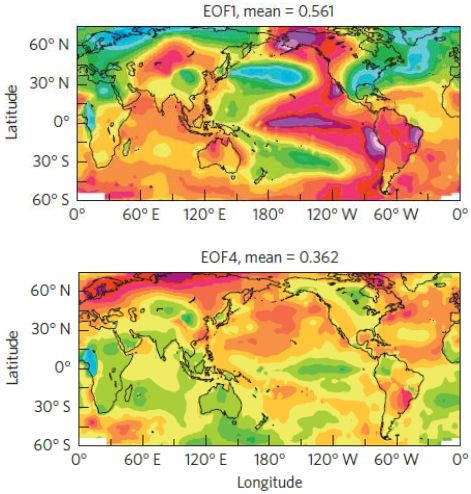


- The Paris Agreement also recognizes “the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including **extreme weather events** ....”
- Clear link between **global temperature** and **extremes** (including food security, heat waves and mortality rates, extreme rainfall, droughts, storms, coral bleaching, …)
- Hence even **temporary excursions** above 1.5ºC are **relevant** for policy makers

Seneviratne et al 2016

Drivers of decadal global temperature

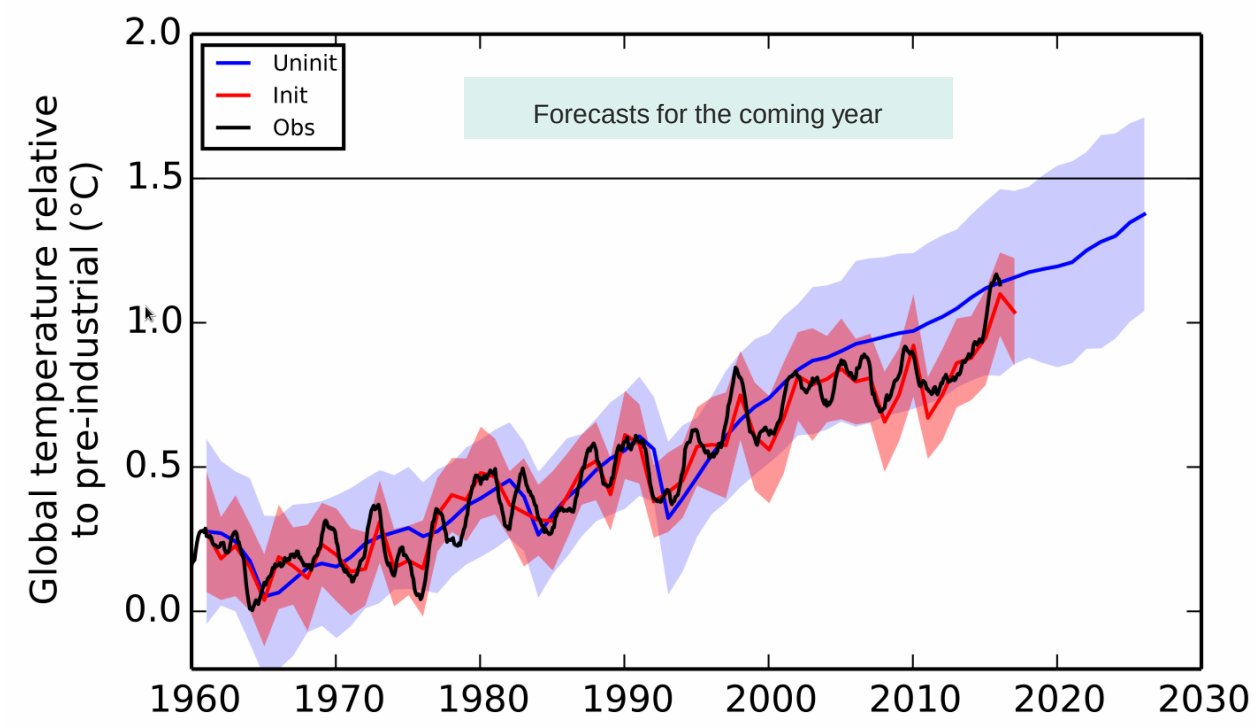




- Observed global mean temperature can be explained by:
  - model ensemble mean (**external forcing**)
  - observed variability in the Pacific and Atlantic (**internal variability?**)

Dai et al 2015

Initialised decadal predictions

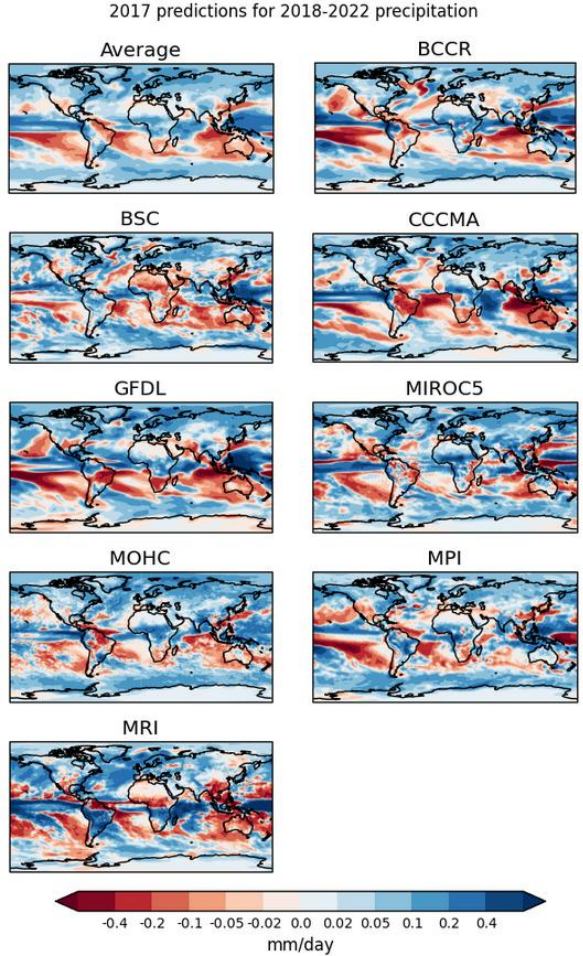


- Initialisation with observations is essential to predict internal variability
- Can also improve response to external forcing
- Narrows the uncertainty compared to uninitialized simulations

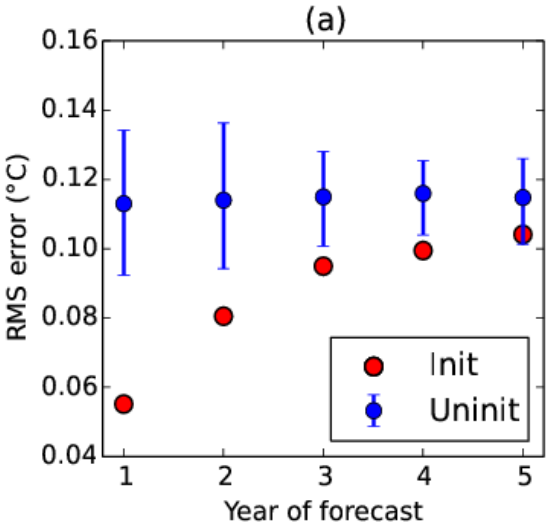
International decadal predictions

Multi-model decadal predictions

- International activity running every year since 2010
- Currently includes UK, Canada, Germany, Spain, Japan, USA, Norway
- Endorsed by the WMO in 2017
- Lead Centre and 4 Global Producing Centres for Annual to Decadal Climate Prediction
- Website: www.wmolc-adcp.org



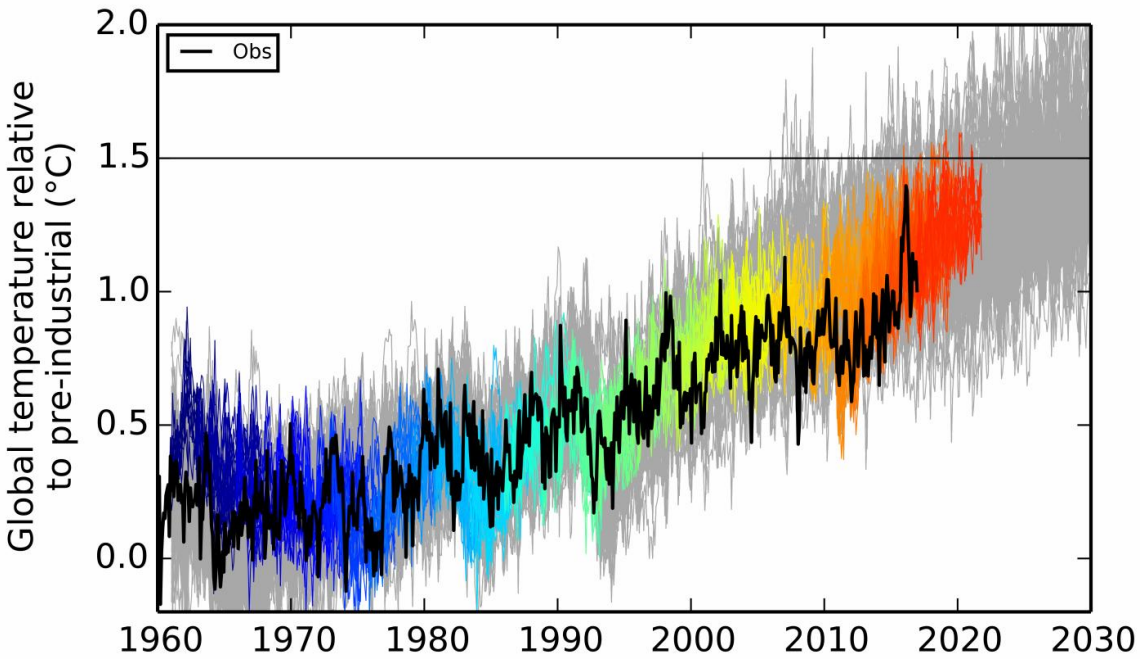
Forecast quality: skill



- RMS error of ensemble mean in initialised compared to uninitialized
- Initialised forecasts have lower RMS error out to 5 years ahead

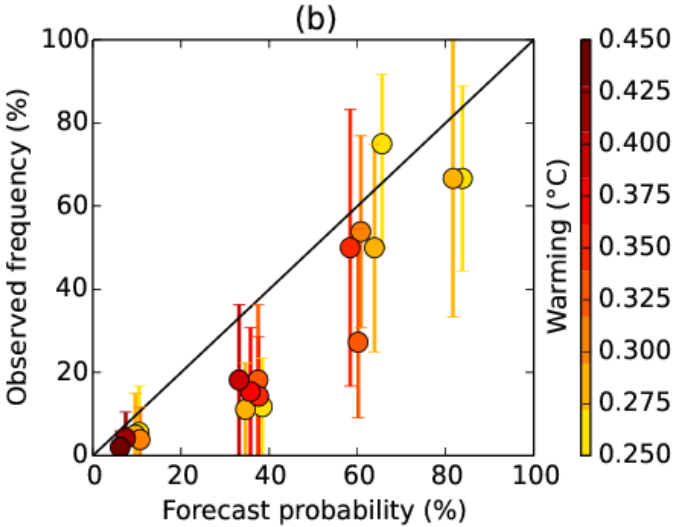
Smith et al 2018

Probability of exceeding 1.5°C



- Colours represent different retrospective forecasts (red is latest forecast)
- Uninitialized simulations are shown in grey
- Compute probability as fraction of ensemble members exceeding 1.5°C at any time during forecast

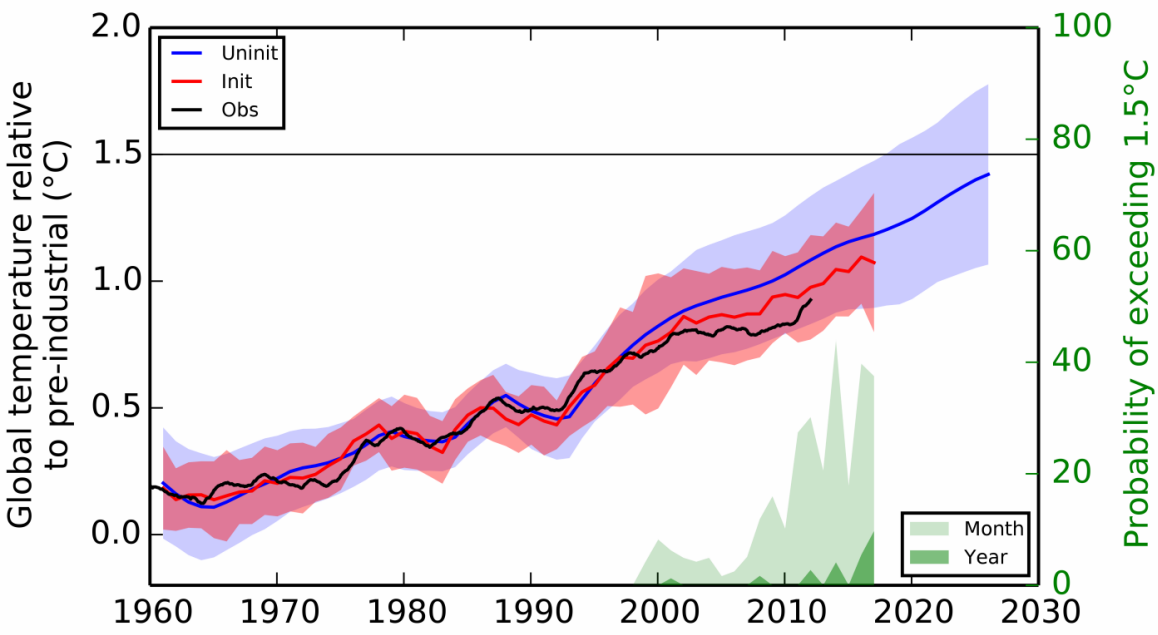
Forecast quality: reliability



- Exceeding 1.5°C requires an increase of 0.36°C relative to the annual mean temperature in 2016
- Assess a range of temperature increases
- Forecast probabilities generally match observed frequencies
- Initialised forecasts are reasonably reliable for a range of warming thresholds

Smith et al 2018

Forecast probability of exceeding 1.5°C

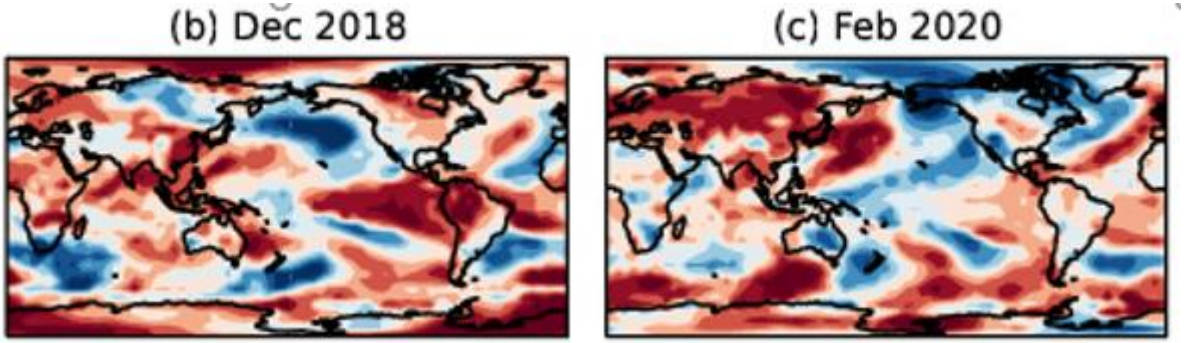


- Five year period 2017 to 2021
  - Month : 38% (initialised) : 89% (uninitialized)
  - Year : 10% (initialised) : 50% (uninitialized)
  - 5 year : 0% (initialised) : 23% (uninitialized)

Smith et al 2018

Patterns associated with peak warming

Example monthly temperature patterns at maximum of global warming

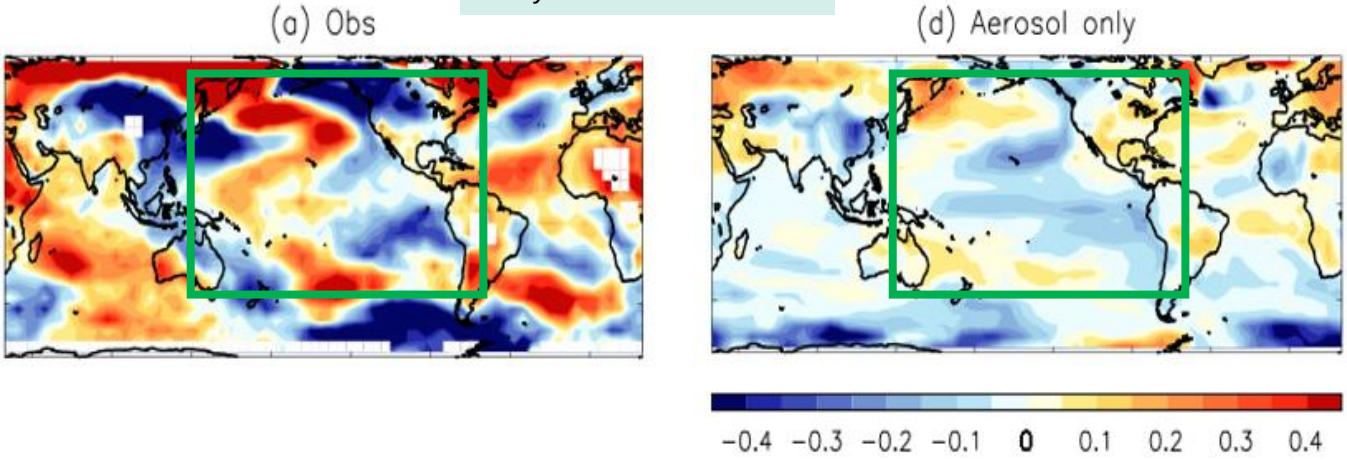


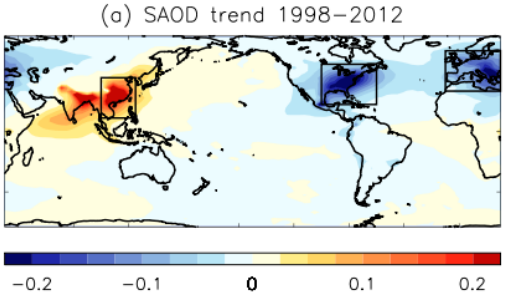
- Impacts depend on temperature patterns
- Usually associated with El Niño and NAO
- ➢ Most likely to occur during **boreal winter and spring** when El Niño and NAO have largest influences

Smith et al 2018

Internal variability or role for aerosols?

15 year trend 1998-2012



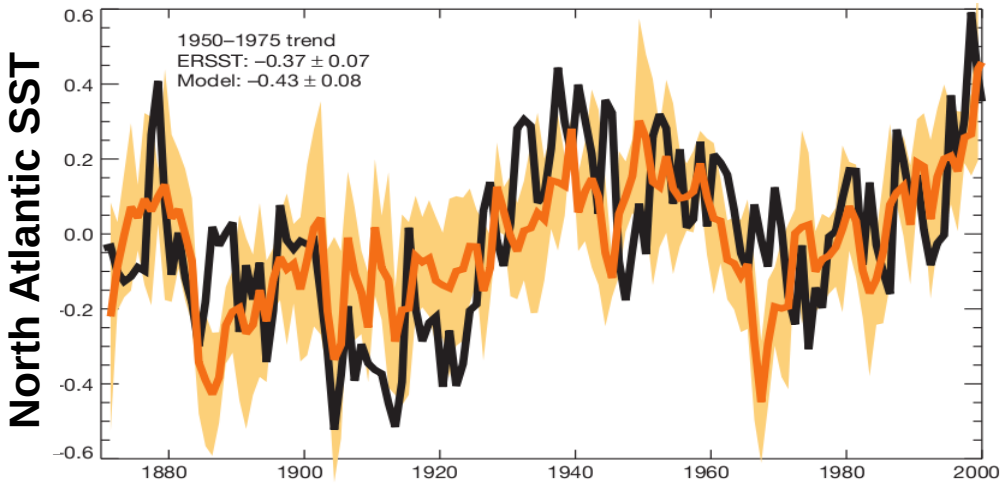


- Negative IPO forced by anthropogenic aerosols
- Reduced emissions from USA and Europe, increased emissions from Asia

Smith et al 2016

Internal variability or role for aerosols?

North Atlantic temperature



- Model ensemble mean captures observed variability of North Atlantic temperature
- Mainly driven by **anthropogenic aerosols**

Booth et al 2012

Summary

• **Temporary** excursions above 1.5ºC provide a **warning** that threshold is being approached and are relevant in terms of **extreme** weather events

• **New capability** to predict probability of temporary excursions in coming 5 years, will be updated each year

- Initialised forecasts: **38%** (month), **10%** (year), **0%** (5 years)
- Uninitialized simulations: 89% (month), 50% (year), 23% (5 years)

• Associated with El Niño and positive NAO, most likely during boreal winter

• Relative roles of **internal variability** and **external factors** (especially aerosols) remains uncertain