When might we begin to reach 1.5°C?

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.
• 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 1.5°C are relevant for policy makers
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**)
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

Forecasts for the coming year
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
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
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)
Patterns associated with peak 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

Example monthly temperature patterns at maximum of global warming
Internal variability or role for aerosols?

- 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?

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

Booth et al 2012
Summary

- **Temporary** excursions above 1.5°C 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.