Observational constraints on the contribution of internal variability to recent climate trends

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Observed DJF temperature trend, 1966-2015

Trend_{obs} (°C/50 yrs)
Observed DJF temperature trend, 1966-2015

Western Canada is more sensitive to anthropogenic forcing
Observed DJF temperature trend, 1966-2015

How much of this trend is due to internal variability?
Large Ensemble shows influence of internal variability
Trend: 0.73 °C/50yrs
Trend: 0.26 °C/50 yrs
Trend: -0.91 °C/50 yrs
Trend: $-0.91^\circ\text{C/50yrs}$
Trend: -0.37 °C/50 yrs
Distribution of trends from white noise
Variable 50-year trends from high-frequency noise

\[ \sigma \gamma \]

also see Thompson et al., (2015), *J Clim*
Variable 50-year trends from high-frequency noise

also see Thompson et al., (2015), *J Clim*
detrended DJF

$\sigma_{\text{obs}}$

obs: BEST

$\sigma_{\text{LENS}}$

$\sigma$ (°C)
Observations tend to be less variable than LENS

Stippling: not significant
Observations tend to be more autocorrelated than LENS
How does this behavior map on to variability in trends?

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- use a non-parametric method: **block bootstrap**
- fit a linear model to the observations
- resample the full spatial field of the residuals using a block size of two years
- add resampled residuals back to original trend, and recalculate the trend
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**Evaluation:** repeat exercise treating all members of the Large Ensemble as the observations.
Validation: can reproduce LENS variability

average across domain: 1.0
LENS overestimates trend uncertainty

Stippling: not significant
Observational Large Ensemble = synthetic ensemble + ensemble mean from LENS
Take home points

Observed and modeled trends are a combination of natural variability and response to forcing.

Variability in ‘long-term’ (e.g. 50 year) DJF temperature trends over North America primarily due to short-timescale variability.

LENS tends to overestimate this variability, so overestimates the contribution of internal variability to trend uncertainty.

By applying block bootstrapping to the observational record, we can make an ‘Observational Large Ensemble’ that has a covariance structure similar to the real world.
extras