Internal variability and surface temperature change

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Canadian Centre for Climate Modelling and Analysis
1. Warming slowdowns since 1920
   Aiguo Dai, John Fyfe, Shang-Ping Xie and Xingang Dai

2. Cooling North American winters since 2002
   Michael Sigmond and John Fyfe
GMST anomalies (annual)

The approach

2. Remove CMIP5 GMST from OBS ST
3. 3-year means and EOF expansion
4. Compute OBS GMST (residual)
5. Add back CMIP5 GMST (total)

GMST anomalies (total)

GMST anomalies (residual)

$r = 0.80, 0.94$


EOF1

EOF4

IPO: $r = 0.81$

AMO: $r = 0.33$

°C
Central North American winters

Sigmond & Fyfe (in prep.)
Winter trends (2002-2014)

Sigmond & Fyfe (in prep.)
Everything but the kitchen sink

1. 100-member initial condition ensemble
2. 10-member pacemaker ensemble with observed tropical surface wind
3. AGCM ensemble with prescribed tropical Pacific SSTs

Sigmond & Fyfe (in prep.)
Winter trends (2002-2014)

Sigmond & Fyfe (in prep.)
a Northwest North America

b Central North America

Sigmoid & Fyfe (in prep.)
Temperature trends associated with observed trades trend

\[ \Delta \vec{T}_i \approx \vec{\beta} \Delta \tau_i \]

\[ \rightarrow \Delta \vec{T}^\tau = \vec{\beta} \Delta \tau^{obs} \]

Sigmond & Fyfe (in prep.)
Figure showing temperature trend (°C per decade) for different scenarios:

- a) Forced (large ensemble)
- b) Wind (large ensemble)
- c) Forced+Wind (large ensemble)
- d) Forced+Wind (wind-constrained)

Sigmond & Fyfe (in prep.)
Large ensemble

Sigmond & Fyfe (in prep.)

Pacemaker

Wind (large ensemble)

Wind (wind-constrained)

Temperature trend (°C per decade)
Sigmond & Fyfe (in prep.)
AGCM with pacemaker SSTs

(a) Forced + Wind (wind-constrained)  (b) AGCM

(c) AGCM  (d) AGCM

Sigmond & Fyfe (in prep.)
AGCM with observed SSTs

Sigmond & Fyfe (in prep.)
Summary

1. Recent warming slowdown, and others since 1920, primarily due to the IPO

2. Recent cold central North American winters not linked to the tropical Pacific
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