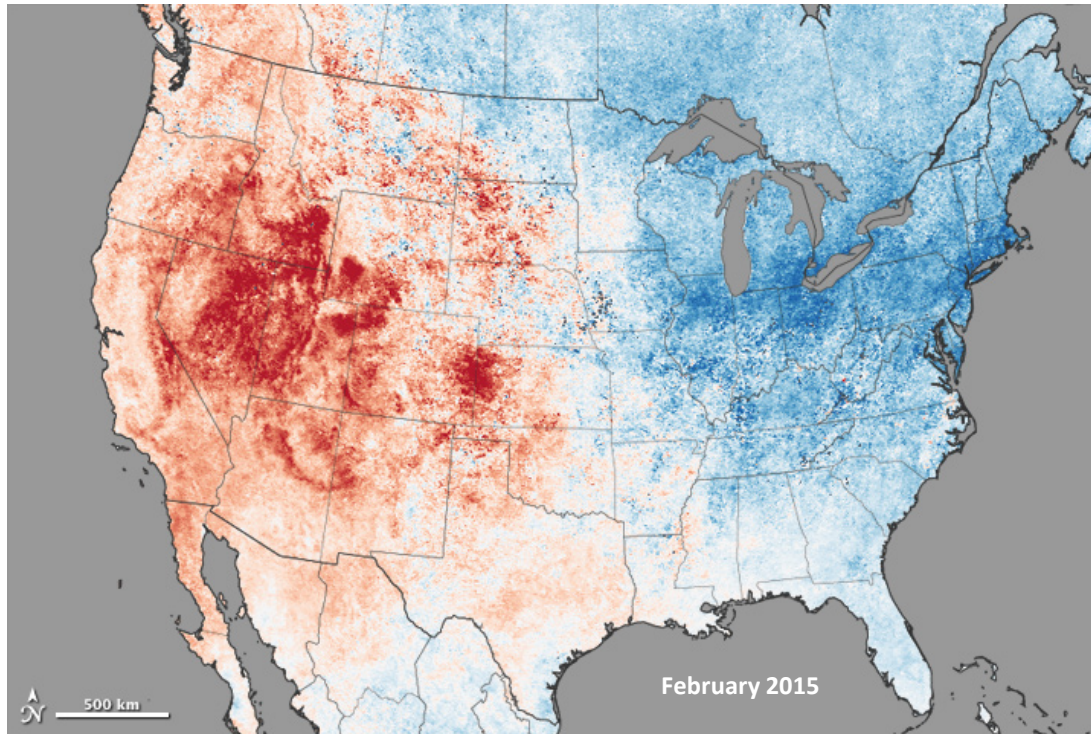


Diagnosing high and low temperature events with a dynamical adjustment technique



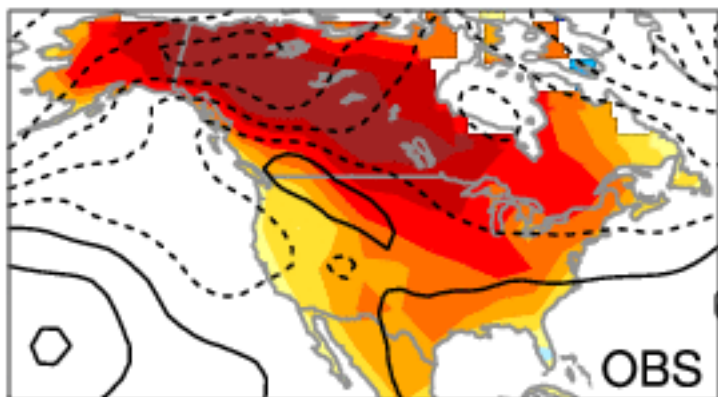
Flavio Lehner¹, Clara Deser¹, Laurent Terray²

¹ *Climate and Global Dynamics Lab, NCAR, USA*

² *Sciences de L'Univers au CERFACS, CERFACS/CNRS, France*

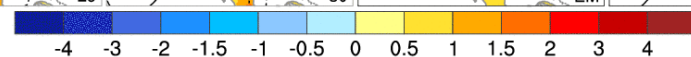
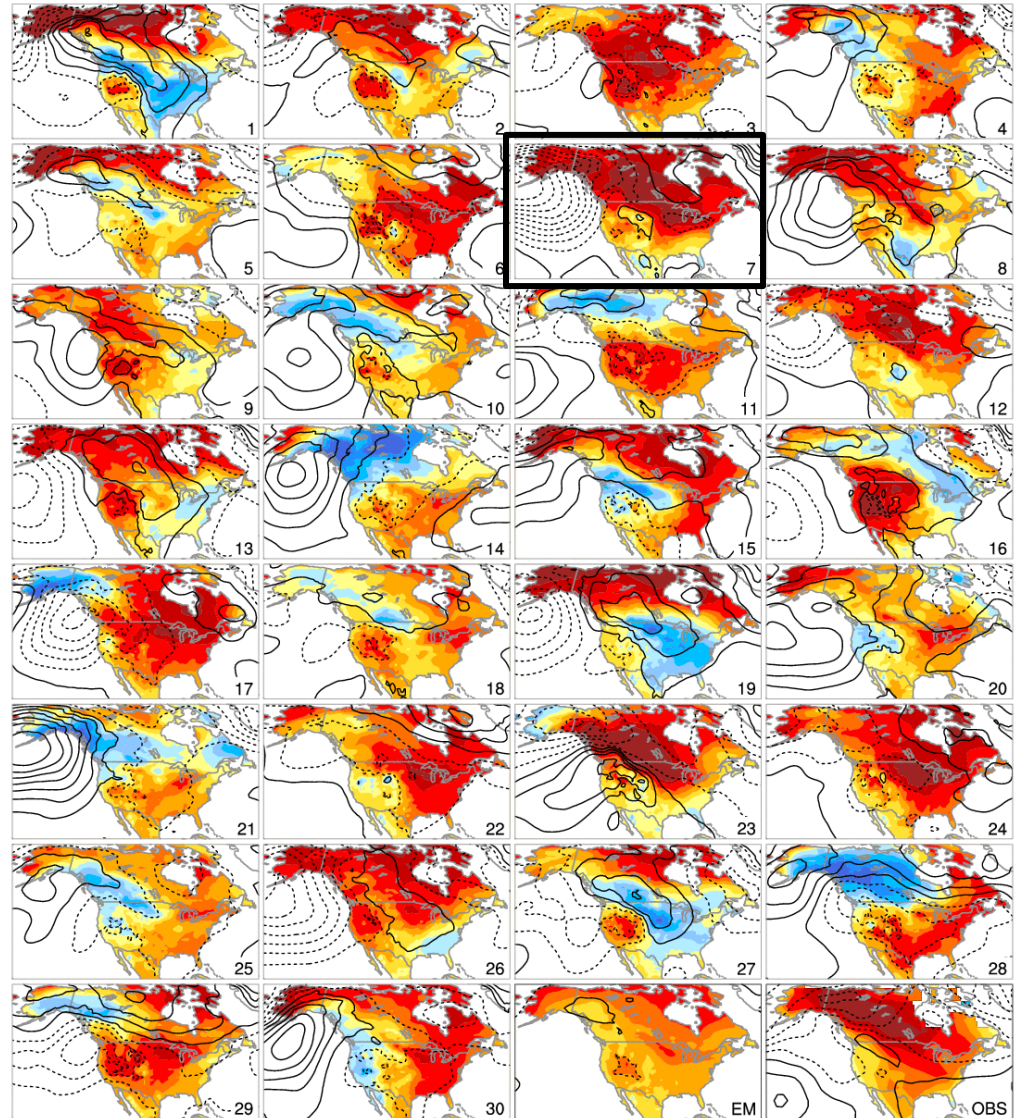
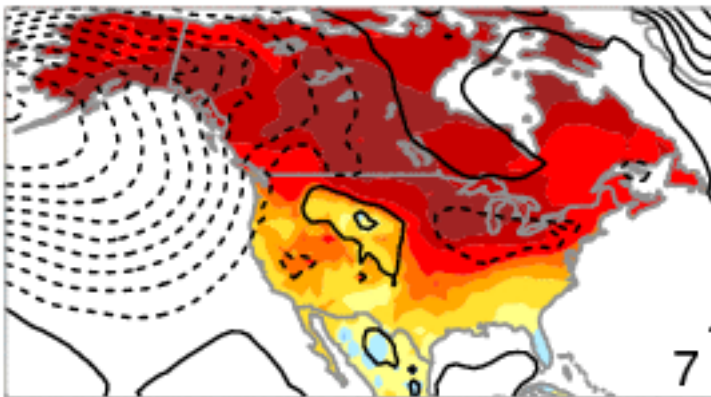
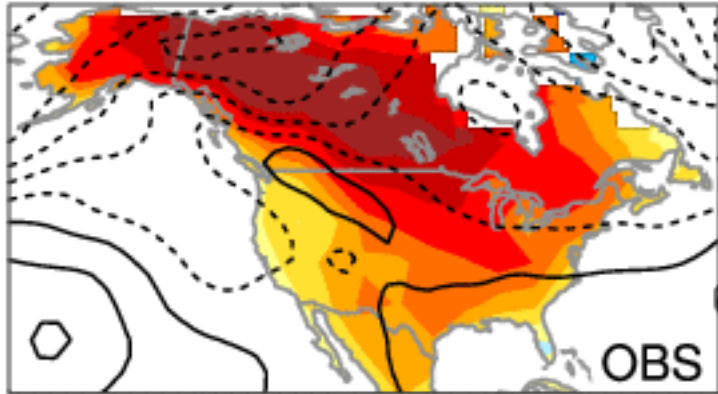
The problem of internal variability

DJF temperature trend 1963-2012



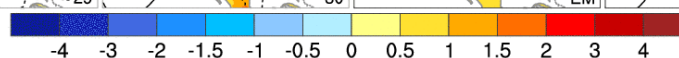
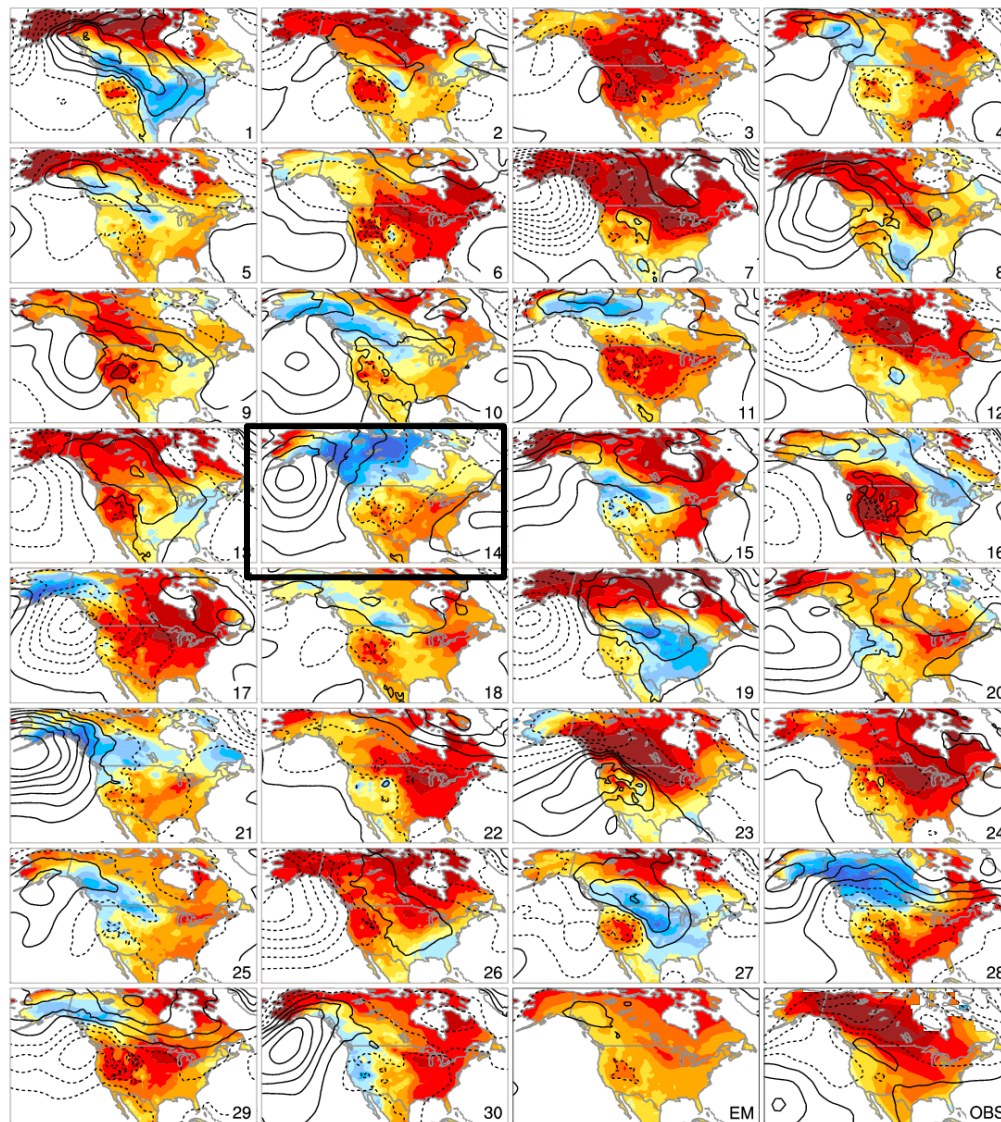
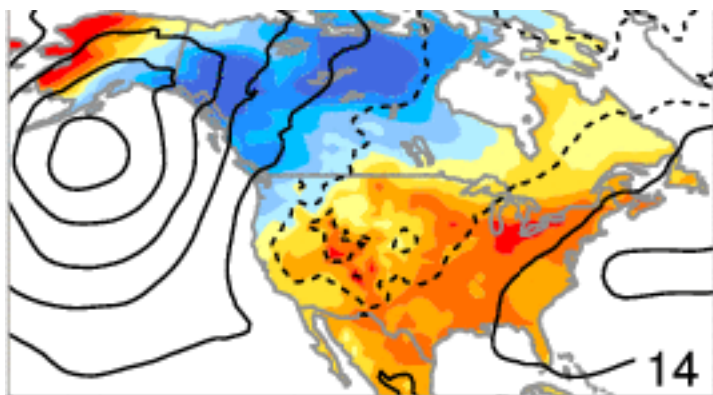
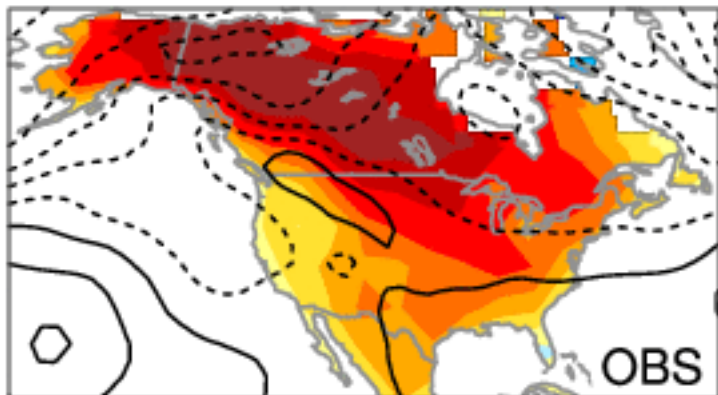
The problem of internal variability

DJF temperature trend 1963-2012



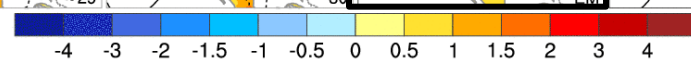
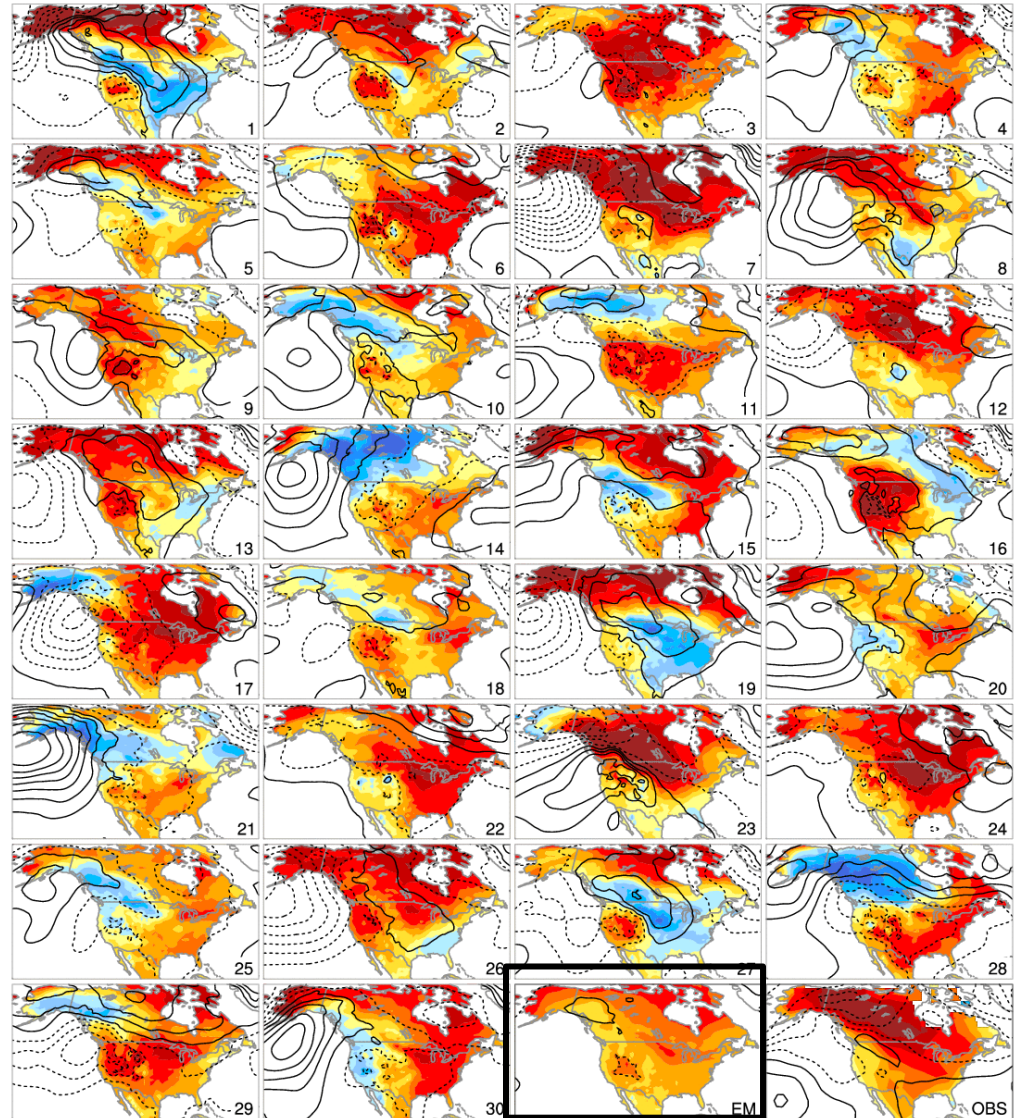
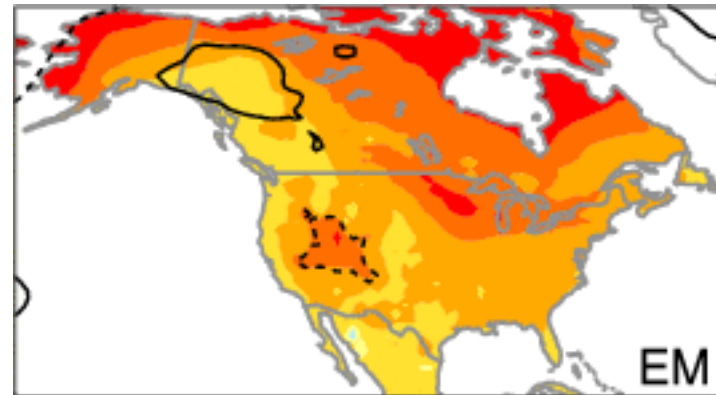
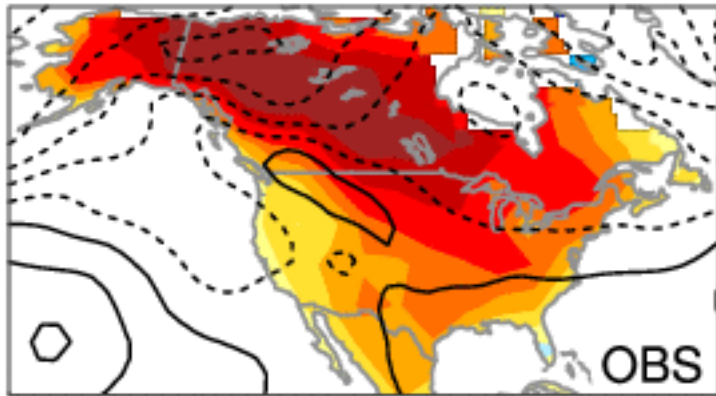
The problem of internal variability

DJF temperature trend 1963-2012



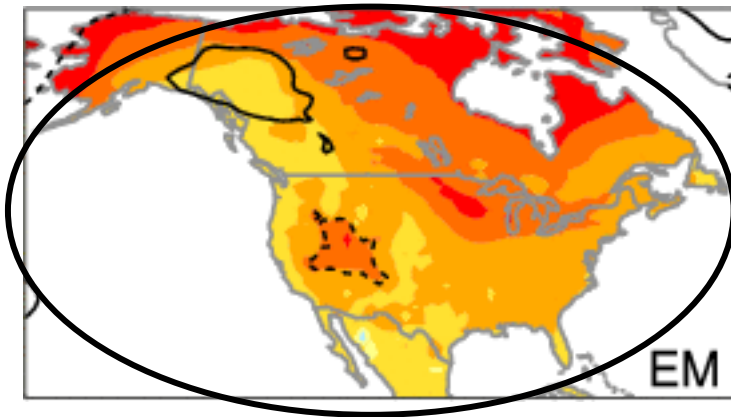
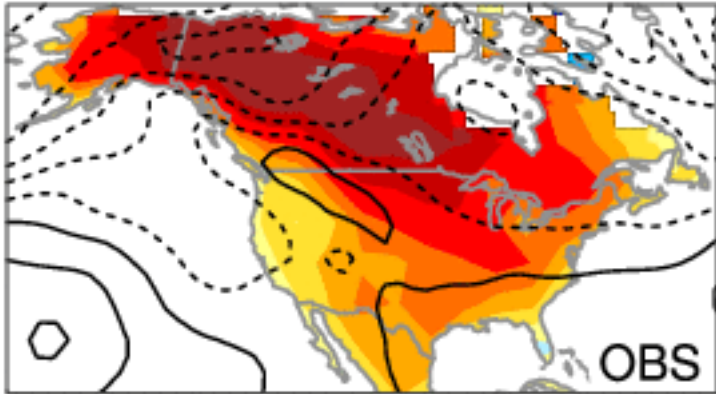
The problem of internal variability

DJF temperature trend 1963-2012

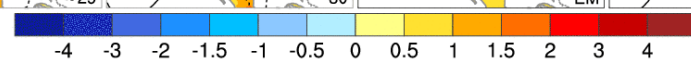
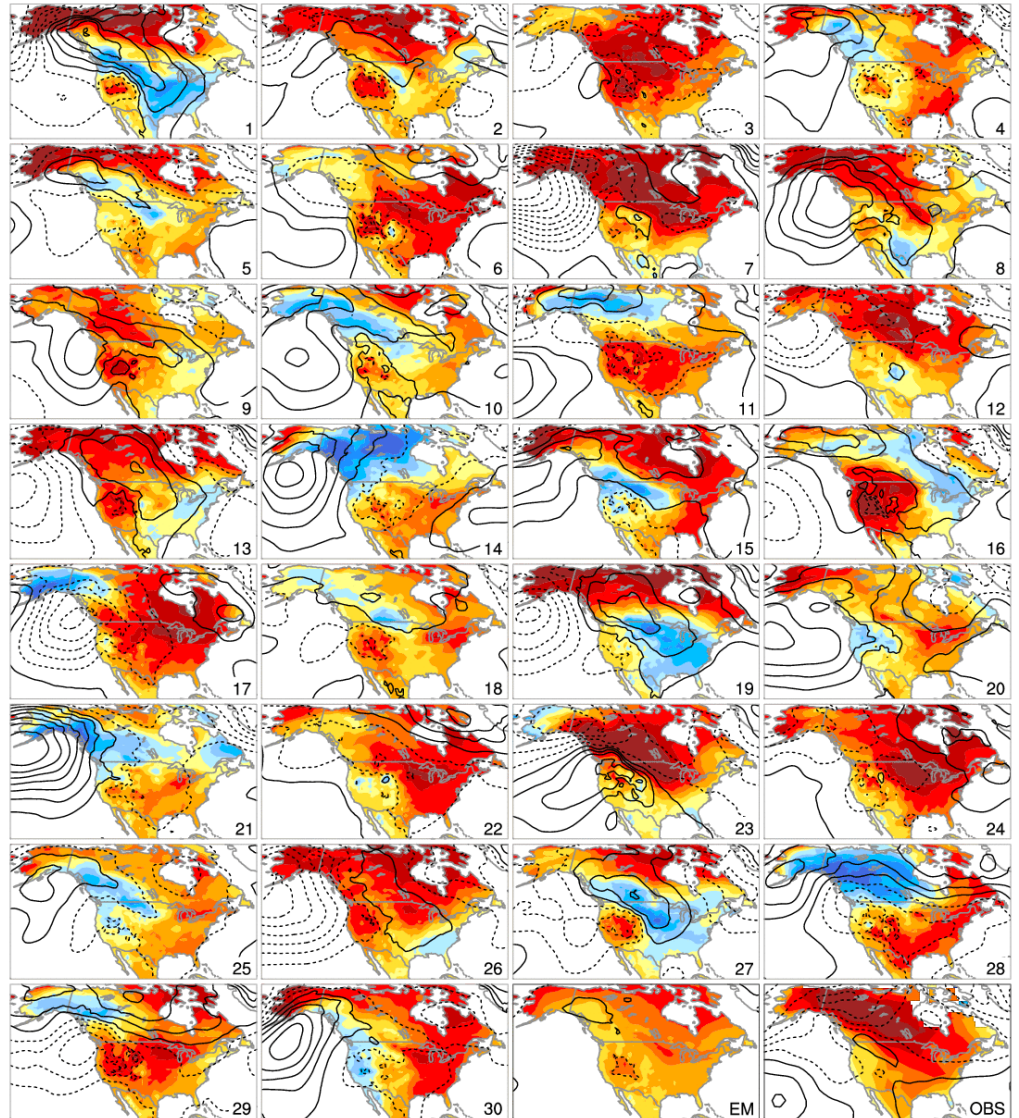


The problem of internal variability

DJF temperature trend 1963-2012



Little *forced* circulation change



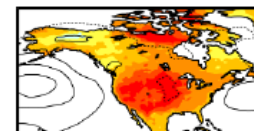
Dynamical adjustment explained (in a nutshell)



Trying to estimate the dynamical components of a surface air temperature (SAT) field

Dynamical adjustment explained (in a nutshell)

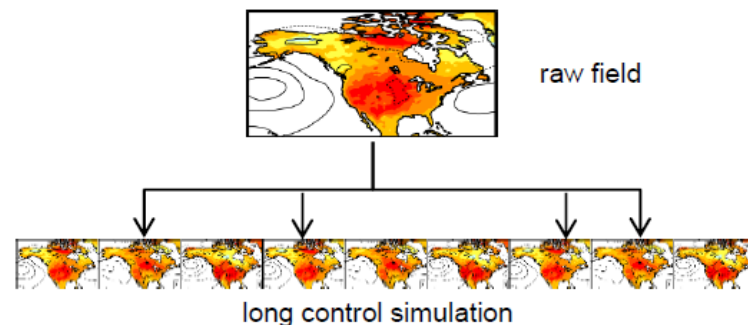
1. Select a monthly mean field (SAT and SLP) from historical simulation



raw field

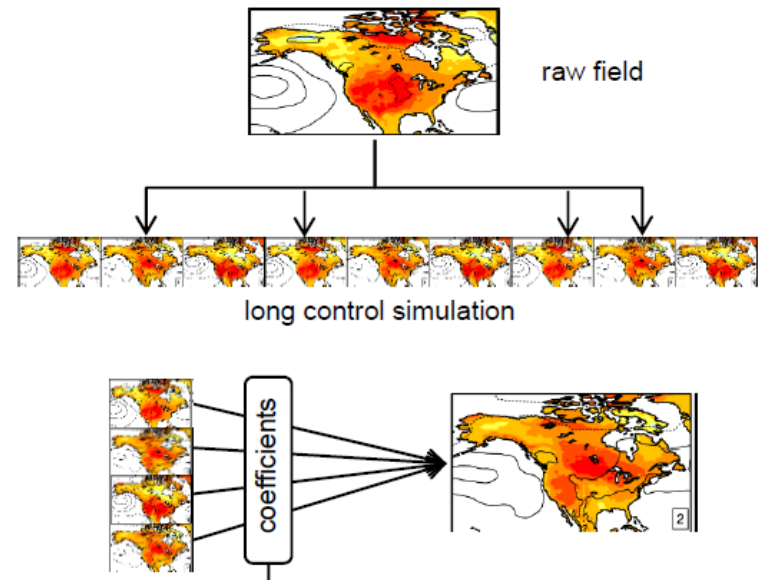
Dynamical adjustment explained (in a nutshell)

1. Select a monthly mean field (SAT and SLP) from historical simulation
2. Search analogues of SLP in a long control simulation (no forcing)



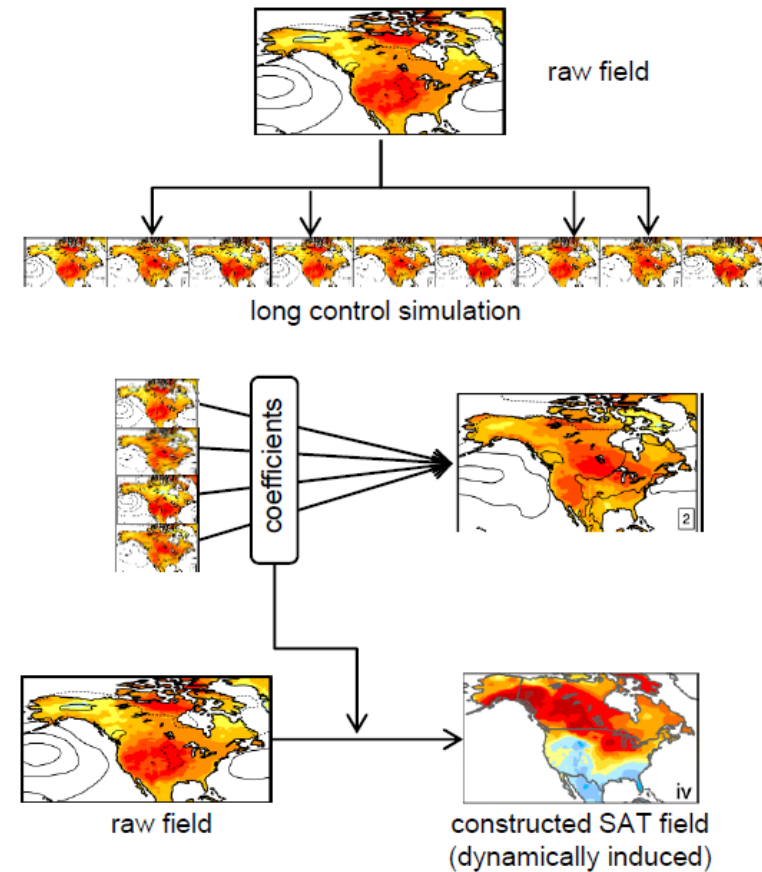
Dynamical adjustment explained (in a nutshell)

1. Select a monthly mean field (SAT and SLP) from historical simulation
2. Search analogues of SLP in a long control simulation (no forcing)
3. Reconstruct the historical SLP pattern from a linear combination of the closest analogues found in the control simulation



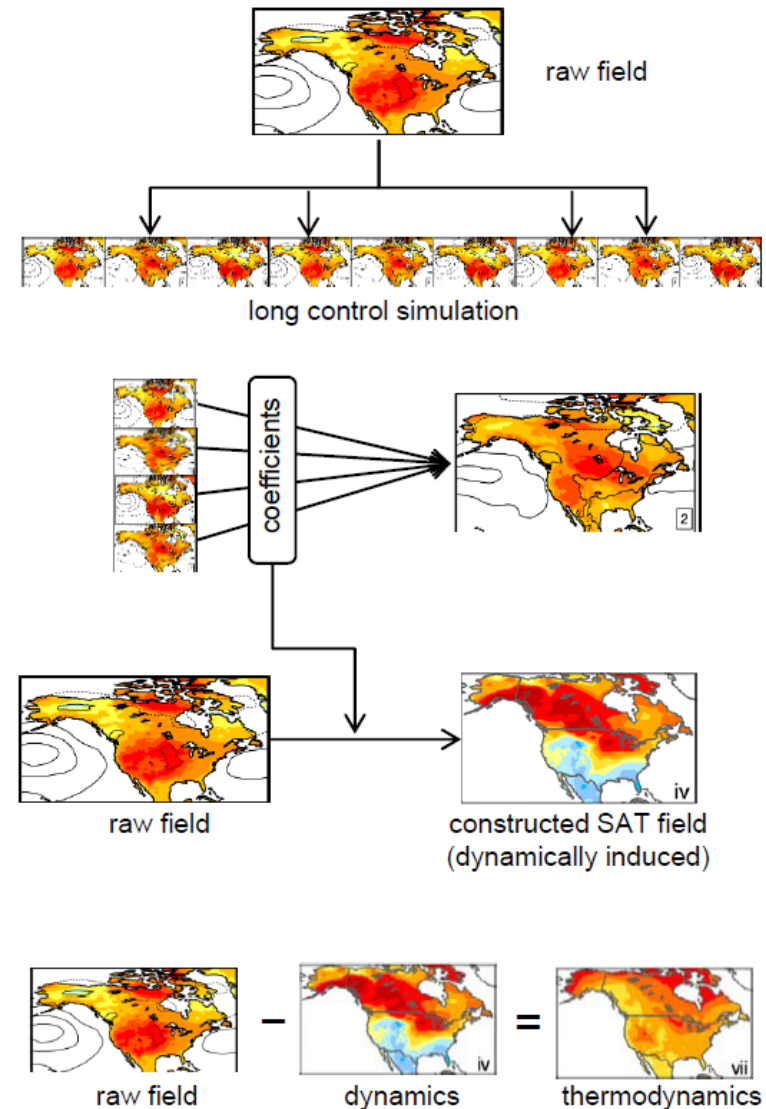
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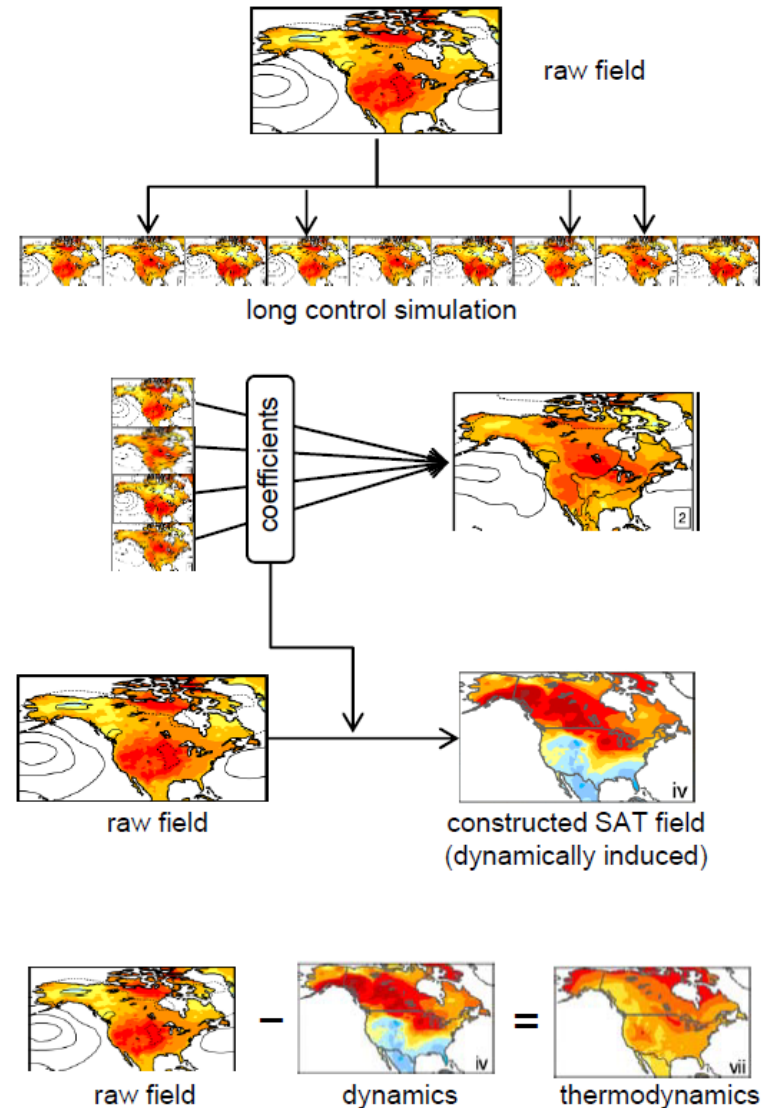
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5. This tells us how much of the SAT field comes from SLP variability, i.e., dynamics; the residual is assumed to be an estimate of 'thermodynamics'

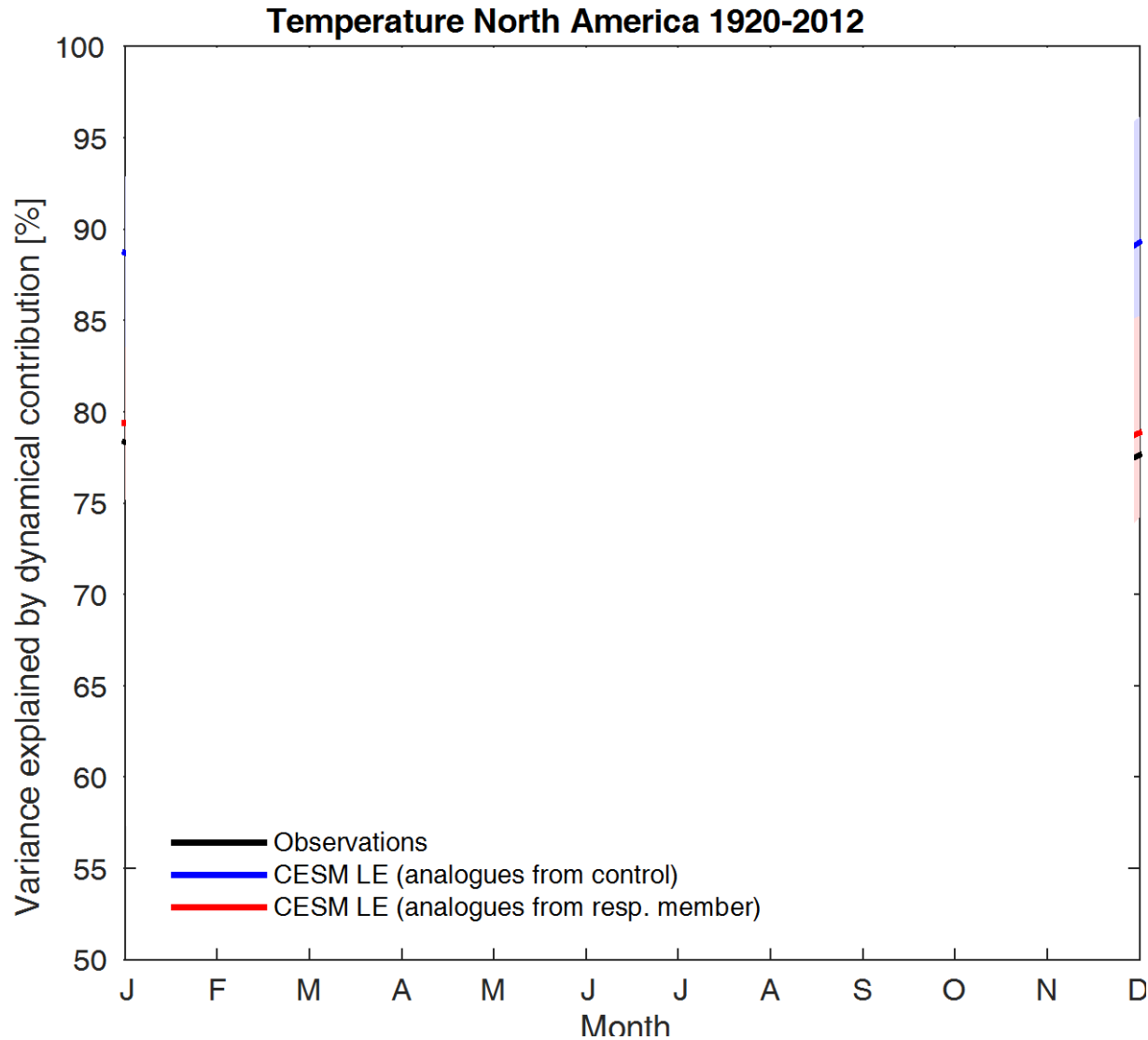


Dynamical adjustment explained (in a nutshell)

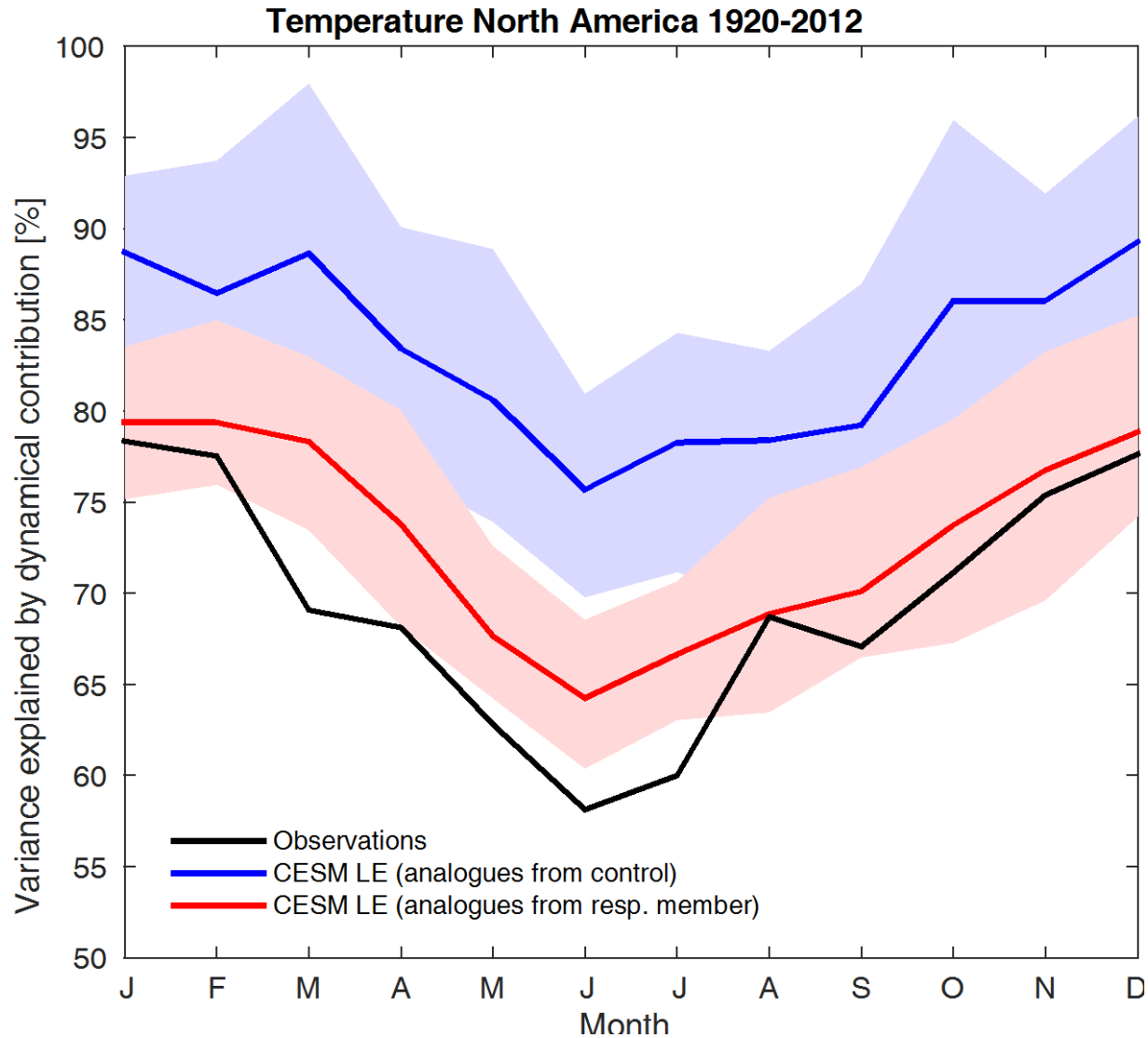
1. Select a monthly mean field (SAT and SLP) from **observations**
2. Search analogues of SLP in **detrended observations** (“no” forcing)
3. Reconstruct the historical SLP pattern from a linear combination of the closest analogues found in the **detrended observations**
4. Use the same linear coefficients to reconstruct SAT, now using the SLP from the respective month in the **observations**
5. This tells us how much of the SAT field comes from SLP variability, i.e., dynamics; the residual is assumed to be an estimate of ‘thermodynamics’



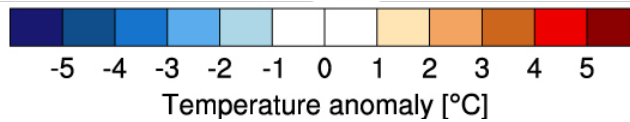
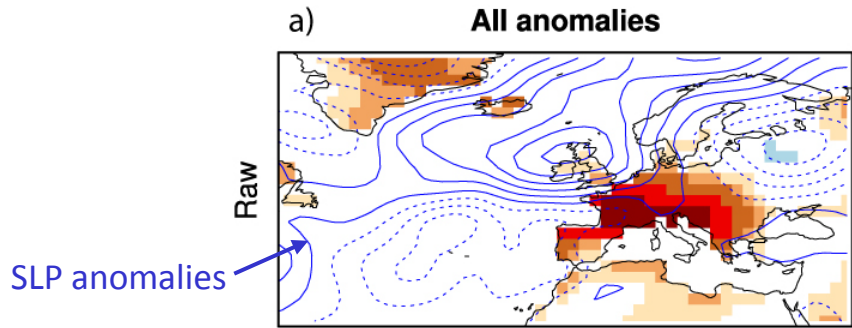
Source of analogues?



Source of analogues?

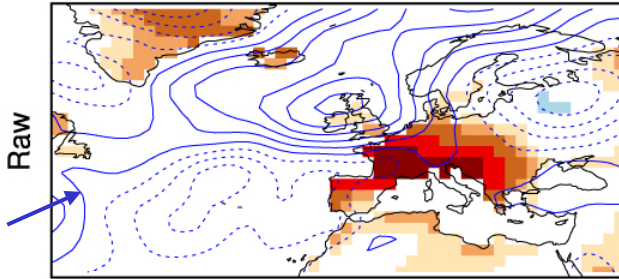


Application: record summer in Europe, August 2003



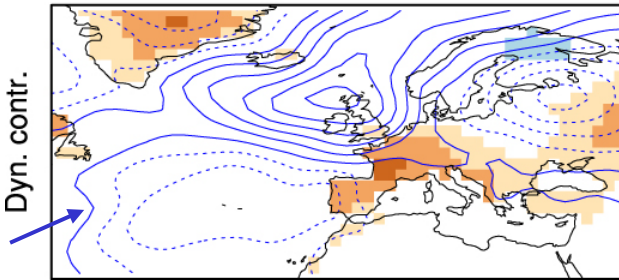
Application: record summer in Europe, August 2003

a) **All anomalies**

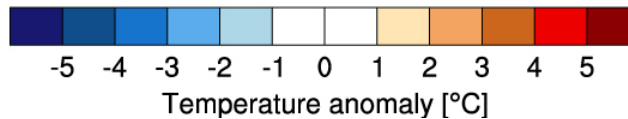


Raw SLP anomalies

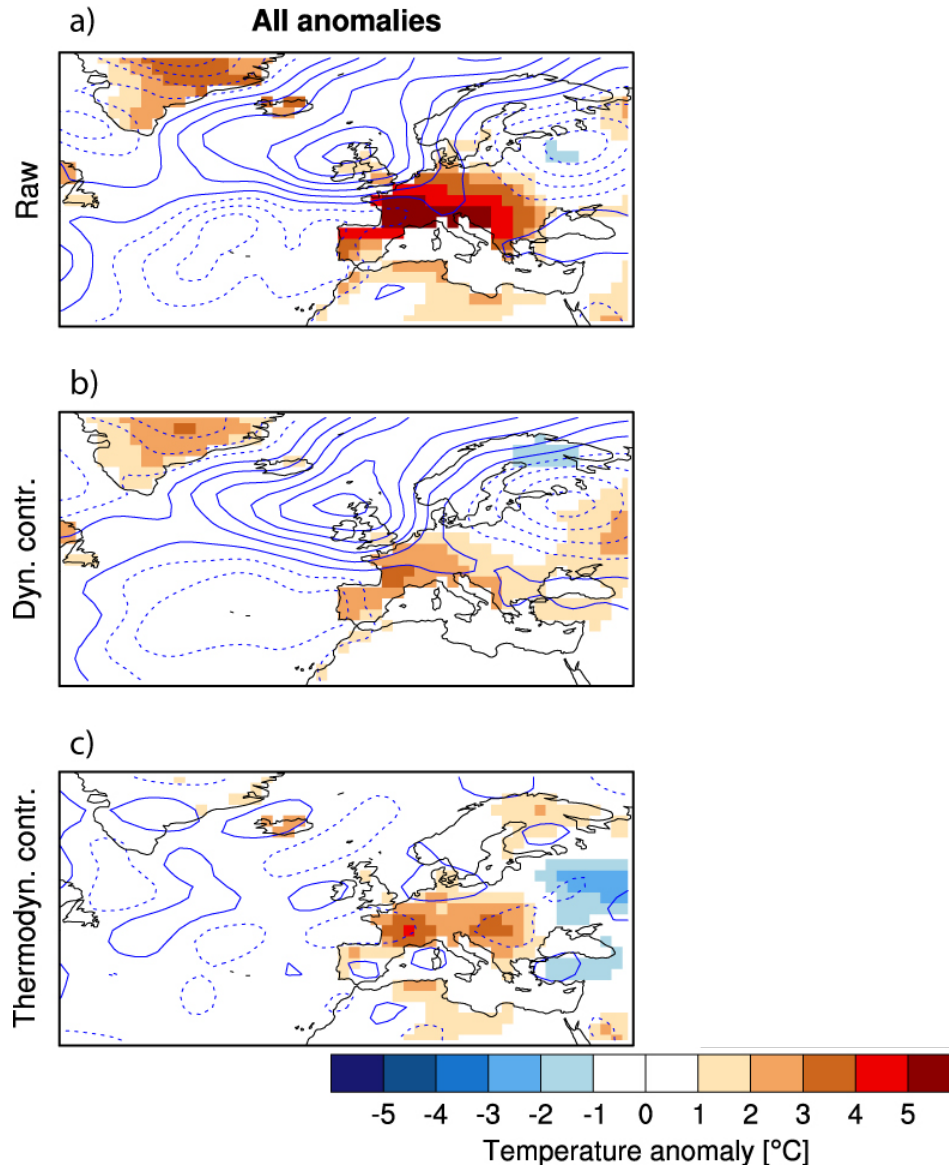
b)



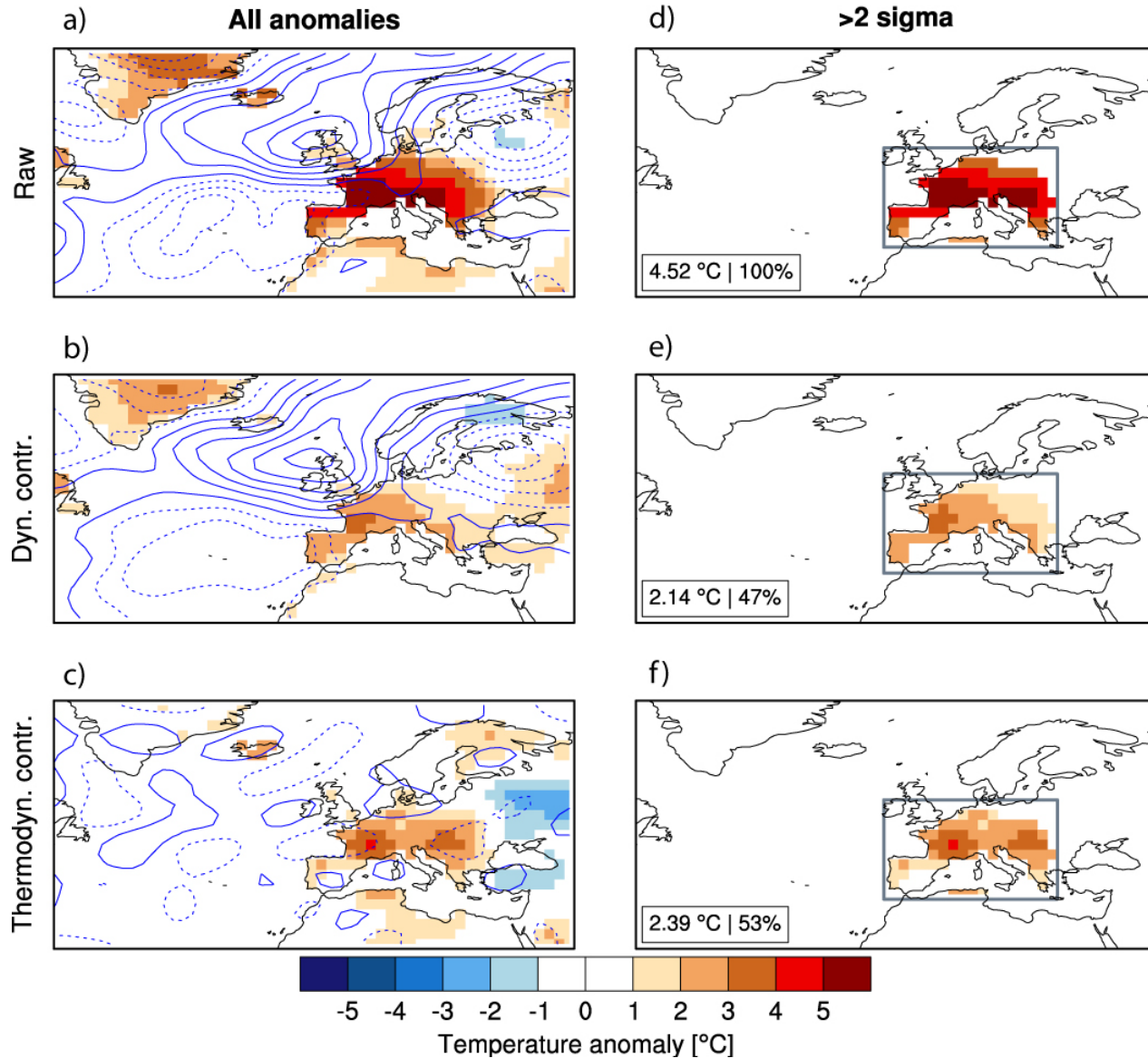
Constructed SLP anomalies



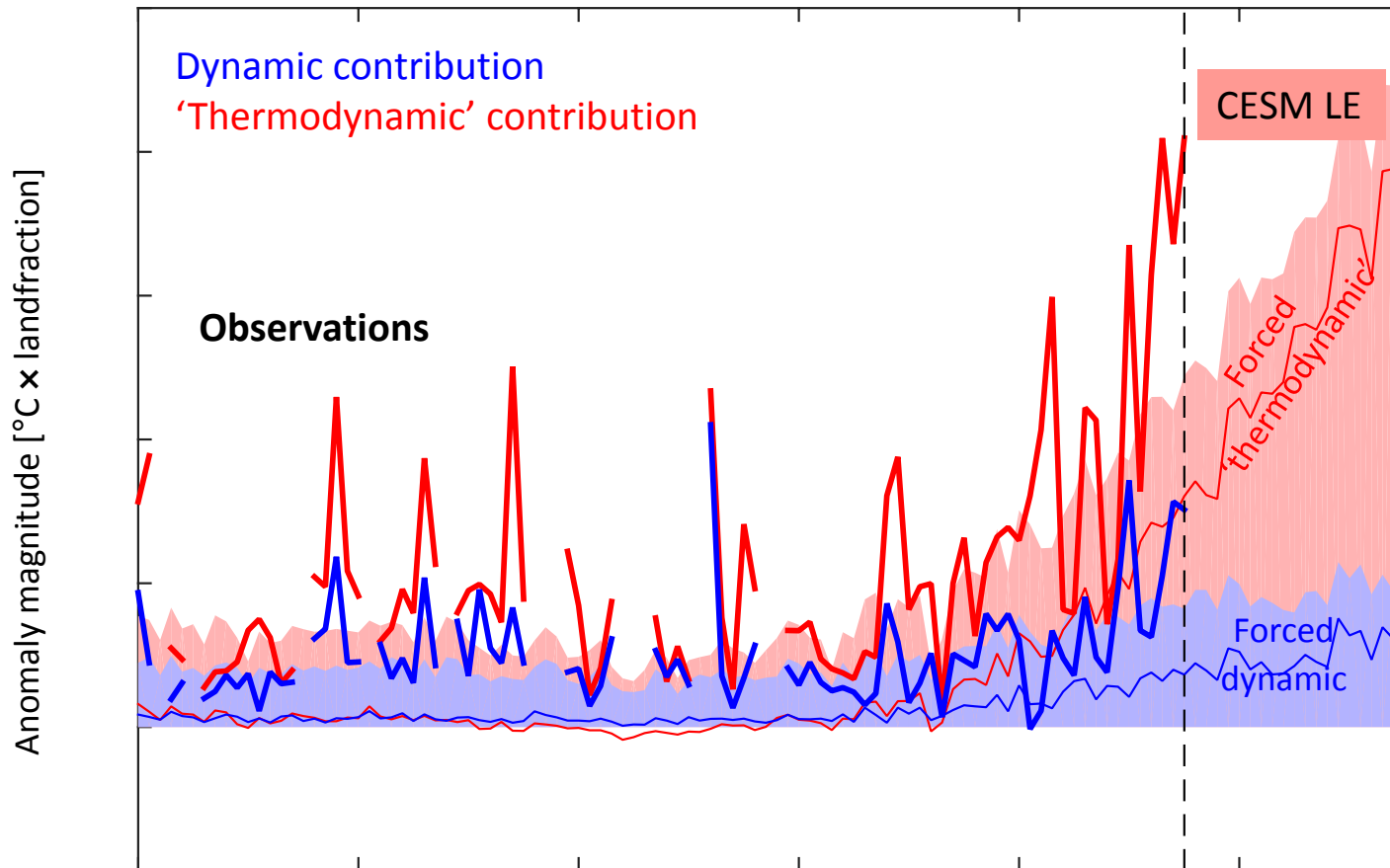
Application: record summer in Europe, August 2003



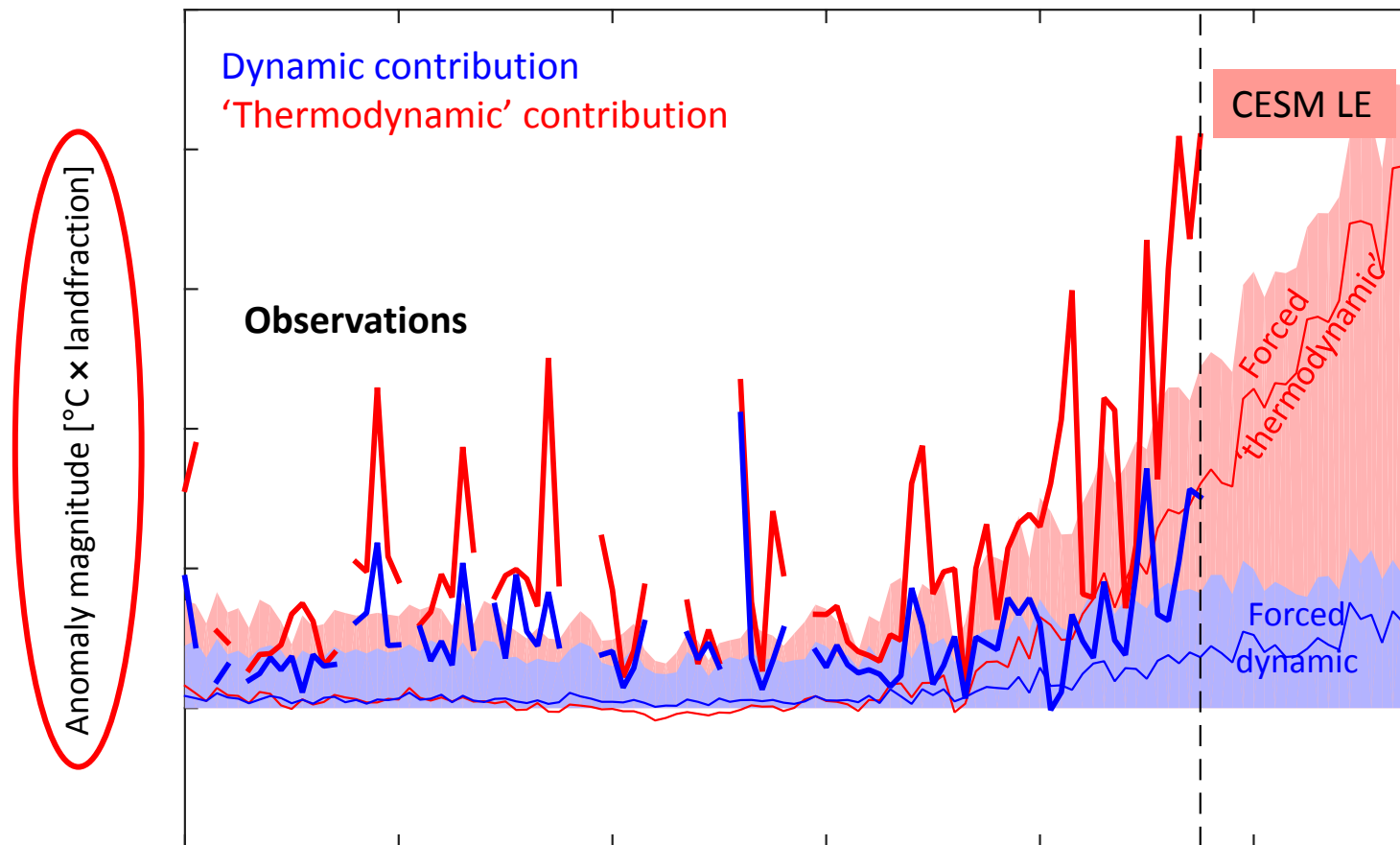
Application: record summer in Europe, August 2003



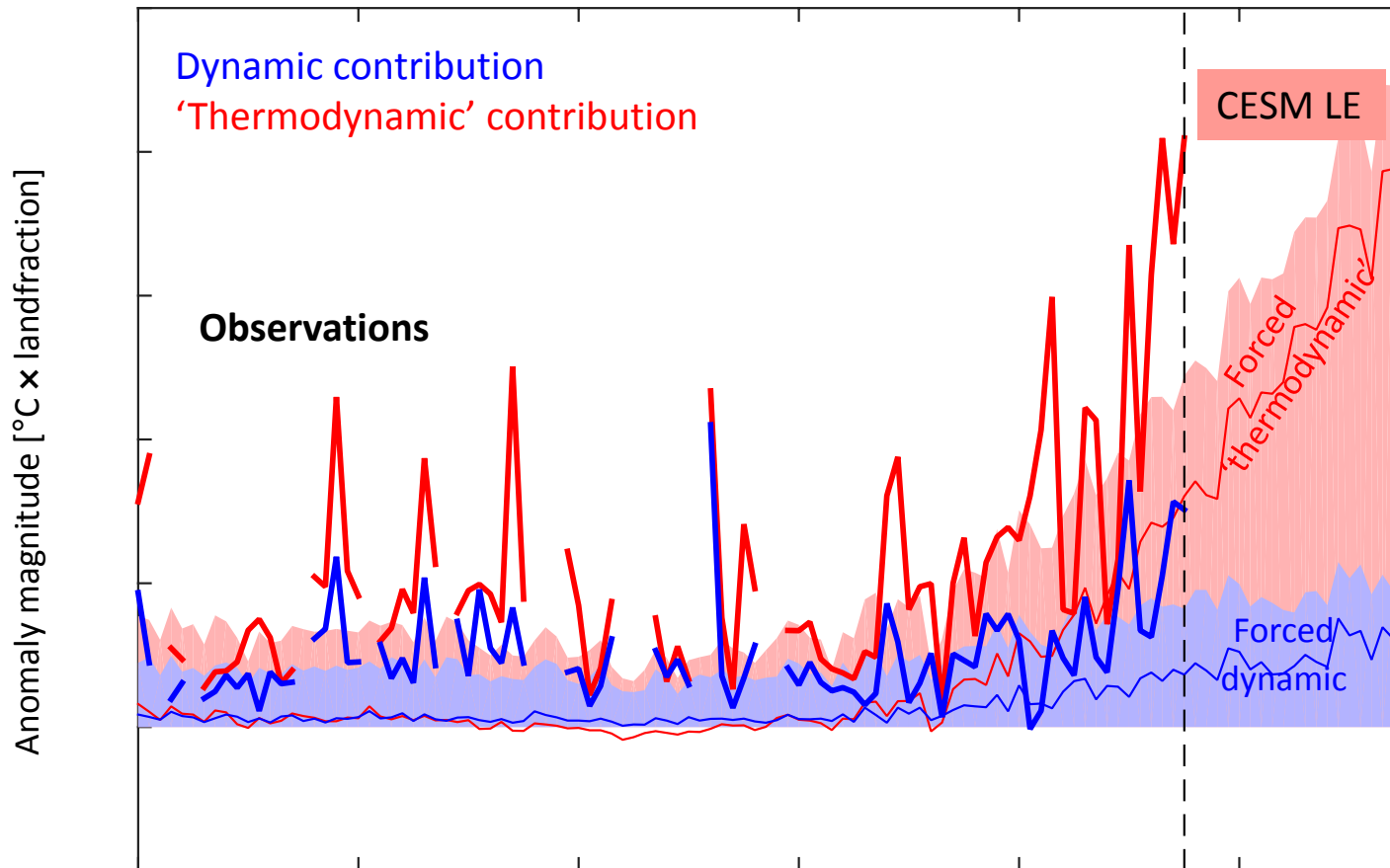
Europe JJA $>1\sigma$ temperatures



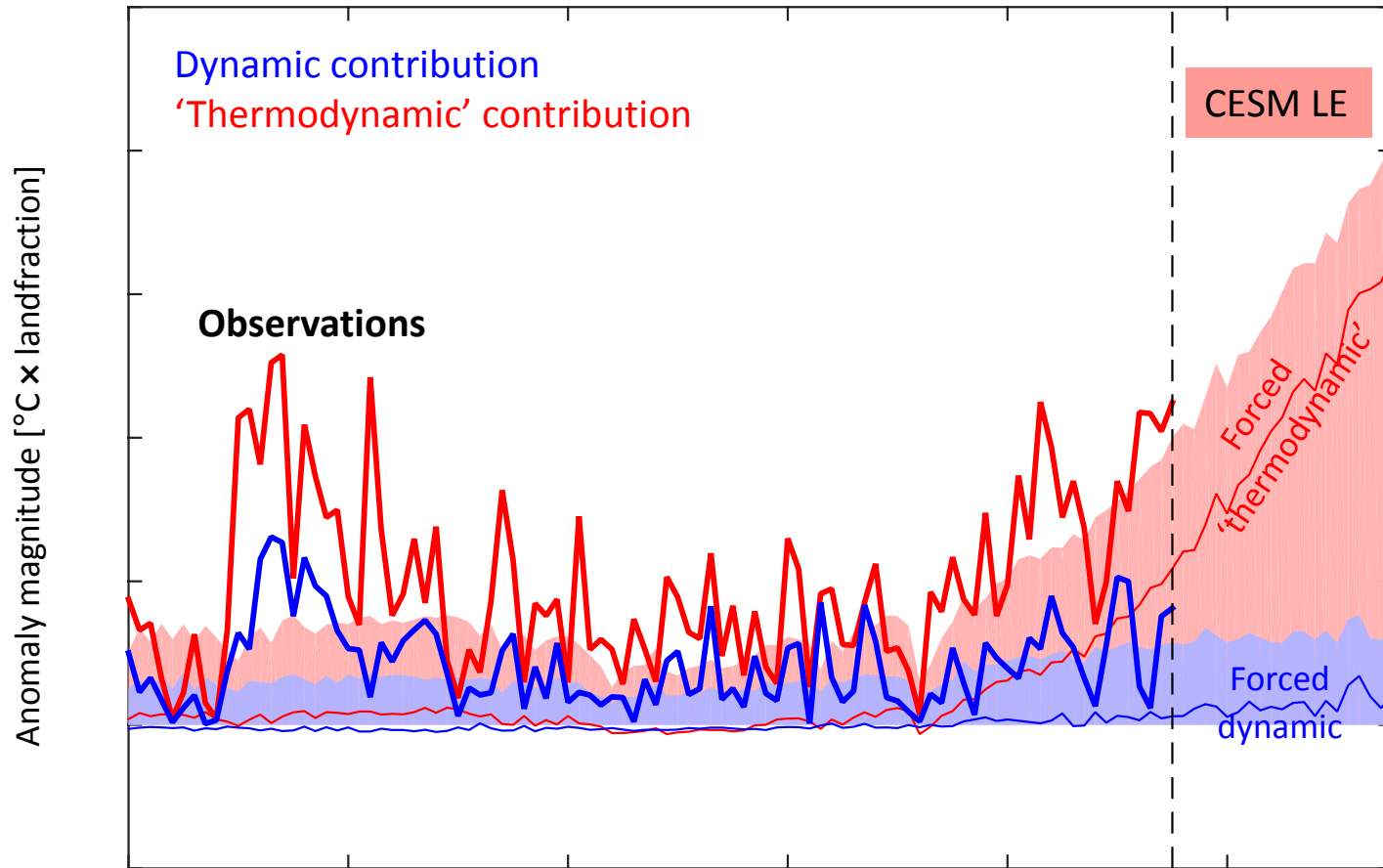
Europe JJA $>1\sigma$ temperatures



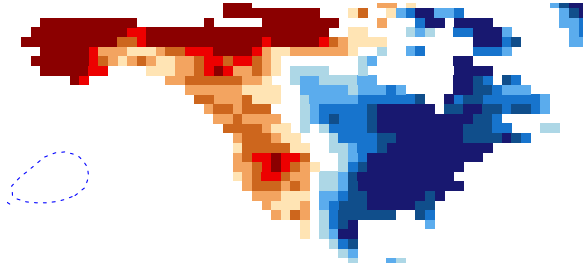
Europe JJA $>1 \sigma$ temperatures



North America JJA $>1 \sigma$ temperatures

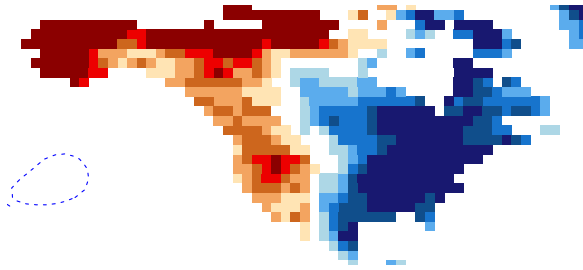


Application: North America, February 2015



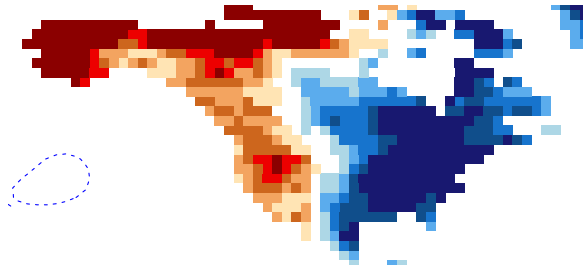
-5 -4 -3 -2 -1 0 1 2 3 4 5
y [°C]

Application: North America, February 2015

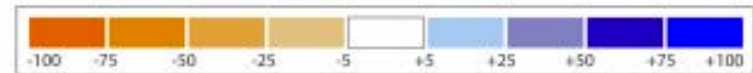
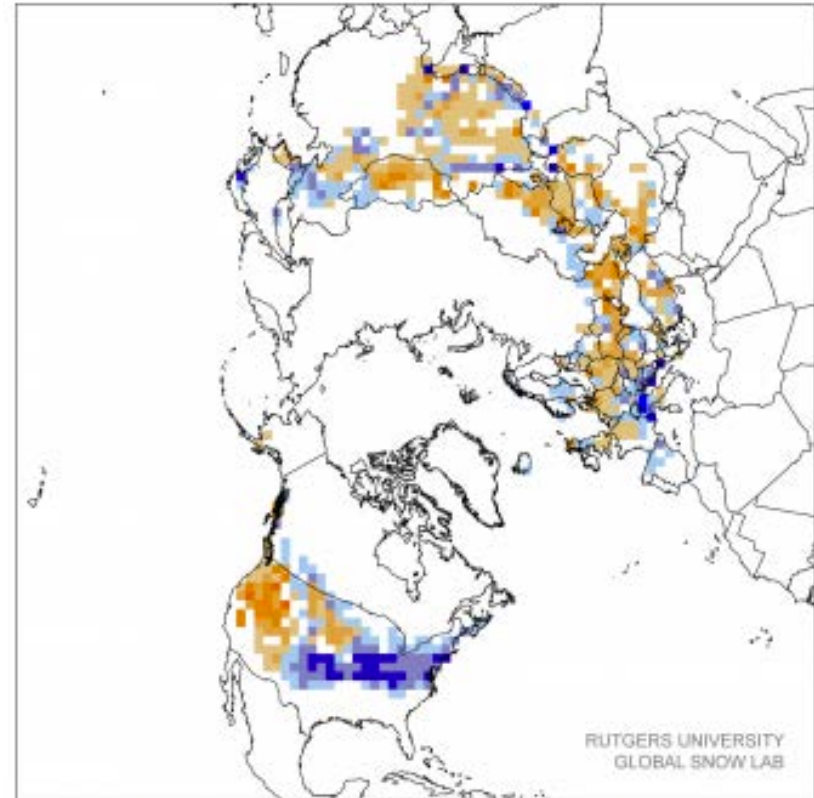


-5 -4 -3 -2 -1 0 1 2 3 4 5
y [°C]

Application: North America, February 2015



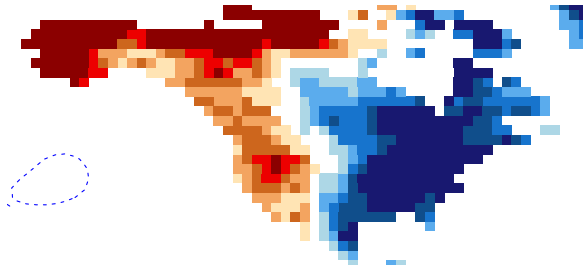
Northern Hemisphere Snow Cover Anomaly
February 2015



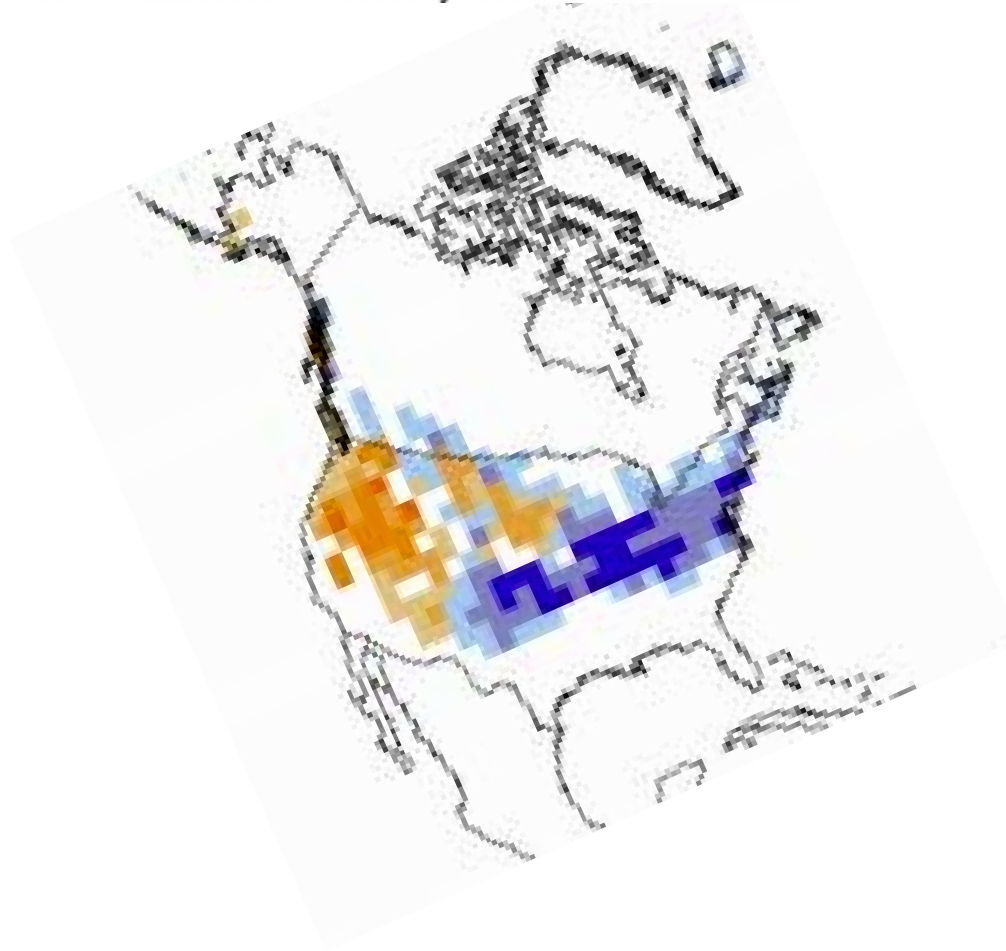
Percent difference from 1981-2010 average February snow cover extent

-5 -4 -3 -2 -1 0 1 2 3 4 5
y [°C]

Application: North America, February 2015

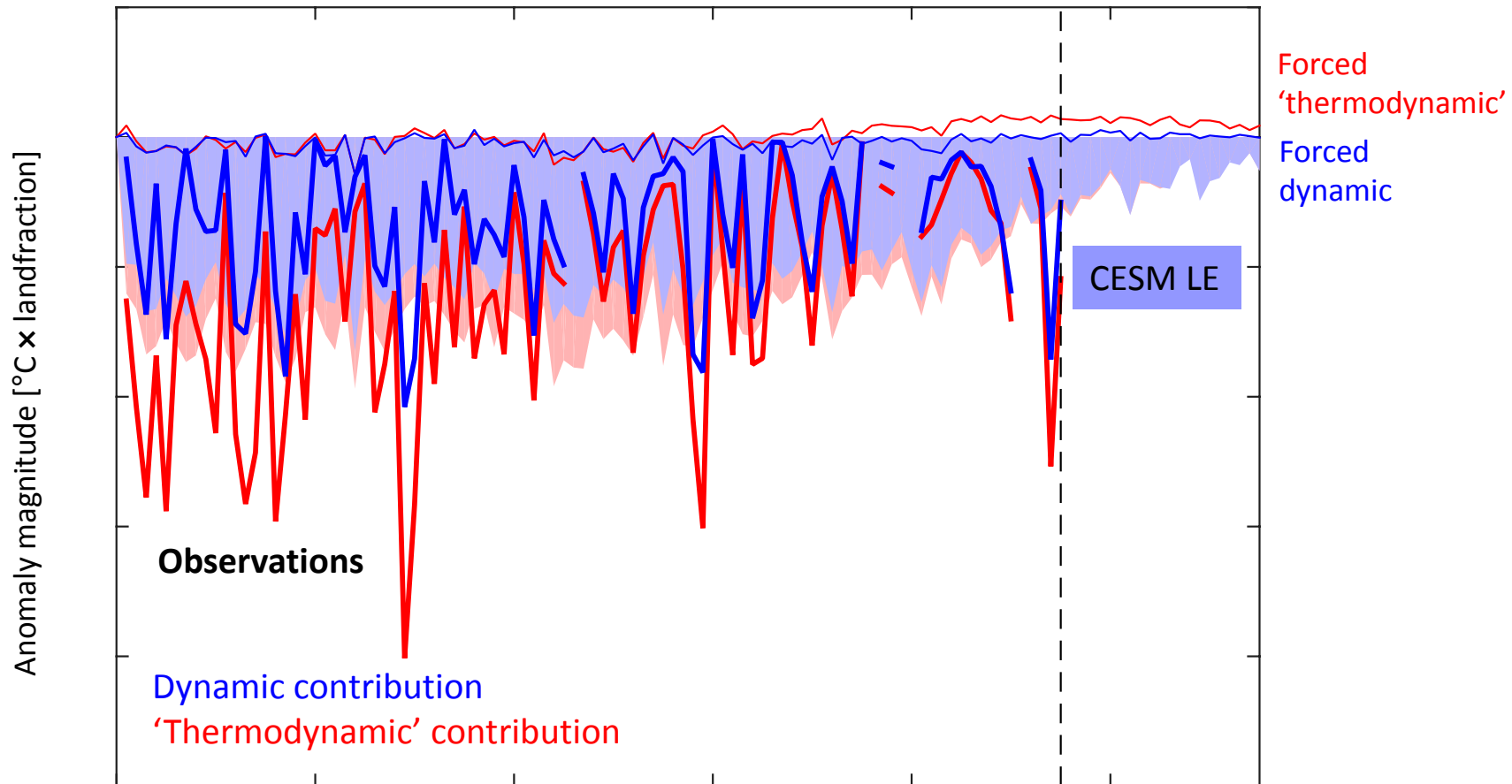


Northern Hemisphere Snow Cover Anomaly
February 2015

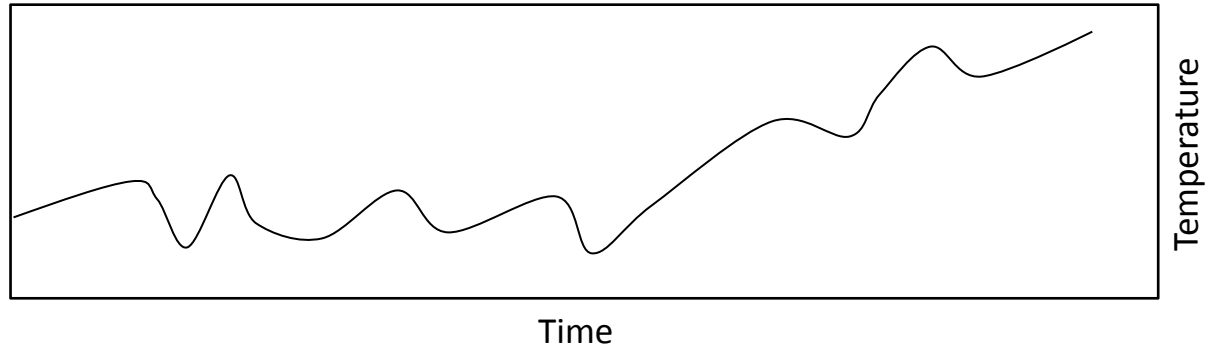


-5 -4 -3 -2 -1 0 1 2 3 4 5
y [°C]

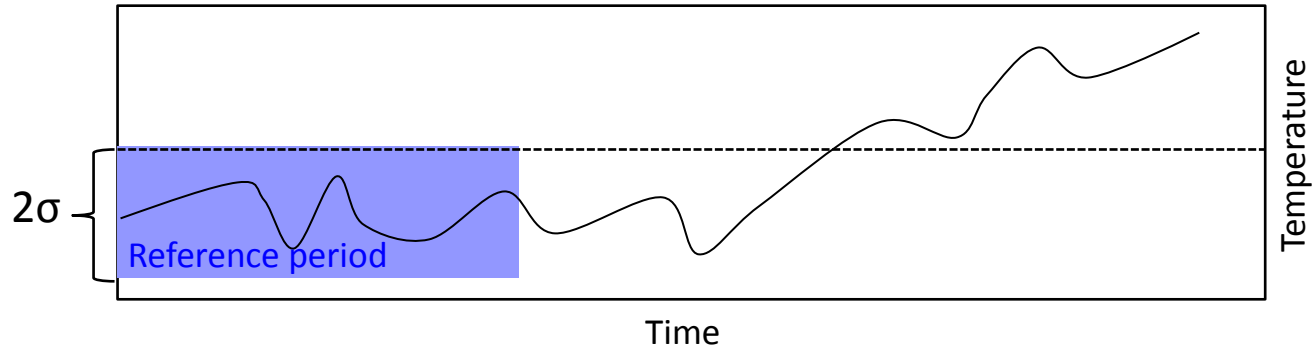
North America DJF $< -1 \sigma$ temperatures



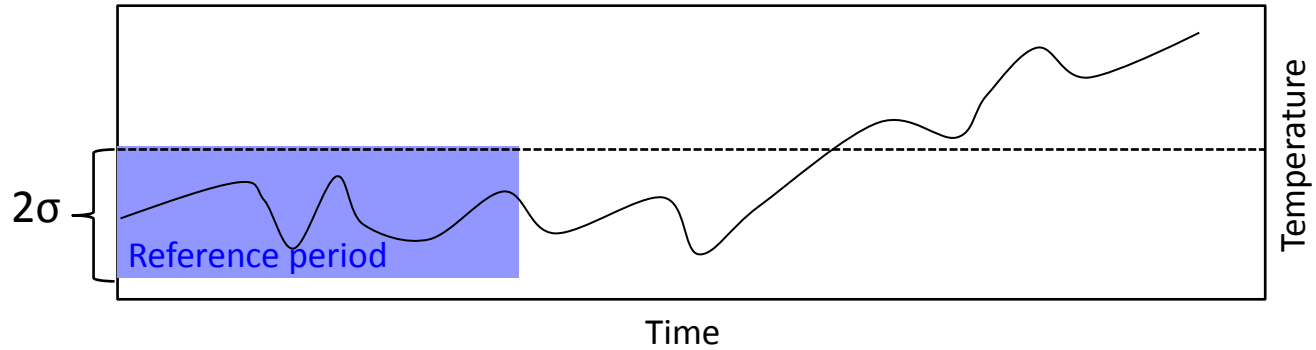
Application: increased signal-to-noise



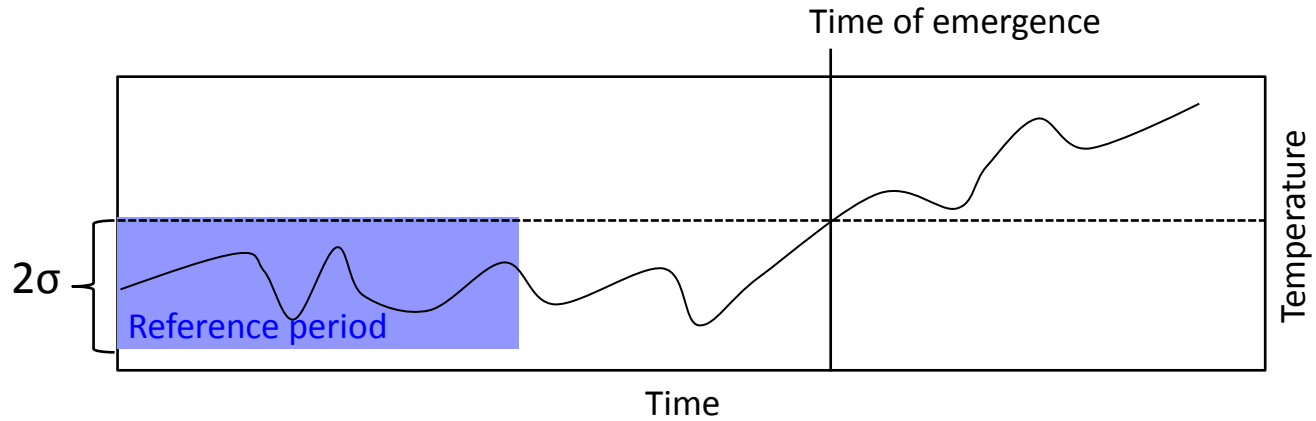
Application: increased signal-to-noise



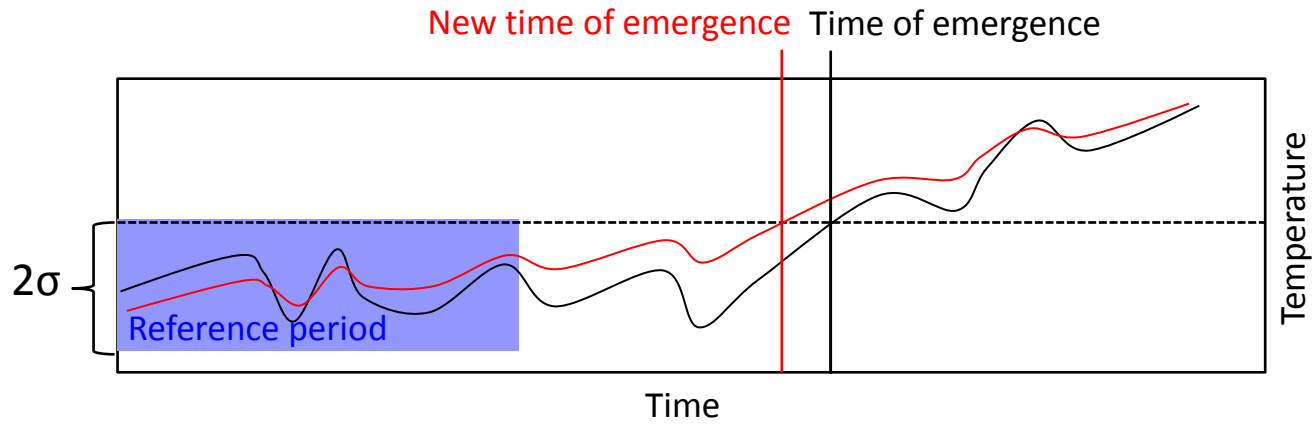
Application: increased signal-to-noise



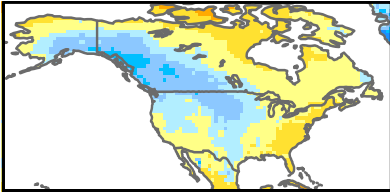
Application: increased signal-to-noise



Application: increased signal-to-noise



Application: increased signal-to-noise



Conclusions

- Dynamical adjustment of observations and model simulations
- Event attribution possible, but also increased signal-to-noise for climate change studies
- Further dissection into forced dynamics and forced thermodynamics

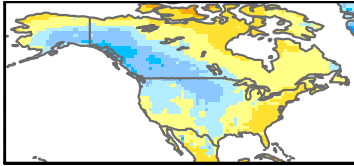
Conclusions

- Dynamical adjustment of observations and model simulations
- Event attribution possible, but also increased signal-to-noise for climate change studies
- Further dissection into forced dynamics and forced thermodynamics

Caveats and further steps:

- Direction of forcing unknown (SLP \rightarrow SAT or SAT \rightarrow SLP?)
- Synoptic time scales (e.g., 5-day means) and lead-lag correlations might help to get at that
- Convolution with other factors (e.g., precipitation)

Application: increased signal-to-noise



0 40 50 60