Making an Extreme Event: Putting the Pieces Together

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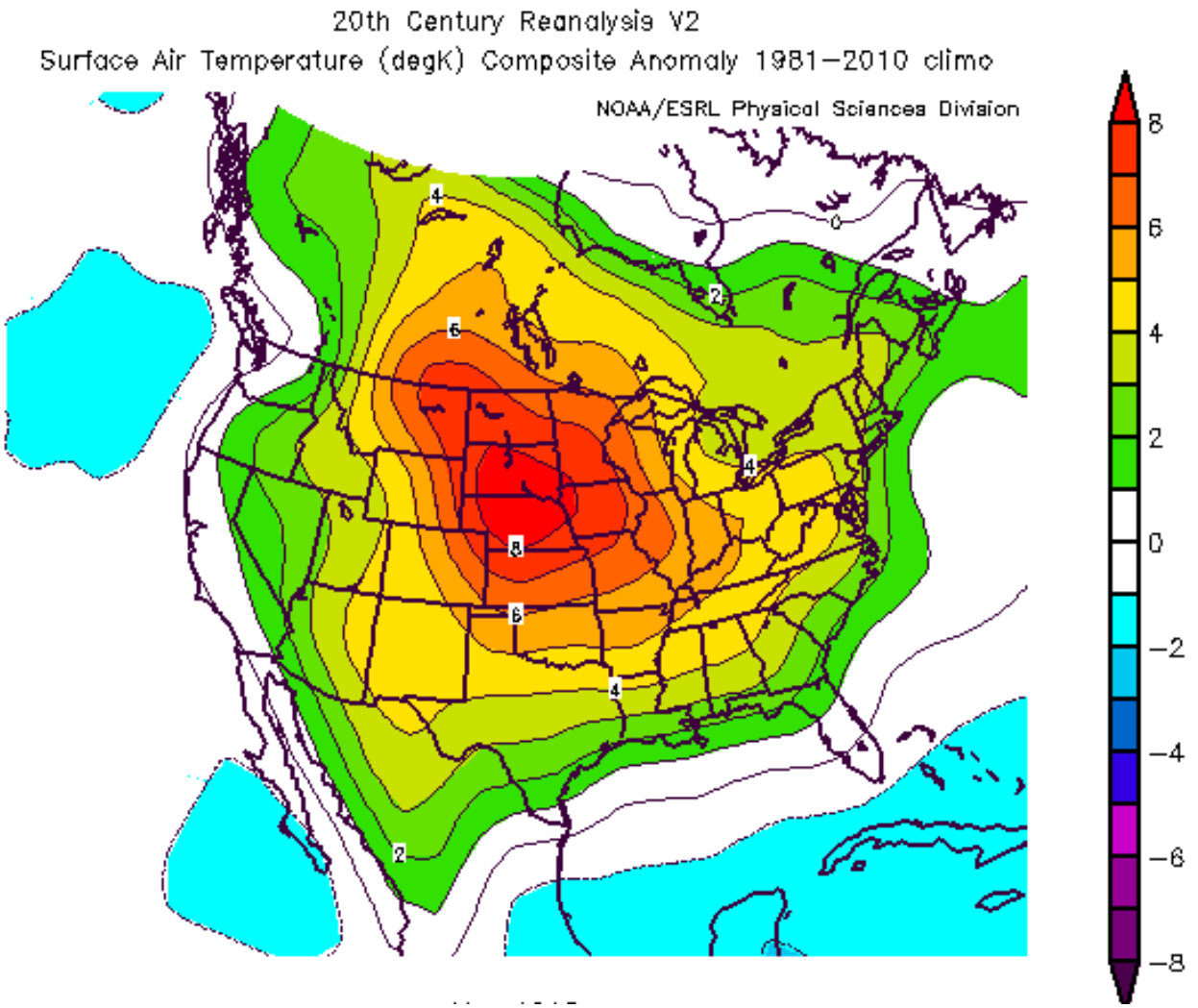
Overview

- Identify factors that contribute to making an event extreme (March 2012 U.S. “heat wave”)

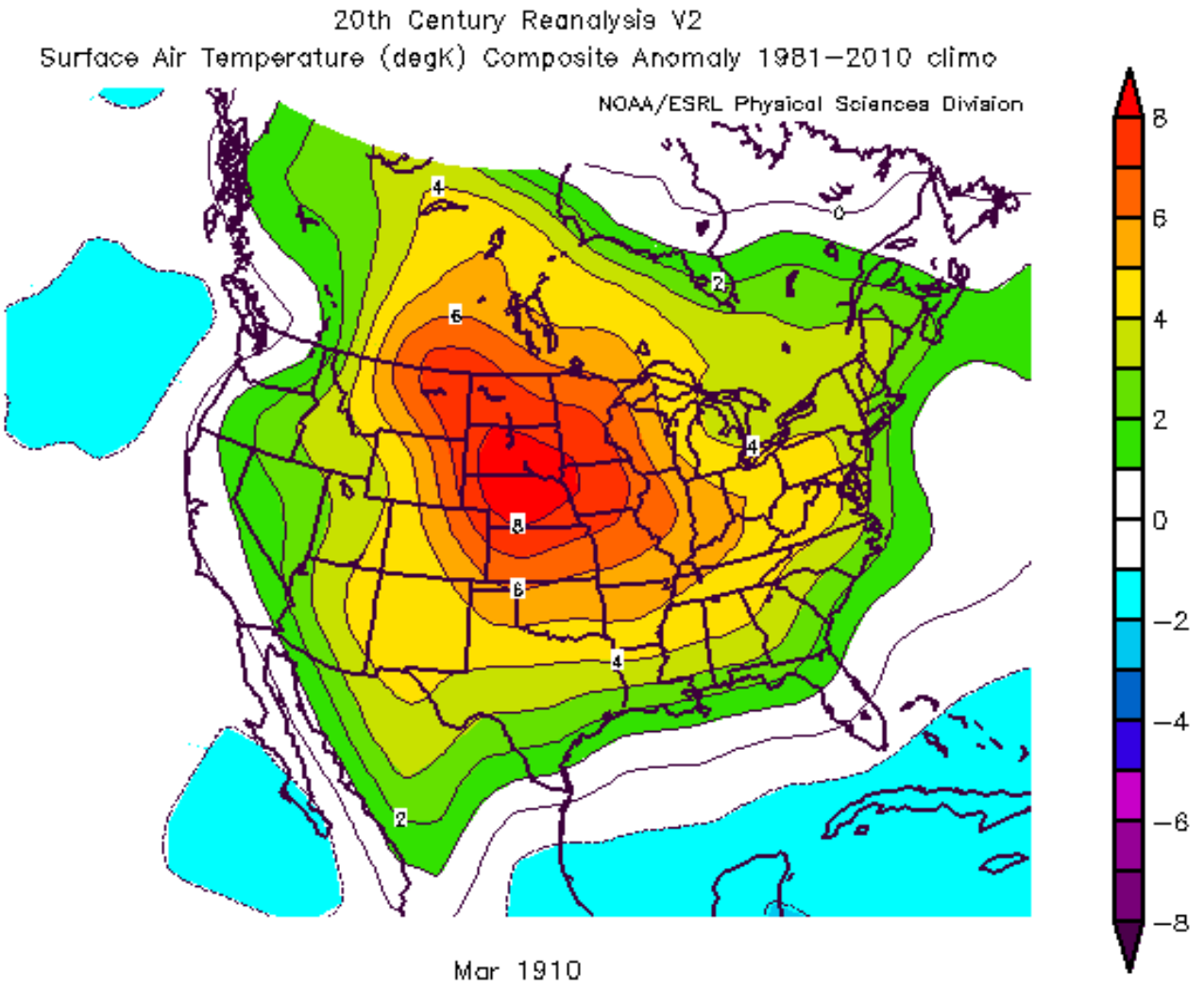
- Consider contributions across time scales from long-term climate trends to weather variability

- Overarching theme: linking climate and weather to better understand and predict extreme events

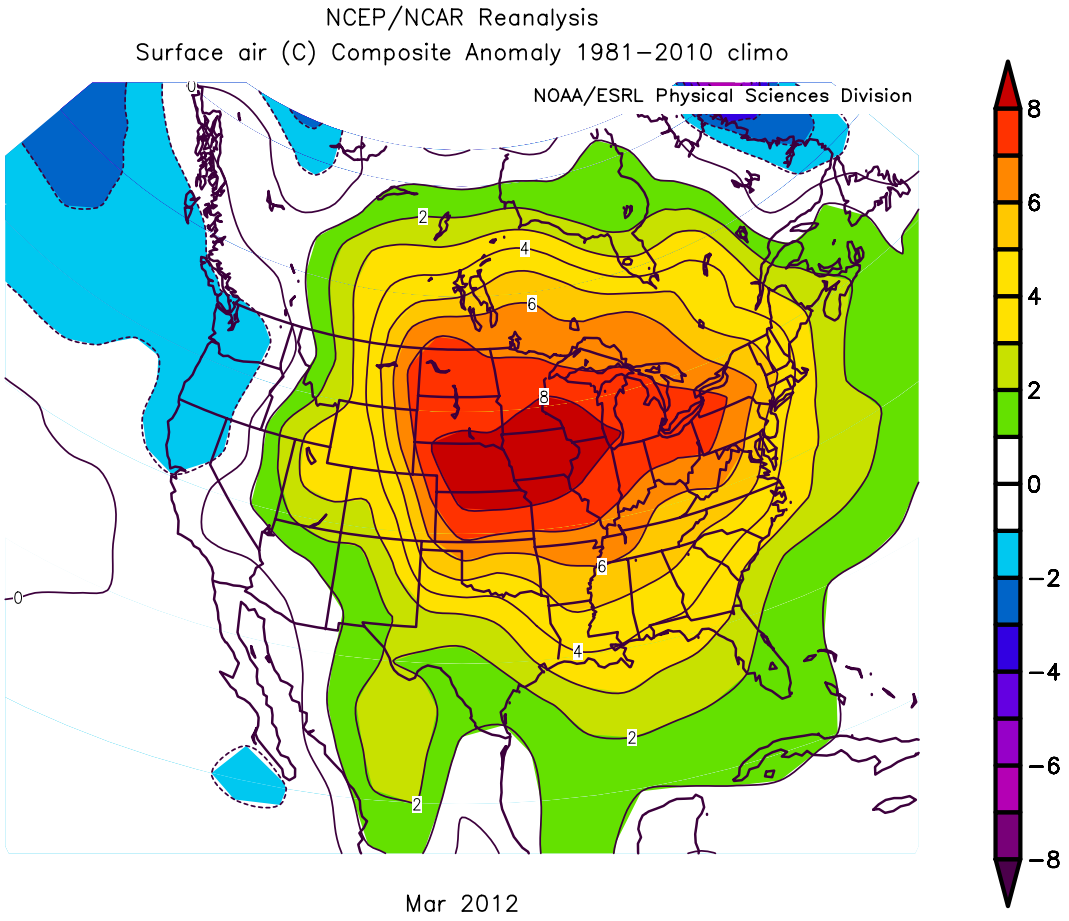
An extreme event: March Madness!



March 1910

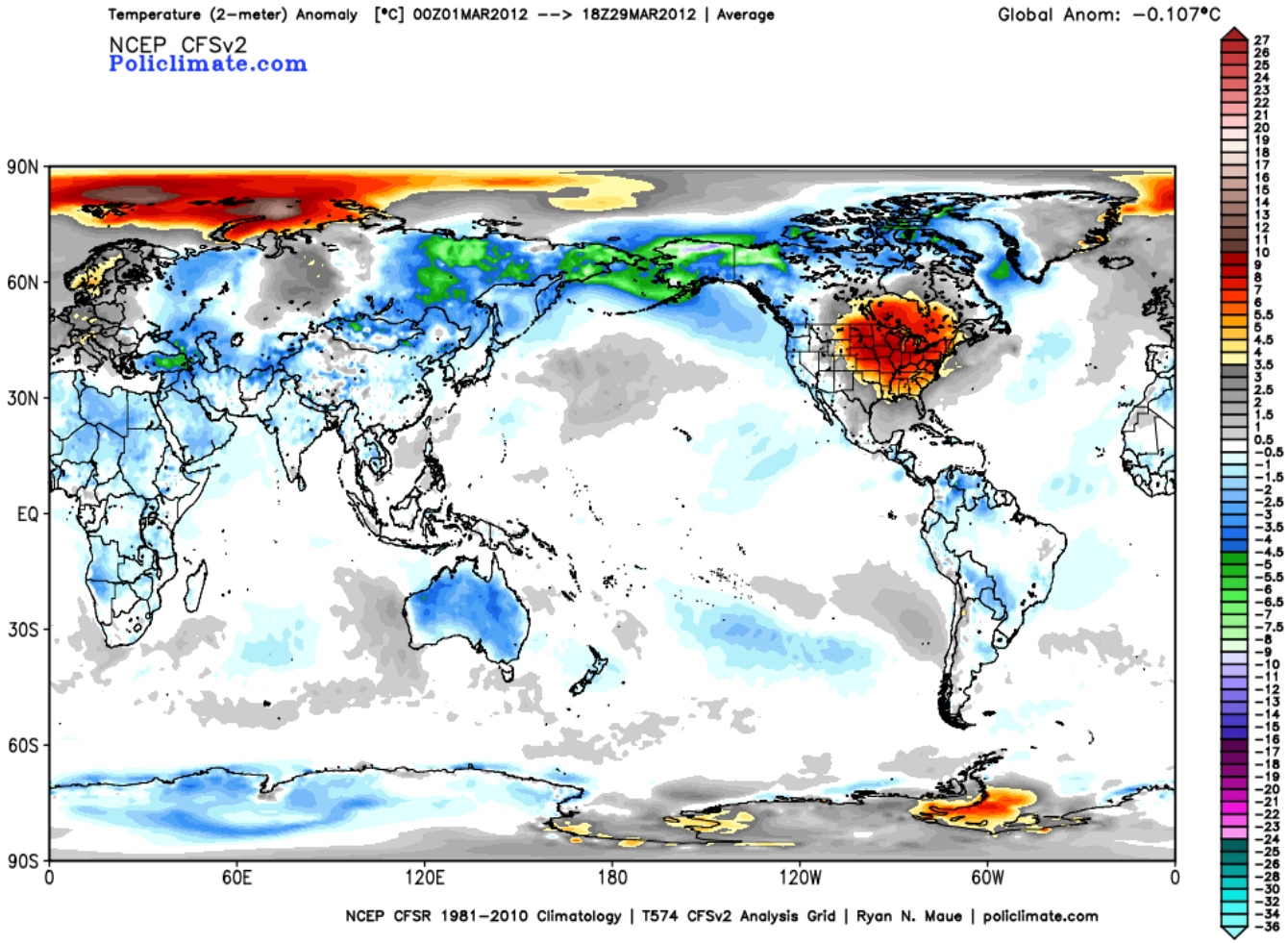

20th Century Reanalysis V2
Surface Air Temperature (degK) Composite Anomaly 1981–2010 climo
NOAA/ESRL Physical Sciences Division
8
6
4
2
0
−2
−4
−6
−8
Mar 1910

March 2012



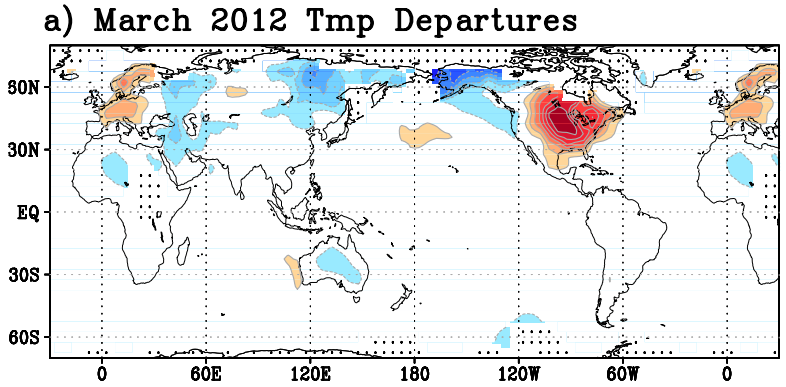
For the contiguous U.S. March 2012 was 4.8° C (8.6° F) above normal, 0.3° C (0.5° F) warmer than March 1910 (NCDC).

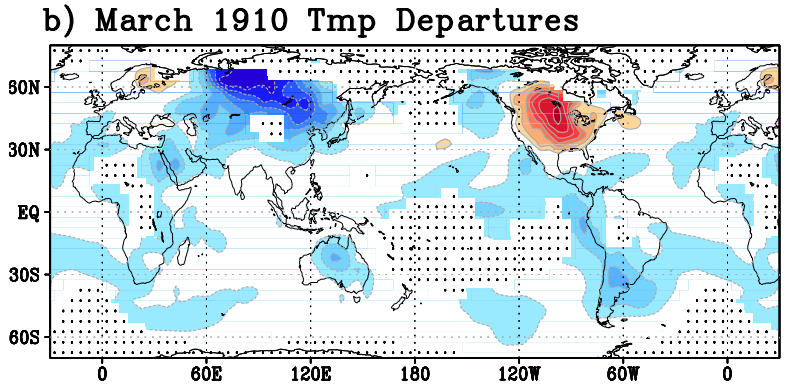
In the global context



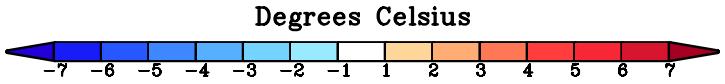
The March 2012 heat wave was a regional event.

Global Temperature Anomalies: March 2012 and March 1910

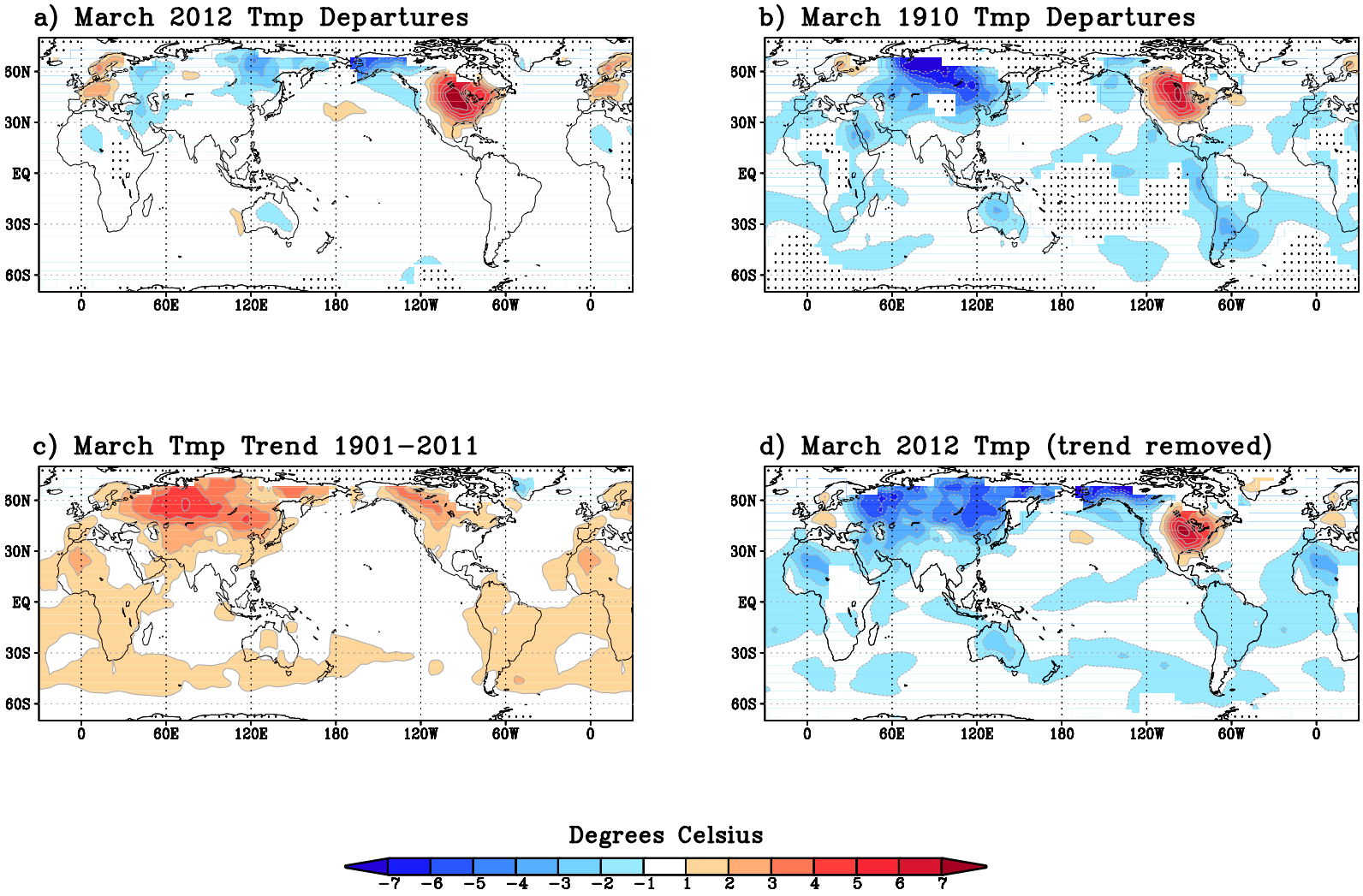




Evidence of similar features outside the U.S. Compared with March 1910, March 2012 is 0.9° C warmer.

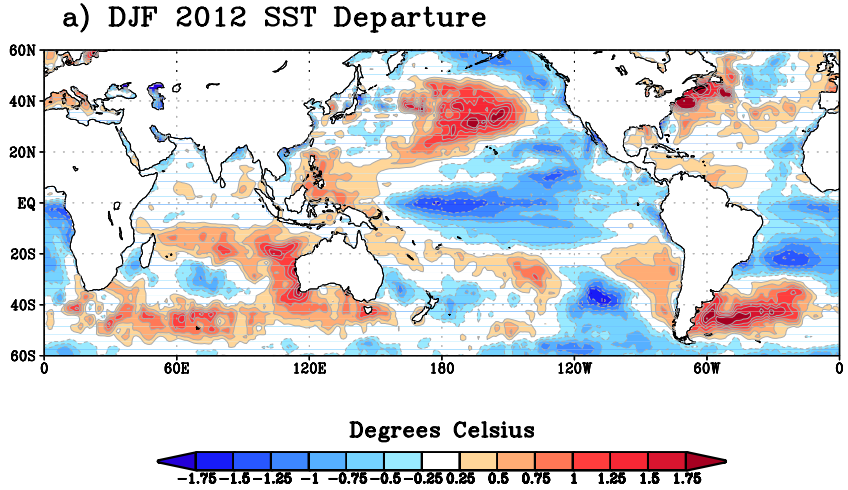


Contribution of Long-term Trend

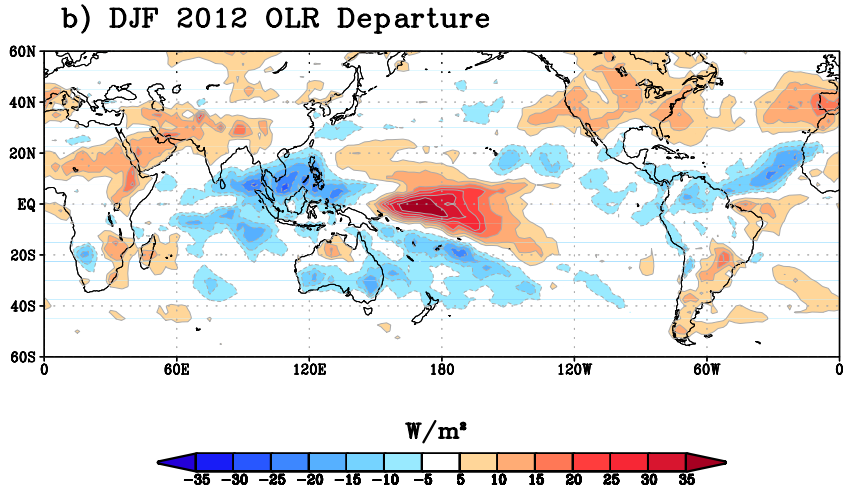


SST and OLR anomalies - DJF

SST



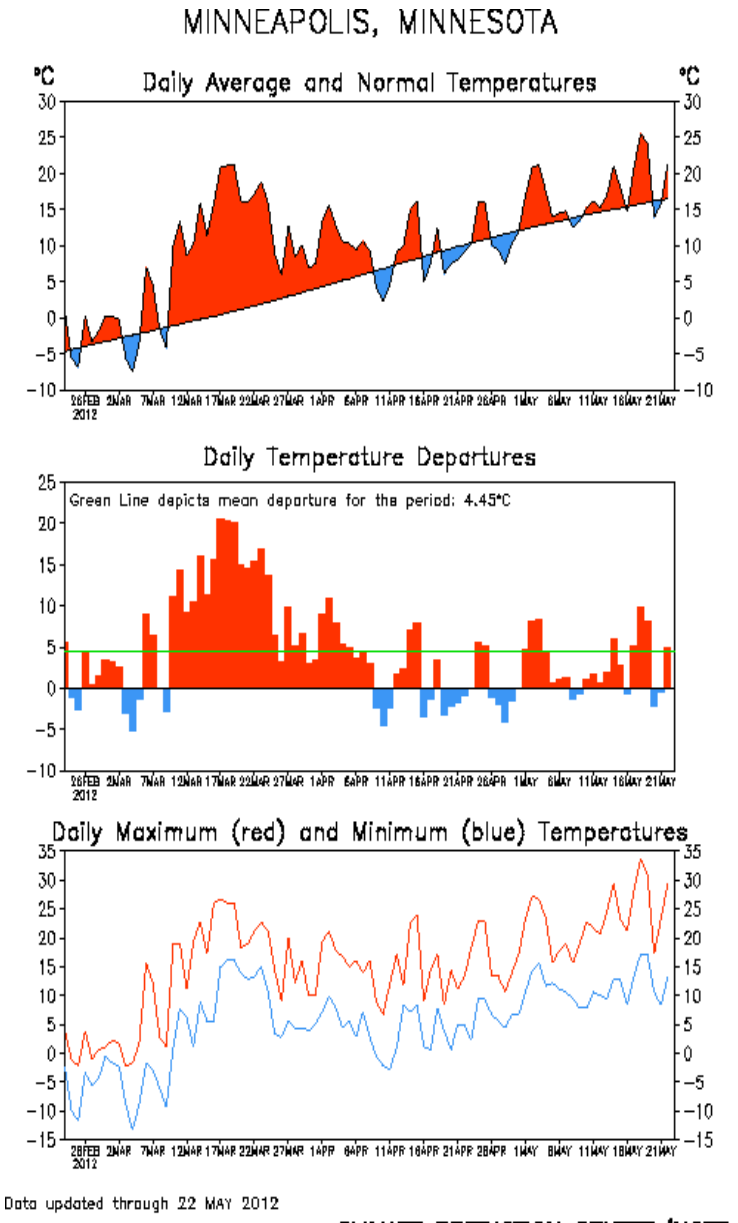
OLR



Event time scale

Zero crossings
March 10 – April 6
~ 27 days

Most intense anomalies
~ March 12-23



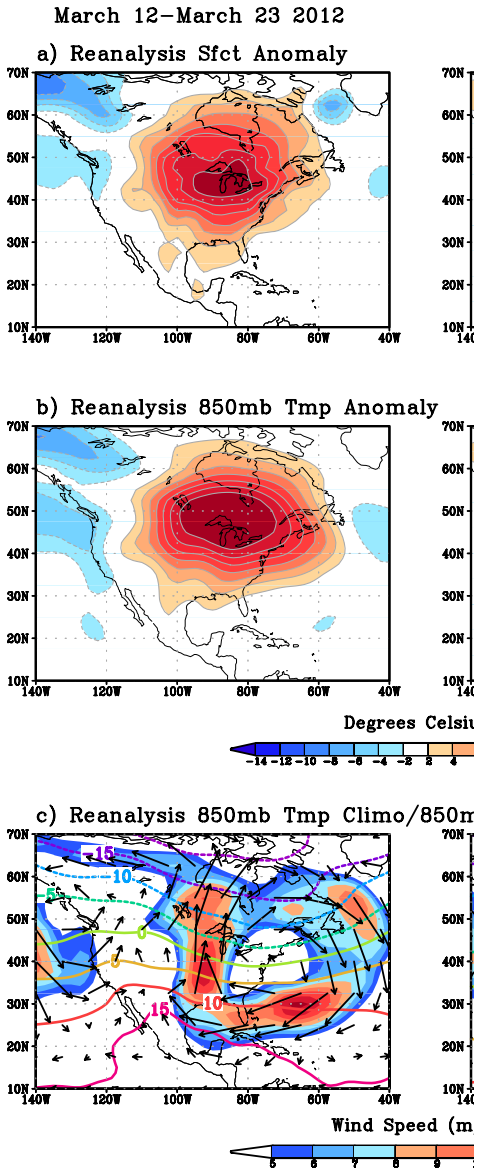
What was the proximate cause for the extreme warm temperatures?

12-23 **March 2012**

T'_{sfc}

T'_{850}

T_{clim}, $\mathbf{V}'_{850}$



Intense and sustained poleward heat transports

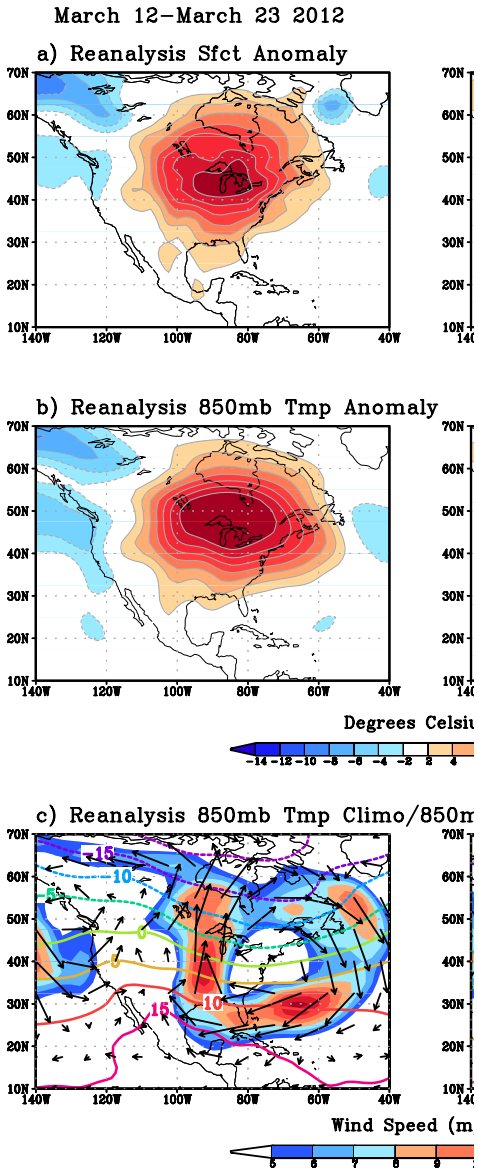
What was the proximate cause for the extreme warm temperatures?

12-23 **March 2012**

T’ sfc

T’ $_{850}$

T_{clim}, **V** ’ $_{850}$



“You do conclude that a lot can be explained by moving heat around.”

Intense and sustained poleward heat transports

What is the proximate cause for the extreme warm temperatures?

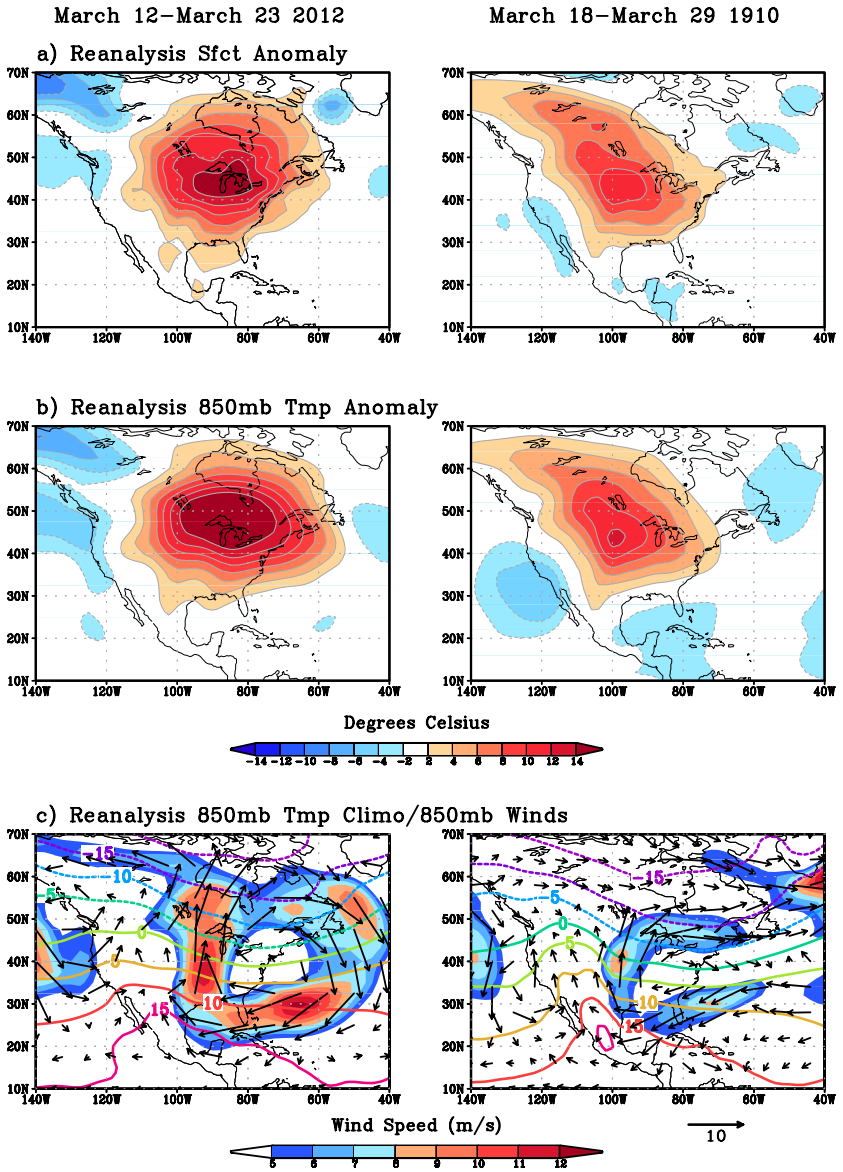
12-23 **March 2012**

18-29 **March 1910**

T’ sfc

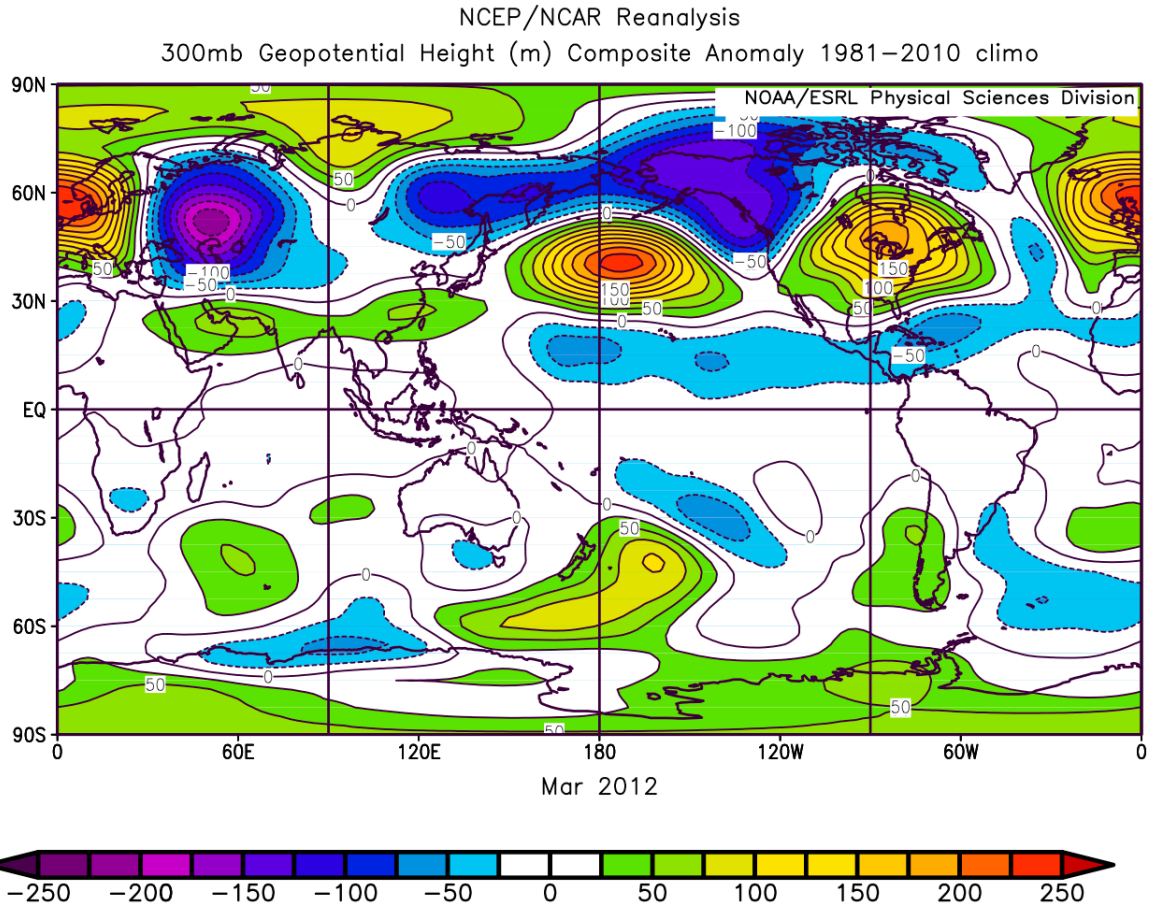
T’ 850

Tclim, **V** ’ 850



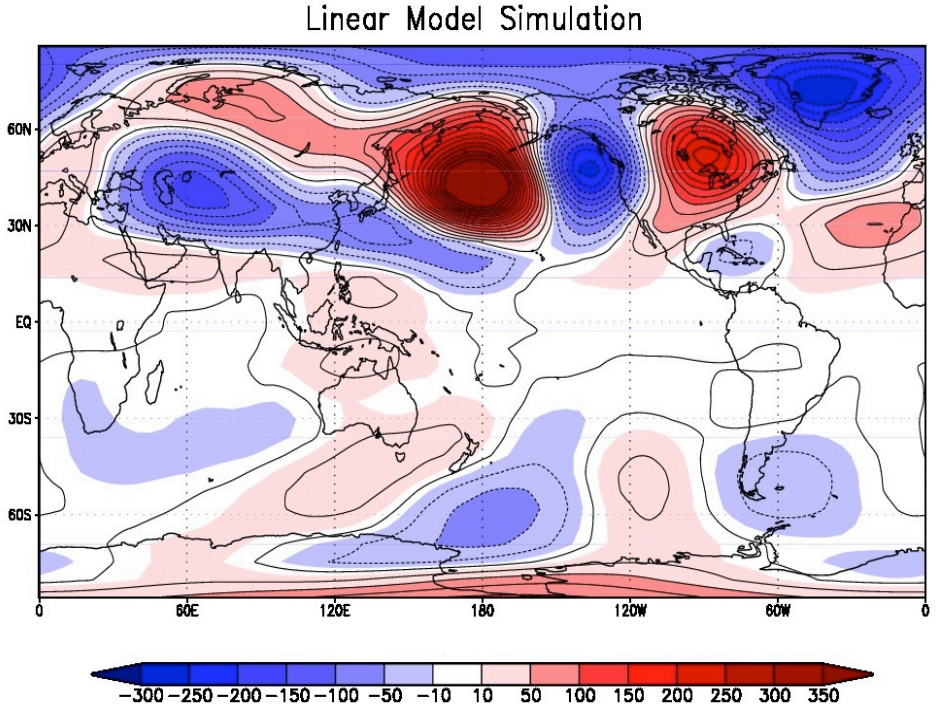
Intense and sustained poleward heat transports

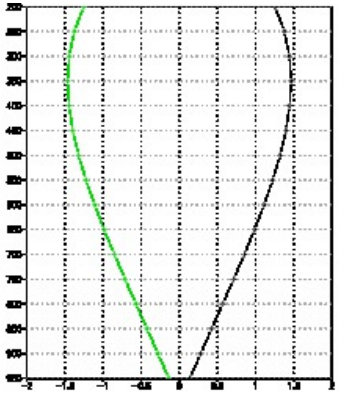
What factors led to the anomalous winds associated with the heat wave?

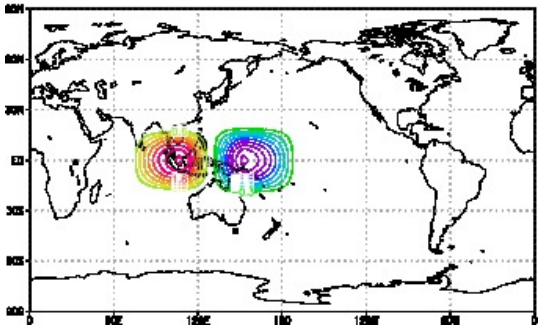


Strong wavetrain emanating from the Pacific

What is the source for this anomalous wavetrain?



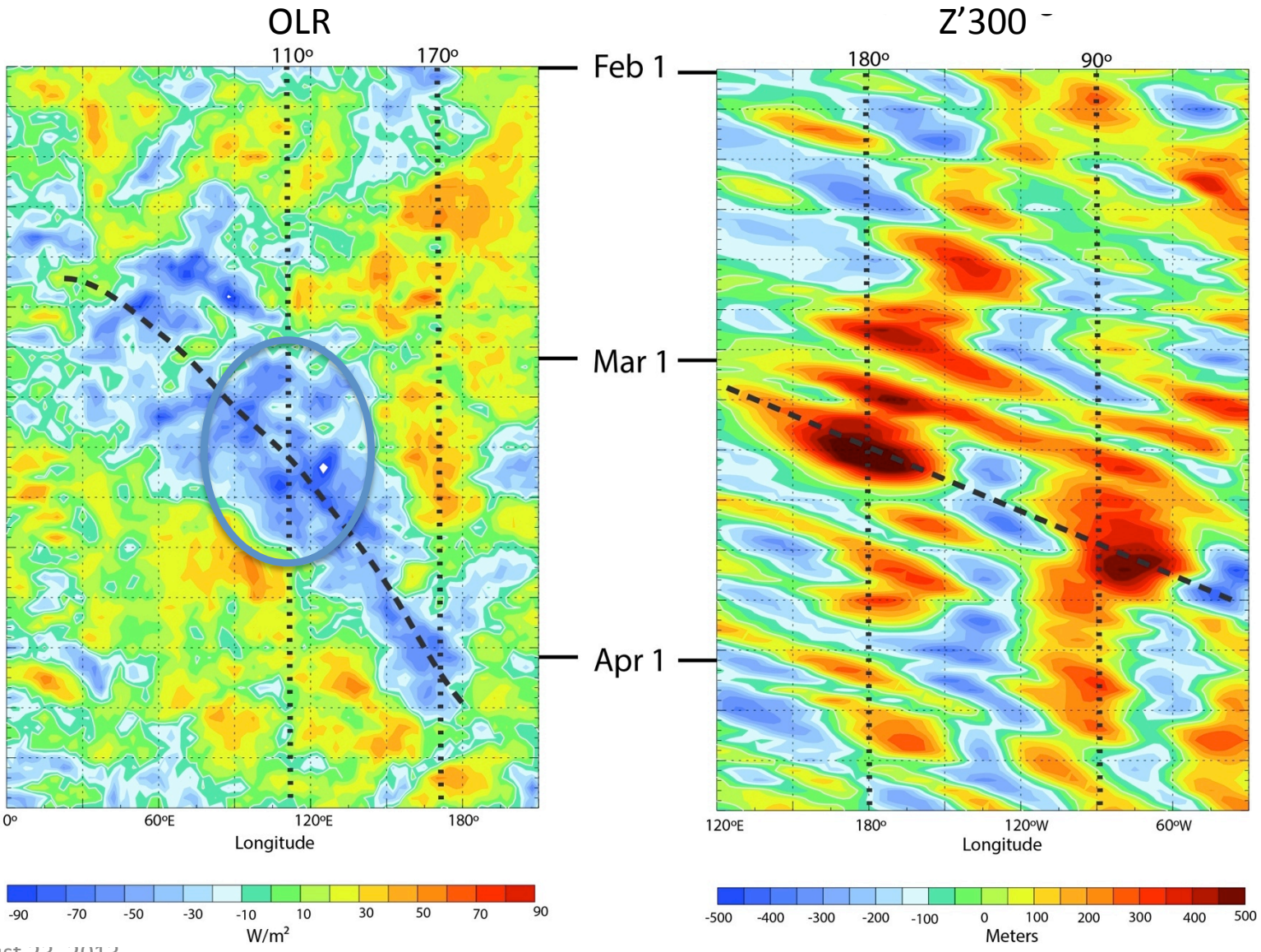




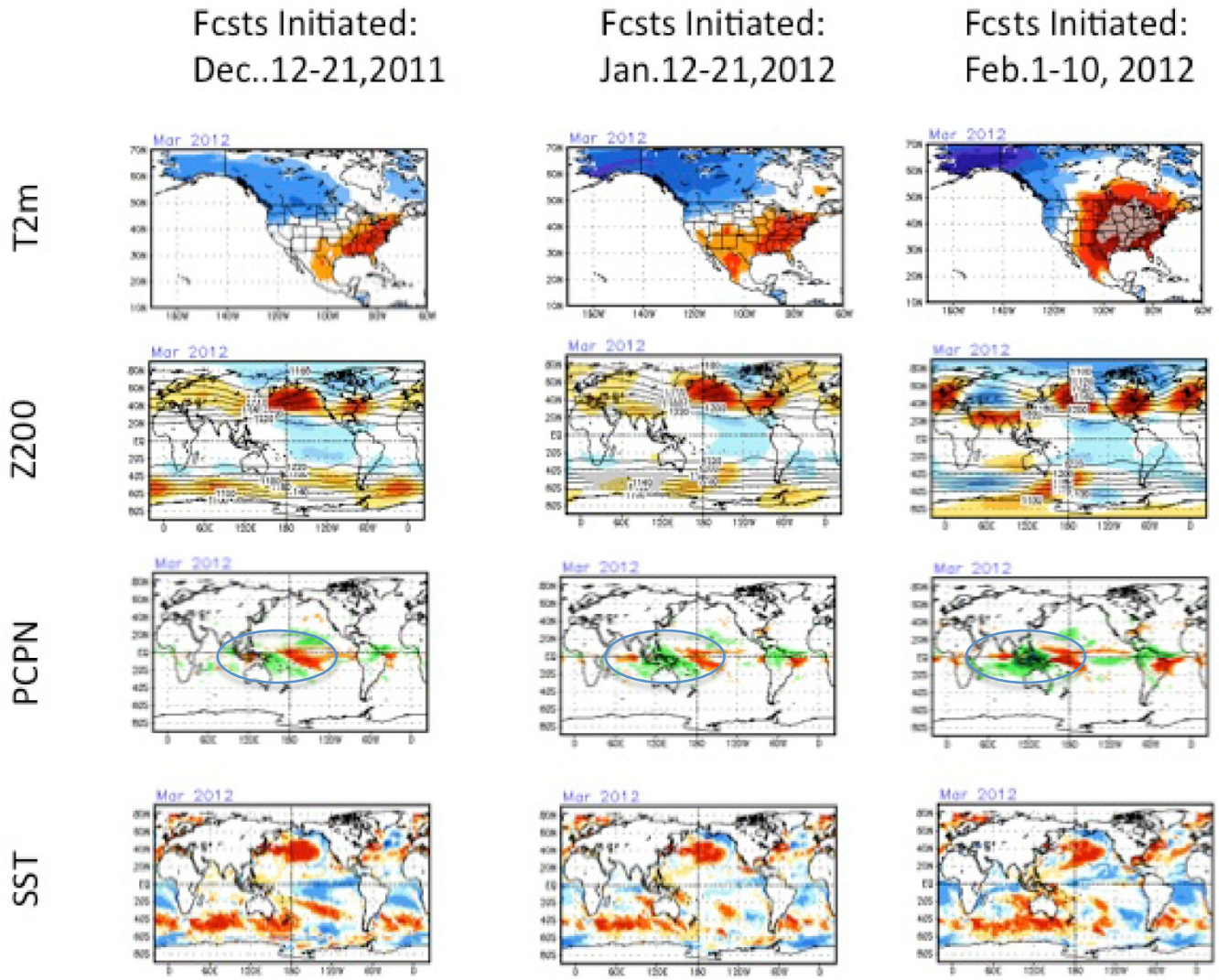
Peng and Whitaker (1999)

Simple linear baroclinic model experiments forced by idealized heating suggest a tropical Pacific wave source

MJO and Rossby Wave Dispersion



Was There Evidence of Predictability?



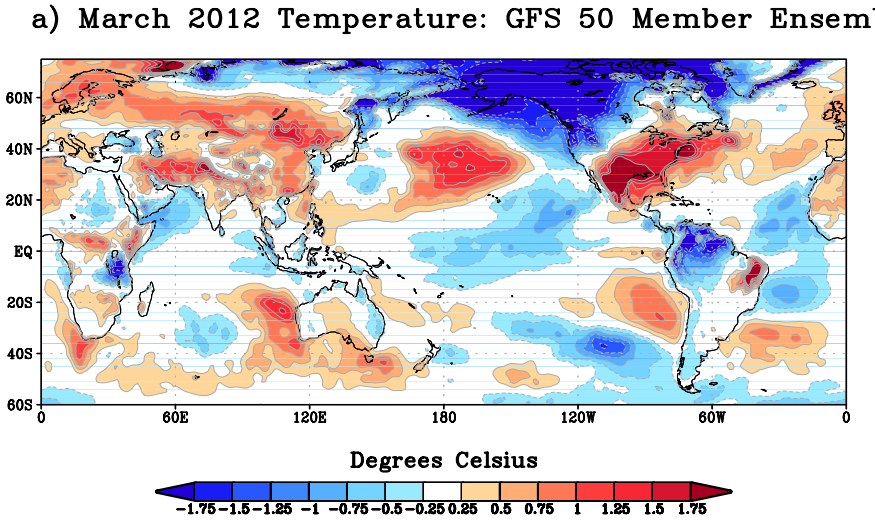
NCEP CFSv2 40-member Ensemble Forecasts for March 2012 initialized in Dec, Jan, and Feb all show a warm signal over the eastern U.S.

What was the Role of Anomalous Boundary Conditions?

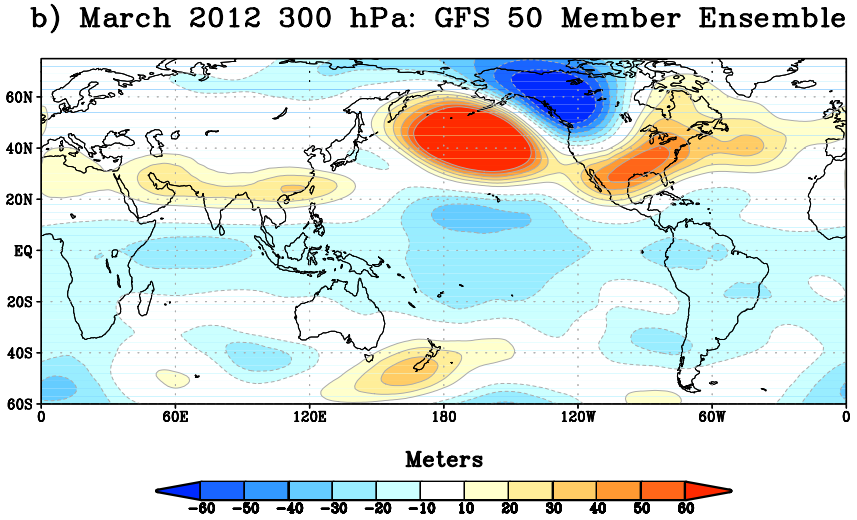
AMIP Simulations with GFS Model, 50-member ensemble

March 2012

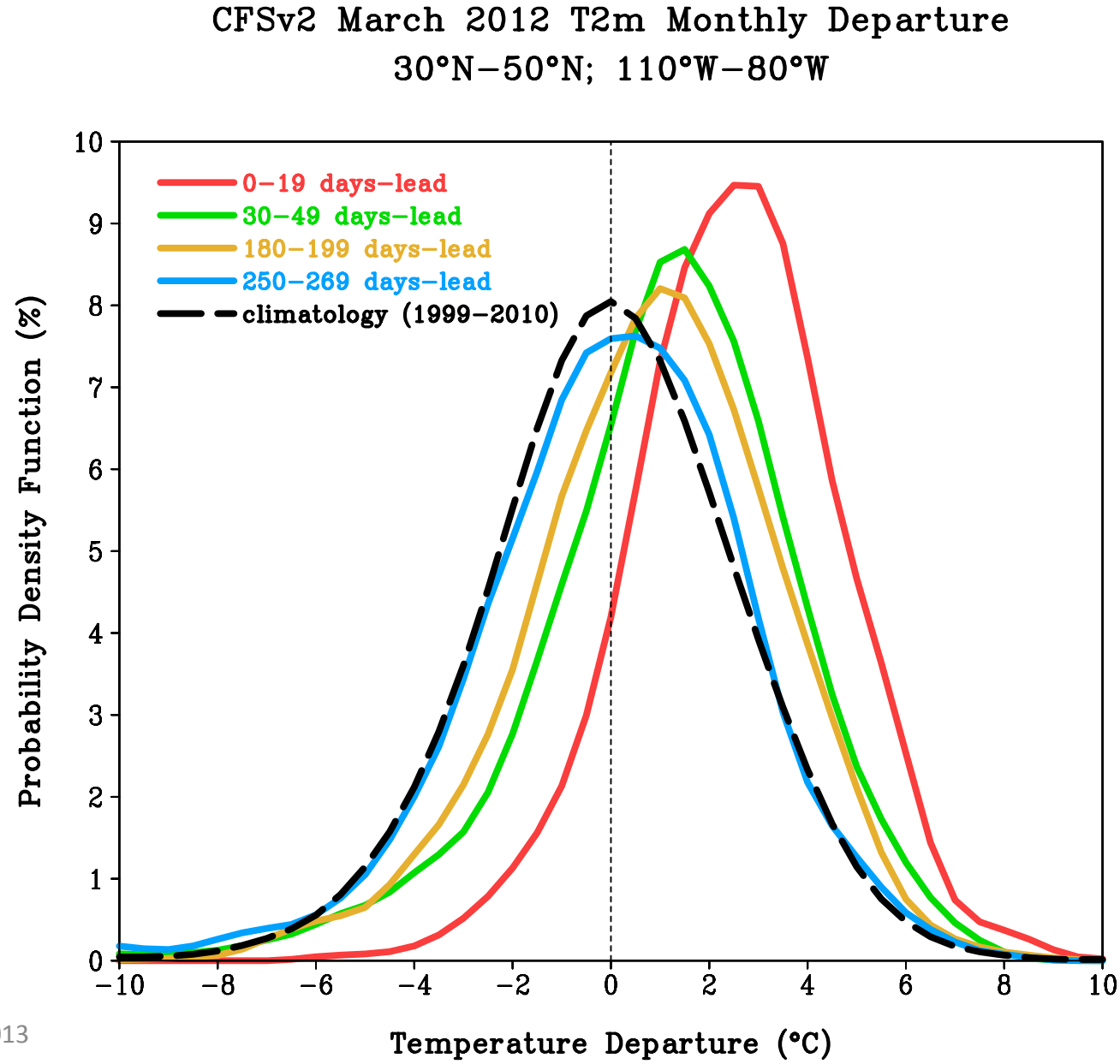
T’



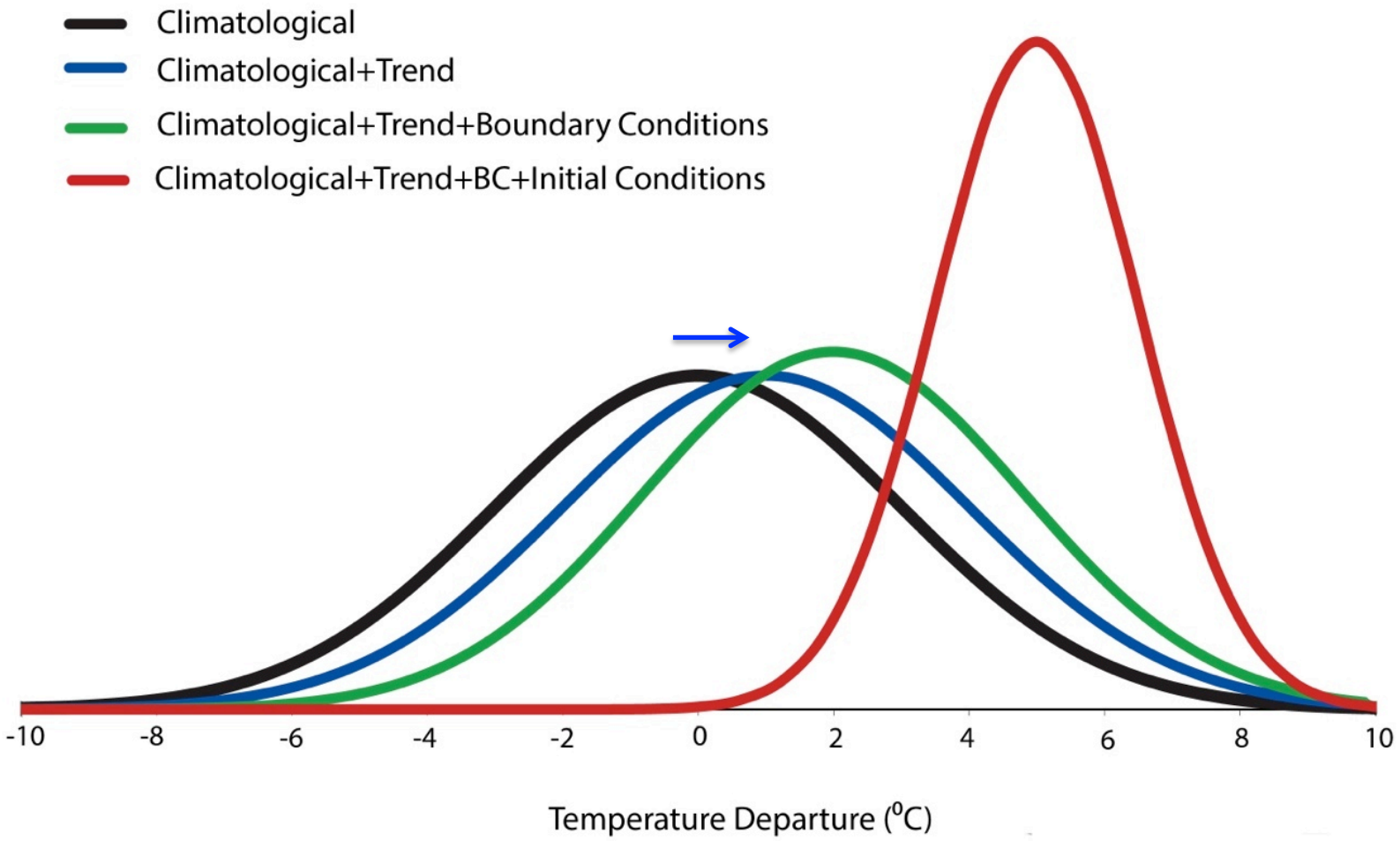
Z’ 300



CFS Forecasts by Lead Time



Contributions from various factors



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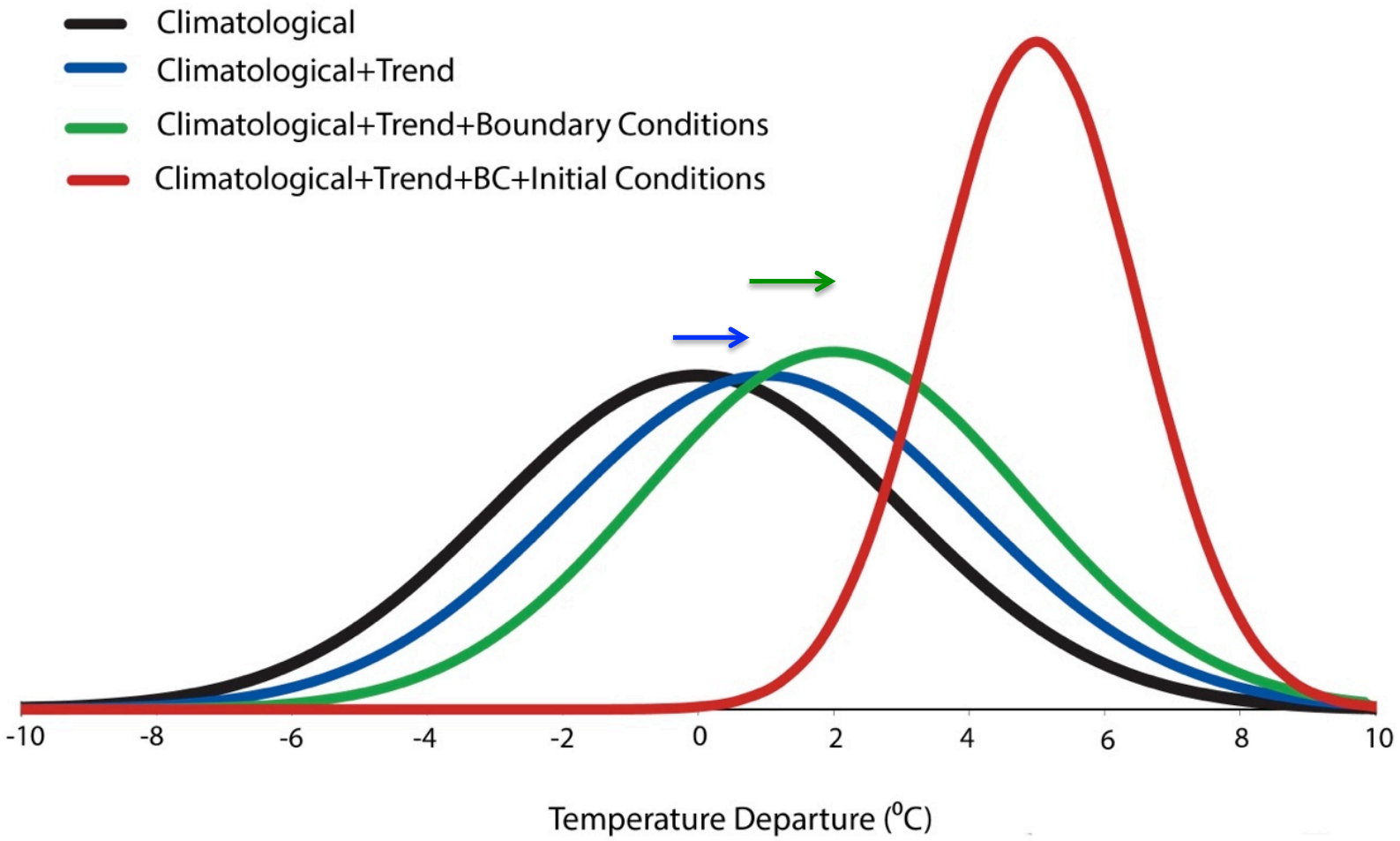

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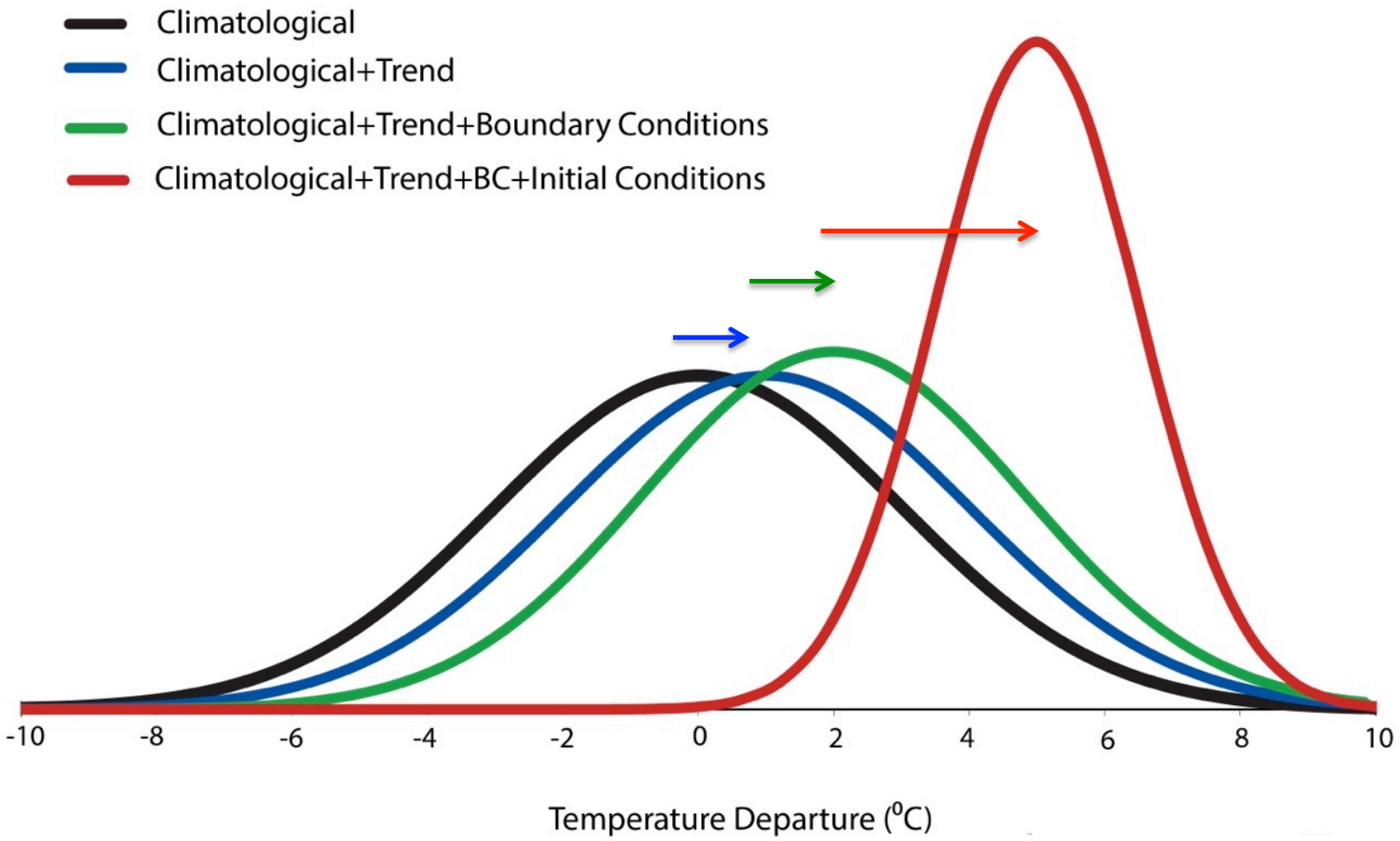
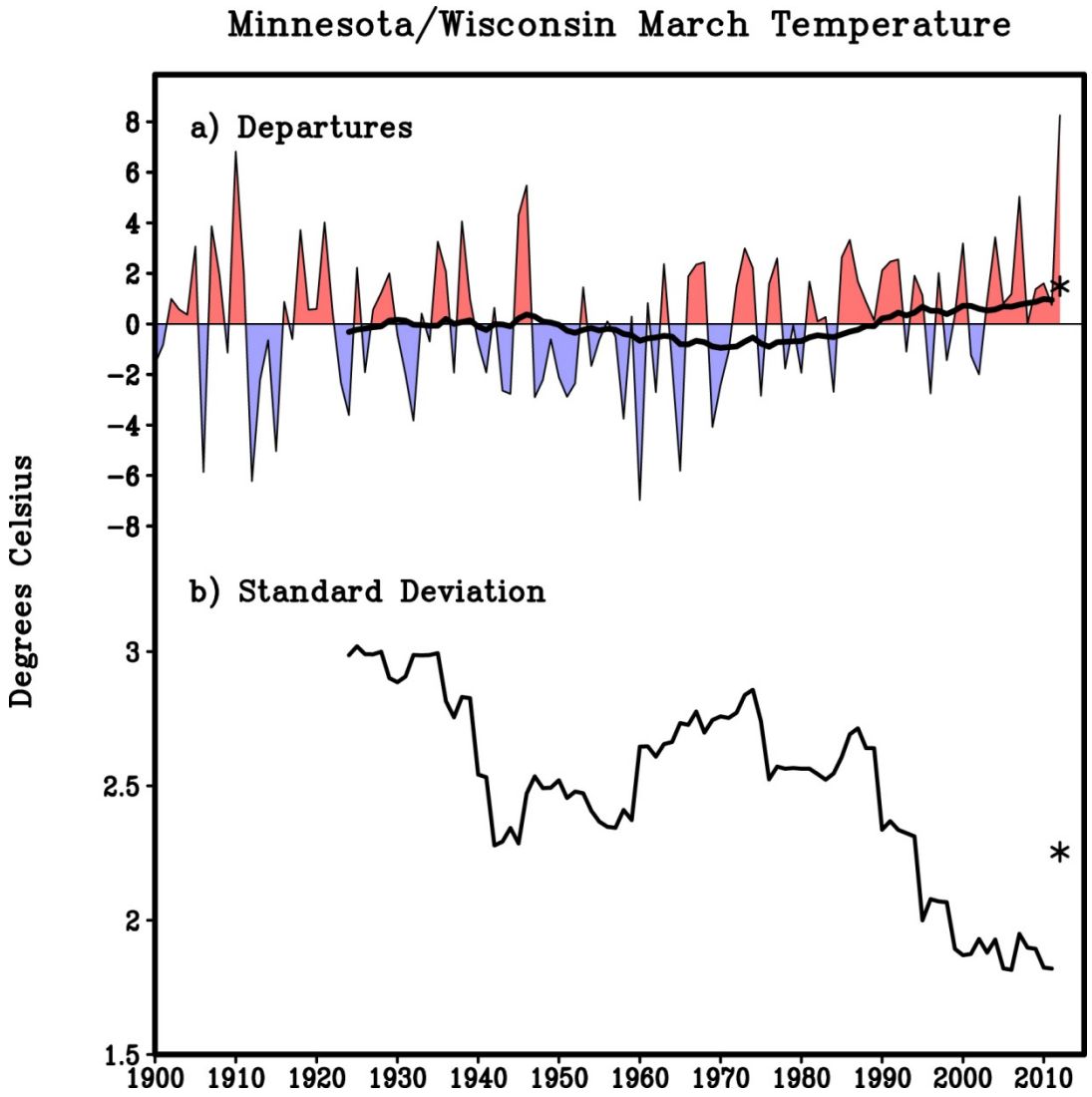


How about other factors?

- Snow cover
- Soil moisture, vegetation
- Sea ice
- Stratospheric circulation
- Mid-latitude dynamical interactions

Is the variability changing?

Is the variability changing?



Putting the Pieces Together

- While the U.S. experienced exceptionally warm temperatures in March 2012, a March that occurred over a century earlier was nearly as warm.

- The superposition of a strong natural climate variation similar to March 1910 together with a long-term warming of the magnitude observed would be sufficient account for the record warm March 2012 U.S. temperatures.

- Coupled model forecasts and atmospheric model simulations forced by observed SSTs show that forcing from anomalous SSTs increased the probability of extreme warm temperatures in the eastern U.S. in March 2012 above that anticipated from the long-term warming trend.

- Forcing associated with a strong MJO further increased the probability for extreme U.S. warmth and provided important additional predictive information on the timing and spatial pattern of the temperature anomalies.

- Phenomena across time scales from climate change to weather all contributed to making this event extreme. This knowledge also successively added predictive information toward anticipating the potential for an extreme warm event in the U.S. in March 2012, bridging predictions from climate to weather.