



## **The Making of An Extreme Event: Putting the Pieces Together**

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We examine how physical factors spanning climate and weather contributed to record warmth over the central and eastern U.S. in March 2012, when daily temperature anomalies in many locations exceeded 20°C. Placing the event in a historical context, we find  $\sim 1^\circ\text{C}$  warming in March temperatures has occurred since 1901. The long-term regional warming is roughly an order-of-magnitude smaller than temperature anomalies observed during the event, indicating the most of the extreme warmth must be explained by other factors. Several lines of evidence strongly implicate natural variations as the primary (but not exclusive) cause for the extreme event. The 2012 temperature anomalies had a close analogue in an exceptionally warm U.S. March occurring over 100 years earlier, providing observational evidence that an extreme event similar to March 2012 could be produced through natural variability alone. Coupled model forecasts and simulations forced by observed sea surface temperatures (SSTs) show that forcing from anomalous SSTs increased the probability of extreme warm temperatures in March 2012 above that anticipated from the long-term warming trend. In addition, forcing associated with a strong Madden-Julian Oscillation further increased the probability for extreme U.S. warmth and provided important additional predictive information on the timing and spatial pattern of temperature anomalies. The results indicate that the superposition of a strong natural variation similar to that occurring in March 1910 on long-term warming of the magnitude observed would be sufficient to account for the record warm March 2012 U.S. temperatures. We conclude that the record warmth over the central and eastern U.S. in March 2012 resulted primarily from natural climate and weather variability, a substantial fraction of which was predictable, with an additional smaller contribution from long-term warming likely due mainly to human causes.