Role for Eurasian Arctic shelf sea ice in a secularly varying hemispheric climate signal during the 20th century

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Citation: M.G. Wyatt and J.A. Curry, "Role for Eurasian Arctic shelf sea ice in a secularly varying hemispheric climate signal during the 20th century," (Climate Dynamics, 2013: DOI 10.1007/s00382-013-1950-2). Below is the press release issued by Georgia Tech:

'Stadium Waves' Could Explain Lull In Global Warming

One of the most controversial issues emerging from the recent Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) is the failure of global climate models to predict a hiatus in warming of global surface temperatures since 1998. Several ideas have been put forward to explain this hiatus, including what the IPCC refers to as 'unpredictable climate variability' that is associated with large-scale circulation regimes in the atmosphere and ocean. The most familiar of these regimes is El Niño/La Niña. On longer multi-decadal time scales, there is a network of atmospheric and oceanic circulation regimes, including the Atlantic Multidecadal Oscillation and the Pacific Decadal Oscillation.

A new paper published in the journal *Climate Dynamics* suggests that this 'unpredictable climate variability' behaves in a more predictable way than previously assumed. The paper's authors, Marcia Wyatt and Judith Curry, point to the so-called 'stadium-wave' signal that propagates like the cheer at sporting events whereby sections of sports fans seated in a stadium stand and sit as a 'wave' propagates through the audience. In like manner, the 'stadium wave' climate signal propagates across the Northern Hemisphere through a network of ocean, ice, and atmospheric circulation regimes that self-organize into a collective tempo.

The stadium wave hypothesis provides a plausible explanation for the hiatus in warming and helps explain why climate models did not predict this hiatus. Further, the new hypothesis suggests how long the hiatus might last.

Building upon Wyatt's Ph.D. thesis at the University of Colorado, Wyatt and Curry identified two key ingredients to the propagation and maintenance of this stadium wave signal: the Atlantic Multidecadal Oscillation (AMO) and sea ice extent in the Eurasian Arctic shelf seas. The AMO sets the signal's tempo, while the sea ice bridges communication between ocean and atmosphere. The oscillatory nature of the signal can be thought of in terms of 'braking,' whereby positive and negative feedbacks interact in such a way as to support reversals of the circulation regimes. As a result, climate regimes — multiple-decade intervals of warming or cooling — evolve in a spatially and temporally ordered manner. While not strictly periodic in occurrence, their repetition is regular — the order of quasi-oscillatory events remains consistent. Wyatt's thesis found that the stadium wave signal has existed for at least 300 years.

The new study analyzed indices derived from atmospheric, oceanic and sea ice data since 1900. The linear trend was removed from all indices to focus only the multi-decadal component of natural variability. A multivariate statistical technique called Multi-channel Singular Spectrum Analysis (MSSA) was used to identify patterns of variability shared by all indices analyzed, which characterizes the 'stadium wave.' The removal of the long-term trend from the data effectively removes the response from long term climate forcing such as anthropogenic greenhouse gases.

The stadium wave periodically enhances or dampens the trend of long-term rising temperatures, which may explain the recent hiatus in rising global surface temperatures.

"The stadium wave signal predicts that the current pause in global warming could extend into the 2030s," Wyatt said, the paper's lead author.

Curry added, "This prediction is in contrast to the recently released IPCC AR5 Report that projects an imminent resumption of the warming, likely to be in the range of a 0.3 to 0.7 degree Celsius rise in global mean surface temperature from 2016 to 2035." Curry is the chair of the Department of Earth and Atmospheric Sciences at the Georgia Institute of Technology.

Previous work done by Wyatt on the 'wave' shows that climate models fail to capture the stadium-wave signal. That this signal is not seen in climate model simulations may partially explain the models' inability to simulate the current stagnation in global surface temperatures.

"Current climate models are overly damped and deterministic, focusing on the impacts of external forcing rather than simulating the natural internal variability associated with nonlinear interactions of the coupled atmosphere-ocean system," Curry said.

The study also provides an explanation for seemingly incongruous climate trends, such as how sea ice can continue to decline during this period of stalled warming, and when the sea ice decline might reverse. After temperatures peaked in the late 1990s, hemispheric surface temperatures began to decrease, while the high latitudes of the North Atlantic Ocean continued to warm and Arctic sea ice extent continued to decline. According to the 'stadium wave' hypothesis, these trends mark a transition period whereby the future decades will see the North Atlantic Ocean begin to cool and sea ice in the Eurasian Arctic region begin to rebound.

Most interpretations of the recent decline in Arctic sea ice extent have focused on the role of anthropogenic greenhouse gas forcing, with some allowance for natural variability. Declining sea ice extent over the last decade is consistent with the stadium wave signal, and the wave's continued evolution portends a reversal of this trend of declining sea ice.

“The stadium wave forecasts that sea ice will recover from its recent minimum, first in the West Eurasian Arctic, followed by recovery in the Siberian Arctic,” Wyatt said. “Hence, the sea ice minimum observed in 2012, followed by an increase of sea ice in 2013, is suggestive of consistency with the timing of evolution of the stadium-wave signal.”

The stadium wave holds promise in putting into perspective numerous observations of climate behavior, such as regional patterns of decadal variability in drought and hurricane activity, the researchers say, but a complete understanding of past climate variability and projections of future climate change requires integrating the stadium-wave signal with external climate forcing from the sun, volcanoes and anthropogenic forcing.

“How external forcing projects onto the stadium wave, and whether it influences signal tempo or affects timing or magnitude of regime shifts, is unknown and requires further investigation,” Wyatt said. “While the results of this study appear to have implications regarding the hiatus in warming, the stadium wave signal does not support or refute anthropogenic global warming. The stadium wave hypothesis seeks to explain the natural multi-decadal component of climate variability.”

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We have also simplified an annotated one of the main figures in the paper for the public:

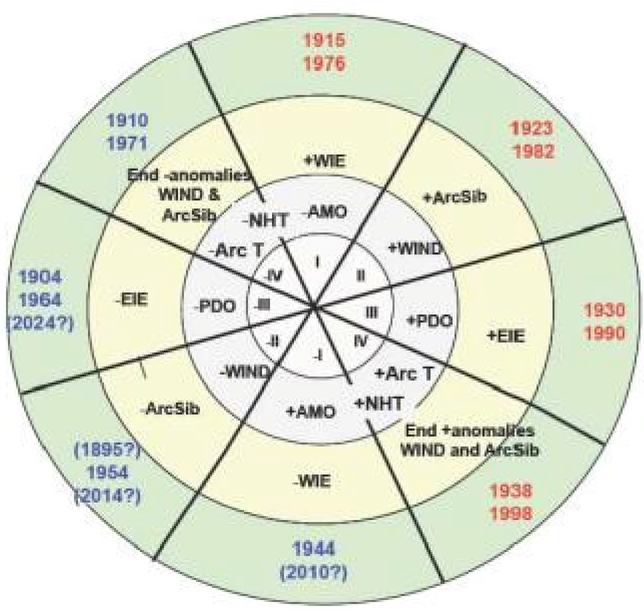

Illustration of the progression of the stadium wave. The stadium-wave 'wheel' is divided into segments (from center to perimeter): the light gray ring identifies the segment number; the dark gray ring indicates key hemispheric indices; sea ice indices are in the yellow ring; and the outer green ring provides peak dates for the segment. Segment I begins with a cold North Atlantic (-AMO), maximum sea ice extent in the European Arctic shelf seas (+WIE). Segments II through IV show evolution of the climate signal initiated in the cold Atlantic. As sea ice growth increases eastward into the Siberian Arctic (+ArcSib), strong winds develop that convert an initially cold ocean-ice signal into a warming atmospheric one (Segment II). Events proceed, carrying the signal across Eurasia and into the Pacific (+PDO; Segment III), ultimately culminating in maximum Arctic and NH surface temperatures in Segment IV. Segment –I follows with maximum warmth in the North Atlantic and minimal sea ice in the European Arctic shelf seas. This marks a shift whereby trends of AMO and WIE decrease and increase, respectively. An initial warm signal converts to a cooling one until reaching Segment –IV, where temperatures dip to their minima, followed soon after by shift to a warming regime (I). (adapted from Wyatt and Curry, 2013).