Global Warming and Winter Weather

IN MID-JANUARY, A LOBE OF THE POLAR VORTEX SAGGED SOUTHWARD OVER THE CENTRAL and eastern United States. All-time low temperature records for the calendar date were set at O’Hare Airport in Chicago [–16°F (–27°C), 6 January], at Central Park in New York [4°F (–15.6°C), 7 January], and at many other stations (1). Since that event, several substantial snow storms have blanketed the East Coast. Some have been touting such stretches of extreme cold as evidence that global warming is a hoax, while others have been citing them as evidence that global warming is causing a “global weirding” of the weather. In our view, it is neither.

As climate scientists, we share the prevailing view in our community that human-induced global warming is happening and that, without mitigating measures, the Earth will continue to warm over the next century with serious consequences. But we consider it unlikely that those consequences will include more frigid winters.

Distinguishing between different kinds of extreme weather events is important because the risks of different kinds of events are affected by climate change in different ways. For example, a rise in global mean temperature will almost certainly lead to an increase in the incidence of record high temperatures. Global warming also leads to increases in atmospheric water vapor, which increases the likelihood of heavier rainfall events that may cause flooding. Rising temperatures over land lead to increased evaporation, which renders crops more susceptible to drought. As the atmosphere and oceans warm, sea water expands and glaciers and ice sheets melt. In response, global sea-level rises, increasing the threat of coastal inundation during storms.

In contrast to the above examples, the notion that the demise of Arctic sea ice during summer will lead to colder winter weather over the United States seems counterintuitive. But that is exactly what an influential study has suggested (2). The authors hypothesize that global warming could perturb the polar vortex in a manner that renders the flow around it more wavy, leading to an increased incidence of both extreme warmth and extreme cold in temperate latitudes. It’s an interesting idea, but alternative observational analyses and simulations with climate models have not confirmed the hypothesis, and we do not view the theoretical arguments underlying it as compelling [see (3–6)].

Other studies have suggested that the loss of Arctic sea ice may influence the atmospheric circulation in mid-latitudes during summer [e.g., (7)]. Sea-ice losses during late summer may indeed lead to regional changes in Arctic climate [e.g., (5, 8)]. But tremendous natural variability occurs in the large-scale atmospheric circulation during all seasons, and even in summer, the links between Arctic warming and mid-latitude weather are not supported by other observational studies (6). The lag between decreases in sea-ice extent during late summer, and changes in the mid-latitude atmospheric circulation during other seasons (when the recent loss of sea ice is much smaller) needs to be reconciled with theory.

Summertime sea-ice extent in the Arctic has been remarkably low since 2007, and the ensuing years have been marked by some notable cold air outbreaks. It was this coincidence that prompted Francis and Vavrus (2) to link the cold air outbreaks to global warming. But coincidence does not in itself constitute a strong case for causality. Cold air outbreaks even more severe than occurred this winter affected the United States in the early 1960s, the late 1970s (most notably 1977), and in 1983, back when the Arctic sea ice was thicker and more extensive than it is today [e.g., (9)]. Over the longer time span of 50 to 100 years, it is well established that there has been a decrease in the rate at which low temperature records are being set relative to all-time high temperature records at stations across the United States (10). For the present at least, we believe that statistics based on the longer record are more indicative of what the future is likely to bring.

The research linking summertime Arctic sea ice with wintertime climate over temperate latitudes deserves a fair hearing. But to make it the centerpiece of the public discourse...
on global warming is inappropriate and a
distraction. Even in a warming climate, we
could experience an extraordinary run of cold
winters, but harsher winters in future decades
are not among the most likely nor the most
serious consequences of global warming.

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The Big Picture for Big Data: Visualization

TO CONVERT INFORMATION FROM MASSIVE
data sets into insights, data centers will need
to support the humans who are trying to make
sense of it all. Fortunately, innovations in
information visualization are demonstrating
that a good user interface is worth a thousand
petabytes (2013 Visualization Challenge,
News, 7 February, p. 600).

When GE Healthcare researcher Nick
Thomas studied a visualization of the critical
RBPI protein—a genomic carrier of vitamin
A necessary for reproduction and vision—
he was surprised by what he saw. Thomas
scanned the mosaic grid of thousands of red
and green dots, as well as the linked scatter-
gram and color-coded plate view. He con-
formed expected patterns, but one unexpected
bright red dot revealed RBPI’s marked influc-
ence in cellular development. This clue gave
Thomas an insight that, with statistical con-
firmation, led to an important scientific con-
tribution (7).

Like a growing number of researchers,
policy-makers, and interested citizens,
Thomas was exploring increasingly complex
data sets by adjusting filters, changing color
palettes, and choosing novel visualizations
to search for relationships, clusters, gaps,
and outliers. Powerful information visual-
ization tools are realizing famed statistician
John Tukey’s 50-year-old prediction: “The
graphical potentialities of the computer...are
going to be the data analyst’s greatest single
resource” (2).

Some Big Data advocates seem to promise
automatic results with little human par-
ticipation [e.g., (3, 4)]. A more effective
approach will be to put human users in con-
trol, since they can often identify patterns that
machines cannot. Statistically and algorithm-
ically oriented researchers are increasingly
recognizing that visual strategies for explor-
ing complex data lead to more potent and
meaningful insights. Automated analyses can
work for well-understood data, but visualiza-
tions increase the efficacy of experts in front-
tier topics, where big breakthroughs happen.

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References

Innovation Goes Global

BY TAKING A U.S.-NATIONAL APPROACH TO
innovative capabilities and comparing the present with the postwar period, W. B.
Bonvillian (“Advanced manufacturing poli-
cies and paradigms for innovation,” Policy
Forum, 6 December 2013, p. 1173) ignores
the truly transformational change that has
occurred over the past several decades: the
growth of the global science system. The
critical knowledge needed to innovate into
the next generation of production is increas-
ingly distributed across the globe, and it is
just as likely to be located in India or China
as in Ohio. The Organization for Economic
Co-Operation and Development reports that
the growth in the number of triadic patents
demonstrates the worldwide spread of inno-

vative activities (J).

U.S. researchers are actively tapping this
global resource by collaborating with researchers from many other countries. The
global network of international links (drawn
from coauthorships on publications) has
tripled in density over the past 20 years (2),
with many new members joining the global
network from developing countries, particu-
larly China. Chinese addresses now appear
more frequently than any other country in pub-
lications coauthored with U.S. researchers.

Scientific globalization does not threaten an
end to U.S. excellence in innovation; quite
the opposite. The diffusion and rooting of sci-
cientific capacity to new places provides oppor-
tunity for greater efficiency in research activ-
ities, particularly by removing redundancy.
Creative problem-solving can be enhanced
by having new entrants grapple with techno-
logical challenges, as many U.S. companies
are finding as they invest in foreign research.

Culturally tied knowledge is often impor-
tant to market access in foreign countries.
These goods require a deliberate policy shift
on the part of U.S. agencies from pushing
knowledge creation to fomenting knowl-
edge scanning and integration. Scanning the
sphere for the best new knowledge and
ensuring local uptake is the more promising
approach to closing the gaps in U.S. know-
how than building a U.S.-only R&D effort, as
Bonvillian suggests.

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1. OECD, OECD Science, Technology and Industry Score-

CORRECTIONS AND CLARIFICATIONS

Perspectives: “Hiding in plain view—An ancient dog in
the modern world” by H. G. Parker and E. A. Ostrander (24
January, p. 376). In the figure, the red branch should have
been labeled “CTV.” The HTML and PDF versions online
have been corrected.

Reports: “Transmissible dog cancer genome reveals
the origin and history of an ancient cell lineage” by E. P.
Murchison et al. (24 January, p. 437). In the title, “Transmis-
sable” should have been “Transmissible.” The
HTML and PDF versions online have been corrected.

Reports: “Identification of a plant receptor for extracellu-
lar ATP” by J. Choi et al. (17 January, p. 290). The doi should
be 10.1126/science.343.6168.290. It is correct in the HTML
and PDF versions online.

Research Article: “The hidden geometry of complex,
network-driven contagion phenomena” by D. Brockmann
and D. Helbing (13 December 2013, p. 1337). In Fig. 2D,
the label “Zamonia” should have read “Latvia.” The HTML
and PDF versions online have been corrected.

Letters to the Editor

Letters (~300 words) discuss material published in
Science in the past 3 months or matters of gen-
eral interest. Letters are not acknowledged upon
receipt. Whether published in full or in part, Let-
ters are subject to editing for clarity and space.
Letters submitted, published, or posted elsewhere,
in print or online, will be disqualified. To submit a
Letter, go to www.submit2science.org.