DRAFT

Response to CEI Request of 14 April 2014 to OSTP under the Data Quality Act

Summary

The Competitive Enterprise Institute (CEI) communicated to the White House Office of Science and Technology Policy (OSTP) on 14 April 2014 a "Request for Correction" under the Data Quality Act, asking that OSTP Director John Holdren's video of 8 January 2014 on the polar vortex be removed from the White House web site on the grounds that the video "does not meet basic standards of quality, including objectivity, utility, and integrity".

The CEI petition is without merit. The video was intended to, and does, inform the viewer that (a)~~)~~ no single extreme-weather event, hot or cold, either proves or disproves global climate change; (b) climate-change dynamics are more complex than most people imagine; (c) in that connection, there is a plausible mechanism, linked to behavior of the polar vortex, by which a world that is warming on the average could include an increase in prolonged winter cold spells in the Northern Hemisphere mid-latitudes; and (d) there is "a growing body of evidence" suggesting that this mechanism is indeed operating.

Points (a) and (b) are not in dispute by anybody, as far as OSTP knows, not even by CEI. Propositions (c) and (d) are readily substantiated by reference to the peer-reviewed scientific literature, as will be shown below. Of course, a growing body of evidence does not mean that everyone in the climate-science community is convinced that the case is proven, and Dr. Holdren was clear about that in the video when he said "Computer models tell us that there are many different factors influencing these patterns and, as in all science, there will be continuing debate about exactly what is happening."

Note that there is virtually nothing about climate science that isn't disputed by somebody. If the criterion for communications from the White House about climate science were that nobody disagrees on any point, there could be no such communication at all. Dr. Holdren made it clear in the video that he was offering his personal judgment on the balance of the evidence when he said "I believe the odds are that we can expect, as a result of global warming, to see more of this pattern…".

Relevant points from the scientific literature

The most relevant points of science (which underpin the video and are needed to understand many of the points made in the literature) are:

1. Under greenhouse-gas induced "global warming", the Arctic is warming more rapidly than the mid-latitudes. This is called "Arctic amplification". The reasons for it ~~are well understood. They~~ include the "ice-albedo feedback", in which warming reduces the area covered by ~~sea~~ ice or snow, which in turn reduces the amount of sunlight that is reflected back to space and, thus, accentuates warming.
2. That the Arctic is warming faster means that the temperature difference between the relatively cold Artic and the relatively warm mid-latitudes is shrinking. This temperature gradient is known to be an important driver of atmospheric circulation patterns that affect both the Arctic and the mid-latitudes. A change in the gradient will therefore affect those patterns (although other factors affect them, as well).
3. A plausible hypothesis is that one of the changes in circulation patterns resulting from the reduced temperature gradient is a weakening of the circumpolar jet stream, which delimits

Commented [PH1]: Although the phenomena of Arctic amplification is well documented for present and past climates, the relative contribution from several different potential mechanisms remains a topic of debate. As you know, relevant mechanisms include regional changes in surface albedo, changes in Arctic clouds, increases in water vapor, changes in ocean heat storage, and changes in ocean and atmospheric heat transport.

Commented [PH2]: Changes in seasonal snow and, to a lesser extent, land ice are also potentially relevant.

the circumpolar vortex. A weakened jet stream means that southward excursions of the jet that bring cold Arctic air to mid-latitudes and the northward excursions that bring warm air from lower latitudes move from west to east more slowly, causing cold and warm temperature conditions to persist for longer. There is also evidence for the extent of northward and southward meanders of the jet to have increased in certain seasons and locations. ~~is associated with both a slowing and increased waviness (larger "Rossby waves") in the boundary of the vortex. That means larger southward excursions of relatively cold Arctic air, accompanied, in the other phase of the wave, by larger northward excursions of relatively warm mid-latitude air; it also means that those waves move from west to east relatively slowly, causing the unusual conditions associated with them to persist.~~

Commented [PH3]: Suggest to make the statement directly in support of point (c) stand alone. There is generally more evidence and theoretical grounds for a slowing of the westerlies in relation to Arctic amplification than for an increase in the meridional amplitude or meanders.

4. There is observational evidence that this behavior has been becoming more frequent and more pronounced in recent decades, although currently available data and model results are incomplete ~~the data are incomplete~~ in ways that ongoing research seeks to remedy.
5. Phenomena that characterize the relevant atmospheric circulation patterns, their links to ocean conditions, and their variations include the Arctic and North Atlantic Oscillations (AO, NAO)~~,~~ as well as~~and~~ the El Niño / La Niña cycle. While these phenomena are part of what is usually termed "natural variability" in the weather/climate system and are sometimes offered as alternatives to anthropogenic climate change as explanations for unusual weather, there is increasing evidence that their frequencies and/or intensities are now intertwined with anthropogenic climate change.

With that background, one is in a position to appreciate the support offered for points made in Dr. Holdren's video by the following examples from the peer-reviewed scientific literature over the period 2008-2014. (Order is chronological. Italicized material is quoted exactly from the indicated sources.)

Jennifer A. Francis, Weihan Chen, Daniel J. Leathers, James R. Miller, and Dana E. Veron (Institute of Marine and Coastal Sciences, Rutgers University; Department of Geography, University of Delaware; College of Marine and Earth Studies, University of Delaware), "Winter Northern Hemisphere weather patterns remembers summer Arctic sea-ice extent", Geophysical Research Letters, vol. 36, pp 1-5 (11 April 2009).

> *By combining satellite measurements of sea-ice extent and conventional atmospheric observations, we find that varying summer ice conditions are associated with large-scale atmospheric features during the following autumn and winter well beyond the Arctic's boundary. Mechanisms by which the atmosphere "remembers" a reduction in summer ice cover includ*~~ing~~*e warming and destabilization of the lower troposphere, increased cloudiness, and slackening of the poleward thickness gradient that weakens the polar jet stream.*

Meiji Honda, June Inoue, and Shozu Yamane (Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology; Department of Environmental Systems Science, Doshisha University), "Influence of low Arctic sea-ice minima on anomalously cold Eurasian winters", Geophysical Research Letters, vol. 36, pp 1-6 (28 April 2009).

> *Observational evidence shows that significant cold anomalies over the Far East in early winter and zonally elongated cold anomalies from Europe to Far East in late winter are associated with the decrease of the Arctic sea-ice cover in the preceding summer-to-autumn*

seasons. Results from numerical experiments using an atmospheric general circulation model support these notions.

James E. Overland and Muyin Wang (NOAA Pacific Marine Environmental Laboratory; Joint Institute for the Study of the Atmosphere and Ocean, University of Washington), "Large-scale atmospheric circulation changes are associated with the recent loss of Arctic sea ice", Tellus, vol. 62A, pp 1-9 (2010).

Recent loss of summer sea ice in the Arctic is directly connected to shifts in northern wind patterns in the following autumn, which has the potential of altering the heat budget at the cold end of the global heat engine. ... The most important conclusion of this and several recent papers is that loss of summer Arctic sea ice can have an impact on the larger Northern Hemisphere atmospheric circulation.

Jiping Liu, Judith A. Curry, Hijun Wang, Mirong Song, and Radley M. Horton (School of Earth and Atmospheric Sciences, Georgia Institute of Technology; Institute of Atmospheric Physics, Chinese Academy of Sciences; and Columbia University Center for Climate Systems Research), "Impact of declining Arctic sea ice on winter snowfall", Proceedings of the National Academy of Sciences, vol. 109, pp 4074-4079 (13 March 2012).

Here we demonstrate that the decrease in autumn Arctic sea ice is linked to changes in the winter Northern Hemisphere atmospheric circulation that have some resemblance to the negative phase of the winter Arctic oscillation. However, the atmospheric circulation change linked to the reduction of sea ice shows much broader meridional meanders in mid-latitudes and clearly different interannual variability than the classical Arctic oscillation. This circulation change results in more frequent episodes of blocking patterns that lead to increased cold surges over large parts of northern continents.

Jennifer A. Francis and Stephen J. Vavrus (Institute of Marine and Coastal Sciences, Rutgers University; Center for Climatic Research; University of Wisconsin, Madison), "Evidence linking Arctic amplification to extreme weather in mid-latitudes", Geophysical Research Letters, vol. 39, pp 1-6 (17 March 2012).

Two effects are identified that each contribute to a slower eastward progression of Rossby waves in the upper-level flow: 1) weakened zonal winds, and 2) increased wave amplitude. These effects are particularly evident in autumn and winter consistent with sea-ice loss, but are also apparent in summer, possibly related to earlier snow melt on high-latitude land. Slower progression of upper-level waves would cause associated weather patterns in mid-latitudes to be more persistent, which may lead to an increased probability of extreme weather events that result from prolonged conditions, such as drought, flooding, cold spells, and heat waves.

World Meteorological Organization, The Global Climate 2001-2010: A Decade of Climate Extremes, WMO No. 1103 (2013).

During the boreal winter 2009/2010, i.e., the period from December 2009 to February 2010, extreme conditions were recorded in many places across the northern hemisphere. Strong negative temperature anomalies and prolonged snowfall events over Europe, the Russian Federation, parts of North America, particularly the USA, and Asia, while many other larger *areas registered above-normal temperatures for this season. ... According to the "Arctic Report Card: Update for 2010" (Richter-Menge, Overland, 2010), the boreal winter 2009/10 showed new connectivity between mid-latitude extreme cold and snowy events on the one hand and changes in the wind patterns in the Arctic on the other. This so-called warm Arctic – cold continents pattern has happened only three times in the last 160 years.*

Quihong Tang, Xuejun Zhang, Xiaohua Yang, and Jennifer A. Francis (Institute of Geographic Sciences, Chinese Academy of Sciences; School of Environment, Beijing Normal University; and Institute of Marine and Coastal Sciences, Rutgers University), "Cold winter extremes in northern continents linked to Arctic sea ice loss", Environmental Research Letters, vol. 8, pp 1-6 (12 March 2013).

The satellite record since 1979 shows downward trends in Arctic sea ice extent in all months, which are smallest in winter and largest in September. Previous studies have linked changes in winter atmospheric circulation, anomalously cold extremes and large snowfalls in mid-latitudes to rapid decline of Arctic sea ice in the preceding autumn. ... [Our] results suggest that the winter atmospheric circulation at high latitudes associated with Arctic sea ice loss, especially in the winter, favors the occurrence of cold winter extremes at middle latitudes of the northern continents. ... If the association between Arctic sea ice and cold winter extremes demonstrated in this study is robust, we would expect to see a continuation and expansion of cold winter extremes as the sea ice cover continues to decline in response to ever-increasing emissions of greenhouse gases.

CEI's attempt to dismiss this entire literature

The writers of the CEI "Request for Correction" attempt to neutralize the large literature on the topic (of which the foregoing is only a sampling) by citing a few narrowly focused critiques in Geophysical Research Letters of aspects of the Francis/Vavrus analysis, a Letter to the Editor published in Science by a group of respected climate scientists questioning whether winters can be expected to get colder, and attacks by a few of the usual suspects from the climate-change contrarian/confusionist community. The respectable critiques can be placed into a broader context as being less than definitive contributions to an active scientific discussion through considering the~~have been placed in context, as a combination of much less than definitive and, in some cases, directed at points the targets of the critiques did not actually make, by responses prepared by Dr. Francis and, more comprehen-ively, by the~~ scientific results reviewed in the January 2014 summary of a workshop on thi~~s~~se topic held by the National Academy of Sciences (NAS) in September 2013 and by a ~~major~~ thorough review paper that appeared in Surveys in~~of~~ Geophysics in March 2014.

Conclusion

The NAS summary (Linkages Between Arctic Warming and Mid-Latitude Weather Patterns: Summary of a Workshop, http://www.nap.edu/catalog.php?record_id=18727, 70 pp, 2014) begins as follows:

The Arctic has been undergoing significant changes in recent years. Surface temperatures in the region are rising twice as fast as the global mean. The extent and thickness of sea ice is rapidly declining. Such changes may have an impact on atmospheric conditions outside the region. Several hypotheses for how Arctic warming may be influencing mid-latitude *weather patterns have been proposed recently. For example, Arctic amplified warming could lead to a weakened jet stream resulting in more persistent weather patterns in the mid-latitudes. Or Arctic sea ice loss could lead to an increase of snow on high-latitude land; snow expands on land in autumn, which in turn impacts the jet stream resulting in cold Eurasian and North American winters. These and other potential connections between a warming Arctic and mid-latitude weather are the subject of active research.*

The NAS summary goes on to discuss in a balanced way the challenges of establishing degrees of responsibility of the different relevant phenomena for what is being observed and, of course, calls for more data and more research.

The essence of the 50-page March 2014 review paper [Timo Vihma (Finnish Meteorological Institute), "Effects of Arctic sea ice decline on weather and climate: A review", Survey of Geophysics, DOE 10.1007/s10712-014-9284-0 (9 March 2014)] is conveyed by the following quote from its abstract:

The areal extent, concentration and thickness of sea ice in the Arctic Ocean and adjacent seas have strongly decreased during the recent decades, but cold, snow-rich winters have been common over mid-latitude land areas since 2005. A review is presented on studies addressing the local and remote effects of the sea ice decline on weather and climate. It is evident that the reduction in sea ice cover has increased the heat flux from the ocean to atmosphere in autumn and early winter. This has locally increased air temperature, moisture, and cloud cover and reduced the static stability in the lower troposphere. Several studies based on observations, atmospheric reanalyses, and model experiments suggest that the sea ice decline, together with increased snow cover in Eurasia, favours circulation patterns resembling the negative phase of the North Atlantic Oscillation and Arctic Oscillation. The suggested large-scale pressure patterns include a high over Eurasia, which favours cold winters in Europe and northeastern Eurasia. A high over the western and a low over the eastern North America have also been suggested, favouring advection of Arctic air masses to North America. Mid-latitude winter weather is, however, affected by several other factors, which generate a large inter-annual variability and often mask the effects of sea ice decline.

This paper, like the NAS workshop summary, calls for more data and more research in order to sort out more definitively the roles of the various (and interacting) natural and human-driven changes in explaining the observed increase in prolonged winter cold spells in the context of a world that is warming on a global-average basis. In the meantime, Dr. Holdren's characterization of the issue in his two-minute polar-vortex video—complete with language conveying t~~w~~hat "a growing body of evidence suggests" (emphasis added) and providing his personal scientific judgment about the probable outcome of further research ("I believe the odds are that we can expect…")—fully satisfies the requirement that information provided by the government meet "basic standards of quality, including objectivity, utility, and integrity".