CLIMATE SCIENCE

Decadal predictions in demand

Decision makers are in need of decadal climate forecasts, for example, to help plan infrastructure investments. When — or whether — climate modellers will be able to deliver is not yet clear.

Mark A. Cane

Over the past decade, the mean global temperature did not rise much, if at all[1,2]. This pause in global warming cannot be attributed to cutbacks in greenhouse-gas emissions by the planet's human population, so it must be nature taking a turn towards colder temperatures. The extent to which such natural climate variability can be predicted on decadal timescales is not known. At a workshop[3] in January on 'Predicting the Climate of the Coming Decades', scientists and policymakers gathered in Miami to discuss the potential and utility of decadal-scale climate predictions. The anomalously frigid weather, which kept everyone in the auditorium in their winter coats, was a visceral reminder that the climate of the next few decades depends as much on natural climate variations as it does on anthropogenic forcing.

Creating useful climate predictions is not straightforward. The first predictions of El Niño and the Southern Oscillation (ENSO) with a physical model[4] arrived before anyone had thought much about how to use them. It soon became evident that the forecasts were not self-explanatory and that commodity brokers were more likely to benefit than the poor farmers that climate forecasters had hoped to help. Thus began an effort that extended two decades, and is still ongoing, to bring together climate forecasters and decision makers who could make use of climate information (see for example ref. 5). Meanwhile, decision theorists have become interested in the problem of using climate predictions (represented at the workshop by H. Kunreuther, Univ. Pennsylvania, USA; D. Krantz, Columbia Univ., USA; D. Letson and B. Meyer, Univ. Miami, USA). Their research has begun to influence the way that forecast information is presented and perceived: as soon as forecasts are created, consideration of what type of forecast information is needed by decision makers should influence which variables are included in the predictions, and which period of time and which regions are considered.


© ISTOCKPHOTO / NASHVILLEDINO2

Figure 1 | A blizzard in Washington DC. The massive snow storms that hit the US East Coast this winter are part of natural climate variability. A workshop held in Miami[3] this January discussed the prospects for predicting the natural swings of the climate system on a decadal timescale.

The Miami workshop[3] turned the attention of both climate scientists and stakeholders to decadal predictions of climate, a field that is still in its infancy (if not prenatal). Decadal climate predictions aim to cover the gap between seasonal to interannual prediction with lead times of two years or less and projections of climate change a century ahead. Seasonal to interannual prediction, which counts ENSO forecasting as its prime success, relies on the ability of climate models to evolve an initial climate state forward in time to tell us something useful about the state of the climate a season, six months or a year in advance. For these types of prediction, in addition to a good simulation model, an accurate specification of the initial state of the climate is essential.

By contrast, climate projections provide insight on expected changes in the mean state of the climate system a century or so ahead, averaged over decades. Since the 'signal' in a climate projection is the changes forced by human activity, averaging is added to suppress natural variability, which is noise in this context. Because the atmosphere is chaotic, the initial state will be forgotten long before and will not influence the projection. Decadal climate prediction falls uncomfortably between seasonal to interannual prediction and climate projections. Because the next decades will be influenced by both anthropogenic forcing and natural variability, in addition to accounting for anthropogenic greenhouse gases and aerosols, the numerical model integrations must start from detailed knowledge of the current state of the climate system. The hope is that this extra information will allow the models to track natural variability, resulting in more accurate forecasts of the next decade or two.

Decadal prediction was described as "demand driven" (K. Broad, Univ. Miami, USA); many decision makers would like to incorporate climate change into their decision process, but the century-long span of typical climate change projections does not fit with the decadal outlook of resource managers and those planning infrastructure investments. At the workshop, a South Florida water manager (J. Obeysekera, South Florida Water Management District, USA) and a natural park resource manager (L. Welling, National Park Service, USA) reported that their management tools could readily accept decadal climate forecasts as inputs. The demand for decadal forecasts is substantial and growing.

An abundant supply of decadal predictions is also assured. As part of the next assessment from the Intergovernmental Panel on Climate Change (IPCC), many climate modelling groups will be producing decadal forecasts that start from estimates of the current state of the atmosphere and ocean, and account for the growing inventory of atmospheric greenhouse gases (D. Smith, UK Met. Office, UK;

J. Meehl, National Center for Atmospheric Research, USA; T. Delworth and T. Rosati, Geophysical Fluid Dynamics Laboratory/National Oceanographic and Atmospheric Administration, USA; S. Power, Australian Bureau of Meteorology, Australia). The hope is that the models can capture the various spatial patterns of decadal climate variability that have been identified in the observational record, such as the Atlantic Multidecadal Oscillation or the Pacific Decadal Oscillation. But in contrast with the interannual ENSO, there is no widely accepted theory for how they work, and it is not known if their past evolution holds the key to their future (L. Goddard, International Research Institute, USA).

Therefore, the hope for useful skill in predicting natural variability is far from assured. The climate system is chaotic and it is not known how predictable decadal variations are, even if we had perfect models and sufficient observations to determine the initial state with high precision. Perhaps there is something special about a decadal timescale that affords predictability, but perhaps not: decadal variability may just be the part of a featureless spectrum of frequencies that we happen to pick out of our instrumental records because they are only about 150 years long. Several valuable efforts to extend the record with palaeoproxy data were reported (L. Stott, Univ. Southern California, USA; B. Horton, Univ. Pennsylvania, USA; P. Swart and H. Wanless, Univ. Miami, USA), but these data are still too sparse and uncertain to allow a firm assessment.

As one example, according to the current leading idea, the Atlantic Multidecadal Oscillation is generated by atmospheric noise (E. Schneider, Center for Ocean, Land, Atmosphere/George Mason Univ., USA). If indeed random processes are at the heart of decadal variability, as strongly supported by the talk of C. Deser (National Center for Atmospheric Research, USA), this might seem to doom hopes for decadal predictability. However, the possibility remains that, once underway, the evolution of important patterns of variability could be projected forward.

Enthusiasm for decadal forecasts was greatly stimulated by two recent attempts[6,7] that do provide forecasts that are closer to observations than the most basic forecasts assuming the persistence of existing conditions or on-average climate conditions. However, both studies are less persuasive in showing that their forecasts are significantly better than models that do not use detailed information about the present state of the climate. It is noteworthy that one of the two forecasts[6,7] predicts that the next five years will be warmer than the past decade, whereas the other predicts the opposite.

Demand for accurate decadal prediction is running ahead of supply. This imbalance challenges us to determine how much of the natural climate variability that will contribute substantially to global climate in the next few decades is predictable. Even if it turns out that climate is essentially not predictable at a decadal scale, projections of future climate will be misleading unless we gain a fuller understanding of the range of natural variability in store for us in a warmer world. ❐

Mark A. Cane is at the Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York 10964-8000, USA.
e-mail: mcane@ldeo.columbia.edu

References

1. http://data.giss.nasa.gov/gistemp/graphs/
2. http://www.columbia.edu/~jeh1/mailings/2010/20100115_Temperature2009.pdf
3. http://www.clivar.org/organization/decadal/rsmas_decadal/rsmas_decadal.php
4. Cane, M. A., Zebiak, S. E. & Dolan, S. *Nature* **322,** 827–832 (1986).
5. http://iri.columbia.edu
6. Smith, D. M. *et al. Science* **317,** 796–799 (2007).
7. Keenlyside, N. S., Latif, M., Jungclaus, J., Kornblueh, L. & Roeckner, E. *Nature* **453,** 84–88 (2008).

Published online: 21 March 2010