How cold will a winter be in two years? Climate models still struggle with medium-term climate forecasts

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Atmospheric teleconnection patterns influence the weather on a large scale. The pattern of the North Atlantic oscillation plays an important role for the North Atlantic-European area. The North Atlantic oscillation is characterised by fluctuations in atmospheric pressure between the Icelandic Low and the Azores High and occurs in two states: the positive and the negative phase. The negative phase of the North Atlantic oscillation is characterised by lower atmospheric pressure over the Azores and higher atmospheric pressure in the area of the Icelandic Low so that the prevailing westerly wind current is weakened and the wave patterns pronounced. This causes cold polar air to be transported to Europe. Photo: Karsten Reise, Alfred Wegener Institute

How well are the most important climate models able to predict the weather conditions for the coming year or even the next decade? The Potsdam scientists Dr. Dörthe Handorf and Prof. Dr. Klaus Dethloff from the Alfred Wegener Institute for Polar and Marine Research in the Helmholtz Association (AWI) have evaluated 23 climate models and published their results in the current issue of the international scientific journal *Tellus A*. Their conclusion: there is still a long way to go before reliable regional predictions can be made on seasonal to decadal time scales. None of the models evaluated is able today to forecast the weather-determining patterns of high and low pressure areas such that the probability of a cold winter or a dry summer can be reliably predicted.

The most important questions currently being asked in climate research concern the impact of global climate change regionally and in the medium term. These are the subjects of national and international research programmes and will play a large role in the next world climate report because societies having to adjust to climatic changes should know which specific changes they must expect. For the energy or agricultural sector, for example, it would be enormously important to know if the weather conditions prevailing in a region in the medium term could be reliably predicted. Against this background, the prediction quality of current climate models for the period of seasons to a decade is of great importance.

The Earth's weather is significantly determined by large-scale circulation patterns of the atmosphere. One example of this is the North Atlantic oscillation which influences the strength and location of the westerly winds over the North Atlantic and therefore determines the tracks of the low pressure systems over North and Central Europe. Circulation patterns of this nature, also referred to as "teleconnection", are

distributed over the entire globe and determine the spatial and temporal distribution of areas of high and low pressure over large distances. Scientists speak here of the formation of "meteorological centres of action" which determine the weather of an entire region. In the case of the North Atlantic oscillation, these are the known weather centres of the "Icelandic Low" and the "Azores High".

"Short-term weather forecasts are now very reliable. The problems for seasonal and decadal, that is medium-term, predictions refer to the enormous variability and the broad range of feedback effects to which atmospheric circulation is subjected", explains AWI meteorologist Dörthe Handorf with respect to the special challenge presented to model makers. To test the forecast quality of the 23 most important climate models, the AWI scientists investigated how well these models were able to reproduce atmospheric teleconnection patterns over the past 50 years. A total of 9 known circulation patterns were investigated retrospectively, four of which in special detail. The result was that the spatial distribution of atmospheric teleconnection patterns is already described very well by some models. However, none of the models were able to reliably reproduce how strong or weak the Icelandic Low, Azores High and other meteorological centres of action were at a particular time over the last 50 years, i.e. the temporal distribution patterns.

"Climate researchers throughout the world are currently working on increasing the resolution of their models and the performance of their climate computers", says AWI researcher Dörthe Handorf in describing an obvious and important possibility of further improving the medium-term prediction quality of climate models. This enables climatic changes to be reproduced on a smaller spatial and temporal scale. "But it will not be enough to increase the pure computer power", says the Potsdam scientist who has worked on questions of climate variability since 1997. "We must continue to work on understanding the basic processes and interactions in this complicated system called "atmosphere". Even a high

power computer reaches its limits if the mathematical equations of a climate model do not describe the real processes accurately enough."

The Arctic plays a key role in optimising climate models. It is one of the most important drivers of our climate and weather and is at the same time one of the regions in which the climate is currently changing the most. The "High North" is also so inhospitable that data on the Arctic is sparse. Future research work of the Potsdam scientists therefore goes in two directions. Firstly, they are developing a climate model which can resolve the small-scale, weather-determining processes in the Arctic particularly well. The TORUS project is funded by the Federal Ministry for Education and Research (BMBF) as part of the "MiKlip – A Research Project on Decadal Climate Prediction" research programme and coordinated by Dörthe Handorf. However, since model improvements are only possible if comprehensive data records in high quality are available, a large international field campaign is planned in the Arctic for the period 2018-2019. It will demand a lot from the participating scientists because part of the field campaign is to be an international Arctic drift station in which a team of researchers will drift through the Arctic Ocean with the sea ice in the Arctic winter for several months.

More information: The original article is entitled: Handorf, D. and K. Dethloff "How well do state-of-the-art Atmosphere-Ocean general circulation models reproduce atmospheric teleconnection patterns?", *Tellus A*, 2012, 64, 19777, doi: 10.3402/tellusa.v64i0.19777 . www.tellusa.net/index.php/tell … a/article/view/19777

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