# Northern Hemisphere Wintertime Regional Trends


## Larissa Nazarenko and Nick Tausnev

Columbia University/NASA Goddard Institute for Space Studies, New York, NY, USA


## Introduction

While there is attribution of the polar warming to human influence, winter-spring warming over northern areas of the Eurasia and the cooling of eastern Canada and southern Greenland during the 1980s and 1990s is argued to be largely associated with internal variability such as the positive phase of the Arctic Oscillation/North Atlantic Oscillation (AO/NAO).

In addition to the amplified high latitude temperature increase, the global warming resulting from anthropogenic emissions of greenhouse gases may be linked with the effects of fluctuations of atmospheric circulation systems on precipitation distributions. The recent severe snow storms in the northwestern Europe, which is believed to be forced by the low NAO index conditions by the large extent, highlight the effect of natural fluctuations in atmospheric circulation systems on precipitation distribution.

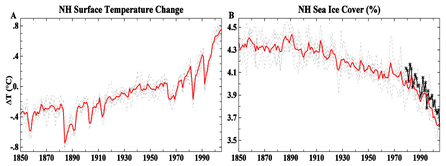
## Model and experiment descriptions

We use the new version of NASA Goddard Institute for Space Studies (GISS) climate model, modelE2 with 2º by 2.5º horizontal resolution and 40 vertical layers, with the model top at 0.1 hPa. The basic physics of the model is similar to the version of GISS ModelE used in CMIP3 [Schmidt et al., 2006] with numerous improvements to the physics.

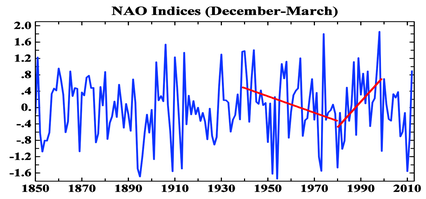
The historical simulations from 1850 to 2005 with both natural and anthropogenic forcings, as well as four 21st century RCP scenarios, are analyzed in terms of DJFM NAO Index variability and its effect on the Northern Hemisphere surface air temperature and snow fall changes.

## Results

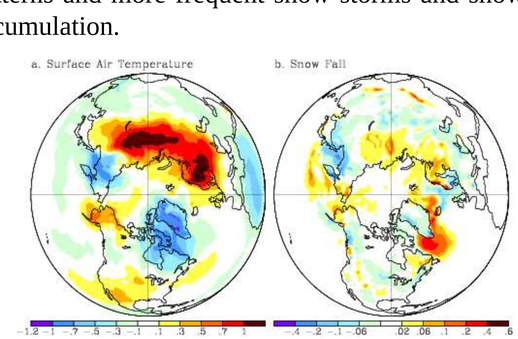
The Northern Hemisphere surface air temperature warming is +0.8°C (based on linear trend) from 1850 to 2005 in the experiment with all climate forcings. The greater surface warming over the Northern Hemisphere than over the whole globe, the so-called Arctic amplification, is largely due to strong positive sea ice albedo feedback. The sea ice for both observed and modeled data is plotted in per cent of the Northern Hemisphere area of the Earth surface. The decrease of the Northern Hemisphere NSIDC sea ice cover is 9.8% from 1979 to 2005 while our model produces a little stronger decline of 10.2% for the Arctic sea ice for the same time period.



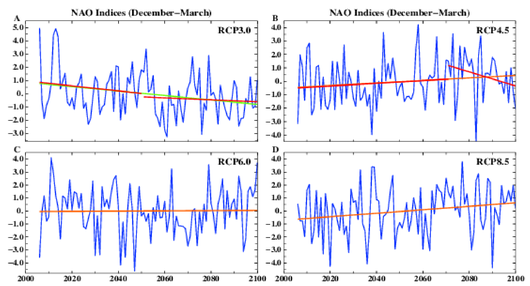

For the experiments with both natural and anthropogenic forcings, the variability of the NAO index is not uniform and it exhibits the negative trend for 1939-80 period and positive trend for 1980-99 period (Fig. 4) that is consistent with the variability of the observed NAO index presented by *Kuzmina et al.* [2005]. The regional impact of the NAO index will be shown for the period from 1980 to 2012, which is the period of strong warming of both global and Northern Hemisphere surface temperatures and fast Arctic sea ice decline



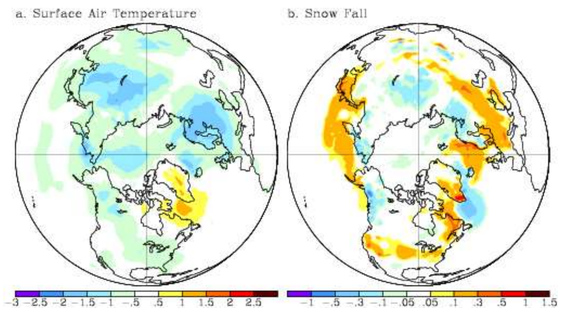

Over Siberia, there is a seesaw pattern of surface temperature and snowfall between the central Siberia and far-east Siberia, Kamchatka and Sea of Okhotsk. When the NAO is in a positive phase, the central Siberia is persistently warmer while the far-east Siberian regions are colder. The increased snow fall during the positive NAO phase is linked to lower than normal sea level pressure over the central Siberia that leads to more cyclonic weather patterns and more frequent snow storms and snow accumulation.




For the anthropogenically forced climate response for the twenty first century RCP emission scenarios, the NAO index shows higher year-to-year variability compared to the historical simulation of the 19th and 20th centuries. The standard deviation of the NAO index for the period 1980-2012 is 0.8 while it doubled to 1.65 in the RCP3.0 scenario and it becomes 1.83 in the RCP8.5 experiment.




Despite that there is overall warming in the case RCP8.5 with global surface air temperature increase by 2.6°C and Northern Hemisphere warming by 3.1°C at the year 2100, the cooling over almost all continental areas are reproduced except for surface temperature warming over Greenland, Labrador Sea, and the area to the south and east from Greenland (Fig. 10a). The intensive snow storms lead to high snow accumulations in the most of European regions and in the middle latitude Eurasia and North America (Fig. 10b) while the most regions in the European North, Siberia and northern North America are affected by deficiency in the snow fall in addition to severe cold winter conditions during low NAO index conditions.




## Literature Cited


Kuzmina, S., L. Bengtsson, O.M. Johannessen, H. Drange, L.P. Bobylev, and M.W. Miles (2005), The North Atlantic Oscillation and greenhouse-gas forcing, *Geophys. Res. Let.*, *32*:L04703; doi:10.1029/2004GL021064.

Schmidt, G. A., Ruedy, R., Hansen, J. E., Aleinov, I., Bell, N., Bauer, M., Bauer, S., Cairns, B., Canuto, V., Cheng, Y., Del Genio,A., Faluvegi, G., Friend, A. D., Hall, T. M., Hu, Y., Kelley,M., Kiang, N. Y., Koch, D., Lacis, A. A., Lerner, J., Lo, K. K., Miller, R. L., Nazarenko, L., Oinas, V., Perlwitz, Ja., Perlwitz, Ju., Rind, D., Romanou, A., Russell, G.L., Sato, M., Shindell, D.T., Stone, P. H., Sun, S., Tausnev, N., Thresher, D., and Yao, M.-S. (2006), Present day atmospheric simulations using GISS ModelE: Comparison to in-situ, satellite and reanalysis data, *J. Climate*, 19, 153–192.


Additional information here about the authors or the name of the conference