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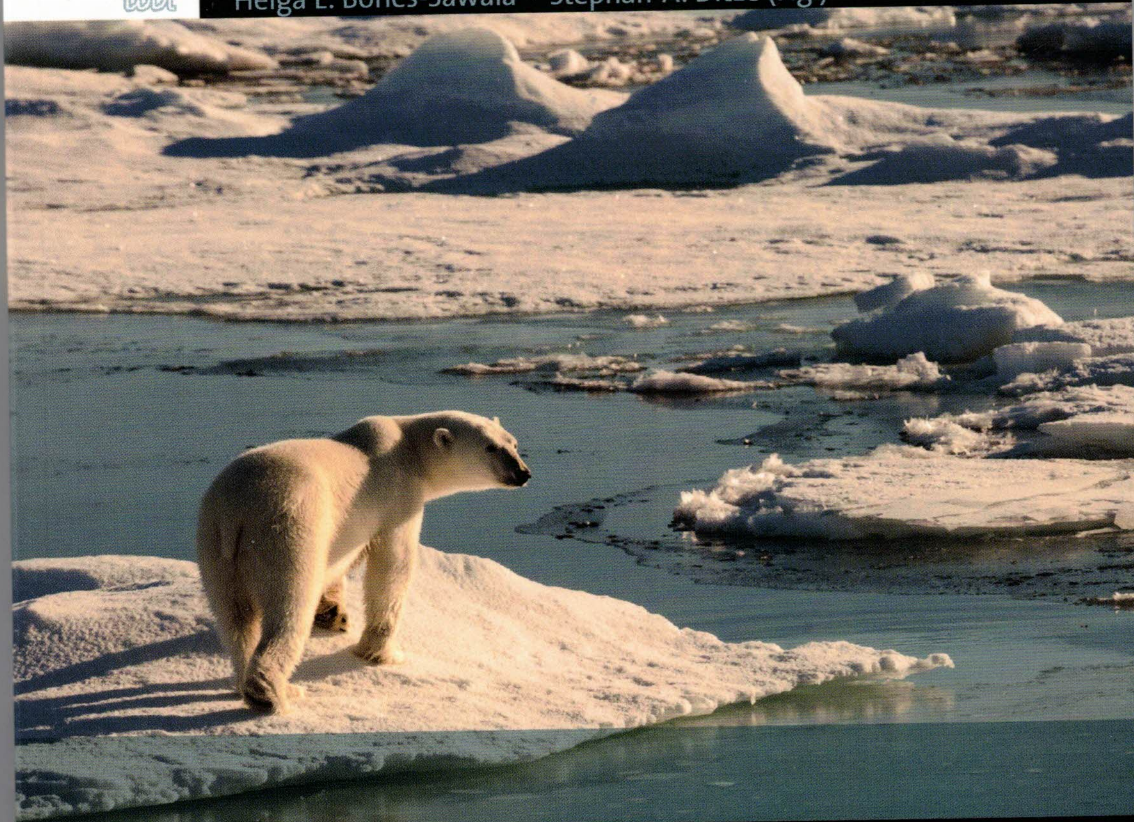
Helga E. Bories-Sawala · Stephan-A. Ditze (Hg.)



Die Arktis stirbt

Der Hohe Norden Kanadas und Québecs: ein faszinierender Lebensraum vor extremen Herausforderungen

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The Arctic Is Dying

The Far North of Canada and Québec:
A Fascinating Habitat Facing Extreme Challenges

L'arctique est en train de mourir

Le Grand Nord du Canada et du Québec:
un écosystème fascinant face à des défis extrêmes

BIKQS
Bremer Institut für Kanada- und Québec-Studien

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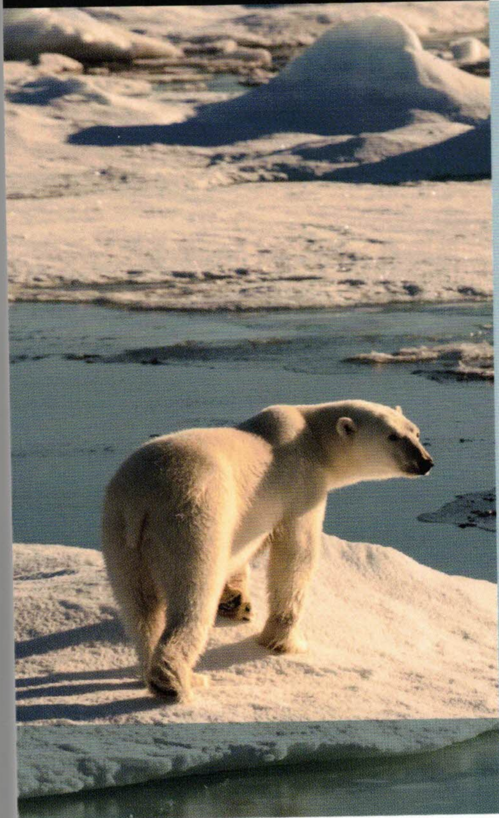

Dies ist kein weiteres Buch über den menschengemachten Klimawandel. Es schaut auf die andere Seite der Medaille: die faszinierenden Facetten einer bedrohten Region, nämlich der Gebiete Kanadas und Québecs im Hohen Norden, die verloren gehen könnten. Welches Konfliktpotential ergibt sich aus neuen Schifffahrtsrouten und Profit versprechenden Rohstoff- und Energievorkommen? Plötzlich ist die Arktis interessant, wird zum Zankapfel zwischen Kanada und anderen Anrainerstaaten, aber auch z.B. der EU und China, mit jeweils eigenen Interessen. Wo bleiben die Rechte der Indigenen, wird die sprichwörtliche Resilienz der Inuit ausreichen, um die Arktis vor dem gierigen Zugriff auf ihren Lebensraum zu bewahren?

Der Band vereint die Blickwinkel von Klimaforschung, Politikwissenschaft, Geschichte, Soziologie, Literatur- und Kulturwissenschaft zu so unterschiedlichen Themen wie die kanadische Arktispolitik, die ökonomische und institutionelle Entwicklung in den Territorien, das internationale Gezerre um Souveränitätsansprüche, den historischen Wettlauf um die Nordwestpassage, die Präsenz des Französischen im Hohen Norden, die Inuit-Kunst aus kunstwissenschaftlicher und gesellschaftstheoretischer Sicht und die Darstellung der Inuit in Literatur und Film, einschließlich didaktischer Perspektiven für den Fremdsprachenunterricht.

Wenn die Arktis mit ihrer einzigartigen Natur und Kultur nicht sterben soll, so der Sprecher der Inuit, Duane Smith, in einem dringenden Appell an die Weltgemeinschaft, muss die Emission von Treibhausgasen drastisch reduziert werden.

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Future Climate in the Far North

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Zusammenfassung

Wir möchten eine Methode vorstellen, die es erlaubt, die klimatischen Schwankungen der Jahreszeiten sowohl räumlich als auch zeitlich einzuschätzen. Diese Methode wird angewendet, um die Änderungen im Jahreszyklus der Oberflächentemperatur in den höheren Breiten, unter dem Einfluss der globalen Erwärmung, besonders in Kanada zu betrachten. Dabei wird der Datensatz ERA40 verwendet, um das derzeitige Klima zu simulieren und die Ergebnisse des Modells ECHAM5, um den jährlichen Temperaturzyklus des Zeitraums von 2157 bis 2200 darzustellen, zu welchem zeitliche Anpassungen bezüglich des Anstiegs von CO2 aufgetreten sein werden. Die Analyse demonstriert, dass eine Periode von ca. 30 Jahren notwendig ist, um – aufgrund der ihnen innewohnenden Zufälligkeit – valide klimatische Mittelwerte zu erzielen.

Résumé

Nous présentons une méthodologie qui permet d'évaluer la variabilité de la saisonnalité climatique à la fois spatialement et temporairement. Ceci est appliqué pour considérer les changements dans le cycle annuel des températures de surface dans les hautes latitudes, et en particulier au Canada, sous le réchauffement climatique en utilisant le jeu de données ERA40 pour le climat contemporain et les résultats du modèle ECHAM5 pour simuler le cycle annuel de température pour la période de 2157 à 2200, date à laquelle l'ajustement à l'augmentation du CO2 aura lieu. L'analyse démontre qu'une période d'environ 30 ans est nécessaire pour obtenir des moyennes climatiques adéquates en raison de leur caractère aléatoire inhérent.

Abstract

We present a methodology which enables the variability in seasonality to be assessed both spatially and temporarily. This is applied to consider the changes in the annual cycle of surface temperatures in the high latitudes, and in particular Canada, under global warming using the ERA40 dataset for the contemporary climate and the ECHAM5 model results to simulate the annual temperature cycle for the period 2157-2200, by which time adjustment to the increase in CO_2 will have occurred. The analysis demonstrates that a period of approximately 30 years is required to obtain adequate climate averages owing to their inherent randomness.

Introduction

In this chapter we introduce a simple method for characterizing seasonal change, which is applied to climate data and to climate model predictions. Canada is a preferred site for significant change under global warming because of the presence of sea ice along its northern coasts including Hudson Bay, which is likely to become much reduced in extent under global warming. This factor alone changes the continental seasonality, and essentially allows the temperate climate regime which prevails in the lower latitudes to propagate poleward. We examine this process within the context of the variability of the contemporary climate.

How is climate defined?

We are accustomed to the commonly used definitions of the seasons (FOWLER & FOWLER 1964), which in the northern hemisphere are Spring: March, April, May; Autumn: September, October, November; Summer: June, July, August, and Winter: December, January and February. In an era of climate change, however, the seasons will also change and hence we need a new definition which takes account of this possibility.

This task has been addressed at the KlimaCampus, and here we present a digest of our findings. Weather is the study of atmospheric variability on a synoptic scale, typically of order a few days. Climate is the study of longer time scale variability which characterizes seasons, years and decades. A time average of the weather therefore defines the climate, including the seasonal cycle.

Consider the specification of the maximum temperature. This could be chosen to be the day of occurrence of the actual maximum temperature, however, because of the weather it is much more useful to average over the synoptic time scale and define the day of occurrence of a *smoothed* maximum temperature. Indeed sometimes daily maximum temperatures are not even available, especially over the ocean and in historical data sets, hence in our work we have used monthly mean temperatures for three consecutive months which we interpolate to give the date and magnitude of the smoothed summer maximum temperature (T_{max}), and similarly the date and magnitude of the smoothed winter minimum temperature (T_{min}). These estimates essentially take out the everyday randomness of weather.

From these two dates the length of the warming period (SP) of the annual temperature cycle, which we call *spring*, and also that of the cooling period (AU), which we call *autumn*, can be obtained (BYE et al. 2013). SP and AU respectively are objective measures of spring and autumn which are uniformly applicable both in space and time, and hence they can be applied to climate change studies on a global basis. When this is done the temporal and spatial variability of T_{max} and T_{min} and of SP and AU describe the randomness of the climate, and any trends in T_{max} and T_{min} and in SP and AU can be interpreted as a climate change signal. We discuss each of these aspects in turn with particular reference to Canada, using reanalysed atmospheric data sets and the results from climate models.

Climate modelling

At the core of climate modelling is an accurate dataset for the current climate with which the climate model results for the present period can be compared. The KlimaCampus group has used the 43 year reanalysis dataset from the European Centre for Medium-range Weather Forecasts (ERA40) for the period 1958-2001 as the reference climate, and the European Centre Hamburg Model (ECHAM5) simulations to investigate the changes in climate under global warming (IPCC 2013) for the period 2157-2200. We selected this 43 year period well into the future as the effects of global warming will have become clear by this period.

There are of course doubts on the accuracy of climate model projections. In the ECHAM5 climate model, the global mean surface air temperature change after adjustment to a doubling in CO_2 concentration is 3.4 degrees C, which is in the mid-range of 3.2 degrees C for 19 AR4 models. This adjustment is realized by 2100 before the 2157-2200 period.

Randomness

A basic property of the randomness of the climate is its standard deviation. This is a property of both the magnitude and the date of the smoothed temperature maximum, and the smoothed temperature minimum. Figure 1 shows that the winter variability in magnitude is much greater than the summer variability, and also that in both hemispheres the winter variability is strongly focussed in the high latitudes. In Canada the standard deviation of T_{min} is about 4°C in comparison with about 1°C for T_{max}. This pattern is also apparent in the date of T_{min} which has a standard deviation in Canada of between 20 and 30 days, whereas that of T_{max} is only about 5-10 days (Figure 2).

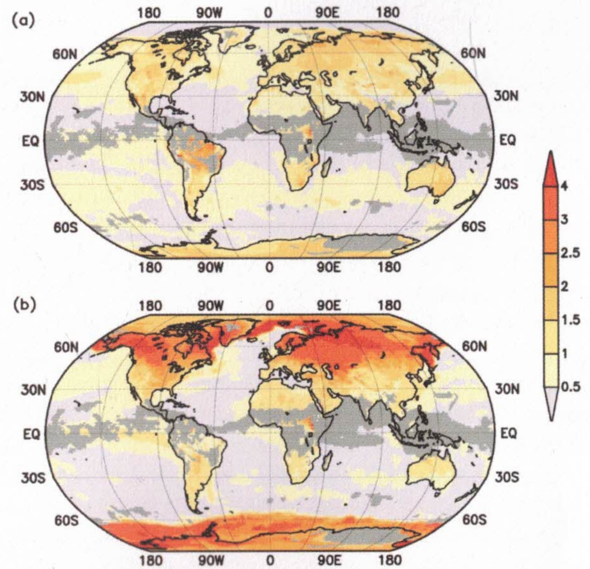

Figure 1: The standard deviation (ºC) of (a) Smoothed surface maximum temperature, and (b) Smoothed surface minimum temperature

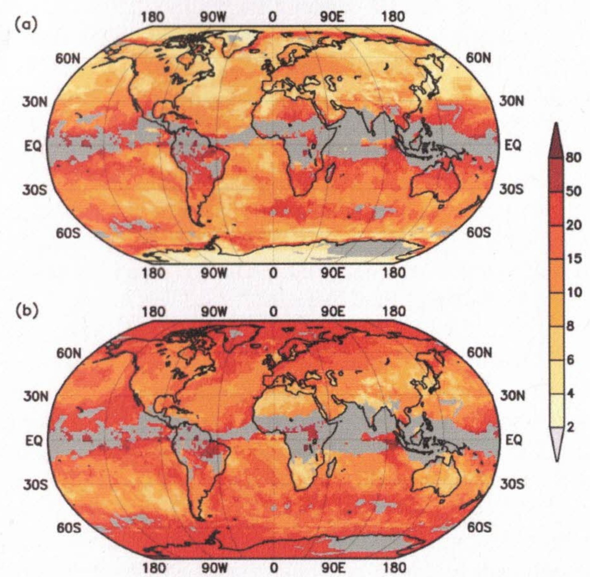

Figure 2: The standard deviation (days) of day of occurrence of, (a) Smoothed surface maximum temperature, and (b) Smoothed surface minimum temperature

The structure of the variability is also apparent in the multi-year random response as illustrated in Figures 3 and 4 where we have averaged the data over three periods: 1958-1972, 1973-1986 and 1987-2001 and then taken the two differences 1973-1986 minus 1958-1972, and 1987-2001 minus 1973-1986. This procedure shows clearly that northern Europe and Canada undergo extended periods of winters with markedly different characteristics. In particular, relative to the mid-period, winters in the earlier period and in the later period were both milder (Figure 3). The warmer winters also occurred later than the colder winters (Figure 4). In the high Arctic throughout the hemisphere the signal is reversed, which gives rise in Canada to a temperature dipole between the north-east and the south-west of the country (Figure 3).

This randomness is part of the randomness in global mean temperature (BYE et al. 2011), which over a hundred year period exhibits a random walk length of about 25 years, with the strongest random walks in T_{min}, for which the maximum excursions (which may be either positive or negative) of temperature on the land and over the ocean are respectively 2.0ºC and 0.6ºC, whereas for T_{max} the maximum excursions are, respectively 1.2ºC and 0.3ºC.

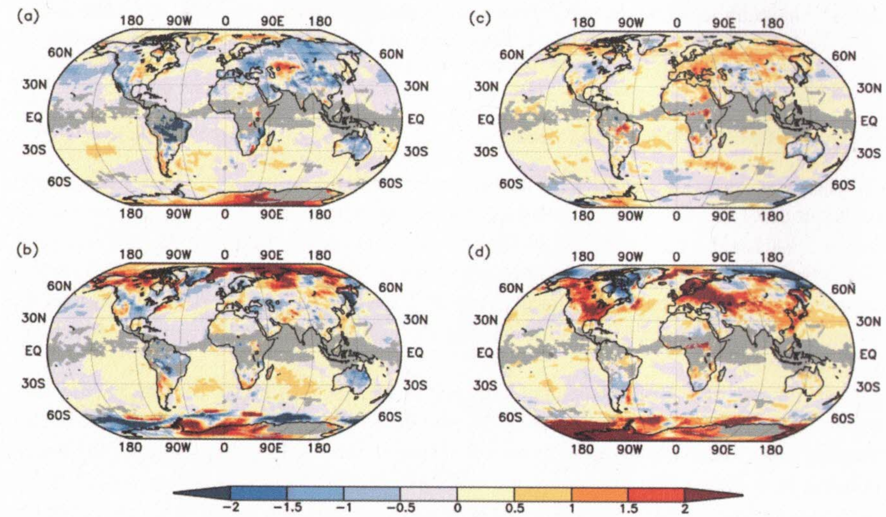

Figure 3: Mean differences (ºC) in smoothed surface temperature for (a) maximum temperature, and (b) minimum temperature for the periods 1973-1986 minus 1958-1972, and (c) maximum temperature, and (d) minimum temperature for the periods 1987-2001 minus 1973-1986

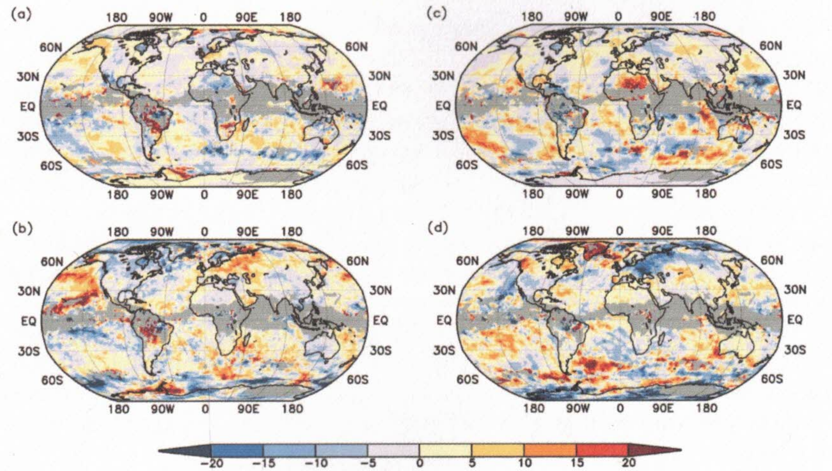

Figure 4: Mean differences (days) in the day of occurrence of smoothed surface temperature for (a) maximum temperature, and (b) minimum temperature for the periods 1973-1986 minus 1958-1972, and (c) maximum temperature, and (d) minimum temperature for the periods 1987-2001 minus 1973-1986

Seasonal climate in Canada today

Before presenting some properties of the contemporary seasonal climate in Canada, we consider carefully the period over which the averages are made. This question was originally discussed by the International Meteorological Organisation in 1935, who adopted the years 1901-1930 as the 'climate normal period', and subsequently a period of thirty years has been retained as the classical period of averaging (IPCC 2007). Our analysis supports a period of similar length, and Figure 5(a) shows the mean conditions for the period, 1958-2001.

Over most of the World except the tropics, there is only one maximum and one minimum in the annual temperature cycle, and the length of *spring* is less over the ocean than on land, which is due to the retention of heat in the stable surface layer of the water column in autumn. This leads to a mean length of *spring* over the ocean which is 22 days shorter than *autumn.* On the western coast of Canada this negative *spring* anomaly increases to about 50 days, and becomes even greater in the Arctic Ocean. In Hudson Bay, however, the length of *spring* is about 80 days greater than *autumn.* This difference is primarily brought about by the earlier winters in Hudson Bay. On the eastern coast of Canada, the length of *spring* is similar to the global average (Figure 5[a]). These three maritime patterns control the present-day seasonality in continental Canada. They are reproduced reasonably well in the ECHAM5 simulation (Figure 5[b]), from which the annual temperature cycles for locations in each of the three regions: (a) Arctic Ocean (81°N, 156°W), (b) Hudson Bay (60°N, 85°W) and (c) North Atlantic Ocean (60°N, 11°E), have been displayed in Figure 6.

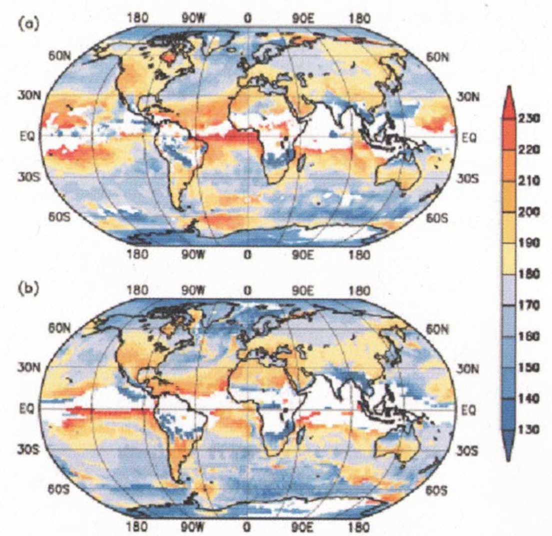

Figure 5: The length of the warming period (days) for the period 1958-2001 from (a) the ERA40 dataset, and (b) the ECHAM5 model. Points with more than one maximum or minimum are shown in white

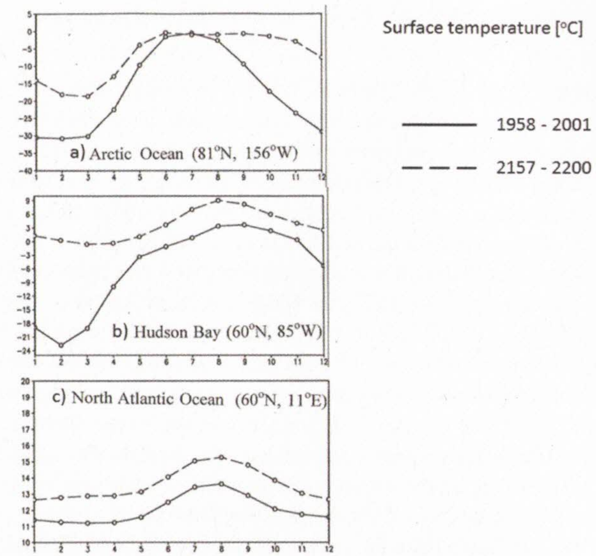

Figure 6: Mean monthly surface temperatures for the periods 1958-2001 and 2157-2200 from the ECHAM5 model for; (a) The Arctic Ocean (81°N, 156°W), (b) Hudson Bay (60°N, 85°W), and (c) The North Atlantic Ocean (60°N, 11°W). The numbers 1-12 indicate January-December

Seasonal climate in Canada under global warming

In the ECHAM5 model the surface parameters except for the snow cover are specified (HAGEMANN et al. 2006), but over the ocean the sea ice distribution adjusts. Figure 7 shows the predicted global changes in the length of *spring* in the climate period 2157-2200 relative to the present (1958-2001). It is clear that in the temperate latitudes the timing of the warming period is essentially unchanged although of course the temperatures have risen by 2-3 degrees C (Figure 6 [c]).

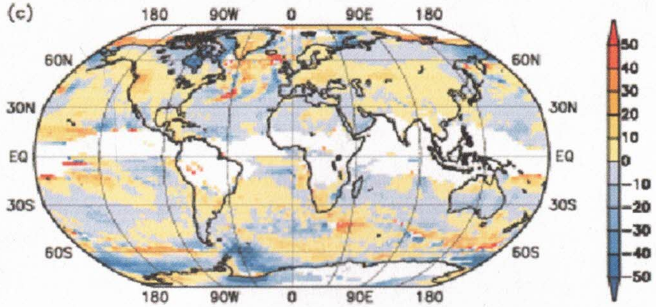

Figure 7: The change in the length of the warming period (days) between 1958-2001 and 2157-2200 from the ECHAM5 model. Points with more than one maximum or minimum are shown in white

The major changes occur in the high latitudes, and in concert with the maxima in the standard deviation of winter temperatures (Figure 1), are almost hemispherically symmetrical, which possibly is a surprising result owing to the hemispheric asymmetry of the land masses. On focussing on the changes in the length of the warming period in Canada, it is apparent that an intense negative anomaly of about 40 days is centred on Hudson Bay, which compensates the positive anomaly of the present climate. The reason for this change is that under global warming almost ice-free conditions exist in Hudson Bay giving rise to later winters (Figure 6[b]). The other region of intense change is in the Arctic Ocean about 1000 km to the north-north west of the Canadian coastline where during the summer an almost constant temperature of just less than 0 degrees C occurs as the result of low salinity water produced by ice melt, giving rise to extended summer conditions late into the year (Figure 6[a]). In the North Atlantic Ocean, unaffected by sea ice, the increase in temperature is fairly uniform throughout the year although the length of spring increases due to an earlier onset of winter conditions (Figure 6[c]). This appears to be due to a weakening of the Gulf Stream. Observations suggest that the strength of the North Atlantic overturning circulation of which the Gulf Stream is a part, can vary significantly on an interannual time scale with a 30% decrease in average current strength occurring in 2009 (MCCARTHY et al. 2012). Most climate modellers however regard the possibility of a 'shut-down' of the overturning circulation with the consequent return to 'ice age conditions' in Canada, as exceedingly unlikely (SCHIERMEIER 2013). The ECHAM5 model has no physical mechanism which would lead to this scenario.

In summary, under global warming the temperate regime in Canada is extended poleward by about 10° of latitude by 2157-2200 (Figure 6[b]), and the maritime influence of the Pacific Ocean becomes more important in north-western Canada, including the Arctic Ocean, bringing extended summer conditions to the region (Figure 6[a]).

Conclusion

In Section 4 we pointed out that the winter variability of temperature is much greater than the summer variability. The north-west of Canada will benefit most from these settled summer conditions as can be seen from the predicted summer conditions in the Arctic Ocean (Figure 6[a]). Along the coast, where the temperatures are higher, the summer season is also extended, as also occurs for the northern coastlines of Alaska and eastern Siberia (Figure 7). Essentially an Arctic Riviera will evolve, quite distinct from the meridional weather patterns which will bring summer warmth into the land of lakes further inland.

Acknowledgements

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Out in the Cold?
Canada's Arctic Foreign Policy in a Changing World

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Zusammenfassung

Als Mitte der ersten Dekade des 21. Jahrhunderts die Arktis weltweit in die Schlagzeilen geriet, waren Beobachter Kanadas ziemlich erstaunt über die sehr forschen und unilateralen außenpolitischen Verlautbarungen aus Ottawa. Während Experten internationaler Beziehungen uneins darüber waren, ob man zukünftig Kooperation oder Konflikt in der Arktis zu erwarten habe, war Kanada daran gelegen, seine eigene spezifische Rolle in der Arktis herauszuarbeiten. Bereits 2010 hatte es sich erfolgreich als wichtige Stimme und Akteur in der Region etabliert. Als aber arktische Geopolitik nicht mehr ein gänzlich neues Politikfeld war, begannen auch andere Mitspieler, Einfluss auf Kanadas nationale Arktis-Politik zu nehmen, sowohl auf der internationalen wie auch der subnationalen Ebene. 2020 ist wohl Geopolitik wieder ein Thema in der Arktis, aber viele Determinanten der kanadischen Arktis-Politik haben sich mittlerweile stark verändert.

Résumé

Quand l'Arctique commença à occuper les nouvelles internationales, au milieu de la première décennie des années 2000, les Canadianistes furent frappés par les annonces assertives et unilatérales en politiques étrangère venant d'Ottawa. Alors que les interprétations faites par les spécialistes en relations internationales oscillaient entre le conflit et la coopération dans la région polaire, le Canada tenta à développer son propre rôle spécifique dans l'Arctique. En 2010, il avait réussi à s'établir dans la région en tant que voix et joueur important. Or, une fois la nouveauté de la géopolitique disparue, différents acteurs commencèrent à agir sur la politique nationale du Canada dans l'Arctique, aussi bien sur le plan international qu'infranational. En 2020, la géopolitique est bien de retour dans l'Arctique, mais de nombreux aspects déterminant la politique canadienne dans l'Arctique ont considérablement changé.

Abstract

When the Arctic made global news in the mid-2000s, scholars of Canada were surprised by the assertive and unilateral foreign policy announcements coming from Ottawa. As interpretations by international relations specialists oscillated between conflict and cooperation in the polar region, Canada aimed to carve out its own specific role in the Arctic. By 2010, it had succeeded in establishing itself as an important voice and player in the region. Yet, once the novelty of Arctic geopolitics wore off, different actors began to impact Canada's national Arctic policy, both on the international and the subnational level. By 2020, geopolitics may have returned to the Arctic but many other aspects determining Canada's Arctic policy have changed significantly.