

ARCTIC ENVIRONMENT BY THE MIDDLE  
OF THIS CENTURY

*by*

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## ARCTIC ENVIRONMENT BY THE MIDDLE OF THIS CENTURY

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### **ABSTRACT:**

At around 2040-2050 we will be in a new major Solar Minimum. It is to be expected that we will then have a new “Little Ice Age” over the Arctic and NW Europe. The past Solar Minima were linked to a general speeding-up of the Earth’s rate of rotation. This affected the surface currents and southward penetration of Arctic water in the North Atlantic causing “Little Ice Ages” over northwestern Europe and the Arctic.

**Keywords:** Arctic environment by 2040-2050, next Solar Minimum, return to Little Ice Age conditions.

### **INTRODUCTION**

Both ACIA (2004) and IPCC (2001) predict a unidirectional opening of the Arctic. This is repeated in the last IPCC-report (2007). This has affected economical and trading scenarios, too. We often hear that, by year 2050 (if not even before), the Arctic will be ice-free allowing trans-Arctic voyages.

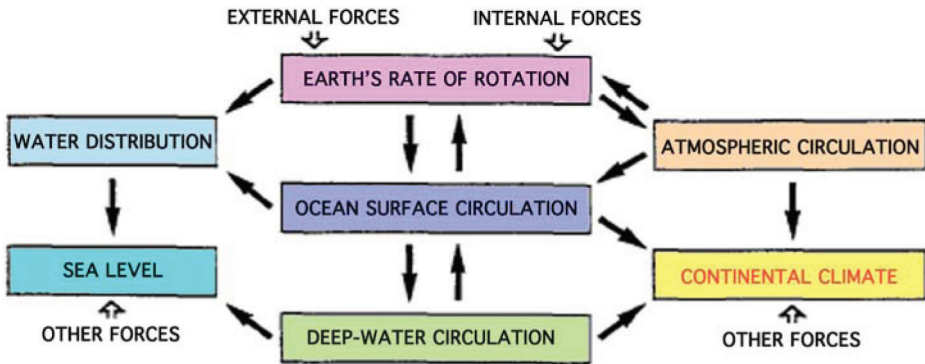
Karlén (2008) showed that there hardly is anything unusual going on in the Arctic region today, rather variations of the same type as recorded throughout the Holocene. Furthermore, he found those variations quite similar to the changes in Solar activity as recorded by the atmospheric <sup>14</sup>C-variations.

Höpner Petersen (1984) has shown that the low summer sun with only around +3-9° C air temperatures cannot compensate the heat loss during the Polar nights with air temperatures at minus 20-40° C. Therefore, he argues that air temperature cannot melt polar ice, only ocean water-heat may do this. He states (Höpner Petersen, 2010) “Millions of years with polar nights created the deep, polar oceans, the polar currents and the polar life systems. The solar system controls the polar nights and their influence on the global climate in periods from tens, to hundreds, to thousands, to millions of years.”

In 1984, I launched the theory that angular momentum might be transferred back and forth between the solid Earth and hydrosphere; affecting primarily the surface circulation of the main ocean currents, and especially the Gulf Stream and Kuro Siwo Current which bring oceanic water masses from low to high latitudes (Mörner, 1984a, 1984b). This was followed up in a series of papers (Mörner, e.g. 1988, 1995, 1996a,

1996b). I then realized that the Solar Wind might affect the rotation of the entire terrestrial system (Mörner, 1996b, 1999). The Solar minima were found to correspond to periods of speeding-up of the Earth rate of rotation (Mörner, 2010).

Changes in the Earth's rate of rotation and their feedback interactions are illustrated in Figure 1. Many variables are interacting. Changes in the oceanic surface circulation are proposed to play the dominant role with respect to centennial and multi-decadal changes in climate (Mörner, 1995). Variations in the Solar Wind are held as the external driving force (Mörner, 2010).



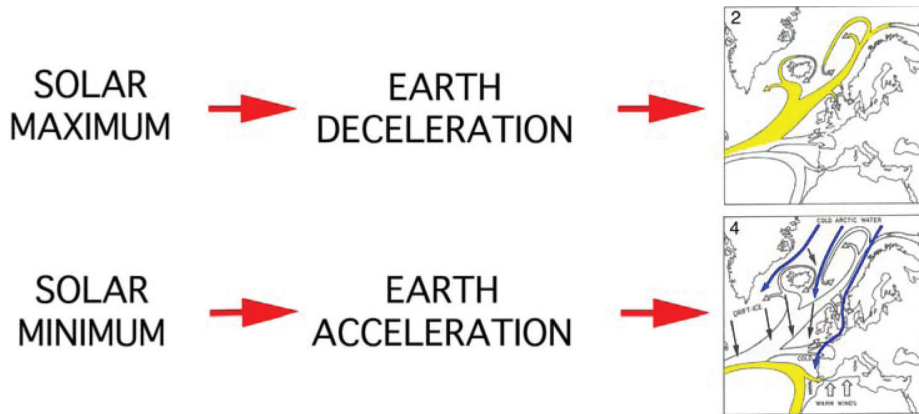
**Figure 1.** Effects and feedback interactions of changes in the Earth's rate of rotation (from Mörner, 1995). Ocean surface circulation is proposed to play the dominant role in the redistribution of ocean-stored energy (recorded by paleoclimate) and water masses (recorded by past sea level changes).

The forcing function in the scenario here proposed is the effect of changes in the Solar Wind upon the Earth's rate of rotation.

Long ago, Eddy (1976) proposed that Little Ice Ages occurred at periods of Solar minima. Indeed, there seems to be a good correlation between cooling events over northern Europe, the North Atlantic and the Arctic. During the Spörer, Maunder and Dalton Solar Minima, Arctic water was forced southwards all the way down to Mid-Portugal and the adjacent land areas experienced "Little Ice Ages" (Mörner, 1995, 2010). At the same time, however, the Gibraltar and NW Africa experienced warm events. This North–South opposed climate conditions are well understood in terms of differential distribution of current flow-masses along the northern and southern branches, respectively, of the Gulf Stream (Mörner, 1995, 2010).

The relation among centennial Solar maxima/minima cycles, the Earth's rate of rotation and the changes in dominant ocean surface current activity in the North Atlantic is illustrated in Figure 2.

Today, we are at the end phase of a Solar Maximum and in some 30-40 years we will be in a new Solar Minimum. This paper will discuss the optional scenarios for the changes in climatic conditions in the Arctic within this century, with special regard to the effects of Solar variability.

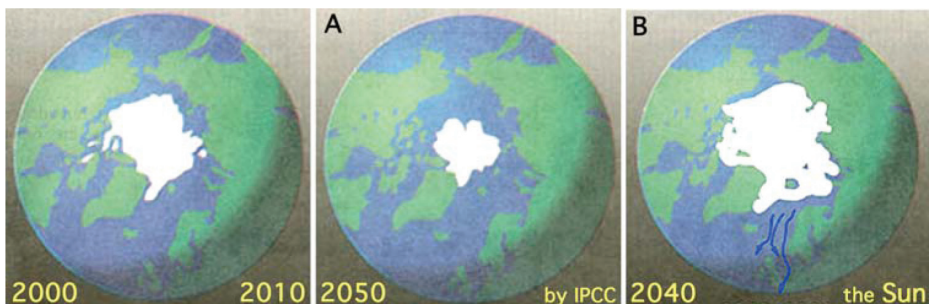


**Figure 2.** Relations among solar cycles, Earth's rate of rotation and the observed changes in the ocean circulation in the North Atlantic (from Mörrer, 2010).

**UNIDIRECTIONAL WARMING**

In the Global Warming scenarios (IPCC, 2001, 2007; ACIA, 2004) the Arctic will face a unidirectional warming. By the middle of this century, the Arctic is said to become ice-free (Figure 3A). This statement has lead economists and businessmen to postulate new trading routes and political competition within the Arctic. This concerns natural resources like oil and gas, water for fishing, location of potential harbours, etc.

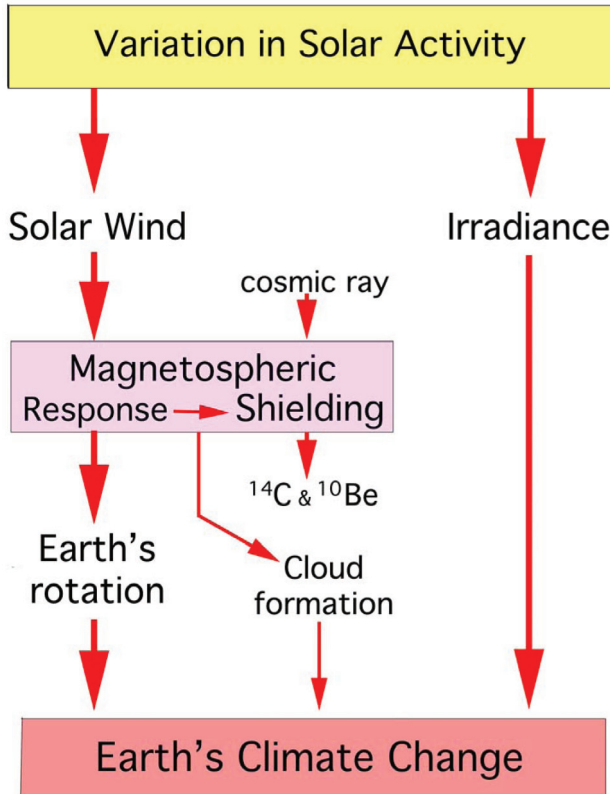
In these scenarios, little or no respect is paid to the natural variability in climate, and the solar-terrestrial interaction.



**Figure 3.** Approximate Arctic ice-cover today (2000-2010) and proposed changes by 2050 according to IPCC (A) allowing trans-Arctic shipping, and by 2040 according to the cyclic long-term Solar changes (B) predicting Little Ice Age climatic conditions.

### THE SUN IN THE CENTRE

If we “put the Sun back in the centre” (Mörner, 2006a, 2006b) – in analogy to what Copernicus did in the 16<sup>th</sup> century with respect to the old Aristotle’s and Ptolemaist geocentric concept – the prospect of the Arctic will be totally different, however (Figure 3B).



**Figure 4.** Variations in Solar activity lead to changes in the Solar Wind and in Solar irradiance, both of which may affect Earth’s climate. The variations in irradiance are known to be small or even minute. The variations in Solar Wind are large and strong, via the interaction with the Earth’s magnetosphere, it affects Earth’s rate of rotation, by that forcing several different terrestrial variables like the Gulf Stream beat in the North Atlantic. Simultaneously, the shielding capacity affects the concentration of cosmogenic nuclides (Bard et al., 2000), like the aa-index (Cliver et al., 1998). At any rate, there are two different ways for how changes in Solar activity may affect Earth’s climate; via irradiance or via the Solar Wind. In the present case, it is the left line that is considered.

## **SOLAR–TERRESTRIAL INTERACTION**

It is common knowledge that the Earth is predominantly heated from the Sun. Any variation in the solar activity might, therefore, be a potential factor for changes in the terrestrial climate.

The 11-year sunspot cycle is well known phenomena, and so are, to a lesser degree, also the 22-year cycle, the 80 year Gleissberg Cycle (sometimes even given as 60 year), the 120 year VMV Cycle and the 240 de Vries Cycle. The search for those cycles in terrestrial variables has a long history (e.g. Schove, 1983; Sanders & Fairbridge, 1995; Finkl, 1995). Still, the matter was far from clear.

Friis-Christensen and Lassen (1991) established an excellent correlation, for the last 150 years, between changes in the length of the sunspot cycle and general changes in global mean temperature. This gave evidence of a strong solar-terrestrial linkage, despite the fact that the physics behind this linkage remained unknown.

On the centennial basis, the solar activity (instrumental, observation, aurora, aa-index,  $^{14}\text{C}$ -production,  $^{10}\text{Be}$  in-fall) exhibits cyclic variations between Solar Maxima and Solar Minima (e.g. Stuiver and Quay, 1980; Hoyt and Schatten, 1993; Lean et al., 1995; Cliver et al., 1998; Lean and Rind, 1999; Bard et al., 2000; Bond et al., 2001; Mazzarella, 2007).

The Solar Minima – the Dalton Minimum 1800–1820, the Maunder Minimum 1645-1705, the Spörer Minimum 1420-1500 and the Wolf Minimum 1290-1350 – have attracted special attention because they have been proposed to correlate (e.g. Eddy, 1976) with cold periods or Little Ice Ages (Lamb, 1979). In the west European records (Guiot, 1992), there are quite clear cold minima at 1440-1460, 1687-1703 and 1808-1821 (Mörner, 1995, 2010), i.e. right within the last three Solar Minima.

The observed solar-terrestrial interaction have been interpreted in the following three ways, illustrated in Figure 4.

### **(1) Solar irradiance**

The solar-terrestrial interaction is often explained in terms of variations in irradiance over the sun-spot cycle and it multiples (e.g. White et al., 1997). The variation in energy output during a sunspot cycle is found to be far too low, however, or only in the order of 0.2 % (Willson, 1997). Therefore, this mechanism does not apply *per se*. Only by assuming unknown and hypothetical amplifying forcing-functions may it be converted to effects large enough to explain observed changes in climate (e.g. Lean et al., 1995).

### **(2) Solar Wind and cosmic ray in-fall**

In a number of papers, Svensmark (e.g. 1998, 2007) has proposed that Earth climate may be strongly controlled by cloud formation driven by cosmic rays which, in its turn, is modulated by the interaction of the Solar Wind with the Earth's geomagnetic field. Svensmark has proposed that this mechanism is responsible not only for the short-term changes in climate, but also for the long-term changes through-out the Earth's history (Svensmark & Calder, 2007). This is a splendid new theory.

### **(3) Solar Wind and Earth's rate of rotation**

Changes in Earth's rate of rotation due to Solar Wind changes is a novel concept (Mörner, 1995, 1996b, 2010; Gu, 1998; Mazzarella, 2008), but several authors have

noted a correlation between sunspot activity and Earth's rotation (e.g. Kalinin and Kiselev, 1976; Golovkov, 1983; Mazzarella and Palumbo, 1988; Rosen and Salstein, 2000; Abarca del Rio et al., 2003; Mazzarella, 2007, 2008; Mörner, 2010, Le Mouél et al., 2010) or Solar-planetary cycles and Earth's rotation (e.g. Scafetta, 2010). Due to the changes in rotation, the oceanic surface current system is forced to respond (Figure 1). As a function of this, the Gulf Stream alters its main distribution of water along the northern and southern branches, and simultaneously cold Arctic water can, at the speeding-up phases of Solar Minima, penetrate far down along the west coasts of Europe creating Little Ice Age environmental conditions (Figure 2).

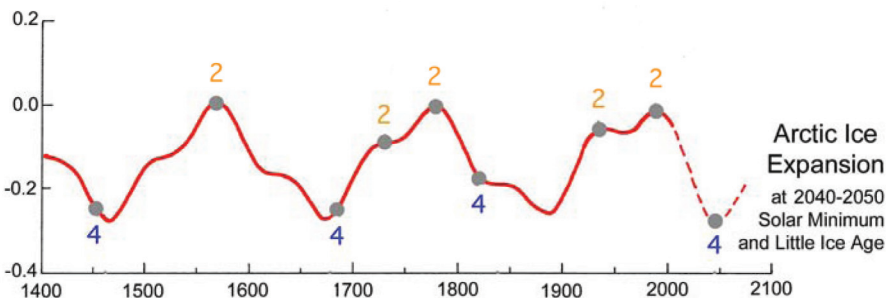
Alternatively, a planetary beat (cf. Mörner, 1984a) may act not only on the Sun causing its variations in time, but also directly on the Solar Wind interaction with the magnetosphere by magnetic torques and/or by gravitational forces on the Earth's rate of rotation (Scafetta, 2010). The correlation between the 60 years terrestrial LOD cycle and the 60 years cycle of changes in the orbital speed of the Sun around the centre of mass of the solar system (SCMSS) is striking (Scafetta, 2010, Fig 14). Whatever, it is the response in oceanic circulation that generates the changes in climate (Mörner, 1995, 1996b, 2010) illustrated in Figure 1 and 2.

#### (4) A combination of points (2) and (3)

Finally, there are all reasons to believe that mechanism 2 and 3 may interact and operate simultaneously.

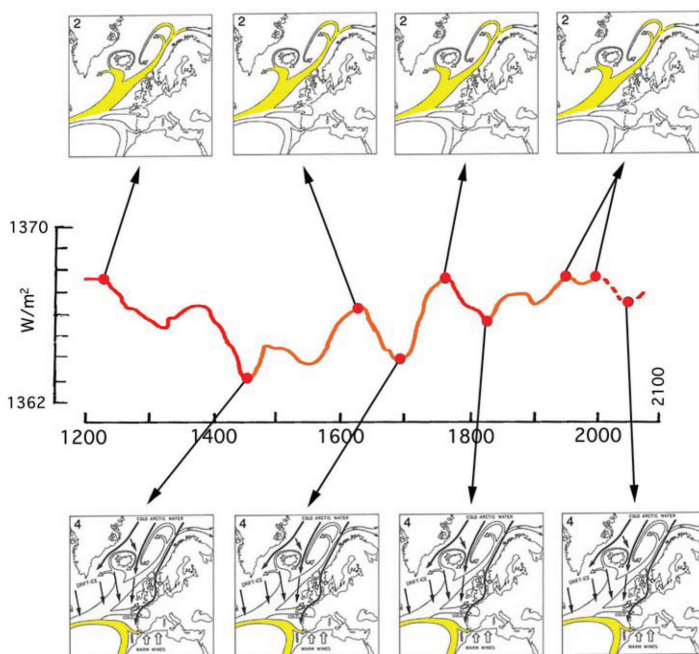
#### NEXT SOLAR MINIMUM

The Solar activity follows cyclic patterns, and can fairly easily be extended into the future. What happened in the past will also happen in the future. The combination of cycles can be done in different ways. Originally, we used a combination of the 60 year "Gleisberg" and 240 year De Vries cycles for the past 600 years and extended it into the Future giving a new Solar Minimum at around 2040-2050 as given in Figure 5 (Mörner et al., 2003; Mörner, 2003, 2006a, 2006b, 2007).



**Figure 5.** Cyclic phasing of the combined "Gleisberg" and De Vries Cycles over the last 600 years giving a new Solar Minimum at about 2040-2050 (from Mörner, 2006b). Vertical scale gives temperature in centigrade.





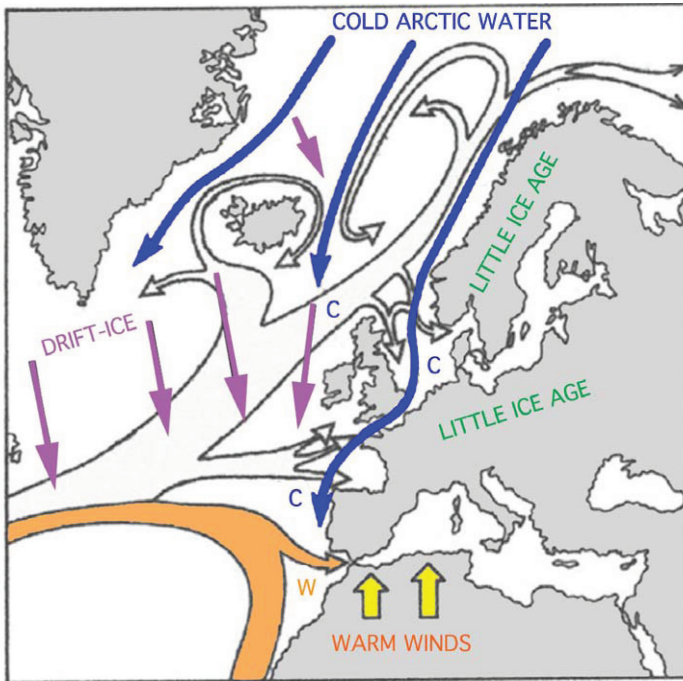
**Figure 6.** The main Solar cycle in the last 800 years and its expected extension into the future using the Solar Wind curve established from the atmospheric  $^{14}\text{C}$  (and  $^{10}\text{Be}$ ) variations. At the three past Solar Minima, NW Europe, the North Atlantic and the Arctic experienced cold phases known as “Little Ice Ages”. It should be noted that the seven maps of past ocean circulation changes are observationally based records. A new Solar Minimum is predicted at 2040-2050 with an expected return to Little Ice Age climatic conditions (from Mörner, 2010).

Later, I use the Solar Irradiance curve of Bard et al. (2000), noting that this curve, in fact, rather should be labelled “a Solar Wind Curve” as it is constructed from the variations in cosmogenic nuclides controlled by the variations in shielding capacity of the Earth’s geomagnetic field as given in Figure 4 (cf. Mörner, 2010). Along this curve (Figure 6) I have marked the changes recorded between Gulf Stream stages 2 (above) and 4 (below) situations as given in Figure 2 (cf. Mörner, 2010). In the middle of this century (at about 2040-2050), we should, by cycle extrapolation, have a Future Solar Minimum when the past Gulf Stream situation should repeat; i.e. we would have a new stage 4 situation with “Little Ice Age” conditions in Europe and in the Arctic (Figure 7).

This is in sharp contrast to the scenarios of IPCC (2001) and ACIA (2004), which predict a unidirectional continued warming leading to the opening of the Arctic basin within this century. Their prediction is based on modelling excluding the effects of the Sun, however.

Personally, I am convinced that we need to have “the Sun in the centre” (Mörner, 2006a, 2006b), and doing so, we are indeed facing a new Solar Minimum in the middle of this century. Whether this minimum will be as the past three once were (Figure 6), or it will be affected by anthropogenic factors, is another question.





**Figure 7.** At around 2040-2050 the extrapolated cyclic behaviour of the observed Solar variability predicts a new Solar Minimum with return to Little Ice Age climatic conditions.

The date of the New Solar Minimum has been assigned at around 2040 by Mörner et al. (2003), at 2030-2040 by Harrara (2010), at  $2042 \pm 11$  by Abdassamatov (2010) and at 2030-2040 by Scafetta (2010), implying a fairly congruent picture despite somewhat different ways of transferring past signals into future predictions.

The onset of the associated cooling has been given at 2010 by Easterbrook (2010) and Herrera (2010), and at “approximately 2014” by Abdassamatov (2010). Easterbrook (2010) backs up his claim that the cooling has already commenced by geological observations facts.

At any rate, from a Solar-Terrestrial point of view, we will, by the middle of this century, be in a New Solar Minimum and in a New Little Ice Age (Figure 7). This conclusion is completely opposite to the scenarios presented by IPCC (2001, 2007) as illustrated in Figure 3. With “the Sun in the centre”, no other conclusion can be drawn, however.

#### ACKNOWLEDGEMENTS

In the years 1997-2003, I headed an INTAS project on “Geomagnetism and Climate”. It was within this project that we lay the ground for the view on the Solar-Terrestrial interaction (presented at the EGU-AGU-EGS meeting in Nice, 2003), later developed and integrated in the way here presented.

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