

Sea ice extent in the subarctic North Atlantic ... current developments since 2015 and an AMO-based trend assessment

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Since February 2015, the author has been documenting the weekly 'floating' ice margins of the Arctic – more precisely, in the area between 30° west and 40° east, i.e. in the North Atlantic north of the Arctic Circle (Greenland Sea/Barents Sea). The distance between the ice edges and the geographic North Pole is recorded each week along the 10° meridians.

The data is based on the daily ice charts of the Canadian Meteorological Service (currently available at: https://weather.gc.ca/data/analysis/350_100.gif). The collected data is graphically processed at the IFHGK to visualize the changes over time.

The aim of this approach is not only to make general statements about the size of the ice surface, but also to show specifically in which regions the Arctic ice is spreading more or less. This makes it possible to track exactly where sea ice has receded or expanded over time. This, in turn, makes it possible to correlate the respective 'regional' temperature changes of water/SST and air/atmosphere with the actual changes in ice masses.

In February 2025, the project was exactly ten years old. During this time, a total of almost 5,000 values were measured on a weekly basis. In addition to the distance of the ice edges from the pole, changes in the speed of ice advance or retreat can also be shown over time.

Through continuous and comprehensive data collection, the author has gained a good understanding of the shifts in ice boundaries in the North Atlantic Arctic region. The detailed graphics show at a glance how the ice has moved from year to year. Typical patterns—such as winter expansions and summer retreats—are clearly visible in their spatial distribution, as are overarching trends.

While these evaluations provide the author with a fairly clear picture (see figures below), the topic is often only dealt with in general terms in the public perception, i.e., it is usually only presented in a comprehensive manner as "the" Arctic. To obtain an initial spontaneous comparison, on May 4, 2025, the author tentatively asked ChatGPT how sea ice extent in the North Atlantic Arctic region had developed since 2015. The boundary condition of the query was that the AI had to rely primarily on scientific data from NOAA or NSIDC (*). The answer was:

„Since 2015, sea ice extent in the North Atlantic Arctic has been declining significantly, as evidenced by scientific data from the National Snow and Ice Data Center (NSIDC) and the National Oceanic and Atmospheric Administration (NOAA).

In 2015, Arctic sea ice extent reached its annual low of 4.43 million km² on September 9. Since then, annual minimum values have tended to decline further. In 2024, the low was 4.28 million km² on September 11, which is the seventh lowest value in satellite records.

The long-term trend shows a decline in sea ice extent of about 12.4% per decade compared to the 1981–2010 average. The last 18 years (2007–2024) have seen the

lowest annual minimum values in satellite records, indicating a progressive decline in sea ice (nsidc.org+1climate.gov+1).

This decline in sea ice has far-reaching implications for the Arctic ecosystem and global climate. The reduction in sea ice cover affects the habitats of animals such as polar bears and seals and contributes to the acceleration of climate change, as less sunlight is reflected and more heat is absorbed by the ocean.

In summary, it can be said that sea ice extent in the North Atlantic Arctic has been steadily declining since 2015, as scientifically proven by data from the NSIDC and NOAA."

(* according to ChatGPT, see 'Sources')

Now, it's not rocket science to look up the relevant ice data yourself without ChatGPT's "servant." Unfortunately, however, the results of this research are not very encouraging for so-called AI. The simple reason for this is that ChatGPT apparently selects and evaluates sources selectively. To put it another way, and more pointedly or succinctly: Unfortunately, ChatGPT cannot be trusted on this topic.

The original values from NOAA (see Fig. 1) show that between 2015 and 2025, the annual average sea ice area actually increased. And this is not only in the North Atlantic region (we will come back to this later), but in the Arctic as a whole:

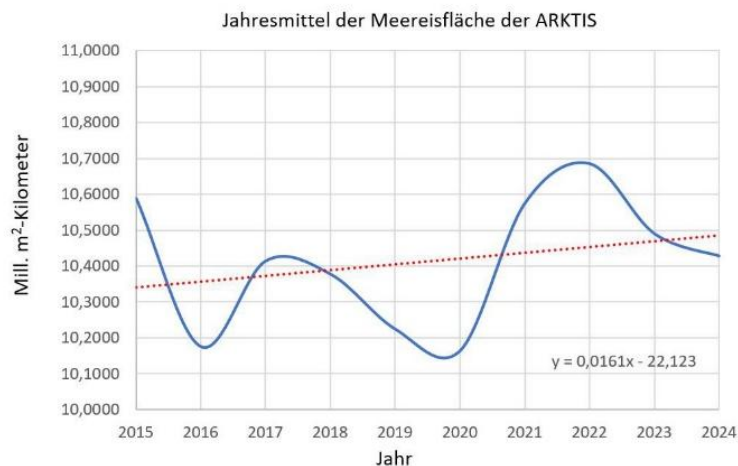


Fig. 1: Sea ice extent (data from NCEI / NOAA , <https://www.ncei.noaa.gov/access/monitoring/snow-and-ice-extent/sea-ice/N/0>)

Our own evaluations of the ice edge locations, which, as mentioned above, were carried out by measuring the ice boundaries at longitudes 30W to 40E on a weekly basis, also show a different development than that presented by ChatGPT (according to NSIDC/NOAA!?) when summarized graphically (Fig. 2):

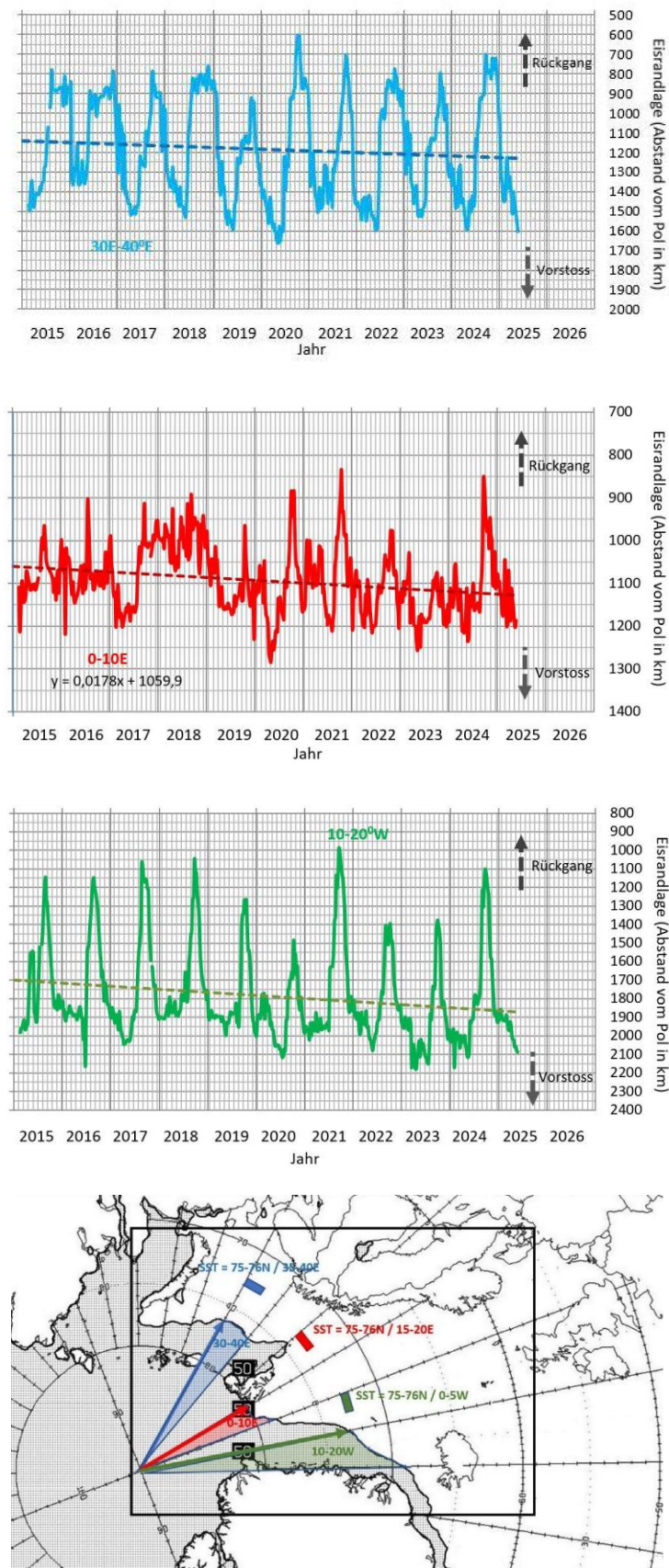


Fig. 2: Ice edge locations in the Arctic North Atlantic between 30W and 40E
 (Map analysis according to ENVIROMENT CANADA, ANALYSIS ICE COVERAGE
https://weather.gc.ca/mainmenu/modelling_menu_e.html)

The fact is: All ice edges have been advancing southward since 2015. Not really dramatic, but clearly visible. And there is no sign of a retreat in the ice boundaries on any of the profile lines... which leads to the conclusion that, at least in the North Atlantic, there can have been no decrease in ice cover at these points/areas. Of course, there remains some uncertainty, as a 'profile' is only a line and does not represent an area.

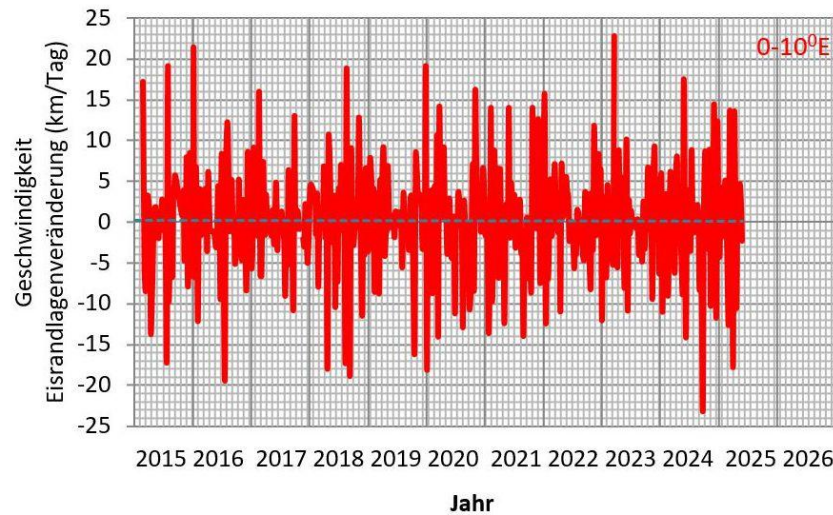
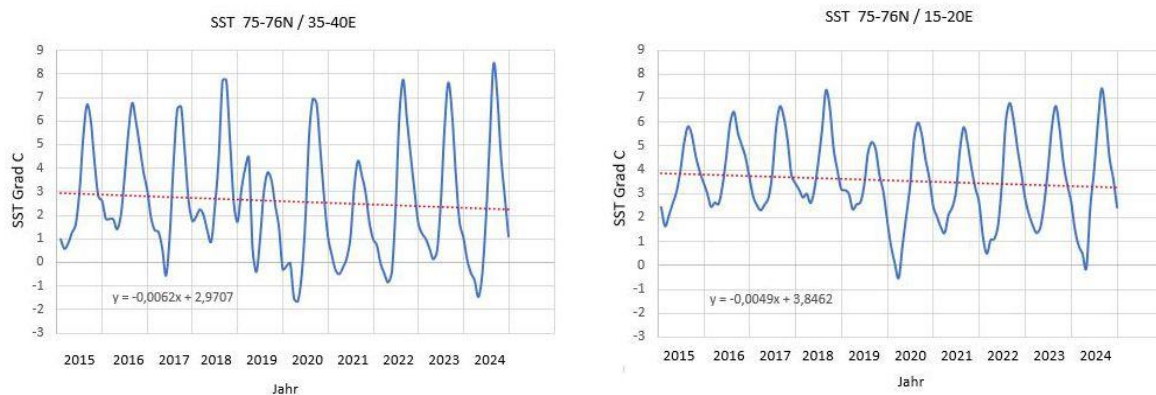


Fig. 3: Ice margin change rate, range 0-10E

The speed at which the ice margins 'move' over time has remained virtually unchanged since 2015, with no discernible trend in any of the meridians.

The water temperatures determined from the ERSST data (see Fig. 4 for ranges) have changed/decreased since 2015 in a manner analogous to that of the ice boundaries. This means that the trend toward meridional ice boundaries, which has been noticeable since at least 2015, reflects (as expected?) to a certain extent the changes in water temperatures in the subarctic North Atlantic:



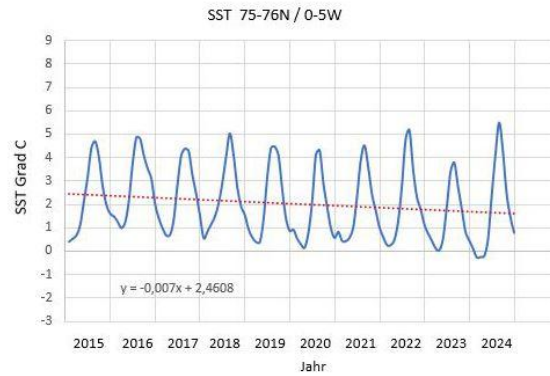


Fig. 4: Water temperatures/SST in the subarctic North Atlantic (data NOAA ERSSTV5 monthly mean, <https://psl.noaa.gov/data/atmoswrit/timeseries/index.html>, area basis see Fig. 2)

It is interesting to note that the decline in SST/water temperatures in the western part of the North Atlantic (75-76N/0-5W, Greenland Sea) is quantitatively and relatively more consistent than in the eastern region (75-76N/35-40E, Barents Sea), with the average changes mainly attributable to winter temperatures (see Fig. 5), while summer temperatures remain virtually unchanged.

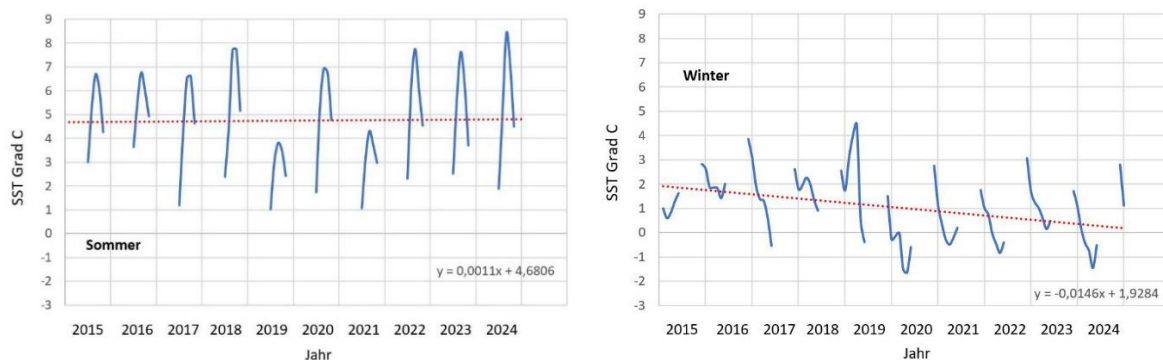


Fig. 5: Water temperatures / SST in the North Atlantic region at 75-76N/35-40E in the summer half-year (left) and in the winter half-year (right), data NOAA ERSSTV5 monthly mean

However, average air temperatures in the subarctic North Atlantic have also been falling since 2015:

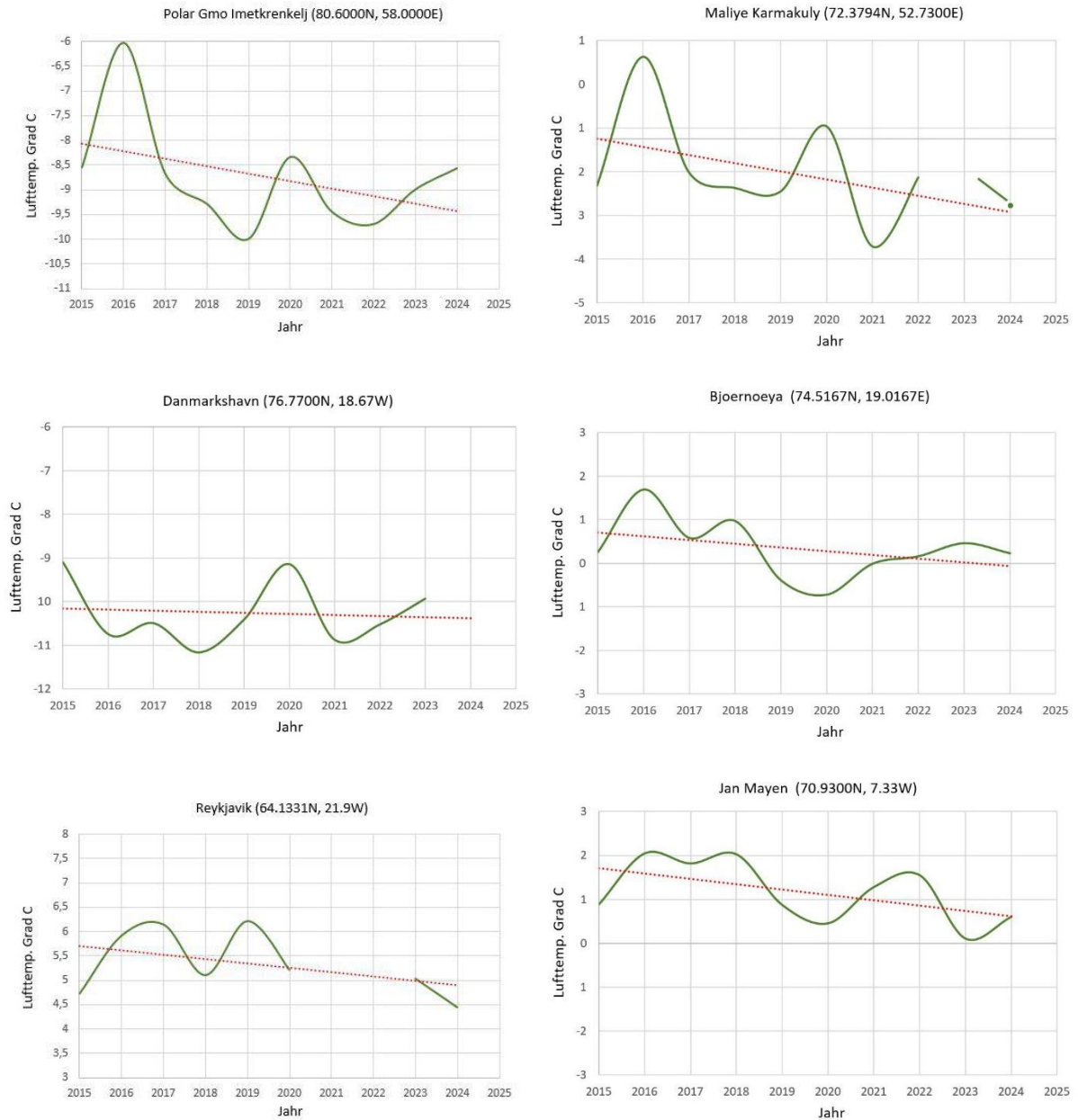


Fig. 6: Air temperatures in the North Atlantic, Iceland-Spitsbergen-Prince George Land region (NASA/GISS data from <https://data.giss.nasa.gov>)

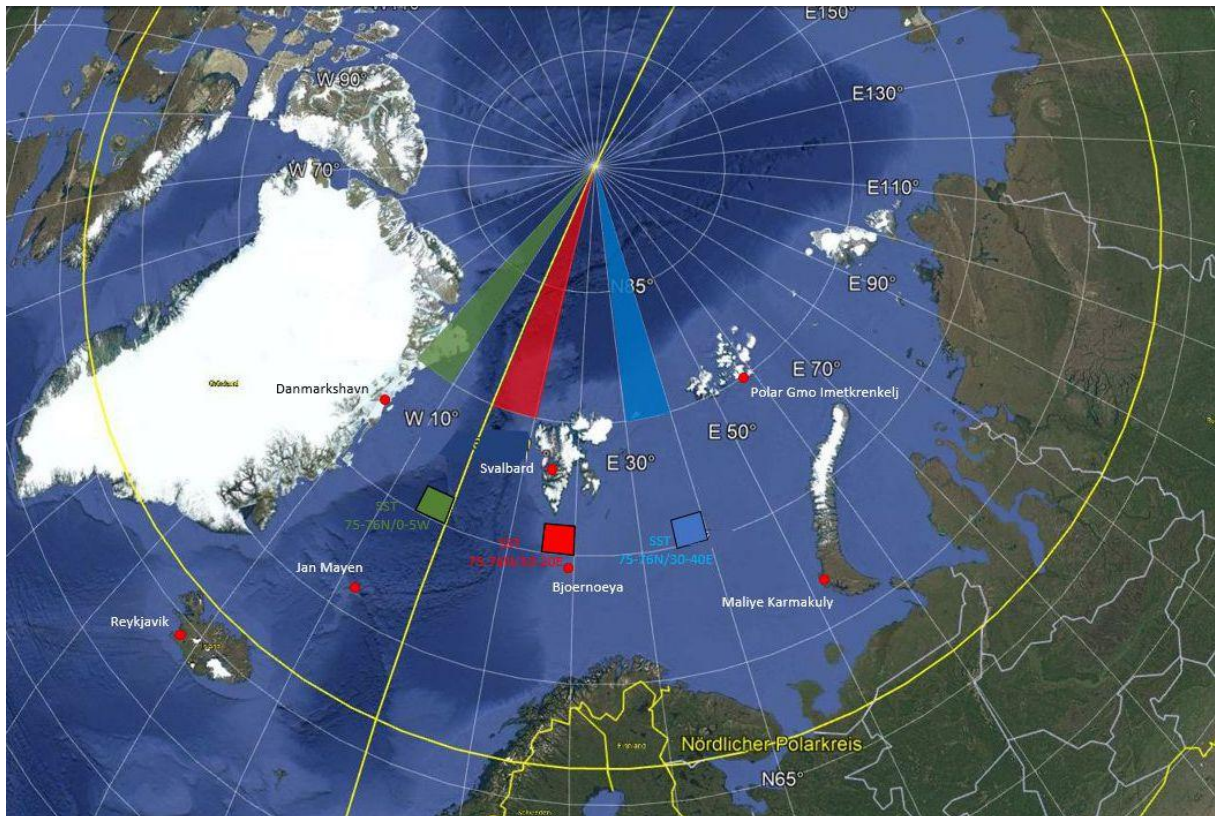


Fig. 7: Sectors of ice edge observations and stations or areas/stations of the SST and air temperature measurements used (map basis: Google Earth)

According to general ideas about global climate change, this should not be the case. ChatGPT says:

"Over the past decade (2015–2025), air temperatures in both the Arctic and the northern North Atlantic have changed significantly.

Arctic air temperatures (60°–90° N)

The Arctic has been warming faster than the global average for decades – a phenomenon known as “Arctic amplification.” Since 1980, temperatures in the Arctic have been rising about three times faster than globally (NOAA Arctic+1NOAA Arctic+1)

- 2023: Was the sixth warmest year since records began in 1900, with an average annual temperature of about -7°C . The summer of 2023 was the hottest on record, with an average temperature of 6.4°C (2noaa.gov+2NOAA Arctic+2)
- 2024: Was the second warmest year since 1900, with a temperature deviation of $+1.20^{\circ}\text{C}$ from the 1991–2020 average (NOAA Arctic+7NOAA Arctic+7NOAA Arctic+7)

This warming is leading to an accelerated decline in sea ice, more frequent extreme weather events, and increased greenhouse gas emissions from thawing permafrost.

Air temperatures in the northern North Atlantic

The northern North Atlantic (especially the Barents Sea) shows similar warming trends to the Arctic, but with regional differences:

- 2023: Above-average temperatures were recorded in the Barents Sea in all seasons, with particularly large deviations in autumn 2022 and winter 2023 (NOAA Arctic)
- 2024: The warming trend continued, with autumn 2023 and summer 2024 being particularly warm (5NOAA Arctic+5NOAA Arctic+5)
This warming affects not only sea ice, but also ocean currents, weather conditions in Europe, and marine ecosystem habitats.

Conclusion

The last ten years have been marked by exceptional warming in the Arctic and the northern North Atlantic. These changes have profound implications for the climate, the environment, and human living conditions in the region.

The data that the author has requested for the above-mentioned stations for the period since 2015 shows the opposite of what ChatGPT says: air temperatures are actually falling significantly!

Let's get one thing straight at this point: the air temperatures of the North Atlantic show clear parallels to the respective 'local' SSTs. In order to better characterize this, the higher-level AMO index is usually used... it is calculated exclusively from the (total) Atlantic SSTs.

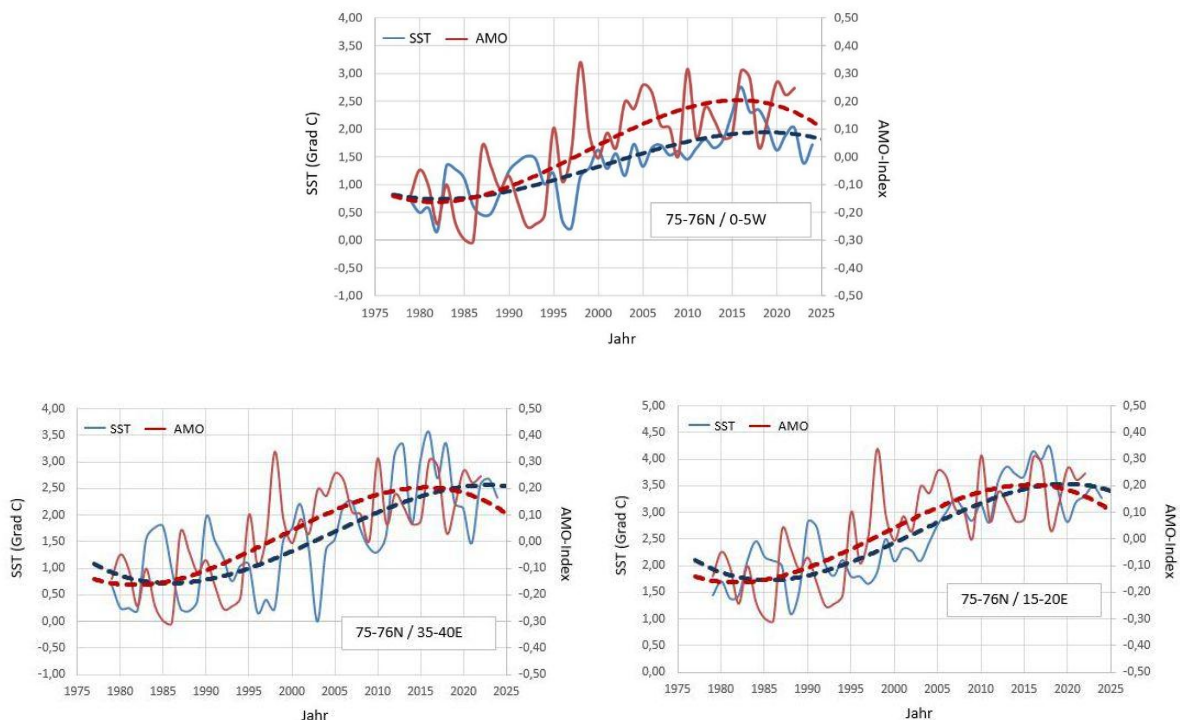


Fig. 8: Water temperature and AMO index since 1979 (see Fig. 7 for ranges, AMO data from <https://psl.noaa.gov/data/correlation/amon.us.long.data>)

The example of Iceland (Reykjavik), but also other stations (see Fig. 9), clearly shows how close the relationship between SST/AMO and air temperatures actually is. Although the correlation with the AMO is not equally strong in all subarctic regions, the six stations selected as 'representative' show

how comparatively close (in the North Atlantic) the AMO oscillation/Atlantic SST is to the course/development of air temperatures here:

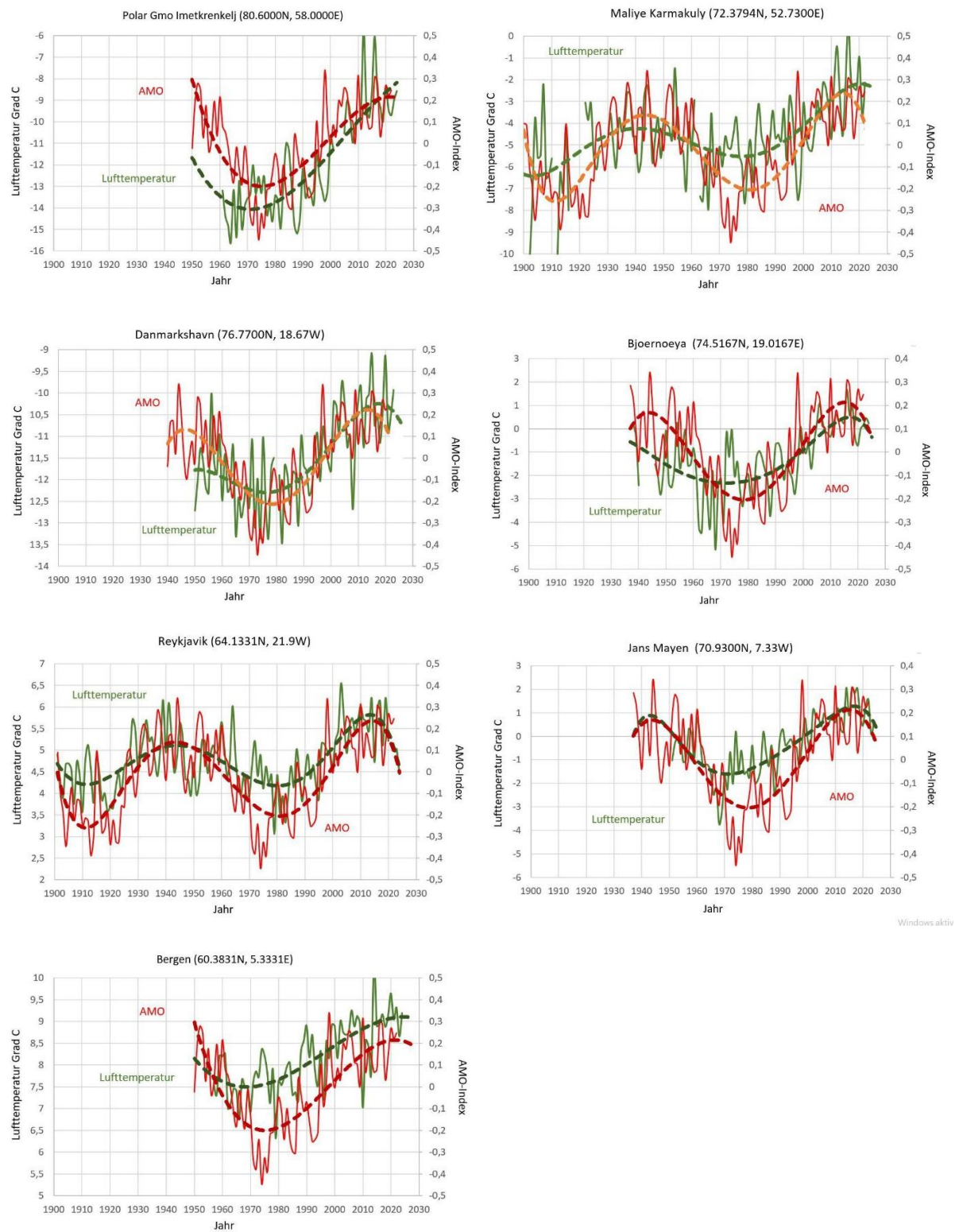


Fig. 9: Air temperature trend (recording series of varying lengths depending on station) and AMO index since 1900 (or earlier/later), various stations in the North Atlantic region and its subarctic eastern region (data from GISS and NOAA, see above)

It is important to note that the AMO is cyclical! This fact is undisputed, and the 'oscillation' will most likely repeat itself in the coming decades. Over the centuries, the frequency has been approximately between 50 and 70 years. Since the AMO has probably already reached a relative maximum again (or will probably reach it in the next 3 years), it should be assumed that (as a logical conclusion, since the AMO is calculated from the SST!) there will then be a relative decrease in water temperatures in the subpolar North Atlantic.

This assumption is not invalidated by the fact that a further increase in CO₂ could cause global temperatures to rise. For if this were/should be the case, the cyclicity of the AMO/SST would STILL remain intact and would at most increase slightly in amplitude due to a further 'underlying' rise in temperature, so to speak... but with almost certainty not completely cancel it out (see trend in Fig. 10).

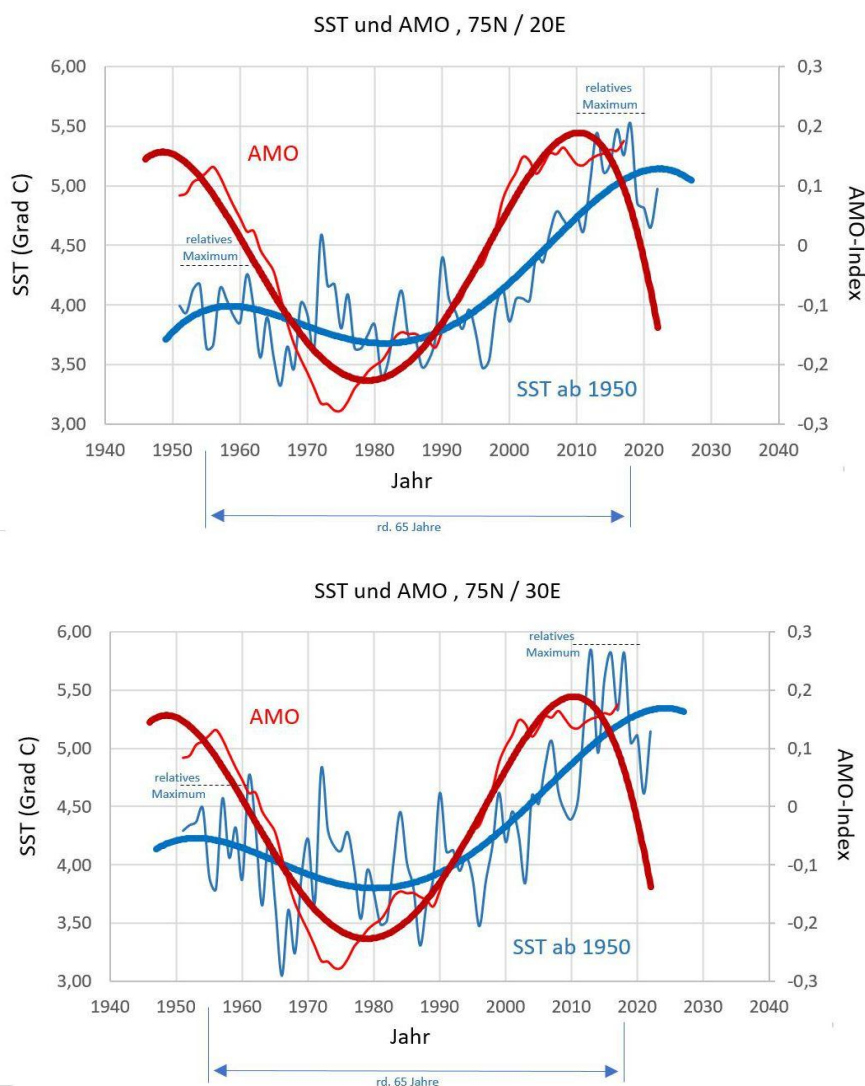


Fig. 10: SST from 1950 onwards (calculated by NOAA until 1979, thereafter ERSST-5 data, see Fig. 8)

And this trend is already evident in the data from Arctic and sub-Arctic stations in the North Atlantic (see Fig. 6). WHY these temperatures are beginning to decline is not clear at this point... in any case,

it contradicts the common perception of 'global warming' and the (see ChatGPT) above-mentioned theory of 'arctic amplification'.

However, there is one possible explanation: cloud cover in the area south of Spitsbergen (75N/10E, 75N/20E, and 75N/30E) exhibits an "oscillation" between 1984 and 2024 (see Figs. 11-12). The NASA source used for this, <https://power.larc.nasa.gov/data-access-viewer/> (MERRA-2), allows for a differentiated query of defined areas with monthly resolution of the "cloud amount." Even if the data quality before 2002 is apparently not entirely consistent (spread?), the picture that emerges from 2002 onwards still reveals an interesting correlation between the AMO (i.e., roughly the SST) and cloud cover.

This means that it can be speculated whether here too (1) cloud cover in the subarctic region could be a relevant factor for the development/change in temperatures (and thus possibly also for the ice edge locations).

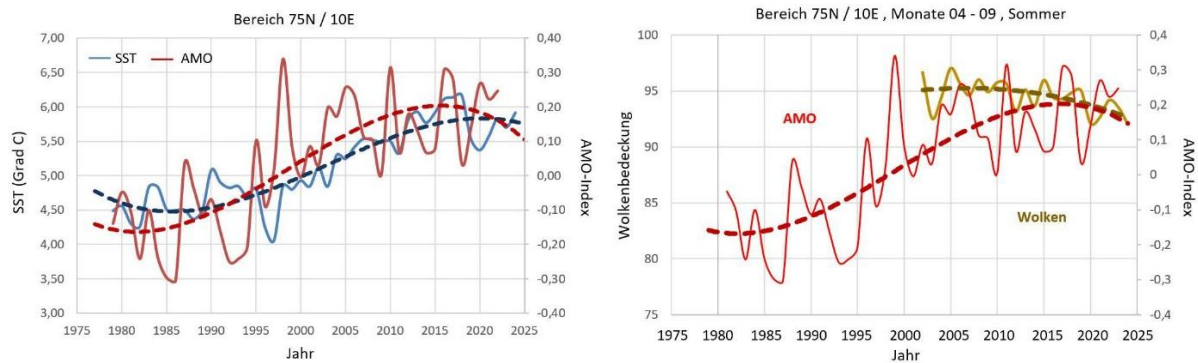


Fig. 11: AMO and SST (year-round, SST at 75N / 10E) and cloud cover (summer months at 75N / 10E)

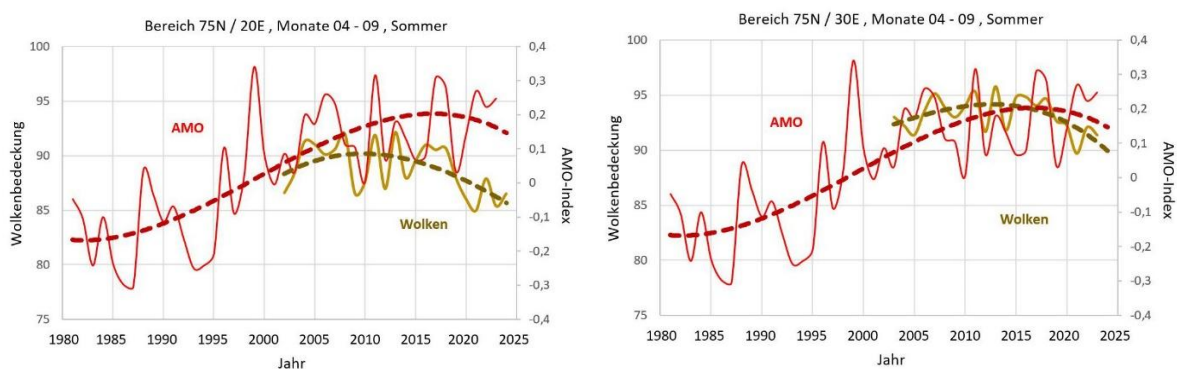


Fig. 12: Cloud cover at 75N / 20E (left) and 75N / 30E (right), summer months, cloud amount data from NOAA MERRA-2 and AMO values

Conclusion:

What numerical atmospheric models claim to be able to predict (namely, the "future of the climate") can, in the author's opinion, also be achieved (at least in part) as an ex-post forecast using real documented data series. The text uses an approach that represents the actual quantitative 'trajectories' of the past (AMO) ... and from this alone, in combination with the SST, cyclical probabilities can be derived. Since we have learned a great deal in recent years about the relationship patterns between Atlantic temperature changes (SST/AMO) and European climate processes, such a

'probability' approach is roughly permissible, even if a statistical evaluation is still pending in the present process structure.

It is fair to say that we know nothing about the future, but we can guess which paths will lead there!

There has never been and never will be absolute certainty about future developments, but there is clearly a probability of a downward trend in both Arctic water temperatures (AMO) and subarctic-North Atlantic air temperatures.

It can therefore be assumed that the ice boundaries shown in Fig. 2 will also continue to shift southward on average (!) in the coming years. Whether and when this could (once again) have a negative impact on the usability of the Northeast Passage (2) remains to be seen.

(1) See for Central Europe:

Lüdecke H.-J., Müller-Plath, G. & Lüning, S. (2024): Central-European sunshine hours, relationship with the Atlantic Multidecadal Oscillation and forecast. In: Scientific Reports (2024) 14:25152
,<https://doi.org/10.1038/s41598-024-73506-5>

(2) The 'Northeast Passage' runs along the coast of Russia, from the Barents Sea in the west to the Bering Sea in the east, and enables shipping traffic across the Arctic Ocean.