Stockholm University

Department of Meteorology

Climate and the general circulation (MO7021)

The Arctic Climate

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Contents

1 Introduction **2**

1.1 Background - The Arctic region 2

2 Data and Methods **3**

3 A brief overview of the regional climate **7**

3.1 Things to write bout 8

4 Regional Climate and the General Circulation **8**

5 Climate Changes: Ongoing and Projected for the Future **8**

6 The Climate Impact on Societal Activities **8**

7 Conclusion **8**

1 Introduction

The Arctic and the Antarctic are two unique regions on Earth that are characterized by extreme cold temperatures, vast ice sheets, and unique ecosystems. The Arctic is located in the Northern Hemisphere and is centred around the North Pole. In this report, we will discuss the climate in the High Arctic together with the island of Greenland to develop a deeper understanding of how this region is affected by the general circulation, climate change, and social activities in the region. This will be done using articles and books on the topic together with reanalysed data from the region.

1.1 Background - The Arctic region

When dealing with the Arctic, it is important to define the region. The Arctic is commonly defined as the area north of the Arctic Circle, which is located at 66°33" N latitude [National Snow and Ice Data Center, 2026, Serreze and Barry, 2014]. However, others define the Arctic based on the extent of the Arctic ecosystem, which requires a July mean temperature under 10°[National Snow and Ice Data Center, 2026]. Using this definition, the Arctic can be divided into two main sub-regions, including the Arctic maritime region and the Arctic continental region according to National Snow and Ice Data Center [2026]. The important geographical locations mentioned in this report can be seen in Figure 1

The Arctic maritime region includes the Arctic Ocean and its surrounding seas such as the Bering and Greenland Seas, as well as the Labrador Sea and Baffin Bay. This region is sometimes described as a Mediterranean-type ocean due to its limited connection to the Atlantic Ocean and the Pacific Ocean [Danilov, 2000]. Looking at the bathymetry of the Arctic Ocean, one can observe that the Bering Strait, but also the Canadian Archipelago and the Barents Sea, are shallow with depths of hundreds of meters. Comparing this with the Fram Strait between Svalbard and Greenland, it is much deeper, allowing a bottleneck water flow between the Arctic and the Atlantic [Jakobsson et al., 2003]. Thus, it is very reasonable to view this ocean as a semi-isolated ocean, just like the Mediterranean.

The Arctic continental region consists of places like Svalbard, northern Canada, Russia, and the Nordic countries. However, the main landmass is Greenland, covering a large area of the Arctic. The Arctic is often split into the Low and High Arctic to distinguish between the more forested regions and the tundra up north [Bliss, 1997]. The landmass of Greenland is thus characterized by a tundra landscape, although along the northern coast it becomes more suitable to talk about a polar desert due to the lack of moisture [Charlier, 1969]. Furthermore, only 2–3% of the polar desert experiences some type of vegetation during the summer months [Bliss, 1997].

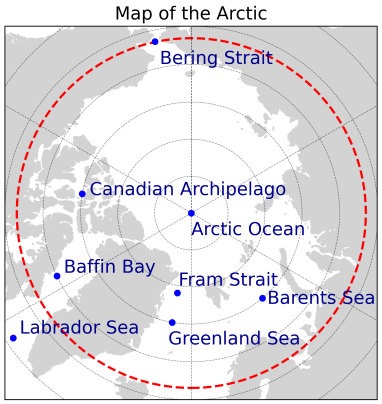


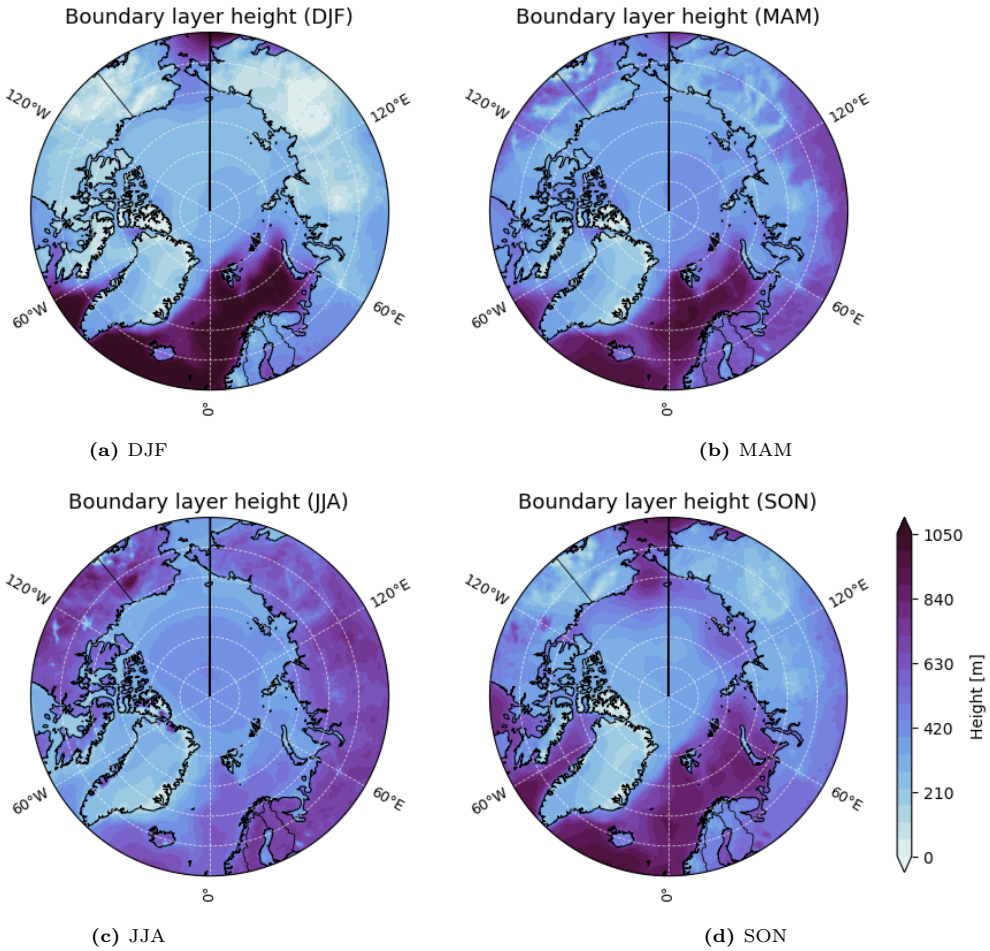
Figure 1: Arctic map showing the Arctic Circle (red dashed line) and some key locations mentioned in the text (marked as blue dots).

When describing the Greenlandic landmass, one can use the categorization developed by Wladimir Köppen [1884] to categorize the terrain. Köppen divided the world's landmasses into five main climate groups: tropical (A), arid (B), temperate (C), continental (D), and polar (E). Furthermore, each subgroup could be divided into more groups depending on precipitation and later on temperature. Due to the constantly cold nature of the Greenlandic landmass, the region was only divided into two main groups: the tundra (ET) and the ice cap (EF).

The Arctic ice cap is an important concept for understanding the Arctic region due to its high albedo and effect on the region. The ice cover in the Arctic is referred to as the cryosphere. On Greenland, the ice cap covers $1759\,\mathrm{km}^2$, which is about 81% of the total area [Serreze and Barry, 2014]. Arctic sea ice also plays a very important role in the region, as it turns the ocean into a land-like state. Furthermore, the melting and freezing of the ice are directly coupled with the atmospheric circulation and energy budget, as it ranges from $15 \times 10^6\,\mathrm{km}^2$ in March to $5 \times 10^6\,\mathrm{km}^2$ in September [Serreze and Barry, 2014]. The extent of the sea ice cover is determined by nearby landmasses, the inflow of warmer water through the Fram Strait, and drainage from large river systems such as the Mackenzie, Lena, Yenisey, and Ob [Serreze and Barry, 2014]. The rivers, together with the inflow of fresh water from the Pacific (freshness being a product of many river drainages in the region) and the region experiencing more precipitation than evaporation, lead to a low saline content, creating ideal conditions for ice formation. The sea ice is constantly in motion due to the Beaufort Gyre and Transpolar Drift, which transport the ice shelves, with some ice being transported through the Fram Strait. From there, the East Greenland Current carries cold Arctic water and sea ice into the North Atlantic, where it eventually melts.

2 Data and Methods

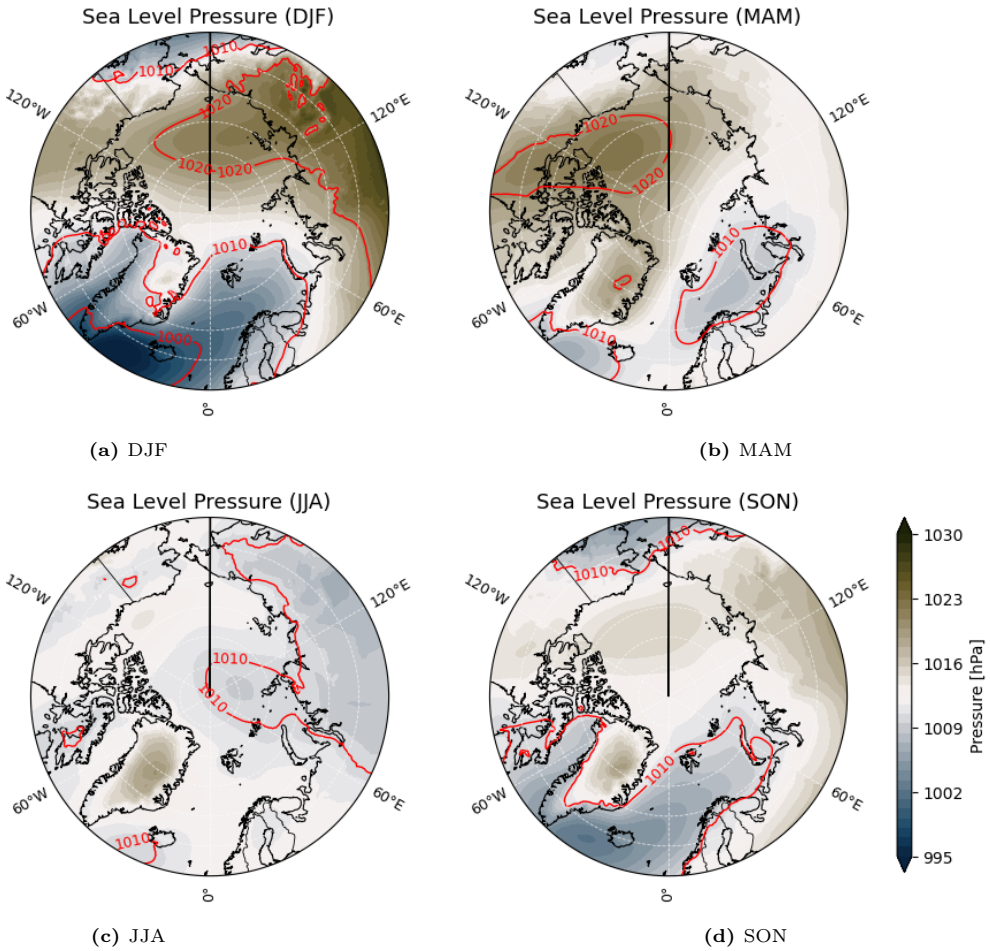
describe through which observations or techniques the data is constructed, as well as the methods you have used to analyse and present the data graphically. Here, it is important to discuss the reliability and limitations of the data as well as the analyses you have used.



(a) DJF **(b)** MAM

(c) JJA **(d)** SON

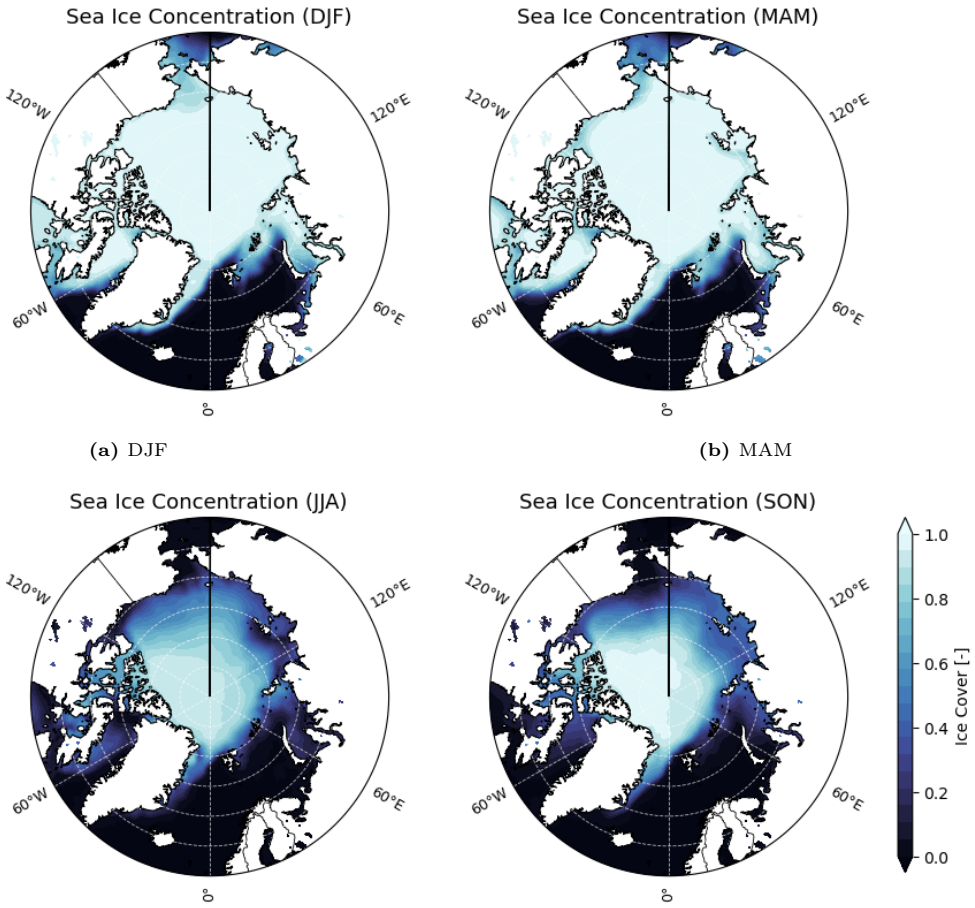
Figure 2: Seasonal mean boundary layer height (m) for 2012–2021 for DJF, MAM, JJA, and SON.



(a) DJF **(b)** MAM

(c) JJA **(d)** SON

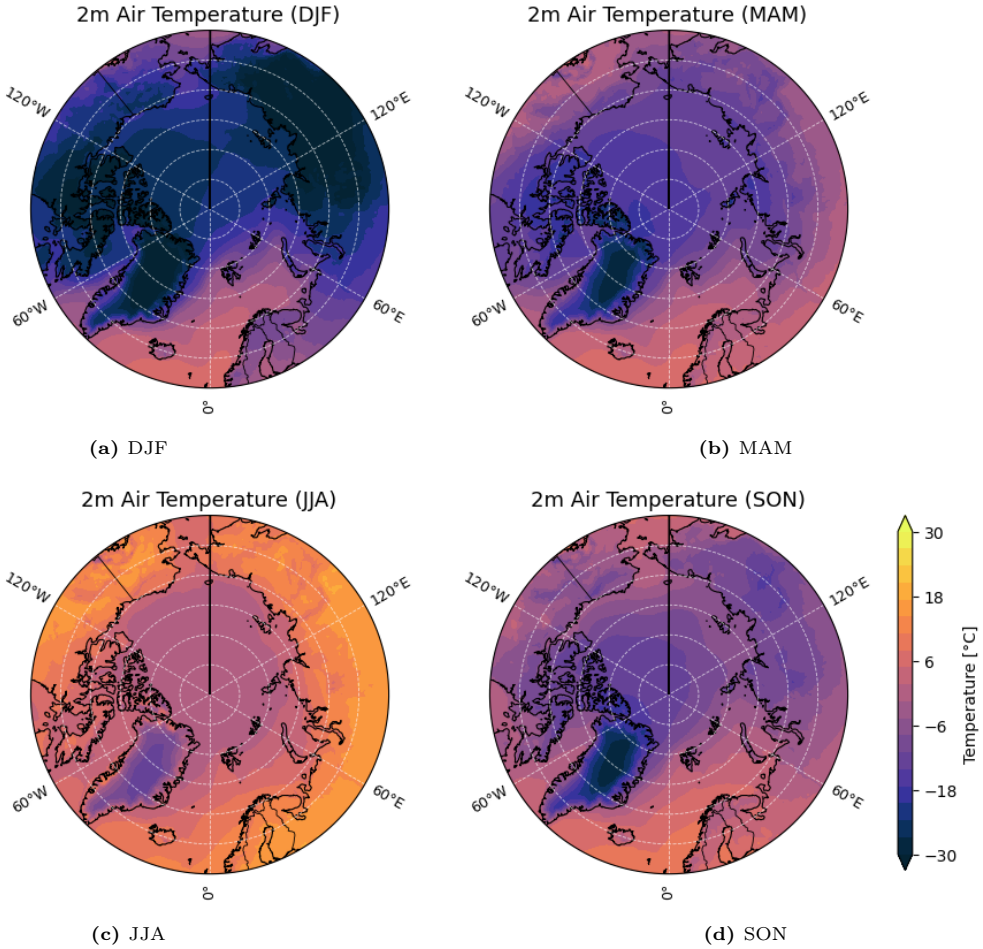
Figure 3: Seasonal mean sea level pressure (hPa) for 2012–2021 for DJF, MAM, JJA, and SON.



(a) DJF **(b)** MAM

(c) JJA **(d)** SON

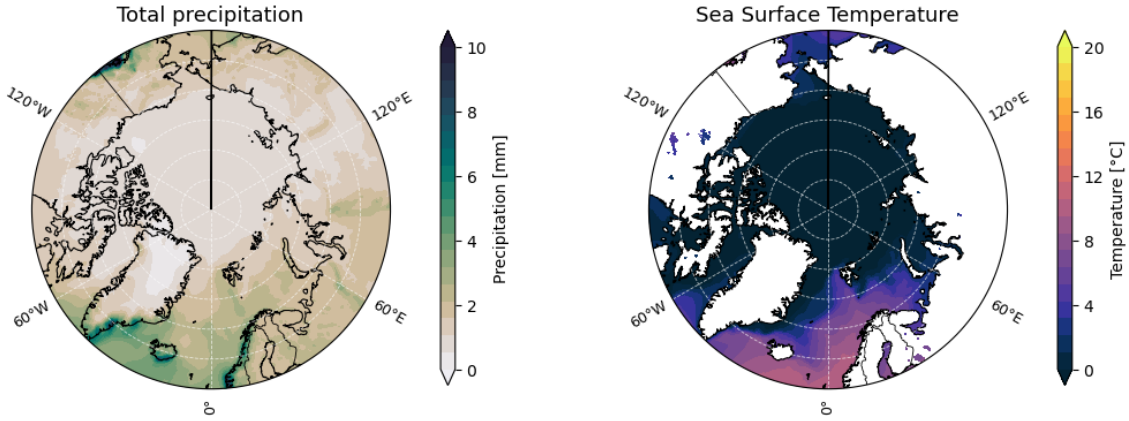
Figure 4: Seasonal mean sea ice concentration (-) for 2012–2021 for DJF, MAM, JJA, and SON.



(a) DJF **(b)** MAM

(c) JJA **(d)** SON

Figure 5: Seasonal mean 2m air temperature (°C) for 2012–2021 for DJF, MAM, JJA, and SON.



(a) Total Precipitation **(b)** Sea Surface Temperature

Figure 6: Annual mean total precipitation and sea surface temperature for 2012–2021.

3 A brief overview of the regional climate

Sea ice: part of the the hydrological cycle Maximum sea ice extent during the spring. Maximum during the spring equanox nad minimum autumn equanox.

3.1 Things to write bout

1. Köppen characteristics
2. Cryosphere
3. Geographical features, the atmospheric general circulation, regional weather patterns, and ocean currents
4. Based on the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (available online) account briefly for ongoing and future **climate change** in your study area
5. human society (ethical aspects)

4 Regional Climate and the General Circulation

5 Climate Changes: Ongoing and Projected for the Future

6 The Climate Impact on Societal Activities

7 Conclusion

References

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