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Comparison of Contemporary Bioclimatic Conditions in SW Greenland Against Conditions in the Second Half of the 18th Century

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The specificity of Greenland's geographical environment and lighting conditions (polar day and night) causes the climate system in this region to differ significantly from other areas on Earth. Polar regions experience conditions that are very harsh for human life.

The paper estimates the bioclimatic conditions in the region of the modern-day capital of Greenland (i.e., Nuuk, formerly known as Godthåb or Neu-Herrnhut) in the second half of the 18th century. Nuuk is located in the SW coastal part of Greenland. Climate conditions at that time have already been analysed in a paper by Przybylak et al. (2024).

The present analysis was based on air temperature and wind speed data from sites of meteorological observations in this area, namely Neu-Herrnhut (1 September 1767 – 22 July 1768) and Godthåb (January 1790 – June 1792). The first series is the oldest available long-term series of instrumental measurements in the Arctic. Data for the year 1767/68 were obtained from the Moravian Archives in Herrnhut (Fig. 1). Thanks to this, it was possible to present the first bioclimatic conditions for humans in this region of the Arctic. The second series of meteorological measurements covers the period from January 1784 to July 1792, but, for the first years, wind speed measurements are either lacking or of low quality. Therefore, based on available data from this period, it is possible to calculate biometeorological indices only for the period 1790–1792. Data from this period were found in The Royal Library in Copenhagen in the manuscript *Astronomiske og Meteorologisk Iagttagelser, Anstillede i Godthaab i Grønland 1782–1792* (Fig. 1).

In the study, two biometeorological indices: Wind Chill Temperature (WCT) and Predicted Clothing Insulation (Iclp) have been used (Błażejczyk and Kunert 2011). These indices were computed using the BioKlima 2.6 software program (BioKlima 2024). Wind Chill Temperature (in °C) was used to examine apparent cold and to assess the risk of frostbite to the human body

in Nuuk. The risk of frostbite according to WCT is as follows: low risk (0 to –9 °C), moderate risk (–10 to –27 °C), high risk (–28 to –39 °C), very high risk (–40 to –47 °C), severe risk (–48 to –54 °C) and extreme risk (–55 °C and colder) (WCT 2013). The predicted thermal insulation of clothing allows for the determination of the thermal insulation needed in given meteorological conditions to maintain the thermal balance of the body (Błażejczyk and Kunert 2011). Iclp was calculated assuming a metabolism of 135 W m^{-2} for a person moving outdoors at 4 km h^{-1}. With reference to the value of the Iclp index (in clo), the thermal environment assessment scale proposed by Krawczyk (2000) may be used: ≤ 0.30 very warm, 0.31–0.80 warm, 0.81–1.20 neutral, 1.21–2.00 cool, 2.01–3.00 cold, 3.01–4.00 very cold, > 4.00 arctic. Calculations of bioclimatic conditions were made for the hours 2–3 pm LT. The results from the historical period from the second half of the 18th century were compared with those for the contemporary period (1991–2000).

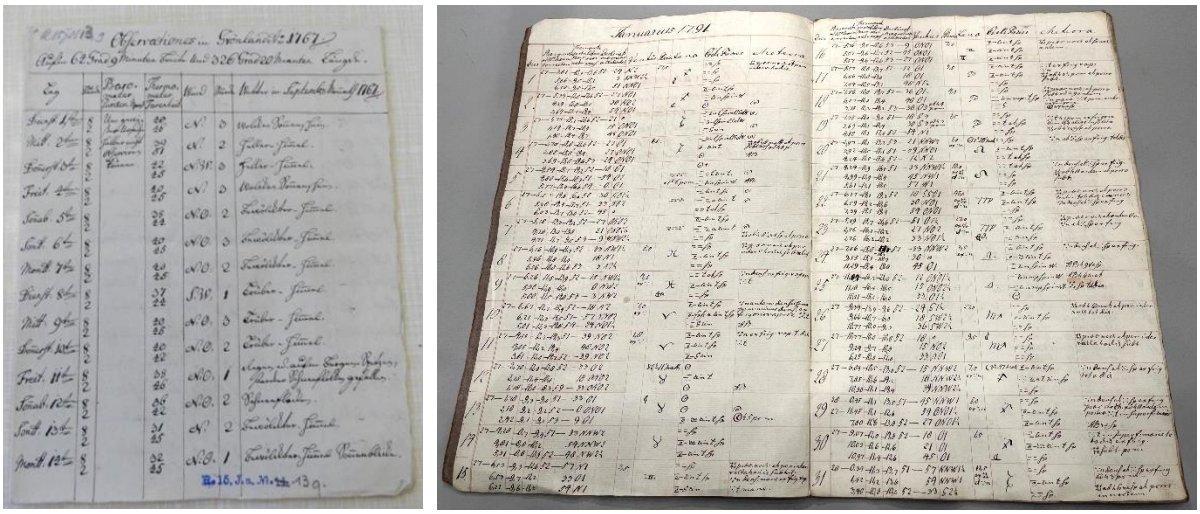

Fig. 1. Examples of manuscripts presenting meteorological observations: (photo on the left) for Neu-Herrnhut (1 September 1767 to 22 July 1768), source – MH R.15 J.a.13.9; and (photo from the right) for Godthåb (1782–1792), source – *Astronomiske og Meteorologisk Iagttagelser, Anstillede i Godthaab i Grønland 1782–1792* (Det Kgl. Bibliotek in Copenhagen; data presented in the manuscript: January 1791).

In the contemporary period, the mean monthly WCT values ranged from –11.4 ÷ –10.5 °C (moderate risk frostbite) in January–March, to 7.9÷8.8 °C (low risk frostbite) in July–August. The average historical monthly values of the WCT are in most cases between extreme values from the contemporary period. In the years 1789–1790 and 1790–1791, there was a higher risk of frostbite than the average from the contemporary period, whereas in 1767–1768 and 1791–1792 the risk of frostbite was lower. In the analysed historical period, the lowest winter values of WCT fell below –30 °C. As a result of low air temperature and high wind speed, the risk of frostbite was very high, i.e. exposed skin could freeze in 10 to 30 minutes.

In the years 1991–2020 in Nuuk, clothing with high thermal insulation properties was necessary for humans to achieve thermal comfort in motion (at metabolism = 135 W m^{-2}). In the annual course, the average monthly Iclp values ranged from 1.3 clo in July and August to 2.4 clo in February. On the other hand, a person who is motionless, i.e. standing (at metabolism = 70 W m^{-2}), needs about 5 clo on average in the winter months. Analysing the historical period in the second half of the 18th century in the years 1789–1792, a person living here required very similar thermal insulation of clothing as today. The only difference noted was that the

weather in period 1767/1768 required, for a person in motion, about 0.3 clo less clothing than in the contemporary period.

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