



BASIC CLIMATE PARAMETERS IN DENMARK

Climate changes based on data from Danish Climate Atlas



Prepared for: Build

24.0058

March 23, 2026 – Revision 4



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Revisions

Revision no.	Date	Comments
4	March 23, 2026	Issued for comments



0 Summary and conclusion

The purpose of the present report is to investigate the influence of climate changes on the basic climate parameters of surface wind speed, temperature, ground snow load and atmospheric icing using the Danish Climate Atlas [1]. This estimation will be used to prepare the National Annexes of the coming Eurocodes on climatic actions and it will provide input on uncertainties originating from climate changes

0.1 Summary

The extreme value analysis has been carried out on the climate data including surface wind speed, temperature, and ground snow load which is provided by Danish Climate Atlas and produced by a combination of global and regional climate models. 50-year extreme values for maximum surface wind as well as maximum and minimum temperatures and ground snow load have been estimated by fitting the Gumbel distribution to the 1-year moving 50-year windows of the data. The evaluation of annual number of icing days during the future years, is also studied.

The results, derived for seven locations, indicate substantial divergence among the climate models, particularly for maximum surface wind speed. Individual models show different tendencies, and the averaging of results across models introduces considerable uncertainty. Therefore, although the projected 50-year averaged surface wind speed suggests no significant change over the next 100 years, this conclusion is associated with a high degree of uncertainty.

The extreme projected maximum temperature shows an increasing trend over the period from 2032 to 2100. However, this trend is more pronounced under the higher-emission scenario compared to lower emission scenarios. A similar pattern is observed for projected minimum temperatures, with higher emission scenarios indicating more substantial warming relative to the lower emission scenario.

The averaged projected 50-year extreme snow load across different models exhibits decreasing trends over the period of 2032 to 2100. However, there is significant deviations between the individual models. It is remarkable that the future extreme snow load does not depend much on the emission scenario.

The projected average annual number of icing days shows different trends across the emission scenarios. The most notable decline occurs under the high-emission scenario, likely due to the projected future temperature increases. This downward trend is less pronounced under the medium-emission scenario and is almost negligible under the low-emission scenario. However, substantial variability remains among the individual climate models (see Appendix A for details on the emission scenarios).

A frequent value analysis of the wind data from the Danish Climate Atlas has also been conducted. The results indicate that the frequent wind distribution is unlikely to be significantly affected by future climate changes.

It should be noted that the main focus of this report is the influence of climate changes, not on the absolute values of the climate parameters considered.



0.2 Conclusion

This study presents an extreme value analysis of future climate projections for Denmark, focusing on surface wind speed, temperature extremes and ground snow load based on data from the Danish Climate Atlas. The annual number of icing days is also studied over the future 100 years.

The findings highlight significant variability among climate models, particularly in projections of extreme wind speeds, which introduces considerable uncertainty into long-term estimates.

While the 50-year projected extreme wind speeds suggest no notable change over the next century, this result should be interpreted with caution due to model divergence.

Both maximum and minimum temperatures exhibit clear increasing trends, especially under higher-emission scenarios, with RCP 8.5 showing the most substantial warming. However, there are still large deviations among different models.

Projected extreme snow loads demonstrate a general decreasing trend, although this appears to be independent of emission scenarios and highly variable between models. The annual number of icing days also declines, most markedly under RCP 8.5, corresponding with rising temperatures, while trends are weaker or absent under lower-emission scenarios.

Lastly, analysis of frequent wind conditions suggests minimal change in future distributions, implying limited impact from climate change on average wind behavior. Overall, the results underline the importance of considering model uncertainty when interpreting projections, particularly for extreme events.

0.3 Limitations

The scope of the study includes synoptic winds. The risk of extreme winds originating from non-synoptical weather systems and tipping points, e.g. tornados and downbursts, has not been part of the scope.

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1 Introduction

Climate changes are reshaping weather patterns across the globe, driven by rising greenhouse gas emissions and warming temperatures. This global change is expected to influence local climate conditions in Denmark, including higher temperatures and less snowfall. Such changes can alter the climatic loads acting on buildings and other structures, particularly wind, snow, rain, and temperature extremes, posing challenges to current design codes. Understanding how these loads might evolve is essential for adapting construction standards and ensuring the long-term safety and resilience of both new and existing structures.

This report which is an update and continuation of [2], focuses on the analysis of maximum surface wind speed, maximum and minimum temperatures, ground snow load, and atmospheric icing. The projected evolution of these climate factors which will affect the environmental loadings on the buildings and other types of structures, are investigated using the forecasted data provided by DMI models.

2 Background

The data used in this study is provided by Danish Climate Atlas and it is based on observational data and models of the expected climate of the future [1]. Future climate data derived from these models was employed with primary focus on future climate changes; otherwise, direct measurements would have been considered. The extreme value analysis has been carried out on the maximum surface wind speed, ground snow load, as well as maximum and minimum temperatures from output of the combination of different global and regional climate models under different emission scenarios. Extreme value analysis methods are extensively described in Annex B. For atmospheric icing, the analysis focuses on the projected annual frequency of days that meet the meteorological criteria for icing events.

For each parameter, the largest annual values are selected in a 50-year moving window, and the yearly extremes are fitted to a Gumbel distribution. The fitted extreme distributions are used to estimate the maximum value with a 50-year return period for each 50-year window. By advancing the window 1-year in time, the temporal evolution of 50-year maximum values was determined. This approach enables characterization of future climatic changes based on the models covered by Danish Climate Atlas.

The global and regional climate models used to produce the data are listed in Annex A.

According to the definition informed by DMI, the term "daily surface wind" in Danish Climate Atlas refers to the average surface wind speed per day, while "daily maximum surface wind" denotes the daily maximum wind speed per time step in the models where the time average duration varies depending on the specific model (typically a few minutes). These surface winds are modelled at a height of 10 m above ground level.

3 Method description

The analysis in this report follows a structured process designed to transform raw climate projections into estimates of future climatic extremes. Climate data for surface wind speed, temperature, and ground snow load were obtained from the Danish Climate Atlas, covering seven locations in Denmark and three emission scenarios (RCP 2.6, RCP 4.5, and RCP 8.5).



Daily model outputs were first organized into annual series by selecting the relevant maximum or minimum values depending on the parameter considered. These annual values provided the basis for the extreme value analysis. A 50-year moving window was then applied to the annual series, and within each window the extremes were fitted to a Gumbel distribution to estimate return levels corresponding to a 50-year recurrence period. By advancing the window one year at a time, the temporal evolution of the estimated extremes could be assessed over the period 2024–2100.

In addition to the estimation of wind, temperature, and snow extremes, two further indicators were derived. The annual number of icing days was evaluated by counting days that satisfied the meteorological criteria for atmospheric icing, while the distribution of daily mean wind speeds was analyzed to investigate potential shifts in frequent wind conditions.

Finally, the results were evaluated both at the level of individual climate models and as multi-model averages. This dual approach allowed assessment of overall tendencies while also highlighting the variability and divergence among models, which represents a key source of uncertainty. The present section provides a general overview of the applied methodology, while detailed mathematical formulations of the extreme value analysis are given in Annex B.

3.1 Studied locations

The analyses in this report are based on simulated data from the model grid points covering a few selected locations as indicated in Table 3.1.

Table 3.1. Locations selected for analysis.

Location no.	Description
1	Lyngbyvej 100
2	Klitmøller
3	Aalborg Airport
4	Karup Airport
5	Billund
6	Roskilde Airport
7	Årslev

It should be noted that the surface roughness of the sites has not been informed in the in Danish Climate Atlas database.

4 Results – Extreme value analysis for wind velocity and temperature

The extreme value analysis of the 50-year windows of maximum surface wind speed and maximum and minimum daily temperature, has been carried out for seven locations listed in Table 3.1. Figure 4.1 and Figure 4.2 present the yearly extremes and Gumbel fit to the data at Lyngbyvej 100.

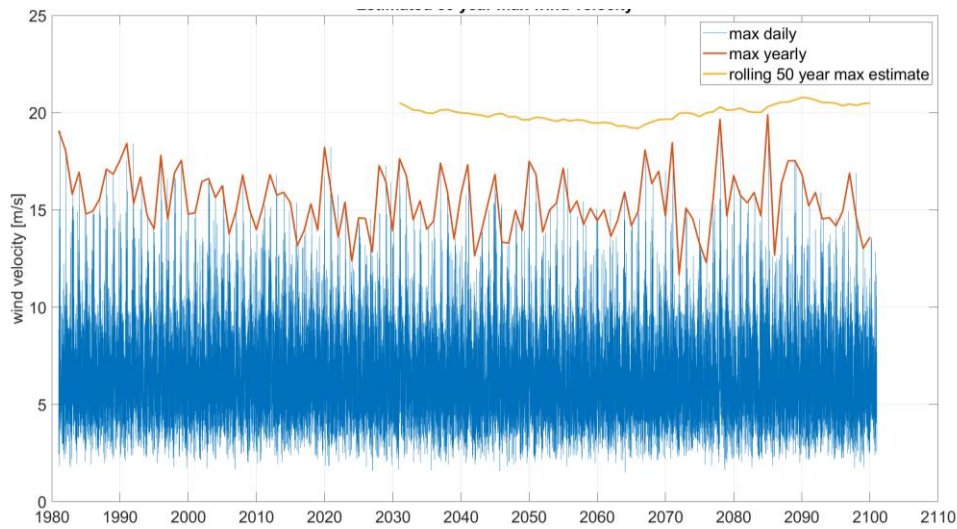


Figure 4.1. Annual maximum of the maximum surface wind from data produced by ICHEC-EC-EARTH global and KNMI-RACMO22E regional climate models at Lyngbyvej 100.

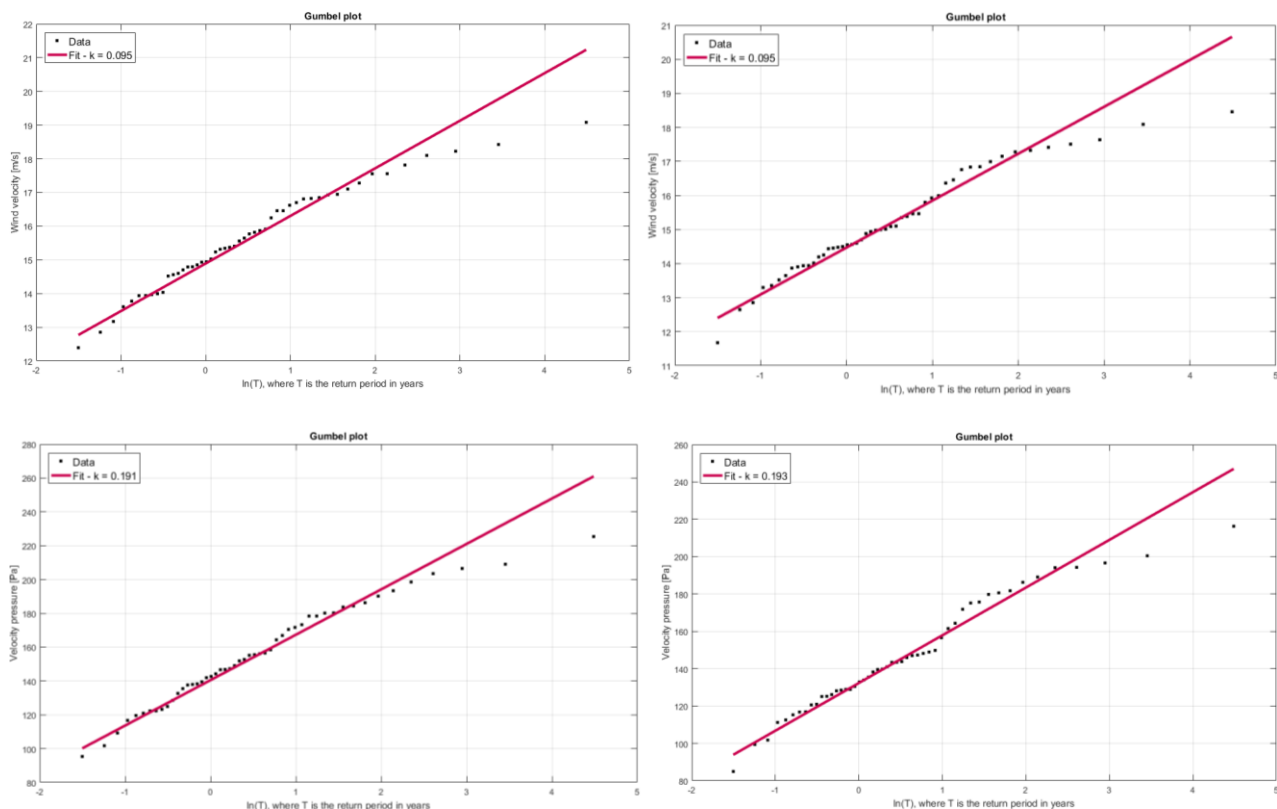


Figure 4.2. Fitting the Gumbel probability distribution function to the probability distribution function of the annual extremes of surface wind velocity (top) and velocity pressure (bottom) from data produced by ICHEC-EC-EARTH global and KNMI-RACMO22E regional climate models at Lyngbyvej 100 under the RCP 8.5 emission scenario. The extreme values shown, cover the periods 1981-2030 (left) and 2025-2074 (right).

The k factor in Figure 4.2 is estimated to be 0.095 for wind velocity, which is consistent with a K_q value of 0.19 (corresponding to a coefficient of variation of 0.23) for velocity pressure, as assumed



in the current Eurocode on wind actions. The shape parameter, K_q , which is described in Annex B, depends on coefficient of variation as follows:

$$COV = \frac{K_q \pi / \sqrt{6}}{1 + \gamma K_q}$$

Where $\gamma \cong 0.5772$ is Euler's constant.

Figure 4.2 indicates that the largest wind velocities and velocity pressures deviate from the fitted Gumbel distribution pattern. Figure 4.2 shows that the extreme velocity pressure values exhibit a slightly better fit to the Gumbel distribution compared to wind velocity, as also noted in Annex B.

The Gumbel fit to the measured wind data at DMI meteorological station at Jægersborg located at latitude: of 55.7664° and longitude of 12.5263° , is presented in Figure 4.3. The Jægersborg station is situated approximately 6 km northeast of Lyngbyvej 100. Comparison of Figure 4.2 and Figure 4.3 shows that the Gumbel distribution fits the measurements better than the projected datasets. Extreme values displayed in Figure 4.3 are the measured values of the site and no conversion to basic condition has been carried out. Thus, these measured values reflect the actual site-specific conditions of roughness and orography at the stations, rather than the standardized basic conditions of 5 cm roughness and flat terrain.

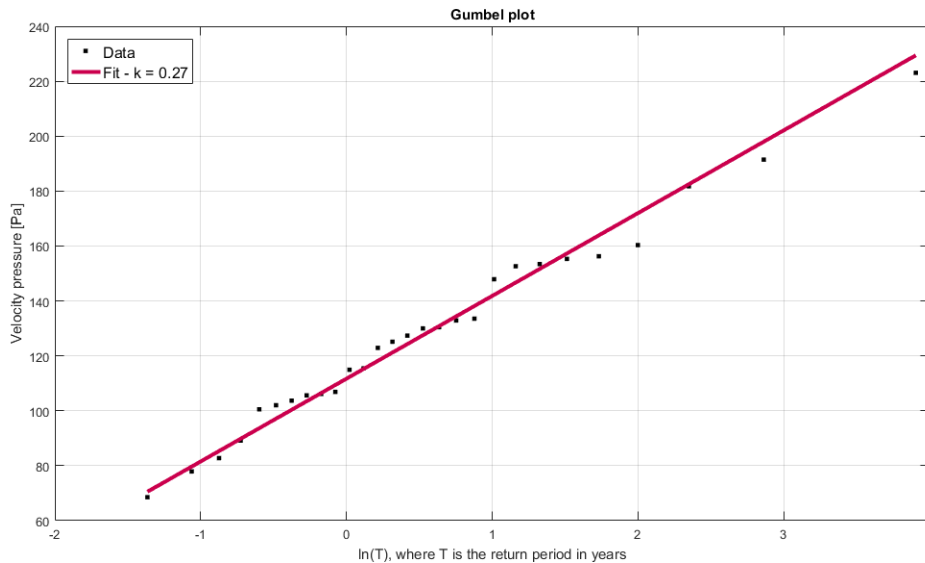


Figure 4.3. Fitting the Gumbel probability distribution function to the probability distribution function of the measured annual extreme velocity pressures at DMI meteorological station at Jægersborg. The extreme values shown, cover the period from 1995 to 2022.

The Gumbel distribution provides a better fit to the projected data for some of the locations, such as Billund and Årslev, compared to the others. Figure 4.4 presents the annual extremes and corresponding Gumbel fit to the data at Årslev.

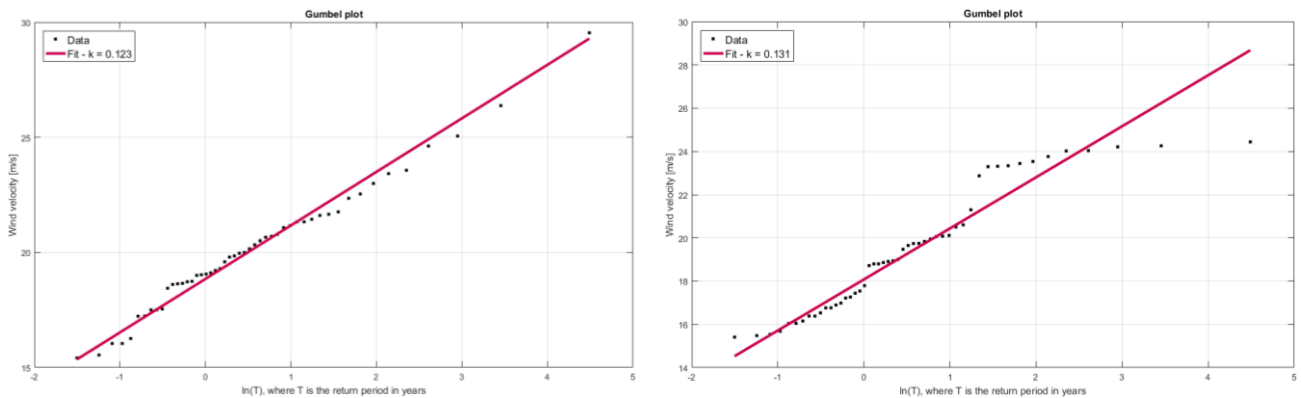


Figure 4.4. Fitting the Gumbel probability distribution function to the probability distribution function of the annual extremes of surface wind velocity from data produced by ICHEC-EC-EARTH global and KNMI-RACMO22E regional climate models at Årslev under the RCP 8.5 emission scenario. The extreme values shown, cover the periods 1981 to 2030 (left) and 2025-2074 (right).

The 50-year extreme estimates of the maximum surface wind speed, and maximum and minimum temperature, at Lyngbyvej 100 and Klitmøller, with emission scenario of RCP 8.5, see Annex A.3, are presented in Figure 4.5 and Figure 4.6, respectively. The 50-year extreme estimate corresponds to a 98% quantile in the distribution of annual maximum wind velocity.

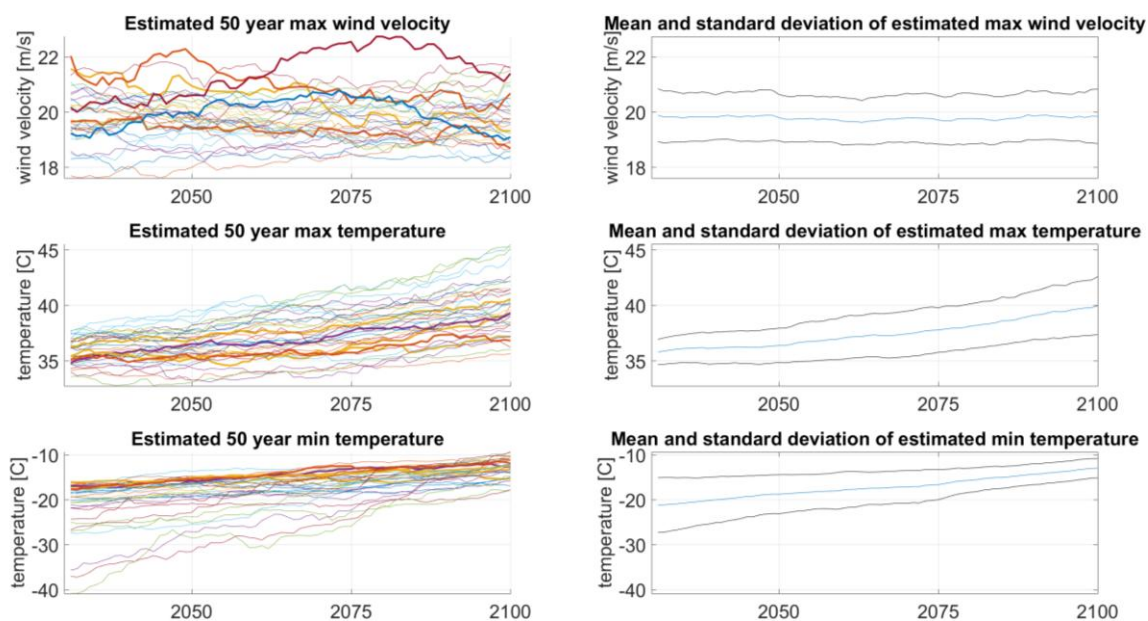


Figure 4.5. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Lyngbyvej 100, with emission scenario of RCP 8.5. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

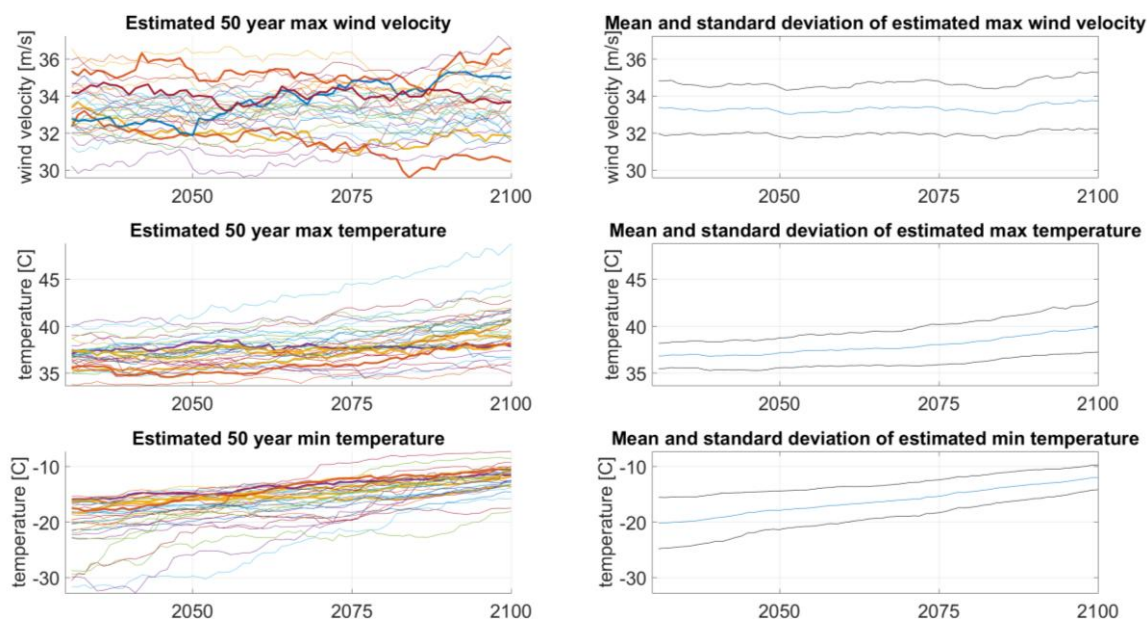


Figure 4.6. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Klitmøller, with emission scenario of RCP 8.5. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The data version used to generate Figure 4.5, Figure 4.6 and Figure 4.7 is v2024b_v2_r1i1p1, and the models behind Figure 4.5 and Figure 4.6 are listed in Annex A.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Lyngbyvej 100 and presented in Figure 4.7.

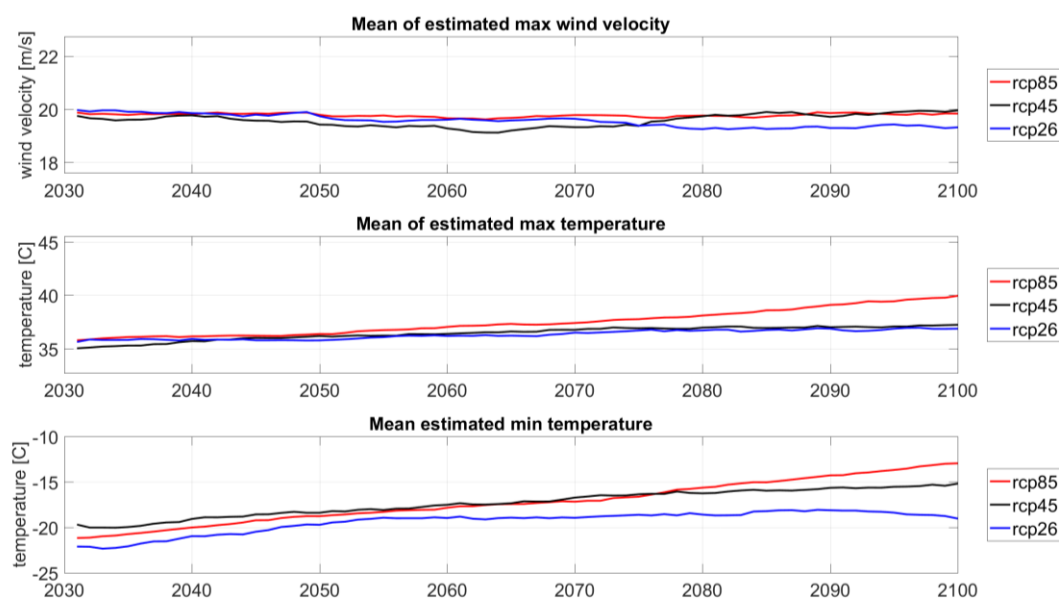


Figure 4.7. The 50-year extreme estimation with different emission scenarios and averaged within different models for Lyngbyvej 100.

Although Figure 4.7 indicates that the averaged projected 50-year wind speed within different models tends to remain relatively constant up to the year 2100, Figure 4.5 and Figure 4.6 show that the



extreme estimates according to the data produced by various models exhibit substantial divergence predicting different tendencies for maximum surface wind speed. Additionally, the plots on the right-hand side of Figure 4.5 and Figure 4.6 indicate significant deviation among the models, however, this deviation remains consistent over the entire period. Therefore, any conclusion derived from averaging of the models will be associated with considerable uncertainty and may potentially be misleading.

In the wind speed plot on the right-hand side of Figure 4.6, a slight increase in the forecasted wind speed can be observed near the year 2100; However, it does not indicate a clear trend, as similar fluctuations have occurred periodically in previous years.

The averaged projected 50-year minimum and maximum temperature across different models show increasing trends during the period of 2032 to 2100 (see Figure 4.5, Figure 4.6 and Figure 4.7). However, there are still large deviations between the individual models.

It is remarkable that the future extreme wind velocity does not depend much on the emission scenario. However, the projected maximum temperature exhibits higher increase under emission scenarios of RCP 8.5 compared to RCP 4.5 and RCP 2.6. A similar tendency is observed for projected minimum temperatures, with RCP 8.5 and RCP 4.5 indicating more pronounced warming relative to RCP 2.6.

Table 4.1 presents the mean 50-year wind speed across different models and during the years 2032 to 2100 for seven locations listed in Table 3.1 and RCP 8.5. The coefficient of variation, also shown in Table 4.1, is calculated as the average of the ratio between the standard deviation and the mean across different models, over the period from 2032 to 2100.

Table 4.1. Mean 50-year wind speed and coefficient of variation for seven locations listed in Table 3.1 and RCP 8.5.

Location name	Mean 50-year wind speed [m/s]	Mean coefficient of variation
Lyngbyvej 100	19.78	0.044
Klitmøller	33.30	0.041
Aalborg Airport	27.50	0.042
Karup Airport	24.65	0.041
Billund	22.28	0.039
Roskilde Airport	20.79	0.043
Årslev	25.73	0.046

The wind velocities reported in Table 4.1 are governed by the climate and surface roughness and do not represent the basic wind velocities.

The mean values presented in Table 4.1 are shown on the map of Denmark, next to the locations coordinates in Figure 4.8.

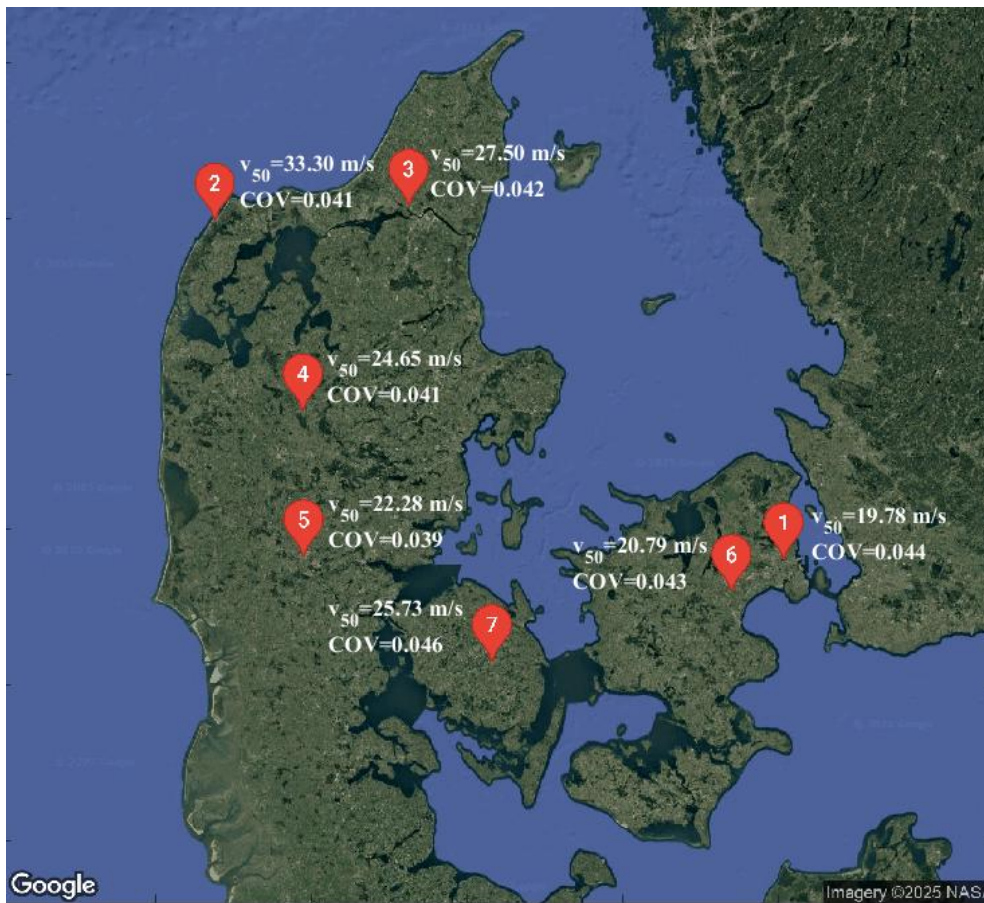


Figure 4.8. Mean 50-year wind speed (v_{50}) and coefficient of variation for seven locations (COV) listed in Table 3.1 and RCP 8.5.

The results from all locations listed in Table 3.1 are presented in Annex C.

5 Results - Extreme value analysis for ground snow load

The extreme analysis of the 50-year windows of ground snow load data has been carried out for seven locations listed in Table 3.1 except Klitmøller. For the extreme analysis of ground snow load, the Klitmøller location was replaced with Holmsø due to a lack of sufficient projected data for Klitmøller. Figure 5.1 presents the Gumbel fit to the data at Lyngbyvej 100.

The k factor of 0.612 (equivalent to a coefficient of variation of 0.58) as shown in the left plot of Figure 5.1 is larger than assumed in the current Eurocode National Annex on snow load. The largest ground snow loads in Figure 5.1 seem to follow a deviating Gumbel distribution.

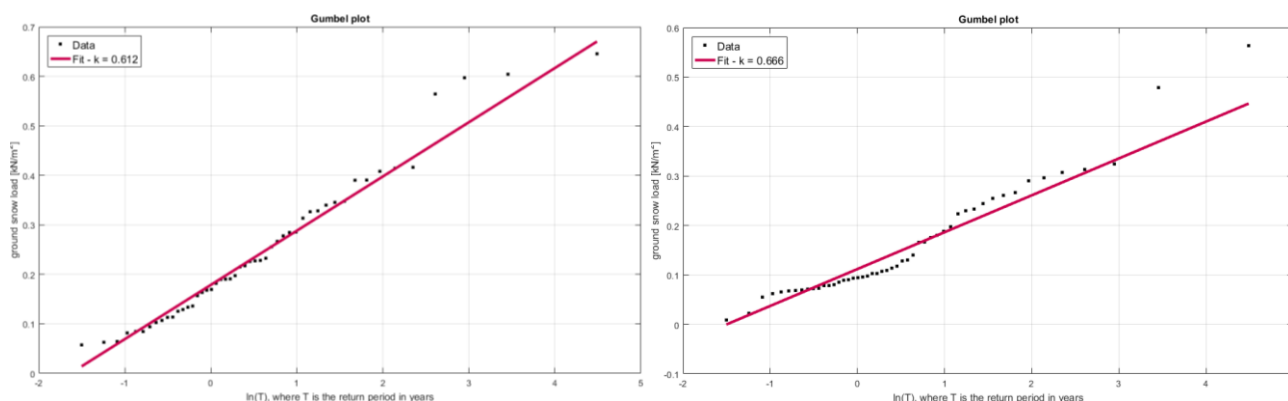


Figure 5.1. Fitting the Gumbel probability distribution function to the probability distribution function of the annual extremes of ground snow load from data produced by ICHEC-EC-EARTH global and KNMI-RACMO22E regional climate models at Lyngbyvej 100 under the RCP 8.5 emission scenario. The extreme values shown, cover the periods 1960-2009 (left) and 2025-2074 (right).

The 50-year extreme estimates of the daily ground snow load, at Lyngbyvej 100, are presented in Figure 5.2.

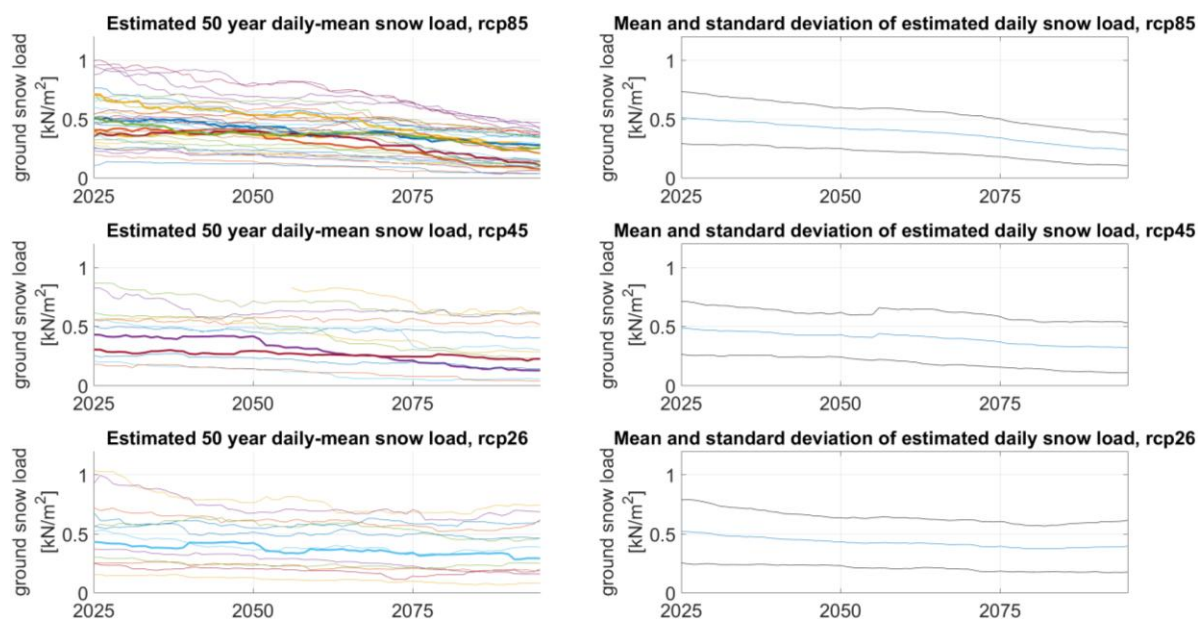


Figure 5.2. 50-year extreme estimate of the daily mean ground snow load at Lyngbyvej 100, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Lyngbyvej 100 and presented in Figure 5.3.

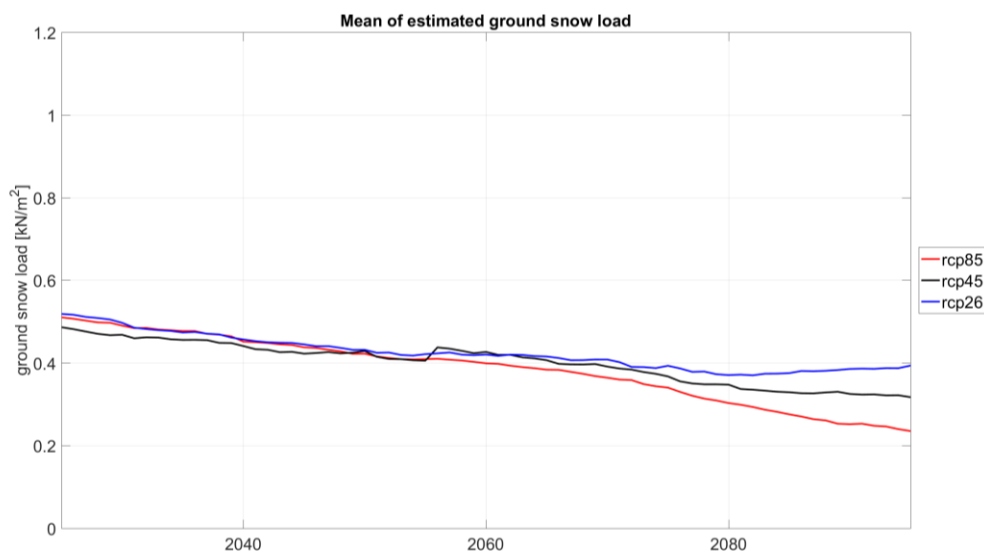


Figure 5.3. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Lyngbyvej 100.

It is remarkable that the future extreme ground snow load does not depend much on the emission scenario.

The averaged projected 50-year extreme snow load across different models exhibits decreasing trends over the period of 2025 to 2100 (see Figure 5.2 and Figure 5.3). However, there are significantly large deviations between the individual models, although these deviations decrease slightly over time under RCP 8.5.

Figure 5.3 shows that the forecasted mean value of the 50-year extreme ground snow load for the year 2025, across various models, is lower than the current 50-year design value specified in the Eurocode National Annex. Analysis of the forecasted data further confirms that, for many model combinations, all annual maximum values within the 50-year period leading up to 2025 remain significantly below the present design value. Figure 5.4 presents an example of the forecasted data under the RCP 8.5 emission scenario at the Lyngbyvej 100 location.

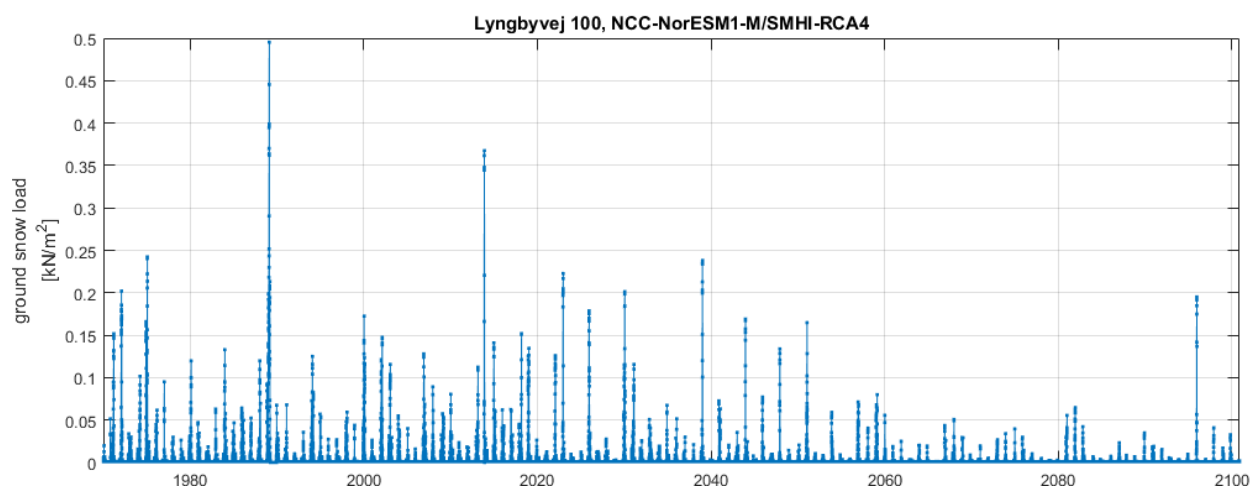


Figure 5.4. Daily ground snow load data produced by NCC-NorESM1-M global and SMHI-RCA4 regional climate models at Lyngbyvej 100

Table 5.1 presents the mean 50-year ground snow load across different models in 2025 and 2100 for seven locations listed in Table 3.1 and RCP 8.5. The coefficient of variation, also shown in Table 5.1, is calculated as the ratio of the standard deviation and the mean across different models for the same year.

Table 5.1. Mean 50-year ground snow load and coefficient of variation in 2025 for seven locations listed in Table 3.1 and RCP 8.5.

Location name	50-year ground snow load [kN/m ²]		Mean coefficient of variation	
	2025	2100	2025	2100
Lyngbyvej 100	0.51	0.23	0.43	0.57
Holmsø	0.41	0.18	0.53	0.72
Aalborg Airport	0.51	0.24	0.41	0.58
Karup Airport	0.39	0.17	0.47	0.66
Billund	0.41	0.19	0.43	0.52
Roskilde Airport	0.46	0.2	0.40	0.59
Årslev	0.43	0.17	0.36	0.49

The mean values presented in Table 5.1 are shown on the map of Denmark, next to the location's coordinates, in Figure 5.5.

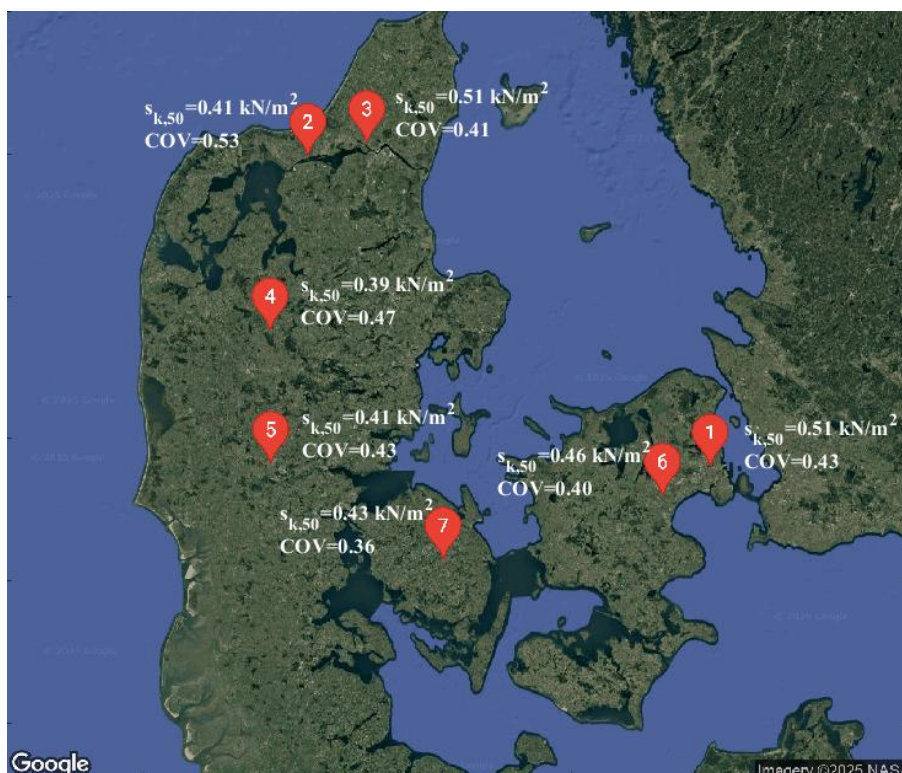


Figure 5.5. Mean 50-year ground snow load ($s_{k,50}$) and coefficient of variation (COV) for seven locations listed in Table 5.1 and RCP 8.5 in 2025.

The results from all the locations listed in Table 3.1 are presented in Annex D.

6 Results – Atmospheric icing

The annual number of icing days has been studied in this section. The meteorological condition for icing occurrence has been defined as:

- Daily mean temperature, T: [-1.5 , 1.5] °C
- Daily mean relative humidity, RH: $\geq 90\%$

The use of daily mean values introduces a degree of uncertainty in identifying icing occurrence conditions. This is because these two conditions might not occur simultaneously during the day, even though the daily mean values meet the thresholds. Similarly, there could be days when the daily mean values do not meet the criteria, but the actual conditions for icing may have occurred at some point during the day.

The annual number of icing days, meeting the above criteria, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas. The plots presented in Figure 6.1 were smoothed using a moving average with a 5-year sliding window to reduce interannual variability and highlight longer-term trends.

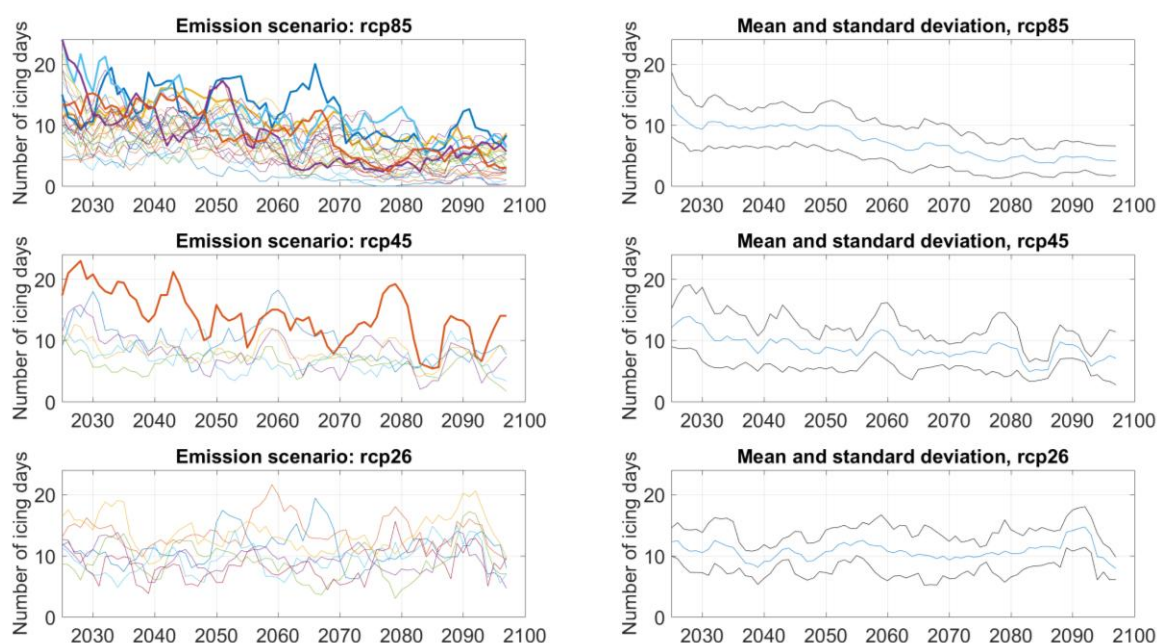


Figure 6.1. Annual number of icing days at Lyngbyvej 100, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Lyngbyvej 100 and presented in Figure 6.2.

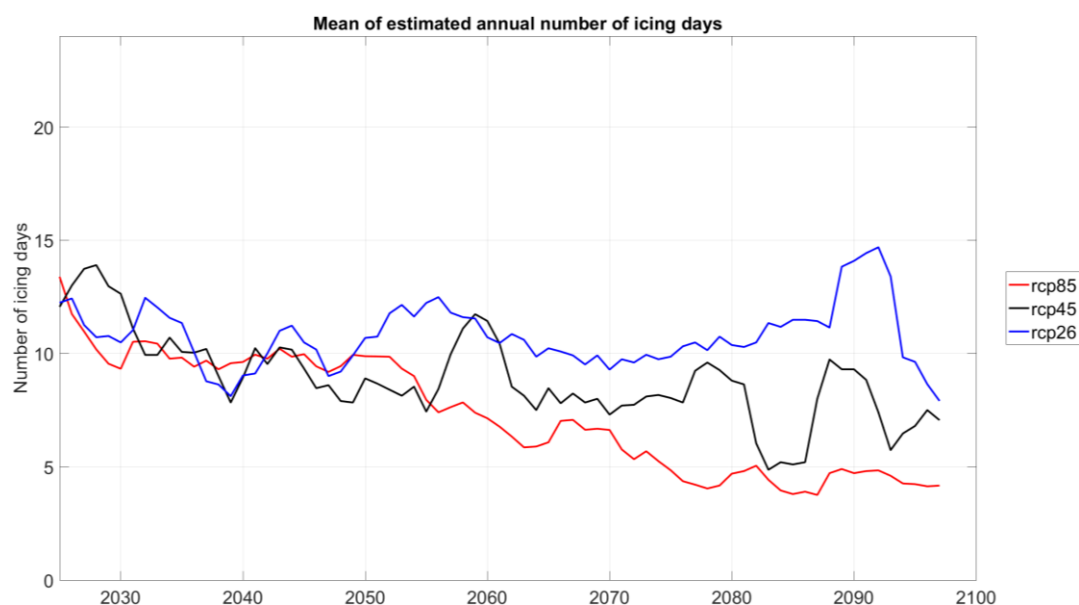


Figure 6.2. The annual number of icing days with different emission scenarios and averaged within different models for Lyngbyvej 100.

The average of projected annual number of icing days across the models presents different trends under different emission scenarios, see Figure 6.2. The most pronounced decreasing trend is observed under the RCP 8.5 scenario, likely due to the expected increase in the future temperatures. This



decreasing tendency is less evident under RCP 4.5 and is nearly absent under RCP 2.6. However, there are significantly large deviations between the individual models.

The results from all the locations listed in Table 3.1 are presented in Annex E.

7 Results - Frequent wind velocity analysis

The frequent wind is studied by fitting the Weibull probability density function (PDF) to the daily surface wind velocity. Figure 7.1 shows the Weibull distribution fit to data generated by combination of “ICHEC-EC-EARTH” and “NCC-NorESM1-M” global and “DMI-HIRHAM5” and “SMHI-RCA4” regional models for emission scenarios of 8.5 and 2.6. The plots in Figure 7.1 include data from January 2050 to December 2100. The theory of frequent wind analysis is described in Annex B.

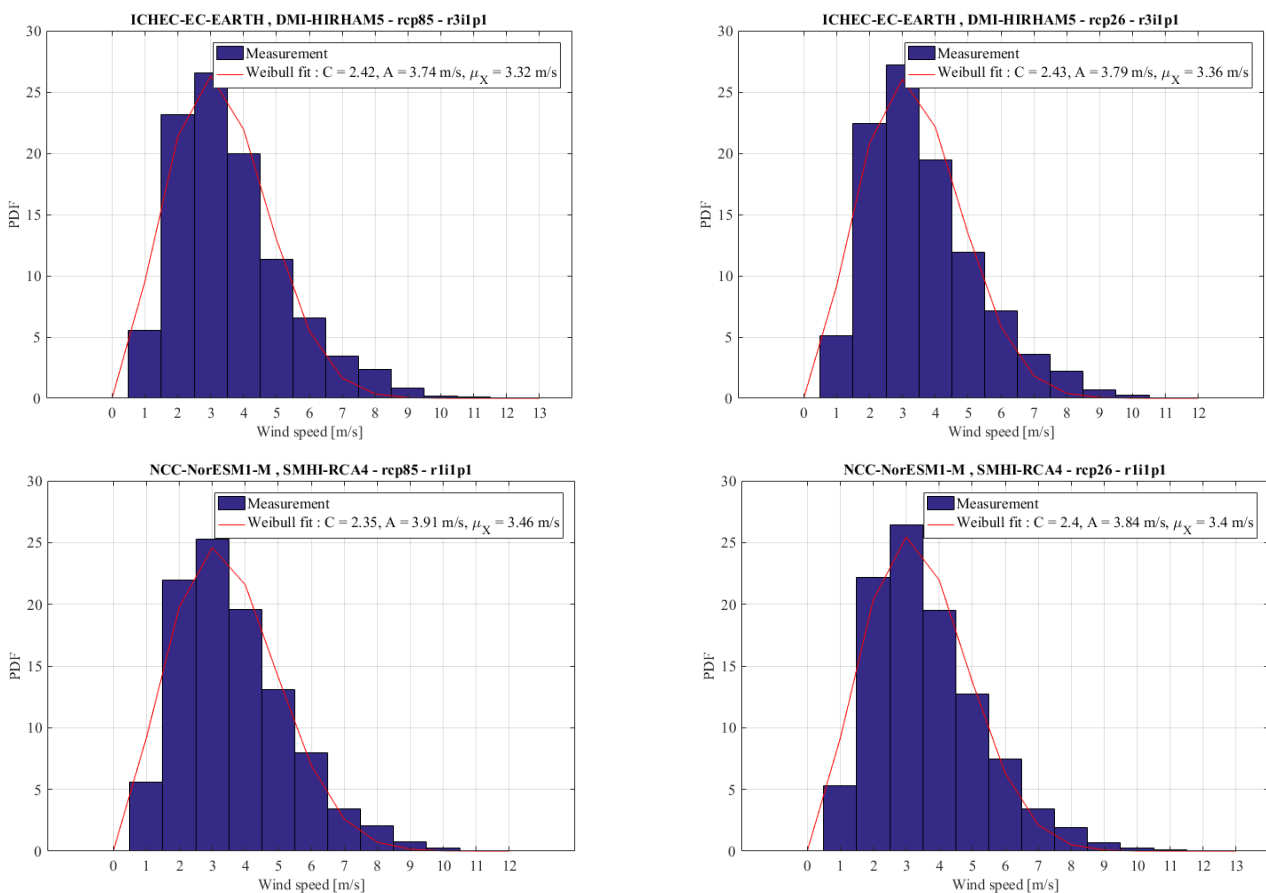


Figure 7.1. Weibull probability density function fit to the daily surface wind speed.

According to the Danish Building Institute (SBI) guidelines [3], the Weibull scale and shape parameters for Terrain Category III are reported as $A = 4.1$ m/s and $C = 1.82$ with the mean wind velocity of $\mu_X = 3.64$ m/s. Given that the terrain at Lyngbyvej 100 is characterized by slightly higher surface roughness, resulting in lower wind speeds compared to Terrain Category III, the Weibull parameters estimated in Figure 7.1 appear to be consistent with [3]. However, wind velocity measurements typically yield a Weibull shape parameter C , close to 2. The relatively large shape parameters observed in Figure 7.1 remain unexplained.



The Weibull parameters estimated based on the simulated data, remain consistent across data corresponding to different time periods. In conclusion, climate changes may not change the distribution of frequent winds significantly. This conclusion is relevant for fatigue considerations.



8 References

- [1] DMI, "Methods used in Klimaatlas, the Danish Climate Atlas (v2024b)," 2024.
- [2] J. D. Sørensen, C. S. Sørensen, J. M. Andersen, S. F. Østbirk, S. O. Hansen, U. Støttrup-Andersen and P. Velk, "Fremtidige klimalaster," 2017.
- [3] C. Dyrbye og S. O. Hansen, Vindlast på bærende konstruktioner, SBI-anvisning 158, København: Statens Byggeforskningsinstitut, 1989.



BASIC CLIMATE PARAMETERS IN DENMARK

Climate analysis based on data from Danish Climate Atlas

ANNEX A

Global and regional climate models from Danish Climate Atlas

24.0058

March 23, 2026 - Revision 0

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A.1. Global and regional models

The global climate models used in this study are as follows:

- ICHEC-EC-EARTH
- MPI-M-MPI-ESM-LR
- MIROC-MIROC5
- MOHC-HadGEM2-ES
- NCC-NorESM1-M
- IPSL-IPSL-CM5A-MR
- CNRM-CERFACS-CNRM-CM5
- CCCma-CanESM2

The regional climate models used to produce the data, are listed below:

- MPI-CSC-REMO2009
- UHOH-WRF361H
- KNMI-RACMO22E
- CLMcom-ETH-COSMO-crCLIM-v1-1
- IPSL-WRF381P
- DMI-HIRHAM5
- SMHI-RCA4
- CLMcom-CCLM4-8-17
- ICTP-RegCM4-6
- MOHC-HadREM3-GA7-05
- GERICS-REMO2015
- CNRM-ALADIN63



A.2. Combined models

The global and regional models used to generate the data from data version v2024b_v2_r1i1p1 for emission scenario 8.5, see A.3, are listed in Table A.1.

Table A.1. Global and regional models generating data for emission scenario 8.5

Global model	Regional model
ICHEC-EC-EARTH	KNMI-RACMO22E
ICHEC-EC-EARTH	CLMcom-ETH-COSMO-crCLIM-v1-1
ICHEC-EC-EARTH	DMI-HIRHAM5
ICHEC-EC-EARTH	SMHI-RCA4
MPI-M-MPI-ESM-LR	MPI-CSC-REMO2009
MPI-M-MPI-ESM-LR	KNMI-RACMO22E
MPI-M-MPI-ESM-LR	CLMcom-ETH-COSMO-crCLIM-v1-1
MPI-M-MPI-ESM-LR	IPSL-WRF381P
MPI-M-MPI-ESM-LR	DMI-HIRHAM5
MPI-M-MPI-ESM-LR	CLMcom-CCLM4-8-17
MPI-M-MPI-ESM-LR	MOHC-HadREM3-GA7-05
MIROC-MIROC5	GERICS-REMO2015
NCC-NorESM1-M	KNMI-RACMO22E
NCC-NorESM1-M	CLMcom-ETH-COSMO-crCLIM-v1-1
NCC-NorESM1-M	IPSL-WRF381P
NCC-NorESM1-M	DMI-HIRHAM5
NCC-NorESM1-M	SMHI-RCA4
NCC-NorESM1-M	MOHC-HadREM3-GA7-05
NCC-NorESM1-M	GERICS-REMO2015
IPSL-IPSL-CM5A-MR	KNMI-RACMO22E
IPSL-IPSL-CM5A-MR	IPSL-WRF381P



IPSL-IPSL-CM5A-MR	DMI-HIRHAM5
IPSL-IPSL-CM5A-MR	SMHI-RCA4
IPSL-IPSL-CM5A-MR	GERICS-REMO2015
CNRM-CERFACS-CNRM-CM5	KNMI-RACMO22E
CNRM-CERFACS-CNRM-CM5	CLMcom-ETH-COSMO-crCLIM-v1-1
CNRM-CERFACS-CNRM-CM5	IPSL-WRF381P
CNRM-CERFACS-CNRM-CM5	DMI-HIRHAM5
CNRM-CERFACS-CNRM-CM5	ICTP-RegCM4-6
CNRM-CERFACS-CNRM-CM5	GERICS-REMO2015
CNRM-CERFACS-CNRM-CM5	CNRM-ALADIN63
CCCma-CanESM2	GERICS-REMO2015



A.3. Emission scenarios

Figure A.1 illustrates the different emission scenarios.

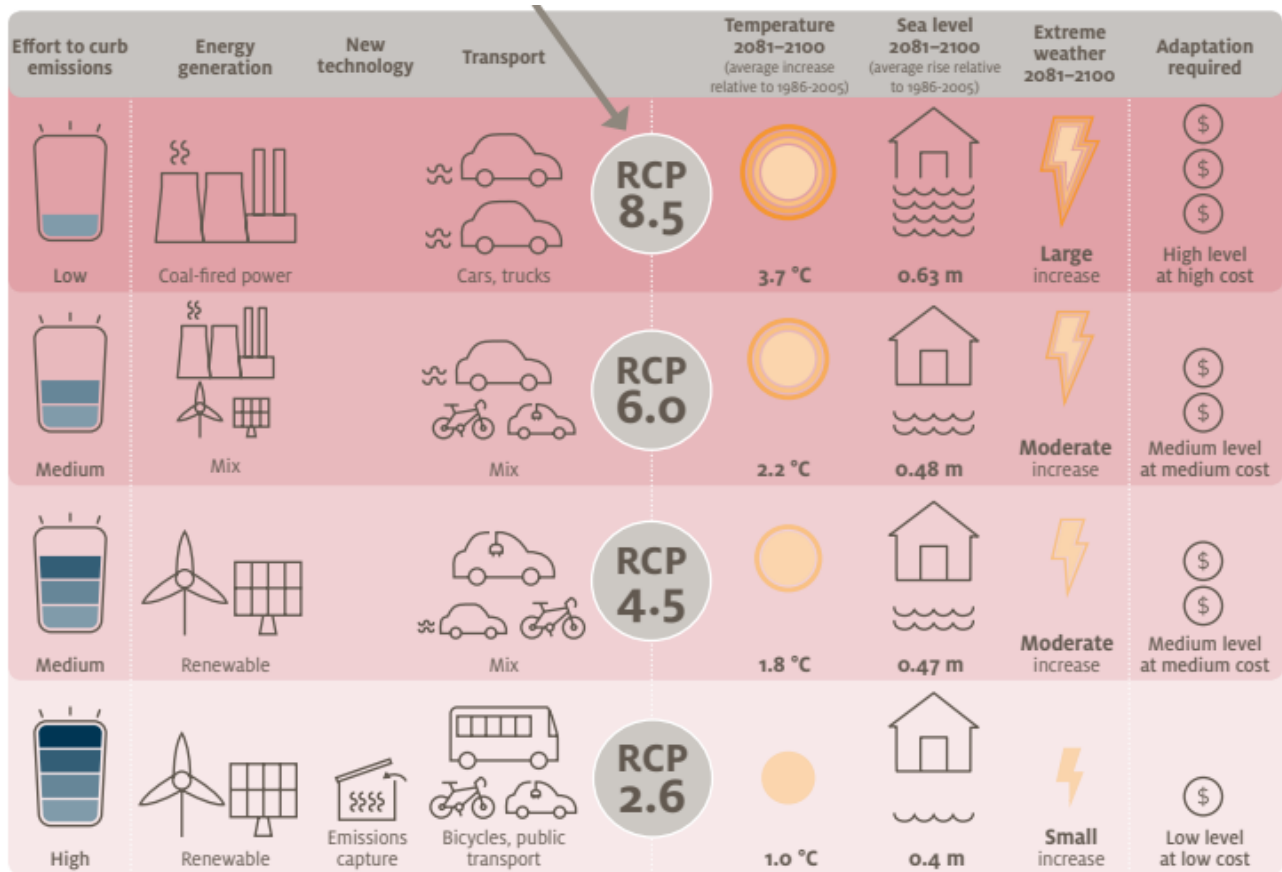


Figure A.1. Illustration of emission scenarios



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ANNEX B
Wind climate analysis theory

24.0058
March 23, 2026 - Revision 3

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B.1. Frequent winds

The Weibull distribution is commonly used to describe the occurrences of frequent winds. Frequent winds may be used as a basis for calculating the occurrences of critical winds for vortex-induced vibrations, information relevant in the subsequent fatigue calculations of the structure. This focus indicates that the mean wind velocity at the site may be the most appropriate variable considering frequent winds.

The Weibull distribution is characterized by two parameters – the scale parameter A and the shape parameter C . Both parameters are positive. The Weibull probability density function $f_X(x)$ is given as

$$f_X(x) = C \frac{x^{C-1}}{A^C} \exp \left[- \left(\frac{x}{A} \right)^C \right]. \quad (\text{B.1})$$

Figure B.1 shows the Weibull probability density function for a shape parameter of $C = 0.5, 1.0$ and 2.0 . As an example, for a shape parameter C equal to 2, the mean and standard deviation of the Weibull distribution is $\sqrt{\pi}/2 \cdot A$ and $\sqrt{1 - \pi/4} \cdot A$, respectively.

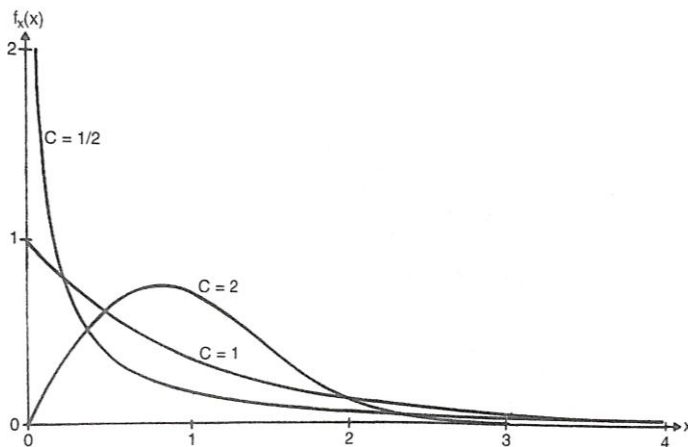


Figure B.1. Weibull distribution with shape parameters equal to $C = 0.5, 1.0$ and 2.0 .

Normally, wind velocity as well as velocity pressure fit a Weibull distribution very well, with the wind velocity being nearly a Rayleigh distribution with a Weibull shape factor of approx. 2 and the velocity pressure being nearly exponential with a Weibull shape factor of approx. 1.

The frequent winds are typically analyzed as function of wind directions, say 8 or 12 wind directions, and the probability of each wind direction is calculated together with the scale parameter and shape parameter also becoming direction dependent.



B.2. Extreme winds

The parent distributions being Weibull shows that the annual extreme wind velocity and the annual extreme velocity pressure both fit an extreme value distribution of Type 1, also called a Gumbel distribution.

The wind load on most structures depends on the velocity pressure, which gives this variable natural preference. The probability distribution function F_q^1 , the mean value μ_q^1 and the standard deviation σ_q^1 of the annual extreme velocity pressure are given by

$$F_q^1(q) = \exp \left[-\exp \left(-\frac{q - \alpha_q}{\beta_q} \right) \right], \quad (\text{B.2})$$

$$\mu_q^1 = \alpha_q + \gamma \beta_q, \quad (\text{B.3})$$

$$\sigma_q^1 = \frac{\pi}{\sqrt{6}} \beta_q, \quad (\text{B.4})$$

where $\gamma = 0.5772$ is Euler's constant, and α and β are the location parameter (mode) and scale parameter, respectively, that characterize the Type 1 extreme-value distribution. The 50-year extreme velocity pressure also fits an extreme value distribution of Type 1. The mean value μ_q^{50} and the standard deviation σ_q^{50} are given by

$$\mu_q^{50} = \mu_q^1 + \beta_q \ln(50), \quad (\text{B.5})$$

$$\sigma_q^{50} = \sigma_q^1. \quad (\text{B.6})$$

The probability density functions of the annual extremes and the 50-year extremes are illustrated in the figure below. It is seen that the standard deviation of the two distributions is the same. Compared to the annual extreme, the 50-year extreme probability density function is shifted towards higher velocity pressures by $\beta_q \ln(50)$, see Equation (B.5).

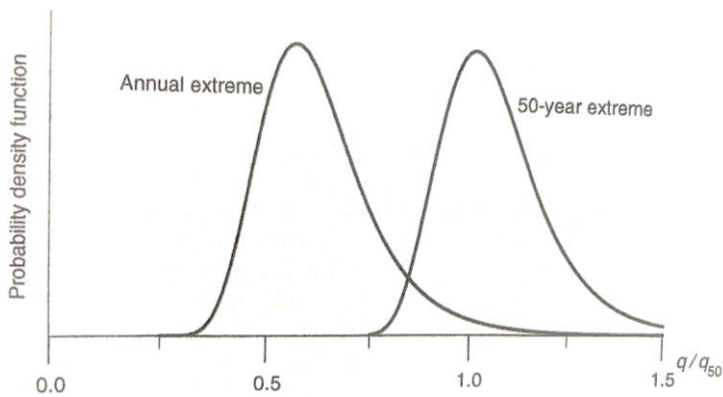


Figure B.2. Probability density function of the annual extreme and the 50-year extreme velocity pressure.

Velocity pressure $q(T)$ which has an annual probability of exceedance equal to $p = 1 - F_q^1(q)$ is given below:



$$q(T) = \alpha_q - \beta_q \ln(-\ln(1-p)) \quad (\text{B.7})$$

The ratio between the velocity pressure $q(T)$ with a return period of T and the 50-year velocity pressure q_{50} is given by

$$\frac{q(T)}{q_{50}} = \frac{1 + K_q \ln(T)}{1 + K_q \ln(50)} \quad (\text{B.8})$$

It can be concluded from the two equations above that the 50-year velocity is defined as the q value with a probability of exceedance equal to 0.02.

where the shape parameter $K_q = \beta_q / \alpha_q$ depends on the coefficient of variation of the extreme value distribution.

The figure below shows the ratio $q(T)/q(50)$.

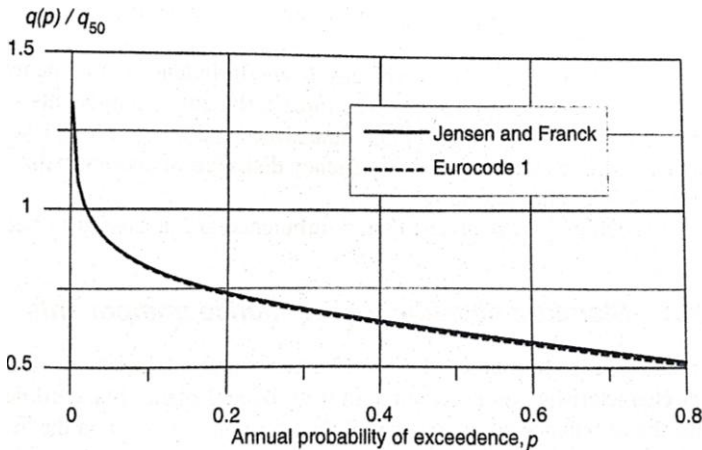


Figure B.3. Velocity pressure as function of return period T [1]

The theory above focus on the velocity pressure as basic parameter, but the mean wind velocity or the mean wind velocity squared are in practice also applied parameters for wind statistics.

The extreme winds are typically analyzed as function of wind direction, say 8 or 12 wind directions. For each wind direction, the 50-year value and the shape parameter K_q are determined using the best-fit line on axes with the reduced variate $y = -\ln(-\ln(m/(N+1)))$ as the ordinate and q as the abscissa; see Equation (B.2).

Wind velocity records should be analyzed using the statistical theory of extreme values. For statistically reliable results, wind velocity records should normally cover periods of 20-years or longer. Wind velocity records for shorter periods could be applicable if they are combined with long-term statistics at nearby sites.



B.3. Wind data records

Wind data records at the meteorological sites should be converted to reference conditions, i.e., 10 m above basic open flat terrain with a roughness length of 0.05 m by applying exposure corrections for altitude, terrain roughness, orography, and height above terrain for the conditions of the wind data records. Normally, these factors depend on wind direction. The wind data for reference conditions may subsequently be converted to wind statistics focusing on the structure in question, again using the exposure corrections for altitude, terrain roughness, orography and height above terrain, now for the site of the structure.

The quality of the recorded wind data should be evaluated as part of the uncertainty analyses. The following aspects should be addressed for the wind data records:

1. Surroundings over the record period.
2. Anemometer type and its calibration.
3. Recording methodology.
4. Anemometer location.
5. Consistency of the data.



B.4. References

- [1] C. Dyrbye og S. O. Hansen, Wind loads on structures, John Wiley & Sons Ltd., 1997.



BASIC CLIMATE PARAMETERS IN DENMARK
Climate changes based on data from Danish Climate Atlas

ANNEX C

Results – Extreme value analysis for wind velocity and temperature

24.0058

March 23, 2026 - Revision 0

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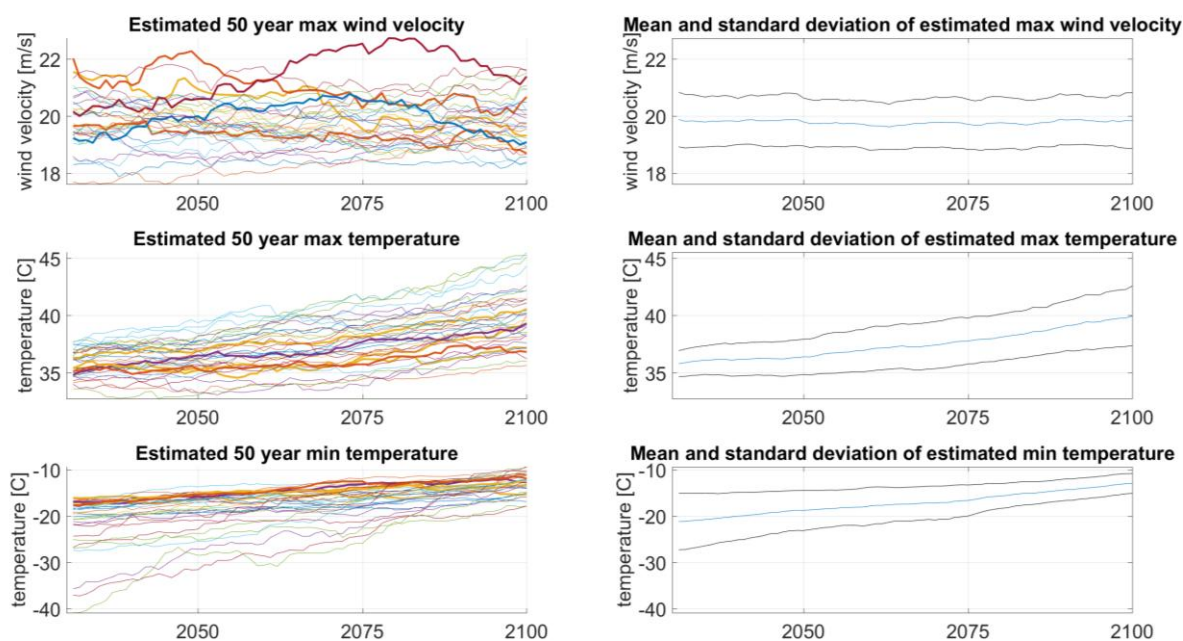
This annex presents the results of statistical extreme value analysis of projected maximum surface wind speed and maximum and minimum daily temperature for seven locations across Denmark. The data used in this study is provided by Danish Climate Atlas.



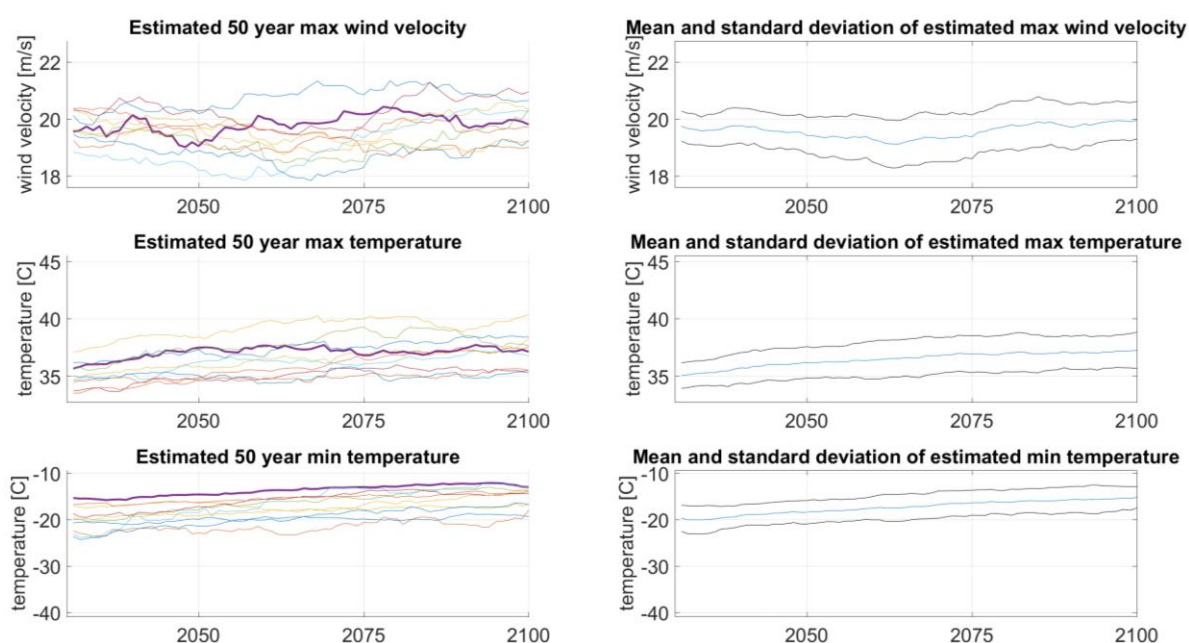
C.1. Lyngbyvej 100

The 50-year extreme estimates of the projected maximum surface wind speed and maximum and minimum daily temperature, at Lyngbyvej 100 is presented in Figure C.1.

RCP 8.5:



RCP 4.5:





RCP 2.6

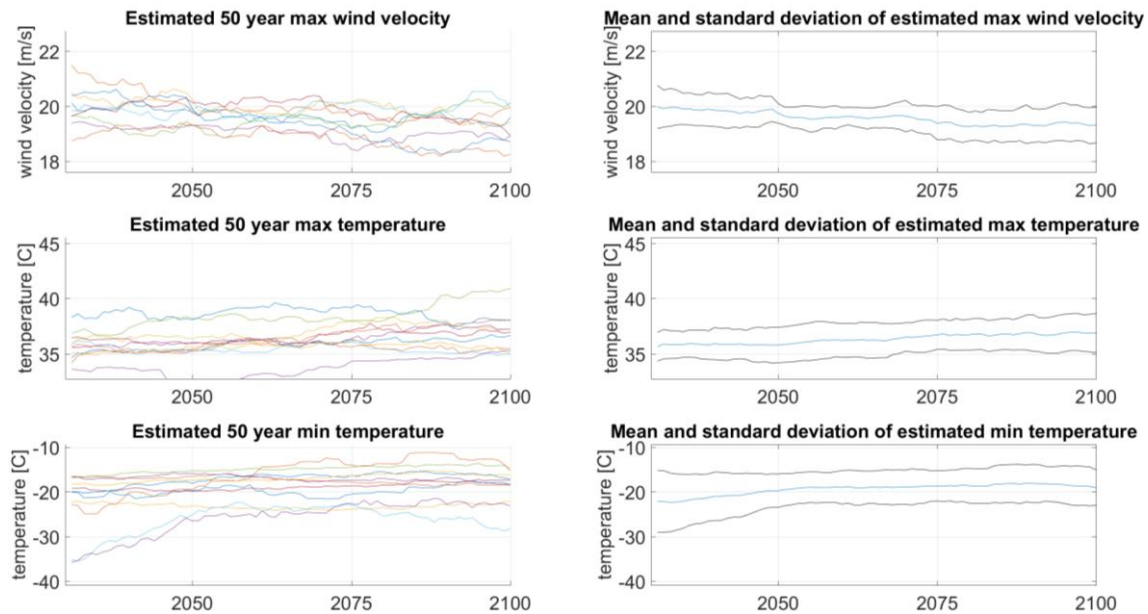


Figure C.1. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Lyngbyvej 100, with emission scenario of RCP 8.5 (top), RCP 4.5 (middle) and RCP 2.6 (bottom). Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Lyngbyvej 100 and presented in Figure C.2.

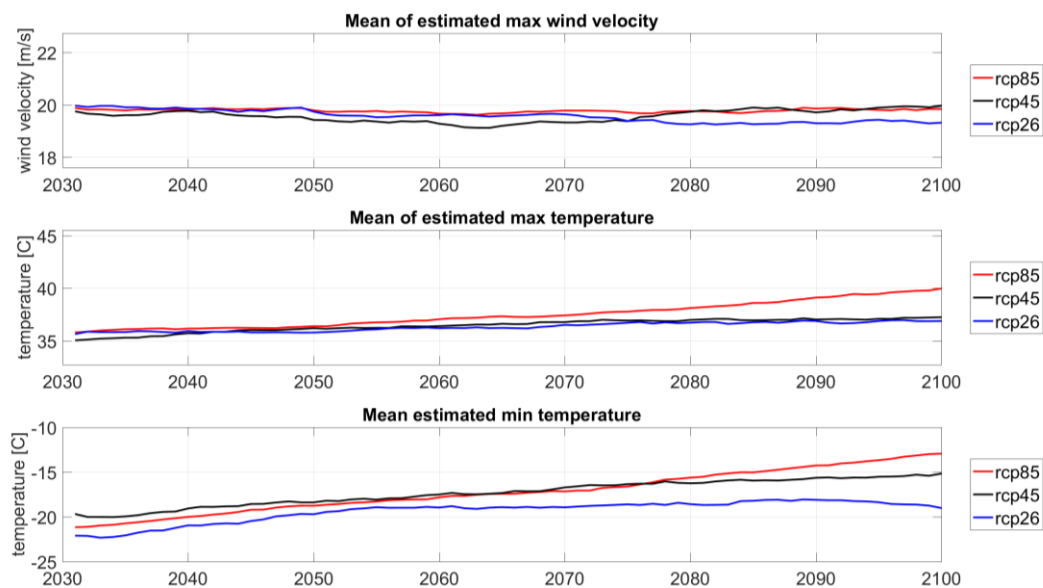


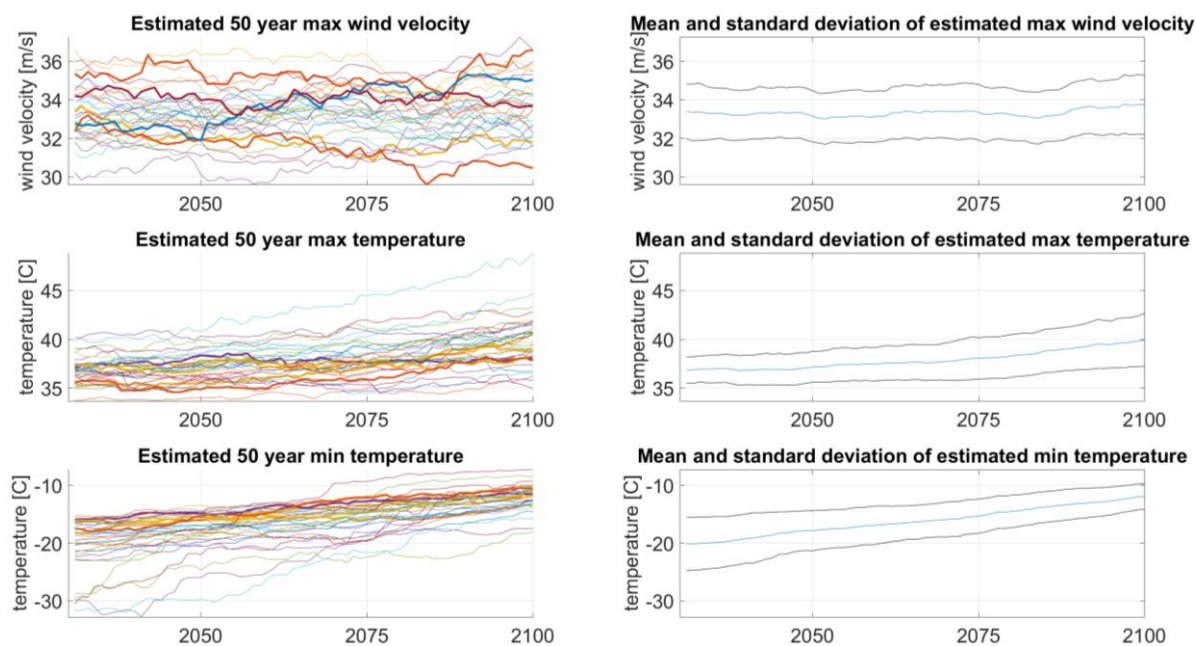
Figure C.2. The 50-year extreme estimation with different emission scenarios and averaged within different models for Lyngbyvej 100.



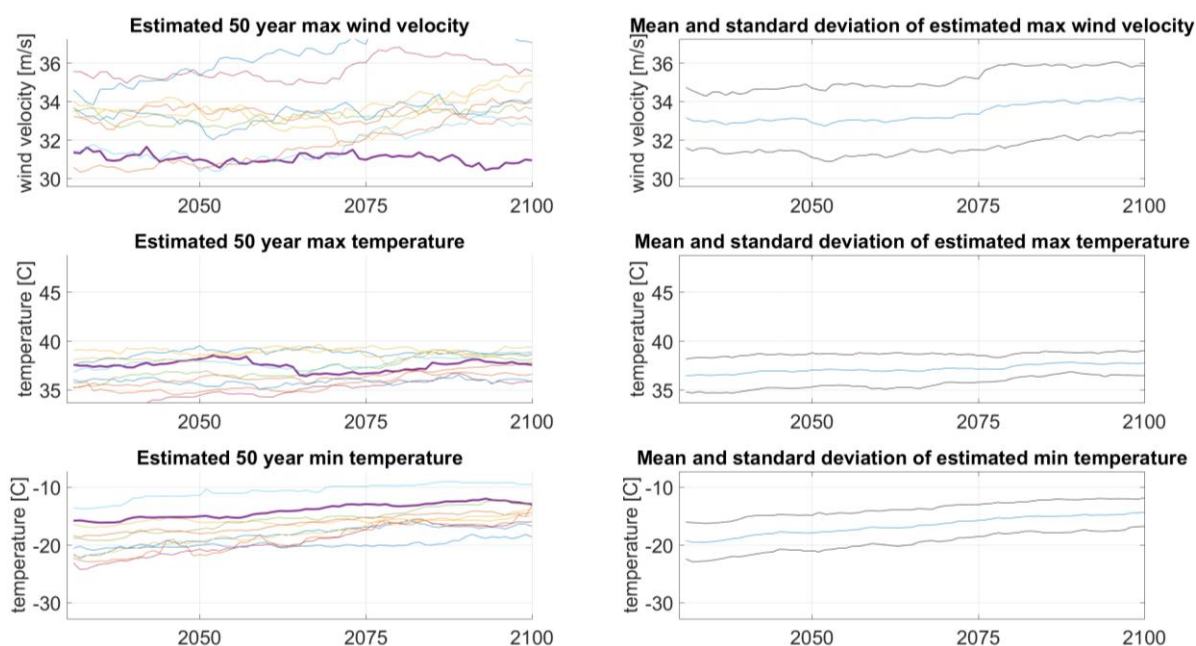
C.2. Klitmøller

The 50-year extreme estimates of the projected maximum surface wind speed and maximum and minimum daily temperature, at Klitmøller is presented in Figure C.3.

RCP 8.5:



RCP 4.5:





RCP 2.6

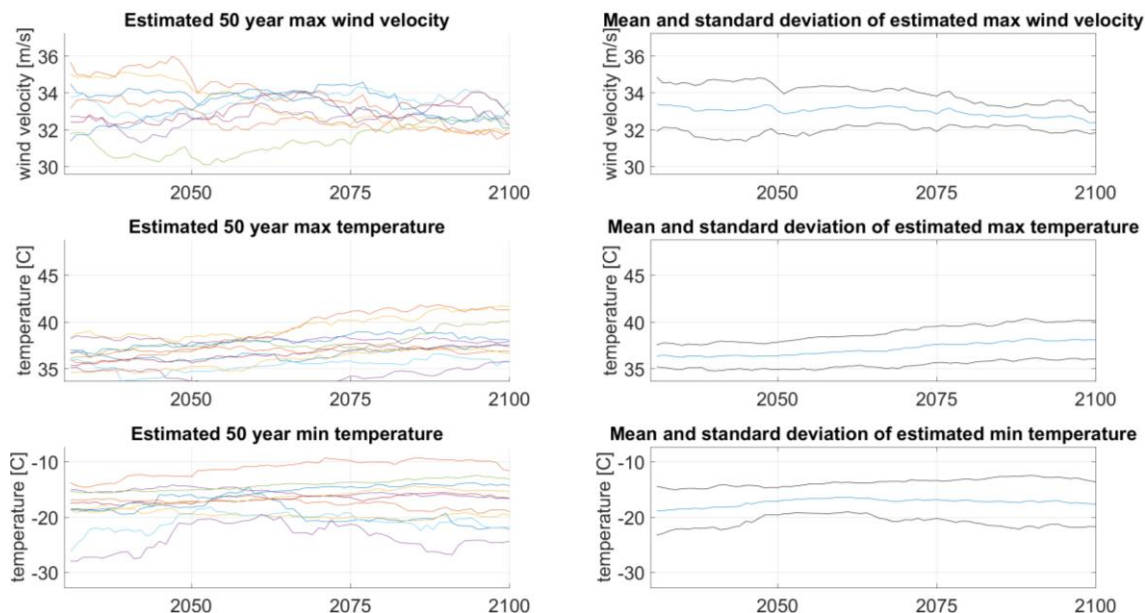


Figure C.3. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Klitmøller, with emission scenario of RCP 8.5 (top), RCP 4.5 (middle) and RCP 2.6 (bottom). Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Klitmøller and presented in Figure C.4.

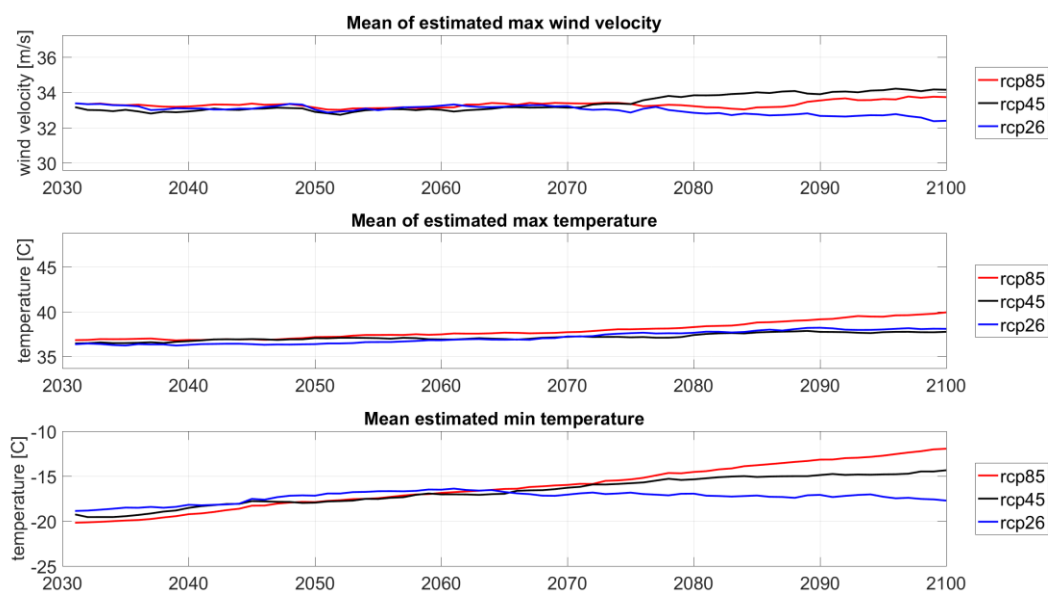


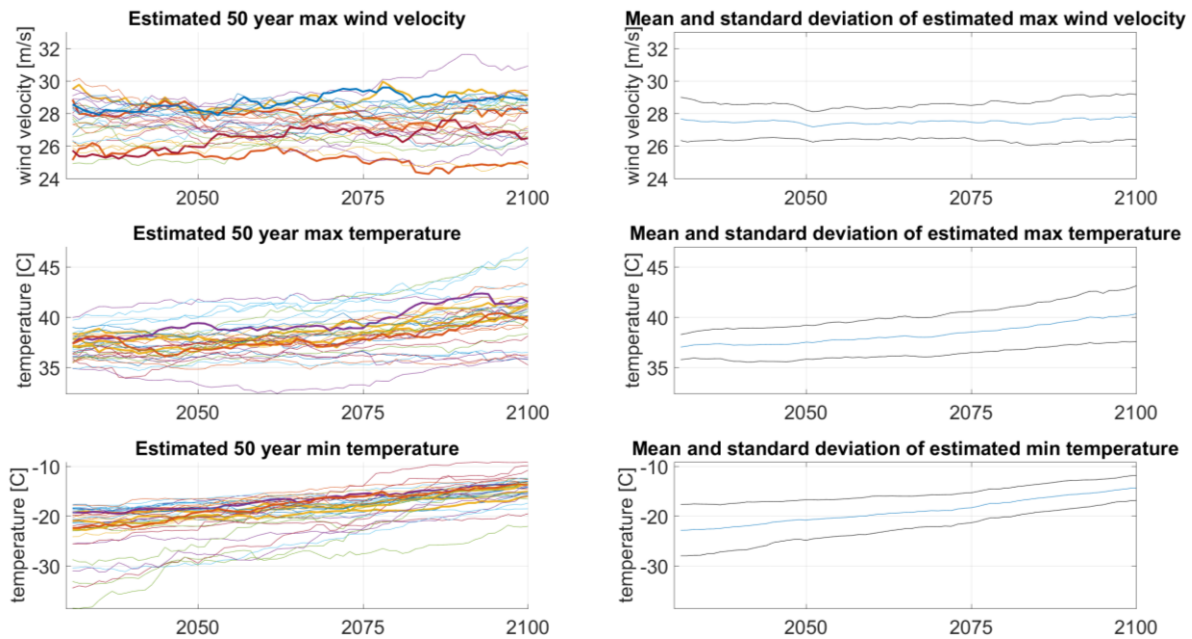
Figure C.4. The 50-year extreme estimation with different emission scenarios and averaged within different models for Klitmøller.



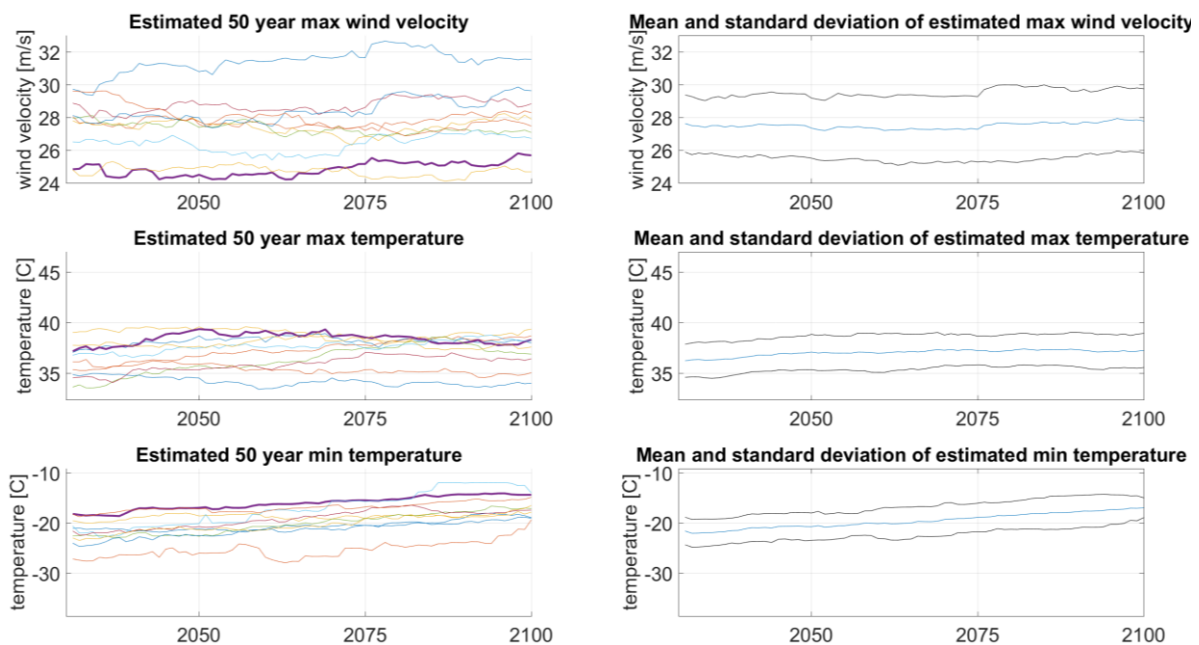
C.3. Aalborg Airport

The 50-year extreme estimates of the projected maximum surface wind speed and maximum and minimum daily temperature, at Aalborg Airport is presented in Figure C.5.

RCP 8.5:



RCP 4.5:





RCP 2.6

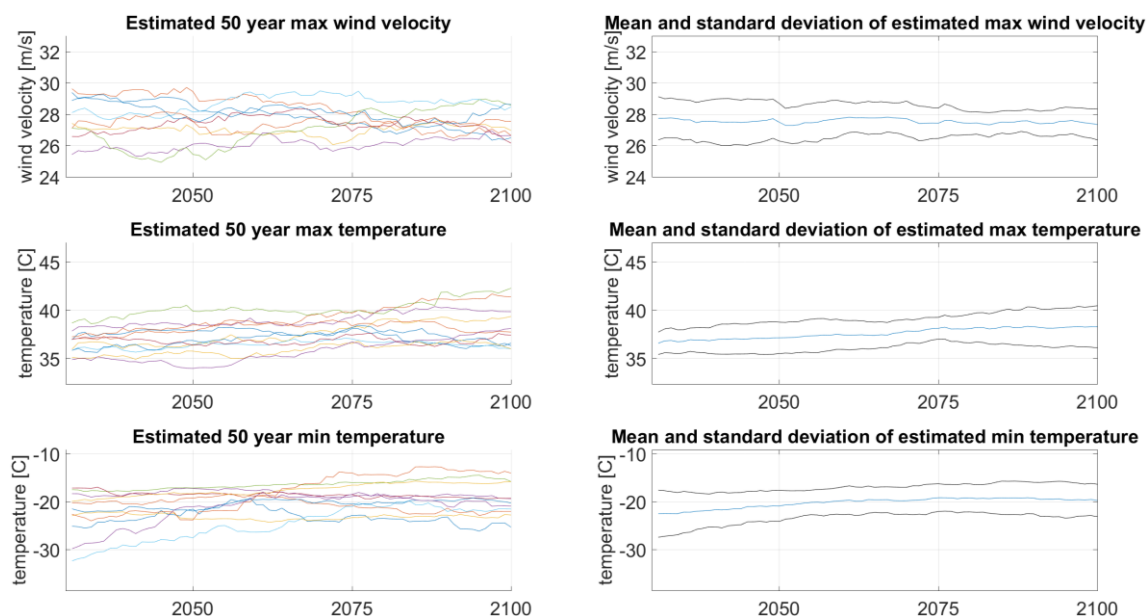


Figure C.5. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Aalborg Airport, with emission scenario of RCP 8.5 (top), RCP 4.5 (middle) and RCP 2.6 (bottom). Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Aalborg Airport and presented in Figure C.6.

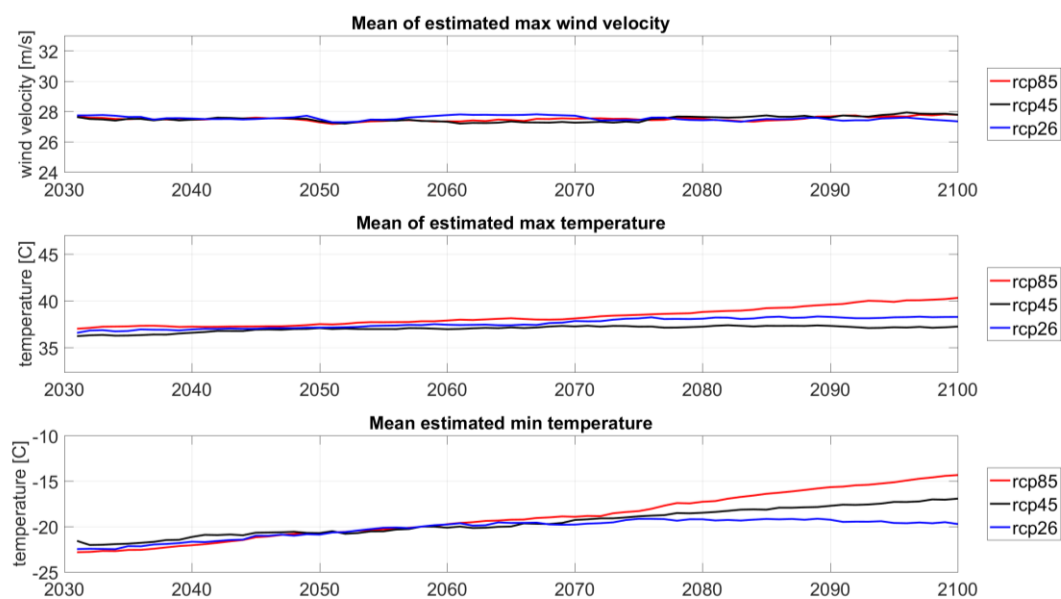


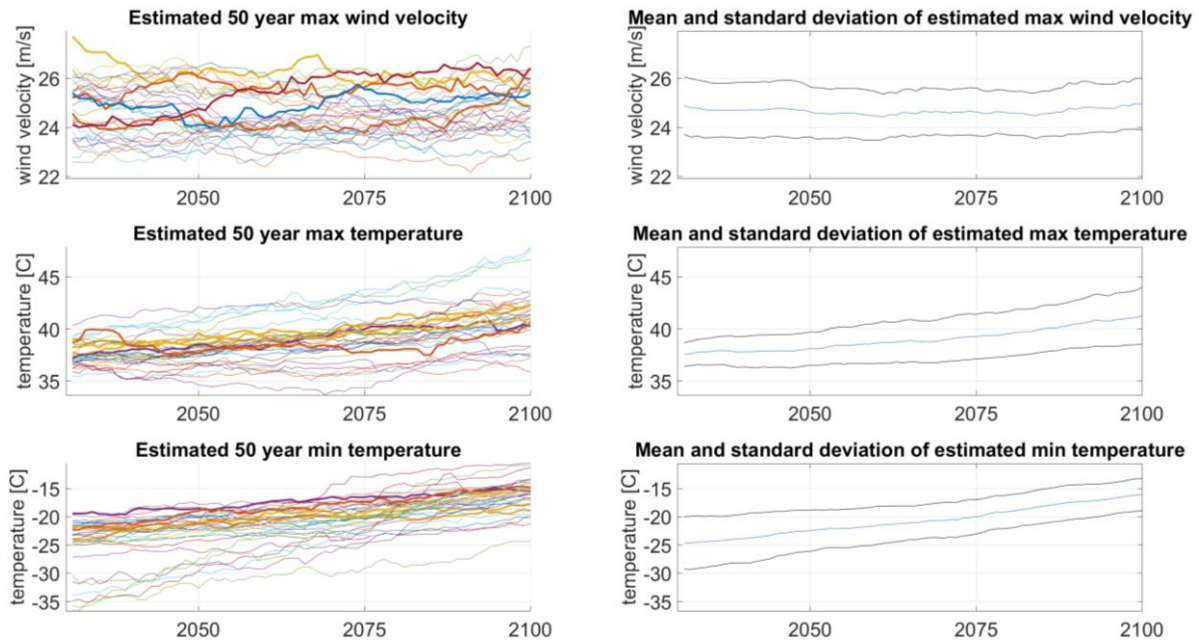
Figure C.6. The 50-year extreme estimation with different emission scenarios and averaged within different models for Aalborg Airport.



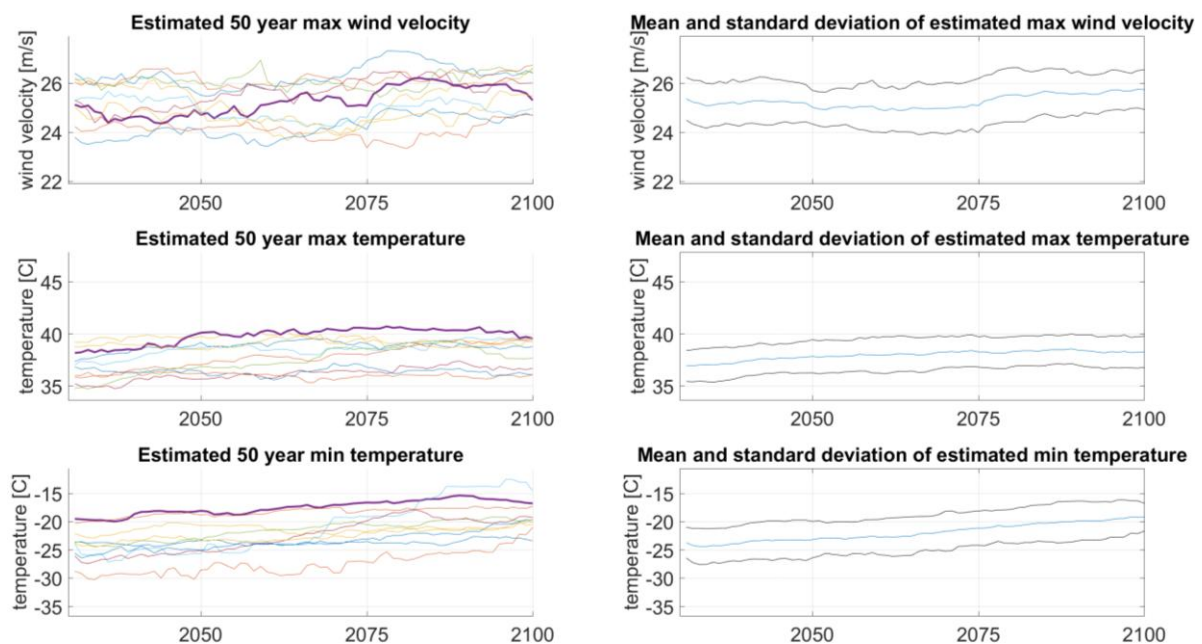
C.4. Karup Airport

The 50-year extreme estimates of the projected maximum surface wind speed and maximum and minimum daily temperature, at Karup Airport is presented in Figure C.7.

RCP 8.5:



RCP 4.5:





RCP 2.6

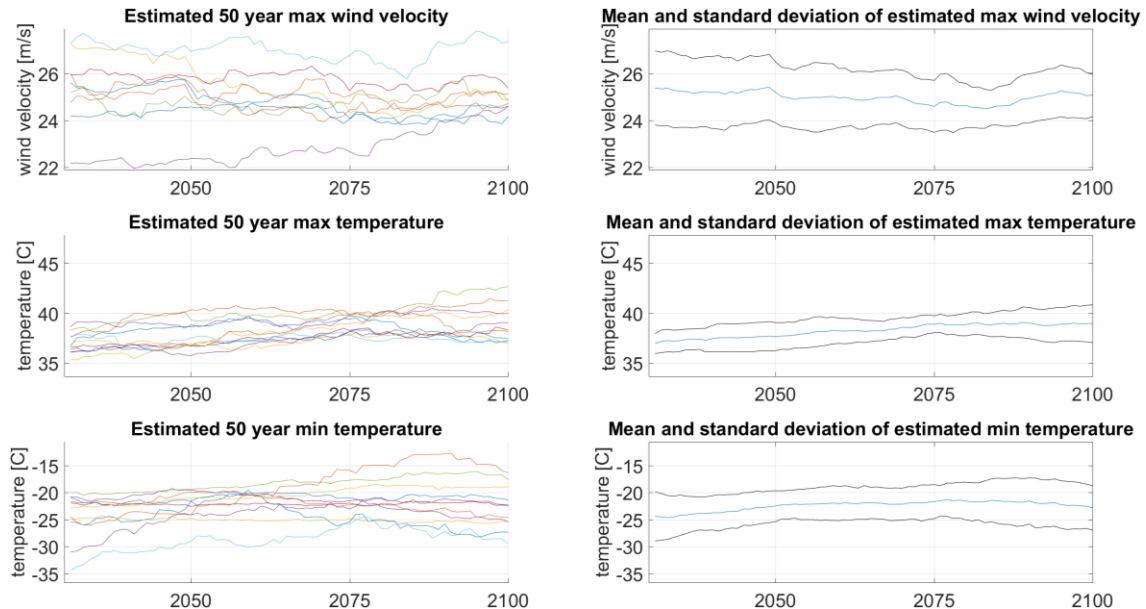


Figure C.7. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Karup Airport, with emission scenario of RCP 8.5 (top), RCP 4.5 (middle) and RCP 2.6 (bottom). Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Karup Airport and presented in Figure C.8.

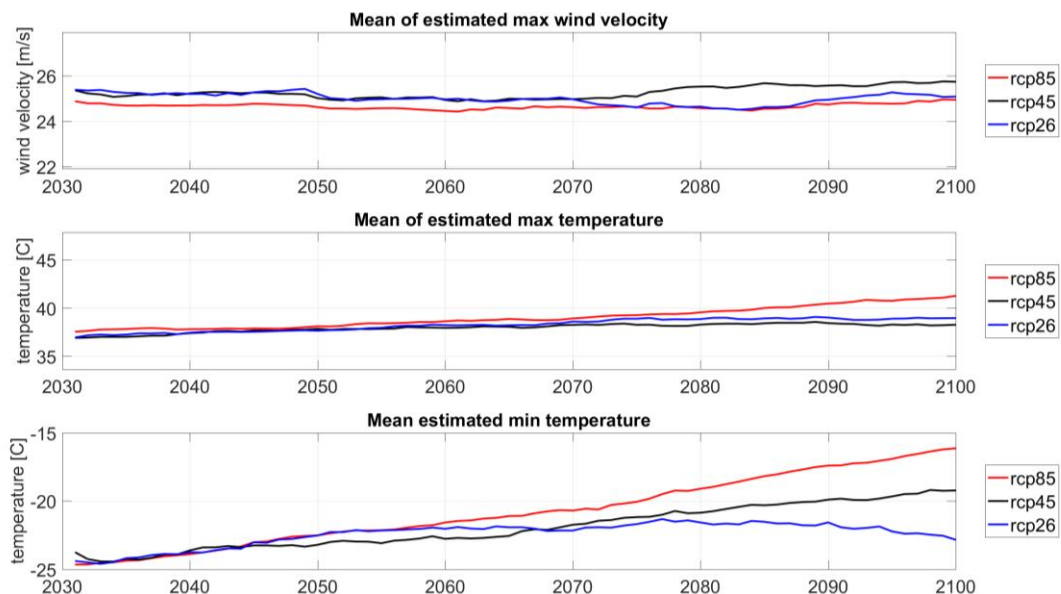


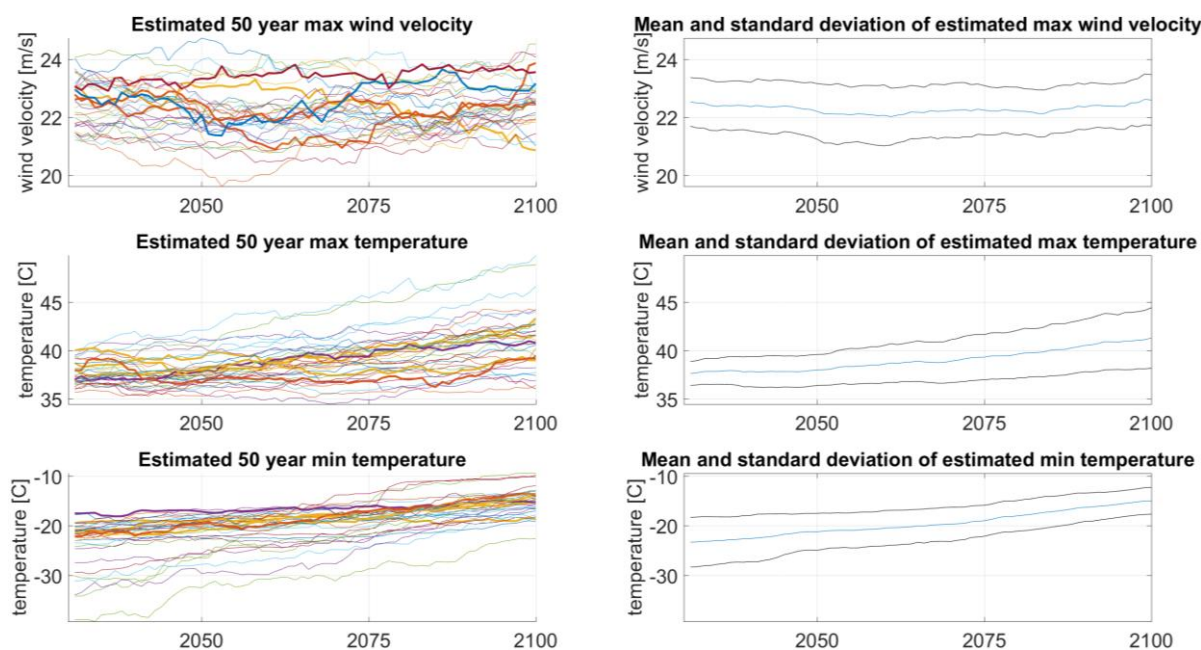
Figure C.8. The 50-year extreme estimation with different emission scenarios and averaged within different models for Karup Airport.



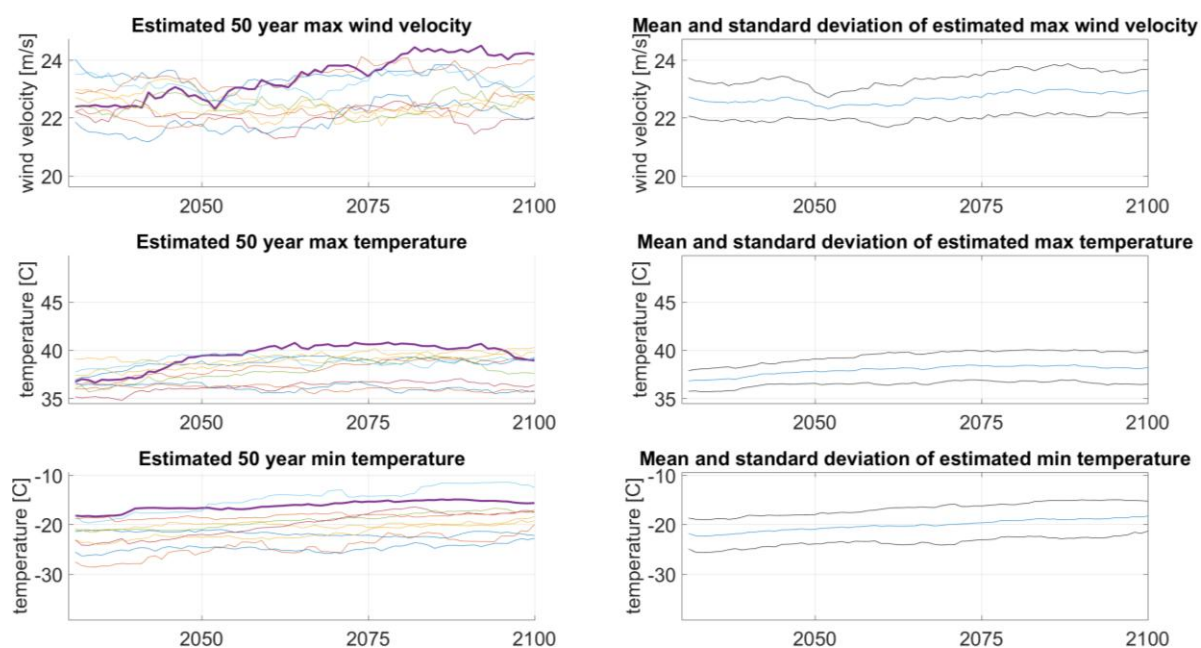
C.5. Billund

The 50-year extreme estimates of the projected maximum surface wind speed and maximum and minimum daily temperature, at Billund is presented in Figure C.9.

RCP 8.5:



RCP 4.5:





RCP 2.6

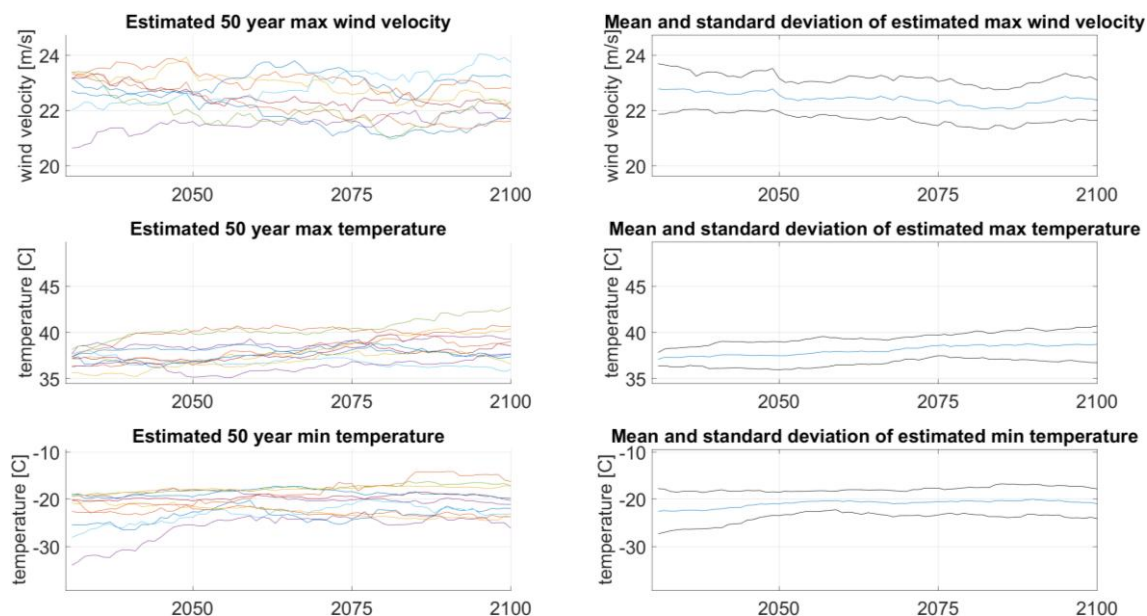


Figure C.9. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Billund, with emission scenario of RCP 8.5 (top), RCP 4.5 (middle) and RCP 2.6 (bottom). Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Billund and presented in Figure C.10.

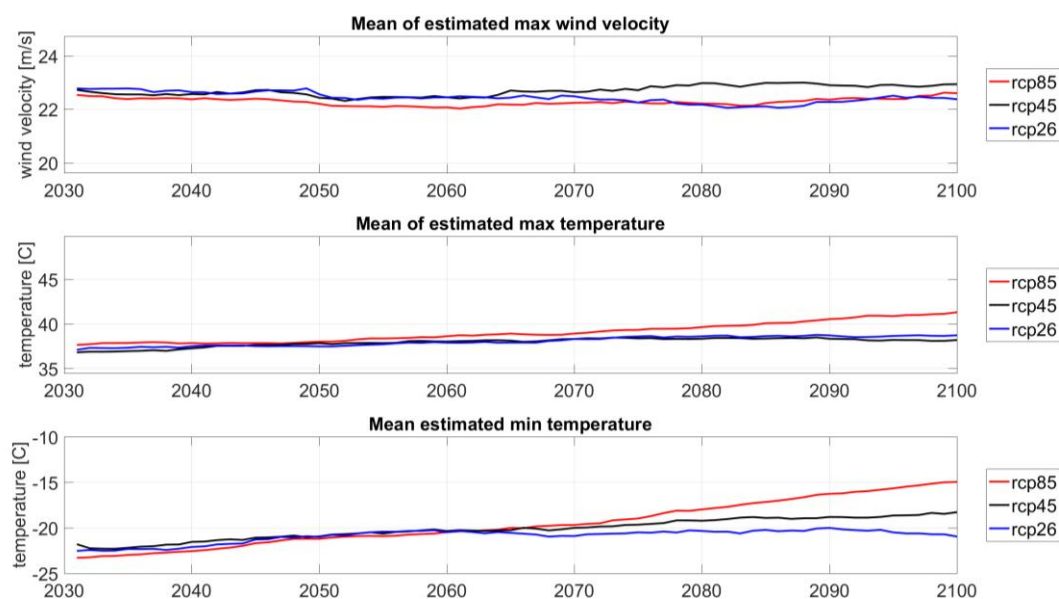


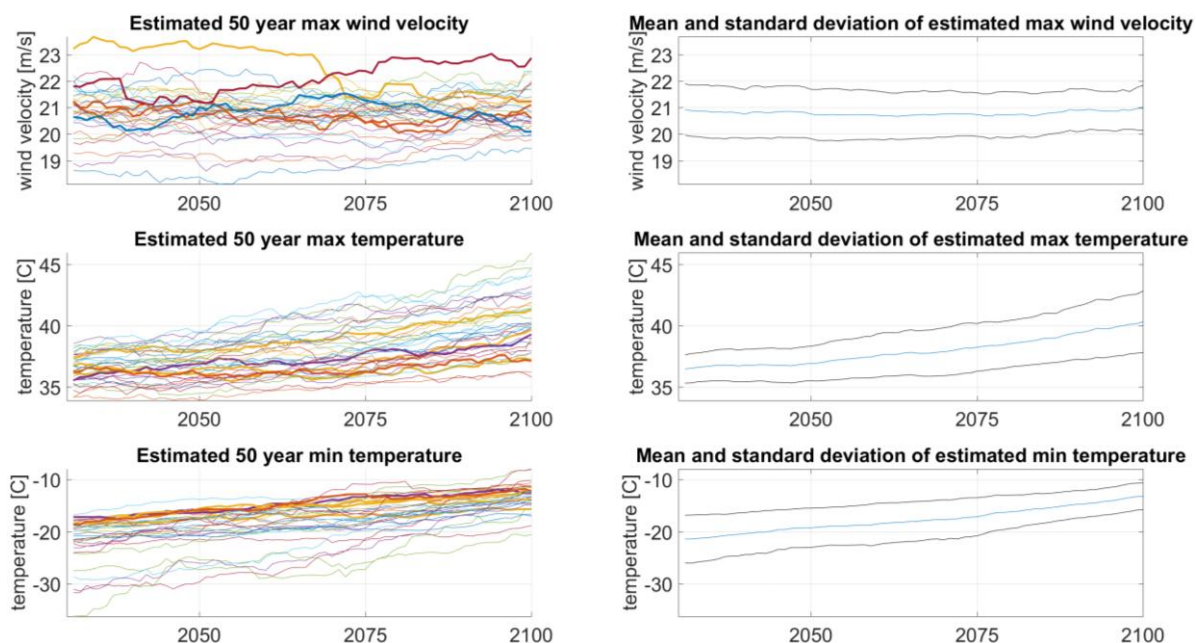
Figure C.10. The 50-year extreme estimation with different emission scenarios and averaged within different models for Billund.



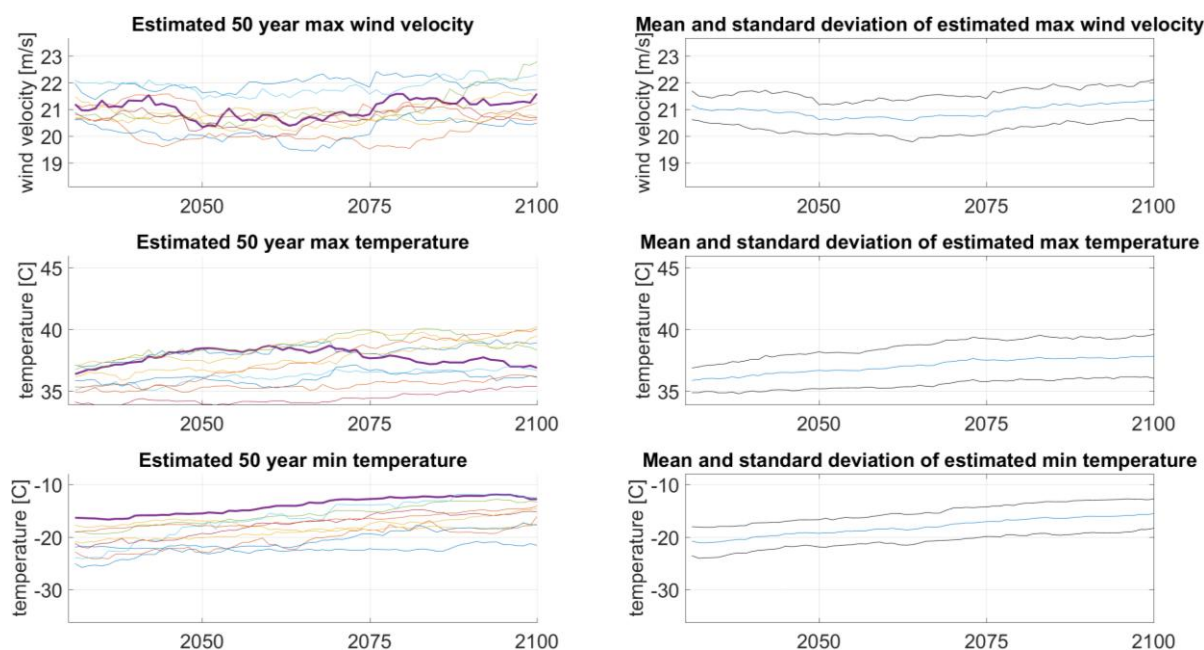
C.6. Roskilde Airport

The 50-year extreme estimates of the projected maximum surface wind speed and maximum and minimum daily temperature, at Roskilde Airport is presented in Figure C.11.

RCP 8.5:



RCP 4.5:





RCP 2.6

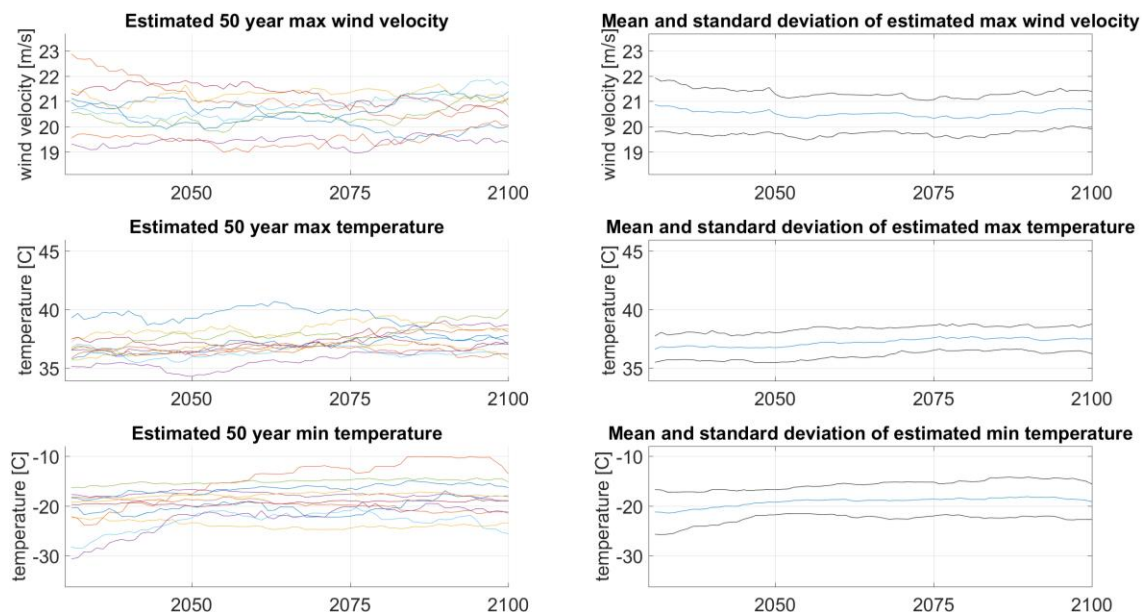


Figure C.11. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Roskilde Airport, with emission scenario of RCP 8.5 (top), RCP 4.5 (middle) and RCP 2.6 (bottom). Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Roskilde Airport and presented in Figure C.12.

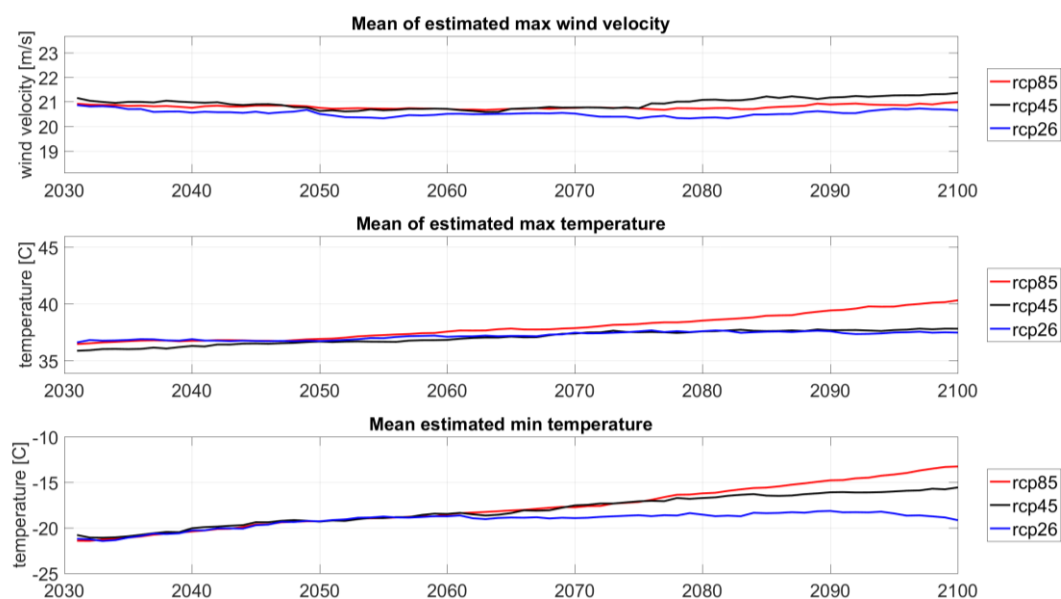


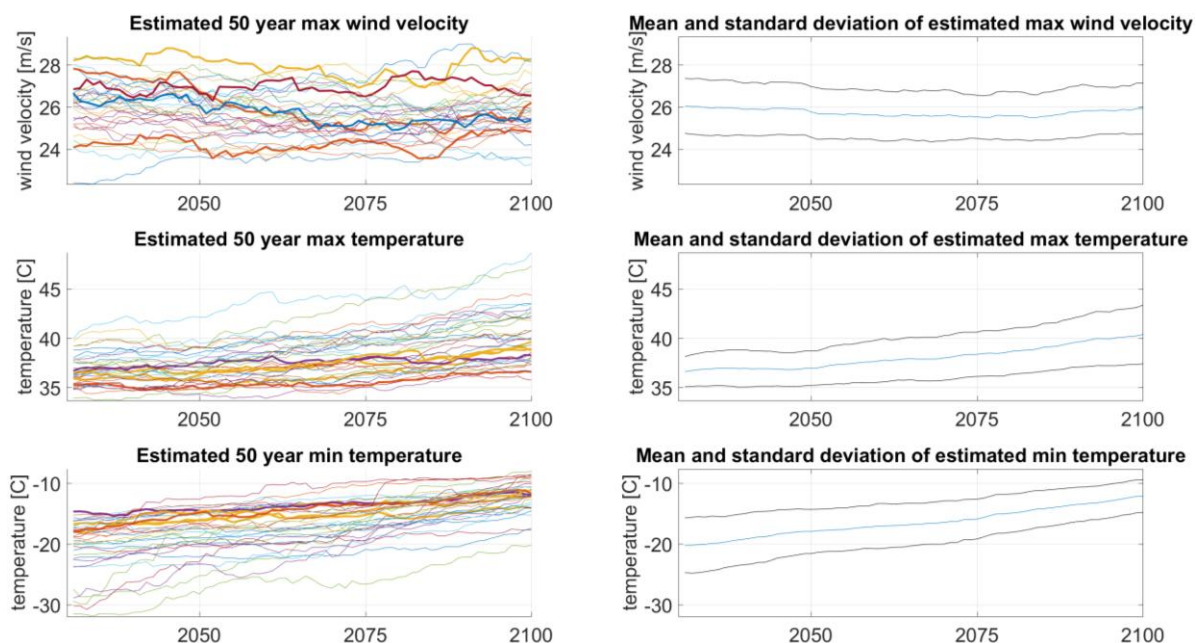
Figure C.12. The 50-year extreme estimation with different emission scenarios and averaged within different models for Roskilde Airport.



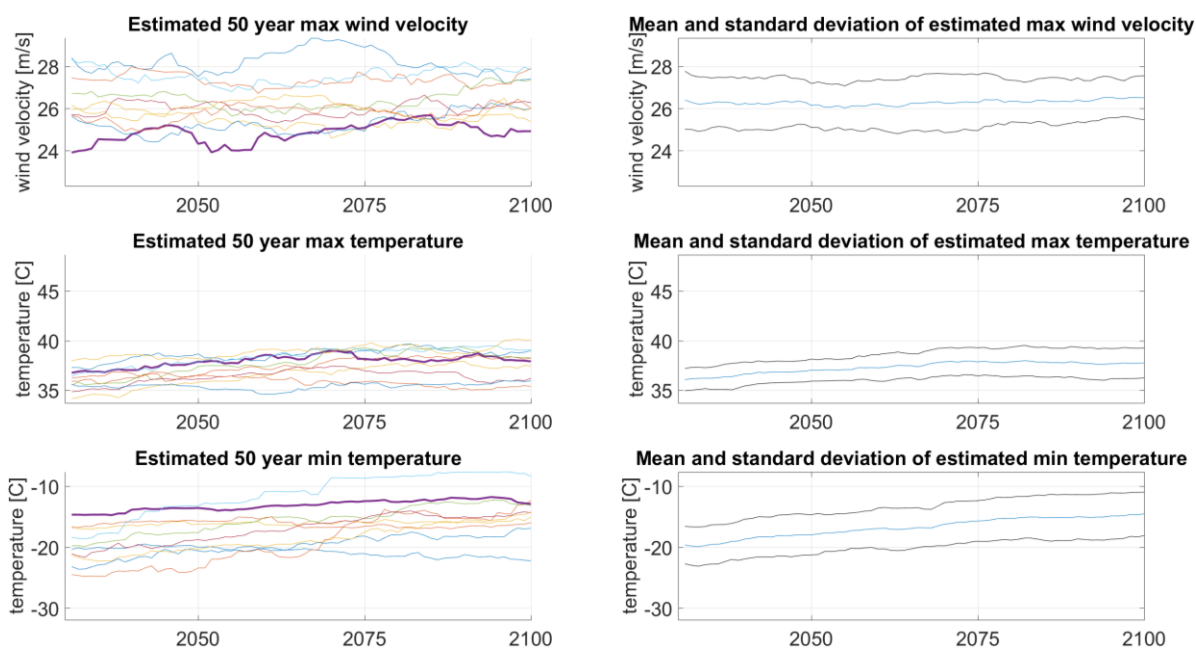
C.7. Årslev

The 50-year extreme estimates of the projected maximum surface wind speed and maximum and minimum daily temperature, at Årslev is presented in Figure C.13.

RCP 8.5:



RCP 4.5:





RCP 2.6

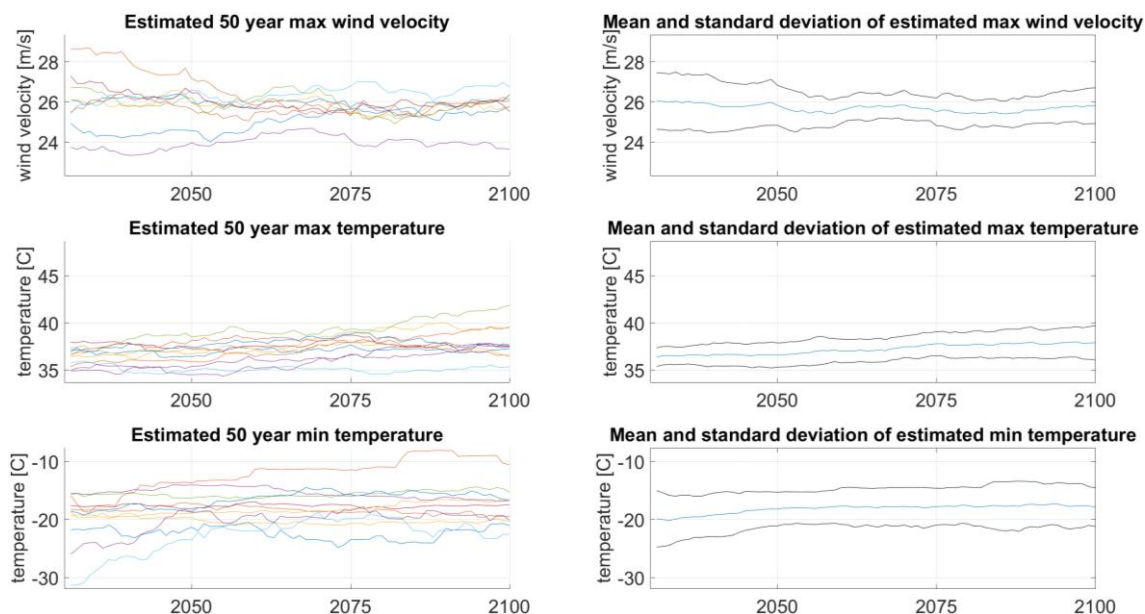


Figure C.13. 50-year extreme estimate of the maximum surface wind speed, and maximum and minimum temperatures at Årslev, with emission scenario of RCP 8.5 (top), RCP 4.5 (middle) and RCP 2.6 (bottom). Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Årslev and presented in Figure C.14.

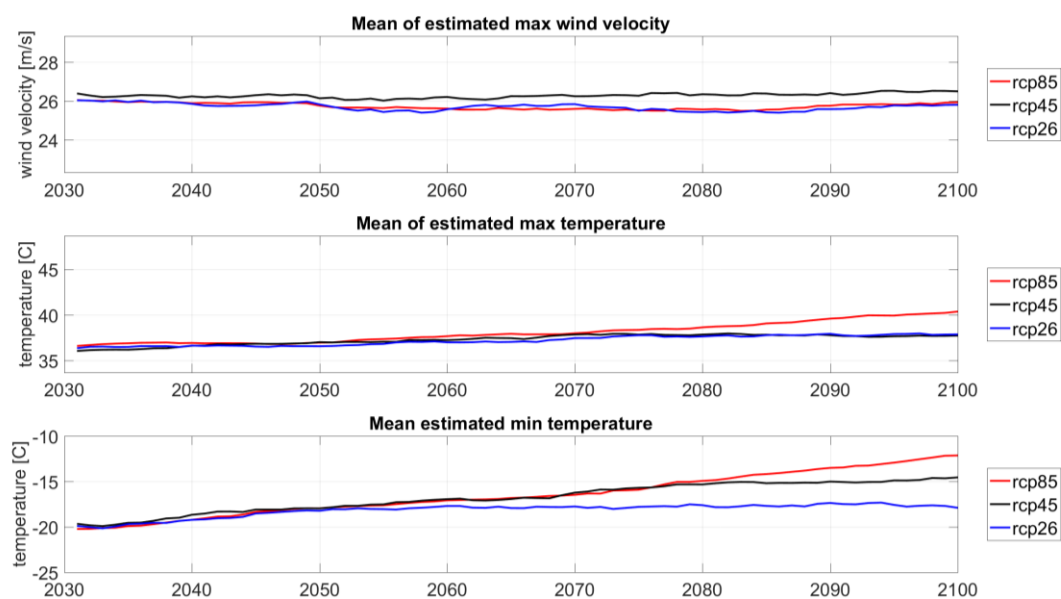


Figure C.14. The 50-year extreme estimation with different emission scenarios and averaged within different models for Årslev.



BASIC CLIMATE PARAMETERS IN DENMARK

Climate changes based on data from Danish Climate Atlas

ANNEX D

Results - Extreme value analysis for ground snow load

24.0058

March 23, 2026 - Revision 1

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This annex presents the results of statistical extreme value analysis of projected ground snow load for seven locations across Denmark. The data used in this study is provided by Danish Climate Atlas.



D.1. Lyngbyvej 100

The 50-year extreme estimates of the daily ground snow load, at Lyngbyvej 100, are presented in Figure D.1.

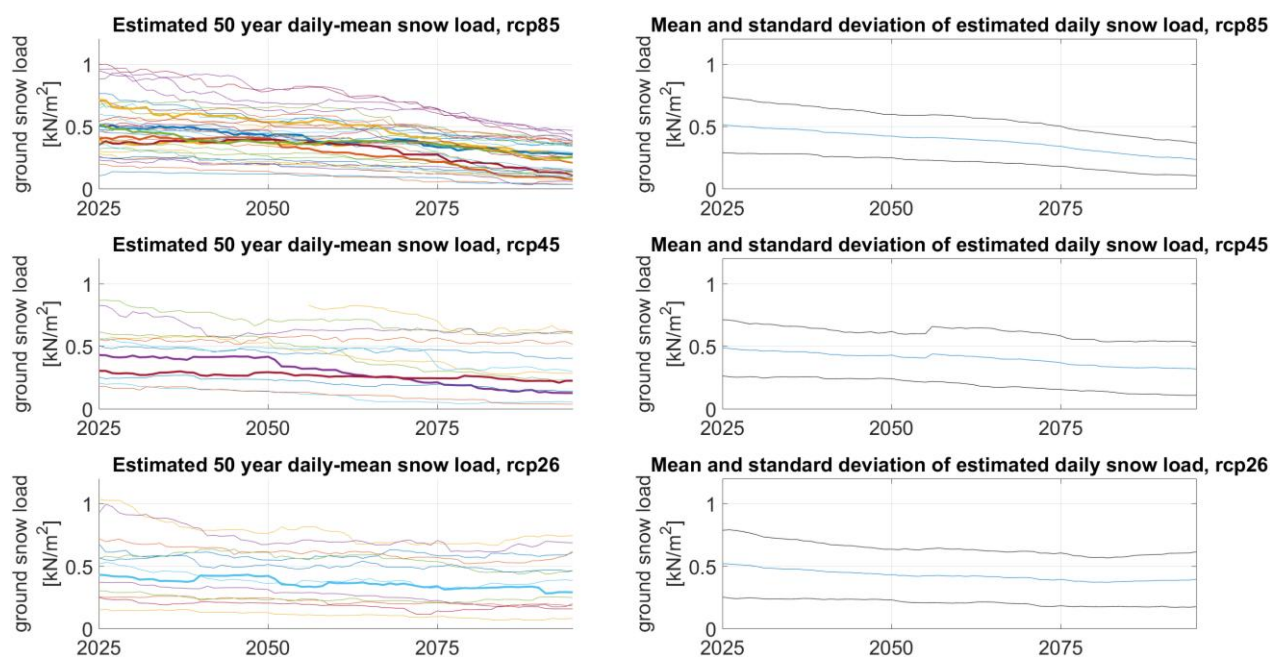


Figure D.1. 50-year extreme estimate of the daily mean ground snow load at Lyngbyvej 100, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Lyngbyvej 100 and presented in Figure D.2.

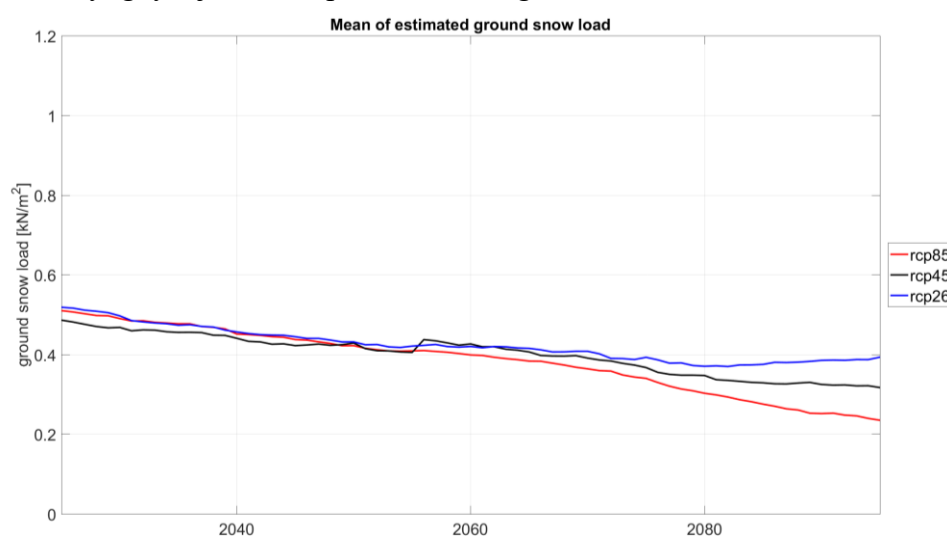


Figure D.2. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Lyngbyvej 100.



D.2. Holmsø

The 50-year extreme estimates of the daily ground snow load, at D.1. Holmsø, are presented in Figure D.3.

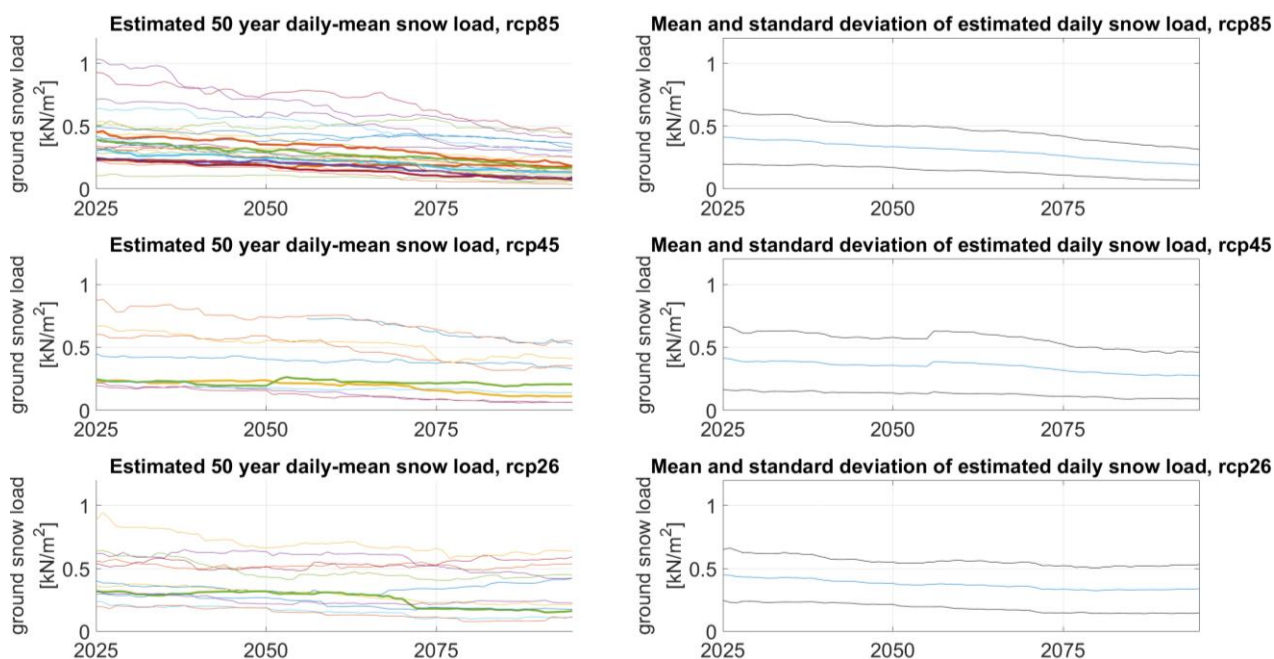


Figure D.3. 50-year extreme estimate of the daily mean ground snow load at Holmsø, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Holmsø and presented in Figure D.4.

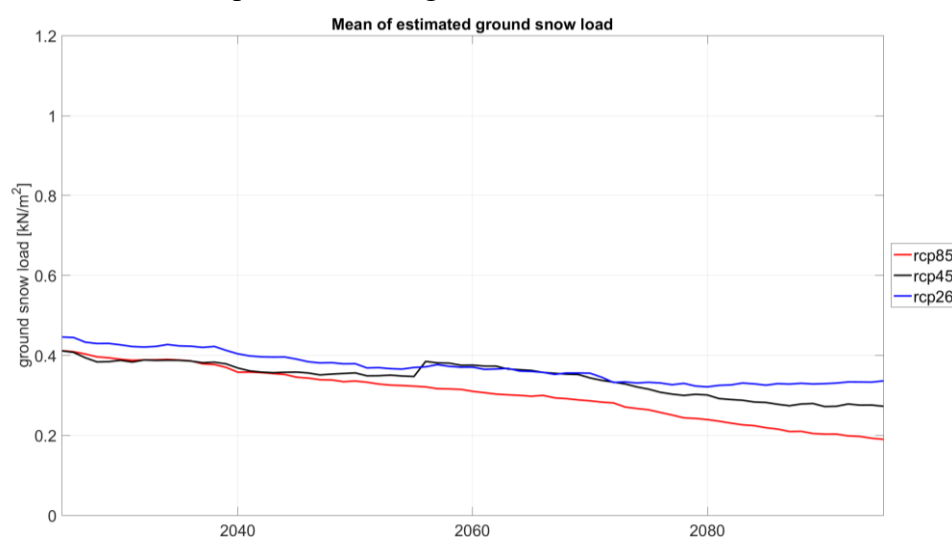


Figure D.4. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Holmsø.



D.3. Aalborg Airport

The 50-year extreme estimates of the daily ground snow load, at Aalborg Airport, are presented in Figure D.5.

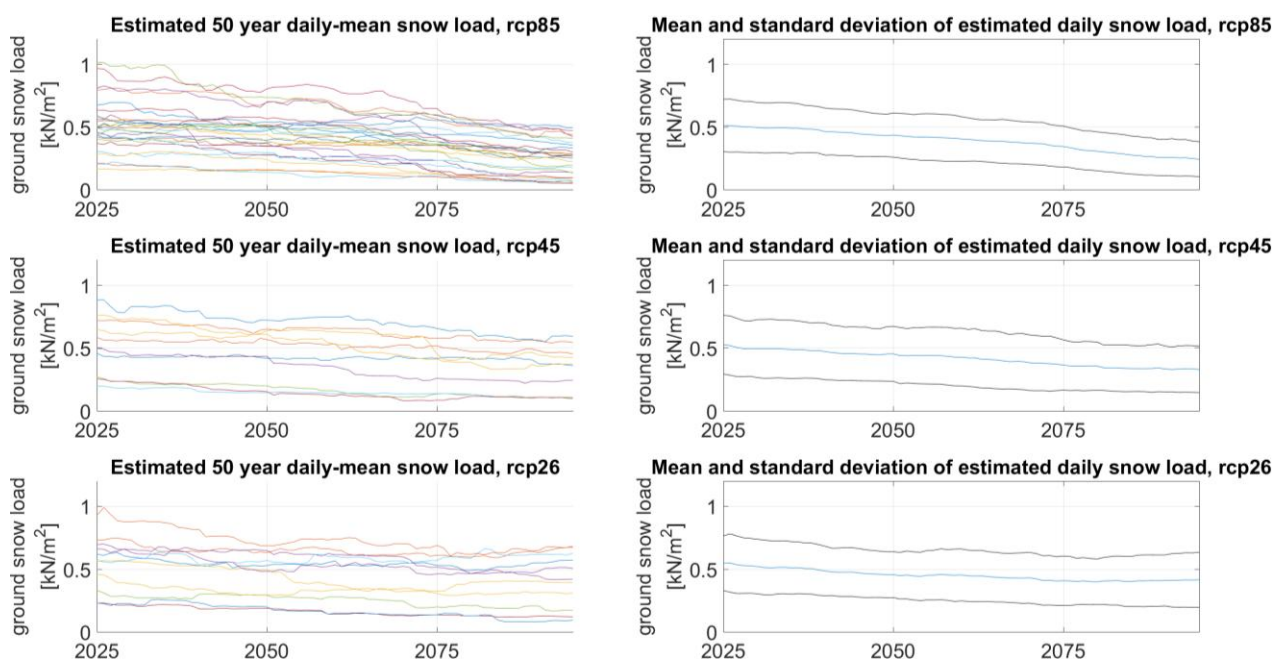


Figure D.5. 50-year extreme estimate of the daily mean ground snow load at Aalborg Airport, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Aalborg Airport and presented in Figure D.6.

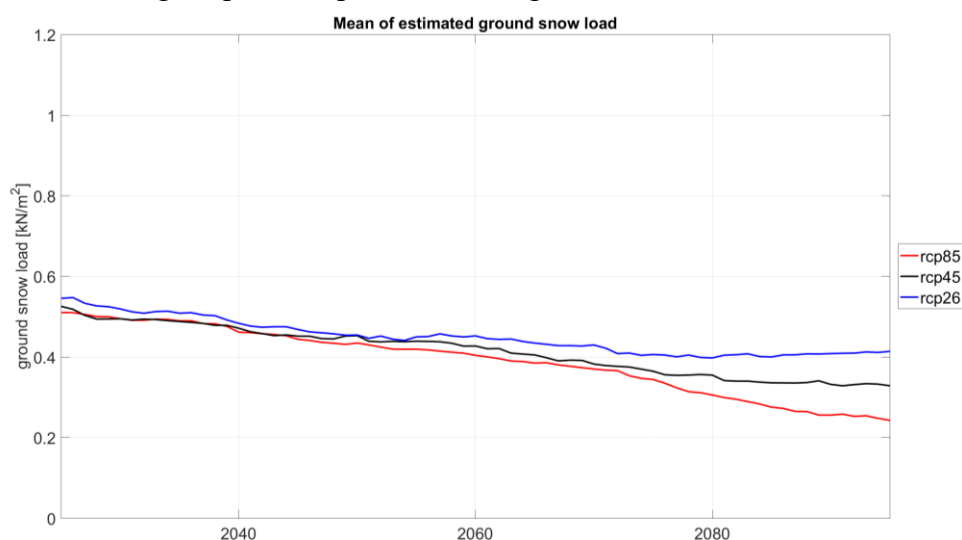


Figure D.6. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Aalborg Airport.



D.4. Karup Airport

The 50-year extreme estimates of the daily ground snow load, at Karup Airport, are presented in Figure D.7.

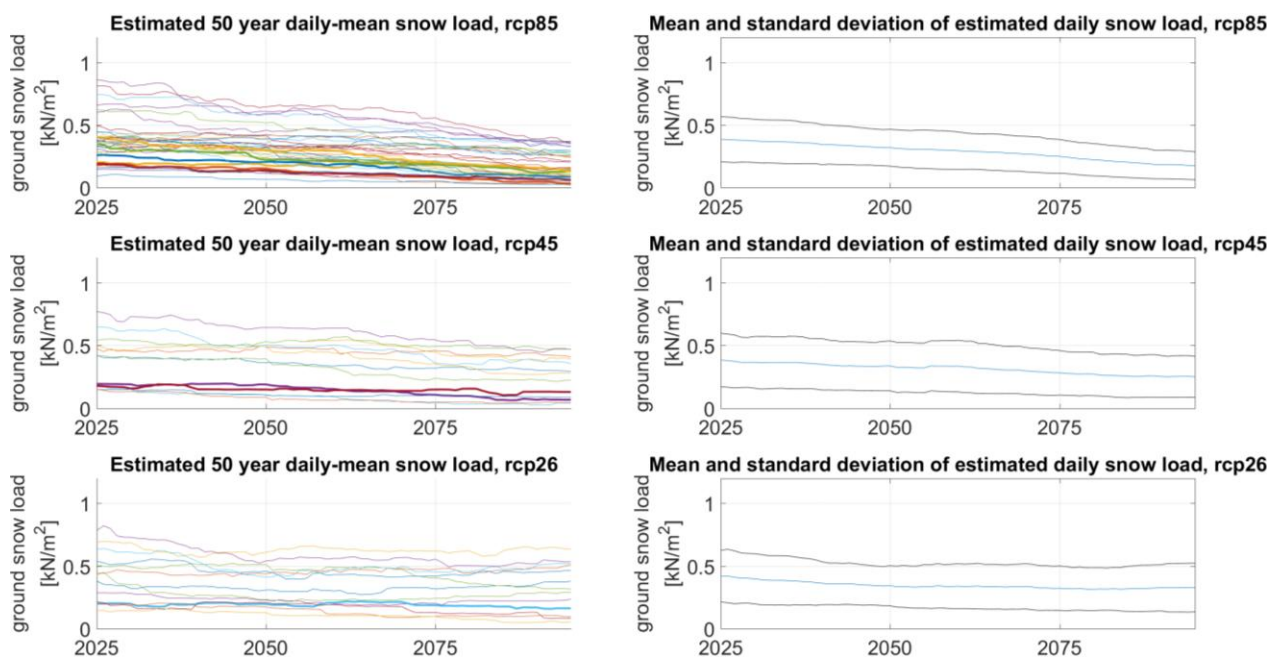


Figure D.7. 50-year extreme estimate of the daily mean ground snow load at Karup Airport, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Karup Airport and presented in Figure D.8.

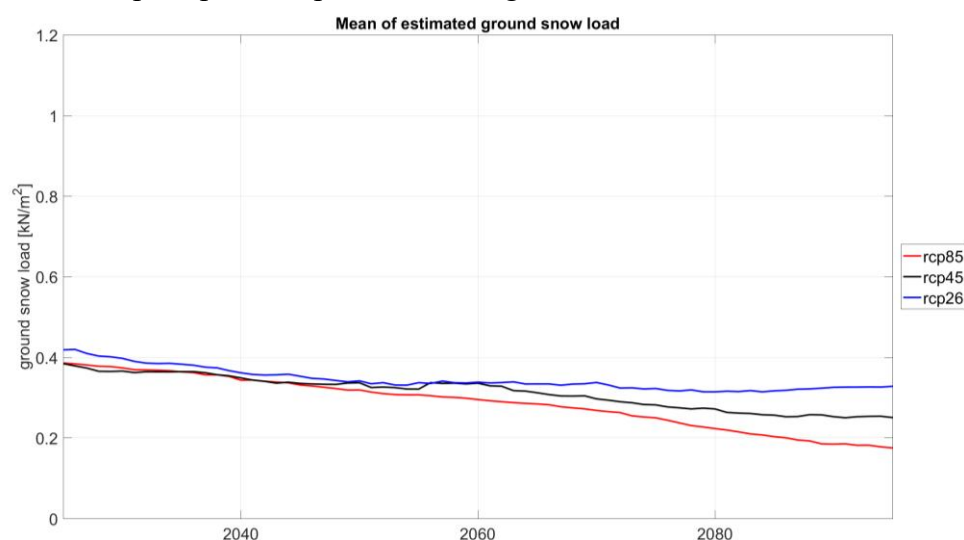


Figure D.8. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Karup Airport.



D.5. Billund

The 50-year extreme estimates of the daily ground snow load, at Billund, are presented in Figure D.9.

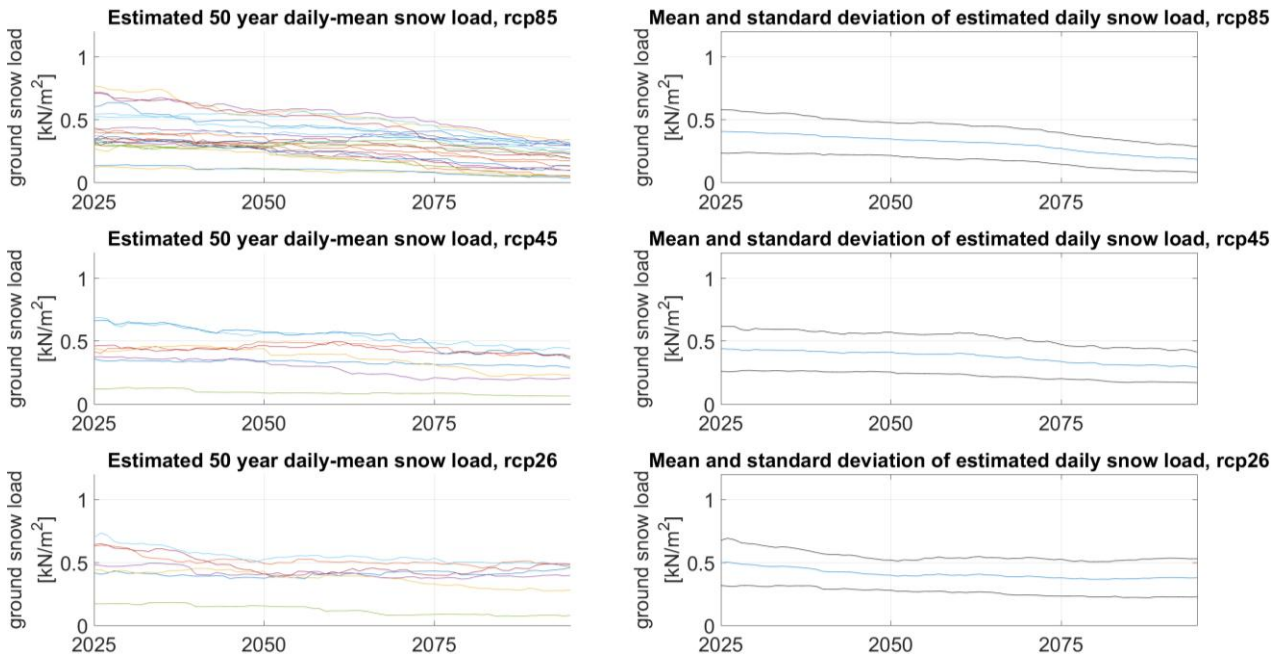


Figure D.9. 50-year extreme estimate of the daily mean ground snow load at Billund, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Billund and presented in Figure D.10.

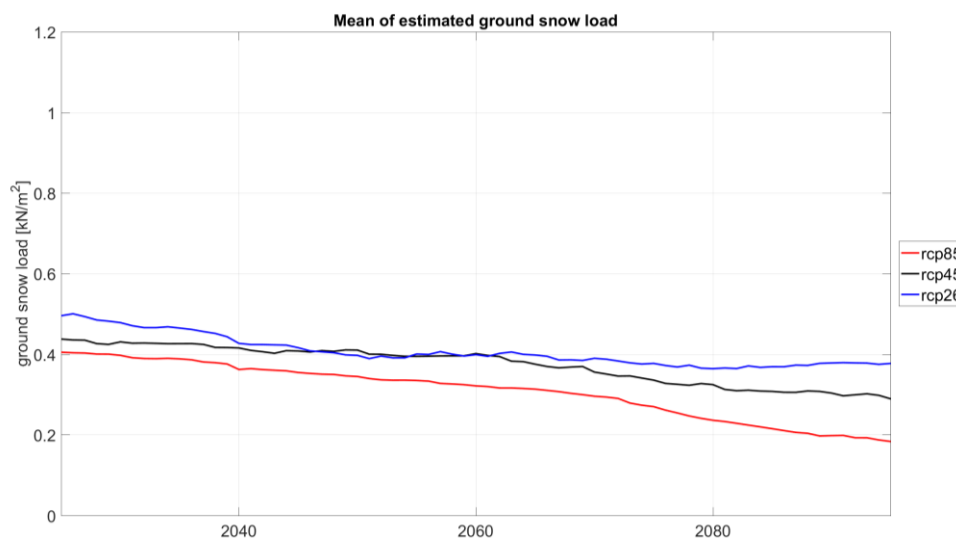


Figure D.10. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Billund.



D.6. Roskilde Airport

The 50-year extreme estimates of the daily ground snow load, at Roskilde Airport, are presented in Figure D.11.

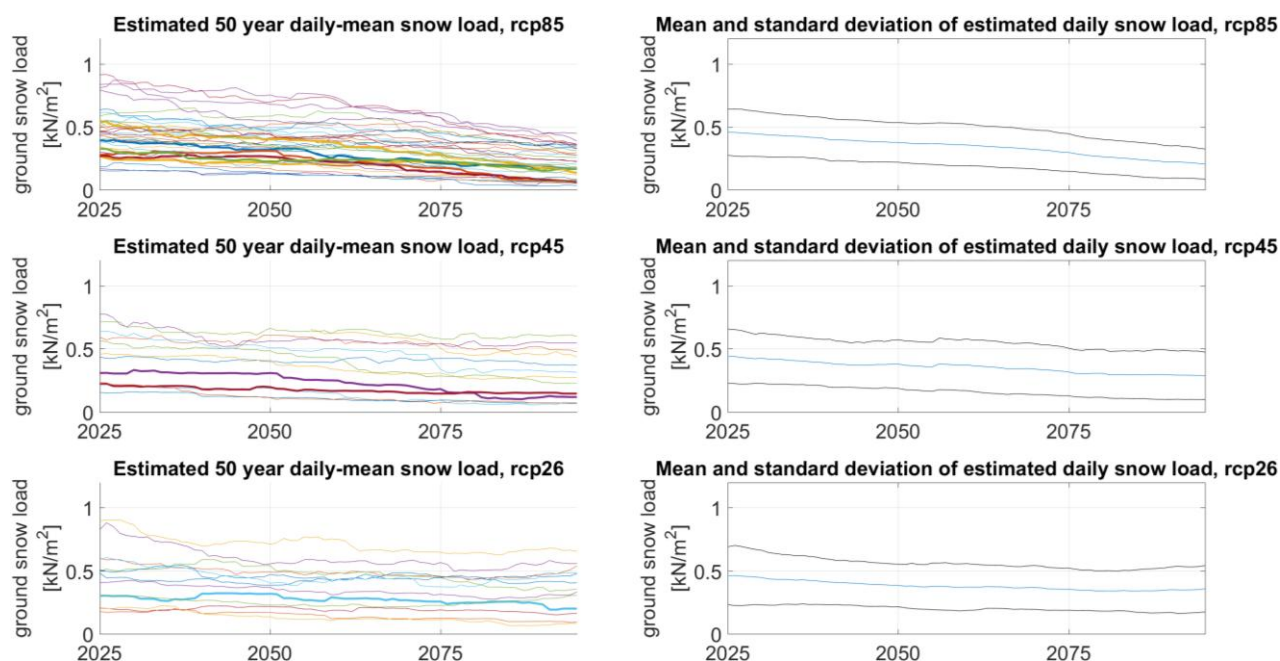


Figure D.11. 50-year extreme estimate of the daily mean ground snow load at Roskilde Airport, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Roskilde Airport and presented in Figure D.12.

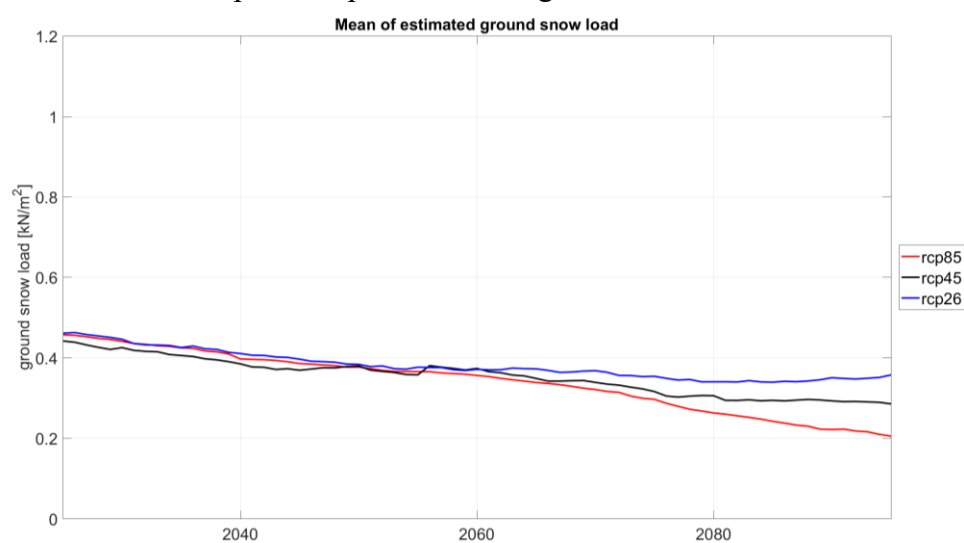


Figure D.12. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Roskilde Airport.



D.7. Årslev

The 50-year extreme estimates of the daily ground snow load, at Årslev, are presented in Figure D.13.

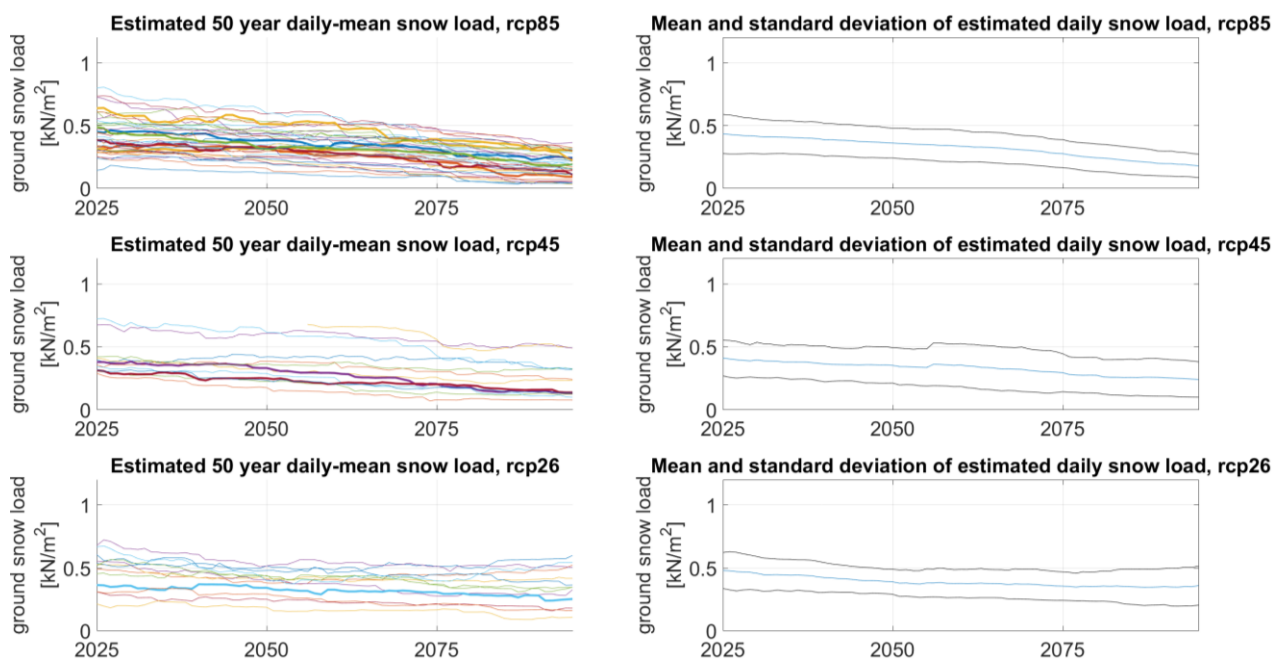


Figure D.13. 50-year extreme estimate of the daily mean ground snow load at Årslev, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The 50-year extreme estimation with different emission scenarios are averaged within different models for Årslev and presented in Figure D.14.

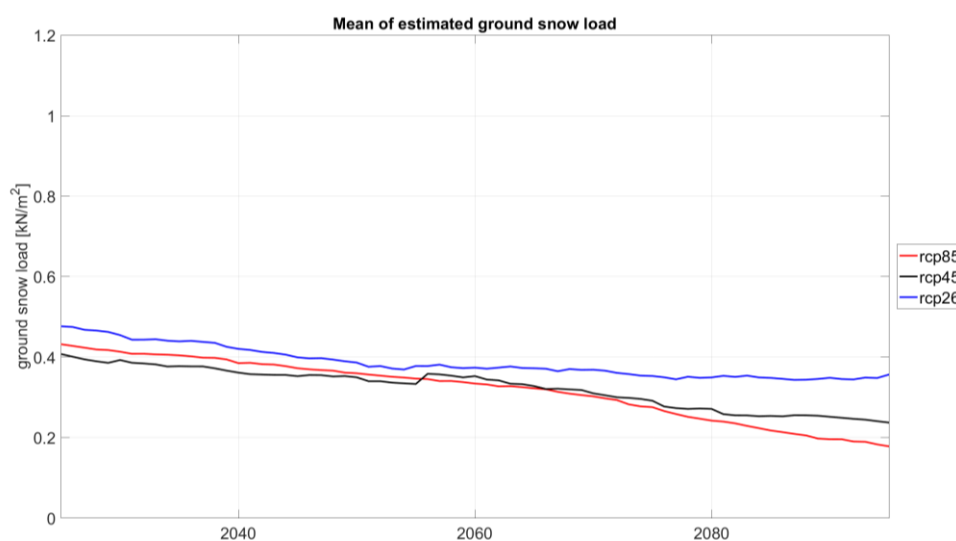


Figure D.14. The 50-year extreme estimation of ground snow load with different emission scenarios and averaged within different models for Årslev.



BASIC CLIMATE PARAMETERS IN DENMARK
Climate changes based on data from Danish Climate Atlas

ANNEX E

Results – Annual atmospheric icing days

24.0058

March 23, 2026 - Revision 0

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This annex presents the results of studying the annual number of atmospheric icing days based on projected daily humidity and temperature for seven locations across Denmark. The data used in this study is provided by Danish Climate Atlas. The meteorological condition for icing occurrence has been defined as:

- Daily mean temperature, T : $[-1.5, 1.5]$ °C
- Daily mean relative humidity, RH : $\geq 90\%$

The plots presented in the following sections were smoothed using a moving average with a 5-year sliding window to reduce interannual variability and highlight longer-term trends.



E.1. Lyngbyvej 100

The annual number of icing days, at Lyngbyvej 100, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas and presented in Figure E.1.

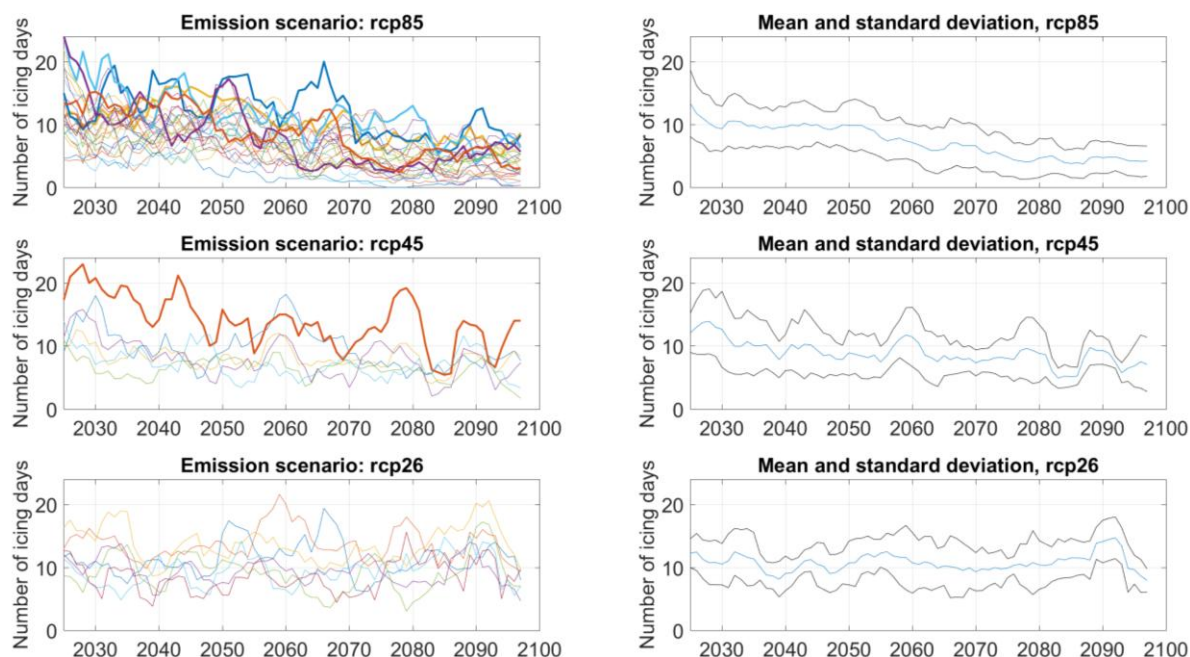


Figure E.1. Annual number of icing days at Lyngbyvej 100, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Lyngbyvej 100 and presented in Figure E.2.

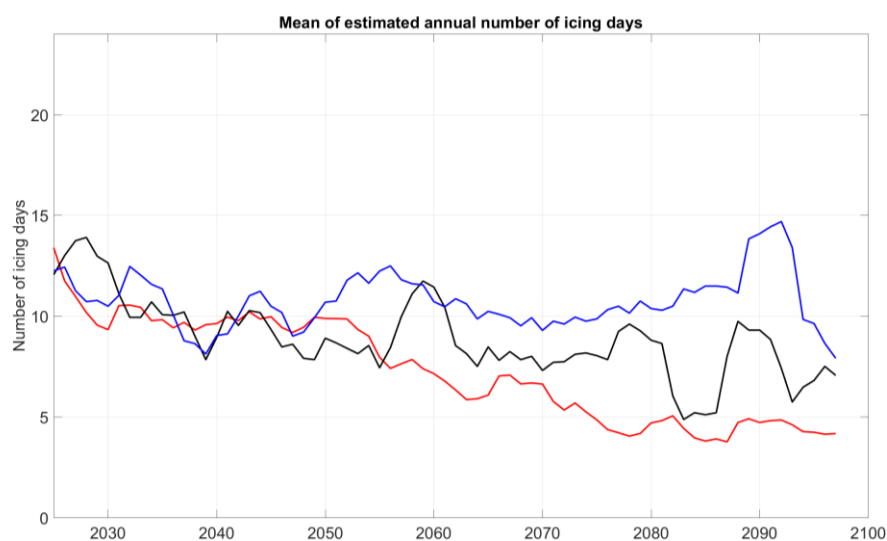


Figure E.2. The annual number of icing days with different emission scenarios and averaged within different models for Lyngbyvej 100.



E.2. Klitmøller

The annual number of icing days, at Klitmøller, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas and presented in Figure E.3.

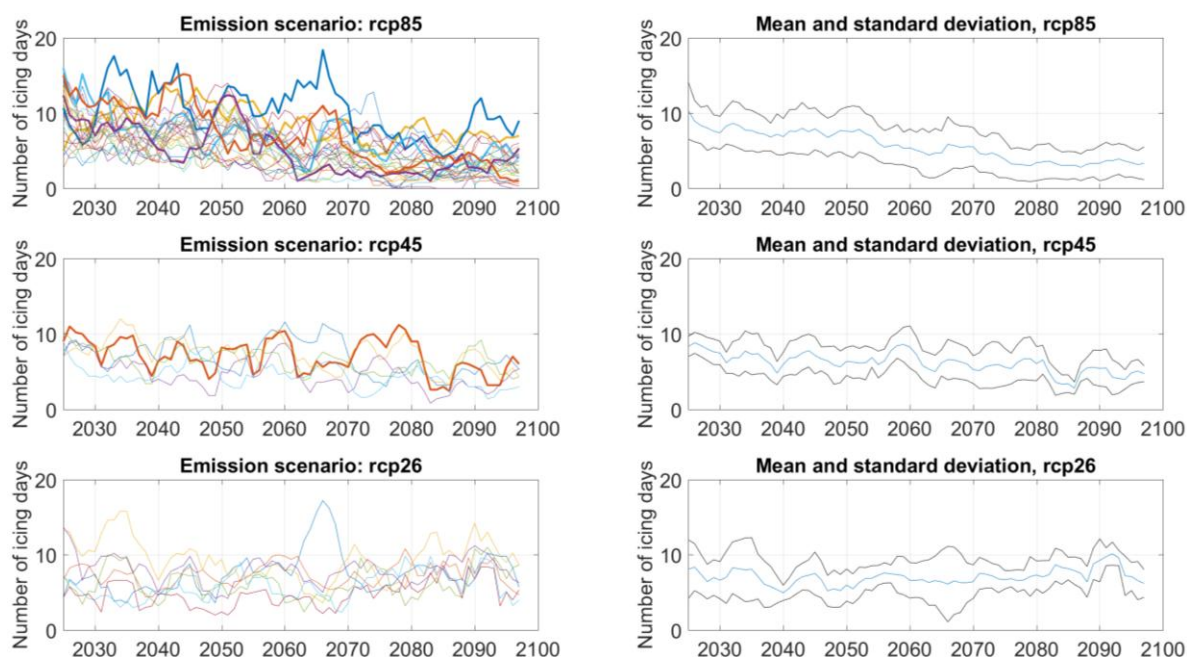


Figure E.3. Annual number of icing days at Klitmøller, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Klitmøller and presented in Figure E.4.

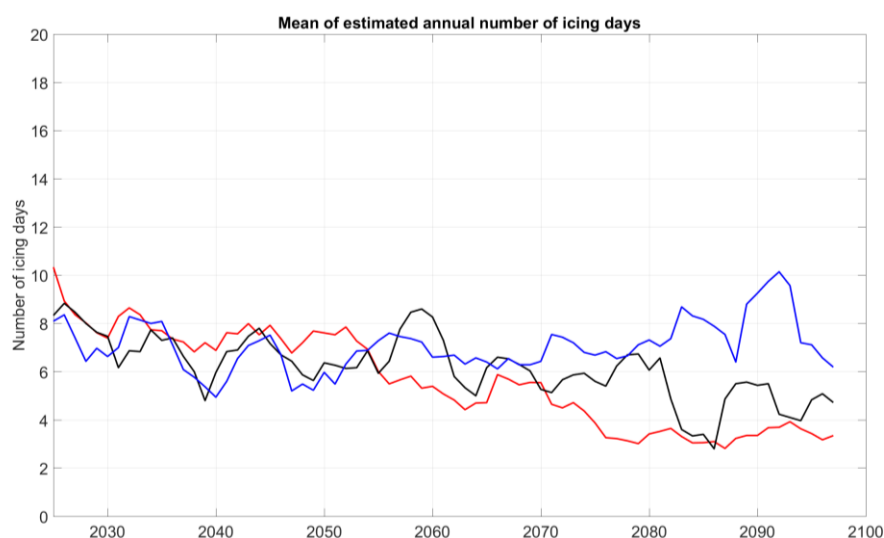


Figure E.4. The annual number of icing days with different emission scenarios and averaged within different models for Klitmøller.



E.3. Aalborg Airport

The annual number of icing days, at Aalborg Airport, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas and presented in Figure E.5.

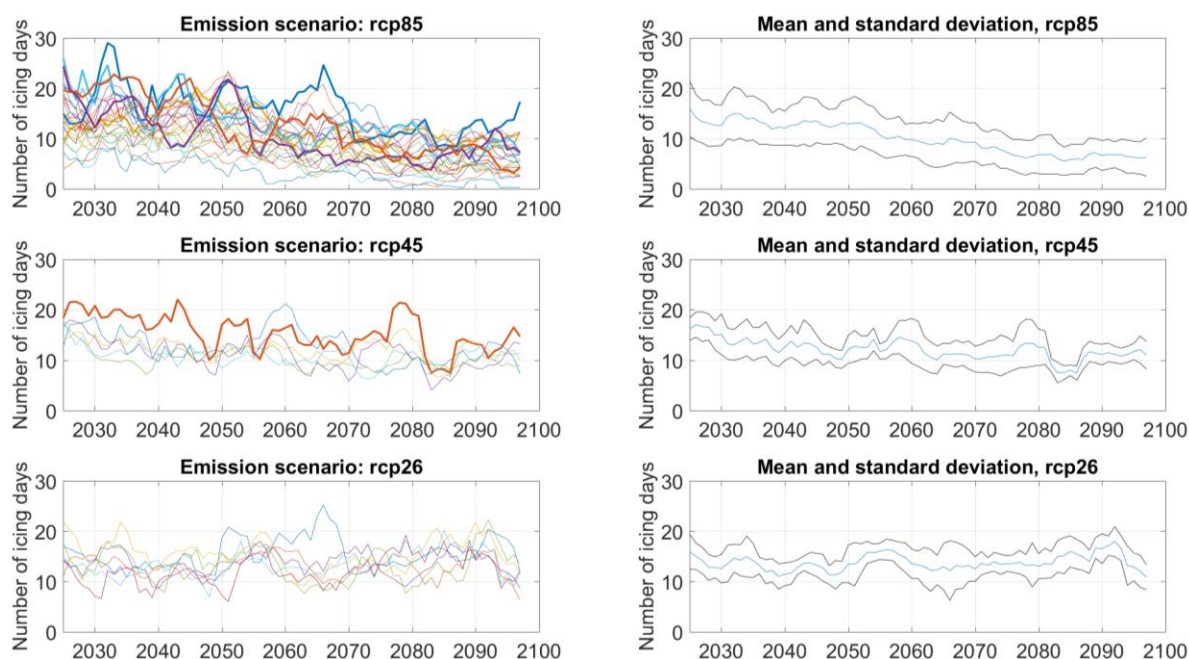


Figure E.5. Annual number of icing days at Aalborg Airport, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Aalborg Airport and presented in Figure E.6.

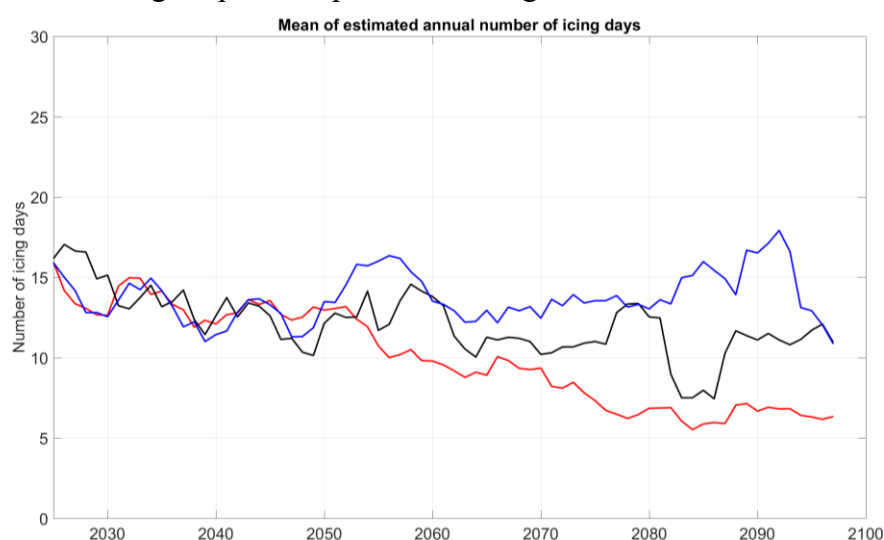


Figure E.6. The annual number of icing days with different emission scenarios and averaged within different models for Lyngbyvej 100.



E.4. Karup Airport

The annual number of icing days, at Karup Airport, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas and presented in Figure E.7.

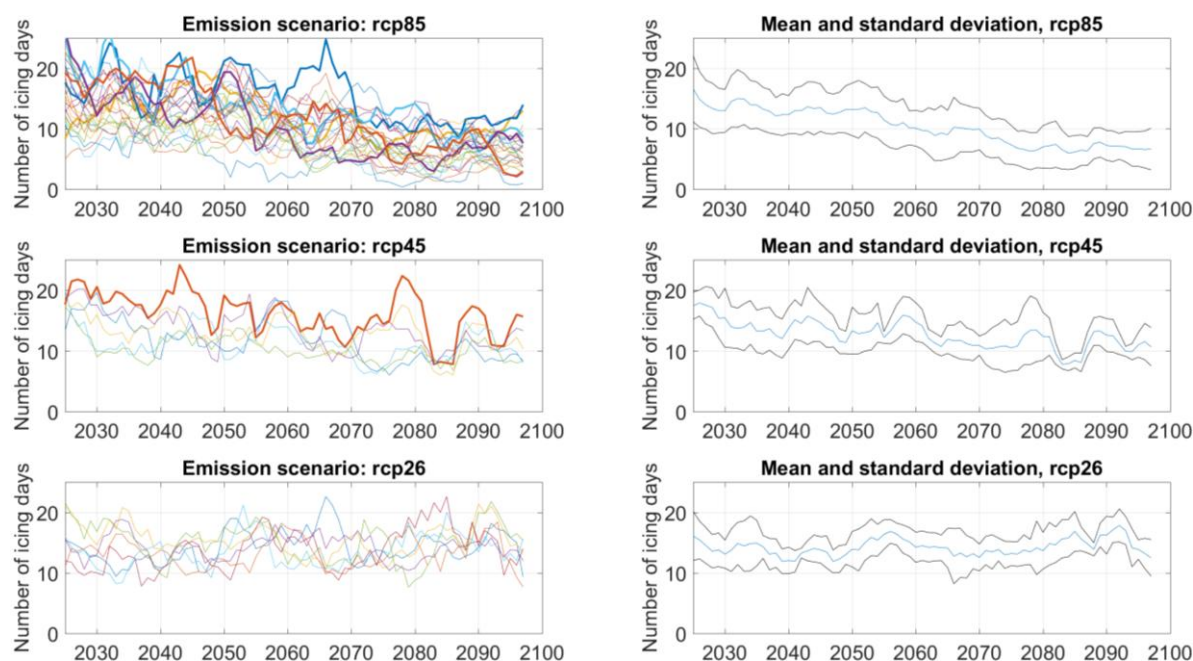


Figure E.7. Annual number of icing days at Karup Airport, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Karup Airport and presented in Figure E.8.

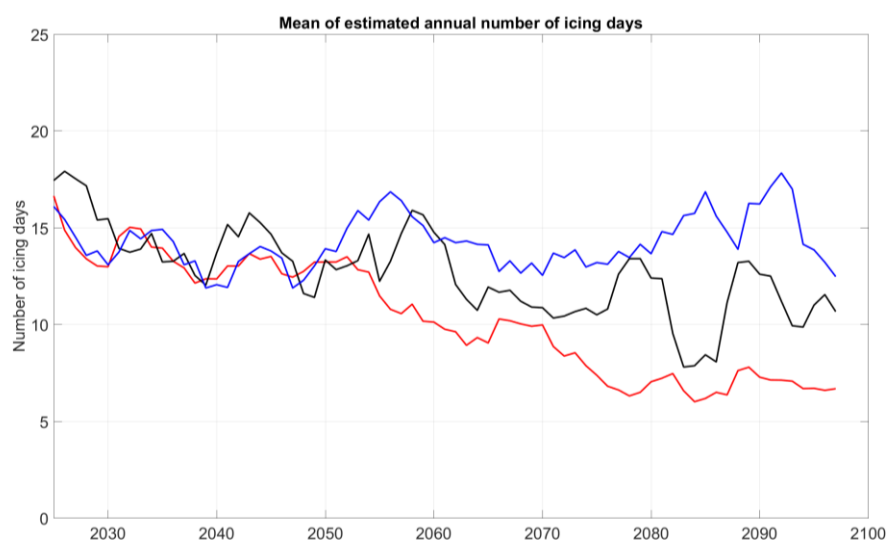


Figure E.8. The annual number of icing days with different emission scenarios and averaged within different models for Karup Airport.



E.5. Billund

The annual number of icing days, at Billund, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas and presented in Figure E.9.

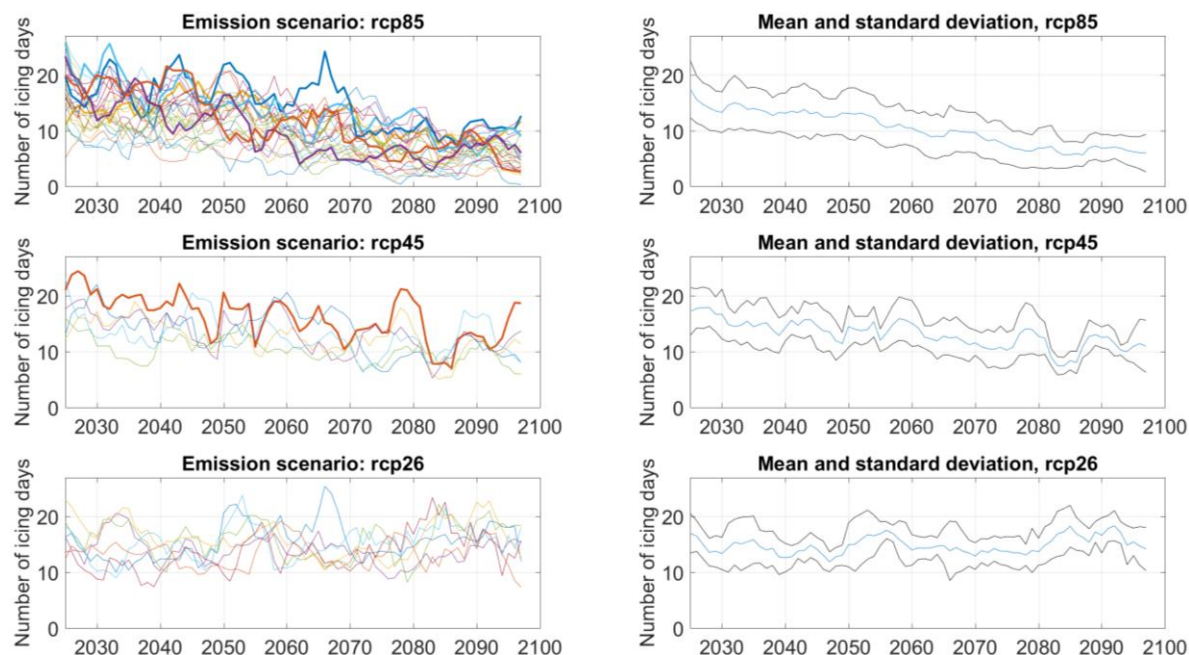


Figure E.9. Annual number of icing days at Billund, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Billund and presented in Figure E.10.

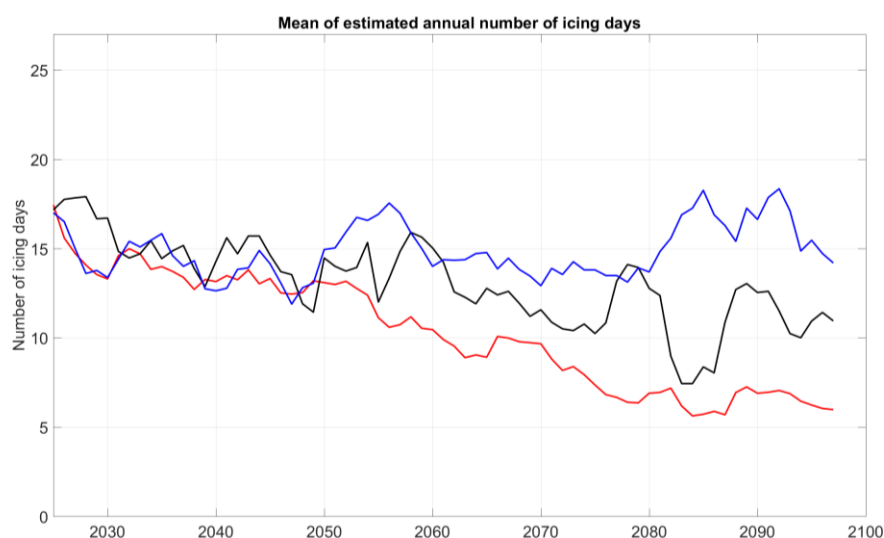


Figure E.10. The annual number of icing days with different emission scenarios and averaged within different models for Billund.



E.6. Roskilde Airport

The annual number of icing days, at Roskilde Airport, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas and presented in Figure E.11.

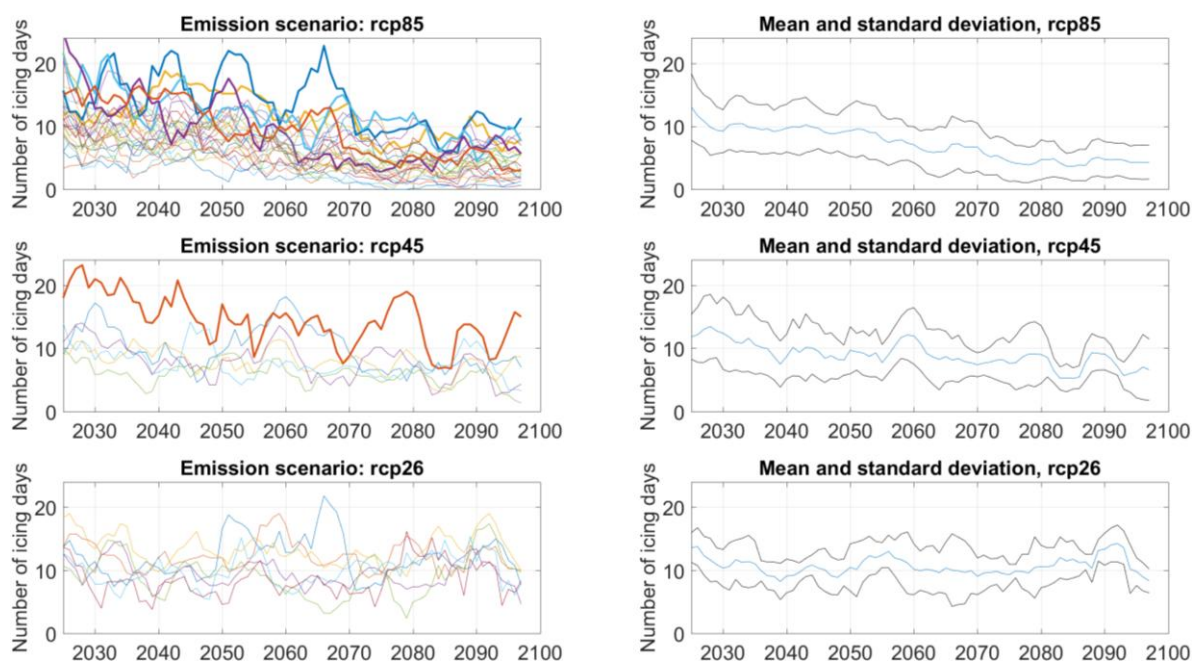


Figure E.11. Annual number of icing days at Roskilde Airport, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Roskilde Airport and presented in Figure E.12.

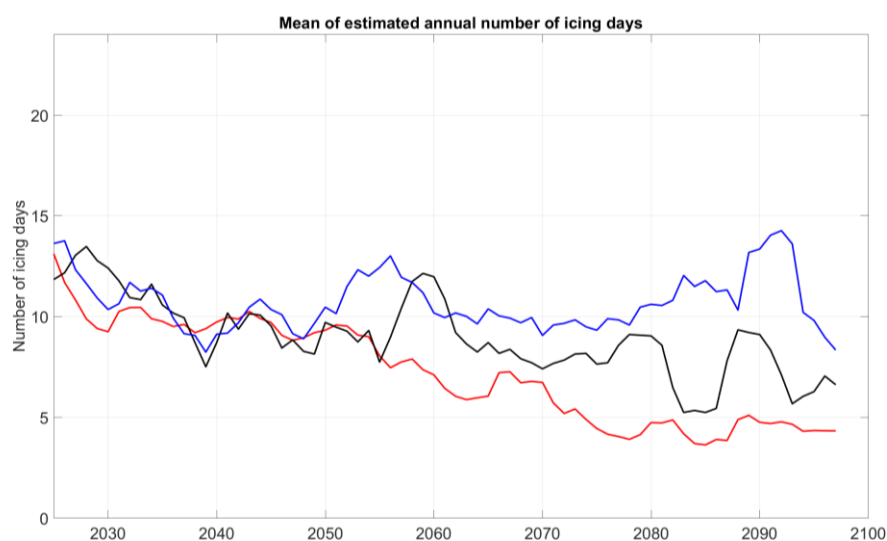


Figure E.12. The annual number of icing days with different emission scenarios and averaged within different models for Roskilde Airport.



E.7. Årslev

The annual number of icing days, at Årslev, has been estimated using the projected humidity and surface air temperature from Danish Climate Atlas and presented in Figure E.13.

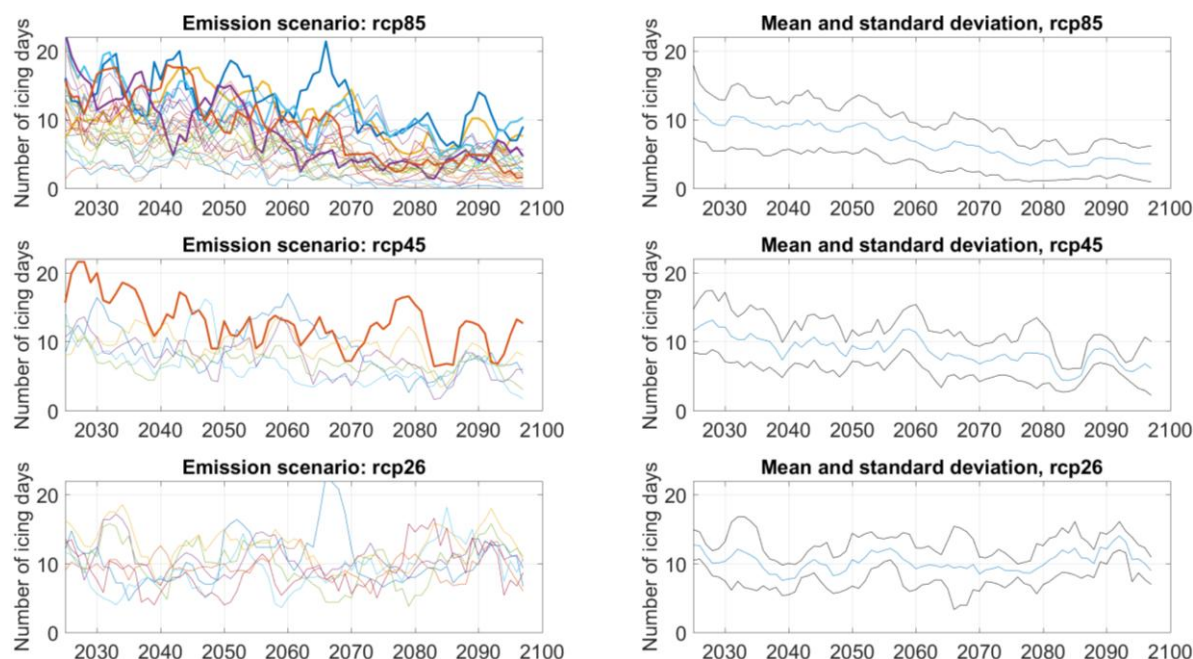


Figure E.13. Annual number of icing days at Årslev, with emission scenarios of RCP 8.5, RCP 4.5 and RCP 2.6. Left: Different colors in plots represent combinations of global and regional climate models, thick lines represent the models combined with DMI regional model. Right: Average of all the models (blue) and average $\pm \sigma$ (black), where σ is the standard deviation.

The annual number of icing days with different emission scenarios are averaged within different models for Årslev and presented in Figure E.14.

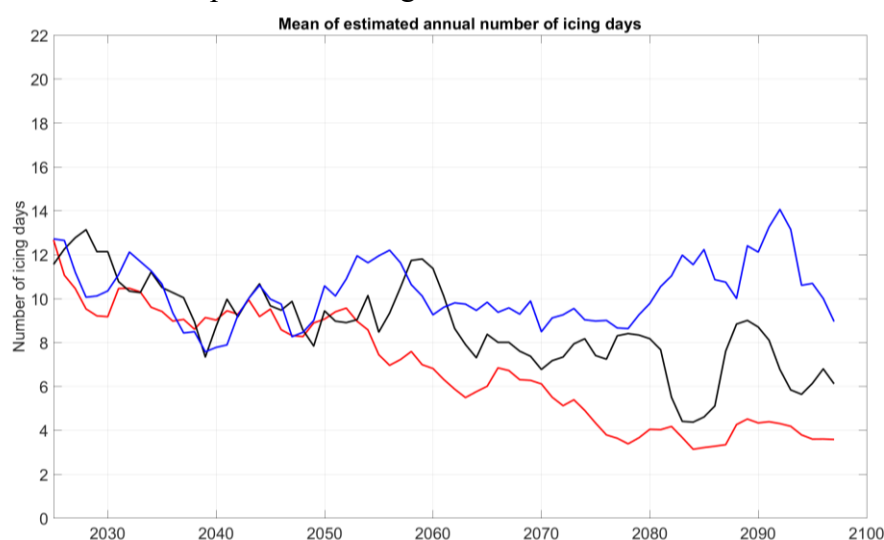


Figure E.14. The annual number of icing days with different emission scenarios and averaged within different models for Årslev.