DMI

# Future Sea Level Rise in Denmark

National Center for Climate Research
Danish Meteorological Institute

December 2025

# Future Sea Level Rise in Denmark

Sea level rise is an unavoidable part of our future. Global warming leads to increased melting of glaciers and ice sheets in Greenland and Antarctica, contributing meltwater to the world's oceans. At the same time, the ocean expands due to warming, causing global sea levels to rise even further.

The primary short-term risks associated with sea level rise in Denmark include more frequent and intense storm surges leading to flooding of coastal areas, infrastructure, and properties. In the longer term, permanent flooding of coastal zones will also become a growing problem, along with saltwater intrusion and rising groundwater levels.

This brief is not a scientific publication but rather The National Centre for Climate Research's (NCKF) communication and overview of a scientific topic with significant societal relevance. The brief outlines both the expected and most likely sea level rise scenarios in Denmark and the uncertainties related to projections, including the risk of higher rises than currently anticipated. The basis of this brief is the IPCC's thorough assessments across all relevant climate research, as well as NCKF's evaluation of whether new knowledge - taken together and across multiple studies - indicates a shift in the IPCC's conclusions. It is NCKF's assessment that there is no scientific basis that alters the validity of IPCC's projections of future sea level rise.

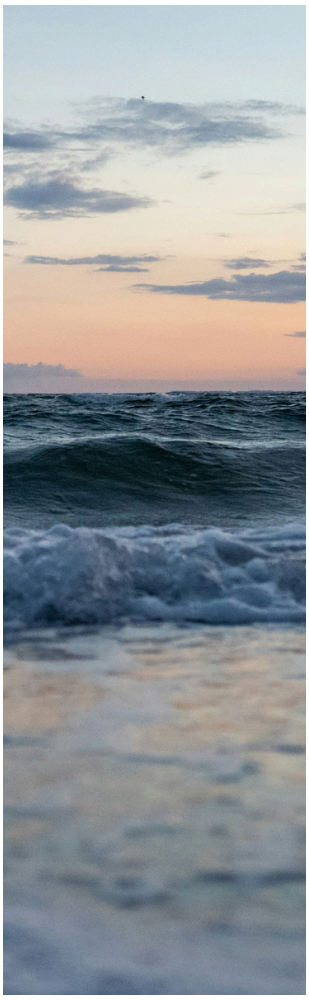
**Box 1**

### National Center for Climate Research at DMI

The National Center for Climate Research (NCKF) at the Danish Meteorological Institute (DMI) conducts internationally recognized climate research, primarily published in scientific journals. In addition, NCKF serves as the Danish government's scientific advisor on climate matters (cf. Section 9 of the Climate Act, *Klimaloven*), which includes gathering knowledge from national and international research and communicating data and assessments on climate change. This is done, for example, through the climate service *Klimaatlas*, which presents authoritative data from the UN's Inter-governmental Panel on Climate Change (IPCC) adapted for Danish conditions.

NCKF also acts as Denmark's official point of contact to the IPCC, meaning that NCKF collaborates with other countries on behalf of the Kingdom of Denmark to help define the basis for the IPCC's work and approve the policy summaries of the major IPCC reports.

## How Much Will the Sea Rise in Denmark by the Year 2100?



- **Large variations in sea level are known from Earth's distant past.** Sea level was 120 meters lower than today during the last Ice Age 20,000 years ago, when the climate was about 5°C colder. Conversely, sea level was up to 75 meters higher about 50 million years ago during a very warm period (10–18°C warmer than today)[1].

- **Global sea level has risen by nearly 25 centimeters[2] since 1900 and the rise is accelerating.** Over the past decade (2015–2024), the global sea level has risen on average by 4.7 millimeters per year, double the rate compared to the period from 1993 to 2002[3].

- **Current global climate policies are expected to lead to a further 40–50 centimeter sea level rise in Denmark by 2100.** The rise in sea level depends on global greenhouse gas emissions. Under current policies, global warming is expected to reach around 3°C by 2100[4]. In this scenario, the sea level in Denmark is projected to rise by 40–50 centimeters compared to the 2025 level[5]. However, due to uncertainties in these estimates, a sea level rise of up to 90 centimeters by 2100 cannot be ruled out[6].

- **A significant increase in greenhouse gas emissions could lead to a sea level rise of up to 1.4 meters in Denmark by 2100.** If global emissions increase substantially (e.g., through the reintroduction of phased-out fossil fuel power plants), sea level rise in Denmark is expected to reach 70 centimeters by 2100. However, due to limited knowledge about ice sheet dynamics (see Box 2), the rise could be as high as 1.4 meters in this scenario, according to Figure 2 (left)[7].

- **A sea level rise of several meters in Denmark this century is not expected.** More than 1.5 meters of sea level rise is considered *very unlikely* over the next 75 years, even in extreme scenarios involving rapid melting of ice sheets and glaciers combined with very high emissions. A rise exceeding 2 meters is considered *extremely unlikely*[8]. Nevertheless, due to uncertainties about ice sheets, such increases cannot be entirely ruled out, a point reflected in the latest IPCC reports from 2021 and 2023. While a rise of several meters is not expected, it also cannot be completely excluded.

- **Extreme storm surge events are expected to occur annually in Denmark in the future.** Klimaatlas shows that even a sea level rise of 40–50 centimeters will result in more frequent and severe storm surges in Denmark. By the end of the century, a storm surge that today occurs once in 20 years could occur every two years or more frequently. A 100-year storm surge event could happen every three years on average[9]. Such extreme storm surges can cause damage to people, homes, infrastructure, etc., and the average annual damage costs in Denmark are expected to rise to several billion DKK[10,11].

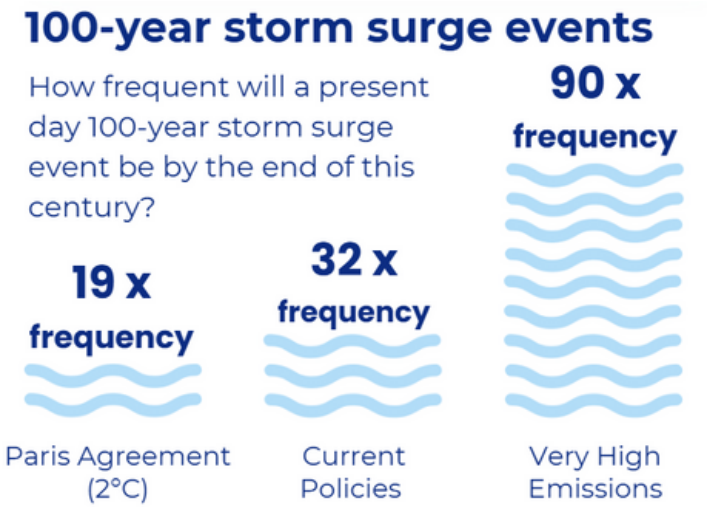



***Figure 1. Future Storm Surges in Denmark**. The frequency of a present-day 100-year storm surge event by the end of the century under three scenarios for future climate change[12]. Source: DMI Klimaatlas (2024b).*

**Box 2**

## Uncertainties in Sea Level Rise Projections

Climate research uses observations, models, and statistics to project how the future climate may develop. However, several uncertainties are unavoidable when projecting variables such as sea level rise. These uncertainties increase the further into the future the projections extend.

The IPCC has reviewed research describing ice sheet processes that could lead to rapid sea level rise. The IPCC characterizes these processes as having *low confidence*, due to limited knowledge about the long-term stability of the Antarctic and Greenland ice sheets. In particular, there is uncertainty about melting and instability caused by water penetrating beneath the ice, as well as the collapse of ice cliffs from coastal areas, primarily in the West Antarctic Ice Sheet[13]. Uncertainties grow over time and with increasing global warming, becoming significantly greater after the year 2100. The processes that make the West Antarctic Ice Sheet unstable may have already begun, but the potential consequences, such as several meters of sea level rise, are very unlikely to occur before 2100.

Based on research available prior to 2021, the IPCC assessed that while several meters of sea level rise over a few centuries is possible, the likelihood is low. Like the IPCC, Klimaatlas includes these processes in scenarios for future sea level rise.

New Research Since the Latest IPCC Reports

Since the IPCC's most recent reports (2021 and 2023), new studies have emerged that either challenge or support the IPCC's conclusions. Some individual studies suggest that uncertainties in projections may be greater than those presented in IPCC reports[14,15]. Conversely, a new 2025 assessment report by over 70 researchers, synthesizing many recent studies, reached conclusions broadly consistent with those of the IPCC[16].

Paleoclimate studies examining Earth's climate thousands of years ago can provide insight into conditions beyond those experienced and measured over the past 150 years. Some individual studies from both paleoclimate[17] and climate science[18,19] confirm the vulnerability of West Antarctica. However, the evidence for the processes required to trigger the most extreme and rapid sea level rise remains limited[20,21]. For example, new paleoclimate research supports the idea that the West Antarctic Ice Sheet has previously collapsed but also concludes that the dataset used in the study weakens the observational basis for the highest end of future sea level rise projections[22].

Although individual studies may challenge or reinforce IPCC conclusions, a broader assessment of the new literature indicates that there is currently insufficient evidence to alter the overall scientific consensus on the expectations and uncertainties related to sea level rise. Therefore, while there is a risk of very high sea level rise over the next century, the probability of the most extreme scenarios (exceeding 1.5 meters by 2100) remains low. However, the risk of such high rises increases with higher levels of global warming and continues with significantly greater rise rates beyond 2100, even in moderate scenarios.

## How Much Will Sea Level Rise After the Year 2100?

- **Sea level rise of several meters is inevitable over the coming centuries.** Global sea level will continue to rise even if global greenhouse gas emissions are reduced or completely halted[23].
- **It is not only a question of how much the sea will rise, but also how fast it will happen.** Greenhouse gas emissions determine the pace of global warming, and therefore the amount of time society has to adapt to the new climate conditions.
- **Sea level could rise by 3 meters by the year 2300, even if the Paris Agreement is met.** In a future where the goals of the Paris Agreement are met and global warming is limited to below 2°C, global sea level is expected to rise by around 1.5 meters by 2300. However, uncertainties associated with processes such as ice sheet dynamics (see Box 2) mean that a rise of up to 3 meters is possible even in this scenario[24].
- **A sea level rise of up to 17 meters by 2300 cannot be ruled out.** In a high-emissions scenario that goes significantly beyond current global climate policies, a rise of approximately 5 meters is expected by 2300. Due to uncertainties associated with ice sheet processes, a rise of up to 17 meters in Denmark is possible in this scenario[25] (see Figure 2, right).
- **Tipping points play a crucial role in the highest sea level rise estimates.** A tipping point is a critical threshold that, if exceeded, can trigger a major and potentially irreversible change in the climate system[26]. There is a risk that ice sheet tipping points could be crossed, even with 1.5–2°C of global warming[27,28]. These risks are currently accounted for in IPCC projections (as shown, for example, in the red shaded area in Figure 2). The risk of crossing tipping points increases significantly after 2100, especially in scenarios with very high greenhouse gas emissions. Even if a tipping point has been or will be crossed, it is expected to take up to 100 years or more before several meters of sea level rise are reached. However, the rise will continue and reach very high levels in the centuries that follow.

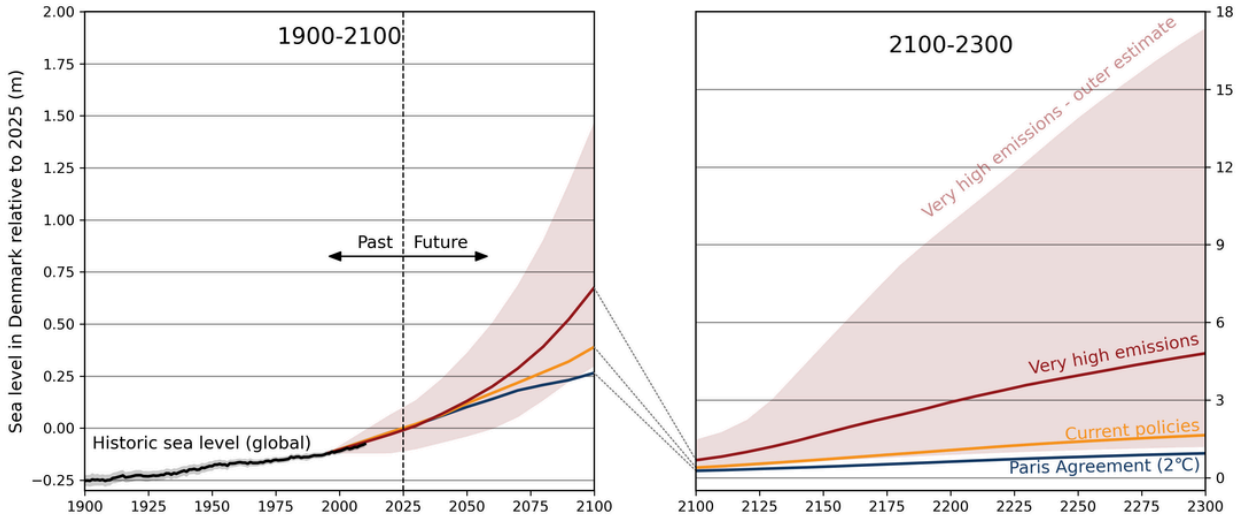



***Figure 2. Historical and Future Sea Level Rise in Denmark.*** *Historical global sea level relative to the year 2025 is shown for the period 1900–2018 (black line, left panel)[29]. Projected sea level relative to 2025 is shown for Denmark toward the year 2100 (left panel) and the year 2300 (right panel) under three scenarios: the Paris Agreement target of 2°C (blue), current global climate policies (orange), and very high emissions (red). Shaded areas indicate the uncertainty range for the very high emissions scenario[30]. Note the change in the vertical axis between the two panels. Source: DMI Klimaatlas (2024b).*

**Box 3**

**How Can the Risk Be Reduced?**

**1) Global reductions in greenhouse gas emissions in line with the Paris Agreement are crucial.** Reducing greenhouse gas emissions slows the rate of sea level rise and lowers the risk of very high increases. Lower global warming will therefore both reduce the risk of storm surges and provide more time to plan climate adaptation for the sea level rise that will occur.

**2) Climate adaptation will help.** Flexible climate adaptation tailored to local conditions can increase the resilience of societal infrastructure, nature, and the environment, e.g. coastal protection designed so that protection can be increased later if needed.

3) **A long planning horizon increases resilience.** Planning adaptation measures that meet both short-term needs and take potential long-term sea level rise into account can enhance safety. Decisions made today can help keep future options open.

**Citation:** *Payne, Mark R. & Rasmussen, Martin Graves; Karsten Arnbjerg-Nielsen, Jorge Andres Concha Bernales, Tina Christensen, Eskil Nordahl Fundal, Chuncheng Guo, Nicolaj Hansen, Christina Hoff Jensen; Asta Raagaard Jønsson, Morten Dahl Larsen, Kristine Skovgaard Madsen, Ruth Mottram, Martin Olesen, Lea Poropat, Christian Rodehacke, Torben Schmith and Adrian Lema. (2025). Future Sea Level Rise in Denmark. Danish Meteorological Institute. DOI: 10.5281/zenodo.15657045.*

***Methods.*** *Figures for sea level rise around Denmark are sourced from DMI's Klimaatlas. Klimaatlas uses sea level projections from the IPCC's Sixth Assessment Report but makes adjustments for e.g. improved estimates of land uplift. Data are available both as 30-year averages (on the website)[31] and as annual values (in an extended dataset)[32], from which sea level rise is calculated relative to the year 2025 as an average across all Danish coastal areas. Further details can be found in Klimaatlas' technical documentation[33].*

***Acknowledgments:*** *This brief has been subject to review. We have received valuable input on the content from experts at DTU, KU, SDU, and GEUS. Any errors and responsibility lie solely with the authors.*

## Notes

Sources, technical details, and further explanations of statements in this document can be found below.

[1] IPCC, 2021 (Sixth Assessment Report, Working Group 1: The Physical Science Basis). Table 9.6.

[2] Global sea level rise from 1901 to 2018 was 20 cm. (IPCC, 2021 Sixth Assessment Report, Working Group 1: The Physical Science Basis). From 2018 to 2024, an additional 3 cm rise occurred (WMO, 2025 State of the Global Climate 2024).

[3] WMO, 2025 (State of the Global Climate 2024).

[4] The UNEP Gap Report 2024 concludes that the world is on track for temperature increases between 2.6 °C and 3.1 °C relative to the period 1850-1900 by the end of this century, corresponding roughly to emissions scenario SSP2-4.5.

[5] Median estimate of sea level rise across Denmark in 2100 relative to 2025 under emissions scenarios SSP2-4.5 and SSP3-7.0, including low-confidence processes where available. See also Methods.

[6] 90th percentile of sea level rise across Denmark in 2100 relative to 2025 under emissions scenario SSP3-7.0 with medium-confidence processes included: projections including low-confidence processes are not available. The corresponding figure for SSP2-4.5 with low-confidence processes is 75 cm. See also Methods.

[7] The 50th and 90th percentiles of sea level rise across Denmark in 2100 relative to 2025 for emissions scenario SSP5-8.5, including low-confidence processes. See also Methods.

[8] The statement “exceptionally unlikely” is based on the use of IPCC calibrated language combined with the uncertainties and data from Klimaatlas for SSP5-8.5 including low-confidence processes. See also the IPCC Sixth Assessment Report for a description of calibrated language and Methods.

[9] Median estimate of the frequency of current 20- and 100-year storm surge events during 2071-2100 relative to the reference period 1981-2010 for scenario SSP2-4.5 as an average across Denmark. Local deviations may occur. Low-confidence processes are included in these figures. DMI. (2024). DMI Klimaatlas v2024b - Projections of the Danish climate [Data set]. Zenodo. https://doi.org/10.5281/zenodo.13753022.

[10] Halsnæs, Kirsten; Per S. Kaspersen, Villy Mik-Meyer, and Tanya Sunding. Economic consequences of flooding – National damage calculations and assessment of climate adaptation needs. (2024). https://cipfonden.dk/wp-content/uploads/2024/11/Rapport_nationale_skadesberegninger.pdf.

[11] The Economic Council of Denmark: Expected future annual damages from storm surge – Estimates including frequent storm surge events. Economy and Environment 2023, chapter II. (2023). https://dors.dk/files/media/M23_KapII_Supplerende_beregninger.pdf.

[12] The scenarios in this figure correspond to SSP1-2.6 (“Paris Agreement”), SSP2-4.5 (“Current Policies”), and SSP5-8.5 (“Very High Emissions”). Low-confidence processes are included in all scenarios. The frequency of storm surges at the end of the century (2071-2100) is calculated relative to the historical period used in Klimaatlas (1981-2010). DMI. (2024). DMI Klimaatlas v2024b - Projections of the Danish climate [Data set]. Zenodo. https://doi.org/10.5281/zenodo.13753022.

[13] IPCC, 2021 (Sixth Assessment Report, Working Group 1: The Physical Science Basis).

[14] Aschwanden, A., et al. Brief communication: A roadmap towards credible projections of ice sheet contribution to sea level, The Cryosphere, 15, 5705–5715, https://doi.org/10.5194/tc-15-5705-2021, 2021.

[15] European Environment Agency: European Climate Risk Assessment, 2024.

[16] Sea Level Rise in Europe: 1st Assessment Report of the Knowledge Hub on Sea Level Rise, Copernicus Publications, State Planet, 3-slre1, https://doi.org/10.5194/sp-3-slre1, 2024.

[17] Wolff, E.W., Mulvaney, R., Grieman, M.M. et al. The Ronne Ice Shelf survived the last interglacial. Nature 638, 133–137 (2025). https://doi.org/10.1038/s41586-024-08394-w.

[18] Mathieu Morlighem et al., The West Antarctic Ice Sheet may not be vulnerable to marine ice cliff instability during the 21st century. Sci. Adv. 10, eado7794 (2024). DOI: https://doi.org/10.1126/sciadv.ado7794.

[19] Hill, E. A., et al. The stability of present-day Antarctic grounding lines – Part 1: No indication of marine ice sheet instability in the current geometry, The Cryosphere, 17, 3739–3759, https://doi.org/10.5194/tc-17-3739-2023, 2023.

[20] DeConto, R.M., Pollard, D., Alley, R.B. et al. The Paris Climate Agreement and future sea-level rise from Antarctica. Nature 593, 83–89 (2021). https://doi.org/10.1038/s41586-021-03427-0.

[21] Stokes, C.R., Bamber, J.L., Dutton, A. et al. Warming of +1.5 °C is too high for polar ice sheets. Commun Earth Environ 6, 351 (2025). https://doi.org/10.1038/s43247-025-02299-w.

[22] Wolff, E.W., Mulvaney, R., Grieman, M.M. et al. The Ronne Ice Shelf survived the last interglacial. Nature 638, 133–137 (2025). https://doi.org/10.1038/s41586-024-08394-w.

[23] Chapuis, A., et al. (2025). Adapting to the changing cryosphere and sea-level rise: recommendations. Zenodo. https://doi.org/10.5281/zenodo.14650681.

[24] Estimates of the 50th and 90th percentiles for scenario SSP1-2.6 for Denmark in 2300 relative to 2025, including low-confidence processes. See also Methods.

[25] Estimates of the 50th and 90th percentiles for scenario SSP5-8.5 for Denmark in 2300 relative to 2025, including low-confidence processes. See also Methods.

[26] McKay et al. Exceeding 1.5°C global warming could trigger multiple climate tipping points. Science 377, eabn7950 (2022). https://doi.org/10.1126/science.abn7950.

[27] Stokes, C.R., Bamber, J.L., Dutton, A. et al. Warming of +1.5 °C is too high for polar ice sheets. Commun Earth Environ 6, 351 (2025). https://doi.org/10.1038/s43247-025-02299-w.

[28] Mathieu Morlighem et al., The West Antarctic Ice Sheet may not be vulnerable to marine ice cliff instability during the 21st century. Sci. Adv. 10, eado7794 (2024). DOI: https://doi.org/10.1126/sciadv.ado7794.

[29] M D Palmer et al 2021 Environ. Res. Lett. 16044043. doi:10.1088/1748-9326/abdaec.

[30] The scenarios in this figure correspond to SSP1-2.6 (“Paris Agreement”), SSP2-4.5 (“Current Policies”), and SSP5-8.5 (“Very High Emissions”). The shaded area under “very high emissions” corresponds to the 90th and 10th percentiles from SSP5-8.5. Low-confidence processes are included in all scenarios.

[31] DMI’s Klimaatlas: https://www.dmi.dk/klimaatlas.

[32] DMI. (2024). DMI Klimaatlas v2024b - Projections of climate indicators in Denmark [Data set]. Zenodo. https://doi.org/10.5281/zenodo.13753022.

[33] DMI (2024). Methods used in Klimaatlas, the Danish Climate Atlas (v2024b). DMI Report 24-12. https://doi.org/10.5281/zenodo.13753022.