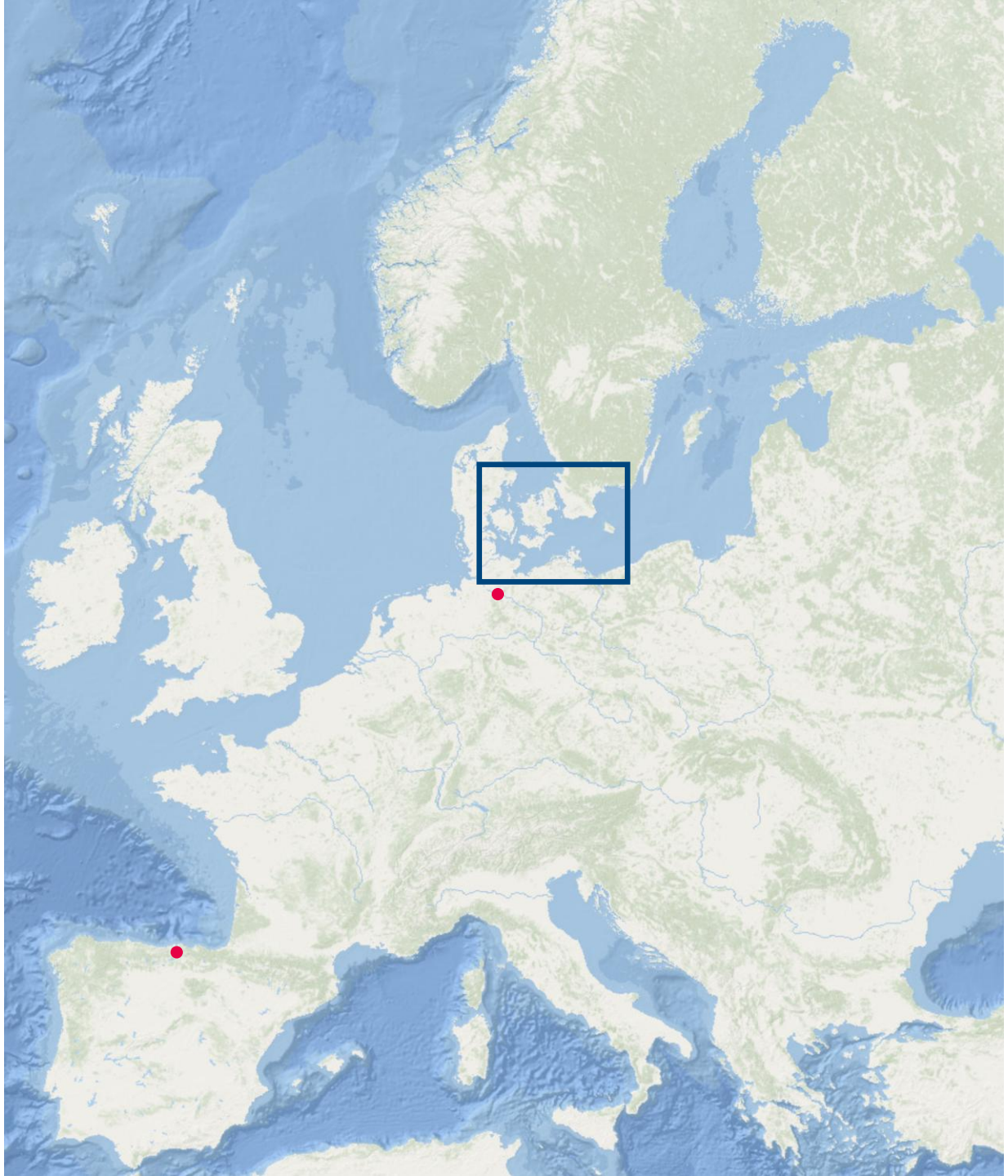
Recent Baltic Sea storm surge events from a climate and a historical perspective

Elke M. I. Meyer, Nikolaus Groll, Lidia Gaslikova

Institute of Coastal Systems - Analysis and Modeling

Santander, 24 September 2025

Helmholtz-Zentrum
hereon

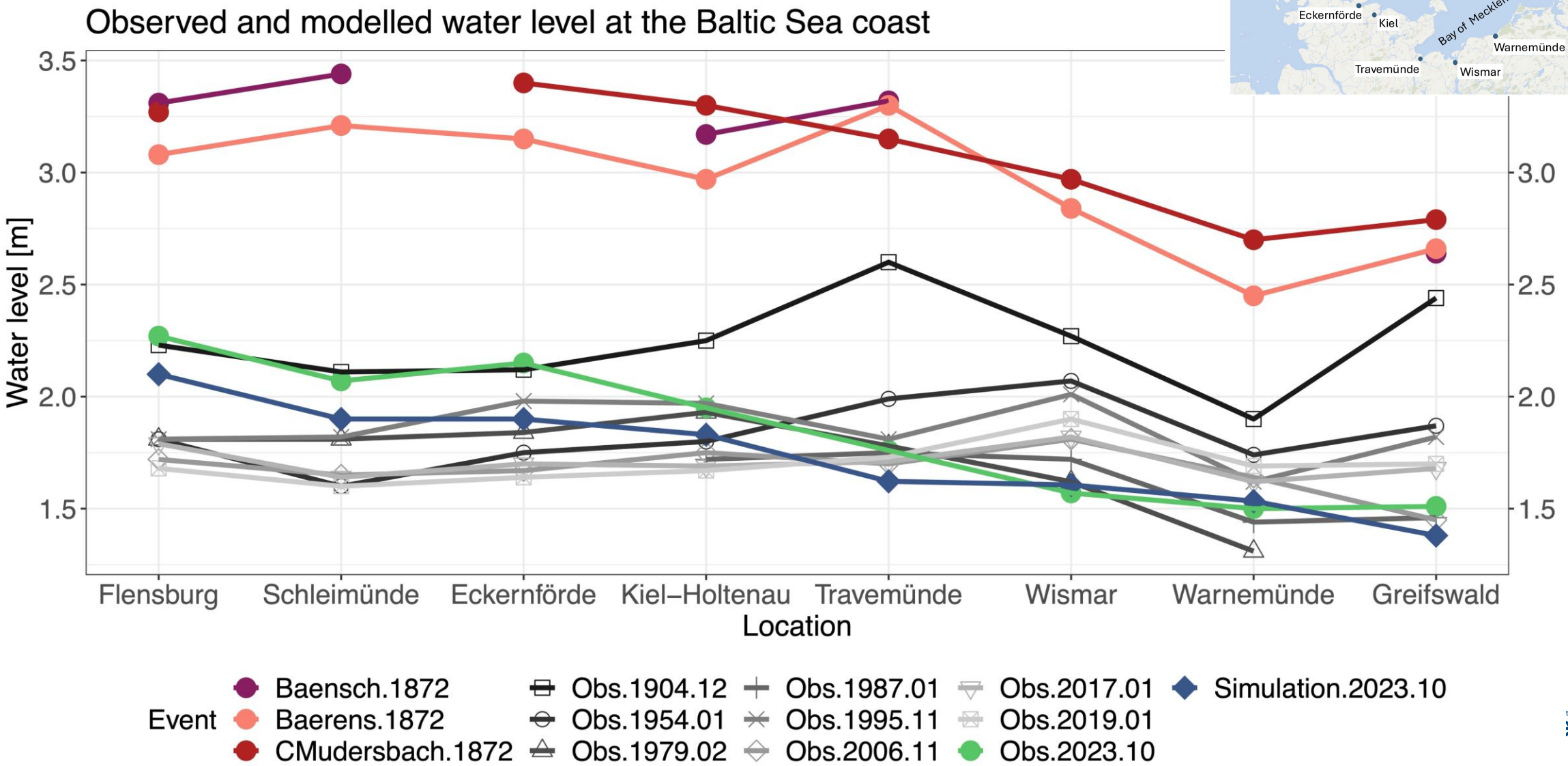


Helmholtz-Zentrum hereon

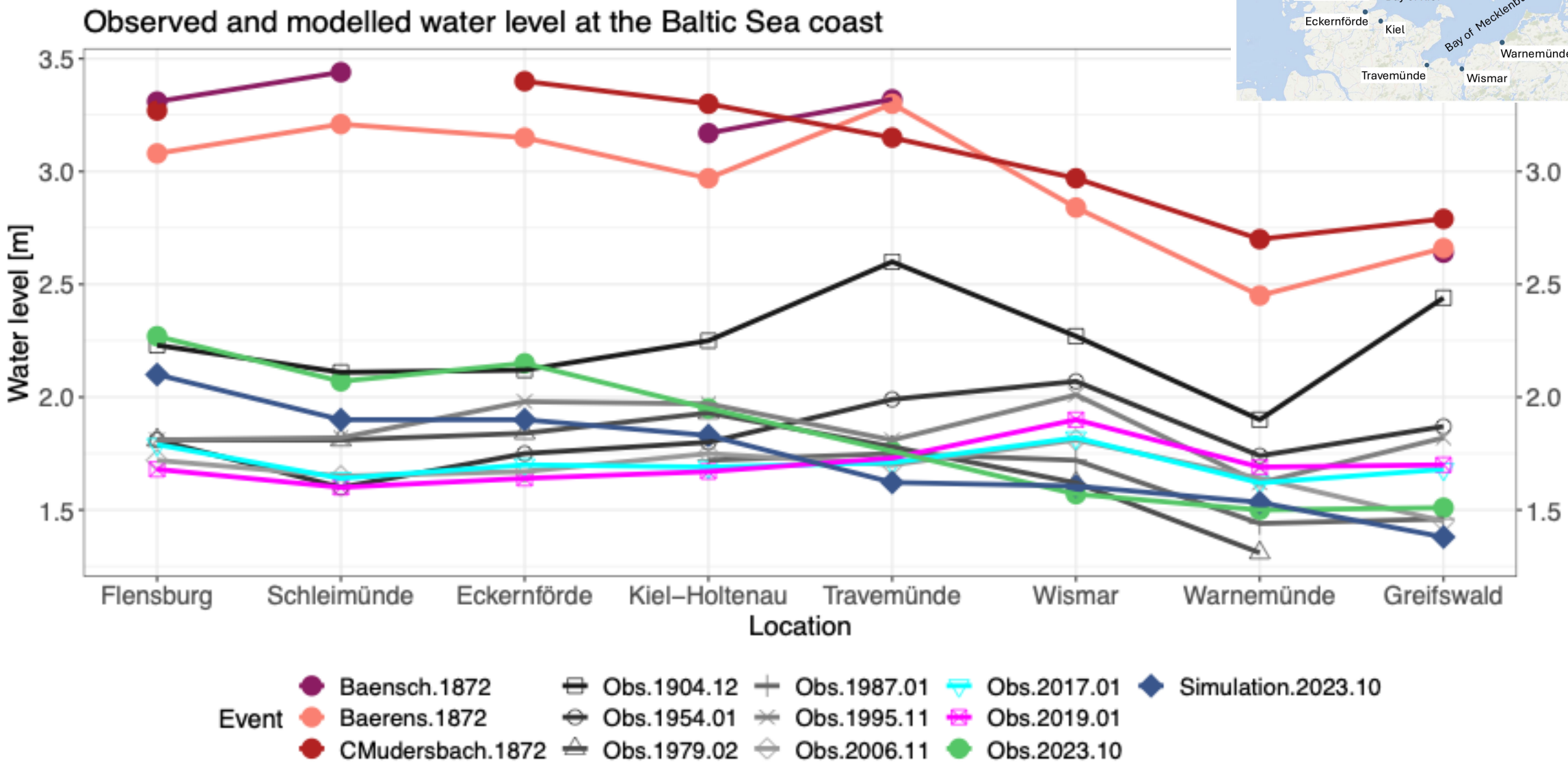
Map of Locations

Helmholtz-Zentrum hereon

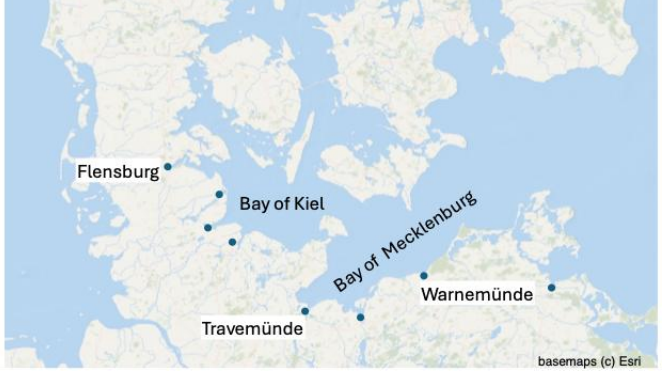
Observed and modelled water levels

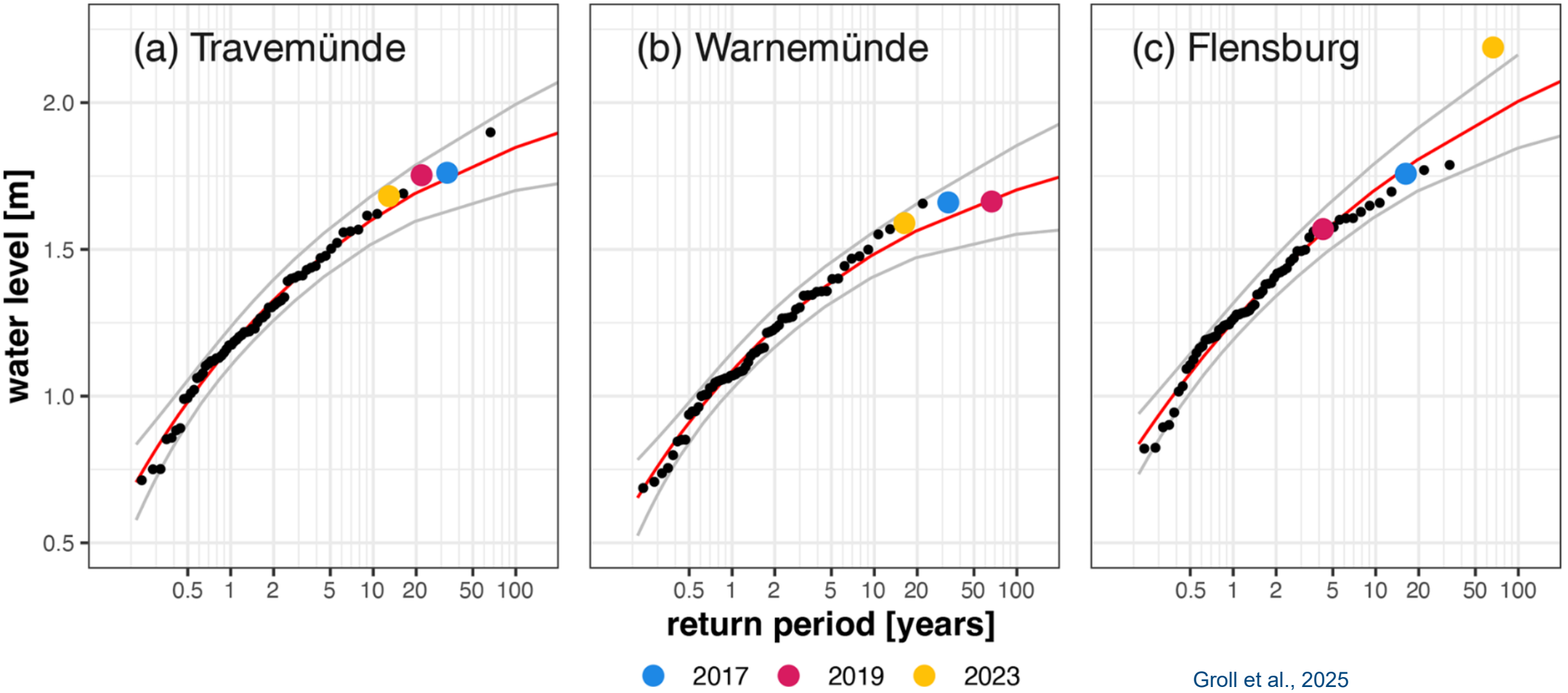


Observed and modelled water levels



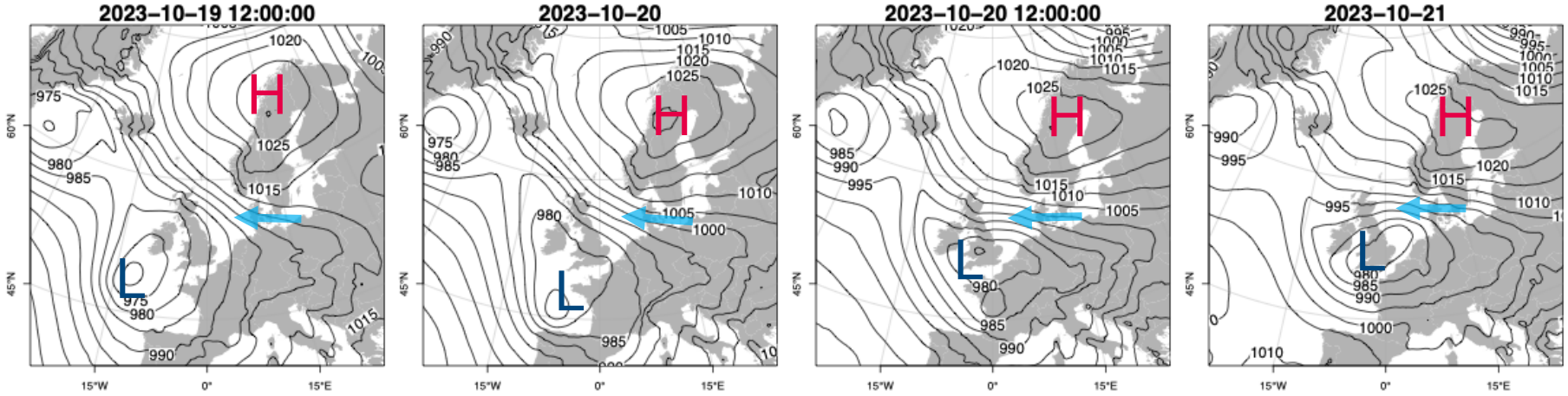
Return Period



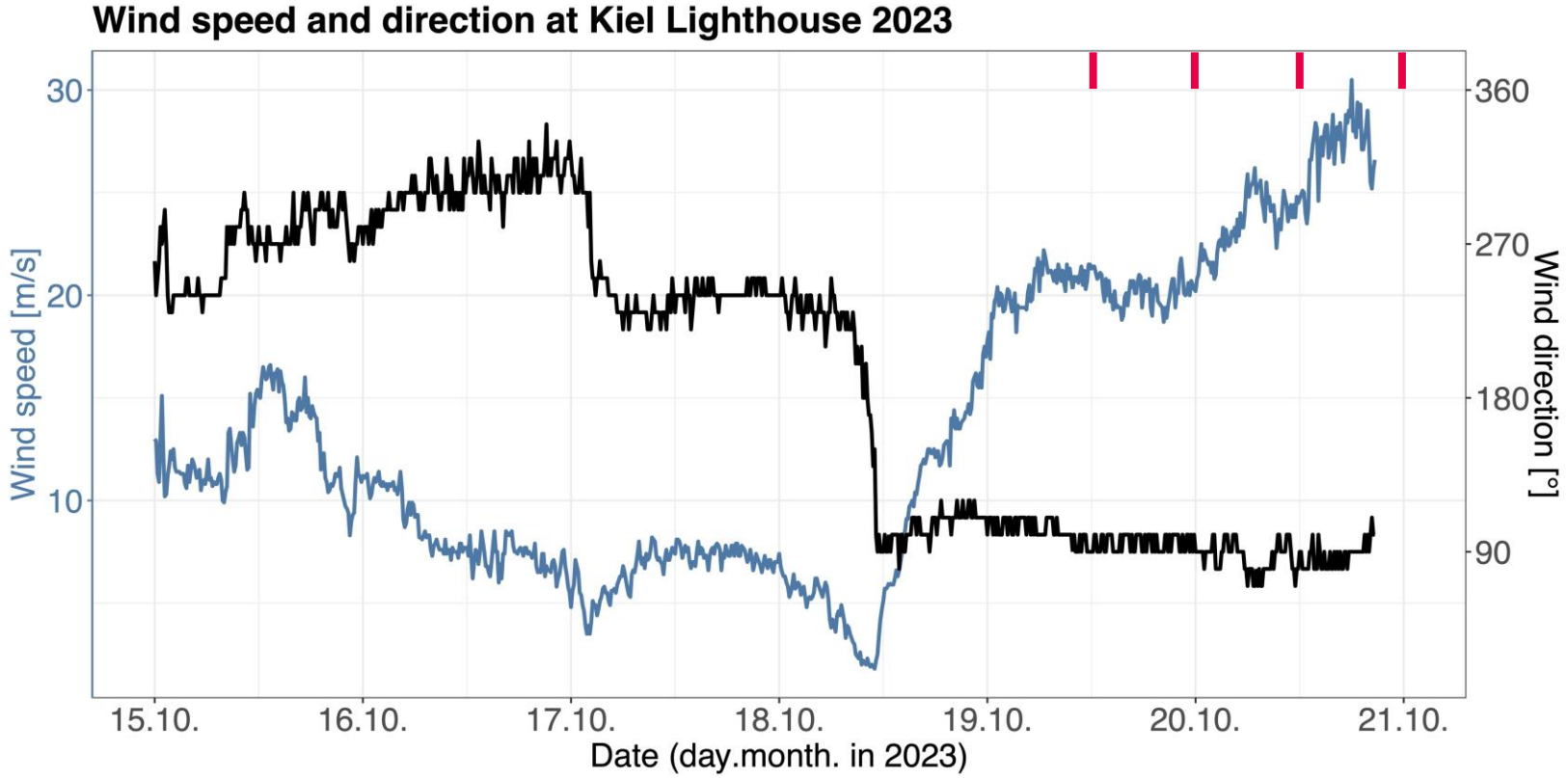


Groll et al., 2025

Sea level pressure, wind speed and wind direction



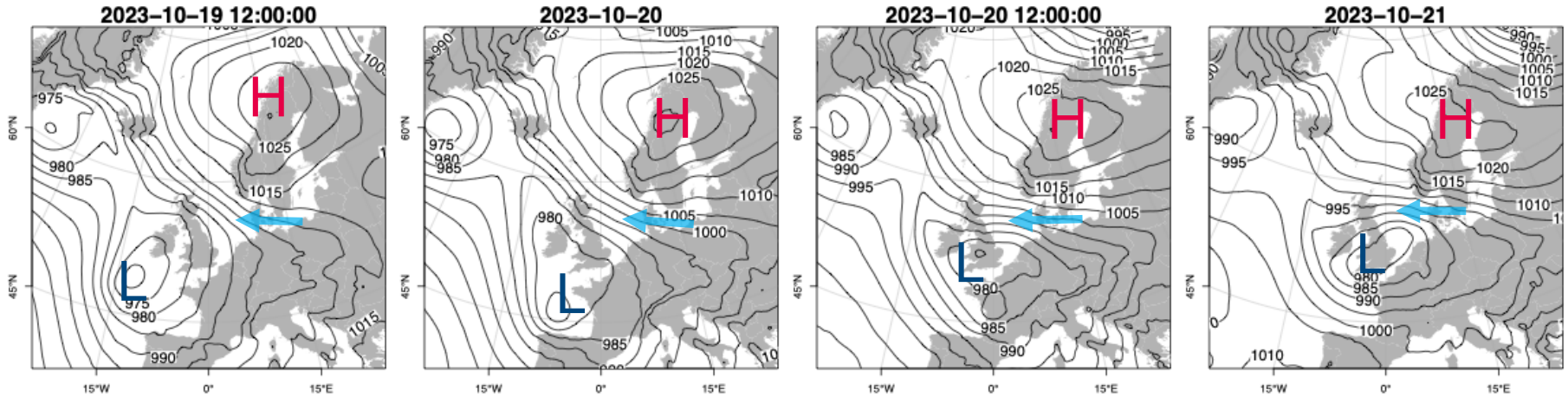
ERA5, 2024

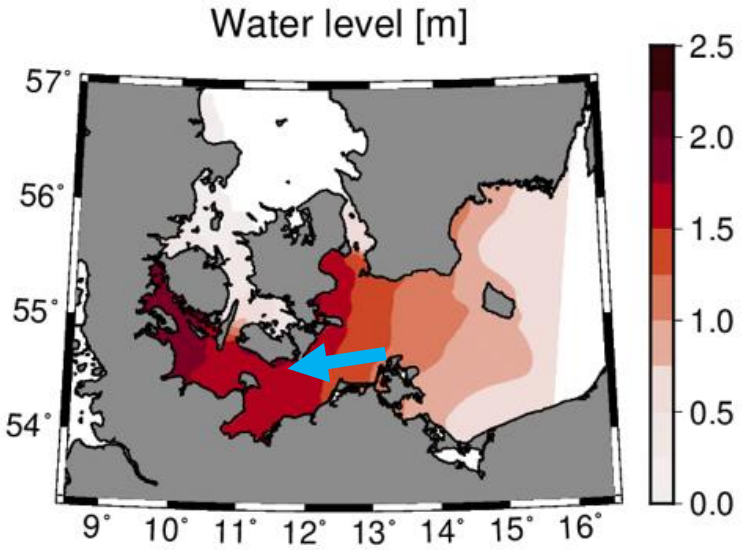


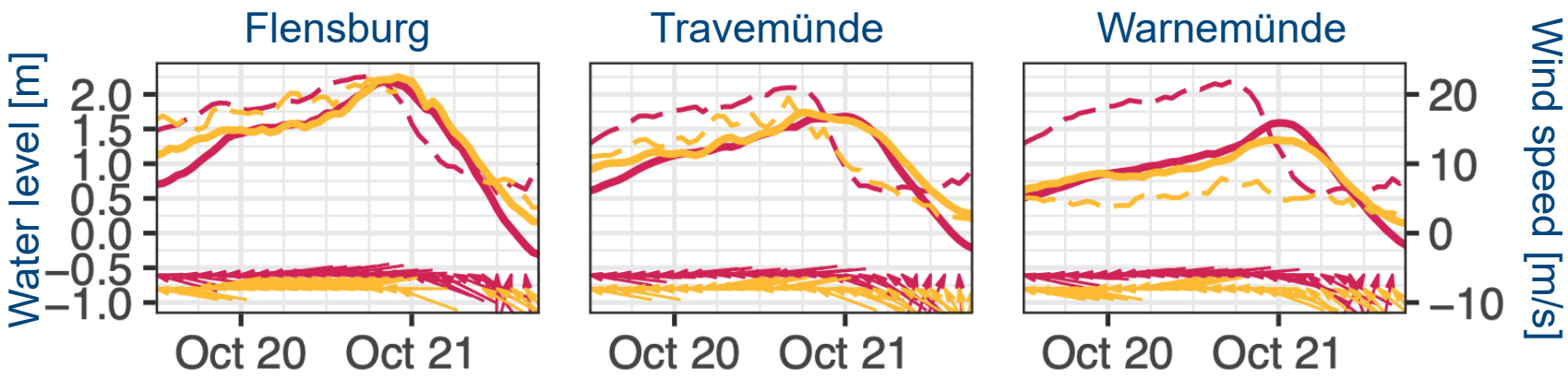
Data by Deutscher Wetterdienst, 2024

Helmholtz-Zentrum hereon

20-21 Oct 2023







colour — mod — obs

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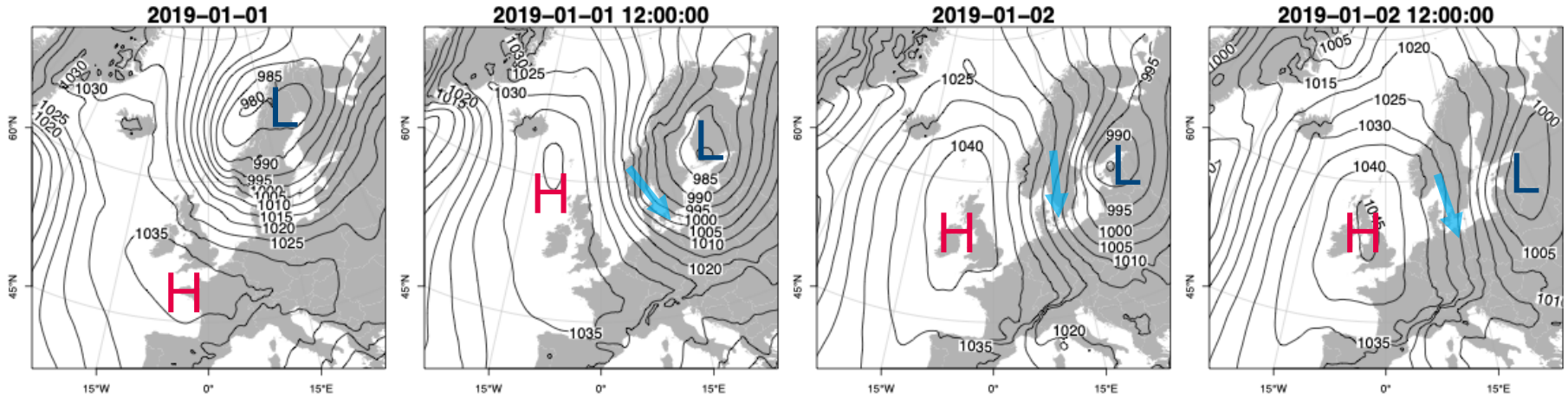
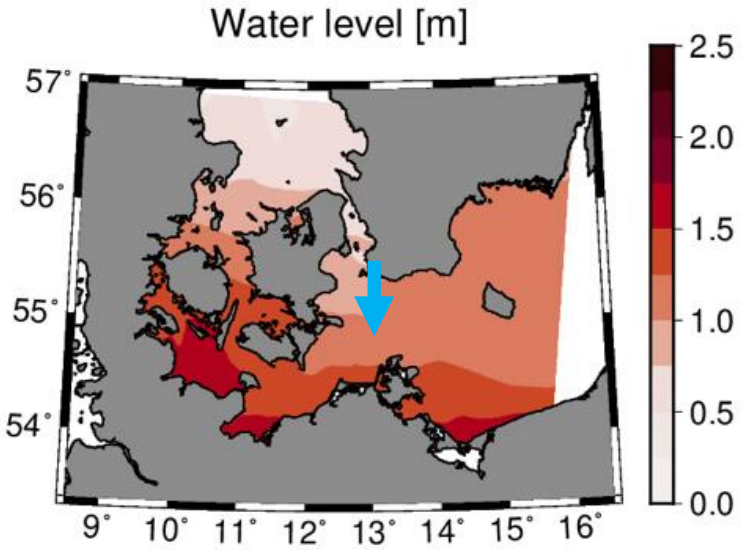
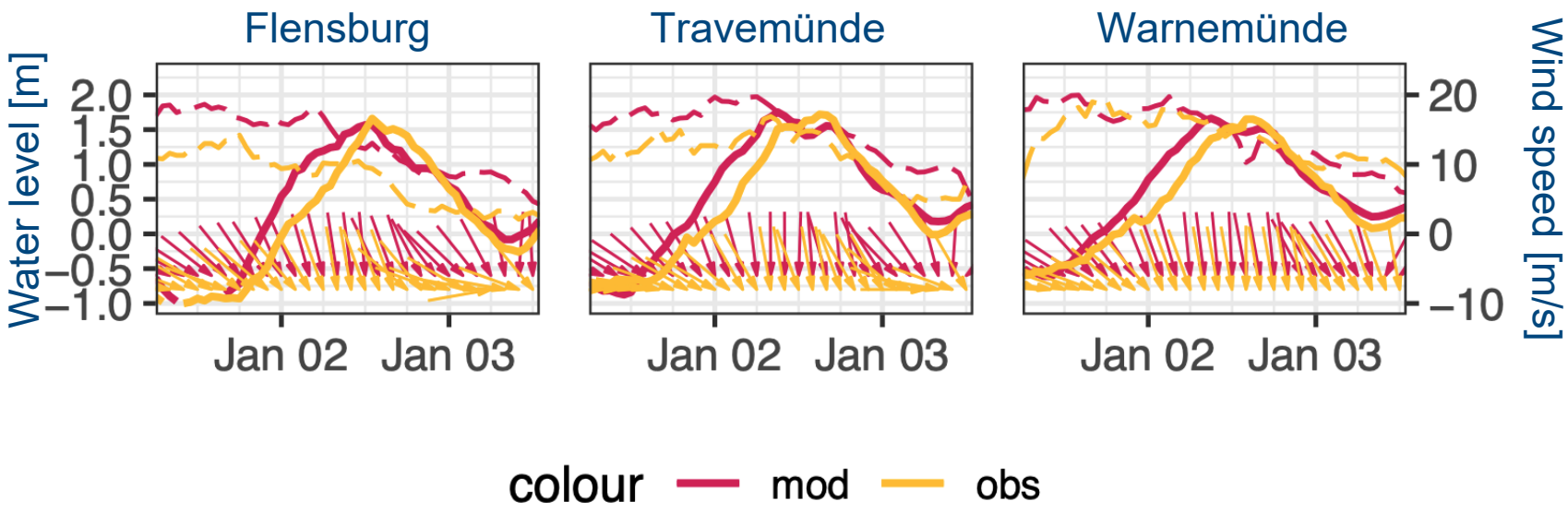
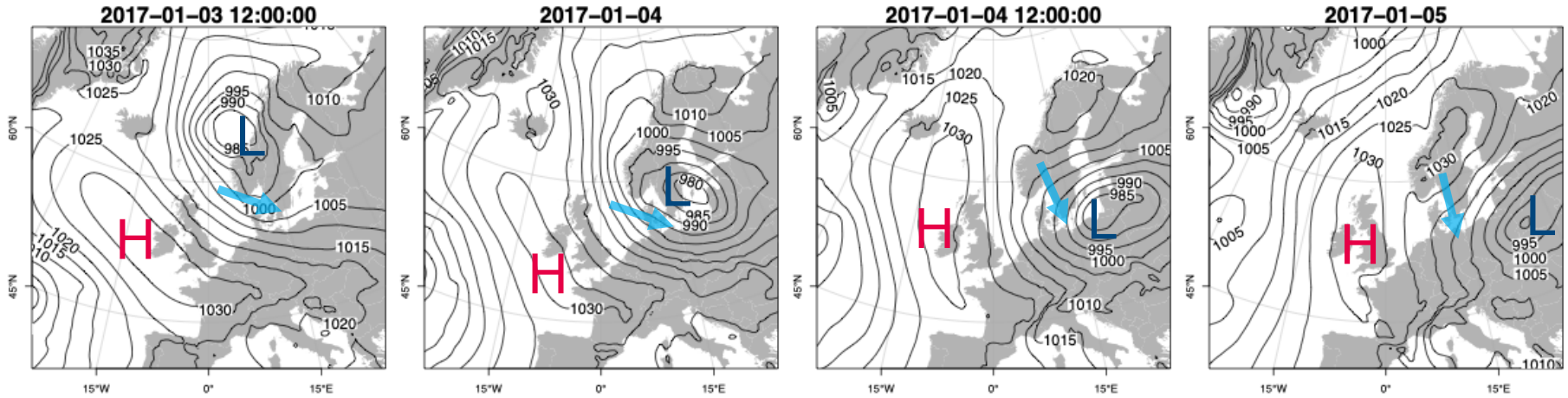
02 Jan 2019

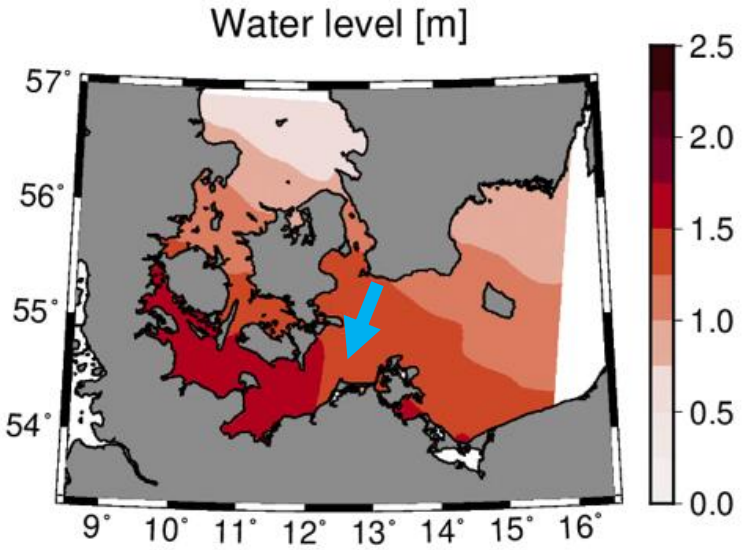

2019–01–01
2019–01–01 12:00:00
2019–01–02
2019–01–02 12:00:00
H
L
60°N
45°N
15°W
0°
15°E

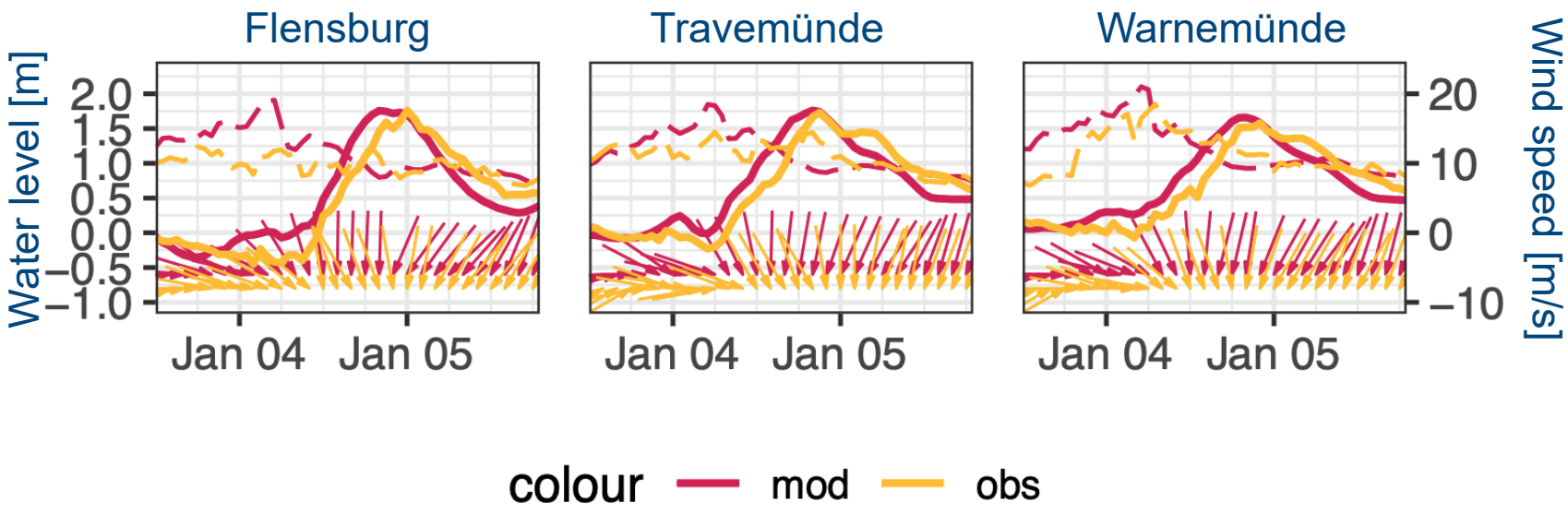

Water level [m]
2.5
2.0
1.5
1.0
0.5
0.0
57°
56°
55°
54°
9°
10°
11°
12°
13°
14°
15°
16°


Flensburg
Travemünde
Warnemünde
Water level [m]
Wind speed [m/s]
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
20
10
0
−10
Jan 02
Jan 03
colour
mod
obs

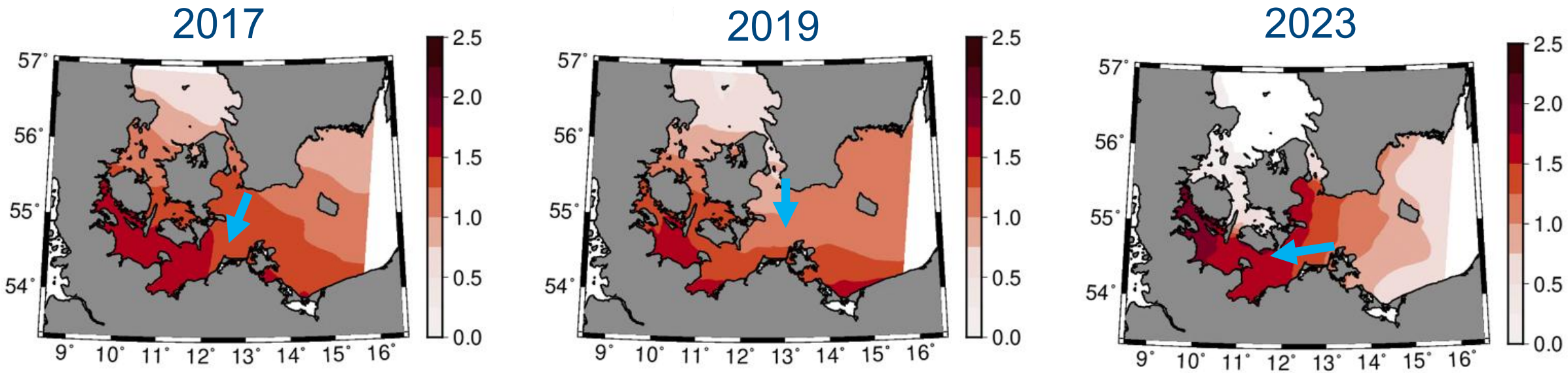
03-04 Jan 2017



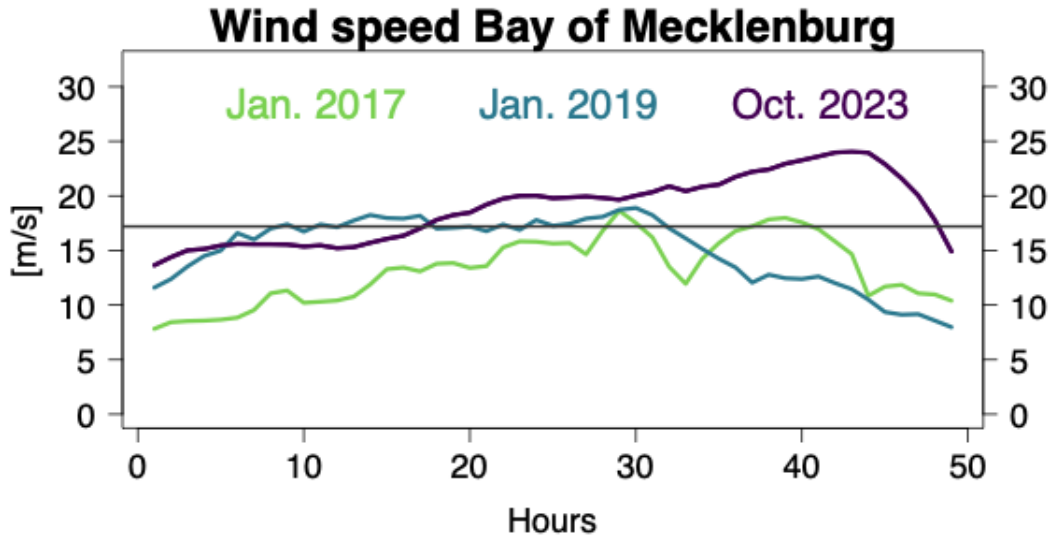


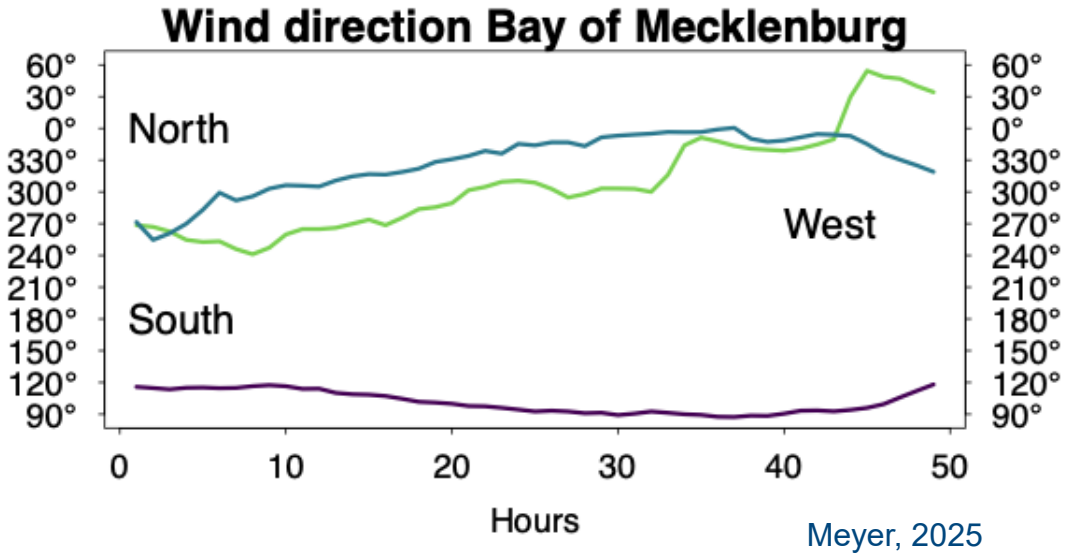


Water level, wind speed and direction



Water level for the storm surges on 04 Jan 2017, 23 UTC; 02 Jan 2019, 09 UTC and 20 Oct 2023, 23 UTC.

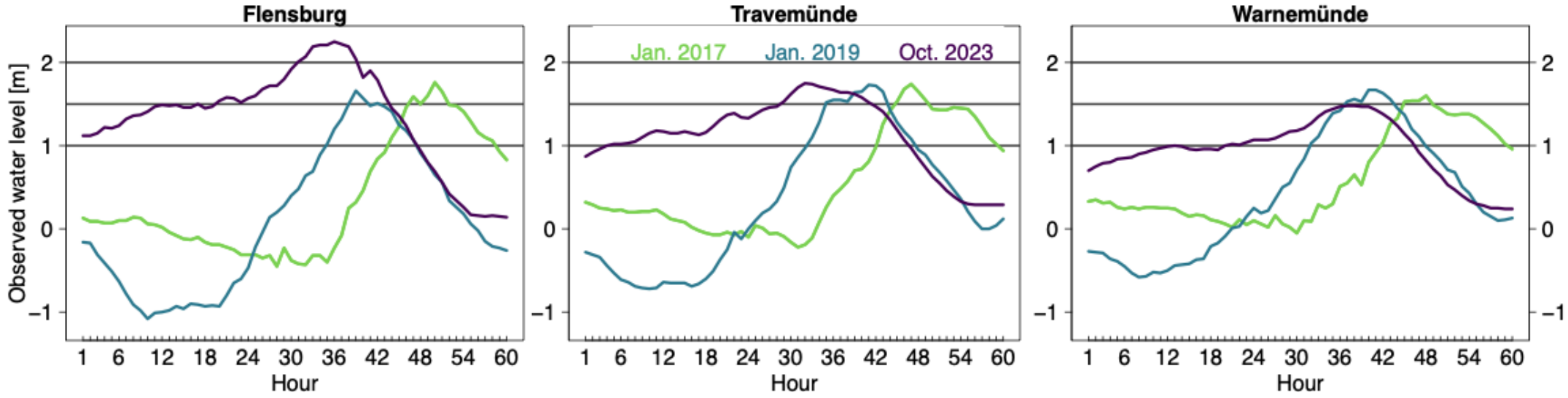




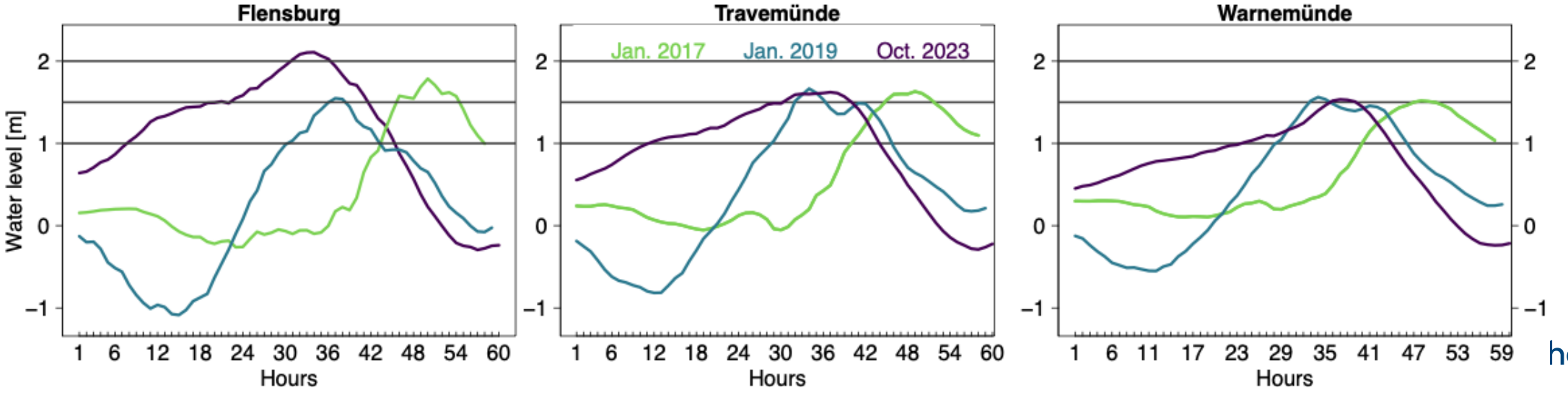
Meyer, 2025

Observed and simulated water levels

Observed



Simulated



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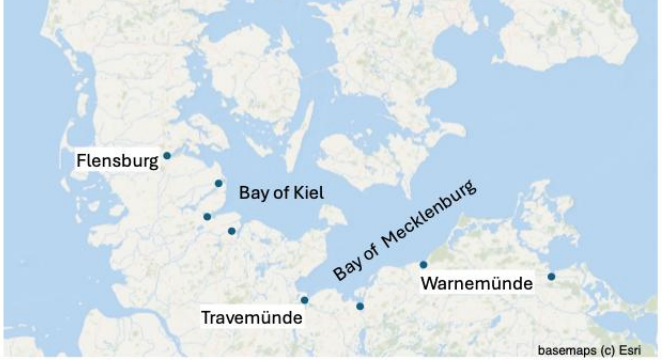
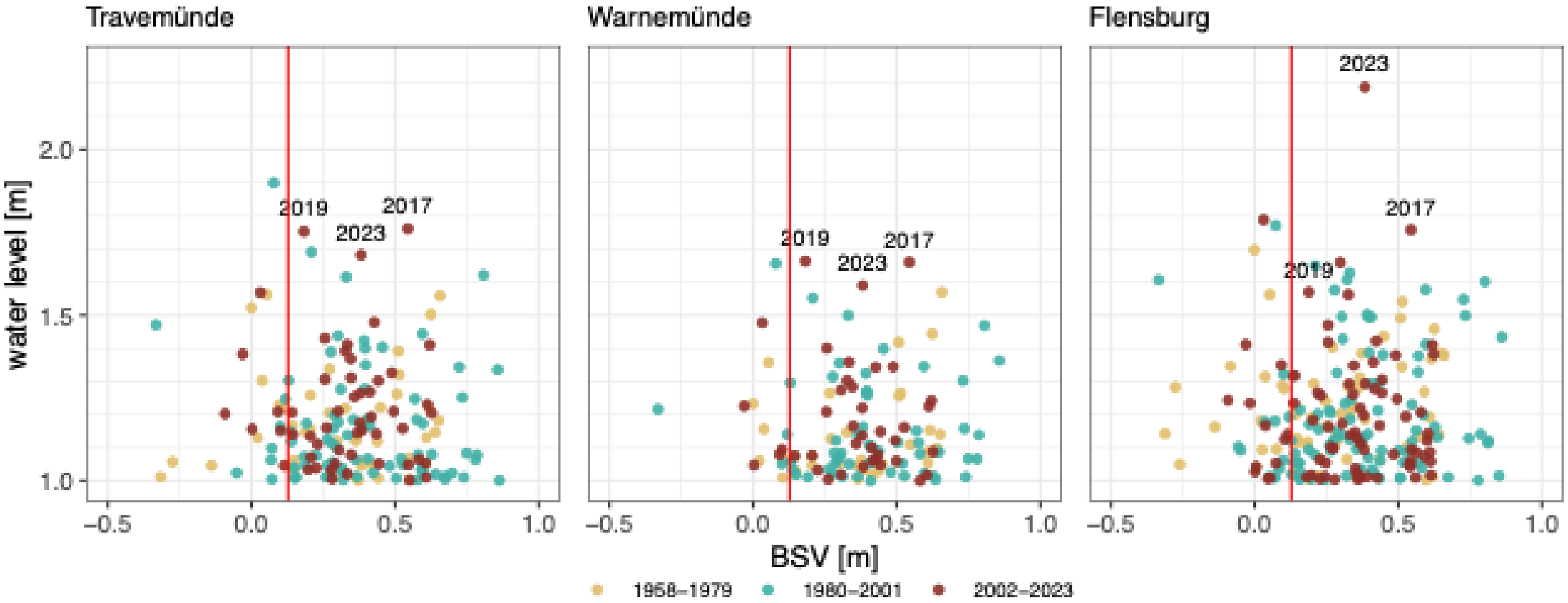
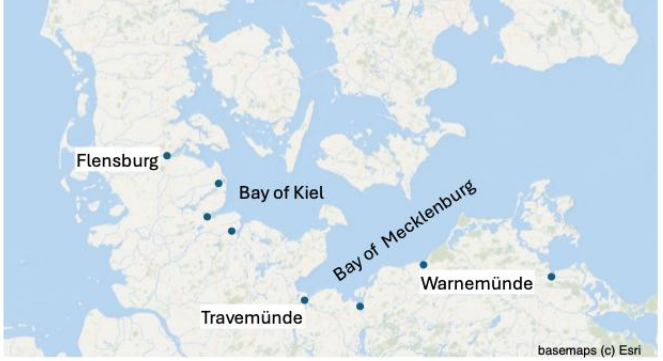
Baltic Sea volume anomaly

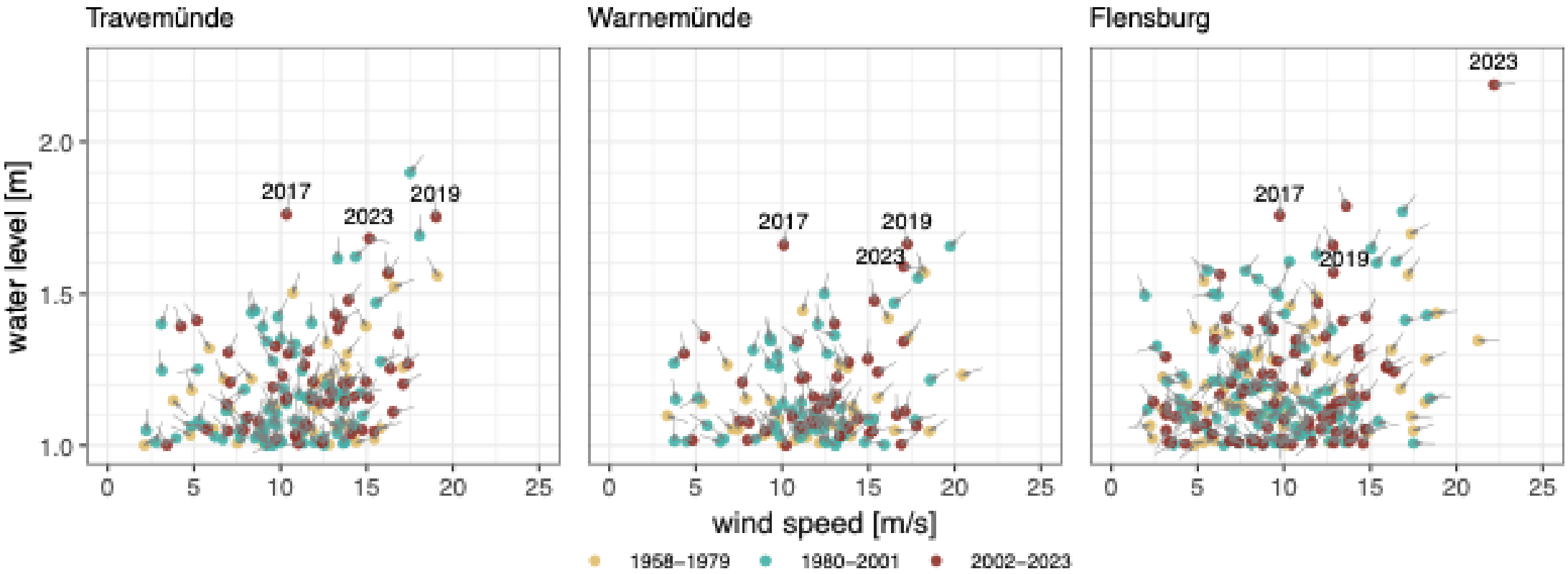




Scatterplot of the water level and Baltic Sea volume anomaly (BSVA) averaged over the 7 d prior to the event maximum at Travemünde (a), Warnemünde (b) and Flensburg (c). Coloured dots indicate events from three 22-year-long periods; the events discussed are annotated with their years. The vertical red line indicates the long-term mean BSVA.

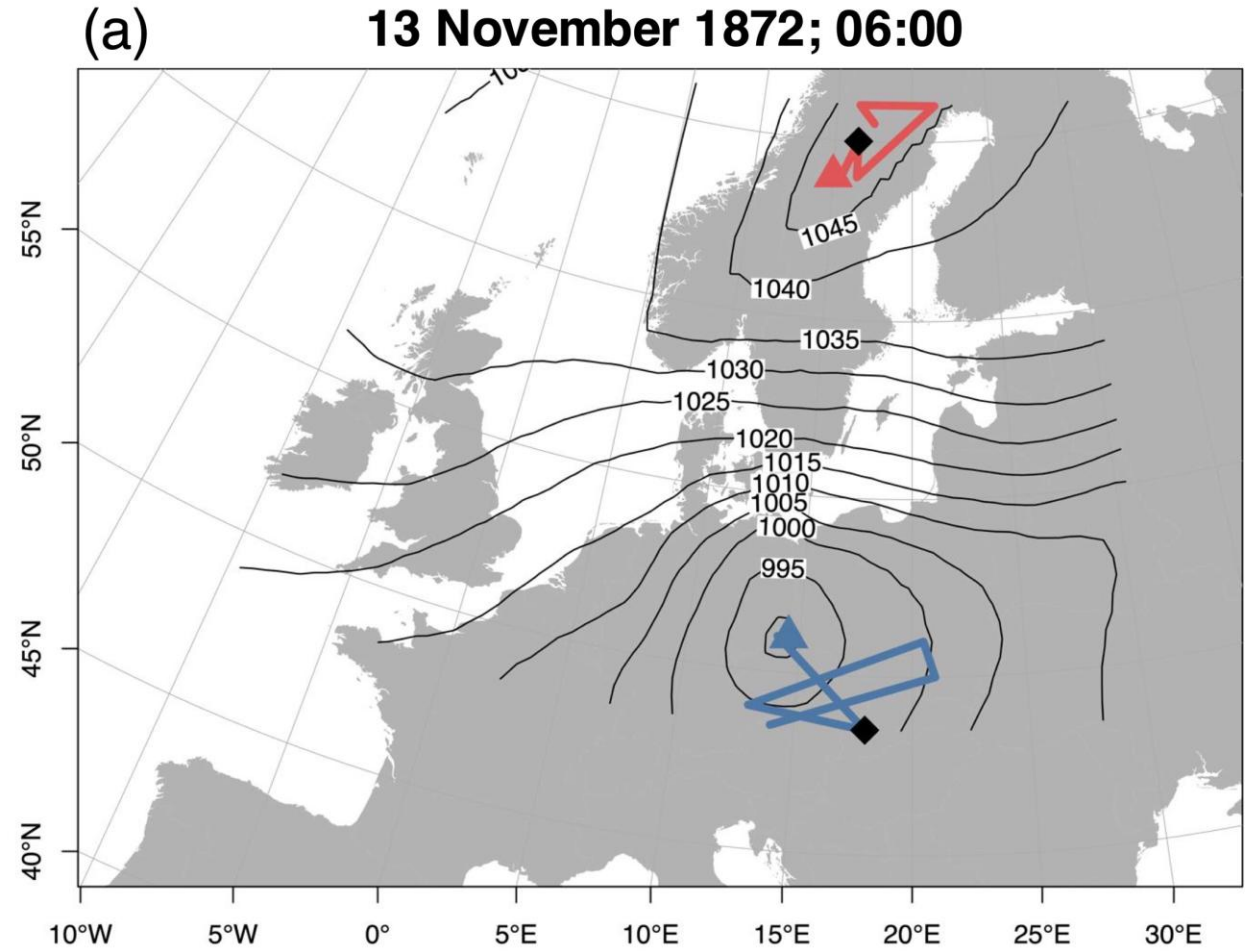
Wind speed

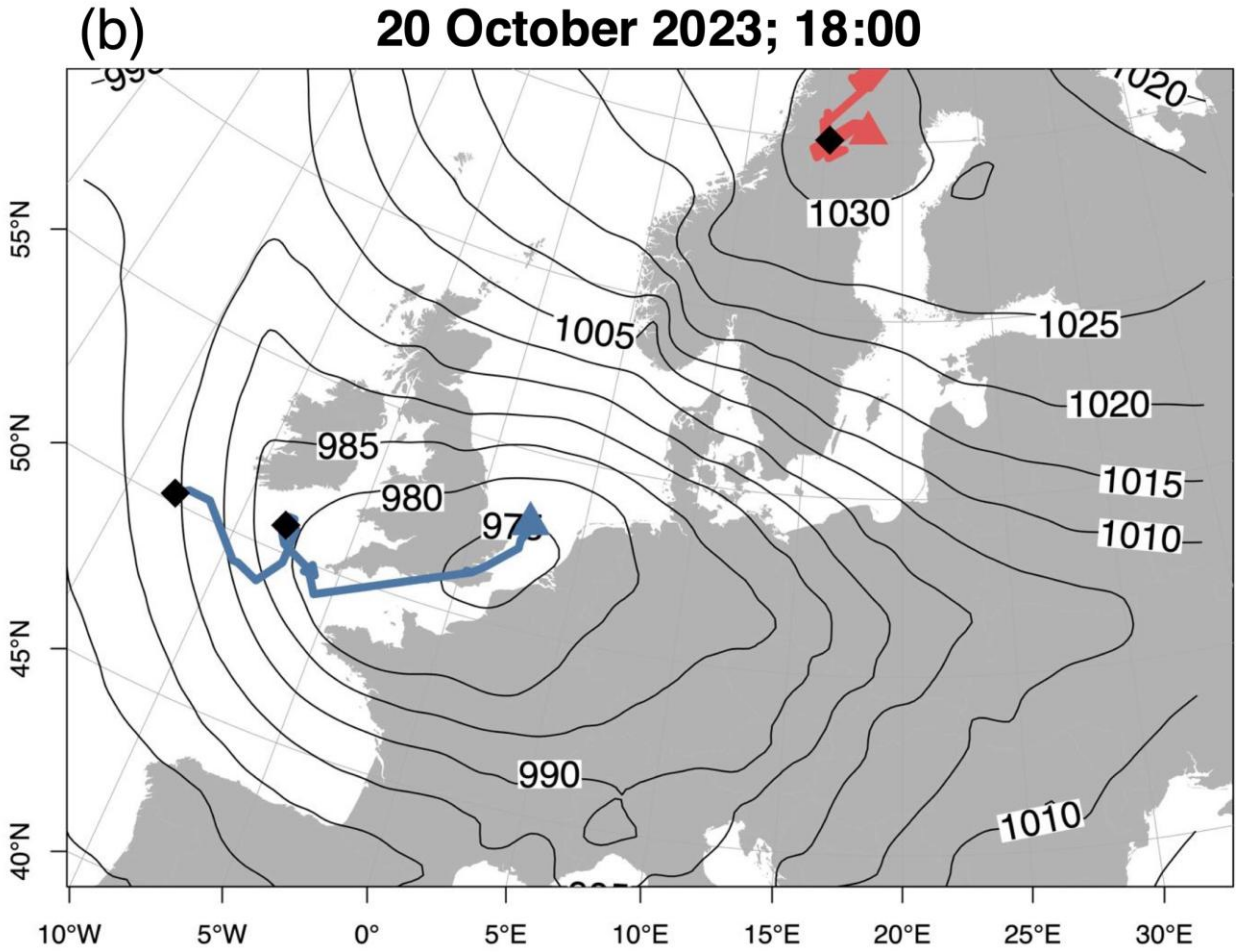




Scatterplot of the water level maximum and wind speed averaged over the 6h before the event maximum at Travemünde (a), Warnemünde (b) and Flensburg (c). Coloured dots indicate three different 22-year periods; the events discussed are annotated with their years. Arrows indicate the average wind directions 6h before each event.

1872 vs 2023





Rosenagen and Bork, 2009; Meyer et al., 2024

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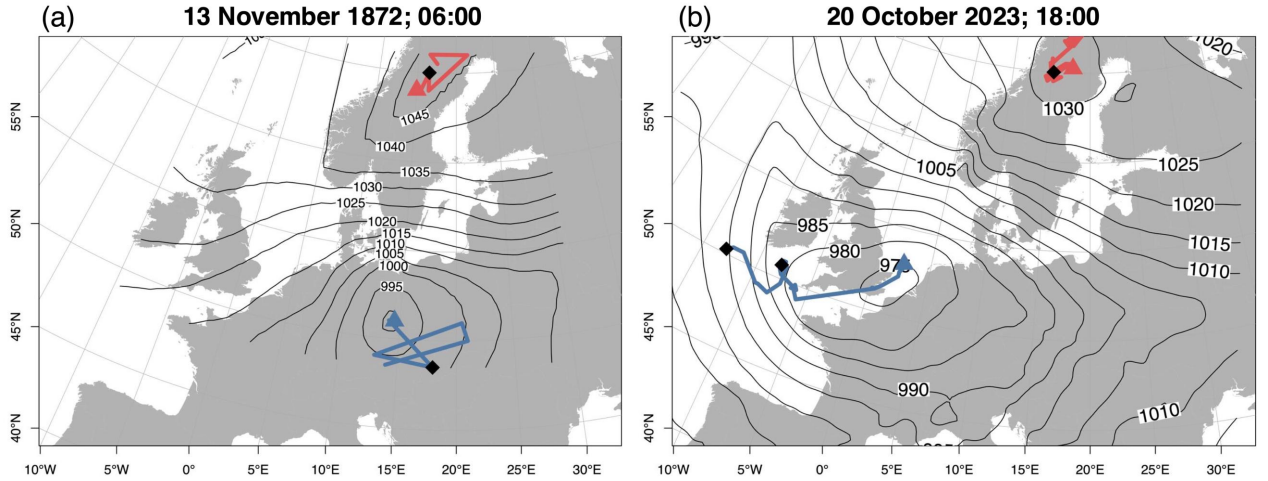
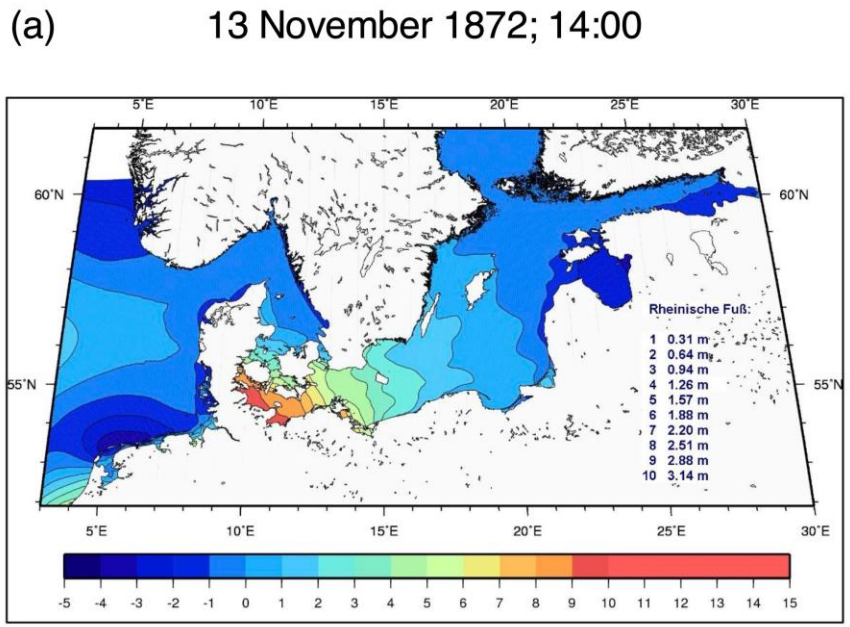
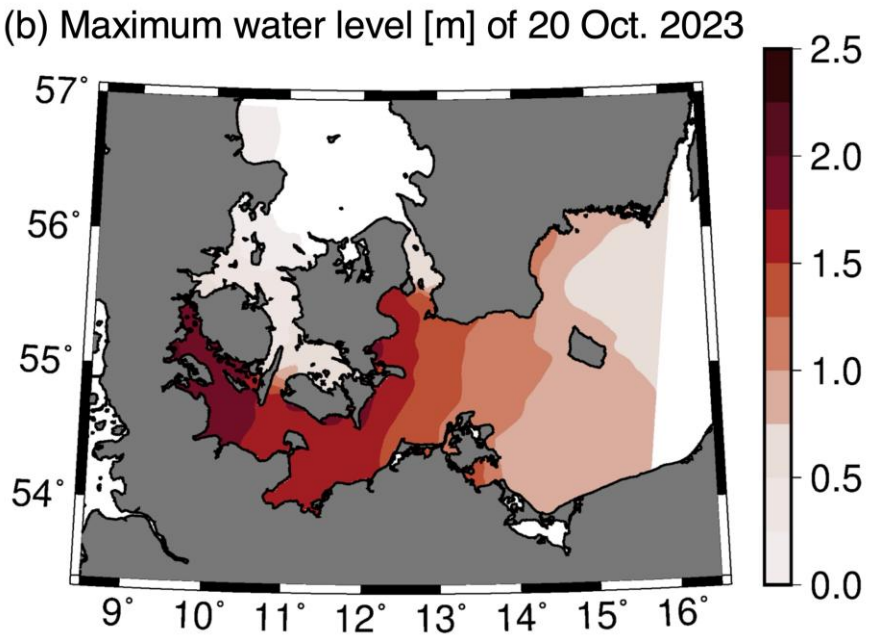
1872 vs 2023







Bork et al., 2022; Meyer et al., 2024

Literature

- Meyer,E.M.I., Gaslikova, L., Groll, N., Weisse, R. (2024): **The Baltic storm surges of 1872 and 2023 – what do they have in common?** Die Küste, 94 - Online First, doi:10.18171/1.094106

- Groll, N.; Gaslikova, L.; Weisse, R. (2025): **Recent Baltic Sea Storm Surge Events From A Climate Perspective**. Natural Hazards and Earth System Sciences. vol. 25, no. 7, 2137-2154. https://doi.org/10.5194/nhess-25-2137-2025

- Meyer, Elke M.I.: **Storm surges: the contextualisation of storm surge weather conditions and high tide in the North Sea or pre-filling in the Baltic Sea using model simulations**, submitted “Die Küste”, 2025

- **Digital storm tide application https://stormsurge.hereon.de**

How do storm surges occur?

Storm surges are extreme events that can cause enormous damage. If we better understand the dynamics of these natural phenomena, we can better protect our coasts from them. To this end, researchers at the Helmholtz-Zentrum Hereon analyse and model storm surges under various conditions. Here you will learn how storm surges occur in the North Sea and Baltic Sea and which factors intensify them. You will learn about the different storm surge categories, and you can actively influence selected storm surge scenarios.

Start here!

https://stormsurge.hereon.de

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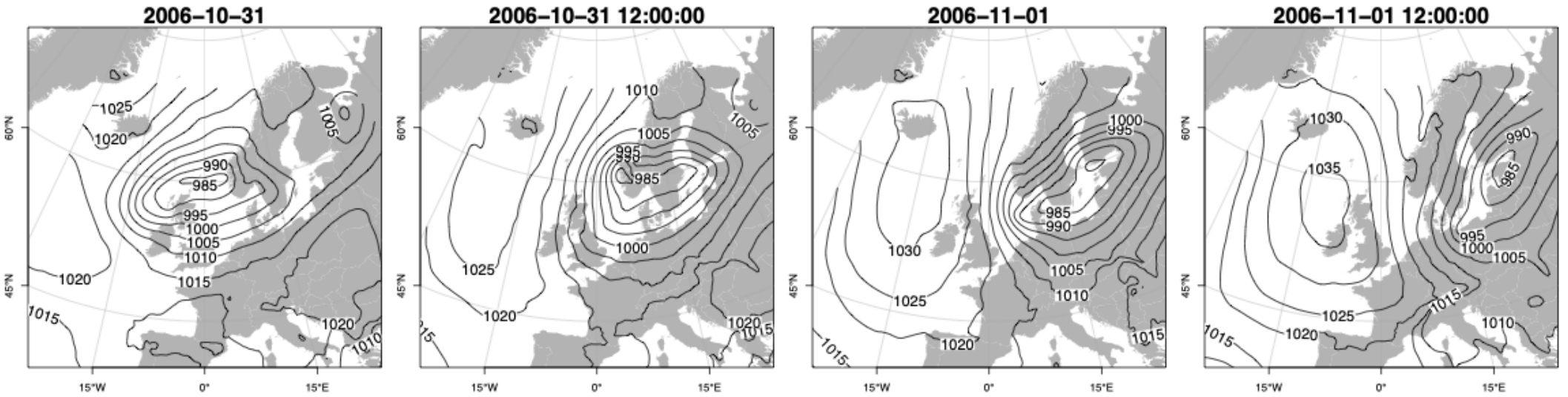
October/November 2006



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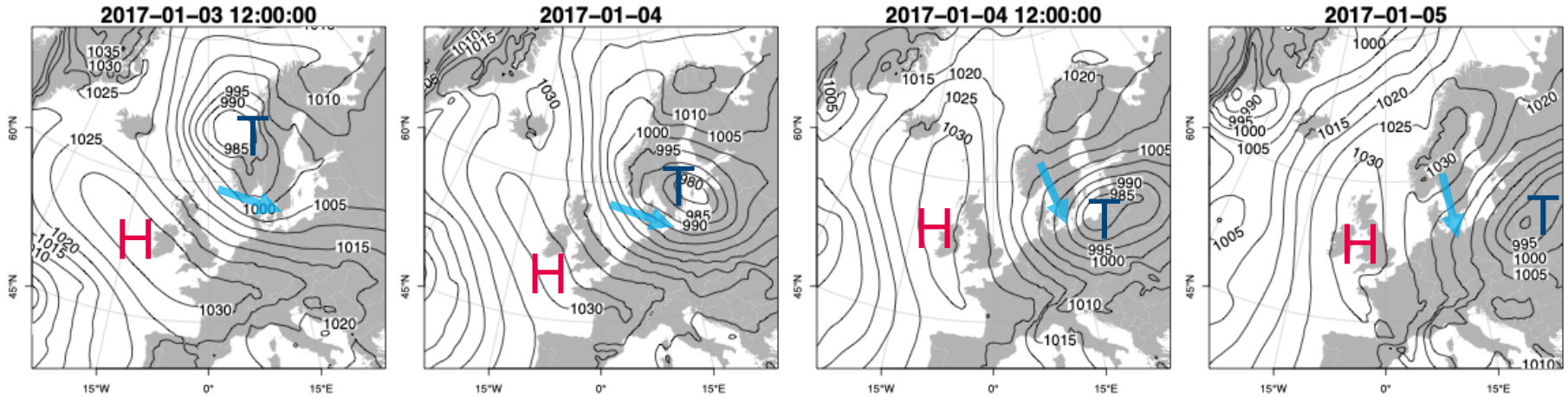
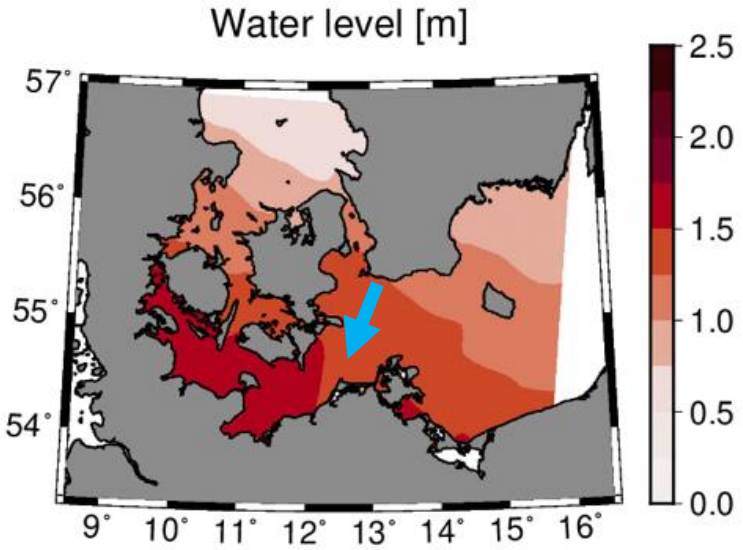
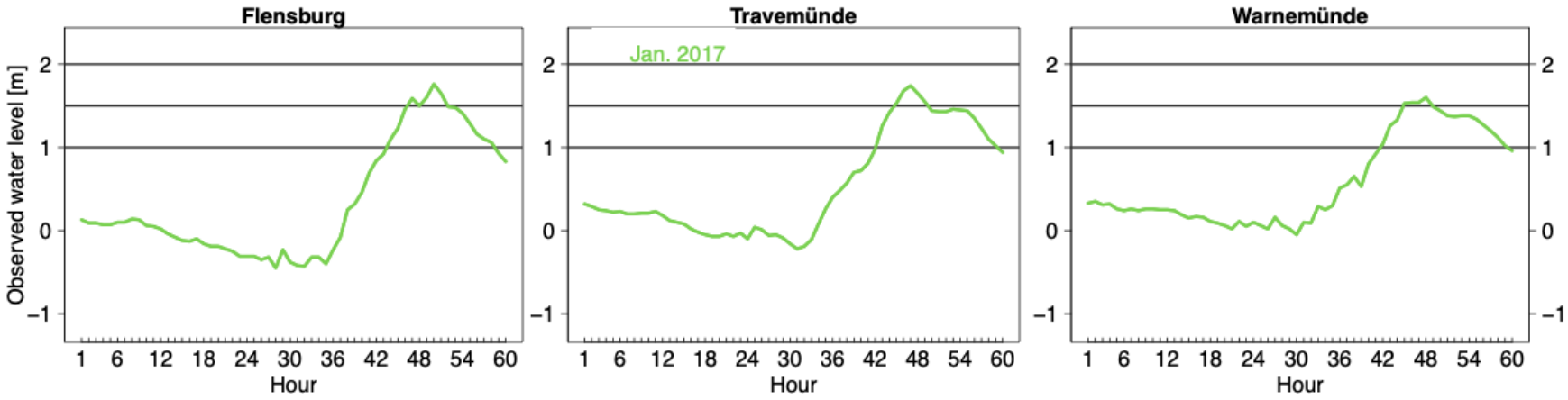
03-04 Jan 2017



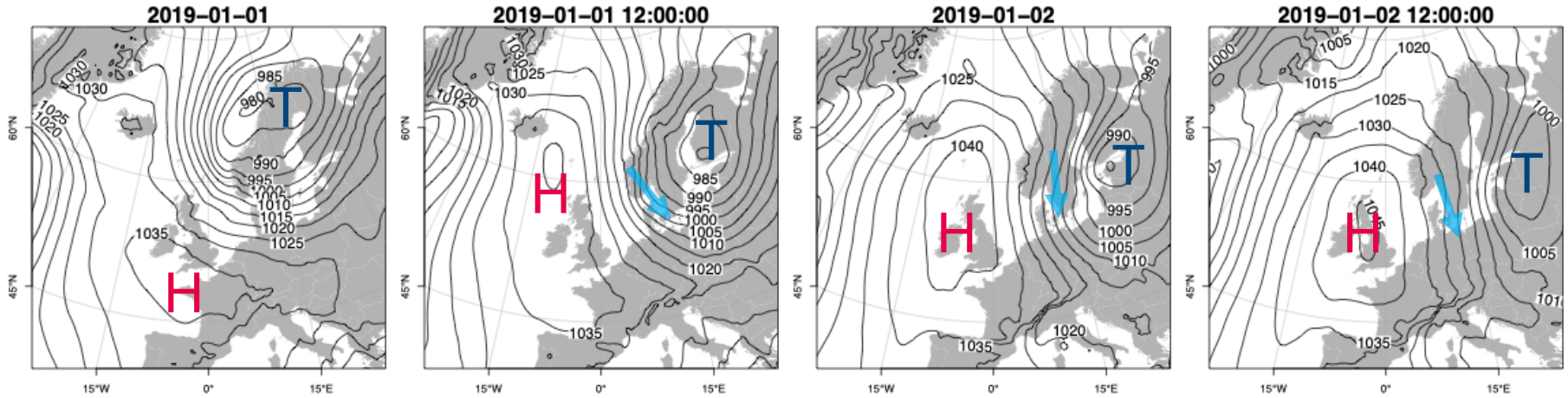


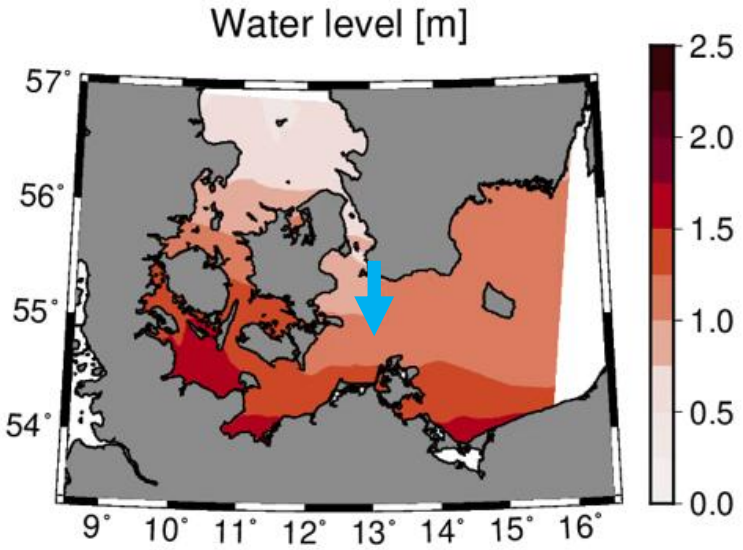


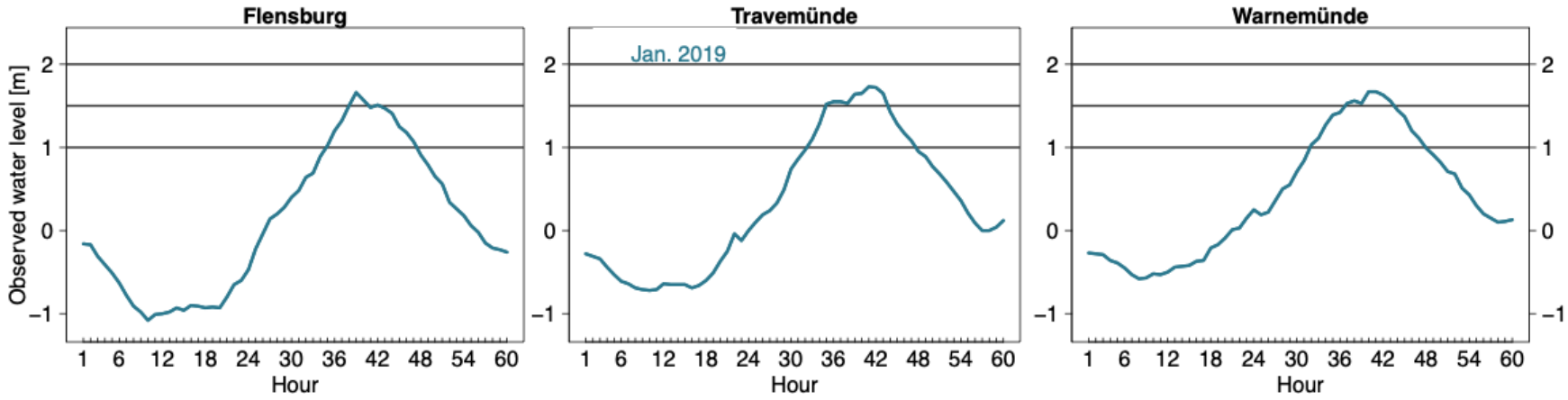
WSV, 2024, Meyer, 2025

Helmholtz-Zentrum hereon

02 Jan 2019







WSV, 2024, Meyer, 2025

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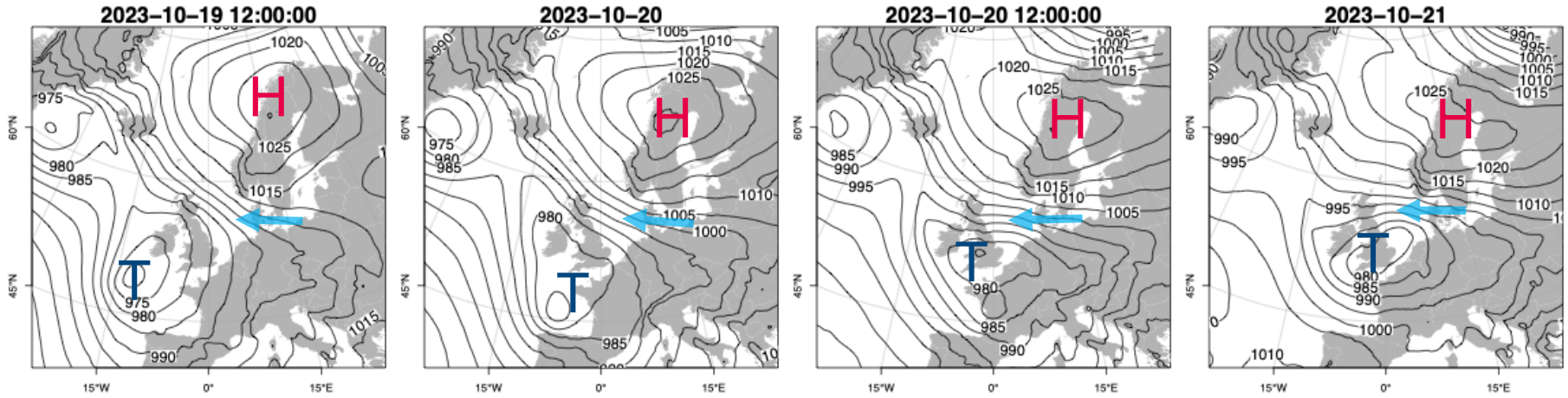
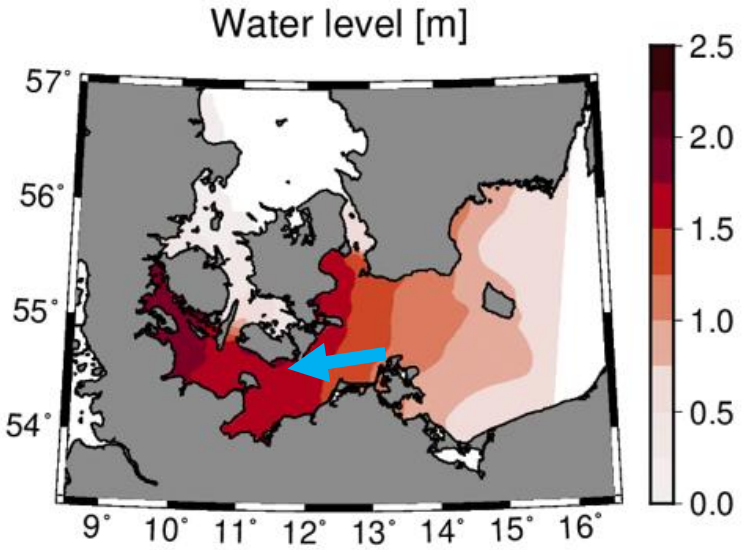
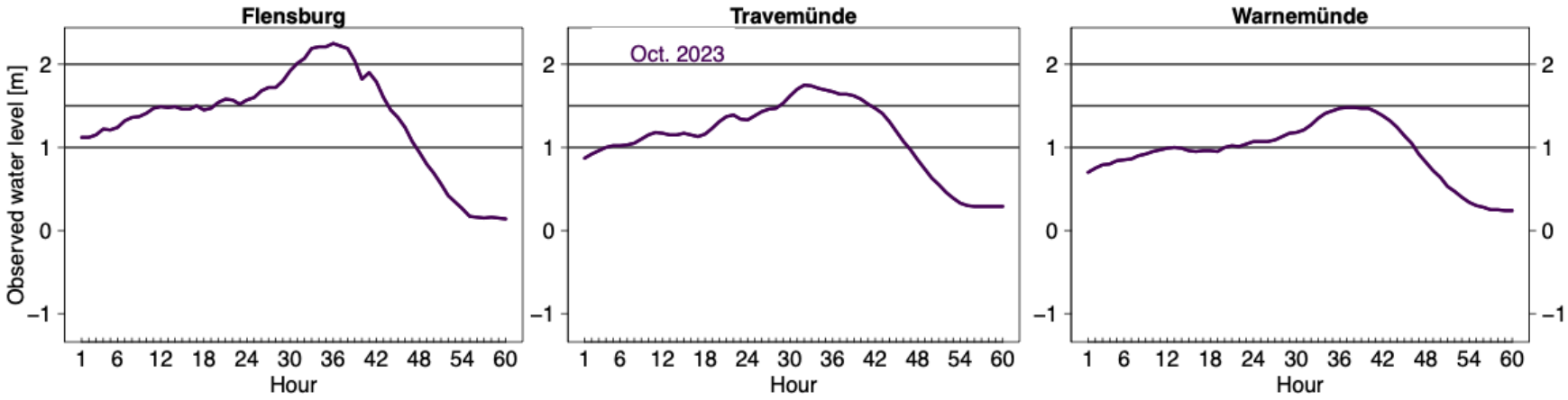
20-21 Oct 2023







WSV, 2024, Meyer, 2025

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