# Synthetically generated low-pressure systems to support studies of sea level extremes in Finland

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Mika Rantanen, Jani Särkkä, Jani Räihä, Matti Kämäräinen, and Kirsti Jylhä
Finnish Meteorological Institute, Finland
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Jarmo Vehkakoski

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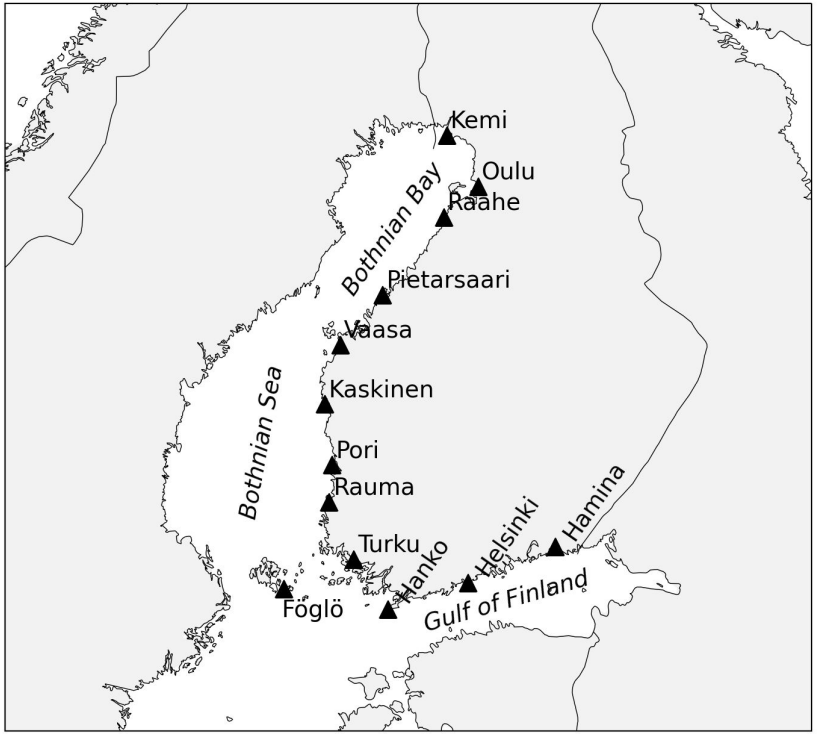
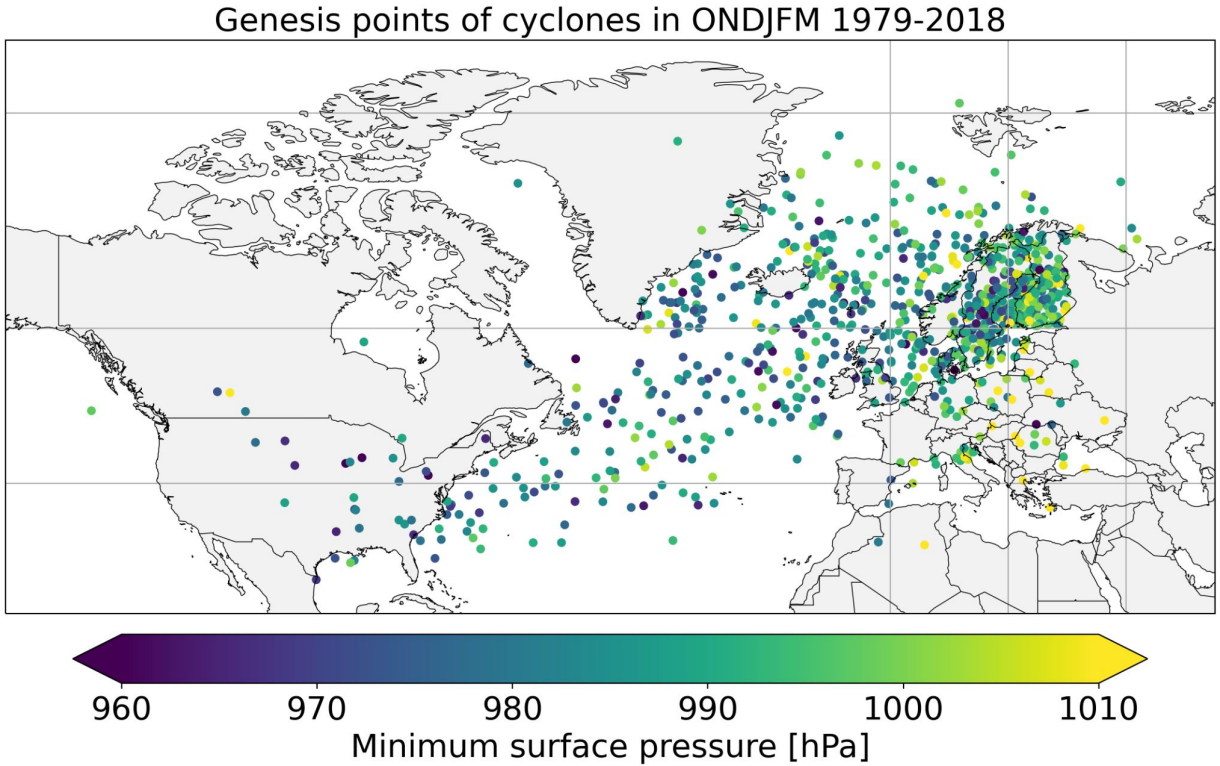
FINNISH METEOROLOGICAL INSTITUTE

# Characteristics of the sea level in the Baltic Sea



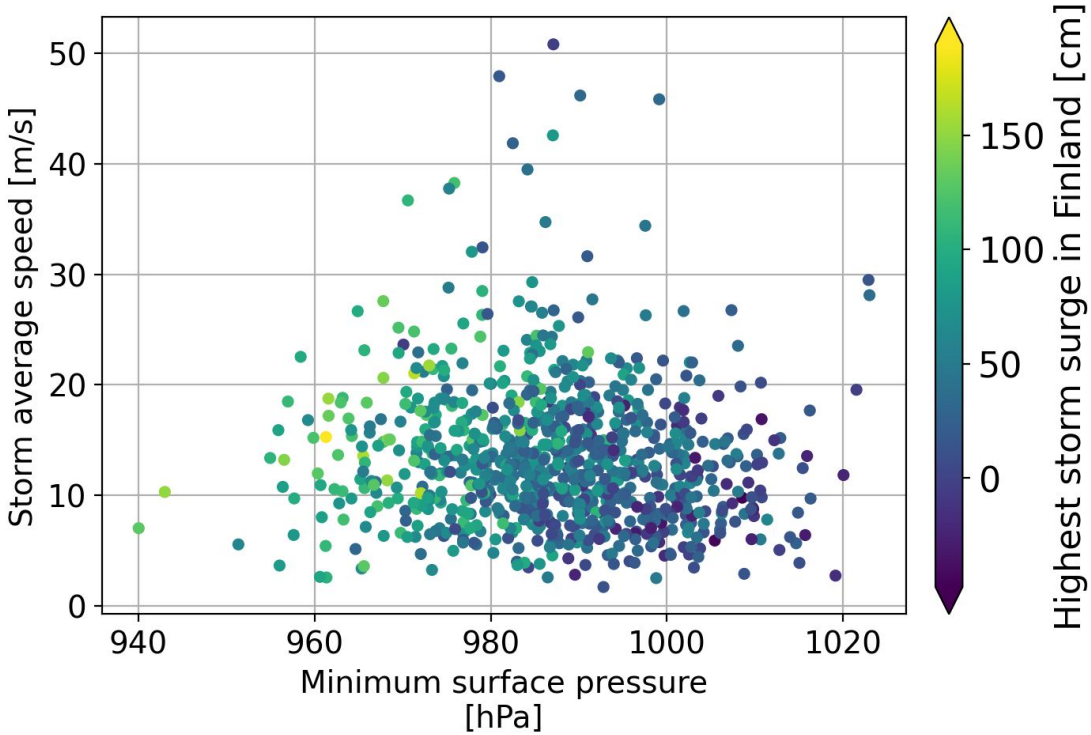

- Sea level affected by wind, air pressure and seiches
- Mean sea level from water flow through the Danish Straits
- Negligible tides, mean depth 54 m
- Extreme sea levels caused by wind storms
- Highest maxima in the ends of bays
- Finnish tide gauges (shown on the map) have 100-year time series
- Highest observed maxima at Hamina (197 cm in 2005) and Kemi (201 cm in 1982)

# Windstorms passing Finland




- Most windstorms passing Finland come from west
- Their points of origin and minimum surface pressure extracted from ERA5 data

# The intensity and speed of the windstorms vs. the highest observed surge in Finland




- The stronger the storm, the higher the storm surge
- The highest surges occur typically with storm speed of ~15 m/s

- What would be the highest storm surge if these storms would have travelled with the most “optimum” track?

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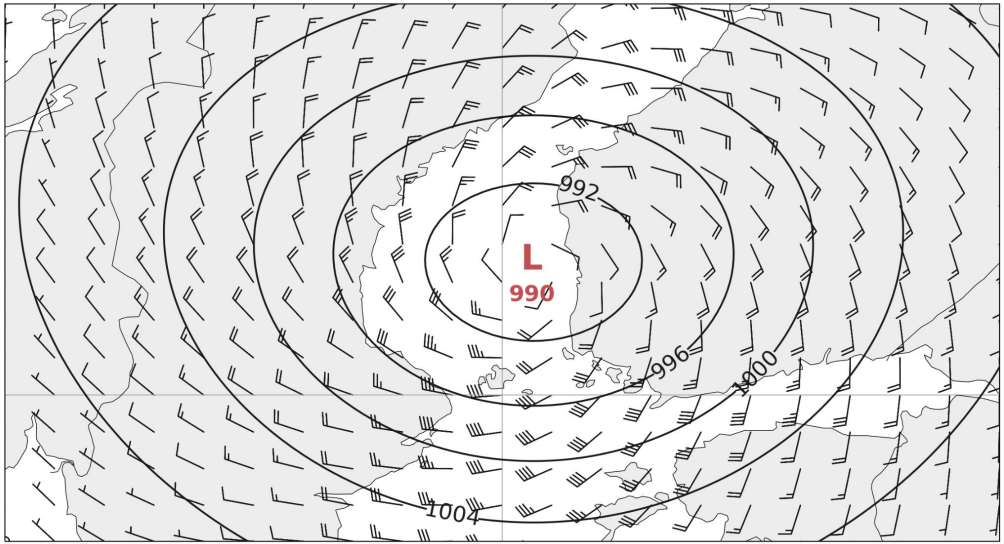
# Method to simulate sea level extremes

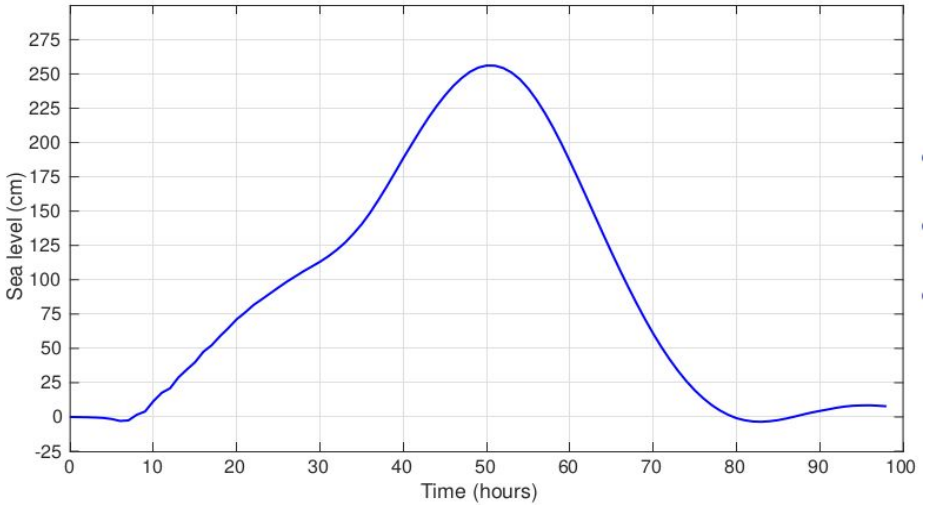
- Aim is to study coastal sea level maxima due to wind storms
- How severe coastal flooding could occur, if the weather conditions are optimal?
- Looking for the storm tracks that cause the highest storm surges
- Generate an ensemble of synthetic cyclones (moving pressure fields)
- Calculate the surface winds from the pressure field
- Sea levels are simulated with a barotropic numerical model, having surface wind and pressure as forcing
- Large ensemble of cyclones with varying tracks is used as forcing to sea level model

# Cyclone generation



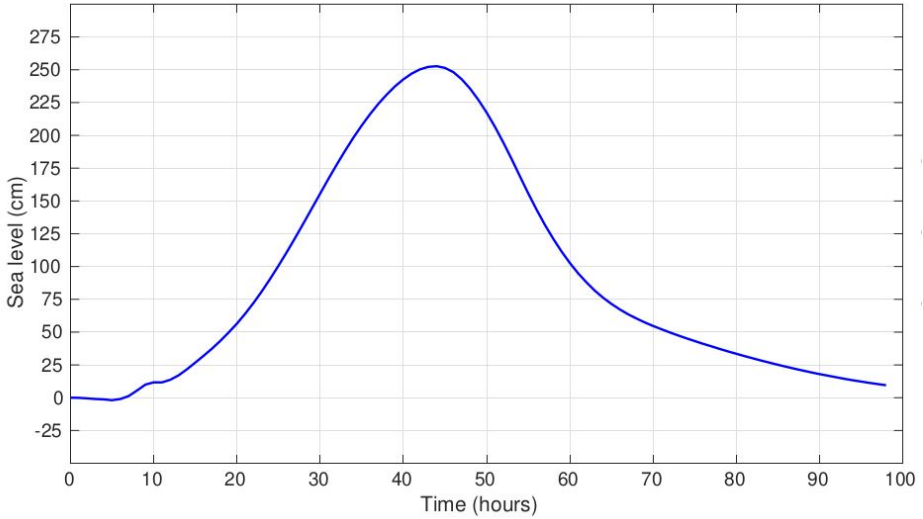

- Pressure distribution has Gaussian shape
- Cyclone moves with constant velocity from the point of origin
- The maximum depth of the pressure distribution is constant
- Surface winds obtained from corrected geostrophic winds
- Correction based on reanalysis data

# Highest simulated sea level at Hamina




- Storm surge in the Gulf of Finland
- Maximum sea level at Hamina 256 cm
- 59 cm higher than the observed extreme in 2005

# Highest simulated sea level at Kemi




- Storm surge in the Bothnian Bay
- Maximum sea level at Kemi 253 cm
- 52 cm higher than the observed extreme in 1982

# Conclusions

- Highest simulated sea level extremes are about 250 cm at the Finnish coast
- Highest extremes are caused by large and slowly propagating wind storms
- Mean water level of the Baltic Sea (up to 100 cm) should be added to the storm surge
- Over 300 cm sea levels are possible when storm surge coincides with preceding high mean sea level
- Probabilities of extremes are not assessed with this method (no weighting for the storm tracks)