

20th Century Variability: Atmospheric Data from Coastal Signal Stations

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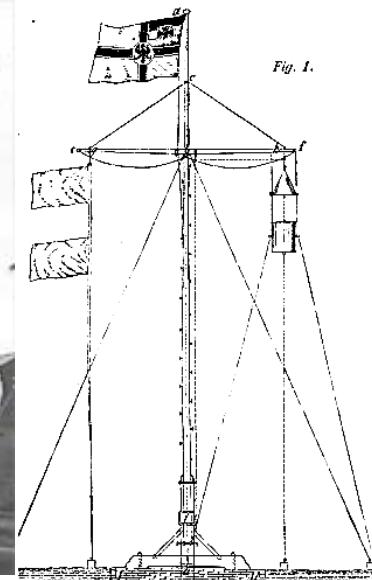
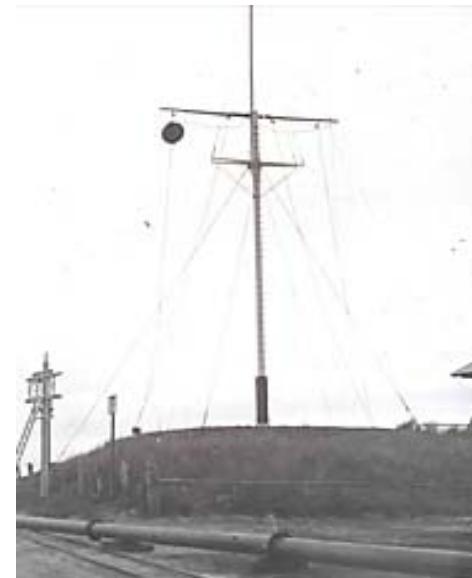


Atmospheric Data from Signal Stations along the German Coastline

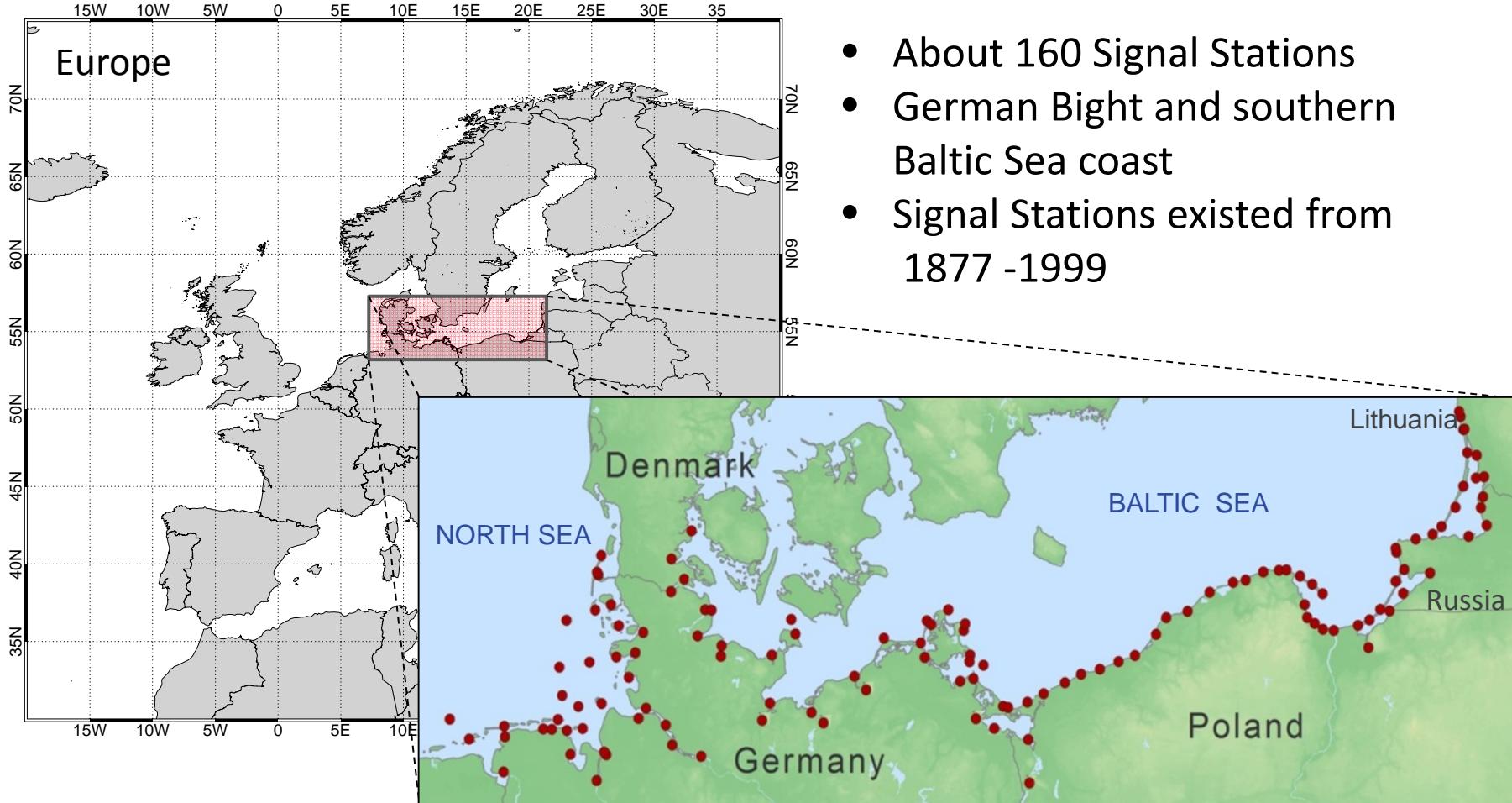
- Introduction to Signal Stations and their atmospheric data
- Spatial and temporal homogeneity of signal station data
 - Case studies: Storm surges in 1906 and 1913
- Summary and outlook

Signal Stations

- Signal Stations were provided by *Deutsche Seewarte (1875 to 1945)*
- Signal Stations were positioned close to the shore to warn sailors of severe weather by optical signals
- Optical signals could be balloons, triangles, cylinders and flags



Signal Stations - Positions



Handwritten Journals



Möglichst bald nach Monatschluss einzufinden.

Tagebuch der Sturmwarnungsstelle zu Dornbusch a. H. 11. XII. 1910

Praes. Sekretär

Monat Januar	a) Tägliche Beobachtungen.	Vitterungsscheinungen.		Säuer		1910	
		Windrichtung und -Stärke (Beauf.-Stufe)	Wetter nach der Telegramm-Stufe	Seegang 0-9	Niederschlag*) in mm	8 ^h a. m.	2 ^h p. m.
1. 1910	S 3 SW 3 SW 2	4 7 4	1 1 1	(°)	0	0	
2. 1910	SW 3 NW 4 W 6	4 4 5	2 3 5	0 0 0	0	0	4 1 7 4 2
3. 1910	W 6 NW 4 W 4	2 4 8	5 3 3	0 0 0	0	0	Vorwintertiefenw.
4. 1910	NW 6 NW 6 W 5	1 1 1	5 5 5	0 0 0	0	0	
5. 1910	NW 5 W 4 NW 5	1 4 4	4 4 3	0 0 0	0	0	

Bemerkungen.
(Zeitangaben sind genau zu machen, vgl. S. 2.)

- Hundreds of handwritten journals are archived at the German Meteorological Service in Hamburg
- Data were not recognized for years
- Data are partly digitized by DWD; all will be digitized and made available.

Data of Signal Stations

Station: Dornbusch
1910

January

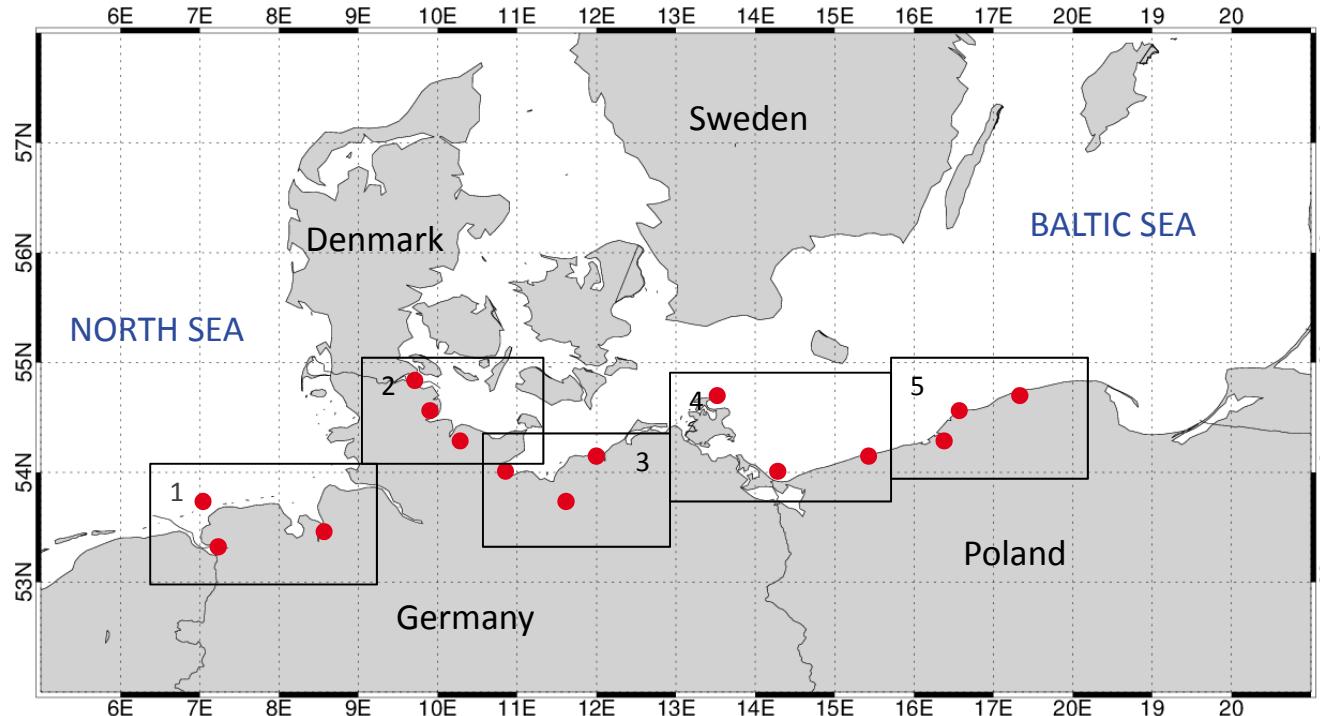
Date	Air pressure in mmHg	Wind direction Wind force in Beaufort				Weather condition 0-9			Sea disturbance 0-9			Precipitation height in mm		
		8 a.m.	8 a.m.	2 p.m.	8 p.m.	8 a.m.	2 p.m.	8 p.m.	8 a.m.	2 p.m.	8 p.m.	8 a.m.	8 p.m.	24h
1.	763.0	s	3	ssw	3	sw	2	4	7	4	1	1	1	0
2.	764.0	sw	3	WSW	4	w	6	4	4	8	2	3	5	0
3.	763.9	w	6	wnw	4	w	4	2	4	8	5	3	3	0
4.	761.0	wnw	6	wnw	6	w	5	1	1	1	5	5	5	0
5.	704.4	wnw	5	w	4	nnw	5	1	4	4	4	4	3	0

Why could these data be valuable for scientific research?

- Air pressure data allow the construction of proxies of storminess (e.g., seasonal percentiles of geostrophic wind distributions, or of local pressure changes)
- The data recorded at signal stations expand the monitoring network at the German Bight and Baltic Sea coast in time and space

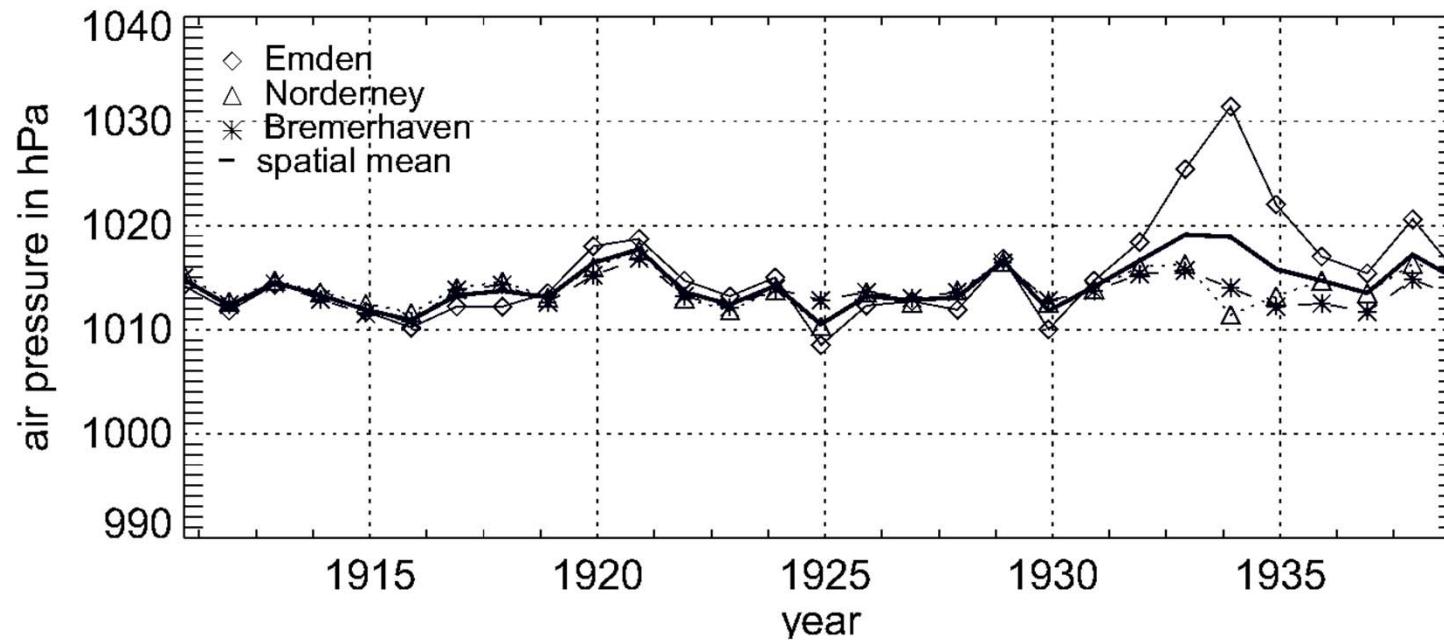
Are the data homogeneous in time and space?
Can we use the data for long-term trend analysis
and for describing historical events?

Temporal Homogeneity – Air Pressure



- Air pressure data of 15 Stations from 1877 to 1939 are digitized
- 5 boxes with three stations each
- Spatial mean of three stations for each region

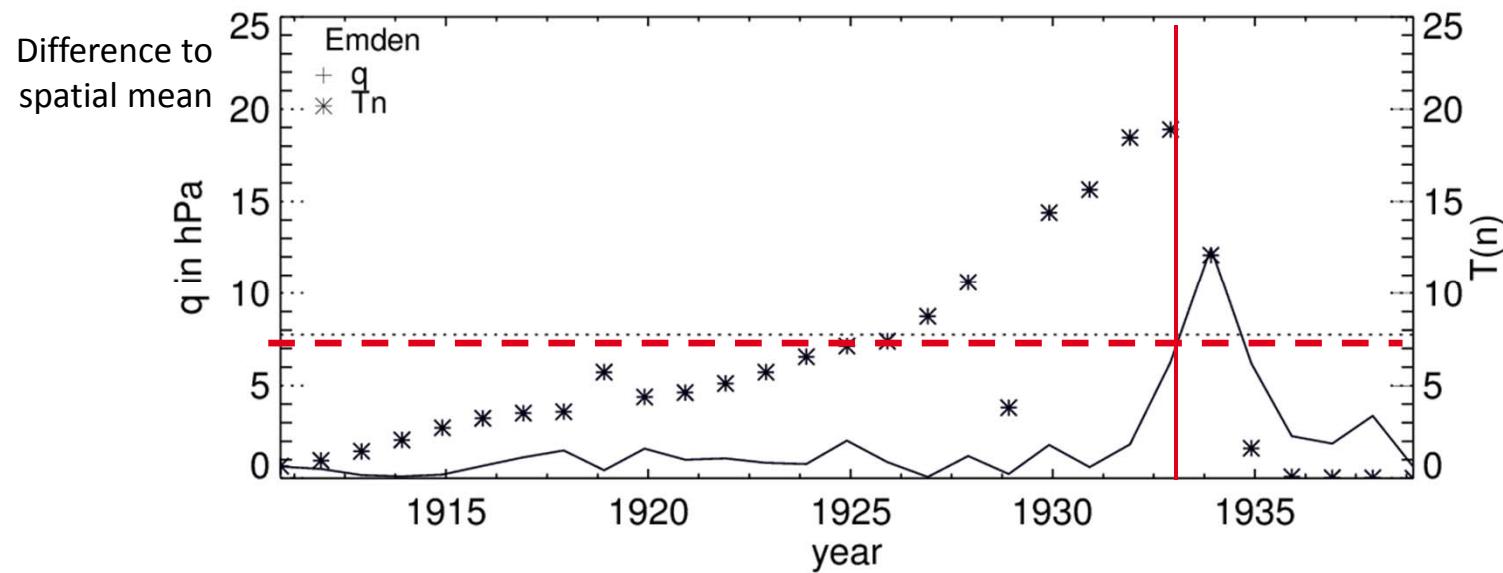
Temporal Homogeneity – Air Pressure



- Yearly mean of air pressure data
- Spatial mean for this region

Standard Normal Homogeneity Test (SNHT)

(Alexanderson 1986)



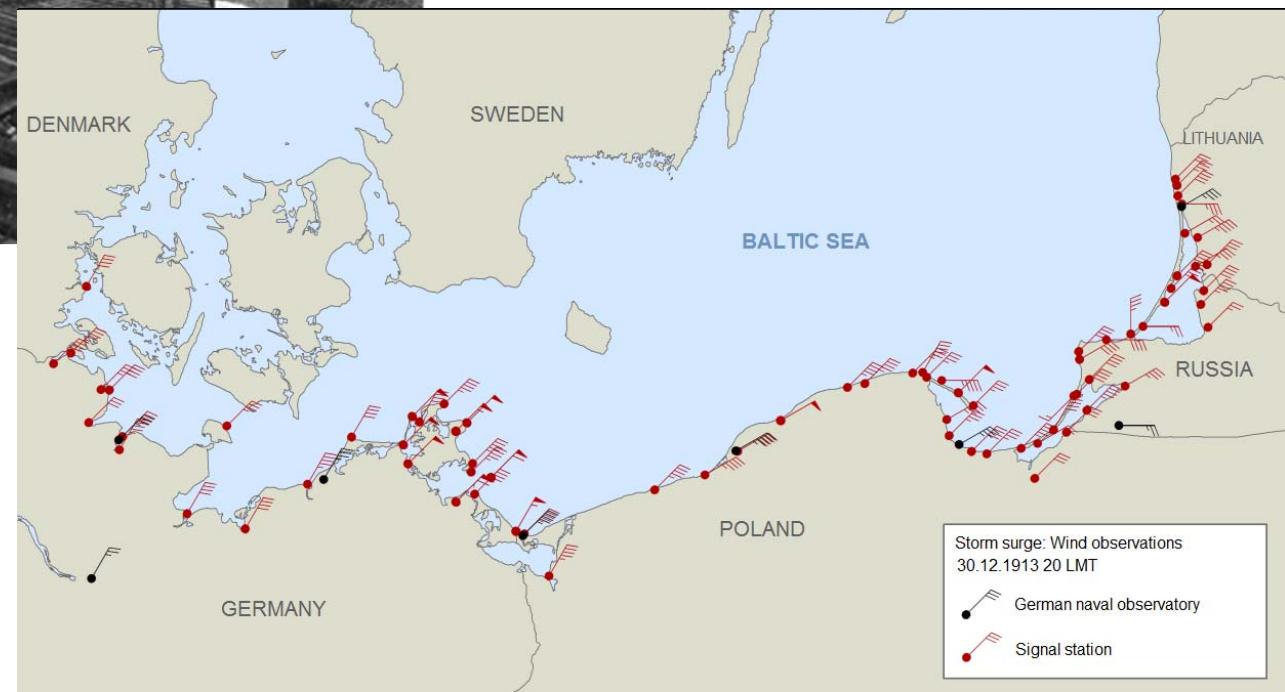
- A test value higher than the critical value indicates a probability of 90% and more for the presence of an inhomogeneity
- The time of the maximum of the test value T describes the point of inhomogeneity

Storm Surge on 31.12.1913

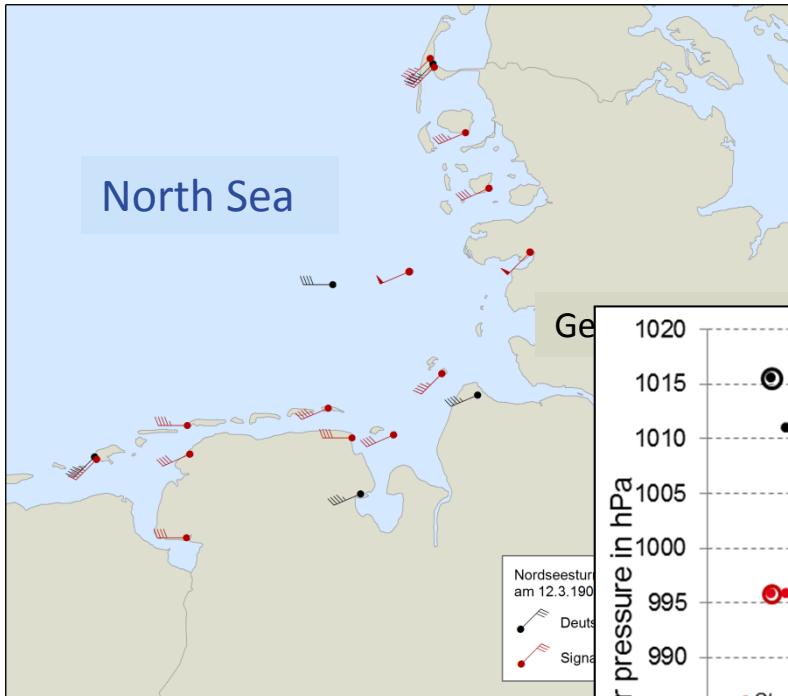


- Data of about 70 stations were digitized
- Same wind direction and high wind speeds

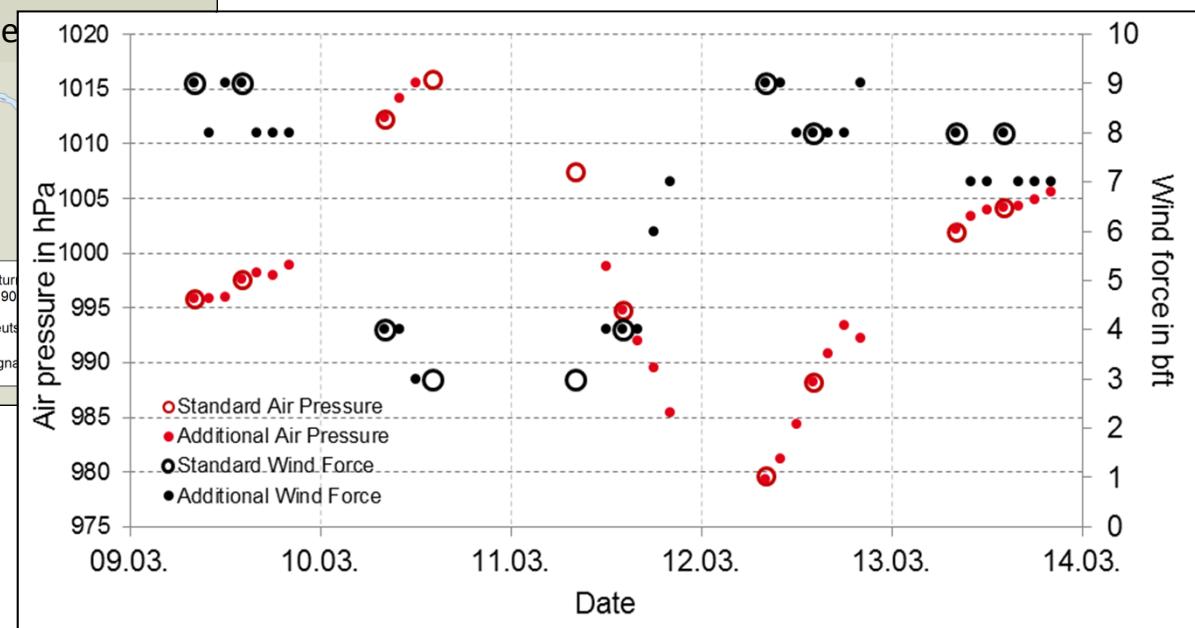
- Third highest known water level at the southwestern shore of the Baltic Sea
- Damage of railway embankments and houses



Storm Surge on 12.03.1906



- Expanding the monitoring network
- Additional observations during storminess



Conclusion and Outlook

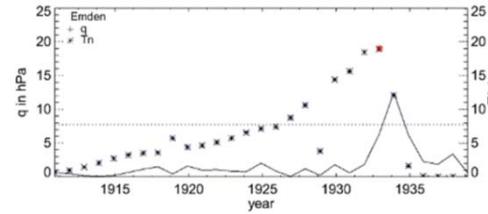
Signal Stations

- Digitisation of handwritten journals



Temporal Homogeneity

- Temporal homogeneity is not given



Spatial Homogeneity

- Spatial homogeneity of signal station data shown by extreme events



Outlook

- Valuable observation data, which have to be homogenized for temporal analysis