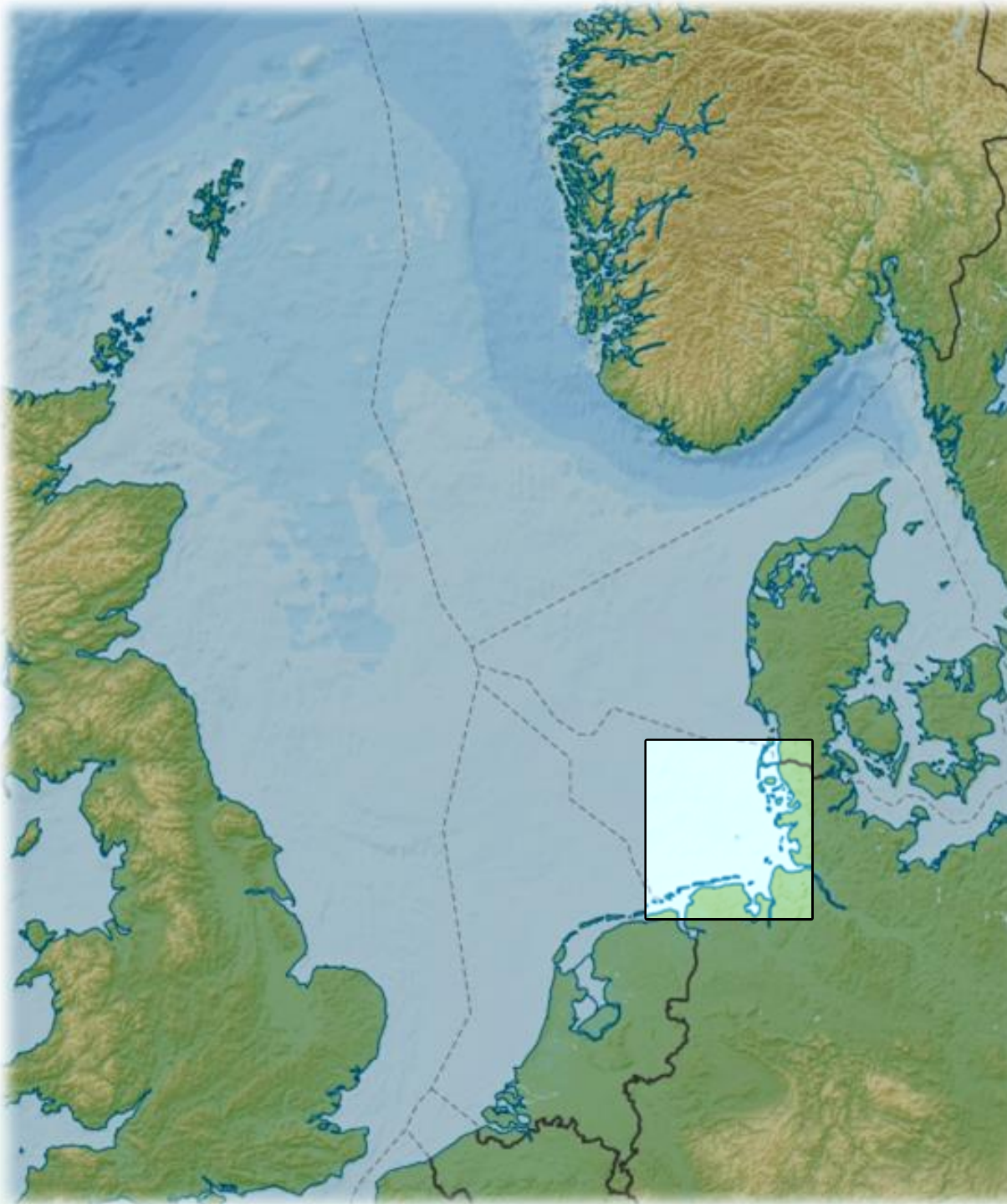
Long-term variability of extreme storm surges in the German Bight

Andreas Lang

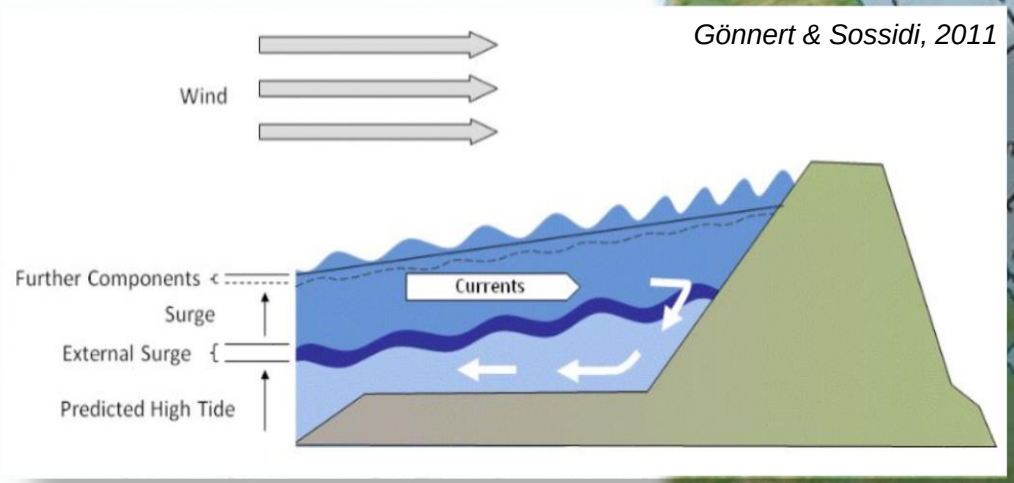
Max-Planck-Institut
für Meteorologie

Introduction



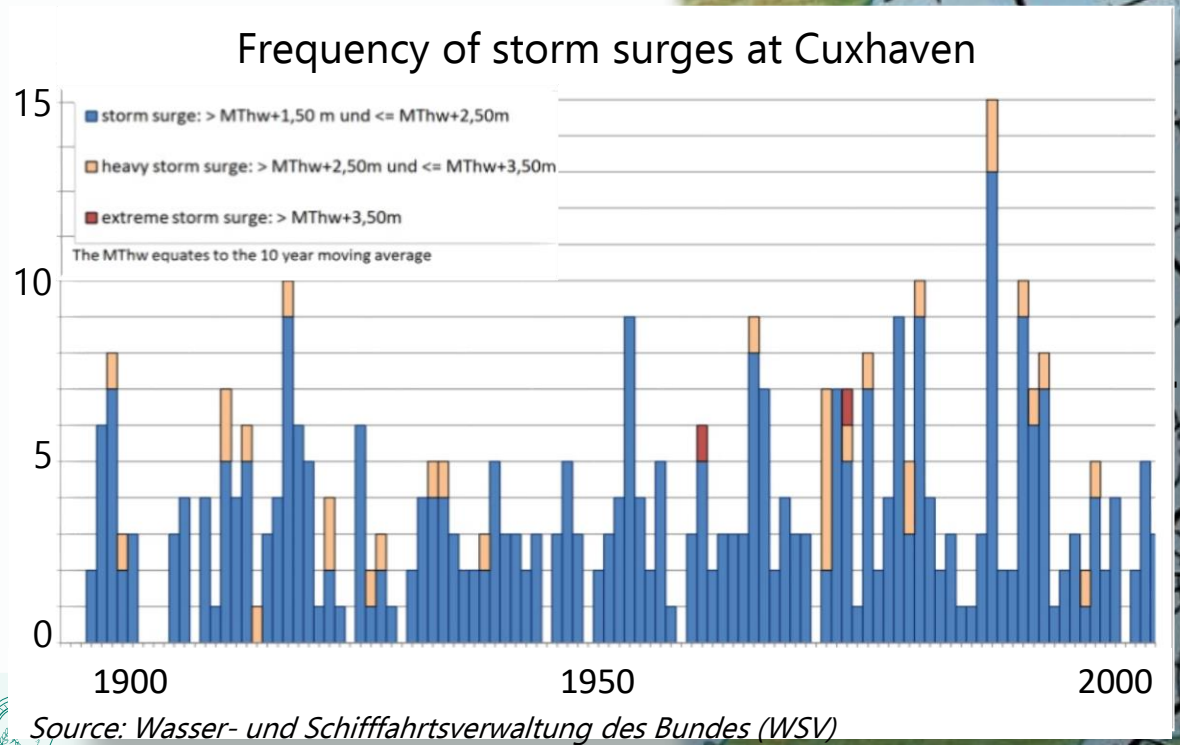
Introduction

- Storm surge components:



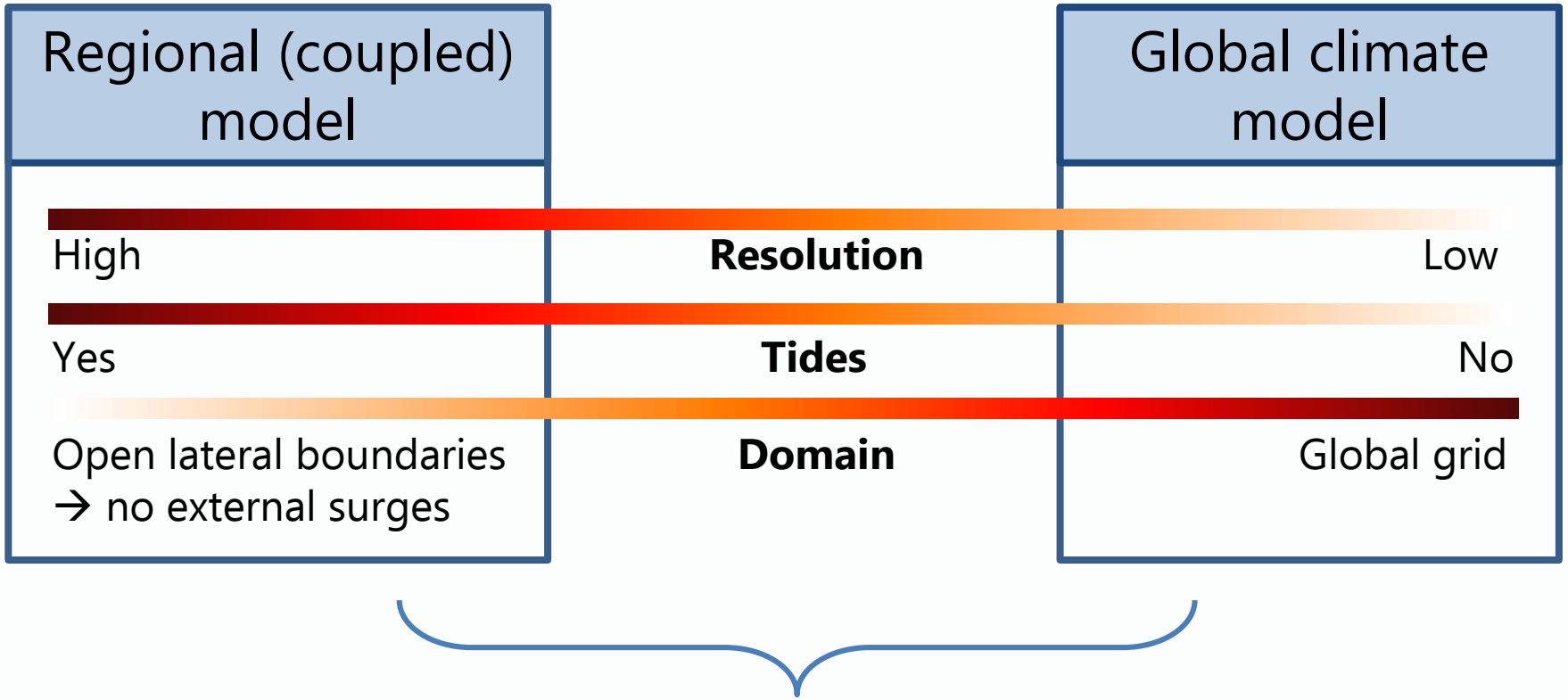
Gönnert & Sossidi, 2011

Observations



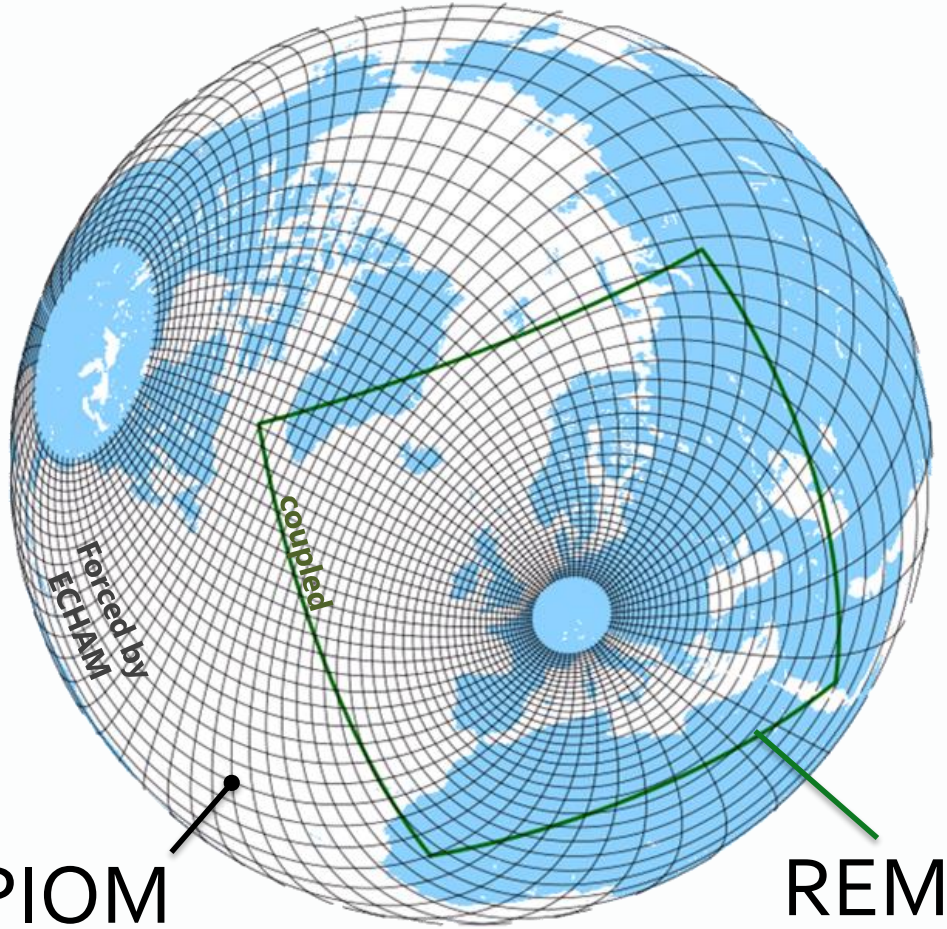
Source: Wasser- und Schifffahrtsverwaltung des Bundes (WSV)

Model setup



High-resolution regionally coupled GCM

Model setup: High-resolution regionally coupled GCM



MPIOM (global)

(not all gridlines shown)

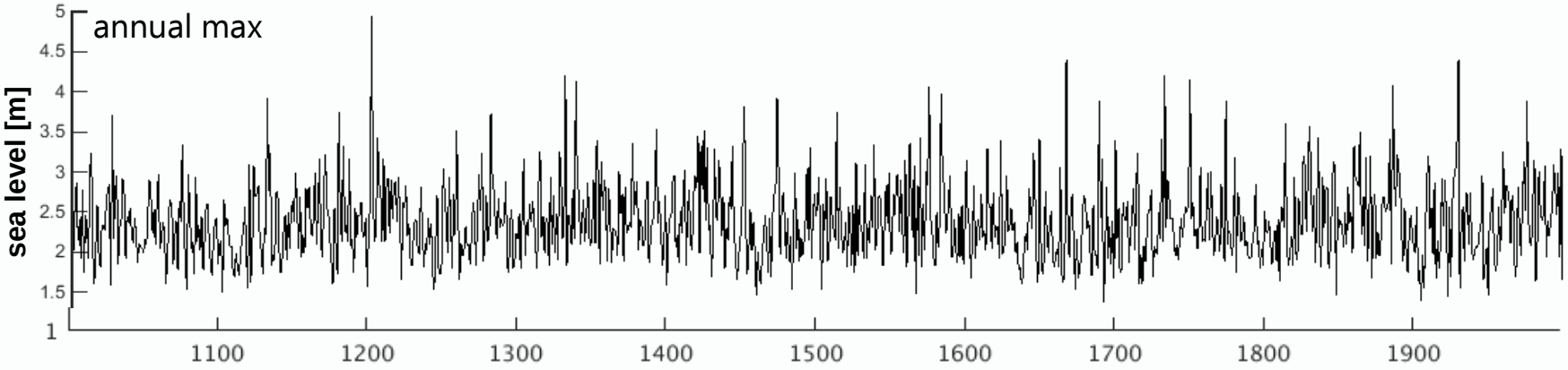
REMO (regional)

- ✓ Global ocean domain
- ✓ High resolution in North Sea (~10 km)
- ✓ Tides

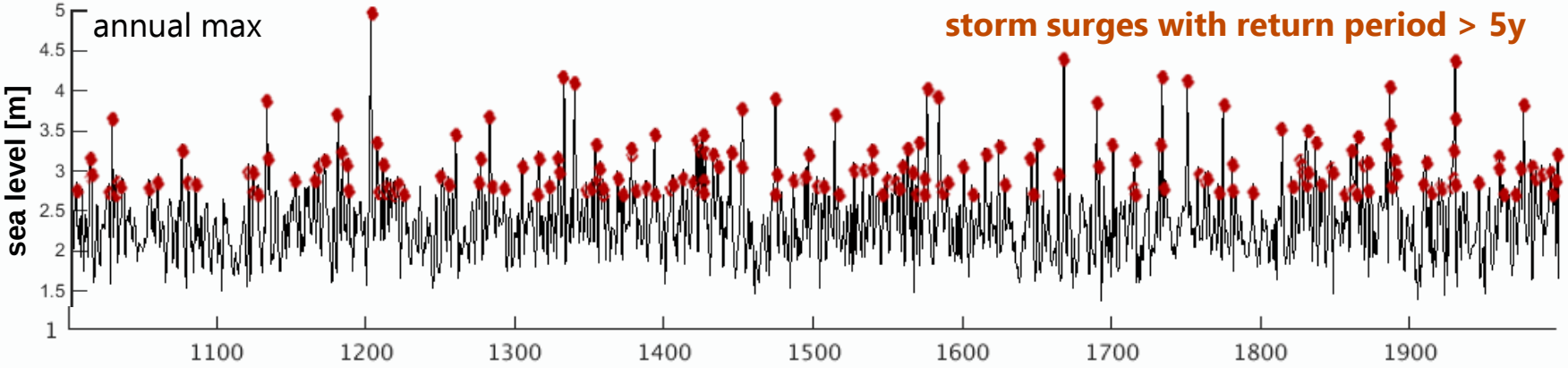
1000 year (1000-1999) downscaling of **Last-Millennium Simulation**

Hourly resolution

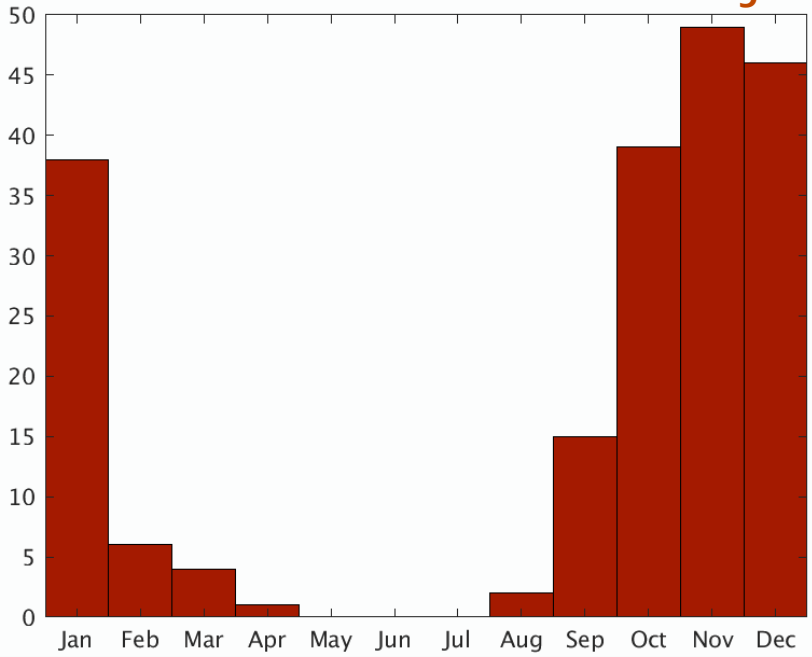
Modelled storm surge statistics



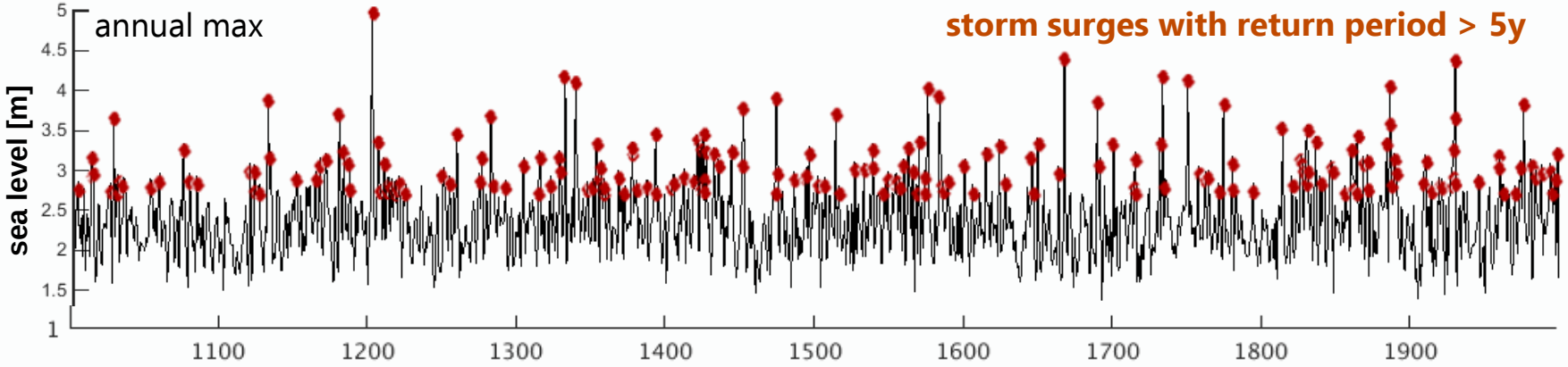
Modelled storm surge statistics

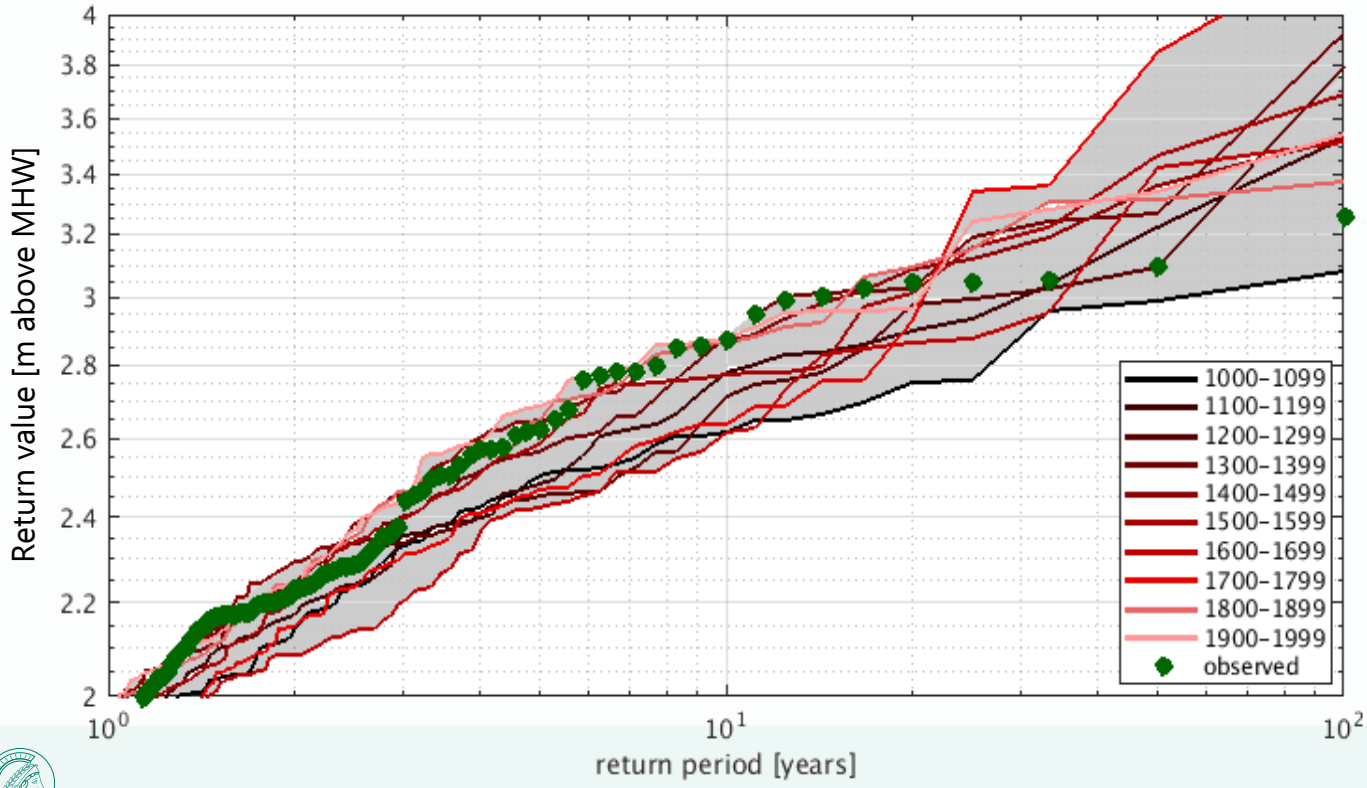


Seasonal occurrence of extreme storm surges

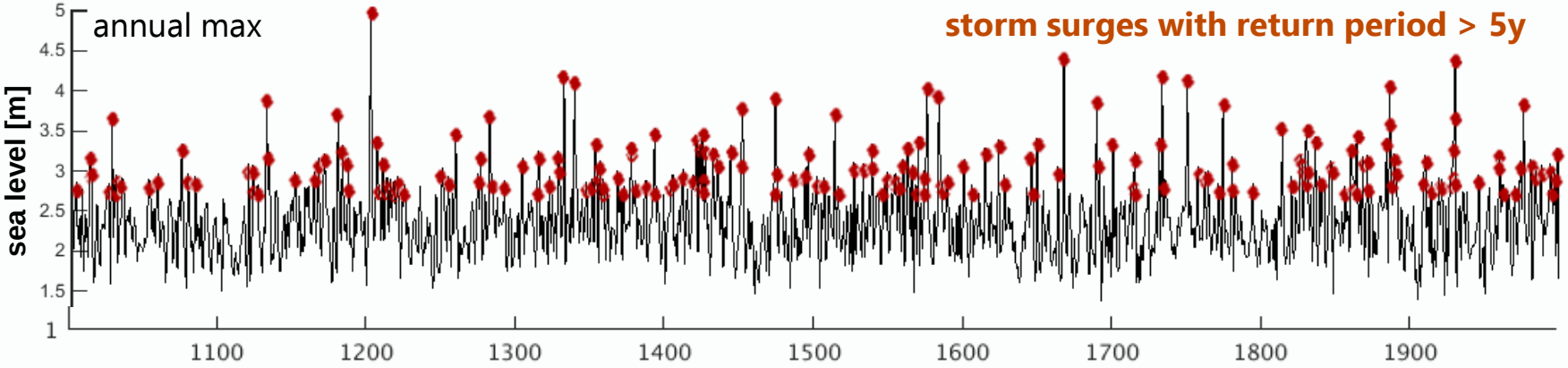


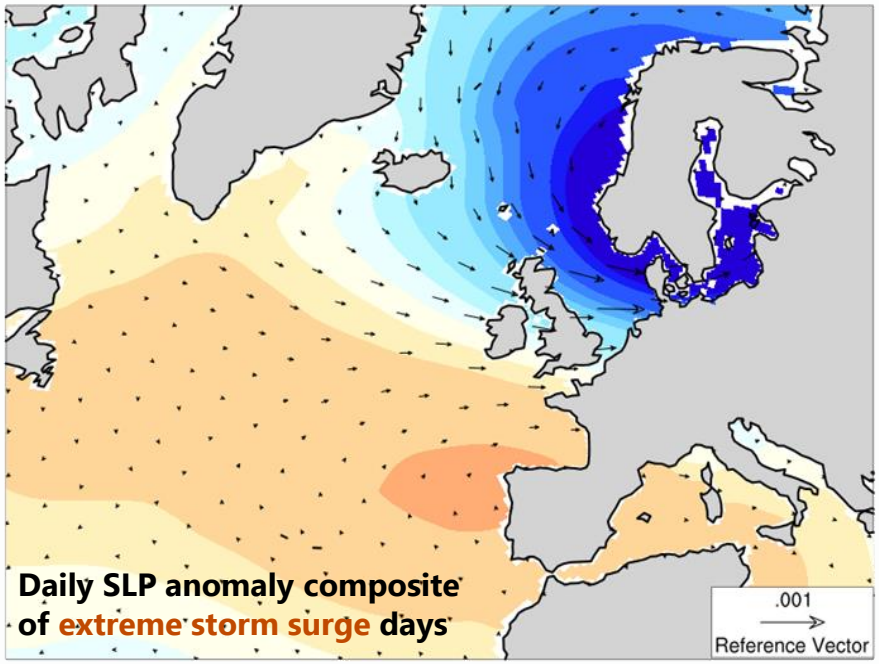
Weather situations & statistics

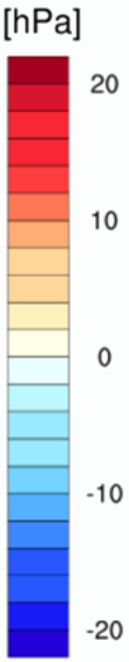


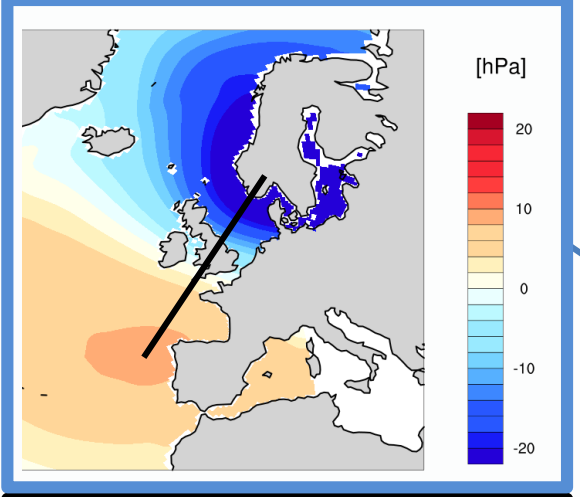


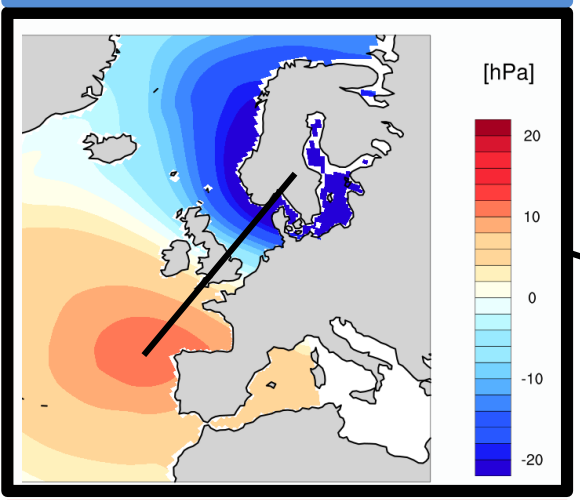
Weather situations & statistics

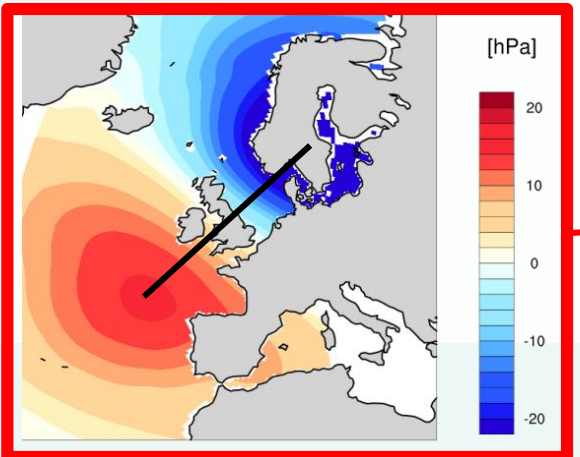


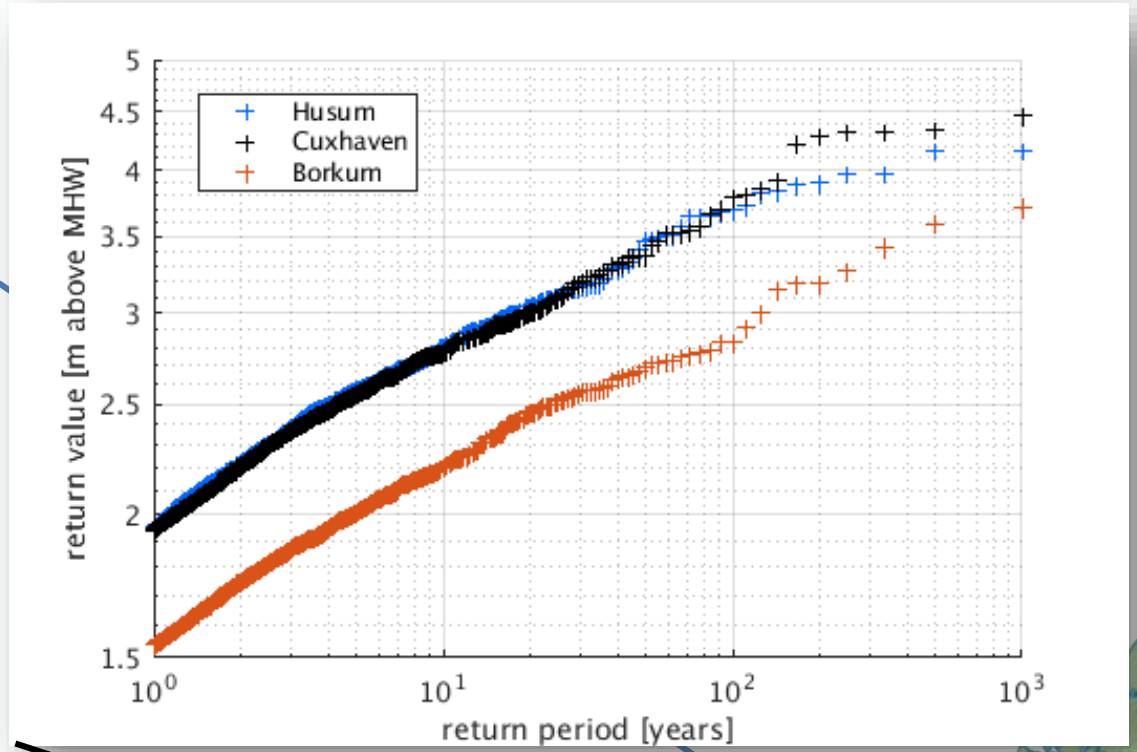


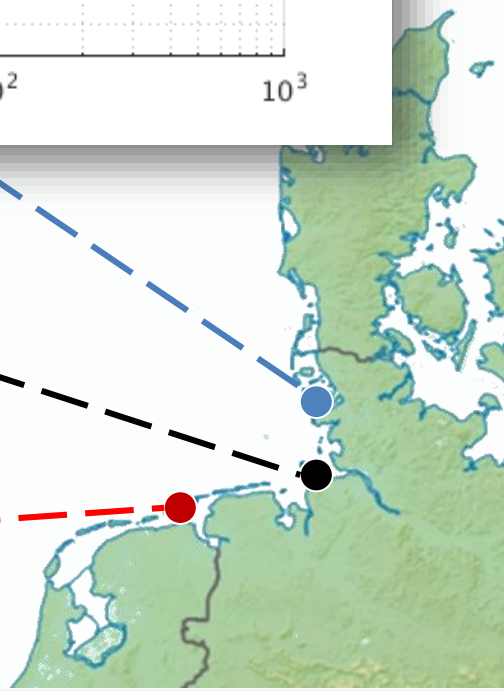








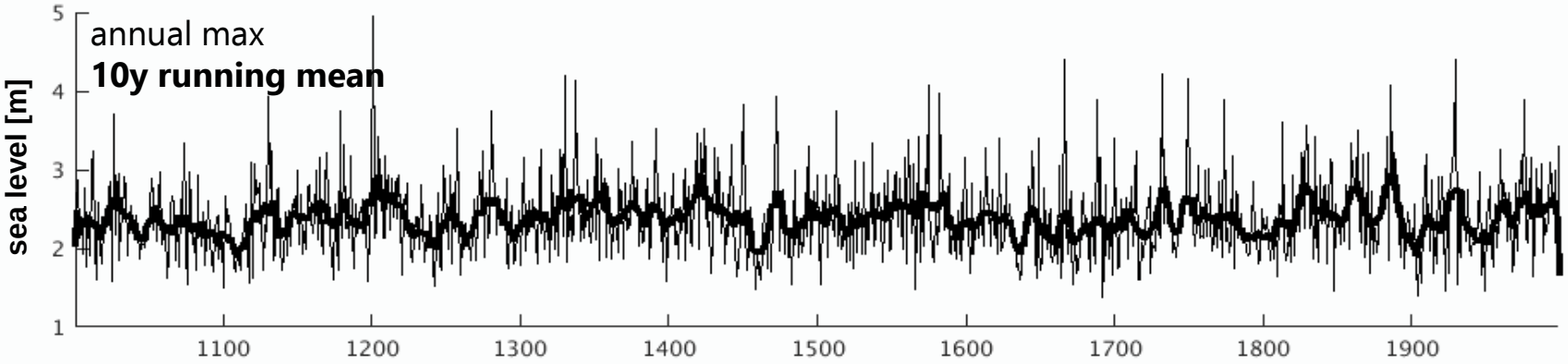


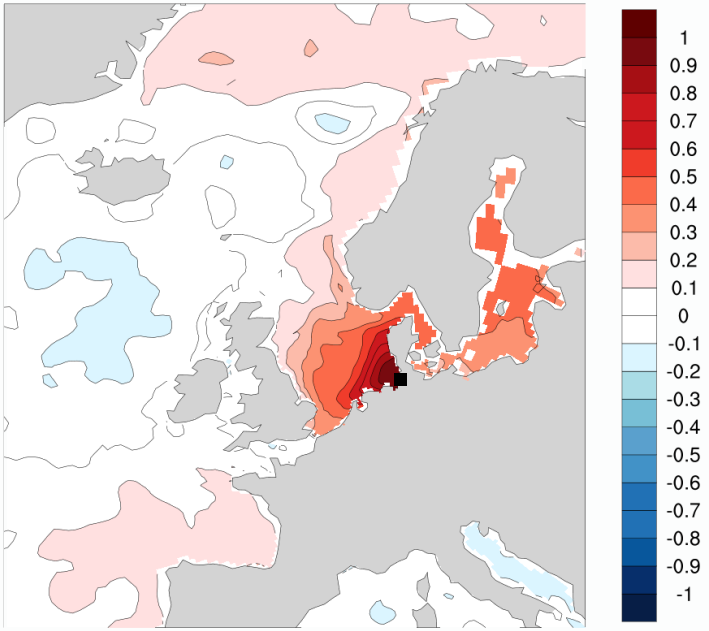


Max-Planck-Institut
für Meteorologie

Multi-decadal scale

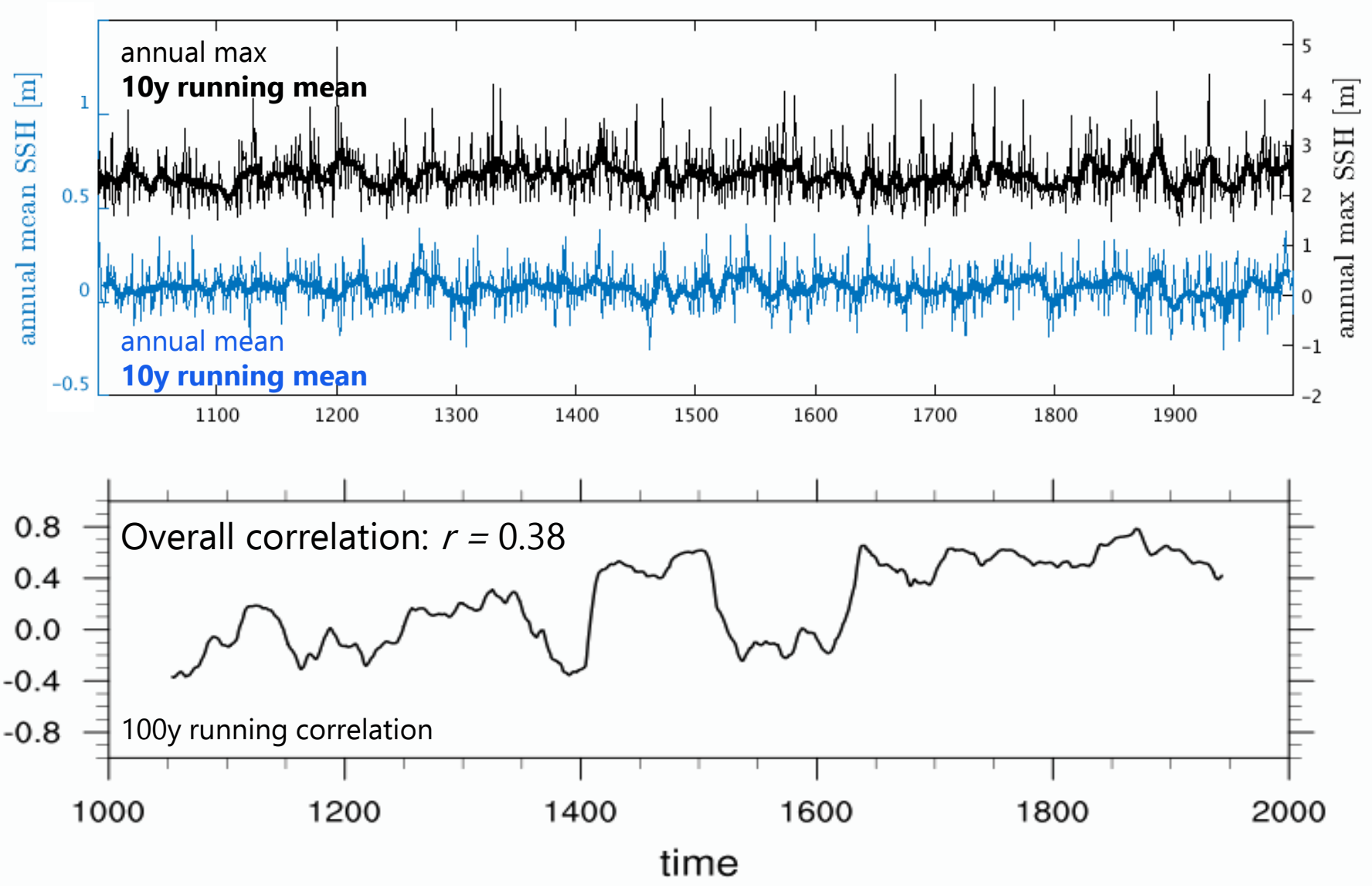
Climate situations favouring extreme storm surge activity?



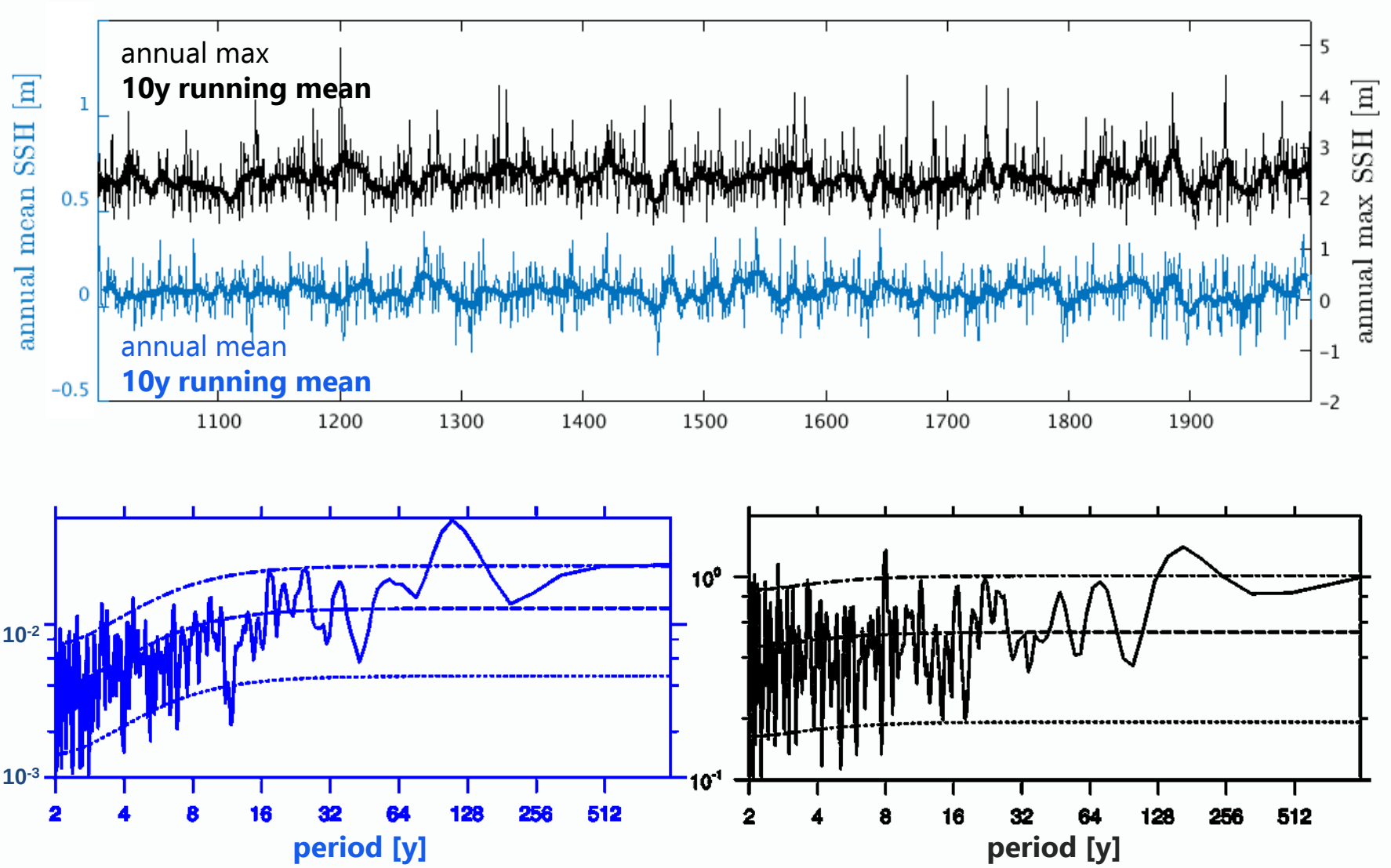


Spatial correlation of annual maximum SSH (10y running mean)

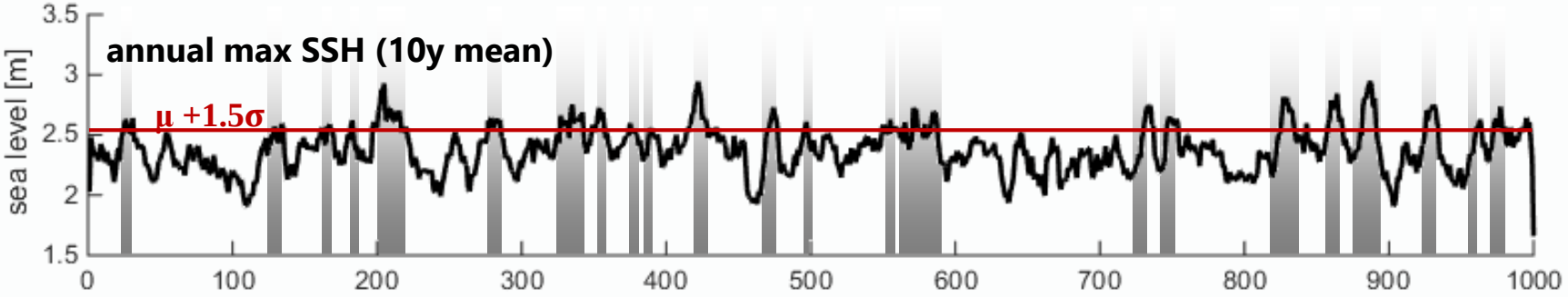
Multi-decadal scale – comparison to mean sea level

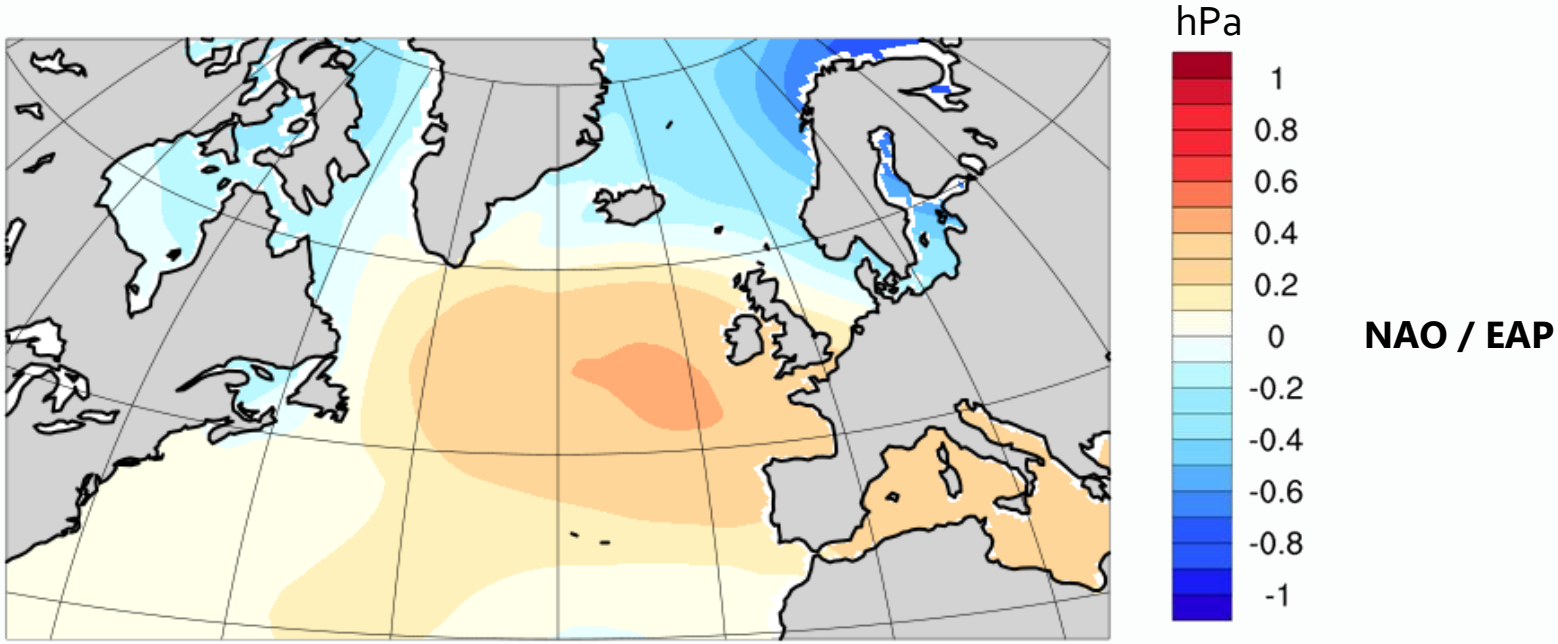


Multi-decadal scale – comparison to mean sea level



Multi-decadal scale – composite analysis: SLP

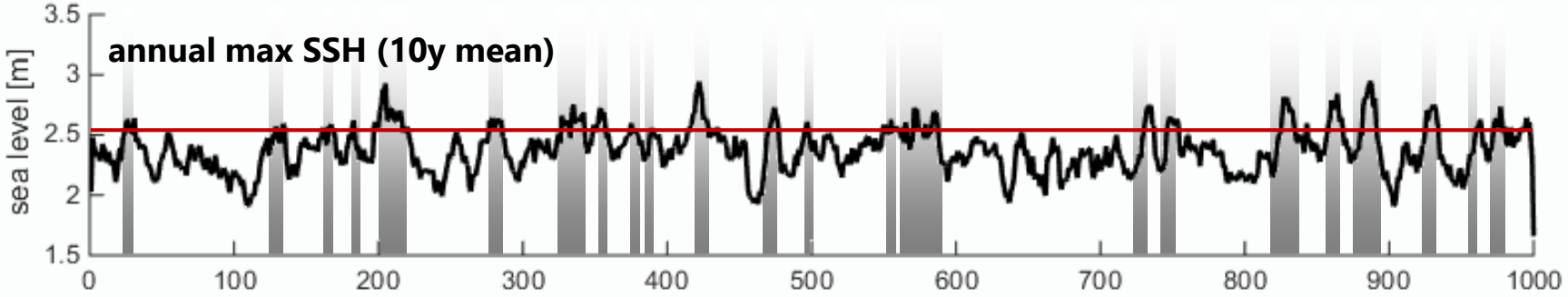




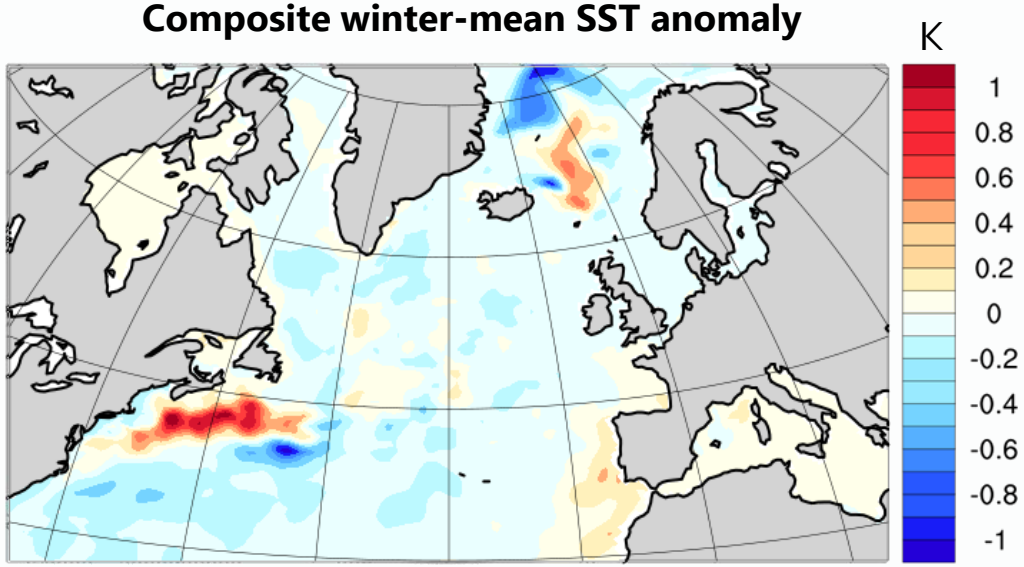
NAO / EAP

Composite winter-mean SLP anomaly for periods of high storm surge activity

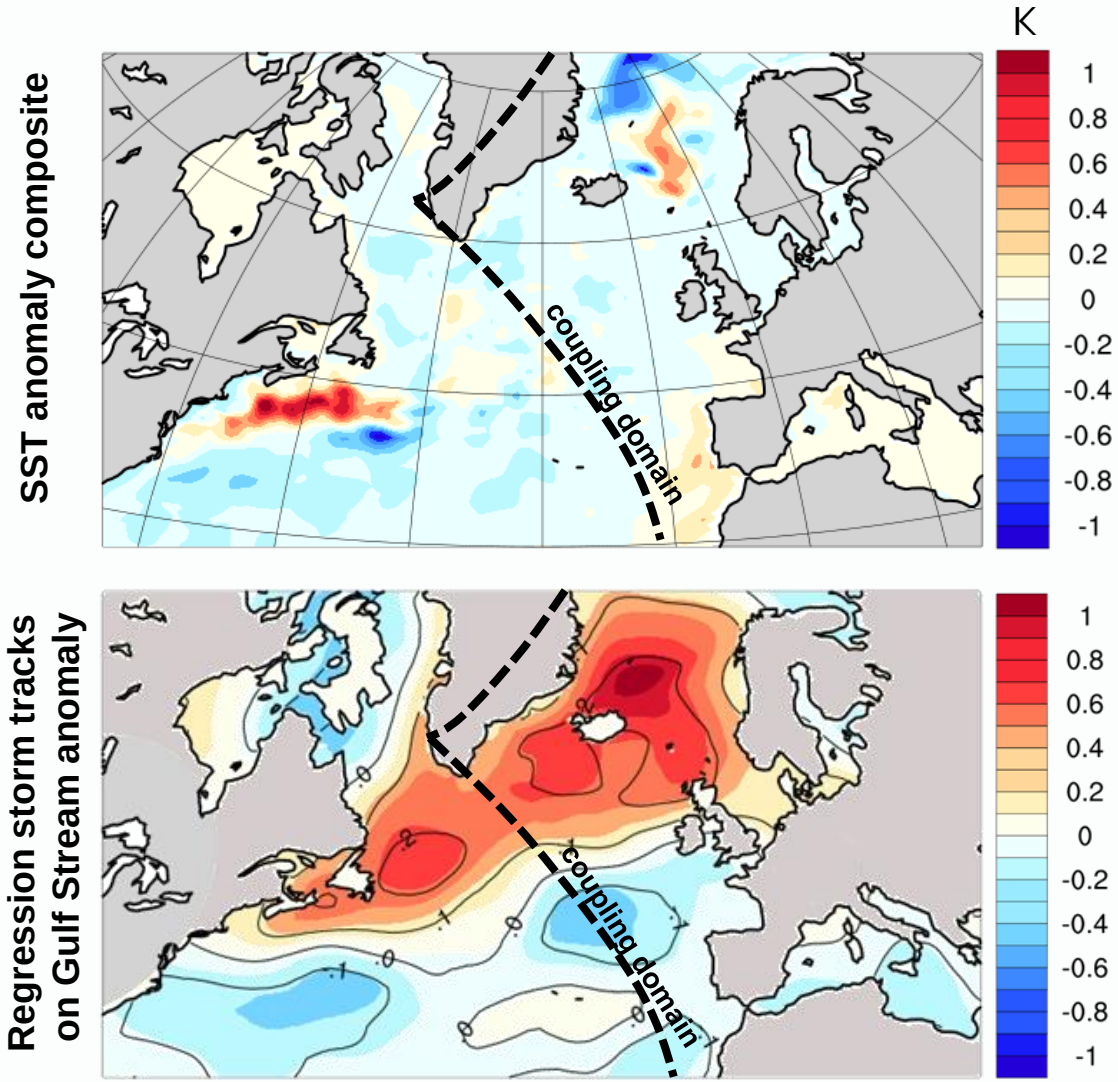
Multi-decadal scale – composite analysis: SST

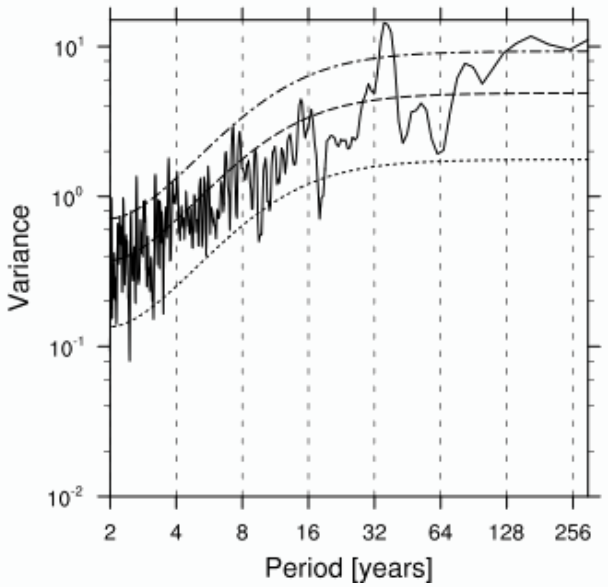


Composite winter-mean SST anomaly



Multi-decadal scale – composite analysis: SST & storm tracks

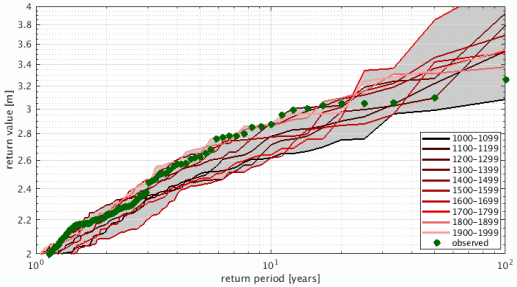




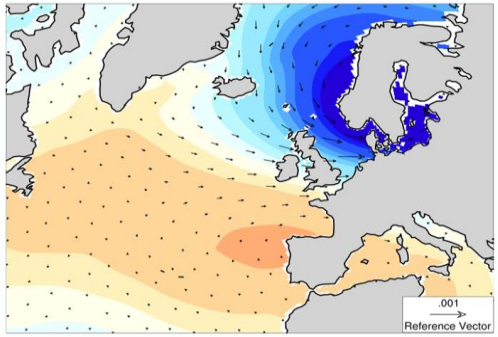
- Gulf Stream linked to NA storminess
- 35y mode as part of AMO
- Yet: not visible any more in annual max time-series

Conclusions

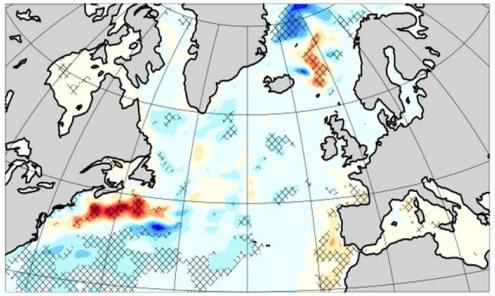
- **Regionally coupled GCM** reasonably reproduces observed storm surges **qualitatively & quantitatively**



- **Individual extreme storm surges events**
  - strong SLP dipole (Scandinavia/Biscay)
    rotation of dipole → location of strongest surges
  - highest storm surges at the eastern margin



- **Climate conditions** favoring extreme storm surge activity
  - SLP dipole resembling NAO+/EAP-
  - northward shifted Gulf Stream
    & enhanced storminess over North Atlantic



- **Multi-decadal variability** of extreme storm surges
  - does not exhibit dominant oscillatory modes
  - mostly decoupled from variability of mean sea level