

Storm surge climatology for the NE Atlantic and the North Sea - where the new RCP 8.5 scenario lead us to?

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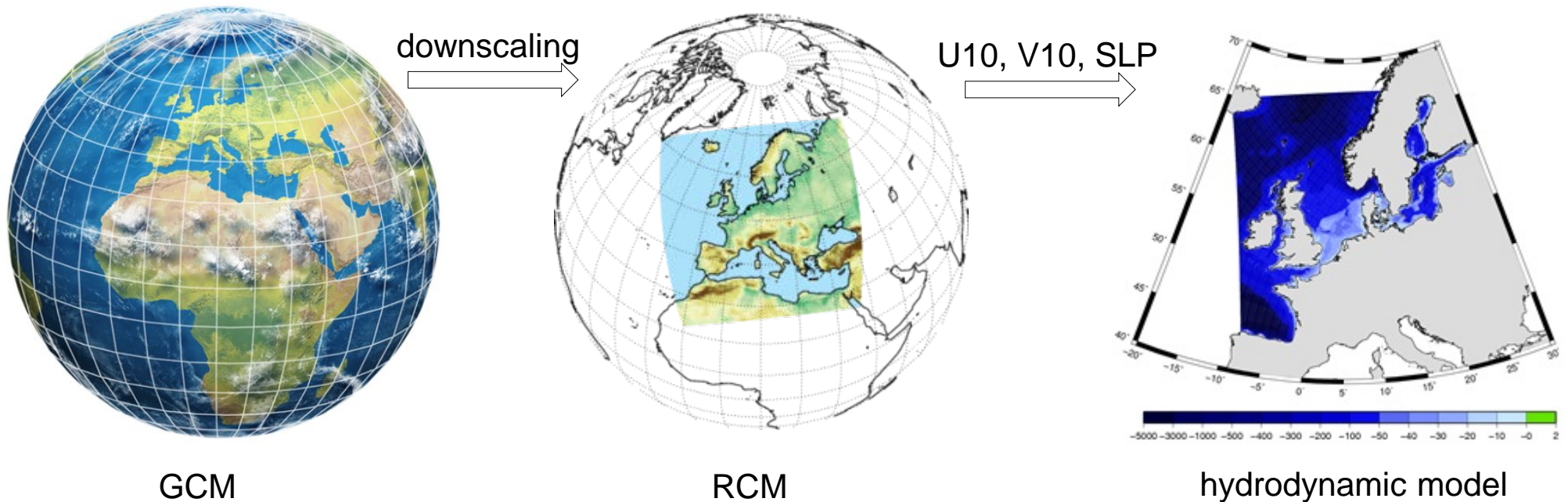
8-13 November 2015, Key West, Florida, USA

Model chain



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Global circulation models (CGMs) – atmosphere+ocean ~100-200km resolution

Regional climate models - atmosphere ~20km resolution

Hydrodynamic model - TRIM-NP: 2D barotropic, 12.8km, tidal forcing FES + U10,V10,SLP
output: hourly water level and current fields

Scenarios

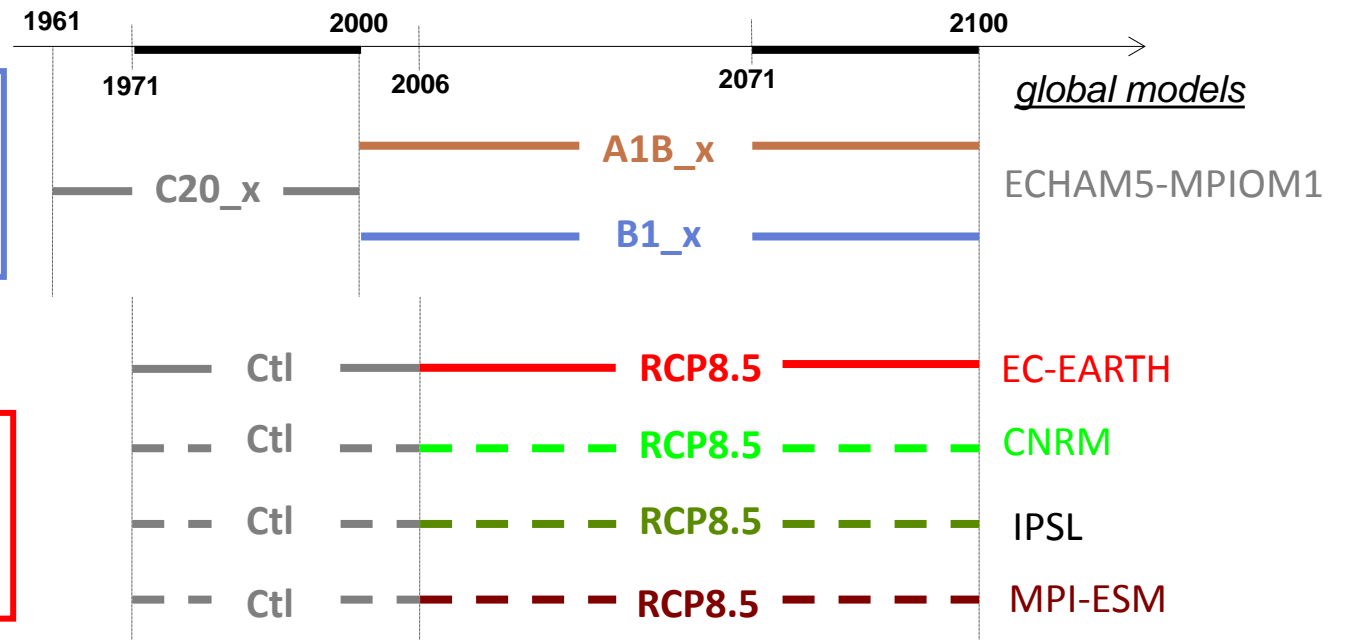


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Global IPCC AR4 scenarios from
CMIP3 (A1B and B1)
+ CCLM regional model

Global IPCC AR5 scenarios from
CMIP5 (RCP8.5)
+ RCA4 regional model



climate projections: simulations based on IPCC emissions scenarios

reference climate: simulations with observed GHG concentrations

climate change signal: difference between climate projection and corresponding reference climate

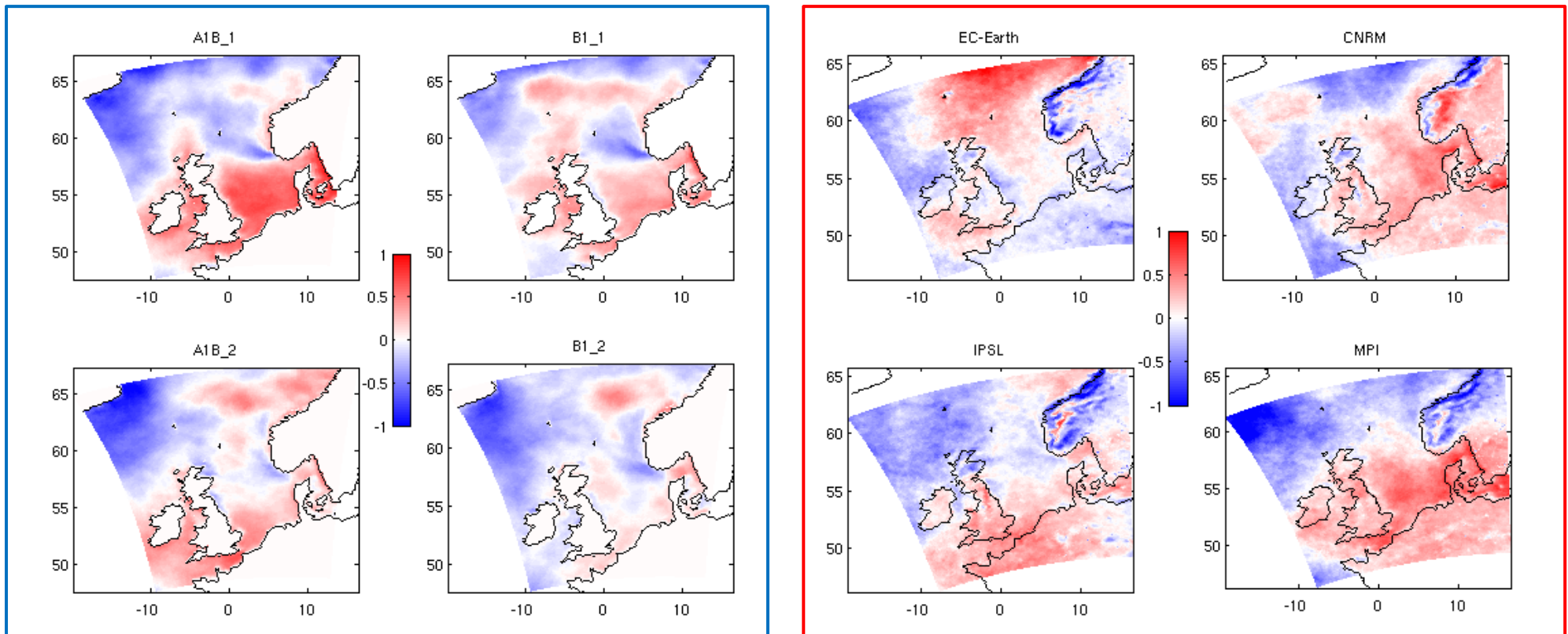
Changes in strong winds



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Differences of mean annual 99-percentiles of wind speed between 2071..2100 and 1971..2000



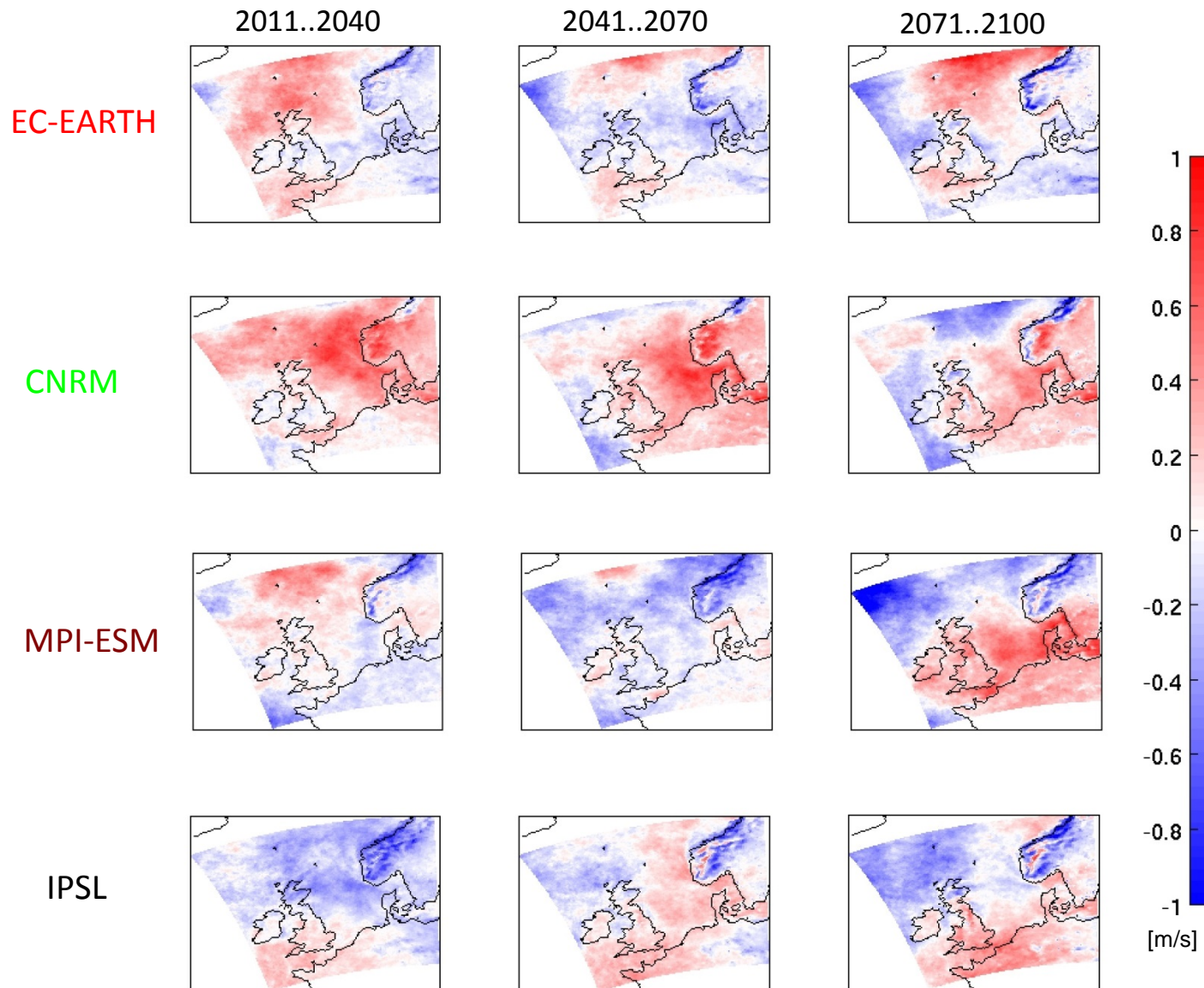
- different spatial patterns of climate change signal
- order of magnitude is comparable between CMIP3 and CMIP5

Changes in strong winds for RCP8.5



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Differences of mean annual
99-percentiles of wind speed
with respect to 1971..2000

- no common spatial pattern
- no steady temporal evolution

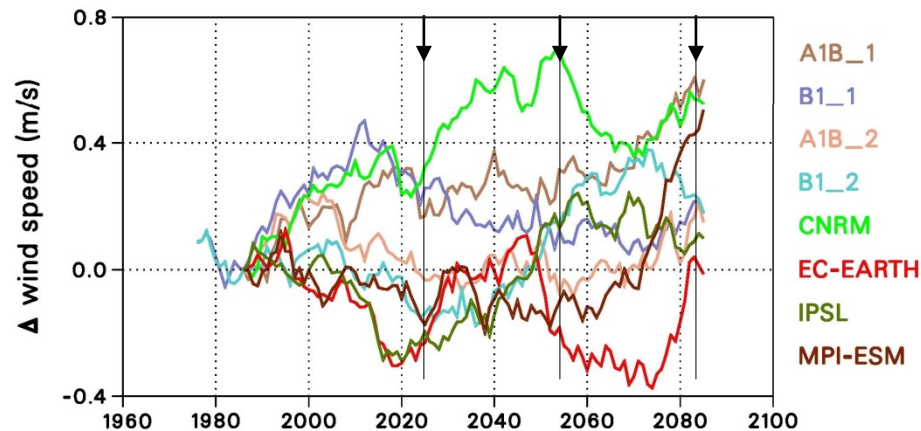
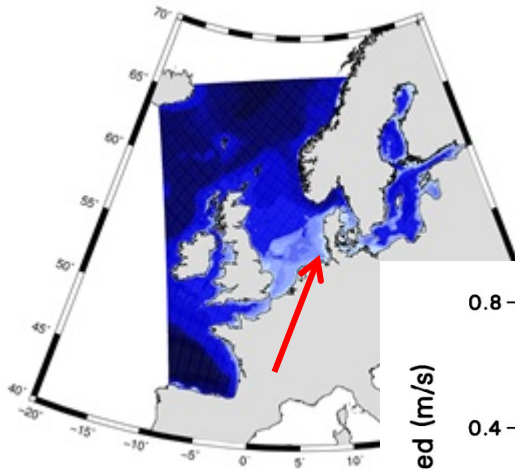
Strong wind multi-decadal variability



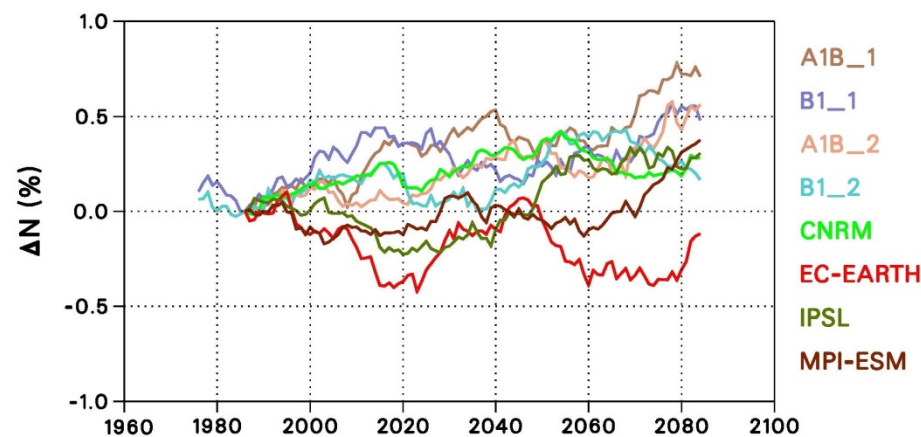
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- strong fluctuations on decadal timescales
- largest signal not necessarily towards the end of the century
- amount of strong westerly winds slightly increases (with exception of EC-EARTH)



30-year running average of **wind speed**
99-percentiles
Differences with respect to 1971..2000



30-year running average of **strong (>17.8m/s)**
westerly wind frequencies
Differences with respect to 1971..2000

Storm surge climate change signal



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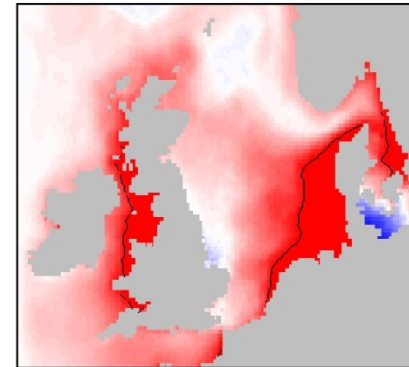
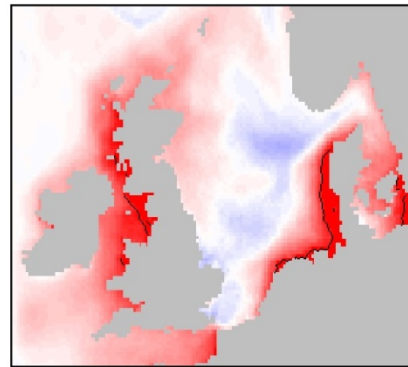
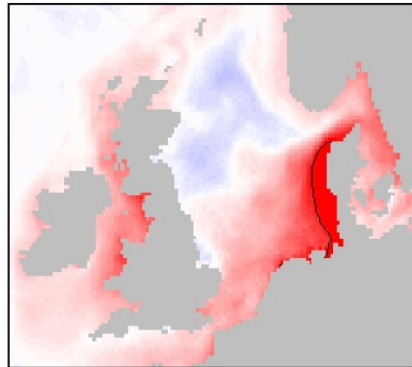
2011..2040

2041..2070

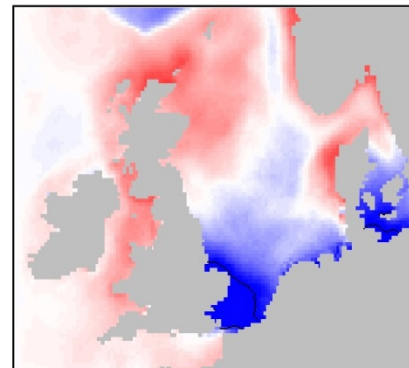
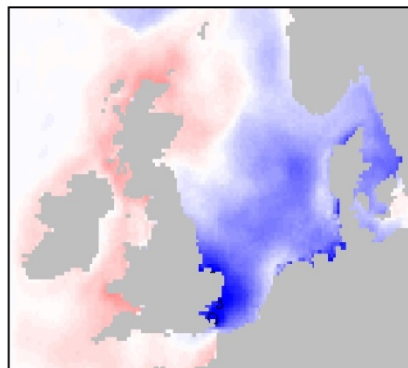
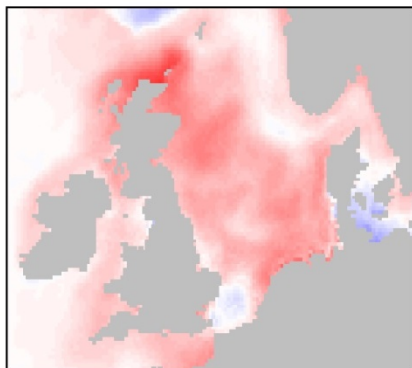
2071..2100

Differences of **mean annual
99-percentiles of storm
surges** with respect to
reference climate 1971..2000

A1B_1



RCP8.5



-0.05 -0.04 -0.03 -0.02 -0.01 0 0.01 0.02 0.03 0.04 0.05 [m]

- for A1B_1 there is a persistent increase for the SE North Sea
- RCP8.5 shows intensifying decrease for the SW North Sea

Storm surge climate change signal



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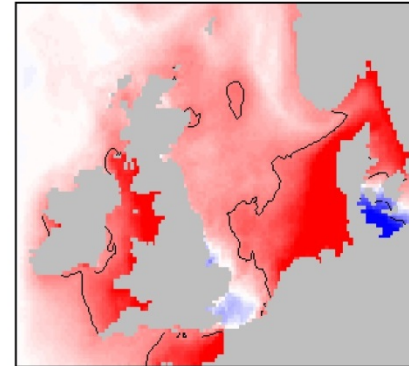
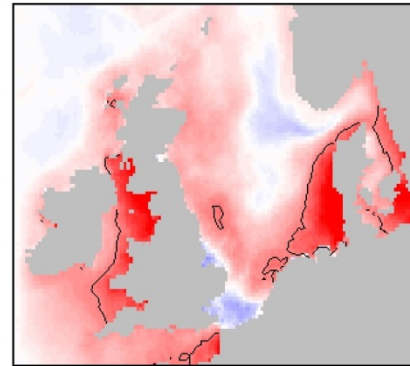
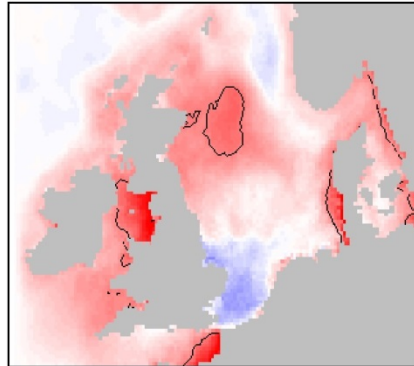
2011..2040

2041..2070

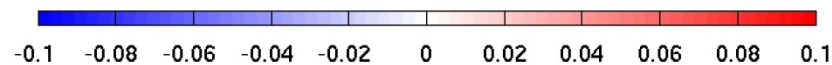
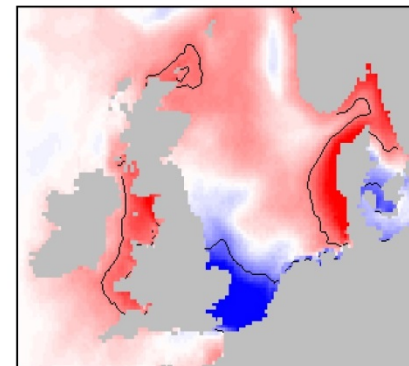
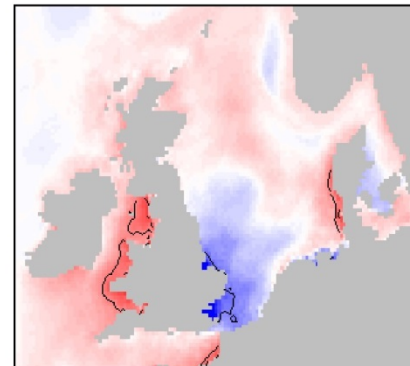
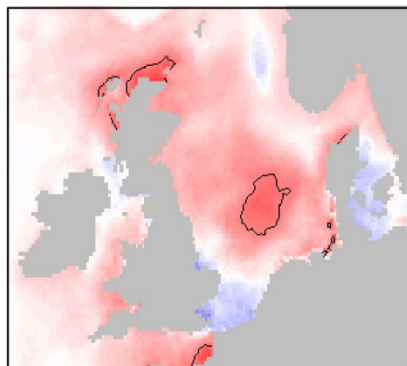
2071..2100

Differences of **mean annual 99.9-percentiles of storm surges** with respect to reference climate 1971..2000

A1B_1



RCP8.5



- for different percentiles the patterns of changes vary
- intensifying increase in south-eastern part of the North Sea

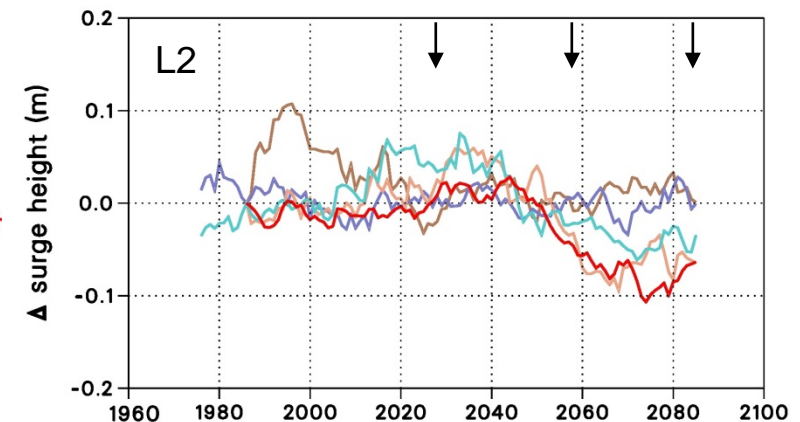
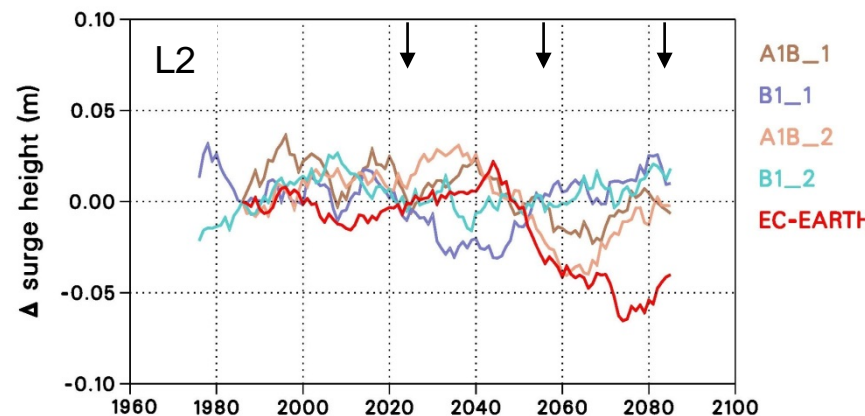
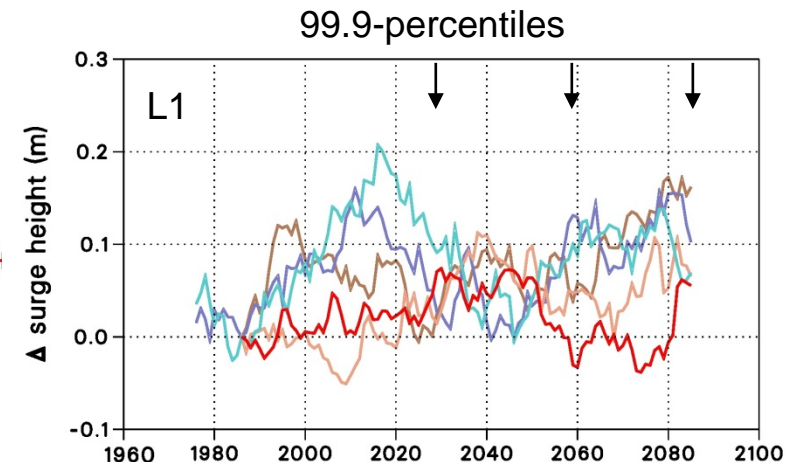
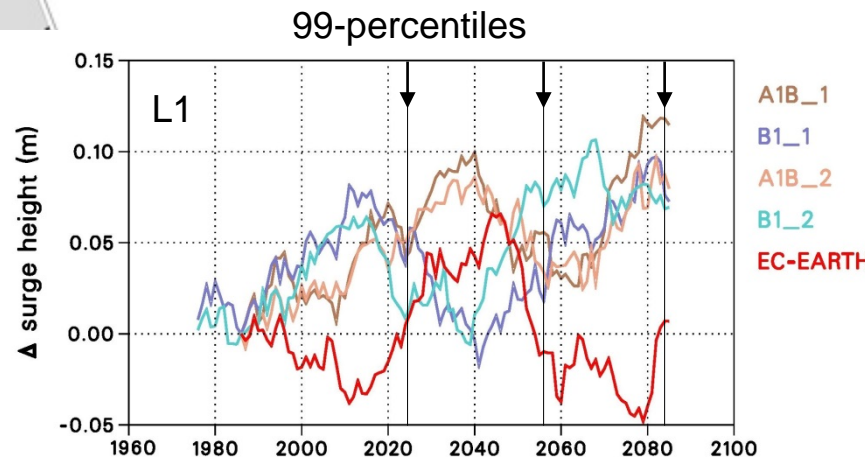
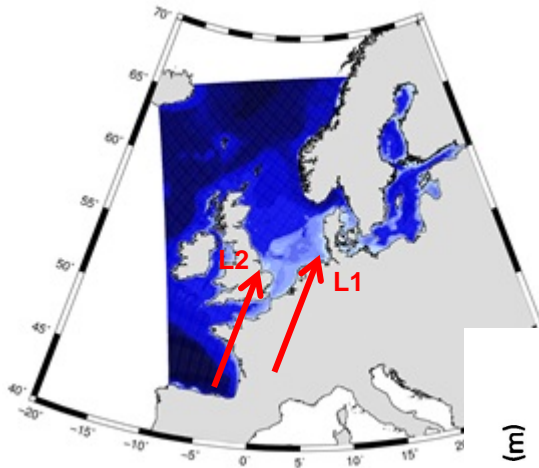
Storm surge multi-decadal variability



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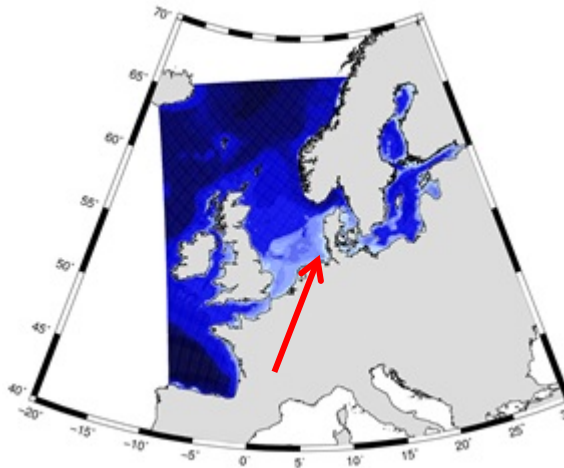
- strong decadal fluctuations
- generally increase for SE and decrease for SW of the North Sea for extremes (99.9-percentiles)



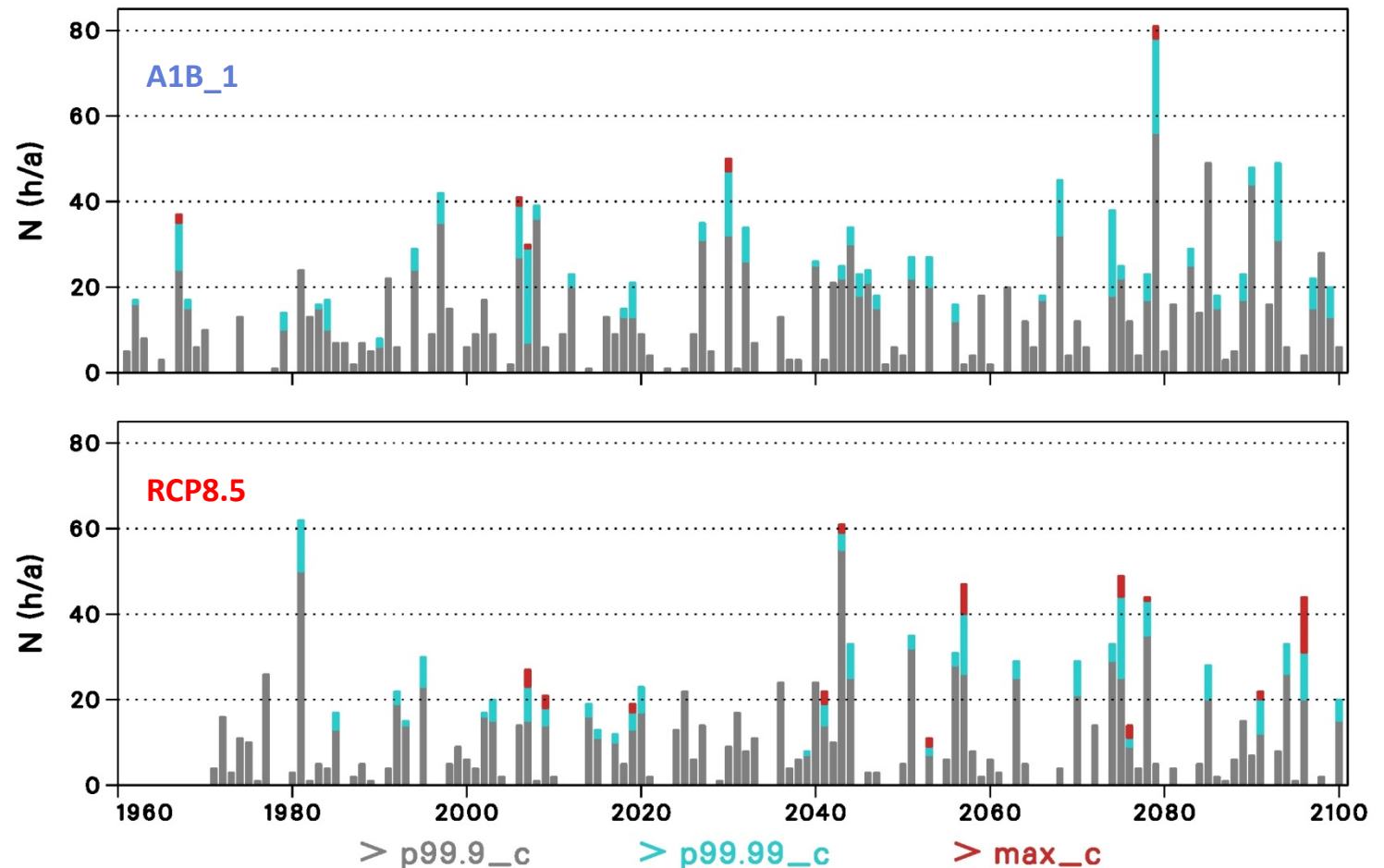
30-year running average
of **storm surge**
percentiles.
Differences with respect
to 1971..2000



Storm surge annual extremes



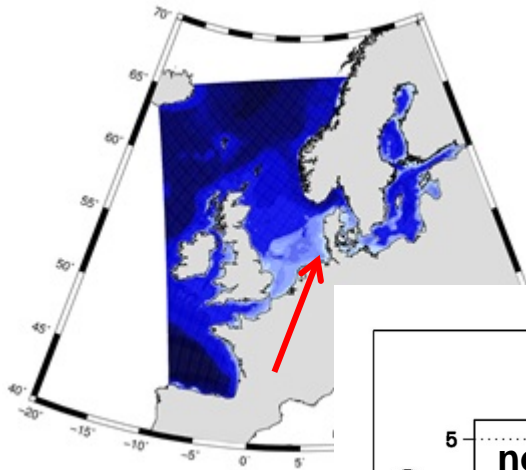
- storm surge events exceeding maxima of reference period for both scenarios
- A1B_1: more frequent high values which already occur within the reference period
- RCP8.5: more frequent high values beyond reference maximum



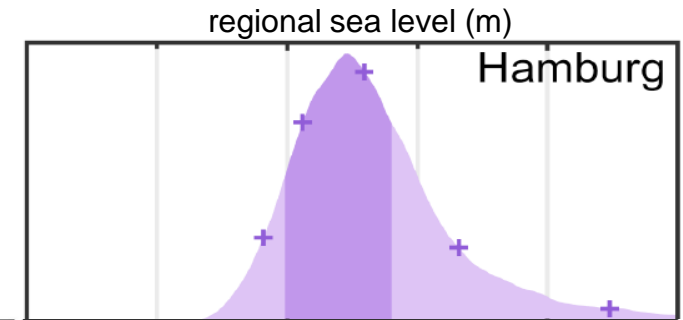
Amount of hours per year
with storm surge heights
greater than 3 thresholds.
Thresholds: long-term
99.9%, 99.99% and maxima
from the reference period
1971..2000.



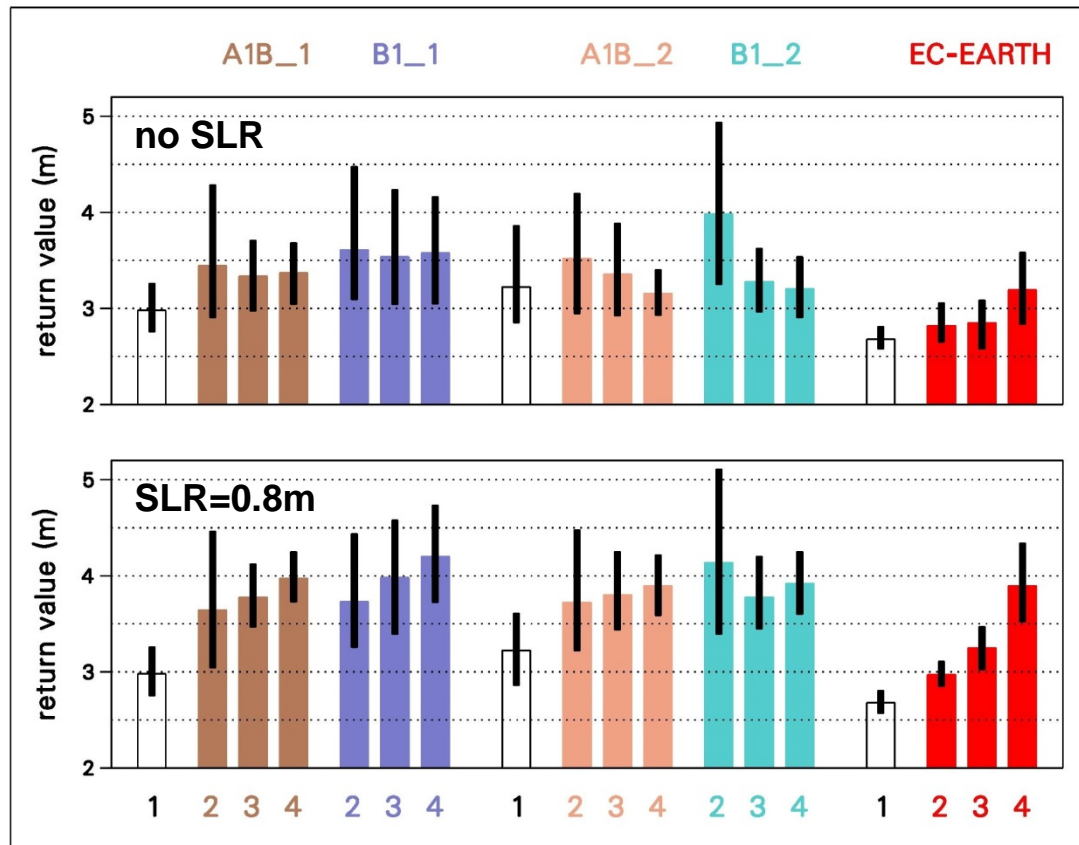
Water level extremes



50-year return values of water level



from Grinsted et al. 2015



(1) 1971..2000 (2) 2011-2040 (3) 2041-2070 (4) 2071-2100

linear SLR
towards 80cm in
2100

- without SLR there are no significant increase in 50-year return values
- with SLR there is almost steady increase of return values which becomes significant towards the end of the 21st century in some projections



variety of studies

- investigate changes in North Sea wind and surge conditions for the 21st century
 - include combinations of different models, initial conditions and emission scenarios
-
- differences/uncertainties in both the magnitude and the spatial patterns of the meteorologically induced climate change signals between the projections
 - wind: choice of GCM, RCM and initial condition seems at least as much important as choice of emission scenario.
 - new scenarios expand the range of ensemble variability

meteorologically induced changes **within the 21st century**:

- large temporal variations within a single projection and between the projections
 - largest changes must not necessarily occur towards 2100 but can occur earlier
-
- changes towards the end of the 21st century might partly be associated with internal variability rather than with systematic changes
 - water level extremes increase significantly when sea level rise is considered
 - new scenarios show no significantly different climate change signal with respect to IPCC AR4