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Future increased risk from extratropical windstorms in northern Europe

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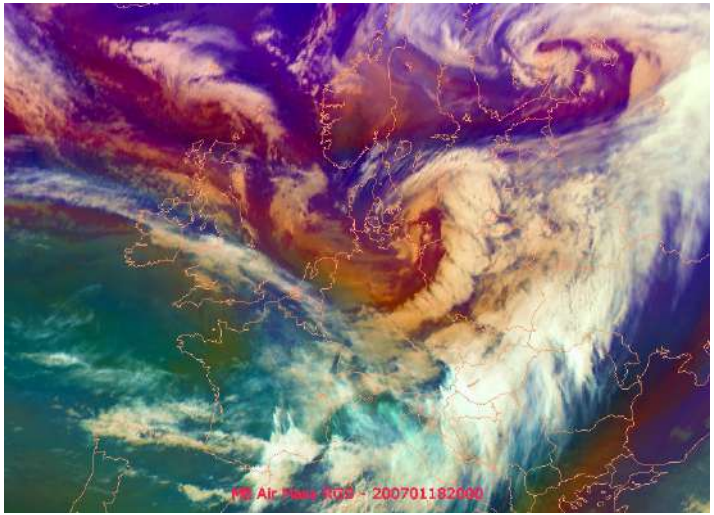
Introduction

- One of the most important natural hazards over Europe
- Uncertainties in future projections of European windstorms – tracks and intensity
- “Future wind speed changes are expected to be small, although poleward shifts in the storm tracks could lead to substantial changes in extreme wind speeds in some regions (medium confidence).” IPCC AR6

- Questions
  - Using measures of storm severity index applied to objectively identified tracks, can we find robust signals in future potential storm losses?
  - Do adaptation or mitigation reduce the future impacts of European storms?



Satellite image of storm Kyrill Meteosat-8 Airmass RGB, 18 January 2007, 20:00 UTC. From EUMETSAT

Storm Data

Lagrangian Feature Tracking - Using TRACK (Hodges 1994,1995) applied to 6-hourly 850hPa relative vorticity (truncated to T42 resolution) from ERA5 (1980-2010) and 8 CMIP6 models.

Models

ACCESS-CM2	MIROC6
BCC-CSM2-MR	MPI-ESM1.2-HR
EC-Earth3	MPI-ESM1.2-LR
KIOST-ESM	MRI-ESM2-0

Present day: Historical simulations for 1980-2010. Winter only (DJF).

Future: SSP2-4.5 and SSP5-8.5 simulations for 2070-2100.

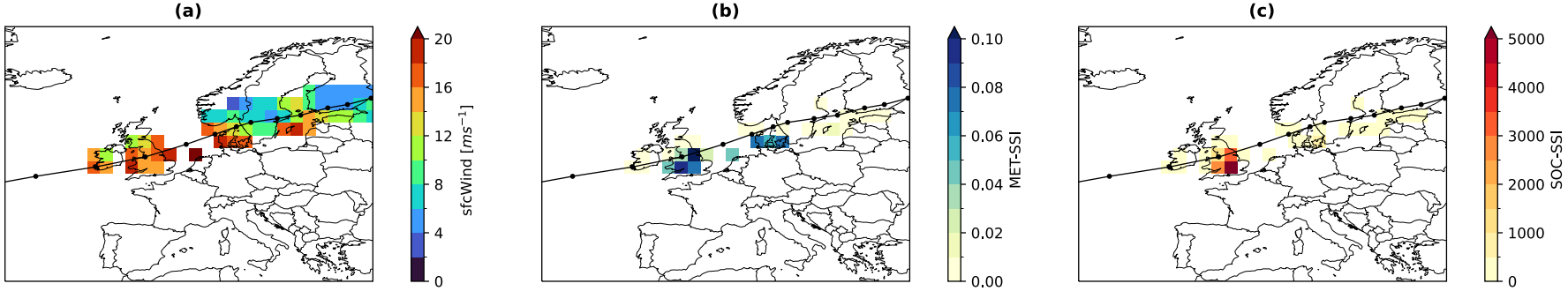
Storm footprints

- Along each track, maximum 10-m wind speeds are calculated and attributed to the cyclone if they are within 5 degrees of the cyclone centre, within 12 hours of the present time and above the 98th percentile threshold (or 9m/s).
- The maximum associated winds are retained for each point along the track to give a maximum cyclonic wind speed footprint (panel a).

- Two storm severity indices are calculated:
  - Met-SSI (panel b), which considers only the severity of the storm,

$$METSSI_{i,j} = \left(\frac{v_{i,j}^{max}}{v_{i,j}^{98}} - 1 \right)^3$$

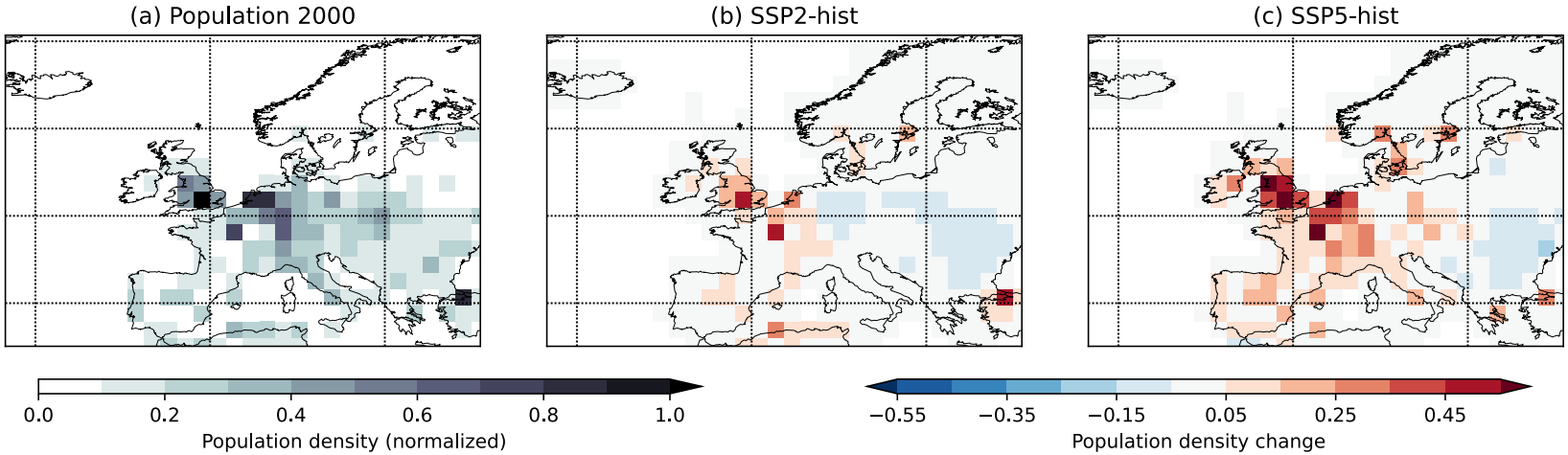
  - Soc-SSI (panel c), which is weighted by population density.



Example storm footprint for storm Daria (Burns' day storm)

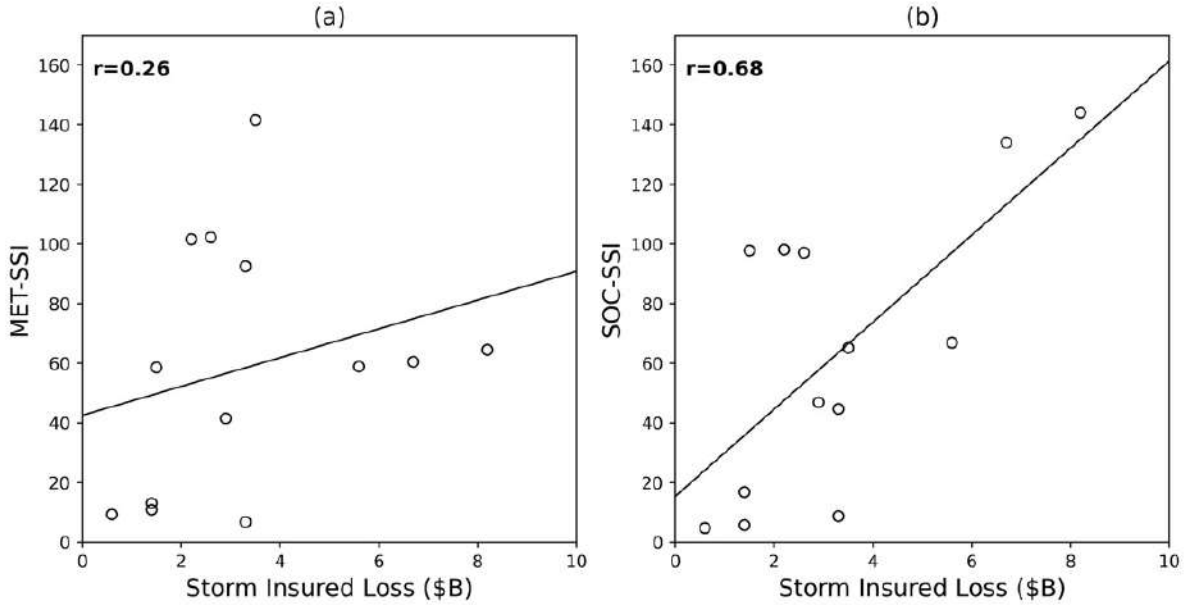
Population Data

Population data are taken from the Socioeconomic data and applications center (SEDAC).



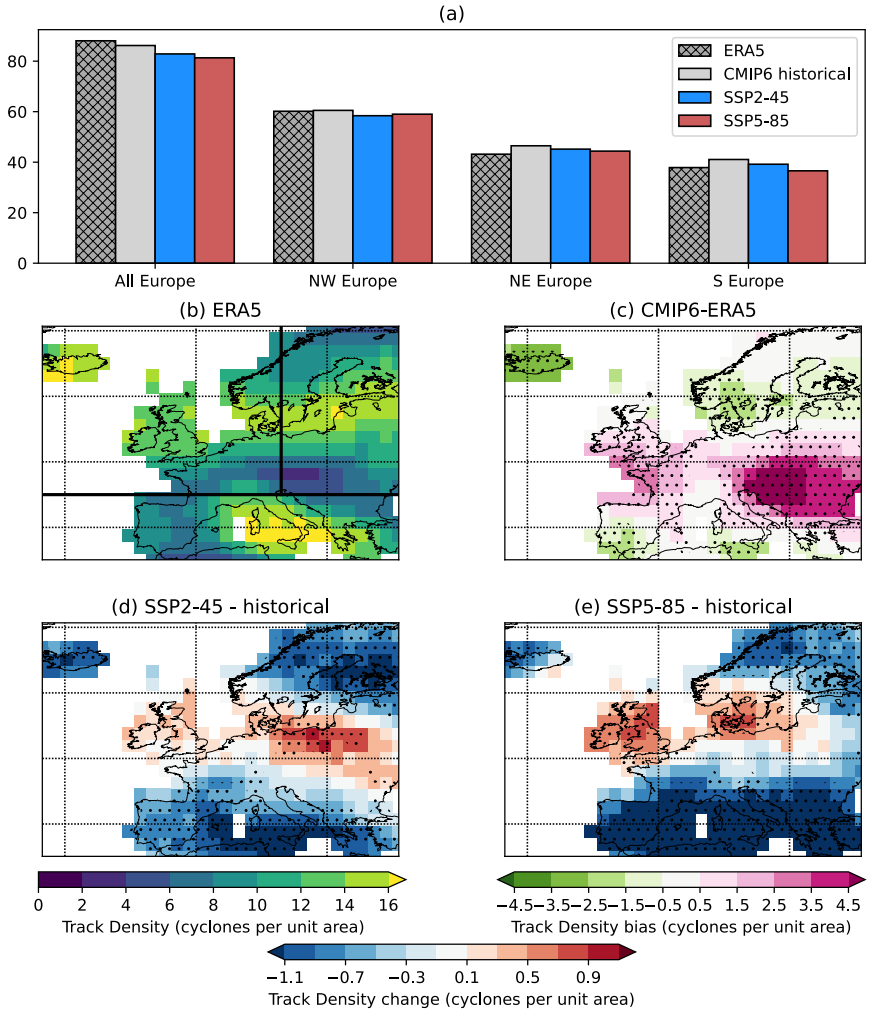
Relation to insured losses

- SOC-SSI (i.e. population weighted storm severity) correlates well with actual insured losses (top 13 storms from the XWS dataset).



Track density

- Overall decrease in ETCs in Europe.
- Robust increase across northwest and central Europe despite (persistent) biases.



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Wind speed climatology

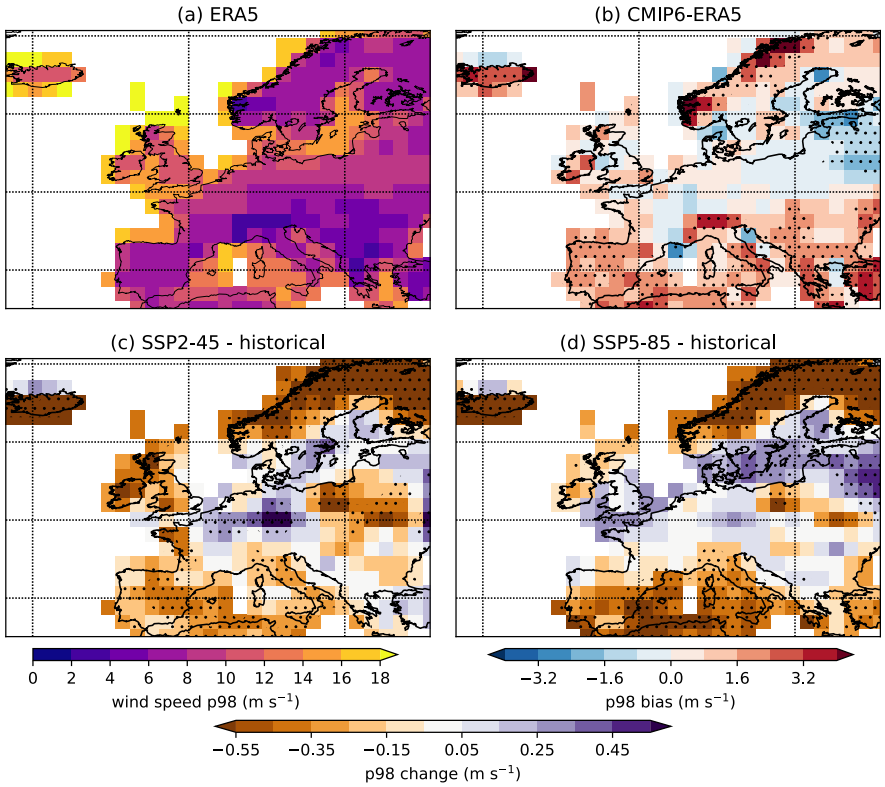
- Large biases in 98th percentile wind speeds over southern Europe.
- Some regions of robust increase in 98th percentile.

Adaptation: To consider the impact of adaptation, we considered two cases:

(1) wind thresholds from the historical period are applied to the future simulations (no adaptation),

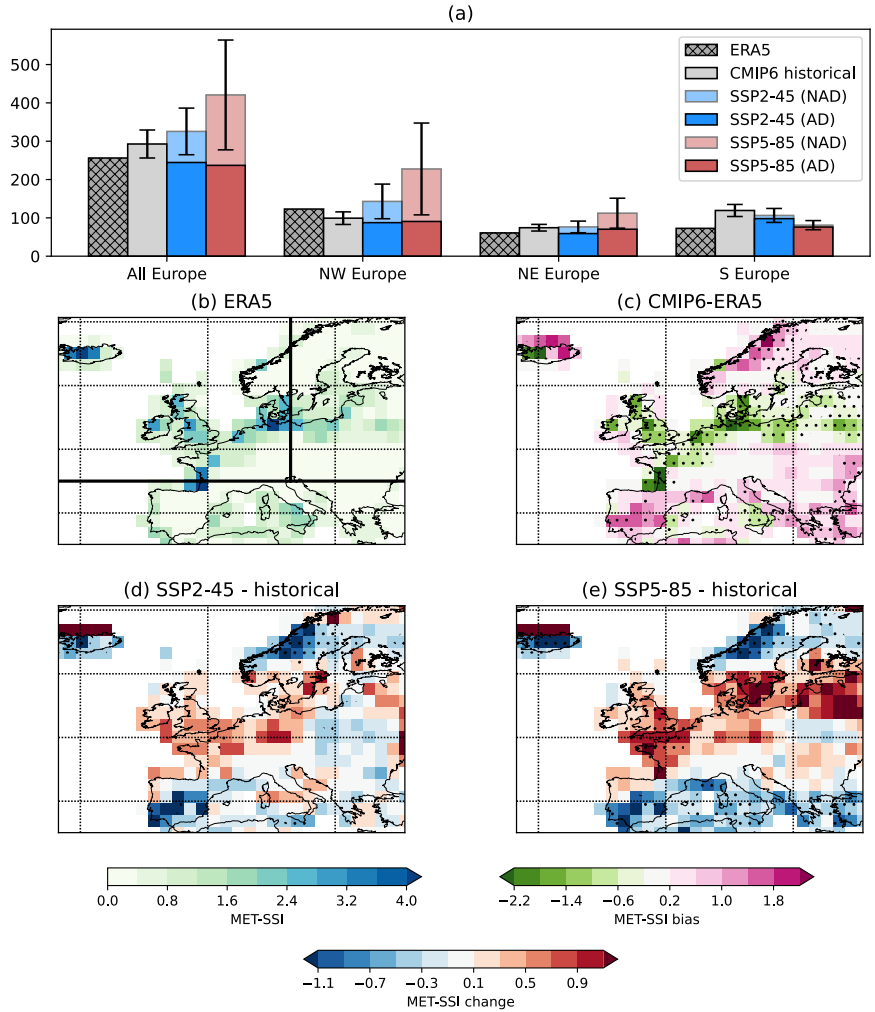
(2) where the wind thresholds from the future simulations are used (adaptation).

- Only using future 98th percentile for adaptation if it has increased.



Storm severity

- Robust increase in METSSI in SSP5-85 over northwest Europe.
- Robust decrease in southern Europe.
- Lower emissions scenario shows weaker signal.



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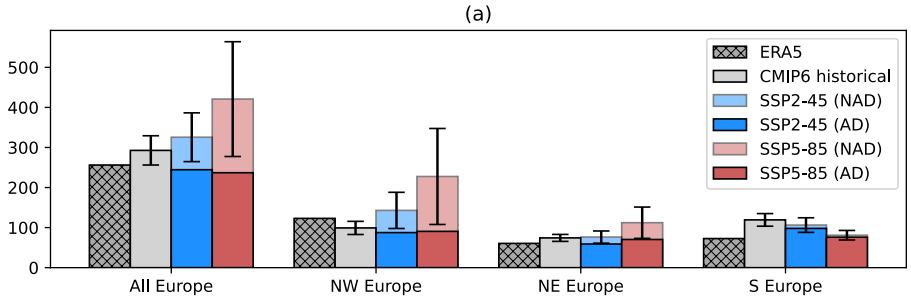
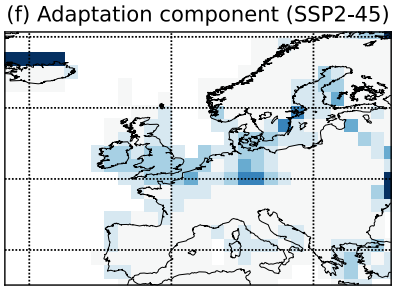
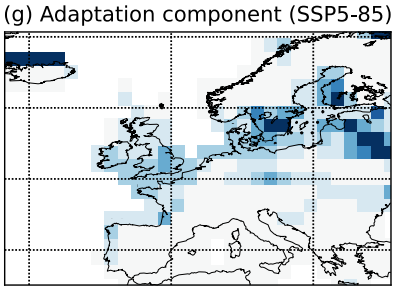
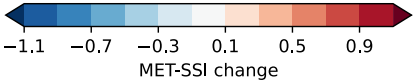
Storm severity with adaptation

- Adaptation (i.e. using future 98th percentile wind threshold) leads to a much smaller change in storm severity or even a decrease.









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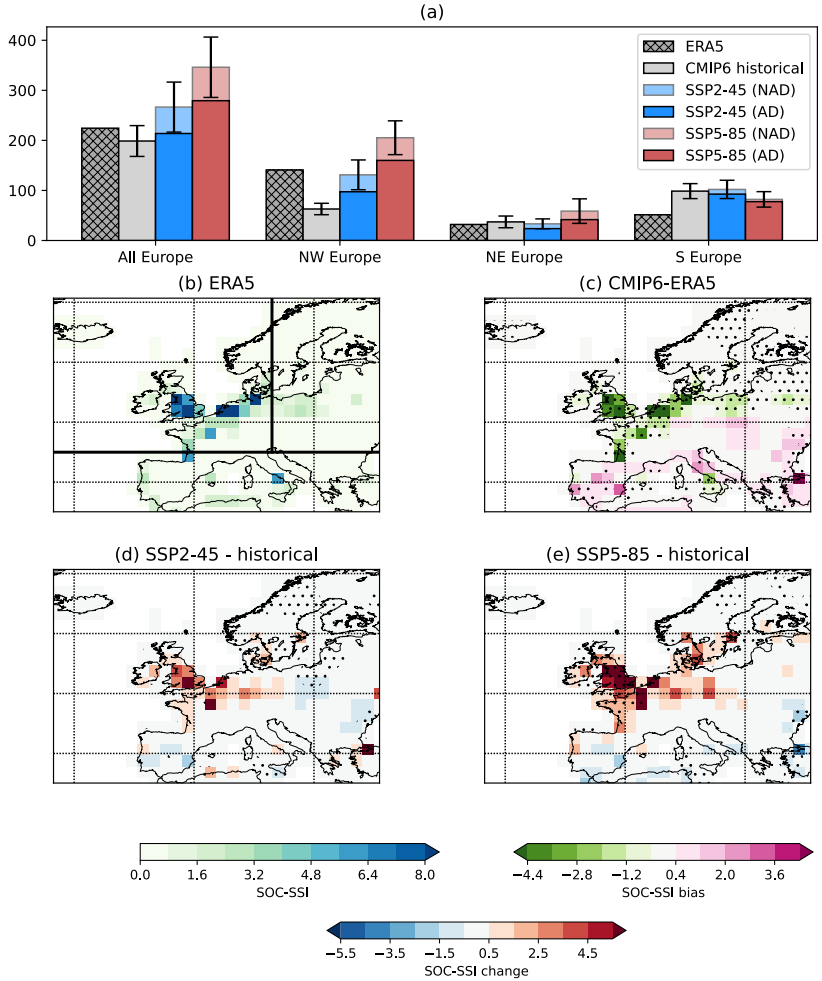
Population weighted storm severity

Large increases in SOCSSI over northwestern Europe.



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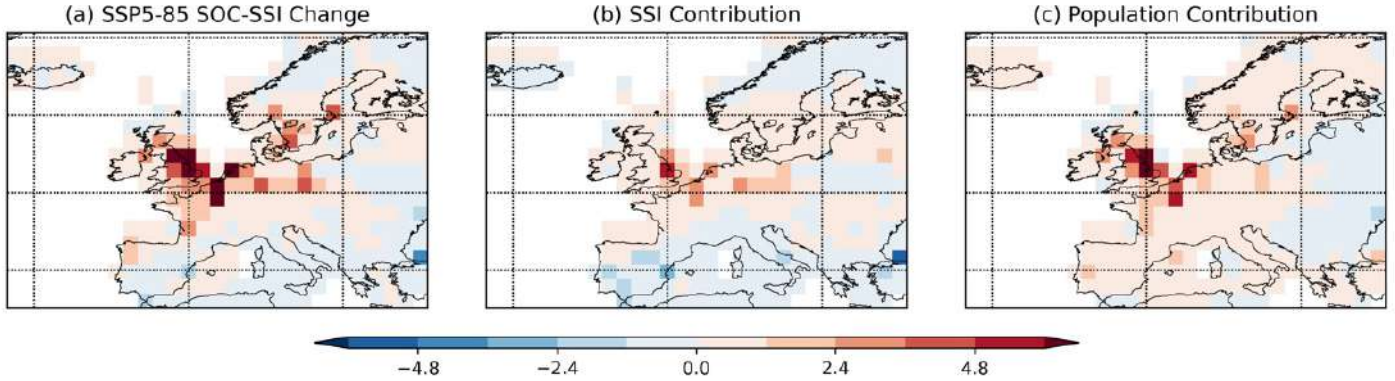
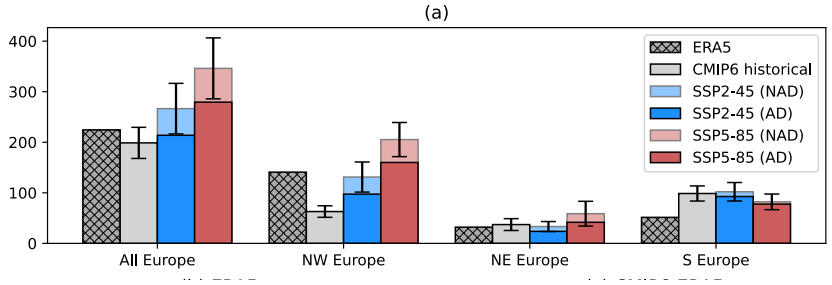
Contribution from storm vs population

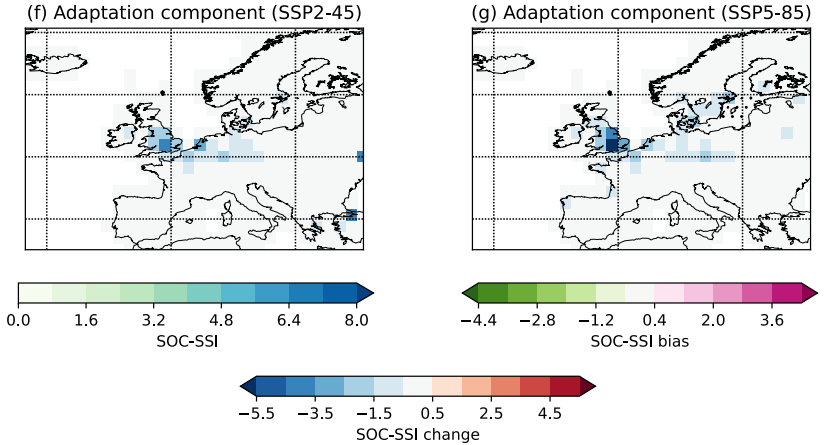
- In Southern Europe, the decrease in SOCSSI is due to the storm severity.
- In the north-west, the storm severity and population both contribute to increased SOCSSI.



Population weighted storm severity with adaptation

- SOCSSI changes are decreased with adaptation in NW Europe.
- Most of the changes in SSP2-4.5 can be offset by adaptation.
- Still much larger increases in SOCSSI for SSP5-8.5.





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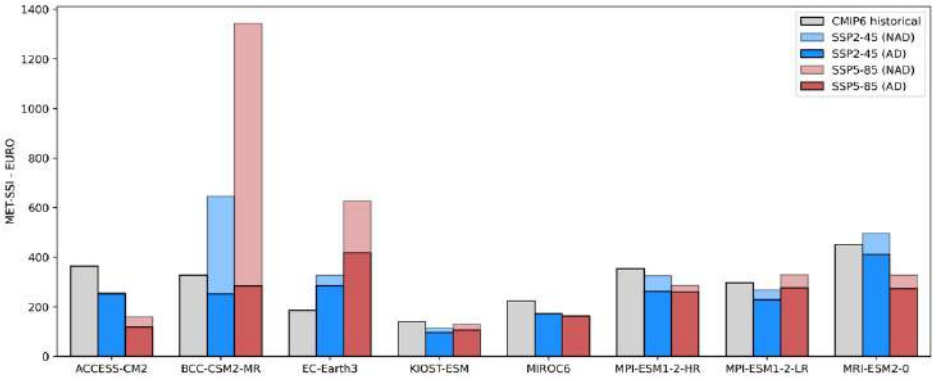
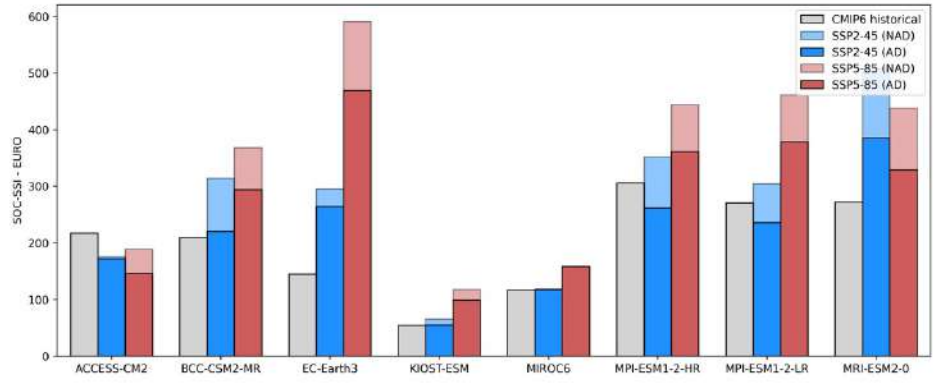
Model variations



MET-SSI



SOC-SSI

A lot of variability between models, but overall conclusion is consistent.

Summary

- By using future estimates of population consistent with the emissions scenarios, we find the population weighted storm severity index more than doubles due to the projected increases in population.
- Through mitigating projected climate change, the future increase in risk can be reduced, with the population weighted storm severity index increase being more than halved for the lower emissions scenario.
- By adapting to the increasing wind speeds, population weighted SSI increases in SSP5-8.5 are only partially offset, despite a reduction in METSSI through adaptation.