ABSTRACT

In this study, we investigate potential changes in simulated winter storminess and extreme precipitation under 1.5°C and 2°C global warming scenarios of the HAPPI project using the highly resolved NCAR Community Atmosphere Model CAM5 (0.25°x0.25°, 3-hourly).

The main results are:

- Improved large-scale circulation pattern over North America and Europe, and a reduced zonal bias in storm track.
- The 2°C warming scenario indicates a poleward shift and intensification of the storms over the Euro-Atlantic region mainly after exceeding the 1.5°C global warming level.
- Increase in precipitation, wind extremes, and storminess over Northern Europe with a maximum over the northwestern coasts of the British Isles and Scandinavia.
- Near-future changes in winter storm activity over the North Atlantic and Western Europe will increase non-linearly with further warming rather than linearly.

Half a Degree Additional warming, Prognosis, and Projected Impacts (HAPPI) project:

  - observed SSTs and sea ice;
  - +1.5°C warming:
    - changes in SST from RCP2.6 runs (2091-2100 mean) are added to the observed SSTs;
    - GHG, aerosols and land-use and cover from year 2055;
  - +2°C warming:
    - changes in SSTs and GHGs from weighted sum of RCP2.6 and RCP4.5 (2091-2100 mean)

Impact of the resolution

Higher horizontal resolution (0.25°) provides considerably better representation of the large-scale atmospheric flow (e.g., midlatitude jet stream). The zonal bias of the mean ambient flow is reduced and this presumably yields better representation of storminess.

Large-scale atmospheric circulation over the North Atlantic

Global warming by 1.5°C:
- weak/no indication for intensification and poleward shift of the meridional cells

Global warming by 2°C:
- strong intensification & poleward shift for the meridional cells, and midlatitude westerlies
- intensified westerlies & increase in precipitation extended eastward (max. the north of British Isles to the north coast of Scandinavia)

Future projections

The additional 0.5°C warming from the +1.5°C levels yields:

- strong intensification and poleward shift of DJF SLP gradient, with maximum anticyclonic anomaly and drying over the northern Bay of Biscay
- north-eastward shift of bipolar DJF precipitation pattern

The additional 0.5°C warming from the +1.5°C levels yields:

- increase in extreme winds, transient poleward temperature flux (VT) and storm track density over the poleward flanks of the DJF climatology (maximum between British Isles and Iceland);
- north-eastward extension for extreme winds and VT (towards the Scandinavian coast);
- negative anomalies of VT and track density north-east of Iceland and central-eastern Europe
- north-eastward shift of bipolar changes in extreme precipitation;
- maximum: in the north-west coasts of British Isles and Scandinavia and over the Norwegian Sea;
- minimum: colocated with anticyclonic DJF SLP anomaly centered over the Bay of Biscay and northwestern Iberian Peninsula

Present climate and future changes in subdaily weather extremes

1980-2005 95th daily wind percentiles [m/s] 2°C minus +1.5°C

DJF 700 hPa transient poleward temperature flux [°C m/s]

Number per decade of 3-h storm occurrences accumulated within 4°x4° grid boxes

10-yr return values in 3-hr precipitation [mm/hr]