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Ensemble of regional climate model projections for Ireland

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The method of Regional Climate Modelling (RCM) was employed to assess the impacts of a warming climate on the mid-21st-century climate of Ireland. The RCM simulations were run at high spatial resolution, up to 4 km, thus allowing a better evaluation of the local effects of climate change. Simulations were run for a reference period 1981–2000 and future period 2041–2060. Differences between the two periods provide a measure of climate change.

To address the issue of uncertainty, a multi-model ensemble approach was employed. Specifically, the future climate of Ireland was simulated using three different RCMs, driven by four Global Climate Models (GCMs). To account for the uncertainty in future emissions, a number of SRES (B1, A1B, A2) and RCP (4.5, 8.5) emission scenarios were used to simulate the future climate. Through the ensemble approach, the uncertainty in the RCM projections can be partially quantified, thus providing a measure of confidence in the predictions. In addition, likelihood values can be assigned to the projections.

The RCMs used in this work are the COnsortium for Small-scale MOdeling–Climate Limited-area Modelling (COSMO-CLM, versions 3 and 4) model and the Weather Research and Forecasting (WRF) model. The GCMs used are the Max Planck Institute's ECHAM5, the UK Met Office's HadGEM2-ES, the CGCM3.1 model from the Canadian Centre for Climate Modelling and the EC-Earth consortium GCM.

The projections for mid-century indicate an increase of 1–1.6°C in mean annual temperatures, with the largest increases seen in the east of the country. Warming is enhanced for the extremes (i.e. hot or cold days), with the warmest 5% of daily maximum summer temperatures projected to increase by 0.7–2.6°C. The coldest 5% of night-time temperatures in winter are projected to rise by 1.1–3.1°C. Averaged over the whole country, the number of frost days is projected to decrease by over 50%. The projections indicate an average increase in the length of the growing season of over 35 days per year.

Results show significant projected decreases in mean annual, spring and summer precipitation amounts by mid-century. The projected decreases are largest for summer, with "likely" reductions ranging from 0% to 20%. The frequencies of heavy precipitation events show notable increases (approximately 20%) during the winter and autumn months. The number of extended dry periods is projected to increase substantially during autumn and summer. Regional variations of projected precipitation change remain statistically elusive.

The energy content of the wind is projected to significantly decrease for the future spring, summer and autumn months. Projected increases for winter were found to be statistically insignificant. The projected decreases were largest for summer, with "likely" values ranging from 3% to 15%.

Results suggest that the tracks of intense storms are projected to extend further south over Ireland relative to those in the reference simulation. As extreme storm events are rare, the storm-tracking research needs to be extended. Future work will focus on analysing a larger ensemble, thus allowing a robust statistical analysis of extreme storm track projections.