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Projected Changes in Northern Europe Storm and Precipitation Characteristics: Uncertainty and the Implications for Climate Services

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Future changes in storm characteristics and storm tracks over the eastern North Atlantic may have profound implications for energy providers, coastal communities and water resources availability across the European sector. Shifts in the storm tracks and the amount and intensity of precipitation are of particular concern to local/ municipal governments as they contemplate climate change adaptation/ mitigation strategies. Communicating the latest science to these end users is a two-pronged problem. On one prong the scientific community still has some way to go before fully understanding the physical mechanisms driving projected changes at local to regional scales and their associated uncertainties (which can be quite large). On the other prong planners require up-to-date, reliable information at just these scales as they seek to make decisions, which will resonate for decades. The present study investigates projected changes to storms and precipitation over Northern Europe and decomposes the sources of uncertainty surrounding these changes. Strategies for communicating these changes and uncertainties with planners are also discussed. The city of Bergen, which is a participant in the ECLISE project, is employed as a case study for how complex and often counterintuitive climate information can be made useful for end users.

Some large-scale, robust changes in storm track statistics have been identified in the ensemble mean climate change response. However, there are often widely varying responses between models and little analysis on the role intra-model variability. A focus on the multi model ensemble mean response is useful in that it isolates externally forced (i.e. climate change) aspects of future variability. However, this approach underestimates the influence of internal variability (weather-related "noise") and its contribution to total uncertainty. Recent research suggests that internal variability can make a large contribution to overall uncertainty with clear implications for future prediction efforts.

The present study investigates projected regional changes to seasonal storm characteristics and precipitation over the eastern North Atlantic and Northern Europe using a high-resolution, stretched grid, AGCM (ARPEGE). An extra-tropical cyclone-tracking algorithm is applied to simulations for present (1980-1999) and future (2020-2060) periods and NCEP reanalysis data (1980-1999). Two present day simulations are carried out: one with spectral nudging toward the large-scale circulation (Nudged) and one without (Free). Four future realizations are run that differ only in their SST specifications, which are taken from four A1B AOGCM simulations from different modeling groups. Storm track statistics are computed for all months with winter (DJF) and summer (JJA) shown. Future changes are evaluated by subtracting the 20th century seasonal mean of the Free run from the ensemble mean of the (2041-2060) 21st century runs. The multiple future realizations allow for the decomposition of total future variability into parts due to forced and internal variability. Despite the dominance of internal variability in the seasonal storm response, robust precipitation signals are identified. These results suggest that, in these simulations at least, the changes in the precipitation come mainly from the thermodynamic rather than the dynamic response of the atmosphere to global warming.