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Summary

- The Autumn season of 2000 saw record rainfall and flooding in western Europe. It was the wettest Autumn in England and Wales since records began in 1766, several regions from France to Norway received double their average rainfall and there were severe floods and mud-slides in the southern Alps (2).
- The extreme weather was linked to changes in the Atlantic jet-stream (3), which were part of an extensive pattern of anomalies stretching from mid-Atlantic across Eurasia (centre: left-panel).
- Wet UK Autumns in the preceding 42 years were associated with a remarkably similar pattern, closely resembling the Scandinavia pattern, which has previously been identified as a preferred pattern of northern hemisphere variability (4; centre: middle-panel).
- There was evidence in Autumn 2000 of anomalous descent and dryness in the tropics, over the Atlantic and South America. Precipitation variability there shows a weak (negative) correlation with the index of the Scandinavia pattern (5). Could anomalies in this region trigger the pattern?
- Numerical experiments with a barotropic model confirm this hypothesis, with anomalous tropical vorticity forcing generating a wavetrain extending over Europe (6; centre: right-panel).

The UK Record-Breaking Wet Autumn of 2000:

Patterns of variability associated with Autumn precipitation in the UK

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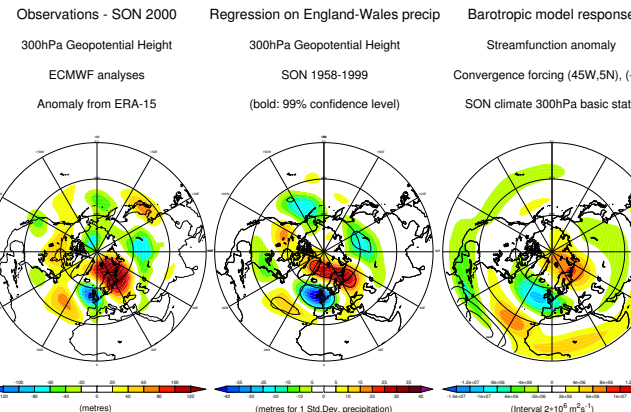
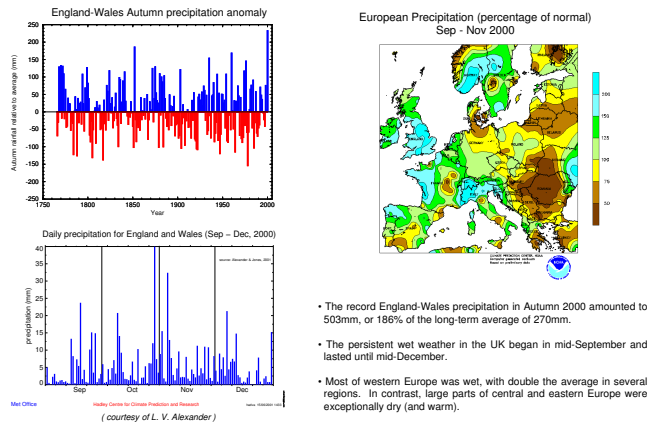
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Discussion

- **Seasonal forecasts** have shown skill in predicting the large-scale climate anomalies associated with the last El Niño in 1997, but they were less successful in predicting the extreme Autumn 2000 European weather. The results here may provide a basis for understanding the current lack of predictability and improving forecast skill.
- Previous studies have shown the potential for **Amazonian deforestation** (either due to direct land-use changes or induced by climate change) to influence Atlantic and European climate in winter. Our results suggest that changes in Amazonian precipitation, associated with natural variability or deforestation, could influence European climate in Autumn.
- Further numerical experimentation is planned using a baroclinic global model, to investigate the wavelength of the response generated by the barotropic model, and the possible influence on the South American region of the anomalous Indonesian precipitation observed in Autumn 2000.
- The England-Wales precipitation time-series contains no significant trend in total Autumn precipitation, but there is the suggestion of increasing interannual variability, which warrants further investigation. Any such trend would increase the risk of future extreme events.

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European Precipitation in Autumn 2000

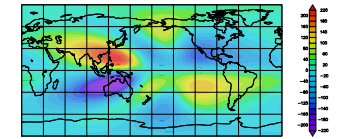


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Barotropic Model Experiments

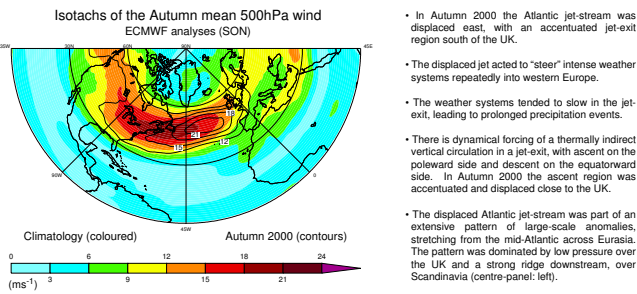
- A global barotropic model has been used to investigate possible triggering of the Scandinavia pattern by anomalous tropical convergence over the Atlantic and South America.
- Idealised convergence centred on (45°W, 5°N) leads to a wavetrain propagating north-east over the Atlantic and Eurasia (centre-panel: right), similar to the Autumn 2000 anomalies and to the regressed field associated with wet UK Autumns.
- The response is robust to modest displacement of the forcing region and other modelling choices.
- The wavelength of the response is longer than observed, possibly due to omission of vertical structure in the barotropic model.
- The barotropic model simulates the global response of the vorticity field to specified vorticity forcing, associated with either divergence, orography or transient weather systems (Saradeshmukh and Hoskins, 1988, *J. Atmos. Sci.*, **45**, 1228-1251).
- In the tropics the model represents the upper tropospheric flow in the layer of divergent convective outflow. In the extra-tropics it represents the deep equivalent-barotropic atmospheric structure.
- The Autumn climatological flow at 300hPa has been held fixed in the model (by computing the climatological vorticity forcing necessary to maintain it against self-adivection) and a specified convergence anomaly has been added. The model is integrated forward in time to obtain a steady state response. Linear damping is included to crudely represent non-adiabatic processes.

Example of the barotropic model's streamfunction response to equatorial divergence forcing over Indonesia, using a super-rotation basic-state.



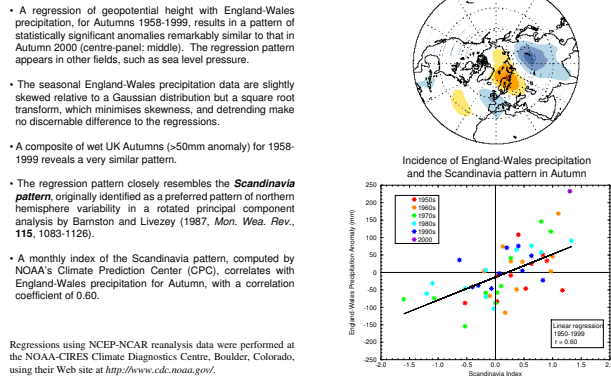
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The Atlantic Jet-stream in Autumn 2000



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Previous wet Autumns: the Scandinavia Pattern



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Links with Tropical South America

