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Observational evidence of European summer weather patterns predictable from spring

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Forecasts of summer weather patterns months in advance would be of great value for a wide range of applications from tourism to agriculture, water resource management, energy production, construction, and retail. However, seasonal dynamical model forecasts for European summers have very little skill, particularly for rainfall. It has not been clear whether this low skill reflects inherent unpredictability of summer weather or, alternatively, is a consequence of weaknesses in current forecast systems.

Here we analyze atmosphere and ocean observations and identify evidence that a specific pattern of summertime atmospheric circulation—-the summer East Atlantic (SEA) pattern—-is predictable from the previous spring. An index of North Atlantic sea-surface temperatures in March–April can predict the SEA pattern in July–August with a cross-validated correlation skill above 0.6. Our analyses show that the sea-surface temperatures influence atmospheric circulation and the position of the jet stream over the North Atlantic. The SEA pattern has a particularly strong influence on rainfall in the British Isles, which we find can also be predicted months ahead with a significant skill of 0.56.

These results raise the question of what is the physical mechanism by which the SST dipole forces the SEA pattern, and why the atmosphere responds to the SST dipole primarily in JA. We suggest that the SEA pattern is the surface fingerprint of a poleward displacement of the North Atlantic jet stream, forced by changes in baroclinicity and in the transient eddy activity (momentum convergence) associated with the SST dipole.

Our results provide an immediate basis for empirical forecasts of important aspects of European summer weather. Even more importantly, they suggest that the potential for improving dynamical model seasonal forecasts of European summers is very considerable.