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Seasonal re-emergence of North Atlantic subsurface ocean temperature anomalies and Northern hemisphere climate

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A high-resolution coupled ocean atmosphere model is used to study the effects of seasonal re-emergence of North Atlantic subsurface ocean temperature anomalies on northern hemisphere winter climate. A 50-member control simulation is integrated from September 1 to 28 February and compared with a similar ensemble with perturbed ocean initial conditions. The perturbation consists of a density-compensated subsurface (deeper than 180m) temperature anomaly corresponding to the observed subsurface temperature anomaly for September 2010, which is known to have re-emerged at the ocean surface in subsequent months. The perturbation is confined to the North Atlantic Ocean between the Equator and 65 degrees North.

The model has 1/4 degree horizontal resolution in the ocean and the experiment is repeated for two atmosphere horizontal resolutions ($\sim$60km and $\sim$25km) in order to determine whether the sensitivity of the atmosphere to re-emerging temperature anomalies is dependent on resolution.

The ensembles display a wide range of reemergence behaviour, in some cases re-emergence occurs by November, in others it is delayed or does not occur at all. A wide range of amplitudes of the re-emergent temperature anomalies is observed. In cases where re-emergence occurs, there is a marked effect on both the regional (North Atlantic and Europe) and hemispheric surface pressure and temperature patterns.

The results highlight a potentially important process whereby ocean memory of conditions up to a year earlier can significantly enhance seasonal forecast skill.