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New insights into decadal North Atlantic sea surface temperature and ocean heat content variability from a high-resolution coupled climate model

Ben Moat (1), Bablu Sinha (2), Simon Josey (3), Jon Robson (4), Pablo Ortega (5), Florian Sévellec (6), N. Penny Holliday (7), Gerard McCarthy (8), Adrian New (9), and Joel Hirschi (10)

(1) National Oceanography Centre, Southampton, United Kingdom (ben.moat@noc.ac.uk), (2) National Oceanography Centre, Southampton, United Kingdom, (3) National Oceanography Centre, Southampton, United Kingdom, (4) NCAS-Climate, University of Reading, Reading, United Kingdom, (5) Barcelona Supercomputing Center, Barcelona, Spain, (6) Laboratoire d'Oce´anographie Physique et Spatiale, France, (7) National Oceanography Centre, Southampton, United Kingdom, (8) Maynooth University, Ireland, (9) National Oceanography Centre, Southampton, United Kingdom, (10) National Oceanography Centre, Southampton, United Kingdom

A novel ocean mixed layer heat budget analysis methodology is developed and used to investigate the physical processes which determine Subpolar North Atlantic (SPNA) SST and OHC variability on decadal-multidecadal timescales using the state-of-the-art coupled climate model HadGEM3-GC2. Contributions to OHC and SST variability from three sources are evaluated i) the net ocean-atmosphere heat flux, ii) divergence of the oceanic horizontal temperature transport and iii) entrainment between the ocean surface mixed layer and the layer beneath.

Anomalies in OHC and SST tendency propagate anticlockwise around the SPNA on multidecadal timescales with a clear relationship to the Phase of the AMOC. AMOC anomalies lead SST tendencies which in turn lead OHC tendencies. This result is common to both eastern and western SPNA, although the primary driver of OHC variability differs with surface fluxes dominant in the west and advection-diffusion in the east. The reciprocal of the mixed layer depth is found to be an important variable which causes SST to respond faster to AMOC changes than OHC. The implications of these new results for interpretation of lower resolution coupled models, including many of those used in the CMIP6 assessment are discussed.