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Fifty years of water cycle change expressed in ocean salinity

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Using new observed estimates of ocean surface salinity changes from 1950-2000, a comparison to the latest results from the Coupled Model Intercomparison Project 3 (CMIP3) is made, with an aim to diagnose explicit rates of water cycle change expressed by this model suite. Examining 20C3M realisations (which most closely resemble the observed 20th century climate system), explicitly dealing with model drift, and using a technique to extract the broad-scale, zonal change patterns, a strong relationship is found between changes in the global freshwater flux (evaporation minus precipitation; E-P) over the oceans (where 90% of global surface water exchange occurs) and changes to surface salinity. New observed surface salinity estimates suggest a change of 16±7% K-1 has occurred since 1950, a marker of change to the oceanic water cycle. Using the CMIP3 relationship between E-P and ocean salinity change, which suggests salinity responds at twice the rate of E-P, allows a new estimate of observed E-P changes to be ascertained, yielding 4% (8±5% K-1) for 1950-2000, closely following Clausius-Clapeyron. The model ensemble mean, a frequently-used metric to express projected changes into the future, greatly underestimates the observed rate of ocean salinity change. Global average rainfall is confirmed to weakly change with surface warming (2-4% K-1), agreeing with past results, however the modelled pattern amplification of both E-P and ocean salinity fields indicate larger responses.The rate of observed 20th century salinity change is also underestimated in future projections under the IPCC SRES scenarios for 2050-2099, expressing similar rates (% K-1) to corresponding 20C3M realisations, and suggesting CMIP3 provides conservative estimates of observed 20th century change.