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Changing ocean freshwater transport in the North Atlantic in observations and CMIP5 models

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Net evaporation over the Atlantic provides the source of moisture that is exported to the Pacific, principally via the trade winds. In the ocean, freshwater is transported southwards throughout the Atlantic sector, principally by the Atlantic Meridional Overturning Circulation (AMOC), in turn favoured by relatively high surface salinity in mid-high latitudes. These atmospheric and oceanic pathways are an intrinsic part of the global hydrological cycle, which is amplifying under global warming. Observations over the last 35 years show that net air-sea freshwater fluxes in the North Atlantic subtropics and mid-latitudes have steadily trended positive (more net evaporation) whereas volume averaged salinity varied at multidecadal scales with a strong salinity gain after the early 1990's. Over 2004-2013, southward freshwater transport (FWT) at 26°N has decreased with the AMOC. But with limited information at other latitudes, relative importance of changing FWT divergence remains uncertain. Over the longer timescale, strong trends in FWT emerge, a part of anthropogenic climate change. Ten models from the Coupled Model Intercomparison Project Phase 5 (CMIP5) are analysed for FWT over 1850-2100, historically-forced and taking RCP4.5 and RCP8.5 scenarios for the 21st century. FWT trends towards more negative values (i.e. strengthens southwards) throughout the subtropical and subpolar North Atlantic over the 21st century, with these changes being more pronounced in the RCP8.5 scenario. The ensemble mean shows that southward FWT at 26°N strengthens in spite of declining AMOC, as the long-term FWT trend is dominated by salinity change. Weaker FWT trends occur further north, where current velocity changes may have a greater influence on FWT. Subtropical FWT divergence consequently trends towards zero in the CMIP5 ensemble – opposing salinity gain in the subtropics. Results demonstrate that under an intensifying hydrological cycle, the global salinity pattern - including salty Atlantic Ocean - amplifies in response to changes in E-P, but Atlantic salinity also responds to changing AMOC, sensitive in turn to changing salinity.