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The forcing, shaping and possible consequences of ocean salinity changes in the global ocean

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The EN3 global ocean dataset (1950-2010) and various observational/reanalysis air-sea freshwater flux datasets are used to investigate long-term global ocean salinity changes in relation to changes in the surface freshwater budget. The obtained spatial pattern of multi-decadal change of surface salinity strongly resembles that of surface freshwater flux, with net evaporation/salinity increases (decreases) found in evaporation (precipitation) dominated regions. Large evaporation increase/saltening in the North Atlantic subtropical gyre and precipitation increase/freshening in the Western Pacific warm pool are highly correlated with the SST increase, suggesting an acceleration of the global hydrological cycle with possible links to the broad-scale surface warming. Moreover, results show an accentuation of the salinity contrast between Atlantic and Pacific Oceans throughout the water column as well as between the upper thermocline salinity maximum and the salinity minimum intermediate waters in both ocean basins. We also find a systematic freshening of the Southern Ocean with the decreasing salinity signal rapidly propagating via Subantarctic mode water (SAMW) at intermediate depths in the southern basins of the Atlantic, Pacific, and Indian Oceans. Using a hindcast of the global ocean circulation, water masses identified with key salinity anomalies are traced using particle trajectories to estimate the advective timescales on which salinity anomalies are spreading through the ocean interior. Based on our present understanding of the influence of salinity in the global ocean, three possible consequences of ongoing trends in the 3-D salinity field are highlighted: the extent to which positive surface salinity anomalies throughout much of the Atlantic are favourable for deep-water formation; the extent to which surface freshening in much of the tropical Pacific may inhibit surface mixed layer depth, and possible implications for SST; the dynamical influence, via stratification, of SAMW freshening at intermediate depths in the southern basins.