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Ocean water cycle: its recent amplification and impact on ocean circulation

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Oceans are the largest reservoir of the world's water supply, accounting for 97% of the Earth's water and supplying more than 75% of the evaporated and precipitated water in the global water cycle. Therefore, in order to predict the future of the global hydrological cycle, it is essential to understand the changes in its largest component, which is the flux of freshwater over the oceans. Here we examine the change in the ocean water cycle and the ocean's response to such changes that were happening during the last two decades. The analysis is based on a data-constrained ocean state estimate that synthesizes all of the information available in the surface fluxes, winds, observations of sea level, temperature, salinity, geoid, etc., as well as in the physical constraints, dynamics, and conservation statements that are embedded in the equations of the MIT general circulation model. Closeness to observations and dynamical consistency of the solution ensures a physically realistic correspondence between the atmospheric forcing and oceanic fluxes, including the ocean's response to freshwater input.

The results show a robust pattern of change in the ocean water cycle in the last twenty years. The pattern of changes indicates a general tendency of drying of the subtropics, and wetting in the tropics and mid-to-high latitudes, following the "rich get richer and the poor get poorer" paradigm in many ocean regions. Using a closed property budget analysis, we then investigate the changes in the oceanic state (salinity, temperature, sea level) during the same twenty-year period. The results are discussed in terms of the origin of surface signatures, and differentiated between those that are attributed to short-term natural variability and those that result from an intensified hydrological cycle due to warming climate.