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# An emergent transition time-scale in the atmosphere and its implications to the global and regional water cycle

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A multi-scale analysis framework is employed to study the global and regional response of the water cycle to temperature fluctuations, across a wide range of temporal scales (from a few days to decades). The results revealed an emergent transition between weak correlations at sub-yearly time-scales (down to ∼5-days) to strong correlations at time-scales larger than ∼1-2 years (up to ∼1-decade). At multi-year time-scales, (i) Clausius-Clapeyron becomes the dominant control of precipitable water vapor; (ii) surface temperature averaged over global-land and over global-ocean (SST) become strongly correlated; (iii) global-averaged precipitation variability is dominated by energetic constraints, specifically the surface downwelling longwave radiative flux (DLR), which displayed stronger correlations than the direct response to temperature fluctuations; (iv) cloud effects are negligible for the energetic constraints in (iii), which are dominated by clear-sky DLR. At sub-yearly time-scales, all correlations underlying these four results decrease abruptly towards negligible values. Such a transition has important implications to understand and quantify the climate sensitivity of the global hydrological cycle. The response of the water cycle components and the emergent time-scale transition display regional variability, although the above results are valid over wide regions, particularly over the oceans. Over land, soil moisture becomes an important variable and its control on the regional water balance is also analyzed under the multi-scale analysis framework.

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