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A simple moisture advection model of specific humidity change over land in response to SST warming

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A new, simple conceptual model of surface specific humidity change (Δq) over land has been developed, based on the effect of increased moisture advection from the oceans in response to sea surface temperature (SST) warming. In this model, future q over land is determined by scaling the present-day pattern of land q by the fractional increase in the oceanic moisture source. Simple model estimates agree well with climate model projections of future Δq (mean spatial correlation coefficient 0.87), so Δq over both land and ocean can be viewed primarily as a thermodynamic process controlled by SST warming. Precipitation change (ΔP) is also affected by Δq, and the new simple model can be included in a decomposition of tropical precipitation change, where it provides increased physical understanding of the processes that drive ΔP over land. Confidence in the thermodynamic part of extreme precipitation change over land is increased by this improved understanding, and this should scale approximately with Clausius-Clapeyron oceanic q increases under SST warming. Residuals between actual climate model Δq and simple model estimates are often associated with regions of large circulation change, and can be thought of as the 'dynamical' part of specific humidity change. The simple model is used to explore inter-model uncertainty in Δq, and there are substantial contributions to uncertainty from both the thermodynamic (simple model) and 'dynamical' (residual) terms. The largest cause of inter-model uncertainty within the thermodynamic term is uncertainty in the magnitude of global mean SST warming.