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Trends in continental temperature and humidity directly linked to ocean warming

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In recent decades, the land surface has warmed substantially more than the ocean surface, and relative humidity has fallen over land. Amplified warming and declining relative humidity over land are also dominant features of future climate projections, with implications for climate-change impacts. An emerging body of research has shown how constraints from atmospheric dynamics and moisture budgets are important for projected future land–ocean contrasts, but these ideas have not been used to investigate temperature and humidity records over recent decades.

Here we show how both the temperature and humidity changes observed over land between 1979 and 2016 are linked to warming over neighboring oceans. A simple analytical theory, based on atmospheric dynamics and moisture transport, predicts equal changes in moist static energy over land and ocean and equal fractional changes in specific humidity over land and ocean. The theory is shown to be consistent with the observed trends in land temperature and humidity given the warming over ocean. Amplified land warming is needed for the increase in moist static energy over drier land to match that over ocean, and land relative humidity decreases because land specific humidity is linked via moisture transport to the weaker warming over ocean. However, there is considerable variability about the best-fit trend in land relative humidity that requires further investigation and which may be related to factors such as changes in atmospheric circulations and land-surface properties.