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The Land-Sea Warming Contrast as the Driver of Tropical Sea Level Pressure Changes

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In this presentation we address the causes of the large-scale tropical sea level pressure (SLP) changes during climate change. The analysis we present is based on climate change model simulations, observed trends and the seasonal cycle. In all three cases the regional changes of tropospheric temperature (T_{tropos}) and SLP are strongly related to each other. This relationship basically follows the Bjerknes Circulation Theorem, with relative low regional SLP where we have relative high T_{tropos} and vice versa. A simple physical model suggests a tropical SLP response to horizontally inhomogeneous warming in the tropical T_{tropos}, with a regression coefficient of about -1.7 hPa/K. This relationship explains a large fraction of observed and predicted changes in the tropical SLP.
It is shown that in climate change model simulations the tropical land-sea warming contrast, is the most significant structure in the regional T_{tropos} changes relative to the tropical mean changes. Since the land-sea warming contrast exist in the absent of any atmospheric circulation changes it can be argued that the large-scale response of tropical SLP changes is to first order a response to the tropical land-sea warming contrast, with decreasing SLP over the sector of strongest warming (South America to Africa) and increasing SLP elsewhere, which is roughly the Indo-Pacific warm pool region. A model intercomparison reveals that climate models with a strong land-sea contrast in surface temperature tend to have also a strong land-sea contrast in T_{tropos} and SLP. In an idealized land-sea contrast experiment a similar response of the SLP and T_{tropos} as in the climate change experiments can be found. As SLP changes and changes in atmospheric circulation go hand in hand, these results suggest an increase in the potential for deep convection conditions over the Atlantic Sector and a decrease over the Indo-Pacific warm pool region in the future.