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Statistical structure of intrinsic climate variability under global warming

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Climate variability is often studied in terms of fluctuations with respect to the mean state, whereas the dependence between the mean and variability is rarely discussed. We propose a new climate metric to measure the relationship between means and standard deviations of annual surface temperature computed over non-overlapping 100-year segments. This metric is analyzed based on equilibrium simulations of the Max Planck Institute-Earth System Model (MPI-ESM): the last millennium climate (800-1799), the future climate projection following the A1B scenario (2100-2199), and the 3100-year unforced control simulation. A linear relationship is globally observed in the control simulation and thus termed intrinsic climate variability, which is most pronounced in the tropical region with negative regression slopes over the Pacific warm pool and positive slopes in the eastern tropical Pacific. It relates to asymmetric changes in temperature extremes and associates fluctuating climate means with increase or decrease in intensity and occurrence of both El Niño and La Niña events. In the future scenario period, the linear regression slopes largely retain their spatial structure with appreciable changes in intensity and geographical locations. Since intrinsic climate variability describes the internal rhythm of the climate system, it may serve as guidance for interpreting climate variability and climate change signals in the past and the future.