Application of the resistor–capacitor (RC)-framework analogy to explain the global-mean surface temperature response to multi-year La Niña events

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Global-mean surface temperature (GMST), which has continued to rise due to the anthropogenic greenhouse gas forcing, is closely related to the sea surface temperature variability in the tropical Pacific. In particular, GMST is known to warm during a strong and short-lived El Niño. By contrast, the global cooling effect of a weak and long-lived La Niña, an opposite but asymmetric phenomenon of an El Niño, has largely been unexplored. Here, we show that multi-year La Niña events tend to have a strong cooling effect on GMST based on observations and climate model simulations, and that we can understand this mechanism using the analogy of the electrical circuit. The persistent La Niña cools the pantropical climate, causing a temporary GMST warming stagnancy, whereas the cooling effect of a single-year La Niñ a is weaker due to the lagged response of other tropical basins and its transience. Yet, further cooling beyond the second year, even in so-called triple-dip or longer event, is likely modest, as the tropics has already been cooled. Applying the resistor–capacitor (RC)-framework analogy, we demonstrate that the lagged GMST cooling and its lower bound during multi-year La Niña episodes arise naturally from the climate system’ s intrinsic transient sensitivity and the heat capacity of the ocean mixed layer.

Keywords: Resistor–capacitor (RC) circuit, El Niño Southern Oscillation, Global mean surface temperature