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El Niño Predictability and The Western Pacific Heat Buildup

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The heat buildup in the western tropical Pacific subsurface that occurs during the growing and recharge phases of an El Niño event modulates its timing and amplitude. Using numerical experiments with the Community Earth System Model, we have studied the sensitivity of El Niño events to the intensity of the heat buildup 21 and 11 months ahead of the event peak, corresponding to its growing and recharge phases, respectively. Non-linear dependency is identified at the longer lead time of 21 months when any initial decrease in the heat content is recompensed by a new recharge phase, and in the case of a considerable decrease the warm event is also delayed by one year. In comparison, when the same experiments are repeated at a later stage, 11 months before the peak, a major heat content decrease leads to weak or borderline El Niño conditions, but not to a delay of one year. These results confirm that the subsurface heat buildup could be a good ENSO precursor at longer lead times. By incorporating such subsurface heat information from different depths and regions of the tropical western and central equatorial Pacific along with zonal wind information as predictors in a statistical ENSO model, we hindcasted temperature in the Niño3.4 region in the period 1970-2016. The model predicted the major warm episodes, including the recent extreme 2015/16 El Niño event at lead times beyond the spring barrier, demonstrating that the selected subsurface information could potentially extend ENSO predictability. Finally, events were also better predicted after 1994, pointing at the availability of better subsurface information after the placement of the Tropical Pacific Observing System as a factor enhancing statistical ENSO predictions.