# Multiyear statistical prediction of ENSO enhanced by the Tropical Pacific Observing System

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The theoretical predictability limit of El Niño–Southern Oscillation (ENSO) is in the range of several years, but long-lead predictions of ENSO are still rare in the literature and virtually missing in real time. Operational forecasting schemes usually do not predict beyond the spring predictability barrier. Recent efforts have been dedicated to the improvement of dynamical models, while statistical schemes still need to take full advantage of the availability of ocean subsurface variables, provided regularly for the last few decades as a result of the Tropical Ocean–Global Atmosphere Program (TOGA). Here we use a number of predictor variables, including temperature at different depths and regions of the equatorial ocean, in a flexible statistical dynamic components model to make long-lead retrospective predictions of the Niño-3.4 index in the period 1970–2016. The major El Niño episodes are successfully predicted up to 2.5 years in advance, including the most recent extreme one in 2015/16 . The analysis suggests that events are predicted more accurately after the completion of the observational array in the tropical Pacific in 1994, as a result of the improved data quality and coverage achieved by TOGA.

Real-time El Niño forecasts performed with this model were made one year in advance for the years 2016 and 2019. These forecasts were then successfully used within a dengue prediction model for the city of Machala in Ecuador, to assess the risks of dengue outbreaks after the strong 2015/16 El Niño and the weak 2018/19 El Niño. Dengue is endemic in Machala and ENSO events strongly affect local climate.