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ENSO continuum and its impacts on worldwide precipitation: Observation vs. CMIP5/6

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It is now widely recognized that El Nino-Southern Oscillation (ENSO) occurs in more than one form, e.g. eastern and central Pacific ENSO. Given that these various ENSO flavours may contribute to climate variability and trends in different ways, this study presents a framework that treats ENSO as a continuum to examine its impact on precipitation, and to evaluate the performance of the last two generations of global climate models (GCMs): CMIP5 and CMIP6.

Uncertainties in the location and intensity of observed El Nino and La Nina events are assessed in various observational and satellite-derived products (ERSSTv5, COBESSTv2, HadSST1 and OISSTv2). The probability distributions of El Nino and La Nina event locations, and intensities, slightly differ from one observational data set to another. For instance, La Nina events are more intense and more likely to occur in the central Pacific using COBESSTv2. All these products also depict consistent decadal variations in the location and intensity of ENSO events: i) central Pacific ENSO events were more likely in the 1940/50s and from the 1980s; ii) eastern Pacific ENSO events were more likely in the 1910/20s and 1960/70s; iii) La Nina events have become more intense during the 20th and early 21st centuries.

These fluctuations in ENSO location and intensity are found to impact precipitation consistently across diverse global precipitation products (CRUv4.03, GPCCv8 and UDELv5.01). Over southern Africa, for instance, more intense eastern (central) Pacific El Nino events are found to favour drought conditions over northern (southern) regions during austral summer. By contrast, over the same regions, more intense La Nina events favours wet conditions, while the location of these events has little effect on precipitation. Over West Africa, ENSO locations favour a zonal (E-W) rainfall gradient in precipitation during boreal summer, while changes in ENSO intensity modulate the strength of the meridional (N-S) rainfall gradient.

Using both historical and pi-Control runs, we demonstrate that most CMIP5 and CMIP6 models favour either eastern or central Pacific ENSO events, but very few models are able to capture the

full observed ENSO continuum. Regarding ENSO impacts on worldwide precipitation, contrasted results appear in most models.