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Dynamical trajectories of analogues as a predictability tool for intraseasonal heat waves in Central Chile

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Central Chile (defined here as the region comprised between 30° and 40°S) presents a wide variety of natural hazards caused by extreme meteorological events. Particularly during summer (December-February), outstanding heat waves have been instrumental for the propagation of wildfires. Due to the national lack of related studies, our ongoing research efforts have focused on building knowledge about intraseasonal summer heat waves in this region. Besides their climatological characteristics, we are deeply interested in their dynamics. How do they form and develop? In particular, are there remote precursors of some of these events, beyond the local factors, that might trigger their onset?

We explore large-scale anomalies that induce the regional temperature perturbations associated with these extreme events. Our current work shows that summer temperature variability in Central Chile is partly driven by the Madden-Julian Oscillation (MJO, Madden and Julian, 1971), which is the dominant mode of intraseasonal variability of the tropical coupled ocean-atmosphere system (Zhang, 2005). As a consequence, the frequency of summer heat waves in Central Chile is also modulated by the MJO. Evidence states that circulation anomalies that trigger such extreme events might arise from the constructive interaction between MJO-related and mid-latitude circulation patterns over the South Pacific Ocean (Jacques-Coper et al., 2015). Therefore, we aim at elucidating this aspect for historical heat waves affecting Central Chile. We use the Twentieth Century Reanalysis version 2, spanning 1871-2010 (Compo et al., 2011), and the 1905-2008 historical reconstruction (Oliver & Thompson, 2011) of a MJO index (Wheeler & Hendon, 2004).

Our research strategy consists of the following steps: we first identify intraseasonal summer heat waves affecting Chile. Second, we select those events that show active MJO signals at the onset day (day 0). Then, the MJO trajectory of each event is tracked backwards until day -16. In this way, we define a 17-day-long set of coordinates in the MJO index phase diagram, which constitute the reference trajectory. Next, for each case, we look for similar trajectories in the phase diagram using the historical MJO reconstruction. Thus, we obtain a group of analogue events that exhibit a comparable development of MJO-related tropical signals as each reference heat wave. The resulting temperature anomaly over Central Chile of each analogue (day 0) might be positive or negative, and this fact defines whether it is classified as warm or cold, respectively. This means that the tropical signal is not a sufficient condition for a warm anomaly to develop in this region. In order to retain just the warm analogues and filter the cold ones out, we complement our selection using further indices of extra-tropical precursors. Finally, we quantify the predictability enhancement of similar events by means of the conditional probability of occurrence associated with these tropical and extratropical predictors.