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Summertime Climate Variability and Teleconnections over Southern South America during the 20th Century

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To properly understand present and future phenomena of the climate system, it is necessary to improve our knowledge of past climate variations. This issue is of high relevance in Southern South America (SSA), a key region for the study of climate processes and dynamics in the Southern Hemisphere. However, the local scarce availability of long-term atmospheric data limits reliable climate reconstructions. Until now, the impact of climate modes (ENSO, PDO, SAM), their interaction, and related teleconnection patterns have been examined mainly based on records from the second half of the 20th century. Such a short data length hinders the assessment of possible instabilities of their incidence. The motivation of the present research is to improve our knowledge about the climate variability over this region by using reliable data. We are particularly interested in 1) describing the temporal and spatial patterns of interannual and interdecadal climate variability over SSA and their relationships to tropical regions, 2) assessing the temporal (in)stability of the incidence of climate modes, and 3) analysing the physical mechanisms underlying the observed phenomena.

Therefore, we explore the interannual-to-interdecadal variability of summertime (DJF) temperature during the whole 20th century over Eastern Patagonia, a region lacking of long-term climate proxies. We focus on 19 instrumental records of DJF air temperature (Ta) located along the Atlantic Coast of SSA, accessed from the Global Historical Climatology Network. We also use interpolated surface temperature fields from the University of Delaware (Ta) and ERSSTv3 (SST) and reanalysis data, namely ECMWF-ERA40 and Twentieth Century Reanalysis version 2 (20CRv2).

We first separated interannual and interdecadal scales from the SSA Ta signal (resulting period: 1907-2001). The time series of its leading interdecadal principal component (PC1, explaining $\sim$80% of total variance, highest significant frequency peak at 64 years) resembles the PDO in the second half of the 20th century (showing the 1970s climate shift), but interestingly diverges from its shape during the first half. On the other hand, the interannual PC1 shows a prominent local mode ($\sim$60% of total variance, highest significant peak at $\sim$3.4 yr). The correlation fields between this interannual mode and geopotential height at upper levels from reanalysis exhibit a pronounced barotropic wave train pattern extending from Oceania along the Southern Pacific to SSA. We investigate the dynamics of this teleconnection, inducing extreme cold and warm events in SSA and discuss the influence of ENSO. Finally, we reveal a significant interdecadal instability of ENSO impacts over SSA through a $\sim$20-yr oscillation of positive and negative temperature phases. However, this behavior seems to be modified in the late 1970s, which could be linked to the known climate shift.