**Figure S1.** Climatological map of rain (mm.day^{-1}) over the South American continent during the September-October-November (SON), December-January-February (DJF), March-April-May (MAM), and June-July-August (JJA) quarters. The black square demarcates the WCB region.
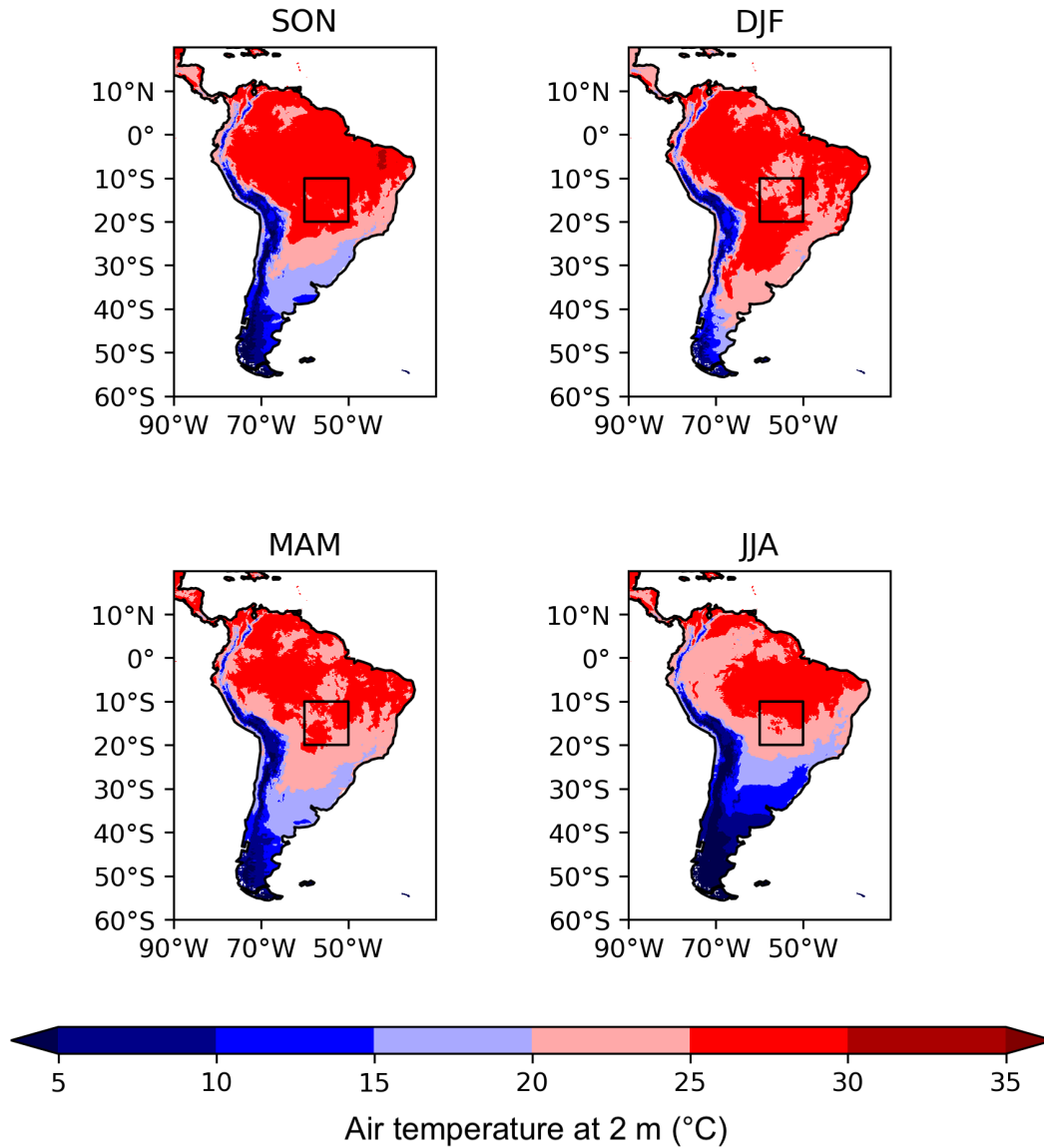
Figure S2. Climatological map of 2-m air temperature (°C) over the South American continent during the September-October-November (SON), December-January-February (DJF), March-April-May (MAM), and June-July-August (JJA) quarters. The black square demarcates the WCB region.

Ideal univariate clustering given k
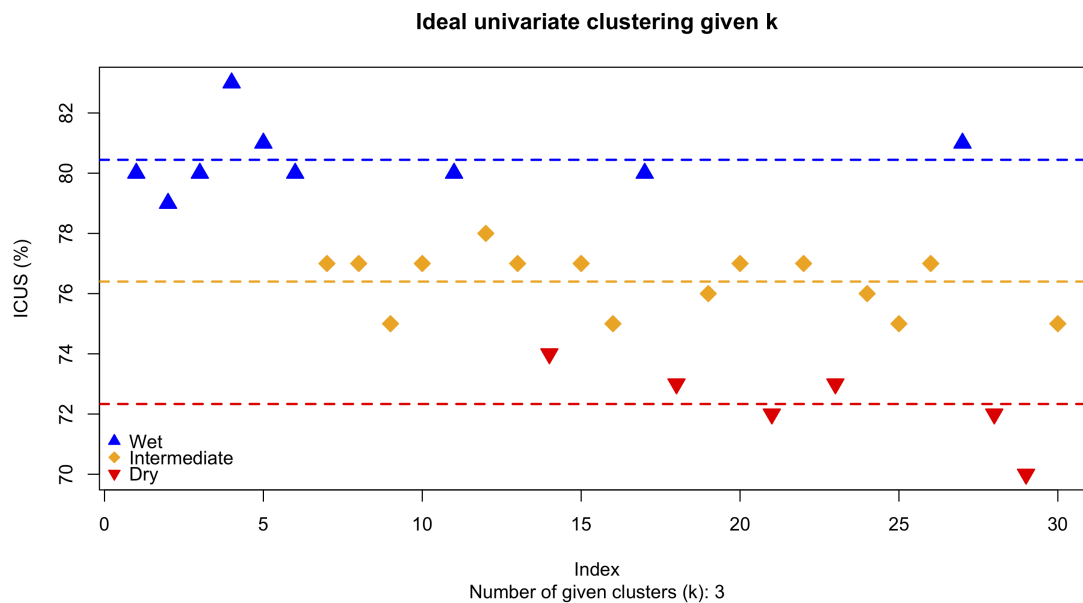
Figure S3. Distribution of soil moisture condition index between 0-7 cm for the wet periods of 1991-2021 in WCB, according to the dry soil group (in red), intermediate group (in orange), and wet soil group (in blue) obtained through 1D k-means clustering method. The dash lines represent the soil group centroid.
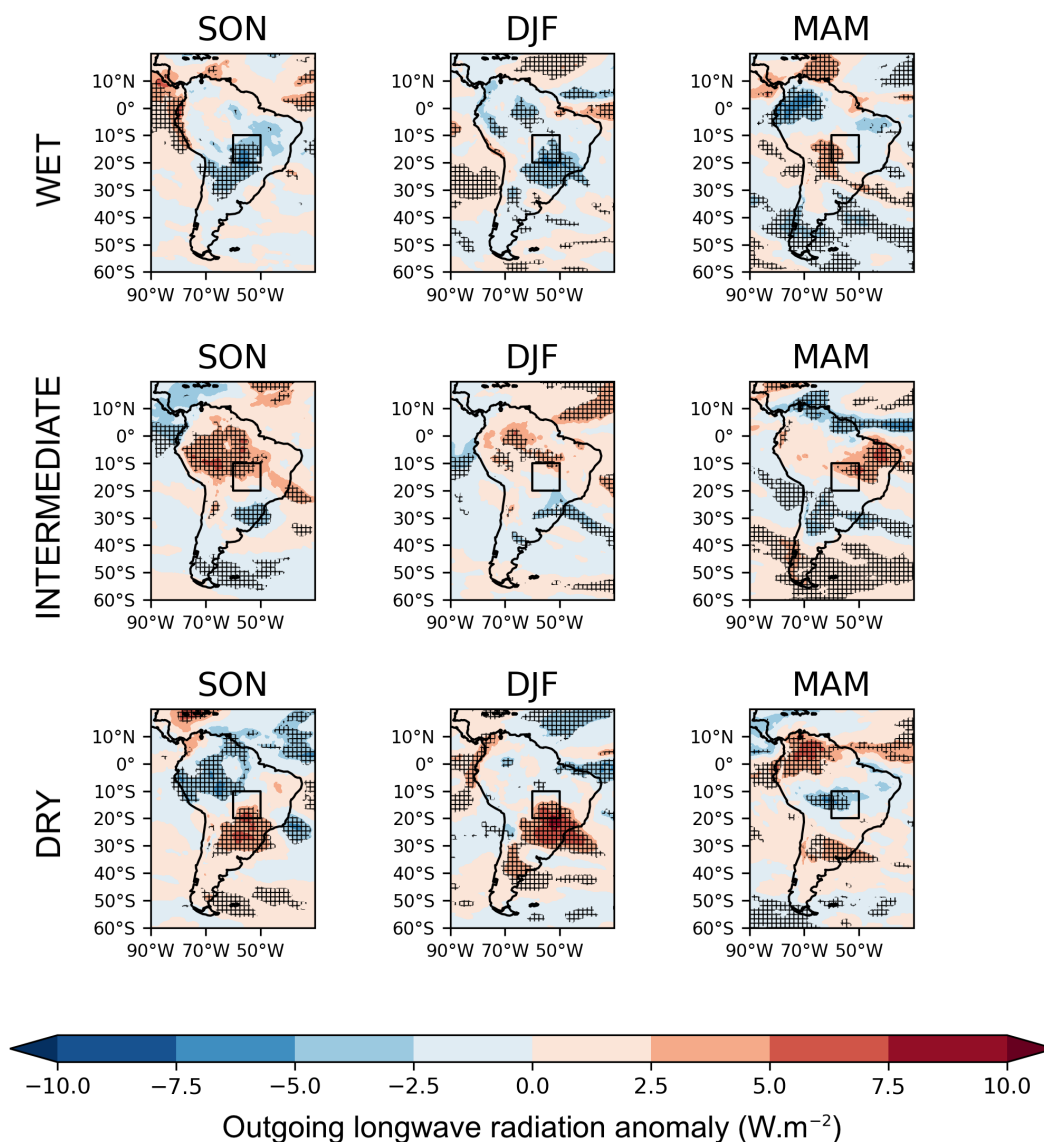
Figure S4. Quarterly composite data for September-October-November (SON), December-January-February (DJF), March-April-May (MAM) for outgoing longwave radiation anomalies. The top row shows the quarterly composites for rainy seasons with wet soils, the second row shows the quarterly composites for rainy seasons with intermediate soil conditions, and the third row, from top to bottom, shows the quarterly composites for rainy seasons with dry soils. These composites were obtained from the monthly ERA5 dataset between 1991-2021. The hatched area shows statistical significance results for p-values less than 0.05.
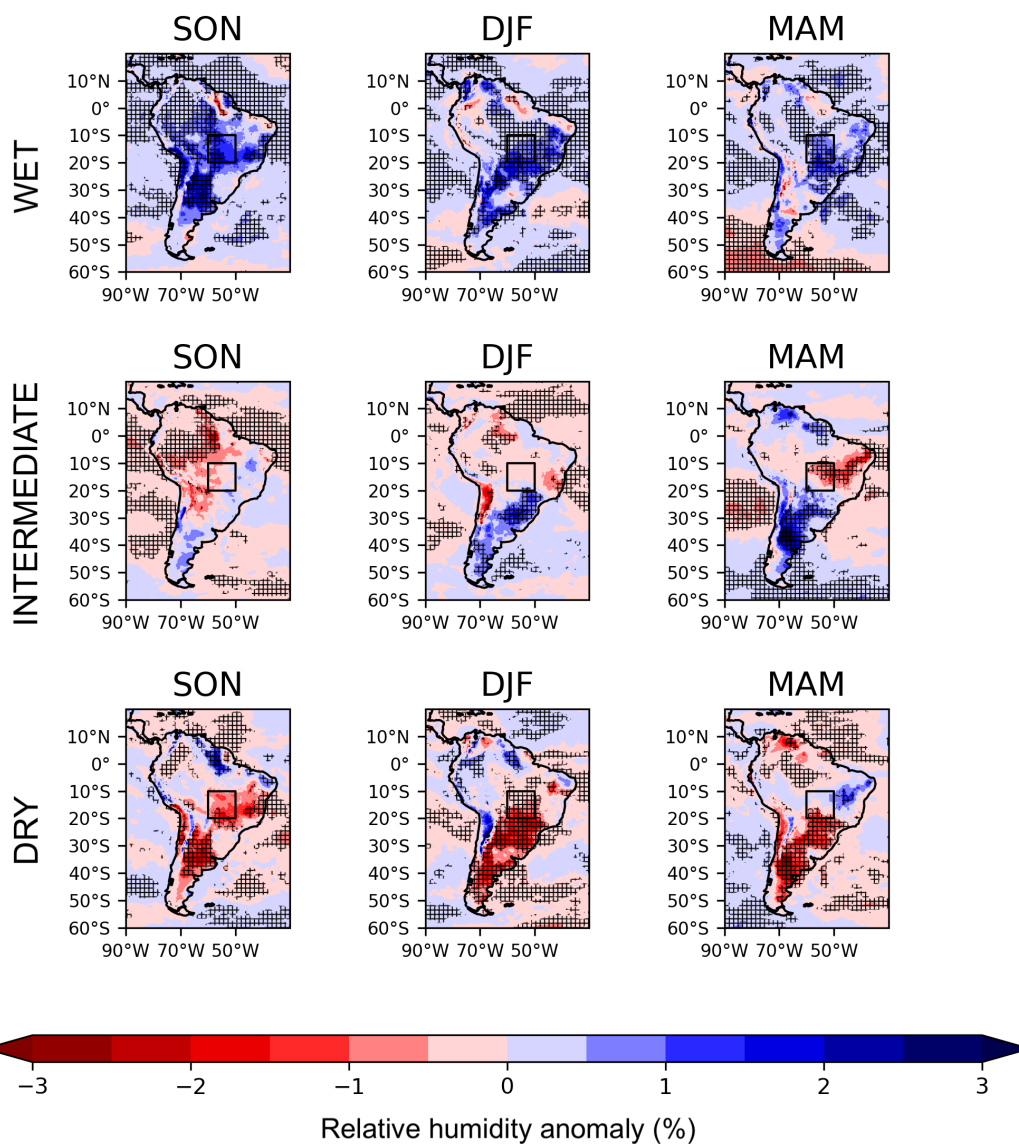
Figure S5. Quarterly composite data for September-October-November (SON), December-January-February (DJF), March-April-May (MAM) for relative humidity anomalies. The top row shows the quarterly composites for rainy seasons with wet soils, the second row shows the quarterly composites for rainy seasons with intermediate soil conditions, and the third row, from top to bottom, shows the quarterly composites for rainy seasons with dry soils. These composites were obtained from the monthly ERA5 dataset between 1991-2021. The hatched area shows statistical significance results for p-values less than 0.05.