Extreme Precipitation during Tropical-Extratropical Cloud Bands over South America: comparing observations and Convective-Permitting Model simulations

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Tropical-extratropical cloud bands are typical of the subtropical South American climate, occurring mainly during the rainy season and producing more than 60% of the seasonal precipitation. Thus, their correct representation in climate models is fundamental for the accuracy of simulated subtropical precipitation. Here, we investigate the occurrence of extreme precipitation during tropical-extratropical cloud band events, considering both observed and simulated events. We use outgoing longwave radiation (OLR) data from the National Oceanic and Atmospheric (NOAA) Climate Data Record (CDR) and precipitation from ERA5 reanalysis to identify the observed events. For simulated events, we use the UK Met Office Unified Model convective-permitting simulations considering two different configurations: a control run forced by a high-resolution global climate model (HadGEM3-GC3.1-n512) and a hindcast run forced by a reanalysis product (ERA-Interim) downscaled by an RCM. Both configurations have ten years of data at 4.5 km spatial resolution. The cloud bands are identified using an objective detection algorithm applied to OLR, as described by Zilli and Hart (2021). The convective-permitting simulations reproduce the location and seasonal cycle of observed cloud bands well. To select the extreme cloud band events, we choose the top 20% of events with (a) the most extensive land area with precipitation above a threshold; and (b) the largest average precipitation over the land areas with precipitation above a threshold. Cloud band events that fulfil both these extent and intensity criteria are considered extreme cloud band events. The precipitation threshold is defined as the precipitation rate with the largest fractional contribution to the cloud band’s total precipitation over the land area. Extreme cloud band events are responsible for a significant fraction of the seasonal precipitation, with the largest precipitation rates occurring over subtropical latitudes. They occur throughout the cloud band season (NDJFM) but are more frequent during its onset (ND), particularly when considering only the transient ones (i.e., those events persisting less than three days). During persistent extreme cloud band events (i.e., those lasting for four or more days), the moisture anomalies are located mainly over Eastern Brazil and the adjacent tropical South Atlantic Ocean, with a similar but more intense than during all persistent events. On the other hand, transient extreme cloud band events are more dependent on the moisture from the western subtropical South Atlantic Ocean when compared to all transient events. The convective-permitting simulations adequately reproduce the ERA5 precipitation during the extreme cloud band events, despite biases in the intensity of the
rain increasing the precipitation threshold values. Despite that, the convective-permitting simulations better represent the precipitation and extremes over subtropical latitudes, providing a valuable tool for improving the understanding and forecasting of cloud band-related extreme precipitation events.