The role of cyclones and fronts for Southern Ocean precipitation and its variability

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Abstract

Exploring the relationship between the occurrence of extratropical cyclones, fronts and precipitation can help to constrain trends in precipitation over the Southern Ocean, as future changes in the cyclone frequencies can likely be identified more easily. Based on the ERA-Interim dataset and objective analysis of cyclones and fronts therein, we present a novel method to attribute intense precipitation (75th percentile) to these weather systems. Our method allows to quantify the amount of intense precipitation falling in association with extratropical cyclones and along fronts outside of cyclones separately.

In certain regions of the Southern Ocean a major portion of intense precipitation is caused by fronts. In particular in the cyclone sparse mid-latitudes of the South Indian Ocean, intense cold fronts, related to cyclones moving more southwards along the coast of Antarctica, account for up to 70% of intense precipitation. In contrast during austral winter along the northern branch of the split storm track in the Pacific, both cyclones and fronts contribute equally about 40% each. In a high-latitude band bending uniformly around the coast of Antarctica, cyclones account for up to 80% of the intense precipitation.

We relate inter-annual variability of seasonal precipitation to changes in storm track activity, i.e., in cyclone and front frequencies. Large variability is found in the south Pacific, where the storm track is strongly influenced by ENSO. In JJA 1998 the Pacific sub-polar storm track was exceptionally strong, causing intense frontal precipitation between 45°S and 60°S. A potential cause of this storm track anomaly was a strongly amplified polar front jet - more than is usual in La-Niña conditions - due to anomalous convective heating east of Australia.