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Understanding future changes in precipitation from an extratropical cyclone perspective

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Much of the precipitation received over California comes from extratropical cyclones in the eastern Pacific region that occur during the winter season. There is a lot of uncertainty in future projections of precipitation in this region associated with changes in the jet stream and the midlatitude storm tracks. Studies have shown projected increases in extratropical cyclone strengths in the future. In addition, stronger cyclones tend to have higher precipitation rates. Therefore, the question this work seeks to answer is how the changes in the frequency and the intensity of the extratropical cyclones in the Pacific storm track influence future changes in Californian precipitation, with a further goal to develop a framework that can be applied to other regions.

We use a Lagrangian cyclone identification method applied to 25 CMIP5 models for the historical and RCP8.5 simulations and investigate the changing relationships between storm frequency, intensity and precipitation. There is a stronger relationship between track density and precipitation than track intensity and precipitation. The historical relationships and future changes in storm track statistics have been used to predict the precipitation projections over California in the RCP8.5 scenario. These predictions were found to underestimate precipitation changes from future projections in the CMIP5 models in contrast to studies using Eulerian storm track measures.

Our results indicate that in the future, for the same number of cyclone tracks or track intensity more precipitation is received. Thus, knowing the changes in cyclone density and intensity is insufficient to predict changes in precipitation, an additional factor–likely moisture–must be considered. This approach may be used in other regions where the shifting storm track may lead to uncertainty in precipitation projections.