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Tropical Cyclones in Future HighResMIP Experiments : Explaining and Reconciling Projections

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Although most GCMs project a decline of tropical cyclone activity in a warmer world, some recent studies have cast doubts on this consensus by suggesting that the number of tropical cyclones might increase in future. The HighResMIP experiments offer such an example of contradicting projections. Indeed, AMIP-type experiments which have been forced by transient SSTs preserving the trend simulated by CMIP6 models in scenario SSP5-8.5, predict an increase of cyclone activity in the North Atlantic, whereas experiments with the same atmospheric models coupled to an ocean model predict a decline. In this paper, we intend to explain and reconcile those results. To do so, we compare several recent and past projects including HighResMIP, CMIP6 scenario SSP5-8.5 and the time-slice experiments of the UPSCALE project. We used several different approaches to explain the future change in TC activity, including SST anomalies relative to the tropical mean, the ventilation index for tropical cyclone genesis and predictors of tropical cyclone precursors.

SST anomalies show that subtle differences in SST trends between basins in the AMIP and coupled experiments can explain the differences in TC projections. This analysis should guide the construction of SST for the transient AMIP experiments used in future HighResMIP protocols. Once the less reliable projections have been discarded from our model ensemble, we show that there exists a remarkable agreement between the projections of HighResMIP coupled, scenario SSP585 and UPSCALE. We find that the saturation deficit is the component of the ventilation index which explains the largest fraction of the change, with the potential intensity and vertical wind shear playing a secondary role. Finally, we find that there is some agreement between models on the different time of emergence of a trend in TC activity in each basin, which we attempt to link to differences in the time of emergence of the trend of saturation deficit.