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Dynamics of Gulf Stream cyclogenesis and the role of El Niño flavours

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This study investigates the relationship between tropical Pacific sea surface temperature (SST) variability and cyclogenesis over the Gulf Stream region of the North Atlantic. We start with an analysis of the precyclogenesis towards cyclogenesis in the Gulf Stream regions. The upper-level precyclogenesis flow takes a subtropical path over North America and Gulf Stream cyclogenesis predominantly occurs under the North Atlantic jet entrance. This holds also true during El Niño-influenced winter seasons. In contrast, during winters when the warmest SST anomalies occur in the central tropical Pacific (CP) rather than in the eastern Pacific, the precyclogenesis flow takes a northern path across North America and Gulf Stream cyclogenesis tends to occur farther north under the jet exit. The shift in preferred cyclogenesis is consistent with changes in transient upstream flow perturbations, detected using potential vorticity (PV) streamer frequencies, which are associated with the stationary wave response. Compared to regular El Niño winters, CP El Niño winters exhibit fewer southward-extending streamers and cyclonic (LC2) flow behavior, resulting in precyclogenesis air bypassing the right entrance of the North Atlantic jet. Downstream, Gulf Stream cyclones penetrate deeper into high Arctic latitudes during CP El Niño winters than in other cases. The results highlight distinct signatures of tropical SST anomalies on synoptic-scale atmospheric features and could help constrain future changes in the North Atlantic storm track and the associated poleward heat transport.