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Acceleration of tropical cyclogenesis by self-aggregation feedbacks

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Though the prediction of tropical cyclone tracks has improved in recent years, understanding the mechanisms responsible for the genesis and intensification of tropical cyclones remains a major scientific challenge. Idealized simulations of tropical moist convection have revealed that clouds can spontaneously clump together in a process called self-aggregation. This results in a state where a moist cloudy region with intense deep convection is surrounded by extremely dry subsiding air devoid of deep convection. Because of the idealized settings of the simulations where it was discovered, the relevance of self-aggregation to the real world is still debated.

Here we will show that self-aggregation feedbacks play a leading-order role in the spontaneous genesis of tropical cyclones in cloud-resolving simulations. Those feedbacks accelerate the cyclogenesis process by a factor of two, and the feedbacks contributing to the cyclone formation show qualitative and quantitative agreement with the self-aggregation process. Once the cyclone is formed, WISHE effects dominate, though we find that self-aggregation feedbacks have a small but non negligible contribution to the maintenance of the mature cyclone. Our results suggest that self-aggregation, and the framework developed for its study, can help shed some new light into the physical processes leading to cyclogenesis and cyclone intensification. In particular, our results point out the importance of the longwave radiative cooling outside the cyclone. This work adds to the growing literature on the importance of self-aggregation for the tropical atmosphere.