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The Signal of Future Tropical Cyclone Intensification in the CloudSat Measurements

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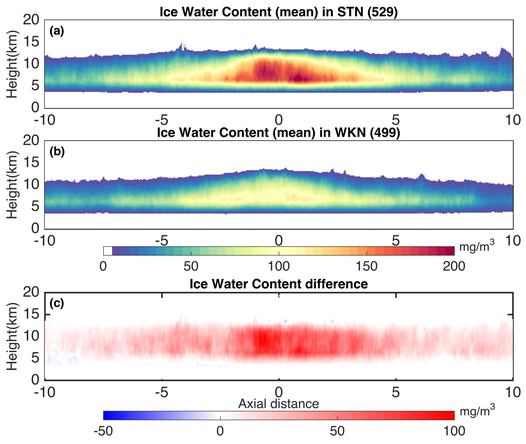
Objective

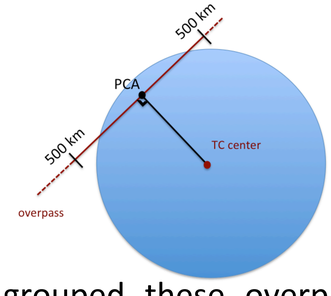
In the last decade, satellite measurements provide fulfilled observations over both ocean and land. With the aid of high-resolution CloudSat measurements, can we improve the prediction of TC intensity?

CloudSat Retrievals



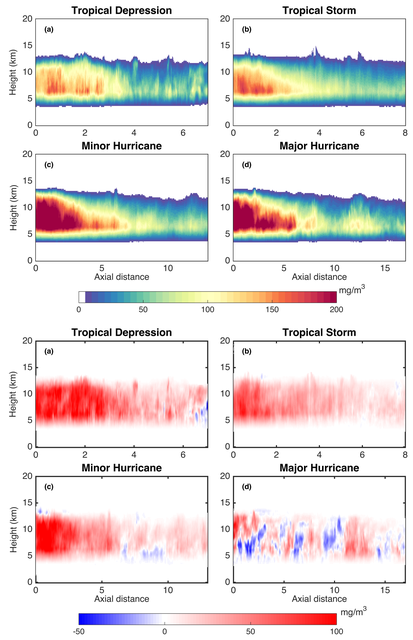
The retrievals of ice water content (IWC) from CloudSat demonstrate clear difference between intensifying and weakening storms.

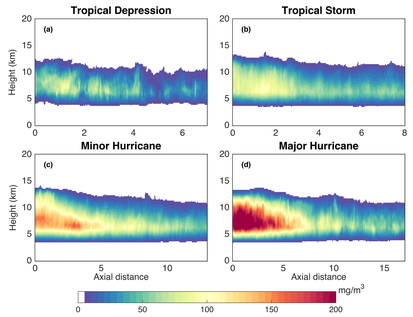
Methodology



First we grouped these overpasses into intensifying and weakening storms by the next 6-h intensity change. Second, the point with the shortest distance to the storm center on overpass is defined as the point of closest approach (PCA), and then used as a center to composite overpasses.

Composites of Ice Water Content





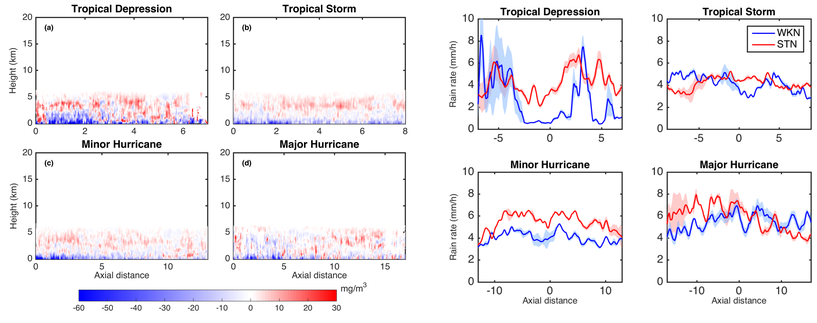
◤ The composites for intensifying storms

▲ The composites for weakening storms

◀ The difference between intensifying and weakening storms in IWC

Intensifying storms tend to have higher IWC than weakening storms, especially within 2 RMW from PCA and the height of 6 to 10 km.

Liquid Water Content & Rainfall Rates



LWC tends to be lower in intensifying storms, specifically in the lowest 2 km.

Rainfall rates from AMSR, however, shows inconsistent difference between intensifying and weakening storms.

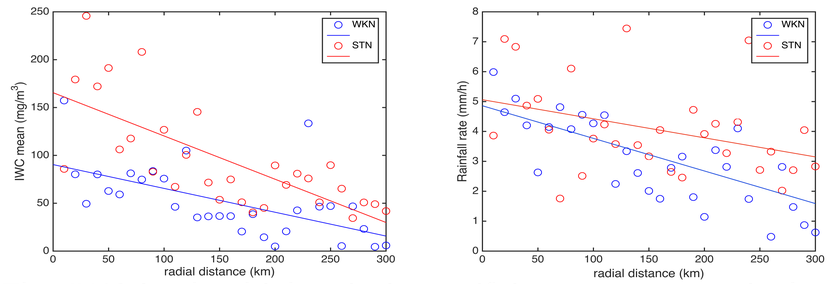
Reference

Nolan, D. S., Y. Moon, and D. P. Stern, 2007: Tropical cyclone intensification from asymmetric convection: Energetics and efficiency. J. Atmos. Sci., 64, 3377-3405.

Zagrodnik, J. P., and H. Jiang, 2014: Rainfall, convection, and latent heating distributions in rapidly intensifying tropical cyclones. J. Atmos. Sci., 71, 2789–2809.

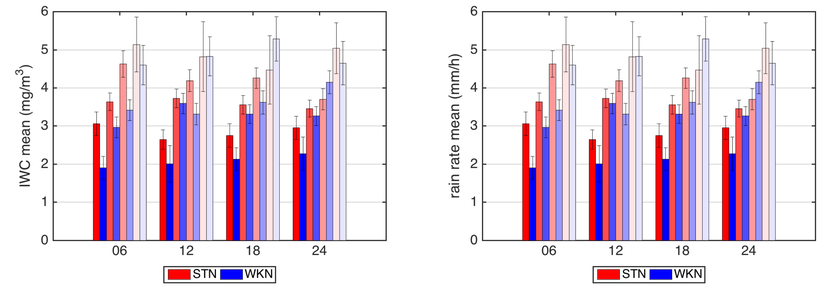
Wu,S.-N., B. J. Soden: The signal of future tropical cyclone intensification in the CloudSat measurements (to be submitted)

The Proximity to The Storm Center



The IWC is also higher in intensifying storms, particularly near the storm center, while the rainfall rates doesn't have clear difference as we approach the storm center.

Dependence on Lead-time



Signature of significant elevated IWC in intensifying storms exists as the lead-time extend out to 24-h.

Rainfall rates only shows the difference in the 6-h lead-time, and demonstrates ambiguous and inconsistent signal in the rest of lead-time.

Concluding Remarks

The IWC from CloudSat retrievals can provide useful information for evaluating and improving model simulations of TC intensity evolution.

One interpretation for these results is that intensifying storms tend to have more deep convection, and thus higher IWC, than weakening storms.

Both the proximity to the storms center and the height of the release of latent heating are pivotal in manipulating TC intensity evolution.