Paper review

mainly refer to

On the Correlation between Total Condensate and Moist Heating in Tropical Cyclones and Applications for Diagnosing Intensity

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Outline

- **Introduction**
- **Simulated tropical cyclones**
  - *Simulations modeled after the hurricane nature run*
- **To**
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  - *Some results with different microphysics schemes*
  - *TC intensity and rain rate*
- **Results with narrow-swath measurements**
  - *Motivation and framework*
  - *Results*
  - *Analogous estimates with real CloudSat profiles*
- **Conclusions**

Use numerical simulations of TCs:

Total condensate or rain rate

→ Diabatic heating

→ Intensity (change)

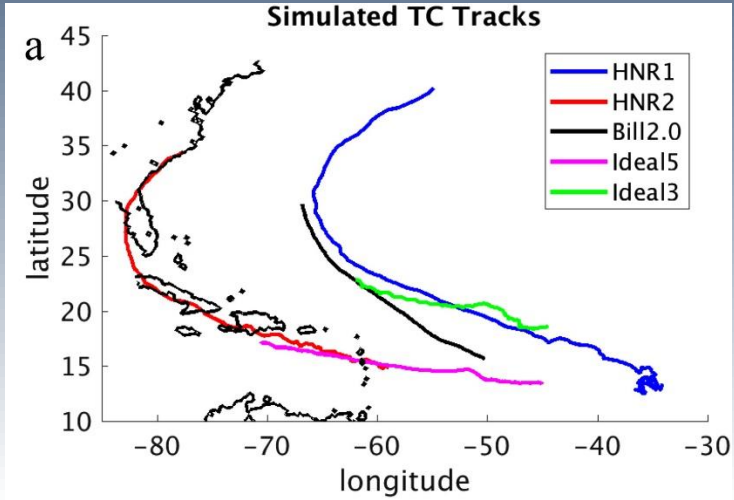
→ Evaluate narrow-swath measurements

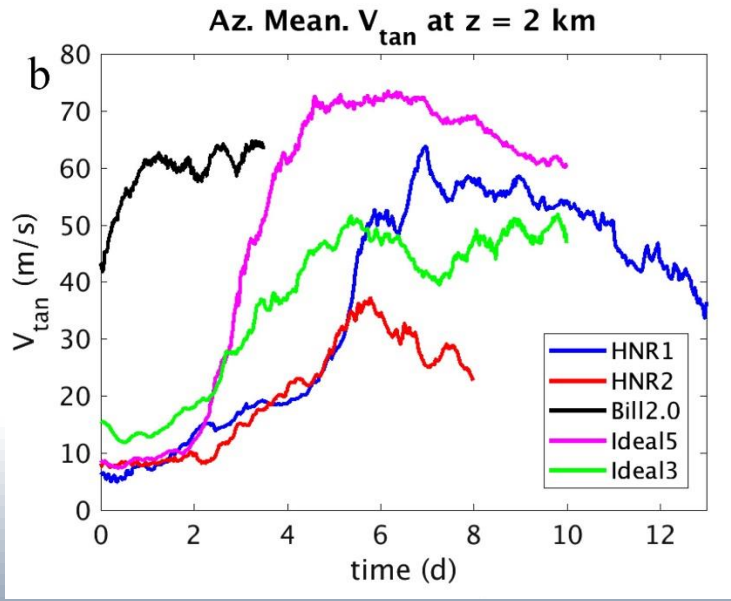
Introduction

- Close relationships between the production of condensate, the release of latent heat, and subsequent precipitation are the physical basis for a long history of efforts to diagnose TC intensity and intensity change from satellites.
- Many previous studies have found that reduced brightness temperatures observed by microwave imagers from precipitating clouds can be correlated with precipitation rates and thus with TC intensity (Adler and Rodgers 1977; Rodgers et al. 1998, 2000; Cecil and Zipser 1999)
- The vertical distribution of heat release near the TC center could provide additional diagnostic and predictive power for remote sensing of TC intensity (Hack and Schubert 1986; Nolan et al. 2007; Vigh and Schubert 2009).
- "Hot towers" or "convective bursts" either precede or occur concurrently with periods of significant intensification (Kelley et al. 2004; Kelley and Halverson 2011; Guimond et al. 2010, 2016; Rogers et al. 2015, 2016; Hazelton et al. 2017; Wadler et al. 2018).
- Broader, more symmetric, and more persistent convection around the storm center is better correlated with intensification (Kaplan et al. 2010; Zagrodnik and Jiang 2014 and Shimada et al. 2017).

Simulated tropical cyclones

3 real cases and 2 ideal cases

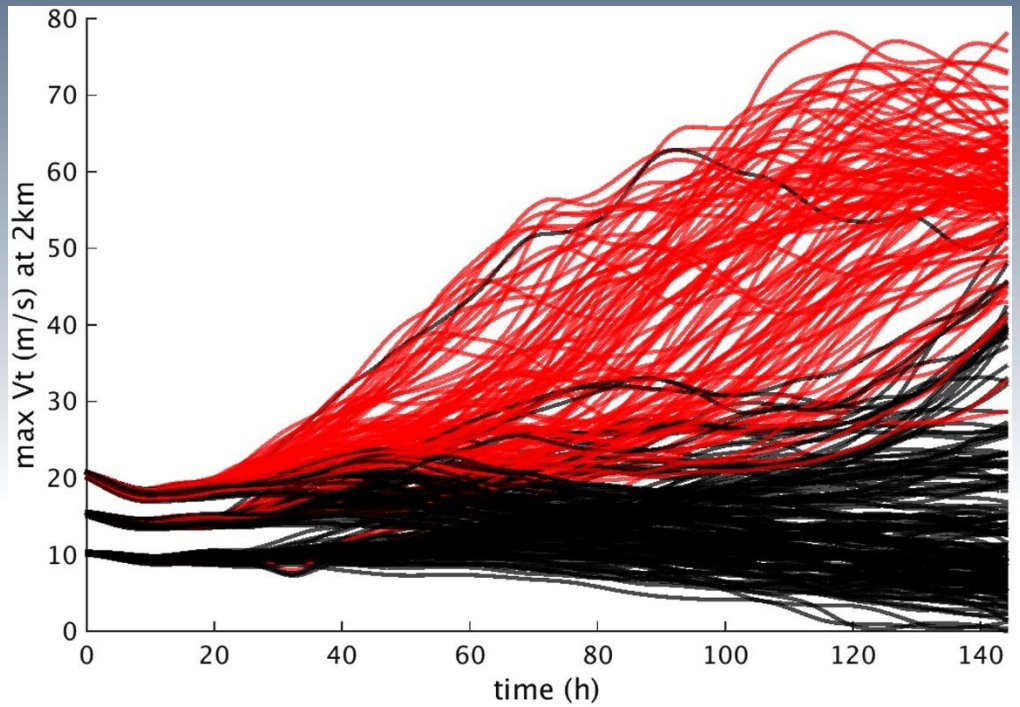




- WRF 3.2.1 and 3.4.1
- Nested grids with 27, 9, 3, and 1 km grid spacing
- WDM6 microphysics scheme
- YSU planetary boundary layer scheme
- RRTMG longwave and shortwave radiation schemes

Simulated tropical cyclones

The Miyamoto and Nolan ensemble

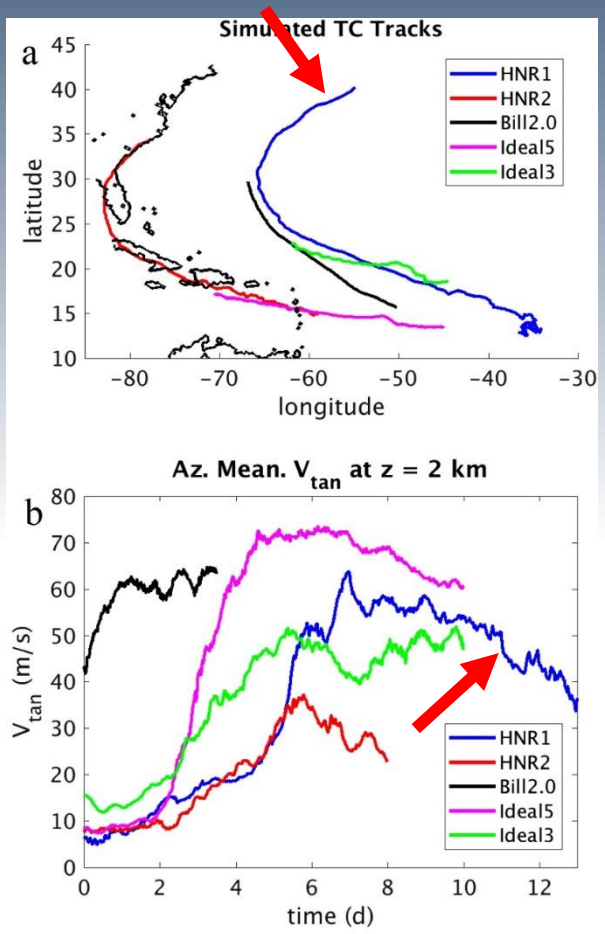


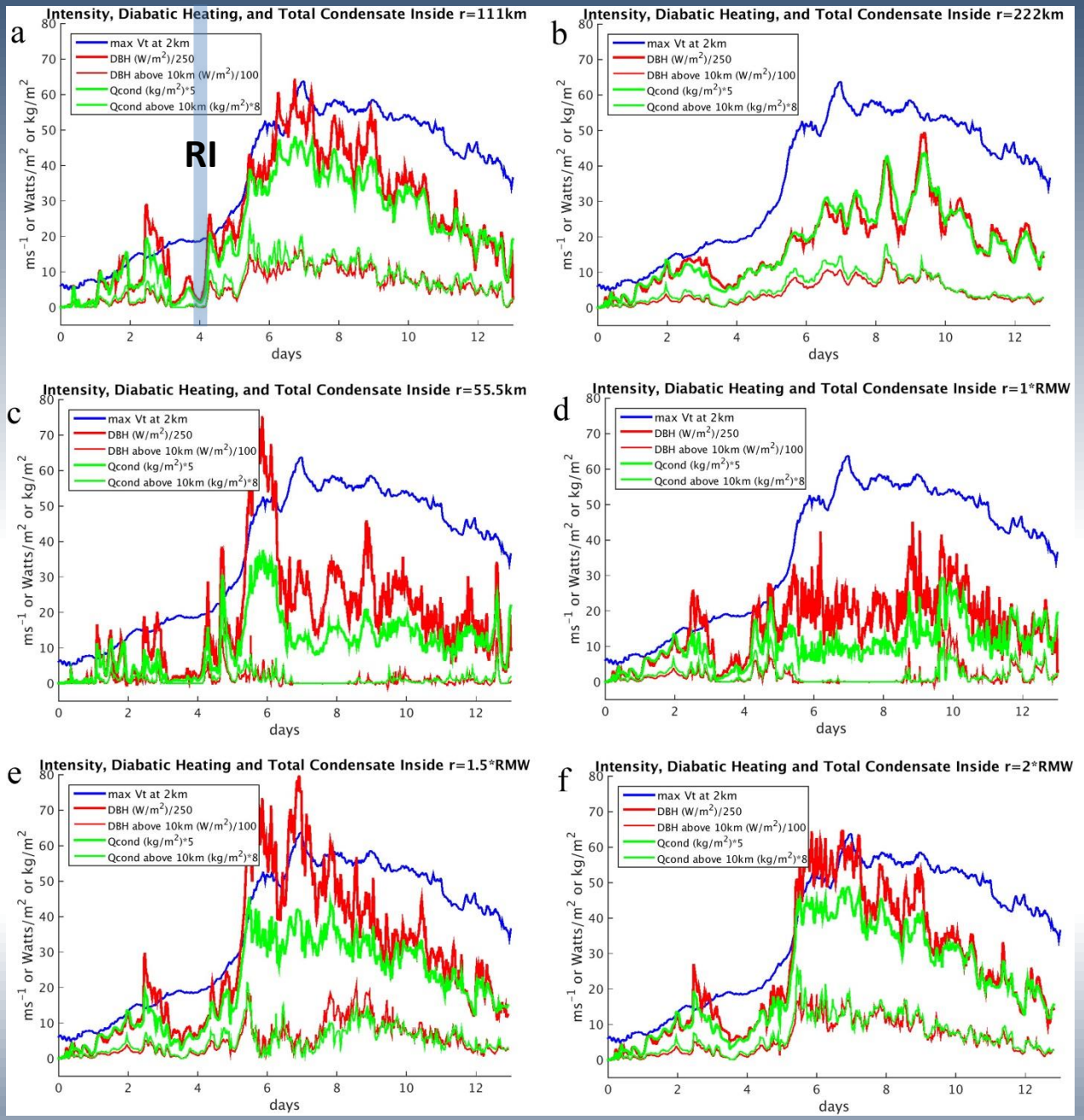
- surface wind speed (5)
- wind shear (6)
- Initial vortex size (3)
- initial vortex strength (3)

Total: 270

- WRF 3.7.1
- Nested grids with 18, 6, 2 km grid spacing
- 40 vertical levels up to 20 km altitude
- WSM6 microphysics scheme
- YSU planetary boundary layer scheme

Integrated heating and condensate

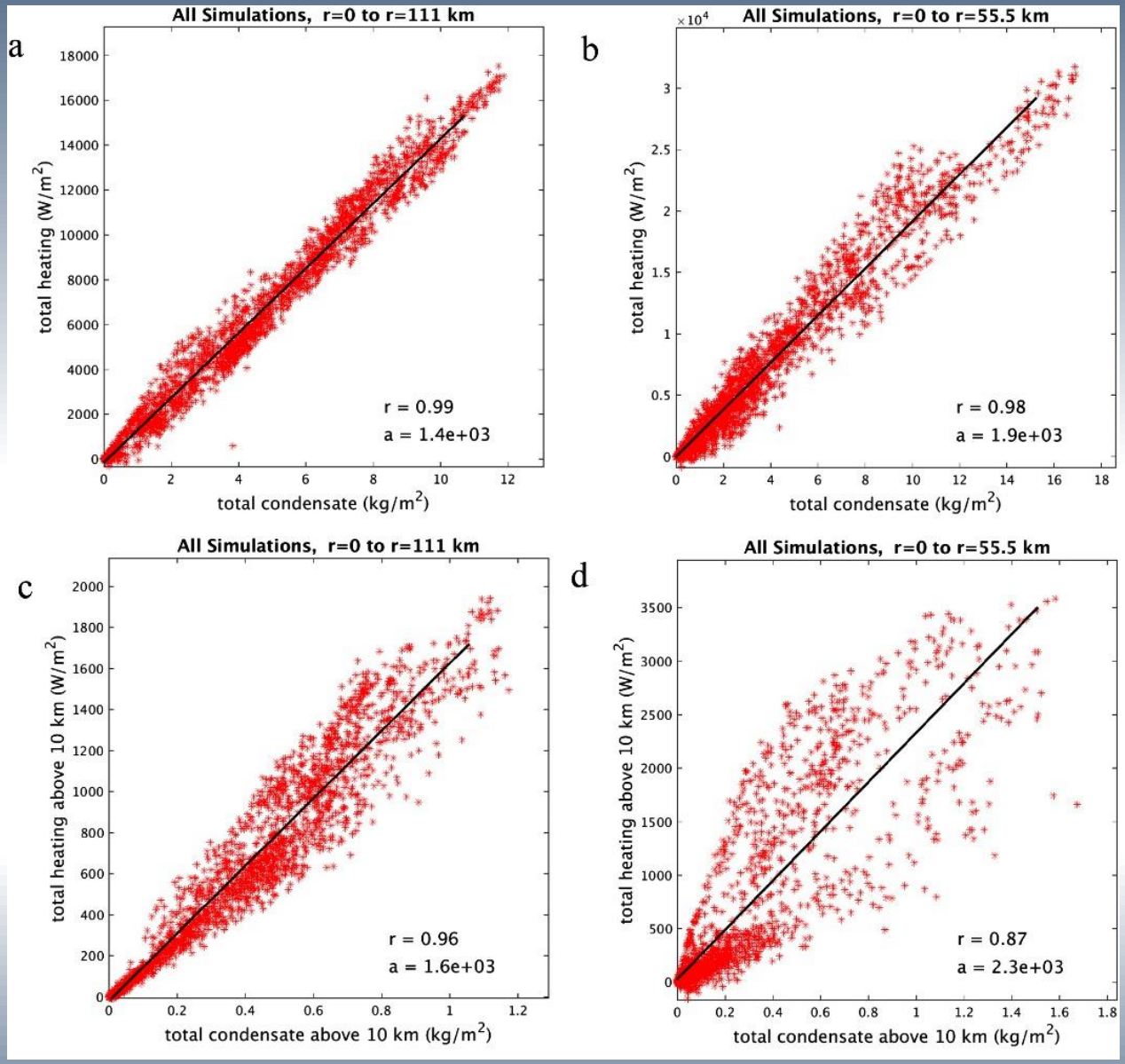




Total condensate and total heating

ALL

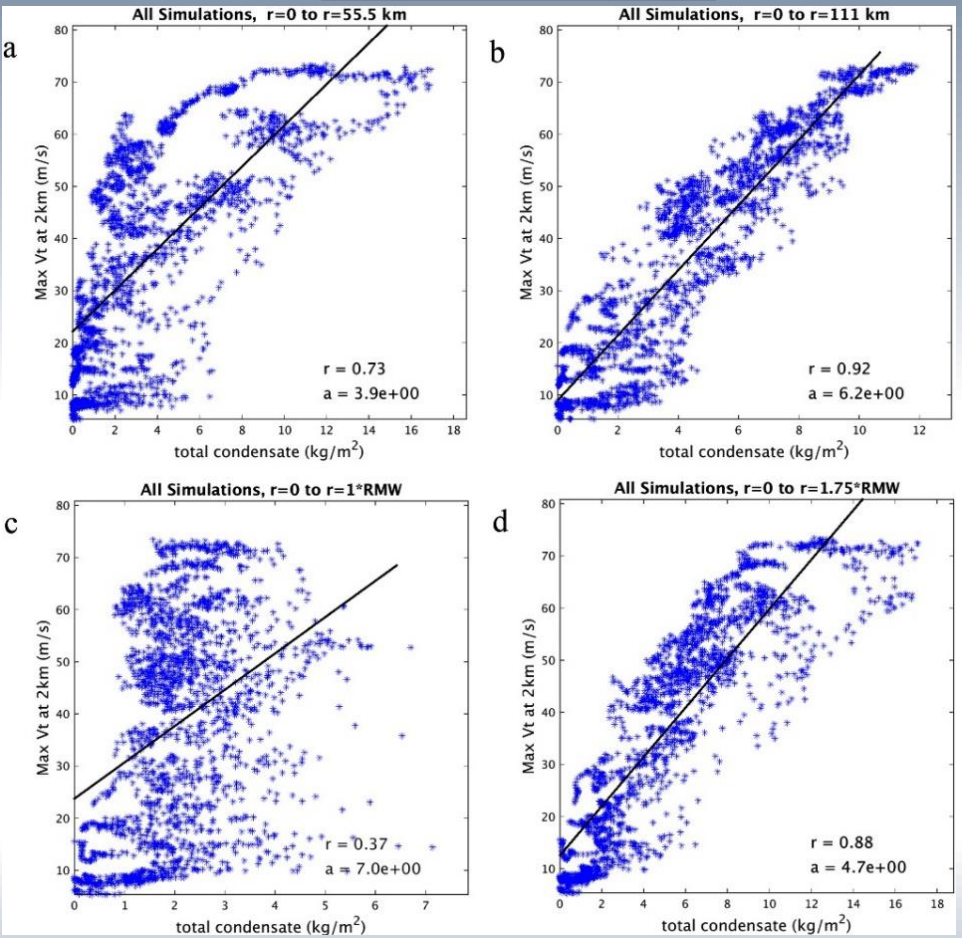
Above 10km



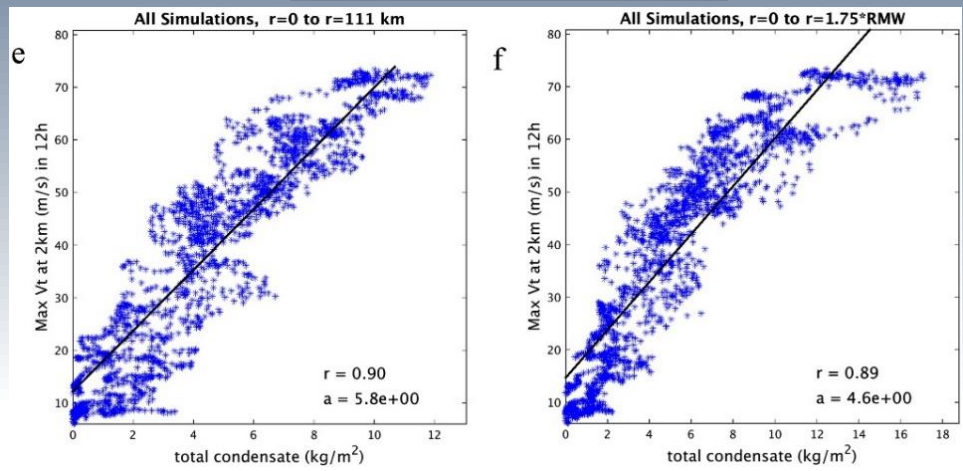
Total condensate and intensity

Intensity

Intensity (current)



Intensity (12 h later)

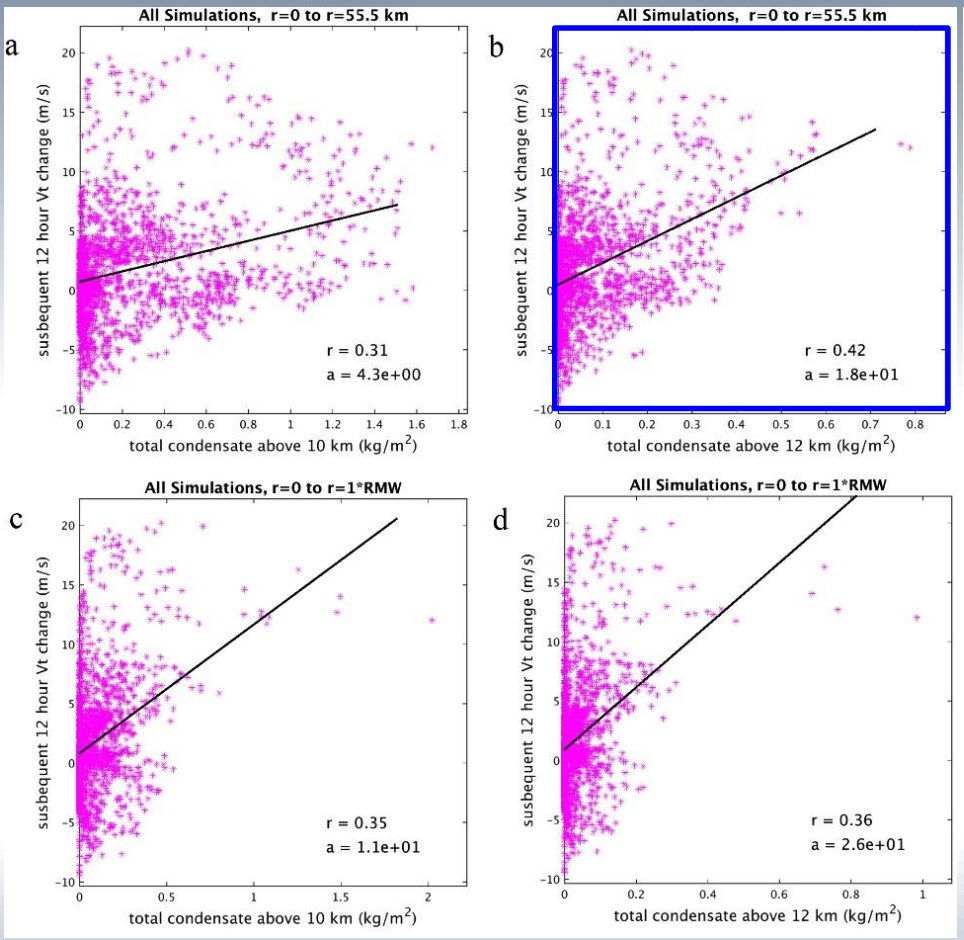


One might expect considerable scatter about this relationship, it does not account for differences in storm size, or factors that contribute to a reduced efficiency in the conversion of heat to wind energy.

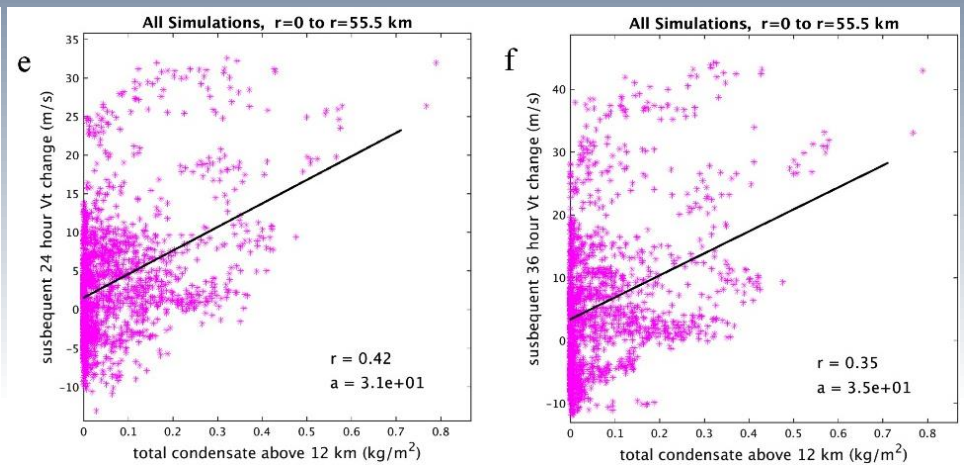
Total condensate and intensity

Intensity change

Intensity change (12 hr)

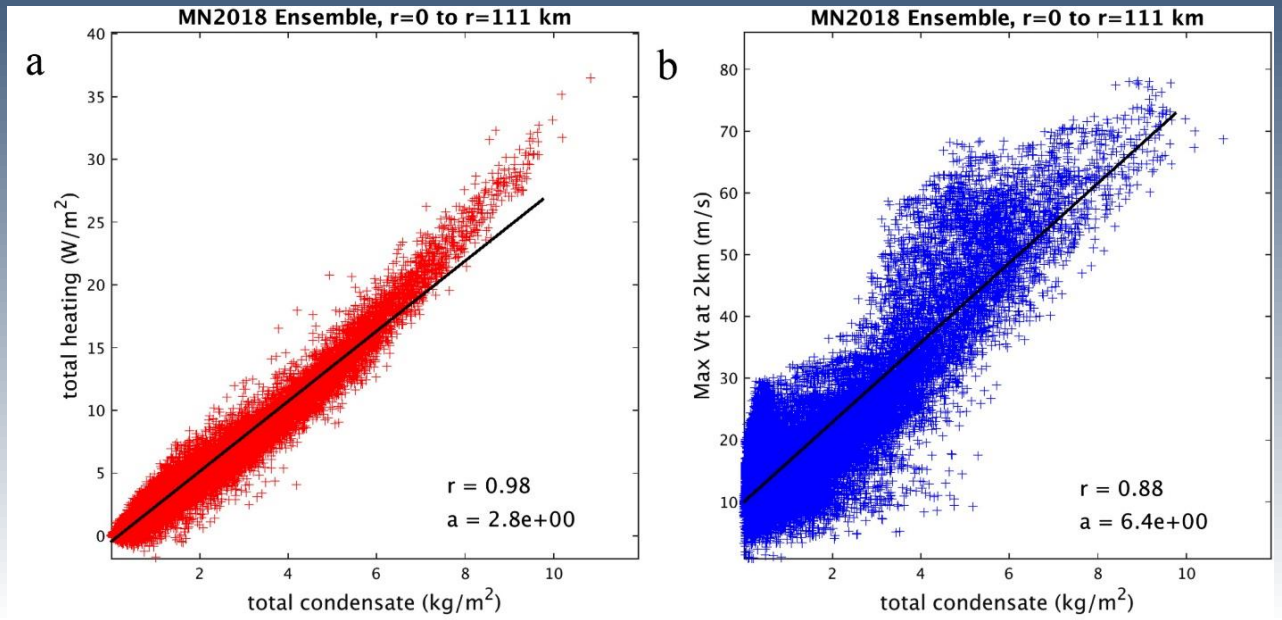


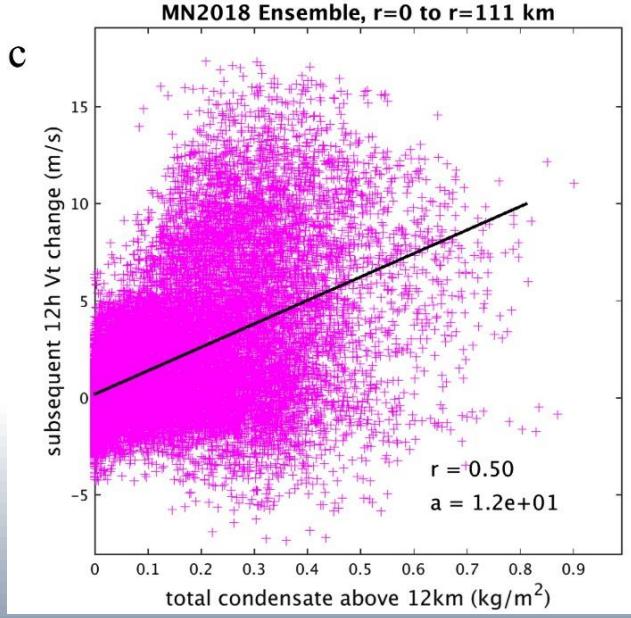
Intensity change (24 h later)

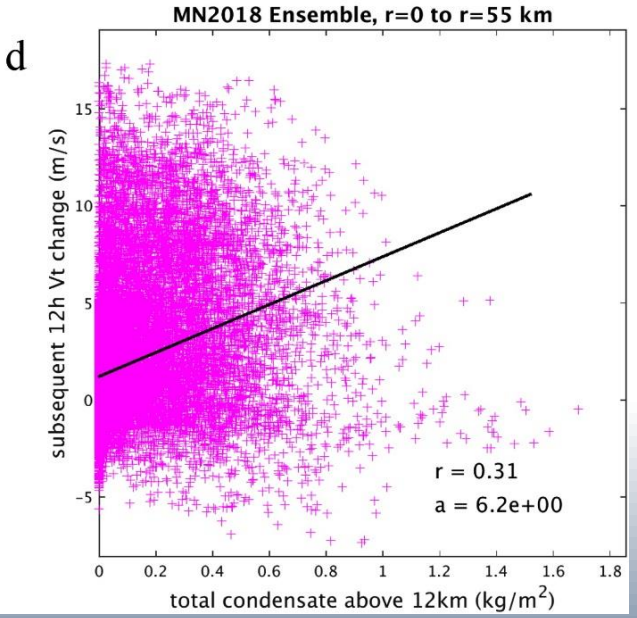


The strongest correlation is found for condensate above 12 km within a radius of 55 km, with r = 0.42

Results for the Miyamoto and Nolan ensemble

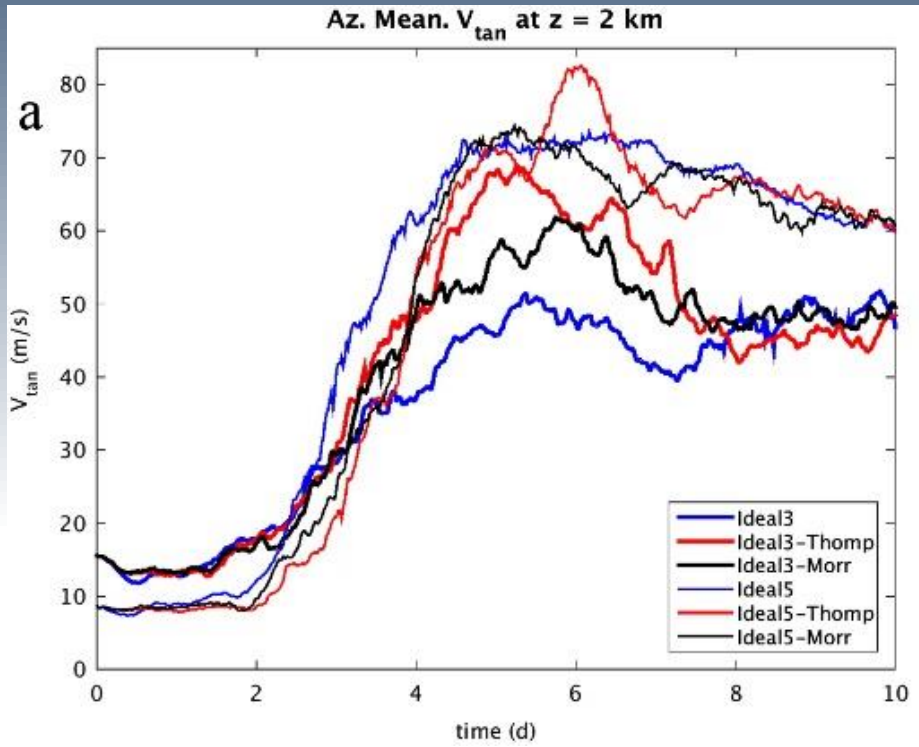




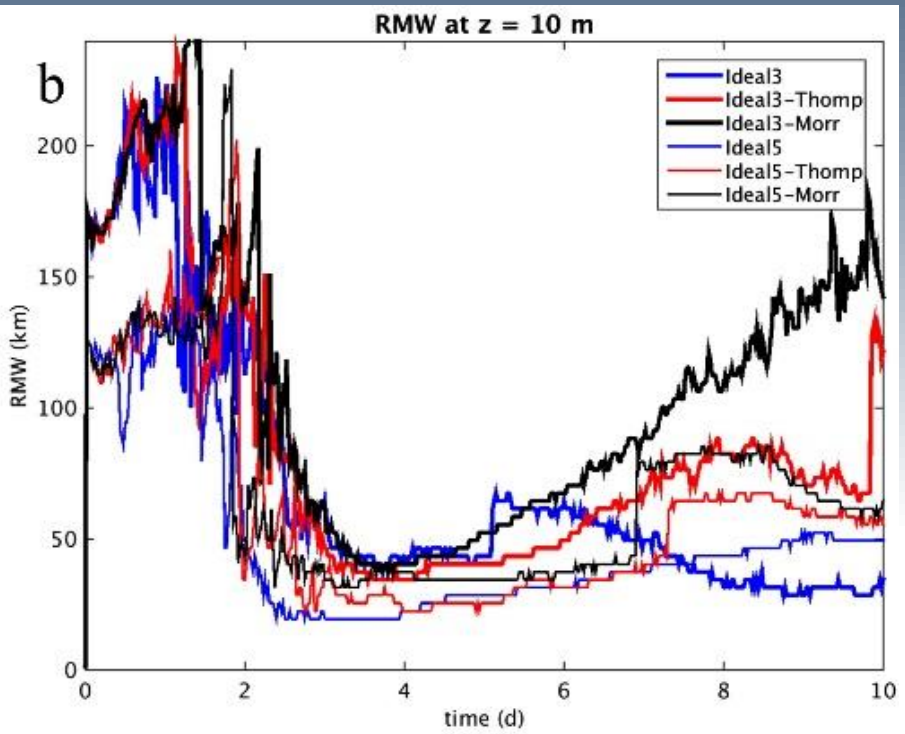


Different microphysics schemes

WDM6, Thompson and Morison



Both schemes make Ideal3 and Ideal5 considerably stronger after their initial intensification phases, but then bring them back closer to the WDM6 results for the last few days of each simulation.



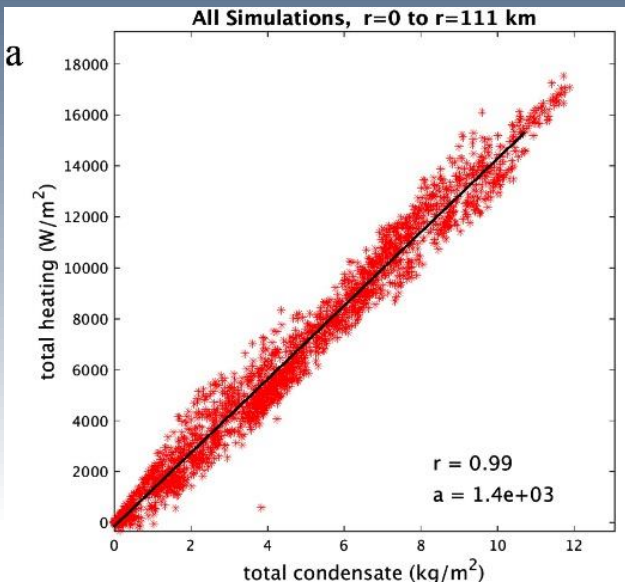
Both Ideal3 and Ideal5, the Thompson and Morrison schemes lead to steadily increasing TC sizes, with the RMW of the Ideal3–Morrison case reaching 150 km by *t* = 10 day , and Ideal3–Thompson showing an eyewall replacement cycle just before day 10, leading to nearly equal size.

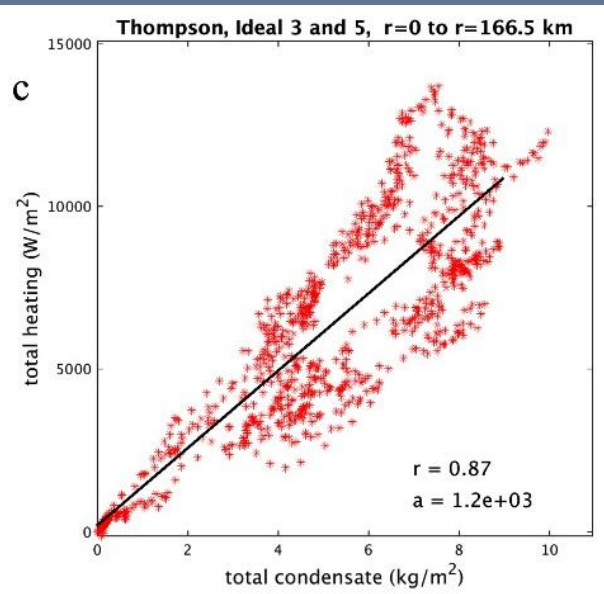
Different microphysics schemes

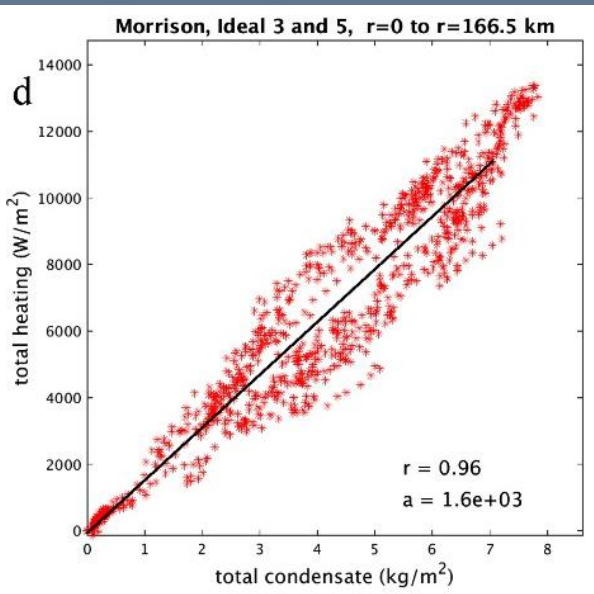
WDM6

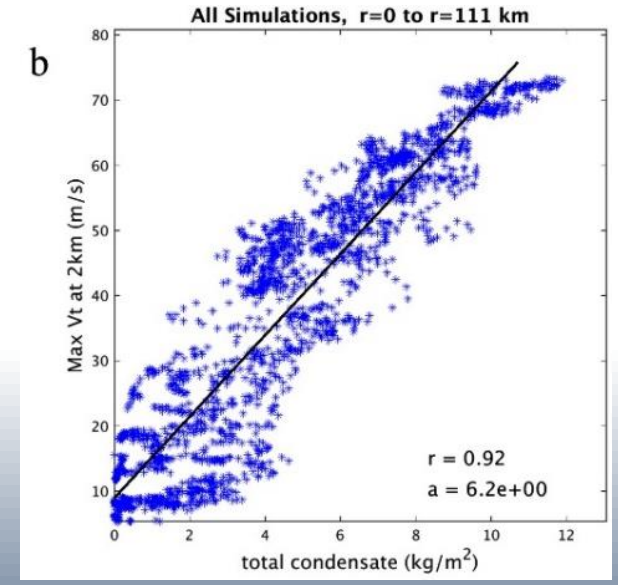
Thompson

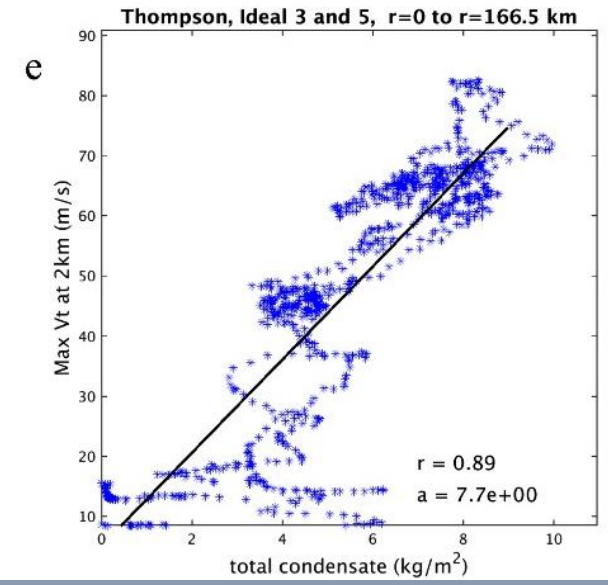
Morison

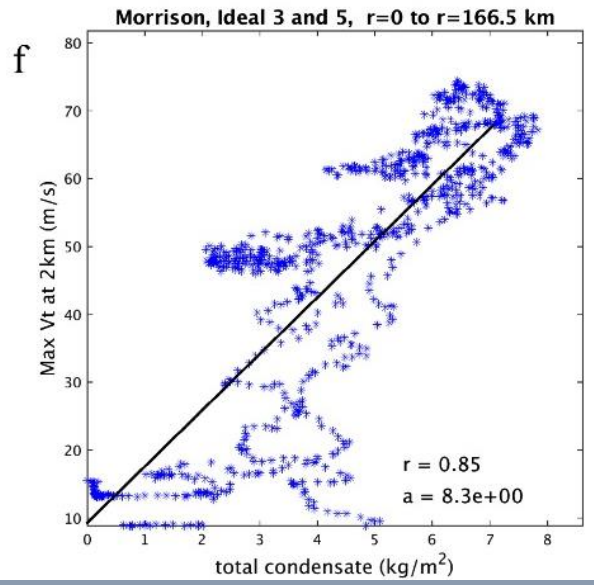












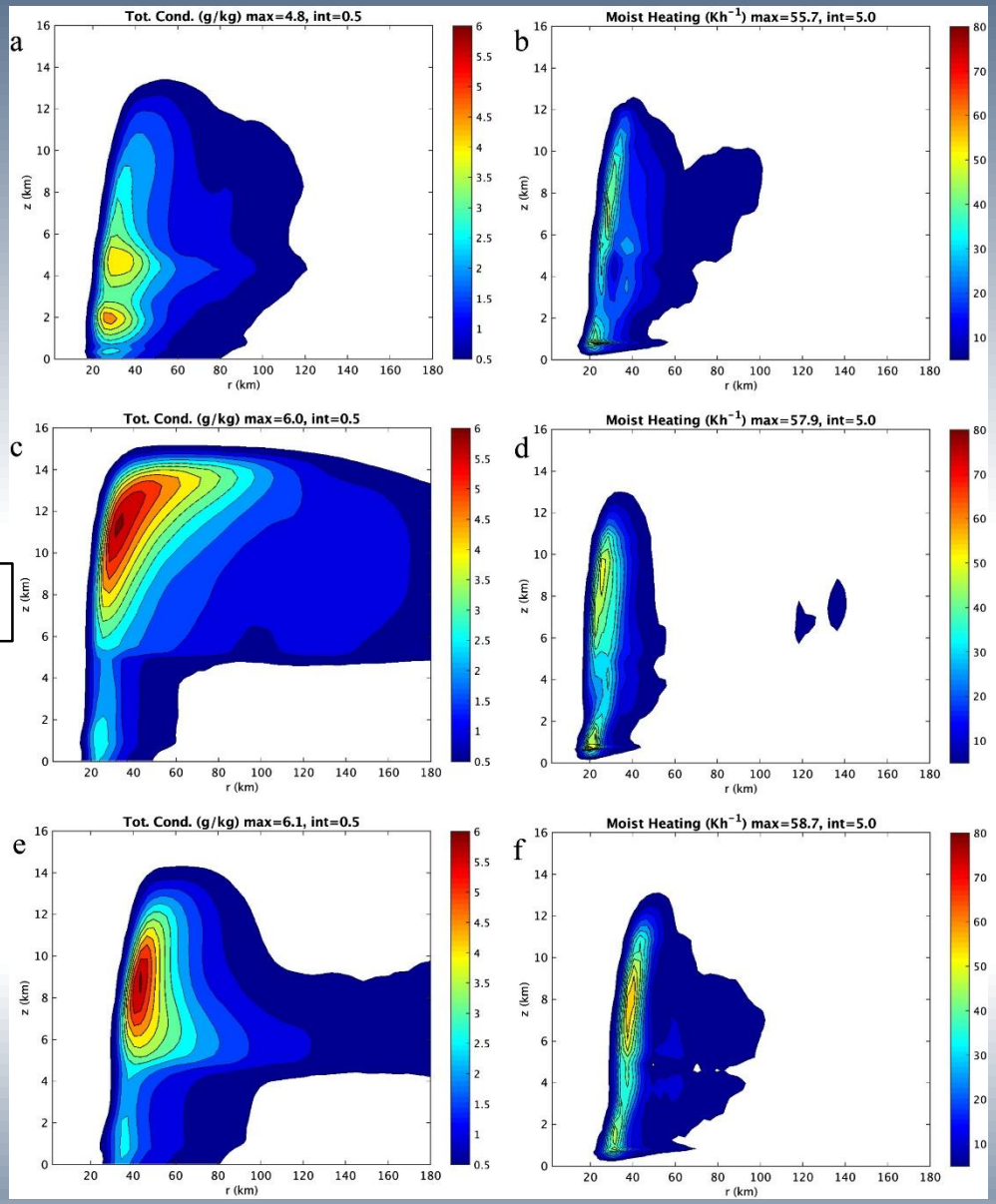
Different microphysics schemes

Moist diabatic heating rates

WDM6

Thompson

Morison

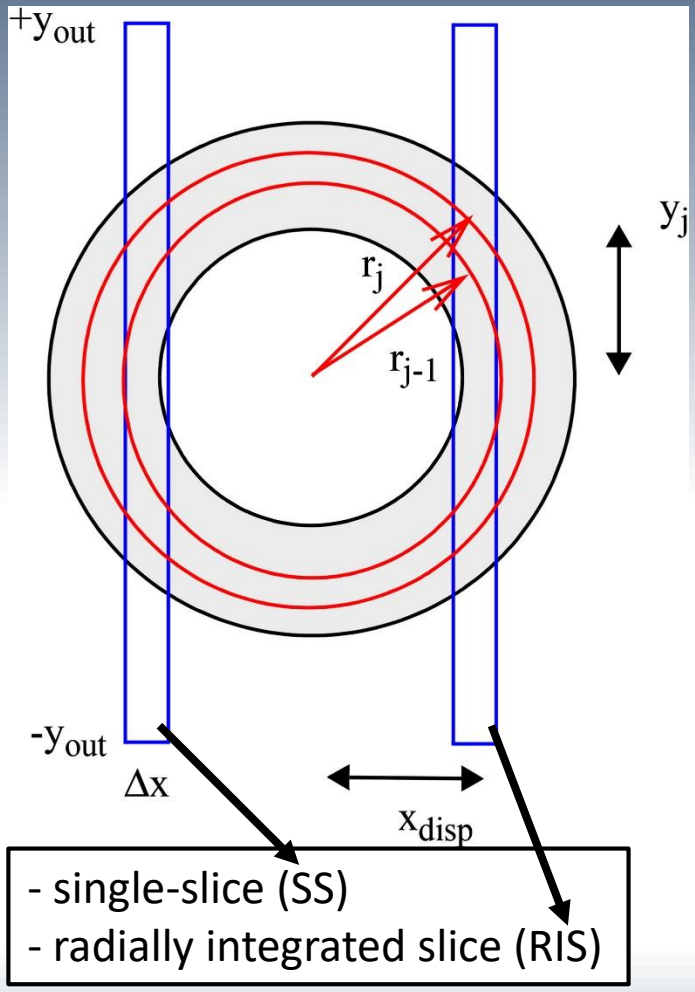


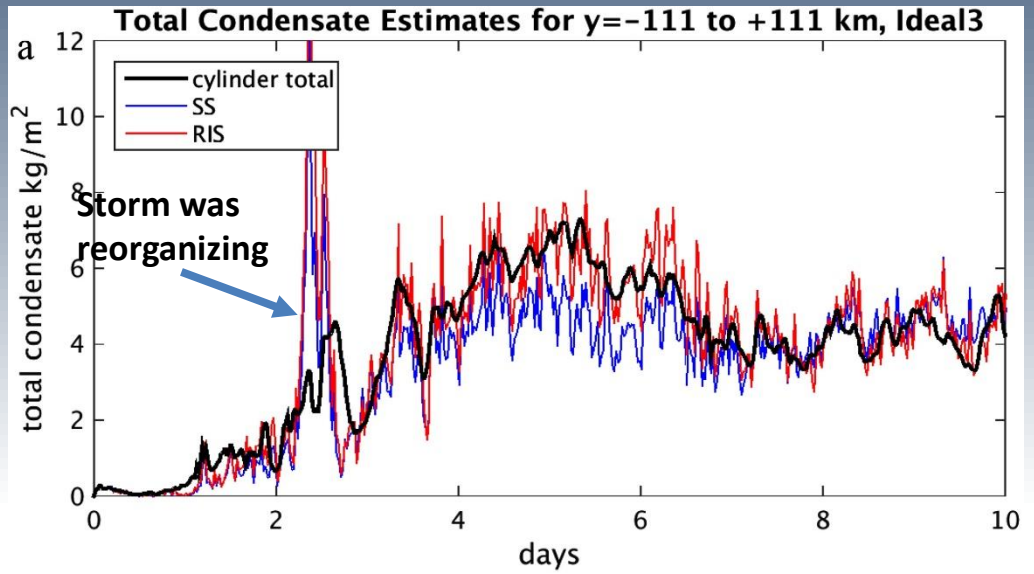
WDM6 has a fairly limited region of condensate, with values exceeding 4 g kg^{-1} only in the eyewall and below 6 km altitude.

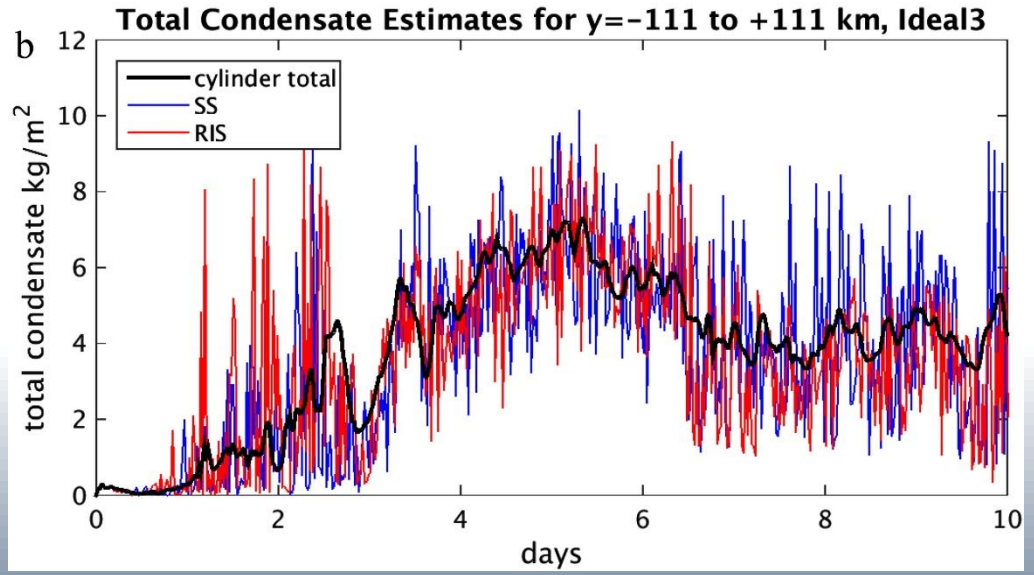
The Thompson scheme has a vast region of higher concentrations, all above 8 km height and extending out beyond 60 km radius.

The distribution for the Morrison scheme is somewhat between the two, but closer to the Thompson scheme.

Narrow-swath measurements







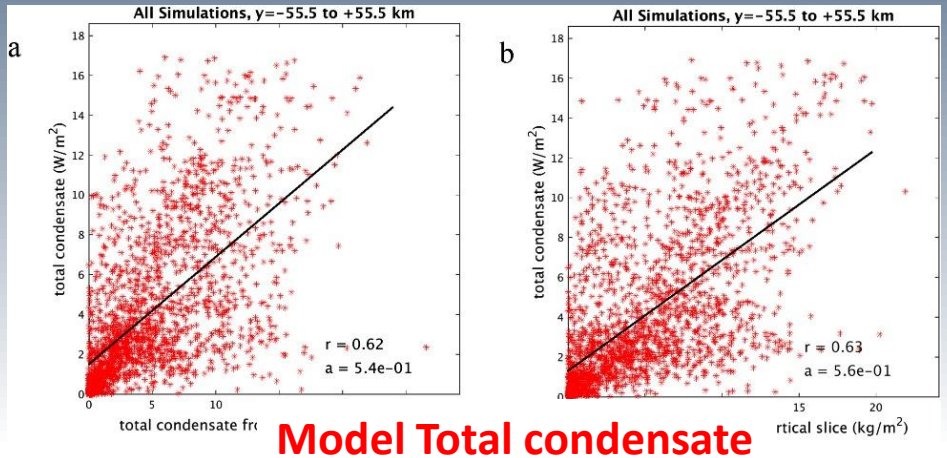
SS and RIS retrieved total condensate

SS

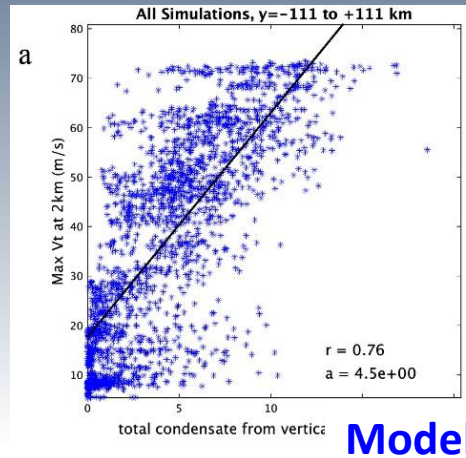
RIS

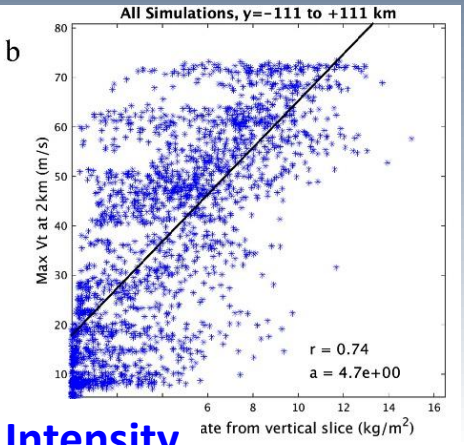
SS

RIS

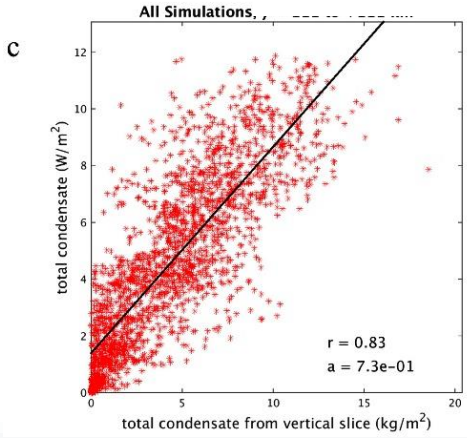


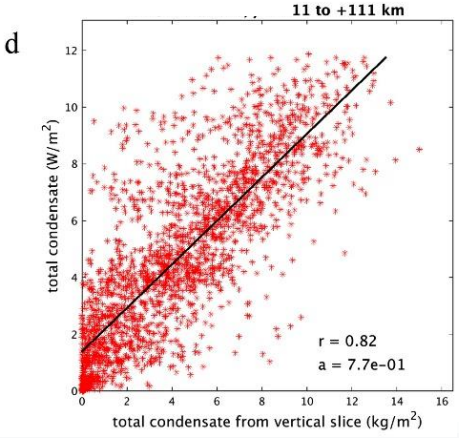
Model Total condensate

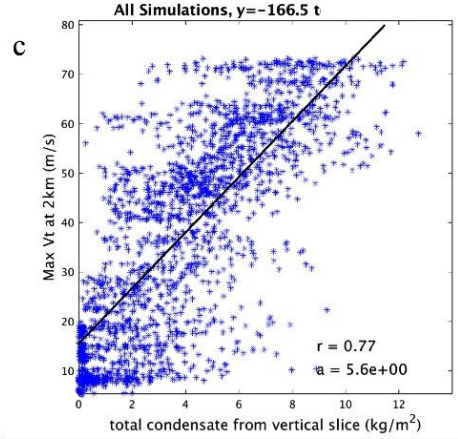


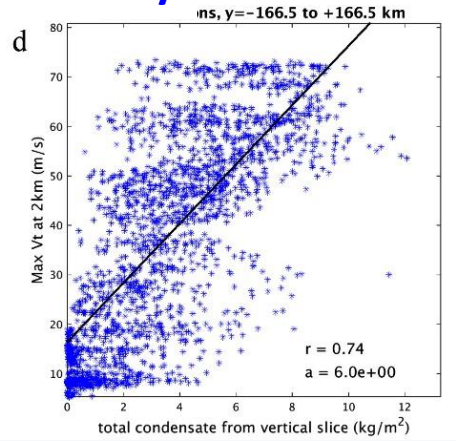


Model Intensity









Conclusions

- The numerical simulations used in this study show a very close correlation between total condensate, total moist diabatic heating and current TC intensity in the same volume.
- Moist heating above certain altitudes is not a reliable indicator of imminent intensity change
- The results were not particularly sensitive to the radius of the cylinder over which the correlations were made (a radius of 111 km generally showed the strongest correlations).
- These weak dependencies suggest compensating factors in the relationship between total heating within a given radius and TC intensity.

Thanks