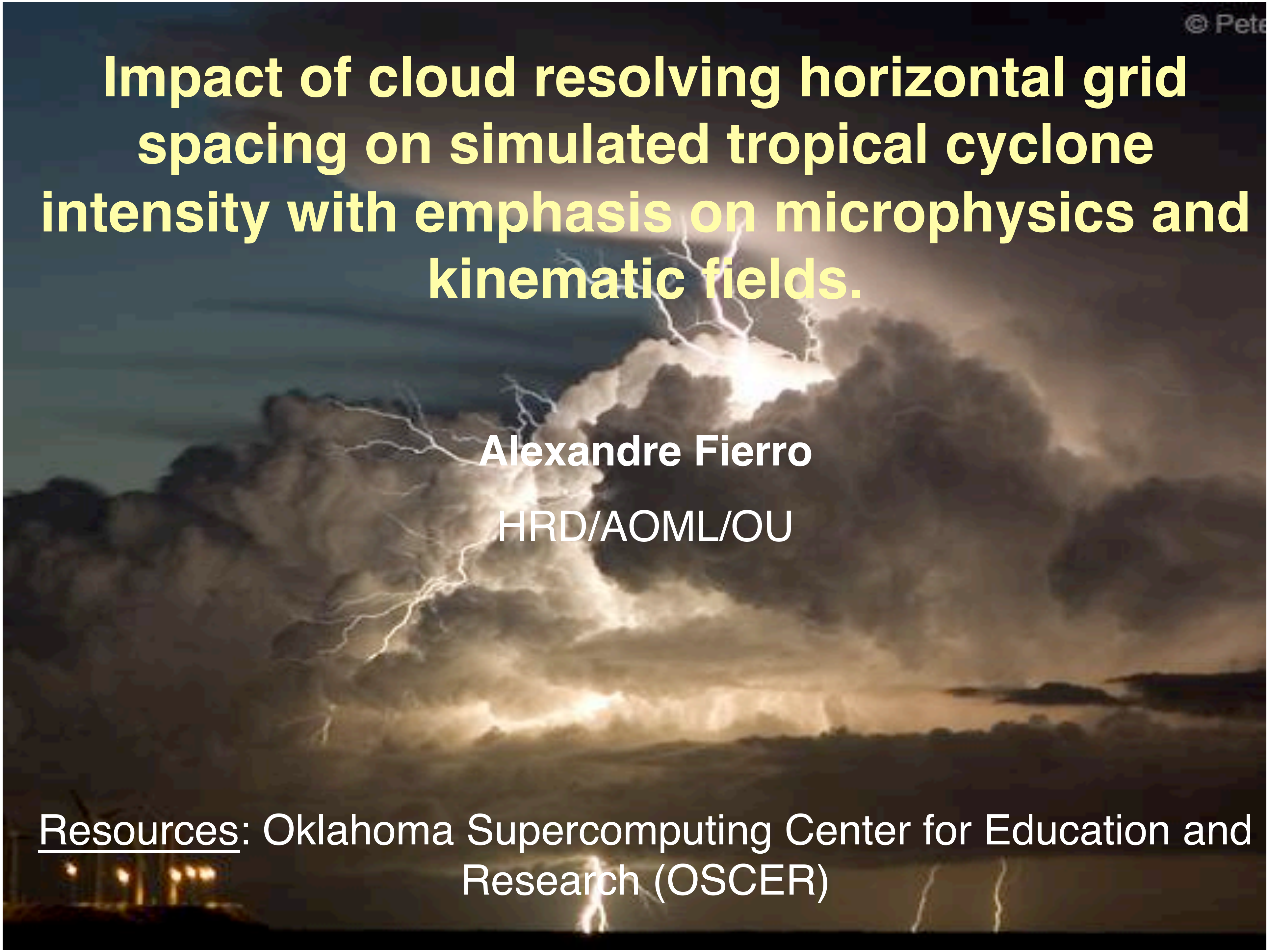


# Impact of cloud resolving horizontal grid spacing on simulated tropical cyclone intensity with emphasis on microphysics and kinematic fields.

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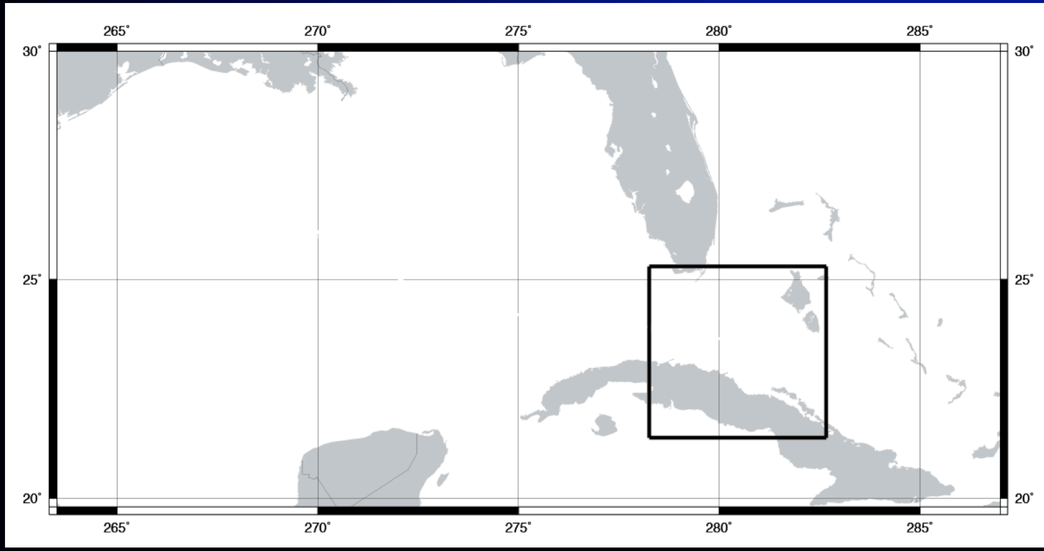
Resources: Oklahoma Supercomputing Center for Education and Research (OSCER)

# MODEL SETUP:

- WRF ARW 2.2
- FNL NCEP 1 x 1 deg BC/IC data for the case of TC RITA (2005). Start 20 sep at 00Z → 24 at 00Z
- 1 storm following inner nest (3:1 ratio), inserted at 20 sep at 06Z. Dt = 45 / 15 s for all cases (as CFL restricted by dz not dx)
- MYJ PBL, Thompson micro, no radiation, 300 K base state temp. KF CPS used in outer domain only.
- based on previous extensive sensitivity experiments, this set up resulted in the deepest storm (and best track), which is the goal here.
- Thompson micro because part of main focus here is microphysics fields (also produces way less Qg than WSM6).
- Tested with 5 cases

# MODEL SETUP ctd:

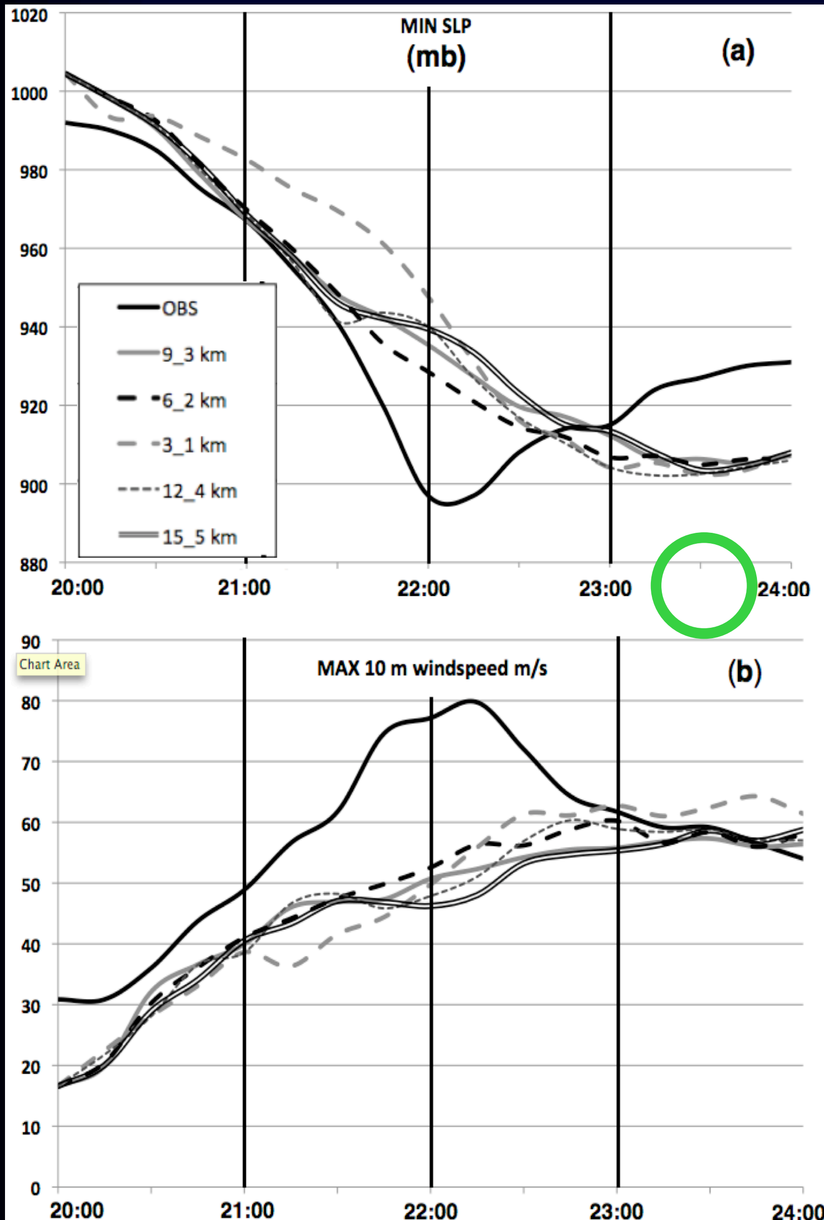
| Cases (outer/inner) | Nx (outer) | Ny (outer) | Nx (inner) | Ny (inner) |
|---|---|---|---|---|
| 15- 5 km | 159 | 75 | 84 | 84 |
| 12-4 km | 200 | 93 | 103 | 103 |
| 9-3 km | 266 | 124 | 139 | 139 |
| 6-2 km | 399 | 186 | 211 | 211 |
| 3-1 km | 797 | 373 | 421 | 421 |

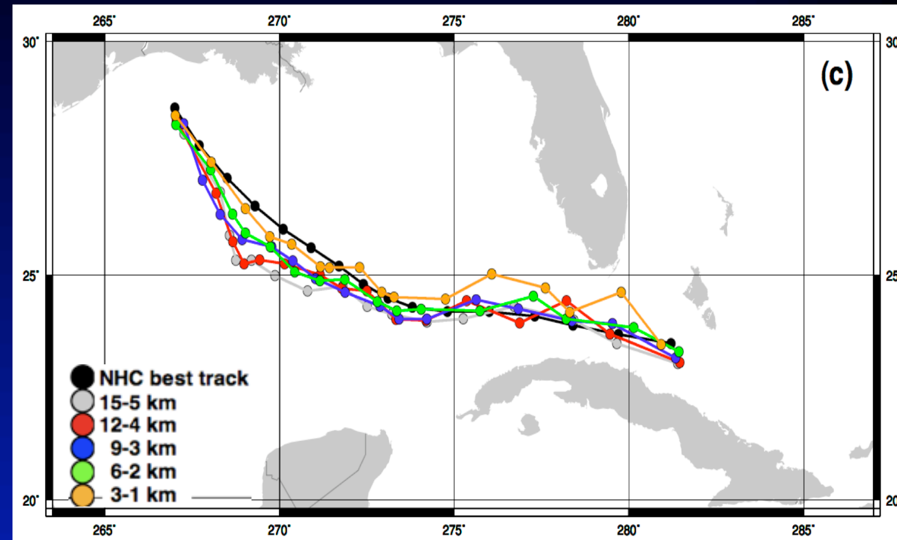



- Domains sizes dimensions
- Why choosing Rita for this idealized work ?

1) Hard/challenging case to model and need to document that all attempts failed (even with data assimilation of Doppler winds)
2) Simulated tracks identical in all 5 case making our comparisons valid

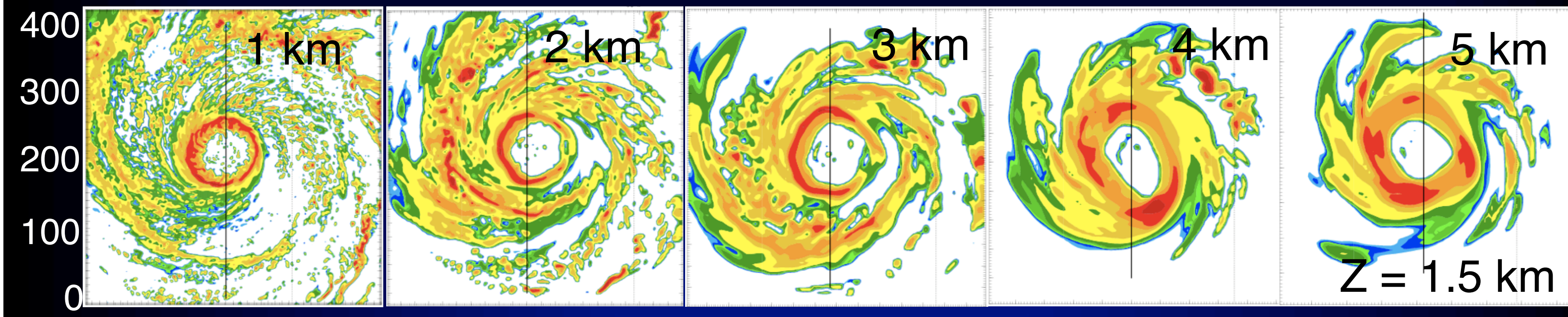
# Tracks/intensity



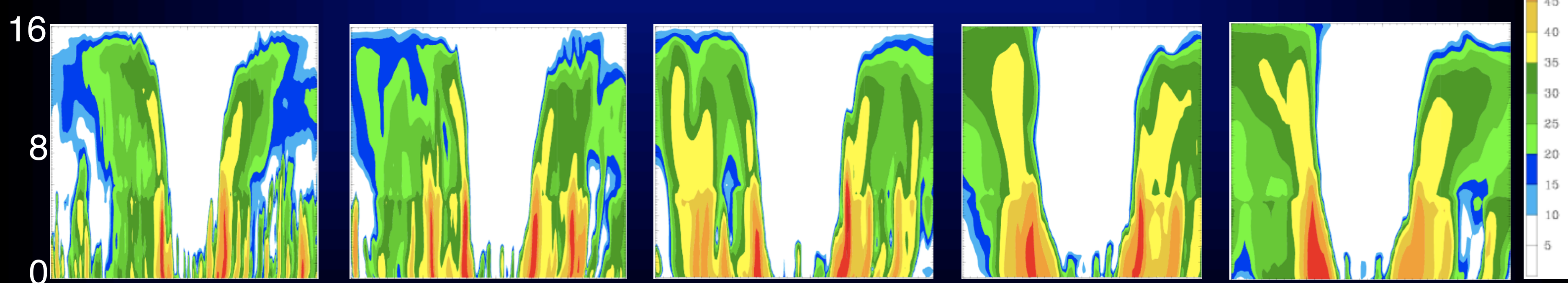




- 3-1 km case took longer to develop but experienced faster deepening (35 mb / 12h) and 10 m wsp increase (12 m $s^{-1}$ / 12h)
- All cases reach same minSLP→ steady state. Note then that 3-1 km case has 10 m wsp as much as 10 m $s^{-1}$ higher.

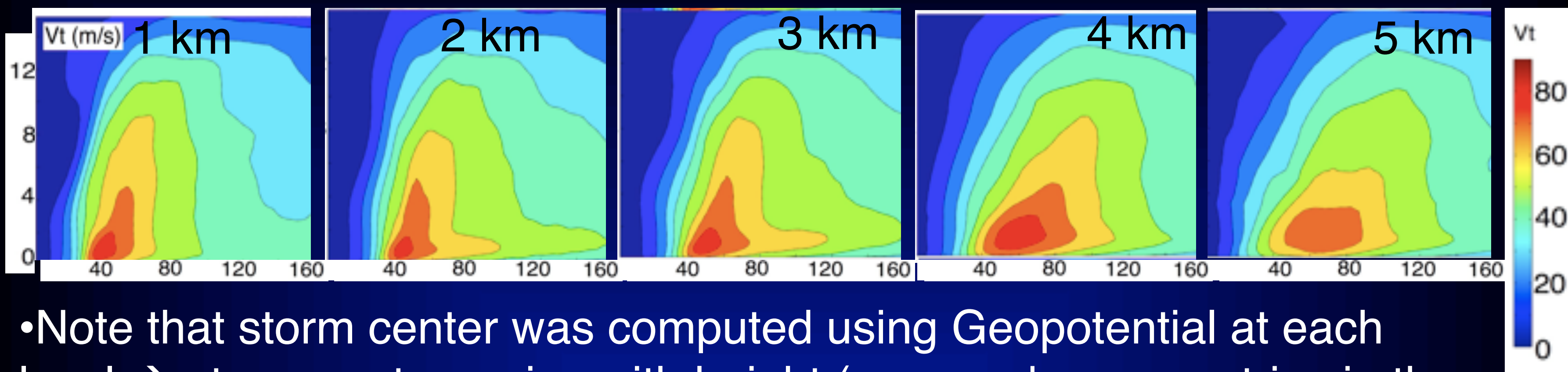
# Steady state period




•Despite similar min SLP notable differences exist: eyewall width increases as dx, dy increases. Eye size not affected as much. Wavenumber 2,3 and 4 asymmetries occasional in 4 and 5 km cases. Fewer rainbands in coarser runs.



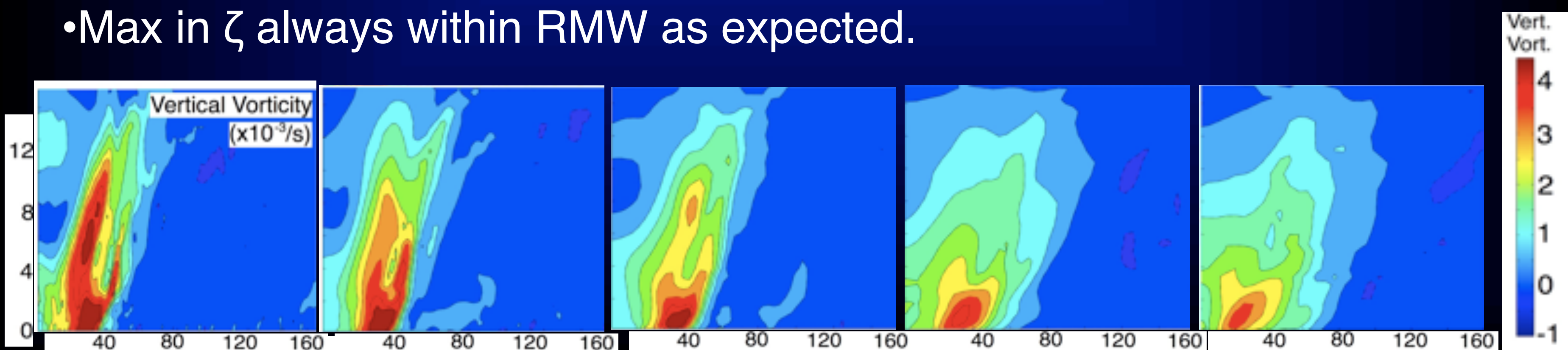
# Azimuthal means



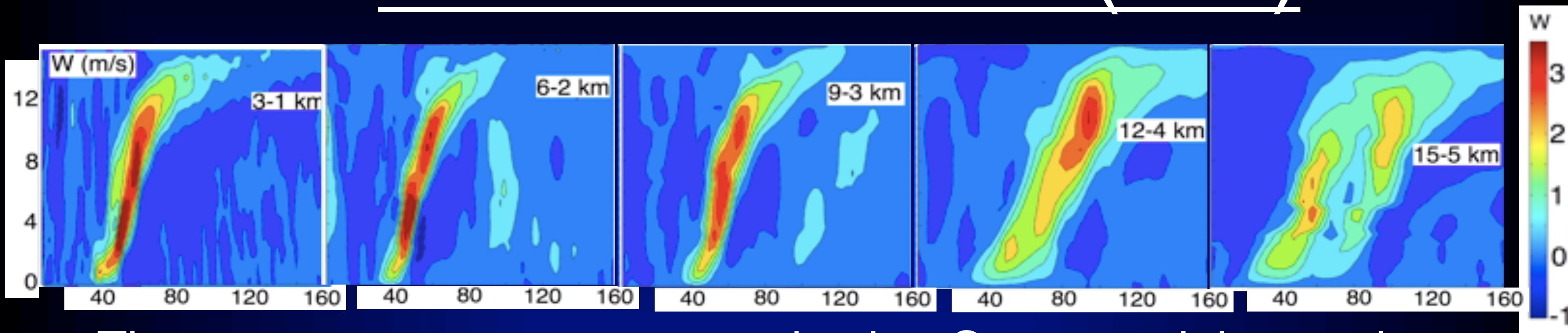

•Note that storm center was computed using Geopotential at each level → storm center varies with height (can mask asymmetries in the vertical)

•More upright 60 m/s Vt contour and also larger ζ in fine cases as radial gradients of Vt better resolved → important for mixing across eye/eyewall inner edge. 3-1 km case only one showing local stronger wind max in excess of 100 m/s there. Wider Vt contour near sfc for coarser run → more surge potential at coarser res.

•Max in ζ always within RMW as expected.



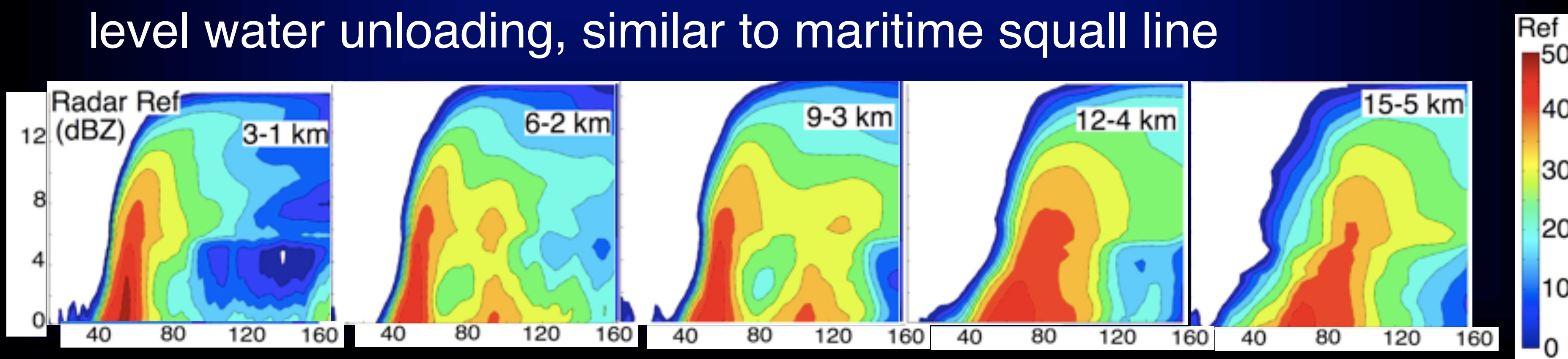
# Azimuthal means (R-Z)



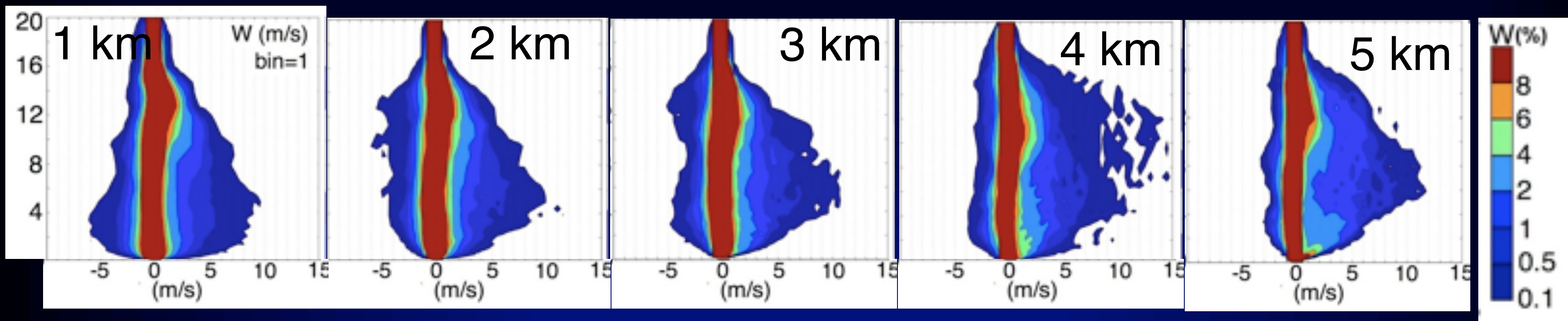

•The storm center was computed using Geopotential at each level → storm center varies with height (can mask asymmetries in the vertical)

•Finer cases have stronger W and more upright dBZ profile (symmetry might play a role in this diff but cross sections revealed stronger isolated entities in finer cases).

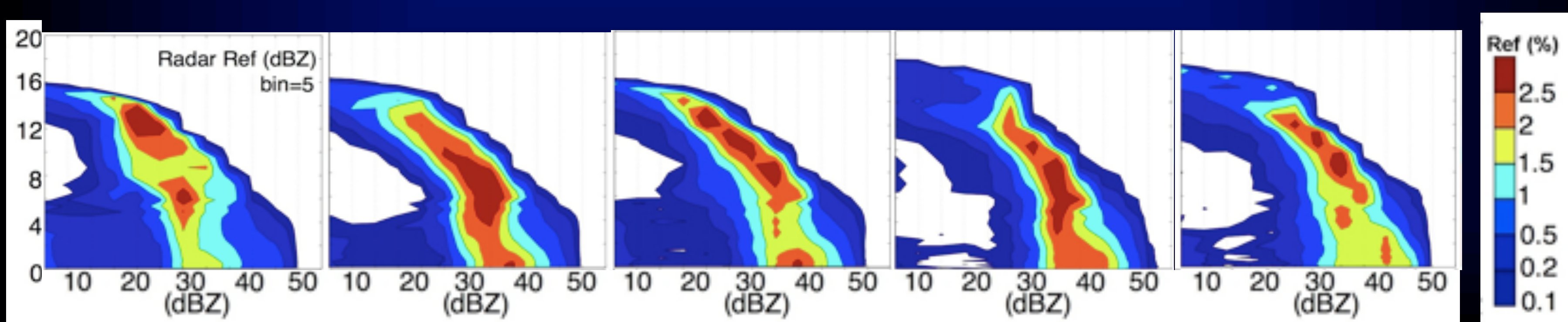
•Bimodal W distribution; low level dynamically forced and upper level water unloading, similar to maritime squall line



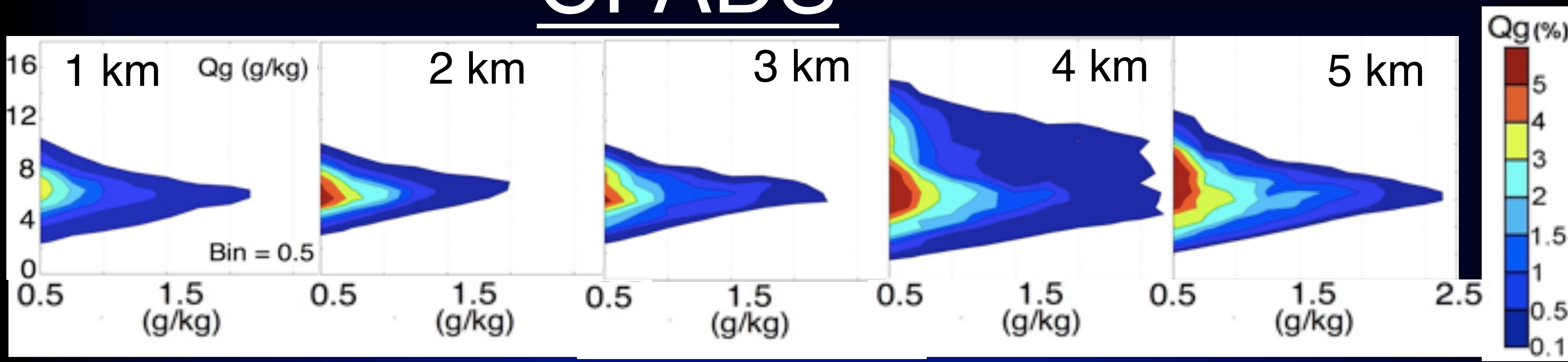
# CFADs




- The storm center was set to be min SLP. Data taken from a box containing the eyewall only.
- Finer cases, in particular 3-1 km case produced overall more stronger downdrafts, while coarser cases produced many more stronger updrafts. Bimodal W profile still evident.
- DBZ profile does not show sharp decrease with height above 0C level as in obs (water unloading/depletion of supercooled water)

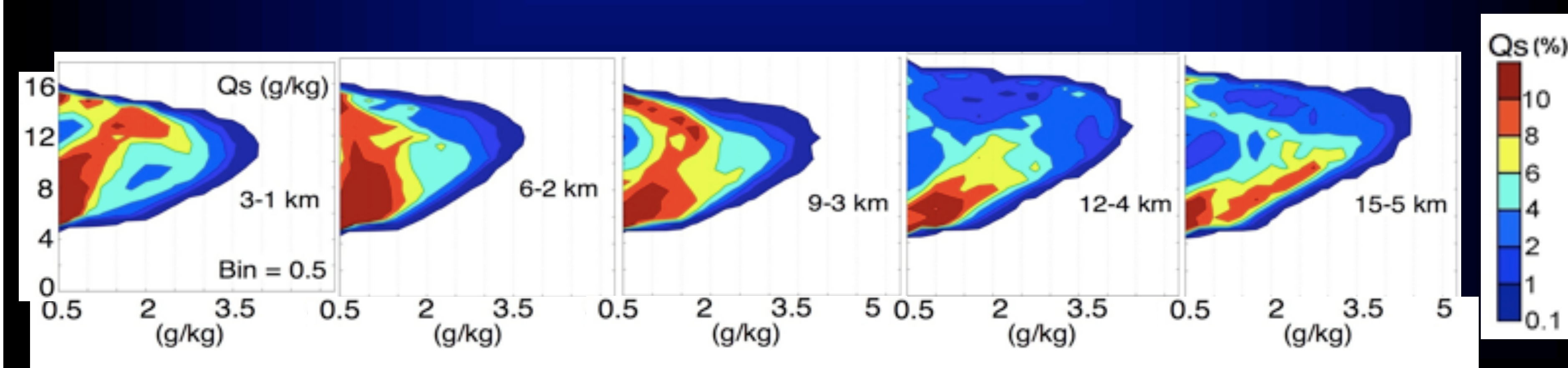


# CFADS

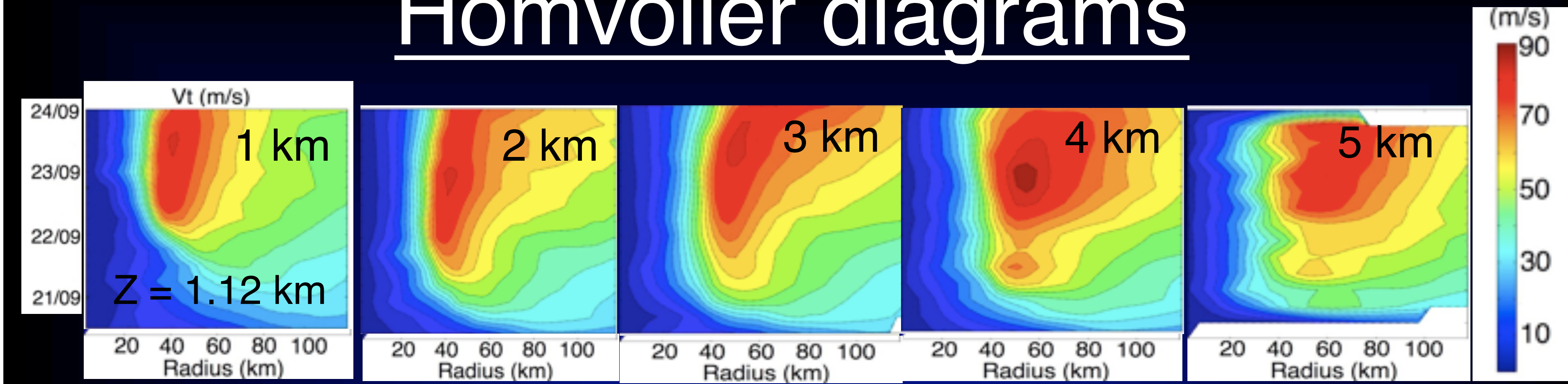



•Coarser cases tend to produce wider distribution of graupel with altitude, particularly more graupel near 8 km AGL and also larger frequencies of larger mixing ratio, despite producing the smallest Azimuthal mean of Qg

•Snow distribution behave in the opposite manner with more snow at lower levels near 6 km AGL in coarser case while finer cases exhibit snow at upper levels as well.

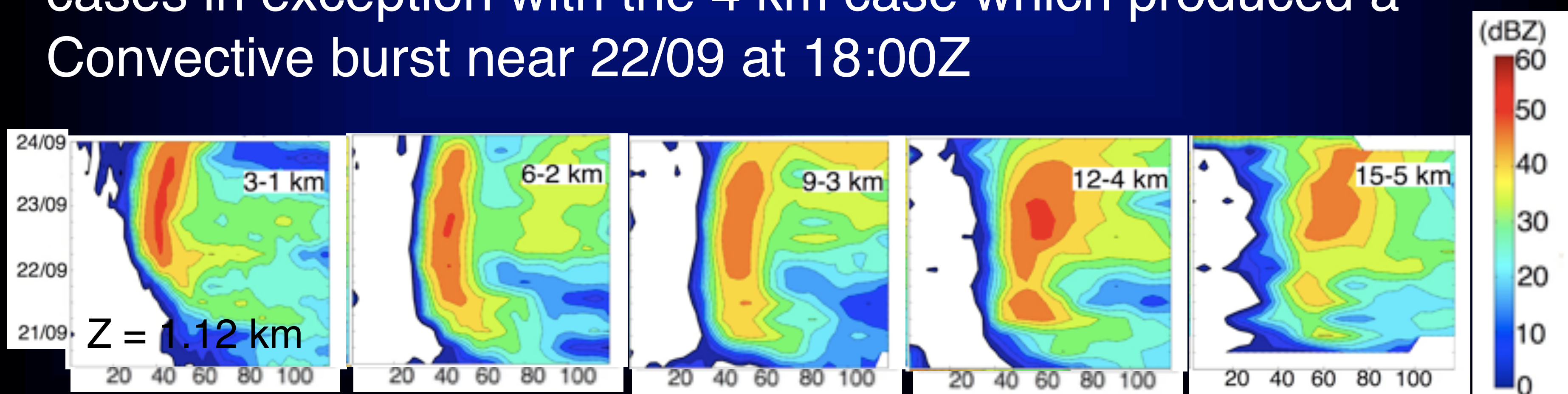


# Homvoller diagrams

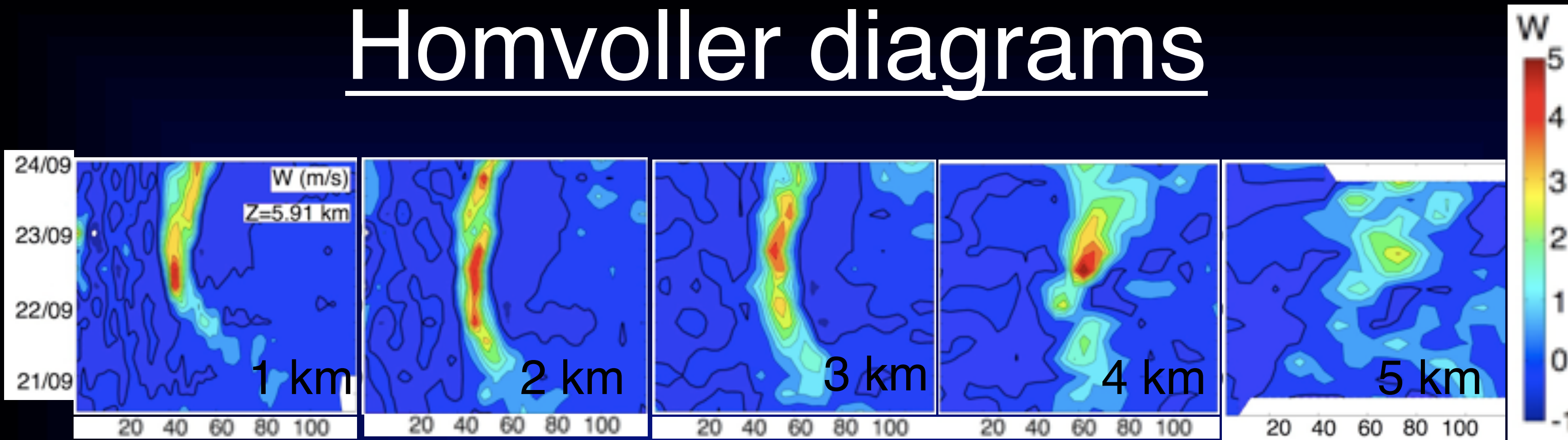



•1 km and 5 km case develop later. Two coarser cases develop wider eyewalls, consistent with wider 45 dBZ and wider 80 m $s^{-1}$ Vt coutours

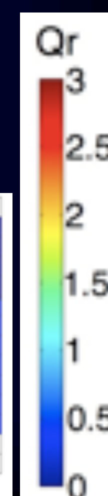
•Azimuthal means remains in Vt overall similar among the cases in exception with the 4 km case which produced a Convective burst near 22/09 at 18:00Z

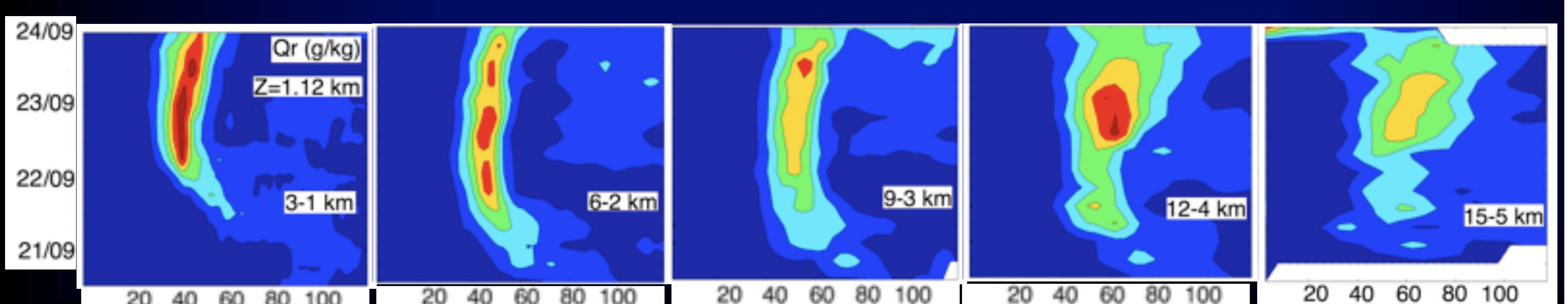


# Homvoller diagrams

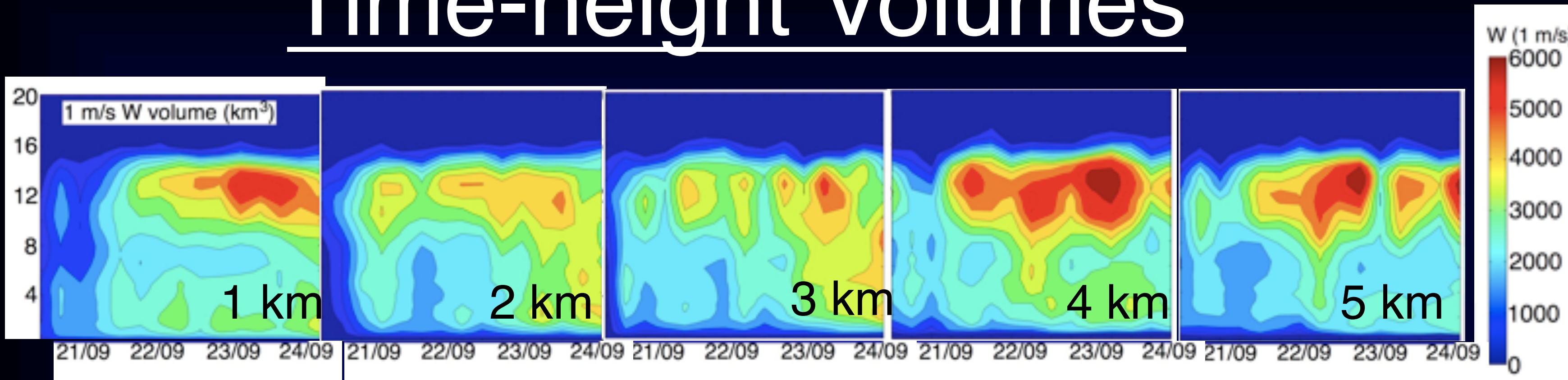



1 km case produced overall larger Qr and Qg azimuhtal means when storm in mature stage. Clearly 4 and 5 km cases less symmetric. Convective burst in 4 km case evident by large W and Qr (Qg not shown). Not coincident with increase in max 10 m wsp or increase in deepening rate.



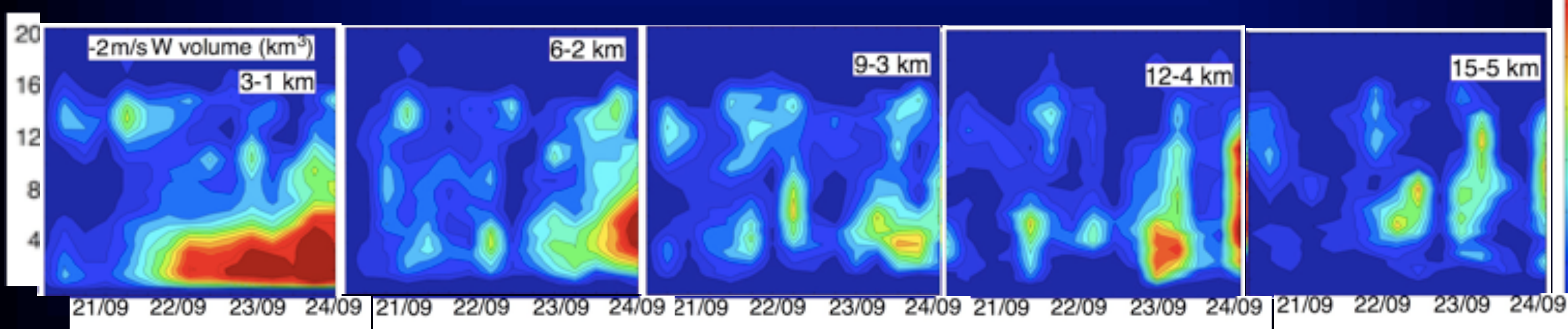
# Time-height Volumes

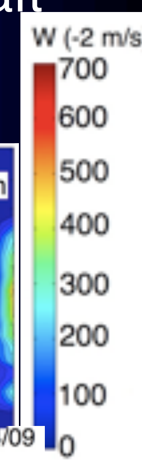



• Generated as for CFADS within a box containing eyewall only. Storm center determined by locating min SLP.

•1 km case produced by far the largest volume of moderate downdrafts (-2 m/s). Bimodal distribution of updrafts still evident. Convective burst in the 4 km case also noticeable here.

•Intensification in all cases coincident with increase in 1, 5 m s$^{-1}$ updraft volume, Qg, Qr and 30 dB echo volume in eyewall.



# Conclusions

- Simulated storms exhibited noticeable difference in their microphysics and kinematics despite similar minSLP and 10 m windspeed during steady state period
- Generally, the coarser cases produced wider eyewalls, consistent with wider updrafts, while eye size did not vary as much → more prone to severe storm surge. Finer res case propuces a tighter eyewall with more upright convection and also more symmetric in time.
- Coarser cases produced larger volumes of moderate updrafts (5m/s), while the finer res. cases revealed larger maximum and azimuthal averaged updraft speed, Qg and Qr.
- Updrafts followed a bimodal distribution similar to maritime squall lines: Low level due to dynamical forcing (frictional convergence vs gust front convergence/PGF)  and at upper level due to water unloading by enhanced warm rain processes.
- Steady deepening in time coincident with increase in Qg, Qr, 30 dBZ and 1, 5 m/s volumes in all cases.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Questions ?