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Effects of vertical wind shear on the predictability of tropical cyclones: sensitivity to **ambient moisture**

Dandan Tao and Fuqing Zhang

Group Meeting

08/17 2017

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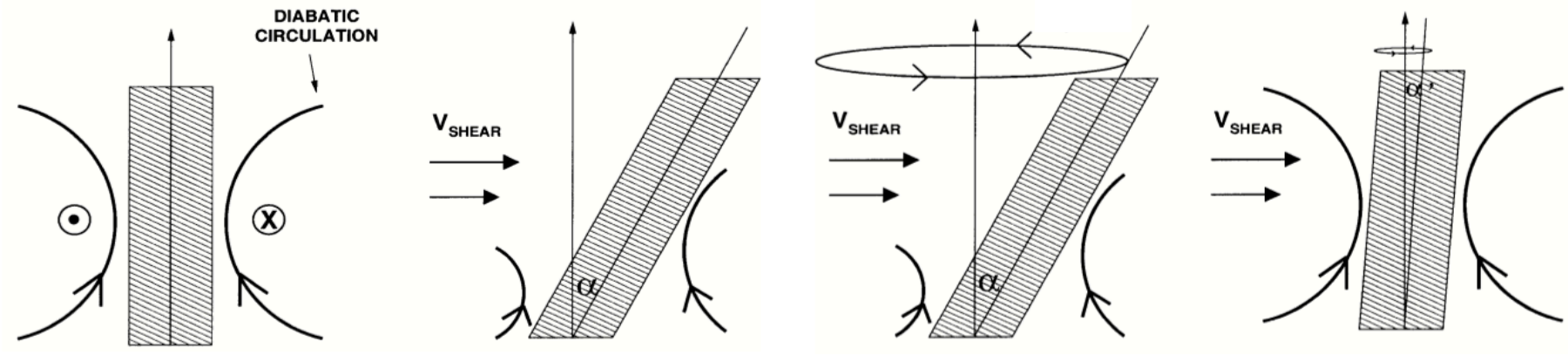
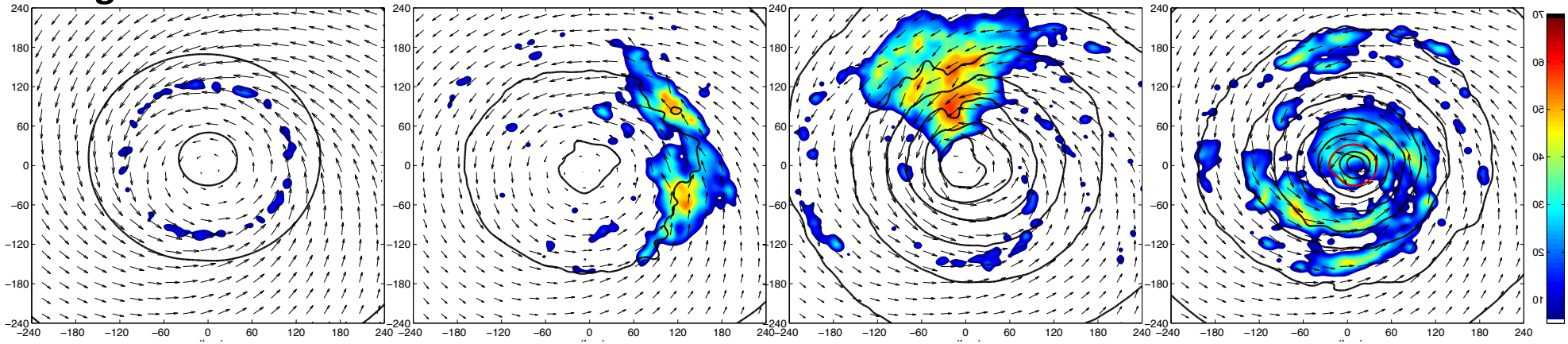
Precession and Alignment



Straight Vortex Column **Tilt** **Precession** **Alignment**



8 h **24 h** **85 h** **106 h**

Shear

RI onset time

Reasor et al. 2004; Zhang and Tao 2013

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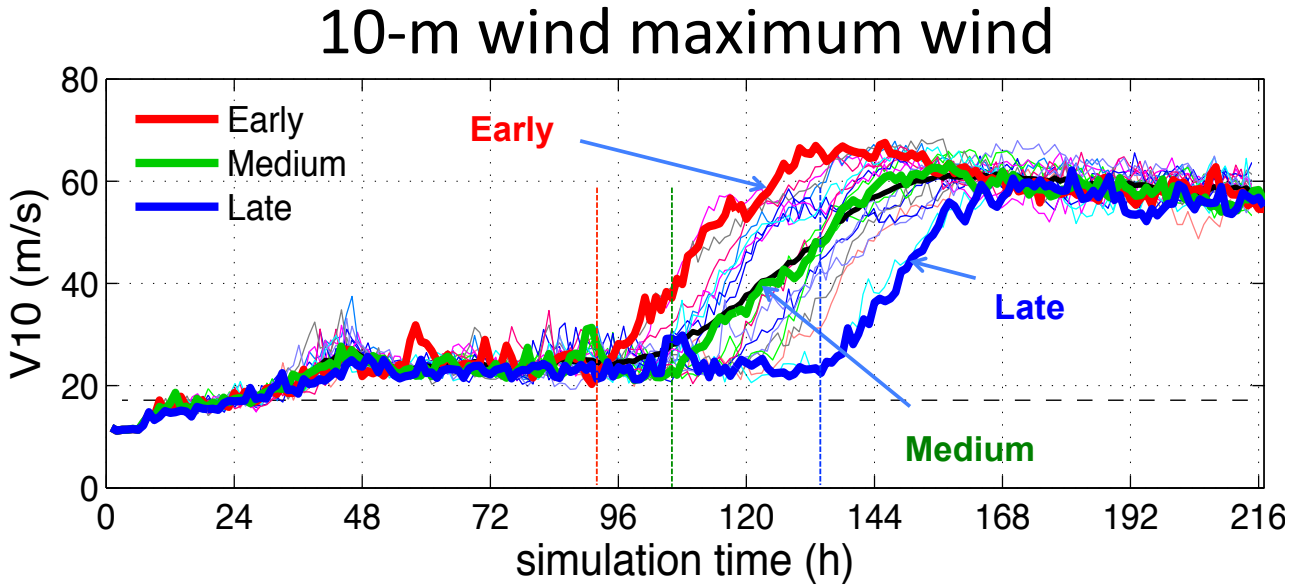
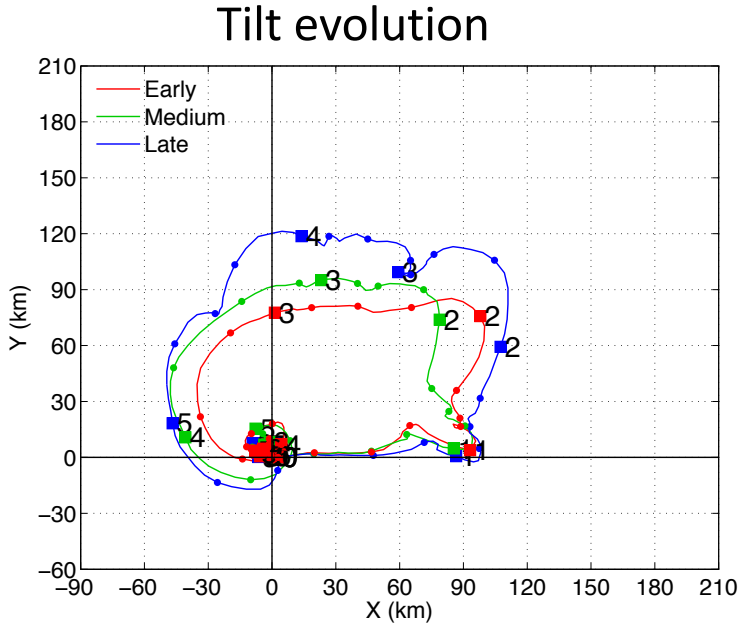
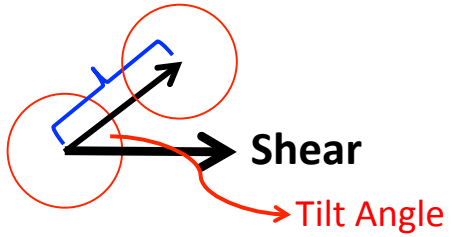
Tropical Cyclone Predictability Under 5m/s Shear





Tilt = $X_{450hPa} - X_{850hPa}$

X is the circulation center location

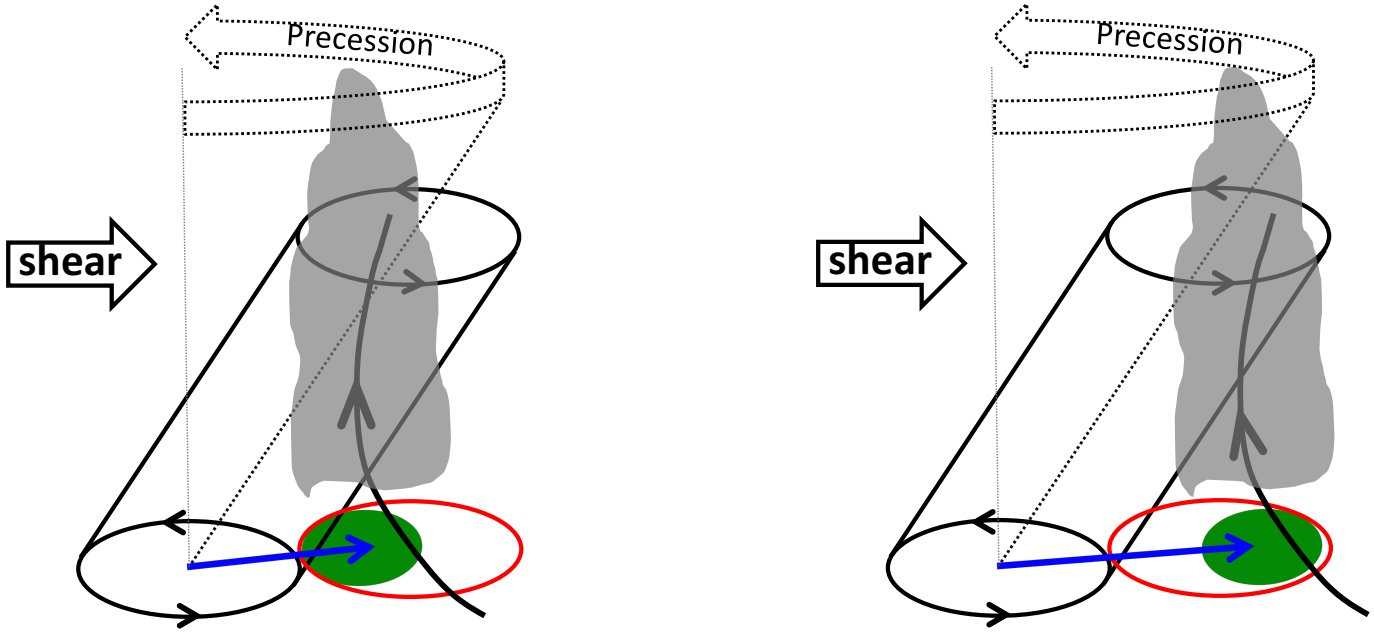


X : Simulation days

: 6 h interval

Impact of Vertical Wind Shear on TC Predictability: a schematic diagram

- Upscale error growth from differences in moist convection first alters the amplitude of the tilt of the incipient storm, which leads to significant differences in the timing of precession

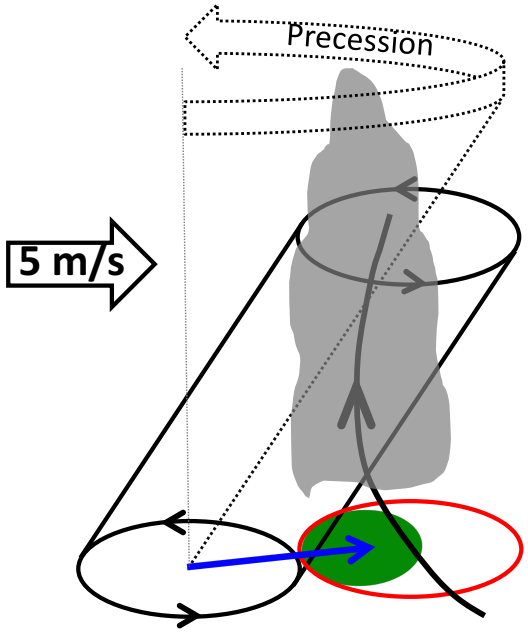


● Projection of strong convection induced midlevel positive vorticity at surface
○ Projection of midlevel vortex related positive vorticity at surface
→ Tilt Vector

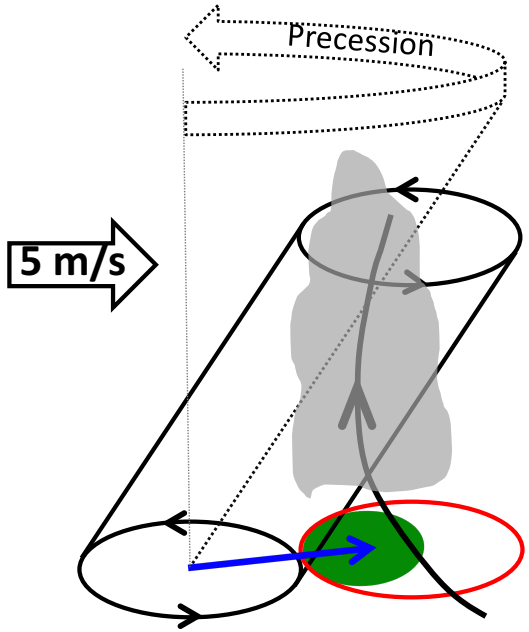
Environment Moisture Sensitivity

- Drier environment, longer RI onset time

Moist



Reduced moisture



● Projection of strong convection induced midlevel positive vorticity at surface
○ Projection of midlevel vortex related positive vorticity at surface
→ Tilt Vector

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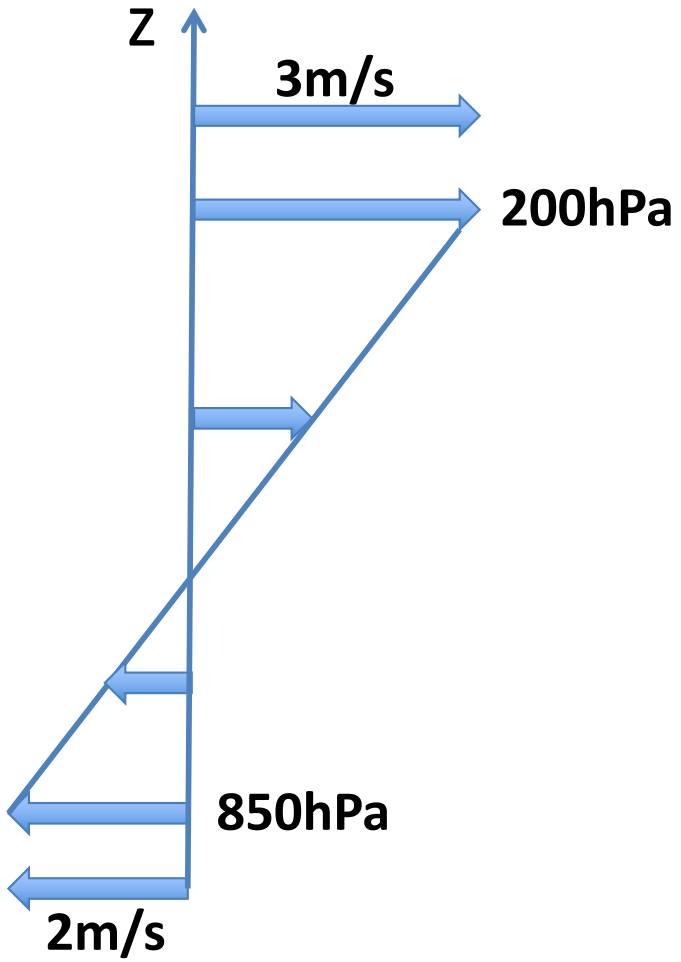
Experimental setup

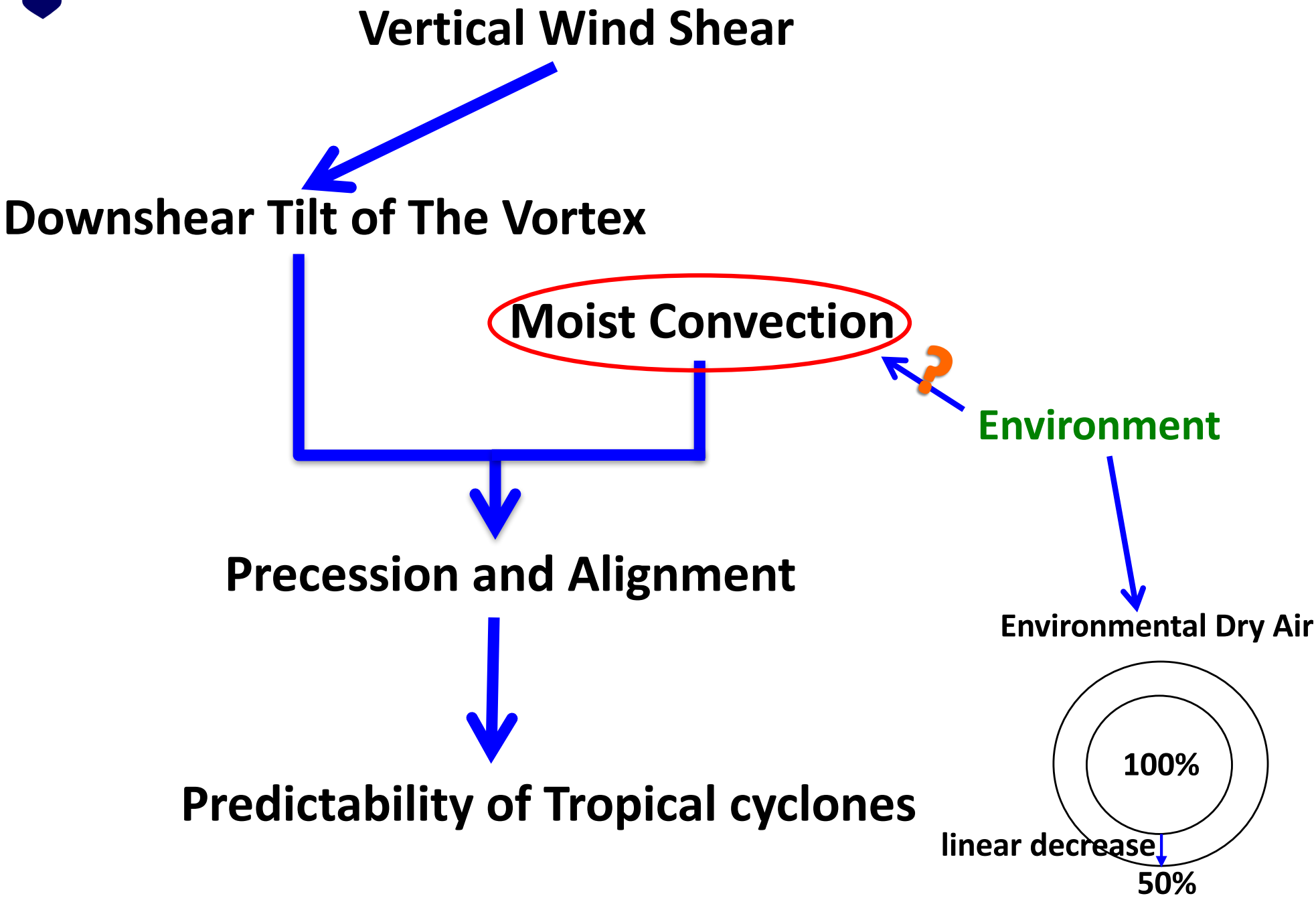
- WRF version 3.1.1
- 18km, 6km, 2km
- 240*240, 240*240, 360*360 grid points
- Doubly periodic boundary condition
- 41 vertical levels
- Physics: YSU, WSM6
- No radiation scheme



- Rankine Vortex with surface maximum
- V_{max} = 15 m/s at R_{max} = 135 km
- SST=27°C
- 200hPa-850hPa shear of 5m/s with 2m/s easterlies below 850hPa

(Point-downscaling method from Nolan 2011)

- Moisture perturbation: ± 0.5 g/kg under 950hPa -> 20 members


Vertical Wind Shear
Downshear Tilt of The Vortex
Moist Convection
?
Environment
Precession and Alignment
Environmental Dry Air
100%
linear decrease
50%
Predictability of Tropical cyclones

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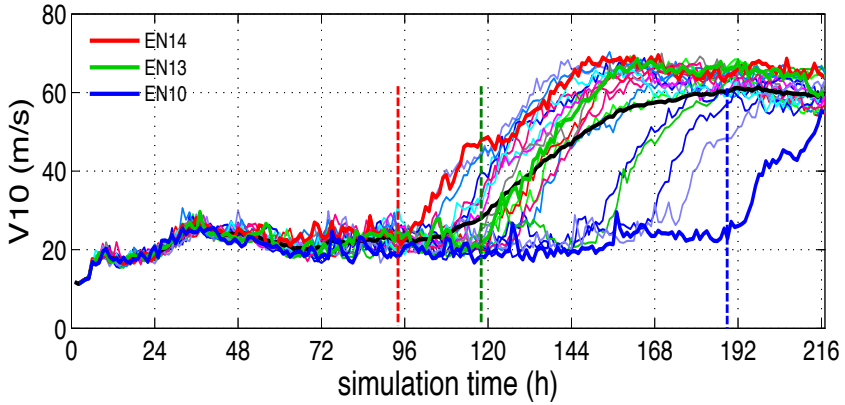
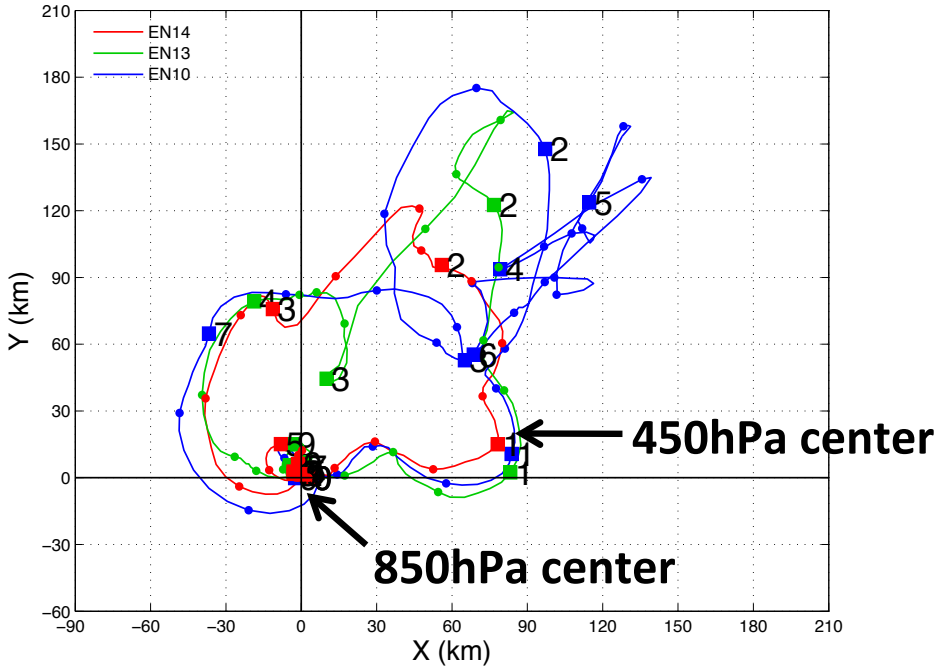
SH5_SST27_Dry50

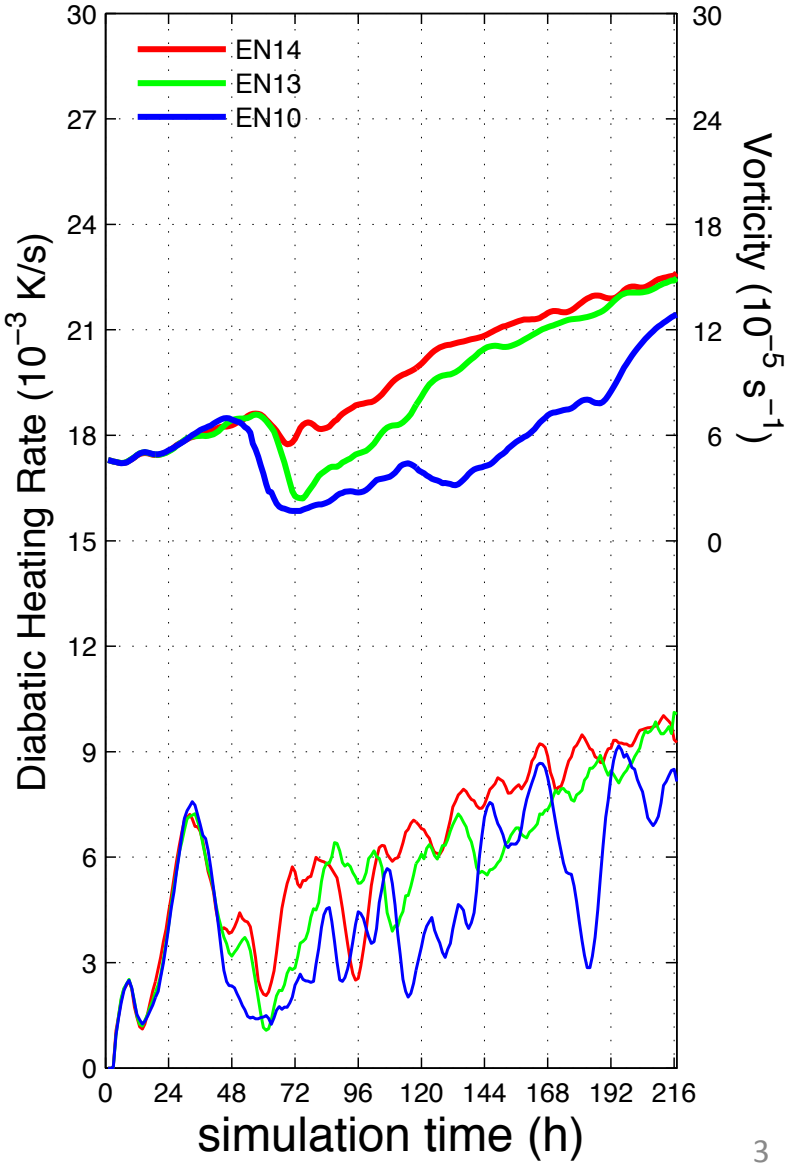
10-m Maximum Wind Speed



Tilt between 850hPa and 450hPa



450hPa Vorticity and Integrated Heating



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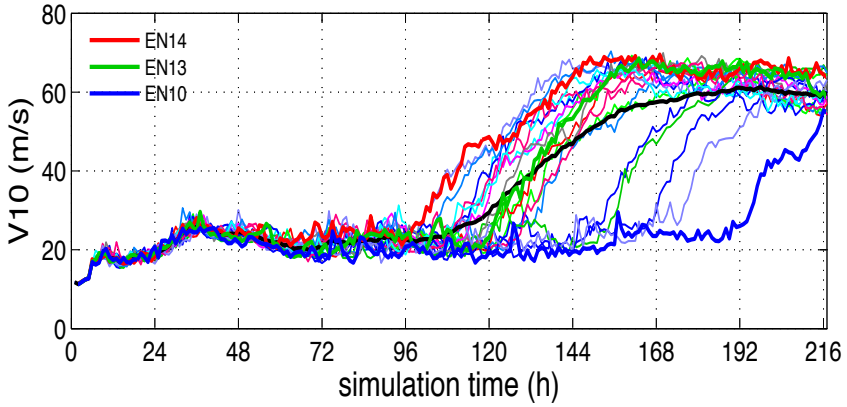
SH5_SST27_Dry50

10-m Maximum Wind Speed



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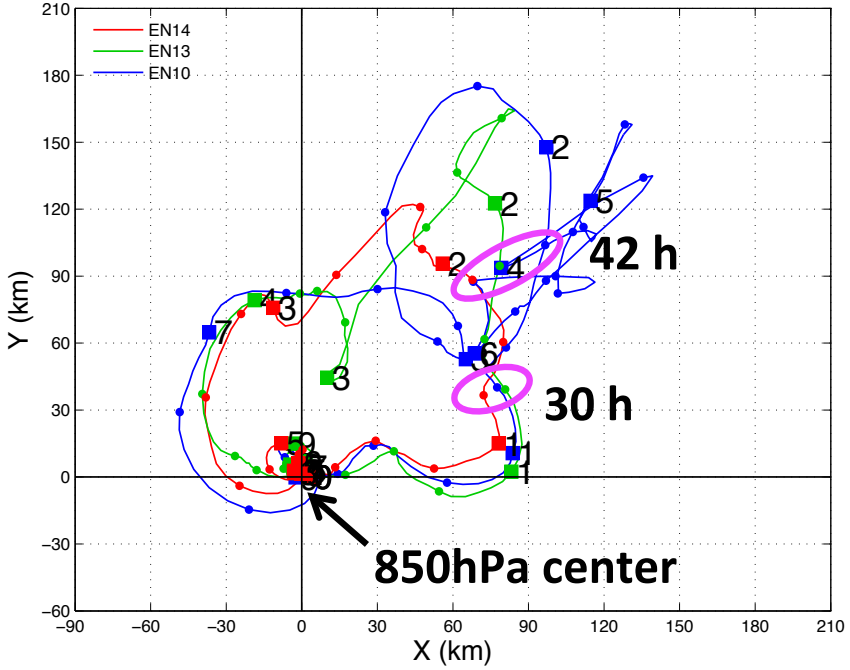
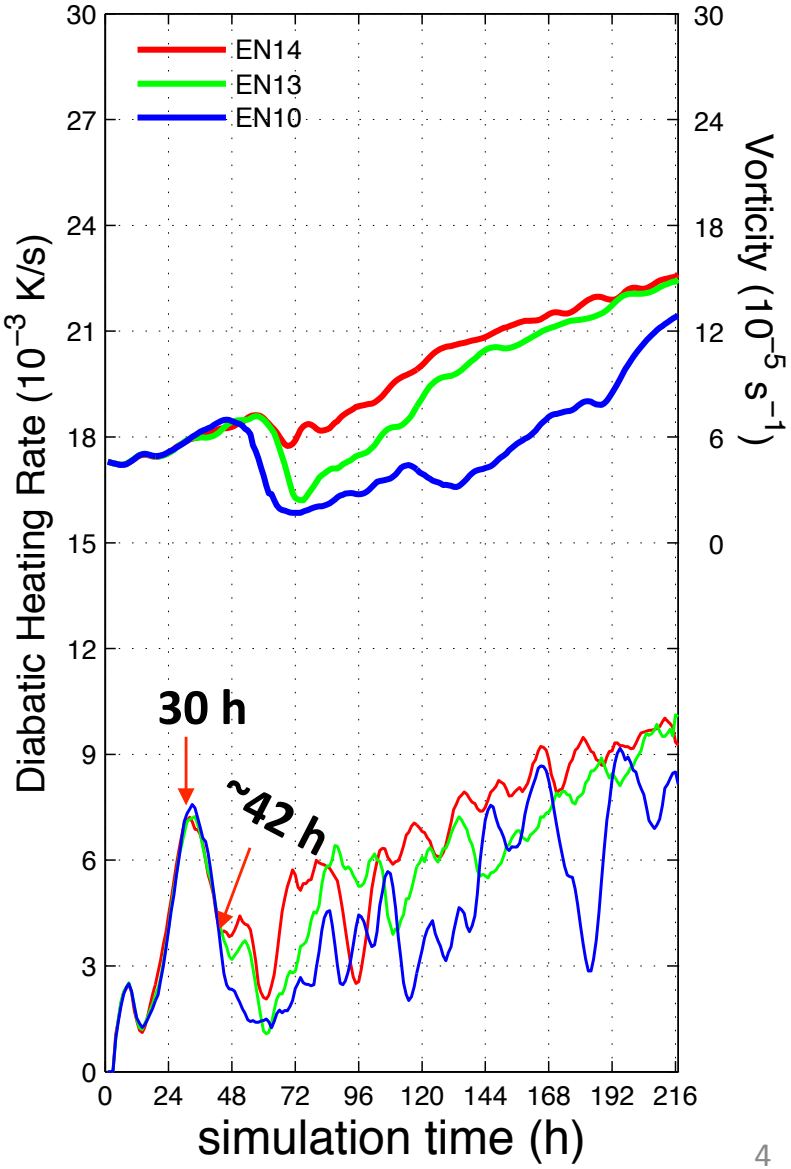


450hPa Vorticity and Integrated Heating



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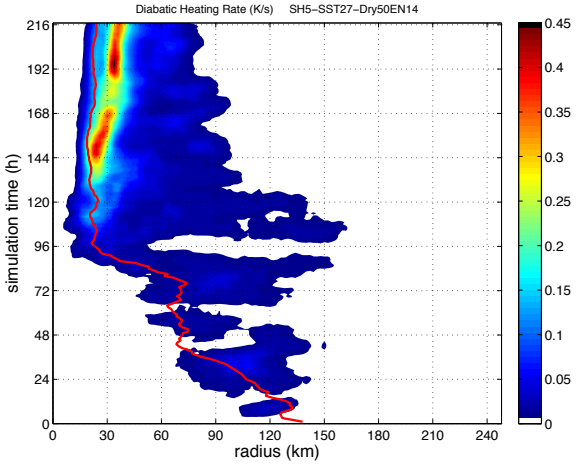
1855

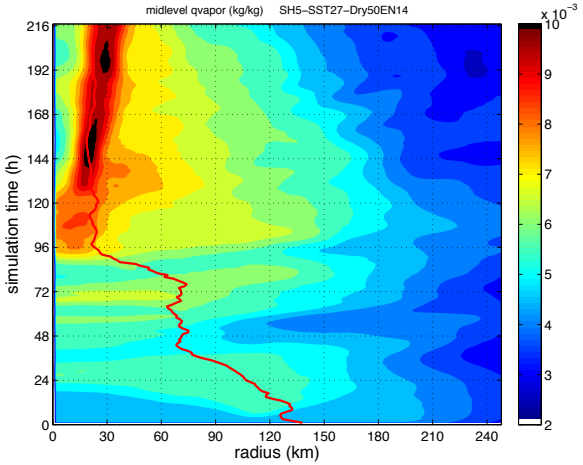
Diabatic Heating

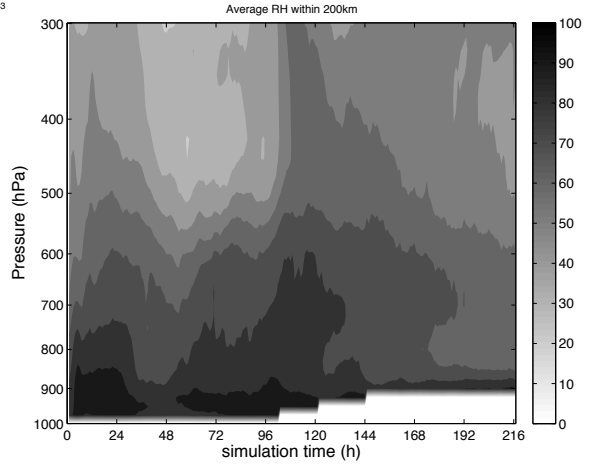
Midlevel Mixing Ratio

RH Averaged within 200km

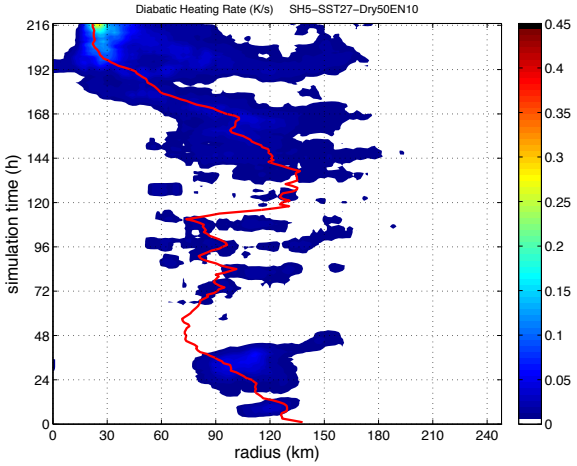
EN14

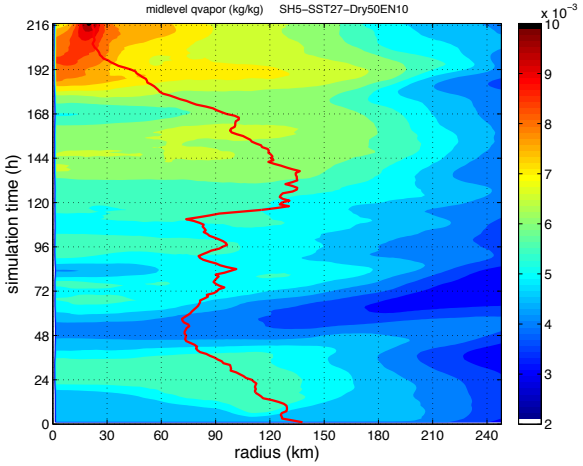


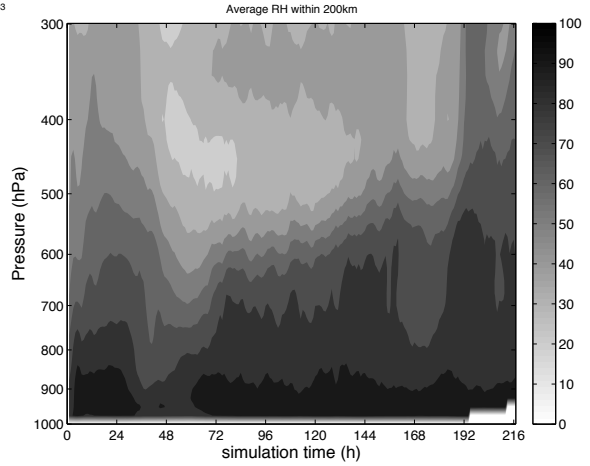




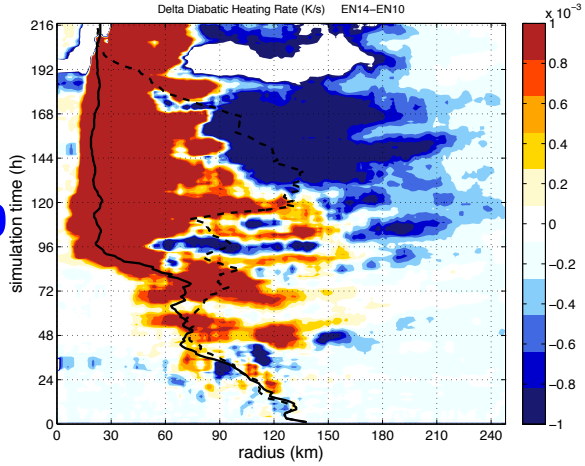
EN10

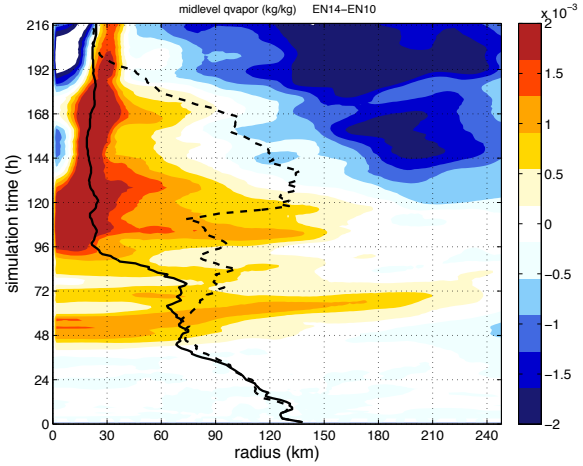


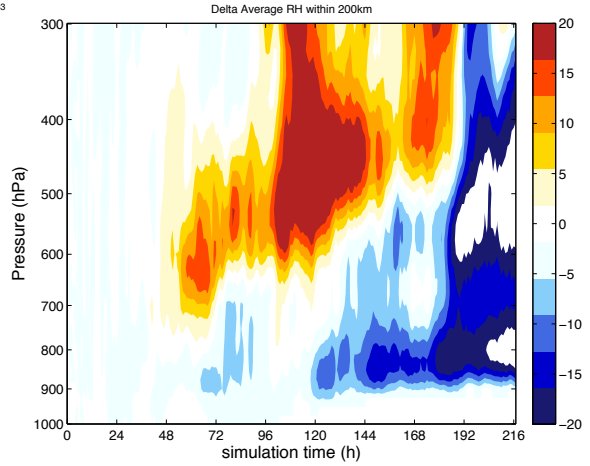




EN14 - EN10







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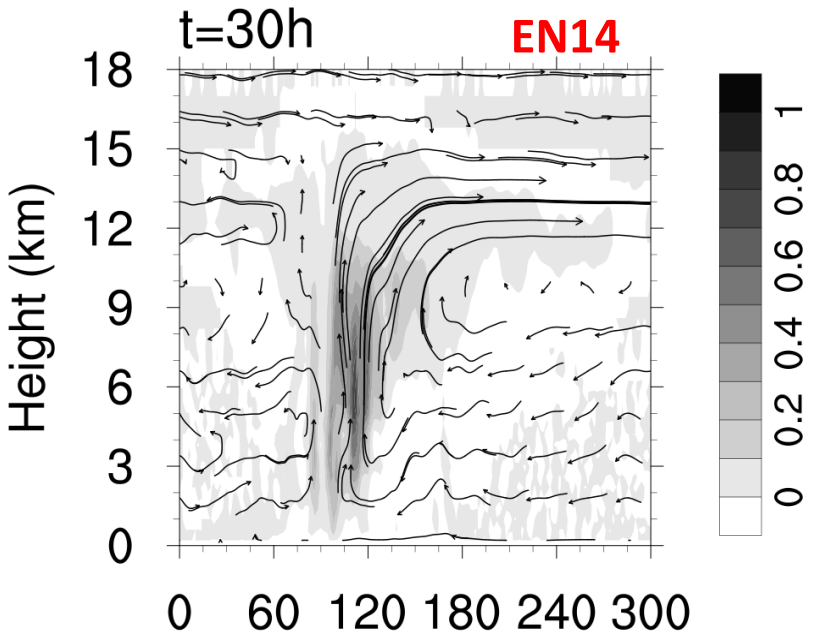
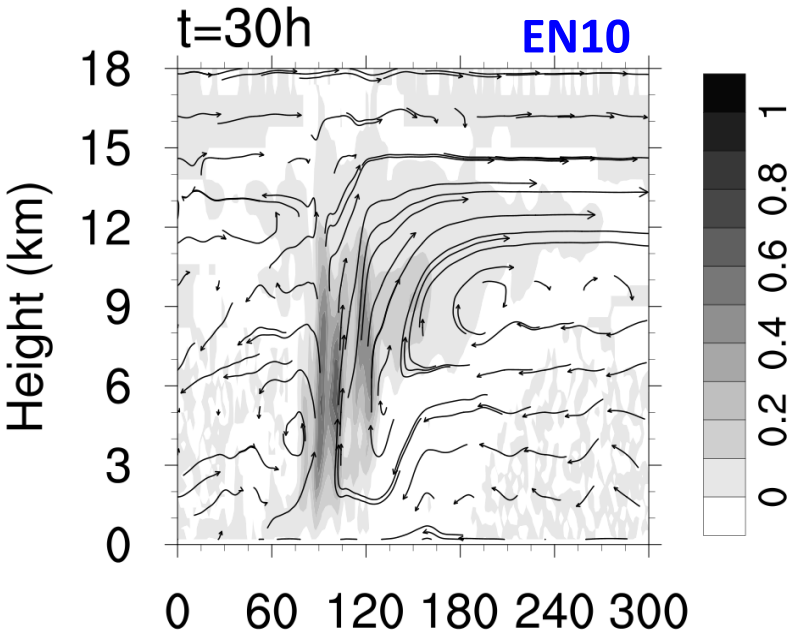
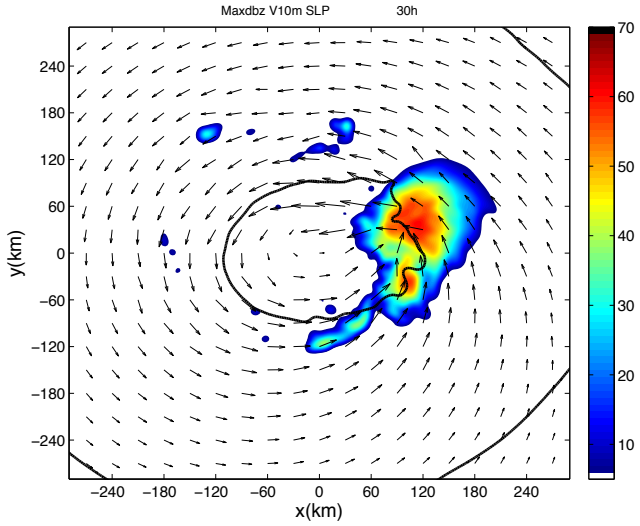
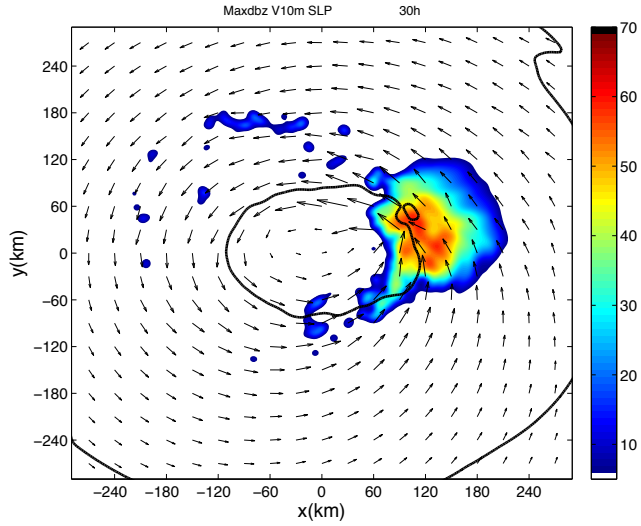
Vertical Heating and Secondary Circulation Horizontal Max dbz and Sea Level Pressure









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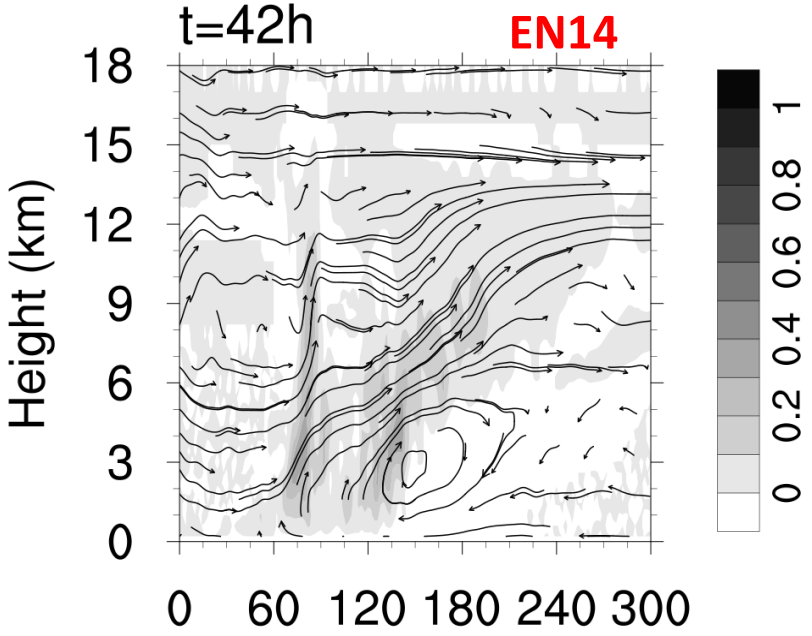

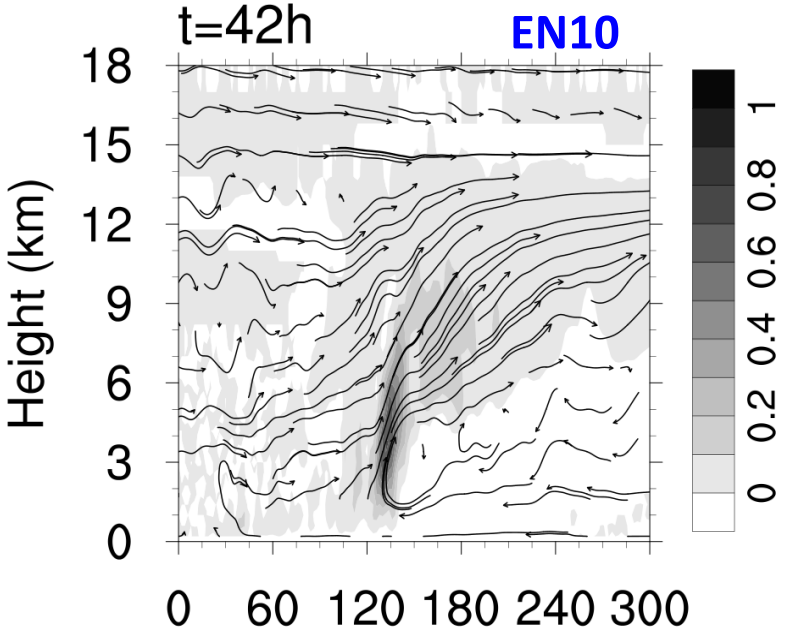

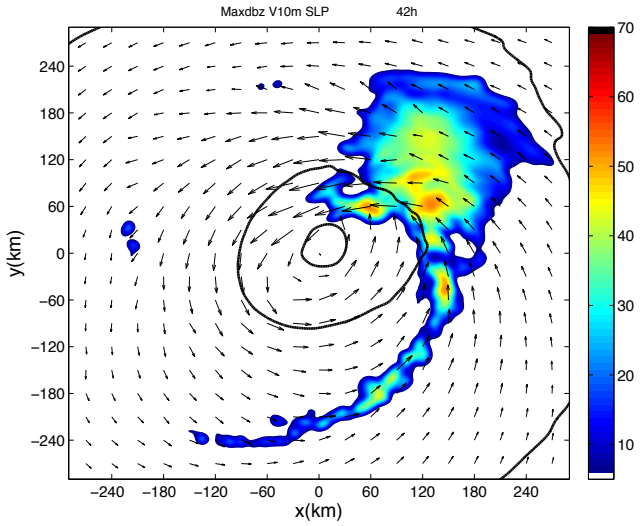

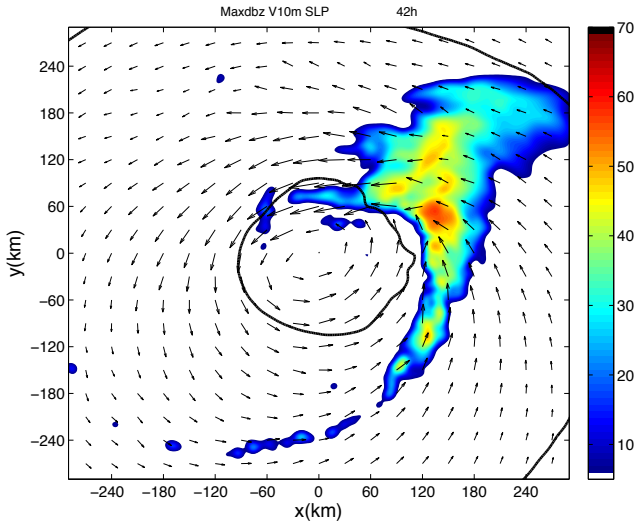

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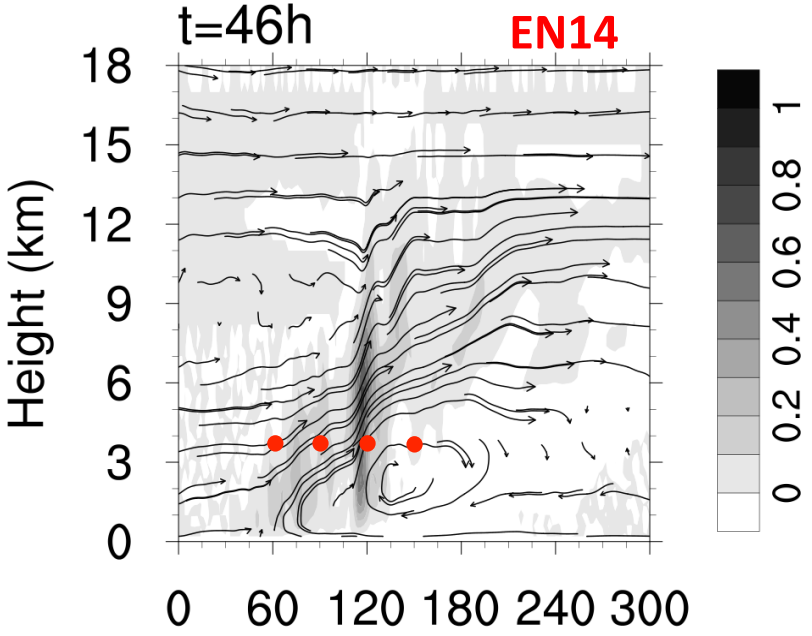
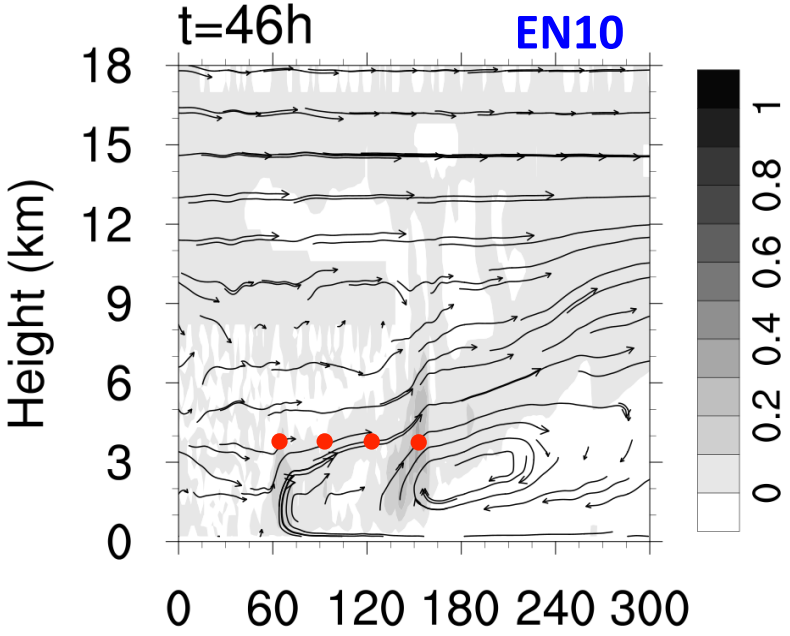
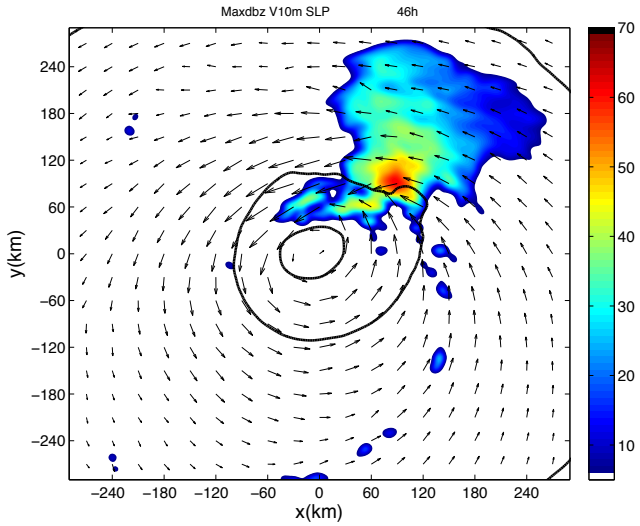
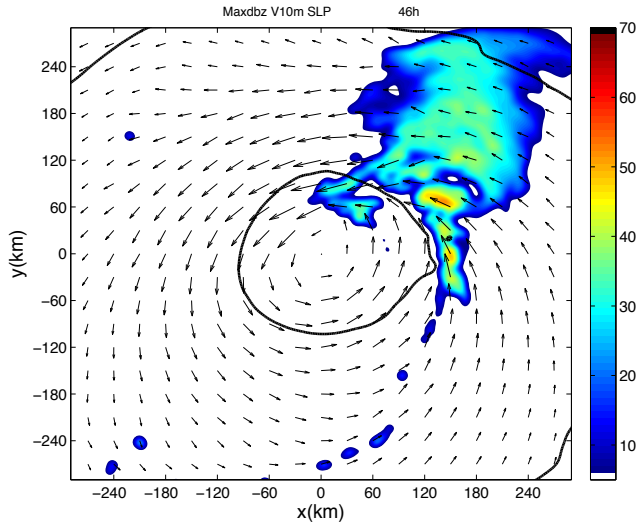
Vertical Heating and Secondary Circulation Horizontal Max dbz and Sea Level Pressure









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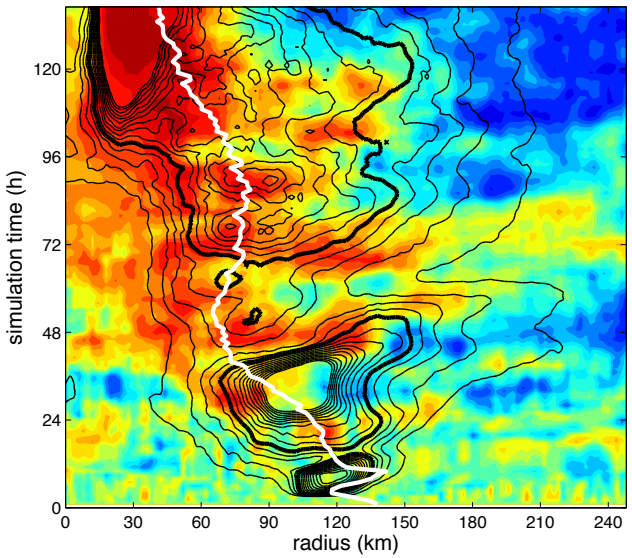
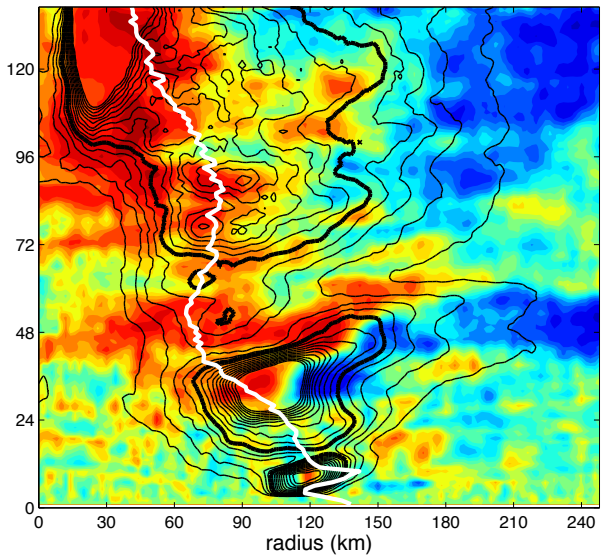
Correlation maps

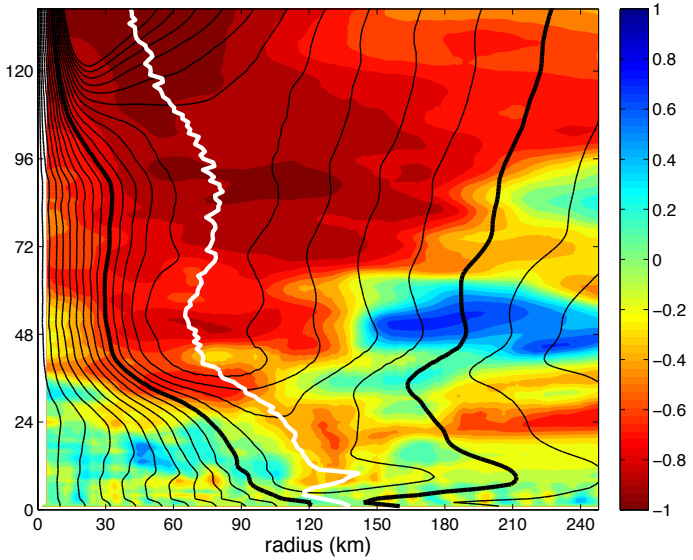
Diabatic heating
vs.
Tilt magnitude

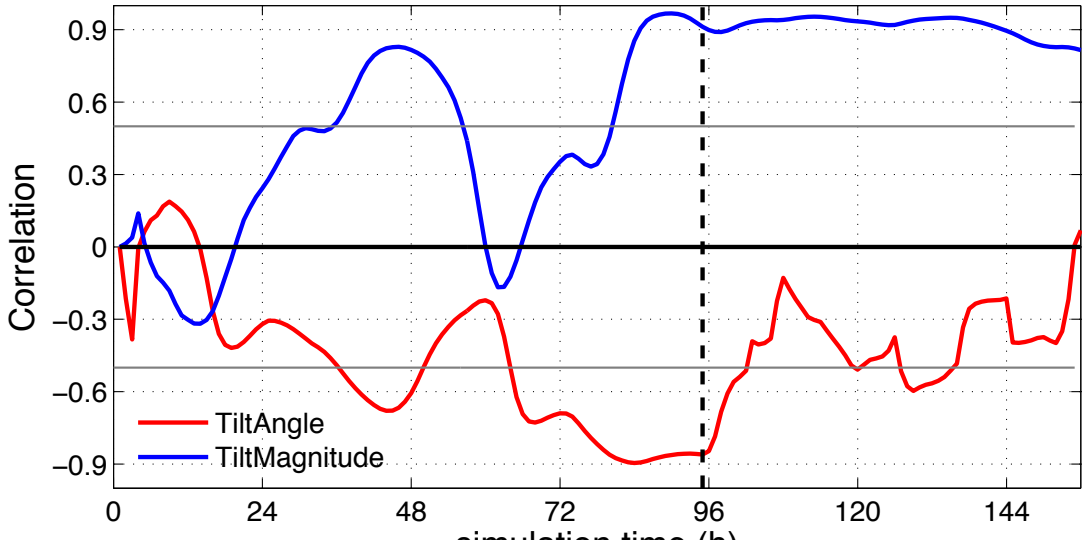


Diabatic heating
vs.
RI onset



10m Tangential Wind
vs.
RI onset





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Questions need to be answered

- What happens before 30h that causes the TC structure change afterward?

- What is the pathway of environmental dry air being taken into updraft in the late developing member?