Secondary eyewall formation in tropical cyclones by outflow-jet-interaction

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Introduction

- SEF: internal processes only?

Montgomery and Kallenbach (1997); Terwey and Montgomery (2008); Huang et al. (2012)

- What is the role of external forcing on SEF?

TC-trough interaction: Molinari and Vollaro (1989, 1990)

Numerical simulations: Nong and Emanuel (2003), Leroux et al (2013)

Model

- WRF V3.4.1

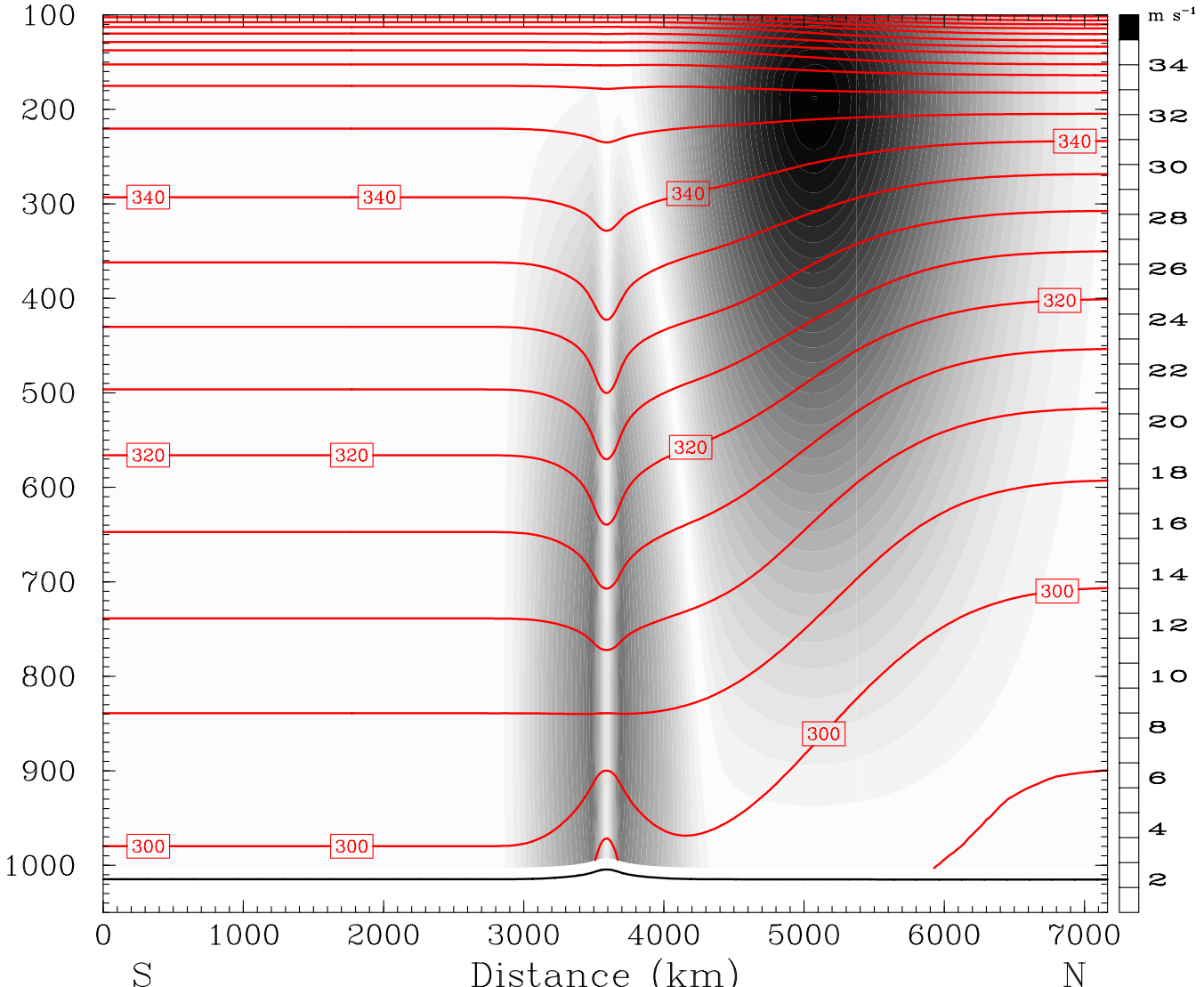
- 18km / 6km / 2km
- 600x400 / 192x192 / 384x384

- f plane

- Rankine-like vortex

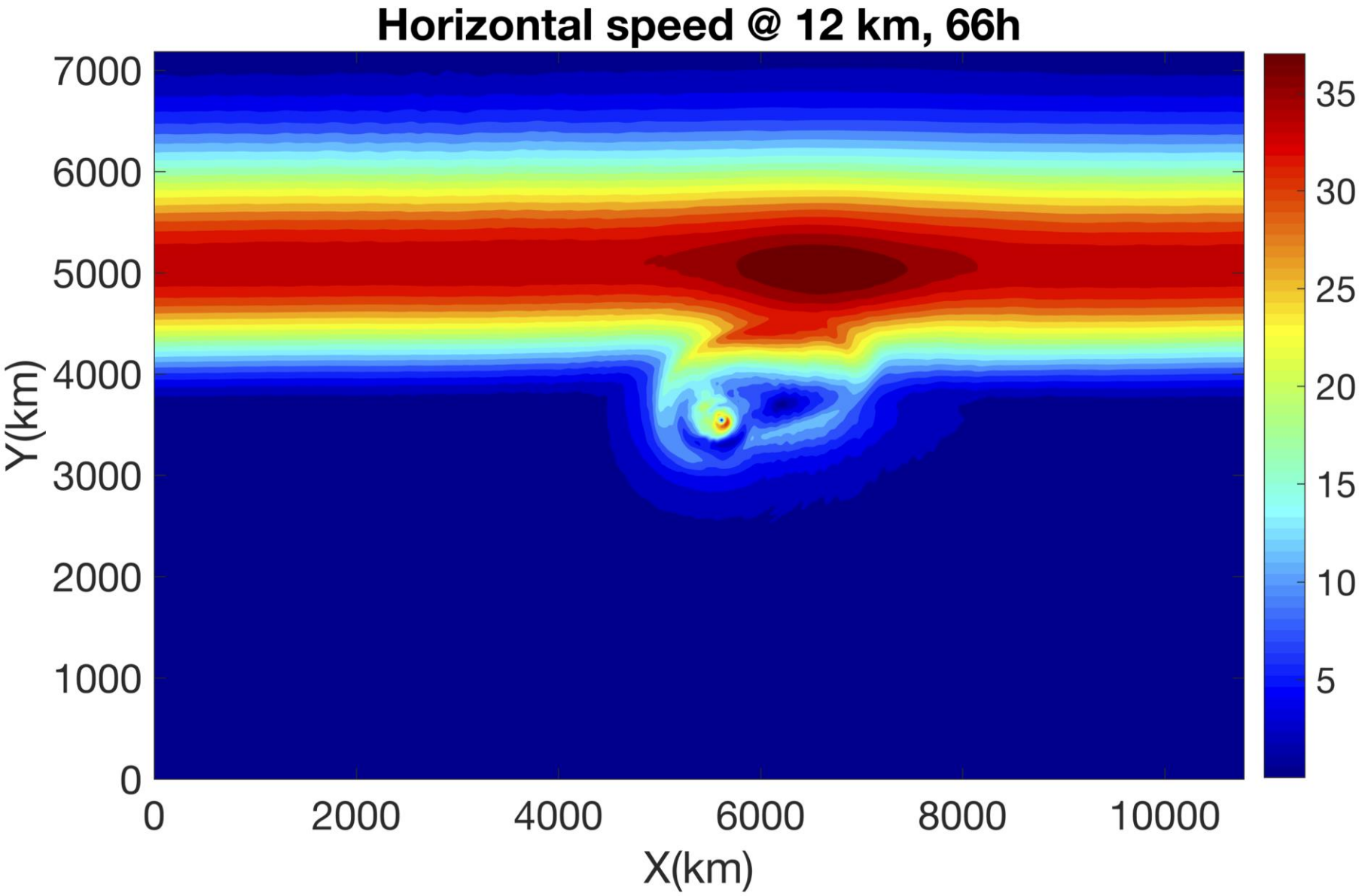
- CTL: JET=35m/s, TC center=25N

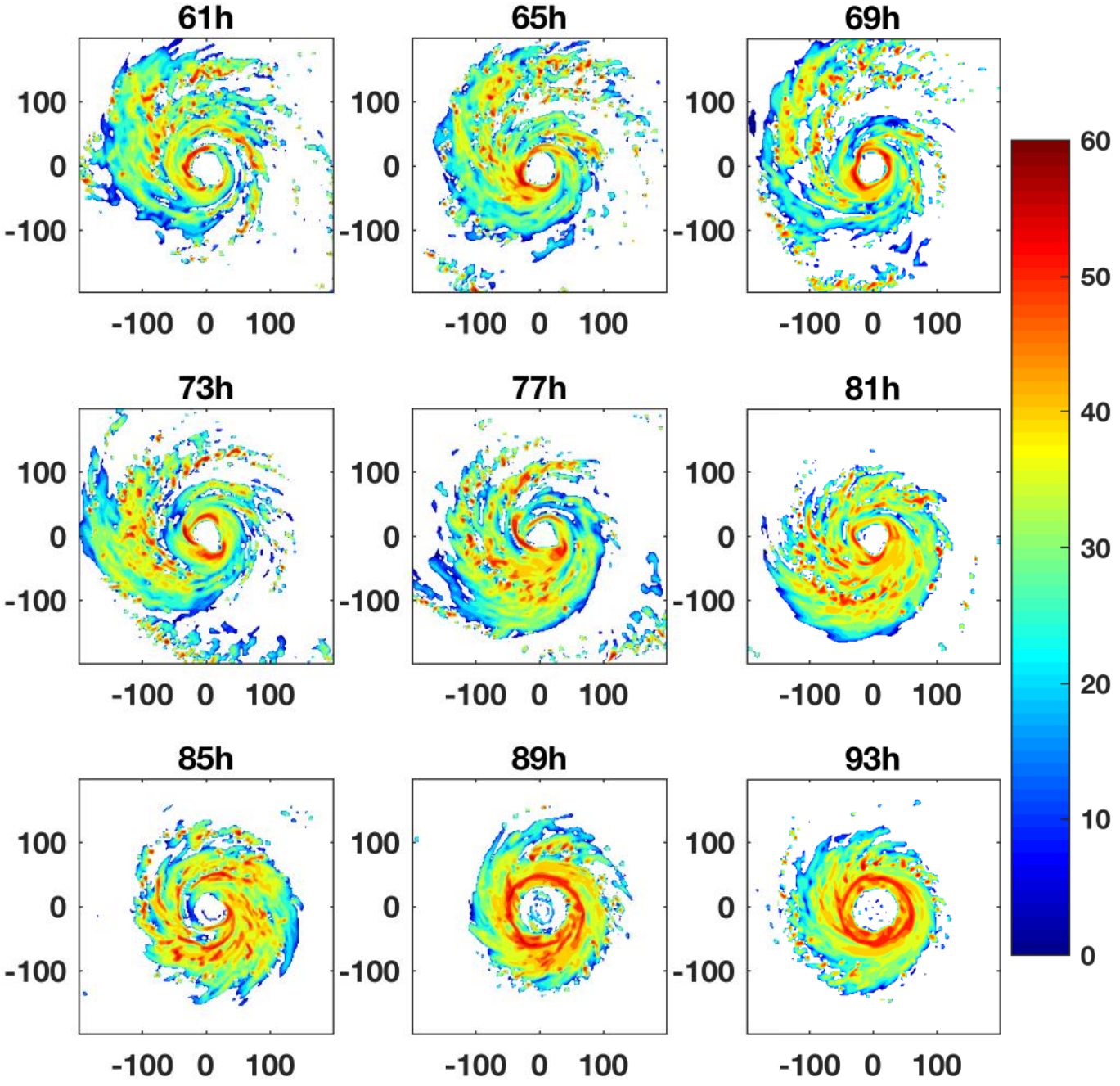
Initial condition

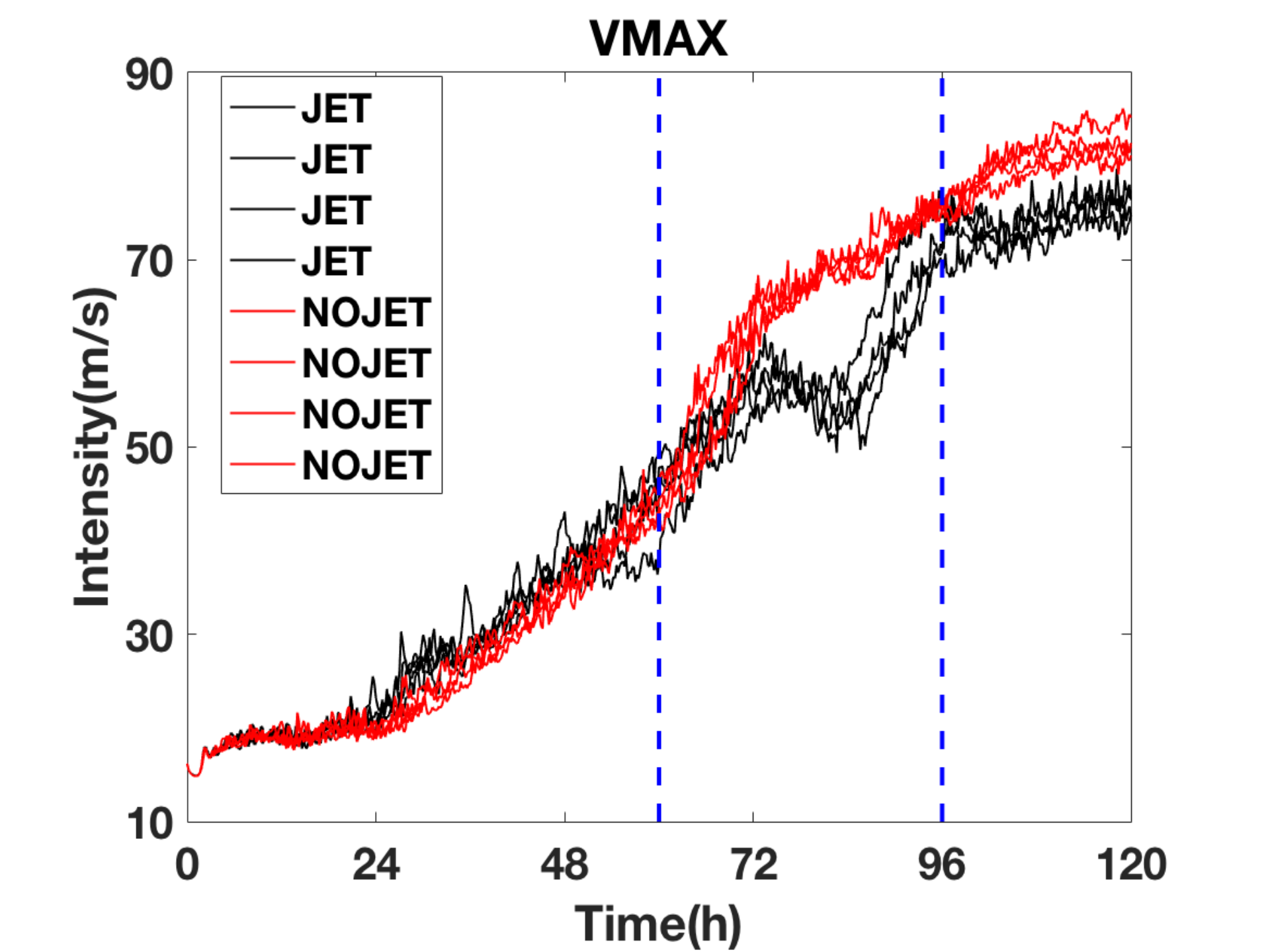


Horizontal wind speed

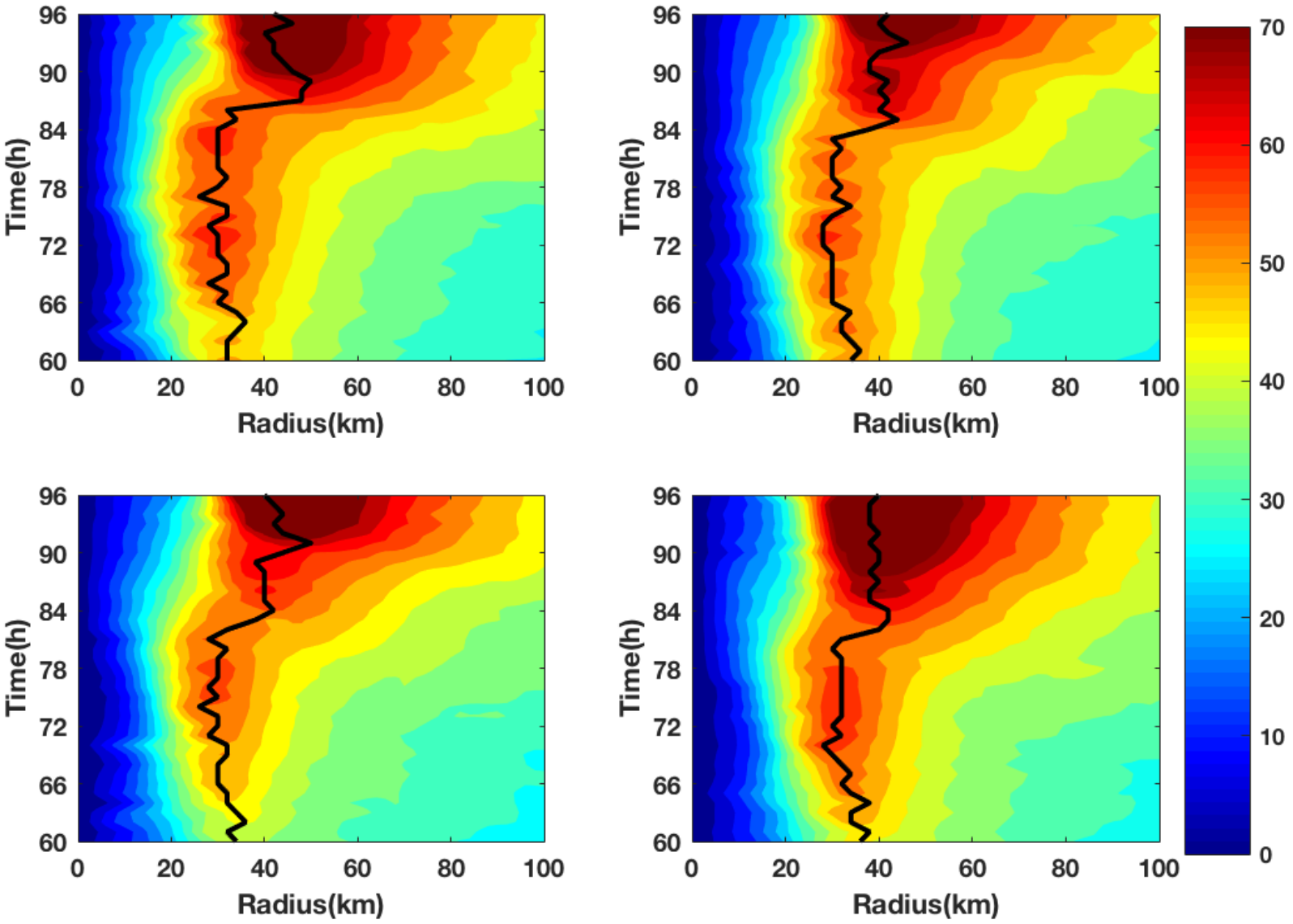
Contour: q_e


Horizontal speed @ 12 km, 66h
7000
6000
5000
4000
3000
2000
1000
0
Y(km)
0
2000
4000
6000
8000
10000
X(km)
35
30
25
20
15
10
5

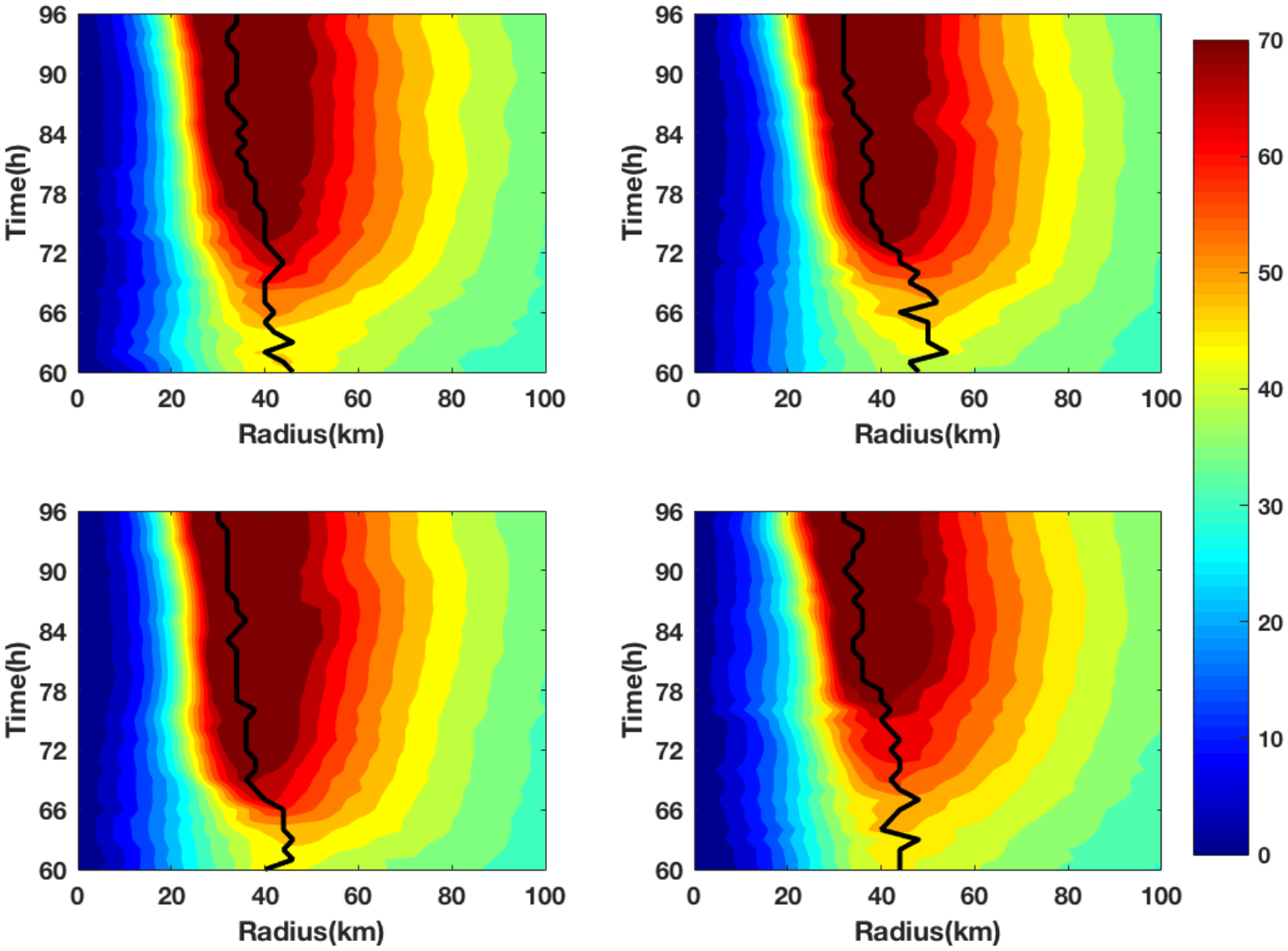

61h
65h
69h
73h
77h
81h
85h
89h
93h
100
0
-100
60
50
40
30
20
10
0


VMAX
JET
JET
JET
JET
NOJET
NOJET
NOJET
NOJET
Intensity(m/s)
90
70
50
30
10
0
24
48
72
96
120
Time(h)

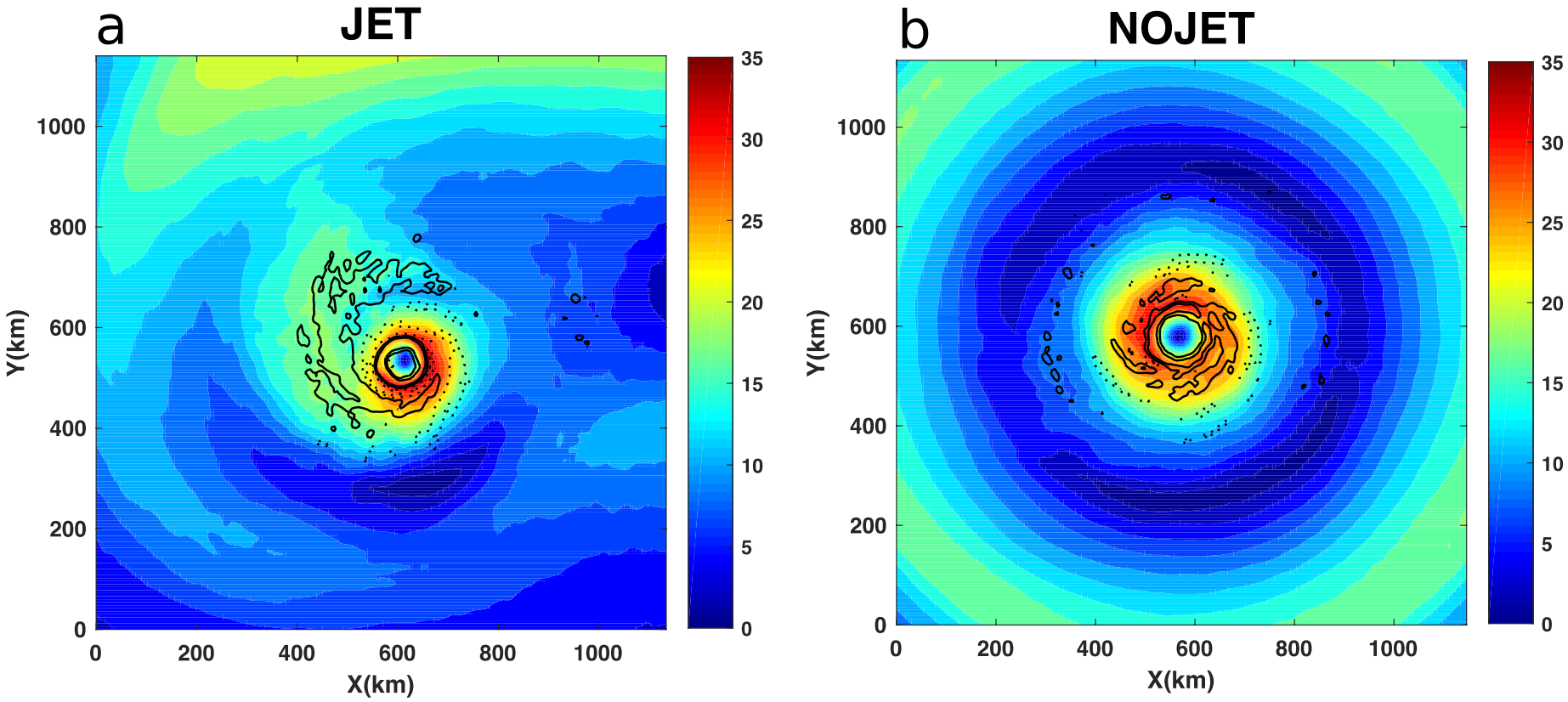
Vmax around z=2 km for JET



Vmax around z=2 km for NOJET



Horizontal Speed and Divergence for domain2 @ z=12 km

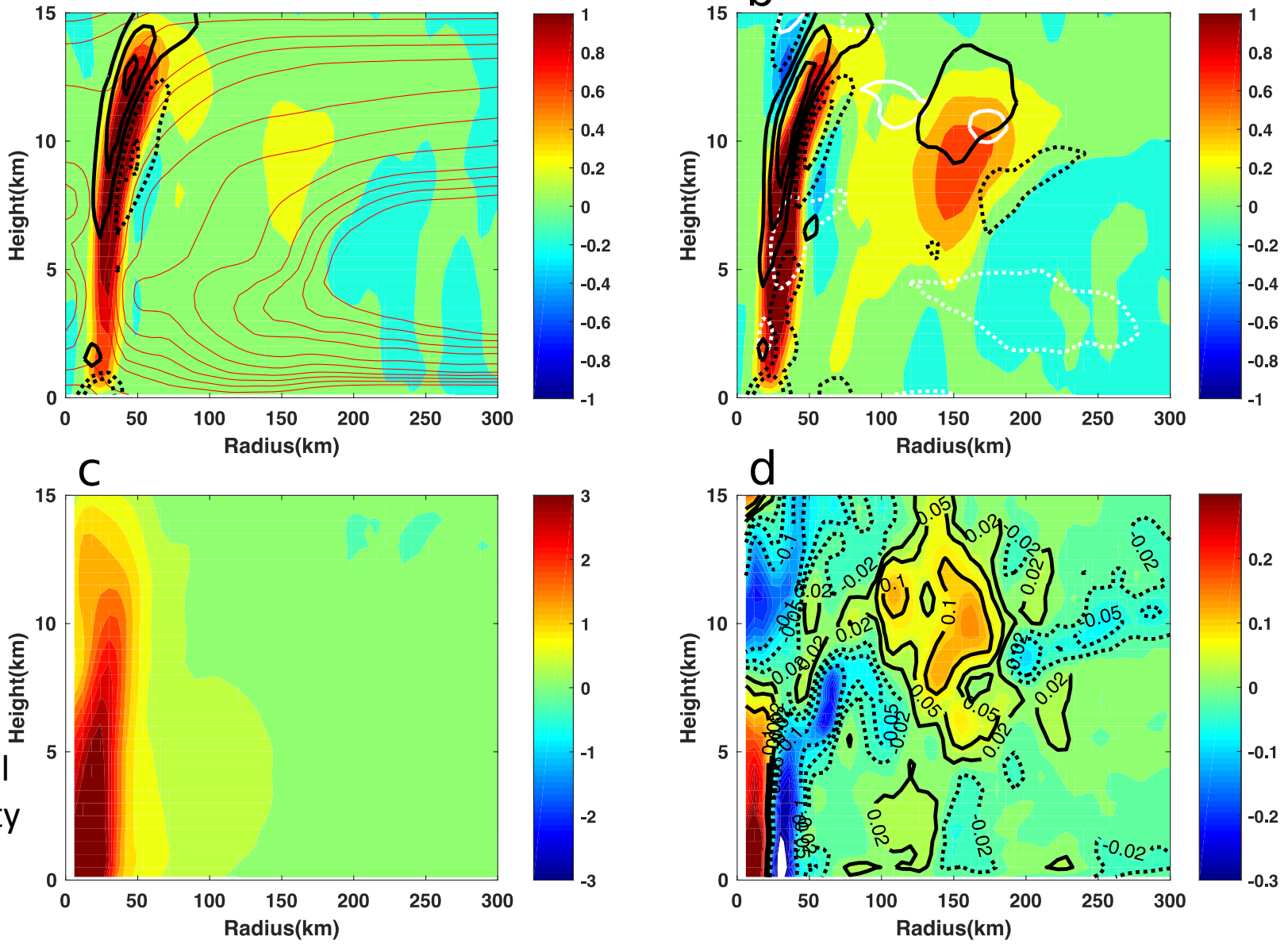


Azimuthal mean

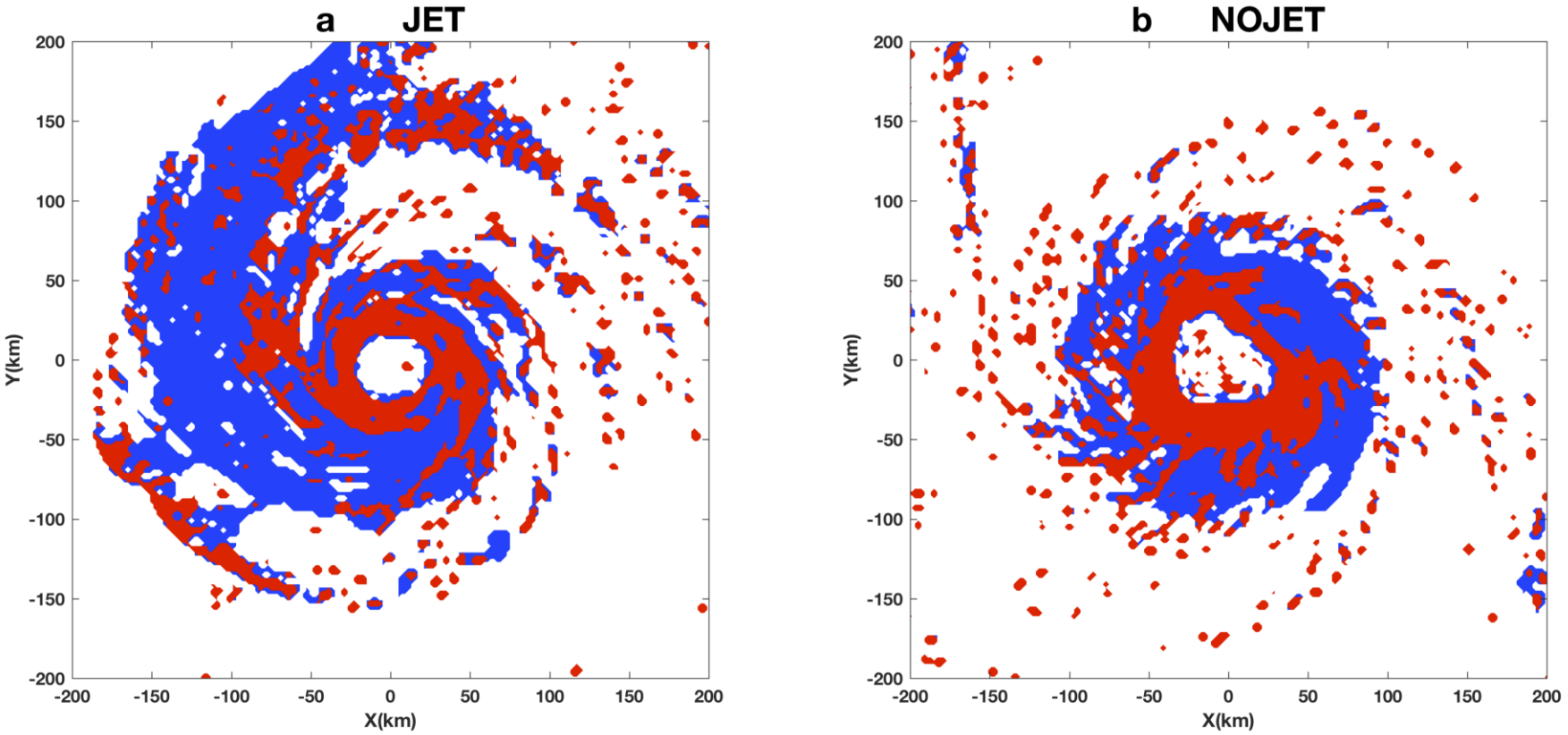
NW-quadrant mean

W
DIV
ThetaE

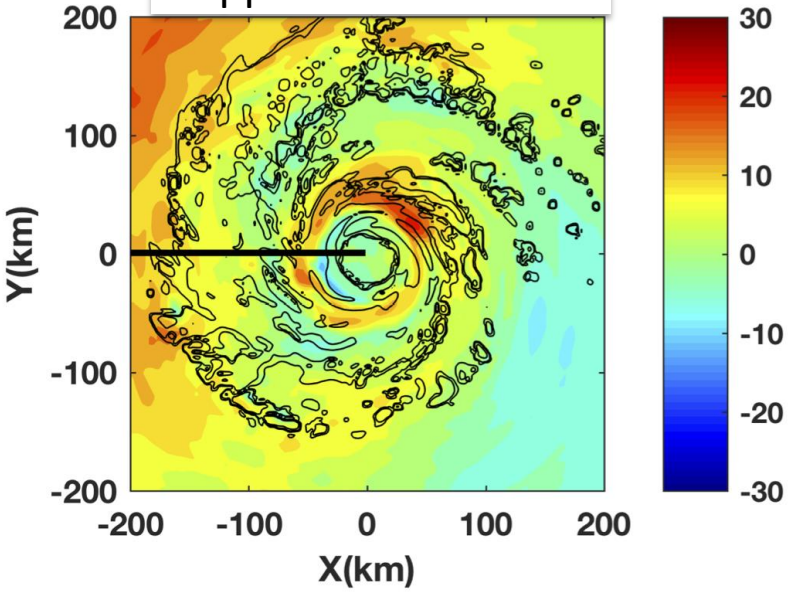
Inertial stability



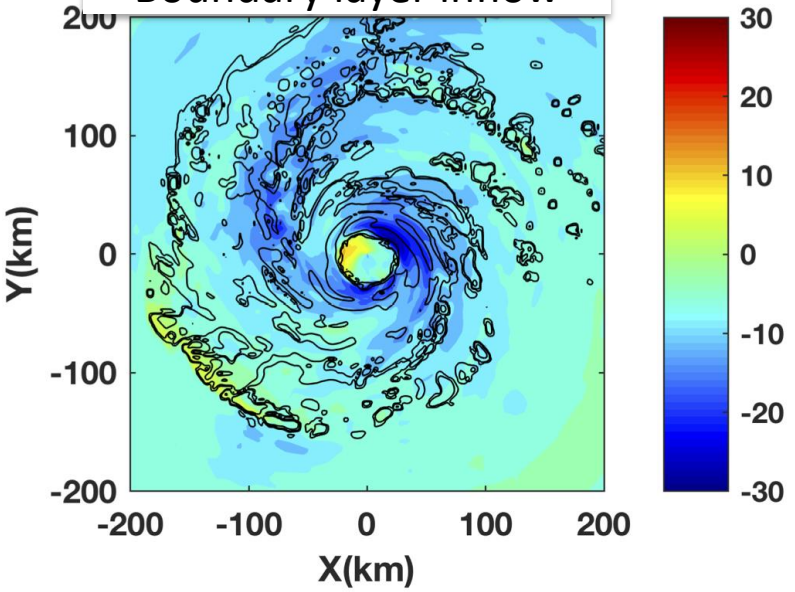
Convective-stratiform algorithm by Braun et al (2010)



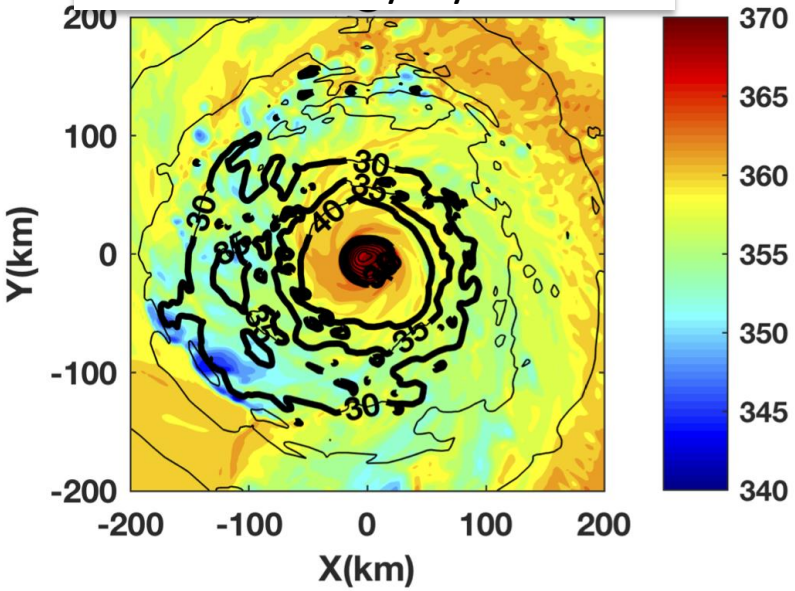
Upper level outflow



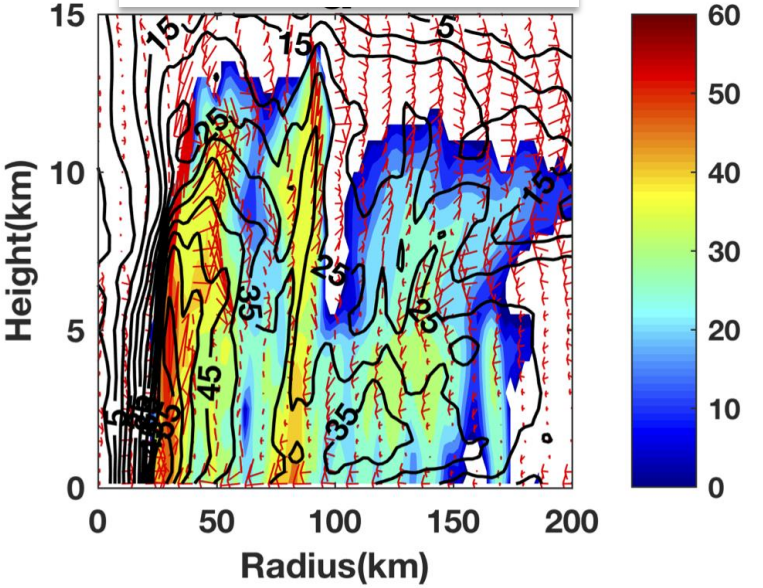
Boundary layer inflow

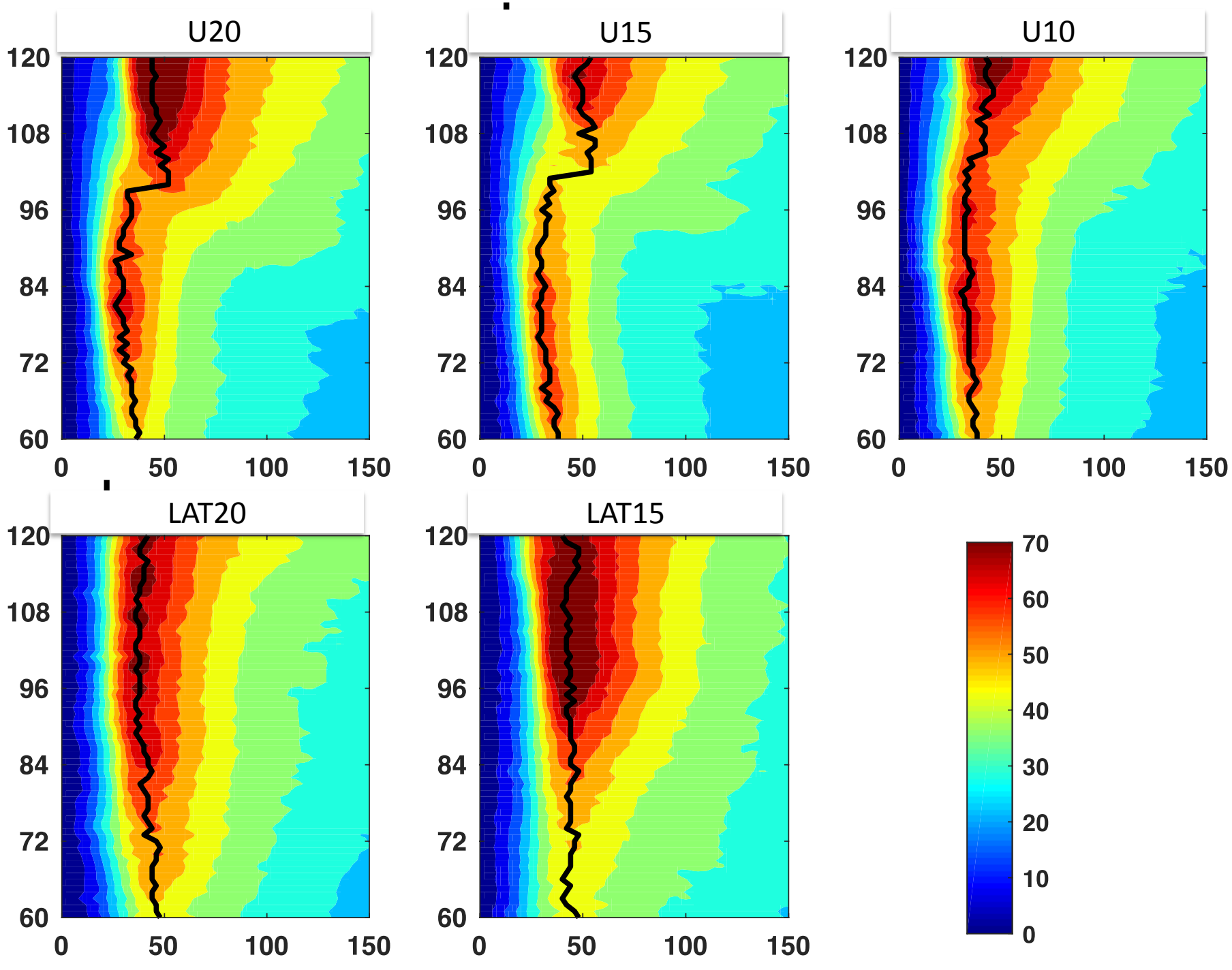


V and boundary layer ThetaE



Vertical cross section




U20
U15
U10
LAT20
LAT15
120
108
96
84
72
60
0
50
100
150
70
60
50
40
30
20
10
0

Conclusions

- Secondary eyewall formation (SEF) can be triggered by the presence of a westerly jet.
- The asymmetric stratiform cloud is the key feature to promote deep convection, thus secondary eyewall.
- Sensitivity experiments show that SEF is more sensitive to jet-TC distance than the strength of the jet

Future work

- Is it evident in observation and reanalysis data?

- Simulate real-case TC, such as Hurricane Edouard (2014) and Gonzalo (2014)