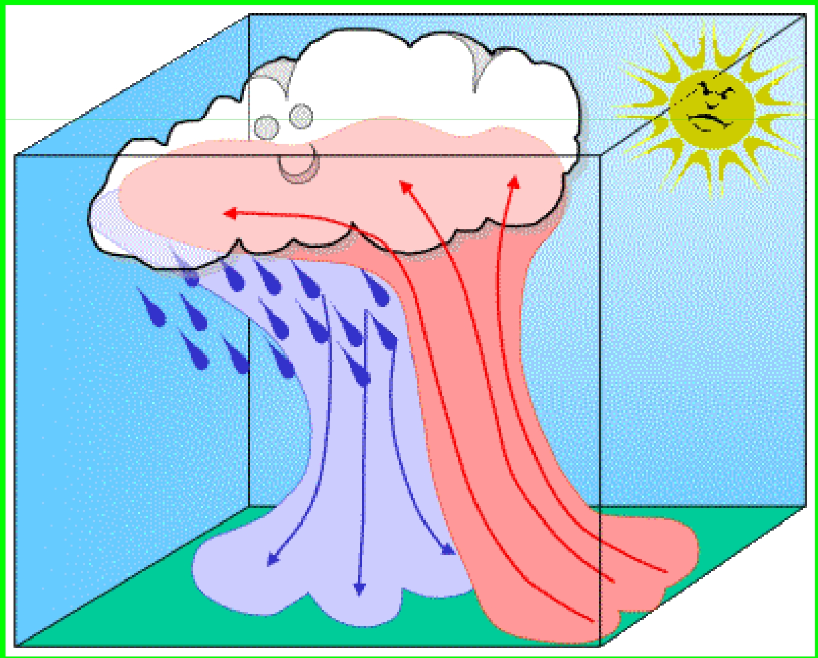
International Workshop on Non-Hydrostatic Numerical Models



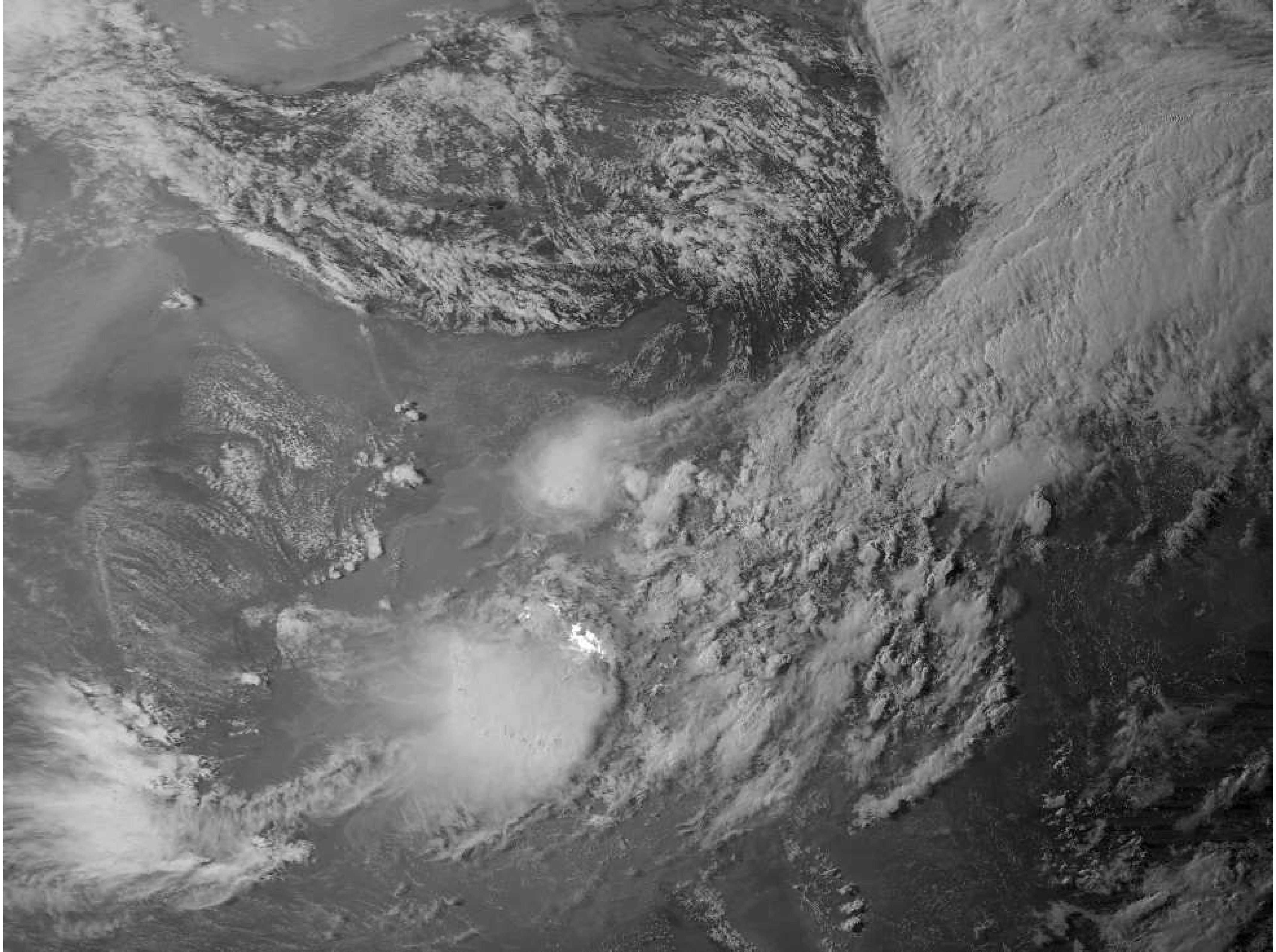
17-19, November, 2010
Sendai, Japan

Organized by
MSJ Research Subcommittee on NHM

More information will be available in January, 2010.

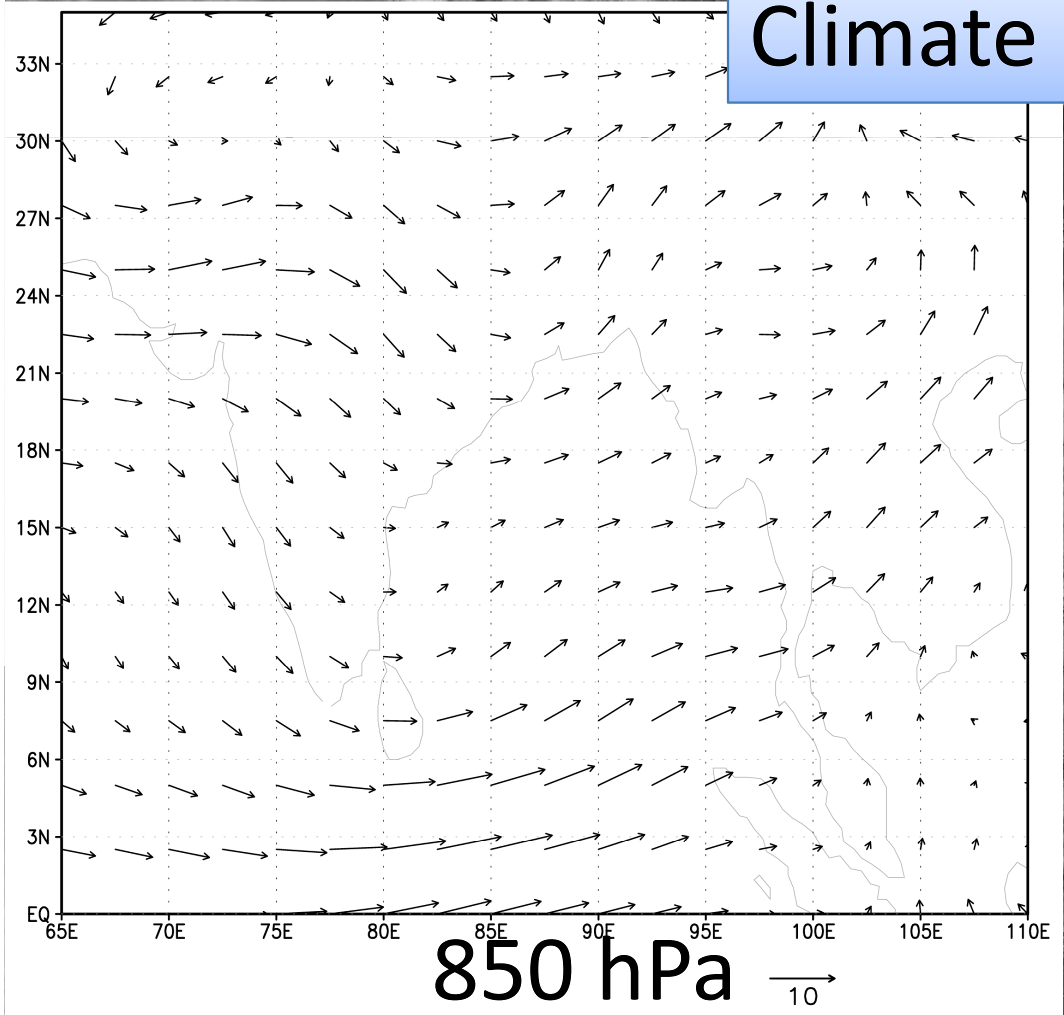
Hosted by **Tohoku University**
Contact: nhm-ws@wind.geophys.tohoku.ac.jp

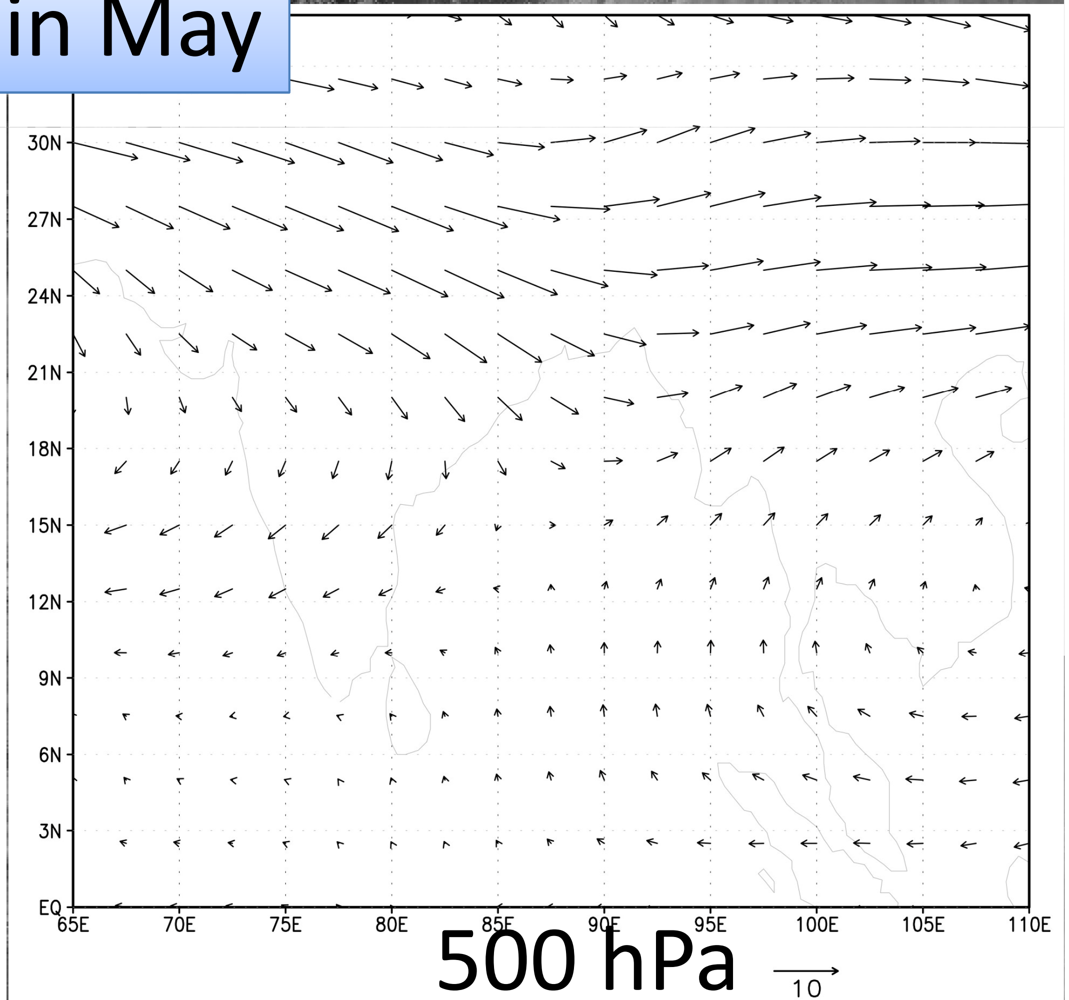
Papers for this workshop will be solicited on all aspects related to non-hydrostatic numerical models（NHM), such as dynamical cores, physics parameterizations, observational systems, data assimilation, predictability, severe weather simulations and applications. This also emphasizes case studies of heavy precipitations, tropical cyclones and other sever events.



Background

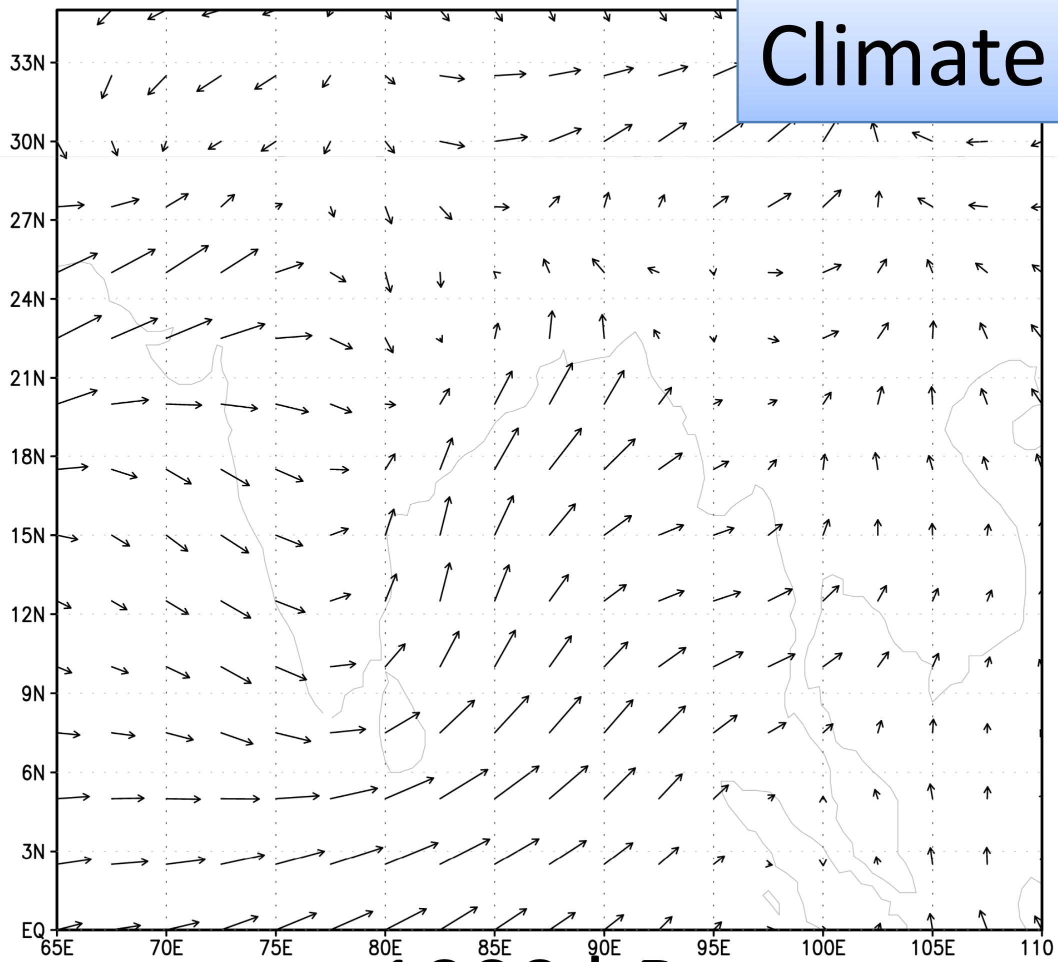
Climate in May



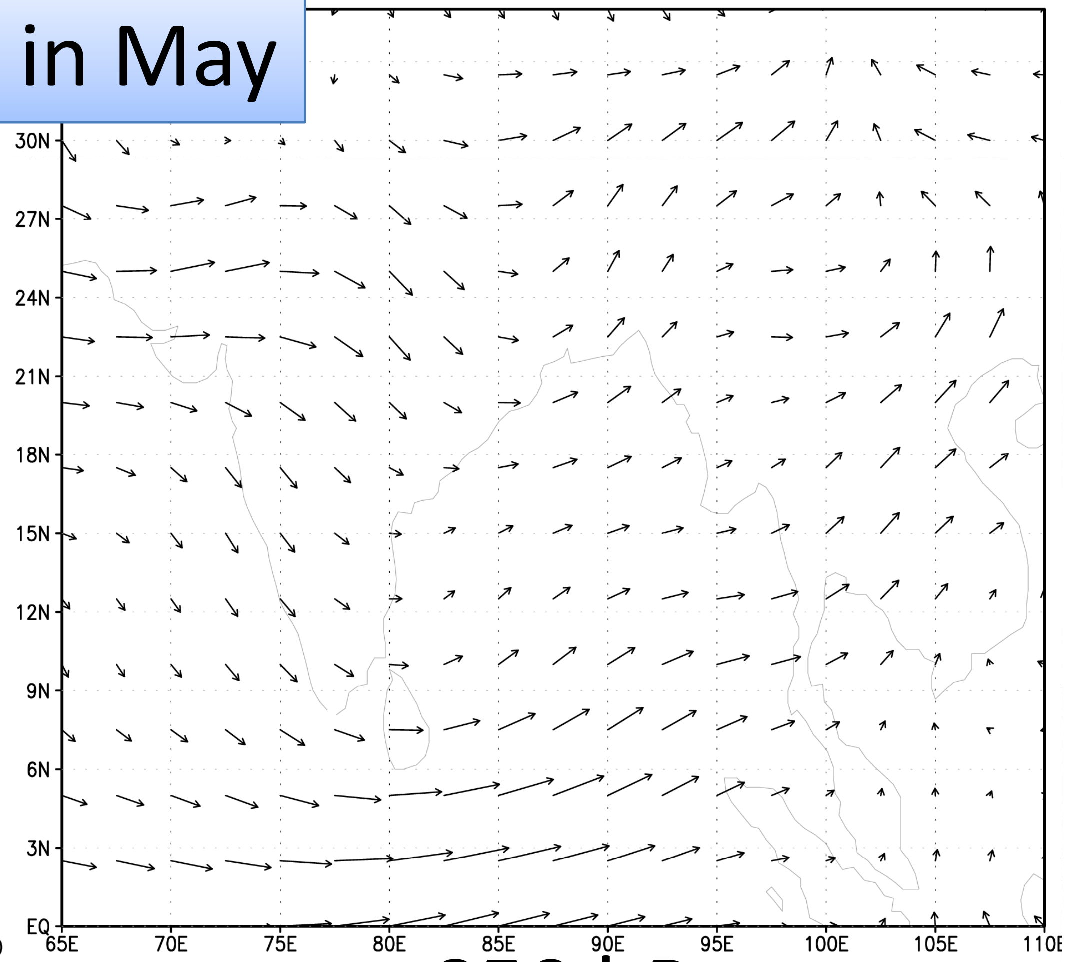


Background

Climate in May



1000 hPa
9

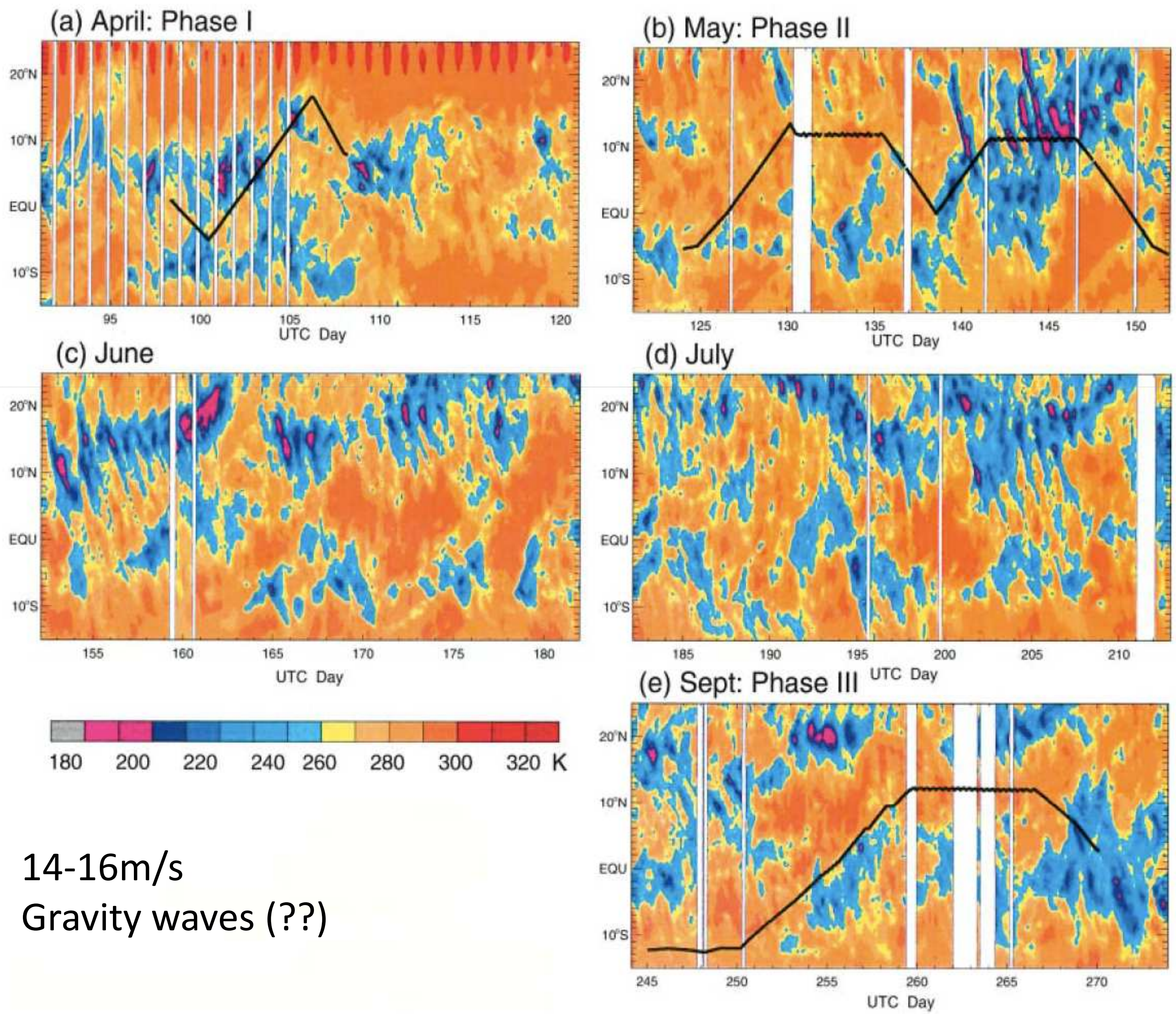


850 hPa
10

Background

- In the summer monsoon season, SW or SSW wind prevails over Bengali and BoB.
- It is known that there are roughly southward moving mesoscale precipitation systems. These systems also show significant diurnal variation.

Webster et al. (2002); Zuidema (2003); Kataoka & Satomura (2005); Miyakawa & Satomura (2006); Liu et al. (2008)



14-16m/s
Gravity waves (??)

FIG. 4. Time–latitude sections of brightness temperature (see color-coded scale) from the European Space Agency *METEOSAT-5* geostationary satellite (a) Apr, (b) May, (c) Jun, (d) Jul, and (e) Sep of 1999. All sections are averaged between 85° and 90°E. Ship tracks for phases I, II, and III are shown in (a), (b), and (e), respectively. Aug 1999 has been omitted because of poor data quality. Cold temperatures are indicative of high cloud tops while relatively clear periods appear as warm temperatures representing infrared radiation emitted at the surface, the moist boundary layer, or from low-tropospheric clouds.

Webster et al. (2002)

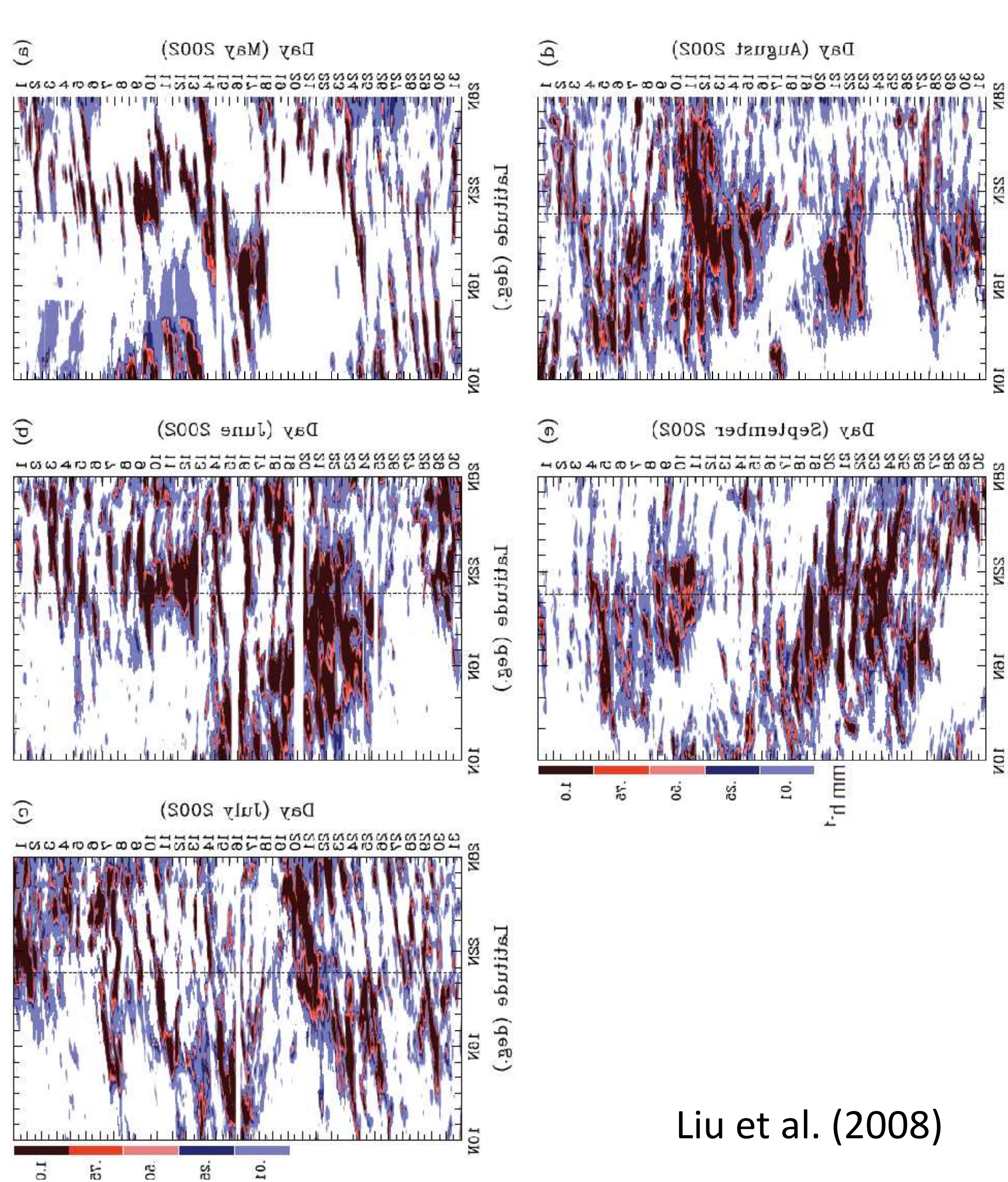
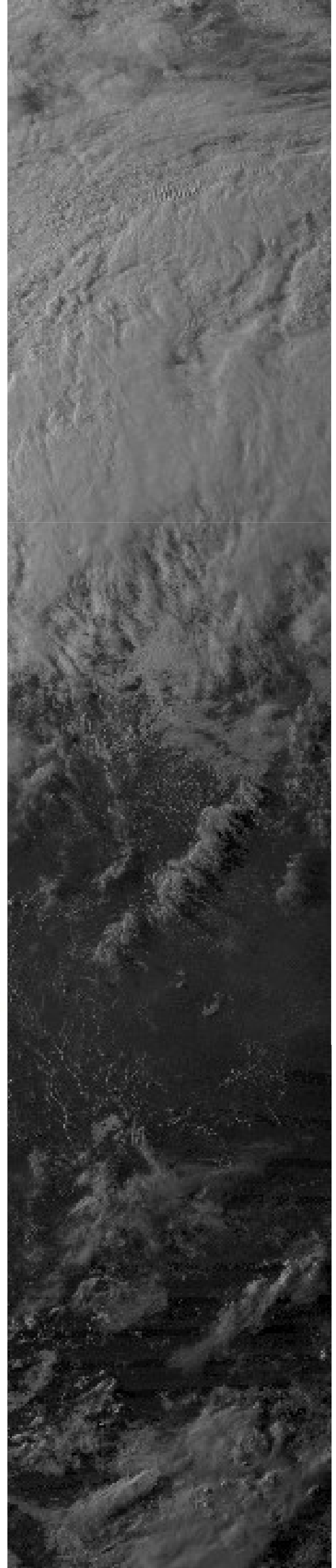
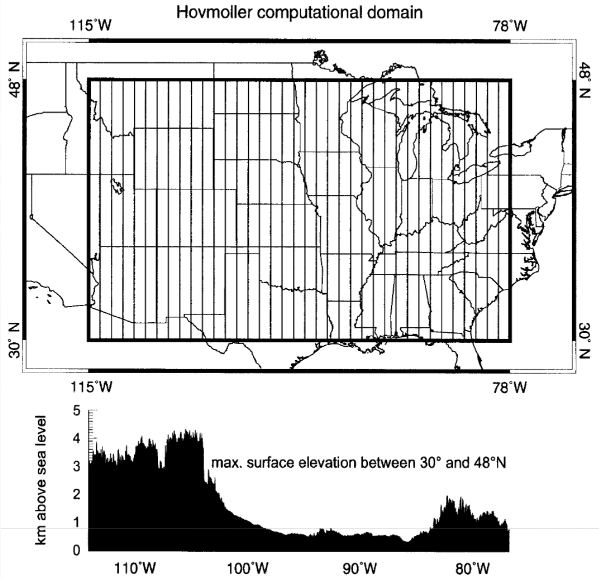
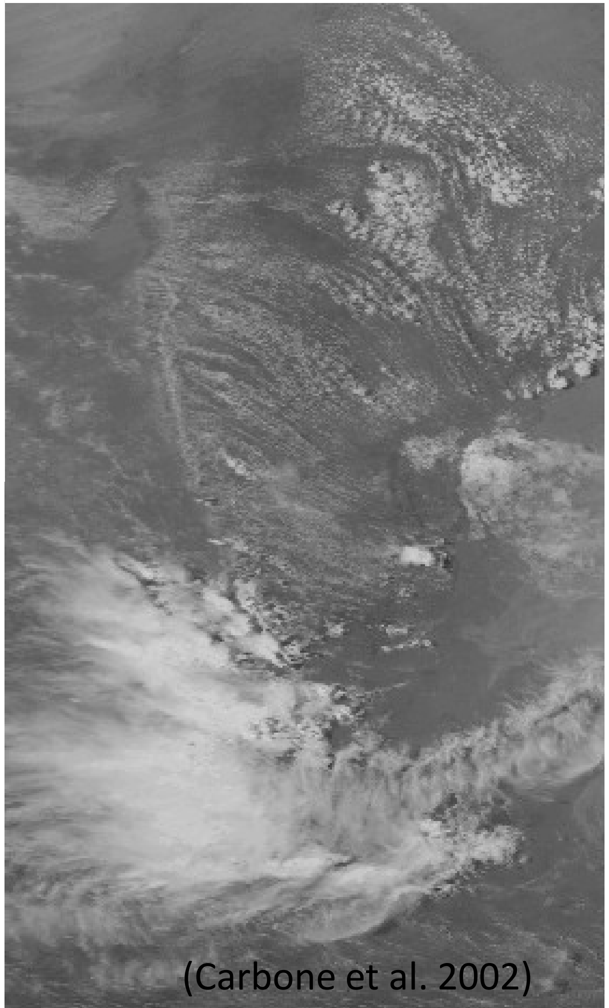


Figure 2. Zonally averaged rain rate (time – latitude diagram (time in UTC) for (a) May, (b) June, (c) July, (d) August and (e) September 2002. The dotted line denotes the mean latitude of the coastline. The shading scale (mm h^{-1}) is shown to the right. This figure is available in colour online at www.interscience.wiley.com/journal/qj

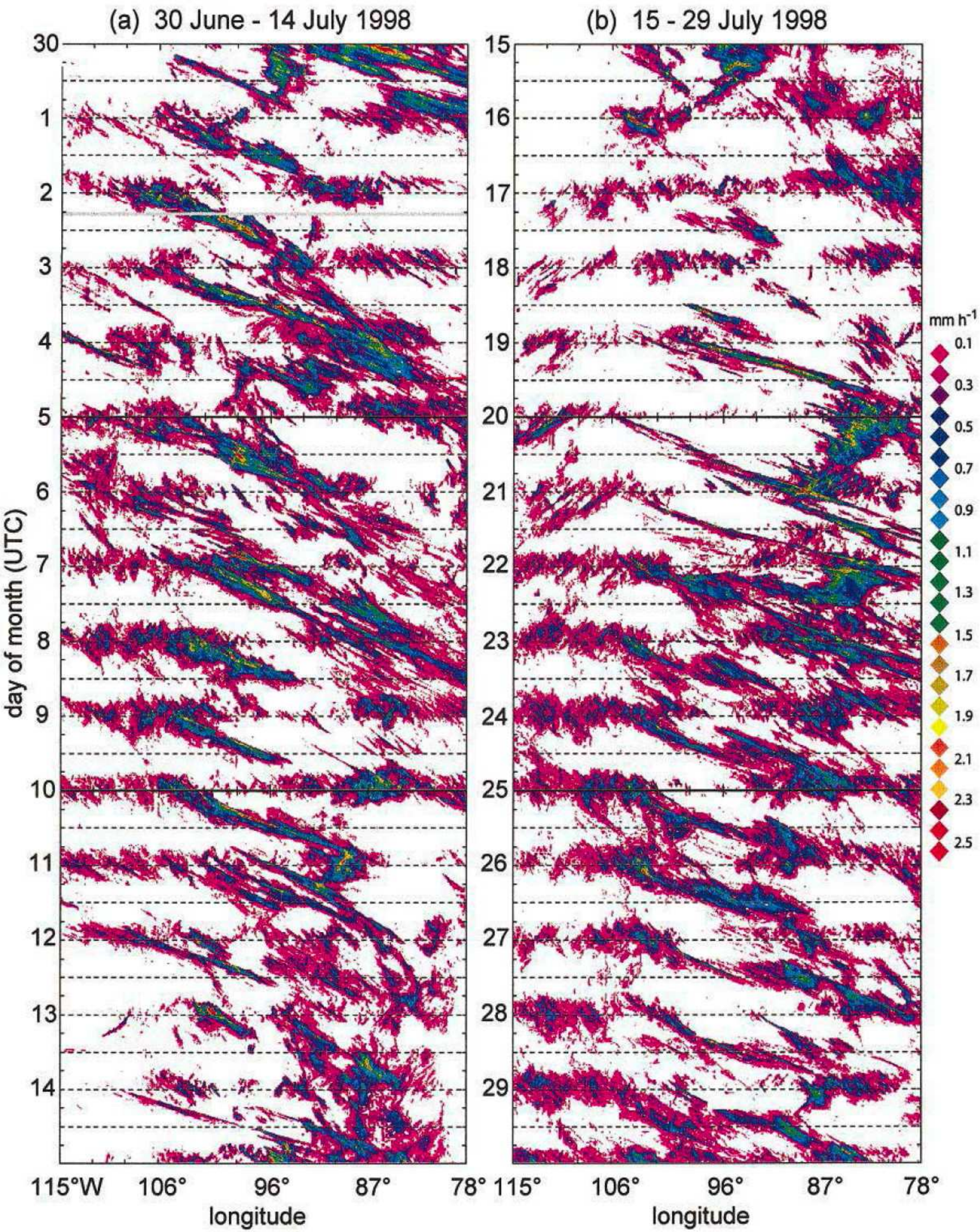
Liu et al. (2008)

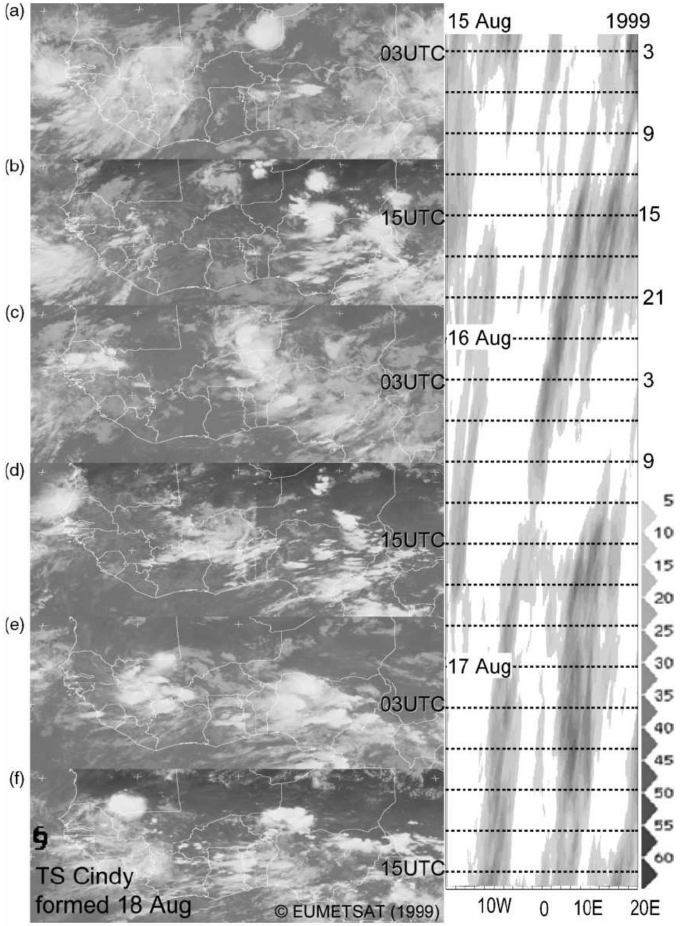


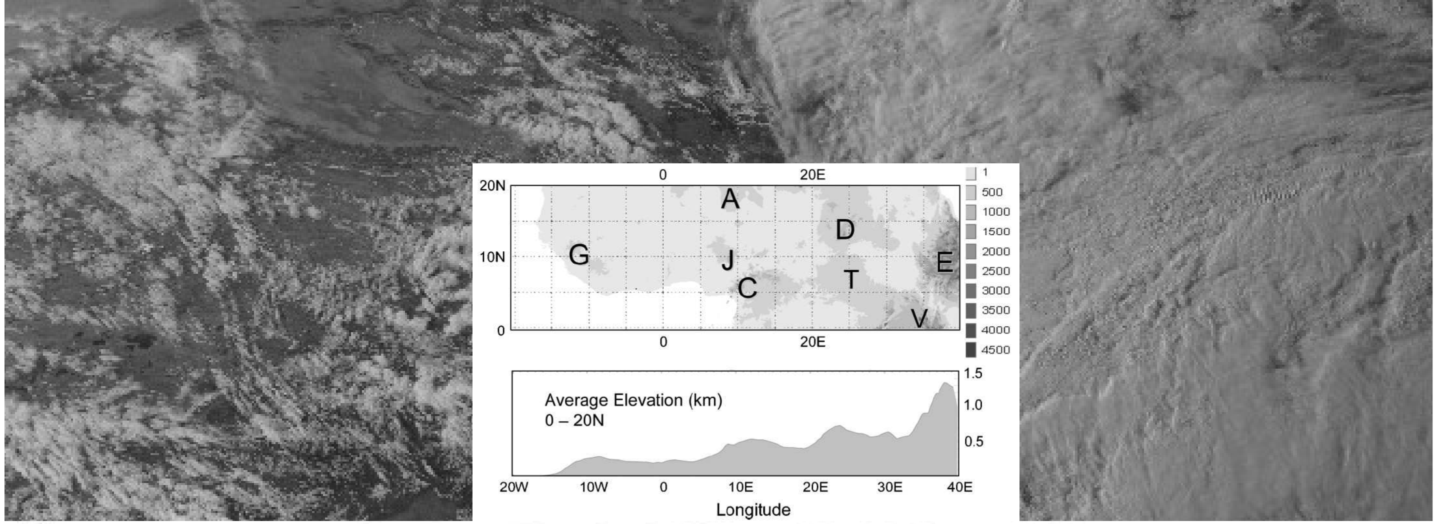


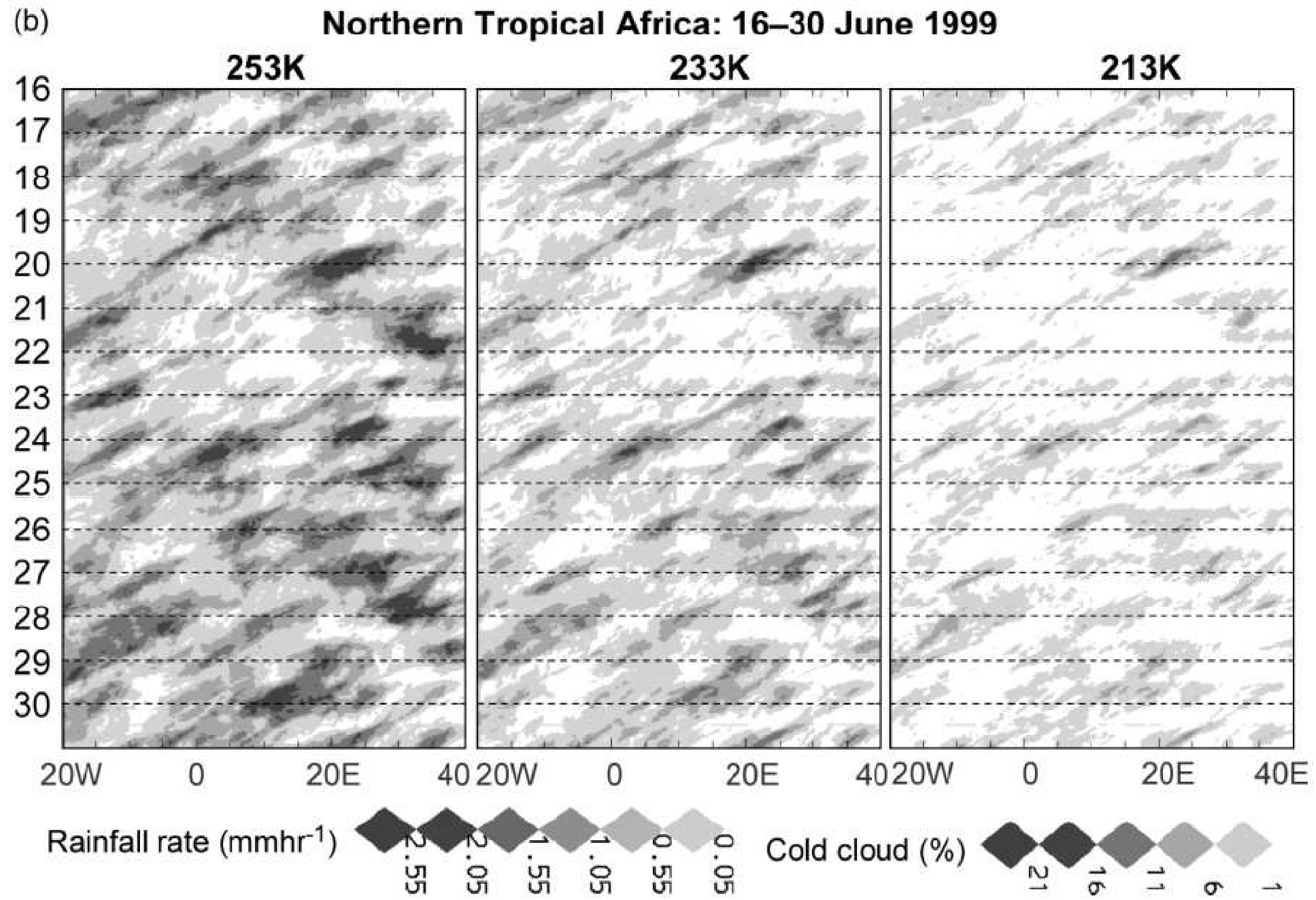


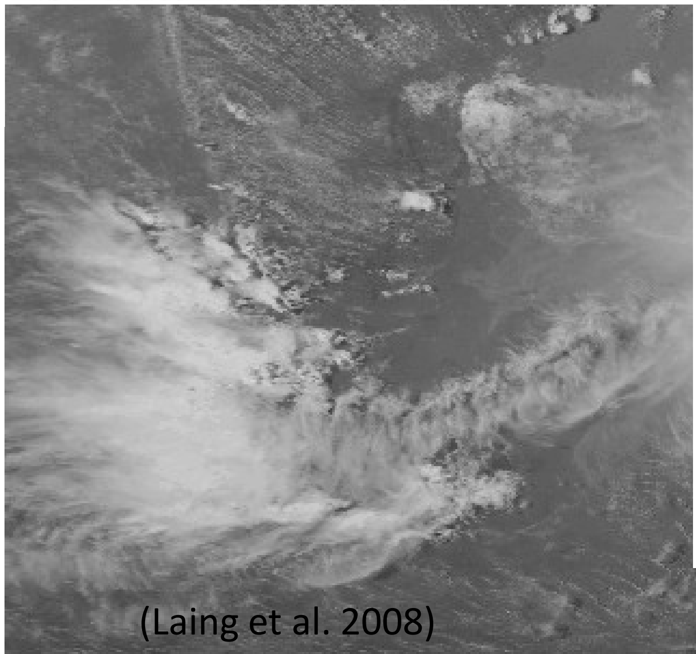
(Carbone et al. 2002)









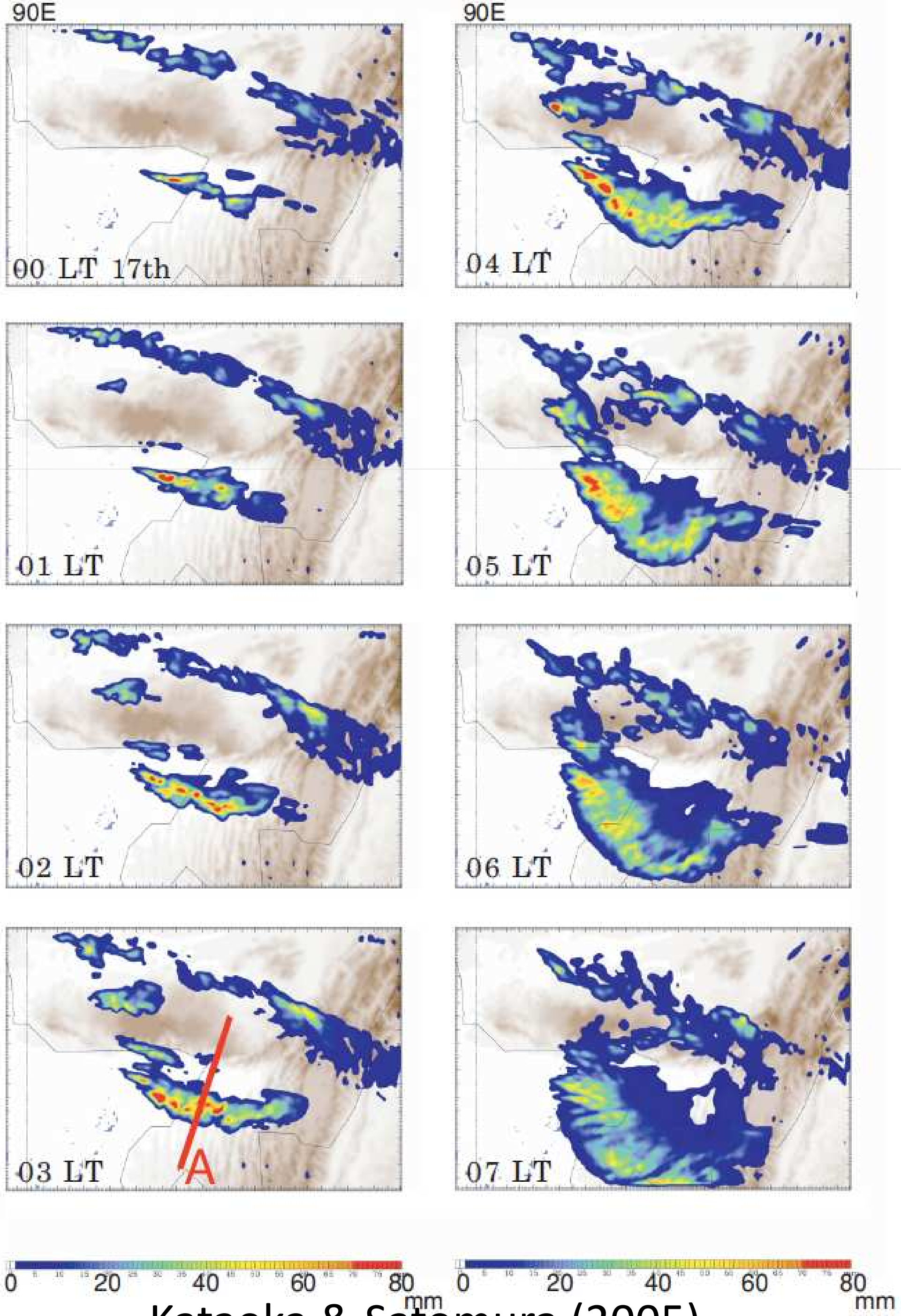


(Laing et al. 2008)

Motivation

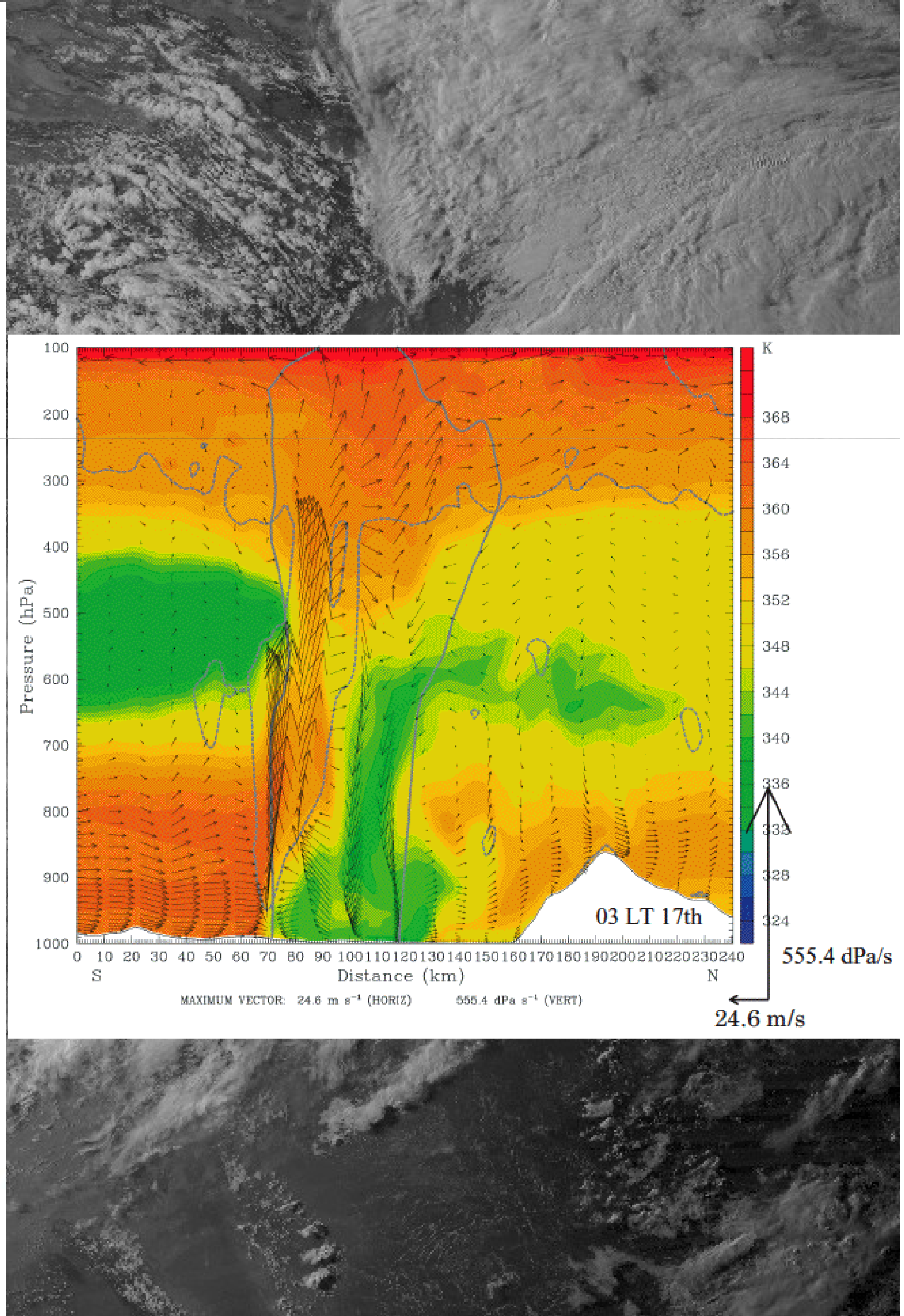
1. What kind of mesoscale systems moves more than 1000 km in the meridional direction against large scale wind?
   – Are they squall line type or gravity wave type?
2. Why do they show significant diurnal variation? What controls the timing?

Today, numerical experiments on #1 are presented.



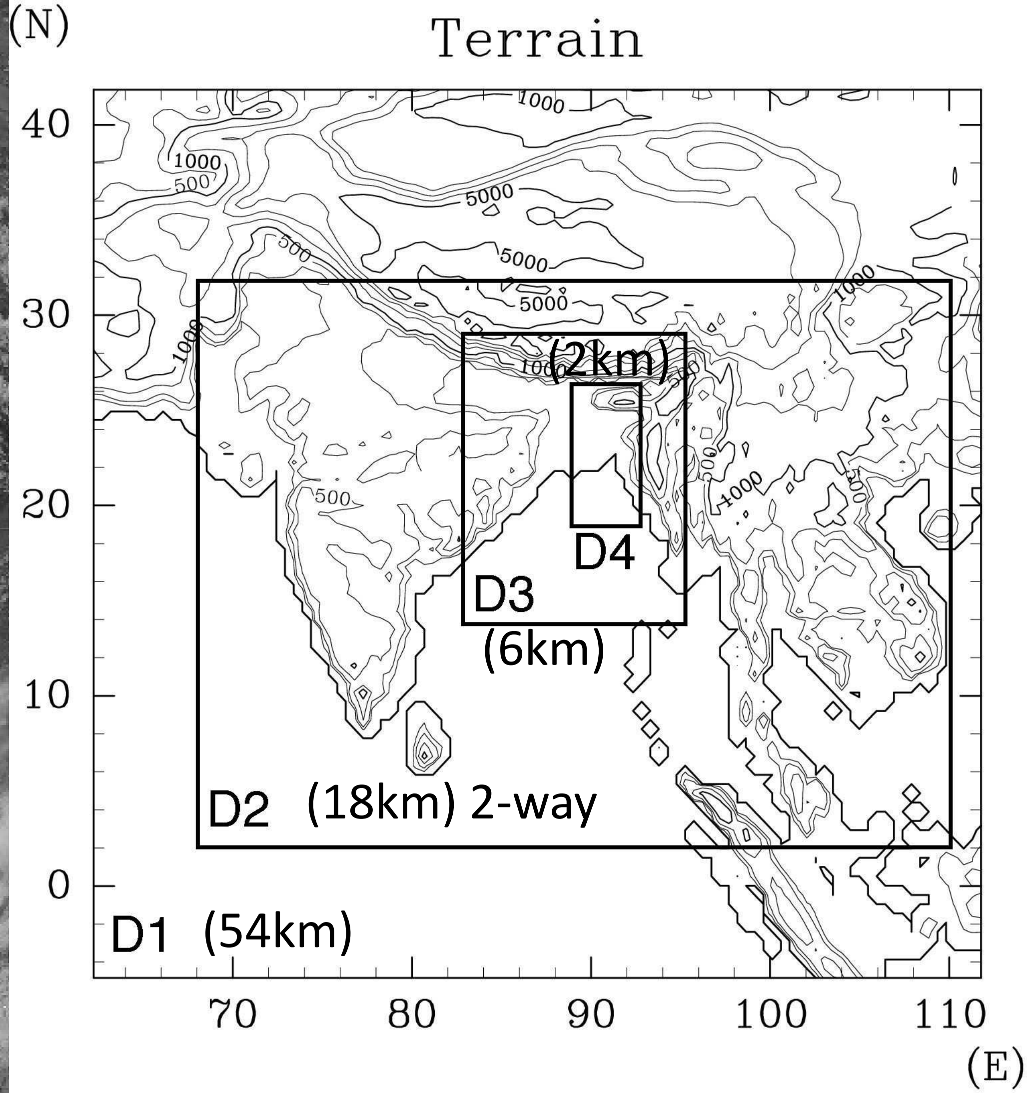
Kataoka & Satomura (2005)

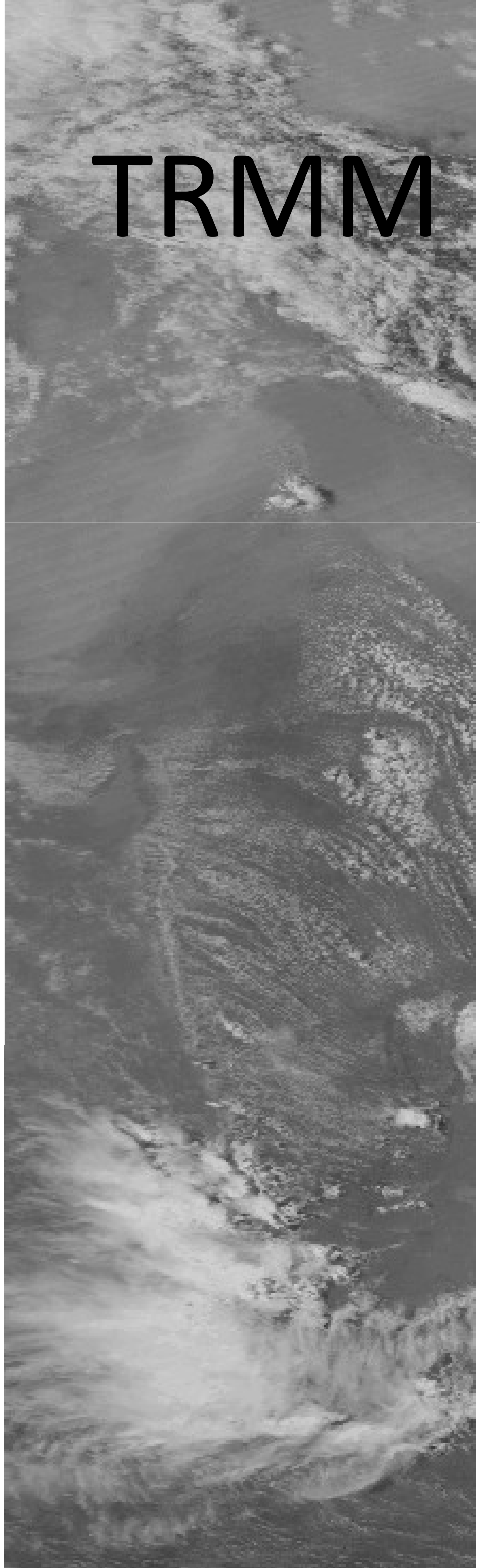
Fig. 3. Simulated hourly precipitation from 00 to 07 LT on 17 June 1995 in D3. Blue to red colors indicate hourly precipitation amount. Brown color shade indicates topography.

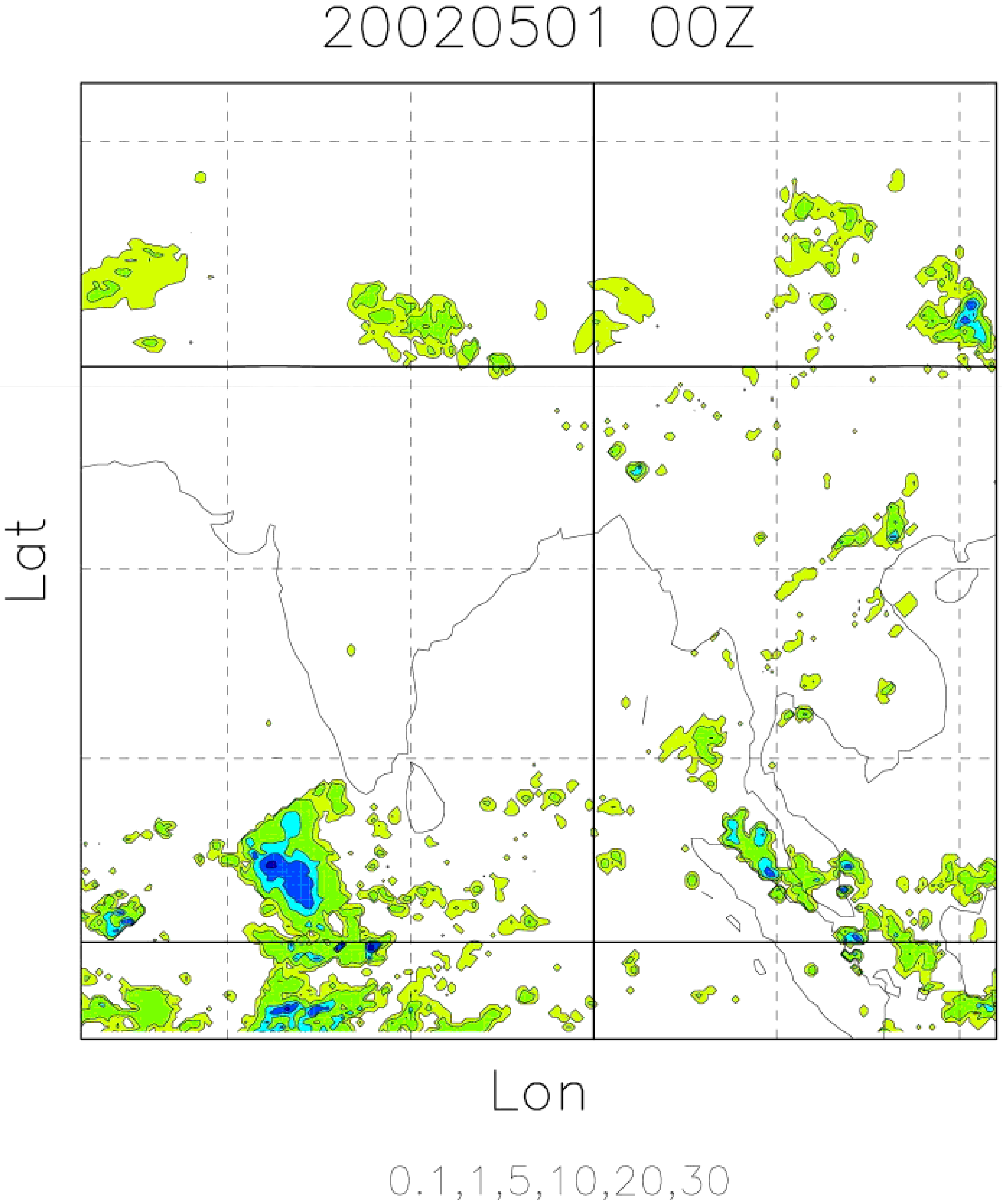


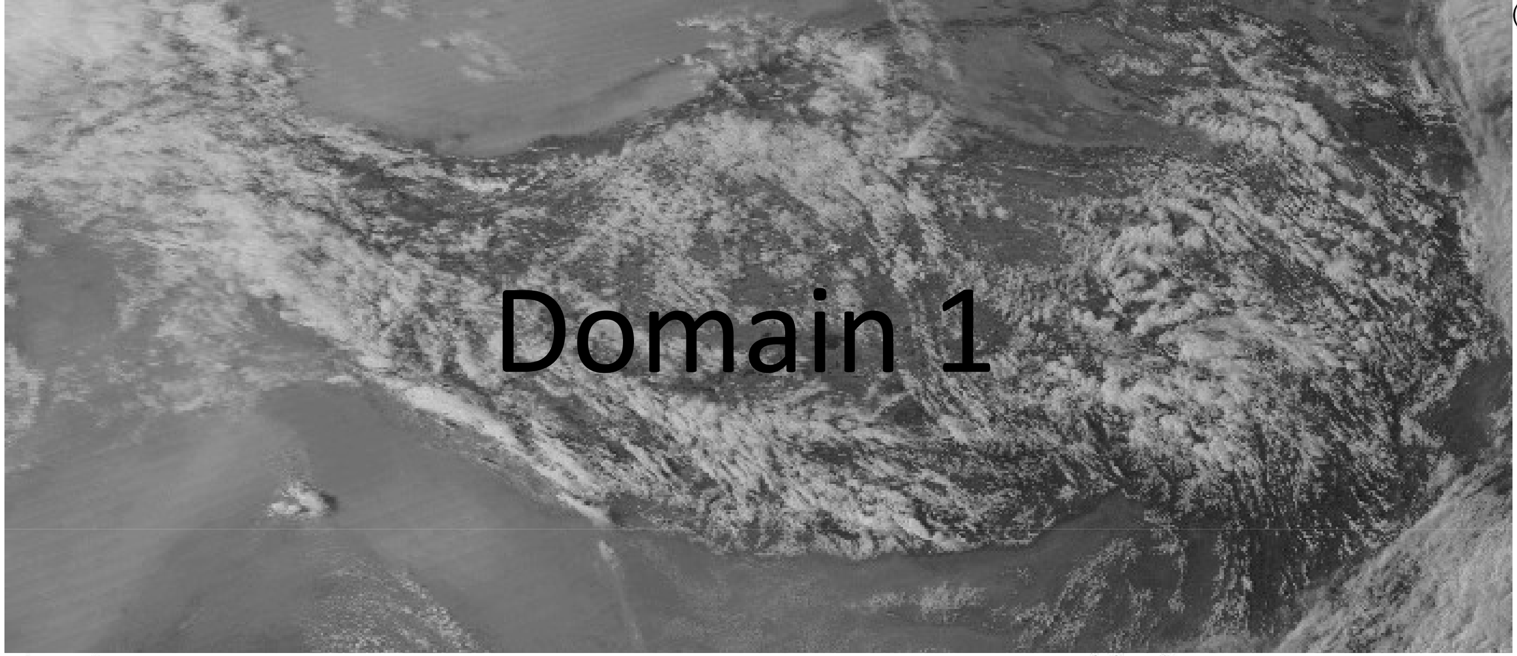
Model and Settings

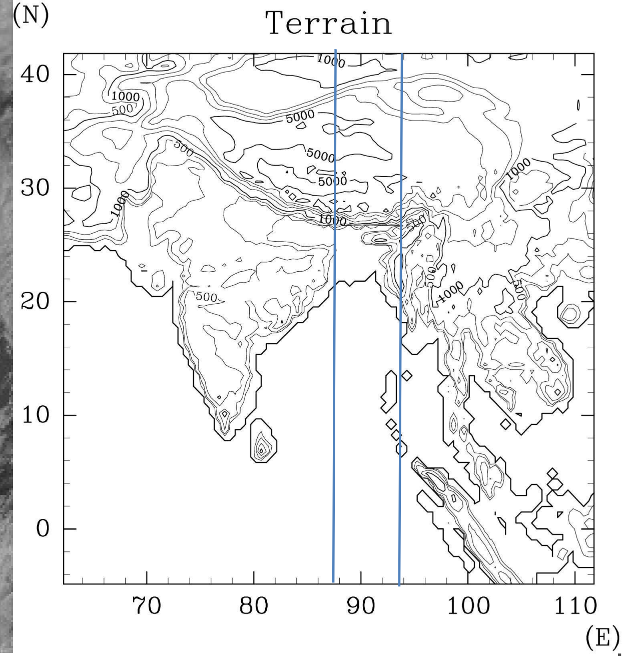
- MM5
- 4 nested domains
  - KF & Ice-microphysics
- Initial and boundary:
  - NCEP RAII
- Integration
  - Domain 1 & 2: 2002.4.30 00Z – 06.01 00Z with nudging
  - Domian 3: 5.05 00Z – 5.16 00Z
  - Domain 4: 5.05 12Z – 5.11 00Z

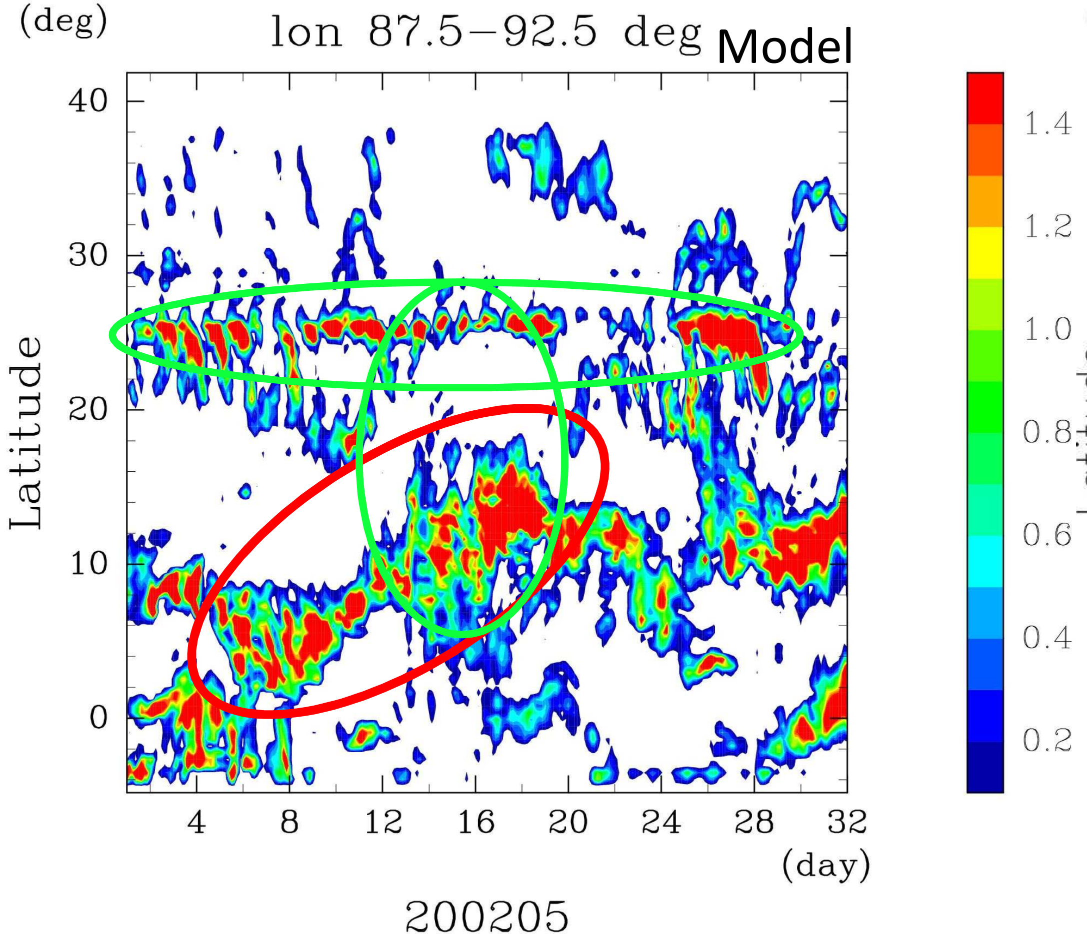


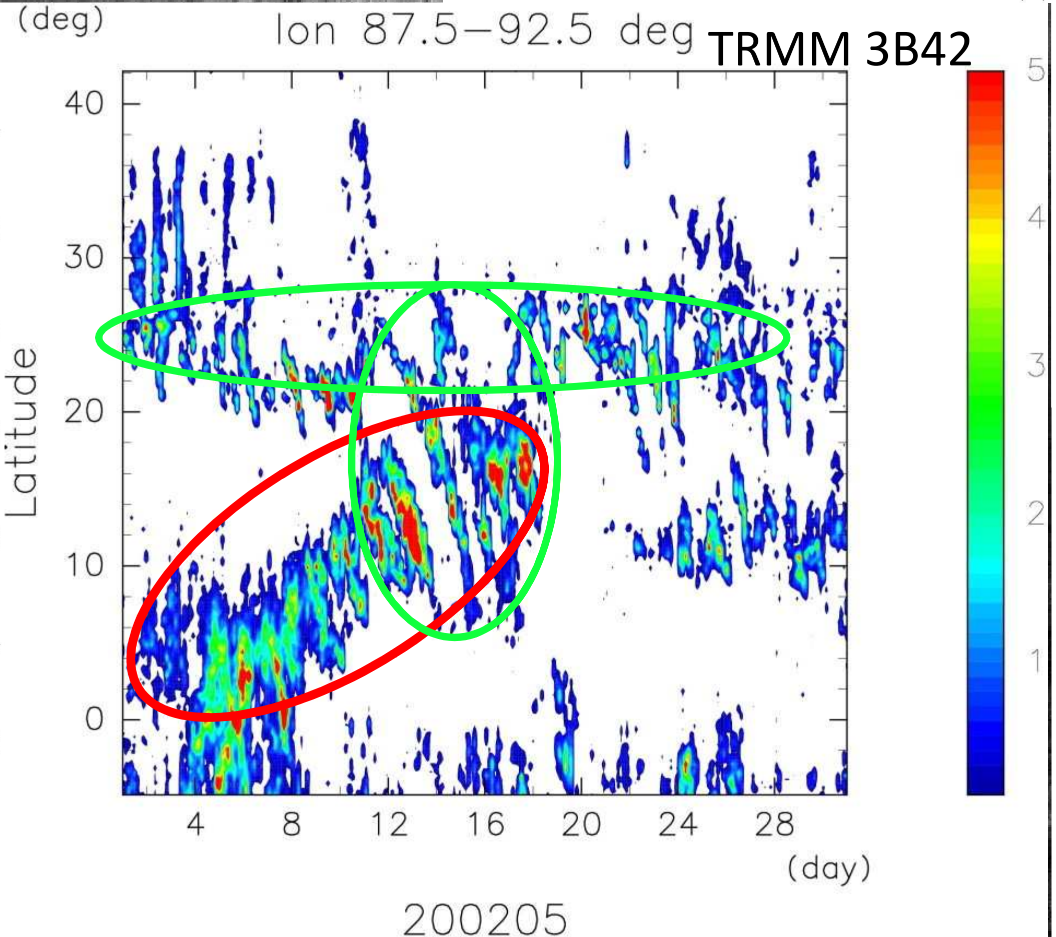

TRMM

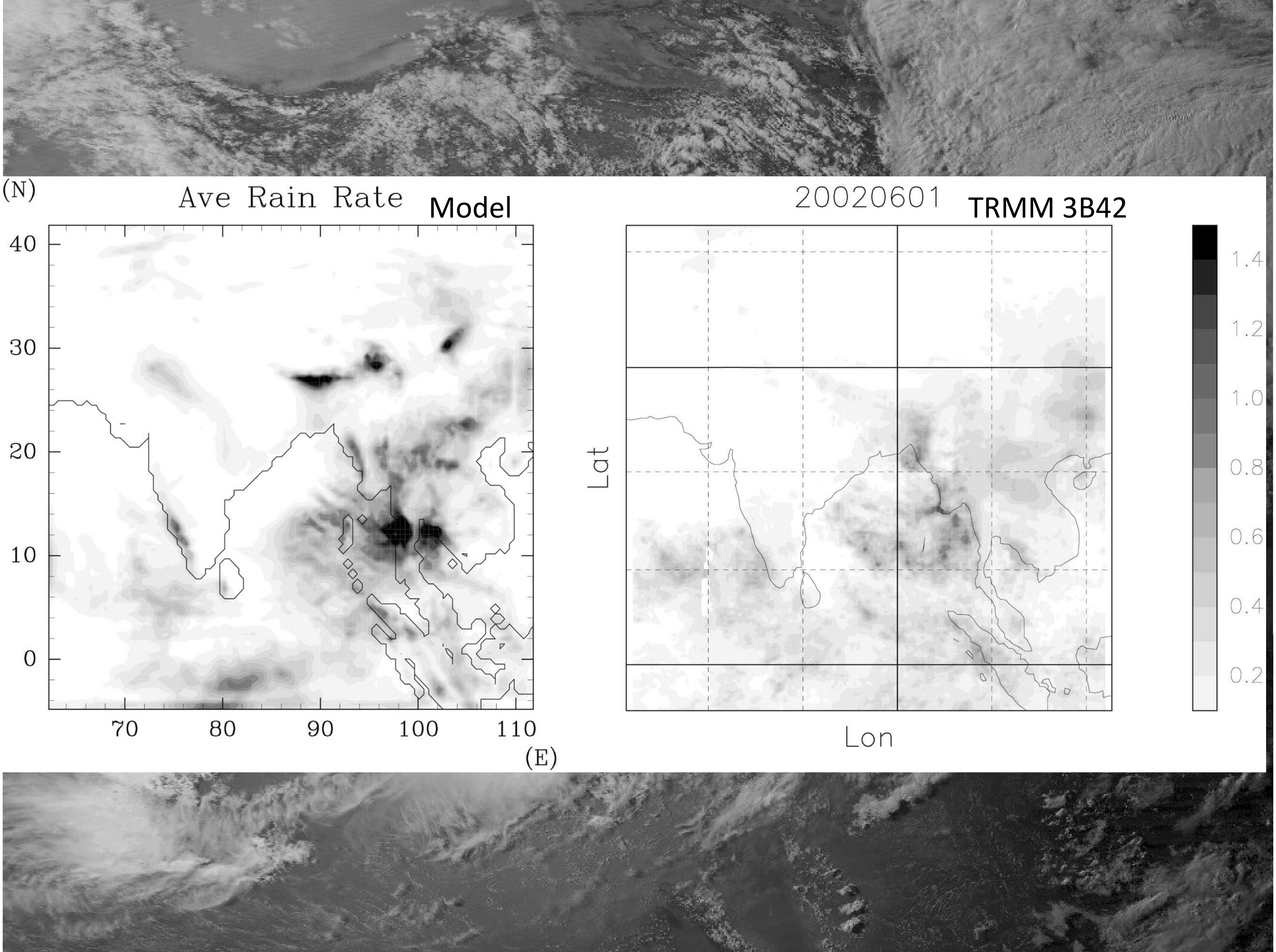

20020501 00Z
Lat
Lon
0.1,1,5,10,20,30


Domain 1

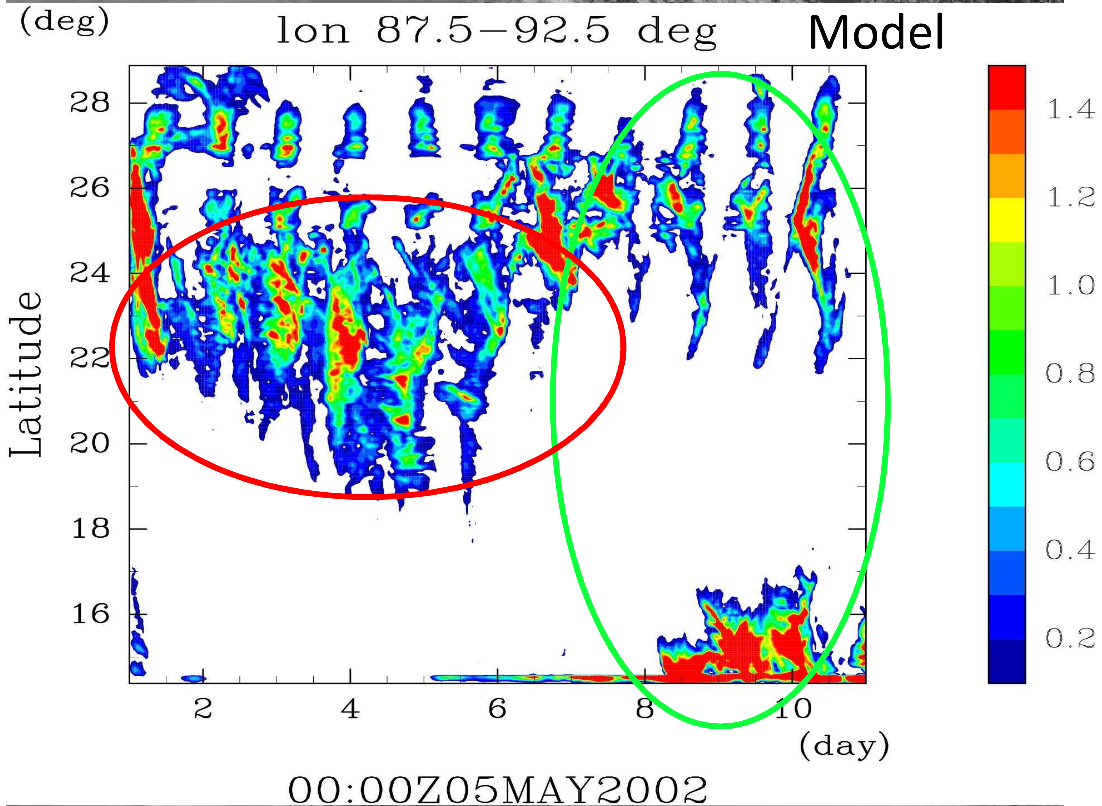

Terrain
(N)
40
30
20
10
0
70
80
90
100
110
(E)
1000
500
5000


(deg)
lon 87.5–92.5 deg
Model
Latitude
40
30
20
10
0
4
8
12
16
20
24
28
32
(day)
200205
1.4
1.2
1.0
0.8
0.6
0.4
0.2

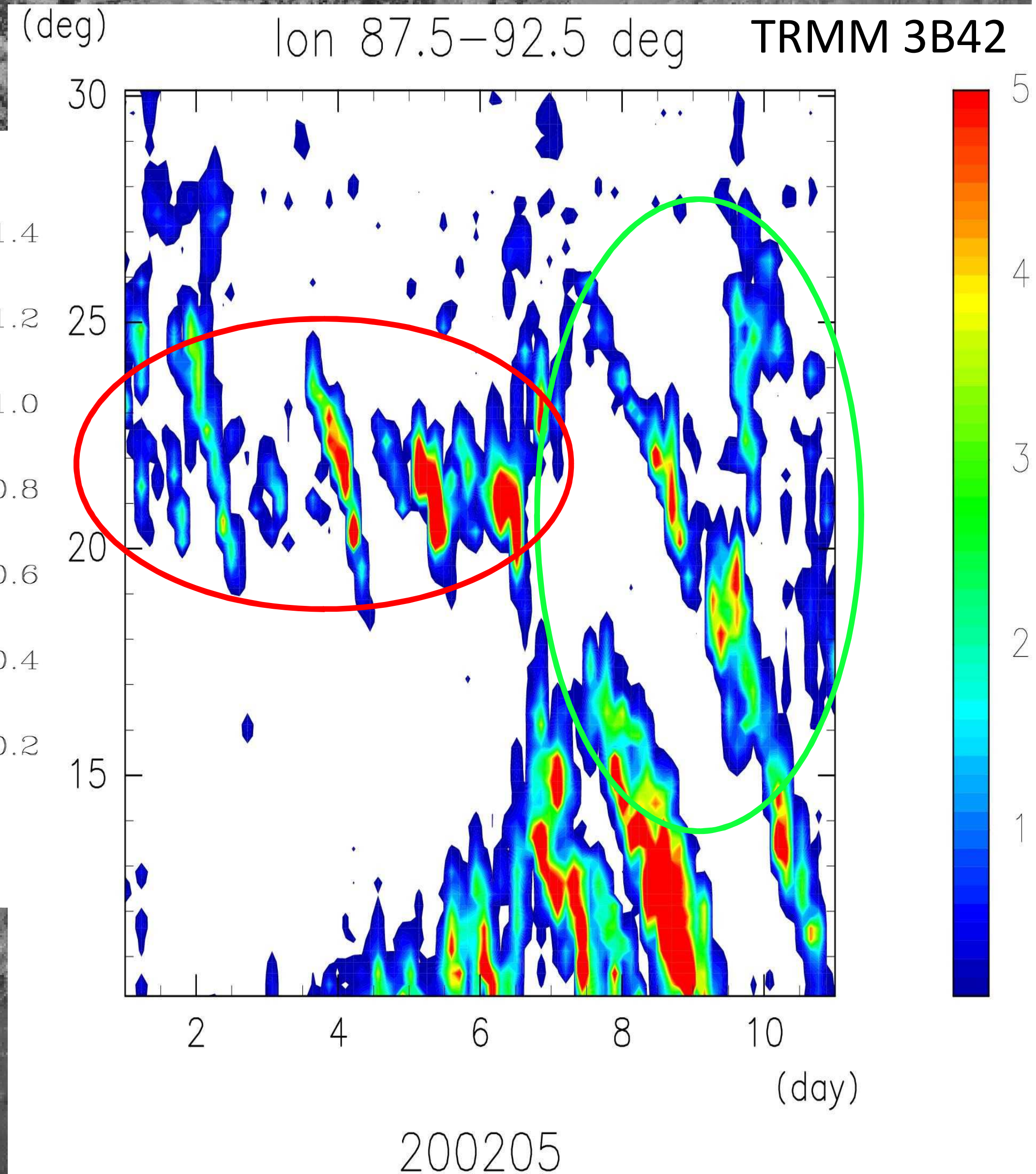

(deg)
lon 87.5–92.5 deg
TRMM 3B42
Latitude
40
30
20
10
0
4
8
12
16
20
24
28
(day)
200205
5
4
3
2
1


(N)
Ave Rain Rate
Model
40
30
20
10
0
70
80
90
100
110
(E)
20020601
TRMM 3B42
Lat
Lon
1.4
1.2
1.0
0.8
0.6
0.4
0.2

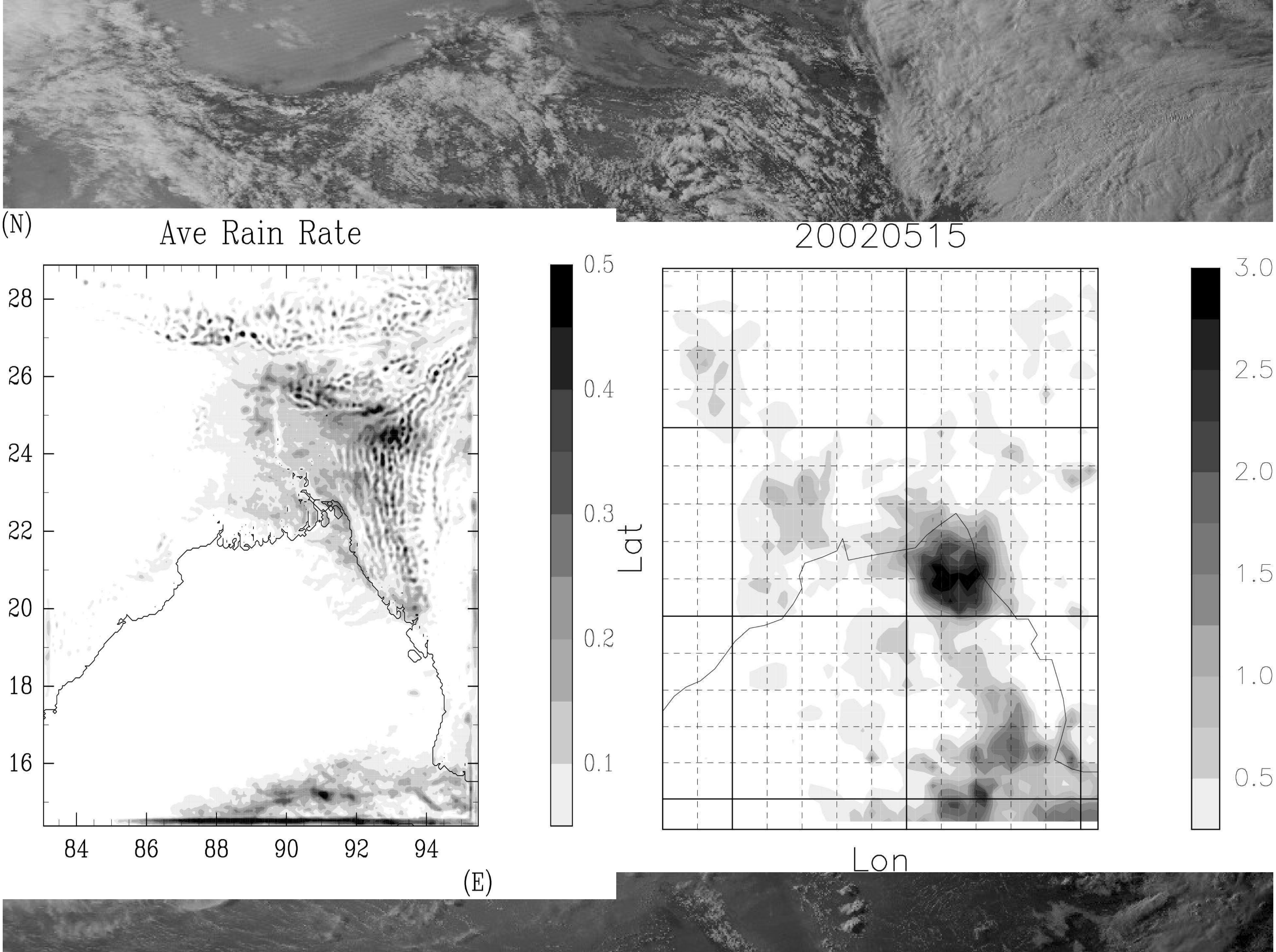
Domain 3



(deg)
lon 87.5–92.5 deg
Model
Latitude
28
26
24
22
20
18
16
2
4
6
8
10
(day)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
00:00Z05MAY2002

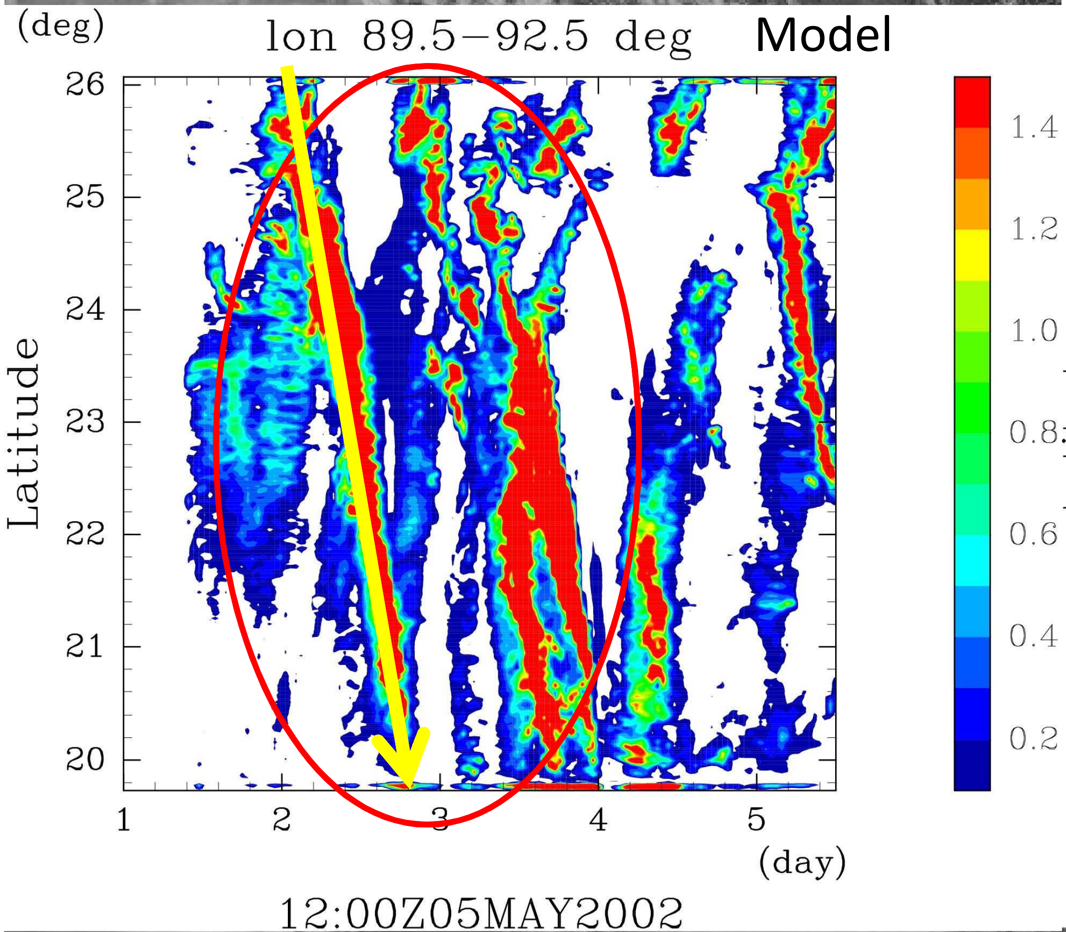


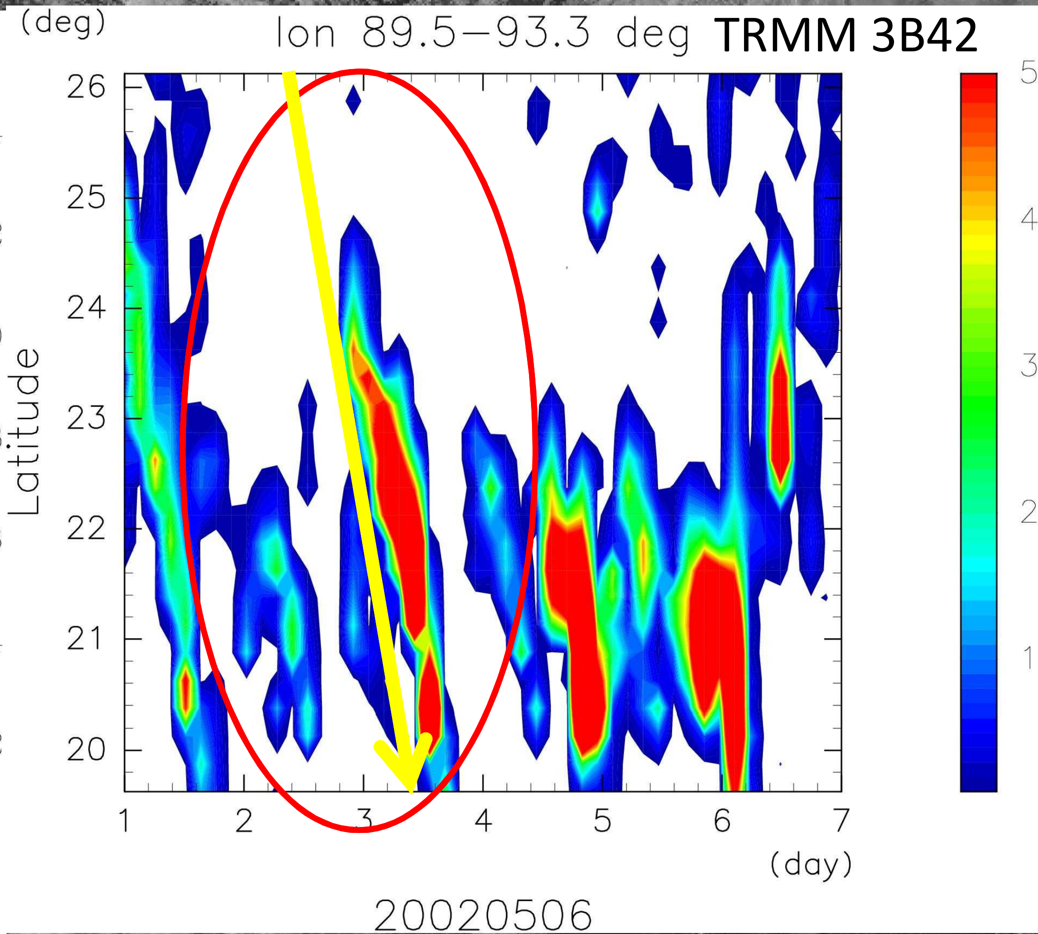
(deg)
lon 87.5–92.5 deg
TRMM 3B42
30
25
20
15
2
4
6
8
10
(day)
5
4
3
2
1
200205



(N)
Ave Rain Rate
28
26
24
22
20
18
16
84
86
88
90
92
94
(E)
0.5
0.4
0.3
0.2
0.1
20020515
Lat
Lon
3.0
2.5
2.0
1.5
1.0
0.5

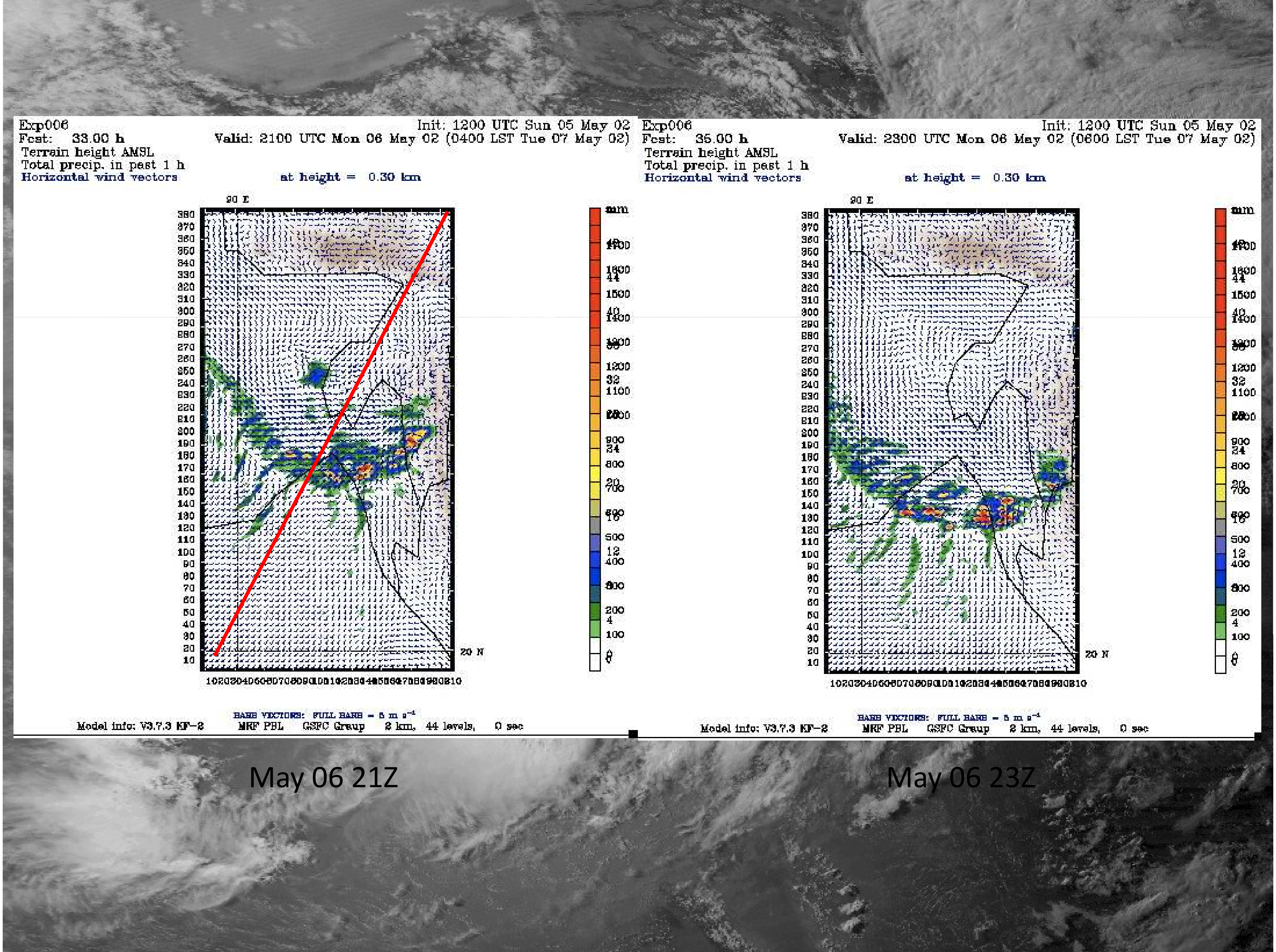
Domain 4





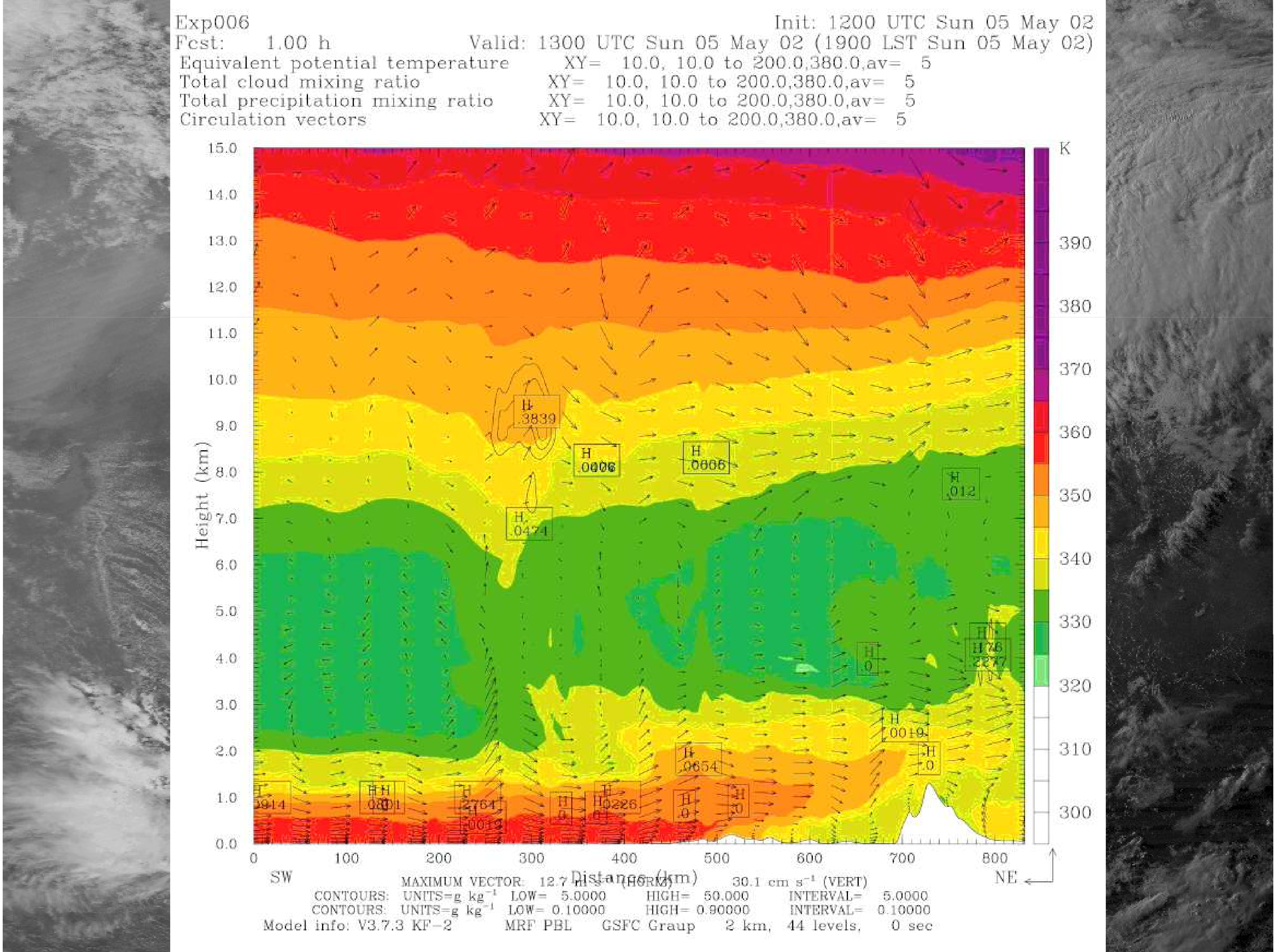
6.2 deg/20h ≈ 9.5 m/s

Appear in the early morning at 25-26N

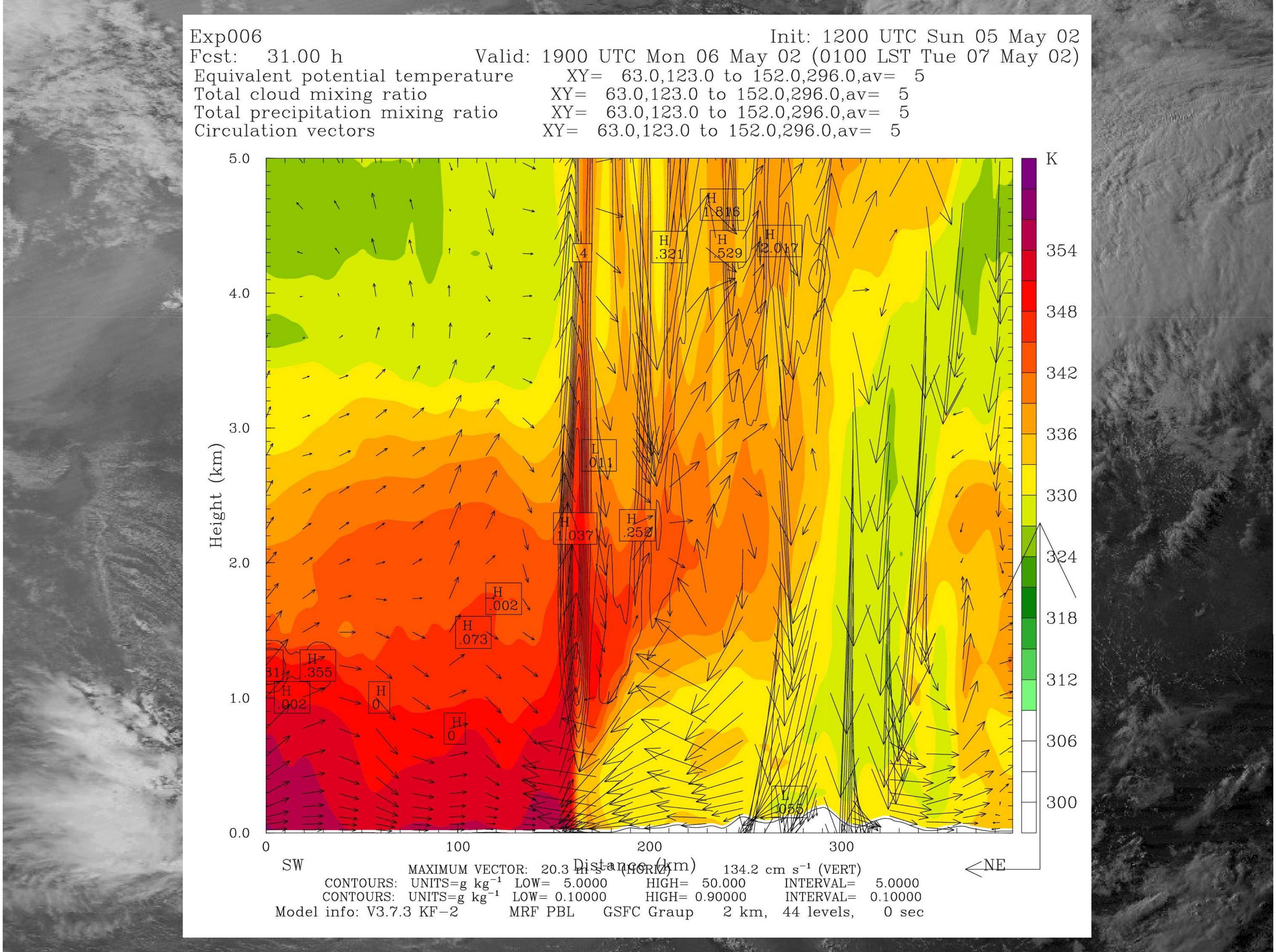


May 06 21Z

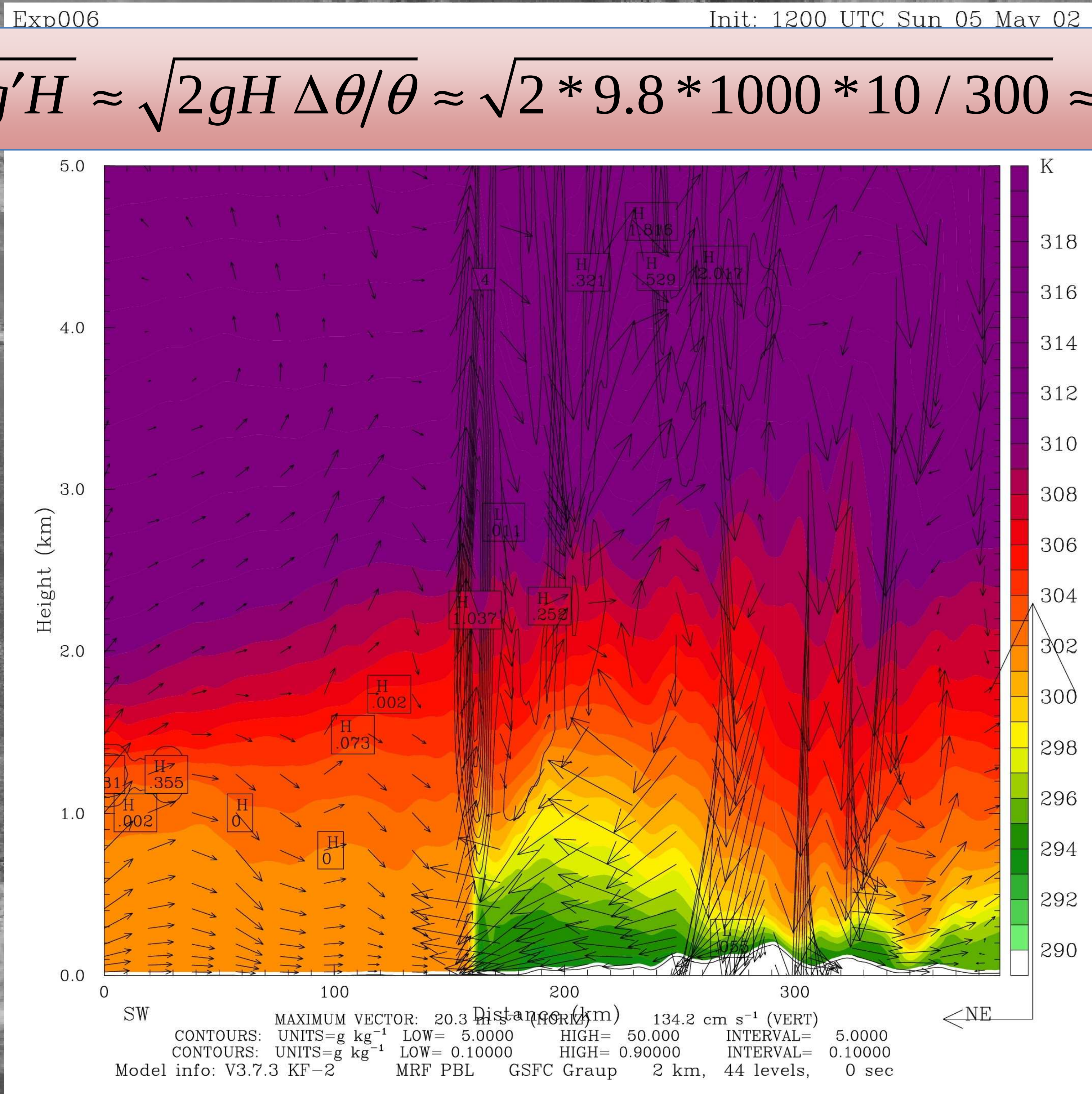
May 06 23Z



Exp006
Init: 1200 UTC Sun 05 May 02
Fcst: 1.00 h
Valid: 1300 UTC Sun 05 May 02 (1900 LST Sun 05 May 02)
Equivalent potential temperature XY= 10.0, 10.0 to 200.0,380.0,av= 5
Total cloud mixing ratio XY= 10.0, 10.0 to 200.0,380.0,av= 5
Total precipitation mixing ratio XY= 10.0, 10.0 to 200.0,380.0,av= 5
Circulation vectors XY= 10.0, 10.0 to 200.0,380.0,av= 5
Height (km)
Distance (km)
SW
NE
K
MAXIMUM VECTOR: 12.7 m s⁻¹ (HORZ) 30.1 cm s⁻¹ (VERT)
CONTOURS: UNITS=g kg⁻¹ LOW= 5.0000 HIGH= 50.000 INTERVAL= 5.0000
CONTOURS: UNITS=g kg⁻¹ LOW= 0.10000 HIGH= 0.90000 INTERVAL= 0.10000
Model info: V3.7.3 KF-2 MRF PBL GSFC Graup 2 km, 44 levels, 0 sec


Exp006
Init: 1200 UTC Sun 05 May 02
Fcst: 31.00 h
Valid: 1900 UTC Mon 06 May 02 (0100 LST Tue 07 May 02)
Equivalent potential temperature XY= 63.0,123.0 to 152.0,296.0,av= 5
Total cloud mixing ratio XY= 63.0,123.0 to 152.0,296.0,av= 5
Total precipitation mixing ratio XY= 63.0,123.0 to 152.0,296.0,av= 5
Circulation vectors XY= 63.0,123.0 to 152.0,296.0,av= 5
Height (km)
Distance (km)
SW
NE
K
354
348
342
336
330
324
318
312
306
300
MAXIMUM VECTOR: 20.3 m s⁻¹ (HORIZ) 134.2 cm s⁻¹ (VERT)
CONTOURS: UNITS=g kg⁻¹ LOW= 5.0000 HIGH= 50.000 INTERVAL= 5.0000
CONTOURS: UNITS=g kg⁻¹ LOW= 0.10000 HIGH= 0.90000 INTERVAL= 0.10000
Model info: V3.7.3 KF-2 MRF PBL GSFC Graup 2 km, 44 levels, 0 sec

$$C \approx \sqrt{2g'H} \approx \sqrt{2gH\,\Delta\theta/\theta} \approx \sqrt{2*9.8*1000*10/300} \approx 25\ \mathrm{ms^{-1}}$$



Summary

- Using nested 2-km resolution nonhydrostatic model, southward travelling precipitation systems with ~9-10 m/s were reproduced.
- Several travelling systems were originated at the inland areas of Bengali region and went offshore over the BoB.
- Squall-line type dynamics can explain the propagation

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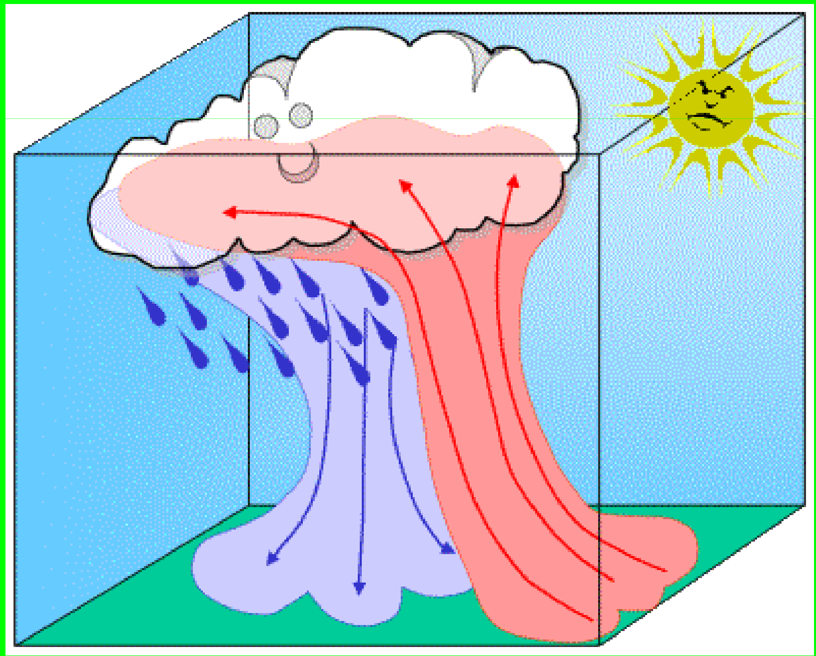

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