Ministério da Ciência e Tecnologia

The Convective System Life Cycle Observed from Remote Sensing

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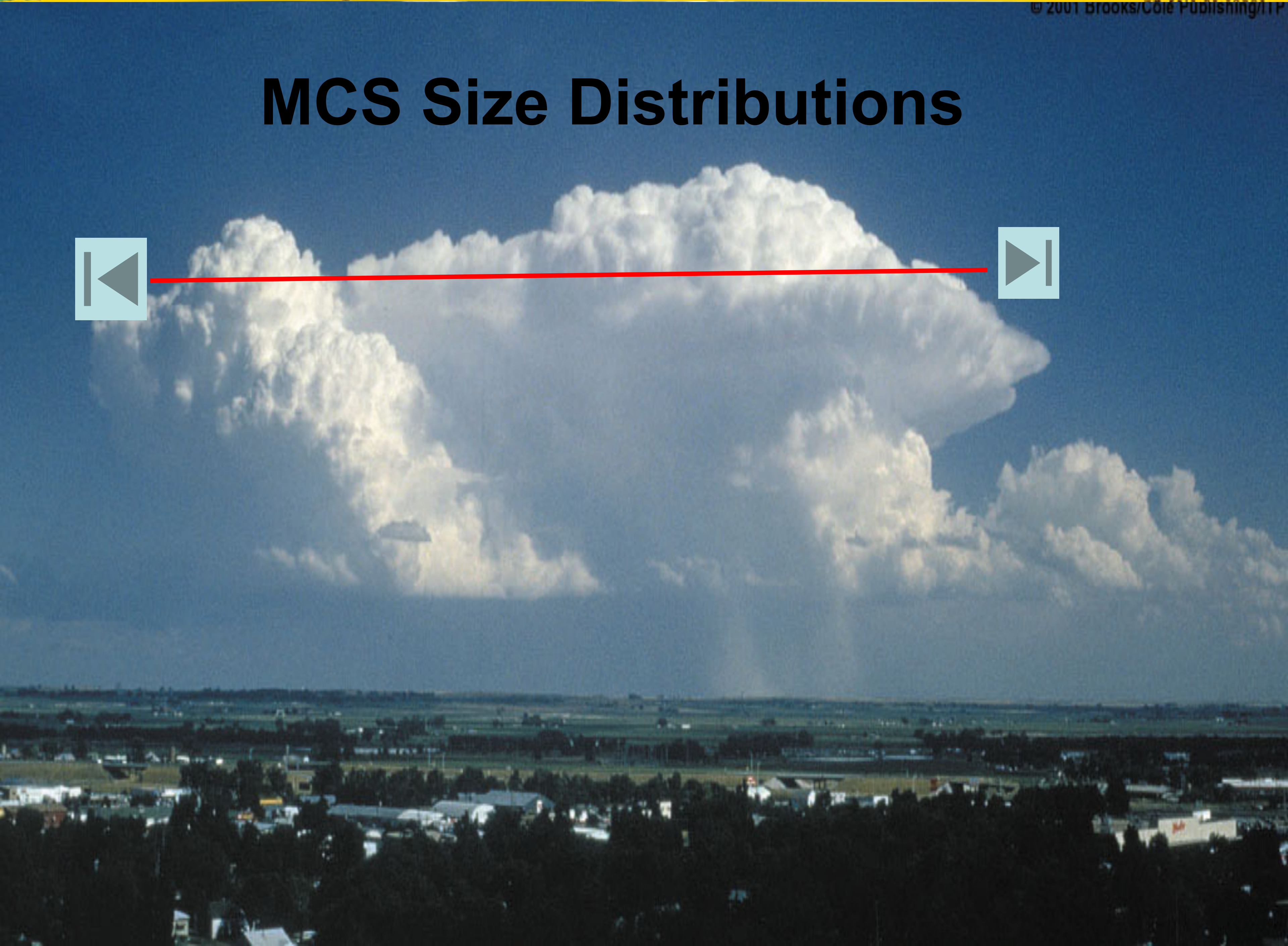
Overview

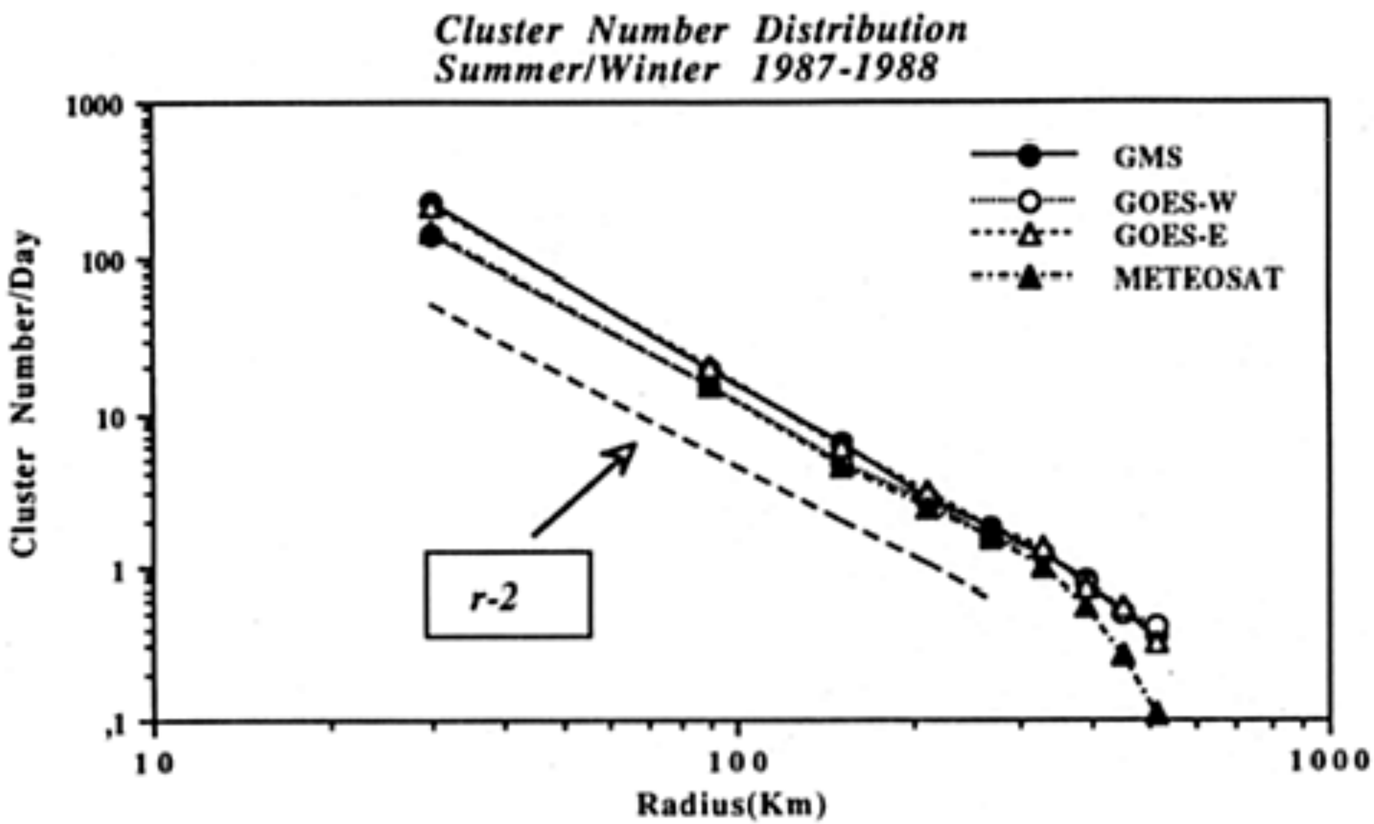
MCS

- Size Distributions
- Average Properties
- Vertical Distribution
- Area Expansion and Upper Level Divergence
- Precipitation
- Propagation
- Microphysics

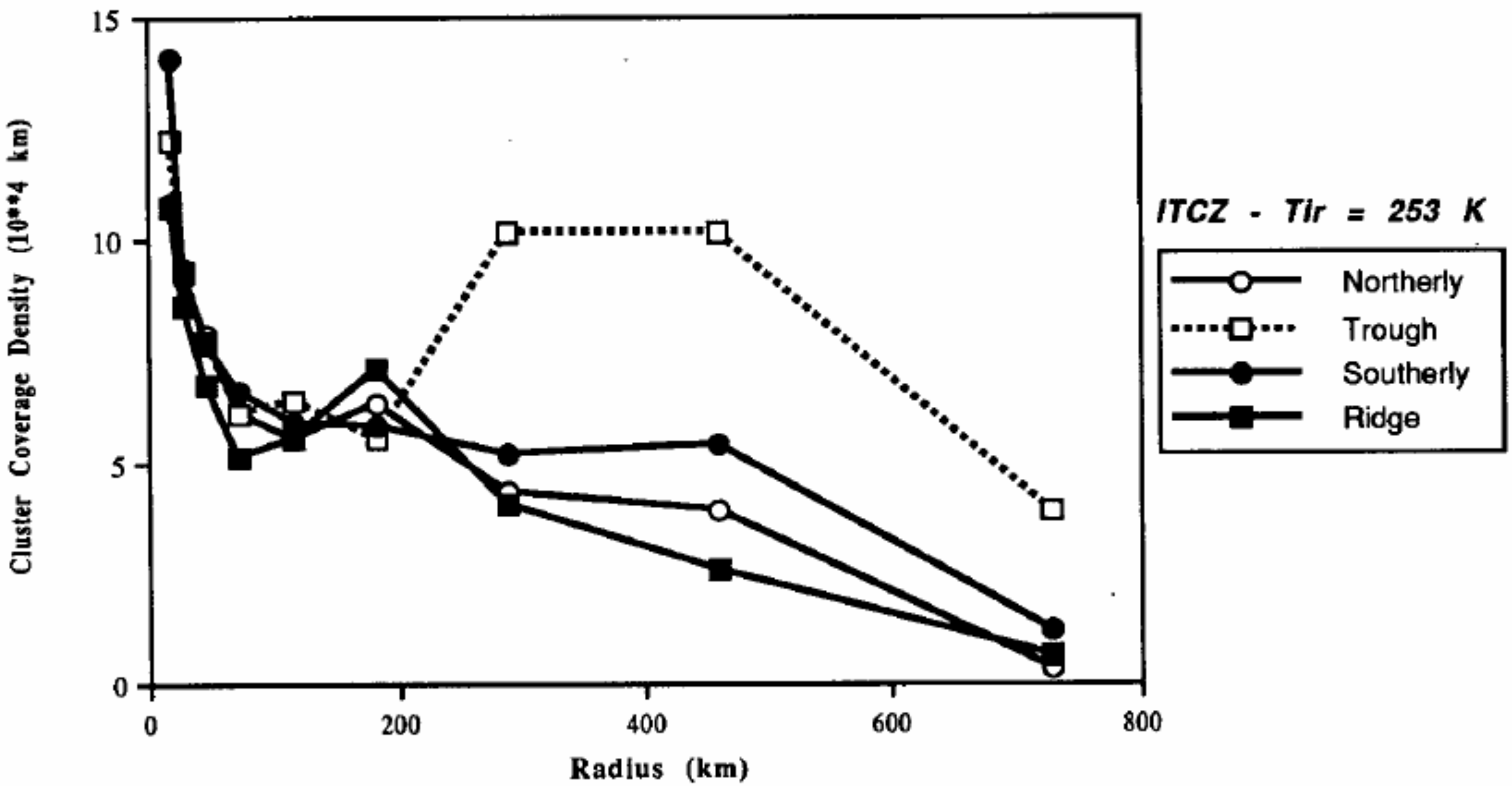
MCS Size Distributions



✓**Convection is organized in a large range of scales, from individual cumulus cloud up to large mesoscale convective systems of hundreds kilometers composed by different cloud types lasting for more than one day.**



The MCS Organization as function of the Easterly Waves in Africa



The MCS Organization as function of the Diurnal Cycle – Africa and Atlantic Ocean

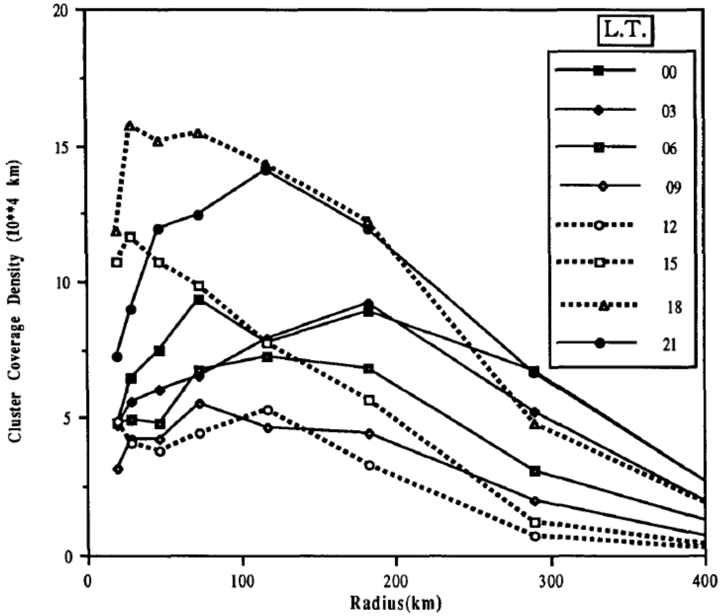


FIG. 4. Diurnal variation of the cluster coverage density $S(\Delta R)$ versus cluster radius for threshold T_{IR} = 218 K over land region.

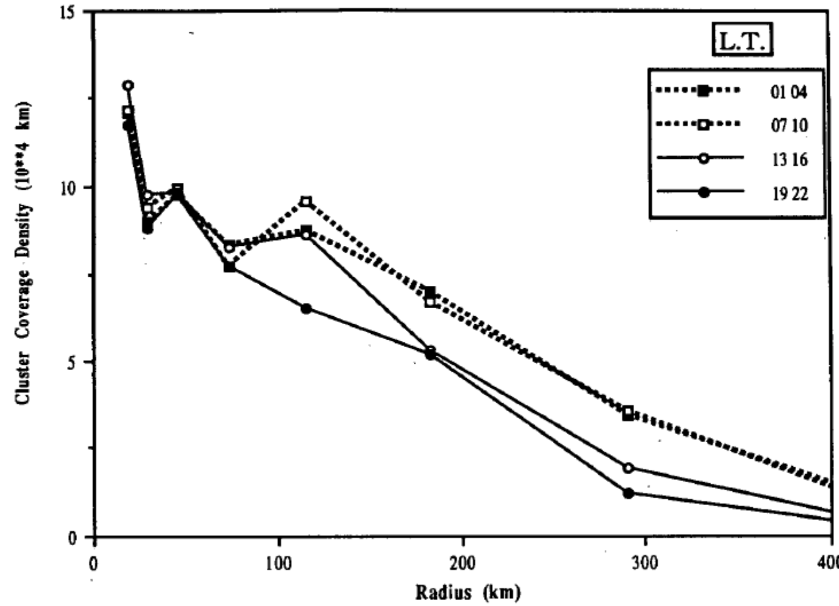


FIG. 5. Diurnal variation of the cluster coverage density $S(\Delta R)$ versus cluster radius for threshold T_{IR} = 218 K over ocean region.

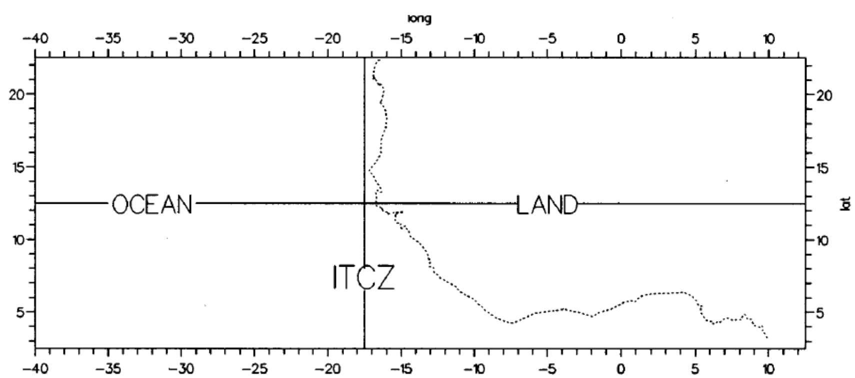
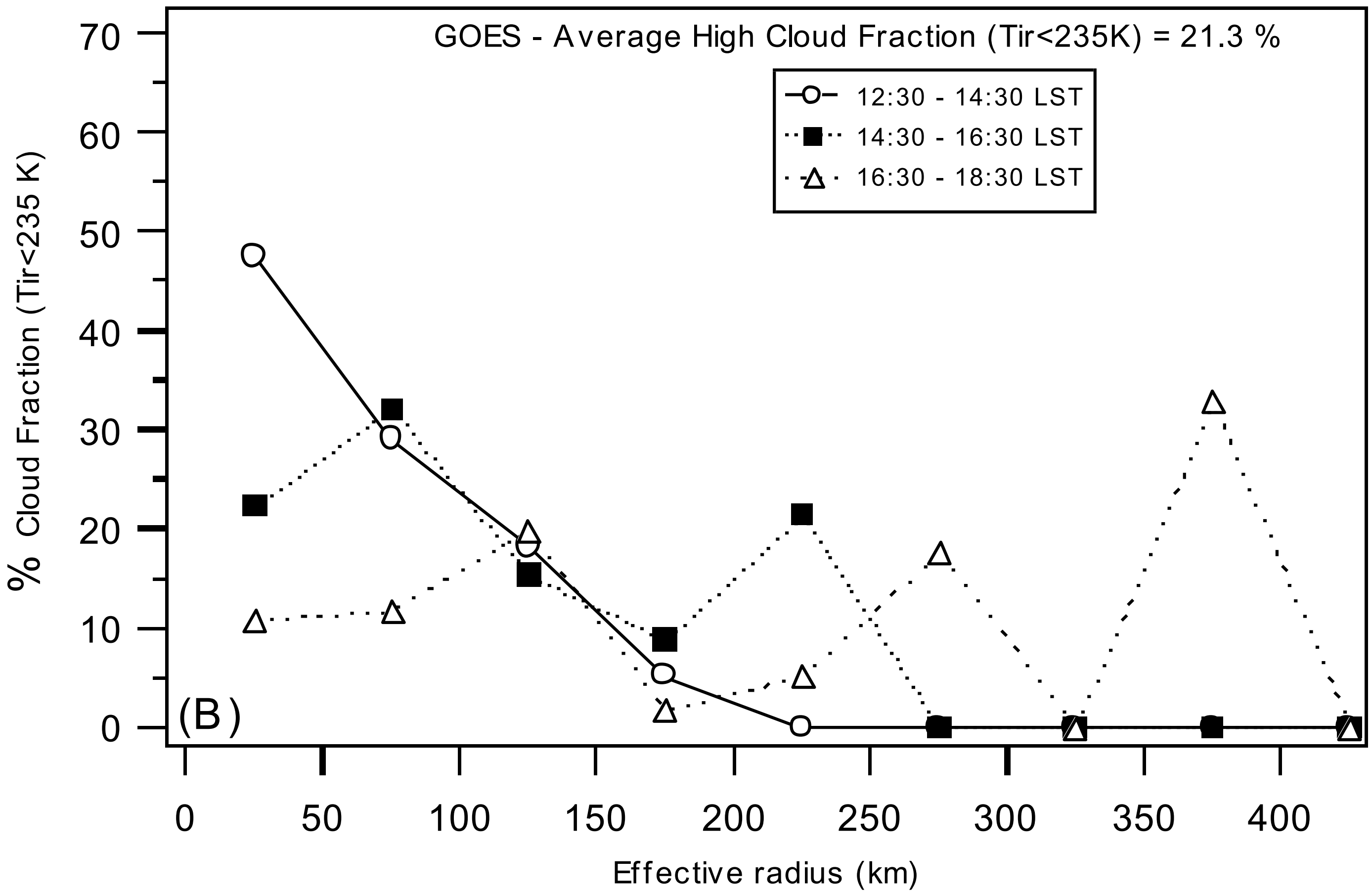
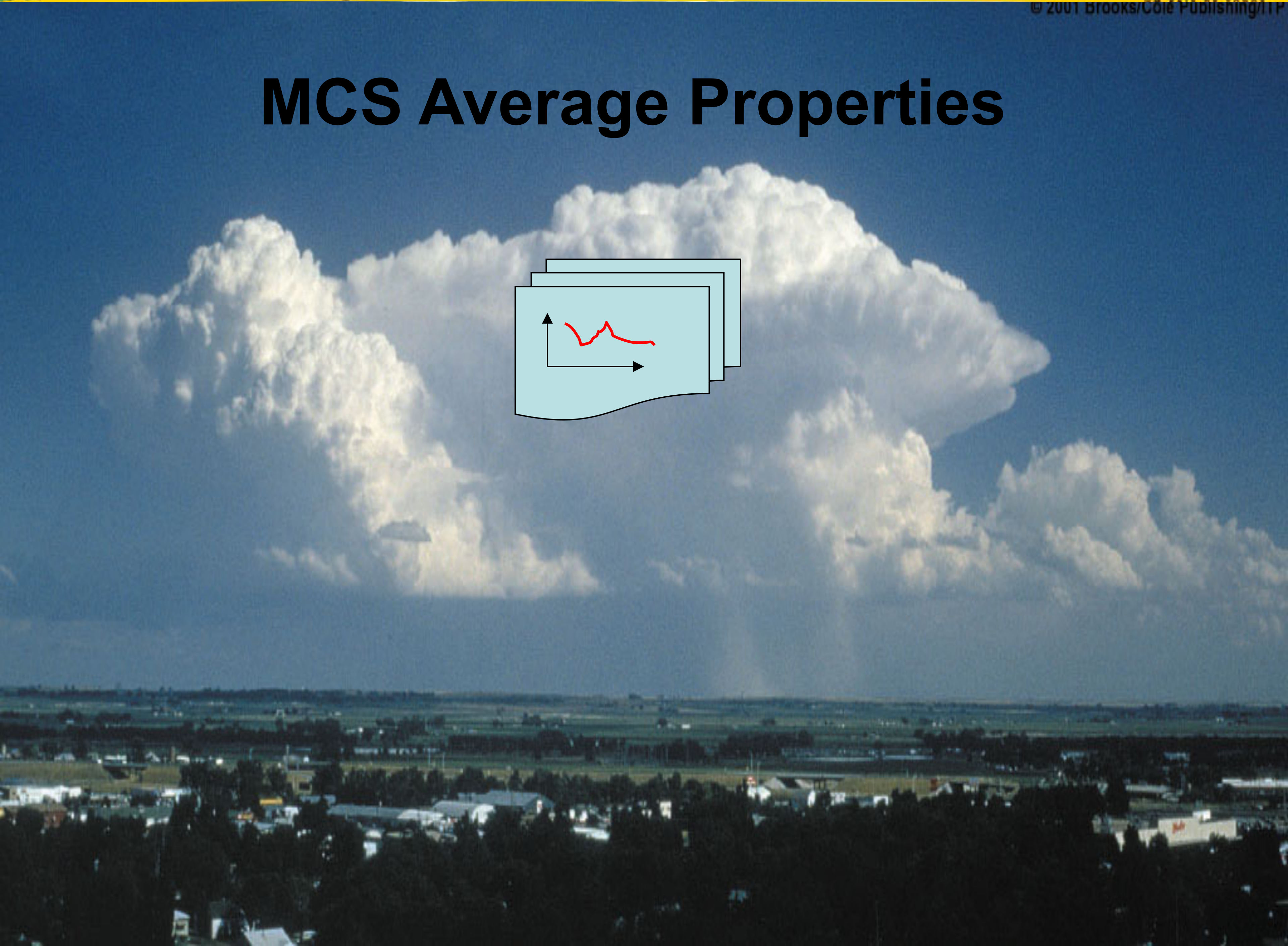


FIG. 1. Map of the studied region and definition of the ITCZ subregion.

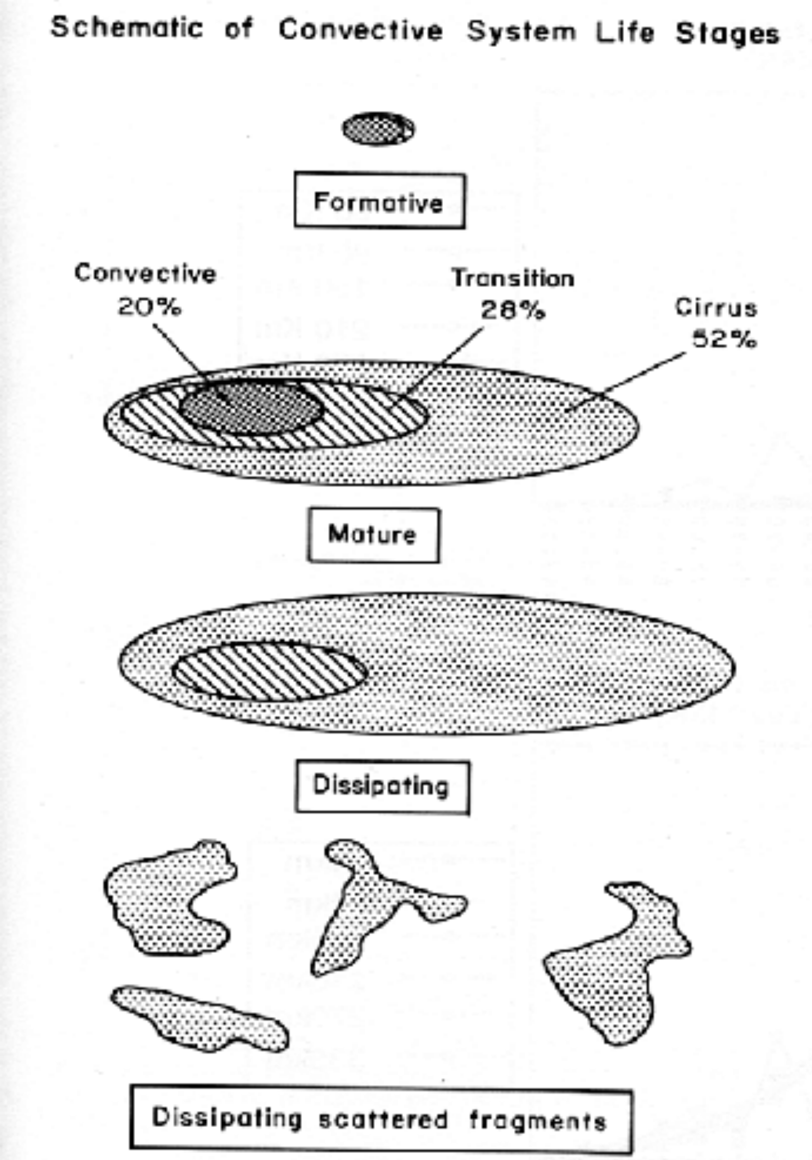
The MCS Organization as function of the Diurnal Cycle – Amazonas

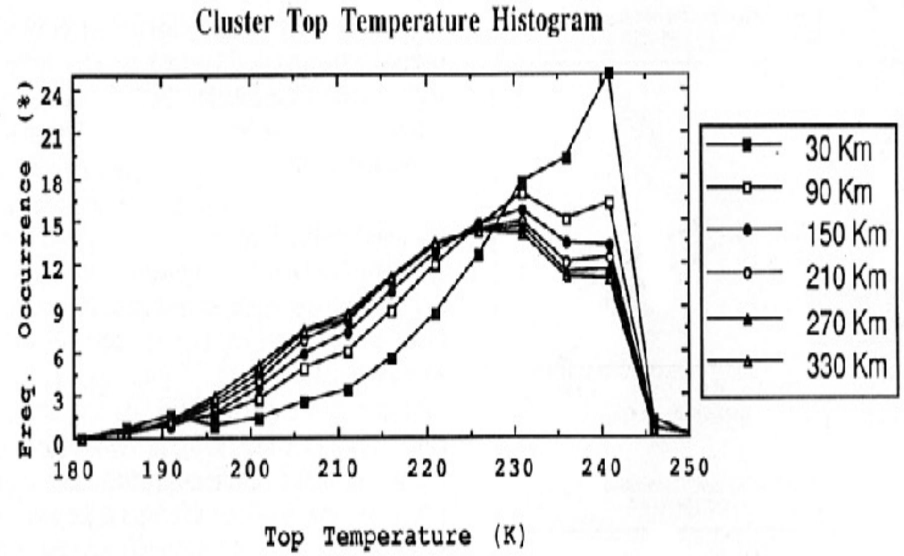


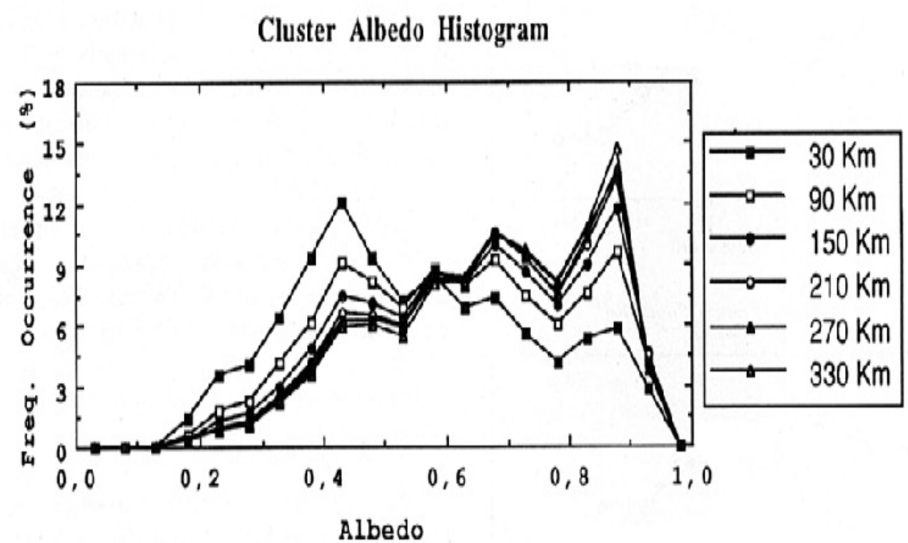
MCS Average Properties



MCS Characteristics and Life Cycle







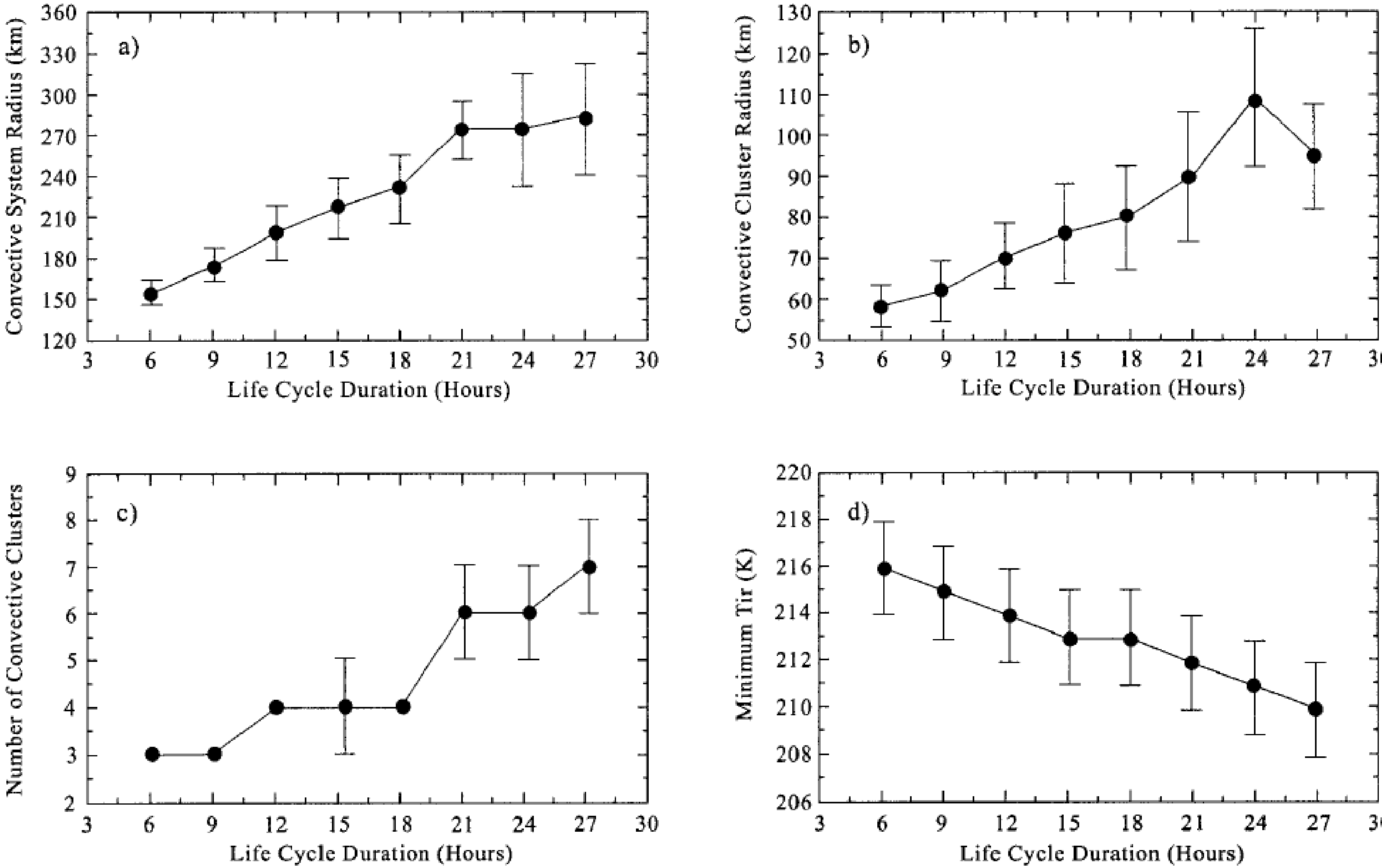
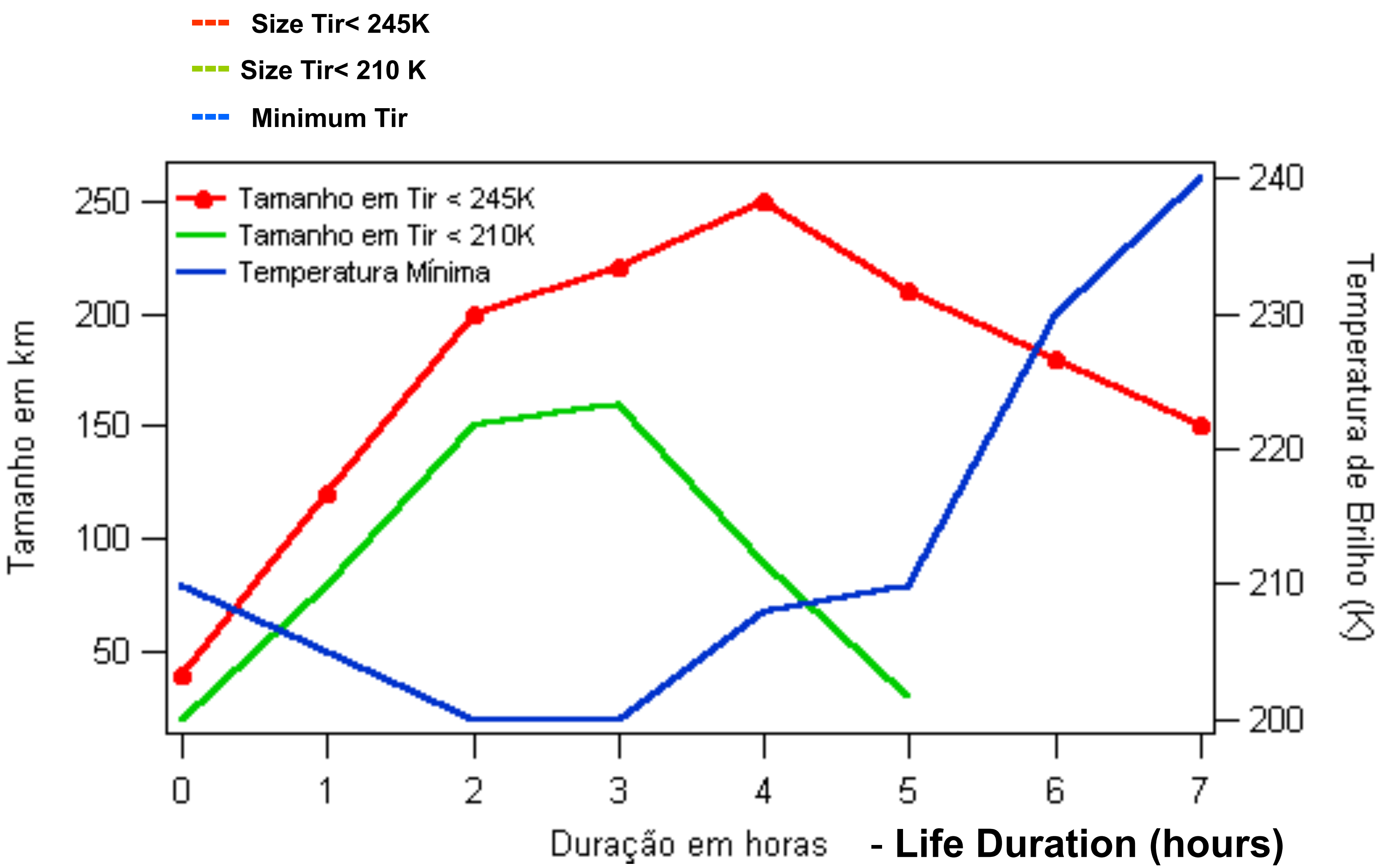
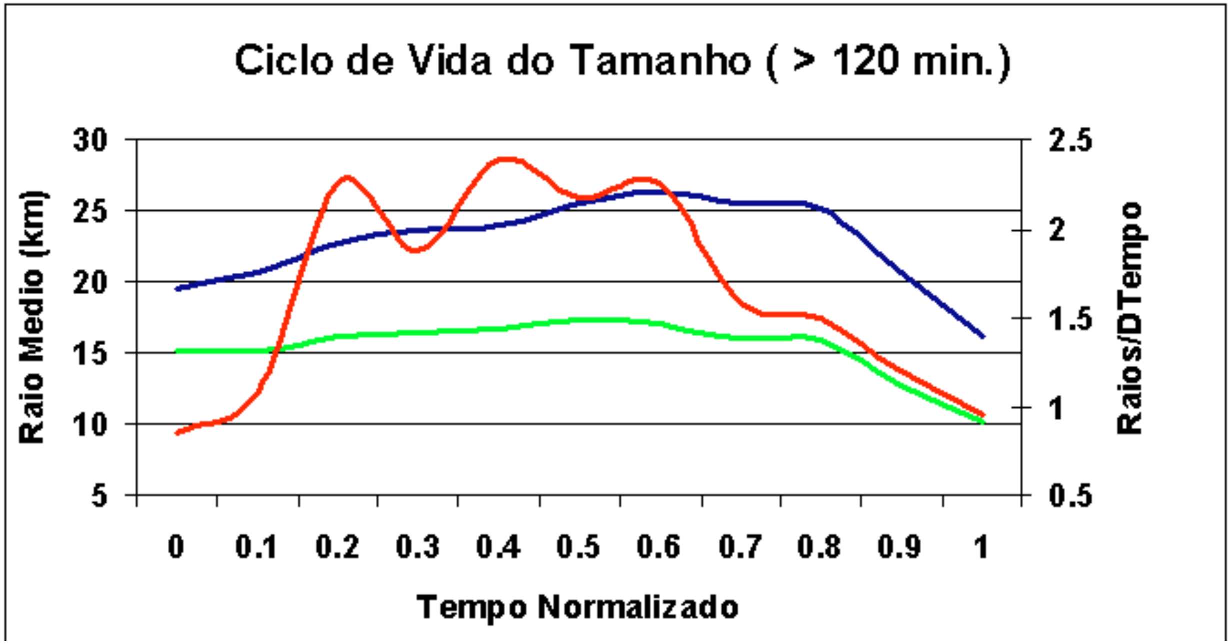


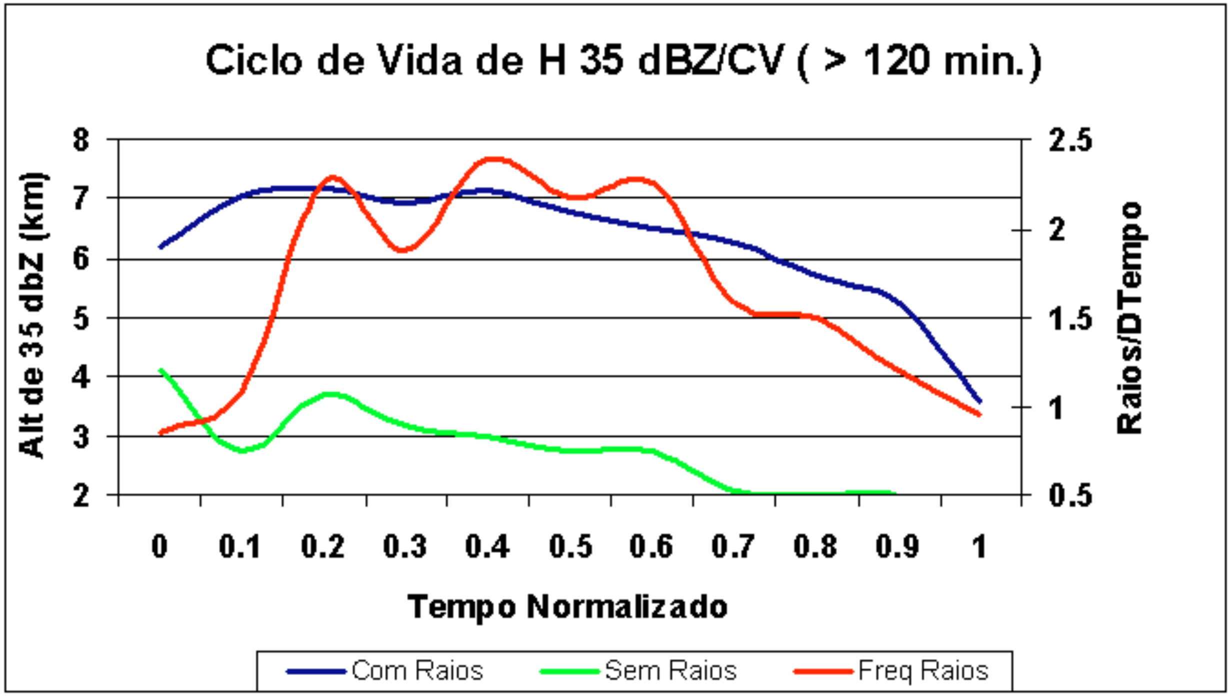
FIG. 8. Average and standard deviation of (a) the effective radius of the convective systems (CS), (b) the effective radius of the largest convective cluster (CC), (c) the number of CC in the CS, and (d) the minimum T_{IR} of the CS as a function of the CS life cycle duration from one year of tracking by the semiautomatic method.



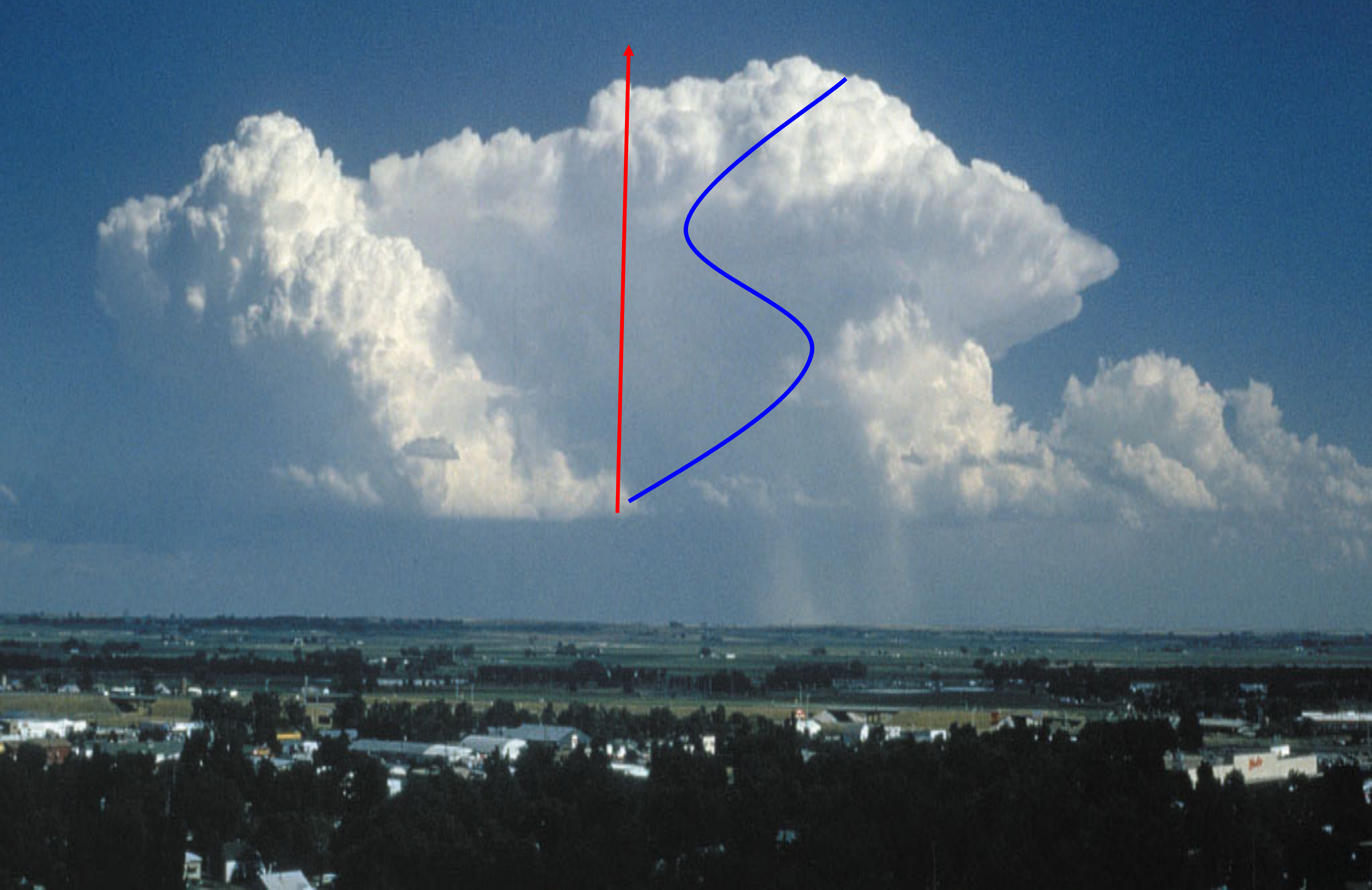
Size Tir< 245K
Size Tir< 210 K
Minimum Tir
Tamanho em Tir < 245K
Tamanho em Tir < 210K
Temperatura Mínima
Tamanho em km
250
200
150
100
50
240
230
220
210
200
Temperatura de Brilho (K)
0
1
2
3
4
5
6
7
Duração em horas
- Life Duration (hours)

RADAR TRACKING





MCS Vertical Distribution



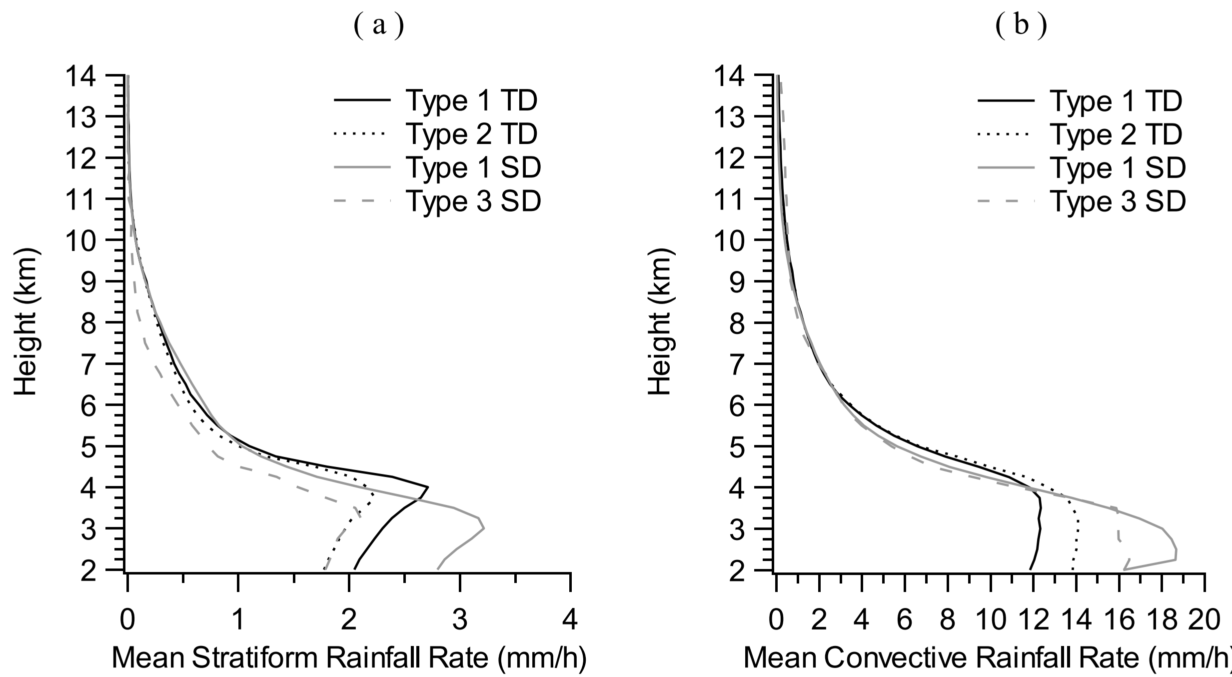
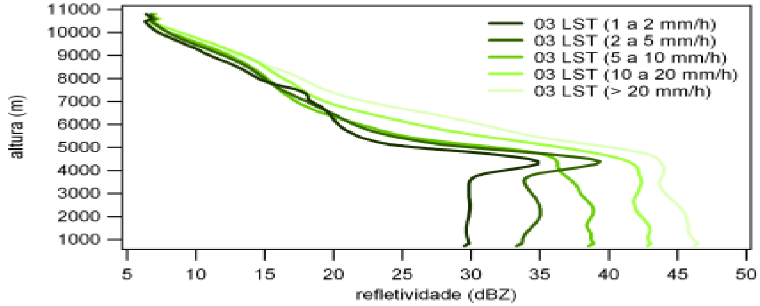
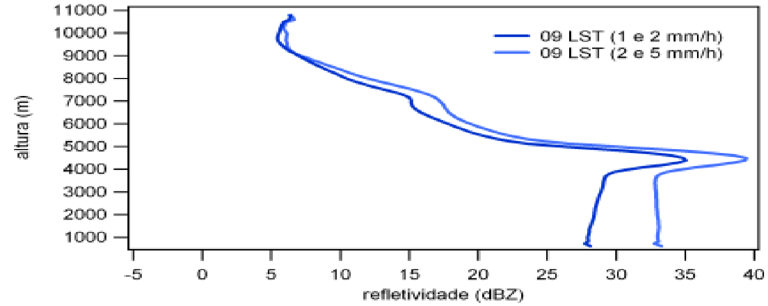


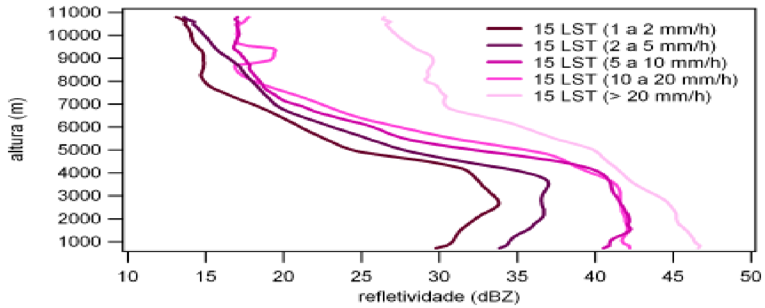
Figure 7 - Mean stratiform (a) and convective (b) rainfall rate profiles for every 0.25 km (above 2 km) estimated from the 2A25/PR pixels at the mature phase of the CS lifecycle for the four CS groups.


03 LST (1 a 2 mm/h)
03 LST (2 a 5 mm/h)
03 LST (5 a 10 mm/h)
03 LST (10 a 20 mm/h)
03 LST (> 20 mm/h)
altura (m)
refletividade (dBZ)

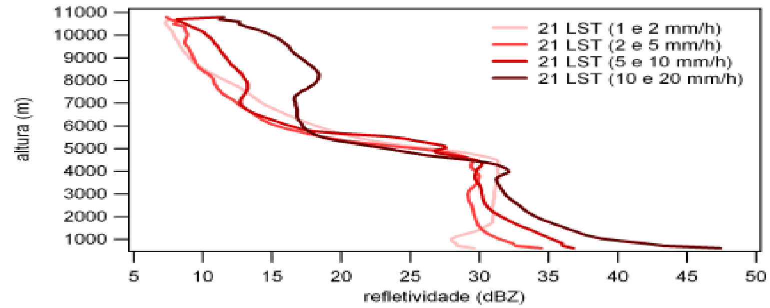
(a)


09 LST (1 e 2 mm/h)
09 LST (2 e 5 mm/h)
altura (m)
refletividade (dBZ)

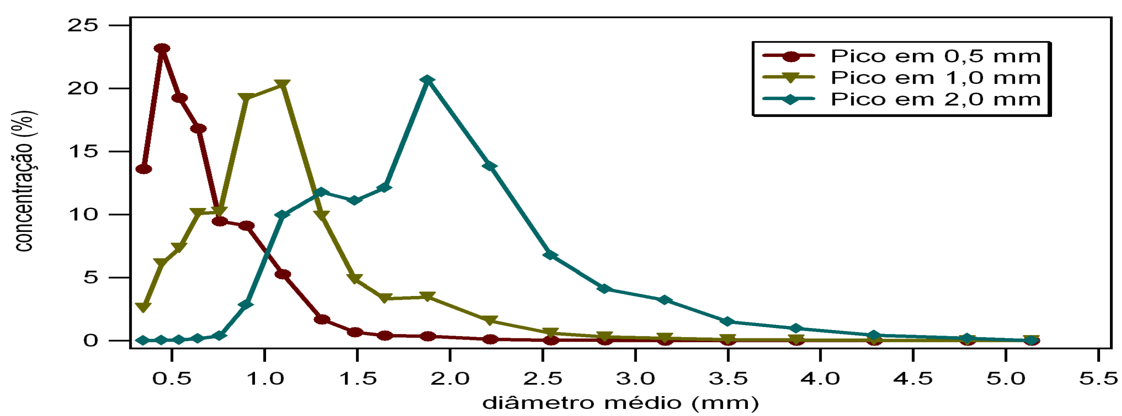
(b)


15 LST (1 a 2 mm/h)
15 LST (2 a 5 mm/h)
15 LST (5 a 10 mm/h)
15 LST (10 a 20 mm/h)
15 LST (> 20 mm/h)
altura (m)
refletividade (dBZ)

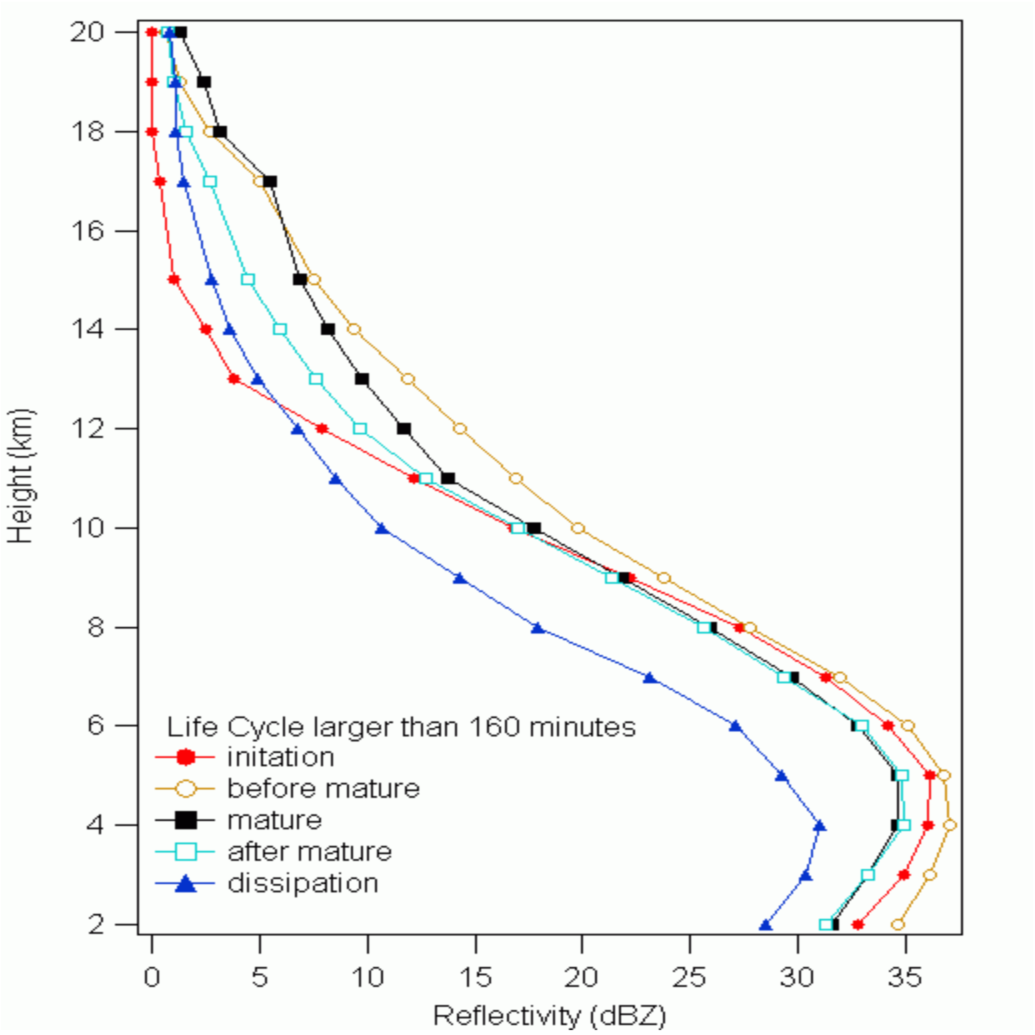
(c)


21 LST (1 e 2 mm/h)
21 LST (2 e 5 mm/h)
21 LST (5 e 10 mm/h)
21 LST (10 e 20 mm/h)
altura (m)
refletividade (dBZ)

(d)


Pico em 0,5 mm
Pico em 1,0 mm
Pico em 2,0 mm
concentração (%)
diâmetro médio (mm)

Composite of the reflectivity vertical profile at different lifetime
Weather Radar – S BAND



These figures show the increase of the ice phase as the cloud evolves to the mature stage.

Cloud with longer lifetime show intense liquid water phase at the initiation stage.

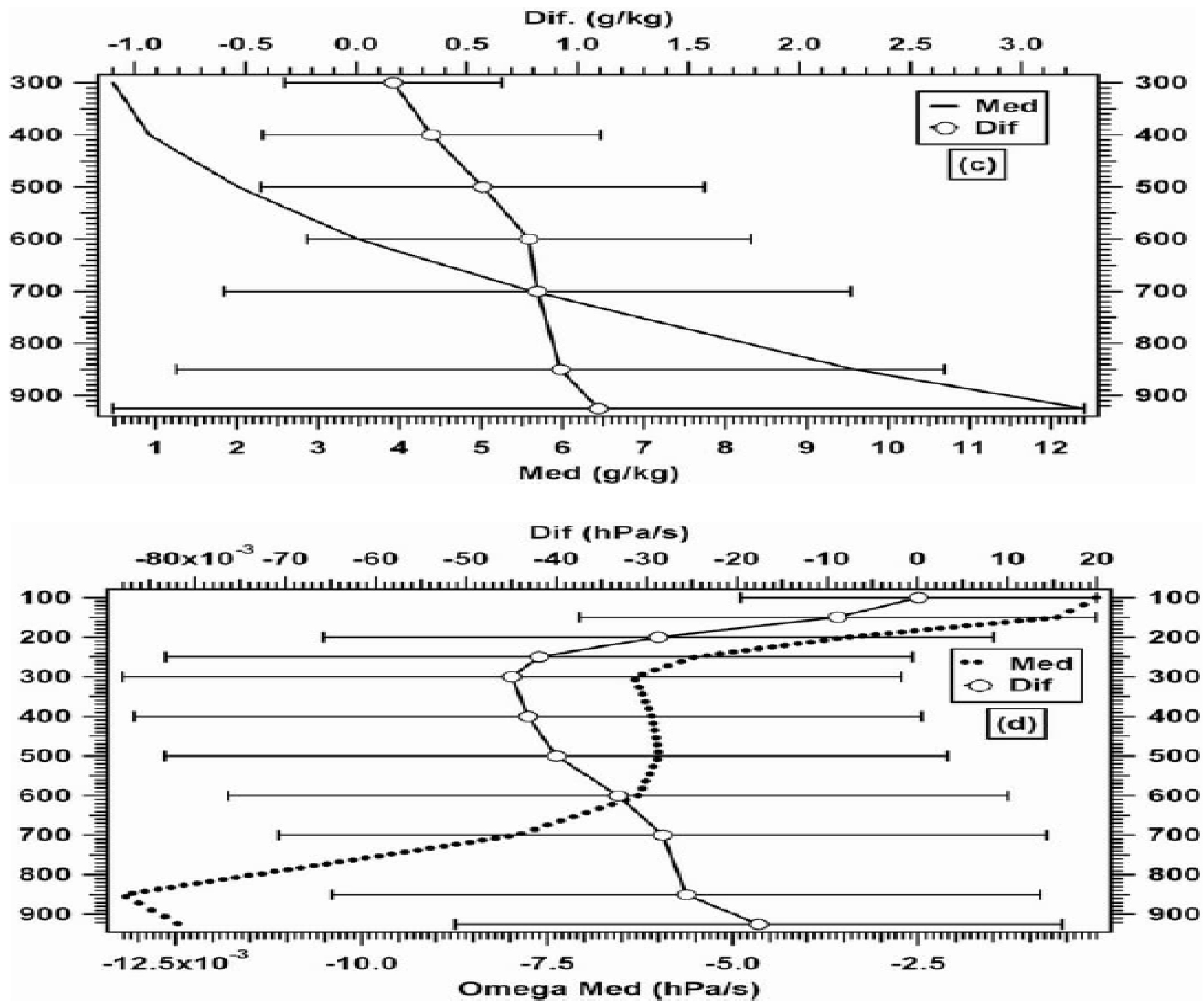


Figura 3: Perfil médio equatorial (Med.) e a diferença (Dif.) entre o perfil perturbado e o perfil médio da temperatura do ar (a), geopotencial (b), umidade (c) e omega (d).

Energy Perturbation from MCS to Clear sky and from Clear to MCS

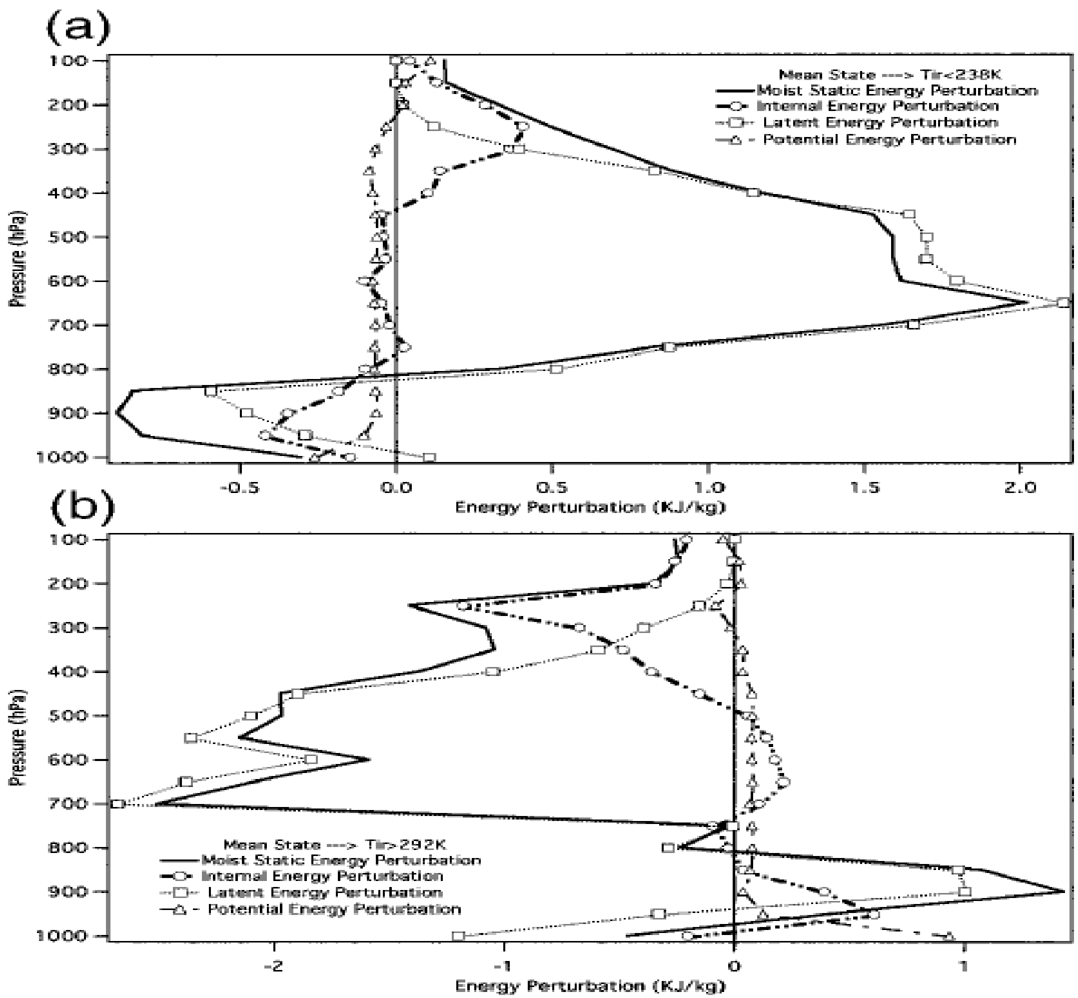
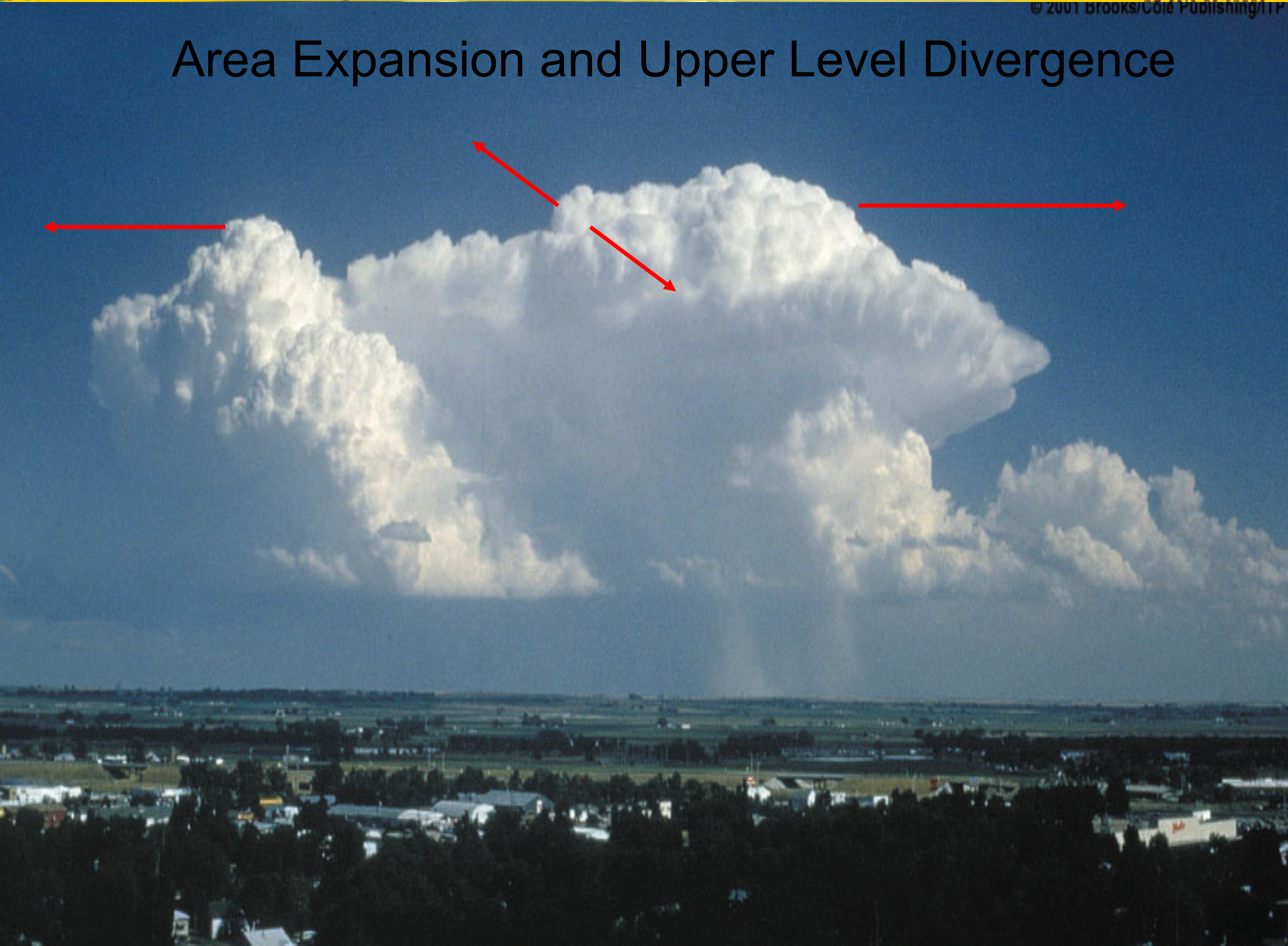
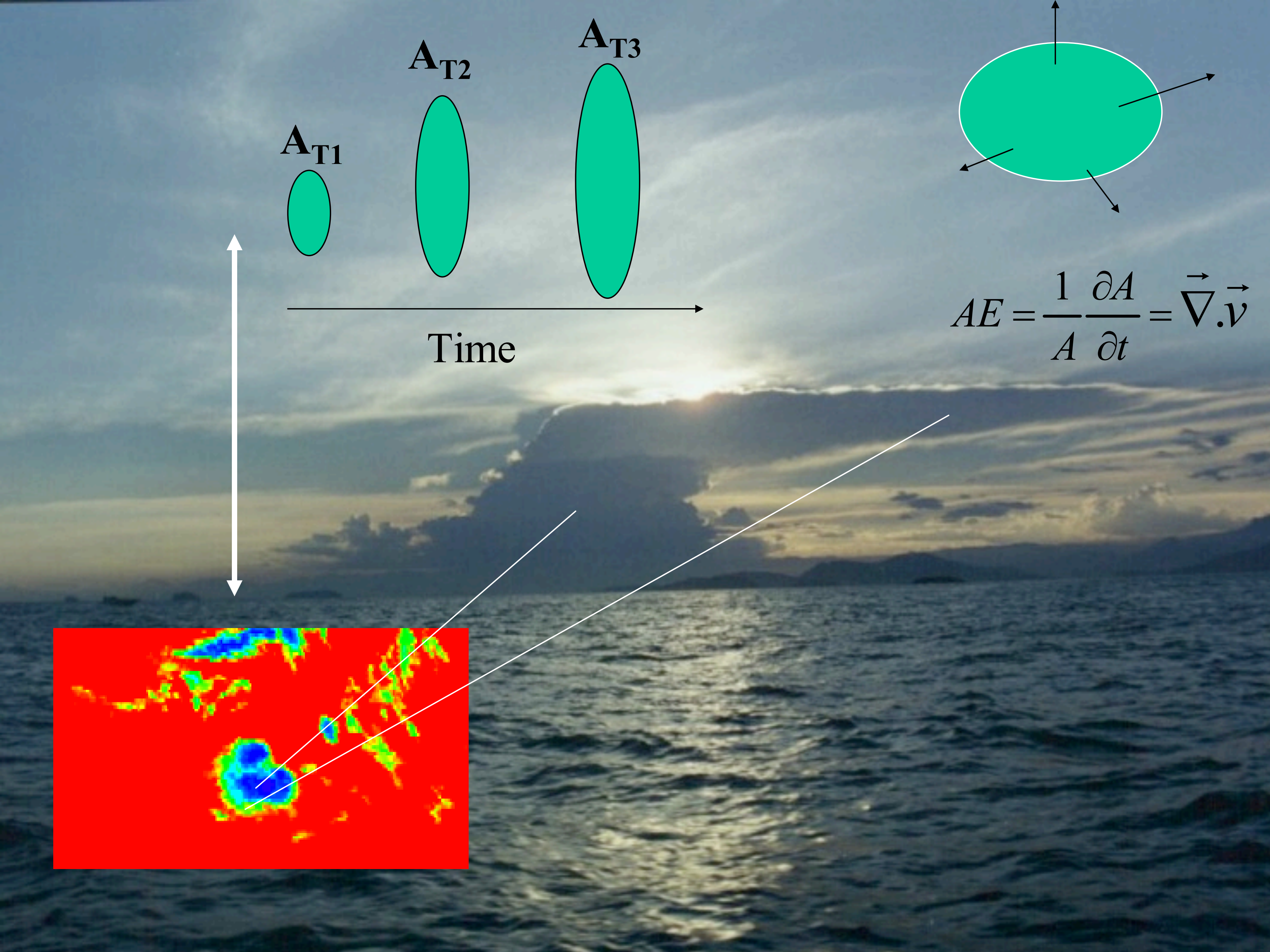


FIG. 3. Profiles of the energy perturbation (moist static energy, internal energy, latent, and potential) from the average state to the condition defined by (a) Tir < av_Tir − 1.5σ (typical of high clouds situation Tir < 238 K) and (b) Tir > av_Tir + 1.5σ (typical of low clouds situation Tir > 292 K).

Area Expansion and Upper Level Divergence





A_{T1}
A_{T2}
A_{T3}
Time
$AE = \frac{1}{A}\frac{\partial A}{\partial t} = \vec{\nabla}.\vec{v}$

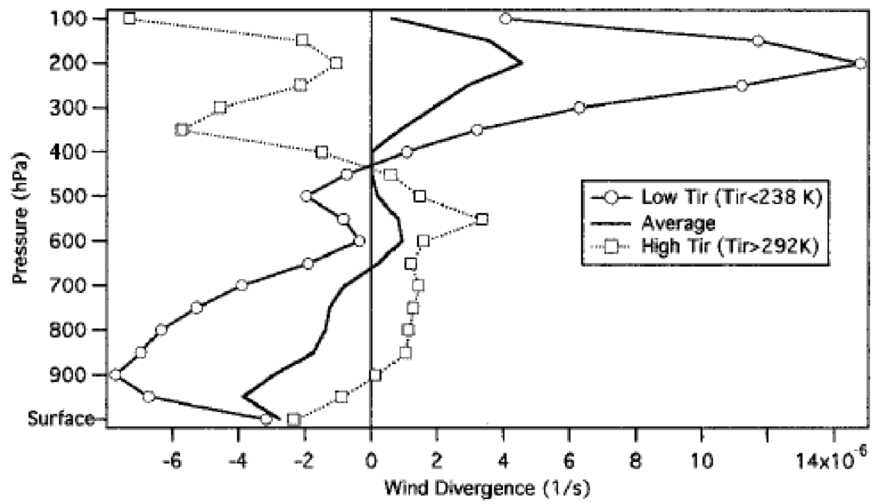
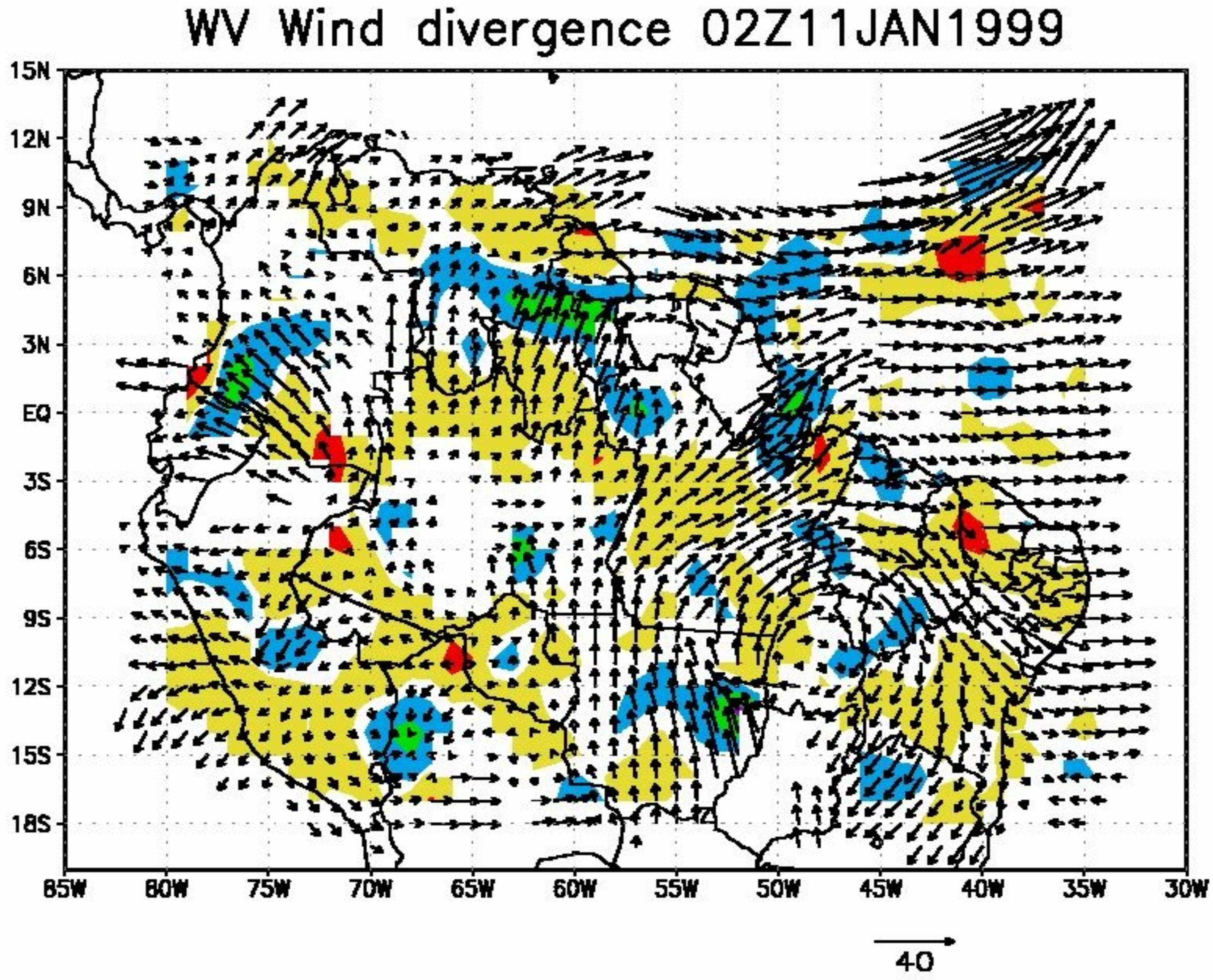
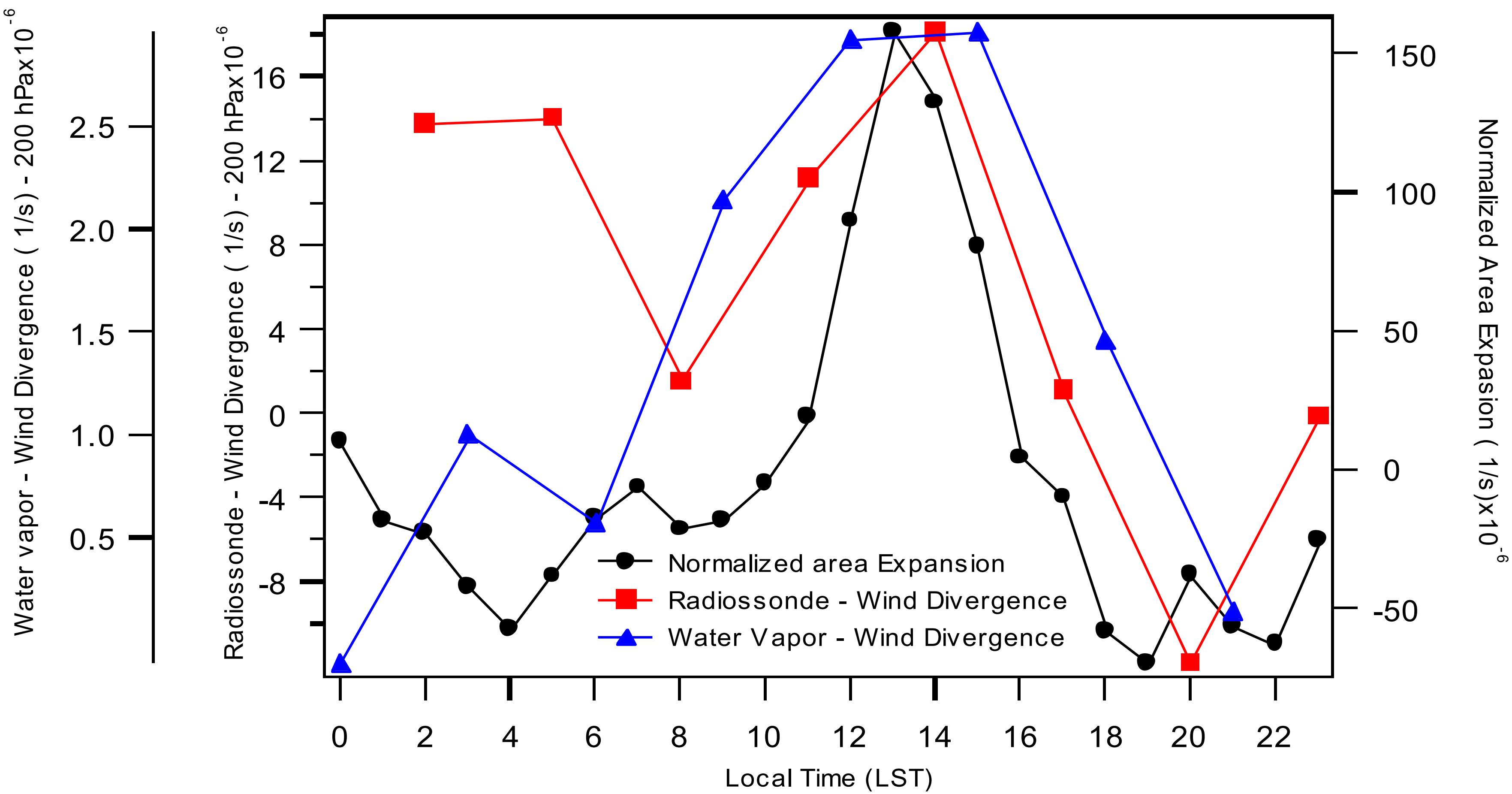
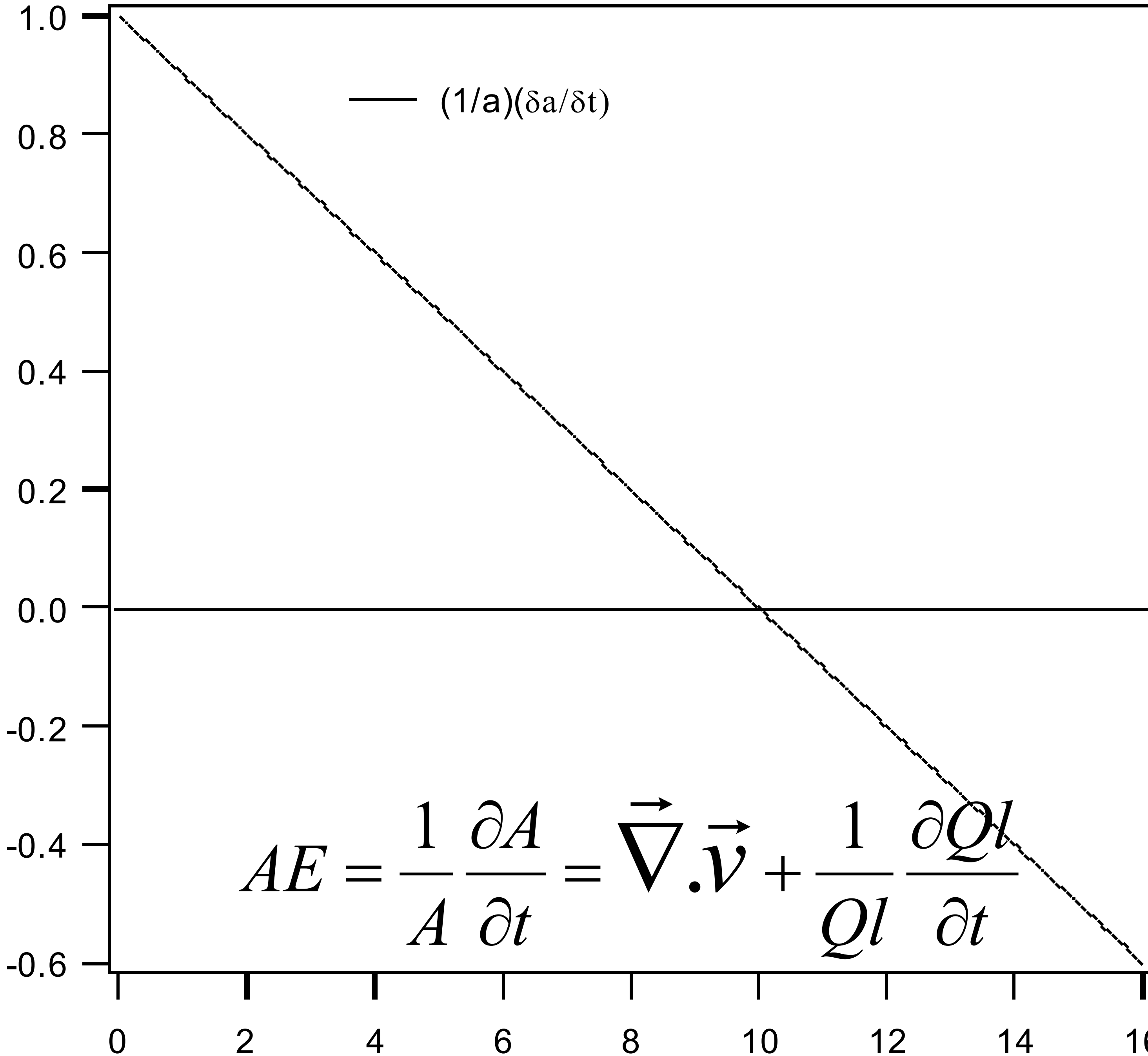


FIG. 5. Average wind divergence profile for the condition of low Tir (Tir < 238 K), mean Tir, and high Tir (Tir > 292 K), for ABLE-2B and FluAmazon.

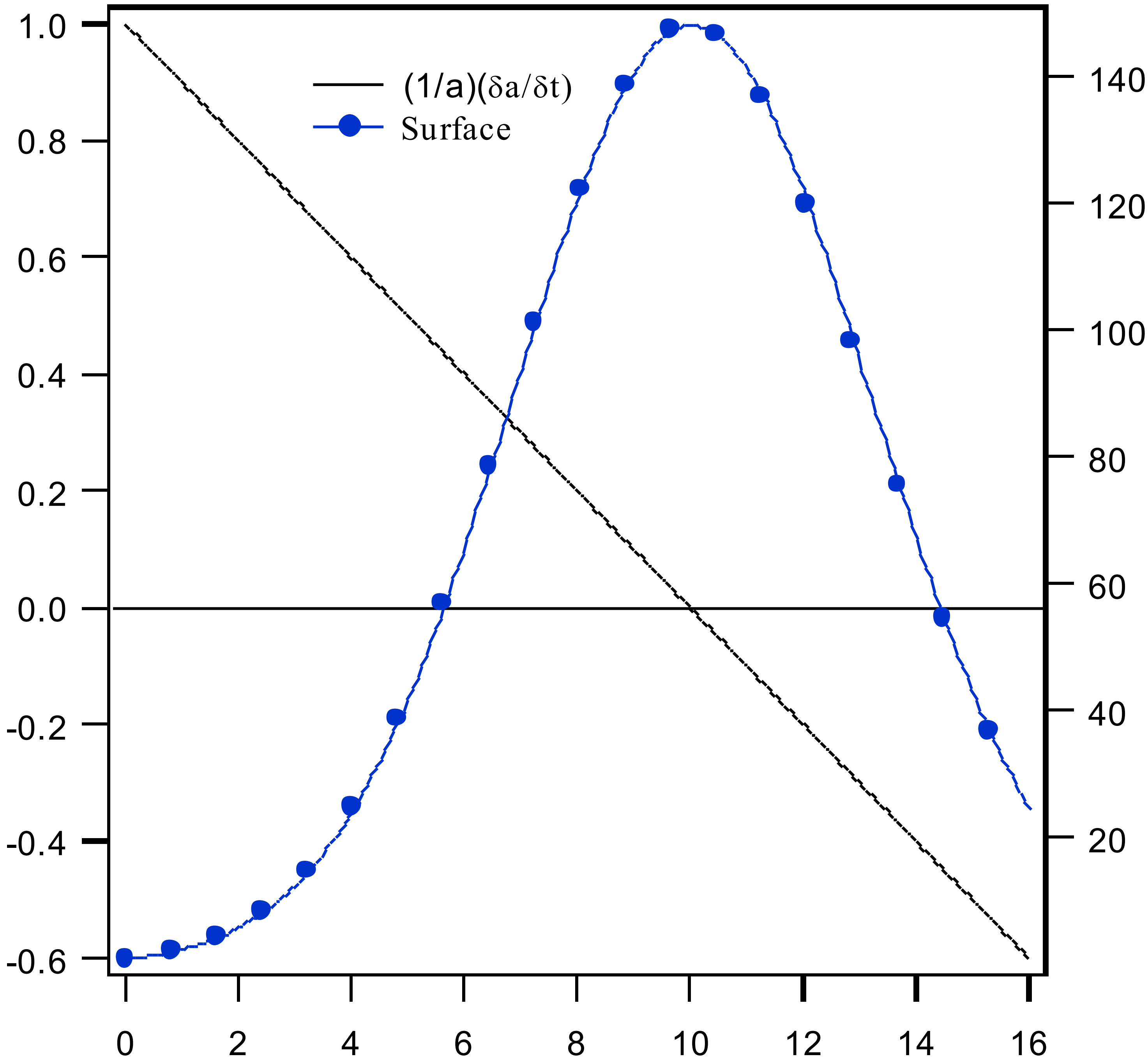

WV Wind divergence 02Z11JAN1999
15N
12N
9N
6N
3N
EQ
3S
6S
9S
12S
15S
18S
85W
80W
75W
70W
65W
60W
55W
50W
45W
40W
35W
30W
40

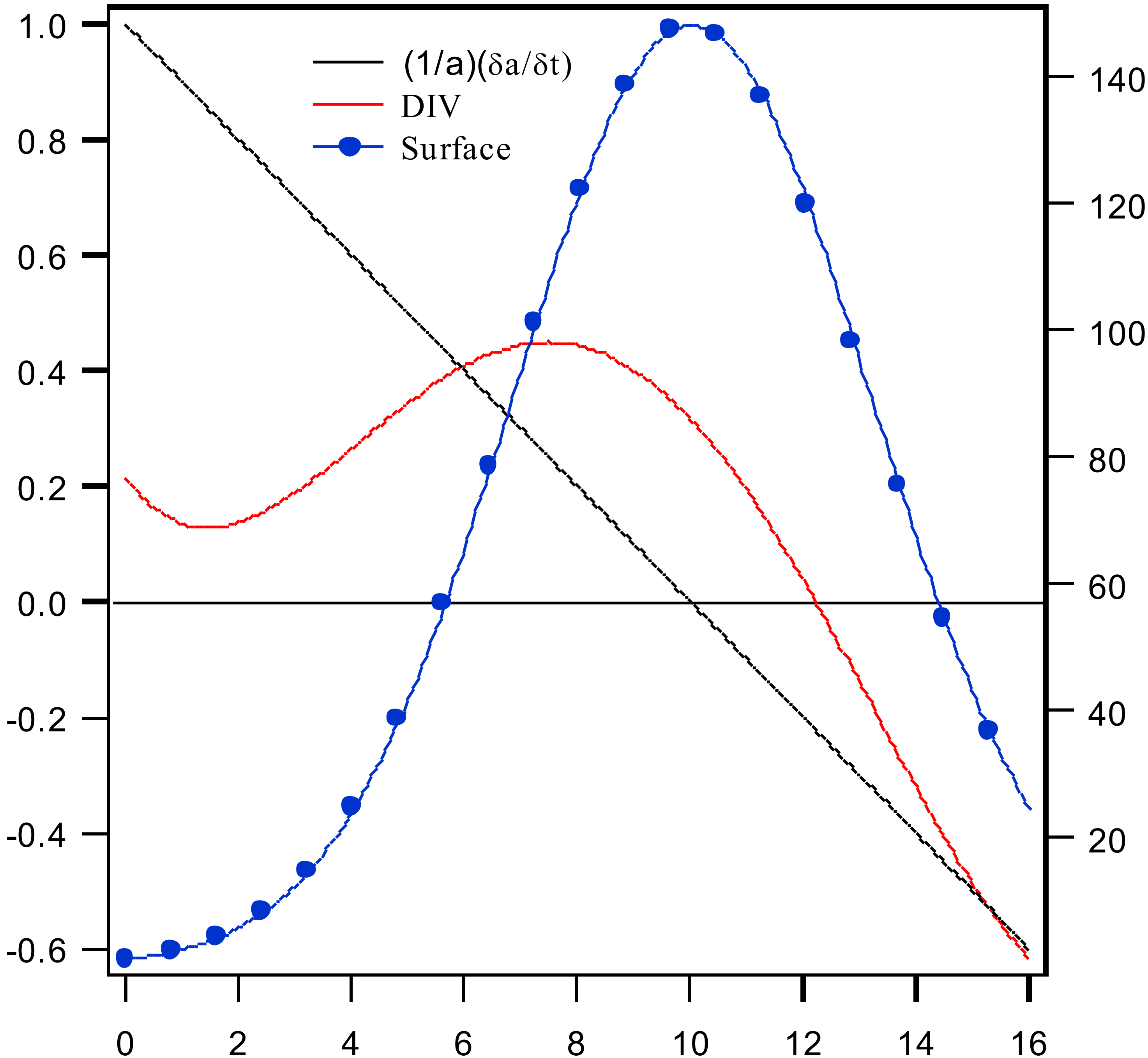
Hourly average area expansion, water vapor wind divergence and wind divergence from radiossonde for 200 hPa level at WETAMC/LBA region.



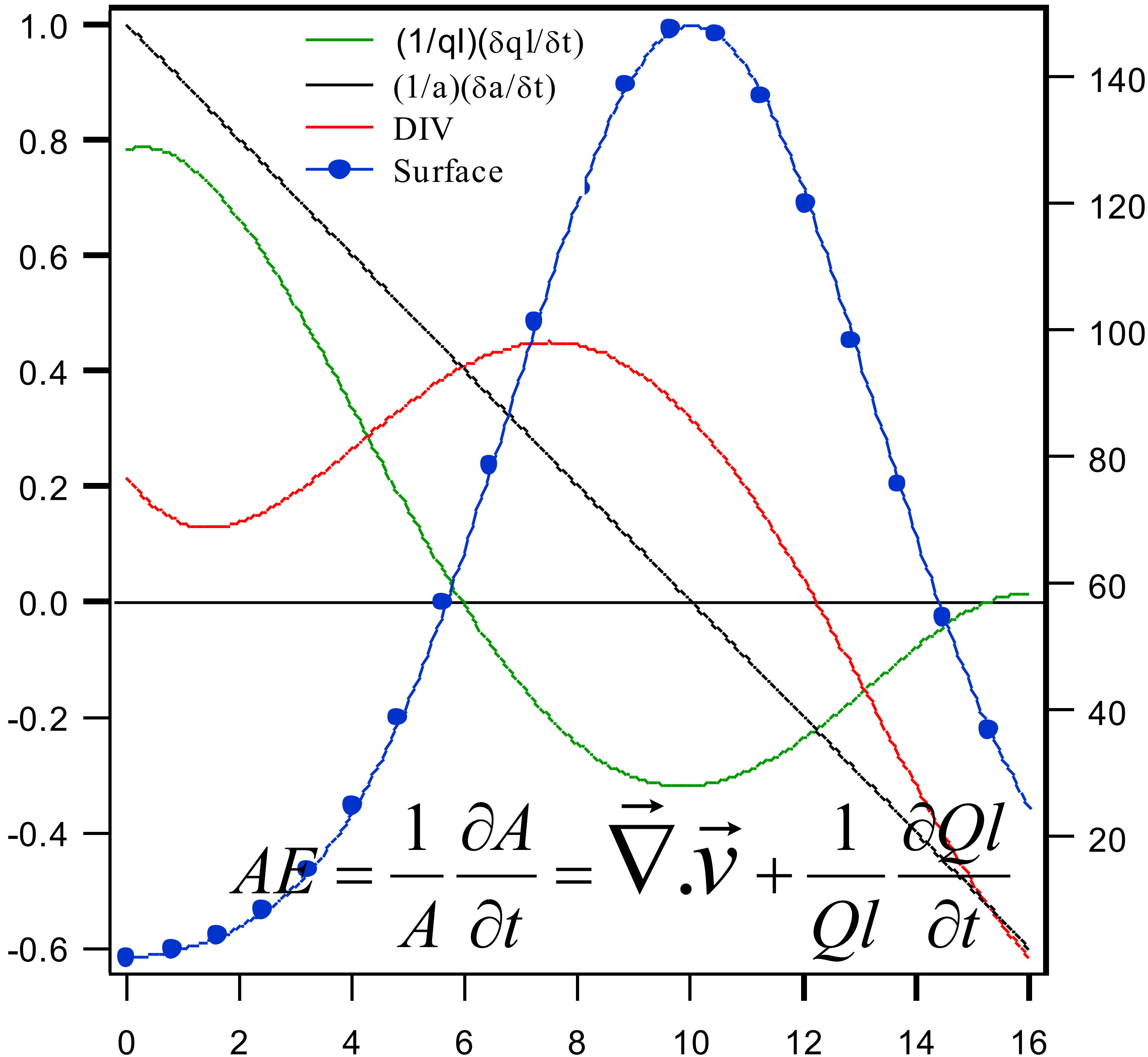


$$AE = \frac{1}{A}\frac{\partial A}{\partial t} = \vec{\nabla}.\vec{v} + \frac{1}{Ql}\frac{\partial Ql}{\partial t}$$


(1/a)(δa/δt)
Surface
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
140
120
100
80
60
40
20
0
2
4
6
8
10
12
14
16

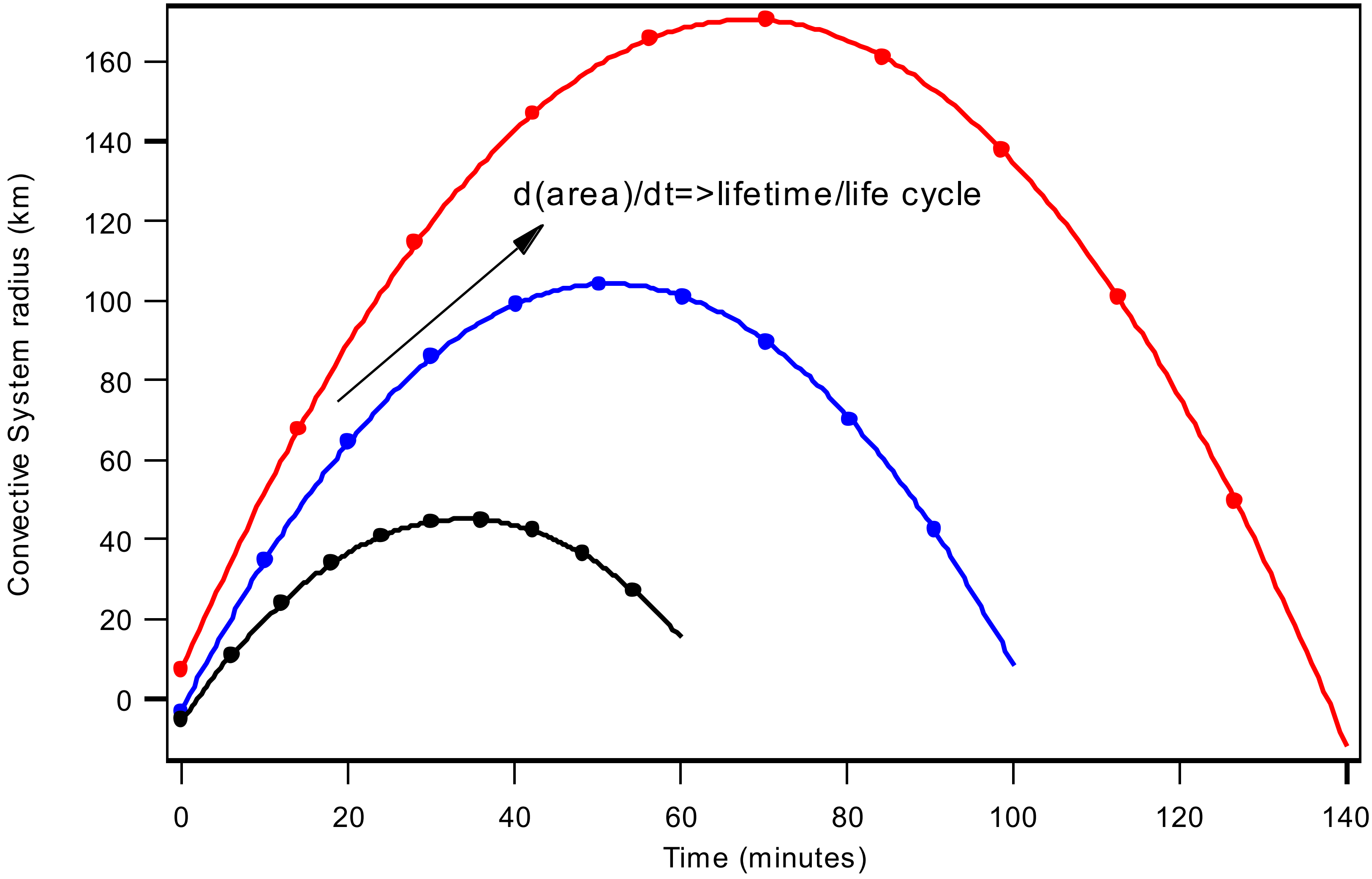


(1/a)(δa/δt)
DIV
Surface
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
140
120
100
80
60
40
20
0
2
4
6
8
10
12
14
16

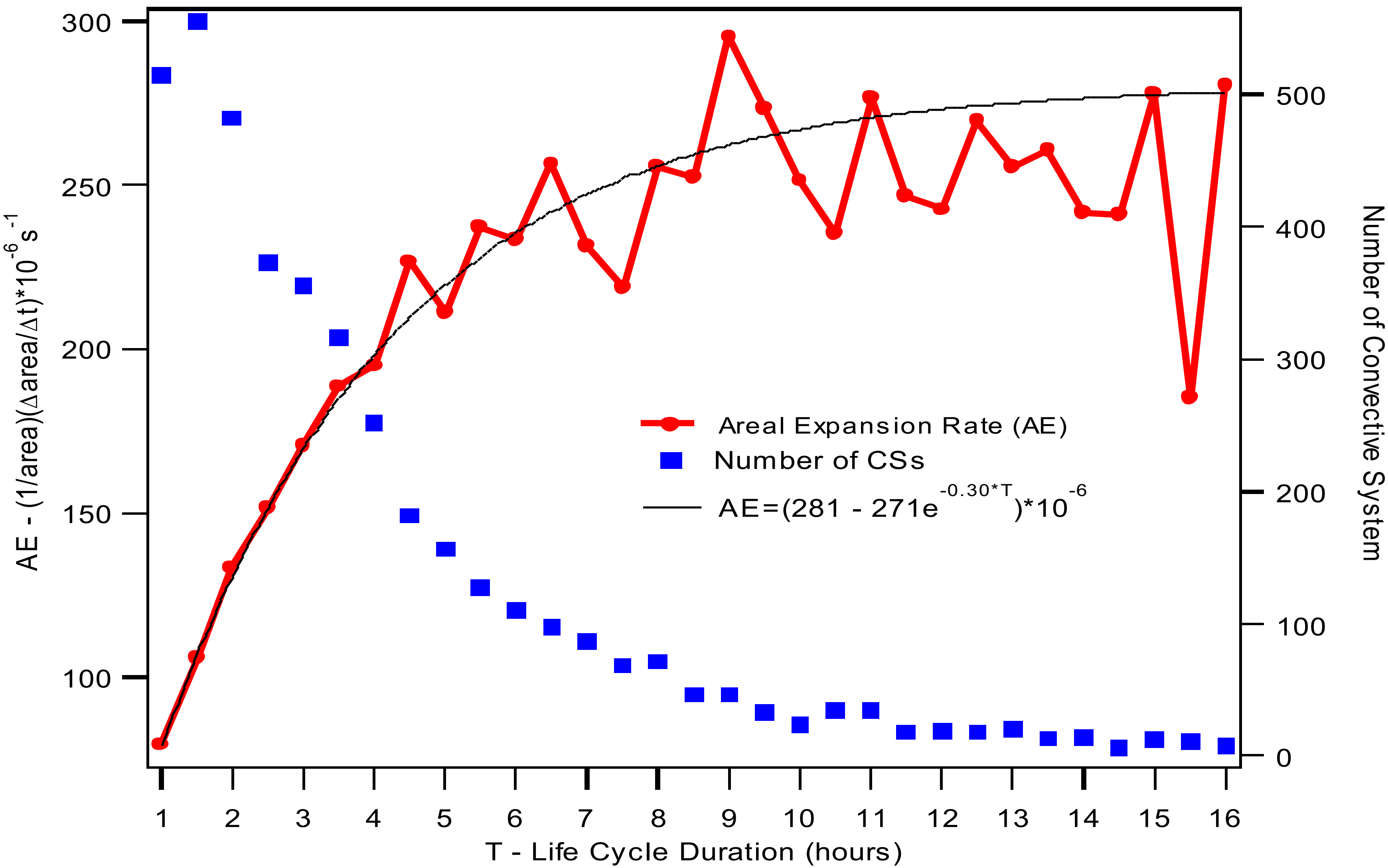


(1/ql)(δql/δt)
(1/a)(δa/δt)
DIV
Surface
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
140
120
100
80
60
40
20
0
2
4
6
8
10
12
14
16
$AE = \frac{1}{A}\frac{\partial A}{\partial t} = \vec{\nabla}.\vec{v} + \frac{1}{Ql}\frac{\partial Ql}{\partial t}$

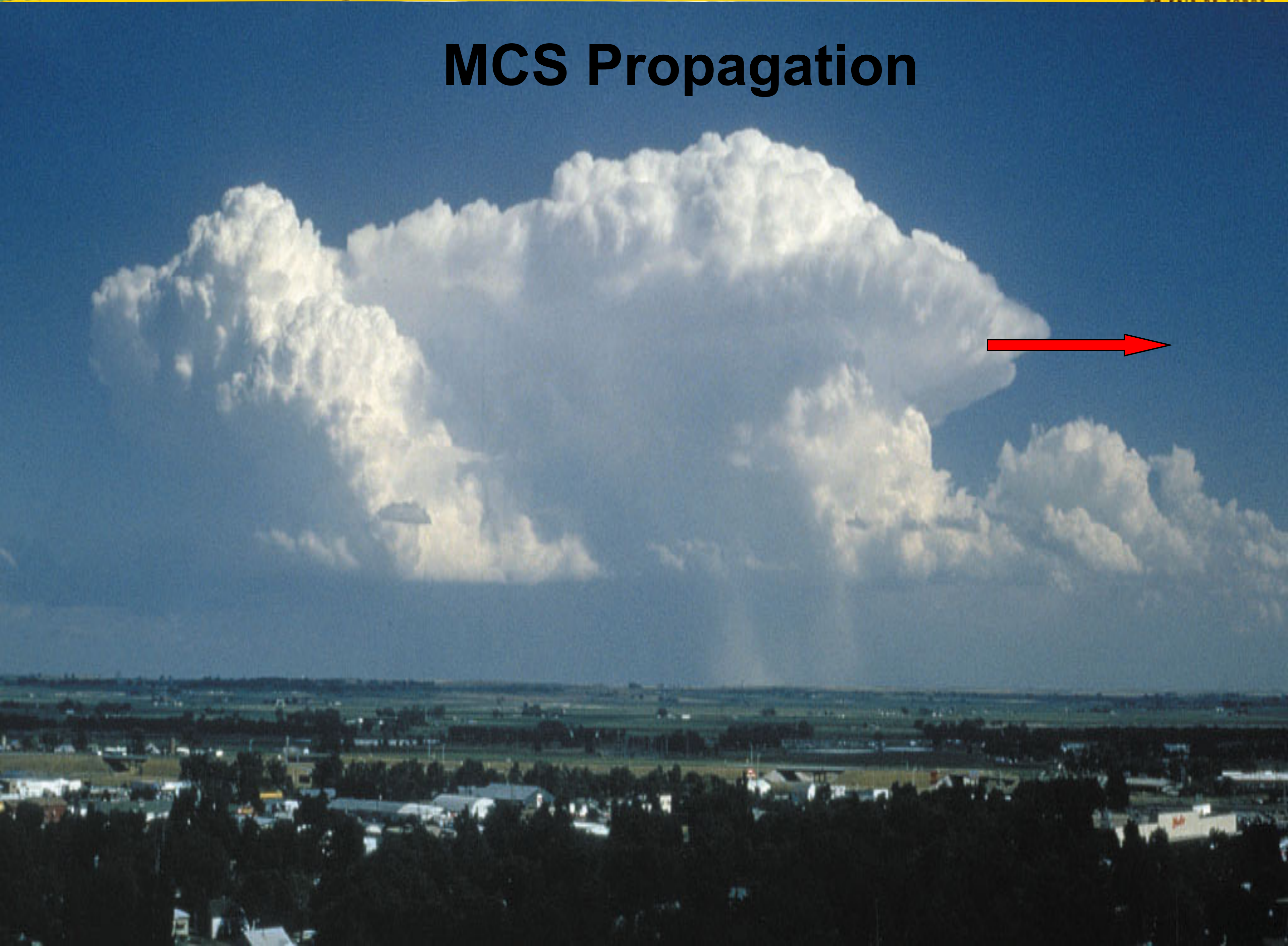
Schematic diagram of the convective system life cycle size evolution.

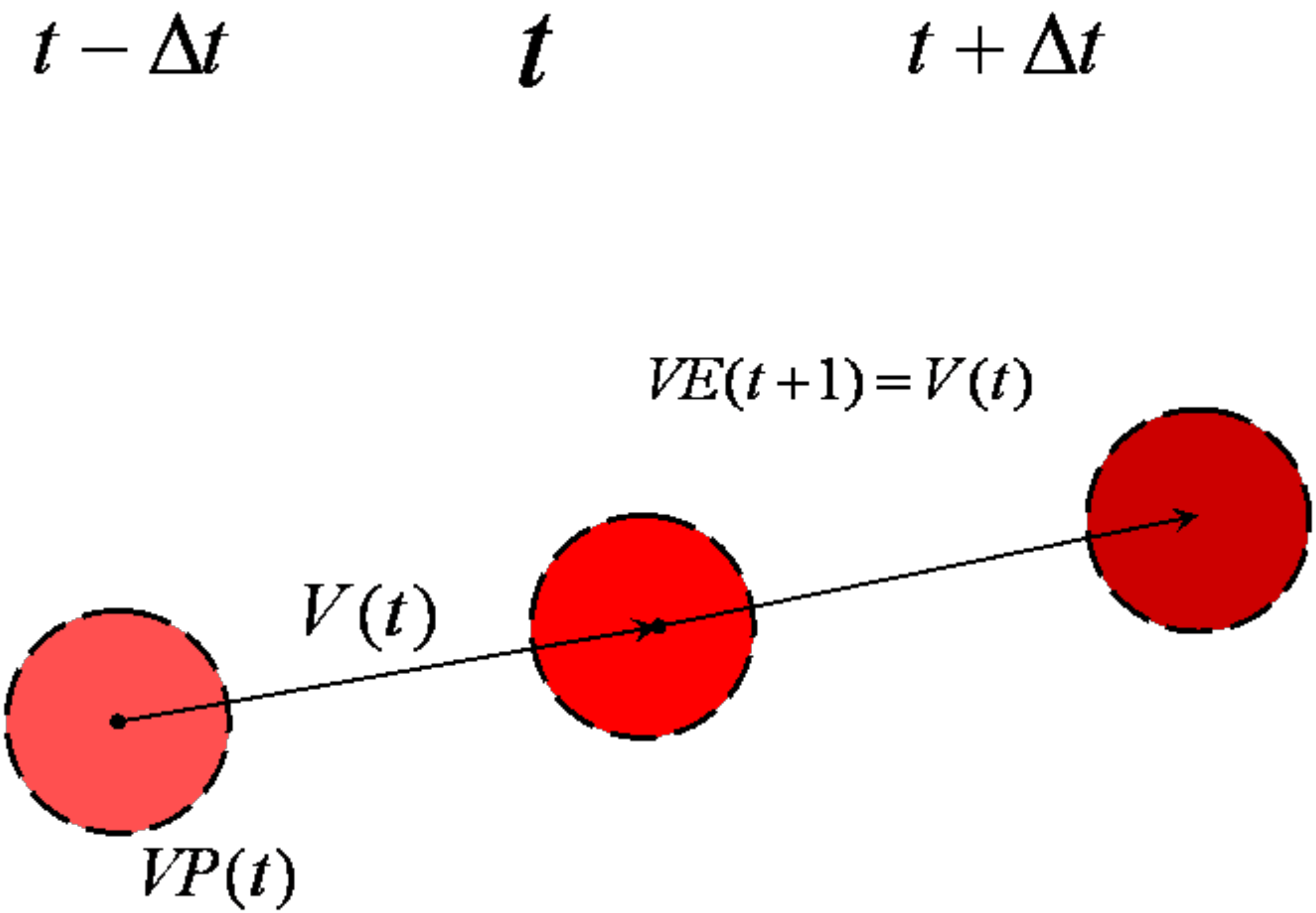


Normalized area expansion (10-6 s-1) as a function of the convective system life duration (hours). The number of cases is also plotted (right axis).

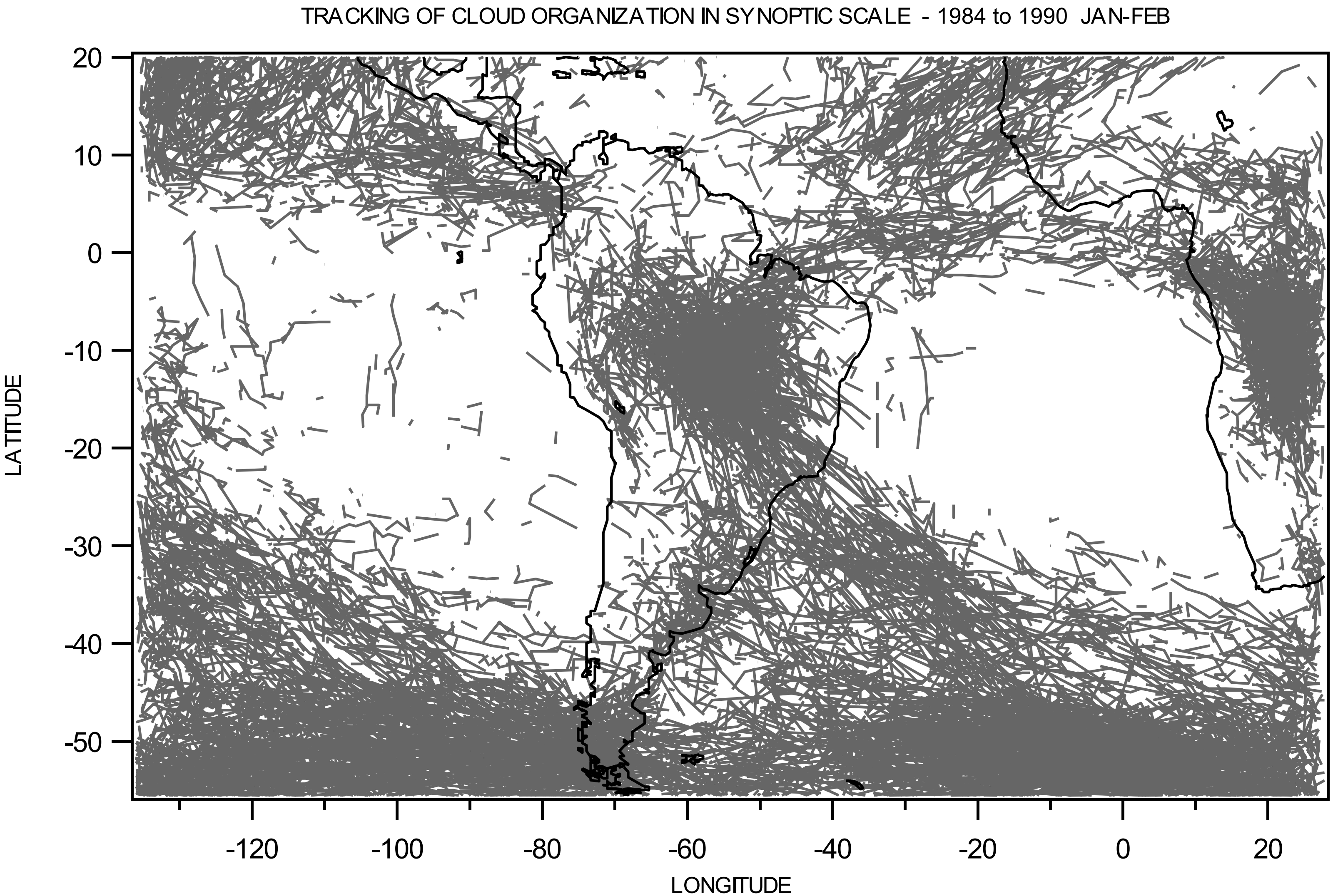


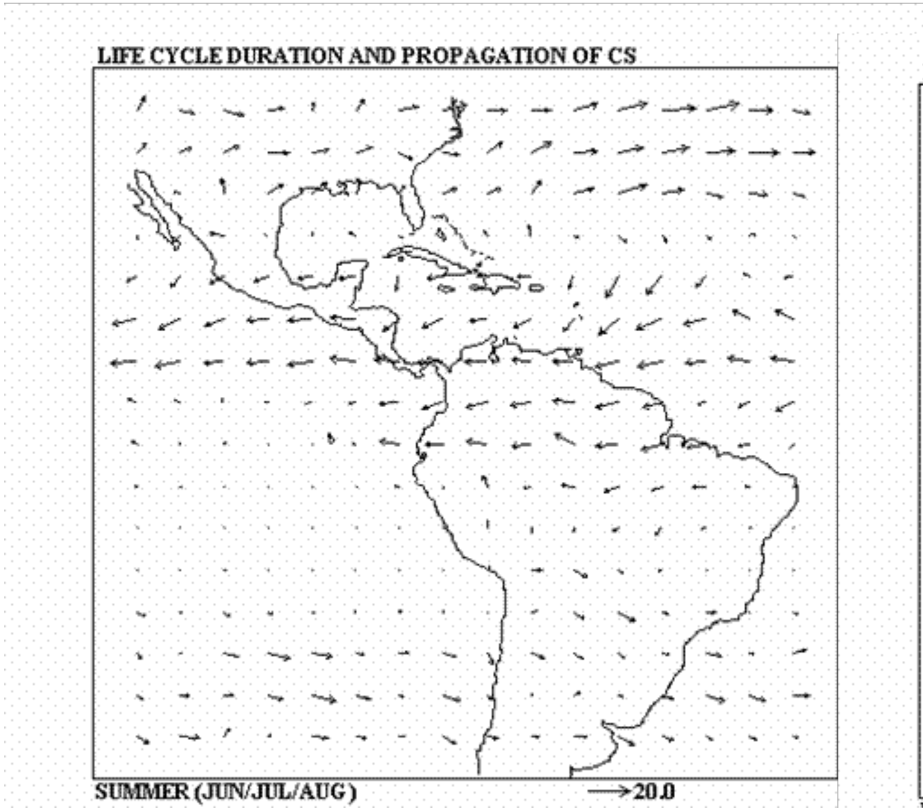
MCS Propagation

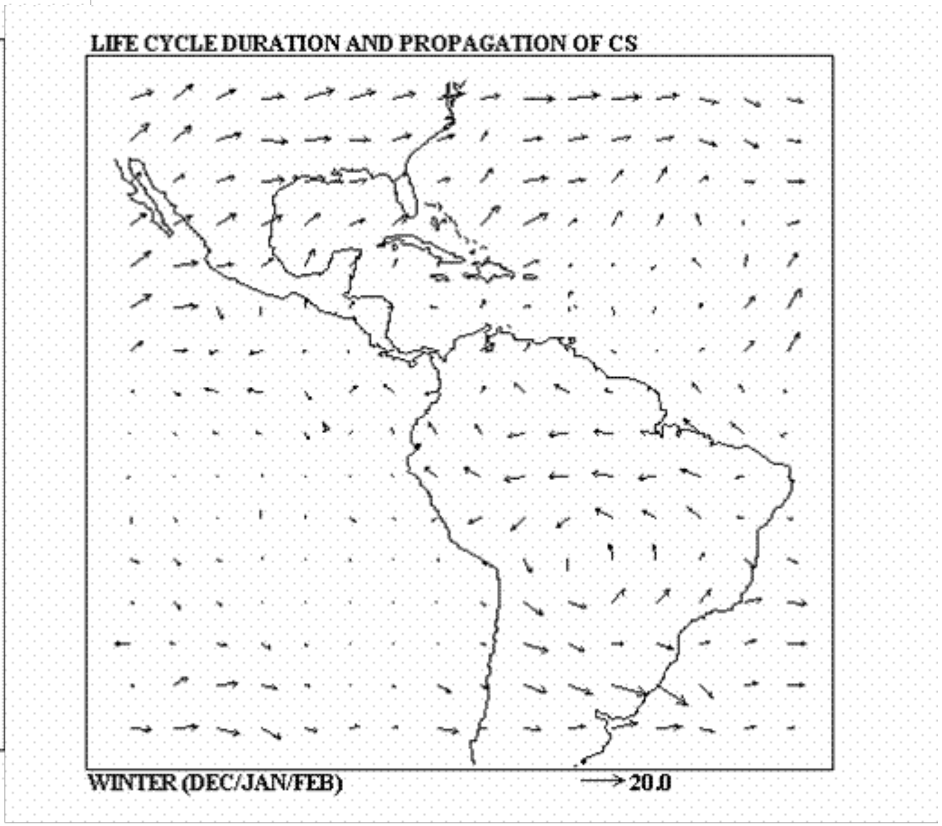


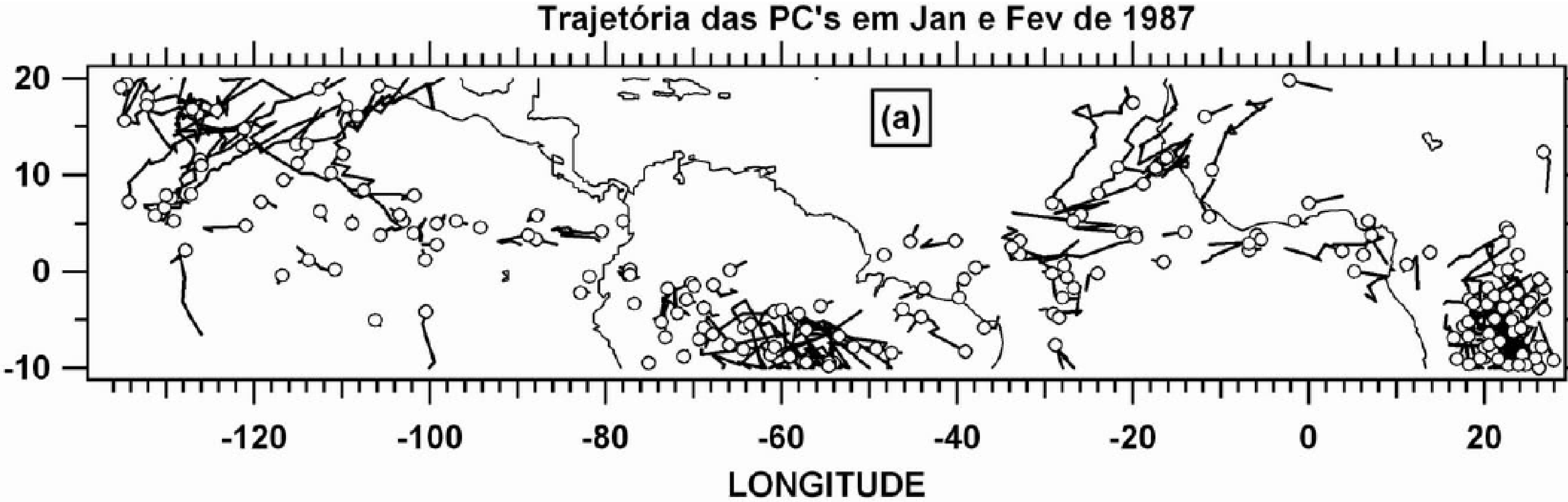

$t - \Delta t$
t
$t + \Delta t$
$VE(t+1) = V(t)$
$V(t)$
$VP(t)$

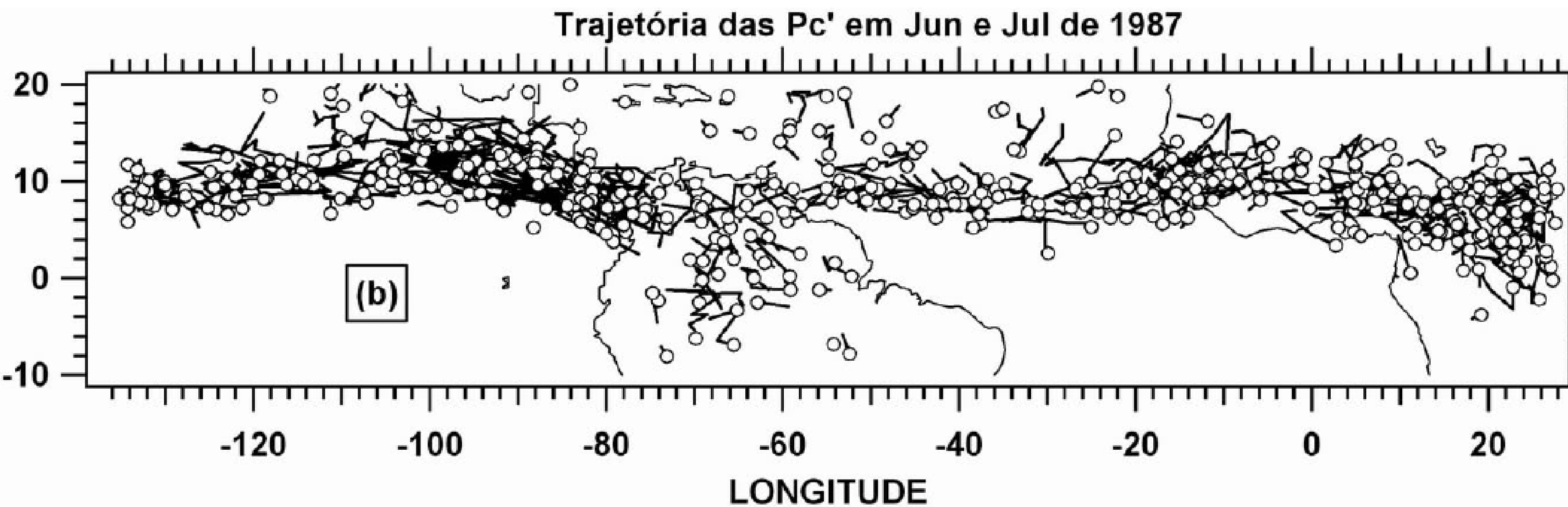
Tracking of Convective Systems



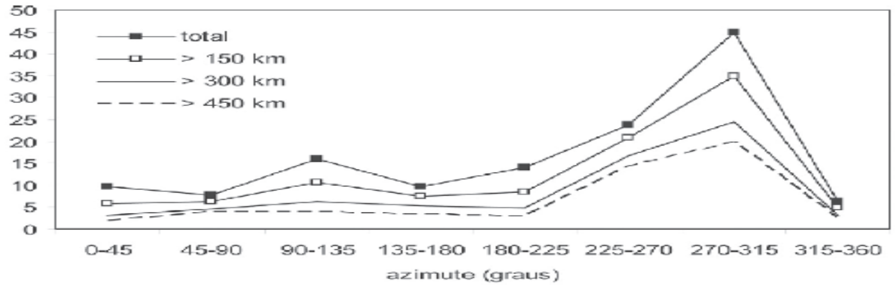

LIFE CYCLE DURATION AND PROPAGATION OF CS
SUMMER (JUN/JUL/AUG)
20.0


LIFE CYCLE DURATION AND PROPAGATION OF CS
WINTER (DEC/JAN/FEB)
20.0





ura 2: Trajetória das perturbações convectivas (PC) que ocorreram em janeiro e fevereiro de 1987 (a), e, as o
rreram em junho e julho de 1987 (b), onde o circulo vazio marca a iniciação da PC.



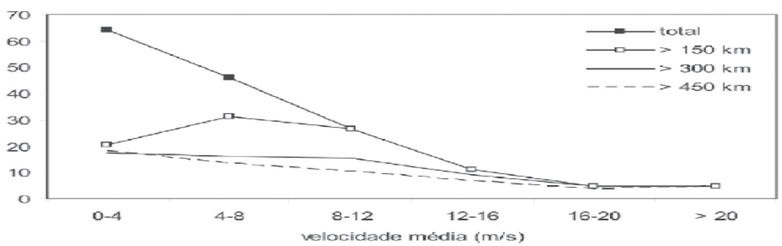


Figura 10 – Distribuição de seqüências não-pontuais (número de seqüências por ano) em função da velocidade média de propagação (deslocamento dividido pelo tempo de vida). Os resultados referem-se ao período de 1984 a 1998.

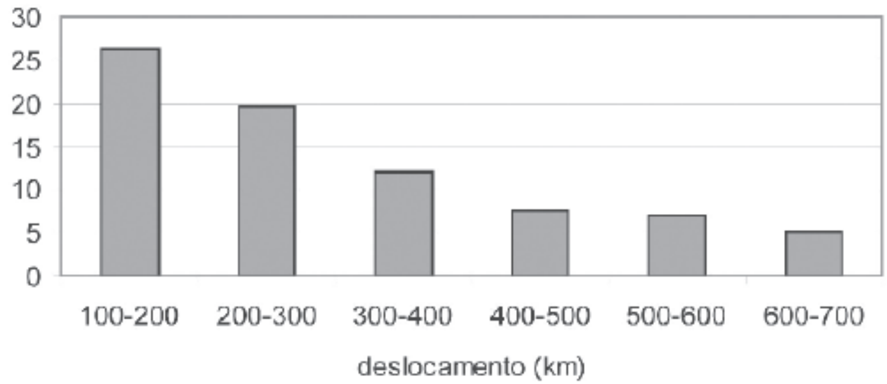


Figura 6 – Distribuição de seqüências não-pontuais (número de seqüências por ano) em função do deslocamento. Há 44 seqüências (por ano) com deslocamento entre 0 e 100 km, e 38 acima de 700 km (não mostrado). Os resultados referem-se ao período de 1984 a 1998.

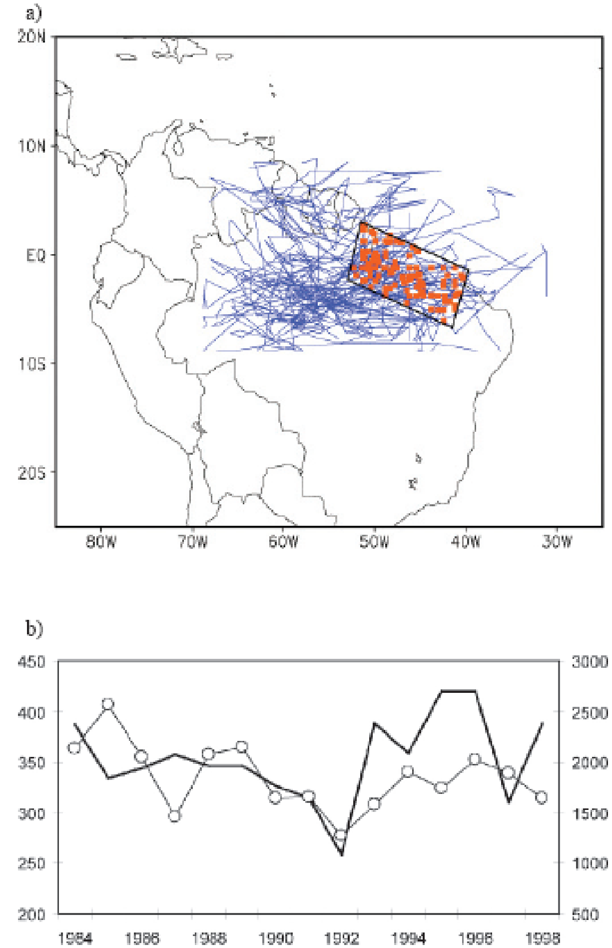
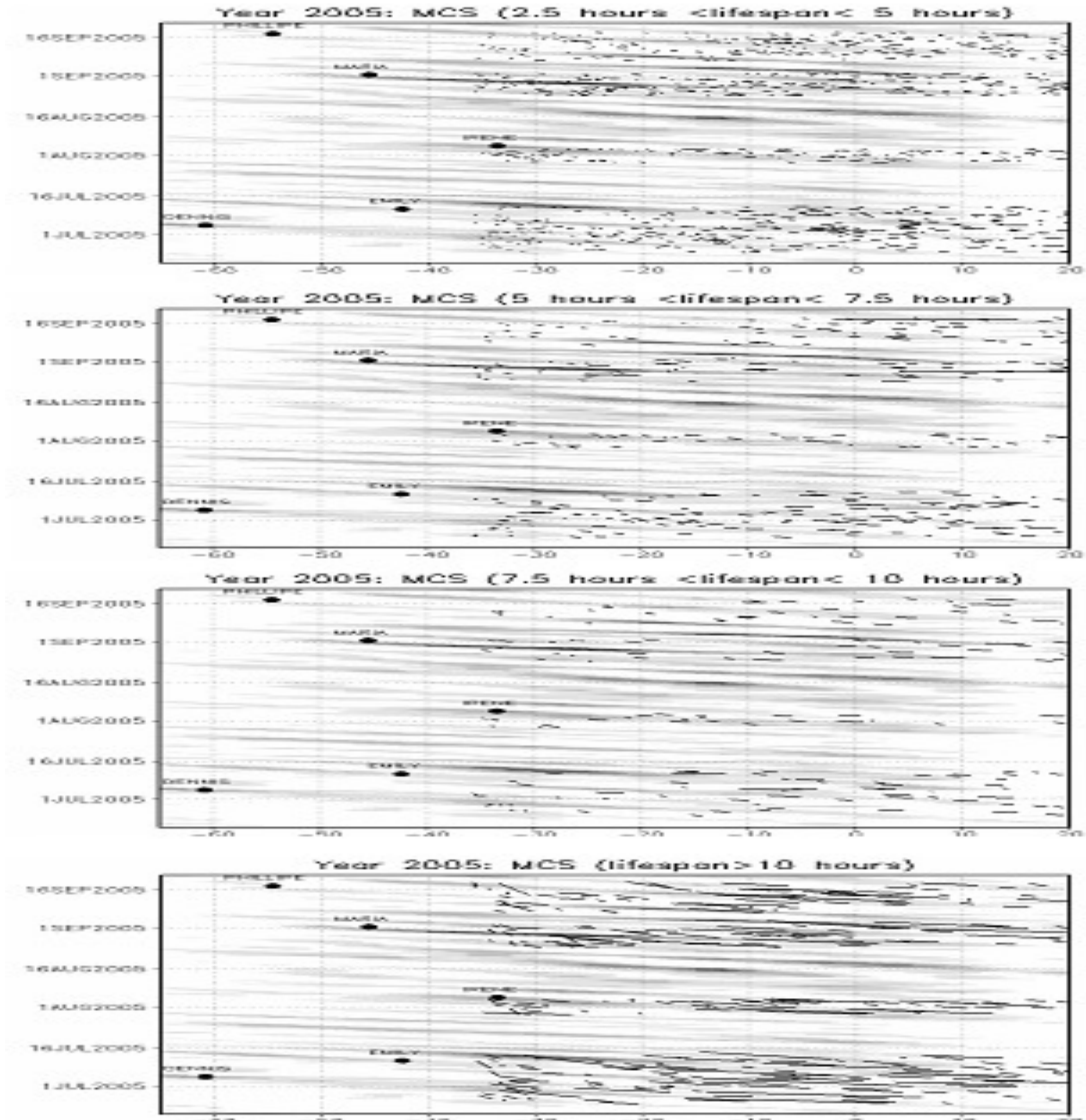
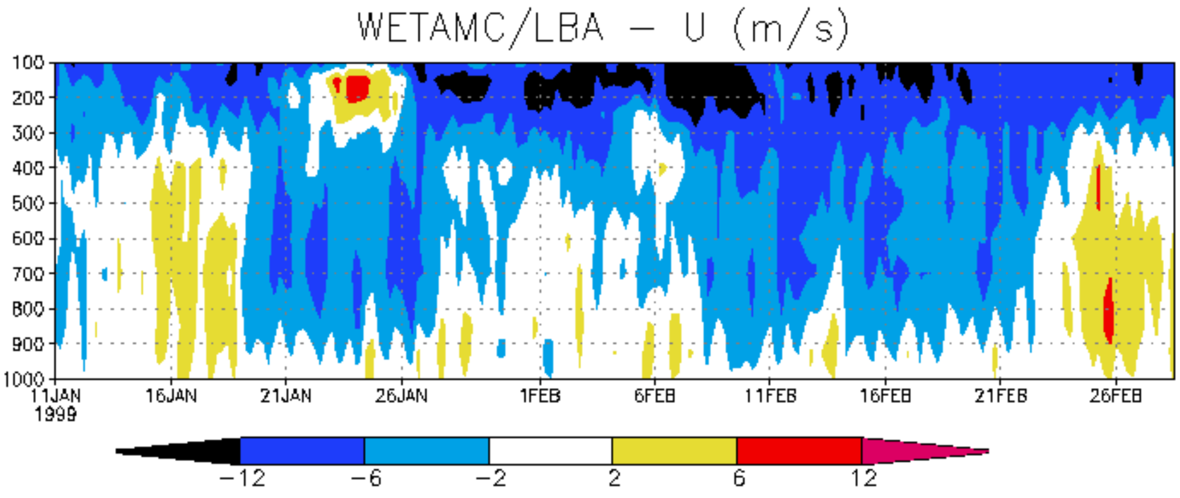


Figura 3 – **(a)** Trajetórias das seqüências de PC iniciadas na CNB em 1987 (358 seqüências no total). Os retângulos vermelhos indicam o local de iniciação; as linhas azuis, a trajetória. **(b)** Total anual de seqüências (linha com círculos, eixo das ordenadas à esquerda) e precipitação anual média em mm (linha sem marcadores, eixo das ordenadas à direita) nas áreas continentais da janela compreendida entre 7ºS-5ºN e 54ºW-38ºW (janela em linha tracejada na Figura 2) no período de 1984 a 1998. Os dados de precipitação provém de http://climate.geog.udel.edu/climate.

Easterly Waves – Hurricanes – MCS Trajectories

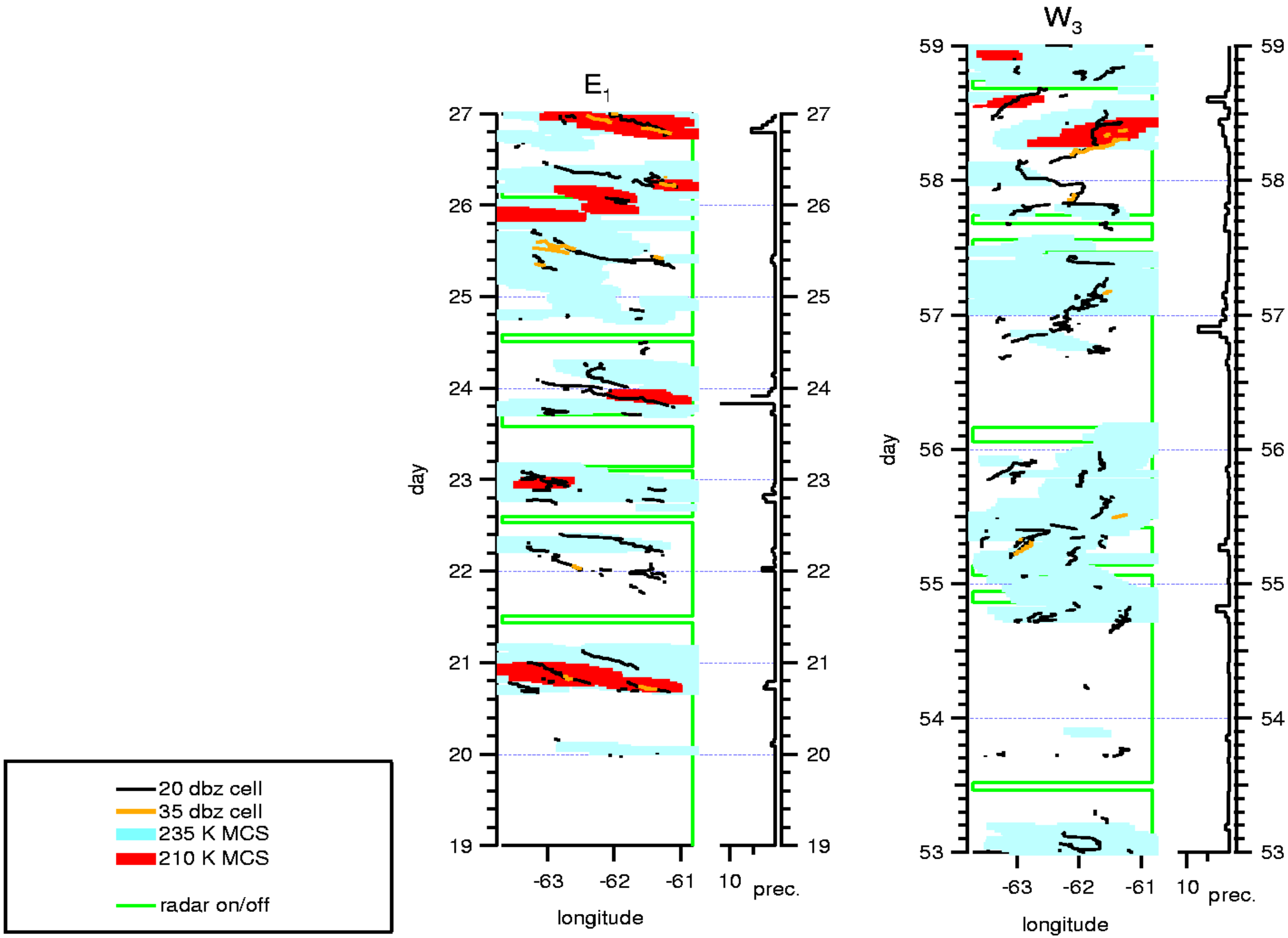




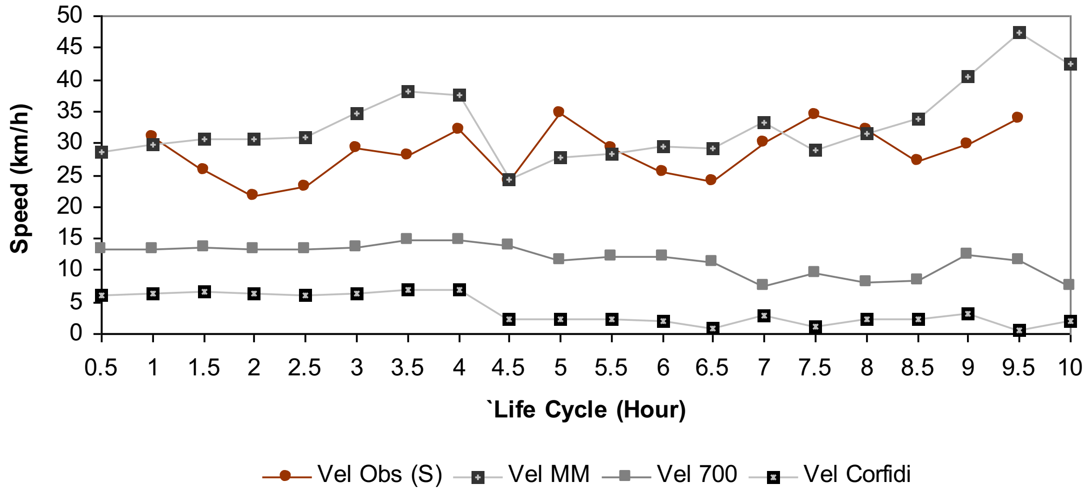
Easterly

Westerly

Radar/Satellite



Middle Latitude MCC



"Squall line tropical" de Moncrieff e Miller (1976):

$$c_m \approx U_m + 0,32\sqrt{CAPE}$$

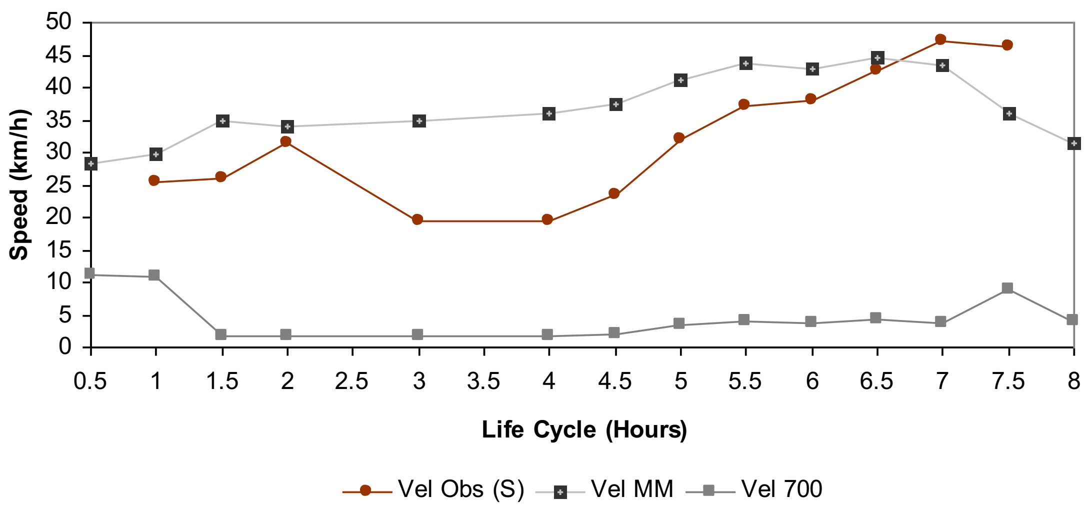
$$CAPE = \int_{-H/2}^{H/2} g\delta\phi_p dz$$

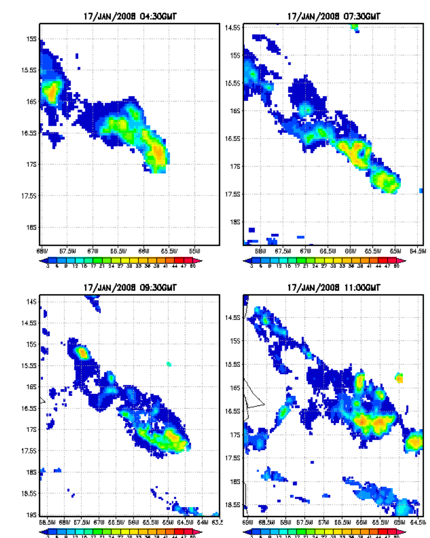
Modelo de Propagação do CCM de Corfidi et al. (1996):

$$V_{CC} = V_M - V_{JBN}$$

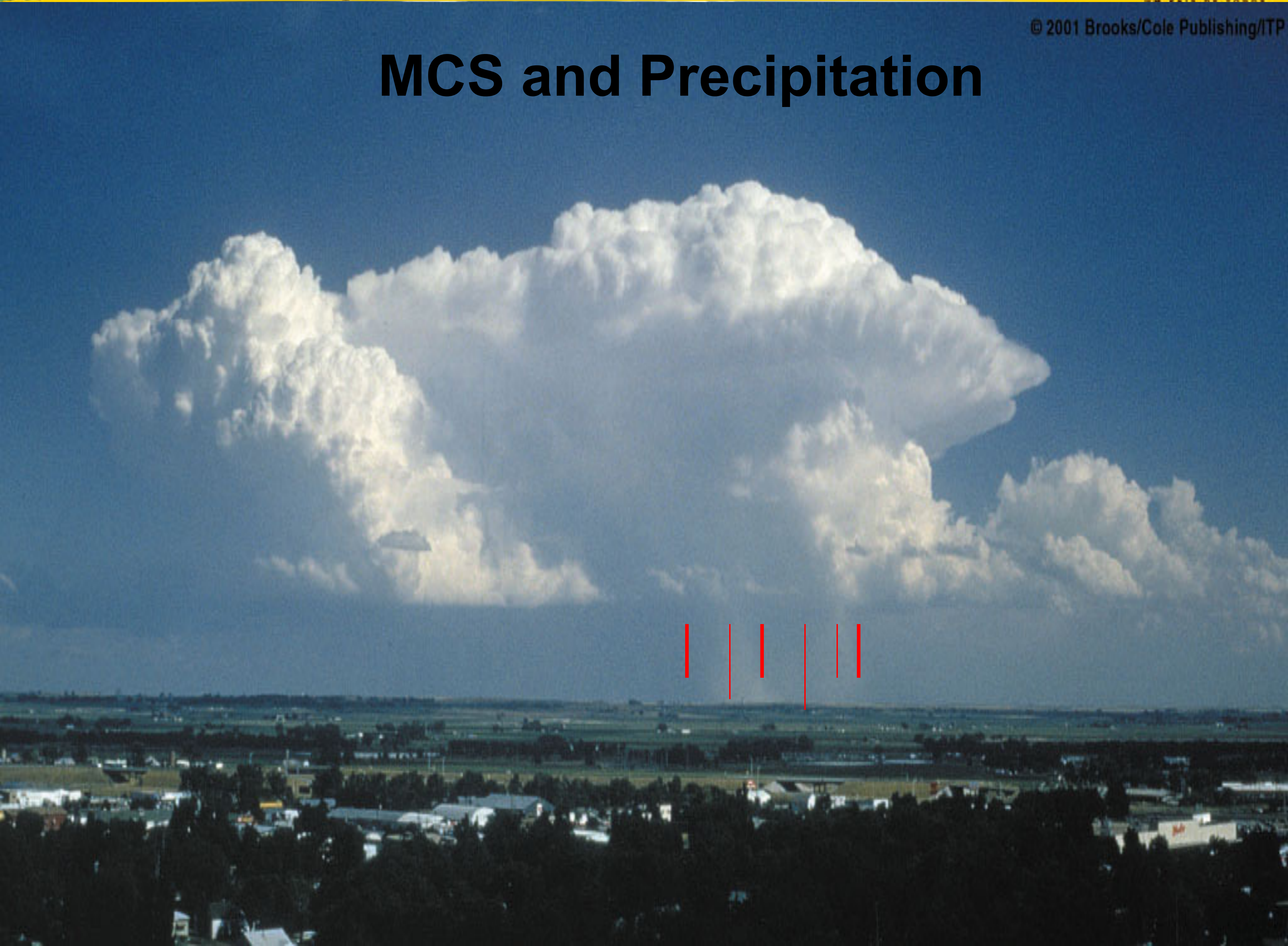
$$V_p = -V_{JBN} \qquad V_M = \left[\frac{V_{850} + V_{700} + V_{500} + V_{300}}{4}\right]$$

Tropical MCS

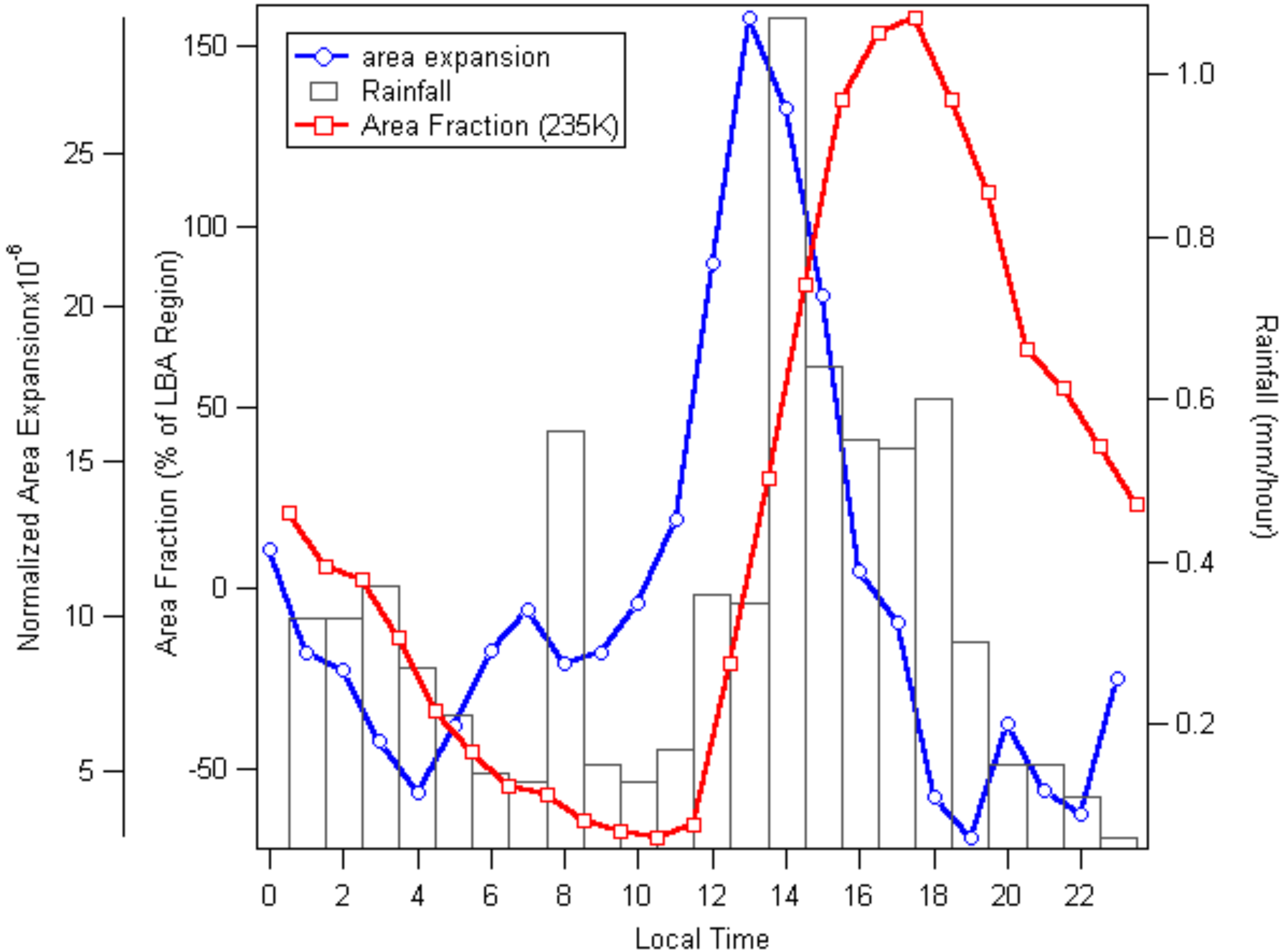


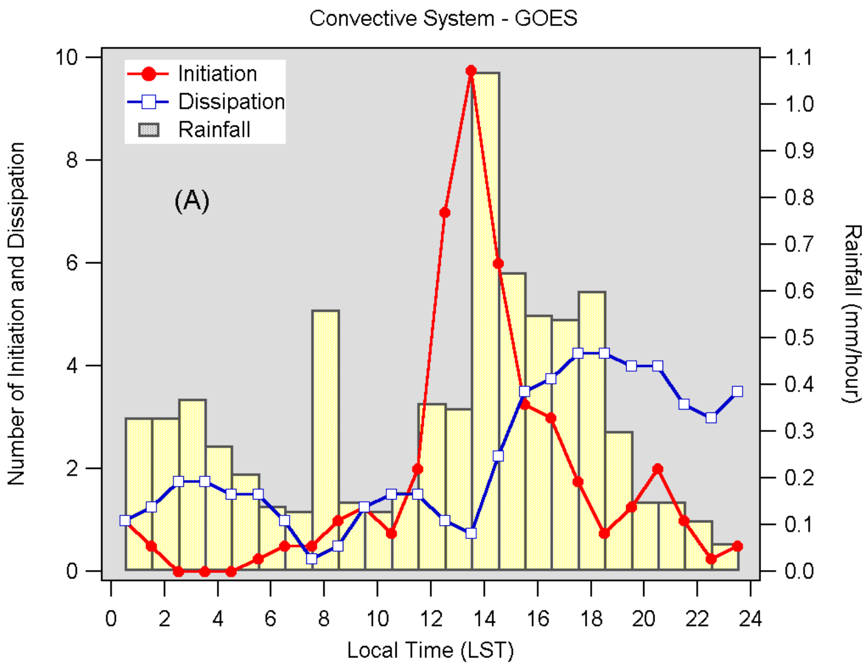


MCS and Precipitation

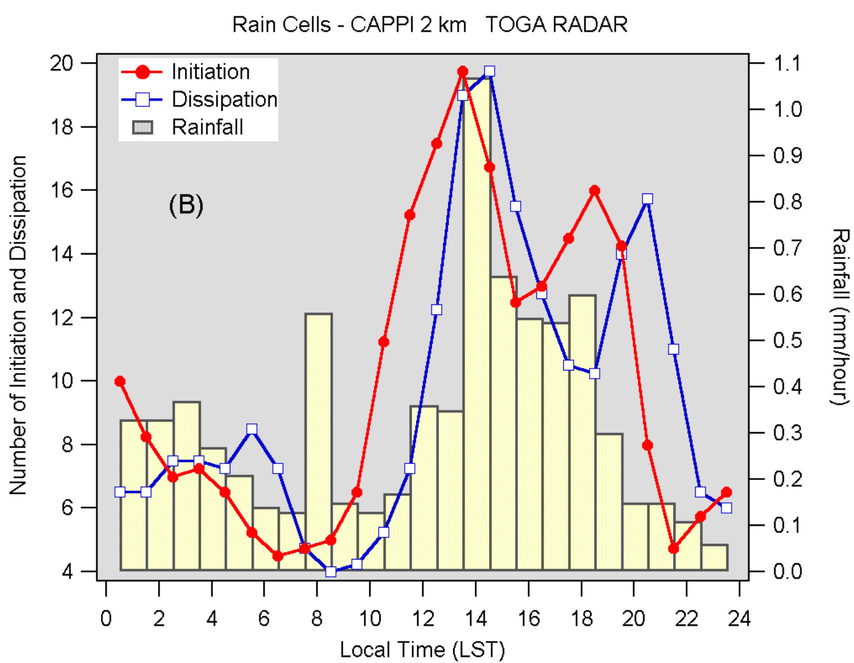


Hourly average area expansion, rainfall and area fraction of brightness temperature of 235K for WETAMC/LBA region.



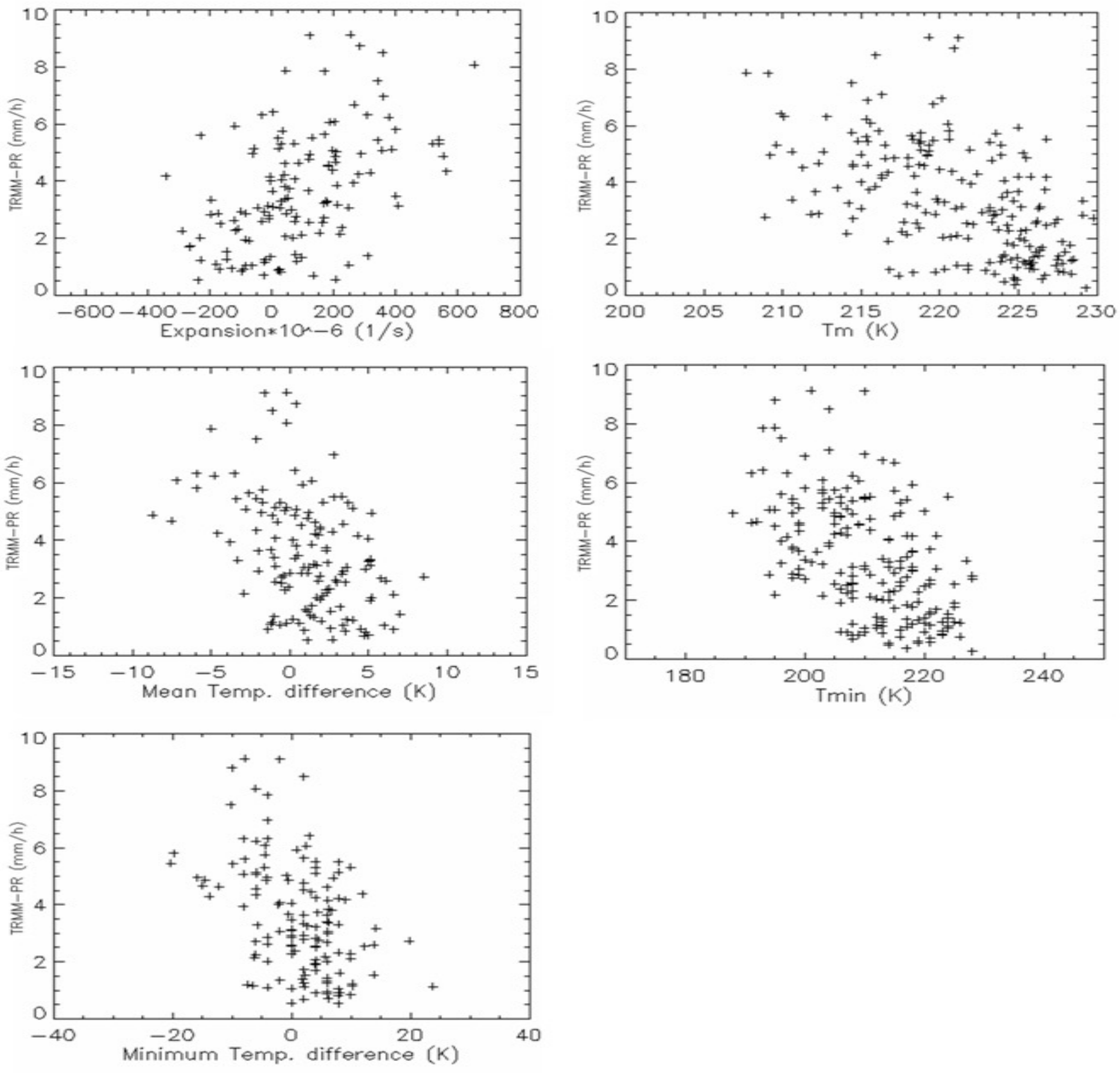


Convective System - GOES
Initiation
Dissipation
Rainfall
(A)
Number of Initiation and Dissipation
Rainfall (mm/hour)
Local Time (LST)

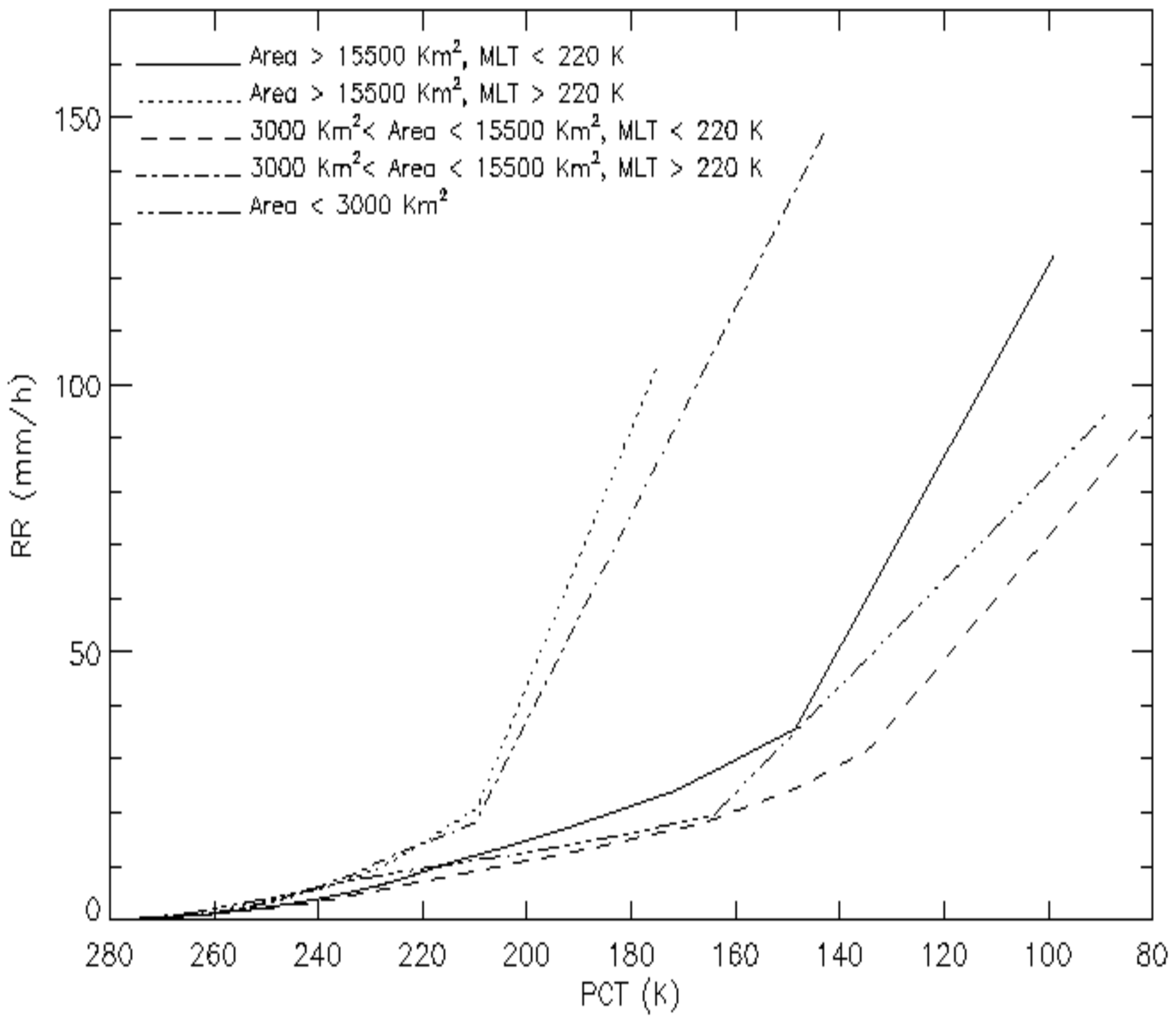


Rain Cells - CAPPI 2 km TOGA RADAR
Initiation
Dissipation
Rainfall
(B)
Number of Initiation and Dissipation
Rainfall (mm/hour)
Local Time (LST)

Rain/no Rain based in cloud classification

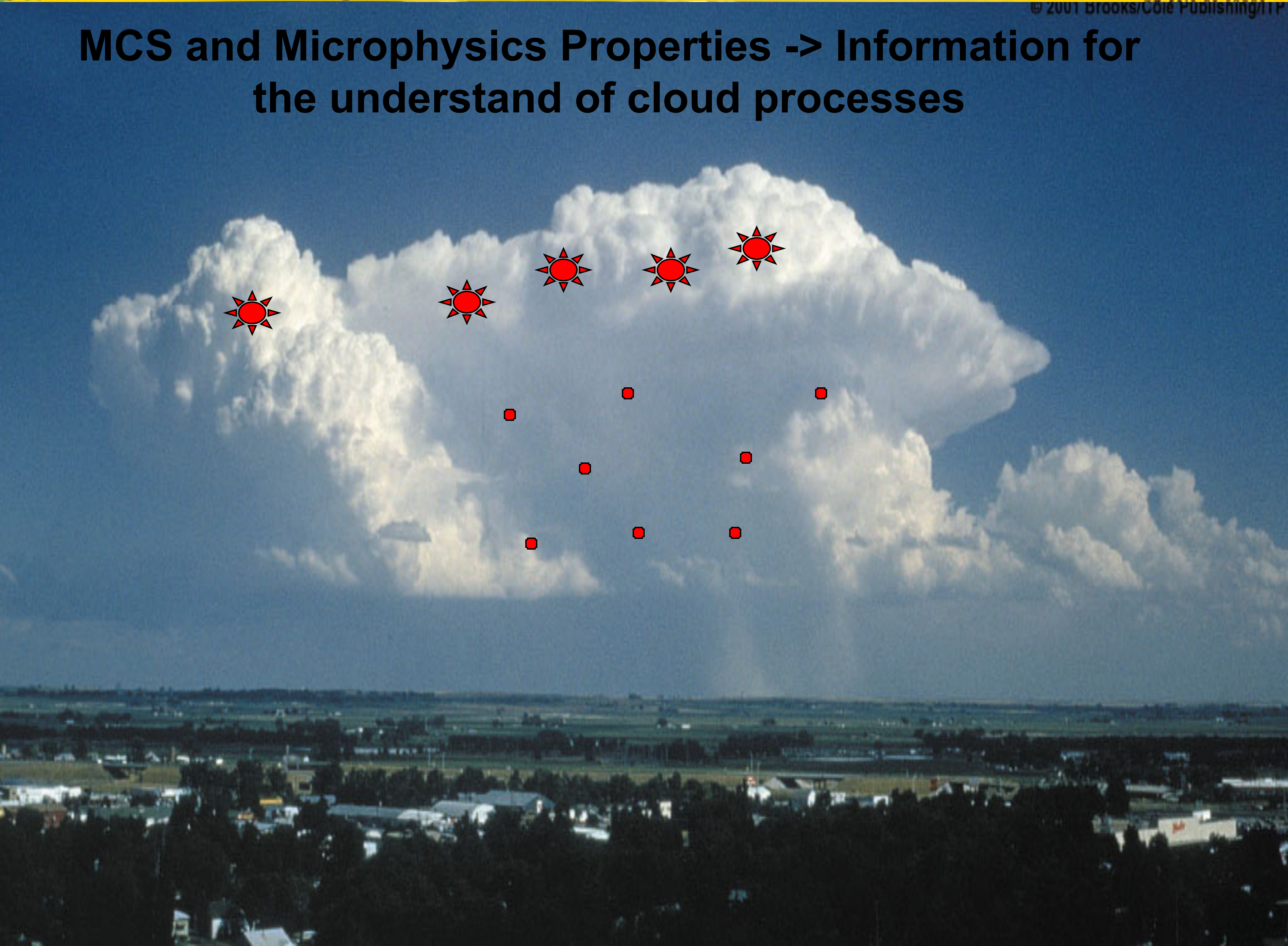


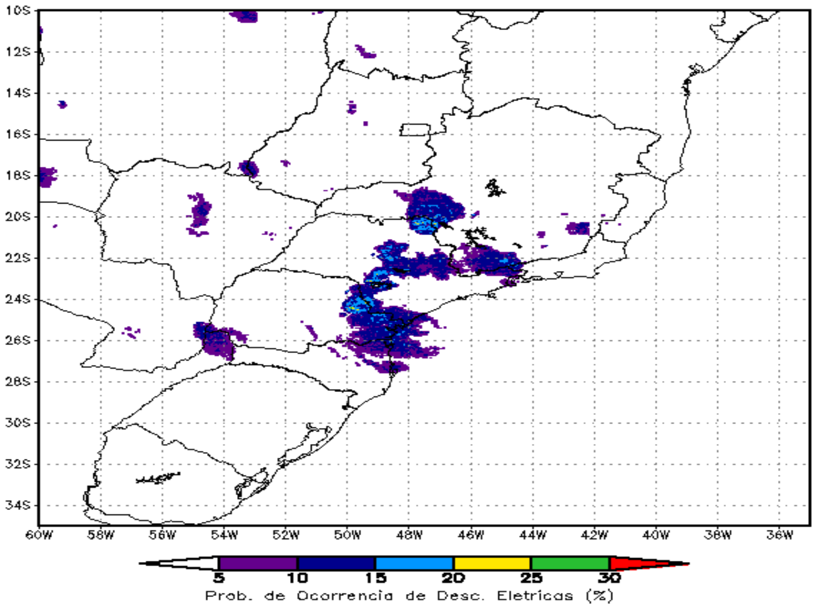
$$Rc = ai^{*}\,\Delta E + bi^{*}\,Tm + ci^{*}\,\Delta Tm + di^{*}\,Tmin + ei^{*}\,\Delta Tmin + fi \quad (1)$$

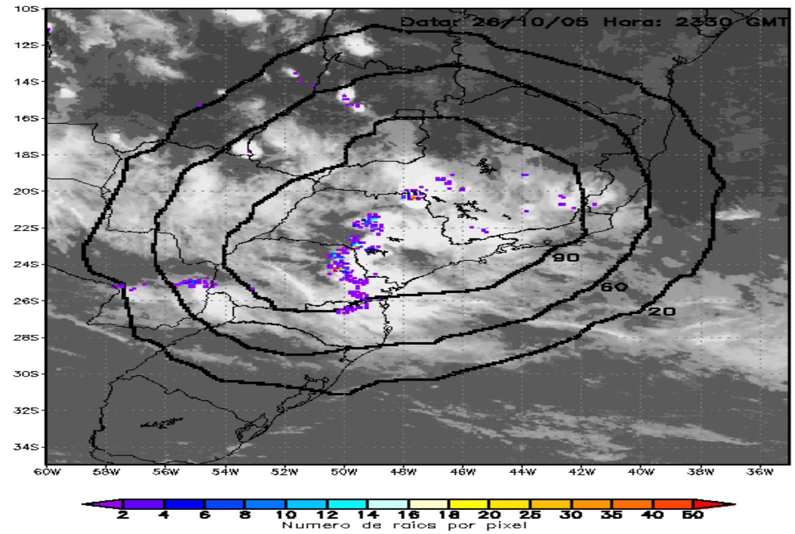


Related paper: Biscaro, and Morales, 2008

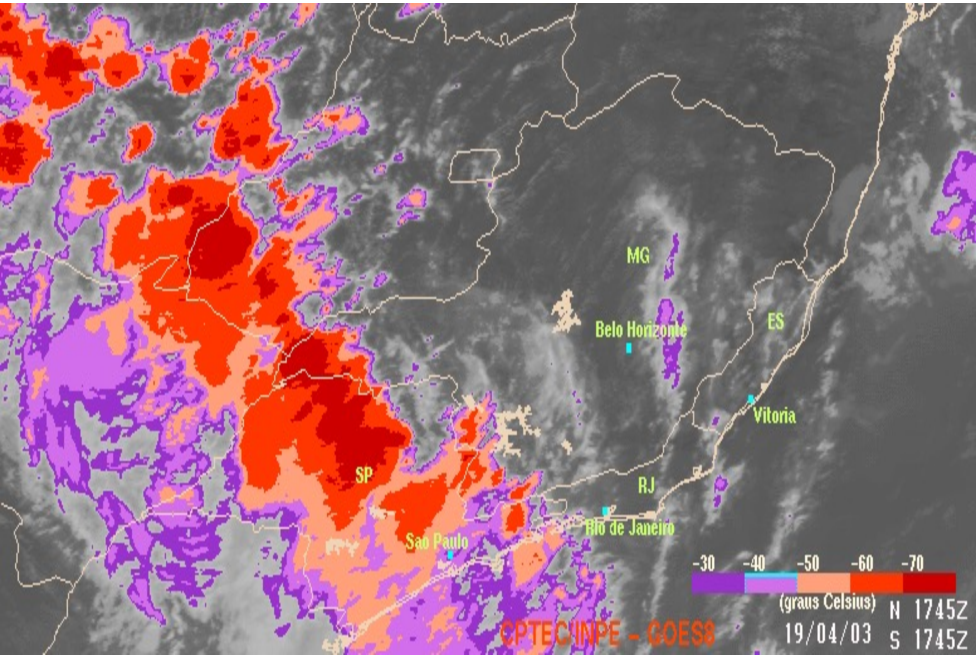
MCS and Microphysics Properties -> Information for the understand of cloud processes

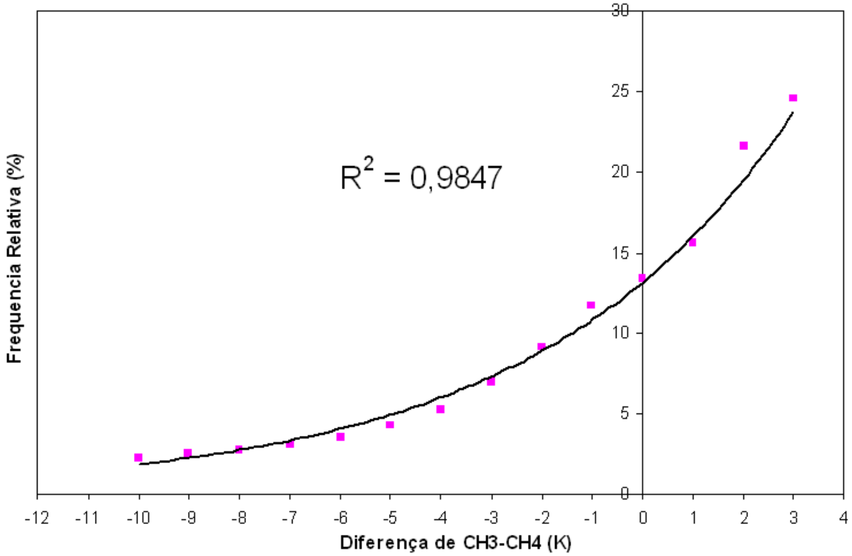


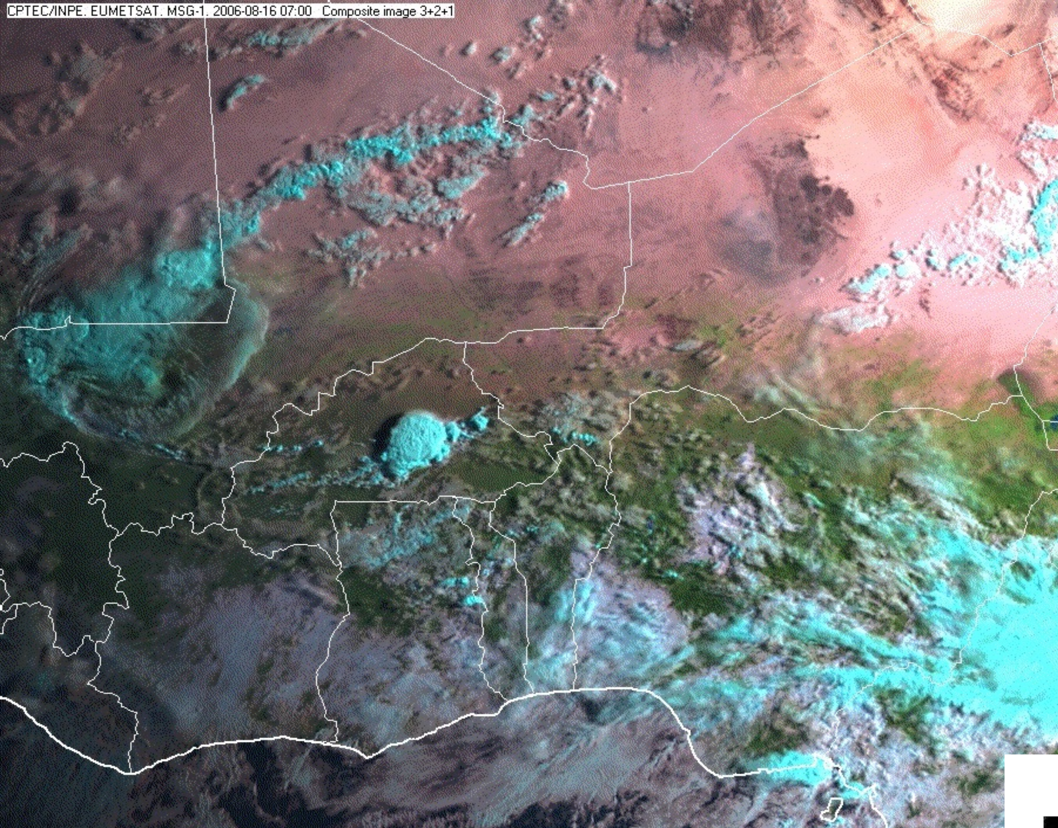


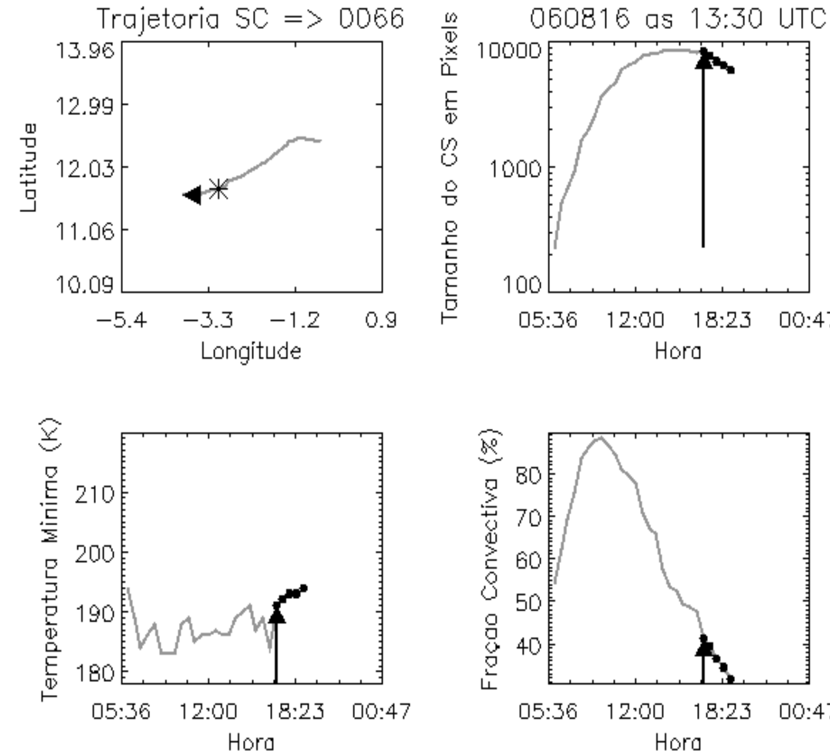


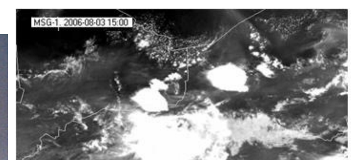
GOES-12 Channel 3 (WV) – Channel 4 (IR)

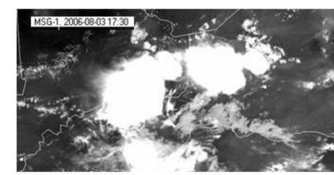


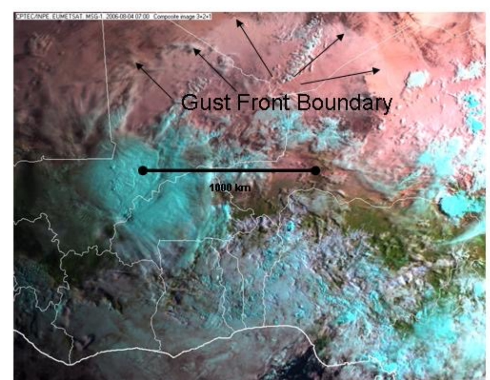


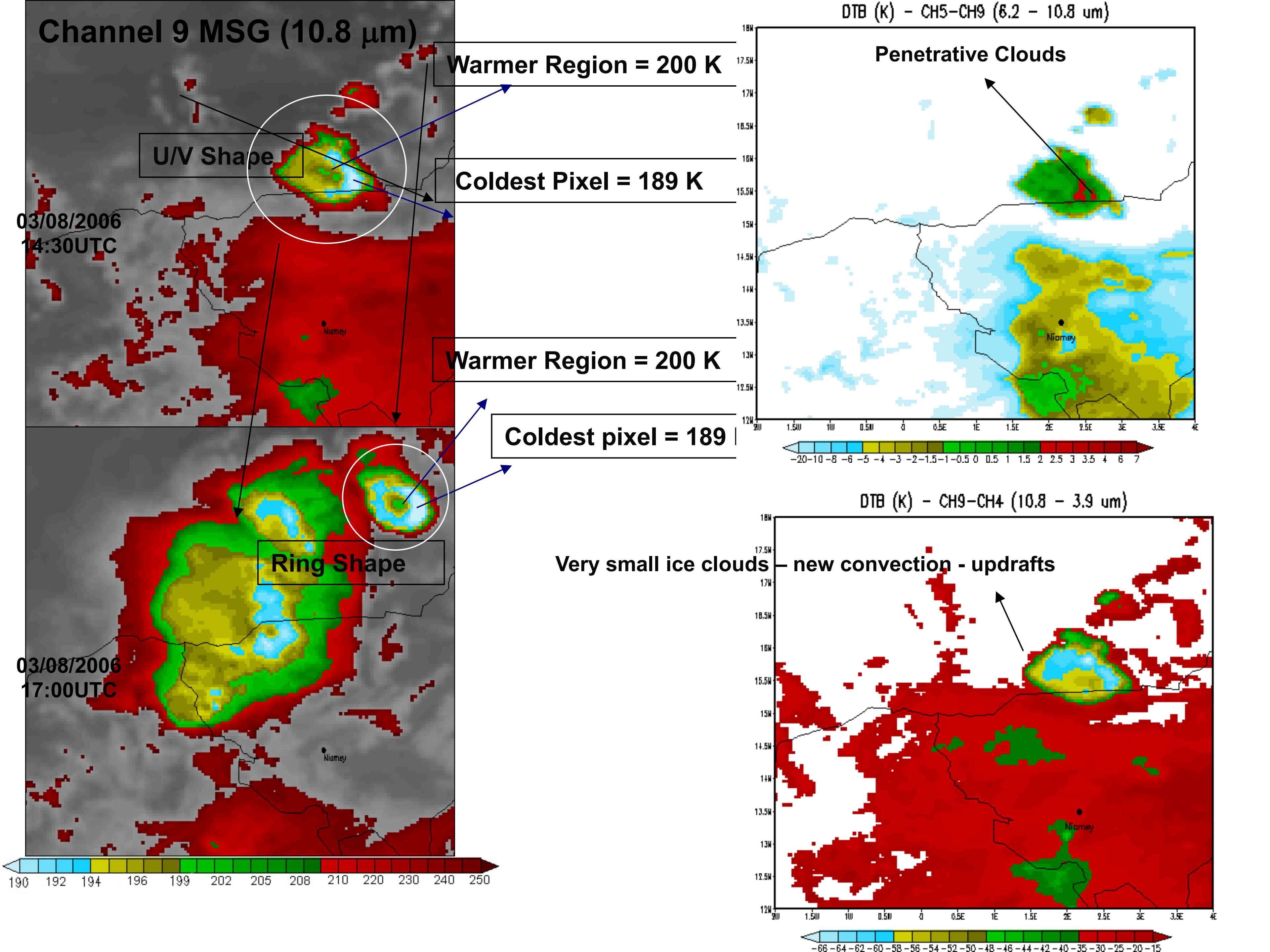

CPTEC/INPE. EUMETSAT. MSG-1. 2006-08-16 07:00 Composite image 3+2+1


Trajetoria SC => 0066
060816 as 13:30 UTC
Latitude
13.96
12.99
12.03
11.06
10.09
−5.4
−3.3
−1.2
0.9
Longitude
Tamanho do CS em Pixels
10000
1000
100
05:36
12:00
18:23
00:47
Hora
Temperatura Minima (K)
210
200
190
180
05:36
12:00
18:23
00:47
Hora
Fraçao Convectiva (%)
80
70
60
50
40
05:36
12:00
18:23
00:47
Hora


MSG-1, 2006-08-03 15:00


MSG-1, 2006-08-03 17:30


Gust Front Boundary
1000 km


Channel 9 MSG (10.8 µm)
Warmer Region = 200 K
U/V Shape
Coldest Pixel = 189 K
03/08/2006
14:30UTC
Warmer Region = 200 K
Coldest pixel = 189
Ring Shape
03/08/2006
17:00UTC
190 192 194 196 199 202 205 208 210 220 230 240 250
DTB (K) - CH5-CH9 (6.2 - 10.8 um)
Penetrative Clouds
Niamey
-20 -10 -8 -6 -5 -4 -3 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 6 7
DTB (K) - CH9-CH4 (10.8 - 3.9 um)
Very small ice clouds – new convection - updrafts
-66 -64 -62 -60 -58 -56 -54 -52 -50 -48 -46 -44 -42 -40 -35 -30 -25 -20 -15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Thank you
Congratulation to the
ISCCP 25th Anniversary