atmospheric dynamics over West Africa during the AMMA 2006 SOP campaign

Françoise Guichard and Jean-Philippe Lafore

With material from / thanks to Serge Janicot, Nicole Asencio, Gareth Berry, Olivier Bock, Dominique Bouniol, Fabrice Chauvin, Fleur Couvreux, Abdoulaye Deme, Florence Favot, Cyrille Flamant, Marielle Gosset, Nick Hall, Christophe Lavaysse, Stephanie Leroux, Mathieu Nuret, Alain Protat, Remy Roca, Georges Scialom, Chris Thorncroft, Mireille Tomasini

2006 West-African monsoon at large scale

a few elements of comparison with climatology
some features of the 2006 monsoon
MJO

2006 West-African monsoon at synoptic scale
African easterly waves
a few words on “dry” intrusions
convectively coupled Kelvin waves

2006 West-African monsoon, MCSs
MCS tracking, example

atmospheric conditions at the AMMA sites

Focus on JJAS, i.e. Corresponding to summer monsoon SOPs

2006 West-African monsoon at large scale

a few elements of comparison with climatology

some features of the 2006 monsoon

MJO

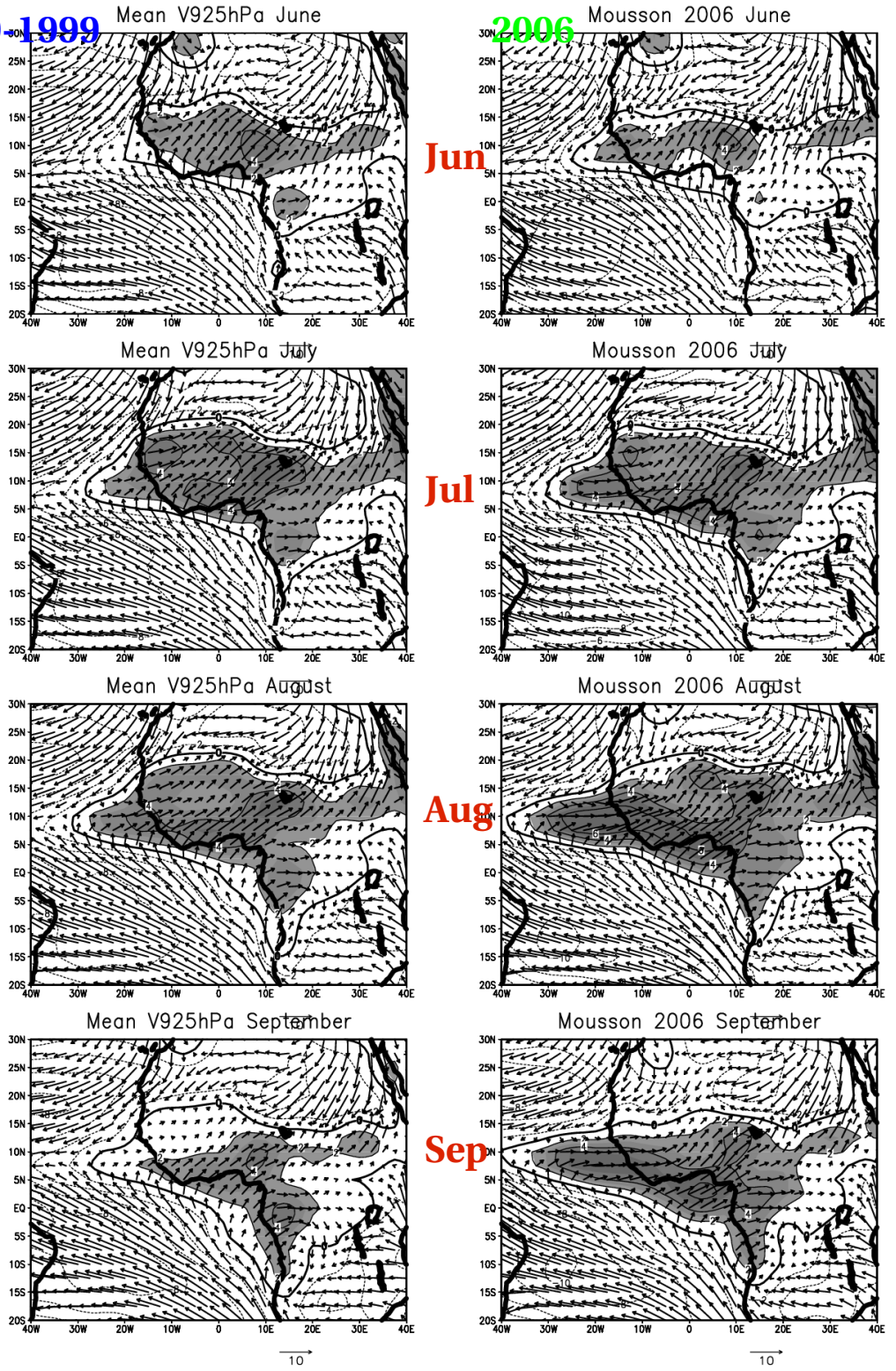
monsoon flow

NCEP wind at 925 hPa

U > 2m.s^{-1} shaded

in 2006:
*weaker & narrower in June
*stronger westerlies in AS
* extends more to the W in AS

From Janicot et al. (2007)



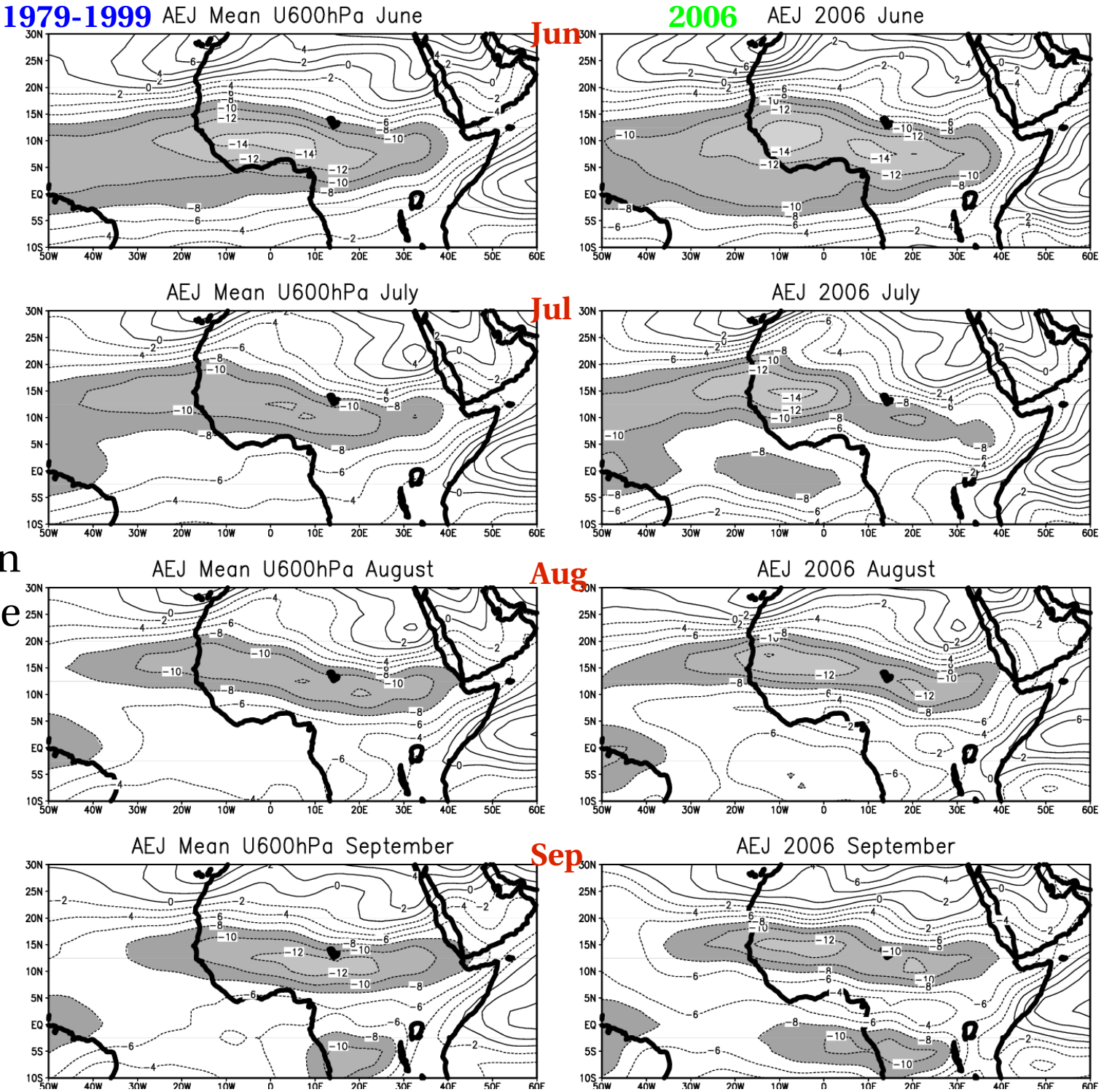
African Easterly Jet

NCEP zonal wind
U at 600 hPa

U <-8m^{-1} shaded

in 2006:
* stronger/wider in June, & in July to the W

From Janicot et al. (2007)



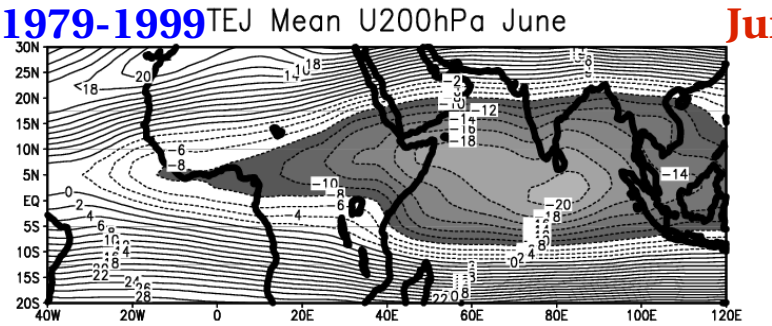
Tropical Easterly Jet

NCEP zonal wind
U at 200hPa

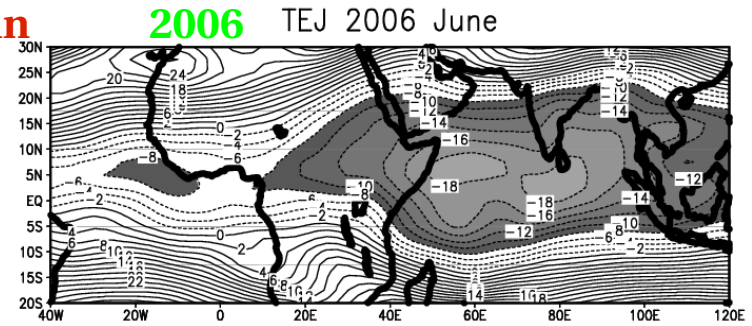
U <-8m^{-1} shaded

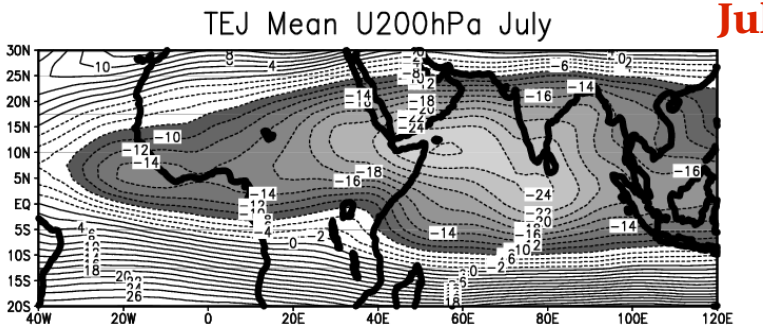
in 2006:
*weaker speed in June
*extend more to the W in July
* stronger in AS

From Janicot et al. (2007)

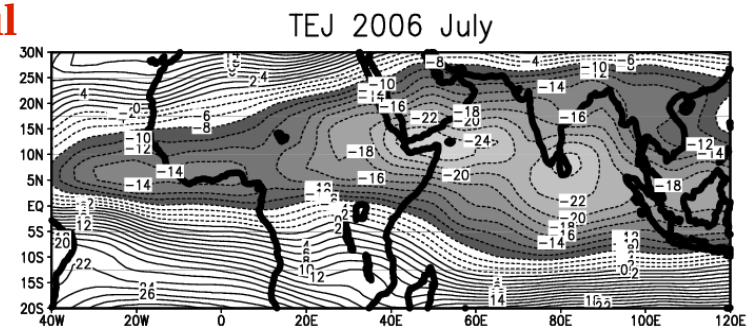


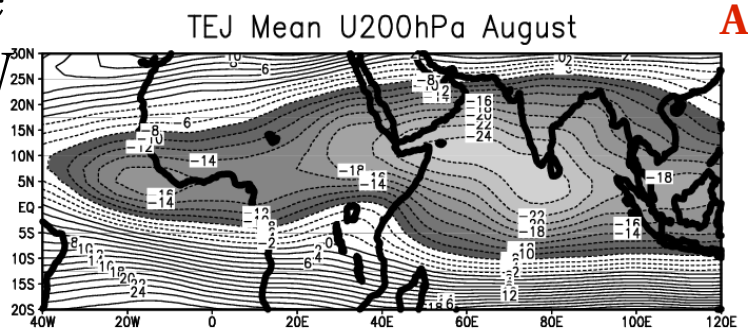
Jun



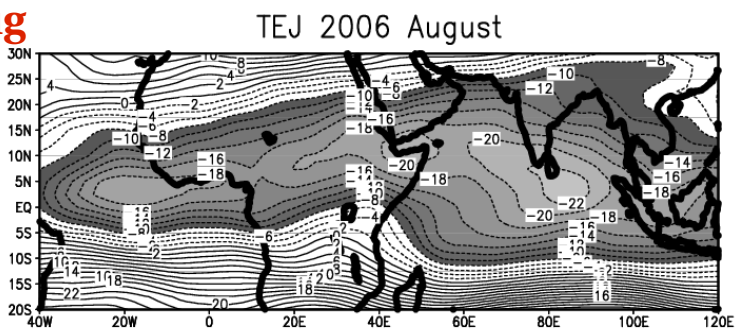


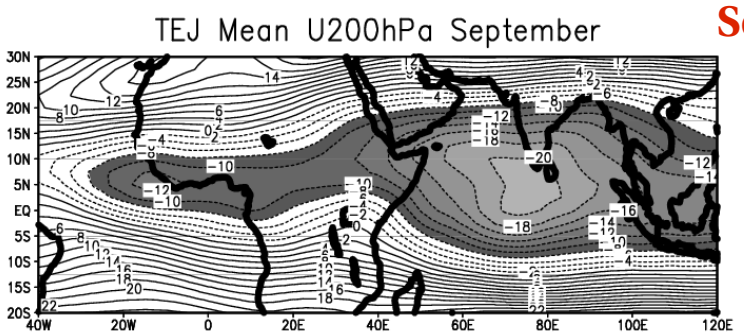
Jul





Aug





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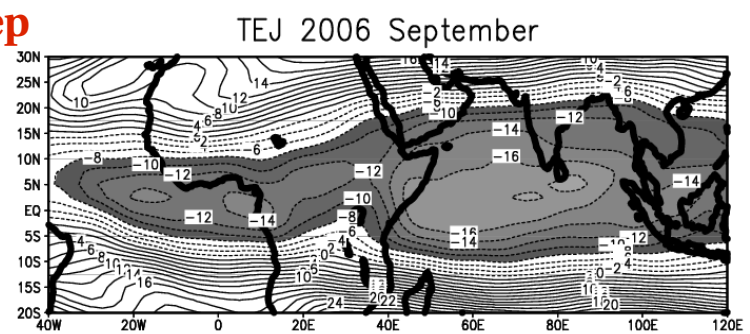


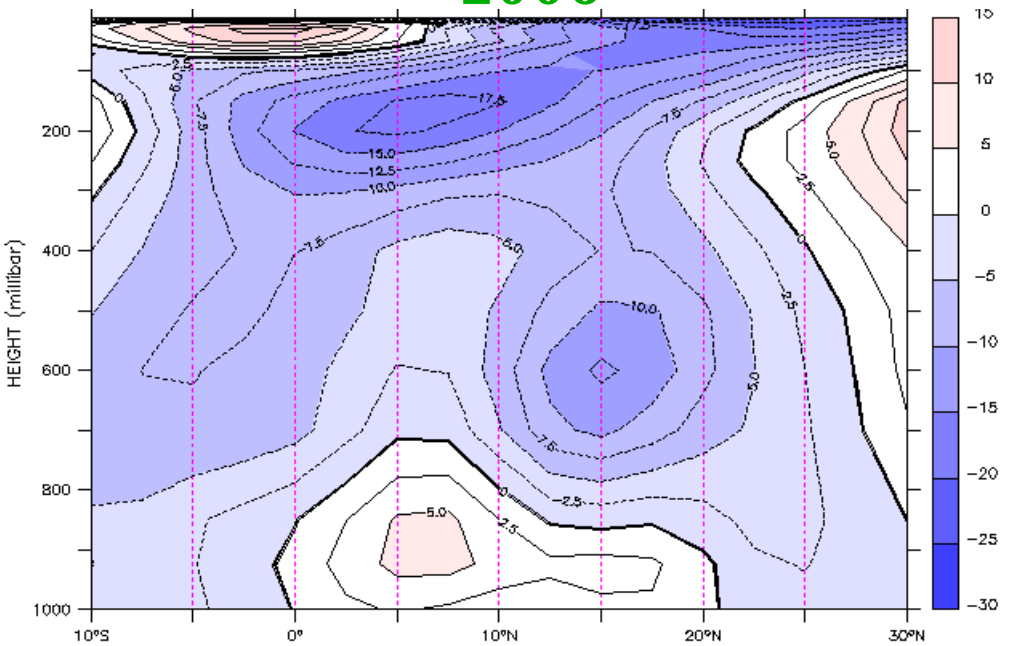
zonal wind, August

(NCEP/NCAR reanalysis**)**

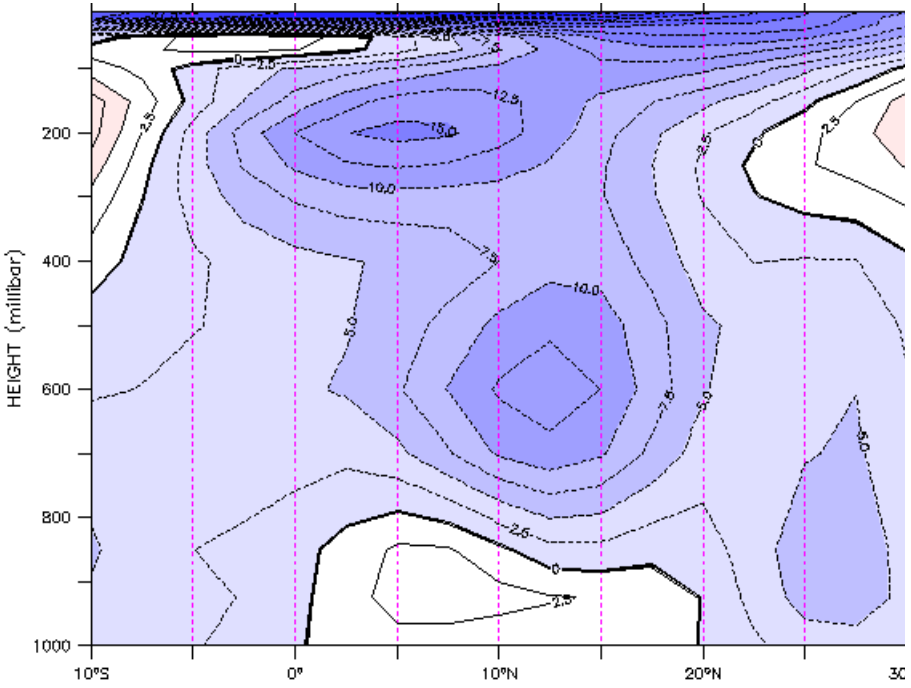
From F. Favot

AMMA-CROSS group

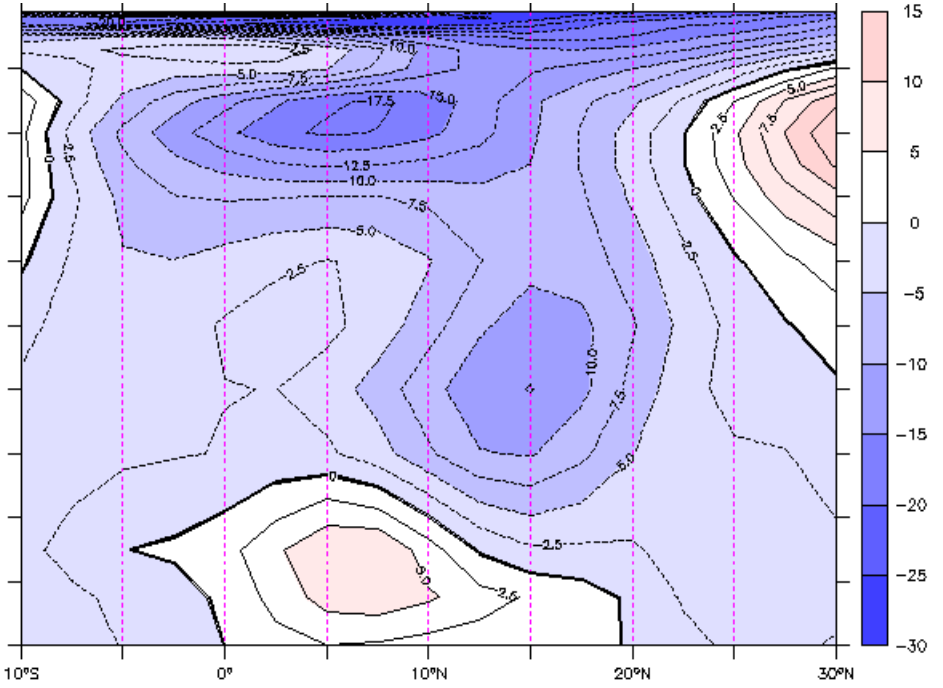
2006



2000



2003



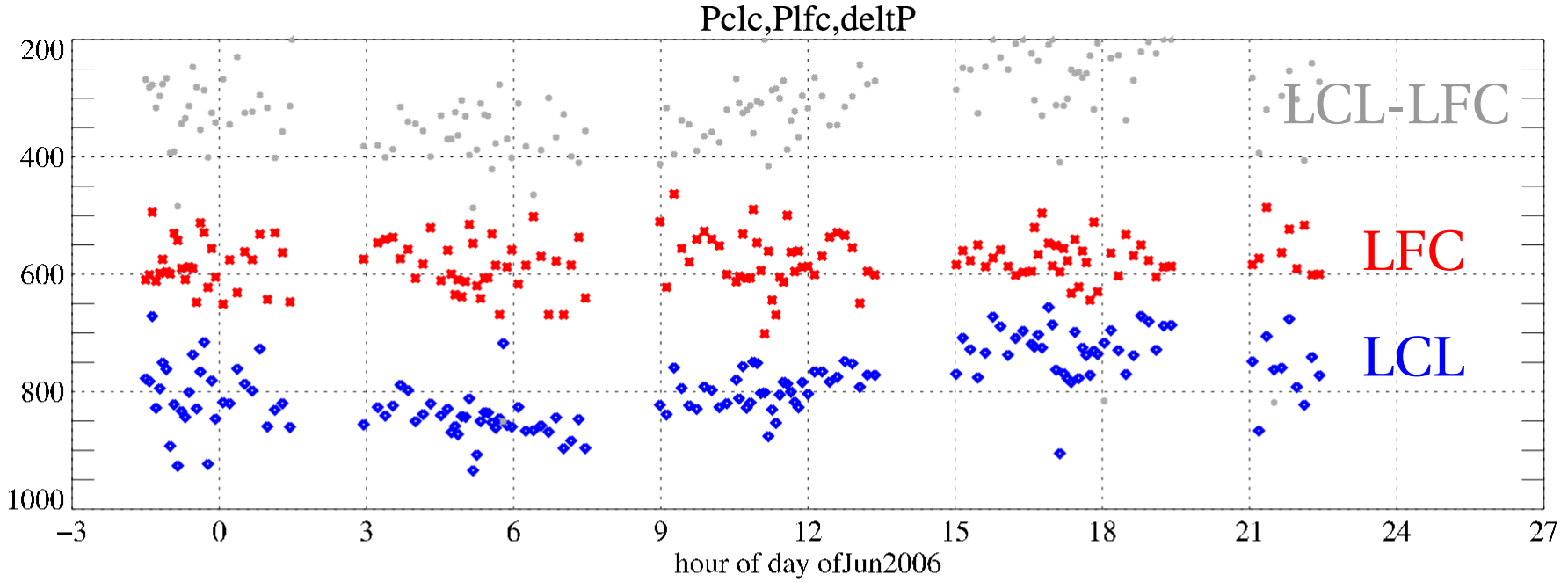
Possibility to document and explore low levels properties and functionning with AMMA sondes, UHF and a number of other boundary layer related intruments

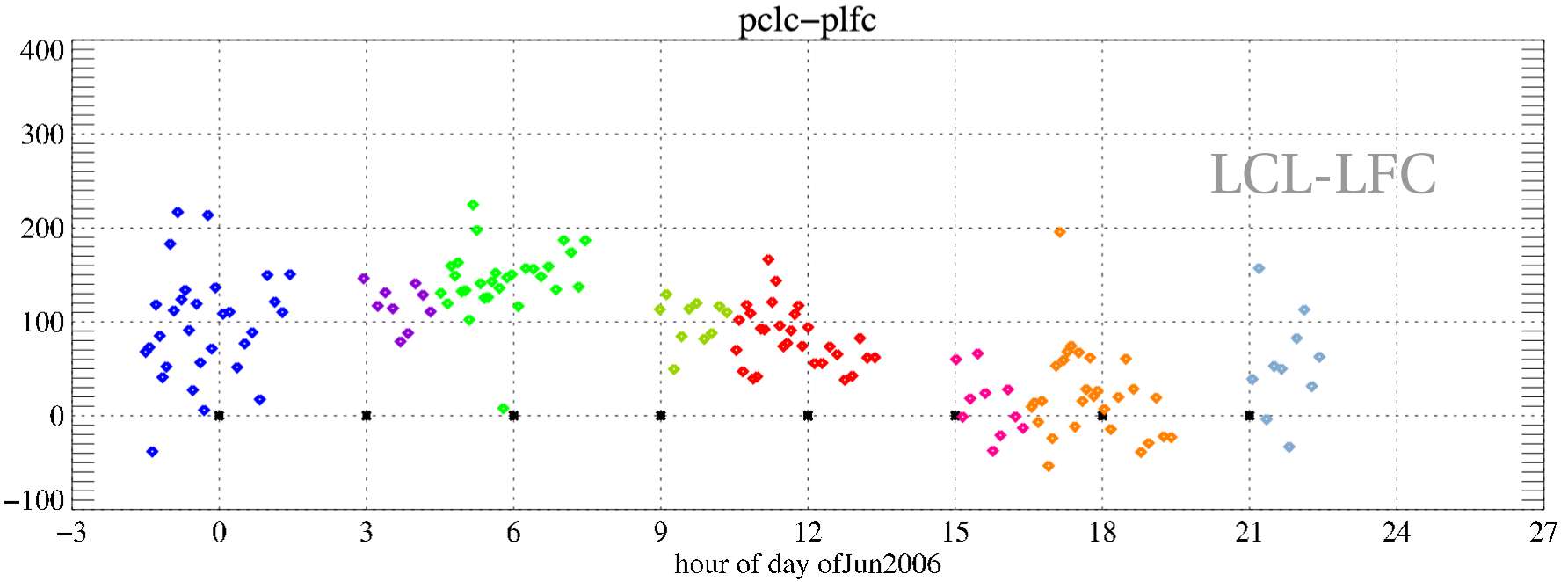
at large scale as well

(limitation of actual analyses products)

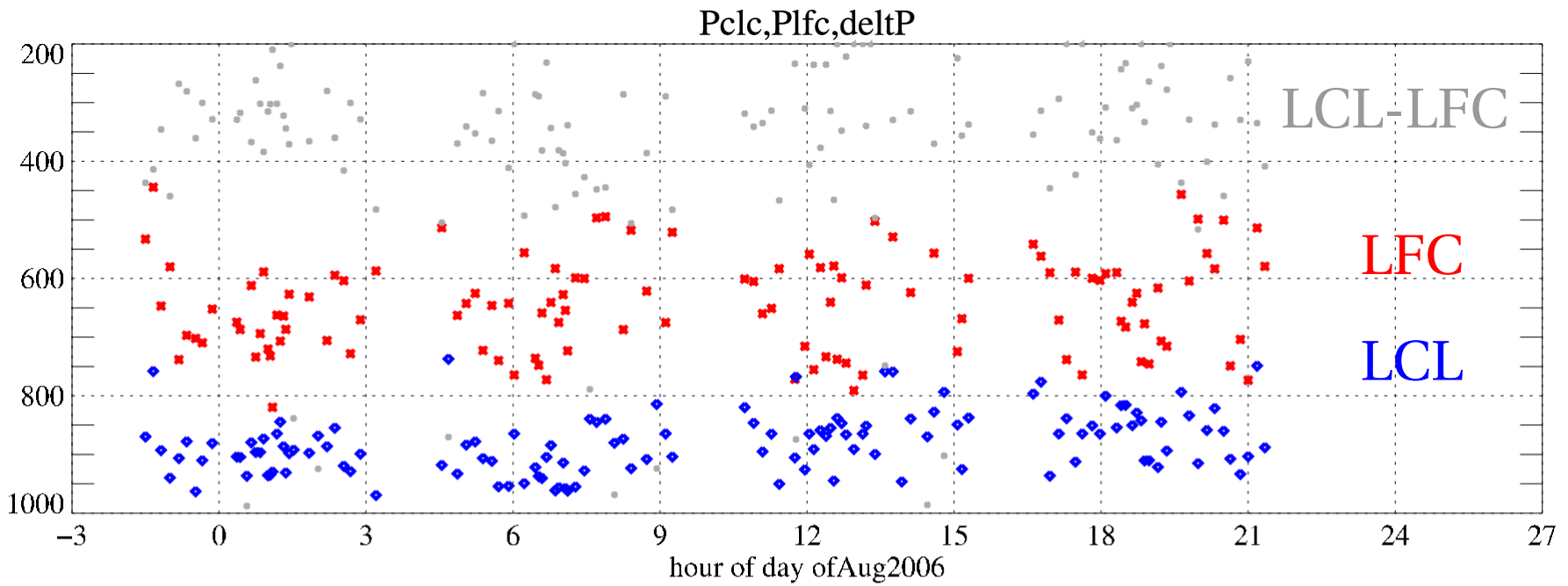
sounding data of Niamey, June 2006

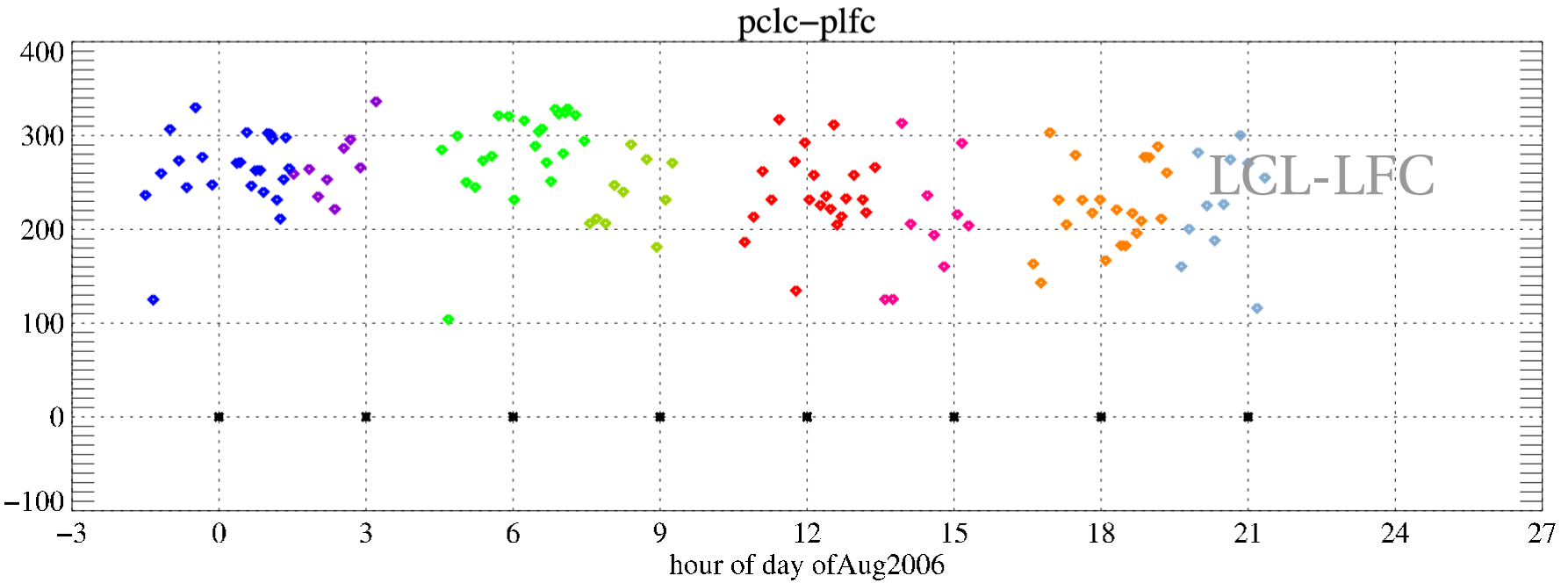
(LCL ~a proxi for convective boundary layer height, for cloudy BLs...)





sounding data of Niamey, August 2006

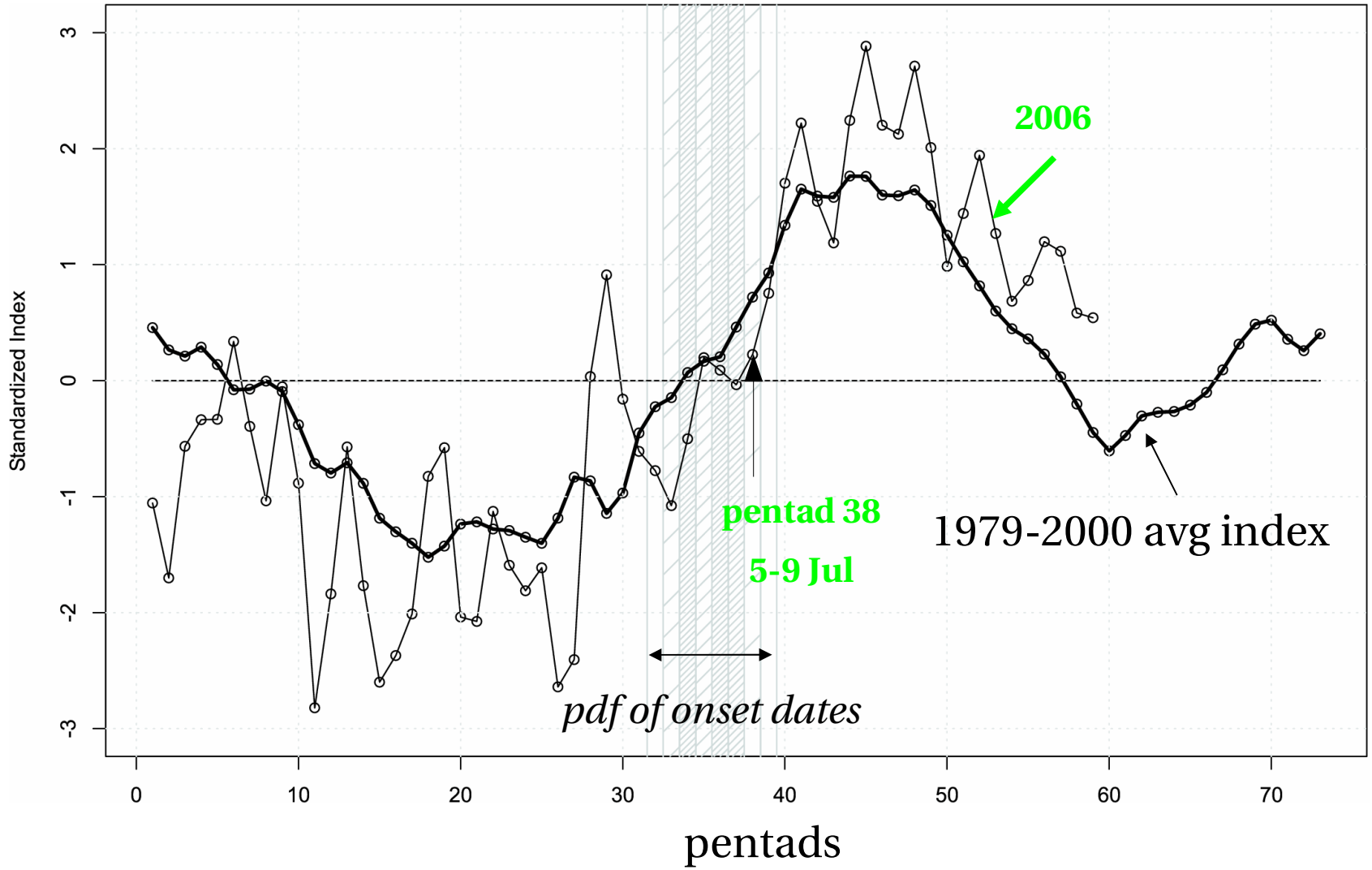




monsoon onset

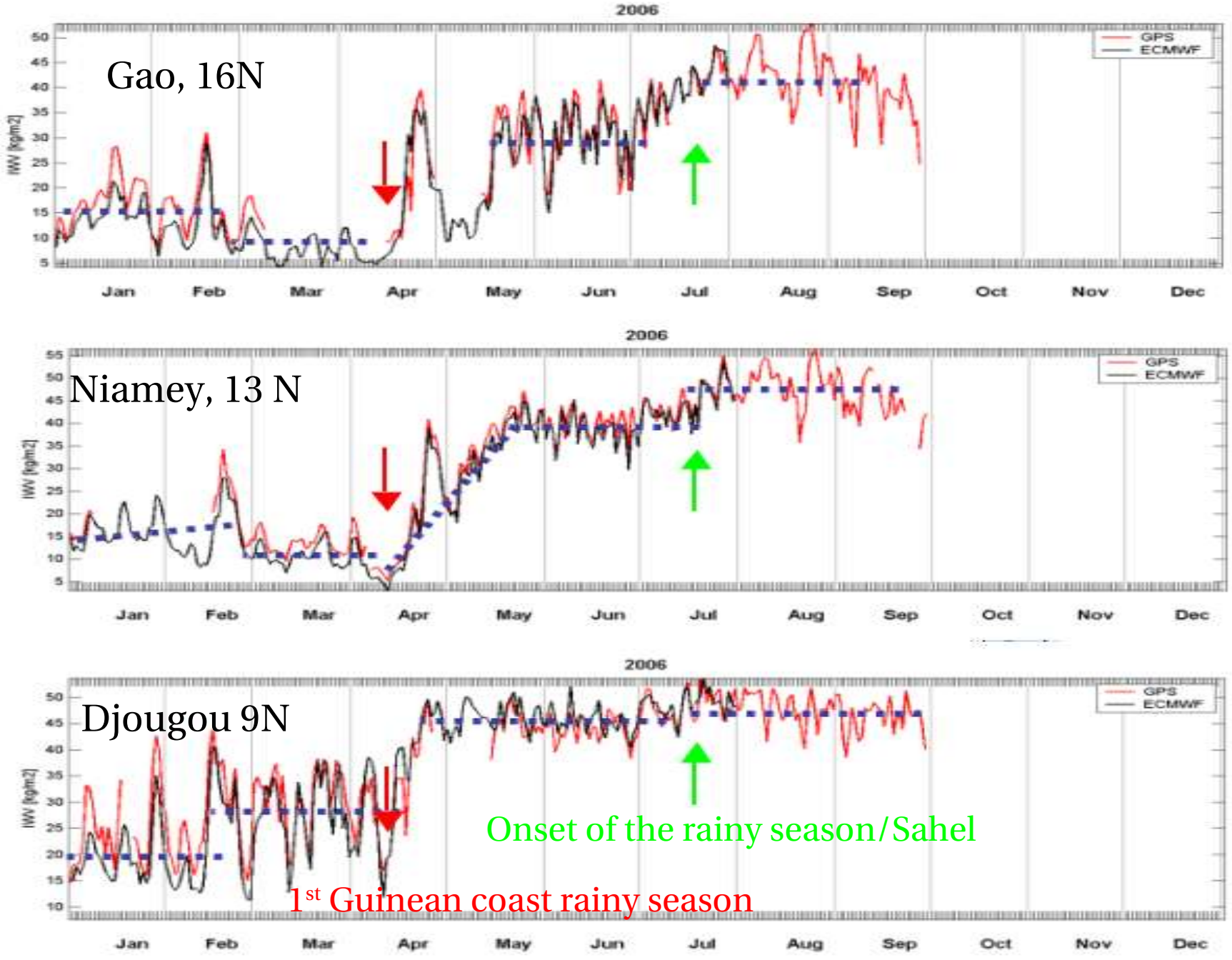
From Janicot et al. (2007)

5-day monsoon onset index (OI, OLR based)



Onset 2006: ~10 Jul, delayed ~ 10days / [1968,2005] mean onset date

Source: Bock


2006
Gao, 16N
GPS
ECMWF
IWV [kg/m2]
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Feb
Mar
Apr
May
Jun
Jul
Aug
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Oct
Nov
Dec
2006
Niamey, 13 N
GPS
ECMWF
IWV [kg/m2]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006
Djougou 9N
GPS
ECMWF
IWV [kg/m2]
Onset of the rainy season/Sahel
1st Guinean coast rainy season
Jan
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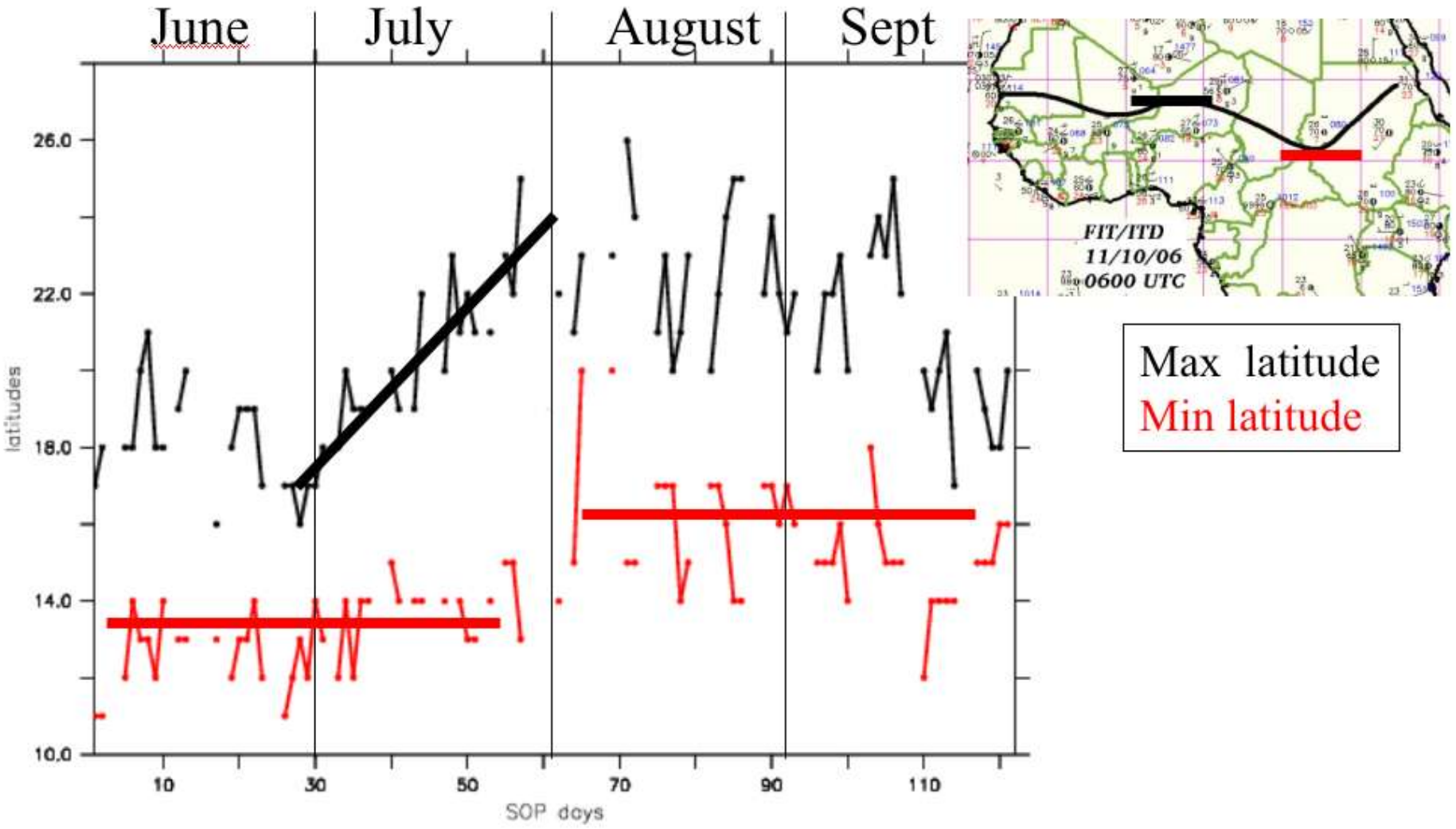
Dec

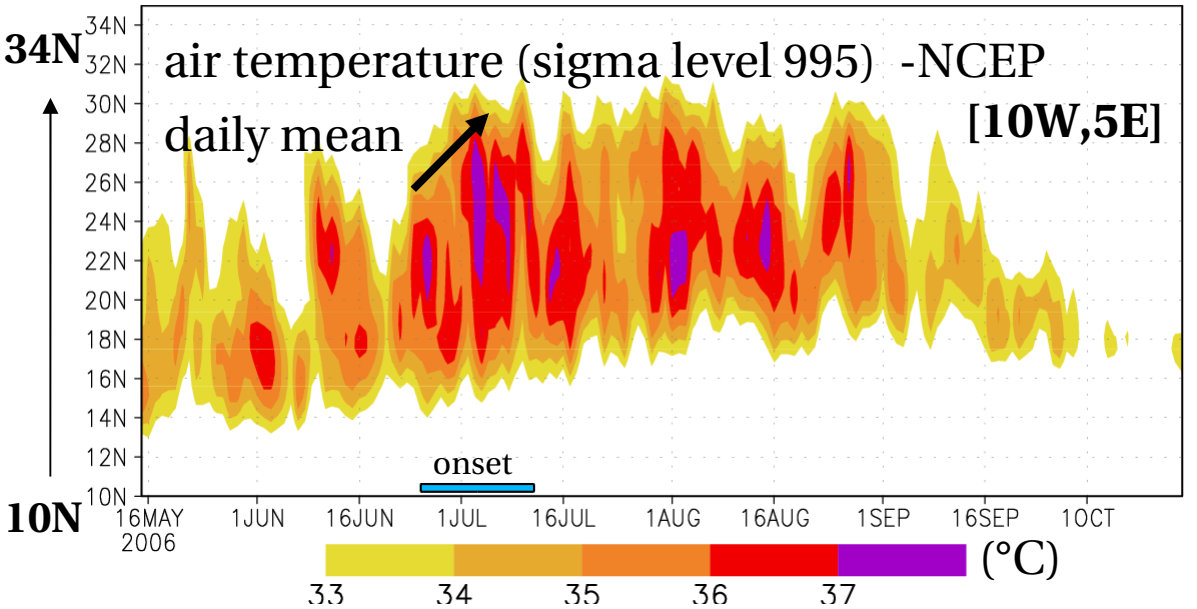
Monitoring of the ITD latitude at ACMAD

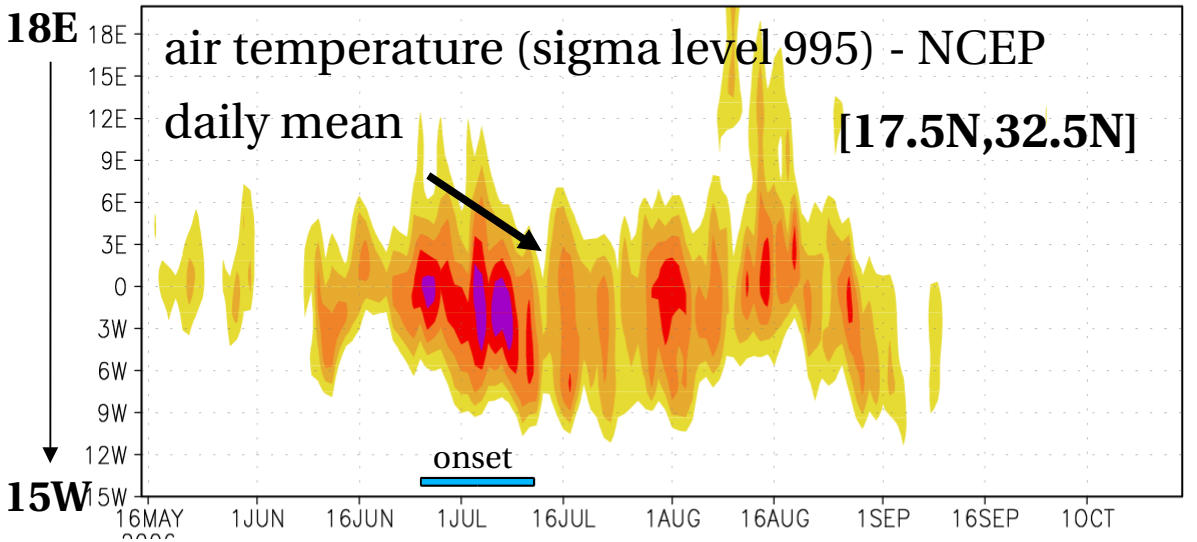
prepared by N. Asencio

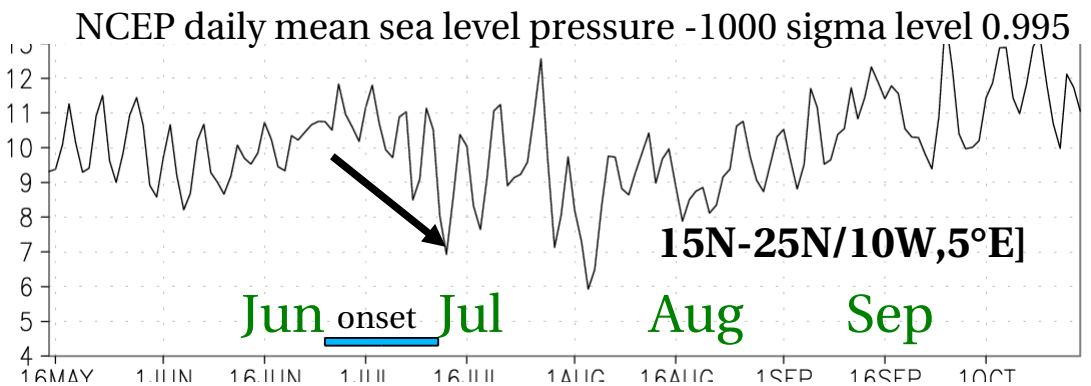


Evolution of the Saharan heat low

Janicot et al. (2007)







2006 West-African monsoon at synoptic scale

African easterly waves

a few words on “dry” intrusions

convectively coupled Kelvin waves

AFRICAN EASTERLY WAVES

identification/characterization : various methods

filtering winds/vorticities often at a given level (700 hPa, 850 hPa), EOFs, wavelets

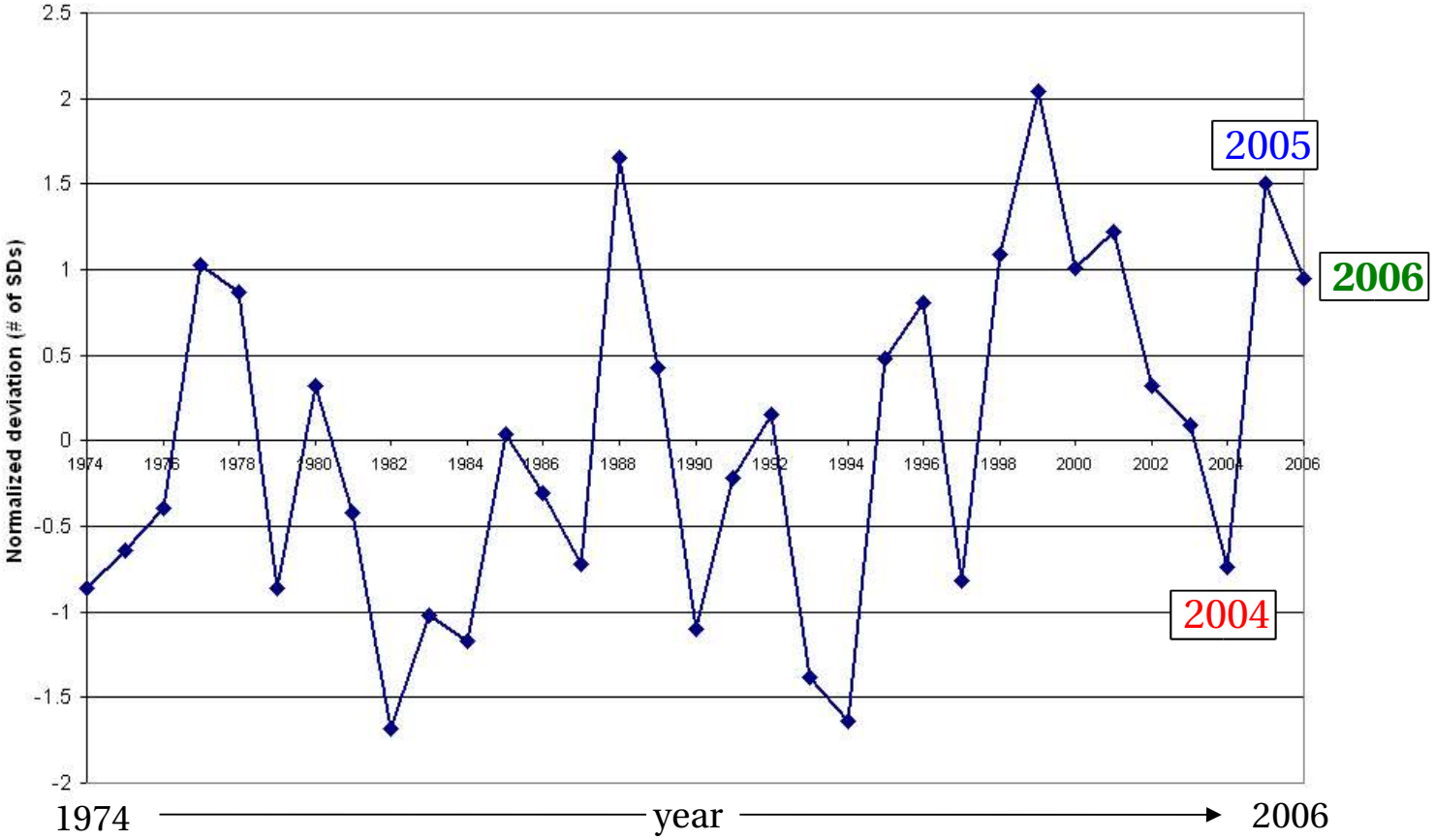
objective and more manual methods in use

(Berry & Thorncroft, Chapelet, Chauvin, Lavaysse)

Berry and Thorncroft (2007)

normalized deviation of 2-6 day filtered 850 hPa eddy kinetic energy [5N-20N, 0-20W] average

(common way to diagnose AEWs)



suggests relatively strong activity

Berry & Thorncroft (2007)

diagnostic prepared for real-time monitoring during the SOP

27 waves / 2006
28 " / 2005
31 " / 2004

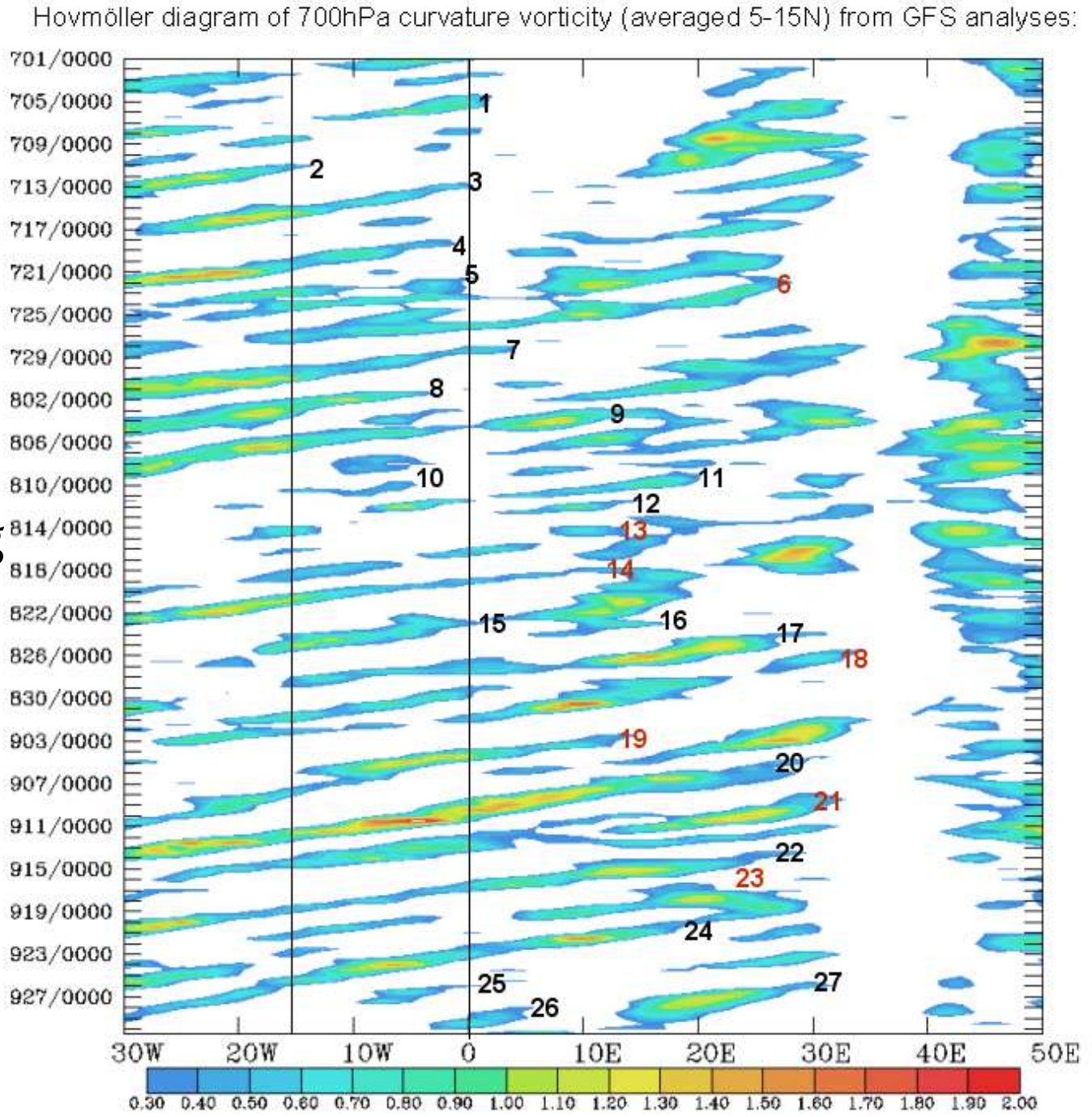
Jul, initiation close to ~ 0°

Aug, initiation further E

still weak

Sep, more coherency,

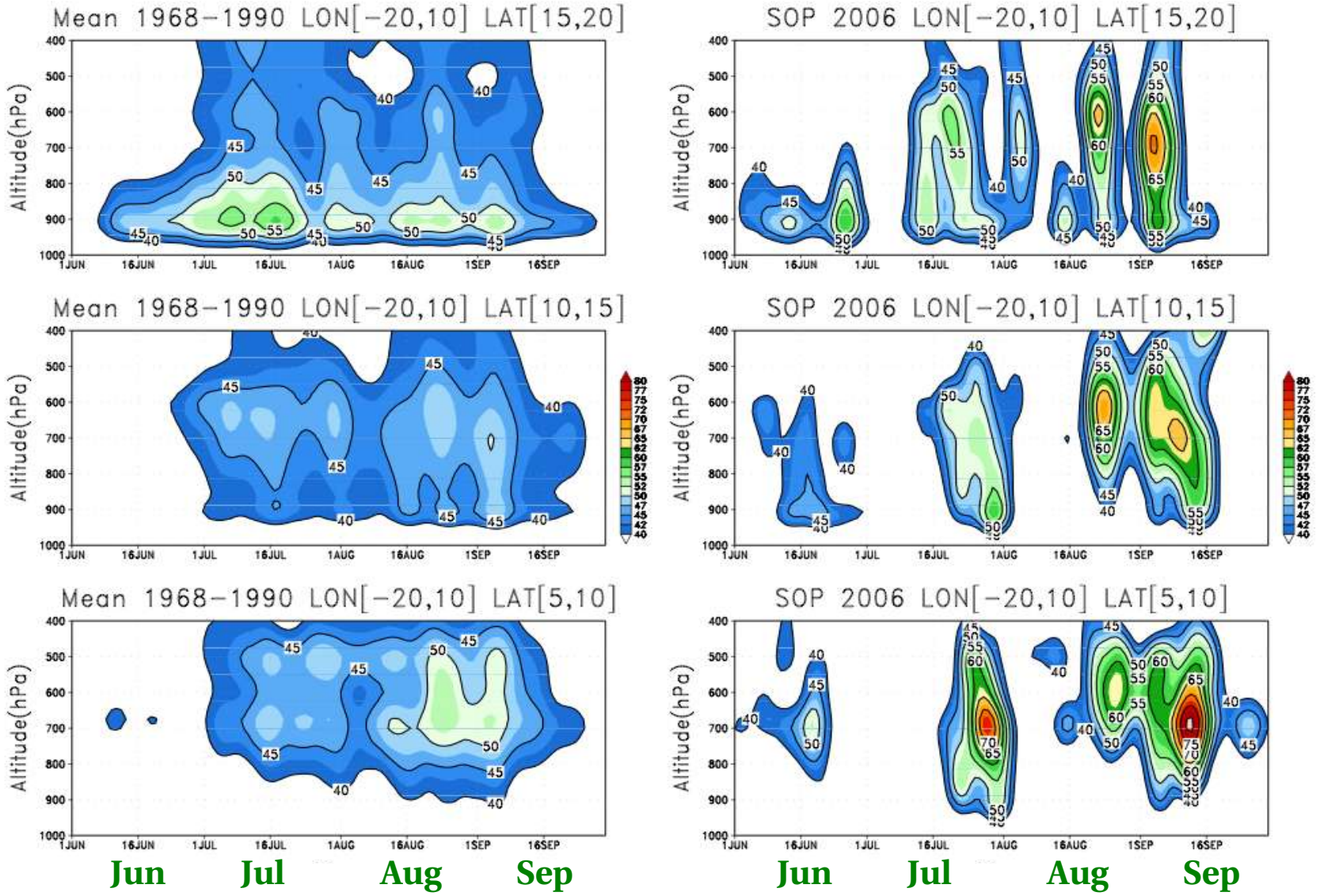
stronger amplitude



numbering for synoptic systems meeting a given tracking criteria
red ones became tropical cyclones 6: Chris, 13: Ernesto, 14: Debby, 18:Florence, 19: Gordon, 21: Helene, 23: Isaac.

Source: Lavaysse

3-5 day spectral density (wavelet-based technique)



850hPa ~ early dry Saharian/north Sahel activity
700 hPa ~ late wet Guinean activity
in 2006: not much activity early in the season, late monsoon strong off Dakar

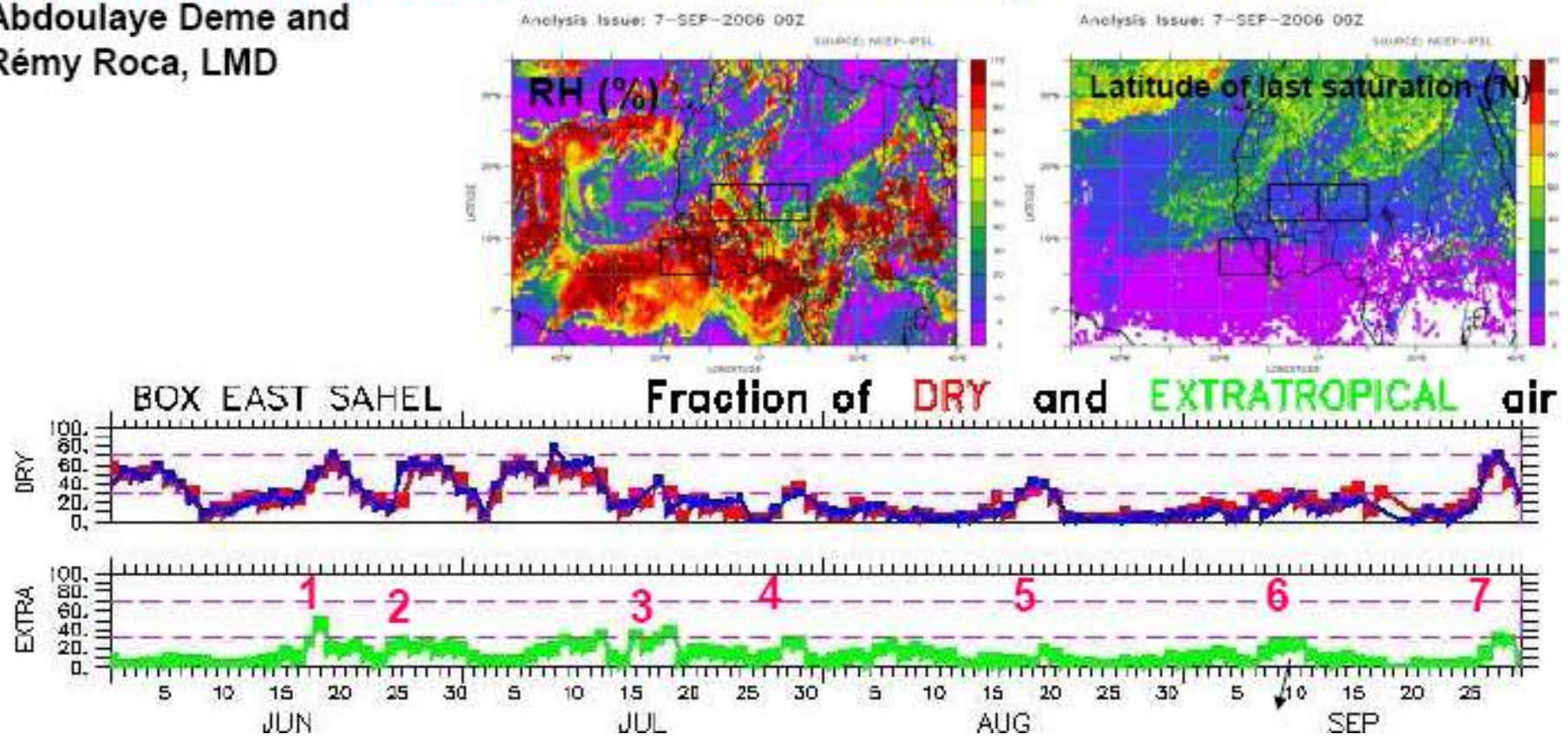
Source: Chapelet & Lafore

AEW	Duration	Position	Convection- AEW	Comments
J1	5-10 June	North ITD 600 hPa	NO - Except 8-9 Night	Weak
J2	10-13 June	600 hPa	12 June MCS –Côte d'Ivoire	Weak Regular progression
J3	18-21 June	600 hPa first 700 hPa 20-21 June	NO?	Weak Merging of 2 waves
J4	21-26 June	Double AEW	NO	Strong to the North Dry air at the initial stage
J5	26-30 June		Suppressed	Dry air over Mali
JL1	3-6 July	Double AEW	MCS from 5 July 12Z Between waves	
JL2	11-14 July		MCS from 14 July at 00Z	Why no MCS previous nights
JL3	15-20 July		MCS on 19 July	
JL4	24-27 July	700 hPa	2 MCSs 24-26 JN-Niamey Mauritania 24-27 JE-Niger Guinea	
A1	31 J-3 Aug	600 hPa	YES at start + regeneration	AEW generation by MCSs
A2	3-6 August	600 hPa	Trough at 300 hPa on 3 Aug suppressed convection?	2 AEWs merging
A3	5-8 August	700 hPa	Weak convection SL onset on 6 Aug. at Niamey	Weak AEJ
A4/A5	10-13 Aug	700 hPa		2 AEWs
A6	17-20 Aug	600 hPa	MCS 18-19 Aug.	
A7	19-25 Aug	700 hPa	MCS 22-24 Aug.	
A8	27-31 Aug.		MCS 28-29 Aug. faster / AEW	
A9	31 A-3 Sep			
S1	6-8 Sept			
S2	6-15 Sept			Nice sequence with 3 waves Dry extra-trop intrusion on 7 Sep
S3	17-18 Sept			
S4	22-26 Sept			

List of the main AEWs and their attributes subjectively detected during the 2006 SOP. It corresponds to the WASA (West African Synthetic Analysis) operationally performed by the African Forecasters Team. Nevertheless it differs by the fact that WASA have been redrawn by Philippe Chapelet to get a more homogeneous analysis and using supplementary fields such as the vorticity one not available in Niamey on the Synergie forecasting system.

Water vapor transport : extra-tropical dry air intrusions

Abdoulaye Deme and
Rémy Roca, LMD



extra-tropical dry intrusions were less frequent in 2006, about half less events than in 1992.

7 clear events detected, with suppressed impact or as an organization factor on convection.

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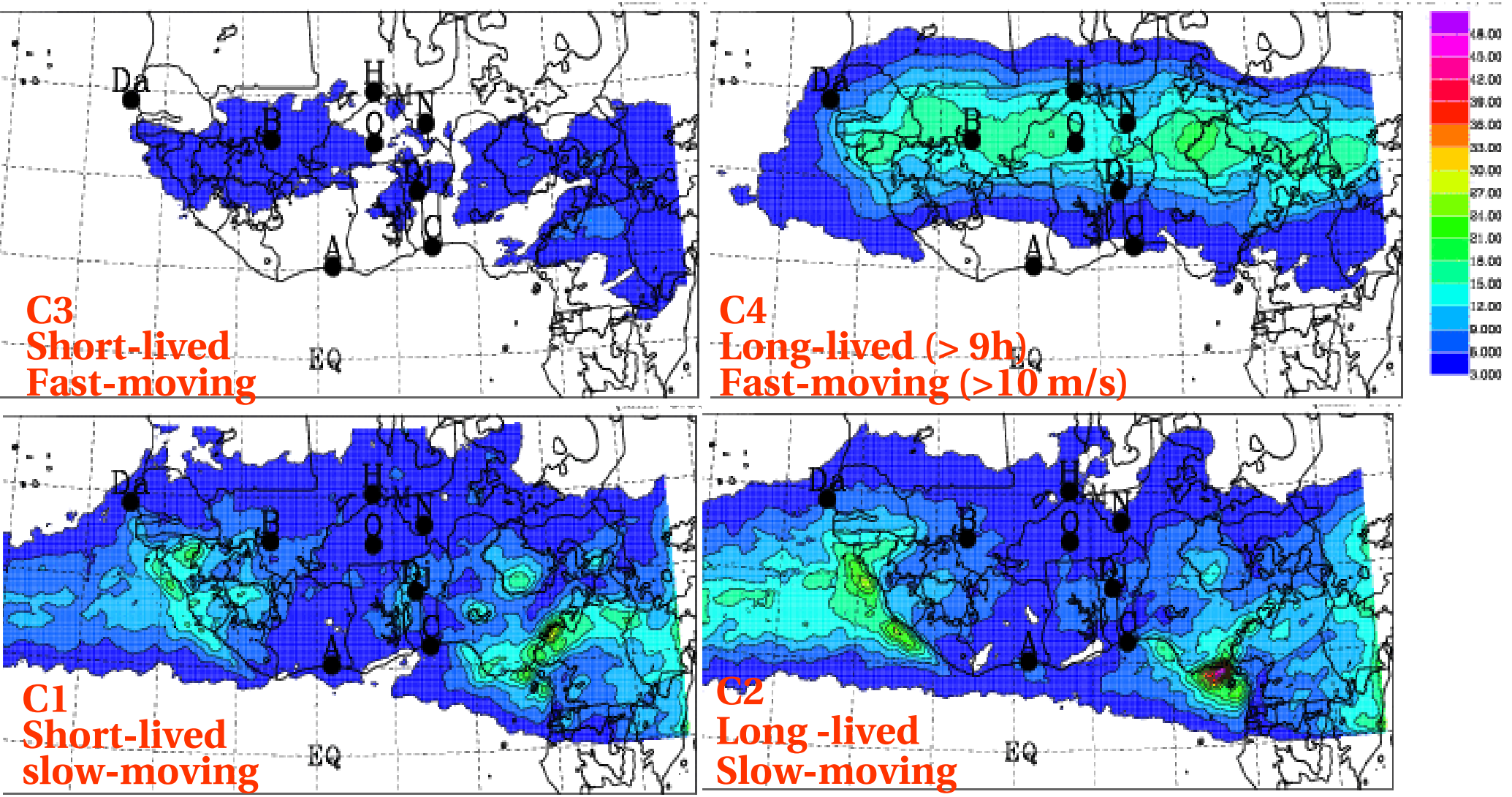
2006 West-African monsoon, MCSs

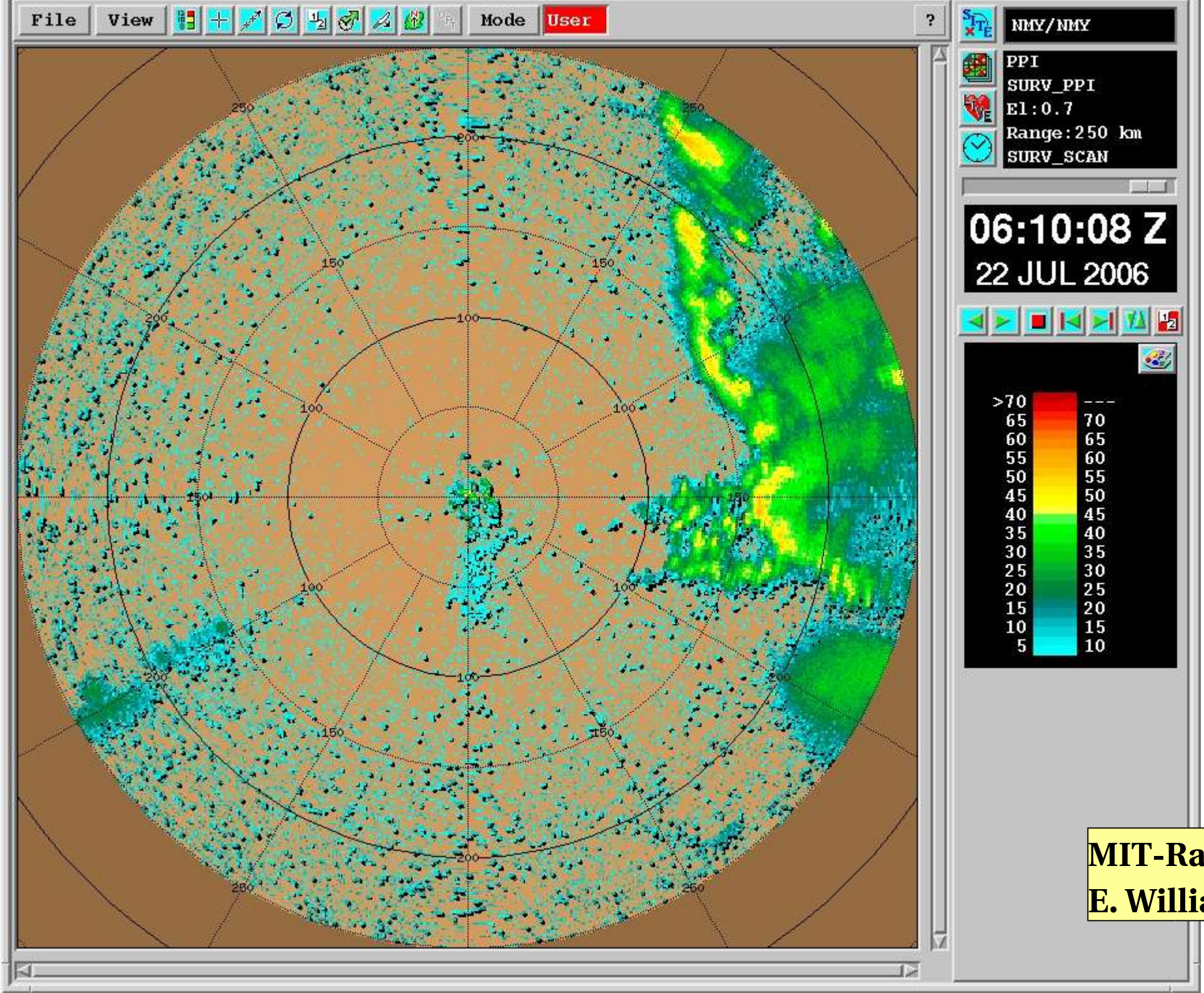
MCS tracking

Mean nebulosity (1996 to 2003, h/month)

MCS tracking from Meteosat IR (Surface (T<-40°C) > 5000 km)
classification in 4 classes function of duration and propagation speed



Tomasini, Asencio & Lafore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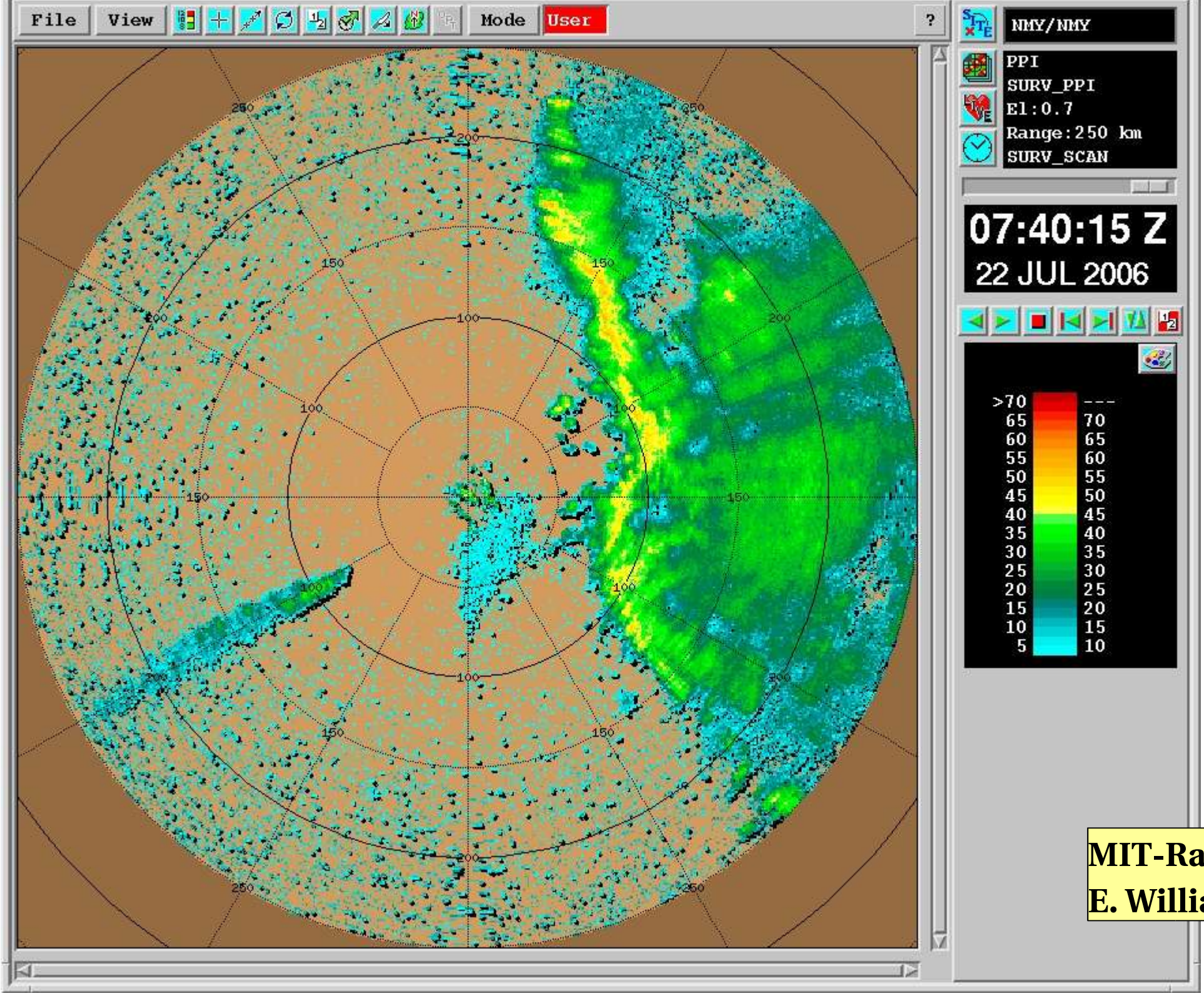
MIT-Radar
E. Williams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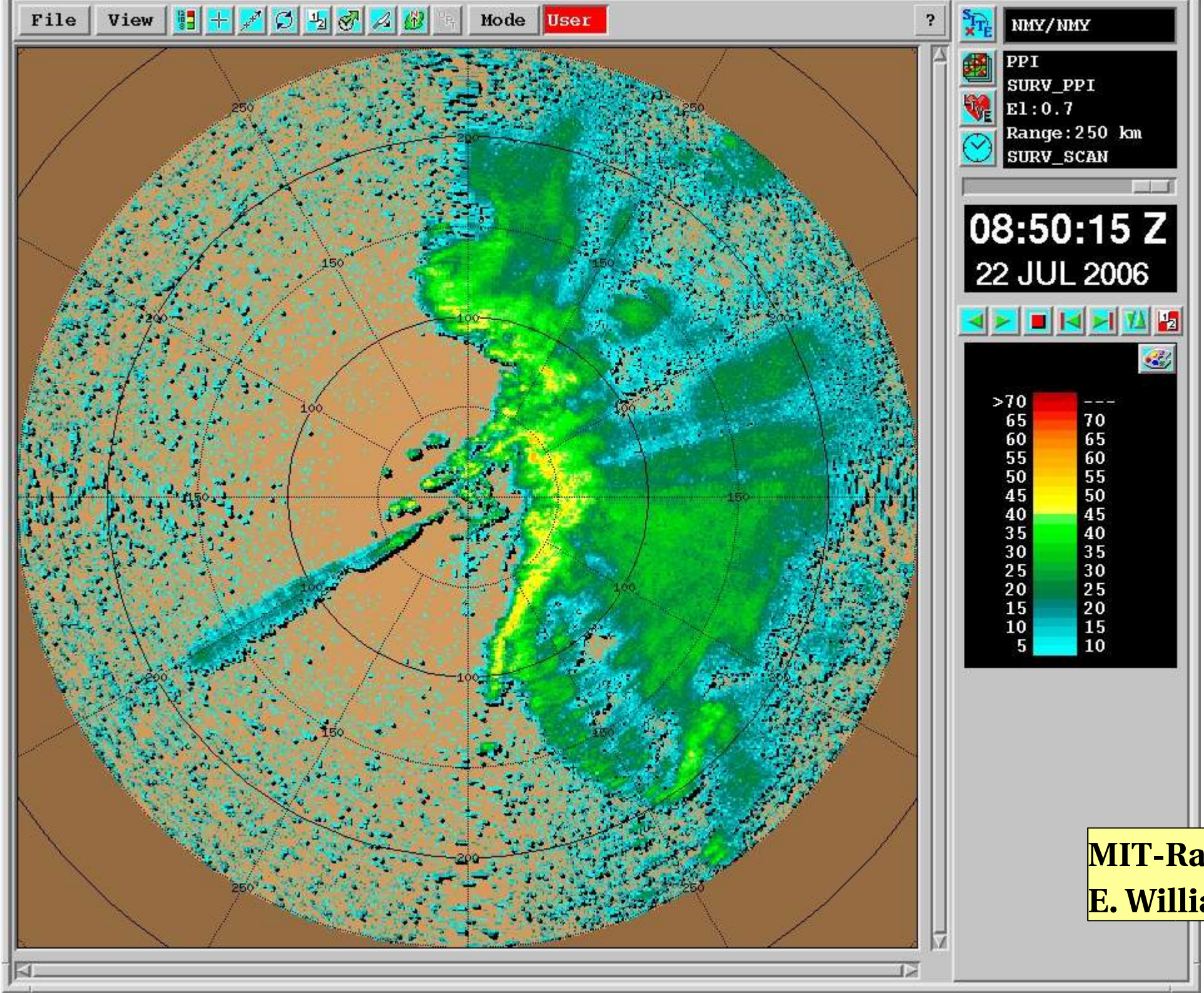
E. Williams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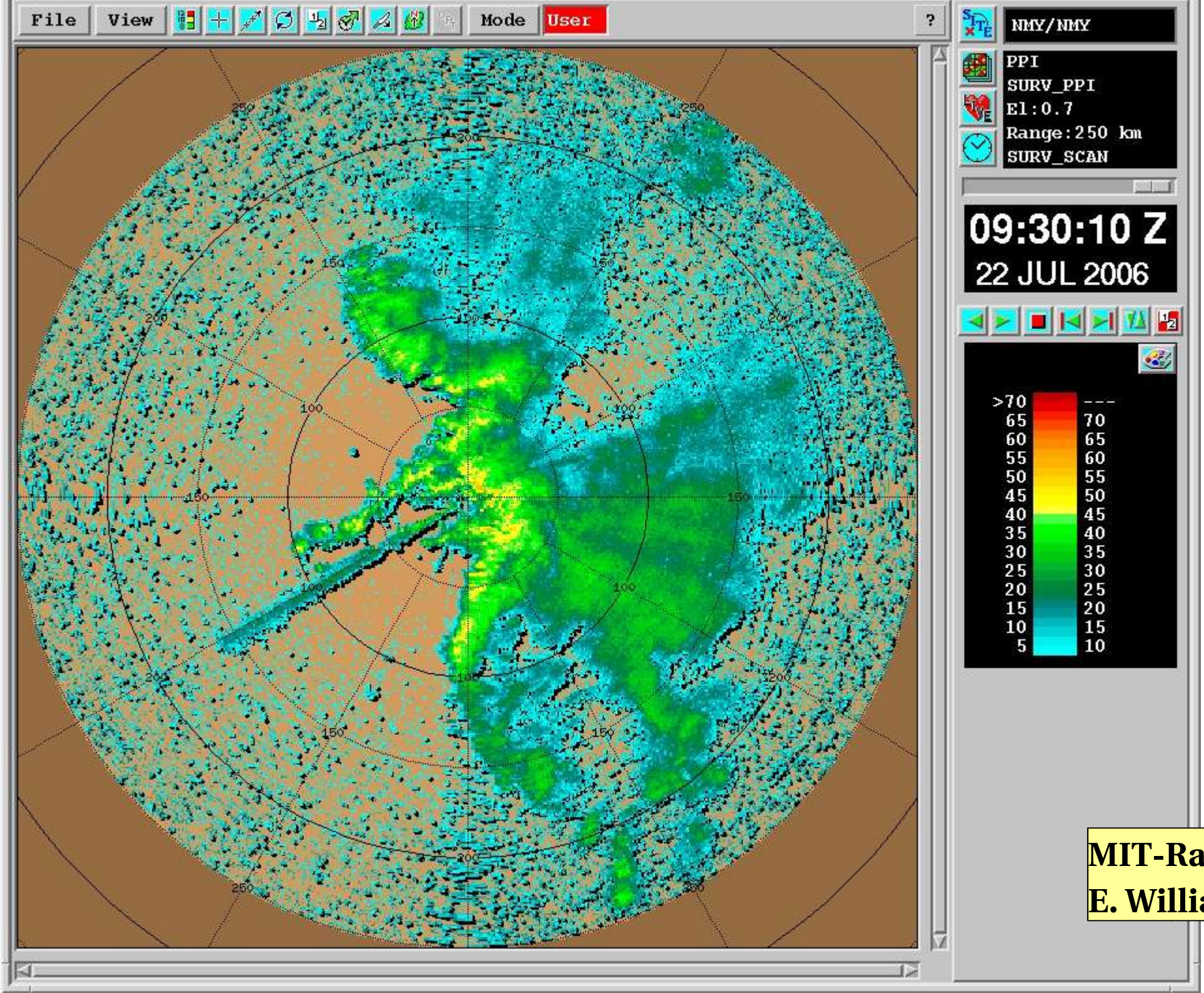
E. Williams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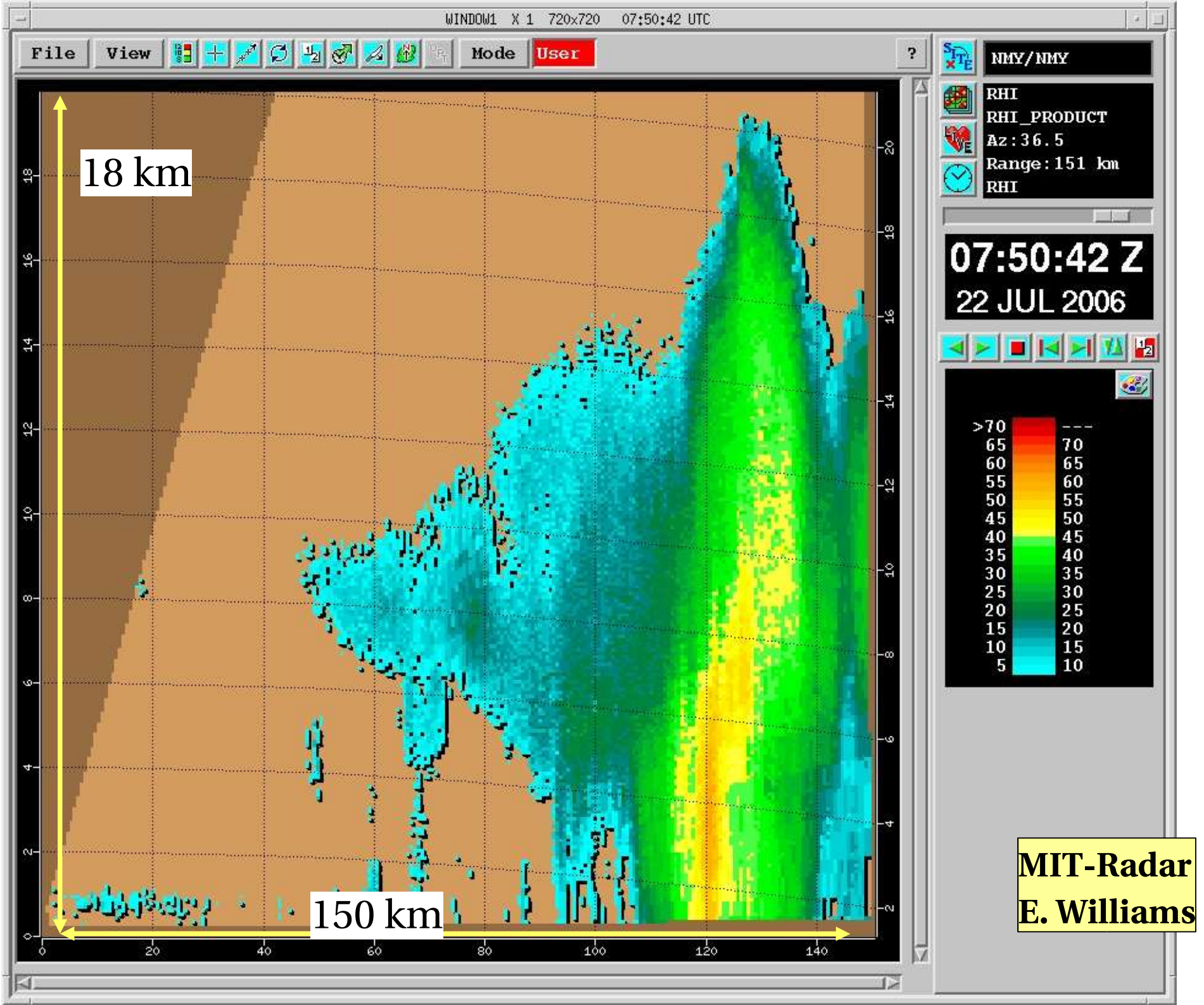
E. Williams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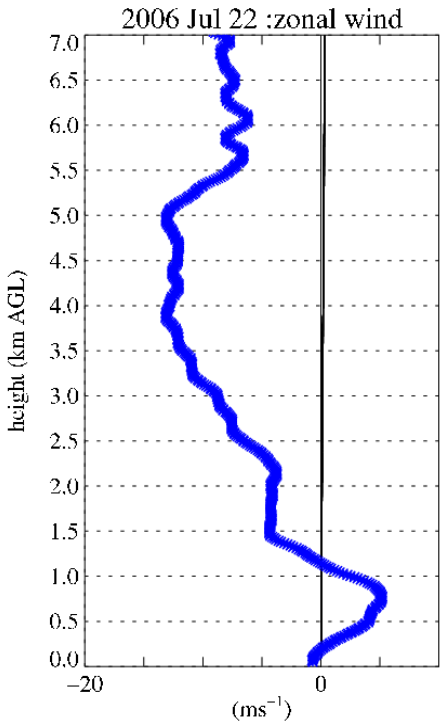
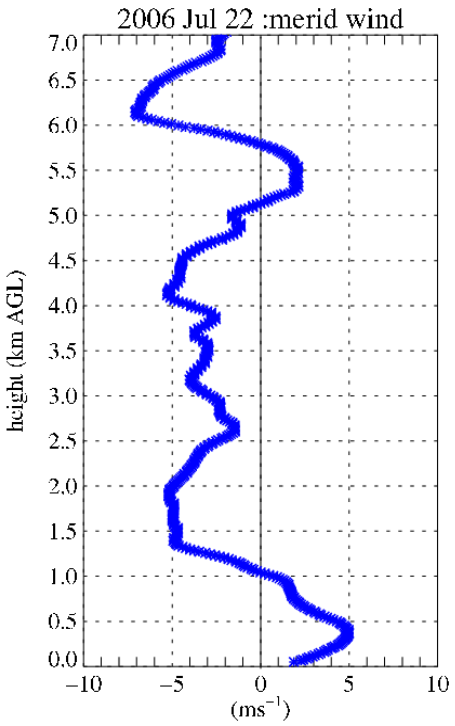
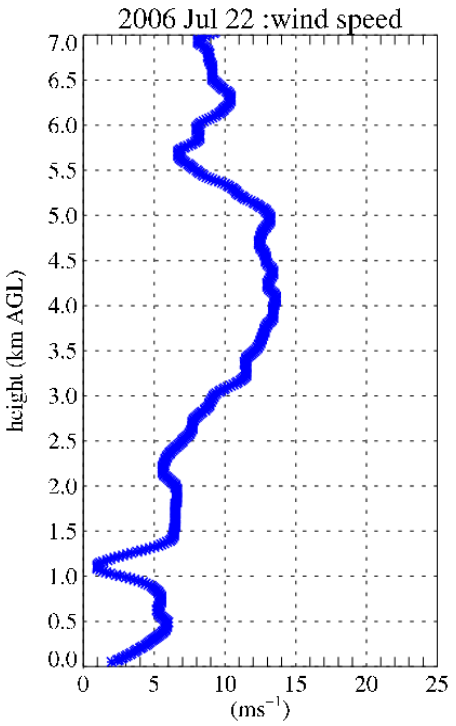
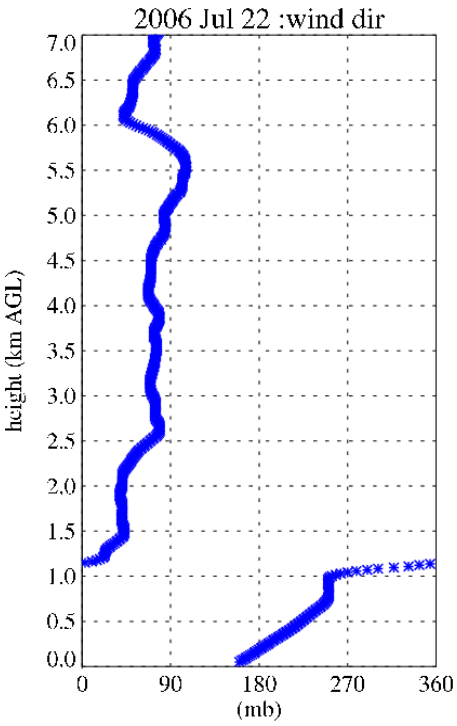
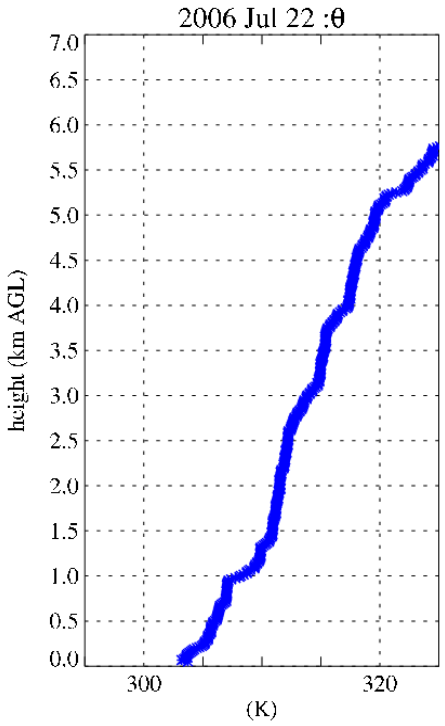
MIT-Radar
E. Williams

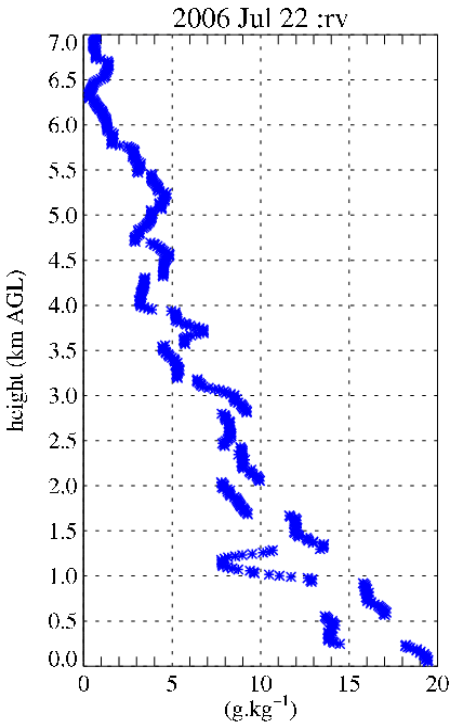


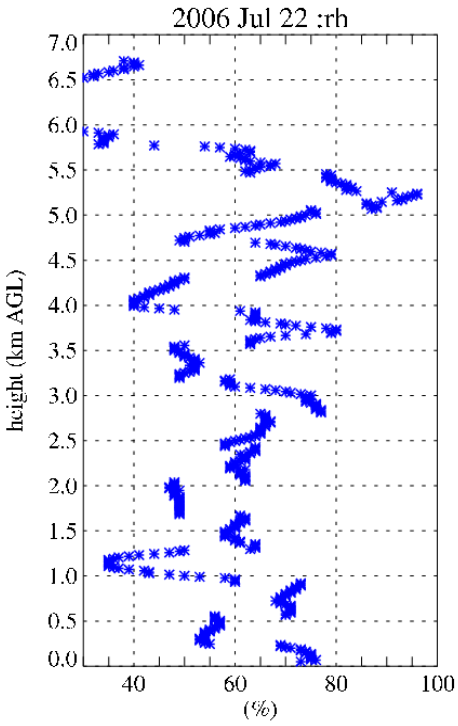


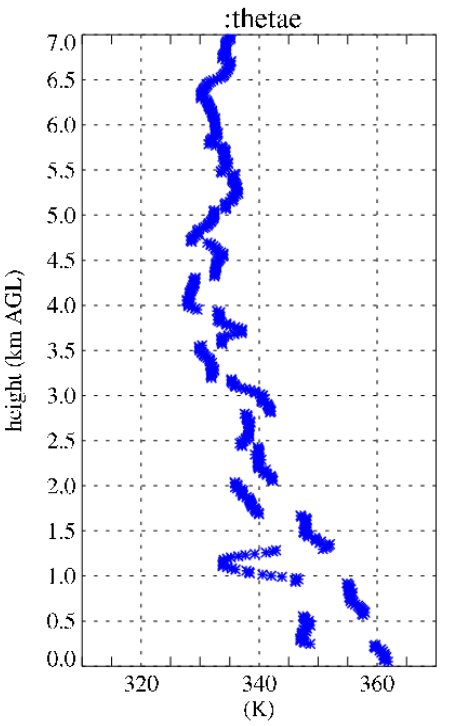












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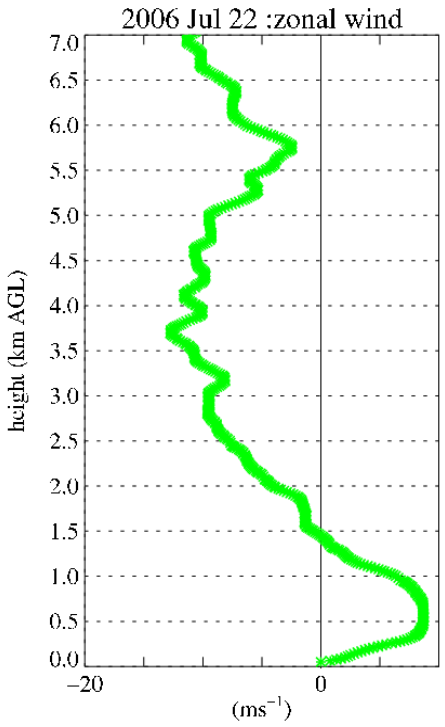
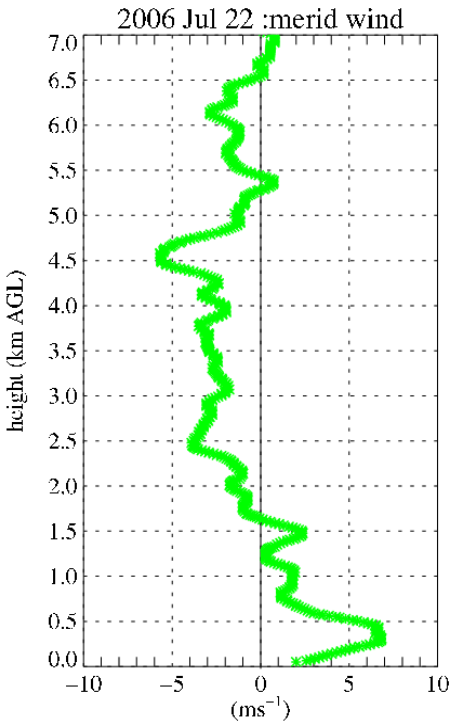
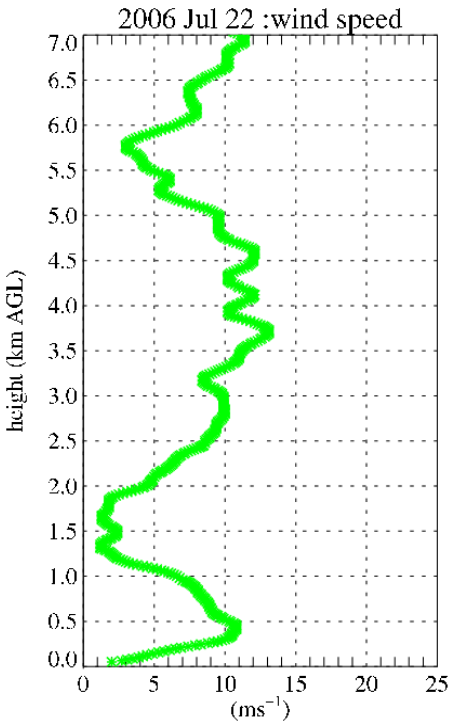
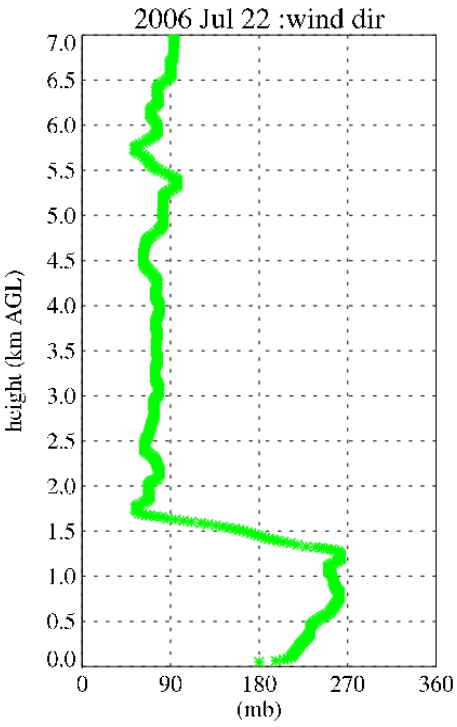
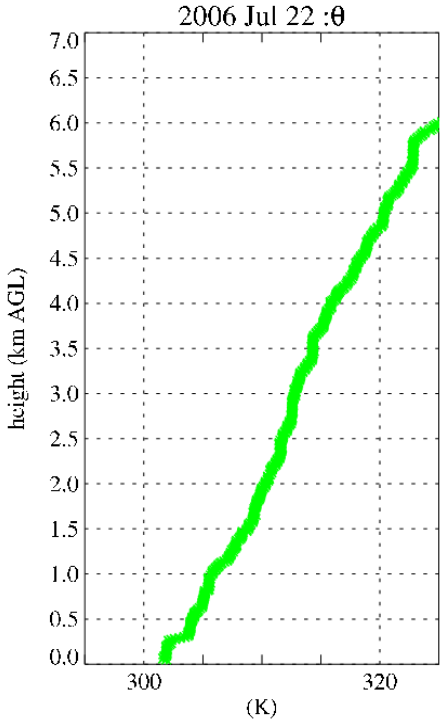
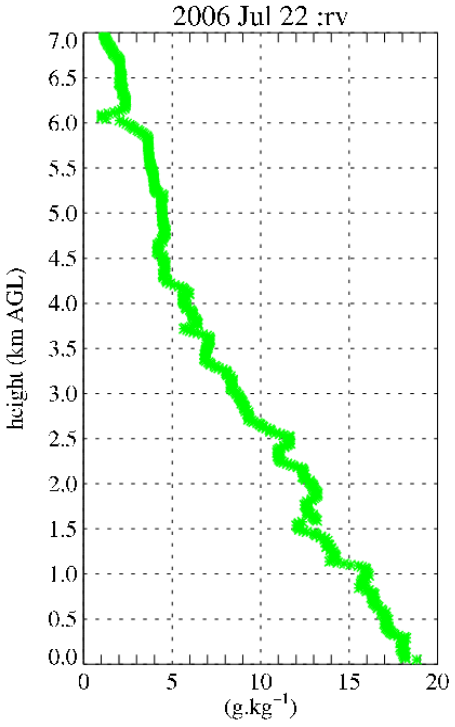


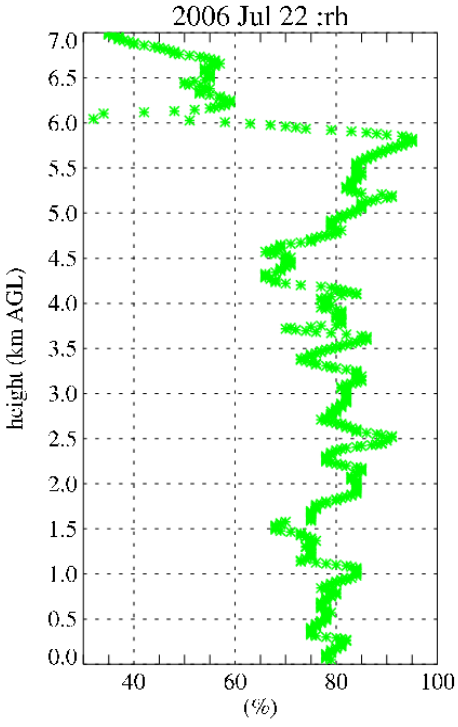


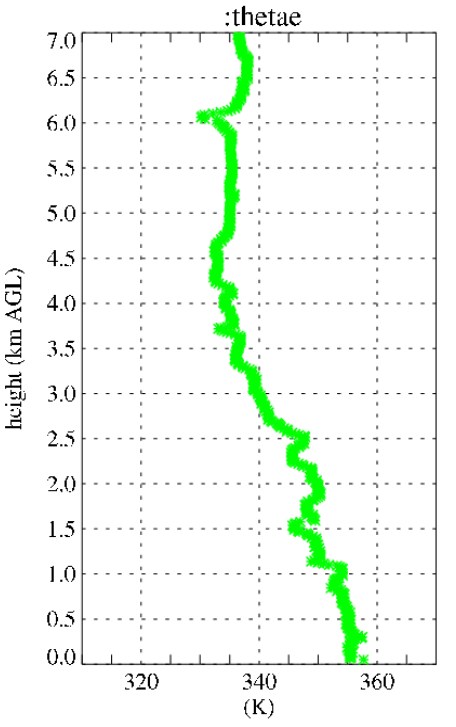




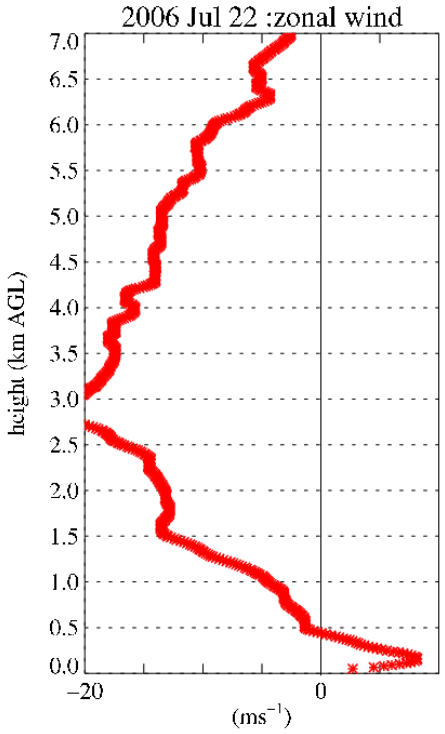


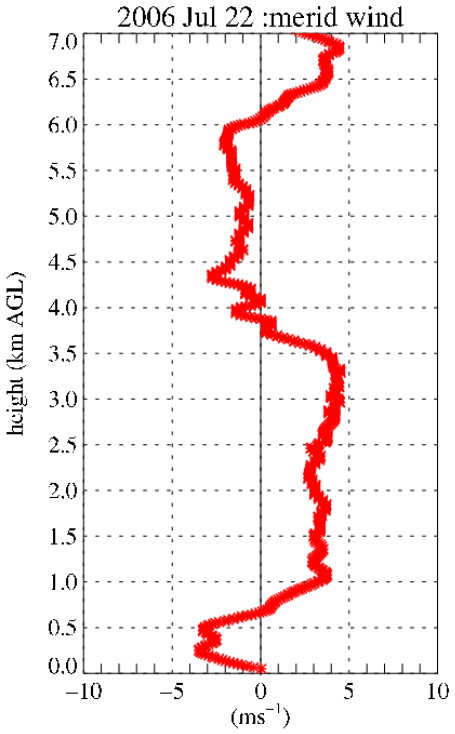


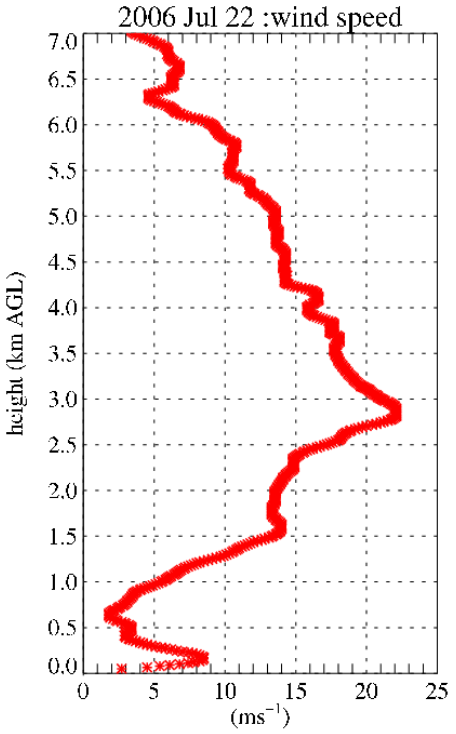


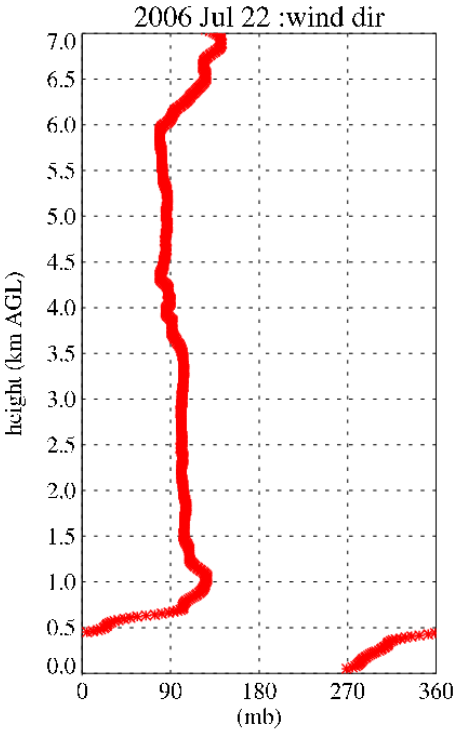


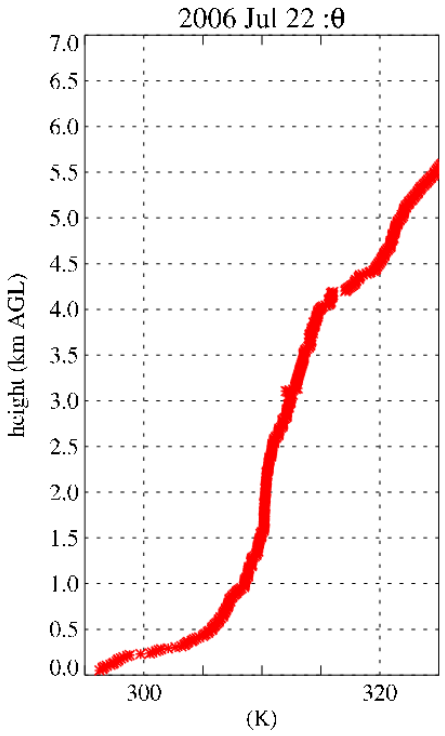
radiosounding start time (hh): 06

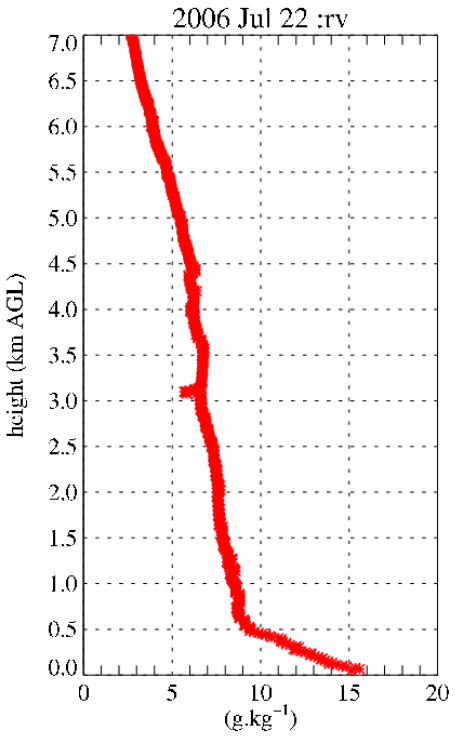


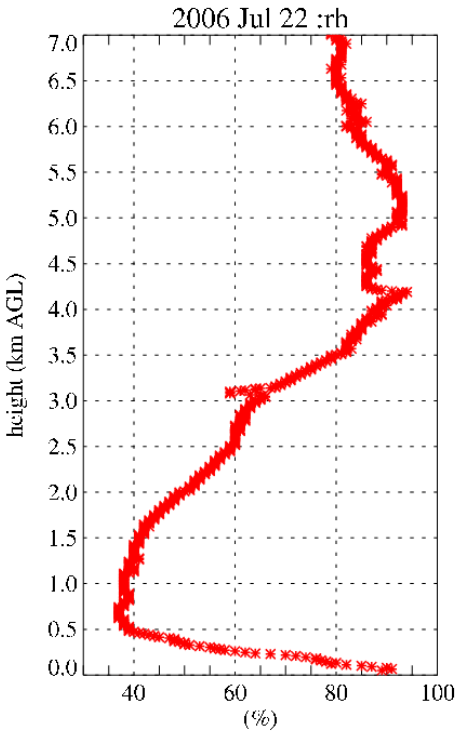


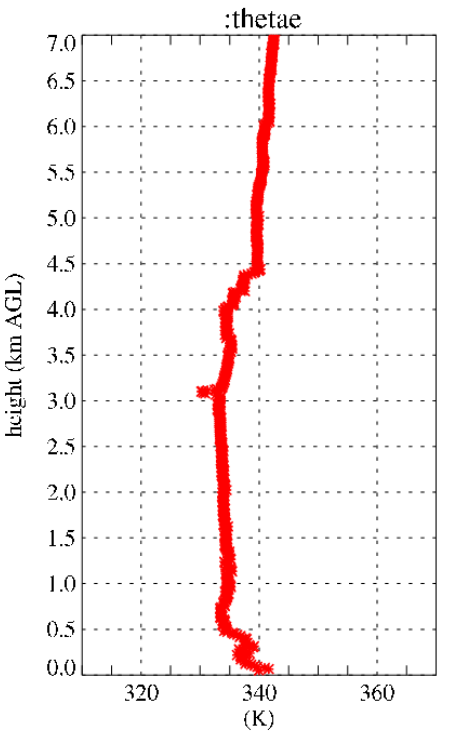




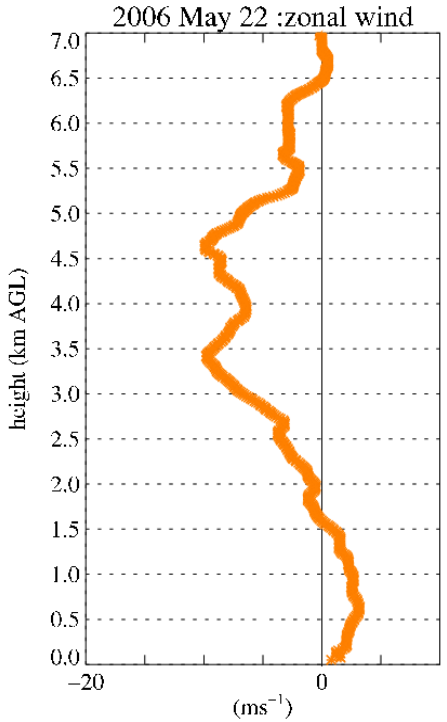


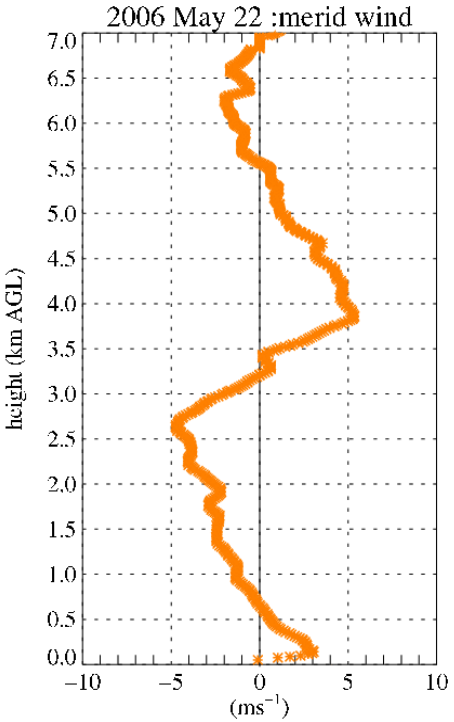


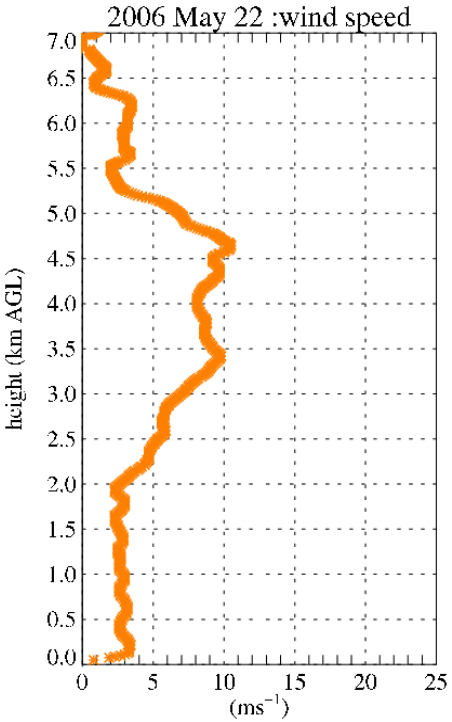


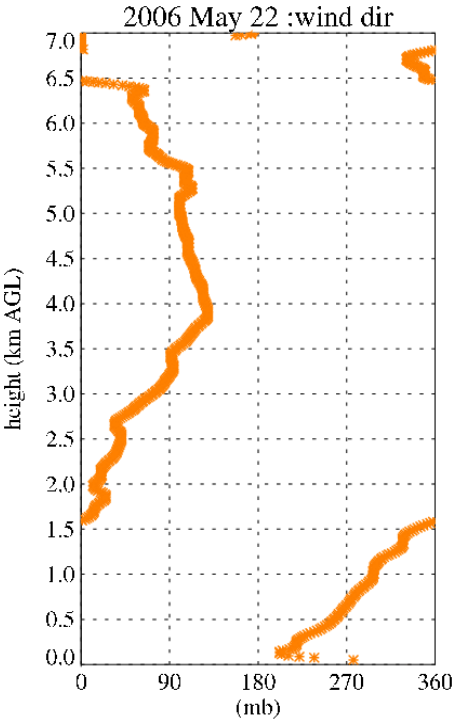


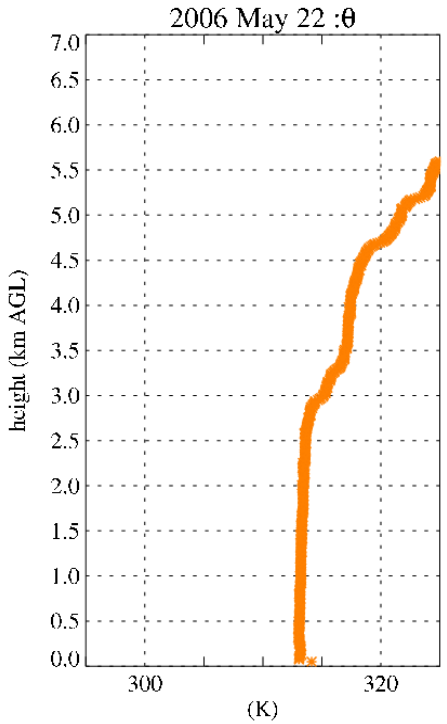
radiosounding start time (hh): 12

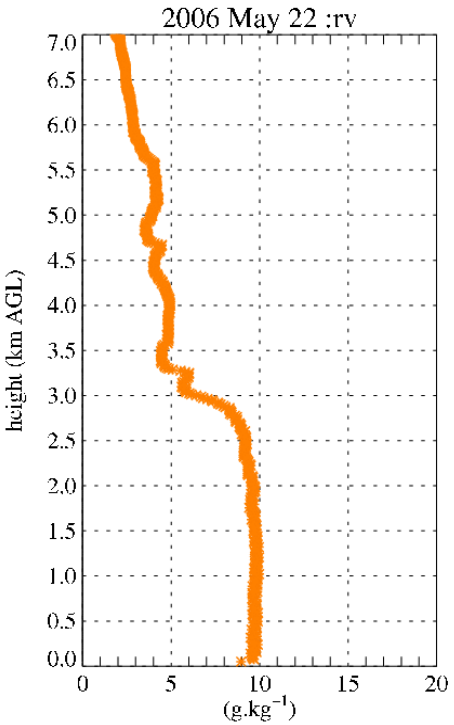


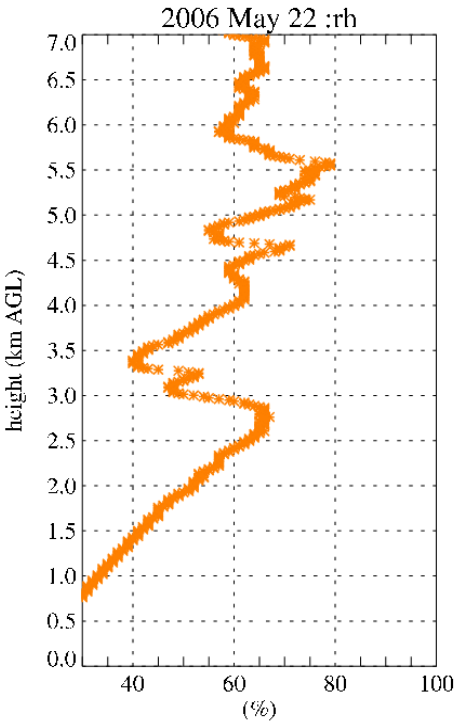


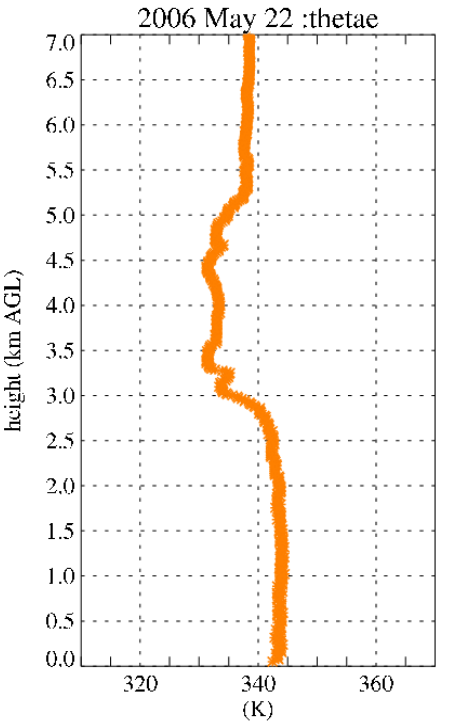




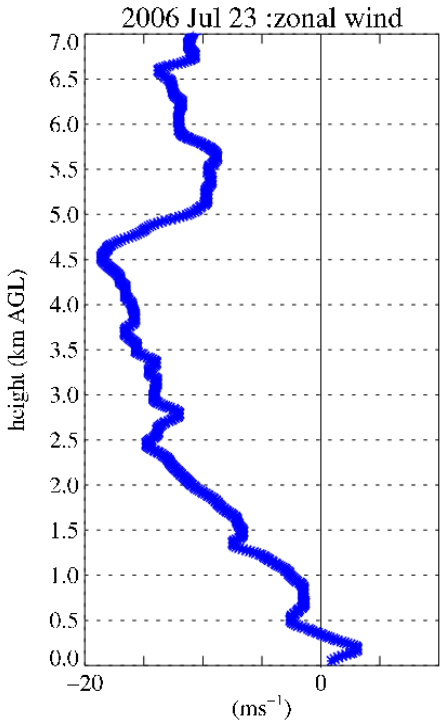


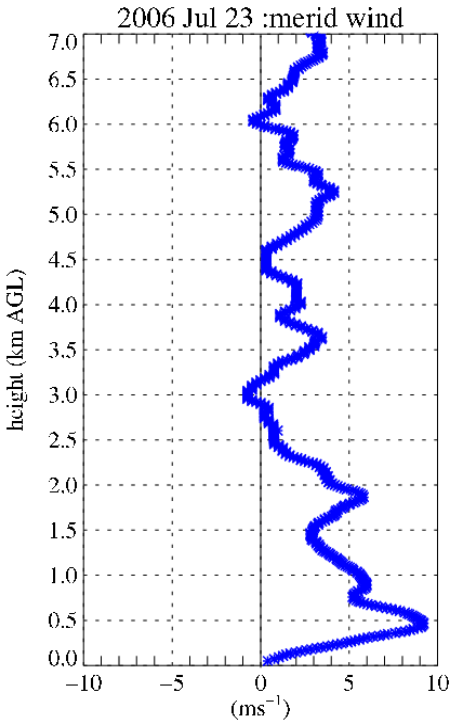


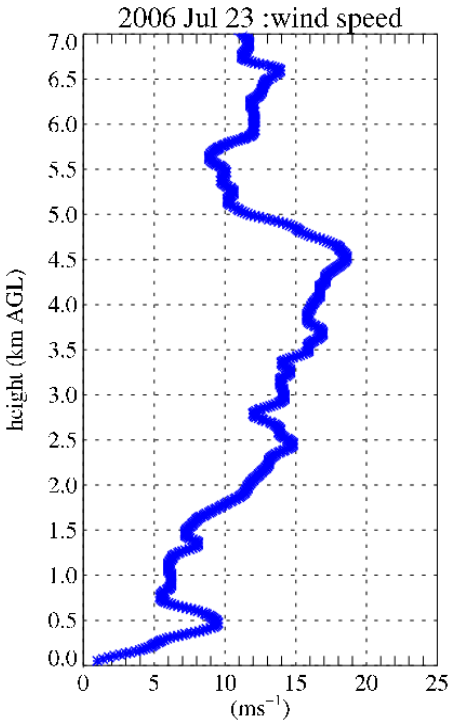


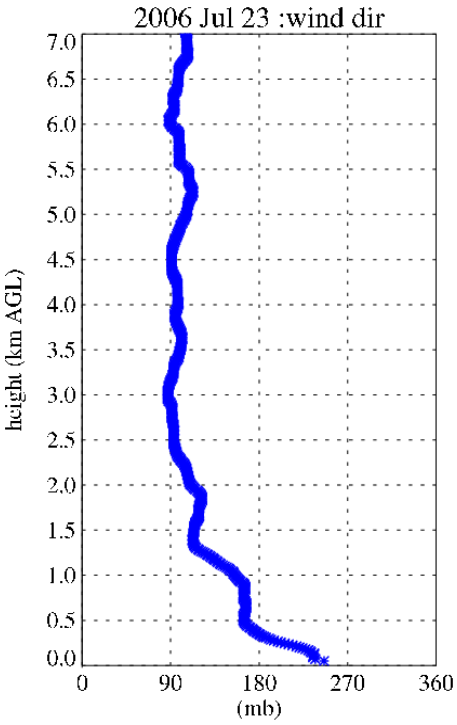


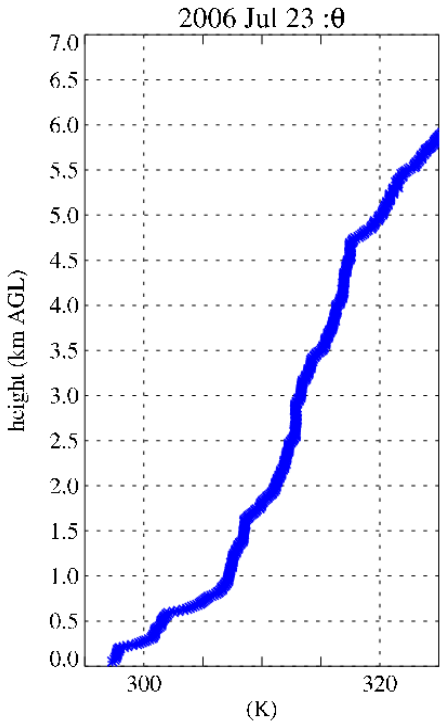
radiosounding start time (hh):

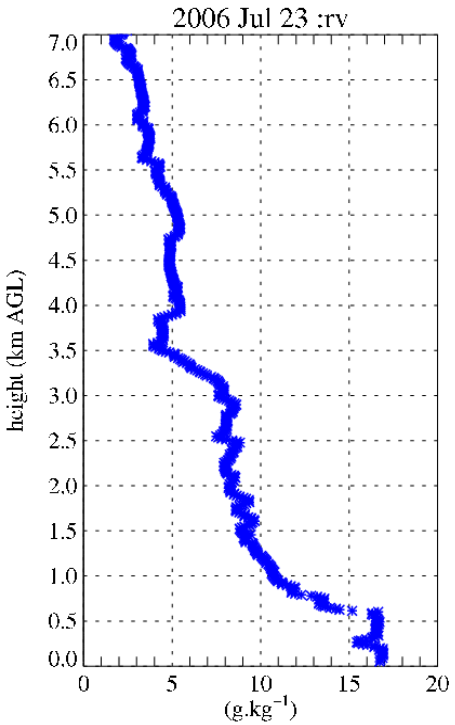


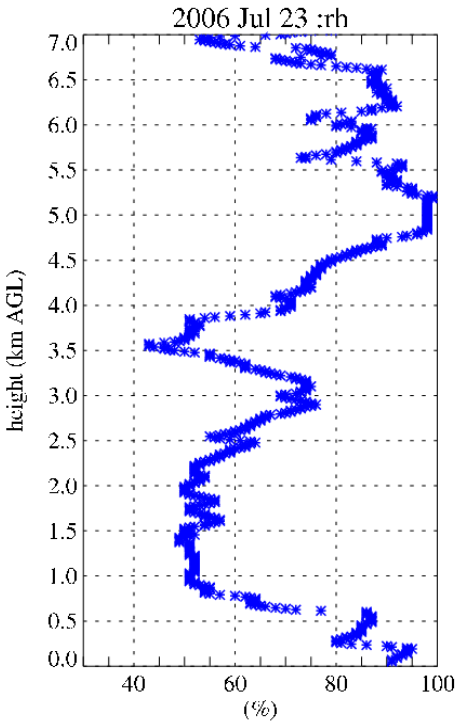


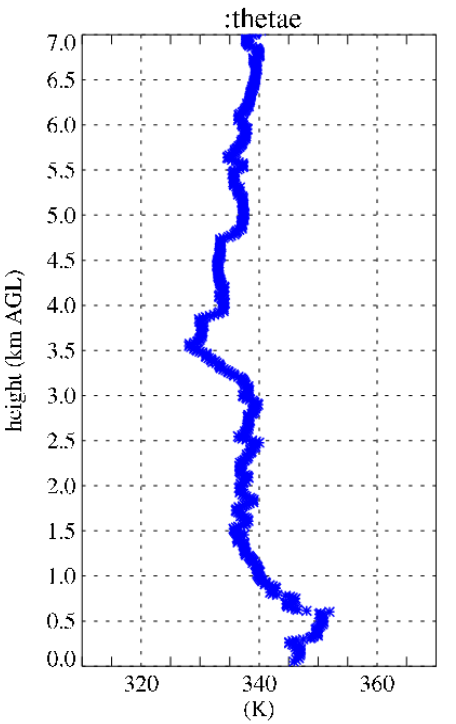








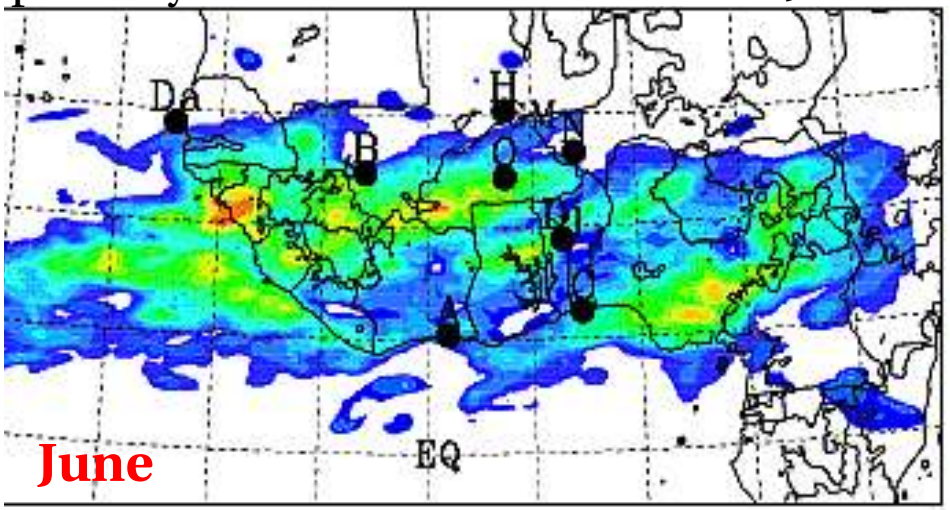


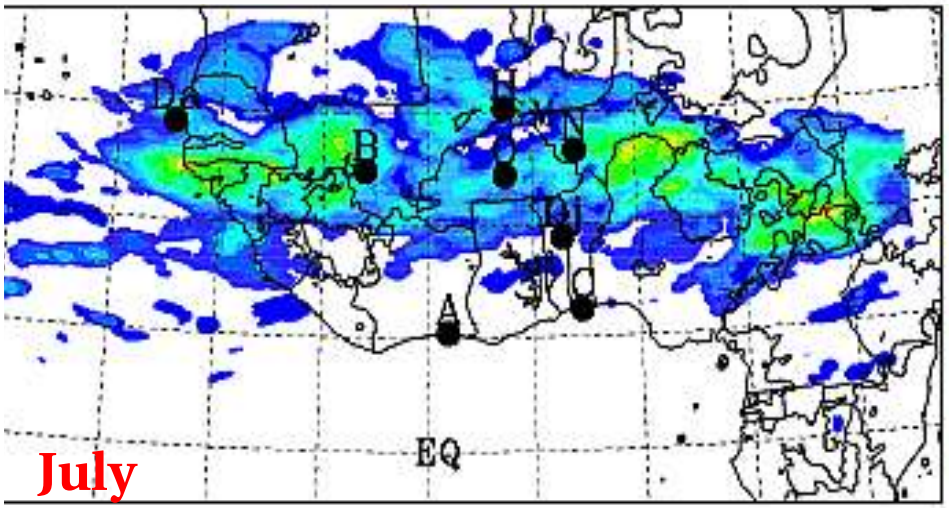


radiosounding start time (hh): 00

C4 in 2006

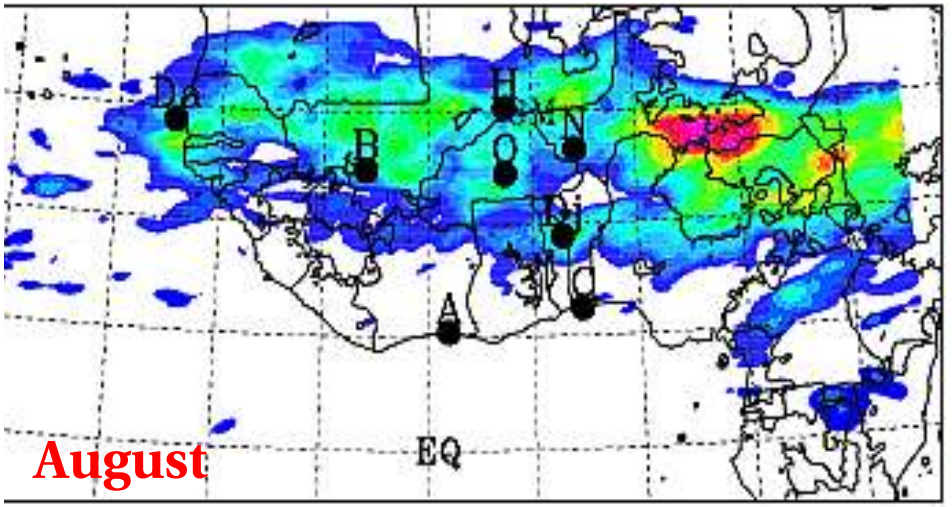
max of convective activity to the West
flash flood over Guinea (5-6 Jun)
possibly more C4 to the South of AEJ

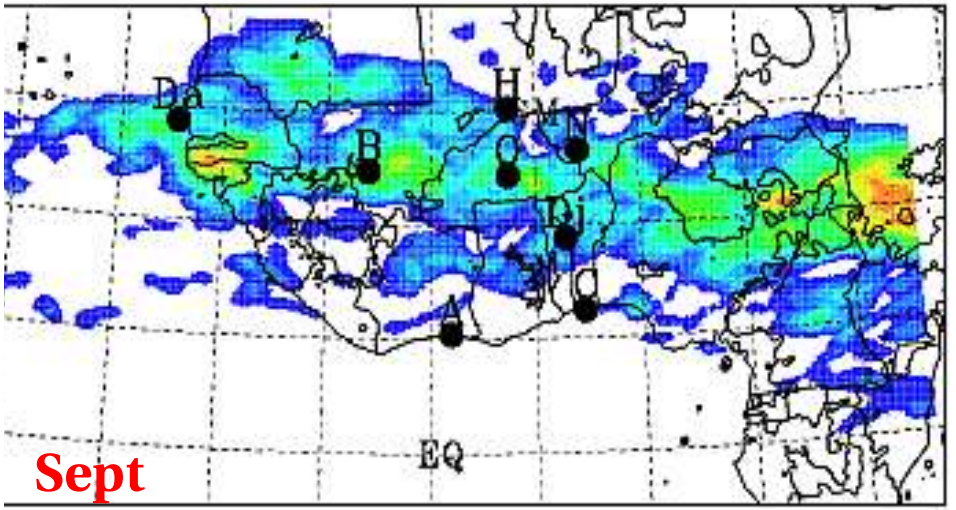




weak activity over Central Sahel
impact from the late moist onset

stronger activity, more northern position
pronounced max along the Niger-Nigeria border

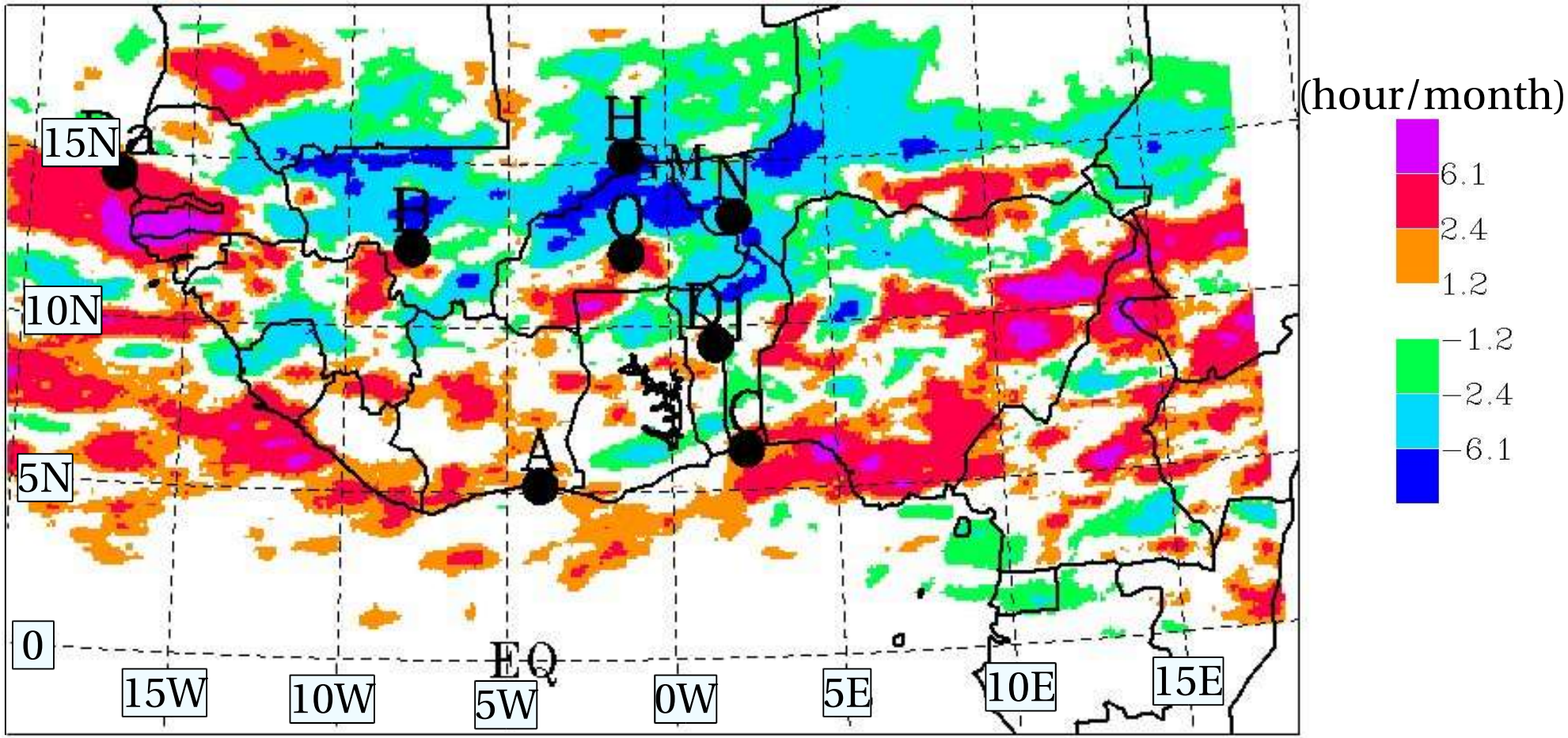




normal activity
stronger at the coast and to the East

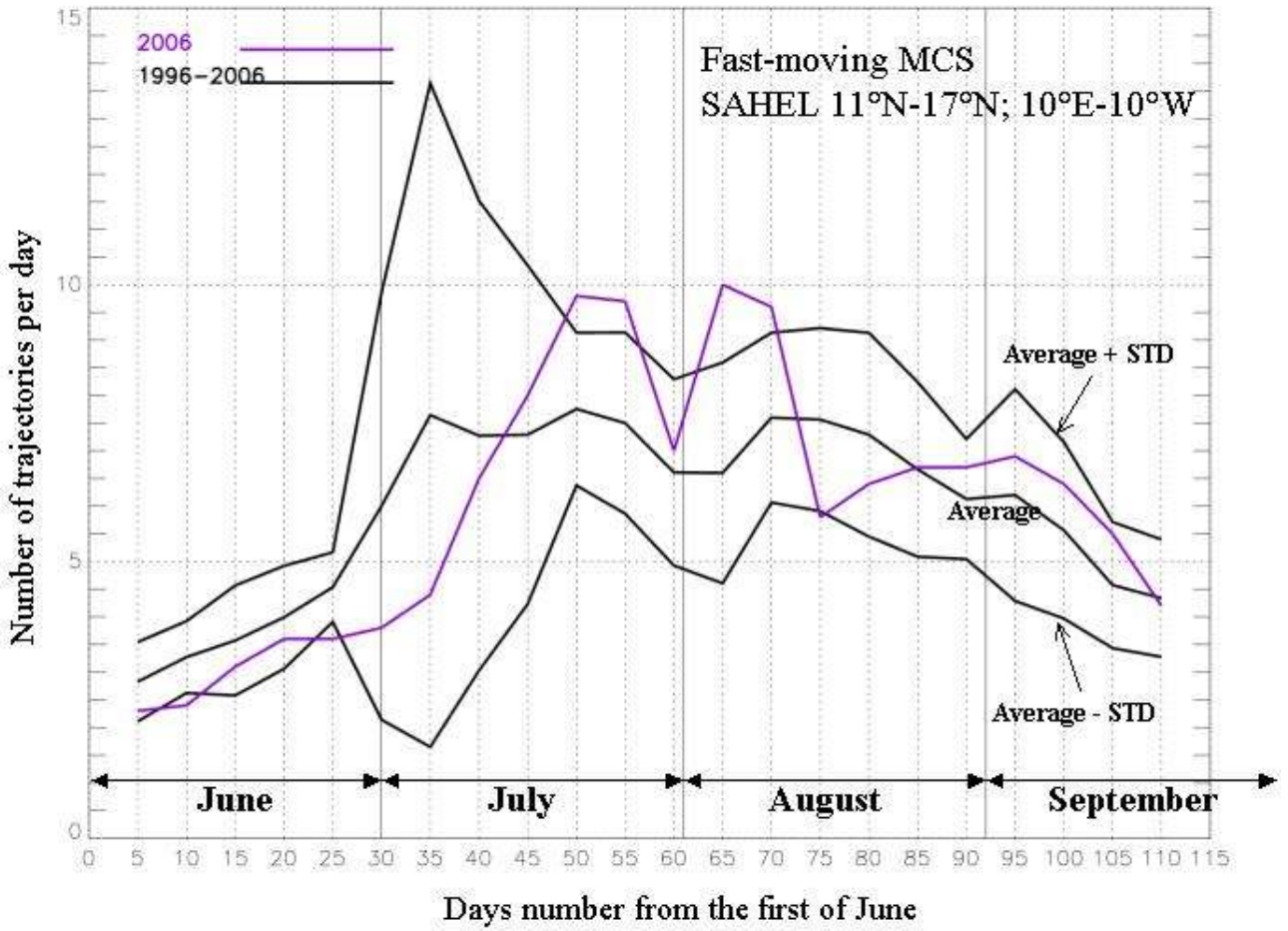
Tomasini, Asencio & Lafore

anomaly of nebulosity for fast-moving MCS (C3+C4) for JJAS 2006 / 10-yr mean

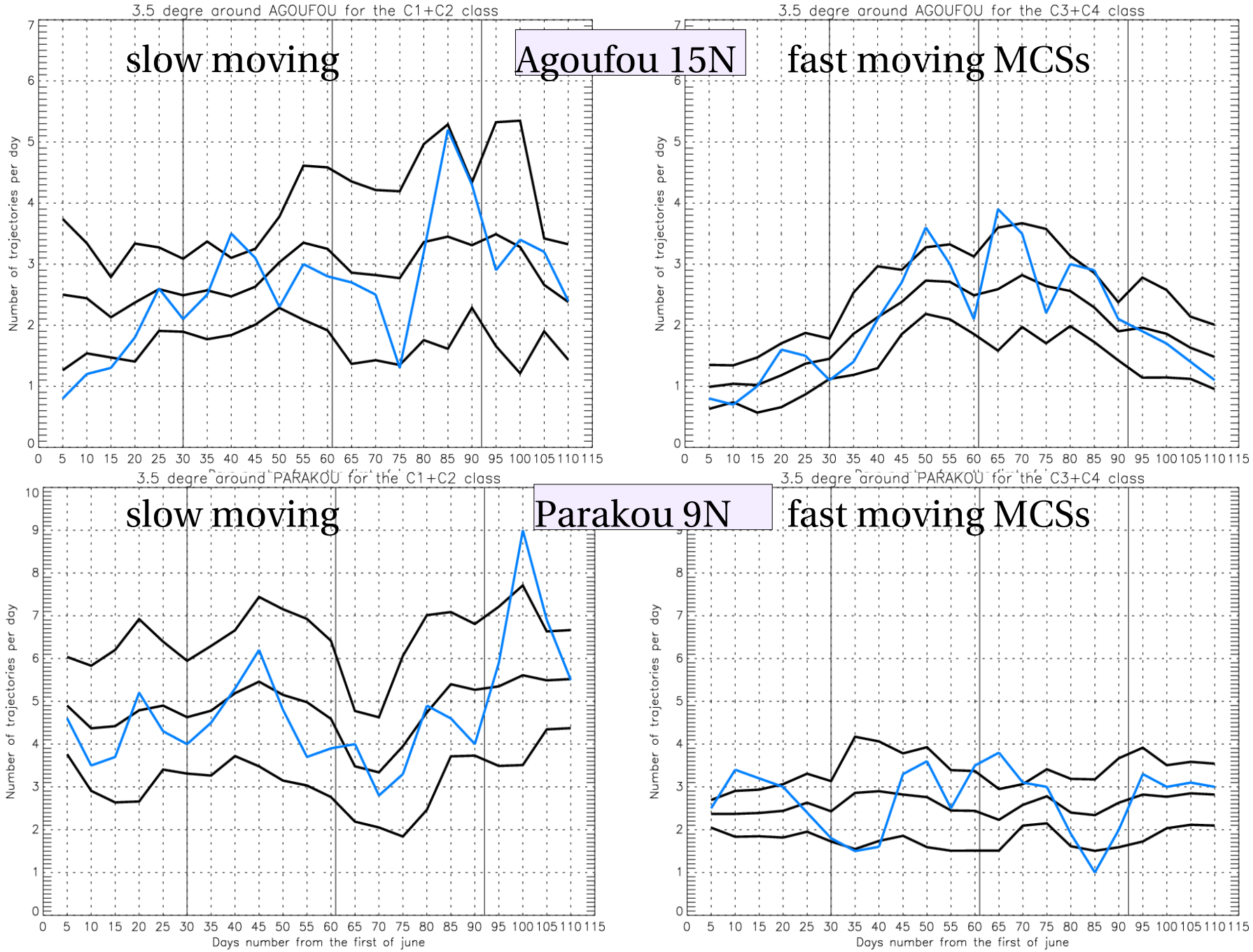


southern shift of the fast propagating MCSs in 2006

Tomasini, Asencio & Lafore



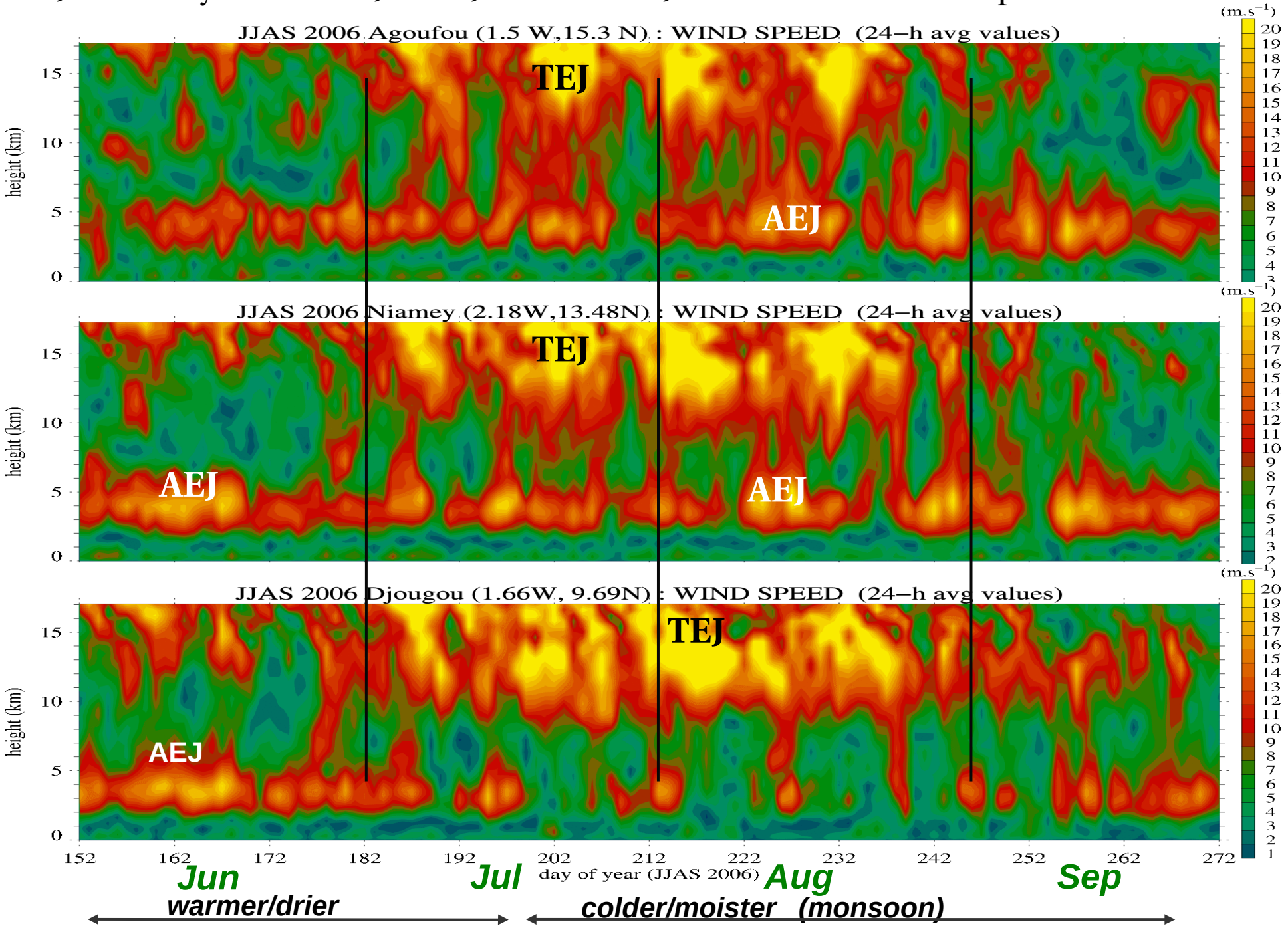
Tomasini & Lafore



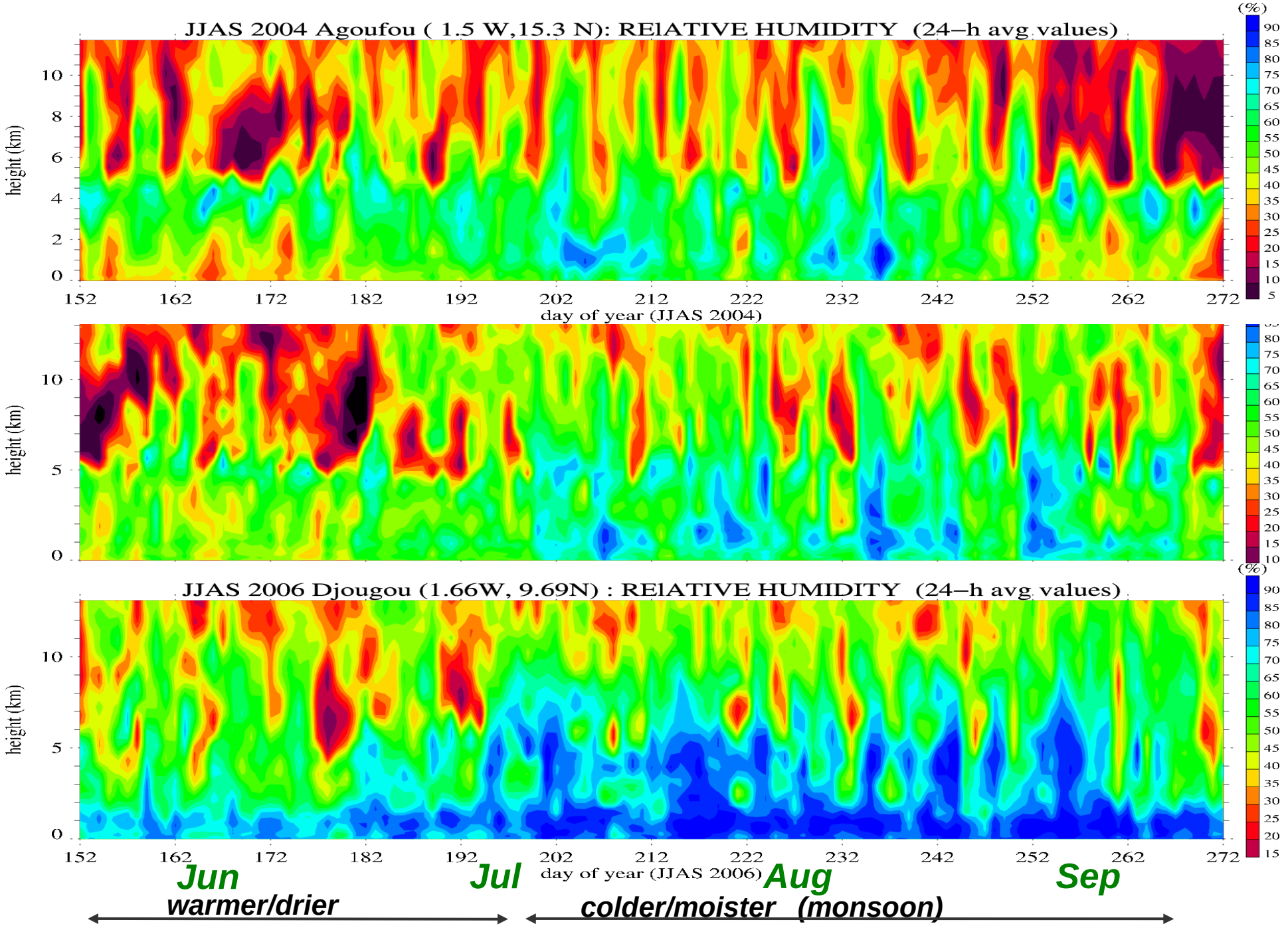
Tomasini & Lafore

AEJ & TEJ seasonal evolutions

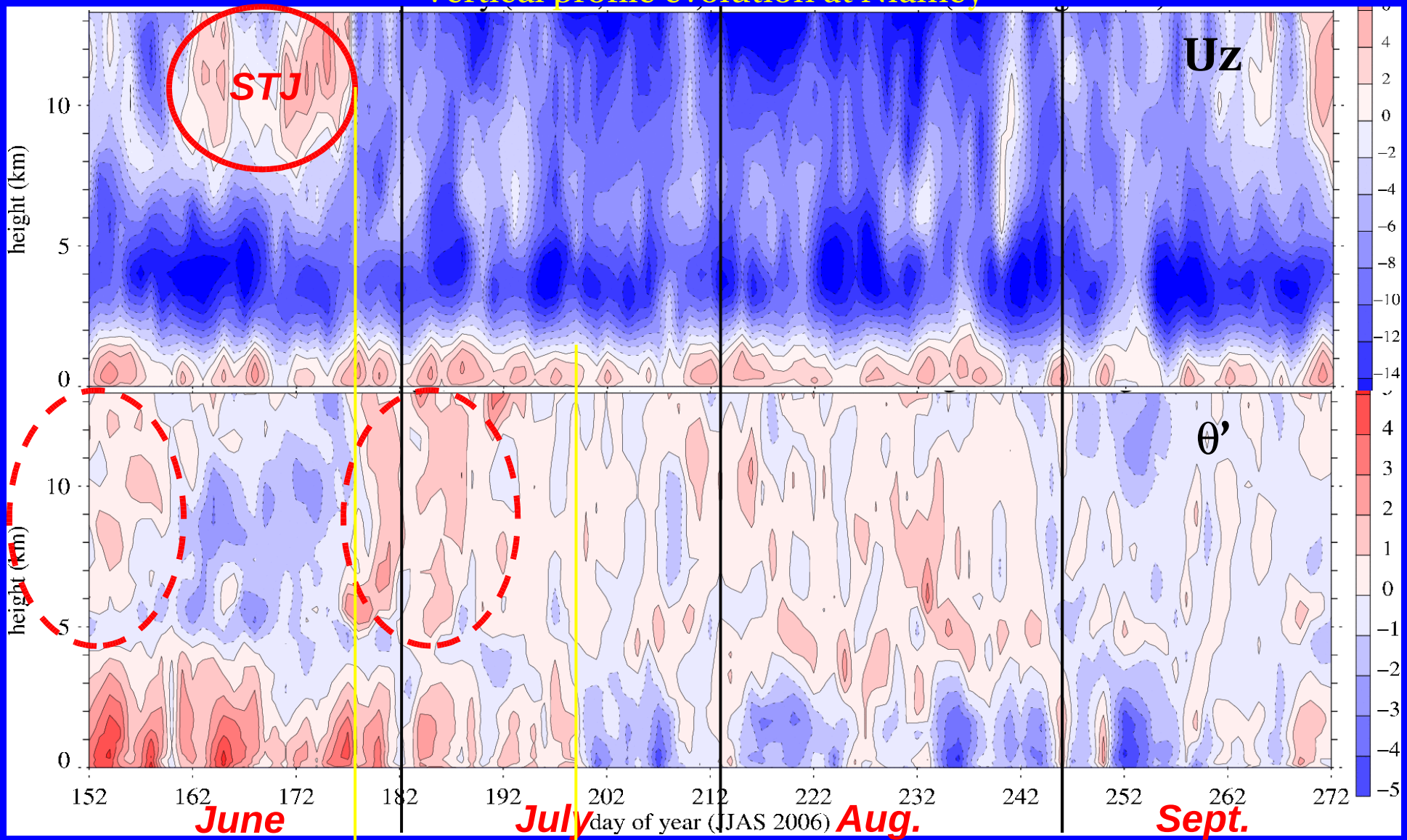
Strong intraseasonal variability of the jets (~10-15 days) – *missing here: Low level jet*
TEJ settled by the end of Jun TEJ settled & AEJ shifted to more north position



relative humidity seasonal evolutions



Vertical profile evolution at Niamey



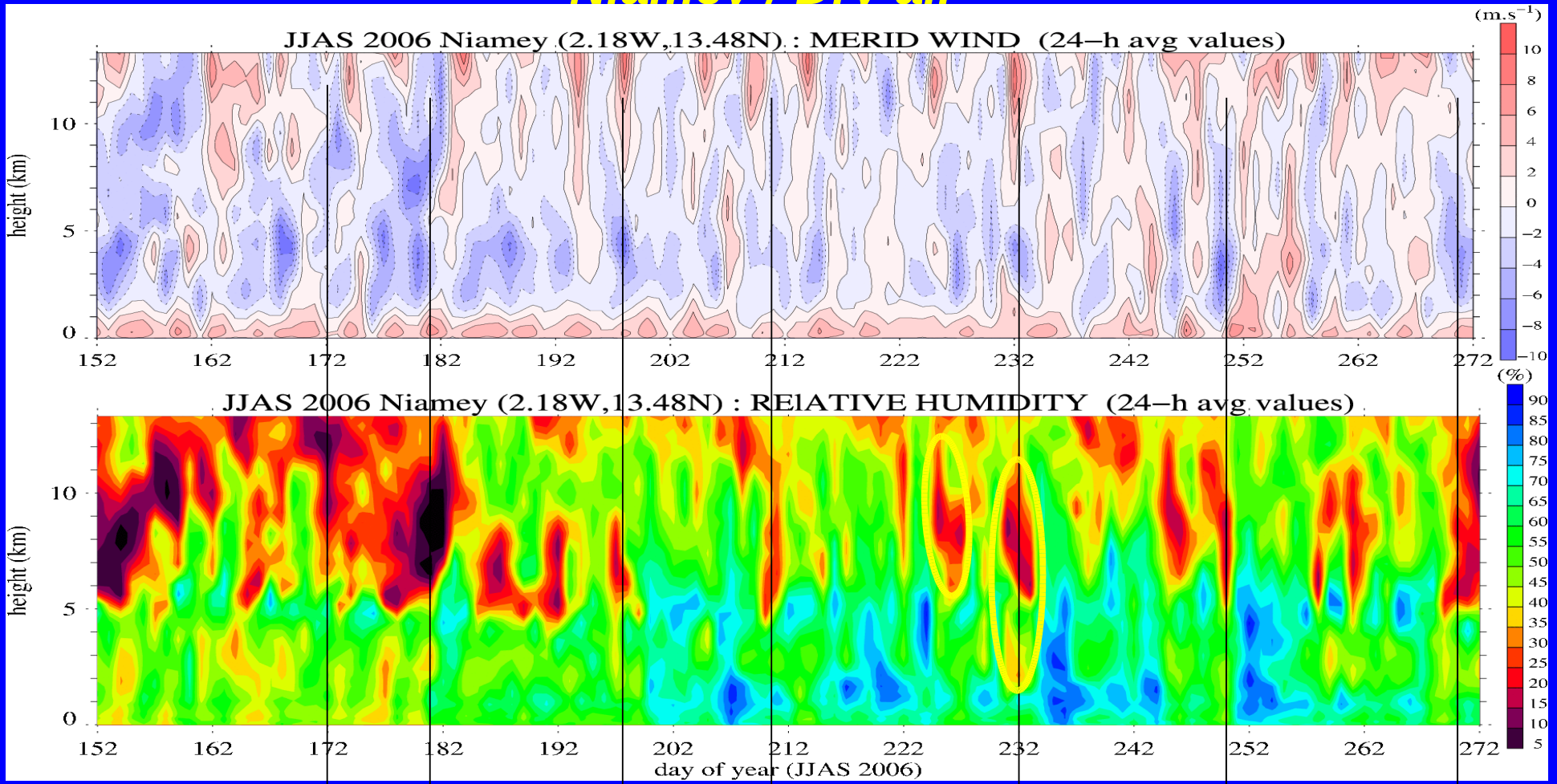
Mid-latitudes Interactions?

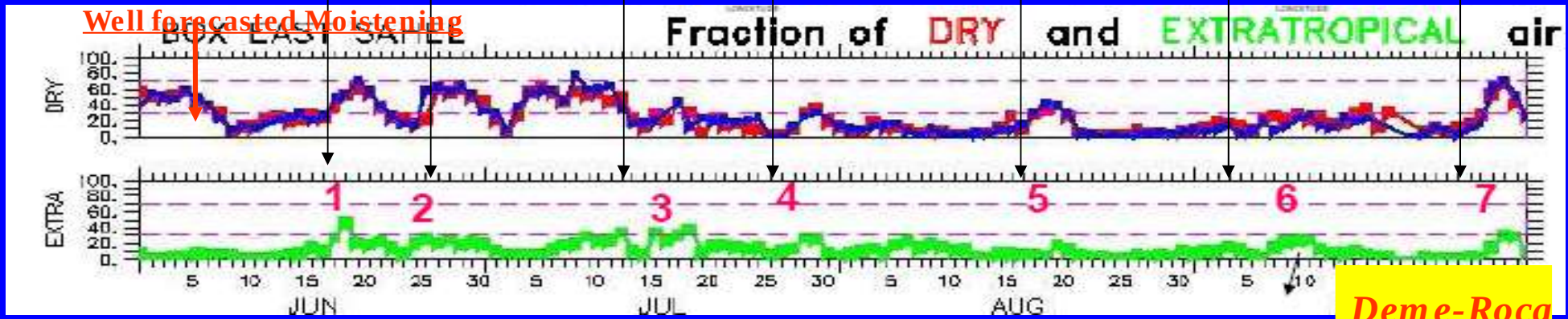
Blocking MJO?

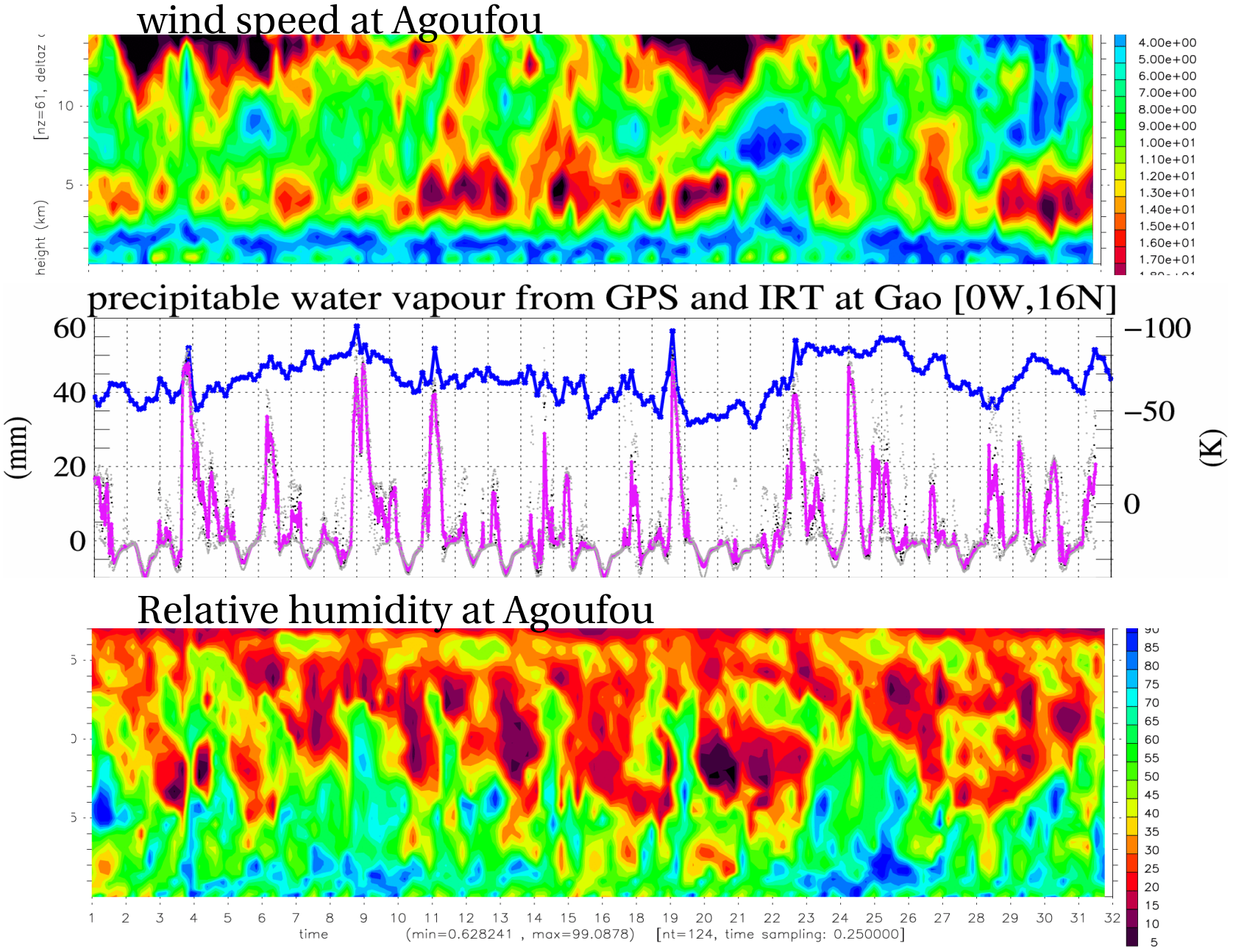
Warmer/Drier

Colder/Moister ≡ Monsoon

Niamey / Dry air






wind speed at Agoufou
[nz=61, deltaz
height (km)
10
5
4.00e+00
5.00e+00
6.00e+00
7.00e+00
8.00e+00
9.00e+00
1.00e+01
1.10e+01
1.20e+01
1.30e+01
1.40e+01
1.50e+01
1.60e+01
1.70e+01
precipitable water vapour from GPS and IRT at Gao [0W,16N]
(mm)
60
40
20
0
−100
−50
0
(K)
Relative humidity at Agoufou
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
time
(min=0.628241 , max=99.0878) [nt=124, time sampling: 0.250000]
Aug 2006

SUMMARY

onset ~10 day delay / climatological average
(possible links with large-scale waves)
strong westerlies , northern Tropical Atlantic

no major dry spell after the onset (as far as I know)

significant intraseasonal variability, of jets, waves

convective activity: no striking anomaly in terms of latitude location
but less fast-moving MCSs over the Sahel than 10 year climatology
a number of interesting situations to study mid-latitudes/tropical interactions (in June), of AEW-convection or dry-air-convection interactions