MESOSCALE ORGANIZATION OF THE CONTINENTAL TROPICAL CONVECTION

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1. INTRODUCTION

The purpose of this study is to analyze the mesoscale spatial organization of summer convection in a continental tropical region and examine the relationship with the environmental conditions that support their development. Organization aspects of the convection have been studied over tropical oceans and less so over land. Previous studies of the southwest region of the Amazon report that the convection is organized in lines (Halverson et al., 2002), convective complexes (Laurent et al., 2002) and arcs (Lima and Wilson, 2008). This study examines the NCAR SPol (S band Polarization) radar and the GOES 8 satellite visible channel collected during the WETAMC / LBA campaign during the summer of 1999 (Silva Dias et al., 2002) to classify the type of organization.

2. DATA

The selection of cases of convective organization was based on radar, satellite and radiosonde data. In addition a nearby sounding needed to be representative of the pre-convective environment, that is, data should not have been modified by circulations associated with clouds. Convection should have initiated in the radar coverage area because, if advected from outside it could not be related to the local environmental condition. Based on these restrictions 22 out of the 44 days of SPol operation were selected for study. Radiosonde data were interpolated to constant pressure levels. The SUDS-NCAR/EOL software was used for the radiosonde analysis. The ABRACOS radiosonde site was chosen for this study because it operated during the entire campaign.

3. ANALYSIS

Each day was analyzed by animation of the radar reflectivity field (data every 10 min) and the satellite data (data every 30 min).The organization of the convection during a day often showed a variety of patterns, but dominant modes of organization emerged near the mature stage of the convective lifecycle. Thus this time was used to classify the organization type for the day.

The following three classifications were used:

1) Lines – this category consisted of days when convection formed lines which could be continuous or composed of minor segments.

2) Arcs or circles – this category showed convection in circles with elements forming semi-circles or full circles.

3) Convective complex – this category showed convection organized on a scale larger than that of individual storms.

Cases shown in the following illustrate the categories defined in this study.

Line – 13 February

Early morning cloud streets can be identified in the visible satellite imagery (Fig.1). Within the cloud streets first convective precipitation started around 1500 UTC (local time is UTC – 4 hours) forming lines of convective precipitation echoes during the later afternoon. Convection peaked around 1900 UTC (Fig 2) and it is estimated this is the time of maximum radar precipitation for the whole period of the WETAMC/LBA experiment (Santos e Silva et al, 2011). Elements of convective precipitation formed lines of up to 100 km. The elements were aligned along the shear vector at middle levels (2-7.5 km): see wind profile in Fig 3.

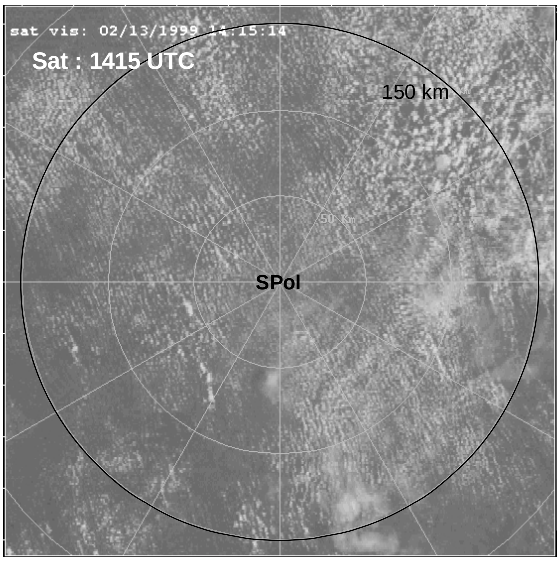

Fig. 1: GOES 8 visible image showing cloud streets over the experiment area on 13 February.

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Arc – 20 February

Without morning cloud cover, the first convective clouds and precipitation initiate over high terrain at mid day. Many of these storms generated cold pools with associated gust fronts. New storms were then initiated by gust fronts typically on the downwind shear side. With time some gust fronts collide and initiate new storms. The sounding indicated an environment with weak shear. In this case the convection at the mature stage was organized in arcs. Fig. 4 shows the initial time (1452 UTC) of storms on this day which is over the highest terrain, while Fig.5 shows the convection pattern at 1826 UTC in its mature stage. Fig 6 shows the wind speed profile.

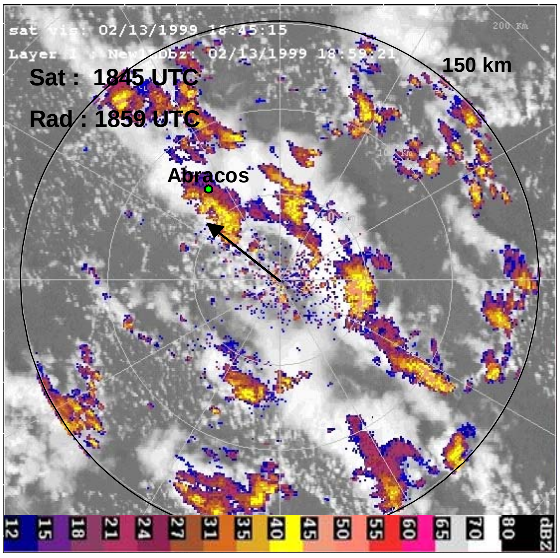

Fig. 2. Radar reflectivity at an elevation angle of 1.1 deg on 13 February at 1859 UTC showing lines of convective precipitation echoes. The arrow shows the direction of the shear vector at middle levels (2-7.5 km).

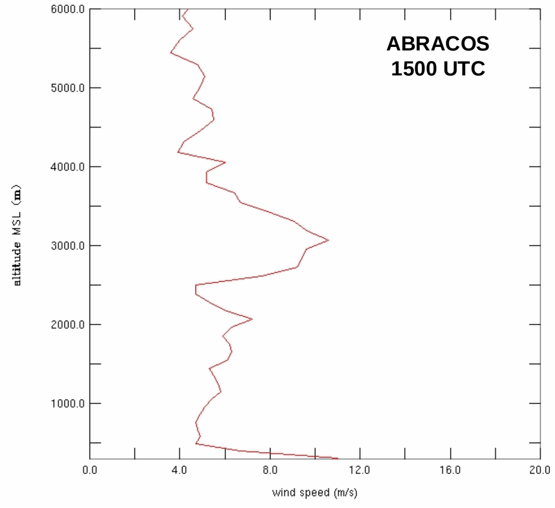

Fig. 3. Wind speed profile (15 UTC) for radiosonde station ABRACOS on 13 February.

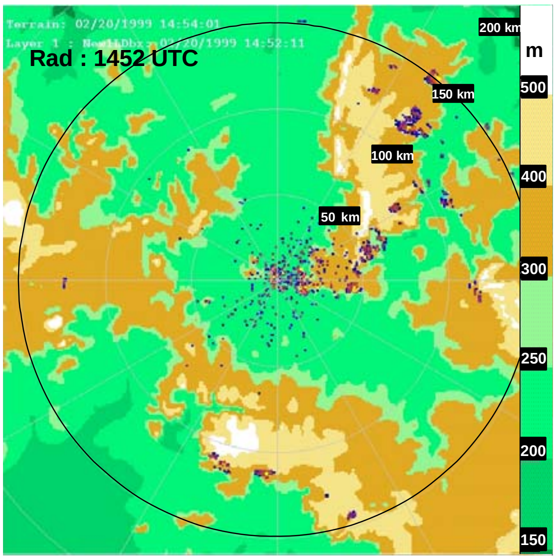

Fig. 4. Initial stage of convection over high terrain on 20 February.

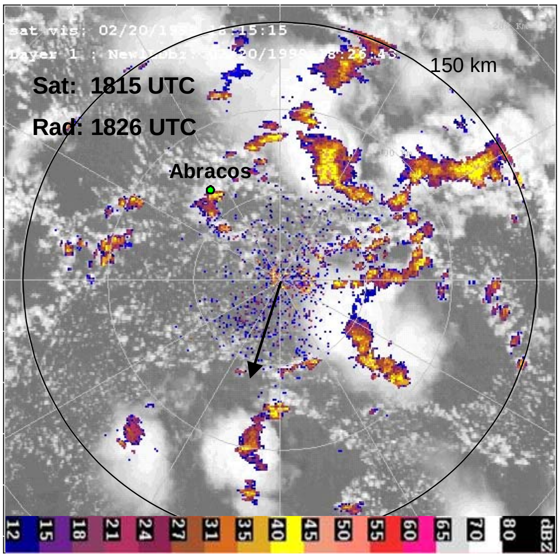

Fig. 5. Convection at its mature stage in arc patterns on 20 February. The arrow shows the direction of the shear vector at middle levels (2-7.5 km).

Complex - 25 January

For convective complex cases the convection often starts over high terrain and organizes into small complexes at its mature stage. This is the case with the 25 January example shown in Fig 7. The anvils from these individual storms organize into one large anvil as observed in the satellite visible image in Fig.8. Weak winds at lower levels (Fig.9) with a west component at the higher levels were common characteristics among this type.

4. RESULTS

Table 1 shows the 22 days selected for this study and the corresponding organization classification for each day. The first mode of convective organization (9 events) was the organization of storms in lines, continuous or not, which typically developed from shallow cumulus associated with convective horizontal rolls (cloud streets). In the second mode (10 events) convection was organized in arcs orientated predominantly along the downwind shear vector at mid levels. The least frequent mode of organization was convective complex (3 events). Organization in arcs mostly occurred in the so called west regime wind while in the east regime wind both lines and arcs were registered. CAPE and CIN, for the selected days in this study, haven't shown high correlation with the organization of convection. This preliminary study has shown the importance of low level winds in modulating the convection organization in the Amazon during summer. The storm lines were mostly associated with a low level jet exceeding 10 m/s while arc storms were associated with low wind speeds.

Table 1: Observed properties

Date	Initiation Trigger	Organization	Mean Layer Vector Wind (980-900) hPa	Low Level Jet	CAPE (J / kg)	CIN (J / kg)
17January	Cloud streets	Line	7.3 m/s	11 m/s (~2 km)	53	-37
30 January	Cloud streets	Line	5.0 m/s	-----	1352	-----
31 January	Cloud streets	Line	2.8 m/s	10 m/s (~2.5 km)	2429	-----
02 February	Cloud streets	Line	1.0 m/s	11 m/s (~1.5 km)	568	-2
13 February	Cloud streets	Line	4.6 m/s	11m/s (~3.0 km)	1626	-7
17 February	Cloud streets	Line	1.7 m/s	------	2449	-----
22 February	Cloud streets	Line	3.8 m/s	8 m/s (~1.5 km)	1017	-----
23 February	Cloud streets	Line	5.4 m/s	10m/s (2.5 km)	1651	-----
25 February	Cloud streets	Line	6.2 m/s	8 m/s (~1.5 km)	1258	-----
19 January (*)	Shallow convection	Arc	0.6 m/s	-----	700	-50
21 January (*)	Shallow convection	Arc	0.6 m/s	-----	789	-11
22 January (*)	Terrain	Arc	1.7 m/s	-----	1362	-----
27 January (**)	Cloud streets	Arc	4.2 m/s	8 m/s (~2.5 km)	118	-56
28 January	Cloud streets	Arc	6.0 m/s	11m/s (~2.0 km)	1205	-----
29 January	Cloud streets	Arc	3.8 m/s	-----	1596	-6
05 February	Terrain	Arc	0.7 m/s	-----	951	-29
06 February	Terrain	Arc	0.6 m/s	-----	2280	-4
14 February	Cloud streets	Arc	1.3 m/s	-----	2866	-----
20 February	Terrain	Arc	1.9 m/s	-----	2752	-----
20 January (*)	Shallow convection	Convective Complex	4.0 m/s	10 m/s (~3.0 km)	1219	-3
24 January	Terrain	Convective Complex	2.0 m/s	-----	804	-11
25 January	Terrain	Convective Complex	3.0 m/s	13 m/s (~2.5 km)	1036	-25

(*) 18 UTC
(**) 12 UTC

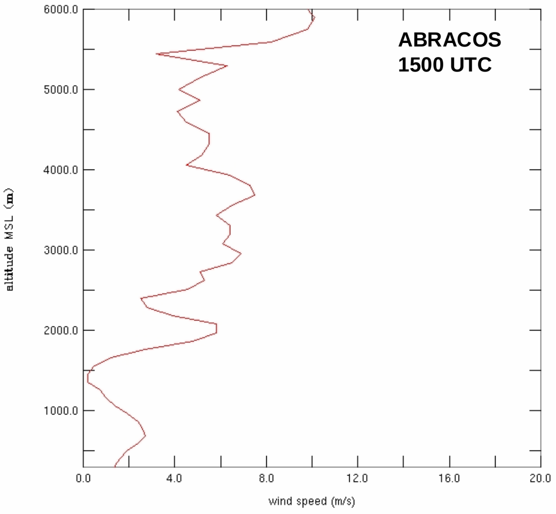

Fig. 6. Wind speed profile on 20 February.

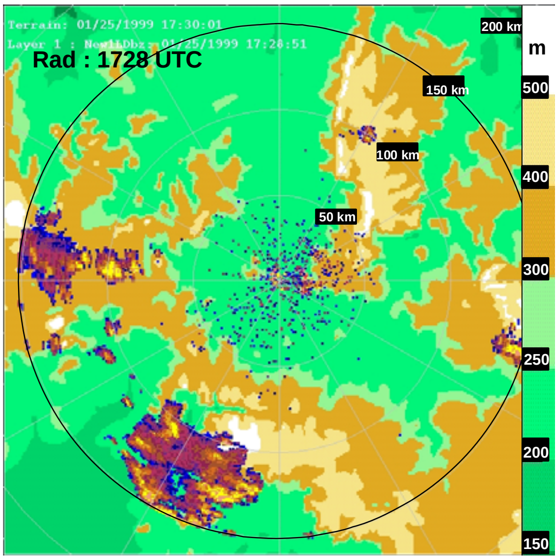

Fig. 7. Radar reflectivity on 25 January showing convective complexes over the higher terrain.

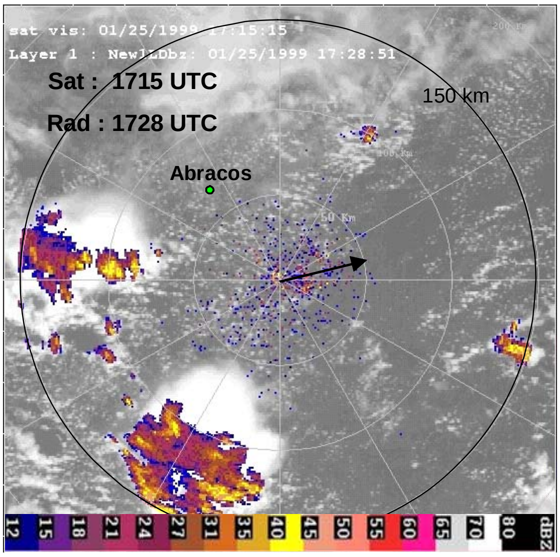

Fig. 8. Overlaid radar and satellite images corresponding to Fig. 7. The arrow shows the direction of the shear vector 2- 7.5 km.

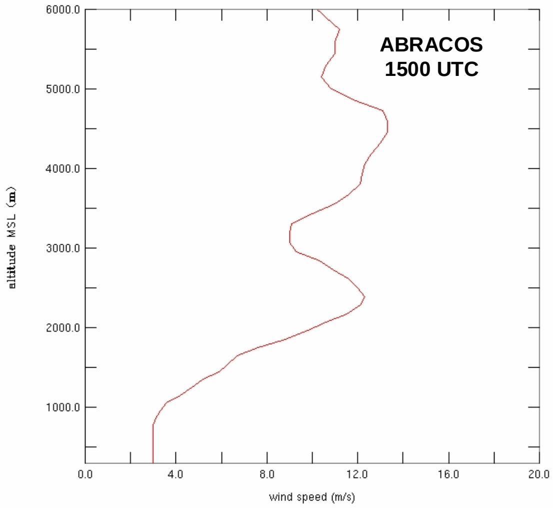

Fig.9. Wind speed profile on 25 February.

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