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SOME ASPECTS OF THE STRUCTURE OF THE STRATIFIED ATMOSPHERIC BOUNDARY LAYER OF SEMI-ARID REGION OF N-E BRAZIL

Sukaran Ram Patel*
Departamento de Ciências Atmosfericas
Universidade federal de Campina Grande-UFCG
Campina Grande-PB, Brazil

Emerson Mariano Da Silva
Departamento da Física
Universidade Estadual de Ceara-UECE
Fortaleza CE Brazil

Magaly de Fatima Correia
Depatramento de Ciências Atmosféricas
Universidade Federal de Campina Grande-UFCG
Campina Grande-PB, Brazil
and
Alysson Marcio Nóbrega Costa
Departamento de Ciências Atmosféricas
Universidade Federal de Campina Grande-UFCG
Campina Grande-PB Brazil

1.INTRODUCTION

Land-atmosphere coupling is widely recognized as a crucial component of regional, continental and global scale numerical models. Prediction from these, large scale- models are sensitive to small scale surface layer processes like heat and momentum fluxes at the air-soil-vegetation interface as well as boundary layer treatments (e.g., Garrat, 1993). The soil moisture boundary condition has a considerable influence on medium- to long- range weather forecasts and on simulated monthly mean climatic states (e. g., Rowntree and Bolton, 1983). The resolution used in most long range models is however relatively coarse so that the turbulent processes in turbulent boundary layer (PBL) which control the surface fluxes are not resolved, but are determined by a parameterization. The shortcomings and sensitivities exhibited by large-scale numerical models are partly a consequence of inadequate modeling the Planetary Boundary layer and its interaction with the land surface. In order to improve existing parameterizations a more complete understanding of the mechanics and thermodynamics of air-soil interaction and transport of water vapor by turbulent processes in PBL is required. During the past decade land-surface-models (LSM) have improved continuously, especially with the help of field experiments. However, evaluation is still needed for semi arid regions (Burose, et al., 2002). Because of the increasing awareness that tropical rain forest and the continental rain forest of the Amazon basin in particular may have an important role in global climatology, there have been a number of international projects on Amazon basin in Brazil as, Anglo-Brazilian collaborative study of the micrometeorology and plant physiology of Amazon rain forest – Amazonian Regional Micrometeorological Experiment –ARME (Shuttleworth et al., 1984 a, b; 1985; Molion et al., 1984 a, b; etc.), ABRACOS – Anglo Brazilian Amazonian Climate Observation Study (Gash, et al., 1996, etc.) and LBA – Large Scale Biosphere – Atmosphere Experiment in Amazon (da Silva et al., 2002, Sakai, et al., 2002 among others). But in the N-E region of Brazil, most of the works are confined to the energy balance or studies on the Surface Boundary Layer (Silva et al., 2002, 2000, 1997; da Silva et al., 2002, Paz et al., 2004 a, b,

*Corresponding author: Sukaran Ram Patel, Dept. Ciências Atmosfericas, Universidade Federal de Campina Grande-UFCG, Campina Grande, PB 58109-970 Brazil,

among others). So it is important to study some characteristics of the structure of the stratified Atmospheric Boundary Layer of semi arid region of N-E Brazil.

2. EXPERIMENTAL DATA

The data of this study were same as described in (Patel, et al., 2004) collected in Fortaleza (3.77S and 38.60 W) a semi-arid region of N-E Brazil, by balloon soundings from the period of 02-04-2002 to 11-04-2002 as a part of the experiment EmfiN experimento de Microfisica de Nuvens- experiments of microphysics of clouds) conducted by Universidade Estadual da Ceara-UECE (Costa et al. 2002). The total data were collected by 28 balloon soundings during the experiment. But in this preliminary study only few days of the following data are analyzed:

TABLE I DETAILS OF SOUNDINGS USED

Day	Local time	Code
03-04-2002	1142	06041142
08-04-2002	0725	08040725
08-04-2002	1103	08041103
08-04-2002	1249	08041249
09-04-2002	0815	09040815
09-04 2002	1437	09041437

As the data were collected for the microphysical clouds research, there are some, limitations in the data for land surface atmosphere interaction work.

2. METHODOLOGY AND DISCUSSION

Eq. de Reynolds may be written in the form

$$\rho\left(\frac{\partial \overline{U}_i}{\partial z} + \frac{\partial \overline{U}_i \overline{U}_j}{\partial z} - f\varepsilon_{ij3}\overline{U}_j\right) = -\frac{\partial \overline{P}}{\partial x_i} - \rho\, g\delta_{i3} + \frac{\partial}{\partial x_j}\left(\mu \frac{\partial \overline{U}_i}{\partial x_j} - \rho\, \overline{u'_i\, u'_j}\right) \quad (1)$$

where,

ρ is density of air

μ is viscosity of air

$\overline{U}_i$ is mean velocity

u'_i fluctuation of the wind velocity

f is a parameter of Coriolis

t is time and

$\overline{P}$ is mean pressure

g is gravitational acceleration

Eq. (1) for the case of horizontal homogeneity may be written in the form

$$\frac{\partial \overline{U}}{\partial t} - f(\overline{V} - \overline{V}_g) = -\frac{\partial \overline{u'w'}}{\partial z} \quad (2)$$

$$\frac{\partial \overline{V}}{\partial t} + f(\overline{U} - \overline{U}_g) = -\frac{\partial \overline{v'w'}}{\partial z} \quad (3)$$

where the viscous stress term is ignored in relation to other terms and $\overline{U}_g$ e $\overline{V}_g$ are the components of geostrophic wind and are given by

$$\overline{U}_g = -\frac{1}{f\rho}\frac{\partial \overline{P}}{\partial y} \quad (4)$$

$$\overline{V}_g = -\frac{1}{f\rho}\frac{\partial \overline{P}}{\partial x} \quad (5)$$

From eqs (2) and (3), the values of $\overline{u'w'}$ and $\overline{v'w'}$ are obtained for steady sate case. The normalized longitudinal and lateral stresses are presented in figures (1) for different stability parameter defined by

$$\mu_* = \frac{u_*}{|f|\, L_M} \quad (12) \quad (6)$$

$$L_M = -\frac{\rho\, c_P\, u_*^3\, T_0}{\kappa\, g\, H} \quad (7)$$

where

L_M is characteristic length scale of Monin-Obukhov

U_* is friction velocity or velocity scale

$T_* = -H_0/(\rho\, c_P\, u_*)$ Temperature scale

κ is von Karman's constant

H is sensible heat flux

The kinematic heat flux may be obtained as

$$\frac{H}{\rho\, c_P} = -u_*\, T_* \quad (8)$$

The methods for estimation of the characteristic length scale of Monin-Obukhov and the frictional velocity (u_*) are given in (Patel et al., 2004).

As it is mentioned earlier that the experiment was performed for the purpose of microphysical research work, so there were some limitations of the data for the research work on Boundary Layer Meteorology. One such limitation was the estimations of the components of the geostrophic wind, which are obtained from the conditions given by Holton(1992), as:

$$\overline{U} \rightarrow \overline{U}_g, \text{ and } \overline{V} \rightarrow \overline{V}_g \text{ for } z \rightarrow h.$$

Where h is a height of the PBL. The similar argument is, also used by Businger and Arya (1974). The longitudinal and lateral stresses distributions, for different values of the stability parameters for the periods in considerations, are shown in Figures 1(a-f) and 2(a-f) respectively. The similar, profiles patterns are obtained by Businger and Arya (1974) and Sundarrajan (1979) but for the north hemisphere. The figure 3 (a-d) shows the distributions of the turbulent diffusivities for momentum (K_M) and (K_H) heat for the soundings indicated. The profiles of the turbulent diffusivities show the expected variations with height.

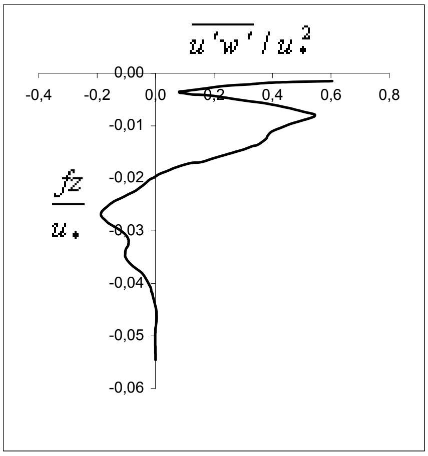

Figure 1 (a) The longitudinal stress profile for: 03 April 2002, 1142

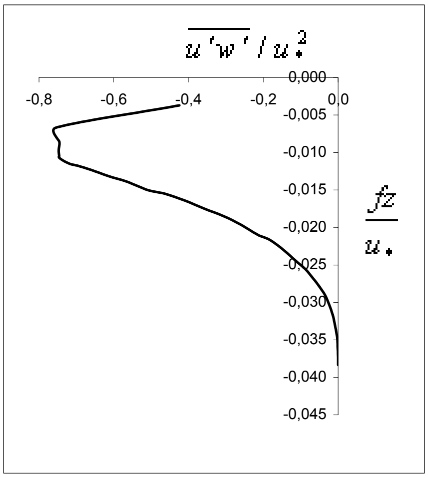

Fig1 (b) The longitudinal stress profile for: 08 April 2002 0725

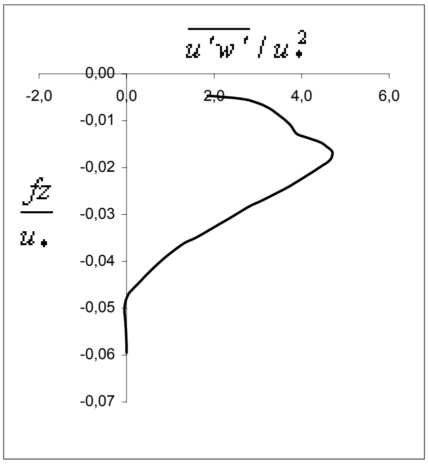

Figure 1 (c) The longitudinal stress distribution for: 09 April 2002 0815

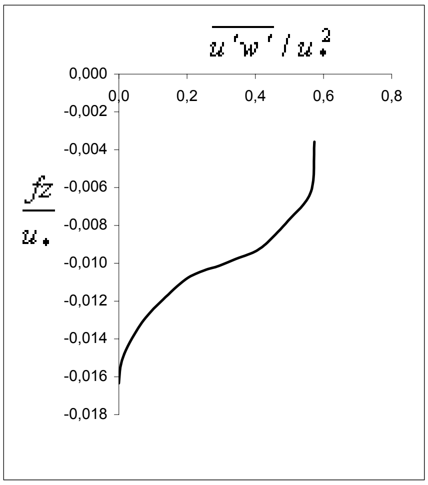

Figure 1 (d) The longitudinal stress distribution for: 08 April 2002 1103

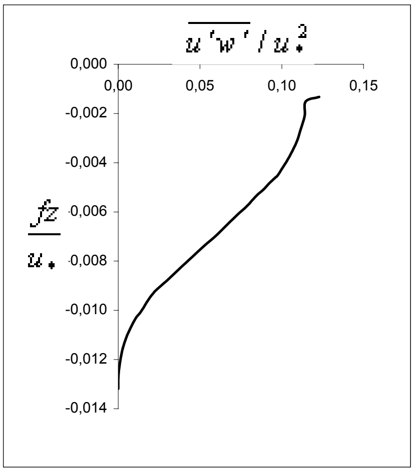

Figure 1 (e) The longitudinal stress distribution for: 08 April 2002 1249

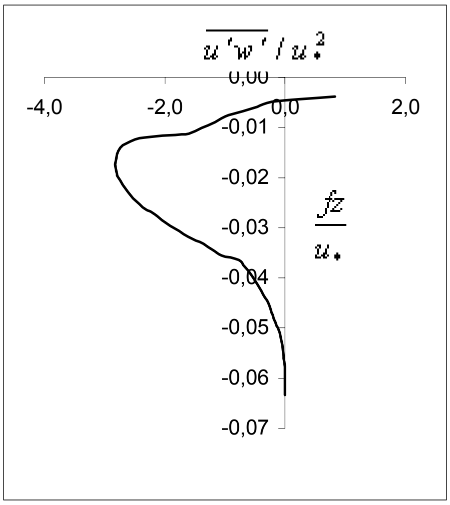

Figure 1 (f) The longitudinal stress distribution for: 09 April 2002 1437

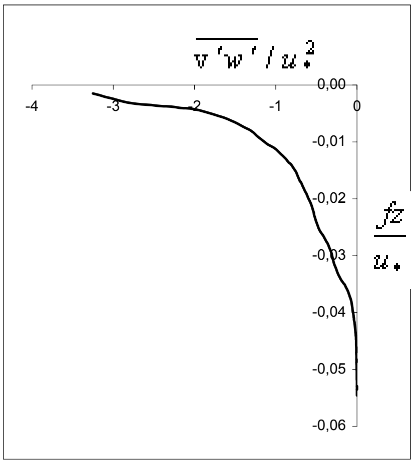

Figure 2 (a) The lateral stress profile for: 03 April 2002, 1142

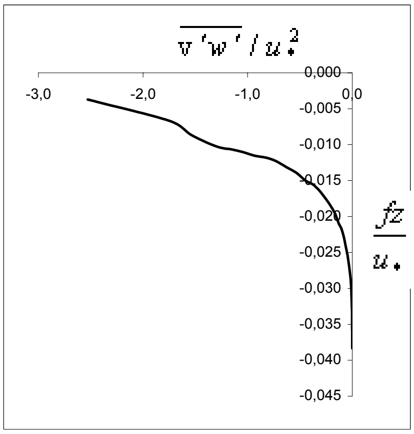

Fig2 (b) The lateral stress profile for: 08 April 2002 0725

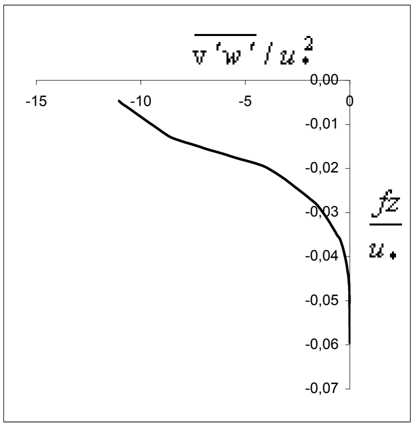

Figure 2 (c) The lateral stress distribution for: 09 April 2002 0815

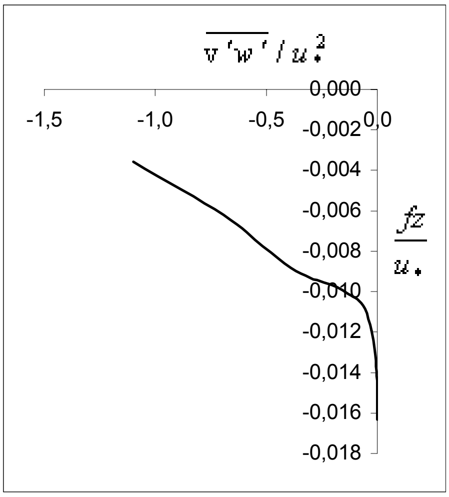

Figure 2 (d) The lateral stress distribution for: 08 April 2002 1103

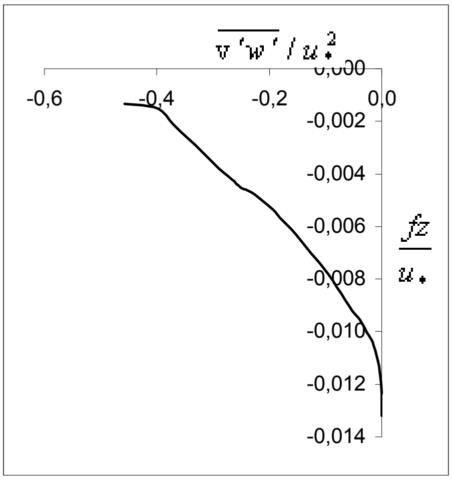

Figure 2 (e) The lateral stress distribution for: 08 April 2002 1249

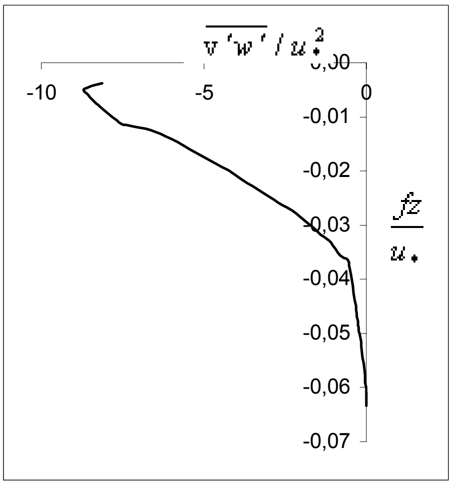

Figure 2 (f) The lateral stress distribution for: 09 April 2002 1437

As mentioned above these data were collected for the research work on microphysics of clouds, so there are some limitations on the data, further this is only a preliminary analysis and further details of the results will be presented in the future paper.

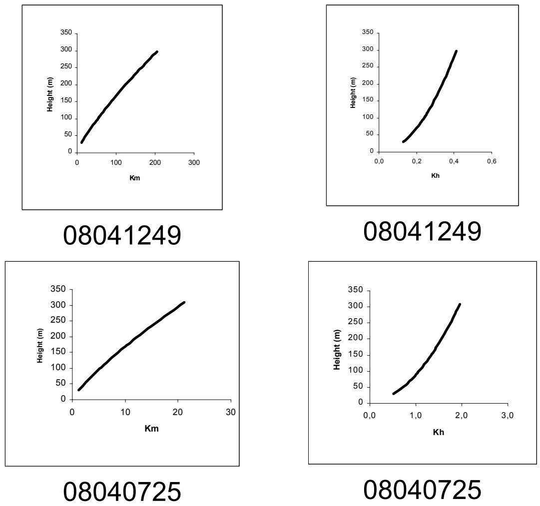

Figure 3 The turbulent diffusivities for momentum and heat.

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