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OBSERVATIONAL CAMPAIGNS OF THE PROJECT "STUDY OF TURBULENCE IN ANTARCTICA"

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Georgia Codato[1,*], Jacyra Soares[1], Amauri Pereira de Oliveira[1], Admir Créso de Lima Targino[2], Caio Jorge Ruman[1]

[1]Grupo de Micrometeorologia, Departamento de Ciências Atmosféricas, USP, Rua do Matão, 1226, CEP 05508-090, SP, Brazil
[2]Engenharia Ambiental, UTFPR, Av. Sete de Setembro, 3165, CEP 80230-901, Londrina, PR, Brazil
*e-mail: gecodato@usp.br

Abstract: *The main objective of ETA ("Estudo da Turbulência na Antártica"- "Study of Turbulence in Antarctica") project is to investigate the interaction of the atmosphere with the surface through the observational determination of the main components of the surface energy balance in the region of the Antarctic Brazilian Station "Comandante Ferraz", in King George Island (62^{0}05'S, 058^{0}23'W). For this purpose, a tower was instrumented in order to measure conventional parameters (air temperature, air humidity and wind velocity) with low and high frequency sampling using slow and fast response sensors, radiation sensors (pyranometer, pyrgeometer and net-radiometer), soil temperature sensor, soil heat flux sensor and precipitation sensor. The observational campaigns will generate a set of unpublished data of long time duration. Here the first and second observational campaigns are described together with the data acquisition and transmission systems.*

Keywords: Turbulent Flux, ETA Project, Data Acquisition System, Data Transmission System.

Introduction

The main objective of the ETA project is the direct observational determination of the components of the radiation balance and of the turbulent vertical fluxes of sensible heat, latent heat and momentum in the Brazilian Antarctic Station Comandante Ferraz (EACF), on King George Island (62°05'S, 058°23'W). For this purpose the South Tower of the EACF will be used, instrumented with sensors of fast and slow response. The fast response sensors (sonic anemometer and CO_2/H_2O analyzer) will provide measurements of fluctuations of wind velocity components, air temperature, CO_2 and humidity, with a sampling frequency between 1 and 30 Hz. The slow response sensors will allow the estimation of the average behavior of the main physical variables such as wind, air temperature, air humidity, barometric pressure, precipitation, short and long wave radiations, soil temperature and soil heat flux.

The knowledge of the radiation balance components (Soares *et al.*, 2004, 2012; Oliveira *et al.*, 2006; Codato *et al.*, 2008) and the turbulent exchanges on different surfaces and interfaces are important - in addition to climate change research - for both diagnostic and prognostic applied to numerical weather prediction, environmental monitoring activities using operational dispersion models oceanic and atmospheric pollutants, oceanographic studies (Ribeiro *et al.*, 2011; Skielka *et al.*, 2011), studies of biogeochemical cycles, etc.

The data obtained during the experiments will have several immediate applications: calculation of the radiation balance, calculation of energy balance, estimation of transfer coefficients of heat and humidity, estimation of the wind shear stress on the region, determination of the temporal evolution of dynamic and thermodynamic structure of the planetary boundary layer and validation and calibration of parameterizations used in numerical atmospheric models.

Materials and Methods

There were 2 observational campaigns of the ETA project.

First observational campaign

The 1st campaign was held during the 3rd phase of Operation XXIX Antarctic (OPERANTAR XXIX) between February, 13 and March, 11 of 2011 and its mail goal was identifying the best location for installing the management system of the observation data and sensors (pyranometer, pyrgeometer, net radiometer and barometric pressure). Details of the instruments are in Table 1 and Figure 1. The data was collected using a sampling rate of 0.05 Hz and was transmitted to USP, as described in Figure 2.

Second observational campaign

The 2nd observational campaign was undertaken during the 3rd phase of OPERANTAR XXX in 2012, between February 6 and 27. The main objectives were the maintenance of the sensors and equipment installed in the 1st campaign and installation of new sensors (wind sensors, air temperature and relative humidity at three levels of height, sensors of precipitation, soil heat and temperature of the soil and two video cameras to monitor the operating conditions of the sensors).

The equipment was connected to a datalogger model CR5000.

Results

The anemometers and sensors of air temperature and relative humidity were installed at different heights (Table 1). Instantaneous observations indicated a difference of about 1° C between the air temperature sensors installed in the lowest and highest height level, indicating an important temperature vertical gradient.

The collected data was automatically sent, every hour, to USP server (Figure 2). A set of FORTRAN routines to read, interpret and automatically make graphs of the observed data, has also been developed. Moreover, the site developed to store the data gathered in EACF was

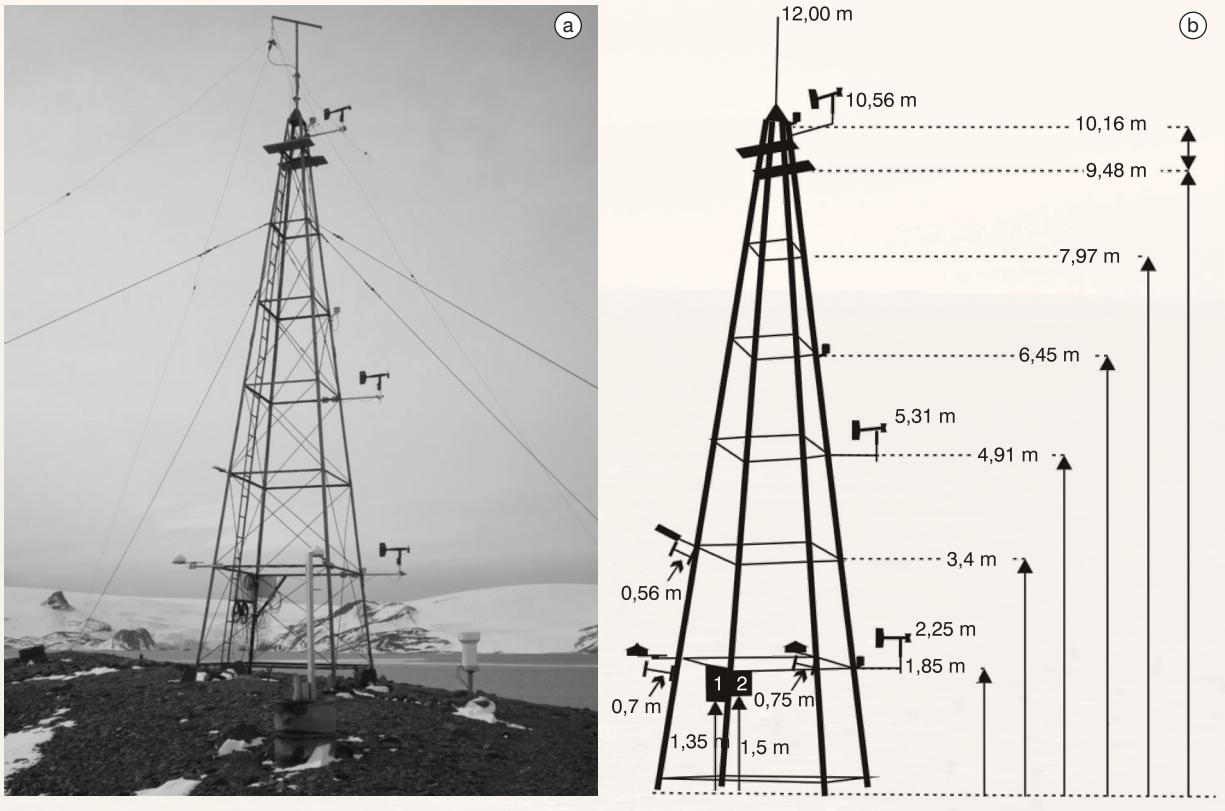

Figure 1. South Tower with the sensors (a) photography and (b) schematic drawing.

Table 1. Equipment installed during the ETA observational campaigns.

Camp.	Sensor	Model	Height (m)	Variable
1st	Pyranometer	CPM11	1,85	Incident solar radiation
1st	Pyrgeometer	CGR3	1,85	Incident longwave radiation
1st	Net-radiometer	CNR4	3,40	Incident and outgoing solar radiation, incident and outgoing longwave radiation
1st	Barometric pressure sensor	CS106	1,50	Atmospheric pressure
1st	Radiometer ventilation system	CFV3	-	Ventilation and heating of the radiometers
1st	Voltage regulators	-	-	Supplying voltage of 12 V
1st	Datalogger	CR5000	-	Data acquisition system
1st	Modem	MD485	-	Data transmission
1st	Laptop	D531	-	Remote access to datalogger
2nd	Thermistor and capacitive transducer	CS215	1.85, 6.45, 10.16	Air temperature Air relative humidity
2nd	Anemometer (wind direction and velocity)	05103	2.25, 5.31, 10.56	Wind velocity Wind direction
2nd	Pluviometer	385	0.5	Precipitation
2nd	Thermistor	107	-0.05	Soil temperature
2nd	Soil flux	HFP01	-0.05	Soil heat flux
2nd	Webcam	-	-	-
2nd	Laptop	XS1473	-	-
2nd	Conversion module (Campbell)	LCC4	-	

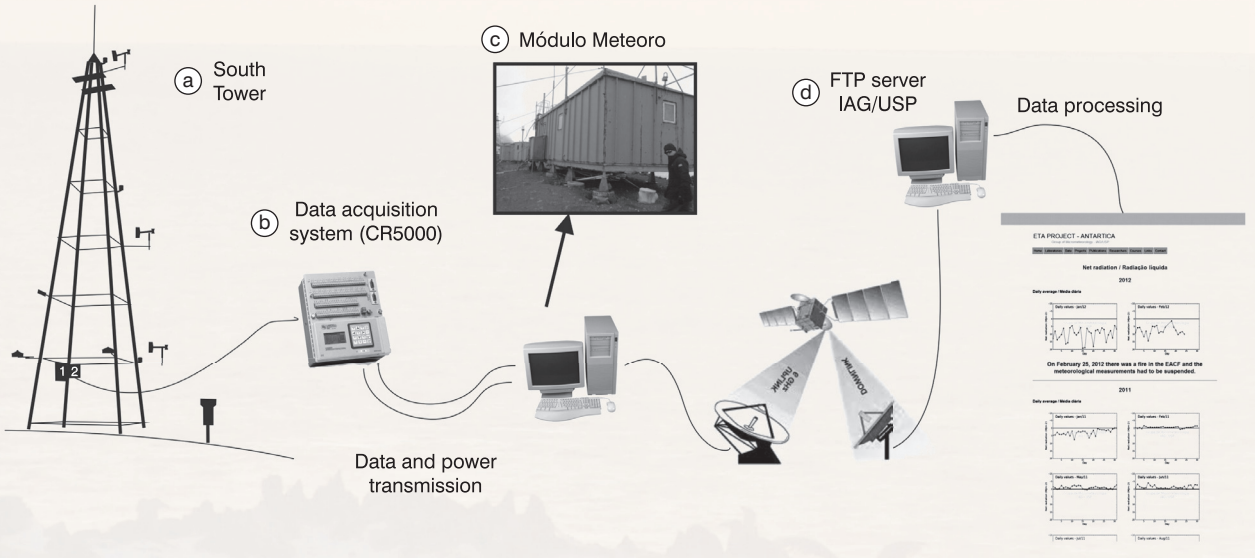

Figure 2. Data acquisition and data transmission systems. (a) South Tower, (b) datalogger CR5000 installed in the South Tower, (c) "Modulo Meteoro" where the laptop receives information from the data acquisition system and (d) data reception on IAG/USP server.

automatically updated every hour and all the observed data is available to the scientific community at the request (http://www.iag.usp.br/meteo/labmicro/Data/Graficos/ETA/data.html).

Discussion and Conclusion

All equipment installed during the first observational campaign of the ETA project (February 2011) were found in excellent condition in the second campaign. This fact ensures the exceptional quality of the continuous one-year data of average values of 5-minutes of the radiation balance components.

The main objectives of the second observation campaign of the ETA project were achieved with the installation of the three anemometers, three air temperature and humidity sensors, rain gauge, soil temperature sensors and soil heat flux. The image capture system was also successfully installed, generating images of the South Tower and of the EACF with hourly frequency.

The next important step - after the reestablishment of energy and after the maintenance or replacement of damaged equipment - is the installation of turbulence sensors (three axis sonic anemometer and gas analyzer) in order to measure the fluctuations of the wind components, air temperature and air density vapor with a sampling frequency between 1 and 30 Hz.

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