Observational campaigns of the ETA Project

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Abstract

The main objective of ETA ("*Estudo da Turbulência na Antártica*") 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" (EACF), in the King George Island ($62^0$05'S, $058^0$23'W). For this purpose, the South Tower of the EACF has been 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 The observational campaigns will generate a set of unpublished data of long time duration.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.

1. Introduction

An important question that has been preoccupying the scientists and the society as a whole is the climatic change what the planet is suffering, whether due to human action or natural climate variability. The quantification of the possible effects of these changes in the Earth´s climate has been performed through numerical models of weather systems. An essential aspect of this simulation is the transfer of energy in the interface - which takes place through the turbulent fluxes of heat, water and moment. These fluxes establish the coupling between the atmosphere and the surface representing, thus, key processes in the climatic system.

Despite recent progress achieved in understanding the surface turbulent fluxes, direct measurements of these fluxes remain limited and attempts to produce climatology and climate variability of these fluxes are quite different in several important aspects. The only way to resolve these discrepancies is through flux direct measurements in the interface.

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^o05'S, 058^o23'W). For this purpose it will be used the South Tower of the EACF instrumented with sensors of fast and slow response. The fast response sensors (sonic anemometer and CO2/H20 analyzer) will provide measurements of fluctuations of wind velocity components, air temperature, CO2 and humidity, with a sampling frequency between 1 and 30 Hz. The slow response sensors will allow the estimation of the average behaviour 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 data obtained during the experiments will have several immediate applications:

- Calculation of the radiation balance,
- Calculation of energy balance,
- Estimation of transfer coefficients when 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,
- Validation and calibration of parameterizations used in numerical atmospheric models.

The knowledge of the radiation balance components (Soares *et al.*, 2004; Oliveira *et al.*, 2006; Codato *et al.*, 2008; Barbaro *et al.*, 2010; Ferreira *et al.*, 2010 and 2011) 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.*, 2010; Skielka *et al.*, 2010 and 2011), studies of biogeochemical cycles, etc.

2. Observational campaigns

There were 2 observational campaigns of the ETA project. The sensors used in the campaigns are described in Table1.

2.1 First observational campaign

The 1st campaign was held during the 3rd phase of Operation XXIX Antarctic (OPERANTAR XXIX) between February, 13 to March, 11 of 2011 (Oliveira *et al.*, 2011).

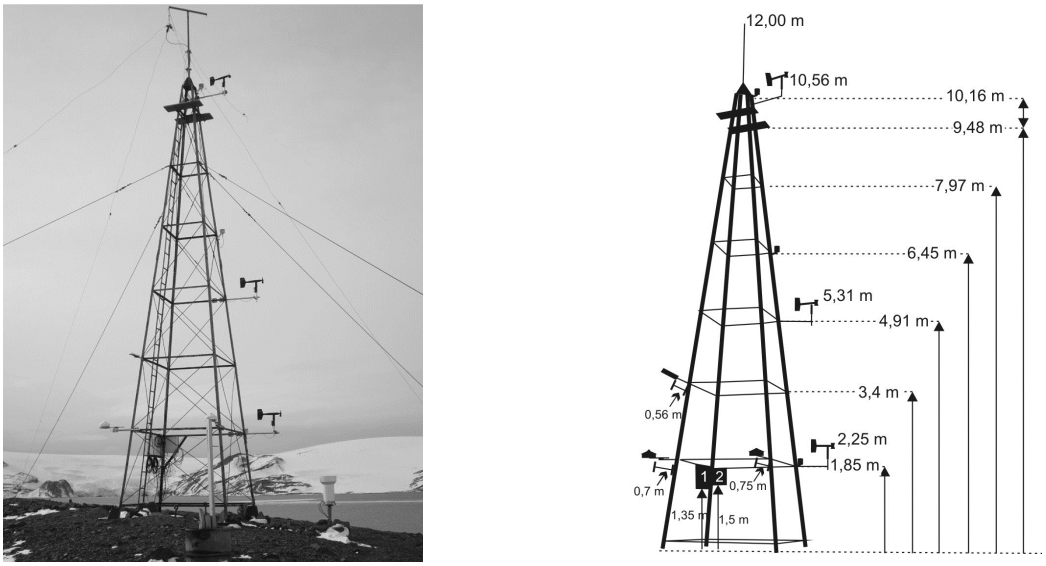

Figure 1: South Tower with the sensors (a) photography and (b) schematic drawing.

The main goals of the 1st observational campaign were:

- Identifying the best location for installing the management system of the observation data. It was located at the "*Módulo Meteoro*".
- Identifying the best location for installing the sensors. The solar radiation (pyranometer), longwave radiation (pyrgeometer) and radiation balance (net radiometer) sensors and the barometric pressure sensor were installed in the South Tower, together with the datalogger (Fig. 1). Details of the instruments are in Table 1. The data were collected using a sampling rate of 0.05 Hz.
- Implementing and testing the data transmission system (Fig. 2).

The collected data was automatically sent, every hour, to USP server (Fig. 2). It has also developed a set of FORTRAN routines to read, interpret and automatically make graphs of the observed data. Moreover, the site developed to store the data gathered in EACF was automatically updated every hour and all the observed data are available to the scientific community at the request (http://www.iag.usp.br/meteo/labmicro/Data/Graficos/ETA/data.html).

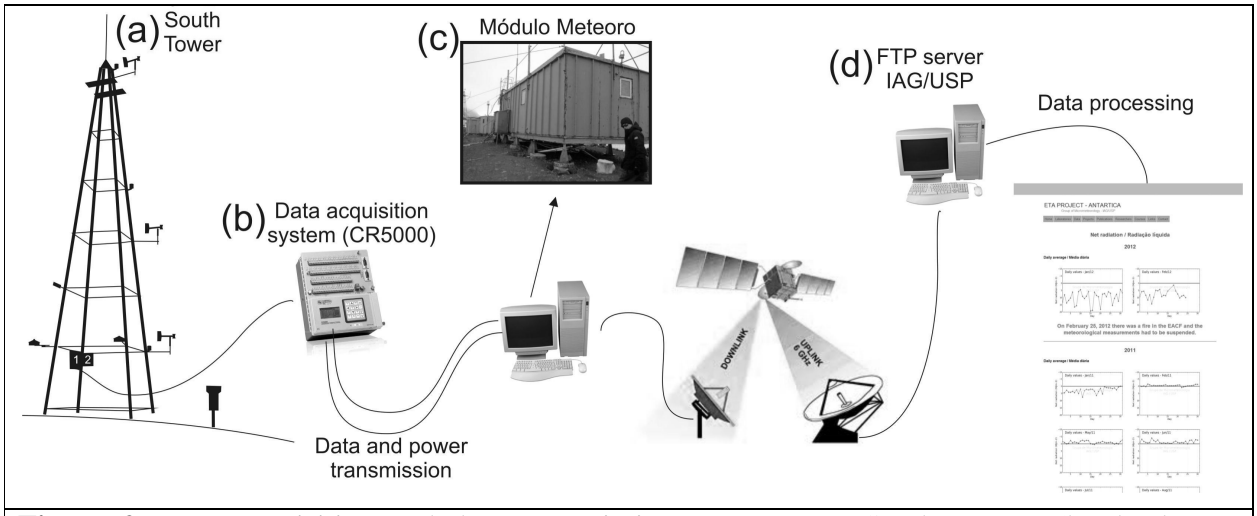

Figure 2: Data acquisition and data transmission systems. (a) South Tower, (b) datalogger CR5000 installed in the South Tower, (c) "Modulo Meteoro" where the laptop receives information from the data acquisition system and (d) data reception on IAG/USP server.

2.2 Second observational campaign

The second observational campaign was held during the 3rd phase of OPERANTAR XXX in 2012, between February 6 and 27. The main objectives were:

- Maintenance of the sensors and equipments installed in the first campaign.
- Installation of wind sensors, air temperature and relative humidity at three levels of height.
- Installation of the sensors of precipitation, soil heat and temperature of the soil.
- Installation of the video cameras to monitor the operating conditions of the sensors.

The equipments were connected to a datalogger model CR5000. 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.

Table 1: Equipments installed during the ETA observational campaigns.

Campaign	Sensor (Manufacturer)	Model	Height (meter)	Variable	Response time
1st	Pyranometer (Kipp Zonen)	CPM11	1,85	Incident solar radiation	< 5 s^{-1}
1st	Pyrgeometer (Kipp Zonen)	CGR3	1,85	Incident longwave radiation	< 18 s^{-1}
1st	Net-radiometer (Kipp Zonen)	CNR4	3,40	Incident solar radiation Outgoing solar radiation Incident longwave radiation Outgoing longwave radiation	< 18 s^{-1}
1st	Barometric pressure sensor (Vaisala)	CS106	1,50	Atmospheric pressure	0,5 s^{-1}
1st	Radiometer ventilation system (Kipp Zonen)	CFV3	-	Ventilation and heating of the radiometers	-
1st	Voltage regulators	-	-	Supplying voltage of 12 V	-
1st	Datalogger (Campbell)	CR5000	-	Data acquisition system	-
1st	Modem (Campbell)	MD485	-	Data transmission	-
1st	Laptop (Dell)	Latitude D531	-	Remote access to datalogger	-
2nd	Thermistor and capacitive transducer (Vaisala)	CS215	1,85 6,45 10,16	Air temperature Air relative humidity	20 s 10 s
2nd	Anemometer (wind direction and velocity) (RMYoung)	05103	2,25 5,31 10,56	Wind velocity Wind direction	2 a 5 min 1 s
2nd	Pluviometer (Met One)	385	0,5	Precipitation	30 s
2nd	Thermistor (Campbell)	107	-0,05	Soil temperature	20 s
2nd	Soil flux (Hukseflux)	HFP01	-0,05	Soil heat flux	4 min
2nd	Webcam (Dell)	-	-	-	-
2nd	Laptop (SempToshiba)	XS1473	-	-	-
2nd	Conversion module (Campbell)	LCC4	-		-

3. Results and discussion

All equipments installed during the first observational campaign of the ETA project (February 2011) were found in excellent conditions 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 (Ruman *et al.*, 2011).

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 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 vapour with a sampling frequency between 1 and 30 Hz.

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