Análise do vento e da temperatura do ar de superfície na EACF durante 2014

Surface wind and air temperature analyzes at EACF during 2014

Mariana Fadigatti Picolo[1], Jacyra Soares[2]

[1]Master's Student, Group of Micrometeorology, Department of Atmospheric Science, University of São Paulo, São Paulo, Brazil

[2]PhD, Group of Micrometeorology, Department of Atmospheric Science, University of São Paulo, São Paulo, Brazil

Resumo

A estação brasileira na Antártica, Estação Antártica Comandante Ferraz (EACF), localiza-se na Ilha Rei Jorge. A circulação atmosférica ao redor dessa ilha é governada por baixas estacionárias em torno da Península Antártica e nos mares Bellingshausen e Weddell. Elevações topográficas chegam a 700 m em torno da EACF e influenciam a circulação atmosférica. O objetivo deste trabalho é analisar o vento e a temperatura do ar na estação brasileira e as mudanças na temperatura relacionadas ao vento durante o ano de 2014. Observou-se que ventos intensos na região eram de norte,onde a topografia apresenta altitudes em torno de 500 m. Durante o inverno de 2014, os ventos mais frequentes observados foram de norte e leste. Ventos de norte estavam associados a temperaturas acima da média para inverno e verão. Ventos de leste apresentaram temperaturas abaixo da média, durante o inverno, relacionadas às águas congeladas da enseda Martel. Durante o verão, ventos de leste, seguidos por ventos de norte, foram as direções mais frequentes observados na região.

Palavras-chave*: Antártica, Ilha do Rei George, vento, temperatura, EACF.*

Abstract

The Brazilian Station in Antarctica, Comandante Ferraz station (EACF), is located on King George Island. The atmospheric circulation around this island is driven by stationary lows around the Antarctic Peninsula and on Bellingshaussen and Weddell seas. Topographic elevations go up to 700 m around the EACF, influencing the atmospheric circulation. The goal of this paper is to analyze wind and air temperature at the Brazilian station and changes in temperature related to the wind during the year of 2014. It was observed that strong winds over the region were from North, where the topography presents altitudes around 500 m. During the winter of 2014, the most frequent winds observed were from North and East and were related to temperatures above average for both summer and winter. Winds from East presented below average temperatures, during winter, related to the frozen water of Martel Inlet. During summer, winds from East, followed by winds from North, were more frequent.

Keywords*: Antarctica, King George Island, wind, temperature, EACF.*

1 Introduction

The Antarctic region is important in the global climatic system, with a primary influence on the Southern Hemisphere. The Antarctic and Subantarctic regions have a greater degree of climate inter annual variability than observed at lower latitudes (Ferron et al., 2004). The Brazilian station Comandante Ferraz, EACF, (62°05S', 58°23'W) is located at Admiralty Bay at King George Island and is situated 20 m above sea level. In this region, the winds predominantly are originated from West.

The King George Island lies between (61°54'S, 57°35'W) and (62°16'S, 59°02'W) in the South Shetlands Archipelago. Generally, the climate can be characterized as relatively warm and humid with average summer temperatures well above 0 °C (Bintanja, 1995). Still according to Bintanja (1995), the rapid succession of low pressure systems moving eastward transport relatively warm and humid air to the coast. Atmospheric circulation in this region is driven by the stationary lows existing nearby in the Antarctic Peninsula and above the Bellingshausen and Weddell Seas (Kejna and Láska, 1999).

According to Parish and Cassano (2003a) katabatic winds are recognizable as a key climatic variable of the low levels in the Antarctic region and are related to the cooling of the lower atmosphere. The majority of the discussion about winds in Antarctic is related to katabatic forcing (Ball, 1960; Mather and Miller, 1966; Parish, 1984; Parish and Bromwich, 1987). Speirs et al. (2010) presents a discussion about Foehn winds in McMurdo Dry Valleys in Antarctica causing dramatic warming.

The general objective of this work is to analyze the observed air temperature and wind data obtained by the ETA Project, in the EACF, during 2014.

The specific objectives are determine the annual, summer and winter average values of the observed air temperature and intensity and direction of the surface wind.

Here June, July and August are considered as winter months and January, February and March as summer months.

2 Methodology

The description of the sensors utilized to measure the investigated variables is shown in Table 2. The observed data was storaged as 5-minute average. The air temperature was measured at 10.2 m and the wind velocity and direction were measured at 10.1 m of height.

The main wind direction was obtained sorting the directions into 12 different intervals starting from 0º and adding increments of 30°.

The number of calms and strong winds were estimated assuming calm winds as winds with speed lower than 0.5 ms^{-1} and strong winds with speed higher than 20 ms^{-1} (adapted from http://www.spc.noaa.gov/faq/tornado/beaufort.html).

Table 2- Description of the sensors installed at the Comandante Ferraz Station.

	Sensor		Range	Acuracy
Wind	Anemômetro RM Young Model: 05103	Speed	0-100 ms^{-1}	± 0.3 ms^{-1}
		Direction	0-360°	± 3 °
Temperature	Vaisala Model: CS215		-40°C - +70°C	±0.9

3 Results and Discussions

The regional topography shows elevations up to 700 m, influencing the atmospheric circulation in the EACF (Fig. 1). Under certain conditions these mountain chains increases the air temperature (Styszynska, 1990). The Northern flank of the EACF is oriented to face the continental land and the Northeastern flank yields an icefield with elevations reaching up to 700 m. To the East is located Martel Inlet, the South is oriented to the Admiralty Bay, to the West is Mackellar Inlet and at Southwest is Arctowski Icefield in the continent. Around Southeast is Kraków Icefield, with lower heights (around 400-450 m), as illustrated in Fig. 1.

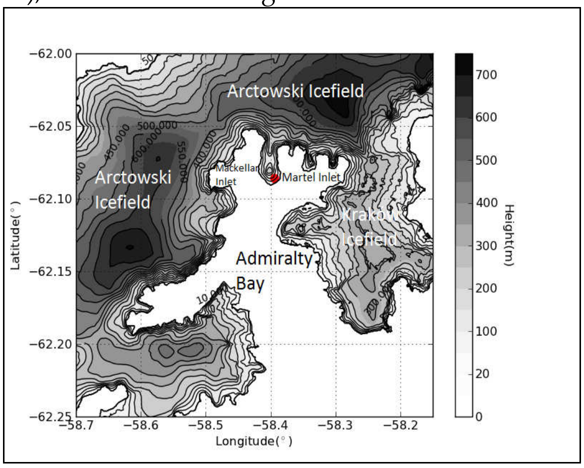

Figure 1- Topography around the EACF, using spatial resolution of 50 m. The EACF is indicated as a red dot (Map adapted from the digital terrain model of Braun et al., 2011).

3.1 Annual analyzes

In this section it was used 5-minute values of air temperature and wind.

The annual average wind speed was 6.44 ± 0.02 ms^{-1} with a mean direction of 10°, from the Arctwoski Icefield. The annual average air temperature was -1.91 ± 0.01.

The wind rose (Fig 2) shows that, during 2014, winds from North and East directions were more frequent, with the same frequency (15%). Winds from the West sector also present high number of occurrences. The high frequencies of winds from North and West are related to the Arctowski Icefield.

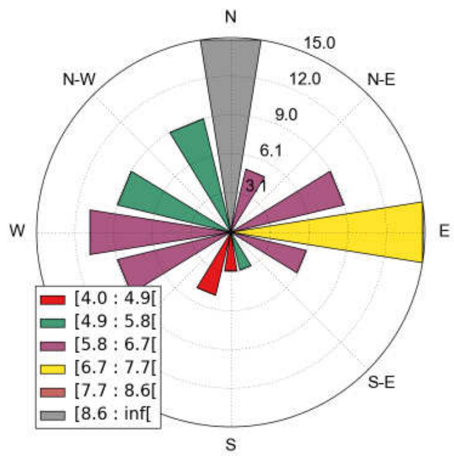

Figure 2- Wind rose for the year of 2014. The color indicates the average wind velocity.

The occurrence of winds from the Admiralty bay presented the lowest frequencies (Fig. 2). The North winds can be calm or strong (Fig. 3), but if the winds are coming from other directions, it is most likely to be calm (Fig 3a). Calm winds were more frequent than strong winds with a frequency of 4% (3355 occurrences), while strong winds had a frequency of 1% as displayed in Fig. 3b.

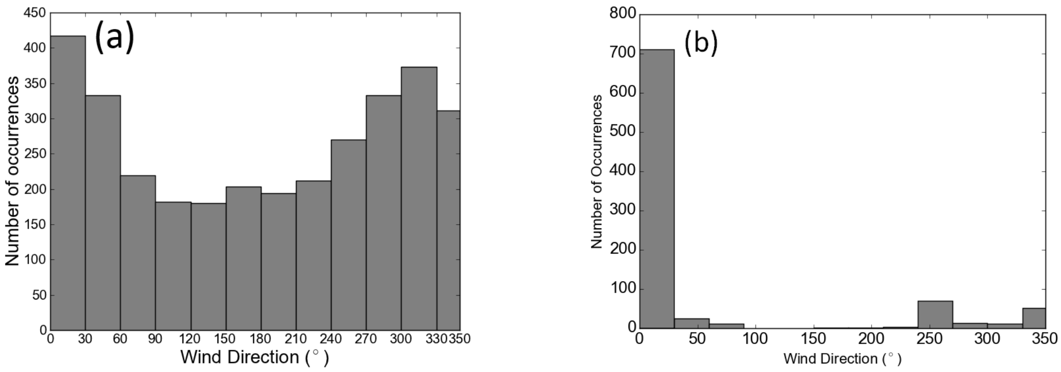

Figure 3- Histogram of the wind direction frequency of (a) calm winds and (b) strong winds for 2014.

3.2 Summer and winter analyzes

In this section it was used 5-minute values of air temperature and wind, except for the diurnal variation, where were used hourly average values of the investigated variables.

The average wind speed for summer was 5.95 ± 0.02 ms^{-1} with a mean wind direction from 56° and 6.93 ± 0.03 ms^{-1} with an average direction of 349° for winter. The average air temperature for winter was -4.16 ± 0.02 °C and for summer was -0.06 ± 0.01°C.

The diurnal variation of the hourly average air temperature for the summer months had temperatures above 0 °C from 10 h to 19 h local time (Fig. 4a). For winter months, the temperature remained below 0 °C (Fig. 4b). The diurnal amplitude of the temperatures for summer months was of 0.9 °C and of 0.4 °C for the winter months.

The diurnal amplitude of the hourly average wind speed shows larger variations during winter than summer (1.1 ms^{-1} and 0.7 ms^{-}1, respectively) with higher values during winter months. The winds from North and East direction were more frequent during winter (Fig. 5). Easterly winds had the highest frequency for summer (20%). Winds coming from the Admiralty bay presented the lowest frequencies (Fig. 5).

For winter and summer months, the winds coming from North direction presented air temperatures higher than the average for the same periods and the winds coming from Martel Inlet presented lower temperatures than the average. The difference between the average temperature for the east direction and the average temperature for the winter months was -3.7 °C. According to (Styszynska, 1990) the waters of both Mackeller Inlet and Martel Inlet were covered with ice during winter. Temperatures related to Mackeller Inlet did not show great differences from the average values for the year studied, which could be related to warmer winds coming from Arctowski Icefield.

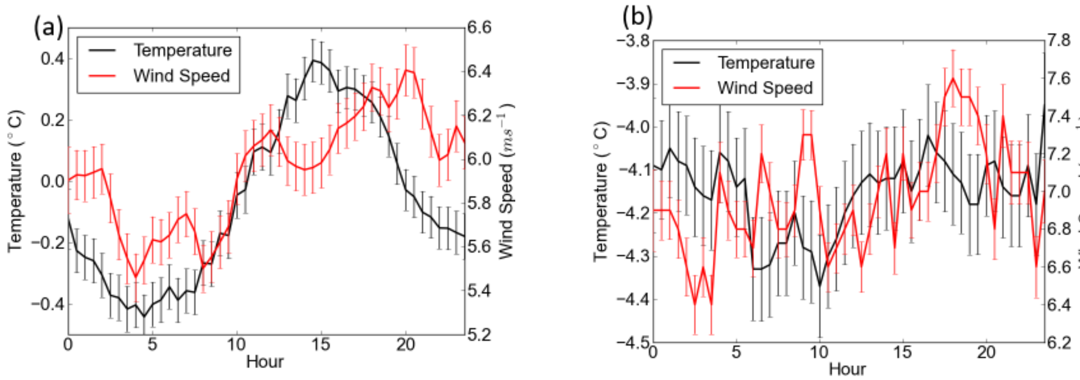

Figure 4- Diurnal variation of the hourly average of air temperature and wind speed for (a) summer and (b) winter. The vertical lines indicate the statistical error.

Changes in temperature can both be associated to katabatic and Foehn winds. Foehn wind causes warming, but katabatic wind can cause positive or negative changes in temperature. According to Parish and Cassano (2003b) the air temperature alone is not reliable to characterize winds as katabatic because this type of wind tends to induce vertical mixing, destroying shallow lower level inversions.

5 Conclusions

This work analyzed the observed surface air temperature and wind during 2014. The annual average wind speed was 6.44 ± 0.02 ms^{-1} with a mean direction of 10°, from the Arctwoski Icefield and the annual average temperature was -1.91 ± 0.01 °C. For the year of 2014, winds from North and East had the highest frequency (15%). Winds from north can be calm or strong, but winds from other directions are most likely calm. Strong winds happened in 1% of the cases with a preferable direction from north. Calm winds happened in 4% of the cases with no preferable direction.

During summer months, the average wind 5.95 ± 0.02 ms^{-1} with a mean wind direction from 56° and 6.93 ± 0.03 ms^{-1} with an average direction of 349° for winter. The average air temperature for winter was -4.16 ± 0.02 °C and for summer was -0.06 ± 0.01°C.

The diurnal variation of the hourly average values for the temperature were invariably below 0 °C, during winter, with diurnal amplitude of 0.4 °C. For summer, the diurnal amplitude was of 0.9 °C.

Winds from the North and East directions presented the highest frequency of occurrence during winter. During summer months, the most frequent wind direction was from East, followed by winds from North.

Temperature values for winds from the North direction had values higher than the summer and winter averages.

The lowest temperature values were for Easterly winds during winter (-3.7 °C), coming from Martel Inlet, which is expected to be covered with ice during winter.

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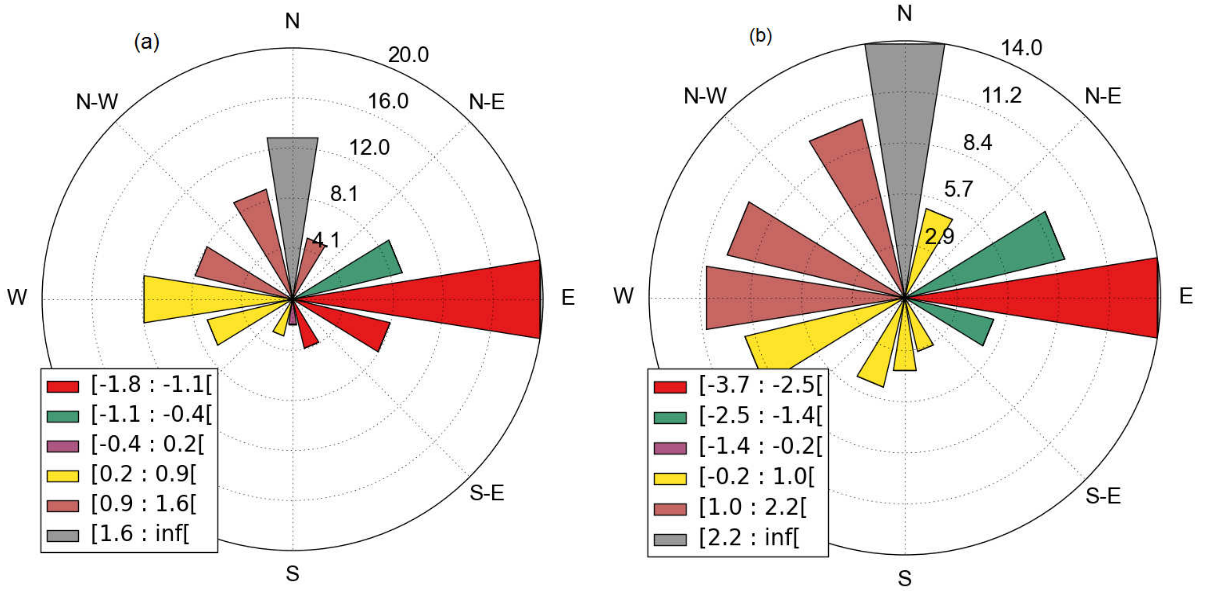

Figure 5-Wind rose with the frequency of occurrences of wind direction (lines) and air temperature deviation from the average (shaded) of (a) summer and (b) winter.

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