Surface radiation balance and radiometric properties at the Brazilian Antarctic Station – Preliminary results of the ETA Project

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Introduction

Measuring the surface radiation balance components at the Antarctic region is important for diagnostic and prognostic studies of climate change and environmental monitoring. This work is running within the framework of the "*Instituto Nacional de Ciência e Tecnologia - Antártico de Pesquisas Ambientais (INCT-APA)*". The data is part of the project ETA (*Estudo da Turbulência na Antártica*).

The primary objective of this investigation is to characterize the seasonal variation of the radiation components at the surface, radiometric properties of the surface (albedo) and of the air (transmissivity) using *in situ* observations at the Comandante Ferraz Brazilian Antarctic Station (EACF) on King George Island (62º05'S, 58º23'W), as Fig. 1, for the period between March, 2011 and February, 2012 .

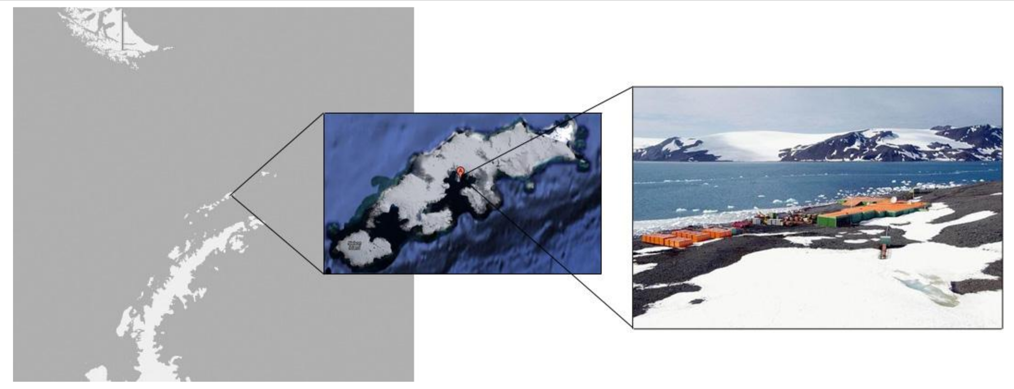

Fig. 1: Comandante Ferraz Brazilian Antarctic Station (EACF) on King George Island (62º05'S, 58º23'W).

Instruments

Instrument	Measurement	Response time (s[-1])
Pyranometer (Kipp & Zonen) **Fig. 2**	Incident shortwave (SW↓)	< 5
Pyrgeometer (Kipp & Zonen) **Fig. 3**	Longwave emitted by the atmosphere (LW↓)	< 18
Net radiometer (Kipp & Zonen) **Fig. 4**	SW↓, LW↓, Reflected shortwave (SW↑), Longwave emitted by the surface (LW↑)	< 18

Table 1: Instruments used in the investigation. The data was obtained using the South Tower of EACF (Fig. 5) with a sampling rate of 0,05 Hz.

Fig. 2: Pyranometer CPM11.

Fig. 3: Pyrgeometer CGR3.

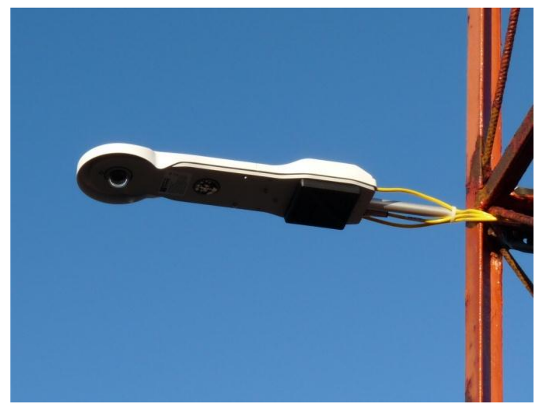

Fig. 4: Net radiometer CNR4.

Fig. 5: East view of the 12 meter South Tower instrumented with radiation, wind, air humidity and air temperature sensors.

Results

Here, by convention, the radiation components are positive when in agreement with the vertical axis. The data was gathered with a sampling rate of 0,05 Hz and a 5-min average was used to calculate the monthly average. The transmissivity and albedo values were considered only when $|SW_{TOA}|$ > 100 Wm^{-2}.

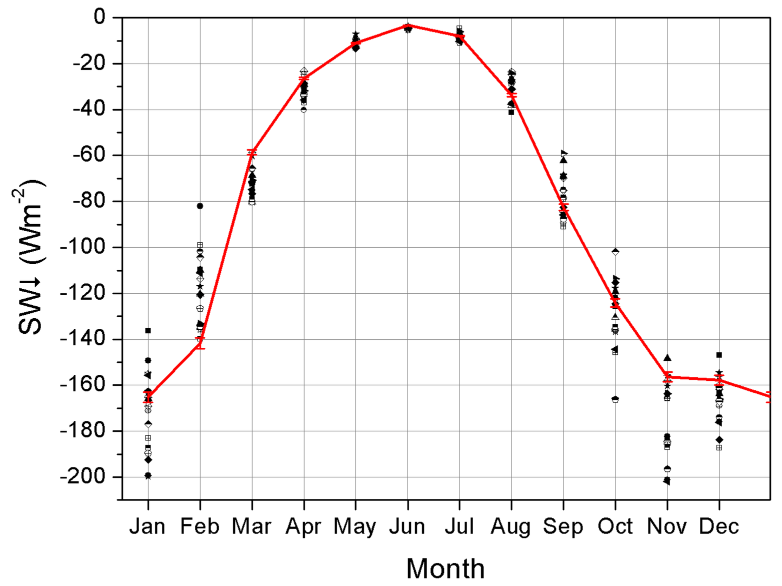

Fig. 6: Monthly averaged values of SW↓, from ETA project (red line) and from "*Meteorologia na EACF*" (1993-2009).

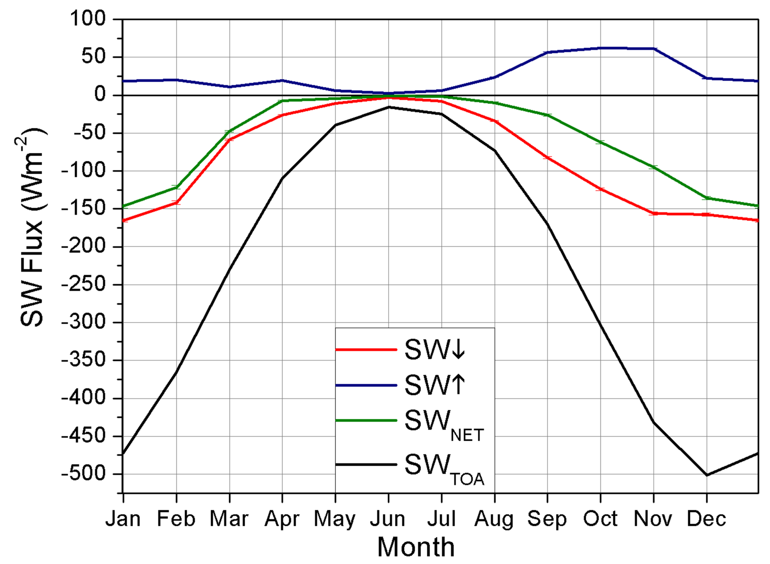

Fig. 7: Monthly averaged values of SW↓, SW↑, SW_{NET} and SW_{TOA}.

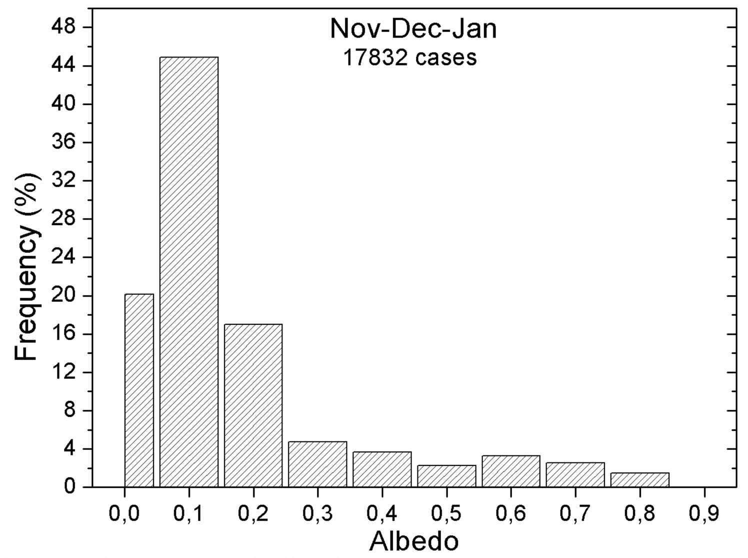

Fig. 8: Histogram of albedo. Nov-Dec-Jan.

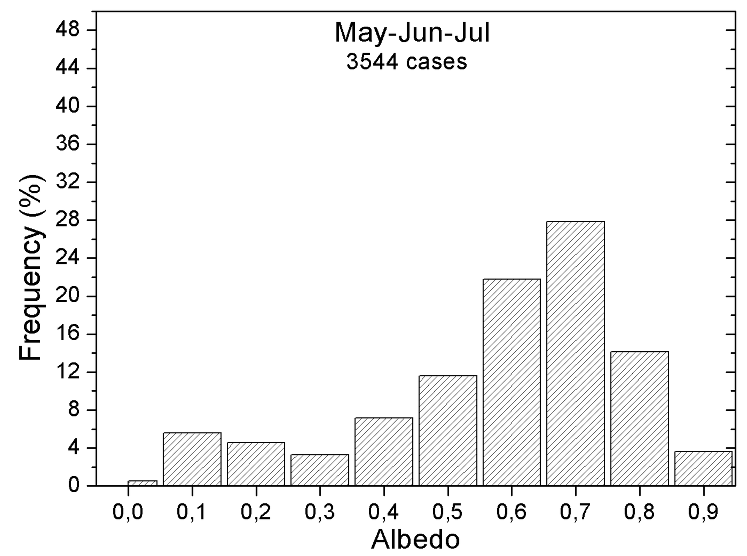

Fig. 9: Histogram of albedo. May-Jun-Jul.

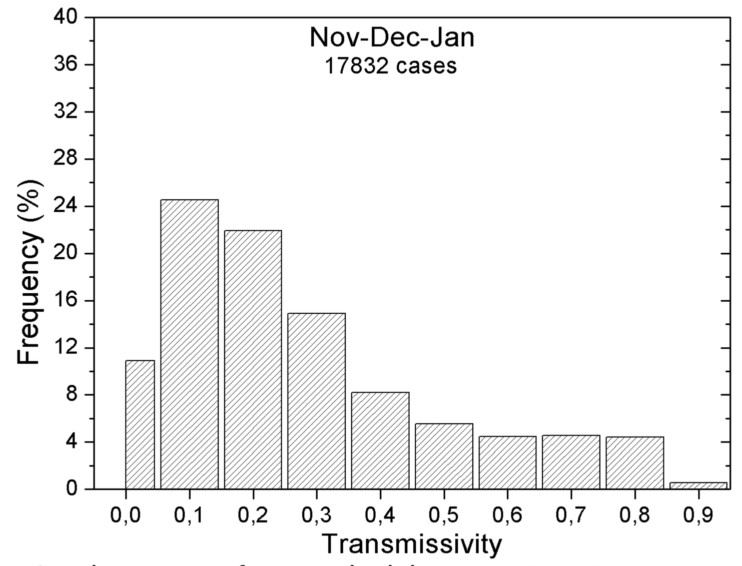

Fig. 10: Histogram of transmissivity. Nov-Dec-Jan.

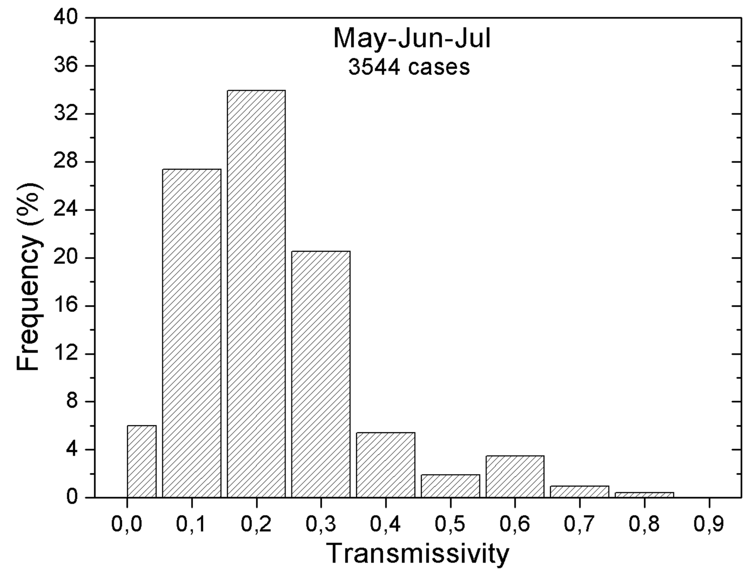

Fig. 11: Histogram of transmissivity. May-Jun-Jul.

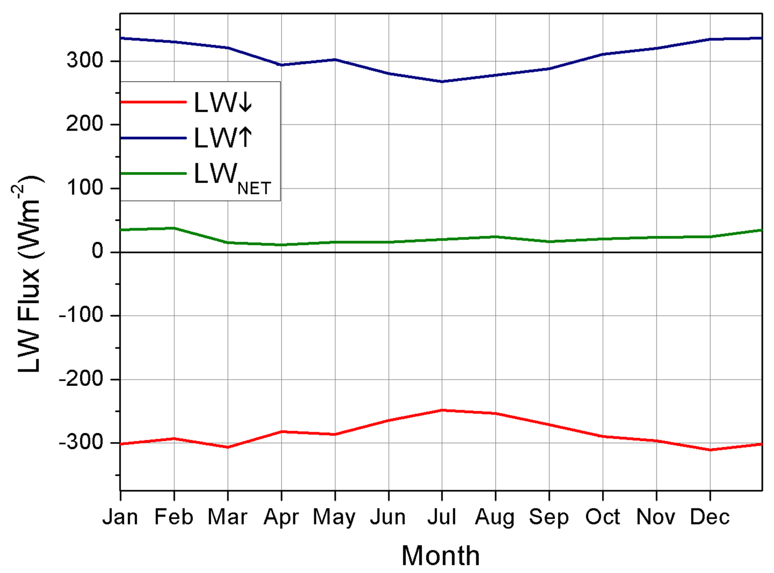

Fig. 12: Monthly averaged values of LW ↓, LW ↑ and LW_{NET}.

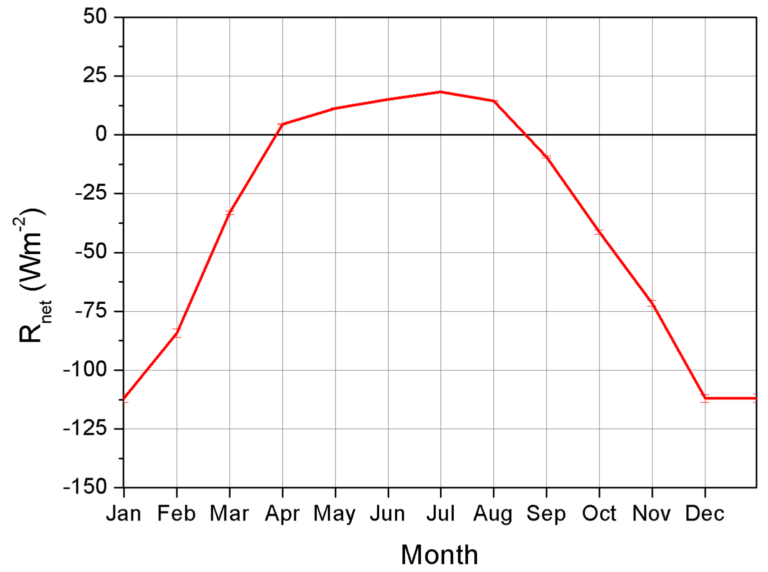

Fig. 13: Monthly averaged values of R_{NET} (=LW_{NET}+SW_{NET}).

Discussion

	Summer (Nov-Dec-Jan)	Winter (May-Jun-Jul)
Albedo	0.2	0.7
Transmissivity	0.1-0.4	0.2
SW↓	-165±4 Wm^{-2}	-7±1 Wm^{-2}
SW↑	34±1 Wm^{-2}	5±1 Wm^{-2}
LW↓	-303±1 Wm^{-2}	-266±1 Wm^{-2}
LW↑	330±1 Wm^{-2}	284±1 Wm^{-2}
R_{NET}	-98±3 Wm^{-2}	15±1 Wm^{-2}

Table 2: Average values of albedo, transmissivity, SW↓, SW↑, LW↓, LW↑ and R_{NET}, for Summer and Winter months.

Based on the SW↓ monthly average values (Fig. 7), here, "summer" was considered the months of November, December and January and "winter" as May, June and July.

The comparison between the monthly average values of SW↓ obtained by the ETA Project during 1 year and the SW↓ monthly average values obtained by the *"Meteorologia na EACF*" (antartica.cptec.inpe.br) during 17 years (1993-2009) shows good agreement (Fig. 6), indicating the representativeness of the ETA data.

The smallest values of SW_{NET}, SW↓ and SW↑ are found during May/Jun/Jul (Fig. 7).

The largest SW↓ values (~l165l Wm^{-2}, Fig. 7) occur during Nov/Dec/Jan but the SW↑ maximum values (~l60l Wm^{-2}, Fig. 7) are found on Sep/Oct/Nov, when the albedo is still high and the snow has not yet melted totally. During summer, the most frequent albedo values are between 0.1 and 0.2 and during winter its values are between 0.6 and 0.8 (Figs. 8 and 9).

The atmospheric transmissivity is, in general, small due to the intense amount of clouds present in the region. During summer, the values present a larger variation (Fig 10) and during winter most of the transmissivity values are between 0.1 and 0.4 (Fig. 11).

The LW↓ values vary from l250l to l310l Wm^{-2} (Fig. 12) being minimum during winter months. The LW↑ values are between l270l Wm^{-2} (July) and l335l Wm^{-2} (January).

During the whole year the surface is, in average, gaining heat from the Sun (SW_{NET}, Fig. 7) and the surface presents a small heat loss (<l35l Wm^{-2}, Fig. 12) by longwave. It results in a radiation balance with an energy loss from the surface to the atmosphere from April through August (<l20l Wm^{-2}) and a surface energy gain from the atmosphere, from September through March (Fig. 13).

In February 25, 2012 the measurements stopped due to a fire that destroyed the Brazilian Antarctic Station. As soon as the energy is restored at the Station, the measurements will be resumed.

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