# Regional weather survey as tool for landscape studies of maritime Antarctica

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**Abstract**

In 2001 the LIMNOPOLAR Project was launched with the aim of addressing the suitability of freshwater ecosystems as appropriate sentinels of climate change. In this, an automatic weather station was deployed at Byers Peninsula (Livingston Island, South Shetland Islands) near many lakes and freshwater ecosystems under research. In the present work, the multi-year data recorded are presented and correlated with meteorological time series from the observatory from Spanish station Base Juan Carlos I. The main results indicate that Byers Peninsula is under an Antarctic Maritime climate, very cloudy and wet. Mean annual temperature is -2ºC and summer mean temperatures are above the freezing point. The region shows moderate winds over the year, with moderate precipitations, mostly liquid during the whole summer season. It is demonstrated that there is a significant lineal relationship with meteorological records obtained from Base Juan Carlos I which is located at the East of Livingston Island. Correlations between both meteorological data are high but face colder and much windier conditions at Byers Peninsula**.** Therefore, here is presented the usefulness and accuracy of meteorological records in the interpretation of ecosystems dynamic.

## *Introduction*

Antarctic climate is characterized by two well-defined regions. The interior of the continent, with an extremely cold and dry climate, and the coast, east and north of the Antarctic Peninsula, which is the warmest region of Antarctica (King and Turner, 1997). The low pressure systems produce a ring of windy and wet conditions in the coastal regions. They are formed over the ocean and move towards the coast in SE direction. Precipitation falls mainly as snow, although in some coastal areas the precipitation is in liquid form during the summer. Except on the coast, the air is extremely dry. Research on the Antarctic climate is complicated by technical difficulties and by its dependence on multiple and interrelated physical processes (Schwerdtfeger, 1984)

The climate in the South Shetland Islands and the northwestern Antarctic Peninsula is clearly different from the rest of the continent. It is the mildest due to the tempering influence of ice-free sea along the year. The location of the region, just south of parallel 60° S, determines the characteristics of atmospheric pressures field, with an area of high cyclogenesis (Turner, 2004, Simmonds et al, 2003). The region is north of the low pressure circumpolar belt, which is on average around 66° S. The annual mean atmospheric pressure decreases to 987 hPa due to the constant movement of cyclones. Precipitation is usually frontal and in snow form (Turner, 1995; Braun, 2001). During the summer, when temperatures often exceed 0° C, the precipitation may be in liquid form. Cloud cover is very high due to the abundant of water vapor and the frequency of cyclones passing over the region. The annual mean cloudiness is approximately 80% (King et al, 1997)

Data from the British Antarctic Service (BAS) and the READER project (Reference Antarctic Data for Environmental Research, Turner, 2004) showed a clear trend of warming in the Antarctic Peninsula and South Shetland Islands (Rau, 2002). Other studies, as Kejna (2003), confirmed the increase of temperature on the Antarctic Peninsula. Quintana and Carrasco (1997) and King (1997) detected slight increasing trends in precipitation in the Antarctic Peninsula and South Shetland Islands, with a greater number of days of liquid precipitation during the summer and slight decrease of days with dry snow during the winter. Calvet (1999) estimated that the glacier area on Livingston Island (South Shetland Islands) has fallen 4.31% between 1956 and 1996. Molina et al. (2007) estimated that the ice volume decreased 10.0±4.5% during the period 1956–2000.

LIMNOPOLAR project started in 2001, with the objective of conducting an ecological study of the inland water bodies in Byers Peninsula (Livingston Island) to assess the sensitivity of these ecosystems to climate change. It seemed clear that environmental variations are of sufficient magnitude to induce fundamental changes in the structure and dynamics of Antarctic ecosystems (Huiskes 2002). Studies of bio-sensitivity to climate change require long periods of observation or, alternatively, to combine information on the organisms response at different latitudes. Therefore, one of the priorities of the limnological study in Byers Peninsula has been to record meteorological data *in situ* with a new weather station, associated with the network of stations operating with the same purpose in other Antarctic regions. For the meta-analysis is particularly important that the features and programming of the stations follow the standards.

This article characterizes the weather and climate of Byers Peninsula. The detailed study of the micrometeorological data is useful for estimating the duration of biological activity throughout the year, also to improve knowledge about the dynamics and functioning of these ecosystems outside the sampling periods in summer. To contextualize the weather conditions of the region, meteorological data of Byers Peninsula are compared with the data registered in the same period at the Spanish Antarctic Station Juan Carlos I (BAEJCI). The automatic weather stations at both locations have similar characteristics and the geographical proximity between the two stations, located on the same island at a distance of 40 km, suggests that records are highly correlated.

## Materials and methods

### S**tudy Site**

Byers Peninsula lies at the western end of Livingston Island (latitudes 62°34’35’’ to 2°40’35’’S and longitudes 60°54’14’’ to 61°13’07’’W), which is the second largest island in the South Shetland Archipelago, in maritime Antarctica (see figure 1). The Peninsula has a surface area of 60.6 $km^2$, a maximum altitude of 265 m (Cerro Start). The central area comprises a plateau of gentle undulating relief around 105 m a.s.l (Toro et al, 2007)**.** Paleoclimatic records and boulders probably carried by ice movement suggest glacial expansion in the area in colder periods (Martínez *et al.*, 1996). During the summer the snow melts, leaving a well developed drainage network, with many lakes and streams. The rest of the island, with an area of about 1100 $km^2$, is permanently covered by glaciers, except in summer when 5% is ice-free (Serrano, 2001).

About 50 km east of Byers Peninsula in the same island is the Mount Friesland, with an altitude of 1770 m. To the west and SW of the island, very close to Byers Peninsula is the Snow Island, a glacier dome of less than 300 m of altitude. Somewhat more distant in the same direction is the Smith Island, a 2012 m altitude mountain that emerges from the ocean.

The meteorological observatory of Byers Peninsula is located at latitude 62 º 38 '50"S, longitude 61 ° 6' 37"W and altitude 70 m, between the Somero and Limnopolar lakes (unofficial names but used frequently in the scientific literature) in a plain open in all directions and 2 km from the sea.

BAEJCI is located at latitude 62 º 39 '46"S, longitude 60 º 23' 20"W and altitude 12 m, about 50 m from the eastern shore of South Bay. The bay is open to the NNE-SSW. Behind the station there is a mountain barrier that reaches 300 m near the station and increases its height to reach the Friesland about 10 km away.

## Meteorological data

All the meteorological variables were recorded by means of an automatic weather station (AWS) which was deployed at the central plateau of Byers Peninsula, where most biological and ecological experiments were carried out. This station was designed to operate continuously with a system of autonomous aeolian power supply requiring only annual maintenance (Bañón, 2004).

The station recorded several weather variables with a datalogger CR10X (Campbell Ltd.). The measurement protocol and the installation of the instruments are listed in table 1. We followed the standards of the World Meteorological Organization (WMO, 1983) and the Regional Sensitivity to Climate Change in Antarctic Terrestrial and Limnetic Ecosystems (RiSCC, 2002). The measured weather variables were temperature to 1,70 m. and 0,10 m above the ground, humidity, wind speed and direction, global radiation and PAR (photosynthetically active radiation; 400-700 nm). Besides these meteorological variables, water temperature, conductivity and PAR radiation at 0,5 m deep in Somero lake were also measured. Precipitation was not measured, because it usually is in solid phase and the area is very windy, making the records very imprecise. The barometer was not included because this variable was already recorded in the nearby BAEJCI (Bañón, 2004) and no significant differences in atmospheric pressure were expected between both locations.

Station works properly from December 2001 to April 2003. Winter records in 2003, 2004 and the complete year 2005 were missing because the adverse climatology in Antarctica produced station malfunctions which were only repaired at the next campaign with research activity in Byers Peninsula.  On February 2006 a vertical axis wind generator (Windside WS-0,15B) was installed to ensure energy supply. There are data of different variables for more than 75% of the time. Since 2007 to February 2011 there are 98% of the data on all variables except those related to the wind. Time series of Antarctic meteorological records typically result incomplete and do not show the quality standards required at other latitudes.

The station recorded data every half hour and provided summary values every 24 hours. Daily statistics as mean, minimum and maximum were calculated for different meteorological variables from data measured every 30s and stored every 30 minutes. In tables 2 and 3 the statistics are denoted by mn, Min and Max (mean, minimum and maximum, respectively). Days with less than 80% of recorded half-hourly data were discarded. This is a compromise between not losing too much information by occasional missing data and not introducing important bias in the statistics since the failures tend to occur in consecutive hours because of power failure, usually during night and winter. Monthly statistics were calculated when more than 80% of daily statistics were recorded. Annual statistics were calculated only for the years with the twelve valid monthly statistics. The number of available years varies from four, for the wind-related variables, to seven for soil and water temperatures and PAR (table 2). Similarly, to calculate seasonal statistics, only years without flaws were used. Summer period comprises December, January and February; autumn term lasts from March to May;

winter season comes from June to August; and spring copes with the remaining three months, September, October and November.

From the ecological point of view the ice and snow cover may be crucial. However, the measurement of this cover was not possible at Byers Peninsula and because of that a proxy that may indicate the cover was searched. In that way, we propose to analyze the annual time series of daily standard deviations of the temperature at 0.1 m above the ground, which is defined as follows,

$$Tsstd_i^r = \left( \frac{1}{47} \sum_{j=1}^{48} \left( Ts_i^r(j/2) - Tsmn_i^r \right)^2 \right)^{1/2} \quad \text{for} \quad i = 1, \ldots, 365 \text{ and } r = 2001, \ldots, 2011,$$

where $Ts_i^r(j)$ and $Tsmn_i^r$ are temperature at time $j$ and daily mean, respectively, at 0.1 m above the ground on day $i$ of year $r$. Whenever the sensor is covered with snow is more protected from temperature changes dependent on air mass changes, therefore a decrease of this parameter indicates that the soil is covered with snow. To give a global estimation of snow cover we consider the mean time series

$$\overline{Tsstd}_i = \frac{1}{n_i} \sum_{k=2001}^{2011} Tsstd_i^k \quad \text{for} \quad i = 1, \ldots, 365,$$

where $n_i$ is the number of years with available temperature at 0.1 m above the ground on day $i$.

Linear regression analysis applied to daily mean data was used to compare the main weather variables between different stations in the South Shetland Islands. The relations were validated with $p$-values and valued with squared correlation coefficients.

## Results and Discussion

### Annual cycle

Average of the annual mean temperatures of the air at 1.70 m above the ground is -2.8 ºC during the registered period from 2002 to 2010. The minimum and maximum temperatures recorded are -27.4 °C and 9.3 ºC, respectively. Usually temperatures are below 0 º C, although positive temperatures are also normal at any time of year. The average of the annual mean of daily temperature range (DTR in table 2), defined as the difference between maximum and minimum daily, is 4 °C. Temperatures at 10 cm above the ground are higher because of the tempering effect of winter snow cover. Average of the annual mean temperature is -1.8 ° C, lowest temperature recorded is -25.5 °C and maximum is 13.1 °C (table 3).

The average relative humidity is very high, above 90% most years, likely by the proximity of the sea and lakes.

Wind speed is moderate, with average speed of 26 km $h^{-1}$ (figure 2). There are frequent storms throughout the year with wind gusts exceeding 100 km $h^{-1}$. The highest gust registered is 139 km $h^{-1}$. The absence of winds from south and the axis formed by SW-NE direction ($1^{st}$ and $3^{rd}$ quadrant), are likely related to the presence of the Antarctic Peninsula located 100 km down south, probably acting as a barrier to the $2^{nd}$ quadrant winds (figure 2a). The wind speed is fairly uniform in all directions, with slightly stronger winds blowing from the NE. Calms are rare, only 1.4% of the records. Besides, no difference in the speed and direction along the year are registered.

Despite the intensive cloudiness, global radiation is high (figure 3a). Average daily radiation is 8936 Kj $m^{-2}$ and maximum record near the summer solstice is 31773 Kj $m^{-2}$. Average daily photosynthetically active radiation, PAR (400-700 nm), is 15.29 mol $m^{-2}$, with maximum record 65.10 mol $m^{-2}$. It is observed that higher values are reached before the summer solstice, in late spring or early summer, when low pressures are still not established and sunny days are predominant. In September begin to appear values above 1000 Kj $m^{-2}$ of global radiation and above 1.00 mol $m^{-2}$ of PAR radiation. The peaks usually take place sometime after noon, between 12:00 and 16:00 hours.

Lake variables, as water temperature and conductivity at 0.5 m deep, provide the freezing moment (figure 4), which typically occur in late spring. It remains below freezing point until early summer (Rochera et al., 2010). Complete freeze up of Somero Lake take place around day 170. Somero Lake remains solid frozen about 80 days a year (until a day around 250) and then bottom water starts thawing and remains liquid until next winter. By early summer the sudden increase in conductivity is probably because of the thawing of the brine formed under the ice that is quickly diluted by the complete thawing of the ice and snow both in the lake and in the watershed. In winter and spring when Somero Lake is ice-covered and the irradiance decreased dramatically in the water column, although due to its shallow profile, some light could reach lake bottom even at mid winter. The PAR sensor installed at 0.5 m depth in the lake recorded daily averages of 1.69 mol $m^{-2}$ (Table 2). After summer ice thawing, maximum PAR is 58.65 mol $m^{-2}$ (table 2), almost equal to the air sensor. The organisms inhabiting at the bottom of the lake are in presence of liquid water during long periods of the year, with reasonable amounts of PAR available, although they are exposed to a variable conductivity due to the salt exclusion during the ice formation process (Hawes et al, 2011)

Regarding the inter-annual variation, data from table 2 show low disparity between mean values of some weather parameters such as wind or humidity. However, air and soil temperatures and radiation differed from one year to another (table 2). There was a difference of 1.3 ºC  for air temperature at 1,70 m about the ground between 2002, which was the coldest year, and 2008 that was the warmest (table 2), which is aligned with the high inter-annual variance previously recorded in the area (Quintana and Carrasco, 1997, King, 1994 and Rochera et al., 2010)

**Seasonal Cycle**

*Summer*

Average of the summer mean temperatures at 1.70 m above the ground is 1.0 ºC, even frosts events are quite common (table 2). The mean of the minimum and maximum temperatures records is between -0.4 ºC and 2.7 ºC (table 2), being -8.5 ºC and 9.3 ° C the lowest and highest temperature recorded (table 3), respectively. The mean daily temperature range is 3.0 °C. The mean temperature at 0.1 m above the ground is 1.5 ºC, which is slightly higher than the recorded at 1.7 m above the ground. However, this sensor is ice free most of the season reaching mean maximum temperatures of 4.5 ºC. and -0.4 in minimum. The temperature data range from -7.5 ºC to 13.1 °C (table 3).

Wind is moderate, with average speed 24 km $h^{-1}$, and shows similar wind roses than the observed for the annual cycle. Frequent storms occur on summer and the maximum gust of 139 km $h^{-1}$ is recorded during one of them.

Global radiation reaches the highest annual values in summer, with some days of sunlight lapses about 20 hours a day in the region. Average daily radiation is 13038 Kj

$m^{-2}$, with values that occasionally exceed 31000 Kj $m^{-2}$. PAR radiation follows similar behavior with mean value 27.85 mol $m^{-2}$ and a maximum record of 65.10 mol $m^{-2}$ (table 3).

Water in Somero Lake is liquid most of the summer, reaching sporadically temperatures up to 16 ºC. The minimum temperature registered is -0.6 ºC when the lake is frozen at the early summer (Rochera et al., 2010**)**. Mean PAR radiation in the water is 6.76 mol $m^{-2}$ and the maximum radiation registered is 58.65 mol $m^{-2}$. The difference is due to partially lake frozen conditions during some summer days.

**Autumn**

During the autumn the temperatures start to fall down rapidly. Average daily temperature is -1.5 °C, maximum ranged around 0.1 ºC and minimum around -3.3 ºC (table 2). The mean daily temperature range is 3.4 °C. Temperatures reach up to 5.7 ºC and fall to -16.5 °C (table 3). Temperature at 0.1 m above the ground is -1.6 °C, with maximum around 0.2 ºC and minimum around -3.5 °C (table 2). The most extreme values are -20.7 ºC and 7.3 ºC (table 3).

The autumnal wind roses do not vary regarding to the annuals. Mean wind speed is higher than in summer, 26 km/h.

The average global radiation decreases fourfold of that in summer, with average value of 3335 Kj $m^{-2}$ and a maximum record of 16745 Kj $m^{-2}$ in early March (table 3). PAR radiation also decreases in the same proportion; the mean value is 6.71 mol $m^{-2}$ and the maximum 33.07 mol $m^{-2}$ (table 3).

Average of daily mean lake water temperatures decreases up to 0.6 ºC in autumn, but since May the temperature is under the freezing point. The ice formation in highest water layers is at sometime between April and May, although liquid water could remain until June (figure 4). Mean PAR radiation in the lake is 1 mol $m^{-2}$ and the maximum 14.80 mol $m^{-2}$.

**Winter**

At the beginning of winter, air temperature falls severely, the mean daily temperature at 1.7 m above the ground is -6.6 ºC (table 2), with means of maximum and minimum values of -9.8 and -4.2 ºC (table 3). The most extreme temperatures are 3.7 and -27.4 ºC, which shows that 0 °C temperatures could be exceed in all seasons (table 3). Mean daily temperature range is 5.6 ºC that is the highest in the year. Temperatures close to the ground are milder, most probably due to the snow and ice cover influence, with mean values -5.1 ºC, although the minimum and maximum temperatures range from -25.5 to 2.2 ºC (table 3).

Wind has the same behavior through the year, with the highest mean speed 28 km $h^{-1}$.

In winter the solar radiation reaches values near darkness, with less than 3 hours of sunlight on the horizon. The shortage of radiation during winter is compensated by the abundance of daylight hours during the summer. Mean global daily radiation is 962 Kj $m^{-2}$, reaching the maximum on September, 9050 Kj $m^{-2}$ (table 3). Average PAR radiation is 2.35 mol $m^{-2}$ with a maximum value of 12.43 mol $m^{-2}$ (table 3). In addition, mean lake water temperature is -0.9 ºC, with extreme values of -3.5 and 0 ºC (table 2 and table 3).

**Spring**

Daily temperature rises in spring, although it remains below freezing many days. Mean daily temperature at 1.7 m above the ground is -3.3 ºC and mean of the minimum and maximum records are -5.5 and -1.5 ºC (table 3). There are some records over 6 ºC and under -21 ºC. Mean daily temperature range is 4 ºC. Temperature near the ground is milder in this season probably due to ice and snow covered conditions. Mean daily temperature is -1.7 ºC and means of the extreme daily records are -2.4 y -1.1 ºC. The minimum and maximum records are -10.6 ºC and 5.3 ºC (table 3).

Average wind speed is 25 km $h^{-1}$, near the annual mean values, with gust reaching 127 km $h^{-1}$.

Global radiation begins to increase in spring reaching the annual maximum in late November and early December. Mean daily radiation is 11496 Kj $m^{-2}$ (table 3), with maximum 27330 Kj $m^{-2}$ reached on November (table 2). This is because solar radiation increases in the same season in which storms do not cross frequently this latitude and there are some sunny days. Average of daily PAR radiation is 26.30 mol $m^{-2}$ and the maximum record is 58.40 mol $m^{-2}$ (table 2 and table 3).

Lakes remain frozen most of the time in spring and the average temperature of the water is -0.4 ºC, with extreme values ranging from -2.2 to 0.1 ºC (table 3). PAR radiation into the lake reachs 0.29 mol $m^{-2}$, while the mean value is 0.01 mol $m^{-2}$, likely due to dimming ice cap effect.

**Relations between weather variables**

Regarding to air temperature as a function of wind speed and direction (Figure 5), is observed that the warm advections come from the fourth quadrant for all wind speeds and from the first one when the speeds are below 60 km / h. The cooler temperature records are likely related with strong winds from the S and SSW and weak winds from the NE and W.

Figure 6 shows the relation between daily standard deviation of the temperature at 0.1 m above the ground, *Tsstd*, and snow height in BAEJCI along 2005. Time series $Tsstd^{2005}$ decreases rapidly to levels approaching zero when the sensor is covered by 0.5 m of snow. *Tsstd* is a good indicator of the periods in which the ground is still covered by snow, probably because in these situations the sensor is protected from temperature variations associated to air mass balances. Applying this result to Byers records, it is observed in Figure 7 that the mean time series $\overline{Tsstd}$ allows to point out that the catchment area is still snow covered between late July and early December with records close to 0.0 ºC.

**Comparison of Byers Peninsula and surrounding meteorological stations**

The meteorological conditions in Byers Peninsula can be compared with the meteorological characteristics of BAEJCI, where summer time-series since1988 have been logged. Moreover, at least 10 years of continuous surveying is available from BAEJCI (Table 4). These series do not fit the requirements of the World Meteorological Organization, but in parameters as temperature start to become valid for a general meteorological description of the area. For instance, when compare monthly temperature records and atmospheric pressures recorded at BAEJCI with their homologous from Bellinghausen Station (King George Island, South Shetland Islands) (see READER project and Turner et al. 2004), correlation coefficients (R) for both variables are 0.97. Slope estimates of the linear regression models are 0.91 for temperature and 0.97 for pressure comparisons (table 5 and figure 8).

Regression analysis based on the daily average data indicate that all meteorological variables recorded in Byers and BAEJCI show a high correlation, always significant with p-values lower than 0.05 (table 5 and figure 8). Temperature records have the highest Pearson correlation coefficient (0.97) at 1.7 m above the ground. Relative humidity, which is very much influenced locally, showed the lowest Pearson correlation coefficient (0.72). Moreover, monthly temperature data from Byers Peninsula and Bellinghausen Station are highly correlated (0.97) and the estimated slope coefficient is 0.891 (table 5 and figure 8).

Comparing air temperature records from Byers Peninsula and BAEJCI, it is observed a difference of approximately 1.4 ºC (estimated constant term in the linear regression model), colder at Byers. This divergence may not be justified by the altitude differences of only 60 m between both locations. Divergences in near ground temperature (0.1 m above the ground) reach -1.4 ºC. In the case of relative humidity the difference in the annual mean values is 10% higher in Byers. Besides, wind speed data show a considerable change, as compared with the 14 km $h^{-1}$ of BAEJCI, the annual average value of Byers is 26 km $h^{-1}$. The dominant wind directions at BAEJCI come from South Bay (figure 1), NNE and SSW, and the frequency of calm periods is 5%, compared with 1% in Byers (figure 2). Annual average of global daily radiation recorded at Byers Peninsula is 33% over its homologous at BAEJCI, about 2200 Kj $m^{-2}$, denoting higher differences during some days due to the local conditions. BAEJCI is located in the nearby of a mountain range that leads winds up increasing the cloudiness. Also this proximity to the mountain range and the bulk amount of snow covering the hills around may cause higher peaks of global radiation by light reflection.

With this comparison we aim to fill missing data and to extrapolate time series for historical reconstruction in Byers Peninsula. In addition we may assume the non measured parameters at Byers Peninsula, as precipitation and atmospheric pressure, from those obtained by the weather station at BAEJCI. Summer precipitation at BAEJCI ranges between 100 and 230 l $m^{-2}$, with a mean value of 159 l $m^{-2}$. The estimation of annual precipitations show values over 500 l $m^{-2}$ by correlation with the meteorological stations of the area, although there are records at some King George Islands´stations with values of 800 l $m^{-2}$ (Turner et al, 2000). Usually precipitations are mostly weak and rainy days are a predominant feature in the area, being liquid through summer. There are two unusual records of intense rainfall events, one in February 1999 with values of 30 l $m^{-2}$ in two hours and another one at February 2003 with more than 50 l $m^{-2}$ registered in less than six hours. During the first field seasons, when meteorological observations were carried out by a meteorological observer following the standards of "Guide To Meteorological Instruments And Methods Of Observation." (WMO, 2008), precipitations events were registered over 80 % of the days. These precipitations are dismissed by the AWS since they are mostly slightly of snowy very influenced by wind. The annual pressure evolution does not follow the pattern set for the interior Antarctic continent with barometric maximum peaks in January and June. Thereafter, meteorological records follow the pattern of coastal stations, more precisely the characteristics of the northern tip of Antarctic Peninsula (King et al, 1997). Records show Livingston Island exhibit marked maximum peaks pressure in July, minimum peaks in April, late spring and early summer. Moreover, the amplitude of recorded pressures ranges from 1028 hPa to 942 hPa. Commonly, the frequency of depressions, especially in summer, cause large atmospheric pressure swings, reaching values of 20 hPa in 12 hours.

## Concluding remarks

The outcomes from the LIMNOPOLAR project are of great interest for the area which is one of the most affected areas by global change in the Earth (Stieg et al 2009 nature). Though the meteorological time-series form Byers Peninsula AWS is short, the study of weather variables can be addressed by nearby stations as BAEJCI and others deployed at King George Island. Given the trends found in the meteorological stations in the South Shetland Islands (Turner et al., 2005) and the indirect effects as the glacier retreat (Calvet et al., 1999), it is possible to assume a quick warming on Livingston Island, though the ecological consequences of this trend on the terrestrial, freshwater and marine ecosystems.

From a climatic point of view, the area is characterized by the existence of warm summer with temperatures above 0 ºC and precipitation of liquid water. Antarctic summer usually comprises December, January and February, air temperature may delay liquid precipitations until late December. The inter-annual variability about temperature and precipitation records is very high. Byers Peninsula is about 1 °C colder than the BAEJCI and extreme values are significantly higher. However, the average wind speed is twofold at Byers Peninsula. This trend is not followed by the extreme winds events, where the differences in the maximum gusts are lower. Predominant winds come from the first and third quadrants at both locations, but mountain range at BAEJCI deflects the wind currents and provokes lower average wind speed. The daily air temperature amplitude is about 4 °C.

Attending to global solar radiation, is significant that the maximum is usually reached before the summer solstice (late November until the beginning of December) maybe due to the higher abundance of low pressures events during mid and late summer than the registered during spring.

Our results also indicate that the lakes in the region remains liquid at the bottom layers for most of the year and freezes solid only for approximately 70 days a year. Sunlight irradiance is able to penetrate the ice cover during most of the ice covered period, which represents important implications for living organisms of bottom lakes.

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