XXXI SCAR OPEN SCIENCE CONFERENCE
BUENOS AIRES, ARGENTINA, 2010.

Recent cooling in the north of the Antarctic Peninsula

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Projeto de Meteorologia Antártica
Project of Antarctic Meteorology

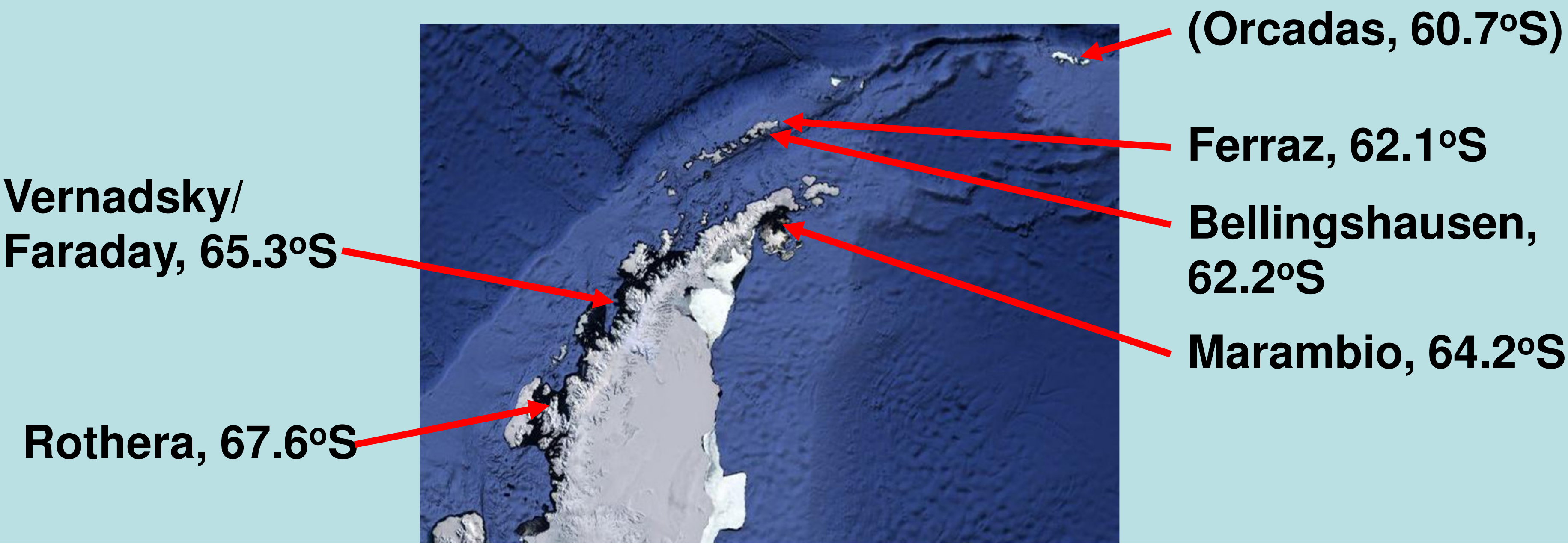
INSTITUTO NACIONAL DE CIÊNCIA E TECNOLOGIA ANTÁRTICO DE PESQUISAS AMBIENTAIS

inct da CRIOSFERA

Warming of the Antarctic Peninsula has been presented in recent years as proof of global warming.

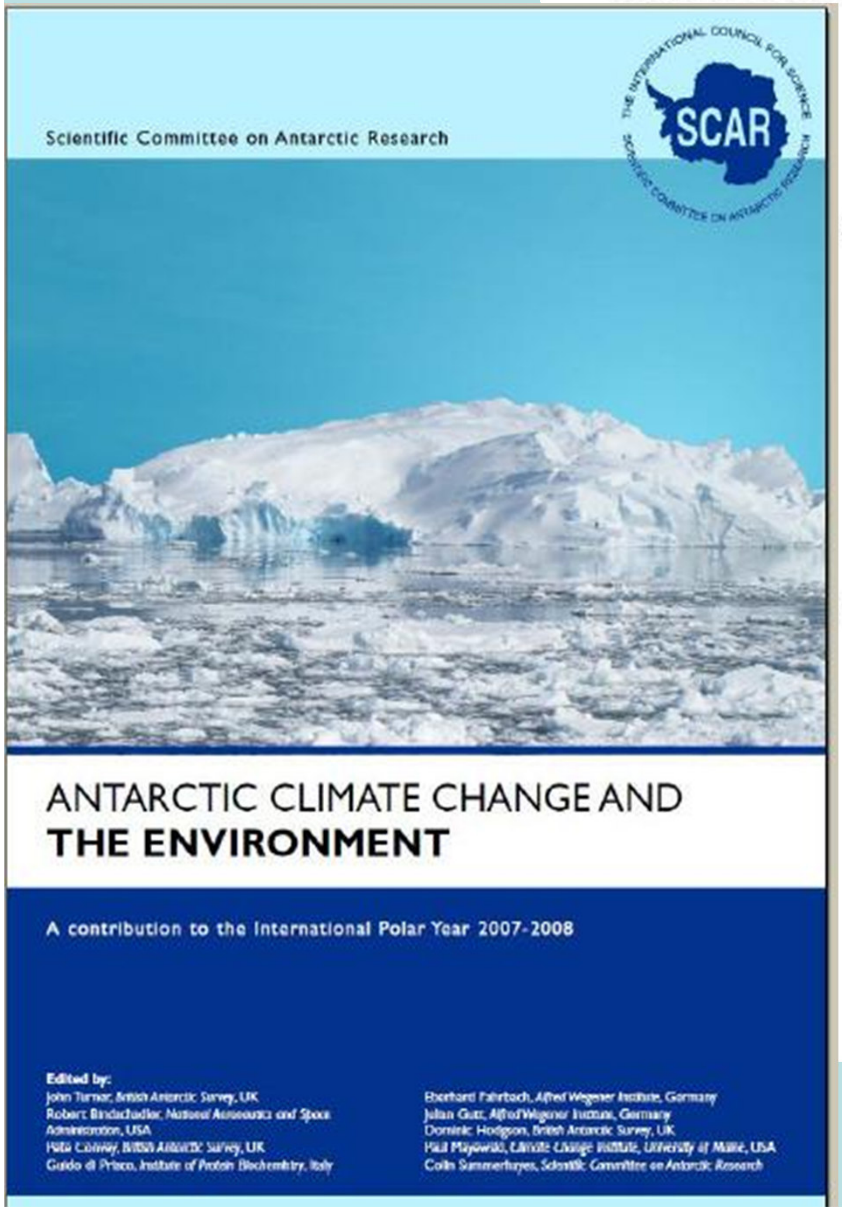
This paper shows that in the last 14 years, 1996-2009, there was actually a decrease in the annual average air temperature in the north of the Peninsula.

Data series for Ferraz (62.1^{o}S; 58.4^{o}W), Bellingshausen (62.2^{o}S; 58.9^{o}W), Marambio (64.2^{o}S ; 56.7^{o}W), Vernadsky/Faraday (65.3^{o}S; 64.3^{o}W) and Rothera (67.6^{o}S; 68.1^{o}W) are presented and indicate decreasing or stable trends;



Let’s start with the (most recent) literature reviews – Dec/2009

Antarctic Climate Change and the Environment



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Chapter 4

The Instrumental Period

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4.1 Introduction

The instrumental period began with the first voyages to the Southern Ocean during the Seventeenth and Eighteenth centuries when scientists such as Edmund Halley made observations of quantities such as geomagnetism. During the early voyages information was collected on the meteorological conditions across the Southern Ocean, ocean conditions, the sea ice extent and the terrestrial and marine biology.

The continent itself was discovered in 1820, although the collection of data was sporadic through the remainder of the Nineteenth Century and it was not possible to venture into the inhospitable interior of Antarctica.

Warming!

Natural or anthropogenic ?

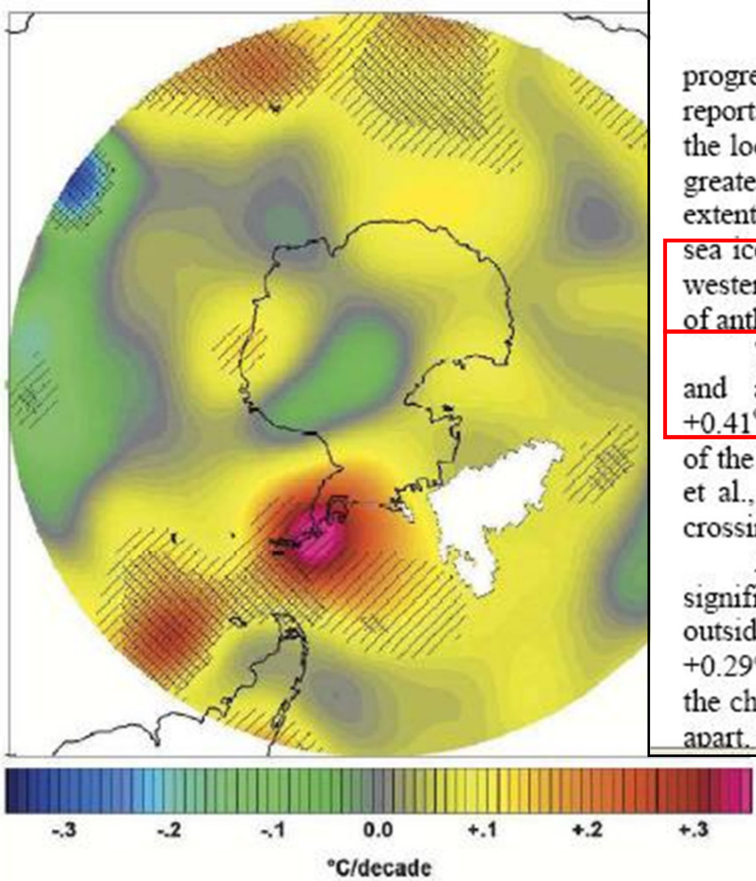
The warming on the western side of the Antarctic Peninsula has been largest during the winter season, with the winter temperatures at Faraday increasing by +1.03°C/decade over 1950-2006. In this area there is a high correlation during the winter between the sea ice extent and the surface temperatures, suggesting more sea ice during the 1950s and 1960s and a

progressive reduction since that time. King and Harangozo (1998) found a number of ship reports from the Bellingshausen Sea in the 1950s and 1960s when sea ice was well north of the locations found in the period of availability of satellite data, suggesting some periods of greater sea ice extent than found in recent decades. However, there is very limited sea ice extent data before the late 1970s, so we have largely circumstantial evidence of a mid-century sea ice maximum at this time. At the moment it is not known whether the warming on the western side of the Peninsula has occurred because of natural climate variability or as a result of anthropogenic factors.

Temperatures on the eastern side of the Peninsula have risen most during the summer and autumn months, with Esperanza having experienced a summer increase of +0.41°C/decade between 1946-2006. This temperature rise has been linked to a strengthening of the westerlies that has taken place as the SAM has shifted into its positive phase (Marshall et al., 2006). Stronger winds have resulted in more relatively warm, maritime air masses crossing the peninsula and reaching the low-lying ice shelves on the eastern side.

Around the rest of the Antarctic coastal region there have been few statistically significant changes in surface temperature over the instrumental period. The largest warming outside the Peninsula region is at Scott Base, where temperatures have risen at a rate of +0.29°C/decade, although this is not statistically significant. The high spatial variability of the changes is apparent from the data for Novolazarevskya and Syowa, which are 1,000 km apart. The former station has warmed at a rate of +0.25°C/decade between 1962–2000, which

(b)



Warming!

http://www.noaanews.noaa.gov/stories2010/20100728_stateoftheclimate.html

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

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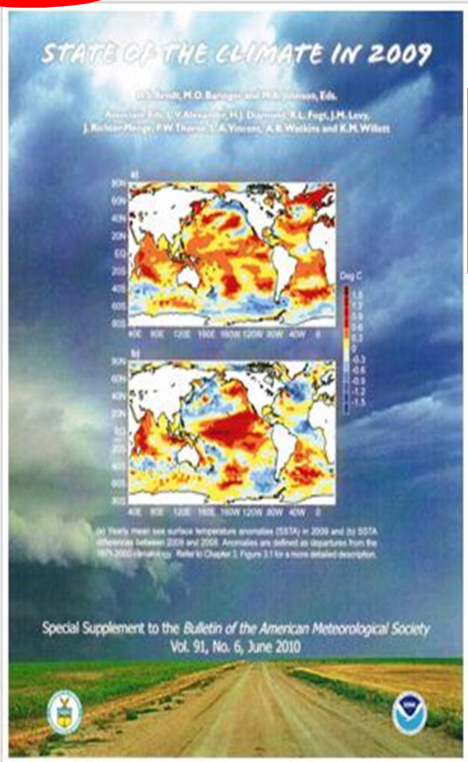
NOAA: Past Decade Warmest on Record According to Scientists in 48 Countries

Earth has been growing warmer for more than fifty years

July 28, 2010



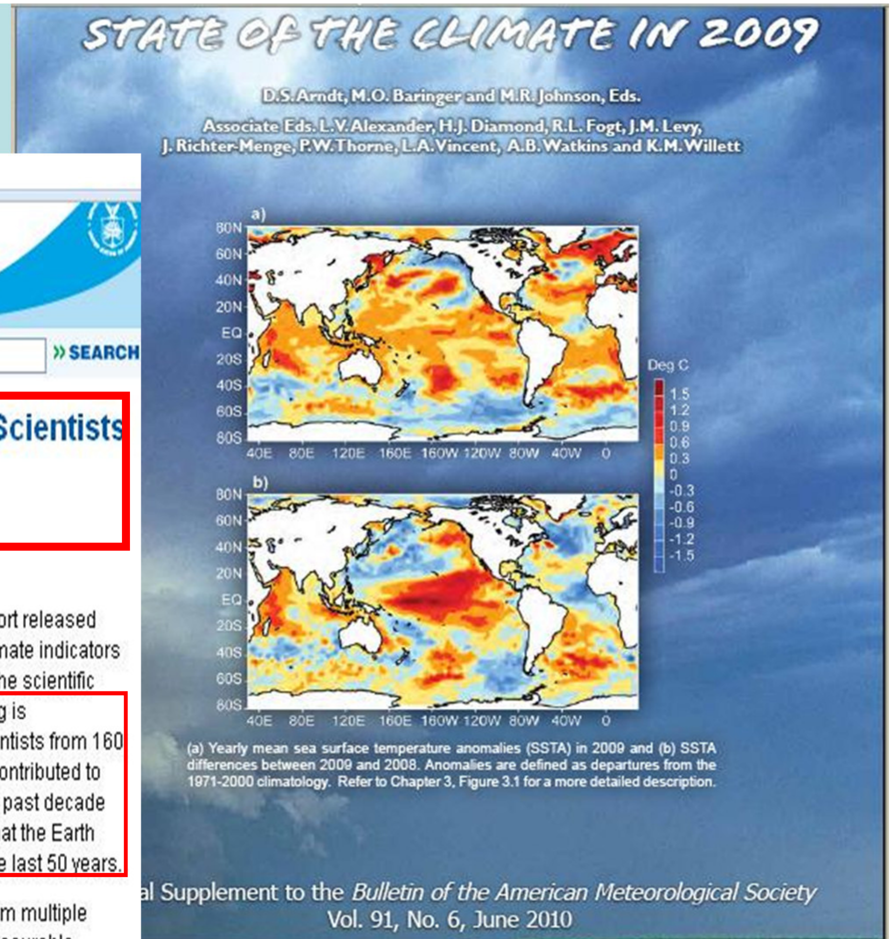
State of the Climate in 2009: Report Cover.

High resolution (Credit: NOAA)

The 2009 *State of the Climate* report released today draws on data for 10 key climate indicators that all point to the same finding: the scientific evidence that our world is warming is unmistakable. More than 300 scientists from 160 research groups in 48 countries contributed to the report, which confirms that the past decade was the warmest on record and that the Earth has been growing warmer over the last 50 years.

Based on comprehensive data from multiple sources, the report defines 10 measurable planet-wide features used to gauge global temperature changes. The relative movement of each of these indicators proves consistent with a warming world. Seven indicators are rising: air temperature over land, sea-surface temperature, air temperature over oceans, sea level, ocean heat, humidity and tropospheric temperature in the "active-weather" layer of the atmosphere closest to the Earth's surface. Three indicators are declining: Arctic sea ice, glaciers and spring snow cover in the Northern hemisphere.

"For the first time, and in a single compelling comparison, the analysis brings together multiple observational records from the top of the atmosphere to the depths of the ocean," said



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x5 Warming!

of 106 km^2 over the past decade. Observations show a general increase in permafrost temperatures during the last several decades in Alaska, northwest Canada, Siberia, and Northern Europe. Changes in the timing of tundra green-up and senescence are also occurring, with earlier green-up in the High Arctic and a shift to a longer green season in fall in the Low Arctic.

The Antarctic Peninsula continues to warm at a rate five times larger than the global mean warming. Associated with the regional warming, there was significant ice loss along the Antarctic Peninsula in the last decade. Antarctic sea ice extent was near normal to modestly above normal for the majority of 2009, with marked regional contrasts within the record. The 2008/09 Antarctic-wide austral summer snowmelt was the lowest in the 30-year history.

This 20th annual *State of the Climate* report highlights the climate conditions that characterized 2009, including notable extreme events. In total, 37 Essential Climate Variables are reported to more completely characterize the *State of the Climate* in 2009.

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HOW DO WE KNOW THE WORLD HAS WARMED?—J. J. KENNEDY, P. W. THORNE, T. C. PETERSON, R. A. RUEDY, P. A. STOTT, D. E. PARKER, S. A. GOOD, H. A. TITCHNER, AND K. M. WILLETT

Although the IPCC AR4 concluded that "warming of the climate system is unequivocal," public debate over the evidence for global warming continues. However, it is often confined to a small set of reiterated disputes about Land Surface Air Temperature (LSAT) records, diverting attention from the broader evidence basis.

The methods used to derive the principal estimates of global surface temperature trends—HadCRUT3 (Brohan et al. 2006), NOAA (Smith et al. 2008), and NASA/GISS (Hansen et al. 2001)—are largely independent (Table 2.2). So, the spread of the three estimates indicates the likely degree of uncertainty in the evolution of the global mean surface temperature. It is noteworthy that independently-derived estimates of tropospheric temperature trends for the whole troposphere channel (distinct from section 2b2) from satellites differ by an order of magnitude more than do estimated surface temperature trends (Thorne et al. 2010,

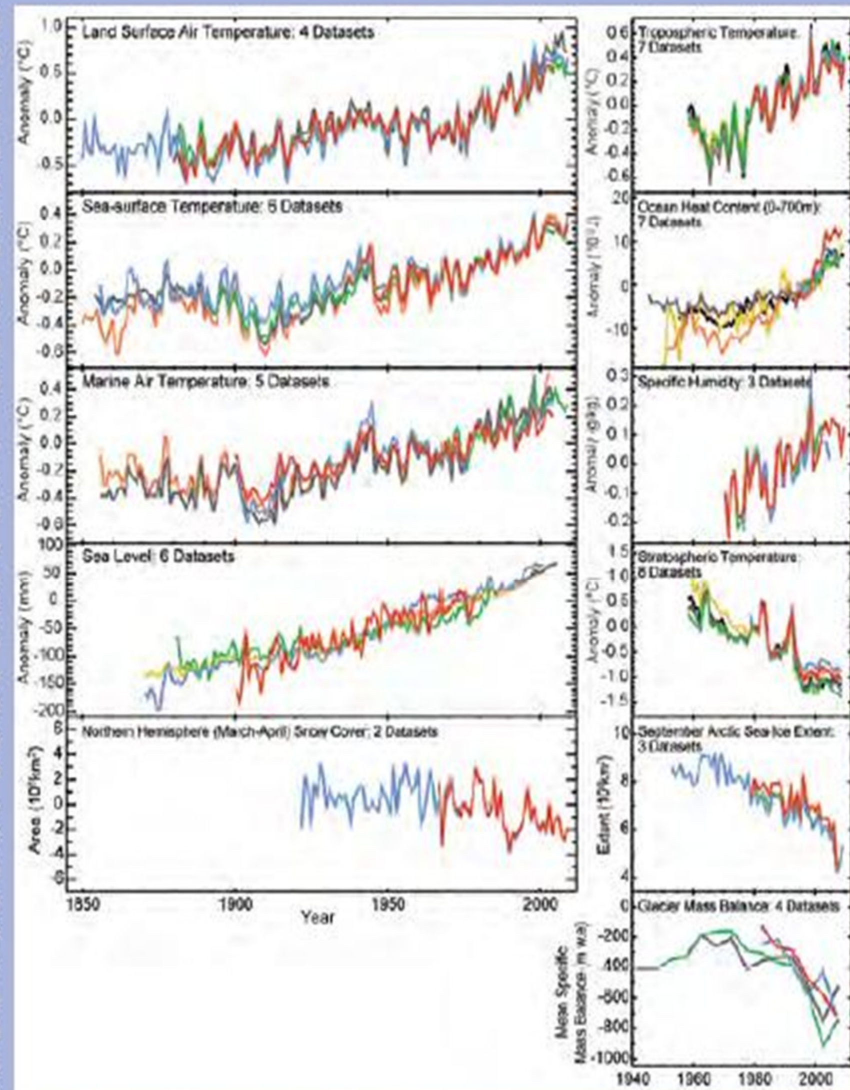

Fig. 2.5. Time series from a range of indicators that would be expected to correlate strongly with the surface record. Note that stratospheric cooling is an expected consequence of greenhouse gas increases. A version of this figure with full references is available at www.ncdc.noaa.gov/bams-state-of-the-climate/.

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x5 Warming!

6. ANTARCTICA

a. Overview—*R. L. Fogt*

The calendar year 2009 was relatively calm, climatologically speaking, for much of Antarctica, especially compared to the past two years which included ice shelf

Antarctic Peninsula.

With the close of 2009 also comes the end of the first decade of the 21st Century. Although Antarctic climate records are much shorter than the rest of the globe, there were still many interesting and noteworthy occurrences during this last decade. A few of these are highlighted in Fig. 6.1, which shows annual and seasonal averages of the decadal mean temperature anomalies at Faraday/Vernadsky and Marambio, situated on the Western and Eastern Antarctic Peninsula, respectively, and the decadal mean Southern Hemisphere Annular Mode (SAM) index anomalies. Notable Antarctic climate events of the last decade include:

- Observations indicate continued rapid warming of the Antarctic Peninsula. The warming on the western Peninsula is most marked during austral winter (June–August; Fig. 6.1a) while the warming on the eastern Peninsula is most marked during austral summer (December–February; Fig. 6.1b). The Peninsula warming trends are approximately five times larger than the global mean warming and are likely associated with anthropogenic greenhouse gas increases (Gillett et al. 2008).

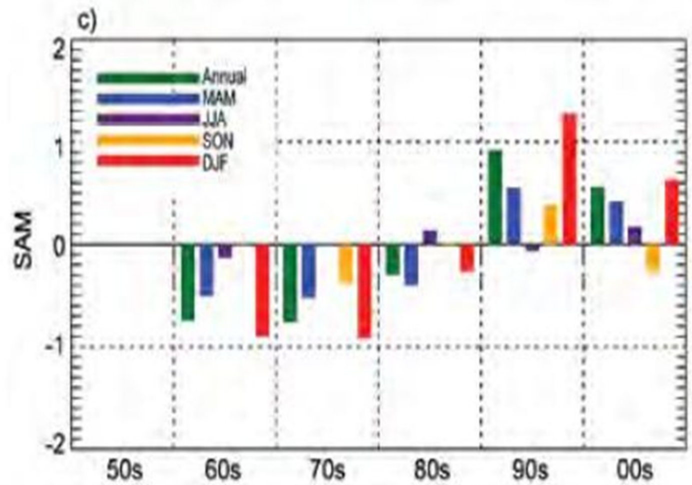

Fig. 6.1. Decadal averages of the seasonal and annual mean anomalies for (a) temperature at Faraday/Vernadsky, (b) temperature at Marambio, and (c) SAM index (http://www.antarctica.ac.uk/met/gjma/sam.html). See Fig. 6.4a for locations of stations used in 6.1a–b.

- Based on a statistical temperature reconstruction, West Antarctica has been warming at a rate of 0.1°C decade^{-1} over the last 50 years (Steig et al. 2009).
- Based on surface observations, interior and coastal East Antarctica have remained stable during the last decade, with no significant warming or cooling trend (Turner et al. 2005).

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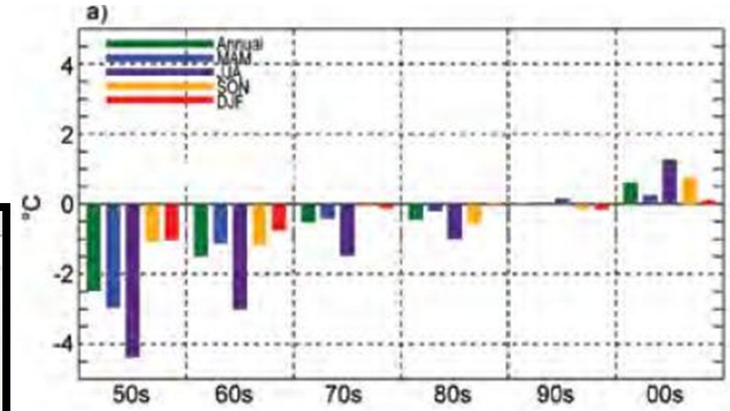

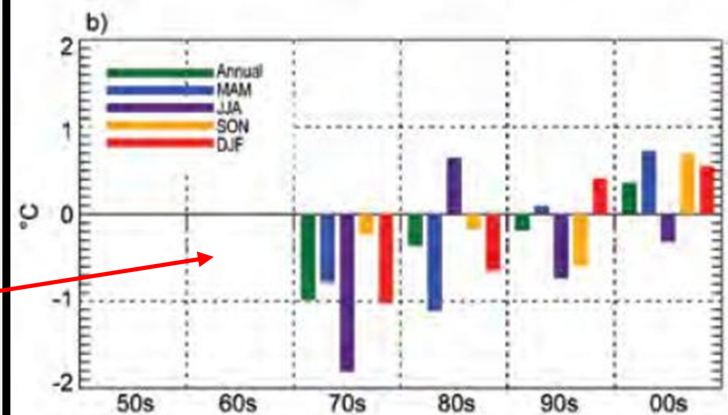

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Warming!

Likely anthropogenic

Warming, but with exceptions...

- Significant ice loss has occurred along the Antarctic Peninsula and West Antarctica in the last decade. In 2002, the Larsen B Ice Shelf on the east side of the Peninsula disintegrated, likely due to the regional warming (see above) (Marshall et al. 2006). In 2008/09, part of the Wilkins Ice Shelf on the west side of the Peninsula collapsed, more likely due to influences other than regional warming (Scambos et al. 2009). More recently, ice loss has been reported in the Pine Island Bay region of West Antarctica (Rignot 2002), due perhaps to oceanic influences (Payne et al. 2007).
- All-time positive records of continent-averaged sea ice extent were reached in December 2007, and March–April 2008, in conjunction with a small but significant increase in overall sea ice extent over the last 30 years (Fogt et al. 2009a). Embedded in this signal are large regional departures: during the last three decades there was an anomalous decrease in sea ice in the Amundsen/Bellingshausen Seas, especially in winter, and an anomalous increase in sea ice extent in the Ross Sea sector.

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c. Surface manned and automatic weather station observations—S. Colwell, L. M. Keller, and M. A. Lazzara

The circulation anomalies are further examined and confirmed here using direct measurements of temperature, wind, and pressure at several manned and automatic weather stations across Antarctica. Fig. 6.4a displays the location of these stations. Two representative manned stations are displayed in Figs. 6.4b,c, and two automatic stations are displayed in Figs. 6.4d,e. A Google Earth file displaying the time series for each station described in this section can be found at: http://www.antarctica.ac.uk/met/momu/BAMS/anomalies.kml. The base period for calculating the anomalies was 1979–2008 for the manned stations and 1980–2008 for the automatic weather stations.

The temperatures in the northern part of the Antarctic Peninsula were below average for most of the year, with June, July, and August being especially cold at Bellingshausen and Marambio (Fig. 6.4c), although not breaking records. Further south on the Peninsula at Rothera station, the temperatures were slightly higher than average for most of the year. In the Weddell Sea region, the temperatures at Halley and Neumayer remained fairly close to the long-term average for most of the year, except for August, which was 3.5°C colder than average and October which was 4°C warmer than average. The pressures in

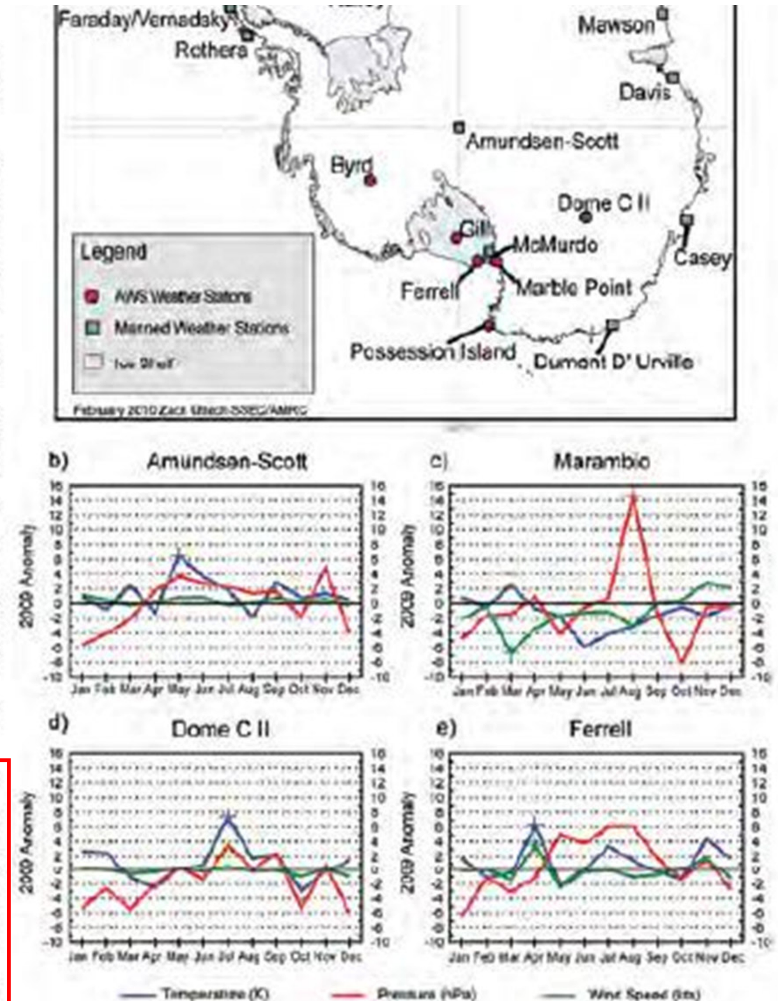

FIG. 6.4. (a) Locations of automatic and manned Antarctic weather stations described in Chapter 6. (b)–(e) 2009 Antarctic climate anomalies at four representative stations (two manned, and two automated). Monthly mean anomalies for temperature (K), MSLP (hPa), and wind speed ($m\ s^{-1}$) are shown, with plus signs (+) denoting all-time record anomalies for a given month at each station. Climatological station data starts in 1957 for Amundsen-Scott, 1970 for Marambio (1983 for Marambio wind speeds), and 1980/81 for the AWS records. The base period for calculating the anomalies was 1979–2008 (1980–2008 for the AWS records).

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Some have noticed different patterns in the north of the Antarctic Peninsula – as seen in this poster, yesterday – here at SCAR XXXI

LUNCH (1330-1430) including POLAR PALOOZA (Salon Amazonas 1330-1430)

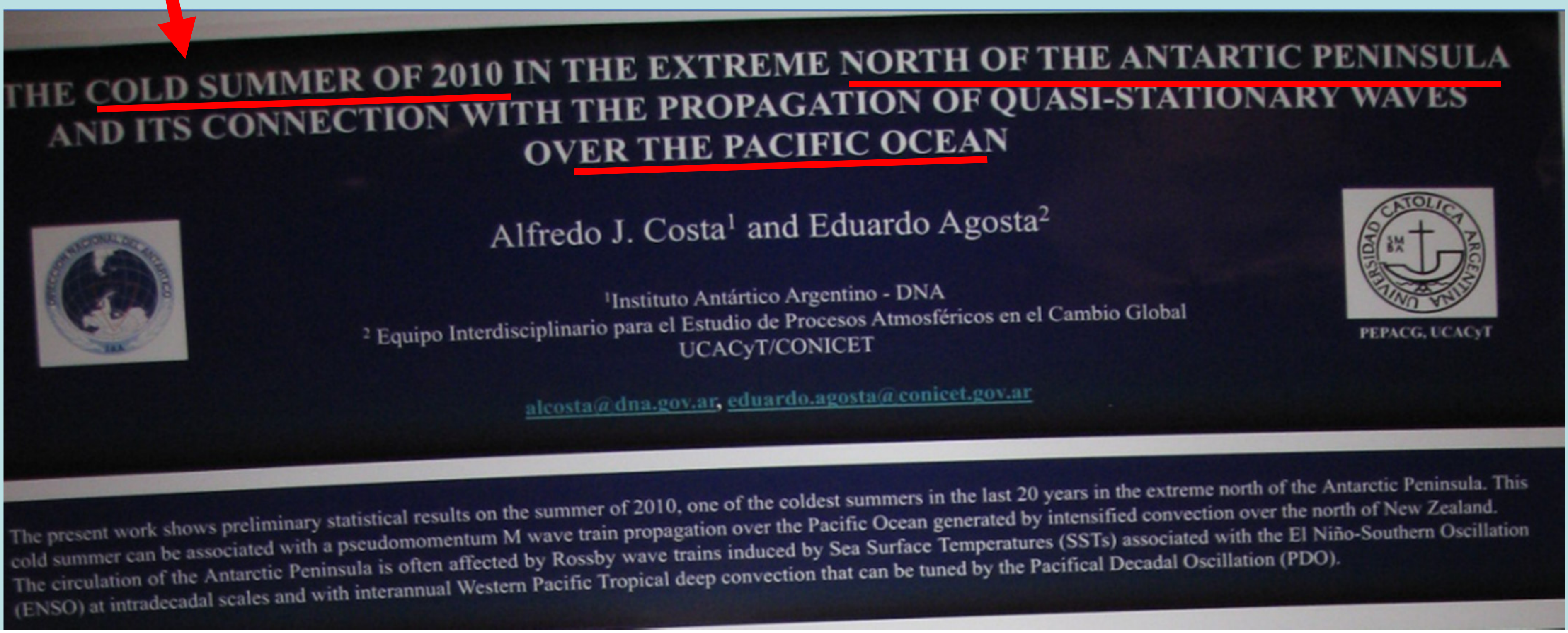
POSTER SESSION/COFFEE

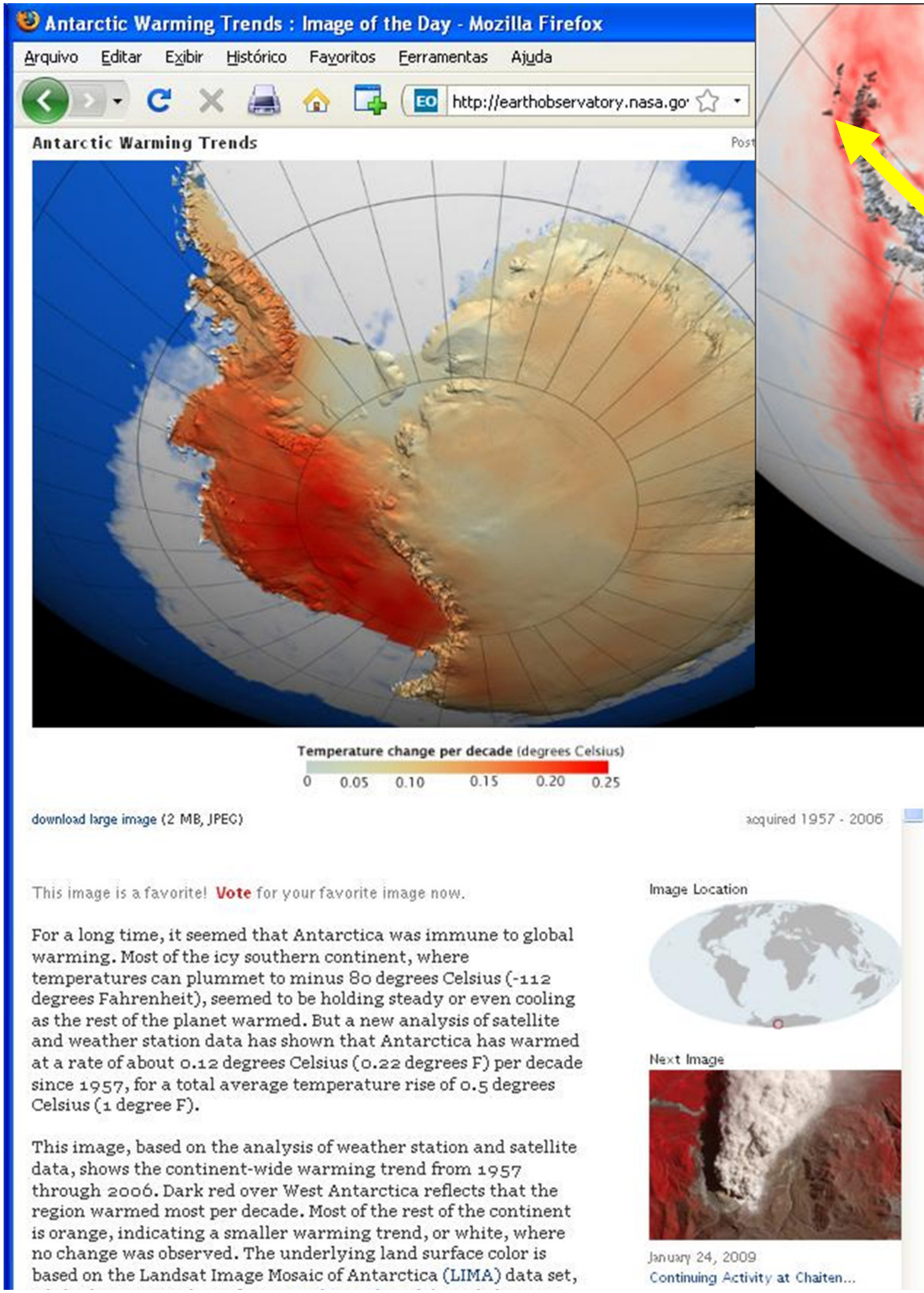
Authors in attendance

Salon Los Jardines: S3,S13,S21,S33,S35,S37

Salon Gran Salon Pan.: S6,S7,S9,S11,S16,S17,S22,S28,S29,S30,S31,S41,S43,S44

4-ago	Wednesday - Parallel Sessions	Session 3 (1600-1800)





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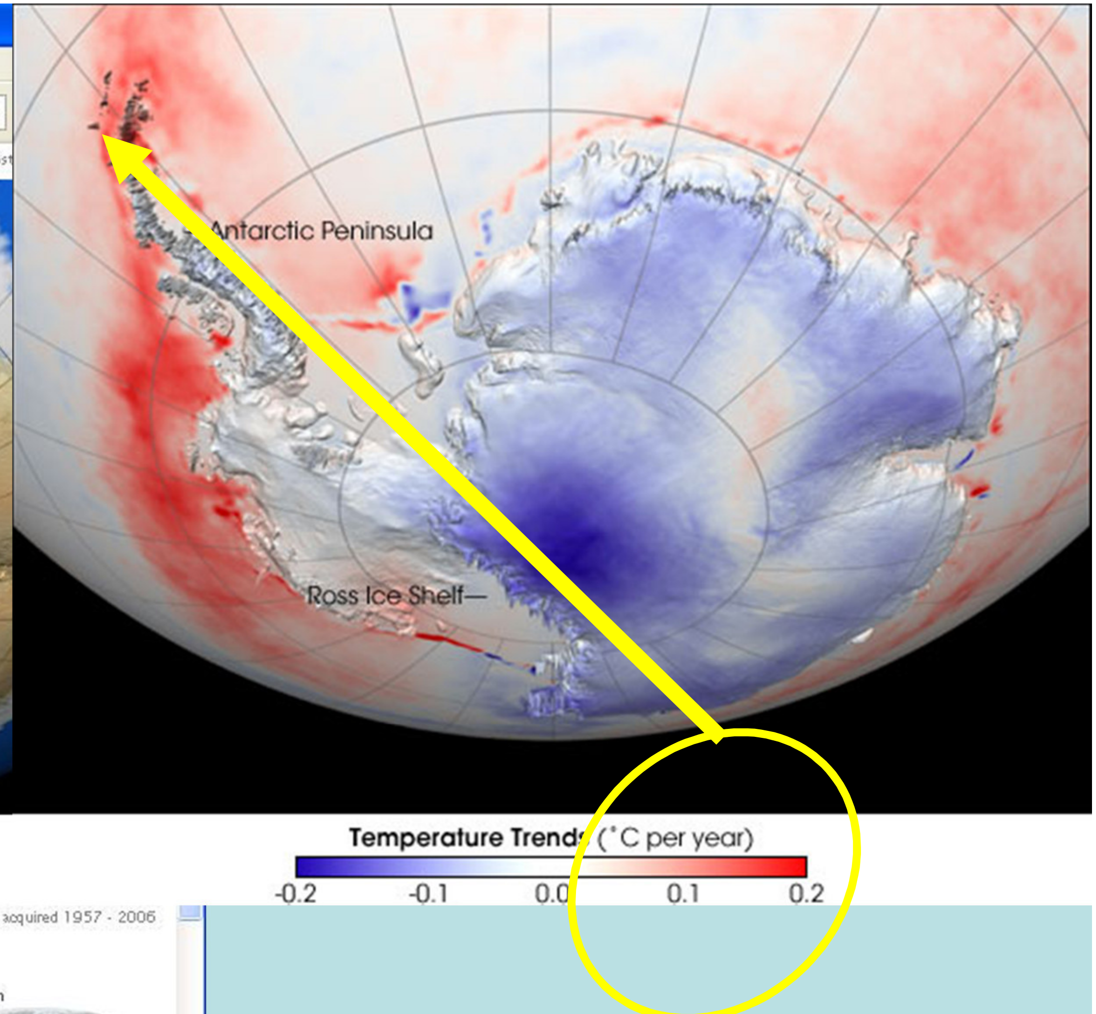
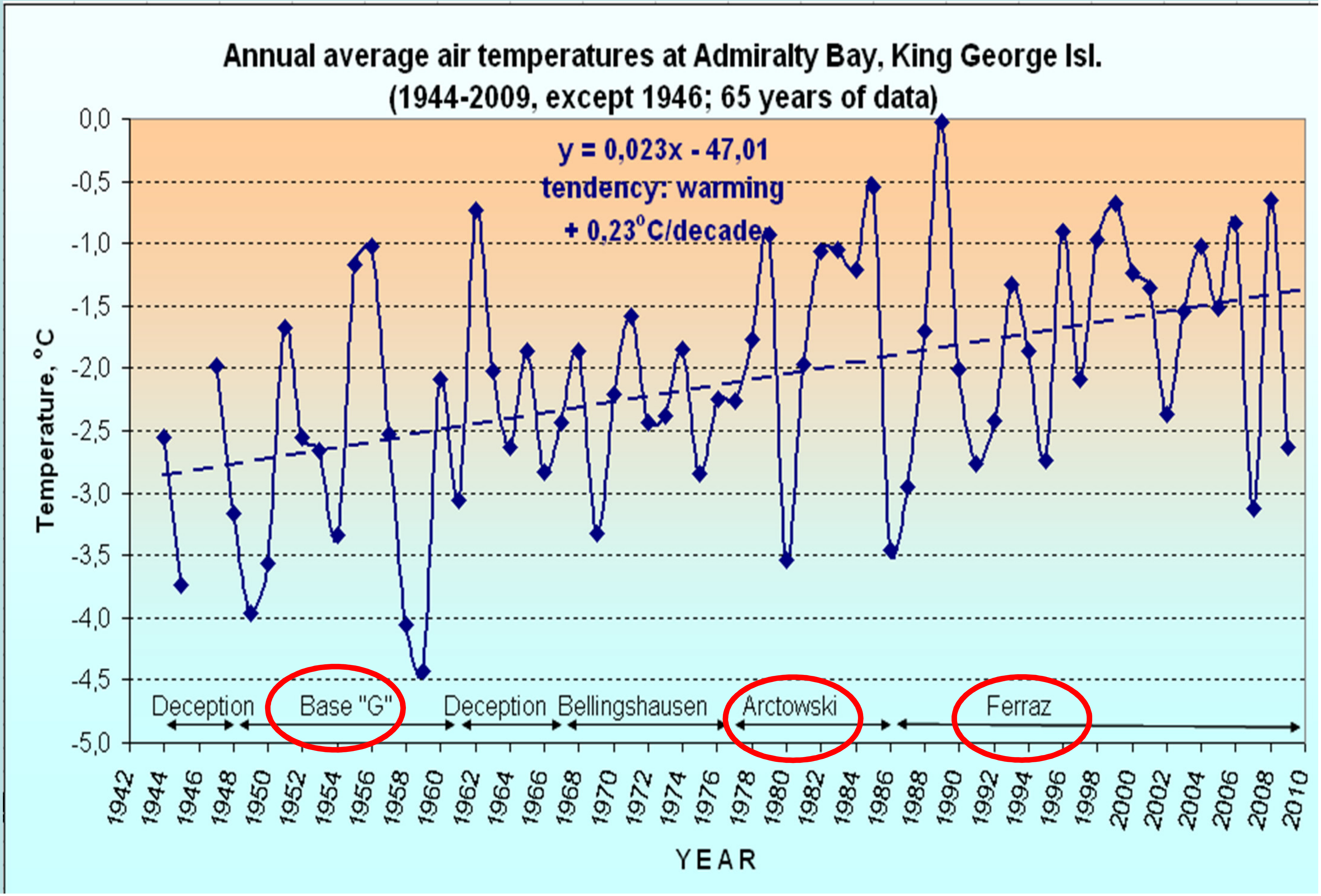
For a long time, it seemed that Antarctica was immune to global warming. Most of the icy southern continent, where temperatures can plummet to minus 80 degrees Celsius (-112 degrees Fahrenheit), seemed to be holding steady or even cooling as the rest of the planet warmed. But a new analysis of satellite and weather station data has shown that Antarctica has warmed at a rate of about 0.12 degrees Celsius (0.22 degrees F) per decade since 1957, for a total average temperature rise of 0.5 degrees Celsius (1 degree F).

This image, based on the analysis of weather station and satellite data, shows the continent-wide warming trend from 1957 through 2006. Dark red over West Antarctica reflects that the region warmed most per decade. Most of the rest of the continent is orange, indicating a smaller warming trend, or white, where no change was observed. The underlying land surface color is based on the Landsat Image Mosaic of Antarctica (LIMA) data set,



This warming has been in the news for a while...

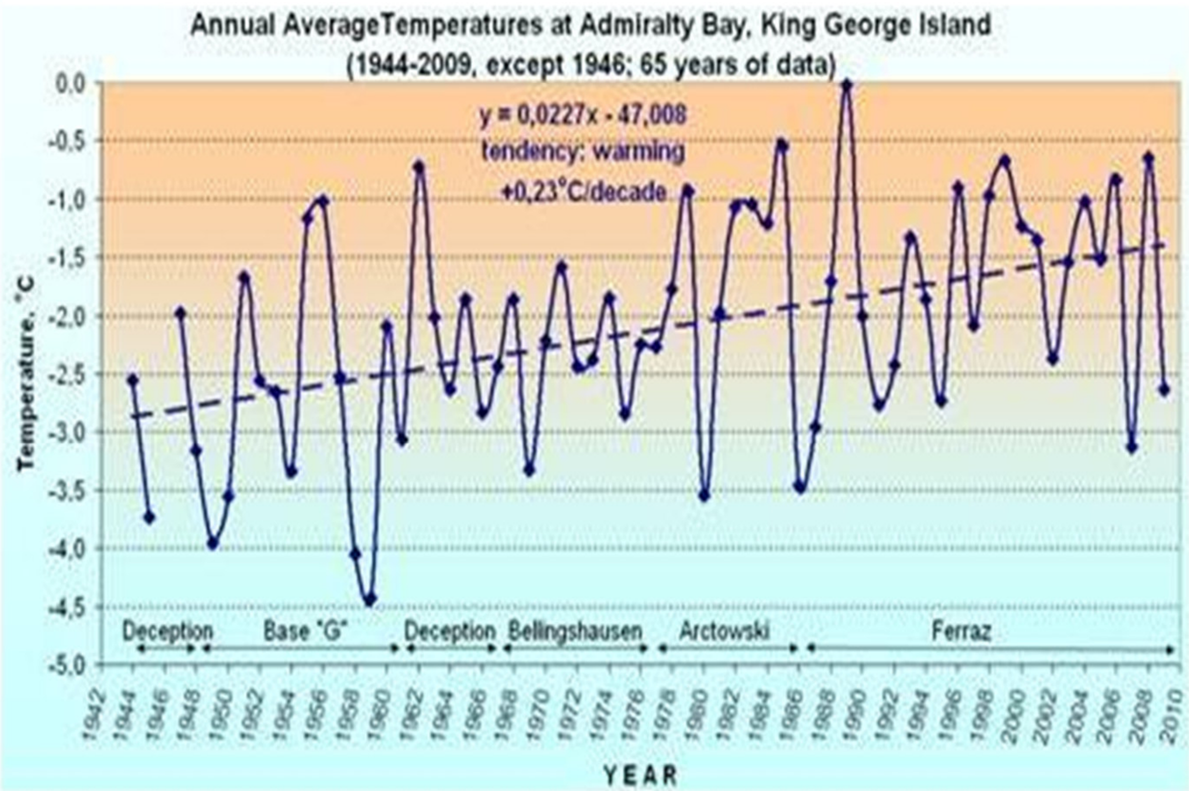
Long series of data are needed for a better unerstanding of climate variations



.no/abstract/383300

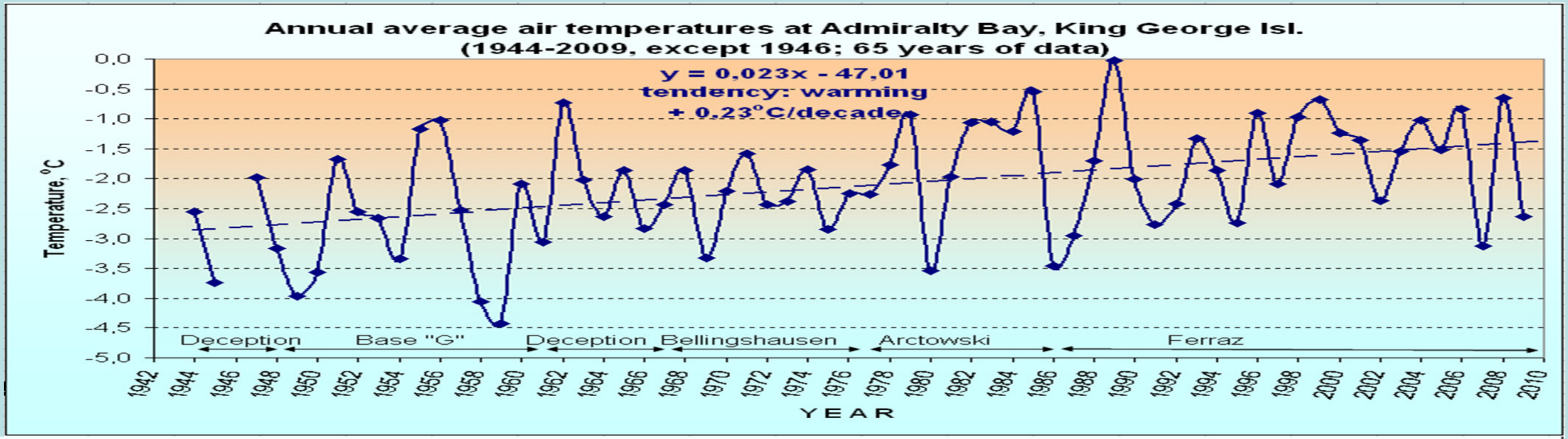
The monthly coefficients used for Deception were: May, -0.2ºC; Jan and Feb, 0.1ºC; Mar, Apr and Jul 0.2ºC; Jun and Dec, 0.3ºC; Aug, 0.4ºC; Oct, 0.5ºC; Nov 0.6ºC; Set ,1.0ºC. For Bellingshausen: Jul, 0.1ºC; Feb, 0.2ºC; Apr and Jun, 0.3ºC; Jan, May and Aug, 0.4ºC; Mar and Sep, 0.5ºC; Oct, 0.6ºC; Dec, 0.8ºC and Nov,1.0ºC. No adjustments were needed for the Arctowski records.

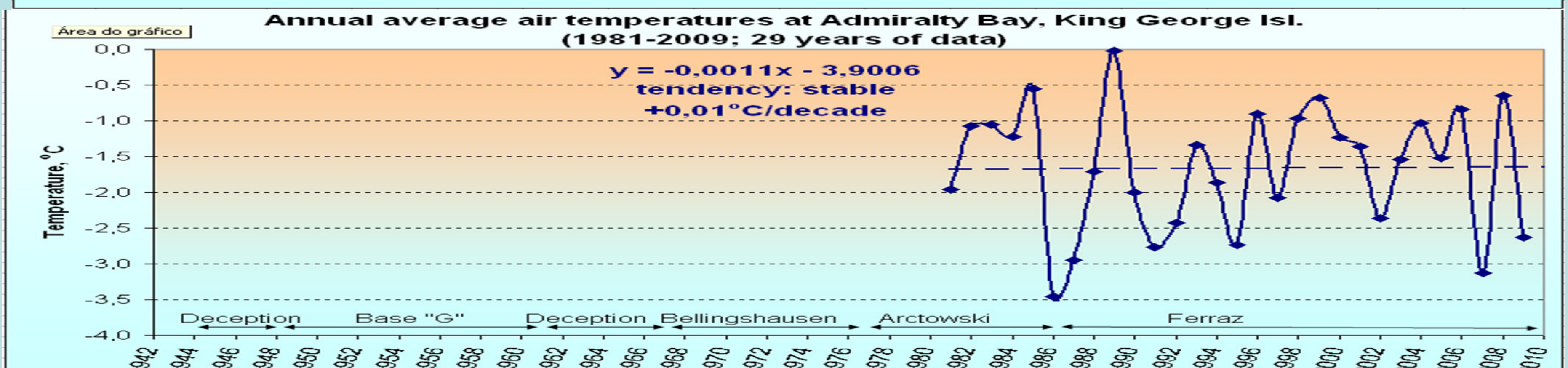
The graph presents the series obtained, indicating an overall warming gradient of 0.23/decade. However, due to the high regional variability and the peak warming in 1989, the same series show the other gradients depending on the time scale: 0.0 ºC for the last 29 years; +0.3 ºC for the last 24 years, and -0.6 ºC (cooling) in the last 14 years.

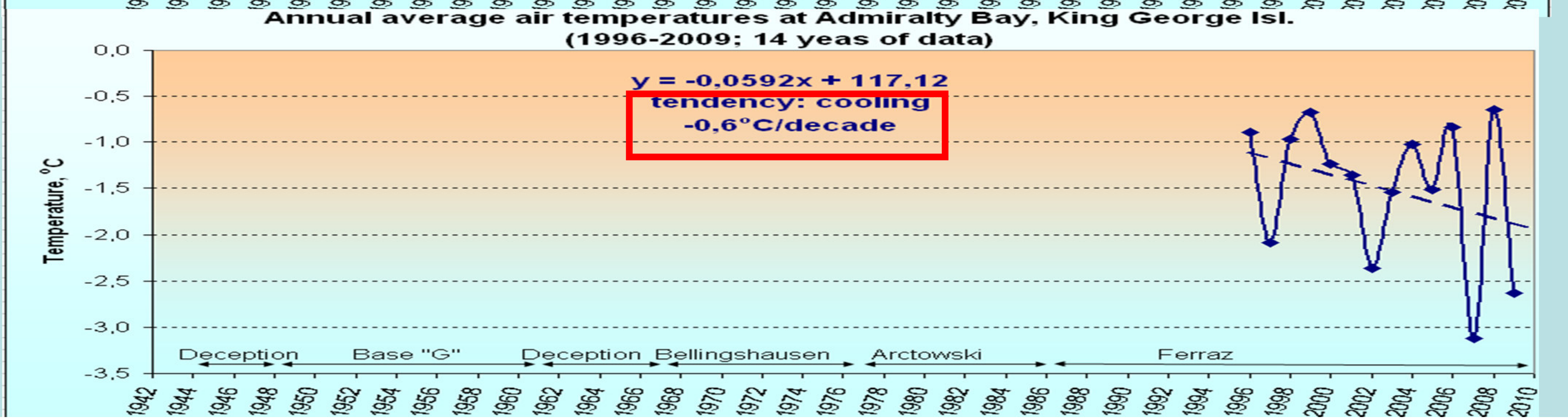


FIDS, 1950s'

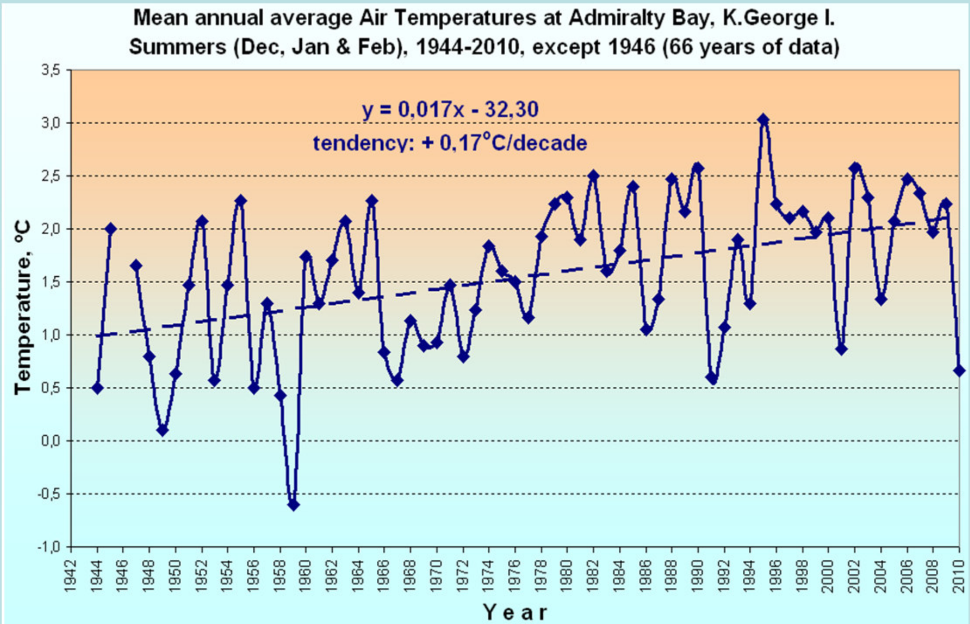
Same tower, today

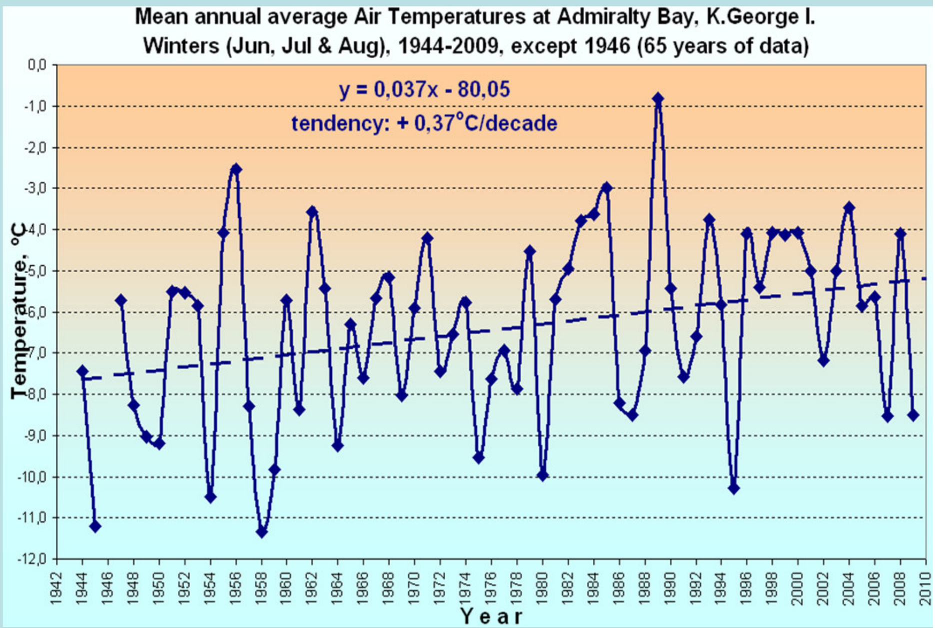

Annual average air temperatures at Admiralty Bay, King George Isl.
(1944-2009, except 1946; 65 years of data)
y = 0,023x - 47,01
tendency: warming
+ 0,23°C/decade
Temperature, °C
Deception
Base "G"
Deception
Bellingshausen
Arctowski
Ferraz
YEAR

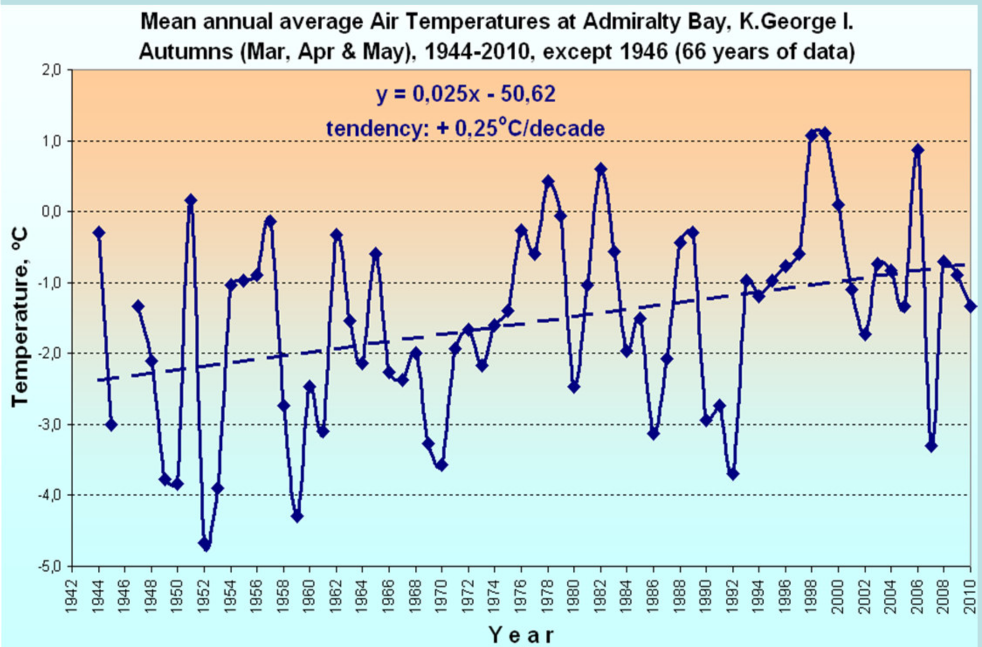

Área do gráfico
Annual average air temperatures at Admiralty Bay, King George Isl.
(1981-2009; 29 years of data)
y = -0,0011x - 3,9006
tendency: stable
+0,01°C/decade
Temperature, °C
Deception
Base "G"
Deception
Bellingshausen
Arctowski
Ferraz

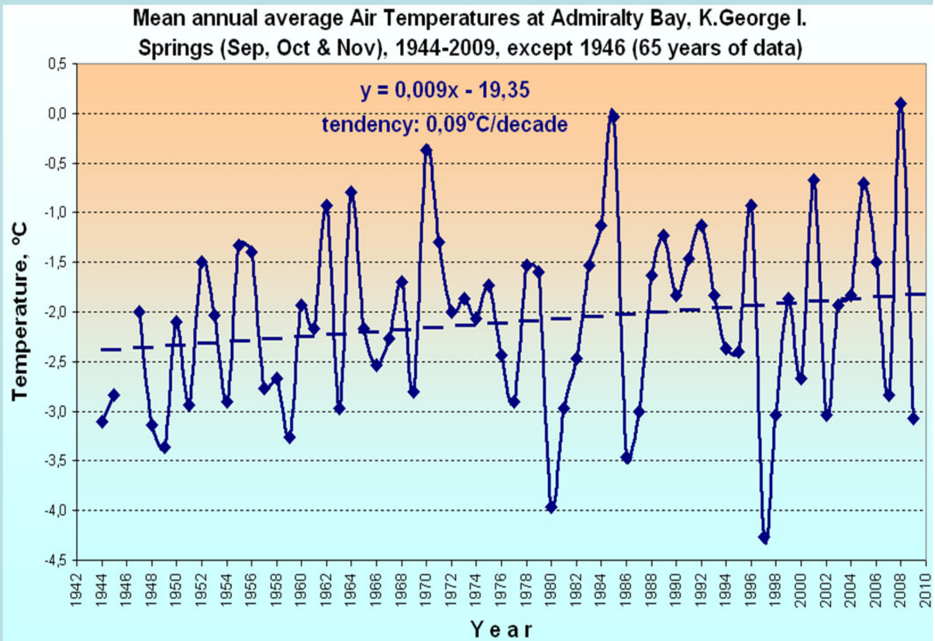

Annual average air temperatures at Admiralty Bay, King George Isl.
(1996-2009; 14 yeas of data)
y = -0,0592x + 117,12
tendency: cooling
-0,6°C/decade
Temperature, °C
Deception
Base "G"
Deception
Bellingshausen
Arctowski
Ferraz

Warming rates vary according to the season, from 0.09 at spring to 0.37 in winter

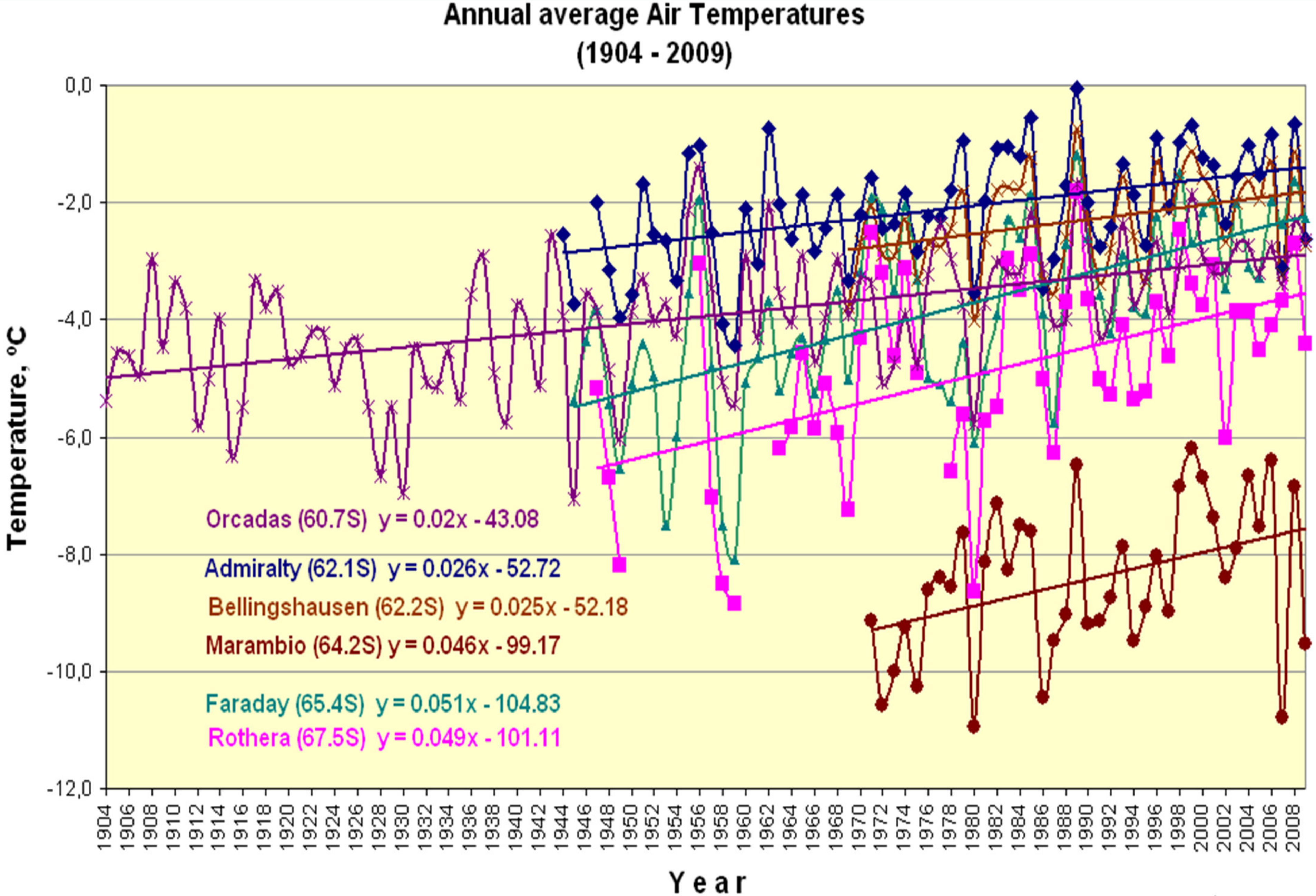




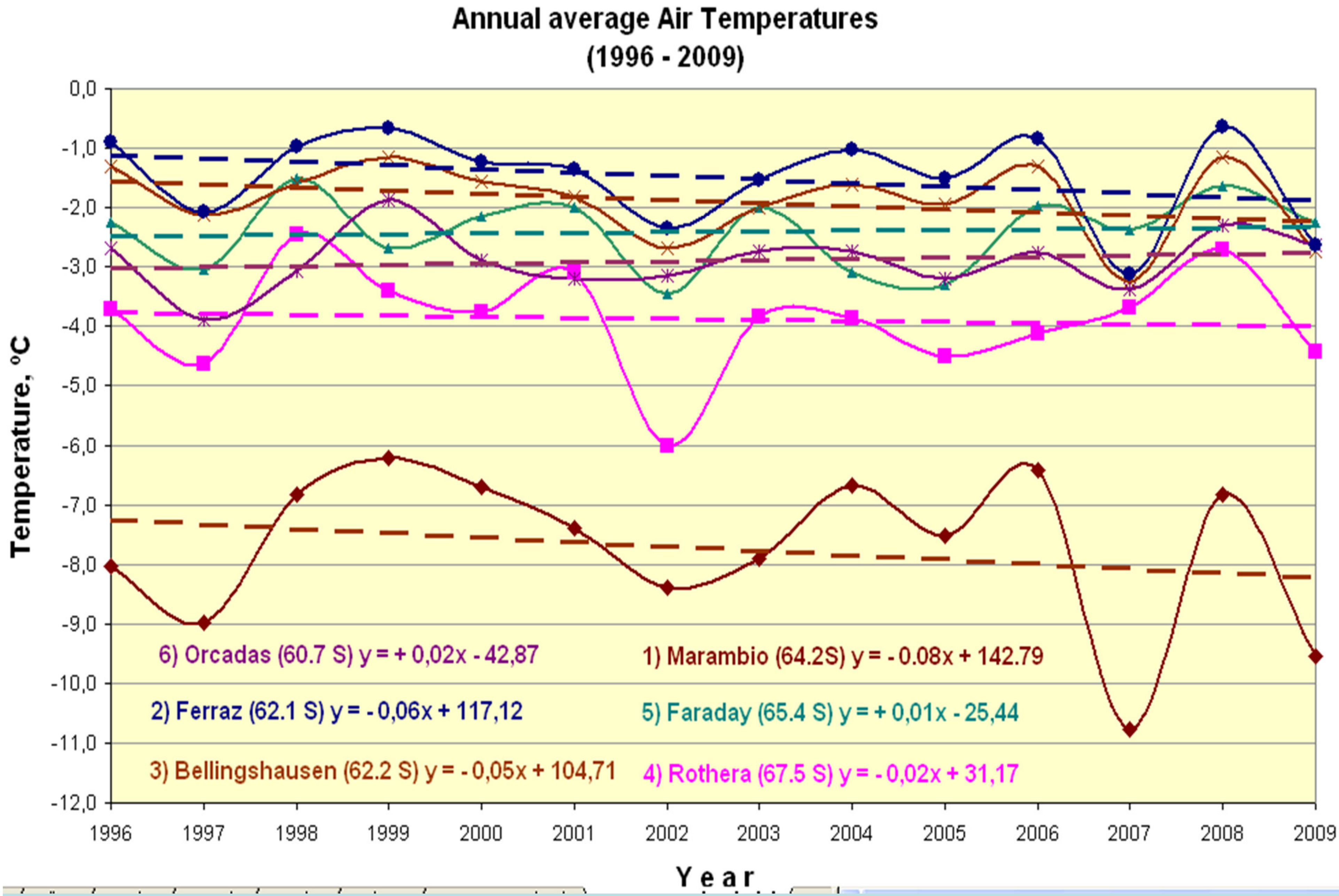




Warming is a common tendency for the region at long term



As is cooling a common tendency for the region at short term



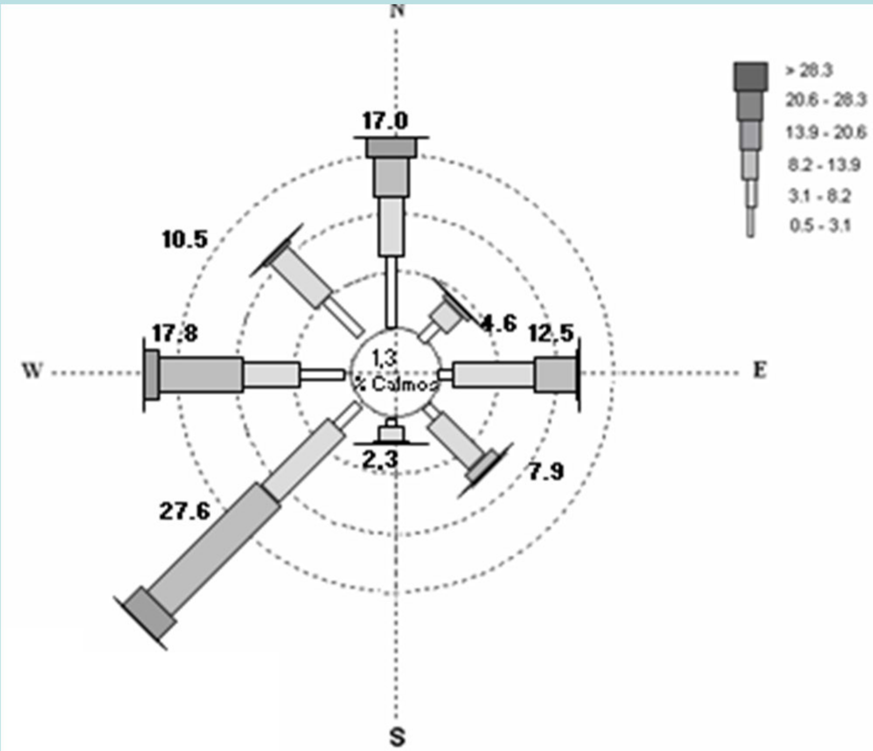
Q) What causes an increase or decrease of temperature in the region ?

A1) The warming or the cooling of the atmosphere ... W R O N G !

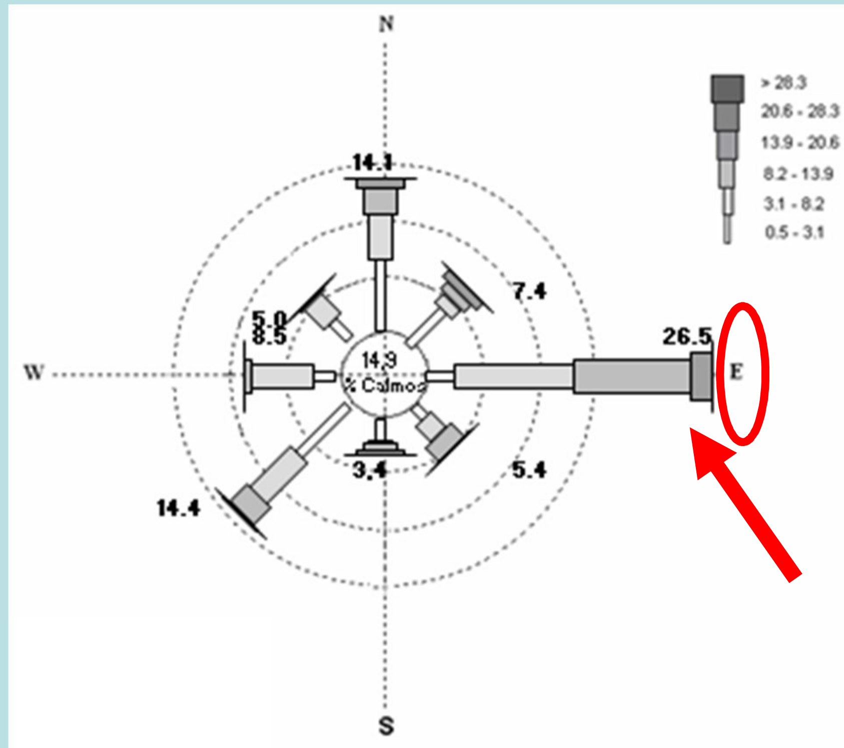
A2) **A change in the synoptic circulation pattern ... R I G H T !**
Cooling results from more cold winds from the NE-E-SE-S sector and less warm winds from the SW-W-NW-N; and vice versa for warming.

Warm Year, 2006 — Ferraz Station — Cold Year, 2007

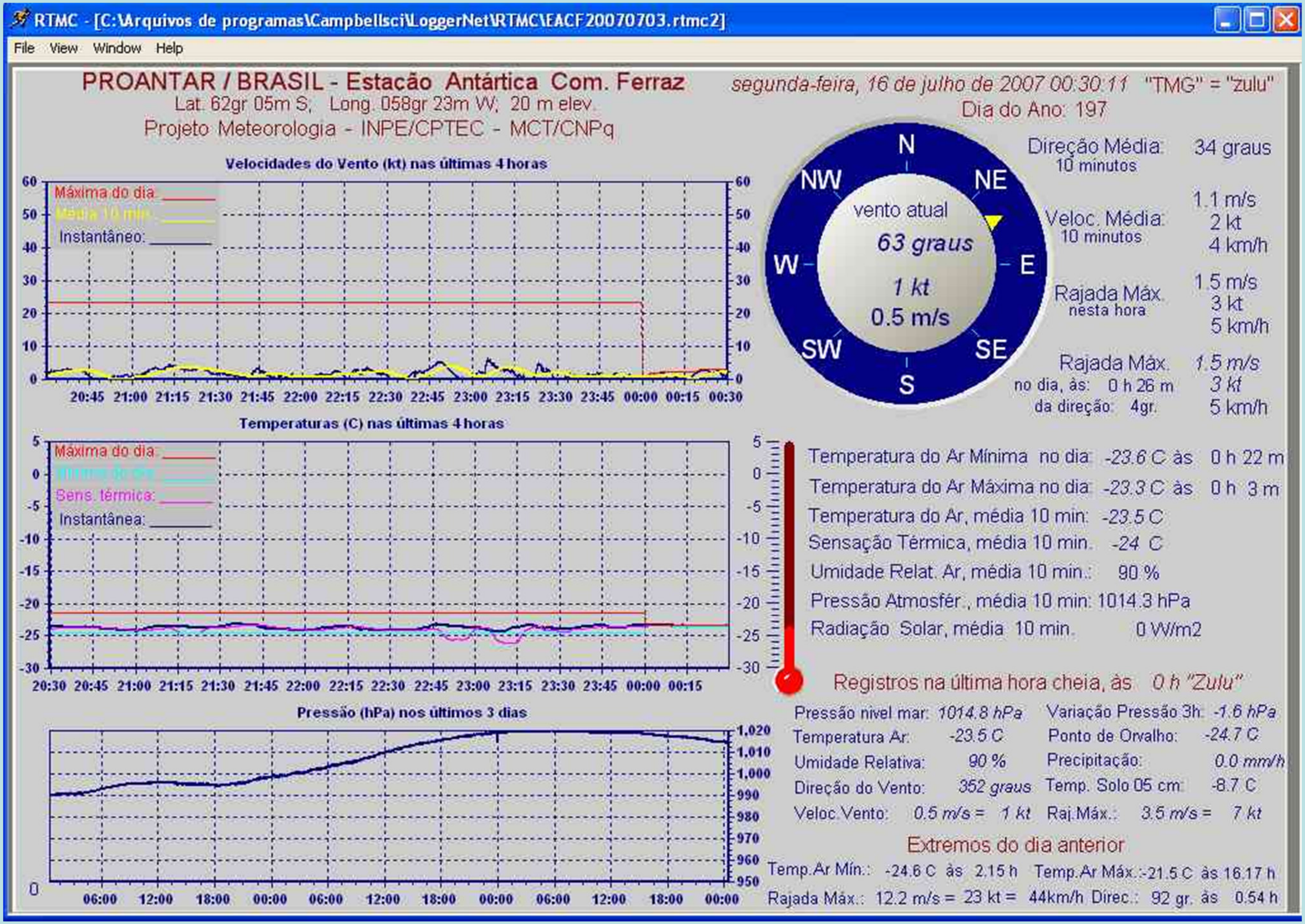
July Avg. Air Temp.: - 4.2 C



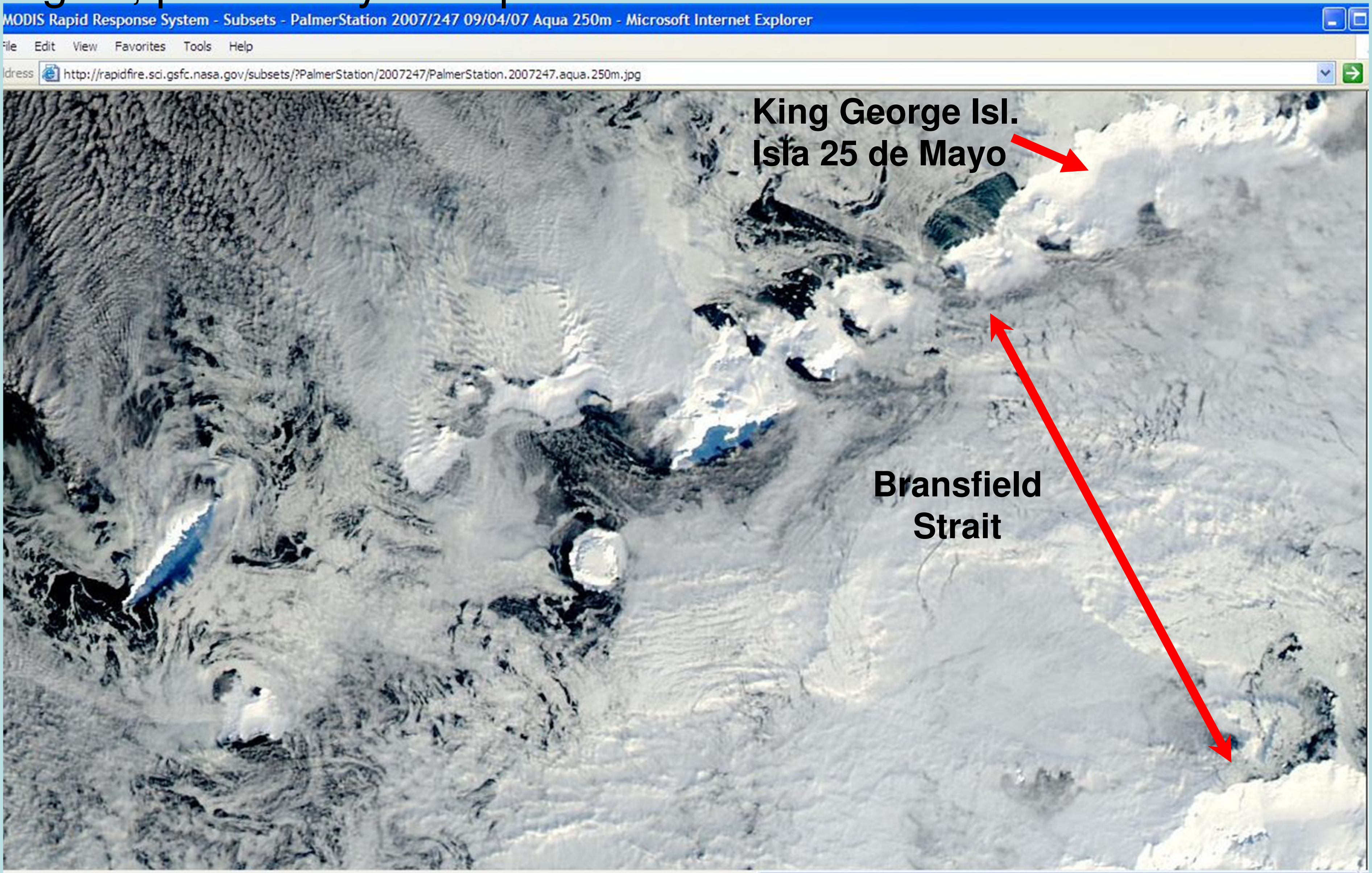
July/2007 Avg. Air Temp.: - 12.6 C



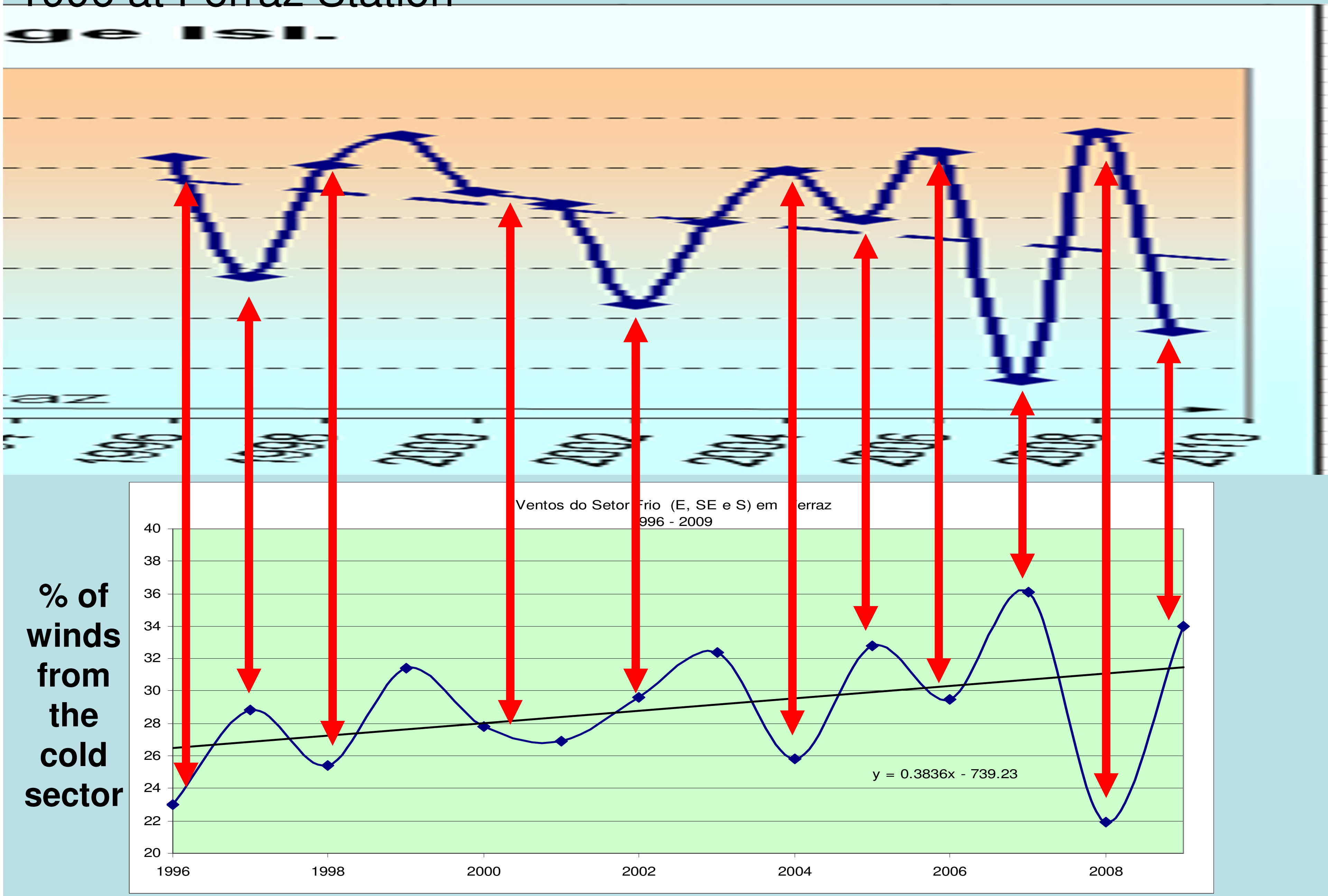
Example showing NE-E winds causing temperatures below -20^{o}C, July/2007



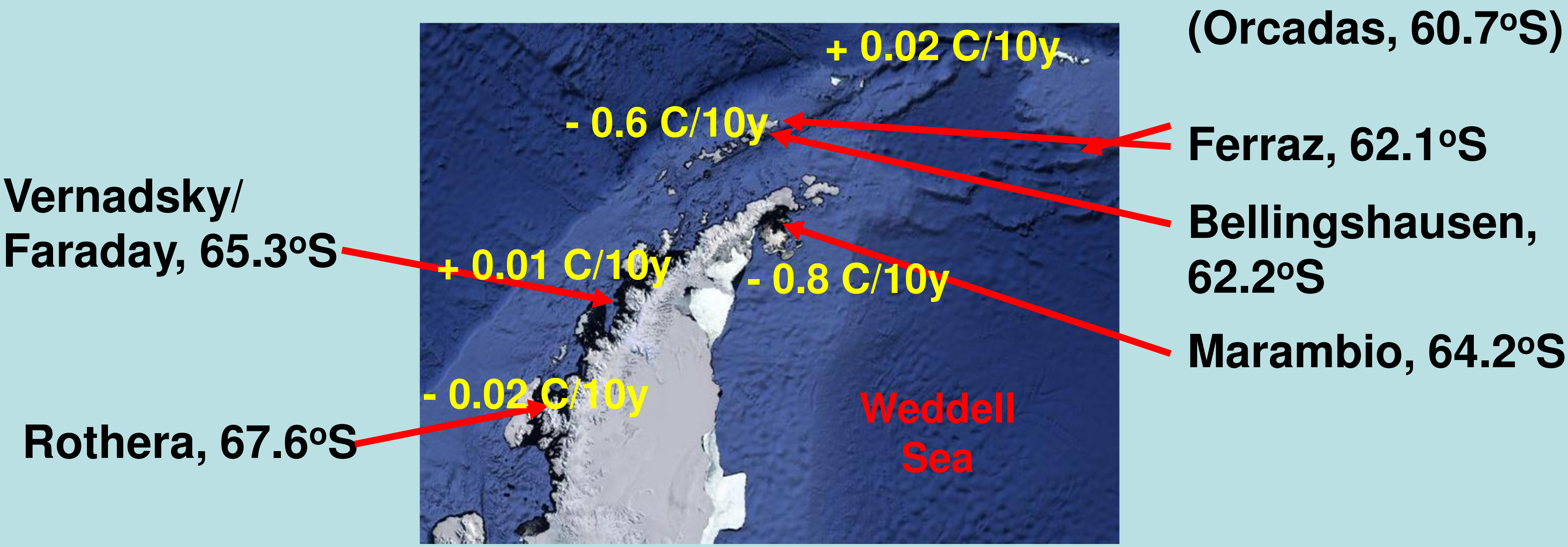
AQUA/NASA satellite, MODIS image, showing the Bransfield Strait frozen on 04/September/2007, something rare in the region, particularly in September !



And the winds from the East (cold) sector have increased since 1996 at Ferraz Station



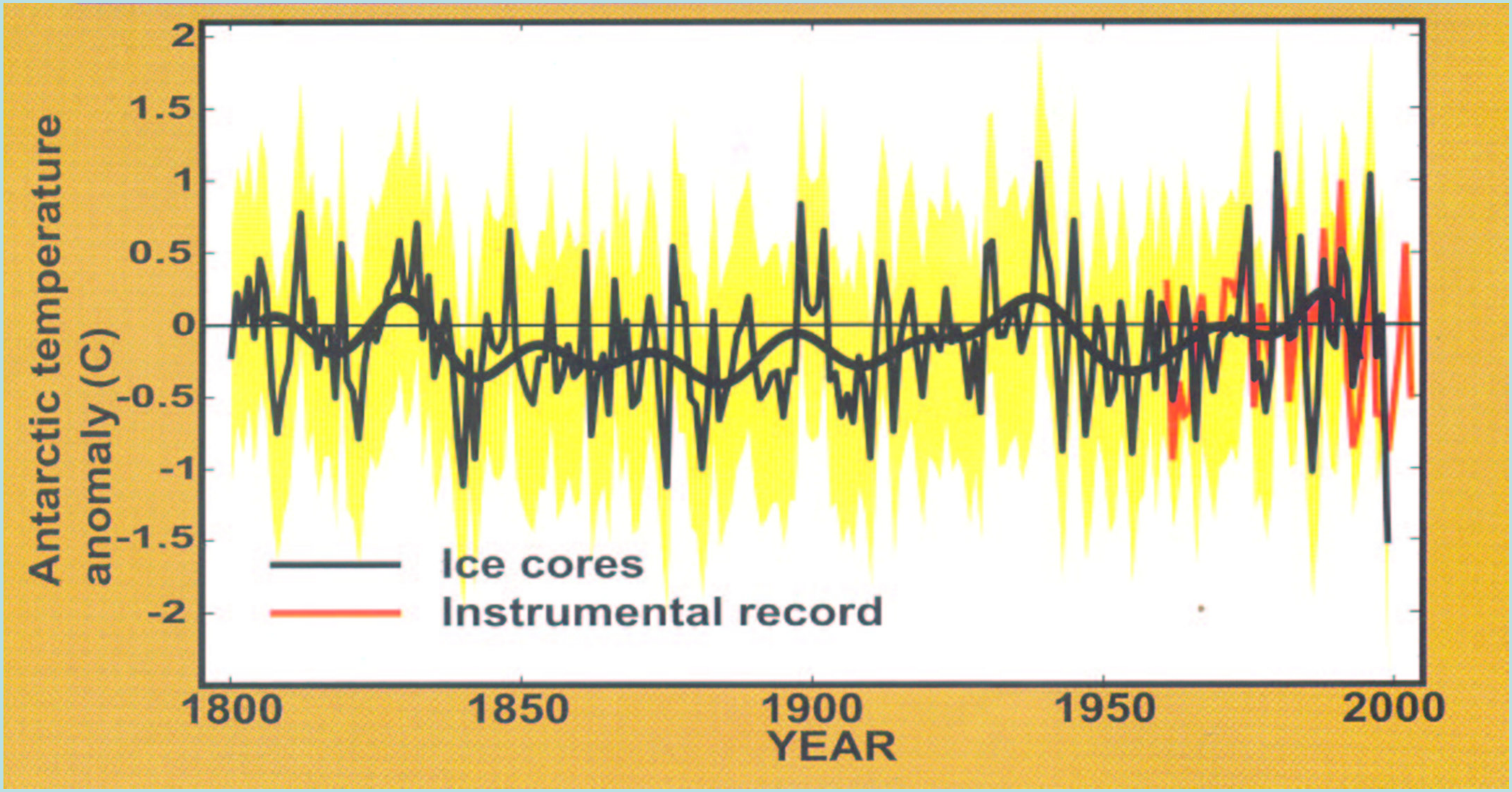
In the north of the Antarctic Peninsula, the Weddell Sea is associated to the cold winds (from the E-SE-S Sector.



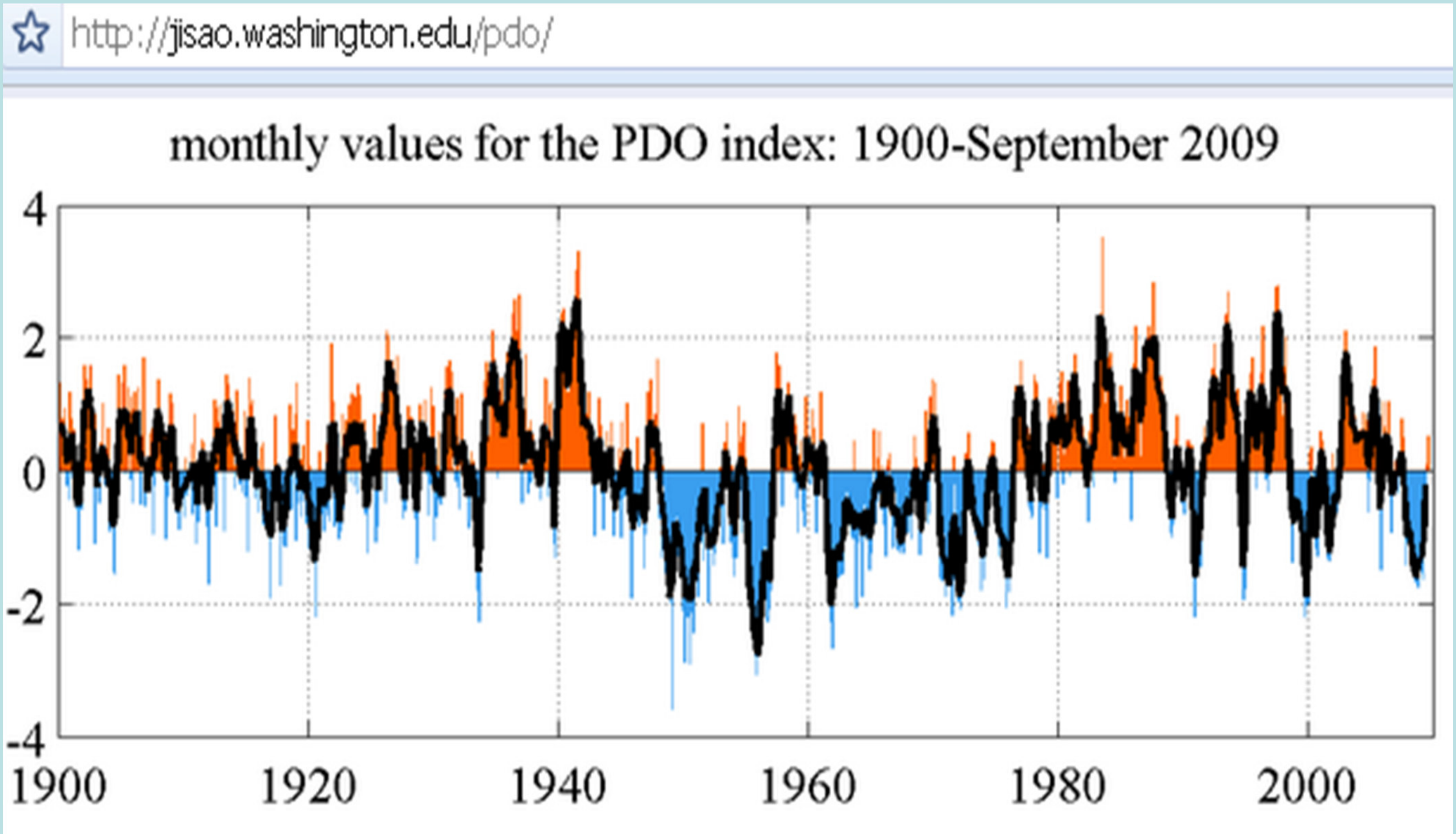
Therefore, the change in the wind pattern results from changes in the regional tropospheric circulation – what involves changes ocean temperatures (Pacific and Atlantic), in the sub-polar and sub-tropical jet streams, in sea-ice extent, etc.

Q) Is this variation natural or anthropogenic-induced – or both?

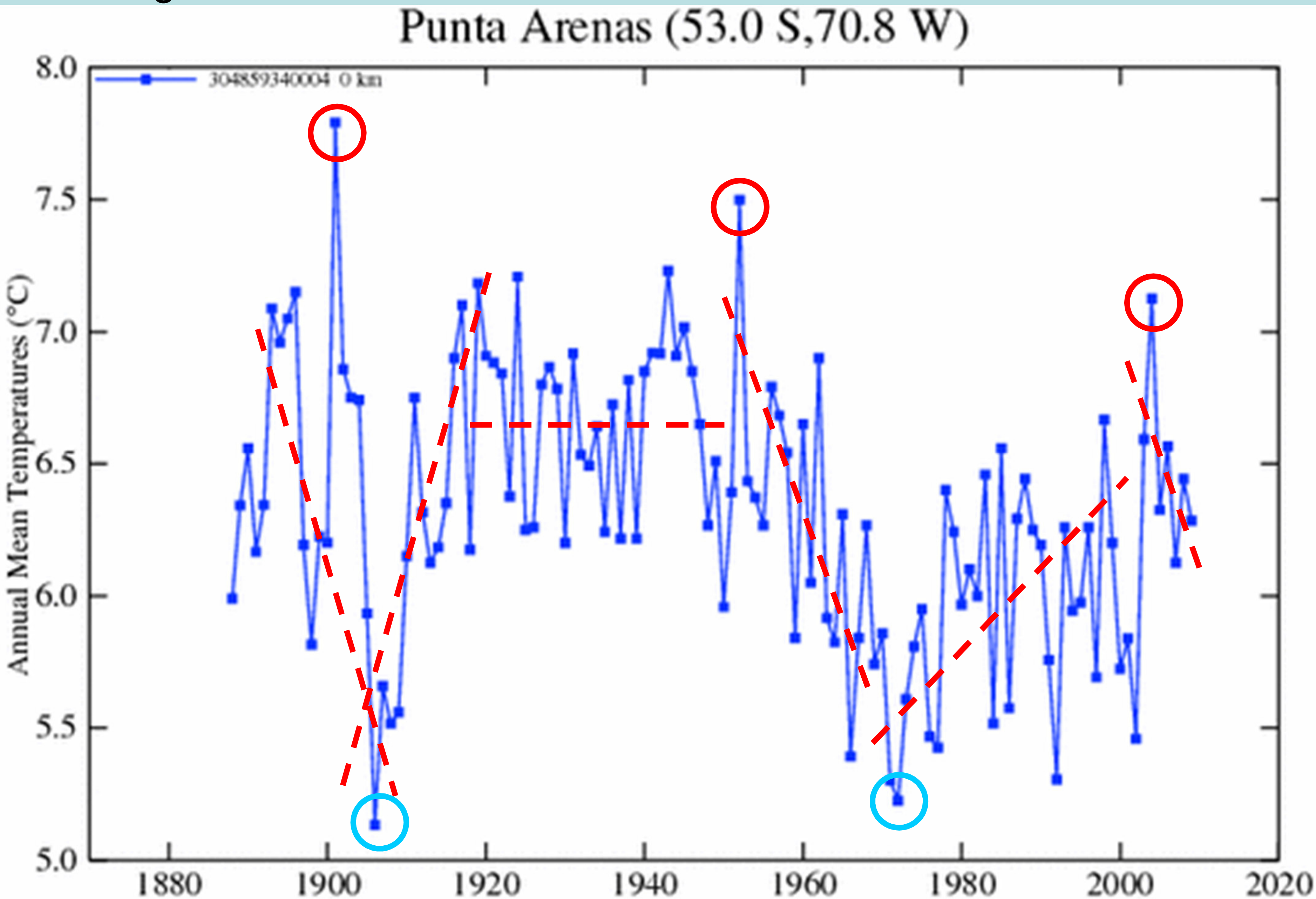
According to Schneider et al, 2007, Antartica has been subject to variations in the its temperature during the last 200 years, without a marked tendency during this period.



Talking about natural causes, the Pacific Decadal Oscillation ("PDO") is a decent candidate that could produce such effects in the circulation of the Southern Hemisphere

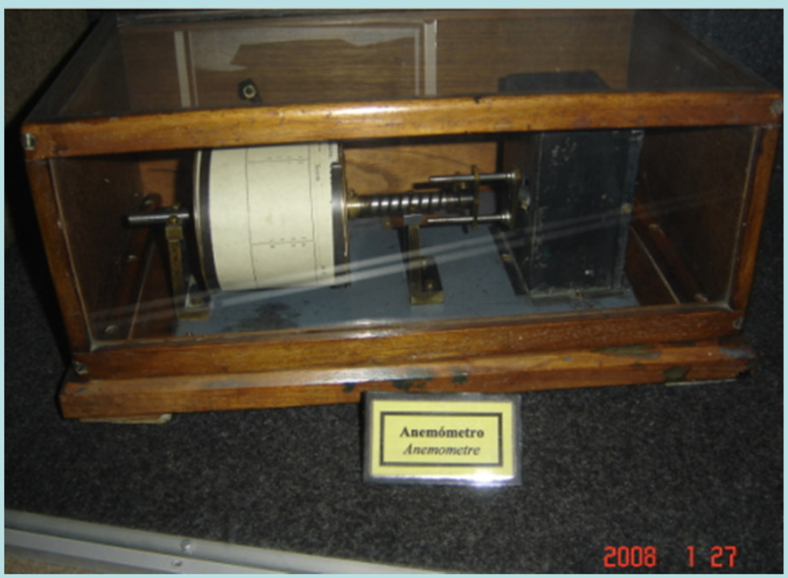


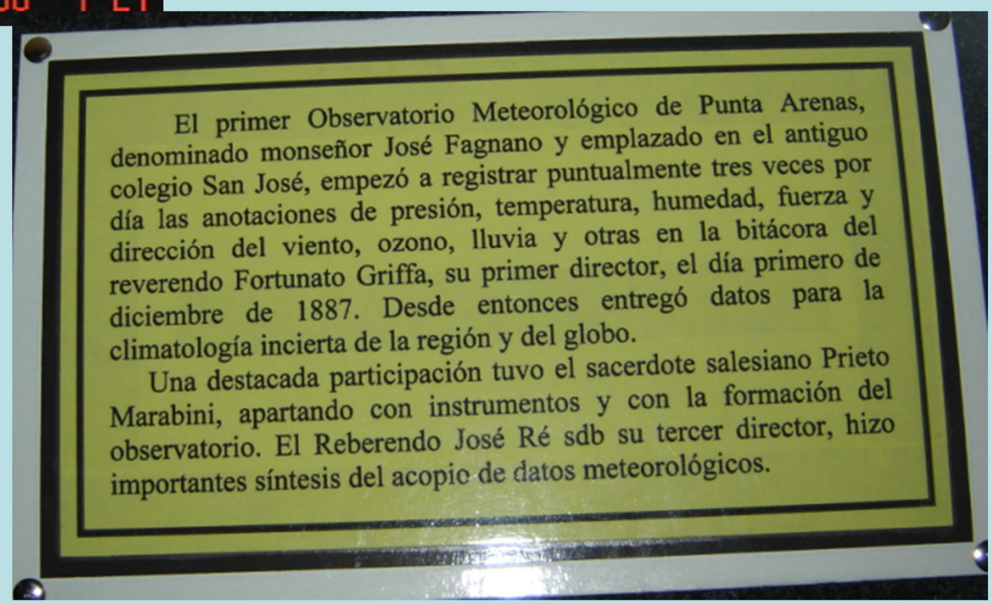
The air tempertarure series at Punta Arenas, Chile, starting in 1887 (!!!) shows a good relation to the PDO. Source: NASA-GISS



The original weather sensors that were used in the late 1800s at the Punta Arenas station, now on display at the "Museo Salesiano".

A very reliable source or data until now.





The strongest recent cooling gradient is at Marambio, - 0.7^{o}C/decade, while the warmest, +0.01^{o}C/decade, occurred at Faraday/Vernadsky.

Although the number of years is small for a significance analysis, the temperature decrease is a fact in the area, and cold years like 2007 and 2009 occurred only ~20 years before.

Considering the standard climatology span of 30 years, there is no defined gradient in the north of the Peninsula.

However, the full length of records for these stations indicate warming, ranging from +0.5^{o}C/decade at Rothera since 1978, to +0.2^{o}C/decade at Orcadas since 1904.

Synoptic circulation patterns that vary on a one-to-two year basis and decadal oscillations in the southern hemisphere oceans seem to explain the current climate variations in the north of the Peninsula.

Admiralty Bay and the Bransfield Strait frozen in the severe winter of 2007