

THE EFFECT OF SURFACE AIR ADVECTION IN DETERMINING COOL AND WARM YEARS IN THE NORTH OF THE ANTARCTIC PENINSULA

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The difference between marked warm and cold years in the north of the Antarctic Peninsula is explained as a result of variations in the regional circulation pattern. In reference to the climatic average air temperature of -1.7°C for the last 30 years at Cmte. Ferraz Station (WMO 89252), 2006 and 2008 were above it with -0.8°C and -0.7°C , while 2007 and 2009 had -3.1°C and -2.6°C , respectively. The north of the Antarctic Peninsula is as a region of strong weather and climate variability, as well as a key spot in climate change. Our results indicate that the annual variations in air temperature reach a few degrees, and that the origin of tropospheric air masses should be looked upon as explaining such oscillations.

1. LOCATION

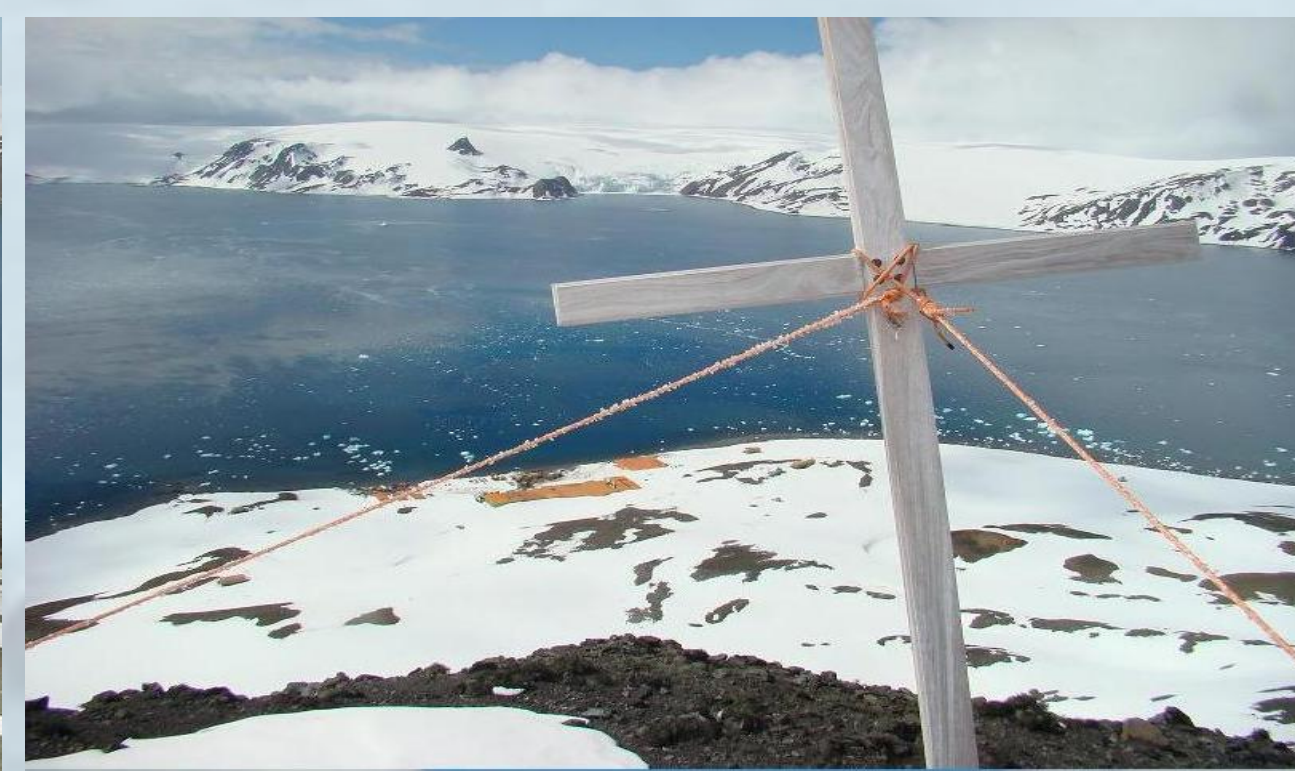
Records of mean monthly air temperatures in Antarctica, especially in the region of the South Shetland Islands and northern Antarctic Peninsula, may vary in a few $^{\circ}\text{C}$ from year to year.

King George Island is the largest island in the South Shetlands Archipelago and is located at the northern tip of the Antarctic Peninsula (Fig.1.1). Approximately 94% of the island is covered with ice. Its highest ice cap elevation is about 650 m. Because of its northerly position (62°S), King George Island is located in the subantarctic westerly wind zone. Its climate is characterized by a rapid succession of eastward moving low pressure systems, which transport relatively warm, humid air towards the coast of Antarctica. An interesting feature is the frequent occurrence of cold, south-easterly winds originating from the Weddell Sea area.

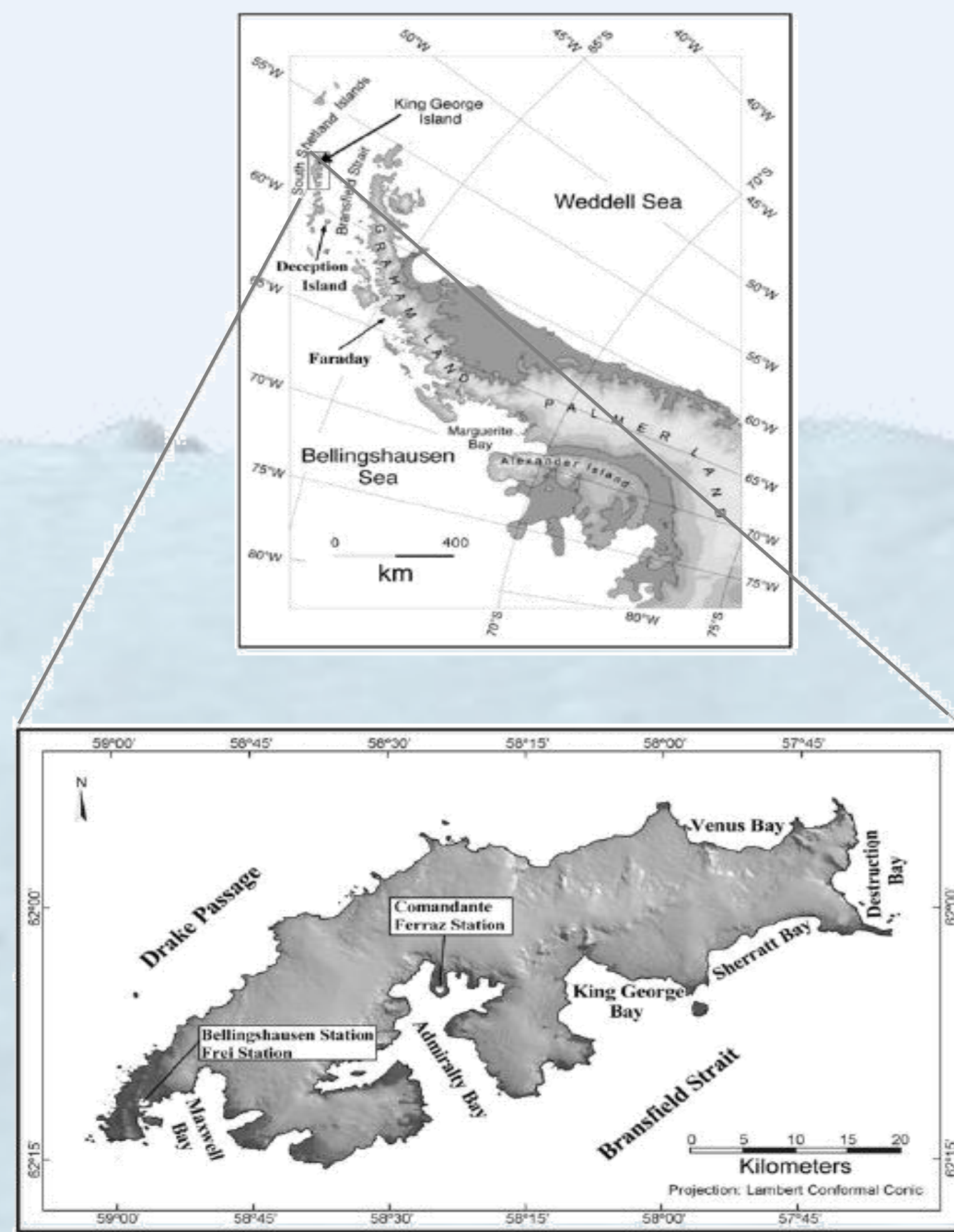
The meteorological station whose data is used in this study is located in the Admiralty Bay, Keller Peninsula, near the Brazilian main Com. Ferraz research station. It's registered at the World Meteorological Organization as 89252, and transmits hourly reports to the GTS. See <http://antartica.cptec.inpe.br>



1.2: Landscape at Comandante Ferraz Station, Dec/2006.



1.3: Landscape at Comandante Ferraz Station, Dec/2007.

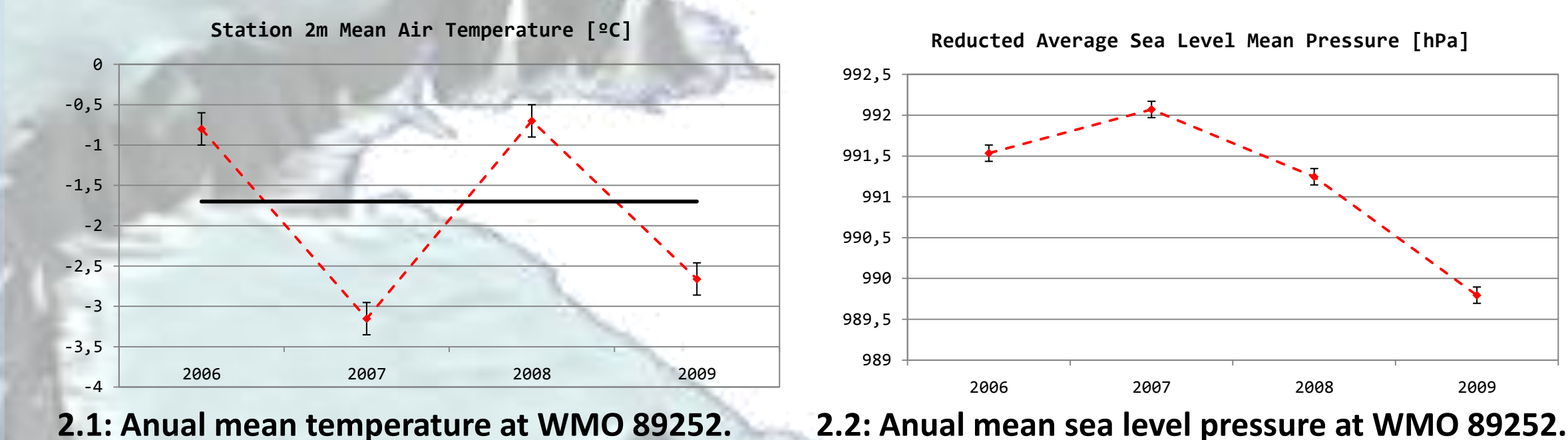


1.1: Map of the region, with King George Island in the insert. WMO 89252 is located at Comandante Ferraz Station (Brazil).

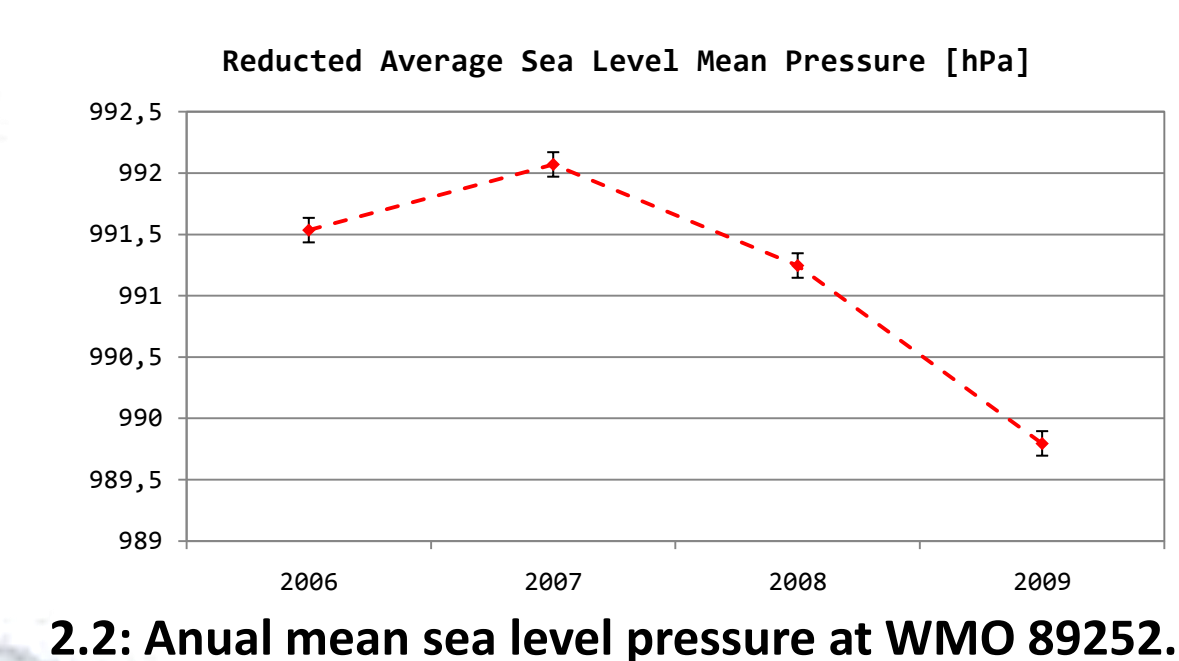
The pictures in Figures 1.2 and 1.3 show the Brazilian Antarctic Research Station (EACF) viewed from the summit of Flagstaff Hill, looking east. The contrast in snow and ice cover between Dec/2006 (Fig.1.2) and Dec/2007 (Fig.1.3), respectively, characterize the difference between warm and cold years.

2. DATA & METHODOLOGY

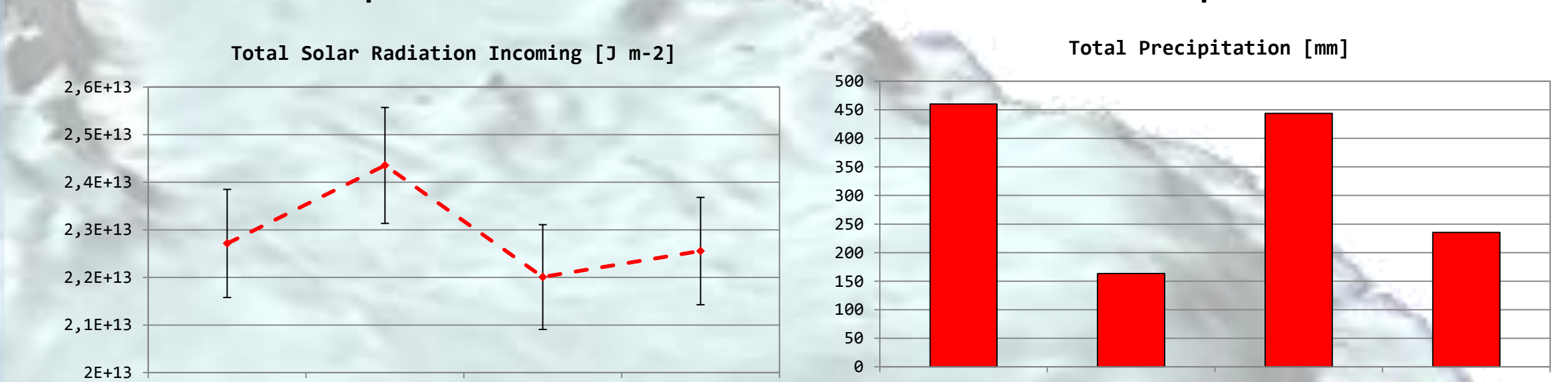
The mean temperature (Fig.2.1), pressure (Fig.2.2), solar radiation incoming (Fig.2.3), cumulative precipitation (Fig.2.4) and the distribution of wind directions (Fig.2.5) are shown for 2006, 2007, 2008 and 2009. 2006 and 2008 were anomalously warm years (0.9°C and 0.8°C above the climatology) and 2007 and 2009 were anomalously cold (1.4°C and 1.0°C below the climatology). The warm years had more precipitation, more cloudiness with less solar radiation and a stronger W-NW-N wind component; E-SE-S winds in the cool years caused the low temperatures with less precipitation and less cloudiness.



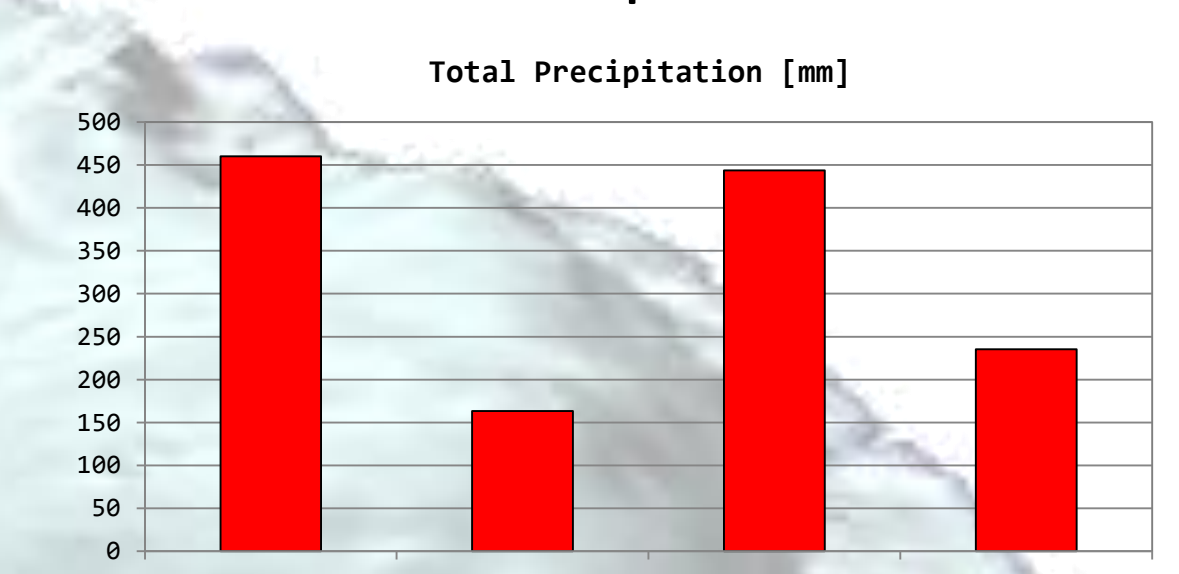
2.1: Annual mean temperature at WMO 89252.



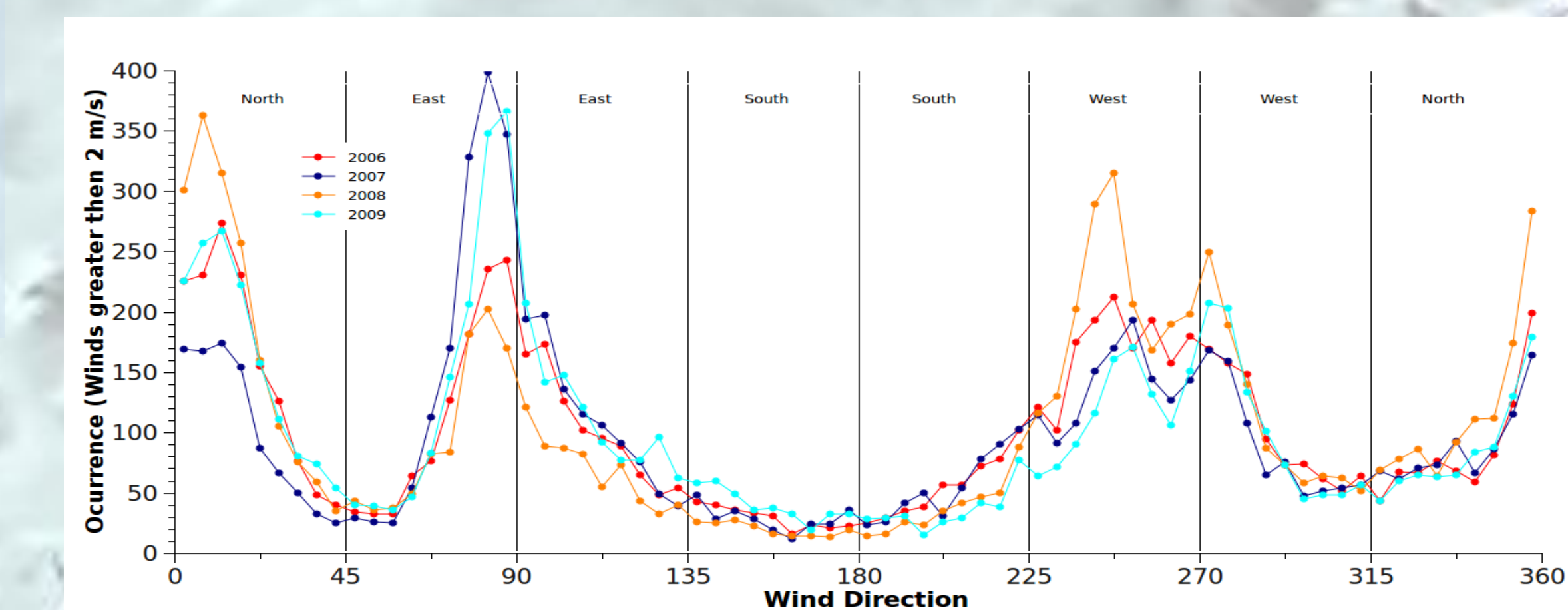
2.2: Annual mean sea level pressure at WMO 89252.



2.3: Annual total solar incoming radiat.at WMO 89252.

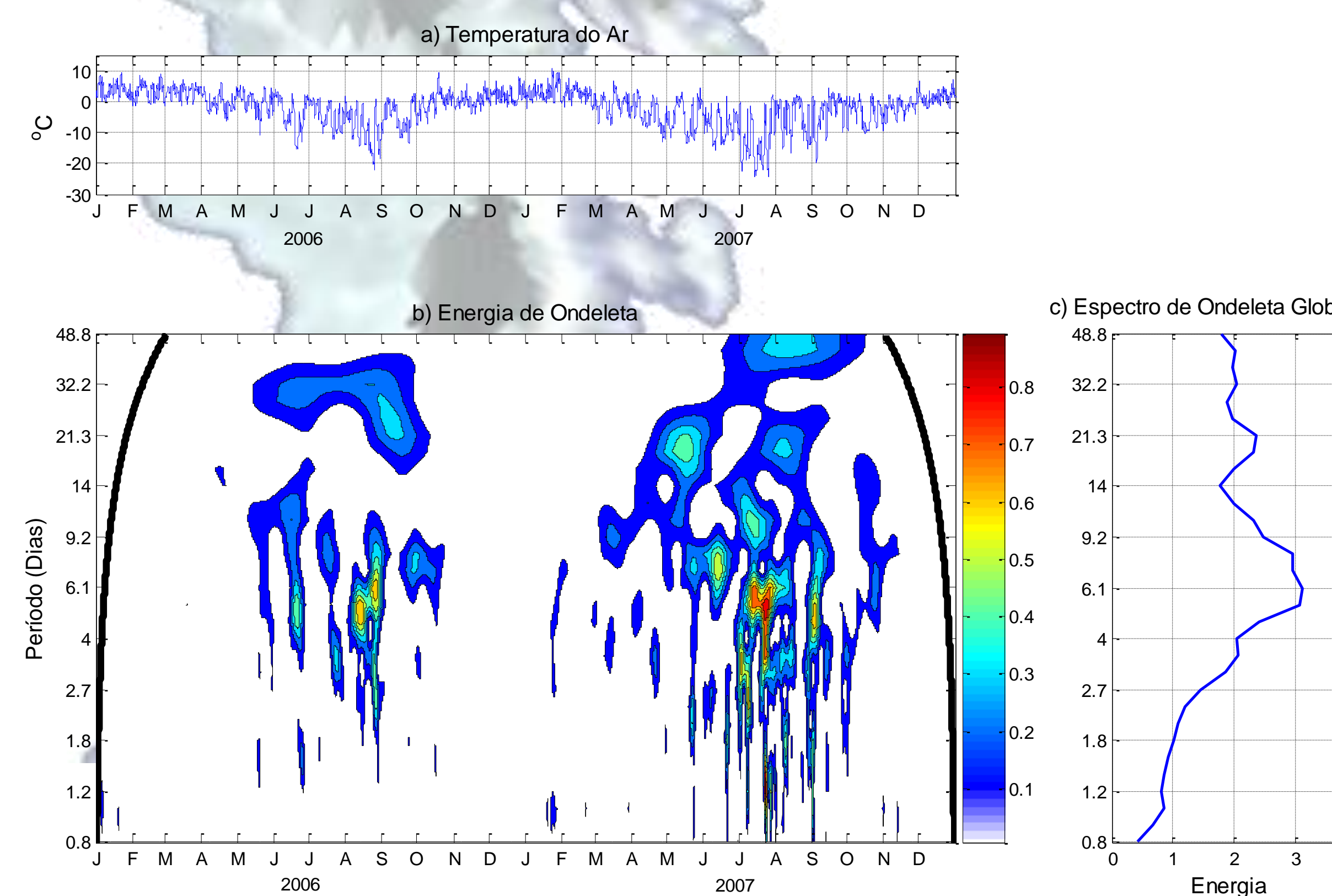


2.4: Annual total precipitation at WMO 89252.



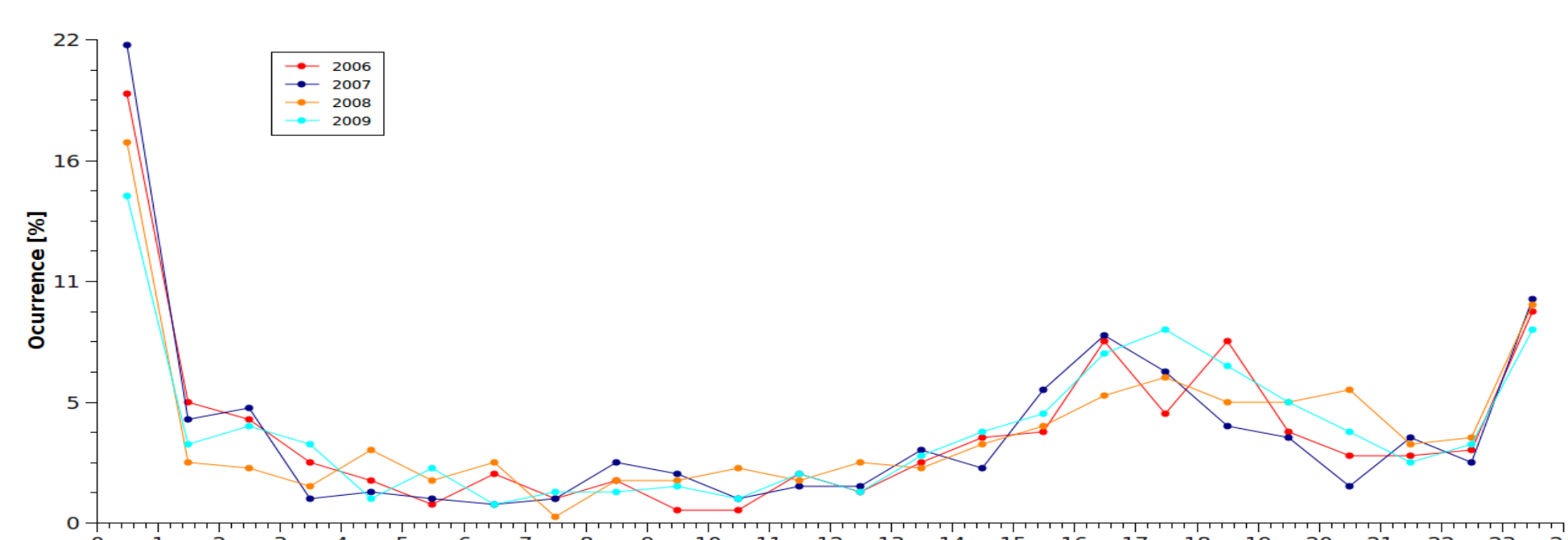
2.5: Annual wind direction distribution at WMO 89252 (only records with speed higher than 2 m/s).

The occurrence of extremes in first and last hours of the day suggests the existence of a cycle longer than the day cycle modulating the temperatures in tropical and equatorial regions. The Morlet's wavelet transform was applied to 2006 and 2007 temperature data to find which periods concentrate more energy. The peaks appear at about 6 and 21 days, as shown in Figure 2.12.

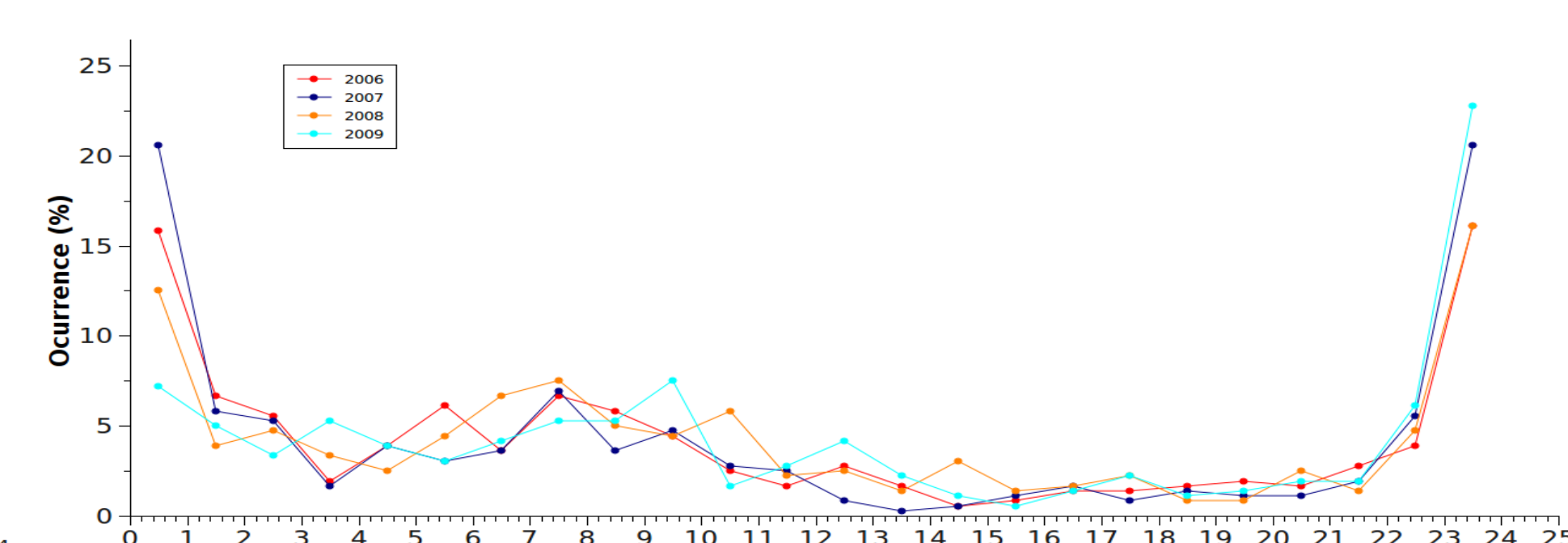


2.12: Morlet's wavelet transforms of temperatures data from 2006 to 2007. a) Original data; b) Energy of transform, period in days; c) Energy spectrum, period in days.

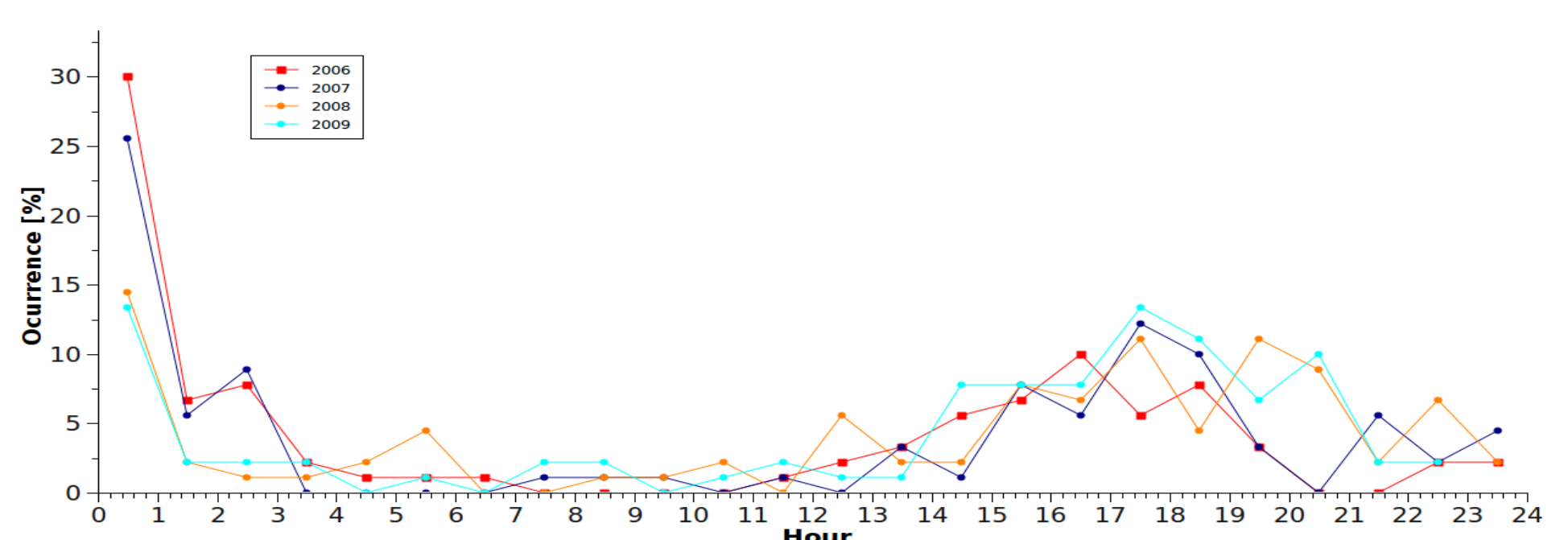
The records of daily extremes of air temperatures include their hour of occurrence, allowing the study of their distribution along the day's 24 hours. Figures 2.6 and 2.7 show the distribution of minima and maxima temperatures for the complete years of 2006-2009, while Figures 2.8, 2.9, 2.10 and 2.11 concentrate on the summer and winter seasons.



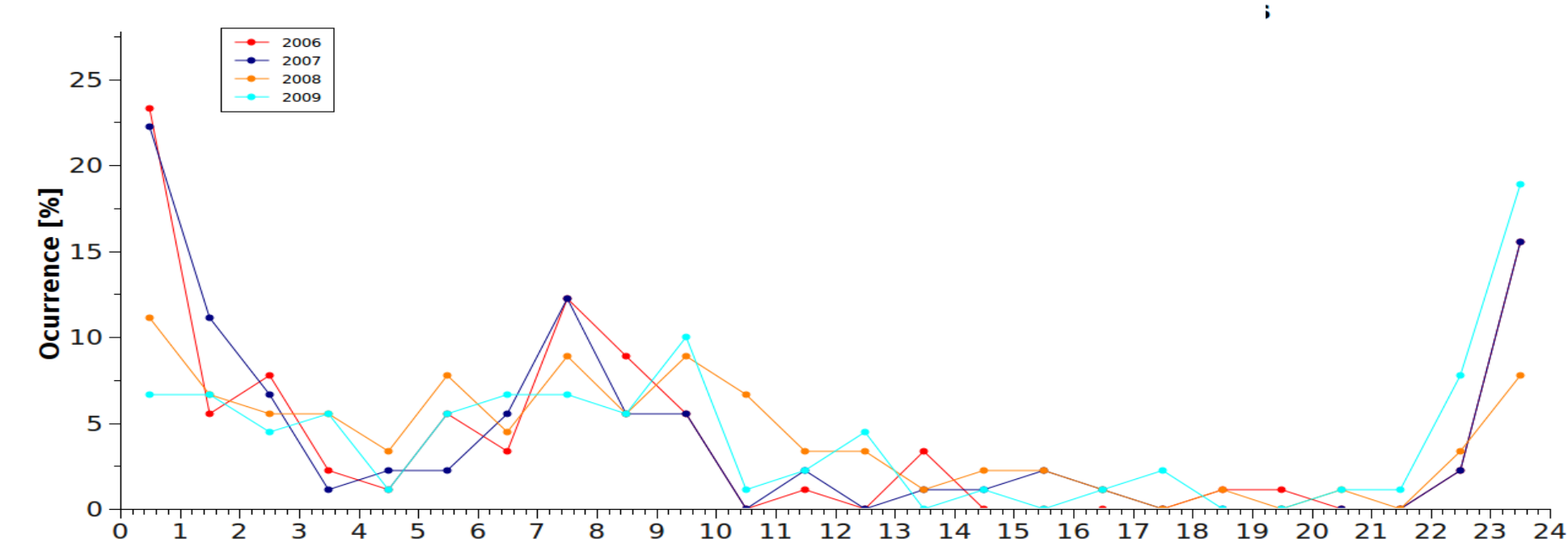
2.6: Distribution of air temperature maxima along the day for 2006-2009.



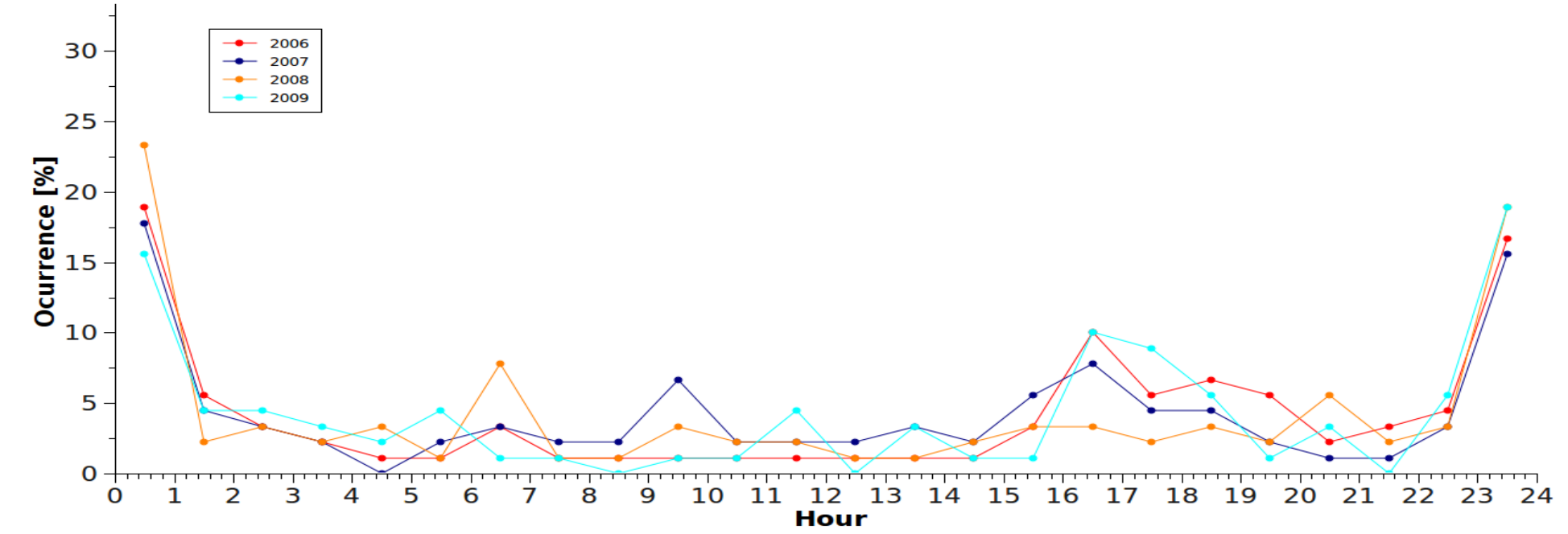
2.7: Distribution of air temperature minima along the day for 2006-2009.



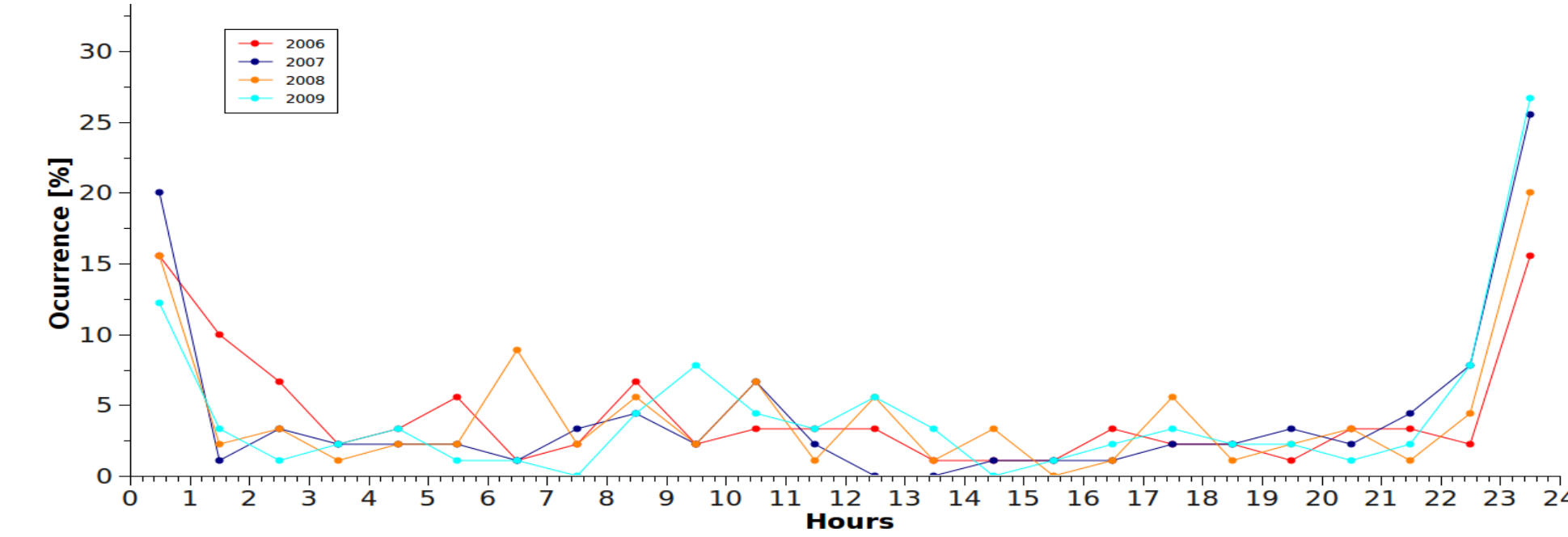
2.8: Distribution of air temperature maxima along the day, summers of 2006-2009.



2.9: Distribution of air temperature minima along the day, summers of 2006-2009.



2.10: Distribution of air temperature maxima along the day, winters 2006-2009.



2.11: Distribution of air temperature minima along the day, winters 2006-2009.

3. CONCLUSION

The observational period of 2006-2009 was analyzed using Ferraz station at King George Island (WMO #89252, $\sim 62^{\circ}\text{S}$, $\sim 58^{\circ}\text{W}$; <http://antartica.cptec.inpe.br>) as primary data source. Regarding the average air temperature of -1.7°C for the last 30 years, 2006 and 2008 were above it, with -0.8°C and -0.7°C , while 2007 and 2009 had -3.1°C and -2.6°C , respectively. Daily maxima and minima temperatures only coincided with the period of higher and lower solar elevation in less than 30% of the days; a similar amount of extremes occurred in the first or last hour of the day, thus indicating that the temperature cycles depend more on the air masses that prevail a few consecutive days in the region. In the cool year of 2007, 25% of the maxima occurred at the end of the day, against 15% in the warm year of 2006. The total incoming radiation was $\sim 8\%$ greater in the cold years, what was interpreted as resulting from clearer skies and stronger radiative heat loss. Winds originating from the cold sector (E, SE and S) accounted for 22% and 29% in 2006 and 2008, and 36% and 34% in 2007 and 2009, respectively, also confirming that the average temperatures depend on the origin of the air masses. Cumulative precipitation was about 450 mm in the warm years of 2006 and 2008, and 150 mm and 235 mm in 2007 and 2009, respectively; this also indicates differences in the air masses for the warm and cool years, since precipitation tends to be higher with the relatively warm and moist air from the W-NW-N sector.

The north of the Antarctic Peninsula is as a region of strong weather and climate variability, as well as a key hot spot in climate change interest. Our results indicate that the annual variations in air temperature can be of a few degrees, and that changes in the regional tropospheric circulation should be looked upon to explain such oscillations.

4. ACKNOWLEDGMENTS

Acknowledgments are due to: the Tinker Fundation, SCAR and "Gaia Soluções em Meio Ambiente" for covering the costs to attend the Oslo IPY Conference; the participants of "Meteorologia na EACF" project, for collecting and providing accurate data since 1985 under the extreme budget difficulties; SECIRM for the extended logistical support in Antarctica, and; CNPq-PROANTAR grants INCT-APA 574018/2008-5 and ATMANANTAR 52.0182/2006-5.