PRELIMINARY RESULTS OF THE PERFORMANCE OF AUTOMATIC WEATHER STATION IN THE PERPETUAL FROST CLIMATE OF EAST ANTARCTICA

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Abstract

In the year 2006-07, India Meteorological Department (IMD) expanded and upgraded its network of Automatic Weather Stations (AWS) by induction of 125 satellite linked AWS. A central receiving earth station in complete redundancy mode is also established at INSAT AWS Laboratory, IMD, Pune for reception of data through KALPANA1 (74 °E) satellite in near real time. IMD has planned to install 550 more AWS and 1350 Automatic Rain Gauge (ARG) Stations by the year 2009.

The present AWS network encompasses multifarious climatic zones of India. During 26th Indian Antarctica Expedition an AWS is installed in the perpetual frost climate [EF] at the Indian Antarctic Station; Maitri [70.77 °S / 11.73 °E] located in Schirmacher Oasis, East Antarctica. The preliminary results of the performance of the Antarctica AWS during March 2007- June 2008 are presented in this paper.

The coldest month during the period under study was June 2008 with monthly mean temperature of -17.5 °C. Spectral analysis of temperature shows dominant periodicity with ½ day and 1 day. With the onset of winter season gradual fall of temperature is observed from March to September. The winds were predominantly ESE to SE during the period of analysis with directional constancy of 0.87. Performance of Maitri AWS during blizzards is observed to be in agreement with conventional observations.

1. Introduction

In 1997, the obsolete network of Data Collection Platform (DCP) was upgraded to AWS network by induction of 15 state of the art microprocessor based systems across India under Test and Evaluation mode. The performance of the network from 1998-2005 was observed to be satisfactory in terms of data reception and data quality. Deviations of AWS data received at the Central Receiving Earth Station from the co-located synoptic surface observatory data are also observed to be within the acceptable limits (Vashishtha R.D, 2005). In the year 2006-2007, the network is expanded and upgraded by induction of 125 AWS system across India (including one at Antarctica). Under modernization program of IMD, it is planned to establish a network of 1000 AWS and 3600 Automatic Rain Gauge Stations (ARG) across the county in a phased manner. In first phase of modernization program it is proposed to establish a network of 550 AWS and 1350 ARGs by the year 2009.

During the 26th Indian Antarctica Expedition, M/s. Sutron Corp. USA make AWS is installed at Indian Antarctic Station; Maitri located at Schirmacher Oasis of East Antarctica. The Maitri AWS become operational in March 2007. Figure 1 shows photograph of Maitri Station and Figure 2 depicts the location of AWS.

Figure 1: Photograph of Indian Antarctic Station "MAITRI"

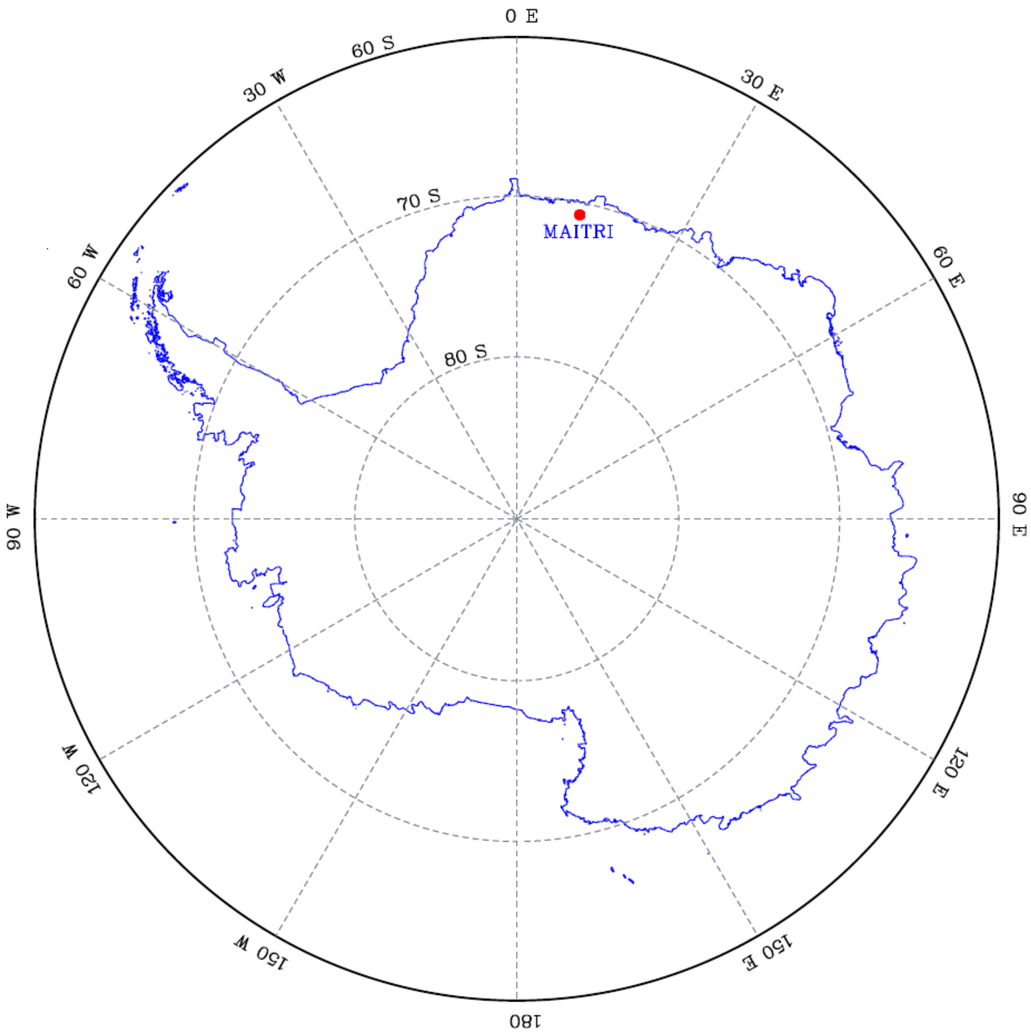

Figure 2: Map depicting location of AWS at Antarctica.

Sensors for meteorological parameters Air Temperature, Relative Humidity, Atmospheric Pressure, Wind Speed and Wind Direction are interfaced with the system. Details of sensors interfaced with the system are given in table 1. The system is configured to log the data for all parameters at an interval of an hour. Instantaneous values of all parameters are logged at every full hour UTC except wind, for which three minutes vector averaged values are logged.

Met Parameter	Type	Range	Accuracy/sensitivity
Atmospheric Pressure	Strain Gauge	600 to 1100 hPa	±0.2 hPa
Air Temperature	Thermistor/Pt 100	-40˚C to +60˚C	± 0.2˚C
Relative Humidity	Rotronic Hygromer C94	0 to 100 %	± 1%
Wind Speed	Ultrasonic	0 to 60 m/s	± 2% (1.2 m/s)
Wind Direction	Ultrasonic	0˚ to 359˚	±3˚

Table1: Details of sensors interfaced to Maitri AWS

2. Data and Methodology

The hourly AWS data for the period March 2007 to June 2008 is analyzed in this study. 3 minute vector averaged wind measured at 10 m is analyzed for directional constancy using wind rose diagram. Antarctic winds are known for very high directional constancy. The measure of directional constancy is taken as ratio of vector resultant wind magnitude to mean wind speed. The spectral estimate of temperature time series is obtained using "R" software. The time series was decomposed into sine and cosine waves of different amplitudes and wavelengths by taking Finite Fourier Transform (FFT). The decomposition was then smoothed using modified Daniell smoothers to generate smoothed periodogram. From hourly air temperature (T_t) data, the daily temperature is derived using, Daily Temperature, $T_d = \frac{1}{24}\sum_{t=0}^{t=23} T_t$, from the daily temperature T_d, monthly mean temperature is obtained. In order to analyze the performance of AWS during blizzard, variation of pressure, wind speed and temperature during the blizzard of 21-22 Oct. 2007 is presented.

3. Results and Analysis

3.1 Temperature

To understand the characteristics of temperature time series the hourly temperature data was spectrally analyzed. Figure 3 shows spectrum with pronounced peak for waves with period of 12h and 24 h. The monthly mean temperature at Maitri AWS is presented in Figure 4. The lowest monthly mean temperature for the period under study was observed in the month of June 2008 with value of -17.5˚C.

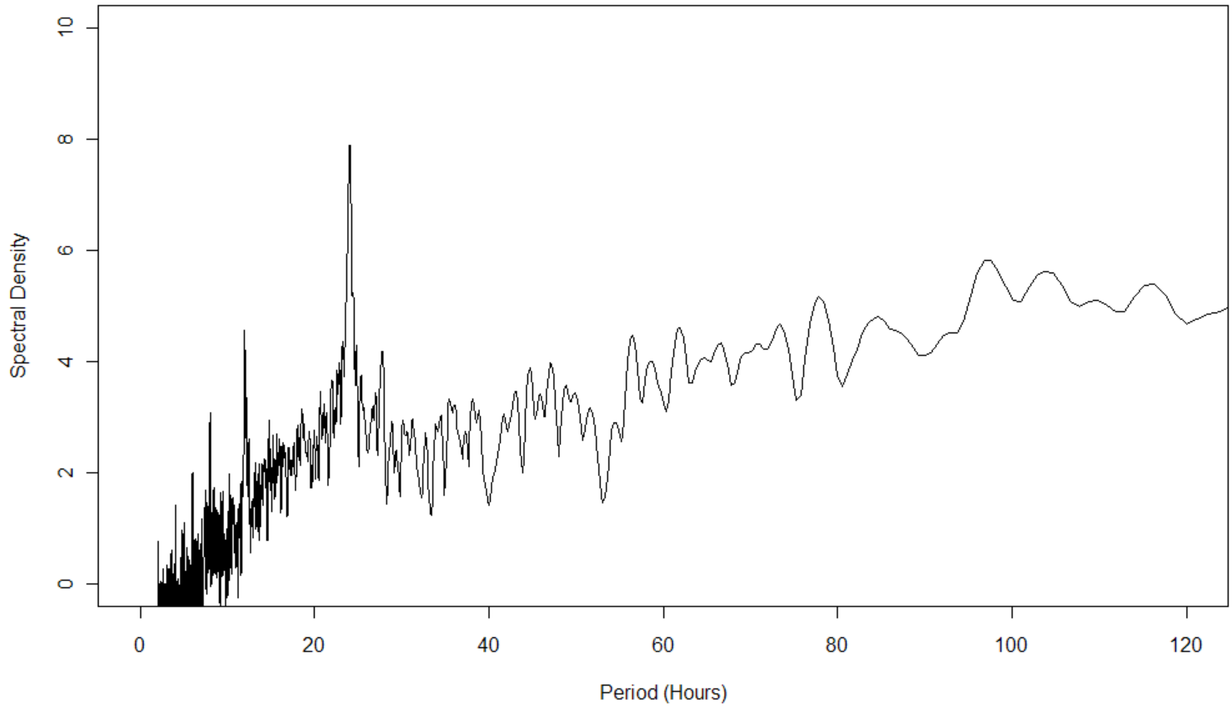

Figure 3: Spectral analysis of temperature time series

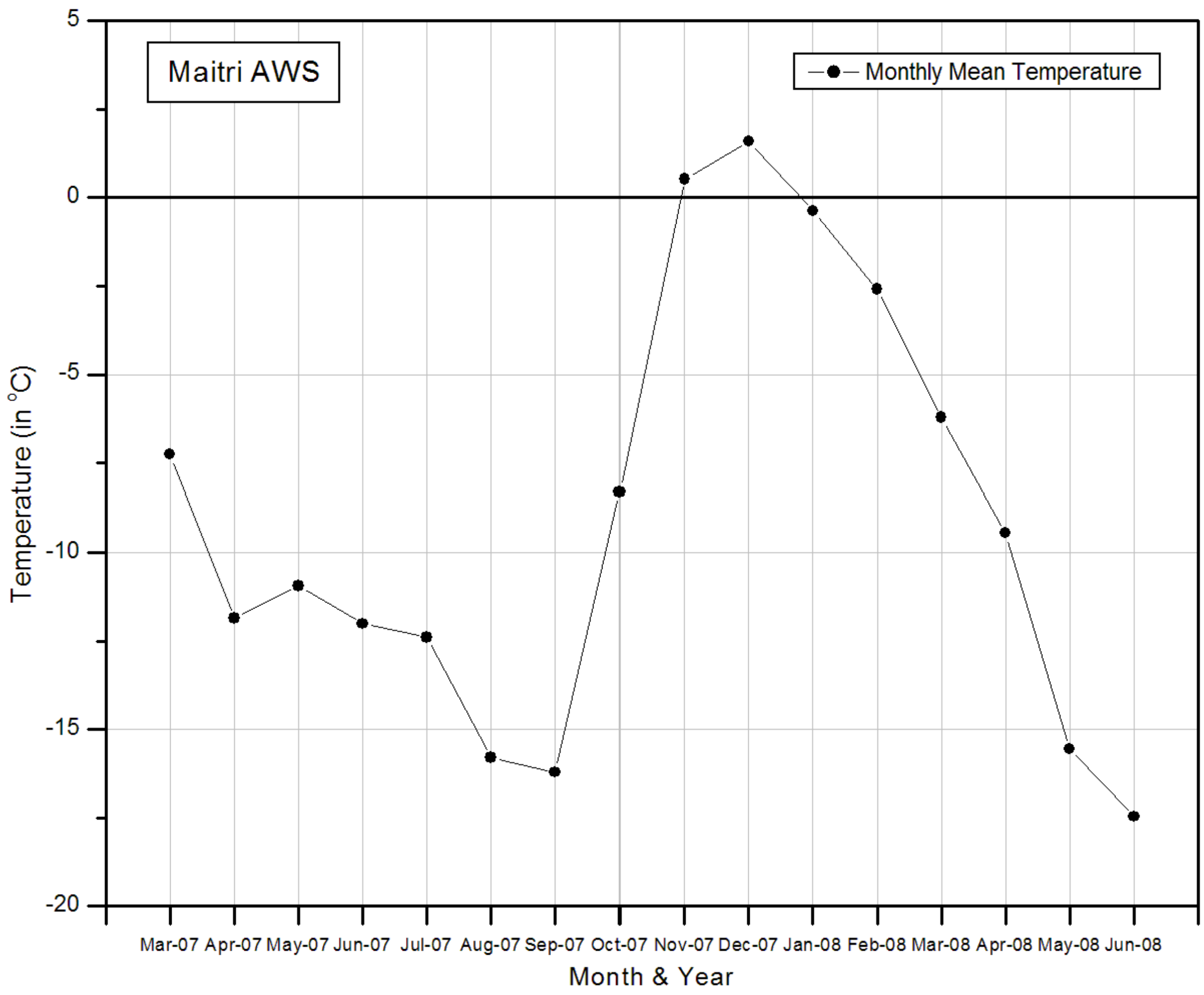

Figure 4: Variation of Monthly Mean Temperature at Maitri AWS.

3.2 Wind Speed and Wind Direction

One of the unique features of the Antarctic surface wind is its extreme persistence. Antarctica is characterized by quasi persistence of strong offshore surface winds. These so called katabatic winds are the result of negative buoyant force that develops along stable cool layer along the mountain slopes.

Surface winds in the Antarctic are known to maintain same general direction for periods up to week at time (Parish, 1982). The forcing of the Antarctic wind can be ascribed to strong cooling of the air adjacent to continental ice surface, producing a sloped inversion pressure gradient force directed down slope. The gravity driven component is the most significant factor in the surface wind regime over Antarctica. (Parish et al, 1987). Figure 5 shows a wind rose diagram for the period March 2007 –June 2008 based on the hourly observations of the Maitri AWS. It can be seen that the general direction of the wind is ESE to SE. The surface wind recorded at the Maitri AWS display very high directional constancy value (ratio of vector resultant wind magnitude to mean wind speed) of 0.87 for the period under consideration.

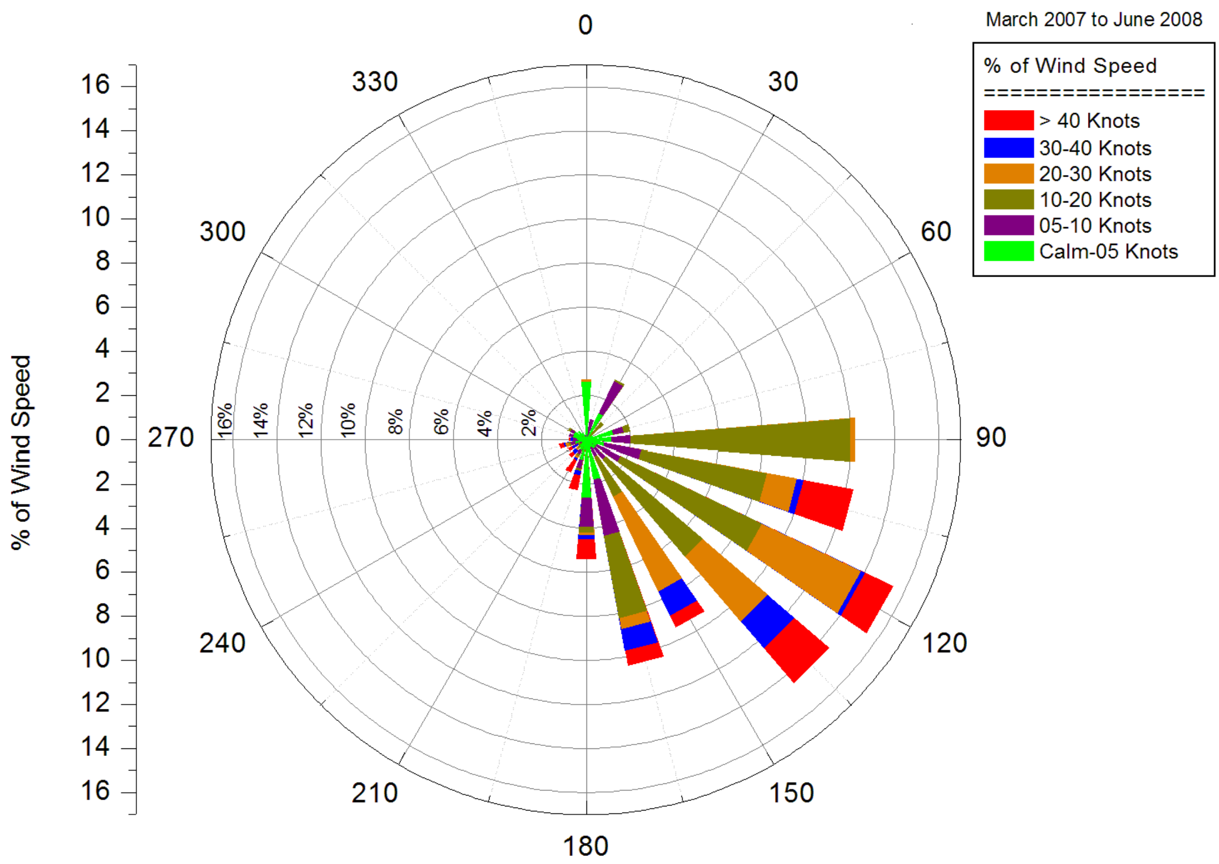

Figure 5: Windrose diagram for Maitri using hourly AWS data

3.3 Performance of AWS during Blizzards

Antarctica is known for frequent and sudden changes in weather due to migratory low pressure systems. Interaction of the low pressure system with high pressure system causes advection of air into the low pressure area. This results in drifting and blowing of snow and drastic reduction in the horizontal visibility. Such a severe winter storm characterized by strong wind and blowing snow is called Blizzard. Performance of AWS during 2007 blizzards is presented here. From March 2007 to October 2007 ten blizzards were reported. A blizzard that occurred on 21st Oct. 2007 is presented here. The classification of blizzard is made on the following criteria:

a) Wind speed greater than 23 Knot with blowing/drifting snow.
b) Visibility less than 1 km and high wind chill factor.

The surface data reported commencement of blizzard at 05 UTC of 21st Oct. 2007 and cessation at 19 UTC of 22nd Oct. 2007. Figure 6 shows variation of station level pressure and wind speed recorded at AWS during this blizzard. It is seen that the AWS could successfully capture the characteristics of the blizzard. It can be seen from Figure 7 that temperature has increasing trend during blizzard. This may be ascribed to cyclonic circulation, forcing warm and moist air mass from lower latitudes into the Polar Regions, thus causing the rise in temperature. The performance of AWS during all blizzards is observed to be satisfactory.

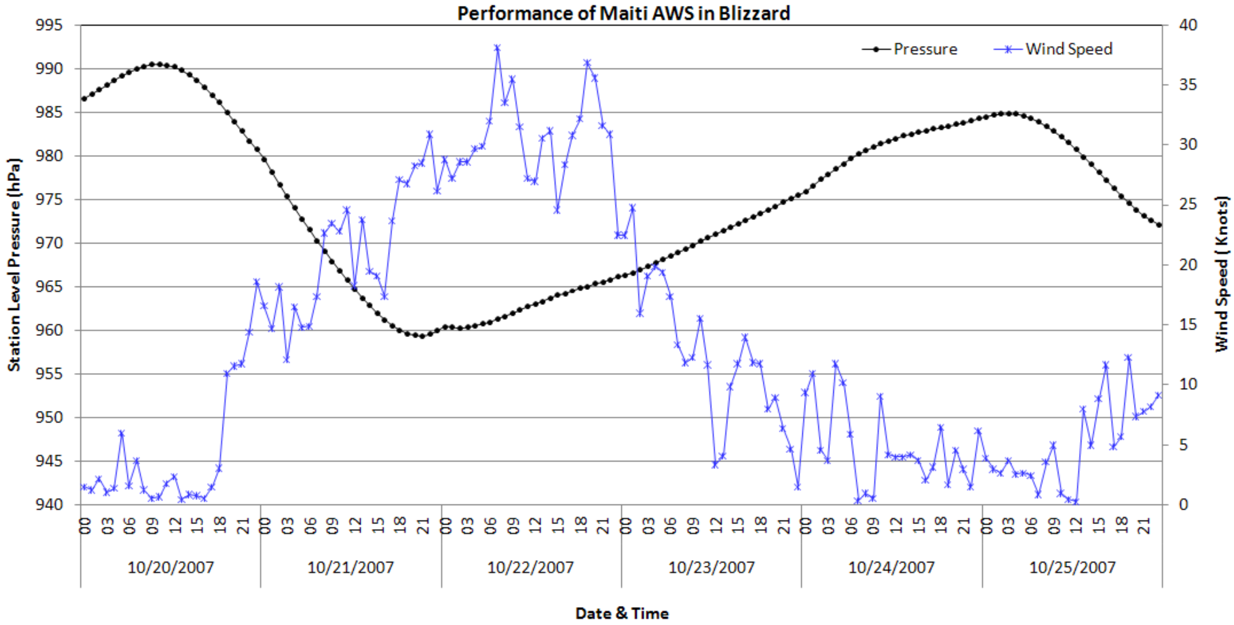

Figure 6: Variation of pressure and wind speed during blizzard.

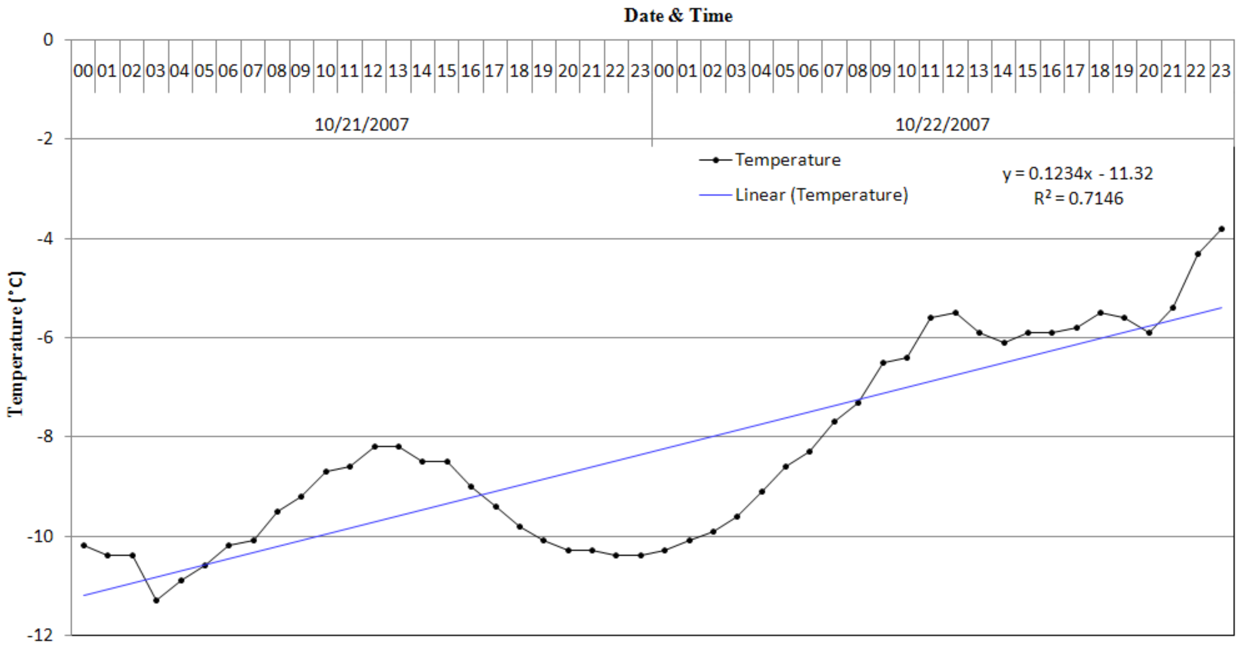

Figure 7: Increase in temperature during blizzard.

4. Conclusion

Following broad conclusions can be drawn from this study

1. The Surface winds at Maitri are predominantly ESE/SE with directional constancy of 0.87. This is in general agreement with the Antarctic wind regime.
2. The Automatic Weather Station could withstand the severe weather during blizzard and the performance is observed to be satisfactory. The temperature during blizzard has increasing trend.

3. The temperature time series has dominant periodicity of ½ day and 1 day. The lowest monthly mean temperature during the period under consideration was recorded in June 2008.

5. References

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2. Parish T.R.,and K.T. Waight, 1987: The forcing of Antarctic Katabatic Winds. *Mon. Wea. Rev.*, **115**, 2214-2226.
3. Parish T.R., 1982: Surface Airflow over East Antarctica. *Mon. Wea. Rev.*, **110**, 84-90.