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Annual variations in the meteorological parameters at Jinnah Station, East Antarctica

Tariq Masood Ali Khan, D. A. Razzaq and M. M. Rabbani

National Institute of Oceanography, St-47, Block-1, Clifton, Karachi, Pakistan

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Abstract The analysis of meteorological data obtained from the installed Automatic Weather Station (AWS) at Jinnah Station (70. 24°S, 25. 45°E), East Antarctica is presented. This paper describes the meteorological conditions of Jinnah Station for the years of 1991 and 1993. Due to some technical problems the data could not be received continuously in the year 1992. The significant temperature difference is found between the warmest and the coldest months. Climate shows the moderating effect of ocean. Low pressure and strong wind are common which represents the location of the station lies in the circum-polar low pressure belt. The prevailing wind direction for all over the year is ESE.

Key words East Antarctica, Jinnah Station, meteorological parameter.

1 Introduction

Weather in Antarctica is unpredictable. Only a few meteorological stations are operating in the antarctic region. Furthermore, the environmental conditions of the area makes it difficult to operate meteorological instruments. Therefore, extensive meteorological data is unavailable for this area (Allison and Wendler, 1992). Over recent years there has been increasing international interest in developing better meteorological services within the antarctic region particularly for aviation and shipping (Streten, 1989). Thus, it was considered essential to install Automatic Weather Stations (AWS) to register small scale variations in weather over various time scales (Wendler *et al.*, 1985).

Despite the unfavorable environment to automatic observing systems due to the combination of low temperatures and high winds at the coastal stations, the data demonstrate that the AWS record, though far from the perfect, can contribute substantially to the study of antarctic weather and climate.

Several nations have independently developed Antarctic Weather Stations (Gube-Lenhardt, 1987). In the Austral summer of 1991, an Automatic Weather Station (AWS) at Jinnah Station (70. 24°S, 25. 45°E) was installed during First Pakistan Antarctic Expedition. Since then continuous meteorological data is being received from that AWS via satellite through ARGOS system (France) at National Institute of Oceanography (NIO), Karachi, Pakistan.

The collected data is being used for research and AWS planning as well as contribute to the global network of meteorological stations in Antarctica. Some of the programs which are being carried out by using meteorological data are global and regional climatic studies, synoptic meteorology of the Antarctic and planning of site selections for other AWS in the vicinity of Jinnah-1. Furthermore, data could be used for the future monitoring and planning of the expedition as well as for the extension of Jinnah Research Station.

Antarctic weather data together with the study of energy cycles building-up in the Southern Oceans will help our scientists to forecast accurately the monsoon behavior and seasonal rain pattern, which are the main weather factors affecting Pakistan.

2 Material and methods

The AWS Aanderaa 2700 (Made in Norway) is being used to record the meteorological observations at Jinnah-1. It is a self-contained station suited for use in remote places. Data is being recorded in a data storage unit and transmitted in real time via satellite through ARGOS system. The installed AWS is capable of recording the surface meteorological parameters.

In antarctic region most of the AWS are measuring air temperature, air pressure, wind speed and direction only (Allison and Wendler, 1992). But at Jinnah Station additional sensors are being used to record almost all meteorological parameters, including wind speed, wind direction, wind gust, surface temperature, atmospheric pressure, relative humidity, net radiation, global radiation, sunshine duration and rainfall. During the selection of AWS the special attention was given to the accuracy of the sensors. The sensors are of the Aanderaa half-bridge type of digital type. Routine meteorological observations are being carried out at three-hour-interval.

3 Results and discussion

Monthly means and extremes for the years of 1991 and 1993 are estimated. The rugged high topography and long polar nights in Antarctica are the cause of the coldest surface temperatures on earth. This is a distinctive features of Antarctic climate, along with desert-like precipitation rates and durable and intense surface inversions.

3.1 The variations of surface air temperature

Mean monthly variations of surface air temperature for both 1991 and 1993 are shown in Fig. 1a and 1b, respectively. The temperature ranges between 5.1 C ~ −42.7 C in 1991 and −1.5 C ~ −44.0 C in 1993. Periodical variations are mainly due to the advection of different air masses, changes in clouds condition and mixing in the atmospheric boundary layer. The temperature difference between warmest and coldest months are −47.0 C and −42.0 C in 1991 and 1993 respectively. The difference between the warmest months in 1991 and in 1993 is 6.6 C. The climate of the coastal re-

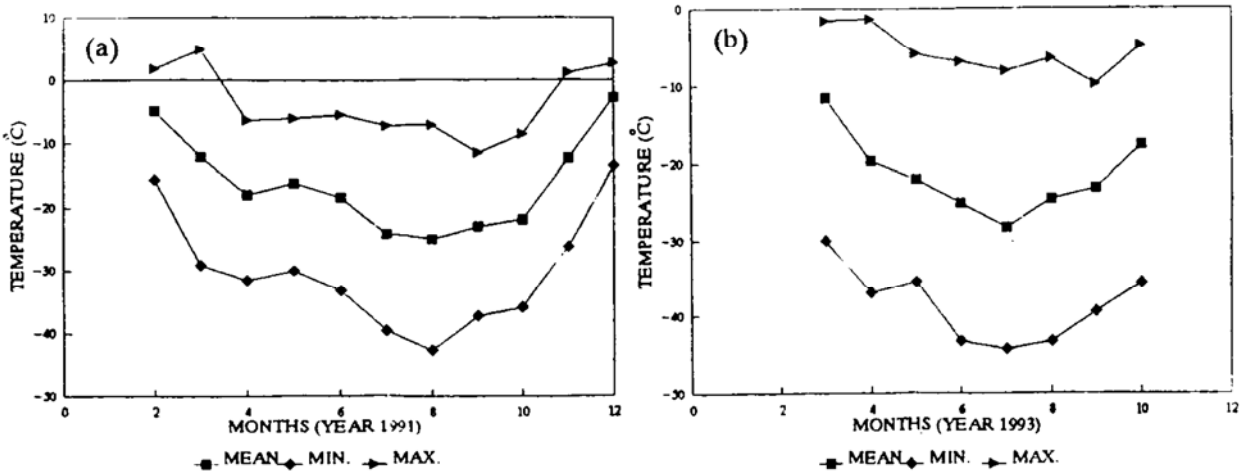

Fig. 1. Annual temperature variations (monthly means and extremes) for (a) 1991 and (b) 1993.

gion shows the moderating effects of the ocean. The interannual temperature variability is larger in winter than in summer.

The coldest months were August in 1991 and July in 1993. The absolute minimum temperature of −42.7 C (August, 1991) is slightly higher than the value of −44.0 C in 1993. The temperature never rose above freezing level in 1993, when the maximum of about −2.0 C was recorded in March and April, while temperature above freezing were recorded during February, March, November and December in 1991.

3.2 The air pressure

Annual fluctuations in the air pressure are shown in Fig. 2a and 2b for the year 1991 and 1993, respectively. The pressure values are generally lower than 1013.3 hPa-standard sea level atmospheric pressure. This is due to the station's locality within the circum-

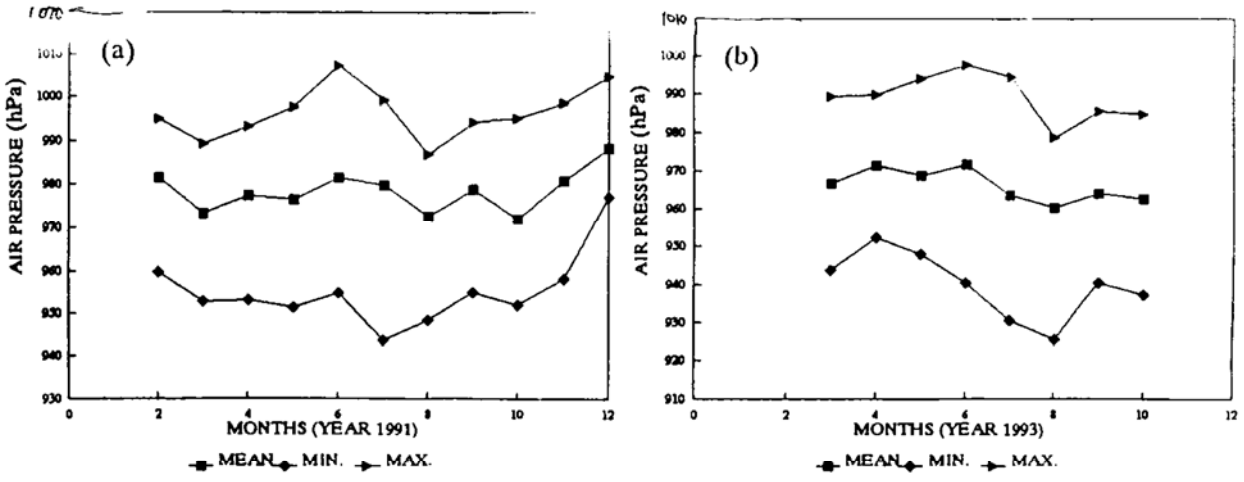

Fig. 2. Monthly means and extremes of air pressure for (a) 1991 and (b) 1993.

antarctic low pressure belt. Pressure fluctuations occur on a temporal scale of few days reflecting the synoptic variability in this region. Cyclonic storms mostly generating in the areas around Antarctica, 60°S～70°S, are very intense and destructive and could continue for several days. The lowest recorded values were 944. 0 hPa in July 1991 which is higher than the exceptionally low value of 925. 0 hPa in August 1993. The difference of yearly average pressure values in 1991 and 1993 are not significant. The inter-annual variations in 1991 and 1993 are not significant. The inter-annual variations in the mean pressure is greater in winter than that in summer.

3. 3 The relative humidity

Not much variations in the relative humidity were observed during most of the time of both years. It is obvious from the Fig. 3a and 3b that the mean monthly relative humidity ranges from 89% to 94% and 82% to 92% during 1991 and 1993, respectively, with the corresponding maximum close to 100%, a state of saturation, and a variable minimum which dropped to as low as 67% in August 1991. Since the Jinnah Station is very near to the sea and by looking the air temperature range, higher average humidity at Jinnah Station is possible.

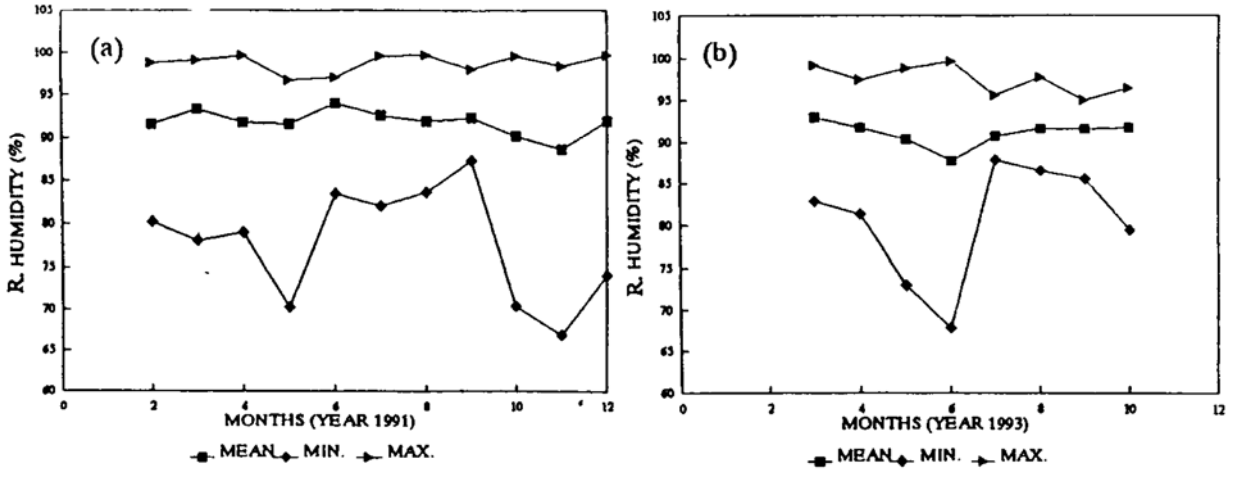

Fig. 3. Variations in the relative humidity (monthly means and extremes) for (a) 1991 and (b) 1993.

3. 4 The variations of wind speed

The annual cycle of mean and extremes of monthly wind speed are shown in Fig. 4a and 4b for 1991 and 1993. The annual variations in the mean wind speed with a maximum in winter and minimum in summer is observed. The annual average wind speed was 5. 9 m/s and 6. 1 m/s in 1991 and 1993, respectively. For both 1991 and 1993 large seasonal changes in the wind speed were observed and the wind speed during winter significantly exceed the summer values.

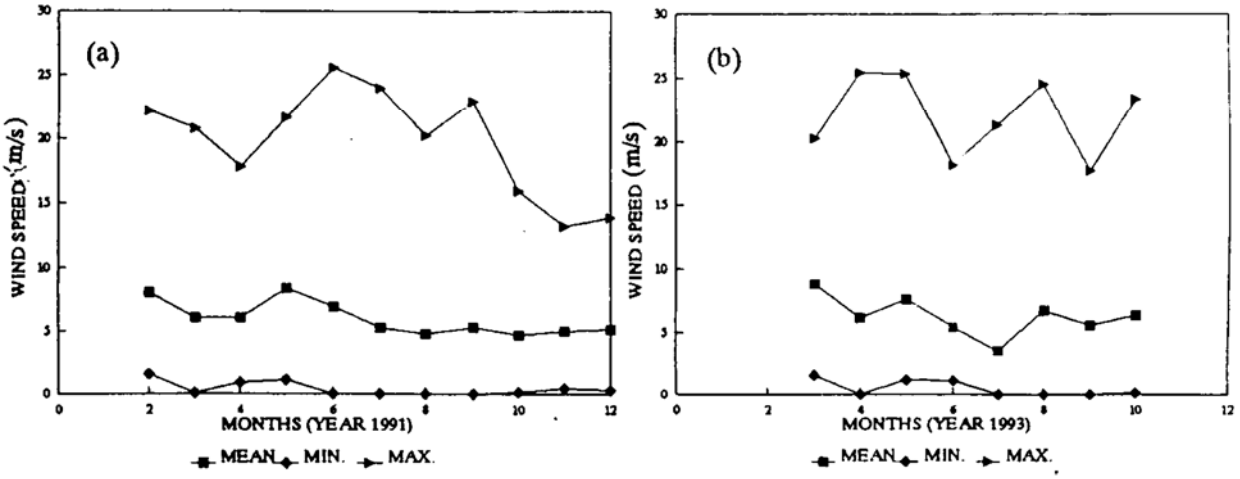

Fig. 4. Annual variations in the prevailing wind speed (monthly means and extremes).

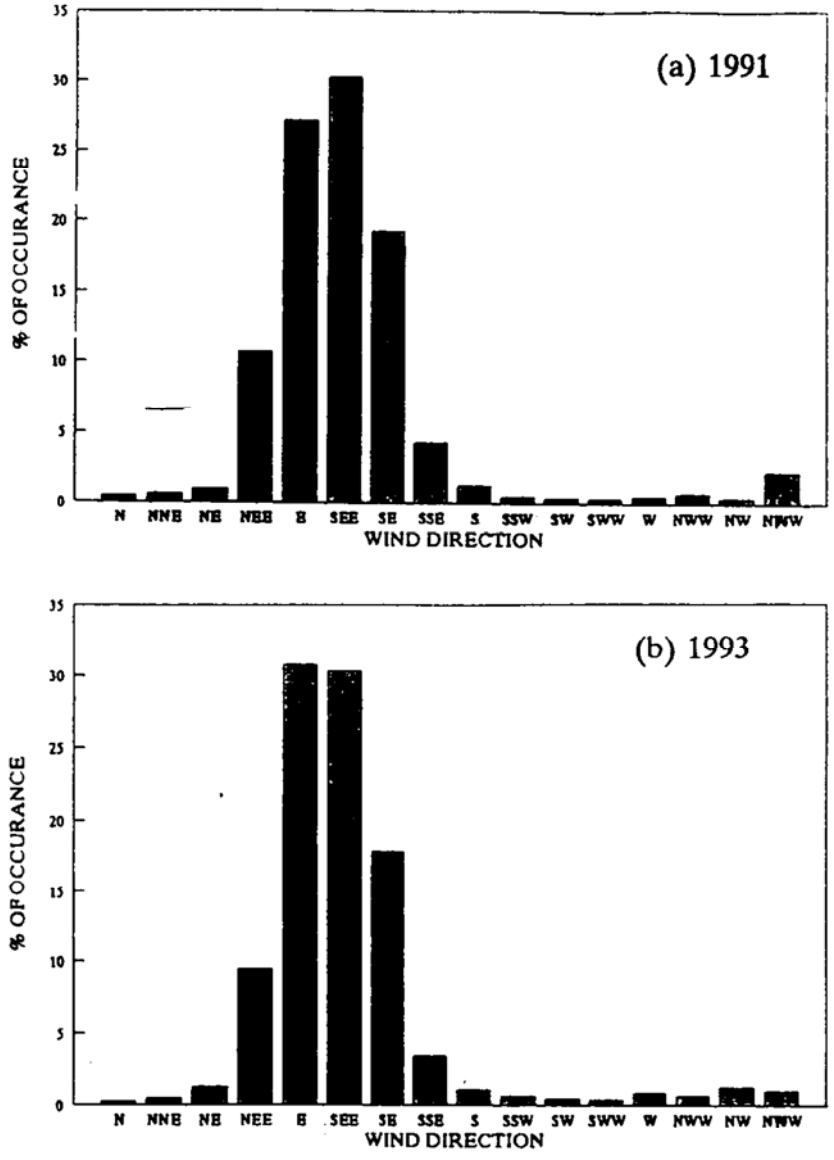

Fig. 5. Histograms of prevailing wind diredtion (a) 1991 and (b) 1993.

The maximum wind gust of about 35 m/s are observed for both of the year 1991 and 1993. The phenomenon of frequent, intense blizzards around the coast of the Antarctic continent is due to the synoptic scale flow associated with intense cyclones which track around the continent in the Southern Ocean (Tchernia, 1980).

From a comparison between the 1991 and 1993 data, similar characteristics of wind direction are found, which are clearly noticeable in the histograms of 1991 and 1993 shown in Fig. 5a and 5b, respectively. The easterlies prevail throughout the year except July 1993 when the south-southeaster lies prevail. Such findings are typical for an antarctic coastal station. Some migrating synoptic depressions occasionally rise to westerly winds. Northerly winds are generally very rare.

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