

A study of wind chill effect at Maitri, Antarctica

E. KULANDAIVELU and SARBJIT SINGH

Meteorological Office, New Delhi

(Received 23 September 1991, Modified 9 June 1994)

सारा — मौसम के घटकों, जैसे, पवन और तापमान के प्रभाव से मनुष्य के शरीर पर शीतलन का निर्धारण होता है। पवन एवं कम तापमान के कारण मनुष्य के शरीर से ऊष्मा निकलने की दर को सिप्ले ने "पवन शीतलन" के नाम से पुकारा। पवन शीतलन के चार्ट का उपयोग करके, 1990 के दौरान, अंटार्कटिका में मैत्री नामक केन्द्र पर पवन शीतलन के प्रभाव का अध्ययन किया गया है तथा शुष्क बलब एवं न्यूनतम मासिक माध्य तापमानों के परंपरागत मान के साथ इसकी तुलना भी की गई है। यह देखा गया कि जब कभी पवन गति 10 नॉट से अधिक हो जाती है, पवन शीतलन तापमान शुष्क बलब तापमान से लगभग 15-25° से°C कम होता है।

ABSTRACT. The influence of meteorological parameters like wind and temperature determine the chillness upon the human body. The rate of heat removal from the human body by wind and low temperature was termed as Wind Chill by Siple and Passel (1945). Using the wind chill chart, wind chill effects at Maitri, Antarctica during 1990 have been studied and compared with conventional value of monthly mean dry bulb and minimum temperatures. It has been observed that the wind chill temperature was about 15°-25°C lower than the dry bulb temperature when the wind speed exceeds 10 kt.

Key words — Wind chill, Temperature, Wind speed.

1. Introduction

Antarctica is the coldest and windiest continent on the earth. Sub-freezing temperatures are common throughout the year, except in summer along the Antarctica coast where they rise above 0°C. The interior of the Antarctica plateau records much lower temperatures than the coastal regions. Wind velocities and gustiness increase in association with the passage of low pressure systems. Pressure gradients built up by intense systems south of 65°S latitude or extra tropical cyclones in the 50°-60°S zonal belt produce blizzards and snow storms (Rathore 1986, Trivedi 1986).

It is well known that strong surface winds cause greater chilling and produce effective temperatures which are much lower than those with light winds. This wind chill effect becomes particularly important for Antarctica scientific workers as it does not remain merely a cause for discomfort but could even lead to problems of survival in the hostile environment (NSF 1984). The authors of the present paper were members of the 9th Indian Antarctic Expedition Team of 1990-91 and they established a full-fledged meteorological observatory in January 1990 at Maitri (70° 45'S, 11° 44'E; about 100 km south of *Dakshin Gangotri*). Based upon their own observations recorded at

this station in 1990-91 and their personal experiences in the field, they have attempted in this paper to bring out the importance of wind chill effect in Antarctica to which scientific works are liable to be exposed.

2. Data Used

Observations made by the authors at Maitri in 1990 of minimum temperature and ambient temperature at 0000, 0300, 0600,....., 2100 UTC daily were used. Simultaneous measurements of wind speed (3 minute average) were also used. To obtain monthly values of wind chill, the lowest minimum temperature and highest wind speed of individual days have been disregarded.

The wind speeds arranged for the month include blizzard days also. However, as seen from Table 1 these situations are not very frequent at Maitri. Maitri experienced 25 days (201 hours) of blizzard during 1990 and blizzard did not occur in 5 months. Blizzards are very common over the ice shelf due to the availability of loose snow. Maitri is surrounded by morainal land and the continental ice edge having very small amount of loose snow. As such, frequency and intensity of blizzards are very low over Maitri as compared to *Dakshin Gangotri* which is in ice shelf.

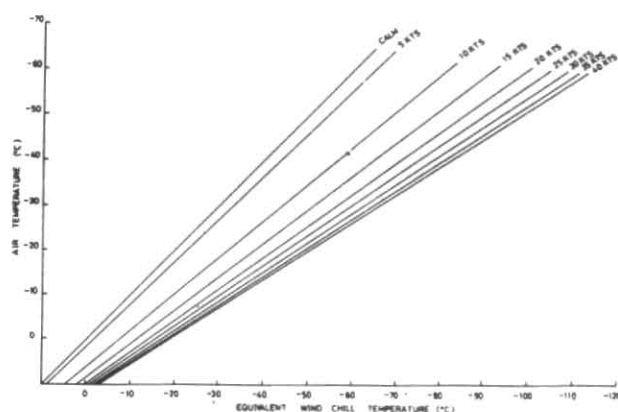


Fig. 1. Wind chill graph

3. Computation of wind chill effect

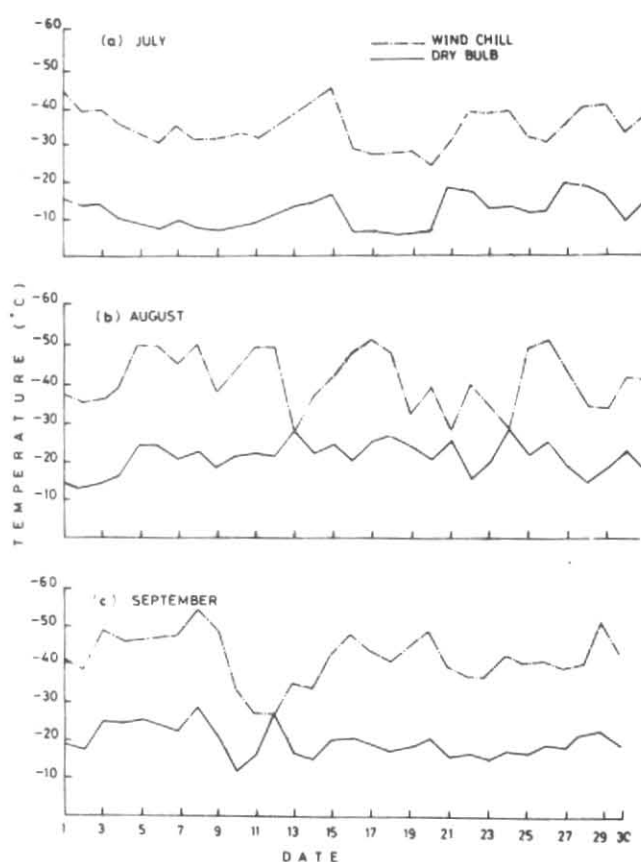
A so-called 'table of wind chill values' was originally compiled by Siple and Passel (1945) in an attempt to include the thermal effects of air movement with those of temperature as a single index. They used a new scale of rate of heat loss in kcal/sq m/hr running from 50 units (hot) to 1,000 units (very cold) and to 2500 units (intolerably cold).

The wind chill charts, in which the wind chill index is read from two variables, wind speed and temperature, has gained considerable usage over the years. One such chart is produced in Table 2. It is also shown diagrammatically in Fig. 1.

For calm wind, the air temperature and its equivalent wind chill temperature are same since loss of heat is normal and there is commensurate production of heat by the body. Loss of heat is little more up to wind speed of 5 kt. When the wind speed exceeds 5 kt, the heat loss from the body rapidly increases up to wind speed of 10 kt. When it exceeds 15 kt the loss of heat energy from the body reduces in slow pace. With a further increase of wind from 40 kt, the body has very little heat to lose as maximum heat energy has already been lost and the additional chill effect is very mild. That is the reason the range between the curves for 5 kt and 10 kt is larger when compared to the range between any other two curves for any temperature of air with equal interval of wind speed.

4. Results and discussion

Table 3 shows the 1990 monthly mean values of daily minimum temperature, daily mean temperature, daily mean wind speed and the wind chill



Figs. 2 (a-c). Daily maximum wind chill temperature and its corresponding dry bulb temperature for July August and September 1990 at Maitri

TABLE 1
Blizzards over Maitri, Antarctica during 1990

Month	Blizzard	
	No. of days	No. of hours
January	0	0
February	0	0
March	4	33
April	6	45
May	6	48
June	2	11
July	2	17
August	0	0
September	1	5
October	4	42
November	0	0
December	0	0

TABLE 2
Wind chill chart

Wind speed (kt)	Temperature (°C)												
	Actual air												
	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
	Equivalent wind chill												
0	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
5	9	4	-2	-7	-12	-17	-23	-28	-33	-38	-44	-49	-54
10	4	-3	-8	-14	-20	-26	-32	-38	-45	-51	-57	-63	-69
15	2	-6	-11	-18	-25	-31	-38	-45	-52	-58	-65	-72	-79
20	0	-8	-14	-21	-28	-35	-42	-49	-57	-64	-71	-78	-85
25	-1	-10	-16	-23	-31	-38	-45	-53	-60	-68	-75	-83	-90
30	-2	-11	-17	-25	-32	-40	-48	-56	-63	-71	-79	-86	-94
35	-3	-12	-19	-26	-34	-42	-50	-57	-65	-73	-81	-89	-97
40	-3	-13	-19	-27	-35	-43	-51	-59	-67	-75	-83	-90	-98

(Source: Siple and Passel 1945).

N.B. — To use the chart, find the estimated or actual wind speed in the left-hand column and the actual temperature in °C in the top row. The equivalent wind chill temperature is found where these two intersect.

temperature derived from them. From January (summer) to September (spring) the wind chill temperature goes on increasing continually and then falls again except, July. This may, perhaps, be due to the passage of more number of extra-tropical synoptic systems moving around the continent; the warm moist air is brought from the lower latitudes and that mixes with the cold, dry continental air resulting in lower wind chill temperatures.

Daily maximum wind chill temperature and its corresponding dry bulb temperatures have been calculated for all 12 months during 1990. As July, August and September are the peak winter periods in Antarctica, the relationships between dry bulb temperature and its corresponding wind chill temperature have been plotted and analysed. From the curves of Figs. 2 (a-c) one can appreciate the significant role of wind speed over sub-zero temperatures at Antarctica.

(i) *July* — July was the windiest month during 1990 with mean wind speed of 26.4 kt and mean temperature of -10.1°C . The mean wind chill temperature has lowered to -29.6°C and the mean maximum wind chill up to -33.9°C . The range of temperature difference between the

maximum wind chill and dry bulb temperature varies between 20°C and 30°C . Most of the days, the maximum wind chill temperature is below the safety limit.

(ii) *August* — August was the coldest month in 1990 with mean temperature of -20.5°C and mean wind speed of 11.5 kt. The mean wind chill and mean maximum wind chill were -32.6°C and -40.9°C respectively. On 13 and 24 August, calm wind were reported and so both dry bulb temperature and wind chill temperature were same. But on 17 and 26 the wind chill temperature would have gone less than -50°C . Most of the days the range of difference between dry bulb and wind chill temperatures being between 15°C and 25°C .

(iii) *September* — The wind chill temperature -33.7°C has been noticed in September which was 14.5°C lower than the mean temperature of the air. It has been observed that except two days, the wind chill was well below -30°C . On 8 September, the wind chill fell to as much as -55°C . Most of the days the difference of

TABLE 3
Temperature ($^{\circ}\text{C}$), mean wind speed (kt) and wind chill temperature ($^{\circ}\text{C}$)
over Maitri, Antarctica during 1990

Year 1990	Temperature ($^{\circ}\text{C}$)			Mean wind speed (kt)	Wind chill temperature ($^{\circ}\text{C}$)		
	Lowest Min	Mean Min	Mean		Mean	Mean Max	Highest Max
Jan	- 7.6	- 1.6	0.9	9.4	- 5.4	-11.3	-25.8
Feb	- 9.2	- 5.5	- 2.6	15.9	-13.5	-18.3	-27.2
Mar	-18.5	-10.1	- 7.1	19.3	-21.6	-27.5	-35.6
Apr	-21.6	-13.9	-10.1	18.6	-25.7	-31.0	-38.8
May	-30.8	-15.7	-12.3	19.7	-28.4	-34.0	-49.3
Jun	-29.5	-19.9	-16.3	17.8	-33.3	-39.2	-51.8
Jul	-21.2	-13.1	-10.1	26.4	-29.6	-33.9	-44.0
Aug	-32.0	-24.2	-20.5	11.5	-32.6	-40.9	-51.0
Sep	-31.5	-23.1	-19.2	13.3	-33.7	-42.3	-55.0
Oct	-22.8	-12.7	- 9.2	19.8	-25.3	-31.7	-44.8
Nov	-16.4	- 7.6	- 4.1	16.5	-16.2	-23.1	-35.2
Dec	- 5.1	- 2.7	1.0	11.8	- 6.9	-13.2	-22.2

temperature range between dry bulb and wind chill varies between 20°C and 25°C which is well below the safety limit.

5. Conclusions

(i) From April to October, in the winter months of Antarctica, the mean wind chill temperature is well below -30°C .

(ii) As practically experienced at Maitri, working bare in -30°C temperature with calm wind deemed more comfortable than to work in -10°C temperature with presence of 25 kt wind speed.

(iii) When the wind speed is above 10 kt, maximum wind chill temperature is approximately 15°C to 25°C lower than the minimum temperature.

(iv) The mean maximum wind chill temperature increases steadily from January to September (except July) and it decreases gradually thereafter.

(v) At Maitri in Antarctica, the wind chill temperature is about 10°C - 15°C lower than the

ambient air temperature during summer period and 20°C - 25°C lower during winter period.

Acknowledgement

The authors are thankful to Dr. R.R. Kelkar, DDGM (Satellite Meteorology), Col. S. Jagannathan, First Station Commander of Maitri and Lt. S. Viswanathan, Member, 9th Antarctic Expedition for their valuable discussions, fruitful suggestions and guidance.

References

- NSF. 1984. Survival in Antarctica, U.S. National Science Foundation, Washington, D.C., 101 pp.
- Rathore, L. S., 1986. "Meteorological studies at *Dakshin Gangotri*", Growing focus on Antarctica (Ed: R.C. Sharma), Rajesh Pub., New Delhi, pp. 109-120.
- Siple, P. A. and Passel, C. F., 1945. "Dry atmospheric cooling in sub-freezing temperatures", Proc. Amer. Philos. Soc., **89**, 177 pp.
- Trivedi, K. L., 1986. Synoptic study of blizzards during Third Antarctica expedition, growing focus on Antarctica (Ed: R.C. Sharma), Rajesh Pub., New Delhi, pp. 97-108.