Atmósfera 20(4), 373-376 (2007)

A short communication on meteorological observations at Mt. Everest 6523 m

A. XIE, D. QIN, J. REN, C. XIAO, X. QIN, S. HOU, X. YANG and Y. JIANG
Joint Key Laboratory of Cryosphere and Environment, Cold and Arid Regions Environment and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou 730000, China
Corresponding author: A. Xie; email: xieaih@lzb.ac.cn

Received November 23, 2006; accepted January 25, 2007

RESUMEN

El Monte Everest es relativamente inaccesible y poco se sabe sobre su meteorología. El 27 de abril de 2005, una estación meteorológica automática fue instalada en la columna del norte (28°01′0.95″N, 86°57′48.4″E, 6523 mslm) del Monte Everest. En este trabajo reportamos los datos medidos durante el periodo del 1 de mayo al 22 de julio de 2005. En particular, presentamos un resumen mensual sobre radiación, temperatura del aire, humedad relativa y presión barométrica. Las observaciones diarias mostraron fluctuaciones sinópticas, mientras que la radiación de onda corta y la velocidad del viento disminuyeron gradualmente al mismo tiempo que los cambios netos de la radiación de onda corta mostraron un aumento leve, y la dirección del viento cambió de dirección norte a sur.

ABSTRACT

Mt. Everest is relatively inaccessible and little is known about its meteorology. On 27 April 2005, an automatic weather station was displayed on the north column (28°01′0.95″N, 86°57′48.4″E, 6523 masl) of Mt. Everest. This paper summarizes the meteorological data collected from 1 May to 22 July 2005. The measured variables included long-wave radiation, air temperature, relative humidity and baromteric pressure. The daily record indicates synoptic scale variability in the thermodynamic variables, while short-wave radiation and wind speed decrease gradually at different degree, net radiation changes little with a slight increase, and wind direction turns from north to south.

Keywords: Mt. Everest, radiation, air temperature, relative humidity, air pressure, wind.

1. Introduction

Mt. Everest, the highest peak in the world, is 8844.43 masl (as promulgated by the News Office of the Chinese State Council in October 2005, 3.7 m lower than 8848.13 m measured in 1975). Because of its unique topography and the remoteness of the region, there is a pressing need for meteorological data there. In an attempt to satisfy this demand, an automatic weather stations (AWS) was installed on Mt. Everest at 6523 m in 2005.

2. Data and methods

On 27 April 2005, an AWS was installed at the Ruopula Pass (28°01′0.95″N, 86°57′48.4″E, 6523 masl) on the northern slope of Mt. Everest. The AWS continuously recorded the meteorological data from 1 May to 22 July 2005, afterwards the record is discontinuous. Therefore this paper will analyze the meteorological features from 1 May to 22 July 2005.

The height of the sensors above snow surface varied with snow depth. When the AWS was installed, the height was 2.5 meters, while on 17 October the height was 1.3 m.

3. Results and discussion

From 1 May to 22 July, Westerly decreases, and plateau and southeast monsoon start to control the region gradually (Ye and Gao, 1979; Bertolani *et al.*, 2000), precipitation increases and cloud strengthens (Lang *et al.*, 2002). Therefore, both the downward long-wave radiation and upward long-wave radiation from reflective snow surface enhance, and downward solar radiation and upward short-wave radiation from reflective snow surface weaken, while net radiation, as the calculated result from the upward and downward radiation, changes little with a slight increase.

In the 83 days, as the total influence of downward and upward radiation, the air temperature rises obviously, increasing slowly with large rebounding in early and middle May, strengthening abruptly from late May to middle June, and keeping rather stable from late June to July with some little fluctuations, in which the most prominent is the abrupt increasing in late May and middle June. The variation of daily maximal temperature is just like that of daily minimal temperature, and is also similar to that of the 10-minute-averaged variation. That is, with the 10-minute-averaged temperature increasing, the daily maximal and minimal temperature also increase.

Relative humidity is low in May with much fluctuation (33 to 93%), increases rapidly with rebounding in June, and almost keeps high in July. In May, Mt. Everest region is controlled by the Westerly and influenced by air from the arid and semi-arid region (Hindman *et al*., 2002), therefore the relative humidity is low, with an average of 41.6%. In June, the Plateau summer monsoon begins in the southern plateau (Ye and Gao, 1979; Bertolani *et al*., 2000; Bollasina and Benedict, 2004), then Indian summer monsoon advances northward, crosses the Himalayas, or moves northward through the Brahmaputra region, then transfers westward, and entries into the Plateau's interior with plenty of water vapor (Barros *et al*., 2003; Ye and Gao, 1979), therefore the relative humidity increases rapidly with rebounding at an average of 65.8%. In July, both of the Plateau summer monsoon and Indian summer monsoon develop into maturation, which dominate in Mt. Everest region, wherefore relative humidity keeps high with the average of 86.0%.

From May to July, daily averaged pressure rises with temperature rising, especially in late May, decreases with temperature decreasing in early June, and then increases slowly, which results from the seasonal variation of heating field in planetary scale. In the Mt. Everest region, the 700hPa geopotential height is a compartmental layer, above which pressure increases with temperature increasing, and below which pressure decreases with temperature increasing (Ye and Gao, 1979).

In May, Mt. Everest area is mostly controlled by the Westerly, wind speed is high with much fluctuation and reaches its maximum on 11 May, Northerly and North-north-westerly predominates and Southerly are little. In June, sensitive heating effect strengthens, the Westerly weakens and retreats gradually from the area (He *et al.,* 1987; Lang and Barros, 2003), therefore wind speed decreases with rebounding, Northerly weaken consequently, and southerly winds occurs more and dominates progressively. In July, the southern branch of the Westerly withdraws from the Mt. Everest area substantially and renders stable by the north of 35 °N, wherefore, wind speed goes on weakening, Southerly is most and predominates exceedingly (Ye and Gao, 1979).

4. Conclusions

Table I illustrates the monthly average variation from 1 May to 22 July in 2005 for the meteorological elements at Mt. Everest 6523 m. Compared with that in June and July, all the meteorological elements fluctuate more in May, which results from the influence of the Westerly. Generally, in May, daily total long-wave radiation, air temperature, relative humidity and air pressure are rather low, daily total short-waver radiation and wind speed are high, and Northerly prevails. In June, the Indian monsoon and plateau summer monsoon commence to control Mt. Everest region, daily total long-wave radiation, air temperature, relative humidity and air pressure increase, wind speed weakens, and wind direction turns from north to south. In July, Mt. Everest region is impacted substantially by Indian monsoon and plateau summer monsoon, therefore all the meteorological elements have little rebounding; air temperature, relative humidity and air pressure keep high, daily total short-wave radiation and wind speed keep low, frequency of calm wind strengthens, and Southerly dominates. As the calculated result of upward and downward radiation, net radiation changes little with a slight increase.

Table I. Monthly average for daily mean, mean daily maximum and minimum, monthly maximum and minimum of net radiation, air temperature, relative humidity, air pressure and wind speed, prevailing wind direction and its occurring frequency on North Column of Mt. Everest.

		Net radiation (Wm^{-2})	Air temperature (°C)	Relative humidity (%)	Air pressure (hPa)	Wind speed (ms^{-1})	Prevailing wind direction (occurring frequency)
May	Mean	36.9	–10.7	41.6	456.2	7.5	Northerly
	Max mean	336.3	–6.0	75.0	459.9	18.8	(30.1%)
	Max	433.2	–1.1	92.4	462.3	30.3	North-north-
	Min mean	–109.4	–15.4	18.4	452.9	0	westerly
	Min	–133.5	–19.5	4.3	450.5	0	(26.5%)
June	Mean	49.7	–5.1	65.8	459.0	3.2	Southerly
	Max mean	397.8	–0.3	91.5	461.3	11.1	(26.5%)
	Max	635.2	4.2	95.8	462.1	22.0	Northerly
	Min mean	–100.3	–9.4	32.5	456.0	0	(15.6%)
	Min	–123.8	–14.0	3.3	455.1	0	
July (1 to 22)	Mean	49.2	–3.2	86.0	461.1	2.2	Southerly
	Max mean	332.1	3.9	95.0	462.2	7.3	(29.8%)
	Max	513.6	7.1	96.6	463.1	10.0	Calm wind
	Min mean	–54.8	–7.0	59.3	459.6	0	(15.4%)
	Min	–109.5	–10.7	38.2	458.6	0	

Notes: In Table I, Mean stands for total mean of 10-minute mean observational values, Max Mean for the mean value of daily maximum, Max for the monthly maximum, Min Mean for the mean of daily minimum, and Min stands for the monthly minimum.

Acknowledgements

This work was partially funded by the National Nature Science Foundation of China (No. 40501015 and 90411003) and the Chinese Academy of Science (No. KZCX3-SW-344 and No. KZCX3-SW-354). We extend our much gratitude to all the crews of 2005 integrated scientific expedition to Mt. Everest for their hard fieldwork, especially to Dr. Shulin Tang for establishing and maintaining the AWS, and to Jianping Duan for measuring site of the AWS. We also thank Xiaoqing Cui, Jianzhong Xu, Wentao Du, Weigang Liu and Shichang Kang for their help in the fieldwork.

References

Ana P. B. and J. L.Timothy, 2003. Monitoring the Monsoon in the Himalayas: Observations in Central Nepal, June 2001. *Mon. Wea. Rev.* **131**, 1408-1427.

Bertolani L., M. Bollasina and G. Tartari, 2000. Recent biennial variability of meteorological features in the Eastern Highland Himalayas. *Geophys. Res. Lett*. **27**, 2185-2188.

Bollasina M. and S. Benedict, 2004. The role of the Himalayas and the Tibetan Plateau within the Asian Monsoon System. *Bull. Am. Meteor*. **85**, 1001-1004.

Edward E. H. and B. P. Upadhyay, 2002. Air pollution transport in the Himalayas of Nepal and Tibet during the 1995-1996 dry season. *Atmos. Environ*. **36**, 727-739.

He H., J. W. McGinnis, Z. Song and M. Yanai, 1987. Onset of the Asian monsoon in 1979 and the effect of the Tibetan Plateau. *Mon. Wea. Rev*. **115**, 1966-1995.

Timothy J. L. and P. B. Ana, 2002. An investigation of the onsets of the 1999 and 2000 monsoons in Central Nepal. *Mon. Wea. Rev*. **130**, 1299-1316.

Ye D. Z. and Y. X. Gao, 1979. *Meteorology of Qinghai-Xizhang (Tibet) Plateau*. Science Press, Beijing (China), 278 pp.