北京大学学报(自然科学版),第 41 卷,第 3 期,2005 年 5 月
Acta Scientiarum Naturalium
Universitatis Pekinensis, Vol. 41, No. 3 (May 2005)

Observational Study of Wind Fields, Temperature Fields over Beijing Area in Summer and Winter[1)]

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Abstract The wind fields and temperature fields data provided by "D files" from 14 surface observation stations around Beijing area are used to produce the mean wind fields and the mean temperature fields over Beijing area in summer and winter. Such results are gotten: (1) Due to the unique topography the wind of Beijing area during the day time is southern anabatic wind and in the night is northern katabatic wind in summer. In winter, this phenomenon disappears due to the affect of the strong synoptic systems. (2) In summer, Haidian and Fengtai lie in an area with high temperature. These areas are the main areas of the Urban Heat Island over Beijing area. In winter Haidian and the area north to Haidian are high temperature areas during the night.

Key words wind field; temperature field; urban heat island; urban boundary layer; Beijing area

0 Introduction

Beijing locates at the transition zone of plain areas and mountain areas in north of HuaBei Plain. It has 16.8 thousand square kilometer. Its urban area is flat, but the surrounding area's topography is very complicated. Yan Mountain lies north. Taihang Mountain lies west. There is great height difference between the surrounding mountain area and the center of Beijing. This unique topography has important effect on the meteorology environment over Beijing area. Meanwhile the activity of more than 11 million people of Beijing shapes very important effect on the environment of Beijing also. These effects are concerned with the living condition, air quality, evaluation of the rationality of the constructions etc.

These years accompanied with people's further attention on city environment of Beijing many

1) 国家自然科学基金(40275004)和香港自然科学基金(4001161948)资助项目
收稿日期: 2003-12-18; 修回日期: 2004-03-04

research about the local meteorology environment of Beijing were done with different methods and results. Zhou Mingyu[1] did the preliminary research of Urban Heat Island (UHI) and the UHI circulation of Beijing with the observational data. Cai Xuhui et al[2] used wind-field diagnostic analysis and historical observation data to reveal general flow patterns of lower atmosphere over Beijing area. Getting the results that air flows in this area could be classified into autumn-winter pattern and spring-summer pattern. The former is under effect of more strong synoptic systems, while the latter shows more characteristics of mesoscale thermal circulation induced by topography. The regional boundary layer model (RBLM) is used by Xu Min[3] to simulate the meteorological environmental characteristics over the Beijing area. The characteristics of the urban heat island in Beijing and its surroundings are analyzed by Zhang Guangzhi[4] using the 40 year data, from 1961 to 2000, from 16 standard climatic stations in the Beijing area. Tong Hua[5] simulated the wind, temperature, concentration and aerosol fields of the atmospheric boundary layer over the Haidian district of Beijing using a three dimensional mesoscale numerical model of Peking Univiersity. Simulation shows that the wind field is affected by the topography and urban heat island. Yang Yuhua et al[6] simulated the winter heat island of Beijing considering the daily changing anthropogenic heat. It indicated that this consideration can improve the numerical simulation of the heat island.

In this paper the wind fields data from 11 surface observation stations and the temperature fields data from 14 surface observation stations around Beijing area are used. These data are all provided by the "D file" of those surface observation stations. "D file" has its unique format and contains all the meteorologic observations of a month. The method averaging all the data in a month of every time respectively was used to research the wind fields and temperature fields around Beijing area. Wish a integrated analysis results can be given which is about diurnal change characters of the mean wind fields and the mean temperature fields and their mutual influence.

1 Data Source

The wind fields and temperature fields data in summer are from the "D file" of July 2000 of 14 surface observation stations around Beijing area. The wind fields and temperature fields data in winter are from the "D file" of January 2003 of these stations. These stations include Changping station (54499), Haidian station (54399), Shijingshan station (54513), Mentougou station (54505), Fangshan station (54596), Fengtai station (54514), Daxing station (54594), Beijing meteorological bureau station (54511), Tongzhou station (54431), Chaoyang station (54433), Shunyi station (54398), Yanqing station (54406), Huairou sation (54419), Pinggu station (54424).

2 Horizontal Structure of Mean Wind Fields

2.1 The Feature of Wind Fields in Summer

Fig. 1 illustrates the mean wind fields of July 2000 over Beijing area. Every station contains the wind fields information of 31 days. By averaging all the wind vectors of 31 days of every time respectively, that is to say, averaging the wind in the transmeridional direction and averaging the wind in the south-north

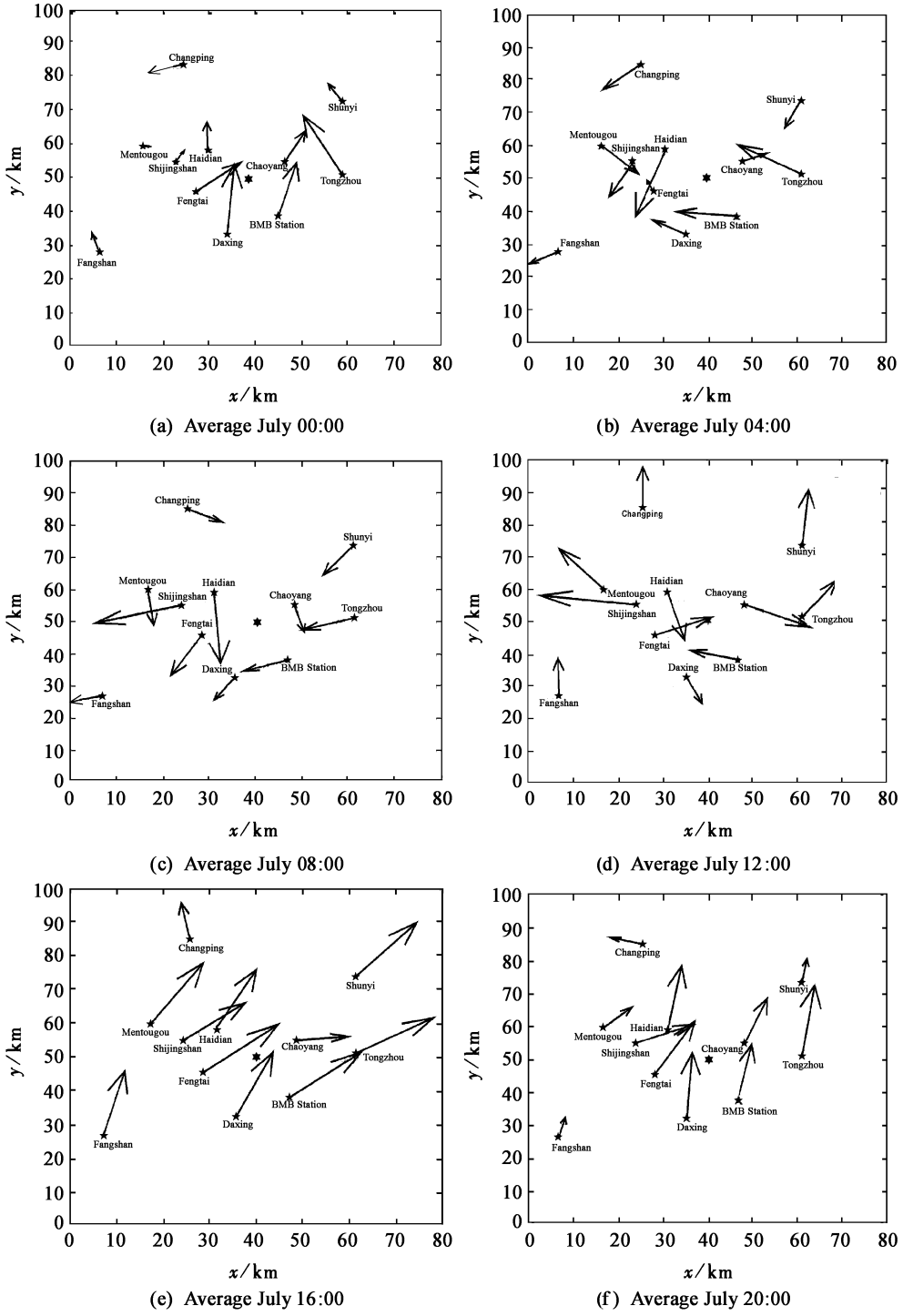

Fig. 1　Mean wind fields of July 2000 (summer)

direction and then composing the total mean wind vectors of every time respectively, the wind vectors sequence are gotten. This sequence reflects the diurnal change of the mean wind fields in July. The wind vectors of six times are selected to analyze the features of the wind fields in July. These times are 0000LST, 0400LST, 0800LST, 1200LST, 1600LST, 2000LST respectively. In the Fig. 1(a), It can be seen that at 0000LST all stations are nearly south wind except Changping station. In Fig. 1(b), at 0400LST because of the influence of the katabatic wind the wind of many stations turn from south wind to north wind. This time there are all north wind in Changping, Shunyi, Mentougou, Haidian, Shijingshan and Fangshan. As time goes on the area of north wind becomes bigger, at 0800LST (illustrated as Fig. 1(c)) all the wind vectors have their north component in the south-north direction. That is to say, this time the katabatic wind is most obvious. As time goes to 1200LST, wind field becomes to turn from north wind to south wind. In Fig. 1(d), besides Haidian, Chaoyang, Daxing, the other wind vectors in the south-north direction become the south wind. At 1600LST and 2000LST, all the wind vectors are all almost south wind. This is obviously seen in Fig. 1(e) and 1(f). That is to say, from 1600LST to 2000LST the influence of the anabatic wind is very obvious.

Surveying the entire process of the change of the wind fields the features of the mean wind fields in July can be summarized below: at 0000LST, there are almost south wind over Beijing area. At 0400LST, the influence of the katabatic wind becomes to appear, south wind becomes to turn to north wind. At 0800LST the influence is most obvious, the wind of all station are almost north wind. At 1200LST, because of the influence of the anabatic wind the wind becomes to turn to south wind, At 1600LST and 2000LST it is most obvious, all the wind are south wind. That is to say, under the circumstance that the synoptic system is weak the mean wind fields in July over Beijing area can be separated into two periods. One is from noon the midnight, this time it is always south anabatic wind over Beijing area; the other one is form midnight to forenoon, it is always north katabatic wind.

2.2 The Feature of Wind Fields in Winter

Fig. 2 illustrates the mean wind fields of January 2003 over Beijing area. The method dealing with the data is the same as the method used dealing with the data in Fig. 1. Every wind vector of each time is the mean result of 31 days (including every day of January). From Fig. 2(a) to 2(f) the diurnal change of wind fields shown as Fig. 1 cann't be seen. The wind direction is relatively invariable. All the wind vectors of all stations in the whole day have north component in the south-north direction. Especially northwest wind and nearly north wind are most prevailing. So Fig. 2 shows this feature: in winter the weather are always influenced by the large scale synoptic system coming from northwest, so the local mountain-plain mesoscale circulation and the UHI circulation disappear by and large, the fluid fields near surface are north wind in the whole day over Beijing area in winter.

3 Horizontal Structure of Mean Temperature Fields

3.1 The Feature of Temperature Fields in Summer

Fig. 3 illustrates mean air temperature fields in July 2000. The value of every station at every time is

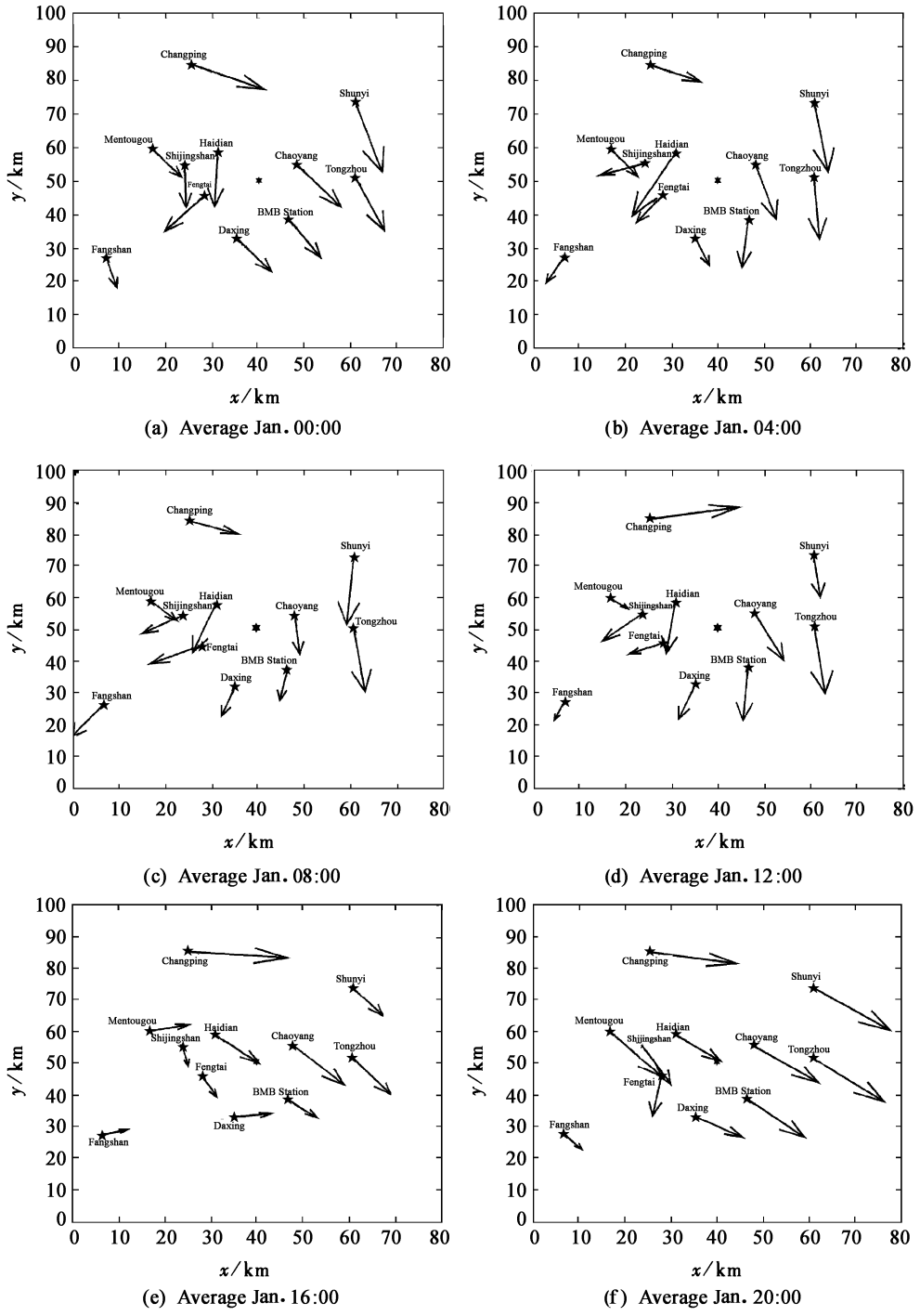

Fig. 2　Mean wind fields of January 2003 (winter)

the mean value of all the 31 days of July 2000 respectively. Before drawing the contours ,the area except the stations are given interpolated value by the “cubic” method. Because lack of the observations of

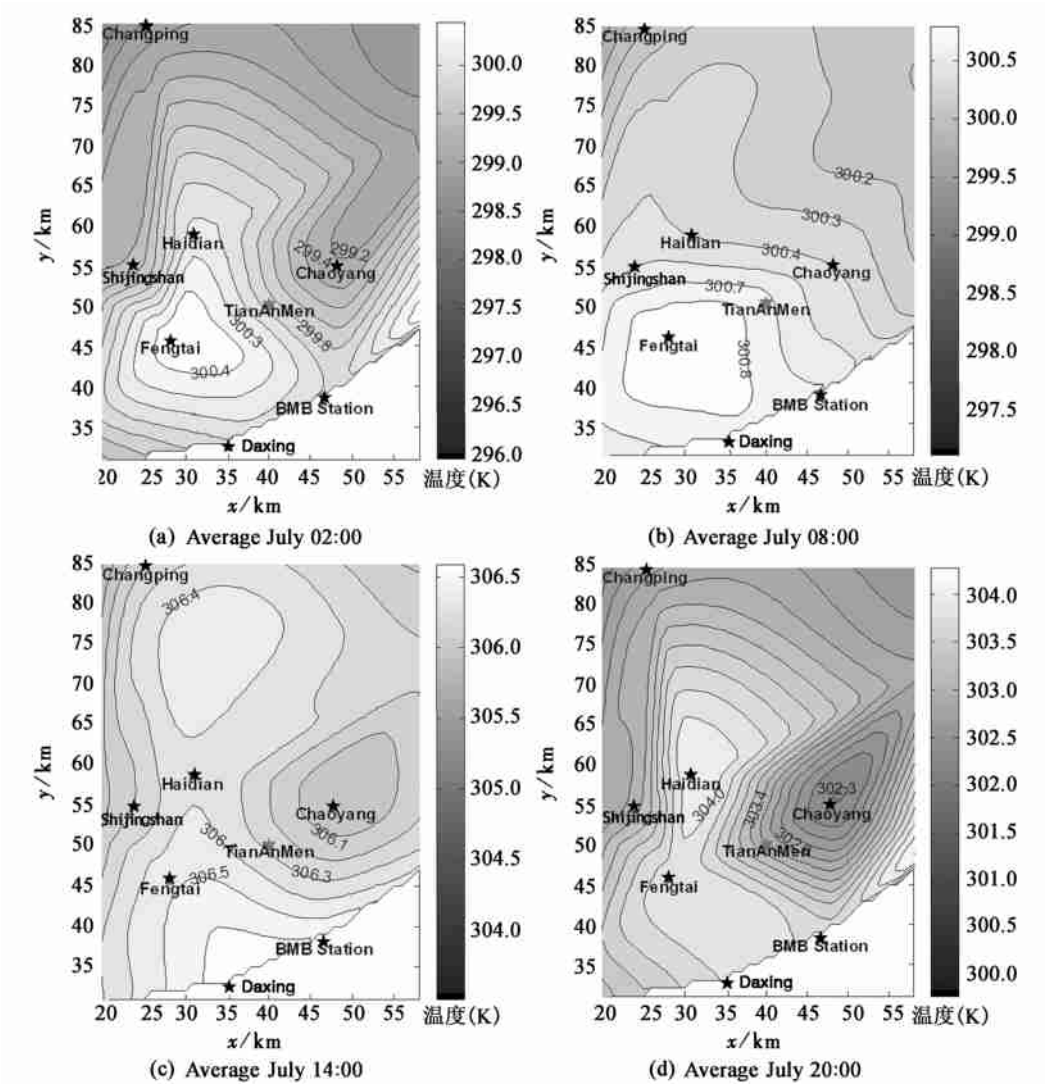

Fig. 3 Mean temperature fields of July 2000 (summer)

Hebei province the area southeast to Beijing meteorological bureau station(54511) is blank in each Fig. At 0200LST, illustrated as Fig. 3(a), Fengtai lies in a relative high temperature area, higher than eastern Chaoyang which is 299.4 K by 1 K. At 0800LST, illustrated as Fig. 3(b), Fengtai still lies in a relative high temperature area, it is a little higher than 300.8 K, higher than Chaoyang by 0.4 K. At 1400LST, illustrated as Fig. 3(c), the high temperature area around Fengtai begins to fade, and a new high temperature area appears over the area around Haidian, At 2000LST, illustrated as Fig. 3(d), the high temperature area around Haidian becomes more obvious, the temperature here is 1.5 K higher than that in Chaoyang.

Summing up the upper analyse, the features of the mean temperature fields over Beijing in summer can be listed below: the western area of Beijing from Haidian to Fengtai lies in an area of high

temperature , this area is the main area of the UHI in Beijing 's summer , this high temperature area has two different emphases during two different periods respectively. From midnight to forenoon the emphasis lies in Fengtai , after noon the emphasis transfers to Haidian. This phenomenon may be relevant with the mean wind fields of Beijing 's summer , from midnight to forenoon the north katabatic wind is prevailing , after noon the south anabatic wind is prevailing. The high temperature area lies nicely in the down wind area respectively. On the other hand eastern Chaoyang area lies in a relatively low temperature area. The highest temperature difference of these two areas (one in the west , one in the east) appears during the night , at 2000LST the difference arrives at 1.5 K.

3.2 The Feature of Temperature Fields in Winter

Fig. 4 illustrates mean air temperature fields in January 2003. The interpolation method is same as it

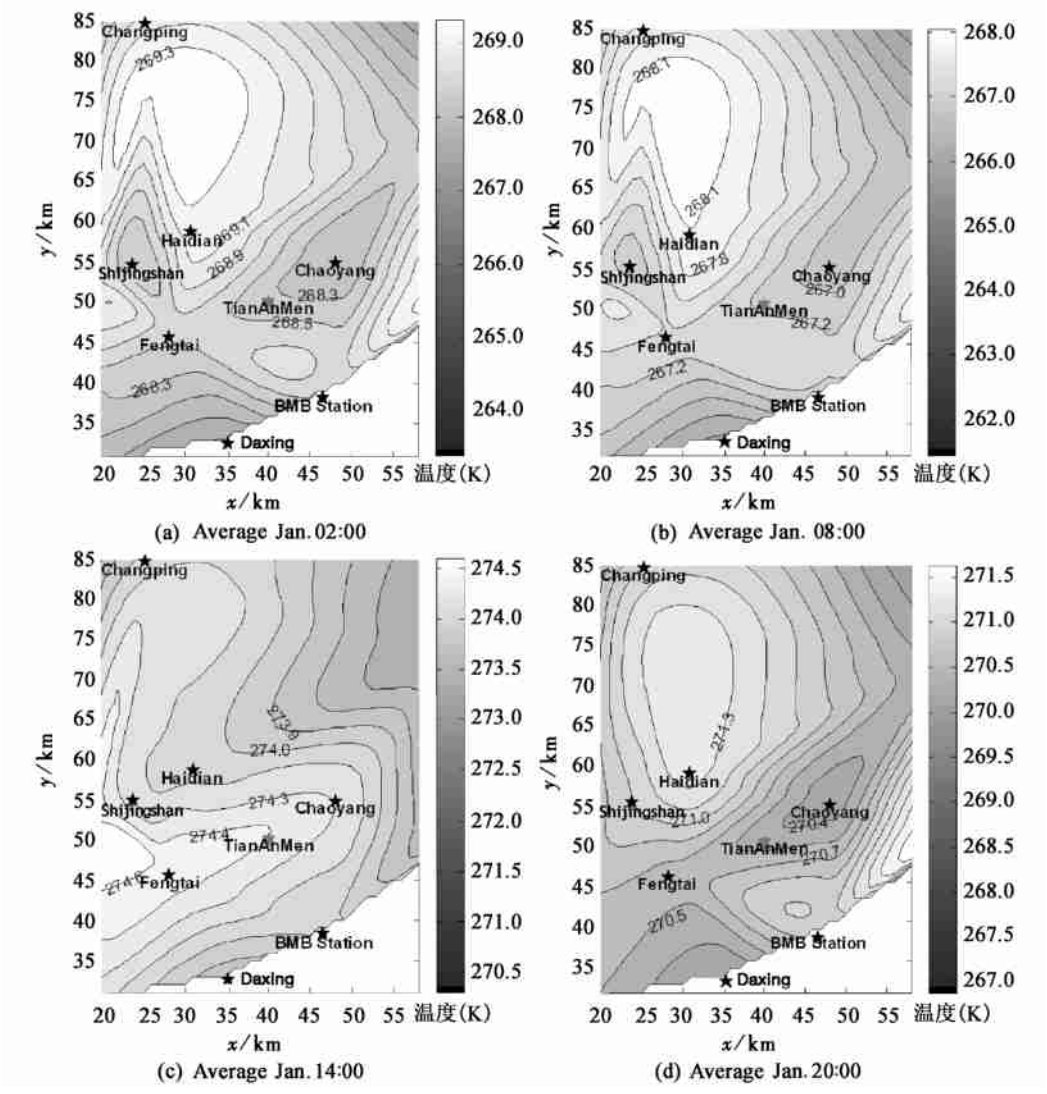

Fig. 4　Mean temperature fields of January 2003 (winter)

is mentioned above. In Fig. 4(a), 4(b), 4(d), (representing 0200LST, 0800LST, 2000LST respectively) the area from the north of Haidian to the south of Changping lies in a high temperature area, while Chaoyang lies in a relatively low temperature area all along. The temperature differences of these two areas are 1, 1.1, 0.9 K respectively. At 1400LST, illustrated as Fig. 4(c), high temperature area transfers to the area west to Fengtai.

Summing up the upper analyse, the features of the mean temperature fields over Beijing in winter can be listed below: During the whole night, from 2000LST to the other day's 0800LST, the area from the north of Haidian to the south of Changping lies in a high temperature area. The temperature difference between this area and Chaoyang is about 1 K. Another obvious feature is: In winter the temperatures of all the stations at 0800LST are lower than that at 0200LST, this is not same as that in summer the lowest temperatures appear at 0200LST.

4 Conclusion

According to the studies the preliminary conclusions are gotten:

(1) under the circumstance that the synoptic system is weak the mean wind fields in summer over Beijing area can be separated into two periods. One is from noon the midnight, at this time it is always south anabatic wind over Beijing area; the other one is from midnight to forenoon, it is always north katabatic wind;

(2) in winter the weather of Beijing are always influenced by the large scale synoptic system coming from northwest, so the local mountain-plain mesoscale circulation and the UHI circulation disappear by and large, the fluid fields near surface are north wind in the whole day over Beijing area in winter;

(3) the features of the mean temperature fields over Beijing in summer can be summed up as: the western area of Beijing from Haidian to Fengtai lies in an area of high temperature, this area is the main area of the UHI in Beijing's summer, this high temperature area has two different emphases during two different periods respectively. From midnight to forenoon the emphasis lies in Fengtai, after noon the emphasis transfers to Haidian; On the other hand eastern Chaoyang area lies in a relatively low temperature area all along;

(4) the features of the mean temperature fields over Beijing in winter can be summed up as: During the whole night, from 2000LST to the other day's 0800LST, the area from the north of Haidian to the south of Changping lies in a high temperature area. The temperature difference between this area and Chaoyang is about 1 K. Another obvious feature is: In winter the temperatures of all the stations at 0800LST are lower than that at 0200LST.

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北京区域夏冬季风场、温度场的观测研究

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摘　要　用北京及市郊地区共 14 个地面气象观测站的全月数据顺序文件"D 文件"提供的风场及温度资料, 采用逐时月平均的方法对北京及周边地区的冬夏两季的风场, 温度场特征进行了研究。研究结果表明: (1) 北京区域夏季边界层风场受西北特殊地形的影响, 夜间低层大气流场常表现为由北向南的下坡风, 白天逐渐转为由南往北的上坡风。而在冬季, 这种山地-平原的局地环流的现象消失。(2) 夏季, 城市西部海淀到丰台一带处在一个高温区, 构成北京"热岛"的一个主要区域。而在冬季, 海淀及海淀以北到丰台南部的地区是夜间的高温中心。

关键词　风场; 温度场; 城市热岛; 城市边界层; 北京区域
中图分类号　P 412.1

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校内要闻

北大地空学院涂传诒院士论文在 *Science* 上发表

北京大学地空学院涂传诒院士及其合作者北京大学周成和赵亮, 中国科技大学夏利东, 北京天文台汪璟秀, 以及德国马普学会太阳系研究所学者合作研究, 利用 ESA(欧空局)和 NASA(美国宇航局)研制的太阳日球层观测飞船(SOHO)上的太阳紫外辐射分光计(SUMER)观测到太阳风来自一种漏斗状结构的磁场区域, 这些漏斗状的磁场结构底部位于太阳表面网状磁结构的边缘。这一新结果发表在 2005 年 4 月 22 日 *Science* 的 Research Article 中。此项研究成果是认识太阳风起源的磁场本质的一大突破, 确定了日冕中太阳风高速流发源地的磁结构。

目前, 在 *Science* 和 *Nature* 以第一作者发表 Article 论文的大陆学者为数不多, 涂传诒院士曾于 1989 年、2001 年两次获国家自然科学二等奖, 2001 年当选中国科学院院士, 2002 年获何梁何利科技进步奖。

涂院士从 1995 年以来一直担任北京大学学报(自然科学版)的编委。2005 年 4 月学报编委会换届, 他被学校任命为新一届编委会的副主任委员。

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