Climate and Weather Guide for Tokyo 2020 Olympic and Paralympic Games

August 2019

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* Values in sentences and figures are calculated by the Tokyo Organising Committee of the Olympic and Paralympic Games using data provided by the Japan Meteorological Agency.
** Unless otherwise specified, mean values in sentences and figures are calculated based on averages of 20-year observed values between 1999 and 2018.

1. Introduction: Overview of climate and weather in Japan

1-1. Overview of climate and weather in Japan

To begin with, Japan's geographic location and the climate classification of Japan are described from the global perspective.

Japan is located at the east of the Eurasian Continent and is a bow-shaped chain of islands composed principally of the main islands of Hokkaido, Honshu, Shikoku and Kyushu.

Hokkaido, the northernmost island among the four main islands, is located at 46 degrees north latitude and 147 degrees east longitude while Okinawa, the southernmost prefecture, is located at 24 degrees north latitude and 122 degrees east longitude. The central part of Japan is located at 35 degrees north latitude and 135 degrees east longitude. The total land area of Japan is approx. 378,000 km^2 (as of October 2018). The country is made up of 6,852 islands (islands here means an area of land with a perimeter of over 0.1 km, and excluding reclaimed land) including the four main islands mentioned above and both the East-West and North-South land ranges are 3,000km. The climate is therefore distinct across the northern part of Japan (Hokkaido) and the southern part (Okinawa).

As Figure 1 shows below, most areas in Japan – including Tokyo, the host city of the Olympic and Paralympic Games Tokyo 2020 – are classified into either a temperate or humid subtropical climate, although certain areas of Japan may have other climatic features such as subarctic. In general, Japan receives a large amount of precipitation, and it does not have an arid climate though it has a dry season in terms of the classification.

It is hot and humid in summer due to southerly winds from subtropical high pressure systems predominating. On the other hand, it is relatively cold in winter due to the impact of northwest seasonal winds from the Asian continent.

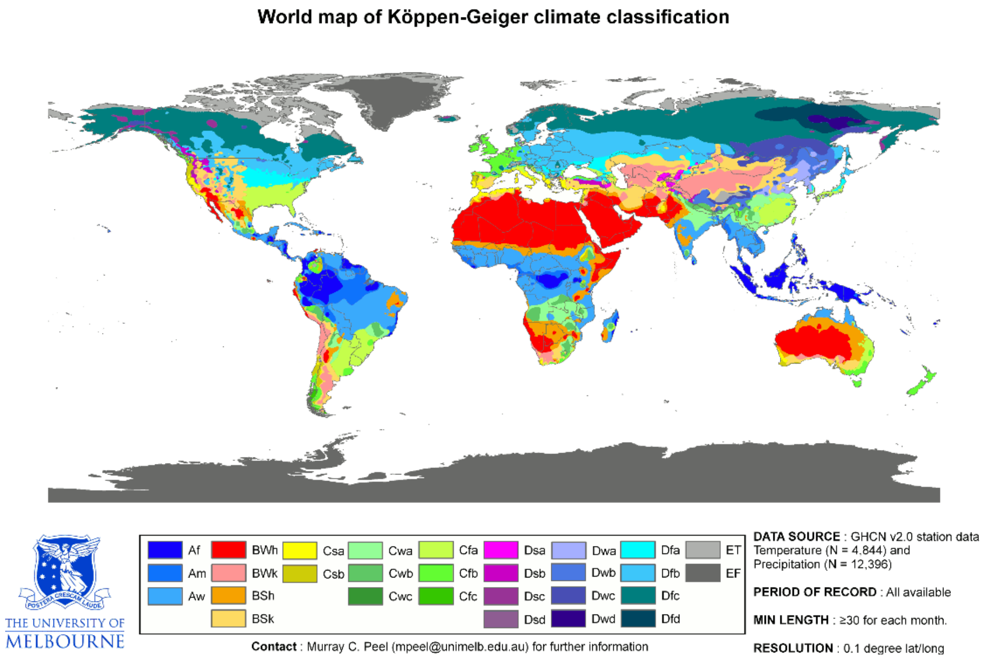
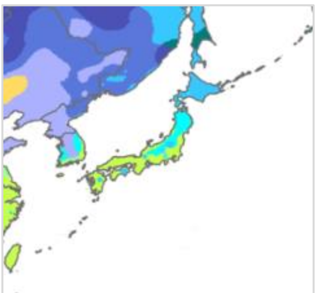


Figure 1 Köppen climate classification (Retrieved from Website of the University of Melbourne https://people.eng.unimelb.edu.au/mpeel/koppen.html)



(Left: Enlarged figure of the above climate classification)

Japan is broadly separated into three classes: 1) Dfb, 2) Dfa (Humid subarctic climate) and 3) Cfa (Humid temperate climate). These are the same classifications as the following classes, respectively.

1) Southwestern Russia (vicinity of Moscow) and Eastern Europe,
2) Ukraine, and 3) Central China, Eastern China, Southern China, Southern Brazil and Northern Argentina

Japan's climate can be roughly divided into six climatic regions.

Tokyo, in which is the majority of the Tokyo 2020 Games venues are located, has a 'Pacific Side Climate', while Sapporo, which houses the Sapporo Dome venue, has a 'Cool Temperate Climate'.

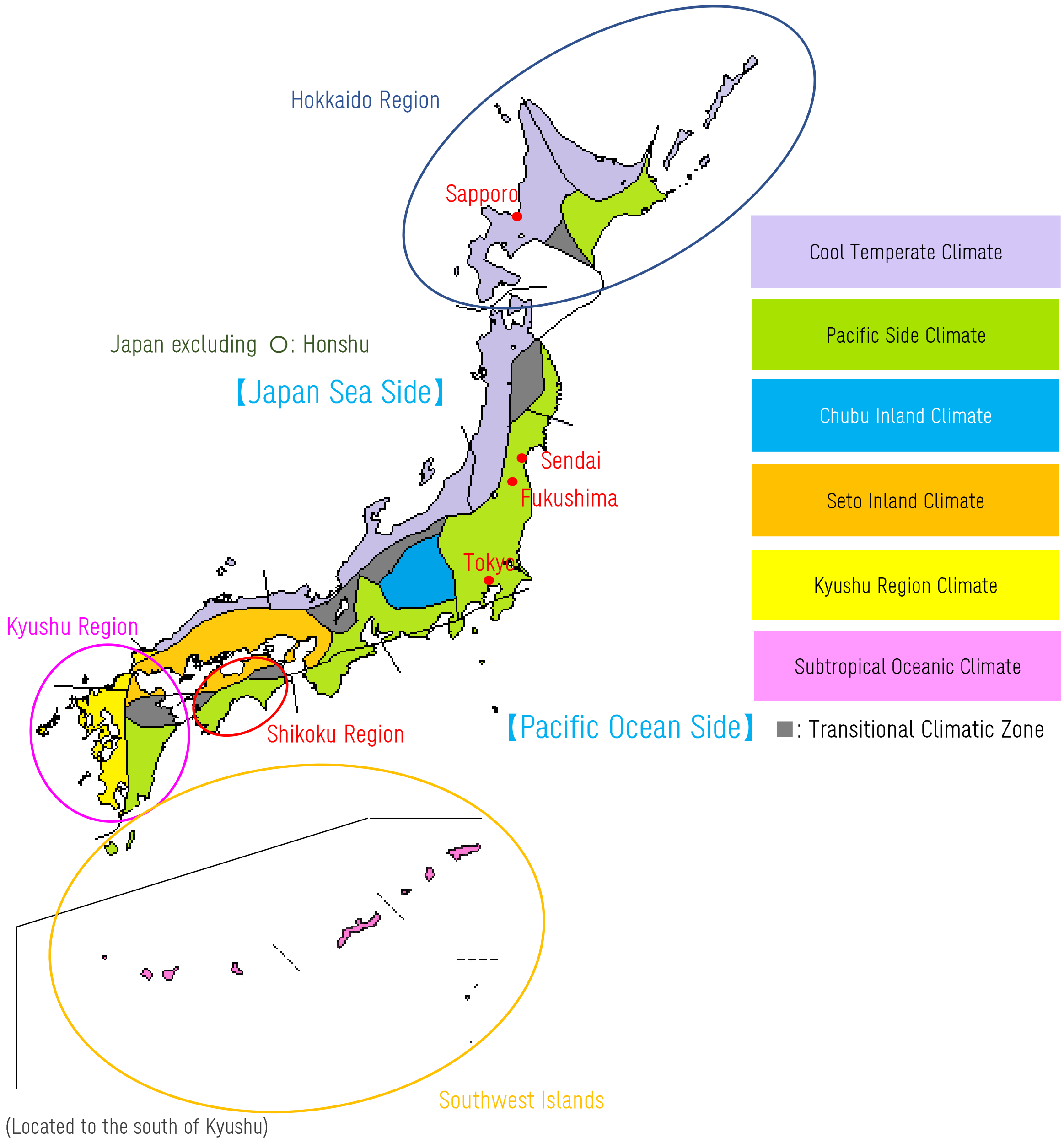


Figure 2 Japan's climatic division and regional names

(based on *The Climatic Divisions of Japan*, by Takeshi Sekiguchi (1959) and retrieved from Website of the Okinawa Regional Headquarters, JMA http://www.jma-net.go.jp/okinawa/know/kaiyo/tenko.html)

Broad features of the two climates are outlined below

Pacific Side Climate: ★Region centred on Tokyo

It is humid in summer. Maximum temperatures can rise to over 35°C in inland areas. There are many days when nighttime temperatures do not fall below 25°C in Tokyo and other major urban areas. Areas with a Pacific Side Climate are also susceptible to typhoons, and fronts and southerly air currents. These areas also receive more rainfall in June, July and September than other climate regions. Dry and cold winds cross the mountains located on the Sea of Japan side of the country bringing a large number of dry and sunny days in winter to the Pacific Side Climate areas. In terms of the broad classification, Sendai, which houses the Miyagi Stadium venue, belongs to this climate as well. However, the average temperature from July to September in the vicinity of Miyagi Stadium is approx.4°C lower than central Tokyo's one.

Cool Temperate Climate (Hokkaido): ★Including Sapporo's

The mean value of maximum temperature from July to September in Sapporo is 24.5°C. Humidity is lower and it is covered by drier air than other climatic regions. It is severely cold in winter and it is 28.3 days on average that the maximum temperature does not reach 0°C from the beginning of January to middle of February.

There are not so many countries which have multiple climate regions in countries of the size similar to Japan. In terms of the annual average temperature, it is 16.6°C in Tokyo whereas it is 6.4°C in the northern part of Hokkaido (Kitamiesashi) which is the coldest region. The difference between the coldest and warmest values in Japan is 18.2°C as it is 24.6°C in Okinawa (Ishigaki Island) which is the warmest. Japan, which its topography extends over the south and north, has four seasons. Each of climates (Figure 2) has its own features in every season. It can be continually cloudy and rainy for about a month between June and the end of July, which is the season from spring to summer.

Regarding the Olympics and Paralympics period and the other period, a summary of weathers of regions especially around Tokyo is described in the following 1-2. Furthermore, the detailed weathers of every region are explained in Chapter 3.

1-2. Overview of the weather during the period of the Olympic and Paralympic Games (24 Jul to 6 Sep)

The weather features of the regions centred on Tokyo and Sapporo, located in the north, during the period of the Olympic and Paralympic Games (24 July to 6 September), which largely corresponds to summer, are briefly explained below. Details of climatic conditions in other regions of Japan are explained in Chapter 3.

[Region centred on Tokyo]

The period between the middle of July and the end of July - just before the period of the Olympic Games - corresponds to the East Asian rainy season, which brings many rainy and cloudy days. The duration of the rainy season differs each year. In some years, it can continue until early August. Once the rainy season has ended, the weather tends to be sunny for consecutive days with plentiful sunshine. Consequently, it is likely to be considerably humid. High temperatures and high humidity are the most distinctive features of summer in Japan. Atmospheric conditions become unstable due to a strong solar radiation, which leads to the generation of cumulonimbus clouds. As a result, brief and localised thunderstorms in the afternoon are common.

From the middle of August, the weather can be changeable with hot and sunny weather sometimes being replaced by several days of cloud or rain. However, throughout this period humidity remains high. In addition, this period is also marked by the appearance of typhoons or tropical cyclones. When typhoons move in the vicinity of Japan, they often move slowly and their trajectories are difficult to predict. The reason for this is that the westerlies, which drive typhoons to the east, are located at higher latitudes than 40 degrees north. This can result in prolonged periods of rainfall, often lasting several days. A detailed description of a typhoon is featured in Chapter 2.2 Typhoons.

[Hokkaido including Sapporo]

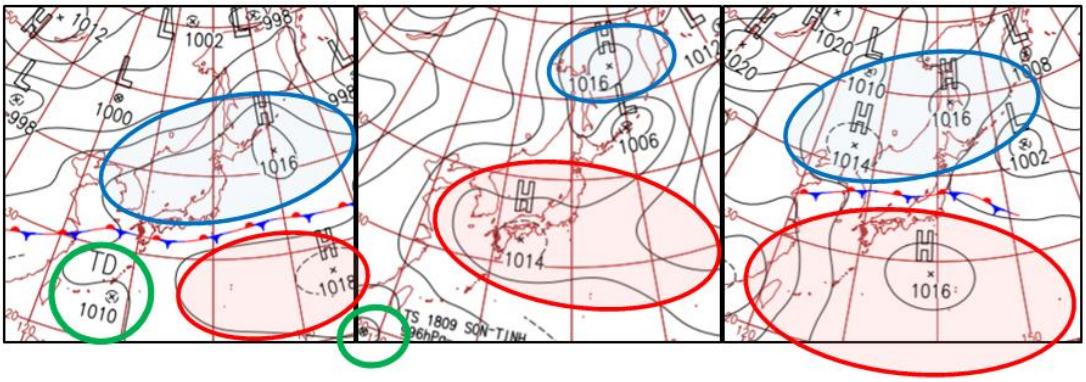
This region does not have an obvious rainy season and rainy or cloudy days do not continue for several weeks, as is the case with many other areas of Japan. It is less humid than Tokyo, and the summer months are marked by many dry and fine days. It is sometimes covered with cool air from around the middle of August.

The system that causes the above-stated weather conditions is explained below.

(Figure 3 Left) The strength of the Pacific High (subtropical high) with warm air expands to Japan from the south from June to the middle of July. On the other hand, there is another high with cold air in northern Japan. A front arises between the two highs causing them to stagnate in the vicinity of Japan, which can result in rainy and cloudy days continuing for weeks. Furthermore, during this period particularly heavy rainfalls can lead to floods, landslides and other natural disasters.

(Figure 3 Middle) As the Pacific High strengthens, it covers Japan from mid to late July. Once it begins its northward trajectory, the high weakens and periods of fine weather continue across the whole of Japan. However, it remains muggy since the high temperature and humid air along the margins of the route of the high takes across Japan. Furthermore, the atmospheric conditions can be unstable even during extended sunny periods.

(Figure 3 Right) The front tends to become stationary again from the middle of August causing several days of fine weather followed by a period of cloudy or rainy weather. If the front intensifies, heavy rainfalls may result. According to the recorded history of Tokyo, the daily amount of precipitation has ever exceeded 150mm.



Left: 29 June, 2017 0:00 (UTC[1]) (9:00 (JST[2]))

Figure 3 Example of the distribution of atmospheric pressure from June to August

■: Pacific High ■: Okhotsk High ○: Typhoon/Tropical cyclone

(Retrieved from Website of the Japan Meteorological Agency

https://www.data.jma.go.jp/fcd/yoho/hibiten/index.html)

This is an example of the distribution of the atmospheric pressure from June to the middle of July. It was cloudy in Tokyo and humidity readings indicated 100% in spite of the fact that no rain had fallen. This high humidity reading was partially caused by morning mists.

Middle: 17 July, 2018 0:00 (UTC) (9:00 (JST))

This is an example of the distribution of the atmospheric pressure from the middle of July to end of July. It was slightly cloudy all day in Tokyo. The daily maximum and minimum temperatures were 34.8°C and 26.9°C respectively. It was extremely muggy.

Right: 27 August, 2018 0:00 (UTC) (9:00 (JST))

This is an example of the distribution of the atmospheric pressure from the middle of August. It was sunny until the evening in Tokyo. The maximum temperature reached 35.8°C. A thunderstorm occurred due to intense solar radiation in the daytime and the rise in temperature. A heavy rain fell for a brief period and a rainfall amount of 16mm/h was observed at 21:00.

1 UTC: "Coordinated Universal Time" The primary time standard by which each country regulates clocks and time.

2 JST: "Japan Standard Time" Coordinated Universal Time (UTC) +9hours.

Figure 3 shows the general summer weather pattern. It rains less and the temperature is higher when the Pacific High is more influential than the average year. In contrast, cloudy or rainy days continue until August and the precipitation amounts are larger when the high is less powerful than usual. Thus, it differs slightly from year to year.

One element used to determine the trend of summer in Japan is the existence and the strength of the Pacific High and Okhotsk High. It is likely to be extremely hot when the strength of the Pacific High expands to Japan. Conversely, it tends to be a cool summer if the influence of the Okhotsk High strengthens from the north.

Figure 4 shows a typical pressure pattern during an extremely hot summer. Maximum temperatures exceeded 35°C at more than 200 observatories out of about 927 throughout Japan on 15 July 2018.

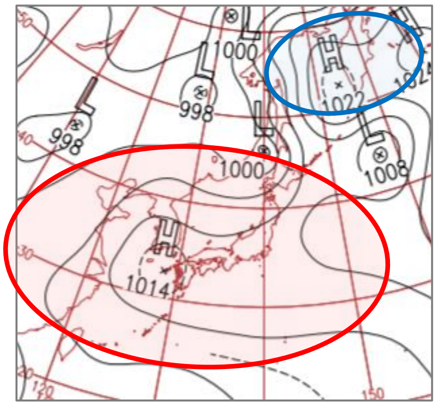


Figure 4 Example of a pressure pattern during an extremely hot summer
15 July, 2018 0:00 (UTC) (9:00 (JST))
■: Pacific High ■: Okhotsk High
(Retrieved from Website of the Japan Meteorological Agency
https://www.data.jma.go.jp/fcd/yoho/hibiten/index.html)

It was sunny in Tokyo. The temperature exceeded 30°C at 8am and it was extremely hot during the daytime.
The daily maximum and minimum temperatures were 34.5°C and 26.3°C, respectively.
The minimum humidity was 55% (around 3pm).

On the other hand, Figure 5 represents a pressure pattern during a cool summer. The Okhotsk High appeared to be gathering in strength as it expanded across the continent and Hokkaido. There was no Pacific High, which brings the heat in summer. Temperatures remained low especially in northern Japan on 12 August 2017. For example, the maximum temperature in the vicinity of Miyagi Stadium on this day was a comfortable 22.6°C (4.5°C lower than the average value for August).

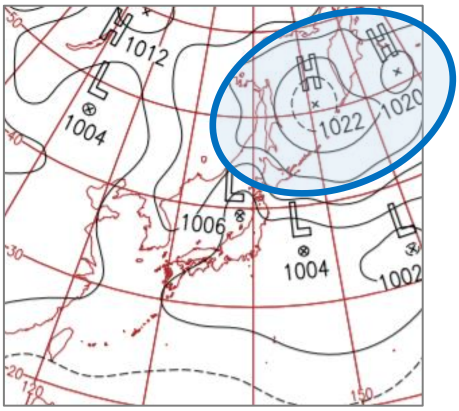


Figure 5　Example of the distribution of atmospheric pressure in a cool summer

12 August 2017　0:00 (UTC) (9:00 (JST))

■: Pacific High　■: Okhotsk High

(Retrieved from Website of the Japan Meteorological Agency

https://www.data.jma.go.jp/fcd/yoho/hibiten/index.html)

It was mainly cloudy with some rain, followed by a short period of sunshine in Tokyo. It was humid with a maximum temperature of 29.3°C in spite of the short duration of sunshine.

On the other hand, temperatures did not rise so much in the Tohoku region. The maximum temperature was 22.6°C in the vicinity of Miyagi Stadium, 4.5°C lower than the average value for August.

1-3. Overview of the weather outside the period of the Olympic and Paralympic Games (Autumn – Spring)

Next, an overview of the weather outside the period of the Olympic and Paralympic Games (Autumn - Spring) for the entire area of Japan is described below.

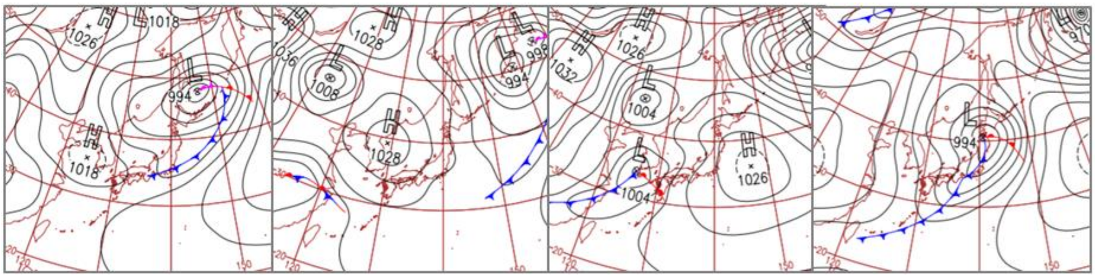
Spring

The period between March and May is defined as spring in Japan.

The weather changes by several day-cycles as high and low pressure systems pass alternately across Japan from west to east (Figure 6). In addition, there can be significant changes in the hourly and daily temperatures. The diurnal temperature range can exceed 15°C in some areas. The largest difference in the average annual daily maximum and minimum temperatures was 9.6°C, which occurred on 9 April. The average maximum temperature for April is 19.3°C, while the average minimum temperature for the month is 10.9°C.

When a migratory high covers with the region, it brings stable sunshine. Mornings and evenings are cold due to a radiational cooling phenomenon while the warm sunshine causes daytime temperatures to rise.

Fierce phenomena such as thunder, tornadoes and hail sometimes occur when a low pressure is accompanied by cumulonimbus clouds passing from the west, and stiff winds often blow. As an example, the maximum instantaneous wind speed was 27.5m/s and the wind direction was south-southwest on the coast of Tokyo in the case of Figure 6. A southerly wind gains in strength and temperatures rise as the low pressure draws near. However, the cold air that flows into it from the north after the low pressure passes often causes temperatures to fall sharply. In Sapporo and other areas of Hokkaido, snow at this time of year is not unusual.



Left: 12 April, Left middle: 13 April, Right middle: 14 April, Right: 15 April

Figure 6　Example of the pressure pattern in spring
(12 April - 15 April 2018)
0:00(UTC) (9:00 (JST)) for all of them
(Retrieved from Website of the Japan Meteorological Agency
https://www.data.jma.go.jp/fcd/yoho/hibiten/index.html)

It was rainy from the afternoon of the 14th to the morning of the 15th in Tokyo.
A precipitation rate of 10.5mm/h was observed at 8am when the front passed.
In addition, a southerly wind with a maximum instantaneous speed of 20.9 m/s was observed in central Tokyo.

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Autumn

The period between September and November is defined as autumn in Japan.

High and low pressure systems pass across Japan alternately and the weather can change by several day-cycles as in spring. When a migratory high covers the region, the weather is dry and sunny. However, as soon as a low pressure passes, the weather deteriorates temporarily; a cold air mass travels southward and cool air expands across the region. Furthermore, it is frequently influenced by an autumn rain front and occasional typhoons. Autumn is also the season when the Pacific side of eastern Japan including Tokyo experiences the highest precipitation levels. Westerly winds force typhoons to move quickly through the upper air causing occasional storms.

The temperature drops rapidly as winter approaches. Of Japan's four seasons, the autumn season experiences the highest differences in temperatures between the beginning and end of the season as well as and the highest differences between the maximum and minimum daytime temperatures.

In Japan, the first day of autumn is generally taken to be 1 September and the final day of the season is 30 November. On 1 September, the daily maximum temperature in Tokyo was 30.3°C while the daily minimum temperature was 23.3°C. The largest difference in the average annual daily maximum and minimum temperatures during the autumn season was 8.1°C, which occurred on 21 November. The daily maximum and minimum temperatures on this day were 16.9°C and 8.8°C respectively.

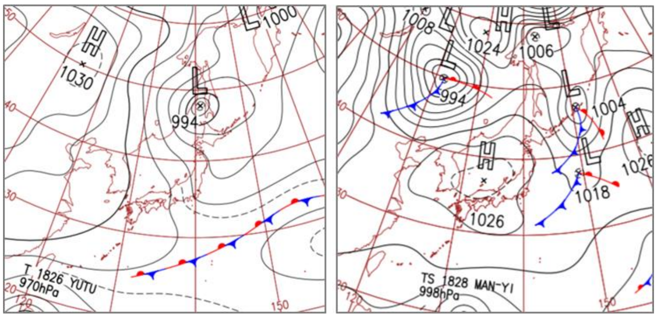


Figure 7　Example of the pressure pattern in autumn

(Retrieved from Website of the Japan Meteorological Agency

https://www.data.jma.go.jp/fcd/yoho/hibiten/index.html)

Left: 30 October 2018 9:00 (JST)

The weather in Tokyo was fine. The daily maximum temperature was 22.9ºC

and the daily minimum temperature was 11.8ºC - a difference of 11ºC.

Tokyo experienced warm and comfortable weather due to predominant northwesterly winds. On the other hand,

Hokkaido and the Sea of Japan side experienced drizzle and some mountainous areas received snow.

Right: 26 November 2018 9:00 (JST)

It was sunny in Tokyo. The daily maximum temperature was 17.7ºC and the daily minimum temperature was

7.1ºC. In addition, it was fine weather throughout Japan.

Winter

The period between December and February is defined as winter in Japan.

In terms of the climate, the regional difference is most pronounced in winter. The dry and sunny weather continues in the Pacific side including Tokyo and Sendai, while Cool Temperate Climate regions including Sapporo and the Chubu Inland Climate regions experience snow on several days.

The distribution of atmospheric pressure such as isobars around Japan is predominant as a result of the development of high-pressure systems over the western side of Japan and low-pressure systems over the eastern side. The cold air mass flows into Japan from the Asian continent. This is the typical pressure pattern during winter in Japan (Figure 8 Left). It snows on a large number of days on the Sea of Japan coast, while the weather on the Pacific Ocean side is largely dry and fine.

Apart from the above, heavy snowfalls can occur on the Pacific side when the cold air mass is powerful. This is caused by a low-pressure system heading east along the southern coast of Honshu or the Pacific side of Hokkaido (Figure 8 Middle).

Additionally, localised storms or heavy snowfalls can occur if a minor low pressure is accompanied by a cold air mass over the Sea of Japan (Figure 8 Right).

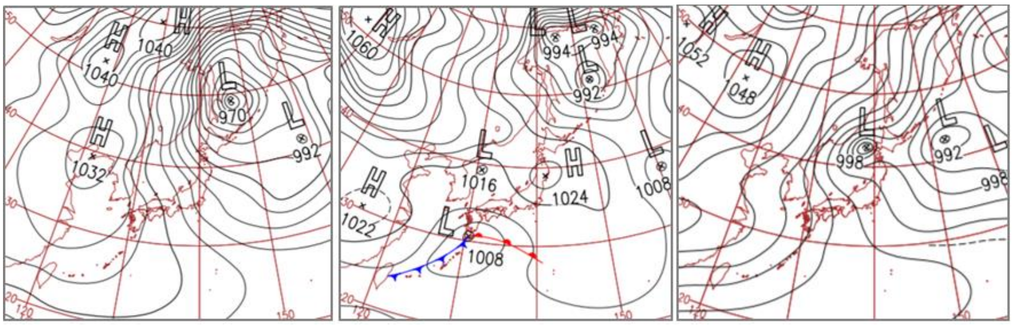


Figure 8　Example of the pressure pattern in winter
(Retrieved from Website of the Japan Meteorological Agency
https://www.data.jma.go.jp/fcd/yoho/hibiten/index.html)
Left: 27 December 2017 9:00 (JST)

The weather in Tokyo was fine. The daily maximum temperature was 9.2°C and the daily minimum temperature was 1°C. A northwesterly wind with a maximum instantaneous speed of 12 m/s was observed greatly increasing the wind-chill factor. A strong wind blew throughout the country and there were heavy snowstorms in northern Japan and the Sea of Japan side.

Middle: 22 January 2018 9:00 (JST)

It snowed heavily in Tokyo with a depth of 23cm recorded. In addition, the temperature at noon was 1°C.

Right: 5 February, 2018 9:00 (JST)

It was sunny in Tokyo. The daily maximum temperature was 8.1°C and the daily minimum temperature was 0.5°C. On the other hand, it snowed across a large swathe of the Sea of Japan coast. Some 66cm of snowfall was observed in the area of Hokkaido, which received the highest snowfall amounts.

1-4. Monthly climate comparisons with past host cities

The monthly climates for Tokyo, which houses the majority of the venues to be used at the Tokyo 2020 Games, are shown in comparison with two cities that have hosted the Olympic and Paralympic Games in recent years.

Important meteorological elements (maximum temperatures, minimum temperatures, rainfall amounts and average humidity) of the Games period are listed in 1) - 4). Monthly average values of the above elements as well as other elements (average temperatures, dew points, surface pressure, prevailing wind directions and wind speed) are listed in 5).

Summary

- In comparison to the other recent host cities, the maximum temperature in Tokyo is the highest during the period of the Olympic Games. The average maximum temperature in August is 31.6°C, which is the highest annual average maximum temperature. Over the past nine years until 2018, between seven and eight days in August have recorded maximum temperatures in excess of 35°C on average.
- The average minimum temperatures in Tokyo are also higher than the other recent host cities during the period of the Games. There are many days when the minimum temperatures exceed 25°C, though the average value is 24.7°C.
- Tokyo also experiences a larger number of precipitation days during the period of the Olympic Games than the other host cities. Precipitation amounts can be extremely large in both July and August, Tokyo experiences about 10 days when precipitation amounts are 0.5mm or higher.

(Points of concern)

※Numerical values in sentences and figures are calculated with data of the Japan Meteorological Agency by the Tokyo Organising Committee of the Olympic and Paralympic Games.

※Average values in sentences and figures are calculated based on averages of 20-year observed values between 1999 and 2018 if there is not any annotation.

1) Maximum temperatures

The maximum temperature in Tokyo is the highest during the period of the Olympic and Paralympic Games among the three host cities. The maximum temperature at the beginning of August, which corresponds to the period in which the Olympic Games will take place, is 32.5°C in Tokyo. August temperatures in Tokyo are the hottest of the year. It is as high as the maximum temperature in December in Rio de Janeiro, which is located at a lower latitude. Also, the change in temperature throughout the year is higher than in any of the three cities.

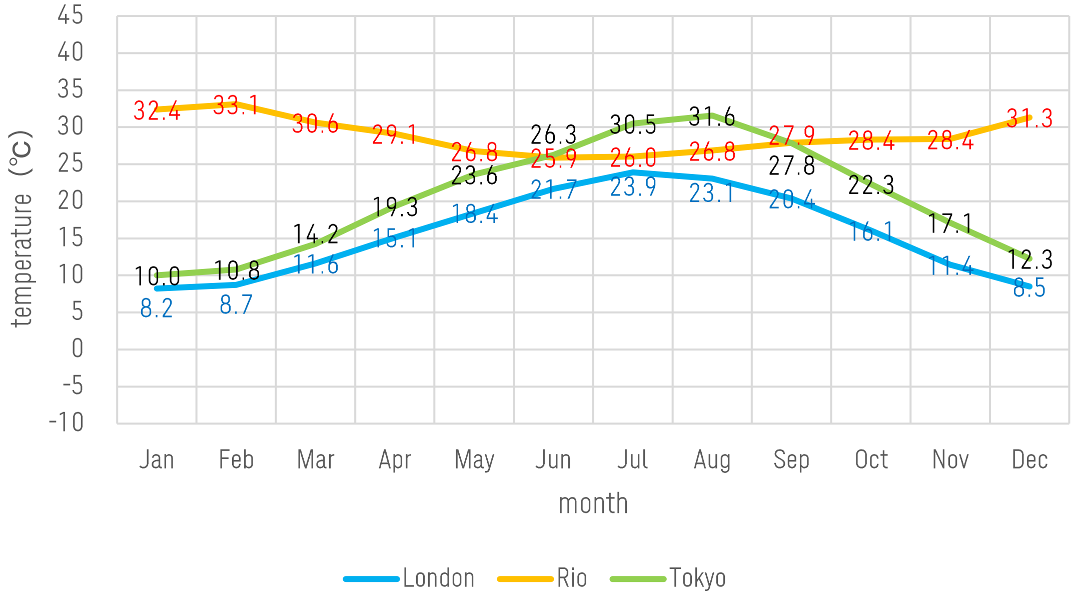


Figure 9 Maximum temperatures in each month
(Tokyo and London: Average maximum temperatures from 1999 to 2018;
Rio de Janeiro: Average maximum temperatures from 2010 to 2018)

As shown in Figure 9, the mean maximum temperature in August in Tokyo is 31.6°C, however, it far exceeds this figure on some days. Figure 10 demonstrates the number of days when maximum temperatures exceed 35°C. It has been observed that temperatures in Tokyo have exceeded 35°C in August every year since 2010. In fact, we have observed an increase in the number of such days in recent years, with the sum of these days during the nine-year period between 2010 and 2018 reaching 68. The highest recorded temperature is 39.5°C, which was observed on 20 July 2004. Furthermore, the third highest temperature recorded in Tokyo, 39.0°C, was observed on 23 July 2018.

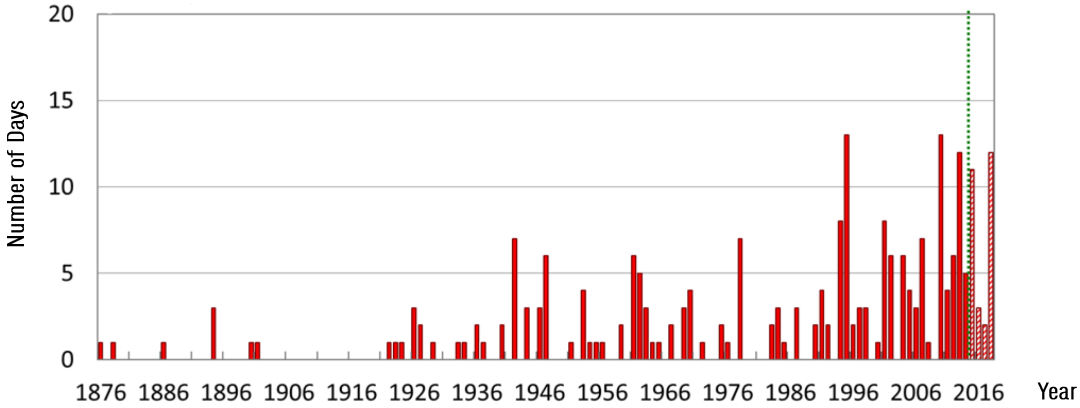


Figure 10 Number of days when daily maximum temperatures exceeded 35°C (1876-2018) Excerpt from the Meteorological Agency Website

*The green dotted line indicates the transfer of the observatory to a new location in December 2014.

2) Minimum temperatures

The minimum temperatures in Tokyo are the highest throughout the period of the Olympic and Paralympic Games among the three cities. Minimum temperatures at the beginning of August, the period during which the Olympic Games will be held, are at their highest, with minimum temperatures of 25.4°C. This is higher than in the summer months (December to February) in Rio de Janeiro.

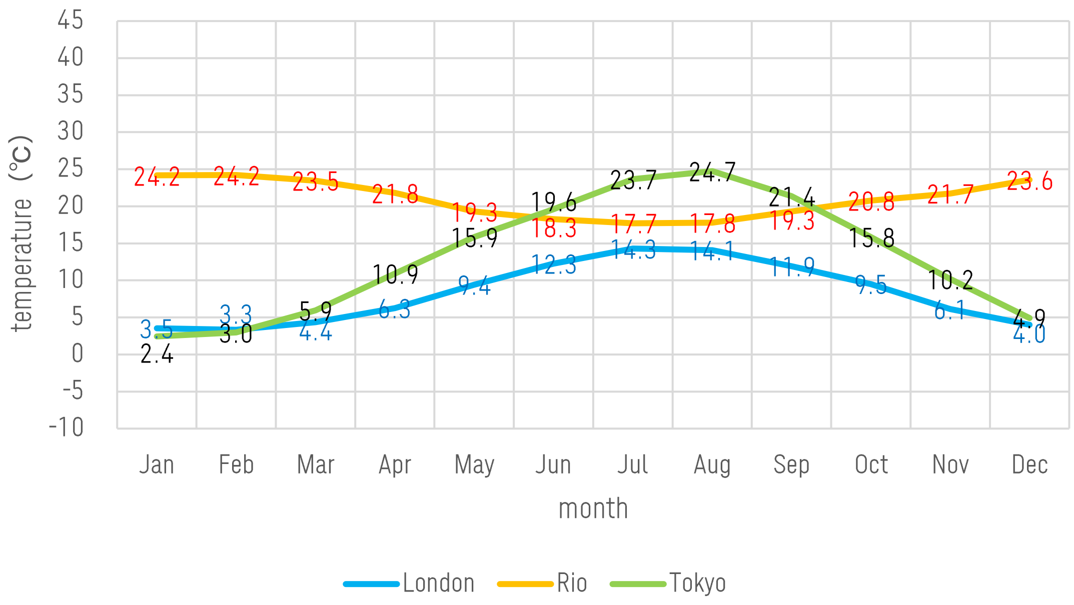


Figure 11 Minimum temperatures in each month
(Tokyo and London: Average minimum temperatures from 1999 to 2018;
Rio de Janeiro: Average minimum temperatures from 2010 to 2018)

As Figure 11 indicates, the mean minimum temperature in August in Tokyo is 24.7°C, however, it exceeds this value on several days. According to Figure 12, the number of such days has been increasing in Tokyo. The value in 2018 (the most recent year) is the sixth highest, with 42 days during which the mean minimum temperature for August was exceeded.

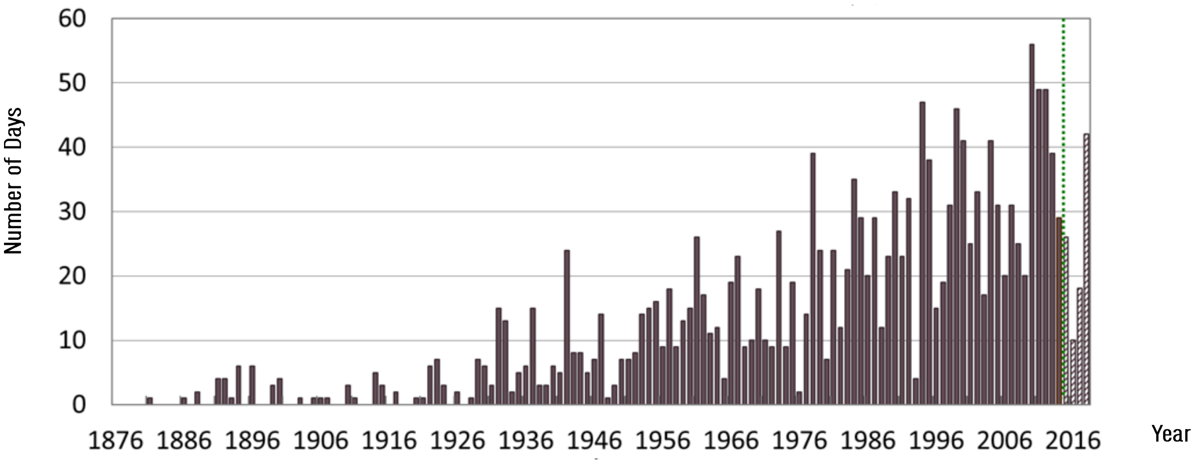


Figure 12 Number of days when daily minimum temperatures exceeded 25°C (1876-2018)
Excerpt from the Meteorological Agency Website

*The green dotted line indicates the transfer of the observatory to a new location in December 2014.

3) Precipitation amounts and number of days with precipitation

The number of days with precipitation during the period of the Olympic and Paralympic Games is likely to be higher in Tokyo compared to the other two host cities (see Figure13). Also, the precipitation amount falling at one time can be extremely large.

With regard to the number of days with precipitation amounts of 0.5mm or higher, around 10 days are recorded for both July and August. The highest precipitation amounts are observed in June when a front stagnates over the Japanese islands, and precipitation is observed on 13 days during the month. London has the highest annual rainfall levels, however, Tokyo receives more rain in the month of June than either of the other two cities. As shown in Chapter 1-2, however, many days are counted as precipitation days during the period of the Olympic Games as a result of temporal rains with rainfalls of 0.5mm or higher recorded in the afternoon, although long, sunny periods predominate.

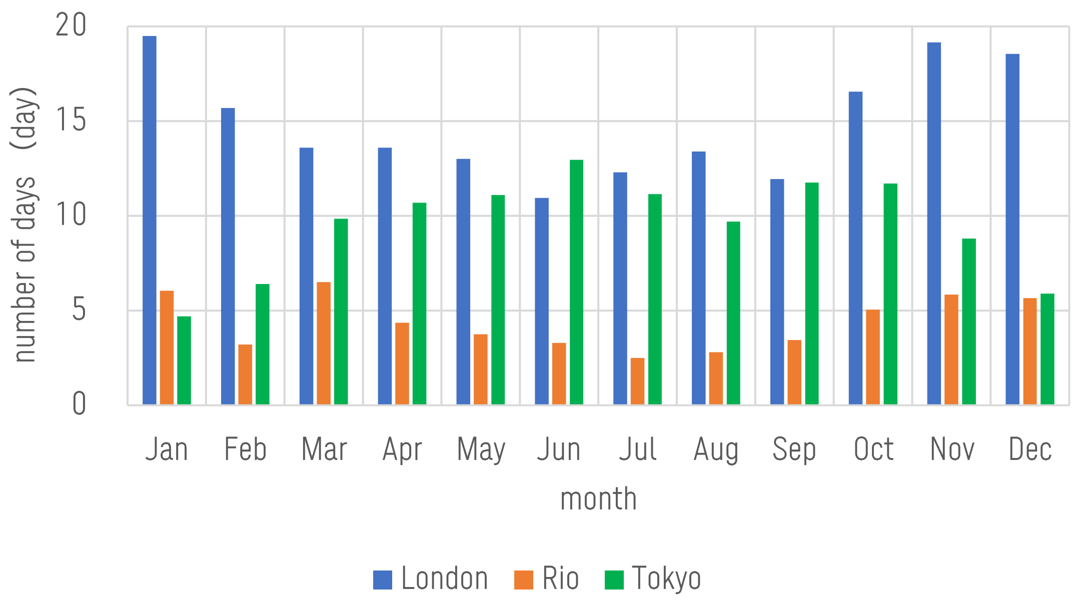


Figure 13 Number of days with precipitation in each month
(Tokyo and London: Average from 1999 to 2018; Rio de Janeiro: Average from 2010 to 2018)

Precipitation amounts in Tokyo are extremely large during the period of the Olympic Games (Figure 14). This is due to phenomena such as a rainy front (please refer to page 6) and localised heavy rainfalls during the period. The number of days with precipitation is relatively high in July. The first half of July receives the highest precipitation amounts as this is the latter period of the rainy season, though precipitation is observed on 11 days in July (i.e. approx. one third of the month).

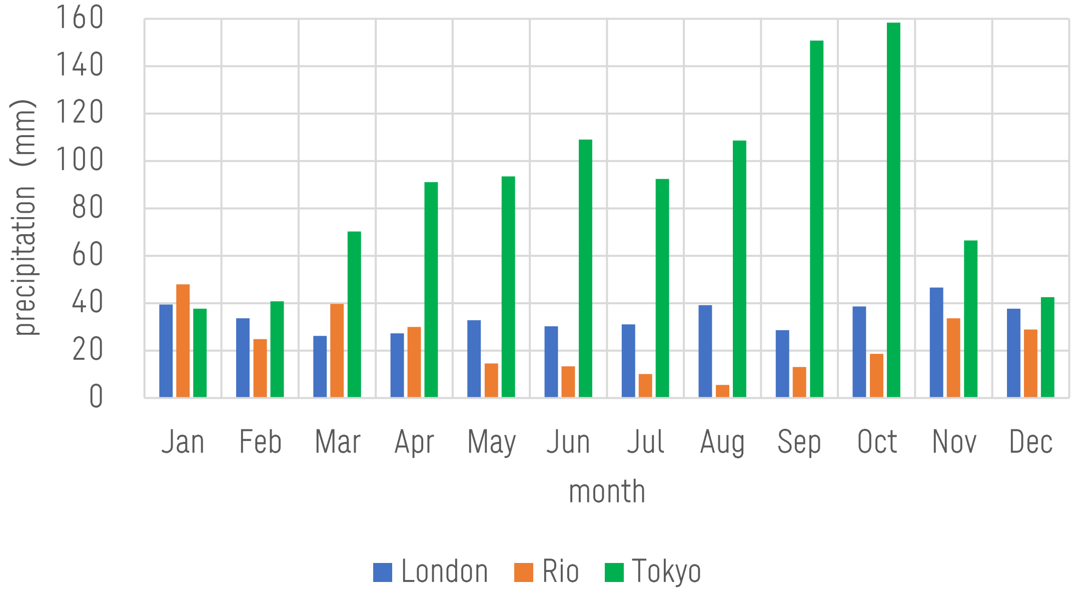


Figure 14 Average monthly precipitation
(Tokyo and London: Average from 1999 to 2018; Rio de Janeiro: Average from 2010 to 2018)

4) Average humidity

As mentioned in 1) Maximum temperatures and 2) Minimum temperatures, one of the major features of a Japanese summer is that both temperatures and humidity are high. It is muggy and uncomfortable well into the early hours of morning. In contrast, humidity is relatively lower in summer in London and in the winter in Rio de Janeiro.

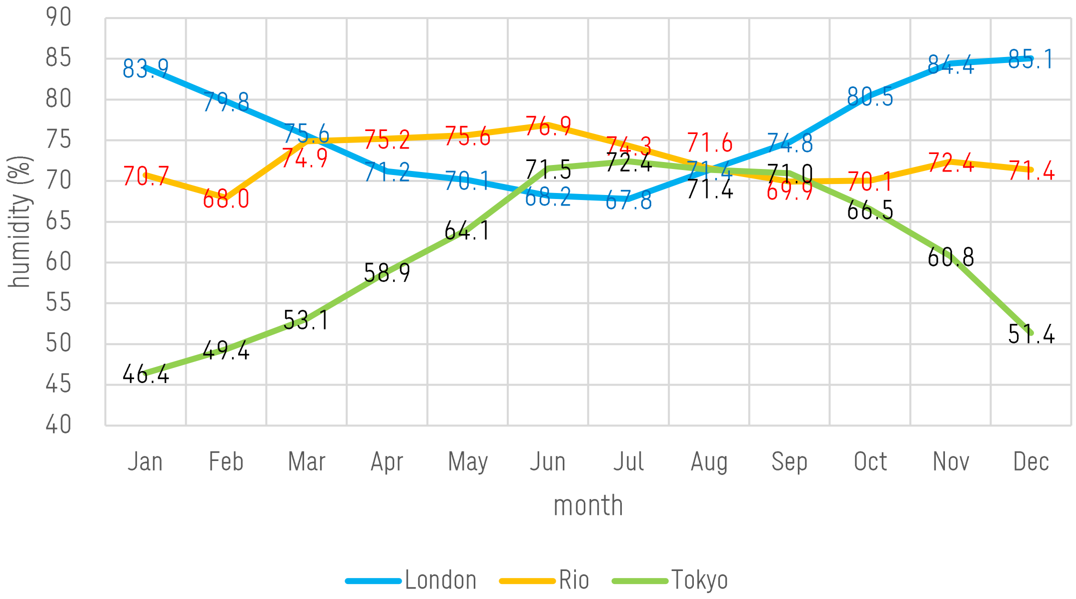


Figure 15　Average monthly relative humidity

(Tokyo and London: Average from 1999 to 2018; Rio de Janeiro: Average from 2010 to 2018)

As mentioned in 1-1, Tokyo is classified as a temperate region. However, it has both hot summer-like tropical zones and cold winters which occasionally cause relatively large amount of snowfall.

5) Monthly mean values and maximum values during the period of the Games

Elements other than figures in 1) – 4) are summarized as follows. Maximum values in the following period are shown in red. Data from Tokyo and London is taken from 1999 to 2018, while data for Rio is recorded from 2010 to 2018.

List 1 Monthly average values of temperature, precipitation, etc. and maximum values (Tokyo 1999-2018)

Climatic Values for Tokyo — from 1999 to 2018 —												
WMO Station Identifier (47662)												
Average Values												
Average Meteorological Parameters	January	February	March	April	May	June	July	August	September	October	November	December
Average temperature (℃)	6.0	6.7	10.0	14.9	19.5	22.6	26.7	27.7	24.3	18.9	13.5	8.5
Maximum temperature (℃)	10.0	10.8	14.2	19.3	23.6	26.3	30.5	31.6	27.8	22.3	17.1	12.3
Minimum temperature (℃)	2.4	3.0	5.9	10.9	15.9	19.6	23.7	24.7	21.4	15.8	10.2	4.9
Dew point temperature (℃)	-5.4	-4.2	-0.2	6.1	11.9	16.9	21.0	21.8	18.4	12.1	5.5	-1.6
Average precipitation (mm)	37.7	40.8	70.2	91.1	93.5	109.0	92.4	108.7	150.8	158.4	66.5	42.6
Number of days with precipitation	5	6	10	11	11	13	11	10	12	12	9	6
Average relative humidity (%)	46.4	49.4	53.1	58.9	64.1	71.5	72.4	71.4	71.0	66.5	60.8	51.4
Wind — average speed (m/s)	3.1	3.3	3.5	3.5	3.3	2.9	3.1	3.1	3.1	2.9	2.7	2.9
Wind — predominant direction	NNW	NNW	NNW	NNW	S	S	S	S	NNW	NNW	NNW	NNW
Atmospheric pressure at the station level (hPa)	1015.9	1016.4	1014.9	1013.8	1011.7	1009.1	1008.6	1009.8	1013.2	1016.8	1017.9	1016.5
Extreme Values												
Average Meteorological Parameters	January	February	March	April	May	June	July	August	September	October	November	December
Highest absolute maximum temperature (℃)	19.5	23.9	25.3	28.9	32.2	36.2	39.5	38.3	37.8	32.3	25.9	24.8
Lowest absolute minimum temperature (℃)	-4.0	-2.4	-0.4	1.0	8.7	12.1	17.2	17.6	13.2	8.6	0.3	-1.3
Highest maximum average temperature (℃)	13.0	18.5	19.7	23.0	26.3	30.8	33.1	33.2	32.0	27.5	19.6	17.7
Lowest minimum average temperature (℃)	0.0	0.3	2.1	4.1	11.4	15.2	19.4	19.1	15.9	10.0	2.8	1.7
Total maximum monthly precipitation (mm)	142.0	157.5	220.0	283.0	255.0	311.0	373.5	414.0	503.5	780.0	229.5	200.5
Maximum precipitation in 24 hours (mm)	68.0	76.5	65.5	99.5	121.5	123.5	130.5	151.0	156.5	222.5	85.0	154.5

■: Maximum values throughout the year (excluding wind direction)

List 2　Monthly average values of temperature, precipitation, etc. and maximum values (Rio 2010-2018)

Climatic Values for RIO DE JANEIRO — from 2010 to 2018 —												
WMO Station Identifier (83746)												
Average Values												
Average Meteorological Parameters	January	February	March	April	May	June	July	August	September	October	November	December
Average temperature (℃)	27.7	28.1	26.5	25.1	22.7	21.6	21.5	21.9	23.1	24.1	24.7	26.9
Maximum temperature (℃)	32.4	33.1	30.6	29.1	26.8	25.9	26.0	26.8	27.9	28.4	28.4	31.3
Minimum temperature (℃)	24.2	24.2	23.5	21.8	19.3	18.3	17.7	17.8	19.3	20.8	21.7	23.6
Dew point temperature (℃)	21.4	21.1	21.4	20.1	17.9	17.1	16.3	16.0	16.8	17.9	19.0	20.8
Average precipitation (mm)	47.9	24.9	39.7	30.0	14.5	13.3	10.1	5.5	13.1	18.6	33.6	28.9
Number of days with precipitation	6	3	7	4	4	3	3	3	3	5	6	6
Average relative humidity (%)	70.7	68.0	74.9	75.2	75.6	76.9	74.3	71.6	69.9	70.1	72.4	71.4
Wind — average speed (m/s)	3.3	3.2	3.0	2.9	2.6	2.4	2.5	3.0	3.3	3.6	3.4	3.4
Wind — predominant direction	SE	E	SE	SE	SE	ESE	SE	E	SE	SE	SE	SE
Atmospheric pressure at the station level (hPa)	1011.8	1012.3	1013.3	1015.4	1017.5	1019.2	1020.4	1019.6	1017.8	1014.9	1012.9	1011.2
Extreme Values												
Average Meteorological Parameters	January	February	March	April	May	June	July	August	September	October	November	December
Highest absolute maximum temperature (℃)	39.2	40.1	38.0	35.5	33.8	32.8	36.3	36.7	39.8	40.1	40.2	40.0
Lowest absolute minimum temperature (℃)	19.0	20.3	19.4	14.8	14.3	12.5	11.6	12.4	12.0	13.9	15.7	16.9
Highest maximum average temperature (℃)	31.8	32.4	31.7	29.0	27.2	26.9	27.4	27.5	30.8	31.8	32.4	33.1
Lowest minimum average temperature (℃)	20.9	21.8	20.8	19.7	18.8	16.7	15.0	16.4	17.3	19.2	18.4	20.4
Total maximum monthly precipitation (mm)	359.8	185.0	379.3	183.7	125.5	60.1	95.1	59.0	88.3	131.0	166.5	202.9
Maximum precipitation in 24 hours (mm)	126.0	87.0	66.7	83.0	38.0	36.1	28.0	22.0	57.0	46.0	83.0	88.0

■: Maximum values throughout the year (excluding wind direction)

List 3　Monthly average values of temperature, precipitation, etc. and maximum values (London 1999-2018)

Climatic Values for London — from 1999 to 2018 —												
WMO Station Identifier (03772)												
Average Values												
Average Meteorological Parameters	January	February	March	April	May	June	July	August	September	October	November	December
Average temperature (℃)	5.7	5.8	7.6	10.3	13.6	16.7	18.7	18.1	15.7	12.4	8.6	6.2
Maximum temperature (℃)	8.2	8.7	11.6	15.1	18.4	21.7	23.9	23.1	20.4	16.1	11.4	8.5
Minimum temperature (℃)	3.5	3.3	4.4	6.3	9.4	12.3	14.3	14.1	11.9	9.5	6.1	4.0
Dew point temperature (℃)	3.1	2.4	3.2	4.8	7.7	10.3	12.0	12.3	10.8	8.9	6.0	3.8
Average precipitation (mm)	39.4	33.6	26.3	27.3	32.9	30.3	31.1	39.2	28.7	38.7	46.7	37.7
Number of days with precipitation	20	16	14	14	13	11	12	13	12	17	19	19
Average relative humidity (%)	83.9	79.8	75.6	71.2	70.1	68.2	67.8	71.4	74.8	80.5	84.4	85.1
Wind — average speed (m/s)	4.5	4.3	4.2	4.0	4.0	4.0	4.0	3.8	3.7	4.0	4.0	4.3
Wind — predominant direction	W	W	W	W	W	W	W	W	W	SSW	W	W
Atmospheric pressure at the station level (hPa)	1015.1	1015.6	1015.2	1014.5	1015.4	1016.7	1015.0	1014.9	1016.6	1014.2	1013.2	1015.8
Extreme Values												
Average Meteorological Parameters	January	February	March	April	May	June	July	August	September	October	November	December
Highest absolute maximum temperature (℃)	15.4	18.1	22.8	28.5	30.7	32.6	36.7	37.9	32.8	28.8	18.5	16.4
Lowest absolute minimum temperature (℃)	-8.2	-6.8	-5.1	-1.6	2.0	5.3	7.5	5.9	3.3	-0.6	-4.8	-9.4
Highest maximum average temperature (℃)	13.4	14.0	15.7	20.1	22.7	26.1	27.0	27.5	24.2	20.4	16.2	14.8
Lowest minimum average temperature (℃)	-3.1	-3.8	-2.7	2.2	6.9	10.4	12.6	12.4	9.7	3.3	-1.9	-3.8
Total maximum monthly precipitation (mm)	154.6	102.0	94.6	100.2	99.4	109.8	119.2	122.8	106.8	154.2	150.2	110.4
Maximum precipitation in 24 hours (mm)	22.0	28.0	21.8	24.2	33.0	30.0	40.0	48.0	30.4	35.4	30.6	32.0

■: Maximum values throughout the year (excluding wind direction)

【Used data specification in this chapter】

Content:

The data used is surface synoptic observations (SYNOP) data that meteorological organisations in countries all over the world observed and reported every 6 hours and daily SYNOP meteorological data produced by the Meteorological Agency. Data for Tokyo, however, is equivalent to the values indicated on the official website of the Meteorological Agency, which is produced and managed by the agency (as of 2 April 2019) (https: //www.data.jma.go.jp/obd/stats/etrn/index.php)

Data collection periods: London and Tokyo: 1 January 1999 to 31 December 2018

Rio de Janeiro: 18 August 2010 to 31 December 2018

(Confirmation of average, maximum or minimum of the period)

Area: 3 areas (【】 shows international index numbers

() shows latitude, longitude and altitude of each observation point)

1)【03772】 Games in 2012: London (51.48N, 0.45W, 24.4m)

2)【83746】 Games in 2016: Rio de Janeiro (22.82S, 43.25W, 6m)

3)【47662】 Games in 2020: Tokyo (Before 2014 35.69N, 139.76E, 6.1m)

(After 2014 35.69N, 139.75E, 25.2m)

Temporal resolution and elements:

1) Data every 6 hours (Observed values at 00Z, 06Z, 12Z and 18Z (UTC)):

Temperature, relative humidity, dew point temperatures, sea level pressures, wind directions, and wind speeds.

2) Daily data:

Daily mean temperature, daily minimum temperature, daily maximum temperature and daily precipitation.

Notes:

- There is some missing data due to local meteorological agencies failing to report local data, etc.
- SYNOP is prompt data. Therefore, SYNOP data is not modified even if observed data has been corrected by the local meteorological agency at a later date. This is the reason that 'data every 6 hours' and 'daily data' are not the same as the formal data announced by the agencies.
- Some abnormal values remain, although most have been removed through various methods.

2. Characteristic natural phenomena in Japan

Many areas of Japan, including Tokyo, are prone to natural disasters such as torrential rains, typhoons and earthquakes. This is due to such factors as the country's geographic location, topography, geology and meteorological phenomenon.

Each section in this chapter describes characteristic weather phenomena in Japan. Section 2-1. features Summer thunderstorms, 2-2. focuses on Typhoons and 2-3. details Earthquakes

※Please refer to the Appendix [Rain intensity and how rain falls] and [Wind intensity and how wind blows] for interpreting numerical values expressed rain or wind intensity in context.

2-1. Summer thunderstorms

As mentioned in Chapter 1-2, the weather in the summer months - the period during which the Olympic and Paralympic Games will take place - is generally fine across most of Japan.

However, heavy rainfalls with an hourly precipitation rate of tens of millimeters are not uncommon during this period. Occasionally, these heavy rainfalls are accompanied by thunder and lightning, heavy gusts and even hailstorms, and usually occur in the afternoon. While the rainfalls can occur at any location across Japan, they tend to occur more frequently in inland or mountainous regions than coastal regions. In addition, although rainfalls are more frequent in the afternoon, they can sometimes occur during the early morning or at night.

【Example of a summer thunderstorm】Tokyo 19 August 2017

Summer thunderstorms differ in scale, duration and area. Below is the description of a summer thunderstorm, which lasted for a longer than usual period and was relatively wide ranging across the Tokyo area, where many Tokyo 2020 Games venues are located.

It was mainly sunny until 15:00 on 19 August 2017 in the vicinity of Tokyo. However, thunderclouds rapidly expanded from around 16:00 bringing driving rain, a hailstorm, lightning strikes and gusty winds.

Rainfalls of 37mm/h were observed in the vicinity of the Asaka Training Field of the Japan Ground Self-Defense Force, where the Tokyo 2020 Games shooting competition will take place (Figure 17), while 25mm/h rainfall was recorded around the Kasumigaseki Country Club where the golf competitions will be held (Figure 18). As Figure 17 and Figure 18 below indicate, temperatures dropped suddenly by 5°C or more and winds strengthened in tandem with the heavy rain.

Figure 16 shows the distribution of rain clouds (radar echo) and the direction and velocity of the wind around the area. A cumulonimbus cloud developed suddenly after the first rain cloud occurred at 15:10. The initial heavy rain moved southward in the direction of Tokyo Bay. However, a new belt-like cumulonimbus cloud formed and expanded in the area in which winds converged leading to organised thunderstorms at around 17:30.

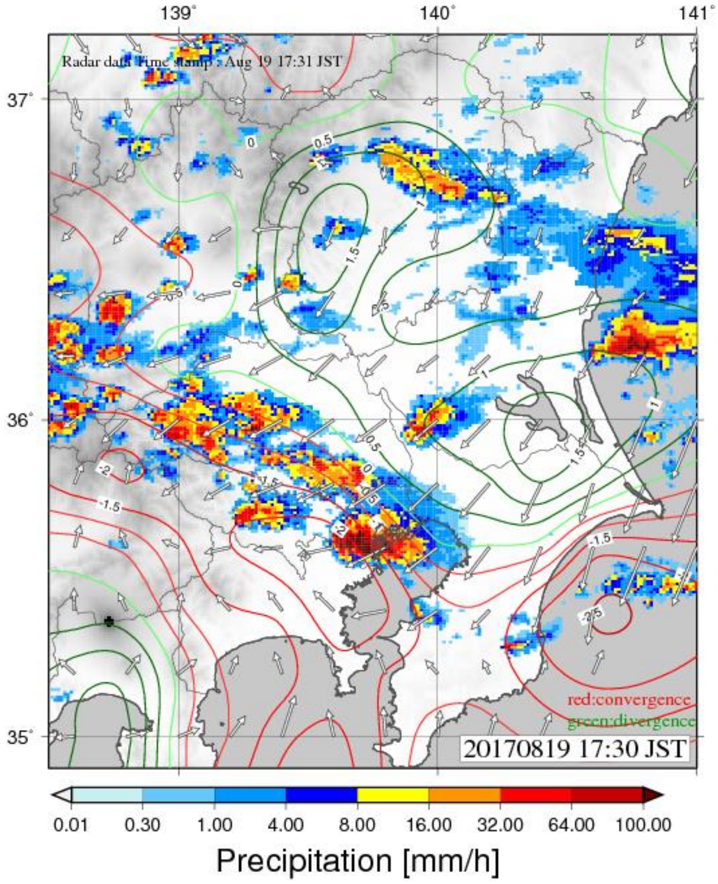


Figure 16　Overlaying of weather radar (19 August 2017 at 17:30 (JST))

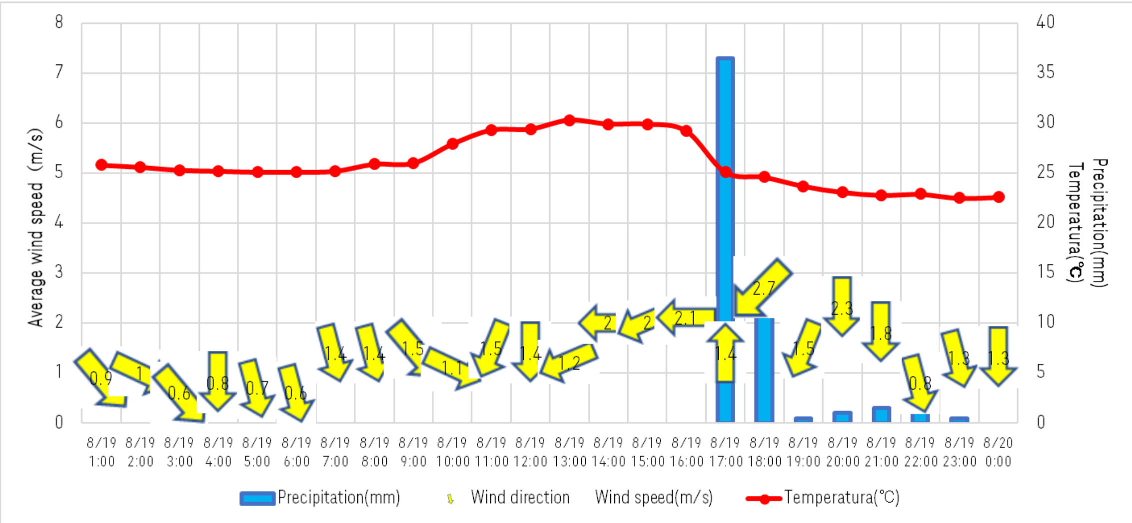


Figure 17 Time series transitions of hourly precipitation, temperatures, and wind directions and wind speeds in the vicinity of the Asaka Training Field of the Japan Ground Self-Defense Force (19 August 2017 values observed by AMeDAS Nerima)

It was sunny until 15:00. However, rainfall started at 16:10 and heavy rain ensued with a precipitation rate of 15mm per 10-minute period recorded at 16:50

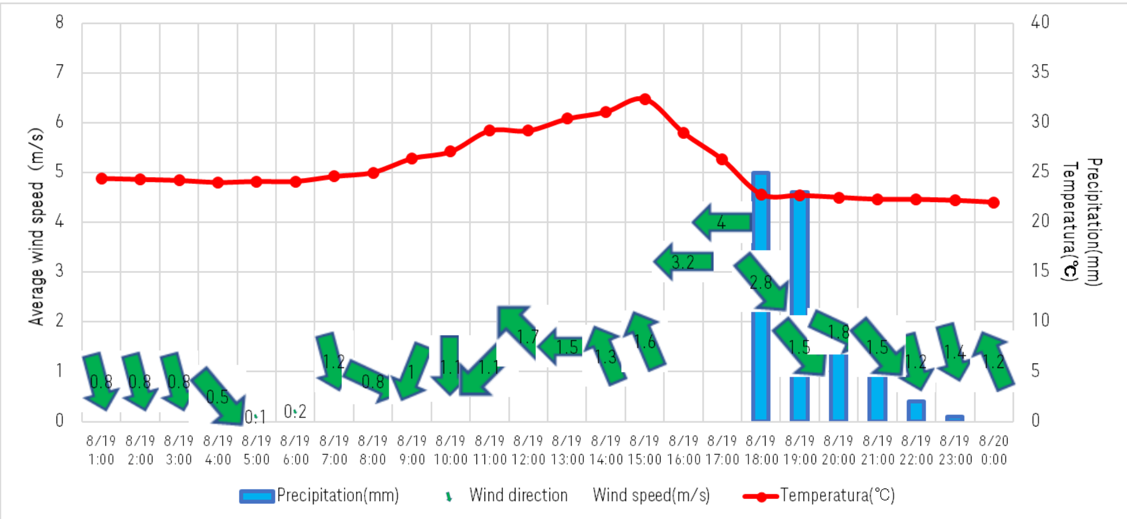


Figure 18 Time series transitions of hourly precipitation, temperatures, and wind directions and wind speeds in the vicinity of the Kasumigaseki Country Club (19th August 2017 values observed by AMeDAS Hatoyama)

It was sunny until 15:00. However, rainfall started at 17:00 and heavy rain ensued with a precipitation rate of 12.5mm per10-minute period recorded at 18:10

Some 2,219 lightning strikes occurred over a period of 4 hours 29 minutes from 16:20 to 20:49 within a 10km radius of the Western Central Tokyo Venues (Page 68). Nine people were injured as a result of these lightning strikes and there were six cases of under-floor inundation in the Setagaya district of Tokyo, where the venue for the Equestrian competitions is located. In addition, eight cases of above-floor level inundation and nine cases of under-floor inundation occurred in the Nerima district of Tokyo, where the shooting venue (Asaka Training Field of Japan Ground Self-Defense Force) is situated.

The system that resulted in the summer thunderstorm involved a damp air warming up around ground level and rising due to an intense insolation, and finally turning into a cumulonimbus. Such systems inevitably lead to such fierce phenomena as described above. Heavy rain and thunder tend to cease in about an hour due to the rapid development of a cumulonimbus, which often disappears after about an hour.

The maximum height (vertical direction) of the cumulonimbus in summer reaches close to the tropopause. The boundary is clear between the rainfall and non-rainfall regions as the width (horizontal direction) of each cumulonimbus is narrow.

The reason that rainfall often occurs in the afternoon is due to ascending air currents which are likely to occur as the difference between the ground-level and upper-air temperatures expand due to the increase in ground-level temperatures in the afternoon. In the case of the summer thunderstorm of 19 August 2017, an high formed over the Sea of Okhotsk and a cold and moist air flowed into the area from the north. On the other hand, a warm and moist air around the Pacific High moved towards the Tokyo area from the south. These two highs collided with each other over the Kanto region. Furthermore, cold air with a temperature of -6°C or lower was prevalent in the air at around 500 hPa and atmospheric conditions became widely unstable. Then, a cumulonimbus cloud made rapid local progress.

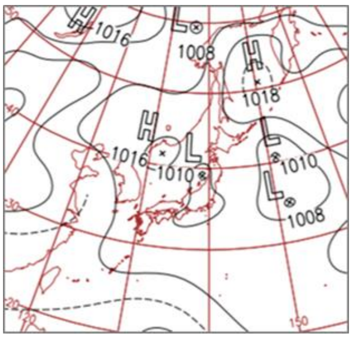


Figure 19 Surface weather chart
19 August 2017 9:00 (JST)

2-2. Typhoons

<Summary of a typhoon>

As mentioned in Chapter 1-2, the weather in the summer months - the period during which the Olympic and Paralympic Games will take place - is generally fine across most of Japan. However, rain or winds can intensify and turn into either a half-day or full-day storm when a typhoon[3] over the seas to the south of Japan heads north and approaches or makes landfall. Rain with a precipitation rate of around 20mm/h and storms with a wind speed of around 40m/s have been observed in Tokyo over the past five years.

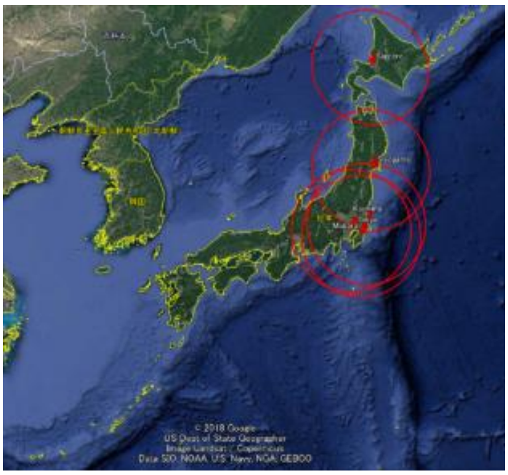
The strength of each typhoon varies. Furthermore, each degree of influence is distinct depending on which course each typhoon takes even if they are similar in strength. Extremely heavy rains and strong winds can occur even if a typhoon is located hundreds of kilometres away from the area.

Typhoons have the potential to cause major disruption including the cancellation of several different modes of public transportation (e.g. air flights and trains). The national meteorological organisation provides updates on typhoon-related information and this information is conveyed various media when the impact is predicted to be significant.

<Typhoons that have occurred in regions in which Tokyo 2020 Games venues are located between 1999 and 2018>

During the period 1999 to 2018, there have been 90 cases of typhoons moving to within 300km of the vicinity of Games venues. Seven of these displayed daily maximum wind speeds of 15m/s or higher.

List 4 shows the typhoons that approached[4] within 300km of any of the AMeDAS stations nearest the main Olympic venues between 1999 and 2008.



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[3] A typhoon is a tropical cyclone which exists on the northwesterly Pacific Ocean (a region of higher latitude than the equator and further west than 180° east longitude) or the South China Sea. Maximum values of 10-minute period mean wind speeds inside the low-pressure area is over 17m/s (34 knots).

[4] Approach and Landfall: The Japan Meteorological Agency defines "Approach" as the centre of a typhoon entering within 300km of a certain point. "Landfall" is defined as it reaching a coast of Hokkaido, Honshu, Shikoku or Kyushu. Therefore, this survey defines the typhoon or tropical cyclone that passed within 300km of any of observatories (Tokyo, Kashima, Mobara, Shiogama and Sapporo) as "typhoon which approached". Red circles on the map show 300km ranges from each AMeDAS station.

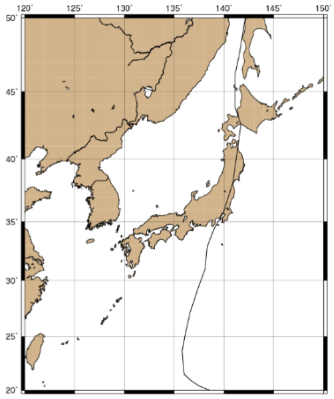
List 4 Typhoons which approached main venues (1999-2018)

NO	Typhoon Number	NO	Typhoon Number	NO	Typhoon Number	NO	Typhoon Number	NO	Typhoon Number
1	199916	21	200402	41	200709	61	201318	81	201722
2	199918	22	200404	42	200711	62	201322	82	201805
3	200003	23	200406	43	200720	63	201326	83	201807
4	200005	24	200410	44	200807	64	201327	84	201812
5	200012	25	200411	45	200811	65	201408	85	201813
6	200017	26	200415	46	200813	66	201416	86	201819
7	200111	27	200416	47	200909	67	201418	87	201820
8	200115	28	200418	48	200911	68	201419	88	201821
9	200117	29	200421	49	200918	69	201506	89	201824
10	200121	30	200422	50	200920	70	201518	90	201825
11	200206	31	200423	51	201004	71	201607		
12	200207	32	200507	52	201007	72	201609		
13	200213	33	200511	53	201009	73	201610		
14	200215	34	200514	54	201014	74	201611		
15	200221	35	200517	55	201102	75	201616		
16	200304	36	200603	56	201115	76	201618		
17	200306	37	200607	57	201204	77	201703		
18	200310	38	200613	58	201217	78	201705		
19	200314	39	200704	59	201304	79	201718		
20	200315	40	200705	60	201317	80	201721		

There were 90 typhoons that met the conditions.

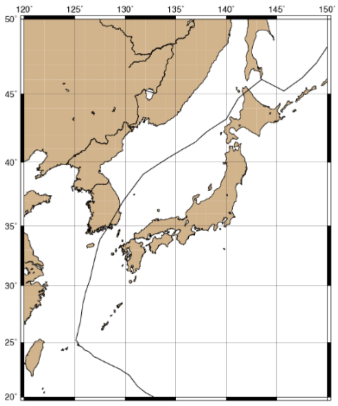
Seven of these typhoons (typhoons with typhoon numbers marked in yellow on List 4) were termed as typhoons that affected regions in which Tokyo 2020 Games venues are located. This means a typhoon or tropical cyclone in which a daily maximum wind speed of 15m/s or higher was observed in at least one observation point (Tokyo, Kashima, Mobara, Shiogama and Sapporo) when it approached. These seven typhoons are explained in detail below.

＊Typhoon Number: No.21 in 2002 (Typhoon Name: HIGOS)



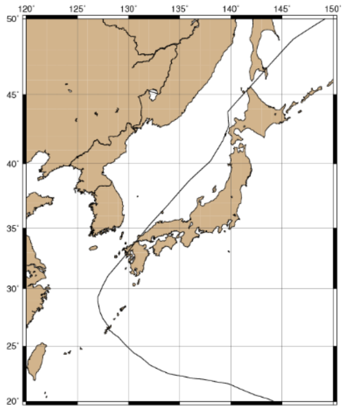
・Period of high influence on venue: 1 October 2002
・Maximum wind speed: 48.9m/s (95KT)
・Atmospheric pressure the closest to venue: 965hPa
・Influence on venue: Gale in the vicinity of the Tsurigasaki Surfing Beach (Page 89)
・Observed values in venue:
Average wind speed of 10m/s or higher for two hours and a maximum wind speed of 16m/s in the vicinity of Tsurigasaki Surfing Beach.

＊Typhoon Number: No.14 in 2003 (Typhoon: MAEMI)



・Period of high influence on venue: 13-14 September 2003
・Maximum wind speed: 54m/s (105KT)
・Atmospheric pressure closest to venue: 980hPa
・Influence on venue: Gale in the vicinity of Sapporo Dome (Page 110)
・Observed values in venue:
Average wind speed of 10m/s or higher for 13 hours, maximum wind speed of 16 m/s and maximum instantaneous wind speed of 31.4 m/s in the vicinity of Sapporo Dome (northwesterly winds)

＊Typhoon Number: No.18 in 2004 (Typhoon Name: SONGDA)



・Period of high influence on venue: 7-8 September 2004

・Maximum wind speed: 48.9 m/s (95KT)

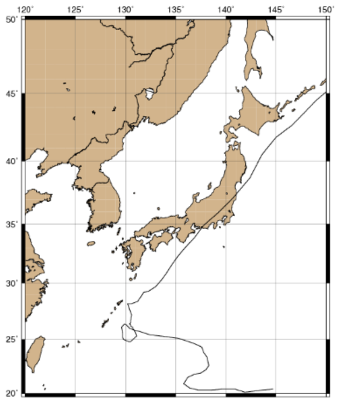
・Atmospheric pressure closest to venue: 968hPa

・Influence on venue: Gale in the vicinity of Sapporo Dome (Page 110)

・Observed values in venue:

Average wind speed of 10m/s or higher for 7 hours, maximum wind speed of 21.7 m/s and maximum instantaneous wind speed of 50.2 m/s in the vicinity of Sapporo Dome (southwesterly winds)

＊Typhoon Number: No.15 in 2011 (Typhoon Name: ROKE)



・Period of high influence on venues: 21-22 September 2011

・Maximum wind speed: 43.7m/s (85KT)

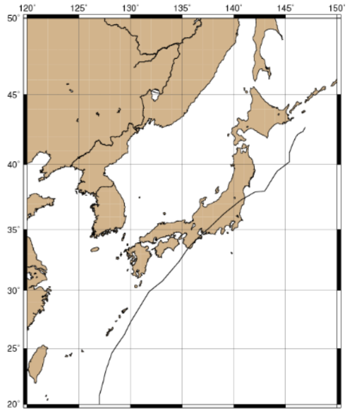
・Atmospheric pressure closest to venues: 955hPa

・Influence on venue: Gale in Tokyo (around Central Tokyo Venues (Page 57) and Bay Venues (Page 63))

・Observed values in venues:

Average wind speed of 10m/s or higher for 4 hours, maximum wind speed of 16.9 m/s and maximum instantaneous wind speed of 36 m/s in Tokyo (southerly winds)

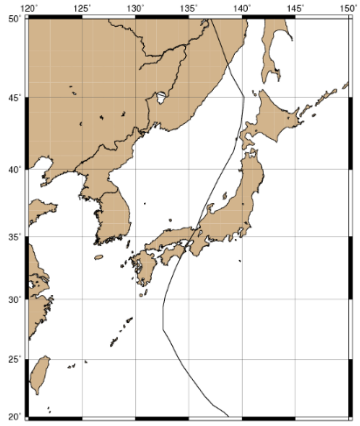
＊Typhoon Number: No.4 in 2012 (Typhoon Name: GUCHOL)



- Period of high influence on venues: 19-20 June 2012
- Maximum wind speed: 51.4m/s (100KT)
- Atmospheric pressure closest to venues: 980hPa
- Influence on venues: Gale in Tokyo (around Central Tokyo Venues (Page 57) and Bay Venues (Page 63)))
- Observed values in venues:

Average wind speed of 10m/s or higher for 3 hours, maximum wind speed of 16.3 m/s and maximum instantaneous wind speed of 32.7 m/s in Tokyo (southerly winds)

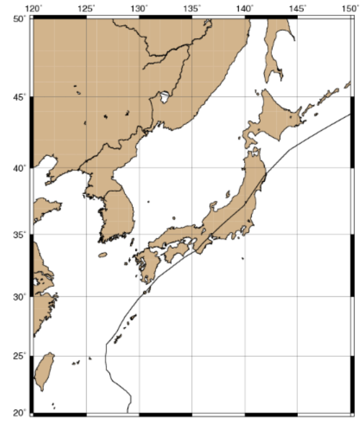
＊Typhoon Number: No.21 in 2018 (Typhoon Name: JEBI)



- Period of high influence on venue: 4-5 September, 2018
- Maximum wind speed: 54m/s (105KT)
- Atmospheric pressure closest to venue: 975hPa
- Influence on venue: Gale in the vicinity of Sapporo Dome (Page 110)
- Observed values in venue:

Average wind speed of 10m/s or higher for 9 hours, the maximum wind speed of 18.4 m/s and maximum instantaneous wind speed of 32.8 m/s in the vicinity of Sapporo Dome (southeasterly winds)

＊Typhoon Number: No.24 in 2018 (Typhoon Name: TRAMI)



- Period of high influence on venues: 30 September-2 October in 2018
- Maximum wind speed: 54m/s (105KT)
- Atmospheric pressure closest to venues: 950hPa (Tokyo), 970hPa (Miyagi Stadium)
- Influence on venues:
  Gale in Tokyo (around Central Tokyo Venues and Bay Venues) and in the vicinity of Miyagi Stadium (Page 105)
- Observed values in venues:
  Tokyo
  Average wind speed of 10m/s or higher for 4 hours, maximum wind speed of 18.2 m/s and maximum instantaneous wind speed of 39.3 m/s in the vicinity of Tokyo (southerly winds)
  Miyagi Stadium
  Average wind speed of 10m/s or higher for 3 hours, maximum wind speed of 15.3 m/s and maximum instantaneous wind speed of 28 m/s in the vicinity of Miyagi Stadium (southeasterly winds)

The frequency and course of typhoons vary depending on the season. The routes taken by the typhoons indicated in List 4 are described by months in Figure 20 only if the relevant typhoons were recorded in order to show these variations.

Typhoons begin to approach and make landfall from May.

Many typhoons, which move eastward over the Pacific side of Japan along the margin of the Pacific High, approach Tokyo in July. Some of these typhoons make a wide berth around the Japanese Islands and head towards Hokkaido via the Sea of Japan.

Both the numbers of occurrences and landfalls increase in August. However, typhoons move slowly around Japan and each of them is on a distinct course since westerlies lean to the north in the sky. In some cases, typhoons have a similar impact to a windstorm, staying over a particular area for an extended period of time due to its slow speed.

From September onwards, typhoons tend to head in a northwestly direction from the seas to the far south of Japan. They then abruptly turn in an easterly direction over the seas to the east of Taiwan or Nansei Islands and move toward the main Japanese island of Honshu. The number of such typhoons also increases during this period. In October, impacted by westerlies, typhoons travel quickly toward the northeast over the Pacific side of Honshu as westerlies go south and are situated in and around Japan. This is the reason that typhoons have a shorter impact than rainstorms can have in August.

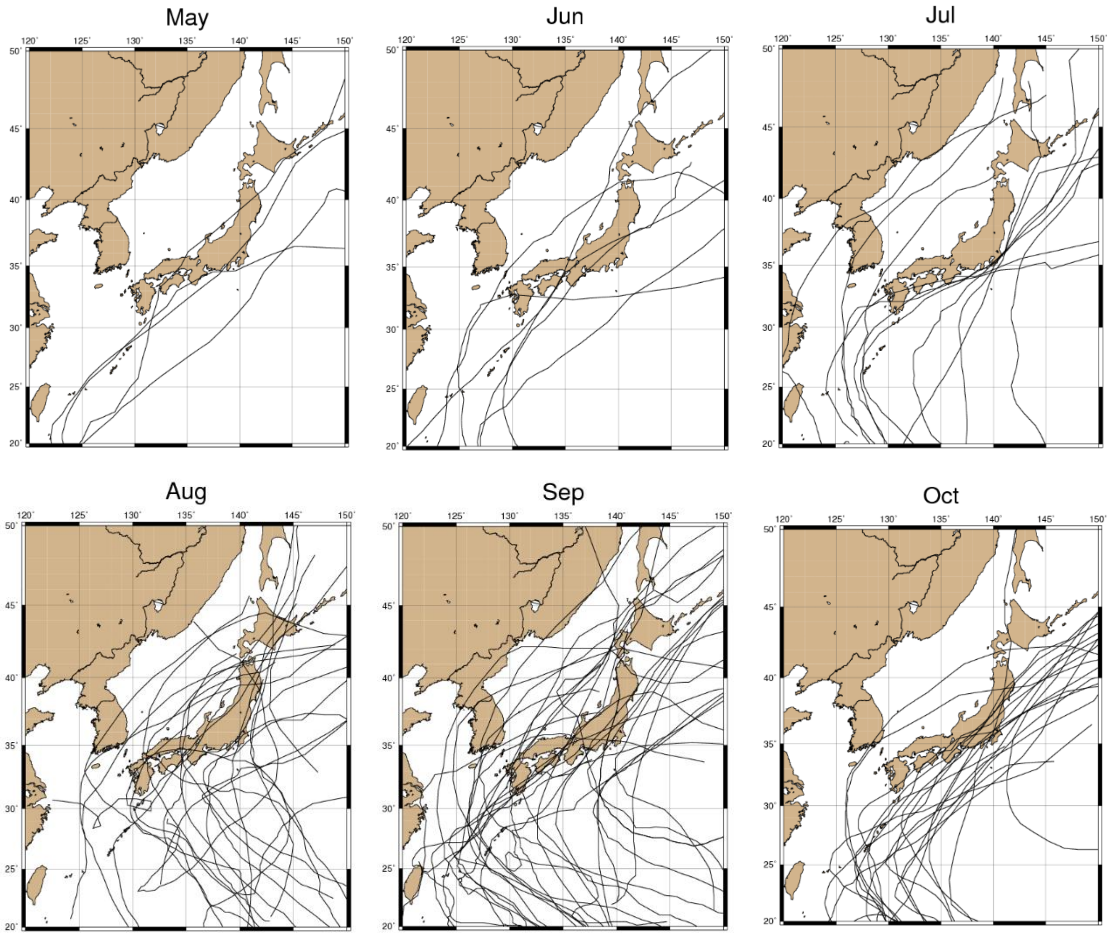


Figure 20　Courses of typhoons approaching main Games venues（1999 to 2018）

Four typhoons out of the 90 observed approaching, Games venues brought heavy rains or storms to Tokyo in the past 5 years, as following List 5 shown. These four typhoons were No.24 in 2018; No.12 in 2018; No.21 in 2017; and No.11 in 2016.

List 5 Typhoons impacting Tokyo in the past five years (2014 to 2018)

Typhoon	Period	Maximum hourly precipitation	Total precipitation amounts	Maximum instantaneous wind speed (Wind direction at the time)
No.24 in 2018	Sep 29–Oct 1 2018	19mm/h	61.5mm	39.3m/s (S)
No.12 in 2018	Jul 28–Jul 29 2018	16mm/h	67mm	19.3m/s (NNE)
No.21 in 2017	Oct 22–Oct 23 2017	15.5mm/h	187.5mm	29.9m/s (SSE)
No.11 in 2016	Aug 22 2016	24.5mm/h	106.5mm	22.9m/s (W)

Typhoon No.24 in 2018 brought an unusually heavy storm to Tokyo. An account of this typhoon is detailed below.

<Typhoon No.24 in 2018>

One typhoon that exerted a huge impact on the Tokyo area, where the majority of Olympic Games venues are situated, is described below.

Typhoon No.24 crossed Honshu longitudinally maintaining considerable power with a maximum wind speed of 45m/s or higher from 30 September to 1 October 2018. Winds with a mean speed of 10 m/s or higher blew for several hours and a maximum instantaneous wind speed of 39.3m/s was recorded in Tokyo. Accordingly, heavy rainstorms continued from 12 to 24 hours over a wide area and winds were so fierce that observatory records were broken especially in western Japan and the Pacific side of eastern Japan.

The moving speed of the typhoon increased from 45km/h to 80km/h as it passed over Kyushu to Honshu. Major damage was caused by strong winds and heavy rain, and traffic was largely brought to a standstill with cancellations of air flights, sea-going vessels and trains. Damage was also caused by fallen trees, flying objects, power and water failures, and extensive disruption of telecommunications, etc.

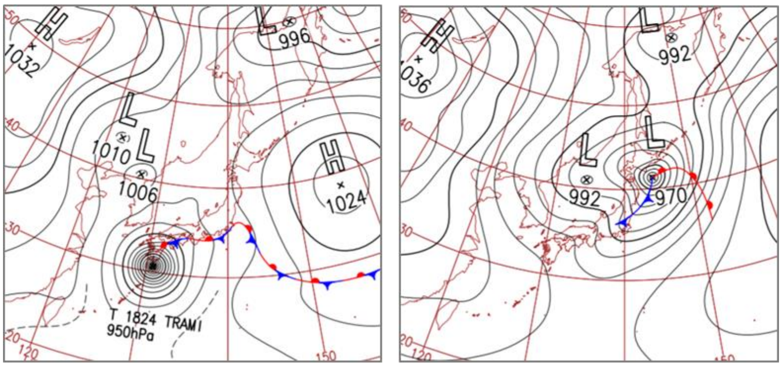


Figure 21 Surface weather chart
(Left: 30 September 2018 0:00 (UTC) Right: 1 October 2018 0:00 (UTC))

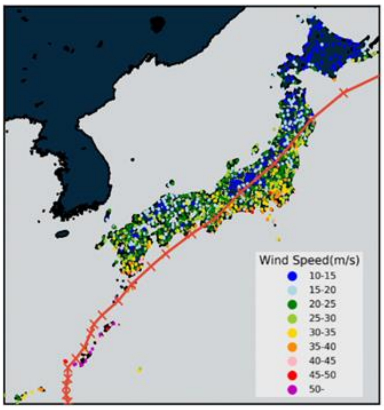


Figure 22 Course of typhoon No.24 and maximum instantaneous wind speed when closest
(September 28 12:00 (JST) - October 1 12:00 (JST))
(Red Line: Typhoon course ×: Centre of the typhoon)

The entire course taken by typhoon No.24 is charted in Figure 23. Figure 24 indicates the actual weather conditions in the vicinity of Tokyo Bay. Wind speeds increased rapidly in the vicinity of Tokyo Bay from around 21:00 on 30 September when the centre of the typhoon (○) was located over the island of Shikoku. The value reached a peak at 2:00 on 1 October with a mean wind speed of 28.8m/s being observed.

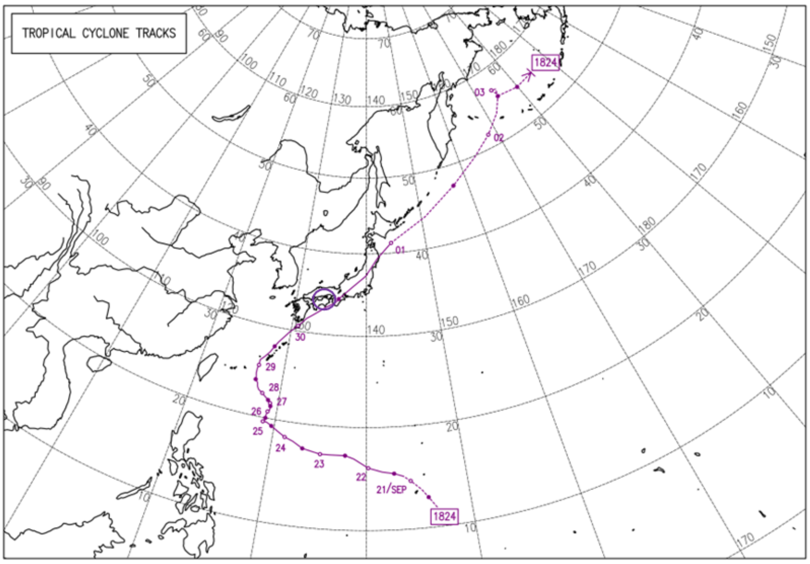


Figure 23 Course of typhoon No.24

(Retrieved from Website of the Japan Meteorological Agency

https://www.data.jma.go.jp/fcd/yoho/typhoon/route_map/bstv2018.html)

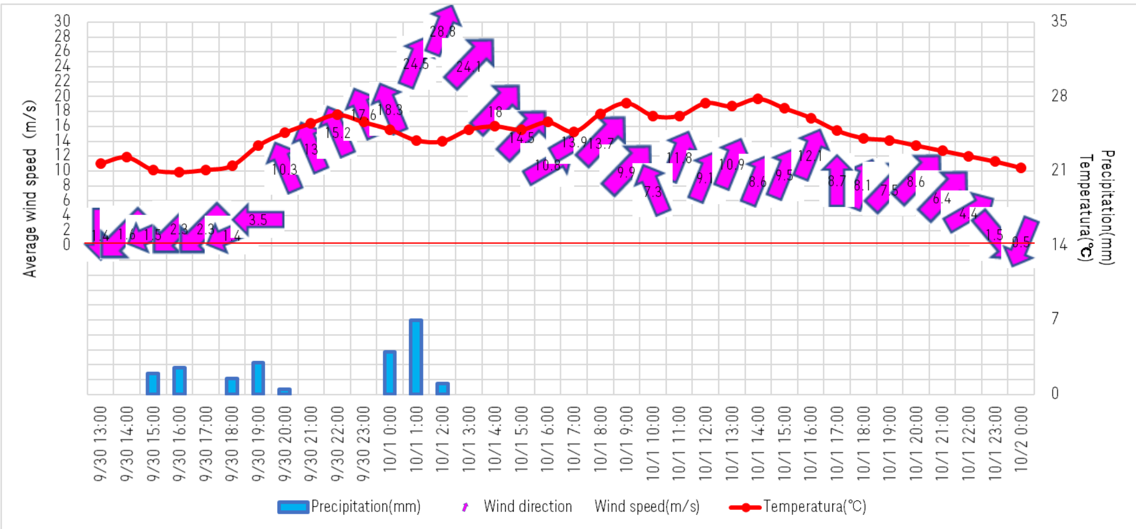


Figure 24　Actual weather conditions in the vicinity of Tokyo Bay (Tokyo Bay Zone)
(Observed values by AMeDAS Edogawa Rinkai
30 September 2018 13:00 - 2 October 0:00 (JST))

Winds with a mean wind speed of around 10m/s continued from 20:00 on 30 September to 16:00 on 1 October. Maximum instantaneous wind speed of 39.3 m/s was observed at 2:10 on 1 October.

2-3. Earthquakes

＜Japan is an earthquake-prone zone＞

The epicentres of earthquakes and volcanoes mainly exist in particular regions shaped like a belt around the earth. Demarcations between the earthquake-prone regions and the other regions are clearly defined. By comparison with earthquake occurrence distribution and plate location (Figure 25), areas located on a plate boundary are also earthquake-prone zones. The entire area of Japan is located in such a zone.

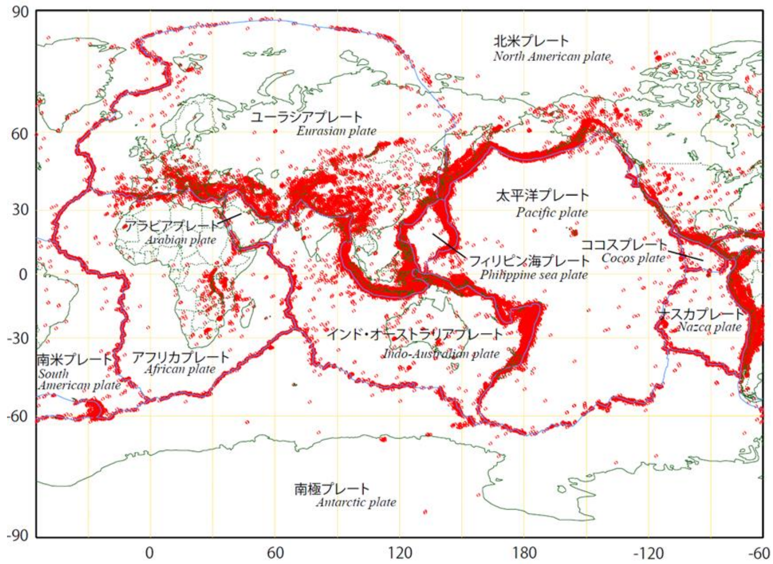


Figure 25 Global earthquake occurrence distribution and plate boundaries.
(Retrieved from Website of the Japan Meteorological Agency
https://www.data.jma.go.jp/svd/eqev/data/jishin/about_eq.html#4_c)
The entire area of Japan is located in an earthquake-prone zone

<Magnitude and Seismic Intensity>

An earthquake is a phenomenon caused by the sliding of underground bedrock. The shaking of felt above ground is a transmission of the underground sliding. The strength of earthquakes is measured by two separate indicators: magnitude, which shows the scale of earthquake itself, and the intensity of shaking that is transmitted at a certain point (seismic intensity). The farther away an area is from the epicentre of the earthquake, the less the seismic intensity (shaking).

Also, the number of earthquakes around the world recorded with a magnitude of 6 or higher between 1996 and 2005 is 912. Of these, 190 earthquakes (or 20.8%) occurred in Japan.

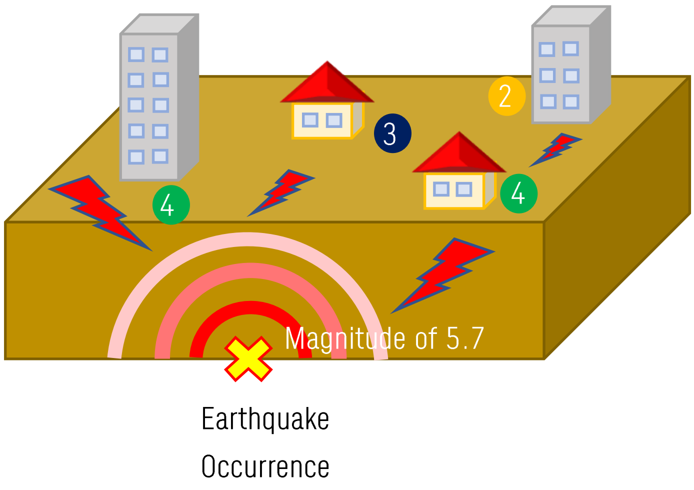


Figure 26 Conceptual figure of magnitude and seismic intensity

●: Seismic Intensity

The magnitude indicates the size and scale of the earthquake itself and each earthquake has its own unique value. The value of magnitude depends on the size of energy released from the epicentre. Therefore, the larger the earthquake, the higher the magnitude. Specifically, an earthquake with a magnitude of 0.2 has twice as much energy as a smaller one. An earthquake with a magnitude of 1 has about 32 times as much energy as a smaller one. An earthquake with a magnitude of 2 has approx. 1,000 times as much energy as a smaller one.

The seismic intensity demonstrates the degree of shaking in a particular location. The intensity depends on such factors as the distance from the epicentre and the firmness of the ground. Hence, seismic intensity differs from location to location even though the magnitude is the same. As List 6 below show, seismic intensity is classified into 10 classes in Japan; a seismic intensity of 0, a seismic intensity of 1, a seismic intensity of 2, a seismic intensity of 3, a seismic intensity of 4, a seismic intensity of lower 5, a seismic intensity of upper 5, a seismic intensity of lower 6, a seismic intensity of upper 6 and a seismic intensity of 7.

List 6　JMA seismic intensity scale and assumed conditions
(Seismic intensity of 0-7)

Seismic Intensity Scale	Human perception and reaction	Indoor situation	Outdoor situation
0	Imperceptible to people, but recorded by seismometers.	-	-
1	Felt slightly by some people keeping quiet in buildings.	-	-
2	・Felt by　many people keeping quiet in buildings. Some people may be awoken.	Hanging objects such as lamps swing slightly.	-
3	・Felt by most people in buildings. Felt by some people walking. Many people are awoken.	Dishes in cupboards may rattle.	Electric wire swings slightly.
4	・Most people are startled. Felt by most people walking. Most people are awoken	・Hanging objects such as lamps swing significantly, and dishes in cupboards rattle. Unstable ornaments may fall.	Electric wire swings significantly. Those driving vehicles may notice the tremor.
5 Lower	Many people are frightened and feel the need to hold onto something stable.	Hanging objects such as lamps swing violently and dishes in cupboards and items on bookshelves may fall. Many unstable ornaments fall. Unsecured furniture may move and unstable furniture may topple over.	In some cases, windows may break and fall. People notice electricity poles moving. Roads may sustain damage.
5 Upper	Many people find it hard to move; walking is difficult without holding onto something stable.	Dishes in cupboards and items on bookshelves are more likely to fall. TVs may fall from their stands, and unsecured furniture may topple over.	Windows may break and fall, unreinforced concrete-block walls may collapse, poorly installed vending machines may topple over, automobiles may stop due to the difficulty of continued movement.
6 Lower	It is difficult to remain standing.	Many unsecured furniture moves and may topple over. Doors may become wedged shut.	Wall tiles and windows may sustain damage and fall.
6 Upper	・It is impossible to move without crawling. ・People may be thrown through the air.	Most unsecured furniture moves, and is more likely to topple over.	Wall tiles and windows are more likely to break and fall. Most unreinforced concrete-block walls collapse.
7		Most unsecured furniture moves and topples over, or may even be thrown through the air.	Wall tiles and windows are even more likely to break and fall. Reinforced concrete-block walls may collapse.

<Earthquake occurrence situation during the past decade years in each venue>

Figures 28, 29 and 30 below show the aggregated numbers of earthquakes during the 10-year period from 2009 to 2018 by years, seismic intensities and host cities.

Many earthquakes may occur after a major earthquake. These are known as aftershocks. The aggregated values include aftershocks. In short, earthquakes do not occur at regular intervals and the aggregation period contains several short periods during which earthquakes frequently occurred.

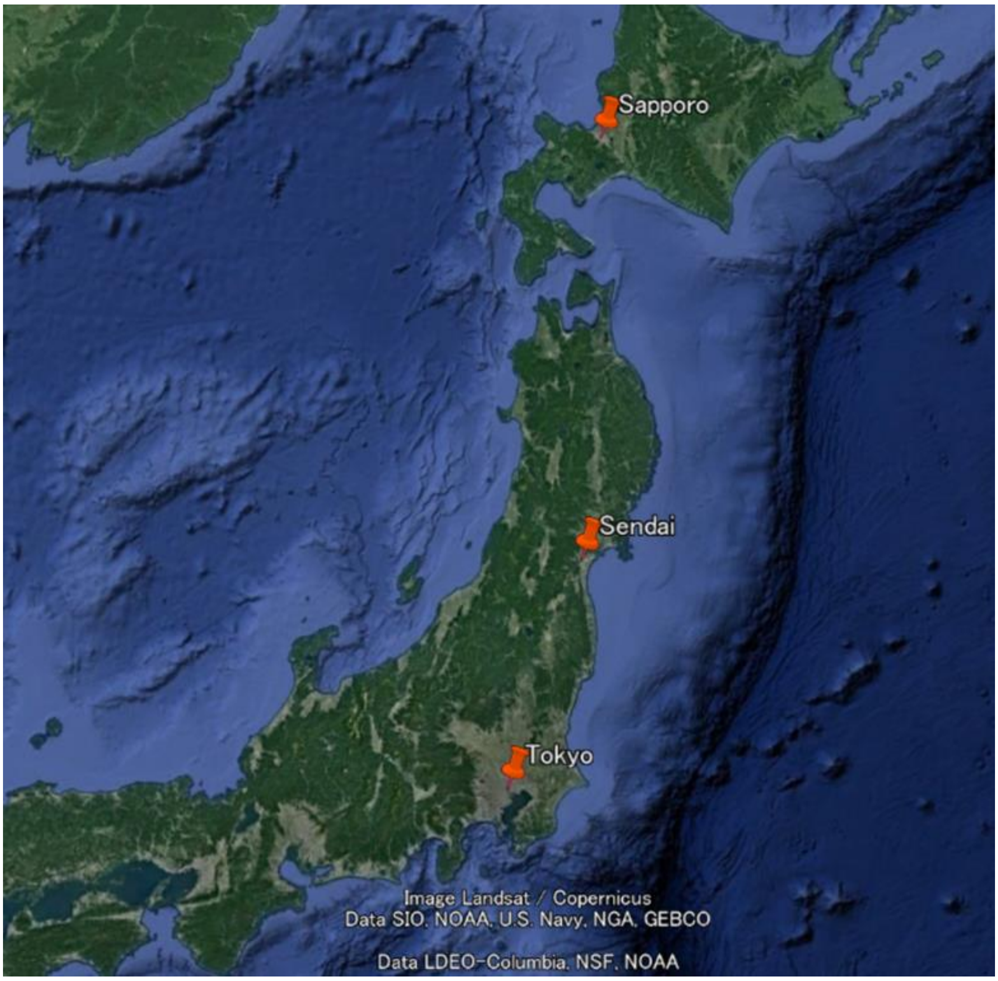


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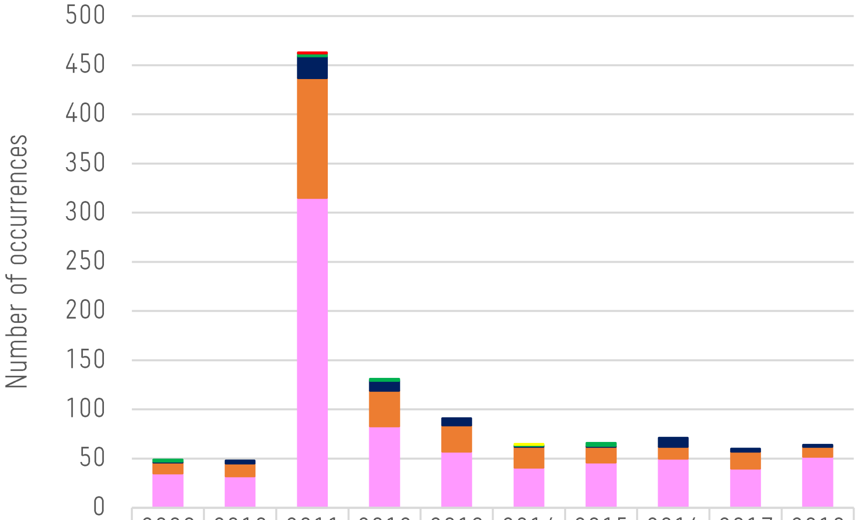
Figure 27 Locations of Tokyo, Sendai and Sapporo

Number of earthquakes by seismic intensity (intensities of shaking) during the past decade in Tokyo

* Refer to List 6 on Page 48 for an explanation of seismic intensity.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5 Higher	0	0	1	0	0	0	0	0	0	0
5 Lower	0	0	0	0	0	1	0	0	0	0
4	2	0	3	2	0	1	3	0	0	0
3	1	3	22	10	7	1	1	9	3	2
2	11	13	122	36	27	21	16	12	17	10
1	35	32	315	83	57	41	46	50	40	52

Year

1 2 3 4 5 Lower 5 Higher

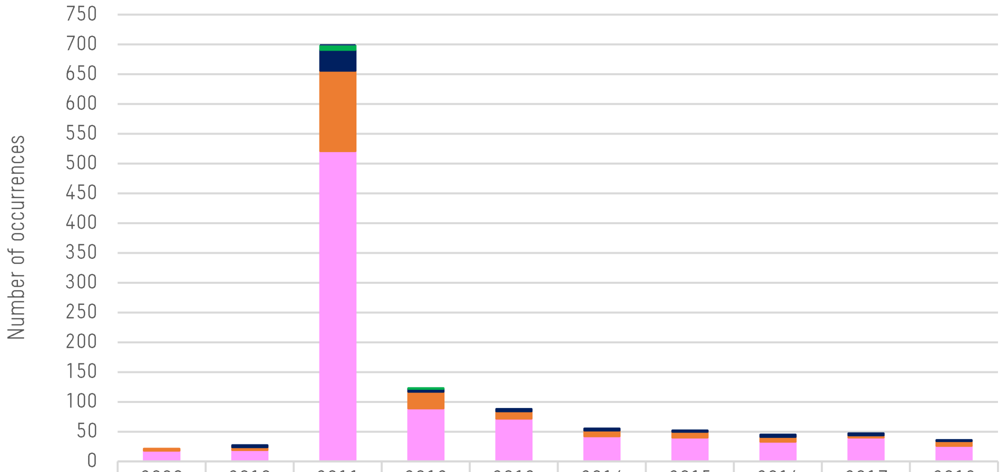
Figure 28 Number of earthquakes by seismic intensity (2009-2018)
(Otemachi, Chiyoda-ku, Tokyo)

In Tokyo, the average annual number of earthquakes with a seismic intensity of 3 (felt by most people in buildings and felt by some people walking) was 4[5]. The average annual number of earthquakes with a seismic intensity of 4 (felt by most people walking) or greater was 1.1.

[5] In 2011 the number of earthquakes with an intensity of 3 was extremely more than other years' because a huge earthquake whose seismic center was in Sanriku offshore with a magnitude of 9 occurred on March 11 and the lively seismic activity continued for a while as aftershocks. Therefore, the value (4 times) excludes 2011's one.

▪Number of earthquakes by seismic intensities (intensity of shaking) during the past decade in Sendai

* Refer to List 6 on Page 48 for an explanation of seismic intensity.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
6 Lower	0	0	2	0	0	0	0	0	0	0
5 Higher	0	0	0	0	0	0	0	0	0	0
5 Lower	0	0	0	0	0	0	0	0	0	0
4	0	0	7	1	0	0	0	0	0	0
3	0	3	35	5	4	3	2	4	3	2
2	3	5	135	28	12	10	10	8	4	8
1	18	19	521	89	72	42	40	33	40	26

Year

1 2 3 4 5 Lower 5 Higher 6 Lower

Figure 29 Number of earthquakes by seismic intensities (2009-2018)
(Okura, Aoba-ku, Sendai City, Miyagi Prefecture)

In Sendai, the average annual number of earthquakes with a seismic intensity of 3 (felt by most people in buildings and felt by some people walking) was 2.4[6]. Also, apart from 2011 when a huge earthquake and tsunami hit the region, and a single earthquake in 2012, there were no earthquakes with a seismic intensity of 4 or higher.

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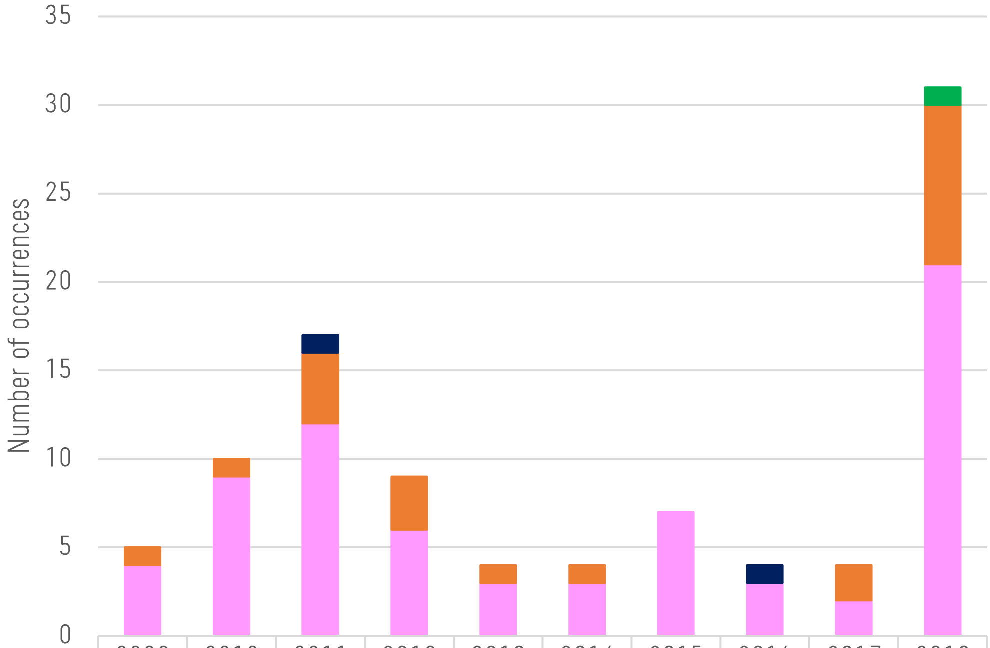
[6] The total number of earthquakes in 2011 was 700. This exceptionally large figure was brought about by the huge earthquake that devastated the Tohoku region of northeastern Japan on 11 March 2011. The seismic centre of the earthquake was also situated close to Sendai. Aftershocks continued until 2013.

▪Number of earthquakes by seismic intensity (intensity of shaking) during the past decade in Sapporo

* Refer to List 6 on Page 48 for an explanation of seismic intensity.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	0	0	0	0	0	0	0	0	0	1
3	0	0	1	0	0	0	0	1	0	0
2	1	1	4	3	1	1	0	0	2	9
1	4	9	12	6	3	3	7	3	2	21

Year

1 2 3 4

Figure 30 Number of earthquakes by seismic intensity (2009-2018)
(Kita, 2-Jo Chuo-ku, Sapporo, Hokkaido)

In Sapporo, the average annual number of earthquakes with a seismic intensity of 3 (felt by most people in buildings and felt by some people walking) was around 0.1[7]. Also, there was no seismic intensity of 4 or higher during the period apart from 2018 when Sapporo was impacted by the major earthquake that struck southern Hokkaido in September 2018.

[7] The number of earthquakes in 2011 and 2018 was twice or more than twice as many as in other years due to the huge earthquakes mentioned above. Hence, the value (0.1 times) excludes the values for 2011 and 2018.

3. Detailed weather conditions for each location hosting Games venues

As mentioned on Chapter 1, it is muggy in Tokyo and across the entire Pacific Ocean side during the period from July to September. Maximum temperatures often exceed 35°C in inland areas. There are many days when nighttime temperatures do not fall below 25°C in Tokyo and other major urban areas. These Pacific Side Climate zones are also susceptible to typhoons, fronts and southerly air currents receive more rainfall in June, July and September than other climate regions. In the summer months, the average maximum temperature in Sapporo is around 27°C. As the city is located in a Cool Temperate Climate zone, it is covered by drier air and humidity levels are lower than Tokyo.

The Tokyo 2020 Games venues have been divided into 11 separate zones for weather classification purposes. Temperatures, duration of sunshine, precipitation amounts and wind between July and September are calculated for each venue. Venues in the vicinity of Tokyo (Kanto and Izu regions) are classified into eight separate areas (A–H) and shown in Figure 31. The venues located in Fukushima and Miyagi prefectures are shown in Figure 32. The chapter concludes with a demonstration of the detailed data and aggregation period used to calculate values in this chapter.

Venue names and main outdoor stadiums are shown below.

A) Central Tokyo Venues (Heritage Zone) □ :

Olympic Stadium, Imperial Palace Garden (Race Walking),

Equestrian Park (Equestrian - Dressage, Eventing and Jumping

B) Bay Venues (Tokyo Bay Zone) □ :

Ariake Urban Sports Park (Cycling – BMX Freestyle and BMX Racing, Skateboarding)

Ariake Tennis Park (Tennis) Odaiba Marine Park (Marathon Swimming and Triathlon)

Shiokaze Park (Beach Volleyball)

Sea Forest Cross-Country Course (Equestrian (Eventing, (Cross Country)

C) Western Central Tokyo Venues □ :

Tokyo Stadium (Football, Rugby, Modern Pentathlon (Swimming, Fencing, Riding, Laser-Run)),

Musashinonomori Park (Cycling – starting point of the Road Race)

D) Saitama Inland Venue □ : Kasumigaseki Country Club (Golf)

E) Izu Venue □ : Izu MTB Course (Mountain Bike)

F) Gotenba Venue □ : Fuji International Speedway (Cycling (Road Race: Finish, Individual Time Trials))

G) Mobara Venue □ : Tsurigasaki Surfing Beach (Surfing)

H) Kashima Venue □ : Ibaraki Kashima Stadium (Football)

I) Fukushima Venue □ : Fukushima Azuma Baseball Stadium (Baseball/Softball)

J) Miyagi Venue □ : Miyagi Stadium (Football)

K) Sapporo Venue □ : Sapporo Dome (Football) ★Indoor

Eleven areas hosting Games venues are shown on the below map.

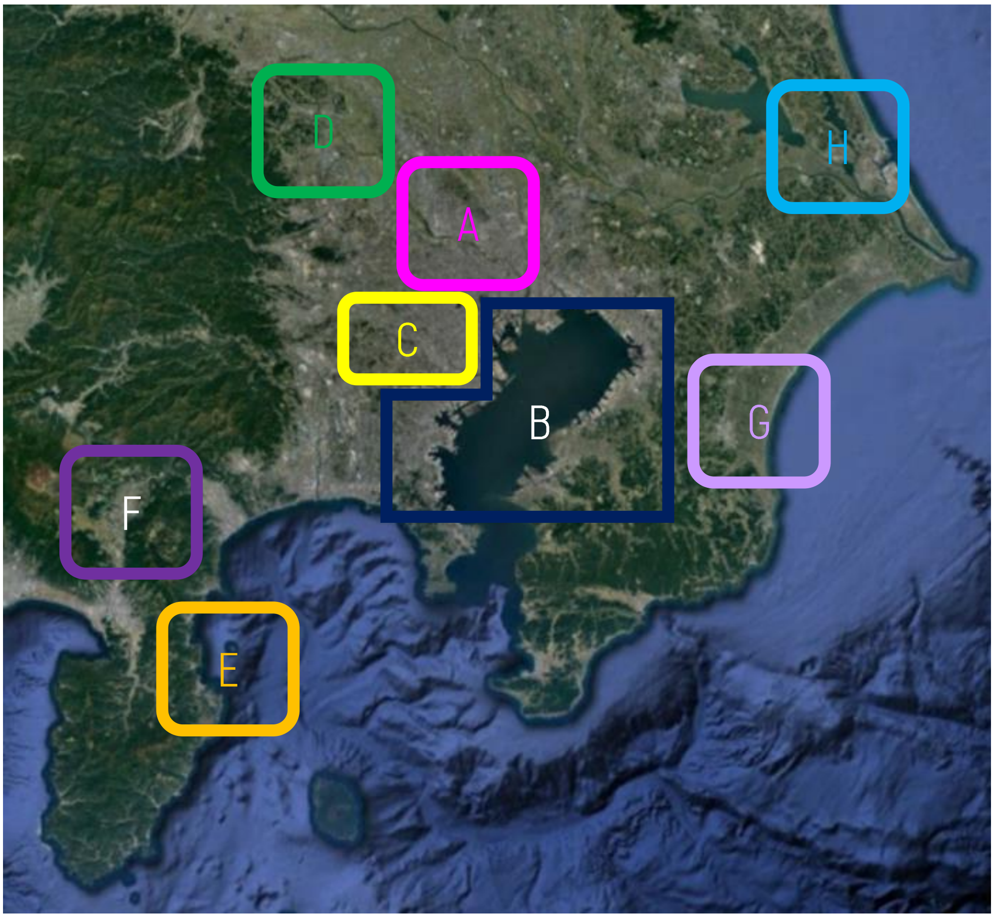


Figure 31 Venues in Kanto and Izu regions

Figure 32 Venues in Fukushima and Miyagi

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Figure 33 Venue in Sapporo

Weather characteristics for each venue.

A) Central Tokyo Venues (Heritage Zone, Olympic Stadium, Imperial Palace Garden, etc.)

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Figure 34 A) Location of the Central Tokyo Venues

List 7 A) Averages in Central Tokyo Venues (Tokyo)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	5.2	5.7	8.7	13.9	18.2	21.4	25	26.4	22.8	17.5	12.1	7.6
	Daily maximum	9.6	10.4	13.6	19	22.9	25.5	29.2	30.8	26.9	21.5	16.3	11.9
	Daily minimum	0.9	1.7	4.4	9.4	14	18	21.8	23	19.7	14.2	8.3	3.5
Monthly average precipitation amounts (mm)		52.3	56.1	117.5	124.5	137.8	167.7	153.5	168.2	209.9	197.8	92.5	51

Venues in the Central Tokyo area include the Olympic Stadium, where the Opening and Closing Ceremonies will be held, the Imperial Palace Garden (Race Walk), and the Equestrian Park (Equestrian).

This area is characterised by many cloudy and rainy days prior to mid-July due to a seasonal rain front. The front often stagnates over the Pacific side of Honshu in mid-June. As the Central Tokyo Venues are located to the north of the front at this time of year, they are likely to be covered by a cold northern air. Daytime temperatures do not differ greatly from morning temperatures, and it can sometimes feel chilly due to the short duration of sunshine added to the cold air.

The front tends to move gradually northward from mid-July. This migration results in the Central Tokyo Venues becoming located to the south of the front. Warm and moist air flows into the areas in which the venues are located, and both temperatures and humidity levels soar. It can feel extremely muggy even if overhead conditions are rainy or cloudy. For example, on 17 July, 2018, the maximum and minimum temperatures were 34.8°C and 26.9°C respectively and the average humidity was 78%. These figures are fairly typical of temperatures and humidity levels at this time of year once the rain front has migrated northwards.

When the rainy season ends in mid-to-late July, the area hosting the Central Tokyo Venues is covered by a Pacific High with subtropical air flowing in from the south. Also, there were 26 days on which maximum temperatures exceeded 30°C in July 2018 and the monthly maximum temperature was 39°C on 23 July. Furthermore, there were 20 days on which minimum temperatures exceeded 25°C.

It is often sunny from the early morning and daytime temperatures increase until around 3pm in early August, which is the hottest time of the year.

The sunny and hot weather continues to the end of August. However, from mid-August daytime temperatures tend not to increase to quite the same extent until an autumn rain front arises during which cloudy or rainy weather may continue for several days. Also, there were 25 days on which maximum temperatures exceeded 30°C in August 2018 and the monthly maximum temperature was 37.3°C on 2 August. Furthermore, there were 17 days on which minimum temperatures exceeded 25°C.

With the onset of September, the climate becomes gradually more comfortable as the number of days on which minimum temperatures reach 30°C falls and the daytime humidity levels drop gradually. The wind direction shifts to the north from midnight to morning and minimum temperatures fall below 20°C. Late September can feel quite cool.

The prevailing wind direction is mainly from the south from early July to late August (Figure 35). The southerly wind tends to blow strongly in the afternoon in the period between the middle of July and beginning of August, which corresponds to the time temperatures are at their highest. This wind also carries a considerably muggy air.

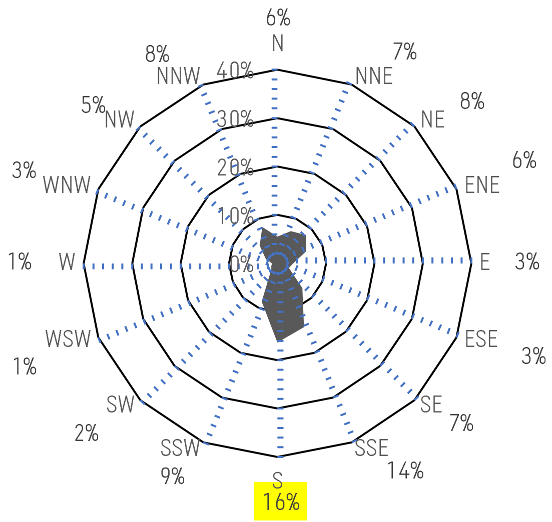


Figure 35 Prevailing wind direction for Central Tokyo Venues
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind directions and wind speeds over a 20-year period are described by months in the following figures 36, 37 Figure 38 respectively.

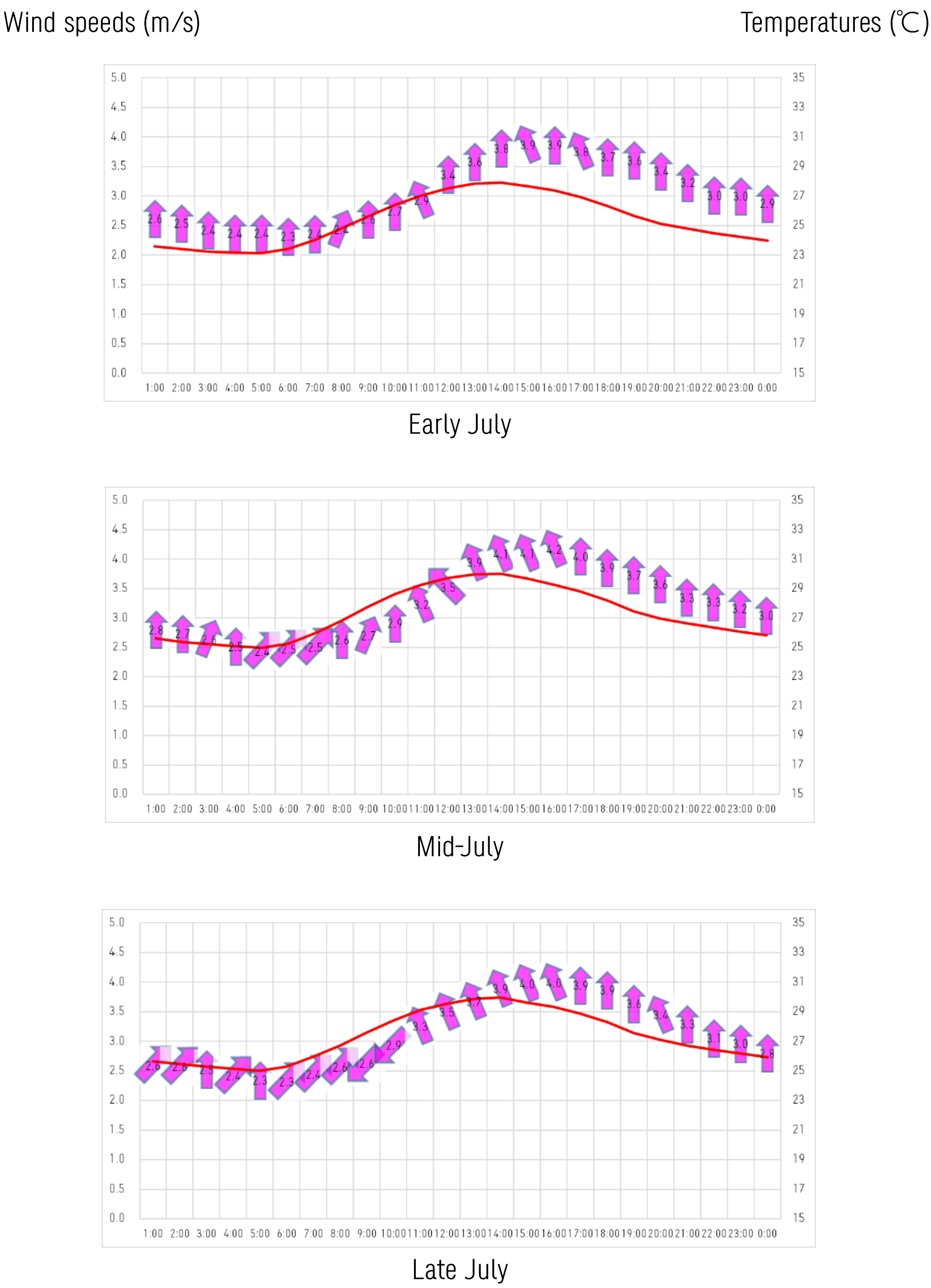
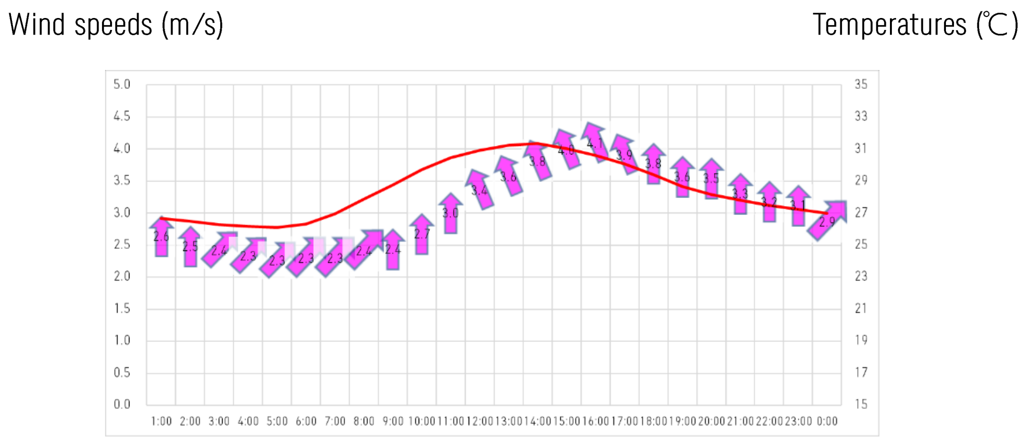


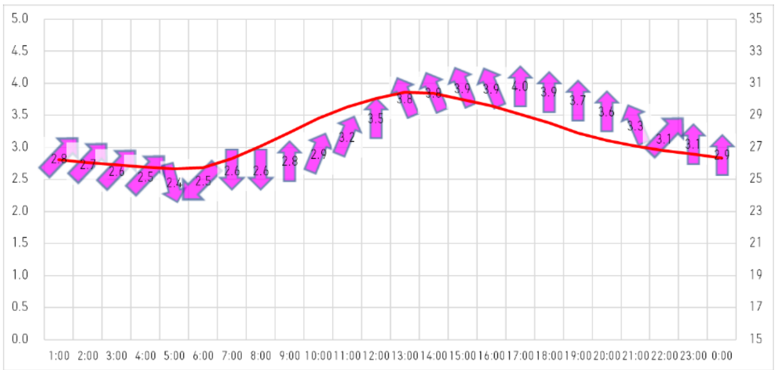
Figure 36　20-year average hourly temperatures and hourly wind direction and speeds in July (Central Tokyo Venues)

【Legend】　Horizontal Axis: Time　　Arrow: Wind direction　　Number in arrow: Wind speed (m/s)

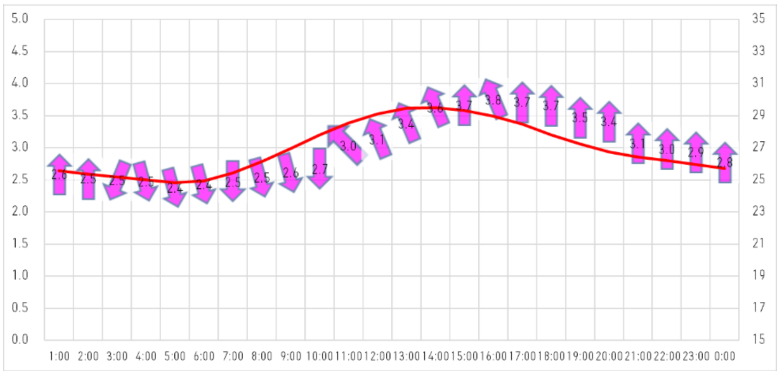
-: Temperature (°C)　<Example of wind direction　⇧: southerly wind>



Early August



Mid-August



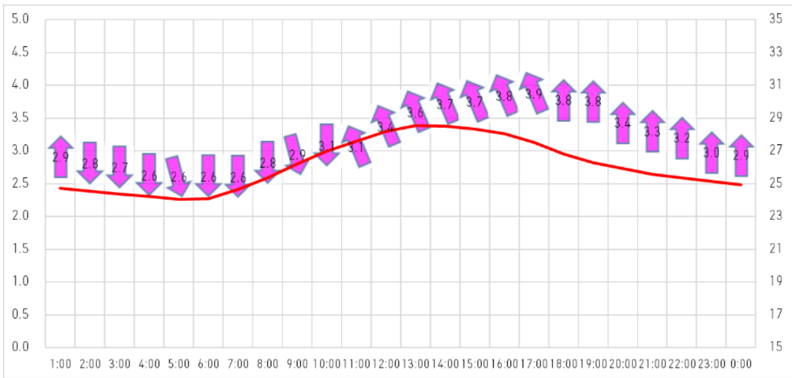
Late August

Figure 37　20-year average hourly temperatures and hourly wind direction and speeds in August (Central Tokyo Venues)

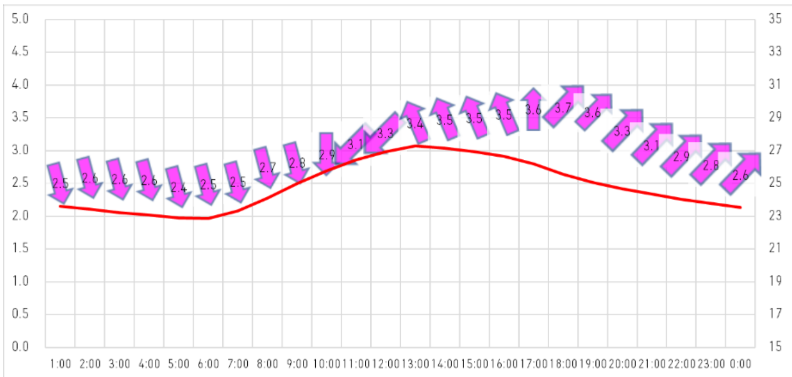
【Legend】　Horizontal Axis: Time　Arrow: Wind direction　Number in arrow: Wind speed (m/s)

-: Temperature (°C)　<Example of wind direction　⇧: southerly wind>

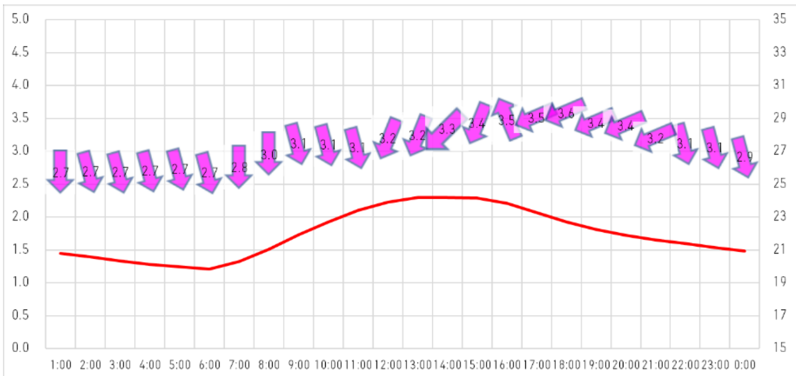
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 38 20-year average hourly temperatures and hourly wind direction and speeds in September (Central Tokyo Venues)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

B) Bay Venues (Tokyo Bay Zone, Yokohama Baseball Stadium, etc.)

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Figure 39 B) Location of the Bay Venues

List 8 B) Averages at Bay Venues (Edogawa Rinkai)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	5.7	6.1	8.8	13.6	17.7	20.9	24.4	26.3	23	17.9	12.9	8.3
	Daily maximum	9.5	9.9	12.7	17.6	21.5	24.4	28	30	26.4	21.3	16.5	12.1
	Daily minimum	2.2	2.5	5	10	14.5	18.1	21.9	23.8	20.4	14.8	9.4	4.7
Monthly average precipitation amounts (mm)		44.4	49.3	105.2	108.4	123	157.7	126	133.9	192.3	178.8	88.9	47.6

Bay Venues consist of the Ariake Urban Sports Park (BMX Freestyle, BMX Racing, and Skateboarding), Ariake Tennis Park (Tennis), Odaiba Marine Park (Marathon swimming and Triathlon), Shiokaze Park (Beach volleyball), Sea Forest Cross-Country Course (Equestrian), Yokohama Baseball Stadium (Baseball and Softball) and the International Stadium Yokohama (Football).

Weather tendencies for July, August and September are very similar to those for the Central Tokyo Venues.

There were 21 days on which maximum temperatures exceeded 30°C in July 2018, which was five days fewer than Central Tokyo Venues. The monthly maximum temperature was 36.4°C on 23 July as with the Central Tokyo Venues. There were 21 days on which minimum temperatures exceeded 25°C in July 2018, one day more than the Central Tokyo Venues.

Looking next at the figures for August, there were 22 days on which maximum temperatures exceeded 30°C in August 2018, which was three days fewer than the Central Tokyo Venues. The monthly maximum temperature was 35.9°C on 3 August. There were 20 days on which minimum temperatures exceeded 25°C in August 2018, which was three days more than Central Tokyo Venues.

The most significant contrasting factor between the Central Tokyo and Bay Venues is the strong wind that blows over the bay area from Tokyo Bay. As many of the venues in the Bay zone face the sea, they often encounter winds with a mean wind speed exceeding 6m/s. These coastal venues do not suffer from the sharp increase in daytime temperatures that affect the inland areas. However, as shown on the previous page, minimum temperatures are likely to be higher, and decreases in temperature levels do not tend to occur as sharply on the coast of Tokyo Bay as in Central Tokyo.

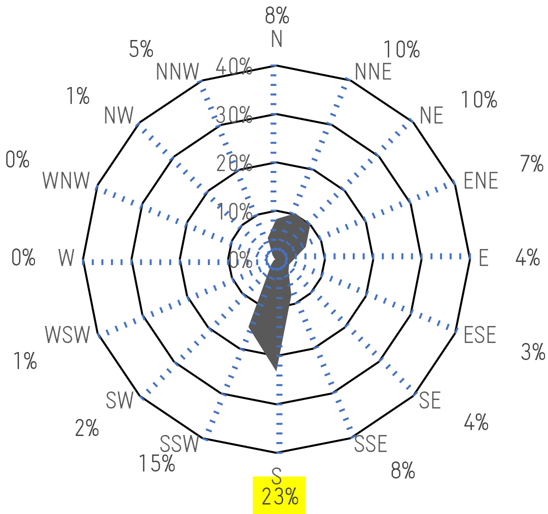
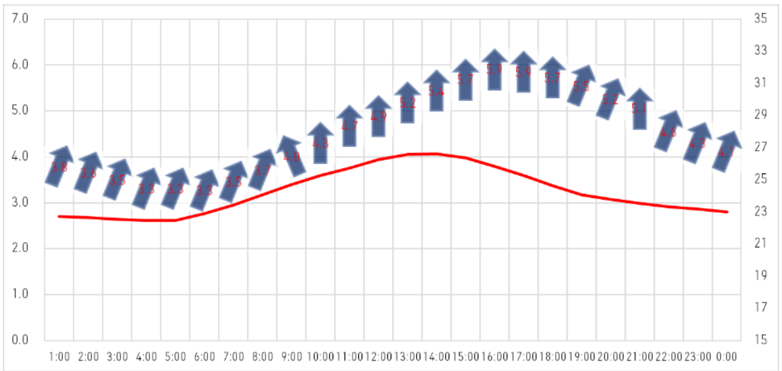


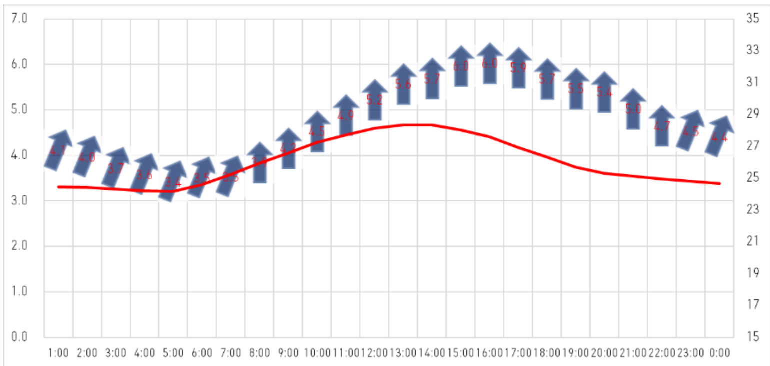
Figure 40　Prevailing wind direction for the Bay Venues
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 41, 42 and 43 respectively.

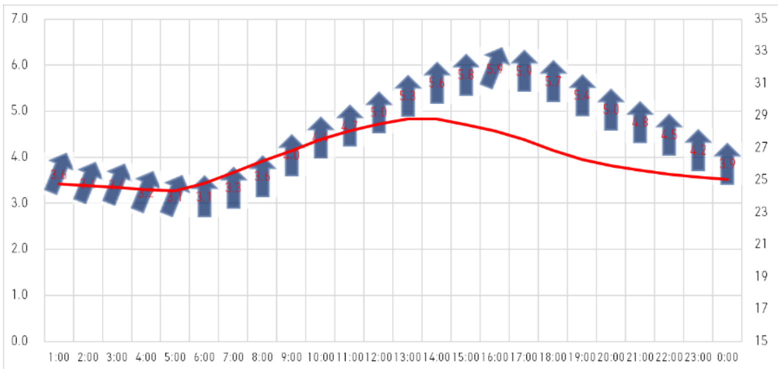
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



Late July

Figure 41 20-year average hourly temperatures and hourly wind direction and speeds in July (Bay Venues)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

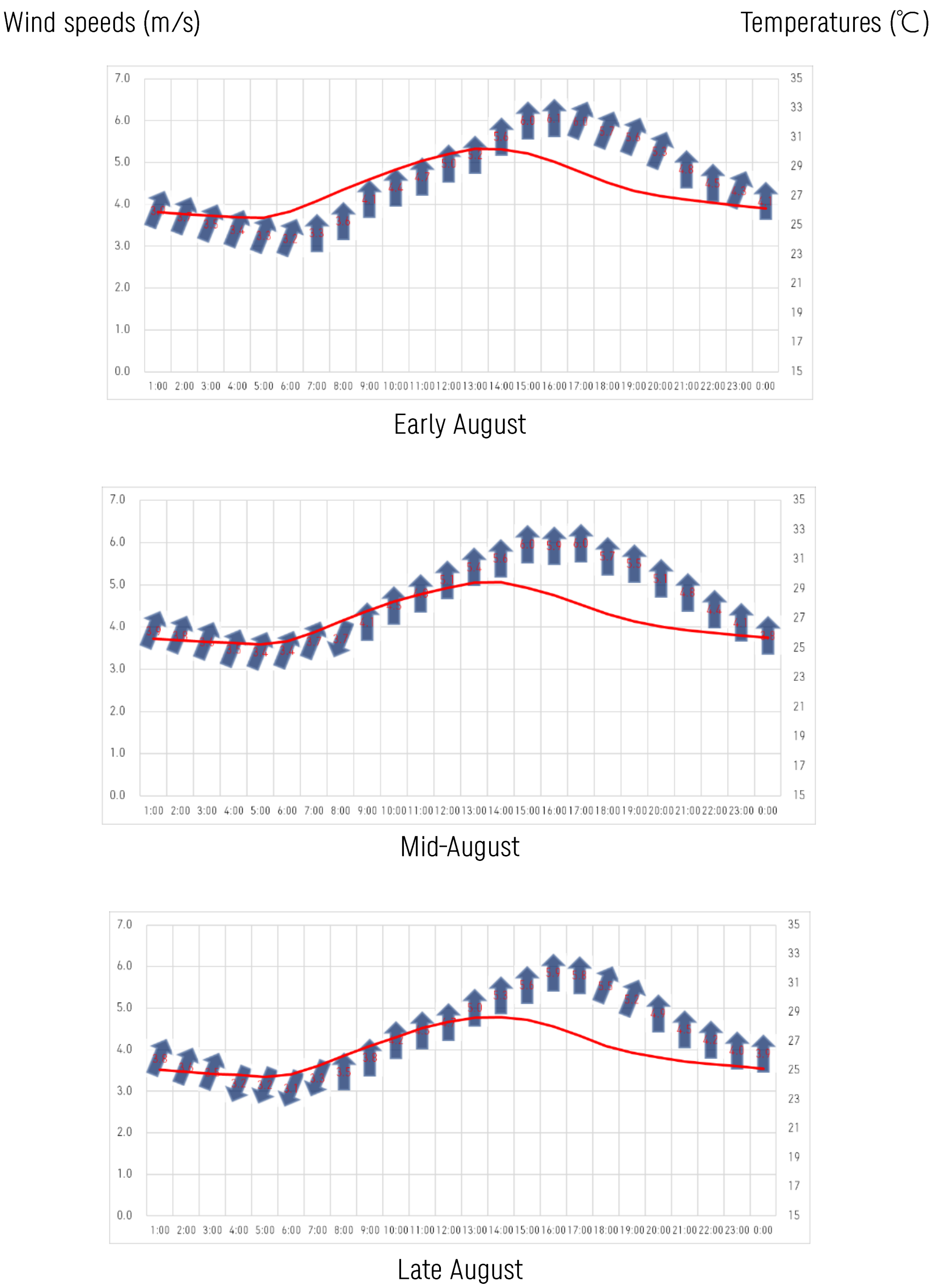
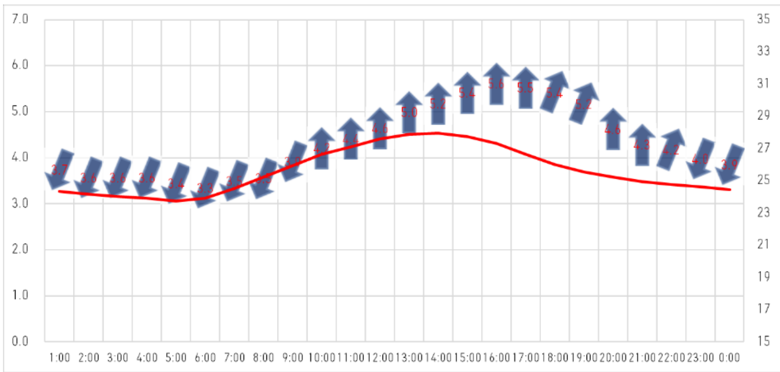


Figure 42 20-year average hourly temperatures and hourly wind direction and speeds in August (Bay Venues)

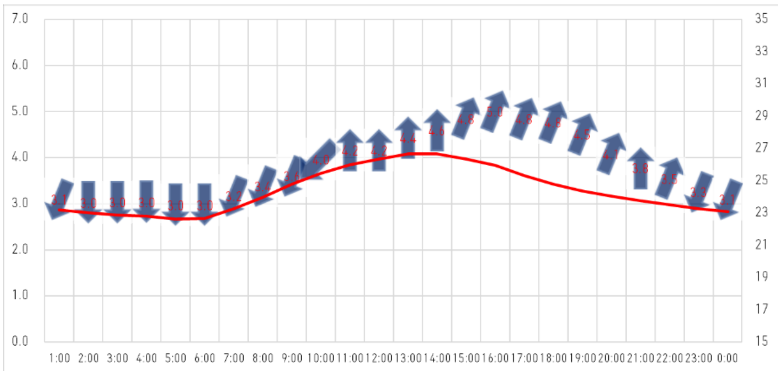
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

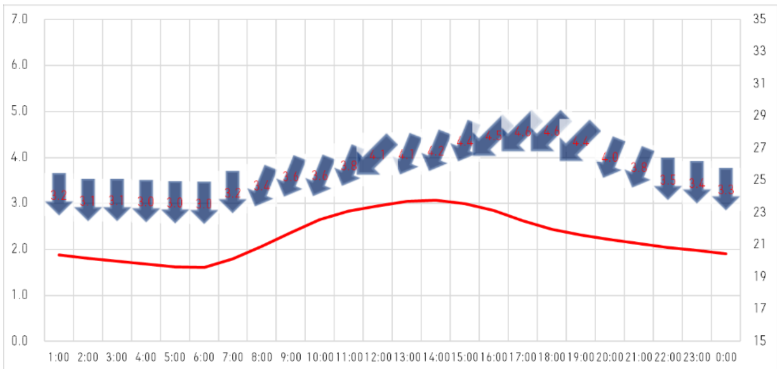
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 43 20-year average hourly temperatures and hourly wind direction and speeds in September (Bay Venues)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

C) Western Central Tokyo Venues (Tokyo Stadium and Musashinonomori Park, etc.)

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Figure 44 C) Location of the Western Central Tokyo Venues

List 9 C) Averages in Western Central Tokyo Venues (Fuchu)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	4.2	5	8.2	13.6	18	21.3	25	26.5	22.7	17	11.4	6.6
	Daily maximum	9.8	10.3	13.3	19	23.2	25.8	29.6	31.4	27.1	21.7	16.6	12.3
	Daily minimum	-0.9	0	3.2	8.5	13.3	17.5	21.5	22.9	19.2	12.8	6.6	1.4
Monthly average precipitation amounts (mm)		49.4	54.5	112.4	122.1	129.4	157.8	162.6	189.6	224.6	187.5	87.9	52.2

Western Central Tokyo Venues include the Tokyo Stadium (Football, Rugby and Modern Pentathlon) and Musashinonomori Park (Cycling).

The climatic tendencies for early, mid and late July, August and September are almost the same as those for the Central Tokyo Venues.

Particularly noteworthy is that both the diurnal temperature ranges and wind speeds are relatively pronounced.

The venues in this zone are situated some distance from the coast, and as with inland areas have a tendency to warm up and cool down quickly. Temperatures are lower at sunrise than the Central Tokyo and Bay venue zones, but tend to increase more significantly during fine days. Specifically, there were 26 days on which maximum temperatures exceeded 30°C in July 2018, the same as Central Tokyo Venues. The monthly maximum temperature was 38.8°C on 23 July, as was also the case with the Central Tokyo Venues. There were only 12 days on which maximum temperatures exceeded 25°C in July 2018, which was eight days fewer than Central Tokyo Venues.

There were 23 days on which maximum temperatures exceeded 30°C in August 2018 – two days fewer than Central Tokyo Venues. The monthly maximum value was 38°C on 3 August. There were 12 days on which maximum temperatures exceeded 25°C in August 2018, which was five days fewer than Central Tokyo Venues.

These figures support the large diurnal temperature ranges mentioned above. In addition, wind speeds can be relatively low and wind directions become unstable at some periods between midnight and 6am. When daytime conditions are sunny and temperatures rise sharply, a southerly wind is likely and tends to blow somewhat strongly in the afternoon. After sunset, the strength of the southerly wind gradually decreases and conditions finally fall calm again. This tendency continues until the middle of September, and in late September, the prevailing daytime wind direction changes to a northerly.

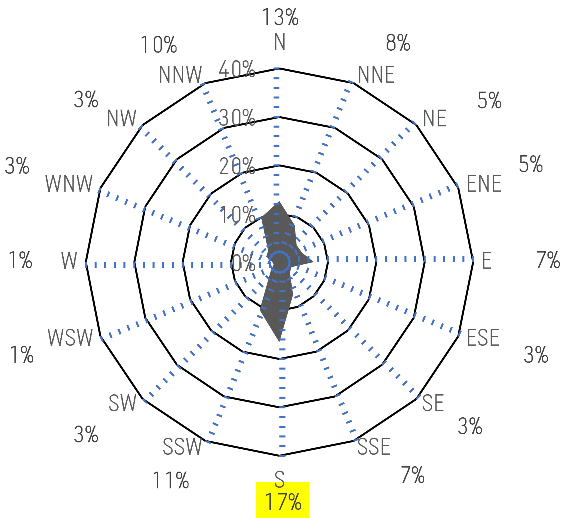
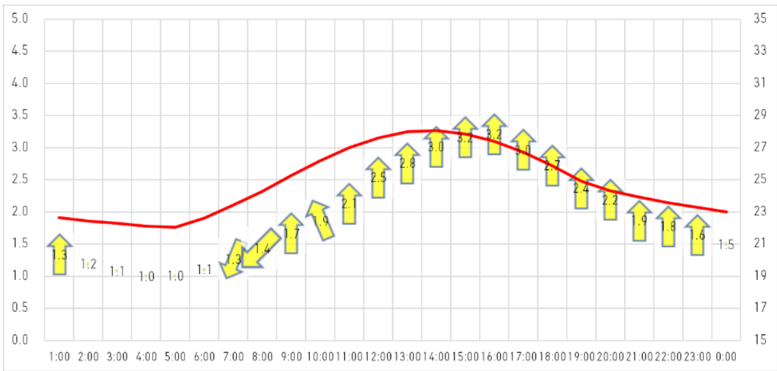


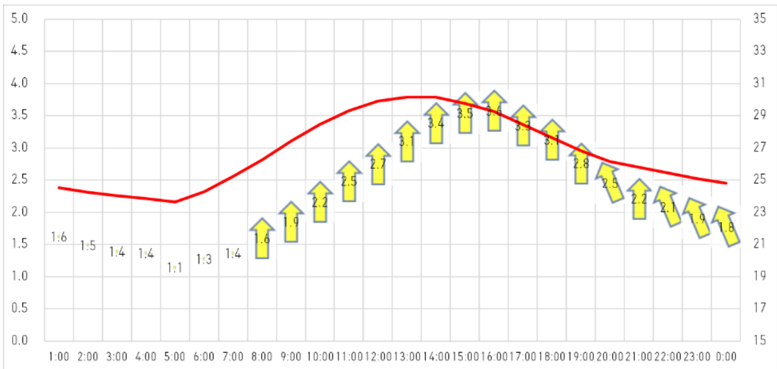
Figure 45　Prevailing wind direction in Western Central Tokyo Venues
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 46, 47 and 48 respectively.

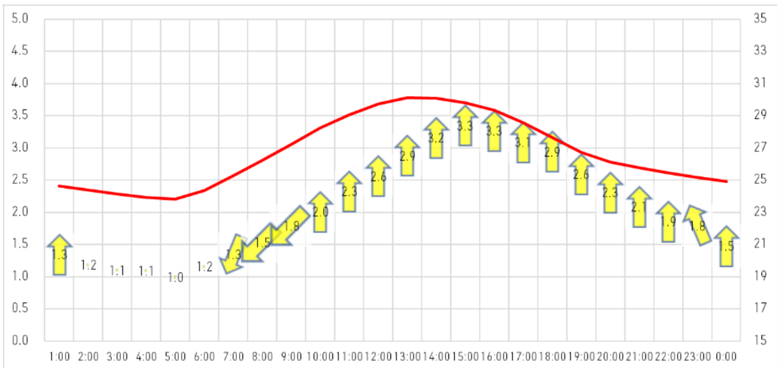
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



Late July

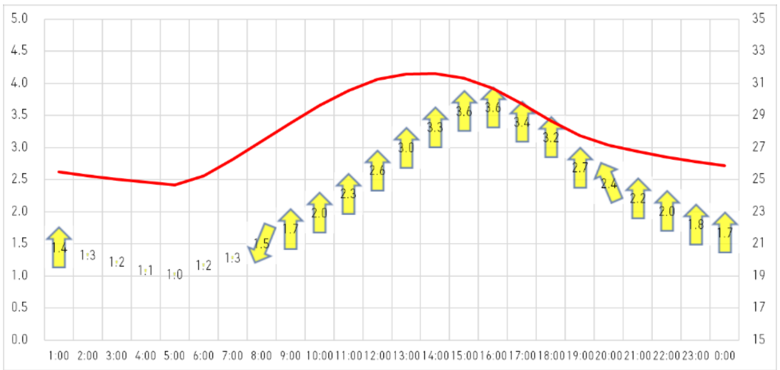
Figure 46 20-year average hourly temperatures and hourly wind direction and speeds in July (Western Central Tokyo Venues)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

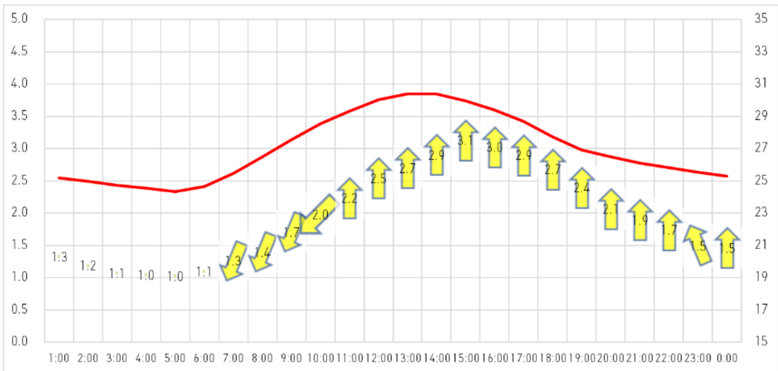
-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

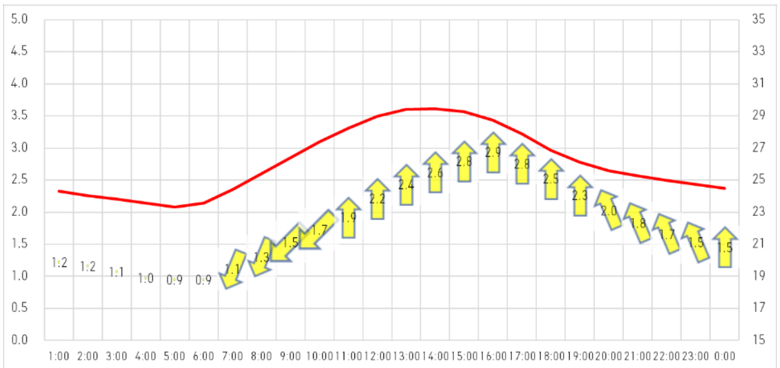
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



Late August

Figure 47 20-year average hourly temperatures and hourly wind direction and speeds in August (Western Central Tokyo Venues)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

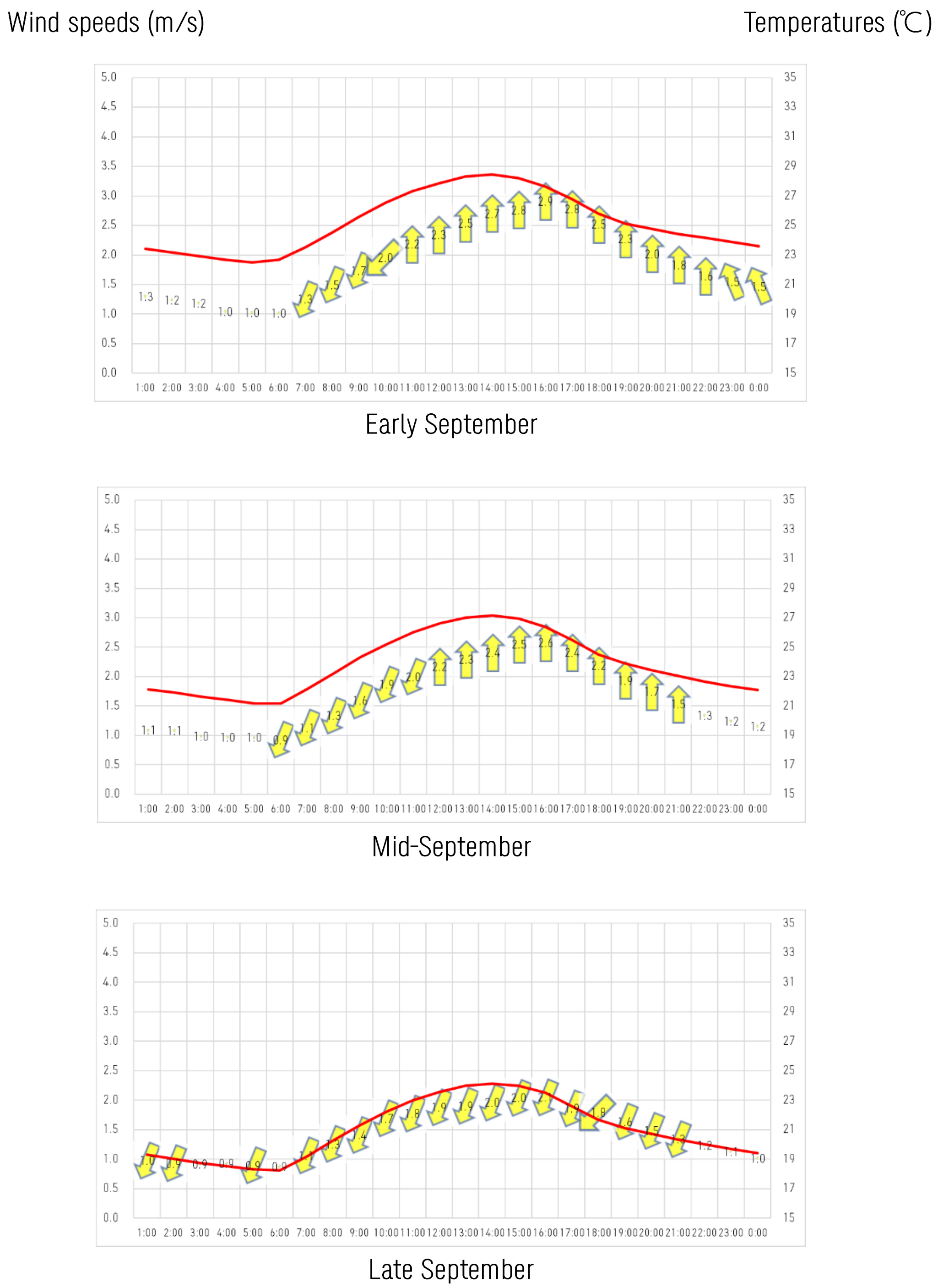


Figure 48 20-year average hourly temperature and hourly wind direction and speed in September (Western Central Tokyo Venues)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

D) Saitama Inland Venue (Kasumigaseki Country Club)

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Figure 49 D) Location of the Saitama Inland Venue

List10 D) Averages in Saitama Inland Venue (Hatoyama)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	2.4	3.4	6.9	12.5	17.1	20.7	24.3	25.7	21.7	15.7	9.7	4.6
	Daily maximum	9.4	10.1	13.4	19.3	23.6	26.1	29.6	31.4	26.8	21.3	16.1	11.8
	Daily minimum	-3.9	-2.9	0.6	6	11.3	16.2	20.4	21.6	17.8	11	4.1	-1.5
Monthly average precipitation amounts (mm)		34.7	38.6	77.3	104.3	108.6	154.2	170.9	211.7	224.7	153.6	63.6	34.7

The sole Saitama Inland Venue is the Kasumigaseki Country Club (Golf).

The tendencies of the weather for early, mid and late July, August and September are almost the same as those for the Central Tokyo Venues.

One significant point to note for this venue is that the difference between the highest and lowest temperatures for each day is relatively pronounced.

The surrounding lands of this venue, which is situated at some distance from the coast, have the remarkable characteristic of tending to warm up and cool down easier than venues located close to the coast. This tendency is also observed with the Western Central Tokyo Venues. The mean maximum temperatures over the 20-year period exceed 30°C in mid- July. However, wind speeds are relatively lower in the daytime and are often lulled for longer periods in the morning and evening as the venue is situated farther from the coastline than Western Central Tokyo Venues. In the prevailing wind directions indicated in Figure 50, north-northwesterly and south-southeasterly winds are notable in accordance with the geographic features in Figure 49. South-southeasterly winds tend to predominate during the daytime from July to mid-September. But by late-September, north-northwesterly winds tend to prevail throughout the day, and daytime temperatures tend to dip below 25°C.

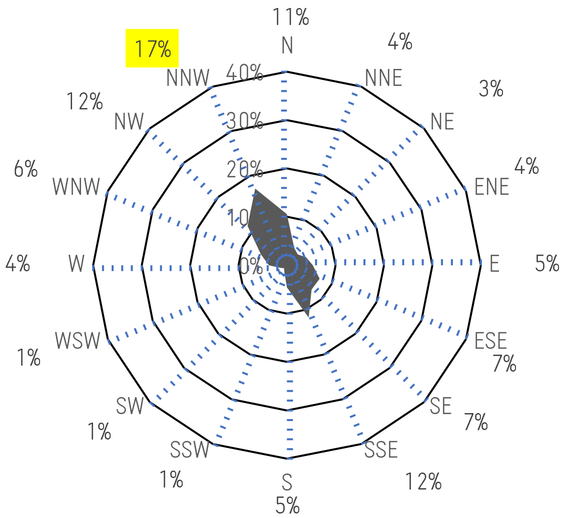
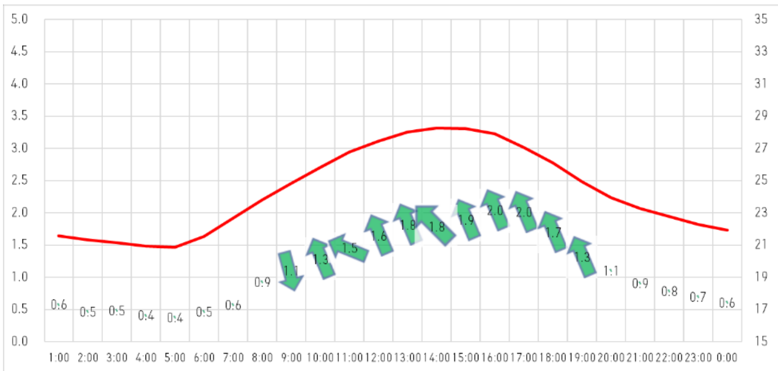


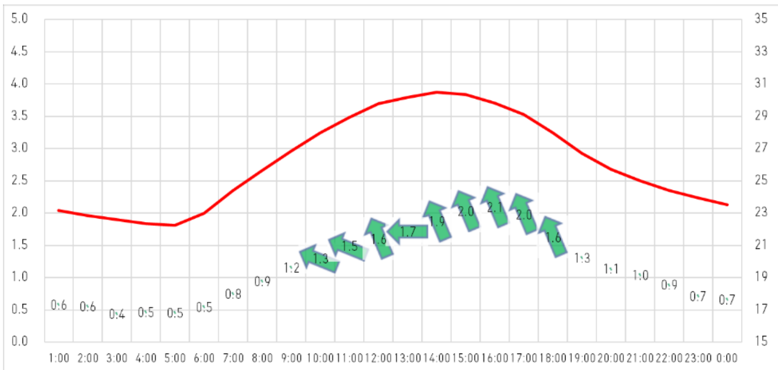
Figure 50　Prevailing wind directions for the Saitama Inland Venue
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds for 20 years are described by month in the following figures 51, 52 and 53 respectively.

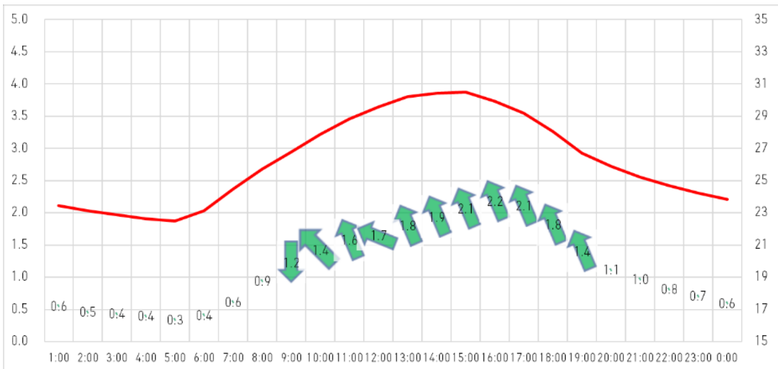
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



Late July

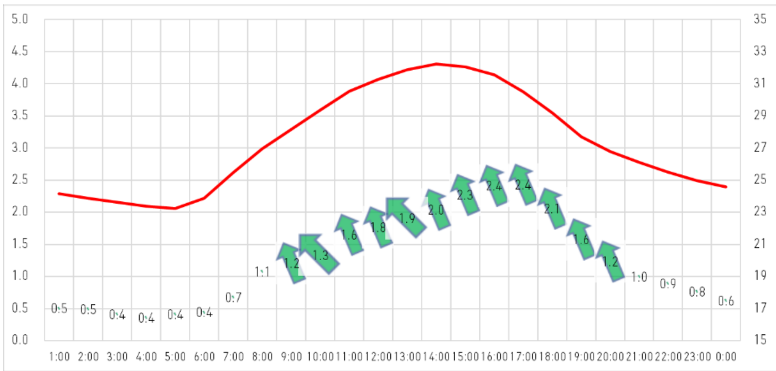
Figure 51 20-year average hourly temperatures and hourly wind direction and speeds in July (Saitama Inland Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

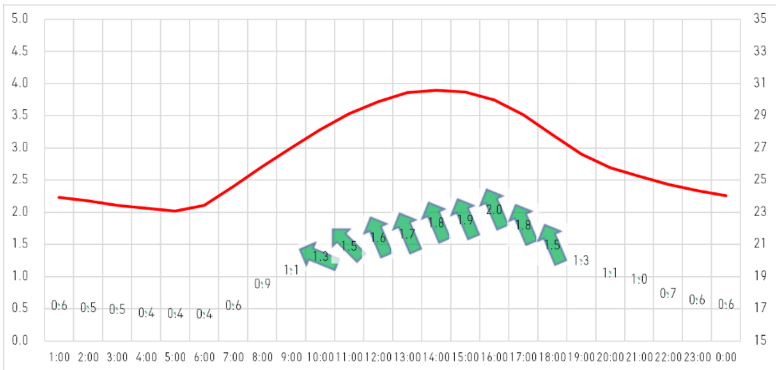
-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

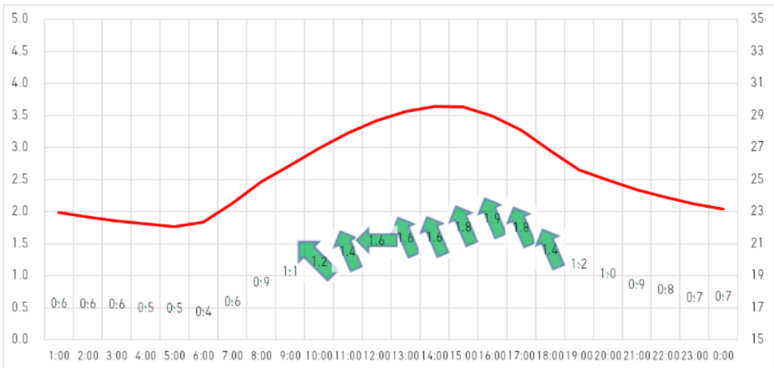
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



Late August

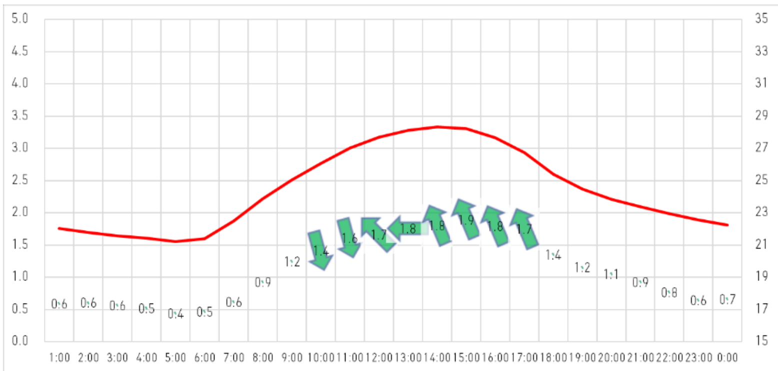
Figure 52 20-year average hourly temperatures and hourly wind direction and speeds in August (Saitama Inland Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

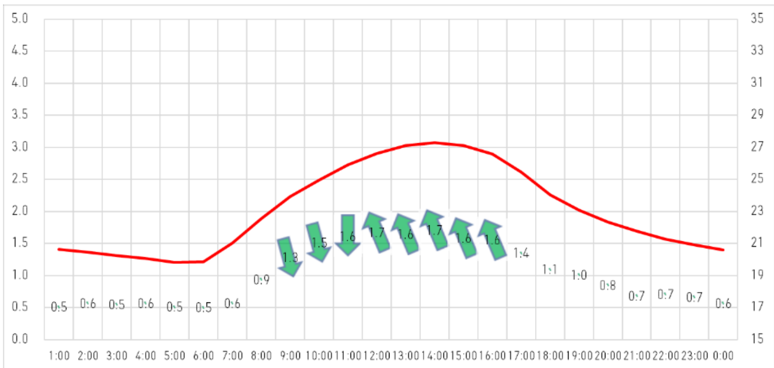
-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

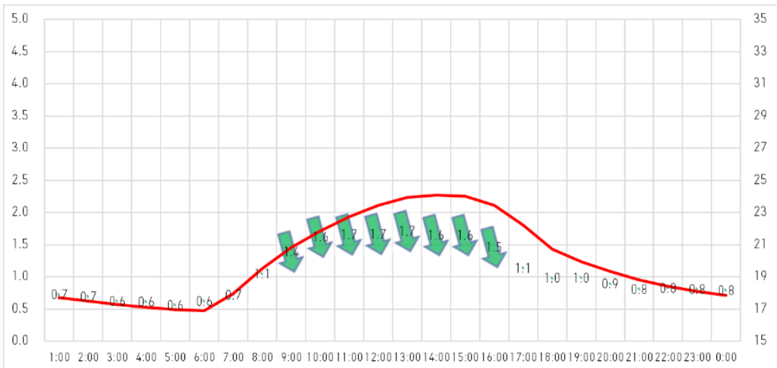
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 53　20-year average hourly temperatures and hourly wind direction and speeds in September　(Saitama Inland Venue)

【Legend】　Horizontal Axis: Time　Arrow: Wind direction　Number in arrow: Wind speed (m/s)

-: Temperature (°C)　<Example of wind direction　⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

E) Izu Venue (Izu Mountain Bike Course)

Figure 54 E) Location and landmarks of the Izu venue

List11 E) Averages in Izu Venue (Ajiro)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	6.9	7	9.5	14.3	18.2	21.1	24.8	26.1	23.1	18.3	13.8	9.6
	Daily maximum	10.5	10.8	13.5	18.5	22.1	24.6	28.3	29.8	26.3	21.4	17	12.9
	Daily minimum	3.9	3.7	6.2	10.8	15	18.5	22.3	23.6	20.6	15.7	11	6.6
Monthly average precipitation amounts (mm)		71.9	84.8	156.7	165.9	166.7	250.8	239	229.7	251.3	194.4	109.4	54.1

The Izu Venue zone consists of the Izu Mountain Bike Course (Cycling).

Mt. Hakone stands to the north of the venue while Mt. Amagi flanks the venue to the south. In addition, the wide Sagami Bay extends to the east. All these geographic features influence the wind conditions found at the venue.

Climatic tendencies for early, mid and late July, August and September are explained below.

The area experiences many cloudy or rainy days from early- to mid-July due to a rain front. During this period, a west-southwesterly wind is generally predominant. The mean minimum temperature in the morning is relatively high at around 23°C in spite of the relative lack of sunshine. However, the difference between the highest and lowest temperatures for each day is comparatively low as temperatures do not increase to a great extent in the daytime. This is one of the most notable climatic characteristics of the area.

There were 23 days on which maximum temperatures exceeded 30°C in July 2018. However, unlike Central Tokyo Venues, the temperature at the Izu Venue has rarely exceeded 35°C since records began and 35°C or higher was not recorded on a single day in 2018. When the rainy season finishes in mid- to late-July, the area is covered by a Pacific High with subtropical air from the south.

The midsummer point arrives in August, and a northeasterly wind is noticeable in the morning, but is generally followed by a southerly wind during the daytime. The area is sometimes covered with clouds when the northeasterly wind is prevalent in the morning. Fine and hot weather continues from the middle to the end of August, however, temperatures sometimes do not rise to levels encountered earlier in the summer season due to the appearance of an autumnal rain front, which is characterised by several days of continuous cloudy or rainy conditions.

The diurnal temperature range remains minimal even into early September. The minimum morning temperatures do not tend to dip below 20°C from early to late September. However, the seasonal change in this area can often be seen in terms of wind directional changes. A northeasterly wind blows for longer periods and strengthens towards late September.

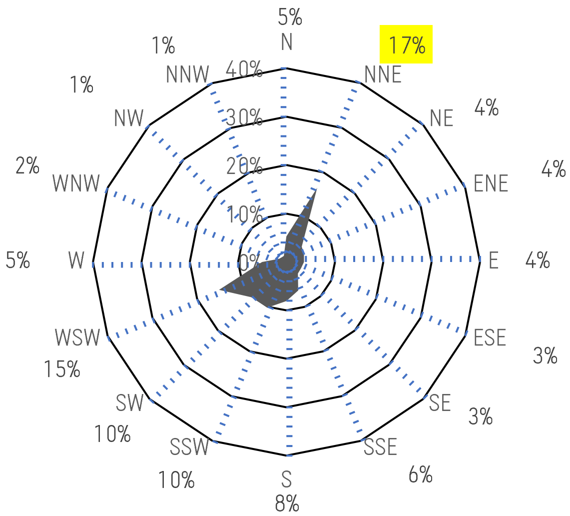
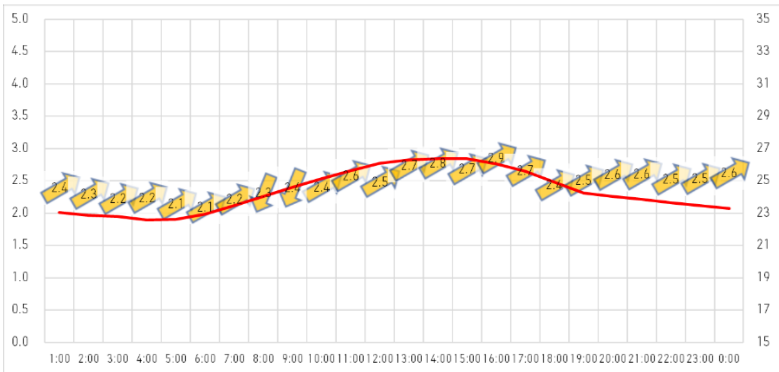


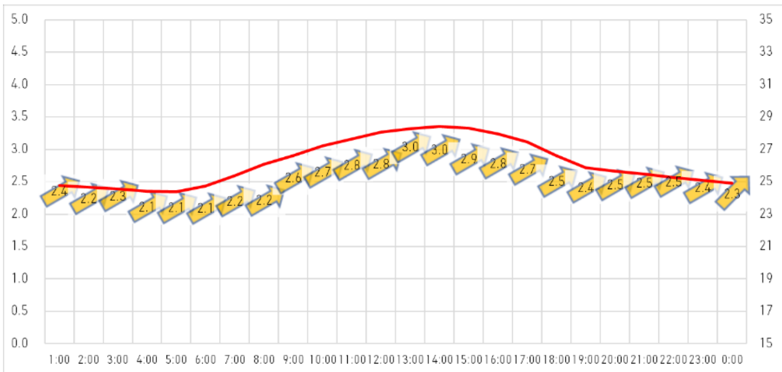
Figure 55　Prevailing wind direction for the Izu Venue
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by month in the following figures 56, 57 and 58 respectively.

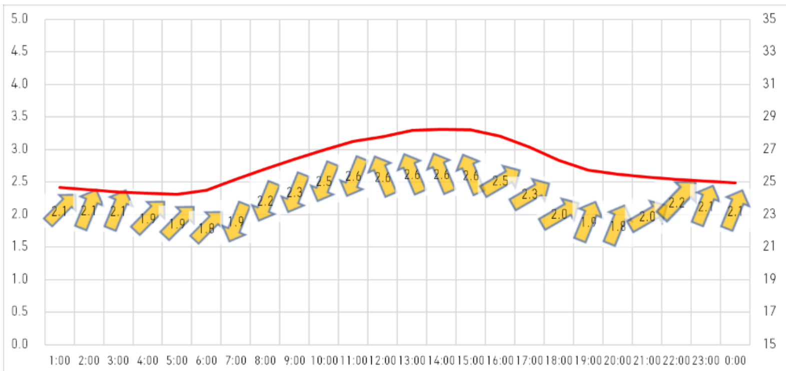
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



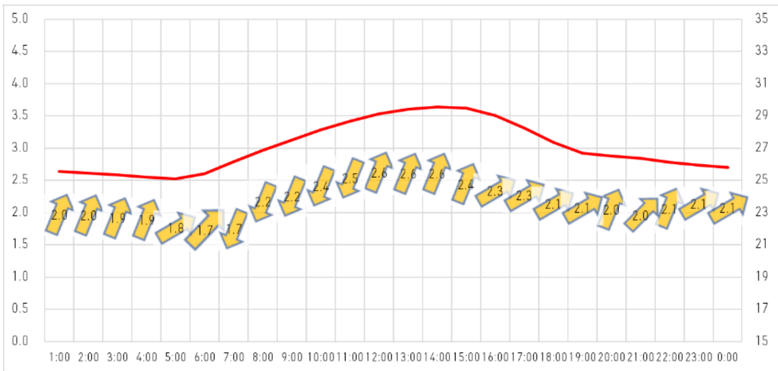
Late July

Figure 56 20-year average hourly temperatures and hourly wind direction and speeds in July (Izu Venue)

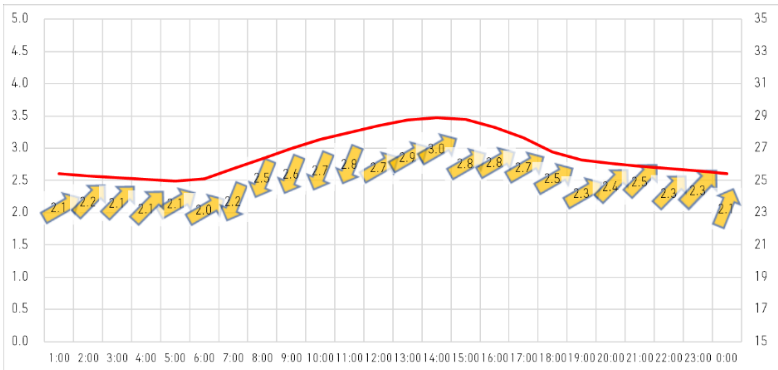
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

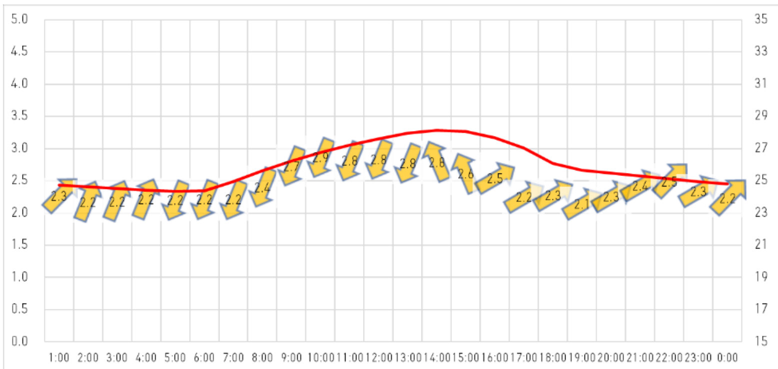
Wind speeds (m/s)　　　Temperatures (℃)



Early August



Mid-August



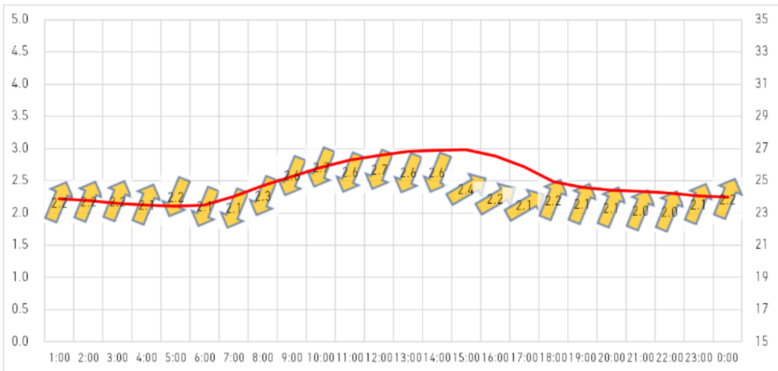
Late August

Figure 57　20-year average hourly temperatures and hourly wind direction and speeds in August (Izu Venue)

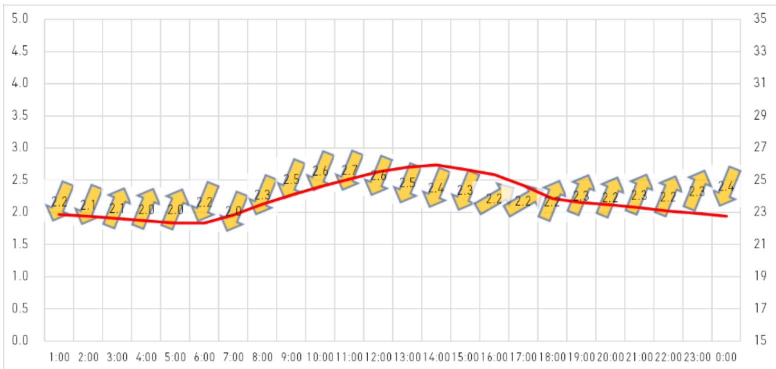
【Legend】　Horizontal Axis: Time　Arrow: Wind direction　Number in arrow: Wind speed (m/s)

-: Temperature (°C)　<Example of wind direction　⇧: southerly wind>

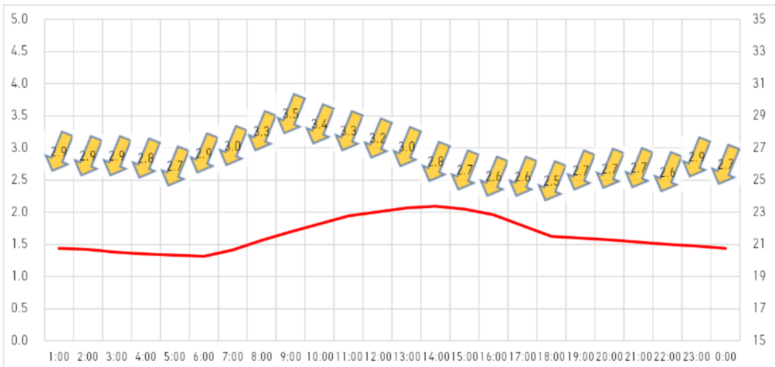
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 58 20-year average hourly temperatures and hourly wind direction and speeds in September (Izu Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

F) Gotenba Venue (Fuji International Speedway)

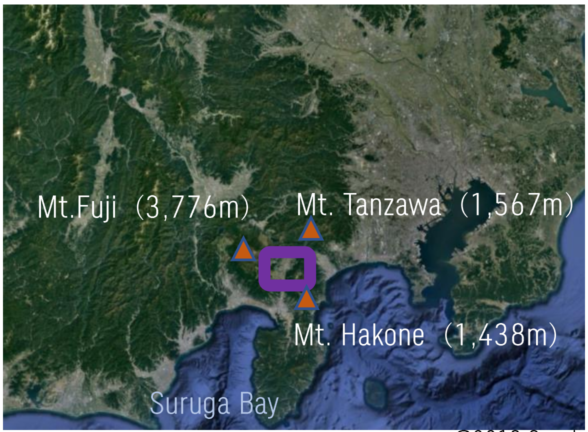


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Figure 59 F) Location and landmarks of the Gotenba Venue

List12 F) Averages in Gotenba Venue (Gotenba)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	2.5	3.1	6.2	11.3	15.5	18.9	22.4	23.7	20.5	15.1	9.9	5
	Daily maximum	7.7	8.1	11.2	16.5	20.4	23.1	26.6	28.4	25.1	20	15.1	10.4
	Daily minimum	-2.1	-1.6	1.6	6.6	11.4	15.6	19.6	20.5	17.1	10.9	5.2	0.2
Monthly average precipitation amounts (mm)		102.7	127.9	257.7	242.6	260.5	321.7	302.3	304.3	368.2	266.5	180.5	84.4

The Gotenba Venue is the Fuji International Speedway track which will be used for Cycling at the Tokyo 2020 Games.

Japan's iconic Mt. Fuji is located to the west-northwest of the venue. Mt. Tanzawa is situated to the northeast and Mt. Hakone stands to the east-southeast. Suruga Bay is located to the south-southwest. Gotenba City is located at an elevation of 450m, making it the highest venue to be used at the Tokyo 2020 Games. The climate features for this venue are distinct from those that affect other venues due to the local topography. As mentioned in "Comparison between venues" on page 117 and after, there are few extremely hot days in summer. It is cool at night even in midsummer and the minimum temperature does not exceed 25°C. The difference between the highest and lowest temperatures for each day is quite pronounced. Specifically, there were 16 days on which maximum temperatures exceeded 30°C in July 2018, which was 10 days fewer than the Central Tokyo Venues. The monthly maximum value was 33.8°C on 23 July, and there were 14 days on which maximum temperatures exceeded 30°C in August 2018, which was 11 days fewer than the Central Tokyo Venues. Maximum temperatures slightly exceeded 30°C on most of these days. The monthly maximum value was 33.8°C on 6 August. There was no day on which the minimum temperature exceeded 25°C throughout the year.

In addition, the area is characterised with many cloudy days with little sunshine and the precipitation amount is significantly high.

The climatic tendencies for the beginning, middle and ending of July, August and September are described below. There are many cloudy or rainy days due to the impact of a rain front from the beginning to middle of July each year.

The rainy season comes to an end in late July, and the area is covered with the Pacific High with subtropical air from the south in August. A south-southwesterly wind from Suruga Bay is generally prominent and blows particularly strongly in the afternoon. The Gotenba Venue has less sunshine than the other venues even on fine days as prevailing winds produce clouds around the nearby mountains.

In September, days on which maximum temperatures exceed 25°C becomes less gradually decline, and temperatures often dip below 20°C in early September mornings. The seasonal transition can be also seen in terms of the changing wind directions. A northerly wind blows for a longer time from the night to morning. By late September, a north to northeastly wind blows throughout the day.

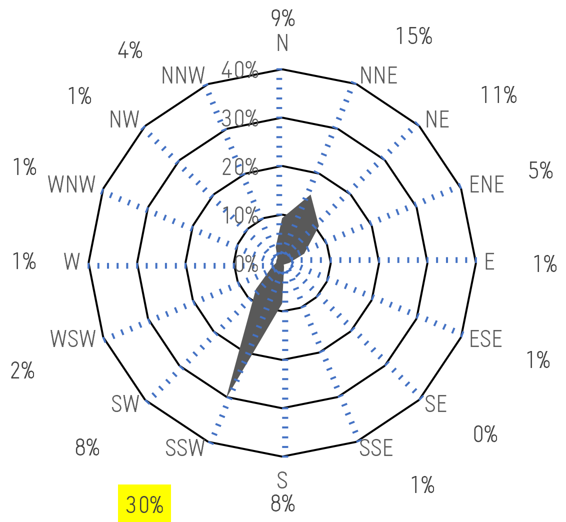
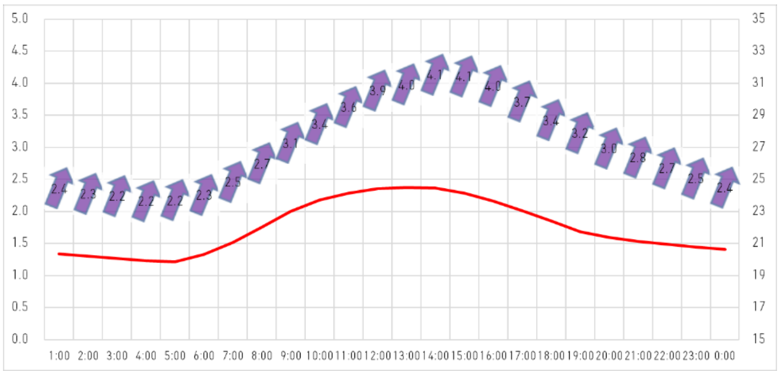


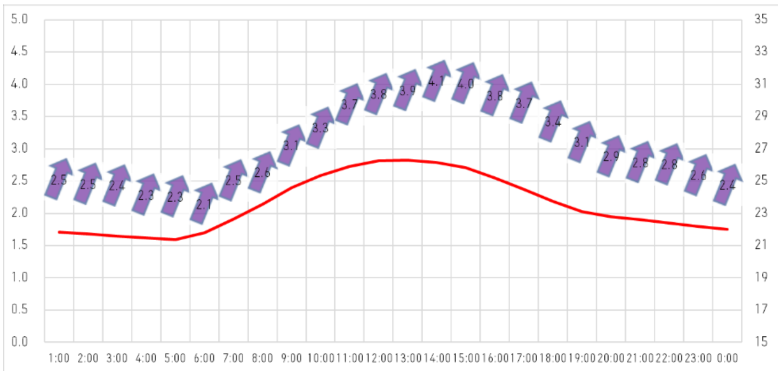
Figure 60　Prevailing wind direction for the Gotenba Venue
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 61, 62 and 63 respectively.

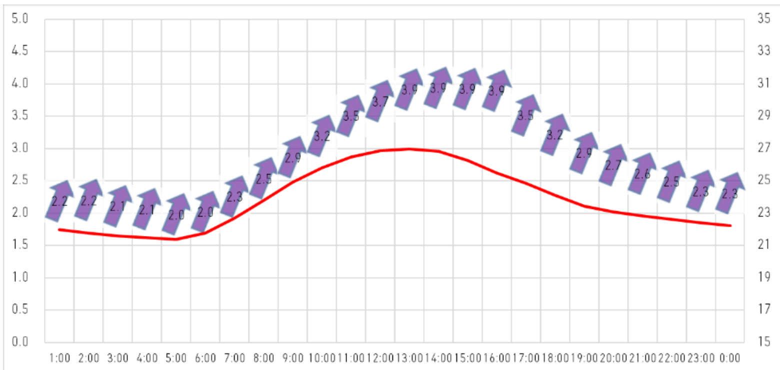
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



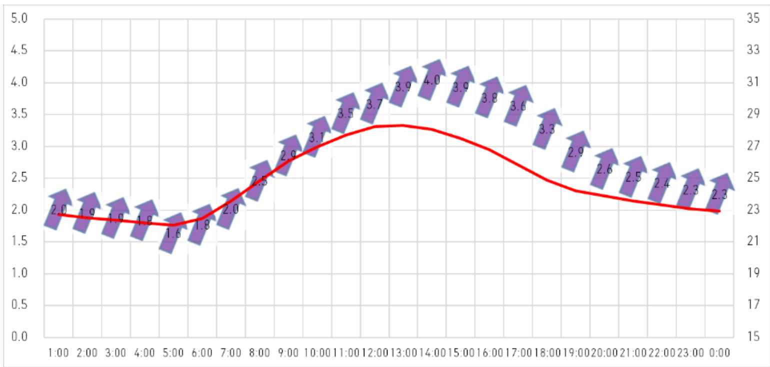
Late July

Figure 61 20-year average hourly temperatures and hourly wind direction and speeds in July (Gotenba Venue)

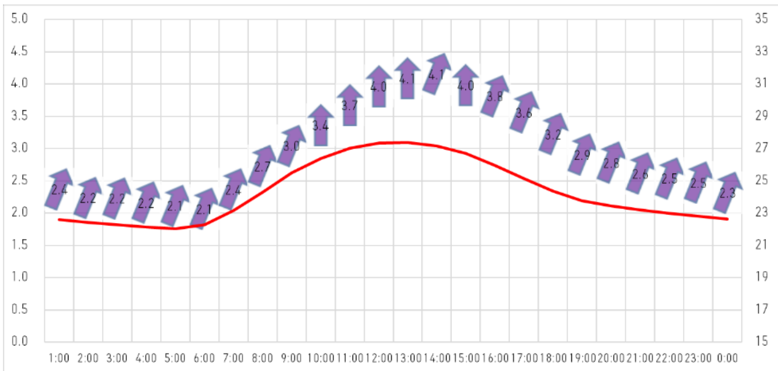
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

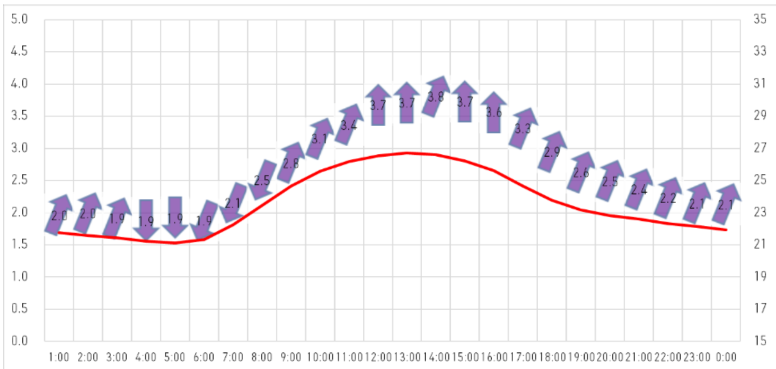
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



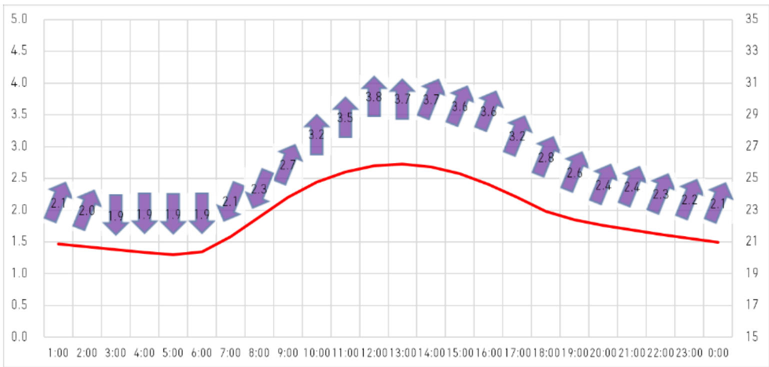
Late August

Figure 62 20-year average hourly temperatures and hourly wind direction and speeds in August (Gotenba Venue)

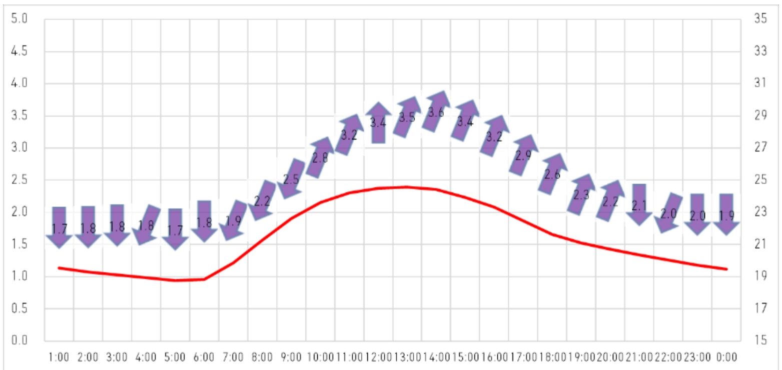
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

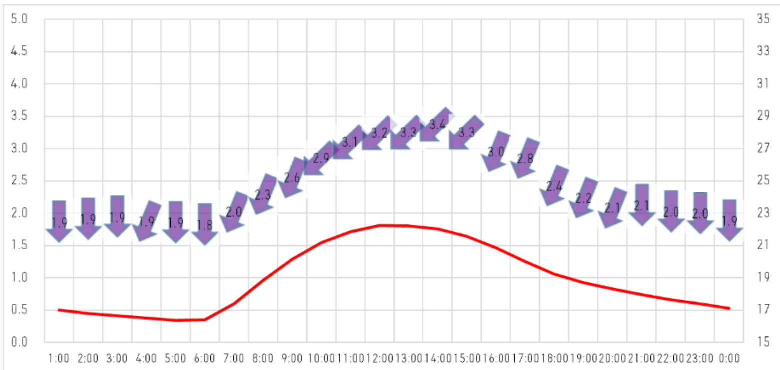
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 63 20-year average hourly temperatures and hourly wind direction and speeds in September (Gotenba Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

G) Mobara Venue (Tsurigasaki Surfing Beach)

Figure 64 G) Location and landmark of the Mobara Venue

List13 G) Averages at the Mobara Venue (Mobara)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	5	5.5	8.6	13.6	17.9	20.9	24.7	26.3	23	17.5	12.3	7.4
	Daily maximum	10.4	10.6	13.5	18.7	22.6	25.1	29.1	31.1	27.3	22.2	17.5	13
	Daily minimum	0.1	0.7	3.7	8.8	13.5	17.4	21.3	22.7	19.6	13.7	7.8	2.5
Monthly average precipitation amounts (mm)		78	78.9	144.8	132.3	145.6	178.4	143.5	122.3	229.4	232.7	115.2	62.8

The Mobara Venue consists of the Tsurigasaki Surfing Beach, which will be used for the Surfing competitions at the Tokyo 2020 Games.

This venue faces the Pacific Ocean to the east, and the ocean extends a significant impact over the venue. Temperature increases are influenced directly by the wind direction. For example, when a southern wind is predominant, both temperatures and humidity levels rise. In contrast, on days when an easterly or northeasterly wind prevails, temperature increases are suppressed, and the heat is more comfortable even to the point of feeling somewhat chilly. From July to September typhoons pass over the area to the east or northeast from the seas to the south and east of the Kanto region. The swell generated by typhoons can often affect surfing conditions.

Climatic tendencies for early, mid and late July, August and September are described below.

There are many cloudy or rainy days due to the impact of a rain front from the beginning to the middle of July each year. Furthermore, the differences between the highest and lowest temperatures for each day are relatively minor. When the venue is located at the southern side of the front, a south to southwesterly wind blowing towards the front is prominent. A cold and wet northeasterly wind blows across the venue from the northern Okhotsk High when it is located on the northern side of the front. Advection fog also occurs frequently during this period.

The rainy season ends in late July, and is followed by fine, sunny days with high temperatures as the Pacific High with subtropical air from the south covers the area. Specifically, there were 26 days on which maximum temperatures exceeded 30°C in July 2018, which was almost the same as the Central Tokyo Venues. The monthly maximum value was 36.1°C on 19 July. There were 14 days on which minimum temperatures exceeded 25°C, which was six days fewer than the Central Tokyo Venues. There were 25 days on which maximum temperatures exceeded 30°C in August 2018, which again was similar to the Central Tokyo Venues. The monthly maximum value was 37.2°C on 26 August. There were 19 days on which minimum temperatures exceeded 25°C, which was two days more than the Central Tokyo Venues.

An easterly wind blowing in from the Pacific Ocean is likely to be prominent during the morning and the wind direction tends to turn to the south in the afternoon when the weather is fine. However, temperatures do not increase to a marked degree on days that the east wind is prominent and it is cloudy or rainy. Cumulonimbus clouds from the inland areas move across the area on days that a southerly wind is predominant, occasionally bringing afternoon thunderstorms.

The prevailing wind direction changes to the north or east as the strength of Pacific High gradually weakens with the arrival of the month of September. In the first half of the month, maximum temperatures can exceed 30°C, however, the number of days on which maximum temperatures does not reach 25°C increases noticeably in the latter half of the month.

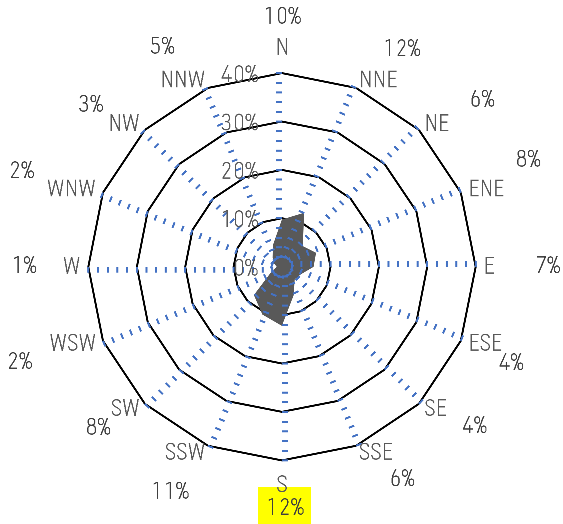
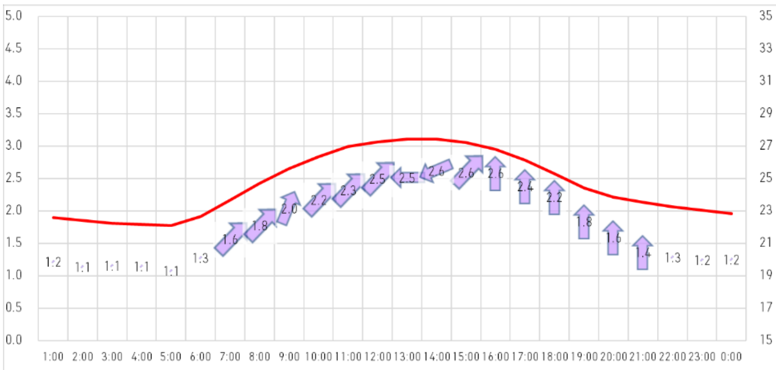


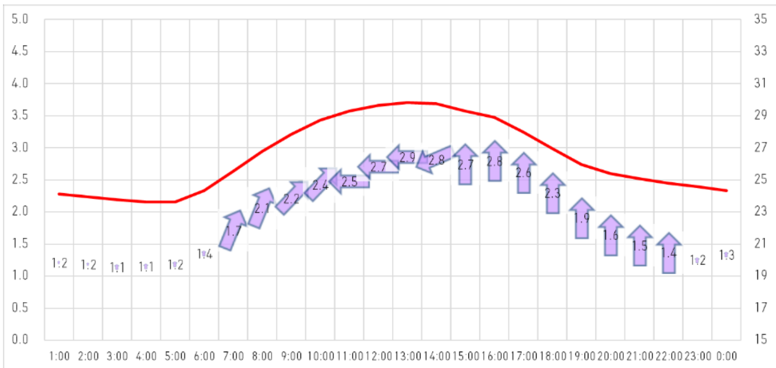
Figure 65 Prevailing wind direction for the Mobara Venue
(Averages between July and September in 2014 - 2018))

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 66, 67 and 68 respectively.

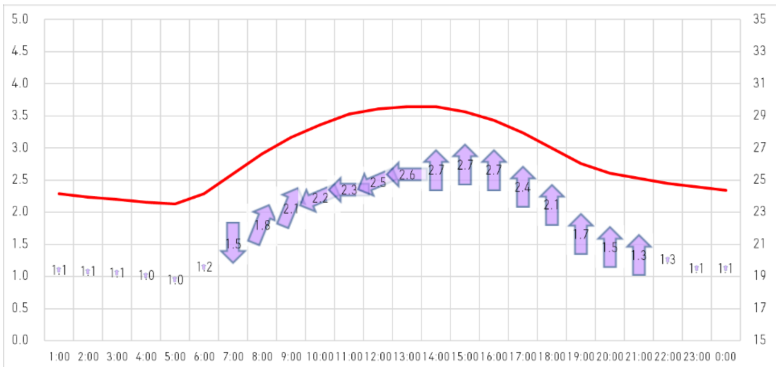
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



Late July

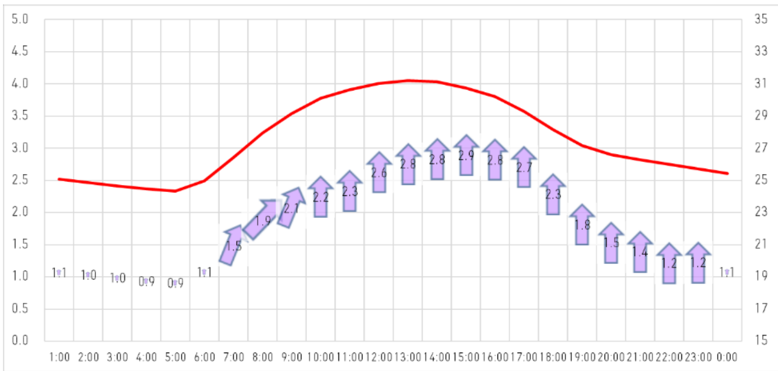
Figure 66 20-year average hourly temperatures and hourly wind direction and speeds in July (Mobara Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

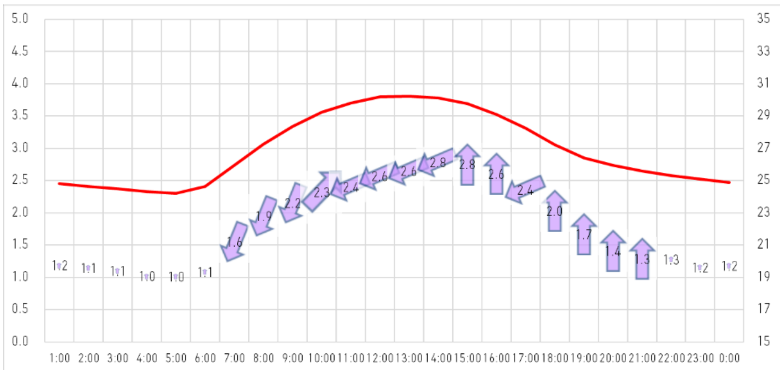
-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

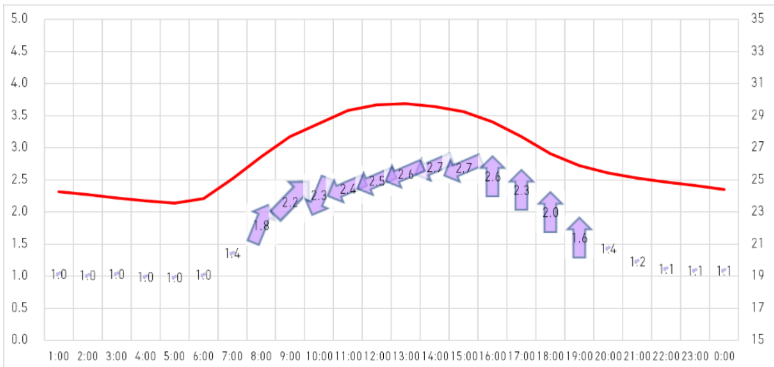
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



Late August

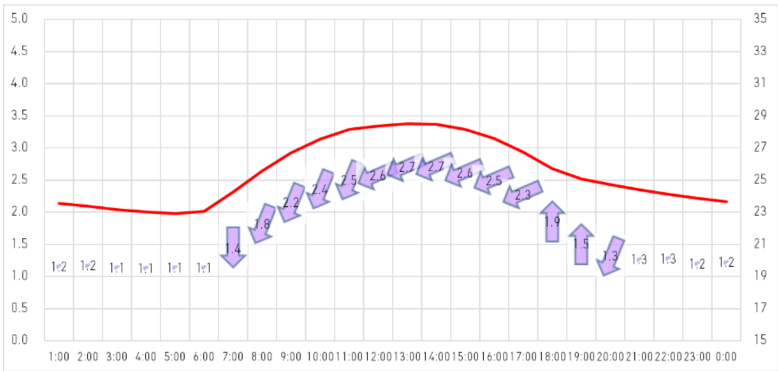
Figure 67 20-year average hourly temperatures and hourly wind direction and speeds in Augutst (Mobara Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

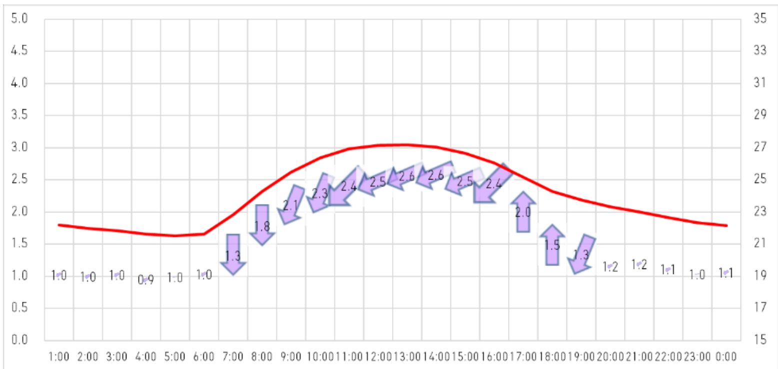
-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

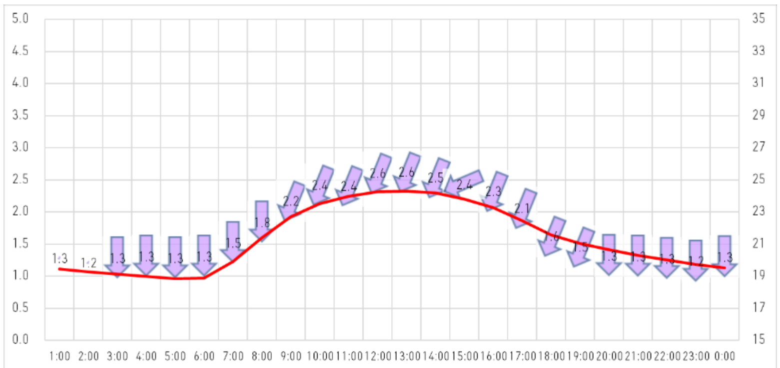
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 68 20-year average hourly temperature and hourly wind direction and speed in September (Mobara Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

H) Kashima Venue (Ibaraki Kashima Stadium)

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Figure 69 H) Location and landmark of the Kashima Venue

List 14 H) Averages at the Kashima Venue (Kashima)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	4.4	5	7.9	12.7	16.7	19.6	23.4	25.3	22.3	17.3	12.1	7
	Daily maximum	9.2	9.5	12.2	17.2	21.1	23.6	27.6	29.6	25.9	21	16.3	11.8
	Daily minimum	0.1	0.7	3.7	8.6	12.9	16.5	20.3	22.3	19.5	14	8	2.6
Monthly average precipitation amounts (mm)		81.1	77.4	135.4	123.6	127.1	146.6	122.8	109.1	212.1	234.8	102.3	60.5

The Ibaraki Kashima Stadium, which will be used for Football, constitutes the Kashima Venue.

As with the Mobara Venue, this area is influenced significantly by the Pacific Ocean, which extends to the east of the venue, and temperature increases depend to a great extent on the wind direction. In short, temperatures are high and it is muggy when a southerly wind is predominant. In contrast, on days when an easterly or northeasterly wind prevails, temperature increases are suppressed, and the heat is more comfortable even to the point of feeling somewhat chilly. However, the northeasterly wind is cooler than that experienced at the Mobara Venue. In addition, the above climatic tendencies, which are dependent on cool winds, are more pronounced than at the Mobara Venue.

Climatic tendencies for early, mid and late of July, August and September are described below.

There are usually many cloudy or rainy days due to the rain front from the beginning to the middle of July. The differences between the highest and lowest daily temperatures are minor. Prevailing wind directions are northeast in the morning and south-southwest in the afternoon.

The area is often covered with cold, moist air on days that the rain front moves south and the northeast wind from the northern Okhotsk High predominates. In addition, a fog frequently appears.

The rainy season ends in late July, and throughout the remainder of the summer the area is covered by a Pacific High with subtropical air from the south. Southerly winds are prominent and daytime temperatures often reach around 35°C, and do not dip below 25°C after sunset on fine days. Accordingly, the area is characterised by extremely high temperatures and extremely high humidity levels. Cumulonimbus clouds from the northern inland areas move towards the south in the afternoon. This can sometimes result in fierce thunderstorms that last for some hours. On the other hand, when powerful easterly-northeasterly winds prevail on cloudy and rainy days, temperatures do not increase markedly.

Northeasterly winds become more pronounced as the Pacific High gradually weakens with the arrival of September. Hence, temperature increases are minor and the diurnal temperature range becomes minimal. There are few days on which maximum temperatures exceed 30°C.

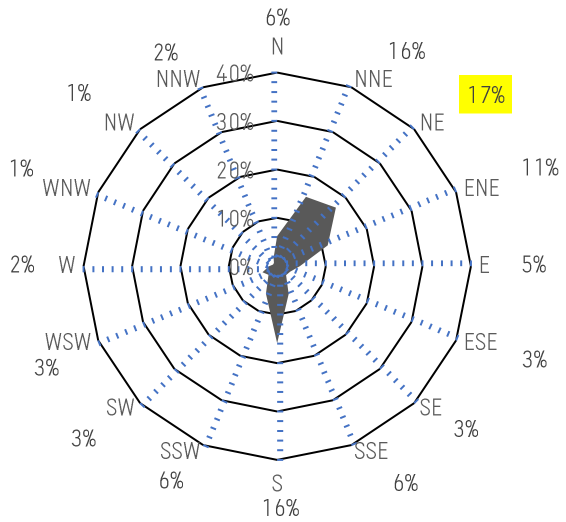
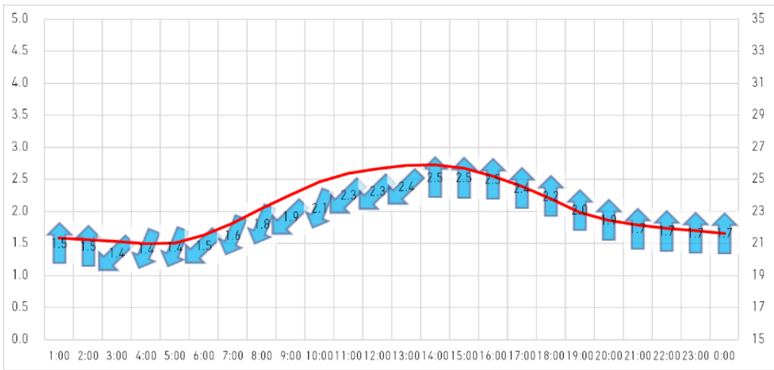


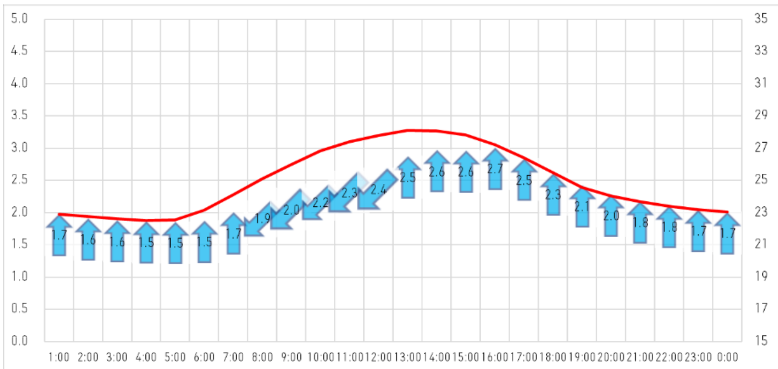
Figure 70 Prevailing wind direction for the Kashima Venue
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 71, 72 and 73 respectively.

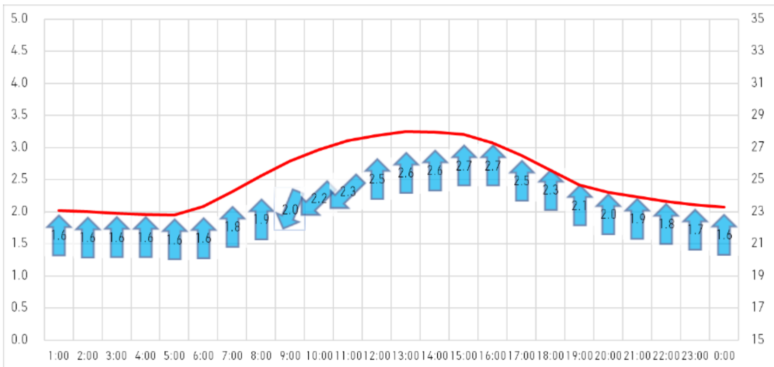
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



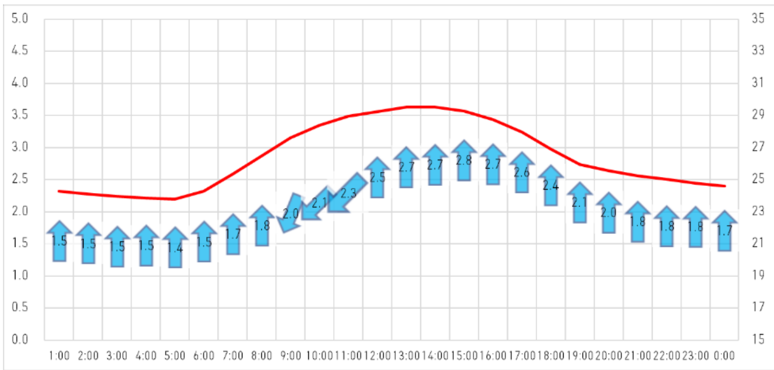
Late July

Figure 71 20-year average hourly temperature and hourly wind direction and speed in July (Kashima Venue)

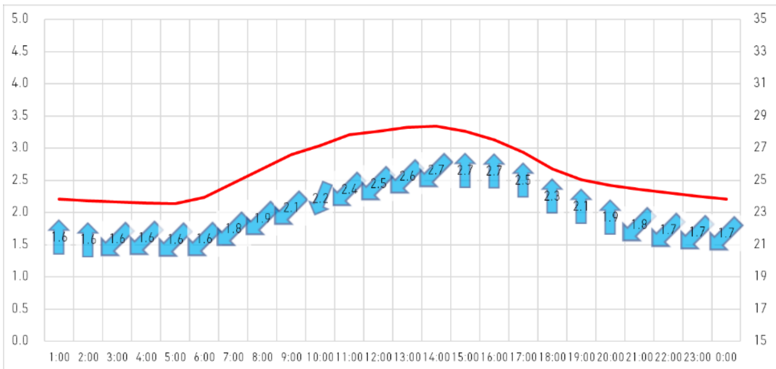
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

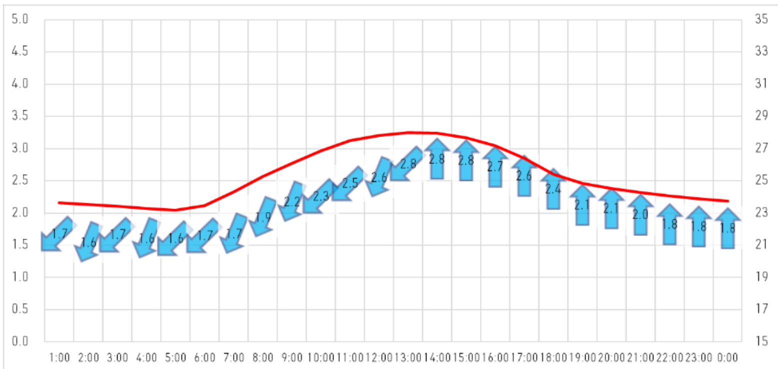
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



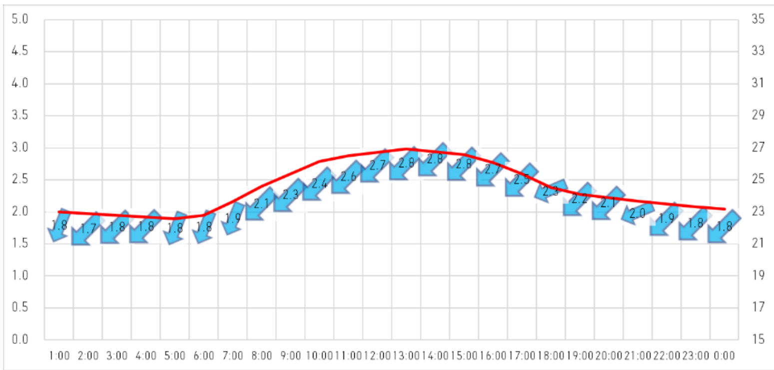
Late August

Figure 72 20-year average hourly temperature and hourly wind direction and speed in August (Kashima Venue)

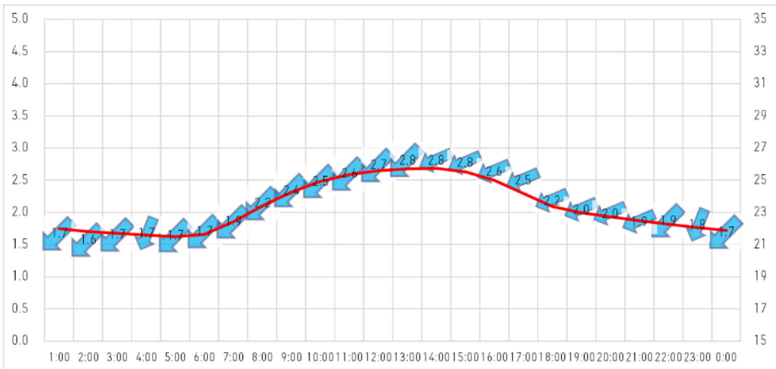
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

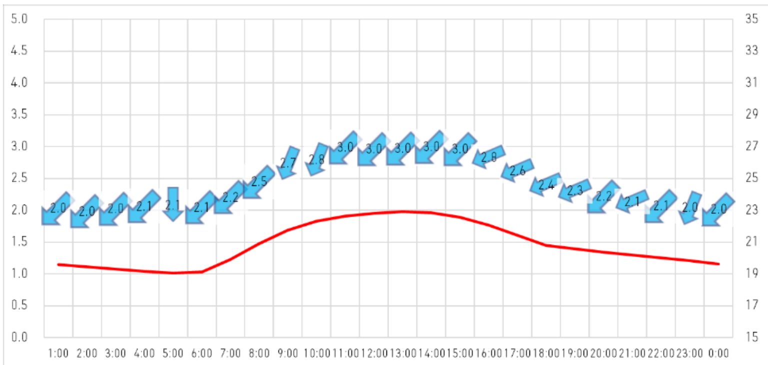
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 73 20-year average hourly temperature and hourly wind direction and speed in September (Kashima Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

I) Fukushima Venue (Azuma Baseball Stadium)

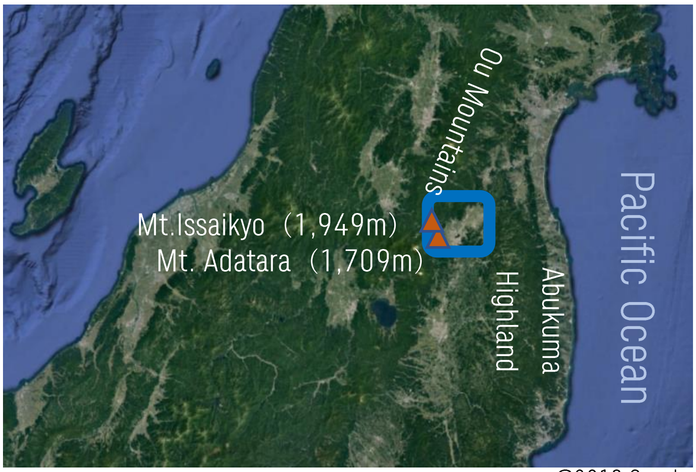


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Figure 74 I) Location and landmarks of the Fukushima Venue

List15 I) Averages at the Fukushima Venue (Fukushima)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	1.6	2.2	5.3	11.5	16.6	20.1	23.6	25.4	21.1	15.1	9.2	4.4
	Daily maximum	5.5	6.5	10.4	17.4	22.5	25.2	28.3	30.4	25.6	20	14.1	8.7
	Daily minimum	-1.8	-1.5	0.9	6.2	11.5	16.1	20.1	21.8	17.6	11	4.8	0.7
Monthly average precipitation amounts (mm)		49.4	44.3	75.6	81	92.6	122.1	160.4	154	160.3	119.1	65.5	41.8

The Fukushima Venue consists of the Fukushima Azuma Baseball Stadium, which will be used to stage both Baseball and Softball matches at the Tokyo 2020 Games.

The Abukuma Highland lies to the eastern side of the venue and the Ou mountain range is located to the western side. Both of these areas run from north to south, and the venue sits in a basin between the two areas. Also, Mt. Adatara stands to the southwest of the Fukushima Azuma Stadium, while Mt. Issaikyo flanks the venue to the west. The stadium is located at the bases of both these mountains, and is significantly influenced by these geographical features.

The climatic tendencies in early, mid and late July, August and September are described below.

There are usually many cloudy or rainy days due to the seasonal rain front in July. Northeasterly winds, which blow towards the front, are prominent as the venue is often located to the north of the front. The rainy season ends in late July.

In August, the area is covered by the Pacific High with subtropical air from the south. The differences between the lowest and highest temperatures for each day are considerable. Temperatures are extremely high and maximum temperatures can exceed 38°C on fine days. In contrast, the number of days on which minimum temperatures rise above 25°C are relatively few. Fine days are marked by a light wind blowing in from the south in the morning, followed by a

gradual change to a northeasterly wind from around noon, which strengthens by degrees as the afternoon continues. Cumulonimbus clouds tend to form around the nearby Mt. Adatara and Mt. Issaikyo bringing occasional thunderstorms around noon or shortly before.
In September, the differences between the lowest and highest temperatures for each day remain quite pronounced. However, temperatures start to decrease as a whole after the middle of the month. The maximum temperature does not usually reach 25°C and the minimum temperature in the morning is around 15°C.

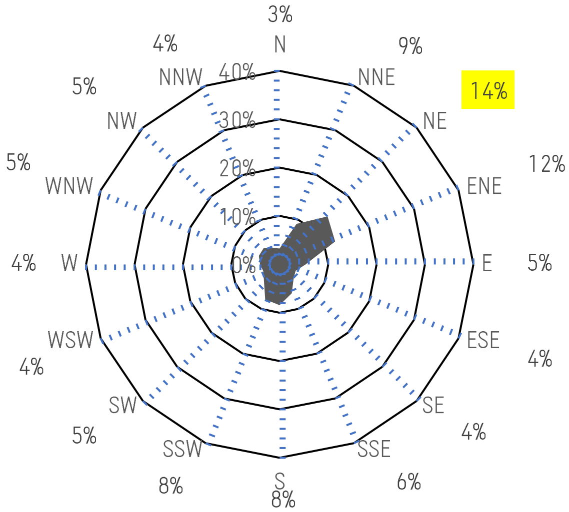
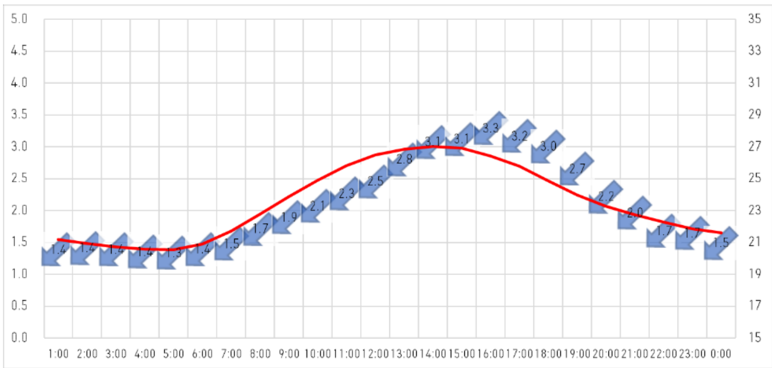


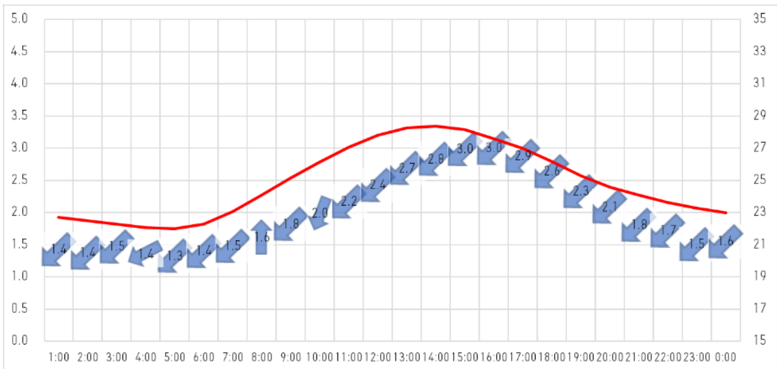
Figure 75 Prevailing wind direction for the Fukushima Venue
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 76, 77 and 78 respectively.

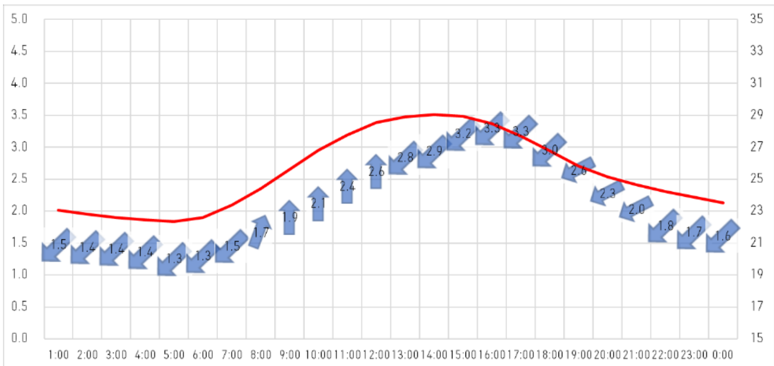
Wind speeds (m/s)　Temperatures (℃)



Early July



Mid-July



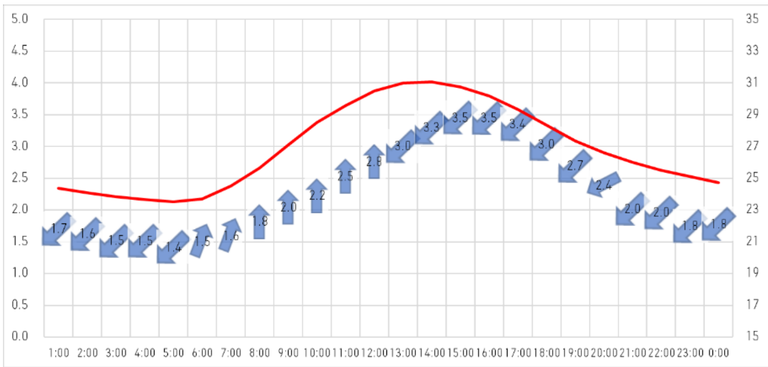
Late July

Figure 76　20-year average hourly temperature and hourly wind direction and speed in July (Fukushima Venue)

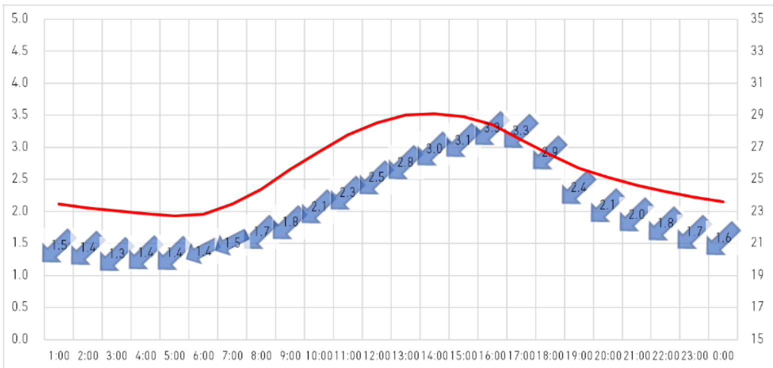
【Legend】　Horizontal Axis: Time　Arrow: Wind direction　Number in arrow: Wind speed (m/s)

-: Temperature (°C)　<Example of wind direction　⇧: southerly wind>

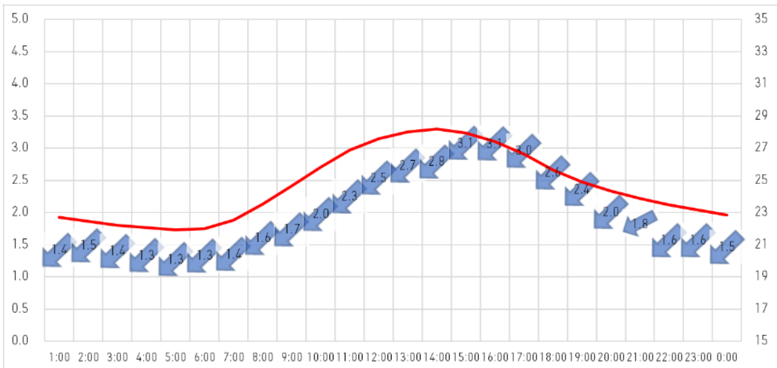
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



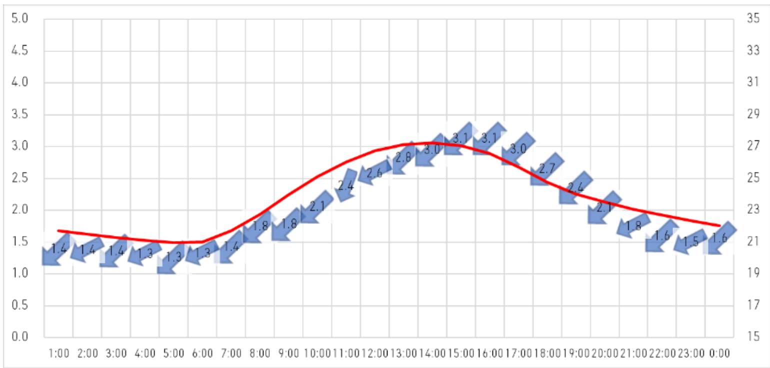
Late August

Figure 77 20-year average hourly temperature and hourly wind direction and speed in August (Fukushima Venue)

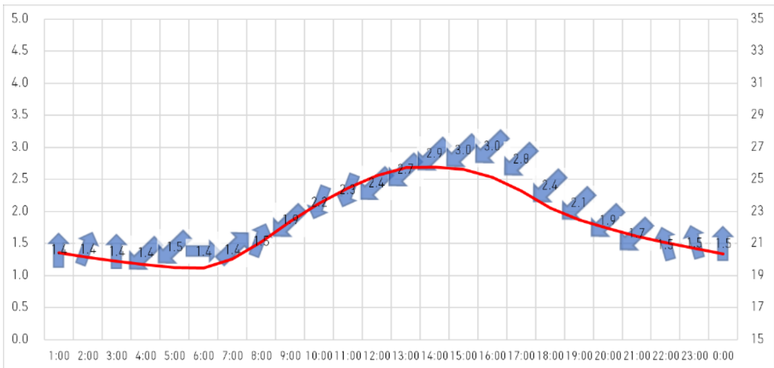
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

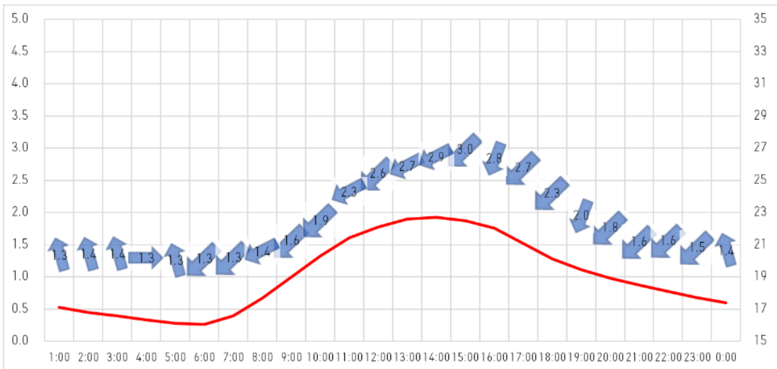
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 78 20-year average hourly temperature and hourly wind direction and speed in September (Fukushima Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

J) Miyagi Venue (Miyagi Stadium)

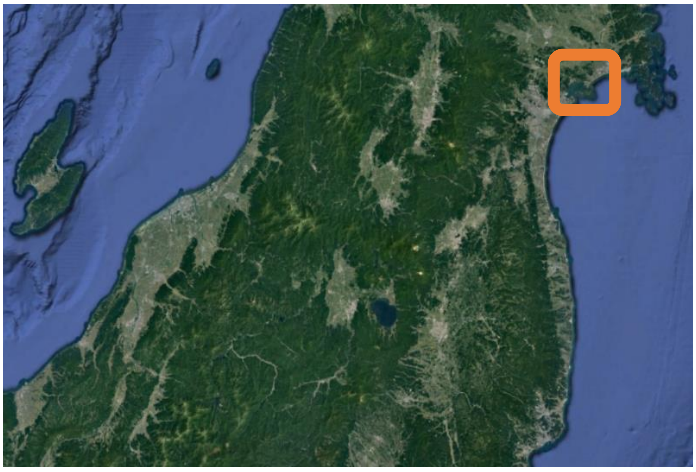


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Figure 79 J) Location of the Miyagi Venue

List16 J) Averages at the Miyagi Venue (Shiogama)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	0.6	0.9	3.8	9.3	14	17.6	21.2	23.2	19.8	14.3	8.5	3.5
	Daily maximum	4.1	4.8	8.2	14.1	18.5	21.5	24.9	27.2	23.5	18.4	12.6	7.3
	Daily minimum	-2.5	-2.3	0.1	5.2	10.2	14.6	18.5	20.5	16.7	10.6	4.7	0.3
Monthly average precipitation amounts (mm)		33.7	37	67.3	99.4	103.3	136.3	169.9	143.7	175.5	121.6	67.1	33.1

The Miyagi Venue is the Miyagi Stadium, which will host Football matches in the Tokyo 2020 Games.

The venue sits in an open plain close to the Pacific Ocean, which is located to the southeast of the stadium. Notwithstanding this close proximity to the sea, wind speeds are relatively low. Also, the differences between the lowest and highest temperatures for each day are fairly minor.

The climatic tendencies for early, mid and late July, August and September are described below.

There are many cloudy or rainy days due to the seasonal rain front in July. However, heavy rainfalls are quite rare. For example, only seven days with an hourly precipitation amount of 20mm or higher have been recorded over a 30-year period. In late July, the prevailing wind direction is southeast and the mean maximum temperature is slightly above 25°C. However, the dry and hot air that crosses the nearby mountains can cause the area in which the venue is situated to become extremely hot with maximum temperatures sometimes exceeding 34°C. This phenomenon is known as a Foehn wind and occurs when northwest winds are sometimes prominent depending on the pressure pattern.

The area is covered by a Pacific High with subtropical air from the south in August after the rainy season ends in late July. It is muggy with maximum temperatures of 30°C or higher in the daytime when it is sunny. However, minimum temperatures do not exceed 25°C, making conditions fell very comfortable after sunset. On cloudy or rainy days, nighttime temperatures can dip below 20°C, giving a distinct chill to the night air.

In September, the maximum temperature seldom exceeds 30°C regardless of the wind direction, and the minimum temperature stays below 20°C as the Pacific High gradually weakens.

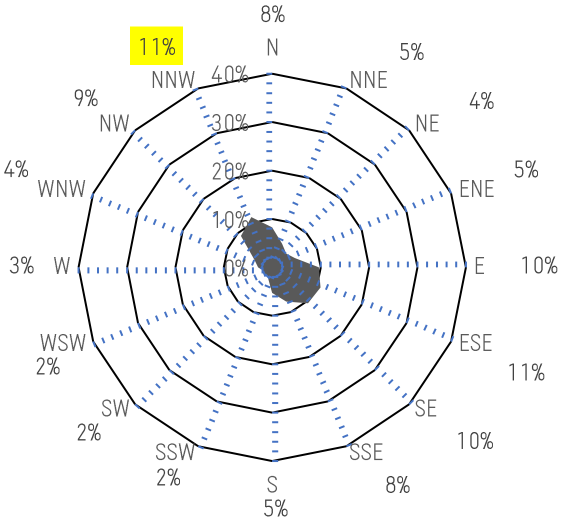
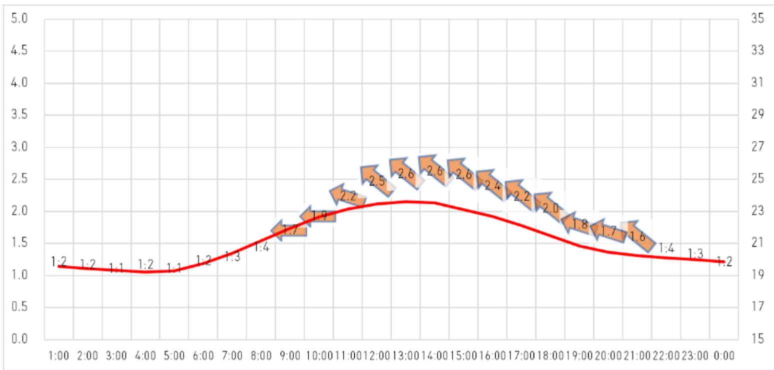


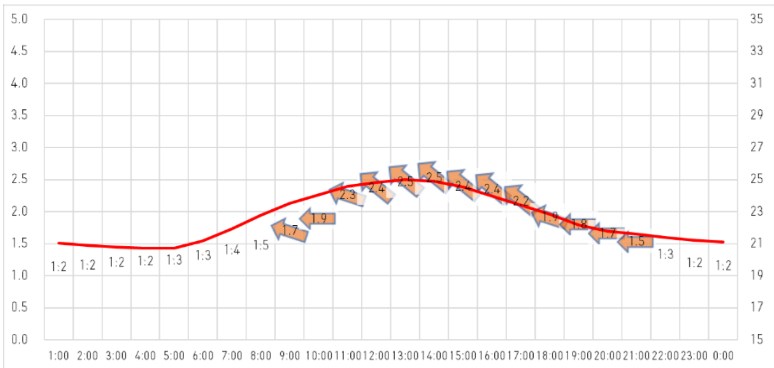
Figure 80　Prevailing wind direction for the Miyagi Venue
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 81, 82 and 83 respectively.

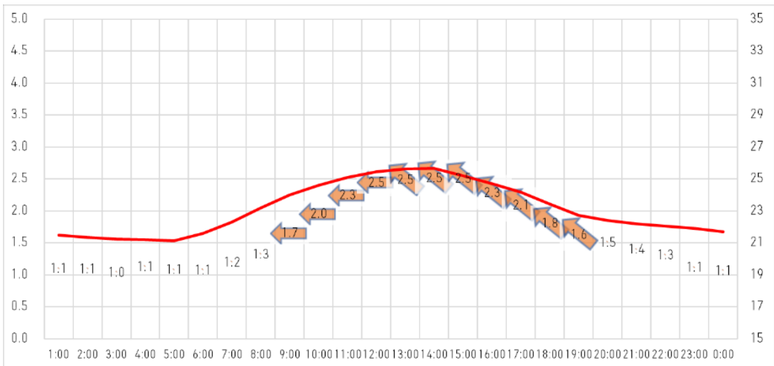
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



Late July

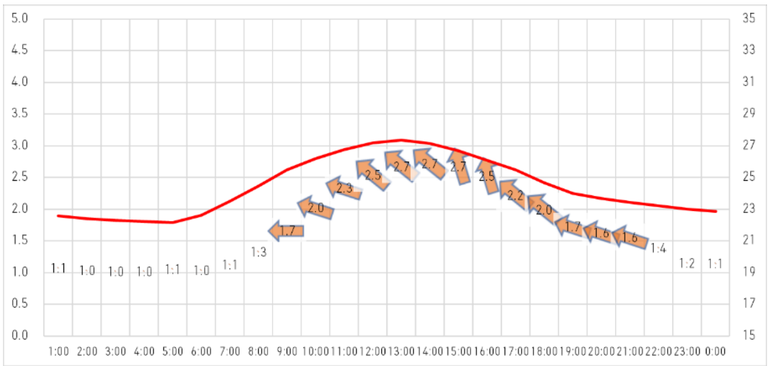
Figure 81 20-year average hourly temperature and hourly wind direction and speed in July (Miyagi Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

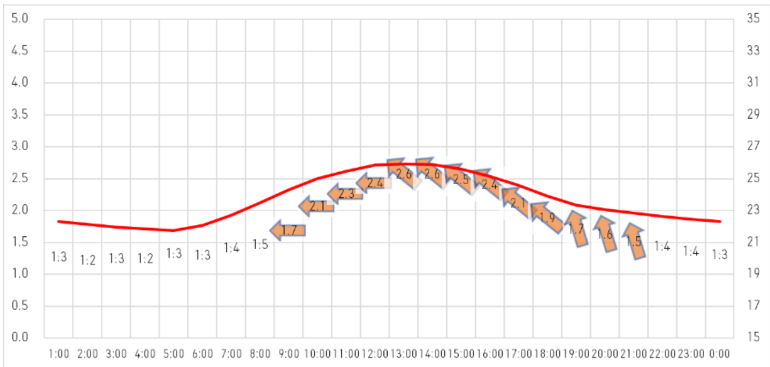
-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

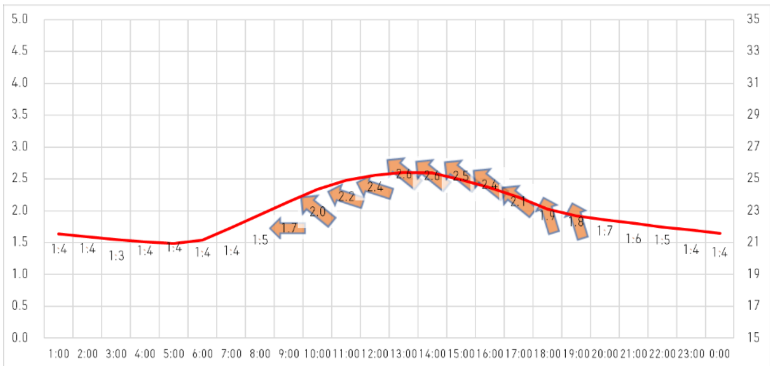
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



Late August

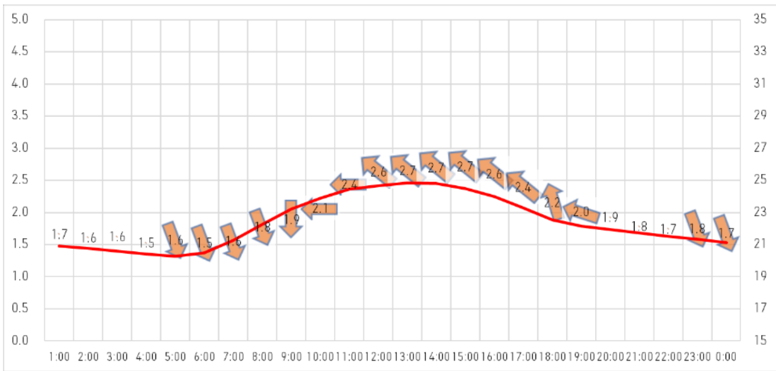
Figure 82 20-year average hourly temperature and hourly wind direction and speed in August (Miyagi Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

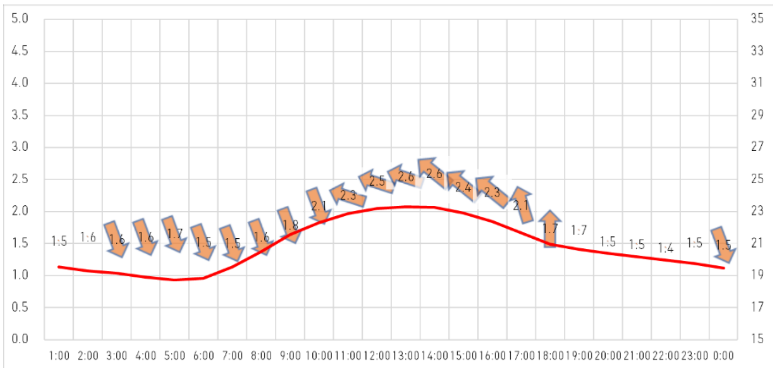
-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

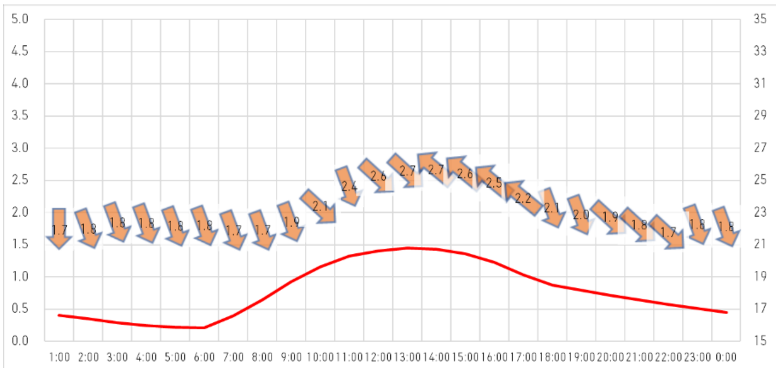
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 83 20-year average hourly temperature and hourly wind direction and speed in September (Miyagi Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind

No arrow denotes that intensity was so minor that the direction could not be fixed. >

K) Sapporo Venue (Sapporo Dome)

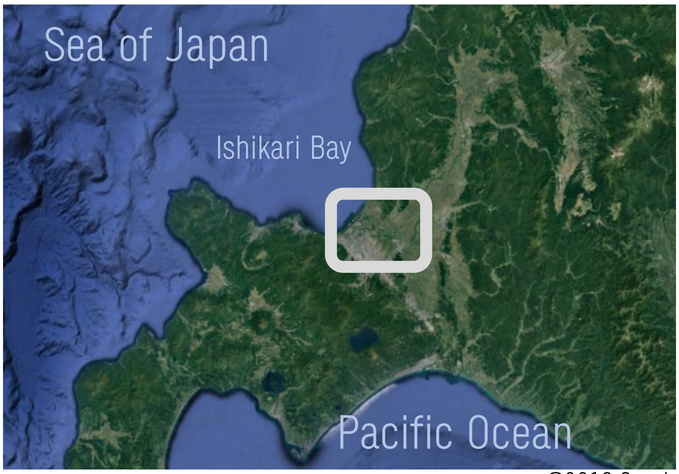


Figure 84 K) Location and landmarks of the Sapporo Venue

List17 K) Averages in Sapporo Venue (Sapporo)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures (°C)	Daily average	-3.6	-3.1	0.6	7.1	12.4	16.7	20.5	22.3	18.1	11.8	4.9	-0.9
	Daily maximum	-0.6	0.1	4	11.5	17.3	21.5	24.9	26.4	22.4	16.2	8.5	2.1
	Daily minimum	-7	-6.6	-2.9	3.2	8.3	12.9	17.3	19.1	14.2	7.5	1.3	-4.1
Monthly average precipitation amounts (mm)		113.6	94	77.8	56.8	53.1	46.8	81	123.8	135.2	108.7	104.1	111.7

The Sapporo Venue consists of the Sapporo Dome (Football). This is the only venue located in a Cool Temperate Climate. The venue opens like a fan towards Ishikari Bay, located some 30kms away to the northwest.

The general climatic tendencies from July to September are described below.

Due to the rainy season, Sapporo experiences many cloudy or rainy days in the middle of July. However, the duration of the rainy period in Sapporo is shorter than those of other venue zones. Even during periods of fine weather, heavy rains can result if the area is influenced by a low pressure or front. The maximum and minimum temperatures are around 30°C and 20°C respectively in early August, which is the hottest time of year. Southeasterly winds blow until around noon, and are followed by predominantly northwesterly winds until sunset.

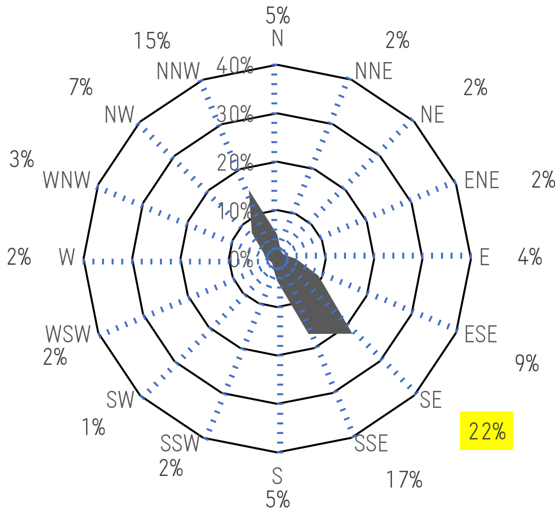
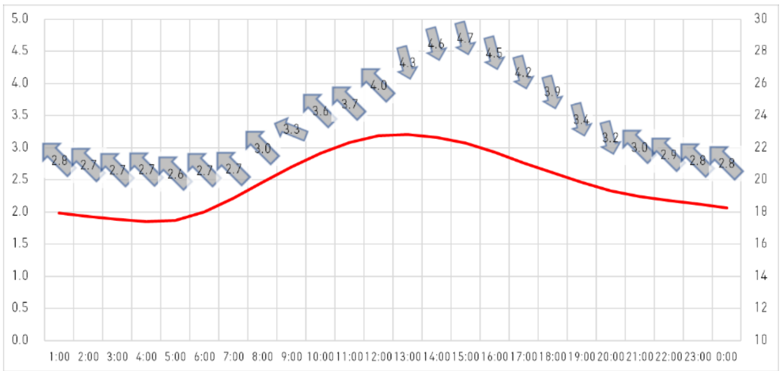


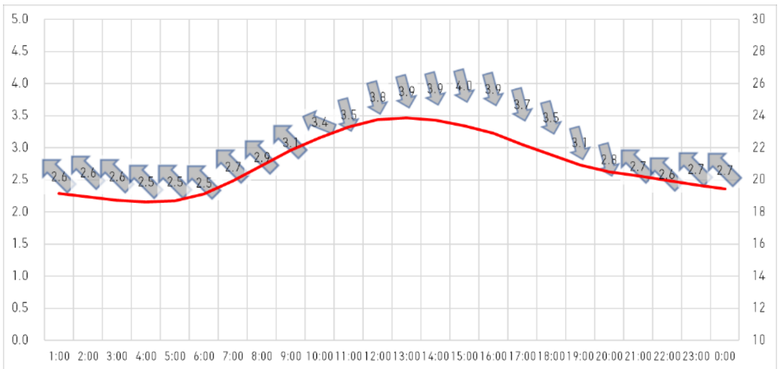
Figure 85 Prevailing wind direction for the Sapporo Venue
(Averages between July and September in 2014 - 2018)

The mean hourly temperatures, wind direction and wind speeds over a 20-year period are described by months in the following figures 86, 87 and 88 respectively.

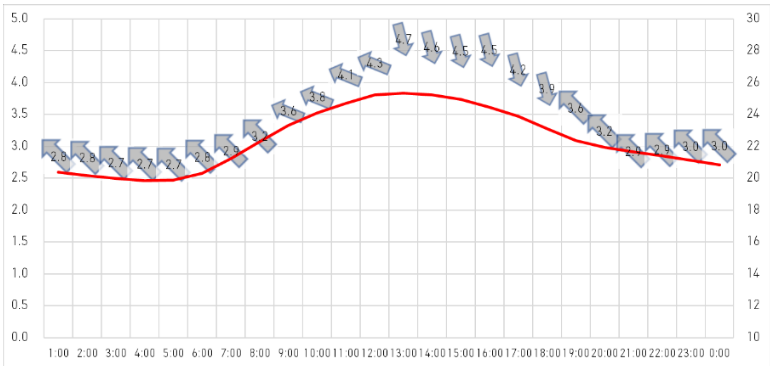
Wind speeds (m/s) Temperatures (℃)



Early July



Mid-July



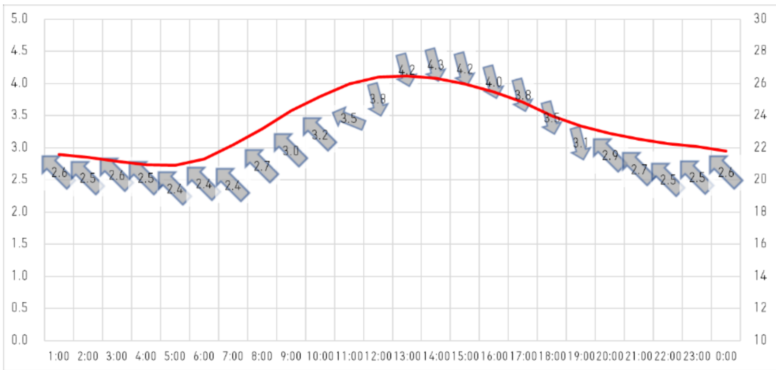
Late July

Figure 86 20-year average hourly temperature and hourly wind direction and speed in July (Sapporo Venue)

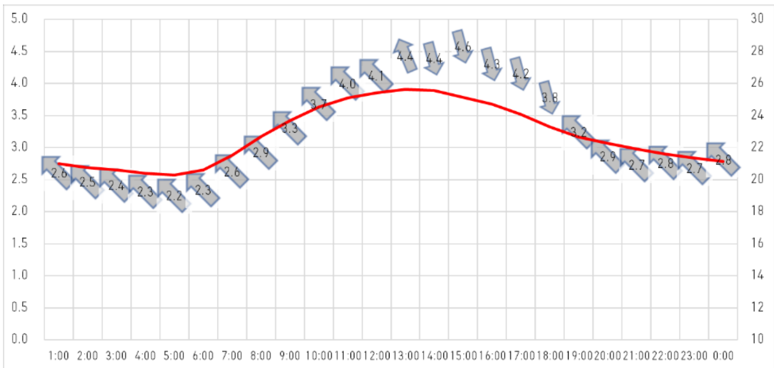
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

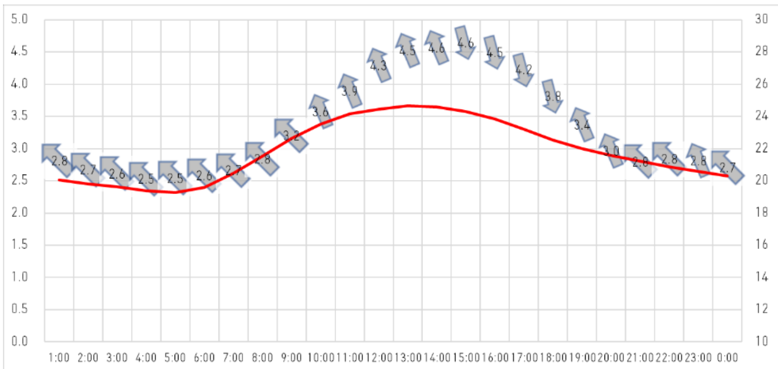
Wind speeds (m/s) Temperatures (℃)



Early August



Mid-August



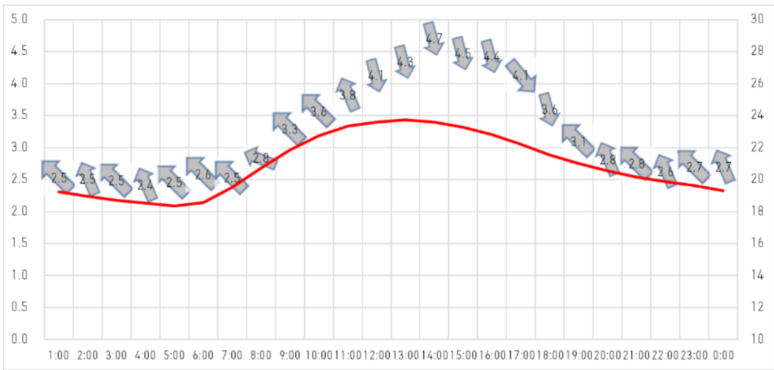
Late August

Figure 87 20-year average hourly temperature and hourly wind direction and speed in August (Sapporo Venue)

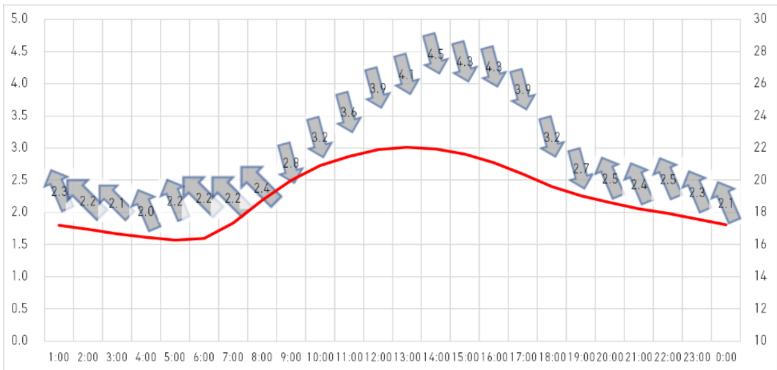
【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

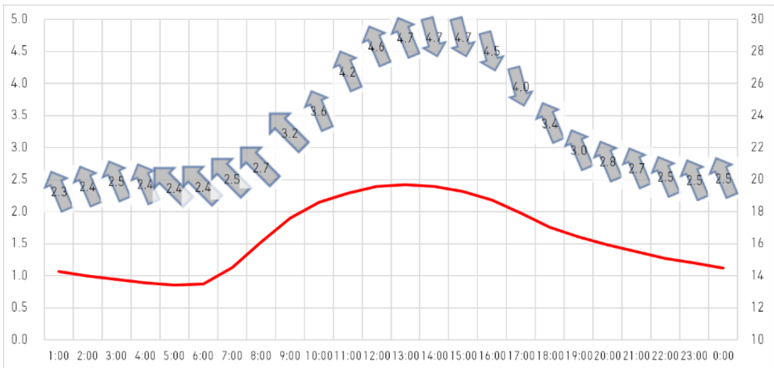
Wind speeds (m/s) Temperatures (℃)



Early September



Mid-September



Late September

Figure 88 20-year average hourly temperature and hourly wind direction and speed in September (Sapporo Venue)

【Legend】 Horizontal Axis: Time Arrow: Wind direction Number in arrow: Wind speed (m/s)

-: Temperature (°C) <Example of wind direction ⇧: southerly wind>

[References]

Meteorological AMeDAS data is used to verify the statistical similarities of climatic conditions in each venue zone. Areas indicating similarities are then classified into the same venue.

【Used data specification】

○Content:

The data used is Automated Meteorological Data Acquisition System (AMeDAS) data, which automatically measures precipitation amounts, wind direction and wind speeds, temperatures and duration of sunshine in 840 locations throughout Japan. This data is equivalent to values on the Japan Meteorological Agency website (https://www.data.jma.go.jp/obd/stats/etrn/index.php), which is produced and managed by the agency (as of 2 April 2019).

○Periods:

(Average values of temperatures and wind direction and wind speeds for each area)
A three-month period from July 1 to September 30 between 1999 and 2018
(Total values of precipitation amounts and duration of sunshine for each area)

○Points: 16 points

(【】 indicates international index numbers () indicates latitude, longitude and altitude of each observation point)
These are classified into 11 venues (A–K) based on the survey of 15 points (Refer to Figure 89 and Figure 90 for locations))

① 【44132】 Tokyo (35.69N, 139.75E, 25m) temperature, precipitation
(35.69N, 139.752E, 20m) wind, sunshine…A) Central Tokyo Venues
② 【44136】 Edogawa Rinkai (35.64N, 139.86E, 5m) …B) Bay Venues
③ 【44116】 Fuchu (35.68N, 139.48E, 59m) …C) Western Central Tokyo Venues
④ 【44071】 Nerima (35.74N, 139.59E, 51m) …A) Central Tokyo Venues
⑤ 【46106】 Yokohama (35.44N, 139.65E, 39m) …B) Bay Venues
⑥ 【46141】 Tsujido (35.32N, 139.45E, 5m) …B) Bay Venues
⑦ 【50281】 Ajiro (35.05N, 139.09E, 67m) …E) Izu Venues
⑧ 【50136】 Gotenba (35.31N, 138.93E, 472m) …F) Gotenba Venue
⑨ 【45212】 Chiba (35.60N, 140.10E, 3m) …B) Bay Venues
⑩ 【45261】 Mobara (35.42N, 140.31E, 9m) …G) Mobara Venue
⑪ 【43256】 Koshigaya (35.88N, 139.76E, 3m) …A) Central Tokyo Venues
⑫ 【43171】 Hatoyama (35.99N, 139.34E, 44m) …D)Saitama Inland Venue
⑬ 【36126】 Fukushima (37.76N, 140.47E, 67m) …I) Fukushima Venue
⑭ 【34331】 Shiogama (38.34N, 141.01E, 105m) …J) Miyagi Venue
⑮ 【14163】 Sapporo (43.06N, 141.3283E, 17m) temperature, precipitation, sunshine
(43.06N, 141.3267E, 17m) wind …K) Sapporo Venue

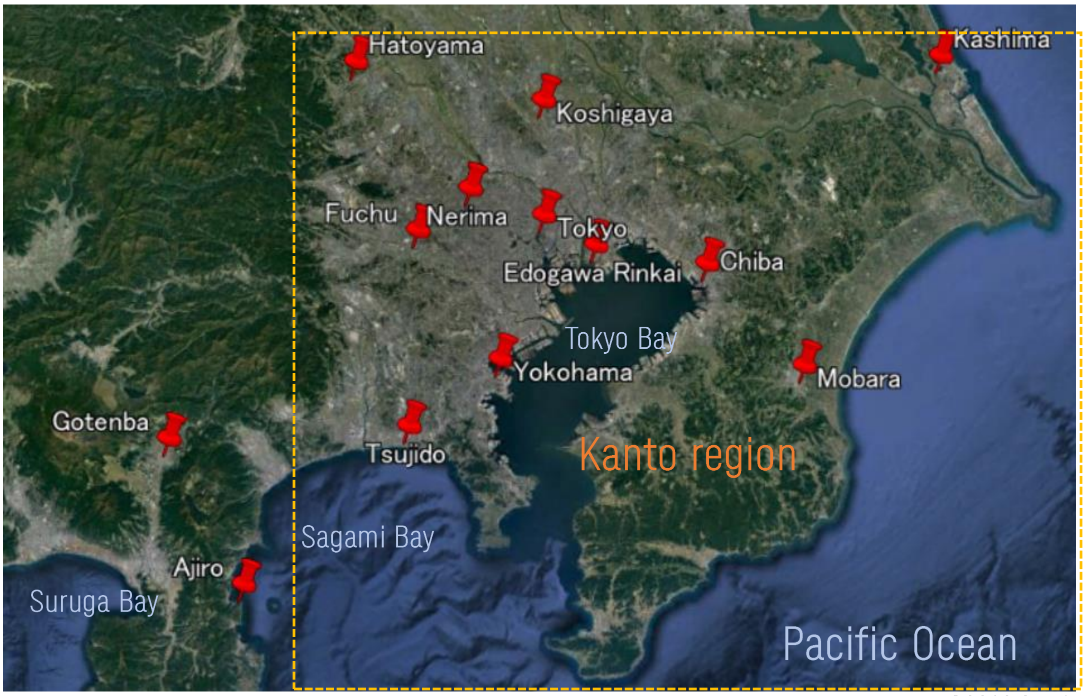


Figure 89 Location of AMeDAS stations used for the analysis ©2019 Google

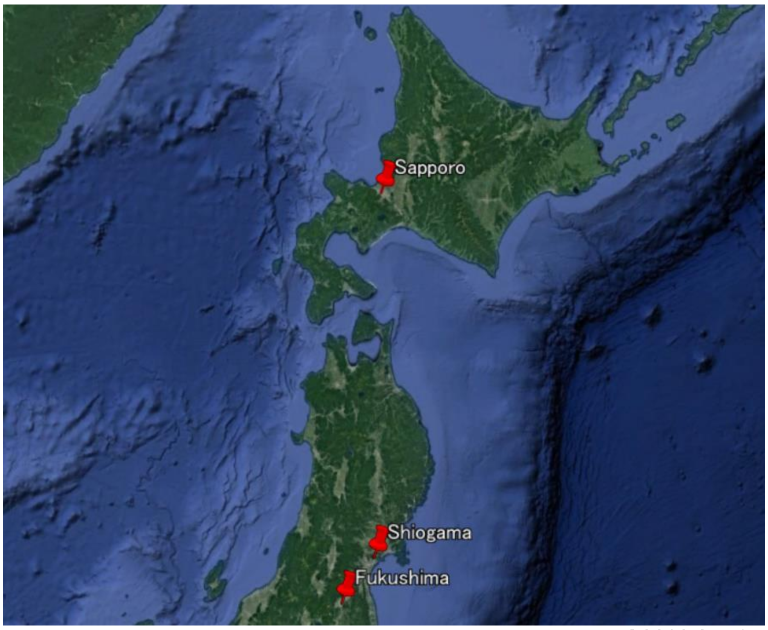


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Figure 90 Location of AMeDAS stations used for the analysis of the Fukushima, Miyagi and Sapporo venues

〇Temporal resolution and element:

①Hourly data: temperatures, wind direction, wind speeds and duration of sunshine

②Daily data: daily maximum temperatures, daily minimum temperatures and daily precipitation amounts

[Comparison between venues]

Temperatures, duration of sunshine and precipitation amounts at observatory points in addition to the reasoning behind the venue classifications are considered. Direction and speed of the wind are described with figures after Page 57.

The details of each meteorological element are described in on the following pages. A summary of meteorological elements is as follows:

Temperatures: The average temperatures for the Central Tokyo Venues between the end of July and the beginning of August, the period during which the Olympic Games will take place, are between 27.6°C - 28.6°C, which is significantly hotter than all other venues.

Duration of sunshine: Although the Central Tokyo Venues and Bay Venues are adjacent to each other, the duration of sunshine in the Bay Venues is 7—14 hours longer per month than the Central Tokyo Venues. Therefore, from the perspective of climatic characteristics, these venues are distinct. Also, the farther the venue is from a coastline, the shorter the duration of sunshine tends to be when compared to the Central Tokyo Venues.

Precipitation amounts: Although the Central Tokyo Venues and Bay Venues are adjacent to each other, the Bay Venues receives less precipitation than the Central Tokyo Venues. Precipitation amounts for the Bay Venues are equivalent to 80% of those for the Central Tokyo Venues.

Direction and speed of wind: From the end of July to August, southerly winds are predominant over many venues from 2-3 hours after sunrise and throughout the daytime. Also, wind speeds are highest around 2-3 pm, when maximum temperatures are also reached.

①Temperatures

Mean hourly temperatures between 2014 and 2018 are aggregated by the beginning, middle and end of July, August and September in List18. Deviations from the values for Tokyo are also found at each observation point. The tendencies observed at each point are then analyzed and the venue classification is considered based on the list.

The mean temperature at the Central Tokyo Venues is highest between the end of July and beginning of August, which corresponds to the period when the Olympic Games will take place. The mean temperature for the Bay Venues is equal or slightly lower than the Central Tokyo Venues. Therefore, it is clear that weather characteristics differ for the two areas even though these venue areas are located close to each other. In addition, it has been ascertained that temperatures for the Central Tokyo Venues are higher than all other venues.

Negative deviations are more noticeable at observatories located on the coast of Tokyo Bay (Edogawa Rinkai, Yokohama, Tsujido and Chiba) in Figure 89 from late July to early August than those in Central Tokyo Venues (Tokyo, Nerima and Koshigaya).

In addition, temperatures at each of these points tend to be higher by 0.1-0.5°C than Tokyo in September. On the other hand, the deviation in Fuchu remains negative during the period.

Thus, the observation points have been classified as follows: A) Tokyo, Nerima and Koshigaya (Central Tokyo Venues), B) Edogawa Rinkai, Yokohama, Tsujido and Chiba (Bay Venues), C) Fuchu (Western Central Tokyo Venues)

Also, the temperature at Gotenba is similar to that observed at Shiogama, which is located at a relatively high latitude. This is due to the similarities in elevations and the fact that both are surrounded by mountains.

List 18 5-year average temperature in Tokyo and the deviation from the values

	Venue	AMeDAS point	July			August			September		
			Early	Mid	Late	Early	Mid	Late	Early	Mid	Late
A) Central Tokyo Venues		Tokyo (5-year average)	25.0	27.7	27.6	28.6	26.8	26.3	24.8	22.9	21.8
Deviation from the value in Tokyo	A) Central Tokyo Venues	Nerima	0.1	0.3	0.1	0.2	-0.2	-0.1	-0.1	-0.3	-0.3
		Koshigaya	0.0	0.1	0.0	-0.1	-0.4	-0.3	-0.4	-0.6	-0.6
	B) Bay Venues	Edogawa Rinkai	-0.6	-0.9	-0.5	-0.7	-0.2	-0.3	-0.1	0.1	0.1
		Yokohama	-0.2	-0.4	-0.3	-0.3	0.0	0.0	0.1	0.1	0.2
		Tsujido	-0.8	-1.3	-0.9	-0.8	0.0	0.0	0.2	0.3	0.5
		Chiba	0.1	-0.1	-0.3	-0.3	0.1	0.2	0.3	0.2	0.3
	C) Western Central Tokyo Venues	Fuchu	-0.4	-0.4	-0.4	-0.3	-0.6	-0.6	-0.6	-0.7	-0.6
	D) Saitama Inland Venue	Hatoyama	-0.5	-0.4	-0.3	-0.4	-0.8	-0.9	-1.1	-1.0	-1.1
	E) Izu Venue	Ajiro	-0.6	-1.1	-1.2	-0.9	-0.6	-0.5	-0.6	-0.5	-0.1
	F) Gotenba Venue	Gotenba	-3.0	-3.5	-3.4	-3.2	-3.0	-2.8	-2.9	-3.1	-2.7
	G) Mobara Venue	Mobara	0.0	-0.5	-0.7	-0.4	0.0	0.0	0.0	-0.1	0.0
	H) Kashima Venue	Kashima	-1.1	-1.6	-1.8	-1.7	-1.4	-1.1	-0.8	-0.5	-0.5
	I) Fukushima Venue	Fukushima	-0.7	-1.3	-0.9	-1.6	-2.0	-2.0	-1.9	-2.0	-2.0
	J) Miyagi Venue	Shiogama	-2.9	-3.8	-3.2	-3.5	-3.6	-3.6	-3.0	-3.0	-3.0
	K) Sapporo Venue	Sapporo	-5.1	-5.7	-4.4	-5.0	-5.0	-4.7	-4.1	-5.1	-4.9

②Duration of sunshine

Total duration of sunshine from July to September between 2014 and 2018.

Differences between in the duration of sunshine for Tokyo and those observed at each of the observation points are compared (List19). Furthermore, proportions of each annual average value (calculated by each 5-year total value) to Tokyo's value are described (Figure 91). The tendencies at each point are then analyzed and the venue classification is considered based on the list.

It was ascertained that the duration of sunshine in the Bay Venues is 7-14 hours longer per month than the Central Tokyo Venues despite the fact that the Central Tokyo Venues and Bay Venues are adjacent to each other. Thus, it is clear that the weather characteristics for the two areas differ.

Deviations of such inland venues (Figure 89) as A) Central Tokyo Venues (Nerima and Koshigaya), C) Western Central Tokyo Venus and D) the Saitama Inland Venue are likely to be slightly negative based on Tokyo. On the other hand, the duration of sunshine for such coastal venues as B) Bay Venues, E) the Izu Venue, G) the Mobara Venue and H) the Kashima Venue are likely to be longer than Tokyo. As shown in Chapter 2-1 'Summer thunderstorms', the increase in daytime temperatures frequently causes atmospheric instability, which can result in thunderstorms in various places. Frequencies of occurrence of thunderstorms and cloud during the earlier stages are particularly high and the duration of sunshine appears to be shorter than Tokyo as the ground is warmed more easily inland than at coastal areas. Therefore, Tokyo, Nerima and Koshigaya are classified as A) Central Tokyo Venues; Edogawa Rinkai, Yokohama, Tsujido and Chiba are classed as B) Bay Venues; while Fuchu is classified as C) Western Central Tokyo Venues.

The Fukushima Venue also shows negative deviations. This is believed to be due to the high frequency of thunderstorms mentioned above as well as the fact that the rainy season ends later than Tokyo.

The Gotenba Venue is noticeable as the area with the lowest duration of sunshine. A moist air from Suruga Bay and Sagami Bay is carried by a southerly wind over Gotenba, which often rises around the Mt. Fuji area and other nearby mountains, forming clouds. As a result, it is frequently cloudy and occasionally foggy.

Conversely, the Sapporo Venue has long hours of sunlight although it is located at a higher latitude. This is because the island of Hokkaido does not have a rainy season, during which cloudy or rainy days continue for several weeks, as is the case with the other venues mentioned in Chapter 1-2 'Weather during the period of the Olympic and Paralympic Games (24 Jul - 6 Sep).'

List19　5-year totals for duration of sunshine between July and September at each observatory and deviations from the Tokyo values

	Venue	AMeDAS point	Year						Average	Deviations from the value in Tokyo
			2018	2017	2016	2015	2014	Total		
	A) Central Tokyo Venues	Tokyo (5-year average)	541.3	397.2	379.6	432.7	502.3	2253.1	450.6	-
Deviation from the value in Tokyo	A) Central Tokyo Venues	Nerima	536.4	402.2	358.7	408.7	483.3	2189.3	437.9	-12.8
		Koshigaya	522.7	382.5	393.6	417.0	497.3	2213.1	442.6	-8.0
	B) Bay Venues	Edogawa Rinkai	608.3	476.3	471.5	473.9	540.8	2570.8	514.2	63.5
		Yokohama	599.9	474.7	470.9	507.0	561.4	2613.9	522.8	72.2
		Tsujido	600.3	477.8	475.2	511.5	540.4	2605.2	521.0	70.4
		Chiba	562.3	427.6	414.7	483.0	539.1	2426.7	485.3	34.7
	C) Western Central Tokyo Venues	Fuchu	535.3	424.2	369.5	410.0	495.7	2234.7	446.9	-3.7
	D) Saitama Inland Venue	Hatoyama	514.7	399.1	393.7	425.7	492.0	2225.2	445.0	-5.6
	E) Izu Venue	Ajiro	553.0	462.0	446.7	487.1	526.6	2475.4	495.1	44.5
	F) Gotenba Venue	Gotenba	427.4	389.8	379.8	363.5	349.4	1909.9	382.0	-68.6
	G) Mobara Venue	Mobara	578.6	464.7	427.3	484.0	546.2	2500.8	500.2	49.5
	H) Kashima Venue	Kashima	555.2	457.8	446.1	464.4	551.0	2474.5	494.9	44.3
	I) Fukushima Venue	Fukushima	432.2	400.6	398.7	392.9	441.8	2066.2	413.2	-37.4
	J) Miyagi Venue	Shiogama	416.5	426.3	415.4	441.6	498.6	2198.4	439.7	-10.9
	K) Sapporo Venue	Sapporo	485.2	568.5	591.4	485.4	582.0	2712.5	542.5	91.9

(Unit: Hour)

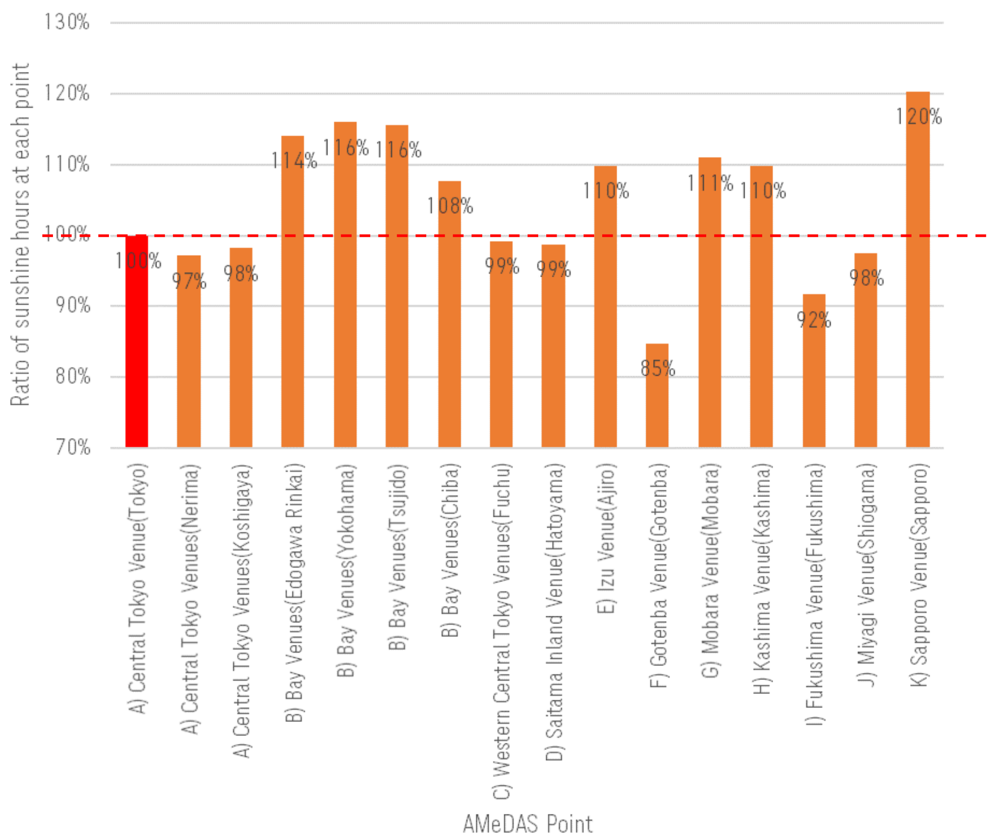

Figure 91 Ratio of sunshine hours at each point
(Annual average)

③Precipitation

Total precipitation amounts from July to September between 2014 and 2018.

Differences between precipitation amounts in Tokyo and other observation points are compared (List 20). Furthermore, each annual average value (calculated by each 5-year total value) and values for Tokyo are described (Figure 92). The tendencies at each observation point are then analyzed and the venue classification is considered based on the list.

It is clear that the Bay Venues have less precipitation than the Central Tokyo Venues despite the fact that these venues are adjacent to each other. The value in the Bay Venues is equivalent to 80% of the value found in the Central Tokyo Venues and therefore it can be said that these venues differ in weather characteristics.

The precipitation amounts in Tokyo in summer are relatively large. The difference between values in Tokyo and Edogawa Rinkai is significantly large despite the fact that the Edogawa Rinkai observation point is the nearest to Tokyo. As mentioned in Chapter 2-1 'Summer thunderstorms', thunderstorms occur in various regions in summer as the increase in temperature in the daytime leads to atmospheric instability. It is possible that unstable rainfall patterns have risen due to temperature increases around Tokyo brought about by urbanization and high-rise buildings acting as barriers to sea breezes.

The venue with exceptionally high precipitation levels is Gotenba. The moist air from Suruga Bay and Sagami Bay is carried by a southerly wind across Gotenba, rises once it reaches Mt. Fuji and other nearby mountains, forming into rain clouds. Also, it tends to rain hard.

Conversely, Sapporo has the lowest precipitation amounts. This is because the island of Hokkaido does not have a rainy season, during which cloudy or rainy days continue for several weeks, as is the case with the other venues mentioned in Chapter 1-2 'Weather during the period of the Olympic and Paralympic Games (24 Jul - 6 Sep).'

List 20 5-year total values of precipitation between July and September at each observation point and deviations from the Tokyo values

	Venue	AMeDAS point	Year						Average	Deviations from the value in Tokyo
			2018	2017	2016	2015	2014	計		
	A) Central Tokyo Venues	Tokyo (5-year average)	558.5	432.0	782.5	841.5	366.0	2980.5	596.1	-
Deviation from the value in Tokyo	A) Central Tokyo Venues	Nerima	629.0	548.0	777.5	797.0	299.5	3051.0	610.2	14.1
		Koshigaya	465.0	469.0	628.0	777.5	251.0	2590.5	518.1	-78.0
	B) Bay Venues	Edogawa Rinkai	450.5	338.5	563.5	725.5	282.0	2360.0	472.0	-124.1
		Yokohama	552.0	551.5	824.5	926.5	282.5	3137.0	627.4	31.3
		Tsujido	477.5	449.0	527.0	666.5	196.0	2316.0	463.2	-132.9
		Chiba	426.5	299.5	631.0	763.5	222.5	2343.0	468.6	-127.5
	C) Western Central Tokyo Venues	Fuchu	589.0	466.5	810.5	815.5	327.5	3009.0	601.8	5.7
	D) Saitama Inland Venue	Hatoyama	577.5	625.5	733.0	742.5	450.5	3129.0	625.8	29.7
	E) Izu Venue	Ajiro	690.5	413.0	769.0	1028.0	306.5	3207.0	641.4	45.3
	F) Gotenba Venue	Gotenba	1494.5	672.0	867.0	1470.0	496.5	5000.0	1000.0	403.9
	G) Mobara Venue	Mobara	447.0	415.0	787.5	734.5	235.0	2619.0	523.8	-72.3
	H) Kashima Venue	Kashima	455.5	378.5	549.0	647.5	518.5	2549.0	509.8	-86.3
	I) Fukushima Venue	Fukushima	351.5	480.5	615.0	634.0	365.5	2446.5	489.3	-106.8
	J) Miyagi Venue	Shiogama	481.5	466.5	445.5	456.5	272.0	2122.0	424.4	-171.7
	K) Sapporo Venue	Sapporo	433.5	341.0	504.5	393.5	440.0	2112.5	422.5	-173.6

(Unit: mm)

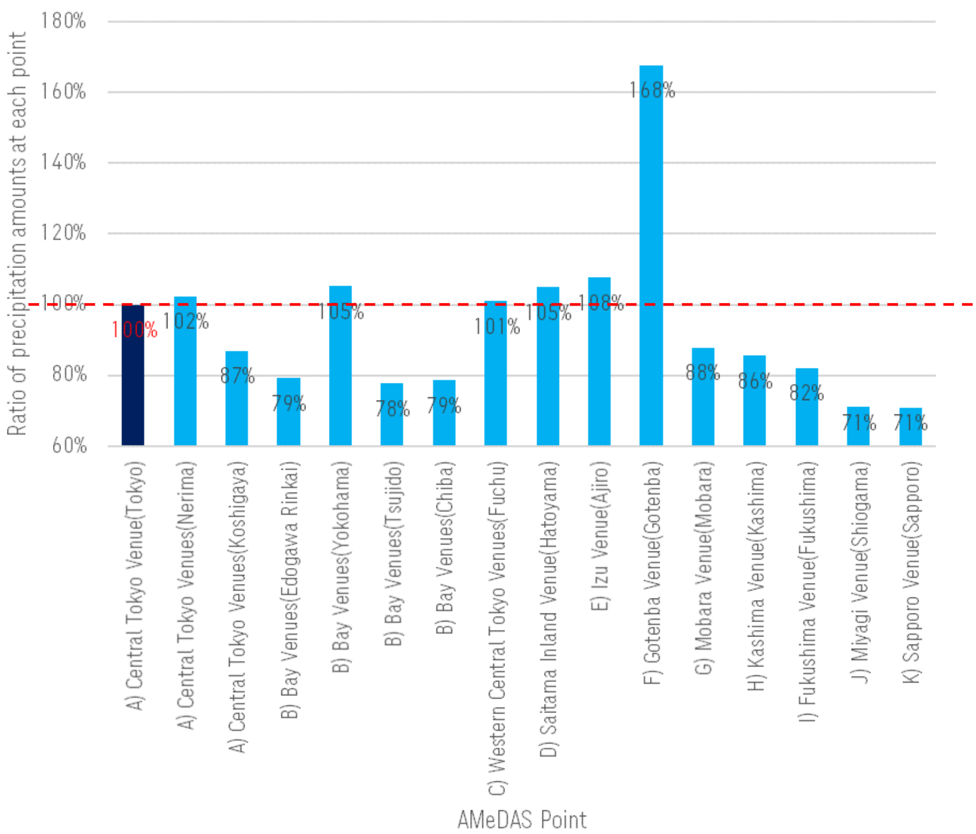

Figure 92 Ratio of precipitation amounts at each point (Annual average)

Appendix

The following indices are produced by the Tokyo Organising Committee of the Olympic and Paralympic Games using the indices of the Japan Meteorological Agency as a reference.

[Rainfall intensity and impact]

<table>
<tr><th>Hourly Rainfall (mm)</th><th>Forecast Term</th><th>Image received by people</th><th>Impact on people</th><th>Indoor (Assume a wooden house)</th><th>Outdoor conditions</th><th>While driving</th></tr>
<tr><td>10mm ≦ ～ ＜20mm</td><td>Slightly Strong</td><td>-</td><td>Feet get wet due to rain splashing up from the ground</td><td>Potential difficulty in hearing spoken voice</td><td rowspan="2">Puddles form to varying degrees</td><td></td></tr>
<tr><td>20mm ≦ ～ ＜30mm</td><td>Strong</td><td>Pouring rain</td><td rowspan="2">Get wet even when carrying an umbrella</td><td rowspan="4">Wakes many people up when sleeping</td><td>Difficult to see even if wipers are moving fast</td></tr>
<tr><td>30mm ≦ ～ ＜50mm</td><td>Heavy</td><td>Excessive rain</td><td>Roads become like rivers</td><td>A water film is created in the space between the wheel and road surface leading to the possibility of brakes becoming ineffective (hydroplaning phenomenon)</td></tr>
<tr><td>50mm≦ ～ ＜80mm</td><td>Extremely Heavy</td><td>Torrential rain</td><td rowspan="2">An umbrella becomes totally useless</td><td rowspan="2">The whole area becomes whitish and visibility is poor due to spray of water</td><td rowspan="2">Dangerous to drive at high speeds</td></tr>
<tr><td>80mm≦ ～</td><td>Fierce</td><td>To feel oppressed, chocky and scary</td></tr>
</table>

[Wind Strength]

Mean Wind Speed Approximate Hourly Speed	Wind Strength	Standard of Speed	Impact on people	Outdoor conditions	While driving	Buildings	Approximate instantaneous wind speed
10m/s≦ ～< 15m/s Around 50km/h	Slightly strong	Car on a general road	Encounter difficulty walking into the wind. Unable to put up an umbrella	Whole trees start to shake. Electrical cables start to shake	Wind streamers become horizontal, and drivers may feel vehicle tending to drift in crosswinds when driving on motorways.	Rain gutters start to shudder	20m/s
15m/s≦ ～< 20m/s Around 70km/h	Strong		Unable to walk towards the wind. Some people fall down. Extremely dangerous to work in high places	Electrical cables begin to emit sounds. Boards or zinc plate start to come off	Drivers encounter increasing difficulty in controlling vehicle caught in crosswinds when driving on motorways.	Roofing tiles or other materials shear off. Rain shutters shake violently.	30m/s
20m/s≦ ～< 25m/s Around 90km/h	Extremely Strong	Car on a highway	Unable to stand without grasping something. Risk of injury caused by flying objects	Thin branches begin to break off trees, and trees that have not taken firm root may be blown over. Advertising boards may be blown down and blown along roads.	Difficult to drive at normal speed	Some of roofing tiles or materials are scattered. Unfixed prefab hut is shifted and overturns. Plastic greenhouse is widely torn	
25m/s≦ ～<30m/s Around 110km/h		Express train	Extremely dangerous to work outside.		High-sided vehicles (trucks, buses, etc.) are blown over while running.	Corrugated iron roofing materials that are not properly attached are blown off. Temporary scaffolding collapses.	40m/s
30m/s ≦ ～< 35m/s Around 125km/h	Fierce			Many trees fall down. Telegraph poles and other items on streets blown down. Block fencing may collapse.		Exterior materials are widely scattered and base materials are exposed.	50m/s
35m/s ≦ ～<40m/s Around 140km/h						Some of houses collapse. Some of steel frame buildings become misshapen	60m/s
40m/s ≦ Around 140km/h-							

Both indices were created in August 2000 and partially revised in September 2017

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