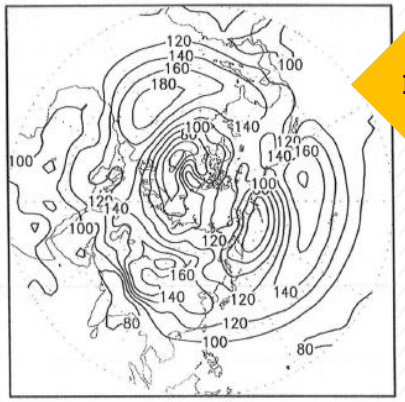
Introduction to Meteorology

28 High Pressure and Blocking (1)

Introduction

The area of relatively high atmospheric pressure is called high pressure (or high). In the weather chart, it appears as a series of isobars of almost circular or oval shape.
The air descends from aloft to its center at the surface, and it becomes a circulation blowing out from the center. Compared to low pressure systems, in general, the high pressure systems move slower and are more sustainable. The high usually brings a slowly changing weather.
Since highs and lows tend to be quasi-stationary, they are pronounced in a time-averaged weather map. There exist stationary highs and lows with large horizontal scale, such as the Siberian High and the Aleutian Low ~~pressures~~ observed during the winter, and the North Pacific High during the summer.
On the other hand, there exist some migratory highs and lows propagating at considerable speed in the mid-latitude.



Isobar ÷ 8 = surface weather map
weather map

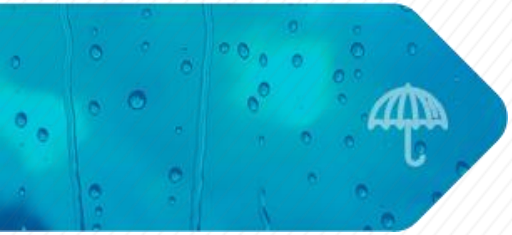
Stationary highs and lows

Some intensity changes are expected compared to those in the summer and winter.

〈Geopotential height at 1000 hPa averaged over 17 years〉

The proposed figure is the 17-year averaged geopotential height at 1000 hPa. Let's identify the stationary high and low mentioned above. Although the intensity of the pressure systems in summer would be differ from that in winter, it is still possible to locate stationary high and low pressure in Figure 1.

Contents



1. Types and characteristics of a high

Learning objectives

1. Describe the types and characteristics of highs affecting Korea.

Learning Activities

1. Types and characteristics of a high

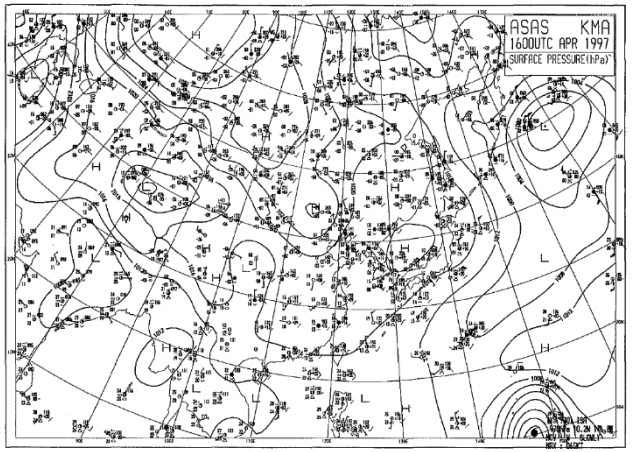
Highs can be classified as stationary high, migratory high, local high, etc. It is common to use the migratory high/low as a general term of high and low unless otherwise specified. The stationary high is a large scale high that normally appears in response to large-scale topography and ocean-continent distribution, such as the North Pacific High.

Migratory high corresponds to the fluctuation of the westerly wind in the upper level. Its radius is about 1,000~1,500 km. Local high is a thermally driven high with short lifespan depending on the terrain condition. Let's look at each type in detail.

What is the difference between high and low? Closed circular isobar in the surface weather chart at a given time indicates an area of high or low pressure. If the central value of the isobar is higher than the surroundings, it is called high pressure. When the situation is reversed, it is called low pressure. Therefore, the low pressure or high pressure is not determined by the absolute value of the pressure center but is determined by the relative value of the center to the surroundings.

Learning Activities

1. Types and characteristics of a high



〈Weather map, April-16 1997〉

The picture above is a weather map of April 16, 1997. It is easy to point out that a high is lying over the East Sea. Although there is no complete closed circle like the low pressure located in China, it is possible to determine the location of low or high subjectively and mark it on the weather map.

Learning Activities

1. Types and characteristics of a high

The low and high travel eastward about 10 degree per day, which corresponds to a speed of about 10 m/s.
In the mid-latitudes, the weather changes with a cycle of about a week, because it takes about one week to get another new low system after the preceding low passed.

The wavelength of a wave associated with the cyclone in the mid-latitude is about 4000-6000 km, which means the distance between two individual lows. Considering that they travel about 1,000 km a day, their period will be between 4 and 6 days, which is somewhat consistent with the above-mentioned moving speed of 10 m/s.

High and low bring very contrasting weather: sunny under the high and overcast under the low. However, the characteristics of the two systems are not symmetric. For example, the pressure at the center of a low can be extremely low theoretically, but it cannot exceed a certain value in a high. The pressure gradient near the center is loose for a high, while it is almost infinite for a low. However, near the center of the low, there is almost no pressure gradient like the vicinity of the high, so the wind is very weak and the wind direction is not constant.

Learning Activities

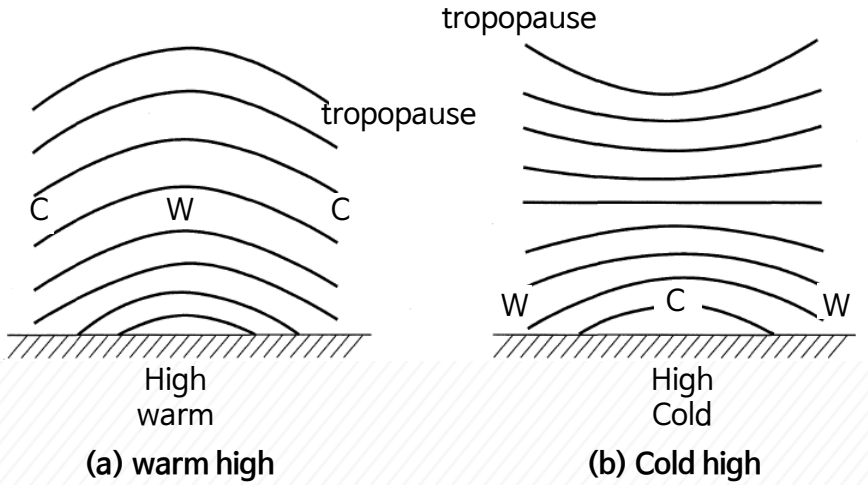
1. Types and characteristics of a high

1) Warm high and cold high

At a given level in the atmosphere, any high of which the center is warmer than its periphery is called warm high; the opposite is a cold high. The vertical pressure gradient of the warm high is smaller than that of the cold high. As a result, the warm high becomes more apparent with increasing height.

On the other hand, since the air pressure of the cold high decreases rapidly, the characteristic of the high is not clear in the upper level. Therefore, the warm high is taller than the cold high.

The difference between these two highs can be seen more clearly in the figure



(a) warm high **(b) Cold high**

〈Vertical cross-section of a high〉

※ Source: H is high, L is low, W is Warm, C is Cold

Learning Activities

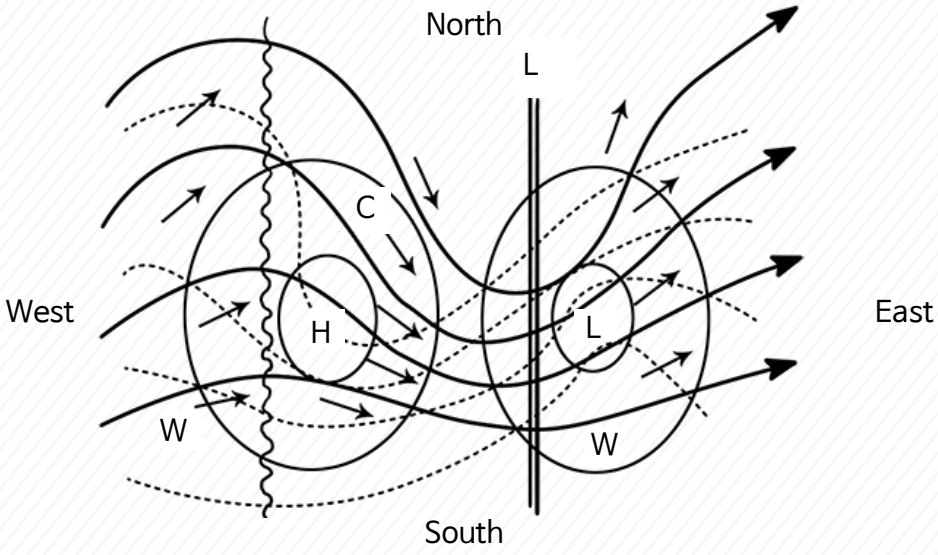
1. Types and characteristics of a high

2) Migratory high

In mid- and high-latitudes, there are many alternating lows and highs in response to the fluctuation of the westerly. The high in this case is called the migratory high.

The migratory highs and lows are directly connected to the previously learned westerlies. There is an upper-level trough to the east of the surface high. The upper-level isobars and isotherms are moving altogether, but they are not completely parallel. The isotherms are more biased to the west than the isobars. If you think that the isotherm moves by the flow of the atmosphere, there will be a cold advection to the east of the surface high and a warm advection to the west.

The cold air is heavy, and the warm air is light, so the pressure increases to the east of the surface high, and pressure drops to the west. In other words, the high moves to the east and becomes migratory. Upper-level air converges above the surface high. Such convergence leads the surface high to develop.



〈Migratory high〉

※ Source: H is high, L is low, W is Warm, C is Cold

Learning Activities

1. Types and characteristics of a high

3) The Siberian High

During the cold season, a large high-pressure system is often stagnated in the Eurasian continent. Especially, the high in the eastern part of the Eurasian continent appears from October to March, which is the Siberian High. Most of the Eurasian continent is covered by this prominent high. On average, the center of this high is located in Mongolia.

The Siberian high-pressure often stays on the continent for a relatively long period. However, it is not literally 'stationary' or 'stable', instead its strength is constantly changing. There are also many cyclones passing through the Siberian High zone.

The Siberian High is caused by an extremely cold continent compared to the surrounding oceans. The air is colder and denser. In addition, it is known that the upper-level westerly is a long wave of which the wavelength is larger than that of the migratory highs. The ridge of the westerly is located near the west of the Siberian High (about 80-100°E) and the trough is located to the east of the Siberian High (the coast of Japan). On the east side of the ridge (and west of the trough), there is equatorward cold air intrusion which increases the surface pressure. Therefore, not only the surface cooling but also the upper-level cold advection induces the Siberian High.

The 'long wave' like the Siberian High is a wave forced by high mountains such as the Tibetan plateau and Himalaya. The mountains prevent the cold air from moving southward and make the air heading eastward near 40°N. Therefore, the Siberian High is zonally elongated.

Learning Activities

1. Types and characteristics of a high

4) The North Pacific High

The North Pacific High is also a stationary high like the Siberian High, but its formation is markedly different. It is observed over the subtropical North Pacific, and it is predominant during the summer when it extends northward.

The North Pacific High is part of the subtropical high. The reason for the formation of the subtropical high is that the upper-level circulation from the equator to the pole is gradually deflected to the right by the Coriolis force and becomes a westerly at about 25~35°N. Air accumulation occurs above this latitude and increases the surface pressure. Therefore, the high is a 'tall' and 'warm' high.

Learning Activities

1. Types and characteristics of a high

5) The Okhotsk High

In the warm season around June and July, sometimes a stationary high is developed over the Sea of Okhotsk and its vicinity. The high pressure called the Okhotsk Sea High is not as large as the Siberia High or North Pacific High. The period is not as long as the period of Siberian High. It has a strong interannual variability.

Therefore, the Okhotsk High is not represented in the monthly averaged map, but a part of the North Pacific High in the summer covers the area of the Okhotsk Sea.

The air mass in the low-level of the Okhotsk High is not a maritime tropical (mT) type like the North Pacific High, but a marine polar (mP) type.

The equatorward polar air becomes even cooler when it moves over the cold Okhotsk Sea, and it causes cold-weather damage in the northern Japan. As the Okhotsk High fluctuates year-to-year, it influences the temperature variation in Japan during summer.

Learning Activities

1. Types and characteristics of a high

6) Local high pressure

Local highs can occur because of the topography. For example, when the inland surface air is cooled during the night, the pressure in the basin becomes greater than the ambient, resulting in a local high. Conversely, if the air in the basin is heated by the sun during the day and becomes lighter, a local low occurs.

Summary

1. Types and characteristics of a high

- Highs can be classified as stationary high, migratory high, and local high.
- The eastward movement of the high is about 10 degree per day.
- Highs and lows bring very different weather: sunny under the highs and mostly cloudy in the lows.
- The Siberian High: During the cold season, a large high-pressure system is often stagnated over the Eurasian continent.
- The North Pacific High: Observed in the subtropical North Pacific and predominant during summer when it expands northward.
- The Okhotsk High: A high developed over the Sea of Okhotsk during the warm season (June and July).