

(二) Pressure, temperature and density

As we have seen, the atmosphere consists of a mixture of gases, of which oxygen and nitrogen are the most abundant. This mixture in essence remains unchanged up to an altitude of about 100 km. Below this height, the density of the air is great enough for the collisions that constantly occur between the gas molecules to keep the air well mixed. Above 100 km, the air gradually becomes less dense until its density is so low that the number of collisions that occur between the molecules can ⁽⁴⁾no longer keep the air well mixed. The composition changes, so that the heavier gases are found in a layer at the bottom and the lightest gases at the top. This means that, vertically, the atmosphere's composition gradually changes from oxygen, to nitrogen, and finally to hydrogen, which is the lightest of all elements. However, even this part of the atmosphere, where the air is extremely thin, is of particular interest because it absorbs the dangerous X-rays and gamma radiation from the sun. These rays would otherwise penetrate down through the atmosphere to the surface of the earth.

The fact is that 90% of the *mass* of the atmosphere is contained in the lowest 15 km and the layer in which all our weather is formed is about 6—8 km thick and comprise 66% of all the air. One can easily see that in relation to the dimensions of the earth, the atmosphere is a very thin envelope around our planet. The radius of the earth is 6370 km, while the atmosphere (from all practical respects) is about 15 km thick. Put another way, it is about $\frac{1}{400}$ of the radius of the earth. The atmosphere is like the skin around an apple. The horizontal dimensions of the atmosphere are much larger than the vertical ones.

(二) 气压、温度和密度

我们已经知道, 大气由多种气体混合组成, 其中氧和氮最多。这种混合直到 100 公里高度基本上保持不变。在此高度以下, 空气的密度相当大, 足以使各种气体分子间经常发生碰撞, 从而使空气保持充分的混合。在 100 公里以上, 空气密度逐渐变小, 小到各种气体分子间发生碰撞的次数不再能使空气保持充分的混合。大气的成分发生了变化, 较重的气体在底层, 而最轻的气体在顶层。这就是说, 大气成分在垂直方向上慢慢从氧到氮, 最后到氢, 依次变化, 因为氢是所有元素中最轻的。但是, 即使是大气十分稀薄的这个部分, 也是非常使人感兴趣的, 因为它吸收来自太阳的有危害性的 X 光和 γ 射线。不然, 这些射线就要向下穿过大气到达地面。

实际上, 大气质量的 90% 存在于最低的 15 公里以内; 而所有天气的形成都是在 6—8 公里以下气层里, 这个气层包含着大气的 66%。显而易见, 与地球大小相比, 大气是包围着我们这个行星的一层很薄的外皮。地球的半径是 6370 公里, 而大气层 (从所有实用方面来看) 只有大约 15 公里厚。换言之, 它只有地球半径的 $\frac{1}{400}$ 左右。大气犹如果皮包着一个苹果一样。大气层的水平尺度远远大于其垂直尺度。

Pressure

We can measure the air pressure at ground level with a barometer. Pressure is simply force per unit area per square centimetre; the unit in common use not so long ago was called an atmosphere (1 kg/cm²). Nowadays meteorologists measure pressure in millibars (abbreviated as mb), 1 mb being $\frac{1}{1000}$ of a bar. One atmosphere corresponds to the pressure 1013 mb. Another common unit is inches of mercury or millimetres of mercury. This unit stems from the time when most barometers were mercury filled and one measured the height of a mercury column in an evacuated glass tube. Air pressure at the surface of the earth was normally capable of pressing the mercury in the tube up about 760 mm (30 in.) which corresponds to the mean sea-level pressure, 1013 mb.

Temperature

Temperature is an important meteorological variable. We also have different units for temperature. In some English-speaking countries, degrees Fahrenheit are still used while in most other countries degrees Celsius are used. In this book we will use the term Celsius, and explain how to convert Fahrenheit degrees to Celsius, and vice versa.* The construction of a temperature scale is based on finding two fixed points, where we define the temperature to be either 100 or 0 (zero). The Celsius scale, named after the Swedish physicist Anders Celsius, has the temperature at which water boils at normal sea surface pressure as +100 degrees. The freezing point of water is chosen to be 0. The Fahrenheit scale is based on the normal temperature of the human body as being 100 and the zero point is the temperature achieved by a mixture of ice and salt.

There is also another temperature scale which is used mainly by scientists. That scale is called the absolute temperature scale and the units used are degrees Kelvin, after the English physicist Lord Kelvin. The zero point in this scale is the absolute zero, i. e.†, the temperature at which all motion ceases, all atoms and molecules come to a rest. This temperature on the Celsius scale is -273°C or 0 degrees Kelvin which is written as 0 K (no degree sign being used), We simply get the Kelvin temperature by adding 273 to the Celsius degrees. For example, $+20^{\circ}\text{C}$ is 293 K.

气压

我们能在地面上用气压表来测量气压。气压只是一平方厘米单位面积上承受的大气压力。不久前通常使用的单位是所谓的一个大气压 (1 公斤/厘米²)。目前,气象工作者测量气压的单位用毫巴 (缩写为 mb), 1 毫巴为 1/1000 巴。一个大气压相当于 1013 毫巴, 另外一个通用的单位是以水银柱高度表示, 用英寸或毫米。采用这种单位, 源自当时大多数人所用的气压表是用真空玻璃管中灌注水银, 观测水银柱的高度来测气压。地面气压通常都能使水银在管中上升到大约 760 毫米 (30 英寸), 这相当于平均海平面气压——1013 毫巴。

温度

温度是气象上的一个重要变量。有各种不同的温度单位。在一些讲英语的国家里仍沿用华氏, 而其它大多数国家则用摄氏。本书采用摄氏, 并说明华氏和摄氏如何相互换算。温标的构成是以找两个固定点为依据的, 我们将这两个固定点确定为 100 和 0。摄氏温标是以瑞典物理学家 Anders Celsius 的名字命名的, 他规定在正常海平面气压的情况下, 水的沸点为 100 度, 选水的冰点为 0 度。华氏温标是根据人体正常温度为 100 度以及冰和盐混合所达到的温度为零度。

科学家通常还用另外一种温标。称为绝对温度, 它的单位用开耳芬, 是以英国物理学家 Kelvin 勋爵的名字命名的, 这种温标的零度称为绝对零度。也就是说, 到此温度时一切运动都停止, 所有原子和分子都不运动。这一温度在摄氏温标上为 -273°C 或开耳芬零度, 写为 0 K (不用“度”的符号)。我们只要在摄氏度数上加上 273 即可得绝对温度, 例如, 20°C 就是 293 K。

* Vice Versa 拉丁语, 反之亦然。

† i. e. = id est 拉丁语, 也就是。