MEASURING PRECIPITATION

Heavy rain event over the city of Kelowna, British Columbia, Canada. (Image Copyright: David Jenkins).

Introduction

Precipitation has both direct and indirect effects to human well-being and economic activities. Too much or too little precipitation can have a significant effect on these factors. As a result, precipitation is measured at thousands of weather stations and other locations around the world.

Standard Rain Gauge

The most common instrument used for measuring rain and some times snow is the standard rain gauge. This meteorological instrument was developed around the beginning of the 20th century and it basically consists of a large funnel connected to a graduated measuring cylinder. Usually, the funnel and cylinder are housed in a larger container (Figure 1). To make measurements more accurate, the funnel cross-sectional area is often 10 times the size of the cylinder cross-sectional area. As a result, 1 mm of rainfall would magnify to 10 mm of water in the graduated measuring cylinder. Measurements from the standard rain gauge are normally made once or twice a day.


Figure 1: Standard rain gauge. (Image Source: Wikimedia Commons, photo by Bidgee. This image is licensed under the Creative Commons Attribution 3.0 Unported license).

Tipping Bucket Gauge

The tipping bucket rain gauge consists of a large cylinder with funnel located at its top for collecting precipitation (Figure 2). Precipitation is channelled to an opening at the bottom of the funnel that causes the water collected to fall into one of two small joined buckets which are balanced in a seesaw fashion.

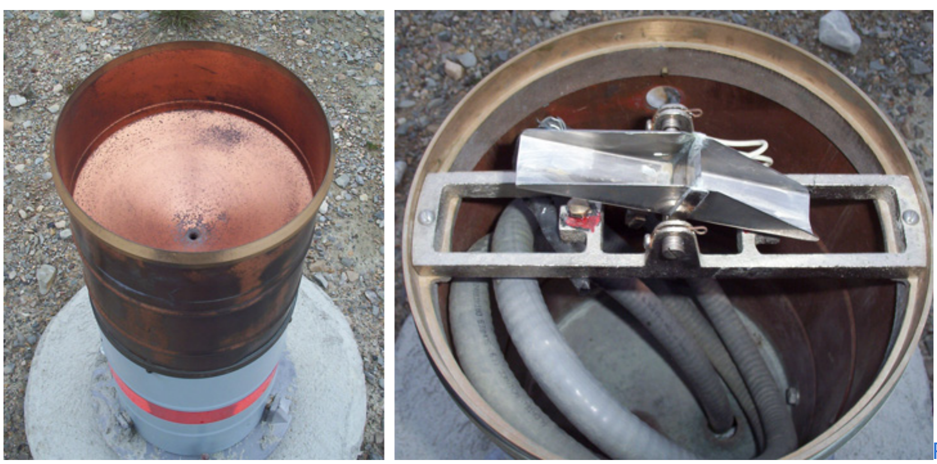
Figure 2: Tipping bucket rain gauge. Top photo shows exterior of the instrument and funnel at the top. Bottom photo shows the tipping buckets found on the inside of the device. (Image Source: Wikipedia).

After a certain amount of precipitation falls into a bucket, the seesaw tips to the other bucket and an electrical response is transmitted to a recording device. Most of these recording devices have a pen mounted on an arm attached to a geared wheel that moves because of a clock mechanism. As the wheel moves, the pen arm moves it leaves a trace on mounted graph paper. Movements in the pen arm documented on the graph paper record the quantity and the time when precipitation fell. From the graph, one can determine rainfall intensity simply by calculating the amount of rain that fell for a particular unit of time. The tipping bucket rain gauge is not as accurate as the standard rain gauge because you need a specific threshold amount of rainfall to cause the bucket to tip.

Measuring Snowfall

Different devices and techniques are used to measure snowfall. Rain gauges are not used for measuring snowfall for several reasons. Measuring snowfall with rain gauges requires that the snow that falls in the funnel be melted so the water can accumulate in the graduated cylinder. This may not be possible on extremely cold days. On windy days, turbulence caused by cylinder can reduce the amount of snow collecting on the funnel. Another potential problem is that heavy snowfalls can quickly overfill the funnel causing the excess snow to fall to the sides of the rain gauge.

A snow gauge is a meteorological instrument specially designed for the collection and measurement of snow (Figure 3). This instrument has of two parts: a catchment cylinder and a funnel. Total length of the snow gauge is about half a meter. Snow gauges are usually mounted on a pipe that is about 1.5 meters high from ground level. The cylinder that collects fallen snow is removable and can be replaced with a spare when measurements are made. The collected snow is then melted in the cylinder and poured into a graduated measuring container.

Another simple technique for measuring snowfall is to measure the snow that accumulates on a flat platform using a measuring stick. This measured snow depth is then converted into an equivalent rain depth. Normally a 10:1 ratio is used to make this conversion. For example, 10 cm of snow would be equal 1 cm of rain. This method can be inaccurate at times because snow can vary considerably in the amount of water it contains. In cold “powder” snow 30 cm of snow may be equal to only 1 cm of water (30:1 ratio), while wet snow common on the East coast of Canada and the United States can have a ratio as low as 4:1.

Radar Systems

Advances in technology have made it possible to measure precipitation using Doppler radar systems. Radar systems operate by emitting a microwave pulse signal towards a desired target. If the signal intercepts an object the signal or part of the signal will be reflected back and picked up by a receiving dish. When used for making measurements of weather, returning signal strength is calibrated to precipitation quantity (Figure 4). Many Doppler radar weather systems have been installed throughout the United States and Canada over the last two decades. These systems produce an image identifying areas of precipitation every 5 minutes. Radar systems cannot tell the difference between rain or snow. Accuracy of precipitation estimates by radar systems is far less than rain and snow gauge measurements. However, they do provide valuable information related to the spatial distribution of precipitation and forecasting the possible future path taken by storm systems.

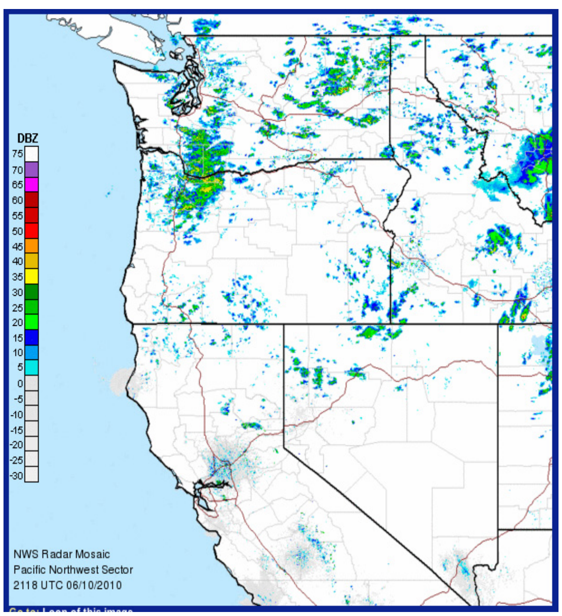

Figure 4: National Weather Service Doppler radar mosaic for the Pacific Northwest of the United States on June 10, 2010. Scale bar shows relative intensity of the Falling precipitation. (Image Source: NOAA).

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