# Something about Automatic Weather Station

PENG ZHAO

Reference: WMO No-8:Guide to Meteorological Instruments and Methods of Observation

# Atmospheric pressure

- Temperature effects are severe and are not always fully compensated by built-in temperature compensation circuits.
- AWS pressure sensors have an intrinsic long-term drift in accuracy, typically less than 0.2 to 0.3 hPa every six months and therefore require regular calibration.

# Temperature

- pure metal resistance thermometers or thermistors. (platinum resistance)
- Of great concern is the proper protection of the sensor against the effects of radiation. Radiation shields adjusted to the size of the sensor are widely used and replace the common naturally ventilated Stevenson screen in an AWS. For accurate measurements, the radiation shields should be artificially ventilated with an air speed of about 3 m/s, but precautions should be taken to prevent the entry of aerosols and drizzle.

# Wind

- The use of conventional cup or propeller anemometers with pulse or frequency output is widespread and presents no particular technical problem other than that associated with icing in severe conditions. This complication can be overcome by heating the sensor in moderate icing conditions, but this results in a significant increase in electrical power consumption.

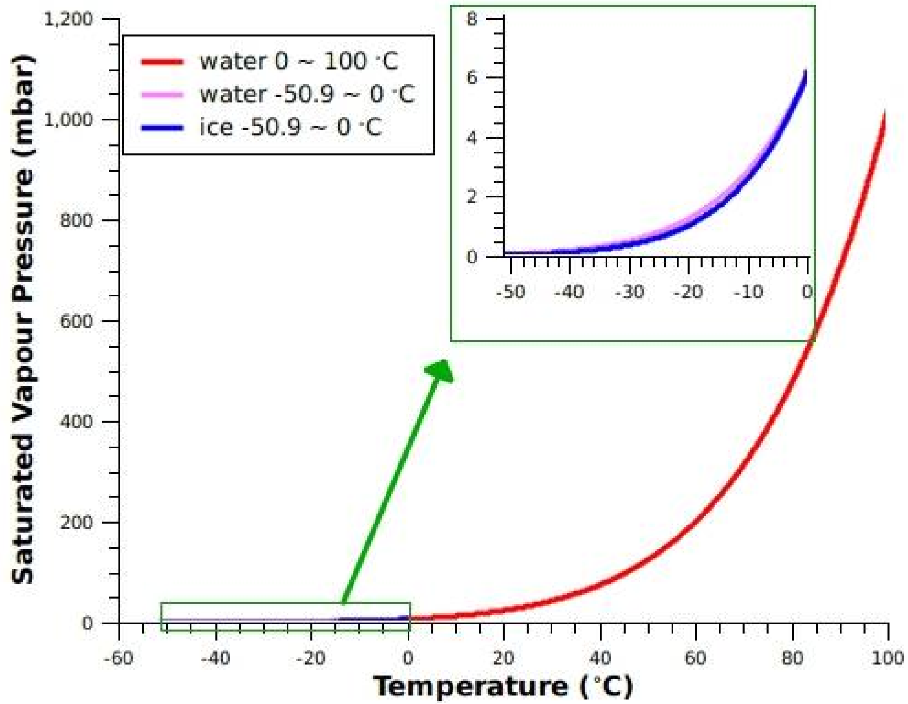
# Humidity

- Although relatively low-cost resistance and capacitive sensors for direct relative humidity measurements are widely employed in AWSs, they are still susceptible to poor performance in the presence of pollutants and require special protection filters.
- Calibrated half a year?

# Humidity

$$p_s = c_1 \cdot e^{\frac{c_2 \cdot T}{c_3 + T}}$$

$p_s$ = Saturated vapour pressure [mbar]
T = Temperature [°C]
C1, C2, C3 see table




| Phase | Process temperature T [°C] | C1 [mbar] | C2 [ ] | C3 [°C] |
|---|---|---|---|---|
| Ice | -50.9 to 0 | 6.10714 | 22.44294 | 272.44 |
| Water | -50.9 to 0 | 6.10780 | 17.84362 | 245.425 |
| Water | 0.0 to 100 | 6.10780 | 17.08085 | 234.175 |

# Precipitation

- Tipping-bucket raingauge
- In general, objects should not be closer to the gauge than a distance of twice their height above the gauge orifice.

# Precipitation

- Gauges are rapidly clogged by debris such as leaves, sand or bird droppings; therefore, care must be taken with AWSs used for long unattended operations.
- For measurements of rain and snowfall below 0°C, different parts of the gauge must be heated properly. This can give rise to serious electrical power problems, in particular for battery-operated AWSs. Care should be taken since heated gauges introduce errors due to evaporation losses.
- An achievable observing accuracy of 5 to 10 per cent is considered to be excellent. Accuracy can be improved by surrounding the raingauge with a proper windshield (for example, a Nipher shield).

# Precipitation

- The amount of precipitation measured by commonly used gauges may be less than the actual precipitation reaching the ground by up to 30% or more. Systematic losses will vary by type of precipitation (snow, mixed snow and rain, and rain). The systematic error of solid precipitation measurements is commonly large and may be of an order of magnitude greater than that normally associated with liquid precipitation measurements. For many hydrological purposes it is necessary first to make adjustments to the data in order to allow for the error before making the calculations. The adjustments cannot, of course, be exact (and may even increase the error). Thus, the original data should always be kept as the basic archives both to maintain continuity and to serve as the best base for future improved adjustments if, and when, they become possible.

# Precipitation

- The true amount of precipitation may be estimated by correcting for some or all of the various error terms listed below:
  - (a) Error due to systematic wind field deformation above the gauge orifice: typically 2% ~ 10% for rain and 10% ~ 50% for snow;

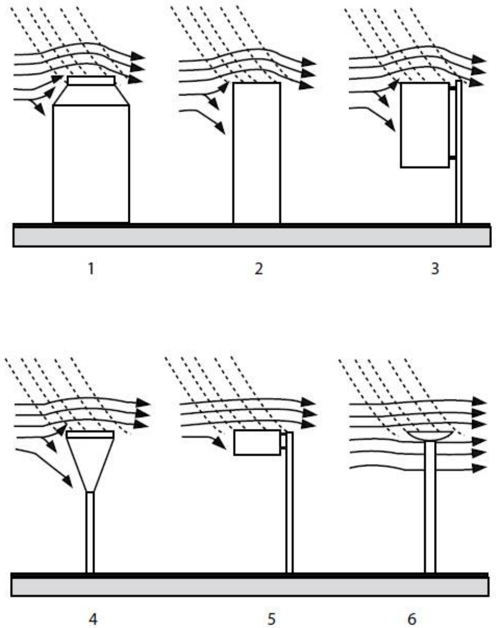



Figure 6.1. Different shapes of standard precipitation gauges. The solid lines show streamlines and the dashed lines show the trajectories of precipitation particles. The first gauge shows the largest wind field deformation above the gauge orifice, and the last gauge the smallest. Consequently, the wind-induced error for the first gauge is larger than for the last gauge (Sevruk and Nespor, 1994).

# Precipitation

- (b) Error due to the wetting loss on the internal walls of the collector;
- (c) Error due to the wetting loss in the container when it is emptied: typically 2% ~ 15% in summer and 1%~ 8% in winter, for(b) and (c) together; The loss of water during the tipping action in heavy rain can be minimized but not eliminated;
- (d) Error due to evaporation from the container (most important in hot climates): 0%~ 4%; With the usual bucket design, the exposed water surface is large in relation to its volume, meaning that appreciable evaporation losses can occur, especially in hot regions. This error may be significant in light rain;
- (e) Error due to blowing and drifting snow;
- (f) Error due to the in- and out-splashing of water: 1% ~ 2%;
- (g) Random observational and instrumental errors, including incorrect gauge reading times.
- (h)The discontinuous nature of the record may not provide satisfactory data during light drizzle or very light rain. In particular, the time of onset and cessation of precipitation cannot be accurately determined;

# Precipitation

$$P_k = kP_c = k\left(P_g + \Delta P_1 + \Delta P_2 + \Delta P_3\right)$$

where $P_k$ is the adjusted precipitation amount;

$k$ is the adjustment factor for the effects of wind field deformation;

$P_c$ is the amount of precipitation caught by the gauge collector;

$P_g$ is the measured amount of precipitation in the gauge;

$\Delta P1$ is the adjustment for the wetting loss on the internal walls of the collector;

$\Delta P2$ is the adjustment for wetting loss in the container after emptying;

$\Delta P3$ is the adjustment for evaporation from the container.

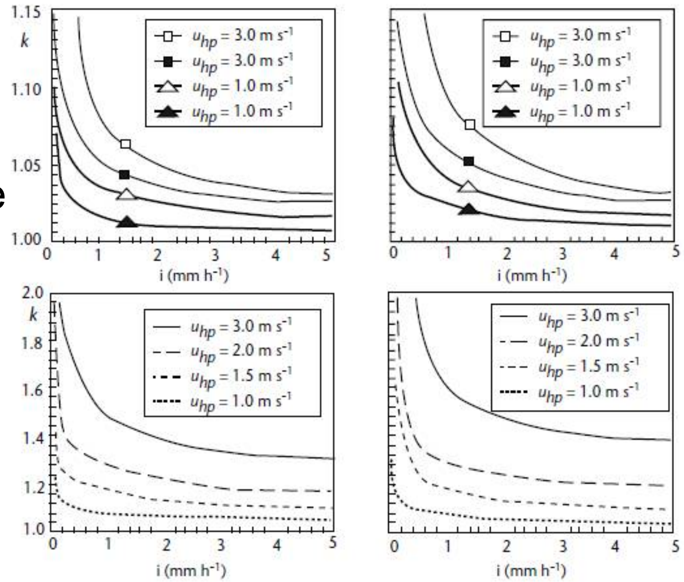



Figure 6.3. Conversion factor $k$ defined as the ratio of "correct" to measured precipitation for rain (top) and snow (bottom) for two unshielded gauges in dependency of wind speed $u_{hp}$, intensity $i$ and type of weather situation according to Nespor and Sevruk (1999). On the left is the German Hellmann manual standard gauge, and on the right the recording, tipping-bucket gauge by Lambrecht. Void symbols in the top diagrams refer to orographic rain, and black ones to showers. Note the different scales for rain and snow. For shielded gauges, $k$ can be reduced to 50 and 70 per cent for snow and mixed precipitation, respectively (WMO, 1998). The heat losses are not considered in the diagrams (in Switzerland they vary with altitude between 10 and 50 per cent of the measured values of fresh snow).