WATER FACT SHEET
U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

SOLID-PRECIPITATION (SNOWFALL) MEASUREMENT INTERCOMPARISON, BISMARCK, NORTH DAKOTA

INTRODUCTION

Difficulties involved in obtaining accurate measurements of solid precipitation (snowfall) have been recognized for many years. Many studies have been conducted to evaluate the accuracy and performance of precipitation gages. These studies show that the type of collection method used can significantly affect the quantity of precipitation measured. Although the types of collection methods evaluated differed for each study and the magnitude of measurement error differed for each study, all of the studies concluded that wind is the major cause of measurement error.

Measurement error caused by wind is the result of turbulence and wind speed in the vicinity of the gage orifice (opening). As air rises to pass over the gage, precipitation particles that would have entered the gage orifice are deflected and carried farther downwind. Measurement errors increase as wind speed increases. Studies have shown that measurement errors as great as 80 percent can be attributed to wind. Wind speed and turbulence can be reduced by shielding the gage from the wind. Several types of windshields have been built to decrease wind-related errors.

The World Meteorological Organization recognized the need for an international comparison of current methods used for measuring solid precipitation and proposed the Solid Precipitation Measurement Intercomparison. The objectives of the Intercomparison are to:

- Determine the wind-related errors in methods of solid-precipitation measurements;
- Derive standard methods for correcting solid-precipitation measurements;
- Introduce a reference method of solid-precipitation measurement for general use to calibrate any type of precipitation gage; and
- Establish a complete solid-precipitation data set that contains all necessary information for research purposes.

INTERCOMPARISON SITES

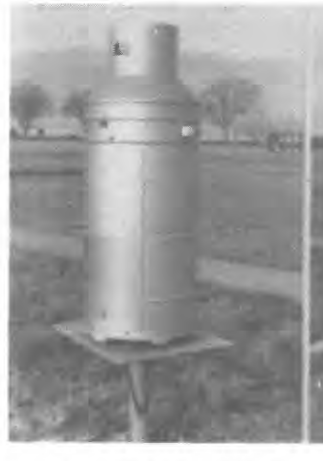
As part of the Intercomparison, about 20 solid-precipitation measurement sites have been established in about 12 countries. Four of these sites are in the United States: Bismarck, N. Dak.; Rabbit Ears Pass, Colo.; Reynolds Creek, Idaho; and Sleepers River, Vt. The Bismarck site is at the National Weather Service Forecast Office at the Bismarck Municipal Airport, which is about 2 miles southeast of the center of the city. The site is on a broad, level plain of the Missouri River valley. Topographic features of the area do not have a significant effect on the climate or on the prevailing winds.

INSTRUMENTATION AT THE BISMARCK SITE

Seven precipitation gages are maintained at the Bismarck site. The gage orifices are either 9.8 feet or 4.6 feet above the land surface. Wind speed is monitored at these two orifice heights. Wind direction and air temperature also are monitored. The seven precipitation gages are:

- Belfort Universal precipitation gage[1];
- Belfort Universal precipitation gage with an Alter-type windshield. This gage is the standard gage in the United States;
- Tretyakov precipitation gage. This gage is the standard gage in the U.S.S.R.;
- Tretyakov precipitation gage with an octagonal, vertical, double-fence windshield. This gage is designated as the reference gage for the Intercomparsion;
- Belfort Universal precipitation gage with an octagonal, vertical, double-fence windshield;
- Belfort Universal precipitation gage with a Wyoming windshield; and
- Aerochem Metrics automatic sensing wet/dry precipitation collector. This collector is the standard gage used in the evaluation of deposition of air pollutants, such as acid precipitation.

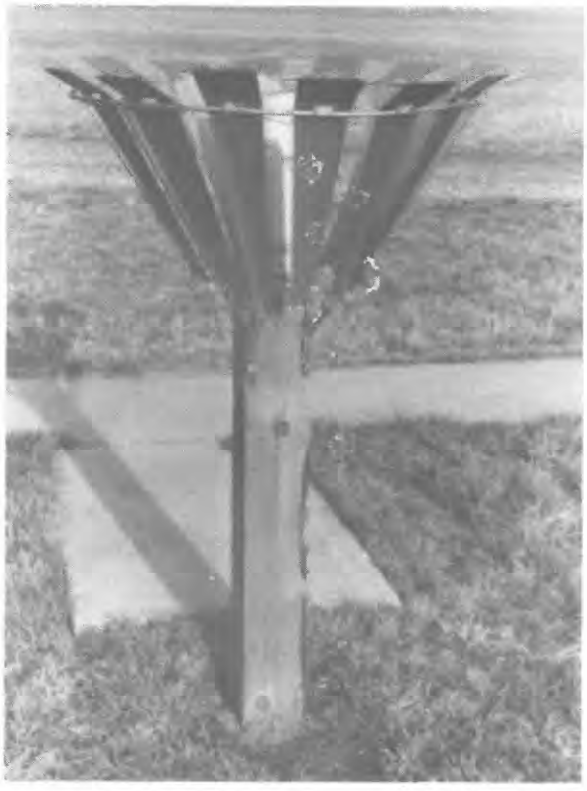
Precipitation containers for the Belfort Universal precipitation gages are mounted on a spring that is connected to a recorder. As the weight of the precipitation compresses the spring, the quantity of precipitation collected is recorded continuously. Precipitation containers for the Tretyakov precipitation gages and the Aerochem Metrics precipitation collector are removed after each precipitation event and weighed to determine the quantity of precipitation.



Belfort Universal precipitation gage.

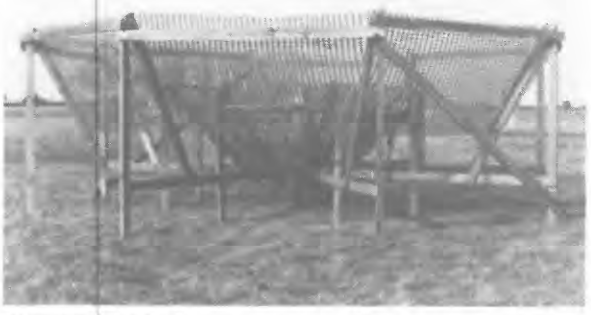
Belfort Universal precipitation gage with an Alter-type windshield.

[1]The use of brand, firm, or trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.



Tretyakov precipitation gage.

Octagonal, vertical, double-fence windshield.



Wyoming windshield.

Aerochem Metrics automatic sensing wet/dry precipitation collector.

DATA APPLICATION

If several types of gages are used in State, regional, or global analysis, then correction to precipitation measurements are necessary. Compatible and consistent data are needed to study the world water balance, address effects of climate change, develop reliable global-circulation models, develop and validate remote-sensing methods, and calculate accurate transport and deposition of air pollutants. The development of standard correction methods will help ensure that compatible and consistent data are available.

Plans are to collect data for at least 5 years. Data will be used to evaluate the differences in measurement among the different types of gages. The World Meteorological Organization will analyze the data from all of the sites around the world.

SELECTED REFERENCES

Goodison, B.E., 1978, Accuracy of Canadian snow gage measurements: Journal of Applied Meteorology, v. 17, no. 10, p. 1542–1548.

Goodison, B.E., Sevruk, B., and Klemm, S., 1989, WMO solid precipitation measurement intercomparison: Objectives, methodology, analysis, *in* Proceedings of the Atmospheric Deposition Symposium, Baltimore, Md., May 1989: International Association of Hydrological Sciences Publication No. 179, p. 57–64.

Hanson, C.L., Morris, R.P., and Coon, D.L., 1979, A note on the dual-gage and Wyoming shield precipitation measurement systems: Water Resources Research, v. 15, no. 4, p. 956–960.

Larson, L.W., and Peck, E.L., 1974, Accuracy of precipitation measurements for hydrologic modeling: Water Resources Research, v. 10, no. 4, p. 857–863.

Rechard, P.A., and Wei, T.C., 1980, Performance assessments of precipitation gages for snow measurement: Laramie, Wyoming University, Water Resources Research Institute Water Resources Series 76, 195 p.

World Meteorological Organization, International Organizing Committee for WMO Solid Precipitation Measurement Intercomparison, 1985, WMO instrument and methods of observation programme: WMO First Session, Norrkoping, Sweden, December 16–20, 1985, Final Report, 31 p.

For additional information about the World Meteorological Organization Solid Precipitation Measurement Intercomparison, or on the instrumentation and data collection at the site in Bismarck, N. Dak., contact:

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