working to advance road weather information systems technology

RESEARCH PROJECT TITLE
Evaluation of the Hotplate Snow Gauge–Aurora Project 2004-01

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ABOUT AURORA
Aurora is an international partnership of public agencies performing joint research, evaluation, and deployment initiatives related to road weather information systems (RWIS).

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Evaluation of the Hotplate Snow Gauge

project summary

Objective

The primary goal of this project was to test the accuracy and utility of the Hotplate snow gauge for use in winter road maintenance. If real-time snowfall rate information is shown to be beneficial and the Hotplate technology practical, then the snow gauge could be added to automated Environmental Sensor Systems (ESS) or Road Weather Information Systems (RWIS) in the future.

Problem Statement

Winter precipitation (e.g., snow, ice, freezing rain) is poorly measured by current National Weather Service (NWS), Federal Aviation Administration (FAA), and state department of transportations' (SDOTs) automated weather observation systems. The lack of accurate winter precipitation measurements, particularly snow, significantly impacts the winter road maintenance decision making process because decision makers are often unsure of the location, intensity, amount, and type of precipitation that is occurring in their region.

The inability to accurately quantify winter precipitation significantly impacts the winter road maintenance decision process and automated systems designed to provide treatment guidance such as the Federal Highway Administration (FHWA) Maintenance Decision Support System (MDSS). If winter precipitation is not identified when it is actually occurring, or is under reported, roads may go untreated for significant periods, or they may be undertreated.

Hotplate snow gauge

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Technology Description

A suite of environmental sensors were installed in December 2003 at the Iowa DOT maintenance garage at Ames, Iowa, and at an RWIS site near Worthington, Minnesota. Sensors included temperature, humidity, propeller-driven anemometer, pyranometer, sonic snow depth sensor, and a GEONOR precipitation gauge.

In January 2005, a Hotplate snow gauge, provided by the National Center for Atmospheric Research (NCAR), was installed at each site and integrated into the data processing system and network. The data were transmitted to NCAR using the Internet and made viewable in real time on an NCAR website.

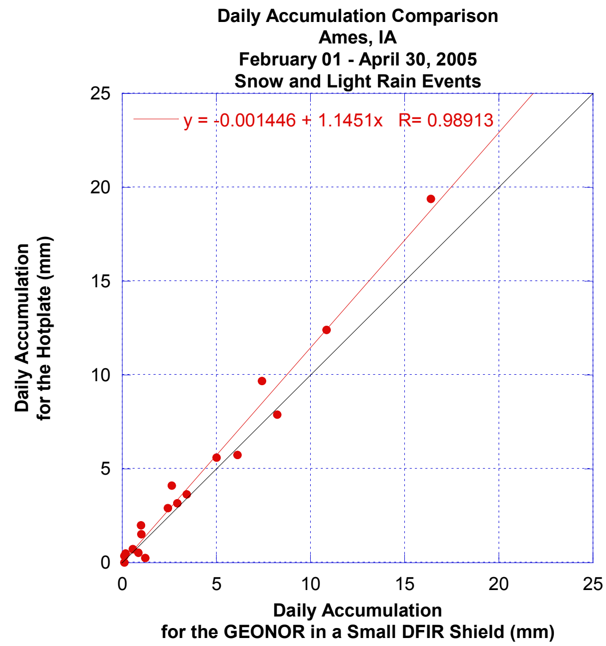
The maximum precipitation rate that the Hotplate can measure is dependent on wind speed and the temperature of the sensor head. The Hotplate, by itself, does not sense precipitation type. The Hotplate assumes precipitation type (rain/snow) based on ambient air temperature and corrects the rate based on the collection efficiency of the gauge for wind speed and assumed precipitation type. This may cause a slight over reporting for freezing precipitation types like freezing rain or freezing drizzle because the gauge assumes that the precipitation type is frozen when air temperatures are below freezing and the latent heat of melting is factored into the precipitation rate calculation.

Key Findings

The Hotplate is able to measure liquid equivalent precipitation rates between 0.01 inches/hour (0.25 mm per hour) and 0.5 inches/hour (12 mm/hour) within 10% of the World Meteorological Organization (WMO) standard.

Hotplate performance problems arose shortly after the deployment at each site due to the siting of the Hotplate. Terrain features at the Worthington site and obstacles at the Ames site initially resulted in several false precipitation reports and a slight reduction in the precipitation capture efficiency.

To correct for these siting deficiencies, a correction algorithm was created specific to each site. The signal coming from the Hotplate was transformed into a precipitation rate based on the wind speed as well as the wind direction. This stabilized the baseline measurements for the Hotplates during the test deployment period.



Daily (24 hour period) comparison between the GEONOR and the Hotplate liquid equivalent precipitation for the Ames, Iowa site.

The data from the Ames site were chosen for the comparison shown above because they were configured with the GEONOR, which provides a better representation of "truth" than the sensor site in Worthington, Minnesota, which had the GEONOR in the double Alter wind shield.

Implementation Benefits

The Hotplate snow gauge is virtually maintenance free. It has no moving parts, no fluids to change, and the heat it produces keeps it free from ice and insects, spider webs, etc. Its small footprint, one-minute update rate, and very low maintenance requirement makes it quite attractive for weather sensing locations such as roadside ESS sites.

Implementation Recommendations

For proper deployment of the Hotplate, a relatively flat, open area without large obstructions near the instrument is required. A 25 ft. radius flat area with no obstructions is desirable. It is also important that the Hotplate itself be level.

The Hotplate can be operated using either 110 or 220 Volts AC. The power consumption is dependent on wind speed. During precipitation events, the power required increases to range closer to 100–250 watts with a maximum power consumption of 600 watts.