Editor's note: Paul Zwaska is a recent graduate from the UW—Madison with a B.S. degree in soil science, specializing in turf and grounds management. Paul has been interested in weather since he was in junior high school and majored in meteorology in his first two and a half years in college. It continues to be a favorite hobby and interest. He was awarded the first Wisconsin Turfgrass Association Scholarship this past year. Since 1979, Paul has been working in the turf and grounds industry, first as a groundskeeper for two large apartment complexes and more recently he has been working under GCS Randy Smith at Nakoma Golf Course for two years. He is a native of Madison and is currently seeking employment as an assistant superintendent of grounds at a stadium or golf course.

A Superintendent's Concern

A Golf Course Weather Station: Design and Use

Figure 1.

Weather; people never really stop to think how much it controls almost everything that happens in life. For the golf course superintendent, weather is the main factor in growth and health of his turf. In order to provide the golf turf with the best environment for healthy growth, the golf course superintendent must adjust his cultural practices to fit the type of weather the area has been experiencing. That information is available from the local radio station. The radio stations usually receive their information from the nearest National Weather Service Station, experimental stations, or volunteer observers from around the state. However, the reports are only valid in the small area around the reporting station. These reports are good for a general idea of the weather.

Weather can vary greatly in a small area. For example, at Nakoma Golf Course in Madison, the lower portion of the course is usually anywhere from 2° to 10° cooler than the higher portion of the course in the early morning. The science covering this variance in weather conditions within small areas is called "micrometeorology." Variances in local weather is the reason it is a good idea for golf course superintendents to set up a weather station on the premises of their golf course. It could be as simple as a few thermometers and a rain gauge or a more elaborate set-up. This article will deal with what is needed for a basic station and how to use it.

The first task is the selection of a site for the instruments. The best place is an open, grassy area away from trees and buildings where there is good air movement. It is best to keep it near the shop area for easy access and security.

The most basic weather instruments every golf course should have are a maximum and a minimum thermometer. Purchase thermometers with degree scales that are engraved on the thermometer's glass stem because a thermometer with its degree scale on the mounting will eventually become inaccurate due to the thermometer shifting in its metal or plastic mounting. I recommend the #111 Maximum-Minimum thermometers with support and sold by Science Associates (see Fig. 1). The support supplied with the package correctly positions the two thermometers at the proper angle and has the facility to reset the thermometers. The price for this instrument is around $105. The thermometers are built to National Weather Service specifications and are very accurate. The Maximum Thermometer #112 costs about $31 and the Minimum Thermometer #113 costs approximately $25 if purchased individually and without the support.

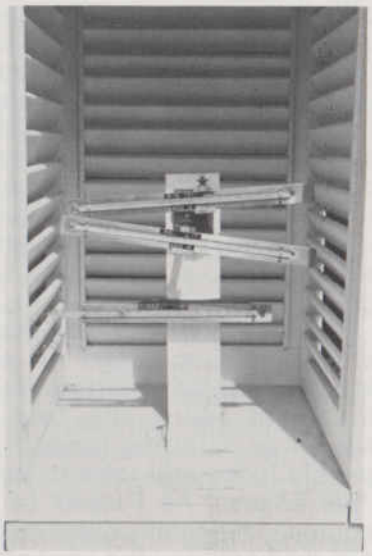

Figure 2. Science Associates #111 Maximum-Minimum Thermometer with Support shown at left and at right properly mounted in an instrument shelter.

A white wooden shelter with louvered sides is recommended for housing the thermometers. The base of the shelter should be about 48 inches from the ground with the door of the shelter facing north. The legs must be anchored to prevent overturning. Science Associates makes instrument shelters. The one illustrated is #176 and is priced around $370. With a little time and effort, a shelter similar to this can be built for much less.

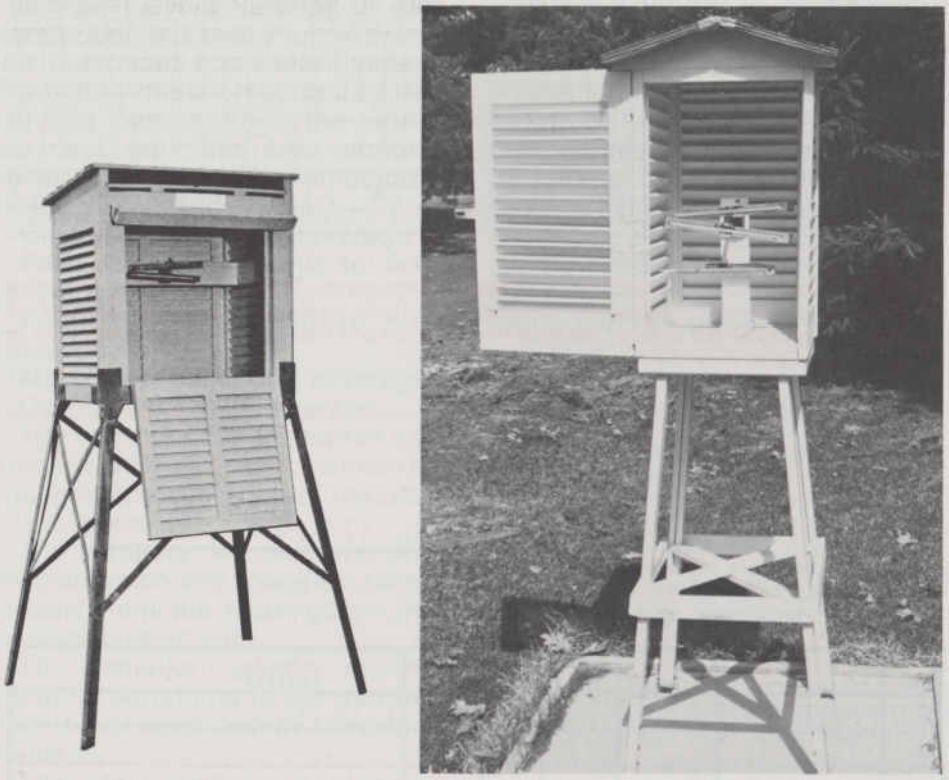

Figure 3. On the left is the #176 Instrument Shelter from The Science Associates, Inc. catalog and a homemade instrument shelter is shown at right.

Another important weather instrument for a golf course is the rain gauge. When searching for a site to place the rain gauge, it is critical to keep it away from buildings and trees which could alter the readings on rain and snowfall. The rain gauge I recommend is the Forester Rain Gauge #509 shown below in a picture from the Science Associates Catalog. For about $40 you get good quality and accuracy. The rain gauge support is a handy accessory that should be considered. Do not place the rain gauge any higher than two feet about the ground.

An additional piece of equipment, helpful to a golf course superintendent, is a wind speed and direction indicator. The stronger the wind, the higher the evapotranspiration rate of the turf. Therefore, a sunny, windy day can dry out a green or fairway faster than a sunny, calm day. Once a good set of records of winds, temperature, and sky conditions are compiled, you can predict at the beginning of the day if you will need to syringe or not. The wind instruments will also help to determine if condition for spraying of pesticides is safe from the threat of spray drift. A good set of wind instruments by Science Associates is the #415-1 Downeaster Combination Wind Set. It sells for approximately $250. Set the anemometer/wind vane apparatus on a sturdy mast, perferably on a hill, above your course's trees.

Figure 5. The anemometer/wind vane apparatus should be mounted on a mast and should be located away from or above any trees or other obstacles in the area.

Another optional instrument would be a barometer. I prefer a recording barometer because it illustrates what has been going on rather than a standard barometer with a dial. A recording barometer utilizes a seven-day chart that rotates on a drum while an indicator arm scribes a line on a graduated chart indicating the barometric pressure. This will help to associate the pressure tendency with different types of weather. Science Associates makes a very good recording barometer at a low price. It is the Electric Magni-Barograph #351(1) priced around $255.

Figure 4. Forester Rain Gauge #509. Collection apparatus is pictured on the left. On the right is the collection cylinder which sits inside the larger collection can. Source: Science Associates Inc. catalog.

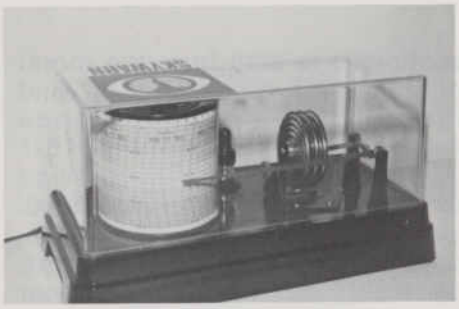

Figure 6. The #351(1) Electric Magni-Barograph scribes a permanent record of the barometeric pressure on seven-day chart.

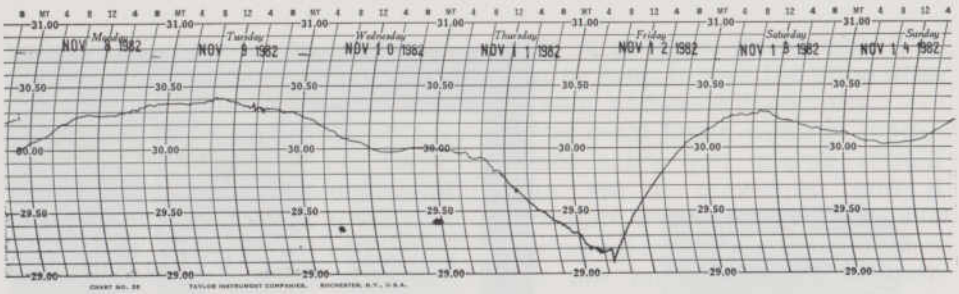

Figure 7. An actual chart taken from a recording barometer. The dive and then rapid rise again in the pressure indicates the passing of a storm system. The erratic changes of pressure observed at the base of the dive in pressure early that Friday morning was due to thunderstorms that moved through the area.

For those who like the automatic digital readout type of equipment the HeathKit Company of Benton Harbor, Michigan, supplies some very reliable electronic weather instruments. One of these is a computerized weather instrument called the Digital Weather Computer. It is almost an all-in-one operation and is an accurate and convenient piece of equipment for the extremely busy superintendent. This instrument measures indoor and outdoor temperature, the maximum and minimum temperature, the current wind chill factor, instantaneous wind speed and direction, the average wind speed and the peak gust, the current barometric pressure and whether it is rising or falling and by how much since the computer was last cleared. Finally, it also keeps the current time and date that the maximum temperature and wind gust occurred and when the minimum temperature was recorded. I highly recommend this piece of equipment. The price of the HeathKit Digital Weather Computer #IDW-4001, fully assembled and tested is about $590. For the person with even the slightest electronics experience, it is available in a ready-to-assemble kit complete with easy to follow instruments. Kit ID-4001 sells for approximately $400.

These are some of the instruments available to equip a golf course weather station. There are other instruments that can be added to measure such things as dew point and humidity, but I feel what I have described are the bare essentials.

Once the station is set up, some type of daily log to record weather observations is needed. A sample log is shown in Figure 8.

DATE Wednesday, July 17, 1979

SURFACE WEATHER OBSERVATIONS

TIME	SKY CONDITIONS	WEATHER	PRESS.	TEMP.	WINDS	REMARKS
0600	CLEAR 0/10	Haze	29.83	68	SW 6	Light Dew
0800	CLEAR 1/10	Haze	29.83	72	SW 8	
1000	P. CLDY 3/10	Haze	29.80	79	WSW 12	
1200	P. CLDY 3/10		29.79	85	SW 13	
1400	P. SUNNY 6/10		29.53	92	SW 17	Pressure Falling Rapidly / Dark to NW
1500	OVERCAST	T-storm	29.41	83	WSW 18	Rain Began 1450 / Wind Gusts to 48
1600	M. CLDY 9/10	Rain Shower	29.57	80	WNW 16	Pea Size Hail From 1505 to 1510 Pressure Rising Rapidly
1700	P. CLDY 5/10		29.64	78	NW 16	Rain Ended 1635
1800	P. CLDY 3/10		29.70	77	NW 12	

	N.W.S.	GOLF COURSE
MAXIMUM TEMPERATURE	91	93
MINIMUM TEMPERATURE	66	66
MEAN TEMPERATURE	79	80
24 HOUR PRECIPITATION ENDING AT 7AM	0.0	0.0
24 HOUR SNOWFALL ENDING AT 7AM	—	—
TOTAL SNOWFALL FOR SEASON TO DATE	—	—
TOTAL PRECIPITATION FOR MONTH TO DATE	1.37	1.02
TOTAL PRECIPITATION FOR YEAR TO DATE	16.07	17.01

COMMENTS Pythium spotted on practice tee and left Front of 14 green. Brown Patch observed on 1, 7, and 15 greens.

Figure 8. A sample daily weather log.

Many of the categories on the log are self-explanatory, however a few may need some clarification. Sky conditions are recorded by taking into consideration the whole sky, not just the area directly above, and judging the amount of cloud coverage in tenths.

Clear = 0/10 to 2/10 coverage

Partly cloudy = 3/10 to 5/10 coverage

Partly sunny = 6/10 to 8/10 coverage

Mostly cloudy = 9/10 coverage

Overcast = 10/10 coverage.

The weather column records any precipitation or weather phenomenon occurring at the time of the observation.

The pressure, temperature, and wind direction and speed are taken directly from the readings on the weather instruments.

The remarks column reports anything pertaining to the weather that is not recorded in the other columns.

The next section is climatological information. One column is for the National Weather Service readings and the other for the golf course's data. This allows a comparison between the golf course's weather station and the closest official weather station. The National Weather Service's climatological data for each day is listed in the newspaper.

The final section is for comments on any problems that showed up that day on the golf course's turf or ornamental plantings.

This is a rather extensive log, but it shows what kind of information can be gathered with a few instruments. Most superintendents will probably want a more simplified log.

A very good book on the basics of Wisconsin's weather called *Wisconsin Weather*, by Richard S. Palm and Anthony R. deSouza (2nd ed., Burgess Publishing Co., Minneapolis, MN, 1983), is excellent background reading for the beginning weather observer. The first three chapters explain the basics of weather. Chapter four gives an overview of Wisconsin's weather month by month. Chapter five deals with weather forecasting. Chapter six contains up-to-date summaries of weather variables (precipitation and temperature averages and extremes) for 147 stations throughout the state.

By correlating weather records with turf reactions to the weather, a superintendent can improve his or her understanding of the course's turf—its weak points and its strong points. With this information, preventative measures can be taken before the turf or ornamental plantings begin to suffer.

Below are the addresses of the companies mentioned. I have found them to be very responsive and reliable.

Heath Company
Benton Harbor, MI 49022

Science Associates, Inc.
P.O. Box 230
Princeton, NJ 08540

WGCSA SEPTEMBER MEETING
Milwaukee Country Club
Milwaukee
September 17

QUIT-QUI-OC HOSTS EXCELLENT MEETING

We couldn't have ordered a more beautiful summer day than the one we were given for our June meeting at Quit-Qui-Oc in Elkhart Lake. Paul Muller had the golf course in beautiful condition and WGCSA members had the opportunity to play around several new water hazards, compliments of heavy weekend rains. Tom Wiese, Golf Pro and Manager of Quit-Qui-Oc had some fun events for the golf participants. The winners were as follows:

Closest to the Pin — #34		Dick Evenson	
Longest Drive — #8		John Krutilla	
CLosest to the Pin — #12		Roy Zehren	
Longest Putt — #18		Steve Blendell	
Best 2 of 4 Man Best Ball Event			
1st	124 — 16 Under	Al Vrana	
		Chad Ball	
		Jim Belfield	
		Steve Blendell	
2nd	125 — 15 Under	Gary Monfre	
		Dewey Laak	
		Mike Lees	
		Ron Grunewald	
3rd	126 — 14 Under	Rod Johnson	Roger Bell
		Paul Muller	Pat Norton

The speaker for the meeting was Dr. David Roberts. Dave, a Plant Pathologist from Michigan State University, updated WGCSA members on the bacterial wilt problem. He was a grad student under Dr. Joe Vargas and his Ph.D. thesis was a study of bacterial wilt on Toronto C-15 Bentgrass — a very thorough and definitive study of the problem. The bottom line of Dr. Robert's remarks is that the problem is potentially serious and devastating for the turf industry and it is not receiving the proper attention nor concern it should be from research or research funding. We all have an obligation to encourage, even insist, on monies from appropriate funding groups to further the research needed for bacterial diseases.

Dr. Roberts was treated to some real Wisconsin hospitality during his two day visit to the Badger State. Jerry Kershasky met him at Mitchell Field and had arrangements made for a tour of County Stadium and of the Milorganite manufacturing facility at Jones Island. After the meeting, they returned to Milwaukee where Dave spent the night. On Tuesday, he was given a tour of Milwaukee Country Club by Dan Quast before returning to East Lansing. We like to think another one of the highlights of his trip here was a donation of $400 from WGCSA members for his research program.

All in all, it was another great meeting.