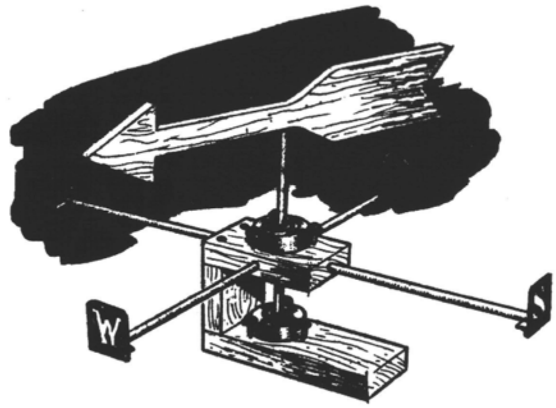

Is The Weatherman Always Wrong?

DR. TERRY GILLESPIE
UNIVERSITY OF GUELPH

Weathermen are constantly criticized and bear the brunt of numerous jokes because the weather at any given hour in the day is not what the radio or TV said it would be. Are they so off base, or is there a reason for their apparent errors?

In most cases the answer is timing. Weather systems are constantly moving in a generally west to east direction, but their rate of movement is subject to change. They may speed up or slow down, intensify or dissipate. The weatherman is not always able to estimate these underlying factors accurately so rain forecast for this morning may not arrive till late afternoon or light showers may turn into steady drizzle.

Understanding the way weather systems move and how to interpret local signs by observing wind direction, cloud patterns and temperature will enable you to adjust the timing of the forecast for your locale and thus adjust your turf management program. This article describes the basics of weather systems as they affect the local weather.

The "prevailing westerlies" that emerge from a description of global-scale circulations are, in reality, a sequence of travelling pressure cells (see Figure 1). These cells are delineated and tracked by drawing lines called *isobars* which join together locations with equal (*iso*) barometric (*bar*) readings on a *ground level* weather map. The resulting pattern is a series of distorted "bull's eyes" that are labelled as having relatively high (H) or relatively low (L) pressure at their centres. By observing several weather maps in a series, we discover that these cells normally move with a strong west-to-east component. Also, a glance at a home barometer suggests that lower pressures accompany "stormy" weather, while higher pressures suggest the weather will be "fair". To understand why these relationships hold, let's begin by examining individual pressure cells in more detail.

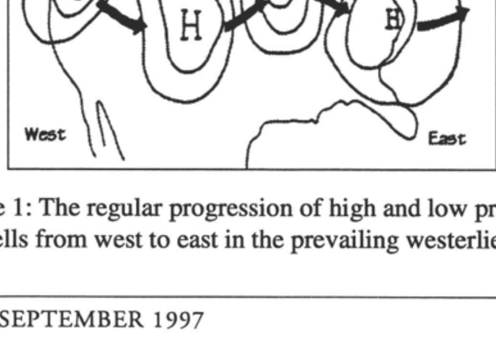

Figure 1: The regular progression of high and low pressure cells from west to east in the prevailing westerlies.

The near-surface pressure cells are mainly a feature of the lowest 4 km of the *troposphere* (from the Greek for "turning sphere"), which is a layer which extends to about 10 km above the earth. In the troposphere the average temperature *decreases* with elevation. "Weather" is confined to the troposphere because more than 90% of the world's water vapour lives in the layer, where it undergoes phase changes from gas to liquid or to solid that we experience as clouds and precipitation.

Our discussion will venture very little into the next layer, the stratosphere, which extends from 10 km to 50 km above the earth. Surprisingly, this layer warms with elevation. The warming results from absorption of ultra-violet solar radiation by the stratospheric ozone, which protects life near the earth's surface from the damaging effects of this radiation.

Low and High Pressure Cells

Figure 2a shows the wind pattern for a stylized low pressure system. Air moves in a gigantic, counter-clockwise, inward-spiralling pinwheel. Intuition might suggest that air should flow directly into a hub of low pressure like the spokes of a wheel, but this expectation is modified by the spinning of the earth. We must recall that we are observing the weather as we ride on a huge merry-go-round named Planet Earth. If you were to pitch a ball from the centre of a merry-go-round directly toward a catcher riding on the outer edge, the catcher would perceive that the ball had travelled a curved path which caused the ball to fly by behind him. In reality, the ball took a straight path and the catcher moved, but an observer stuck to the merry-go-round sees the motion as a curved path. You would also miss your target if you threw a ball from outside of a merry-go-round directly toward the centre, or from the outside toward another person sitting on the outside, but one-quarter of the circle ahead of you. Weather observers are stuck to the spinning earth, so we perceive the air motions (the wind) as curved trajectories which always twist to the right when we stand with our back to the wind.

What becomes of the air that makes its way toward lower pressure? It cannot escape through the ground or disappear, so the inward spiralling must have a slow drift upward. Whenever air drifts upward, it encounters ever-lowering pressure, and therefore expands. Expansion is a cooling process, and eventually this cooling results in condensation which produces cloud and precipitation. Here we have discovered a fundamental rule of meteorology ... ***unsettled weather is associated with regions of rising air.***

If air is constantly spiralling out of a region of high pressure near the ground (Figure 2b) where does this air come from? You may have guessed by now that this pressure system must be accompanied by a slow downward drift of air, which results in compression because the pressure increases as the ground is approached. Compression produces slight warming, which discourages condensation and suppresses cloudiness. ***Settled weather is associated with regions of sinking air.***

Air Streams and Weather Fronts

The winds near the ground in a typical low pressure cell can be seen as three air streams (Figure 3). A *cool air stream* rides in on the easterlies ahead of the cell's centre, accompanied by vigorous pressure (barometric) falls as lower pressure approaches. A *warm air stream* flows up from the south. Moving west of the cell, we find strong rising pressures bursting in from the northwest on the wings of a *cold air stream* as the whole pressure system moves off toward the east.

The cold air stream west of a low pressure cell pulls a fresh, chilly blob of polar air out of the northwest, and drives it against the west flank of the warm air stream. The temperature difference between these two streams is large, so the dense, heavier polar air wedges under the tropical air. Enhanced vertical lifting occurring along this collision zone usually results in a band of aggravated weather. In summer we see showers from heavy *cumulus* (lumpy) clouds, or even thunderstorms from *cumulonimbus* (lumpy and dark) clouds. In winter, precipitation is from less vigorous *nimbostratus* (dark and layered) clouds. Crossing this zone results in a quick wind shift into the cold air stream, so it is called a *cold front* (Figure 3). Figure 4 illustrates the undermining and lifting of the warm air mass as a cold front approaches. The cool air stream typically brings *stratocumulus* cloud (a layer of lumpy cloud). Check any introductory weather text for pictures of cloud types.

The east winds of the cool air stream in advance of a low pressure cell do not tap the depths of the polar air. Therefore, when the warm air stream attacks the south flank of the cool air stream ahead of a low cell, only sometimes is there a sufficient temperature contrast to form a front. If the contrast is strong enough, warm air will slide up over the cool, and this lifting will provide additional cloud and precipitation. The typical cloud sequence starts with wispy *cirrus* (mare's tails) followed by *altostratus* clouds (middle level of troposphere and layered, produces "ground glass sun") and then precipitation begins to fall from nimbostratus clouds. The zone where the flow shifts from the cool to the warm air stream is called a *warm front* (Figure 3). Figure 5 illustrates the rising of the warm air over the cool air mass and the resulting cloudiness and chance for precipitation.

A strong low pressure cell may collide the warm air stream vigorously with both the cold air west of the cell, and the cool air to the east. In this case, the enhanced cloud and precipitation caused by both fronts will be clearly visible on satellite images.

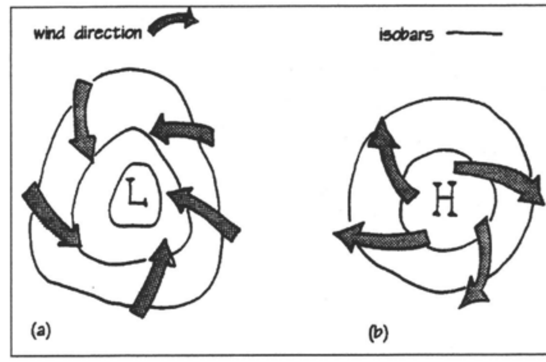

Figure 2: Winds spiralling counter clockwise into a low cell and clockwise out of a high cell.

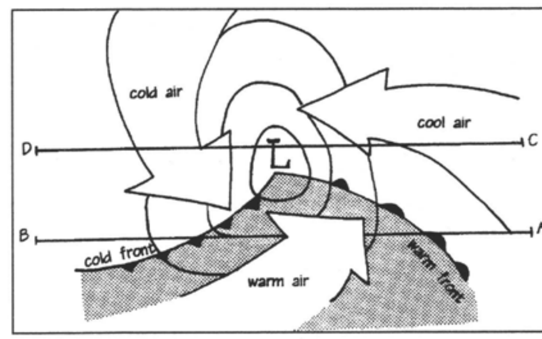

Figure 3: Air streams in a low pressure cell.

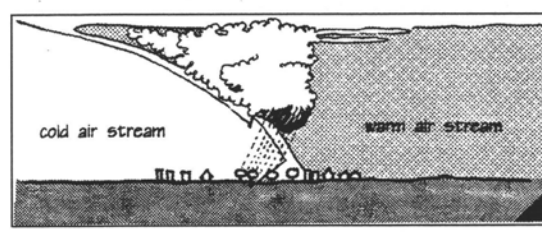

Figure 4: A cross section of a typical cold front that pushes under a warm air mass, forcing the warm and lighter air upward, resulting in condensation, cloudiness and precipitation (often heavy storms) as the air is rapidly cooled.

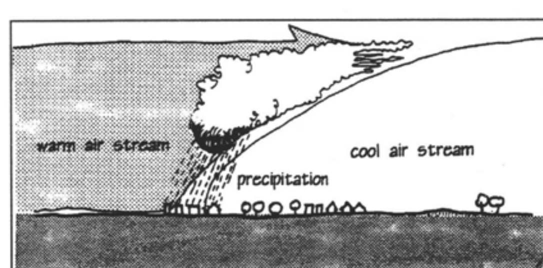

Figure 5: A cross section of a typical warm front overriding cool air resulting in cloudiness and precipitation.

Sometimes only a cold front is visible because the contrast between the cool and warm air streams is too weak.

High pressure areas, with their *outward spiralling winds,* push air mass borders away from their centres. Thus, fronts do not generally exist in the heart of high cells. A high cell is typically tucked into the burst of polar air behind a strong low. From that location, the eastern half of this cell feeds the cold air stream of the low to the east, while its western half blends into the cool air stream of the next low to the west (Figure 6).

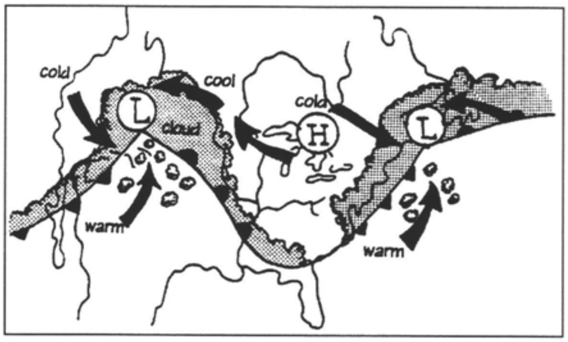

Figure 6: A typical weather map showing the highs and lows, areas of cloudiness and potential precipitation and the wind direction.

As a cell of low pressure with well developed cold and warm fronts moves by to the north of your location, the resulting sequence of weather events can be seen by following along line A - B in Figure 3 (remember you are stationary while point A in the weather mass moves east until point B is over you). Easterly winds of the cool air stream at A will be accompanied by increasing cloud and a falling barometer. Precipitation is likely as the warm front approaches, but this will diminish or cease as the warm front passes and you note a shift to warm southerly winds. After a period in the warm air stream, the cold front will approach with its band of heavy weather. Then the cold air stream will bluster from the northwest and the pressure will rise quickly. As the low cell moves eastward and is replaced by higher pressure, the weather will settle by the time position B is reached.

If the low cell moves by to the south of your location, you will travel along line C - D in Figure 3. Cloud and precipitation will develop in the cool easterly air stream as the system approaches. Gradually the wind will back around to the northwest as you blend into the cold air stream, but you will never enjoy the warm air mass which is confined south of the fronts. Finally, higher pressure will settle the weather again as you approach position D.

ACKNOWLEDGEMENT

The Sports Turf Association appreciates the permission to use Figures 1 - 6 from Robert D. Brown and Terry J. Gillespie, *Microclimatic Landscape Design*, John Wiley & Sons, New York, 1995.

WEATHER FORECASTING SKILLS

How can the knowledge presented in these pages be used by you to fine tune your management decisions?

Let us suppose the weather forecast at noon was for hot and humid with thunderstorms this evening, clearing and sunny tomorrow with northwest winds. The temperature forecast is for 32C this afternoon dropping to 18C overnight. The night was warm and humid and when you arrived at work, and the wind was still southerly. You had planned a seeding operation today, should you proceed?

The assessment of the forecast is that an approaching cold front has slowed up and the potential for heavy rains or thunderstorms still exists. Seeding this morning may be subject to heavy washing and erosion. Best wait for those cool northwesterlies

The forecast at noon was for increasing cloud this afternoon with light rain overnight. The temperature is forecast for 15C overnight, with a high of 28C tomorrow afternoon. Southeasterly winds will shift to the southwest tomorrow. The rain had started by the time you left work, and at sundown mild breezes were blowing from the south. You had planned a weed spraying program tomorrow, should you proceed?

The assessment of the forecast is a warm front has arrived earlier than expected. You may proceed with your spraying program with due caution for drift caused by the strengthening southerlies.

Note: In both cases, the forecast of weather events was correct, but the timing was off. Plan your program, listen to the forecasts, observe the local weather conditions and be prepared to change your plans.