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Mid-West Growing Season Weather

Kern E. Kenyon

Del Mar, CA, USA
Email: kernken@aol.com

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Abstract

An earlier discussion of the summer northward heat flux at ground level at one location in northwest Iowa, based on observing the winds there over 30 consecutive summers, is extended geographically west to the Rocky Mountains and southward. Also the time-scale is stretched well past 30 years. Evidence cited is the eastward increase in plant size and greenery at constant latitude starting at the mountains, which is easily noticed from Texas to North Dakota. One dynamical element, the Coriolis force, acting on the north and south winds over long time periods helps explain the observations. Conservation of mass is another important ingredient.

Keywords

Mid-West, Summer Weather, Growing Season

1. Introduction

Comments below build on a previous discussion that arose from more than thirty consecutive summers, spent at the same location in northwest Iowa, observing the wind speed and direction at ground level, and sensing the temperature and humidity [1]. A wind out of the north is cold and dry; out of the south it is warm and humid. Most of the time the wind direction alternates between being out of the north to being out of the south and back again, which is an amazing fact. One consequence is that a net northward transport of heat is taking place at that location, whether or not there exists any understanding of the physical mechanism causing it to happen. Such a northward heat transport by the air in the middle of a large land mass is consistent with the theoretical requirement for maintaining the Earth's heat budget because the oceans are too far away to help. Only the air can do this job inside a continent.

Thirty years of observations may seem sufficient, but a single location could reasonably be questioned. Therefore, consider a different widening geographical approach which simultaneously is an extension of the time frame well past 30 years. Pick a latitude within the US, between Texas and North Dakota, and move eastward from the Rocky Mountains during the growing season. Whether the vegetation seen is farmed (corn, beans, sun flowers) or natural (grass, bushes, trees) it steadily increases in size, density and greenery to the extent that in Iowa irrigation of farms, for example, is no longer needed since enough rain usually falls there.

Rain typically develops when cool dry air interacts with warm humid air. What the east/west vegetation transects are implying is that integrated over time the amount of rain during the growing season monotonically increases from the mountains to the east. Given that the cool dry air going south and the warm humid air going north are not steady state flows, but take place in pulses of variable duration and width, the existing vegetation picture also implies that the frequency with which warm humid air and cold dry air collide increases eastward from the Rockies. In a strip of almost arid land adjacent and east of the Rockies there is either no wind or a cool dry wind going south. Very rarely does a warm humid wind penetrate into this region. On the other hand, in northwest Iowa a south wind occurs about as often as a north wind does. In between, going west, there must be fewer times when a wind out of the south happens on the average.

2. Qualitative Modeling

As is well known, excess solar (short wave) radiation is absorbed by the atmosphere at low latitudes, and at high latitudes there is a deficit of absorbed solar radiation. Long wave radiation exiting the atmosphere is nearly independent of latitude. Therefore, a northward transport of heat is required to occur in the Northern Hemisphere. One of the strengths of the heat budget requirement is its generality. Many different configurations of fluid flows can accomplish the goal. A variable circulation is the result, which is particularly true of the mid-west weather in summer. For that reason the following discussion of modeling has to be qualitative, even though very many weather stations have been collecting enormous amounts of meteorological data over many years.

Consider a burst of cold dry air moving south across the Canadian border somewhere into the mid-west. It does so because of an unstable situation set up by the sun: warm air at low latitudes and colder air at high latitudes at the same elevation (ground level). East/west band width, longitude, speed and duration of the outburst are variables which are not given. They are not predicted well at all by weather experts. However, conservation of mass dictates that an equal amount of warm air must head north somewhere else at the same time. Experience leads to the idea that the northward warm air usually does not flow on top of the cold air going south in a two-layer configuration, as will be explained more below. When cold air going south runs into warm air, being denser it will push the warm air aside out of the way.

In addition, the time of day that the cold air starts south is not bound by any rules, in contrast to what has been found in the air over the North Pacific [2] since and including the discovery by a Japanese scientist in the 1950s [3]. At a fixed location at sea level off Japan the expected noon maximum in air temperature was found to be split in two by a shallow minimum in a mean over three years of data at two weather ships. Then weather data from a 35-day oceanographic cruise in March/April of 1976 found the same thing, but even more marked, while crossing the whole ocean along 35 N. Not on every day but enough times that the average of all measurements taken on the cruise showed the noon minimum (please see figure 1 of Ref. [2]), a cold dry wind went south at noon when this happened. Very likely this is an example of atmospheric heat balance taking place over the open ocean, which comes close to having a regularity about it. On the other hand, from three years of data obtained at the closest weather station in northwest Iowa I searched but could not find any noon minimum in those air temperatures.

Because the instability that drives the cold dry air south is oriented north/south, the burst coming across the Canadian border will probably be nearly straight south to begin with. But any movement of air relative to the earth's surface will experience the Coriolis force acting at right angles to the flow, and in the northern hemisphere that will be to the right or west in this case. Supposing there is no force opposing the Coriolis force, then that is what will happen: the burst of cold dry air will migrate west toward the Rockies.

Consider that a bunch of cold dry air from Canada heads southwest through the upper Midwest and does reach the Rockies. Then a relatively large triangular region north and adjacent to the mountains is temporarily closed off preventing any southern warm humid air from entering. But normally that would not happen anyway. Conservation of mass dictates that simultaneously an equal mass of warm humid air must head north while the Coriolis force acts to steer it eastward. This concept is consistent with what radar weather maps quite often show during summer: a long thin green band of rain oriented southwest to northeast where the two different air masses meet.

3. Discussion

A common experience, not restricted to the mid-west, is that after a period of rain, the air is noticeably colder. It does not become colder before or during a rain storm in my experience. Coming from southern California my first awareness of that happening occurred shortly after entering college in Boston. One deduction is that the likelihood of a two-layer system with warm humid air on top and cold dry air on the bottom is very small, although such a configuration would be hydrostatic stable and therefore physically possible.

Second among weather commonalities in northwestern Iowa, familiar to most locals, is that windy days, whether from the north or south, often grow calmer as evening approaches: the speed of the wind decreases. That by itself suggests that the sun may directly have something to do with some of these winds.

Amongst the variabilities of wind speed and duration in northwest Iowa, as well as the time of day they occur, the wind direction is much more consistent and easily observed all around town. American flags are everywhere present and there is one wind mill operating continuously. Also from our house on a small lake the wind direction can be inferred during daylight by looking at the surface wave motion. What is almost a constant, so to speak, is the switching back and forth of the north and south winds all summer long. There is one obvious conclusion as to the explanation: the atmospheric heat balance is happening.

To end this story two extreme examples of straight line winds in summer are mentioned. One of them I watched out of the window. There used to be two identical trees, tall and thin (all branches at the tops) in front of the cottage next door. A few years back along came a very strong wind out of the north and it snapped one of the trees off at the base and dumped it in the lake. The next year an equally strong wind out of the south snapped off the other tree and dropped it on the roof of the cottage. Anemometers at the nearest weather station stopped working in both cases but estimates of the wind speeds were at least 60 mph. Strong winds from the north and south, that occur more than once per summer, are in the range of 30 - 45 mph. Although my experience in winters is very limited, it makes sense to think that the characteristics of the heat balance mechanism can be more vigorous in summer and during the day since the sun is higher in the sky, and because the north/south distance between relatively warm and colder air at ground level is shorter making the instability stronger.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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