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Avocados and Weather Cycles

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INTRODUCTION

Some weather cycles are obvious to all—the twenty-four hour daily cycle in temperature, humidity, and wind; the yearly cycle of seasons at midand high-latitudes; and others are so apparent that they are not commented upon except as to how cold or warm, wet or dry, or how cloudy or clear the weather has been. Other weather cycles occur which are not so apparent. Examples include the yearly fluctuations in carbon dioxide at the top of Mauna Loa in Hawaii or the twenty-three month cycle in the winds in the equatorial stratosphere.

The causes of these cycles are uncertain, but may be assigned in certain cases to variations in astronomical factors, and in others to natural resonances in the earth's geophysical system. Some of the astronomical cycles are too long for the individual human experience. For example, the 50,000 year ice age cycles, which are closely related to the variations in the earth's tile angle in its orbit about the sun and the changes in the elliptical shape of the orbit are too long to affect any individual grower, or even any human organization. Currently, we are at the end of a climatically optimum warm period with a clear trend to colder temperatures in the northern hemisphere. It could become as cold as the "mini ice age" during the 14th Century (Dansgaard, et al 1975). But it will require another 25,000 years before a full ice age will start.

Other astronomical cycles include the eleven year sunspot cycle, the 22 year magnetic cycle of the sun (c.f. Sonnett, 1982), the possible slight expansion and contraction of the sun's disc, and the 18.6 year precession of the nodal crossing of the moon's orbit about the earth across the plane of the earth's orbit (the plane of the ecliptic) about the sun.

But it is only recently that the development of computer analysis using maximum entropy spectra (Levine and Tribus, 1979) and the increasing length of weather records either from observation or derived from such sources as the ratio of oxygen isotopes in the snow of the Greenland ice cap (Dansgaard et al, 1975) and tree ring thickness (Fritts, 1974) that these cycles have been detectable.

There is one important cycle which has been known for many years because it is so strong. This is the southern oscillation/El Nino or Walker cycle of wind and ocean currents in the south Pacific Ocean. This pattern was first observed by Hildebrandsson (1897) and defined by Walker and Bliss (1932). Some of the known cycles are shown in Table 1.

Table 1. Identified weather cycles

Weather cycle	Period	Probable cause
Diurnal	24 hours	Earth's rotation
Seasonal	yearly	Inclination of earth's axis in orbit
Ice Ages	50,000 360,000 years	Earth's orbital variations
El Nino (Walker and Bliss, 1932)	48 months	Ocean resonances
Midwest drought (Borchert, 1971)	18.6 years	Moon's orbital tides interacting with Rockies
Air temperatures over North America (Currie, 1979)	18.6 years	Moon's orbital tides, sunspots
Tree ring width (rain and temperature), (Fritts, 1974)	22 years	Sunspots
Northern China Floods, 500 year record (Hameed et al, 1983)	20 years	Moon nodes of orbit
Tree rings, Patagonia Andes (drought), (Carrie, 1983)	18.6 years	Moon nodes of orbit
Western Agricultural Production, (Thompson, 1973)	20 years	Moon nodes of orbit
Nile, (maximum flows) 1300 year record (Budgor and West, 1980)	22 years	Sunspots
Hurricanes in southern California, (this paper)	18 years	Moon nodes of orbit

THE SOUTHERN OSCILLATION/EL NINO

The oscillations in the South Pacific Ocean's water currents and winds are caused by the geography of the western Pacific about Indonesia and Australia. The drag of the many islands on the ocean currents (which are driven by the easterly trade winds along the equator), causes a pile-up of water near Indonesia. When a random weak spot develops in the prevailing easterly trade winds (about every 48 months), pulses of warm water surge eastward along the equator (Rasmusson and Carpenter, 1982). The surges spread into the north and south Pacific along the western coasts of North and South

America, the spread along South America usually being the strongest. In the case of exceptionally strong El Nino events, such as 1981-82, the warm water can spread far north, reaching even the northern California coast. The effect of this northward surge of warm water is twofold: (a) it raises the water temperature and consequently the humidity of the air near the coast and (b) it causes strong cold high pressures to develop over Alaska, the Yukon, and British Columbia during the winter.

The higher humidities are important to the avocado grower because the evapo-transpiration of water from avocado and other plant leaves is significantly reduced, which lowers the water demand of the trees and consequently irrigation requirements.

Computer modeling (Blackmon *et al.*, 1983) have shown that the effect of the El Nino warm water is to initially greatly increase the speed of the westerly jet stream over the North Pacific Ocean in the fall. As illustrated in Figure 1, later in the fall-winter season, the jet stream drops southward as the developing cold high pressure area over the Yukon, Alaska, and British Columbia forces the Aleutian low southward. The fall storm path entered the west coast in northern California, bent northward over the Rocky mountains, and then curved southward along the eastern slopes of the Rockies into the central United States before turning eastward. This flow brings cold weather between the Rockies and Appalachians and south to the Gulf coast. During the fall, the storms weaken as they approach southern California, so that the fine, warm Indian Summer weather is only briefly interrupted by showers.

In late December and January, the Pacific storms are forced southward over southern California, bring heavy precipitation (3 to 5 times normal) and occasional cold outbreaks of Arctic air.

SOUTHERN CALIFORNIA HURRICANES

As shown in Figure 2, there is an approximately 18 to 20 year cycle of incidence of hurricanes in southern California. This correlates with the lunar nodal cycles. The strength of the cycle was shown in the 1983 hurricane season as they quickly dissipated upon approaching southern California from the south, in spite of the much above normal sea surface temperatures, as the cycle ends.

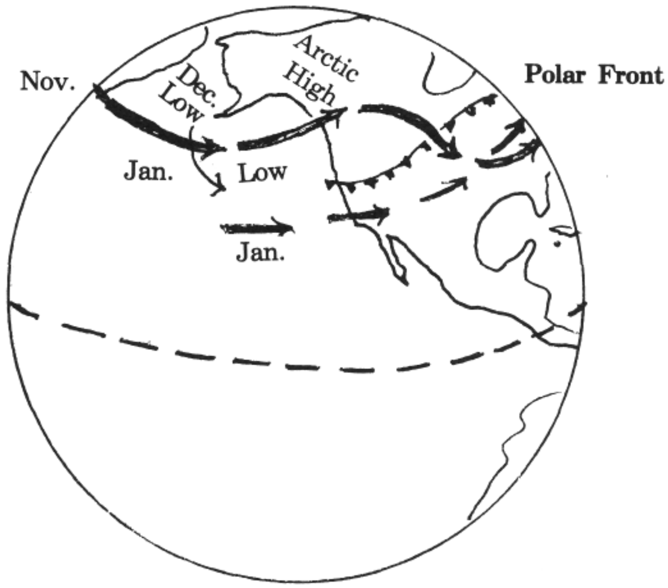

FIGURE 1. High pressure over northwestern North America forces the storm track to southern California in January.

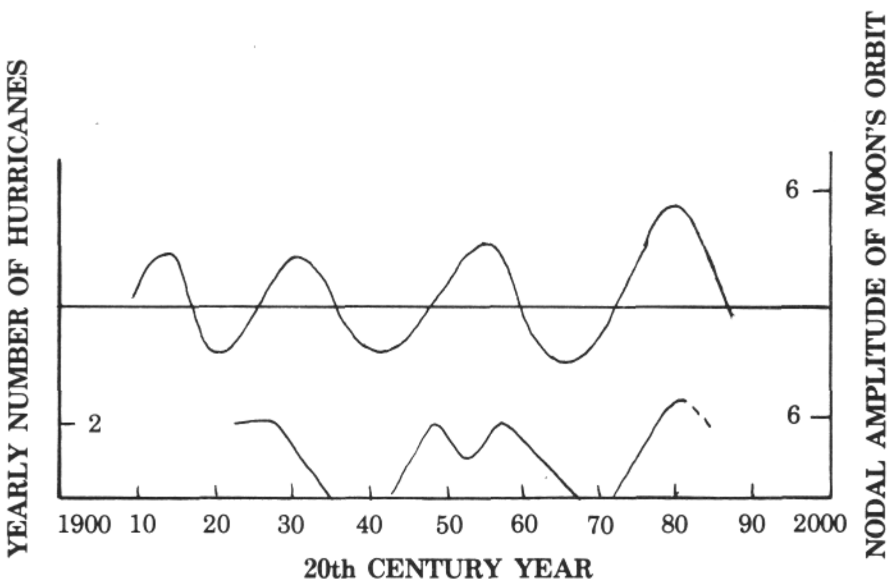

FIGURE 2. The 18.6 (average) lunar nodal wave form (upper curve) is nearly in phase with the five year running mean (lower curve) of hurricanes making landfall over southern California.

CONCLUSIONS

Continued study of climate patterns is revealing previously unknown cyclical weather patterns. Various factors are combining so as to cause a trend toward colder winters in southern California with a summertime decrease in humidity and the occasional August showers of the past several years.

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