JUPITER, THE PLANETS, AND THE WEATHER DURING THE EIGHTIES

(from an address to the Lapidary Club of Tasmania, by Professor S. Warren Carey)

Short-term weather in our latitudes is dominated by the behaviour of air masses--cyclonic, with low pressures, eddying clockwise inwards and rising, and anticyclonic, with high pressures, circulating anticlockwise outwards and descending. Meteorologists have developed a high level of expertise in the observation, analysis, and short-term prediction of such air masses, and of the weather likely to ensue.

Long-term climate suffers secular changes, many of them cyclic, governed by the interaction with other members of the solar system. Some of these are short, like the daily cycle of insolation, temperature, and other effects of the Earth's rotation. Moon's 28 day revolution, Earth's annual perihelion and aphelion, and Earth's 25,800-year precession, all have clear effects on our climate.

We also know about the alternation of ice ages and interglacials lasting several tens of thousands of years. We emerged from the last ice age about 10,000 years ago, and are currently in an interglacial rather cooler than the long interglacial which preceded it. There is no reason to think that the present interglacial won't be followed by another ice age a few tens of thousands of years hence. On a larger scale, these ice ages and interglacials come in groups a couple of hundred million years apart. The glacial group we are now experiencing commenced about a million years ago. The group before it commenced about 250 million years ago, the one before that about 450 million years ago, and before that 700 million years ago, and there were others earlier.

Between the very short and the very long cycles there are others of more immediate interest to us, particularly the tidal effects of the planets on the Sun. Sun, a turbulent ball of plasma, is far and away the master of our weather, and any perturbation of the Sun affects out weather.

Let us compare tides on Earth and Sun. Earth's tides are dominated by Moon and Sun, and Moon being so very much closer is three times as effective as Sun. Tides come 1/28 of a day later each day because Moon takes 28 days for a revolution, and twice in this revolution Moon and Earth and Sun are all roughly in a straight line, so high tides are much higher and low tides are much lower. When Sun and Moon are in quadrature these effects are separated, so the range between high and low tide is much less.

The same thing happens to tides on the Sun, but it is not Earth or Moon that dominates but Jupiter, the largest planet. Jupiter's orbital period is 11.86 years, which is the reason for the sunspot waxing and waning cycle of about 11 years. Sunspots are great eddies in the Sun's "atmosphere", rather like tornadoes in the Earth's atmosphere (but in the opposite direction). The larger ones are much larger than the Earth, which would be sucked down like a cork in a whirlpool.

Sun-spots do affect the weather on Earth. From historic records the years of sun-spot maxima were marked on the growth rings of a Douglas fir tree. The growth rings were much thicker around every sun-spot maximum, and conspicuously thinner around sun-spot minima. This tree certainly thrived better during those years when sun-spots were numerous. Records of the level of Lake Victoria Nyanza through half a century showed high levels around sun-spot maxima and lower levels around sun-spot minima. This region enjoyed higher rainfall or lower evaporation or both during sun-spot maxima.

We must conclude from this that sun-spots mean more rain or better growth condition for the forests generally. The opposite can be true. Climate is latitudinal--the humid tropical zone extending ten degrees or so each side of the equator where humidity and rainfall are high but temperatures rarely reach 100°F. (nearly 40°C). Next is the high pressure belt, 15° to 20° latitude, with low rain, low humidity, and high temperature above 40°C for long periods. In this belt are the Sahara and Gobi deserts, and the arid zones of Iran Iraq and Mexico, and the Great Australian desert. Next is the humid belt to about 40, then the 'roaring forties', then the frigid zones of the polar regions.

The effect of increased insolation is to cause these belts to move further poleward, and reduced insolation to move them further equatorward. So Townsville could get much wetter as the tropical humid belt breathed poleward, while Brisbane could get much drier, as the desert belt shifted south--floods in North Queensland and droughts in south Queensland from the same cause. Places in the middle zone would see little change. Tasmania could suffer increase in strong westerlies as the zones creep northward with increased rain in western Tasmania and droughts in eastern Tasmania.

Such a change would also affect different trees differently. In Tasmania, citrus are beyond the limit of their range, but with selected micro-climate siting and careful husbandry, some can do well, but apples are well within their climatic range here. Trees well within their range would be less affected by the breathing of the climatic belts, but those near the margins of their range would be sensitive.

Although the sun-spot cycle is on average about 11 years, they vary greatly in amplitude and period, because Jupiter, although the largest planet, is not the only one. If Earth had no moon, our tides would be very regular with Sun as the only attractant of importance (although winds would still modify the tides). Likewise the tidal perturbations of the Sun are a symphony in which all the planets fiddle.

If Sun had only one planet (Jupiter) Jupiter would revolve its regular orbit about the centre of gravity of the Sun-Jupiter system, and Sun would also revolve with the same period in a very small circular orbit about the same point. But each of the other planets does its bit of pulling on Sun, so his orbit becomes more irregular. Six years ago Paul Jose calculated Sun's path for 179 years from 1834 to 2013 AD as a result of the attraction of the five outer planets (Jupiter, Saturn, Uranus and Pluto), and I have redrawn his data in the attached figure. On earth we adopt Greenwich from which to measure longitude, and similarly for the celestial sphere we arbitrarily adopt the first point of the Aries constellation. In the figure, 0 is the centre of gravity of the solar system, and the revolution of each of the planets and of Sun himself is about this point. The axes of the figure are marked off in 1 and 2 solar radii (about 70,000 km).

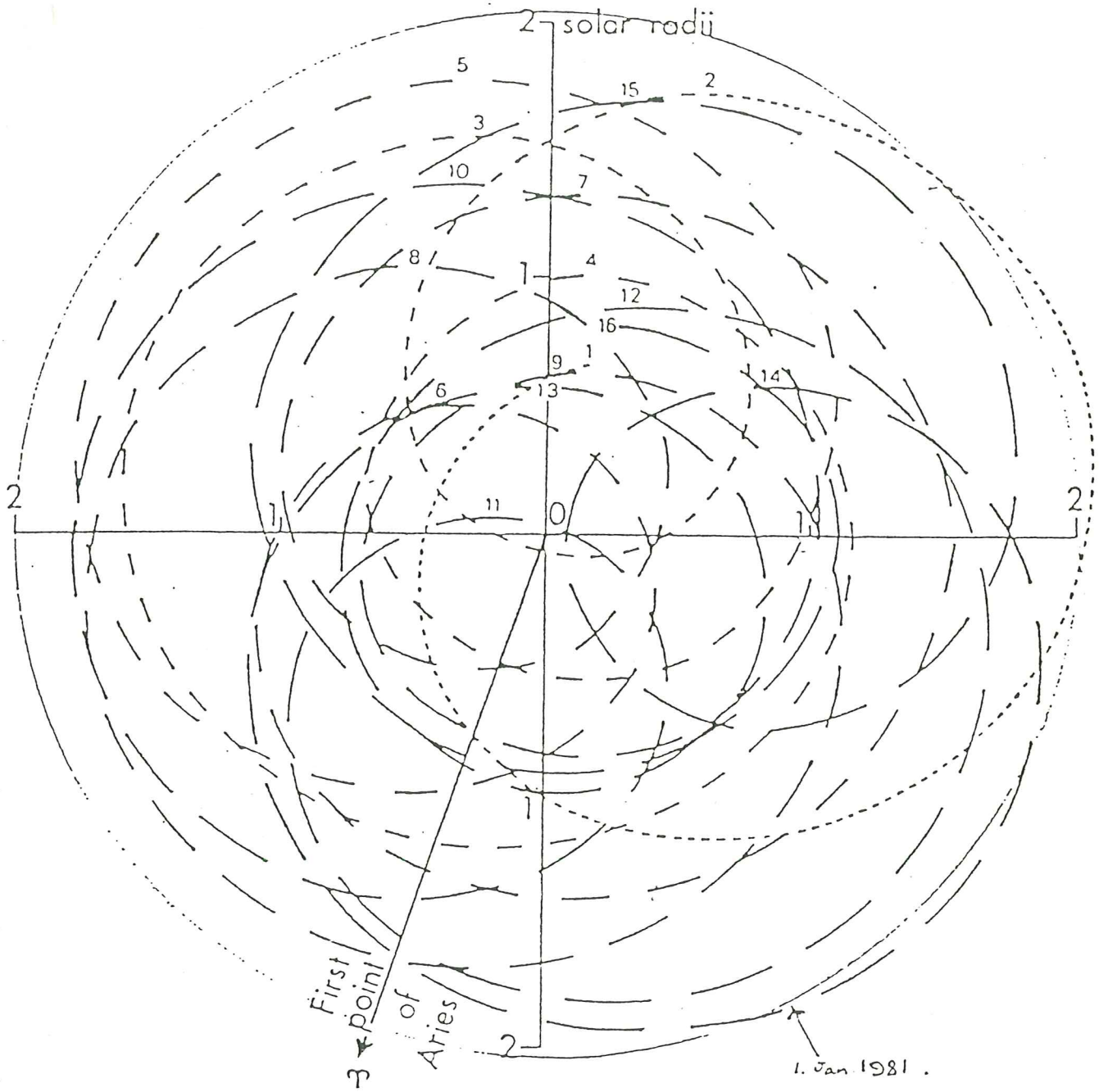
Let us look closely at the course of the Sun during this period. On October 13, 1834 Sun was at point 1, which is about 2½ cm above the centre of the diagram. Follow Sun's orbit along the small dashes for one cycle to point 2 on December 4, 1847 (13.1 years later), then follow the slightly larger dashes round the next orbit to point 3 on September 5, 1856 (8.76 years later), then the next orbit with dashes slightly larger again to point 4 on March 17, 1869 (12.53 years later) and so on round the next nine successive orbits to point 13 on December 19, 1974 (which is an average of 11.76 for these nine orbits). From point 13 follow the last orbit (marked with the longest dashes) to next New Years Day, January 1, 1981, which is indicated by the arrow (lower right).

Now observe the unusual characters of the present decade. For the first time since 1843 Sun is more than 140,000 km from the centre of gravity of the solar system. This is because all the major planets are lining up on one side of the Sun, which only happens every 178 years. The present space missions, sending a probe vehicle to Jupiter, then on to Saturn, thence on to Uranus and Neptune, and even Pluto, is only possible because all the planets are lined up--like hitting five rabbits with one bullet! It could not have been done ten years ago, or ten years hence.

When Sun and Moon line up with respect to Earth, we experience exceptionally high and exceptionally low tides. Likewise during the current decade Sun will experience exceptionally high and low tidal perturbations of the solar corona. This only happens every 178 years and certainly affects our global weather. The inner planets (Mars, Earth, Venus, and Mercury) are not included in this diagram, but cause an irregular wavy modulation of Sun's orbit, superimposed on the diagram. When these are added, the combination we are about to experience has not occurred since 1308 AD, 637 AD, and 34 BC.

For the next few years Sun will be furthest out from the centre of the solar system, peaking on September 23, 1983. Then, just as Earth tides have maximum extremes of high and low together, Sun's orbit then fails to even reach the centre of the system, the only time in the whole period covered by the diagram that this occurs (September 12, 1985). At this time, Sun will actually have negative moment of inertia! The previous such occasion was in 1811.

These facts lead to the conclusion that we have just entered a decade of weather extremes around the globe. Droughts will be more severe; elsewhere floods will be more severe. There will be many departures from average conditions. Tasmania will have bouts of more severe westerlies. The eastward tracks of cyclones and anticyclones will fluctuate further north as well as further south. Those of us whose responsibility concerns long range weather (water storages, crop planning, fire hazard, etc.) should make their decisions more conservatively, so that they are not caught by unusual extremes of weather.


2 solar radii
2
1
0
1
2
First point of Aries
1. Jan 1981.