A THEORY FOR LONG TERM CHANGES IN THE GENERAL CIRCULATION - COROILIS EFFECT IN THE SOLAR SYSTEM

P2.10

John C. Freeman and Jill F. Hasling
Certified Consulting Meteorologists
Weather Research Center, Houston, Texas

The general circulation of the atmosphere is governed by the barotropic vorticity equation which contains a term for the angular velocity of the coordinate system in which the equation is studied. Traditionally the angular velocity term is taken constant but there is evidence that the time dependent terms in the elliptic orbits that affect the earth should be taken into account in the equation.

The orbits that affect the atmosphere are the orbit of the earth about the center of the sun and because the earth follows the center of the sun, the orbits of five planets. These are Jupiter, Saturn, Neptune, Uranus, and Pluto. The weather of the earth is affected by time variations in seven different elliptical orbits. The time variations average out to zero over 2000 to 3000 years, the time it takes for an orbit to change the angular velocity of the solid earth so that it remains constant throughout the process.

The inclusion of the time variations in the basic velocity adds new terms to the vorticity equation that have periods of 28 days to 250 years. This forms the physical basis for long term changes in the general circulation of the earth's atmosphere furnish the link between sunspot activity and the earth's weather.

The Sun's orbit is not as stable as the individual orbits of the planets but almost repeats nearly every 178.7 years. Figure 1 shows this instability of the Sun's orbital path. This diagram represents one completion of the Sun's 178.7-year orbit through the solar system. The authors have named this 178.7-year orbital period of the Sun a "helio-epoch" and it can be seen in the diagram that one circle represents one helio-epoch. From Figure 1 notice the variance in the sixteen circuits of the sun about the center of gravity of the solar system that are graphed. This is evidence that the Sun's orbit, or helio-epoch, is variable.

Jose [1965] developed a graph when he made use of computers to compare the motion over several hundred years of all the planets and the Sun. The Sun's orbit ranges from 0 to 1.5 million miles where the radii of orbits of the outer planets range from 480 million to 3,670 million miles. Therefore, the radius of the Sun's orbit is much smaller than the radii of the orbits of these five outer planets.

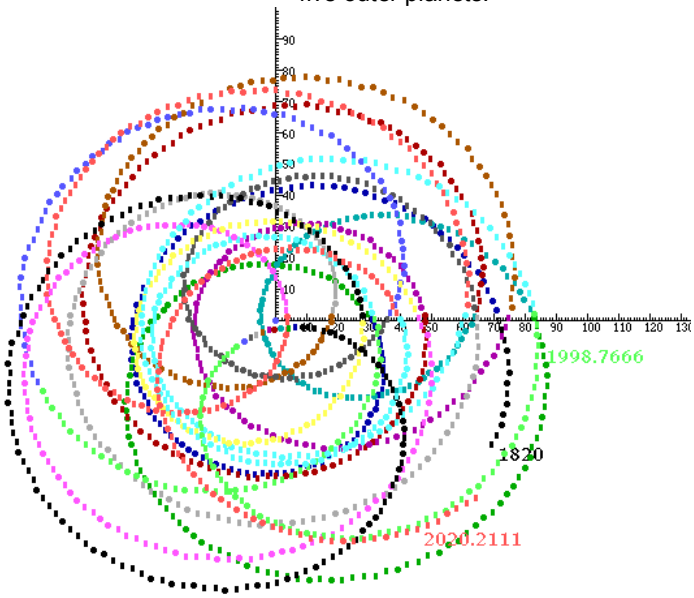

Figure 1: Projection of the 178.8 Period of the Sun on the Invariant Plane.

The orbit of the sun about the center of gravity of the solar system is shared by the earth like the moon shares the orbit of the earth about the sun was shown by Freeman and Hasling (2003). The principal method by which this sharing takes place is explored in this paper. Each of the shared orbits has an angular velocity that shows up in the vorticity equation for the body being studied.

Coriolis determined that if a space ship were accelerating in a curved path that any motion studied in the space ship must take the change in speed and the angular velocity of the space ship into account. If this space ship were moving in the same direction as the center of a planet or star this fact would still be true. The motion of the center of a planet or a star can be calculated from all of the orbits that cause significant motions of that body.

In general an orbit is the path of a body in a plane. It is an ellipse and it has a period, T, which is the time between subsequent passes of the same point of the ellipse. Its angular velocity varies with the distance from the center of rotation which forms one focus of the ellipse. However, the instantaneous angular velocity is a variable. The angular velocities have the relationship

$$\Omega\,(t) = \Omega_a + \omega(t)$$

where $\omega(t)$ is the time variation of the angular velocity. Notice that when the angular velocity is averaged over one period that $\omega_a(t) = 0$.

Ω_a, the average angular velocity, the normal direction to the plane of the orbit and
the period are all constant.

To find the total effect of several orbits on one body the vector angular velocities are added, so that

$$\Omega_o(t) = \Omega_{oa} + \omega_o(t).$$

Now the body has its own fossil constant angular velocity left over from its formation, Ω_f, so that its total angular velocity is

$$\Omega_T(t) = \Omega_f + \Omega_{oa} + \omega_o(t)\ .$$

The two constant values are combined:

$$\Omega_T(t) = \Omega_{Ta} + \omega_o(t).$$

Two examples from the solar system will be given. The sun is in orbit with the five outer planets, Jupiter, Saturn, Uranus, Neptune and Pluto. The orbital angular velocity of the sun

$$\Omega_{os}(t) = \Omega_j(t) + \Omega_s(t) + \Omega_u(t) + \Omega_n(t) + \Omega_p(t)$$

$$\Omega_{os}(t) = \Omega_{ja} + \Omega_{sa} + \Omega_{ua} + \Omega_{na} + \Omega_{pa} + \omega_j(t) + \omega_s(t) + \omega_u(t) + \omega_n(t) + \omega_p(t) = \Omega_{osa} + \omega_{os}(t).$$

If Ω_{sf} is the fossil value for the sun and $\Omega_{ss}(t)$ is the total angular velocity

$$\Omega_{ss}(t) = \Omega_{sf} + \Omega_{os}(t).$$

Ω_{ssa} is the fossil value plus the average of the angular velocities of the orbits. This is the angular velocity that is measured and used for the sun.

$$\Omega_{ss}\,(t) = \Omega_{ssa} + \omega_j(t) + \omega_s(t) + \omega_u(t) + \omega_n\,(t) + \omega_p(t) = \Omega_{ssa} + \omega_{ss}(t)\ .$$

The outer planets and the sun are in orbit about the center of gravity of the solar system and the four inner planets are in orbit about the center of the sun. The inner planets are not massive enough to cause significant motion of the sun so they do not have to be taken into account in calculating the orbit of the sun but the planets share the orbit of the sun. In other words $\Omega_{ss}(t)$ must be taken into account when calculating the angular velocity of the earth.

The effect of the orbits of the earth about the sun and the moon about the earth are added to the effect of the orbit of the sun on the earth to get the formula:

$$\Omega_{eo}(t) = \Omega_{os}\,(t) + \Omega_{mo}\,(t) + \Omega_{es}(t)$$

$\Omega_s(t)$ is the angular velocity of the orbit of the Earth about the sun. $\Omega_{mo}(t)$ is the angular velocity of the moon about the earth which is the same as the angular velocity of the Earth about the center of gravity of the earth-moon system which is a significant motion.

$$\Omega_{eo}(t) = \Omega_{osa} + \Omega_{moa} + \Omega_{esa} + \omega_{ss}(t) + \omega_{mo}(t) + \omega_{es}(t)$$

Add the fossil value Ω_{fe} to this and get the value of the rotation of the earth which is

$$\Omega_{ee}(t) = \Omega_{eea} + \omega_{ee}(t)$$

$\Omega_{eea} = 2\pi$/day and it is the value of Ω that is accepted by scientists.

$$\omega_{ee}(t) = \omega_j(t) + \omega_s(t) + \omega_u(t) + \omega_n(t) + \omega_p(t) + \omega_{mo}(t) + \omega_{es}(t) + 2\pi/\text{day}$$

So the angular velocity of the earth has seven orbital terms. Those are due to Jupiter, Saturn, Uranus

Neptune, Pluto, the orbit of the earth about the sun and the orbit of the moon about the earth.

The Coriolis parameter $2\Omega_{eea} \sin \phi = f$ (where ϕ is the latitude) is the only term of the absolute vorticity that is used at the present time in equations of geophysics.. This paper shows that $2\Omega_{ee}(t)\sin \phi = f(t)$ should be used instead.

A portrayal of the coriolis parameter is shown in Figure 2a. Figure b shows the overlay of

$$f(t)\text{-}f=2\omega(t)\sin\phi$$

the time dependent value that will be added to it. This shows what the proposed change in Ω would result in .

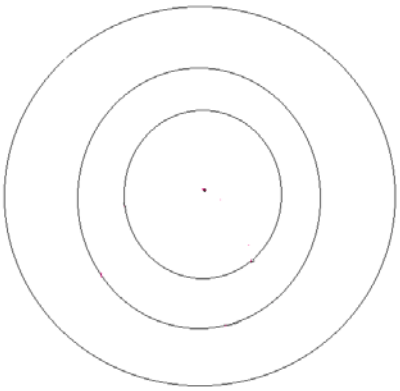

Figure 2a

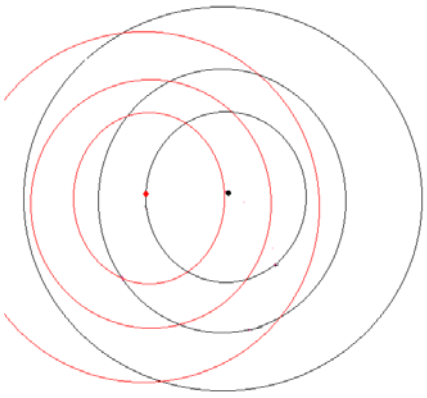

Figure 2b

Looking down on the pole the value f is 1f at the pole and steadily decreases to the equator. A difference of about 0.01f is added and its center is displaced from the pole and the center stays still in the solar system and the earth rotates under it.

The simplicity of the discussion evaporates when the problem of expressing the vertical component of the atmosphere's vorticity at a place on the earth but is a function of time and position and the vorticity of the flow is added to get the vorticity equation. This new vorticity equation for the atmosphere has terms involving the longitude and time that must be taken into account in calculating the forecast relative vorticity.

This equation could lead to many new discoveries in geophysics. Some topics where new discoveries are expected are solar-terrestrial relationships, extended range forecasting, seasonal outlooks, Madden-Julian oscillation, quasi-biennial oslation, ENSO events and other atmospheric phenomena. In addition topics in space weather, ionospheric circulation, oceanography, motion in the earth's core, planetary science and solar physics.

The authors have been inspired for twenty years by a paper written by Clyde Stacey, in an encyclopedia edited by Rhodes .W. Fairbridge (1967). Stacey showed that the response of the sun to Jupiter and Saturn led to an orbit about the center of gravity of the solar system and this orbit had the same period as the sunspot cycle. Stacey's idea was adopted and emphasized by Fairbridge and the details of the orbit given by Jose(1965). To get a program that would reproduce Jose's results, a program giving Kepplers laws by Myles Standish of JPL was modified.

There are plenty of indications that the orbit has something to do with events on the sun and earth. Starting with work of Jose (1965) in which he related sunspots to the torque of the orbit, the work of Landscheidt(1976) related the orbit to phenomena on the earth and the sun and the similar work of Freeman and Hasling(1985 –2003). Hopfner(1999) showed that the QBO and ENSO signals existed in the length of day records and that opens a question: Is the LOD signal a result of the phenomena or is the signal in the LOD caused by the orbit which caused the phenomena.

The behavior of bodies or solid bodies in orbital motion does not confirm this spaceship analogy of the instantaneous response to differences in angular momentum. However, a solid planet or other body because of its enormous mass has a tremendous amount of angular momentum in its rotation and the small torque involved in the time dependent terms cannot change the detectable in the time of the period of the orbit of a planet. The fluid envelope however does not have this great angular momentum and can respond the changes in angular velocity.

There are many experiments that would indicate the truth of this theory. Two of them are proposed, J. Qin and Huug van den Dool(1995) of CPC have a barotropic

model for the global atmosphere that they run in real time to make 15 day forecasts. After four or five days their model shows more skill than more sophisticated models. One experiment would be to the vorticity equation discussed above in their model and see if the skill increases. A second experiment would be to start with the normal annual barotropic flow and perturb it with the new vorticity equation and see if the resulting flow shows any signs of ENSO, QBO, Madden-Julian or other circulation patterns that existed in the time covered.

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