Sun tides: an unexplored astronomical approach to climate cycles and trends

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(Manuscript received July 7, 1967)

ABSTRACT

Numerical indices expressing the strength of postulated sun tides and dependent solar energy output were computed from the heliocentric positions and radius vectors of the major planets at 8 or 10 day intervals for the years 1855–1980 on the University of Oklahoma IBM 650; from which accordant Global Index and Northern Hemisphere Zonal Clear Sky Insolation Indices were derived. The resulting numerical series display very complex though orderly quasiperiodic variations. Cyclic recurrences appear in the index patterns at intervals of 118.5 days, the mean hemi-synodic period of Jupiter and Venus; 12 years, caused by the recurrent orientation and alignment of Jupiter, Venus, and Earth; and 59–60 and 83–84 years in which the outer planets and Mercury are also involved. The validity of the energy relation assumptions made in computing the index models is supported by: Adem, J., (1964), A positive $r = 0.88968$ SE 0.07698 correlation during the last solar cycle, 1954–1965, between the December–January Zonal Clear Sky Insolation Index for latitude 45° N and December–January normalized nucleon intensity monitored at 11,000 feet on Mt. Washington by Lockwood & Kaplan; Birot, Pierre, (1965) June and July precipitation 1900–1960 at White River, Ontario, Bismarck, North Dakota, and Edmonton, Canada, are also positively correlated with the May–June–July 7 planet index for 45° N Latitude.

Weather forecasting by numerical methods has progressed rapidly in recent years, but the development of models for seasonal and longer range prediction has not been realized, Adem, J., (1964), Eliassen, Arnt, Nemias, Jerome, (1966). M. Milankovitch, (1920) developed an Astronomic approach but neglected solar energy output variation Milankovitch, M. Sunspot cycles have received much attention, and correlations with climate for relatively short time intervals have been found; but the sunspot cycles undergo change in phase, duration, and amplitude and are not rigorously predictable.

Recent advances in astrophysics and geophysics have revealed that variations of the so called "solar constant" are involved in meteorological processes for which terms must be included in weather and climate forecasting models. Since the sun is a variable star located at the gravitational center of the Solar System and the atmosphere is a single indivisible system, it is not unreasonable to assume that world climate variations may be inherent in the mechanical and thermodynamic nature of the Solar System and accordingly are ordered and not random. Instead it is postulated that the planets, according to their heliocentric positions and degree of alignment, cause sun tides to which the generation and escape radiant energy from the sun is related. The physical laws of Celestial Mechanics, as formulated by Kepler and Newton, are relevant and provide a basis for rigorous investigation.

Three series of indices expressing sequential stages in the postulated energy chain reactions are recognized: Adem, J., (1964) The Sun Tide Solar Radiation Index (STR), Birot, Pierre, (1965) The Global Insolation Index (GI), and Bollinger, C. J., The Northern Hemisphere Latitude-zone Clear Sky Insolation Index (LZI).

Sun tide computation

The existence of sun tides is postulated by analogy with ocean and atmospheric tides where it has been found that the tide raising forces of individual planets vary directly with mass and inversely with the cube of distance or as (m/r^3). The combined tidal influence of two or more planets on the sun, if heliographic declinations are neglected, can be computed from any heliocentric configuration:

$$\mathrm{ST} = \frac{m_1}{r_1^3}\mathrm{P}_1 + \frac{m_2}{r_2^3}\mathrm{P}_2 \cos\,(l_{p_1} - l_{p_2}) \quad \text{etc.},$$

where m = mass, r = radius vector, and l = heliocentric longitude. In this numerical system the tide force of earth at mean distance (one astronomical unit) = 1.0.

Seven planet (Neptune neglected) sun tide indices were computed at 8- or 10-day intervals on the University IBM 650 from data given in the annual volumes of the American Ephemeris for the years 1855–1959 and the British Ephemeris for 1960–1980; along with a separate series for the Jupiter-Venus-Earth tidal component (Bollinger, 1960, 1961 3a 3b). All other computations were made on a Monroematic desk calculator. The precise relation between the resultant sun tide index ST) and solar energy output (STR) cannot be determined from data now available. However, phase relations between ST index cycles and observed climatic element variations indicate positive

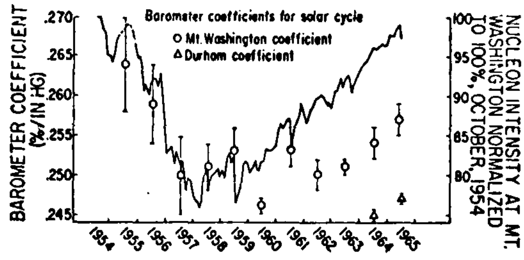

Fig. 1 a.

correlation, which is also supported by a positive r = 0.8698 S.E. 0.07698 correlation (Fig. 1) during the last solar cycle between December–January normalized nucleon intensity monitored at 11,000 ft. on Mt. Washington, as reported by Lockwood & Kaplan (1967) and the 1954–1965 December–January LZI index for 45° N Latitude (Bollinger (1966), Lockwood, J. A. & Kaplan, J. (1967), Bollinger, C. J. (1963)). Accordingly it appears that sun tide indices (ST) may be used as radiation (STR) indices in first-approximation exploratory computations (Fig. 1 *a* and *b*).

The Global Insolation Index is derived from

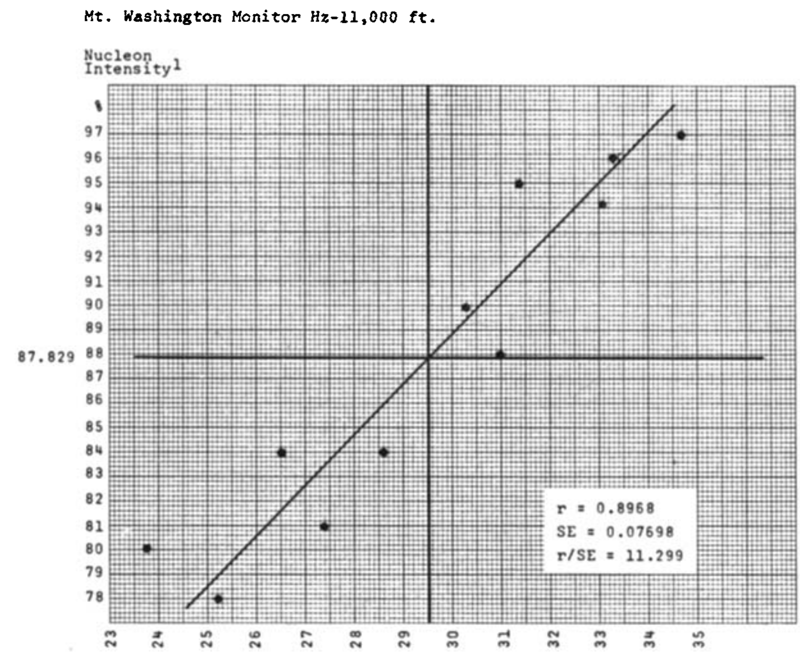

Fig. 1 *b*.

Fig. 1. (*a*) Variation of normalized December–January Nuclean intensity at 11,000 ft on Mt. Washington in the 1954–1965 Solar Cycle. After Lockwood and Kaplan. (*b*) variation of LZI 45° N. Latitude Clear Sky Insolation Index Expressed as percentages of 20.4 kg-cal cm², the normal clear sky insolation on the equator in the equinoxal months March and September (Budyko).

		Phase	Component JVE-GI	Seven planets	Phase	Global Index GII
1928	Jan. 24	+	5.05785	Feb. 1	+	6.7128025
1934	Jan. 16	−	2.210848	Jan. 16	−	2.4279719
1940	Jan. 25	+	5.0159519	Feb. 18	+	6.498477
1946	Jan. 17	−	2.1795239	Feb. 17	−	2.6296148

the STR index by multiplying by $1/r^2$ earth: GI = STR × $1/r^2$ earth. The Global Index represents the postulated theoretical solar radiation striking the earth hemisphere facing the sun.

The Latitude-zone Clear Sky Insolation Index (LZI) varies with latitude and season and provides data hopefully pertinent to heat balance and seasonal weather investigations. The LZI index represents monthly clear-sky, direct and diffuse, insolation $(Q+q)$ in a given latitude in a given month expressed as a percentage of 20.4 kg-cal cm² month, the normal clear sky $Q+q$ received at the equator in the equinoctial months March or September (Budyko, 1956).

Since in these sun-tide related computations rotation of the sun and declinations of the planets relative to the plane of the sun's equator have been neglected, the derived indices are only first approximations of true index values. However, the index tables provide frames of reference and numerical values by which their relevancy to meteorological and climatological variables can be tested.

Indices cycles

The sun-tide-energy index tables reveal very complex quasiperiodic large amplitude variations. The orderliness and magnitude of the component Jupiter–Venus–Earth 12-year cycle, and the seven-planet index values at extremes of the strong solar index cycle in which the North American "Dust Bowl" developed, are presented for illustration. The indices and phase dates are exact except for a possible error of 0–4 days in timing.

At mean distances the tide forces of Jupiter and Venus are respectively 2.2330804 and 2.1333 or 34.57% and 33.03% of the eight major planet total. Bolinger, C. J. (1960) Since Venus' orbit is approximately circular its tide force is constant. Jupiter's orbit has high eccentricity with tide force when in perhelion (heliocentric long 13.58°) 2.586123 and when in aphelion, 5.93111 years earlier or later, it is only 1.9377574.

The mean hemisynodic period of Jupiter and Venus is 0.3244309388 tropical year or 118.498 days, a little less than four months. Since three of their alignments (conjunction or opposition) are completed in 355.4952927 days, or 9¾ days less than a tropical year, corresponding phases recur about 10 days earlier in successive years. In 37 JV hemisynods, or 12.003944756 years, Jupiter, Venus, and Earth complete revolutions (siderial)

Earth	12.0034659
Venus	19.5119467
Jupiter	1.011063

and have recurrent reorientation and realignment. At 59–60 year and 83–84 year intervals the JVE 12-year recurrence is strengthened by in phase relation to Saturn, Uranus and Mercury.

Many illustrations of correlation between index cycles and climatic variation could be given but detailed explanation will involve very complex oceanographic and meteorologic processes as well as heat balance and the general and monsoonal circulations of the atmosphere including solar wind and ionosphere influences. As illustrations of the relevancy of Sun Tide Index Cycles to Climatic variation the following are submitted.

1. The average March precipitation for the state of Kentucky was positively correlated with the Global Index in 69% of the years in the period 1889–1954. And, in the same period October precipitation was positively correlated with the October global index in only 37% of the years. Bollinger, C. J., (1963).
2. Variation of June–July precipitation in the years 1900–1960 at the continental stations White River, Bismarck, and Edmonton are shown graphically in Fig. 2. Along with averages of the May–July Latitude-zone Clear Sky Insolation Index for 45° N latitude. The 12-year index cycle is evident with minima in 1909, 1921, 1933, 1945, and 1956–7. All three stations had below normal precipitation in 1909, Bismarck in 1921, White River in 1933, and White River, Bismarck

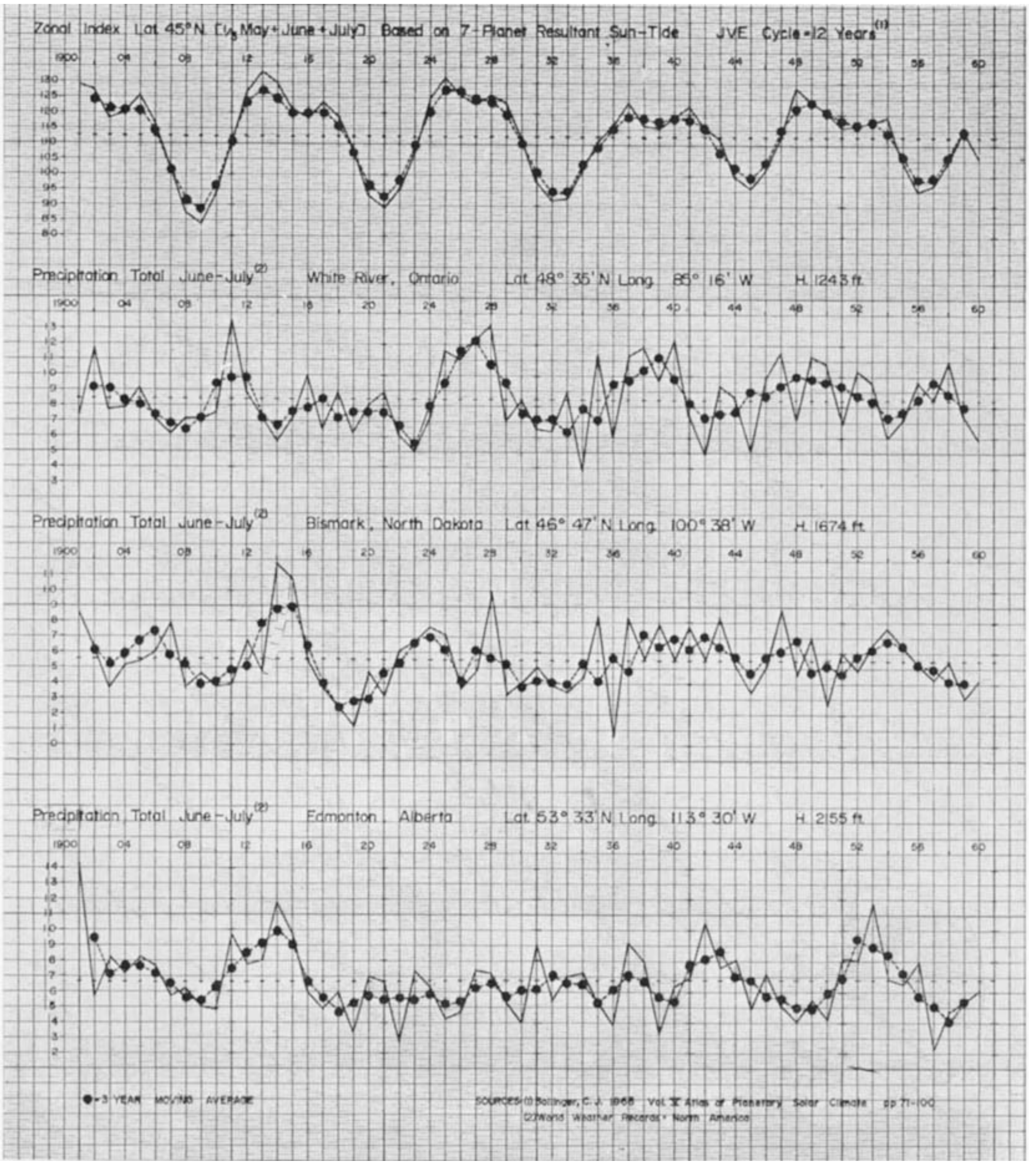

Fig. 2. Variation of June–July precipitation at white River, Ontario; Bismarck, North Dakota and Edmonton, Alberta 1900–1960 as related to the seven planet sun-tide LZI Clear Sky insolation index for Lat. 45° North.

and Edmonton in 1945. Index maxima occurred in 1901, 1913, 1925, 1937, 1941, 1948, and 1959. Bismarck and Edmonton were very wet in 1901, Bismarck and Edmonton in 1913, White River and Edmonton in 1925. All three stations were wet in 1937, and White River and Bismarck in 1949. The index cycle exhibits a secular decrease in amplitude and also phase changes. May indices were included to allow for lag effects. If the May data were excluded the index crests and troughs would be shifted slightly to the right.

It is concluded:

1. That the orderliness and mechanical stability of the Solar System is reflected in terrestrial weather and climate.
2. That the sun tide-solar energy hypothesis provides a method of exploring the overlapping twilight zone between astrophysics and geophysics.
3. That through the development of improved models it may be possible to evolve a numerical system of seasonal and longer range climatic forecasting.

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ПРИЛИВЫ НА СОЛНЦЕ: НЕИССЛЕДОВАННЫЙ АСТРОНОМИЧЕСКИЙ ПОДХОД К КЛИМАТИЧЕСКИМ ЦИКЛАМ И ТЕНДЕНЦИЯМ

Из гелиоцентрических положений и радиусов-векторов основных планет для 8- или 10-дневных интервалов за период 1855–1980 гг. на машине ВМ650 Университета Оклахомы были вычислены числовые индексы интенсивности постулированных солнечных приливов и соответствующего выхода солнечной энергии, из которых были получены глобальный индекс и зональные индексы инсоляции при ясном небе для северного полушария. Полученные числовые ряды проявляют очень сложные, хотя и упорядочения квазипериодические вариации. Циклические повторяемости проявляются в ходе индекса на интервалах 118,5 дней — среднем полусинодическом периоде Юпитера и Венеры, на интервалах 12 лет, что вызывается повторяющейся ориентацией и расположением на одной линии Юпитера, Венеры и Земли, и на интервалах 59–60 и 83–84 года, в которых играют роль также и внешние планеты и Меркурий.

Правильность предположений об энергетических соотношениях, сделанных при вычислении моделей индексов, подтверждается: 1) положительной корреляцией ($r = 0{,}88968$ со стандартной ошибкой 0,07698), вычисленной для последнего солнечного цикла 1954–55 гг. между зональным индексом инсоляции при ясном небе в декабре–январе для 45° с. ш. и нормализованный интенсивностью радиоактивности для тех же месяцев, измерявшейся на г. Вашингтон на высоте 3,7 км Локвудом и Капланом; 2) тем фактом, что осадки за июнь–июль 1900–1960 гг. в Уайт Ривер, Онтарио, Бисмарке (Северная Дакота) и Эдмонтоне (Канада) также имеют положительную корреляцию с семипланетным индексом за май–июль для 45° с. ш.