Mediation of the Sun-Climate Connection by a Hypothesized Earth Ring System

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Introduction

O'Keefe (1980) first suggested that the Earth might have a faint, variable ring system that could be climate-important: As ring density varied over time, the ring shadow's cooling effect would be intensified or weakened.

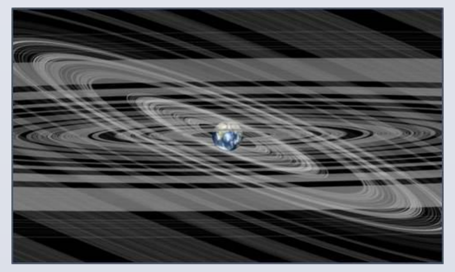
O'Keefe pointed out that climate change driven by a ring system would have statistical peculiarities. For example, an equatorial ring would shadow only the winter; thus its fading would warm only winter.

The aim of this presentation is to extend the list of climate effects/trends that would distinguish climate/trends driven by an Earth ring system.

Four Elements of Earth Ring Hypothesis

I. ***The Earth has a ring in its equatorial plane, densest from 1.4 R_{earth}, to 3 R_{earth}. For simplicity it is called hereafter the "Main" ring (like Saturn's).***

II. ***The Earth has a ring oriented in the plane of the Moon's orbit. Its outer ringlets orbit the Earth-Moon barycenter.*** Saturn has such a ring called the Phoebe ring. By analogy, let us call this one the Moon Ring, even though it's a bit confusing because "Moon Ring" sounds as though it orbits the Moon, which it does not. It approximately orbits Earth; the barycenter is in the Earth, after all. This ring's density structure is unknown, and could could include ringlets out to the Moon and beyond.



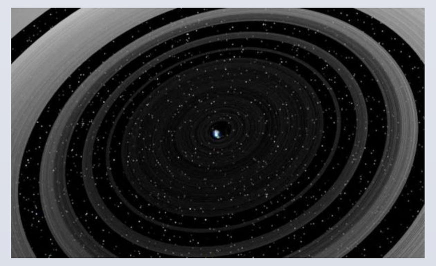


Figure 1(a). A sketch of the two rings in the hypothesized system - one in the plane of the equator, the other in the plane of the Moon's orbit. 1(b) The scale of the ring in the plane of the Moon's orbit.

III. ***Dust is constantly generated in both rings*** by the YORP effect, by which sunlight makes rocks spin and burst, grinding them continually to dust. Collisions may possibly also matter.

IV. ***The rings are unstable, and the dust, which contributes strongly to optical density, is sensitive even to radiation pressure and solar wind.*** **Ring dust that has been unsettled may fly out to a dust halo, exit the system, re-settle to the rings or fall to Earth.**

Figure 2. Ring matter falling to Earth must be frequent, thus should be some phenomena we know of. What about those gigantic dust storms, oddly seasonal, amazingly tall, surprisingly cold, very coherent, sometimes powerfully windblown and sometimes not very windy at all, that occur in late spring? If they are dust falling inward from LEO many pecularities would immediately make sense. Maybe dust storms look like local material because they are its source, not the other way around. http://www.environmentalgraffiti.com/featured/sandstorms-on-earth/)

Climate/trends from an equatorial ring

Distinction between trends of summer and winter

O'Keefe's 1980 note remarked that the shadow of a "Main Ring" in the equatorial plane would always fall on the winter hemisphere, deepening the cold of winter; when the shadow lightened, winter would warm, but summer would not be directly affected. These are the statistics of the Eocene boundary. It is an important point but hard to visualize. The video below provides a visualization that may be helpful.

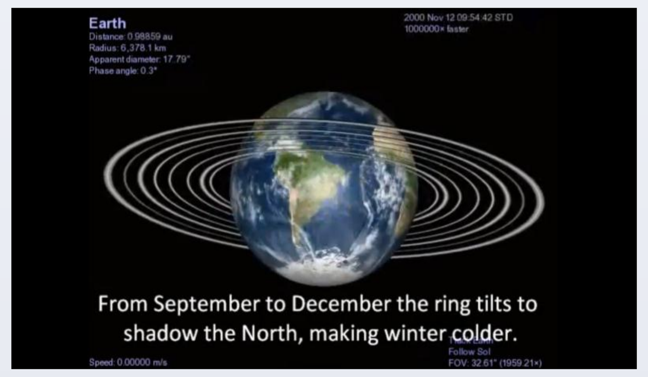


Figure 3(a): The planet's equatorial plane is the likeliest location for a planetary ring. In that plane, a ring would always shade the hemisphere in winter. If such a ring faded, the warming would therefore also be in winter. To help with that visualization, see as well the video linked by the barcode above, found at http://www.youtube.com/watch?v=YwO93KeCrml

Winter shading depends on latitude

The rings of Jupiter, Saturn, Uranus and Neptune have matter mainly though not exclusively concentrated between 1.4 - 3 R_{planet}.

For Earth, that would be a ring concentrated 9K to 20K from the center of the Earth, the area between the dotted lines in Fig. 4.

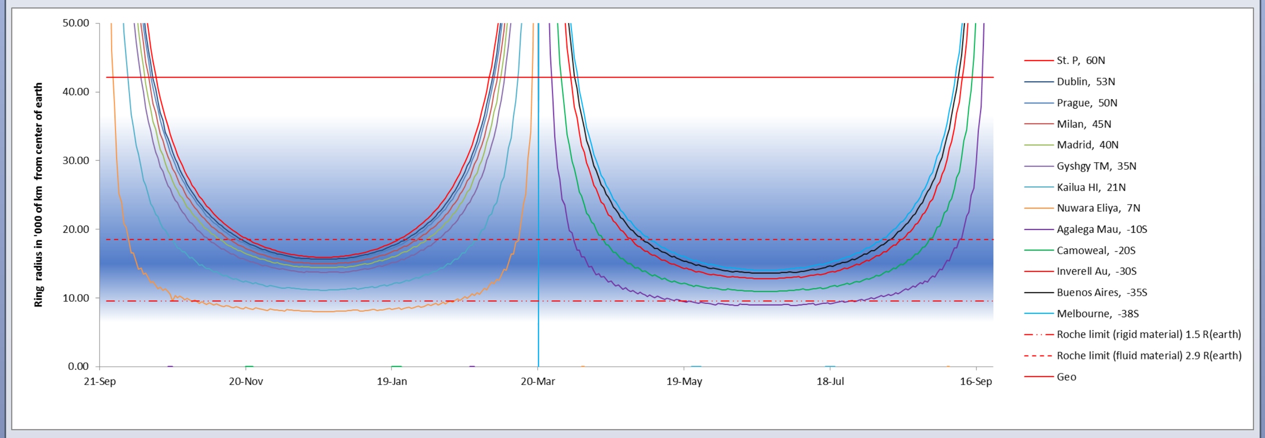


Figure 4 depicts the yeardays in which an equatorial ring would shade an area on Earth for selected latitudes. Curves represent latitudes; when a curve has dipped into shadow, the noontime sun would be shaded by a ringlet of the radius on the Y axis. See note 1.

- ***The equator*** is shaded heavily for a day or two near the equinox.
- ***High latitudes*** are shaded from October until early March.
- ***The tropics*** are shaded in early autumn and late spring, but have a "keyhole" of warming centered on the solstice, as O'Keefe pointed out.

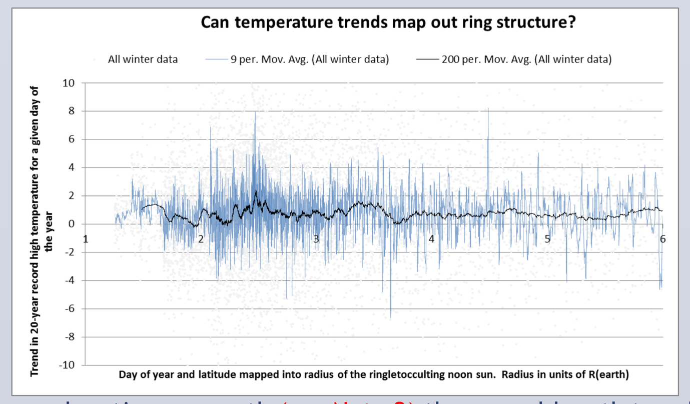


Figure 5. For several score locations on earth (see Note 2) the record-length trend of 20-year record high T_{max} was obtained for each yearday. All these temperature trends were then mapped into the respective equatorial ring radius that would shadowing the respective noontimes at the respective latitudes, using the relationship given in Note 1. All are plotted above, and a running mean taken. Peaks in that running mean are evident. These peaks are presented as an admittedly crude effort to map ring density structure, on the hypothesis that rising temperature is caused by ring density loss, that density loss at a given radius is proportional to density there, and thus that larger temperature trends highlight higher densities. The ring structure that results is typical for the Solar System, densest at radii less than 3 R_{earth}.

Climate/trends from a "Moon" ring

Solar eclipses bring temperature change and flooding

The shadow of a "Moon Ring" would oscillate north/south and back again every "eclipse year," bringing a relative chill with it that would cycle through the seasons. Because this ring would be at a tilt with respect to the equator, its effects would not always be distinctly Northern Hemisphere/Southern Hemisphere; rather, often it would affect the tropics both North and South at the same time.

A solar eclipse at the moon's ascending node should bring chill to the northern hemisphere; a solar eclipse at the moon's descending node, chill to the Southern hemisphere. Either kind of solar eclipse season should bring flooding to the tropics.

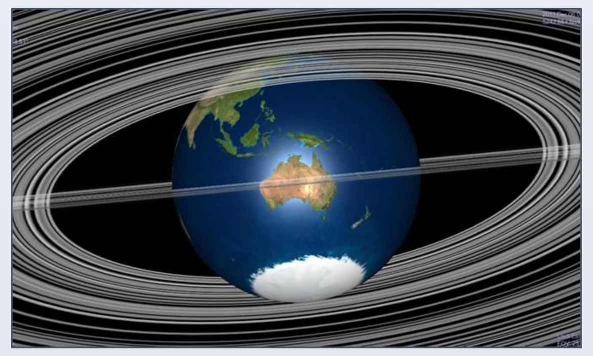


Figure 6. A visualized Moon Ring flipping south to north during the solar eclipse period of December 2011, bringing chill to Australia. The QR code links to a video visualization of this event. The video is at: http://www.youtube.com/watch?v=SjnEYI1TgCM

Precession of lunar nodes would cause an ENSO-like climate cycle every 18.3 years

Chill from the shade of a Moon Ring would cycle through the seasons, deepening winter, then cooling summer, in an 18.3-year cycle caused by the precession of the nodes of the lunar orbit.

The two QR codes link to visualization of the difference between a year when the chill of the Moon Ring occurred in winter (1997) http://www.youtube.com/watch?v=0dX05esUIsU versus in summer (2007) http://www.youtube.com/watch?v=OmzyyTBcRFQ

Ring shadows would *also and as a consequence* bring a sequence of high pressure ridges that would in turn drive drought or rainfall.

The result: Precession of the lunar nodes would cause a quasi-ENSO, an alternation between

several years of deep winter and hot still summer (like El Nino),
several years of moderate winter and cool, flood-prone summer (like La Nina).

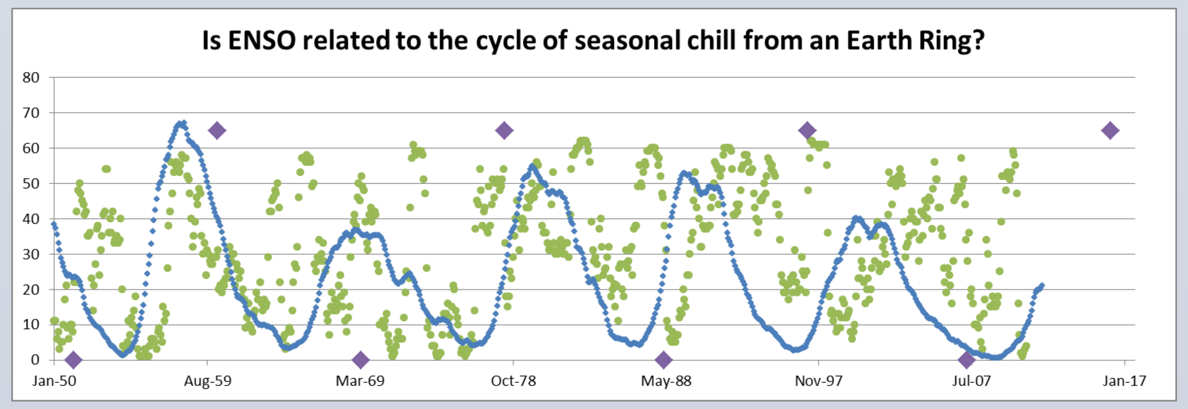


Figure 7. As quasi-ENSO (18.3 years) and the sunspot cycle (usually 11 years) swing in and out of phase with each other, do they affect ENSO? Sunspots should fade quasi-ENSO. ***Green dots:*** an ENSO index month by month from 1950 (green). ***Purple diamonds*** represent turning points of the precession of lunar nodes – that is, quasi-ENSO). ***Blue dots*** are smoothed sunpot number.

30-60 day climate wave

The Moon Ring would orbit the Earth-Moon barycenter, not the Earth's center, so its shadow would swing back and forth over the earth's surface at a near-monthly period bringing a cycle of cool weather and rain that would seem to circulate around the Earth –"quasi-MJO." This circulation might not be recognized as a monthly regular cycle: because the shadow would be moving north-south as well as around, by a reverse of the "barber-pole" illusion the circulation could appear to have a varying period instead of north-south motion.

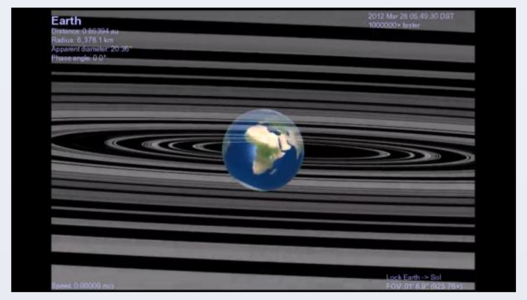


Figure 8. The Moon Ring is not centered on the Earth, but on the Earth-Moon barycenter. Therefore its shadow would move on earth as the barycenter rotates; it would appear to circulate. See video linked at the QR code, also at http://www.youtube.com/watch?v=eUxM3OPZxB8

How to test it: Seasonal forecasts for 2012-2013

- Hypothesizing that the Main Ring fading has been a cause of 20th century warming, and that it is still fading, we expect a warm summer and autumn in the northern hemisphere until November 2012.
- The Moon Ring would be expected to transit from south to north in the November 2012 eclipse season; accordingly, the northern hemisphere climate will then become chilly and stormy until the end of April 2013.
- Because the Moon Ring is concentrated at large radii, the chilly and stormy effects will be largest (for the mid-latitudes, anyway) in mid-December 2012 to mid-January 2012, and again in April 2013.
- Thus a frosty, stormy April 2013 in northern hemisphere mid-latitudes.
- Hypothesizing a dust halo, we decline to comment on weather in May 2013 at all! The dust halo is a reservoir of all kinds of variability.
- From June 2013 forward, a warm summer, not the worst drought ever, but dry.
- Then in late October 2013, rain and chill return to the Northern Hemisphere.
- As for the MJO, it should be particularly active in October-November of 2012 and again in April and May of 2013. Quasi-MJO ought not be apparent just at the solstices, because when the equator and ecliptic are parallel, the Moon Ring's shadow even when present would not appear to circulate.

REFERENCES

O'Keefe, John A. (1980), "The terminal Eocene event: formation of a ring system around the Earth?" *Nature* 285, 309 - 311 (29 May 1980); doi:10.1038/285309a0, and later papers.

For the YORP effect (Yarkovsky, O'Keefe, Radzievskii, and Paddack), see Rubincam, D. P., Radiative spin-up and spin-down of small asteroids, Icarus 148, 2-11. (2000)

Celestia, astronomical visualization software, the brainchild of C. Laurel. See celestia.sourceforge.net

NOAA's re-analysis and its weather data archive provided means of testing this hypothesis on historical data.

The Solar Influences Data Center is source for sunspot number used in Figure 7. http://sidc.oma.be

K. Wolter and M.S. Timlin are source for MEI index. See e.g., http://www.esrl.noaa.gov/psd/enso/mei/

Note 1. Radius=R_{earth}*cos(solar altitude)/sin(solar declination). Solar declination is a function of yearday; solar altitude a function of solar declination and of latitude. Solar declinations are from MICA.

Note 2. Stations used in Figure 5: Northern Hemisphere: These stations were selected for geographic variety from all stations that had maintained relatively long, relatively continuous records of daily maximum temperature. Nuwara Eliya (Sri Lanka), Isabella (PR), Kailua (US), Izana (Spain), Gyshgy (Turkmenistan), Lisbon (Portugal), Albacete (Spain), Madrid (Spain), Tashkent (Uzbekistan), Tbilisi (Georgia), Sochi (Russia), Toronto (Canada), Huron SD (USA), Bologna (Italy), Milan (Italy), Zagreb (Croatia), Pecs (Hungry), Geneva (Switzerland), Chateaux Roux (France), Stuttgart (Germany), Poronajsk (Russia), Frankfurt (Germany), Prague (Czech Republic), Soesterberg (Netherlands), Irkutsk (Russia), Berlin (Germany), Barkerville CA (USA), Kustinai (Kazakhstan), Dublin (Ireland), Mogoca (Russia), Ufa (Russia), Petropavlovsk (Kazakhstan), Nordby (Denmark), Tranebjerg (Denmark), Nizhny Novgorod (Russia), Vaexjoe (Sweden), Stornoway Airport (Great Britain), St. Petersburg (Russia), Archangelsk (Russia), Sodankylam (Finland), Ilulissat (Greenland). Southern Hemisphere: Again, stations were selected for having maintained relatively long, relatively continuous records of daily maximum temperature, and again this was aimed to be as representative as possible of the Southern Hemisphere's stations, though of course an equivalently representative station set was impossible. *In Australia:* Gunnedah Pool, Sydney, Deniliquin, Cape Otway, Burketown, Melbourne, Inverell, Goondiwindi, Rockhampton, Gayndah, Boulia, Camoweal, Burdekin, Georgetown, Darwin, *and also* Buenos Aires (Argentina) , East London (South Africa), Paysandu (Uruguay), Agalega (Mauritius), Estanzuela (Uruguay), Plaisance (Mauritius), La Boulaye (Argentina).

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