Where the plane of the lunar orbit meets the surface of the Earth

21st Conference on Space Weather – Abstract 427317

American Meteorological Society Annual Meeting 2024

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More and more rings … but never at roundest planets….

Jupiter	**Saturn**	**Uranus**	**Neptune**	**Haumea**	**Chariklo**	**Quaoar**
Gas giant 1979 – Voyager	Gas giant 1610 – Galileo	Gas giant 1977 -	Gas giant 1989 – Voyager 2	Minor planet - 2017	Centaur 2013 -	Dwarf planet - 2023
In this case oblateness defined as $\frac{R(equatorial) - R(polar)}{R(equatorial)}$						
0.065	0.108	0.03	0.02	A triaxial ellipsoid	About 0.3	0.12
But not at Mercury	**Not at Venus**	**Not at Earth**	**Not at Mars**	Maybe just a detection problem? It is the oblateness of a planet that flattens the equatorial rings…		
0.0	0.0	0.0034	0.005			

Source: Royal Museums Greenwich. https://www.rmg.co.uk/stories/topics/solar-system-data

Maybe just a detection problem? (O'Keefe 1991)

Maxwell (1859) noted (per Laplace) the oblateness of a planet flattens the equatorial rings. O'Keefe reminds us that Earth is relatively round.

Simplified case: Gravitational potential outside a uniform spheroid is approximately

$$\Phi \simeq -\frac{GM}{r} + \frac{kG}{2r^3}(3\cos^2\theta - 1),$$

(where theta is polar angle and k is a measure of oblateness). *(ProfRob 2020, see refs).*

In general: Gravity due to an oblate spheroid has a non-central component. *(Hofmeister et al., 2018)*

It is this component of gravity that flattens equatorial rings (Maxwell). Less-flattened, at lower contrast Earth's rings could be less conspicuous. (O'Keefe)

George Jones (1856) suggested the zodiacal light is due to a ring near the ecliptic plane.

Fig 1. Are we seeing our own ring side-on? The zodiacal light (ZL)
https://commons.wikimedia.org/wiki/File:Zodiacal_Light_Seen_from_Paranal.jpg

- Jones saw changes in appearance of ZL as the ship moved in latitude. He argued this suggests the dust is nearby.
- Jones saw a node in the zodiacal light, where it crossed the ecliptic. This suggests a ring near but not on ecliptic.
- Jones observed a “Moon zodiacal light”. This would be explicable for dust in circumterrestrial orbit but how so for dust in circumsolar orbit?

John O’Keefe suggested that tektite anomalies imply a ring in the equatorial plane (Refs).

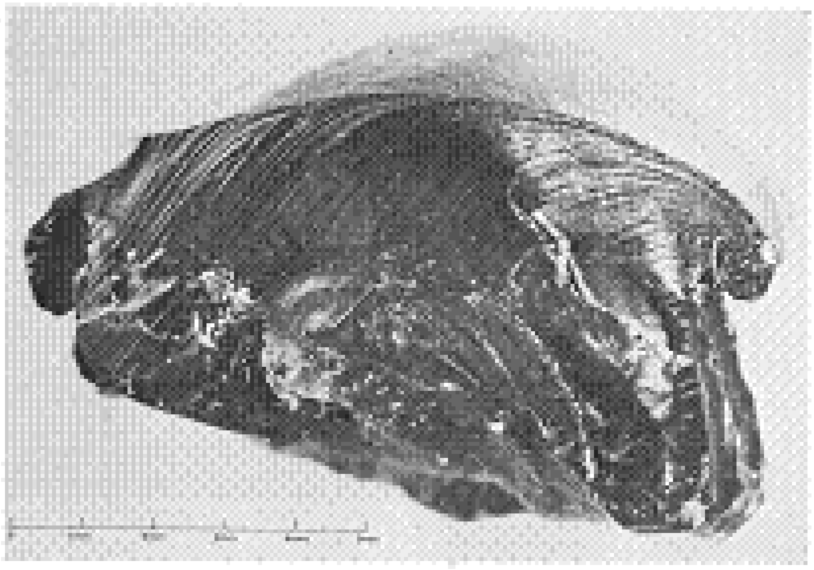


Fig 2. Javanite tektite. Plate 10 from Tektites and Their Origin (O’ Keefe 1976)

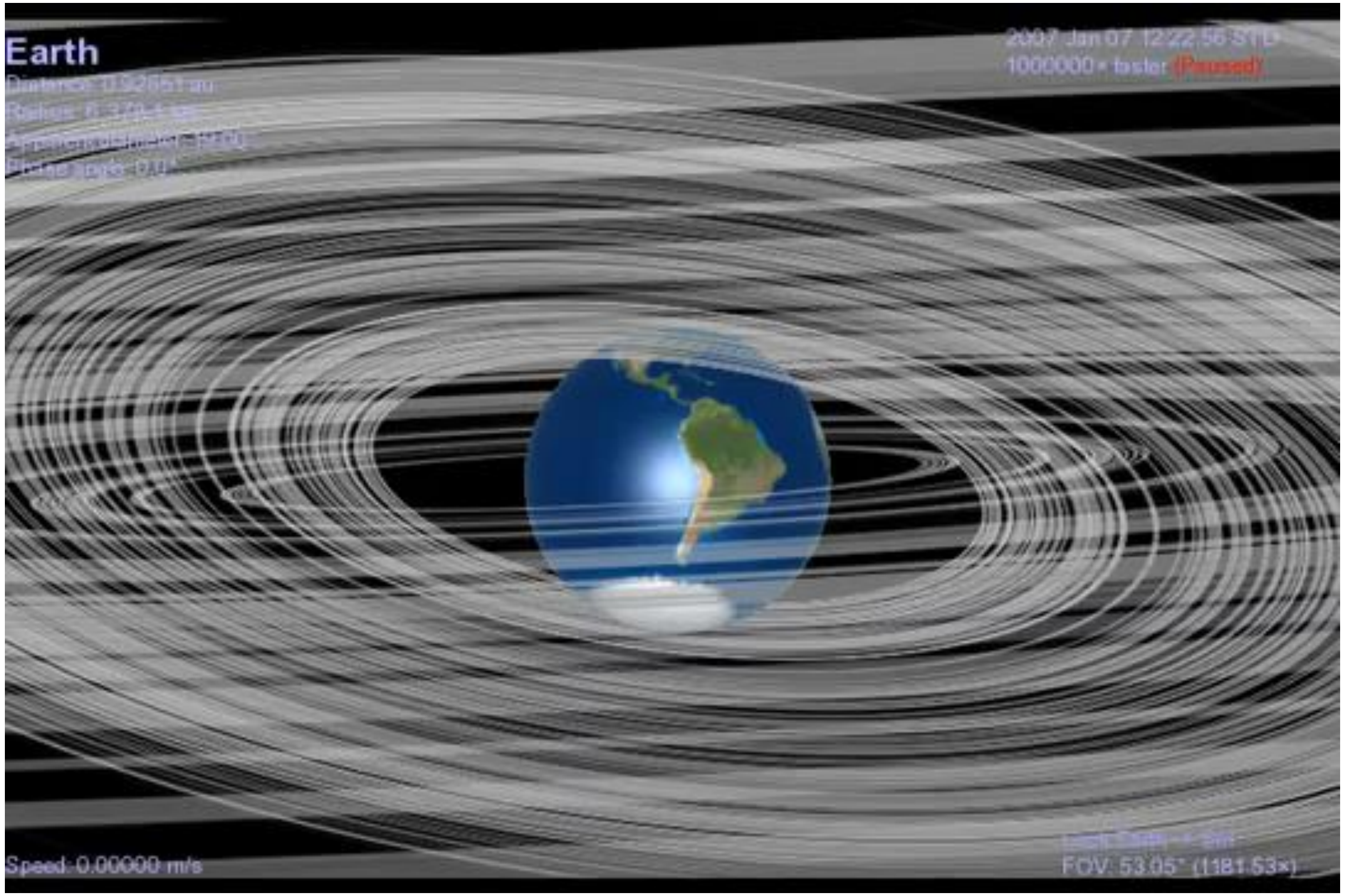
- Tektites have the form of lava with the composition of desert sand (see citations in O’Keefe 1976)
- They are too dry and fine to be made by any process, including any volcano, on Earth, but … the Moon might work…. (O’Keefe)
- Tektite dates are discrete… (see O’Keefe book for refs)
    - Then, if tektites are extraterrestrial, more matter not intercepted at first pass must have been deposited to the Earth-Moon neighborhood (a point made by Harold Urey);
    - That larger mass would have formed a cloud of rocks / dust in space in the Earth-Moon neighborhood (also Urey);
    - Such a cloud would be organized into an equatorial ring by the non-central component of the gravitational field of Earth, an oblate spheroid (O’Keefe).

The Jones and O’Keefe proposals comprise the two ring orientations known in the Solar System. Hypothesize Earth has both.

Jones: Ring “near the ecliptic” - Take it as ring in the plane of the lunar orbit	**O’Keefe: Equatorial ring**
Objection in its time: No reason for dust to gather around Earth near the ecliptic plane. No solar system analogues. (Note, I ***infer*** this was the problem. Maxwell published about this time, explaining why equatorial plane is favored.)	***Objection in its time*:** Requires recent lunar geological activity.
***Solution*:** Consider this as a ring in the plane of the lunar orbit. Then the Phoebe ring of Saturn (Verbiscer et al., 2009) is analogue, provided we accept Moon is dust source	***Solution:*** The Dead Moon is no longer a consensus. E.g., Stopar et al., 2017.
Its cause: An accretion disk mediating mass exchange Moon to Earth	***Its cause:*** It is a subsidiary structure of the other ring - dust collapses to equatorial plane per Maxwell... slowly bc Earth not very oblate
Visible as: The zodiacal light	***Visible as:*** At a given location, a dim static light below the celestial equator, and the light disappears around midnight then returns. Could be taken for urban light pollution.
Made of: Desert sand - Very little unusual dust is found in the cosmic dust collection program. On the other hand desert sand is at times found in the upper atmosphere. If that dust may be falling inward, not necessarily blown upward, then there is a candidate for ring material.	

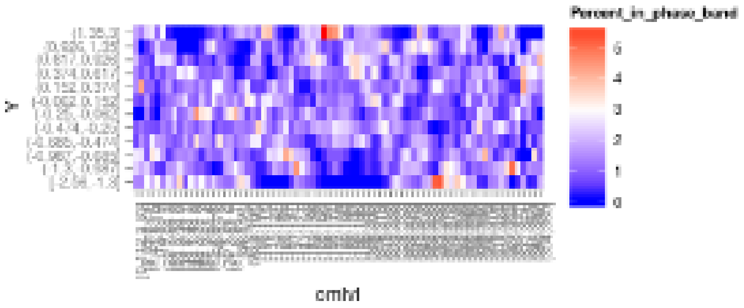
Video: Visualization of a two-ring system
(Note Earth appears to rotate the wrong way – that's just an artifact of video sampling)

Fig 3. Visualization of Earth with an equatorial ring and a ring in the plane of the lunar orbit that orbits Earth, and a ring in the plane of the lunar orbit orbiting the EMB, each with an imaginary radial structure. It was made in Celestia. **See "Refs" for the URL for video URL for a web page explaining use of Celestia.**



VIDEO URL: https://youtu.be/OmzyyTBcRFQ

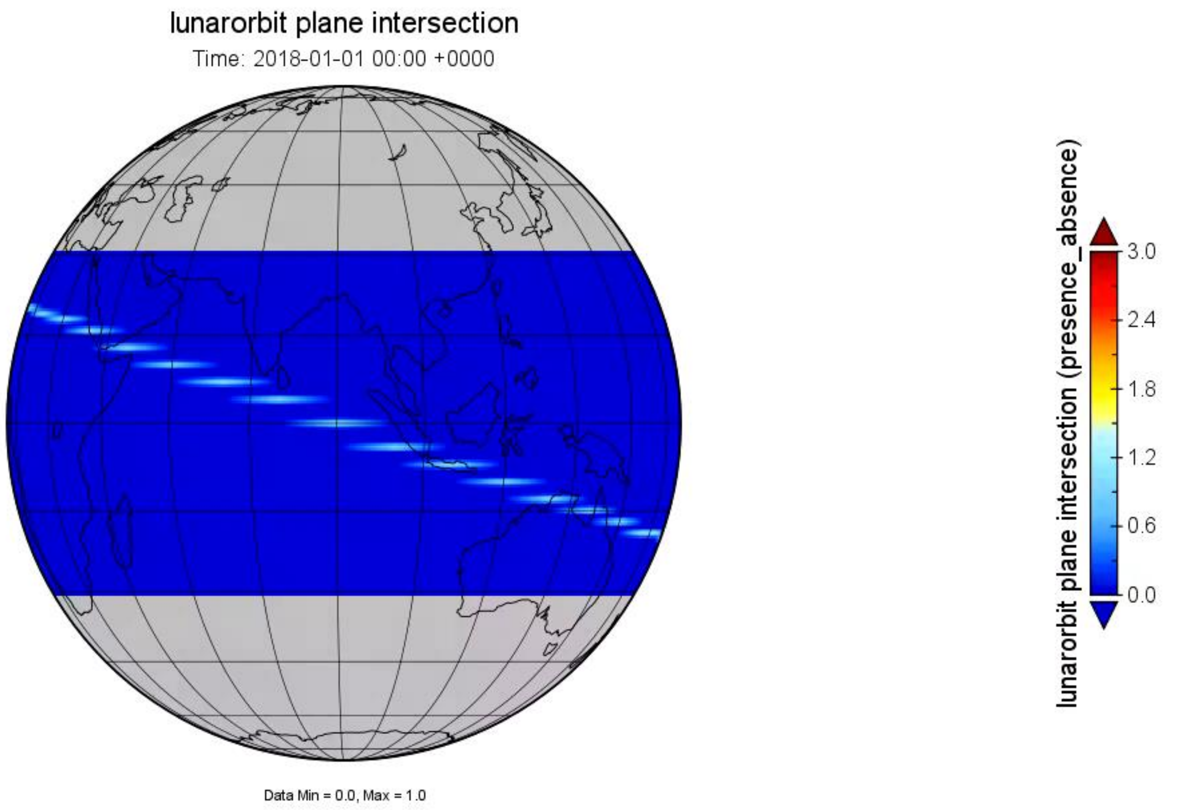
Some weather effects to expect from rings in these orientations

Ring "near the ecliptic" – taken as in the plane of the lunar orbit	Ring in the plane of Earth's equator
<u>Weather effects when?</u> Basic cycle is ecliptic year, thus effects would be cyclic but occur year round. Opacity to solar radiation greater in summer hemisphere (at midlatitudes)	**<u>Weather effects when?</u>** Basic cycle is solar year. Effects greatest in winter hemisphere.
<u>Weather effects where?</u> Winter hemisphere of the ecliptic year. Final sink for dust would be a band centered on the great circle of the plane of lunar orbit.	**<u>Weather effects where?</u>** The winter hemisphere. Final sink for dust would be a band centered on the great circle of the Equator.
<u>Evidence of that?</u>  ENSO index (Y) depends on phase of precession of lunar nodes (X), ***i.e., where is the winter hemisphere of the ecliptic year?***	**<u>Evidence of that?</u>** Ice Ages (O'Keefe 1980) on the consideration those are predominantly winter effects. The underlying cycle is the solar year so these effects would be well known to climatology. Don't need a new driver to forecast them.

MP4

Fig 4. This mp4 shows the database for 2018, based on data from JPL, presented as a movie by using Panoply, the netCDF visualization software.

See "Data" for this database. See "Code" for the code. See "Refs" for directions to JPL data and Panoply



mp4 URL:
https://drive.google.com/file/d/14p2UvpKopuCDrzo7Rc4orXO67jk4sm2-/view?usp=drive_link

Data

Code

Refs

lunarorbit plane intersection

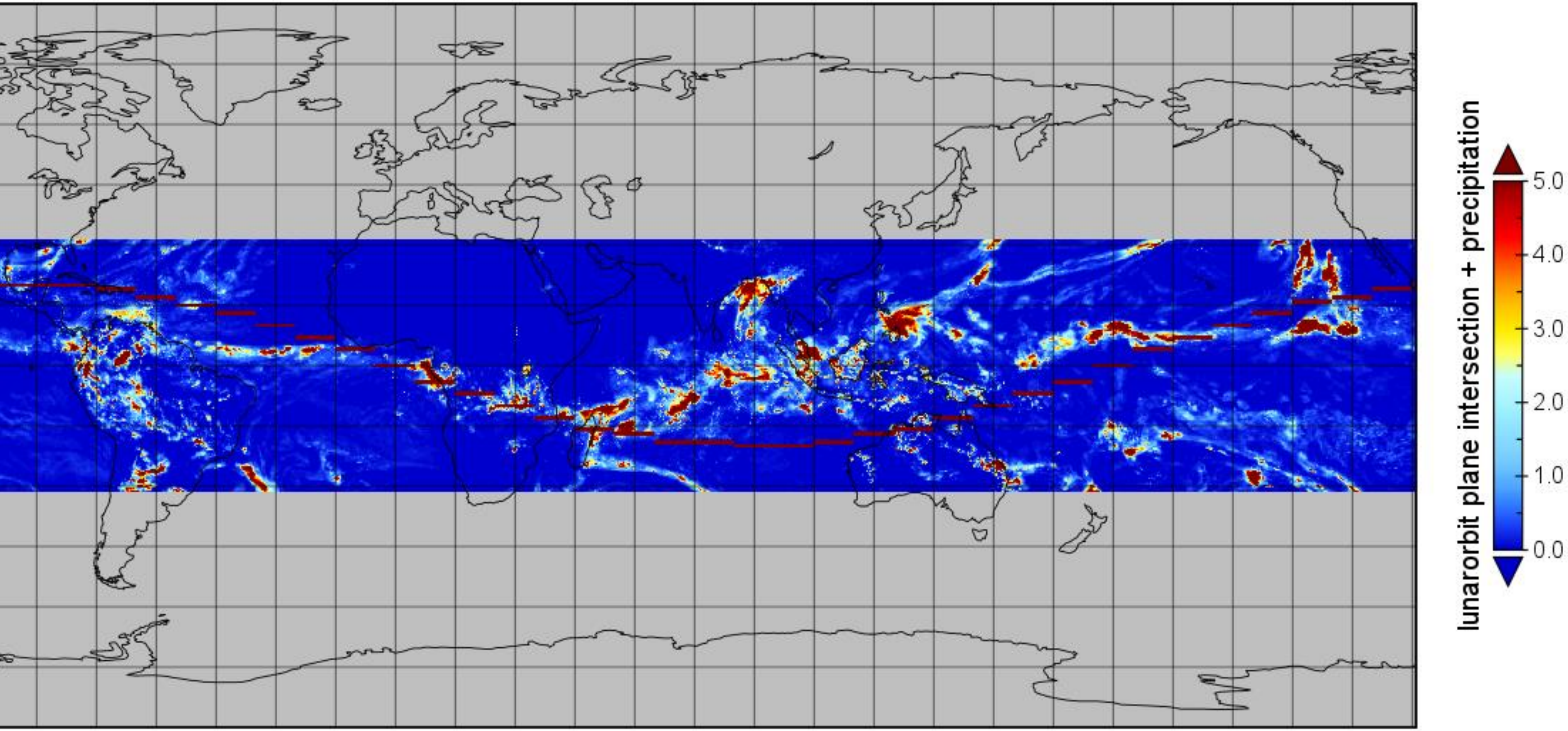


Fig 5. Precipitation data from Multi-Source Weighted-Ensemble (MSWEP) (Beck et al.,2019, Refs) for January 1, 2018, 0600Z, in color per legend to the right, overlain by the great circle where the plane of the lunar orbit intersects Earth (dashed line)

The intersection of the lunar orbit with the surface of the Earth Is within a few degrees of the ecliptic – but offset – with time-varying differences – that do not exactly repeat

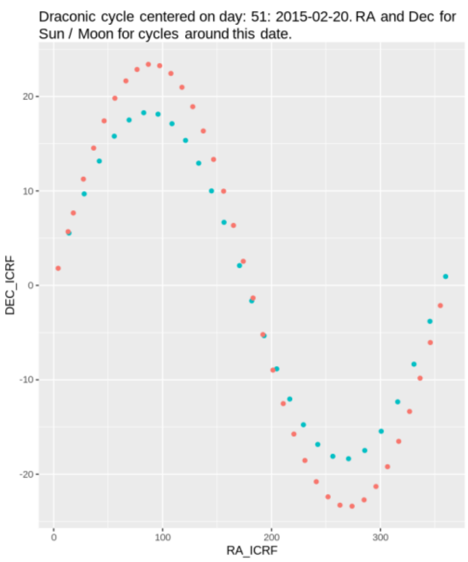


Fig 6(a) On one day, the position of ecliptic (orange) and of the projected lunar orbit (blue). X axis is right ascension which is a rotation version of longitude, Y is declination = latitude.
See "Code"

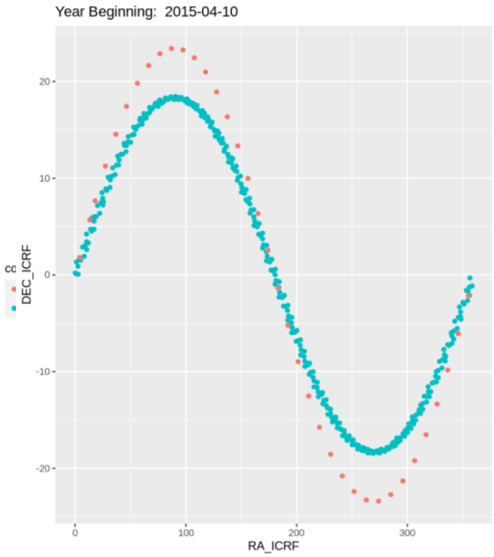


Fig 6(b) Same thing as (a), all positions over one year.
See "Code"

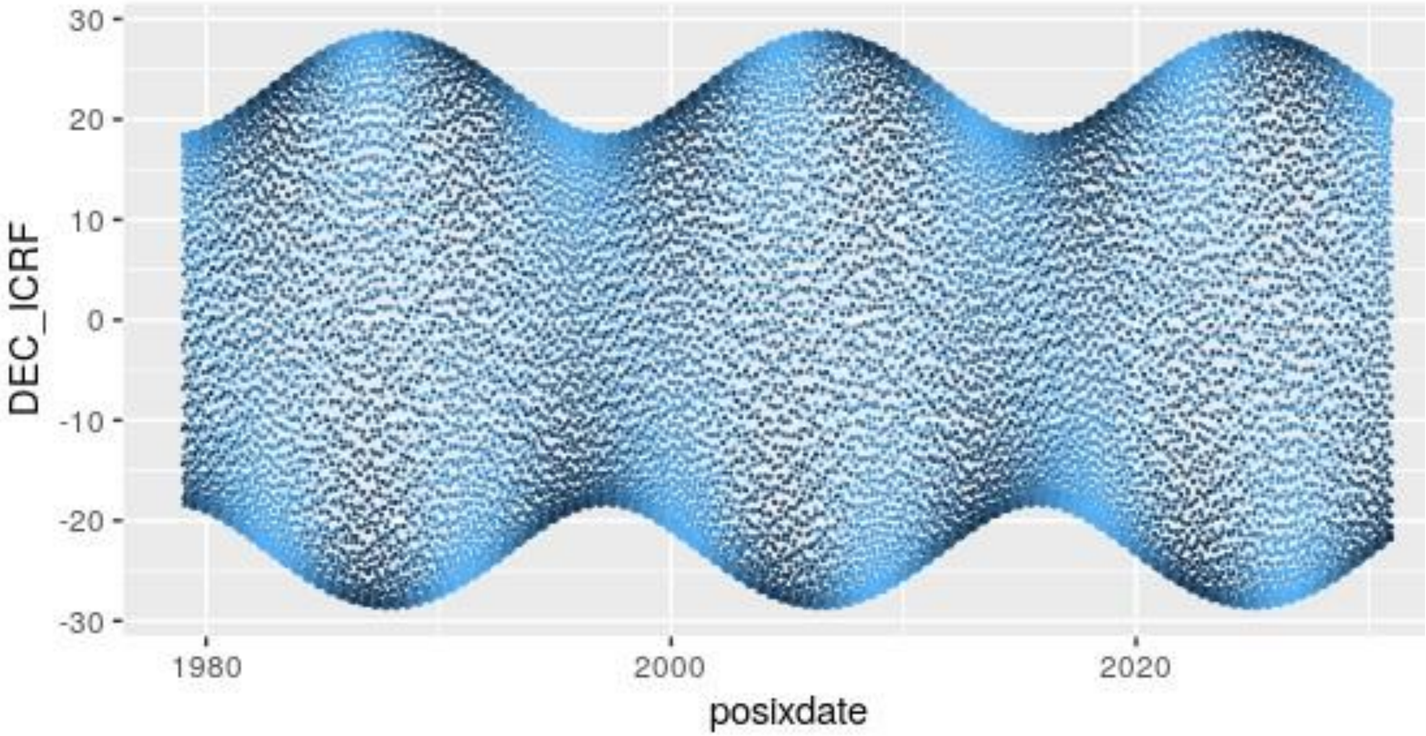


Fig 6(c) Variation of the north-south extent of the projected lunar orbit. About 3 cycles in 60 years. X is time, Y is the declination of the Moon.
See "Code"

These sums of global precipitation show that Earth' s total rainfall does not change much.
Flood and drought are essentially rearrangements.
The distribution has an annual pattern … (left side)
… and the total has an annual cycle (right side).
Most rain falls along the footprint of the proposed ring system (black dots are N-S extent of the footprint)

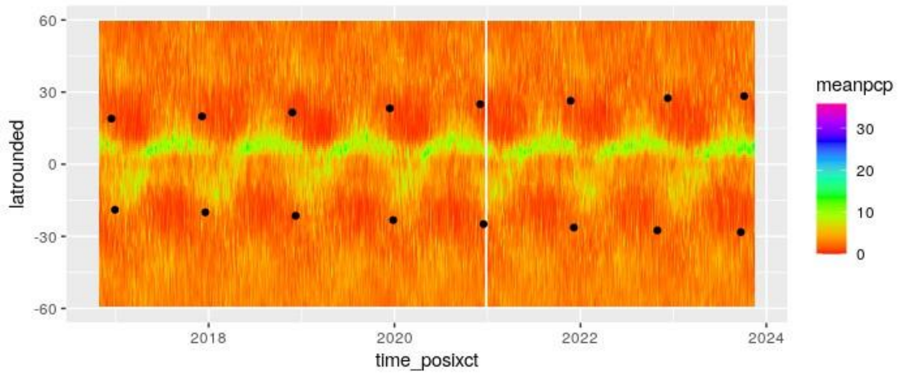


Fig 7(a) Total rainfall (MSWEP) by day and by latitude 2017 to 2023. Black dots are N-S extent of the projected plane of the lunar orbit. See Code.

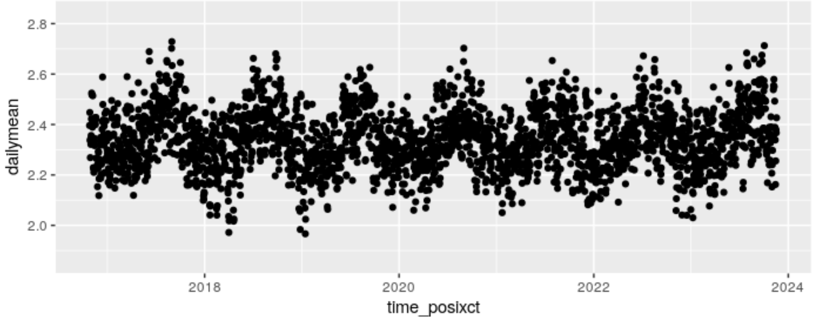


Fig 7(c) Total rainfall (MSWEP) by day 2017 to 2023. See Code.

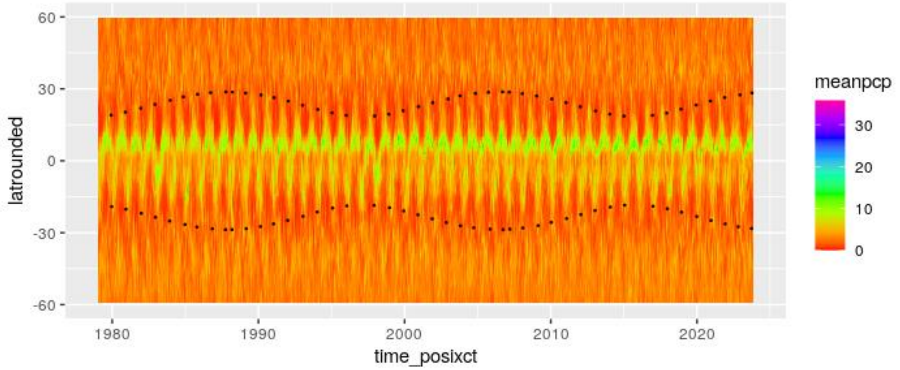


Fig 7(b) Total rainfall (MSWEP) by day and by latitude 2017 to 2023. Black dots are N-S extent of the projected plane of the lunar orbit. See Code.

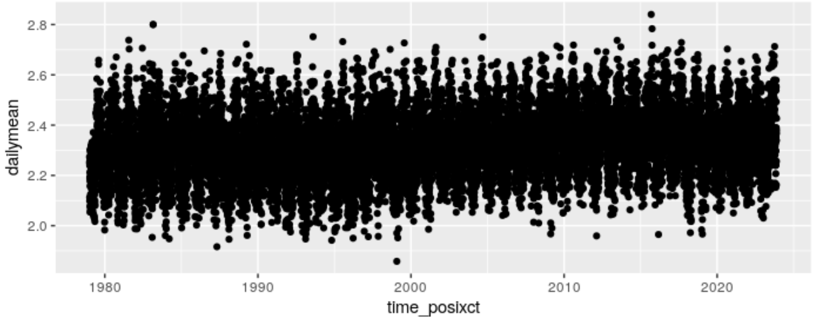


Fig 7(d) Total rainfall (MSWEP) by day 1979 to 2023. See Code.

Suppose there is a set daily budget of dust that spirals inward from space

of which a slightly varying share is sized to initiate rainfall.

And that this is a limiting input for rainfall.

Considering that infall might reasonably be favored --

– where solar radiation pressure is most effective

– where terrestrial magnetism would attract charged dust

– at the leading edge of bumps in the uppermost atmosphere

(over land/sea boundaries, or ongoing atmospheric disturbances…)

(***recalling*** that which side of a bump is the leading edge depends on relative velocity)

a non-trivial issue

– at the leading edge of the hemisphere furthest from the Moon

(orbiting the EMB would be favored over orbiting Earth, and these orbits would encounter Earth opposite the Moon)

Note there is traditional knowledge in Malawi that rain is less likely when the moon is visible.

Pers comm., James, doorman, Southern Sun, Malawi, 2016, see Refs.)

– where the overflying ring itself is densest

(recall eccentricity of the Moon's orbit, etc.)

Could we forecast the varying configuration of drought/rainfall ?

Thank you for your attention

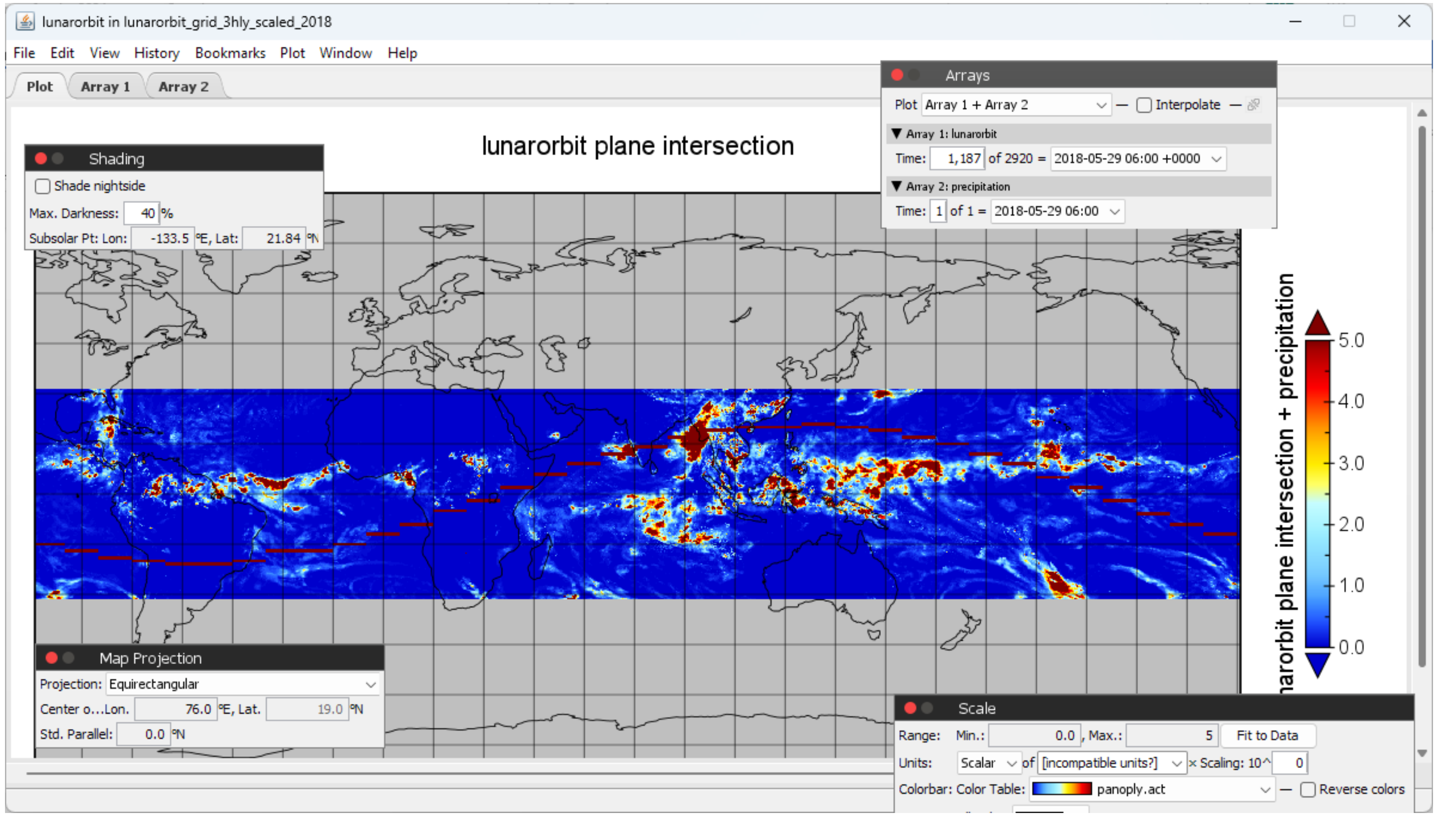


Fig 8. Precipitation data from Multi-Source Weighted-Ensemble (MSWEP) (Beck et al., 2019, Refs) for May 29, 2018, 0600Z, in color per legend to the right, overlain by the great circle where the plane of the lunar orbit intersects Earth (dashed line)