

Trying out a planetary ring system for ENSO prediction

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Two planetary ring orientations are known

Ring in the plane of a planet's equator

- Many examples in the Solar System.
- Develop as a consequence of planetary oblateness (Maxwell 1859).
- Published evidence at Earth: O'Keefe noted such a ring would explain why Ice Age cold anomaly was predominantly in winter.
- Sky position: Celestial equator down to the horizon: dimming of stars behind. Reflected light dimmed by shadow of Earth near midnight.
- Need to disambiguate from light pollution.
- Observational test proposal: Compare extinction of the Milky Way at different latitudes

Ring in the plane of a planet's moon's orbit

- Only one known solar system example: Saturn's Phoebe ring. But this is orientation of binary system accretion disks, of which many exist.
- Sky position: Along the zodiac within 5 degrees of ecliptic, down to horizon. Compare zodiacal light and gegenschein. Stars behind would be dimmed; light would be reflected from an arch but Earth's shadow would modulate that.
- Published evidence arguing for such a ring: G. Jones, 1853, ZI observations.
- Need to disambiguate from zodiacal light and gegenschein.
- Observational test proposal: Redo G. Jones's observation, i.e., Look for singular point where nodes of lunar orbit cross ecliptic

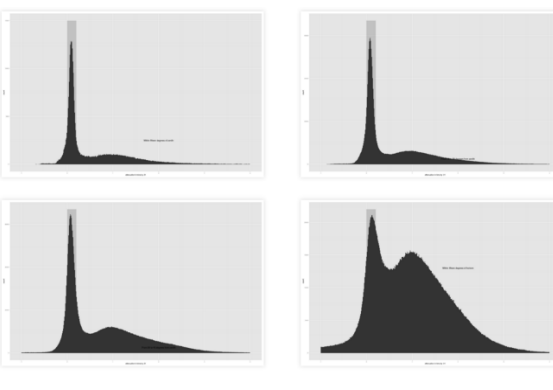
At Earth, either ring requires a tendency for the other to form.

Shape, size, composition, charge, temperature?

Ring material must fall inward (dynamical papers) and thus must be a common aeolian deposit. Sand? Charge: proportional to volume is rule of thumb for interplanetary dust. Blackbody temperature like the near-Earth space environment would be near 1 degree C. Angular momentum – either like lunar orbit or else equatorial orbit – not far from atmospheric. Jagged shape while in space due to cycles of YORP spinup and rotational bursting (for small rock, every 10K years in space, cf. dissertation and later work of S. Paddack, pers. comm.) Size distribution would depend on space history of a given filament. At a guess, like sand.

Potential effects on climate

attenuation as function of zenith angle



Attenuation of solar radiation. Ring attenuation by several percent is consistent with CWOP observations. The CWOP solar radiation database comprises about a half-billion observations. This is adequate to resolve the existence of a component of attenuation of solar radiation that is independent of solar elevation (Hancock and Chadwick 2016). See figure. As such the attenuation does not appear to be atmospheric. Its position and magnitude are comparable to zodiacal dust extinction, a permanent belt of attenuation along the ecliptic. The coincidence is easily explained if the zodiacal dust belt is partly circumterrestrial as G. Jones first proposed; specifically, a ring of dust in the plane of the lunar orbit.

OTHER EFFECTS - Lighter and more-charged material would tend to fall inward at the geomagnetic poles, e.g., chilling e.g. the Labrador Sea in an erratic way. Otherwise, because solar radiation pressure is relatively important for tiny particles (see Esposito figure below), material would fall inward under the effect especially of midday sun. Time of infall varying, this could fall anywhere in seasonal and diurnal patterns. All other material would land ultimately near the equator or in the tropics. Depending on its relative angular momentum anomaly it could plummet and burn or simply “join” the upper atmosphere. Such a deposit ongoing for a few billion years on and off could contribute to the climatology of wildfires, sandstorms, lightning, atmospheric vortices, silicosis-driven human illness, and the geological consequences of the aeolian deposit.



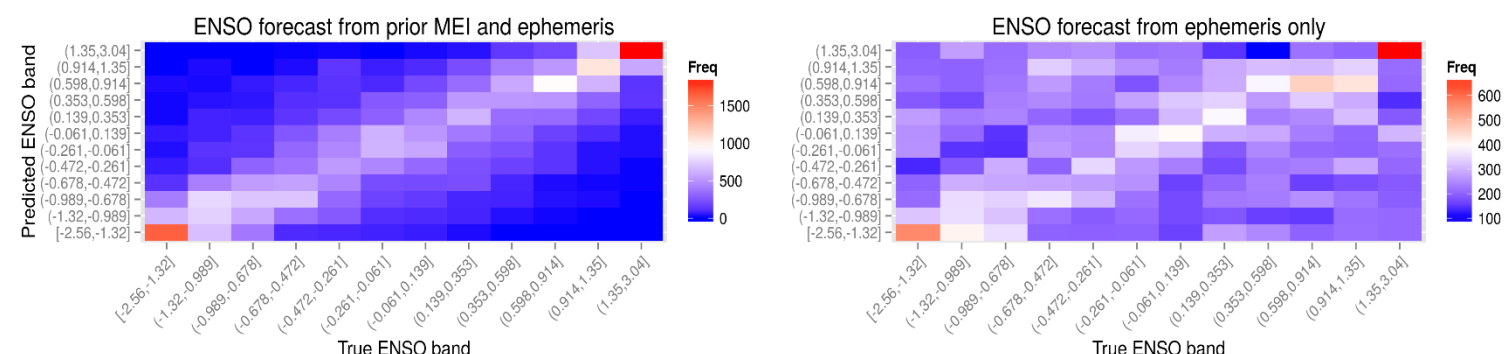
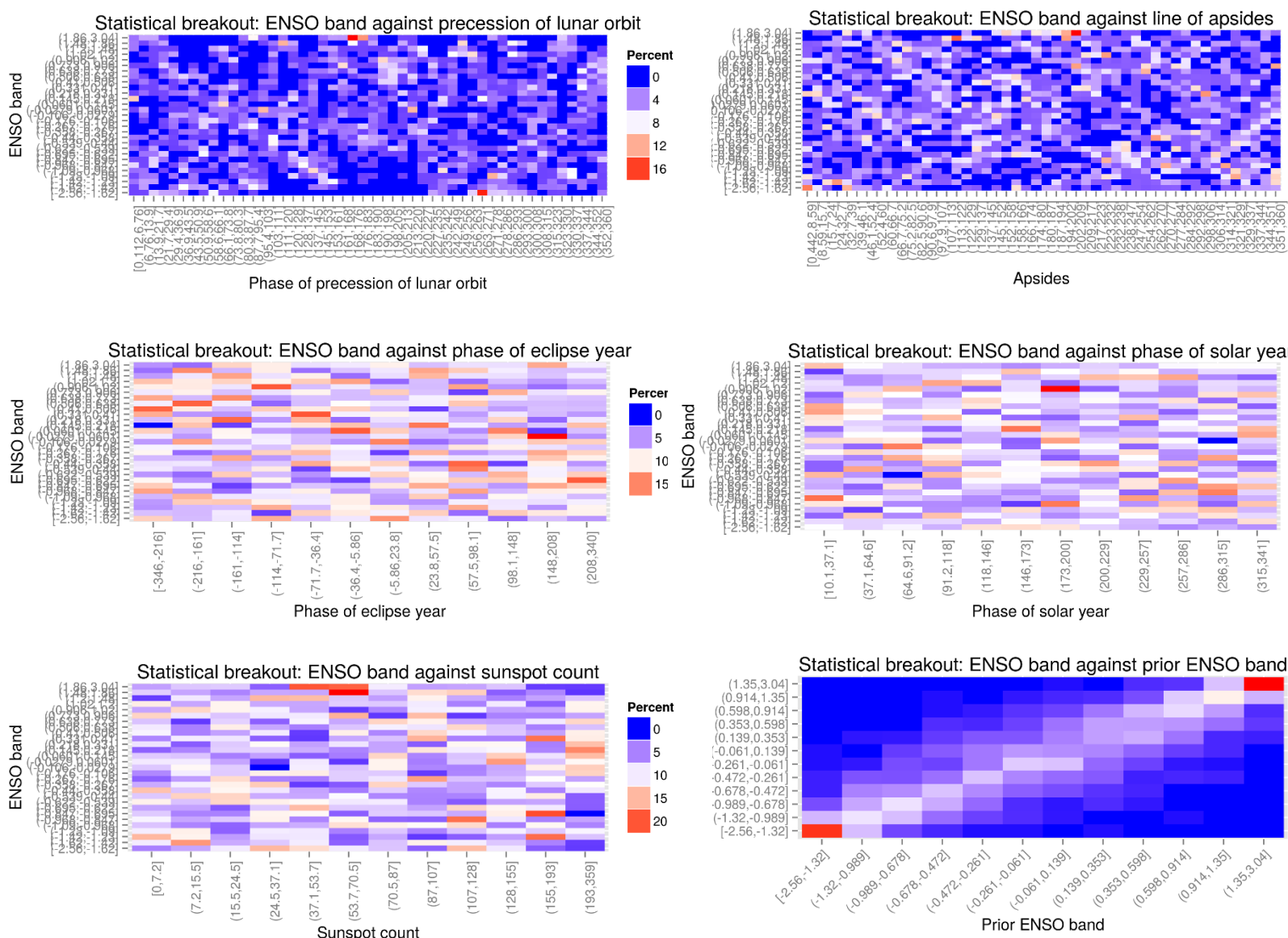
Hypothesis:

The La Nina climate state is one in which the Pacific is broadly “overcast” by a cloud of ring dust in space that lies in the line of sight from Sun to ocean, in excess of seasonal averages. The El Nino climate state is the other extreme: the Pacific is clear of ring dust between Sun and ocean, compared to seasonal averages.

Under hypothesis, which ephemerides likeliest to affect ENSO?

If ENSO is due to configuration cycles in a ring system, then these variables should be explored as predictors:

- Phase of the solar year (e.g., month), because the equatorial ring is edge on at the equinoxes, and fanned out at the solstices. See video at panel. On average this effect is removed by climate averages but density changes over time would re-introduce it.
- Phase of the eclipse year. See video panel 1.
- Rotation of the line of apsides of the moon's orbit: At what time of year is the moon nearest? When fanned out or when not?
- Solar activity. This is important because small particles are sensitive to solar radiation. Ring organization would be disturbed (promoting La Nina) and dust blown away (promoting El Nino).
- Above all, the precession of lunar nodes**, as this is the cycle on which the two rings would swing in and out of phase. Expect La Nina when they are maximally fanned out; expect El Nino when they maximally overlap (nodes coincide with the equinoxes; * is 180 degrees). See videos this panel.
- Finally, note that prior value of MEI likely influences current MEI (e.g., thermal inertia).



The leftmost figure depicts the skill of a Bayesian model of MEI that uses all six variables from panel 3. The rightmost figure depicts the skill of a model that does not use prior MEI, only the astronomical variables.

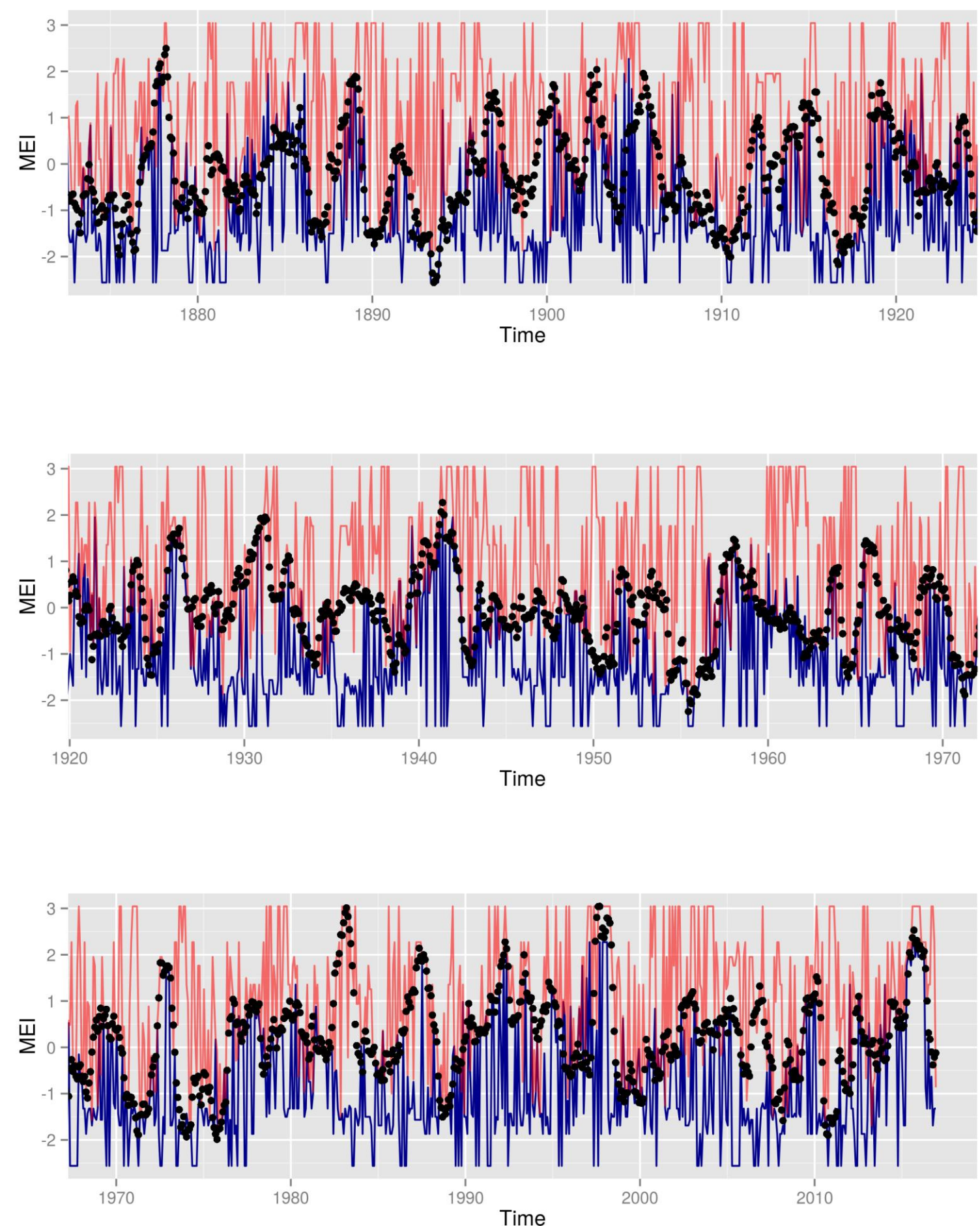
Hindcast

Use naïve Bayes approach to develop a predictive model for MEI based on the five astronomical variables and prior MEI.

To wash out dependence on knowing prior MEI, run the model replacing prior MEI with constant values, (a) the high extreme (draw the result in red) and (b) the low extreme (draw the result in blue). Take these two values to be the constraints that the model places on MEI, valid as constraints up to the skill of the with-MEI model.

See below for a hindcast made this way..

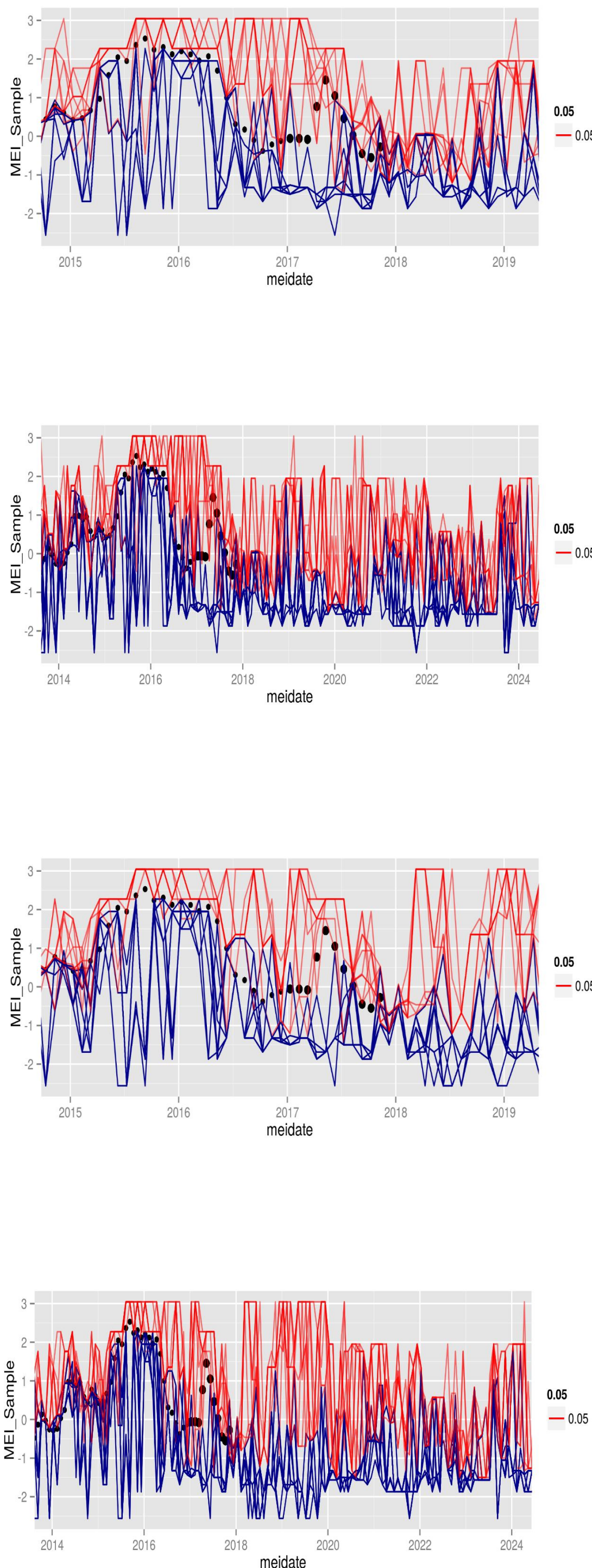
The forecast is obtained the same way (see Panel 4) except that an assumption must be made about future sunspots.



Forecast

The forecast below assumes sunspot count of 7 or less, for all times forecast. The forecast is presented at high time resolution and then at low resolution. Note: the forecast is undertaken ten times and the entire ensemble is printed.

The second forecast assumes a sunspot count of 25.



CONCLUSION

We have suggested a two-ring system comprising analogues of the two solar system ring types is a climate driver: dust rings overlying each other are optically less effective than rings fanned out.

We have assessed the statistical relationships between ENSO and configuration cycles of the Earth-Moon system. A strong relationship appears for the precession of lunar nodes, consistent with hypothesis. (Panel 2)

We have used naïve Bayes techniques to develop a statistical model for ENSO (MEI) prediction on the basis of solar system cycles, with and without prior MEI. (Panel 3.)

We have run the “with-prior-MEI” model substituting two dummy datasets for prior MEI: once using a high value and once using a low value, to predict constraints on MEI. We used this method to hindcast MEI. (Panel 3.)

We have prepared the statistical model ten times (each using a random selection of 80 percent of MEI history) and run it into the future to 2025 assuming sunspot count is consistently 6; and the same again using sunspot count of 25. The two ensemble forecasts are in panel 4, at high resolution and low.

The ensemble forecasts suggest ENSO will remain low or neutral for the next few years, except that from the second half of 2018 to mid 2019, if sunspot count is above 7, then there may be a brief excursion into El Nino values. If sunspot count stays low, strong La Nina signals are forecast in late 2019 and early 2020.

References

- Jones, G. *Observations of the Zodiacal Light, April 2, 1853 to April 22, 1855.* Washington, DC. A.O.P. Nicholson, Printer. 1856.
- O'Keefe, J.A. “The terminal Eocene event: formation of a ring system around the Earth?” *Nature* 285, 309-311 (29 May 1980).
- Esposito, L.W. *Planetary Rings*, Cambridge University Press, 2006.
- Hancock, L. and R. Chadwick, “The CWOP Solar Radiation Database,” Session on Innovative Measurements, AMS 2016, <https://ams.confex.com/ams/96Annual/webprogram/Paper276916.html>
- DATA**
- Ephemerides (precession of lunar nodes, rotation of the line of apsides, phase of solar year and eclipse year) from Jet Propulsion Laboratory Horizons system, <https://ssd.jpl.nasa.gov/?horizons>
- Multivariate ENSO Index (MEI) 1950 to present: <https://www.esrl.noaa.gov/psd/enso/mei/table.html>
- MEI 1875 to 2005: <https://www.esrl.noaa.gov/psd/enso/mei/ext/#data>
- Sunspot number 1750 to present: <http://www.sidc.be/silso/datafiles>
- Projected sunspot number: https://solarscience.msfc.nasa.gov/ssn_predict.txt - Note that the projection is not used directly, but rather as a justification for using ss=6 and ss=25 to bracket likelihood.
- Package “e1071”, Misc. Functions of the Department of Statistics, Probability Theory Group, TU Wien. <https://cran.r-project.org/web/packages/e1071/e1071.pdf>

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REPRODUCIBLE RESEARCH: Code for figures to be archived at <https://github.com/lohancock/enso-forecast>.
PHOTO CREDITS: NOAA, Astronomy Photo of the Day