CORRELATED VARIATIONS OF PLANETARY ALBEDOS AND SOLAR-INTERPLANETARY PARAMETERS

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The brightnesses of Titan and Neptune have been monitored photoelectrically at 472 and 551 nm since 1972 at the Lowell Observatory, yielding annual mean magnitudes accurate to 0.3 percent (0.003 mag). Both objects increased steadily in brightness until 1976 and declined thereafter (Lockwood 1977, Lockwood and Thompson 1979). The range of variation was about 0.08 mag for Titan and 0.03 mag for Neptune.

This period of observation coincides with the decline of solar activity in cycle 20 and the subsequent rise in cycle 21. Because there is no evidence to suggest that the solar flux in the visible region varies by more than a small fraction of one percent (White 1977), we hypothesize that some variable component of the solar output influences the albedos of Titan and Neptune. Correlation studies (Suess and Lockwood, in preparation) of the observed planetary brightness variations and various solar and solar-interplanetary parameters have allowed us to rule out some of these as candidates for a cause-effect relationship but do not lead yet to a conclusive identification of the controlling parameter and the mechanism by which it operates upon planetary atmospheres.

The observed seasonal mean planetary variations are shown in Figure 2 along with the monthly mean Zurich sunspot number and an index of the monthly number of flares of importance ≥ 1. In Figure 1, monthly mean planetary magnitudes have been scaled and merged into a single unified data set and are shown along with a number of solar and solar-interplanetary parameters: sunspot number, Ca plage area index, 10.7-cm radio flux, 21-cm radio flux, geomagnetic aa index, solar wind speed, and geomagnetic recurrence index. The aa index is an indirect measure of solar wind speed and the recurrence index is a measure of the tendency of the solar wind to be dominated by recurrent streams.

From Figure 1 it can be seen that the rises in sunspot number, 10.7- and 21-cm radio flux and Ca plage index following sunspot minimum

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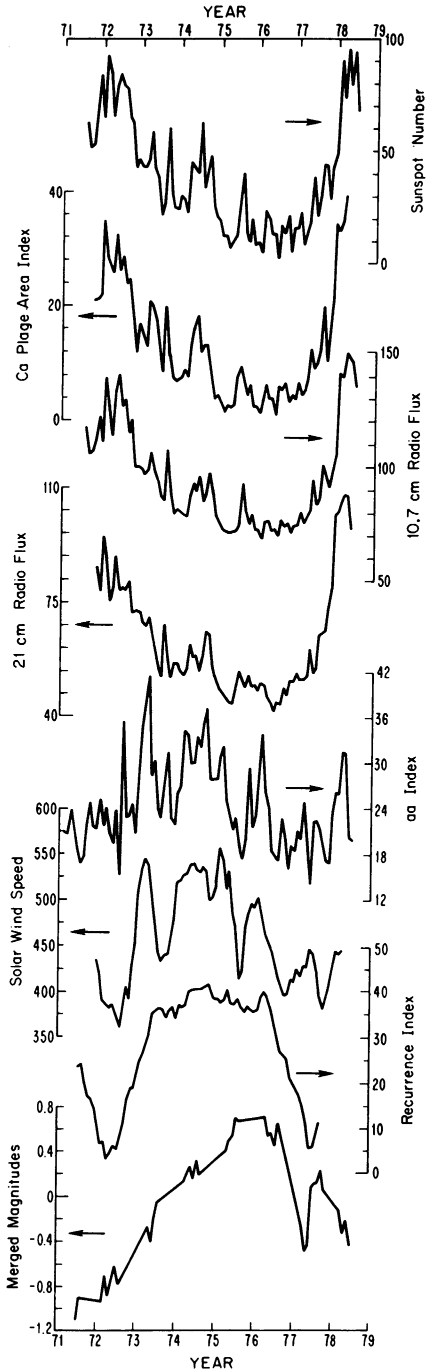

Figure 1. The variation of scaled and merged planetary magnitudes and various solar and solar-interplanetary parameters.

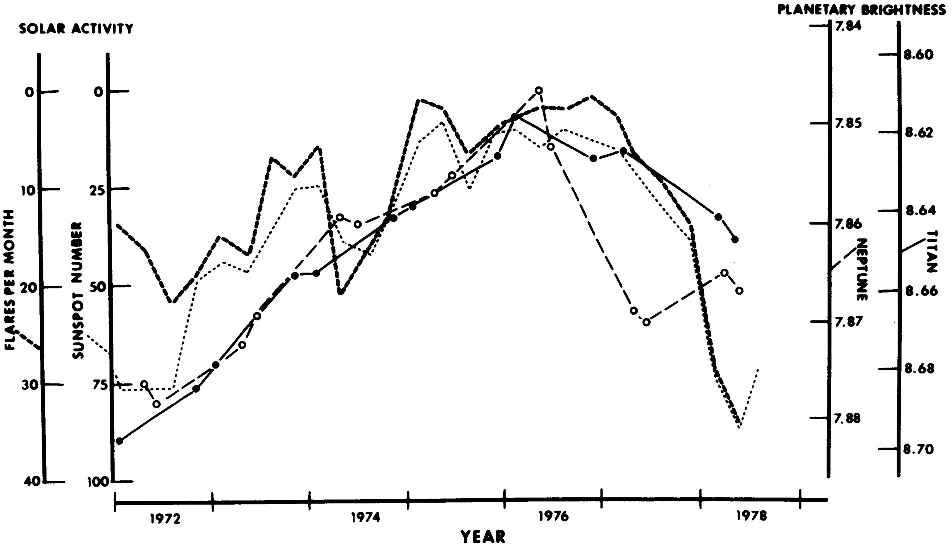

Figure 2. Pre- and post-opposition mean b and y magnitudes of Titan and Neptune, monthly mean Zurich sunspot number and number of flares per month of importance 1 or greater.

in 1976 are preceded by the planetary variations and hence are unlikely sources of a direct solar-planetary effect. However, the solar wind speed, aa index, and recurrence index correlate well with the merged magnitudes and lead them in phase by as much as 1.5 years. The available solar EUV data suggest that its most recent minimum may have occurred about a year prior to the 1976 maxima of Titan and Neptune (Hinteregger 1979).

Hence, our conclusion is that, among the parameters studied, the solar EUV output and the solar wind are the most viable candidates for the cause of the observed planetary variations.

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References

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DISCUSSION

Ahluwalia: What is the recurrence index? How do you define it? Is this your invention?

Suess: The recurrence index measures the tendency for high levels of the geomagnetic aa index to reoccur with the solar rotation period-hence measuring the organization level of the solar wind into high speed streams. The index was developed by T. Sargent, III, at the Space Environment Laboratory, National Oceanic and Atmospheric Administration/Environmental Research Laboratories, Boulder, Colorado 80303. Plots of the recurrence index for the last 100 years are available from Mr. Sargent.