Response: The main issue addressed in my report (1) was whether results from stellar photometry substantially increase the evidence that the sun’s luminosity may have varied enough over the past century to explain the global warming reported since the 1880s. My analysis suggested that, at the present early stage of analysis of these interesting stellar data, the answer is probably negative. I do not believe that the points raised by Radick alter this conclusion.

Even the most sunlike of the more highly variable stars in the sample of Lockwood et al. (such as HD 10476) appear to differ from the present sun in ways that make similar solar irradiance behavior unlikely. The behavior of HD 10476 can be explained in terms of photospheric magnetic activity (that is, the “two-component” model consisting of spots and faculae). For instance, the photosphere of HD 10476 could carry only dark spots and no faculae. In such a star, both the CaK band and total luminosity could rise and fall in phase, as one observes on HD 10476. This interpretation would be quite consistent with the arguments given in my report.

Alternatively, the behavior of HD 10476 could be explained if its surface were covered mainly by faculae; the intensity enhancement ratio of faculae in chromospheric versus photospheric radiations was three times higher than on the present sun, and the modulation in facular area (over decadal time scales) was twice that of the present sun. There is no direct observational evidence for a constant value of the ratio described above, common to all sunlike stars. On the contrary, there are sound reasons to expect this value (which expresses the ratio of nonthermal to thermal energy transport through the photosphere) to vary substantially, even between similar stars.

I agree that in the second interpretation given above, the luminosity variation of HD 10476 would not be dominated by sunspots. But a more important point is that both of the above explanations of HD 10476’s behavior model describe a star with photospheric magnetic structures quite different from those observed on the present sun. We must ask: How likely is it that these parameters on the sun could change from their present solar values to HD 10476–like values over the relevant global warming time scale?

No measurements exist of the chromospheric to photospheric intensity ratio of faculae over the past century. But the remarkable fit of two-component models to the active cavity radiometer irradiance monitor (ACRIM) radiometry between 1980 and 1990 indicates that, at least over the declining phase of cycle 21 and ascending phase of cycle 22, that ratio did not change significantly. It seems unlikely (although not impossible) that this ratio increased over the last century by a factor of 3, which would be required to reach HD 10476–like values, given that this would imply a roughly 300% change in the ratio of the sun’s nonradiative to radiative power outputs. I conclude that whichever model (sunspot or facula-dominated) describes HD 10476, the main point is that the sun is unlikely to behave like HD 10476 in our epoch (3).

I agree with Radick that climatologically significant irradiance variations in the present sun cannot be ruled out by evidence at our disposal, and I pointed this out in the last paragraph of my report. Unfortunately, this important qualification was not emphasized in the summary that appeared in the “This Week in Science” section of that issue or in the newspaper reports that followed.

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REFERENCES

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