matters arising

Backwarming due to circumstellar shells

IN a recent publication, Donnison and Williams[1] discussed the possible effects which a circumstellar dust shell could have on the evolution of a premain sequence star surrounded by it. If λ is the fraction of energy emitted by the star that returns back to it, then they concluded that $(1-\lambda)/\lambda$ can have a value as low as

$$(1-\lambda)/\lambda \simeq (T_O/T_I)^4 \quad (1)$$

where T_I and T_O represent the temperatures of the inner and the outer surfaces of the shell. We intend here to draw attention to the fact that equation (1) could be misleading since it represents the smallest value that can ever be allowed by the ratio, and is by no means a realistic limit. The full expression for this ratio can simply be derived as follows.

If we assume that the shell stores no energy, then

$$R^2T^4_{eff}(1-\lambda) = \alpha_1 R^2_O T^4_O \quad (2)$$

where R and R_O are the stellar radius and outer radius of the shell and T_{eff} is the effective temperature of the star, α_1 is a constant, which is included because the outer surface in reality will not be a perfect black body characterised by the temperature T_O.

Simple geometry implies that the fraction of the radiation emitted by the inner surface which strikes the star is

$$\alpha_2 \mu R_I^2 T_I^4 \quad (3)$$

where α_2 compensates for the inner surface not being a perfect black body and μ is the fraction of the total solid angle which is subtended by the star at the inner surface of the shell, so that $\mu = \beta(R^2/R_I^2)$ with β a numerical constant which is easy to determine if the star is small but more complicated if the star and shell have similar radii. Hence, from (3)

$$\lambda R^2 T^4_{eff} = \alpha_2 \beta R^2 T_I^4 \quad (4)$$

From (2) and (4)

$$\frac{(1-\lambda)}{\lambda} = \left(\frac{\alpha_1 R_O^2}{\alpha_2 \beta R^2}\right)\left(\frac{T_O}{T_I}\right)^4 \quad (5)$$

And it is immediately evident that equation (1) as used in the reference[1] is only applicable to a very restricted set of physical parameters where

$$\alpha_1 R_O^2 = \alpha_2 \beta R^2 \quad (6)$$

In general $R_O \gg R$ and the ratio $(1-\lambda)/\lambda$ is very much greater than the value given by equation (1) (that is, λ is smaller).

We conclude, therefore, that even though it is theoretically possible to have a situation where λ is close to unity, which results in a drastic change in the evolution of the central star, generally, in physical meaningful situations $\lambda \ll 1$ and backwarming has no real effect.

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1 Donnison, J. R. & Williams I. P. *Nature* **261**, 674 (1976).

Possible solar control of North Atlantic oceanic climate

TRENDS in the climate of the North Atlantic Ocean over the past century have been described recently by Colebrook[1]. He discussed the variation in the average sea level, the number of cyclones and the sea-surface temperature. He showed that low sea-surface temperatures in the North Atlantic are associated with a higher-than-normal flow in the Gulf Stream and a lower-than-normal frequency of tropical cyclones, indicative of above average intensity in mid-latitude westerlies. The sea-surface temperature data were smoothed by the application of eigenvector filters which were approximately equivalent to 7-yr running means. A 10–11-yr periodicity, which tended to be in phase with the sunspot cycle, was found following the removal of long-term trends from the smoothed data. I point out here a very significant long-term correlation between the sea-surface temperature and the 7-yr running mean of the annual sunspot numbers. I have redrawn the sea-surface temperature data of Colebrook[1] and compared it with the 7-yr running mean of the annual sunspot number for Marsden squares 145 D and 182 B (Fig. 1). In both cases the vertical scales were adjusted so as to make the total amplitude of the long-term variation approximately the same on the graph.

There is very good correlation between the two sets of data for Marsden square 145 D (45°–50°N,

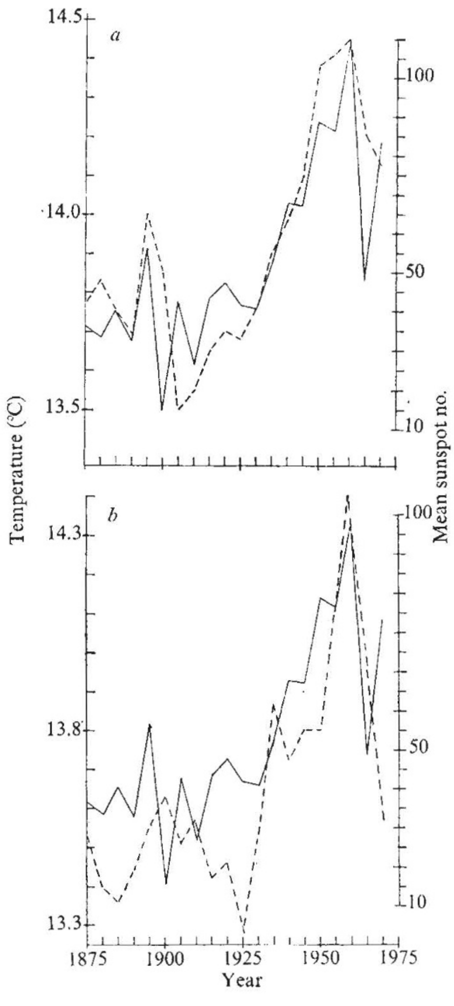

Fig. 1 Smoothed variations of sea-surface temperature redrawn from ref. 1 (broken lines) compared with the 7-yr running mean of the annual sunspot number (solid line). *a* Refers to Marsden square 145 D (45–50°N, 5–10°W) and *b* refers to Marsden square 182 B (50°–55°N, 15°–20°W).

5°–10°W) while the correlation is less marked for Marsden square 182 B (50°–55°N, 15°–20°W). This difference in the degree of correlation between the two sets of data might be accounted for by the difference in latitude between the two areas under consideration. The effect of latitude on the