OBSERVATIONS OF THE LATITUDINAL VARIATION OF THE SOLAR RADIANCE OF NON ACTIVE REGIONS OF THE SUN

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Kuhn et al. (1988) have found that there are variations in the photospheric temperature with the solar cycle that depend on solar latitude. This would be an independent mechanism, other than the effects of sunspots and faculae, contributing to the change in solar irradiance (Kuhn 1991). It is important to pursue this investigation as such variations would be related to the transport of energy through the convection zone, and thus give a good indication of its structure and evolution.

Aboard SOHO, the VIRGO instrument (Fröhlich et al. 1995), measures the total solar irradiance and its variations, and also, with the Luminosity Oscillations Imager (LOI) (Appourchaux et al., 1997), measures the radiance of the Sun at 500 nm in an image of the Sun in 16 pixels, the outer narrow four being used, with a servo system, to achieve fine pointing and the other 12 distributed in four latitudinal bands. This instrument gives us the opportunity to try to find a photometric equivalent of the temperature measurements by observing the variation of the radiance at four different latitudinal bands. SOHO, by being operated at the transition between two solar cycles, may provide a particularly good occasion to measure changes in the structure of the energy flow in the convection zone.

To select observations of the Sun with "no active regions" during the period April 1996-August 1997 we have chosen intervals of time when no region of the solar disk had a magnetic field above the arbitrary level of 500 microtesla, in the Wilcox Observatory synoptic charts (Solar Geophysical Data, 1996 and 1997, and University of Stanford web site http://solar.stanford.edu/SolarData/). Figure 1 shows the result of comparing the normalized intensities of the pixels that observe the Sun above about 30 degrees heliolatitude (called "polar" thereafter) and those that observe the latitudes below 30 degrees("equatorial"). On December 1996 one observes (Fröhlich 1997) a step increase of the solar irradiance of about 1.3×10^{-4}. If the irradiance change is due to change in the equatorial band, as could be expected following the temperature changes reported by Kuhn et al. (1988) for the previous solar cycle, the

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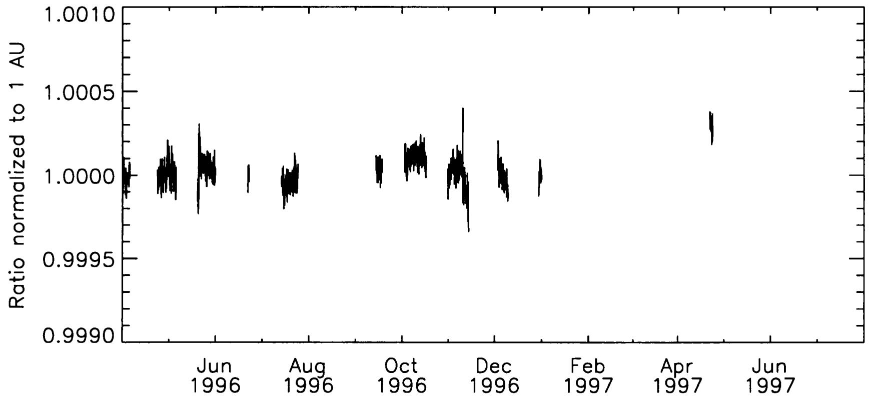

Figure 1. Ratio of the solar radiance measured in two bands, one (polar), comprising the heliolatitude above 30 degrees north and south and the other (equatorial) combining the regions below 30 degrees. The ratio has been normalized to 1 AU. Periods of "quiet" sun have been selected

ratio of polar to equatorial radiance would change about twice as much or about 3×10^{-4}. We have only two "quiet" intervals after the solar irradiance change. The observation during the first one, on 30-31 December 1996, would indicate no change or a change smaller than 10^{-4}, thus suggesting that the change in solar irradiance seen at the start of the 23rd solar cycle is not due to a latitudinal change of the temperature. On 22-23 April 1997, the ratio "polar"/"equatorial" radiance is higher than in 1996, but we consider, pending further analysis of higher resolution data, that this may not be a "quiet" sun period: the sunspot number is higher in this interval than in the others.

In conclusion, at first glance this result would contradict what we would expect by extrapolating the observations of Kuhn et al. (1988) to the present solar cycle. But it is important to realize that this is a very preliminary analysis of the VIRGO data and more detailed analysis taking into account the effect of solar active regions, including higher resolution data from the Michelson Doppler Imager (MDI), is underway.

References

Appourchaux, T., Andersen, B. N., Fröhlich, C., Jimenez, A., Telljohann, U., Wehrli, C.: 1997, In-flight Performance of the Luminosity Oscillation Imager of VIRGO Aboard SOHO, *Solar Phys.* **170**, 27

Fröhlich, C. et al.: 1995, Virgo: Experiment for Helioseismology and Solar Irradiance Monitoring, *Solar Phys.* **162**, 101

Fröhlich, C.: 1997, Solar Irradiance Variations, *This issue.*

Kuhn, J. R., Libbrecht, K. G., Dicke, R. H.: 1988, The Surface Temperature of the Sun and Changes in the Solar Constant, *Science* **242**, 908-910

Kuhn, J. R.: 1991, Inferring Solar Structure Variations from Photometric and Helioseismic Observations, *Adv. Space Res.* **11**, No. 4, pp. 171-184