SOLAR IRRADIANCE VARIATIONS AND ACTIVE REGIONS OBSERVED BY VIRGO EXPERIMENT ON SOHO

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ABSTRACT

Using total and spectral irradiance measurements as well as low resolution radiance data from the VIRGO experiment on SOHO, the irradiance variability induced by the passage of an active region and of an emerging sunspot is analysed in terms of spectral contributions and temporal evolution.

1. INTRODUCTION

Although variations of solar irradiance are of great importance in solar reasearch and Sun-Earth interaction, knowledge about the underlying physical processes is still limited. Current empirical models based on Photometric Sunspot Index (PSI) and other indices can not fully explain the observed irradiance variations of the active sun. It is known, that the UV flux below 300nm contributes 20-30% to the total irradiance variability over the solar cycle, but very little is known about the spectral distribution in the visible and infrared domain. The VIRGO experiment on SOHO measures the total solar irradiance (TSI) with two absolute radiometers (DIARAD and PMO6) and the spectral irradiance (SSI) in 5nm wide bands at 402, 500 and 862nm with sunphotometers (SPM). Spectral radiance is also observed at 500nm by the Luminosity Oscillation Imager (LOI) with 12 pixels resolution. Detailed information can be found in [1].

1.1 DATA PREPARATION

A periode from 1-May through 31-July was selected for analysis. Data are based on hourly means of irradiance measurements at 1 minute cadence. The degrading spectral channels were detrended by a 5th. order polynomial through daily means and divided by that polynomial, whereas TSI variations were obtained relative to the mean solar constant of $1366 W/m^2$ A further smoothing was obtained by filtering with a 6 hour running mean of triangular shape. Solar data published in SGD[2] were consulted for identification of active regions and spots. From several passages of active regions (AR), occuring at intervals of the solar rotation, those containing sunspot groups NOAA #7962 and #7978 are examined in this paper. Data from 25 June to 17 July are shown in Fig. 1 while those for May can be found in [4]. Group #7978 formed on 7 July at about 10 deg southern lattitude and slightly western longitude and passed over the limb in 12 July, thus the irradiance dip has an asymmetric shape. Irradiance enhancement starts already on 28 June due to 3 active regions visible in the Mt Wilson magnetograms while no or very few spots were present.

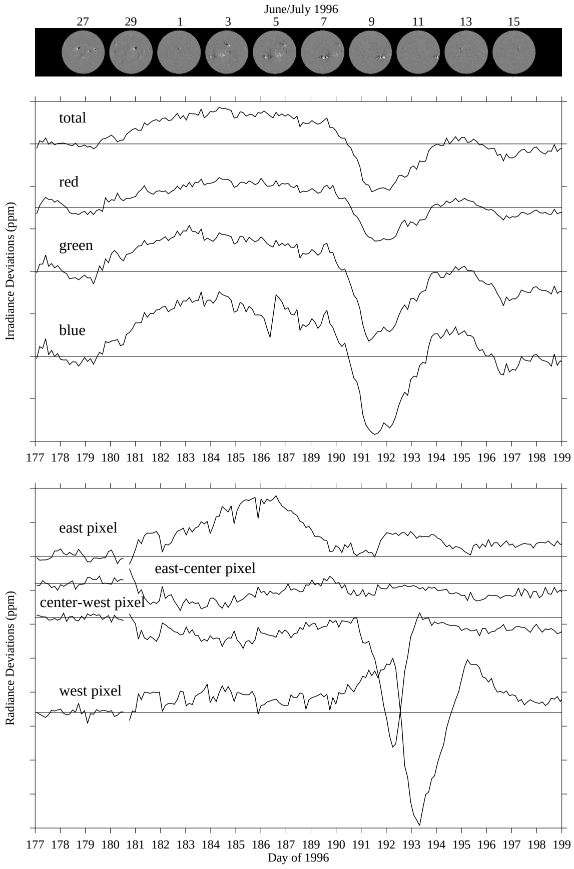

Figure 1: Passage of active region from 25-June to 17-July illustrated by Mt Wilson magnetograms (black and white correspond to ±5 Gauss); total and spectral irradiance variations from VIRGO; and radiance variations observed by southern LOI pixels. (Top to bottom, all data ppm)

1.2 IRRADIANCE CORRELATIONS

The correlation between spectral and total solar ir-

radiance is obviously high as demonstrated by Fig. 1 with correlation coefficients greater than 0.95. Relative amplitudes of irradiance variations were determined as slopes of a linear regressions between spectral channels and the total irradiance. They amount to 0.70 for 862 nm, 1.1 for 500 nm and 1.65 for 402 nm. The UV spectral range thus dominates irradiance variations well above 300nm.
Similarly, the AR around 12 May and associated spot group NOAA #7962 had slopes of 0.63, 0.78 and 1.27 rsp. with somewhat lower correlations around 0.8 This AR contained less and smaller (max area 180 μh) spots than the one in July (max 500 μh)
It should be possible to compensate the TSI variations by adding the Photometric Sunspot Index (PSI) and substracting the Facular Index (PFI). Such indices were obtained from San Fernando Observatory (SFO) [3], their PSI uses a contrast $\alpha = 0.328$, and applied to VIRGO irradiance variations. Results for May and June/July episodes are shown in Fig. 2.

2. CONCLUSION

The PSI represents reasonably well the spot deficit, but the PFI is much too small to explain the irradiance excess in both cases. The PSI corrected measurements always show an excess irradiance, yet while the AR is near the meridian, but the PFI models assume zero or negative contrast at disk center. Thus it cannot explain the measured variation even if scaled by a factor of 3 to 4. If the observed persistent excess is not a specific feature of the current solar minimum condition, it may help to understand the mechanisms of solar irradiance variability.

3. ACKNOWLEDGMENTS

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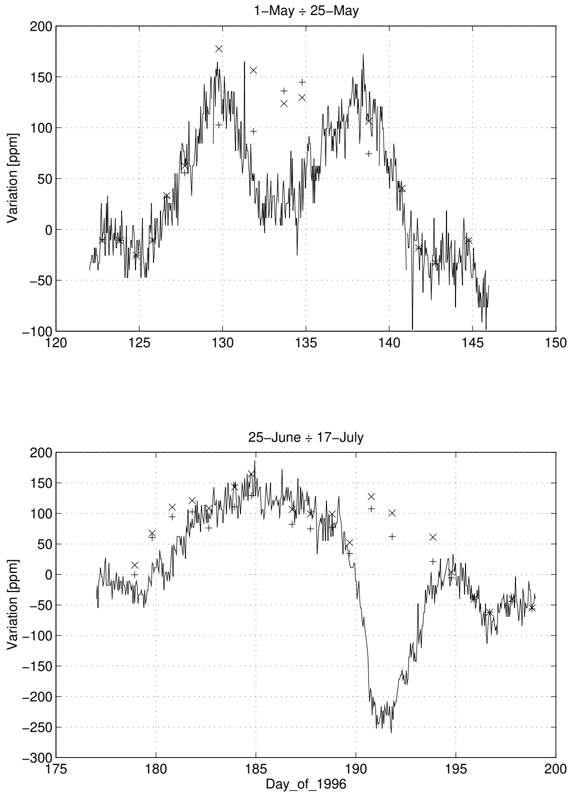

Figure 2: Total solar irradiance variation and values 'corrected' by (×) TSI+PSI and (+) TSI+PSI-PFI
top panel: May bottom panel: June/July

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