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Creating a sunspot database at the Solar Observatory of Ica National University in Perú

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Abstract. We describe the database and the method used to analyze the sunspot data recorded at the Solar Observatory of the University of Ica in Peru. The parameters that are measured include the relative sunspot number (R), the sunspot area, their positions on the disk, and an estimate of the constant (k) included in R. Sunspots in the database are classified following the Zurich Classification System. From these observations, the active region area, the sunspot rotation speed, and other active regions properties can be estimated.

Keywords. instrumentation: miscellaneous, methods: data analysis

1. Introduction

The Sun's visible surface is called the photosphere. To observe this first layer of the solar atmosphere, the integrated white light is used. Sunspots are the most relevant features observed at the photospheric level. They are the locations of strong magnetic fields and their lower temperature, when compared to the surrounding photosphere, makes them be seen as dark regions. Their darker center is known as the umbra which is surrounded by the penumbra, with an average diameter 2.5 times that of the umbra. The measured magnetic field in the umbra can be of 2000 to 3000 Gauss, in average, and can reach values larger than 4000 Gauss. The effective temperature of the sunspot umbra is around 3700 K compared to the temperature of the penumbra which is approximately 5600K (Bhatnagar & Livingston 2005, Bhatnagar & Ulmschneider 2010)

The sunspot number is considered a simple measure of solar activity as the solar magnetic field, which is concentrated in sunspots, is the root cause of all solar active phenomena. However, it is not the only activity index. Nowadays, solar activity is measured by several parameters but the oldest, easiest, and best measured is the sunspot number. Houtgast & van Sluiters (1948) have empirically shown that the maximum magnetic flux density B_n in Gauss, at the disk center, is related to the area of the spot, A_i, by the equation $B_n = 3700A_i/(A_i + 60)$ where the sunspot area is measured in millionths of the visible hemisphere of the Sun and can be obtained by projection. This equation applies to stable spots and not to spots which are in developmental phases.

2. Instrument and method

Sunspot data are obtained using a 15 cm Takahashi refractor telescope with a 1050 mm focal length. The database includes observations from June 2003 to January 2006. The Sun's image is projected using an eyepiece which produces a solar disk image with a 15 cm diameter. To sunspots are classified using the Zurich Classification System and the sunspot group evolution is registered.

The relative sunspot number is estimated as defined by Rudolf Wolf in 1848, $R = k(10f + g)$, where k is the observer's correction factor, f is the total number of spots, and g is the total number of sunspot groups. Using this equation we compare or measurements with the values obtained by the other observatories and world data centers and we can estimate the quality of our observations.

In each daily observation, the total area of sunspots is measured and a monthly average is calculated. The area of a sunspot group is calculated as $A_M = A_F N \cos\rho$, where A_M is the area in millionths of the visible hemisphere of the Sun, ρ is the angular distance on the surface of the Sun from the center of the disk to the sunspot, A_F is the area factor that depends on the diameter of the disk and grid size, and N is the number of grid points covering the penumbra and umbra of all spots in a group.

3. Dicussion

The sunspot number is considered as a simple measure of solar activity; however, it is not the only index that can be used but it is the oldest and best measured. We have described the measurements that are obtained at the Solar Observatory of the University San Luis Gonzaga de Ica in Perú. The sunspot number values using the projection method have a 70% reliability. The area, birth, and evolution of sunspot groups (using the Zurich Classification System) is also registered as a contribution to the knowledge of solar activity.

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