SOLAR DIAMETER OBSERVATIONS ON THE MAXIMUM OF CYCLE 23

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ABSTRACT.

The Réseau de Suivi au Sol du Rayon Solaire numbers four stations, in France, Brasil, Turkey and Algeria. Though formally established in 2002, the common works of those groups was started as early as ten years before, particularly involving the CERGA and the ON.

The method and instruments used by this network are introduced. Results of solar semi-diameter variation campaigns are presented for the years corresponding to the peak of the solar activity cycle 23. The outcome shows that the average value for a session of measurements is obtained with accuracy better than few tenths of arc second, what enables to establish a positive correlation with the sunspots count to a level of certainty better than 0.99.

1. THE RÉSEAU DE SUIVI AU SOL DU RAYON SOLAIRE

The principle of measurement of the solar diameter with astrolabe derived instruments is based on the time difference of the upper and lower limb summit transit by an instrumentally defined zenith distance. Several prior experiments had shown that the astrometry of such type of measurement was accurate to the level of some tenths of arc second, and remained coherent on the scale of years (Andrei et al., 2000). As early as 1975 solar diameter observations with a modified Danjon astrolabe were started at the CERGA (Laclare et al., 1996). In 1989, the same group introduced the CCD acquisition of the solar images, followed in 1996 by the fully digitized treatment of the observations, and automation of the analysis. It is interesting to remark that, even though the different modes of observation, which lead to the diminution of the results dispersion by a factor of 10, there is no discontinuity on the measured values. Figure 1 shows the CERGA measurements made with the series of modified astrolabes.

Since then several solar astrolabes stations (eg., Brasil, Spain, Chili, Turkey) confirmed the variations observed by Laclare at CERGA. Presently, the Réseau de Suivi au Sol du Rayon Solaire (R2S3) was established, by the groups of the CERGA/Observatoire de la Côte d'Azur (France), Observatório Nacional (Brasil), Tubitak National Observatory (Turkey), and CRAAG/Observatoire d'Alger (Algeria). At the CERGA there is a prototype, DORAYSOL, of the second generation instrument that will be at work among the R2S3 groups. The new in-

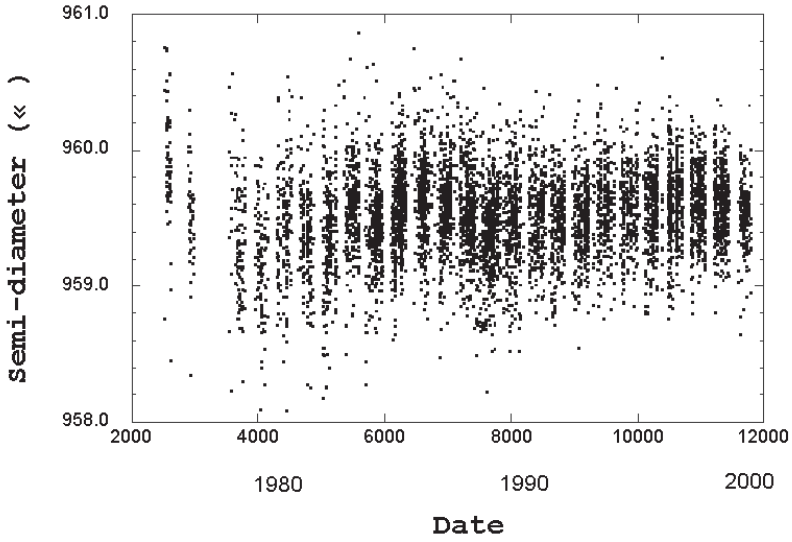

Figure 1: Solar Astrolabes CERGA series (values corrected to zenith conditions).

struments are characterized by a highly stable frontal prism of variable angle, multi-wavelength capability, tele-commanded pointing and image acquisition, and a telescope replacing the objective lense of the classical astrolabe. The combination of the characteristics enable to obtain a much larger number of independent measurements (up to 40/day), and enhanced accuracy (at the level of 0".1). A seeing monitor will work at the CERGA station, which will also harbor test measurements for the SODISM instrument on board the solar satellite PICARD. Table 1 schematizes the instruments of the Network

Réseau de Suivi au Sol du Rayon Solaire R2S3
(Christian Delmas, **Astrométrie et Métrologie Solaires**, septembre 2002)

Sites	**Calern**	**Rio de Janeiro**	**Tamanrasset**	**Antalya** (Turquie)
Instrument de Référence	AstroSol de FL 11 Prismes fixes Série Visuelle **1975-2002** 7000 mesures, **σ = 0.28"**	AstroSol de AHA **PV1** (prototype Calern 1986) Série CCD **1997-2002** 14000 mesures, **σ = 0.40"**	DORAYSOL 2 Télescope + CCD **2003** Prisme Variable **PV3**	AstroSol de FC et OG 3 Prismes fixes Série CCD **1999-2002** 1500 mesures, **σ = 0.30"**
2ème Instrument	DORAYSOL 1 Télescope + CCD Prisme Variable **PV2** (prototype CNRS 1989) Série CCD **1999-2002** 6000 mesures, **σ = 0.24"**	Type DORAYSOL Télescope + CCD **2003** Prisme Variable **PV3** (*à l'étude*)		DORAYSOL 3 **2004 ?** Prisme Variable **PV3**
3ème Instrument	MISOLFA Paramètres et profils de turbulence atmosphérique **2003** Observations simultanées avec DORAYSOL 1			

Table 1: Instruments of the Réseau de Suivi au Sol du Rayon Solaire - R2S3 Network.

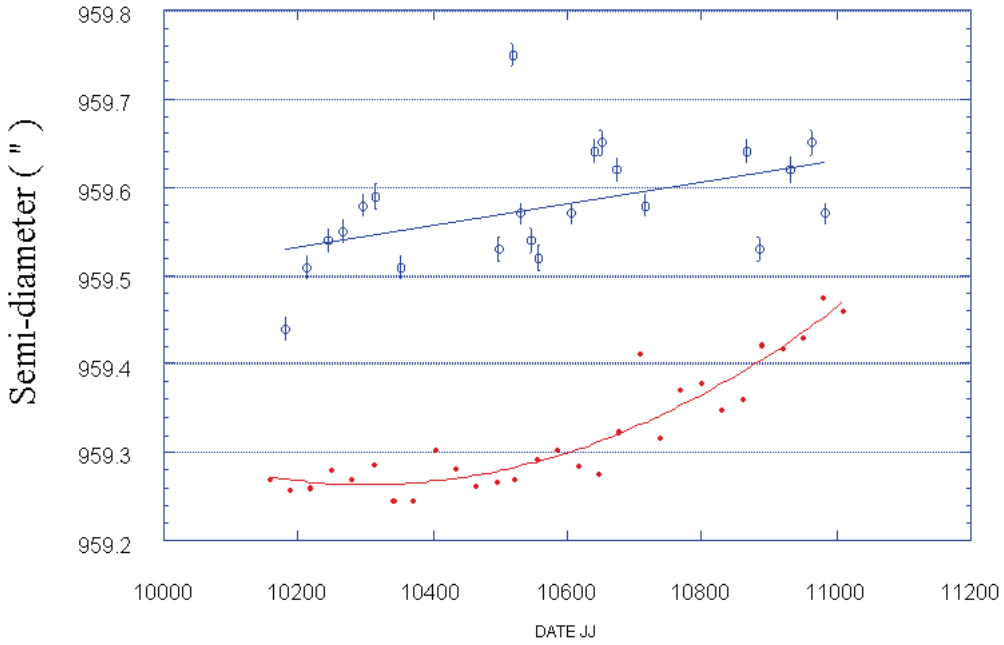

Figure 2: The semi-diameter measurements (corrected to zenith conditions) from the CERGA solar astrolabe are shown by the upper curve. The bottom curve shows the sunspot count number.

2. COMPARISON WITH THE SOLAR ACTIVITY

The very different atmospheric conditions and the different helio latitudes of the measured solar diameter, give a complementary nature to the results from the four stations. From the Rio de Janeiro station, the observations can be carried out all year around.

During the rise and maximum of the solar activity cycle 23, a positive correlation between the solar diameter variation and the sunspot count number was verified. Figure 2 compares the measured diameter, obtained by the CERGA solar astrolabe, and the sunspot count number, for the period from 1996.5 to 1998.5, which corresponds to the rise of cycle 23. Emilio et al. (2000) found similar agreement analyzing MDI SOHO observations.

The correlation close to the maximum of the cycle (from 1998 to 2000) is shown in Figures 3, for the Rio de Janeiro observations. In this case, the Mann-Whitney non-parametric correlation test does not distinguish between the two normalized distributions even to the level of 99%.

3. CONCLUSION

The results from solar semi-diameter variation monitoring programs are increasingly being used to derive constraints on solar models (Pap et al., 2001; Rozelot et al., 2002, Reis Neto et al., 2002). Important advances on the reliability of the measures have been obtained by DORAYSOL like, second generation instruments. Also the use of frontal prism of variable angle increased the quantity of possible measures by one order of magnitude.

A next important step has been done by the establishment of the Réseau de Suivi au Sol du Rayon Solaire network, which groups four stations, that had already long term forms of cooperation. The R2S3 network, aims to common measurements, similar equipment facilities, and interchange of methods.

Here we present results from the R2S3 observations, showing a statistically significant positive correlation between the increasing on the measured semi-diameter and the increasing on the sunspot count number, during the rise and maximum of the solar activity cycle 23.

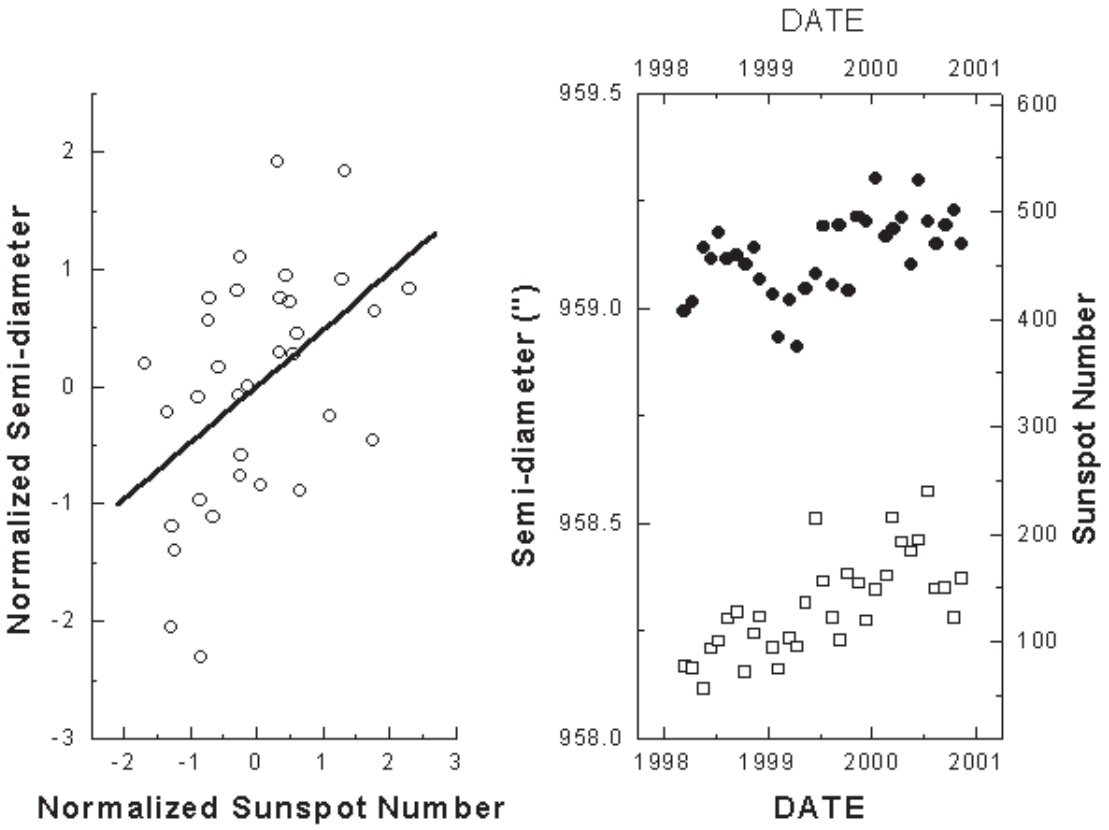

Figure 3: Rio de Janeiro station monthly average for the measured solar semi-diameter and the monthly average for the sunspot count number. On the left the direct comparison, where the linear correlation is verified at 3σ. On the right the time evolution of the average values (filled circles for semi-diameter values and open squares for sunspot numbers).

4. REFERENCES

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