DETECTION OF A SIGNIFICANT CHANGE IN THE SOLAR DIAMETER

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Abstract. Drift-time measurements of the solar diameter made at Izaña and Locarno in 1990-1992 show a significant increase of the observed angular semidiameter when compared to results obtained at the same two sites in 1981. The observed increase of ≈0.4" is not due to a systematic (or long-term) variation, but seems to reflect a more complicated behaviour with time: As both series of measurements were made around a maximum of the 11-year cycle, it seems that a variation in phase with solar activity (in the sense of the Secchi-Rosa law) can be ruled out.

1. Introduction

When made with large telescopes under good seeing conditions, measurements of the solar semidiameter (or angular radius) by the drift-timing technique (Wittmann, 1973) may achieve an accuracy of about ±1" for a single measurement, or about ±0.2" for a series of (typically 16-32) individual measurements (Wittmann, Alge, and Bianda, 1991). We have made such measurements at two different sites (Izaña/Tenerife and Locarno/Switzerland) in 1981 (Wittmann, Bonet, and Wöhl, 1981) and from 1990 onwards (Wittmann, Alge, and Bianda, 1991). Some problems associated with these measurements are: a) observer bias (change of observer or observer performance), b) instrumental bias (change of telescope or timing equipment), c) sky quality bias (change of site or local seeing conditions), and d) methodological bias (change of computer or reduction algorithms).

2. Observations and Reduction

We have been fully aware of these problems and have tried to minimize them by: a) restricting the analysis to measurements made by the same three observers (viz. the present authors), b) using large telescopes (aperture ≈ 40-45 cm) and employing digital timers of high quality (Izaña 1981, where a mechanical stopwatch was used, is the only exception), c) restricting the present analysis to measurements made under good or very good (or even excellent) seeing conditions, and d) verifying the reduction routines as rigidly as possible (e.g. by calculating local circumstances of solar and lunar ecplipses using basically the same code).

3. Results

Our measurements made under good seeing conditions (viz. 48 % of all) are summarized in Table I. It is evident that a significant increase of the solar semidiameter (of magnitude ≈ 0.4") has occurred between 1981 and 1991: An instrumental origin can practically be ruled out, in particular as a similar increase (of ≈ 0.2", but with an offset of about 1.2" between the absolute semidiameters and a local maximum in 1968) is also indicated in the CERGA data (cf. Delache et al., 1993, their Figure 1).

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TABLE I. Solar semidiameter results 1981 and 1990–1992 (derived from observations made under good or very good seeing conditions).

Year	N	Locarno	N	Izaña
1981	1202	960.38±0.03	481	960.12±0.04
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1990	83	960.69±0.09	99	960.59±0.05
1991	176	960.77±0.06	432	960.57±0.02
1992	240	960.72±0.05	384	960.61±0.03

We briefly mention a few other results from the present investigation:

1) The typical mean error of a series (N=16–32) is ±0.08" at Izaña and ±0.15" at Locarno; this clearly reflects the systematic difference in atmospheric resolution between these two sites.

2) The linear correlation coefficient for two series of measurements made strictly simultaneously by two different observers at the same site is always close to +0.71, indicating that the larger fluctuations due to atmospheric image motion are being conceived quite similarly by two experienced observers.

3) Short-period (P ≈ 25 min) fluctuations of amplitude about ±0.3" are sometimes conspiciuos (e.g on August 4, 1992, between 9.10 and 10.33 UT at Izaña), but these occur uncorrelated between the two sites and seem to be of local (atmospheric) origin.

4) There is a global dependence on seeing, in the sense that larger semidiameters tend to be observed when the seeing is bad. There is no such dependence, however, if the seeing is not too bad: The smallest semidiameters were sometimes found when the seeing was good but not excellent.

Further measurements are needed to study the solar radius variations in more detail, and in particular the Istituto Ricerche Solari Locarno (IRSOL) intends to continue these measurements on a regular basis.

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