Large-Scale Schmidt Plate Errors and Guide Star Catalog Analysis

1. Introduction

Although it is well known that large-scale Schmidt telescopes are not suitable for wide-field coordinate determination, they are used sometimes for such kind of work.

An example is the Hubble Space Telescope Guide Star Catalog (GSC). Its authors (Lasker et al. 1990) do not pretend to consider it as a true reference catalogue and this list of star coordinates was designed only to support the operational requirement of the Hubble Space Telescope for off-axis guide stars.

Astrometrical properties of the GSC were investigated by its authors (Russel et al. 1990) and by other astronomers (Taff et al. 1990) and all of them conclude that systematic errors of GSC positions are rather large. Nevertheless, nobody proposes any algorithm or correction tables which could improve GSC in the astrometrical sense.

2. GSC versus PPM

Besides such properties, the deepness of GSC and the absence of good reference catalogues needed for the reduction of faint object observations made with narrow field telescopes or CCD receptors make GSC very attractive for this kind of work.

Trying to investigate the GSC properties we have found that, due to the perfect GSC CD-ROM data organisation, it is possible to fulfil the plate analysis of the GSC systematic errors by the comparison of GSC with other independent catalogues.

Our aim is to use these estimations afterwards to correct GSC star coordinates in faint objects observation reduction procedure. As an external standard we use the PPM catalogue (Bastian et al. 1991, 1992) which contains about 400,000 stars over the whole sky with high-quality positions and proper motions in the FK5 system. The mean PPM precision is about 0.2" for positions and 0.003"/year for proper motions. Thus, results of GSC and PPM comparison for the GSC observation epochs can be considered as the GSC systematic errors estimation.

2. GSC Plate-based Errors Analysis

Schmidt plate errors relative to a plate-based coordinate system are so large and complex that usual single plate reduction procedures cannot eliminate them.

The PPM catalogue is a good base for investigation of such kind of errors because it gives about 300 – 400 stars in 7 - 11 magnitude range for every GSC plate. Taking all GSC plates from pole to pole, considering 400 cells 19.2 per 19.2 arcmin and averaging (GSC - PPM) star coordinate differences in every cell, we obtained the results shown in Fig. 1 and Fig. 2.

Figure 1 represents the Palomar Schmidt plate errors (northern hemisphere) and Fig. 2 the UK Siding Spring Schmidt plate errors (southern hemisphere). Both figures show approximate results but they look very regular due to the large quantity of stars included in the investigation. Each error vector is the mean of about 500 stars for the northern sky and about 600 stars for the southern one. The vector scale (1") is shown in the lower right corner of the figures.

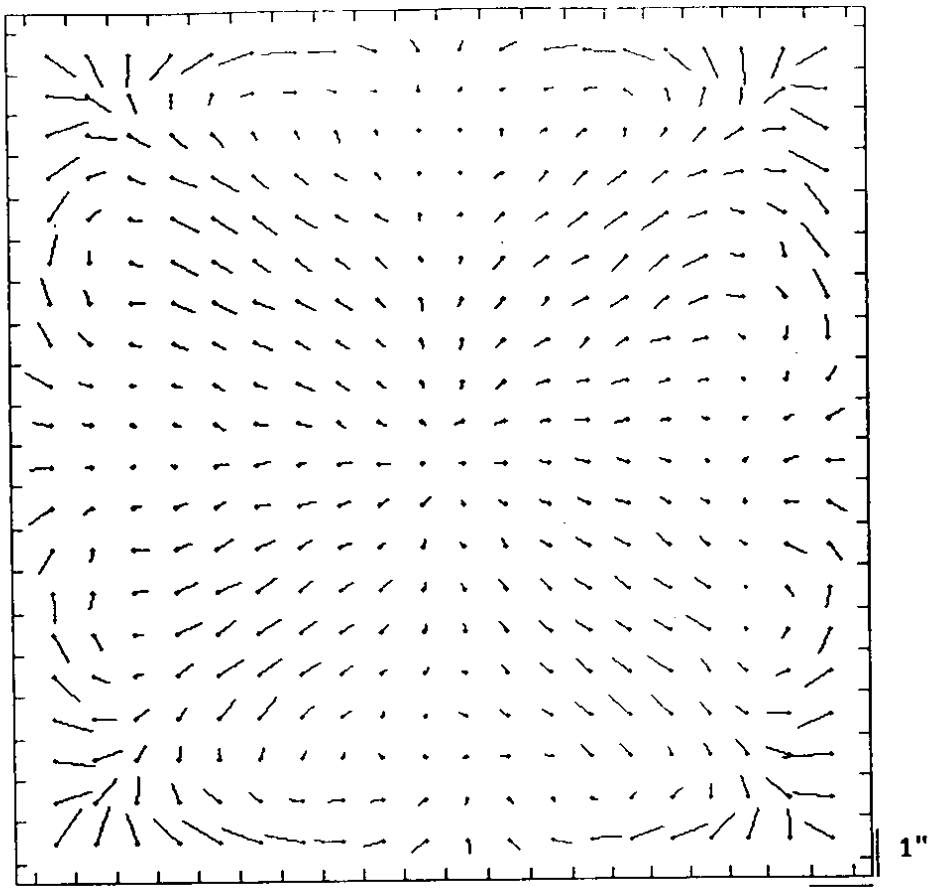

Figure 1. (GSC - PPM) differences vs. star position on GSC plates before correction. Northern hemisphere.

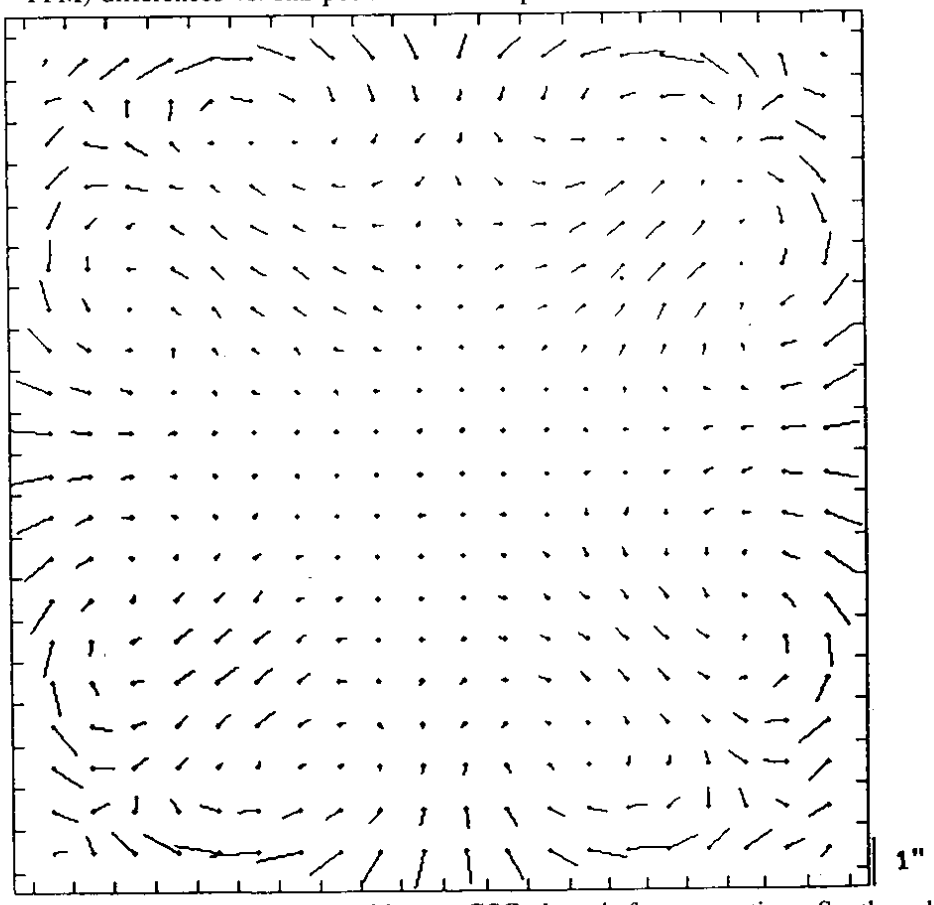

Figure 2. (GSC - PPM) differences vs. star position on GSC plates before correction. Southern hemisphere.

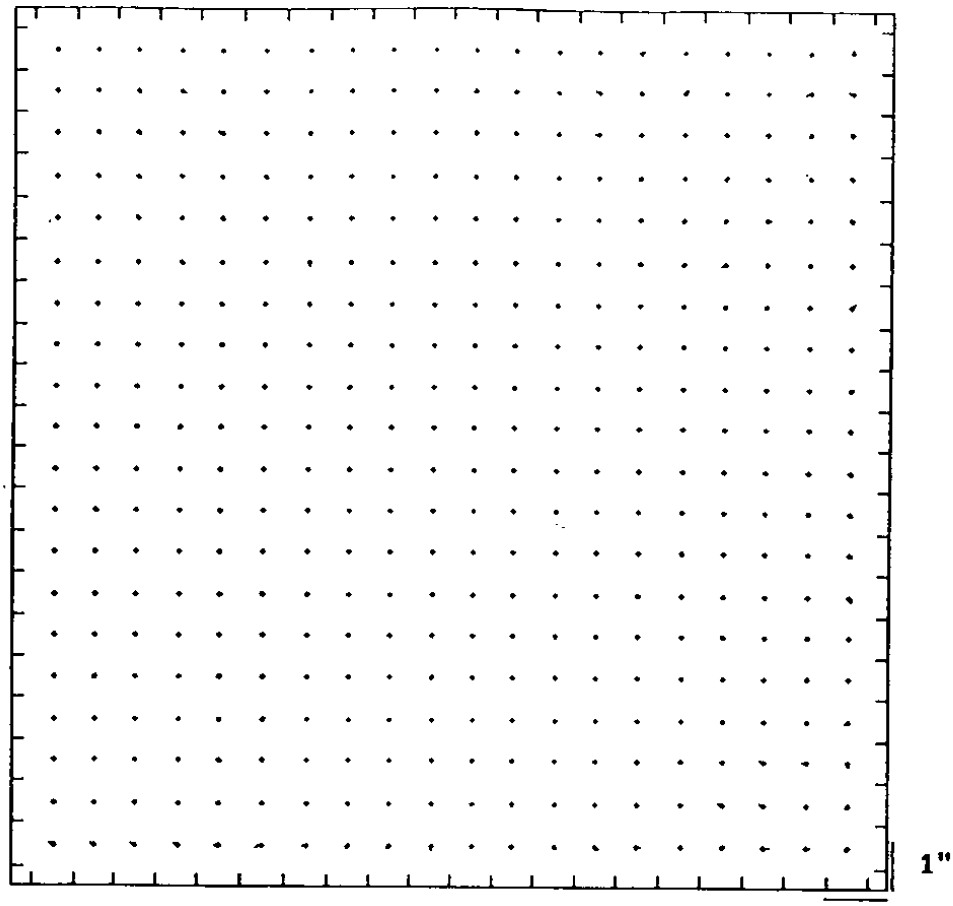

Figure 3. (GSC - PPM) differences vs. star position on GSC plates after correction. Northern hemisphere.

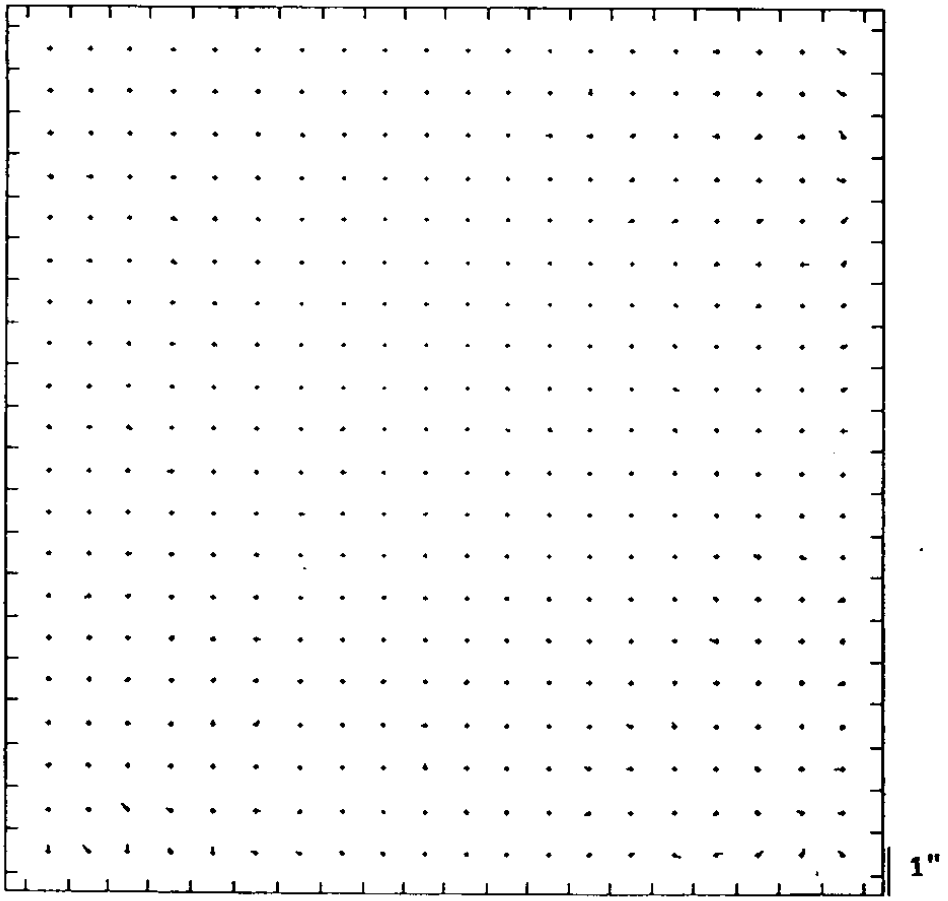

Figure 4. (GSC - PPM) differences vs. star position on GSC plates after correction. Southern hemisphere.

It can be said that:

- both figures are very similar to one another, i.e. they reflect mainly properties of Schmidt telescope optics;
- both figures show significant plate errors not only near the plate edges, but also at the central parts, i.e. GSC is worse than it is thought to be;
- both figures show that plate errors are very regular and symmetric, i.e. they can be easily and reliably corrected and GSC can be significantly improved.

Figure 3 and Fig. 4 show similar representations after applying mean corrections to each cell. Systematic plate differences are now practically absent.

3. Concluding Remarks

We present our examination of the Hubble Space Telescope Guide Star Catalog. We have found that this catalogue is distorted by two kinds of systematic errors. Some of them are plate-based errors produced by Schmidt telescope optics and by the pure reduction model. The other ones are sky-based errors produced by reference catalogues.

We have developed a subroutine (in BASIC and FORTRAN for PC) that, connected with GSC CD-ROM, gives out GSC star positions corrected for both kinds of systematic errors. Stars for any magnitude range and any sky field, limited by two right ascension and declination circles, can be obtained.

We hope that our work will be useful for those who need better reference stars in dense fields, at least till the appearance of the Hipparcos catalog or of a new reduction of the Guide Star Catalog.

References

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