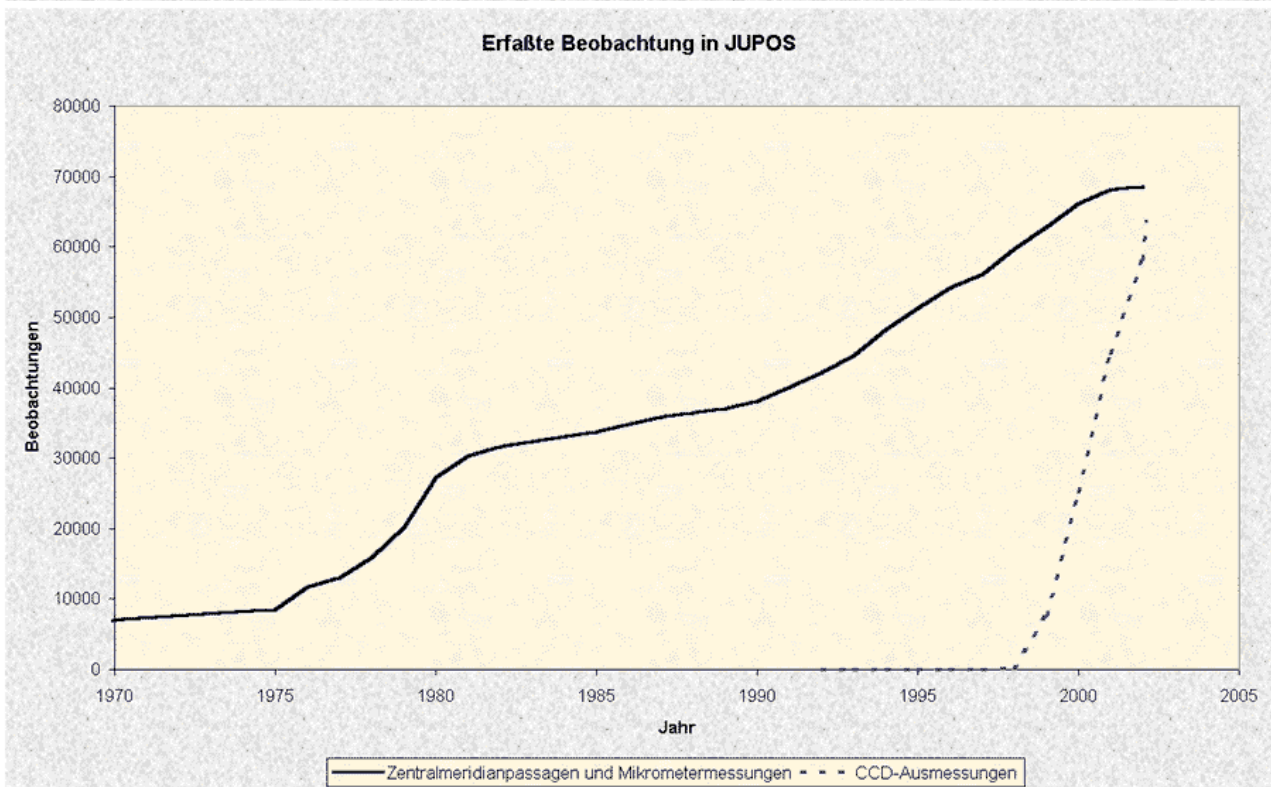
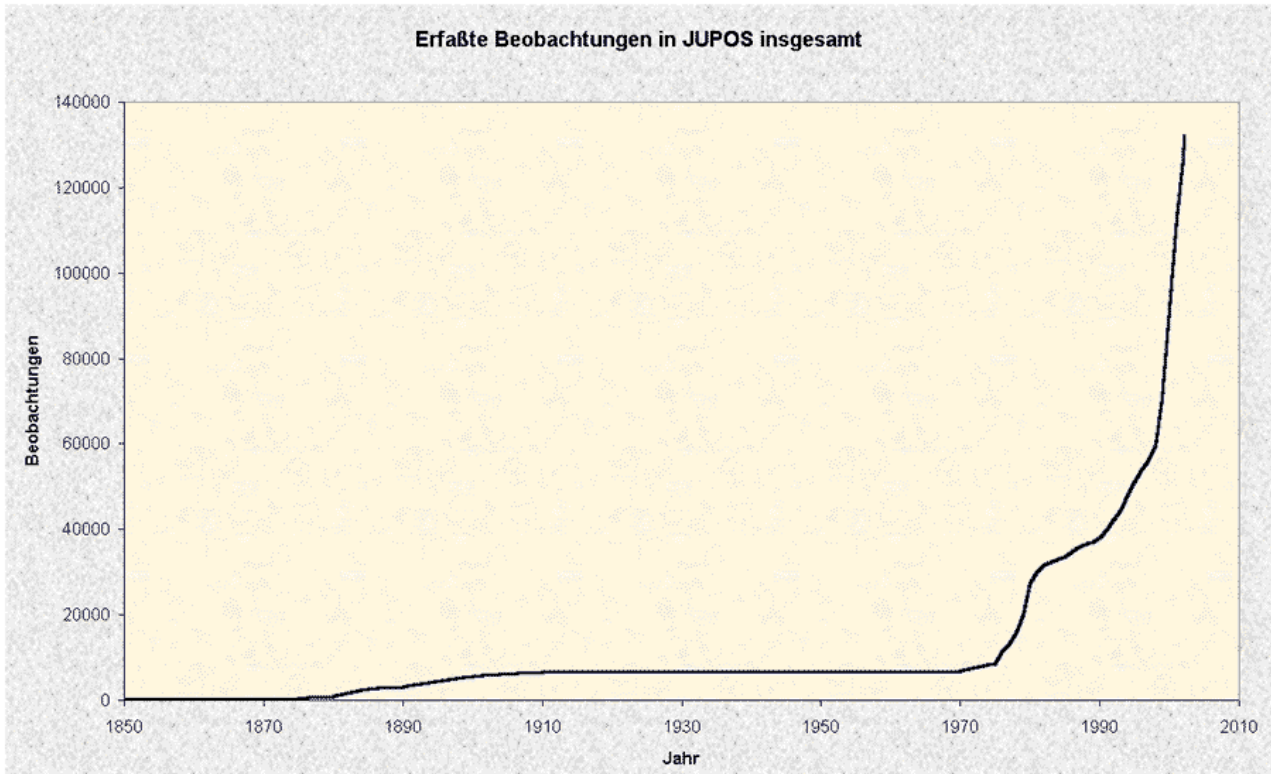


Some thoughts on JUPOS

Hans-Jörg Mettig, April 2002

CCD images of Jupiter are regularly measured using PC-JUPOS since 1998. Four years ago I never dreamed that the project will soon become that successful. Since then, tens of thousands of positional measurements on images of almost 50 observers have been made.



Statistics by Grischa Hahn as of March 2002

Four amateur astronomers from Great Britain, Italy, and Germany take part in measuring, further two have announced their interest. This state permits - and requires! - to note down a few thoughts on the project's further improvement. The following lines are a mix of technical and organizational issues I am presently concerned with. I apologize if someone should find "trivialities": The text is also meant for instructing new measurers.

The CCD images used in figures are by António Cidadão, Brian Colville, Damian Peach, and Clay Sherrod.

Software

PC-JUPOS will not continue to be developed as a DOS version. However, Grisca would eliminate functional errors which have remained undiscovered in the current version (at present, 6.17).

Grischa plans to implement a new program version for Microsoft Windows. It will essentially contain the same functionality as PC-JUPOS but be designed for a more up-to-date operating system which one can handle more comfortably and will, hopefully, still be standard on home PCs in ten years. However it is open at present when a first Windows version will be released.

Wishes and suggestions for the Windows version should be sent directly to Grisca (address see JUPOS homepage, "Contact"). Of course I can pass them on to him as well.

A native English speaker who manages the translation of the new version to his mother tongue would be very welcome. Thus one could avoid a recurrence of the numerous errors and imperfections which crept into the software during its translation in the early and mid-90's.

Project aims

I regard two aims as particularly important for the next years:

1. The growing quantity of good CCD images has to be met by a larger but still manageable number of measurers.
2. The accuracy of measurements has to be improved. Grossly incorrect records of well defined objects with deviations > 3 degrees have to be eliminated.

Growing data volume

The quantity of Jupiter images with sufficient quality will continue to rise in the next years. I am near the very limit and hardly able to manage new observers - unless current observers become inactive in the future. Moreover the organizational overhead for communication and data handling is getting larger, so less time remains for measuring. The other measurers also seem to have no more resources.

Thus we need a larger number of measurers. On the other hand, I fear that not only too many people would exceed the limits of this amateur project, but also too many positional records. I think that altogether five or six measurers (incl. me), who each process ~30 images on average per month, are optimal.

People who want to start as a measurer must have observational Jupiter experience and should bring along also some experience in analyzing observations of the planet. It is clear that the last point will not be met in most cases. For interested amateurs without Jupiter experience I suggest a training phase of about 12 months. During that time the new measurer would deal with images in parallel to an experienced one in order to gain a feeling for the planet. Of course, during this test phase only results of the experienced measurer are stored in the database.

Very important: Each measurer should manage several observers. Own results can be verified (or rejected) much better then, and error sources are more rapidly detected. For this reason I make available the complete, up-to-date database on the JUPOS homepage in a monthly rhythm from now.

Starting with a new observer

Please contact me briefly before you begin to measure: maybe his images have reached also on my harddisk. When giving green light, I determine the identifier of the new observer (i.e. the name of his MES file). The file must be created in PC-JUPOS at "Measurements - New", its name can be modified at any time via [F6].

Cataloguing images

I strongly recommend to create a separate directory (folder) for each combination:

- Jupiter apparition
- image type, i.e., original file, or PCX file to be measured
- observer

otherwise chaos will rule your harddisk in a few years. The PC-JUPOS directory structure on my computer is basically as follows (A, B, etc. are the individual observers):

```
..\1999_00\incoming\A_in\  (original files of A, 1999/2000)
                        \B_in\  (      "      B, 1999/2000)
                        \C_in\  (      "      C, 1999/2000)
                        ...
        \measured\A\      (PCX files of A, 1999/2000)
                        \B\      (      "      B, 1999/2000)
                        \C\      (      "      C, 1999/2000)
                        ...
\2000_01\incoming\B_in\  (original files of B, 2000/2001)
                        \D_in\  (      "      D, 2000/2001)
                        ...
        \measured\B\      (PCX files of B, 2000/2001)
                        \D\      (      "      D, 2000/2001)
                        ...
etc.
```

A lot of work when measuring, and annoyance when you later search for a special observation, can be avoided if you name each PCX image according to the Miyazaki convention, i.e. date and time of image exposure are coded in the file name (for details see F1 help or JUPOS homepage, menu item "Image requirements"). However this name does not include the year. Thus the assignment of a PCX file to its correct apparition in the directory structure above is most important.

Preparing a measuring session

The basic approach is described in the F1 help texts at "Measurements - Image files" and of the measurement screen. (The same texts but in an older state you find in the PC-JUPOS Software Handbook.) It follows some supplements.

- Only use Windows 98, ME, or 95 as the PC's operating system. The reason is explained on the JUPOS homepage, menu item "Windows configuration". A resolution of 320 x 240 pxs. for the measurement screen, the highest available under Windows 2000 and NT, is too poor to get precise positions.

- I recommend to store a separate settings file for each observer ("Measurements - Image files - Save settings") and to use these settings as templates for later measurements: After re-loading an observer's settings ("... - Load settings"), his images are immediately available even if they are situated in a special subdirectory. And if all settings include your measurer code, it will never be missing in the MES files...

- Please never forget to enter your measurer code ("pea", "ani", etc.) in the "Note" field. This information has always to appear, together with the color code, in the column "Note" of the measurements list. You can verify this by pressing [F4] and, if necessary, [F3] when the list is displayed.

- In case the "Monochrome" colour option has been selected, please specify the channel's type in the entry field behind "Monochrome" as follows:

inte ... integrated light
red ... red
blue ... blue
gree ... green
ired ... broad-band infrared
XXX ... narrow-band infrared, with XXX= average transmission wavelength in nanometers.

If another colour option than "Monochrome" is selected, it will automatically be written to the MES file.

Setting the outline frame

The quality of positioning Jupiter's outline frame determines the precision of measured positions. Unfortunately that positioning is seldom unambiguous; images of different observers show quite clear differences between visible and true limb, and even in sets of the same observer there are noticeable deviations. Also an automatic setting of the outline frame is mostly not sufficient to get best results, i.e., a manual (post-)adjustment becomes necessary.

If a moon or moon shadow is captured on an image, its measured position should always be used to verify the outline frame: When the measurement screen is visible, press [F8], [Enter], and [M], write down the x-y coordinates of the moon/shadow, hit [Esc] to return to the measurement screen, move the cursor to the moon/shadow, and compare its x-y coordinates displayed in the upper right part of the screen with the ephemeris values. Now, if necessary, correct the outline frame so that theoretical and measured coordinates correspond as good as possible. - When this turns out to be impossible in longitude, most probably a wrongly recorded time is the reason.

On most occasions however no moon or shadow is shown. Then I find it very useful to use well known latitudes of belt edges or long-lived features (e.g. the SSTC ovals at ~-40.5 degrees) as a reference. That is not a strictly scientific approach, but I do not know a better procedure to obtain best positions in that situation...

Jupiter should be zoomed as large as possible since a maximum disc diameter improves the measurement accuracy!

What to measure, what to omit?

It is hard to give a general rule. Unfortunately the most interesting features are not necessarily the largest and most conspicuous ones. Sometimes even very difficult objects show most interesting results, like the tiny projections on the SEB north edge did in this apparition. However one should avoid to measure finest features everywhere on the planet's disc for two reasons (with "finest features" I mean objects which do not leap to the eye at first sight on images a lá Antonio, Damian, Don or Ed):

- finest features are often indistinguishable from image artefacts
- they are often extremely short-lived and therefore show up as useless "noise" in drift charts

For these reasons I would ask to generally omit finest structures when measuring. If this rule should be broken because a region shows interesting developments, I will send an alert to all measurers.

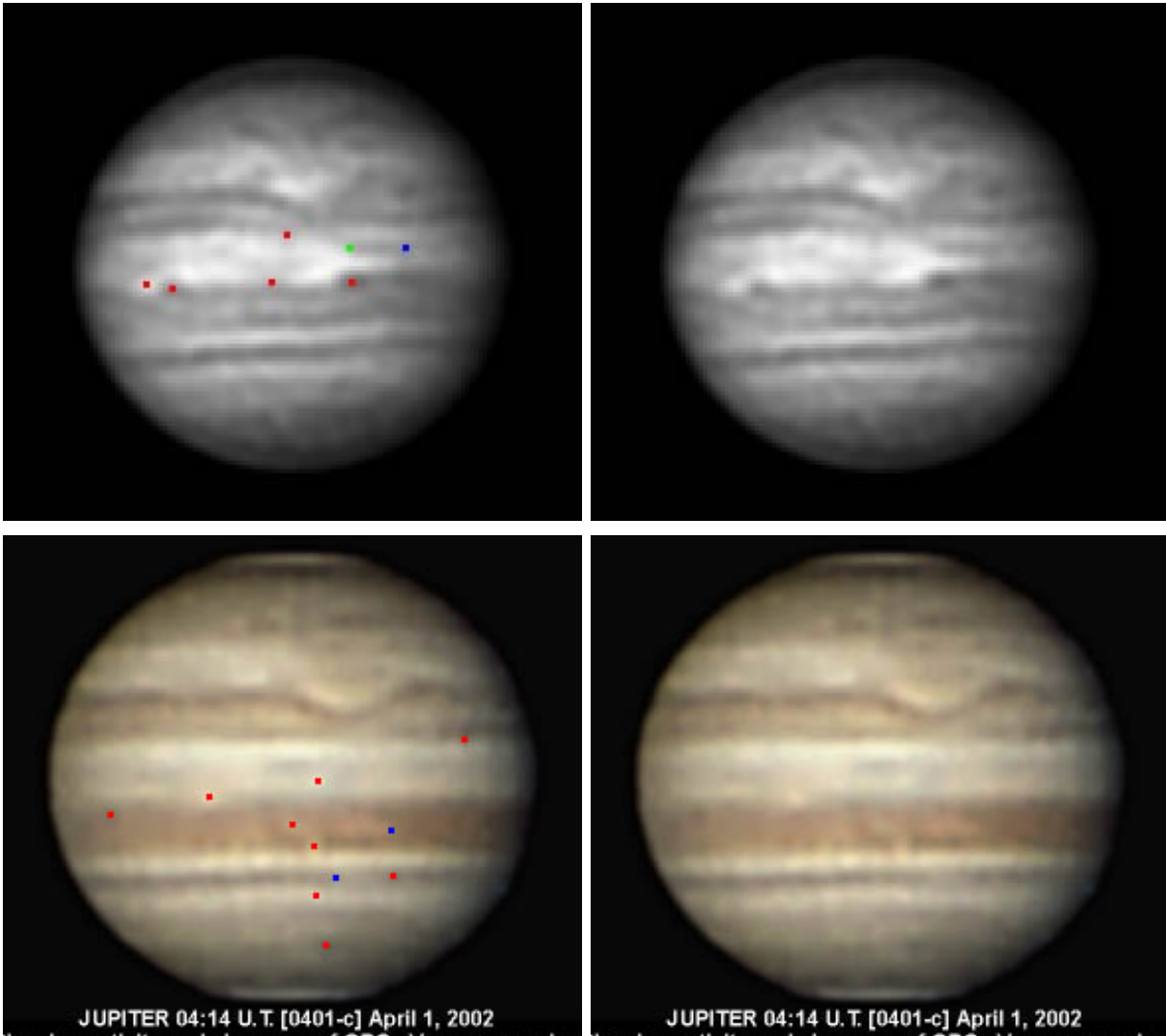
On images with lower resolution the term "finest features" has another meaning, of course. However one should avoid to move the cursor to detail near the limit of visibility also on such observations: Features are blurred and distorted though often better represented on other images taken at about the same time. Thus concentrate on extensive features (e.g., NEBs plateaux) and omit "crucial" objects like the GRS or BA on images of poor resolution.

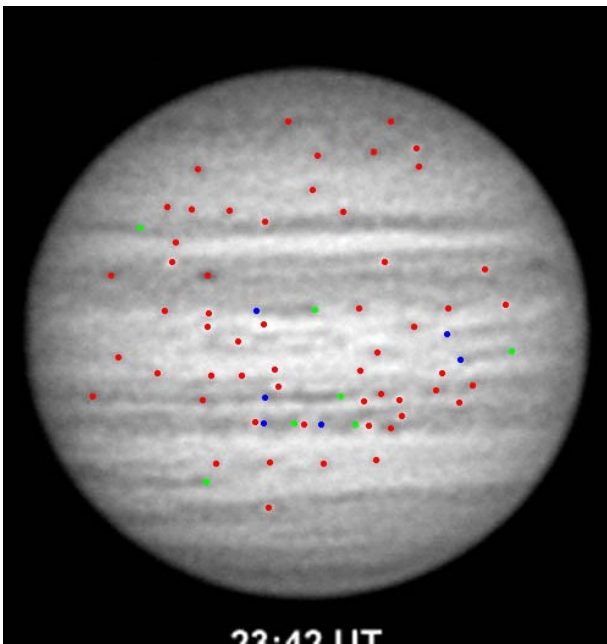
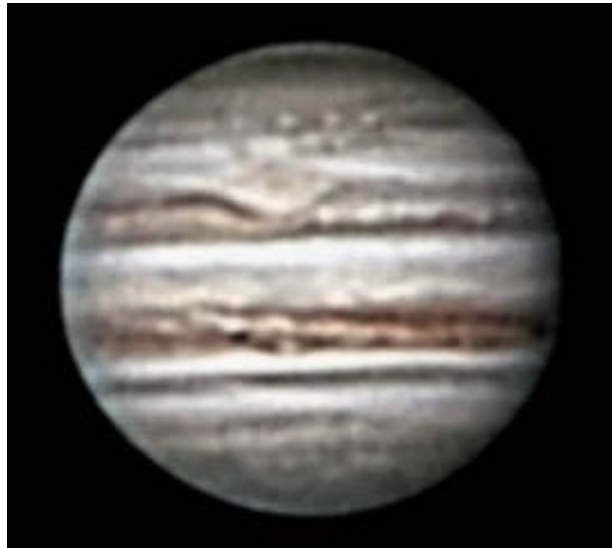
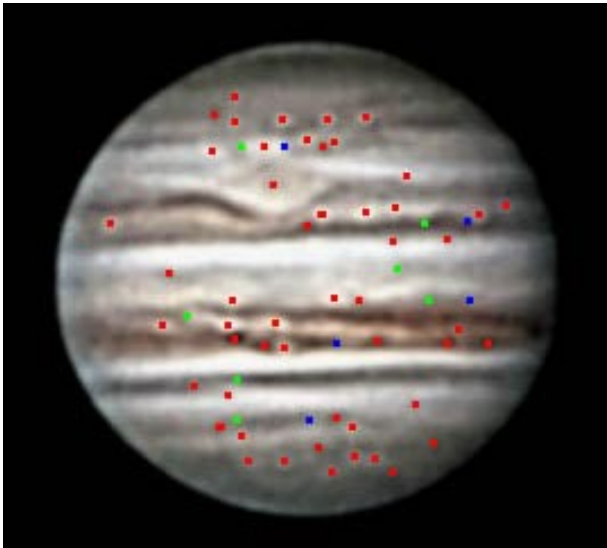
Please measure p. and f. ends of extensive features only on images with higher resolution where they are *unmistakably* defined.

Do not measure features too close to the planet's limb (p. or f.). Even on high-resolution images the measurement range should not extend beyond +/-40...45 degrees from the CM. - Objects near the poles are, of course, not bound by this restriction!

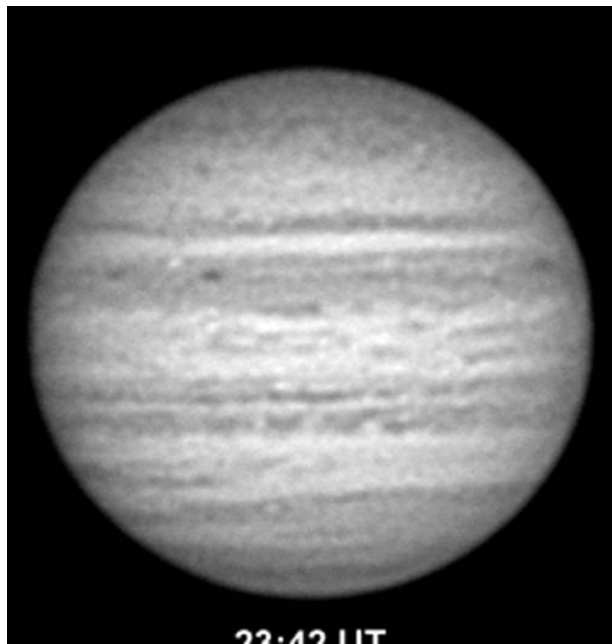
When measuring p. and f. ends of an equator-parallel structure, please attempt that both ends (also the object's center if recorded) get the same latitude integer. E.g., if the p. end was measured at -12.9 degrees, and -13.1 degrees are shown for the f. end, check whether the f. end could also be put to -12.9 degrees (or the p. end to -13.1) without remorse. Equal integer latitudes are advantageous for the graphic analysis of data. - Features that clearly show a shift in latitude along their longitudinal extent are not meant of course, e.g., NEB rifts emerging in the southern part of the belt and running out several degrees to the north.

It follow a few sample images where all features I would measure (or already measured) are marked. Red, centers; green, p. ends; blue, f. ends.

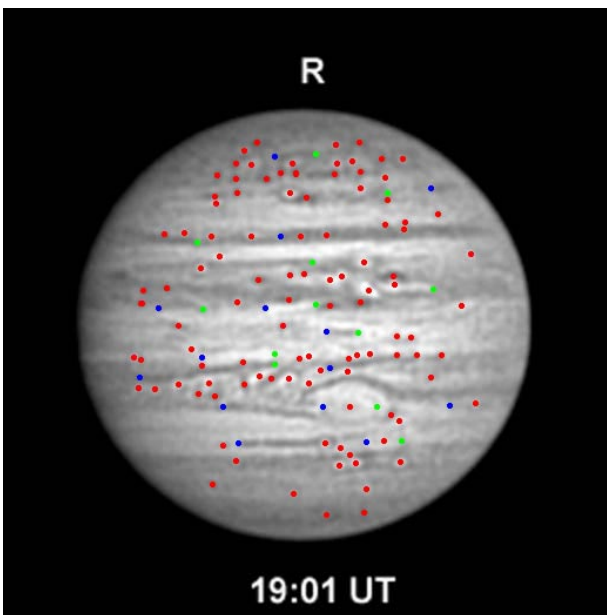




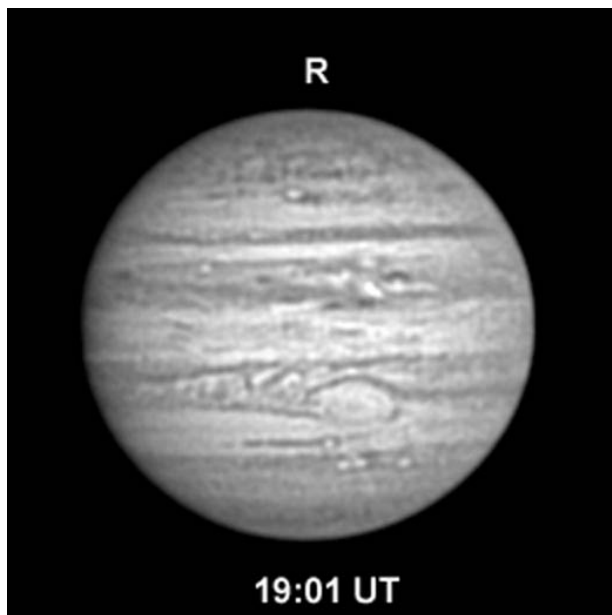
22:42 UT



22:42 UT



19:01 UT



19:01 UT

Examples of measured features. Red, centers; green, p. ends; blue, f. ends.

Typical pitfalls

- Incorrect image timing

There is not much to say about this well-known matter... The measurer please contacts "his" observer as soon as possible!

- Images span several minutes

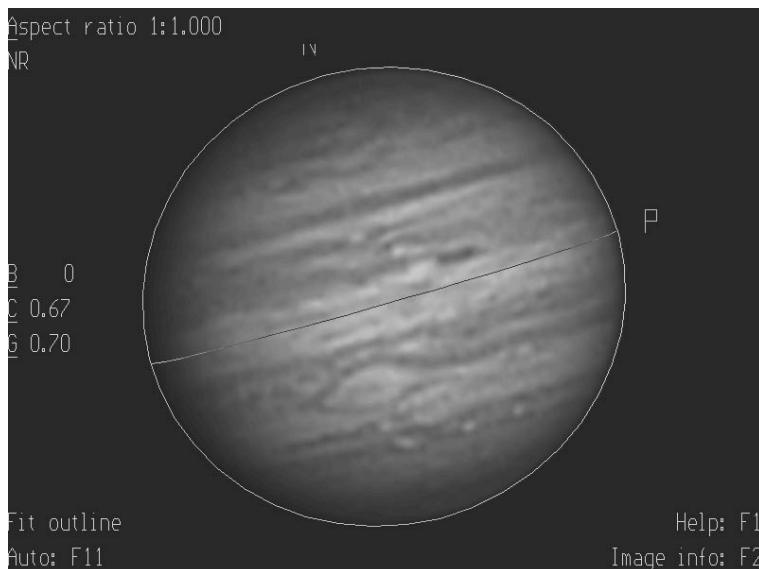
Please ask all observers which time intervals their (monochrome or colored) images span. If an exposure takes several minutes, it is helpful to state the total time range instead of a single point in time, e.g., "18:45.9-53.1 UT". If a picture spans more than four minutes, avoid to measure it completely, or measure just diffuse extensive features. For colored CCD images, an information on the recording times of the individual monochrome frames is very useful.

- Images are laterally (east-west) inverted

This happens occasionally but almost exclusively to new or irregular observers.

- Phase

Always align the outline frame on Jupiter's illuminated limb, never at its terminator. The latter becomes invisible outside opposition time even on high-resolution images! The distance between displayed limb and frame line has to be identical from pole to pole. (As the limb is vaguely represented in most cases, one should better say, the outline frame has to be evenly embedded into it.)



Example for setting the outline frame, with different image brightness.

Observations of Antonio suggest that in the broad-band infrared even the *illuminated* limb shows a tiny phase, perhaps an effect induced by the methane band at 890 nm (where the planet is not flattened at the poles but at the eastern and western limb). For that reason, be especially careful when measuring infrared images.



Two IR images at opposition 2002 indicate a slight phase at the p. and f. limbs.

- Systematic errors of center estimations

Please check if the visually estimated center of extensive features is identical for different image orientations. I and many other observers get quite different results: Generally I estimate the center too far to the right, also on the PC-JUPOS screen. Thus measurements of, e.g., the GRS center on images with *south up* and *north up* give clearly different longitudes. There is an easy "bugfix": Put the cursor to the object center to be measured, stand up from your chair, look at the image from above (with the head turned by 180 degrees), and see whether the cursor is still at the center. If not, choose an average of both cursor positions.

Data synchronisation

The measurers please send me their MES files in a monthly rhythm so I can import their new results to the central data base. I e-mail an attendant alert about one week earlier. Please meet the communicated deadline as I begin data processing a few minutes later! When the import and some appertaining tasks are finished, I copy the updated archive of MES files to the JUPOS homepage, not just two or three times per year as done in recent apparitions. Thus the complete dataset becomes faster available, and the measurers can compare their own results with those of others.

Outliers

An important aim is to eliminate gross positional errors. What is a serious error in JUPOS?

The accuracy obtainable in a "mass project" like JUPOS is generally overestimated. Even measurements of images with highest resolution show differences in the range of one degree. I estimate the Gaussian standard deviation of JUPOS' CCD positions to 1.2 degrees, i.e. 70% of total observations are in a +/-1.2 degs. interval around the true value. This estimation refers to small, well defined objects (e.g. the SSTC ovals). Diffuse structures with vague boundaries, which are also subject to different interpretation by the measurers, show higher deviations of course.

Gross positional errors - or "outliers" - I call longitudes of well defined features which differ by more than three degrees from the apparently true value, i.e. the average of all other observations. The most practicable way of detecting them is an analysis of drift charts. For the current apparition, the bright ovals in the SSTC and on the NEBn are examples of suitable targets, also some NEB barges.

Eliminating outliers

I myself search through the database for incorrect records already because my own positions are not immune to errors. However I would ask the other measurers to check their data for outliers independently, and to delete them. To that end I make available the basic Selection and Graphics settings used for creating the GRS, BA, and SSTC drift charts on the JUPOS homepage. It is easy to detect and eliminate outliers with their help. Installation and chart generation have to be done as follows.

Installation (once):

- Create a new subdirectory "macros" in the JUPOS main directory provided it does not yet exist.
- Download three ZIP files from following addresses, and copy them to following JUPOS subdirectories:

```
http://home.t-online.de/home/h.j.mettig/public_Makros.zip  
---> macros\
```

```
http://home.t-online.de/home/h.j.mettig/public_Selecta.zip  
---> parametr\selecta\
```

```
http://home.t-online.de/home/h.j.mettig/public_Grafik.zip  
---> parametr\grafik\
```

- Unpack each ZIP archive to its associated subdirectory.

Always before generating drift charts:

- Go to the JUPOS main directory, and start PC-JUPOS twice with different command line parameters:

```
jupose.exe macros\ccd_alt.mak  
jupose.exe macros\ccd_neu.mak
```

Now the drift charts "new_grs", "new_ba", and "new_sstc" can be viewed and modified in the Graphics module. Outliers are localized as follows: Note down date and longitude, select "Data files", choose the proper selection file, press [Enter] and search the observation in question. Note that all records actually displayed in the diagram are listed with black characters, invisible ones (outside the choosen time-longitude-latitude range) are shown red.

Outliers are completely eliminated only if they are deleted in the MES files. Do not just delete them from the selection files!

The cause of outliers is usually an incorrect image timing, or a wrong positioning of the outline frame. Delete *all* measurements of the concerning image in the MES file then, not only the found outlier(s).