Observer's guide to Jupiter's cloud features

by Zac Pujic

Jupiter not only has the largest disk visible through telescopes, it also shows the greatest amount of detail. The moons of Jupiter orbit the planet with such speed that only several hours of observing will reveal obvious changes in the pattern of the moons, something I never tire of observing.

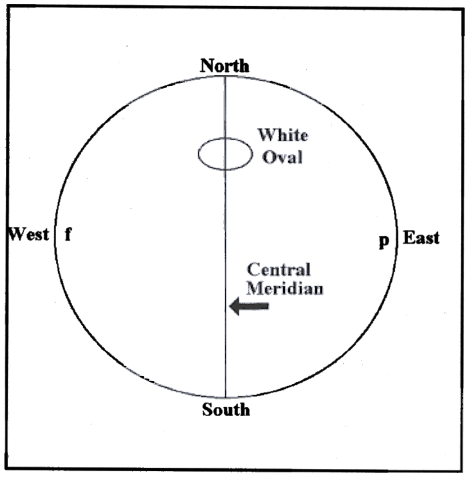
The abundance of visible detail on Jupiter offers the amateur astronomer the chance to contribute to professional astronomy. Professional astronomers can rarely afford to patrol the planets as thoroughly as can amateurs. One of the most important ways an amateur can contribute is to observe the central meridian transit times of cloud features on Jupiter.

The Central Meridian (CM) is the imaginary line between the poles of the planet on the visible face of the disk. When a feature crosses the CM, it crosses the central part of the planet. This fact by itself is not very useful, however astronomers have devised a system of latitudes and longitudes on Jupiter similar to that present on Earth. Furthermore, the value of the longitude which crosses the CM at any moment in time can be calculated and tabulated extensively. Unfortunately, the cloud belts of Jupiter (and Saturn) do not rotate as a solid body and so at least two such longitude systems are required.

System 1 serves cloud features from the southern edge of the North Equatorial Belt through to the north edge of the South Equatorial Belt (and thus includes the equatorial zone). System 11 serves cloud features in all the other regions. The value of the longitude present at the CM will be different for the two systems because the two longitude systems have different rotation periods.

How to make timings

While making CM transit timings of cloud features, it is first important to determine which longitude system the cloud feature is in. Secondly, you have to know how to convert from local time to Universal Time. For example, if there is a white oval present in the North Temperate Belt then it is System 11 (see diagram). If it also crosses the CM at 0 hours UT on July 19, then its longitude is 87.3°. This information can be obtained from tables of CM longitudes in magazines such as *Astronomy 1994* by



A white oval crossing the central meridian (CM) from left to right. Preceding (p) refers to the side of the cloud feature that first touches the CM while the following side of the feature is the side that crosses the CM last. The following limb is the edge of the planet where the rotation of the disk brings features into view.

Quasar Publishing. If you observe the cloud feature to cross the CM at a time other than 0 hours UT, you will have to add a certain number of degrees to that shown in the table. For example, a small, white oval, in System 11 latitudes, crosses the CM at 10.15 hours UT on July 20, then its longitude will be 249.2°:

0 hours July 20 UT	=	237.5°
10 hours UT	=	2.6°
15 minutes UT	=	9.1°
Total	=	249.2°

Notice that because the white oval didn't cross the CM at 0 hours UT, you have to add on a certain number of degrees (in this case 11.7° in total) to the value quoted for 0 hours UT. Had the number been greater than 360° say 370°, you simply subtract 360° to get a System 11 longitude of 10°.

Instead of just recording the time that the centre of a cloud feature passes through the CM, it is more important to note when the front end and back end of the feature pass through the CM. In this way, you can determine the longitudinal extent of the feature.

Consider another example. You might want to observe the front (preceding) end of a festoon (in System 1 latitudes) to pass through the CM at 13.24 hours UT on May 4, while the back (or following) end passes through the CM 11 minutes later at 13.35 hours UT. The System 1 longitude of the front end will be 37.6°:

0 hours for May 4	=	267.4°
13 hours	=	115.5°
20 minutes	=	12.2°
4 minutes	=	2.5°
Total	=	397.6°
subtract 360°	=	37.6°

and the System 1 longitude of the back end will be 44.2°:

0 hours for May 4	=	267.4°
13 hours	=	115.5°
35 minutes	=	21.3°
Total	=	404.2°
subtract 360°	=	44.2°

Clearly, the festoon is 6.6° long, and its middle is around 40.9°.

These timings are extremely important for two reasons. If the CM transit times of all features on the disk of Jupiter could be determined, then they could be used to plot the positions of the features on a Mercator projection map. Such a map would be more accurate than one made at the eyepiece due to the subjective observations of the astronomer. Secondly, if the CM value of a feature changes every time it crosses the CM, this indicates that the feature is moving either slower or faster than the surrounding cloud deck. For example, if a cloud feature in System 1 crosses the CM five minutes earlier after every rotation, then the feature is moving 3° per rotation faster than the surrounding cloud features and so its System 1 longitude will gradually decrease with time, something which an observer making transit timings will be able to document. Conversely, if a cloud feature crosses the CM about 13 minutes later each rotation, then it is moving 7.9° per rotation slower than the surrounding cloud features and so its System 1 longitude will increase over time.

All this sounds very confusing but it simply involves recording the time (and date) when an interesting cloud crosses the CM. If you can't or don't know how to do the reductions, give the transit times to the Lunar and Planetary observations coordinator of your astronomical society who should know how to do the calculations.

These types of observations will be especially important during the impact of Comet Shoemaker-Levy 9 in July. Although its unlikely that the impacts will have much effect on Jupiter, they may change the appearance of some of the cloud bands and CM transit timings may reveal any change in their rotation times. Of particular interest is the fact that the latitude of the impacts (between 45° - 47°) corresponds roughly to the latitudes of the long-enduring white ovals FA, BC and DE on Jupiter. The effect of the impact of a nucleus of Comet-Shoemaker-Levy 9 into one of these ovals is unknown at the moment, but it will be interesting to see if any changes in their rotation rates can be detected. This is one challenge amateurs should consider taking up.

Drawings of Jupiter

Jupiter will be particularly fascinating to watch this year due to the imminent crash of comet Shoemaker-Levy 9 into its southern hemisphere. Furthermore, its high altitude of culmination means that it will pass close to the zenith and so will be clear of most of the murky atmosphere, allowing amateurs a clear view of its cloud features. During April, I made several drawings of the cloud features of Jupiter, as well as some transit timings of the white ovals on Jupiter.

The cloud features I have drawn are only some of the many visible in good seeing conditions with a telescope capable of delivering high resolution. The only way to see more detail on Jupiter is to observe it regularly and consistently with scrutiny. With time, detail will become visible.

I made these drawings from a suburban backyard using a 32-cm f/5.75 Newtonian using either 9 or 4.8mm Nagler eyepieces to give magnifications of 204 or 383. Seeing was about 8/10 (ALPO scale) and transparency was about 4/5 (ALPO scale). After making the drawings I scanned them into a PC and enhanced the contrast using Photostyler to improve the visibility of the features.

Drawing 1 – April 7, 1994 between 13.22 and 13.33 UT. Three white ovals are visible in this drawing. The two large ovals in the South Temperate Zone are BC (right) and DE (left). A smaller oval is just south of and following DE. Its location in the South Temperate Zone makes it difficult to see. The SII longitude of oval BC was about 199.2° and that of DE was about 208.9°.

Drawing 2 April 7, 1994 between 14.33 and 14.46 UT. This view shows a bizarre structure (appearing in the previous drawing near the following limb) on the southern edge of the North equatorial Belt, associated with the Olivarez Blue Festoon near the central meridian (SI longitude of 137.5°). This festoon, appearing like a stretched out J connects to the Equatorial Band which was unusually dark. Olivarez Blue Festoons are named after Jose Olivarez, an American amateur astronomer and member of ALPO who first recognised these features as long-lived cloud structures on Jupiter. In the southern hemisphere, the enduring white oval FA was clearly visible in the South Temperate Belt and had a dark collar around it. SII longitude was 279.0°. A white rift was visible in the South Equatorial Belt and this extended for quite a distance in longitude. Lastly, the North Temperate Belt was very narrow, dark and well defined.

Drawing 3 April 9, 1994 between 18.10 and 18.20 UT. Two shadow transits of Io and Ganymede were in progress in the northern hemisphere while I made this drawing. The rift in the SEB, visible in the previous drawing, is extended in longitude and bisects the SEB into the SEB-north and SEB-south. Two festoon are visible in the Equatorial Zone, and one of these was an Olivarez Blue Festoon at SI longitude 216.1°. Lastly, two white ovals were located in the South Tropical Zone and South Temperate Zone. The presence of white ovals in zones makes them difficult to see due to the low contrast offered by the pale colour of the zones. However, both ovals had dark collars which made them look like rings in the clouds.

Drawing 4 April 23, 1994 between 12.17 and 12.29 UT. This view shows the Great Red Spot at SII longitude 44.7°. Rarely, in the past has this feature been as red as it was in the early part of this century. At the moment, its appearance is unusual since its southern half is more pink than its northern half which is very light in colour. The Spot is easy to see because it has a dark collar. The entire southern hemisphere at the longitudes shown above is very bland and has a soft, yellow colour. In the North Equatorial Belt, a line of white patches gives an appearance of turbulence in this band. Most curious was the presence of a very bright white spot in the northern edge of the NEB. It appears larger than a Jovian moon transiting the disk of Jupiter and can be seen in 15 cm reflectors. Its SII longitude was about 79.7°. This value has been decreasing with time, indicating that the spot is moving eastward relative to the surrounding cloud deck.