Voyager 3 project
part II
by Johan Warell

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Section II: object measurements and calculation of drift profile, written by

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While working in a team to obtain Jupiter images as often as possible during a three month period, it is inevitable that a few images will be significantly sharper than others. It is really only during the past two or three years that Swedish amateurs have been able to capture small enough details on Jupiter's disk that allow studying the evolution of individual features and to measure their positions. In this project, about 50 or so images were of sufficiently high resolution to perform this exercise, and five or so were exceptionally good with our standards.

In comparison to the impressive results that are consistently obtained by the most skilled planetary imagers around the globe, our images are still mediocre. This is not only due to the suboptimal weather conditions and generally low altitudes of the planets from our sites (latitudes 55-60 N). Equally important is our relative inexperience and the fact that the equipment and techniques are commercially available, run-of-the-mill, and thus not highly optimized to squeeze out the finest details. Thus, we are certain that anyone with sufficient effort can produce results similar to ours, from almost any location.

An natural continuation of the animation part of the Voyager 3 project was to obtain object positions to calculate drift rates of individual features, and compare the resulting drift profile to professional measurements. The drift rate is a measure of an object's velocity relative to a specified system, in our case system 2; plotting all measured object positions against time results in a drift chart. A drift profile is a plot of the drift rates of individual objects against latitude, also known as a longitudinal drift chart or a zonal velocity profile. This exercise had never been attempted with Swedish Jupiter images but was possible now with the large number of well spaced images. How would the results compare to professional measurements?

There is an immense amount of detail, morphology and motion in Jupiter's clouds which is revealed with increasing resolution. Not only is the visible cloud layer divided into two rotational systems with clearly separated rotation rates. The individual dark belts and bright zones are separated by fast jet streams moving alternatingly eastward and westward with velocities of up to 150 m/s, translating to drift rates of up to 11 degrees of longitude per day (330 deg/month). The jet velocities vary drastically with latitude and strongly and act to constantly affect the evolution of cloud features. This causes the formation of cyclonic and anti-cyclonic vortices, the most well known of which is the GRS. A persistent string of fast moving and constantly evolving white ovals are similarly present in the SSTB at about 45 S latitude. The reddish oval BA ("Little Red Spot") at the latitude of STB appeared in 2000 and is currently the next most prominent vortice after the GRS. Smaller dark and bright ovals are found at other System 2 latitudes on both hemispheres.

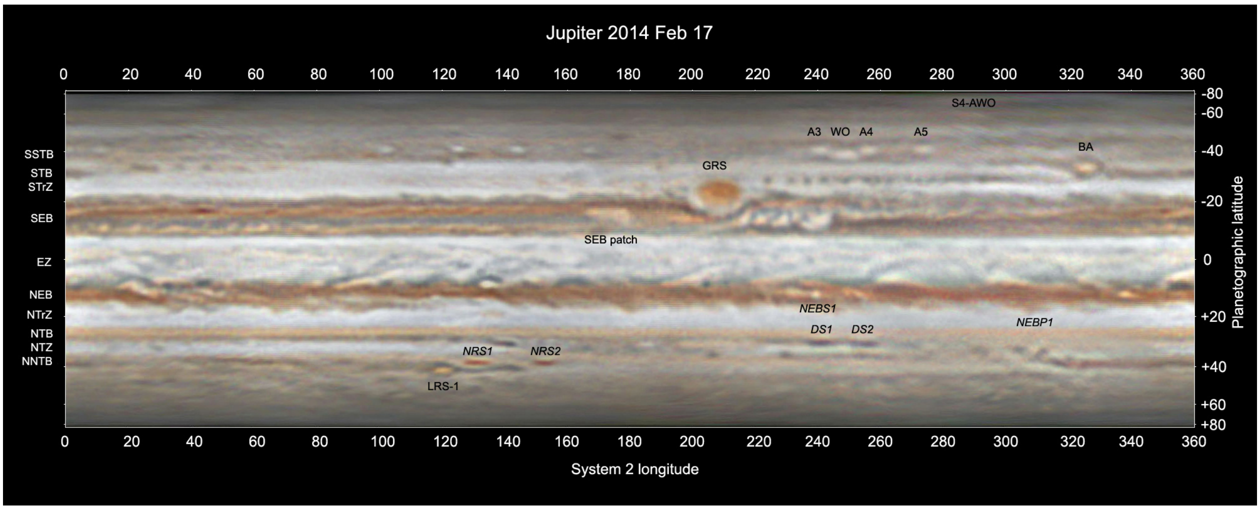
In taking the project from digital imaging art to numbers of some analytic value, Johan measured over 500 object positions on 30 images obtained from December 29, 2013, to April 7, 2014. As in the process of mapping images to cylindrical and polar projections, the marvellous WinJupos software was used to navigate the images to the coordinate grids, measure positions, calculate drift rates and plot the results.

The drift measurements were concentrated to the GRS-BA hemisphere, on which 18 objects in system 2 were selected and followed. At the resolution of our images, high contrast features with sufficient size and life span to be accurately measured only occurred at certain latitudes. Some could be followed during the whole three month period, while others appeared, evolved and disappeared in less than a month's time. The resulting drift profile is thus not complete but sampled at a number of latitudes.

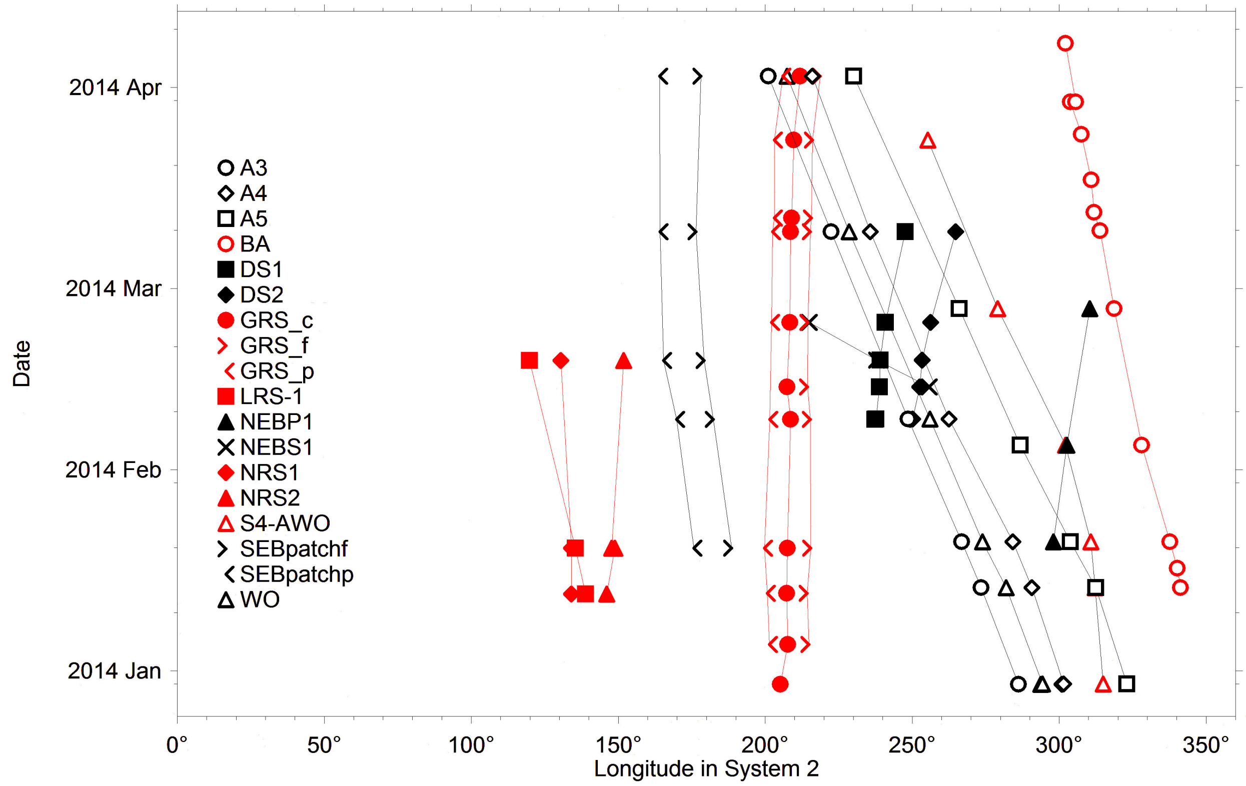
Our drift chart show a number of fast moving objects that are highly apparent in the animation. In system 2 longitude, the GRS moved slowly at about +1,4 deg/month, while the two prominent dark spots in the NTB (labelled here DS1 and DS2), as well as a projection at the northern edge of the NEB, moved even slower at +5-10 deg/month. The measured SSTB white ovals showed a common drift of around -28 deg/month and all closed in on the longitude of GRS, with the Mickey Mouse constellation (ovals A3, WO and A4) overtaking it in early April. Oval BA moved slower at about half this velocity. The fastest moving object measured was a temporary white spot in the NEB at latitude 11 N with a system 2 drift of -123 deg/month. On our images it could only be followed with certainty during a two week period in February.

The drift rates for these features were plotted in a longitudinal drift chart and compared to an HST drift profile obtained in 2012. The correlation between the two data sets is exceptionally good, with our data points closely matching the HST data at all latitudes. Minor deviations are due to the variation of jet velocities which are constantly underway in the upper cloud deck of the giant planet. This variation of zonal wind speeds with time can be seen in the drift chart as a change of slope in some of the object tracks. This is particularly evident for the reddish anticyclonic oval S4-AWO at high southern latitude (60 S). This feature strongly increased its drift rate in early February from an almost stationary system 2 longitude, and thus matched the drift rate of the more northern SSTB white ovals.

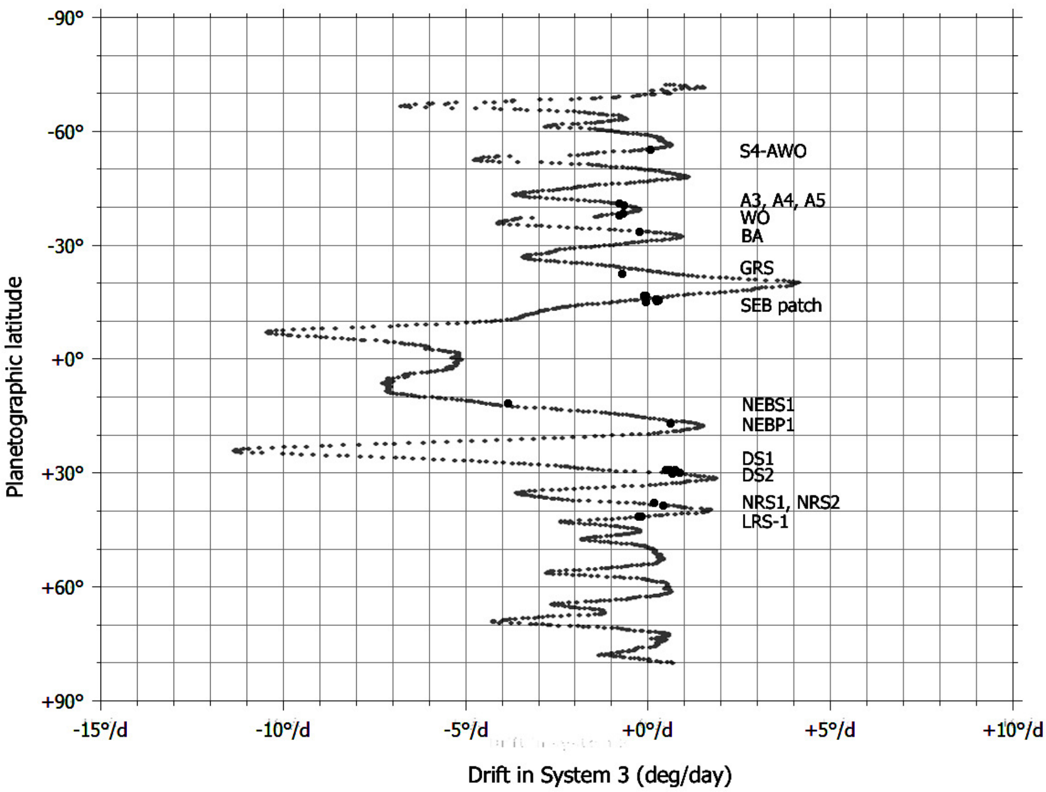
Figures and captions, with logical order in the text.



Cylindric map of Jupiter for 2014 February 17, with labels for measured objects. Longitudes are for System 2, latitudes are planetographic.



2. SuW drift chart:
Drift chart for measured objects on Jupiter, with longitudes in System 2 versus date. Reddish objects are shown with red markers, dark objects with black filled markers. The remaining markers indicate white ovals and patches. Object labels conform to those shown on the cylindric map.



3. SuW drift profile:
Drift profile for our measured objects (black dots) compared to a complete zonal wind profile (gray line) measured from Hubble Space Telescope images obtained in September 2012 (Glenn Schneider, Univeristy of Arizona, HST Proposal 13067). The drift rates are in degrees per day in System 3 versus planetographic latitude. Object labels conform to those shown on the cylindric map.