JUPITER IN 2005 AND 2006

EXTENDED SUMMARY
(2015 March 18)

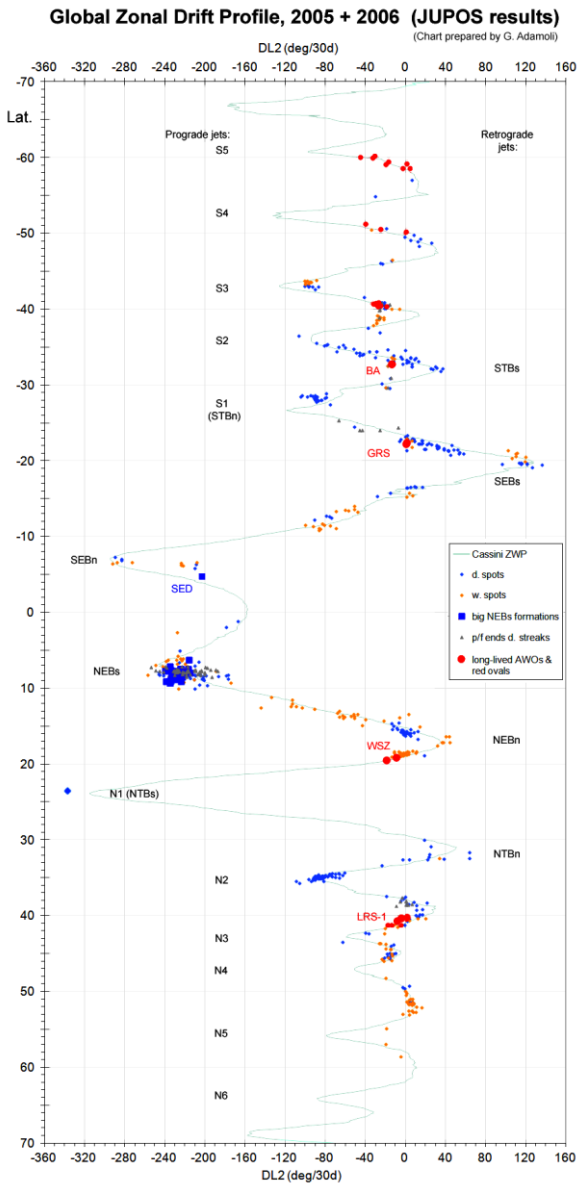
John Rogers & Gianluigi Adamoli,
using results from the JUPOS team (Hans-Joerg Mettig, Gianluigi Adamoli, Michel Jacquesson, Marco Vedovato, Grischa Hahn)

This report is dedicated to the memory of two expert observers:
Erwin van der Velden, resident in Australia, who died aged 39 in 2005; and
Dr Donald C. Parker, resident in Florida, who died aged 76 in 2015.

The apparitions of 2004/05 and 2006 are considered together in this report, as the aspect and activity of the jovian atmosphere was much the same in both years. The four largest domains (South and North Temperate and Tropical) were all in 'normal' phases between their major cycles of activity. These were the last years of 'normal' behaviour before the onset of the global upheaval of 2007. Indeed the main changes in 2006 – altered motions in the STropZ, and brown shading in the EZ – turned out to be fore-runners of this global upheaval.

Many of the phenomena have already been described in our posted interim reports, or in our publications or posted final reports.

In addition to the usual report, we have analysed the JUPOS database to provide drifts and latitudes for many smaller features so as to give a comprehensive zonal drift profile (ZDP) *[Figure at right]*. This can be compared with the global ZDP which we have already published for 2007. There do not appear to be any systematic differences except for the previously recognised distortions of the jets undergoing outbreaks in 2007. In both years, except for certain systematic exceptions, our ZDP agrees well with the spacecraft-derived zonal wind profile (ZWP).



SOUTHERN HEMISPHERE

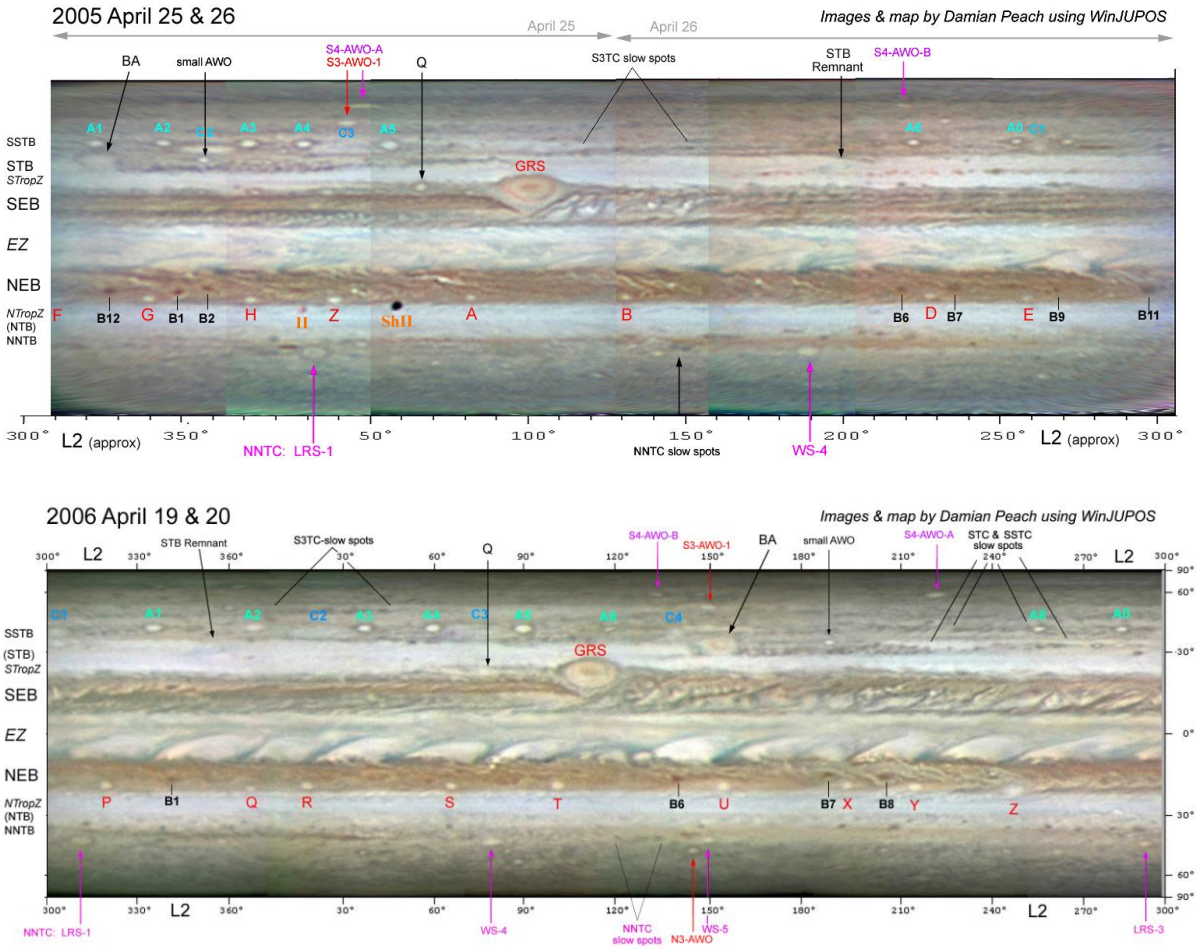
The South Temperate domain and higher-latitude domains showed typical features, which we have described in our long-term reports. Thus the following were observed in the S3 and S2 and S1 domains, and also in the N2 domain (see below):
--The prograde jet (full speed).
--Slow-moving spots on or near the retrograde jet.
--Long-lived anticyclonic white ovals (AWOs). Two were also observed in the S4 domain; these, like the one in the S3 domain, had oscillating tracks. Seven were present in the S2 domain, joined by an eighth in 2006. The latter one, as well as a small transient AWO in 2005, first appeared near oval BA, and were accompanied by cyclonic ovals.

In the S1 (S. Temperate) domain, throughout these years there were just two structured sectors. One comprised the single large anticyclonic circulation, called Oval BA, and a long dark STB segment f. it. The other was a long-lived faint blue-grey oblique streak, thought to be a cyclonic circulation,

which we named the STB Remnant. Oval BA was a white oval up to late 2005; but in 2005 Dec, it was turning orange. The colour intensified up to 2006 April, and remained strong thereafter. This development may resemble the way in which the GRS first became red.

There was just one dark segment of STB, f. oval BA, with a 'tail' of slower-moving dark spots Sf. it. The 'tail' included spots retrograding at the full speed of the STBs jet, never before detected in ground-based images. We suspect that this outbreak of spots in the STBs jet resulted from the collision of STB segments in 2003/04. The STZ Sf. the STB Remnant also showed an altered ZDP.

The S1 (STBn) jet had begun a major outbreak of dark spots p. oval BA in 2004 Feb., as a consequence of the collision of STB segments f. oval BA. This outbreak was continuing in 2005, but was declining in 2006, when the spots were much smaller and sparser.



The SEBs jet showed full-speed activity in 2005, but this was no longer detectable in 2006. Instead, four of the residual dark spots with lower retrograding speeds wandered south into the STropZ and reversed their drifts. This tendency to recirculation may have led to the formation of the two South Tropical Disturbances which were visible at the start of 2007.

The GRS sometimes contained a grey streak which enabled us to track the circulation. The period was 4.7 days in 2005 (our new measurement), and 4.5 days in 2006, consistent with the gradual shrinkage of the GRS. From 2006 August, the GRS was an isolated light orange oval, as the SEBs activity had ceased.

Within the southern SEB, there were three small white spots in 2005, which we infer were white clouds on the N edge of very small cyclonic circulations (mini-barges).

In mid-SEB there was the usual rifted region f. the GRS, which re-erupted from higher longitudes in late 2004 and 2005 April. In 2005 Dec., two separate 'mid-SEB outbreaks' were observed at even higher longitudes So by 2006 Feb, most of the SEB was in turmoil. The ZDP was unchanged, indicating that mid-SEB outbreaks follow the ZWP and do not change it, although short-lived white spots showed more scatter.

EQUATORIAL REGION

This was the one region of the planet which showed large-scale changes during these two apparitions: most obviously, progressive darkening of the EZ, during 2006, but also, changes in the behaviour of the large features on the north and south sides.

In 2005, the EZ was bright, largely white (especially the southern part); modest blue-grey festoons and streaks were present as usual. A faint yellow-orange tint in the central part was a remnant of the previous year's coloration. In 2006, dark features accumulated all across the EZ, intensifying gradually from January to July. The bluish-grey festoons in EZ(N) became much bigger and darker, a brown EB developed and later turned grey, and diffuse stretches of yellowish-brown shading spread over EZ(S) as well.

SEBn/EZ(S):

On the SEBn, there was one long-lived feature, the S. Equatorial Disturbance (SED). In 2005 it was quiescent and very inconspicuous. It did not interrupt the flow of the SEBn jet, which was evident as disturbed sectors moving at full jet speed, while the tiny SEBn spots within them moved more slowly.

In 2006, in contrast, the SEBn jet was not detectable, and the SED was initially difficult to identify, as the EZ(S) darkened. The SED seems to have become visible as it passed the GRS in 2006 April, and again when approaching or passing the GRS in May-June, July, and Sep., but between each passage it shifted ~30-40º p. (eastward). There was also a 'secondary SED' slightly further p. We suggest that there was a cryptic pattern of up to 4 waves with wavelength ~30-40º, p. the original SED track throughout 2006, with small SED-like features coming and going at the crests of the waves. This would be consistent with what we recorded in the next year, 2007.

EZ(N)/NEBs:

In 2005, the region was dominated by slow-moving irregular dark formations. From 2004 Dec. to 2005 Feb., there were only six persistent formations, mostly long dark plateaux with DL1 ~ +22 deg/month, but they were then disrupted, apparently by passing rifts.. From 2005 March to July, there were more dark formations, and they had mean DL1 ~ +13 deg/month. Many of the changes in the dark formations appear to have been caused by the passage of rifts in the NEB, with multiple examples of the various interactions previously reported, in which NEB rifts either disrupt a NEBs formation, or cause it to enlarge and darken.

The large dark formations are thought to represent waves, with phase speed related to wavelength, and our results from 2004-2006 are broadly consistent with this correlation. In contrast, the p. and f. ends of these formations often adopt short-term drifts that may cover a wide range of speeds, sometimes due to interference by smaller adjacent features, but often apparently random.

The aspect and motions were very different in 2006, when the region was dominated by a very regular array of 12-13 conspicuous dark NEBs formations ('projections') with DL1~ 0 to +5 deg/month; i.e. they returned to a normal drift rate. All this represented a reversion to the state last seen in 1999.

Tracking of short-lived white spots revealed two interesting types of behaviour, involving convective bright storms in the NEB and plumes on the NEBs, which may be more common than has been appreciated hitherto: (1) Retrograding white spots in southern NEBs breaking through into EZ, p. or f. dark projections; (2) Prograding bright spots within plumes f. dark projections.

NORTHERN HEMISPHERE

In early 2005, several rapidly-changing rifts appeared in the NEB, with DL2 ~ -1.7 deg/day. Each of them generated white spots drifting Sp. at DL2 ~ -3.4 to -3.8 deg/day, and the track of each rifted region as a whole eventually accelerated up to this speed range, suggesting that the waning source region would decay until only short-lived, fast-moving spots were left. These rifts had effects right across the NEB, ranging from destruction of the the large dark formations on NEBs as described above, to disturbance on the NEBn jet as decribed below.

The NEB was in the post-expansion phase of one of its quadrennial cycles, having undergone a classical expansion event in 2004, so it was very broad throughout the 2005 and 2006 apparitions. A common sequel, reddening of the belt, was suggested by the images at the start of 2006.

In 2004/05, the other classic sequel was developing: an array of bright AWOs and dark brown 'barges'. By 2005 April there were 9 AWOs and 8 barges. The only AWO to have survived the 2004 NEB expansion event was white spot Z (WSZ), which was still prograding more rapidly than any other spots of this type.

The NEB showed well-defined ZDPs consistent with previous understanding:
--Most spots lie close to the ZWP, including white spots on the NEBn jet, and WSZ.
--The well-defined circulations – barges and AWOs – lie on shallower ZDP gradients indicating that they are less affected by the retrograding jet.
--Several small white spots in the NEB in 2006 lie anomalously far S for their speeds, because they are on the S edges of barges, presumably linked to them.

The rarely-detected NEBn jet was evident both in the wake of some NEB rifts, and in the wake of WSZ, where instability in the jet was manifested by retrograding bright spots. Where they disappeared, new barges and AWOs were appearing. For one new barge, observations suggested that the circulation formed from ripples on the jet at a critical distance downstream from WSZ.

P. WSZ, mergers were being caused by its relentless advance. Mergers of barges were observed in 2005 May and 2006 March, and collisions of WSZ with other AWOs were observed in 2006 June and Sep. Although these collisions appeared at low resolution to result in mergers, the best images showed that the p. oval actually squeezed past WSZ then shrivelled away.

The NTB was still absent in 2005 and 2006, but a tenuous N.Tropical Band was visible at the latitude of the NTBs jet. In 2005, several small dusky spots here revealed the peak speed of the NTBs jet, faster than in preceding years, suggesting that the jet was beginning to return to the super-fast state.

In the whitened NTB latitudes, there were a few faint spots and streaks still revealed the typical N. Temperate Current. Also in each year there was a dark spot in the retrograding jet, which then decelerated in the NTZ or even (in 2006) recirculated and merged with a N2 jet spot. The N2 (NNTBs) jet carried many small dark spots in 2005 and 2006, continuing the vigorous outbreak which began in 2003/04. The ZDP was a well-defined anticyclonic gradient from the jet peak southwards, consistent with the dark spots being vortices which 'roll' along the jet peak.

The main dark northern belt was NNTB. A long dark segment became strikingly reddish in early 2005. In the N2 domain, the following phenomena were observed, which appear to be typical of this domain, and are also all observed in the high southern domains:
--A dark barge (at 38ºN) turned red before fading away.
--There were retrograding dark spots (at 40ºN) in the NNTZ and the retrograde jet, though with less than its peak speed.
--These were in a long-lived slow-moving sector, and may have stemmed from a long-lived cyclonic disturbance.
--When an AWO encountered the leading spot in a retrograding chain, the AWO sometimes decelerated, its progress blocked.
--Four anticyclonic ovals (at 41ºN) were present in the NNTZ in each year, including the long-lived LRS-1, and in 2006, a rare second little red spot. These ovals have variable speeds and latitudes, on anticyclonic ZDPs which depend on the size of the oval.

Further north, the N3 jet was detected, and there were numerous spots moving with typical N^3TC and N^4TC.
