Jupiter's southern high-latitude domains: long-lived features and dynamics, 2001-2012

John Rogers, Gianluigi Adamoli, Grischa Hahn, Michel Jacquesson, Marco Vedovato, & Hans-Jörg Mettig
(JUPOS team and British Astronomical Association) (2014 March)

Extended Summary

Here we present an overview of the three domains in high southern latitudes of Jupiter, from 36 to 61ºS. Domains are defined as latitude bands bounded by prograde jets, and we propose a simplified nomenclature for the high-latitude domains and jets. We survey the dynamical characteristics of the S2, S3, and S4 domains, and of the S2, S3, and S4 prograde jets on their north edges. We also summarise the long-term history of the major features, especially the long-lived anticyclonic ovals.

This report covers the years 2001-2012, from the JUPOS database, with more limited summaries of some aspects back to 1986. We analyse the drift rates and latitudes both for long-lived ovals and for many smaller, short-lived features. These establish speed-vs-latitude relations for these spots (Zonal Drift Profiles, ZDP) over most of the latitude range considered. At these high latitudes the ZDPs are close to the Zonal Wind Profile (ZWP) derived from spacecraft imagery. A compilation of ZDPs over the whole range is shown below**,** with the Cassini ZWP for comparison. In the S3 and S4 domains, the ZDPs for major ovals and small dark spots do not deviate from the ZWP as much as they do in lower-latitude domains. The form of the deviation is the same for all three domains.

The most conspicuous and long-lived features of these three domains are **anticyclonic white ovals (AWOs)**. Three or four have been tracked for 27 years in the S2 domain (40.5ºS); one probably for 15 years in the S3 domain (~50ºS) and one probably for 26 years in the S4 domain (~60ºS). All of these may have existed for much longer, before modern imaging could detect them. In the S2 domain, from 1986 to 2012, there were always 6-9 long-lived AWOs, among which three disappeared (probably all by mergers) and five appeared; the nominal mean lifetime is ~50-60 years but this may be limited only by occasional, stochastic mergers. Small shorter-lived AWOs are also seen, lasting only 1-2 years. One small S2 AWO shows oscillations of speed and latitude with period ~128 d, excited when it passes oval BA. Whereas the AWOs in the S2 domain mostly show little variation in speed, those in S3 and S4 show large variations in speed and simultaneously in latitude, which often comprise oscillations with periods mostly in the range ~33-50 d.

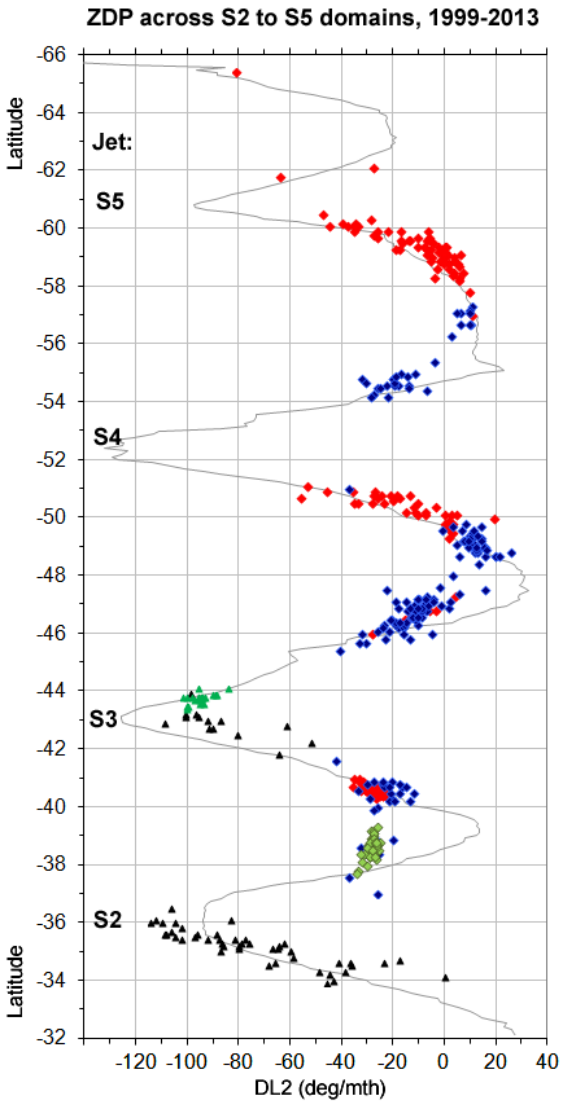
Cyclonic features are conspicuous only in the S2 domain, where short SSTB sectors sometimes turn into white oblongs, which can last up to 5.6 years. These are probably closed circulations, and always expand at rates which depend on their length. Other cyclonic features are folded filamentary regions (FFRs), and dark streaks or 'mini-barges', which sometimes turn red before they disappear.

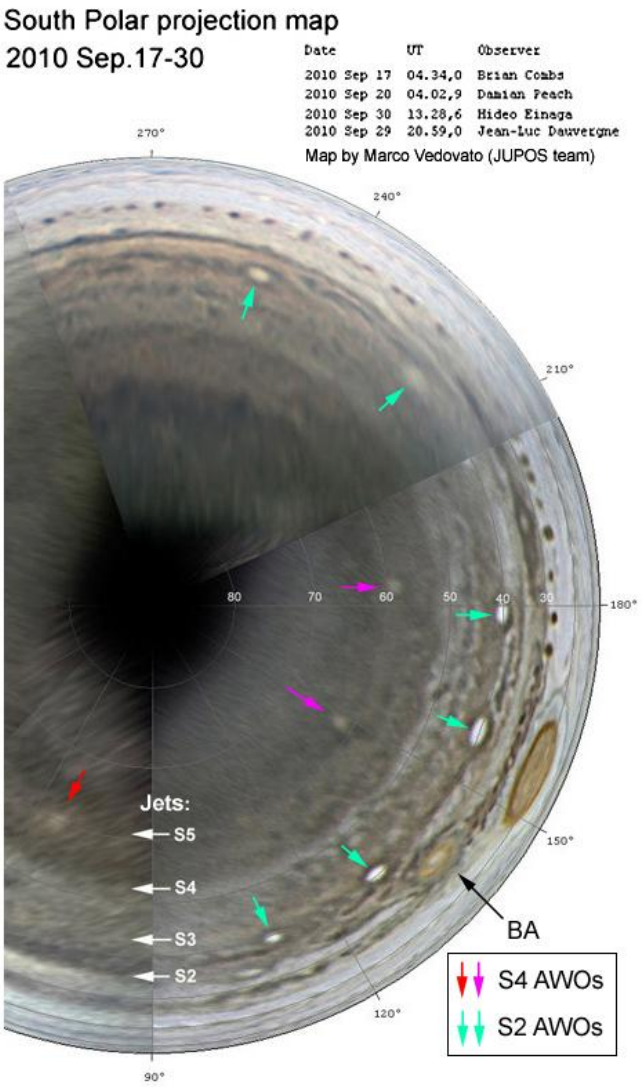
Chains of slow-moving dark spots are sometimes seen in the S2 and S3 domains, as in the S1 (S.Temperate) domain; they may straddle the **retrograde jet**, or lie on its anticyclonic flank, depending on the local ZWP. Although these spots are often most noticeable f. AWOs, our results suggest that they are actually generated from persistent cyclonic turbulent sectors, which in S1 and S2 are trapped against AWOs: viz. a dark STB segment in S1, a large FFR in S2, and hypothetically a long-lived FFR in S3. The spotty sector in S3 lasted for 6 years and showed evidence for an alteration of the canonical ZWP.

The prograde jets differ in their characteristics. The S2 jet (36ºS) carries small dark spots in every apparition, although their number appears to vary. In recent years their maximum speed averages DL2 = -110 deg/mth at 36ºS, close to the average peak from spacecraft ZWPs. The spots show a great range of speeds, with a ZDP showing that they are on the anticyclonic side of the jet peak, consistent with the lower-latitude paradigm of dark jet spots as anticyclonic vortices rolling along the flank of the peak. The S3 jet (43ºS), not previously detected from Earth, is recorded in every apparition from 2003 onwards in our data. Dark jet spots, which are infrequent, have a peak speed of DL2 = -101 deg/mth at 43.0ºS, with others following an anticyclonic ZDP, as for the S2 jet. Uniquely, though, the S3 jet mainly carries white spots, with the same speed but at ~43.7ºS, on the south side of the jet, with a cyclonic ZDP. They apparently arise from specific sectors in the S3 domain which may represent unresolved disturbances. The S4 jet (53ºS) does not carry detectable spots, but its presence is confirmed by rapid

motions of the S3 AWOs on its N flank and rare impact-generated clouds on its S flank. The S5 jet (61ºS) is also not directly detected, but rapidly-prograding white spots have been recorded on its flanks.

Each domain does have its particular characteristics. The S2 domain is dominated by numerous AWOs, often forming regular chains separated by cyclonic regions which may be FFRs or white oblongs or dark mini-barges. The S3 domain has only one long-lived AWO, and spacecraft images reveal very extensive cyclonic FFRs which are unresolvable from Earth. The S4 domain is largely featureless but has one long-lived AWO. Thus, although these higher-latitude domains are more difficult to observe and contain smaller features, they show phenomena comparable to those of lower-latitude domains, and some remarkable features of their own.





Left: **ZDPs across the S2 to S5 domains, 34 to 66ºS,** from 1999-2013 or selected apparitions within this range. For key and details see the full report. Grey line: ZWP from Cassini. (Chart by G. Adamoli from JUPOS data.)

Right: **Polar projection map,** 2010 Sep. Positions of prograde jets and long-lived AWOs are marked. (Map by Marco Vedovato from images by 4 observers.)
