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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)

FIGURE LEGENDS & MINIATURES

South is up in all figures.

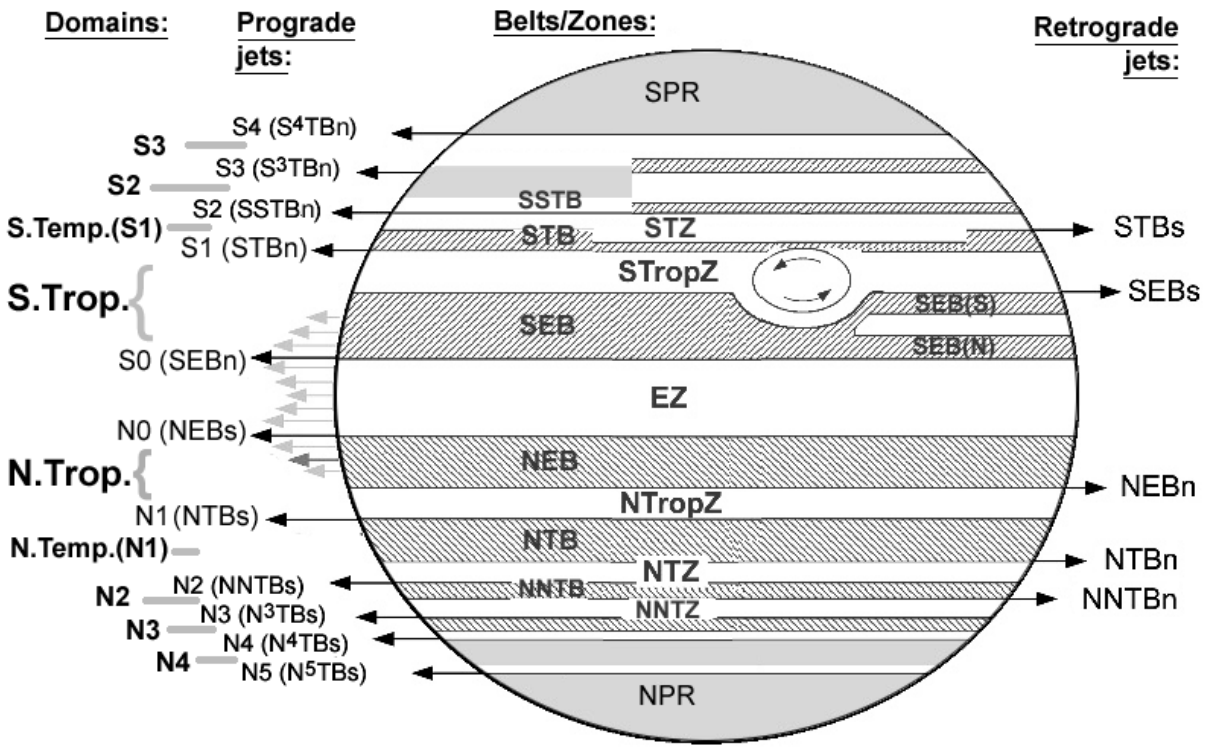

Figure 1. Diagram of Jupiter's belts, zones, and jets, with (at left) our proposed new nomenclature for the domains. (Temp., Temperate; Trop., Tropical; other abbreviations as previously).

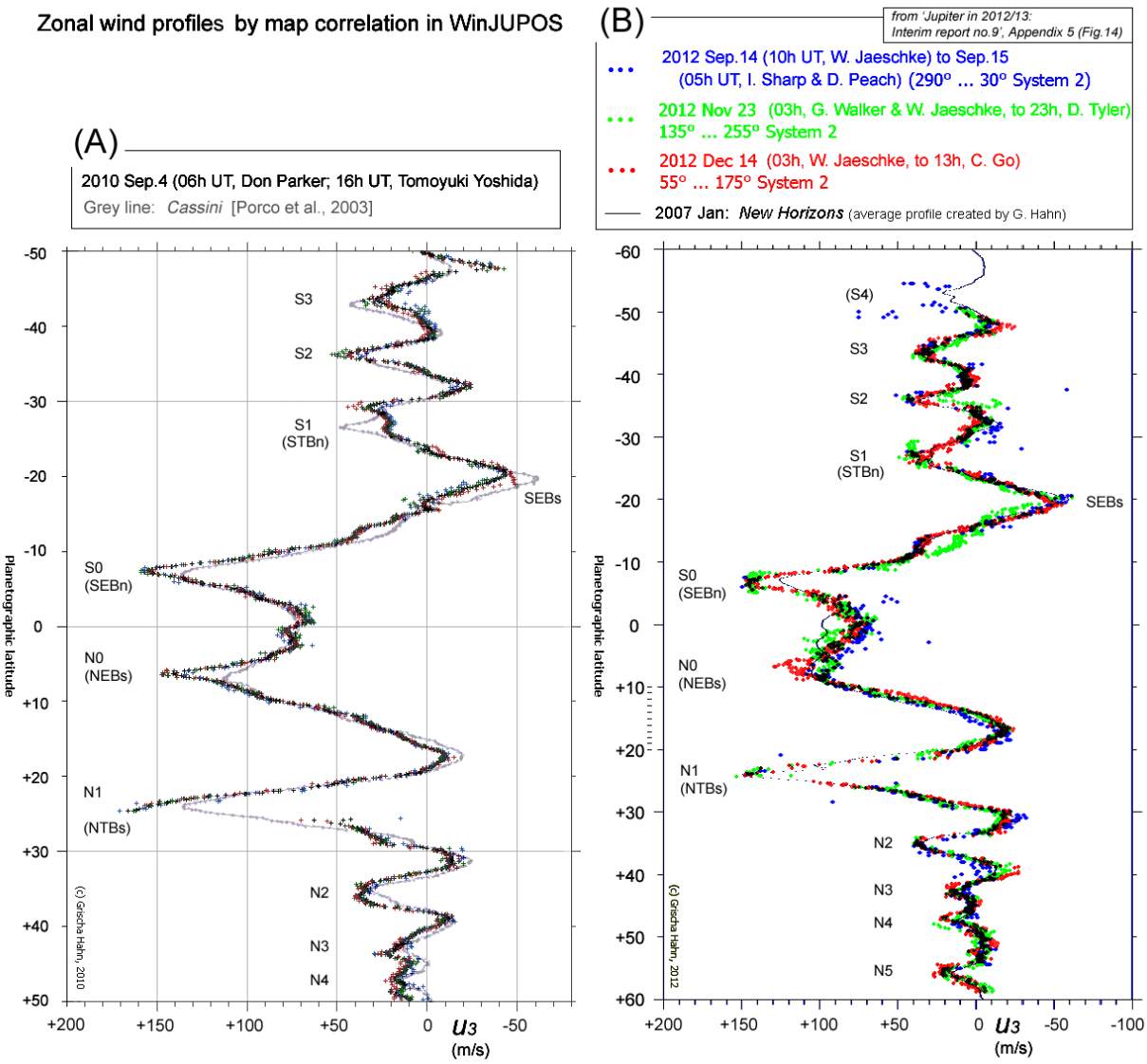

Figure 2. Zonal wind profiles from amateur images, by map correlation in WinJUPOS (analysis by Grischa Hahn: Ref.15).
(A) 2010 Sep.4; compared with ZWP from Cassini.
(B) 2012 Sep.-Dec; compared with ZWP from New Horizons.
(All credits and references are on the figure.)

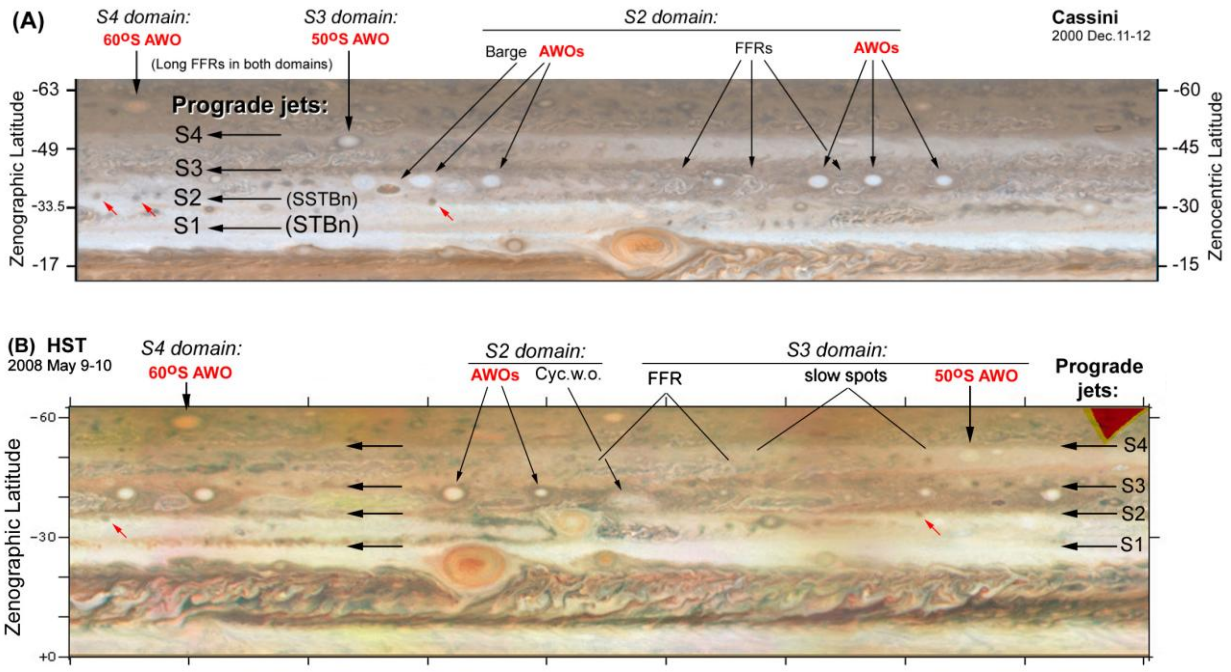

Figure 3. Hi-res maps from spacecraft showing the major features of the four domains. These maps use equirectangular projection which does not distort high-latitude features excessively.

(A) Map from Cassini (2000 Dec.11-12: credit NASA/JPL/University of Arizona). About 270º of longitude are shown; see **Fig.4** for a full-length version. Latitudes of the prograde jets are indicated. Typical major features are indicated in each domain. AWO, anticyclonic white oval; FFR, folded filamentary region (cyclonic). Oblique red arrows indicate S2 jet spots on SSTBn.

(B) Map from HST (2008 May 9-10; credit NASA/ESA/STScI/UC Berkeley, M.H. Wong & I. de Pater) [Ref.16]. About 270º of longitude are shown. See **Fig.4** for a full-length map from amateur images taken at the same time.

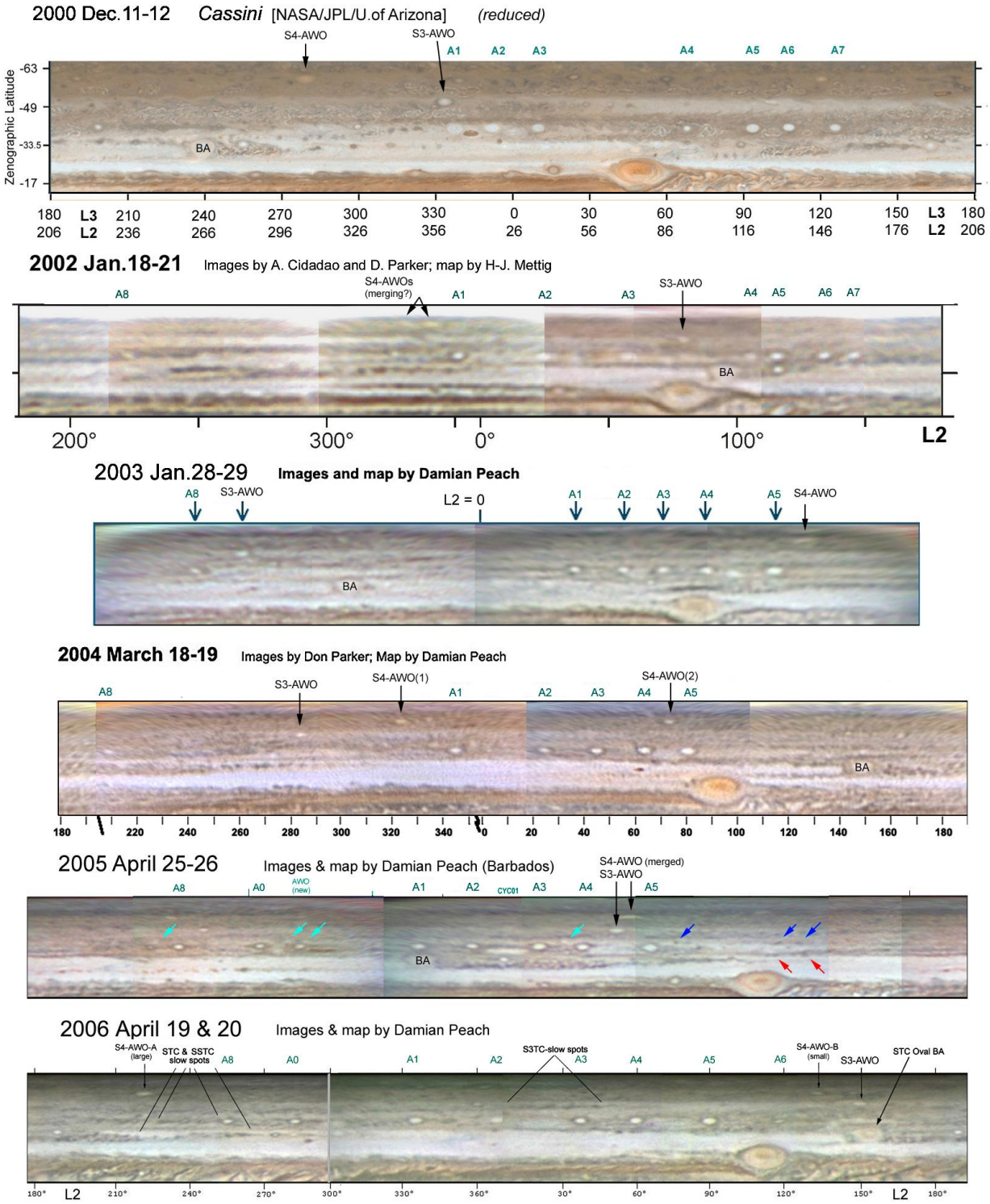

Figure 4. Maps in each apparition. One of the best available maps for each apparition is shown, from mid-SEB to the south pole, with the high-latitude features labelled. All maps use cylindrical projection and System II longitude (L2), and were made using WinJUPOS, except the Cassini map which uses equirectangular projection (reduced copy from Ref.7). These are the same maps used in our long-term S.Temperate report [Ref.1]. All the long-lived AWOs are labelled on each map, those in the S4 and S3 domains by black arrows, and those in the S2 domain by cyan labels above the map.

[Figure & caption continued on next page]

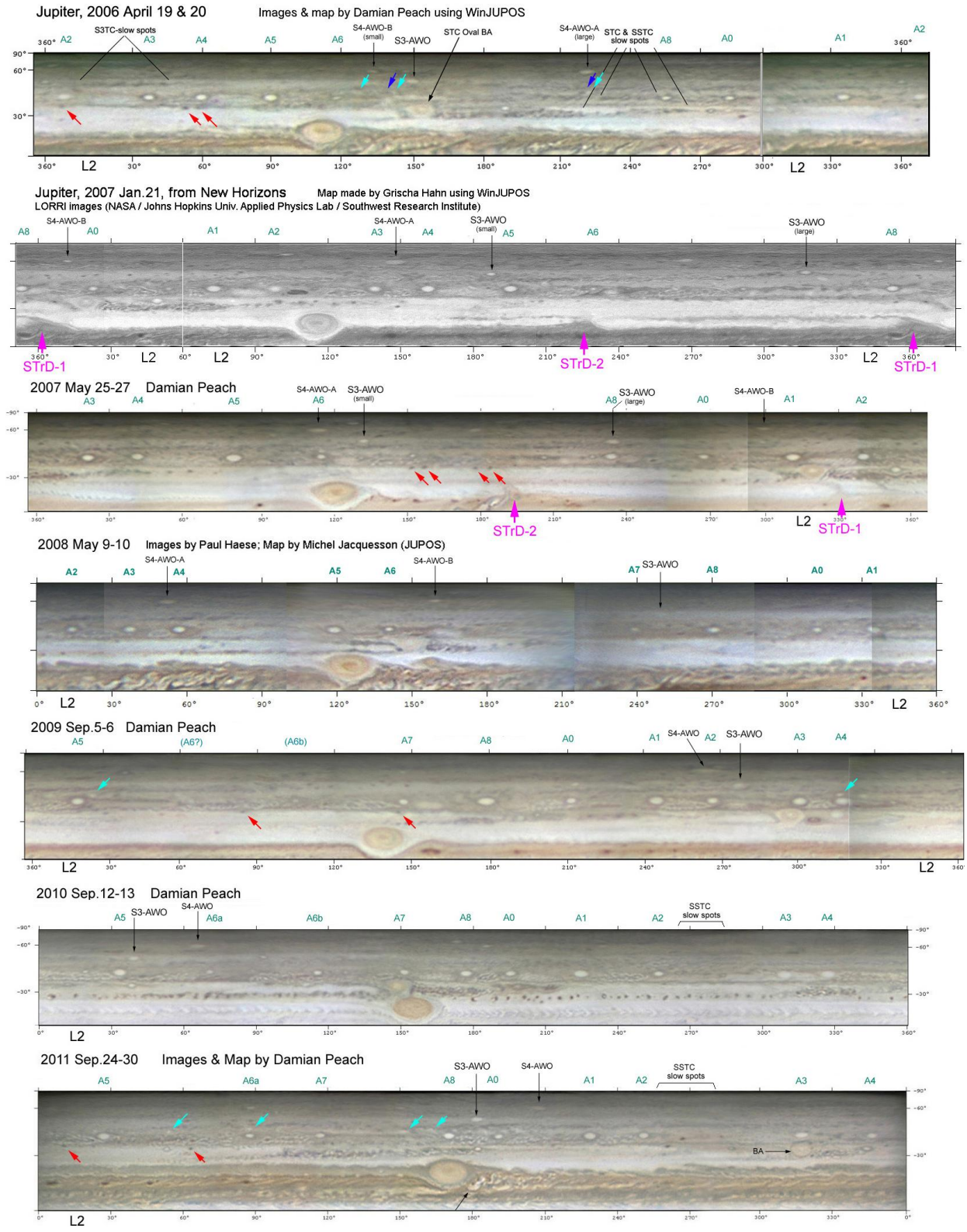

Figure 4 (cont.).
Oblique arrows on some maps indicate examples of jetstream spots: red for dark S2 jet spots, dark blue for dark S3 jet spots, light blue for white S3 jet spots.

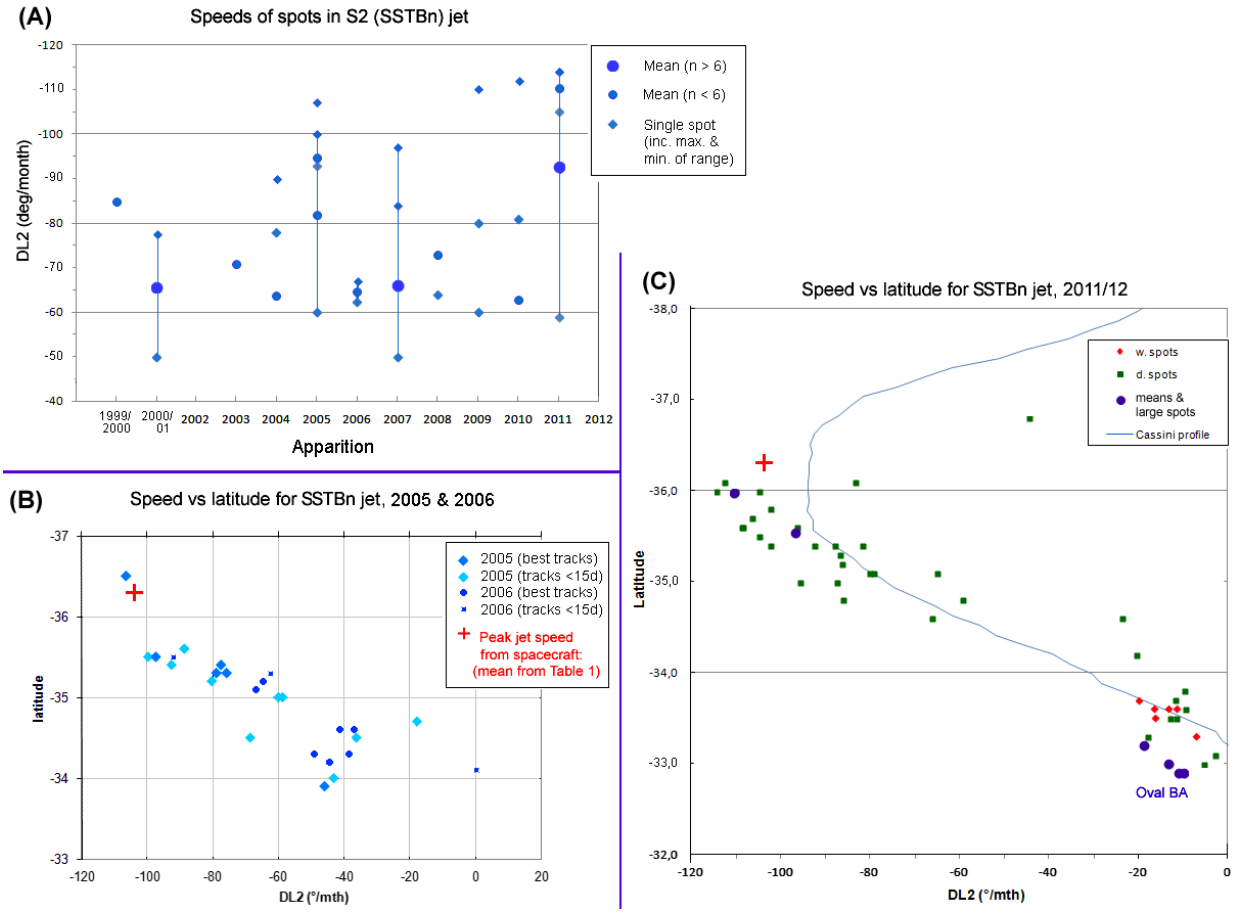

Figure 5. The S2 prograde jet.
(A) Records of observed speeds, 1988-2012.
(B,C) ZDPs in 2005 and 2006 and 2011/12 (analysis by G.Adamoli, from draft JUPOS/BAA reports). A red cross marks the average peak of the jet from spacecraft.

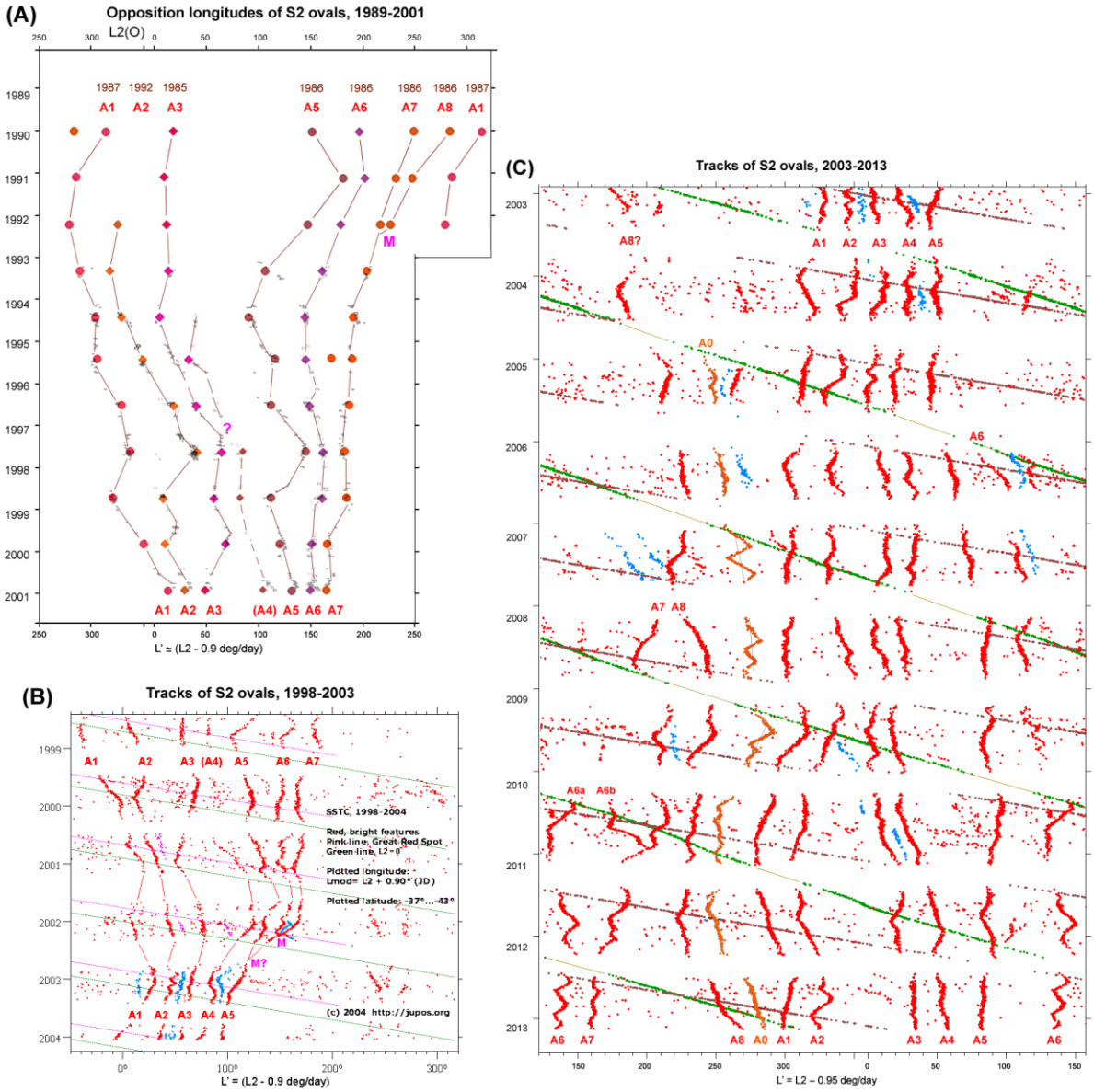

Figure 6. Longitude-vs-time charts for the S.S.Temperate (S2) domain, especially the long-lived AWOs. Longitude is plotted as L2 – 0.9 or 0.95 deg/day. These are compact charts; see **Appendix 1(b)** for full-size JUPOS charts from 2001 onwards. In all charts, ticks on the vertical axis denote the start of each calendar year.

(A) Diagram indicating the tracking of the AWOs from 1989-2001. Coloured points are the L2 of each oval at opposition, from published BAA reports; during the 13.3-month mean interval between oppositions, ovals with mean speed DL2 = -27.05 deg/month travel exactly 360º. Our actual tracks are not shown on this diagram, but small grey points are photographic measurements from Morales-Juberias et al.[Ref.10], adjusted to a scale with DL2 ~ -27 deg/mth, matching the BAA data. Our ovals A1 to A7 are identical to their ovals A,B,C,Z,D,E,F. At top, the year in which the BAA first recorded each oval is noted. From 1986-1988, it is unclear whether A1 and A2 existed throughout, or whether there were shorter-lived ovals which were later replaced. An earlier oval A8 probably merged with A7 in 1992 March ('M'). Dashed lines indicate intervals where the tracking of the newest and smallest oval, A4, was uncertain. Otherwise, no ovals appeared or disappeared in this time period.

(B) JUPOS chart, 1998-2003. (Chart plotted by H-J. Mettig.) 'M' indicates the merger of two ovals at the f. end of the chain in early 2002, and a probable second merger during solar conjunction. Because the chart also includes cyclonic latitudes, cyclonic oval tracks are also present and the more persistent ones have been recoloured purple or cyan for clarity.

(C) JUPOS chart, 2003-2013. (Chart plotted by G. Hahn.) AWO A0 is coloured orange-brown so that its oscillations after passing oval BA can be easily seen; track of oval BA, green; track of GRS, dark brown. Again, some cyclonic oval tracks are also present and the more persistent ones have been recoloured cyan.

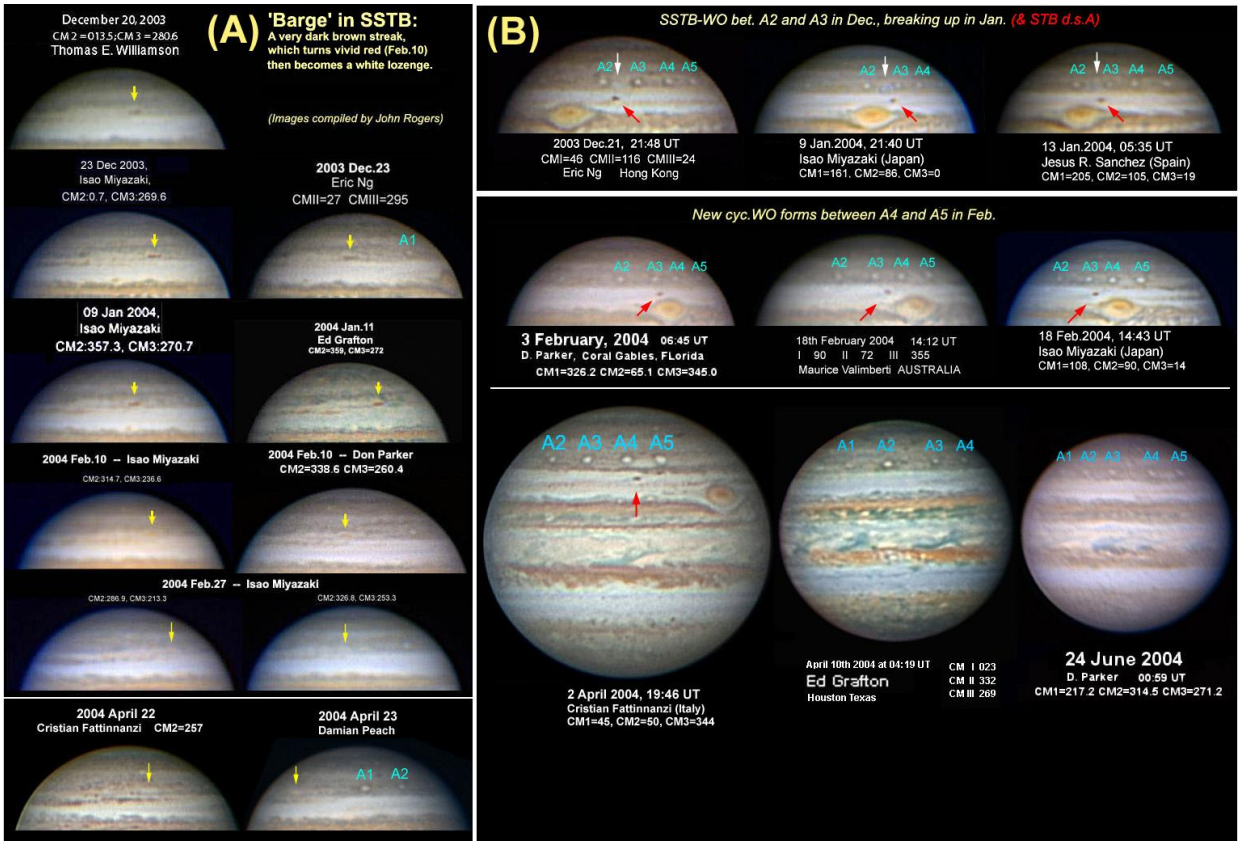

Figure 7. Sets of images in 2003-2006 showing features in the S.S. Temperate domain.
(A) 2003 Dec.—2004 April. A dark brown streak or barge turns red as it fades, and then becomes a white lozenge.
(B) 2003 Dec.—2004 June. The main array of AWOs (A1-A5), with cyclonic regions between them. A cyclonic white oval between A2-A3 in Dec. breaks up into a FFR in Jan. Then a new cyclonic white oval forms between A4-A5 in Feb. (See Ref.1 for further images.)
[Figure & caption continued on next page]

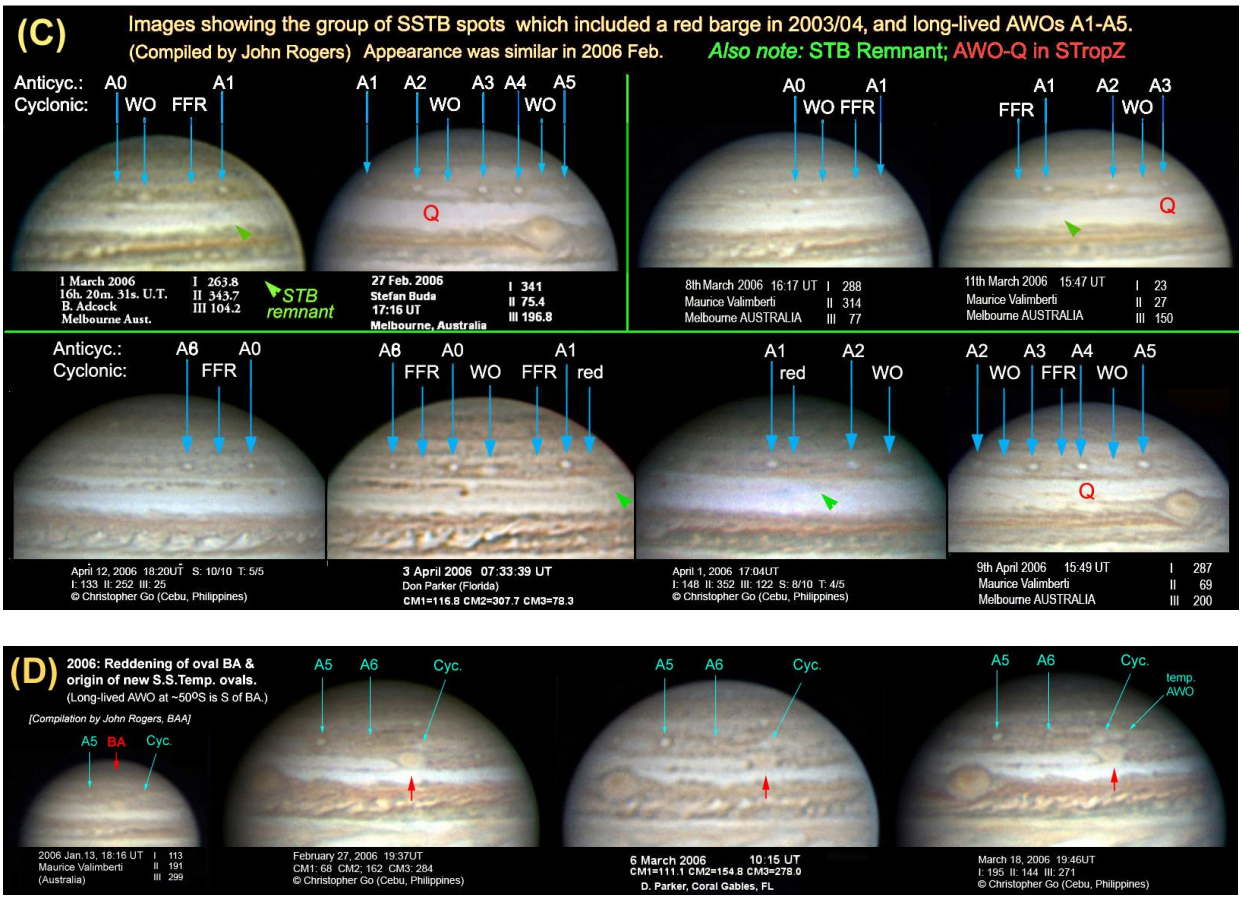

Figure 7 (cont.).
(C) 2006 March-April. The same sectors, with a long array of AWOs interspersed with cyclonic white ovals and FFRs. [This was posted in Ref.9.]
(D) 2006 Jan.-March. Further f., including first images of new tiny oval A6, plus a new cyclonic white oval, both just passing oval BA. There is also a new, transient, rimless AWO just f. the cyclonic oval. The long-lived S3-AWO is due S of oval BA. This was at the start of the apparition when oval BA was red for the first time.

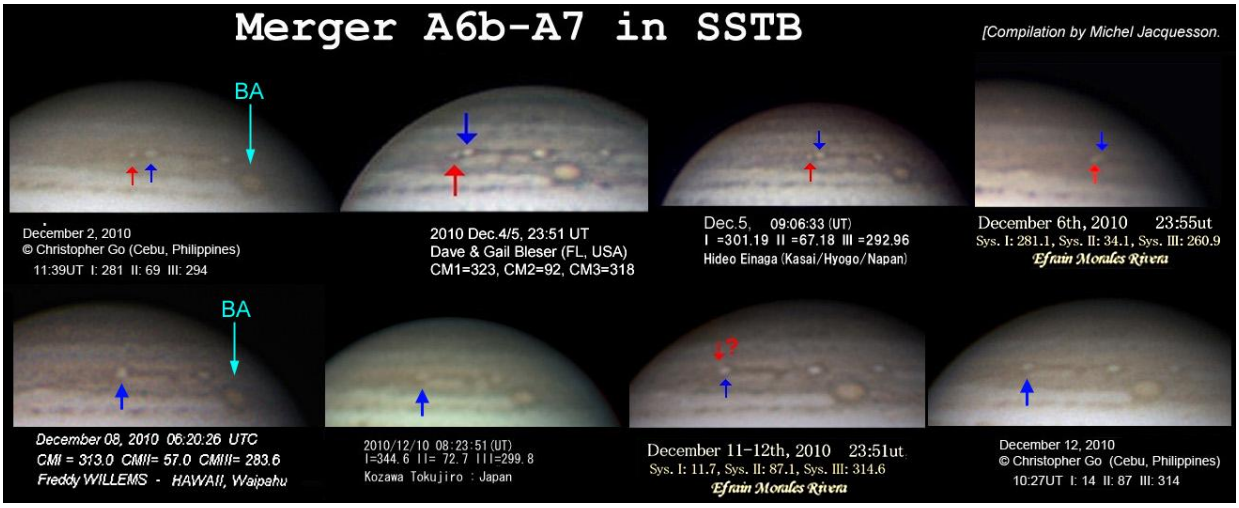

Figure 8. Set of images in 2010 Dec. showing merger of a minor AWO (A6b) with a long-lived one (A7), shortly after they passed oval BA.

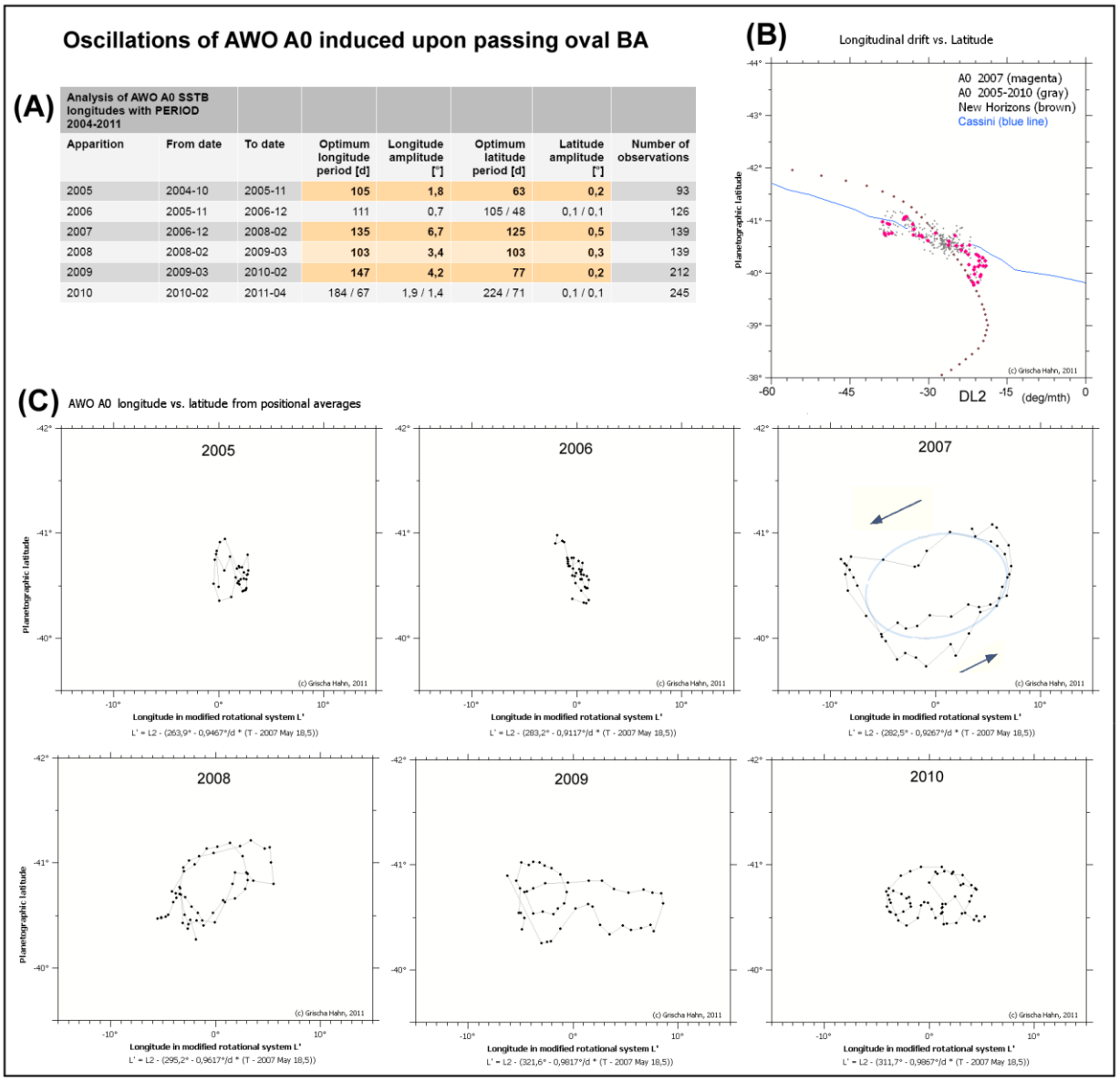

Figure 9. Oscillations of a S2-AWO (A0) induced by passages past oval BA.
(Analysis by Grischa Hahn.)
(A) Table showing best-fit parameters obtained independently for longitude and latitude in each apparition, using the PERIOD program by G. Hahn. Oscillations were significant in each year except 2006.
(B) ZDP for this AWO, compared with the ZWP from New Horizons.
(C) Charts of latitude vs longitude for each apparition. Longitude is relative to the mean drift rate calculated separately for each apparition. Latitude is a rolling average and is plotted on a tenfold larger scale. In 2007, the light blue oval is the best fit from PERIOD; the phase difference (longitude vs latitude) was 38 days or approx. ¼ cycle, as the latitude correlates with the speed.

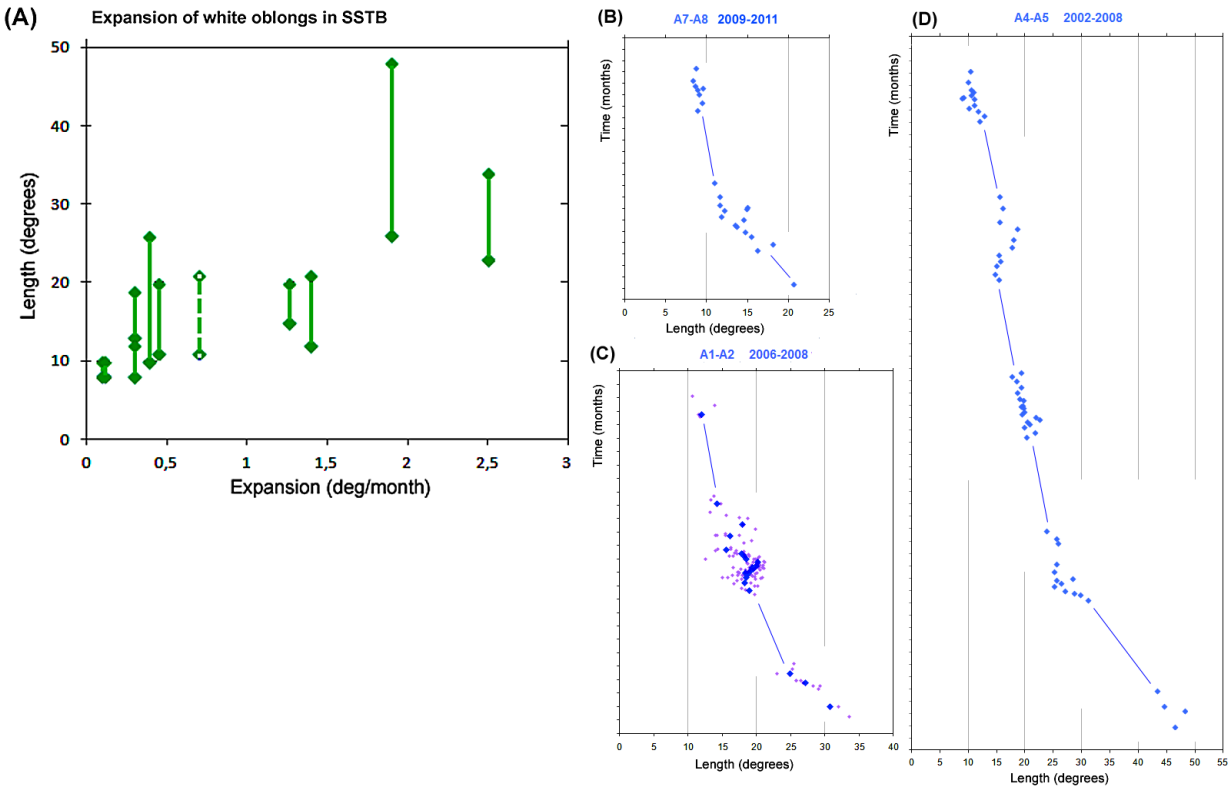

Figure 10: Longitudinal expansion of white oblongs in the SSTB.
(A) Expansion rates were measured for the 8 oblongs listed in the text. Expansion was barely perceptible when the oblong was an oval <10º long, but proceeded 0.3 to 1.4 deg/mth once the oval was longer than this threshold. In three cases when the oblong grew to 20-26º long, the expansion suddenly accelerated even more. *Below*: Examples of charts. Time is plotted downwards in units of 30 days. Length is plotted as 5-point means (blue diamonds), with individual points also plotted (mauve dots) for the A1-A2 panel.
(B) Oblong between A7-A8, plotted from 2009 April 27 to 2011 March 18.
(C) Oblong between A1-A2, plotted from 2006 May 13 to 2008 July 31.
(D) Oblong between A4-A5, plotted from 2003 Oct.26 to 2008 Nov.28.

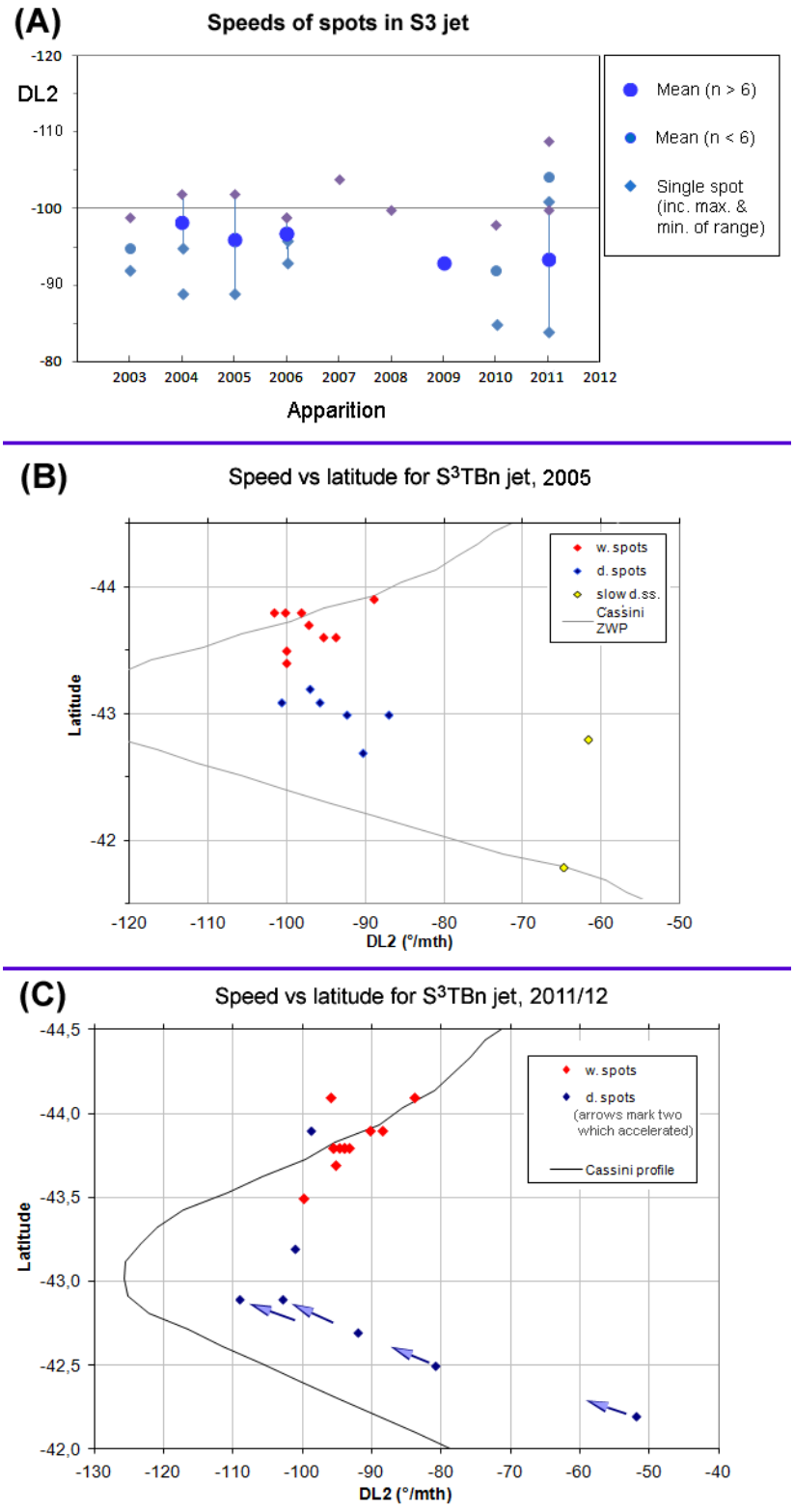

Figure 11. The S3 prograde jet.
(A) Records of observed speeds, 2003-2012.
(B,C) ZDPs in 2005 and 2011/12 [analysis of JUPOS data by G. Adamoli].

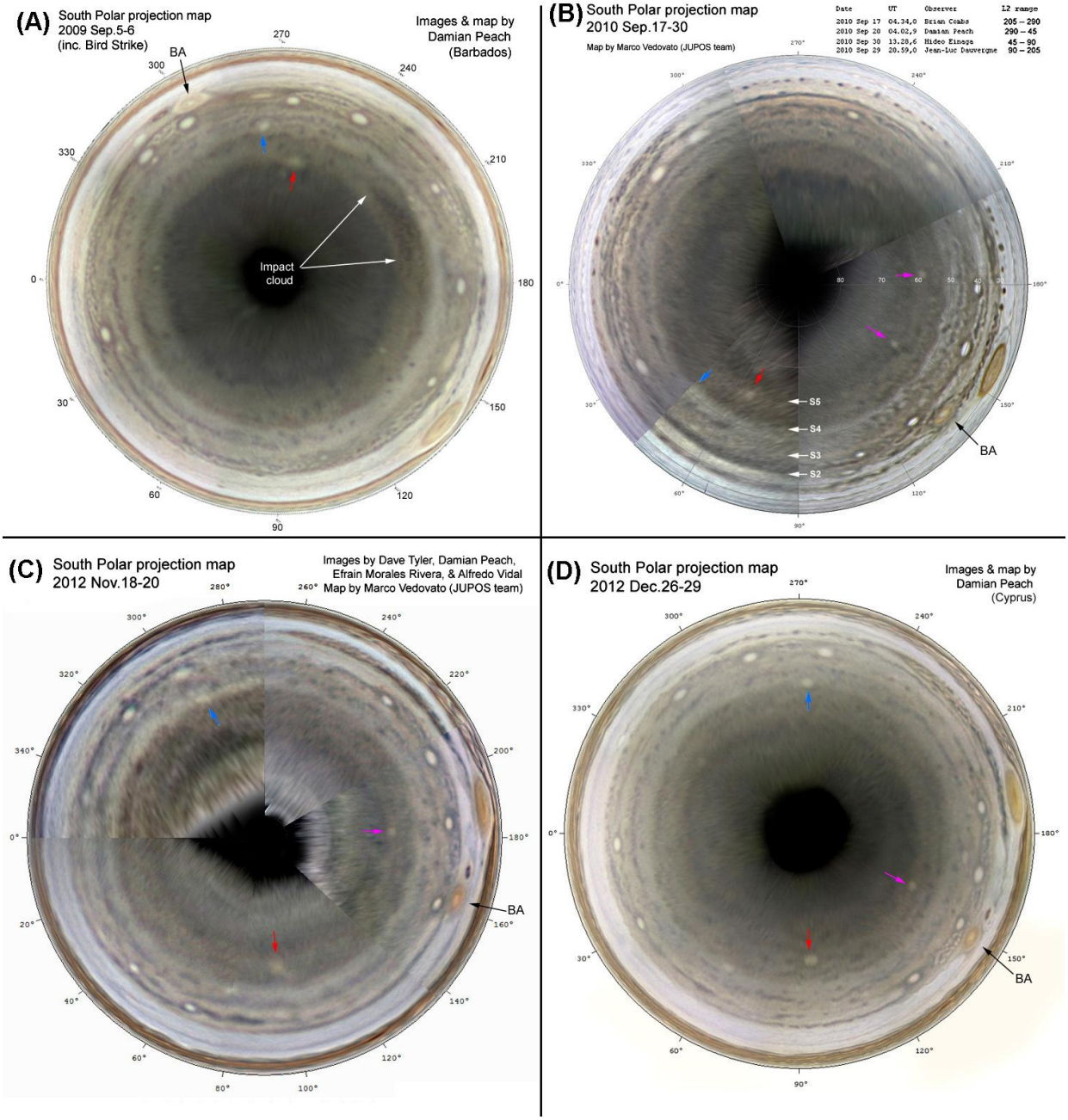

Figure 12. Polar projection maps

(A) 2009 Sep.(including the dark debris cloud of the 'Bird Strike' impact);
(B) 2010 Sep; (C) 2012 Nov; (D) 2012 Dec. (Credits are on the maps.)
All longitudes are in System II. Latitude scale and positions of prograde jets are marked on (B). Blue arrow, long-lived S3-AWO at ~50ºS; red arrow, long-lived S4-AWO at ~60ºS; mauve arrow, secondary AWO at ~60ºS.
For earlier maps, by Cassini in 2000 and by D. Peach in 2007, see our 2007 report [Ref.4]. Partial maps plotting the expansion of the dark impact cloud in 2009 July-August were published in our report [Ref.14].

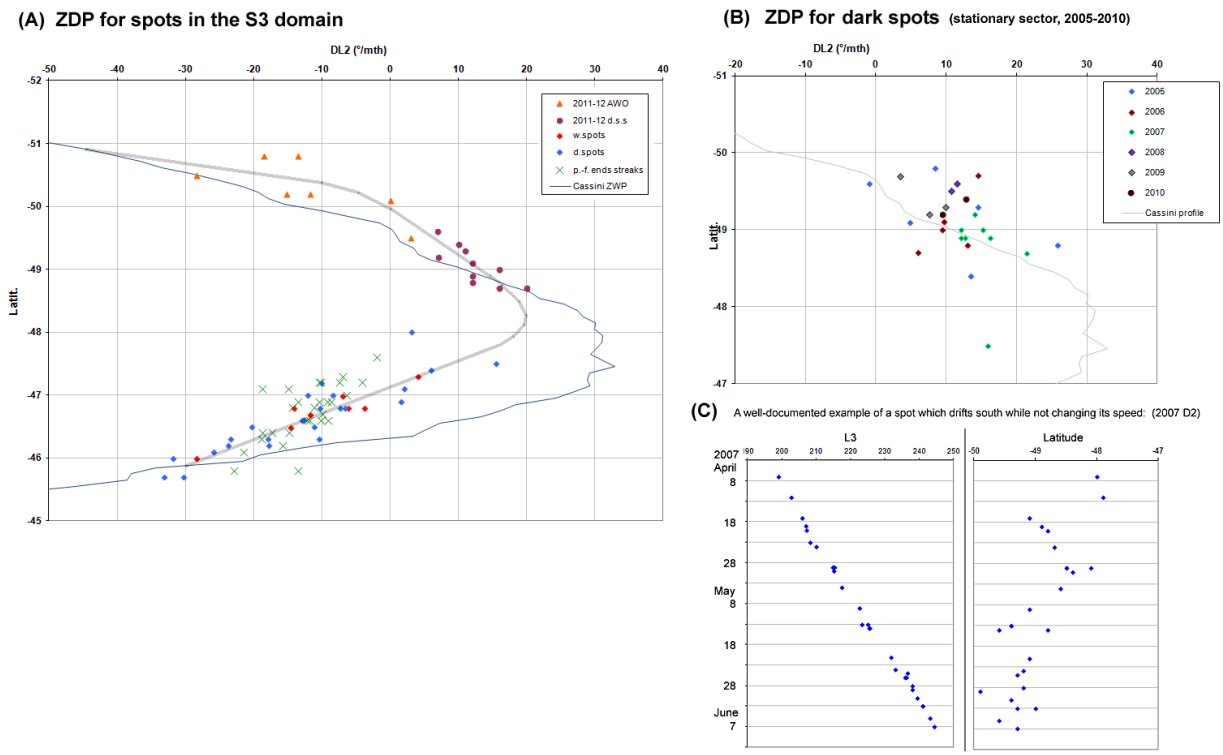

Figure 13. ZDPs for the S3 domain. [Analysis of JUPOS data by G. Adamoli].
(A) ZDP for spots in the S3 domain. Below 48ºS, all reliable tracks from 1999-2013 are shown. Above 48ºS, only data from 2011/12 are shown, for clarity; see subsequent figures for other years. Grey line, ZDP fitted by eye to these data; blue line, ZWP from Cassini. [From JUPOS/BAA report, in preparation]
(B) ZDP for the dark spots at ~49ºS, in the stationary spotty sector, 2005-2010.
(C) Example of one of these dark spots which drifted south without change of speed (the best documented case, in 2007).

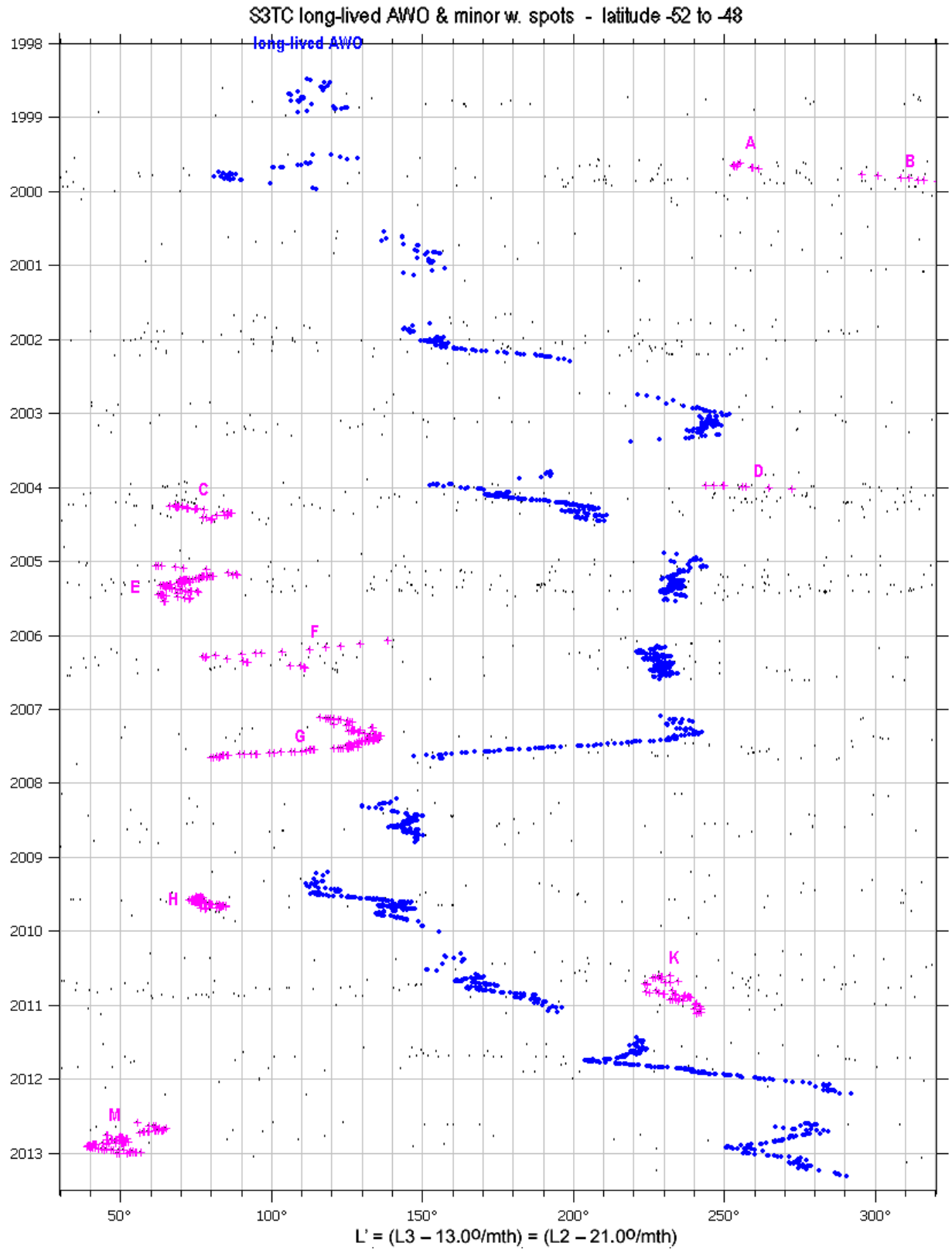

Figure 14. JUPOS charts for the white oval(s) around ~50ºS (S3 domain). Charts of longitude (L2) vs. time. As in all JUPOS charts, times runs downwards and the start of each year is marked. Identified ovals are highlighted (blue for S3-AWO-1, purple for shorter-lived ones); small dots represent transient spots. [Chart by G. Adamoli]

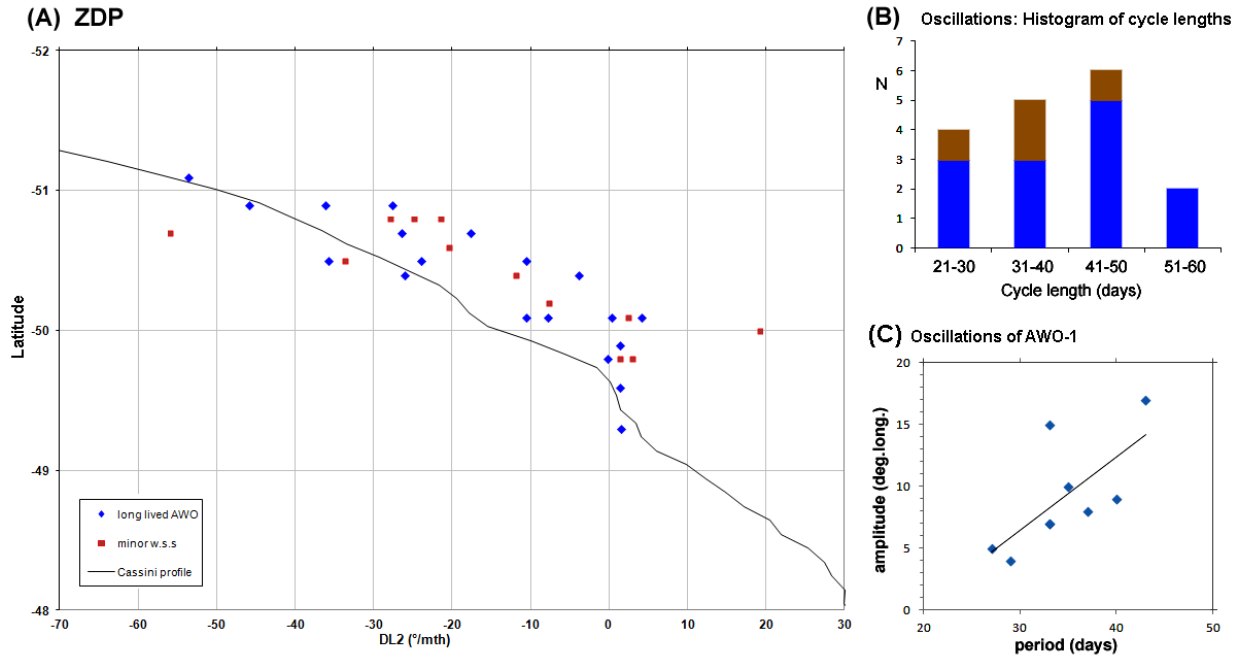

Figure 15. The white ovals at ~50°S. (A) ZDP for the AWOs. (B) Oscillations: Histogram of cycle lengths (for individual cycles). (C) Oscillations: Mean amplitude vs mean period, for 9 track segments spanning 1-5 cycles each. [Analysis of JUPOS data by G. Adamoli]

Figure 16. JUPOS charts for the bright oval(s) around ~60°S *[ON NEXT PAGE]*

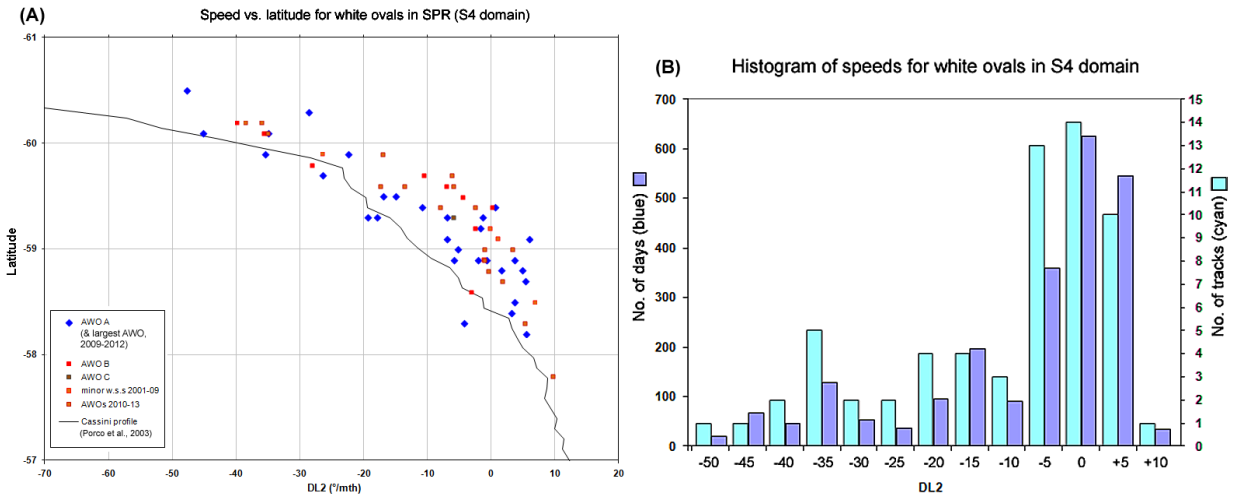

Figure 17. (A) ZDP for the bright ovals around ~60°S, from JUPOS data, compared with the Cassini ZWP. (B) Histogram of drift rates for these ovals (all white spots, 2001-2013), by number of days (blue) and number of tracks (cyan). Values indicated for DL2 (deg/mth) represent the middle of each bin. **[**Analysis by G. Adamoli]

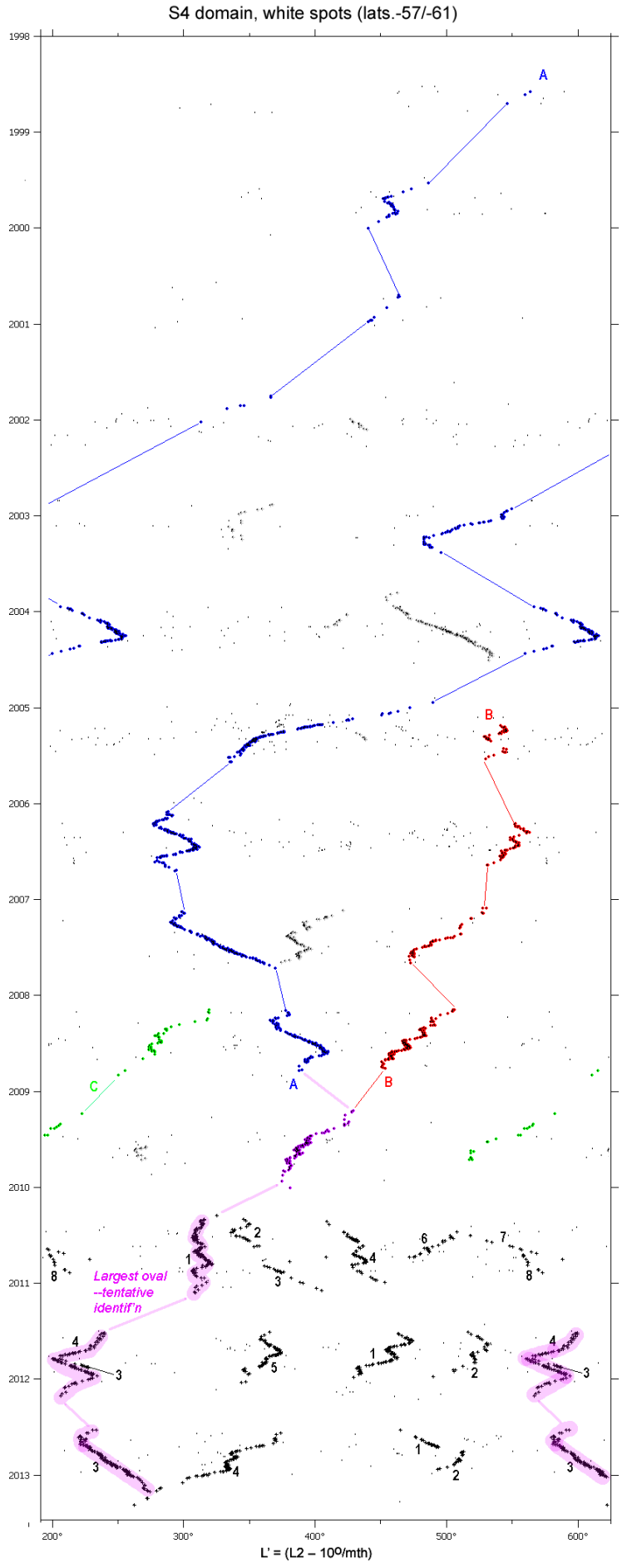

Figure 16. JUPOS charts for the bright oval(s) around ~60ºS (S4 domain). Charts of longitude (L2) vs. time. As in all JUPOS charts, times runs downwards and the start of each year is marked. Identified ovals are highlighted (dark blue for S4-AWO-A, other colours for shorter-lived ones); small dots represent transient spots. The track identified as AWO-A is often uncertain between apparitions due to its large changes in speed, but has been chosen to connect the largest oval in each apparition. [Chart by G. Adamoli]

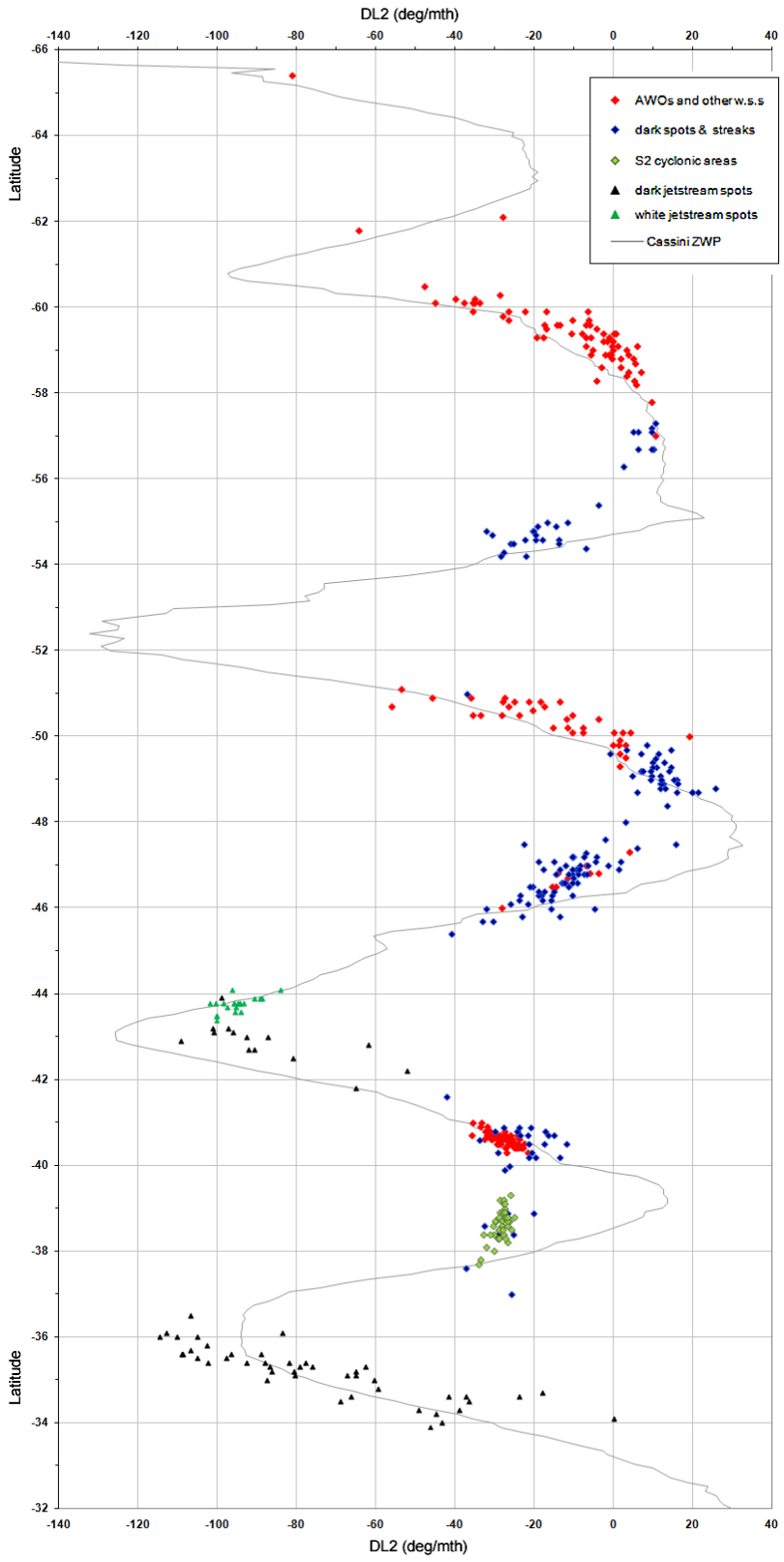

Figure 18. Complete chart of ZDPs across the whole of the S2 to S5 domains, 34 to 66ºS. This chart shows comprehensive results for 2001-2012 when available (with a few from 1999-2013), or results for specific apparitions when only these have been analysed (2005, 2006, 2011/12). Most of the data are shown on larger scales in previous figures in this report. [Chart by G. Adamoli]