

Jupiter's South Equatorial Belt Revival in 2010/11

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Abstract

A Revival of the South Equatorial Belt (SEB) is the most impressive organised disturbance that occurs on Jupiter. It starts with a single vigorous outbreak from which vigorous storms and disturbances spread around the planet in the different zonal currents. The Revival that began in 2010 has been better observed than any before it. Here we present analysis of the amateur images of the event, in visible light and a methane absorption band. These results substantiate previous descriptions of SEB Revivals with much greater precision, showing a high degree of organisation, but also raise new puzzles as the usual zonal wind patterns were altered.

1. Introduction

The SEB Revival is the most spectacular meteorological phenomenon to be seen on Jupiter [ref.1], but only occurs at irregular intervals. Since the modern era of hi-res imaging, we have awaited an opportunity to investigate one in detail. A Revival did occur in 2007, and was a well-observed event which taught us much. Nevertheless, the 2007 Revival was weaker than some in the historical records, occurring with the SEB only partially faded. In 2010, the SEB had faded again, much more completely. The Revival began under favourable viewing conditions, and displayed the classical phenomena clearly.

Historically, SEB Revivals have been considered to comprise a source region and three branches which stream out from it [ref.1; Fig.1d]. At the source, visibly bright plumes emerge, as though from a deeper storm which is the source of it all. This source produces vigorous disturbances which spread in latitude, and are entrained by the permanent zonal winds so they spread in longitude.

These divisions have been confirmed by the observations this year, which have also shown that the source and central branch are even more organised than might have been suspected.

2. Methods

Numerous amateur observers around the world, contributed images for this report, taking images on every possible night. Lists of the observers are posted on the BAA web site:

<http://www.britastro.org/jupiter/reports.htm>

Images are taken with a variety of telescopes, mostly with apertures 20-40 cm using webcams. They are processed with software such as Registax. Measurements of 'spots' are done on-screen using the WinJUPOS program created by G. Hahn and H-J.M. <http://jupos.org>. [See abstract in OA6.]

3. Results

The observations analysed here largely validate the historical descriptions of these events: the major features recognised in them, albeit at lower resolution, are indeed the large structural features described here. The major conclusions about the 2010 SEB Revival so far are as follows.

- 1) The Revival started with a bright white plume erupting in a pre-existing barge (Fig.1a) (as also in 2007). Subsequent white plumes continued to appear on the track of this barge (Fig.2), which was the location of the sub-surface source of the whole Revival.
- 2) These plumes were extremely bright in the methane absorption band, i.e. thrusting up to very high altitudes, especially when new (Fig.1a,b).
- 3) Brilliant white spots (methane-bright plumes) also appeared along the leading edge of the central branch (Fig.1b,c).
- 4) The central region of the outbreak was entirely composed of large convective cells, each of which was initiated by a bright plume, but the plume only occupies a part of the cell. Each new plume at the source marked the creation of one of these

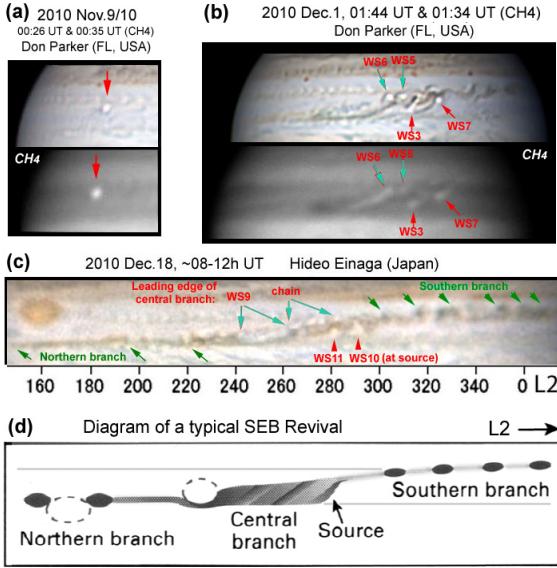


Fig.1. Appearance of the SEB Revival. South is up. (a) Nov.9/10: The initial bright plume, 12 hrs after its first appearance: Visible and methane band ($0.89\text{ }\mu\text{m}$) images. (b) Dec.1: Two subsequent bright plumes which arose at the source (red arrows) and two which arose in the leading edge (cyan arrows). All are methane-bright. (c) Dec.18 (cylindrical projection): Structure of the expanding Revival. (d) Diagram of a typical SEB Revival [ref.1].

expanding cells, and a very dark streak ('column') persisted to define its west edge.

- 5) The southern branch began with darkening of pre-existing mini-projections which accelerated. Subsequent darker spots in the southern branch were complex structures, not coherent vortices.
- 6) Dark spots in the southern branch had typical SEBs jetstream speed but were unusually far south (Fig.3). This indicates a large real acceleration westwards of the latitude band $20\text{--}21^\circ\text{S}$, to the same speed as the jet 1° further north.

References

- [1] Rogers JH, *The Giant Planet Jupiter* (CUP, 1995)
- [2] BAA/JUPOS: Reports on the 2010 apparition at: <http://www.britastro.org/jupiter/2010reports.htm>
- [3] Porco CC et al, (2003) *Science* 299, 1541-7.

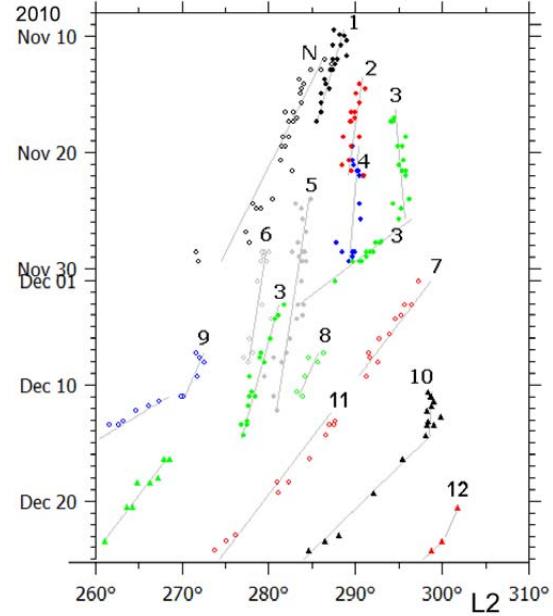


Fig.2. Chart of longitude vs time for the bright spots (plumes) in the SEB Revival, colour-coded by spot number. WS-1,-2,-3 appeared exactly on the track of the pre-existing 'barge' (not shown), and WS-7,-10,-12 continued to define the source close to that track. WS-N,4,-5,-6,-9 all appeared in the leading edge of the disturbance (Fig.1). The spots moved coherently in spite of their wide range of latitudes.

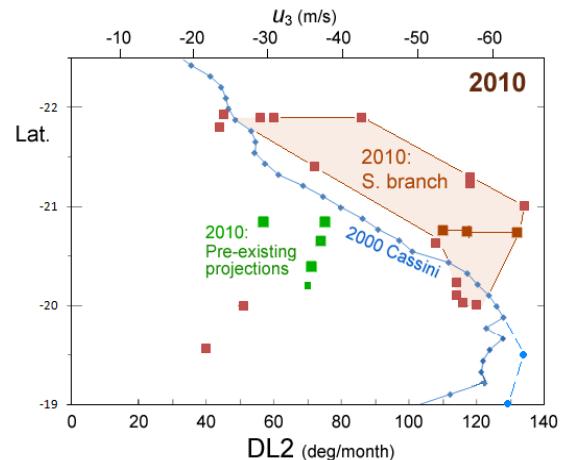


Fig.3. Charts of speed vs latitude for SEB(S) spots. (Blue line:) Zonal wind profile from Cassini [ref.3] with additional points from New Horizons.