OAG JUPITER PROJECT 2007+

FOURTH REPORT

February 2019

OBSERVATIONS ON THE GREAT RED SPOT 2007 & 2008

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Publications of Garraf Astronomical Observatory

Barcelona, Spain. Nº 03/2019

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1. Introduction

This report summarizes the position measurements and morphological observations of the Great Red Spot (GRS) of Jupiter in 2007 and 2008, made from selected images obtained by J.A.Soldevilla (JAS) at the Canyelles Observatory. The GRS is considered a remarkably stable structure of the Jovian atmosphere at least from the mid to late nineteenth century, although suffering notable variations related to the major changes in the SEB.

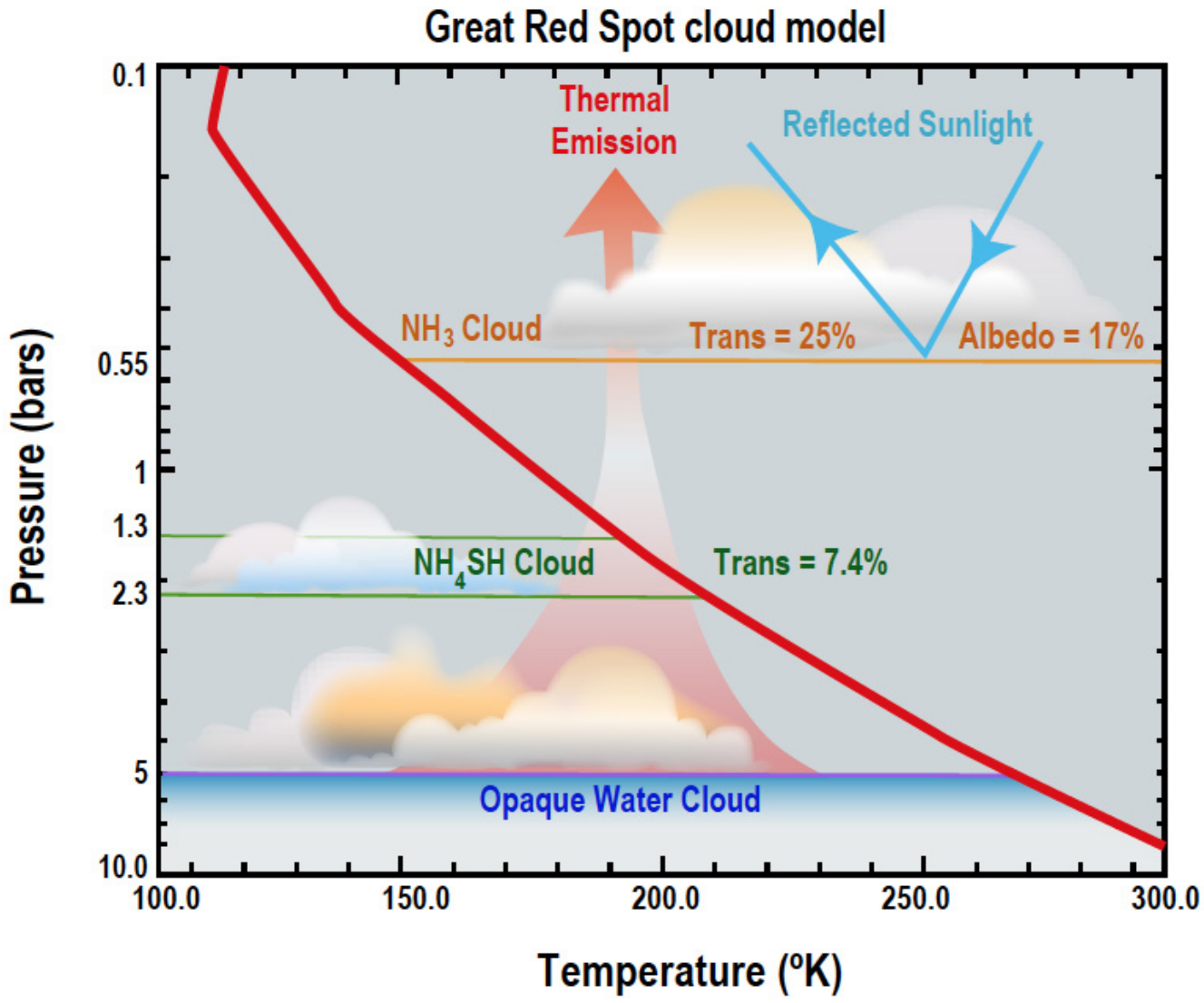


Fig.1 Currently model for the formation of GRS on Jupiter

A model of the clouds in Jupiter's Great Red Spot showing three layers where temperature and pressure (red line) are such that ammonia (NH3), ammonium hydrogen sulfide (NH4SH) and water condense into cloud droplets. When viewing Jupiter from Earth, we see sunlight reflected from the highest ammonia clouds. (Graphic by Bjoraker et al)

A total of 56 measurements (see 3.) have been made on Longitude, Zenographic Latitude of the centre, N & S edges and dark spots (if they exist) that usually determine the limits *p* and *f* (preceding & following). When the centre is occupied by a dark vortex is measured on it, if not exist the geometric centre is estimated visually. The eccentric details within the main oval have also been referenced by their coordinates.

The first JAS observation of the GRS took place on July 7, 2007 at 23h02m TU through his Newton reflector of 250mm F / 6. In red -infrared light the oval is little defined at its N edge, the darkest part being the S arc being limited in *p* by a dark condensation and in *f* by two dark spots in the N / S direction. A bar joins these spots with the dark central vortex. It is possible that a tiny dark spot is located in the arc S of the main oval. The Hollow has lost its usual shape due to the outbreak of dark spots from the S margin of the SEBs

Fig.2a-2b. Images of Jupiter by JAS. Left: 20070707 / right: 20080722

The morphology of the GRS and the surrounding regions showed notable variations between the initial observation of July 7, 2007 and those of July 22, 2008, which can be seen in Fig.2. The SEB had recovered showing wide with abundant details. The Hollow had been recomposed and the entire GRS contour was defined, although somewhat broken in the N arch. The dark central vortex and the bar towards the limit f had disappeared, being replaced by diffuse eccentric spots with symptoms of curvature in the anticyclonic sense of internal rotation. Two small bright spots marked the *f* limit of the main oval. The reappearance phenomena of the bands are preceded by the outbreak of chains of dark spots,that are gradually supplying the necessary material for their regeneration. Images taken on October 10, 2008 show no significant changes in the morphology of the region or in the main oval (with different albedo and a possible small dark spot in its *p*-quadrant) showing the GRS-Hollow-SEB set in its more usual appearance.

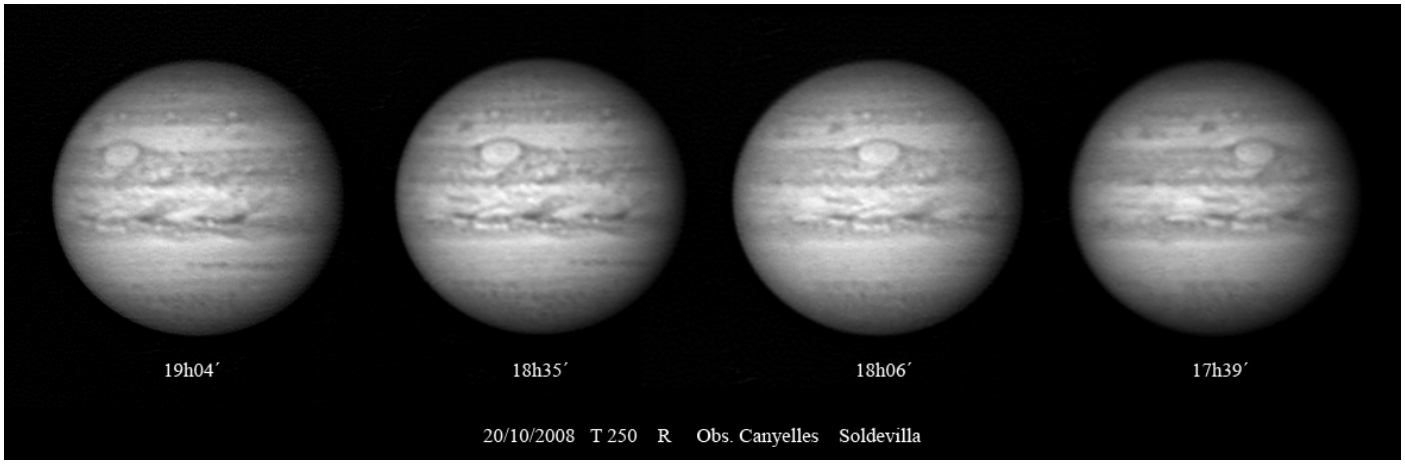


Fig 3a. 20081020_JAS. Series of images showing the GRS

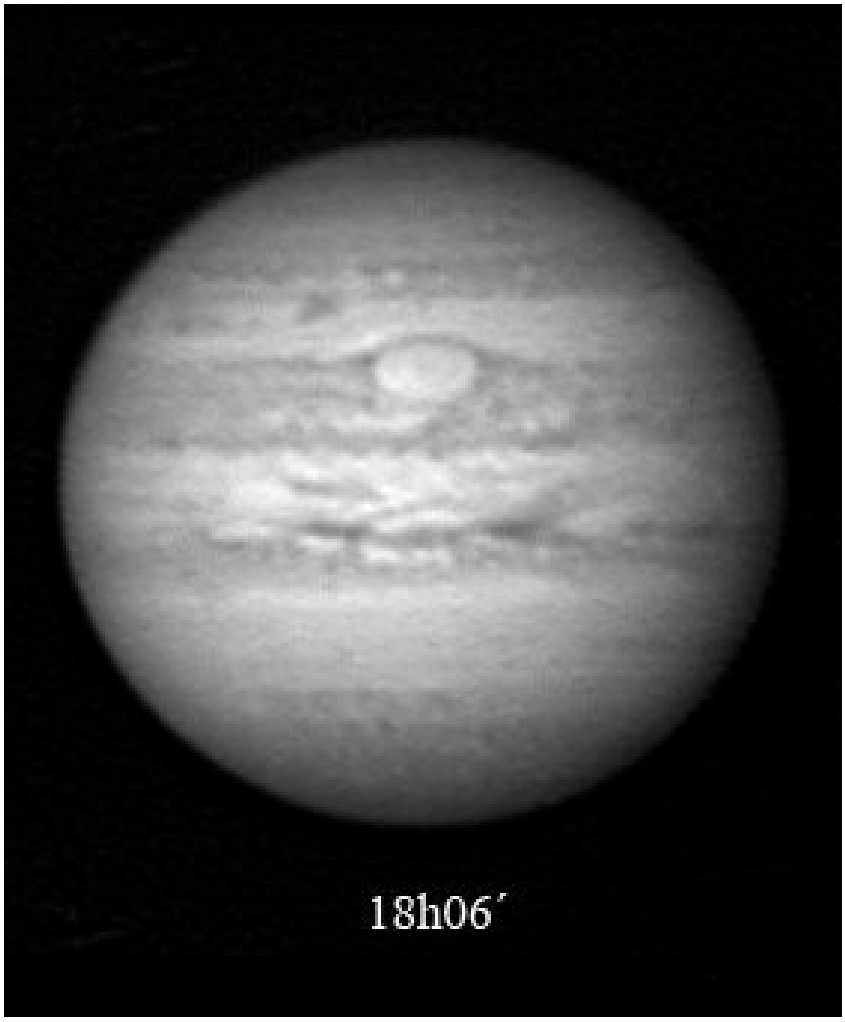


Fig 3b. 20081020_JAS. The GRS crossing de CM

2. Size, Zenographic Latitude and rotation period of GRS

The size variation of the GRS was notable, increasing the internal oval about 11,700km to 19,300km in the E-W direction and about 12,000km to 13,800km in the N / S direction. The central dark vortex observed in 20070707 had an E-W length of about 4,800km, being replaced in 20080722 and 2008010 by more diffuse spots adding up a length of about 12,000km.

Size	20070707	20080722 20081020	increase
External oval (p-f)	18.400 km	24.500 km	+33%
Internal oval (p-f)	11.700 km	19.300 km	+64%
External oval N/S	12.000 km	13.800 km	+15%
Central vortex E/W	4.800 km	7.800 km	+62%
Composite vortex E/W	7.900 km	12.000 km	+51%

The results confirm that the centre and the two dark spots in the margins p and f moved jointly, belonging to the same structure, as well as the dark spot of the N edge, but not the less defined dark spot delimiting the S edge. For the centre of the GRS the historical average values were -23.8º / 1.3º (1879-1891), -21.6º / 1.1º (1914-1928) and -22.3º / 0.3º (1952- 1990). The N edge between 1952-1990 was located at -16.5º / 0.4º and the S edge at -28.4º according the compilations published by Rogers (1995). The Zenographic Latitude of the GRS centre maybe it showed a slight shift to the N, from -22,3º to -21,6º.

Zenographic Latitudes	**ß”**	**σ st**	**ß”**	**σ st**
Centre	-22,3º	…	-21,6º	0,1º
Preceding Dark Spot	-22,7º	…	-22,8º	0,2º
Following Dark Spot	-24,3º	…	-22,5º	0,3º
North edge Dark Spot	-15,7º	…	-16,1º	0,1º
South edge Dark Spot	-28,2º	…	-27,6º	0,2º
	20070707	n=1	20080722 20081020	n= 8

The rotation periods were obtained through the Winjupos application on the series of images obtained by JAS between 20080722 and 20081020, these being of good quality. The consistency of the values and the low dispersion obtained confirms this. Historical records of the period of rotation of the GRS (Peek 1958) indicate values between 9h55m32sec (1924) for the shortest and 09h55m44sec (1939-40) for the longest

Rotation period	**20070707**	**20080722 20081020**	**σ st**	**ß”**	**σ st**
Centre	ND	09h55m42,6seg	0,1 seg	-21,6º	0,1º
Preceding Dark Spot	ND	09h55m42,4seg	0,6 seg	-22,8º	0,2º
Following Dark Spot	ND	09h55m42.4seg	0,2seg	-22,5º	0,3º
North edge Dark Spot	ND	09h55m43,7seg	0,2seg	-16,1º	0,1º
South edge Dark Spot	ND	09h52m58,3seg	0,2seg	-27,6º	0,2º
			n= 8	n= 8	n= 8

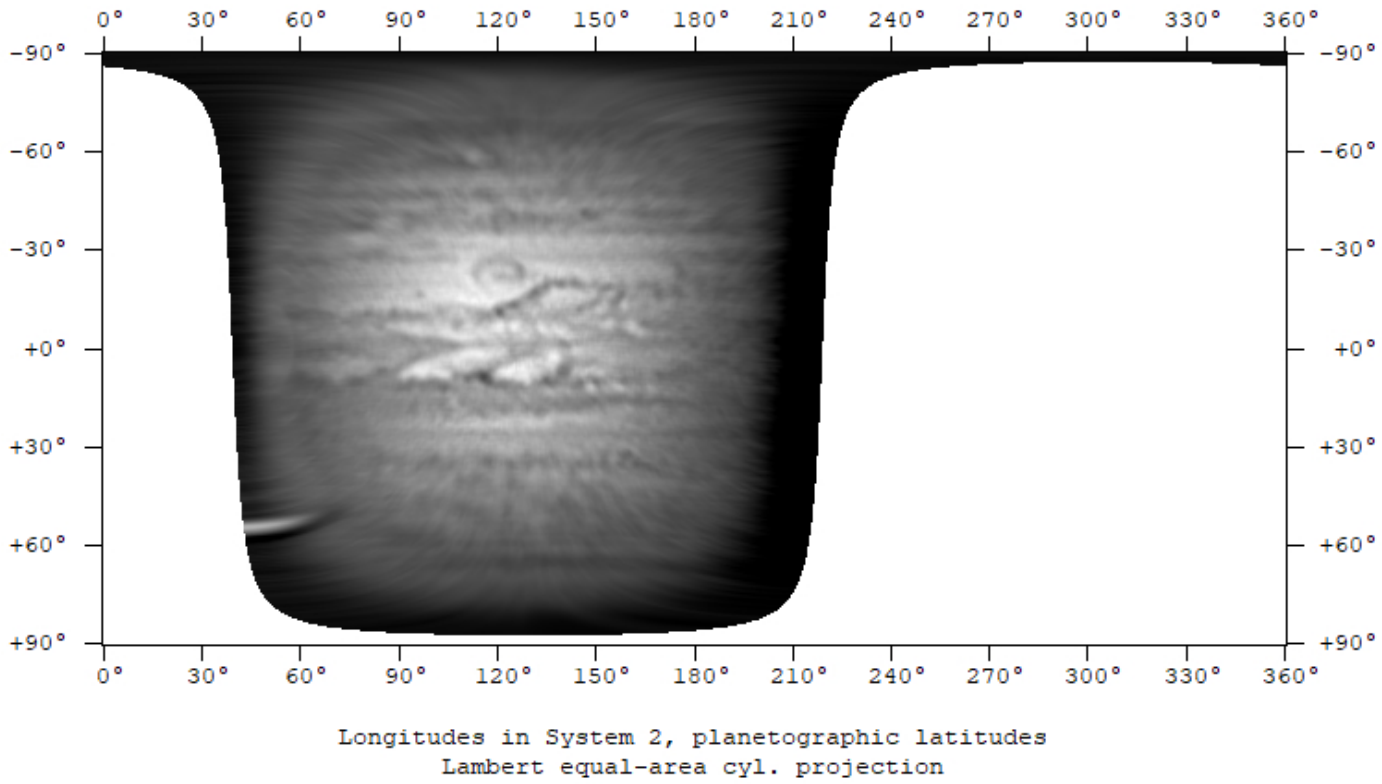


Fig 4a: 20070707_JAS**.** Lambert equal area cyl-projection (Winjupos)

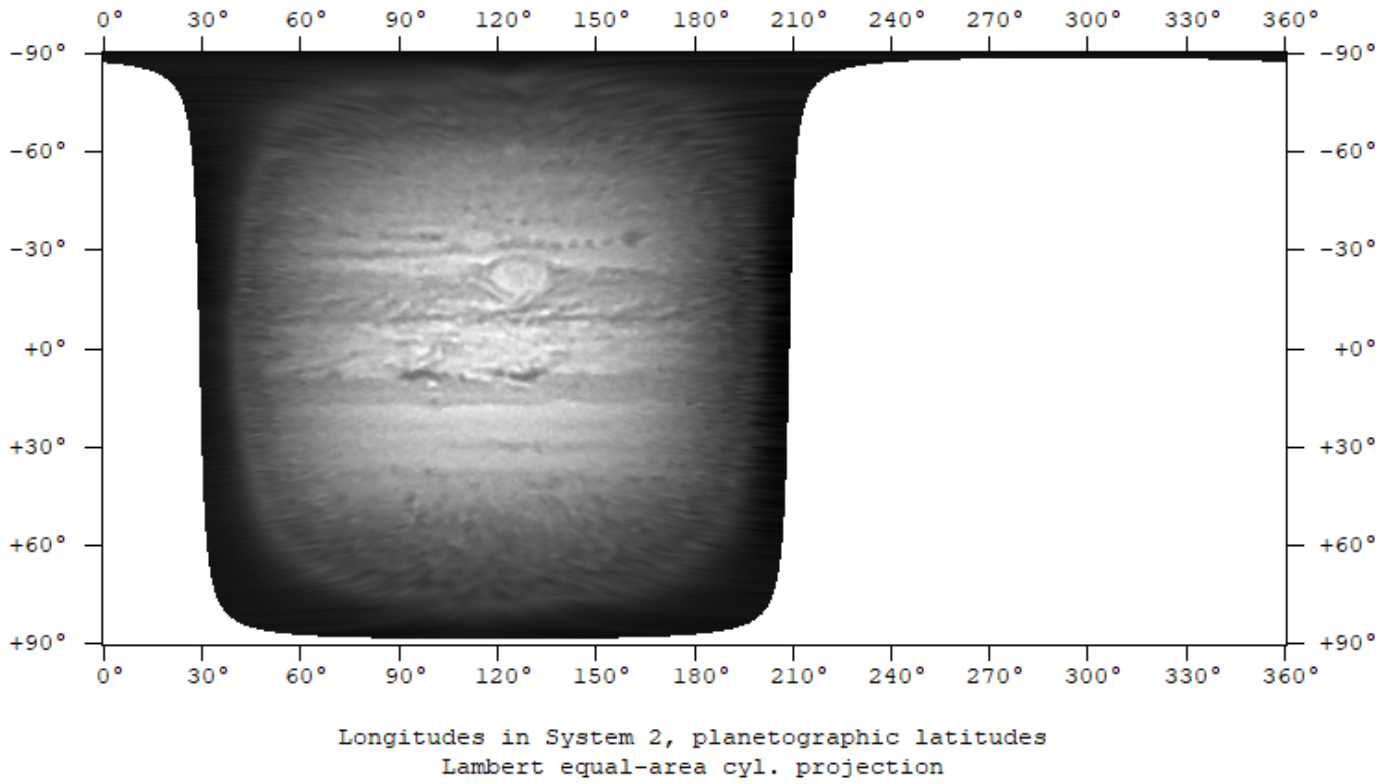


Fig 4b: 20081020_JAS**.** Lambert equal area cyl-projection (Winjupos)

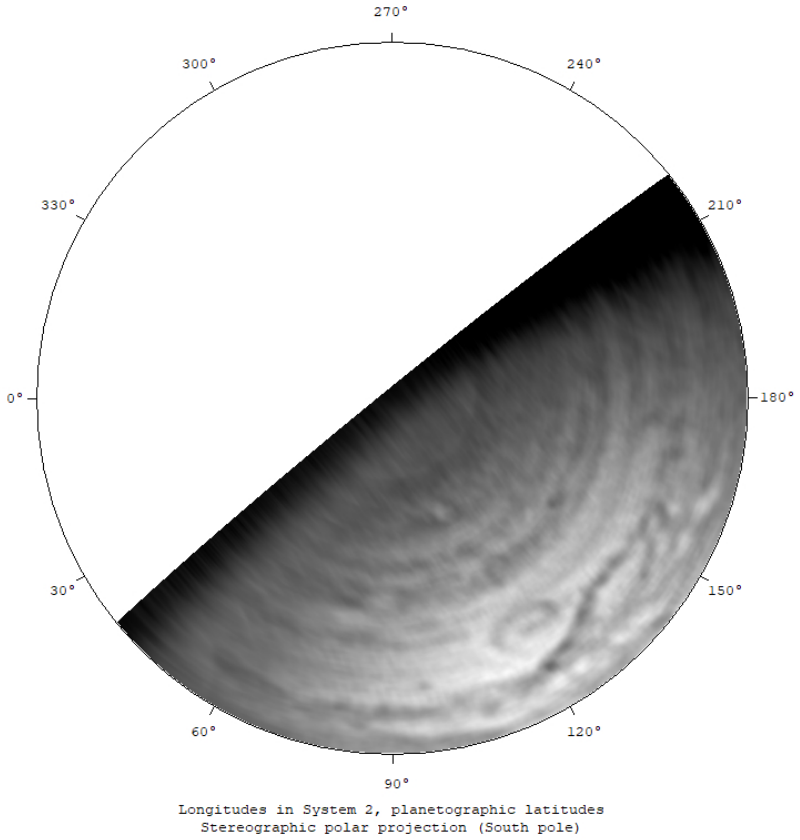


Fig 5a: 20070707_JAS**.** Stereographic polar projection (Winjupos)

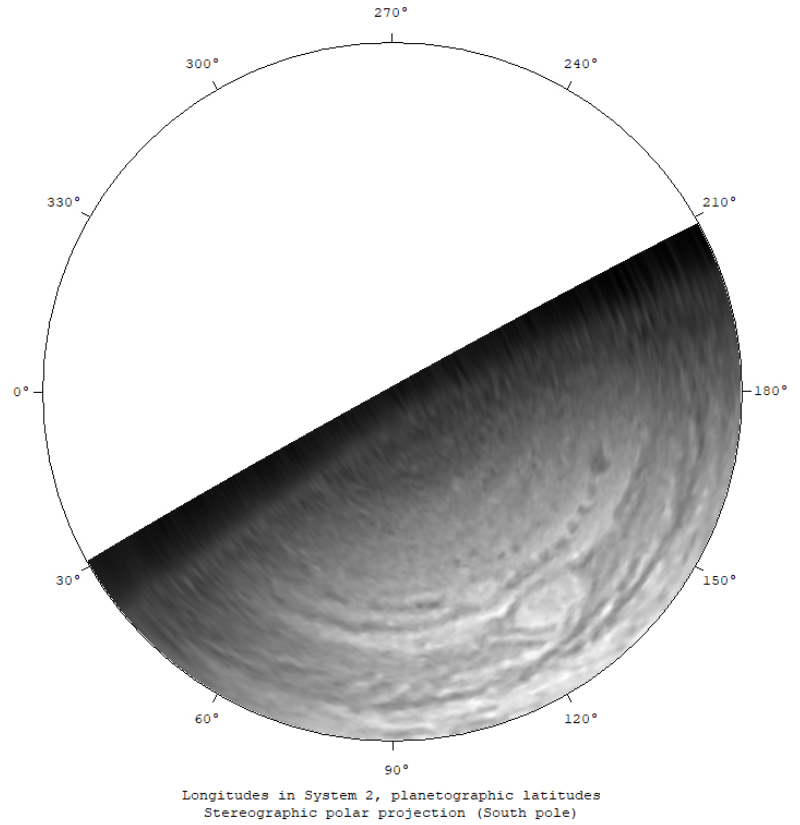


Fig 5b: 20081020_JAS**.** Stereographic polar projection (Winjupos)

3. Table of measurements (Winjupos)

Record	Object	R	ID	yyyy/mm/dd	hh:mm,t	L1	L2	L3	+/-	S	Phase	B"	Mea	Chan
1	DC3_SPOT	D1	SPOT	2007/07/07	23:01,0	204,7	120,8	12,5		2	-6,2	-28,2	TOB	ired
2	DS1_SPOT	D1	SPOT	2007/07/07	23:01,0	204,7	120,9	12,5		2	-6,2	-27,6	TOB	ired
3	DF1_RS	E3	SPOT	2007/07/07	23:01,0	210,4	126,6	18,3		2	-6,2	-24,1	TOB	ired
4	DC1_RS	E3	SPOT	2007/07/07	23:01,0	204,1	120,3	12,0		2	-6,2	-22,1	TOB	ired
5	DP1_RS	E3	SPOT	2007/07/07	23:01,0	197,2	113,4	5,0		2	-6,2	-22,0	TOB	ired
6	DN1_SPOT	G1	SPOT	2007/07/07	23:01,0	201,7	117,9	9,5		2	-6,2	-16,6	TOB	ired
7	DC3_SPOT	G1	SPOT	2007/07/07	23:01,0	202,2	118,4	10,0		2	-6,2	-15,7	TOB	ired
8	DS1_SPOT	D1	SPOT	2008/07/22	22:31,0	237,8	127,1	120,1		2	-2,9	-27,7	TOB	ired
9	DF1_RS	E3	SPOT	2008/07/22	22:31,0	248,0	137,3	130,3		2	-2,9	-23,9	TOB	ired
10	DC2_SPOT	E1	SPOT	2008/07/22	22:31,0	236,9	126,2	119,2		2	-2,9	-23,4	TOB	ired
11	DP1_RS	E3	SPOT	2008/07/22	22:31,0	227,8	117,1	110,1		2	-2,9	-22,9	TOB	ired
12	DN1_SPOT	G1	SPOT	2008/07/22	22:31,0	235,0	124,3	117,3		2	-2,9	-16,9	TOB	ired
13	DS1_SPOT	D1	SPOT	2008/07/22	22:49,0	238,9	128,1	121,1		2	-2,9	-27,5	TOB	ired
14	DC3_SPOT	E1	SPOT	2008/07/22	22:49,0	243,0	132,2	125,2		2	-2,9	-22,8	TOB	ired
15	DP1_SPOT	E1	SPOT	2008/07/22	22:49,0	228,0	117,2	110,2		2	-2,9	-22,0	TOB	ired
16	DC1_RS	E3	SPOT	2008/07/22	22:49,0	237,4	126,6	119,6		2	-2,9	-21,9	TOB	ired
17	DF1_SPOT	F1	SPOT	2008/07/22	22:49,0	246,9	136,1	129,1		2	-2,9	-21,7	TOB	ired
18	DS1_SPOT	G1	SPOT	2008/07/22	22:49,0	235,0	124,2	117,2		2	-2,9	-16,7	TOB	ired
19	DS1_RS	E3	SPOT	2008/07/22	23:08,0	237,4	126,5	119,5		2	-2,9	-27,2	TOB	ired
20	DC3_SPOT	E1	SPOT	2008/07/22	23:08,0	234,4	123,5	116,5		2	-2,9	-23,4	TOB	ired
21	DP1_RS	E3	SPOT	2008/07/22	23:08,0	228,3	117,3	110,4		2	-2,9	-21,6	TOB	ired
22	DC1_RS	E3	SPOT	2008/07/22	23:08,0	236,8	125,9	118,9		2	-2,9	-21,6	TOB	ired
23	DF1_RS	E3	SPOT	2008/07/22	23:08,0	245,6	134,7	127,7		2	-2,9	-20,8	TOB	ired
24	DN1_SPOT	G1	SPOT	2008/07/22	23:08,0	234,9	124,0	117,0		2	-2,9	-16,1	TOB	ired
25	DS1_SPOT	D1	SPOT	2008/07/22	23:18,0	237,3	126,3	119,4		2	-2,9	-27,8	TOB	ired
26	DP1_RS	E3	SPOT	2008/07/22	23:18,0	227,8	116,9	109,9		2	-2,9	-22,8	TOB	ired
27	DF1_RS	E3	SPOT	2008/07/22	23:18,0	246,8	135,8	128,8		2	-2,9	-22,7	TOB	ired
28	WF1_SPOT	E1	SPOT	2008/07/22	23:18,0	245,1	134,1	127,1		2	-2,9	-22,4	TOB	ired
29	DC1_RS	E3	SPOT	2008/07/22	23:18,0	237,0	126,0	119,1		2	-2,9	-22,1	TOB	ired
30	DC3_SPOT	E1	SPOT	2008/07/22	23:18,0	242,8	131,8	124,8		2	-2,9	-22,1	TOB	ired
31	WF2_SPOT	F1	SPOT	2008/07/22	23:18,0	243,9	132,9	126,0		2	-2,9	-20,3	TOB	ired
32	DN1_SPOT	G1	SPOT	2008/07/22	23:18,0	235,3	124,3	117,3		2	-2,9	-16,5	TOB	ired

33	DS1_SPOT	D1	SPOT	2008/10/20	17:39,0	207,3	131,4	148,3	2	-10,9	-27,8	TOB ired
34	DP1_RS	E3	SPOT	2008/10/20	17:39,0	196,8	121,0	137,9	2	-10,9	-22,8	TOB ired
35	DC3_SPOT	E1	SPOT	2008/10/20	17:39,0	201,4	125,6	142,4	2	-10,9	-22,2	TOB ired
36	DF1_RS	E3	SPOT	2008/10/20	17:39,0	216,1	140,3	157,2	2	-10,9	-21,5	TOB ired
37	DC1_RS	E3	SPOT	2008/10/20	17:39,0	206,4	130,6	147,5	2	-10,9	-21,1	TOB ired
38	DN1_SPOT	G1	SPOT	2008/10/20	17:39,0	206,0	130,1	147,0	2	-10,9	-16,2	TOB ired
39	DS1_SPOT	E1	SPOT	2008/10/20	18:06,0	205,8	129,8	146,7	2	-10,9	-27,3	TOB ired
40	DP1_RS	E3	SPOT	2008/10/20	18:06,0	196,8	120,8	137,7	2	-10,9	-23,4	TOB ired
41	DC3_SPOT	F1	SPOT	2008/10/20	18:06,0	200,9	124,9	141,8	2	-10,9	-21,8	TOB ired
42	DC1_RS	E3	SPOT	2008/10/20	18:06,0	206,3	130,3	147,2	2	-10,9	-21,8	TOB ired
43	DF1_SPOT	F1	SPOT	2008/10/20	18:06,0	215,7	139,7	156,6	2	-10,9	-21,7	TOB ired
44	DN1_SPOT	G1	SPOT	2008/10/20	18:06,0	206,3	130,3	147,2	2	-10,9	-15,8	TOB ired
45	DS1_SPOT	D1	SPOT	2008/10/20	18:35,0	206,1	130,0	146,9	2	-10,9	-27,8	TOB ired
46	DF1_RS	E3	SPOT	2008/10/20	18:35,0	215,9	139,7	156,7	2	-10,9	-23,9	TOB ired
47	DP1_RS	E3	SPOT	2008/10/20	18:35,0	197,0	120,9	137,8	2	-10,9	-23,8	TOB ired
48	DC3_SPOT	F1	SPOT	2008/10/20	18:35,0	201,2	125,1	142,0	2	-10,9	-21,1	TOB ired
49	DC1_RS	E3	SPOT	2008/10/20	18:35,0	207,0	130,8	147,7	2	-10,9	-21,1	TOB ired
50	DN1_SPOT	G1	SPOT	2008/10/20	18:35,0	207,4	131,3	148,2	2	-10,9	-15,7	TOB ired
51	DS1_SPOT	D1	SPOT	2008/10/20	19:04,0	205,2	129,0	145,9	2	-10,9	-27,5	TOB ired
52	DF1_RS	E3	SPOT	2008/10/20	19:04,0	216,2	139,9	156,8	2	-10,9	-23,7	TOB ired
53	DP1_RS	E3	SPOT	2008/10/20	19:04,0	197,4	121,2	138,1	2	-10,9	-23,4	TOB ired
54	DC3_SPOT	F1	SPOT	2008/10/20	19:04,0	201,4	125,2	142,1	2	-10,9	-21,3	TOB ired
55	DC1_RS	E3	SPOT	2008/10/20	19:04,0	207,0	130,7	147,6	2	-10,9	-21,3	TOB ired
56	DN1_SPOT	G1	SPOT	2008/10/20	19:04,0	208,0	131,8	148,7	2	-10,9	-15,9	TOB ired

*TOB: T.Tobal

APPENDIX I

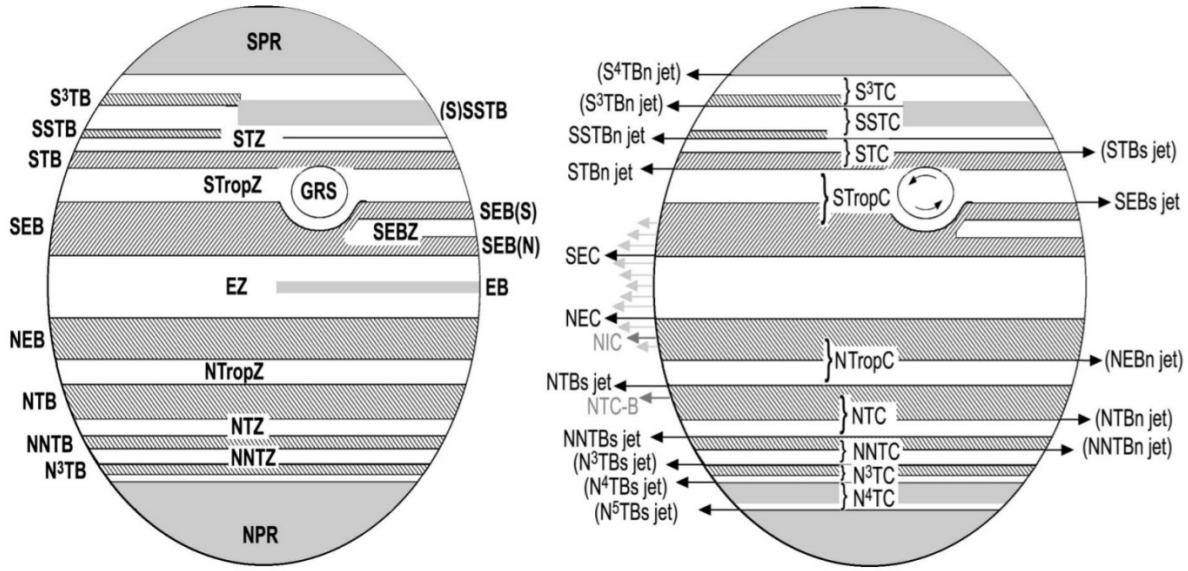
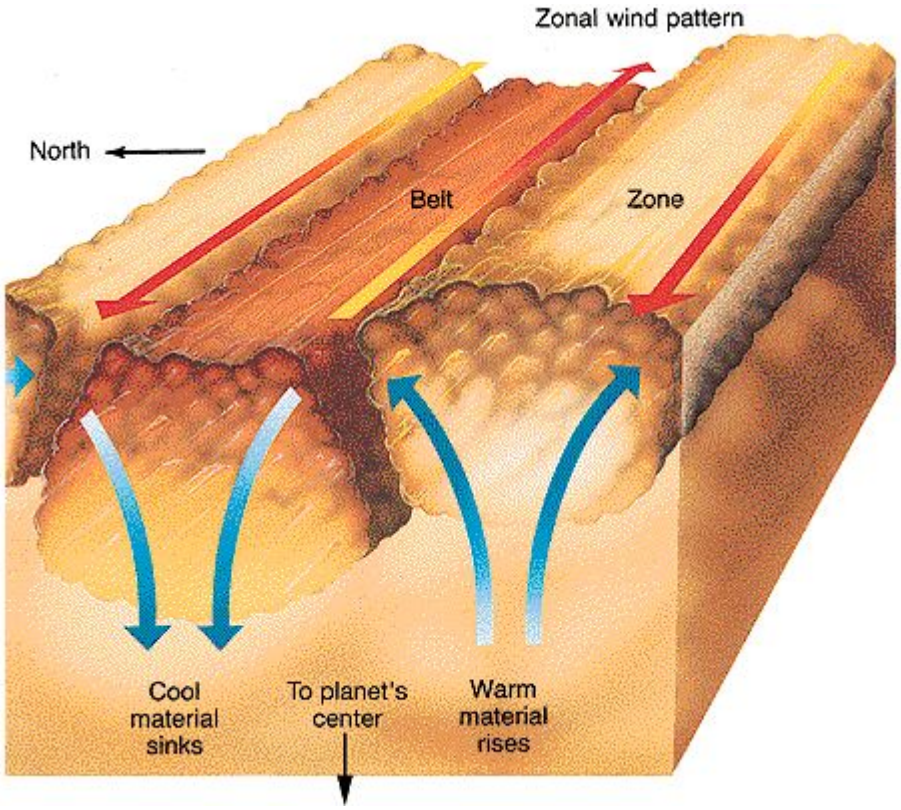


Fig.6 Belts, Zones and Currents in Jupiter (Rogers 1995)



Jupiter's vertical and horizontal atmospheric flows (Astrobioloblog)

APPENDIX II

Average Reference Positions of Jupiter Belts 1907-2018. Zenographic Latitudes
(Tobal-Soldevilla 2019)

BELTS NH	ß”	σ st		BELTS SH	ß”	σ st
1907-2018	Average	Average		1907-2018	Average	Average
NPR/NPH	+65,0	1,20		EB-sn	-1,5	0,20
N5TB-n	+59,9	0,20		EB-sc	-3,0	0,25
N5TB-c	+57,1	0,35		EB-ss	-4,7	0,10
N5TB-s	+52,3	1,00		SEB-nn	-6,9	0,20
N4TB-n	ND	ND		SEB-nc	-7,8	0,30
N4TB-c	+50,9	0,20		SEB-ns	-8,6	0,55
N4TB-S	+48,2	0,50		SEB-n	-7,0	1,00
N3TB-n	+47,0	0,68		SEB-sn	-9,0	0,30
N3TB-c	+44,5	0,80		SEB-sc	-11,9	0,20
N3TB-s	+41,8	0,67		SEB-ss	-12,7	0,40
N2TB-n	+39,0	0,60		SEB-sn	-17,5	0,57
N2TB-s	+37,6	0,80		SEB-sc	-20,1	0,73
N2TB-s	+35,6	0,70		SEB-ss	-24,3	0,25
NTB-nn	+33,9	0,40		STB-n	-26,6	0,85
NTB-nc	+32,4	0,40		STB-c	-29,7	0,67
NTB-ns	+30,9	0,93		STB-s	-32,6	0,75
NTB	+28,6	0,60		S2TB-n	-36,2	0,63
NTB-sn	+25,8	0,55		S2TB-c	-39,0	0,65
NTB-sc	+24,3	0,83		S2TB-s	-41,7	1,28
NTB-ss	+22,2	0,70		S3TB-n	-43,7	0,73
NEB-n	+17,3	1,53		S3TB-c	-47,2	0,60
NEB-c	+12,6	0,40		S3TB-s	-48,7	0,90
NEB-s	+7,7	0,75		S4TB-c	-53,1	0,63
EB-nc	+1,5	0,10		S4TB-s	-57,2	0,60
				S5TB-n	-61,4	2,00
				S5TB-c	-65,1	0,50
				S5TB-s	ND	ND
				SPR/SPH	-68,2	1,20

n= nord, **c**= center, **s**= south, **H**=hood

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