Final version, 2020 June 4. This is Part I (Sections 1-5). Part II will follow later.

The Great Red Spot in 2019 and its interaction with retrograding vortices as monitored by the amateur planetary imaging community

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with contributions from

the JunoCam team (Candy Hansen (PI), Glenn Orton, Tom Momary, Gerald Eichstädt, & J.H.R.) & the JUPOS team (Gianluigi Adamoli, Rob Bullen, Michel Jacquesson, M.V., & Hans-Jörg Mettig) & other leading observers (Anthony Wesley, Christopher Go, Niall MacNeill, Phil Miles, Tiziano Olivetti, & others).

Figures (small copies):

Figure 1 [below]. Some early images of flakes, illustrating how they appeared attached to the f. side of the GRS. (*Left*) Maps from JunoCam (images by the JunoCam team, maps made by Gerald Eichstädt & John Rogers). (Methane-band images of the GRS were taken at PJ19 and subsequent perijoves, but not at PJ17 or PJ18.) (*Right*) Images from amateurs. Orange arrows: red flakes. Dark blue arrows: incoming SEBs rings.





Figure 2

Below: Figure 3. A hi-res JunoCam image of SEBs structures: waves (all along the SEBs), rings (red arrows), and one of the rings that recirculated into the STropZ. From the PJ23 flyby on 2019 Nov.3. Credit: NASA / JPL / SwRI / MSSS.



Below: Figure 4:



by Shinji Mizumoto @ALPO-Japan

Below: Figure 5:









Below: Figure 7. Images showing the origin of flake no.1.

Below: Figure 8:

Cylindrical map of SEB & GRS from PJ18 images Credit: NASA / SwRI / MSSS / Kevin M. Gill / Christopher Go



Below: Figure 9:



Below: Figure 10:



Below: Figures 12 & 13:



Below: Figures 14 & 15. Fig.14 shows the entry of SEBs ring no.9 (May 13) and consequent appearance of the 'blade' or flake no.6a (May 17) with a diagram of the inferred interactions. Fig.15 shows the expansion of the flake material (black arrows) both W on the SEB(S), and E around the S side of the GRS to reappear as flake no.6b at the p. end.



Next page: Figures 16 & 17.

These show some of the best images from May 20-23, as prepared by the observers. On May 22-23, flake 6b is expanding on the p. side of the GRS, there is also disturbance on the N side, and SEBs ring no.7 enters the RSH..

Figure 16: May 20, imaged and annotated by Clyde Foster.

Figure 17A: May 22, multispectral set by Andy Casely.

Figure 17B: May 23 (one rotation later), multispectral set by Clyde Foster.

Figure 17C: Cylindrical map projection, May 17-25, by Andy Casely) showing further developments.









Above left: Figure 17A. Left: Figure 17B. Above: Figure 17C.

(On May 25, as ring no.7 approaches the f. end of the GRS, flake no.7a begins to appear there.) **Below:** Figure 18. Excerpts from S. Mizumoto's comprehensive series of cylindrical map projections, here presented with north up. These maps show the development of the two greatest flakes, nos.6 & 7, in RGB (left) and CH4 (right). Blue arrows: incoming SEBs rings. Red arrows: GRS flakes. On May 28-31, these include red arrows marking the p. and f. ends of flake material squeezing round the S side of the GRS, and a methane-bright blob prograding on the STropB.

Activity of GRS regions by Shinji Mizumoto @ALPO-Japan					
L2	340 320 300 280		L2	340 (L2) 320 300 280	340 320 300 (L2) 280
2019/05/20 23:16 C.Foster	6	0	2019/05/27 13:59 C.Go		-
2019/05/21 08:38 D.Carlish (CH4: 19:16, P. Miles)	-	0	2019/05/28 00:15 C.Foster	A A	
2019/05/22 04:58 W.Martins (CH4: F. Carvalho)		20.	2019/05/28 20:11 C.Foster	2 1 1	
2019/05/22 14:10 A.Casely		-77	2019/05/29 05:18 E.Sussenbach		
2019/05/23 00:19 C.Foster		70	2019/05/29 15:51 C.Go		9.
2019/05/23 11:19 A.Casely			2019/05/30 01:15 J.Camarena		9
2019/05/23 20:25 D.Ellemor (CH4: C. Foster)			2019/05/30 21:43 C.Foster		
2019/05/24 06:27.5 G.Lamy	-		2019/05/31 16:31 T.Olivetti (CH4: C. Go)		-
2019/05/24 16:47 N.MacNeill			2019/06/01 03:24 F.Carvalho		
2019/05/25 02:28.5 C.Foster		*	2019/06/01 12:58 A.Casely (CH4: C. Go)		•
2019/05/25 13:25 A.Casely (CH4: C. Go)	1	*	2013/06/01 22:40 C.Foster		
2019/05/25 22:31 C.Foster		•	2019/06/03 05:12 E.Sussenbach (CH4: C.Foster)	A A A	*
2019/05/26 07:14 D.Carlish	6.77		2019/06/04 00:15 C.Foster		-
2019/05/26 17:54 C.Go		6.	2019/06/04 20:20 C.Foster	ŤŢ.	• *
2019/05/27 03:53 B.Macdonald (CH4: C. Foster)		-		340 (L2) 320 300 280	340 320 300 (L2) 280



Left: Figure 19.

Below: Figure 20A.





Below: Figure 22



Below: Figures 23 (L) & 24 (R)



Figure 23. Images of the GRS region, August 1-8, in RGB (left) and CH4 (right). They show the first appearance of one of the bright plumes in the SEB, which rapidly expanded to form a rift. At this time there were no SEBs rings nor flakes near the GRS.

Figure 24. The GRS region in cylindrical maps, with north up. **(A)** From amateur images, Oct.11-17; excerpt from the long series of maps by S. Mizumoto (ALPO-Japan).

(B) From JunoCam at PJ23, Nov.3: RGB & CH4. Streamers derived from flakes are wrapped completely round the outside of the GRS. The f. end of the STB Spectre is passing the GRS; note that the Spectre is dark in CH4. Below: Figure 25 (PJ22):



Below: Figure 26 (PJ23 & PJ24):



Above left: PJ23: Excerpts from the outbound maps, showing the GRS encircled by narrow red methane-bright streaks, probably remnants of flakes that emerged during the autumn. *Above right:* PJ24, Excerpts from the outbound maps, RGB & CH4, not previously published as such.



Below: Figure 27: Drift of GRS (JUPOS charts)

Next pages: Figures 28-31: Charts of GRS length & width:





Figure 29: GRS length since 2010 or 2011 (again, plotted independently by ALPO-Japan and JUPOS recorders).



Figure 30: *Left:* Latitudes of the N and S edges, and the distance between them, from 2011 to 2019. *Right:* The same in 2019. (JUPOS data.)



Figure 31:

