Amateur observations of Saturn's 2010 Great White Spot

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Marc Delcroix, Commission des observations planétaires, Société Astronomique de France (**delcroix.marc@free.fr**)
based on amateur images from all around the world (directly received by the author, or from French Astronomical Society (SAF), ALPO Saturn, ALPO Japan, …)
imaged displayed here by S.Ghomidadez (Iran), A.Wesley (Australia), D.Parker (USA), T. Akutsu (Philippines), T. Barry (Australia), C.Go (Philippines), J.Melka (USA)

Abstract

The occurrence of huge giant storms on Saturn, called Great White Spots (GWSs), is **once per Saturnian year** (29,5 years). For the last GWS (1990, cf. [1]), amateur astronomers did not have the means to image planets as they have nowadays, and could not participate to the study of that rare event. **Since Dec. 2010, a new GWS** appeared in Saturn's northern hemisphere, around **34° planetocentric latitude**. This event have been **covered by all amateurs around the world** using up to date imaging technology, leading to professional papers using their data and analysis. Their coverage allowed a **daily tracking of this GWS' evolution.**

Data

Since a few years, amateurs images mostly with reflectors with an aperture from 15 to 40 cm were used as a coverage for Saturn's storm studies (cf. [2]). With the 2010 GWS **easily accessible** to lower apertures, the number of amateur images has increased dramatically: **from Dec. 2010 to end of August 2011**, around **1700 images from 130 observers** have been available from different sources, most of them showing the GWS.

This gave a **coverage in detail of the evolution of the GWS** on Saturn almost rotation after rotation, here presented after a selection of the best images in **visual wavelengths** for each rotation available. Images from **85 observers** were processed with Winjupos (cf. [4]), a software used by amateur astronomer associations (cf. [2]), to generate **more than 500 cylindrical projection maps** *(cf. figure left)*, measure the **position of features** within GWS, and **derive their drift rates** in longitude.

Birth of a Great North Tropical Storm (2010.12.05-12.19)

Georg Fischer issued an alert to amateurs in December as Cassini's RPWS detected again lightning in Saturn on Dec. 5th/6th. Question was were would be the storm located in latitude (information not given by RPWS). **Amateurs on Dec. 8th** confirmed what Georg Fischer suspected, the new storm is located in Saturn **tropical zone**, but not south as what has been observed by amateurs since 2003 and Cassini ISS since 2004, **but North**! This shows clearly a **seasonality effect of lightning on Saturn**, as the northern hemisphere has just entered the spring after 2009 equinox, and lead to a **paper cosigned by amateurs** *(cf. [6]).*

From the first image showing the storm at the very beginning, the **storm rapidly grew more than 10 times bigger**, so spread in latitude that due to the difference in wind speed upon this latitude range it left **a long southern tail preceding it** *(cf. fig. 1)*. It appeared at a **38°N** planetographic latitude, then **drifted in latitude to 40°N** latitude on Dec. 14 (**latitude of a strong westward jet**).
This storm observed by amateurs was the **brightest feature seen on Saturn since at least 14 years**, very easy to image by amateurs and even visible on individual raw frames!

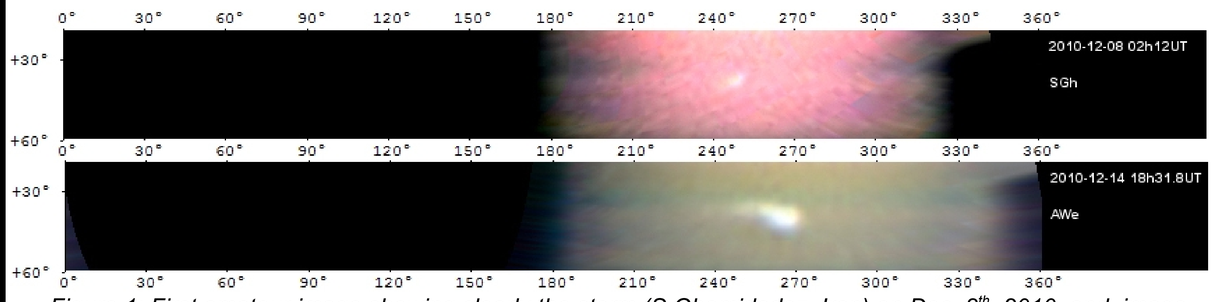

Figure 1: First amateur image showing clearly the storm (S.Ghomidadez, Iran) on Dec. 8th, 2010, and image showing a southern tail six days later (A.Wesley, Australia). (long SIII and planetographic lat.)

Evolution to a GWS (2010.12.20-12.30)

The storm evolved very rapidly. As soon as Dec. 22nd *(cf. fig.2)*, details appear, showing a **bright "head" elongated** in longitude, with a **darker core**. North East of this zone, the storm shows the a bright yellowish spot, followed by **a long tail extending to the east** (almost 50° in longitude) with several **white spots**. An extension to the North of the head shows the **start of a northern tail** *(cf. [5], cosigned by amateurs)*

Only 18 rotations later on Dec. 30th*(cf. fig.2),* the **tail has elongated to the east**, and the **bright head drifted to the west while spreading**. At this date the whole zone is spread over **100°** in longitude (System III), that is around **100 000 km long** (and 10 000 km in latitude). This makes this atmospheric feature a truly giant one on Saturn's scale, **comparable to previous GWS**. The **initial dark core, ended by two white spots on each tail**, was then followed west by a new dark core closer to the edge of the head.

A detailed drift analysis shows that the **western most part of the head** follows the westward jet in the North Tropical zone around **2.82° LIII/day**.

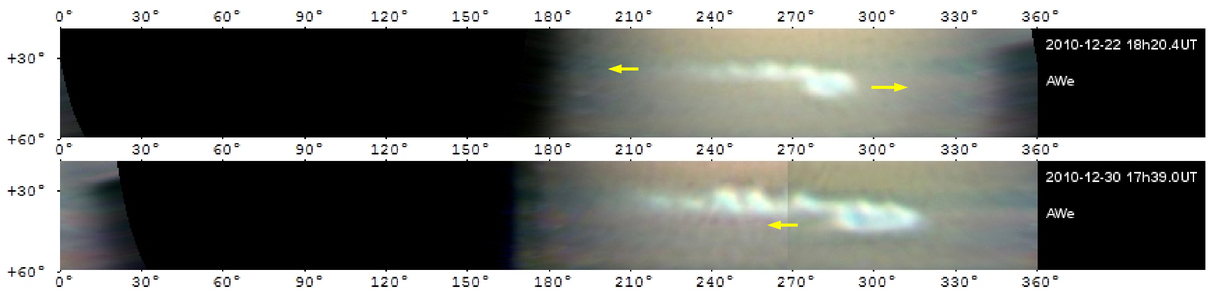

Figure 2: Images (A.Wesley, Australia) showing the evolution to a GWS from Dec. 22nd to Dec.30th (long SIII and planetographic lat.)

Encircling the planet (2010.12.31-2011.02.22)

In the following weeks, the **southern tail** continue to develop to the East with **many bright spots**, while the **northern tail, fainter**, expanded also *(cf. fig. 3.1st image)*.

The **initial dark core in the head increased in size**, encircled by white clouds and always delimited by the same spots on the tail side *(cf. fig. 3.1st and 2nd images)*.

A **white spot** even appeared on Feb. 8th/9th located at **27°N** latitude and 11° longitude syst. 3*(cf. Fig. 3),* **on the edge of the NEBn** (North Equatorial Band – North) and southern of the southern tail. Due to the small latitude of this spot, wether it is related to the GWS is unsure.

Finally, in the visible wavelengths **the tails appeared to catch up with the head on Feb. 22nd** *(cf. Fig. 3)* , making the **GWS totally encircling the planet along 300 000km**.

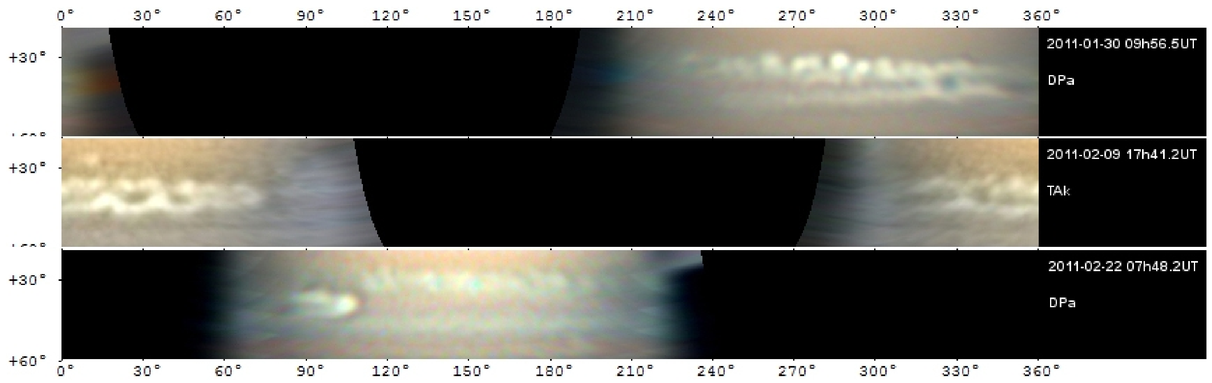

Figure 3: Images showing the evolution of the tails on Jan.30th(D.Parker, USA), the elongation of the head on Feb.9th(T.Akutsu, Philippines), the tails reaching the head on Feb.22nd (D.Parker) (long SIII and planetographic lat.)

Chain of spots in the southern tail

A **chain of white spots** moved along the **east-jet at 30°N latitude** *(cf. images 1/2 in fig.4)*. As shown on Jan. 23rd on the 1st image around longitude 130°, two of them after passing the head even seemed to be connected to the beginning of the tail, while others come to the tail (2nd image). One month later, there were identical spots in the same configuration (3rd/4th image).

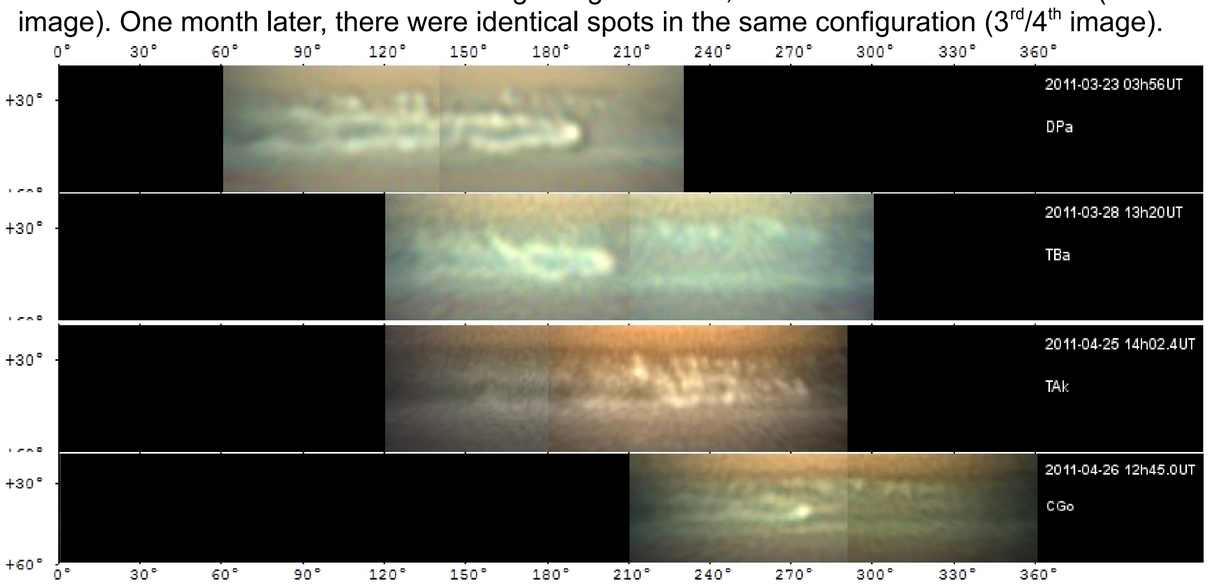

Figure 4: Images showing the spots in the Southern tail passing above the head on Mar.23rd (D.Parker, USA), Mar.28th (T.Barry, Australia), Apr.25th (T.Akutsu, Philippines) and Apr. 26th (C.Go, Philippines) (long SIII and planetographic lat.)

Disappearance of the head

The **end of the head**, with the initial dark core and two white spots ending, continued to **drift** to the east **with a decrease to 0,71°LIII/day end of January** *(cf. fig.6)*. It **reached the western part of the head around June 15th** *(cf. Fig. 5)*. After that moment, it seemed that the **head itself disappeared**, with no distinct white spot being visible on latitude 40°N at the predicted position. Till **end of August**, the whole zone was covered by **two white bands** with no really distinct feature.

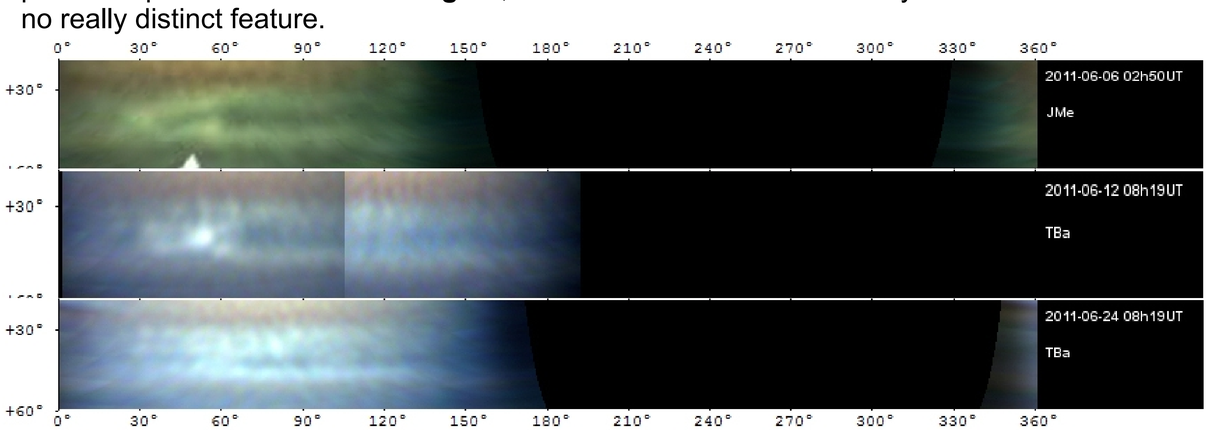

Figure 5: Images showing the disappearance of the head between June 6th (J.Melka, USA), June 12th and 24th (T. Barry, Australia) (long SIII and planetographic lat.)

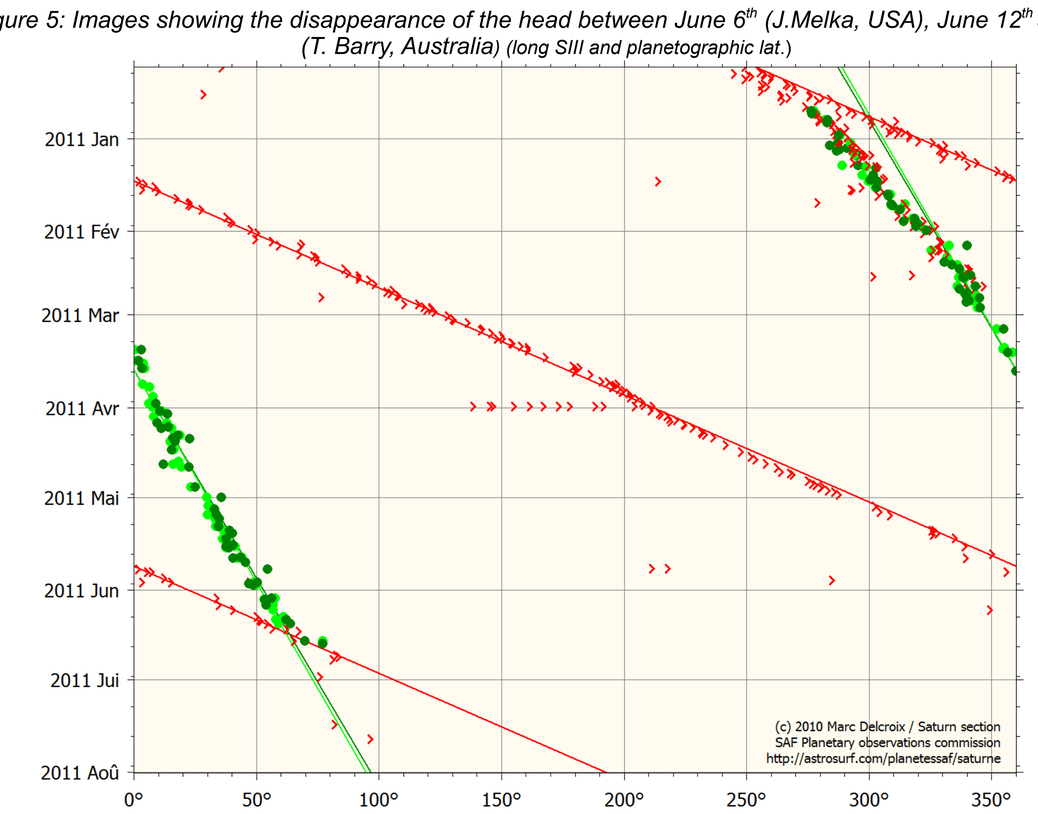

Figure 6: Longitudinal drift (date vs SIII longitude) of the western most point of the GWS head in red and the two white spots ending the head (east of the initial dark core) in light green (North spot) and dark green (South spot)

Conclusion

Saturn's 2010 GWS had an **exceptional coverage** by amateurs, which was used by professional. This coverage was also useful to study the evolution of the GWS globally and of its largest features, bringing an **unprecedented detailed tracking** of such a rare event.

References

[1] Sánchez-Lavega, A. et al.: *"The Great White Spot and disturbances in Saturn's equatorial atmosphere during 1990"*. Nature, 353, 397 – 401, 1991
[2] Delcroix M. & Fischer G. : *"Contribution of amateur observations to Saturn's storm studies"*, EPSC2010-132, 2010
[3] Hueso R. et al: *"The international outer planets watch atmospheres node database of giant-planet images"*, Planetary and Space Science 58 1152–1159, 2010
[4] Hahn G.:*" Automatische Auswertung von Zeichungen, photographischen und CCD-Aufnahmen des Planeten Jupiter"*, Diploma work, Technische Universität Dresden, Faculty of Computer Science, 2000
[5] Sánchez-Lavega, A. et al.: *"Deep winds beneath Saturn's upper clouds from a seasonal long-lived planetary scale storm, Nature"*, 475, 71-73, 2011
[6] Fischer G. et al: *"A giant thunderstorm on Saturn"*, Nature, 475, 75-77, 2011