



Contribution of amateur observations to Saturn storm studies

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and

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Storms observations from **Cassini**

-The **Radio and Plasma Wave Science** (RPWS) instrument has been observing **Saturn Electrostatic Discharges** (SEDs, radio signatures of lightning) – regularly since 2004, giving:

- **Occurrences in time** with a time coverage **24h/24h** on the hemisphere facing Cassini
- **Number of SEDs** (with a frequency scan allowing **only detection of 1/3rd** of SEDs)
- very **approximate positioning** and resolution of the lightning sources (**due to low resolution**)
- allowing calculation of an **approximate longitudinal drift rate**

-The **Imaging Science System** (ISS) instrument performs **high-res observations** from UV to IR wavelengths giving :

- extremely **accurate** in **positioning** and **resolution**
- **Direct lightning observation** around equinox on the night side of Saturn
- a **poor coverage** (very rare observations, one from March to July 2010 for example)

Findings: since Cassini arrived in orbit around Saturn, SEDs have been observed associated to storms located in the **same zone** of Saturn, around **-35° planetocentric latitude**, nicknamed « Storm Alley » (**South Tropical Zone**)

Storms observations from amateurs

- **Observations from amateurs** have the following characteristics:
 - in **diverse wavelengths** (different filters can be used, but usually visible wavelengths, sometimes infrared)
 - **variable** in resolution quality, processing, timing accuracy (~**180 observers worldwide** (Europe, USA, Asia))
 - give **a good coverage** (More than **2500 images** starting in **1993**) 6 months around opposition
 - **major atmospheric features** can be **detected** (**780 large white spots positions measured**)
- Their **analysis** (with WinJUPOS software by G.Hahn) brings:
 - Identification of **white spots in storm alley**
 - **Longitudinal drift rate** measurement after selection of measures
 - **Shape evolution** tracking

SAF planetary observations commission - Saturn section

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SATURN section

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Observer	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
MSt: Marc Stemmelin (France)	0	0	0	0	0	0	0	0	0	6	0	0	0	6	6					
DEA: Peter Edwards (United Kingdom)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PLa: Paul Maxson (USA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RVA: Robert Van Arman (USA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SKh: Sadeq Ghomizadeh (Iran)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SKo: Sylvia Kowolik (Germany)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWe: Sylvia Weiler (Germany)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TaK: Tomáš Kříž (Czech Republic)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TBa: Trevor Bannister (USA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THa: Torsten Hain (Germany)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YLe: Yann Le Gall (France)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																				
Total obsen																				
Total obsen																				

1. Collection of observations
(<http://astrosurf.com/planetesaf/saturne>)

WinJUPOS 8.3.3 - Banque de données des positions des formations sur Saturne - [Sélections Saturne - saturn_c1_white_center.wse]

Programme Enregistrement Exploitation Listes Administration Outils Fenêtre Aide

Fiche (F9) 367 Date (F10) 2010/06/28 [aaaa/mm/jj]

N°	Formation	R	ID	Description	Date	UT	+/-	JJ	L1	L2	L3	+/-	Sy.	APL
350	WC1_SPOT	C1	StormE''2		2010/06/03	21:19,5		2455351,38854	344,7	37,7	61,0		3	-5,2
351	WC1_SPOT	C1	StormE''1		2010/06/06	01:52,0		2455355,57778	28,7	11,0	31,6		3	-5,2
352	WC1_SPOT	C1	StormE''1		2010/06/06	01:52,0		2455355,57778	42,8	25,1	45,7		3	-5,2
353	WC1_SPOT	C1	StormE''1		2010/06/06	01:52,0		2455355,57778	53,2	35,5	56,1		3	-5,2
354	WC2_SPOT	C1	StormE''1		2010/06/10	03:56,0		2455357,66389	180,7	31,0	46,7		3	-5,2
355	WC2_SPOT	C1	StormE''1		2010/06/10	03:56,0		2455357,66389	193,6	43,9	59,6		3	-5,2
356	WC2_SPOT	C1	StormE''1		2010/06/10	03:56,0		2455357,66389	200,0	50,3	66,0		3	-5,2
357	WC1_SPOT	C1	StormE''1a		2010/06/11	21:44,7		2455359,40604	234,1	28,1	41,7		3	-5,2
358	WC1_SPOT	C1	StormE''1b		2010/06/11	21:44,7		2455359,40604	245,1	39,1	52,7		3	-5,2
359	WC1_SPOT	C1	StormE''1		2010/06/11	21:44,7		2455359,40604	256,0	50,0	67,7		3	-5,2
360	WC1_SPOT	C1	StormE''2		2010/06/24	03:06,3		2455371,64931	316,9	38,4	49,3		3	-5,2
361	WC2_SPOT	C1	StormE''3		2010/06/24	03:07,0		2455370,92153	256,1	37,2	36,9		3	-5,2
362	WC2_SPOT	C1	StormE''1		2010/06/23	10:07,0		2455370,92153	268,2	50,3	50,0		3	-5,2
363	WC2_SPOT	C1	StormE''2		2010/06/23	10:07,0		2455370,92153	277,9	60,0	59,7		3	-5,2
364	WC1_SPOT	C1	StormE''3		2010/06/24	03:06,3		2455371,63771	283,4	35,9	34,5		3	-5,2
365	WC1_SPOT	C1	StormE''1		2010/06/24	03:06,3		2455371,63771	296,0	48,5	47,2		3	-5,2
366	WC1_STRK	C1	StormE''2		2010/06/24	03:06,3		2455371,63771	305,9	58,4	57,1		3	-5,2
367	WC3_STRK	C1	StormE''		2010/06/28	08:18,0		2455375,85972	80,8	63,4	57,2		3	-5,2

3. Selection of measures
(WinJUPOS)

WinJUPOS 8.3.3 - Banque de données des positions des formations sur Saturne - [Mesures d'images Saturne - 2010-05-10-11]

Programme Enregistrement Exploitation Listes Administration Outils Fenêtre Aide

Img. Aj. Pos. Div. Opt. MC1 225,7° MC2 357,2° MC3 50,0° LatC +2,2° X +0,873 NR

Réticule X +0,151 Y +0,358

Dérive [°] ~ +26,7 L1 226,1°

2009-10 -5,6 L2 347,6°

2009-11 -6,8 L3 40,40

2009-12 X

2010-01 X

2010-02

2010-03 X X X X

2010-04 X X X X

2010-05 X X X X

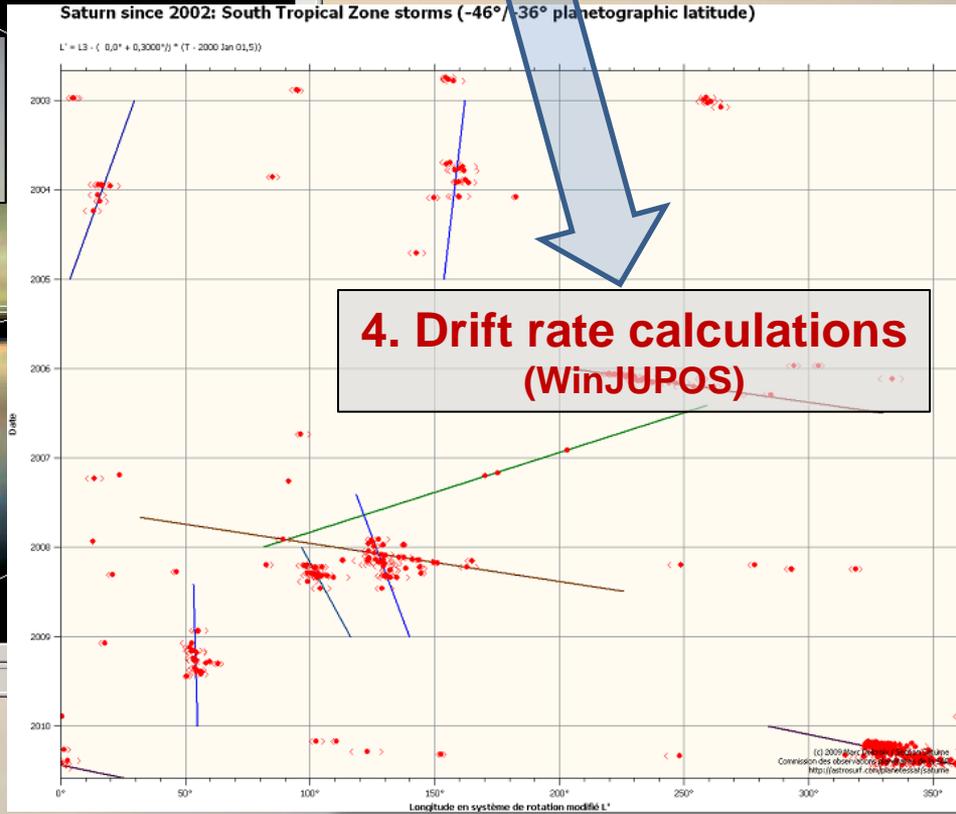
2010-06 X X X X

2010-07 X X X X

Type Croix et contour Taille (Pt) Afficher (Barre-espace) Réinitialiser Fichier de mesures AWe.me Position de l'objet et sauvegarde Pos. des formations mesurées Afficher (Ctrl+Barre-espace) Description de la formation Taille Interv. de temps ±1 minute(s)

2010/05/10 11:21,0 F:\Divers\Perso\Saturne\img2010a\AWe\ls20100510-11h21UT-AWe.jpg

2. White spots measures
(WinJUPOS)
(<http://www.grischa-hahn.homepage.t-online.de>)



Saturn storms at 35°S during apparitions

Table 1: Storm measurements (2004-2009). A1 and A2 denote different longitude ranges, so do B1 and B2, and C1, C2, and C3 (see Figure 1 for the latter).

Apparition- Storm reference	No. of positions	Time range
2003-2004-A1	12	13/09/03-01/02/04
2003-2004-A2	9	12/12/03-27/03/04
2005-2006-B1	9	22/01/06-20/04/06
2005-2006-B2	11	24/01/06-25/02/06
2007-2008-C1	23	01/12/07-18/06/08
2007-2008-C2	13	01/12/07-23/03/08
2007-2008-C3	20	14/03/08-18/06/08
2008-2009-D	18	07/12/08-11/06/09

Table 2: Latitude/drift rates of storms (2004-2009)

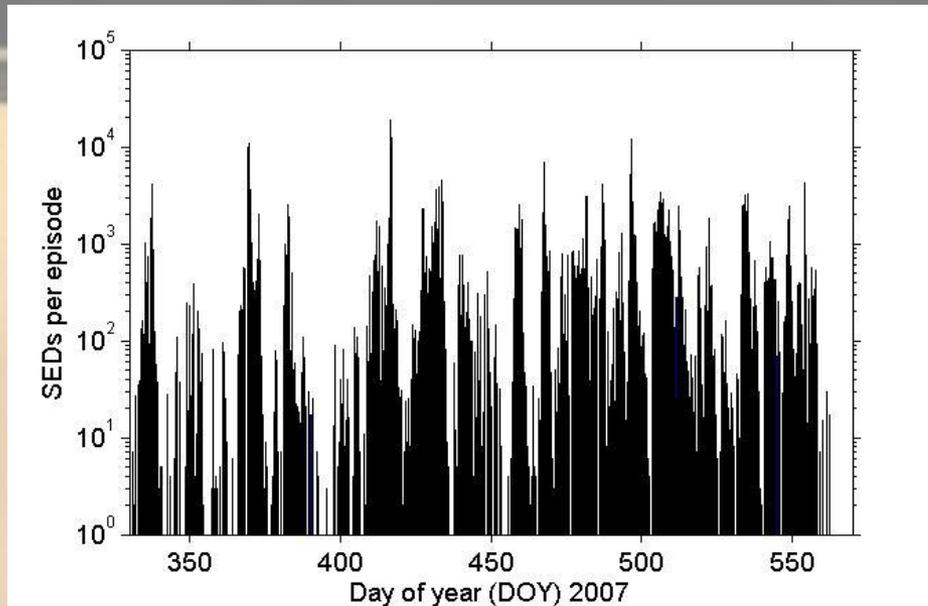
Apparition- Storm reference	Latitude (° centric)	LIII drift rate (°/day)
2003-2004-A1	-35.3 +/-0.2	0.289 +/-0.020°
2003-2004-A2	-35.2 +/-0.2	0.265 +/-0.015°
2005-2006-B1	-35.1 +/-0.4	1.033 +/-0.021
2005-2006-B2	-34.9 +/-0.2	0.597 +/-0.035°
2007-2008-C1	-35.0 +/-0.2	0.337 +/-0.009°
2007-2008-C2	-34.4 +/-0.4	0.983 +/-0.014°
2007-2008-C3	-34.9 +/-0.2	0.354 +/-0.026°
2008-2009-D	-35.0 +/-0.2	0.303 +/-0.007°

2003-2004 A1, A2 **before arrival of Cassini at Saturn** (observations also in 2002-2003)

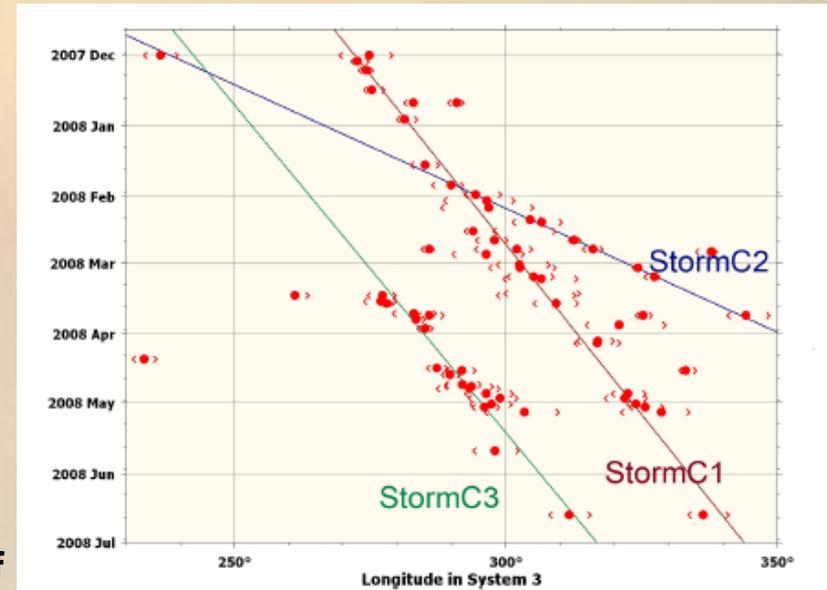
2005-2006-B2 **consistent with 0.6°/day** found by ISS and RPWS

For 2007-2008 C1,C3 and 2008-2009-D RPWS finds **~0.3°/day**

Saturn storms in 2007-2008 apparition



Left figure shows **number of SEDs as a function of time** as measured by Cassini RPWS
(semi-logarithmic plot from Nov. 26, 2007 until July 23, 2008)

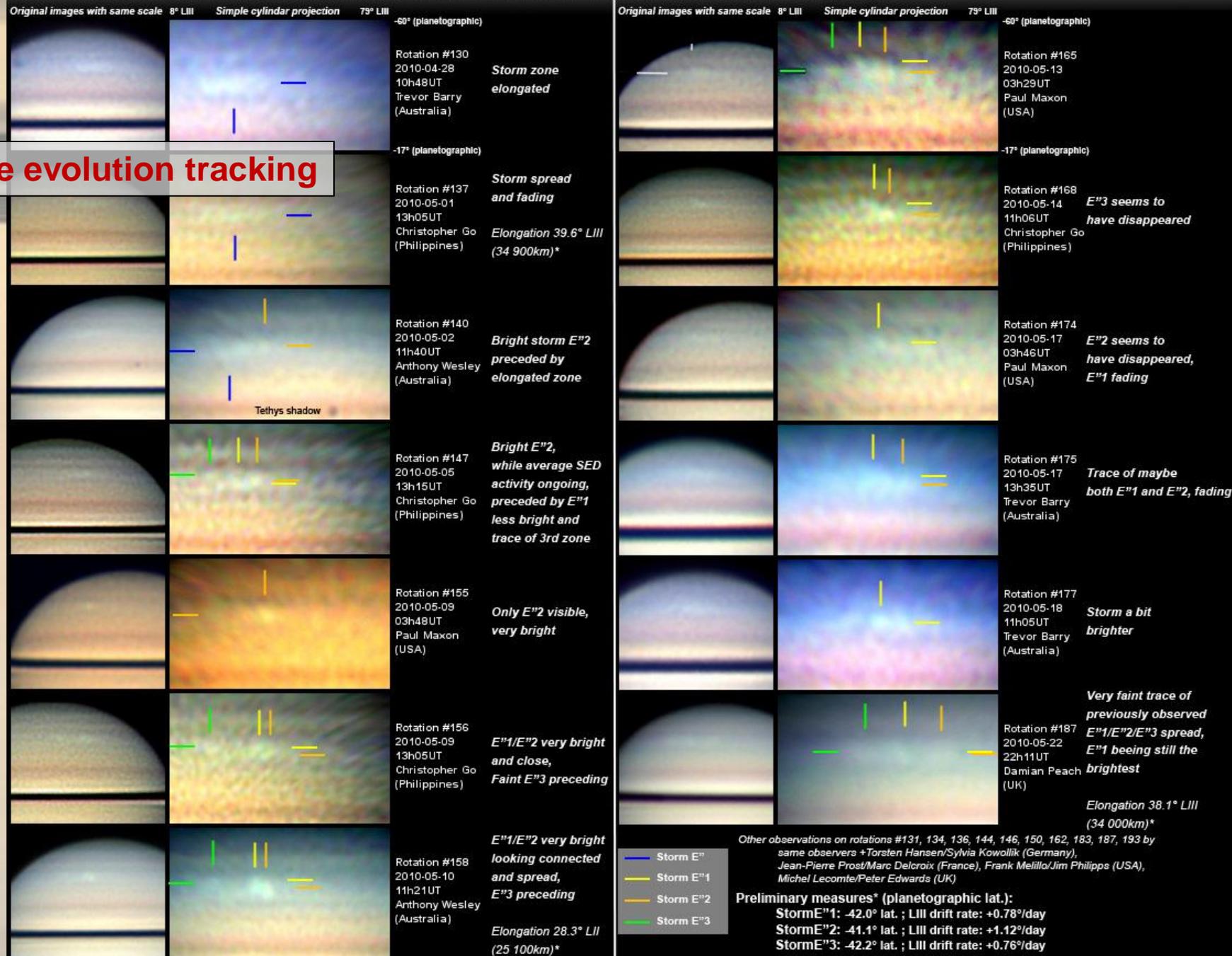


Right figure shows **drift in longitudes** of this storm
as measured by amateurs in this apparition
(from Dec. 1, 2007 until June 18, 2008)

Saturn's 2010 storm ("StormE") evolution - April 25th-May 31st, 2010

images compiled/scaled/reprocessed on 2010/07/02 by Marc Delcroix, Société Astronomique de France (delcroix.marc@free.fr - http://astrosurf.com/planetessaf/saturne)

Shape evolution tracking



Other observations on rotations #131, 134, 136, 144, 146, 150, 162, 183, 187, 193 by same observers +Torsten Hansen/Sylvia Kowollik (Germany), Jean-Pierre Prost/Marc Delcroix (France), Frank Mellillo/Jim Phillips (USA), Michel Lecomte/Peter Edwards (UK)

Preliminary measures* (planetographic lat.):
 StormE"1: -42.0° lat. ; LIII drift rate: +0.78°/day
 StormE"2: -41.1° lat. ; LIII drift rate: +1.12°/day
 StormE"3: -42.2° lat. ; LIII drift rate: +0.76°/day

* : measures to be considered only as indicative (affected by filters used and length of acquisition time)

Correlations Amateur / RPWS observations: results

- Amateurs and RPWS **both observe the storms** around **-35° planetocentric latitude**
- Calculated **drifts rates are similar** (around 0.3 LIII/day or 0.6 LIII/day)
- **Correlation** is found between **brightness of storms** in amateurs images and **SEDs detection** (with a probable inertia of a few days)
- **Correlation** is found between **longitude range of SED detection** suggesting more than one source and **several storms visible in the same amateur images** (in 2008 and 2010), leading to the conclusion that **lightning occurred in more than one cloud at the same time**

Conclusions

- **Amateurs** can provide a **good coverage of the larger spots and storms visible in Saturn's atmosphere**
- They can be **triggered** by RPWS SEDs observation providing approximate positioning, from which ephemerides can be calculated
- **Amateur organizations** can analyze this data to **derive drift rates and track major shape evolution**
- **Pros** can use this data as a **complementary coverage** of radio frequencies observation, joining the two data helping to determine how the storms behave

**Ask amateur organizations whenever you need observations,
they could help!**