

Uranus et Neptune, nouvelle frontière de la collaboration pro-am en planétaire

Novembre 2015, Giron, France

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***Planetary Observations section,
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Sommaire

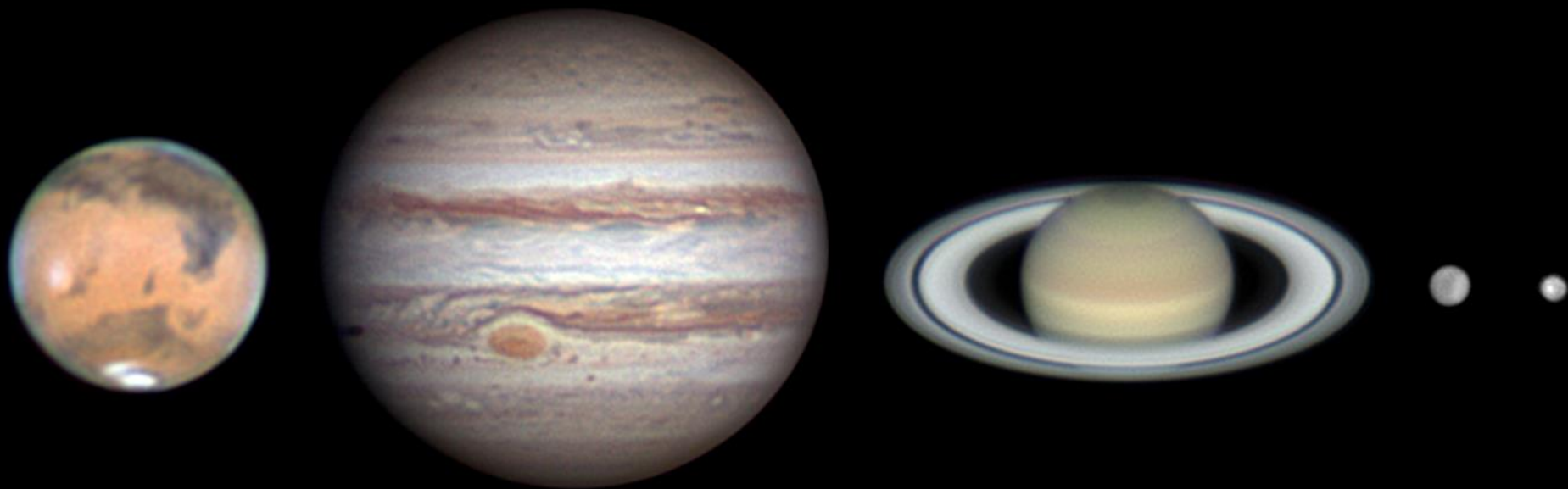
Spécificités de l'imagerie d'Uranus et Neptune

Tempêtes sur Uranus:
la première collaboration pro-am à grande échelle en 2014

Tempêtes sur Neptune:
la première collaboration pro-am à grande échelle en 2015

Synthèse

Spécificité de l'imagerie d'Uranus et de Neptune Cherchez la différence ;) (taille apparente à l'opposition) ...

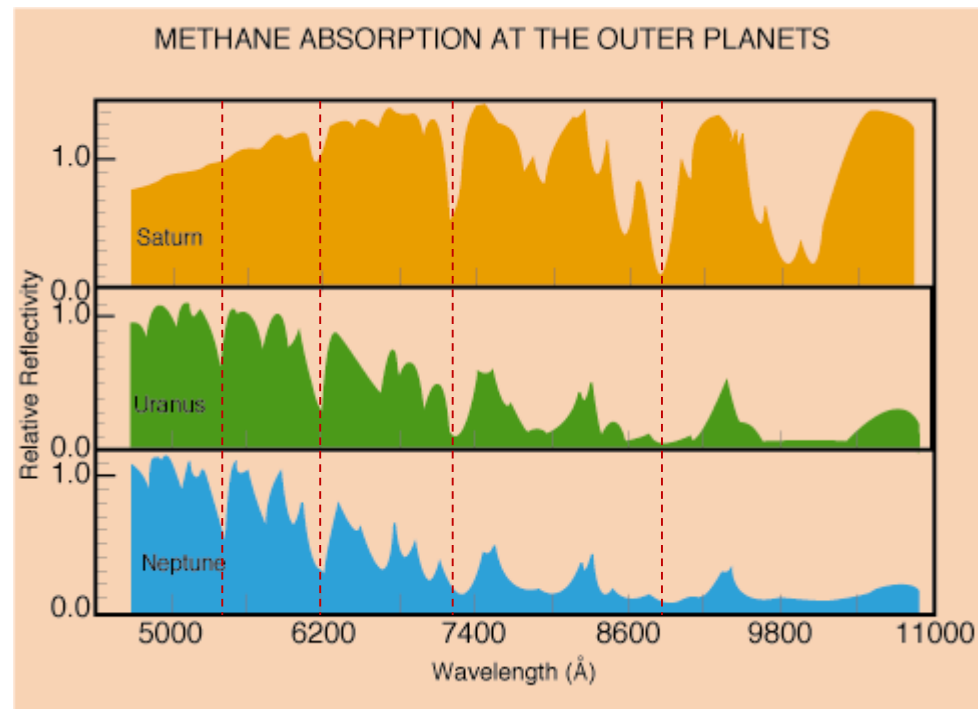


Luminosité à l'opposition et albedo

Mars	-2,8m
Jupiter	-2,9m
Saturne	-0,3m
Uranus	+5,3m
Neptune	+7,8m

Détails non détectables dans le visible pour Uranus et Neptune, mais dans l'IR (contraste supérieur).

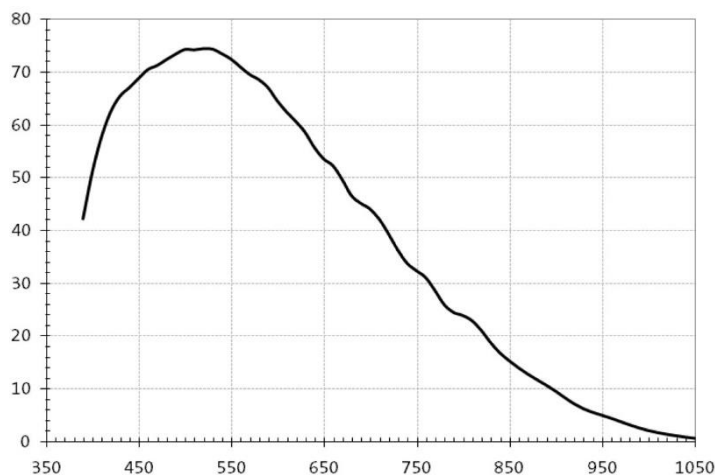
Bandes d'absorptions du méthane élargies : 544nm, 620nm, 728nm, 889nm – plus présent dans l'atmosphère d'Uranus et Neptune



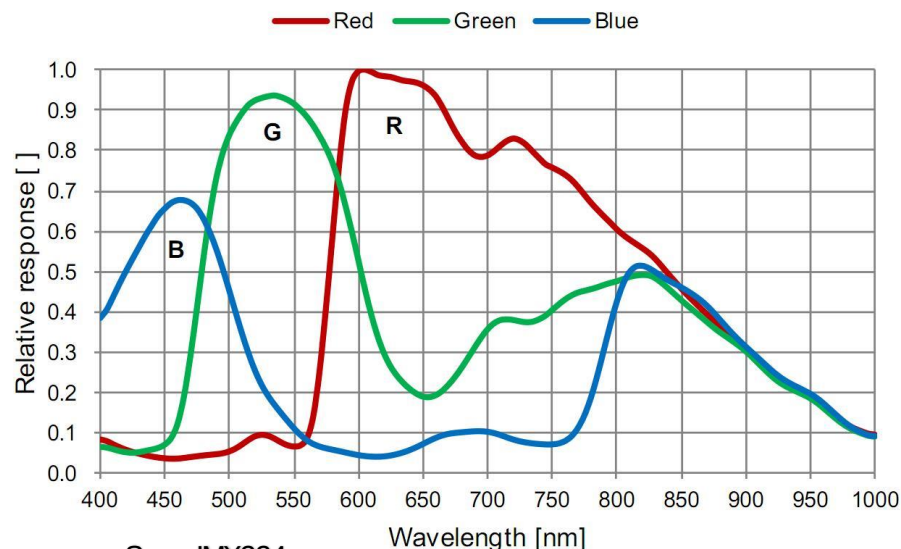
Imager en IR avec une caméra sensible

Composer entre quantité de signal (bande passante plus ou moins large) et contraste (pousser plus dans l'IR) ...

Filtres IR passe-haut disponibles sur le marché: Baader RG610, RG685, Astronomik 742nm ...



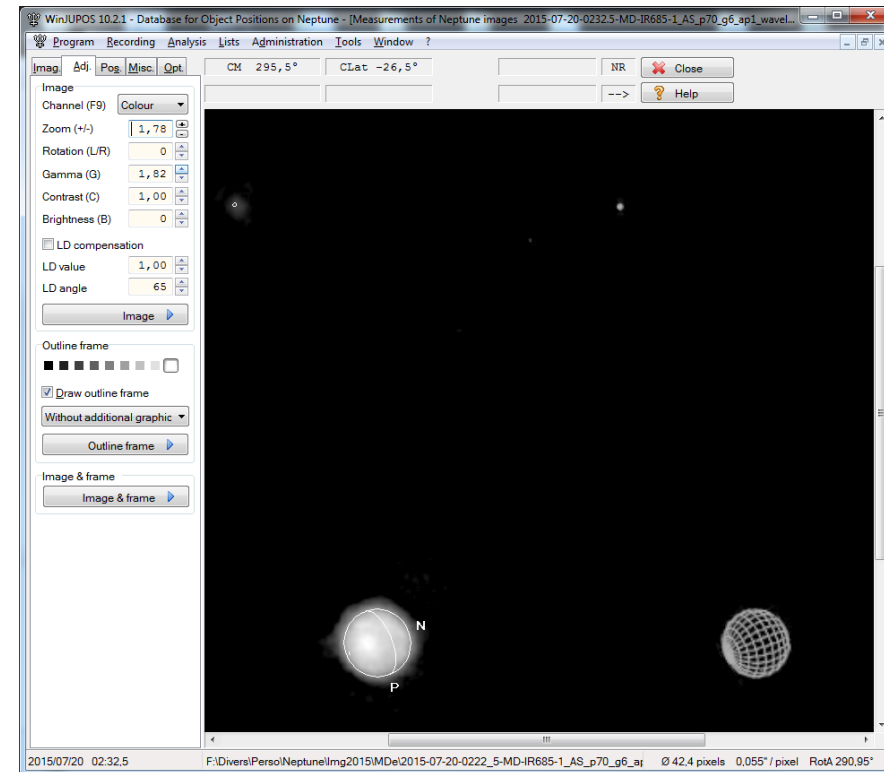
Sony ICX618



Sony IMX224

Points de vigilance

- A la limite du pouvoir résolvant ... **traiter simplement et légèrement** pour ne pas confondre détails réels et artefacts
- **Garder les satellites** dans l'image pour aider à la **calibration/orientation**, difficile sans détails et avec un contour de taille variable dépendant fortement de la turbulence et du traitement.
- Réaliser **plusieurs images différentes/animation** pour confirmer que les détails tournent avec la rotation de la planète
- **Temps d'acquisition à limiter** pour ne pas avoir un bougé du détail avec la rotation de la planète (~10-15min ou ~20-30min?) ... et **indiquer le temps de milieu d'acquisition**
ex: pour une acquisition de l'ordre du quart d'heure, la différence de longitude du méridien central entre temps de début et de milieu d'acquisition est de l'ordre de $2,5/3^\circ$!



Besoins des professionnels

- Quelques observations par an (Keck, HST, VLT, ...), **couverture** des observations professionnelles très **limitée**
- Besoin **d'éphémérides** réalisées à partir d'observations confirmées pour **planifier** au mieux les rares observations et **postuler** à des observations non planifiées (ex: HST: ToO, DD)
- Besoin d'être **alertés** si de l'activité est détectée
- Reflexe désormais d'alerter** et de faire appel aux amateurs en cas de détection d'activité sur ces planètes (Larry Sromovsky en 2014 pour Uranus et Asgustin Sanchez-Lavega en 2015 pour Neptune)

Uranus



Context

1986: faint activity (Voyager 2)
 1994: discrete clouds (HST)
 1997+: growing # of clouds (HST, IRTF)
 2000+: regular Keck detections

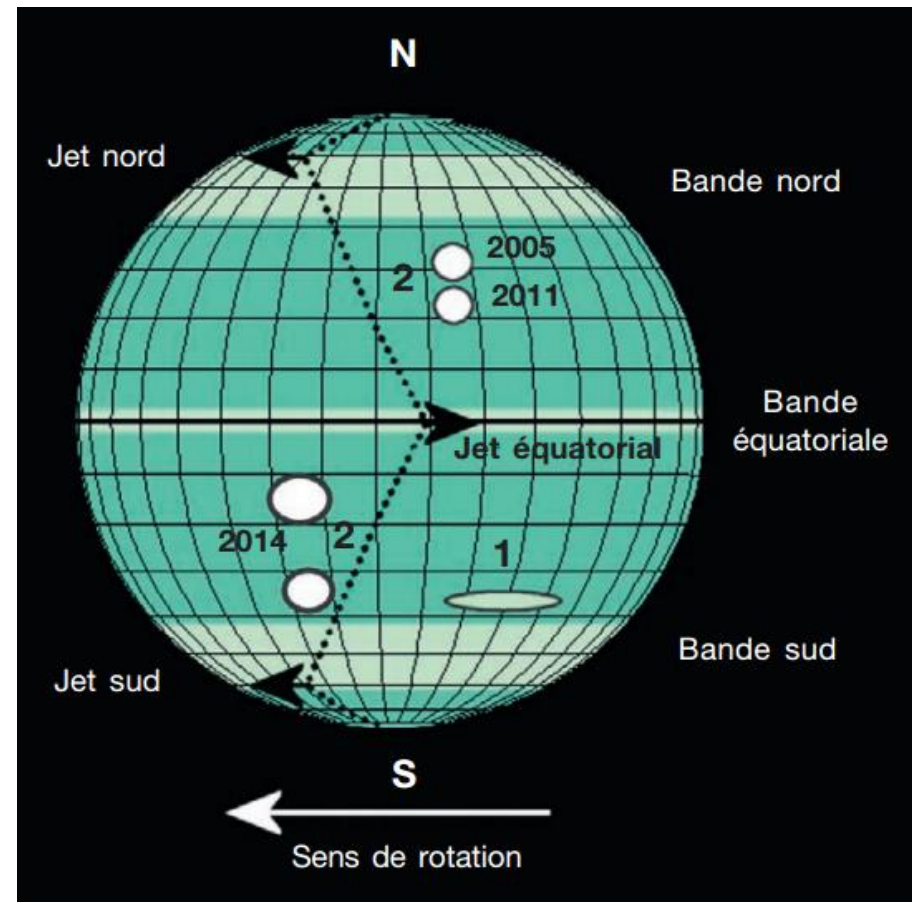
2004-2009: major long-lived storm “**the Berg**” in Southern hemisphere

2005: convective eruption detected (Keck) in Northern hemisphere

2007: spring equinox

2011: convective eruption detected (Gemini) in Northern hemisphere

2014: major outbreak detected in Southern hemisphere (Keck on Aug. 5th)

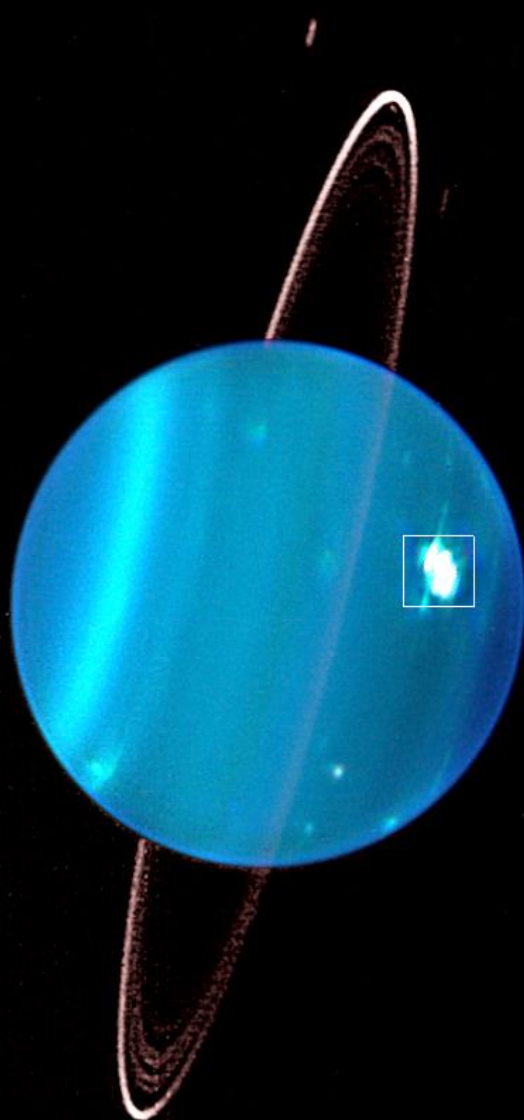


© Pellier C., Delcroix M., Viladrich C. et al. 2015 - *Astronomie planétaire observer, comprendre et étudier les planètes* - Axilone

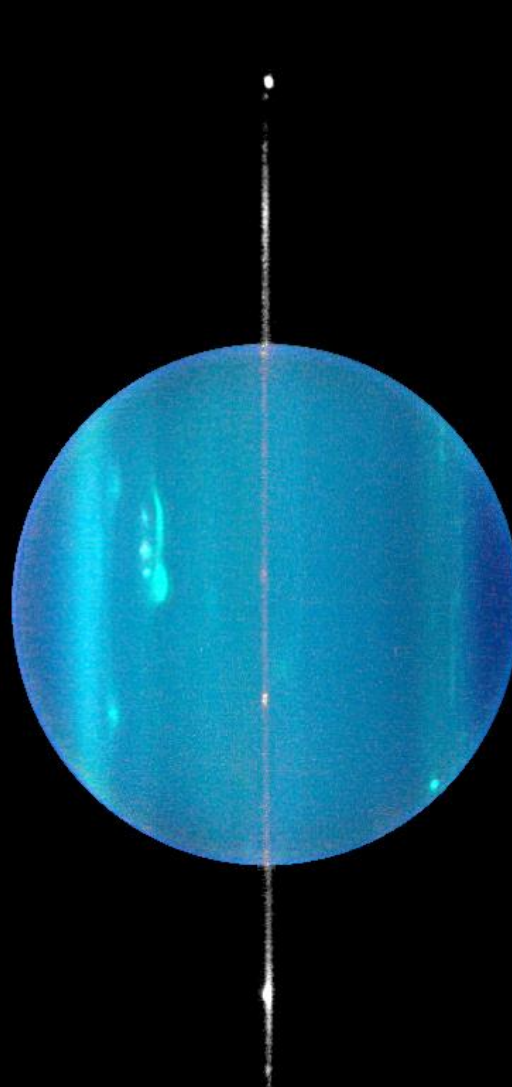
Hammel H. et al. 2005 - New Cloud Activity on Uranus in 2004-First Detection of a Southern Feature at 2.2 microns - *Icarus* jan. 2005

Sromovsky L. et al. 2012 - Episodic bright and dark spots on Uranus - *Icarus* vol.220 issue 1 pp 6-22, 2012

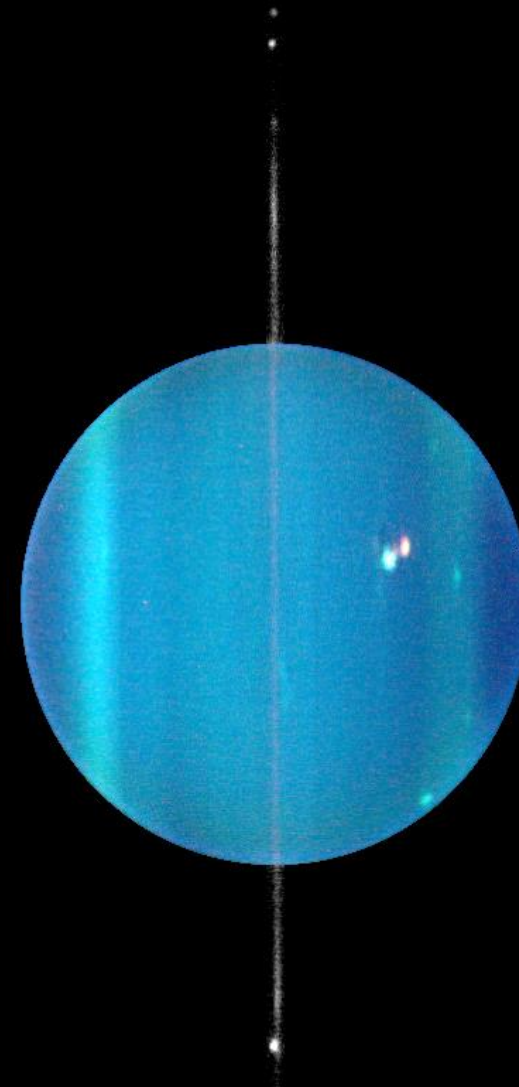
de Pater I. et al. 2015 - Record-breaking storm activity on Uranus in 2014 - *Icarus* vol.252 pp121-128 2015



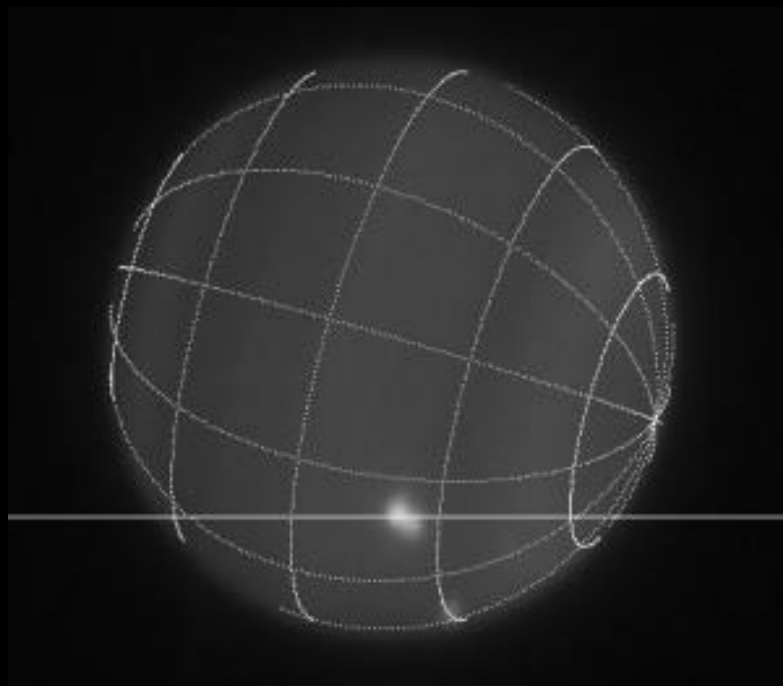
15 August 2005



8 August 2007



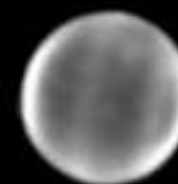
9 August 2007



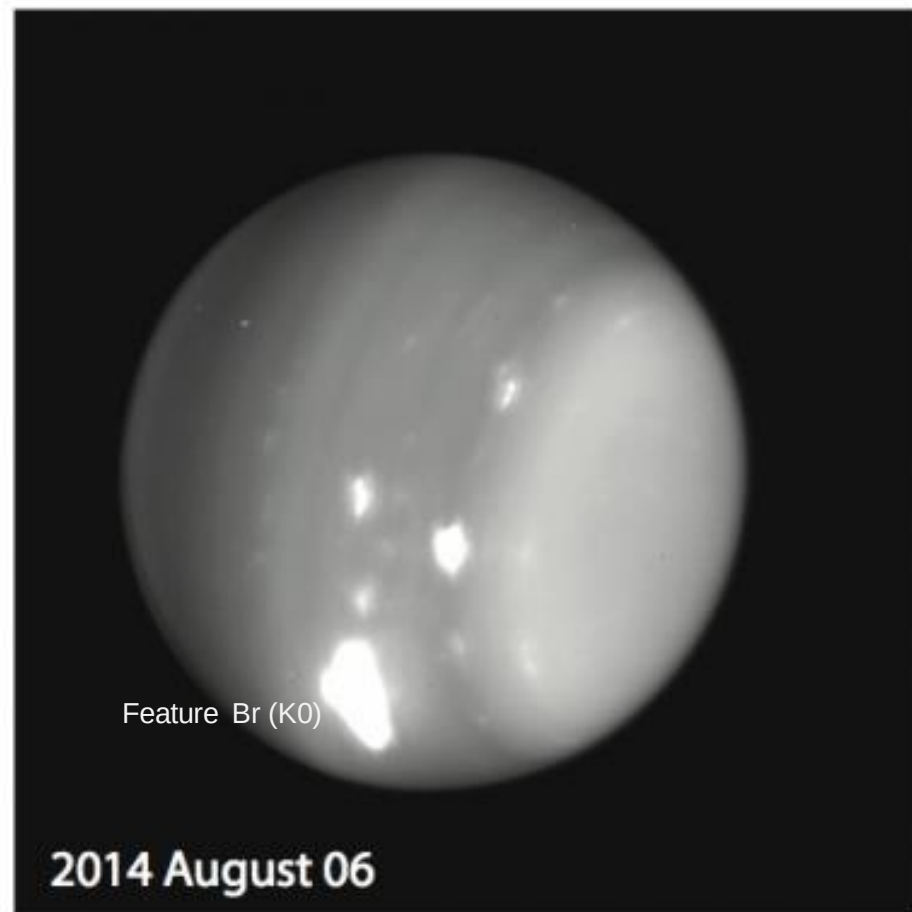
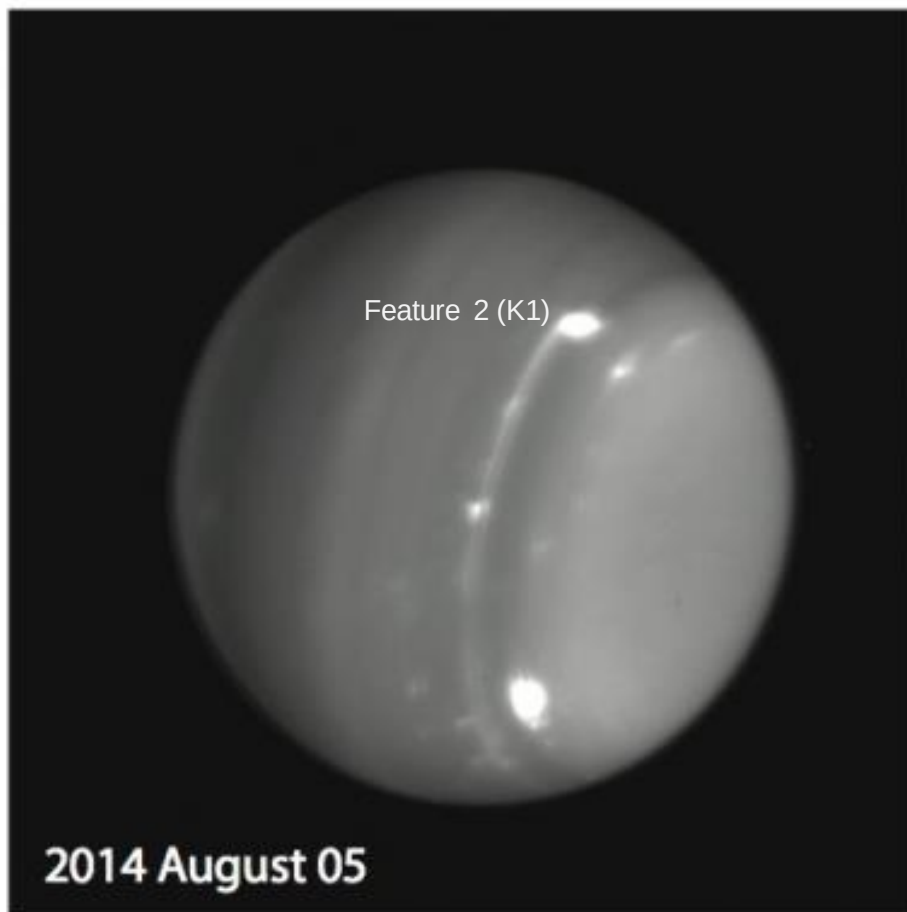
© Imke de Pater (UC Berkeley)/Gemini November 2011



2011/08/10 2H40



© S2P/IMCCE/OMP .L. Dauvergne/F. Colas Aug 2011

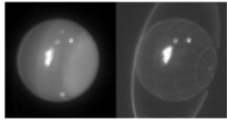


Amateur, professional astronomers alike thrilled by extreme storms on Uranus

By Robert Sanders | November 10, 2014

The normally bland face of Uranus has become increasingly stormy, with enormous cloud systems so bright that for the first time ever, amateur astronomers are able to see details in the planet's hazy blue-green atmosphere.

"The weather on Uranus is incredibly active," said Imke de Pater, professor and chair of astronomy at the University of California, Berkeley, and leader of the team that first noticed the activity when observing the planet with adaptive optics on the W. M. Keck Observatory in Hawaii.



Infrared images of Uranus (1.6 and 2.2 microns) obtained on Aug. 6, 2014, with adaptive optics on the 10-meter Keck telescope. The white spot is an extremely large storm that was brighter than any feature ever recorded on the planet in the 2.2-micron band. The cloud swirling into view at the lower right limb grew into the large storm that was seen by amateur astronomers at visible wavelengths. Imke de Pater (UC Berkeley) & Keck Observatory images.

"This type of activity would have been expected in 2007, when Uranus's once-every-42-year equinox occurred and the sun shined directly on the equator," noted co-investigator Heidi Hammel of the Association of Universities for Research in Astronomy. "But we predicted that such activity would have died down by now. Why we see these incredible storms now is beyond anybody's guess."

In all, de Pater, Hammel and their team detected eight large storms on Uranus's northern hemisphere when observing the planet with the Keck Observatory on Aug. 5 and 6. One was the brightest storm ever seen on Uranus at 2.2 microns, a wavelength that senses clouds just below the tropopause, the lower boundary of the stratosphere — where the pressure ranges from about 200 to 500 mbar, or half the pressure at Earth's surface. The storm accounted for 20 percent of all light reflected by the rest of the planet at this wavelength.

When amateur astronomers heard about the activity, they turned their telescopes on the planet and were amazed to see a bright blotch on the surface of a normally boring blue dot.

"I got it!"

French amateur astronomer Marc Delcroix processed the amateur images and confirmed the discovery of a bright spot on an image by French amateur Régis De-Benedictis, then in others taken by fellow amateurs in September and October. He had his own chance on Oct. 3 and 4 to photograph it with the Pic du Midi one-meter telescope, where on the second night, "I caught the feature when it was transiting, and I thought, 'Yes, I got it!'" said Delcroix.



Animation showing the movement of the bright spot as Uranus rotated over a two-hour period on Oct. 4, 2014. The infrared images were taken at the Pic du Midi telescope in the French Pyrenees. Courtesy of Marc Delcroix and F. Gales (CDS).

"I was thrilled to see such activity on Uranus. Getting details on Mars, Jupiter or Saturn is now routine, but seeing detail on Uranus and Neptune is the new frontier for us amateurs and I did not want to miss that," said Delcroix, who works for an auto-parts supplier in Toulouse and has been observing the skies — Jupiter in particular — with his backyard telescope since 2006 and, since 2012,

occasionally with the Pic du Midi telescope. "I was so happy to confirm myself these first amateur images on this bright storm on Uranus, feeling I was living a very special moment for planetary amateur astronomy."

Story in 2014

- After **Keck** observations of several spots, **call for amateur observations of brightest "Feature Br"** (K0) from Larry Sromowsky
- **2nd observation of Br at Keck on August 20th**
- **1st amateur observation and confirmation of another bright spot "Feature 2 (K1)"** by French amateurs Régis De-Benedictis, Yann Le-Gall and Pascal Bayle (analyzed by Marc Delcroix)
Leads to accurate drift rate calculation and **prediction allowing usage of HST (ToO) and other professional telescopes** (Pic du Midi, WHT, GTC, VLT, Keck) targeting the storm
- finally **19 observations of Feature 2 from 10 amateurs** most of which planned their observation according to the prediction

Data

- **Observations from amateurs :**
 - From Sep. 11th 2014 to Nov. 19th 2014 (2 months)
 - From 19 amateurs astronomers from all around the world (France, USA, Australia, Russia, Romania, Greece)
 - in **infrared wavelengths** (longpass filters >610nm, 685nm, ...)
 - 73 potential white spots measurements
- **Analysis** with WinJUPOS software by Grischka Hahn) identifying one persistent bright white spot
- Longitudinal drift rate measurement after selection of measures

First amateur confirmation Sept. 11th



Uranus - 2014-09-11 - R>685nm (30min acquisition of 300ms exposures, gain 95%, orientation defined from Ariel/Umbriel/Oberon)
 diam. 3.7" - mag. 5.7 - alt. 48° - $L_{\text{sun}} = 14^\circ$, $D_{\text{sun}} = 26.2^\circ$, $D_{\text{earth}} = 27.5^\circ$



02h51UT CMI 254.6°

(unsharp mask, resized x200%, 30min acquisition, 2500 frames)



Measures of spot's position:

(longitude, planetographic latitude)

02h51.0 UT: 271.8° +/-5° L1, 35.1°N +/-5°

02h43.5UT: 273.5° +/-5° L1, 34.8°N +/-5°

02h58.5UT: 271.0° +/-5° L1, 35.1°N +/-5°



02h43.5UT CMI 252.0°

(slight unsharp mask, resized x200%, first 15min)

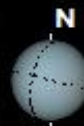


02h58.5UT CMI 257.2°

(slight unsharp mask, resized x200%, last 15min)

Régis DE-BENEDICTIS (analysis by Marc Delcroix) - France
 Schmidt-Cassegrain 356mm - PLA-Mx - 0.087"/pixel (0.115"/pixel at acquisition)

Sept. 27th



Uranus 2014/09/27 01h43 ut
CM 329,6°



Uranus 2014/09/27 02h13 ut
CM 340,1°



Redim 200%



Redim 200%

LE GALL YANN
NEWTON 374mm F/D 23
MANTA 283
FILTRE IR 685 BAADER
ADC

LE GALL YANN
NEWTON 374mm F/D 23
MANTA 283
FILTRE IR 685 BAADER
ADC

Oct. 1st

brightness increase at CM, deep cloud ?



Uranus

2014-10-01

23:07.0 UT CM 261,1°



Redim 200%

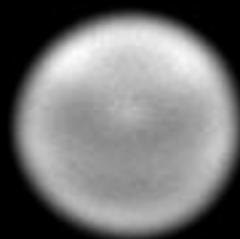
LE GALL YANN
NEWTON 374mm F/D 23
MANTA 283
FILTRE IR 685 BAADER
ADC

Oct. 4th

Amateur using 1 meter Pic du Midi telescope



Uranus - 2014-10-04 - IR>685nm 00h52.7UT (24.0min derotation)
diam 3.7'' - mag 5.7 - alt. 51° - CM 220.2° - $D_{\text{sun}} = 28.5^\circ$, $D_{\text{earth}} = 28.7^\circ$, $L_{\text{sun}} = 14^\circ$



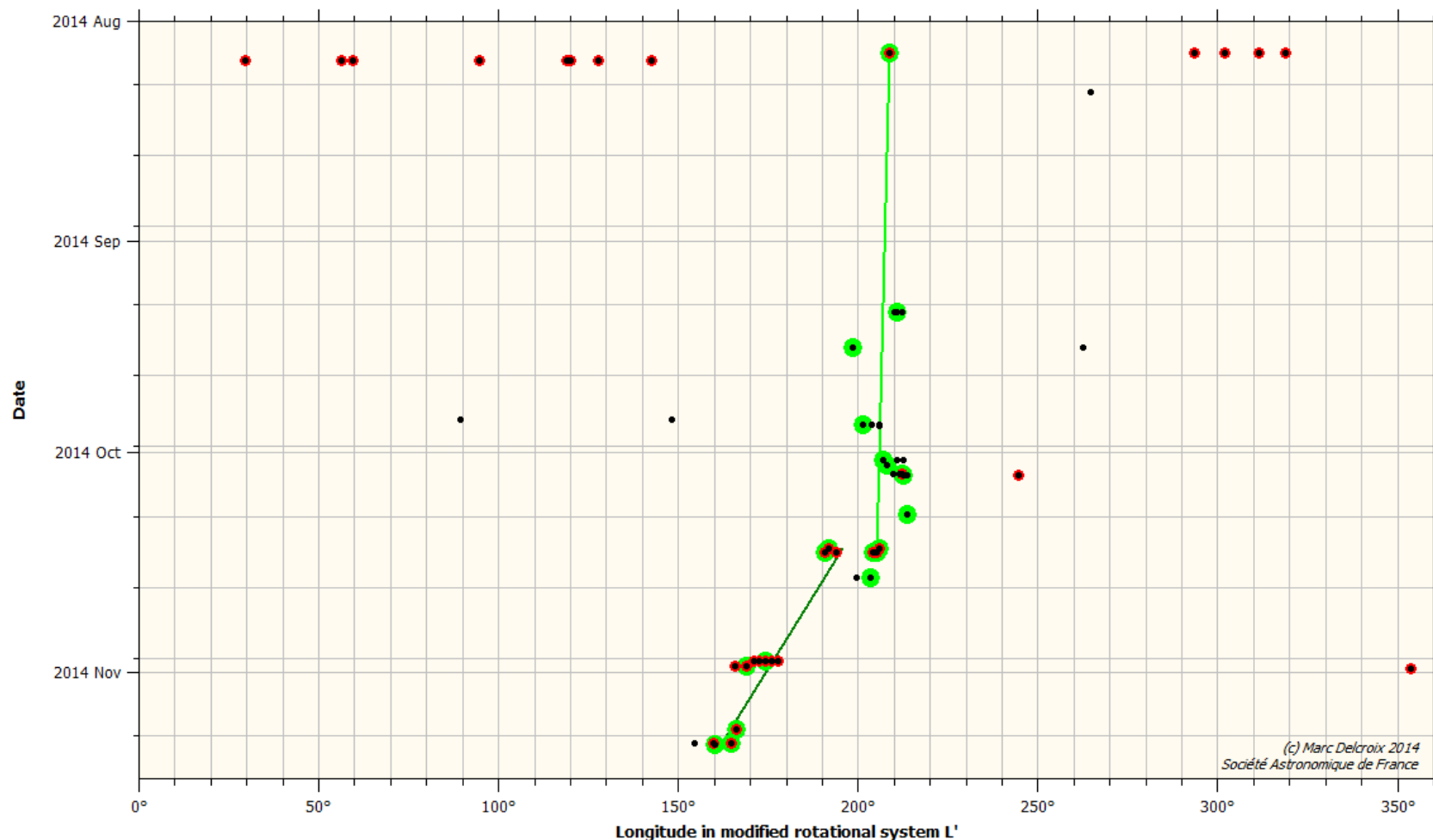
106cm Cassegrain, Pic du Midi, France - ZWO ASI120MM-S - 0.043''/pixel
(c) S2P/IMCCE/OMP/M. Delcroix/F. Colas

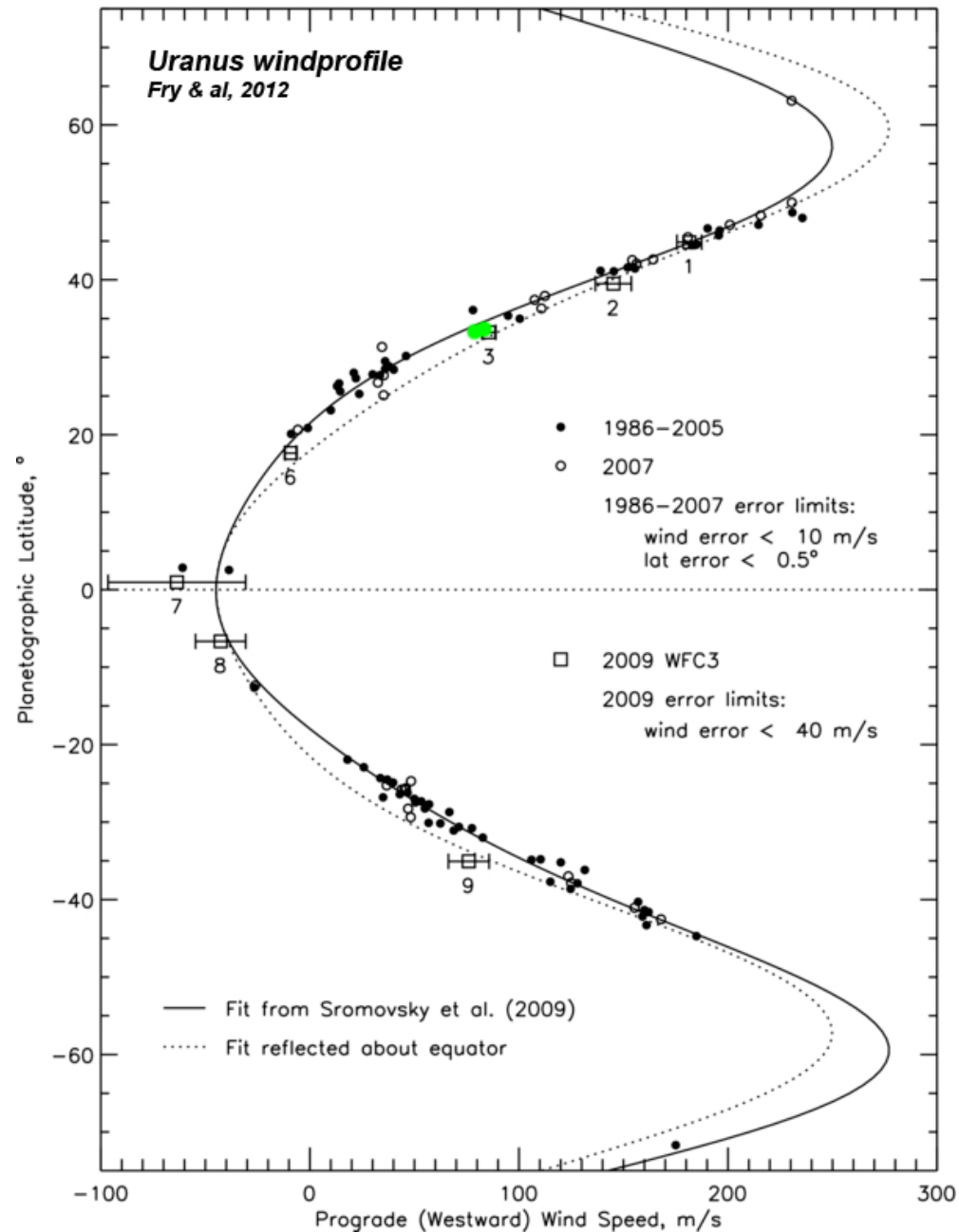
Uranus in 2014 with two main white spots (from professional and amateur telescopes) at [30°,40°] planetographic latitude

- uranus_all.wse
- uranus_all_pro.wse
- uranus_spots_2014.wse

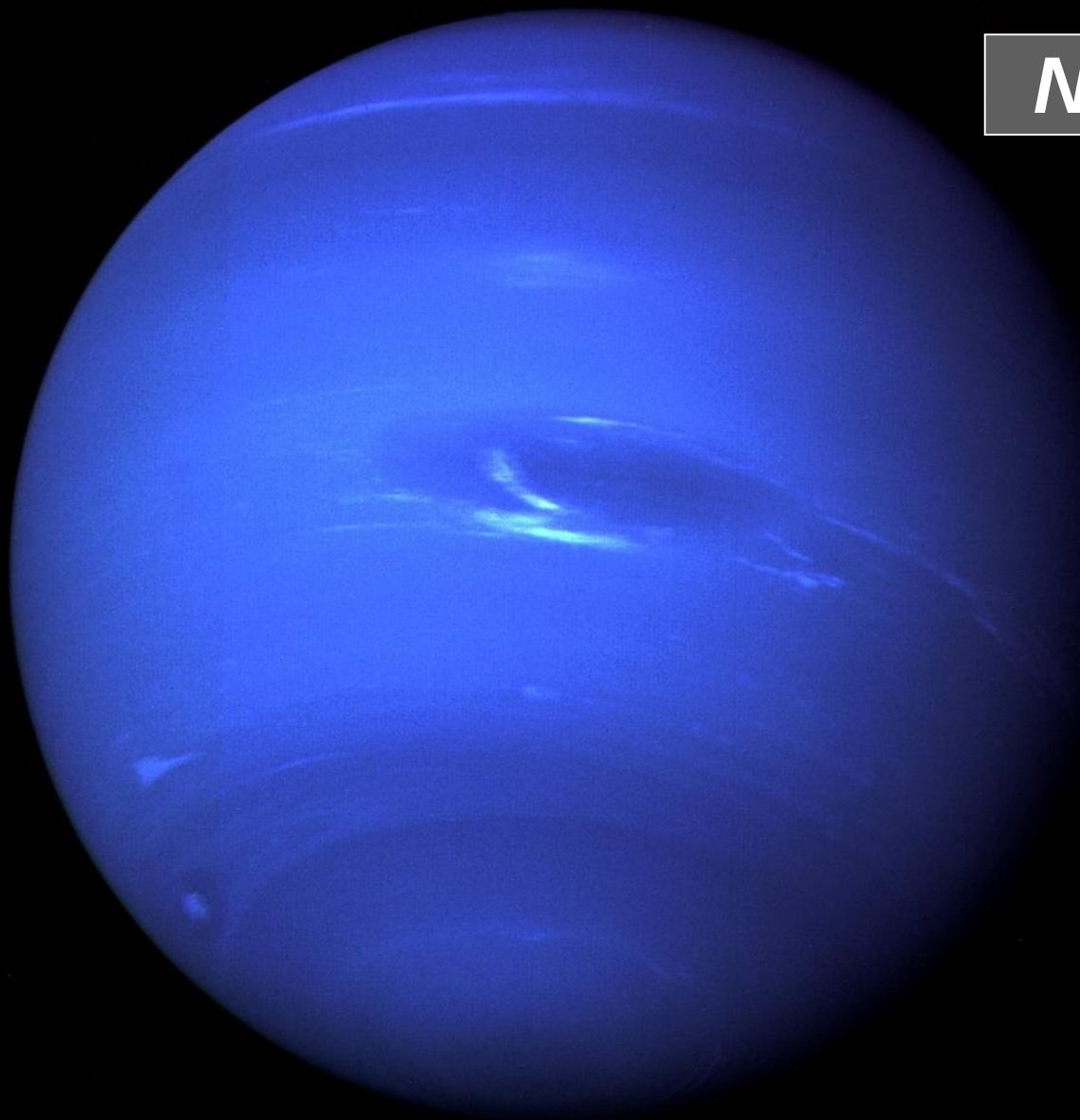
— L = $87,2^\circ - 19,2262^\circ/d * (T - 2014 \text{ Oct } 29,5)$ [2014 Oct 14,4 ... 2014 Nov 11,1]; B" = +33,7°
 — L = $332,0^\circ - 18,0508^\circ/d * (T - 2014 \text{ Sep } 27,5)$ [2014 Aug 05,5 ... 2014 Oct 15,1]; B" = +33,3°

L' = L - (0,0° - 18,0000°/d * (T - 2014 Aug 05,5))





Neptune



Context

1963: spring equinox

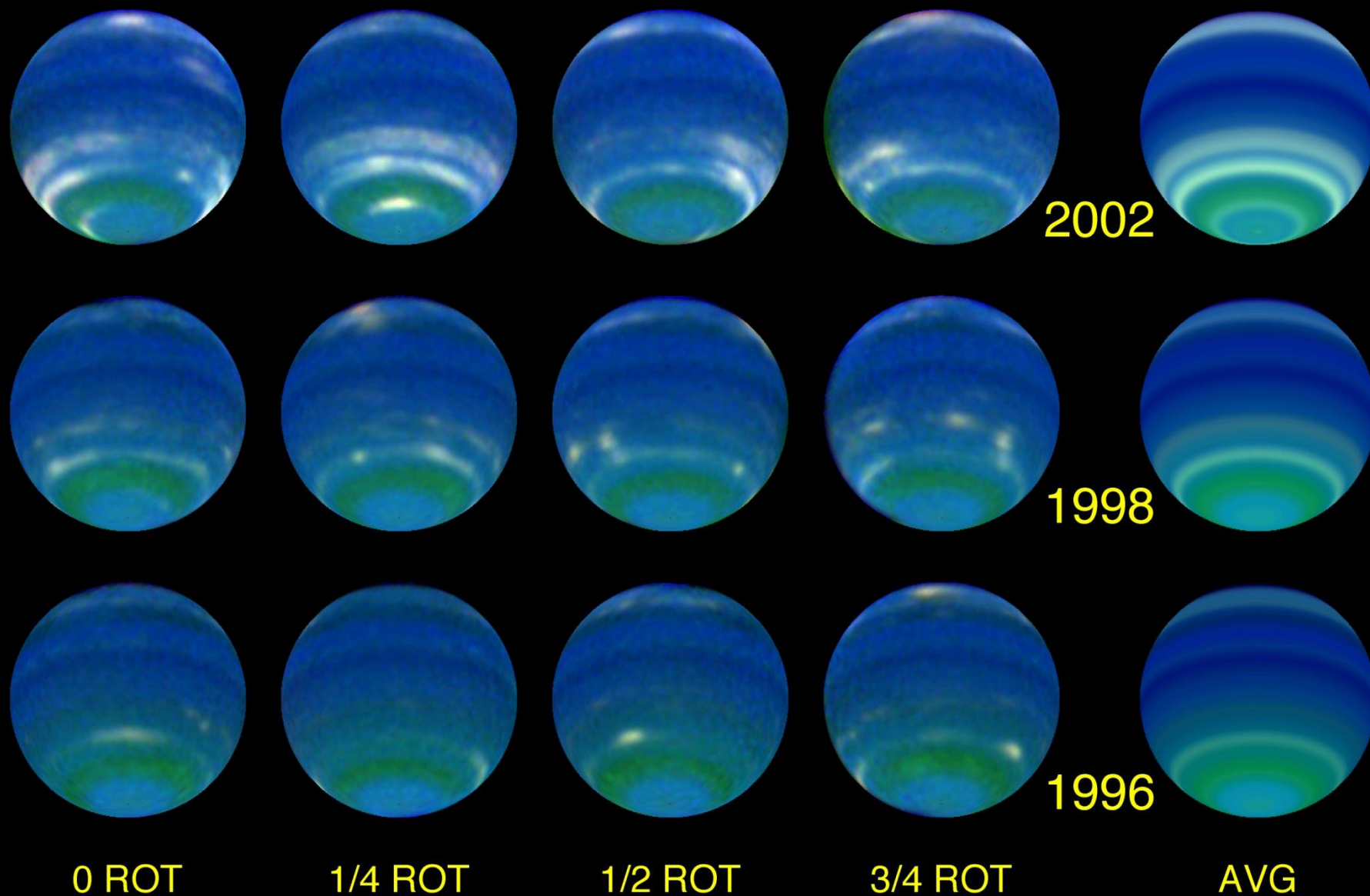
1989: important activity (Voyager 2) (Great Dark Spot" - South of equator, "scooter" - South hemisphere, ...)

1994+: many spots (HST, ...) - increasing activity in Southern hemisphere

2005: summer solstice

2011: activity observed

2015: Major outbreak detected with Keck on Aug. 5th/6th



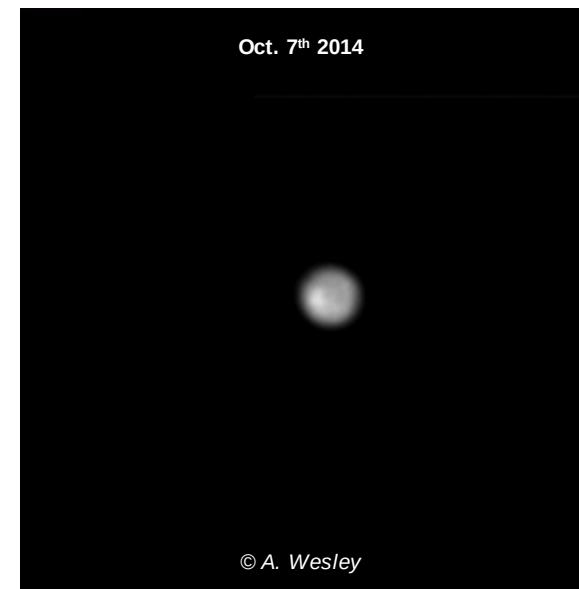
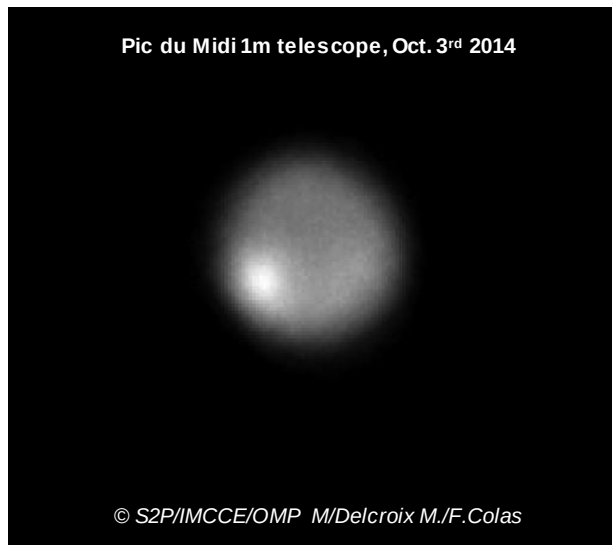
In 2013

- **mid-august 2013, first discovery** of a **white spot** on Neptune **by an amateur**, Peter Gorczynski (USA) with a 350mm
- In 2013, **9 observations** of potential spot in Southern hemisphere
- Out of these observations, **4 are for the same spot located ~46° latitude** (pg)
- Spot found a posteriori by Marc Delcroix on his image with 1m telescope at Pic du Midi in July 2013



In 2014

- Observations of candidate spots (43 measures) by 7 amateurs, 4 months from Aug. 9th to Nov. 13th

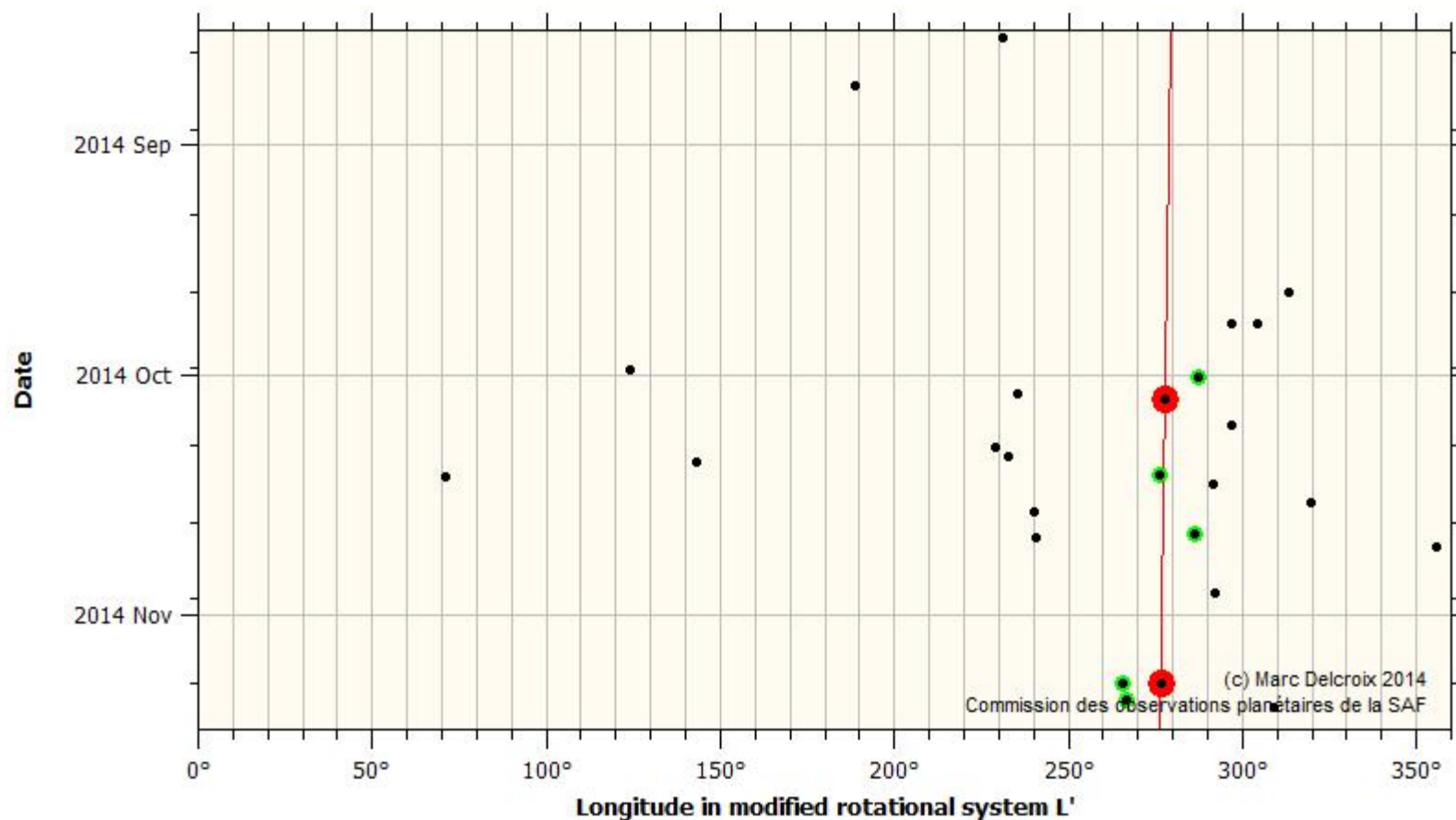


Neptune white spots [-50°, -30° lat.]

- neptune_2014_spots.wse
- neptune_spots.wse
- neptune_spots_pro.wse

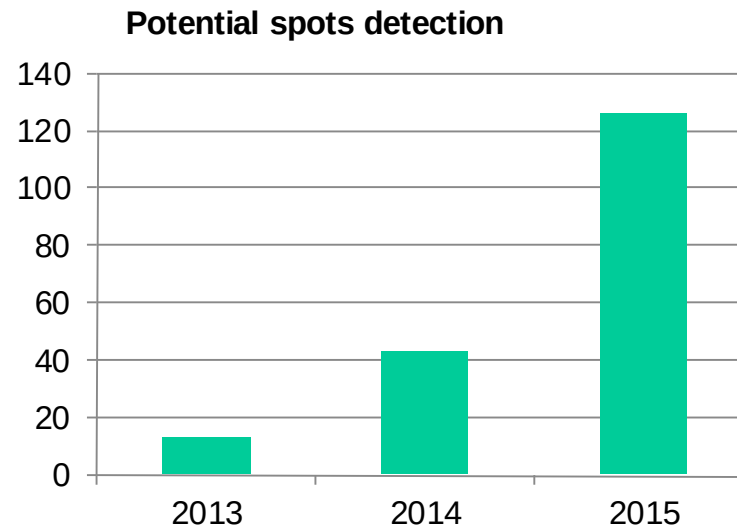
$$L = 99,5^\circ + 22,7637^\circ/d * (T - 2014 \text{ Oct } 22,5) [1583 \text{ Jan } 01,0 \dots 2100 \text{ Jan } 01,0]; B'' = -40,1^\circ$$

$$L' = L - (0,0^\circ + 22,8000^\circ/d * (T - 2000 \text{ Jan } 01,5))$$



In 2015

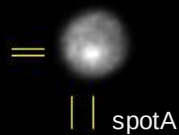
- **July 13th 2015, discovery** of a **white spots** on Neptune at **Calar Alto**, alert to the amateur community
- July 20th 2015, **confirmation** of bright spot **by amateur** (Marc Delcroix)
- Since then, **many observations of multiple spots** not only by **pros** (Keck, Lick, Calar Alto, Hubble, Palomar) but also **by 24 amateurs** (from France, USA, UK, Netherlands, Australia, Brazil, Russia, Romania, Germany)
- **Spots** detected at **different latitudes** (mainly around **-40°**, but also **20°**, ...)
- First results presented at DPS2015 (Hueso R., Delcroix M. et al.)



Neptune & Triton



2015-07-20
 CM 295.5°



2015-07-21
 CM 119.2°



2015-07-24
 CM 263.4°



John Sussenbach

Neptune
UT 13:52:51 Sept. 18th 2015

1 September 2015 21:56 UT
C14 f/22, ASI224MC camera
and 742 nm filter

Triton

D. Millika & Pat Nicholas

SEPTEMBER 24th, 2015
21:44 UTC (25min)
RG610 filter LRGB

N
└─P

Diam: 2.35"

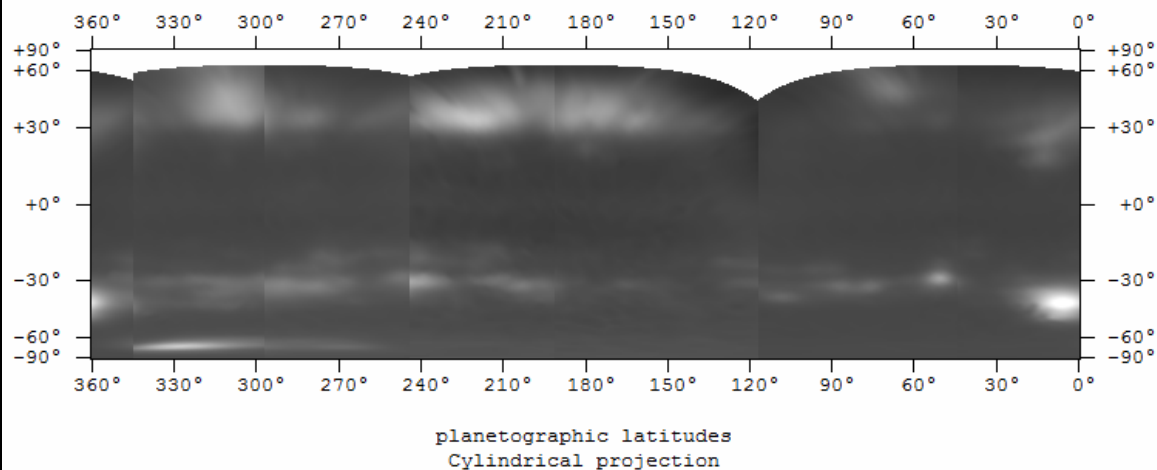
D. Peach

Neptune, Hubble Space Telescope Sept. 18th 2015 - F845M processing by Marc Delcroix from raw public data



spotA

Date	UT	Observer	Channel	Longitude	Sy.	Latitude
2015 Sep 18	16:48,3	HST	Colour	345°... 44°	(1)	-90°...+90°
2015 Sep 18	17:35,3	HST	Colour	44°...117°	(1)	-90°...+90°
2015 Sep 18	07:15,3	HST	Colour	117°...191°	(1)	-90°...+90°
2015 Sep 18	08:02,3	HST	Colour	191°...244°	(1)	-90°...+90°
2015 Sep 18	12:01,3	HST	Colour	244°...297°	(1)	-90°...+90°
2015 Sep 18	12:48,3	HST	Colour	297°...345°	(1)	-90°...+90°

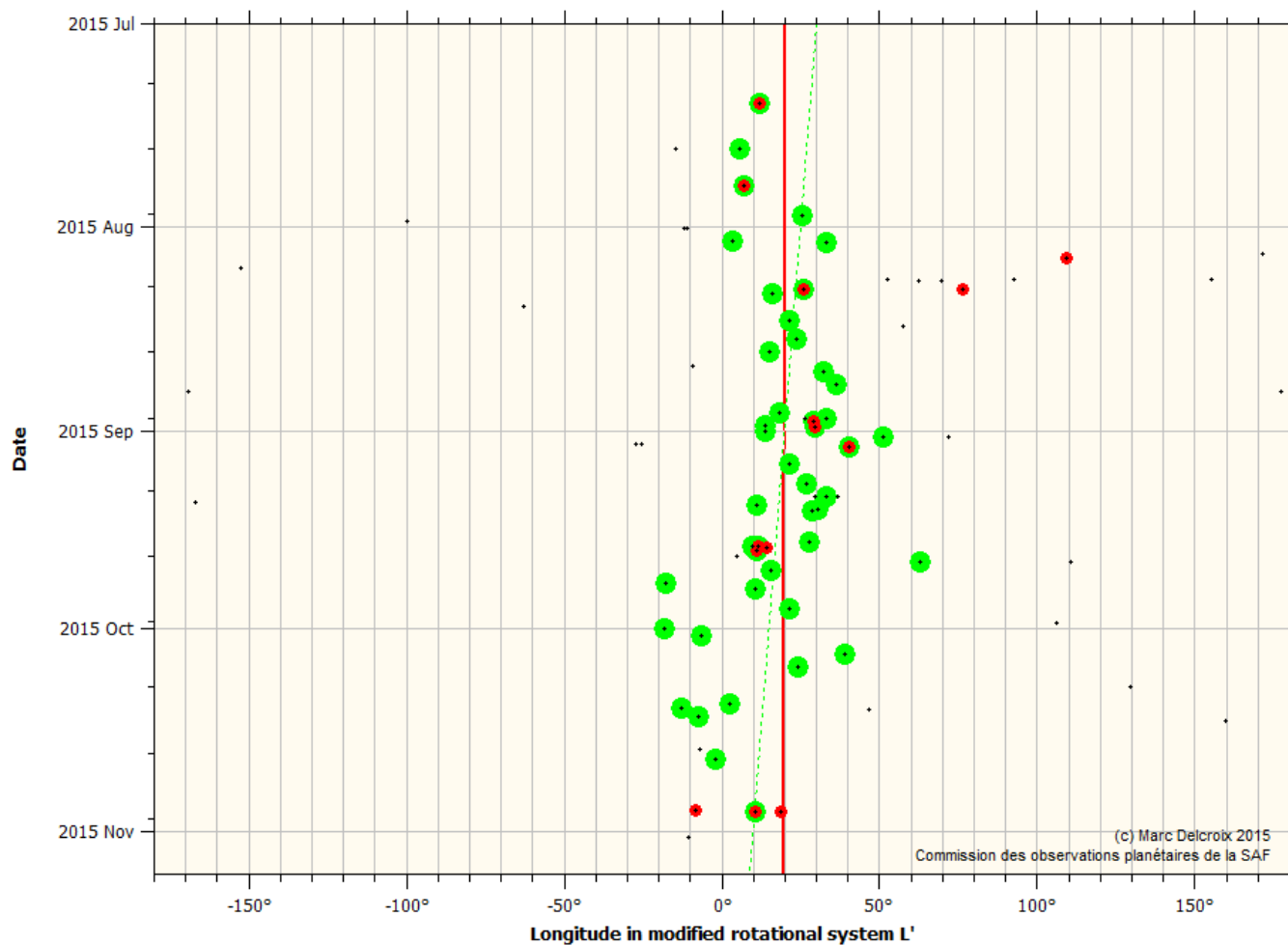


Neptune white spots (inc. 2015 spotA) [-46°, -36° lat.]

- neptune_2015_spots.wse
- neptune_spots.wse
- neptune_spots_pro.wse

$L = 257,7^\circ + 24,6419^\circ/d * (T - 2015 \text{ Aug } 30,5) [1583 \text{ Jan } 01,0 \dots 2100 \text{ Jan } 01,0]; B'' = -41,1^\circ$
 $L = 94,0^\circ + 24,4844^\circ/d * (T - 2015 \text{ Sep } 07,5) [1583 \text{ Jan } 01,0 \dots 2100 \text{ Jan } 01,0]; B'' = -41,0^\circ$

$L' = L - (0,0^\circ + 24,6500^\circ/d * (T - 2000 \text{ Jan } 01,5))$

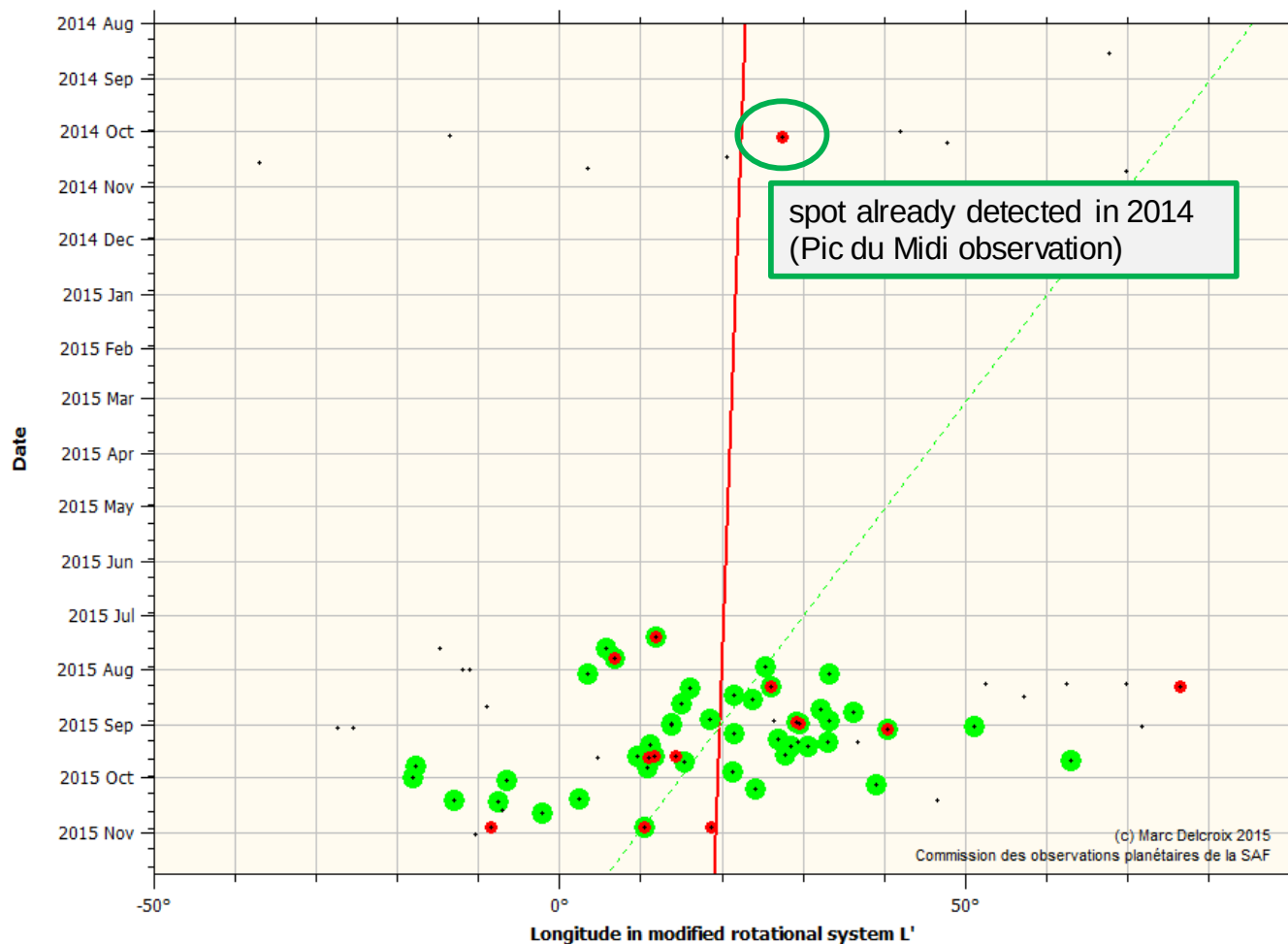


Neptune white spots (inc. spotA) [-46°, -36° lat.]

- neptune_2015_spots.wse
- neptune_spots.wse
- neptune_spots_pro.wse

— $L = 257,7^\circ + 24,6419^\circ/d * (T - 2015 \text{ Aug } 30,5) [1583 \text{ Jan } 01,0 \dots 2100 \text{ Jan } 01,0]; B'' = -41,1^\circ$
 - - - $L = 94,0^\circ + 24,4844^\circ/d * (T - 2015 \text{ Sep } 07,5) [1583 \text{ Jan } 01,0 \dots 2100 \text{ Jan } 01,0]; B'' = -41,0^\circ$

$L' = L - (0,0^\circ + 24,6500^\circ/d * (T - 2000 \text{ Jan } 01,5))$

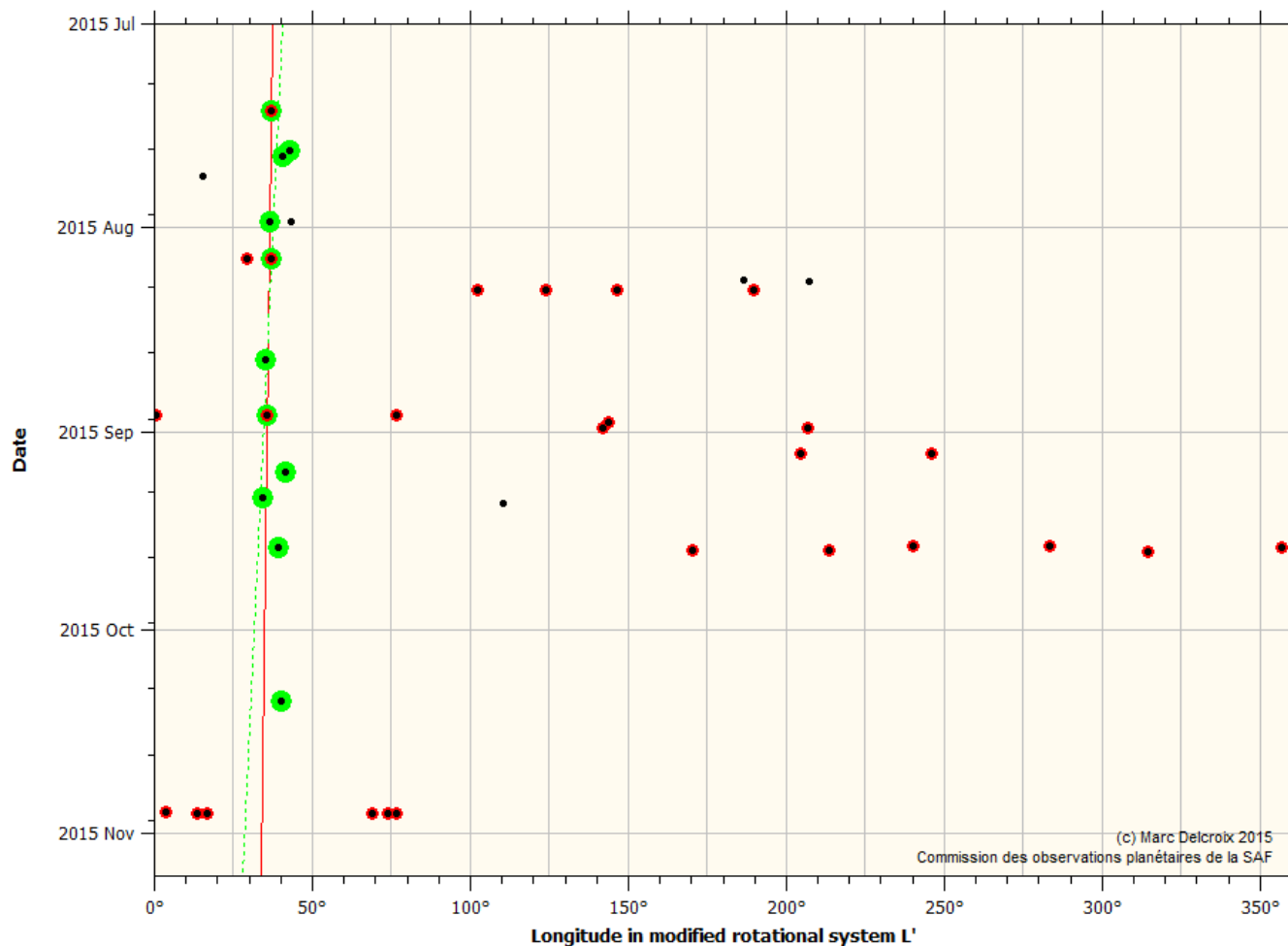


Neptune northern white spots (incl. 2015 spotB) [+10°, +40° lat.]

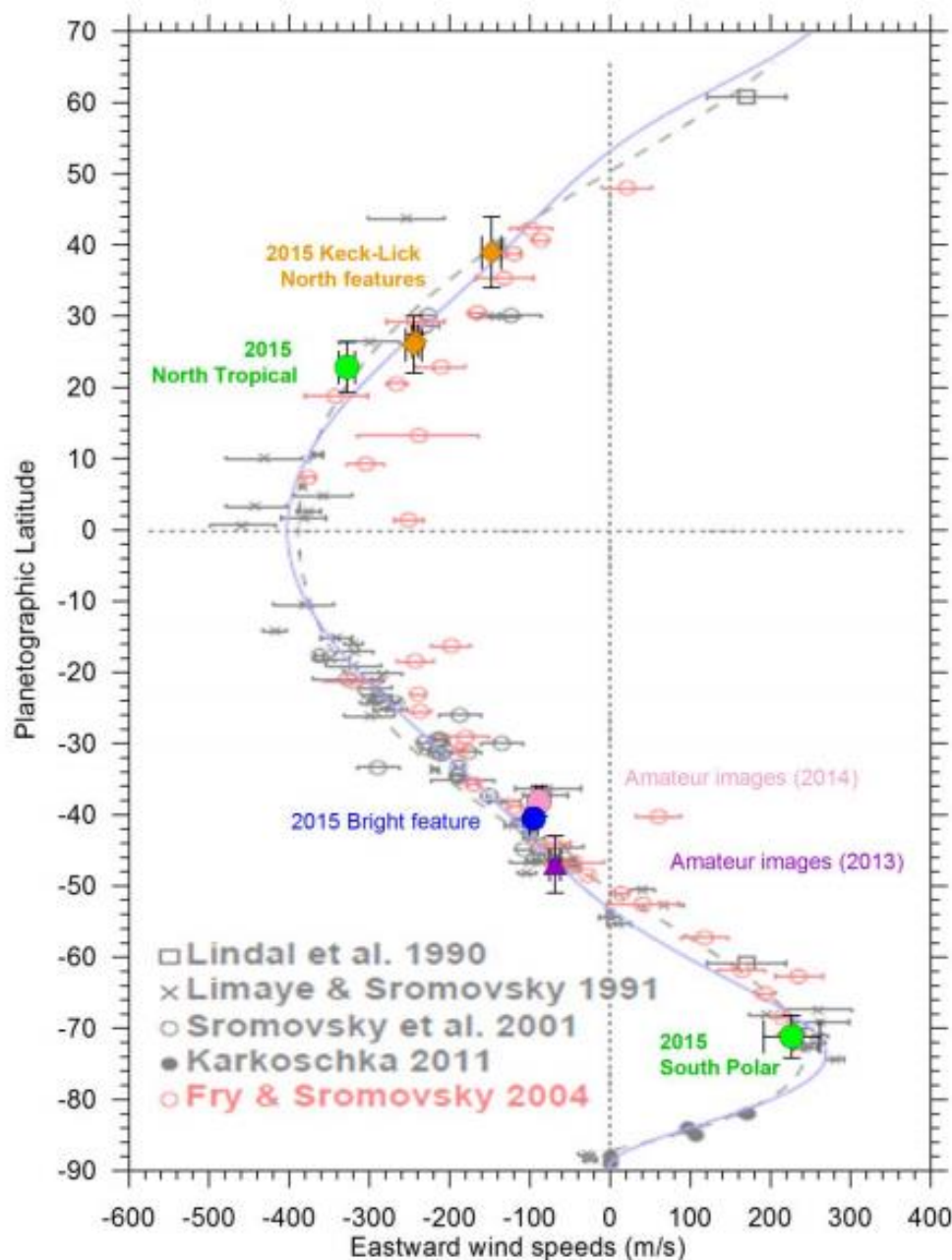
- neptune_2015_spots.wse
- neptune_spots.wse
- neptune_spots_pro.wse

$L = 172,4^\circ + 70,9716^\circ/d * (T - 2015 \text{ Aug } 06,5) [1583 \text{ Jan } 01,0 \dots 2100 \text{ Jan } 01,0]$
 $L = 9,2^\circ + 70,9028^\circ/d * (T - 2015 \text{ Aug } 24,5) [1583 \text{ Jan } 01,0 \dots 2100 \text{ Jan } 01,0]; B'' = +20,7^\circ$

$L' = L - (0,0^\circ + 71,0000^\circ/d * (T - 2000 \text{ Jan } 01,5))$



(c) Marc Delcroix 2015
Commission des observations planétaires de la SAF



Hueso R., Delcroix M. et al., Bright features in Neptune on 2013-2015 from ground-based observations with small (40cm) and large telescopes (10m) - DPS 2015

En synthèse

Uranus et Neptune sont des planètes **délicates à imager**, mais le sont **de plus en plus par des amateurs** rigoureux et expérimentés.

Les amateurs **détectent** années après années **plus de détails**, à l'occasion d'évènements exceptionnels sur Uranus ou de manière régulière Neptune

Leurs images sont **attendues par les pros**, et servent à **détecter**, ou à défaut **confirmer**, **suivre** et **prévoir** la position de spots permettant de **justifier l'utilisation de moyens professionnels**

Ces observations sont **cruciales** pour **comprendre** ces phénomènes atmosphériques variables

