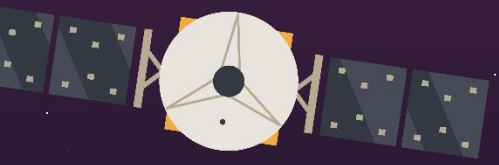
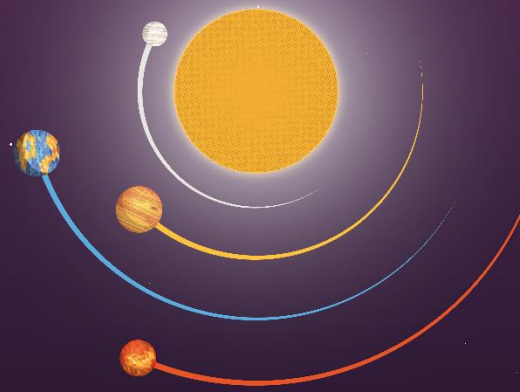
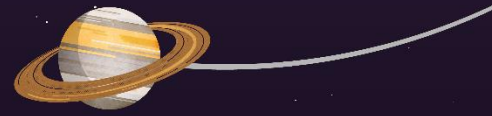
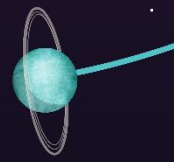
EUROPLANET SCIENCE CONGRESS
EPSC 2020
VIRTUAL



The growing extent of professional and amateur astronomy collaborations in planetary sciences (keynote)







Marc Delcroix
French Astronomical Society (SAF) planetary observations section president
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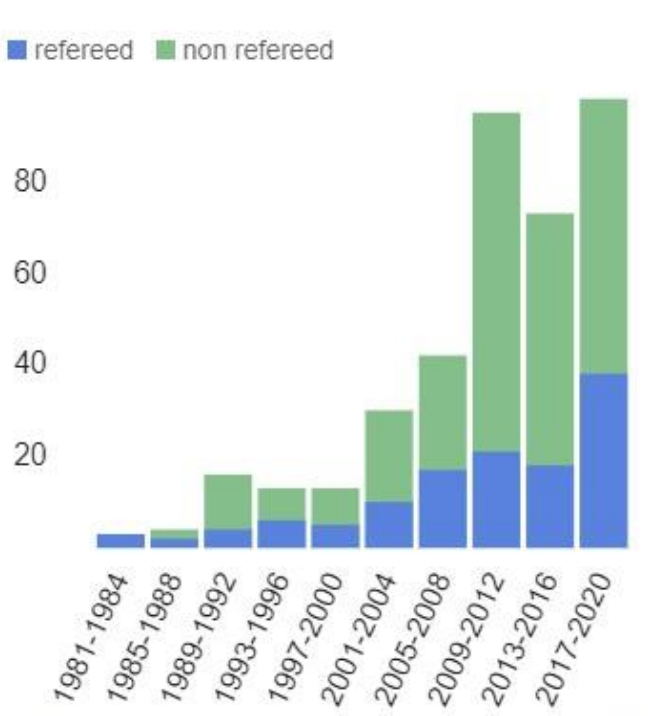
Pro-am collaborations, a reality - increasing since 20 years

- Constant increase of co-authored papers (*Mousis et al., Exp. Astr. 2014*)



- Dedicated EPSC session growing since 2008

- Many workshops funded by Europlanet 2020 since 2016

1.Jean-Luc Dauvergne 2.Glenn Orton 3.Peter Rosen 4.Manos Kardasis 5.Clyde Foster 6.Silvia Kowollik 7.Leigh Fletcher 8.Ricardo Hueso 9.Simon Kidd 10.Tirs Abril 11.Christopher Go 12.Joaquin Camarena 13. Agustin Sanchez-Lavega 14.Josep Soldevilla 15.Paulo Casquinha 16.John Rogers 17.Peter Edwards 18.John Sussenbach 19.Martin Lewis 20.Patrick Irwin 21.Candy Hansen 22.Ashwin Braude 23.Constantin Sprianu 24.Kuniaki Horikawa 25.Michel Jacquesson 26.Anthony Wesley 27.Sean Doran 28.Padma Yanamandra-Fisher 29.Peter Lawrence 30.Emil Kraaikamp 31.Matt Brealey 32.Gerald Eichstaedt 33.Marc Delcroix 34.Arrate Antuñano 35.Padraig Donnelly 36.Alexei Pace 37.Johan Warell 38.Christophe Pellier 39.Mike Foulkes 40.Manuel Scherf 41.Marco Vedovato 42.Miguel Araújo 43.Scott Bolton

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Amateurs' observations – key contributions for science

Strength of planetary amateur community:

- Spatial/time context e.g. for planets from hi-res imaging with 25-50cm scopes, lucky imaging with highly sensitive and fast cameras, between 300nm-1µm (complementary to pro instruments)
- Time coverage through hundreds of connected observers all around the world
- Availability of images in databases (e.g. for planets pro PVOL, ALPO Japan, SAF, …)

A . Wesley (Australia)

Some of the DeTeCt impact detection project amateur participants

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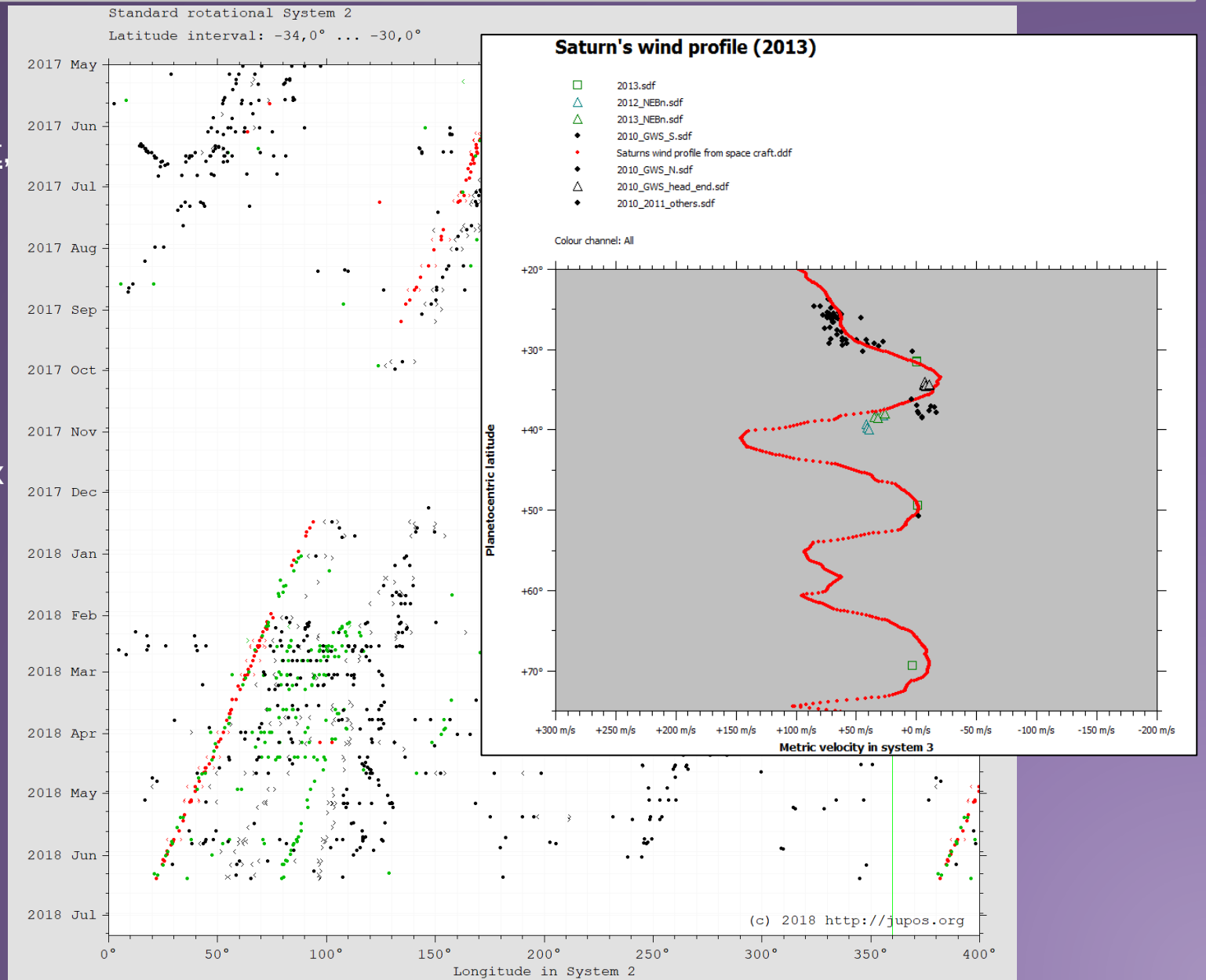
Amateurs process and analyse their own data

- Planning/processing softwares from amateurs
  (e.g. for planets lucky imaging w/ Autostakkert, derotation, measures, analysis w/ WinJupos; for occultations Tangra, Occult, …)

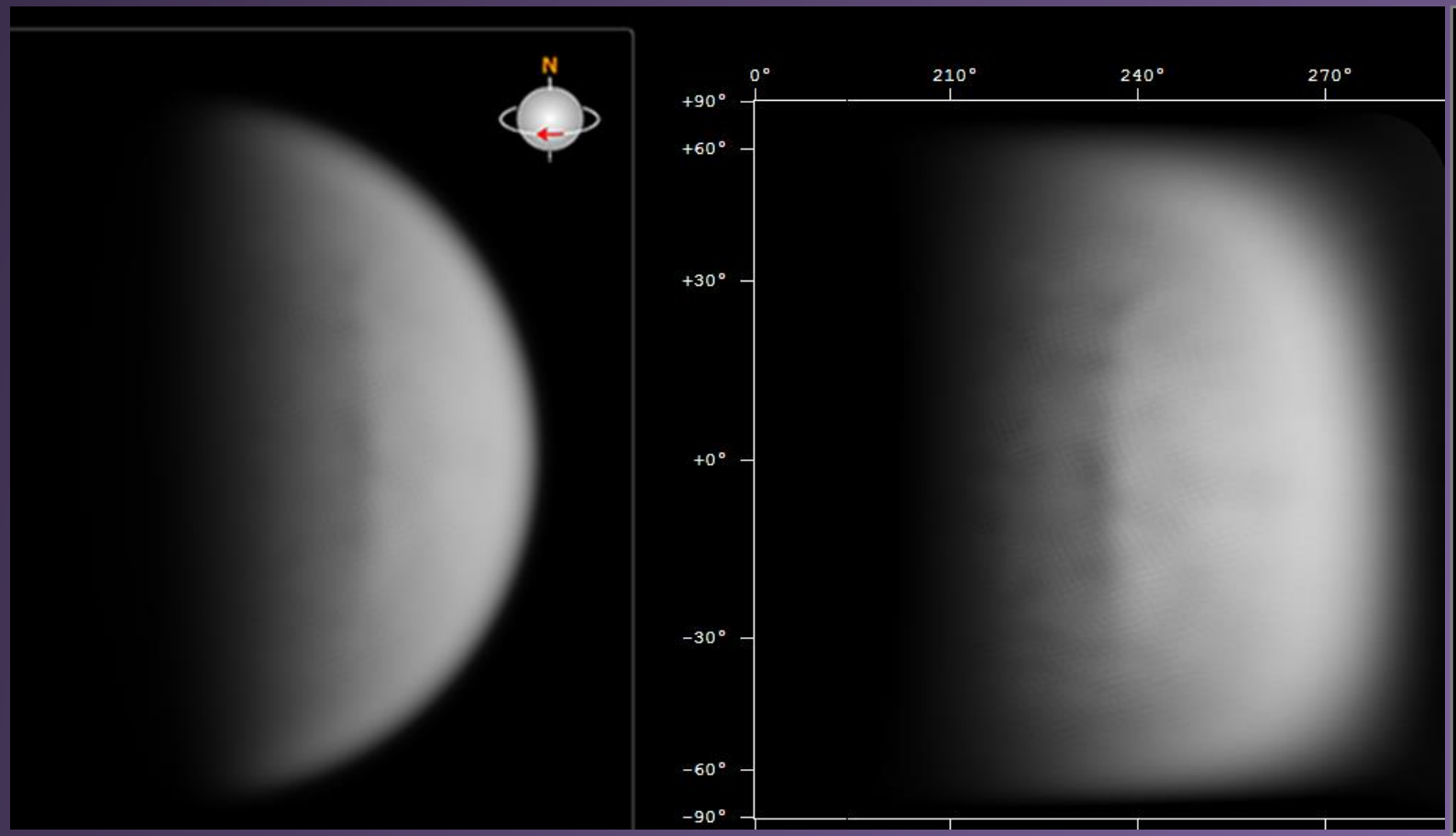
- Measures, analysis, ephemeris performed by amateurs themselves
  (e.g. J. Rogers/JUPOS for Jupiter, M. Delcroix for Saturne, Uranus et Neptune)

Monitoring of the planet atmospheres, with zonal wind profile evolution
Asteroids occultations
Exoplanet detections



TP: Venus

- Venus' clouds in UV and IR (complementary to Akatsuki, support of Bepi-Columbo fly-bys)
- Surface thermal emissions @ 1µm



Sharp long-lived disruption
E. Kardasis (Greece)
2020,03,21

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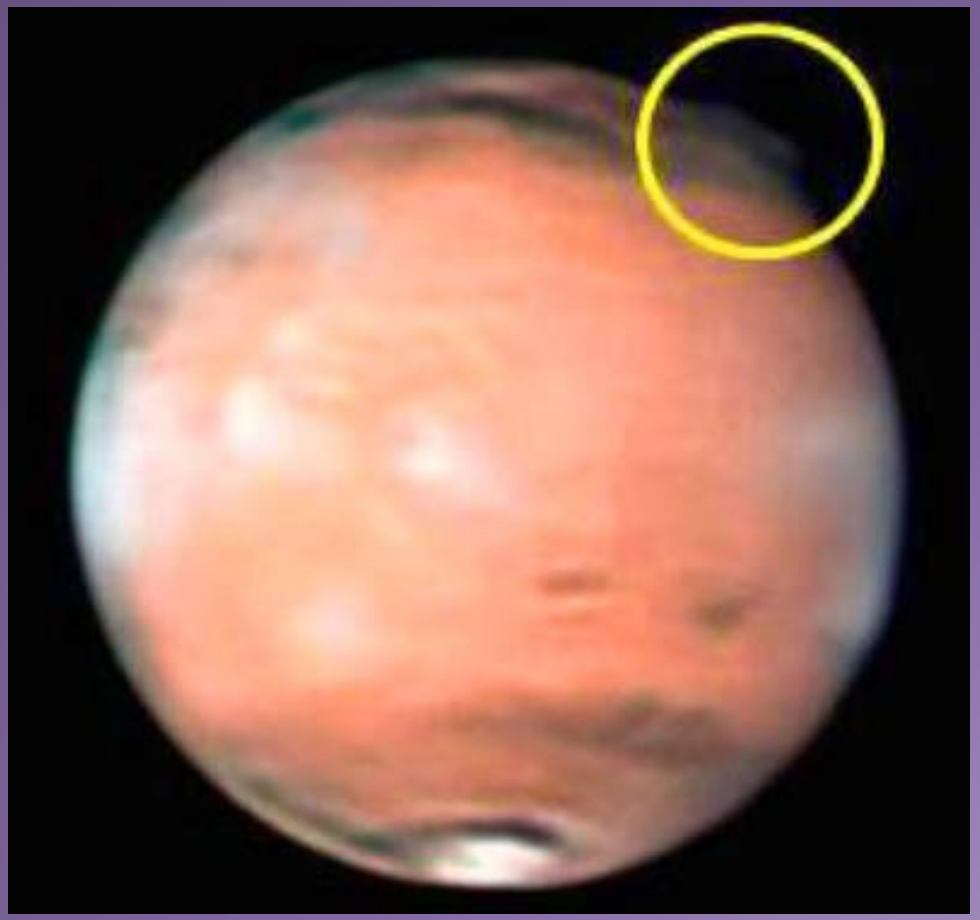
TP: Mars

- Clouds, dust storms, polar caps evolution observations

Great Dust Storm 2018
A . Yamazaki (Japan)
2018-06-04

- High altitude plumes detection
  (Sanchez-Lavega et al. Nature 2015)



High plume
W. Jaeschke (USA)
2012-03-20

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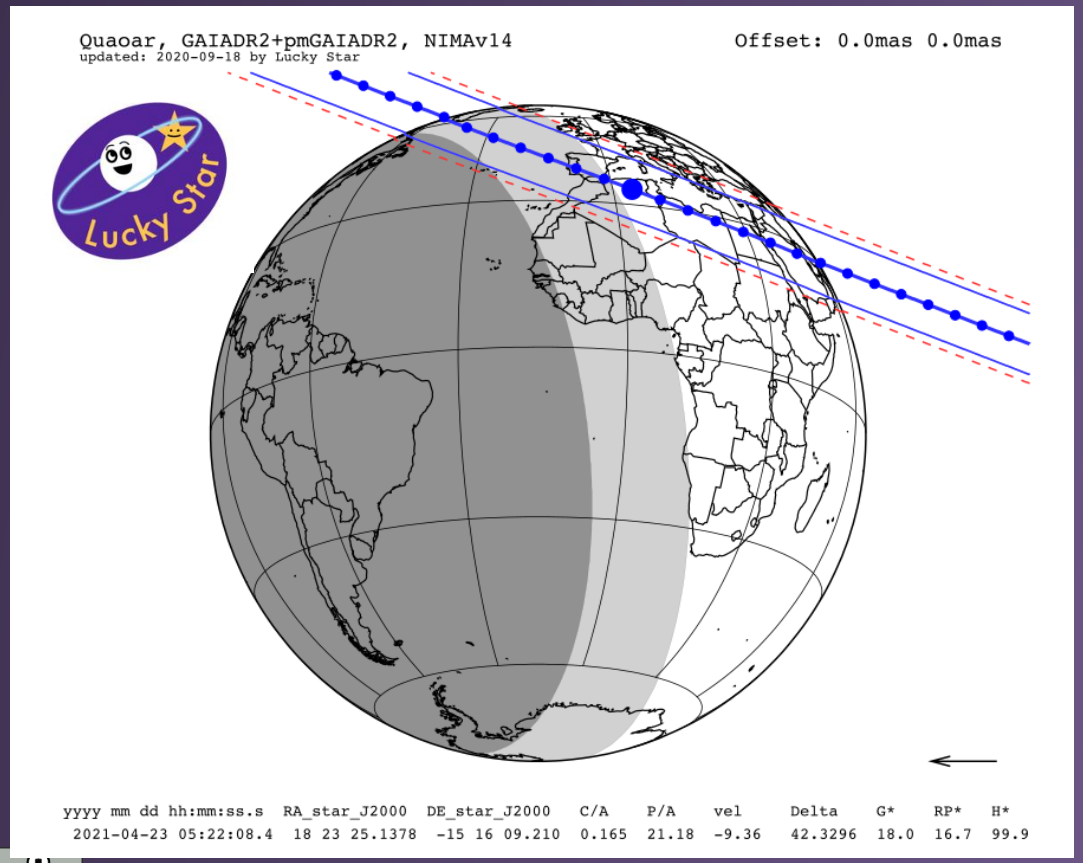
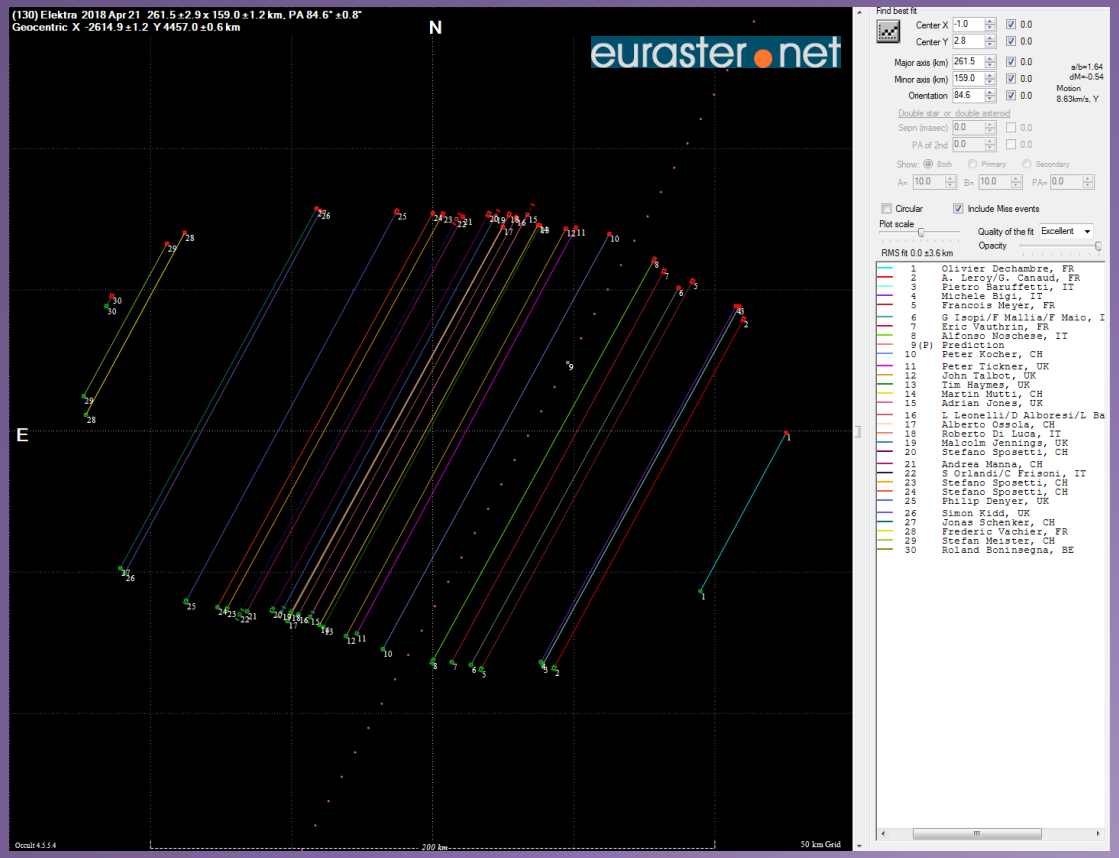
SB: Small bodies, stellar occultations

- Discovery/recovery by amateur observations
- Astrometry, photometry and occultations to characterize shape, satellites, rings *(New Horizons support (Buie M. et al., AAS 2020))*
- Comets imaging, activity monitoring
- Occultations by planets' atmospheres, mutual satellites phenomena *(Saquet E. et al., MNRAS 2018)*



Prediction of occultation by Quaoar 2020-09-18

Occultation by (130) Elektra 2018-04-21



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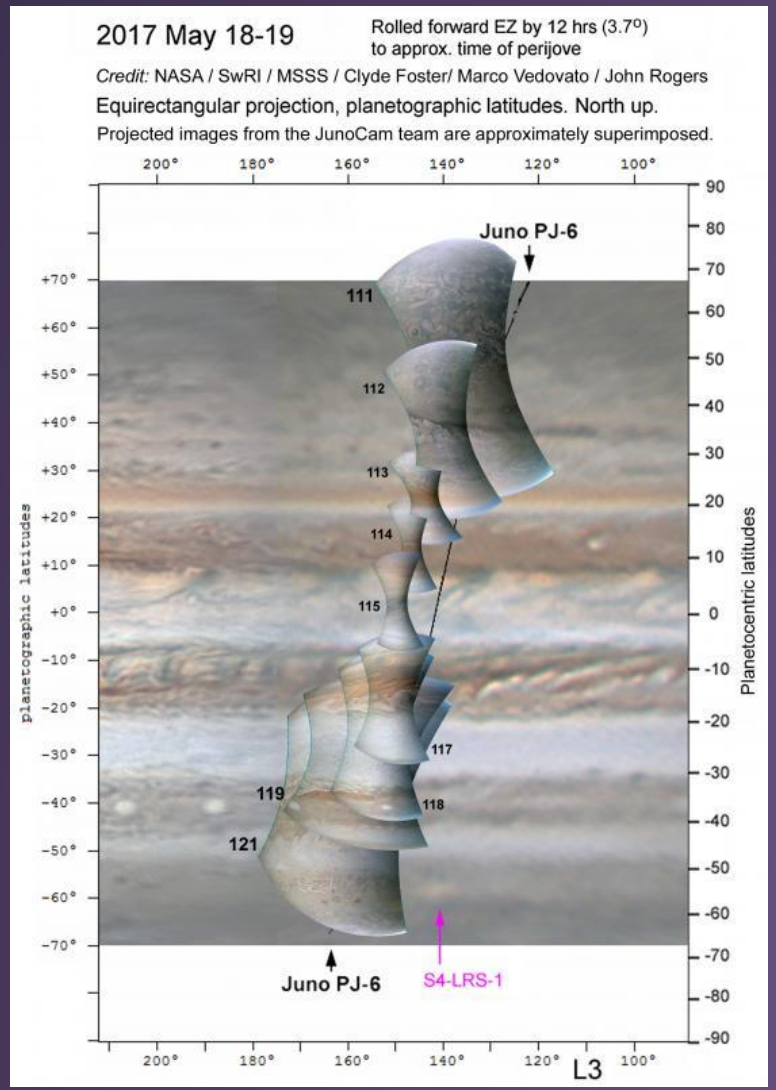
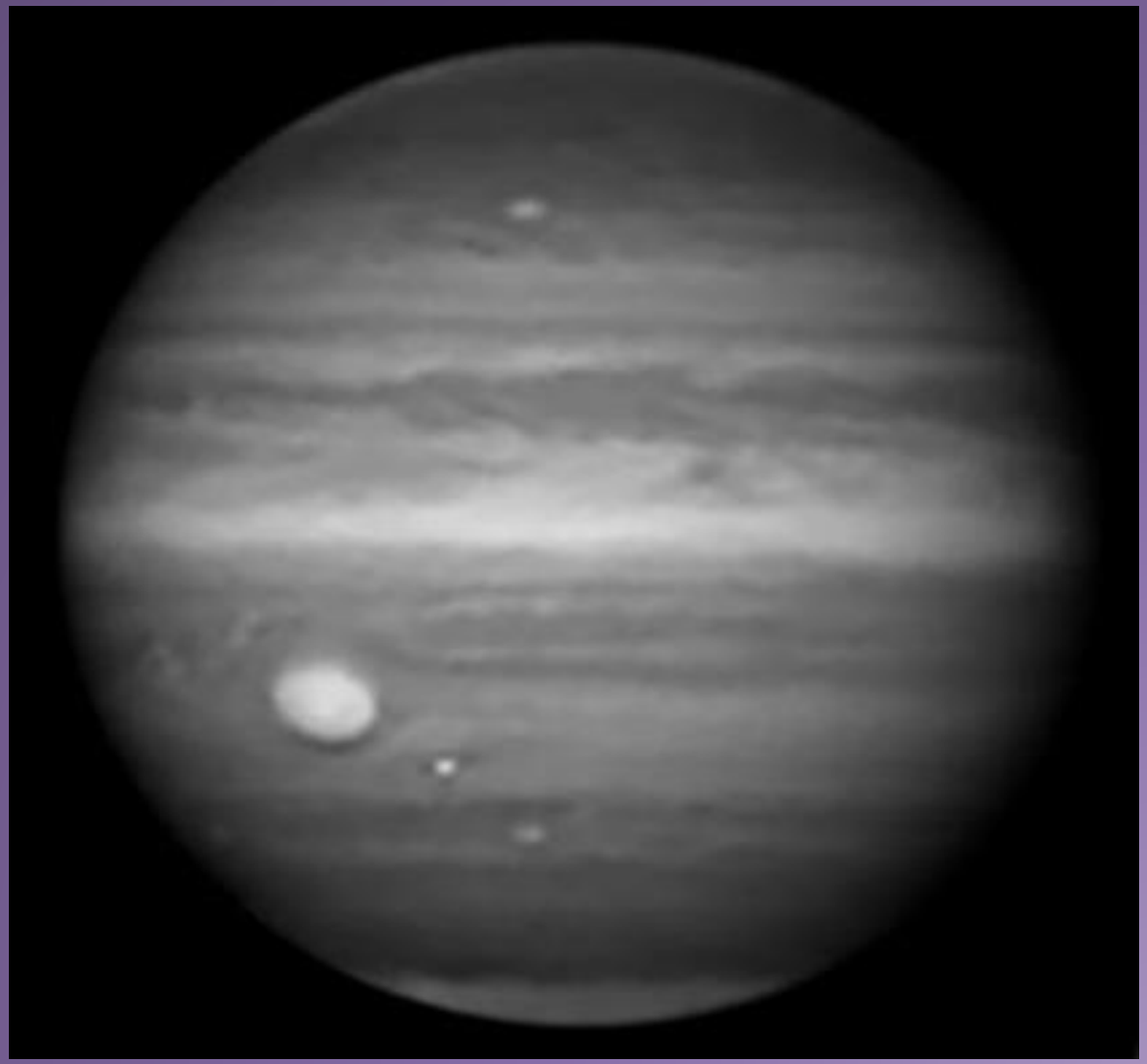
OPS: Jupiter

- Complementary observations required for JunoCam

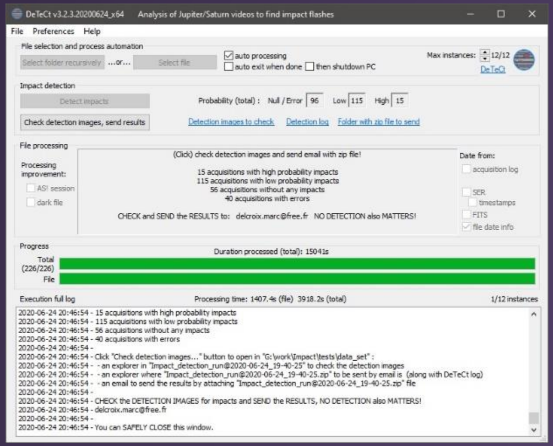


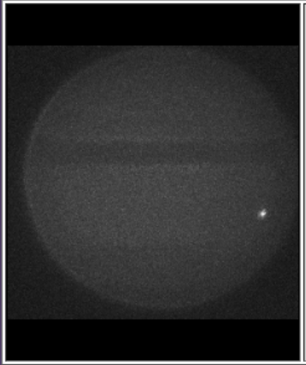
- Monitoring/discoveries of disturbances, features, waves evolutions (e.g. Clyde's spot, BA oval reddening, …)



Discovery of "Clyde's spot"
C. Foster (S. Africa)
2020-05-31

OPS: Impact detection project



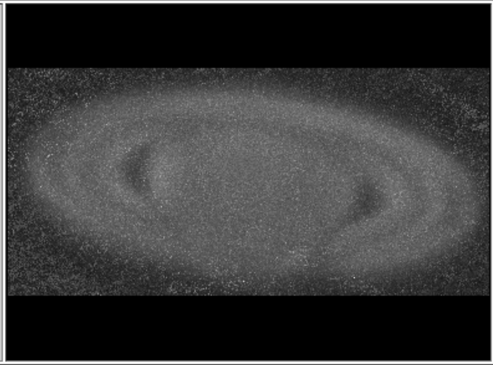


Impact flashes detection with DeTeCt software project /
Projet de détection de flash d'impacts avec le logiciel DeTeCt
by/*par* Marc Delcroix

NEW v3.3.0! Software download / téléchargement du logiciel **for participating to the project / pour participer au projet**
NEW! DeTeCt quick user guide
Presentation of the project (EPSC2013, BAA workshop)

email address for distribution list to stay tuned & discuss about impact detectio | Subscribe

I have fun running the project/developping the software, but it takes a lot of my private time and needs computing power, storage, etc. Thanks a lot if you want to support this!
Donate



Jupiter
estimation of 14,1 impacts per year (absolute number)
total excludes 9,457 days of simultaneous observations

Observer	Duration	Number of videos	Date range
Total : 106 observers	155.909 days	143692 videos	2003/04/18 - 2020/09/06
Zac Pujic (Australia)	22.511 days	9081	2005/02/22 - 2020/09/04
Michel Jacquesson (France)	19.773 days	10158	2014/03/12 - 2020/08/26
Benito Loyola (USA)	18.038 days	18481	2018/02/17 - 2020/09/05
Paul Rolet (France)	15.781 days	13158	2012/09/07 - 2020/09/05
Manos Kardasis (Greece)	9.506 days	8161	2004/02/29 - 2019/11/27
Clyde Foster (South Africa)	7.108 days	8867	2015/01/30 - 2020/08/11
Thomas Ashcraft (USA)	5.046 days	6114	2013/10/09 - 2020/09/03
Bernd Gaehrken (Germany)	4.432 days	6025	2016/03/06 - 2020/08/10
Sauveur Pedranghelu (France)	4.223 days	5202	2017/05/26 - 2020/08/08
Alan Coffelt (USA)	3.799 days	2801	2013/10/04 - 2020/09/03
Marc Delcroix (France)	3.765 days	2847	2006/04/13 - 2020/08/18
Jose Luis Pereira (Brazil)	3.553 days	4765	2019/01/30 - 2020/09/04
Ethan Chappel (USA)	[illegible]	2037	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Christophe Pellier (France)	2.374 days	906	2012/02/20 - 2019/07/28
[illegible]	2.062 days	1867	2012/08/16 - 2015/04/25
[illegible]	[illegible]	[illegible]	[illegible]
Grant Blair (USA)	1.988 day	1874	2013/08/20 - 2016/04/21
[illegible]	1.822 day	1607	2016/05/04 - 2020/08/17
[illegible]	1.695 day	1533	2003/04/18 - 2020/07/20
Trevor Barry (Australia)	1.615 day	2425	2009/07/06 - 2012/12/30
[illegible]	1.494 day	1702	2012/11/30 - 2017/05/21
[illegible]	[illegible]	907	2016/02/25 - 2017/04/10
Torsten Mellenthin (Germany)	1.218 day	1416	2016/01/28 - 2017/06/24
Lammertus de Vries (Spain)	1.171 day	635	2009/08/03 - 2015/05/08
Pic du Midi (Colas/Delcroix/Dauvergne/Sylla) (France)	1.164 day	1861	2010/09/29 - 2019/08/16
Jocelyn Serot (France)	1.154 day	880	2014/01/10 - 2019/06/02
[illegible]	1.131 day	1243	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Martin Lewis (UK)	1.020 day	1509	2015/03/22 - 2019/09/05
Matic Smrekar (Slovenia)	0.956 day	1648	2009/07/29 - 2019/06/10
Arnaud Claisse (France)	0.941 day	842	2014/01/19 - 2016/05/03
Oleg Zaharciuc (Moldova)	0.822 day	1120	2016/05/19 - 2020/08/30

Saturn
estimation of less than 33,6 impacts per year (absolute number)
total excludes 0,173 days of simultaneous observations

Observer	Duration	Number of videos	Date range
Total : 40 observers	21.724 days	10411 videos	2003/11/07 - 2020/09/04
Zac Pujic (Australia)	5.252 days	2131	2005/02/04 - 2018/04/21
Marc Delcroix (France)	2.983 days	1186	2007/01/20 - 2020/08/18
Sauveur Pedranghelu (France)	2.649 days	819	2019/06/03 - 2020/08/06
Paul Rolet (France)	2.242 days	623	2015/05/12 - 2020/08/18
Ethan Chappel (USA)	1.600 day	927	2013/07/30 - 2020/05/01
Manos Kardasis (Greece)	1.069 day	713	2008/03/10 - 2018/10/27
Oleg Zaharciuc (Moldova)	0.649 day	325	2016/05/22 - 2020/08/30
Michel Miniou (France)	0.636 day	474	2003/11/07 - 2019/12/04
Benito Loyola (USA)	0.497 day	567	2018/07/11 - 2019/07/30
Pic du Midi (Colas/Delcroix/Dauvergne/Sylla) (France)	0.454 day	434	2012/08/06 - 2019/08/15
Grant Blair (USA)	0.445 day	255	2014/03/14 - 2016/04/24
Philippe Chatelain (France)	0.421 day	43	2017/05/21 - 2019/08/02
Wellington Pereira Fonseca (Brazil)	0.377 day	192	2020/06/10 - 2020/09/04
[illegible] (Greece)	0.331 day	274	2019/09/03 - 2020/07/19
Arnaud Claisse (France)	0.260 day	62	2015/05/21 - 2016/05/04
Societe Astronomique de Touraine (France)	0.223 day	92	2014/03/14 - 2016/07/16
[illegible] (France)	0.195 day	89	2015/05/23 - 2017/06/05
David Domine (France)	0.171 day	35	2016/04/23 - 2017/04/08
Alan Coffelt (USA)	0.167 day	62	2015/05/03 - 2020/08/09
Martin Lewis (UK)	0.167 day	169	2015/05/21 - 2019/07/28
Jose Luis Pereira (Brazil)	0.162 day	160	2019/05/22 - 2020/08/28
Isaac Lozano Rey (Spain)	0.156 day	126	2020/06/24 - 2020/09/04
Emmanuel Thiers (France)	0.095 day	34	2016/05/06 - 2016/06/18
Matic Smrekar (Slovenia)	0.092 day	88	2011/06/27 - 2019/05/08
Christian Pinter (Austria)	0.092 day	9	2019/06/29 - 2020/08/25
Denis Huber (France)	0.080 day	63	2019/07/20 - 2020/08/27
Charles Galdies (Malta)	0.078 day	82	2014/06/08 - 2015/07/17
[illegible] (Austria)	0.072 day	55	2017/06/10 - 2020/08/08
[illegible] (Mexico)	0.067 day	51	2020/05/25 - 2020/07/16
Charles Triana (Colombia)	0.064 day	96	2017/08/10 - 2019/08/19
Blake Estes (USA)	0.055 day	79	2016/05/08 - 2016/05/13
Lee Keith (USA)	0.035 day	20	2020/07/25 - 2020/08/19
Michel Jacquesson (France)	0.031 day	4	2019/09/03 - 2019/09/04

« DeTeCt » project evaluating impacts frequency on Jupiter (and Saturn) since 2012, led by an amateur *(Hueso R., Delcroix M. et al. A&A 2018)*
158d of survey, 146 000 videos,
2019 impact discovered with the software

NB: Lunar impacts detections is a also a pro-am collaboration field

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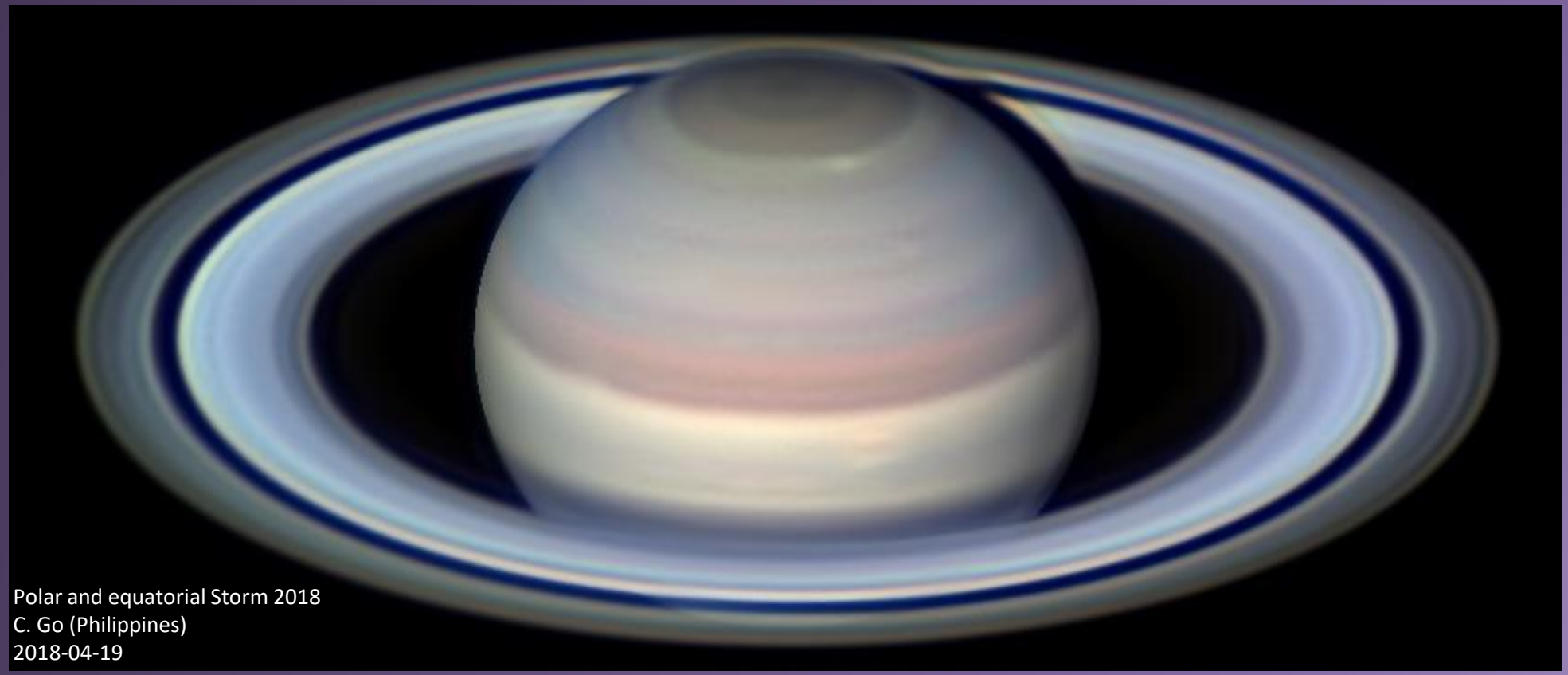
OPS: Saturn

- Clouds tracking complementary to Cassini radio observations (RPWS) *(Fischer et al. Nature 2011)*
- Continuous monitoring of 2010-2011 GWS *(Sanchez-Lavega et al. Nature 2011)*
- Spokes *(Delcroix et al., DPS/EPSC 2011)*



Polar and equatorial Storm 2018
C. Go (Philippines)
2018-04-19

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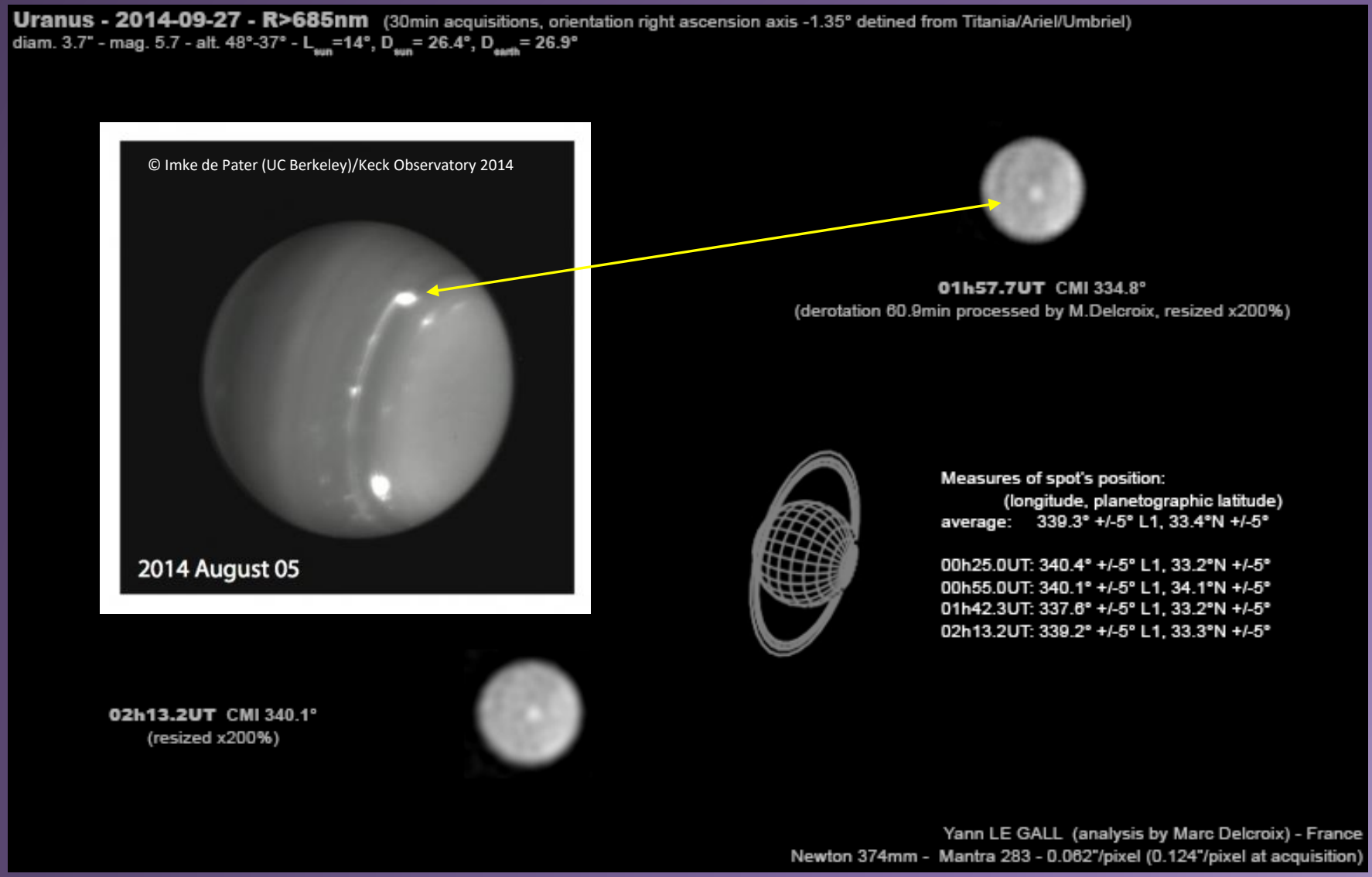
OPS: Uranus

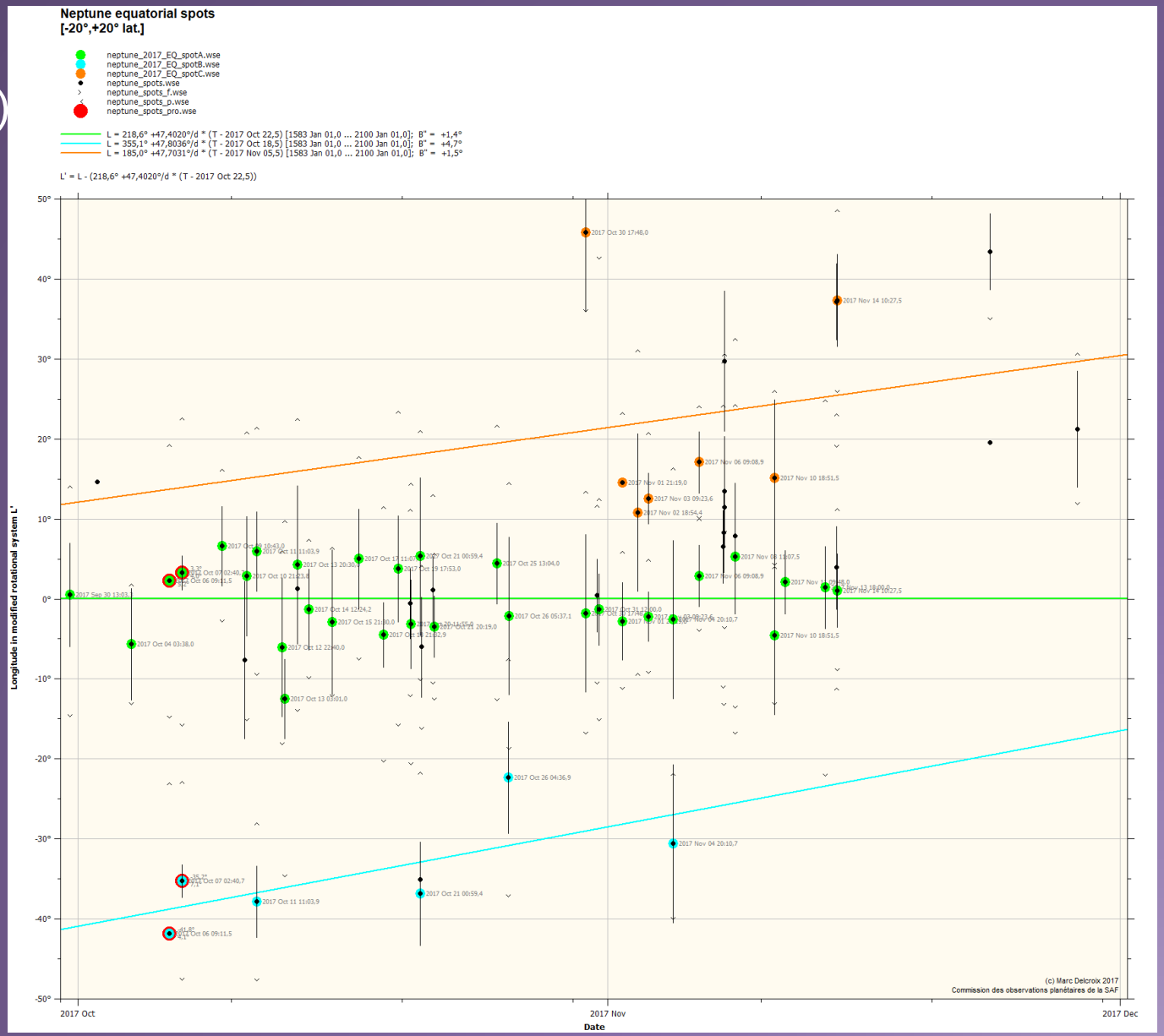
- Bands and clouds observations in NIR (justifying pro observations)
- 2014 storm tracking



OPS: Neptune

- Bright zones observed in NIR since 2013 (triggering complementary pro observations)
  (Wong et al. Astr. Journal 2018)

Neptune features
Marc Delcroix (France)
2017-10-10



2017 Neptune equatorial spots drifting
Analysis by Marc Delcroix (France)

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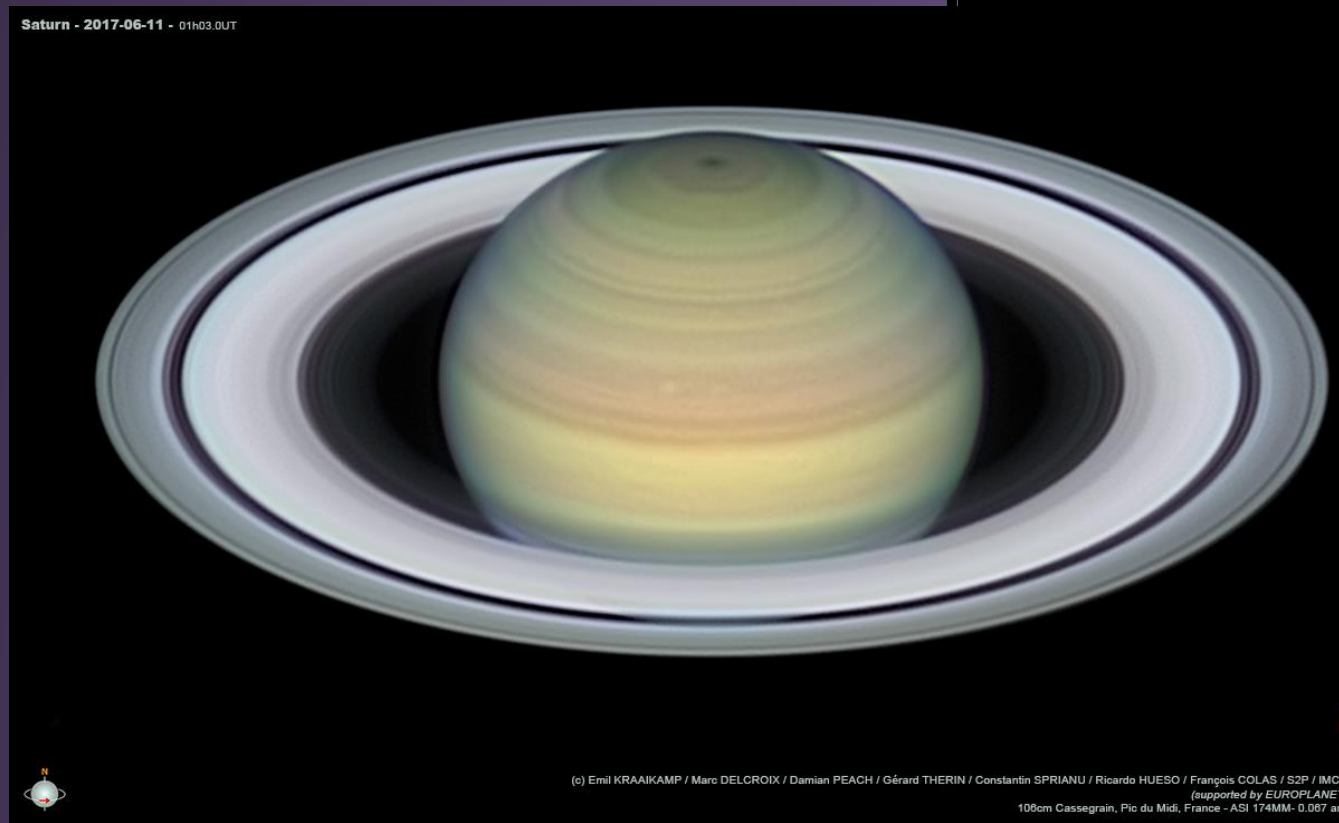
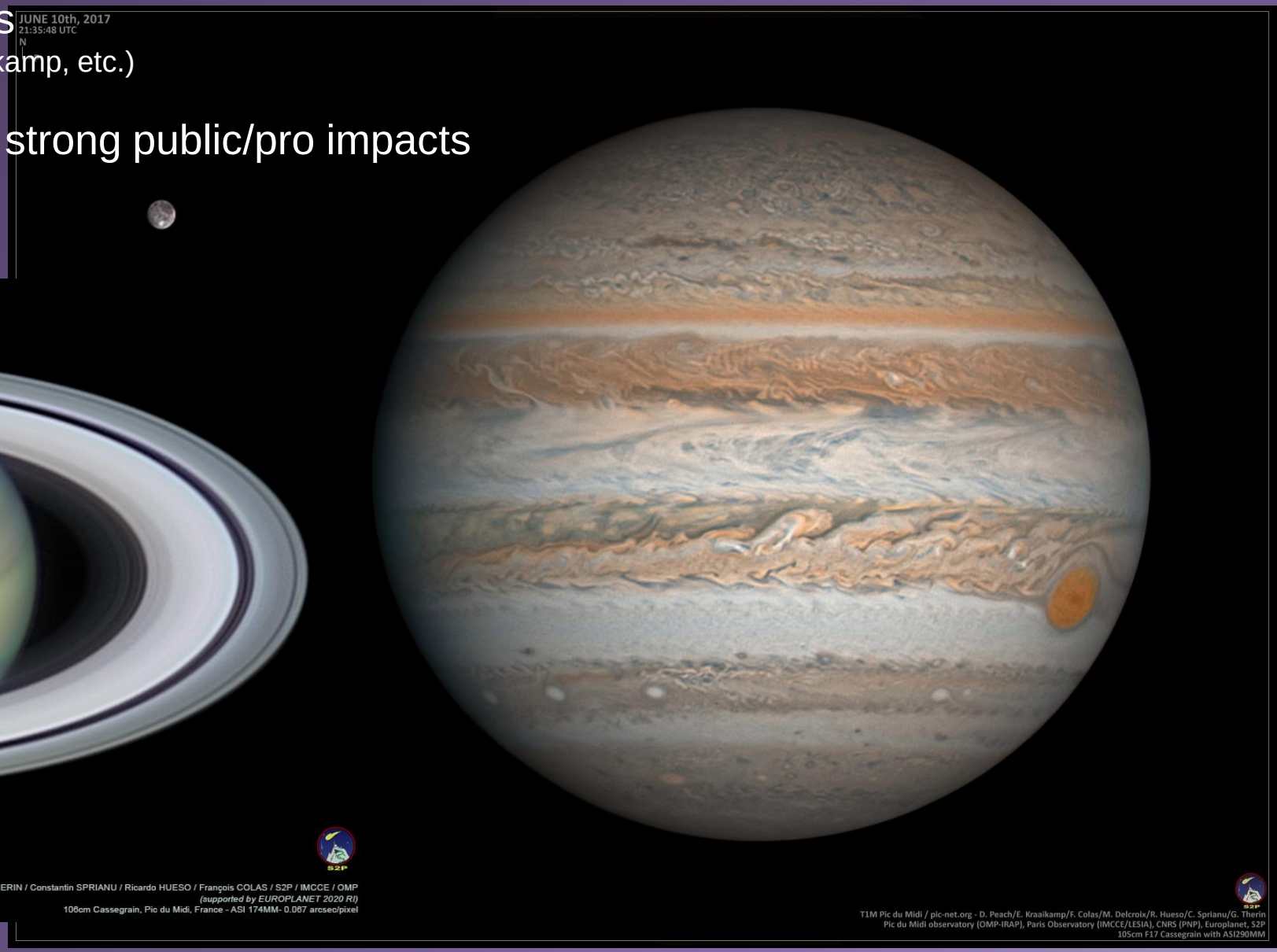
1m telescope @ Pic du Midi

- Used by a few advanced amateurs
  (JL. Dauvergne, M. Delcroix, D. Peach, E. Kraaikamp, etc.)

- Best images from the ground with strong public/pro impacts
  (Simon A. et al., Astr. Journal 2018)





EXO: Exoplanets

- Transit/Transit Time Variations observations *(support to Kepler, TESS, Ariel w/ exoclock project, ...)*

- Discoveries (transit, microlensing) *(Udalsky et al. Astr. J 2005)*

... complete ... worldwide ... continuously growing ...
ETD Exoplanet Transit Database
http://var.astro.cz/ETD

ETD - Exoplanet Transit Database

Observers community | How to contribute to ETD | Model-fit your data | Transit predictions | *KEPLER* predictions | *TESS* Predictions

ETD is here to suply quickly and easily the **list of all ever observed transits of transiting exoplanets** to observers and researchers.

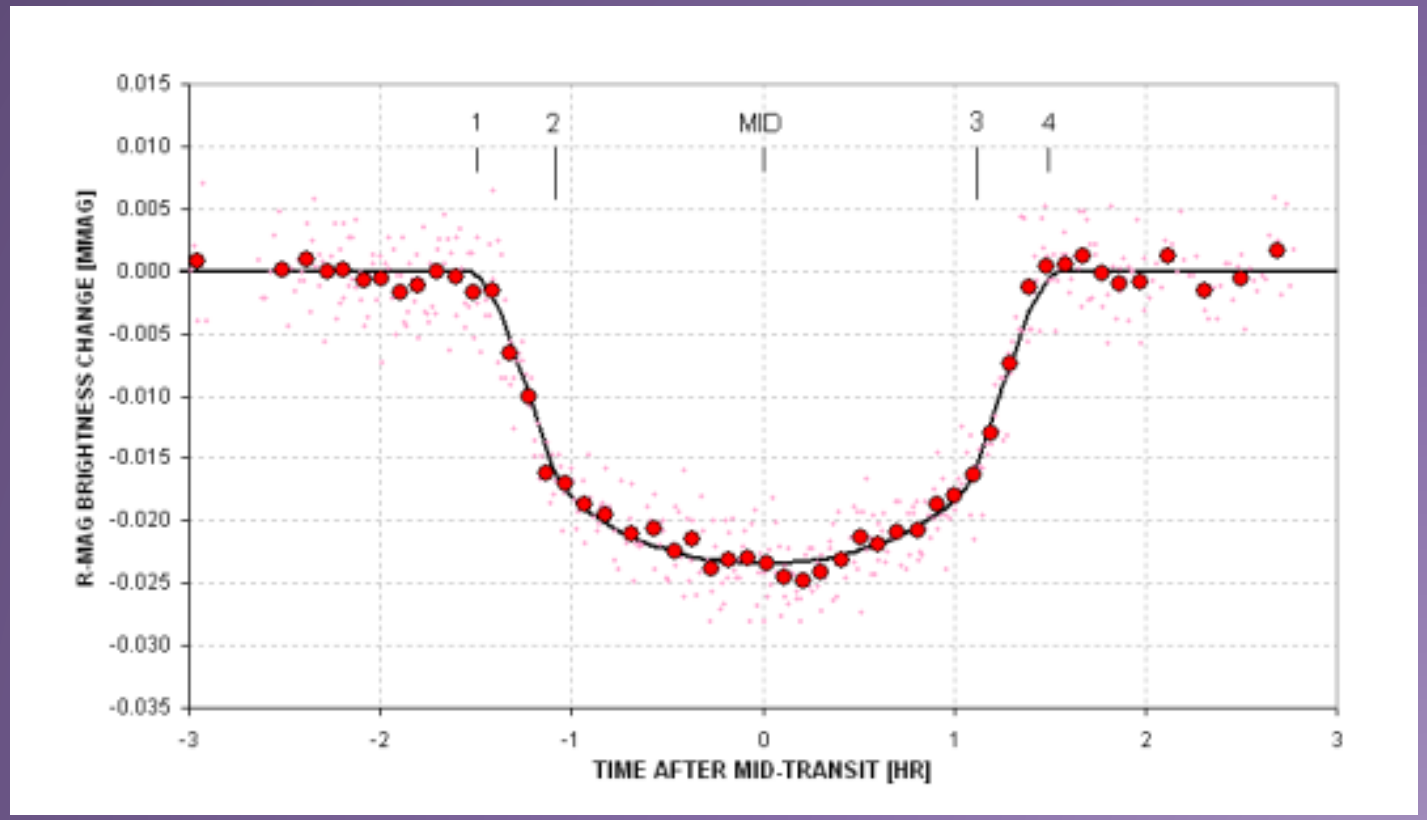
Our database administrators are periodically checking for new transits - both in literature and in on-line internet sources. Each transit is stored with complete citations, link to the paper / on-line source URL.

For each exoplanet, there is available graphical output of relations:
- transit **TIMINGS vs. EPOCH**
- transit **DURATION vs. EPOCH**
- transit **DEPTH vs. EPOCH** and
- **list of available transits**.

Data quality is rated for each observation and the DQ index is taken into account while plotting graphs.

Tools for observers :
- Observers can plot their own observations in diagrams.
- Model-fitting of transit observation and finding out parameters HJDmid, Depth, Duration.
- Global transit predictions.

	OBJECT	CONST	# OF DATA	TIME SPAN FROM - TILL		LAST CHANGES (DAYS) Red if less than 1 week ago
1	CoRoT-1 b	Mon	104	2007-02	2020-02	*25. May 2020 (**121**)*
2	CoRoT-10 b	Aql	2	2007-06	2017-08	*25. Dec 2018 (**638**)*
3	CoRoT-11 b	Ser	5	2008-05	2012-06	*21. Dec 2018 (**643**)*



XO-1 transit
by Bruce Gary 2006

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Take away –

Ams: dreams come true!

Pros: involve amateurs whenever ground-based observations can help your research!

- Amateurs' **observations** are **essential, complementary to pro observations**, or **for new discoveries**
- They have **experience in data processing**
- **Advanced amateurs analyse community data** to do science
- They have **some capability to operate professional resources**
- **Workshops/Funding/specific projects stimulates** involvement and **cooperation**

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