Bright features in Neptune on 2013-2015 from ground-based observations with small (40 cm) and large telescopes (10 m)

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A. Antuñano, J.F. Sanz-Requena, and many others
Neptune: A difficult target for high-res imaging & small telescopes

Small Size (2.31-2.35”)  
Low brightness (Magnitude = 7.85; about 6,000 darker than Jupiter)  
Low contrast of atmospheric features in the visible range.  
Atmospheric features are contrasted in the near infrared where the planet is at best 8 times darker.

But Neptune is also a difficult target for atmospheric dynamics:  
There is always a lack of enough temporal data.

HST & Keck II observations of Neptune over the last 25 years

About 200 dates of Keck or HST observations over the last 25 years.  
+ Observations by many other telescopes (VLT, IRTF...) with lower image resolution.

Small telescopes (if they are able to find atmospheric features repeatedly) may have a role in Neptune atmospheric sciences.

Background image from Michael Phillips
Neptune in 2013-2014: First unambiguous detections of atmospheric features with small telescopes

Latitude ($P_g$) = $-47 \pm 4^\circ$

$u = -69 \pm 7$ m/s

3 months of tracking,
5 amateur detections

Latitude ($P_g$) = $-38 \pm 2^\circ$

$u = -88.8 \pm 3.2$ m/s

3 months of data,
9 amateur detections
2015: Further bright spots in Neptune

Contrast provided by the strong absorptions due to atmospheric methane

PlanetCam “lucky imaging” instrument in Calar Alto (Spain)
PI: A. Sánchez-Lavega
2015: Further bright spots in Neptune

Contrast provided by the strong absorptions due to atmospheric methane
A challenge for amateurs

Triton (enhanced)

Triton's position: Geometry required to navigate the planet

20 July 2015 1.59 UT North up
C14 f/22, QHY5LII camera and R 610nm longpass filter 500/2000 frames

Neptune & Triton 2015-07-20 - IR>685nm 02h32.5UT
diam. 2.3" - mag. 7.8 - alt. 38°

White spot
Lat: -34° planetographic
Long: 354° SI

Bright white spot
Lat: -41° planetographic
Long: 303° SI

High contrast image

Marc DELCROIX (http://astrosurf.com/delcroix), Tournefeuille (31), France
Newton 320 mm - ZWO ASI 224MC - 0.055 arcsec/pixel (0.111 arcsec/pixel at acquisition)

SEPTEMBER 24th, 2015
21:44 UTC (25min)
RG610 filter LRGB
Diam: 2.35"

D. Peach

1 September 2015 21.56 UT
C14 f/22, ASI224MC camera and 742 nm filter

John Sussenbach
A challenge for amateurs really well solved

- More than 90 positive detections of the same cloud feature from 18 amateurs.
- Several atmospheric features are observable on amateur data (not only the main bright system)
- Observations from 28 cm – 50 cm telescopes. Last detection on 10 November.
- Improvements in observational techniques specific for Uranus and Neptune widely disseminated now among amateurs.
Keck II NIRC2 Camera with AO: 25 July and 5 August | Cris Baranec
Keck II - NIRC: 29-30 August  
PI: Imke de Pater

Key dataset to identify and confirm other atmospheric features, in particular in comparison with Lick data.

Shape preserved over 1 month but may be not the size. Small size decrease.
The bright large feature is accompanying a dark feature (possibly a vortex like the Great Dark Spot but much much smaller).

Possible explanation of the long-lived nature of this feature.

What are amateurs exactly seeing?

D. Millika & Pat Nicholas

Everything is real except for one single small artifact.
2015: Amateurs take the challenge to regularly observe Neptune

- ~ 90 amateur detections of the main feature
- ~ 10 of other features
- 9 high-res observations

Mean drift rate of 1.023°/hr
2015: Amateurs take the challenge to regularly observe Neptune

Blue: Fit to the linear drift model
Amplitude 13.5 deg,
Period = 90.4 days

Red: Fit to the parabolic drift model
Amplitude 7.5 deg,
Period = 53 days

DATE

Amateur data with the parabollic drift model
Wind results

Background figure from:

Zonal Jets and Eddies - Planetary Science and Satellite Oceanography at the Crossroads - ISSI Team, editors: Boris Galperin & Peter Read
Cambridge University Press (submitted, 2015)

Figure compilation by Larry Sromovsky
Wind results

Background figure from:
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Figure compilation by Larry Sromovsky

Robo AO, 10 November

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Image Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013-08-25</td>
<td>4h45UT</td>
<td>Peter Gorczynski (USA - 36cm)</td>
</tr>
<tr>
<td>2013-08-25</td>
<td>06h27UT</td>
<td>John Boudreau (USA - 36cm)</td>
</tr>
<tr>
<td>2013-09-08</td>
<td>05h06UT</td>
<td>Paul Jones (USA - 38cm)</td>
</tr>
</tbody>
</table>
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Figure compilation by Larry Sromovsky
Conclusions

• Amateur observations are now good enough to play a role in the understanding of time-variable phenomena in Neptune (not only for triggering observing programs).

• Neptune in 2013-2015 shows consistently a belt of clouds with large long-lived features that can be tracked in time and follow the main winds each year with small differences from previous profiles.

• The main bright features in 2014 and 2015 seems to be the same cloud system drifting southwards. This bright clouds is linked to a Small Dark Spot deeper in the atmosphere.
2015: Amateurs take the challenge to regularly observe Neptune

Drift rate:
Model 1: Linear fit with a constant drift rate of 1.023 °/hr
Model 2: Quadratic fit with a drift rate of 1.062°/hr to 0.988 °/hr
(July 13) (Oct. 28)

PlanetCam: 28 October | Seeing 2’’
First wind measurement in Neptune with small telescopes: \( \text{Latitude (Pg)} = -47 \pm 4^\circ \)  
\( \text{u} = -69 \pm 7 \text{ m/s} \)
Neptune in 2014: A brighter feature and larger interest from the side of amateur astronomers

Pic du Midi, 3 October

M. Delcroix / F. Colas

Latitude (Pg) = -38 ± 2°
υ= -88.8 ± 3.2 m/s

Image courtesy of C. Baranec, R. Riddle, N. Law