How Amateur Astronomers Can Support the Juno Mission

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Summary

Context

Where amateur can support:
- predicting features locations
- contextual observations

What and when?

How?

Take away
How Amateur Astronomers Can Support the Juno Mission

Context

• Arrival at Jupiter **July 2016**

• The mission will investigate Jupiter’s Origin, Interior, **Atmosphere** and Magnetosphere.

Remote-sensing instruments:

**Visible cam.** : JunoCam
no scientific-grade calibration, taking images depending on the ‘votes’ of the general public.

**Infrared cam.** : JIRAM

**Radio**: MWR

**UV spectrograph**

predicting features locations

- Need to know 3-6 months ahead of the arrival the timing of the initial perijove (PJ)

- Location of features must be based on predictions from data before 2016 Jan-Apr (the 2015-2016 apparition)

- Use this information to plan initial orbit timing
  - ± 20 min
  - ± 12° of longitude

- Features of interest:
  - Great Red Spot (generally easy to predict)
  - 5-μm hot spots (not so easy)
  - …
JunoCam longitudinal swath

limited range of longitude (5 to 10°) …

orbit 7 -- 2016 Dec 24
contextual observations over the globe scientific questions

- Is the narrow regions Juno senses part of wave structure?
- Do they represent global-mean properties?
- Are there perturbations in zonal (E-W) or meridional (N-S) winds?
- What has been the evolution of these features?
- What is the relationship between the properties detected in the upper atmosphere and the deeper atmosphere?
# Juno’s orbits

<table>
<thead>
<tr>
<th>EVENT</th>
<th>DATE</th>
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<th>Elongation</th>
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</thead>
<tbody>
<tr>
<td>JOI</td>
<td>2016 Jul 5</td>
<td></td>
<td>Orbit 21 PJ</td>
<td>2017 Jul 12</td>
<td>85°E</td>
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<tr>
<td>Orbit 1C</td>
<td>2016 Aug 27</td>
<td>23°W</td>
<td>Orbit 22 PJ</td>
<td>2017 Jul 26</td>
<td>73°E</td>
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<td>Orbit 3 Cleanup</td>
<td>2016 Nov 2</td>
<td>29°W</td>
<td>Orbit 24 PJ</td>
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<td>50°E</td>
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<td>30-min point</td>
<td>2016 Nov 12</td>
<td>35°W</td>
<td>Orbit 25 PJ</td>
<td>2017 Sep 5</td>
<td>40°E</td>
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<td>2016 Nov 16</td>
<td>40°W</td>
<td>Orbit 26 PJ</td>
<td>2017 Sep 19</td>
<td>29°E</td>
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<td>Orbit 5 PJ</td>
<td>2016 Nov 30</td>
<td>52°W</td>
<td>Orbit 27 PJ</td>
<td>2017 Oct 3</td>
<td>18°E</td>
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<td>Orbit 6 PJ</td>
<td>2016 Dec 14</td>
<td>63°W</td>
<td>Orbit 28 PJ</td>
<td>2017 Oct 17</td>
<td>7°E</td>
</tr>
<tr>
<td>Orbit 7 PJ</td>
<td>2016 Dec 28</td>
<td>76°W</td>
<td>Orbit 29 PJ</td>
<td>2017 Oct 31</td>
<td>3°E</td>
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<tr>
<td>Orbit 8 PJ**</td>
<td>2017 Jan 11</td>
<td>89°W</td>
<td>Orbit 30 PJ</td>
<td>2017 Nov 14</td>
<td>14°W</td>
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<td>Orbit 10 PJ</td>
<td>2017 Feb 8</td>
<td>116°W</td>
<td>Orbit 32 PJ</td>
<td>2017 Dec 12</td>
<td>37°W</td>
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<tr>
<td>Orbit 11 PJ</td>
<td>2017 Feb 22</td>
<td>130°W</td>
<td>Orbit 33 PJ</td>
<td>2017 Dec 26</td>
<td>49°W</td>
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<tr>
<td>Orbit 12 PJ</td>
<td>2017 Mar 8</td>
<td>146°W</td>
<td>Orbit 34 PJ</td>
<td>2018 Jan 9</td>
<td>60°W</td>
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<tr>
<td>Orbit 13 PJ</td>
<td>2017 Mar 22</td>
<td>161°W</td>
<td>Orbit 35 PJ</td>
<td>2018 Jan 23</td>
<td>73°W</td>
</tr>
<tr>
<td>Orbit 14 PJ**</td>
<td>2017 Apr 5</td>
<td>176°W</td>
<td>Orbit 36 Pjextra</td>
<td>2018 Feb 6</td>
<td>85°W</td>
</tr>
<tr>
<td>Orbit 15 PJ</td>
<td>2017 Apr 19</td>
<td>172°E</td>
<td>Orbit 37 Pjextra</td>
<td>2018 Feb 20</td>
<td>99°W</td>
</tr>
<tr>
<td>Orbit 16 PJ</td>
<td>2017 May 3</td>
<td>152°E</td>
<td>Orbit 35 Deorbit</td>
<td>2018 Mar 6</td>
<td>113°W</td>
</tr>
<tr>
<td>Orbit 17 PJ</td>
<td>2017 May 17</td>
<td>138°E</td>
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<tr>
<td>Orbit 18 PJ</td>
<td>2017 May 31</td>
<td>124°E</td>
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<td></td>
<td></td>
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<tr>
<td>Orbit 19 PJ</td>
<td>2017 Jun 14</td>
<td>110°E</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Orbit 20 PJ</td>
<td>2017 Jun 28</td>
<td>97°E</td>
<td></td>
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</tbody>
</table>

*Jupiter available for 30 min for airmass<2.0

*with MWR-required S/C tilt

Remote-Sensing (MWR) Orbits
Gravity-Sensing (GS) Orbits
**what and when?**

Images of the whole disk in **RGB** filters, plus additional filters as possible (e.g. 890 nm “**methane**” and other narrow filters)

i. **Before**, to predict locations of features to help Juno in planning

ii. **At the same time as the orbit perijoves** for global **context**

iii. **In between**, to detect **short-term time changes** of atmospheric features, creation of movies

iv. **After**, to follow up **evolution** of features.

This will also help **building cylindrical maps** of Jupiter for the **voting** of the public on which features to target with JunoCam.
how?

“Participe in the mission” on Juno website [http://missionjuno.swri.edu/](http://missionjuno.swri.edu/)

Upload images in any standard format but for scientific value rather non destructive formats (PNG, TIF, FITS), as well as WinJupos packages.
How Amateur Astronomers Can Support the Juno Mission

Welcome to Mission Juno Beta!

EMAIL:
you@example.com

PASSWORD:

LOGIN

forgot password

UPLOADS

Welcome to the uploads section. Here you can view the content you’ve submitted as well as their approval status.

21 Apr 2015 20:49 UT

PLANNING

INFO

ADMIN ACTIONS

1/1

TIME TO JUPITER ARIVAL

01 01 02 25 27

(beta screenshots)
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The following are highly encouraged, but not required:

- Data on amateur stations
- Observation data
- Description

Encouraged, but optional:

- CM1
- CM2
- CM3

Observation data:

- Observation latitude
- Observation longitude
- Exposures length

Misc. Offer

Preparation and analysis of images.

SUCCESS

Success! Your data has been submitted for approval. You can expect your data to go live on the site within 24 hours. You can check the status of your submission in your profile.
How Amateur Astronomers Can Support the Juno Mission

JUNOCAM
Upload your images of Jupiter, comment on the images, and vote on what pictures JunoCam will take when it reaches Jupiter.

PLANNING
Upload your telescopic images and data of Jupiter to help the team plan the mission

DISCUSSION
Create and comment on points of interest in Jupiter’s atmosphere

VOTING
Vote on points of interest for JunoCam to capture during its orbit of Jupiter

PROCESSING
Browse other users’ processed images from JunoCam or download, process, and submit your own images.

PLANNING
We’re calling all amateur astronomers to upload their telescopic images and data of Jupiter. These uploads are critical for the upcoming Discussion section (coming this fall) and will help NASA successfully plan the future of the mission.

If you’re a veteran astrophotographer or if you’re just getting started with your first telescope, we highly recommend you read our Submission Guidelines (link to PDF) before submitting data. In the PDF you’ll find information about the best capture and process workflows as well as links to free software and tutorials.

DISCUSSION COMING IN FALL
In the Discussion section, you can select a point of interest in Jupiter’s atmosphere and share it with the community or browse through other users’ suggestions and comment on them. These points will form the foundation for the voting phase.

VOTING COMING IN 2016
This is where the magic happens! During this voting phase you will determine the best locations in Jupiter’s atmosphere that JunoCam will capture. You will get a limited number of votes per orbit to devote to your favorite points of interest. You can also track the results as other users cast their ballots too.

Make sure to favorite any points of interest you’re following in the Discussion section to know when you can vote on it. We’ll even notify you if tagged in or linked to notifications settings as profile event link to sign up page when it’s time to vote!

PROCESSING COMING IN 2016
Once JunoCam has taken the images you have voted on, we’ll post them for you in Processing. From here you can download the raw images, process them with your choice of software and upload them to the site for other users to view.
how ?

Usual workflow for amateur imaging:

<table>
<thead>
<tr>
<th>Action</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. <strong>Acquisitions</strong> with one filter</td>
<td>acquisition movies</td>
</tr>
<tr>
<td>b. <strong>Alignment+Stacking</strong> of the best frames (ex: <em>Autostakkert</em>)</td>
<td>stacks w/ Jupiter centered enhanced images</td>
</tr>
<tr>
<td>c. <strong>Enhancement</strong> of stacks (ex: <em>Registax</em> wavelets)</td>
<td>calibrated images</td>
</tr>
<tr>
<td>d. <strong>Calibration</strong> of image (Measurement in <em>WinJupos</em>)</td>
<td>one single derotated image</td>
</tr>
<tr>
<td>e. <strong>Derotation</strong> of images (<em>WinJupos</em>)</td>
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or:

<table>
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<tbody>
<tr>
<td>a1. One single long <strong>acquisition</strong> with one filter</td>
<td>one acquisition movie</td>
</tr>
<tr>
<td>a2. <strong>Calibration</strong> of video (Measurement in <em>WinJupos</em>)</td>
<td>one single derotated image</td>
</tr>
<tr>
<td>a3. <strong>Derotation</strong> of video (<em>WinJupos</em>)</td>
<td>raw stack image calibration</td>
</tr>
<tr>
<td>b1. <strong>Stacking</strong> of the best frames (ex: <em>Autostakkert</em>)</td>
<td>one stack w/ Jupiter centered</td>
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<td>c1. <strong>Enhancement</strong> of stack (ex: <em>Registax</em> wavelets)</td>
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**how?**

Optionnaly for **uploading of raw images** for the Juno team:

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<td>raw calibrated images</td>
</tr>
<tr>
<td>d2. <strong>Load of</strong> b. <strong>raw stack in d. calibrated images</strong></td>
<td>one single derotated image</td>
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Glenn Orton

16
how to calibrate raw image (1/2)

Phase d.
how to calibrate raw image (2/2)

Phase d2.
how to create transmission package
to be uploaded as zip file on Juno website
**Take away**

- Amateur coverage needed before arrival, during and around perijoves by Juno team (2016-2018)

- Upload required of these images on dedicated webpage

- Useful for predicting interesting features locations and understanding global context of Juno’s observations

JUNO WANTS YOU!