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Results of Joint Observations of Jupiter's Atmosphere by Juno and a Network of Earth-Based Observing Stations

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Abstract

Well over sixty investigator/instrument investigations are actively engaged in the support of the Juno mission. These observations range from X-ray to the radio wavelengths and involve both space- and ground-based astronomical facilities. These observations enhance and expand Juno measurements by (1) providing a context that expands the area covered by often narrow spatial coverage of Juno's instruments, (2) providing a temporal context that shows how phenomena evolve over Juno's 53-day orbit period, (3) providing observations in spectral ranges not covered by Juno's instruments, and (4) monitoring the behavior of external influences to Jupiter's magnetosphere. Intercommunications between the Juno scientists and the support program is maintained by reference to a Google table that describes the observation and its current status, as well as by occasional group emails. A non-interactive version of this invitation-only site is mirrored in a public site. Several sets of these supporting observations are described at this meeting.

1. Motivation

The Juno mission coordinates a network of Earth-based observations including Earth-proximal, Earth-orbiting, airborne and ground-based facilities, to extend and enhance the scientific return of the mission. The spectral range of this program covers X-ray through radio wavelengths, and it currently involves over 60 investigator / facility pairs. The observations (1) cover spectral regions not included in Juno's instrumentation, 92) provide spatial context for Juno's often spatially limited coverage of Jupiter, and (3) describe the evolution of atmospheric features measured only once or separated by long time intervals by Juno, and (4) measure the extend of external influences on the magnetosphere.

2. Organization

The program is coordinated at JPL. Coordination of the investigations is done sometimes by group email, but the status of programs is given by modifications to a Google Table listing contemplated, proposed, planned and completed observations. The table is hosted by Radical Media, Inc., in association with the general Mission Juno website, and it is curated by Glenn, Tom and Fachreddin. The table is continuously updatable and updated by the individual contributing investigators or contact-representatives of their teams. Investigators interested in participating in this program email one of us and are subsequently invited to the Google site to contribute and indicate the status of their programs. These plans are publicly available on a continuously (every 5 minutes) updated, non-interactive mirror of this site: **https://www.missionjuno.swri.edu/planned-observations.** An example of a graphical table of contemporaneously acquired data is shown in Figure 1. The investigations are listed by mission phase, beginning with approach and segmented by orbit, with one extra time in January 2017, when a suite of observations remained that were scheduled to support a previously planned orbit in the original 14-day orbit plan.

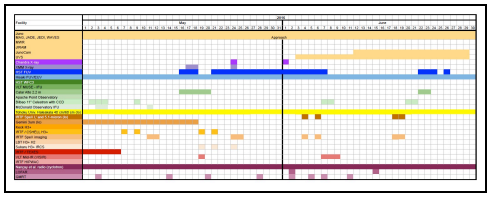

Figure 1: Example of planning table from the approach phase.

3. Highlights

Here we describe examples of results showing instances of useful Earth-based supporting observations benefiting the mission or new discoveries made by the observations themselves.

3.1 Approach

The Juno approach to Jupiter in 2016 provided the rare opportunity to observe auroral activity at Jupiter simultaneously with in-situ measurements of upstream solar-wind characteristics. Simultaneous auroral characteristics from the HST STIS instrument and interplanetary data from Juno were made. On DoY 142, HST observed the most powerful auroras ever observed by the telescope. Three solar-wind compression regions were observed. The first, on DoY 142, is near an enhancement in Jupiter's sodium nebula on DoY 140 and with an eruption observed on Io on DoY 138. The power emitted by the noon active region did not show any dependence on any interplanetary parameter. Details are given by Nichols et al. [1]. Combined observations of X-ray emission were also taken between 17 May and 1 June, showing a regular pulsing south-polar counterpart to a north-polar emission region [2].

Perijove 2

Although Jupiter was less than 17º from the sun, the NASA Infrared Telescope Facility (IRTF) obtained images, including those at 2.16 μm and 3.8 μm, that verified the development of a very unusual disturbance in Jupiter's North Temperate Belt (NTB) that was suggested by lower-resolution images from JunoCam's approach movie. Details are given by [3].

Frequent IRTF observations at these and other diagnostic wavelengths continue in an ongoing program and are hosted by the Juno Science Operations Center at http://junoirtf.space.swri.edu.

Perijove 4

Observations from the NIRI instrument on Gemini N that were stabilized against atmospheric seeing by adaptive optics (AO) extended upward in altitude a sensitivity to particulate properties from the JunoCam "methane" filter at 0.89 μm (Figure 2, left panel). Although not nearly the same spatial resolution as the JunoCam imaging, they showed clearly the vertical changes in morphology of the stratospheric haze generated by auroral-related chemistry that is partly entrained by a polar vortex. In fact, in some of the strongest gaseous absorption at 2.17 μm they showed an optically thick inner "core" of the haze with particles implied to be higher than the rest - a new discovery (Figure 2, right panel).

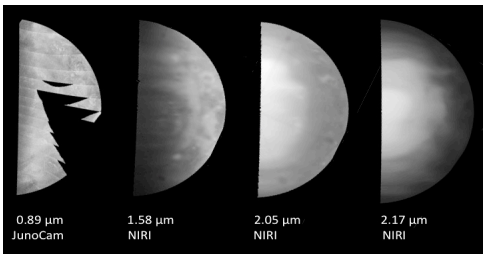

Figure 2: Polar projection of JunoCam "methane" filter image on PJ4 (2017 Feb 2), together with AO-stabilized images of Jupiter on 2017 Jan 30, taken at the Gemini North Telescope using NIRI.

4. Summary and Conclusions

The support program continues to be successful in the four areas outlined. Several more examples will be illustrated, including updates through the current perijove of Juno at the meeting.

Acknowledgements

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References

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