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Amateur – professional collaborations in Giant Planets Atmospheres Research through the Planetary Virtual Observatory of the International Outer Planets Watch (PVOL - IOPW)

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Abstract

The atmospheres node of the International Outer Planets Watch (IOPW) maintains a large database of observations of the Giant Planets called Planetary Virtual Observatory Laboratory (PVOL) [1]. This image repository is contributed by amateur astronomers worldwide and its images keep a record of atmospheric activity on Jupiter, Saturn and Uranus over the years. PVOL was created as an unfunded project that has been online since 2004. Its data content has been growing ever since then, now containing about 25,000 image files that cover the period 2000-2015. The main characteristic of PVOL, when compared with other amateur images repositories, is that it is built as a database with different searching tools. This characteristic has made PVOL an important research tool over the years for various scientific teams. Here we update the description of the data in PVOL and we discuss new development plans in the context of the Virtual European Solar and Planetary Access (VESPA) collaboration which will bring life to a Virtual Observatory for Planetary Sciences. The database is available in the following address:

http://www.pvol.ehu.es

1. Introduction

The Giant Planets Jupiter and Saturn have dynamic atmospheres with complex weather patterns that vary in time in a largely unpredictable way. Continuous monitoring of both planets is not possible by professional astronomers but amateur astronomers worldwide observe them during most of the year. The increasing quality of these observations has been essential in discovering unexpected events such as impacts [2-4], the development of large-scale storms [5, 6] or the study of changes in the coloration or dynamics of Jupiter clouds [7]. The combined analysis of images acquired by hundredths of amateurs can be also used to characterize zonal winds in Jupiter [8] or study particularly interesting atmospheric features.

2. Driving themes for improving databases of amateur images

1. Excellent observations. Observers use a variant of the "lucky imaging" technique that in many cases achieve spatial resolutions that match the diffraction limit of the telescope. The relevance of these observations has been acknowledged by professionals many times in the last few years and excellent collaborations are under way [9]. We plan to incorporate tools in PVOL to measure and quantify the quality of observations so that observations matching a certain quality criteria can be found in the historical database.

2. Juno collaboration The Juno spacecraft on route to Jupiter (arrival in July 2016) will require a broad collaboration from amateurs to observe the atmospheric dynamics at cloud level while Juno peers into the planet interior with its dedicated instrumentation. We plan to network with the Juno team and amateurs to contribute to the atmospheric characterization of Jupiter at the time of the Juno mission.

3. Saturn atmosphere. Cassini extended mission (2004-2017) is well complemented by ground based observations of the planet. While Cassini keeps on its polar orbits around the planet ground-based observers can obtain valuable data concerning the

low and mid-latitudes as well as the north polar hexagon [10].

4. Uranus and Neptune. While intrinsically difficult, Uranus and Neptune have been the subject of recent collaborations between amateurs and professionals with bright features detected repeatedly by amateurs [11].

5. Objects. Amateurs have started to achieve images with enough spatial resolution to observe surface features on Io and Ganymede. Amateur images of Mars and Venus have shown the capability to produce novel scientific results that go from Venus cloud top tracking to studies of Mars high cloud features not generally observable from spacecrafts [12].

3. A Planetary Virtual Observatory

The Europlanets Research infrastructure plans to develop a virtual observatory for Solar System Sciences. VESPA (Virtual European Solar and Planetary Access) works towards that aim. VESPA will provide common data mining capacities, advanced visualization, cross-comparison potential, and data analysis functions to all connected data services. We will network with VESPA to largely improve the contents, search capabilities and visualization tools available at present in PVOL.

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