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An unusual single row of quasi-equidistantly spaced identical vortices in Jupiter's South Temperate Belt

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Abstract

We analyze the evolution of a disturbance in Jupiter's South Temperate belt consisting of a chain of quasi-equidistantly spaced vortices. We evaluate their averaged properties and motions and compare them with that of the ambient winds.

1. Introduction

Along 2010 a chain of regularly spaced vortices developed at latitude -28ºPG, probably steaming from a folded filamentary region in a cyclonic area at -31ºPG. We present a study of the evolution of this disturbance, concentrating in the analysis of the drift of the small vortices and their spatial distribution relative to rotation System III.

2. Observations

The continuous monitoring of the giant planets by amateur astronomers, and their contribution with their images to databases that make them easily retrievable allows an unprecedented coverage of the temporal evolution of phenomena in the planets' atmospheres. In order to study the evolution of the STB disturbance we have surveyed the International Outer Planet Watch PVOL [1] from the beginning of the disturbance until December 2010. Retrieved images have been navigated using LAIA [2], and projected so that individual vortices can be identified and tracked. On the other hand, a very small set of high resolution images taken by the Hubble Space Telescope HST-WFC3 on the 7th of June in a variety of filters allowed a characterization of the morphology of the vortices.

3. Description

Vortices are situated at an average latitude of $-28.2 \pm 0.5º$ PG ($-25.2 \pm 0.5º$ PC). They encircle the planet while they slowly drift to the south. They are regularly distributed, with an average longitudinal distance between vortices of $4.0 \pm 0.5º$, corresponding to 4500 ± 500 km at this latitude with sizes ranging from 1 to 4º. The HST high resolution images are too close in time to infer the internal motion of the vortices. Nevertheless, since it is possible to track some of the vortices during periods longer than a month, one can assume that their vorticity is equal to ambient vorticity, or else they would dissipate much faster.

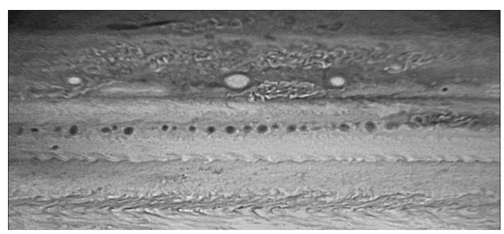

Figure 1: Detailed view of the disturbance (HST WFPC3 7th June 2010)

3. Longitude drift rates and winds

The presence of many vortices and their regular separation imply that one has to be very meticulous in the visual identification of individual vortices, to avoid aliasing. In figure 2 one can se the result of tracking of 32 individual vortices during August 2010, together with their corresponding linear fits. On the average, the vortices moved eastward with an average velocity of $27 \pm 2\text{ms}^{-1}$.

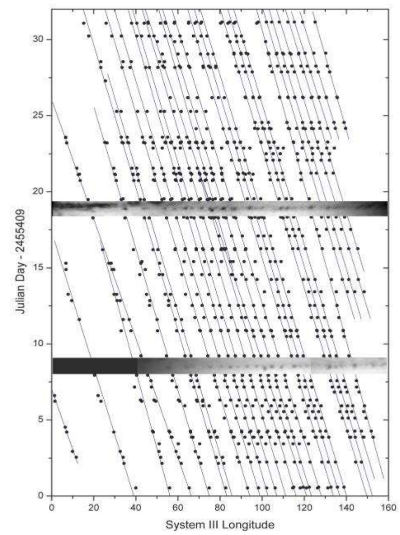

Figure 2: Drift of vortices during August 2010

We have plotted in Figure 3 the velocity of individual vortices as a function of their latitude. The black square represents the average velocity versus average latitude for all vortices. We have compared these velocities with two wind profiles obtained by our group using an automatic correlation technique with images taken by the HST in 2007 and 2008 [3]. The velocity of the vortices falls within the error bar of the 2008 winds, the most recent profile that we have available. Finally we remark that both 2007 and 2008 profiles have anticyclonic vorticity at the latitude of the vortices, implying that they probably are small anticyclones.

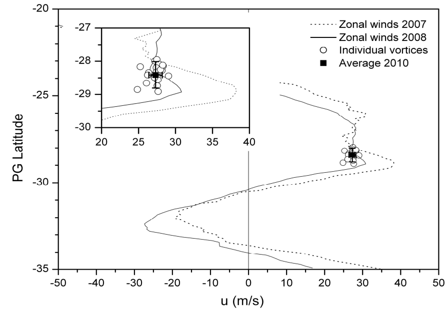

Figure 3: Averaged zonal drift of the vortices as compared to most recent zonal wind profile

4. Discussion

The ovals form a regular single chain of vortices in a sheared flow with an ambient vorticity ranging from $du / dy = -5\text{x}10^{-6}\text{s}^{-1}$ to $du / dy = -9\text{x}10^{-6}\text{s}^{-1}$. Within measurement uncertainties, the vortex row moved with the ambient speed, being therefore advected by the winds. The equilibrium and stability of a single row of quasi-equidistantly spaced identical vortices is a classical problem in vortex dynamics, and we are studying it in order to infer the structure of the Jovian atmosphere below upper clouds at this latitude. Non-linear numerical calculations are being developed in order to simulate the observed phenomenon.

Acknowledgements

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