EPSC Abstracts
Vol. 9, EPSC2014-291, 2014
European Planetary Science Congress 2014

Horizontal velocity in Saturn's northern polar region and Hexagon

A. Antuñano (1), **T.del Río-Gaztelurrutia**, (1, 2), A. Sánchez-Lavega (1,2) and R. Hueso (1,2)
(1) Departamento de Física Aplicada I, ETS Ingeniería de Bilbao (UPV / EHU) Alameda de Urquijo s/n 48013 Bilbao, Spain.
(2) Unidad Asociada Grupo Ciencias Planetarias UPV/EHU-IAA (CSIC), Bilbao, Spain,

Abstract

We study the horizontal velocity field of Saturn's North Polar Region, including the region were the hexagonal wave is prominent. With the aid of an automated two dimensional correlation algorithm we determine mean zonal and meridional winds. We analyze the stability of the zonal jets and calculate vorticity and turbulence maps.

1. Introduction

Images from Voyager 1 and 2 flybys in 1980 and 1981 showed a hexagonal feature at planetocentric latitude 75°N enclosing a strong eastward jet with peak speed of 120 ms^{-1} [3]. The same feature was later re-observed in 1990–1995 with ground-based telescopes and the Hubble Space Telescope [3,7], After the arrival of Cassini Mission to Saturn, the feature was visible again, first in the infrared with VIMS instrument [1] and after the Saturn's equinox in 2009 by the ISS. The hexagonal feature and its associated jet are remarkably stable and the hexagon has remained essentially stationary in System III for longer than 30 years [8]. The hexagon surrounds a region where a field of puffy clouds, most likely of convective origin, is manifest. Closer to the pole another strong jet centered around planetocentric 88º forms a polar vortex. Here we present a study of the region along 7 months in the northern summer, from November 2012 to July 2013, concentrating mainly in the latitudes surrounding the hexagonal wave and the field of puffy clouds enclosed by it.

2. Image selection, navigation and measurement

We searched Planetary Data System node looking for Cassini Imaging Science System (ISS) images of the region of interest, captured using the filters CB2 and CB3 (centered at wavelengths 752nm and 939nm respectively) [6]. In order to measure horizontal velocity using our automated correlation algorithm, we selected pairs of images displaying the same region at two different times separated by 1 to 2.5 hours. Images with longer time intervals were also used to check our results using manual cloud tracking. Most of the images we analysed were captured with the Wide Angle Camera (WAC), and had resolutions in the range 73-142 km/pixel. A few images with higher resolution of 8 km/pixel, taken with the Narrow Angle Camera (NAC), were used to measure zonal winds near the polar vortex.

Once selected, Cassini images are navigated and polar-projected using the software PLIA [5]. Navigation is corrected via limb fitting where the limb is visible, and / or adjusting the position of the pole. Wind velocities are measured over polar projected images using two different methods: A supervised two-dimensional brightness correlation method [4], and cloud tracking over images separated by at least one complete rotation of the planet. Typical wind velocity errors, of the order of ~ 10-15 ms^{-1}, arise from uncertainties in navigation and tracer misidentification.

2. Results

The study shows that the eastward jet associated to the hexagon is located at planetocentric latitude 75.5º N with a velocity of 120 ms^{-1}. For higher latitudes, the velocity decreases rapidly until it reaches ~8 ms^{-1} at 79.6º N and starts increasing rapidly to reach a maximum 150 ms^{-1} / at 88º N, near the polar vortex. A meridional component of the mean velocity field, with velocities in the range -20 ms^{-1} to 20 ms^{-1} is clearly detected in the jet associated to the hexagonal wave. In other regions mean meridional velocity is below detection level.

An example of the velocity field in the region of interest is show in the figure below. In our work, we measure the velocity field for different pairs of images with the aim of analyzing its structure and its eventual evolution in time, and we calculate maps of vorticity and divergence, and study turbulent components of the flow.

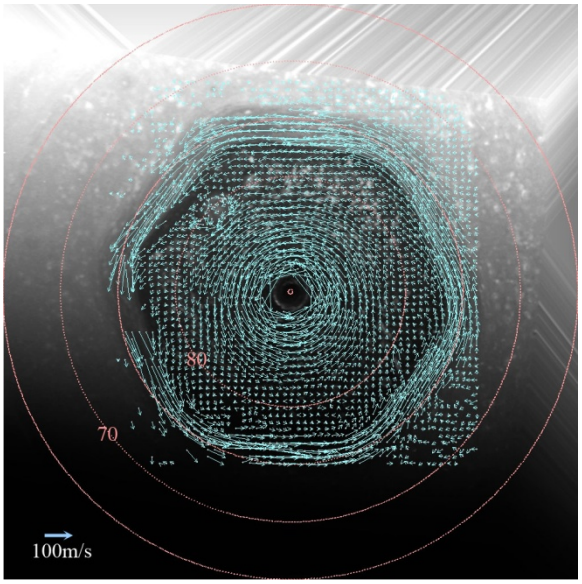

Figure 1: Wind velocity vectors over a polar projected image. Wind vectors are deduced using a supervised 2-D correlation algorithm in two images taken by Cassini ISS WAC camera on the 26th June 2013 separated by 133min.

Acknowledgements

We gratefully acknowledge the work of the Cassini ISS team that made the data available. This work was supported by the Spanish MICIIN project AYA2012-36666 with FEDER support, Grupos Gobierno Vasco IT765-13, and UPV/EHU UFI11/55.

References

[1] Baines, K. H., Momary, T. W., Fletcher, L. N., Showman, A. P., Roos-Serote, M., Brown, R. H., Buratti, B. J., Clark, R. N. and Nicholson, P. D.: Saturn's north polar cyclone and hexagon at depth revealed by Cassini/VIMS, Planet. Space Sci., 57, 1671–1681, 2009.

[2] Caldwell, J., Benoit, T., Hua , X.-M., Barnet, C. D., and Westphal, J. A.: An observed drift of Saturn's Polar Spot by HST, Science, 260, 326–329, 1993.

[3] Godfrey, D. A.: A hexagonal feature around Saturn's north pole, Icarus, 76, 335–356, 1988.

[4] Hueso, R., Legarreta, J., Garcı´a-Melendo, E., Sánchez-Lavega, A., and Pérez-Hoyos, S.: The Jovian anticyclone BA: II. Circulation and models of its interaction with the zonal jets, Icarus, 203, 499–515, 2009.

[5] Hueso, R., Legarreta, J., Rojas, J. F., Peralta, J., Pérez-Hoyo, S., del Río-Gaztelurrutia, T. and Sánchez-Lavega, A.: The Planetary Laboratory for Image Analysis (PLIA), Adv. Space Res., 6, 1120–1138, 2010.

[6] Porco, C. C., et al.: Cassini imaging science: Instrument characteristics and anticipated scientific investigations at Saturn, Space Sci. Rev.,115, 363–497, 2004.

[7] Sánchez-Lavega, A., Lecacheux, J., Colas, F., and Laques, P.: Ground-based observations of Saturn's North Polar Spot and Hexagon,Science, 260, 329–332,1993.

[8] Sánchez-Lavega et a.: The long-term steady motion of Saturn's hexagon and the stability of its enclosed jet stream under seasonal changes. Geophys. Res. Lett. 41 1425-1431, 2014.