SGEPSS 2014, Nov. 2, R009-P018

A wave structure of haze in Jupiter's polar regions observed by the ground-based telescope

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In Jupiter's polar regions, there is stratospheric haze that formed by scattering aerosol particles. Those structures show up as bright caps in the image captured with deep methane band filter at 889 nm. In latitudinal range of 60° - 70°S, their edges were seen as wave structure propagating in longitudinal direction by the Cassini ISS in 2000 and the Hubble Space Telescope (HST) from 1994 to 1999 [*Barrado-Izagirre at al*., 2008].

In previous work, it has shown that wavenumber of Jupiter polar wave at 67°S was 12 - 14 and their westward phase velocity in SystemⅢ was 0 - 10 m/s. It is pointed out that this wave is a planetary Rossby wave, although the wave structure in the vertical direction is not clear. Final goal of this study is to determine whether or not the polar wave at 67°S is Rossby wave. Here, we investigate the meridional and vertical wavenumber, the phase speed of the wave structure and zonal wind speed at 67°S.

In this paper, we will introduce the observational results about the wave structure in Jupiter's polar regions from 2011 to 2014 by the ground-based telescope. From those observation we found three points. First, the wave structure is similar between 0° and 80° longitude in different times of 2011. Second, the wave structures at different latitudes show north-south asymmetry. Third, the wave structure at 67°S in the vertical direction varied between altitude of 361 mbar and 750 mbar.

1. Introduction

In Jupiter's both polar regions in the stratosphere, there is stratospheric haze that formed by scattering aerosol particles (squares in Fig. 1.1). This structure can be seen as bright cap using deep methane band filter at 889 nm, whose edges show a wave structure propagating in longitudinal direction in latitudinal range of 60° - 70°S.

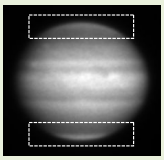


Fig. 1.1 The Pirka image of Jupiter (889 nm)

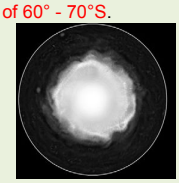


Fig. 1.2 The Cassini image of Jupiter's south polar (890 nm) [*Barrado-Izagirre at al.*, 2008]

Jupiter's polar regions have been observed by the Hubble Space Telescope (HST) from 1994 to 1999 and by the Cassini ISS in 2000.

→ It was shown those wavenumber was 12 - 14 and westward velocity of the wave structure in SystemⅢ was 0 - 10 m/s [*Barrado-Izagirre at al.*, 2008].

In previous works, propagation velocity of this wave was shown, but the variance of short time scale (about month) and the wave structure in the vertical direction are not clear.

<Purpose>
We determine whether or not the wave observed at the edge of the stratospheric haze in polar regions is Rossby wave. We investigate the meridional / vertical wavenumbers and phase speed of the observed wave structure and zonal wind speed.

2. Observation

We have observed Jupiter since 2011 by the 1.6 m Pirka telescope and Multi-Spectral Imager (MSI). We can obtain images at multiwavelengths (infrared and visible wavelength regions) with short time exposure, which enables high spacial resolution.

< Spec. of MSI >

Minimum exposure time (Full frame, EM-CCD mode)		31 ms
LCTF VIS-10		400- 720 nm
	Bandwidth	5- 19 nm
LCTF SNIR-10		650- 1100 nm
	Bandwidth	5- 15 nm

Fig. 2.1 The 1.6 m Pirka telescope and Multi-Spectral Imager (MSI)

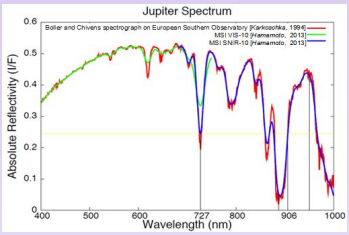


Fig. 2.2 Jupiter Spectrum by European Southern Observatory [*Karkoschka*, 1994] and by MSI [*Hamamoto*, 2013]

・In the south polar regions of Jupiter, sensitivity altitude at 889 nm and 750 nm are 361mbar and 750 mbar, respectively.
・The longer wevelength between 890 and 950 nm, the lower observed Jupiter altitude.

<Observation data>

Date	Jupiter angular diameter (arcsec)	Seeing size (arcsec)	Wavelength (nm)
Oct. 19- 20 2011	49.5	2- 2.6	727, 750, 830, 850, 889 601- 634, 700- 757, 872- 950 (step 3 nm)
Oct. 29- 31 2011	49.6	1.56- 2	727, 750, 889, 950
Nov. 16- 17 2011	48.8	2.26- 4	619- 945 (10 colors)
Mar. 27 2014	38.8	1.8- 2	619, 727, 750, 889, 950

3. Analysis

We plotted the brightness of Jupiter image observed by MSI image at 67°S (red line in Fig. 3.1). We used the polar wave of longitude direction with longitudinal width of 40° around center meridian (Fig. 3.2). And we composed image taken on different time by same longitude. By longitudinal width of 3°, we made one point of composite of wave (Fig. 3.3).

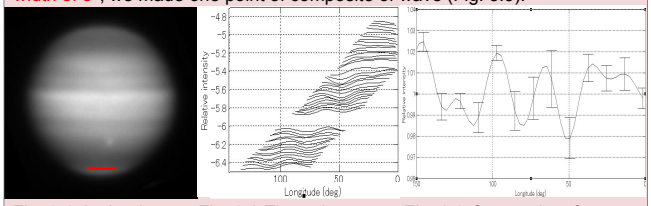
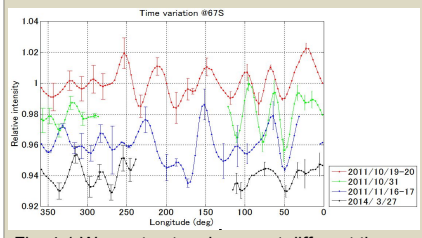


Fig. 3.1 Jupiter image Fig. 3.2 The polar waves Fig. 3.3 Composite of wave

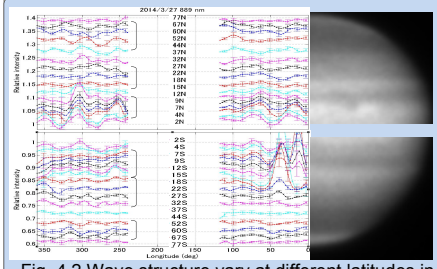
4. Results



Between 0° and 80° longitude, wave structure is similar in different times of 2011.

The black line is similar to the blue line between 240°- 300° longitude.
→ The wave structure is maintained.

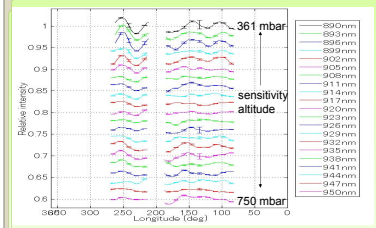
Fig. 4.1 Wave structure in vary at different time



The wave structure by different latitudes is north-south asymmetry, north wave spread lower latitude than south wave.

It is separated three latitudinal area per hemisphere by wave sharp.

Fig. 4.2 Wave structure vary at different latitudes in 2014



As observation wavelength become longer, those wave structure varies between 890 nm and 950 nm.

From Fig. 2.2, the wave structure in the vertical direction has varied between altitude of 361 mbar and 750 mbar.

Fig. 4.3 Wave structure vary at vertical direction in 2011 (Bandwidth is 10.3- 11.8 nm)

5. Conclusions & Future Work

We investigate the wave behavior at the polar regions in 2011 and 2014. (1) The wave structure is maintained over few years. (2) North-South asymmetry in the polar regions. (3) Between altitude of 361 mbar and 750 mbar, the wave structure in the vertical direction has varied.

We will analyze Jupiter data in 2014 and measure Jupiter clouds for estimate zonal wind speed in Jupiter polar regions.

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