EPSC Abstracts
Vol. 11, EPSC2017-226, 2017
European Planetary Science Congress 2017

Spatial distribution of Neptune's stratospheric temperature obtained with ALMA cycle-0 continuum observation

T. Iino (1), T. Yamada(2) and Y. Tanaka (3)
(1) Tokyo University of Agriculture and Technology, Japan (iino@nagoya-u.jp) (2) Tokyo Institute of Technology, (3) Kagoshima University, Japan

Abstract

Neptune's stratospheric temperature map has shown the presence of relatively warm south polar region whereas the origin and driving mechanism is veiled in mystery. Since the observed pressure region varies with respect to the observation wavelength, multi-wavelengh observation of the continuum emission is useful for the derivation of three-dimensional atmospheric structure. A high spatial resolution observation of 17.6 and 18.7 μm wavelength performed with Very Large Telescope (VLT) in 2006 reported that 100 mbar pressure region on Neptune's south pole is $\sim$10 K warmer than 40 - 60S region (Orton et al. 2007). To obtain the three dimensional structure of warm south south polar region, we analysed the archival data of ALMA (2011.0.00747.S) observed in 2012 as a flux calibration. Deeper stratosphere as 1000 - 500 mbar pressure region than the previous mid-IR observation was observed. The obtained temperature variation with modeled result was within $\pm$ 5K, smaller than that of measured at 100 mbar region. This result represent the relatively flat temperature variation at just above the tropopause, and the previously detected temperature perturbation may be resulted in stratospheric physical and chemical events.

1. Observation and analysis

Neptune's stratospheric atmospheric structure is characterized by warm region on southern mid-latitude region and south pole. In particular, excess of atmospheric temperature measured at south polar warm region was $\sim$10 K in 100 mbar pressure region (Orton et al. 2007). To constrain the origin and the driving mechanism of the region, observational illustration of three-dimensional structure of the region is useful.

We analysed an archival data of ALMA (2011.0.00747.S) that contains Neptune observation as a flux calibration. Observation was performed in 28 August 2012, and spatial resolution was high as 0.35 $\times$ 0.25 arcsec. Center frequencies of each spectral windows were 643 to 648 GHz. A continuum emission map was produced with multi frequency synthesis method that achieves high S/N using all the spectral windows. Figure 1 shows a produced continuum emission map in false color.

From the radiative transfer analysis of Collision Induced Absorption, we estimated that the observed frequency has sensitivity peak at 1000 (disk center) to 500 (60 degree emission angle) mbar pressure regions (Iino et al. submitted). This range is deeper than previous mid-IR observation results of 100 mbar (Orton et al. 2007)

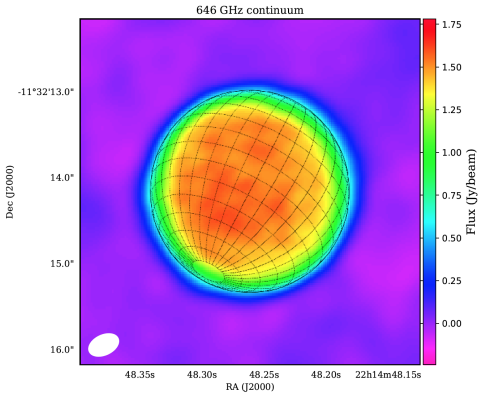

Figure 1: Neptune's 646 GHz continuum map obtained with ALMA in 2012.

2. Discussion

From the initial analysis, observed continuum intensity shows $\pm$5 K agreement with modeled intensity on the entire disk. No clear structure exceeds the random noise level was found on the data. The absence of hot spot may indicate that the hot spot is driven by the

stratospheric perturbation, not the upwelling of warm tropospheric air parcel. However, for the further observational constraint, higher spatial resolution is needed because the beam dilution effect cause decreasing of hot spot intensity. ALMA's high capability possibly achieve the observational needs.

Acknowledgements

This paper makes use of the following ALMA data: ADS/JAO.ALMA#2011.0.00747.S. ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), NSC and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ. The analysis was supported by Mitaro Namiki of TUAT and Kunihiko Tanaka of Keio University. This work was supported by The Telecommunications Advancement Foundation of Japan, Japan Society for the Promotion of Science, East Asia ALMA Regional Center and ISEE international joint research program.

References

[1] Orton, G. S., Encrenaz, T., Leyrat, C., Puetter, R., Friedson, A. J.: Evidence for methane escape and strong seasonal and dynamical perturbations of Neptune's atmospheric temperatures. Astronomy and Astrophysics, 473(1), L5–L8. 2007

[2] Iino, T., Yamada, T. and Tanaka Y.: A simulation study on terahertz continuum-wave observations of Neptune's atmosphere focusing on future ALMA observation, Submitted to Journal of Remote Sensing Society of Japan, in revision