EPSC Abstracts
Vol. 6, EPSC-DPS2011-1329, 2011
EPSC-DPS Joint Meeting 2011


# Spatial Variability of Neptune's Clouds

**S.H. Luszcz-Cook** (1), I. de Pater (1), M. Ádámkovics (1) and H.B. Hammel (2,3)
(1) Astronomy Department, University of California, Berkeley, CA, USA
(2) Association of Universities for Research in Astronomy, Washington, DC, USA
(3) Space Science Institute, Boulder, CO 80303, USA

## Abstract

Near-infrared observations of Neptune were performed using OSIRIS, the integral-field spectrograph on the 10-m Keck II telescope. By utilizing the adaptive optics system, we are able to image the planet with a spatial resolution of 0.035" at 1651 wavelengths in both H and K bands. On 25 and 26 July 2009, we observed more than 90% of a hemisphere in a single night, allowing us to derive the properties of individual cloud features across many latitudes and longitudes. On 22 August 2010, we performed a series of observations of Neptune's bright southern cloud band. We will present our preliminary analysis of these data, and discuss the implications for the seasonal and spatial variability of Neptune's clouds.

## 1. Introduction

In the near-infrared, where we probe Neptune's stratosphere and upper troposphere, Neptune's active nature is perhaps most evident. Bright bands and cloud features stand out against a dark disk (Fig. 1), and evolve in timescales as short as hours [2, 6, 5]. These features can be modeled with radiative transfer codes to explore their physical properties. From such analyses we can investigate the planet's atmospheric chemistry and dynamics [1, 4, 3].

Slit spectroscopy of select near-infrared-bright features has suggested that those in the northern hemisphere tend to be at higher altitudes than those in the south [1]. This might imply a difference in origin for the different features-perhaps southern mid-latitude features are methane haze circulated from below, while northern bright features are due to the subsidence of stratospheric haze material- or may be due to a difference in the altitude of the tropopause between the two hemispheres. Clouds within a given latitude band appear to travel with a wide range of velocities [2]; it has yet to be shown if their speeds are correlated with other physical properties, such as altitude.

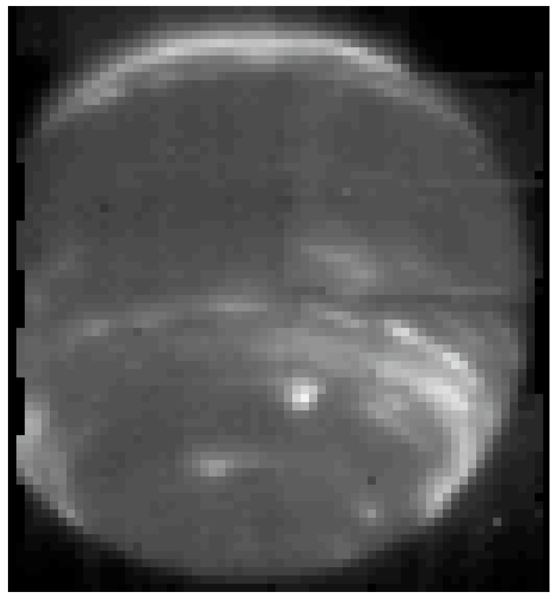

Figure 1: Preliminary OSIRIS H-band data cube from July 2009, summed over frequency. Neptune's north pole points up in this image.

To explore these previous findings, we require detailed near-infrared spectra of individual cloud features over a range of latitudes and longitudes.

## 2. Observations

On 25 and 26 July 2009 we collected OSIRIS data in H (1.473-1.803 $\mu$m) and K (1.965-2.381 $\mu$m) bands (Fig. 1). We chose a plate scale of .035", which corresponds to $\sim$ 400 km at disk center. Each 300 second exposure covers a 0.56" x 2.24" region, allowing us to cover the majority of Neptune's 2.3" disk in 6 exposures. The spectrum at each pixel has an average resolution of R $\sim$ 3800 (Fig. 2).

To augment these data, we obtained four new H-band data cubes of Neptune's southern bright band on 22 August 2010 (Fig. 3). These new data should provide us with additional information on the vertical structure of the clouds and hazes in this particularly active region of the planet.

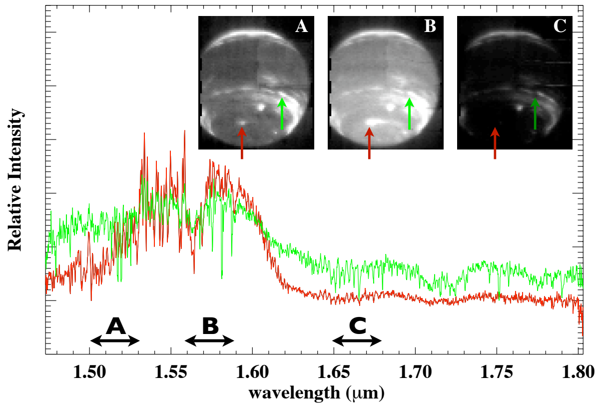


Figure 2: Examples of OSIRIS spectra from one of our July 2009 data cubes (same as Fig. 1). Three images are shown for context, covering 1.50-1.53 $\mu$m (A), 1.56-1.59 $\mu$m (B), and 1.65-1.68 $\mu$m (C). The red spectrum corresponds to the feature indicated in the images by a red arrow, while the green spectrum corresponds to the feature indicated by a green arrow; differences between the spectra are evident.

## 3. Summary

Traditional slit spectroscopy does not facilitate the clean separation of individual features from the quiescent background. The resulting confusion translates into an uncertainty in cloud altitudes and other properties. OSIRIS, the near-IR AO-assisted field-integral spectrometer on the 10-m Keck telescope, is capable of obtaining spatially-resolved spectral information over a significant fraction of Neptune at once, allowing us to address this major obstacle.

With the aid of our newly-developed radiative transfer code [3], we will be able to retrieve cloud and haze properties such as height, composition, and optical depth for features across 90% of Neptune's disk in a single set of observations. We will look at the variations in cloud properties across many latitudes, to comprehensively study the seasonal differences in cloud properties; and across many longitudes, to study the variability of cloud properties in relation to the variation in cloud speeds.

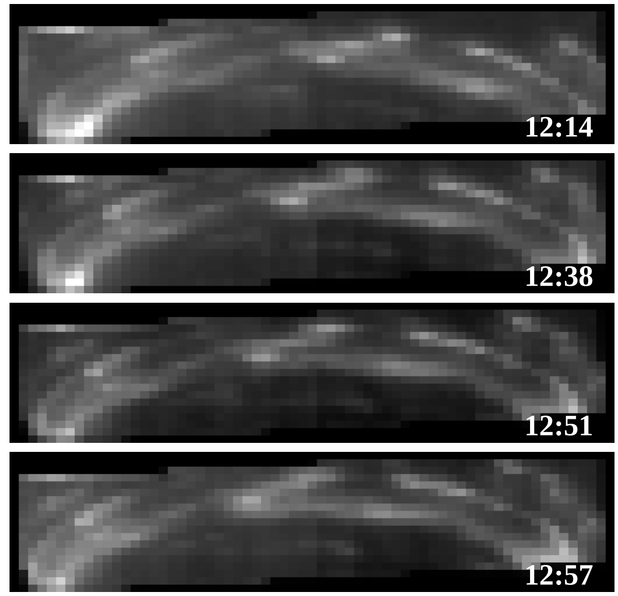


Figure 3: Time series from 10 August 2010, summed over frequency. The time (UT) of each data cube is marked on the image; the motion of individual clouds is clearly evident over the $\sim$ 40 minute time series.

## Acknowledgements

This work was supported by NASA Headquarters under the NASA Earth and Space Science Fellowship program- Grant NNX10AT17H; and by NSF Grants AST-0838258 and AST-0908575.

## References

[1] Gibbard, S. G., de Pater, I., Roe, H. G., Martin, S., Macintosh, B. A., & Max, C. E. 2003, *Icarus*, 166, 359.

[2] Limaye, S. S. & Sromovsky, L. A. 1991, *J. Geophys. Res.*, 96, 18941.

[3] Luszcz-Cook, S. H., de Pater, I., Ádámkovics, M., & Hammel, H. B. 2010, *Icarus*, 208, 938.

[4] Max, C. E., Macintosh, B. A., Gibbard, S. G., Gavel, D. T., Roe, H. G., de Pater, I., Ghez, A. M., Acton, D. S., Lai, O., Stomski, P., & Wizinowich, P. L. 2003, *AJ*, 125, 364.

[5] Sromovsky, L. A., Fry, P. M., Dowling, T. E., Baines, K. H., and Limaye, S. S. 2001, *Icarus*, 150:244–260.

[6] Sromovsky, L. A., Limaye, S. S., and Fry, P. M. 1995, *Icarus*, 118:25–38.