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ORIGINAL ARTICLE

Neptune's zonal winds from near-IR Keck adaptive optics imaging in August 2001

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Abstract We present H-band (1.4–1.8 μm) images of Neptune with a spatial resolution of $\sim 0.06''$, taken with the W.M. Keck II telescope using the slit-viewing camera (SCAM) of the NIRSPEC instrument backed with Adaptive Optics. Images with 60-second integration times span 4 hours each on UT 20 and 21 August, 2001 and ~ 1 hour on UT 1 September, 2001. These images were used to characterize the overall brightness distribution on Neptune, and to determine rotations periods (which translate into wind speeds) of individual cloud features.

The images show that the spatial brightness distribution of cloud features, in particular the bright bands at mid-southern latitudes and near 30°N, changed considerably between 1989 (Voyager era) and 2001. The brightest features extend latitudinally over several degrees, and despite the different velocities in different latitude bands, these bright features remain coherent. We show that these features are bright in part because of the foreshortening effect near the limb, which suggests that the features may be composed of small bright clouds that happen to line up near the limb.

At certain latitudes (mid-southern and northern latitudes), there is considerable dispersion in relative rotation periods (and hence zonal velocities) of faint and moderately bright features, while there is essentially no velocity dispersion of features at 50°S. While the zonal speeds of the brightest features are consistent with the Voyager-derived zonal-mean wind profile, there are many cloud features that do not appear to move with the flow. The data are further suggestive of oscillations in longitude, with periods > 4 hrs. We suggest that tidal forcing by Triton could play a role in exciting the waves responsible for the velocity variations of the observed period.

Keywords Infrared · Planetary systems · Planets and satellites: Neptune · Atmospheres

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1 Introduction

The atmospheres of the giant planets are characterized by zonal winds that have been derived by tracking cloud features in their atmospheres. The winds on Jupiter, Saturn and Uranus appear to be quite stable over time. Small variations have been detected at particular latitudes in the winds on Jupiter (see e.g., Asay-Davis et al. 2011, and references therein). Asay-Davis et al., however, point out that care must be taken to check such reported variations carefully—in particular near a latitude of 8°N some retrieval methods incorrectly found slower zonal winds because the eastward drift of the dark projections (associated with 5-μm hot spots) "fooled" the retrieval algorithms—and such "errors" can lead to incorrect reports on changes in the zonal wind. Both Limaye (1989) and Asay-Davis et al. (2011) further argue that the Jovian zonal flow has temporal variations on timescales of hours to years that are ~ 10 m/s, which is of order 10% of the maximum speed. Despite these reports, it is clear that overall Jupiter's zonal wind can be considered quite stable. Reports on changes in Saturn's equatorial jet