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DISSERTATION ABSTRACTS

THE ATMOSPHERE OF NEPTUNE STUDIED WITH CCD IMAGING AT METHANE-BAND AND CONTINUUM WAVELENGTHS

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The atmosphere of Neptune changes on many time scales. By imaging the planet through contrast-enhancing filters and analyzing the images with a variety of techniques, I investigated different aspects of the atmosphere and variability of Neptune. Information about both discrete cloud features and general vertical distribution of clouds was obtained in addition to time scales for planetary rotation and for growth and dissipation of discrete cloud features.

The global distribution of clouds was determined from inspection of the images. At methane-band wavelengths, discrete cloud features were obvious in the southern hemisphere, but no cloud features were visible in the northern hemisphere of the planet. This is a distinct change from earlier imaging which always showed bright features in both hemispheres, and implies that some substantial change has occurred in the northern hemisphere. The brightest clouds were found at midlatitudes ($-30°$ to $-50°$), but fainter discrete clouds were sometimes seen further south. These fainter cloud features were only visible in conditions of excellent seeing. From the fact that the bright clouds were not spatially resolved, and from an analysis of the flux reflected by the bright cloud in 1987, approximate limits on the cloud diameter were derived: 4000 km $< d_{cld} <$ 10,700 km.

The brightest cloud feature could be tracked as the planet rotated, leading to a determination of an atmospheric rotation period of 17.0 ± 0.1 hours for a specific latitude on the planet ($-38° \pm 3°$). Disk-integrated photometry in June 1987 confirmed the atmospheric rotation period at this latitude. This period is somewhat shorter than other periods derived from disk-integrated photometry and earlier observations of cloud motion on Neptune, which may indicate zonal wind structure.

Disk-integrated photometry derived from the imaging demonstrated conclusively that, in 1986 and 1987, a bright cloud feature was responsible for the diurnal variation observed at 8900 Å. The amplitude of this rotational modulation also varied on time scales of days, evidence for the development of the cloud features.

The best images of Neptune had sufficient spatial resolution to allow center-to-limb profiles to be obtained for the quiescent northern hemisphere and equatorial region. Center-to-limb (CTL) brightness profiles at methane-band wavelengths provided constraints on the location, optical depths, and single scattering albedos of scattering layers in the stratosphere. The CTL profiles required the presence of some material above the 4-mbar level. The optical depths of the material cannot be greater than 0.15 for hazes with single scattering albedos higher than 0.6. The reflectivity at the 6340 Å continuum region required a scattering layer deeper than 1.5 bars. The methane-band data could tolerate thin scattering hazes in the pressue level from 0.4 to 1.5 bars, but the optical depths must be less than 0.05. Such a thin haze did not provide sufficient flux at 6340 Å. A cloud with optical depth 1.0 at 2.6 bars provides a good fit to 6340 Å reflectivity.

The lack of detectable variability at shorter wavelengths constrains the vertical aerosol structure of the brightest feature. Specifically, the difference of the bright cloud from its surroundings in 1986 was probably caused by an increase in optical depth or increase in height of a stratospheric haze layer.