

Methane migration in the atmosphere of Neptune: Analysis of thermal imaging and spectroscopy from the Very Large Telescope

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The VISIR mid-infrared camera and spectrometer was used at the European Southern Observatory's UT-3 ("Melipal") unit of the Very Large Telescope on 2-4 September 2006. Single images of Neptune were made at 17.6 and at 18.7 μm , sensitive to temperatures around its 100-mbar tropopause level. They show sharply peaked temperatures at the south pole, which are probably the result of continuous radiative heating for some 80 years. This temperature increase is sufficient to cause a breakdown of the cold trap which elsewhere keeps methane confined primarily to the tropopause. Thus, methane migrates into the stratosphere from the south pole and establishes a sharp meridional gradient northward of the pole which depends on the rate of stratospheric transport. Spatially resolved observations of the variation of Neptune's molecular hydrogen S(1) quadrupole along its central meridian, which are sensitive to 0.1-mbar temperatures, show that the upper-level temperatures vary less than 3 K from south to north. Images of Neptune at 8.6 μm , sensitive to methane emission, show a greater variability of brightness temperature and, thus, confirm the existence of a strong stratospheric methane gradient. Furthermore, the images reveal a discrete feature near the pole which is thermally enhanced by 3 K, rotates with the neutral atmosphere, and is mirrored in 12.3- μm emission from stratospheric ethane. We note that it is also possible that this bright feature represents a substantial enhancement of methane and ethane rather than a temperature change, because we do not see an enhancement of the hydrogen quadrupole emission at any longitude on the planet.