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Latitudinal variation in abundance of hydrogen sulphide (H_2S) and methane (CH_4) in the atmosphere of Neptune

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Observations of the visible and near-infrared spectra of Neptune have been made recently with two integral-field spectrometers: the MUSE instrument at ESO's Very Large Telescope, and the NIFS instrument at the Gemini/North telescope. These observations image the entire observable disc of Neptune at sub-arcsecond resolution with each 'pixel' containing a complete spectrum from either 480 – 930 nm (MUSE) or 1.45 – 1.80 μm (NIFS). The VLT/MUSE spectral range includes a collision-induced absorption band of hydrogen near 825 nm and the observed spectra can be used to disentangle cloud-top height variations from variations in methane (CH_4) abundance. We find that the cloud-top abundance of methane mole fraction decreases from $\sim 4\%$ at equatorial and mid latitudes to values closer to 2% at polar latitudes, in agreement with an earlier analysis HST/STIS observations [Karkoschka and Tomasko, 2011]. At longer wavelengths, the Gemini/NIFS spectral range includes a weak absorption band of hydrogen sulphide (H_2S) and from these observations we directly detect, for the first time, the presence of this gas in Neptune's atmosphere. We find that the cloud-top abundance (at 2.5 – 3.5 bar) of H_2S is 1–3 ppm, with a clearer detection near Neptune's south pole. The observed cloud-top presence of H_2S constrains the deep bulk sulphur/nitrogen abundance to exceed unity and adds to the weight of evidence that H_2S ice likely forms a significant component of the main observable cloud deck. We have also analysed both sets of data using a Principal Component Analysis (PCA) and we will discuss what these observations reveal about the vertical and latitudinal distribution of cloud, hydrogen sulphide and methane in Neptune's atmosphere.