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Investigating the Chemical Composition of the CIRS-Observed 160 cm-1 Ice Cloud in Titan's Stratosphere

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Remote sensing observations from Voyager 1's InfraRed Interferometer Spectrometer (IRIS) and Cassini's Composite InfraRed Spectrometer (CIRS) confirmed the presence of nitrile ice clouds in Titan's stratosphere (Samuelson 1985, 1992; Khanna, R.K. et al., 1987; Samuelson et al., 1997, 2007; Coustenis, A. et al., 1999; Mayo and Samuelson, 2005; Anderson, C.M. et al., 2010, 2018a,b; Anderson and Samuelson, 2011). While individual gases in Titan's stratosphere are expected to condense to form pure ices, some of these gases will enter altitude regions where they undergo simultaneous saturation, or co-condensation, and form a mixed ice. The infrared spectral features resulting from a mixed ice have their own unique spectral signatures that notably diverge from the weighted sum of the individual species, and must therefore be experimentally determined as functions of temperature and mixing ratio (Anderson and Samuelson, 2011; Anderson et al. 2018a,b).

The first observation of a co-condensate in Titan's stratosphere was acquired by CIRS, which revealed a spectrally broad quasi-continuum ice emission feature with a spectral peak near 160 cm^{-1}. Based on the altitude of the observed cloud top, combined with preliminary experimental efforts (Anderson and Samuelson, 2011), the co-condensate was determined to predominately contain cyanoacetylene (HC_3N) and hydrogen cyanide (HCN). Here we present experimentally-measured absorbance spectra for the far-, mid-, and near-IR spectral regions (1.25 – 200 μm; 8000 – 50 cm^{-1}), along with the corresponding optical constants, of HC_3N-HCN co-condensed ices utilizing the SPECtroscopy of Titan-Related ice AnaLogs (SPECTRAL) Chamber (Anderson et al., 2018a). Various deposition temperatures and mixing ratios of mixed HC_3N and HCN were systematically studied to quantify the chemical composition of Titan's CIRS-observed 160 cm^{-1} stratospheric ice cloud emission feature.