Investigating Benzene (C_6H_6) Cloud Formation in Titan's South Polar Vortex

A Multi-disciplinary, Cross-Divisional Effort Leveraging Earth and Space Science

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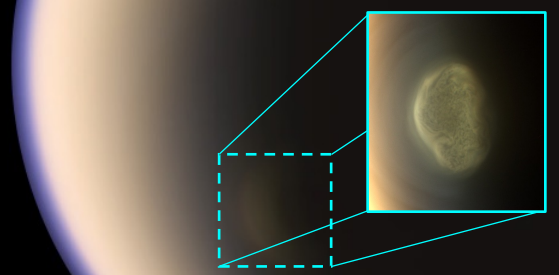

~~Science Question:~~ High-altitude clouds containing C_6H_6 ice signatures were observed by Cassini in Titan's south pole. Microphysical models used to simulate the formation of clouds and predict their vertical distribution need vapor pressures of the species condensing as input. Until now, no measured vapor pressure of C_6H_6 at Titan low temperature (< 180K) were available, and published extrapolations from higher temperature were insufficient to explain the formation of C_6H_6 cloud in Titan's high altitude south polar vortex.

For the first time, we have measured the vapor pressure of C_6H_6 at Titan-relevant temperatures. We used the Atmospheric Chemistry Laboratory (an Earth Science experimental facility at NASA Ames Research Center) to characterize the condensation and growth of C_6H_6 ices from 134–158 K. These experimental results were used in the CARMA microphysics model (SwRI) and also to reanalyze Cassini observations (Observatoire de Paris Meudon). We found C_6H_6 condensed deeper in the stratosphere than previously estimated using extrapolations, and abundances of up to 1000x higher.

~~Impact:~~ Synergistic studies combining laboratory, modeling and observation efforts across different disciplines are essential to better understand the complex physico-chemical processes in planetary atmospheres. The results of this CDAP project provided new experimental data that will enable the scientific community to conduct further analysis for multiple applications, and our synergistic approach enabled us to better characterize and predict C_6H_6 cloud formation in Titan's atmosphere, hence enhancing the science return of the NASA Cassini mission.

D. Dubois, L. Iraci, E. Barth, F. Salama, S. Vinatier, E. Sciamma-O'Brien, "Investigating the Condensation of Benzene (C_6H_6) in Titan's South Polar Cloud System with a Combination of Laboratory, Observational, and Modeling Tools", 2:121, The Planetary Science Journal, (2021)
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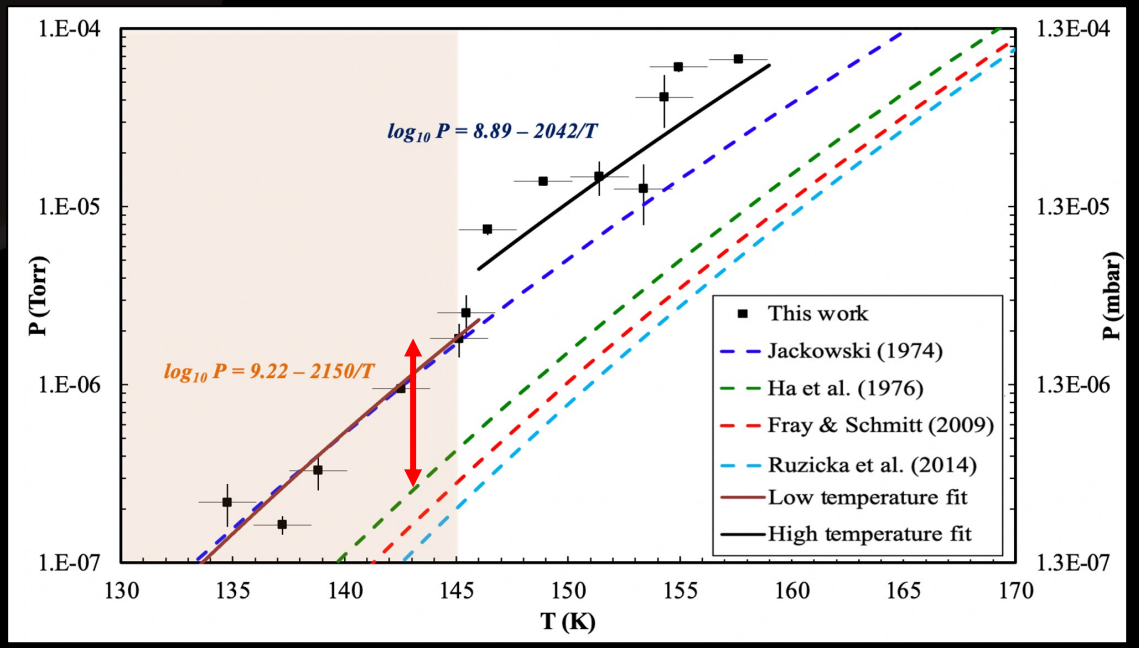

Experimental vapor pressure measurements of benzene ice (black) compared with extrapolations from higher temperature data in the literature (Dubois et al. 2021). Note the large difference (red arrow) between current measurements and the red dashed line, which is the most-commonly used parameterization.