EGU26-2276, updated on 26 Mar 2026
https://doi.org/10.5194/egusphere-egu26-2276
EGU General Assembly 2026

First N_2 Profile for Venus' Deep Lower Atmosphere

Rakesh Mogul[1,2], Sanjay Limaye[3], and Michael Way[4,5]
[1]California State Polytechnic University, Pomona, Chemistry & Biochemistry Department, Pomona, United States of America (rmogul@cpp.edu)
[2]Blue Marble Space Institute of Science
[3]University of Wisconsin, Madison
[4]NASA Goddard Institute for Space Studies
[5]Theoretical Astrophysics Group, Department of Physics and Astronomy, Uppsala University, Uppsala, Sweden

We present the first N_2 profile for Venus' deep lower atmosphere (<15 km) and a constrained isotopic composition for cloud N_2 [1]. *This work directly addresses unresolved questions for Venus using legacy observations*. Prior to this work, there were no reported measurements for N_2 abundances at <15 km and the isotopic composition remained unconstrained [2]. The N_2 parameters are critical to understanding the evolution and thermal properties of the atmosphere [3-7]. Our N_2 results were obtained by re-analysis of data acquired in 1978 by the Pioneer Venus Large Probe Neutral Mass Spectrometer (LNMS) [8]. The archived mass spectra from 64.2 to 0.2 km were treated using the analytical procedures specifically developed for the LNMS [9-11]. Judicious peak fitting permitted disambiguation of (A) N_2^+ and CO^+ at 28 u and (B) $^{14}N^{15}N^+$, $^{13}CO^+$, and $C_2H_5^+$ at 29 u. Quality controls included comparing the (A) LNMS CO^+/CO_2^+ ratios to the NIST database and literature and (B) fitted counts for CO^+ to the expected counts of CO^+ calculated from $C^{18}O^+$ and $^{13}CO^+$ using the LNMS $^{16}O/^{18}O$ and $^{12}C/^{13}C$ ratios (obtained from CO_2). Our results show that N_2 is *uniformly* mixed across the deep lower atmosphere between ~0.2 and 15 km (2.49 ± 0.10 *v*%). In contrast, N_2 is *non-uniformly* mixed across the sub-cloud atmosphere and clouds (~15–59 km), where N_2 abundances increase by ~ 2-fold between ~15 km (2.45 ± 0.32 *v*%) and ~59-51 km (5.21 ± 0.18 *v*%). Using the cloud data, we also obtained a constrained $^{15}N/^{14}N$ ratio (2.93×10^{-3} ± 0.13×10^{-3}) and $\delta^{15}N$ value (-204 ± 35‰). Thus, the LNMS results [1] suggest that (A) the atmosphere is unstable at <15 km, (B) N_2 is not well-mixed >15 km, and (C) the cloud $\delta^{15}N$ falls between Earth and the solar wind [12, 13]. Comparisons of the N_2 abundances and isotopic compositions for nitrogen, carbon, and oxygen to other Venus measurements will be discussed.

References:

[1] Mogul R. et al. (2025) *GRL* **52**.

[2] Hoffman J. H. et al. (1979) *Science* **205**.

[3] Moroz V. et al. (1997) *Adv. Space Res.* **19**.

[4] Avice G. et al. (2022) *Space Sci. Rev.* **218**.

[5] Vandaele A. C. et al. (2016) *Adv. Space Res.* **57**.

[6] Morellina S. et al. (2020) *Icarus* **350**.

[7] Limaye S. S. et al. (2017) *Icarus* **294**.

[8] Hoffman J. H. et al. (1980) *JGR Space Sci.* **85**.

[9] Mogul R. et al. (2023) *Icarus* **392**.

[10] Mogul R. et al. (2023) *MethodsX* **11**.

[11] Mogul R. et al. (2025) *JGR Planets* **130**.

[12] Marty B. et al. (2011) *Science* **332**.

[13] Füri E. et al. (2015) *Nature Geosci.* **8**.