V*f*Ox: VENUS OXYGEN FUGACITY, DAVINCI's STUDENT COLLABORATION EXPERIMENT. Noam. R. Izenberg[1], Sarah M. Hörst[2], David R. B. Kraemer[2], Stergios J. Papadakis[1], James B. Garvin[3], Stephanie Getty[3], Giada N. Arney[3], Natasha Johnson[3], and Erika Kohler[3] [1]Johns Hopkins Applied Physics Laboratory, Laurel, MD, USA, noam.izenberg@jhuapl.edu, [2]Johns Hopkins University, Baltimore, MD, USA, [3]Goddard Space Flight Center, Greenbelt, MD, USA.

Introduction: Knowledge of the atmospheric composition very near the Venus surface is required for assessing the stable mineralogy of the rocks present there. Oxygen fugacity (fO_2) of the near-surface atmosphere plays a key role in rock-gas chemical interactions. Current knowledge Venus' near-surface fO_2 is not based on direct measurement, but on derivations from atmospheric observations of CO by Pioneer and Venera descent probes (to altitudes no lower than 12 km), extrapolations of CO gradients, knowledge of CO, O_2, CO_2 equilibrium chemistry, laboratory experiments on Earth, and kinetic modeling, resulting in a possible range of -19 to -22 ($\log_{10}$ fO_2) [1]. While the primary instruments of the Deep Atmosphere of Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI) mission [2,3] will measure atmospheric constituents such as CO to high precision down to the lowest scale height of the atmosphere, from which fO_2 may be derived, Venus Oxygen Fugacity (V*f*Ox) instrument will provide a direct measurement of oxygen partial pressure, independently corroborating atmospheric composition and constraining the stability zones of surface mineralogy. V*f*Ox measurements will be used to determine fO_2 below the clouds. Frequent measurements (on the order of 1/sec) will generate a profile down through the last hundreds of meters above the touchdown surface, where the atmosphere and surface should be in thermodynamic equilibrium – and at the surface itself, should the Descent Sphere (DS) survive contact.

V*f*Ox Science Goal: We need to understand the atmospheric oxygen concentration at the surface to assess the mineralogy at the surface, and directly measuring fO_2 will improve that understanding, telling us, for example whether minerals like hematite or magnetite are stable on the planetary surface [4]. fO_2 is an essential boundary condition on gas and mineral stability at the surface of Venus [1] and relates to the trace gas species DAVINCI intends to measure in the final 1000m of descent using its Venus Mass Spectrometer (VMS) and its final Venus Tunable Laser Spectrometer (VTLS) measurement suite.

Student Collaboration: V*f*Ox, DAVINCI's Student Collaboration Experiment (SCE), is a small single-objective sensor used to measure the partial pressure of molecular oxygen (O_2) in Venus' lower atmosphere. V*f*Ox is a simple sensor derived from off-the-shelf ceramic oxygen sensors and will be mounted on the outside of the DAVINCI DS. Throughout the duration of the mission, V*f*Ox will be designed, fabricated, tested, operated, and its results analyzed by undergraduate and graduate students mentored by the DAVINCI team in partnership with Johns Hopkins University and other programs, with an emphasis on building and encouraging STEM careers for underserved student populations.

Students will build the VfOx experiment, analyze the data it returns, and participate with science activities of the DAVINCI science team. The motivating goals for DAVINCI's SCE are educating and training young scientists and engineers in planetary science and engineering skills, and providing a real-world applications for those skills. The V*f*Ox experiment poses a single, simple question about Venus' atmosphere; but the ramifications of the answer require an understanding of planetary atmosphere dynamics and equilibria and the relationships between a planet's atmosphere and surface chemistry. This knowledge determines the parameters that must be understood and/or measured to answer the experiment's motivating question, which in turn determines the design approach necessary to obtain that answer. The production and operation of a working flight sensor will require students to learn and understand the basics of instrument systems, design, and incorporation into a larger flight project. Learning through participation in an end-to-end experience is the objective for SCE participants, regardless of which phase of the mission intersects with their university career. V*f*Ox flies to Venus as part of DAVINCI at the end of the 2020s, supported by several college generations of student scientists and engineers.

Schedule: V*f*Ox is currently at the start of a science optimization and risk reduction period where accommodation with the DS and academic plans are being solidified. The first SCE students will likely begin as summer interns in the 2022, working on long-lead plans. The first program classes are planned for the academic year 2023-2024.

References:

[1] Fegley et al., 1997 *Icarus* 125, 416-439; [2] Garvin et al., 2020 *AGU Fall Meeting Abstracts* (Vol. 2020, pp. P026-0001). [3] Getty et al., *AGU Fall Meeting Abstracts* (Vol. 2020, pp. P022-01). [4] Fegley et al., 1997 *Icarus* 118, 373-383