

Hot Environments Lab: A New Lab for Venus Experimental Investigations.

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Introduction: The selection of three new Venus missions, has drastically increased the need for in situ experiments simulating hot planetary environments. The new data from these campaigns will help us address many outstanding questions in Venus science, however, the observations and measurements themselves can only be understood with supporting theoretical and laboratory research. In situ and analytical experiments are necessary for the interpretation of Venus observations, and the verification of theoretical models.

Venus hosts an oppressive environment with high surface temperatures and pressures (~740K and ~95bar, respectively), and a chemical regime primarily composed of CO₂ (~96.5%) and N₂ (~3.5%) with trace amounts of other reactive gases including sulfur species (SO₂, H₂SO₄, etc.). This environment creates many technical challenges but it is crucial to design systems that can simulate the temperature, pressure, and chemical conditions to (1) develop and test exploration technologies, and (2) for the scientific study of the current environment and what natural processes led Venus to the enigmatic body it is today.

Specifications: To meet this need, the Hot Environments Laboratory at NASA Goddard Space Flight Center has been developed to serve the community by providing in situ laboratory data at temperature regimes frequently difficult to simulate and maintain. The laboratory hosts two Venus simulation chambers capable of simulating a range of Venus relevant temperatures and pressures up to 740K and 95bar, a wide range of gas species, and offers viewing ports and/or throughputs for data and power.

There are two thermogravimetric systems (one of which can reach temperatures of 2500K), one with differential thermal analysis (DTA) and differential scanning calorimetry (DSC) capabilities and can also provide evolved gas analysis (EGA) of materials via a heated connection pathway to an FTIR.

The available FTIR spectrometers can take spectra from VIS-MidIR and include two variable temperature (ambient - 1200K) and pressure (10⁻¹⁰ – 100bar) FTIR cells that can be used for experiments with gases, liquids, and solids.

With the listed equipment the Hot Environments Lab can take in situ measurements over a wide range of extreme conditions. The flexibility of this equipment allows for a wide range of tests and can be used to simulate various hot environments such as early Earth, planetary interiors, and to date, has been used in studies

focused on Venus and exoplanets. Going forward, this lab will be supporting the DAVINCI (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging) mission by assisting with the plan, development, and testing of hardware for Venus exploration. Additionally, it will provide a testbed facility for scientific investigations of the Venus environment to prepare for, test, and assist in interpreting data acquired by DAVINCI.

The equipment listed here is available for community use and there are frequent positions available for interns, grad students, and postdocs.

Interpretations of mission and ground-based observations require an accurate understanding of the chemical and physical properties of planetary materials, regardless if the target in our local neighborhood or is an exoplanet in a faraway system. This understanding can only occur by utilizing results from modeling and laboratory experiments.

The Hot Environments Lab will serve a role in supporting planetary research by serving to validate and test planetary observations and models, and to ensure maximum science return of observations during this new Decade of Venus.

How to gain access: In order to obtain time for any of this equipment, please contact Erika Kohler at Goddard Space Flight Center (phone: 301-614-5756 or email: Erika.kohler@nasa.gov).