Opportunity Title: The Venus lower atmosphere: Direct and Large Eddy Simulations of turbulent high-pressure chemical-species mixing
Opportunity Reference Code: 0181-NPP-NOV23-JPL-PlanetSci

Organization National Aeronautics and Space Administration (NASA)

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Application Deadline 11/1/2023 6:00:59 PM Eastern Time Zone

Description The planet Venus lower atmosphere, defined as that below approximately 40-50 km of altitude, has a composition dominated by carbon dioxide, with a small percentage of nitrogen and a multitude of species having molar fractions in the range of 10^{-5}. The pressure at ground level is 92 bar and the temperature is 750 K. During the early Venus history, this Venus Planetary Boundary Layer (PBL) must have been instrumental in the establishment of the planet super-rotation, a term designating the fact that the Venus atmosphere rotates faster than the planet rotates upon itself (Venus rotates completely in 243 Earth days, but its atmosphere completely rotates in only four Earth days. In the Solar System, only Titan, a Saturn moon, is subject to super-rotation.). The PBL is also one of the governing features in determining the characteristics of the planet's upper troposphere and tropopause. Understanding the Venus PBL is crucial in Venus exploration, particularly in the design of potential landers. Experiments are currently been conducted in the NASA Glenn Extreme Environment Rig (GEER facility; https://www.nasa.gov/centers/glenn/technology/venus_chamber.html.) to explore aspects of species mixing on Venus. Our current research uses fundamental concepts from fluid mechanics, transport-property theory and real-gas thermodynamics to model the flow in the lower Venus atmosphere. We perform Direct Numerical Simulations (DNSs) to gain insights into the transient behavior of vertical three-dimensional slices of the lower Venus atmosphere and we plan to perform Large Eddy Simulations (LESs) in order to address the estimated turbulent characteristics of the lower Venus atmosphere. Experience with fluid dynamics modeling, DNS and LES coding and supercomputing is required; a solid background on high-pressure thermodynamics is desirable.

References:

[1] E. Masi, J. Bellan, K. Harstad and N. Okong'o , Multi-species turbulent mixing under supercritical-pressure conditions: modeling, Direct Numerical Simulation and analysis revealing species spinodal decomposition, J. Fluid Mech., 721, 578-626, 2013 [2] J. Bellan, Direct Numerical Simulation of a high-pressure turbulent reacting mixing layer, Combust. Flame, 176, 245-262, 2017 [3] A. Gnanaskandan and J. Bellan, Side-jet effects in high-pressure turbulent flows: Direct Numerical Simulation of nitrogen injected into carbon dioxide, J. Supercritical Fluids, 140, 165-181, 2018 [4] G. Castiglioni and J. Bellan, On models for predicting thermodynamic regimes in high-pressure turbulent mixing and combustion of multi-species mixtures, Journal of Fluid Mechanics, 843, 536-574, 2018

Location:

Jet Propulsion Laboratory
Pasadena, California

Field of Science: Planetary Science

Advisors:

Josette Bellan
Josette.Bellan@jpl.nasa.gov
818-354-6959

Applications with citizens from Designated Countries will not be accepted at this time, unless they are Legal Permanent Residents of the United States. A complete list of Designated Countries can be found at: https://www.nasa.gov/oiir/export-control.

Eligibility is currently open to:

- U.S. Citizens;
- U.S. Lawful Permanent Residents (LPR);
- Foreign Nationals eligible for an Exchange Visitor J-1 visa status; and,
- Applicants for LPR, asylees, or refugees in the U.S. at the time of application with 1) a valid EAD card and 2) I-485 or I-589 forms in pending status

Eligibility Requirements

- **Degree:** Doctoral Degree.