**An experiment to investigate Venus's deep atmosphere**

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**Context** The characteristics of the Venus atmosphere closest to the ground are still unknown to a large degree. The only reliable temperature profile measured below 12 km altitude was obtained in 1985 by the VeGa-2 lander [1,2]. This profile, obtained during the ~1h descent, is highly unstable in the lowest 7 km. This would imply that the near-constant vertical gradient is steadier than the adiabat – a characteristic that may be explained by a variation of the abundance of nitrogen from 3.5% at 7 km altitude to 0 at the surface [3] (see Fig.1).

**Motivation** The physics of the composition gradient is difficult to understand in the absence of more information. However, considering the observations in a recent experiment (Hendry et al., 2013 [4], see Fig. 2), we conjectured that this gradient could result from gravity effects inducing a density-driven separation of nitrogen and carbon dioxide.

**GEER experiment** To investigate the behavior of the CO\(_2\)-N\(_2\) mixture under conditions ranging from the Hendry et al. (2013) experiment to the near-surface atmosphere of Venus, we designed an experiment that was conducted at the Glenn Extreme Environment Rig (GEER) [5], at NASA Glenn Research Center in Cleveland in August 2013 (Figs. 3 and 4). This experiment was funded by the NASA Solar System Workings Program.

**Results**

1. For the well-mixed batch of gas, the composition was measured at all three ports during roughly 15 hours in each configuration. The results are always the same: the composition is identical at all three ports, and stable. No density-driven separation is observed.

2. To understand the Hendry et al. experiment, the same protocol was used: introducing CO\(_2\) first, then N\(_2\). To reproduce the same mix of gas, the same masses were used for each gas. In these cases, the first samples indicated nearly 100% CO\(_2\) at the bottom port and nearly 100% N\(_2\) at the top port. The composition evolved very slowly over time at each port, with time scales of the order of 10 days. The composition was measured over at least 24 hours, over 3 days for the first and last tests, with continuous (but slow) composition variations. This may explain the results of the Hendry et al. experiment. It was not a stable situation, but rather a slowly evolving mix. A full analysis of the experiment results will be done in the coming months.

**Pressure evolution (non-ideal behavior)** At 296K and 310K, inserting the gases one after the other results in a slow increase in pressure. When these two gases are well-mixed, they stay nearly 100% N\(_2\) at the top port.

**Diffusion timescales** In the vessel, diffusion may occur through small-scale turbulence during the initial fill, but may be dominated by molecular diffusion after resting for a while.

Each experiment was done first with a well-mixed batch of gas, then, using the same masses of each gas, for a mix done by inserting first CO\(_2\), then N\(_2\), as was done in the Hendry et al. (2013) experiment.

**Conclusions - Perspectives**

This experiment clearly showed that there is no peculiar density-driven separation in the CO\(_2\)/N\(_2\) mixture occurring at 100 bar. When these two gases are well-mixed, they stay well-mixed over the time scales used in this experiment. However, it also showed that when CO\(_2\) and N\(_2\) are stratified, it may be difficult to mix them.

How to explain the gradient in composition suggested by the VeGa-2 temperature profile in the 7-kilometer layer above the surface of Venus, then? Could there be unexpected sources or sinks of CO\(_2\) and/or N\(_2\) near the surface of Venus? This question needs to be thoroughly investigated.

We also emphasize that additional in-situ data from the near-surface layer of the Venusian atmosphere is crucial! We will not be able to understand the processes occurring near and at the surface of Venus without a new mission to investigate this harsh but surprising environment.

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**References**