Virtual Research Presentation Conference

Ground Campaign for Volcanic CO_2 Measurements

Principal Investigator: Joshua B. Fisher (329G)
Co-Is: Ryan P. Pavlick (382); Chad Deering (Michigan Tech)
Program: Spontaneous Concept

Assigned Presentation #RPC-042

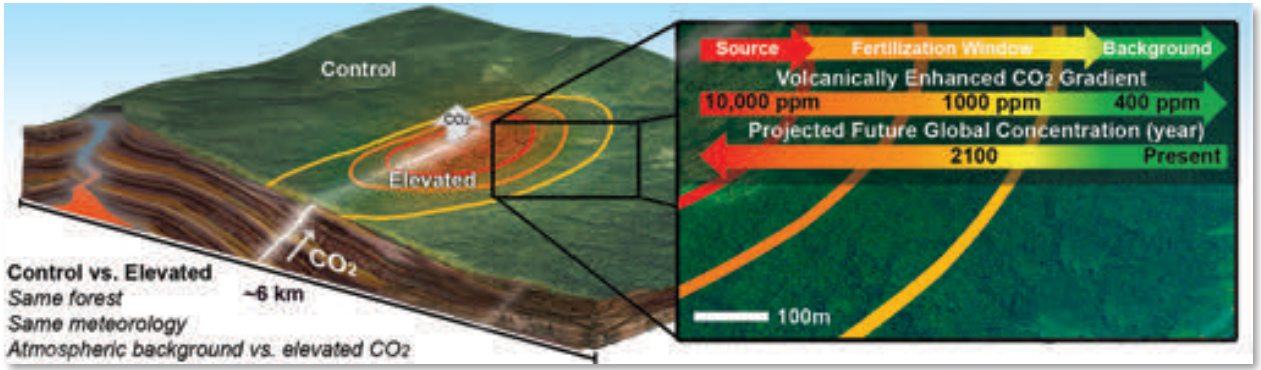
Jet Propulsion Laboratory
California Institute of Technology

Tutorial Introduction

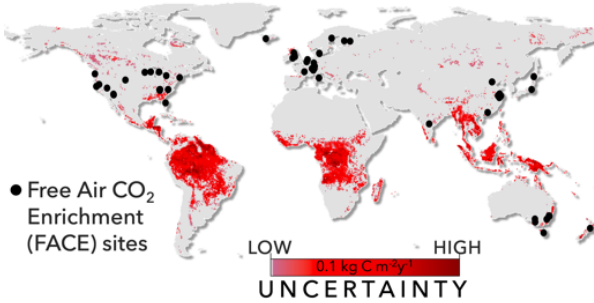
Abstract

One of the largest uncertainties in climate projections is the tropical CO_2 effect: *How much CO_2 will tropical rainforests take up in the future under elevated atmospheric concentrations?* In lieu of a multi- decadal-scale CO_2 fertilization experiment, recent work has shown that CO_2 emitted from the flanks of volcanoes into the surrounding ecosystems can be used as natural CO_2 fertilization experiments. To that end, JPL has invested in an airborne mission concept (ELEVATE: Enhanced Levels of Emissions in Volcanically Active Tropical Ecosystems) that leverages the interdisciplinary intersection of volcanology and ecology to tackle this critical uncertainty, focusing on rainforests at volcanic sites in Costa Rica.

The top priority for advancing the mission concept, as explicitly stated by NASA HQ, is for JPL to *generate base maps of the volcanic-derived elevated CO_2 spatial distribution at one or more of the sites*. Spontaneous funding supports a volcanic CO_2 ground campaign, final data product and map generation, analysis, and publication.



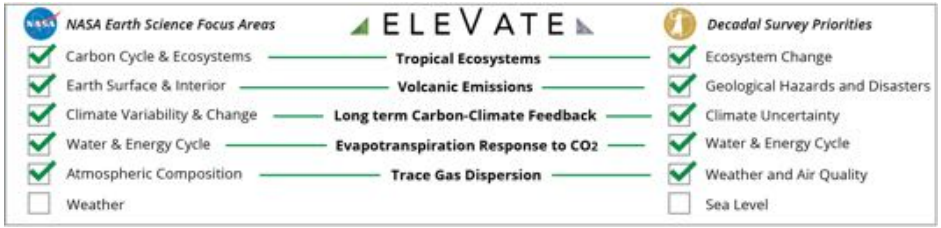
Problem Description



Problem: Our state-of-the-art understanding of the CO_2 effect comes from Free Air CO_2 Enrichment (FACE) experiments, wherein CO_2 is artificially pumped into forests. **No FACE experiment has ever been conducted in tropical rainforests**—*where they are needed most*—due to **unsurmountable hurdles not only of the challenging environment, but also the need to considerably expand the spatial extent** for the enormous species diversity. Hence, we remain at a critical impasse in our ability to understand one of the most important scientific questions of our time: how will the tropical biosphere respond to increasing atmospheric CO_2?

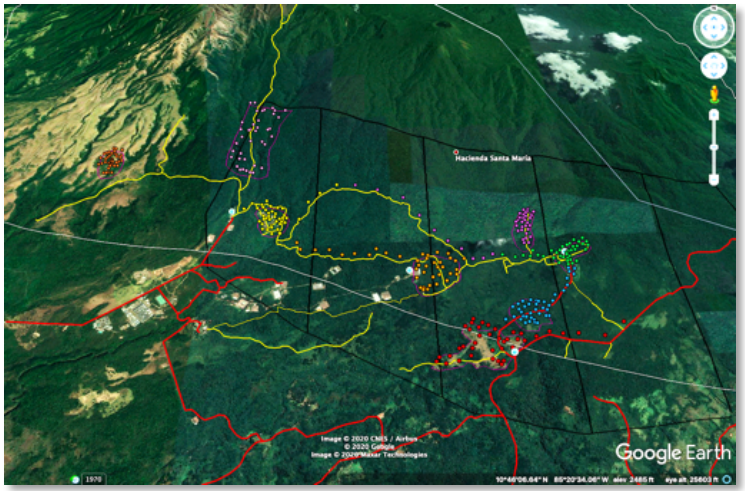
Urgency: Costa Rica has been forward-thinking in forest protection and conservation. Nowhere else in the world exists this combination of protected, accessible, and bioclimatically representative rainforests intertwined with large volcanic CO_2 gradients. There is urgency to **leverage this opportunity now both to break through this critical science barrier, as well as to capitalize on the forest protection while it is strong**. *Nature has conducted this experiment over centuries, and our investigation will uncover the results now; the opportunities elsewhere have been lost.* The field campaign must take place in the 2020 dry season for results to be included in the EVS-4 proposal in 2021.

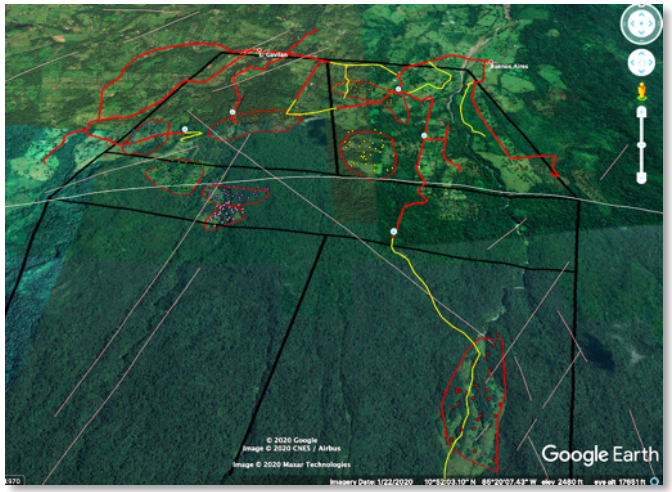
Relevance: Our investigation advances NASA's Earth Science Program goals in the Carbon Cycle & Ecosystems focus area. This focus is prioritized as the **MOST IMPORTANT** science objective within the Decadal Survey ecosystem science area.



Methodology

We conducted a CO_2 mapping field campaign in Spring 2020 at Volcán Rincón de la Vieja, Costa Rica. We focused measurement activities along fault lines identified from existing geologic maps and known degassing areas on the forested flanks, far from the volcanic crater, where cold gas seeps continuously emit excess volcanic CO_2 through the soil. We targeted emission hotspots, sampling with accumulation chambers around hotspots and working outward until CO_2 concentrations declined to ambient. Our measurements spanned two distinct ecosystems: humid rainforests of the north flank of the volcano and low and high-elevation seasonally dry forests on the south. Additionally, we collected complementary vegetation measurements of tree species and size for plots along the CO_2 sampling transects.





Field campaign landscape of Rincón de la Vieja, Costa Rica.

Photo credit: Dado Galdieri

Tablet used to locate measurement points and record data.

Photo credit: Dado Galdieri

Collecting CO_2 and vegetation measurements in the wet jungle of the northern face of Rincón de la Vieja.

Photo credit: Dado Galdieri

Traversing the dry southern face of Rincón de la Vieja.

Photo credit: Dado Galdieri

Results

a) The field campaign was successful: we obtained and generated the CO_2 map. Additional data were collected that open up further analyses. The campaign was picked up by *The Washington Post* and *New Scientist*. NASA Headquarters was very impressed by these articles, as well as with the data collected.

b) The results from this project satisfy the guidance from NASA HQ to improve the selection chances for the next EVS-4 mission proposal, ELEVATE.

c) Next steps include further publications, presentations, and continued collaborations with colleagues expanding the measurements at these sites. These results will be included in the EVS-4 ELEVATE proposal in 2021.

Publications and References

Tropical CO_2 fertilization using volcanic CO_2: results from a recent CO_2 mapping field campaign at Volcán Rincón de la Vieja in Costa Rica. Katie Nelson (1,4), Jacob Bonessi (1), Nel Rodríguez-Sepúlveda (1), Chad Deering (1), Fiona Soper (2), Benton Taylor (3), Ryan Pavlick (4), Daniel Sousa (4), Robert Bogue (2), Eliecer Duarte (5), Maynor Carranza Varela (6), Warner Gonzáles Valle (6), Isaac Mesén Montano (6), Florian M. Schwandner (7), Joshua B. Fisher (4). American Geophysical Union, 2020.

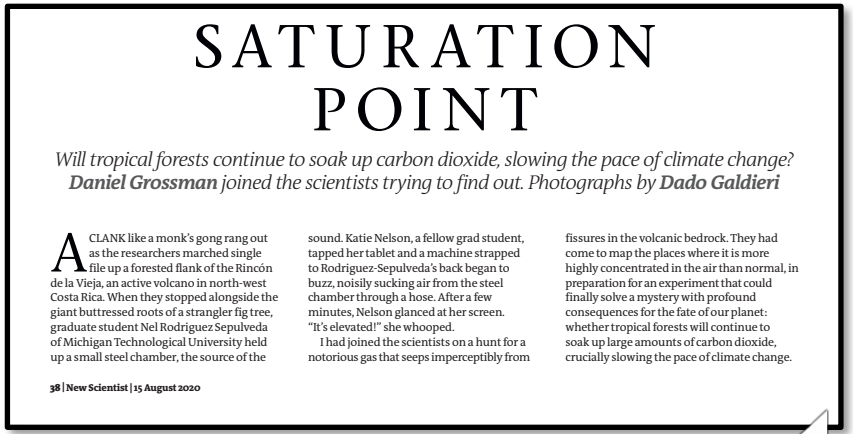
Acknowledgements: All those listed in the co-authors above. JPL Spontaneous Concepts funding.

The Washington Post
Democracy Dies in Darkness

Science

Clues to the impact of climate change may seep from a volcano in Costa Rica

Scientists study whether elevated carbon dioxide levels such as those found at Rincón de la Vieja might help or hurt tropical environments globally.



SATURATION POINT

Will tropical forests continue to soak up carbon dioxide, slowing the pace of climate change? ***Daniel Grossman*** *joined the scientists trying to find out. Photographs by* ***Dado Galdieri***

A CLANK like a monk's gong rang out as the researchers marched single file up a forested flank of the Rincón de la Vieja, an active volcano in north-west Costa Rica. When they stopped alongside the giant buttressed roots of a strangler fig tree, graduate student Nel Rodriguez Sepulveda of Michigan Technological University held up a small steel chamber, the source of the sound. Katie Nelson, a fellow grad student, tapped her tablet and a machine strapped to Rodriguez-Sepulveda's back began to buzz, noisily sucking air from the steel chamber through a hose. After a few minutes, Nelson glanced at her screen. "It's elevated!" she whooped.

I had joined the scientists on a hunt for a notorious gas that seeps imperceptibly from fissures in the volcanic bedrock. They had come to map the places where it is more highly concentrated in the air than normal, in preparation for an experiment that could finally solve a mystery with profound consequences for the fate of our planet: whether tropical forests will continue to soak up large amounts of carbon dioxide, crucially slowing the pace of climate change.

38 | New Scientist | 15 August 2020