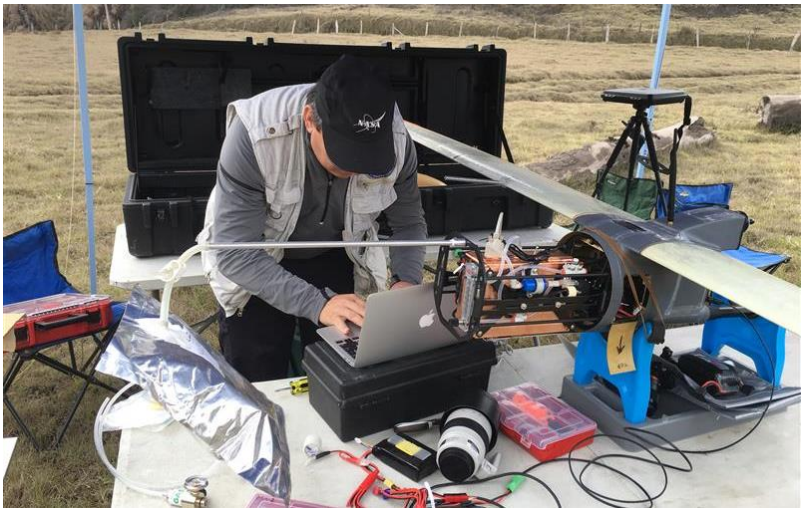
2025 NASA Ames CRATER Mission

The CRATER mission seeks to advance our understanding of the interactions between volcanic gas emissions and tropical ecosystems.

Volcanoes are effective natural laboratories. Persistent volcanic gas emissions offer a unique opportunity to study how tropical ecosystems respond to elevated levels of carbon dioxide (CO_2), providing insight into how rising atmospheric CO_2 may impact forest health, growth, and resilience on a changing planet.



Jorge Andres Diaz, professor at the Universidad de Costa Rica, checks trace gas data gathered from a recent flight. Photo courtesy of Jorge Andres Diaz

Emission Influence on Ecosystems

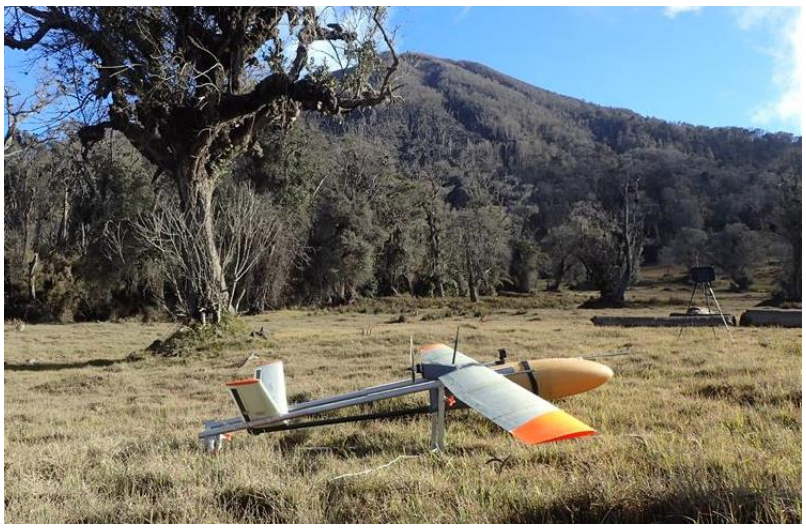
CRATER, which stands for Costa Rica Airborne research on foresT Ecosystem Response to volcanic gas emissions, aims to characterize and track the location, distribution, and fate of these gases.

These low-altitude airborne observations, when combined with existing ground-based datasets available from collaborators on site, will provide a more complete picture of how persistent volcanic emissions influence surrounding ecosystems.

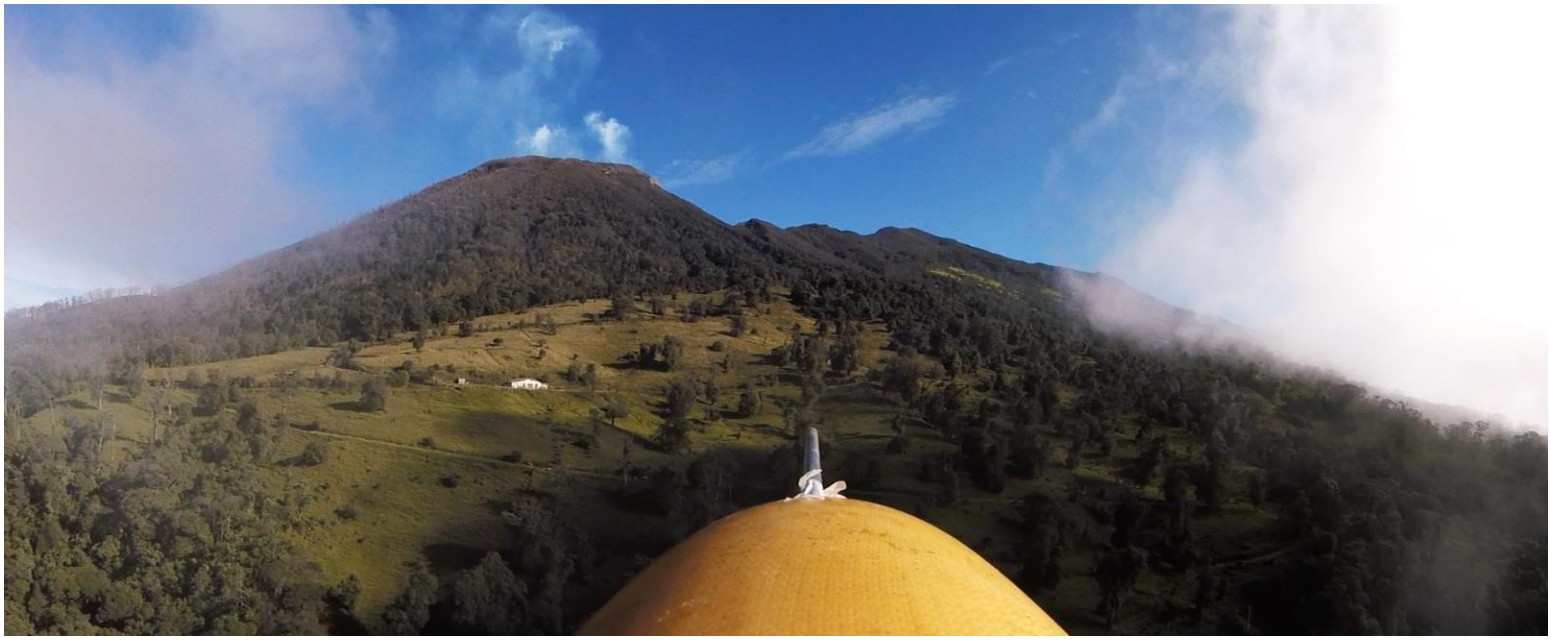
UAS Advancement

The campaign will advance strategies for volcano monitoring using uncrewed aircraft systems (UAS) by allowing NASA and Costa Rican researchers to test and refine technology and operations in remote, mountainous tropical environments – where many of the world's active volcanoes and diverse ecosystems coexist.

Lessons learned from this mission will inform future rapid-response deployments and support larger-scale airborne studies of volcano-atmosphere-biosphere interactions.



A S2 Black Swift UAS prepares to launch for a data collection flight in Costa Rica. Black Swift/Jack Elston



The view from the S2 Black Swift UAS nosecone as it flies towards Turrialba Volcano, Costa Rica. UCR/Jorge Andres Diaz

Vegetation & Volcanic Behavior

Vegetation response could provide early insight into changes in volcanic behavior. Changes in vegetation health and composition may offer early warnings of shifting volcanic activity, opening a new frontier in biosphere-based volcano monitoring.

Volcanic Gases

Tracking volcanic gas emissions is critical to monitoring volcanoes and forecasting their impacts. By mapping how volcanic gases move, the mission will help improve our ability to understand volcanic behavior and assess risk from the ground and from space.

Uncrewed Aircraft

UAS technology is transforming volcanic science. Lightweight, fixed-wing electric platforms can safely and precisely measure gas fluxes in hazardous terrain, advancing the capability for rapid, scalable response to dynamic Earth system processes.

Broader Application

Results from CRATER will improve our understanding of volcano-atmosphere-biosphere interactions, support better global carbon accounting, and contribute to the development of remote sensing tools for broader Earth system science and hazard applications.

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