Rocket Plume Sampling using a Balloon Deployed Unmanned Aerial Vehicle

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Abstract:

The steadily rising frequency of worldwide, commercial rocket launches has resulted in new concerns about potential environmental impacts. Addressing these concerns requires in-situ observations in the upper troposphere and lower stratosphere to advance our scientific understanding. Such high-altitude observations have been limited due to the expense of specialized aircraft required to deploy the necessary instruments. The weight and size of such instruments has greatly reduced over the last decade, enabling deployment on smaller unmanned platforms. There are now proven platforms for deploying these miniaturized instruments, such as high-altitude balloons, unmanned aerial vehicles (UAVs), and stratospheric gliders that can deploy instrumentation up to 30 km altitude. Gliders have proven effective at low (-60 °C) temperatures, in challenging (180 km/hr) wind conditions, and during high (9 G) maneuvering. Autonomous systems that combine such glider platforms with miniaturized in-situ instruments are able to conduct high-frequency atmospheric sampling up to 30 km where most piloted aircraft cannot fly. A field project is proposed to demonstrate that such an autonomous system can obtain stratospheric measurements of rocket plumes. A detailed operations plan is under refinement for sampling a Falcon 9 launch conducted from Cape Canaveral, Florida. The project would deploy a new instrumentation suite onboard a hybrid, balloon launched, stratospheric glider unmanned aircraft system (UAS) to measure meteorological conditions and evaluate pre- and post-rocket launch environments to obtain a data set useful to regulatory agencies and climatic researchers. Such systems are uniquely capable of testing instruments and for in-situ sampling in support of NASA's climate change mitigation goals. The new space economy brings growing concern of the impact of rocket exhaust gases, particulates, and flow dynamics on the environment and climate. New observation methods and sensors are needed at extreme weather conditions to constrain models on environmental impacts; otherwise, regulatory agencies will continue to rely on limited model simulations, negatively impacting space commerce. The proposed campaign directly addresses these concerns offering a new dataset that will enable responsible stewardship in the context of the high-volume rocket launch tempo of the new space economy.