Rocket Plume Sampling using a Balloon Deployed Unmanned Aerial Vehicle

1Ronald Fevig, 1David Delene, 2Ismail Gultepe, 3Nick Craine and 3Gary Pundsack
1University of North Dakota; 2Environment and Climate Change (ECCC) and Ontario Tech University, Stratodynamics Aviation Inc.

Motivation
The steadily rising frequency of worldwide rocket launches has resulted in new concerns about potential environmental and climate impacts. Addressing these concerns requires in-situ observations in the upper troposphere and lower stratosphere to advance our scientific understanding. 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 instruments up to 30 km.

Sampling Platform and Methodology
The UAV platform has proven effective at low (-60 °C) temperatures, in challenging (180 km/hr) wind conditions, and during high (9 G) maneuvering. A systems that combines the platforms with miniaturized instruments are able to conduct sampling up to 30 km. A field project is proposed to demonstrate that such an autonomous system can obtain stratospheric measurements of rocket plumes and measure meteorological conditions to evaluate pre- and post-rocket launch environments. An autonomous System for In-situ Stratospheric Sampling (ASISS) is a new, all-in-one instrument suite/platform for observing atmospheric state parameters, aerosols and ice particles.

Instruments
The weight and size of instruments has greatly reduced over the last decade, enabling deployment on smaller platforms.

Conclusions and Future Work
• 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 data set that will enable responsible stewardship in the context of the high-volume rocket launch tempo of the new space economy.

Field Operations and Objectives
A field project is planned to demonstrate that an autonomous system can obtain stratospheric measurements of rocket plumes. The 3-week project is planned for Cape Canaveral with a 3-4 scientists, instrumentation personnel and a 3-person crew from the flight platform provider.