PoSSUM NLC Research from Balloon and High-Performance Jet: Setting the Stage for Suborbital Research

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Project PoSSUM, an acronym for 'Polar Suborbital Science in the Upper Mesosphere', is a 501(c)3 astronautics research and education program with members from 43 different countries. The PoSSUM Aeronomy Program seeks to characterize the roles of gravity wave and instability dynamics in the mixing and transport processes of the upper atmosphere through coordinated ground, airborne, balloon, and spaceborne observations of noctilucent cloud (NLC) structures.

In July 2017, a team of 17 PoSSUM members deployed to northern Alberta, Canada and collected imagery of NLCs from both ground and airborne cameras. Airborne imagery was obtained using a Mooney M20K flying at FL230. From these observations, cameras to be later flown on the PMC-Turbo balloon were validated and the MSIS-E-90 atmospheric model was used to estimate PMC altitude, and imaging geometry information was used to compute distances and rates of motion for PMC features. Motion rate estimates are within family of historical chemical releases from suborbital rockets.

In 2018, NASA's *PMC-Turbo* experiment, led by PoSSUM's Director of Aeronomy Dave Fritts, successfully launched and is the first dedicated mission to explore the small-scale dynamics of our mesosphere and is also the first balloon mission to employ a balloon-borne lidar system, provided by the DLR.

Concurrent with the 2018 PMC-Turbo mission, PoSSUM had teamed with the Royal Canadian Air Force (RCAF) to continue airborne observations at altitudes up to FL500 using a CT-155 'Hawk' aircraft. These validate the imagery taken by aircraft with that of the PMC-Turbo balloon to determine if small-scale turbulence could be discernable from aircraft.

PoSSUM currently maintains a global citizen-scientist network of noctilucent cloud observers organized through social media. to demonstrate that social media platform can contribute to NLC science thanks to bulk worldwide reports, including a detailed description with the location, date, time, direction, brightness and duration, that would not have been possible using a network of a few cameras.

PoSSUM intends to use rSLVs to deploy an instrument developed for the Noctilucent Cloud Imagery and Tomography Experiment, selected by the NASA Flight Opportunities Program as Experiment 46-S in March 2012. This instrument suite will employ high-resolution noctilucent cloud and OH-layer imagery coincident with in-situ temperature measurements and neutral and charged particle densities in a manner from which 3D tomography may be constructed, which will better characterize the roles of gravity wave and instability dynamics in the mixing and transport processes of the upper atmosphere.