The PoSSUM Campaign: Polar Suborbital Science in the Upper Mesosphere

Jason D. Reimuller[1,2,4], Dave Fritts[2], Gary E. Thomas[3], Steve Mitchell[5], Michael Taylor[6], Steve Watchorn[7], John Plane[8], Gerald Lehmacher[9], Gerd Baumgarten[10].

[1]Space Science Institute, Boulder, Colorado, USA; [2]GATS Inc., Boulder, Colorado, USA; [3]Laboratory for Atmosphere and Space Physics, Boulder, CO, USA; [4]Astronauts for Hire, San Francisco, California, USA; [5]University of Colorado, Boulder, Colorado, USA; [6]Utah State University, Provo, Utah, USA. [7]Scientific Solutions Inc., Stanford, California, USA, [8]Leeds University, Leeds UK, [9]Clemson University, Clemson, South Carolina, USA, [10]Leibniz-Institut of Atmospheric Physics, University of Rostok, Kühlungsborn, Germany.

Introduction

The Polar Suborbital Science in the Upper Mesosphere (PoSSUM) campaign will employ a manned reusable suborbital vehicle that will launch from a high-latitude spaceport (e.g. Alaska or Kiruna, Sweden) during a weeklong deployment scheduled for July 2014 to study numerous aspects of Polar Mesospheric Clouds (PMCs). PoSSUM will optimize the opportunity created by the "PMC Imagery and Tomography Experiment", a high-latitude campaign selected by the NASA Flight Opportunities Program (Experiment 46-S) to study the small-scale dynamics of PMCs [1]. The PoSSUM Project will make full use of the 46-S opportunity by fully utilizing all available payload space and campaign deployment time to optimize technology maturation and science return while validating a repeatable, low-cost means to study seasonal trends of PMCs.

What are PMCs and why are they important?

PMCs are the highest clouds in the Earth's atmosphere, 83 km (50 miles) and are observed slightly below the mesopause in the polar summertime [2]. These clouds are of special interest as they are sensitive to both global climate change and to solar/terrestrial influences. The first recorded sightings of PMCs were reported in 1885 and both satellite and ground-based observations over the past four decades have indicated that the presence of these clouds has been increasing in both frequency and brightness [3]. Scientists now realize that these clouds are very sensitive indicators for what is going on in the atmosphere at higher altitudes as small changes in the atmospheric environment can lead to large changes in the properties of these clouds. Further, since these clouds form on condensation nuclei through cold temperatures and the presence of water vapor – and these properties of the mesosphere are tied to carbon dioxide and methane, the anthropogenic causes of climatic change may be directly related to the presence of PMCs [4].

Science Objectives

PoSSUM will use the capability of manned reusable suborbital vehicles to address key under-answered questions pertaining to PMCs. Specifically, PoSSUM will answer: 1) What are the small-scale dynamics of PMCs and what does this tell us about the energy and momentum deposition from the lower atmosphere? 2) What is the seasonal variability of PMCs, mesospheric dynamics, and temperatures? 3) Are structures observed in the OH layer coupled with PMC structures? 4) How do PMCs nucleate? and 5) What is the geometry of PMC particles and how do they stratify?

In addition to addressing the above questions, PoSSUM will also validate a method to conduct repeatable, low cost, in-situ PMC and aeronomy observations. The instrument suite used on PoSSUM will mature through subsequent campaigns into an integrated, modular laboratory (the 'Uppik Observatory'), which will be an OCT "Technology Area 8" payload that will serve the ground observation, glaciology, forestry, agriculture, and aeronomy communities.

Mission Profile and Instrumentation

Each PoSSUM sortie will employ a manned reusable suborbital vehicle (e.g. the XCOR Lynx Mark II) from a high-latitude spaceport. When strong cloud formations are observed from the ground or from LiDAR, the spacecraft will be launched to an altitude that transitions the PMC layer. The clouds will be under direct illumination from the sun and the attitude of the spacecraft would be oriented north to the presumed region of highest cloud density. Instrumentation will include video and still-frame cameras, an infrared camera, a mesospheric temperatures experiment, a depolarization LiDAR, a mesospheric winds experiment, and a meteoric smoke detector.

References [1] NASA Flight Opportunities website, www.flightopportunities.nasa.gov. [2] Gadsden, M., Schröder, W., 1989. Noctilucent Clouds, Springer, Berlin. [3] Deland, M.T., et al. 2006. A quarter-century of satellite polar mesospheric cloud observations, *Journal of Atmospheric and Solar-Terrestrial Physics* 68, pp. 9–29. [4] Thomas, G. E., 2003. Are noctilucent clouds harbingers of global change in the middle atmosphere? *Adv.Space Res., 32*, 9, 1737-1746.

Contact. Jason Reimuller, (720) 352-3227, Jason@integratedspaceflight.com.