The PoSSUM Mesospheric Winds Experiment

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Introduction.

Trimethyl aluminum (TMA) has been used extensively as a tracer for measuring both wind profiles and small-scale turbulence and wave structure in the mesosphere-lower thermosphere region. Since the early 1960's more than 500 such measurements have been made. TMA has the advantage that it is chemiluminescent and can be seen and tracked with cameras and the naked eye any time during the night when the solar depression angle is 8 degree or more. The two most difficult aspects of using TMA for such measurements is that (1) each measurement requires the launch of a sounding rocket, which makes it difficult to make series of measurements on a given night, and (2) clear skies are required if the optical tracking sites are ground-based. The combination of a reusable launch vehicle and aircraft-based cameras offers the possibility to routinely carry out series of measurements on a given night. The wind profiles provided by the trails are useful, of course, but can be duplicated by other techniques, such as Doppler LiDAR, at least in the mesosphere. The major advantage of a series of trail releases is that they give a direct visualization of the turbulent and small-scale wave structure in the atmosphere and its temporal evolution. Linking the evolution of such structure to the stability of the background atmosphere can provide important insights into atmospheric dynamics in this critical part of the atmosphere.

Background

The Mesospheric Winds Experiment is a payload supporting the Polar Suborbital Science in the Upper Mesosphere (PoSSUM) campaign, scheduled in July 2014 from a high-latitude spaceport. The PoSSUM Project has a primary mission to study Polar Mesospheric Clouds (PMCs), and understanding mesosphere dynamics are an important element to the overall campaign objectives. The PoSSUM Project will make full use of the NASA Flight Opportunities 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 conduct aeronomy observations [1].

Suborbital Applications

The PoSSUM Mesospheric Winds Experiment is a self-contained experiment designed to be mounted within a 20cm x 15cm diameter pod, such as would be available on the XCOR Lynx mark II. At apogee, assumed to be at mesopause altitudes, a pod would be ejected from the vehicle and allowed to freefall. This pod would initiate a tracer of TMA once a safe distance from the vehicle has been achieved which would be viewed from a supporting aircraft flying at 21,000ft. The supporting aircraft, a Mooney M20K provided by Aerospatial Systems of Boulder CO, will house a camera suite that will be able to image the falling TMA tracers in much greater resolution than might be possible from ground observation stations while flying a 90 degree arc around the point where the suborbital spacecraft would eject the TMA pod, thus capturing the tracer through a range of angles that would allow for the 2D characterization of mesospheric winds.

The combination of the rapid reusability of manned reusable suborbital vehicles, coupled with the improved capabilities introduced by the addition of aircraft support, enable the characterization of the mesosphere dynamics to a greater precision than previously available. Further, sorties flown concurrent with PMC observations introduce supporting data that improve PMC modeling capabilities.

References. [1] NASA Flight Opportunities flightopportunities.nasa.gov.

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