Novel Observations of the High Latitude Phenomena from New Platforms Larry Paxton[1], Karl Hibbitts[1], William Swartz[1], [1]JHU/APL, Laurel Maryland. Larry.Paxton@jhuapl.edu [1] JHU/APL, Laurel, MD, karl.hibbitts@jhuapl.edu

Introduction: Imaging of the aurora is a powerful tool, routinely used in groundbased installations. The issues with groundbased observations are:

1) Large instruments are immobile; located at one site
2) Tropospheric weather affects the 'seeing', both in transmittance and background signal due to scattering, etc)
3) Some observations, such as those of solar energetic particles (SEP), are impossible because the SEP do not reach the ground.

Polar "orbiting" long duration high altitude balloons and unattended aerial systems (UAVs, sometimes called "drones") offer a new, unique capability. Combining balloons and UAS greatly enhances the capability to provide measurements that are

1) not tied to ground systems,
2) (potentially ubiquitous),
3) Capable of being repositioned for focused campaigns
4) Capable of keeping a particular region under observation for long periods
5) Flexible as the payload can be changed to accommodate in situ energetic particle measurements as well as optical and RF sensors.

Importance: One of the more compelling questions in Heliophysics is that of hemispheric symmetry or asymmetry in the auroral region drivers (Joule and particle heating) and the response. The question is how do we systematically observe this and which are the most important regions to observe? Consider the dayside aurora. While the nightside aurora is largely controlled by reconnection in the magnetotail, the dayside aurora is linked to magnetic field merging on the dayside magnetopause. TIMED/GUVI data have been used to study these processes. A solar flux dependence was observed [1]. Dayside auroras are most intense around 14 to 16hrs MLT with the peak at about 15hrs where auroral electron precipitation maximizes. This is impossible to observe from the ground because of the large amount of sunlight scattered by the troposphere. In the Southern Hemisphere the challenges are greater because the magnetic pole is significantly offset from the Antarctic landmass. Balloons, especially those launched in the Southern Hemisphere summer drift along the circumpolar vortex which does not allow significant observation time in the aurora because of the limited intersection. A UAS can be carried aloft from a station and fly out to the auroral oval region (e.g. cusp or auroral bright spot) or to the region of interest.

Approach: Many aspects of this system and concept of operations were studied by the authors for the purpose of downward looking Earth observations. The key elements are that a high altitude capable balloon carries an instrumented UAS into the lower stratosphere. The balloon is a 'free ride' for the UAV that reduces the UAV's energy expenditure required to attain altitude. The predominate characteristics of the polar circulation pattern are used to provide the transport of the balloon to the point most advantageous to the release of the UAS. The UAS can be precisely positioned as it has its own propulsion once separated from the balloon. The UAS carries optical or in situ sensors at altitudes up to 30km. This is far above tropospheric weather, aerosol and most Rayleigh scattering. This is important because the aurora can be then be observed against what is, from that altitude, a dark sky even under sunlit conditions. Optical remote sensing can be used to observe the red, green and blue lines of O and N_2^+ from long duration UAS. The current state of the art for these platforms consists of flight durations of several days to a month [2,3].

Applications: The long duration of these stratospheric mobile platforms may enable studies that are not possible by other means such as daytime auroral imagery at a groundsite (e.g. PFISR) or to provide continuous, contiguous coverage in the auroral zone by having a 'conveyor belt' of these drones, launched in sequence from Alaska and recovered in Greenland or Europe. This system would be expected to be significantly less expensive that maintaining a piloted aircraft flying for much shorter periods of time in this regime.

Summary: New developments in groundbased auroral imaging could be carried out from unattended controlled stratospheric platforms capable of flying long duration missions.

NOTE: This abstract was submitted to the Helio 2050 Measurements workshop

References:

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