NITEOWL

Nightsky Imaging Tomography Experiment to Measure Ozone with Starlight

Faculty, staff, and students from five departments across three faculties at the University of Saskatchewan, together with SCI-TEC Instruments Inc. of Saskatoon, are preparing a response to the CSA AO for the Small Payloads Program. We propose to measure the night-time stratospheric ozone distribution in three dimensions at sub-Arctic latitudes, by applying tomographic reconstruction techniques to horizontal column ozone data acquired by multiple payloads descending through the stratosphere. The column ozone data will be obtained by measuring the absorption by ozone of visible starlight in the Chappuis bands.

We propose to fly identical experimental payloads on up to three Orion sounding rockets, to be launched concurrently along a North-South baseline running through SpacePort Canada at Churchill Rocket Range. Each of the payloads will include a compact imaging spectrograph with CCD detector for visible wavelength observations, a GPS receiver for real-time inertial position information, onboard data selection and compression circuitry, high-speed telemetry equipment capable of sustained 10 Mbps transmission to the ground, and payload recovery equipment in the form of a parachute for high-altitude deployment. After reaching the 80 km apogee the payloads will be despun from 4 rps to less than 0.1 rps (ideally 1 rpm) and deployed below parachutes.

During the descent phase from apogee to approximately 40 km altitude the spectrographs, viewing horizontally through the side of the payloads, will observe stars and measure their spectra in the absence of ozone absorption and other attenuation processes (Rayleigh scattering, NO_2 absorption, aerosol acattering). Subsequent observations of these stars from within the ozone layer will allow the column ozone concentrations along the lines of sight to the stars to be measured from the fractional absorption of the starlight in the Chappuis band region (450 - 750 nm wavelengths). Stars will be observed in many directions from a range of altitudes as the slowly rotating payload descends through the stratosphere. These observations, taken from up to three experiments along three descent paths through the stratosphere, can be inverted to yield the horizontal and vertical distributions of ozone over a large geographic area enclosing the payload trajectories.

Stars will be observed over a 5-10° field of view, with a low-resolution blazed transmission grating dispersing the collimated light from each star into a bright first order spectrum adjacent to the zeroth order star image. A fast lens will focus the light onto the large-format CCD. Spectrograph images will be transmitted to ground, along with real-time GPS-determined inertial positions, with onboard data selection and/or compression as needed to allow the required data volume to be transmitted ove a 10 Mbps telemetry link. The possibility of limited onboard data storage for redundancy is being investigated. Data will be telemetered from apogee to impact or loss of signal,

in the hope of measuring ozone in the troposphere as well as the stratosphere. The requirement to recover the expensive payloads constrains the available launch azimuths, and the relatively mild (6-8g) acceleration of the Orion vehicle creates a vulnerability to wind weighting even as it reduces the mechanical stresses on the payload components.

While a primary launch site at CRR is assumed, tomography considerations favour additional launches at remote sites such as Gillam, Eskimo Point, Rankin Inlet or Chesterfield Inlet. The cost, logistical, and regulatory issues involved in launches from these sites will determine whether, and where, additional launches are planned. Among the costs are those of providing the needed sets of ground support equipment, including that for TM reception and recording. Full tape backup of the TM is envisaged. The additional costs of establishing temporary launch facilities at remote sites may preclude one or both additional launches, although the science impact of losing both remote launches would be significant. Another consideration is the difficulty of securing the required licenses for a remote launch, which may vary from site to site.

In order to submit a fully compliant proposal to CSA we will require letters from all major subcontractors in the proposed activity, detailing the services they would provide and the cost of those services. This would include, in Akjuit's instance, the number of nights of launch readiness you would provide within the stated cost, as well as the cost per night thereafter. It is our hope that, after our meeting in November, Akjuit Aerospace will be in a position to prepare and provide such a letter, to be appended to our proposal. The proposal must be complete in every respect by December 13th in order to receive all required signatures before the University closes for Christmas.