A nighttime experiment using stars as light sources also offers unique opportunities to make measurements of other species which are undetectable during the daytime. The nitrogen oxide family is an important example of such species, which undergo large diurnal variations. The conversion of NO to NO_2 at night is a rapid process, while the photolysis rate of NO_3 is large, such that NO_3 is nearly absent during the day. A secondary objective of the NiteOwl experiment is to determine vertical profiles of these nighttime species. Such measurements may provide valuable information on ozone chemistry and will enhance the interpretation of the ozone results. Both NO_2 and NO_3 have strong absorption features within the spectral range from 400 to 700 nm. Preliminary calculations for a tangent altitude of 24 km indicate 7% absorption at 431 nm by NO_2. This should be detectable with the target resolution and sensitivity of the NiteOwl instrument. The wide spectral range of the instrument (400-780 nm) also allows more accurate determination of the column concentrations of the absorbing and scattering species, including aerosols. We will also conduct a detailed investigation of the possibility of NO_x measurements during Phase A.

2 The NiteOwl Experiment

The NiteOwl instrument will be launched from SpacePort Canada (Churchill, MB) aboard an Orion rocket. This rocket will take the payload to an altitude of 80km. From apogee the payload will descend using a parachute specially designed to provide a low spin rate. Measurements of stellar spectra attenuated by atmospheric absorption will be taken using an imaging spectrograph (ISG) viewing horizontally. As the payload rotates the ISG will scan the full horizon. The position of the payload will be monitored using an onboard Global Positioning System (GPS) receiver, which will also facilitate post-flight recovery. An attitude video camera (AVC) in the payload will image the star field to determine the look direction of the ISG. Data transmitted to the ground will include measurements made by the ISG and the GPS receiver, an attitude video camera (AVC), a temperature sensor, and possibly a chemiluminescent ozonesonde to measure ozone *in situ*. A block diagram of the payload is shown in Figure 1-3.

draft

The ISG will disperse incident starlight using a transmission diffraction grating and focus the light onto a charge coupled device (CCD) detector which will measure the spectral irradiance reaching the instrument. The planned spectral resolution of the measurements is 3 - 5 nm, and the wavelength range from 400 to 780 nm will span the Chappuis bands of ozone, as well as absorption bands of NO_2 at shorter wavelengths and NO_3 at longer wavelengths. The CCD detector readout will undergo lossless compression and will be transmitted, together with the data from the GPS receiver and the other sensors, via an interface to the telemetry system, which will transmit the data to a receiving system on the ground over an S-band PCM-FM link.

2.1 Description of Experimental Methods

The NiteOwl experiment will measure ozone concentrations using a stellar occultation technique. The rotation of the payload during its descent through the atmosphere allows observations of stars all around the horizon, and measurements of ozone column concentrations at all azimuths where sufficiently bright stars are seen. Measurements may be made at any local time during the night, because the method does not depend on tracking any particular star. The sun or moon need only be far enough below the horizon that scattered light may be neglected. In each 1-s image from the ISG several stars will be visible; however, the signal-to-noise ratio (SNR) required for accurate spectral and tomographic inversion will only be achieved for stars of magnitude 3.0 or brighter. Repeated observations of each star provide a set of lines of sight through the atmosphere. The combination of all sight lines through the region to be reconstructed provides the raw data on which tomographic analysis will be performed.

The initial measurement of each stellar spectrum from above the stratospheric ozone layer provides a reference spectrum for all subsequent observations of that star.Subsequent measurements of a star's spectrum from within the stratospheric ozone layer are divided by the initial (unabsorbed) spectrum to yield fractional transmissions, from which column concentrations of O_3 (and possibly NO_2, NO_3, and M) may be derived. In this way the ISG is self-calibrating, as there is no dependence

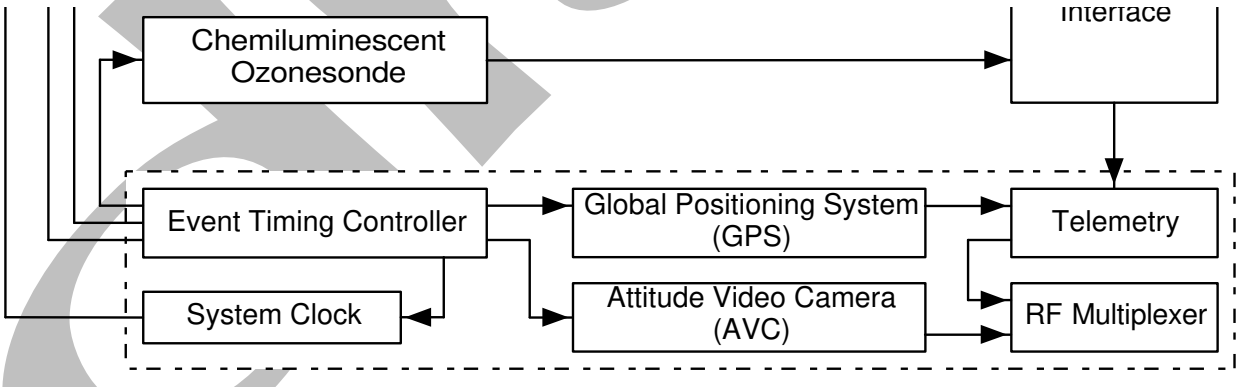

Fig. 1-3. Block diagram of the NiteOwl payload showing flow of control and data.