The occultation technique to be used for the NiteOwl mission is based on taking the ratio of the spectral irradiance I(λ) from a particular star when seen through the atmosphere, to the unattenuated spectral irradiance from the same star when seen above the atmosphere $I_0(\lambda)$ (Eq. 1-1).:

$$\frac{I(\lambda)}{I_0(\lambda)} = \exp(-\sigma(\lambda)\ N) \qquad (1\text{-}1)$$

where σ(λ) is the absorption cross section per molecule and N is the column number density of the absorbing species (cm^{-2}). If the atmospheric attenuation is due solely to ozone, the column density of ozone in the path may be calculated from Eq. 1-1. If other species absorb significant amounts of radiation at the wavelength of interest then additional terms must be added (Eq. 1-2):

$$\frac{I(\lambda)}{I_0(\lambda)} = \exp(-\Sigma_j\ (\sigma_j(\lambda)N_j)) \qquad (1\text{-}2)$$

As starlight passes through an absorbing atmosphere, the irradiance decays exponentially, with the amounts of ozone and other absorbing/scattering species along the light path determining the degree of attenuation. Working with the logarithm of the ratio of spectral irradiances transforms the governing equation to a linear one, permitting a tomographic solution process.

The tomographic reconstruction of the ozone distribution presents a number of challenges. These arise from the slenderness and curvature of the domain, the dominance of the vertical component of the ozone density gradients, the very weak absorption cross section in the Chappuis bands necessitating large column lengths, and the requirement to reconstruct geographic variations using a small range of source elevation angles. These factors conspire to make the problem ill- posed.

Because each potential source star must be viewed at least once above the stratosphere, the 80 km apogee limits data gathering to stars which are no lower than 5° below the horizon, *i.e.*, the set of all points 90° from the local zenith. Assuming such a star is present and bright enough and observed by the instrument, the lowest of its rays that clear the aerosol contaminated region below 10 km altitude will provide data on ozone no further away than 1200 km from the instrument and then only at 40 km altitude. Above the horizon, elevation angles greater than 6° pass through too little atmosphere for attenuation to be clearly different from noise.

If ozone varied only with altitude, the tomographical problem would be governed by Abel's integral equation [Vest 1979] which is only moderately ill-posed. Preliminary simulations, however, show that if ozone varies horizontally, a purely vertical inversion yields poor results. To incorporate the horizontal variation in ozone, a technique other than Abel inversion must be used.

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