THE STELLAR OCCULTATION TECHNIQUE: PAST ACHIEVEMENTS AND FUTURE CHALLENGES

S. Yee*(1)

(1) APL/Johns Hopkins University, Laurel, MD, U.S.A.

Two types of occultation techniques, extinctive and refractive, have been used for many years to determine the composition and structure of the atmospheres of Earth, and other planets, and their satellites. Historically these two occultation techniques have been used separately. However, they are complementary, and an occultation using both methods together would allow occultation measurements to probe more accurately a larger altitude range. In this paper, we will present a brief summary of these two techniques using star as a light source and the history of their development, applications and achievements. In particular, we will present a new approach to probe the Earth's atmosphere by using combined extinctive and refractive stellar occultation measurements. The technique is demonstrated using data from the Ultraviolet and Visible Imagers and Spectrographic Imager (UVISI) on the Midcourse Space Experiment (MSX) satellite. We show that this combine occultation technique can provide number density profiles of atmospheric species from spectrographic measurements of the relative extinction of starlight as well as the bulk properties of the atmosphere from observations of the refraction of light. Over 150 stellar occultation experiments were conducted by MSX/UVISI. Comparisons with results obtained by groundbased lidar, balloon ozonesondes, and other ozone profiling instruments such as SAGE, POAM, and HALOE clearly show that the stellar occultation technique has the potential to be a powerful, self-calibrating method for remote sensing the Earth's atmosphere in general and for the determination of ozone profiles in the stratosphere and upper troposphere in particular.

Stellar occultation techniques have been developed for many years. However, the successful application of a combined refractive and extinctive technique to Earth's remote sensing requires a combination of a capable spacecraft, a suite of optimized instruments, and a clear understanding of the various optical processes that affect the measured stellar radiation signals. Although MSX/UVISI was not designed for stellar occultation experiments, it did provide a unique opportunity for us to identify key measurement, instrument design, and spacecraft resources requirements for a future optimized stellar occultation experiment. In this paper, we will present the lessons learned and our experience gained from the MSX/UVISI experiments and the atmospheric composition retrieval process. We will summarize the implementation requirements for conducting a successful stellar occultation experiment, its possible future applications, and associated technical challenges.