CHAPTER 1

INTRODUCTION

The atmosphere of the Earth is a dynamical, evolving system dependent upon its composition. The concentration of various atmospheric species is dependent upon altitude, geographical location, and time of day. These species interact with the incoming sunlight to absorb, scatter, and emit the incoming radiance. Using spectroscopy, concentrations of different species can be determined to discover the composition of the atmosphere. Over a period of time changes to the composition caused by natural and anthropogenic sources can be used to infer the climate change effects. One important species in determining the radiative forcing effect is stratospheric sulfuric aerosol, which are submicron droplets that scattering incoming irradiance away from Earth and assist in the formation of clouds causing a cooling effect overall. The source for these aerosols come from the burning of fossil fuels, biomass burning, and marine processes and consist of the background aerosol layer. A large unpredictable perturbation of this aerosol layer occurs after large volcanic eruptions that can inject large quantities of sulfur directly into the stratosphere.

Many instruments over the past decades have been used to determine and monitor the atmospheric state. However, many of these instruments are no longer operational or are operating well past there expected lifetimes. In this work a proposal for a new passive remote sensing instrument, named the Aerosol Limb Imager (ALI), will be discussed which images the polarized limb radiance of the atmosphere to determine stratospheric aerosol profiles. The prototype instrument, although a prototype for a satellite instrument, will be test on a stratospheric balloon flight and has been designed for this platform

Chapter 2 will outline the atmospheric background on which this project is based. An overview of the stratospheric aerosol, including its discovery and discussion about the important of aerosol in the atmosphere, effect on climate change, sources, and microphysical properties. Following will be an overview of the different techniques used to measure aerosols including in-situ and satellite based methods. Then a brief overview of radiative transfer theory will underwent including scalar and polarized theory. Following is a brief discussion of the SASKTRAN-HR model used within this work.

Chapter 3 starts with an overview of acousto-optics tunable filters (AOTF), since this device is at the core of the ALI system. Continuing will be a discussion of the optical and system design of the ALI instrument including calibration, testing, and operation software. Since ALI is a linear polarized instrument, a study was underwent to determine the best polarization to achieve the highest possible aerosol sensitivity, accuracy, and precision possible. Furthermore, the optimal geometry for a limb scatter polarized instrument is also determine. The results of this study will be the focus of Chapter 4. The final discussion section, Chapter 5, is a discussion of the ALI test flight from a stratospheric balloon and the results from the measurements recorded from the flights. This includes calibrated images, retrieved aerosol profiles, precision estimates, and particle size estimation.