TABLE OF CONTENTS

page

ABSTRACT iii

ACKNOWLEDGMENTS iv

LIST OF TABLES viii

LIST OF FIGURES ix

LIST OF ABBREVIATIONS xv

INTRODUCTION 1

BACKGROUND 2

2.1 Introduction 2

2.2 Stratospheric Aerosol 4

2.2.1 Aerosol Sources and Microphysics 6

2.2.2 Climate Effects 9

2.3 Aerosol Measurements 10

2.3.1 In-Situ Measurements 10

2.3.2 Occultation 11

2.3.3 Lidar 13

2.3.4 Limb Scatter 15

2.4 Radiative Transfer 18

2.4.1 Scalar Radiative Transfer 18

2.4.2 Vector Radiative Transfer 21

2.4.3 Rayleigh Scattering 23

2.4.4 Mie Scattering 23

2.4.5 SASKTRAN Radiative Transfer Model 25

2.5 ALI Prototype and Stratospheric Balloon Flight 26

OPTICAL DESIGN AND CALIBRATIONS 28

3.1 AOTF Theory and Background 28

3.1.1 Solution to the Acoustic Equation 28

3.1.2 Diffraction Efficiency 32

3.1.3 Diffraction Angle 33

3.1.4 Tuning Curve 36

3.2 AOTF Calibration and Operation 38

3.2.1 AOTF Operation 38

3.2.2 AOTF Tuning Curve Analysis 40

3.2.3 AOTF Point Spread Function 43

3.2.4 AOTF Diffraction Efficiency 44

3.3 Optical Chain Development 44

3.3.1 Telecentric System Prototype 45

3.3.2 Telescopic System Prototype 52

3.3.3 ALI Optical Design 57

3.3.4 Correction to the Optical Design 62

3.4 Opto-Mechanical Design and Thermal Balancing 63

3.4.1 Opto-Mechanical Design 64

3.4.2 Baffle Design 69

3.4.3 Light Tight Case 74

3.4.4 Thermal Considerations 75

3.5 Control Software 77

3.6 ALI Calibrations and System Test 81

3.6.1 Exposure Time Determination 81

3.6.2 DC Offset Removal 83

3.6.3 Dark Current Correction 85

3.6.4 Stray Light Calibration 86

3.6.5 Relative Flat-Fielding Correction 88

3.6.6 Integrated Testing 90

AEROSOL SENSITIVITY TO POLARIZATION 92

STRATOSPHERIC BALLOON FLIGHT AND AEROSOL RETRIVALS 93

5.1 Stratospheric Balloon Flight 93

5.1.1 Preflight Preparations 93

5.1.2 Balloon Flight 97

5.2 Limb Measurements 101

5.3 Aerosol Retrievals 107

5.3.1 Aerosol Extinction Retrieval Methodology 108

5.3.2 Aerosol Extinction Retrievals 113

5.3.3 Particle Size Retrieval Methodology 117

5.3.4 A Sample Particle Size Retrieval 122

5.4 Results 126

CONCLUSION 128

LIST OF REFERENCES 129

TITLE OF APPENDIX A 140

TITLE OF APPENDIX B 141