

Contents

Acknowledgements	iv
Abstract	vii
1 Introduction	1
1.1 Atmospheric aerosols: Classification, production and removal processes and effects	1
1.2 Need for aerosol studies	4
1.3 Importance of tropical aerosols	7
1.4 Indian scene	8
1.5 Objective and Scope of the present investigation	9
2 Physical and Optical properties of aerosols	11
2.1 Size distributions	11
2.1.1 Junge power law size distribution	12
2.1.2 Lognormal distribution	13
2.1.3 Modified Gamma distribution	15
2.2 Optical properties	17
2.2.1 Scattering processes	17
2.2.2 Mie scattering	18
2.2.3 Mie scattering of individual particle	20
2.2.4 Angular distribution of the scattered light intensity of single particle	24
2.2.5 Mie scattering for many particles	25
2.2.6 Size range of aerosols for optical investigations	32

2.2.7	Spectral dependence of aerosol extinction coefficients and its dependence on relative humidity	34
3	Tropospheric aerosols	38
3.1	Introduction	38
3.2	Ground based Sun-tracking photometer observations over Ahmedabad	41
3.2.1	Instrumentation	42
3.2.2	Theory	44
3.2.3	Experiment and Data analysis	45
3.2.4	Determination of $I_o(\lambda)$ and Optical depth τ	48
3.3	Results and Discussion	52
3.3.1	Diurnal, day to day and monthly variations in aerosol optical depths over Ahmedabad	52
3.3.2	Spectral dependence of aerosol optical depth	58
3.3.3	Variations in wavelength exponent α	59
3.3.4	Variations in ozone optical depth	60
3.3.5	Variations in aerosol optical depth with relative humidity and temperature	62
4	Stratospheric aerosols	65
4.1	Formation, Physical, Chemical, Radiative and Optical effects	65
4.2	Volcanic aerosols: An assessment of the effects	69
4.3	Measurement techniques	76
4.4	Balloon-borne optical studies of Pinatubo aerosols over tropical India	79
4.4.1	Instrumentation	80
4.4.2	Experiment	83
4.5	Results and Discussion	87
4.5.1	Aerosol extinction coefficients	87
4.5.2	Aerosol number density and size distribution parameter	94
4.5.3	Ångström coefficient	98
4.5.4	Mode radius	100
4.5.5	Asymmetry factor	103

4.5.6	Mass density of Pinatubo aerosols	107
4.5.7	Comparison of Pinatubo results with previous major eruptions	108
4.5.8	Synthesis of results	112
4.6	Nd:YAG backscatter lidar measurements	114
4.6.1	Lidar system specifications and Data collection	114
4.6.2	Data analysis	117
4.6.3	Lidar observations	118
4.7	Results and Discussion	119
4.7.1	Scattering ratios	119
4.7.2	Aerosol extinction coefficients	119
4.7.3	Decay of Pinatubo aerosol layer mass	123
4.7.4	Aerosol mass decay at three stratospheric altitude regions	125
4.7.5	Peak scattering ratio	127
4.7.6	Comparison of results with El Chichon data	128
4.8	Modeling studies of aerosol characteristics	129
4.8.1	A brief survey of existing aerosol models	129
4.8.2	Aerosol microphysical processes responsible for the formation and decay of stratospheric aerosol layer	133
4.9	A time dependent stratospheric aerosol layer model: Present work	135
4.9.1	Model specifications	136
4.9.2	Results and Discussion	139
5	Summary and Scope for future work	146
5.1	Summary of results obtained	146
5.1.1	Tropospheric aerosols	146
5.1.2	Stratospheric aerosols	147
5.2	Scope for future work	151
5.2.1	Tropospheric aerosols	151
5.2.2	Stratospheric aerosols	152
	References	154
	List of Publications	173