CONTENTS

Chapter 1:  INTRODUCTION

1.1  Relevance of the study 1
1.2  Justification of the study 2
1.3  General circulation of the lower and middle atmosphere 4
1.4  Quasi-biennial oscillation 5
1.5  Sudden stratospheric warming 6
1.6  Static stability of the stratospheric air 8
1.7  Tracers and their transport in middle atmosphere 9
1.8  Stratosphere-troposphere exchange 11
1.9  Dynamical aspects of stratosphere-troposphere exchange 12
1.10 International activities about stratospheric processes and their role in climate 14
1.11 Ozone measurement from space 15
1.12 Vertical distribution of ozone 16
1.13 Geographical distribution of total ozone 18
1.14 Photochemical lifetime of ozone 18
1.15 Meteorology and ozone variability 20
1.16 Catalytic ozone destruction 22
1.17 Depletion of ozone in the polar region 24
1.18 Consequences of stratospheric ozone depletion 25
1.19 Recovery of ozone layer 27
Chapter 2: LITERATURE REVIEW

2.1 Tropospheric biennial oscillation / Quasi biennial Oscillation 28
2.2 Total ozone variability 32

Chapter 3: DATA AND METHODOLOGY

3.1 General 37
3.2 High-resolution radiosonde data over Thumba, Trivandrum 37
3.3 NCEP/NCAR reanalysis data 38
3.4 All India summer monsoon rainfall series 40
3.5 Breaks in Indian summer monsoon activity 41
3.6 Global total ozone data 43
3.6.1 Comparison of TOMS data with ground based total ozone measurements 46
3.6.2 Problems with the TOMS version-7 data 46
3.7 Wavelet analysis 48
3.7.1 Wavelet transforms 49
3.7.2 Graphical representation 50
3.7.3 Wavelet choice 51

Chapter 4: STRATOSPHERE-TROPOSPHERE INTERACTIONS IN BIENNIAL TIMESCALE

4.1 Introduction 52
4.2 Data and methodology 52
4.3 Results and discussion 54
4.3.1 Constant phase of temperature TBO with height 54
4.3.2 Link between QBO and TBO in temperature 60
4.3.3 QBO/TBO in zonal wind 62
4.3.4 Link between monsoon activity and phase of QBO/TBO in temperature and zonal wind 65
4.4 Conclusion 67
Chapter 5: **INTERANNUAL TIMESCALE STRATOSPHERE-TROPOSPHERE EXCHANGE OF OZONE BY ASIA PACIFIC WAVE**

5.1 Introduction 68
5.2 Data 74
5.3 The Asia Pacific Wave in the lower stratosphere 74
5.4 The Asia Pacific Wave and the meridional mass exchange 79
5.5 Signature of Asia Pacific Wave in total ozone 82
5.6 The Asia Pacific Wave during the monsoon season 84
5.7 The Asia Pacific Wave in post-monsoon season 87
5.8 Counter-part of Asia Pacific Wave in Southern Hemisphere 88
5.9 Asia Pacific Wave induced total ozone variability and its possible implication on total ozone trend 91

Chapter 6: **SYNOPTIC SCALE STRATOSPHERE-TROPOSPHERE EXCHANGE OF OZONE BY LONG WAVES**

6.1 Introduction 95
6.2 Data 96
6.3 The characteristics of upper tropospheric long waves over Indian subcontinent and associated ozone variations 97
6.3.1 Winter-time westerly upper tropospheric troughs 97
6.3.2 Summer-time upper tropospheric blocking highs and trough 98
6.3.3 Upper tropospheric long waves and total ozone variations 102
6.4 Case studies 105
6.4.1 Winter season 105
6.4.1.1 January 01-04, 1988 UTT 106
6.4.1.2 February 24-28, 1992 UTT 109
6.4.2 Summer season 111
6.5 Summary 116
Chapter 7: SUMMARY AND CONCLUSIONS

7.1 Summary and conclusions

7.2 Scope for future studies

REFERENCES

LIST OF PUBLICATIONS