

Table of Contents

<i>Table of Figures</i>	VIII
<i>List of Tables</i>	XV
CHAPTER 1: INTRODUCTION.....	1
1.1. Background of the Work.....	2
1.2. Objective and Significance	3
1.3. Outline of the Thesis	8
CHAPTER 2: REVIEW OF RELATED RESEARCHES.....	11
2.1. Hyperspectral Remote Sensing	12
2.2. Use of Spectroradiometer.....	14
2.3. Studies on Atmospheric Carbon Dioxide.....	17
2.4. Hyperspectral Sensing of CO₂	18
2.5. Seasonal Variability of CO₂	20
2.6. CO₂ in India	21
2.7. Recent CO₂ Scenario at Global Level	22
2.8. Relevant Parameters.....	25
2.8.1. Solar-Induced Chlorophyll Fluorescence	25
2.8.2. Atmospheric Aerosols.....	25
2.8.3. Wavelet Analysis	27
CHAPTER 3: NEW METHODOLOGY FOR ESTIMATING CO₂....	44

3.1. Materials and Method	45
3.1.1. Ground Measurements	45
3.1.2. AVIRIS-NG Image Analysis	46
3.1.3. Methodology for a-DOAS	47
3.1.4. Correction for Sensor Altitude.....	50
3.2. Ground-Measured and Image-Derived Spectra	52
3.2.1. General Hyperspectral Features.....	53
3.2.2. Spectral Standardizations.....	55
3.3. Results on CO₂ Concentration.....	57
3.4. Water Vapour (H₂O) Correction.....	59
3.5. Water Vapour (H₂O) Correction using Martian Spectra	62
3.5.1. Data Sources	63
3.5.2. Image-derived Spectra	63
3.5.3. Synthetic Spectra	64
3.5.4 Martian and Terrestrial Radiance Spectra	65
3.5.5. Correction Parameter (R).....	68
3.5.6. Spatial CO ₂ Distribution with H ₂ O Correction.....	70
3.6. Inferences	73
CHAPTER 4: SPATIAL AND TEMPORAL CO₂ CHANGE IN INDIAN CONTEXT	77
4.1. Stimulus to the Work	78
4.2. Data and Methodology.....	79
4.2.1. Open-Source CO ₂ Data Procurement	79
4.2.2. CO ₂ from AVIRIS-NG Images	81
4.3. Gross Results on Temporal CO₂ Change Over India.....	81
4.4. Spatial CO₂ Map from AVIRIS-NG	83

4.5. Balanced Condition of CO₂	87
4.6. Estimating Water Vapour (H₂O).....	90
4.7. Detecting Point Sources of CO₂	93
4.8. Inferences	98
 CHAPTER 5: NEW METHODOLOGY FOR ESTIMATING AEROSOL	 103
5.1. Purpose of the Work	104
5.2. Methodology and Data.....	105
5.2.1. Developing the Optical Depth Model.....	105
5.2.2. Ground measurements and Image analysis.....	107
5.3. Results on Optical Depth.....	108
5.4. Inferences	111
 CHAPTER 6: SEASONAL VARIABILITY OF CO₂ IN INDIA.....	 113
6.1. Motivation of the Work	114
6.2. Data and Methodology.....	115
6.2.1. Satellite Data	115
6.2.2. Ground Measurements	119
6.3. CO₂ Redistribution Model.....	120
6.3.1. Parameter Assessment in Redistribution	125
6.3.2. Validation of the Model	126
6.4. Results and Discussion.....	126
6.4.1. CO ₂ Trend and Effect of Vegetation.....	126
6.4.2. The Role of Atmospheric Pressure	130
6.4.3. Long-Term Variation of Parameters.....	132
6.4.4. Fourier Transform Analysis.....	134

6.4.5. Vertical Redistribution of CO ₂	136
6.5. Inferences	141
 CHAPTER 7: RECENT GLOBAL CO₂ SCENARIO 145	
7.1. Inspiration for the Work	146
7.2. Data and Methodology.....	148
7.2.1. Selection of xCO ₂ Data and Fitting	149
7.2.2. Wavelet Analysis of the Seasonal CO ₂	151
7.3. Results and Discussion.....	152
7.3.1. Variations in xCO ₂ and SIF on an annual basis.....	152
7.3.2. CO ₂ Deviation in OCO-3 from Wavelet Analysis.....	160
7.3.3. AOD	162
7.4. Inferences	162
 CHAPTER 8: DISCUSSIONS AND CONCLUSIONS..... 166	
8.1. Spectral Calibration of CO₂ Absorption Features.....	168
8.2. New Techniques for CO₂, Aerosol and H₂O Retrievals	169
8.3. Spatial Variation and Point Source of CO₂	170
8.4. Seasonal CO₂ Change	171
8.5. CO₂ in Indian and Global Contexts	172
REFERENCES.....	174
ANNEXURES	196