Table of Contents

1. Introduction 1
1.1 The Earth's atmosphere 3
1.1.1 Composition 3
1.1.2 Vertical structure 3
1.2 Radiation 5
1.2.1 What is radiation? 5
1.2.2 Main quantitative characteristics of a radiation field 7
1.2.3 Solar radiation 11
1.2.4 The electromagnetic spectrum 12
1.2.5 The Earth's energy budget 14
1.3 Ultraviolet radiation 16
1.3.1 Definition of the UV-index 17
1.3.2 Factors that influence surface UV radiation 17
1.3.3 Effects of UV-B radiation 19
1.3.4 Measurements of UV 20
1.4 Aerosols 20
1.4.1 Basic information 20
1.4.2 Effects of aerosols 23
1.4.3 Definition of Aerosol Optical Depth 27
1.4.4 Measurement of Aerosol Optical Depth 27
1.5 Ozone 27
1.5.1 What is ozone? 27
1.5.2 Sources of ozone 28
1.5.3 Effects of ozone: 'good' versus 'bad' ozone 33
1.5.4 Measurements of ozone 34
1.6 Measurements 34
1.6.1 In situ measurements 34
1.6.2 Remote sensing 36
1.7 Aim of this work 54
2. Instruments and location 57
2.1 The Brewer spectrophotometer 57
2.1.1 The spectrophotometer 59
2.1.2 Direct Sun (DS) ozone measurements 62

2.1.3 UV measurements 66
2.1.4 AOD retrievals 67
2.1.5 Calibration history 69
2.2 The CIMEL sun photometer 69
2.3 Pyranometer 70
2.4 Pyrheliometer 71
3. AOD retrieval method using sun scan Brewer measurements 73
3.1 The Beer-Lambert law 73
3.2 The Langley Plot Method 75
3.2.1 Selection of cloudless days 76
3.2.2 Stability of the Calibration Factors 78
3.2.3 Basic requirements for the Langley Plot Method 80
3.3 Sources of uncertainty 81
3.3.1 Earth-Sun distance 81
3.3.2 Uncertainties in the ozone term 82
3.3.3 Uncertainties in the Rayleigh term 84
3.3.4 Uncertainties by not including NO_2 in the calculations 87
3.3.5 Uncertainties by not including SO_2 in the calculations 87
3.3.6 Instrumental issues 88
3.3.7 Summary 89
4. Cloud screening of AOD values 91
4.1 Initial cloud screening 91
4.2 Improved cloud screening technique 92
5. AOD data analysis 95
5.1 Comparison with CIMEL data 95
5.2 Comparison with Direct Sun $\tau_{aer,320}$ measurements 97
5.3 Monthly and seasonal analysis 98
5.4 Weekly periodicity 103
6. Relationship between erythemal UV dose, global solar radiation, total ozone and AOD at Uccle 105
6.1 Monthly anomalies 105
6.2 Change point analysis 106
6.3 Linear trend analysis 107
6.3.1 Method 107

6.3.2 Results 108
6.3.3 Discussion of trends 112
6.4 Multiple linear regression (MLR) analysis 120
6.4.1 Method 120
6.4.2 Results 123
6.4.3 Discussion of the results 130
7. Conclusion and outlook 133
References 137
Appendices 167
Appendix A: Seasonal MLR 2 results 169
Appendix B: Table of quantities and constants mentioned in this work 171
Appendix C: list of publications 175
Articles: 179