

Contents

1	Introduction	1
2	Discovery of Ozone in the Atmosphere	5
	References	10
3	The Ozone Layer	13
3.1	Photochemistry of Atmospheric Ozone	13
3.1.1	The Chapman Reaction Cycle	13
3.1.2	Dynamical Processes	16
3.1.3	Catalytic Reaction Cycles	17
3.1.4	Heterogeneous Reactions	22
3.2	Global Ozone Distribution	25
3.3	UV Radiation and Ozone Layer Thickness	26
3.4	Solar and Cosmic Effects	30
3.5	Heavy Ozone and Isotope Effects	35
3.6	Measurement Techniques	36
3.6.1	Ground-Based Measurements	36
	References	43
4	Ozone in the Troposphere	49
4.1	The Natural Troposphere: Early Ozone Measurements	49
4.2	Stratospheric-Tropospheric Exchange	50
4.3	Photochemistry in the Troposphere	54
4.3.1	Oxidation Capacity	54
4.3.2	Methane Oxidation	55
4.4	Natural Source Gases	58
4.4.1	Biogenic Sources	58
4.4.2	The Global Carbon Cycle	60
4.4.3	The Global Nitrogen Cycle	64
4.4.4	Nitrous Oxide (N ₂ O)	66
4.4.5	Methane (CH ₄)	68
4.4.6	Carbon Monoxide (CO)	71

4.4.7	Hydrogen (H ₂)	72
4.4.8	Methyl Chloride (CH ₃ Cl)	75
4.4.9	Methyl Bromide (CH ₃ Br)	76
4.4.10	Biogenic Hydrocarbons	77
	References	79
5	Human Impact	83
5.1	Stratospheric Ozone Depletion	83
5.1.1	Ozone-Depleting Substances	83
5.1.2	Global Ozone Loss	86
5.1.3	Polar Ozone Loss	89
5.1.4	Future Evolution of Stratospheric Ozone	93
5.1.5	Impact of Aviation	97
5.2	Tropospheric Ozone Increases	97
5.2.1	Photochemical Smog	98
5.2.2	Photosmog in Megacities	102
5.2.3	Biomass Burning	104
5.2.4	Global Impact: Present Tropospheric Ozone Distribution	107
5.2.5	Impact on Vegetation, Humans, and Materials	110
5.3	Surface UV and Ozone Layer Changes	113
5.3.1	Long-Term Trends	113
5.3.2	Effects of the Ozone Hole and Its Breakdown	114
5.4	Ozone and Climate Change	116
	References	119
6	International Legislation: The Vienna Convention and the Montreal Protocol	125
	References	130
7	Historical Highlights	131
7.1	The Discovery of the Antarctic Ozone Hole and Elucidation of Its Sources	131
7.2	The 1995 Nobel Prize of Chemistry Awarded to Three Pioneers of Ozone Research	133
7.3	Gordon M.B. Dobson, the International Ozone Commission and Its Quadrennial Ozone Symposia	135
	References	137