

# Contents

<b>Abstract</b>	<b>i</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Stratospheric Ozone – Overview . . . . .	1
1.2 Polar Ozone Depletion . . . . .	5
<b>2 Stratospheric Chemistry</b>	<b>9</b>
2.1 The Chemistry of Stratospheric Ozone . . . . .	9
2.1.1 Loss Cycles of Ozone . . . . .	9
2.1.2 Chlorine-Containing Trace Species . . . . .	11
2.2 The Chemistry of Stratospheric Polar Ozone . . . . .	12
2.2.1 Polar Stratospheric Clouds (PSCs) and Sulphate Aerosols	12
2.2.2 Heterogeneous Chemistry . . . . .	13
2.2.3 Deactivation of Chlorine . . . . .	14
2.2.4 Denitrification . . . . .	15
<b>3 The Arctic Polar Vortex</b>	<b>17</b>
3.1 Dynamics of the Stratospheric Polar Vortex . . . . .	17
3.1.1 The Polar Vortex Edge Region . . . . .	22
3.2 Dynamical Tracers . . . . .	23
3.3 Total Ozone in High Northern Latitudes Based on TOMS Observations . . . . .	24
<b>4 The Quantification of Chemical Ozone Loss in the Polar Region</b>	<b>29</b>
4.1 The Principles of the Tracer-Tracer Correlation (TRAC) Technique . . . . .	30
4.2 Presentation of Several Methods of Calculating Ozone Loss . . . . .	35
4.3 Criticism of the TRAC Technique . . . . .	37
4.4 Specific Improvements and Extentions in the TRAC Methodology . . . . .	39
4.4.1 New Methodology for the Meteorological Analysis . . . . .	39
4.4.2 Improved Determination of the Early Winter Reference Function . . . . .	41
4.4.3 Specific Improvements to the HALOE Analysis . . . . .	45

<b>5 Verification of the (TRAC) Technique Using ILAS Data in 1996–97</b>	<b>47</b>
5.1 Meteorology of the Polar Vortex 1996–97 . . . . .	47
5.2 Evolution of Ozone-Tracer Relations in the Early Vortex . . . . .	49
5.3 Evolution of Ozone Loss over the Entire Lifetime of the Vortex . . . . .	51
5.4 Influence of Mixing on the Ozone-Tracer Relationship . . . . .	54
<b>6 Re-analysis of HALOE and ILAS Observations in Winter 1996–97</b>	<b>57</b>
6.1 Comparison of ILAS and HALOE Ozone Observations . . . . .	57
6.2 Ozone Loss in the Winter 1996–97, ILAS and HALOE in Comparison . . . . .	60
6.2.1 Ozone Loss Derived From HALOE Measurements . . . . .	60
6.2.2 Ozone Loss Derived From ILAS Measurements . . . . .	70
6.2.3 Comparison of HALOE and ILAS Results . . . . .	70
<b>7 Development of the Tracer-Tracer Relation from 1991 to 2003</b>	<b>75</b>
7.1 The CH <sub>4</sub> /HF Relation for all Winters . . . . .	75
7.2 The Early Winter Ozone-Tracer Reference Relation . . . . .	79
7.3 Meteorological Conditions and the HCl-Tracer and O <sub>3</sub> -Tracer Relation in Arctic Winters 1991–2003 . . . . .	87
<b>8 Column Ozone Loss and Ozone Loss Profiles</b>	<b>95</b>
8.1 Vertical Ozone Loss Profiles in Arctic Winters 1991–2003 . . . . .	95
8.2 Column Ozone Loss in Arctic Winters 1991–2003 . . . . .	99
8.3 Discussion of the TRAC Technique . . . . .	106
<b>9 Comparison of Results With Earlier Studies</b>	<b>111</b>
9.1 HALOE Results in Comparison With Earlier Studies Based on HALOE . . . . .	111
9.2 Comparison of Ozone Loss Derived Using Different Methods . . . . .	114
9.3 Impact of Meteorological Conditions on Ozone Loss . . . . .	119
<b>10 Summary and Outlook</b>	<b>125</b>
<b>A Satellite Measurements</b>	<b>127</b>
A.1 ILAS . . . . .	127
A.2 HALOE . . . . .	128
<b>B Tracer-Tracer Reference Relations</b>	<b>131</b>
<b>List of Figures</b>	<b>137</b>
<b>List of Tables</b>	<b>141</b>
<b>Abbreviations and Symbols</b>	<b>143</b>
<b>Bibliography</b>	<b>147</b>

