

# CONTENTS

<i>LIST OF FIGURES</i>	xiii
<i>LIST OF TABLES</i>	xv
<i>FOREWORD BY MARTIN L. PARRY</i>	xvii
<i>PREFACE</i>	xix
<i>ACKNOWLEDGEMENTS</i>	xxv
<b>I. THE SETTING</b>	<b>1</b>
A. CLIMATE SENSITIVITY - POLITICAL REALITY	1
B. WEATHER AND CLIMATE: IS THERE A DIFFERENCE?	2
C. UNDERSTANDING THE ATMOSPHERIC RESOURCE	3
1. The Setting	3
2. Information and Decision-Making	4
D. IMPORTANCE OF WEATHER AND CLIMATE VARIATIONS	4
E. WEATHER AND CLIMATE: A SERIOUS GAME	5
F. CLIMATIC SOLUTIONS TO PROBLEMS	6
G. FOOD, WEATHER INFORMATION, AND POLITICS	8
H. POLITICAL AND STRATEGIC ECONOCLIMATOLOGY	9
<b>II. THE CHANGING ECONOMIC CLIMATE</b>	<b>10</b>
A. THE REAL ECONOMIC CLIMATE	10
1. Area, Time, and Business Aspects	10
2. Information, Economics, and Politics	11
3. Weather and Climate and Human Well-Being	12
B. CHANGING DIRECTIONS IN CLIMATOLOGY	13
1. An Overview	13
2. Climate Data	13
3. The Development Phase	14
4. 1960-70 Changes and Socio-Economic Developments	15

5. National, Regional, and International Programmes	16
6. The 1980's	17
7. Directions for the Future	17
C. HUMAN RESPONSES TO ATMOSPHERIC RESOURCES	18
1. The Media Speak	18
2. Atmospheric Interactions and Decision-Making	18
D. SPECIFIC NATIONAL RESPONSES: THE ROLE OF THE PUBLIC, EDUCATION, AND PRIVATE SECTORS	19
1. National Business and Government	19
2. The New Zealand Approach	19
3. The United States Approach	20
4. The Universities	21
E. NATIONAL SENSITIVITY TO WEATHER AND CLIMATE EVENTS	21

### III. THE GLOBAL SCENE 23

A. THE INTERNATIONAL SCENE	23
1. International Responses and Concerns	23
2. World Meteorological Organization	23
3. Weather and Food: A Case Study Response of International Organizations	24
4. World Climate Programme	25
B. SPECTRUM OF WEATHER AND CLIMATE VARIATIONS	26
1. An Overview	26
2. The Atmospheric Component	27
3. Political and Marketing Realities	27
C. GREENHOUSE GASES / CLIMATE CHANGE DILEMMA	28
1. An Overview	28
2. 1985 Villach Conference Findings	29
3. 1987 Villach Workshop on Climate Change	30
4. Management Options for Responding to Climate Change	33
5. Timing of Responses to Climate Change	34
6. Costs of Responding to Climate Change	35
7. The Role of the Market and International Initiatives	35
D. OZONE - ENVIRONMENTAL AND CLIMATIC EFFECTS	37
1. Ozone: Creation and Destruction	37
2. The Antarctic Ozone Hole	38
3. The Montreal Protocol	38
4. Ozone Impacts	38
E. WEATHER AND CLIMATE MODIFICATION	39
1. An Overview	39
2. Weather Modification and Tomorrow's Weather: Essential Linkages	40
3. The Acid Rain Problem	40

4. Implications of a 'Nuclear Winter'	41
F. CLIMATE CHANGE AND POLITICAL REALITIES	41
<b>IV. INFORMATION, COMMODITIES, AND COMMUNICATIONS</b>	<b>44</b>
A. DATA AND INFORMATION	44
B. CLIMATE EFFECT STUDIES	46
C. ECONOMIC AND WEATHER / CLIMATE DATA SOURCES	47
1. The Data Problem	47
2. Sampling the National Scene	47
3. The Use of Commodity-Weighted Data	47
D. WEATHER AND CLIMATE INFORMATION	48
1. The Value of Weather and Climate Information	48
2. Presentation of Weather and Climate Information	49
3. Weather and Climate Information and Decision-Making	49
4. Realizing the Value of Weather and Climate Information	50
E. BENEFITS AND COSTS OF WEATHER / CLIMATE INFORMATION	51
1. Actual and Potential Aspects	51
2. Agricultural Benefits	52
3. Building and Construction Benefits	52
4. National Benefits	52
F. RESPONSES TO WEATHER / CLIMATE VARIATIONS	53
G. COMMUNICATING WEATHER AND CLIMATE INFORMATION	54
1. Communications	54
2. The Popular and the Business Press	54
3. Television Weathercasting	55
4. Videotex Systems	56
<b>V. WEATHER MONITORING AND FORECASTING</b>	<b>58</b>
A. MONITORING AND UNDERSTANDING THE WEATHER/CLIMATE RESOURCE	58
1. Observing the Weather	58
2. Climate Data Sources	59
3. Climate Change and Climate Variations	60
4. Monitoring Climate Variability	60
B. WEATHER FORECASTS	61
1. Balancing Scientific Enquiry with the Value of the Product	61
2. The Weather Forecast: Its Use and Value	62
3. Weather Forecasting: Analysis into Words	63

4. Weather Forecasts and the User	63
5. The Value of Weather Forecasting: Future Aspects	65
<b>VI. IMPACTS AND SENSITIVITIES</b>	<b>66</b>
A. CLIMATE SENSITIVITY	66
1. An Overview	66
2. Characterizing Climate Sensitivity	67
3. Identifying and Assessing the Sensitivities	67
4. Review of Weather and Climate Sensitivity Studies	68
5. Analysis of Information Uses and Value	70
6. Quantitative Analyses	71
B. WEATHER AND CLIMATE: THE CHALLENGE OF OPERATIONAL DECISION-MAKING	72
C. THE IMPACT OF CLIMATE	73
1. An Overview	73
2. Climate Impacts Research: Two Examples	75
<b>VII. WEIGHTING THE WEATHER</b>	<b>77</b>
A. THE VALUE OF WEATHER AND CLIMATE TO AN AREA	77
B. COMMODITY-WEIGHTED WEATHER INDICES: THE WHY, WHAT, AND HOW	77
1. An Overview	77
2. The New Zealand Experience	78
3. A United States Example	81
C. NATIONAL COMMODITY-WEIGHTED WEATHER AND CLIMATE INDICES	82
1. The Setting	82
2. National Weather, Consumption, and Production	84
3. New Zealand National Rainfall Indices: 1950-84	84
4. Weighted National Agricultural Soil Water Deficit Indices	84
5. Application of National Commodity-Weighted Weather and Climate Indices	85
<b>VIII. THE AGRICULTURAL SCENE</b>	<b>87</b>
A. DROUGHTS	87
1. Drought Impact Pathways	87
2. Costs of Drought: Problems of Measurement	88

3. Beneficial Effects of Drought	88
4. Drought and an Intense Freeze: An Example	89
5. Drought in Canterbury, New Zealand: What the Climate Record Revealed	89
6. Drought in Africa: The Sahel Experience	91
<b>B. PASTORAL PRODUCTION AND WEATHER RELATIONSHIPS</b>	93
1. The World Scene from a New Zealand Viewpoint	93
2. Livestock Investment Response: A New Zealand Example	95
<b>C. THE COMMODITIES MARKET</b>	95
1. Weather and the Futures Market: A United States Example	95
2. Commodity Prices: A Specific Example	97
<b>D. CLIMATE PRODUCTIVITY INDICES: NATIONAL AND INTERNATIONAL</b>	97
1. National Climate Productivity Indices: A New Zealand Example	97
2. International Climate / Agriculture Linkages	99
3. International Climatic Productivity Indices	101
<b>IX. WEATHER RELATIONSHIPS</b>	103
<b>A. ELECTRIC POWER / WEATHER RELATIONSHIPS</b>	103
1. An Overview of Early Studies	103
2. Electric Power Consumption and Temperatures: A New Zealand Example	103
3. Monitoring Electric Power Consumption: The Value of Weather Information to the New Zealand Decision-Maker	105
4. Summer Electric Power Consumption and Temperatures: A United States Example	106
5. Application of Weather Modification to the Electric Power Industry: Two Case Studies	108
<b>B. MANUFACTURING / WEATHER RELATIONSHIPS</b>	109
1. Perception of the Effects of Weather on Manufacturing	109
2. Impact of Severe Weather Conditions on Manufacturing Activities	110
<b>C. RETAIL TRADE / WEATHER RELATIONSHIPS</b>	111
1. Some Previous Weather / Retail Trade Analyses	111
2. A Japanese Example	112
3. A United States Example	113
<b>D. ROAD CONSTRUCTION / WEATHER RELATIONSHIPS</b>	116
1. The Setting	116
2. The Effects of Weather on Road Construction: A Simulation Model	116
3. The Effects of Weather on Road Construction: Applications of the Simulation Model	119
<b>E. TRANSPORT / WEATHER RELATIONSHIPS</b>	122
1. Productivity and Transport	122

2. Transport Costs Beyond the Farm Gate: A New Zealand Example	122
<b>F. CONSTRUCTION / WEATHER RELATIONSHIPS</b>	123
1. Impact of Weather on Construction Planning	124
2. The Economic Impact of Weather on the Construction Industry of the United States	124
3. Applications of Probability Models in Using Weather Forecasts to Plan Construction Activities	124
<b>G. NATIONAL INCOME AND PRODUCT ACCOUNTS: A NEW ZEALAND EXAMPLE</b>	125
<b>X. FORECASTING PRODUCTION</b>	127
A. THE ASSESSMENT ROLE	127
B. WEATHER / ECONOMIC MODELS	127
1. An Overview	127
2. Explanatory Models	128
3. Empirical Models	128
C. WEATHER AND CLIMATE BASED FORECASTS OF AGRICULTURAL PRODUCTION	129
1. An Overview	129
2. Dairy Production Forecasts: A New Zealand Example	129
3. Wool Production Forecasts: A New Zealand Example	135
D. WEATHER AND CLIMATE BASED FORECASTS OF BUSINESS ACTIVITY	138
1. Business Activities: Sensitivity Analysis	138
2. National Economic Indicators: A United States Example	138
3. Adjusting the <i>Business Week Index</i>	141
4. The Way Ahead	144
<b>XI. THE FUTURE</b>	146
A. THE WEATHER ADMINISTRATOR OF THE FUTURE	146
1. The Ministry of Atmospheric Resources	146
2. Seasonal Forecasts and Climate Impacts	147
B. WEATHER / CLIMATE: THE INFORMATION OPPORTUNITY	149
C. THE CHALLENGE AHEAD	149
<b>NOTES</b>	153
<b>BIBLIOGRAPHY</b>	158
<b>INDEX</b>	168