

Contents

1 The State of Weather Radar Operations, Networks and Products

<i>Frank Gekat, Peter Meischner, Katja Friedrich, Martin Hagen, Jarmo Koistinen, Daniel B. Michelson, and Asko Huuskonen</i>	1
1.1 Introduction	1
1.2 Doppler Radars	3
1.3 Polarimetric Radars	13
1.4 Weather Radar Networking	17
1.5 Data Quality	19
1.6 Products of Modern Weather Radars and Networks	35

2 Operational Measurement of Precipitation in Mountainous Terrain

<i>Urs Germann and Jürg Joss</i>	52
2.1 Introduction with a Focus on the Variability of Precipitation in the Alps	52
2.2 Clutter Elimination	58
2.3 Correction for Visibility	63
2.4 Profile Correction	67
2.5 Adjustments by Gauges	71
2.6 What Next?	74
References	75

3 Operational Measurement of Precipitation in Cold Climates

<i>Jarmo Koistinen, Daniel B. Michelson, Harri Hohti, and Markus Peura</i> ..	78
3.1 Introduction	78
3.2 Problems Due to Ducting over Cold Surfaces	80
3.3 Precipitation Phase	90
3.4 Shallow Precipitation: the Main Limiting Factor	94
3.5 Nowcasting	104
3.6 Future Outlook	109
3.7 Acknowledgements	110
References	110

4 Using Radar in Hydrometeorology	
<i>Christopher Collier, Paul Hardaker</i>	115
4.1 The Role of Radar in Flood Forecasting and Water Resources Management.....	115
4.2 Radar Data Quality Control	116
4.3 Flood Forecasting	118
4.4 Coupled Atmospheric and Hydrologic Numerical Models	123
4.5 Engineering Design	125
4.6 Future Prospects	127
References	127
5 Improved Precipitation Rates and Data Quality by Using Polarimetric Measurements	
<i>Anthony Illingworth</i>	130
5.1 Introduction	130
5.2 The Polarisation Parameters	131
5.3 Raindrop Shapes and Size Spectra	139
5.4 Identification of Ground Clutter and Anomalous Propagation	144
5.5 Improved Rainfall Rates using Polarisation Parameters.....	145
5.6 Improved Rainfall Rate Using Integrated Polarisation Parameters	150
5.7 Improved Rainfall Rates When Ice May Be Present	157
5.8 Correction for Attenuation	158
5.9 Identification of Hydrometeors	159
5.10 Conclusion	160
References	163
6 Understanding Severe Weather Systems by Advanced Weather Radar Observations	
<i>Peter Meischner, Nikolai Dotzek, Martin Hagen, Hartmut Höller</i>	167
6.1 Introduction	167
6.2 Frontal Systems	168
6.3 Deep Convective Systems.....	172
6.4 The Future	195
References	196
7 Precipitation Measurements from Space	
<i>Jacques Testud</i>	199
7.1 Correcting for Attenuation: A Major Problem with a Space Borne or an Airborne Radar	199
7.2 Statistical Properties of the Drop-Size Distribution and Parameterisation of the Rain Relations	204
7.3 Algorithms for Rain Retrieval with a Spaceborne Weather Radar	215
7.4 Airborne Dual Beam Doppler Radar	218
7.5 Validation of the Algorithm Product with Airborne or Space Borne Radars	222

7.6 The Spaceborne Technology Applied to Ground Based Polarimetric Radar: Algorithm ZPHI	226
7.7 The Rain Profiling Algorithm in Future Operational Applications	232
References	232
8 Radar Sensor Synergy for Cloud Studies; Case Study of Water Clouds	
<i>Herman Russchenberg, Reinout Boers</i>	235
8.1 Introduction	235
8.2 Particle Scattering	236
8.3 Sensor Synergy	240
8.4 Case Study: Retrieval of the Microstructure of Water Clouds	243
8.5 Acknowledgements	252
9 Assimilation of Radar Data in Numerical Weather Prediction (NWP) Models	
<i>Bruce Macpherson, Magnus Lindskog, Véronique Ducrocq, Mathieu Nuret, Gregor Gregorič, Andrea Rossa, Günther Haase, Iwan Holleman, and Pier Paolo Alberoni</i>	255
9.1 Introduction	255
9.2 Data Assimilation	256
9.3 Assimilation of Radar Precipitation Data in NWP Models	259
9.4 Assimilation of Radar Wind Data	268
9.5 Quality Control of Radar Data for NWP	273
9.6 Treatment of Radar Data Errors in Assimilation	274
9.7 Future Prospects	275
References	276
Glossary	281
Color Plates	313
Index	333