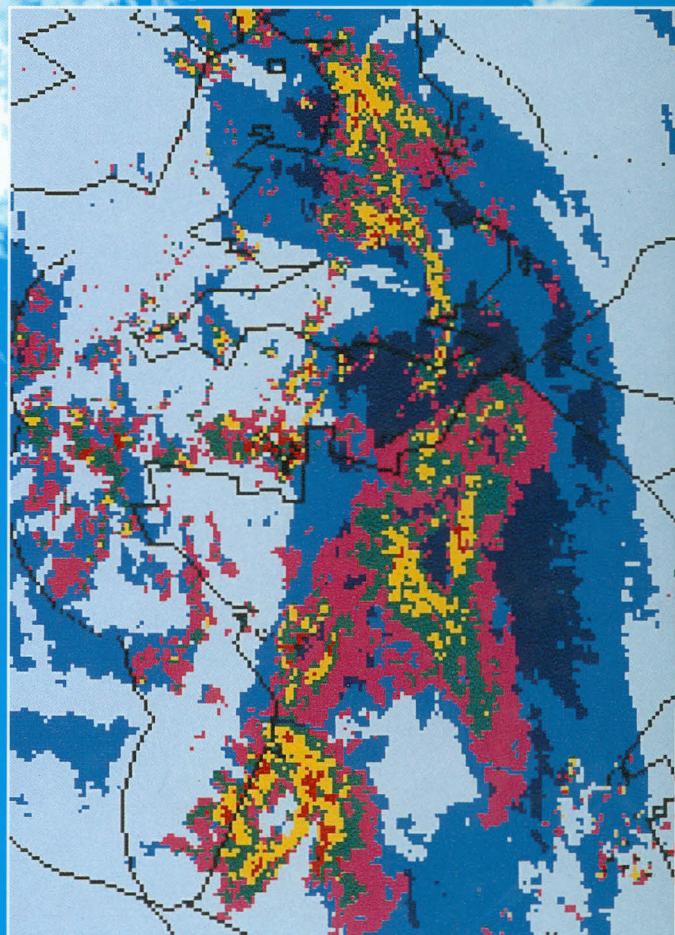


# Images in weather forecasting

A practical guide for interpreting satellite and radar imagery



**M.J. Bader, G.S. Forbes, J.R. Grant, R.B.E. Lilley and A.J. Waters**

CI 20

DK 551.501.8

551.509.3

# Images in weather forecasting

A practical guide for interpreting satellite and radar imagery

Edited by

M. J. Bader, *Meteorological Office, UK*

G. S. Forbes, *Pennsylvania State University, USA*

J. R. Grant, *Meteorological Office, UK*

R. B. E. Lilley, *Meteorological Office, UK*

A. J. Waters, *Meteorological Office, UK*

Foreword by

K. A. Browning, *Joint Centre for Mesoscale Meteorology, University of Reading, UK*

313/3910 INSTITUT  
FÜR METEOROLOGIE U. KLIMATOLOGIE  
UNIVERSITÄT HANNOVER  
HERRENHÄUSER STR. 2 - 30419 HANNOVER



CAMBRIDGE  
UNIVERSITY PRESS

# Contents

<i>List of contributors</i>	xiv	
<i>Foreword</i>	xvii	
<i>Editorial</i>	xix	
<i>Acknowledgements</i>	xxi	
<i>Synopses of chapters: R. K. Anderson</i>	xxii	
<b>Introduction: The use of imagery in forecasting</b>	1	
<i>Lead authors: A. Woodroffe, P. G. Wickham</i>		
1 Overview	1	
2 Subjective weather analysis	1	
2.1 Synoptic-scale analysis		
2.2 Mesoscale analysis		
3 Numerical model analyses	1	
3.1 The role of human intervention		
3.2 Mesoscale model data assimilation		
4 Imagery and weather	4	
4.1 Satellite imagery		
4.2 Radar imagery		
5 Imagery in the forecasting process	5	
5.1 Use of animation		
5.2 Interactive nowcasting systems		
5.3 Monitoring the performance of a numerical forecast		
<b>1 Satellite imagery</b>	7	
<b>1.1 Basic principles</b>	7	
<i>Lead authors: R. Brown, P. G. Wickham</i>		
1.1.1 Fundamental ideas in satellite remote sensing		
1.1.1.1 Physical principles		
1.1.1.2 Satellite imagery		
1.1.2 Types of meteorological satellite		
1.1.2.1 Polar-orbiting satellites		
1.1.2.2 Geostationary satellites		
1.1.3 Satellite characteristics		
1.1.4 Dissemination of satellite imagery		
1.1.4.1 Digital and analogue transmissions		
1.1.4.2 Data from polar-orbiting and geostationary satellites		
1.1.5 Basic interpretation of VIS imagery		
1.1.5.1 General principles		
1.1.5.2 Problem areas in interpreting VIS imagery		
(a) Distinguishing clouds from snow-covered ground		
(b) Small clouds		
(c) Thin clouds		
1.1.6 Basic interpretation of IR imagery		
1.1.6.1 General principles		
1.1.6.2 Problem areas in interpreting IR imagery		
1.1.7 Basic interpretation of WV imagery		
1.1.7.1 Principles of operation		
1.1.7.2 Interpretation of WV imagery		
1.1.8 Basic interpretation of 3.7 µm (channel-3) imagery		
1.1.8.1 General principles		
1.1.8.2 Interpretation of night-time 3.7 µm imagery		
1.1.8.3 Use of combined 3.7 µm and IR data for fog identification		
1.1.8.4 Interpretation of daytime 3.7 µm imagery		
<b>1.2 Simple identification</b>	17	
<i>Lead authors: R. S. Scorer, P. G. Wickham</i>		
1.2.1 Introduction		
1.2.2 Cloud types		
1.2.2.1 Convective clouds		
(a) Oceanic convective clouds		
(b) Continental convective storms		
1.2.2.2 Frontal layer clouds		
1.2.2.3 Stratus and fog		
1.2.2.4 Anticyclonic stratocumulus		
(a) Oceanic anticyclonic vortex		
(b) A continental anticyclone		
1.2.3 Cloud patterns		
1.2.3.1 Linear patterns		

<ul style="list-style-type: none"> <li>(a) Streets, bands and lines of convective clouds</li> <li>(b) Lee waves and orographic clouds</li> <li>(c) Rope clouds</li> </ul>	<ul style="list-style-type: none"> <li>2.1.3.8 'Clear-air' echo</li> </ul>
<ul style="list-style-type: none"> <li>1.2.3.2 Vortices           <ul style="list-style-type: none"> <li>(a) Small vortices</li> <li>(b) Synoptic-scale depressions</li> <li>(c) Tropical storms</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>2.1.4 Adjustment of radar rainfall estimates using raingauge data</li> </ul>
<ul style="list-style-type: none"> <li>1.2.3.3 Cells</li> <li>1.2.3.4 Clusters</li> </ul>	<ul style="list-style-type: none"> <li>2.1.5 Doppler radar           <ul style="list-style-type: none"> <li>2.1.5.1 Basic principle</li> <li>2.1.5.2 Applications of Doppler radars in forecasting</li> <li>2.1.5.3 Interpretation of Doppler PPI displays</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>1.2.4 The Earth's surface           <ul style="list-style-type: none"> <li>1.2.4.1 Land surface features               <ul style="list-style-type: none"> <li>(a) Snow cover</li> <li>(b) Deserts and vegetated areas</li> </ul> </li> <li>1.2.4.2 Sea surface features               <ul style="list-style-type: none"> <li>(a) Sun glint</li> <li>(b) Sea temperature gradients</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>2.2 Simple identification <span style="float: right;">61</span></li> </ul>
<ul style="list-style-type: none"> <li>1.2.5 Atmospheric pollutants           <ul style="list-style-type: none"> <li>1.2.5.1 Dust and haze</li> <li>1.2.5.2 Aircraft condensation trails (contrails)</li> <li>1.2.5.3 Ship trails</li> </ul> </li> </ul>	<p><i>Lead author: P. G. Wickham. Contribution from D. Zrnić (in Section 2.2.4)</i></p>
50	<ul style="list-style-type: none"> <li>2.2.1 Introduction</li> <li>2.2.2 Rainfall from layered clouds           <ul style="list-style-type: none"> <li>2.2.2.1 Warm front rainbands</li> <li>2.2.2.2 Warm sector rainbands</li> <li>2.2.2.3 Cold front rainbands</li> </ul> </li> <li>2.2.3 Rainfall from convective clouds           <ul style="list-style-type: none"> <li>2.2.3.1 Scattered showers</li> <li>2.2.3.2 Lines of showers</li> <li>2.2.3.3 Thunderstorms</li> </ul> </li> <li>2.2.4 Severe storms           <ul style="list-style-type: none"> <li>2.2.4.1 Squall lines and thunderstorms</li> <li>2.2.4.2 Rotating thunderstorms and tornadoes</li> </ul> </li> </ul>
<h2>2 Radar imagery</h2>	<h2>3 Synoptic-scale cloud and moisture patterns</h2>
<h3>2.1 Basic principles</h3> <p><i>Lead authors: G. L. Austin, P. G. Wickham</i></p> <ul style="list-style-type: none"> <li>2.1.1 The basic radar–rainfall relationship</li> <li>2.1.2 Radar data presentation           <ul style="list-style-type: none"> <li>2.1.2.1 Plan position indicator (PPI)</li> <li>2.1.2.2 Constant altitude plan position indicator (CAPPI)</li> <li>2.1.2.3 Range–height indicator (RHI)</li> </ul> </li> <li>2.1.3 Problems in radar imagery interpretation           <ul style="list-style-type: none"> <li>2.1.3.1 Spurious echoes</li> <li>2.1.3.2 Anomalous propagation (anaprop)</li> <li>2.1.3.3 Secondary radar echoes               <ul style="list-style-type: none"> <li>(a) Second-trip echoes</li> <li>(b) Sidelobe echoes</li> <li>(c) Flare echoes</li> </ul> </li> <li>2.1.3.4 Screening of precipitation by hills</li> <li>2.1.3.5 Growth and evaporation of precipitation below the beam</li> <li>2.1.3.6 Drop-size effects</li> <li>2.1.3.7 Snow and ice: bright bands</li> </ul> </li> </ul>	<p><b>50</b> <span style="float: right;">70</span></p>
	<p><i>3.1 Introduction</i> <span style="float: right;">70</span></p> <p><i>Lead authors: R. K. Anderson, T. N. Carlson, J. R. Grant. Contributions from M. J. Bader (in Section 3.1.1) and K. B. Katsaros (in Section 3.1.3.2)</i></p> <ul style="list-style-type: none"> <li>3.1.1 Panorama           <ul style="list-style-type: none"> <li>3.1.1.1 Clues from the satellite picture</li> <li>3.1.1.2 Physical and dynamical processes</li> <li>3.1.1.3 Interpretation of a satellite and radar picture</li> </ul> </li> <li>3.1.2 Kinematics           <ul style="list-style-type: none"> <li>3.1.2.1 Relative motion</li> <li>3.1.2.2 Deformation zones</li> <li>3.1.2.3 Vorticity and vorticity advection</li> </ul> </li> <li>3.1.3 Conveyor belts associated with fronts and waves           <ul style="list-style-type: none"> <li>3.1.3.1 Introduction to the conveyor belt conceptual model</li> <li>3.1.3.2 Warm conveyor belt (WCB)</li> <li>3.1.3.3 Cold conveyor belt (CCB)</li> <li>3.1.3.4 The dry airstream</li> </ul> </li> </ul>

<b>3.2 Interpreting large-scale patterns of cirriform cloud and moisture</b>	96	<b>3.4.4 Vortex</b>	
<i>Lead author: R. K. Anderson</i>		3.4.4.1 Characteristics of shape	
3.2.1 Introduction		3.4.4.2 Relationship to analysis	
3.2.2 Cirrus cloud bands		3.4.4.3 The vortex and turbulence	
3.2.2.1 Locating polar jet streams		<b>References</b>	137
3.2.2.2 Locating the sub-tropical jet stream			
3.2.2.3 Locating turbulence associated with jet streams			
3.2.3 Cirrus shields			
3.2.3.1 Locating thermal and upper ridges			
3.2.3.2 Locating thermal gradients			
3.2.3.3 Locating turbulence			
3.2.4 Deformation zone cirrus and moisture			
3.2.4.1 Locating upper anticyclones			
3.2.4.2 Locating turbulence in deformation zones			
(a) Identification with cirrus		4 <b>Fronts and waves</b>	138
(b) Identification with WV			
<b>3.3 Interpreting patterns of cumuliform clouds</b>	112	<b>4.1 Classical cold fronts</b>	138
<i>Lead author: R. K. Anderson</i>		<i>Lead author: G. A. Monk. Contributions from M. Kurz (in Sections 4.1.2.1–4.1.2.3) and V. Zwatz-Meise (in Section 4.1.7)</i>	
3.3.1 Introduction		4.1.1 Differences between classical and split fronts	
3.3.2 Locating thermal troughs		4.1.2 Development of cold frontal cloud bands	
3.3.3 Locating upper short-wave troughs		4.1.2.1 Characteristics on satellite images	
3.3.4 Locating jet-stream axes		4.1.2.2 Upper air analysis	
3.3.5 Locating surface ridges		4.1.2.3 Surface analysis and precipitation distribution	
<b>3.4 Interpreting features associated with baroclinic troughs</b>	120	4.1.2.4 Frontogenesis using Q-vectors	
<i>Lead author: R. K. Anderson. Contributions from R. B. Weldon (in Sections 3.4.2 and 3.4.3)</i>		4.1.3 Conceptual model	
3.4.1 Introduction		4.1.4 Guidance on analysis from imagery	
3.4.2 Leaf		4.1.4.1 A well developed cold front	
3.4.2.1 Characteristics of a leaf		4.1.4.2 Weakening fronts	
3.4.2.2 Relationship to analysis		4.1.5 Surface weather	
3.4.2.3 Leaf variations		4.1.5.1 Line convection	
3.4.2.4 Leaf to comma transition		4.1.5.2 Precipitation ahead of the surface front	
3.4.3 Comma		4.1.5.3 Precipitation behind the surface front	
3.4.3.1 Characteristic appearance		4.1.6 Squall line development	
3.4.3.2 Comma clouds in frontal zones		4.1.7 Interaction with jet streaks	
3.4.3.3 Comma clouds in cold air			
3.4.3.4 The comma and turbulence		<b>4.2 Split cold fronts</b>	154
(a) In the cusp region		<i>Lead author: G. A. Monk</i>	
(b) In the dry slot of the comma		4.2.1 Development of split frontal cloud bands	
(c) Near the comma tail		4.2.2 Features on satellite images	
(d) Near the poleward edge of the cold cloud shield		4.2.3 Surface and upper air analyses	
		4.2.4 Conceptual model and surface weather	
		4.2.4.1 The shallow moist zone	
		4.2.4.2 Release of potential instability	
		4.2.4.3 The surface front	
<b>4.3 Warm fronts</b>	162		
<i>Lead author: V. Zwatz-Meise. Contribution from J. R. Grant (in Section 4.3.5)</i>			
4.3.1 Introduction			
4.3.2 The cloud band			
4.3.3 Cloud development in the warm sector			

4.3.4 ‘Detached’ warm frontal cloud		5.1.2 Identifying key components	
4.3.4.1 Characteristics		5.1.3 Upper-flow patterns from satellite images	
4.3.4.2 Examples		5.1.3.1 Frontal band and separate comma cloud	
4.3.5 Precipitation distribution		5.1.3.2 Frontal band alone	
<b>4.4 Instant (pseudo) occlusions</b>	176	5.1.3.3 Frontal band with emerging cloud initially limited in extent	
<i>Lead author: M. Kurz. Extract from papers by McGinnigle, Young and Bader (in Section 4.4.1) and Browning and Hill (in Section 4.4.3)</i>		5.1.3.4 Frontal band with emerging cloud elongated along the flow	
4.4.1 Introduction		<b>5.2 Types of cyclogenesis</b>	213
4.4.2 Synoptic scale		<i>Lead author: M. V. Young. Contributions from R. A. Bosworth (in Section 5.2.2.1), G. S. Forbes (in Section 5.2.3.1) and L. Neil (in Sections 5.2.2.1, 5.2.3.2 and 5.2.3.3)</i>	
4.4.2.1 Early in the evolution		5.2.1 Introduction	
(a) Cloud characteristics and frontal analysis		5.2.2 Evolutions from enhanced cumulus or comma	
(b) Diagnostics		5.2.2.1 Cold air cyclogenesis	
4.4.2.2 Later in the evolution		5.2.2.2 Interaction with frontal cloud	
(a) Cloud characteristics and frontal analysis		(a) Instant occlusion cyclogenesis	
(b) Diagnostics		(b) Split flow cyclogenesis	
(c) Airflow model		5.2.3 Evolutions from the main frontal cloud	
4.4.2.3 Final stage		5.2.3.1 Meridional trough cyclogenesis	
(a) Cloud characteristics and frontal analysis		5.2.3.2 Flat trough, diffluent flow cyclogenesis	
(b) Diagnostics		5.2.3.3 Induced wave cyclogenesis	
(c) Airflow model		5.2.4 Flat trough, confluent flow cyclogenesis (cloud head)	
4.4.3 Mesoscale		5.2.4.1 Structure of a cloud head	
4.4.3.1 Alternative surface analysis		5.2.4.2 Conceptual model	
4.4.3.2 Movement of precipitation areas		5.2.4.3 Surface weather	
<b>4.5 Synoptic-scale waves</b>	187	5.2.5 Summary	
<i>Lead author: M. Kurz. Contribution from V. Zwätz-Meise (in Section 4.5.4.4)</i>		5.2.5.1 Locating the surface low centre	
4.5.1 Introduction		(a) Developing low within frontal cloud	
4.5.2 Basic dynamical concepts		(b) Developing low poleward of frontal cloud	
4.5.2.1 Stable waves		(c) Mature low	
4.5.2.2 Unstable waves		5.2.5.2 Overview of seven types of cyclogenesis	
4.5.3 Features on satellite images		5.2.5.3 Decision tree for determining cyclogenesis type	
4.5.4 Examples		<b>5.3 Mid-latitude cyclogenesis associated with tropical storms</b>	287
4.5.4.1 A cold front wave		<i>Lead author: M. V. Young. Contributions from R. J. Graham (in Section 5.3.3.2) and V. Pircher (in Section 5.3.3.1)</i>	
4.5.4.2 A stable warm front wave		5.3.1 Introduction	
4.5.4.3 An unstable wave		5.3.2 Tropical storm regeneration	
4.5.4.4 Upper-level waves		5.3.2.1 Tropical storm ‘Helene’	
References	205	5.3.2.2 Tropical storm ‘Felix’	
<b>5 Depressions in mid-latitudes</b>	206		
<b>5.1 Cloud signatures preceding cyclogenesis</b>	206		
<i>Lead authors: M. V. Young and J. R. Grant</i>			
5.1.1 Introduction			

5.3.3 Cyclogenesis initiated by tropical storms		A. J. Waters ( <i>in Section 6.1.2</i> )	
5.3.3.1 Tropical storm 'Hortense'		6.1.1 Introduction	
5.3.3.2 Hurricane 'Charley'		6.1.2 Maritime patterns	
5.3.4 Forecasting guidelines		6.1.3 Continental patterns	
<b>5.4 Occlusions and mature depressions</b>	302	6.1.3.1 Depiction in satellite imagery	
<i>Lead authors: M. Kurz, M. V. Young. Contributions from J. R. Grant (in Sections 5.4.2.2, 5.4.2.3 and 5.4.2.4)</i>		6.1.3.2 Depiction in radar imagery	
5.4.1 Introduction		<b>6.2 Convection initiated over oceans</b>	362
5.4.2 Occluded fronts		<i>Lead authors: E. M. Agee, B. A. Hall, E. McCallum, G. A. Monk, A. J. Waters</i>	
5.4.2.1 Development of an occlusion		6.2.1 Introduction	
(a) Synoptic evolution		6.2.2 Cloud patterns and their relation to atmospheric structure	
(b) Characteristics of the occluded system		6.2.2.1 Clear zones	
5.4.2.2 Surface weather associated with an occlusion		6.2.2.2 Cloud streets	
5.4.2.3 Locating the point of occlusion (triple point)		6.2.2.3 Closed cells	
5.4.2.4 Examples of mesoscale phenomena		6.2.2.4 Open cells	
(a) A new development in the cloud band		6.2.2.5 Other patterns	
(b) Overrunning dry air		6.2.3 Further examples of maritime convection	
5.4.3 Cloud and weather in occluded depressions		6.2.3.1 Mesoscale vortices in a thermal trough	
5.4.3.1 Synoptic scale		6.2.3.2 The use of channel 3	
5.4.3.2 Mesoscale		6.2.3.3 Enhancement over warm ocean currents	
5.4.3.3 Examples		6.2.4 Modifications near coasts	
(a) Spiral band breaking up		6.2.4.1 Shelter effects of land	
(b) Commas forming from a frontal band		6.2.4.2 Cloud growth downwind of the coast	
<b>5.5 Non-deepening depressions</b>	327	6.2.4.3 The effect of bay and inlet shape	
<i>Lead author: M. V. Young</i>		6.2.4.4 Topographically induced convergence of flows	
5.5.1 Clues from imagery		6.2.4.5 Cellular convection over land	
5.5.2 Upper-air patterns		<b>6.3 Topographically induced convective cloud patterns</b>	376
5.5.3 Examples		<i>Lead authors: D. Parsons, J. F. W. Purdom. Contributions from G. S. Forbes (in Section 6.3.10), R. B. E. Liley (in Section 6.3.5.2) and G. A. Monk (in Section 6.3.2.2)</i>	
<b>5.6 Polar lows</b>	331	6.3.1 Introduction	
<i>Lead author: E. A. Rasmussen</i>		6.3.2 Convection associated with sea-breezes	
5.6.1 Introduction		6.3.2.1 Effects of the coastline shape: light winds	
5.6.2 Weather associated with polar lows		6.3.2.2 Effects of the coastline shape: moderate winds	
5.6.3 Polar lows within a synoptic-scale cold core aloft		6.3.3 Convection associated with land-breezes	
5.6.4 Polar low development within a surface trough		6.3.4 Land-based convection near inland water bodies	
5.6.5 Comma cloud associated with an upper trough		6.3.5 Winter time cloud bands	
5.6.6 Waves associated with shallow baroclinic zones		6.3.5.1 Winter bands over and downwind of inland water bodies	
5.6.7 Reverse-shear polar lows		6.3.5.2 Winter bands near coasts	
5.6.8 A polar-low-like vortex in the Mediterranean		6.3.5.3 Summary of winter time convective bands	
References	349		
<b>6 Convective cloud patterns</b>	350		
<b>6.1 Overview</b>	350		
<i>Lead author: J. F. W. Purdom. Contribution from</i>			

6.3.6 The influence of initial cloud cover on subsequent convection	6.5.6.4 Wedge shapes
6.3.7 The influence of wet ground and vegetation on convection	6.5.6.5 Radar signatures
6.3.8 The influence of cities on convection	6.5.7 Summary of forecasting convection
6.3.9 Convection over elevated terrain	References
6.3.10 Orographically induced convergence zones and mesoscale vortices	443
<b>6.4 Thunderstorm outflow and convective interaction</b> 393	<b>7 Fog and low cloud</b>
<i>Lead author: J. F. W. Purdom</i>	445
6.4.1 Introduction	<b>7.1 Radiation fog and stratus</b>
6.4.2 Convective storm low-level outflow and arc cloud lines	445
6.4.3 Outflow boundaries and new thunderstorm development	<i>Lead author: J. J. Gurka. Contribution from R. J. Allam (in Section 7.1.3.1)</i>
<b>6.5 Organized mesoscale convective systems</b> 400	7.1.1 Detection of fog in the daytime
<i>Lead author: J. F. W. Purdom. Contributions from G. S. Forbes (in Sections 6.5.3 and 6.5.6), R. B. E. Lilley (in Section 6.5.6.5), D. Parsons (in Sections 6.5.3 and 6.5.6), V. Pircher (in Section 6.5.5.2), R. Scofield (in Section 6.5.2.3, 6.5.4 and 6.5.7) and A. J. Waters (in Sections 6.5.1, 6.5.2.3, 6.5.5 and 6.5.6.2)</i>	7.1.2 Distinguishing between fog and stratus
6.5.1 Introduction	7.1.3 Detection of fog at night
6.5.2 Features in the pre-storm environment	7.1.3.1 Bispectral method
6.5.2.1 Moisture information in IR imagery	7.1.3.2 Black fog
6.5.2.2 Clouds as a clue to stability	7.1.4 Formation of fog and stratus within moisture boundaries
6.5.2.3 Water vapour imagery	7.1.5 Guidelines on formation and detection of fog
6.5.3 Types of mesoscale convective systems	7.1.6 Dissipation of fog and stratus: the role of inward mixing
6.5.3.1 Mobile squall lines	7.1.7 Guidelines for forecasting dissipation of fog
6.5.3.2 Slow-moving squall lines	<b>7.2 Sea fog</b>
6.5.3.3 Mesoscale convective complexes	456
6.5.4 Life-cycle and evolution of an MCS	<i>Lead author: J. J. Gurka. Extract from paper by J. Findlater (in Section 7.2.1)</i>
6.5.4.1 Forward propagating systems	7.2.1 Day-time imagery
6.5.4.2 Backward propagating systems	7.2.2 Night-time imagery
6.5.4.3 MCS evolution within a comma	7.2.3 Sea fog motion
6.5.5 Precipitation patterns in MCSs	7.2.4 The effect of coastlines and other mesoscale influences on fog
6.5.5.1 Convective and stratiform areas	<b>7.3 Stratocumulus</b>
6.5.5.2 Distribution of precipitation beneath a cloud shield	464
6.5.6 Severe weather associated with MCSs	<i>Lead author: P. G. Wickham. Contributions from R. J. Allam (in Sections 7.3.1 and 7.3.6), G. Holpin (in Section 7.3.5) and W. T. Roach (in Section 7.3.3)</i>
6.5.6.1 Interaction of boundaries	7.3.1 The appearance of stratocumulus
6.5.6.2 Overshooting tops	7.3.2 The importance of stratocumulus
6.5.6.3 Cold-to-warm couplets	7.3.3 The physical environment and evolution of stratocumulus
	7.3.4 The motion of stratocumulus
	7.3.5 Satellite observations of stratocumulus cloud-top temperature
	7.3.6 Small-scale structure of stratocumulus
	References
	471

---

<b>8 Orographic and polar phenomena</b>	472	8.3.2 High-latitude cloud types	
<b>  8.1 Clouds generated by mountains</b>	472	8.3.2.1 Convective clouds	
<i>Lead authors: R. S. Scorer, R. K. Anderson. Contribution from G. Ellrod (in Section 8.1.2)</i>		8.3.2.2 Stratiform clouds	
8.1.1 Lee waves and orographic cirrus		8.3.2.3 Cirrus clouds	
8.1.2 Inferring areas of turbulence		8.3.3 Topographical phenomena	
8.1.3 Other examples		8.3.3.1 Drainage flow	
<b>  8.2 Mountain barrier effects: föhn</b>	478	8.3.3.2 Downslope winds	
<i>Lead author: H. P. Roesli</i>		8.3.3.3 Lee effects	
8.2.1 The barrage cloud		8.3.3.4 Wind and sea ice motion	
8.2.2 Fog		8.3.4 Vortices in the polar regions	
<b>  8.3 Polar phenomena</b>	484	8.3.4.1 Ice-edge vortices	
<i>Lead authors: J. Turner, M. Row</i>		8.3.4.2 Polar lows	
8.3.1 Identifying clouds in polar imagery		8.3.4.3 Mid-latitude depressions in the polar regions	
8.3.1.1 VIS and IR imagery		References	490
8.3.1.2 3.7 µm (near-IR) imagery			
8.3.1.3 Discriminating clouds from sea ice		<i>Glossary of terms and abbreviations</i>	491
		<i>Index</i>	495