

<b>Index</b>		<b>Seite</b>
Introduction . . . . .	7	
List of symbols . . . . .	9	
<b>1 BASIC EQUATIONS . . . . .</b>	<b>11</b>	
1.1 Equations of thermodynamics . . . . .	11	
1.2 Equations of motion . . . . .	11	
<b>2 RELATIONS BETWEEN WIND, PRESSURE AND TEMPERATURE FIELDS . . . . .</b>	<b>13</b>	
2.1 Order of magnitude of synoptic systems . . . . .	13	
2.2 Hydrostatic equilibrium . . . . .	13	
2.3 Forms of equilibrium with horizontal motion . . . . .	14	
2.4 Trajectories and streamlines . . . . .	16	
2.5 Pressure as vertical coordinate . . . . .	18	
2.6 Vertical change of the geostrophic wind . . . . .	19	
2.7 Temperature advection and local temperature change . . . . .	20	
2.8 Changes in vertical stability . . . . .	22	
2.9 Vertical structure of pressure systems . . . . .	23	
2.10 Ageostrophic wind components . . . . .	24	
2.11 Dynamic stability . . . . .	27	
<b>3 PRINCIPLES OF DYNAMICS . . . . .</b>	<b>29</b>	
3.1 Characteristics of the horizontal wind field . . . . .	29	
3.1.1 Translation . . . . .	29	
3.1.2 Deformation . . . . .	29	
3.1.3 Divergence . . . . .	31	
3.1.4 Rotation (vorticity) . . . . .	33	
3.1.5 Computation of vorticity . . . . .	35	
3.2 The equation of continuity . . . . .	35	
3.3 The pressure tendency equation . . . . .	37	
3.4 The vorticity equation . . . . .	38	
3.5 Potential vorticity . . . . .	40	
3.6 Circulation and circulation theorem . . . . .	41	
<b>4 AIR MASSES . . . . .</b>	<b>44</b>	
4.1 Origin, classification and characteristics of air masses . . . . .	44	
4.2 Air mass transformation . . . . .	46	

<b>5</b>	<b>FRONTS AND FRONTAL ZONES</b>	49
5.1	Conditions of equilibrium on front surfaces	49
5.2	Conditions of equilibrium on frontal zones	50
5.3	The structure of the polar front	52
5.4	Classification of surface fronts; front movement	56
5.5	Appearance of fronts	57
5.6	Front models	60
5.6.1	Warm fronts	61
5.6.2	Cold fronts	62
5.6.3	Occluded fronts	64
5.6.4	Mesoscale structures in the area of frontal systems	65
5.7	Front analysis	65
<b>6</b>	<b>JET STREAMS</b>	68
6.1	Appearance	68
6.2	Horizontal and vertical wind shear	69
6.3	Course of the jet axis	70
<b>7</b>	<b>FRONTOGENESIS AND FRONTOLYSIS</b>	73
7.1	General aspects	73
7.2	Frontogenesis and frontolysis in the horizontal wind field	73
7.3	Cross circulations with frontogenesis and frontolysis	74
7.3.1	Theory	74
7.3.2	Application to frontogenetic fields	76
7.3.3	Influence of diabatic heat transfers	79
7.4	Conditions near the ground	81
7.5	Examples of frontogenetic processes	81
<b>8</b>	<b>THE STRUCTURE OF CYCLONES AND ANTICYCLONES IN THE MID LATITUDES</b>	92
8.1	Historical review	92
8.2	Life cycle of cyclones	93
8.3	Thermal and vertical structure of cyclones during their development	97
8.4	Cyclone families	99
8.5	Anticyclones	99
<b>9</b>	<b>TROPOSPHERIC WAVES</b>	101
9.1	Appearance	101
9.2	Identification and behaviour of long waves	101
9.3	Upper level cyclones and anticyclones	105

9.4	Index cycle . . . . .	110
<b>10</b>	<b>KINEMATICS OF LARGE SCALE STRUCTURES . . . . .</b>	<b>111</b>
10.1	Kinematics of pressure systems . . . . .	111
10.2	Kinematics of vorticity extremes . . . . .	113
10.3	Relative motions of the air particles within moving pressure systems . . . . .	118
<b>11</b>	<b>MODELS OF CYCLOGENESIS AND ANTICYCLOGENESIS . . . . .</b>	<b>122</b>
11.1	Conceptual models of development and movement of surface cyclones and anticyclones . . . . .	122
11.2	On the divergence distribution in the upper current . . . . .	123
<b>12</b>	<b>QUASI-GEOSTROPHIC DIAGNOSTICS . . . . .</b>	<b>126</b>
12.1	Temperature and geopotential change . . . . .	126
12.2	Vorticity and geopotential change . . . . .	126
12.3	The omega equation . . . . .	127
12.4	Q-vector diagnostics . . . . .	128
<b>13</b>	<b>CONSIDERATIONS OF DEVELOPMENT IN A BAROCLINIC TWO LAYER MODEL . . . . .</b>	<b>130</b>
13.1	Model equations . . . . .	130
13.2	Baroclinic instability . . . . .	131
13.3	Energetics . . . . .	133
13.4	Stable baroclinic waves . . . . .	134
13.4.1	Waves with geopotential and temperature fields in phase . . . . .	134
13.4.2	Waves with 180° phase difference between geopotential and temperature fields (frontal waves) . . . . .	137
13.5	Unstable baroclinic waves; cyclogenesis – anticyclogenesis . . . . .	139
13.5.1	General . . . . .	139
13.5.2	Origin . . . . .	140
13.5.3	Further development . . . . .	144
13.5.4	Final conditions . . . . .	145
13.5.5	Linkage with developments downstream and upstream . . . . .	146
13.6	Damped baroclinic waves . . . . .	147
13.7	Moving upper level cyclones (“cold air drops”) . . . . .	148
13.8	Potential vorticity and cyclogenesis . . . . .	148
<b>14</b>	<b>SUPPLEMENTARY FACTORS CONCERNING CYCLOGENESIS AND ANTICYCLOGENESIS . . . . .</b>	<b>152</b>
14.1	Surface friction . . . . .	152
14.2	Exchange of sensible heat . . . . .	153