



Sea breeze and local winds



JOHN E. SIMPSON

Department of Applied Mathematics and Theoretical Physics, University of Cambridge



CAMBRIDGE
UNIVERSITY PRESS

Contents

<i>Foreword</i>	xi
<i>Preface</i>	xiii
1 <i>The sea breeze</i>	
1.1 Introduction	1
1.2 Sea-breeze clouds	3
1.3 The sea breeze in history	4
1.4 The onset of the sea breeze	6
2 <i>Formation of the sea breeze</i>	
2.1 Land and sea-breeze generation	7
2.2 Pressure patterns and the sea breeze	7
2.3 Sea-breeze strength and direction: hodographs	12
2.4 Horizontal extent of the land-sea-breeze system	19
3 <i>Sea-breeze fronts</i>	
3.1 Structure of a sea-breeze front	27
3.2 Generation of sea-breeze fronts (frontogenesis)	32
3.3 Clouds at the sea-breeze front	34
3.4 Advance of sea-breeze front	36
3.5 Retreating sea-breeze fronts	42
3.6 Sea-breeze undular bore	46
4 <i>Sea-breeze forecasting</i>	
4.1 Land and sea temperatures through the year	49
4.2 Sea-breeze index	50

4.3	Prediction of inland penetration	52
4.4	Forecasting from the state of the tide	55
5	<i>Other local winds</i>	
5.1	Winds from diurnal heating on mountains	59
5.2	Orographic winds	68
5.3	Other local winds induced by differential heating	74
6	<i>Air quality</i>	
6.1	Pollution	85
6.2	Pollution in the sea breeze	85
6.3	Pollution at sea-breeze fronts	88
6.4	Diurnal recycling of pollution	91
6.5	Chemistry of sea-breeze pollution	94
7	<i>Sea breeze interactions</i>	
7.1	Sea-breeze convergence zones	101
7.2	Effects of headlands and peninsulas	101
7.3	Bifurcations	105
7.4	Meetings of fronts	106
7.5	Head-on collisions	108
7.6	Islands	113
7.7	Land-breeze convergence	116
8	<i>Life and the sea breeze</i>	
8.1	Pollen	121
8.2	Insect pests	124
8.3	Birds and the sea breeze	133
8.4	The sea breeze and humans	136
9	<i>Sports</i>	
9.1	Gliding and the sea breeze	141
9.2	Ballooning and the sea breeze	145
9.3	Sailing	148
10	<i>Technology: field measurements of the sea-breeze</i>	
10.1	Near the ground	157
10.2	Airborne measurements	165
10.3	Remote sensing: radar	167
10.4	Remote sensing: acoustic sounding or sodar (sonar)	175

10.5	Remote sensing: lidar	176
10.6	Satellite imagery	178
11	<i>Laboratory measurements</i>	
11.1	'Land- and sea-breeze' simulation in water tanks	183
11.2	The generation of sea-breeze fronts	185
11.3	Sea-breeze fronts	190
11.4	Use of tanks with moving floor	195
11.5	Ambient stratification: two-layer system	196
11.6	Collision of fronts	200
11.7	Requirements of laboratory models	204
12	<i>Theoretical models</i>	
12.1	Analytic models	208
12.2	Numerical models	214
	<i>References</i>	221
	<i>Index</i>	229