

Index

- Aberdeen, sea-breeze hodograph, 16
 acid rain, 97
 acoustic sounding, sodar, 67, 175
 Adelaide, airborne pollution, 15
 aerosols in sea-breeze pollution, 97
 African army worm, radar observations, 172
 ‘air avalanche’, in katabatic flow, 63
 air pollution, 85
 Athens, 91
 automobile exhaust, 99
 Los Angeles, 85
 recycling, 91–2
 airborne pollen over Long Island, 123
 aluminium powder, used in experiments, 184
 ambient stratification, two-layer model, 196
 anabatic flow, 60
 used by glider pilots, 61
 analytic models, 207–13
 anemometers
 cup, 158
 Dynes, 38
 hot wire, 159
 pressure plate, 159
 pressure tube, 158
 sonic, 159
 angels, radar echoes, 167
 antitriptic wind, 208
 aphids, 131
 Aristotle, 7
 arrival time of sea breeze, 6, 36, 52, 150
 asphalt, to induce sea-breeze circulation, 10
 Athens, air pollution, 90, 91, 94
 atmospheric bore, formed by sea breeze, 39,
 46, 48, 110, 196
 Austen, Jane, sea breeze and complexion, 136
 Australia, vortex at sea-breeze front, 46
 automobile exhausts, in sea-breeze pollution,
 99
 ‘badgir’, name for wind catcher, 138
 balloons, in the sea breeze, 145–8
 American Civil War, 5, 145
 Eloy and Lhote, 145, 147
 Calais, 145
 Godard and Courty, 146
 John La Fountain, 5
 Tissandier, 145
 Toulon, 146
 barometer, diurnal march of, 8
 Bay of Aden, converging winds, 104
 bifurcations, in sea breeze, 105
 billows at sea-breeze front, 28, 193
 birds in the sea breeze, 133–6
 blocking, by obstacle in stratified flow, 199
 Boeing Field, sea-breeze hodograph, 18
 ‘bolting’ in sugar beet, 122
 bora, 68, 70–1
 airborne measurements, 71
 Boulder windstorm, 70
 Dubrovnik, 70
 Novorossisk, 70
 stone-laid roofs of houses, 71
 wind-shaped trees, 70
 vegetation, 70
 bore, atmospheric, formed by sea breeze, 39,
 46–8, 110, 196
 bore, internal between two layers, 46
 bottleneck, sea breeze, 107
 Boulder, Colorado, drainage flows, 67
 ‘bracing winds’, 136
 Bridport, sea-breeze convergence, 108–10
 Brooms Barn, research on sugar beet, 121

230

Butser Hill, sea breeze onset, 40, 43–4

Canberra, insects and radar, 126, 172

Centre for Overseas Pest Research, radar study, 172

chemistry of sea-breeze pollution
 carbon monoxide, 99
 nitrogen compounds, 96
 ozone accumulation, 99
 reactive hydrocarbons, 97
 sulphur compounds, 97

Chicago
 lake-breeze index, 51
 use of tetrons, 91

Chilbolton Radar, 169–71

chinook wind, 71

Chongqing, river breeze, 79

clashing fronts, south-east England, 107

cold outflow from thunderstorm, 48

collisions of sea breeze-fronts
 experiments, 201
 head-on, 112
 identical fronts, 48
 Morning Glory formation, 48

concentration of airborne insects, 130–2

condensation level of clouds near front, 35

convergence zones
 Africa, north-east coast, 105
 Denmark, 102
 Malta, 113
 Majorca, 113
 Meteosat observations, 115
 produced by collisions, 200
 San Fernando, 106
 south-west England, 104

Coriolis force, on sea breeze, 6, 154, 207–16

‘crossing fronts’, 200

curtain clouds, 29, 34–5, 142

curved coastline, effect on sea breeze, 101

cut-off head at sea-breeze front, 46

Dampier, William, sea captain, 6

Davis, Antarctica, katabatic jump, 63

DC3 aircraft, measuring insects, 127

Defant, Coriolis force in model, 210

Denmark, line of cloud from convergence, 102

density current, 28
see also gravity current

depth of sea breeze, 1, 27–8, 30, 90

Devon and Cornwall coast, convergence zone, 102–3

dew point, changes at sea breeze, 37

diffuse onset of sea breeze, 39

Index

distance inland, Australia, 19

distance of sea breeze out to sea
 India, 21
 Baltic coast, 22

distortion of front, 44

diurnal recycling of pollution, 91

‘The Doctor’, name for sea breeze, 136

doppler lidar, 112

doppler sodar, 176

‘double-coast’ sea breeze, 110

Dutch coast, sea breeze and sand flats, 56

Dynes anemometer, 38

eclipse, winds, 81, 83
 America 1918, 83
 India 1818, 83

fall-out of insects, 130

Florida, converging effects, 102

föhn, 68, 71–4

forecasting sea breeze, 49–57
 effect of tide
 inland penetration, 52–4
 sea-breeze index, 50–2
 temperature difference required, 49

foremost part of front, nose, 29, 191, 193, 204–5

frontogenesis, 32–3
 effect of turbulent mixing, 188
 field case study, 39
 horizontal density gradients, 186
 laboratory experiments, 185–7

Froude number, 69, 198–9, 204

fumigation, in sea breeze, 87

Gemini, photograph of India, 178

generation of sea-breeze fronts, 32

gliding, 141–5
 anabatic winds, 61
 convergence zones, 143
 curtain clouds, 34
 Elsinore shearline, 106, 143–4
 pseudo-sea-breeze front, 143
 ‘sea-breeze bottleneck’, 107
 smooth rising air at wave, 46
 swifts at sea-breeze fronts, 136

Great Lakes, snow storm and land breeze, 24

Greenland, katabatic winds, 61

gravity current,
 descending from Alpine mountains, 66,
 generated in land breeze, 117
 laboratory experiments, 188, 190–201
 Reynolds number, 205
 sea-breeze-front model, 28

- turbulence, and its effects, 188
- Gulf, sea breeze in, 15
- Halifax, Nova Scotia, hodograph, 14
- Hargeisa, Somali Republic, locust swarm, 125
- Harrogate, sea breeze, 21
- head of sea-breeze front, 28
- head and tail winds, 196
- headlands and peninsulas, 101–4
- heat island
 - Leicester, 81
 - London, 81
- height of foremost point, nose, 195, 204
- Helm Wind, 70
- Herat, Afganistan, form of wind catchers, 139
- hodographs, 12–19
 - anticlockwise rotation, 13
 - clockwise rotation, 12
 - effect of tides on Dutch coast, 57
 - Halifax, 14
 - Haurwitz theory, 210
 - use in sailing, 152
- Hollentaa peak, oscillations in katabatic flow, 64
- Honsu, Japan, bora wind, 70
- horizontal temperature gradients, measured
 - near front, 32
- Horndean, sea-breeze onset, 44
- hot-air ballooning, 147
- house martin, 134
- humidity
 - cross-section of changes at front, 30, 38–9
 - dew point hygrometer, 11
 - humidity mixing ratio, 11
 - relative humidity, 11
 - spectroscopic measurements, 163
- Husband's Bosworth, pseudo-sea-breeze
 - front, 143
- Hyderabad, Sind, sea-breeze wind catcher, 139, 162–3
- hydraulic jump, in down-slope winds, 63, 64
- hygrometer,
 - hair, 38, 161
 - wet-and-dry bulbs, 162
- India, extent of sea breeze, 201
- inland penetration of sea breeze, 52–3, 141
 - forecasting, 52
 - Australia, 52
 - Britain, 52; Scampton, 53
- insects at the sea-breeze front,
 - Canberra, 12
 - concentration of, 130–2
 - densities of, 127
- instability at sea-breeze front, 29
- instrumented aircraft, 30
 - glider used in investigation, 77
 - measurements of horizontal temperature
 - gradients, 32
 - motor glider, instrumented, 44
- Intertropical Convergence Zone, 125
- inversion, evening stable layer, 46, 65, 66
- island sea breezes,
 - Majorca, 114
 - Malta, 113, 137
- Jagdalbur, India, sea breeze, 20
- Jersey, pressure pattern, 8
- Juan de Fuca Strait and sea-breeze
 - hodograph, 18
- Katabatic winds, 60–7
 - front, 66
 - Greenland, 61
 - laboratory experiments, 61
 - Mawson, Antarctica, 61–2
 - oscillations, 64, 66
 - walking through a standing jump, 63
- Kelvin–Helmholtz billows,
 - laboratory, 193–4
 - sea-breeze front, 28
- Kinloss, hodograph, 16
- laboratory experiments
 - frontogenesis, 185–9
 - head-wind on front, 31
 - land-and-sea breeze, 183–5
 - requirements of, 204
 - Reynolds number involved, 191–2, 204
 - turbulence and fronts, 32, 190
- Lake Baikal, 70
- Lake Kiwo, central Africa, ‘air avalanche’, 63
- Lake Maggiore, descending gravity current, 66
- Lake Michigan,
 - fumigation progress, 87
 - lake breeze, 45
 - retreating lake breeze, 45
- Lake Ontario, sodar observations, 175
- lake-breeze index, 52
- land breeze
 - convergence, 11, 25, 117, 174
 - fronts, 36–7, 116, 174
 - horizontal extent, 24
- land and sea temperatures, 49
- ‘large’ island, 115
- Larkhill, sea breeze with bore-wave, 38, 39
- LASBEX project, 17–18

Lasham Gliding Centre,
 cloud breeze, 76–8
 forecasting sea breeze, 54
 frontogenesis near, 40
 map of flights, 42
 opposing winds, 43
 retreating front, 41
 sea breeze and state of the tide, 55
 time-lapse cloud photography, 165
 Leicester, heat island, 81
 Lidar, 176
 and sea-breeze front, 177–9
 lobes and clefts at front, 193–5
 local winds
 bora, 68–71
 cloud breeze, 76–8
 eclipse winds, 81
 föhn, 71–4
 mountain winds, 59–68
 river breeze, 79
 snow breeze, 74
 locust, desert, 124–5
 London, heat island, 81
 Long Island, airborne pollen, 123–4
 Los Angeles,
 bifurcating sea breeze, 105
 pollution, 85
 reactive hydrocarbons in sea breeze, 97
 Lyman Alpha psychrometer, 163
 Madras, sea breeze, 20
 Majorca, sea-breeze convergence zones, 115
 Malta, sea-breeze convergence zones, 113
 Manby, forecasting inland breeze, 53
 Marconi, radar in south-east England, 167–9
 Mawson, Antarctica, katabatic winds, 61
 Meteosat, 179
 convergence zones seen, 115
 Mexico City, pollution, 90
 Middlesborough Muck, smog front, 88
 Milwaukee, land breeze, 116
 mistral, 70
 models,
 analytic, 207
 applied to three dimensions, 215
 breeze round circular island, 217
 experimental forecast, 218
 horizontal scale of motion, 213
 limitations of linear theory, 213
 numerical, 207
 sea breeze with opposing wind, 211
 topography included, 218
 Monterey Bay,
 lidar measurements, 178

sodar sea-breeze observations, 176
 Morning Glory, 48
 motor gliders, 166
 mountain effects and sea breeze, 16
 mountain–plain winds, 59
 mountain–valley winds, 59, 64
 moving-floor tank experiment, 195
 New Brunswick, radar study, 172
 Nordkette, Innsbruck, slope winds, 60
 nose, overhanging, at front, 29, 191, 193
 Novorossisk, bora, 70
 numerical models, 207, 214
 observation methods, 37
 obstacles, disturbance caused by, 198
 offshore wind, effect on fronts, 27, 33
 onset of katabatic winds, 63
 onset of sea breeze, diffuse case, 39
 opposing winds, sensitivity of sea-breeze
 advance, 42
 Oroshi, wind in Japan, 70
 oscillation in winds
 katabatic flows, 64
 mountain winds, 66
 outflows from thunderstorms, 48
 ozone, in sea-breeze pollution, 92
 PAN (peroxyacetyl nitrate) changes at sea
 breeze, 88
 photochemical smog, 92, 99
 Pietermaritzburg, wind oscillations, 66
 pilot balloons, 15
 at Danzig, 27
 case study in south-east England, 39
 pollen, 121
 airborne in sea breeze, 123
 ragwort pollen, 123
 tree pollen, 123
 pollution, 85
 diurnal recycling, 91
 in the sea breeze, 85
 Los Angeles, 85
 Poona, India, 20
 potential temperature, definition, 32
 pressure field
 development during day, 7, 12
 on strong sea-breeze day, 12
 profile measurements at sea breeze front, 30
 humidity profile, 30
 modified by opposing wind, 30
 pseudo-sea-breeze front, 76, 143
 psychrometers, 162
 Assman, 162

- Lyman Alpha spectrometer, 163
- radar
 angels, 167
 bands, 'C, L, S and X', 170
 bird echoes, 136, 169
 Chilbolton, 169–71
 colliding fronts, 111–12
 detection of sea breeze, history, 167
 displays, PPI and RHI, 169
 insect echoes, 127, 169, 171
 refractive-index discontinuities, 168
 retreating front, 44
 two different wavelengths, 169
- radio-sondes, 166
- ragwort pollen, 123
- Raichur, India, eclipse of the sun, 82
- rawinsondes, 166
- Red Sea, convergence zone, 125
- 'relaxing winds', 136
- retreating sea breeze, 42, 44, 45
- return of previous day's pollution, 93
- reversed advection of pollution, Japan, 93
- Reynolds number, importance in gravity currents, 191
- rising air at sea breeze fronts, 141
- river breeze, 79
- Riverside, California, pollution measurements, 86
- Robinson–Beckley, wind-direction recorder, 157
- roll clouds, marking atmospheric bores, 48
- sailing, 148–55
 bays and headlands, 152
 British coast, 154
 circulation of sea breeze carried out to sea, 114
 effect of inland mountains, 153
 forecasting sea breeze, 149–52
 Isle of Wight sea breezes, 154
 Solent sea breeze, 154
 small boats, 148
 straight coast, 149
- St. Vincent's Gulf, 15
- Salamis, battle of, 5
- San Fernando convergence zone, 105–6
- sand flats, tidal effect on sea breeze, 56
- sand martin, 134
- Santa Monica Mountains, 105
- satellite imagery
 convergence zones seen, 111
 Denmark, line of sea-breeze clouds, 103
 geostationary, 178
- Lake Michigan cloud line, 117
- Meteosat 4, 179
- NOOA–9 and 10, 181
- polar-orbiting, 178
- sea-breeze convergence zones, 102
- snow breeze, 75
- Scampton, forecasting sea-breeze penetration, 53
- Schiermonni Island, tidal effect of sand flats, 56
- 'sea-breeze bottleneck', in Dorset, 10
- sea-breeze forecasting, 49–37
- sea-breeze fronts
 cloud forms, 4
 Danzig, 27
 head-wind effect on profile, 30
 humidity cross-section, 30
 Lasham, 40, 41, 43, 44–5
 Long Island, 124
 structure, 27 *et seq.*
 wind behind the front, 27, 148
- sea-breeze index, 50–1
 Lake Erie, 51
 Thorney Island, 154
- 'sea of clouds', forming pseudo sea breeze, 76
- semi-diurnal wave of pressure, 8
- shadowgraph technique in laboratory, 188
- shearline, 77, 101
- 'small island', 115
- smog front, 35, 88, 89
- snow breeze, 74
- sodar (sonar or acoustic sounding), 175
 bi-static, 175
 Boulder, Colorado, at drainage flow, 67
 Lake Michigan lake breeze, 175
 mono-static, 175
- solitary wave, from wall collision, 201
- Somali Republic, convergence zones, 104
- South Farnborough, sea-breeze case study, 38
- South Petherton, meeting of fronts, 107
- Southsea, oscillating sea-breeze onset, 42
- spruce budworm moth, 127, 131, 172
- state of the tide, effect on sea breeze, 55
- Stevenson screen, 161
- stone-laid roofs, indicators of strength of bora, 71
- subcritical flows, 198
- sugar-beet and the sea breeze, 121
- supercritical flow, 71, 198
- swallows, 133
- swifts, 133
 glider pilot observations, 135
 soaring at shearline, 111
 'thunder-swallows', 135

234

Tacoma City, sea-breeze hodograph, 18
 tellurium oxide, flow tracer in experiments, 185
 temperature
 changes, mean values, 10
 difference needed for sea breeze, 49
 horizontal gradient near front, 32
 inversion, effect on pollution, 85
 measurement methods, 159
 tetrons, 90, 166
 thermals, reduced by sea breeze, 141
 thermometers, different types, 159–60
 Thornaby-on-Tees, smog fronts, 89
 Thorney Island
 land–sea temperature during year, 49
 mud flats and the sea breeze, 55
 sea-breeze case study, 38, 149–50
 sea-breeze index, 51
 thermal wave of pressure, 8, 9
 thunderstorm outflows, 27, 48, 191
 ‘thunder-swallows’, name for swifts, 135
 tilting-tank experiment for frontogenesis, 187
 time of arrival of sea breeze, 6, 36, 52, 150
 time-lapse cloud photography, 165
 Tissandier, balloon flights, 145
 Tokyo, Japan, 90, 177
 topography, effect considered in models, 218
 Toulon, balloob flight, 145
 trajectories, of tetrons, 90
 tree pollen, 123
 Trieste, bora, 70

Index

turbulent mixing in laboratory experiment, 188
 undular bore, from sea breeze, 46, 199–200
 up- and down-slope winds, 59
 urban heat islands, 80
 Vaisala hygrometer sensor, 163
 vehicle exhausts, pollution, 90
 vortex, formed at sea-breeze front, 46
 Wallops Island, radar measurements, 24, 167, 169–70, 174
 wall-collision, 201
 ‘wall of smoke’, lake breeze at Chicago, 91
 weather station, automatic, 163
 ‘weed-beet’ and the sea breeze, 122
 wind catchers
 Banda Abbas, 137
 Egypt, in New Kingdom, 137
 Herat, local forms, 139
 Hyderabad, Sind, 139–40
 Persian Gulf, 137
 Yazd, 138
 wind-shaped trees, as indicators of Bora, 70
 wind-direction recorders, 157
 wind-surfing, 148
 Yangtse River, Gorge project, 80
 Yazd, wind catchers for local wind, 138