

## Index

- absolute frequency, 81
- absolute momentum, 17
- absolute velocity, 17
- absolute vorticity, 17
- action, 38
- adiabatic invariance, 38, 87
- adiabatic invariant, 91
- anelastic, 108
- anelastic equations, 144
- angular pseudomomentum, 96
- angular pseudomomentum, exact definition, 247
- asymptotic expansion, 35
- available potential energy, 110
- available potential energy, 20
- balanced dynamics, 72
- balanced mode, 25
- bang, see whimper, 296
- baroclinic, 15
- barotropic flows, GLM theory, 240
- barotropic impulse law, 304
- basic flow, 102
- bath-tub vortex, 338
- Bernoulli's theorem, 282
- billow clouds, 164
- bolus velocity, 220
- bolus velocity, 220
- bores, 319
- bottom topography, 19
- Boussinesq system, 107
- breaker line, 309
- Bretherton flows, 292
- buoyancy, 109
- buoyancy frequency, 109
- buoyancy oscillations, 114
- causal, 59
- causal solution, 57, 159
- caustic, 51
- caustics, 45
- centrifugal forces, 16
- characteristic system, 41
- circulation form of the GLM momentum equation, 237
- classical wave–particle duality, 42
- clear-air turbulence, 164
- continuity equation, 4
- Coriolis force, 17
- Coriolis forces, 17
- Coriolis parameter, 70, 71
- Coriolis vector, 17, 248
- Craik–Leibovich instability, 267
- critical layer, 140, 155
- critical layer, definition, 161
- critical layers, 148
- critical level, 155
- curl–curvature formula, 86
- deep-water surface waves, 86
- density scale height, 144
- diffraction, 54
- dipole flow, 293
- discontinuity surfaces, 4
- dispersion relation, 29
- dispersive caustics, 61
- dissipative pseudomomentum rule, 262
- dissipative pseudomomentum rule, 296
- disturbance energy, 23
- disturbance part, 105
- divergence effect, 228
- Doppler shift, 81
- eddy fluxes, 130
- effective mean density, 225
- eikonal, 34
- eikonal equation, 35
- Eliassen–Palm flux, 134, 184
- ensemble averaging, 90
- enstrophy, 16
- enthalpy, 10
- entropy, 9
- equipartition of energy, 30
- Euler's equation, 8

- Eulerian variables, 6
- Eulerian zonal pseudomomentum, 118
- Eulerian-mean momentum flux, 119
- evanescent, 32, 36
- evanescent waves, 123
- evolute, 45
- Fermat's principle, 84
- Fermat's theorem, 43
- finite-volume scheme, 165
- finite-volume schemes, 320
- Fjørtoft's theorem, 153
- fluid particle, 5
- Froude number, 121
- gas-dynamical analogy, 19
- gauge transformation, 253
- gauged pseudomomentum, 254
- geodesics, 43
- geometric phase, 80
- geopotential, 16
- geostrophic balance, 68
- GLM identity, 224
- GLM wave action, 241
- group velocity, 29
- group-velocity condition, 60
- group-velocity ray, 61
- Hamilton–Jacobi equation, 77
- Hamiltonian, 42
- Hamiltonian mechanics, 89
- Hilbert transform, 51
- hydrostatic relation, 18, 125
- hydrostatic wave regime, 125
- impulse, spherical geometry, 301
- incompressible flow, 6
- index of refraction, 34
- inertia–gravity waves, 68, 182
- inertial oscillation, 69
- inertial oscillations, 182
- inertial waves, 193
- internal energy, 10
- internal gravity waves, 79, 107
- intrinsic frequency, 81
- irrotational, 15
- irrotational flows, GLM theory, 238
- isentrope, 13
- isopycnal surfaces, 109
- Jacobian of the lifting map, 225
- Jensen's theorem, 256
- jet stream, 180
- jets, self-sharpening mechanism, 211
- Kelvin's cat's eyes, 163
- Kelvin's circulation theorem, 13
- Kelvin's impulse, 197, 297
- Lagrangian disturbance field, 222
- Lagrangian pseudoenergy, 93
- Lagrangian pseudomomentum, 92
- Lagrangian variables, 6
- Lagrangian zonal pseudomomentum, 116
- Lagrangian-mean momentum flux, 118
- Langmuir circulations, 267
- least travel time, 43
- lee waves, 121
- lee waves, three-dimensional, 187
- lifting map, 221
- linear waves, 103
- local conservation law, 11
- longshore current, 307
- Longuet–Higgins, 308
- mass conservation, 4
- mass density, 3
- mass transport velocity, 220
- material derivative, 5
- material invariance, 6
- material trajectories, 5
- mean part, 105
- mesospheric jet, 145
- method of characteristics, 41
- momentum density, 4
- multiple time scales, 167
- Newtonian cooling, 120, 138
- Noether's theorem, 89
- non-acceleration conditions, 140
- non-acceleration conditions, GLM theory, 235
- non-canonical Hamiltonian mechanics, 89
- non-dispersive, 29
- off-diagonal fluxes of mean zonal momentum and zonal pseudomomentum, 237
- parametric sub-harmonic instability, 169
- Parseval's theorem, 63
- perfect fluid, 8
- phase, 27
- phase average, 28
- phase space, 79
- phase velocity, 27
- plane waves, 26
- polytropic fluid, 256
- potential vorticity, 15
- Prandtl's ratio, 181
- principle of least time, 85
- prograde, 71
- pseudomomentum rule, 140, 284
- pseudomomentum rule, momentum-conserving forces, 262
- pseudomomentum vector, 89
- pseudomomentum vector, /beta-plane, 254
- pseudomomentum, horizontal, 185
- quasi-biennial oscillation, 167
- quasi-geostrophic dynamics, 195
- radiation condition, 57, 58
- radiation stress tensor, 256
- radiative damping, 161
- ray curvature proportional to curl of velocity, 86

360

ray tracing, 73  
 ray tube, 44  
 Rayleigh friction, 263  
 Rayleigh's instability theorem, 152  
 rays, 41  
 remote recoil, 336, 341  
 residual meridional circulation, 189  
 resonant triads, 169  
 retrograde, 71  
 Richardson number, 137, 149  
 rigid-lid shallow-water equations, 321  
 Rossby adjustment problem, 181  
 Rossby deformation length, 68  
 Rossby waves, 67, 70  
 rotation lines, 191  
 scalar phase velocity, 27  
 sheared-over disturbance, 148  
 simple geometry, 104  
 singular absorption, 148  
 singular perturbation method, 167  
 singular wave absorption, 161  
 slowly varying wavetrain, 33  
 small-angle approximation, 310  
 St Andrews cross, 115  
 stationary phase, 48  
 still water depth, 19  
 Stokes correction, 117  
 Stokes corrections, 217  
 Stokes drift, 217  
 stratification surfaces, 14  
 strong interaction, 103  
 surface gravity waves, 65  
 Taylor columns, 191, 193  
 Taylor identity, 205, 206  
 Taylor–Goldstein equation, 157  
 thermal wind relation, 180  
 topographic Rossby waves, 71  
 total internal reflection, 36, 143  
 traditional approximation, 70  
 transformed Eulerian-mean, 188  
 transport equation, 35  
 transversal, 112  
 virial theorem, 24  
 vortex ring, generated by dissipating sound  
   waves, 305  
 vortical mode, 104  
 vorticity, 14  
 vorticity edge waves, 153  
 wave breaking, definition, 316  
 wave rollers, 330  
 wave saturation, 311  
 wave action, 87  
 wave action in shear flow, 154  
 wave action, GLM, 242  
 wave breaking, 162  
 wave capture, 83, 336, 344  
 wave drag parametrization scheme, 165

*Index*

wave fronts, 27, 42  
 wave property, 23  
 wave refraction, 31  
 wave saturation, 165  
 wavelength, 27  
 weak damping, 138  
 weak interaction, 103  
 whimper, not bang, 296  
 WKB approximations, 34  
 Wronskian, 32, 158  
 zonal, 71  
 zonal averaging, 32, 105  
 zonal pseudomomentum, with rotation, 184