

SUBJECT INDEX

A

- Adsorption, *see* Sorption
- Advection, 173
- Albedo, 306
- Apoplast, 85, 101
- Approach
 - empirical, 442–443
 - process-based, 2, 443
- Area burned, 534, 541, 550
 - atmospheric conditions, 358
 - future warming, 365–369
 - Ontario, 545
 - predictors, 354
- Arrhenius
 - equation, 489–491
 - number, 490
- Atmosphere
 - height anomalies, 356
 - mixed phase region, 376
 - upper, 354–357
 - vertical structure, 357–358

B

- Backfire, 181
- Balance
 - cyclostrophic, 264–265
 - energy, 317–318
- Bark, 486
 - density, 496
 - heat capacity, 495

- thermal diffusivity, 495–496
 - thickness, 491, 518
- Bayes Information Criterion, 430–431
- BEHAVE, 158, 183
- Biomass, burned, 56
- Biosphere-Atmosphere Transfer Scheme,
336–338
- Biot number, 94, 128, 510
- Black body, 445
- Boundary layer, 4, 107–108, 266
 - planetary, 315
- Brunauer-Emmett-Teller theory, 120
- Burn fraction, 544
- Burst, turbulent, 266
- Byram index, 162

C

- Cambium, vascular, 486
 - mortality, 486
 - necrosis, 488–489, 497–505
- Canadian Fire Weather Index System, 343,
354, 385
- Capillary
 - flow model, 124
 - pressure, 99
- Capillarity, 123–124
- Carbon, release, 63–65
- Cell wall
 - primary, 85
 - secondary, 88

- Cells, convective, 295–299
 - Centrifugal pump effect, 501
 - Change points, 422–424
 - location, 430–435
 - significance test, 426
 - Char, 450
 - composition, 452
 - oxidation, 452–455, 460, 462
 - production, 83, 443, 450–452
 - Charge separation, 376–377
 - Chimney effect, 502–503
 - Chromatography, gas, 21
 - Circulation, 290–292
 - atmospheric modeling, 269–272
 - Climate, 351
 - Cloud, smoke ingestion, 411
 - Combustion, 3, 12, 13
 - chemistry, 58–59
 - efficiency, 16, 64–65
 - flaming, 62, 83, 442, 443–448
 - glowing, 62, 448–449
 - governing equations, 13–15
 - incomplete
 - products, 15
 - flame temperature, 15
 - phases, 60–62
 - products, 58–59
 - residence time, 235–236
 - smoldering, *see* Smoldering combustion
 - Concentration, chemical species, 18
 - measurement, 21
 - Condensation, 132
 - Condensed phase, 26
 - Conduction, 4, 456–457, 459, 480–481
 - Fourier's law, 480, 494, 511
 - transient, 487
 - Conductivity, thermal, 481
 - air, 401
 - bark, 495
 - measurement, 494
 - soils, 514
 - Cone, opening, 508–509
 - Conflagration, 259
 - Conservation
 - angular momentum, 263
 - energy, 198
 - equations, 13–15, 98–100, 154, 226, 228, 245, 270, 293, 394, 506
 - Constant-rate period, 126–127
 - Contagion effect, 424
 - Dirichlet distribution, 424
 - overdispersed multinomial model, 424–427
 - Convection, 4, 268, 275, 290, 481–482, 487
 - atmospheric, 3
 - coefficient, heat transfer, 483, 505, 508, 510–513
 - forced, 482
 - free, 481
 - Cooling
 - Newtonian model, 236–237
 - Newton's law, 482, 507, 511
 - Coupling, atmosphere-fire, 266–268
 - modeling approach, 272–277
 - problems, 289
 - Crown death, 230, 507–508
- D**
- Damköhler number, 27–28, 212
 - Darcy's law, 99, 124
 - Decision support systems, 529
 - Deployment, air tanker, 530–531
 - Desorption, *see* Sorption
 - Diffusion, *see also* Water transport mechanisms
 - bound water, 99, 124
 - surface, 124
 - theory, 93, 115, 128, 129
 - transverse, 92
 - Diffusivity
 - moisture, 85, 92–93, 129, 135
 - thermal, 8, 159, 488, 491–497
 - bark, 493, 495
 - equation, 492
 - measurement, 493–494
 - Dimension, characteristic, 510
 - Dimensional analysis, 5, 226
 - Dirichlet distribution, 424
 - Distillation, 132
 - Drag, frictional, 263, 265
 - Drought Code, 343
 - Duff, 81, 437
 - characteristics, 439–441
 - consumption, 83, 438
 - empirical approach, 443, 464
 - empirical studies, 441–443
 - flaming combustion, 444–448
 - heat budget model, 444–447

- depth, 404, 440–441, 447, 465, 467
- moisture content, 91–92, 467–468
- moisture transport, 98
- specific heat, 446
- types, 391
- Duff Moisture Code, 343, 354
- Dynamics
 - atmospheric, model, 286
 - vorticity, 260–266

E

- Ecology, fire, 2, 5
- El Niño, 359–361
 - fire occurrence, 360
 - seasonal precipitation, 363
- Emission
 - factors, 63–64, 67
 - trace gases, 69–72
 - carbon monoxide, 71–72
 - nitrogen, 69–70
 - nonmethane hydrocarbons, 72
 - sulfur, 70–71
 - methane, 72
 - methyl chloride, 71
- Emissivity, 445
- Energy budget, surface, 337
 - remote sensing, 339–340
- Entrainment, mass, 244–245
- Environment, near-surface, 333–336
- Epochs, 420
 - determining, 430–435
- Eulerian approach, 185
- Evaporation
 - pan, 325–326
 - coefficients, 326
 - rate, 310
 - potential, 107
 - resistance, 88
 - temperature effects, 313
 - vertical mixing, 313–317
 - processes, 314
 - wind speed, 313
- Evapotranspiration, 108, 305
 - actual, 319, 327–328
 - characteristics, 329
 - functional dependence, 327–328
 - models
 - radiation, 324–325

- temperature, 326–327
 - Thornthwaite, 326
- potential, 319, 327–328
 - characteristics, 329–333
 - elevation dependence, 330–332
 - estimation, 317–324
 - seasonal cycle, 329–330
 - topographic effects, 332–333
- rate, 109
- understory, 333
- Extinction criterion
 - Damköhler number, 27–28, 212
 - forced-convection, 201
 - Zel'dovich, 27–28
- Extractives, 84–85

F

- Falling-rate period, 126–127
- FARSITE, 183
- Fiber saturation point, 89–90
- Fick's law, 99
- Fine Fuel Moisture Code, 343, 387, 556
- Fire(s), 12
 - arrival, 555
 - behavior, 271
 - models, 158, 183–184, 286
 - blowup, 258, 276
 - control status, 547
 - crib, wood, 38–40
 - cycle, 427–433
 - danger, 138, 156
 - indices, 366–368, 385, 341–343, 353, 385
 - detection, 558
 - unorganized system, 559
 - organized system, 559–563
 - patrol route planning, 560
 - probability, 560–562
 - economics, 534
 - least cost plus damage, 535–538
 - suppression, 550–553
 - effects
 - bole, tree, 483–505
 - canopy, 505–514
 - mortality, tree, 515–517
 - roots, 514–515
 - exclusion, 579
 - policy, 573

Fire(s) (*continued*)

- extreme events, 172
 - flanks, 188
 - frequency, 3, 420, 553, *see also* Time-since-fire
 - grass, 267
 - head(ing) 152–158, 185
 - holdover, 391
 - impacts
 - assessing, 534–544
 - recreation, 543
 - timber supply, 538–544
 - large, 258
 - life cycle, 547–548
 - line, 278–282
 - intensity, 485
 - parabolic/hyperbolic, 280–281
 - wind effects, 278
 - management, *see* Management, fire
 - modeling, whole fire, 160, 269
 - resolution, 273
 - number, 545
 - occurrence
 - daily, 554–557
 - lightning-caused, 557
 - people-caused, 555–556
 - pool, 36, 230
 - smoke, 17
 - scaling laws, 37
 - prevention, 530, 553–554
 - propagation function, 186
 - protection
 - planning, 572–576
 - zones, 573–574
 - regime, 530, 544
 - scar, 498–504, 516
 - science, 528
 - season, 368
 - shape, 160–163, 172–176, 184–186
 - circular, 276–277, 549
 - ellipse model, 160–161, 175, 184
 - fire intensity, 162–163
 - wedge, 175, 190–191
 - wind speed, 161–162
 - size, detection, 558
 - stand-replacement, 198
 - structures, 288
 - suppression, 528, 563–572
 - economics, 550–553
 - model, 546–553
 - strategic, 564–566
 - surface, 258
 - temperature profile, 154, 225–226
 - transition, surface to crown, 80, 100
 - visibility, 560
 - vortices, 258, 287
 - weather rating systems
 - Canada, 343
 - United States, 341–343
 - whirls, 259
 - wildland, 176
- Firebrand, trajectories, 181, 251–252, 357
- Firefront, 172–176
 - elliptic, 184
 - locus, 189
 - perimeter, 173–175, 184, 189, 217–218
 - velocity, 186–187
 - propagation, 180–181, 185, 188, 197–203
 - tracking, 189
- Fire spread, 42
 - atmospheric stability effects, 282–285
 - Australia, 155–156
 - Canada, 158
 - chaparral, 186–192, 208
 - equation, fundamental, 456
 - equilibrium, 218
 - fuel factors, 179, 206, 208, 212, 214–217
 - fundamental equation, 153
 - models
 - containment, 550
 - McArthur, 155–156
 - Parks, 548
 - probabilistic, 163, 194
 - Rothermel, 156–158, 202–203
 - wind-aided, 179–194
 - one-dimensional, 192, 193, 201
 - radiation effects, 272
 - rate, 152–158, 173–174, 178, 185, 196, 202, 249, 258–259, 485, 504
 - slope effects, 157, 193, 203, 282–285
 - surface, 180
 - three-dimensional, 227
 - two-dimensional, 202
 - United States, 156–158, 180–181
 - wind-aided, *see* Chapter 6
 - wind effects, 157, 178, 203, 212, 214–217

- FIRETEC, 286
 Fire Weather Index, 366–368
 Fisher information matrix, 425, 428
 Flame, 3, 12, 198
 characteristics, 483–486
 color, 20
 curvature, 185
 diffusion, 13, 23–24, 185–186, 398
 color, 33
 extinction, 27–28
 laminar, 29–35
 methane-air, 30–35
 model, 61
 scaling analysis, 29
 turbulent, 30, 36
 height, 18, 231, 503
 measurement, 22, 32
 premixed, 23–24
 velocity, burning, 24–25
 thickness, 24–25
 residence time, 485, 489, 497–498, 500–501
 spreading, 41–45
 downward, 43
 horizontal, 43
 upward, 44
 structure, 45–47
 temperature, 484
 adiabatic, 15, 27
 maxima, 229–243, 517–518
 measurement, 19, 484–485, 517–518
 moisture effects, 83
 profile, 503–504
 vegetation fires, 69
 velocity, 18
 measurement, 20
 Flaming combustion, 62, 83, 442, 443–448
 Flammability, 517
 factors, 111–113
 limits, 26
 Floor, forest, 437
 Flow, rotational/irrotational, 499–500
 Fourier
 law of heat conduction, 100
 number, 128
 Froude number, 29, 259, 267–268
 Fuel(s), *see also* Smoldering combustion
 arrangement, 205–209
 characteristics, 84
 chemical, 84–85
 structure, 93–93
 physical, 93–96
 chemistry, 57, 65–66, 84–85
 consumption, 83
 curing, 114
 depth, 231, 465
 drying, 126–129
 forest, 80, 81–96
 classification, 81–82
 inert content, 209–212
 loading, 83, 194, 201, 205, 207
 management, 553
 moisture content, 3, 79, 304, 403–404, 486
 burning rates, 82–84
 coarse fuels, 305
 dead fuel, 115–137, 305
 diurnal prediction models, 136
 equilibrium, 115
 estimation, 137–139
 fine fuels, 305
 fire sensitivity, 286
 hysteresis, 115
 indicator sticks, 138
 live fuel, 110–115
 timelag, 130
 response time, 130
 soil moisture effect, 133
 weather factors, 130, 304, 353
 moisture relationships, 96
 porosity, 205
 reduction, 251
 shrubland, 236
 state, 383
 type, 43, 383
 Fuel-bed
 porous, 45
 parameters, 157
 properties, 193, 205, 233
- G**
 Gas law, ideal, 246
 Gasification, 13
 General Circulation Models, 365–366
 Gibbs free energy, 96–97, 120
 Girdling, 497

Gradients

- moisture/nutrient, 467
- vertical, 333–334

Graupel, 377, 411

H

Hazard, burning, 420, 423

- confidence interval, 426, 433
- maximum likelihood estimates, 423–424, 427, 431–433
- variance, 425

Heat

- capacity, 492
 - measurement, 494–495
- flux, 241, 319, 399–401, 481
 - downward, 199
- latent, 4, 337, 340
 - vaporization, 305, 446, 514
- loss, 19
- sensible, 275, 288, 340
- soil, 337–338
- transfer, 3
 - bole, 486–505
 - equation, one-dimensional, 486
 - fire to trees, 477–479
 - lightning to forest fuels, 401
 - mechanisms, 479–483
 - model, 7–8
 - rates, 4
 - scales, 273

Heating

- soil, 514–515
- unsteady state, 486

Hessian matrix, 425, 428

HIGRAD, 286

Humidity, relative, 311–313

- vertical profile, 334

Humus, 437

Huygens' principle, 184

Hygroscopicity, 84–85

I

Ice, crystal growth, 377

Ignition, 25–26, 184

- autocatalytic, 25
- canopy, 269
- defining, 403

experiments, 402–406

fuel depth, 404

heat of, 82, 159

lightning, *see* Lightning, ignition

minimum energy, 27

modeling, 393

piloted, 26, 398–399, 483

probability, 82, 368

process, 391–401

spontaneous, 26, 398–399

temperature, 26

thunderstorm type, 381–382

time, 82

tracing, 274–277

unpiloted, 26

Infiltration, 123

Infrared

- observations, 286–288, 340
- thermograph, 19

Initial attack, 546, 570–571

dispatching, 570

queues, 567–568

resource deployment, 566–570

Intensity, fire or reaction, 156

Interception, precipitation, 339

Intertropical convergence zone, 412

Inversion, 357

Islands, unburned, 176

K

Keetch-Byram Drought Index, 114

Kirchhoff's law, 445

L

La Niña, 359–361

Laminar sublayer, 333–334

Land-surface interactions, 336–339

Land Surface Model, 336–338

Laplace transform, 199–200, 487

Lapse rate, 357

adiabatic, 314

Layer, surface, 315–316

Leader, stepped, 377

Leaf-atmosphere models, 107–110

Leaf, drying, 109–110

Least cost plus damage, 535–538

limitations, 536–538

Lightning, 3, 376
 channel, 378
 collapse, 396
 structure, 394–397
 temperature, 396–397
 cloud microphysics, 410–411
 cloud-to-ground, 377
 continuing current, 378
 probability distributions, 407–408
 fires, 383, 386, 411–412
 flashover, 389
 heat, 379
 ignition, 376
 arc duration, 403
 criteria, 398
 efficiency, 386–389, 405–406, 413
 probability, 406–407, 408–409
 requirements, 398–399
 studies, 381–383
 intracloud, 377
 location, 385–386, 407
 maps, global, 411–412
 reduction experiments, 384
 return stroke, 378
 sheet, 379
 sprites and elves, 379
 strike path, 390
 stroke multiplicity, 386
 tree damage, 390
 Lignin, 439
 Line fire, 196
 Litter, 81, 437, 440
 Local volume averaging, 98
 Lower Atmosphere Severity Index, 357–358
 Lumped-heat-capacity model, 509, 518

M

Management, 534
 fire, 3, 528, 534
 decision-making, 530–531
 load, 553–563
 models, 574–576
 objectives, 527–528, 537–538, 545
 planning process, 544
 production function, 537
 fuel, 553
 land, planning, 532–533
 large fire, 571–572

Mass flow, 96–97
 Matts, root, 438, 440
 Maximum likelihood estimate, 423–424, 427, 431–433
 Mechanics, fluid, 227–229
 Meteorology, 3
 Meteorological, 333
 Modeling, grid scales, 271
 Moisture, *see also* Fuel moisture content, Water
 characteristic curve, 101
 content, canopy, 110–115
 Australian annuals, perennials, 114
 California chaparral, 113
 Canadian conifer, 111
 grasslands, 114
 seasonal variation, 111
 Monin-Obukhov length, 321
 Mortality
 tree, 515–517
 understory, 438, 439, 441

N

National Fire-Danger Rating System, 341–343, 353, 385
 National Lightning Detection Network, 379
 Navier-Stokes equations, 226, 228, 270
 Necrosis
 cambium, vascular, 488–489, 497–505, 513–514
 canopy, 506–514
 carbon budget, 516
 foliage, bud and twig, 513
 root, 514–515
 tissue and cell, 489–491
 Newton's law, 482, 507, 511
 Nocturnal drainage flow, 285
 Normalized Difference Vegetation Index, 138
 North Pacific Oscillation, 361, 363
 Nusselt number, 401, 511–513

O

Ohm's law, 103–106, 107, 294, 320
 Operations research, 529
 Optical Transient Detector, 412
 Osmosis, 86
 Osmotic potential, 97, 101

Overdispersion parameter, 424–425, 428–429, 431
 Pearson estimate, 426

P

Pacific North America Pattern, 357, 362
 Parameterization, subgrid-scale, 274
 Peat, characteristics, 449
 Peclet number, 29
 Penman-Monteith
 equation, 108, 319
 method, 317–324
 application, 323–324
 Percolation
 approach, 163
 theory, 172, 194
 Permeability
 longitudinal, 90–91
 specific, 90–92
 Phase, mixed, 376
 Pits, 90
 Plants, components, 478–479
 Plasmalemma, 86, 101
 Plume, fire, 195–196, 226
 axisymmetric, 243
 characteristics, 505–506
 constant, 232–233
 cross-wind, 243–252
 equation, 227
 parameters, 233
 experimental data, 233–235
 models, 227
 three-region, 232–235
 two-dimensional, 243–247
 modeling approaches, 227–228
 residence time, 513
 studies, 230–231
 temperature, 227, 229
 profile, 230, 232, 505–506
 turbulent, 227
 Prandtl number, 511, 512
 Prefire properties, 193
 Presuppression, 536
 Priestly-Taylor equation, 325
 Processes, wildfire, 2–3
 Project Skyfire, 380, 383–385, 391, 407
 Protoplast, 85, 101
 Pyrolysis, 59–60, 198, 398, 403, 443, 455

cellulose, 450–452
 products, 450
 temperature, 450
 Pyrometer, two-color, 20

Q

Quasi likelihood function, 424

R

Radiation, 4, 272, 306–310, 324
 net, 307–310, 324
 thermal, 482–483
 Radiometry, microwave, 340
 Rainfall, simulated, 91
 Ratio
 mixing, 311–312
 packing, 94–95, 156, 444
 temperature, excess, 487
 Rayleigh scattering, 379
 Reactions, chemical, 25
 thermal, 25
 autocatalytic, 25
 Regeneration, boreal forest, 438, 441
 Regional Climate Model, 367
 Residence time
 particle, 82
 Resistance
 aerodynamic, 320–322
 excess, 320–321, 335
 heat transfer, 481, 510
 leaf, 105–106, 108
 stomatal, 108, 322–323
 water flow, 90
 Reynolds number, 29, 401, 498–499, 504, 511
 Richards equation, 106, 338
 Richardson number, 315, 321
 Ridge
 blocking, 356
 breakdown, 355–356
 Rossby waves, 355
 Rotation, vertical
 convective cells, 295–297
 development, 292–295
 generation, 297–299
 Roughness length, 316–317, 321

S

Scaling

- analysis, 29
- laws, 36–38

Scorch

- crown, 506
- height, 227, 243, 506–507

Seasonal Severity Rating, 366

Seeding, cloud, 383–385

Shear, vertical, 260

Smoke, 16–18, 560

- liquid pool fires, 17
- particles, 65–69
- production, 62–72
 - minimizing, 72–74
- solid fuels, 18

Smoldering combustion, 3, 62, 158, 188, 448–450

- dependent, 448
- downward, 458
- extinguishment, 459–462, 466
- forward, 453–455
- free flow, 454
- fuel
 - depth, 465
 - moisture, 467
 - parameters, 465–466
- models, 456–464
 - vertical, 458–462
 - horizontal, 462–463
- peat, moisture content, 405
- propagation, 453–455
 - velocity, 456–457, 459, 462
- reverse, 453
- roots, 479, 515
- spread rate, 158–159
- transient, 444
- transition to flaming, 159, 449
- wave, 453–455
 - length, 453
 - structure, 453–454, 462–463
- zones, 452

Soil, organic, 437

Soil-root models, 106–107

Soot

- formation, 15–16
- collection, 16–17

Sorption, 93, 115–119, 130–131

- Anderson-McCarthy equation, 120

hysteresis, 117–118, 123

isotherms, 116, 120–123

models, 119–121

types, 119–120

Southern Oscillation, 359

Index, 360–361

SPAC

- concept, 97
- water transport, 102–110

spotting, 181, 251–252, 357

Stability, atmospheric, 314–316, 358

Stand age distribution, 539–540

Stefan-Boltzmann law, 306, 445, 482

Suction, matric, 123

SURFRAD, 308

Survival, seeds, 242

T

Teleconnections, 359–365

Temperature

- air, vertical profile, 334
- bark, 5
- dew point, 310
- fire, *see* Fire
- ignition, 202
- lethal time, 241
- plume, *see* Plume
- potential, 315, 335
- pre-heating zone, 199
- pseudo-wet-bulb, 125
- radiative, surface, 339
- time
 - curves, 238–240, 250
 - history, 235–238
 - profiles, 249–230
 - trace, transient, 487–488

Thermal death, 238

number, 242

Thermocouples, 5–6, 19, 229, 231

shielded-aspirated, 484

time history, 179

Timber harvest, 540

mean value formulation, 541

scheduling models, 542

supply models, 542

Time-since-fire

- distributions, 421–422, 427, 432–434
- graphical analysis, 420–422

Time-since-fire (*continued*)

- map, 419
- sample, 419
- sample vs map, 427–430
 - contagion effect, 429–430
 - efficiency, 428
 - examples, 428–430

Tolerance, thermal, 489–491

Torus, 90

Transfer

- mass, 4
- momentum, 4, 314
- efficiency, 320–321

Transpiration, 108

- cuticular, 87
- rate, 104
- stomatal, 87

Turgor, 86, 97, 101, 103

V

Vapor pressure

- deficit, 310
- profile, 334

Velocity, friction, 316

Viscosity, kinematic, 512

Volatilization, 444

Vortex

- street, 499
- structures, 273
- tilting, 266

Vortices, 498

- fire-scale, 280–282
- horizontal roll, 357
- microscale, 282

Vorticity, 290–292

- vertical, 293

W

Water

- capillary, 122
- movement, *see* transport

potential, 97

- leaf, 103

relative water content, 101

root uptake, 107, 304

transport, 96–97

- leaf-atmosphere models, 107–110
- live fuel, 102–110
- mechanisms, 123–126
- Ohm's law, 103–106, 107, 320
- radial, 107
- soil-root models, 106–107

vapor

- atmospheric content, 310–313
- pressure
 - deficit, 310
 - profile, 334
- surface content, 336

Weather, 351

- area burned, 352–358
- synoptic surface, 352–354
- upper air, 354–358

Wilting, 114

- point, physiological, 110
- process, 109–110

Wind

- profile, 247–249, 316–317, 334
- shear, 357
- velocity attenuation coefficient, 317

Wind tunnel, facility, 176–179, 204–205

fuel

- arrangement, 205–209
- bed width, 201–205
- inert content, 209–212
- moisture, 212
- substratum, 212–214

test results, 214–217

Z

Zel'dovich extinction criterion, 27–28