

---

---

# INDEX

## A

Aber, J.D., 3, 97, 168, 210, 213

*Abies balsamea*, 165, 188

*Abies grandis*, 188

*Abies lasiocarpa*, 217

Abiotic disturbance agents, 203–218

atmospheric factors, 207–214

gases, 207–209

wet- and dry-fall, 209–214

fire, 203–207

forest harvesting, 214–216

mechanical forces, 216–218

overview, 203

Abiotic site variables, 231–236

Abiotic weathering, 116

Absorbed PAR (APAR), 64, 77, 93,  
94, 309

Absorbing surface area, 41

*Acacia aneura*, 29

Accumulation, snow, 46–48

*Acer saccharum*, 187, 218

Acid-neutralizing capacity, 142

Adams, J.M., 311

*Adelges piceae*, 187

Adsorption, 136

Advanced Very High Resolution

Radiometer (AVHRR), 245,

249, 256, 273, 296, 312

Advection, 26

Aerodynamic transfer equation, 26

Aerosols, 118

Agee, J.K., 204

Aggregation errors, 234

*Ahies balsamea*, 187

Airborne canopy lidar sensors, 335

Air saturation deficit, 26

Air temperatures, 237, 241

Albedo, 22, 250

Allocation, carbon, 82–96

annual assessment of, 86–94

indices of, 94–96

overview, 82–83

seasonal dynamics in, 83–86

Allometric equations, 93

Allometric relations, 87, 109

*Alnus*, 113, 328

*Alnus incana*, 218

*Alnus rubra*, 218

Alpha species diversity, 310

Altitude, 293

Aluminum hydroxides, 121

Aluminum ions, 142

Ambient partial pressure, 63

Ambrose, S.H., 270

Ammonia, 136, 207

Ammonium, 113, 130

Ammonium nitrogen, 205

Angiosperms, 34

Animals

browsing, 198–203

wildlife habitat analysis, 269–272,  
337

Anion

adsorption, 142

exchange, 133–135

Annual global atmospheric loading,  
309

Annual net primary product

allocation assessment, 86–94

Annual snowpack map, 284

APAR (absorbed PAR), 64, 77, 93,  
94, 309

Arctic timberline, 293

Aridity, 13

*Armillaria mellea*, 198

Arrhenius-type relationships, 63

Asner, G.P., 335

Atmosphere-forest interactions,  
272–274

Atmospheric carbon dioxide, 61

Atmospheric carbon pool, 304

Atmospheric circulation patterns, 45

Atmospheric deposition, 111–112,  
138, 141, 210, 214

Atmospheric disturbance factors,  
207–214

gases, 207–209

wet- and dry-fall, 209–214

Atmospheric humidity, 52

Atmospheric inputs, 100, 112

Atmospheric transmittance, 239

Attiwill, P.M., 203

Autotrophic respiration, 59, 67–71,  
82, 91, 332

Avalanches, 218

AVHRR (Advanced Very High  
Resolution Radiometer), 245,  
249, 256, 273, 296, 312

## B

B (Bowen ratio), 22–23, 252, 327

Bacteriostatic compounds, 185

*Balanites*, 153

*Balanites willsoniana*, 153

Ball, J.T., 63

Band, L.E., 231, 233, 275, 279, 281

Bark beetles, 193–195

Bark sloughing, 187

Bartlein, P.J., 176

Base cations, 214

Beaufils, E.R., 104

Beer–Lambert law, 30, 48

Beer’s law, 254

Beets, P.N., 91

Before present (BP), 293

Beta diversity, 310

Beven, K.J., 232

Bhupinderpal-Singh, 320

Bigfoot project, 329

“Big-leaf” Penman–Monteith  
equation, 53

Biochemical plant defenses,  
185–188

- Biochemical reactions, 11  
 Biodiversity, 310–313, 336–338  
 Biogeochemistry, 3, 16. *See also*  
   Regional ecological analysis  
   biogeochemical cycling, 335  
   biogeochemical models, 170  
   ecosystem models, 168–170  
   and eddy-flux measurements,  
     327–328  
   and potential forest distribution,  
     294–296  
 Biological fixation, 100  
 Biological nitrogen fixation, 113  
 Biomass, 87, 159, 254–257,  
   335–336  
 BIOMASS model, 97, 170  
 Biome, 126  
 Biophysical model analysis, 283  
 Biospheric process models, 306–  
   307  
 Biotic agents of disturbance,  
   184–203  
   bark beetles, 193–195  
   biochemical defenses in plants,  
     185–188  
   browsing animals, 198–203  
   defoliating insects, 188–193  
   overview, 184–185  
   pathogens, 195–198  
 Biotic analysis of forest patterns,  
   262–272  
   disturbance propagation, 267–269  
   overview, 262–263  
   spatial heterogeneity, 266–267  
   temporal changes in forest cover,  
     263–266  
   wildlife habitat analysis, 269–272  
 Biotic variables, 234  
 Biotic weathering, 116  
 Bonan, G.B., 96, 175, 303  
 Bond-Lamberty, B., 336  
 Boreal forests, 291  
 Boreal zones, 84  
 Bossel, H., 180  
 Botkin, D., 173  
 Boundary-layer conductance, 26, 30,  
   31–32  
 Bowen ratio ( $\beta$ ), 22–23, 252, 328  
 BP (before present), 293  
 Bridgham, S.D., 109  
 Bristow, K.L., 238  
 Browsing animals, 198–203  
 Bryant, J.P., 198  
 Buchmann, N., 139  
 Bulk canopy conductance, 31  
 Bulk density, 50  
**C**  
 Calcium, 101, 108  
*Calvaria major*, 153  
 Cambium, 35  
 Campbell, G.S., 238  
 Candau, J.-N., 343  
 Cannell, M.G.R., 84  
 Canopies  
   chemistry, 142  
   and eddy-covariance fluxes,  
     328–333  
   evapotranspiration, 52  
   gas, 7, 9  
   leaf mass, 64  
   leaf nitrogen, 64  
   level, 3  
   photosynthesis, 77  
   radiation models, 254  
   remote sensing light absorbed by,  
     253–254  
   stomatal conductance, 32  
   transpiration from plant, 31–32  
 Carbohydrates, 84  
 Carbon. *See also* Carbon cycle;  
   Gross primary production; Net  
   primary production  
   acquisition, 82  
   allocation, 84, 89, 168  
 Carbonate rock, 40  
 Carbonation, 116  
 Carbon balance, 6  
 Carbon cycle, 59–98  
   autotrophic respiration, 67–71  
   carbon balances  
     landscape, 281–283  
     net ecosystem, 341–342  
   comparison of ecosystem models,  
     96–98  
   forests in global, 303–310  
   elements of carbon cycle,  
     303–305  
   global net primary production,  
     306–309  
   other gas emissions from  
     forests, 309–310  
   source/sink dynamics,  
     305–306  
   heterotrophic respiration, 71–75  
   modeling photosynthesis and  
     respiration, 76–82  
   assessment of heterotrophic  
     respiration, 80–82  
   carbon balance of vegetation,  
     78–80  
   gross and net photosynthesis,  
     76–78  
   net primary production and  
     allocation, 82–96  
   allocation indices, 94–96  
   annual assessment of, 86–94  
   overview, 82–83  
   seasonal dynamics in allocation,  
     83–86  
   overview, 59–62  
   photosynthesis, 62–67  
 Carbon dioxide, 40  
 Carbon isotope discrimination, 40  
 Carboxylation capacity, 76  
 Carboxylation enzymes, 298  
 Carboxylation rate, 63  
*Castanea dentata*, 195  
*Casuarina*, 113  
 Cation components, 115  
 Cation exchange, 133–135, 210  
 Cation-exchange capacity (CEC),  
   133  
 Cattelino, P.J., 176, 178  
*Ceanothus velutinus*, 113  
 CEC (cation-exchange capacity),  
   133  
 Cellulose, 125, 195  
 CENTURY model, 97, 167  
 Ceulemans, R., 298  
 C fixation, 76  
 Chemical weathering, 115  
 Chemistry, canopy, 333–335  
 Chen, J.M., 254  
 Chlorophyll, 101, 333  
   levels, 64  
   pigments, 65, 298

- Chloroplasts, 62  
*Choristoneura fumiferana*, 188  
*Choristoneura occidentalis*, 188  
 Ciaï, P., 305  
 Cihlar, J., 254  
 Clay minerals, 116  
 Clements, F.E., 150  
 Cleugh, H.A., 332  
 Climate  
   changes in, 339–344  
     climatic trends, 339  
     impact on forests, 339–344  
     response of forests, 298–299  
   and forest interactions, 300–303  
   and potential forest distribution, 294–296  
   stabilization and forest planting, 315  
 Climatological extrapolations, 228  
 Climatology, 237–240  
 Climax vegetation, 150  
 C : N ratio, 73  
 Cobalt, 102  
 Cohen, W.B., 256, 266  
 Columbia River basin, 285–287  
 Composition, forest, 344  
 Computer simulation models, 7  
 Condensation, 45  
 Conductivity, hydraulic, 37–39  
 CONIFER model, 228  
 Conifers, 38, 39  
 Core area, 257  
 Coughlan, J.C., 48, 236  
 Cowles, H.C., 150  
 Coyea, M.R., 165, 188  
 Creed, I.F., 279  
 Crop Moisture Index, 273  
 Cropper, W. P., Jr., 170  
 Crow, T.R., 267  
 C-sequestration rates, 341  
*Cyanocitta cristata*, 153
- D**  
 Daily time step model  
   (DAYTRANS), 236  
 Dale, V.H., 297  
 Dalton's equation, 31  
 Daly, C., 241  
 Darcy's law, 52  
 Data layer inconsistencies, 259  
*Daviesia mimosoides*, 205  
 DAYMET model, 286  
 DAYTRANS (daily time step model), 236  
 Dead soil animals, 122  
 Decomposition, 14, 73, 121, 124–128, 132, 133, 151, 160, 184, 193, 198  
 Defensive compounds, 185  
 Defoliating insects, 87, 188–193  
 Delbart, N., 332  
 DEM (digital elevation model), 231–232  
 Dendrochronology, 162–166, 341  
*Dendroctonus ponderosae*, 194  
 DeNiro, M.J., 270  
 Denitrification, 137  
 Density, stand, 254–257  
 Desjardins, Ray, 288  
 DeSteven, D., 218  
 Detrital pool, 87  
 Detritus, 71, 124  
 Dewar, R.C., 63, 84  
 Dew point, 25  
 Diameter xylem elements, 37  
 Digital elevation model (DEM), 231–232  
 Dinitrogen, 113, 114, 137  
 Directional options, remote sensing, 249  
 Discrimination, carbon isotope, 40  
 Dissolved organic carbon (DOC), 138  
 Distribution, global forest. *See* Global forest assessment  
 Disturbance, 13, 183–219. *See also*  
   Atmospheric disturbance factors  
   abiotic factors, 203–218  
   fire, 203–207  
   forest harvesting, 214–216  
   mechanical forces, 216–218  
   overview, 203  
   biotic factors, 184–203  
   bark beetles, 193–195  
   biochemical defenses in plants, 185–188  
   browsing animals, 198–203  
   defoliating insects, 188–193  
   overview, 184–185  
   pathogens, 195–198  
   and climate change, 342–344  
   and landcover, 336  
   overview, 183–184  
   propagation of, 267–269  
 Diurnal variation, 23  
 Diversity, 257  
 Dixon, R.K., 305, 314  
 DOC (dissolved organic carbon), 138  
 Dormancy, 70  
*Dothistroma*, 197, 343  
 Douglas-fir, 104  
 Driving variables. *See* Spatial scaling  
 Drought analysis, regional, 272–273  
 Dryfall, 112, 209–214
- E**  
 Earth Observing System (EOS), 249  
 Earthworms, 121, 124  
 Ecological process models, 15  
 Ecophysiology, 3  
 Ecosystem analysis. *See* Forests, ecosystem analysis  
 Ecosystem carbon balances, net, 341–342  
 Ecosystem models, 168–180  
   biogeochemistry models, 168–170  
   comparison of, 96–98  
   coupled water balance, 52–57  
   evaporation, 30–31  
   gap models, 170–179  
   growth submodel, 173–175  
   mortality, 175–179  
   overview, 170–173  
   recruitment, 173  
   hybrid models, 179–180  
   overview, 4–10, 168  
   photosynthesis and respiration, 76–82  
     assessment of heterotrophic respiration, 80–82  
     carbon balance of vegetation, 78–80  
     gross and net photosynthesis, 76–78

- Ecosystem models (*continued*)  
 simplifications for spatial scaling, 228–231  
 snow in hydrologic balance, 48–50
- Ecosystem respiration, 319–321
- Ecotone, 295
- Ectotrophic mycorrhizae*, 103
- Eddy-covariance fluxes, 317–344  
 biogeochemistry, 327–328  
 climate change, 339–344  
 climatic trends, 339  
 impact on forests, 339–344  
 ecosystem respiration, 319–321  
 gross primary production, 318–319  
 hydrologic and energy partitioning, 325–327  
 net ecosystem production, 321  
 net primary production, 321–324  
 overview, 317–318  
 remote sensing, 328–338  
 canopy fluxes, 329–335  
 forest structure, 335–338  
 overview, 328–329  
 trace gas emissions, 324–325
- Electron transport, 63
- Electron transport rate, 76
- Elemental balance, 6
- Elements, essential, 100–102
- Eluvial* processes, 119
- Emissions, trace gas, 324–325
- Empirical models, 33–34
- Endotrophic mycorrhizae*, 103
- Energetic optimization, 198
- Energy balance, 6, 21–24
- Energy exchange, 46–48
- Energy partitioning, 325–327
- Enhanced vegetation index (EVI), 331, 336
- Entry, J.A., 198
- Enzymatic activity, 67
- Enzymatic reactions, 101
- Enzyme nitrogenase, 113
- EOS (Earth Observing System), 249
- Epiphytes, 28
- Epsilon, 94
- Equilibrium evaporation rate, 32
- Equivalent water thickness (EWT), 335
- Erosion, 115, 215
- E. sieheri*, 106
- ET (evapotranspiration), 207, 237, 275, 325, 332
- Eucalyptus*, 106, 110, 205, 313
- Evaporation, 25–27
- Evapotranspiration (ET), 207, 237, 275, 325, 332
- EVI (enhanced vegetation index), 331, 336
- EWT (equivalent water thickness), 335
- Extrapolations, topographic, 240–243
- Exudation, 106
- F**
- Fagus grandifolia*, 218
- Farquhar, G.D., 62, 164, 298
- Farquhar model, 76
- Fecal materials, 122
- Federer, A., 97, 168
- Fertilization, 200, 214
- Fire, 158, 203–207, 273–274
- FIRE-BGC model, 285
- Fisher, J.I., 332
- Fixation, ion, 136
- Flannigan, L.B., 299
- F layer, of forest floor, 119
- Fleming, R.A., 343
- Flow, water. *See* Water cycle
- Fluvic acids, 121
- Foley, J.A., 293
- Foliage  
 elongation, 187  
 respiration, 80  
 temperature, 31
- Foliar biomass, 211
- FORDYN model, 180
- FOREST-Bio-Geo-Chemical simulation model (FOREST-BGC), 7–9, 164, 168, 170, 179, 228, 236, 281, 287
- Forests. *See also* Biotic analysis of forest patterns; Global forest assessment  
 biodiversity, 336  
 and climate change, 339–344  
 and climate interactions, 300–303
- composition, 344
- ecosystem analysis, 1–16  
 management applications of, 14–16  
 overview, 1–2, 317–318  
 scientific process for, 2–3  
 spatial scaling, 13–14  
 stand/seasonal level of, 4–10  
 temporal scaling, 10–13
- forest-atmosphere interactions, 272–274
- forest cover, 263–266
- harvesting, 214–216
- structure, 335–338
- Forest Stand Dynamics*, 16
- FORGRO model, 96
- Forman, R.T.T., 266
- Fossil fuel emissions, 303
- Fossilized wood, 292
- FPAR, 309
- Fragmentation, litter, 122–124
- FRAGSTATS software package, 258, 259
- Franklin, J.F., 266
- Fraxinus pennsylvanica*, 43
- Frelich, L.E., 266, 274
- Fritz, S., 162
- Fuel, 314–315
- Functional biodiversity, 310–313
- Functional stand responses, 159–162
- Fung, I., 309
- Fungistatic compounds, 185
- Fuzzy systems theory, 178
- G**
- Gamma species diversity, 310
- Gap ecosystem models, 170–179  
 growth submodel, 173–175  
 mortality, 175–179  
 overview, 170–173  
 recruitment, 173
- Gap-phase vegetation, 150
- Garnier, B.J., 238, 241
- Garten, C.T., Jr., 131
- Gas analyzers, 288
- Gases, 207–209, 309–310, 324–325
- Gash, J.H.C., 31
- Gauged watersheds, 21
- GCM (Global Circulation Model), 293, 299, 300

- G'DAY (Generic Decomposition and Yield model), 97
- Gear, A.J., 293
- GEM, 97
- Gemmell, F.M., 256
- Generic Decomposition and Yield model (G'DAY), 97
- Genetic diversity, 310
- Geographic information system (GIS), 13, 229
- Geographic range, 344
- Geographic representation, 231–234
- Geologic weathering, 100
- Geostationary Operational Environmental Satellites (GOES), 248
- GEP (gross ecosystem production), 61
- Gholz, H.L., 170
- Gillett, N.P., 342
- GIS (geographic information system), 13, 229
- Glacier National Park, 284–285
- Global carbon balance, 215, 291
- Global carbon cycle, 303
- Global Circulation Model (GCM), 293, 299, 300
- Global climate database, 301
- Global forest assessment, 291–316
  - biodiversity, 310–313
  - forest-climate interactions, 300–303
  - global carbon cycle, 303–310
    - elements of carbon cycle, 303–305
    - global net primary production, 306–309
    - other forest gas emissions, 309–310
    - source/sink dynamics, 305–306
  - global forest distribution, 292–300
  - bioclimatic definition of potential, 294–296
  - future response to climate change, 298–299
  - monitoring future changes in, 299–300
  - paleoecological evidence of past, 292–294
  - satellite estimates of current, 296–297
  - overview, 291–292
  - sustainability, 314–315
- Global precipitation trends, 339
- Global Production Efficiency Model (GLO-PEM), 254
- Global scale monitoring, 300
- Global vegetation modeling analysis, 336
- Global warming, 300–302
- GLO-PEM (Global Production Efficiency Model), 254
- GOES (Geostationary Operational Environmental Satellites), 248
- Goodale, C.L., 341
- Gosz, J.R., 108
- Goulden, M.L., 82
- Goward, S.N., 250, 252, 254
- Gower, S.T., 159
- GPP (gross primary production), 318–329, 320, 329–331
- Grace, J.C., 159
- Graham, R.L., 315
- Graumlich, L.J., 164
- Graustein, W.C., 136
- Gravimetric water content, 73
- Gravitational component, 35
- Gravitational potential, 50
- Green, D.S., 333
- Greenhouse gas-induced warming, 300
- Grier, C.C., 54
- Groisman, P.Y., 301
- Gross ecosystem production (GEP), 61
- Gross primary production (GPP), 318, 318–319, 329–331
- Growth, 69–71, 340–341
- Growth ecosystem submodel, 173–175
- Gustafson, E.J., 267
- Gymnosperms, 34
- H**
- Habitat analysis, wildlife, 269–272, 338
- Hall, F.G., 266
- Hansen, A.J., 269, 338
- Hardwoods, 39
- Harvest index, 96
- Harvesting, forest, 214–216
- Haxeltine, A., 294, 296
- Heartwood, 34
- Heat transfer from vegetation, 21–34
  - energy balance, 21–24
  - evaporation from wet surfaces, 25–27
  - interception, 27–30
  - modeling evaporation, 30–31
  - seasonal estimation of leaf area index, 30
  - stomatal conductance, 32–34
  - transpiration from plant canopies, 31–32
- Heavy metals, 209
- Hemicellulose, 125
- Henderson-Sellers, 303
- Herbicides, 214
- Herbivores, 87
- Heterogeneity, spatial, 266–267
- Heterotrophic fungi, 211
- Heterotrophic metabolism, 59
- Heterotrophic microbial activity, 138
- Heterotrophic organisms, 111
- Heterotrophic respiration, 61, 71–75, 80–82
- Historical “natural” sequence, 184
- H layer, of forest floor, 119
- Högberg, P., 320
- Hogg, E.H., 343
- Houghton, R.A., 314
- Huff, M.H., 204
- Humidity, 237
- Humus, 119, 128–129
- Hunsaker, C.T., 281
- Hunt, E.R., 164
- Huntley, B., 293
- Hybrid ecosystem models, 179–180
- Hydraulics, plant, 34–40
  - carbon isotope discrimination of limitations on, 40
  - restrictions on water flow, 34–37
  - seasonal variation in conductivity, 37–39
- Hydrogen, 11, 142
- Hydrogen ions, 135
- Hydrogen sulfide, 137
- Hydrologic analyses, 227

- Hydrologic and energy partitioning, 325–327
- Hydrologic balance, watershed, 275–279
- Hydrologic cycle, 19
- Hydrologic equilibrium theory, 14
- Hydrologic gas, 7, 9
- Hydrologic recovery, 56, 278
- Hydrologic routing, 232–233
- Hydrologic system, 52
- Hydrology, snow, 48–50
- Hydrophobic soil, 50
- Hydrostatic pressure, 35
- Hydroxide radicals, 133
- Hyperspectral sensors, 333
- I**
- IBP (International Biological Program), 141, 228
- Ice, 217–218
- Illuvial* horizon, of mineral soil, 120
- Immobilization, nutrient, 129–133
- Inconsistencies, data layer, 259
- Indices, allocation, 94–96
- Infiltration, 50–52
- Initiation stage of stand development, 152–153
- Insects, defoliating, 87, 188–193
- Interception, 27–30, 46–48
- Intermediate regeneration, 179
- Internal recycling, 103–106
- Internal tree physiology, 9
- International Biological Program (IBP), 141, 228
- Invertebrates, 184
- Ion exchange, 133–135
- Ips typographus*, 194
- Isoprene, 209
- Isotopes, stable, 11–12
- Isotope-tracer study, 138
- Isotopic analyses, 75, 168, 305
- Isotopic composition, 298
- Isotopic forms, 39
- Isotopic fractionation, 45, 73, 75
- Iverson, L.R., 256
- J**
- JABOWA model, 173
- Jarrah leaf litter, 73
- Jarvis, P.G., 64, 77
- Johnston, C.A., 267
- Jolly, W.M., 319
- Joules (J), 22
- Juniperus*, 38, 80
- K**
- Karl, T.R., 301, 303
- Karri substrate, 73
- Kaufmann, M.R., 206
- Keane, R.E., 285
- Keeling, C.D., 75, 309
- Kelliher, F.M., 25, 32, 311
- Kelvin temperature, 22
- Kern, J.S., 233
- Kicklighter, D.W., 229
- Kimball, J.S., 237, 332
- Kinetic reactions, 11
- Kirkby, M.J., 232
- Koerper, G., 297
- Körner, C., 32, 311
- Korol, R.L., 168, 179
- Kull, O., 64
- Kuusisto, E., 302
- L**
- Lagarostrobos franklinii*, 163
- LAI. *See* Leaf area index
- Lamberson, R.H., 269
- Laminated root rot, 197
- Land cover, 250, 336
- Landsat Thematic Mapper (TM), 231, 254, 284, 312
- Landsberg, J.J., 77, 90, 93, 94, 170
- Landscapes. *See also* Regional ecological analysis  
carbon balances, 281–283  
efficient representation with abiotic variable, 234–236  
patterns and processes, 226–228  
spatially explicit pattern analysis, 257–259
- Land surface temperature (LST), 336
- Lapse rates, 241
- Larix*, 332
- Latent heat transfer, 46
- Law, B.E., 327
- Leachate, 106–109
- Leaching, 137–138, 140, 210, 213
- Leaf abscission process, 108
- Leaf area index (LAI), 9, 54, 151, 156, 159, 193, 229, 321  
and remote sensing, 253–254  
seasonal estimation of, 30
- Leaf–gas exchange measurements, 32
- Leaf litter, 87, 109
- Leaf photosynthesis, 75
- Leaf-specific conductivity (LSC), 36, 40
- Leaf stomatal conductance, 32
- Lefsky, M.A., 336
- Leith, H., 306
- Lemon, P.C., 218
- Lepers, E., 336
- Leverenz, 77
- Levine, E.R., 281
- Li, H., 267
- Lichens, 113
- Lidar measures, 335, 335–336
- Light absorbed by canopy, 253–254
- Light compensation point, 64
- Light Use Efficiency (LUE), 9, 94, 226, 254, 283, 306
- Lignin, 73, 127, 136, 195
- Lipid-soluble compounds, 185
- Litter  
and mineral cycles, 106–109  
and soil processes, 119–138  
adsorption and fixation, 136  
cation and anion exchange, 133–135  
fragmentation and mixing, 122–124  
humus formation, 128–129  
microbial decomposition, 124–128  
mineralization and immobilization, 129–133  
overview, 119  
soil profile development, 119–122  
volatilization and leaching, 137–138
- Liu, 141
- L layer, of forest floor, 119
- Lloyd, J., 32, 298
- Long-wave radiation, 21–22
- Lonicera japonica*, 339

- LSC (leaf-specific conductivity), 36, 40
- LST (land surface temperature), 336
- Luan, J., 180
- LUE (Light Use Efficiency), 9, 94, 226, 254, 283, 306
- LUE models, 13
- Luxury consumption, 104
- Lysimeters, 100
- M**
- Macrozamia riedlei*, 205
- MAESTRO model, 96, 97
- Magnesium, 101
- Maintenance respiration, 61, 67–69
- Management applications of ecosystem analysis, 14–16
- Marks, P.L., 259, 298
- Mass balance, 138–143
- Mass movement, 218
- Mather, A.S., 78, 314
- Matric potential, 35, 50
- Maximum leaf conductance, 311
- McGarigal, K., 259
- McGuire, A.D., 97, 298
- McKay, D.S., 279
- McMurtrie, R.E., 77, 97, 170
- McNulty, S.G., 343
- Mean residence time (MRT), 125, 215
- Mechanical disturbance forces, 216–218
- Mechanical weathering, 115
- Mechanistic approach, 3
- Melillo, J.M., 3, 306, 314
- Mencuccini, M., 159
- Metamorphic rocks, 115
- Meteorological satellites, 250–252
- Methane, 137, 207
- Microbial biomass, 72
- Microbial decomposition, 100, 124–128
- Micrometeorology, 3
- Milne, B.T., 236
- Milner, K.S., 283
- Mineral cycles, 99–144
  - and mass balance, 138–143
  - overview, 99–100
  - plant processes affecting, 100–111
  - essential elements, 100–102
- nutrient use efficiency, 109–111
- plant uptake, 102–103
- return in litter and leachate, 106–109
- storage and internal recycling, 103–106
- soil and litter processes, 119–138
  - adsorption and fixation, 136
  - cation and anion exchange, 133–135
  - fragmentation and mixing, 122–124
  - humus formation, 128–129
  - microbial decomposition, 124–128
  - mineralization and immobilization, 129–133
  - overview, 119
  - soil profile development, 119–122
  - volatilization and leaching, 137–138
- sources of nutrients, 111–119
  - atmospheric deposition, 111–112
  - nitrogen fixation, 113–114
  - weathering, 114–119
- Mineralization, 124, 129–133, 193, 198
- Mineral weathering, 143
- Mixing, litter, 122–124
- Models, ecosystem. *See* Ecosystem models
- MODIS (Moderate Resolution Imaging Spectroradiometer), 249, 329–331
- Moisture and heterotrophic respiration, 73
- Molybdenum, 102, 204
- Monoterpenes, 209
- Monteith, John, 31, 94
- Morphological responses, 187
- Mortality, 175–179
- Mousseau, 298
- MRT (mean residence time), 125, 215
- MT-CLIM, 236, 240, 272, 285
- Mu, Q., 332
- Mull forest floors, 121
- Multifactor growth multipliers, 175
- Mycorrhizae, 91, 102, 103, 324
- Mycorrhizal fungi, 103
- Myers, N., 297
- Myneni, R.B., 309
- N**
- Nadelhoffer, K.J., 71
- NASA Earth Observing System program, 249, 273
- National Fire Danger Rating System, 274
- National Oceanic and Atmospheric Administration (NOAA), 245
- National Soil Geographic Data Base (NATSGO), 233
- National Weather Service, 273
- NATSGO (National Soil Geographic Data Base), 233
- NDSI (Normalized Difference Snow Index), 332
- NDVI (Normalized Difference Vegetation Index), 246, 254, 272, 329, 332
- NDWI (Normalized Difference Water Index), 332
- Near-infrared radiation (NIR), 21–22, 246, 331
- Near-term forecasting, 275
- NEE (net ecosystem exchange), 61, 127, 318, 341
- Needle-leaf trees, 30
- Neilson, R.P., 294, 296, 298
- Nemani, R.R., 56, 231, 252, 254, 273, 274, 279, 296
- Nematodes, 122
- NEP (net ecosystem production), 59, 318, 321
- Net carbon exchange, 318
- Net ecosystem exchange (NEE), 61, 127, 318, 341–342
- Net ecosystem production (NEP), 59, 321
- Net forest carbon balances, 341
- Net nitrification, 211, 213
- Net photosynthesis, 62, 64, 286
- Net photosynthetic rates, 64
- Net primary production (NPP), 3, 59, 159, 168, 286, 299, 309, 321, 336
  - allocation indices, 94–96
  - annual assessment of, 86–94

- Net primary production (NPP)  
(*continued*)  
contribution of forests to global,  
306–309  
and eddy-covariance fluxes,  
321–324  
NPP/gross photosynthesis (GPP)  
ratio, 80  
overview, 82–83  
remote sensing of, 331–332  
seasonal dynamics in allocation,  
83–86
- Net radiation, 27, 31
- Net sinks, 305
- N fixation, 102, 114
- N-fixing lichens, 114
- Nicholas, N.S., 218
- NIR (near-infrared radiation), 21–22,  
246, 331
- Nitrate nitrogen, 201
- Nitrification, 130
- Nitrobacter*, 131
- Nitrogen, 73, 93, 100–101, 111–112,  
137, 193, 209  
compounds containing, 186  
deposition, 211  
ecosystems saturated with, 210  
fixation, 113–114
- Nitrogenase, 113
- Nitrogen oxides, 207
- Nitrosomonas*, 130–131
- Nitrous oxide, 137, 213, 310
- NOAA (National Oceanic and  
Atmospheric Administration),  
245
- Norby, R. J., 165
- Normalized Difference Snow Index  
(NDSI), 332
- Normalized Difference Vegetation  
Index (NDVI), 246, 254, 272,  
331, 332
- Normalized Difference Water Index  
(NDWI), 332
- Normalized ratios, 39
- Norman, J.M., 252
- Nothofagus*, 80, 218, 313
- NPP. *See* Net primary production
- Nutrients  
accumulation of soil organic  
matter and, 159–162  
cycling models, 141  
efficiency of use, 109–111  
immobilization, 129  
reabsorption, 142  
sources of, 111–119  
atmospheric deposition,  
111–112  
nitrogen fixation, 113–114  
weathering, 114–119
- Nyssa aquatica*, 43
- O**
- Odocoileus hemionus*, 201
- Oerlemans, 301
- O'Hara, K.L., 158
- Ohm's law, 36, 37
- Old-growth stage of stand  
development, 158
- Ollinger, S.V., 238, 241, 279
- Olsson, H., 256
- Optimum nutrient balance, 104
- Oregon transect, 15
- Organic matter, 159–162
- Overpeck, J.T., 299
- Overstory canopy, 162
- Oxygen, 11
- Ozone, 207
- P**
- Paleoecology, 162, 292–294
- Pan, Y., 331
- PAR (photosynthetically active  
component of radiation), 21, 77,  
309, 330
- Parton, W.J., 138
- Patch, 257
- Pathogens, 186, 195–198
- Pearson, S.M., 270
- Peat bog, 109, 292
- Pedology, 166–168
- Pee Dee Belemnite formation, 40
- Penman equation, 26, 31
- Penman–Monteith equation, 31, 34,  
53, 76, 332
- Penman's equation, 31
- Percolation, 50–52, 142
- PGEN, 96
- Phellinus weirii*, 197
- Phenolic acids, 116
- Phenology, 84, 332–333, 339
- Phloem, 35
- Photorespiration, 61, 66, 67
- Photosynthate, 82, 84, 86, 96, 179
- Photosynthesis, 3, 39, 40, 73, 111,  
168, 184, 207  
and carbon cycle, 62–67  
discrimination of, 298  
modeling respiration and, 76–82  
assessment of heterotrophic  
respiration, 80–82  
carbon balance of vegetation,  
78–80  
gross and net photosynthesis,  
76–78
- Photosynthetically active component  
of radiation (PAR), 21, 77, 309,  
330
- Photosynthetic capacity, 7, 69
- Photosynthetic gas exchange, 75
- Photosynthetic pathways, 167
- Photosynthetic rates, 298
- Phytoalexins, 185
- Picea*, 216
- Picea mariana*, 321
- Picea rubens*, 86, 218
- Picea sitchensis*, 217
- Pielke, R.A., 272
- Pierce, L.L., 236, 254, 276, 283
- Pinus*, 110, 216
- Pinus banksiana*, 333
- Pinus contorta*, 43, 194, 344
- Pinus jeffreyi*, 217
- Pinus monticola*, 198
- Pinus radiata*, 43, 90, 93, 165, 170,  
197
- Pinus sylvestris*, 66
- Pinus taeda*, 328
- Plant biochemical defenses, 185–188
- Plant canopies, transpiration from,  
31–32
- Planting forests, 315
- Plant phenology, 84
- Plant processes. *See* Mineral cycles
- PnET model, 168, 331
- Podzolization, 120
- Pollution-producing aerosols, 300
- Population modeling, spatially  
explicit, 269–272
- Populus*, 332
- Populus tremuloides*, 321, 339, 344

- Pore size distribution, 50  
 Potassium, 101  
 Potential global forest distribution, 294–296  
 Precipitation, 45–46, 241  
 Predawn plant water potential, 46  
 Prentice, I.C., 293, 294, 296  
 Pressure component, 35  
 Price, C., 299  
 Primary succession, 150  
 Protein, 185  
*Pteridium aquilinum*, 159
- Q**  
 Quantitative descriptors, 257  
 Quantum efficiency, 64  
 Quartz, 115
- R**  
 Radiances, 244  
 Radiant energy, 62  
 Radiata pine, 313  
 Radiation, solar, 237–241  
 Radiation balance, 21  
 Radiative gases, 216  
 Radiometric surface temperatures, 247  
 Raich, 71  
 Rainfall, 112  
*Raphis cucullatus*, 153  
 Raster (square) cells, 283  
 Raster format, 231  
 Rastetter, E.B., 283  
 Rayleigh distillation kinetics, 114  
 Ray parenchyma cells, 105  
 Recruitment, seedling, 173  
 Recycling, internal, 103–106  
 Reflectances, 244  
 Reflectivities, 22  
 Regional carbon balances, 215  
 Regional drought analysis, 272–273  
 Regional ecological analysis, 261–289  
   biogeochemistry analysis, 274–288  
   landscape carbon balances, 281–283  
   overview, 274  
   regional applications, 284–287  
   validating models, 287–288  
   watershed biogeochemistry, 279–281  
   watershed hydrologic balance, 275–279  
 biotic analysis of forest patterns, 262–272  
 disturbance propagation, 267–269  
 overview, 262–263  
 spatial heterogeneity, 266–267  
 temporal changes in forest cover, 263–266  
 wildlife habitat analysis, 269–272  
 forest-atmosphere interactions, 272–274  
 overview, 261–262  
 Regional Ecosystem Simulation System (RESS), 13–14  
 Regional forest-atmosphere interactions, 272  
 Regional Hydroecological Simulation System (RHESys), 232, 254, 275, 279, 281, 284  
 Regional scale monitoring, 300  
 Reich, P.B., 266  
 Relative equivalent mass, 133  
 Relative humidity, 25  
 Relative water content (RWC), 38  
 Remote sensing, 243–257  
   and eddy-covariance fluxes, 328–338  
   canopy fluxes, 328–333  
   forest structure, 335–338  
   overview, 328–329  
 of landscape attributes, 250–257  
   albedo, land cover, and snow, 250  
   biomass, structure, and density, 254–257  
   LAI and fraction of light absorbed by canopy, 253–254  
   satellite-derived surface meteorology, 250–252  
   surface resistance, 252–253  
 principles of, 243–249  
   directional options, 249  
   overview, 243–245  
   spatial resolution, 245–246  
   spectral resolution, 246–248  
   temporal resolution, 248–249  
 Representation, geographic, 231–234  
 Resistant soil materials, 121  
 Resolution  
   spatial, 245–246  
   spectral, 246–248  
   temporal, 248–249  
 Resource management decisions, 262  
 Respiration  
   of carbon dioxide, 73–75  
   ecosystem, 319–321  
   modeling photosynthesis and, 76–82  
   assessment of heterotrophic respiration, 80–82  
   carbon balance of vegetation, 78–80  
   gross and net photosynthesis, 76–78  
*Respiration quotient*, 68  
 RESS (Regional Ecosystem Simulation System), 13–14  
 RHESys (Regional Hydroecological Simulation System), 232, 254, 275, 279, 281, 284  
 Ribulose biphosphate (RuBP), 62  
 Ring chronologies, 162  
 Riparian zone, 117  
 River flow dynamics, 275  
 Robinson, J.S., 232  
 Romme, W.H., 274  
 Roots, 102, 324  
   depth, 42–43  
   growth, 71  
   respiration, 135  
   rooting zone, 20, 41  
   temperatures, 43  
   water available to, 43–46  
 Rose, C.L., 48, 201  
 Roughness length, 30  
 Rubidium/strontium ratios, 118  
 Rubisco enzyme, 67, 96  
 RuBP (ribulose biphosphate), 62  
 Ruel, J.C., 216  
 Running, S.W., 48, 54, 56, 170, 234, 236, 241, 252, 274, 275, 279, 281, 283, 296, 314

- Runoff, surface, 50  
 Runyon, J., 78, 80, 94  
 Rutter, A.J., 28, 31  
 RWC (relative water content), 38  
 Ryan, M.G., 80, 159  
 Rykiel, E.J., Jr., 9
- S**
- Sakai, A., 294  
 Salinization, 276  
 Sapwood, 67–68  
 Sarr, D.A., 336  
 Satellites  
   estimates of current global forest  
   distribution, 296–297  
   satellite-borne laser altimeters,  
   257  
   surface meteorology derived from,  
   250–252  
 Saturated hydraulic conductivity,  
 51  
 Schlesinger, W.H., 128  
 Schwartz, M.D., 303  
 Scientific process for ecosystem  
 analysis, 2–3  
 Scots pine, 28  
 Scotter, 25  
 Sea of nitrogen, 113  
 Seasonal carbon allocation, 83–86  
 Seasonal leaf area index, 30  
 Seasonal level of analysis, 4–10  
 Seasonal patterns, in soil water  
 depletion, 52  
 Seasonal water flow and plant  
 hydraulics, 37–39  
 Sedjo, R.A., 315  
 Seedling recruitment, 173  
 Self-thinning rule, 154  
 Sellers, P.J., 303, 306  
 Sensitivity analyses, 76  
*Sequoiadendron*, 205  
*Sequoia sempervirens*, 158, 218  
 Sesquioxides, 121  
 Sharma, N.P., 314  
 Short-wave radiation, 21–22, 250  
 Shugart, H., 173  
 Silvicultural handbooks, 218  
*Simaba cedron* trees, 153  
 Simple Ratio (SR), 246, 254, 284  
 Simulation models, mineral cycling,  
 141–143  
 Sinks, carbon, 305–306  
 Sisk, T.D., 312  
 Site descriptors, 52  
 Site indices (SI), 170, 341  
 Site quality, 170  
 Skole, D.L., 303  
 SLM (specific leaf mass), 64–65  
 Snow  
   as factor of disturbance, 217–218  
   hydrology, 48  
   and remote sensing, 250  
   snowpack dynamics, 52  
   snow pillows, 48  
   water storage and losses from,  
   46–50  
 Soil, 19  
   accumulation of organic matter  
   and nutrients, 159–162  
   bulk densities, 41, 43  
   fertility multipliers, 175  
   and geographic representation,  
   233–234  
   hydraulic properties, 52  
   limitations on flow of water, 40–  
   43  
   and litter processes, 119–138  
   adsorption and fixation, 136  
   cation and anion exchange,  
   133–135  
   fragmentation and mixing,  
   122–124  
   humus formation, 128–129  
   microbial decomposition,  
   124–128  
   mineralization and  
   immobilization, 129–133  
   overview, 119  
   soil profile development,  
   119–122  
   volatilization and leaching,  
   137–138  
   organic matter, 87  
   temperatures, 46, 237  
   temperatures of, 237  
   texture, 42  
   water available in rooting zone,  
   43–46  
   water flow across and through,  
   50–52  
 Soil–Vegetation–Atmosphere–  
 Transfer (SVAT) models, 226,  
 272  
 Solar radiation, 77, 237–241, 300  
 Solar zenith angles, 48  
 Sollins, P., 130  
 Solomon, A.M., 176  
 Solute potential, 35  
 SOM, 128  
 Sources, carbon, 305–306  
 Spanner, M.A., 254  
 Spatial heterogeneity, 266–267  
 Spatial isolation, 184–185  
 Spatially explicit population  
 modeling, 269–272  
 Spatial resolution, 245–246  
 Spatial scaling, 225–259. *See also*  
   Eddy-covariance fluxes; Global  
   forest assessment; Regional  
   ecological analysis; Remote  
   sensing  
   abiotic site variables, 231–236  
   data layer inconsistencies, 259  
   environmental driving variables,  
   236–243  
   climatology, 237–240  
   overview, 236  
   topographic extrapolations,  
   240–243  
   landscape patterns and processes,  
   226–228  
   model simplifications, 228–231  
   overview, 13–14, 221–226  
   spatially explicit landscape pattern  
   analysis, 257–259  
   stand/seasonal level of analysis,  
   4–10  
 Specht, R.L., 56  
 Species diversity, 310  
 Specific leaf mass (SLM), 64–65  
 Spectral resolution, 246–248  
 Spies, T.A., 256, 267  
 Split-window approach, 252  
 SPM model, 96  
 SPOT sensor, 249  
 SPOT-VGT satellite, 332  
 Square (raster) cells, 283

- Square picture element, 245  
 SR (Simple Ratio), 246, 254, 284  
 Stable isotopes, 11–12, 73–75  
 Stands  
   functional responses of during development, 159–162  
   and seasonal level of analysis, 4–10  
   structural stages in development of, 151–158  
   initiation, 152–153  
   old-growth, 158  
   overview, 151–152  
   stem exclusion, 154–156  
   understory reinitiation, 156–157  
 State Soil Geographic Data Base (STATSGO), 233  
 State–space diagram, 263  
 State variables, 3  
 STATSGO (State Soil Geographic Data Base), 233  
 Steady-state climax vegetation, 150  
 Stefan–Boltzmann constant, 22  
 Stem  
   elongation, 70  
   mortality, 156  
   stem exclusion developmental stage, 154–156  
 Stenberg, P., 75  
 Stochastic models, 13  
 Stomata, 34, 62, 298  
 Stomatal closure, 37  
 Stomatal conductance, 31–32, 63, 209  
   and carbon isotope discrimination, 40  
   empirical model of, 32–34  
   soil limitations on, 40–43  
 Storage, 103–106  
 Stream discharge, 227  
 Streamflow, 19, 275, 279  
 Stress indices, 13  
 Strontium, 117  
 Structure  
   remote sensing of forest, 335–338  
   remote sensing of stand, 254–257  
   stand development stages, 151–158  
   initiation, 152–153  
   old-growth, 158  
   overview, 151–152  
   stem exclusion, 154–156  
   understory reinitiation, 156–157  
 Subalpine, 84, 175  
 Sublimation, 46  
 Substrate quality, 72–73  
 Sulfur, 101, 111–112, 209  
 Sulfur dioxide, 137, 207  
 Supervised spectral reflectance data, 244  
 Surface meteorology, 250–252  
 Surface resistance, 252–253  
 Surface runoff, 50  
 Surface wetness, 252  
 Sustainability, global forest, 314–315  
 SVAT (Soil–Vegetation–Atmosphere–Transfer) models, 226, 272  
 Swartzman, G.L., 4  
 Swedish National Forest Inventory, 341  
 Swenson, J.J., 338  
 Swift, L.W., 238, 241  
 Symbiotic N fixation, 113  
 Synthesis respiration, 61, 69–71  
*Syringa vulgaris*, 339  
 System states, 3
- T**  
 Tannins, 185, 201  
 Tans, P.P., 305  
 Target cell, 226  
*Taxodium distichum*, 43  
 TEM model, 97  
 Temperate forests, 291  
 Temperature  
   air, and topographic extrapolations, 241  
   and climatology, 237  
   and heterotrophic respiration, 73  
 Temporal biodiversity, 310  
 Temporal changes in forest cover, 263–266  
 Temporal resolution, 248–249  
 Temporal scaling, 149–182. *See also* Disturbance; Gap ecosystem models  
 dendrochronology, 162–166  
 ecosystem models, 168–180  
   biogeochemistry models, 168–170  
   hybrid models, 179–180  
   overview, 168  
 functional responses during stand development, 159–162  
 overview, 10–13, 145–151  
 paleoecology, 162  
 pedology, 166–168  
 of standlevel, 10  
 structural stages in stand development, 151–158  
   initiation, 152–153  
   old-growth, 158  
   overview, 151–152  
   stem exclusion, 154–156  
   understory reinitiation, 156–157  
 Termites, 124  
*Terrestrial Ecosystems*, 16  
 Terrestrial vegetation, 303  
 Thornton, P.E., 241  
 Tiessen, H., 215  
 Tiktak, A., 141  
*Tilia americana*, 218  
 Tilman, D., 311  
 Tissue composition, 12  
 Tissue turnover, 168  
 TM (Landsat Thematic Mapper), 231, 254, 284, 312  
 TOMS (Total Ozone Mapping Spectrometer), 250  
 TOPMODEL logic, 232–233, 234, 284  
 Topographic climatic extrapolation, 13  
 Topographic partitioning, 277  
 Topographic Saturation Index (TSI), 233  
 Topographic variables, 48  
 Topography, 231–232, 240–243  
 Total Ozone Mapping Spectrometer (TOMS), 250  
 Townsend, A. R., 167  
 Townshend, J., 296  
 Trace gas emissions, 137, 215, 324–325  
 Tracheids, 34

- Transition zone, 295  
 Transmittance, 239  
 Transpiration, 31–32, 184  
 TREE-BGC, 179  
 TREEDYN3, 96, 180  
 Tree pollen, 292  
 Tree-ring data, 162–163  
 Tree seedlings, 172  
 TREGRO, 96  
 Trumbore, S.E., 128, 166, 215  
 TSI (Topographic Saturation Index), 233  
*Tsuga heterophylla*, 204, 217  
*Tsuga mertensiana*, 197, 217  
 Tuomisto, H., 312  
 Turbulence, 26  
 Turbulent transfer, 31  
 Turner, D.P., 234, 263, 274, 297  
 Turner, M.G., 263, 270, 296
- U**  
 UAVs (unmanned aerial vehicles), 338  
 Understory regeneration, 179  
 Understory reinitiation stage of stand development, 156–157  
 Unmanned aerial vehicles (UAVs), 338  
 Unsaturated hydraulic conductivity, 51  
 Unsupervised spectral reflectance data, 244  
 Uptake, 102–103  
 Urea, 136  
 U.S. National Atmospheric Deposition Program, 279  
 U.S. National Weather Service and World Meteorological Organization, 236
- V**  
*Vaccinium ovalifolium*, 201  
 Validation, ecosystem analysis model, 9–10, 287–288  
 Vapor pressure deficit, 237  
 Vapor transfer. *See* Water cycle
- Variable disturbance sensitivities, 175  
 Variable-plot surveys, 87  
 Variables, driving. *See* Spatial scaling  
 Vascular tissue, 34  
 Vector format, 231  
 Vegetation carbon balance, 78–80.  
   *See also* Water cycle  
 Vegetation dynamics, 150  
 VEMAP (Vegetation/Ecosystem Modeling and Analysis Program), 7, 299  
 Vertebrate animals, 198  
 Vessels, 34  
 Vetter, M., 341  
 Vidal, A., 274  
 Visible radiation, 156  
 Vitousek, P.M., 314, 335  
 Volatilization, 137–138  
 Volcanic eruptions, 112  
 Volumetric water content, 41
- W**  
 Walcroft, A.S., 165  
 Wallin, D.O., 267  
 Walsh, J.E., 302  
 Waring, R.H., 93, 94, 338  
 Warming, climate, 300–302  
 Water cycle, 19–57  
   coupled water balance models, 52–57  
   flow across and through soil, 50–52  
   flow through trees, 34–46  
     carbon isotope discrimination, 40  
     hydraulic restrictions on, 34–37  
     seasonal variations, 37–39  
     soil limitations on, 40–43  
     water available in soil rooting zone, 43–46  
   heat and water vapor transfer from vegetation, 21–34  
   energy balance, 21–24  
   evaporation from wet surfaces, 25–27  
   interception, 27–30  
   modeling evaporation, 30–31  
   seasonal estimation of leaf area index, 30  
   stomatal conductance, 32–34  
   transpiration from plant canopies, 31–32  
   overview, 19–21  
   storage and losses from snow, 46–50  
 Waterlogging, 276  
 Watershed biogeochemistry, 279–281  
 Watershed hydrologic balance, 275–279  
 Weathering, 114–119  
 Weinstein, D.A., 84  
 Western spruce budworm, 190  
 Wetfall, 112, 209–214  
 Wetness, 252–253  
 Whitehead, D., 91  
 Wigmosta, M.S., 232, 275  
 Wildfires, 173  
 Wildlife habitat analysis, 269–272, 338  
 Wind, 216–217, 242  
 Wood cellulose, 46  
 Wood fiber, 315  
 Wood permeability, 36  
 Wood relative water, 46  
 Woods, A.S., 343  
 Wood supply, global, 314–315  
 Woodward, F.I., 294, 311
- X**  
 Xylem, 34, 38, 46, 76
- Y**  
 Yellowstone National Park, 263
- Z**  
 Zarco-Tejada, P.J., 333  
 Zero point charge (ZPC), 134  
 Zheng, D., 234, 237  
 Zhu, A.-X., 234  
 ZPC (zero point charge), 134