

Index

- absorptivity, 43, 196, 200
- adiabatic, 82
 - lapse rate, 82
 - dry, 82, 83, 99, 168
 - moist, 94
- aerosol model, 157
- aerosols, 46, 222, 226
- albedo, 46
- annular modes, 141
- anthropogenic
 - climate change, 1
 - forcing, 248
 - perturbation, 65
- atmospheric boundary layer, 47, 82
- atmospheric chemistry model, 157
- atmospheric circulation, 50–58, 79–80
- atmospheric window, 42

- Beta effect, 74, 99
- biogeochemistry, 34, 177
- biogeochemistry model, 157
- biophysical land surface models, 154
- biosphere, 2, 34, 37
- Bjerknes hypothesis, 18, 103
- blackbody radiation, 41

- carbon cycle, 8, 157
- CFC, 7
- climate, definition of, 1
- climate change, 5, 7–13, 24–28
 - anthropogenic, 1
 - mitigation, 256
 - observed to date, 246–252
- climate drift, 178
- climate dynamics, 1
- climate feedback parameter, 199, 201, 202
- climate feedbacks, 201, 204
 - cloud, 208
 - lapse rate, 211
 - snow/ice, 207
 - water vapor, 205
- climate model hierarchy, 175
- climate modeling, 2, 145, 157–158
 - time scales, 162, 163
- climate sensitivity, 205
 - climate sensitivity parameter, 204
 - climate system modeling, 157–158
- climatology, 2
- cloud fraction, 208
- cloud top feedback, 210
- clouds
 - effect on climate change, 39
- computational cost, 150
- computational instability, 151
- conditional instability, 170
- conservation of mass, 85, 119
 - applied to moisture, 89
 - applied to salinity, 91
- convection, 35
 - dry, 47, 83, 168–169
 - moist, 35, 90, 94, 148, 169–171
- convective adjustment, 171
- convective heating, 47, 90
- Coriolis force, 54, 72–74
- Coriolis parameter, 74
- cryosphere, 34, 37

- data assimilation, 126
- delayed oscillator model, 123
- discretization, 145
- doubled-CO₂ response, 205
- drag coefficient, 154
- dynamical climate system, 3

- Earth system model, 2, 157
- eddy transports, 41, 53
- El Niño, 4, 13, 103–136
 - dynamics of transition phases, 116
 - extreme phases, 106
 - first forecast, 22
 - forecast limits, 127–131
 - history, 14, 18
 - observations, 19–22
 - prediction, 125–127
 - remote impacts, 131–136
- El Niño/Southern Oscillation
 - see* ENSO
- electromagnetic spectrum, 41
- emission temperature, 198
- emissions scenarios, 221–225, 252

- emissivity, 42, 200
 energy budget, 2, 46–48, 193, 197
 ENSO, 13, 106, 124
 and hurricane frequency, 139
 forecast limits, 127–131
 index regions, 15
 remote impacts, 131–136
 simulation, 188–191
 equation of state, 77
 for the atmosphere, 77
 for the ocean, 77
 equatorial cold tongue, 20, 58
 equatorial radius of deformation, 120
 evaporation, 47, 167
 evapotranspiration, 47, 63, 171, 172
 feedbacks
 see climate feedbacks
 finite-difference models, 158
 Fourier series representation, 159
 geopotential, 77
 geostrophic balance, 75
 global energy balance, 193, 208, 209
 global warming, 2, 221
 and extreme events, 243
 and land ice, 240, 250
 and sea ice and snow, 238, 250
 and sea level rise, 80, 250
 antropogenic forcing, 248
 attribution, 249
 best-estimate prognosis, 244
 distinguishing from natural variability, 248
 emissions scenarios, 222
 energy balance model, 198
 history of, 10–13
 modeling, 176, 187
 observed trends, 246
 oceans, 215
 polar amplification, 237
 projections, 232–235
 response to scenarios, 225
 spatial patterns, 238
 greenhouse effect, 2, 47, 193
 in a one-layer atmosphere, 196
 in completely IR-absorbing atmosphere, 195
 increases in, 198
 greenhouse gases, 2
 Hadley circulation, 51–54
 hierarchical modeling, 175
 hybrid coupled models, 176
 hydrostatic balance, 82
 ice fraction, 174
 ice sheets, 240–242
 ice shelves, 241
 infrared emissions, 193, 194, 197, 200
 infrared radiation, 2, 35, 47, 148
 Intergovernmental Panel on Climate Change, 10
 Intertropical Convergence Zone (ITCZ), 53, 55
 IPCC, 10, 29
 see also emissions scenarios
 see also Intergovernmental Panel on Climate Change
 Kelvin waves, 96
 Kyoto protocol, 11
 La Niña, 108, 115, 125, 131
 see also El Niño
 land surface processes, 63–64
 and soil moisture, 171–172
 land surface types, 154, 155
 lapse rate, 50, 82
 lapse rate feedback, 237
 latent heat, 47, 90
 leaf area index, 154, 172
 lifting condensation level, 93
 linearization, 200
 longwave radiation
 see infrared radiation, 35
 mass flux scheme, 171
 mitigation scenarios, 256
 moist adiabatic processes, 94, 169, 170
 moist convection
 see convection, moist, 35
 moisture equation, 89
 monsoon circulations, 55
 noise
 see weather noise
 North Atlantic Oscillation, 141, 142
 numerical instability, 162
 ocean
 gyres, 60
 surface currents, 58, 59, 105
 thermohaline circulation, 62
 ocean heat storage, 217–219, 250
 role in slowing global warming, 215
 ocean model, 152
 outgoing longwave radiation (OLR), 35
 paleoclimate variability, 24–28
 parameterization, 37, 39
 physical climate system, 2, 3
 polar amplification, 229, 237, 238
 poleward amplification
 see polar amplification
 power spectrum, 16, 31
 predicted climate changes, 245
 pressure coordinates, 76

- pressure gradient force, 71, 74
 in the ocean, 108, 109
- radiative forcing, 41, 48–50, 199, 222–223, 225–253
- recharge oscillator model, 123
- regional climate models, 149, 177
- Rossby waves, 96–98, 121
- salinity, 62
- sea ice, 172, 238
- sea ice model, 154, 172–175
- sea ice simulations, 187, 188, 239
- sensible heat, 47
- solar energy input, 44
- spectral models, 158
- stefan–Boltzmann law, 42
- storm tracks, 56, 132
- sublimation, 173
- surface mass balance, 241, 242
- systematic model error, 178
- teleconnections, 103
see also ENSO, remote impacts
- temperature equation, 81
 for the air, 81
 for the ocean, 81
- thermal expansion, 241, 245, 252
 and sea level rise, 80, 241
 and sea level rise, observations, 251
 coefficient of, 77
- thermals, 47
- thermocline, 21, 34, 61, 88, 108, 110
 and ENSO, 105, 112–124
 and upwelling, 88, 106
- thermohaline circulation, 62
- time scales, 35–37
 geological, 25
- time-stepping, 161
- trace gases, 7–9
- transient response experiments, 213
- tropical convection zone, 55
- upwelling, 58
 coastal, 87
 equatorial, 88
- vegetation model, 157
- velocity equations, 75
- vertical shear, 138
- Walker circulation, 56
- weather, definition of, 1
- weather noise, 129, 130
- zonal average, 51