

Index

- absorption of radiation, 23–24, 26, 117, 130, 200
- Africa
 climate change, 68, 71, 113–114
 and disease, 160, 162, 165, 170, 176
 general climate, 29, 42–43, 45, 93, 132
 and ‘greenhouse’ warming, 133, 139–140
 during Ice Ages, 85
 during the Holocene, 90
 during the modern record, 124, 194
 and vegetation, 182
- albedo (reflectance of radiation), 25–27, 110, 188, 194, 199
 and ‘greenhouse’ warming, 122, 138
 during Ice Ages, 85, 98, 107–108, 110, 114, 200–203
 planetary, 3, 19–20, 25, 194, 196, 200–203
 and sulphates, 129–130
 and vegetation, 25, 185–186
- Antarctic, 4, 29, 37, 39, 46–47, 50, 56, 59, 63–64, 68, 77, 137
 and ‘greenhouse’ warming, 133, 137
 during Ice Ages, 83, 85, 87–88, 100, 106, 108, 110, 114
 and ozone depletion, 143–145, 147, 169
- aridity
 climate, 11, 44, 62, 98, 131
 during Ice Ages, 80, 85, 107, 110, 114, 201–202
 places with, 3, 25, 29, 70, 140
- Asia
 climate change, 11, 68, 71, 113, 128, 130–132
 and cooling from sulphates, 139
 and disease, 157–158, 160, 162, 166, 174, 176
 general climate, 29, 36–37, 40, 43–47, 67–68, 91, 93
 and ‘greenhouse’ warming, 133, 135, 140
 during Ice Ages, 79, 107, 109
 during the historic record, 90, 113, 125
 during the Holocene, 90
 during the modern record, 128, 167–168
 and ‘nuclear winter’, 146
 and vegetation, 182
- atmosphere
 composition, 21–23
 effect on radiation, 19–20, 23–27
 during Ice Ages, 80, 100
 scales and response times in, 65–66, 167
- atmospheric instability, 9, 35–37, 40, 43–44, 53, 55–56, 62, 64, 68–69, 71, 136
- atmospheric stability, 9, 22, 35, 37, 41, 44, 53, 61–62, 67, 89, 110, 114, 131, 146–147, 200
- Australia
 and cataracts, 171–172, 174
 climate change, 68, 71–72, 124, 128, 144, 167, 173
 and disease, 161–162, 164, 174
 economic cost of enhanced UV radiation, 173–174, 176
 general climate, 29, 37–38, 41, 43, 45–47, 53–54, 58, 63–65, 67–68, 93, 132
 and ‘greenhouse’ warming, 137, 139
 during Ice Ages, 79, 83, 107
 during the Holocene, 142
 during the modern record, 124, 128, 142, 167, 178–179
 and skin cancers, 170, 172, 174
 and UV radiation, 170–175
 and vegetation, 193
- biomass burning *see* vegetation
- biomes, 182, 186, 191–192
 changes in boundaries of, 192–197
 climatic limitations, 182
 and ‘greenhouse’ warming, 193–194
 types of, 182–183, 191–197:
 desert, 185, 193, 196
 grasslands, 191–192, 194, 196
 taiga (boreal forest), 191, 194
 temperate forest, 183, 187–188, 191–196
 tropical rainforest, 186, 191, 194, 196
 tundra, 183–184, 186, 191–194
- Brunhes-Matuyama magnetic reversal, 78–79, 105
- carbon 14, 11, 66, 77–78, 88
 and climate change, 98
- carbon dioxide (CO₂), 21, 26, 118–119
 anthropogenic enhancement, 21, 117
 atmospheric composition:
 on Mars, 3–4
 on Venus, 3–4
 on Earth, 2–4, 21
 biological activity, 119
 ‘greenhouse’ effect, 21, 24, 118–120, 122, 125
 ‘fertiliser’ effect, 123, 165–166, 168, 187, 190, 196, 202–203
 during glacials, 102–103, 106–107, 111, 114, 117, 191, 202
 during the historic record, 118, 120
 during the modern record, 111, 119–121, 125, 189–190, 197
 radiative forcing, 122, 200–201
 sinks, 119, 123, 196
 sources, 119, 123
 Southern Oscillation, 119
 and ‘The Great Northern Absorber’, 123, 190
 and vegetation, 186–190, 196–197
- chaos, 10, 12, 59, 73, 82, 93, 125
 theory, 10–12
see also uncertainties of climate change
- chlorofluorocarbons (CFCs) *see* halocarbons
- cities
 climate, 53–56, 167
 and disease, 157–158, 160, 165–166, 175, 177
 heat islands, 53, 56, 126, 128, 142, 147, 200, 203
 and ozone, 144, 169
 and pollution, 25, 129
 and population growth, 52–55, 126, 142, 147, 154, 157, 167–168
- civilisation, 80, 94, 131–132, 156–157
 climate change, 46, 48, 56, 59, 62, 114–115, 155
 and crime, 158, 178
 Earth’s geological history, 4–5, 77, 100–101
 and global cooling, 27–28, 30–31, 91–93, 104–105,

- climate change *continued*
 111–112, 124–132, 138–139,
 142, 145, 147–148, 199–203
 and global warming, 109,
 111–112, 124, 128, 140–141,
 147–148, 159, 164, 168,
 177–178, 183, 191–192, 194,
 199–203
 and human health, 155–157, 160,
 163–164, 176–179
 during the historic record, 90–91,
 99, 103
 during the Holocene, 89–90, 104
 during Ice Ages, 99–102, 108,
 114–115, 201–203
 and the measured record, 91–94,
 111–112
 nature of:
 coherence, 6, 70–71, 92, 107,
 114, 124
 cycles, 9–11, 125, 140
 extremes, 6–8, 43, 72–73,
 80–81, 90, 125, 140–141, 145,
 147, 203
 feedback, 8–9, 97, 106–111, 114,
 137–138, 147, 201–203
 noise, 5, 12–13, 59, 80, 97, 115,
 124–125, 139, 199
 persistence, 8–9, 67, 71–72
 randomness, 12–13, 97, 125, 140
 serial correlation, 9, 125
 suddenness, 80–83, 89–90, 109,
 125, 140
 trends, 5–6, 115, 124–125, 139,
 147
 variability, 5–6, 80–81, 108, 115,
 125, 140, 199
 during the Pleistocene, 80–83,
 86–89, 99–102, 108
 and the Southern Oscillation,
 66–73
 and vegetation, 107–108,
 110–111, 186–191, 202–203
 uncertainties 117, 203
- climate evolution
 on Earth, 2–4
 on Mars, 3–4
 on Venus, 3–4
- cloud, 49, 58, 194
 changes:
 across the Earth's surface, 27–31
 over time, 11, 46, 56, 68, 72, 91,
 128–129, 147, 173, 196, 199,
 200–201
 during glacials, 91, 98, 107,
 109–111, 114, 147, 202–203
- effect on radiation:
 shortwave, 25–26, 58, 109–110,
 169, 171
 longwave, 26–38
- effect on temperature, 128, 130,
 148, 202–203
 and 'greenhouse' warming,
 137–138, 147
- nuclei, 110, 128, 200–201
 radiative forcing, 25, 109–110, 138,
 200–201
 and sulphates, 109–110, 129, 132,
 147
 and weather systems, 40–42,
 45–46
- computer modelling, 12, 56, 94, 147
 of icecap growth, 83
 of monsoon circulation during Ice
 Ages, 85
 of 'nuclear winter', 146
see also General Circulation Models
 and Simple Biosphere Model
- convection, 26–27, 40–44, 49, 55, 58,
 63, 66, 68, 88–89, 107, 145,
 167, 194
 and greenhouses, 118
 and 'greenhouse' warming, 136–137
- cores
 ice, 80–81, 83, 88, 89, 103,
 106–107, 109–111
 deep-sea, 78–79, 82–83, 85–86
- Coriolis force, 33–35, 37, 40–42, 55,
 62, 143
 effect on ocean currents, 60–61,
 63–64
- cycles, 9–13, 22, 43, 46, 92, 99–102,
 125, 140
 during the Holocene, 98
 during Ice Ages, 10–13, 78,
 81–83, 97:
 Bond cycles, 82
 Dansgaard-Oeschger oscillations,
 80–83, 94, 111
 Milankovitch periodicities,
 99–101, 106, 111, 114
 M_N lunar, 9, 11, 36, 113–114
 precession of Earth's orbit:
 Ice Ages, 10–11, 99–100, 106
 modern records, 99, 125–126, 138
 sunspot, 9, 11, 22, 36, 111–115
see also Quasi-Biennial Oscillation,
 Southern Oscillation
- dating techniques, 77–79
 carbon 14, 77, 80
 dendrochronology, 77, 103–104
- deglaciation, 81, 86–89, 98–99,
 107–109, 111, 114, 192, 201
- dimethylsulphides (DMS), 110, 114,
 129, 132, 148, 199, 202–203
- disease
 asthma, 166, 178
 Black (bubonic) plague, 91,
 157–159, 175
 cholera, 103, 159, 165–166, 178
 dengue, 160–161, 163, 178
 diarrhoea, 154, 165–166, 178
 encephalitis, 160–162, 178
 ergotism (St. Anthony's fire), 91,
 158, 179
 of the eye, 154, 159, 171–173:
 cataracts, 172–173, 178
 pterygium, 172–173, 178
 haemorrhagic fevers, 160,
 175–178
 history of, 156–158
 immune system and UV radiation,
 169, 173, 178
 influenza, 154, 159, 166
 Legionnaires, 177–178
 Lyme, 155, 164–165, 178
 malaria, 159–162, 174, 178
 Q-fever, 164, 178
 respiratory, 166
 Rocky Mountain spotted fever, 164,
 178
 Ross River fever (epidemic
 polyarthritis), 155, 162–163,
 178
 schistosomiasis, 160, 165, 178
 of the skin, 170–171:
 cancer, 154, 159, 170–171, 173,
 178
 economic cost in Australia,
 173–174
 sleeping sickness, 165
 tuberculosis, 154, 159, 173, 175,
 178
 typhoid, 165–166
 typhus, 103, 164, 178
 yellow fever, 157, 160–163, 178
see also reservoirs, uncertainties,
 vectors
- drought, 45, 66–68, 71–73, 91–93,
 112–113, 124, 132, 140, 142,
 146, 155, 164, 168, 178, 185,
 190, 195, 203
- dust, 3, 24–25, 66, 138, 145, 147,
 164, 176
 and cooling, 1, 130–133, 200–203
 cosmic, 97–98
 during Ice Ages, 80–82, 85, 88–89,
 97, 107, 114
 dust veil index, 103–104
 iron enrichment of the oceans, 110,
 114, 132, 148, 202–203
 loess, 79–80, 89
 radiative forcing, 131–132, 200–201
- Earth's orbit, 19–21, 138
 changes in, 10–11, 99–101, 106,
 126
 and the moon, 113
- east coast lows, 43–45, 53, 61, 65, 134,
 167
 and 'nuclear winter', 146
- ecosystems, 183, 187, 191
- Ekman transport, 60–64, 67
- electromagnetic spectrum, 17
- El Niño *see* Southern Oscillation
- ENSO event *see* Southern Oscillation
- errors
 in computer modelling, 12, 31,
 49–50, 122–123
 in measurement, 33, 77, 88, 91–92,
 123–126, 128, 199–201

206 • Index

- errors *continued*
 in rates of deforestation, 123
- Europe
 climate change, 1, 6, 11, 124–125, 129–130
 and disease, 157–158, 164, 174, 176, 179
 general climate, 43, 52–53, 59
 and ‘greenhouse’ warming, 109, 133, 135, 137
 during Ice Ages, 78–79, 83, 85–86, 88–89, 108–109
 during the historic record, 90–91, 103, 157–158, 167
 during the Holocene, 90–91, 98
 during the Little Ice Age, 125, 142
 during the modern record, 105, 124, 159, 168
 and vegetation, 182
- evapotranspiration, 186, 188–189, 194, 196–197
 potential, 183–184
- extratropical cyclones, 37, 41–43, 46–48, 50, 52–53, 105, 167
 and ‘greenhouse’ warming, 134, 140
 during Ice Ages, 85
- famine, 91, 93, 103, 131, 156–157, 167–168
- fires, 20, 123, 142, 145–147, 155, 167–169, 178–179, 185–186, 193, 196, 200
 in cities, 145–146
 Kuwaiti oil wells (1991), 146–147
 in Siberia (1915), 146
- floods, 56, 66, 70–73, 112–113, 140, 155, 167–168, 178
 and ‘greenhouse’ warming, 140, 147, 165–167
 during Ice Ages, 87–88, 94–95, 109, 114
 during the Holocene, 90, 94–95, 140
- foraminifera, 78, 82, 105–106
- fronts, 37–38, 40–43, 46–48, 50, 56, 86–87, 114, 192
- geomagnetism, 98, 105–106
- General Circulation Models (GCMs), 31, 48–51, 56, 67, 147, 185–186
 and ‘greenhouse’ warming, 122–123, 127, 132–134, 192–196
 United Kingdom Meteorological Office model, 134–136, 138–139, 193
 shortcomings of, 48–50, 136–138, 193, 196
- glacials, 48, 77, 79–83, 87, 106–107, 109, 140
 Last Glacial, 5, 77–78, 82–83, 86, 89, 94, 106–111, 191–193
 and vegetation, 107–108, 110–111, 191–193
- see also* Ice Ages
 glaciation, 48, 77–78, 98, 102–103, 108, 114
see also Ice Ages
 global cooling (present day), 1, 12, 25, 27–28, 30–31, 72, 91–93, 104–105, 109, 111–112, 124–132, 138–139, 142, 145, 147–148, 199–203
 global warming (present day), 4, 20, 40, 56, 59, 91–92, 94, 111–112, 123–132, 140, 142, 147–148, 159, 164, 168, 177–178, 183, 191–192, 194, 199–203
see also ‘greenhouse’ warming
 ‘greenhouse’ gases, 1, 2–4, 21–24, 26–27, 49–50, 55, 117–122, 193
 during Ice Ages, 102
 during the modern record, 118–122, 138, 147
 during the historic record, 120, 202
 radiative forcing, 122–123, 130, 147, 196, 199–201
see also carbon dioxide, halocarbons, methane, nitrogen oxides, ozone, water vapour
 ‘greenhouse’ warming, 1, 21, 27–28, 30–31, 108, 114–115, 117–118, 122, 130, 131–142, 182, 199–203
 caveats on, 140–142
 discovery of, 117–118
 and disease, 160, 164–166, 177–178
 and evapotranspiration, 188–189
 modelling of, 122–123, 127, 132–141
 and ozone depletion, 144–145
 stratospheric evidence of, 124
 and vegetation, 186–190, 193–196
- Greenland, 11, 80–82, 87–88, 94, 108–109
 and Viking colonisation, 90–91
- gyres. *see* ocean currents
- Hadley cell. *see* high pressure cells
- halocarbons (including CFCs), 24
 anthropogenic enhancement, 118, 120–121, 147
 composition in the atmosphere, 24, 120–121
 and the ‘greenhouse’ effect, 24
 and ozone depletion, 23, 120, 142, 145
 radiative forcing, 122, 200–201
 sinks, 121
- health and climate change, 155–157
 and cold, 158, 175, 178
 and heat, 155, 158–159, 178
 and natural disasters, 155, 167–169, 178
 and UV radiation, 169–174, 178
- see also* disease
- heat transfer
 sensible, 33–34, 38, 46, 185, 188
 latent heat of evaporation, 27, 33–34, 40–45, 47–48, 52, 54, 58–59, 62, 65, 70, 100, 184–185, 188
- heat waves, 50, 55–56, 134, 140, 142, 159, 179
- Heinrich iceberg events, 82–83, 87, 108–109
- high pressure, 34–38, 61–63, 66–68, 70, 141
 blocking of, 11, 35, 53, 73, 105–106
 Hadley cells, 37–38, 45–47, 50, 52, 56, 104, 134, 146
 and Ice Ages, 83, 85–86
 Siberian, 37–38, 45, 50, 56
see also mobile polar highs
- Holocene, 11, 78, 80–82, 88–90, 94, 104, 115
 Climatic Optimum, 89–90, 94, 98, 100, 105, 139–140, 192
- hurricanes. *see* tropical cyclones
- Ice Ages, 47, 58–59, 83, 98, 107, 111, 114–115, 140–141, 147
 causes, 97–111, 114–115, 201–203:
 albedo changes, 107–108, 202
 Antarctic ice surges, 108
 Arctic ocean freezing, 109
 atmospheric circulation, 83–86, 88, 94–95
 continental drift, 101–102
 cosmic factors, 97–98
 dimethylsulphides and cloud, 109–110, 114, 202
 geomagnetism, 105
 ‘greenhouse’ gases, 106–107, 202
 icesheet thermal inertia, 100
 iron enrichment of oceans, 110–11, 114–115, 202–203
 Milankovitch cycles, 10–13, 21, 99–101, 106, 111, 114, 201
 mountain building, 102
 North Atlantic salinity sink, 59, 108–109, 114
 solar output change, 98–99
 volcanism, 102–105
- Little Ice Age, 1, 5, 18, 90–91, 98, 104, 107, 115, 118, 125, 140, 157, 202
- Pleistocene, 1, 5, 26, 77–81, 97–103
see also glacials
- icebergs, 64, 71, 82–83, 108–109
- ice caps (icesheets), 46, 80, 82–84, 87–89, 94, 98, 102, 114, 182
 Antarctic, 80, 85–86, 107–108, 132
 effect on climate, 84–85, 102, 109
 effect on radiation, 26, 39, 77
 Greenland, 80, 103–105, 107, 142

- ice caps *continued*
 Laurentian, 82, 85–89
 Scandinavian, 86–89
 thermal inertia of, 100–101, 109, 114
- ice cores. *see* cores
- Indonesian-Australian ‘maritime’ continent, 37, 45, 53, 66, 68, 72
- Indonesian Throughflow, 59, 63–64, 79, 105
- interglacials, 77–78, 80, 87–89, 98–99, 106–114
 Last Interglacial, 78–80, 82, 103, 106, 111, 140
- interstadials, 79, 81, 99, 108, 114
 Allerød-Bøiling, 81–82
- iron fertilisation of oceans, 110, 114, 132, 148, 202–203
- jet stream, 34–38, 42, 45–47, 50, 52, 70–71, 105, 130, 141
 during Ice Ages, 80
- Kelvin waves, 70
- La Niña events. *see* Southern Oscillation
- Little Climatic Optimum. *see* Mediaeval Warm Epoch
- longwave radiation. *see* radiation
- low pressure, 34–37, 62–63, 67–68, 94
 Aleutian, 38, 46–47, 59, 140
 Icelandic, 28, 46–47, 52, 140:
 during Ice Ages, 85
- marginalisation of people, 147, 154–155, 159, 164–166, 175, 177
- Mediaeval Warm Epoch, 5, 90, 94, 134, 139, 157
- methane (CH₄)
 anthropogenic enhancement, 120–121
 atmospheric composition, 21–22, 118, 120
 ‘greenhouse’ effect, 24, 120–121
 during glacials, 106, 202
 during the historic record, 120
 during the modern record, 120, 197
 and ozone depletion, 145
 radiative forcing, 122, 200–201
 sinks, 120
 sources, 120, 200
- methanesulfonic acid, 106, 110, 202
- Middle Ages warm period. *see* Mediaeval Warm Epoch
- mid-latitude cyclones, depressions or lows. *see* extratropical cyclones
- Milankovitch cycles. *see* cycles, Ice Ages
- M_N (18.6 year) lunar cycle. *see* cycles
- mobile polar highs, 50, 52–53, 56, 59, 68, 141, 143
- characteristics, 46–48
 and ‘greenhouse’ warming, 139–141
 during the Holocene, 90
 during Ice Ages, 47, 83–86, 88, 94, 101, 110, 200
- monsoon, 37–38, 44–47, 50, 53, 103, 141, 165
 and ‘greenhouse’ warming, 137, 140
 during the Holocene, 90
 during Ice Ages, 85, 94, 100
- Indian, 37–38, 44–45, 50, 56, 66, 68, 71–72, 113
- mountains
 effect on air masses, 46–48, 50, 52–53
 effect on glaciation, 98
 effect on storms, 43
 effect on wind and air circulation, 35–38, 45, 52, 101–102
 and Ice Ages, 83, 101–102
 Himalayas, 38, 44, 100–102
 Rocky, 36, 50, 52, 71, 86–87, 102, 113
- nitrogen oxides (NO_x)
 anthropogenic enhancement, 118, 121–122
 atmospheric composition, 21, 119, 121
 ‘greenhouse’ effect, 24, 121–122
 during the historic record, 120–121
 during the modern record, 119–122
 and ozone depletion, 143
 radiative forcing, 122, 200–201
 sources, 122, 145
- normalised difference vegetation index (NDVI), 185
- North America
 climate change, 6–7, 10, 11, 67, 70–71, 124, 128–130
 and disease, 160
 general climate, 29, 36–37, 40–43, 46–47, 50, 52, 65, 91, 93, 109
 and ‘greenhouse’ warming, 133–135, 190
 during the historic record, 103
 during the Holocene, 192–193
 during Ice Ages, 78, 82–88, 102, 107, 192–193
 during the modern record, 105, 112, 124, 128
 and ‘nuclear winter’, 146
 and vegetation, 191–195
- North Atlantic salinity sink, 52, 59, 66, 92, 94
 and global warming, 108, 137
 and Ice Ages, 59, 82, 87, 88–89, 106, 111, 114
 ‘nuclear winter’, 117, 145–148
- oceans
 as carbon dioxide sinks, 123, 191
 and clouds, 29–30, 58, 128
 and dust, 132–133, 203
- feedback on the atmosphere, 37–38, 44–45, 49, 52–53, 58–59, 61–63, 66–67, 100, 107
 and pollution, 115, 199, 203
 properties of, 58–61, 70–71
 scales and response times in, 65–66, 92, 134
 and storms, 37, 40, 42–44, 50, 52, 134
see also cores
- ocean currents (circulation), 33–34, 43, 49, 59, 61–66, 100, 138
 Antarctic circumpolar, 59, 63–65
 East Australian current, 43, 53, 58, 64
 Gulf Stream, 43, 52, 58–59, 63–66, 88
 Humboldt, 61, 63–64
 Kuroshio, 43, 64–65, 71
 Leeuwin, 53, 63–64
- ocean current structure
 eddies, 64–65
 gyres, 60–61, 64–66, 83
 pools, 64–65
 rings, 65
- oxygen isotopes (¹⁸O, ¹⁶O), 78–81, 83, 105
 records, 78–82, 99, 106, 108
- ozone (O₃)
 atmospheric composition, 1, 22, 119, 122
 ‘greenhouse’ effect, 22–24, 199–200
 depletion of, 142–145, 169, 171, 173:
 by solar flares, 1, 19, 145
 by human activity, 117, 120, 122, 143–145, 147
 by nuclear explosions, 145
 during the modern record, 122
 and the ‘Ozone Hole’, 144–145, 147, 169, 191
 as a pollutant, 22, 122, 169, 201
 radiative forcing, 122, 200–201
 sources, 122, 145
 and the stratosphere, 112–113
 and UV radiation, 22, 14, 169, 190–191
- Palmén-Newton model of general circulation, 36–39, 46, 56, 63, 66–67
 and ‘greenhouse’ warming, 139–140
- photosynthesis, 21, 110–111, 185–187, 189–190
- phytoplankton (algae), 105–106, 110–111, 114, 132, 148, 165, 191, 199, 202–203
- planetary albedo. *see* albedo
- Pleistocene, 1, 5, 79, 97–98, 105, 108, 140
see also Ice Ages
- pollution, 24–25, 55, 66, 115, 128, 130, 147–148, 166

208 • Index

- pollution *continued*
 and cooling, 126, 128–130, 148, 199–203
 from ozone, 22, 122
 from smoke, 25, 145–146, 200–201
 and warming, 139
 population growth, 153–154, 167, 175, 196
 in Australia, 173–175
see also cities, marginalisation
 precipitation
 cycles, 11, 113
 and disease, 158, 162, 165–166, 177
 and ‘greenhouse’ warming, 108, 132–134, 137, 156, 193
 during the historic record, 91, 157–158
 during the Holocene, 89–90
 during Ice Ages, 80, 82–86, 88–89, 94, 107–108
 during the modern record, 68, 92–94, 114, 124, 167
 and the Southern Oscillation, 66, 68, 71–73
 and storms, 43, 50, 53
 and vegetation, 182–185, 190, 193
 and ‘nuclear winter’, 146
 probability of exceedence, 7–8
- Quasi-Biennial Oscillation (QBO), 22–23, 42, 68, 112–113
- radiation
 balance, 184, 199
 blackbody, 17–20
 global budget, 26–31, 50, 59, 124, 144, 200–201, 203
 solar (shortwave), 2–3, 17–31, 49, 58, 109–110, 122, 131, 142–143, 145–146, 169, 171, 185–186, 200–201:
 variations across the Earth’s surface, 20–21, 28–29, 99
 variations during Ice Ages, 83, 85, 87–89, 94, 99–101, 103, 107, 111, 115
 variations over time, 18, 112
 longwave, 2, 17, 23–24, 26–30, 37–38, 44, 46, 49–50, 83, 106, 117–118, 122, 127, 131, 143, 145–146, 158, 199–201
 UV (ultraviolet), 17–18, 22, 112, 142, 156:
 changes in, 169, 173
 components, 169
 and human health, 169–175, 178
 and vegetation, 190–191
see also absorption, albedo, scattering
 radiative forcing, 199–201
 by cloud, 25, 109–110, 138, 200–201
 by dust, 131–132, 200–201
 by ‘greenhouse’ gases, 122–123, 130, 147, 196, 199–201
 by sulphates, 129–131, 200–201
 uncertainties, 118, 122, 199–200
 reflectance of radiation. *see* albedo
 reservoirs of disease, 157, 161, 164–165, 175–176
 rodents, 157, 159
see also disease
 Rossby waves, 34–37, 42, 46, 71, 102, 105, 113
- scattering of radiation, 24–27
 sea-ice, 33, 49, 58–59, 91, 122
 cycles in, 11
 effects on climate, 25, 68, 101, 107, 122
 and ‘greenhouse’ warming, 136–138
 during Ice Ages, 87–88, 101, 107, 114, 200
 sea-level, 6, 26, 58–62, 64–68, 70, 93
 and deglaciation, 86–88, 107–109, 111, 114
 and glaciation, 77, 79, 114, 201
 and ‘greenhouse’ warming, 118, 137, 165
 sea surface temperatures, 45, 49, 52–53, 58, 62, 92–93, 107, 124–125, 135
 during glacials, 82–84, 87–88, 94, 100, 110:
 paradox of the tropics, 83, 110
 and the Southern Oscillation, 68–69, 70–73, 83, 105
 Simple Biosphere Model (SiB), 185–187, 193, 196–197
 Simpson theory of Ice Ages, 98–99
 snow, 9, 50, 71–72, 81, 83–85, 88, 92, 98–99, 109, 111, 114, 122, 142
 effects on climate, 26, 68, 122
 and ‘greenhouse’ warming, 136–137
 society and climate change, 89–91, 94, 103
 and ‘greenhouse’ warming, 140
 and increased atmospheric dust, 131–132
 solar radiation. *see* radiation, sun
 South America
 climate change, 70–72, 113, 129
 and disease, 165–166
 general climate, 29, 62–63, 132
 during Ice Ages, 83, 85
 during the modern record, 124
 and vegetation, 182
 Southern Oscillation, 42, 45–46, 52, 66–73, 91–93, 114, 119, 126–127, 140
 and disease, 160, 162, 165, 167–168, 176, 178
 El Niño (ENSO) events, 43, 66, 68–73, 93, 119–120, 125, 127, 147, 160, 165, 168, 176, 185, 190, 193, 199, 203
 during Ice Ages, 83, 107
 index of, 68, 70
 La Niña events, 43, 66, 72–73, 93, 127, 162, 167–168, 182, 193, 199
 precursors, 68
 and prediction, 52
 and the Quasi-Biennial Oscillation, 11, 112
 and volcanism, 72, 105
 stochastic resonance, 12–13, 111
 storms, 11, 37, 42–44, 50, 53, 59, 91, 105, 109–110, 125, 130, 134–135, 142, 157–158, 167–168, 203
 All Saints Day (1570), 1, 43, 91
 Ash Wednesday (1962), 44
 and dust, 132
 and ‘greenhouse’ warming, 140
 and ‘nuclear winter’, 146
see also east coast lows, extra-tropical cyclones, tropical cyclones
 stratosphere, 22–23, 66, 103, 106, 109, 112, 118, 120, 125, 142–147
 sulphate aerosols, 55, 110, 147, 199–201
 and cooling, 128–131, 133, 138–139, 148, 202–203
 and glaciation, 106, 109–110, 200
 and ozone depletion, 145
 radiative forcing, 129–131, 200
 and volcanism, 103, 105, 145
see also dimethylsulphides
 sulphur dioxides, 147
 and human activity, 103, 129
 and volcanoes, 103, 147
 sun, 17, 105
 faint sun paradox, 2–3
 during Ice Ages, 98
 solar activity, 98, 115, 125–126
 solar flares (solar proton events), 1, 17–18, 22, 105, 115, 145
 solar luminosity, 111–112
 solar radiation on Earth, 2, 17–31
 solar radiation on Venus, 3
 solar wind, 105
see also radiation
 sunspot cycles, 9, 11, 18–19, 98, 105, 111–112, 125, 200–201
 11-year cycle, 9, 11, 18, 22, 113, 200–201
 22-year (Hale) cycle, 36, 113
 and climate change, 19, 98, 111–115
 Maunder minimum, 18–19, 98
 teleconnections, 52, 56, 64
 Southern Oscillation, 71–72
 during Ice Ages, 83, 106–108, 114–115

- temperature
 cycles, 9–11, 18
 and disease, 160, 162, 164–165
 during the geologic record, 2–5, 101
 extremes, 6–8, 72, 138, 145, 159, 190
 and ‘greenhouse’ warming, 118, 122–123, 126, 132–134, 137–139, 156, 193
 during the Holocene, 89, 105, 115
 during the historic record, 90–91, 103–104, 157
 during the modern record, 5–6, 9, 56, 59, 91–92, 103–104, 111–112, 122–123, 124, 126–128, 138, 158, 191
 and ‘nuclear winter’, 145–146
 and physiological stress, 158–159
 and the Southern Oscillation, 72–73, 126–127
 in the stratosphere, 124
 and urban growth, 54, 126
 variability, 33, 72, 124
 and vegetation, 183–185, 189–191, 193
- thermocline, 68, 70–71
 thunderstorms, 10, 19, 20, 38, 40, 42, 49–50, 132, 144
 in cities, 56
 Tibetan Plateau, 36–37, 44–45, 68, 79, 85, 100–102, 113
 tornadoes, 20, 27, 40, 42, 50
 tropical cyclones, 20, 34, 37, 40–42, 45, 49–50, 53, 70–72, 140, 142, 144, 155, 167–168
 and ‘greenhouse’ warming, 40, 134–137, 140
 tropopause, 22–23, 38, 42, 66
 troposphere, 22–23, 38, 41, 66, 110, 112, 118, 122, 130–131, 140, 143, 147
 turbulence, 27, 30, 40, 55, 63, 185
 typhoons. *see* tropical cyclones
- uncertainties
 about aerosol radiative forcing, 118, 122, 199–200
 about carbon dioxide sinks, 123, 196
 of climate change, 117, 203
 about disease, 174–175, 178–179
 about global population growth, 153–154
 of global warming, 123–132, 140–141, 147, 203
- about ‘greenhouse’ gas
 concentrations, 122
 of ‘nuclear winter’, 146–147
 of ozone depletion, 145
 about vegetation change, 196–197
 United States, 6–7, 11, 43, 45, 58, 65, 71–77, 132
 and disease, 160, 162, 164, 171, 174–177, 179
 during Ice Ages, 83–84
 and climate change, 113, 132, 169
 and ‘greenhouse’ warming, 136, 190
 and the modern record, 142, 159, 167–168, 179
see also North America
- urban climate. *see* cities
 UV (ultraviolet) radiation. *see* radiation
- vectors of disease, 154, 159–166
 mosquitoes, 154–155, 160–164, 174–175
 ticks and mites, 164–165, 175
 lice, 157
 blood flukes, 160, 165
 tsetse fly, 165
 triatomid bug, 165
- vegetation
 and albedo, 25, 185
 and biomass burning, 120, 122, 132, 144–145, 185, 200
 and C₃ and C₄ plants, 186–190, 193
 and carbon dioxide, 186–190, 197, 202–203
 and carbon sinks, 119–120, 123, 189–191, 193, 196
 changes in, 25, 89
 classification:
 Budyko, 184, 193–194
 Holdridge Life–Zone, 182–183, 193–194, 196
 effect on climate, 54, 185–186, 189, 194, 196–197
 during glacials, 94, 107–108, 110–111, 191, 202
 regrowth, 182, 202–203
 Simple Biosphere Model (SiB), 185–187, 193
 and UV radiation, 190–191
 volcanoes, 2–3, 20, 22, 66, 72, 103–105, 125–127, 138
 and dust, 103–104, 107, 146, 200–201
 eruptions:
 El Chichon (1982), 72, 105, 126–127, 145
 Krakatoa (1883), 102, 145
 Mt. Pinatubo (1991), 72, 91–92, 103, 105, 120, 126–127, 145, 147, 197
 Tambora (1815), 103, 145
 during the Holocene, 103–105
 during Ice Ages, 80, 97, 102, 105, 107, 111, 155
 during the modern record, 104, 111–112, 145, 200
 and ozone depletion, 145
 and the Southern Oscillation, 105
 and sulphates, 103, 105, 109–110, 126, 145, 147, 200
 vortices and vorticity, 34–37, 40–41, 46–47, 66, 68
 polar vortex, 144
- Walker circulation, 67–69, 70–72, 102, 144
see also Southern Oscillation
- water vapour, 49, 66, 114, 120
 atmospheric composition, 21–22
 and the ‘greenhouse’ effect, 1, 21–22, 24, 118, 138
 and ozone depletion, 143, 145
 and shortwave radiation, 24, 26
 Wilson’s theory of ice surging, 108
- wind, 34, 36–47, 50, 52–53, 55, 168
 changes in, 11, 70, 80
 during glacials, 80, 82, 85, 89, 94, 107–108, 110, 202
 and ‘greenhouse’ warming, 135, 137, 140
 and mobile polar highs, 46–47
 and oceans, 58–61, 63, 66
 trades, 6, 37–38, 40, 42–47, 50, 53, 61–63, 67–68, 85, 94
 westerlies, 11, 35, 37, 41–42, 46, 52, 59, 68, 70
- world patterns
 climate:
 for the atmosphere, 28–29, 39, 47, 67, 131, 133
 in cross-sections, 34, 38, 51, 141, 169
 for ‘greenhouse’ warming, 135–136, 139
 during Ice Ages, 84
 of disease, 162–163
 oceans:
 currents, 60, 63
 sea surface temperature, 84
 of vegetation, 183
- Younger Dryas, 81, 86–89, 94, 108