

Index

This index should be cited as:

IPCC, 2013: Index. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Note: * indicates the term also appears in the Glossary (Annex III). Bold page numbers indicate page spans for entire chapters. *Italicized* page numbers denote tables, figures and boxed material.

A

Abrupt climate change*, 70-72, 151, 386-387, 432-

435, 1114-1119

abrupt glacial events, 483

paleoclimate*, 386-387, 432-435, 434

permafrost thawing and, 530-531

projections, 88, 1005, 1033, 1114-1119

summary, 1005, 1115

Aerosols*, 151, 174-180, 571-575

absorption on snow and ice, 574, 617-618, 685, 685

aerosol-climate feedbacks, 574, 605-606

aerosol-cloud interactions*, 127, 573, 578, 606-614, 607, 618-621, 623, 625-626, 683-685

aerosol optical depth (AOD), 161, 174-176, 176, 179, 596-599, 599, 692, 757, 794-795, 794-795, 1429-1430

aerosol-radiation interactions*, 574, 576, 578, 604-605, 614-618, 615, 617, 622, 682-683, 683

aviation contrails, 574, 592-594, 686

carbonaceous*, 606

climate relevant properties, 573, 602-604, 622-623

cloud condensation nuclei (CCN)*, 603-604, 609, 886

composition and mixing state, 602-603

effective radiative forcing (ERF), 574, 576-578, 577-578, 614-624, 619-621, 1404-1409

feedbacks, 574, 576-578, 577, 605-606

formation and types, 595

general concepts, 595-606, 595, 597, 622-623

glaciation effect, 578

in situ surface measurements, 176-180, 177

lifetime effects, 578, 609-610

mineral dust (MDA), 394, 600, 605, 617

models, 16, 608-609, 744, 752, 757, 794-795

new terminology, 578, 578

observations, 161, 175, 595-599, 596, 598

organic*, 1048-1050, 1052, 1419, 1428

paleoclimate*, 394

precipitation effects, 624-627

projections, 1000-1001, 1002-1003, 1007-1008, 1048-1050, 1052

radiative forcing*, 13-14, 14, 127, 186, 574, 576-578, 577, 614-621, 662, 675, 682-686, 1007, 1048-1050, 1052, 1404-1409

sea spray, 599-601, 605

size and optical properties, 603

sources, 599-601

thermodynamic effect, 578

volcanic aerosols, 14, 662, 691-693

See also specific aerosols

Africa, 1266-1268, 1267

African monsoon, 1234, 1235

climate indices, changes in, 211-212
projections, 106, 1281-1282, 1288, 1358-1365

Air quality, 684-685, 955, 1001-1002
climate-driven changes, 999-1000, 1005-1006
extreme weather and, 1005
projections, 24, 88-89, 957, 996-1004

Aircraft. See Aviation**Albedo***, 126

cloud albedo effect, 578, 610, 1048-1050
snow, 321, 358, 359, 757
surface, 628, 662, 686-687, 687, 819
urban, 687

Altimetry*, 286, 287, 348-349**Ammonia**, 1418**Ammonium**, 605-606

Annular modes*, 233-235, 900-901, 900, 1243-1246
projections, 108, 1220, 1288-1289

Antarctic ice sheet, 9, 25, 29, 137, 320, 351-353, 909

dynamical change, 1172-1174
ice loss, 351-353, 352-353, 367, 381-382
irreversible changes, 71-72, 356, 1174
mass balance*, 348, 1139, 1170-1171
models, 753, 1171
observed changes, 351-353, 352-353
paleoclimate*, 387, 428-431, 1174
polar amplification, 397
sea level equivalent, 320, 321, 352-354
sea level rise and, 1139, 1154-1155, 1170-1176, 1177-1179, 1182
West Antarctic (WAIS), 320, 332, 349, 352-354, 357, 1174, 1175

Antarctic region, 151, 939, 1276-1277

bottom water, 279-280
circulation, 284
ice shelves, 320, 353, 367
oceans, 279-280
paleoclimate*, 387, 420, 459-460
polar amplification, 385, 396-398
projections, 106, 1277, 1285, 1289, 1390-1393
Weddell Sea, 280

Antarctic sea ice, 9, 25, 69, 319, 330-335

changes in, 333-334, 368, 906-909, 908, 931
drift, 332
extent and concentration, 330, 331, 332
models, 787-790, 787-789
projections, 1089, 1092
seasonality and trends, 332-335

Anthropogenic climate change*. See Detection and attribution of climate change

Aragonite, 94-95, 533**Arctic region**

anthropogenic influence, 19, 956
climate projections, 956, 1031, 1062-1064
ocean salinity, 271-273
polar amplification, 385, 396-398, 1031, 1062-1064
projections, 106, 1257-1258, 1278, 1288, 1322-1324
temperature, 9, 10, 20, 931, 956, 1062-1064, 1257-1258, 1278

Arctic sea ice, 9, 10, 69, 136-137, 319, 323-330

attribution of changes, 19, ,870, 906-909, 908, 931, 938

changes in, 333-334, 367, 368

decadal trends, 329-330

drift, 328-329

extent and concentration, 324-326, 325, 326

irreversible changes, 1115, 1117-1118

models, 16, 18, 744, 787-790, 787-789

projections, 24-25, 956, 1032, 1087-1092, 1089-1091

salinity effects on, 271-273

seasonality, 329

summary, 9, 10, 319, 367

thickness and volume, 319, 327-328, 328

Asia

climate indices, changes in, 211-212

precipitation extremes, 211-212

projections, 106, 1268-1273, 1278, 1282-1284, 1288-1289, 1366-1381

Asian-Australian monsoon, 1227-1232, 1230-1231**Atlantic Meridional Mode (AMM)**, 802, 1224**Atlantic Meridional Overturning Circulation (AMOC)**, 8, 282-284, 782-783

irreversibility and, 70, 433-435, 1115-1116, 1115

paleoclimate*, 386-387, 433-435, 456

projections, 24, 956, 973-974, 995, 1033, 1094-1095

variability, 801, 802, 806

Atlantic Multi-decadal Oscillation/Variability (AMO/AMV)*, 230, 233-235, 801, 802, 806, 869, 1254-1255

impacts, 1224

projections, 108, 971-973, 972, 1220

Atlantic Niño, 233, 803, 806, 1224, 1239-1240**Atlantic Ocean**

carbon storage, 495

hurricanes, 809

modes, 1239-1240

salinity, 271, 280

temperature, 280

tropical, models, 787

variability, 233-235

water mass properties, 279

Atlantic Ocean Multidecadal Variability, 233-234**Atmosphere***, 5, 159-254

free*, 197-198, 197-200

global reanalyses*, 185-186

models, 144, 746, 747, 748-750, 756-757, 760-777

observations, 5, 6, 159-254

projections, 19-24, 28, 980-993

radiation budget, 161, 180-186

summary of observations, 5, 130, 161-163

temperature, 4-5, 6, 66-68, 161-162, 187-201, 984

See also Hydrological cycle; Temperature

Atmospheric chemistry, 669-675**Atmospheric circulation**, 163, 223-232, 899-901,

899-900

attribution of changes, 871, 899-901, 899-900,

937-938

geopotential height, 223, 223, 226

jets, storm tracks and weather types, 229-230

projections, 88, 90, 956, 972-975, 988-990, 989-

1032, 1071-1074, 1071-1072

sea level pressure (SLP), 223-224, 223-224, 1071-

1072, 1071

- stratospheric circulation, 230
 surface wind speed, 224-226, 225
 teleconnections*, 233, 805, 1224, 1243, 1243
 tropical circulation, 226-230, 899-900, 989-990, 989, 1073
 upper-air winds, 226
 variability in, 163, 230-232, 231-235
- Atmospheric composition**, 126, 161, 165-180
 aerosols*, 161, 174-180, 576
 clouds, 576
 gases, 161, 165-170, 166
 models, 17-18
 observed changes, 165-180
 projections, 996-1004
See also specific constituents
- Attribution of climate change**. *See Detection and attribution*
- Australia and New Zealand**, 106, 1273-1275, 1274, 1284, 1289, 1382-1385
 monsoon, 1230-1231, 1232
- Aviation contrails/cloud effect**, 574, 592-594, 686
- B**
- Baseline/reference***, 1034
Bayesian method/approach*, 83, 755
Biogeochemical cycles, 11-12, 465-570
 before fossil fuel era, 480-486
 carbon removal/storage techniques, 546-552
 connections of carbon, nitrogen, and oxygen cycles, 475-480, 477-479
 ocean, 259, 291-301, 312
 overview, 11-12, 470-480
 projections, 93-95, 96-97, 468-469, 514-539
 since industrial revolution, 474-475, 486-514
See also Carbon cycle
- Biological pump***, 472
Biomass* burning, 507, 509, 600-601, 616, 663, 671, 714
Black carbon*, 600, 616, 685, 685, 1432
 global warming potential, 740
 metrics, 718
 projections, 955, 1048-1050, 1419
 radiative forcing*, 1048-1050, 1052, 1404-1409
- Blocking***, 229-230, 796, 1220, 1224, 1246-1248
- Brewer-Dobson circulation***, 90, 163, 230, 1073-1074, 1248
- Bromocarbons**, 733
- Budgets**. *See Energy budget; Radiation budget*
- C**
- Carbon**
 cumulative emissions, 1108-1109, 1109, 1112-1113, 1114
 dissolved inorganic carbon (DIC), 95, 472, 497, 546-552
 land storage, 26, 93
 models, 502-504
 oceanic, 259, 291-293, 294, 300, 301, 472
 organic, 1048-1050, 1052, 1419, 1431
- permafrost*, 480, 526-528
 sinks*, 93, 468, 470-472, 471, 480, 495-503, 503, 519-523, 538-539, 543, 551-552
 total, 178
 transient climate response to emissions (TCRE), 16-17, 1108-1109
See also Black carbon
- Carbon cycle***, 11-12, 96-97, 470-480, 502-504
 before fossil fuel era, 480-486
 carbon removal/storage techniques, 469, 546-552, 547
 climate-carbon cycle feedback*, 514-523, 515, 516-518, 551-552
 in climate models, 16, 468, 516-518, 751-752, 792-794
 commitments, 543-546
 feedbacks, 26, 475-480, 477-478, 514-523, 515-518, 520
 geoengineering and, 469, 546-552
 global, 470-473, 471
 long-term, 543-546, 543
 models, 502-504, 514-528, 516-518, 520-522, 524-529, 744, 751-752, 757, 792-794, 793-794
 nitrogen cycle and, 475-480, 476-479, 537-539, 538
 observations, 11-12, 12, 50-53
 ocean carbon balance, 498-499
 paleoclimate*, 468
 perturbations and uncertainties, 96-97
 projections, 26-27, 93-95, 96-97, 468-469, 523-528, 542-546, 1033, 1096-1099, 1097-1098
 regional fluxes, 499-502, 500-501
 sensitivity of, 503-504, 504-505
 since industrial revolution, 474-475, 486-504
 sinks*, 468, 470-472, 471, 480, 495-503, 503, 519-523
 summary, 11-12, 467-469
 terrestrial processes and feedbacks, 502-504, 503-505
- Carbon dioxide (CO₂)***, 166-167
 air-sea fluxes, 497, 498, 499-501, 500-501
 airborne fraction*, 495
 atmosphere-to-land fluxes, 501-502
 atmospheric concentration, 11-12, 12, 28, 161, 166-167, 166-167, 467, 476, 1401-1402
 atmospheric, growth rate, 491-494, 493-494
 atmospheric, residence times, 472-473
¹³C/¹²C ratio, 476
 carbon cycle and, 470-473
 climate change commitment and, 27-28, 28, 1033
 compatible emissions*, 523-528, 526-529
 current rate of rise as unprecedented, 385
 emissions, 486-488, 487, 544-545, 1108-1109, 1109, 1410
 emissions metrics, 716-717, 731
 emissions, natural, 1421
 feedbacks, 26
 fertilization*, 475, 501, 502
 glacial-interglacial changes, 385, 480-483, 482, 483
 global budget, 488-494
 industrial era, 474-475
 lifetime and radiative efficiency, 731
- observations, 50-52
 observed changes, 11-12, 12, 132-134, 132, 161, 165-167, 166, 467
 observed changes, last millennium, 485-486, 486
 ocean absorption of, 11, 12, 26-27, 291-293, 295-300, 300, 472, 472-473, 495-499
 ocean sink for, 495-499, 496, 519-520
 paleoclimate*, 385, 391-394, 399-400, 400, 457, 459-460, 468, 483-484, 483
 permafrost*, 27, 530-531
 projections, 19, 26-27, 27-28, 28, 148, 156, 468, 514-528, 524, 662, 1048-1050, 1096-1097, 1097, 1422
 proxy methods and data, 394, 457
 radiative forcing*, 13, 14, 126, 165, 661, 676-678, 678, 1048-1050, 1404-1409, 1433
 rapid adjustments* to, 590
 regional budgets, 503
 summary, 11-12, 12
 temperature and, 398-399
 timescale of persistence in atmosphere, 469
- Carbon Dioxide Removal (CDR)***, 29, 469, 546-551, 547
 methods, 547-550, 548-549, 632-633
 side effects, 633
 summary, 552
- Carbon monoxide (CO)**, 13, 14, 174, 1416
 lifetime and global warming potential, 718, 740
 radiative forcing*, 662
- Carbon tetrachloride (CCl₄)**, 169-170, 678, 733
- Caribbean region**. *See Central America and Caribbean*
- Cement production**, 489
- Central America and Caribbean**, 106, 1260-1261, 1260, 1280, 1288, 1338-1341
- Central and North Asia**, 106, 1268-1269, 1269
- Chaotic system***, 955, 959, 1033
- Chlorocarbons**, 733
- Chlorofluorocarbons (CFCs)**, 161, 169-170, 672, 1403, 1427
 lifetime and radiative efficiency, 731
 radiative forcing*, 127, 661, 678, 679, 1048-1050
- Chloroform**, 733
- Circulation**
 atmospheric, 163, 223-232, 899-901, 899-900, 937-938, 956, 1032
 models, 773-774, 782-784, 810-813
 oceanic, 258, 281-285, 283, 433-435, 481, 995, 1094-1095
 planetary-scale overturning circulations, 1072-1074
 projections, 90, 956, 972-975, 989-991, 989-990, 995, 1071-1074, 1071-1074, 1094-1095
- Clathrates***, 70-71, 1115, 1116-1117
- Clausius-Clapeyron equation/relationship***, 208, 1083
- Climate***
 key concepts, 123-129
 weather and, 123-126, 914-917
- Climate change***
 baseline period*, 1034
 direct observations of, 124, 130
 drivers of, 13-14, 14, 124, 126, 170-174, 1033

- general concepts, 119-158, 124-125
 historical overview of assessments, 124-125
 indicators of, 130-137, 130, 164
 irreversible aspects of, 28, 70-72, 129, 386-387, 433-435, 469, 1033
 long-term, 19-20, 89-93, 1029-1136
 multiple lines of evidence for, 121, 129-130
 near-term, 85-89, 953-1029
 observations, summarized, 4-12, 130
 sun and, 394-395, 885-886
 timescales, 28, 125, 128-129, 128, 1033, 1105-1107
 21st century projections, 1054-1102
 weather vs., 123-126
- Climate change commitment***, 27-29, 28, 105, 128-129, 129, 1033, 1102-1105, 1103
 constant composition, 1103
 stabilization scenarios, 102-105, 1107-1113
 zero emission commitment, 1104, 1104, 1106-1107
- Climate change projections**. See Climate projections
- Climate feedbacks***. See Feedbacks
- Climate forcing**. See Radiative forcing
- Climate forecast**. See Climate predictions
- Climate indices***, 1223
 extreme events, 221-222
 indices of climate variability, 230-232, 231-235
 regional changes in, 209-213, 211-212
- Climate models***, 15-16, 75-76, 741-866
 advances in, 121-122, 142-150, 748-753, 749-750, 824-825
 aerosols, 744, 752, 794-795
 assumptions, 146, 754, 755
 atmosphere models, 748-750, 760-777
 Atmosphere-Ocean General Circulation Models (AOGCMs)*, 83, 405, 516, 746, 747, 810-813, 822-823, 822-823, 919, 1144
 Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP), 958, 1052-1054
 Atmospheric General Circulation Models (AGCMs), 813
 capabilities of, 143-145, 144-150
 carbon cycle, 516-518, 751-752, 792-794
 chemistry-climate interactions, 752, 1052
 climate sensitivity and feedbacks, 745, 817-821, 817-819
 climate simulations, 122, 147-150, 743, 767-809, 959-961, 1013-1014
 climate variability and, 61-62, 129, 142-143, 230-232, 743, 769-770, 795-806
 comparison of, 16, 27, 29, 523-526, 1099-1102, 1099-1101
 comparison with observations, 74, 146, 822-823, 1013-1014
 confidence in, 743-745, 762, 768, 769-772, 793, 806, 813, 822, 824-825
 Coupled Model Intercomparison Project Phase 5 (CMIP5), 19-20, 21, 79-81, 146, 514-523, 516-518, 521-522, 670, 745, 747-748, 756-759, 759-760, 766, 818-819, 822-823, 968-969, 971-978, 1031, 1035, 1047-1052, 1048-1050, 1099-1102
 development and tuning, 144, 749-750
 downscaling*, 744, 810-817
 drift*, 967-970, 978
 dynamic global vegetation, 752, 791
 Earth System Models*, 16, 19, 26-27, 146, 468, 516, 518, 520, 523-526, 524-529, 743-745, 746, 747, 751-753, 822-823, 822-823
 Earth System Models of Intermediate Complexity (EMICs)*, 744-745, 746-748, 748
 emergent constraints, 826-827
 ensemble*, 146, 754-755, 793, 966, 1041-1043
 evaluation, 15-16, 75-76, 741-866
 evaluation, limitations of, 755-756
 evaluation, observations used in, 756-758
 experimental strategies and intercomparisons, 128, 759-760, 759
 extremes, 806-809
 flux adjustments*, 825
 global, 810-814, 811-813
 initialization*, 754, 760, 770, 796, 958
 land, 750-751, 752, 790-791
 long-term simulations, 15
 model errors, 62-63, 771-772, 809-810, 815, 1039
 multi-model ensembles (MMEs), 755, 817-819, 967, 970, 1039
 new components of, 751-753
 ocean, 750, 751-752, 777-787
 overview, 746-753, 1036-1037
 parameterizations*, 748, 750
 performance, assessment of, 753-758, 809-810, 821-827, 822-825
 performance, climate sensitivity and, 820-821
 performance metrics, 765-766, 766-767
 perturbed-parameter, 755, 1040
 process-based*, 98-99, 806, 1144-1145
 projections from, 19-29, 79-81, 127-128, 523-528, 825-827, 958, 978, 997-998, 1014-1015, 1035-1044, 1047-1052
 proxy methods*, 388, 394, 404, 457
 reanalyses*, 143-144, 185-186, 756-758, 760
 recent and longer-term records in, 760-795
 regional-scale, 15, 748, 810-817, 816, 1013-1014
 resolution*, 57, 753, 809
 sea ice, 744, 751, 787-790
 semi-empirical*, 99-100, 1140, 1144-1145
 summary, 15-16, 18, 743-746, 822-823
 temperature, 743, 760-761, 767-773, 777-778
 top-down vs. bottom up, 886
 trend models, 179-180
 uncertainties*, 139-142, 140-141, 809-810, 815, 1035-1040, 1038, 1197-1198
 vegetation, 752, 791
 See also specific topics and models
- Climate patterns***, 232-235, 1224
- Climate penalty**, 685
- Climate phenomena**, 105-108, 106, 1217-1308
 See also Regional climate change
- Climate predictions***, 953-1028
 concepts and terms, 959-961
 decadal prediction, 955, 958, 966-978
 hindcasts*, 965, 967, 970, 973-974, 975
 initialization, 85, 961-962, 968-969, 975, 975
 near-term, 963-978
 predictability studies, 962-965, 963
 probability and, 961-962, 974-975
 quality/skill*, 85-86, 86, 958, 960-961, 976-977
 retrospective, 85
 scientific basis for, 958
 summary, 955, 1011-1012, 1011
 temperature, 973, 975, 977-978, 977
 See also Climate projections
- Climate projections***, 19-29, 79-108, 125, 953-1136
 abrupt change*, 1033, 1114-1119
 air quality, 957, 996-1004
 atlas of, 1311-1393
 atmosphere and land surface, 980-994, 996-1004
 atmospheric circulation, 90, 956, 972-975, 988-990, 989-990, 1032, 1033, 1071-1074, 1071-1072
 carbon cycle, 93-95, 96-97, 514-534, 1033, 1096-1099, 1097-1098
 climate models and, 79-81, 958, 978, 997-998, 1013-1014, 1035-1044, 1036-1037, 1047-1052
 climate models, consistency and differences, 1099-1102, 1099-1101
 climate stabilization and targets, 27-29, 102-105, 1033, 1107-1113
 clouds, 1070-1071, 1070
 commitment and irreversibility, 1033, 1102-1119, 1106-1107, 1114-1119
 comparison with observations, 64-65
 cryosphere*, 92, 92-93, 956, 995-996, 1087-1093, 1088-1092
 data sources and, 155-158, 155-157
 energy budget*, 1069-1071, 1069-1070
 ensemble*, 1041-1043
 equilibrium climate sensitivity, 1033, 1105-1107, 1110-1112
 extremes, 956, 990-993, 990-991, 1003-1004, 1064-1068, 1067-1068
 global, 19-29, 1054-1058
 global projections, 1318-1321
 greenhouse gases, 955, 998-1000, 1006-1007, 1048-1050
 hydrological cycle, 44-45, 88, 91-92, 91, 956, 984-988, 985, 987, 1032, 1074-1087
 initialization, 85, 960-961, 968-969
 joint multivariate projections, 1044
 key concepts, 959-962, 1036-1037, 1084-1085, 1106-1107, 1256-1257
 long-term, 1029-1136
 long-term, 21st century, 1054-1102
 long-term, beyond 2100, 1102-1119
 long-term projections, 89-93
 model agreement, 1041-1043
 near-term, 978-1012
 near-term projections, 85-89
 oceans, 93, 956, 993-995, 993-994, 1033, 1093-1095
 pattern scaling, 1058-1062, 1061
 precipitation, 7, 956, 984-986, 985, 992-993, 992, 1014-1015, 1032, 1278-1287
 precipitation, long-term, 91-92, 91, 1032, 1055-1057, 1057, 1076-1079, 1078
 probability in, 961-962
 quality/skill*, 85-86, 86, 958, 960-961, 976-977
 radiative forcing*, 79-80, 700-701, 701, 955,

- 1005-1010, 1006-1007, 1046-1052, 1048-1050
 reference period, 958, 1034, 1313
 regional projections, 956, 957, 1001-1002, 1001-1003, 1014-1015, 1217-1308, 1288-1289, 1322-1393
 scenarios, 955, 956, 997, 1031, 1034, 1045-1047
 sea level change*, 7, 25-26, 26, 98-101, 125, 1140, 1150-1191
 sensitivity of, 979, 1007
 summary, 19-29, 955-957, 1009-1012, 1011-1012, 1031-1033
 temperature, 7, 955-956, 973-974, 980-984, 981-983, 1006, 1006, 1010-1012, 1012-1014, 1278-1287
 temperature, long-term, 89-90, 1031-1032, 1054-1057, 1054-1056, 1062-1068, 1063
 transient climate response, 1033, 1110-1112
 tropical cyclones, 993-994, 993
 uncertainties*, 115, 955, 978-1039, 979, 1004-1012, 1034, 1035-1040, 1038, 1057-1058, 1058
 vs. predictions, 978
See also Regional climate change; specific topics
- Climate regime***, 1225
- Climate scenarios***, 29, 131-132, 147-150, 1031, 1034, 1036-1037, 1045-1047
 comparison of, 1047
 tables, 1395-1445
 uncertainty*, 1038-1039, 1038
See also Emissions scenarios
- Climate sensitivity***, 82-85, 164, 745, 817-821
 equilibrium climate sensitivity (ECS), 16, 81, 82-85, 385, 405-407, 405-406, 817-819, 817, 821, 920-926, 925, 1110-1112
 probability density functions (PDFs)*, 134-135, 134
 transient climate response (TCR), 16-17, 84-85, 128, 817-818, 821, 920-921, 925, 1110-1112
- Climate simulations**, 122, 147-150, 743, 767-795, 959-961, 1013-1014
- Climate stabilization**, 27-29, 102-105, 1033, 1107-1113
- Climate system***, 15, 15-19, 60-78, 871, 920-931
 climate models, 15-16
 environmental data, 1437-1445
 historical data, 1401-1409
 nonlinear, chaotic nature of, 955, 960, 1033
 observed changes, 4-12, 37-52
 quantification of responses, 16-17
 responses of, 16-17, 81, 1004
 scenario tables, 1395-1445
 transient climate response, 16-17, 920-921, 925
 warming of, 4-5, 5-6, 7, 198-199
- Climate targets**, 102-105, 1033, 1107-1113
- Climate variability***, 121, 138, 142-143, 164, 232-235, 795-806, 959
 indices of, 230-232, 231-235
 interannual-to-centennial, 799-806, 806
 internal, 61-62, 769-770, 919, 923, 959
 modes of*, 415-416, 744, 801-803, 1220, 1222-1223, 1223-1225, 1288-1289
 patterns of*, 232-235, 900-901, 900, 1243-1246
- Clouds**, 208, 571-657
 aerosol-cloud interactions*, 164, 573, 578, 606-614, 607, 618-623, 623, 625-626, 683-685
 anthropogenic sources of moisture, 592-595
 aviation-induced cloudiness, 574, 592-594, 686
 cloud albedo effect, 578, 610, 1048-1050
 cloud condensation nuclei (CCN)*, 603-604, 608, 886
 cloud convection effects, 573, 585
 cloud feedbacks*, 587-592, 819-820
 cloud lifetime effect, 1048-1050
 cloud radiative effect (CRE)*, 580-582, 582, 585-586, 764, 765
 cold clouds, 611-612
 cosmic ray effects on, 613-614, 691
 effects on Earth's radiation budget, 580-582, 582
 feedbacks, 573-574, 576-578, 577, 587-592
 formation and types, 576, 578-580, 579-581
 general concepts, 578-595, 593-594
 geoengineering methods, 628
 ice clouds, 585
 lifetime effects, 578, 609-610
 liquid clouds, 585, 609-611
 mixed-phase clouds, 585
 models, 16, 573, 582-587, 591-592, 592, 608-611, 743, 762-766, 764
 observations, 578-595
 opacity, 590
 precipitation effects, 624-627
 in present-day climate system, 578-582
 processes, 582-587, 592
 projections, 1070-1071, 1070
 radiative forcing (CRF)*, 126, 126, 576-578, 577, 618-621, 682-684
 sea-ice interactions, 590
 water vapour feedbacks, 574
- Cold days/cold nights***, 162, 210-212, 221
 projections, 86, 956, 990, 1065-1066, 1067
- Commitment**. See Climate change commitment
- Compatible emissions***, 523-528, 526-529, 1104
- Confidence***, 4, 36, 139-142, 142
- Contrails**, 574, 592-594, 686
- Cosmic rays**, 573, 613-614, 691
- Cryosphere***, 9, 69, 317-382
 area, volume, and sea level equivalents, 321-322
 attribution of changes, 870, 906-910, 931, 936-937
 components, 321, 321, 322
 feedbacks, 27, 321, 358, 359, 757
 frozen ground*, 320, 362-366, 367
 glaciers*, 319, 335-344, 367
 ice sheets*, 320, 344-357, 367
 impact of changes in, 321-323
 irreversible changes, 71-72
 lake and river ice, 320, 361-362, 367
 observation methods, 323, 335-338, 338, 368
 observations, 9, 10, 136-137, 317-382
 projections, 24-25, 88, 323, 956, 995-996
 projections, long-term, 92, 92-93, 1032-1033, 1087-1093, 1088-1092
 sea ice*, 319, 323-335, 367, 870
 seasonal snow, 320, 358-361, 358-360
 summary, 319-320, 367-368, 367
- Cyclones**, 110, 162, 1220, 1248-1253
 attribution of changes, 871, 913-914, 938
 extratropical*, 113, 217-220, 743, 913, 1220, 1251-1253, 1288-1289
 models, 743, 807
 observations, 7
 projections, 7, 107-108, 108, 110, 113, 956, 992-993, 993, 1219, 1249-1253, 1250, 1288-1289
 tropical, 7, 107-108, 108, 113, 162, 216-217, 216, 807, 871, 913-914, 938, 956, 992-993, 993, 1220, 1248-1251, 1288-1289

D

- Dansgaard-Oeschger (DO) events***, 432-433
- Deforestation***, 50, 55, 1008
- Detection and attribution of climate change***, 7, 17-19, 125, 867-952
 anthropogenic radiative forcings, 13-14, 14, 17, 146, 617, 661-662, 675-688, 932-934, 1005-1008
 atmosphere and surface, 878-901
 atmospheric circulation, 871, 899-901, 899-900, 931, 937-938
 atmospheric temperatures, 869-870, 878-893
 climate models and, 825, 869, 872, 875-876
 climate system properties, 871, 920-927
 combination of evidence, 871, 924-926, 931
 context, 151, 872-874
 cryosphere*, 870, 906-910, 931, 936-937
 definition, 872-873
 Earth system properties, 926-927
 extremes, 110, 871, 910-917, 911
 fingerprinting, 873-874, 877-878, 894-895
 greenhouse gases, 127, 150, 869, 887, 932
 human attribution, 7, 17-19, 121, 125, 127, 869-871, 927-931, 932-939
 hydrological cycle, 72, 870, 895-899, 931, 935-936
 irreversibility and, 28
 lessons from the past, 919-920
 methods, 872-878, 875-876, 894-895
 models, 825, 869, 872, 875-876
 multi-century to millennia, 917-920, 938
 multi-variable approaches, 878, 927
 null hypothesis, 878
 ocean properties, 293-294, 870, 901-906, 926, 934-935
 precipitation, 72, 870, 871, 896-897, 897-898
 regional changes, 888-891, 889, 919, 938-939
 scaling factors, 873-874
 sea level change, 870, 905, 1156, 1176-1179
 single-step and multi-step attribution, 878
 solar irradiance and forcing, 885-886
 summary, 869-871, 893, 927-931, 932-939
 temperature, 17-19, 60, 869-870, 871, 878-893, 918-920, 930, 932-934
 time series methods, 874-877, 887-888, 895, 1223
 weather and climate events, 914-917
 whole climate system, 927-931, 930
- Dimethyl sulphide (DMS)**, 601
- Direct air capture***, 550
- Diurnal temperature range (DTR)**. See Temperature
- Doha Amendment**, 169
- Downscaling***. See Climate models
- Drivers of climate change**, 13-14, 53-59, 392-393
 long-term, 1033

near-term, 170-174, 668
 summary, 13-14, 14, 124, 126
 uncertainties, 114
Droughts*, 110, 112, 212, 214-215, 1118
 attribution of changes, 912-913
 megadroughts, 110, 112, 422, 423-424
 models, 807-809
 observations, 7, 162, 211-212, 212
 paleoclimate*, 386, 422-425, 423-424
 projections, 7, 91-92, 110, 986, 1086, 1118
Dust, 394, 600, 605, 1048-1050

E**Earth system**

energy budget, 1069-1071, 1069-1070, 1140, 1159-1161
 properties, 926-927
 responses and feedbacks, 388, 395, 398-415
El Niño-Southern Oscillation (ENSO)*, 106-107, 232, 233-235, 1240-1243
 Atlantic Niño, 233, 803, 806, 1224, 1239-1240
 changes, 1240-1242, 1242
 impacts, 1224
 indices, 231, 232, 233-234
 models, 15, 744, 803-805, 804, 806, 1220
 paleoclimate*, 386, 415-416, 416
 projections, 23, 106-107, 1240-1243, 1242, 1259, 1288-1289
 tropical Pacific mean state, 1240, 1241
 variability, 129, 744, 806

Electromagnetic spectrum*, 126

Emission metrics, 17, 58-59, 59, 662-663, 710-720, 731-738

application of, 716-720
 concepts, 710-716, 710-712
 by sector, 719-720, 720

Emissions scenarios*, 516-517, 523-528, 662-663, 997, 1106-1107, 1410-1421
 compatible emissions*, 523-528, 526-529, 1104
 Representative Concentration Pathways (RCPs)*, 79-81, 147-150, 468, 523-526, 524-529, 1045-1047, 1100
 SRES scenarios*, 131-132, 146-147, 149-150, 955, 997, 1045, 1100
 zero emission commitment, 1104, 1104, 1106-1107

Energy budget of the Earth*, 67-68, 1140, 1159-1161

glaciers and, 344
 projections, 1069-1071, 1069-1070

Energy inventory (global), 257, 264-265

Equilibrium climate experiment*, 128

Equilibrium climate sensitivity (ECS), 16, 81, 82-85,

385, 405-407, 405-406, 817-819, 817, 821, 920-926, 925, 1110-1112
 projections, 81, 1033, 1105-1107
 summary, 1110-1112

Europe and Mediterranean, 1264-1266, 1265

climate indices, changes in, 211-212
 flood frequency, 424, 915-916, 915
 precipitation extremes, 211-212, 213, 991

projections, 106, 991, 1264-1266, 1265, 1281, 1288, 1350-1357
 severe storms, 217
 temperature, 939, 991
 wind speeds, 217, 220

Evaporation, 205, 269-270

projections, 91-92, 573, 986-988, 1032, 1081-1082, 1082

Extratropical circulation, 415-416, 773

Extratropical cyclones*, 113, 217-220, 743, 913, 1220, 1251-1253, 1288-1289

Extremes, 72-73, 109-113, 121, 134-136, 162-163,

209-222

air pollution and, 1005

attribution of changes, 110, 871, 910-917, 911, 931

changes in, 209-222, 218-219

confidence levels, 134-136, 135

cyclones, 113, 217

extratropical storms, 217-220, 1074, 1075

fraction of attributable risk, 47

hydrological cycle, 110-112, 213-216, 912-913, 1082-1087

indices of, 221-222

models, 15, 744, 758, 806-809, 808

observations, 46-50, 110, 162-163, 164, 209-222

precipitation, 23, 110-112, 211-212, 626-627, 807, 808, 871, 912, 956, 991, 992

probability density functions (PDFs)*, 134-135, 134

projections, 956, 990-993, 990-991, 1003-1004, 1031-1032, 1064-1068, 1067-1068, 1082-1087

regional, 211-212

sea level, 7, 101, 110, 258, 290-291, 290, 1140, 1200-1204

severe local weather, 216

small-scale, 163

SREX, 7, 110, 209, 212-214, 217

temperature, 109-112, 209-212, 209-212, 211-212, 218-219, 871, 910-912, 931, 990-992, 990-991, 1031-1032, 1064-1068, 1067-1068

tropical storms, 216-217, 216

waves, 1141

F**Feedbacks***, 16, 57-58, 82-85, 127, 128

carbon cycle*, 26, 475-480, 477-478, 514-523, 515-518, 520

climate*, 57-58, 817-821, 817-819

climate-carbon cycle, 514-523, 515, 516-518, 551-552

climate-vegetation, 752, 791

cloud and aerosol, 573-574, 576-578, 577, 587-592, 593-594, 605-606

cryosphere*, 27, 321, 358, 359, 757

distinguished from forcing and rapid adjustments, 576-578

Earth System (global and hemispheric scales), 388, 395, 398-415

models, 16, 19, 26, 514-521, 516-518, 817-821, 818

permafrost-climate, 27

projections, 24

snow-albedo, 321, 358, 359, 757

timescales of, 128-129, 128, 1105-1107

water vapour, 586-587, 587, 667, 819

Fingerprints*, 873-874, 877-878, 894-895

Fires, 542, 693, 752

Floods, 112, 214, 290, 915-916, 915

paleoclimate, 386, 422-425, 424

Forests*, 543, 1115, 1117

deforestation*, 50, 55, 1008

potential irreversible changes, 70-71

Fossil fuel emissions*, 467, 477, 489, 616

compatible emissions, 93, 94, 523-528, 526-529

Frequently Asked Questions (FAQs)

Are climate models getting better, and how would we know?, 824-825

Are glaciers in mountain regions disappearing?, 345-346

Climate is always changing. How do we determine the causes of observed changes?, 894-895

Could geoengineering counteract climate change and what side effects might occur?, 632-634

Could rapid release of methane and carbon dioxide from thawing permafrost or ocean warming substantially increase warming?, 530-531

Do improvements in air quality have an effect on climate change?, 684-685

Have there been any changes in climate extremes?, 218-219

How are future projections in regional climate related to projections of global means?, 1256-1257

How do aerosols affect climate and climate change?, 622-623

How do clouds affect climate and climate change?, 593-594

How do volcanic eruptions affect climate and our ability to predict climate?, 1008-1009

How do we know the world has warmed?, 198-199

How does anthropogenic ocean acidification relate to climate change, 297-298

How important is water vapour to climate change?, 666-667

How is climate change affecting monsoons?, 1228-1229

How is sea ice changing in the Arctic and Antarctic?, 333-334

How unusual is current sea level rate of change?, 430-431

How will the Earth's water cycle change?, 1084-1085

If understanding of the climate system has increased, why hasn't the range of temperature projections been reduced?, 140-141

If you cannot predict the weather next month, how can you predict climate for the coming decade?, 964-965

Is the ocean warming?, 266-267

Is the Sun a major driver of recent changes in climate?, 392-393

Is there evidence for changes in the Earth's water cycle?, 269-270

What happens to carbon dioxide after it is emitted to the atmosphere?, 544-545
 What would happen to future climate if we stopped emissions today?, 1106-1107
 When will human influence on climate become obvious on local scales?, 928-929
 Why are so many models and scenarios used to project climate change?, 1036-1037
 Why does local sea level change differ from the global average?, 1148-1149
 Will the Greenland and Antarctic ice sheets contribute to sea level change over the rest of the century?, 1177-1179

Freshwater ice, 320, 361-362

Frozen ground*, 320, 362-366, 367
 permafrost*, 320, 362-364, 362-363
 seasonally frozen, 320, 364-366, 365-366

G

Geoengineering*, 29, 98, 546-552, 632, 632-634
 Carbon Dioxide Removal (CDR)*, 469, 547-551, 548-549, 632-633
 carbon sequestration in ocean, 549-550
 climate response and, 629-635, 629-631
 side effects and risks, 29, 575, 627-628, 632-634
 Solar Radiation Management (SRM)*, 29, 469, 574-575, 627-635, 629-631, 633-634, 693
 volcanic eruptions as analogues for, 693

Geopotential height, 223, 223, 226

Glaciation
 future, 387, 435
 glacial-interglacial cycles*, 385, 399-402, 480-483, 482-483
 last glacial termination, 389, 400-401, 428-432

Glaciers*, 319, 335-344, 345-346, 367
 abrupt glacial events, 483
 anthropogenic influence, 19
 attribution of changes, 870, 909-910, 931
 calving*, 335, 336, 337, 342, 343
 current area and volume, 335, 336-337
 deglaciation*, 385, 400
 dynamic change potential, 1164-1165
 equilibrium line*, 338, 345-346
 greenhouse gases and, 480-483
 mass balance/budget*, 319, 341-344, 343, 1151, 1153
 measurement methods, 335-338, 338
 models, 1145, 1163-1164
 observed changes, 9, 319, 338-344, 339-340
 paleoclimate, 385, 421
 projections, 24, 25, 1145, 1164-1165
 sea level change and, 367, 1139, 1151-1153, 1151, 1163-1165, 1164-1165, 1182
 sea level equivalent, 319, 321
 summary, 9, 24, 137, 319, 367
 volume and mass changes, 338-344, 339-344

Global Damage Potential (GDP), 715

Global dimming*, 161, 183-184, 794

Global Positioning System (GPS), 143, 196, 207

Global Temperature change Potential (GTP), 17, 663, 712-714, 714-715, 720

Global Warming Potential (GWP)*, 17, 663, 710-714, 711-712

GRACE satellite mission, 349, 351-353, 380, 1156, 1157

Gravity field. *See* GRACE satellite mission

Greenhouse effect*, 124, 127, 666-667

Greenhouse gases (GHGs)*, 126, 127, 161, 165-170, 385
 anthropogenic*, 17, 27-28, 391, 869, 887, 932, 1410-1420
 commitment and irreversibility, 1033
 emissions scenarios, 516-517, 523-528, 662-663, 997-1001, 1410-1421
 feedbacks, 17, 128, 667
 glacial-interglacial changes, 385, 480-483, 482, 483
 global trends, 164
 lifetimes, 128-129, 128
 observed changes, 4, 11-12, 132-134, 132-133, 164, 165-170
 observed changes, last millennium, 485-486, 486
 paleoclimate*, 385, 391-398, 483-484, 483
 projections, 19, 27-28, 148, 955, 997-1001, 1006-1007, 1410-1420, 1422-1427
 radiative forcing*, 13-14, 14, 126, 164, 165, 391-398, 470, 661, 675-676, 1404-1409
 since industrial revolution, 486-514
 spectral properties, 675-676
 well-mixed, 165-170, 166, 661, 668, 676-679, 677-678, 1006-1007
See also Emissions; specific gases

Greenland ice sheet, 9, 137, 320, 349-351, 397, 909
 attribution of changes, 870, 909, 931
 dynamical change, 1168-1169
 loss of (possibility), 71-72, 353, 363, 1140, 1169-1170
 mass balance*, 347, 380-381, 1139, 1153-1155, 1154-1155, 1165-1168, 1166
 models, 753, 1166-1168
 observed changes, 349-351, 350, 357, 367, 368
 paleoclimate*, 387, 1170
 projected loss of, 29
 projections, 25, 1140, 1165-1170
 sea level equivalent, 320, 321, 350, 353-354
 sea level rise and, 1139, 1140, 1153-1154, 1154-1155, 1165-1170, 1177-1179, 1182
 thresholds and irreversibility, 71-72, 1169-1170

H

Hadley Circulation*, 226-229, 227, 871, 899-900, 899
 projections, 90, 956, 989-990, 989, 1032, 1073

Halocarbons*, 13, 14, 675, 717
 radiative forcing*, 678-679, 678

Halogenated alcohols and ethers, 734-737

Halons, 733

Heat flux, 182, 274-275, 786

Heat waves*, 5, 7, 110, 211-212, 212
 attribution of changes, 915, 916, 939
 projections, 110, 1066
 Russia (2010), 212, 915, 916

Texas (2011), 212, 916

Hindcasts*, 965, 970, 973-974, 975
 precipitation, 976
 sea surface temperature*, 967

Holocene*. *See* Paleoclimate

Human effects on climate, 7, 17-19, 121, 127, 928-929
 carbon cycle, 467-468
 detection and attribution studies, 867-952
 irreversible aspects of, 28, 469
 ocean acidification, 293-294, 295-298
 oceanic carbon dioxide, 292-293, 293
 radiative forcing*, 13, 14, 17, 146, 617, 661-662, 675-688
See also Detection and attribution

Humidity, 162, 201, 205-208, 206, 870
 in climate models, 819
 projections, 956, 987, 988, 1032, 1076, 1076
 relative*, 987, 988, 1076
 specific*, 206, 206, 956, 987, 988, 1032
 surface, 205-206, 206
 tropospheric, 206-208

Hurricanes, 809, 994
See also Cyclones

Hydrochlorofluorocarbons (HCFCs), 161, 170, 1403, 1427
 lifetime and radiative efficiency, 661, 731

Hydrofluorocarbons (HFCs), 168-169, 998, 1402
 atmospheric concentration, 161, 168-169, 168
 lifetime and radiative efficiency, 732-733
 projections, 1414-1416, 1424-1427
 radiative forcing*, 678, 679, 1434

Hydrological cycle*, 17, 72, 162, 201-208
 abrupt/irreversible changes, 1115, 1118-1119
 attribution of changes, 17, 72, 870, 895-899, 931, 935-936
 changes in, 42-45, 269-270, 273
 extremes, 110-112, 213-216, 912-913, 1082-1087, 1083, 1086
 greenhouse effect and, 666
 land water storage, 1151, 1155-1156, 1176-1179, 1182
 observations, 40-46, 42-45, 162, 164, 201-208
 oceans and, 265, 273
 paleoclimate*, 386, 421-422
 projections, 20-23, 88, 956, 984-988, 985, 987, 1084-1085
 projections, long-term, 44-45, 91-92, 91, 1032, 1074-1087, 1082-1087, 1083, 1086
 proxy data, 421-422
 radiative forcing*, 624-625
 surface hydrology, 790-791, 897-899
See also Precipitation; Water vapour

I

Ice, 136-137, 319-320
 aerosol absorption on, 574
 annual melt rates, 264
 freshwater ice, 320, 361-362, 367
 river and lake ice, 320, 361-362, 367
 sea ice*, 319, 323-335, 367, 870

See also Glaciers
Ice age*, 386, 389, 413
Ice clouds, 585
Ice cores*, 391-394, 432, 485
Ice nuclei, 604
Ice sheets*, 320, 344-357, 367, 1177-1179
 Antarctic, 9, 25, 29, 137, 320, 321, 351-353, 352-353, 356-357, 368, 909, 1170-1176
 attribution of changes, 870, 909-910, 931
 basal lubrication*, 354-355
 calving*, 355
 causes of changes, 353-355
 climate-ice sheet interactions, 402-403
 dynamics and stability, 25, 1159, 1168-1169, 1172-1174, 1175-1176, 1179
 Greenland, 9, 25, 29, 137, 320, 321, 349-351, 350, 357, 870, 909, 1165-1170
 grounding line*, 347, 351, 353, 357
 ice loss, 320, 349-353, 353-354, 380-382
 irreversible changes, 29, 71-72, 355-356, 433, 1115, 1116, 1169-1170, 1174
 marine ice-sheet instability hypothesis (MISI), 1175-1176
 mass balance/budget*, 344-353, 347-348, 380-382, 1139
 measurement techniques, 347-349, 347-348
 models, 25-26, 753, 1145
 observed changes, 9, 10, 320, 346-353, 347-348
 ocean interactions, 354, 355, 356-357
 paleoclimate*, 387, 426-431, 1170, 1174
 polar amplification, 397, 907
 processes, 354-355
 projections, 25, 29, 1145, 1165-1176
 rapid changes, 355-357
 sea level change and, 29, 355, 367, 1139, 1145, 1151, 1153-1155, 1154-1155, 1165-1176, 1177-1179, 1182
 sea level equivalents, 321, 352-354, 355
 subsurface melting, 356-357
 summary, 320, 353-354, 367
Ice shelves*, 320, 353, 367
Indian Ocean, 233-235, 280, 495
 models, 787
 projections, 1219
Indian Ocean Dipole (IOD)*, 233-235, 1220, 1237-1239
 impacts, 1224
 models, 744, 805, 806
 projections, 1237-1239, 1238-1239
Indonesian Throughflow, 284-285
Industrial Revolution*, 474-475, 486-514, 697-698
Insolation*, 794-795
Inter-Tropical Convergence Zone (ITCZ)*, 387, 786, 1077, 1219, 1236
Iron fertilization*, 481, 543
Irreversibility*, 27-29, 70-72, 129, 386-387, 433-435, 469
 ice sheets*, 29, 71-72, 355-356, 433, 1115, 1116, 1154, 1169-1170
 long-term projections, 1033, 1114-1119
 paleoclimate perspective, 386-387, 433-435
 sea level and, 29
Islands. *See* Pacific islands

K

Kyoto Protocol*, 715
Kyoto Protocol gases, 161, 166-170, 997, 1005, 1401-1402

L

Lake ice, 320, 361-362, 367
Land carbon storage, 26, 93
Land surface, 790-791
Land surface air temperature*, 162, 164, 187-189, 187
Land use and land use change*, 127, 162, 188-189, 686-688
 carbon dioxide emissions, 467, 474-475, 489-491, 490-492
 future scenarios, 523
 land cover, 686-687
 land water storage, 1151, 1155-1156, 1176-1179, 1182
 models, 752, 791
 projections, 1006-1007, 1038, 1048-1050, 1052, 1099
 radiative forcing*, 662, 686-688, 687, 1048-1050, 1052, 1404-1409
 urban effects, 162, 188-189
Land water storage, 1151, 1155-1156, 1176-1179, 1182
Lapse rate*, 586-587, 587, 819
Likelihood*, 36, 139-142
See also Confidence; Uncertainty
Long-term climate change, 19-20, 89-93, 1029-1136
See also Climate projections

M

Madden-Julian Oscillation (MJO)*, 796-798, 798, 1220, 1224, 1237
Mediterranean region. *See* Europe and Mediterranean
Meridional Overturning Circulation (MOC). *See* Atlantic Meridional Overturning Circulation
Methane (CH_4)*, 11, 165, 167, 385, 486, 508-510
 anthropogenic, 509, 663, 955, 1411
 atmospheric changes, 505-508
 atmospheric concentration, 156, 161, 166-167, 167, 1401-1402
 clathrates*, 70-71, 1115, 1116-1117
 couplings and feedbacks, 674-675
 glacial, 482-483, 483
 global budget, 505-510, 507-508
 growth rate, 385, 506, 506
 industrial era, 475
 lifetime and radiative efficiency, 731, 1432
 methane cycle, 473-474, 474, 752
 models, 509-510, 752
 natural sources, 508-509
 observed changes, 11, 133, 134, 161, 165-166, 166, 167, 467, 505-508

paleoclimate, 385, 485

permafrost*, 508, 530-531, 541-542
 projections, 24, 27, 148, 156, 468-469, 539-542, 540, 997-998, 999, 1048-1050, 1411, 1422
 radiative forcing*, 13, 14, 126, 661, 662, 674-675, 677, 678, 1048-1050, 1433

Methane hydrate, 542

Methyl chloroform (CH_3CCl_3), 678, 733

Methylene chloride (CH_2CH_2), 733

Metrics*

emission metrics, 17, 58-59, 59, 662-663, 710-720, 731-738

model performance metrics, 765-766, 766-767

Microwave Sounding Unit (MSU), 194-196, 195

Mineral dust aerosol (MDA), 394, 600, 605, 617

Mitigation*, 27-29

Models. *See* Climate models

Modes of climate variability*, 415-416, 744, 801-803, 1222-1223

definitions and impacts, 1223-1225

projections, 1220, 1288-1289

regional impacts, 1224

responses to climate change, 1222-1223

Monsoons*, 105, 1222, 1225-1235, 1228-1229, 1288-1289

abrupt/irreversible changes, 1115, 1118-1119

African, 1234, 1235

American, 1232-1234, 1233

Asian-Australian, 1227-1232, 1230-1231

East Asian, 1230-1231, 1231-1232

Indian, 1229-1231

models, 15, 798-799, 799, 1219

observations, 163, 227

overview, 1225-1227, 1226-1227

paleoclimate*, 387, 401-402, 401, 421-422

projections, 23, 105, 107, 1118-1119, 1219, 1225-1235, 1288-1289

Montreal Protocol*, 661, 672, 678

Montreal Protocol gases, 161, 170, 678, 1403, 1427, 1435

N

Natural forcings, 13-14, 14

Near-term climate change, 85-89, 953-1029

See also Climate projections

Near-term climate forcers (NTCFs)*, 668, 717-718

New Zealand. *See* Australia and New Zealand

Nitrate aerosols, 605-606, 616-617, 1048-1050

Nitrogen, 93, 127, 468, 535-539, 538

global budgets, 510-514, 511-512

Nitrogen cycle, 475-480, 477-479

projections, 535-539, 536-540

Nitrogen dioxide (NO_2), 174, 174

Nitrogen fertilizers, 469, 510, 512, 535-536, 536

Nitrogen fixation, 475, 477, 511, 514, 1419-1420

Nitrogen oxides, 717-718, 739

Nitrogen trifluoride (NF_3), 169, 678, 679, 733

Nitrous oxide (N_2O)*, 11, 167-168, 475

atmosphere burden and growth rate, 385, 510-512, 511-513

atmospheric concentration, 161, 167-168, 168, 476, 1401-1402
 feedbacks and sensitivity, 512-514, 513
 glacial, 482-483, 483
 global budget, 510-514, 511-512
 global warming potential, 717
 lifetime and radiative efficiency, 731, 1433
 observed changes, 11, 133, 134, 161, 166, 167-168, 467-468, 486
 paleoclimate*, 385, 485
 projections, 148, 157, 469, 535-537, 537, 998, 1048-1050, 1412, 1423
 radiative forcing*, 13, 14, 126, 127, 661, 675, 677-678, 688, 1048-1050

Non-methane volatile organic compounds (NMVOCS)*, 13, 14, 174, 996, 1000, 1417

Nonlinearity*, 955, 960, 1033

North America

climate indices, changes in, 211-212, 212
 cyclones, 217
 monsoon, 1233, 1233
 precipitation extremes, 211-212, 213
 projections, 106, 1258-1260, 1259, 1279, 1288, 1334-1337

North Atlantic Oscillation (NAO)*, 230, 231, 233-235, 354, 1244-1245

impacts, 1224
 models, 744, 801, 806
 paleoclimate*, 386, 415-416
 projections, 989, 1220, 1244-1245, 1245
 summary, 806

North Pacific Oscillation (NPO), 801, 1224

Northern Annular Mode (NAM)*, 233-234, 900, 900, 1244
 impacts, 1224
 models, 415, 806
 paleoclimate*, 415-416
 projections, 108, 989, 1245, 1245
 summary, 806

O

Observations. *See specific topics*

Oceans, 8, 255-315

acidification*, 11, 12, 12, 52, 69, 136, 259, 295-296, 300, 751, 870, 905-906
 acidification, anthropogenic influence, 293-294, 295-298
 acidification projections, 22, 27, 94, 105, 469, 528-532, 532
 attribution of changes, 870, 901-906, 926, 934-935
 biogeochemical changes, 259, 291-301
 carbon balance, 300, 301, 498-499
 carbon dioxide absorption, 11, 12, 26, 51-52, 93, 259, 291-293, 293, 295-300, 300, 472, 495-499, 751, 870
 CDR methods and, 549-550, 551
 circulation, 258, 281-285, 283, 481, 956
 circulation, projections, 994-995, 1094-1095
 deep and bottom waters, 263, 279-280
 evaporation, 274-275, 275, 276
 fluxes, 258, 273-278

freshwater content, 257, 272, 273
 freshwater fluxes, 275-276, 276, 994
 heat content, 17, 18, 257, 260-263, 262, 264, 266, 301, 779-781, 782, 901-903, 902
 heat content, modeling, 743
 heat content, projections, 1162
 heat fluxes, 274-275, 786
 heat uptake*, 93, 267, 821, 1161-1163, 1162
 human influences, 17, 292-294, 293
 inertia and, 958
 iron deposition/fertilization*, 481, 543
 irreversible changes, 433-435
 mass observations, 1156, 1157
 models, 750, 751-752, 753, 758, 777-787
 nitrogen concentration, 475
 nutrients, 298-300
 observations, 8, 10, 22, 255-315, 302
 observations, capabilities and methods, 144, 302, 311-316
 ocean-atmosphere coupling, 753, 1118-1119
 ocean heating rate (OHR), 182, 183
 oxygen concentrations, 259, 294-298, 300-301, 300, 469, 535, 870, 905-906
 oxygen projections, 532-534, 534-535
 paleoclimate*, 433-435, 456, 484, 783-784
 precipitation and, 275-276, 276
 projections, 24, 88, 468, 469, 519-520, 528-532, 956, 993-995, 993-994
 projections, long-term, 93, 1033, 1093-1095
 salinity, 8, 257, 265-273, 280, 301, 870, 903-905, 904, 994, 994, 1094, 1094
 solubility/biological pumps*, 472
 summary, 257-259, 301-302, 302
 surface temperature, 5, 6, 777-779, 778-780
 temperature, 5, 6, 68-69, 257, 260-265, 266-267, 901-903, 902, 993-995, 993-994
 temperature projections, 24
 thermal expansion*, 99, 99, 1139, 1143, 1150-1151, 1159, 1161-1163, 1180, 1182
 thermal forcing, 354
 upper ocean salinity, 268-273
 upper ocean temperature, 257, 258, 261-262, 261, 263, 265, 301, 870, 901
 warming (observed), 8, 10, 17, 24, 257, 260-265, 280
 warming rates, 263, 263
 water exchange between ocean basins, 284-285
 water mass properties*, 258, 278-281
 wave heights, 258, 277-278
 wind stress, 276-278, 784-785, 784-785
 See also Sea level; Sea level change

Optimal fingerprinting, 877-878

Orbital forcing, 385-388, 399, 400

Oxygen (O_2)

atmospheric concentration, 476, 480, 1437
 dissolved in oceans, 95, 259, 294-298, 300-301, 300, 469, 905-906
 feedbacks, 480
 oceanic, projections, 532-534, 534-535

Ozone*, 1000

depletion, 739, 869, 937, 998-999, 1000, 1078
 long-term trends, 172-173
 models, 744, 752, 757, 774-775, 775

monitoring sites, 173

ozone hole*, 171, 752

projections, 24, 542, 957, 997, 1000, 1001-1002, 1048-1050, 1428, 1438-1442
 radiative forcing*, 13, 17, 127, 661-662, 670-672, 672, 679-681, 1048-1050, 1404-1409, 1434
 stratospheric, 161, 171-172, 172, 672-674, 681-682, 681, 774-775, 999, 1048-1050, 1078, 1428
 tropospheric, 161, 172-173, 670-672, 672-673, 679-681, 680-681, 684, 775, 998-999, 1048-1050, 1428-1429

Ozone-depleting substances, 161, 169-170

P

Pacific Decadal Oscillation (PDO)*, 230, 231, 233-235, 1253

impacts, 1224

models, 806, 806, 1253

predictions, 971, 972

Pacific Decadal Variability*, 233-235, 972

Pacific Islands region, 106, 1275-1276, 1285, 1289, 1386-1389

Pacific/North American (PNA) pattern*, 231, 233-235, 806, 1224, 1253

Pacific Ocean, 271, 280, 495

circulation systems, 281-282

tropical, mean state, 743, 786-787

Pacific/South American (PSA) index, 231, 233-235

Pacific/South American (PSA) pattern, 1221, 1224, 1253

Paleoclimate*, 124, 383-464

8.2 ka event, 389, 434

abrupt change and irreversibility, 386-387, 432-435, 434

carbon dioxide, 385, 391-394, 399-400, 400, 457, 459-460, 468, 483-484, 483

droughts*, 386, 422, 423-424

Earth system responses and feedbacks, 388, 395, 398-415

equilibrium climate sensitivity, 923-924

floods, 386, 422-425, 424

glacial-interglacial cycles, 385, 399-402, 480-483, 482-483

greenhouse gases, 385, 391-398, 483-484, 483

Holocene*, 389, 417-425, 428-435, 434, 776-777, 776-777, 1146

ice sheets*, 387, 426-428, 1170, 1174

interglacials*, 386, 407-409, 425-428, 1146

last 2,000 years, 389, 409-415, 409-410

Last Glacial Maximum (LGM)*, 385, 389, 394, 403-407, 404, 776-777, 776-777

last glacial termination, 389, 400-401, 428-432

Last Interglacial (LIG), 385, 389, 407-409, 408, 425-428, 427, 1146

last millennium, 917-920, 918

Little Ice Age*, 386, 389, 413

Medieval Warm Period*, 5, 386, 389

methods, 385, 388

models, 388, 403-405, 411-415, 413-414, 456-464, 776-777, 820-821

modes of climate variability*, 386, 415-416

next glacial inception, 387, 435
ocean circulation, 433-435, 456, 783-784
orbital forcing, 385, 386, 388, 399
periods assessed, 389
Pliocene*, 1145-1146
polar amplification, 385, 396-398
pre-industrial perspectives, 388-398, 389
proxy methods*, 388, 394, 403-404, 457-458
radiative forcing*, 385, 388-398
reconstructions*, 77-78, 411-415, 414-415
sea level, 47, 385, 425-432, 427-429, 1139, 1145-1150, 1147
temperature, 385-386, 395, 409-415, 417-420, 461-464
uncertainties*, 404, 411-412
volcanic forcing, 390, 391

Particulate matter. See *Aerosols*

Pattern scaling, 1058-1062, 1061

Perfluorocarbons (PFCs), 161, 168-169, 679, 733-734, 1000

Permafrost*, 320, 362-364
active layer*, 364-366, 365
carbon storage in, 480, 526-528
irreversible changes, 70-71, 1115, 1116
methane from, 508, 530-531, 541-542
models, 752
near-surface*, 996
observed changes, 9
permafrost-climate feedback, 27
projections, 25, 27, 468, 541-542, 997
projections, long-term, 1032-1033, 1092, 1093
subsea, 364
temperature, 9, 25, 362-364, 362-363

Perturbed physics experiments (PPEs), 1040

Phosphorus, 542

Photosynthesis, 470, 471-472, 475, 478, 480, 502, 545

Polar amplification, 385, 396-398, 907, 1031, 1062-1064

Polynyas, 329, 332-334

Precipitation, 201-204
aerosol effects, 624-627
attribution of changes, 72, 870, 871, 896-897, 897-898
extremes, 5, 7, 23, 110-112, 162, 211-212, 213-214, 573, 626-627, 807, 808, 871, 912, 956, 991, 992, 1082-1087
extremes, indices of, 221
extremes, physical basis for changes in, 626-627
global changes and projections, 1320-1321
global distribution of, 1225
global warming effects on, 624, 625
large-scale changes, 201-204, 202-203, 624
models, 743, 761-762, 763, 811-813, 811-813, 1013-1014
observations, 5, 7, 8, 22, 162, 201-204
ocean precipitation, 275-276, 276
projections, 7, 20-23, 22, 573, 956, 984-986, 985, 991, 1014-1015, 1278-1287
projections, global, 1320-1321
projections, long-term, 91-92, 91, 1032, 1055-1057, 1057, 1076-1079, 1078
regional, 573, 1219-1220

runoff*, 91-92, 204-205, 956, 1081, 1081
summary, 5, 7-8
trends, 202-203, 215, 624, 898
warmer-get-wetter, 1219, 1240
wet-get-wetter, 624
See also Monsoons

Predictability*, 131, 953-1029
near-term predictions, 963-978
prediction quality/skill*, 85-86, 86, 958, 960-961, 966-978
terminology, 960
See also Climate predictions

Principal component, 1223

Probability density functions (PDFs)*, 134-135, 134, 697

Probability in climate predictions/projections, 961-962

Projections. See *Climate projections*

Proxy methods*, 388, 394, 404, 457-458

Q

Quasi-Biennial Oscillation (QBO)*, 230, 744, 806, 806, 1224, 1254

R

Radiation

radiative imbalance, 264
surface solar (SSR), 183-184, 184, 185-186
surface thermal and net, 184-185
top of the atmosphere (TOA), 180-181, 580-582, 618, 620, 765, 1069, 1069

Radiation budget,

161, 180-186, 576
cloud effects on, 580-582, 582
global mean, 127, 181, 182-183, 183
rapid adjustments and, 573, 576
surface, changes in, 183-186, 184

Radiative effect*,

573, 576, 578, 1161
cloud radiative effect (CRE)*, 580-582, 582, 585-586, 764, 765

Radiative efficiency,

717, 731-738

Radiative forcing (RF)*,

13-14, 14, 53-57, 54, 127, 659-740, 1404-1409, 1433-1436
aerosols*, 13-14, 14, 576-578, 577, 614-623, 682-684, 1404-1409

aircraft and contrails, 574, 592-594, 686

anthropogenic, 13, 13-14, 14, 17, 146, 617, 661-662, 675-688, 932-934, 1005-1008

atmospheric carbon dioxide, 13

atmospheric chemistry, 669-675

calculation methodologies, 668-669, 669

climate response, 395

clouds, 576-578, 577, 580-582, 582, 585-586, 620-622

common properties of forcing compounds, 668

comparison of previous reports, 696

concentration/emission changes, 668-669

concept, 53, 661, 664-668

confidence levels, 694-695, 694-695

definitions, 664-665, 665

distinguished from feedbacks, 573

drivers of, 124

effective (ERF)*, 53, 574, 576-578, 578, 614-621, 619-621, 661, 770, 1052-1053, 1160-1161, 1404-1409, 1433-1436

effective (ERF)*, defined, 664-665, 665

effective (ERF)*, probability density function*, 697

effective (ERF)*, total anthropogenic, 661

emission metrics, 710-720, 711, 731-738

external*, 388-398, 917-919

geographic distribution, 702-709, 703-705

global mean, 89, 693-701, 696-697

Global Warming Potential and Temperature change

Potential, 663, 710-714

industrial-era, 661-662, 697-698, 697-698, 705-708, 705

land surface changes, 686-688, 1404-1409

limitations of, 667-668

models, 146, 700-701, 701, 818

natural forcings, 13-14, 14, 55-56, 126, 662, 688-693, 760, 1008

orbital forcing, 385, 386, 387, 388, 399, 400

paleoclimate*, 130, 385, 388-398

polar amplification, 396-398

pre-industrial, 388-398

projections, 79-81, 662-663, 700-701, 701, 955, 1005-1010, 1006-1007, 1044-1054, 1048-1050, 1053

radiative transfer codes, 675-676

scenarios, 79-81, 1046-1047, 1046

solar forcing, 388-391, 885-886, 1007, 1404-1409
solar irradiance, 14, 14, 126-127, 126, 662, 688-691, 885-886

spatial and temporal patterns, 662, 702-709, 703-705, 709

summary, 13-14, 56-57, 57, 126, 129, 661-663, 693-701, 1052-1054, 1159-1161

surface albedo and energy budget, 360-361, 662, 686-687, 687

time evolution of, 698-700, 698

timescales and, 128-129, 128

uncertainties*, 667, 694-698, 694, 955, 1004-1008, 1005-1006

volcanic, 390, 391, 662, 691-693, 692-693, 923, 1007, 1404-1409

well-mixed greenhouse gases, 164, 661, 668, 676-679, 677-678

See also specific gases and components

Radiosonde records, 194-196, 195, 200-201, 206-207

Rapid adjustments*, 355-357, 573, 576, 590, 605, 661, 664-665, 665, 1005

See also Abrupt climate change

Rebound effect*, 546

Region(s)*, 1222

atlas (map), 1317

carbon cycle feedbacks, 522

radiative forcing*, 705-708, 705

Regional climate change, 73-74, 105-108, 106, 1217-1308

annular and dipolar modes, 108, 1220, 1243-1246, 1288-1289

Atlantic Multi-decadal Oscillation (AMO), 1220

Atlantic Ocean modes, 1239-1240
 blocking, 1220, 1224, 1246-1248
 changes and projections, 1322-1393
 climate indices, 209-213, 211-212
 climate system, 930
 CO_2 budgets, 501
 CO_2 fluxes, 499, 500
 confidence in projections, 1286-1287
 cyclones, 1220, 1248-1251, 1288-1289
 El Niño-Southern Oscillation (ENSO)*, 106-107, 1240-1243, 1241-1243, 1288-1289
 extreme events, 211-212
 global means and, 1256-1257
 in Holocene (paleoclimate), 417-425
 large-scale storm systems, 1248-1253, 1250
 models, 748, 810-817, 816, 1013-1014, 1219
 modes of climate variability*, 1222-1223, 1223-1225
 monsoon systems*, 105, 1219, 1222, 1225-1235, 1288-1289
 Pacific South American pattern, 1221, 1253
 precipitation, 1032, 1078-1079
 projections, 956, 1001-1002, 1001-1003, 1014-1015, 1031, 1032, 1078-1079, 1255-1277, 1256, 1278-1289
 projections, summary, 1288-1289
 sea level, 100-101, 101, 288-289, 1140, 1191-1199, 1194-1197, 1195-1199
 temperature, 89-90, 869, 888-891, 889, 919, 930, 938-939, 1278-1285
 tropical cyclones, 1248-1251, 1288-1289
 tropical phenomena, 105-106, 1219-1220, 1222, 1235-1240, 1288-1289
 See also specific regions

Regional Climate Models (RCMs)*, 748, 810-817, 816, 1013-1014, 1145, 1222
Representative Concentration Pathways (RCPs)*, 19-20, 22, 25, 79-81, 147-150, 468, 523-526, 524-529, 1045-1047, 1100
 compared with SRES, 149-150, 997
 described, 29
 extensions, 1102, 1103
 projections and, 955-956, 1031, 1034, 1045-1047, 1100
 uncertainties*, 1004-1005, 1005-1006, 1038-1039, 1038
Respiration*, 470, 471-472, 477-478, 545
River and lake ice, 320, 361-362, 367
River discharge. See Streamflow
Runoff*, 91-92, 204-205, 956, 1081, 1081

S

Salinity (of oceans), 257, 265-273, 269-270, 280, 301, 904-905, 904
 attribution of changes, 870, 904-905
 before fossil fuel era, 481
 defined, 265
 measurement, 312
 models, 778-779, 778, 783
 projections, 994, 994
 sea ice and, 271-273

sea surface, 267-268, 268, 270, 1094, 1094
 trends in, 257, 273
 upper ocean, regional changes, 271-273, 301
 upper ocean, subsurface, 268-271
Satellite-based methods, 164, 175, 182, 191, 207, 208
 altimetry*, 286, 287, 348-349
 GRACE, 349, 351-353, 380, 1156, 1157
 Microwave Sounding Unit (MSU), 194-196, 195
 sea level measurement, 1150
Scenarios*. See Climate scenarios; Emissions scenarios
Scientific method, 123
Sea ice*, 69, 136-137, 323-335, 333-334, 367, 481
 aerosol absorption on, 617-618
 Antarctic, 9, 18, 69, 319, 330-335, 333-334, 368, 906-909, 908, 1092
 Arctic, 9, 10, 18, 24-25, 69, 271-273, 319, 323-330, 333-334, 367, 368, 906-908, 908, 1087-1092, 1089-1091
 attribution of changes, 870, 906-909, 908, 931, 936-937
 as climate change indicator, 136-137
 cloud interactions, 590
 drift, 328-329, 332
 extent and concentration, 324-326, 325-326, 330, 331-332
 irreversible changes, 1115, 1117-1118
 land-fast ice, 329, 334-335
 models, 18, 20, 744, 751, 787-790, 787-789
 observations, 40
 observed changes, 136-137, 319, 367, 368, 386
 paleoclimate*, 420-421
 projections, 20, 21-22, 24-25, 956, 995-996
 projections, long-term, 92, 92, 1032, 1087-1092, 1088-1091
 rate of decrease, 319, 386
 salinity effects on, 271-273
 sea level equivalent, 321
 summary, 9, 319, 367
 thickness and volume, 319, 327-328, 328, 330-332
 trends, 329-330, 331, 333-334, 335
Sea level, 11, 127, 1137-1216
 anomalies, 286, 287
 geocentric, 1142, 1143
 irreversible aspects of, 29
 mean*, 1142, 1151, 1156-1159
 measurement, 285-286, 312, 1142, 1146-1150
 models, 779-781, 781, 1139-1140, 1192-1193
 processes affecting, 1143-1144, 1143-1144
 projections, 20, 23, 26
 relative (RSL)*, 1142, 1143, 1194-1197, 1195-1199
 storm-surge models, 1200-1202
 trends in, 286-288, 287, 289, 291
Sea level change*, 12, 47-49, 98-101, 258, 285-289, 1137-1216
 atmospheric pressure change and, 1193, 1193
 attribution of changes, 19, 110, 870, 905, 1156, 1176-1179
 budget, 1156-1159, 1157-1158
 commitment, 28, 1140
 confidence in projections, 1184-1186
 contributions to, 11, 25-26, 288, 291, 1139, 1142-1145, 1150-1179, 1177-1179, 1182
 extremes, 7, 101, 110, 112, 258, 290-291, 290, 1140, 1200-1204
 freshwater forcing and, 1193-1194
 glaciers and, 367, 1139, 1151-1153, 1151, 1163-1165, 1164-1165, 1182, 1184
 global average, 10, 11, 1148-1149
 global mean sea level rise, 90, 1140, 1152, 1156-1159, 1157-1158, 1179-1191
 ice sheets* and, 367, 1139, 1140, 1151, 1153-1155, 1154-1155, 1159, 1165-1176, 1177-1179, 1182
 instrumental record (1700-2012), 1146-1161
 land water storage and, 1151, 1155-1156, 1176-1179, 1182
 long-term scenarios, 98-101, 1186-1191, 1188, 1190-1191
 measurements, 1146-1150
 models, 1139-1140, 1142, 1144-1145, 1179-1183, 1180-1184, 1192-1193, 1192-1193
 models, compared with observations, 1152, 1158
 nonuniformity of, 26
 observed changes, 4, 10, 11, 46, 110, 124, 136, 137, 157-158, 258, 291, 301, 1151, 1198
 ocean heat content/uptake*, 905, 1161-1163, 1162, 1183-1184
 ocean mass observations, 1156, 1157
 ocean waves, 1202-1204, 1203
 paleoclimate*, 46, 47, 385, 425-432, 427-429, 1139, 1145-1150, 1147
 past sea level change, 1139, 1145-1150, 1147
 process-based projections, 99-100, 1179-1180, 1180-1182
 processes and linkages, 1143-1144, 1143-1144
 projected extremes, 1200-1204, 1201, 1203
 projections, 7, 20, 23, 25-26, 26, 97-101, 125, 137, 157, 1140, 1150-1191, 1445
 projections with loss of Greenland ice sheet, 1140, 1169-1170
 rate of, 258, 289-290, 291, 430-431
 regional changes, 288-289, 1191-1199
 regional projections, 100-101, 101, 1140, 1194-1197, 1195-1199
 satellite altimeter record (1993-2012), 1150
 semi-empirical projections, 99-100, 1182-1184, 1184
 summary, 1139-1141, 1204-1205, 1204
 thermal expansion* and, 99, 99, 1139, 1143, 1150-1151, 1151, 1159, 1161-1163, 1180, 1182
 timescales, 1142
 uncertainties*, 47-49, 1197-1198, 1204-1205
Sea level equivalent (SLE)*, 319, 320, 321, 344, 349-350, 350, 352-354, 353, 1153
Sea level pressure (SLP), 223-224, 223-224, 871, 901
 projections, 1071-1072, 1071
Sea salt, 1048-1050
Sea spray aerosols, 599-601
Sea surface temperature (SST)*, 164, 190-194, 190-193, 480-481
 models, 777-779, 778-780
 observations, 5, 6

- paleoclimate*, 416, 420, 422, 458
 projections, 994-995, 1093
 proxy methods, 458
 tropical phenomena and, 1235, 1236
 variability, 107
- Sectors**
 emission metrics and impacts, 719-720, 720
 radiative forcing and temperature, 663
- Snow, ice and frozen ground**, 320, 358-360, 367
 aerosol absorption on, 574, 617-618, 685
 attribution of changes, 870, 906-910, 931, 936-937
 frozen ground, 320, 362-366, 367
 glaciers*, 9, 24, 319, 335-344
 ice sheets and shelves*, 9, 320, 344-357, 367
 models, 790, 790
 observed changes, 4, 320
 projections, 24-25, 92, 92-93, 996, 1032-1033, 1092-1093, 1092
 river and lake ice, 320, 361-362, 367
 seasonal snow, 320, 358-361, 358-360
 snow albedo, 321, 358, 359
 snow cover (Northern Hemisphere), 9, 10, 24, 25, 92, 93, 320, 358, 358-359, 367, 870, 910, 931, 937, 996, 1092-1093, 1092
 snow-cryosphere interactions, 360-361
 snowfall, 204, 358-361
- Soil moisture***, 790-791, 897
 projections, 91-92, 956, 988, 1079-1080, 1080
- Solar activity***, 393
- Solar forcing**, 388-391, 885-886, 1007, 1048-1050
- Solar irradiance**, 14, 14, 19, 126-127, 126, 392-393, 688-691, 885-886
 global dimming*, 161, 183-184, 794
 measurement, 689-690, 689
 paleoclimate*, 388-391
 projections, 86, 690, 955-956
 radiative forcing*, 662, 688-691, 1404-1409
 surface solar radiation (SSR), 183-184, 184, 185-186
 total (TSI)*, 19, 388-391, 394-395, 662, 689-690, 689
 variations, 689-690, 689
- Solar radiation***, 126-127, 126, 662
 projections, 543, 662
See also Orbital forcing
- Solar Radiation Management (SRM)***, 29, 469, 574-575, 627-635, 633-634
 cirrus thinning, 628
 climate response and, 629-635, 629-631
 cloud brightening, 628
 impacts on carbon cycle, 551-552
 side effects and risks, 575, 627-628, 634
 stratospheric aerosols, 627-628, 693
 summary, 635
 surface albedo, 628
- Solubility pump***, 472
- South America**
 climate indices, changes in, 211-212
 monsoon, 1233-1234, 1233
 precipitation extremes, 211-212, 213
 projections, 106, 1261-1264, 1262-1263, 1280-1281, 1288, 1338-1349
- South American Convergence Zone**, 1221
- South Atlantic Convergence Zone (SACZ)**, 1237
- South-east Asia**, 106, 211-212, 1273, 1274, 1378-1381
- South Pacific Convergence Zone (SPCZ)***, 1219, 1236-1237
- Southern Annular Mode (SAM)***, 231, 233-235, 354, 871, 900-901, 900, 937, 1245-1246
 impacts, 1224
 models, 415-416, 801, 806
 paleoclimate*, 386, 415-416
 projections, 108, 1220, 1245, 1246
 summary, 806
- Southern Ocean**, 273, 783, 1141
 polar amplification, 396-398
 projections, 24, 1095
 temperature, 354, 387, 780
- SRES scenarios***, 131-132, 146-147, 149-150, 955, 997, 1034, 1045, 1100
- Stabilization**. *See* Climate stabilization
- Storm surge***, 1200-1202
- Storm tracks***, 229, 743, 773, 956
 projections, 1074, 1075, 1220
- Stratosphere***, 130
 aerosols*, 627-628, 693
 Brewer-Dobson circulation*, 163, 230, 1073-1074, 1248
 ozone, 161, 171-172, 172, 672-674, 681-682, 681, 774-775, 1000, 1048-1050, 1078, 1428
 stratospheric-tropospheric relations, 753
 temperature, 162, 197, 892-893, 893
 water vapour, 161, 170-171, 171, 661-662, 681-682
- Streamflow***, 204-205
- Sulphate aerosols**, 81, 605-606, 616
- Sulphur cycle**, 537, 539
- Sulphur dioxide (SO₂)**, 127, 538, 684, 794, 1402
 geoengineering with, 627
 models, 744, 794, 795
- Sulphur hexafluoride (SF₆)**, 161, 168, 169, 733
 projections, 1412, 1423
 radiative forcing*, 678, 679, 1434
- Surface**
 climate projections*, 980-993
 land surface changes, 684-688
 models, 131-132, 132, 750-751
 observations, 5, 6-7, 130, 159-254
 wind speed, 224-226
See also Atmosphere; Hydrological cycle
- Surface air temperature**, 760-761, 761, 974-975, 980-984, 981-982
- Surface fluxes**, 784-786, 784-785, 897
- Surface solar radiation (SSR)**, 183-184, 184, 185-186
- Surface temperature***, 5, 6-7, 60-66, 60, 187-194, 461-462, 577, 760-761, 761-762, 878-881, 879-881
 interannual variability, 6, 207-208
 projections, 980-984, 981-982

T

- Teleconnections***, 233, 1224, 1243, 1243
 models, 805, 806
- Temperature**, 5, 187-201, 926
 anomalies, 197, 461-462, 768, 1059
 atmosphere and surface, 4-5, 6, 60-68, 161-162, 187-201, 869-870, 984
 attribution of changes, 17-19, 60, 869-870, 871, 878-893, 918-920, 930, 932-934
 cold days/cold nights*, 86, 162, 210-212, 221, 956, 990, 1065-1066, 1067
 commitment, 20
 diurnal temperature range (DTR)*, 188
 evidence for warming, 198-199
 extremes, 19, 109-112, 209-212, 209-212, 218-219, 807, 808, 871, 910-912, 931, 1064-1068
 free atmosphere, 196-201, 197-201, 984
 geoengineering and, 29, 574-575
 global changes and projections, 1318-1319
 global diurnal temperature range (DTR), 162
 global instrumental record, 881-885, 882
 global mean surface air surface temperature, 131-132, 132, 955-956, 1409
 global mean surface air temperature, 23
 global mean surface temperature (GMST)*, 20, 21, 23, 90, 121, 161-162, 164, 192-194, 192-194, 385, 878-880, 879, 1011
 global mean surface temperature, models, 743, 769-772
 global mean surface temperature, variability, 887-888, 888-889
 global temperature change potential, 17, 663, 712-714, 714-715, 720
 global warming potential*, 17, 663, 710-714, 711-712
 heat waves*, 110, 162, 211-212, 212, 915, 916, 939
 interannual variability, 5, 6, 207-208
 land-surface air temperature (LSAT)*, 162, 164, 187-189, 187
 last 2,000 years, 409-415, 409-410
 marine air temperature (MAT), 191
 mitigation*, 27-28
 models, 15-16, 20, 743-745, 760-761, 761-762, 767-771, 768, 769-772, 777-779, 778-780, 807, 810, 811-813, 1013-1014
 observed changes, 4, 6-7, 22, 121, 124, 131-132, 132, 187-201, 878-881, 879-881
 observed variability, 393, 744, 869
 oceans, 5, 6, 8, 10, 68-69, 257, 260-265, 266-267, 274-275, 280, 311, 311-312, 901-903, 902
 paleoclimate*, 385-386, 395, 398-399, 409-420, 418-419, 461-464
 radiative forcing overview, 62
 sea surface temperature (SST)*, 6, 107, 164, 190-194, 190-193, 777-779, 778-780, 806, 994-995, 1093
 summary, 5, 6-7, 161-162
 surface*, 5, 6-7, 60-66, 60, 161-162, 187-194, 461-462, 577, 743, 878-881, 879-881
 surface air temperature, 760-761, 761, 974-975, 980-984, 981-982

- trends, 194, 194, 197-201, 222, 880, 895
 upper air, 162, 194-201, 197, 772-773, 774
 upper ocean, 257, 258, 261-262, 261, 263, 265, 301, 301
 warm days/warm nights*, 86, 162, 210-212, 221-222, 956, 990, 1065-1066, 1067
 warming hiatus, 61-63, 769-772, 798, 909
 warming hole in N. America, 212
- Temperature projections**, 7, 20, 21-23, 125, 155, 929, 1278-1287, 1444-1445
 extremes, 991-992, 991, 1031-1032, 1064-1068, 1067-1068
 free atmospheric temperature, 984
 global mean surface temperature, 972, 980-984, 981, 1010-1012, 1012-1013, 1444-1445
 global projections, 1318-1319
 long-term, 89-90, 1031-1032, 1054-1057, 1054-1056, 1062-1068, 1063, 1065, 1067-1068
 near-term, 85-86, 87, 955-956, 980-984, 993-995, 993-994, 1009-1012, 1011-1012
 ocean temperature, 956, 993-995, 993-994
 regional projections, 1014, 1031
 skill in, 974, 977-978, 977
 summary, 955-956, 1009-1012, 1011-1012
 surface air temperature, 974-975, 980-984, 981-982
 timescale, 28
 uncertainties*, 140-141, 1006, 1006
 zonal average, 1064, 1065
 See also Regional climate change
- Thematic Focus Elements (TFEs)**
 Carbon cycle perturbations and uncertainties, 96-97
 Climate extremes, 109-113
 Climate sensitivity and feedbacks, 82-85
 Climate targets and stabilization, 102-105
 Comparing projections from previous IPCC assessments with observations, 64-65
 Irreversibility and abrupt change, 70-72
 Sea level change: scientific understanding and uncertainties*, 47-49
 The changing energy budget of the global climate system, 67-68
 Water cycle change, 42-45
- Thermal expansion***, 1139, 1143, 1150-1151, 1159
 projections, 99, 99, 1161-1163, 1180, 1182
- Thermal radiation**, 184-185
- Tide gauge* records**, 285-286, 1146-1150, 1201
- Timescales**, 28, 125, 128-129, 128, 1033, 1105-1107
- Tipping points***. See Irreversibility
- Top of the atmosphere (TOA) radiation**, 180-181, 580-582, 618, 620, 765, 1069, 1069
- Transient climate response (TCR)**, 128, 817-818, 821, 871, 920-921, 925
 projections, 81, 84-85, 1033
 summary, 16-17, 1110-1112
- Transient climate response to cumulative CO₂ emissions (TCRE)***, 16-17, 871, 926-927
 projections, 102-104, 1033, 1108-1109, 1113
- Trend models**, 179-180
- Tropical Atlantic Ocean Variability**, 233-235
- Tropical cyclones**, 7, 107-108, 108, 110, 162, 216-217, 216, 807, 871, 913-914, 938, 956, 992-993, 993, 1220, 1248-1251, 1288-1289
- Tropical Indian Ocean Variability**, 233-235
- Tropics**, 1217, 1219-1220, 1235-1240
 atmospheric circulation, 226-230, 989-990, 989, 1073
 convergence zones, 421-422, 1219, 1221, 1222, 1235-1237, 1236-1237
 extratropical modes, 415-416
 paleoclimate*, 415, 420
 precipitation, 1219
 projections, 1235-1240, 1288-1289
 tropical modes, 415
 tropical Pacific mean state, 1240, 1241
 tropical phenomena, 105-106, 1219-1220, 1222, 1235-1240, 1288-1289
 tropical storms, 216-217
 warmer-get-wetter pattern, 1219, 1240
- Tropopause***, 226, 228
- Troposphere***, 130
 humidity, 206-208
 ozone, 161, 172-173, 670-672, 672-673, 679-681, 680-681, 684, 775, 998-999, 1048-1050, 1428-1429
 stratospheric-tropospheric relations, 753
 temperature, 5, 162, 195, 197, 772-773, 774, 891-892
 water vapour, 207, 207
- Tropospheric Biennial Oscillation (TBO)**, 805, 1224, 1253-1254
- U**
- Uncertainty***, 36, 114-115, 121, 139-142, 140-141
 carbon cycle*, 96-97
 climate models*, 139-142, 140-141, 809-810, 815, 1035-1040, 1038, 1197-1198
 climate projections, 115, 955, 978-980, 979, 1004-1012, 1035-1040, 1038, 1057-1058, 1058, 1197-1198
 in observations, 36, 114, 165, 810
 quantification, 1040-1044
 scenario uncertainty, 1038-1039, 1038
 sea level change*, 47-49
 temperature projections, 140-141
 See also Variability
- Urban albedo**, 687
- Urban heat islands***, 162, 188-189
- V**
- Variability**, 121, 129-130, 138, 163, 164, 232-235
 internal*, 61-62, 138, 769-770, 869, 919, 923
 models, 795-806
 natural, 121, 129-132, 138, 140
 paleoclimate*, 386
 See also Climate variability
- Vegetation**
 models, 752, 791
 projections, 1097-1099, 1098
- Volatile organic compounds (VOCs)***, 127, 718, 740
- Volcanic aerosols**, 14, 662, 691-693
- Volcanic eruptions**, 15, 86, 140, 393-394, 691-693
 as analogues, 693
 climate prediction and, 1008-1009
 models, 391
 projections, 693, 1007
 volcanic forcing, 390, 391, 662, 691-693, 692-693, 923, 1007, 1048-1050, 1404-1409
- W**
- Walker Circulation***, 163, 226-229, 227
 projections, 90, 991, 1032, 1073
- Warm days/warm nights***, 162, 210-212, 221-222
 projections, 86, 956, 990, 1065-1066, 1067
- Warmer-get-wetter pattern**, 1219, 1240
- Water cycle**. See Hydrological cycle
- Water vapour**, 207, 624, 666-667, 896
 feedbacks, 586-587, 587, 667, 819
 projections, 1076, 1076
 radiative forcing*, 126, 661-662, 666-667
 stratospheric, 161, 170-171, 171, 661-662, 681-682
 tropospheric, 207, 207, 265
 water vapour-lapse rate, 586-587, 587, 819
 See also Humidity
- Wave height**, 258, 277-278, 1141
 projections, 101, 1202-1204, 1203
- Weather**, 229-230
 climate and, 123-126, 914-917
- Wetlands**, 539-541
- Winds**
 mid-latitude westerlies, 956
 models, 784-785, 784-785
 projections, 1072, 1072
 upper-air, 226
 wave height and, 258, 277-278, 1141
 wind speeds, 217, 220, 224-226, 225
 wind stress (oceanic), 276-278, 784-785, 784-785

