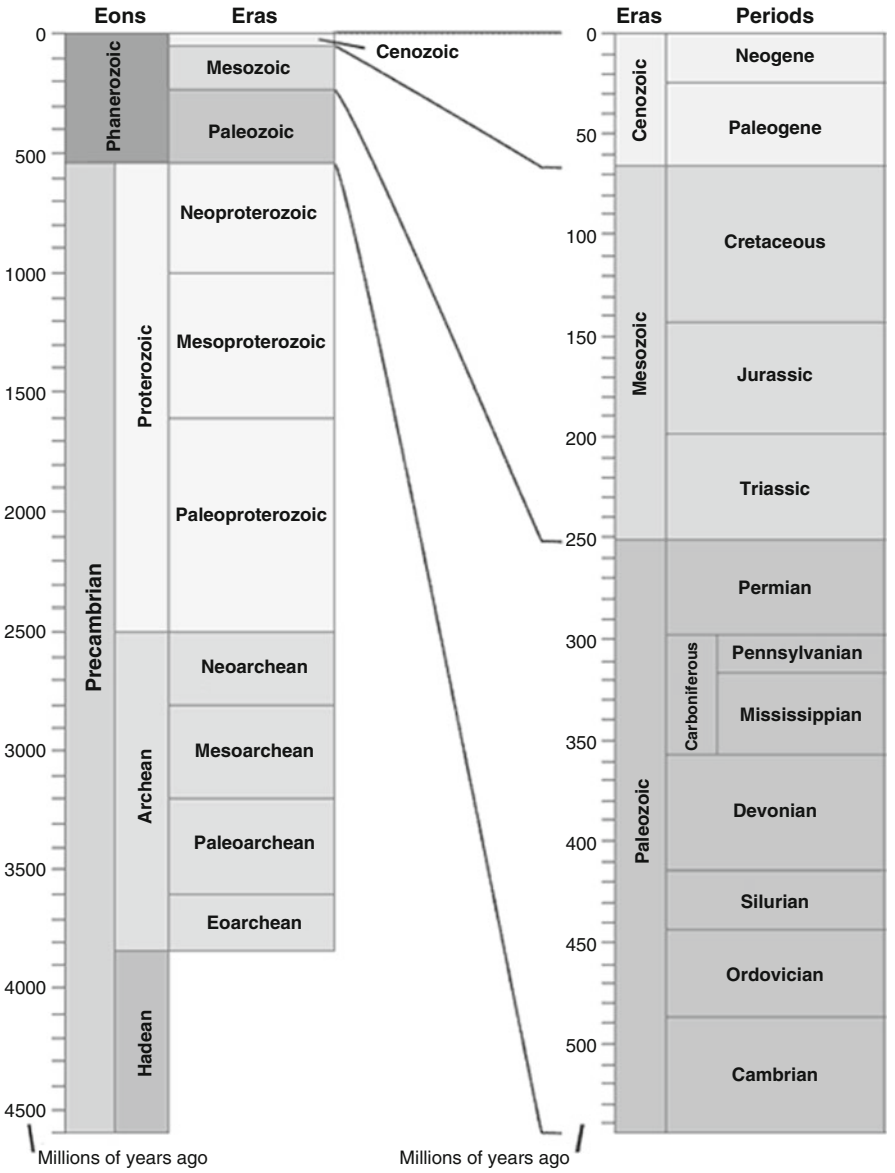
Appendices

Appendix I: Geological Time Scale

G.T. Farmer and J. Cook, *Climate Change Science: A Modern Synthesis: Volume 1 - The Physical Climate*, DOI 10.1007/978-94-007-5757-8,



Geological Time Scale

Appendix II: Metric Weights and Measures

Tables of Metric Weights and Measures

Linear Measure

10 millimeters (mm) =	1 centimeter (cm)	
10 centimeters =	1 decimeter (dm)	= 100 millimeters
10 decimeters =	1 meter (m)	= 1,000 millimeters
10 meters =	1 dekameter (dam)	
10 dekameters =	1 hectometer (hm)	= 100 meters
10 hectometers =	1 kilometer (km)	= 1,000 meters

Area Measure

100 square millimeters =	1 sq centimeter
10,000 square centimeters =	1 sq meter
=	1,000,000 sq millimeters
100 square meters =	1 are (a)
100 ares =	1 hectare (ha)
=	10,000 sq meters
100 hectares =	1 sq kilometer
=	1,000,000 sq meters

Volume Measure

10 milliliters (ml) =	1 centiliter (cl)	
10 centiliters =	1 deciliter (dl)	= 100 milliliters
10 deciliters =	1 liter (l)	= 1,000 milliliters
10 liters =	1 dekaliter (dal)	
10 dekaliters =	1 hectoliter (hl)	= 100 liters
10 hectoliters =	1 kiloliter (kl)	= 1,000 liters

Cubic Measure

1,000 cubic millimeters =	1 cubic centimeter
1,000 cubic centimeters =	1 cubic decimeter
=	1,000,000 cubic millimeters
1,000 cubic decimeters =	1 cubic meter
=	1 stere
=	1,000,000 cubic centimeters
=	1,000,000,000 cubic millimeters

Weight

10 milligrams (mg) =	1 centigram (cg)	
10 centigrams =	1 decigram (dg)	= 100 milligrams
10 grams =	1 dekagram (dag)	
10 dekagrams =	1 hectogram (hg)	= 100 grams
10 hectograms =	1 kilogram (kg)	= 1,000 grams
1,000 kilograms =	1 metric ton (t)	

Multiply	By	To Calculate
Centimeters	0.0328	Feet
Centimeters	0.3937	Inches
Feet	30.4801	Centimeters
Feet/minute	0.507	Centimeters/second
Gallons	3,785.4	Cubic Centimeters
Gallons	3.7853	Liters
Grams	0.0353	Ounces
Grams	0.0022	Pounds
Inches	2.54	Centimeters
Inches	0.0833	Feet
Kilograms	2.2046	Pounds
Kilometers	3,280.833	Feet
Kilometers	0.6214	Miles
Kilometers/hour	54.68	Feet/minute
Kilometers/hour	0.6214	Miles/hour
Knots	1.8532	Kilometers/hour
Liters	1.0567	Quarts
Meters	3.2808	Feet
Meters	39.37	Inches
Meters	1.0936	Yards
Meter-kilograms	7.2307	Foot-pounds
Meters/minute	1.667	Centimeters/second
Meters/minute	0.0547	Feet/second
Miles	1.6093	Kilometers
Miles/hour	0.8684	Knots
Miles/hour	1.6093	Kilometers/hour
Miles/hour	0.447	Meters/second
Ounces	28.3495	Grams
Ounces	2.8349×10^2	Kilograms
Pounds	453.5924	Grams
Pounds	0.4536	Kilograms
Quarts	0.946	Liters
Quarts (dry)	67.2	Cubic inches
Quarts (liquid)	57.75	Cubic inches
Square centimeters	0.0011	Square feet
Square kilometers	0.3861	Square miles
Square kilometers	1.196×10^6	Square yards
Square meters	10.7639	Square feet
Square meters	1.196	Square yards
Square miles	2.59	Square kilometers
Square yards	0.8361	Square meters
Yards	91.44	Centimeters
Yards	0.9144	meters

Appendix III: Measures and Statistics of the Earth

Measures and Statistics of the Earth

- Surface Gravity: 9.78 m/s^2
- Diameter: 12,753 km (7,926 miles)
- Equatorial Radius: 6,378 km
- Mean radius: 6,371 km (3,981 miles)
- Rotation Period with respect to Sun (Length of Day): 24 h
- Average distance from Sun: 149.6 million km (93 million miles)
- Closest to Sun (perihelion): 147.1 million km (91.5 million miles) about Jan. 3
- Farthest from Sun (aphelion): 152.1 million km (94.5 million) miles about July 4
- Mass: $5.98x10^{e24}$ kg (6.5^{e21} tons)
  Of the Earth's mass:
  About 1/3 is in the core, 2/3 in the mantle, 4/1,000 in the crust, 2/10,000 in the oceans, 1/1,000,000 in the atmosphere, and 1/100,000 in ice caps
- Rotation Period with respect to stars (Sidereal Day): 23 h 56 min
- Density: 5,515 kg/m^3
- Revolution Period about the Sun (Length of a Year): 365 days 5 h
- Minimum Distance from Sun: 146 million km (91 million miles)
- Tilt of Axis: 23° 27"
- Maximum Distance from Sun: 152 million km (94.5 million miles)
- Temperature: −89 to 57.7°C (−128 to 136°F)
- Orbital Semimajor Axis: 1.0 AU
- Average Surface Temperature (K): 287 K = 14°C

Abbreviations

$\delta^{13}C$	Ratios of environmental isotopes, such as $^{18}O/^{16}O$ and $D/^{1}H$ from waters are displayed using delta notation $\delta^{18}O$ and δD, respectively. A temperature dependent isotope of carbon
$\delta^{18}O$	A temperature dependent isotope of oxygen using delta notation
δD	Changes in deuterium using delta notation
*.edu	An educational website or at least one from an educational institution.
*.gov	A government website.
μm	one millionth of a meter
A	
A1	An IPCC scenario that describes a future world of very rapid economic growth, global population that peaks in mid-Century and declines thereafter, and the rapid introduction of new and more efficient technologies.
A1B	An IPCC scenario that describes a future world where there is a balance across all sources.
A1F1	An IPCC scenario that describes a future world where it is fossil fuel-intensive.
A1T	An IPCC scenario that describes a future world that is not fossil fuel-intensive.
A2	The A2 scenario describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other scenarios.
AABW	Antarctic Bottom Water
ACC	Anthropogenic Climate Change
ACEX	Arctic Coring Expedition
ACRIM I	Active Cavity Radiometer Irradiance Monitor I

G.T. Farmer and J. Cook, *Climate Change Science: A Modern Synthesis: Volume 1 - The Physical Climate*, DOI 10.1007/978-94-007-5757-8,

ACRIM-Sat	Active Cavity Radiometer Irradiance Monitor I Satellite
AD	Anno Domini, Latin for "Year of our Lord"
AER	Aerosols only
Af	Tropical rainforests in the Köppen-Geiger climate classification
AGAGE	Advanced Global Atmosphere Gas Experiment
AGU	American Geophysical Union
ALE	Atmospheric Lifetime Experiment
ALL	Anthropogenic and Natural Forcings
AMO	Atlantic Meridional Oscillation
AMOC	Atlantic Meridional Overturning Circulation
AMS	American Meteorological Society
AO	Arctic Oscillation
AOGCMs	Atmospheric-Ocean General Circulation Models
API	American Petroleum Institute
AR3	IPCC Third Assessment Report
AR4	IPCC Fourth Assessment Report
AR5	IPCC Fifth Assessment Report
ARGO	Ocean temperature measurement device
ARM	Atmospheric Radiation Measurement
Aw	A tropical savanna grassland in the Köppen-Geiger climate classification.
AZ	Arizona

B

B1	An IPCC scenario that describes a convergent world with the same global population that peaks in mid-Century and declines thereafter, as in the A1 scenario, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.
B2	An IPCC scenario that describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 scenarios. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.
BC	Before Christ
BEST	Berkeley Earth Surface Temperature project
BP	British Petroleum
BW	A warm desert climate in the Köppen-Geiger climate classification.
BWh	A hot desert climate in the Köppen-Geiger climate classification.

C

CA	California
CanESM2	A Canadian Climate Model
CC	CC Attribution-Share Alike 3.0 Unported License
CCDG	NASA/GSFC Coupled Climate Dynamics Group
CCN	Cloud Condensation Nuclei
CCSM	NCAR Community Climate System Model
CDAT	Climate Data Analysis Tools
CDC	Center for Disease Control
CDML	XML representation (CDML) for datasets
CE	Current or Common Era
CIA	Central Intelligence Agency
CRU	Climate Research Unit of the University of East Anglia
CRUTEM's	Climate Research Unit of the University of East Anglia's Temperature Analysis
CSM	NCAR Climate Systems Model
Cwa	The humid subtropical climate zone (Cfa, Cwa) is where winter rainfall (and sometimes snowfall) is associated with large storms that the westerlies steer from west to east.

D

DC	District of Columbia
Dfa	A humid continental climate in the Köppen-Geiger climate classification
DI	Dryness Index
DKRZ	German Climate Science Computing Center
DNA	Deoxyribonucleic Acid
DOD	Department of Defense
DOE	Department of Energy
DSOW	Denmark Strait Overflow Water

E

e.g.	For Example
EBMs	Energy Balance Models
ECMWF	European Centre for Medium-Range Weather Forecasts
EIA	Energy Information Administration
$E=MC^2$	Energy equals mass times the speed of light squared.
EMR	Electromagnetic Radiation
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
EPICA	European Project for Ice Coring in Antarctica
EPRI	Electric Power Research Institute
ERBE	A space platform. Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
ERSST	NOAA Extended Reconstructed Sea Surface Temperature

ESRI	Earth Sciences and Resources Institute
ESRL	Earth System Research Laboratory
ET	Evapotranspiration
et al.	And others
EUROCS	EUROpean Cloud Systems

F

FAR	IPCC First Assessment Report

G

Ga	Giga Annum, a billion years
GAGE	Global Atmospheric Gas Experiment
GCM	General Circulation Model
GCMs	General Circulation Models
GCOS	Global Climate Observing System
GCSM	Global Climate Systems Model
GCSS	Global Cloud System Study
GEWEX	Global Energy and Water cycle Experiment
GFDL	Geophysics Fluid Dynamics Laboratory
GHCN	Global Historical Climatology Network
GHCN-M	Global Historical Climatology Network Monthly
GHG	Greenhouse Gas
GHGs	Greenhouse Gases
GHRSST	U.S. Group for High Resolution Sea Surface Temperatures
GISP2	Greenland Ice Sheet Project 2. GISP2 produced an ice core 3,053.44 m in depth, the deepest ice core recovered in the world at the time (July 1993).
GISS	Goddard Institute of Space Studies.
GISTEMP	GISS Temperature Analysis
GLOFs	Glacial Lake Outbreak Floods
GMD	Global Monitoring Division of NOAA
GMSL	Global Marine Sea Level
GNU	"GNU" is a recursive acronym that stands for "GNU's Not Unix."
GODAE	Global Ocean Data Assimilation Experiment
GOE	Great Oxygenation Event
Gpc	A gigaparsec (Gpc) is equal to a billion parsecs.
GPP	Gross Primary Production
GPS	Global Positioning System
GRACE	NASA's Gravity and Recovery Climate Experiment satellite system
GRL	Geophysical Review Letters
GSFC	Goddard Space Flight Center
Gt CO_2	Gigatons of Carbon Dioxide
GtC	Gigatons of Carbon
GTP	Global Temperature Potential
GWP	Global Warming Potential

H

HadCRU	Hadley Centre Climate Research Unit
HCFCs	hydrochlorofluorocarbons
HI	Humidity Index
HTM	Holocene Thermal Maximum
http	The Hypertext Transfer Protocol (HTTP) is an application protocol for distributed, collaborative, hypermedia information systems.

I

i.e.	*id est*., that is
ICESat	NASA's Ice, Cloud and Elevation satellite
ICOADS	International Comprehensive Ocean-atmosphere Data Set
IEA	International Energy Agency
IETM	Initial Eocene Thermal Maximum
IGY	International Geophysical Year
IMO	International Meteorological Organization
IPCC	Intergovernmental Panel on Climate Change
IPO	Interdecadal Pacific Oscillation
IR	Infrared longwave radiation
IRBM	Intermediate Range Ballistic Missile
ITCZ	Intertropical Convergence Zone

J

JMA	Japanese Meteorology Agency
JPL	Jet Propulsion Laboratory

K

ka	A thousand years ago
KFC	Kentucky Fried Chicken

L

LAS	An integrated Climate Data Analysis Tool
LGM	Last Glacial Maximum
LHC	Large Hadron Collider
LIA	Little Ice Age
LIDAR	Light Detection and Ranging
LNG	Liquid Natural Gas

M

M.I.T.	Mass. Institute of Technology
m/s	Meters per second
Ma	A million years ago
MBH	Mann, Bradley, and Hughes
MECCA	Model Evaluation Consortium for Climate Assessment
MECCA.html	Model Evaluation Consortium for Climate Assessment html website
MHTM	Mid-Holocene Thermal Maximum

MI	Moisture Index
MIS	Marine Isotope Stage
MISR	The Multi-angle Imaging SpectroRadiometer (MISR) is a scientific instrument on the Terra satellite launched by NASA on December 18, 1999.
MJO	Madden-Julian Oscillation
MODIS	Moderate Resolution Imaging Spectroradiometer (MODIS) on
NASA	's Aqua satellite
MOHC	The U. K. Meteorological Office Hadley Centre-
MSFC	NASA's Marshall's Space Flight Center
MSU	Microwave Sounding Unit
MWP	Medieval Warm Period
MYD28M	http://earthobservatory.nasa.gov/GlobalMaps/view.php?d1=MYD28M

N

NADW	North Atlantic Deep Water
NAM	Northern Annular Mode
NAMO	North Atlantic Multidecadal Oscillation
NAO	North Atlantic Oscillation
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NAT	Near-surface air temperature
NCAR	National Center for Atmospheric Research
NCDC	National Climate Data Center
NDBC	National Data Buoy Center
NO	Nitric oxide
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen oxides
NP	Northern Pacific
NPOESS	In October 2011 a satellite, NPOESS Preparatory Project (NPP) delivered a scanning radiometer called VIIRS into orbit that measures aerosol content in the atmosphere.
NPP	In October 2011 a satellite, NPOESS Preparatory Project (NPP) delivered a scanning radiometer called VIIRS into orbit that measures aerosol content in the atmosphere.
NRC	National Research Council
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
NY	New York

O

°C	Degrees Centigrade or Celsius
ODSs	Ozone depleting substances
°F	Degrees Fahrenheit
OH	Ohio

OPeNDAP	Open Data Package
ORBIMAGE	GeoEye Inc. (NASDAQ: GEOY) (formerly Orbital Imaging Corporation or ORBIMAGE) is a commercial satellite imagery company based in Herndon, Virginia that is the world's largest space imaging corporation.
OSHA	Occupational Safety and Health Administration
OSTM	The Ocean Surface Topography Mission (OSTM) on the Jason-2 satellite is an international Earth observation satellite mission that continues the sea surface height measurements begun in 1992 by the joint NASA/CNES TOPEX/Poseidon mission and followed by the NASA/CNES Jason-1 mission launched in 2001.

P

PA	Pennsylvania
PBL	Planet boundary layer
PCMDI	Program for Climate Model Diagnosis and Intercomparison
PDO	Pacific Decadal Oscillation
PE	Potential evapotranspiration
PETM	Paleocene-Eocene Thermal Maximum
Ph.D.	Doctor of Philosophy
PIOMAS	The University of Washington's Pan-Arctic Ice Ocean Modeling and Assimilation System (**PIOMAS**) model. Arctic sea ice volume anomaly from PIOMAS updated once a month. Daily Sea Ice volume anomalies for each day are computed relative to the 1979–2010 average for that day of the year.
PMOD	Physikalisch-Meteorologisches Observatorium Davos
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per thousand
pptv	Parts per thousand volume

Q

QA	Quality assessment
QC	Quality control
QDO	Quasi-Decadal Oscillation

R

RCMs	Radiative-Convective Models
RF	Radiative forcing
RSS	Remote Sensing Systems

S

SAG	Screen Actors Guild
SAR	Second assessment report (IPCC)
SAT	Satellite and Terrestrial RF Spectrum Monitoring, Interference and Geolocation
SDMs	Statistical Dynamical Models

SeaWifs	A now defunct satellite (SeaWifs) provided three decades and longer satellite data on aerosols which is the longest single-satellite record of aerosols to date (July 2011).
SIO	Scripps Institution of Oceanography
SMM	The Solar Maximum Mission (SMM) was launched on 14 February 1980 to, primarily, study the Sun during the high part of the solar cycle. The payload included the Active Cavity Radiometer Irradiance Monitor (ACRIM), the Gamma-Ray Spectrometer (GRS), the Hard X-Ray Burst Spectrometer (HXRBS), the soft X-Ray Polychromator (XRP), the Hard X-ray Imaging Spectrometer (HXIS), and the Ultraviolet Spectrometer and Polarimeter (UVSP).
SMOW	Standard Marine Ocean Water
SOHO	NASA's Solar and Helispheric Observatory
SOI	Southern Oscillation Index
SPECMAP	Detailed charting of glacial cycles over the last million years, according to isotopic oxygen analyses of foraminifera (SPECMAP project).
SRES	Special Report on Emissions Scenarios
SSC	Spatial Synoptic Classification System (SSC) is based on the Bergeron classification scheme.
SSEC	University of Wisconsin-Madison Space Science and Engineering Center (SSEC) (USA)
SSTs	Sea surface temperatures
SSU	Seasonal anomalies of global average temperature (°C), 1958–2000, relative to 1979–1990 for the lower stratosphere, as observed from satellites (MSU 4 and SSU 15X) and balloons (UKMO 4). The times of the major explosive eruptions of the Agung, El Chichón and Mt. Pinatubo volcanoes are marked and the lower stratosphere warms. Image adapted from IPCC TAR 2001. (From http://www.atmosphere.mpg.de/enid/20c.html)

T

T	Temperature
T/ET	Temperature/Evapotranspiration
TAR	IPCC Third Assessment Report
TOA	Top of the atmosphere
TOPEX	Launched in 1992, **TOPEX/Poseidon** was a joint satellite mission between NASA, the U.S. space agency, and CNES, the French space agency, to map ocean surface topography. The first major oceanographic research vessel to sail into space, TOPEX/Poseidon helped revolutionize oceanography by proving the value of satellite ocean observations. The distinguished oceanographer Walter Munk described TOPEX/Poseidon as "the most successful ocean experiment of all times." A malfunction ended normal satellite operations January 2006.
TSI	Total Solar Irradiance (or Total Solar Index)

U

U.K.	United Kingdom
U.S.	United States
UAH	University of Alabama Huntsville
UARS	Upper Atmosphere Research Satellite
UC	University of California
UCAR	University Corporation for Atmospheric Research
UEA	University of East Anglia
UKMO	United Kingdom Met Office
UM	University of Michigan
UNFCCC	United Nations Framework Convention on Climate Change
URL	Uniform Resource Locator it is the global address of documents and other resources on the World Wide Web.
USA	United States of America
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet shortwave radiation

V

VA	Virginia
VCDAT	Graphical user interface for climate data analysis called CDAT (Climate Data Analysis Tools)
VCS	Visualization system for CDAT.
VIIRS	In October 2011 a new satellite, NPOESS Preparatory Project (NPP) delivered a scanning radiometer called VIIRS into orbit that measures aerosol content in the atmosphere.
VIRGO	Radiometers measuring the Total Solar Irradiance (TSI) on different space platforms since November 1978: HF on Nimbus7, ACRIM I on SMM, ERBE on ERBS, ACRIM II on UARS, VIRGO on SOHO, and ACRIM III on ACRIM-Sat.
VOCs	Volatile organic carbons or Volatile organic compounds

W

W	Watt
W/m^2	Watts per square Meter
W·s	Watts per second
WGI	The World Glacier Inventory (WGI) contains information for over 130,000 glaciers. Inventory parameters include geographic location, area, length, orientation, elevation, and classification. The WGI is based primarily on aerial photographs and maps with most glaciers having one data entry only. Hence, the data set can be viewed as a snapshot of the glacier distribution in the second half of the 20th century. It is based on the original WGI (WGMS 1989) from the World Glacier Monitoring Service (WGMS).
WMO	World Meteorological Organization

WWI	World War I
WWII	World War II
WWR	World Weather Records
www.	The World Wide Web (abbreviated as WWW or W3, commonly known as the Web, or the "Information Superhighway"), is a system of interlinked hypertext documents accessed via the Internet.

X

XML	Extensible Markup Language

Z

ZAMS	Zero-age main sequence

Glossary

.edu Web site from an educational institution.
.gob A government web site.
μm One millionth of a meter
4.5 billion years ago Age of Earth
540 million years ago Beginning of the Paleozoic Era
65.5 million years ago Beginning of the Cenozoic Era
2.5 million years ago Beginning of the Pleistocene Epoch
8.2 ka event Following the last post-glacial warming, a rapid climate oscillation with a cooling lasting about 400 years that occurred about 8.2 ka. This event is also referred to as the 8.2 k year event.

A

A1 A growth scenario that describes a future world of very rapid economic growth, global population that peaks in mid-century and declines afterward, with the rapid introduction of new and more efficient technologies. The A1 scenario includes a balance of growth and technology.
A1B A growth scenario where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies.
A1FI A growth scenario that is fossil fuel-intensive with new non-fossil energy sources.
A1T A growth scenario that is a balance across all sources where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies.
A2 The A2 scenario describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other scenarios.
Ablation Surface removal of ice or snow from a glacier or snowfield by melting, sublimation, and/or calving.

G.T. Farmer and J. Cook, *Climate Change Science: A Modern Synthesis: Volume 1 - The Physical Climate*, DOI 10.1007/978-94-007-5757-8,

Abrupt climate change Sometimes called rapid climate change, abrupt events or even surprises. Abrupt often refers to time scales faster than the typical time scale of the responsible forcing. However, not all abrupt climate changes need be externally forced. Some possible abrupt events that have been proposed include a dramatic reorganization of the thermohaline circulation, rapid deglaciation and massive melting of permafrost or increases in soil respiration leading to fast changes in the carbon cycle. Others may be truly unexpected, resulting from a strong, rapidly changing forcing of a nonlinear system (IPCC).

Ablation Zone Region in a glacier where there is a surface net removal of snow and/or ice by melting, sublimation, and/or calving.

Absolute Zero Temperature of −273.15°C. At this temperature atomic motion stops.

Absorption (1) Process of taking in and being made part of an existing amount of matter. (2) Interception of electromagnetic radiation or sound.

Absorption (Atmospheric) Atmospheric absorption is defined as a process in which solar radiation is retained by a substance and converted into heat energy. The creation of heat energy also causes the substance to emit its own radiation. In general, the absorption of solar radiation by substances in the Earth's atmosphere results in temperatures that no higher than 1,800°C. According to Wien's Law, bodies with temperatures at this level or lower would emit their radiation in the longwave band (IPCC).

Abyss Deep water in the ocean.

Abyssal Plain Ocean floor in deep water.

Accumulation Surface addition of snow to a glacier or snowfield.

Accumulation Zone (1) Region in a glacier where there is a surface net addition of snow. (2) Part of a hillslope that has a net gain of material leading to a progressive raising of the slope's surface.

Acid (1) Substance having a pH less than 7. (2) Substance that releases hydrogen ions (H+). (3) Sialic rocks.

Acid Deposition Atmospheric deposition of acids in solid or liquid form on the Earth's surface. Also see acid precipitation

Acidic Any substance with a pH below 7 Sialic rocks.

Acid Precipitation Atmospheric precipitation with a pH less than 5.6. Normal pH of precipitation is 5.6.

Acid Rain Rain with a pH less than 5.6. Normal pH of precipitation is 5.6.

Active Layer Upper zone of soil in higher latitude locations that experiences daily and seasonal freeze-thaw cycles.

Adiabatic A process in which heat does not enter or leave a system. In the atmospheric sciences, adiabatic processes are often used to model internal energy changes in rising and descending parcels of air in the atmosphere. When a parcel of air rises it expands because of a reduction in pressure. If no other non-adiabatic processes occur (like condensation, evaporation and radiation), expansion causes the parcel of air to cool at a set rate of 0.98°C per 100 m. The opposite occurs when a parcel of air descends in the atmosphere. The air in a descending parcel becomes compressed. Compression causes the temperature within the parcel to increase at a rate of 0.98°C per 100 m. An adiabatic process is a process in which

no external heat is gained or lost by the system. The opposite is called a diabatic process (IPCC).

Adiabatic Cooling The cooling of a rising parcel of air due to adiabatic processes.

Advection Advection involves the transfer of heat energy by means of horizontal mass motions through a medium. Advection transport of water or air along with its properties (e.g., temperature, chemical tracers) by the motion of the fluid. Regarding the general distinction between advection and convection, the former describes the predominantly horizontal, large-scale motions of the atmosphere or ocean, while convection describes the predominantly vertical, locally induced motions (IPCC).

Aeolian Geomorphic process involving wind. Alternative spelling *eolian*.

Aeolian Landform A landform originating from the erosion or deposition of weathered surface materials by wind. This includes landforms with some of the following geomorphic features: sand dunes, deflation hollows, and desert pavement.

Aerobic (1) Presence of molecular oxygen. (2) Occurring only in the presence of molecular oxygen. (3) Growing in the presence of molecular oxygen.

Aerosols A collection of airborne solid or liquid particles, with a typical size between 0.01 and 10 μm that reside in the atmosphere for at least several hours. Aerosols may be of either natural or anthropogenic origin. Aerosols may influence climate in several ways: directly through scattering and absorbing radiation, and indirectly by acting as cloud condensation nuclei or modifying the optical properties and lifetime of clouds (see indirect aerosol effect) (IPCC).

Agronomy Field of science that studies phenomena related to agriculture.

Air Mass A widespread body of air, the approximately homogeneous properties of which (1) have been established while that air was situated over a particular region of the Earth's surface, and (2) undergo specific modifications while in transit away from the source region (AMS 2000). A body of air whose temperature and humidity characteristics remain relatively constant over a horizontal distance of hundreds to thousands of kilometers. Air masses develop their climatic characteristics by remaining stationary over a source region for a number of days. Air masses are classified according to their temperature and humidity characteristics (IPCC).

Air Pollution Toxification of the atmosphere through the addition of one or more harmful substances in the air. Substance must be in concentrations high enough to be hazardous to humans, other animals, vegetation, or materials. Also see primary pollutant and secondary pollutant.

Air Pressure See atmospheric pressure.

Albedo Is the reflectivity of a surface. The fraction of solar radiation reflected by a surface or object, often expressed as a percentage. Snow-covered surfaces have a high albedo, the surface albedo of soils ranges from high to low, and vegetation-covered surfaces and oceans have a low albedo. The Earth's planetary albedo varies mainly through varying cloudiness, snow, ice, leaf area and land cover changes (IPCC).

Albedo feedback A climate feedback involving changes in the Earth's albedo. It usually refers to changes in the cryosphere, which has an albedo much larger

(~0.8) than the average planetary albedo (~0.3). In a warming climate, it is anticipated that the cryosphere would shrink, the Earth's overall albedo would decrease and more solar radiation would be absorbed to warm the Earth still further (IPCC).

Aleutian Low Subpolar low pressure system found near the Aleutian Islands most developed during the winter season. This large-scale pressure system gives rise to mid-latitude cyclones.

Algae A simple photosynthetic plant that usually lives in moist or aquatic environments. The bodies of algae can be unicellular or multicellular.

Alkaline (1) Having a pH greater than 7. (2) Substance that releases hydroxyl ions (OH-).

Alpha Particle Particle of matter that is positively charged. This particle consists of two neutrons and two protons and is emitted as a form of radioactivity from the nuclei of some radioisotopes. Also see beta particle and gamma rays.

Alpine Glacier Small glacier that occupies a U-shaped valley on a mountain. Also called mountain glacier and valley glacier. Glaciers that flow together at the foot of mountains are called piedmont glaciers.

Alpine Permafrost Form of permafrost that exists at high altitudes in mountainous environments.

Alpine Tundra High altitude biome dominated by a few species of small shrubs, a few grasses, sedges, lichens, and mosses. Productivity is low because of the extremes of climate. Similar to tundra.

Altimetry A technique for measuring the height of the sea, lake or river, land or ice surface with respect to the center of the Earth within a defined terrestrial reference frame. More conventionally, the height is with respect to a standard reference ellipsoid approximating the Earth's oblateness, and can be measured from space by using radar or laser with centimetric precision at present. Altimetry has the advantages of being a geocentric measurement, rather than a measurement relative to the Earth's crust as for a tide gauge, and of affording quasi-global coverage (IPCC).

Altitude Vertical distance above sea-level. Usually expressed in feet, inches, millimeters, or centimeters.

Altocumulus Clouds Middle altitude cloud that is from white to gray in color, composed of a mixture of water droplets and ice crystals. It appears in the atmosphere as layers or patches that are well rounded and commonly wavelike. Found in an altitude range from 2,000 to 8,000 m.

Altostratus Clouds Gray-looking middle altitude cloud composed of water droplets and ice crystals. Appears in the atmosphere as dense sheet- like layers. Can be distinguished from stratus clouds by the fact that the Sun can be seen through it. Found in an altitude range from 2,000 to 8,000 m.

Anaerobic (1) Absence of molecular oxygen. (2) Occurring only in the absence of molecular oxygen. (3) Growing in the absence of molecular oxygen.

Anemometer Mechanical instrument used to measure wind speed. These instruments commonly employee three methods to measure this phenomenon: (1) A device with three or four open cups attached to a rotating spinal. The speed of

rotation is then converted into a measurement of wind speed; (2) A pressure plate that measures the force exerted by the moving wind at right angles; (3) An instrument consisting of a heated-wire where electrical resistance (temperature of the wire) is adjusted to account for heat lost by air flow (IPCC).

Angle of Incidence Angle at which the Sun's rays or insolation strike the Earth's surface. If the Sun is positioned directly overhead or 90° from the horizon, the incoming insolation strikes the surface of the Earth at right angles and is most intense (IPCC).

Antarctic High A region of high pressure that occupies central Antarctic throughout the year. This pressure system is responsible for very cold temperatures and extremely low humidity.

Anthropogenic Resulting from or produced by human beings.

Aphelion The point in the Earth's orbit when it is farthest from the Sun (152.5 million kilometers). Aphelion occurs on the 3rd or 4th of July.

Archean Geologic Eon that occurred from 2,500 to 3,800 million years ago. During this time period, the first single-celled prokaryote organisms evolved and developed.

Archipelago A group of islands that have an arc shaped distribution. These islands are usually of volcanic origin and are associated with subduction zones.

Atlantic Multi-decadal Oscillation (AMO) A multi-decadal (65–75 year) fluctuation in the North Atlantic, in which sea surface temperatures showed warm phases during roughly 1860–1880 and 1930–1960 and cool phases during 1905–1925 and 1970–1990 with a range of order 0.4°C (IPCC).

Atmosphere The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium and radiatively active greenhouse gases such as carbon dioxide (0.035% volume mixing ratio) and ozone. In addition, the atmosphere contains the greenhouse gas water vapor, whose amounts are highly variable but typically around 1% volume mixing ratio. The atmosphere also contains clouds and aerosols (IPCC).

Atmospheric boundary layer The atmospheric layer adjacent to the Earth's surface that is affected by friction against that boundary surface, and possibly by transport of heat and other variables across that surface (AMS 2000). The lowest 10 m or so of the boundary layer, where mechanical generation of turbulence is dominant, is called the surface boundary layer or surface layer (IPCC).

Atmospheric lifetime See Lifetime.

Attribution See Detection and attribution.

B

Barometer An Instrument that measures atmospheric pressure.

Base (1) Substance having a pH greater than 7. (2) Substance that releases hydroxide ions (OH-).

Basic Substance having a pH greater than 7 Simatic rocks.

Bay A body of sheltered water found in a crescent shaped coastal configuration of land.

Beach The terrestrial interface area in between land and a water body where there are accumulations of unconsolidated sediments like sand and gravel.

Bedrock Rock at or near the Earth's surface that is solid and relatively unweathered

Benthos The plants and animals that live on the sea floor. Often divided into two categories: deep-sea benthos, below 200 m and the littoral benthos, from 200 m to the high-water spring tide level.

Bermuda High High pressure system that develops over the western subtropical North Atlantic. Also called the Azores High.

Beta Particle Electron emitted from the nucleus of a radioactive isotope. Also see alpha particle and gamma rays.

Biome Largest recognizable assemblage of animals and plants on Earth. The distribution of the biomes is controlled mainly by climate.

Biosphere Part of the Earth where life is found. The biosphere consists of all living things, plant and animal. This sphere is characterized by life in profusion, diversity, and clever complexity. Also called the ecosphere.

Biotic (1) Referring to life. (2) Influences caused by living organisms.

Black Body (or blackbody) An object that emits electromagnetic radiation, at any temperature, at the maximum possible rate per unit surface area. A black body also absorbs all electromagnetic radiation that is intercepted by it.

Black carbon (BC) Operationally defined aerosol material based on measurement of light absorption and chemical reactivity and/or thermal stability; consists of soot, charcoal and/or possible light-absorbing refractory organic matter (IPCC) (Charlson and Heintzenberg, 1995, p. 401).

Boreal Forest High to mid-latitude biome dominated by coniferous forest. Predominant vegetation of this biome is various species of spruce, fir, pine, and cedars. Also called Taiga.

Brackish Environment that is influenced by sea water with a salinity less than 35 parts per thousand (usually caused by the presence of an inflow of fresh water).

Breccia Coarse-grained sedimentary rock composed of cemented angular rock fragments.

C

^{13}C Stable isotope of carbon having an atomic weight of approximately 13. Measurements of the ratio of $^{13}C/^{12}C$ in carbon dioxide molecules are used to infer the importance of different carbon cycle and climate processes and the size of the terrestrial carbon reservoir (IPCC).

^{14}C Unstable isotope of carbon having an atomic weight of approximately 14, and a half-life of about 5,700 years. It is often used for dating purposes going back some 40 ka. Its variation in time is affected by the magnetic fields of the Sun and Earth, which influence its production from cosmic rays (see Cosmogenic isotopes) (IPCC).

Calcite A mineral consisting of calcium carbonate ($CaCO_3$)**.** The major constituent of limestone.

Calcium Carbonate A compound consisting of calcium, carbon and oxygen. Calcium carbonate has the following chemical formula, $CaCO_3$ and is he major constituent of limestone.

Calving Literally, to give birth to a calf. Used as a term to refer to the breaking up of glacial ice sometimes giving rise to icebergs.

Cambrian Geologic Period that occurred from 540 to 488.3 million years ago. During this period, invertebrates (animals without backbones) become common in the oceans and the Burgess Shale was formed. The Cambrian is known as the "Age of Trilobites."

Cambrian Explosion Great diversification of multicellular life forms in the Earth's oceans that started during the Period about 540 million years ago.

Carbonate A compound consisting of a single atom of carbon and three atoms of oxygen. Carbonate has the following chemical formula (CO_3^{2-}).

Carbonation (1) A form of chemical weathering where carbonate and bicarbonate ions react with minerals that contain calcium, magnesium, potassium, and sodium. (2) The dissolving of carbon dioxide in water.

Carbon Cycle Storage and cyclic movement of organic and inorganic forms of carbon between the biosphere, lithosphere, hydrosphere, and atmosphere.

Carbon Dioxide Gas found naturally occurring in the atmosphere. Has the ability to selectively absorb radiation in the longwave band. This absorption by carbon dioxide and other chemicals in the atmosphere causes the greenhouse effect. The concentration of this gas has been steadily increasing in the atmosphere over the last three centuries mainly due to the burning of fossil fuels, deforestation, and land-use changes. Most scientists and a majority of the general public believe higher concentrations of carbon dioxide and other greenhouse gases will result in an enhancement of the greenhouse effect and increase global warming. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. I t is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1. The chemical formula for carbon dioxide is CO_2.

Carbon Monoxide A colorless, odorless, and tasteless gas that is produced by the incomplete burning of fossil fuels. The chemical formula for carbon monoxide is CO.

Cascading System A system where energy and/or matter flows from one form to another including the processes that cause this movement.

Catastrophism General theory of Earth history that suggests that certain phenomena on the Earth are the result of catastrophic events. For example, that the "Biblical Flood" is responsible for sedimentary rock formations and the extinction of the dinosaurs.

Celsius temperature scale One of the three scales commonly used in climate science for measuring temperature. In this scale, water boils at 100° and freezes at 0°. The Celsius scale is the same as the centigrade scale. The term Celsius if used by scientists while centigrade is used by non-scientists.

Cenozoic Geologic Era that occurred from 65.5 million years ago to today.

Centripetal Force Force required to keep an object moving in a circular pattern around a center of rotation. This force is directed towards the center of rotation. Common in meteorological phenomena like tornadoes and hurricanes.

Chalk A form of limestone. This is a sedimentary rock composed of the shells and skeletons of marine microorganisms.

Chaos theory Chaos theory deals with a dynamical system such as the climate system, governed by nonlinear deterministic equations (see Nonlinearity), may exhibit erratic or chaotic behaviour in the sense that very small changes in the initial state of the system in time lead to large and apparently unpredictable changes in its temporal evolution. Such chaotic behaviour may limit the predictability of nonlinear dynamical systems (IPCC).

Chemical Energy Energy consumed or produced in chemical reactions.

Chemical Reaction Reaction between chemicals where there is a change in the chemical composition of the elements or compounds involved.

Chemical Weathering Breakdown of rock and minerals into smaller-sized particles through chemical decomposition.

Chlorofluorocarbons (CFCs) Artificially created gases that have become concentrated in the Earth's atmosphere. These very strong greenhouse gases are released from aerosol sprays, refrigerants, and the production of foams. The basic chemical formula for chlorofluorocarbons is CFx Clx .

Chronology Arrangement of events according to dates or times of occurrence.

Circle of Illumination A line that bisects areas on the Earth receiving sunlight and those areas in darkness. The circle of illumination cuts the spherical Earth into lighted and dark halves. The line is not a sharp one as the light gradually turns into dark.

Circum-Pacific Belt (or "Ring of Fire") A zone circling the edge of the Pacific Ocean basin where tectonic subduction causes the formation of volcanic island arcs and trenches.

Cirrocumulus Clouds Patchy white high altitude clouds composed of ice crystals. Found in an altitude range from 5,000 to 18,000 m.

Cirrostratus Clouds High altitude sheet like clouds composed of ice crystals. These thin clouds often cover the entire sky. Found in an altitude range from 5,000 to 18,000 m.

Cirrus Clouds High altitude cloud composed of ice crystals. The appearance of these clouds is white feather like patches, filaments or thin bands. Found in an altitude range from 5,000 to 18,000 m.

Clathrate (methane) A partly frozen mix of methane gas and ice, usually found in sediments.

CLIMAP Project Multi-university research project that reconstructed the Earth's climate for the last million years by examining proxy data from ocean sediment cores.

Climate General pattern of weather conditions for an area or region over at least 30 years. Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or

millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization (WMO). The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. See also Climate variability; Detection and Attribution (IPCC).

Climate feedback An interaction mechanism between processes in the climate system is called a climate feedback when the result of an initial process triggers changes in a second process that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it (IPCC).

Climate Feedback Parameter A way to quantify the radiative response of the climate system to a global surface temperature change induced by a radiative forcing (units: $W\,m^{-2}\,°C^{-1}$). It varies as the inverse of the effective climate sensitivity. Formally, the Climate Feedback Parameter (Λ) is defined as: $\Lambda = (\Delta Q - \Delta F)/\Delta T$, where Q is the global mean radiative forcing, T is the global mean air surface temperature, F is the heat flux into the ocean and Δ represents a change with respect to an unperturbed climate.

Climatic Optimum Warmest period during the Holocene Epoch. The Holocene Climatic Optimum is dated from about 5,000–3,000 BC. During this time average global temperatures were 1–2°C warmer than they are today.

Climate model (spectrum or hierarchy) A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for all or some of its known properties. The climate system can be represented by models of varying complexity, that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical parameterizations are involved. Coupled Atmosphere-ocean General Circulation Models (AOGCMs) provide a representation of the climate system that is near the most comprehensive end of the spectrum currently available. There is an evolution towards more complex models with interactive chemistry and biology (see

Chap. 9). Climate models are applied as a research tool to study and simulate the climate, and for operational purposes, including monthly, seasonal and interannual climate predictions (IPCC).

Climate prediction A climate prediction or climate forecast is the result of an attempt to produce an estimate of the actual evolution of the climate in the future, for example, at seasonal, interannual or long-term time scales. Since the future evolution of the climate system may be highly sensitive to initial conditions, such predictions are usually probabilistic in nature. See also Climate projection; Climate scenario; Predictability (IPCC).

Climate projection A projection of the response of the climate system to emission or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/concentration/radiative forcing scenario used, which are based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty IPCC.

Climate scenario A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate. A climate change scenario is the difference between a climate scenario and the current climate (IPCC).

Climate sensitivity In the IPCC reports, equilibrium climate sensitivity refers to the equilibrium change in the annual mean global surface temperature following a doubling of the atmospheric equivalent carbon dioxide concentration. Due to computational constraints, the equilibrium climate sensitivity in a climate model is usually estimated by running an atmospheric general circulation model coupled to a mixed-layer ocean model, because equilibrium climate sensitivity is largely determined by atmospheric processes. Efficient models can be run to equilibrium with a dynamic ocean. The effective climate sensitivity is a related measure that circumvents the requirement of equilibrium. It is evaluated from model output for evolving non-equilibrium conditions. It is a measure of the strengths of the climate feedbacks at a particular time and may vary with forcing history and climate state. The climate sensitivity parameter (units: °C $(W\ m^{-2})^{-1}$) refers to the equilibrium change in the annual mean global surface temperature following a unit change in radiative forcing. The transient climate response is the change in the global surface temperature, averaged over a 20-year period, centered at the time of atmospheric carbon dioxide doubling, that is, at year 70 in a 1% $year^{-1}$ compound carbon dioxide increase experiment with a global coupled climate model. It is a measure of the strength and rapidity of the surface temperature response to greenhouse gas forcing (IPCC).

Climatology Scientific study of the Earth's climate over long time spans. May also involve an investigation of climate's influence on flora and fauna, and other aspects of climate's influence on the environment.

Climate shift or climate regime shift An abrupt shift or jump in mean values signaling a change in regime. Most widely used in conjunction with the 1976/1977 climate shift that seems to correspond to a change in El Niño-Southern Oscillation (ENSO) behavior (IPCC).

Climate system The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the land surface (geosphere) and the biosphere, and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forcings such as volcanic eruptions, solar variations and anthropogenic forcings such as the changing composition of the atmosphere and land use change (IPCC).

Climate variability Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also Climate change (IPCC).

Closed System A system that transfers energy, but not matter, across its boundary to the surrounding environment. The Earth has often been erroneously viewed as a closed system.

Cloud A collection of tiny particles of liquid or solid water occurring above the Earth's surface. Clouds are classified accord to their height of occurrence and shape. The major types of clouds include: Cirris, Cirrocumulus, Cirrostratus, Altocumulus, Altostratus, Nimbostratus, Stratocumulus, Stratus, Cumulus, and Cumulonimbus.

Cloud condensation nuclei (CCN) Airborne particles that serve as an initial site for the condensation of liquid water, which can lead to the formation of cloud droplets. See also Aerosols.

Cloud feedback A climate feedback involving changes in any of the properties of clouds as a response to other atmospheric changes. Understanding cloud feedbacks and determining their magnitude and sign require an understanding of how a change in climate may affect the spectrum of cloud types, the cloud fraction and height, and the radiative properties of clouds, and an estimate of the impact of these changes on the Earth's radiation budget. At present, cloud feedbacks remain the largest source of uncertainty in climate sensitivity estimates. See also Cloud radiative forcing; Radiative forcing IPCC.

Cloud radiative forcing Cloud radiative forcing is the difference between the all-sky Earth's radiation budget and the clear-sky Earth's radiation budget (units: W m^2) (IPCC).

CO_2-equivalent See Equivalent carbon dioxide.

Coal A sedimentary (bituminous) or metamorphic rock (anthracite) composed of compacted lithified and in the case of anthracite, altered remains of plants. Coal is

a solid, combustible mixture of organic compounds, hydrocarbons, with 30–98% carbon by weight, mixed with various amounts of water and small amounts of sulphur and nitrogen compounds. It is formed in several stages as the remains of plants are subjected to heat and pressure over millions of years. It is an extremely dirty fuel and is one of the main causes in increasing concentrations of carbon dioxide in the atmosphere. "Clean coal" is an oxymoron.

Coastline The line that separates a land surface from an ocean or sea.

Cold Desert A desert found in the high latitudes and at high altitudes where precipitation is low. Surface air temperatures are generally cold in these dry environments. The continent of Antarctica is a cold desert.

Comet A large mass of ice and dust that has an orbit around a star.

Compound A compound consists of the atoms of different elements bonded together.

Condensation The change in state of matter from vapor to liquid that occurs with cooling. The term is used in meteorology when discussing the formation of liquid water from vapor. This process releases latent heat energy to the surroundings.

Condensation Nuclei Microscopic particle of dust, smoke or salt that allows for condensation of water vapor to water droplets in the atmosphere. Nucleus for the formation of a rain drop. Condensation normally occurs on these particles when relative humidity becomes 100%. Some condensation nuclei, like salt, are hygroscopic and water can condense on them at relative humidities lower than 100%.

Conduction Conduction consists of energy transfer directly from atom to atom and represents the flow of energy along a temperature gradient.

Coniferous Vegetation Cone-bearing vegetation of middle and high latitudes that are mostly evergreen and that have needle-shaped or scale like leaves. Compare with deciduous vegetation.

Confidence The level of confidence in the correctness of a result. See also Likelihood; Uncertainty (IPCC).

Convection Vertical motion driven by buoyancy forces arising from static instability, usually caused by near-surface cooling or increases in salinity in the case of the ocean and near-surface warming in the case of the atmosphere. At the location of convection, the horizontal scale is approximately the same as the vertical scale, as opposed to the large contrast between these scales in the general circulation. The net vertical mass transport is usually much smaller than the upward and downward exchange (IPCC).

Continental Arctic Air Mass An air mass that forms over extensive landmass areas of the high latitudes in the Northern Hemisphere. In the Northern Hemisphere, these systems form only in winter over Greenland, northern Canada, northern Siberia, and the Arctic Basin. Continental Arctic air masses are very cold and extremely dry. These air masses are also very stable.

Continental Crust The granitic portion of the Earth's crust that makes up the continents. Thickness of the continental crust varies between 20 and 75 km. See sial.

Continental Drift Theory that suggests that the Earth's continents have migrated to their current positions across the globe. First proposed by A. Snider in 1858 and developed by F.B. Taylor (1908) and Alfred Wegener (1915).

Continental Effect The effect that continental surfaces have on the climate of locations or regions. This effect results in a greater range in surface air temperature at both daily and annual scales. Also see maritime effect.

Continental Glacier Largest type of glacier with a surface coverage in the order of 5 million km^2.

Continental Ice Sheet See continental glacier.

Continental Margin The area between a continent's shoreline and the beginning of the ocean floor. It includes the continental shelf, continental rise, and continental slope.

Continental Plate A rigid, independent segment of the lithosphere composed of mainly granite that "floats" on the viscous plastic asthenosphere and moves over the surface of the Earth. T he Earth's continental plates are an average 125 km thick and were formed more than 3 billion years ago. Also see oceanic plate.

Continental Polar Air Mass (cP) An air mass that forms over extensive landmass areas of middle to high latitudes. In North America, these system form over northern Canada. Continental Polar air masses are cold and very dry in the winter and cool and dry in the summer. These air masses are also atmospherically stable in both seasons.

Continental Rise Thick layers of sediment found between the continental slope and the ocean floor or abyssal plain.

Continental Shelf Shallow submerged margin of the continents that lies between the edge of the shoreline and the continental slope. This nearly level area of the continental crust has surface layers composed of sediment or sedimentary rock.

Continental Slope Steeply sloping portion of continental crust found between the continental shelf and the continental rise.

Convection Convection involves the transfer of heat energy by means of vertical mass motions through a medium, in the case of meteorology or climate, through the atmosphere.

Convection Current The movement of a gas or a fluid in chaotic vertical mass motions because of heating.

Convectional Lifting The vertical lifting of parcels of air through convective heating of the atmosphere. This process can initiate adiabatic processes inside the air parcel.

Convectional Precipitation The formation of precipitation due to surface heating of the air at the ground surface. If enough heating occurs, the mass of air becomes warmer and lighter than the air in the surrounding environment, and just like a hot air balloon it begins to rise, expand and cool. When sufficient cooling has taken place saturation occurs forming precipitation. This process is active in the interior of continents and near the equator forming cumulus clouds and possible later thunderstorms. Rain is usually the precipitation type that is formed, and in most cases this moisture is delivered in large amounts over short periods of time in extremely localized areas.

Convergence Horizontal inflow of wind into an area. Once at the area, the wind then travels vertically.

Convergence Precipitation The formation of precipitation due to the convergence of two air masses. In most cases, the two air masses have different climatological characteristics. One is usually warm and moist, while the other is cold and dry.

The leading edge of the latter air mass acts as an inclined wall or front causing the moist warm air to be lifted. Of course the lifting causes the warm moist air mass to cool due to expansion resulting in saturation. This precipitation type is common at the mid-latitudes where cyclones form along the polar front. Also known as frontal precipitation.

Coral Simple marine animals that live symbiotically with algae. In the symbiotic relationship, algae provide the coral with nutrients, while the coral provides the algae with a support structure in which to live. Coral animals secrete calcium carbonate ($CaCO_3$) to produce a hard external skeleton (exoskeleton).

Coral Bleaching When coral lose their colorful symbiotic algae. Thought to be caused by unusually warm water, changes in salinity of ocean waters, excessive exposure to ultraviolet radiation, or ocean acidification.

Coral Reef A reef or ridge of limestone found generally below the ocean surface (except in the case of fossil coral reefs). This marine feature is produced by numerous colonies of tiny coral animals, called polyps that create calcium carbonate structures around themselves for protection. When the corals die, their vacant exterior skeletons form layers of limestone that new polyps use as a substrate upon which to grow. Coral reefs are found in the coastal zones of warm tropical and subtropical oceans where waters are clean and well aerated.

Coriolis Force An apparent force due to the Earth's rotation. Causes moving objects to be deflected to the right in the Northern Hemisphere and to the left in the Southern hemisphere. Coriolis force does not exist on the equator. This force is responsible for the direction of flow in meteorological phenomena like mid-latitude cyclones, hurricanes and anticyclones.

Craton Stable core of Earth's various plates of continental crust. Composed of the shield and platform.

Cretaceous The Cretaceous Period of geologic time that occurred roughly 65.5–145.5 million years ago. During this interval, the first flowering plant species appear and dinosaurs are at their greatest diversity. Dinosaurs die out at the end of the Cretaceous.

Crevasse (1) Opening on a levee that allows for the drainage of water from the floodplain to the stream channel. (2) Fracture on the brittle surface of a glacier.

Crust Earth's outer most layer of solid rock. Between 7 and 70 km thick. Two types of crust exist: oceanic crust and continental crust.

Cryosphere The component of the climate system consisting of all snow, ice and frozen ground (including permafrost) on and beneath the surface of the Earth and ocean. See also Glacier; Ice sheet (IPCC).

Cumulus Cloud Puffy clouds with relatively flat bases. Cumulus clouds form when moist warm air bubbles vertically escape from the Earth's surface. Found in an altitude range from 300 to 2,000 m.

Cumulonimbus Cloud A well developed vertical cloud that often has a top shaped like an anvil. These clouds are very dense with condensed and deposited water. Weather associated with this cloud includes: strong winds; hail; lightning; tornadoes; thunder; and heavy rain. When this weather occurs, these events are then thunderstorms. These clouds can extend in altitude from a few hundred meters above the surface to more than 12,000 m.

Cyclogenesis Process of cyclone formation, maturation, and death.

Cyclone Area of low pressure in the atmosphere that displays circular inward movement of air. In the Northern Hemisphere circulation is counterclockwise, while Southern Hemisphere cyclones have clockwise wind patterns.

D

Dansgaard-Oeschger events Abrupt warming events followed by gradual cooling. The abrupt warming and gradual cooling is primarily seen in Greenland ice cores and in paleoclimate records from the nearby North Atlantic, while a more general warming followed by a gradual cooling has been observed in other areas as well, at intervals of 1.5–7 kyear during glacial times.

December Solstice Date during the year when the declination of the Sun is at 23.5° South of the equator. During the December solstice, locations in the Northern Hemisphere experience their shortest day. The December solstice is also the first day of winter in the Northern Hemisphere. Locations in the Southern Hemisphere have their longest day on the June solstice. This date also marks the first day of summer in the Southern Hemisphere.

Deciduous Vegetation Type of vegetation that sheds its leaves during winter or dry seasons. Compare with coniferous vegetation.

Decomposition (1) To chemically or physically breakdown a mass of matter into smaller parts or chemical elements. (2) Breakdown of organic matter into smaller parts or inorganic constituents by decomposing organisms.

Deduction Inference in which the conclusion about particulars follows necessarily from general theory. In a science, deductive reasoning would involve stating a theory or hypothesis first and then trying to find facts that reject this idea.

Deforestation Removal of trees from a habitat dominated by forest. Conversion of forest to non-forest. For a discussion of the term forest and related terms such as afforestation, reforestation, and deforestation see the IPCC Special Report on Land Use, Land-Use Change and Forestry (IPCC, 2000). See also the report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003).

Density (of Matter) Refers to the quantity of mass per unit volume. For gases, density involves the number of atoms and molecules per unit volume.

Deoxyribonucleic Acid (DNA) Form of nucleic acid that is organized int o a double-helix molecule. DNA is used by most organisms to chemically code their genetics and to direct the development and functioning of cells. This direction requires RNA which represents a copy of a portion of DNA. Found in the nucleus of cells.

Deposition (1) The change in state of matter from gas to solid that occurs with cooling. Usually used in meteorology when discussing the formation of ice from water vapor. This process releases latent heat energy to the environment. (2) Laying down of sediment transported by wind, water, or ice.

Desert (1) Biome that has plants and animals adapted to survive severe drought conditions. In this habitat, evaporation exceeds precipitation and the average amount of precipitation is less than 25 cm a year. (2) Area that receives low precipitation.

Desertification Conversion of marginal rangeland or cropland to a more desert- like land type. Desertification can be caused by overgrazing, soil erosion, prolonged drought, or climate change. Land degradation in arid, semi-arid, and dry sub-humid areas may result from various factors, including climatic variations and human activities. The United Nations Convention to Combat Desertification defines land degradation as a reduction or loss in arid, semi-arid, and dry sub-humid areas, of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest, and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and (iii) long-term loss of natural vegetation (IPCC).

Detection and attribution Climate varies continually on all time scales. Detection of climate change is the process of demonstrating that climate has changed in some defined statistical sense, without providing a reason for that change. Attribution of causes of climate change is the process of establishing the most likely causes for the detected change with some defined level of confidence (IPCC).

Deuterium An isotope of hydrogen, with a nucleus containing one proton and one neutron, and an atomic number of 2.

Devonian Geologic Period that occurred roughly 360–408 million years ago. During this period, the first amphibians and trees appear.

Diatoms Silt-sized algae that live in surface waters of lakes, rivers and oceans and form shells of opal. Their species distribution in ocean cores is often related to past sea surface temperatures (IPCC).

Direct Solar Radiation Solar radiation received by the Earth's atmosphere or surface which has not been modified by atmospheric scattering.

Discontinuous Permafrost Form of permafrost that contains numerous scattered pockets of unfrozen ground.

Dispersal A group of organisms leaving their place or birth or activity for another location.

Dissolution The process of a substance dissolving and dispersing into a liquid.

Disturbance (1) Partial or complete alteration of a community or an ecosystem by a biotic or abiotic factor. (2) A cyclonic low pressure system.

Diurnal temperature range The difference between the maximum and minimum temperature during a 24-h period.

Dobson unit (DU) A unit to measure the total amount of ozone in a vertical column above the Earth's surface (total column ozone). The number of Dobson units is the thickness in units of 10^{-5} m that the ozone column would occupy if compressed into a layer of uniform density at a pressure of 1,013 hPa and a temperature of 0°C. One DU corresponds to a column of ozone containing $2.69 \times 1{,}020$ molecules per square meter. A typical value for the amount of ozone in a column of the Earth's atmosphere, although very variable, is 300 DU (IPCC).

Doldrums Area of low atmospheric pressure and calm westerly winds located at the equator. Similar to Intertropical Convergence zone.

Downdraft Downward movement of air in the atmosphere.

Drought In general terms, drought is a 'prolonged absence or marked deficiency of precipitation', a 'deficiency that results in water shortage for some activity or for some group', or a 'period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance' (Heim, 2002). Drought has been defined in a number of ways. Agricultural drought relates to moisture deficits in the topmost 1 m or so of soil (the root zone) that affect crops, meteorological drought is mainly a prolonged deficit of precipitation, and hydrologic drought is related to below-normal stream flow, lake and groundwater levels. A megadrought is a long-drawn out and pervasive drought, lasting much longer than normal, usually a decade or more.

Dry Adiabatic Lapse Rate (DALR) The rate of decline in the temperature of a rising parcel of air before it has reached saturation. This rate of temperature decline is 9.8° Celsius per 1,000 m because of adiabatic cooling.

Dry-Bulb Thermometer Thermometer on a psychrometer used to determine current air temperature. This measurement and the reading from a wet-bulb thermometer are then used for the determination of relative humidity or dew point from a psychrometric table.

Dune (1) Stream bed deposit found in streams whose channel is composed mainly of sand and silt. Dunes are about 10 or more centimeters in height and are spaced a meter or more apart and are common in streams with high velocities. (2) Terrestrial deposit of sand that resembles a mound or ridge that was formed from aeolian processes. Also see sand dune.

Dynamical system A process or set of processes whose evolution in time is governed by a set of deterministic physical laws. The climate system is a dynamical system. See Abrupt climate change; Chaos; Nonlinearity; Predictability.

E

Ecosystem A system of living organisms interacting with each other and their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus, the extent of an ecosystem may range from very small spatial scales to, ultimately, the entire Earth (IPCC).

El Niño-Southern Oscillation (ENSO) The term **El Niño** was initially used to describe a warm-water current that periodically flows along the coast of Ecuador and Perú, disrupting the local fishery. It has since become identified with a basin-wide warming of the tropical Pacific Ocean east of the dateline. This oceanic event is associated with a fluctuation of a global-scale tropical and subtropical surface pressure pattern called the Southern Oscillation. This coupled atmosphere-ocean phenomenon, with preferred time scales of 2 to about 7 years, is collectively known as the El Niño-Southern Oscillation (ENSO). It is often measured by the surface pressure anomaly difference between Darwin and Tahiti and the sea surface temperatures in the central and eastern equatorial Pacific. During an ENSO event, the prevailing trade winds weaken, reducing upwelling and altering ocean currents such that the sea surface temperatures warm, further weakening the trade

winds. This event has a great impact on the wind, sea surface temperature and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world, through global teleconnections. The cold phase of ENSO is called **La Niña** (IPCC).

Equivalent carbon dioxide (CO_2) emission The amount of carbon dioxide emission that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a well mixed greenhouse gas or a mixture of well mixed greenhouse gases. The equivalent carbon dioxide emission is obtained by multiplying the emission of a well mixed greenhouse gas by its Global Warming Potential (GWP) for the given time horizon. For a mix of greenhouse gases it is obtained by summing the equivalent carbon dioxide emissions of each gas. Equivalent carbon dioxide emission is a standard and useful metric for comparing emissions of different greenhouse gases but does not imply exact equivalence of the corresponding climate change responses (IPCC).

Evapotranspiration The combined process of evaporation from the Earth's surface and transpiration from vegetation.

External forcing External forcing refers to a forcing agent outside the climate system causing a change in the climate system. Volcanic eruptions, solar variations and anthropogenic changes in the composition of the atmosphere and land use change are external forcings.

Extreme weather event An extreme weather event is an event that is rare at a particular place and time of year. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. Single extreme events cannot be simply and directly attributed to anthropogenic climate change, as there is always a finite chance the event in question might have occurred naturally. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

F

Faculae Bright patches on the Sun. The area covered by faculae is greater during periods of high solar activity.

Feedback See Climate feedback.

Fingerprint The climate response pattern in space and/or time to a specific forcing is commonly referred to as a fingerprint. Fingerprints are used to detect the presence of this response in observations and are typically estimated using forced climate model simulations (IPCC).

Fossil fuel emissions Emissions of greenhouse gases (in particular carbon dioxide) resulting from the combustion of fuels from fossil carbon deposits such as oil, gas and coal.

Framework Convention on Climate Change See United Nations Framework Convention on Climate Change (UNFCCC).

G

General circulation The large-scale motions of the atmosphere and the ocean as a consequence of differential heating on a rotating Earth, which tend to restore the energy balance of the system through transport of heat and momentum.

General Circulation Model (GCM) See Climate model.

Geologic time time from the beginning of Earth through 4.5 billion years of its history.

Geostrophic winds or currents A wind or current that is in balance with the horizontal pressure gradient and the Coriolis force, and thus is outside of the influence of friction. Thus, the wind or current is directly parallel to isobars and its speed is inversely proportional to the spacing of the isobaric contours.

Glacial isostatic adjustment See Post-glacial rebound.

Glacier A mass of land ice that flows downhill under gravity (through internal deformation and/or sliding at the base) and is constrained by internal stress and friction at the base and sides. A glacier is maintained by accumulation of snow at high altitudes, balanced by melting at low altitudes or discharge into the sea (IPCC).

Global dimming Global dimming refers to perceived widespread reduction of solar radiation received at the surface of the Earth from about the year 1961 to around 1990 (IPCC).

Global warming A positive (upward) trend in Earth's average temperature throughout the world. Some areas may show a negative trend (cooling) but the average global temperature has been increasing since 1880 with slight cooling during the 1970s.

Ground temperature The temperature of the ground near the surface (often within the first 10 cm). It is often called soil temperature (IPCC).

Global surface temperature The global surface temperature is an estimate of the global mean surface air temperature. However, for changes over time, only anomalies, as departures from a climatology, are used, most commonly based on the area-weighted global average of the sea surface temperature anomaly and land surface air temperature anomaly (IPCC).

Global Warming Potential (GWP) An index, based upon radiative properties of well-mixed greenhouse gases, measuring the radiative forcing of a unit mass of a given well-mixed greenhouse gas in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame (IPCC).

Greenhouse Effect Greenhouse gases effectively absorb thermal infrared radiation, emitted by the Earth's surface, by the atmosphere itself due to the same gases, and by clouds. Atmospheric radiation is emitted to all sides, including downward to the Earth's surface. Thus, greenhouse gases trap heat within the surface-troposphere system. This is called the greenhouse effect. Thermal infrared radiation in the troposphere is strongly coupled to the temperature of the atmosphere at the altitude at which it is emitted. In the troposphere, the temperature generally decreases with height. Effectively, infrared radiation emitted to space originates from an altitude with a temperature of, on average, −19°C, in balance with the net incoming solar radiation, whereas the Earth's surface is kept at a much higher temperature of, on average, +14°C. An increase in the con-

centration of greenhouse gases leads to an increased infrared opacity of the atmosphere, and therefore to an effective radiation into space from a higher altitude at a lower temperature. This causes a radiative forcing that leads to an enhancement of the greenhouse effect, the so-called enhanced greenhouse effect (IPCC).

Greenhouse gas (GHG) Greenhouse gases (GHGs) are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) (IPCC).

Gyre Basin-scale ocean horizontal circulation pattern with slow flow circulating around the ocean basin, closed by a strong and narrow (100–200 km wide) boundary current on the western side. The subtropical gyres in each ocean are associated with high pressure in the centre of the gyres; the subpolar gyres are associated with low pressure (IPCC).

H

Hadley Circulation A direct, thermally driven overturning cell in the atmosphere consisting of poleward flow in the upper troposphere, subsiding air into the subtropical anticyclones, return flow as part of the trade winds near the surface, and with rising air near the equator in the so-called Inter-Tropical Convergence Zone (IPCC).

Halocarbons A collective term for the group of partially halogenated organic species, including the chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), halons, methyl chloride, methyl bromide, etc. Many of the halocarbons have large Global Warming Potentials. The chlorine- and bromine-containing halocarbons are also involved in the depletion of the ozone layer (IPCC).

HCFC See Halocarbons.

HFC See Halocarbons.

Holocene The Holocene geological Epoch is the latter of two Quaternary epochs, extending from about 11.6 ka to and including the present.

Hydrosphere The component of the climate system comprising liquid surface and subterranean water, such as oceans, seas, rivers, fresh water lakes, underground water, etc.

I

Ice age An ice age or glacial period is characterized by a long-term reduction in the temperature of the Earth's climate, resulting in growth of continental ice sheets and mountain glaciers (glaciation) (IPCC).

Ice cap A dome shaped ice mass, usually covering a highland area, which is considerably smaller in extent than an ice sheet (IPCC).

Ice core A cylinder of ice drilled out of a glacier or ice sheet.

Ice sheet A mass of land ice that is sufficiently deep to cover most of the underlying bedrock topography, so that its shape is mainly determined by its dynamics (the flow of the ice as it deforms internally and/or slides at its base). An ice sheet flows outward from a high central ice plateau with a small average surface slope. The margins usually slope more steeply, and most ice is discharged through fast-flowing ice streams or outlet glaciers, in some cases into the sea or into ice shelves floating on the sea. There are only three large ice sheets in the modern world, one on Greenland and two on Antarctica, the East and West Antarctic Ice Sheets, divided by the Transantarctic Mountains. During glacial periods there were others (IPCC).

Ice shelf A floating slab of ice of considerable thickness extending from the coast (usually of great horizontal extent with a level or gently sloping surface), often filling embayments in the coastline of the ice sheets. Nearly all ice shelves are in Antarctica, where most of the ice discharged seaward flows into ice shelves (IPCC).

Indirect aerosol effect Aerosols may lead to an indirect radiative forcing of the climate system through acting as cloud condensation nuclei or modifying the optical properties and lifetime of clouds. Two indirect effects are distinguished:

- Cloud albedo effect
- A radiative forcing induced by an increase in anthropogenic aerosols that cause an initial increase in droplet concentration and a decrease in droplet size for fixed liquid water content, leading to an increase in cloud albedo. This effect is also known as the first indirect effect or Twomey effect.
- Cloud lifetime effect
- A forcing induced by an increase in anthropogenic aerosols that cause a decrease in droplet size, reducing the precipitation efficiency, thereby modifying the liquid water content, cloud thickness and cloud life time. This effect is also known as the second indirect effect or Albrecht effect.

Apart from these indirect effects, aerosols may have a semi-direct effect. This refers to the absorption of solar radiation by absorbing aerosol, which heats the air and tends to increase the static stability relative to the surface. It may also cause evaporation of cloud droplets (IPCC).

Industrial Revolution A period of rapid industrial growth with far-reaching social and economic consequences, beginning in Britain during the second half of the eighteenth century and spreading to Europe and later to other countries including the United States. The invention of the steam engine was an important trigger of this development. The Industrial Revolution marks the beginning of a strong increase in the use of fossil fuels and emission of, in particular, fossil carbon dioxide (IPCC).

Infrared radiation See Thermal infrared radiation.

Insolation The amount of solar radiation reaching the Earth by latitude and by season. Usually insolation refers to the radiation arriving at the top of the atmosphere. Sometimes it is specified as referring to the radiation arriving at the Earth's surface. See also: Total Solar Irradiance (IPCC).

Interglacials The warm periods between ice age glaciations. The previous interglacial, dated approximately from 129 to 116 ka, is referred to as the Last Interglacial (AMS, 2000).

Inter-Tropical Convergence Zone (ITCZ) The Inter-Tropical Convergence Zone is an equatorial zonal belt of low pressure near the equator where the northeast trade winds meet the southeast trade winds. As these winds converge, moist air is forced upward, resulting in a band of heavy precipitation. This band moves seasonally.

IPCC The Intergovernmental Panel on Climate Change, part of the United Nations Environmental Program. The IPCC assesses the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change.

Isostatic or Isostasy Isostasy refers to the way in which the lithosphere and mantle respond visco-elastically to changes in surface loads. When the loading of the lithosphere and/or the mantle is changed by alterations in land ice mass (glaciers), ocean mass, sedimentation, erosion or mountain building, vertical isostatic adjustment results, in order to balance the new load (IPCC).

K

Kyoto Protocol The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties (COP) to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most Organization for Economic Cooperation and Development countries and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas emissions (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride) by at least 5% below 1990 levels in the commitment period 2008–2012. The Kyoto Protocol entered into force on 16 February 2005. The United States of America was not a party to the Kyoto Protocol.

L

Land use and Land use change Land use refers to the total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction and conservation). Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have a radiative forcing and/or other impacts on climate, locally or globally. See also the IPCC Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000).

La Niña See El Niño-Southern Oscillation.

Land surface air temperature The surface air temperature as measured in well-ventilated screens over land at 1.5 m above the ground (IPCC).

Lapse rate The rate of change of an atmospheric variable, usually temperature, with height. The lapse rate is considered positive when the variable decreases with height.

Last Glacial Maximum (LGM) The Last Glacial Maximum refers to the time of maximum extent of the ice sheets during the last glaciation, approximately 21 ka. This period has been widely studied because the radiative forcings and boundary conditions are relatively well known and because the global cooling during that period is comparable with the projected warming over the 21st century (IPCC).

Last Interglacial (LIG) See Interglacial.

Lithosphere The upper layer of the solid Earth, both continental and oceanic, which comprises all crustal rocks and the cold, mainly elastic part of the uppermost mantle. Volcanic activity, although part of the lithosphere, is not considered as part of the climate system, but acts as an external forcing factor (IPCC). See Isostatic.

Little Ice Age (LIA) An interval between approximately AD 1400 and 1900 when temperatures in the Northern Hemisphere were generally colder than today's, especially in Europe (IPCC).

M

Mean sea level See Relative sea level.

Medieval Warm Period (MWP) An interval between AD 1000 and 1300 in which some Northern Hemisphere regions were warmer than during the Little Ice Age that followed.

Meridional Overturning Circulation (MOC) Meridional (north-south) overturning circulation in the ocean quantified by zonal (east-west) sums of mass transports in depth or density layers. In the North Atlantic, away from the Subpolar regions, the MOC (which is in principle an observable quantity) is often identified with the **Thermohaline Circulation (THC)**, which is a conceptual interpretation. However, it must be borne in mind that the MOC can also include shallower, wind-driven overturning cells such as occur in the upper ocean in the tropics and subtropics, in which warm (light) waters moving poleward are transformed to slightly denser waters and subducted equatorward at deeper levels (IPCC).

Metadata Information about meteorological and climatological data concerning how and when they were measured, their quality, known problems and other characteristics (IPCC).

Metric A consistent measurement of a characteristic of an object or activity that is otherwise difficult to quantify.

Mitigation A human intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC).

Mixing ratio See Mole fraction.

Model hierarchy See Climate model (spectrum or hierarchy).

Modes of climate variability Natural variability of the climate system, in particular on seasonal and longer time scales, predominantly occurs with preferred spatial patterns and time scales, through the dynamical characteristics of the atmospheric circulation and through interactions with the land and ocean surfaces. Such patterns are often called regimes, modes or teleconnections. Examples are the North

Atlantic Oscillation (NAO), the Pacific-North American pattern (PNA), the El Niño-Southern Oscillation (ENSO), the Northern Annular Mode (NAM; previously called Arctic Oscillation, AO) and the Southern Annular Mode (SAM; previously called the Antarctic Oscillation, AAO). Many of the prominent modes of climate variability are discussed in Section 3.6, of the IPCC AR4, 2007. See also Patterns of climate variability.

Mole fraction Mole fraction, or mixing ratio, is the ratio of the number of moles of a constituent in a given volume to the total number of moles of all constituents in that volume. It is usually reported for dry air. Typical values for long-lived greenhouse gases are in the order of μmol mol^{-1} (parts per million: ppm), nmol mol^{-1} (parts per billion: ppb), and fmol mol^{-1} (parts per trillion: ppt). Mole fraction differs from volume mixing ratio, often expressed in ppmv etc., by the corrections for non-ideality of gases. This correction is significant relative to measurement precision for many greenhouse gases. (Schwartz and Warneck 1995) (IPCC).

Monsoon A monsoon is a tropical and subtropical seasonal reversal in both the surface winds and associated precipitation, caused by differential heating between a continental-scale land mass and the adjacent ocean. Monsoon rains occur mainly over land in summer.

Montreal Protocol The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in Montreal in 1987, and subsequently adjusted and amended in London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997) and Beijing (1999). It controls the consumption and production of chlorine- and bromine-containing chemicals that destroy stratospheric ozone, such as chlorofluorocarbons, methyl chloroform, carbon tetrachloride and many others (IPCC).

Microwave Sounding Unit (MSU) A satellite-borne microwave sounder that estimates the temperature of thick layers of the atmosphere by measuring the thermal emission of oxygen molecules from a complex of emission lines near 60 GHz. A series of nine MSUs began making this kind of measurement in late 1978. Beginning in mid 1998, a follow-on series of instruments, the Advanced Microwave Sounding Units (AMSUs), began operation (IPCC).

MSU See Microwave Sounding Unit.

N

Nonlinearity A process is called nonlinear when there is no simple proportional relation between cause and effect. The climate system contains many such nonlinear processes, resulting in a system with a potentially very complex behaviour. Such complexity may lead to abrupt climate change. See also Chaos; Predictability (IPCC).

North Atlantic Oscillation (NAO) The North Atlantic Oscillation consists of opposing variations of barometric pressure near Iceland and near the Azores. It therefore corresponds to fluctuations in the strength of the main westerly winds across the Atlantic into Europe, and thus to fluctuations in the embedded cyclones with their associated frontal systems (IPCC).

Northern Annular Mode (NAM) A winter fluctuation in the amplitude of a pattern characterized by low surface pressure in the Arctic and strong mid-latitude

westerlies. The NAM has links with the northern polar vortex into the stratosphere. Its pattern has a bias to the North Atlantic and has a large correlation with the North Atlantic Oscillation (IPCC).

O

Ocean acidification A decrease in the pH of sea water due to the uptake of anthropogenic carbon dioxide (IPCC).

Organic aerosol Aerosol particles consisting predominantly of organic compounds, mainly carbon, hydrogen, oxygen and lesser amounts of other elements. (Charlson and Heintzenberg, 1995, p. 405) (IPCC). See Carbonaceous aerosol.

Ozone Ozone, the tri-atomic form of oxygen (O_3), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (smog). Tropospheric ozone acts as a greenhouse gas. In the stratosphere, it is created by the interaction between solar ultraviolet radiation and molecular oxygen (O_2). Stratospheric ozone plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the ozone layer (IPCC).

Ozone hole See Ozone layer.

Ozone layer The stratosphere contains a layer in which the concentration of ozone is greatest, the so-called ozone layer. The layer extends from about 12–40 km above the Earth's surface. The ozone concentration reaches a maximum between about 20 and 25 km. This layer is being depleted by human emissions of chlorine and bromine compounds. Every year, during the Southern Hemisphere spring, a very strong depletion of the ozone layer takes place over the Antarctic region, caused by anthropogenic chlorine and bromine compounds in combination with the specific meteorological conditions of that region. This phenomenon is called the ozone hole (IPCC). See Montreal Protocol.

P

Pacific decadal variability Coupled decadal-to-inter-decadal variability of the atmospheric circulation and underlying ocean in the Pacific Basin. It is most prominent in the North Pacific, where fluctuations in the strength of the winter Aleutian Low pressure system co-vary with North Pacific sea surface temperatures, and are linked to decadal variations in atmospheric circulation, sea surface temperatures and ocean circulation throughout the whole Pacific Basin. Such fluctuations have the effect of modulating the El Niño-Southern Oscillation cycle. Key measures of Pacific decadal variability are the North Pacific Index (NPI), the Pacific Decadal Oscillation (PDO) index and the Inter-decadal Pacific Oscillation (IPO) index.

Paleoclimate Climate during periods prior to the development of measuring instruments, including historic and geologic time, for which only proxy climate records are available.

Parameterization In climate models, this term refers to the technique of representing processes that cannot be explicitly resolved at the spatial or temporal resolution of the model (sub-grid scale processes) by relationships between model-resolved larger-scale flow and the area- or time-averaged effect of such sub-grid scale processes (IPCC).

Permafrost Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years (Van Everdingen, 1998).

pH pH is a dimensionless measure of the acidity of water (or any solution) given by its concentration of hydrogen ions (H^+). pH is measured on a logarithmic scale where $pH = -\log_{10}(H^+)$. Thus, a pH decrease of 1 unit corresponds to a tenfold increase in the concentration of H^+, or acidity (IPCC).

Philosophy of science Philosophy of science is the study of general and fundamental problems, such as those connected with existence, knowledge, values, reason, mind, and language and how these relate to science.

Photosynthesis The process by which plants take carbon dioxide from air (or bicarbonate in water) to build carbohydrates, releasing oxygen in the process. There are several pathways of photosynthesis with different responses to atmospheric carbon dioxide concentrations. See Carbon dioxide fertilization; C3 plants; C4 plants (IPCC).

Plankton Microorganisms living in the upper layers of aquatic systems. A distinction is made between phytoplankton, which depend on photosynthesis for their energy supply, and zooplankton, which feed on phytoplankton.

Pleistocene The earlier of two Quaternary Epochs, extending from the end of the Pliocene, about 1.8 Ma, until the beginning of the Holocene about 11.6 ka.

Pollen analysis A technique of both relative dating and environmental reconstruction, consisting of the identification and counting of pollen types preserved in peat, lake sediments and other deposits. See Proxy (IPCC).

Post-glacial rebound The vertical movement of the land and sea floor following the reduction of the load of an ice mass, for example, since the Last Glacial Maximum (21 ka). The rebound is an isostatic land movement (IPCC).

Precursors Atmospheric compounds that are not greenhouse gases or aerosols, but that have an effect on greenhouse gas or aerosol concentrations by taking part in physical or chemical processes regulating their production or destruction rates.

Predictability The extent to which future states of a system may be predicted based on knowledge of current and past states of the system. Since knowledge of the climate system's past and current states is generally imperfect, as are the models that utilize this knowledge to produce a climate prediction, and since the climate system is inherently nonlinear and chaotic, predictability of the climate system is inherently limited. Even with arbitrarily accurate models and observations, there may still be limits to the predictability of such a nonlinear system (AMS 2000)

Projection A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasize that projections involve assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realised, and are therefore subject to substantial uncertainty. See also Climate projection; Climate prediction.

Proxy A proxy climate indicator is a local record that is interpreted, using physical and biophysical principles, to represent some combination of climate-related variations back in time. Climate-related data derived in this way are referred to as proxy data. Examples of proxies include pollen analysis, tree ring records, characteristics of corals and various data derived from ice cores.

Q

Quaternary The period of geological time following the Tertiary (65–1.8 Ma). Following the current definition (which is under revision at present) the Quaternary extends from 1.8 Ma until the present. It is formed of two epochs, the Pleistocene and the Holocene.

R

Radiative forcing Radiative forcing is the change in the net, downward minus upward, irradiance (expressed in W m^{-2}) at the tropopause due to a change in an external driver of climate change, such as, for example, a change in the concentration of carbon dioxide or the output of the Sun. Radiative forcing is computed with all tropospheric properties held fixed at their unperturbed values, and after allowing for stratospheric temperatures, if perturbed, to readjust to radiative-dynamical equilibrium. Radiative forcing is called instantaneous if no change in stratospheric temperature is accounted for. For the purposes of this report, radiative forcing is further defined as the change relative to the year 1750 and, unless otherwise noted, refers to a global and annual average value. Radiative forcing is not to be confused with cloud radiative forcing, a similar terminology for describing an unrelated measure of the impact of clouds on the irradiance at the top of the atmosphere.

Radiative forcing scenario A plausible representation of the future development of radiative forcing associated, for example, with changes in atmospheric composition or land use change, or with external factors such as variations in solar activity. Radiative forcing scenarios can be used as input into simplified climate models to compute climate projections.

Reanalysis Reanalyses are atmospheric and oceanic analyses of temperature, wind, current, and other meteorological and oceanographic quantities, created by processing past meteorological and oceanographic data using fixed state-of-the-art weather forecasting models and data assimilation techniques. Using fixed data assimilation avoids effects from the changing analysis system that occurs in operational analyses. Although continuity is improved, global reanalyses still suffer from changing coverage and biases in the observing systems.

Reconstruction The use of climate indicators to help determine (generally past) climates.

Reforestation Planting of forests on lands that have previously contained forests but that have been converted to some other use. For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the IPCC Report on Land Use, Land-Use Change and Forestry (IPCC, 2000). See also the Report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003)

Regime A regime is preferred states of the climate system, often representing one phase of dominant patterns or modes of climate variability.

Region A region is a territory characterized by specific geographical and climatological features. The climate of a region is affected by regional and local scale forcings like topography, land use characteristics, lakes, etc., as well as remote influences from other regions. See Teleconnection.

Relative sea level Sea level measured by a tide gauge with respect to the land upon which it is situated. Mean sea level is normally defined as the average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides. See Sea level change.

Reservoir A component of the climate system, other than the atmosphere, which has the capacity to store, accumulate or release a substance of concern, for example, carbon, a greenhouse gas or a precursor. Oceans, soils and forests are examples of reservoirs of carbon. Pool is an equivalent term (note that the definition of pool often includes the atmosphere). The absolute quantity of the substance of concern held within a reservoir at a specified time is called the stock.

Response time The response time or adjustment time is the time needed for the climate system or its components to re-equilibrate to a new state, following a forcing resulting from external and internal processes or feedbacks. It is very different for various components of the climate system. The response time of the troposphere is relatively short, from days to weeks, whereas the stratosphere reaches equilibrium on a time scale of typically a few months. Due to their large heat capacity, the oceans have a much longer response time: typically decades, but up to centuries or millennia. The response time of the strongly coupled surface-troposphere system is, therefore, slow compared to that of the stratosphere, and mainly determined by the oceans. The biosphere may respond quickly (e.g., to droughts), but also very slowly to imposed changes. See lifetime for a different definition of response time pertinent to the rate of processes affecting the concentration of trace gases.

S

Scenario A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a narrative storyline. See also SRES scenarios; Climate scenario; Emission scenario.

Sea ice Any form of ice found at sea that has originated from the freezing of seawater. Sea ice may be discontinuous pieces (ice floes) moved on the ocean surface by wind and currents (pack ice), or a motionless sheet attached to the coast (landfast ice). Sea ice less than 1 year old is called first-year ice. Multi-year ice is sea ice that has survived at least one summer melt season.

Sea level change Sea level can change, both globally and locally, due to (i) changes in the shape of the ocean basins, (ii) changes in the total mass of water and (iii) changes in water density. Sea level changes induced by changes in water density are called steric. Density changes induced by temperature changes only are called thermosteric, while density changes induced by salinity changes are called halosteric. See also Relative Sea Level; Thermal expansion.

Sea surface temperature (SST) The sea surface temperature is the temperature of the subsurface bulk temperature in the top few metres of the ocean, measured by ships, buoys and drifters. From ships, measurements of water samples in buckets were mostly switched in the 1940s to samples from engine intake water. Satellite

measurements of skin temperature (uppermost layer; a fraction of a millimetre thick) in the infrared or the top centimetre or so in the microwave are also used, but must be adjusted to be compatible with the bulk temperature.

Sink Any process, activity or mechanism that removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol from the atmosphere.

Snow line The lower limit of permanent snow cover, below which snow does not accumulate.

Soil moisture Water stored in or at the land surface and available for evaporation.

Solar activity The Sun exhibits periods of high activity observed in numbers of sunspots, as well as radiative output, magnetic activity and emission of high-energy particles. These variations take place on a range of time scales from millions of years to minutes. See Solar cycle.

Solar ('11 year') cycle A quasi-regular modulation of solar activity with varying amplitude and a period of between 9 and 13 years.

Solar radiation Electromagnetic radiation emitted by the Sun. It is also referred to as shortwave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the Sun, peaking in visible wavelengths. See also: Thermal infrared radiation, Insolation.

Source Any process, activity or mechanism that releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol into the atmosphere.

Southern Oscillation See El Niño-Southern Oscillation (ENSO).

Spatial and temporal scales Climate may vary on a large range of spatial and temporal scales. Spatial scales may range from local (less than 100,000 km^2), through regional (100,000–10 million km^2) to continental (10–100 million km^2). Temporal scales may range from seasonal to geological (up to hundreds of millions of years).

SRES scenarios SRES scenarios are emission scenarios developed by Nakićenović and Swart (2000) and used, among others, as a basis for some of the climate projections shown in Chap. 11 of this report. The following terms are relevant for a better understanding of the structure and use of the set of SRES scenarios:

Scenario family Scenarios that have a similar demographic, societal, economic and technical change storyline. Four scenario families comprise the SRES scenario set: A1, A2, B1 and B2.

- Illustrative Scenario
- A scenario that is illustrative for each of the six scenario groups reflected in the Summary for Policymakers of Nakićenović and Swart (2000). They include four revised scenario markers for the scenario groups A1B, A2, B1, B2, and two additional scenarios for the A1FI and A1T groups. All scenario groups are equally sound.
- Marker Scenario
- A scenario that was originally posted in draft form on the SRES website to represent a given scenario family. The choice of markers was based on which of the initial quantifications best reflected the storyline, and the features of specific models. Markers are no more likely than other scenarios, but are considered by the SRES writing team as illustrative of a particular storyline. They are included in revised form in Nakićenović and Swart (2000). These scenarios received the

closest scrutiny of the entire writing team and via the SRES open process. Scenarios were also selected to illustrate the other two scenario groups.

Stratosphere The highly stratified region of the atmosphere above the troposphere extending from about 10 km (ranging from 9 km at high latitudes to 16 km in the tropics on average) to about 50 km altitude.

Subduction Ocean process in which surface waters enter the ocean interior from the surface mixed layer through Ekman pumping and lateral advection. The latter occurs when surface waters are advected to a region where the local surface layer is less dense and therefore must slide below the surface layer, usually with no change in density.

Sunspots Small dark areas on the Sun. The number of sunspots is higher during periods of high solar activity, and varies in particular with the solar cycle.

Surface temperature See Global surface temperature; Ground temperature; Land surface air temperature; Sea surface temperature.

T

Thermal expansion In connection with sea level, this refers to the increase in volume (and decrease in density) that results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence an increase in sea level. See Sea level change.

Thermal infrared radiation Radiation emitted by the Earth's surface, the atmosphere and the clouds. It is also known as terrestrial or longwave radiation, and is to be distinguished from the near-infrared radiation that is part of the solar spectrum. Infrared radiation, in general, has a distinctive range of wavelengths (spectrum) longer than the wavelength of the red colour in the visible part of the spectrum. The spectrum of thermal infrared radiation is practically distinct from that of shortwave or solar radiation because of the difference in temperature between the Sun and the Earth-atmosphere system.

Thermocline The layer of maximum vertical temperature gradient in the ocean, lying between the surface ocean and the abyssal ocean. In subtropical regions, its source waters are typically surface waters at higher latitudes that have subducted and moved equatorward. At high latitudes, it is sometimes absent, replaced by a halocline, which is a layer of maximum vertical salinity gradient.

Thermohaline circulation (THC) Large-scale circulation in the ocean that transforms low-density upper ocean waters to higher-density intermediate and deep waters and returns those waters back to the upper ocean. The circulation is asymmetric, with conversion to dense waters in restricted regions at high latitudes and the return to the surface involving slow upwelling and diffusive processes over much larger geographic regions. The THC is driven by high densities at or near the surface, caused by cold temperatures and/or high salinities, but despite its suggestive though common name, is also driven by mechanical forces such as wind and tides. Frequently, the name THC has been used synonymously with Meridional Overturning Circulation.

Tide gauge A device at a coastal location (and some deep-sea locations) that continuously measures the level of the sea with respect to the adjacent land. Time

averaging of the sea level so recorded gives the observed secular changes of the relative sea level.

Total solar irradiance (TSI) The amount of solar radiation received outside the Earth's atmosphere on a surface normal to the incident radiation, and at the Earth's mean distance from the Sun.

Aljwhsd Reliable measurements of solar radiation can only be made from space and the precise record extends back only to 1978. The generally accepted value is 1,368 W m^{-2} with an accuracy of about 0.2%. Variations of a few tenths of a percent are common, usually associated with the passage of sunspots across the solar disk. The solar cycle variation of TSI is of the order of 0.1% (AMS 2000). See also Insolation.

Tree rings Concentric rings of secondary wood evident in a cross-section of the stem of a woody plant. The difference between the dense, small-celled late wood of one season and the wide-celled early wood of the following spring enables the age of a tree to be estimated, and the ring widths or density can be related to climate parameters such as temperature and precipitation. See Proxy.

Trend The word trend designates a change, generally monotonic in time, in the value of a variable.

Tropopause The boundary between the troposphere and the stratosphere.

Troposphere The lowest part of the atmosphere, from the surface to about 10 km in altitude at mid-latitudes (ranging from 9 km at high latitudes to 16 km in the tropics on average), where clouds and weather phenomena occur. In the troposphere, temperatures generally decrease with height.

U

Uncertainty An expression of the degree to which a value (e.g., the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures, for example, a range of values calculated by various models, or by qualitative statements, for example, reflecting the judgment of a team of experts (see Moss and Schneider 2000; Manning et al. 2004). See also Confidence.

United Nations Framework Convention on Climate Change (UNFCCC) The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. It contains commitments for all Parties. Under the Convention, Parties included in Annex I (all OECD countries and countries with economies in transition) aim to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention entered in force in March 1994. See Kyoto Protocol.

Uptake The addition of a substance of concern to a reservoir. The uptake of carbon containing substances, in particular carbon dioxide, is often called (carbon) sequestration.

Urban heat island (UHI) The relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, the concrete jungle effects on heat retention, changes in surface albedo, changes in pollution and aerosols, and so on.

V

Ventilation The exchange of ocean properties with the atmospheric surface layer such that property concentrations are brought closer to equilibrium values with the atmosphere (AMS 2000).

W

Walker Circulation Direct thermally driven zonal overturning circulation in the atmosphere over the tropical Pacific Ocean, with rising air in the western and sinking air in the eastern Pacific.

Water mass A volume of ocean water with identifiable properties (temperature, salinity, density, chemical tracers) resulting from its unique formation process. Water masses are often identified through a vertical or horizontal extreme of a property such as salinity.

Weather The state of the atmosphere at a place and time as regards heat, cloudiness, dryness, sunshine, wind, rain, etc.

Y

Younger Dryas A period 12.9–11.6 kyear, during the deglaciation, characterized by a temporary return to colder conditions in many locations, especially around the North Atlantic.

Index

G.T. Farmer and J. Cook, *Climate Change Science: A Modern Synthesis: Volume 1 - The Physical Climate*, DOI 10.1007/978-94-007-5757-8,

C

H

N

S

T