Appendix I

Glossary

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A → indicates that the following term is also contained in this Glossary.

Adjustment time
See: →Lifetime; see also: →Response time.

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

The term has also come to be associated, erroneously, with the propellant used in "aerosol sprays".

Afforestation
Planting of new forests on lands that historically have not contained forests. 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).

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

Altimetry
A technique for the measurement of the elevation of the sea, land or ice surface. For example, the height of the sea surface (with respect to the centre of the Earth or, more conventionally, with respect to a standard "ellipsoid of revolution") can be measured from space by current state-of-the-art radar altimetry with centrimetric precision. Altimetry has the advantage of being a measurement relative to a geocentric reference frame, rather than relative to land level as for a →tide gauge, and of affording quasi-global coverage.

Anthropogenic
Resulting from or produced by human beings.

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 water vapour, whose amount is highly variable but typically 1% volume mixing ratio. The atmosphere also contains clouds and →aerosols.

Attribution
See: →Detection and attribution.

Autotrophic respiration
→Respiration by photosynthetic organisms (plants).

Biomass
The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass.

Biosphere (terrestrial and marine)
The part of the Earth system comprising all →ecosystems and living organisms, in the atmosphere, on land (terrestrial biosphere) or in the oceans (marine biosphere), including derived dead organic matter, such as litter, soil organic matter and oceanic detritus.

Black carbon
Operationally defined species 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. (Source: Charlson and Heintzenberg, 1995, p. 401.)

Burden
The total mass of a gaseous substance of concern in the atmosphere.

Carbonaceous aerosol
Aerosol consisting predominantly of organic substances and various forms of →black carbon. (Source: Charlson and Heintzenberg, 1995, p. 401.)

Carbon cycle
The term used to describe the flow of carbon (in various forms, e.g. as carbon dioxide) through the atmosphere, ocean, terrestrial →biosphere and lithosphere.

Carbon dioxide (CO_2)
A naturally occurring gas, also a by-product of burning fossil fuels and →biomass, as well as →land-use changes and other industrial processes. It is the principal anthropogenic →greenhouse gas that affects the earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a →Global Warming Potential of 1.

Carbon dioxide (CO_2) fertilisation
The enhancement of the growth of plants as a result of increased atmospheric CO_2 concentration. Depending on their mechanism of →photosynthesis, certain types of plants are more sensitive to changes in atmospheric CO_2 concentratioin. In particular, →C_3 plants generally show a larger response to CO_2 than →C_4 plants.

Charcoal
Material resulting from charring of biomass, usually retaining some of the microscopic texture typical of plant tissues; chemically it consists mainly of carbon with a disturbed graphitic structure, with lesser amounts of oxygen and hydrogen. See: →Black carbon; Soot particles. (Source: Charlson and Heintzenberg, 1995, p. 402.)

Climate
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 is 30 years, as defined by the World Meteorological Organization (WMO). These 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 statistically significant variation in either the mean state of the climate or in its variability, persisting 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.

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.

Climate model (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, i.e. for any one component or combination of components a *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 →parametrizations are involved. Coupled atmosphere/ocean/sea-ice General Circulation Models (AOGCMs) provide a comprehensive representation of the climate system. There is an evolution towards more complex models with active chemistry and biology.

Climate models are applied, as a research tool, to study and simulate the climate, but also for operational purposes, including monthly, seasonal and interannual →climate predictions.

Climate prediction
A climate prediction or climate forecast is the result of an attempt to produce a most likely description or estimate of the actual evolution of the climate in the future, e.g. at seasonal, interannual or long-term time scales. See also: →Climate projection and →Climate (change) scenario.

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 emphasise that climate projections depend upon the emission/concentration/

radiative forcing scenario used, which are based on assumptions, concerning, e.g., future socio-economic and technological developments, that may or may not be realised, and are therefore subject to substantial uncertainty.

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.

Climate sensitivity
In IPCC Reports, *equilibrium climate sensitivity* refers to the equilibrium change in global mean surface temperature following a doubling of the atmospheric (→equivalent) CO_2 concentration. More generally, equilibrium climate sensitivity refers to the equilibrium change in surface air temperature following a unit change in →radiative forcing (°C/Wm^{-2}). In practice, the evaluation of the equilibrium climate sensitivity requires very long simulations with Coupled General Circulation Models (→Climate model).

The *effective climate sensitivity* is a related measure that circumvents this requirement. It is evaluated from model output for evolving non-equilibrium conditions. It is a measure of the strengths of the →feedbacks at a particular time and may vary with forcing history and climate state. Details are discussed in Section 9.2.1 of Chapter 9 in this Report.

Climate system
The climate system is the highly complex system consisting of five major components: the →atmosphere, the →hydrosphere, the →cryosphere, the land surface 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 human-induced forcings such as the changing composition of the atmosphere and →land-use change.

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 temporal and spatial 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.

Cloud condensation nuclei
Airborne particles that serve as an initial site for the condensation of liquid water and which can lead to the formation of cloud droplets. See also: →Aerosols.

CO_2 fertilisation
See →Carbon dioxide (CO_2) fertilisation

Cooling degree days
The integral over a day of the temperature above 18°C (e.g. a day with an average temperature of 20°C counts as 2 cooling degree days). See also: →Heating degree days.

Cryosphere
The component of the →climate system consisting of all snow, ice and permafrost on and beneath the surface of the earth and ocean. See: →Glacier; →Ice sheet.

C_3 plants
Plants that produce a three-carbon compound during photosynthesis; including most trees and agricultural crops such as rice, wheat, soyabeans, potatoes and vegetables.

C_4 plants
Plants that produce a four-carbon compound during photosynthesis; mainly of tropical origin, including grasses and the agriculturally important crops maize, sugar cane, millet and sorghum.

Deforestation
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 Report on Land Use, Land-Use Change and Forestry (IPCC, 2000).

Desertification
Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Further, the UNCCD (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.

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.

Diurnal temperature range
The difference between the maximum and minimum temperature during a day.

Dobson Unit (DU)
A unit to measure the total amount of ozone in a vertical column above the Earth's surface. 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 1013 hPa, and a temperature of 0°C. One DU corresponds to a column of ozone containing 2.69×10^{20} 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.

Ecosystem
A system of interacting living organisms together with 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.

El Niño-Southern Oscillation (ENSO)
El Niño, in its original sense, is a warm water current which periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation of the intertropical surface pressure pattern and circulation in the Indian and Pacific oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation, or ENSO. During an El Niño event, the prevailing trade winds weaken and the equatorial countercurrent strengthens, causing warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This event has 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. The opposite of an El Niño event is called *La Niña.*

Emission scenario
A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g. →greenhouse gases, →aerosols), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change) and their key relationships.

Concentration scenarios, derived from emission scenarios, are used as input into a climate model to compute →climate projections.

In IPCC (1992) a set of emission scenarios was presented which were used as a basis for the →climate projections in IPCC (1996). These emission scenarios are referred to as the IS92 scenarios. In the IPCC Special Report on Emission Scenarios (Nakićenović *et al*., 2000) new emission scenarios, the so called →SRES scenarios, were published some of which were used, among others, as a basis for the climate projections presented in Chapter 9 of this Report. For the meaning of some terms related to these scenarios, see →SRES scenarios.

Energy balance
Averaged over the globe and over longer time periods, the energy budget of the →climate system must be in balance. Because the climate system derives all its energy from the Sun, this balance implies that, globally, the amount of incoming →solar radiation must on average be equal to the sum of the outgoing reflected solar radiation and the outgoing →infrared radiation emitted by the climate system. A perturbation of this global radiation balance, be it human induced or natural, is called →radiative forcing.

Equilibrium and transient climate experiment
An *equilibrium climate experiment* is an experiment in which a →climate model is allowed to fully adjust to a change in →radiative forcing. Such experiments provide information on the difference between the initial and final states of the model, but not on the time-dependent response. If the forcing is allowed to evolve gradually according to a prescribed →emission scenario, the time dependent response of a climate model may be analysed. Such experiment is called a *transient climate experiment.* See: →Climate projection.

Equivalent CO_2 (carbon dioxide)
The concentration of →CO_2 that would cause the same amount of →radiative forcing as a given mixture of CO_2 and other →greenhouse gases.

Eustatic sea-level change
A change in global average sea level brought about by an alteration to the volume of the world ocean. This may be caused by changes in water density or in the total mass of water. In discussions of changes on geological time-scales, this term sometimes also includes changes in global average sea level caused by an alteration to the shape of the ocean basins. In this Report the term is not used with that sense.

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

External forcing
See: →Climate system.

Extreme weather event
An extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called *extreme weather* may vary from place to place.

An *extreme climate event* is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g. rainfall over a season).

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

Feedback
See: →Climate feedback.

Flux adjustment
To avoid the problem of coupled atmosphere-ocean general circulation models drifting into some unrealistic climate state, adjustment terms can be applied to the atmosphere-ocean fluxes of heat and moisture (and sometimes the surface stresses resulting from the effect of the wind on the ocean surface) before these fluxes are imposed on the model ocean and atmosphere. Because these adjustments are precomputed and therefore independent of the coupled model integration, they are uncorrelated to the anomalies which develop during the integration. In Chapter 8 of this Report it is concluded that present models have a reduced need for flux adjustment.

Forest
A vegetation type dominated by trees. Many definitions of the term forest are in use throughout the world, reflecting wide differences in bio-geophysical conditions, social structure, and economics. 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).

Fossil CO_2 (carbon dioxide) emissions
Emissions of CO_2 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).

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

General Circulation Model (GCM)
See: →Climate model.

Geoid
The surface which an ocean of uniform density would assume if it were in steady state and at rest (i.e. no ocean circulation and no applied forces other than the gravity of the Earth). This implies that the geoid will be a surface of constant gravitational potential, which can serve as a reference surface to which all surfaces (e.g., the Mean Sea Surface) can be referred. The geoid (and surfaces parallel to the geoid) are what we refer to in common experience as "level surfaces".

Glacier
A mass of land ice flowing downhill (by internal deformation and sliding at the base) and constrained by the surrounding topography e.g. the sides of a valley or surrounding peaks; the bedrock topography is the major influence on the dynamics and surface slope of a glacier. A glacier is maintained by accumulation of snow at high altitudes, balanced by melting at low altitudes or discharge into the sea.

Global surface temperature
The global surface temperature is the area-weighted global average of (i) the sea-surface temperature over the oceans (i.e. the subsurface bulk temperature in the first few meters of the ocean), and (ii) the surface-air temperature over land at 1.5 m above the ground.

Global Warming Potential (GWP)
An index, describing the radiative characteristics of well mixed →greenhouse gases, that represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing →infrared radiation. This index approximates the time-integrated warming effect of a unit mass of a given greenhouse gas in today's atmosphere, relative to that of →carbon dioxide.

Greenhouse effect
→Greenhouse gases effectively absorb →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 *natural greenhouse effect.*

Atmospheric radiation is strongly coupled to the temperature of the level 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 concentration 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, an imbalance that can only be compensated for by an increase of the temperature of the surface-troposphere system. This is the *enhanced greenhouse effect.*

Greenhouse gas
Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and 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 (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Gross Primary Production (GPP)
The amount of carbon fixed from the atmosphere through →photosynthesis.

Grounding line/zone
The junction between →ice sheet and →ice shelf or the place where the ice starts to float.

Halocarbons
Compounds containing either chlorine, bromine or fluorine and carbon. Such compounds can act as powerful →greenhouse gases in the atmosphere. The chlorine and bromine containing halocarbons are also involved in the depletion of the →ozone layer.

Heating degree days
The integral over a day of the temperature below 18°C (e.g. a day with an average temperature of 16°C counts as 2 heating degree days). See also: →Cooling degree days.

Heterotrophic respiration
The conversion of organic matter to CO_2 by organisms other than plants.

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

Ice cap
A dome shaped ice mass covering a highland area that is considerably smaller in extent than an→ice sheet.

Ice sheet
A mass of land ice which is sufficiently deep to cover most of the underlying bedrock topography, so that its shape is mainly determined by its internal dynamics (the flow of the ice as it deforms internally and slides at its base). An ice sheet flows outwards from a high central plateau with a small average surface slope. The margins slope steeply, and the 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 two large ice sheets in the modern world, on Greenland and Antarctica, the Antarctic ice sheet being divided into East and West by the Transantarctic Mountains; during glacial periods there were others.

Ice shelf
A floating →ice sheet of considerable thickness attached to a coast (usually of great horizontal extent with a level or gently undulating surface); often a seaward extension of ice sheets.

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

First indirect effect
A radiative forcing induced by an increase in anthropogenic aerosols which cause an initial increase in droplet concentration and a decrease in droplet size for fixed liquid water content, leading to an increase of cloud →albedo. This effect is also known as the *Twomey effect*. This is sometimes referred to as the *cloud albedo effect*. However this is highly misleading since the second indirect effect also alters cloud albedo.

Second indirect effect
A radiative forcing induced by an increase in anthropogenic aerosols which 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 *cloud life time effect* or *Albrecht effect*.

Industrial revolution
A period of rapid industrial growth with far-reaching social and economic consequences, beginning in England 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. In this Report the terms *pre-industrial* and *industrial* refer, somewhat arbitrarily, to the periods before and after 1750, respectively.

Infrared radiation
Radiation emitted by the earth's surface, the atmosphere and the clouds. It is also known as terrestrial or long-wave radiation. Infrared radiation 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 infrared radiation is practically distinct from that of →solar or short-wave radiation because of the difference in temperature between the Sun and the Earth-atmosphere system.

Integrated assessment
A method of analysis that combines results and models from the physical, biological, economic and social sciences, and the interactions between these components, in a consistent framework, to evaluate the status and the consequences of environmental change and the policy responses to it.

Internal variability
See: →Climate variability.

Inverse modelling
A mathematical procedure by which the input to a model is estimated from the observed outcome, rather than *vice versa*. It is, for instance, used to estimate the location and strength of sources and sinks of CO_2 from measurements of the distribution of the CO_2 concentration in the atmosphere, given models of the global →carbon cycle and for computing atmospheric transport.

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

Kyoto Protocol
The Kyoto Protocol to the United Nations →Framework Convention on Climate Change (UNFCCC) was adopted at the Third Session of the Conference of the Parties (COP) to the United Nations →Framework Convention on Climate Change, in 1997 in Kyoto, Japan. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most OECD countries and countries with economies in transition) agreed to reduce their anthropogenic →greenhouse gas emissions (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) by at least 5% below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol has not yet entered into force (April 2001).

Land use
The total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation).

Land-use change
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 →albedo, →evapotranspiration, →sources and →sinks of →greenhouse gases, or other properties of the →climate system and may thus have an impact 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.

Lifetime
Lifetime is a general term used for various time-scales characterising the rate of processes affecting the concentration of trace gases. The following lifetimes may be distinguished:

Turnover time (T) is the ratio of the mass M of a reservoir (e.g., a gaseous compound in the atmosphere) and the total rate of removal S from the reservoir: T = M/S. For each removal process separate turnover times can be defined. In soil carbon biology this is referred to as *Mean Residence Time (MRT)***.**

Adjustment time or *response time* (T_a) is the time-scale characterising the decay of an instantaneous pulse input into the reservoir. The term *adjustment time* is also used to characterise the adjustment of the mass of a reservoir following a step change in the source strength. *Half-life* or *decay constant* is used to quantify a first-order exponential decay process. See: →Response time**,** for a different definition pertinent to climate variations. The term ***lifetime*** is sometimes used, for simplicity, as a surrogate for *adjustment time***.**

In simple cases, where the global removal of the compound is directly proportional to the total mass of the reservoir, the adjustment time equals the turnover time: $T = T_a$. An example is CFC-11 which is removed from the atmosphere only by photochemical processes in the stratosphere. In more complicated cases, where several reservoirs are involved or where the removal is not proportional to the total mass, the equality $T = T_a$ no longer holds. →Carbon dioxide (CO_2) is an extreme example. Its turnover time is only about 4 years because of the rapid exchange between atmosphere and the ocean and terrestrial biota. However, a large part of that CO_2 is returned to the atmosphere within a few years. Thus, the adjustment time of CO_2 in the atmosphere is actually determined by the rate of removal of carbon from the surface layer of the oceans into its deeper layers. Although an approximate value of 100 years may be given for the adjustment time of CO_2 in the atmosphere, the actual adjustment is faster initially and slower later on. In the case of methane (CH_4) the adjustment time is different from the turnover time, because the removal is mainly through a chemical reaction with the hydroxyl radical OH, the concentration of which itself depends on the CH_4 concentration. Therefore the CH_4 removal S is not proportional to its total mass M.

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. See: →Isostatic land movements.

LOSU (Level of Scientific Understanding)
This is an index on a 4-step scale (High, Medium, Low and Very Low) designed to characterise the degree of scientific understanding of the radiative forcing agents that affect climate change. For each agent, the index represents a subjective judgement about the reliability of the estimate of its forcing, involving such factors as the assumptions necessary to evaluate the forcing, the degree of knowledge of the physical/ chemical mechanisms determining the forcing and the uncertainties surrounding the quantitative estimate.

Mean Sea Level
See: →Relative Sea Level.

Mitigation
A human intervention to reduce the →sources or enhance the →sinks of →greenhouse gases.

Mixing ratio
See: →Mole fraction.

Model hierarchy
See: →Climate model.

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 (parts per million: ppm), nmol/mol (parts per billion: ppb), and fmol/mol (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. (Source: Schwartz and Warneck, 1995).

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 CFCs, methyl chloroform, carbon tetrachloride, and many others.

Net Biome Production (NBP)
Net gain or loss of carbon from a region. NBP is equal to the →Net Ecosystem Production minus the carbon lost due to a disturbance, e.g. a forest fire or a forest harvest.

Net Ecosystem Production (NEP)
Net gain or loss of carbon from an →ecosystem. NEP is equal to the →Net Primary Production minus the carbon lost through →heterotrophic respiration.

Net Primary Production (NPP)
The increase in plant →biomass or carbon of a unit of a landscape. NPP is equal to the →Gross Primary Production minus carbon lost through →autotrophic respiration.

Nitrogen fertilisation
Enhancement of plant growth through the addition of nitrogen compounds. In IPCC Reports, this typically refers to fertilisation from anthropogenic sources of nitrogen such as human-made fertilisers and nitrogen oxides released from burning fossil fuels.

Non-linearity
A process is called "non-linear" when there is no simple proportional relation between cause and effect. The →climate system contains many such non-linear processes, resulting in a system with a potentially very complex behaviour. Such complexity may lead to →rapid climate change.

North Atlantic Oscillation (NAO)
The North Atlantic Oscillation consists of opposing variations of barometric pressure near Iceland and near the Azores. On average, a westerly current, between the Icelandic low pressure area and the Azores high pressure area, carries cyclones with their associated frontal systems towards Europe. However, the pressure difference between Iceland and the Azores fluctuates on time-scales of days to decades, and can be reversed at times.

Organic aerosol
→Aerosol particles consisting predominantly of organic compounds, mainly C, H, O, and lesser amounts of other elements. (Source: Charlson and Heintzenberg, 1995, p. 405.) See: →Carbonaceous aerosol.

Ozone
Ozone, the triatomic 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 decisive role in the stratospheric radiative balance. Its concentration is highest in the →ozone layer.

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 to 40 km. 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, also caused by human-made chlorine and bromine compounds in combination with the specific meteorological conditions of that region. This phenomenon is called the ***ozone hole***.

Parametrization
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 the area or time averaged effect of such sub-grid scale processes and the larger scale flow.

Patterns of climate variability
Natural variability of the →climate system, in particular on seasonal and longer time-scales, predominantly occurs in preferred spatial patterns, through the dynamical non-linear characteristics of the atmospheric circulation and through interactions with the land and ocean surfaces. Such spatial patterns are also called "regimes" or "modes". Examples are the →North Atlantic Oscillation (NAO), the Pacific-North American pattern (PNA), the →El Niño-Southern Oscillation (ENSO), and the Antarctic Oscillation (AO).

Photosynthesis
The process by which plants take CO_2 from the air (or bicarbonate in water) to build carbohydrates, releasing O_2 in the process. There are several pathways of photosynthesis with different responses to atmospheric CO_2 concentrations. See: →Carbon dioxide fertilisation.

Pool
See: →Reservoir.

Post-glacial rebound
The vertical movement of the continents and sea floor following

the disappearance and shrinking of →ice sheets, e.g. since the Last Glacial Maximum (21 ky BP). The rebound is an →isostatic land movement.

Ppm, ppb, ppt
See: → Mole fraction.

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

Pre-industrial
See: →Industrial revolution.

Projection (generic)
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 emphasise that projections involve assumptions concerning, e.g., future socio-economic 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 are: tree ring records, characteristics of corals, and various data derived from ice cores.

Radiative forcing
Radiative forcing is the change in the net vertical irradiance (expressed in Watts per square metre: Wm^{-2}) at the →tropopause due to an internal change or a change in the external forcing of the →climate system, such as, for example, a change in the concentration of →carbon dioxide or the output of the Sun. Usually radiative forcing is computed after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with all tropospheric properties held fixed at their unperturbed values. Radiative forcing is called *instantaneous* if no change in stratospheric temperature is accounted for. Practical problems with this definition, in particular with respect to radiative forcing associated with changes, by aerosols, of the precipitation formation by clouds, are discussed in Chapter 6 of this Report.

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.

Radio-echosounding
The surface and bedrock, and hence the thickness, of a glacier can be mapped by radar; signals penetrating the ice are reflected at the lower boundary with rock (or water, for a floating glacier tongue).

Rapid climate change
The →non-linearity of the →climate system may lead to rapid climate change, sometimes called *abrupt events* or even *surprises*. Some such abrupt events may be imaginable, such as a dramatic reorganisation of the →thermohaline circulation, rapid deglaciation, or massive melting of permafrost leading to fast changes in the →carbon cycle. Others may be truly unexpected, as a consequence of a strong, rapidly changing, forcing of a non-linear system.

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).

Regimes
Preferred →patterns of climate variability.

Relative Sea Level
Sea level measured by a →tide gauge with respect to the land upon which it is situated. Mean Sea Level (MSL) 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.

(Relative) Sea Level Secular Change
Long term changes in relative sea level caused by either →eustatic changes, e.g. brought about by →thermal expansion, or changes in vertical land movements.

Reservoir
A component of the →climate system, other than the atmosphere, which has the capacity to store, accumulate or release a substance of concern, e.g. 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 substance of concerns, held within a reservoir at a specified time, is called the *stock*.

Respiration
The process whereby living organisms convert organic matter to CO_2, releasing energy and consuming O_2.

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 comes into 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 fast, 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.

Scenario (generic)
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 scenarios.

Sea level rise
See: →Relative Sea Level Secular Change; →Thermal expansion.

Sequestration
See: →Uptake.

Significant wave height
The average height of the highest one-third of all sea waves occurring in a particular time period. This serves as an indicator of the characteristic size of the highest waves.

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

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
Radiation emitted by the Sun. It is also referred to as short-wave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the Sun. See also: →Infrared radiation.

Soot particles
Particles formed during the quenching of gases at the outer edge of flames of organic vapours, consisting predominantly of carbon, with lesser amounts of oxygen and hydrogen present as carboxyl and phenolic groups and exhibiting an imperfect graphitic structure. See: →Black carbon; Charcoal. (Source: Charlson and Heintzenberg, 1995, p. 406.)

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

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 to 10 million km^2) to continental (10 to 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 *et al*. (2000) and used, among others, as a basis for the climate projections in Chapter 9 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.

(Scenario) Group
Scenarios within a family that reflect a consistent variation of the storyline. The A1 scenario family includes four groups designated as A1T, A1C, A1G and A1B that explore alternative structures of future energy systems. In the Summary for Policymakers of Nakićenović *et al*. (2000), the A1C and A1G groups have been combined into one 'Fossil Intensive' A1FI scenario group. The other three scenario families consist of one group each. The SRES scenario set reflected in the Summary for Policymakers of Nakićenović *et al*. (2000) thus consist of six distinct scenario groups, all of which are equally sound and together capture the range of uncertainties associated with driving forces and emissions.

Illustrative Scenario
A scenario that is illustrative for each of the six scenario groups reflected in the Summary for Policymakers of Nakićenović *et al*. (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.

(Scenario) Marker
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 *et al*. (2000). These scenarios have received the closest scrutiny of the entire writing team and via the SRES open process. Scenarios have also been selected to illustrate the other two scenario groups (see also 'Scenario Group' and 'Illustrative Scenario').

(Scenario) Storyline
A narrative description of a scenario (or family of scenarios) highlighting the main scenario characteristics, relationships between key driving forces and the dynamics of their evolution.

Stock
See: →Reservoir.

Storm surge
The temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). The storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place.

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

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.

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.

Thermohaline circulation
Large-scale density-driven circulation in the ocean, caused by differences in temperature and salinity. In the North Atlantic the thermohaline circulation consists of warm surface water flowing northward and cold deep water flowing southward, resulting in a net poleward transport of heat. The surface water sinks in highly restricted sinking regions located in high latitudes.

Tide gauge
A device at a coastal location (and some deep sea locations) which continuously measures the level of the sea with respect to the adjacent land. Time-averaging of the sea level so recorded gives the observed →Relative Sea Level Secular Changes.

Transient climate response
The globally averaged surface air temperature increase, averaged over a 20 year period, centred at the time of CO_2 doubling, i.e., at year 70 in a 1% per year compound CO_2 increase experiment with a global coupled →climate model.

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 in mid-latitudes (ranging from 9 km in high latitudes to 16 km in the tropics on average) where clouds and "weather" phenomena occur. In the troposphere temperatures generally decrease with height.

Turnover time
See: →Lifetime.

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 (e.g. a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgement of a team of experts). See Moss and Schneider (2000).

United Nations Framework Convention on Climate Change (UNFCC)
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 aim to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention entered into 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*.

Volume mixing ratio
See: →Mole fraction.

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