Appendix E
Glossary Terms

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Abrupt climate change
Change in the climate system on a timescale shorter than the timescale of the responsible forcing. In the case of anthropogenic forcing over the past century, abrupt change occurs over decades or less. Abrupt change need not be externally forced. (*CSSR, Ch. 15*)

Aerosol–cloud interaction
A process by which a perturbation to aerosol affects the microphysical properties and evolution of clouds through the aerosol role as cloud condensation nuclei or ice nuclei, particularly in ways that affect radiation or precipitation; such processes can also include the effect of clouds and precipitation on aerosol. The aerosol perturbation can be anthropogenic or come from some natural source. The radiative forcing from such interactions has traditionally been attributed to numerous indirect aerosol effects, but in this report, only two levels of radiative forcing (or effect) are distinguished:

The radiative forcing (or effect) due to aerosol–cloud interactions (**RFaci**) is the radiative forcing (or radiative effect, if the perturbation is internally generated) due to the change in number or size distribution of cloud droplets or ice crystals that is the proximate result of an aerosol perturbation, with other variables (in particular total cloud water content) remaining equal. In liquid clouds, an increase in cloud droplet concentration and surface area would increase the cloud albedo. This effect is also known as the cloud albedo effect, first indirect effect, or Twomey effect. It is a largely theoretical concept that cannot readily be isolated in observations or comprehensive process models due to the rapidity and ubiquity of rapid adjustments. This is contrasted with the effective radiative forcing (or effect) due to aerosol–cloud interactions (ERFaci)

The total effective radiative forcing due to both aerosol–cloud and aerosol–radiation interactions is denoted aerosol effective radiative forcing (ERFari+aci). See also **aerosol–radiation interaction**. (condensed from IPCC AR5 WGI Annex III: Glossary)

Aerosol–radiation interaction (RFari)
The radiative forcing (or radiative effect, if the perturbation is internally generated) of an aerosol perturbation due directly to aerosol–radiation interactions, with all environmental variables remaining unaffected. It is traditionally known in the literature as the *direct aerosol forcing* (or *effect*).

The total effective radiative forcing due to both aerosol–cloud and aerosol–radiation interactions is denoted aerosol effective radiative forcing (ERFari+aci). See also **aerosol-cloud interaction**. (condensed from IPCC AR5 WGI Annex III: Glossary)

Agricultural drought
See **drought**.

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, 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 AR5 WGI Annex III: Glossary)

Altimetry
A technique for measuring the height of the Earth's surface with respect to the geocenter of the Earth within a defined terrestrial reference

frame (geocentric sea level). (IPCC AR5 WGI Annex III: Glossary)

Anticyclonic circulation
Fluid motion having a sense of rotation about the local vertical opposite to that of the earth's rotation; that is, clockwise in the Northern Hemisphere, counterclockwise in the Southern Hemisphere, and undefined at the equator. It is the opposite of **cyclonic circulation**. (AMS glossary).

Atlantic meridional overturning circulation (AMOC)
See **Meridional overturning circulation (MOC)**.

Atmospheric blocking
See **Blocking**.

Atmospheric river
A long, narrow, and transient corridor of strong horizontal water vapor transport that is typically associated with a low-level jet stream ahead of the cold front of an extratropical cyclone. The water vapor in atmospheric rivers is supplied by tropical and/or extratropical moisture sources. Atmospheric rivers frequently lead to heavy precipitation where they are forced upward—for example, by mountains or by ascent in the warm conveyor belt. Horizontal water vapor transport in the midlatitudes occurs primarily in atmospheric rivers and is focused in the lower troposphere. (AMS glossary).

Baroclinicity
The state of stratification in a fluid in which surfaces of constant pressure (isobaric) intersect surfaces of constant density (isosteric). (AMS glossary).

Bias correction method
One of two main statistical approaches used to alleviate the limitations of global and regional climate models, in which the statistics of the simulated model outputs are adjusted to those of the observation data. (The other approach is **empirical/stochastic downscaling**, described under **downscaling**). The rescaled variables can remove the effects of systematic errors in climate model outputs. (derived from Kim et al., 2015)

Biological pump
The suite of biologically mediated processes responsible for transporting carbon against a concentration gradient from the upper ocean to the deep ocean. (Passow and Carlson, 2012)

Blocking
Associated with persistent, slow-moving high pressure systems that obstruct the prevailing westerly winds in the middle and high latitudes and the normal eastward progress of extratropical transient storm systems. It is an important component of the intraseasonal climate variability in the extratropics and can cause long-lived weather conditions such as cold spells in winter and heat waves in summer. (IPCC AR5 WGI Annex III: Glossary)

Carbon dioxide fertilization
The enhancement of the growth of plants as a result of increased atmospheric CO_2 concentration. (IPCC AR5 WGI Annex III: Glossary)

Carbon dioxide removal
A set of techniques that aim to remove CO_2 directly from the atmosphere by either (1) increasing natural sinks for carbon or (2) using chemical engineering to remove the CO_2, with the intent of reducing the atmospheric CO_2 concentration. CDR methods involve the ocean, land and technical systems, including such methods as iron fertilization, large-scale afforestation and direct capture of CO_2 from the atmosphere using engineered chemical means. (truncated version from IPCC AR5 WGI Annex III: Glossary)

Climate engineering
See **geoengineering**.

Climate intervention
See **geoengineering**.

Climate sensitivity
In Intergovernmental Panel on Climate Change (IPCC) reports, **equilibrium climate sensitivity** (units: °C) refers to the equilibrium (steady state) change in the annual global mean surface temperature following a doubling of the atmospheric equivalent carbon dioxide concentration. The **effective climate sensitivity** (units: °C) is an estimate of the global mean surface temperature re-

sponse to doubled carbon dioxide concentration that is evaluated from model output or observations 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, and therefore may differ from equilibrium climate sensitivity. The **transient climate response** (units: °C) is the change in the global mean surface temperature, averaged over a 20-year period centered at the time of atmospheric carbon dioxide doubling, in a climate model simulation in which CO_2 increases at 1% per year. It is a measure of the strength and rapidity of the surface temperature response to greenhouse gas forcing. (IPCC AR5 WGI Annex III: Glossary)

Cloud radiative effect

The radiative effect of clouds relative to the identical situation without clouds (previously called cloud radiative forcing). (drawn from IPCC AR5 WGI Annex III: Glossary)

Clouds can act as a greenhouse ingredient to warm the Earth by trapping outgoing longwave infrared radiative flux at the top of the atmosphere (the **longwave cloud radiative effect [LWCRE]**). Clouds can also enhance the planetary albedo by reflecting shortwave solar radiative flux back to space to cool the Earth (the **shortwave cloud radiative effect [SWCRE]**). The net effect of the two competing processes depends on the height, type, and the optical properties of the clouds. (edited from *NOAA*, Geophysical Fluid Dynamics Laboratory)

CMIP

The Coupled Model Intercomparison Project is a standard experimental protocol for studying the output of coupled atmosphere–ocean general circulation models (AOGCMs). Phases three and five (CMIP3 and CMIP5, respectively) coordinated and archived climate model simulations based on shared model inputs by modeling groups from around the world. The CMIP3 multi-model data set includes projections using the SRES scenarios drawn from the Intergovernmental Panel on Climate Change's Special Report on Emissions Scenarios. The CMIP5 dataset includes projections using the **Representative Concentration Pathways**. (edited from IPCC AR5 WGII Annex II: Glossary).

Compound event

An event that consists of 1) two or more extreme events occurring simultaneously or successively, 2) combinations of extreme events with underlying conditions that amplify the impact of the events, or 3) combinations of events that are not themselves extremes but lead to an extreme event or impact when combined. The contributing events can be of similar or different types. (*CSSR, Ch. 15*, drawing upon *SREX 3.1.3*)

Critical threshold

A threshold that arises within a system as a result of the amplifying effects of positive **feedbacks**. The crossing of a critical threshold commits the system to a change in state. (*CSSR, Ch. 15*)

Cryosphere

All regions on and beneath the surface of the Earth and ocean where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers and ice sheets, and frozen ground (which includes permafrost). (IPCC AR5 WGI Annex III: Glossary)

Cyclonic circulation

Fluid motion in the same sense as that of the earth, that is, counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere, undefined at the equator. (AMS glossary).

Denitrification

As used in this report, refers to the loss of fixed nitrogen in the ocean through biogeochemical processes. (*CSSR, Ch. 13*).

Deoxygenation

See **hypoxia**.

Downscaling

A method that derives local- to regional-scale (10–100 km) information from larger-scale models or data analyses. Two main methods exist. **Dynamical downscaling** uses the output of regional climate models, global models with variable spatial resolution, or high-resolution global models. **Empirical/statistical downscal-**

ing methods develop statistical relationships that link the large-scale atmospheric variables with local/regional climate variables. In all cases, the quality of the driving model remains an important limitation on the quality of the downscaled information. (IPCC AR5 WGI Annex III: Glossary)

Drought
A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term; therefore, any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture drought, also termed **agricultural drought**), and during the runoff and percolation season primarily affects water supplies (**hydrological drought**). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a **meteorological drought**. (IPCC AR5 WGI Annex III: Glossary)

Dynamical downscaling
See **downscaling**.

Earth System Model
A coupled atmosphere–ocean general circulation model in which a representation of the carbon cycle is included, allowing for interactive calculation of atmospheric CO_2 or compatible emissions. Additional components (for example, atmospheric chemistry, ice sheets, dynamic vegetation, nitrogen cycle, but also urban or crop models) may be included. (IPCC AR5 WGI Annex III: Glossary)

Effective radiative forcing
See **radiative forcing**.

El Niño–Southern Oscillation
A natural variability in ocean water surface pressure that causes periodic changes in ocean surface temperatures in the tropical Pacific Ocean. El Niño–Southern Oscillation (ENSO) has two phases: the warm oceanic phase, El Niño, accompanies high air surface pressure in the western Pacific, while the cold phase, La Niña, accompanies low air surface pressure in the western Pacific. Each phase generally lasts for 6 to 18 months. ENSO events occur irregularly, roughly every 3 to 7 years. The extremes of this climate pattern's oscillations cause extreme weather (such as floods and droughts) in many regions of the world. (*USGCRP*)

Empirical/statistical downscaling
See **downscaling**.

Equivalent carbon dioxide concentration
The concentration of carbon dioxide that would cause the same radiative forcing as a given mixture of carbon dioxide and other forcing components. Those values may consider only greenhouse gases, or a combination of greenhouse gases and aerosols. Equivalent carbon dioxide concentration is a metric for comparing radiative forcing of a mix of different greenhouse gases at a particular time but does not imply equivalence of the corresponding climate change responses nor future forcing. There is generally no connection between equivalent carbon dioxide emissions and resulting equivalent carbon dioxide concentrations. (IPCC AR5 WGI Annex III: Glossary)

Eutrophication
Over-enrichment of water by nutrients such as nitrogen and phosphorus. It is one of the leading causes of water quality impairment. The two most acute symptoms of eutrophication are **hypoxia** (a state of oxygen depletion) and harmful algal blooms. (IPCC AR5 WGII Annex II: Glossary).

Extratropical cyclone
A large-scale (of order 1,000 km) storm in the middle or high latitudes having low central pressure and fronts with strong horizontal gradients in temperature and humidity. A major cause of extreme wind speeds and heavy precipitation especially in wintertime. (IPCC AR5 WGI Annex III: Glossary)

Feedbacks

An interaction between processes in the climate system, in which the result of an initial process triggers changes in a second process that in turn influences the initial one. A **positive feedback** magnifies the original process, while a **negative feedback** attenuates or diminishes it. Positive feedbacks are sometimes referred to as "vicious" or "virtuous" cycles, depending on whether their effects are viewed as harmful or beneficial. (*CSSR, Ch. 15*)

Geoengineering

A broad set of methods and technologies that aim to deliberately alter the climate system in order to alleviate the impacts of climate change (also known as **climate intervention** (National Academy of Sciences) or climate engineering). Most, but not all, methods seek to either 1) reduce the amount of absorbed solar energy in the climate system (**Solar Radiation Management**) or 2) increase net carbon sinks from the atmosphere at a scale sufficiently large to alter climate (**Carbon Dioxide Removal**). Scale and intent are of central importance. Two key characteristics of geoengineering methods of particular concern are that they use or affect the climate system (e.g., atmosphere, land, or ocean) globally or regionally and/or could have substantive unintended effects that cross national boundaries. (adapted from IPCC AR5 WGI Annex III: Glossary)

Glacial isostatic adjustment (GIA)

The deformation of the Earth and its gravity field due to the response of the earth–ocean system to changes in ice and associated water loads. It includes vertical and horizontal deformations of the Earth's surface and changes in geoid due to the redistribution of mass during the ice–ocean mass exchange. GIA is currently contributing to relative sea level rise in much of the continental United States. (IPCC AR5 WGI Annex III: Glossary)

Glacier

A perennial mass of land ice that originates from compressed snow, shows evidence of past or present flow (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 and/or discharge into the sea. An ice mass of the same origin as glaciers, but of continental size, is an **ice sheet**, defined further below. (IPCC AR5 WGI Annex III: Glossary)

Global mean sea level

The average of relative sea level or of sea surface height across the ocean.

Global warming potential (GWP)

An index, based on radiative properties of greenhouse gases, measuring the radiative forcing following a pulse emission of a unit mass of a given 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 causing radiative forcing. (truncated from IPCC AR5 WGI Annex III: Glossary)

Gravimetry

Measurement of the Earth's gravitational field. Using satellite data from the Gravity Recovery and Climate Experiment (GRACE), measurements of the mean gravity field help scientists better understand the structure of the solid Earth and learn about ocean circulation. Monthly measurements of time-variable gravity can be used to study ground water fluctuations, sea ice, sea level rise, deep ocean currents, ocean bottom pressure, and ocean heat flux. (modified from *NASA Earth Observatory on the* GRACE *project*)

Greenhouse gas (GHG)

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 terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapor (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 dealt with the greenhouse gases sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). (adapted from IPCC AR5 WGI Annex III: Glossary)

Hydrological drought
See **drought**.

Hypoxia
Deficiency of oxygen in water bodies, which can be a symptom of **eutrophication** (nutrient overloading). **Deoxygenation** (the process of removing oxygen) leads to hypoxia, and the expansion of **oxygen minimum zones** (IPCC AR5 WGII Annex II: Glossary supplemented with other sources).

Ice sheet
A mass of land ice of continental size that is sufficiently thick to cover most of the underlying bed, 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 two ice sheets in the modern world, one on Greenland and one on Antarctica. During glacial periods there were others, including the Laurentide Ice Sheet in North America, whose loss is the primary driver of **glacial isostatic adjustment** in the United States today. (adapted from IPCC AR5 WGI Annex III: Glossary)

Ice wedge
Common features of the subsurface in permafrost regions, ice wedges develop by repeated frost cracking and ice vein growth over hundreds to thousands of years. Ice wedge formation causes the archetypal polygonal patterns seen in tundra across the Arctic landscape. (adapted from Liljedal et al., 2016)

Instantaneous radiative forcing
See **radiative forcing**.

Irreversible
Changes in components of the climate system that either cannot be reversed, or can only be reversed on timescales much longer than the timescale over which the original forcing occurred. (*CSSR, Ch. 15*)

Longwave cloud radiative effect (LWCRE)
See **cloud radiative effect**.

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 Atlantic MOC (AMOC, which is in principle an observable quantity) is often identified with the thermohaline circulation (THC), which is a conceptual and incomplete interpretation. It must be borne in mind that the AMOC is also driven by wind, and can also include shallower 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. (adapted from IPCC AR5 WGI Annex III: Glossary)

Meridional temperature gradient
North–South temperature variation

Meteorological drought
See **drought**.

Mode water
Water of exceptionally uniform properties over an extensive depth range, caused in most instances by convection. Mode waters represent regions of water mass formation; they are not necessarily water masses in their own right but contribute significant volumes of water to other water masses. Because they represent regions of deep sinking of surface water, mode water formation regions are atmospheric heat sources. Subantarctic Mode Water is formed during winter in the subantarctic zone just north of the subantarctic front and contributes to the lower temperature range of central water; only in the extreme eastern Pacific Ocean does it obtain a temperature low enough to contribute to Antarctic Intermediate Water. Subtropical

Mode Water is mostly formed through enhanced subduction at selected locations of the subtropics and contributes to the upper temperature range of central water. Examples of Subtropical Mode Water are the 18°C water formed in the Sargasso Sea, Madeira Mode Water formed at the same temperature but in the vicinity of Madeira, and 13°C water formed not by surface processes but through mixing in Agulhas Current eddies as they enter the Benguela Current. (AMS glossary).

Model ability/model skill
Representativeness of the ability of a climate model to reproduce historical climate observational data.

Model bias
Systematic error in model output that over- or under-emphasizes particular model mechanism or results.

Model ensemble
Also known as a multimodel ensemble (MME), a group of several different global climate models (GCMs) used to create a large number of climate simulations. An MME is designed to address **structural model uncertainty** between different climate models, rather than **parametric uncertainty** within any one particular model. (*UK Met Office, Climate Projections*, Glossary)

Model independence
An analysis of the degree to which models are different from one another. Also is used as an interpretation of an ensemble as constituting independent samples of a distribution which represents our collective understanding of the climate system. (summarized based on Annan and Hargreaves, 2017)

Nationally determined contributions (NDCs)
See **Paris Agreement**.

Negative feedbacks
See **feedbacks**.

Nitrogen mineralization
Mineralization/remineralization is the conversion of an element from its organic form to an inorganic form as a result of microbial decomposition. In nitrogen mineralization, organic nitrogen from decaying plant and animal residues (proteins, nucleic acids, amino sugars and urea) is converted to ammonia (NH_3) and ammonium (NH4+) by biological activity. (IPCC AR5 WGI Annex III: Glossary)

Ocean acidification
The process by which ocean waters have become more acidic due to the absorption of human-produced carbon dioxide, which interacts with ocean water to form carbonic acid and lower the ocean's pH. Acidity reduces the capacity of key plankton species and shelled animals to form and maintain shells. (*USGCRP*)

Ocean stratification
The existence or formation of distinct layers or laminae in the ocean identified by differences in thermal or salinity characteristics (e.g., densities) or by oxygen or nutrient content. (adapted from AMS glossary).

Oxygen minimum zones (OMZs)
The midwater layer (200–1,000 m) in the open ocean in which oxygen saturation is the lowest in the ocean. The degree of oxygen depletion depends on the largely bacterial consumption of organic matter, and the distribution of the OMZs is influenced by large-scale ocean circulation. In coastal oceans, OMZs extend to the shelves and may also affect benthic ecosystems. OMZs can expand through a process of **deoxygenation**. (supplemented version of IPCC AR5 WGII Annex II: Glossary).

Pacific Decadal Oscillation
The pattern and time series of the first empirical orthogonal function of sea surface temperature over the North Pacific north of 20°N. The PDO broadened to cover the whole Pacific Basin is known as the Interdecadal Pacific Oscillation. The PDO and IPO exhibit similar temporal evolution. (IPCC AR5 WGI Annex III: Glossary)

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 variables and the area- or time-averaged effect of such subgrid scale processes. (IPCC AR5 WGI Annex III: Glossary)

Parametric uncertainty
See **uncertainty**.

Paris Agreement
An international climate agreement with the central aim to hold global temperature rise this century well below 2°C above preindustrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. For the first time, all parties are required to put forward emissions reductions targets, and to strengthen those efforts in the years ahead as the Agreement is assessed every five years. Each country's proposed mitigation target (the intended nationally determined contribution [INDC]) becomes an official **nationally determined contribution (NDC)** when the country ratifies the agreement. The Paris Agreement was finalized on December 12, 2015, at the 21st Conference of Parties (COP 21) of the United National Framework Convention on Climate Change (UNFCCC). "Paris" entered into force on November 4, 2016, after ratification by 55 countries that account for at least 55% of global emissions). The agreement had a total of 125 national parties by early 2017. (summarized/edited from *UNFCCC*)

Pattern scaling
A simple and computationally cheap method to produce climate projections beyond the scenarios run with expensive global climate models (GCMs). The simplest technique has known limitations and assumes that a spatial climate anomaly pattern obtained from a GCM can be scaled by the global mean temperature anomaly. (Herger et al., 2015)

Permafrost
Ground that remains at or below freezing for at least two consecutive years. (*USGCRP*)

Permafrost active layer
The layer of ground that is subject to annual thawing and freezing in areas underlain by permafrost. (IPCC AR5 WGI Annex III: Glossary)

Petagram
One petagram (Pg) = 10^{15} grams or 10^{12} kilograms. A petagram is the same as a gigaton, which is a billion metric tons, where 1 metric ton is 1,000 kg. Estimated 2014 global fossil fuel emissions were 9.855 Pg = 9.855 Gt = 9,855 million metric tons of carbon. (CDIAC – Carbon Dioxide Information Center: Boden et al., 2017)

Positive feedbacks
See **feedbacks**.

Proxy
A way to indirectly measure aspects of climate. Biological or physical records from ice cores, tree rings, and soil boreholes are good examples of proxy data. (*USGCRP*)

Radiative forcing
The change in the net (downward minus upward) radiative flux (expressed in $W/m^{2)}$ at the tropopause or top of atmosphere due to a change in an external driver of climate change, such as a change in the concentration of carbon dioxide or in the output of the Sun. Sometimes internal drivers are still treated as forcings even though they result from the alteration in climate, for example aerosol or greenhouse gas changes in paleoclimates. The traditional 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 **instantaneous** if no change in stratospheric temperature is accounted for. The radiative forcing once rapid adjustments are accounted for is the **effective radiative forcing**. Radiative forcing is not to be confused with cloud radiative forcing, which describes an unrelated measure of the impact of clouds on the radiative flux at the top of the atmosphere. (truncated from IPCC AR5 WGI Annex III: Glossary)

Relative sea level
The height of the sea surface, measured with respect to the height of the underlying land. Relative sea level changes in response to both changes in the height of the sea surface and changes in the height of the underlying land.

Representative Concentration Pathways

Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover. The word "representative" signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term "pathway" emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome. RCPs usually refer to the portion of the concentration pathway extending up to 2100. Four RCPs produced from Integrated Assessment Models were selected from the published literature for use in the Intergovernmental Panel on Climate Change's Fifth Assessment Report: **RCP2.6**, a pathway where radiative forcing peaks at approximately 3 W/m^2 before 2100 and then declines; **RCP4.5** and **RCP6.0**, two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W/m^2 and 6.0 W/m^2, respectively, after 2100; and **RCP8.5**, a high pathway for which radiative forcing reaches greater than 8.5 W/m^2 by 2100 and continues to rise for some amount of time (truncated and adapted from IPCC AR5 WGI Annex III: Glossary, excluding discussion of extended concentration pathways)

Rossby waves

Rossby waves, also known as planetary waves, naturally occur in rotating fluids. Within the Earth's ocean and atmosphere, these waves form as a result of the rotation of the planet. These waves affect the planet's weather and climate. Oceanic Rossby waves are huge, undulating movements of the ocean that stretch horizontally across the planet for hundreds of kilometers in a westward direction. Atmospheric Rossby waves form primarily as a result of the Earth's geography. Rossby waves help transfer heat from the tropics toward the poles and cold air toward the tropics in an attempt to return the atmosphere to balance. They also help locate the jet stream and mark out the track of surface low pressure systems. The slow motion of these waves often results in fairly long, persistent weather patterns. (adapted from NOAA National Ocean Service)

Saffir-Simpson hurricane scale

A classification scheme for hurricane intensity based on the maximum surface wind speed and the type and extent of damage done by the storm. The wind speed categories are as follows: 1) 33–42 m/s (65–82 knots or 74–95 mph); 2) 43–49 m/s (83– 95 knots or 96–110 mph); 3) 50–58 m/s (96–113 knots or 111–129 mph); 4) 59–69 m/s (114–134 knots or 130–156 mph); and 5) 70 m/s (135 knots or 156 mph) and higher. These categories are used routinely by weather forecasters in North America to characterize the intensity of hurricanes for the public. (adapted from AMS glossary).

Saturation

The condition in which vapor pressure is equal to the equilibrium vapor pressure over a plane surface of pure liquid water, or sometimes ice. (AMS glossary).

Scenarios

Plausible descriptions of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are useful to provide a view of the implications of developments and actions. (IPCC AR5 WGI Annex III: Glossary)

Sea level pressure

The atmospheric pressure at mean sea level, either directly measured or, most commonly, empirically determined from the observed station pressure. In regions where the Earth's surface is above sea level, it is standard observational practice to reduce the observed surface pressure to the value that would exist at a point at sea level directly below if air of a temperature corresponding to that actually present at the surface were present all the way down to sea level. In actual practice, the mean temperature for the preceding 12 hours is employed, rather than the current temperature. This "reduction of pressure to sea level" is responsible for many anomalies in the pressure field in mountainous areas on the surface synoptic chart. (AMS glossary).

Shared Socioeconomic Pathways
A basis for emissions and socioeconomic scenarios, an SSP is one of a collection of pathways that describe alternative futures of socioeconomic development in the absence of climate policy intervention. The combination of SSP-based socioeconomic scenarios and **Representative Concentration Pathway (RCP)-**based climate projections can provide a useful integrative frame for climate impact and policy analysis. (updated from IPCC AR5 WGIII Annex I: Glossary).

Shortwave cloud radiative effect (SWCRE)
See **cloud radiative effect**.

Snow water equivalent
The depth of liquid water that would result if a mass of snow melted completely. (IPCC AR5 WGI Annex III: Glossary)

Solar radiation management (SRM)
The intentional modification of the Earth's shortwave radiative budget with the aim to reduce climate change according to a given metric (for example, surface temperature, precipitation, regional impacts, etc). Artificial injection of stratospheric aerosols and cloud brightening are two examples of SRM techniques. Methods to modify some fast-responding elements of the longwave radiative budget (such as cirrus clouds), although not strictly speaking SRM, can be related to SRM. See also **geoengineering**. (edited from IPCC AR5 WGI Annex III: Glossary)

Static-equilibrium (sea level change) fingerprint
The near-instantaneous pattern of **relative sea level** change associated with changes in the distribution of mass at the surface of the Earth, for example due to the melting of ice on land. Near a shrinking ice sheet (within ~2,000 km of the margin), sea level will fall due to both crustal uplift and the reduction of the gravitational pull on the ocean from the ice sheet. Close to the ice sheet, this fall can be an order of magnitude greater than the equivalent rise in global mean sea level associated with the meltwater addition to the ocean. Far from the ice sheet, sea level will generally rise with greater amplitude as the distance from the ice sheet increases, and this rise can exceed the global mean value by up to about 30%. (draws on Hay et al., 2012)

Structural model uncertainty
See **uncertainty**.

Teleconnection
A statistical association between climate variables at widely separated, geographically fixed spatial locations. Teleconnections are caused by large spatial structures such as basin-wide coupled modes of ocean–atmosphere variability, Rossby wave-trains, midlatitude jets and storm tracks, etc. (IPCC AR5 WGI Annex III: Glossary)

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 the **Meridional Overturning Circulation**. (IPCC AR5 WGI Annex III: Glossary)

Thermokarst
The process by which characteristic landforms result from the thawing of ice-rich permafrost or the melting of massive ground ice. (IPCC AR5 WGI Annex III: Glossary)

Threshold
The value of a parameter summarizing a system, or a process affecting a system, at which qualitatively different system behavior emerges. Beyond this value, the system may not conform to statistical relationships that described it previously. For example, beyond a threshold level of ocean acidification, wide-scale collapse of coral ecosystems may occur. (*CSSR, Ch. 15*)

Tipping elements
Systems with critical thresholds, beyond which small perturbations in forcing can—as a result of positive feedbacks—lead to large, nonlinear, and irreversible shifts in state. In the climate system, a tipping element is a subcomponent of the climate system (typically at a spatial scale of approximately 1,000 km or larger). (*CSSR, Ch. 15*)

Tipping point
The critical **threshold** of a tipping element. Some limit its use to critical thresholds in which both the commitment to change and the change itself occur without a significant lag, while others also apply it to situations where a commitment occurs rapidly, but the committed change may play out over centuries and even millennia. (*CSSR, Ch. 15*)

Transient climate response
See **climate sensitivity**.

Tropopause
The boundary between the troposphere and the stratosphere. (IPCC AR5 WGI Annex III: Glossary)

Uncertainty
A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (for example, a probability density function) or by qualitative statements (for example, reflecting the judgment of a team of experts) (cut from IPCC AR5 WGII Annex II: Glossary).

Given that no model can represent the world with complete accuracy, **structural model uncertainty** refers to how well the physical processes of the real world are represented in the structure of a model. Different modeling research groups will represent the climate system in different ways, and to some extent this decision is a subjective judgement. The use of climate **model ensembles** can address the uncertainty of differently structured models. (adapted from *UK Met Office, Climate Projections*, Glossary)

In contrast, **parametric uncertainty** refers to incomplete knowledge about real world processes in a climate model. A parameter is well-specified in that it has a true value, even if this value is unknown. Such empirical quantities can be measured, and the level of uncertainty about them can be represented in probabilistic terms. (adapted from *Morgan and Henrion, 1990, pp 50-52*)

Urban heat island effect
The relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, effects on heat retention, and changes in surface albedo. (IPCC AR5 WGI Annex III: Glossary)

Zonal mean
Data average along a latitudinal circle on the globe.