### Summary of edit to be made

<table>
<thead>
<tr>
<th>SPM Page:Line</th>
<th>Chapter/Su pp. Material</th>
<th>Chapter Page:Line</th>
<th>Summary of edit to be made</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3.5 &amp; footnote 12, &quot;compound extreme events&quot;</td>
<td>Annex VII: Glossary</td>
<td>16:17-18</td>
<td>Please add: &quot;The terms 'compound events', 'compound extremes' and 'compound extreme events' are used interchangeably in the literature and this report and refer to....&quot;</td>
</tr>
<tr>
<td>17:Footnote 22</td>
<td>Annex VII: Glossary</td>
<td>32:50</td>
<td>To be consistent with the wording in CCBox 1.3 and the LLHI outcome definition in SPM Footnote, the words in the parenthesis need to be deleted behind the Glossary term &quot;Impacts&quot;, which should then only be &quot;Impacts: The consequences of realised risks on natural and human systems, .... * Note that this doesn't change the definition as agreed with WGII.</td>
</tr>
<tr>
<td>17:Footnote 22</td>
<td>Annex VII: Glossary</td>
<td>37:14</td>
<td>The wording in the term and definition of Low-likelihood, high impact events needs to be change to read &quot;Low-likelihood, high impact outcomes: Outcomes/events whose probability...&quot;</td>
</tr>
<tr>
<td>18:2</td>
<td>Annex VII: Glossary</td>
<td>62:13</td>
<td>Add the following definition for 'Urbanization' to the glossary: In the WGI report, urbanization is used to mean the process of soil sealing with the change of natural land cover to built environment and urban areas, together with its associated albedo changes, and increased surface runoff and elevated warming. See also Urban heat island (UHI). Revise the glossary definition for 'Urban heat island' to the following: The relative warmth of a city compared with surrounding rural areas, associated with heat trapping due to the close proximity of tall buildings, the heat-absorbing properties of urban building materials, reduced ventilation, and heat generated directly from human activities. See also Urbanization.</td>
</tr>
</tbody>
</table>
### ANNEX VII (GLOSSARY)

<table>
<thead>
<tr>
<th>Document (Chapter, Annex, Supp. Mat…)</th>
<th>Section</th>
<th>Page :Line</th>
<th>Detailed info on correction to make</th>
<th>TSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annex VII – Glossary</td>
<td></td>
<td>1 : 35</td>
<td>Replace “that the term” by “that the italicized term”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td></td>
<td></td>
<td>Added definition (was omitted)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The response to an agent perturbing the climate system that is driven directly by the agent, independently of any change in global surface temperature. For example, carbon dioxide and aerosols, by altering internal heating and cooling rates within the atmosphere, can each cause changes to cloud cover and other variables thereby producing an effective radiative forcing even in the absence of any surface warming or cooling. Adjustments are usually rapid in the sense that they begin to occur right away, before climate feedbacks which are driven by global surface warming (although some adjustments may still take significant time to proceed to completion, for example those involving vegetation or ice sheets).</td>
<td></td>
</tr>
<tr>
<td>Annex VII (Glossary)</td>
<td></td>
<td>19:7</td>
<td>Replace “Agricultural or ecological drought” with “Agricultural and ecological drought“. Note “and”, not “or”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td></td>
<td>37:7</td>
<td>Replace “fluorinated gases” with “halogenated compounds”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Apparent hydrological sensitivity</td>
<td></td>
<td>Replace “global mean temperature change” by “global mean surface air temperature (GSAT) change”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Arctic oscillation (AO)</td>
<td></td>
<td>Added definition (was omitted): See Northern Annular Mode (NAM) (under Annular modes).</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Baseline/reference</td>
<td></td>
<td>Updated definition: See Reference scenario (under Scenario) and Reference period.</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Carbon cycle</td>
<td></td>
<td>Replace “1GtC corresponds to 3.667 GtCO2” by “1GtC corresponds to 3.664 GtCO2”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Chlorofluorocarbons (CFCs)</td>
<td></td>
<td>Replace “they break down ozone (O3). It is one…” by “they lead to ozone (O3) depletion. They are some…”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Category</td>
<td>Original Definition</td>
<td>Updated Definition</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>----------</td>
<td>---------------------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td>Climate feedback parameter</td>
<td>Remove “which are GHGs covered under the Kyoto Protocol”</td>
<td>Replace “to a global surface temperature change” by “to a change”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate scenario</td>
<td>Remove definition (added in error)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud feedback</td>
<td>Replace “global mean surface temperature” by “global surface temperature”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remove “At present, cloud feedbacks remain the largest source of uncertainty in climate sensitivity estimates.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud radiative effect</td>
<td>Remove “In previous IPCC reports this was called cloud radiative forcing, but that terminology is inconsistent with other uses of the forcing term and is not maintained in this report.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold days/cold nights</td>
<td>Remove definition (added in error)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmogenic radioisotopes</td>
<td>Remove definition (added in error)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diatoms</td>
<td>Updated definition</td>
<td>Microscopic (2-200µm) unicellular photosynthetic algae that live in surface waters of lakes, rivers and oceans and form shells of opal. In the global ocean, marine diatom species distribution is primarily driven by nutrient availability. On regional scales, their species distribution in ocean sediment cores can be related to past sea surface temperatures (Abrantes et al., 2013).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct emissions</td>
<td>Remove definition (added in error)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Earth’s energy budget | Added definitions (they were omitted) | **Earth’s energy budget** encompasses the major energy flows of relevance for the *climate system*: the top-of-atmosphere energy budget; the surface energy budget; changes in the global energy inventory and internal flows of energy within the climate system that characterise the climate state.

*Top-of-atmosphere energy budget* comprises the energy fluxes associated with incoming *solar radiation*, reflected solar radiation and emitted thermal radiation. Typical units: W m⁻².

*Surface energy budget* comprises the exchanges of heat at the surface of the Earth associated with both radiative and non-radiative processes. Typical units: W m⁻².

*Global energy inventory* quantifies the excess energy absorbed or lost by the Earth system (*ocean, land atmosphere and cryosphere*). |
 mostly in the form of heat, associated with radiative forcing of the climate. Typical units: Joules.

**Global energy budget**  For a given time period, the global energy budget expresses the balance between change in the global energy inventory, the time-integrated effective radiative forcing and time-integrated radiative response of the climate system. Typical units: Joules.

See also Earth’s energy imbalance.

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Earth’s energy imbalance</th>
<th>Added definition (was omitted)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>The persistent and positive (downward) net top of atmosphere energy flux associated with greenhouse gas forcing of the climate system. See also Earth’s energy budget and Radiative response (of the climate system).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Emulators</th>
<th>Replace “one or few line climate models” by “simple climate models”</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Replace “An energy balance model is a simplified model that analyses the energy budget of the Earth to compute changes in the climate.” by “An energy balance model is a simplified climate model that is typically used as an emulator of climate to analyse the energy budget of the Earth to compute changes in the climate.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Extreme/heavy precipitation event</th>
<th>Replace “space” by “place”</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Glacial or glaciation</th>
<th>Replace “was near its most recent lowest stand” by “was nearly at its lowest level”</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>East Asian monsoon (EAsiaM)</th>
<th>Replace “Lately in July” by “In July” Replace “north, northeast” by “north and northeast”</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Gravity Recovery And Climate Experiment (GRACE)</th>
<th>Replace “A pair of satellites to measure…” by “A pair of satellites that measured…”</th>
</tr>
</thead>
</table>

|----------------------|-------------------|------------------------------------------------|

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Hindcast or retrospective forecast</th>
<th>Remove definition (added in error)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Hydrofluorocarbons (HFCs)</th>
<th>Updated definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A type of greenhouse gas (GHG), HFCs are organic compounds that contain fluorine, carbon and hydrogen atoms and they are produced commercially as a substitute for chlorofluorocarbons (CFCs). They are mainly used in refrigeration and semiconductor manufacturing.</td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Hydrological sensitivity ($\eta$)</td>
<td>Updated definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>Updated definition</td>
<td>The linear change in global mean precipitation per degree Celsius of global mean surface air temperature (GSAT) change once precipitation changes related to fast atmospheric and land surface adjustments to radiative forcings have occurred. Units are $%$ per $^\circ$C although it can also be calculated as $W m^{-2}$ per $^\circ$C. See also Apparent hydrological sensitivity ($\eta_a$).</td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Interstadial or interstade</td>
<td>Added definition (was omitted)</td>
</tr>
<tr>
<td></td>
<td>Added definition</td>
<td>A brief period of regional climatic warming during a glacial or interglacial interval, often characterized by transient glacial retreats. Interstadials are generally of short duration (hundreds to a few thousand years) compared to glacial or interglacial intervals (lasting many thousands to tens of thousands of years). One example of a regional interstadial event is based on millennial scale warming recorded by oxygen isotope ratios in Greenland ice cores, the so called “Greenland Interstadials” (Johnsen et al., 1992). See also Stadial or stade.</td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Light-absorbing particles</td>
<td>Replace “smelting” by “melting”</td>
</tr>
<tr>
<td></td>
<td>Removed “smelting” by “melting”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Long-lived climate forcers (LLCF’s)</td>
<td>Replace “Long-lived climate forcers (LLCFs)” by “Long-lived greenhouse gases (LLGHGs)”</td>
</tr>
<tr>
<td></td>
<td>Renamed term “Low-likelihood, high impact outcomes” from “Low-likelihood, high impact events” for cross-report consistency</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Methane (CH4)</td>
<td>Removed “One of the seven greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol.”</td>
</tr>
<tr>
<td></td>
<td>Removed “One of the seven greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol.” by “The greenhouse gas (GHG) methane is the major…”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Replace “there is risk of increased methane emissions from thawing permafrost, coastal wetlands…” by “there is potential for increased methane emissions from thawing permafrost, wetlands…”</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Model drift</td>
<td>Remove definition (added in error)</td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Montreal Protocol</td>
<td>Updated definition</td>
</tr>
<tr>
<td></td>
<td>Updated definition</td>
<td>The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in Montreal in 1987, and subsequently adjusted and amended (including London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997), Beijing (1999) and Kigali (2016)). It controls the consumption and production of chlorine- and bromine-containing chemicals that destroy stratospheric ozone (O$_3$), such as chlorofluorocarbons (CFCs), methyl chloroform, carbon tetrachloride and many</td>
</tr>
</tbody>
</table>
Since the Kigali Amendment in 2016, hydrofluorocarbons (HFCs), which were used as alternatives to ozone-depleting substances, have been targeted for a phase-down due to their climate effect as greenhouse gases.

### Annex VII – Glossary

<table>
<thead>
<tr>
<th>Natural systems</th>
<th>Updated definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dynamic physical, physicochemical and biological components of the Earth system that would operate independently of human activities.</td>
<td></td>
</tr>
</tbody>
</table>

| Nitrous oxide (N₂O) | Remove "One of the seven greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol." Replace "The main anthropogenic source of N₂O is" by "The main anthropogenic source of N₂O, a greenhouse gas (GHG), is" |

| Non-linearity | Replace "may lead to abrupt climate change" by "may lead to abrupt climate change and tipping points" |

<table>
<thead>
<tr>
<th>Sub-terms of Pathways</th>
<th>Added definitions (were omitted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission pathways</td>
<td>Modelled trajectories of global anthropogenic emissions over the 21st century.</td>
</tr>
<tr>
<td>Mitigation pathways</td>
<td>A temporal evolution of a set of mitigation scenario features, such as greenhouse gas (GHG) emissions and socio-economic development.</td>
</tr>
<tr>
<td>Non-overshoot pathways</td>
<td>Pathways that stay below a specified concentration, forcing, or global warming level during a specified period of time (e.g., until 2100).</td>
</tr>
<tr>
<td>Overshoot pathways</td>
<td>Pathways that first exceed a specified concentration, forcing, or global warming level and then return to or below that level again before the end of a specified period of time (e.g., before 2100). Sometimes the magnitude and likelihood of the overshoot is also characterized. The overshoot duration can vary from one pathway to the next, but in most overshoot pathways in the literature and referred to as overshoot pathways in the AR6, the overshoot occurs over a period of at least one decade and up to several decades.</td>
</tr>
</tbody>
</table>

### Annex VII – Glossary

<table>
<thead>
<tr>
<th>pH</th>
<th>Updated definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A dimensionless measure of the acidity of a dilute solution (e.g., seawater) based on the activity, or effective concentration, of hydrogen ions (H⁺) in the solution. pH is measured on a logarithmic scale where pH = −log₁₀[H⁺]. Thus, a pH decrease of 1 unit corresponds to a 10-fold increase in the acidity, or the activity of H⁺.</td>
<td></td>
</tr>
<tr>
<td>Annex VII – Glossary</td>
<td>Plankton</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Pleistocene</th>
<th>Replace “at 11.65 ka” by “at approximately 11.7 ka”</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Pool, carbon and nitrogen</th>
<th>Added definition (was omitted)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A reservoir in the Earth system where elements, such as carbon and nitrogen, reside in various chemical forms for a period of time. See also Reservoir, Sequestration, Sequestration potential, Sink, Source and Uptake.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Radiative effect</th>
<th>Removed definition</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Rapid adjustment</th>
<th>Removed definition</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Radiative response (of the climate system)</th>
<th>Added definition (was omitted)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>The net top-of-atmosphere radiative flux that opposes a change in radiative forcing as a result of climate feedbacks. Typical units: W m(^{-2}). See also Earth’s energy budget, Climate feedback and Climate feedback parameter.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Reference period</th>
<th>Updated definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A time period of interest, or a period over which some relevant statistics are calculated. A reference period can be used a baseline period or as a comparison to a baseline period.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Baseline period (subterm of Reference period)</th>
<th>Updated definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A time period against which differences are calculated (e.g., expressed as anomalies relative to a baseline).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Regional climate scenario</th>
<th>Removed definition</th>
</tr>
</thead>
</table>

| Annex VII – Glossary | Sea level equivalent (SLE) | Removed “However, more accurate estimates of SLE must account for additional processes affecting mean sea level rise, such as shoreline migration, changes in ocean area, and for vertical land movements.” |

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Semi-empirical model</th>
<th>Replace “global mean surface temperature change” by “global surface temperature change”</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Stadial or stade</th>
<th>Updated definition:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A brief period of regional climatic cooling during a glacial or interglacial interval, often characterized by transient glacial advances. Stadials are generally of short duration</td>
</tr>
</tbody>
</table>
(hundreds to a few thousand years) compared to glacial or interglacial intervals (lasting many thousands to tens of thousands of years). One example of a regional stadial event is based on millennial scale cooling recorded by oxygen isotope ratios in Greenland ice cores, the so called “Greenland Stadials” (Johnsen et al., 1992). See also Interstadial or interstade.

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Sulphur hexafluoride (SF₆)</th>
<th>Updated definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SF₆, a greenhouse gas (GHG), is mainly used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems and semiconductors.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Teleconnection pattern</th>
<th>Updated definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spatial structure of climate anomalies that are linked to each other through teleconnection processes or that are the large-scale fingerprint of modes of climate variability. Teleconnection patterns can be visualized using correlation and/or regression maps of climate variables with some climate indices (i.e., those derived from the temporal variation of the main modes of climate variability). They can also be obtained from principal component analysis, singular value decomposition/maximum covariance analysis, clustering based on spatial recurrence criteria, etc. See also Section Atlas.3.1 of the AR6 WGI report and Teleconnection.</td>
<td></td>
</tr>
</tbody>
</table>

| Annex VII – Glossary | Total solar irradiance (TSI) | Remove “It has recently been estimated to 1360.8 ± 0.5 W m⁻² for the solar minimum of 2008.” |

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Interpolation uncertainty (subterm of Uncertainty)</th>
<th>Added definition (was omitted)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Uncertainty arising from a statistical or physical model-based interpolation of a field between available estimates to create a more spatio-temporally complete estimate.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Trend estimates uncertainty (subterm of Uncertainty)</th>
<th>Added definition (was omitted)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Uncertainty arising from data fitting to a time-series with potential non-linear and autorgressive character.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Warm days/warm night</th>
<th>Removed definition</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Warm spell</th>
<th>Removed definition</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Annex VII – Glossary</th>
<th>Younger Dryas</th>
<th>Replace “A period 12.85 to 11.65 ka…” by “The period from approximately 12.9 to 11.7 ka…”</th>
</tr>
</thead>
</table>
Annex VII - Glossary

Coordinating Editors:
J. B. Robin Matthews (France/United Kingdom), Jan S. Fuglestvedt (Norway), Valérie Masson-Delmotte (France), Vincent Möller (Germany), Carlos Méndez (Venezuela), Renée van Diemen (The Netherlands/United Kingdom), Andy Reisinger (New Zealand), Sergey Semenov (Russian Federation)

Editorial Team:
Rondrotiana Barimalala (South Africa/Madagascar), Roxana Bojariu (Romania), Annalisa Cherchi (Italy), Peter M. Cox (United Kingdom), Sergio Henrique Faria (Spain/Brazil), Piers Forster (United Kingdom), Christopher Jones (United Kingdom), Nana Ama Browne Klutse (Ghana), Charles Koven (United States of America), Svitlana Krakovska (Ukraine), Sawsan K. Mustafa (Sudan), Friederike Otto (United Kingdom/Germany), Matthew D. Palmer (United Kingdom), Tamzin Palmer (United Kingdom), Wilfried Pokam Mba (Cameroon), Roshanka Ranasinghe (The Netherlands/Sri Lanka, Australia), Pedro Scheel Monteiro (South Africa), Joeri Rogelj (United Kingdom/Belgium), Sharon L. Smith (Canada), Ying Sun (China), Andrew Turner (United Kingdom), Bart van den Hurk (The Netherlands), Émilie Vanvyve (United Kingdom/Belgium), Martin Wild (Switzerland), Cunde Xiao (China), Prodromos Zanis (Greece)

This glossary defines some specific terms as the Lead Authors intend them to be interpreted in the context of this report. Italicized words in definitions indicate that the italicized term is defined in the Glossary. Subterms appear in italics beneath main terms.

Date: August 2021

This document is subject to copy-editing, corrigenda and trickle backs.

This Annex should be cited as:
1.5°C pathway  See Pathways.

Ablation (of glaciers, ice sheets, or snow cover)  See Mass balance / budget (of glaciers or ice sheets).

Abrupt change  A change in the system that is substantially faster than the typical rate of the changes in its history.

Abrupt climate change  A large-scale abrupt change in the climate system that takes place over a few decades or less, persists (or is anticipated to persist) for at least a few decades and causes substantial impacts in human and/or natural systems. See also Tipping point and Abrupt change.

Accumulation (of glaciers, ice sheets, or snow cover)  See Mass balance / budget (of glaciers or ice sheets).

Active layer  Layer of ground above permafrost subject to annual thawing and freezing.

Adaptation  In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects. See also Adaptation options, Adaptive capacity and Maladaptive actions (Maladaptation).

Adaptation options  The array of strategies and measures that are available and appropriate for addressing adaptation. They include a wide range of actions that can be categorised as structural, institutional, ecological or behavioural.

Adaptive capacity  The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014; MA, 2005).

Added value  Improvement of the representation of some climatic aspects by one methodology compared to another methodology. For instance, downscaling a coarse resolution global climate model (GCM) may improve the representation of regional climate in complex terrain.

Adjustment time  See Response time or adjustment time.

Advection  Transport of water or air along with its properties (e.g., temperature, chemical tracers) by winds or currents. Regarding the general distinction between advection and convection, the former describes transport by large-scale motions of the atmosphere or ocean, while convection describes the predominantly vertical, locally induced motions.

Aerosol  A suspension of airborne solid or liquid particles, with typical diameters between a few nanometres and a few micrometres and atmospheric lifetimes of up to several days in the troposphere and up to years in the stratosphere. The term aerosol, which includes both the particles and the suspending gas, is often used in this report in its plural form to mean ‘aerosol particles’. Aerosols may be of either natural or anthropogenic origin in the troposphere; stratospheric aerosol mostly stems from volcanic eruptions. Aerosols can cause an effective radiative forcing directly through scattering and absorbing radiation (aerosol-radiation interactions), and indirectly by acting as cloud condensation nuclei or ice nucleating particles which affect the properties of clouds (aerosol-cloud interactions), and upon deposition on snow- or ice-covered surfaces. Atmospheric aerosols may be emitted as primary particulate matter (PM), and form within the atmosphere from gaseous precursors (secondary production). Main classes of aerosol chemical composition are sea salt, organic carbon, black carbon (BC), mineral species (mainly desert dust), sulphate, nitrate, and ammonium. See also Short-lived climate forcers (SLCFs).

Aerosol effective radiative forcing (ERFari+aci)  See Aerosol-radiation interaction.

Aerosol optical depth (AOD)  Wavelength-dependent aerosol optical depth is a measure of the aerosol...
contribution to extinction of top-of-the-atmosphere solar intensity measured at the ground. AOD is unitless.

Fine-mode aerosol optical depth  Aerosol optical depth due to aerosol particles smaller than 1 μm in radius.

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: See also Aerosol-radiation interaction.

Effective radiative forcing (or effect) due to aerosol-cloud interactions (ERFaci)  The final radiative forcing (or effect) from the aerosol perturbation including the adjustments to the initial change in droplets or crystal formation rate. These adjustments include changes in the strength of convection, precipitation efficiency, cloud fraction, lifetime or water content of clouds, and the formation or suppression of clouds in remote areas due to altered circulations. See also Aerosol-radiation interaction.

Instantaneous radiative forcing (or effect) due to aerosol-cloud interactions (IRFaci)  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 ubiquity of adjustments.

Aerosol-radiation interaction  An interaction of aerosol directly with radiation produce radiative effects. In this report two levels of radiative forcing (or effect) are distinguished:

Aerosol effective radiative forcing (ERFaci)  The total effective radiative forcing due to both aerosol-cloud and aerosol-radiation interactions is denoted aerosol effective radiative forcing (ERFaci).

Effective radiative forcing (or effect) due to aerosol-radiation interactions (ERFari)  The final radiative forcing (or effect) from the aerosol perturbation including adjustments to the initial change in radiation. These adjustments include changes in cloud caused by the impact of the radiative heating on convective or larger-scale atmospheric circulations, traditionally known as semi-direct aerosol forcing (or effect). See also Aerosol-cloud interaction.

Instantaneous radiative forcing (or effect) due to aerosol-radiation interactions (IRFari)  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. Traditionally known in the literature as the direct aerosol forcing (or effect).

Afforestation  Conversion to forest of land that historically has not contained forests. [Note: For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and their 2019 Refinement, and information provided by the United Nations Framework Convention on Climate Change (IPCC, 2006, 2019, UNFCCC, 2021a, 2021b).] See also Deforestation, Reducing Emissions from Deforestation and Forest Degradation (REDD+), Reforestation, Anthropogenic removals and Carbon dioxide removal (CDR).

Agreement  In this report, the degree of agreement within the scientific body of knowledge on a particular finding is assessed based on multiple lines of evidence (e.g., mechanistic understanding, theory, data, models, expert judgement) and expressed qualitatively (Mastrandrea et al., 2010). See also Confidence, Likelihood, Uncertainty and Evidence.
Agricultural or ecological drought  See Drought.

Air mass  A widespread body of air, the approximately homogeneous properties of which (1) have been established while that air was situated over a particular region of the Earth's surface, and (2) undergo specific modifications while in transit away from the source region (AMS, 2021).

Air pollution  Degradation of air quality with negative effects on human health or the natural or built environment due to the introduction, by natural processes or human activity, into the atmosphere of substances (gases, aerosols) which have a direct (primary pollutants) or indirect (secondary pollutants) harmful effect. See also Short-lived climate forcers (SLCFs).

Airborne fraction  The fraction of total CO₂ emissions (from fossil fuel and land use change) remaining in the atmosphere.

Albedo  The proportion of sunlight (solar radiation) reflected by a surface or object, often expressed as a percentage. Clouds, snow and ice usually have high albedo; soil surfaces cover the albedo range from high to low; vegetation in the dry season and/or in arid zones can have high albedo; whereas photosynthetically active vegetation and the ocean have low albedo. The Earth's planetary albedo changes mainly through changes in cloudiness and of snow, ice, leaf area and land cover.

Alkalinity  See Total alkalinity.

Altimetry  A technique for measuring the height of the Earth's surface with respect to the geocentre of the Earth within a defined terrestrial reference frame (geocentric sea level).

Annular modes  Hemispheric scale patterns of atmospheric variability characterized by opposing and synchronous fluctuations in sea-level pressure between the polar caps and midlatitudes, with a structure exhibiting a high degree of zonal symmetry, and with no real preferred timescales ranging from days to decades. In each hemisphere, these fluctuations reflect changes in the latitudinal position and strength of the mid-latitude jets and associated storm tracks. Annular modes are defined as the leading mode of variability of extratropical sea-level pressure or geopotential heights and are known as the Northern Annular Mode (NAM) and Southern Annular Mode (SAM) in the two hemispheres, respectively.

Northern Annular Mode (NAM)  A see-saw latitudinal fluctuation in Northern Hemisphere sea-level pressure or geopotential height between the Arctic and the mid-latitudes. The NAM has some links with the stratospheric polar vortex and is related to the fluctuation in strength and latitude of the mean westerlies. Its variance is maximum in winter and its pattern has a strong regional expression in the North Atlantic being strongly correlated with the North Atlantic Oscillation index. The NAM is also known as the Arctic Oscillation (AO). In its positive phase, the NAM is characterized by anomalously low pressure over the Arctic and high pressure over the mid-latitudes/subtropics, with a strengthening of the zonally averaged westerly winds on their polar flank that confines colder air across the Arctic. The negative NAM phase is characterized by a more distorted wind pattern and jet meanders which increases storminess in the midlatitude regions. See Section AIV.2.1 in Annex IV of the AR6 WGI report.

Southern Annular Mode (SAM)  The leading mode of climate variability of Southern Hemisphere sea-level pressure and geopotential height, which is associated with the strength and latitudinal shifts in the mid- to high-latitudes westerly wind belt. The SAM is also known as the Antarctic Oscillation (AAO). A positive SAM phase is defined as lower-than-normal pressures over the polar regions and higher-than-normal pressures in the southern mid-latitudes, with a contraction towards Antarctica and strengthening of the westerly wind belt. The negative SAM phase exhibits positive high latitude pressure anomalies, negative mid-latitude pressure anomalies and a weaker westerly flow expanded towards the equator. See Section AIV.2.2 in Annex IV of the AR6 WGI report. See also Annular modes.

Anomaly  The deviation of a variable from its value averaged over a reference period.

Do Not Cite, Quote or Distribute
Antarctic amplification  See *Polar amplification*.

Antarctic ice sheet (AIS)  See *Ice sheet*.

Antarctic oscillation (AAO)  See *Southern Annular Mode (SAM)* (under *Annular modes*).

**Anthropocene**  A proposed new geological epoch resulting from significant human-driven changes to the structure and functioning of the Earth System, including the *climate system*. Originally proposed in the Earth System science community in 2000, the proposed new epoch is undergoing a formalization process within the geological community based on the stratigraphic *evidence* that human activities have changed the Earth System to the extent of forming geological deposits with a signature that is distinct from those of the Holocene, and which will remain in the geological record. Both the stratigraphic and Earth System approaches to defining the Anthropocene consider the mid-20th Century to be the most appropriate starting date (Steffen et al., 2016), although others have been proposed and continue to be discussed. The Anthropocene concept has already been informally adopted by diverse disciplines and the public to denote the substantive influence of humans on the Earth System.

**Anthropogenic**  Resulting from or produced by human activities.

**Anthropogenic emissions**  Emissions of greenhouse gases (GHGs), precursors of GHGs and aerosols caused by human activities. These activities include the burning of fossil fuels, deforestation, land use and land use changes (LULUC), livestock production, fertilisation, waste management, and industrial processes. See also *Anthropogenic and Anthropogenic removals*.

**Anthropogenic removals**  The withdrawal of greenhouse gases (GHGs) from the atmosphere as a result of deliberate human activities. These include enhancing biological sinks of CO$_2$ and using chemical engineering to achieve long term removal and storage. Carbon capture and storage (CCS), which alone does not remove CO$_2$ from the atmosphere, can help reduce atmospheric CO$_2$ from industrial and energy-related sources if it is combined with bioenergy production (BECCS), or if CO$_2$ is captured from the air directly and stored (DACCS). [Note: In the 2006 IPCC Guidelines for national GHG Inventories (IPCC, 2006), which are used in reporting of emissions to the UNFCCC, ‘anthropogenic’ land-related GHG fluxes are defined as all those occurring on ‘managed land’, i.e., where human interventions and practices have been applied to perform production, ecological or social functions’. However, some removals (e.g. removals associated with CO$_2$ fertilisation and N deposition) are not considered as ‘anthropogenic’, or are referred to as ‘indirect’ anthropogenic effects, in some of the scientific literature assessed in this report. As a consequence, the land-related net GHG emission estimates from global models included in this report are not necessarily directly comparable with LULUCF estimates in national GHG Inventories.] See also *Carbon dioxide removal (CDR), Afforestation, Biochar, Enhanced weathering, Ocean alkalinisation / Ocean alkalinity enhancement, Reforestation and Soil carbon sequestration (SCS)*.

**Anthropogenic subsidence**  Downward motion of the land surface induced by anthropogenic drivers (e.g., loading, extraction of hydrocarbons and/or groundwater, drainage, mining activities) causing sediment compaction or subsidence/deformation of the sedimentary sequence, or oxidation of organic material, thereby leading to relative sea level rise.

**Apparent hydrological sensitivity** ($\eta_a$)  The change in global mean precipitation per degree Celsius of global mean temperature change with units of % per °C although it can also be calculated as W m$^{-2}$ per °C. See also *Hydrological sensitivity* ($\eta$).

**Arid amplification**  See *Polar amplification*.

**Arid zone**  Areas where vegetation growth is severely constrained due to limited water availability. For the most part, the native vegetation of arid zones is sparse. There is high rainfall variability, with annual averages below 300 mm. Crop farming in arid zones requires irrigation.
Aridity  The state of a long-term climatic feature characterised by low average precipitation or available water in a region. Aridity generally arises from widespread persistent atmospheric subsidence or anticyclonic conditions, and from more localised subsidence in the lee side of mountains (adapted from Gbeckor-Kove, 1989; Türkeş, 1999). See also Drought.

Artificial ocean upwelling (AOUpw)  Artificial ocean upwelling (AOUpw) is a potential carbon dioxide removal method that aims to artificially pump up cooler, nutrient-rich waters from deep in the ocean to the surface. The aim is to stimulate phytoplankton activity and thereby increase ocean CO₂ uptake.

Assets  Natural or human-made resources that provide current or future utility, benefit, economic or intrinsic value to natural or human systems.

Atlantic Equatorial Mode  See Atlantic Zonal Mode (AZM) (under Tropical Atlantic Variability (TAV)).

Atlantic Meridional Mode (AMM)  See Tropical Atlantic Variability (TAV).

Atlantic Meridional Overturning Circulation (AMOC)  See Meridional overturning circulation (MOC).

Atlantic Multidecadal Oscillation (AMO)  See Atlantic Multidecadal Variability (AMV).

Atlantic Multidecadal Variability (AMV)  Large-scale fluctuations observed from one decade to the next in a variety of instrumental records and proxy reconstructions over the entire North Atlantic ocean and surrounding continents. Fingerprints of Atlantic Multidecadal Variability (AMV) can be found at the surface ocean, which is characterized by swings in basin-scale sea surface temperature anomalies reflecting the interaction with the atmosphere. The positive phase of the AMV is characterized by anomalous warming over the entire North Atlantic, with the strongest amplitude in the subpolar gyre and along sea-ice margin zones in the Labrador Sea and Greenland/Barents Sea and in the subtropical North Atlantic basin to a lower extent. In the AR6 WGI report, the term AMV is preferred to Atlantic Multidecadal Oscillation (AMO) used in previous IPCC reports because there is no preferred timescale of decadal variability as the term oscillation would indirectly implied. See Section AIV.2.7 in Annex IV of the AR6 WGI report.

Atlantic Niño  See Atlantic Zonal Mode (AZM) (under Tropical Atlantic Variability (TAV)).

Atlantic Zonal Mode (AZM)  See Tropical Atlantic Variability (TAV).

Atmosphere  The gaseous envelope surrounding the Earth, divided into five layers – the troposphere which contains half of the Earth’s atmosphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere, which is the outer limit of the atmosphere. 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 (GHGs) such as carbon dioxide (CO₂) (0.04% volume mixing ratio), methane (CH₄), nitrous oxide (N₂O) and ozone (O₃). In addition, the atmosphere contains the GHG water vapour (H₂O), whose concentrations are highly variable (0-5% volume mixing ratio) as the sources (evapotranspiration) and sinks (precipitation) of water vapour show large spatio-temporal variations, and atmospheric temperature exerts a strong constraint on the amount of water vapour an air parcel can hold. The atmosphere also contains clouds and aerosols. See also Hydrological cycle, Stratosphere and Troposphere.

Atmosphere-ocean general circulation model (AOGCM)  See General circulation model (GCM).

Atmospheric boundary layer  The atmospheric layer adjacent to the Earth’s surface that is affected by friction against that boundary surface, and possibly by transport of heat and other variables across that surface (AMS, 2021). The lowest 100 m of the boundary layer (about 10% of the boundary layer thickness), where mechanical generation of turbulence is dominant, is called the surface boundary layer or surface layer.

Atmospheric lifetime  See Lifetime.
Atmospheric rivers (ARs)  Long, narrow (up to a few hundred km wide), shallow (up to a few km deep) and transient corridors of strong horizontal water vapour transport that are typically associated with a low-level jet stream ahead of the cold front of an extratropical cyclone (Ralph et al., 2018).

Attribution  Attribution is defined as the process of evaluating the relative contributions of multiple causal factors to a change or event with an assessment of confidence.

Australian and Maritime Continent monsoon (AusMCM)  See Global monsoon.

Autotrophic respiration  Respiration by photosynthetic (see photosynthesis) organisms (e.g., plants and algae).

Avalanche  A mass of snow, ice, earth or rocks, or a mixture of these, falling down a mountainside.

Barystatic  See Sea level change (sea level rise/sea level fall).

Basal lubrication  Reduction of friction at the base of an ice sheet or glacier due to lubrication by meltwater. This can allow the glacier or ice sheet to slide over its base. Meltwater may be produced by pressure-induced melting, friction or geothermal heat, or surface melt may drain to the base through holes in the ice.

Baseline/reference  The baseline (or reference) is the state against which change is measured. See Baseline scenario (under Scenario) and Baseline/reference (period). See also Baseline period (under Reference period) and Reference period.

Baseline period  See Reference period.

Baseline scenario  See Scenario.

Bifurcation point  See Tipping point.

Biodiversity  Biodiversity or biological diversity means the variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems (UN, 1992). See also Ecosystem and Ecosystem services.

Bioenergy with carbon dioxide capture and storage (BECCS)  Carbon dioxide capture and storage (CCS) technology applied to a bioenergy facility. Note that depending on the total emissions of the BECCS supply chain, carbon dioxide (CO₂) can be removed from the atmosphere. See also Bioenergy, Carbon dioxide capture and storage (CCS), Anthropogenic removals and Carbon dioxide removal (CDR).

Biogenic volatile organic compounds (BVOCs)  See Volatile organic compounds (VOCs).

Biogeophysical potential  See Mitigation potential.

Biological (carbon) pump  A series of ocean processes through which inorganic carbon (as carbon dioxide, CO₂) is fixed as organic matter by photosynthesis in sunlit surface water and then transported to the ocean interior, and possibly the sediment, resulting in the storage of carbon.

Biomass  Organic material excluding the material that is fossilised or embedded in geological formations. Biomass may refer to the mass of organic matter in a specific area (ISO, 2014). See also Bioenergy and Biofuel.

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.

Bipolar seesaw (also interhemispheric seesaw, interhemispheric asymmetry, hemispheric asymmetry) A phenomenon in which temperature changes in the northern and southern hemispheres are related but out of phase, generally inferred to represent a change in the magnitude or sign of net heat transport across the equator. Originally called hemispheric asymmetry and linked to changes in thermohaline overturning circulation on multi-millennial scales (Mix et al., 1986), later named bipolar seesaw and applied to millennial scales (Broecker, 1998) with a similar thermohaline mechanism (Stocker and Johnsen, 2003). See also Meridional overturning circulation (MOC) and Deglacial or deglaciation or glacial termination.

Black carbon (BC) A relatively pure form of carbon, also known as soot, arising from the incomplete combustion of fossil fuels, biofuel, and biomass. It only stays in the atmosphere for days or weeks. BC is a climate forcing agent with strong warming effect, both in the atmosphere and when deposited on snow or ice. See also Aerosol and Atmosphere.

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 summer heat waves.

Blue carbon Biologically-driven carbon fluxes and storage in marine systems that are amenable to management. Coastal blue carbon focuses on rooted vegetation in the coastal zone, such as tidal marshes, mangroves and seagrasses. These ecosystems have high carbon burial rates on a per unit area basis and accumulate carbon in their soils and sediments. They provide many non-climatic benefits and can contribute to ecosystem-based adaptation. If degraded or lost, coastal blue carbon ecosystems are likely to release most of their carbon back to the atmosphere. There is current debate regarding the application of the blue carbon concept to other coastal and non-coastal processes and ecosystems, including the open ocean. See also Ecosystem services and Sequestration.

Brewer-Dobson circulation The meridional overturning circulation of the stratosphere transporting air upward in the tropics, poleward to the winter hemisphere, and downward at polar and subpolar latitudes. The Brewer-Dobson circulation is driven by the interaction between upward propagating planetary waves and the mean flow.

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

Business as usual (BAU) The term business as usual scenario has been used to describe a scenario that assumes no additional policies beyond those currently in place and that patterns of socio-economic development are consistent with recent trends. The term is now used less frequently than in the past. See also Reference scenario (under Scenario).

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

\(^{14}\)C Unstable isotope of carbon having an atomic weight of approximately 14, and a half-life of about 5700 years. It is often used for dating purposes going back some 40 kyr. Its variation in time is affected by the magnetic fields of the Sun and Earth, which influence its production from cosmic rays (see Cosmogenic radioisotopes).

Calcification The process of biologically precipitating calcium carbonate minerals to create organism shells, skeletons, otoliths, or other body structures. The chemical equation describing calcification is \(\text{Ca}^{2+}\) (aq) + 2\(\text{HCO}_3^-\) (aq) → \(\text{CaCO}_3\) (s) + \(\text{CO}_2\) + \(\text{H}_2\text{O}\). Aragonite and calcite are two common crystalline forms of biologically precipitated calcium carbonate minerals that have different solubilities.
Calving (of glaciers or ice sheets) The breaking off of discrete pieces of ice from a glacier, ice sheet or an ice shelf into lake or seawater, producing icebergs. This is a form of mass loss from an ice body.

Canopy temperature The temperature within the canopy of a vegetation structure.

Carbon budget Refers to two concepts in the literature: (1) an assessment of carbon cycle sources and sinks on a global level, through the synthesis of evidence for fossil-fuel and cement emissions, emissions and removals associated with land use and land use change, ocean and natural land sources and sinks of carbon dioxide (CO₂), and the resulting change in atmospheric CO₂ concentration. This is referred to as the Global Carbon Budget; (2) the maximum amount of cumulative net global anthropogenic CO₂ emissions that would result in limiting global warming to a given level with a given probability, taking into account the effect of other anthropogenic climate forcers. This is referred to as the Total Carbon Budget when expressed starting from the pre-industrial period, and as the Remaining Carbon Budget when expressed from a recent specified date.

Note 1: Net anthropogenic CO₂ emissions are anthropogenic CO₂ emissions minus anthropogenic CO₂ removals. See also Carbon Dioxide Removal (CDR).

Note 2: The maximum amount of cumulative net global anthropogenic CO₂ emissions is reached at the time that annual net anthropogenic CO₂ emissions reach zero.

Note 3: The degree to which anthropogenic climate forcers other than CO₂ affect the Total Carbon Budget and Remaining Carbon Budget depends on human choices about the extent to which these forcers are mitigated and their resulting climate effects.

Note 4: The notions of a Total Carbon Budget and Remaining Carbon Budget are also being applied in parts of the scientific literature and by some entities at regional, national, or sub-national level. The distribution of global budgets across individual different entities and emitters depends strongly on considerations of equity and other value judgements.

Carbon cycle The flow of carbon (in various forms, e.g., as carbon dioxide (CO₂), carbon in biomass, and carbon dissolved in the ocean as carbonate and bicarbonate) through the atmosphere, hydrosphere, terrestrial and marine biosphere and lithosphere. In this report, the reference unit for the global carbon cycle is GtCO₂ or GtC (one Gigatonne = 1 Gt = 10¹⁵ grams; 1GtC corresponds to 3.667 GtCO₂).

Carbon dioxide (CO₂) A naturally occurring gas, CO₂ is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land use changes (LUC) and of industrial processes (e.g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a Global Warming Potential (GWP) of 1. See also Land use and Land-use change (LUC).

Carbon dioxide (CO₂) fertilisation The increase of plant photosynthesis and water-use efficiency in response to increased atmospheric carbon dioxide (CO₂) concentration. Whether this increased photosynthesis translates into increased plant growth and carbon storage on land depends on the interacting effects of temperature, moisture and nutrient availability.

Carbon dioxide capture and storage (CCS) A process in which a relatively pure stream of carbon dioxide (CO₂) from industrial and energy-related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere. Sometimes referred to as Carbon Capture and Storage. See also Bioenergy with carbon dioxide capture and storage (BECCS), Carbon dioxide capture and utilisation (CCU), Sequestration, Anthropogenic removals and Carbon dioxide removal (CDR).

Carbon dioxide removal (CDR) Anthropogenic activities removing carbon dioxide (CO₂) from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes...
existing and potential anthropogenic enhancement of biological or geochemical CO$_2$ sinks and direct air capture and storage, but excludes natural CO$_2$ uptake not directly caused by human activities. See also Anthropogenic removals, Afforestation, Biochar, Enhanced weathering, Ocean alkalisation / Ocean alkalinity enhancement, Reforestation, Soil carbon sequestration (SCS), Bioenergy with carbon dioxide capture and storage (BECCS) and Carbon dioxide capture and storage (CCS).

Carbon neutrality  Condition in which anthropogenic CO$_2$ emissions associated with a subject are balanced by anthropogenic CO$_2$ removals. The subject can be an entity such as a country, an organisation, a district or a commodity, or an activity such as a service and an event. Carbon neutrality is often assessed over the life cycle including indirect (“scope 3”) emissions, but can also be limited to the emissions and removals, over a specified period, for which the subject has direct control, as determined by the relevant scheme.

Note 1: Carbon neutrality and net zero CO$_2$ emissions are overlapping concepts. The concepts can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms carbon neutrality and net zero CO$_2$ emissions are equivalent. At sub-global scales, net zero CO$_2$ emissions is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while carbon neutrality generally includes emissions and removals within and beyond the direct control or territorial responsibility of the reporting entity. Accounting rules specified by GHG programmes or schemes can have a significant influence on the quantification of relevant CO$_2$ emissions and removals.

Note 2: In some cases achieving carbon neutrality may rely on the supplementary use of offsets to balance emissions that remain after actions by the reporting entity are taken into account.

See also Greenhouse gas neutrality, Land use, land-use change and forestry (LULUCF) and Net zero CO$_2$ emissions.

Carbon sequestration  See Sequestration.

Carbon sink  See Sink.

Carbon source  See Source.

Carbon-climate feedback  See Climate-carbon cycle feedback.

Carbonaceous aerosol  Aerosol consisting predominantly of organic substances and black carbon.

Carbonate counter pump  See Carbonate pump.

Carbonate pump  Ocean carbon fixation through the biological formation of carbonates, primarily by plankton that generate bio-mineral particles that sink to the ocean interior, and possibly the sediment. It is also called carbonate counter-pump, since the formation of calcium carbonate (CaCO$_3$) is accompanied by the release of carbon dioxide (CO$_2$) to surrounding water and subsequently to the atmosphere.

Catchment  An area that collects and drains precipitation.

Cenozoic Era  The third and current geological Era, which began 66.0 Ma. It comprises the Paleogene, Neogene and Quaternary Periods.

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

Chaotic  A dynamical system such as the climate system, governed by nonlinear deterministic equations (see Nonlinearity), may exhibit erratic or chaotic behaviour in the sense that very small changes in the initial state of the system in time lead to large and apparently unpredictable changes in its temporal evolution. Such chaotic behaviour limits the predictability of the state of a nonlinear dynamical system at specific future
times, although changes in its statistics may still be predictable given changes in the system parameters or boundary conditions.

**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.

**Chlorofluorocarbons (CFCs)** A chlorofluorocarbon is an organic compound that contains chlorine, carbon, hydrogen, and fluorine and is used for refrigeration, air conditioning, packaging, plastic foam, insulation, solvents, or aerosol propellants. Because they are not destroyed in the lower atmosphere, CFCs drift into the upper atmosphere where, given suitable conditions, they break down ozone \( \text{O}_3 \). It is one of the greenhouse gases (GHGs) covered under the 1987 Montreal Protocol as a result of which manufacturing of these gases has been phased out and they are being replaced by other compounds, including hydrofluorocarbons (HFCs) which are GHGs covered under the Kyoto Protocol.

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

**Cirrus cloud thinning (CCT)** See Solar radiation modification (SRM).

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

**Clausius-Clapeyron equation/relationship** The thermodynamic relationship between temperature and the vapour pressure of a substance in which two phases of the substance are in equilibrium (e.g., liquid water and water vapour). For gases such as water vapour, this relation gives the increase in equilibrium (or saturation) vapour pressure per unit change in air temperature.

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

**Climate change** A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods’. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. See also Climate variability, Detection and attribution, Global warming and Ocean acidification (OA).

**Climate change commitment** Climate change commitment is defined as the unavoidable future climate change resulting from inertia in the geophysical and socio-economic systems. Different types of climate change commitment are discussed in the literature (see subterms). Climate change commitment is usually quantified in terms of the further change in temperature, but it includes other future changes, for example in the hydrological cycle, in extreme weather events, in extreme climate events, and in sea level.

**Constant composition commitment** The constant composition commitment is the remaining climate change that would result if atmospheric composition, and hence radiative forcing, were held fixed at a given value. It results from the thermal inertia of the ocean and slow processes in the cryosphere and land surface.
**Constant emissions commitment**  The constant emissions commitment is the committed climate change that would result from keeping anthropogenic emissions constant.

**Zero emissions commitment**  The zero emissions commitment is an estimate of the subsequent global warming that would result after anthropogenic emissions are set to zero. It is determined by both inertia in physical climate system components (ocean, cryosphere, land surface) and carbon cycle inertia. In its widest sense it refers to emissions of each climate forcer including greenhouses gases, aerosols and their precursors. The climate response to this can be complex due to the different timescales of response of each climate forcer. A specific sub-category of zero emissions commitment is the Zero CO₂ Emissions Commitment which refers to the climate system response to CO₂ emissions after setting these to net zero. The CO₂-only definition is of specific use in estimating remaining carbon budgets.

**Climate extreme (extreme weather or climate event)**  The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classified as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., high temperature, drought, or heavy rainfall over a season). For simplicity, both extreme weather events and extreme climate events are referred to collectively as 'climate extremes'.

**Climate feedback**  An interaction in which a perturbation in one climate quantity causes a change in a second and the change in the second quantity ultimately leads to an additional change in the first. A negative feedback is one in which the initial perturbation is weakened by the changes it causes; a positive feedback is one in which the initial perturbation is enhanced. The initial perturbation can either be externally forced or arise as part of internal variability. See also Climate-carbon cycle feedback, Cloud feedback and Ice-albedo feedback.

**Climate feedback parameter**  A way to quantify the radiative response of the climate system to a global surface temperature change induced by a radiative forcing. It is quantified as the change in net energy flux at the top of atmosphere for a given change in annual global surface temperature. It has units of W m⁻² °C⁻¹.

**Climate forecast**  See Climate prediction.

**Climate index**  A time series constructed from climate variables that provides an aggregate summary of the state of the climate system. For example, the difference between sea level pressure in Iceland and the Azores provides a simple yet useful historical NAO index. Because of their optimal properties, climate indices are often defined using principal components—linear combinations of climate variables at different locations that have maximum variance subject to certain normalisation constraints (e.g., the NAM and SAM indices which are principal components of Northern Hemisphere and Southern Hemisphere gridded pressure anomalies, respectively). Definitions of observational indices for Modes of variability can be found in the Annex VI.

**Climate indicator**  Measures of the climate system including large-scale variables and climate proxies. See also Global surface temperature indicators and Climate metrics.

**Key climate indicators**  Key indicators constitute a finite set of distinct variables that may collectively point to important overall changes in the climate system of broad societal relevance across the atmospheric, oceanic, cryospheric and biospheric domains, with land as an implicit cross-cutting theme. Taken together, these indicators would be expected to both have changed and continue to change in the future in a coherent and consistent manner. See Cross-Chapter Box 2.2, Table 1 in the AR6 WGI report.

**Climate information**  Information about the past, current state, or future of the climate system that is relevant for mitigation, adaptation and risk management. It may be tailored or “co-produced” for specific contexts, taking into account users' needs and values.
Climate metrics   Measures of aspects of the overall climate system response to radiative forcing, such as equilibrium climate sensitivity (ECS), transient climate response (TCR), transient climate response to cumulative CO₂ emissions (TCRE) and the airborne fraction of anthropogenic carbon dioxide. See also Greenhouse gas emission metric, Climate indicator and Key climate indicators (under Climate indicator).

Climate model   A qualitative or quantitative representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes and accounting for some of its known properties. The climate system can be represented by models of varying complexity; that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical parametrisations are involved. There is an evolution towards more complex models with interactive chemistry and biology. Climate models are applied as a research tool to study and simulate the climate and for operational purposes, including monthly, seasonal and interannual climate predictions. See also Chemistry-climate model, Earth system model (ESM), Earth system model of intermediate complexity (EMIC), Energy balance model (EBM), Simple climate model (SCM), Regional climate model (RCM), Dynamic global vegetation model (DGVM), General circulation model (GCM) and Emulators.

Climate pattern   A set of spatially varying coefficients obtained by "projection" (regression) of climate variables onto a climate index time series. When the climate index is a principal component, the climate pattern is an eigenvector of the covariance matrix, referred to as an Empirical Orthogonal Function (EOF) in climate science.

Climate prediction   A climate prediction or climate forecast is the result of an attempt to produce (starting from a particular state of the climate system) an estimate of the actual evolution of the climate in the future, for example, at seasonal, interannual or decadal time scales. Because the future evolution of the climate system may be highly sensitive to initial conditions, has chaotic elements and is subject to natural variability, such predictions are usually probabilistic in nature.

Climate projection   Simulated response of the climate system to a scenario of future emissions or concentrations of greenhouse gases (GHGs) and aerosols and changes in land use, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised.

Climate response   A general term for how the climate system responds to a radiative forcing.

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 the observed current climate. See also Regional climate scenario.

Climate sensitivity   The change in the surface temperature in response to a change in the atmospheric carbon dioxide (CO₂) concentration or other radiative forcing. See also Climate feedback parameter.

Earth system sensitivity   The equilibrium surface temperature response of the coupled atmosphere-ocean-cryosphere-vegetation-carbon cycle system to a doubling of the atmospheric carbon dioxide (CO₂) concentration is referred to as Earth System sensitivity. Because it allows ice sheets to adjust to the external perturbation, it may differ substantially from the equilibrium climate sensitivity derived from coupled atmosphere-ocean models.

Equilibrium climate sensitivity (ECS)   The equilibrium (steady state) change in the surface temperature following a doubling of the atmospheric carbon dioxide (CO₂) concentration from pre-industrial conditions.
**Transient climate response (TCR)**  The surface temperature response for the hypothetical scenario in which atmospheric carbon dioxide (CO₂) increases at 1% yr⁻¹ from pre-industrial to the time of a doubling of atmospheric CO₂ concentration (year 70).

**Transient climate response to cumulative CO₂ emissions (TCRE)**  The transient surface temperature change per unit cumulative carbon dioxide (CO₂) emissions, usually 1000 GtC. TCRE combines both information on the airborne fraction of cumulative CO₂ emissions (the fraction of the total CO₂ emitted that remains in the atmosphere, which is determined by carbon cycle processes) and on the transient climate response (TCR).

**Climate services**  Climate services involve the provision of climate information in such a way as to assist decision-making. The service includes appropriate engagement from users and providers, is based on scientifically credible information and expertise, has an effective access mechanism, and responds to user needs (Hewitt et al., 2012).

**Climate simulation ensemble**  A group of parallel model simulations characterising historical climate conditions, climate predictions, or climate projections. Variation of the results across the ensemble members may give an estimate of modelling-based uncertainty. Ensembles made with the same model but different initial conditions characterise the uncertainty associated with internal climate variability, whereas multi-model ensembles including simulations by several models also include the effect of model differences. Perturbed parameter ensembles, in which model parameters are varied in a systematic manner, aim to assess the uncertainty resulting from internal model specifications within a single model. Remaining sources of uncertainty unaddressed with model ensembles are related to systematic model errors or biases, which may be assessed from systematic comparisons of model simulations with observations wherever available.

**Climate system**  The global system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the lithosphere and the biosphere and the interactions between them. The climate system changes in time under the influence of its own internal dynamics and because of external forcings such as volcanic eruptions, solar variations, orbital forcing, and anthropogenic forcings such as the changing composition of the atmosphere and land-use change.

**Climate threshold**  A limit within the climate system (or its forcing) beyond which the behaviour of the system is qualitatively changed. See also Abrupt climate change and Tipping point.

**Climate variability**  Deviations of climate variables from a given mean state (including the occurrence of extremes, etc.) at all spatial and temporal scales beyond that of individual weather events. Variability may be intrinsic, due to fluctuations of processes internal to the climate system (internal variability), or extrinsic, due to variations in natural or anthropogenic external forcing (forced variability). See also Climate change and Modes of climate variability.

**Decadal variability**  Decadal variability refers to climate variability on decadal time scales. See also Pacific Decadal Variability (PDO), Atlantic Multi-decadal Oscillation/Variability (AMO/AMV) and Pacific Decadal Oscillation (PDO) (under Pacific Decadal Variability (PDO)).

**Internal variability**  Fluctuations of the climate dynamical system when subject to a constant or periodic external forcing (such as the annual cycle). See also Climate variability.

**Natural variability**  Natural variability refers to climatic fluctuations that occur without any human influence, i.e. internal variability combined with the response to external natural factors such as volcanic eruptions, changes in solar activity and, on longer time-scales, orbital effects and plate tectonics. See also Orbital forcing.

**Climate velocity**  The speed at which isolines of a specified climate variable travel across landscapes or seascapes due to changing climate. For example, climate velocity for temperature is the speed at which
isotherms move due to changing climate (km yr\(^{-1}\)) and is calculated as the temporal change in temperature (°C yr\(^{-1}\)) divided by the current spatial gradient in temperature (°C km\(^{-1}\)). It can be calculated using additional climate variables such as precipitation or can be based on the climatic niche of organisms.

**Climate-carbon cycle feedback**  A *climate feedback* involving changes in the properties of land and ocean carbon cycle in response to *climate change*. In the ocean, changes in oceanic temperature and circulation could affect the *atmosphere-ocean* CO\(_2\) flux; on the continents, *climate change* could affect plant *photosynthesis* and soil microbial *respiration* and hence the flux of CO\(_2\) between the *atmosphere* and the land *biosphere*.

**Climatic impact-driver (CID)**  Climatic impact-drivers (CIDs) are physical *climate system* conditions (e.g., means, events, extremes) that affect an element of society or *ecosystems*. Depending on system *tolerance*, CIDs and their changes can be detrimental, beneficial, neutral, or a mixture of each across interacting system elements and regions. See also *Risk, Hazard and Impacts (consequences, outcomes)*.

**Cloud condensation nuclei (CCN)**  The subset of *aerosol* particles that serve as an initial site for the condensation of liquid water, which can lead to the formation of cloud droplets, under typical cloud formation conditions. The main factor that determines which *aerosol* particles are CCN at a given supersaturation is their size.

**Cloud feedback**  A *climate feedback* involving changes in any of the properties of clouds as a response to a change in the local or *global mean surface temperature*. Understanding cloud feedbacks and determining their magnitude and sign require an understanding of how a change in *climate* may affect the spectrum of cloud types, the cloud fraction and height, the radiative properties of clouds, and finally the Earth’s radiation budget. At present, cloud feedbacks remain the largest source of *uncertainty* in *climate sensitivity* estimates.

**Cloud radiative effect**  The *radiative effect* of clouds relative to the identical situation without clouds. In previous IPCC reports this was called cloud *radiative forcing*, but that terminology is inconsistent with other uses of the forcing term and is not maintained in this report.

**Cloud-resolving models (CRMs)**  Numerical models that are that of high enough resolution and have the necessary physics to represent the dynamical and physical processes of cloud formation.

**CMIP6**  See *Coupled Model Intercomparison Project (CMIP)*.

**CO\(_2\) equivalent (CO\(_2\)-eq) emission**  The amount of *carbon dioxide* (CO\(_2\)) emission that would have an equivalent effect on a specified key measure of *climate change*, over a specified time horizon, as an emitted amount of another *greenhouse gas* (GHG) or a mixture of other GHGs. For a mix of GHGs it is obtained by summing the CO\(_2\)-equivalent emissions of each gas. There are various ways and time horizons to compute such equivalent emissions (see *greenhouse gas emission metric*). CO\(_2\)-equivalent emissions are commonly used to compare emissions of different GHGs, but should not be taken to imply that these emissions have an equivalent effect across all key measures of climate change. [Note: Under the Paris Rulebook [Decision 18/CMA.1, annex, paragraph 37], parties have agreed to use GWP100 values from the IPCC AR5 or GWP100 values from a subsequent IPCC Assessment Report to report aggregate emissions and removals of GHGs. In addition, parties may use other metrics to report supplemental information on aggregate emissions and removals of GHGs.]

**Coast**  The *land* near to the sea. The term ‘coastal’ can refer to that land (e.g., as in ‘coastal communities’), or to that part of the marine environment that is strongly influenced by land-based processes. Thus, coastal seas are generally shallow and near-shore. The landward and seaward limits of the coastal zone are not consistently defined, neither scientifically nor legally. Thus, coastal waters can either be considered as equivalent to territorial waters (extending 12 nautical miles / 22.2 km from mean low water), or to the full Exclusive Economic Zone, or to *shelf seas*, with less than 200 m water depth.

**Cold days/cold nights**  Days where maximum temperature, or nights where minimum temperature, falls
below the 10th percentile, where the respective temperature distributions are generally defined with respect to the 1961-1990 reference period. For the corresponding indices, see Box 2.4.

Common era (CE)  CE (Common Era) and BCE (Before the Common Era) are alternative names for AD (Anno Domini) and BC (Before Christ) in the Gregorian international standard calendar-year system. CE/BCE are preferred in an international context because they are neutral with respect to religion. The numbering of calendar years is the same under both terminologies. The CE began in year AD 1 and extends to the present day.

Compatible emissions  Earth System Models that simulate the land and ocean carbon cycle can calculate CO₂ emissions that are compatible with a given atmospheric CO₂ concentration trajectory. The compatible emissions over a given period of time are equal to the increase of carbon over that same period of time in the sum of the three active reservoirs: the atmosphere, the land and the ocean.

Compound events  See Compound weather/climate events.

Compound weather/climate events  The combination of multiple drivers and/or hazards that contributes to societal and/or environmental risk (Zscheischler et al., 2018).

Concentrations scenario  See Scenario.

Confidence  The robustness of a finding based on the type, amount, quality and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and on the degree of agreement across multiple lines of evidence. In this report, confidence is expressed qualitatively (Mastrandrea et al., 2010).

Constant composition commitment  See Climate change commitment.

Constant emissions commitment  See Climate change commitment.

Convection  Vertical motion driven by buoyancy forces arising from static instability, usually caused by near-surface cooling or increases in salinity in the case of the ocean and near-surface warming or cloud-top radiative cooling in the case of the atmosphere. In the atmosphere, convection gives rise to cumulus clouds and precipitation and is effective at both scavenging and vertically transporting chemical species. In the ocean, convection can carry surface waters to deep within the ocean.

Convection-permitting models  See Cloud-resolving models (CRMs).

Coral bleaching  Loss of coral pigmentation through the loss of intracellular symbiotic algae (known as zooxanthellae) and/or loss of their pigments.

Coral reef  An underwater ecosystem characterised by structure-building stony corals. Warm-water coral reefs occur in shallow seas, mostly in the tropics, with the corals (animals) containing algae (plants) that depend on light and relatively stable temperature conditions. Cold-water coral reefs occur throughout the world, mostly at water depths of 50-500 m. In both kinds of reef, living corals frequently grow on older, dead material, predominantly made of calcium carbonate (CaCO₃). Both warm and cold-water coral reefs support high biodiversity of fish and other groups, and are considered to be especially vulnerable to climate change.

Cosmogenic radioisotopes  Rare radioactive isotopes that are created by the interaction of a high-energy cosmic ray particles with atoms nuclei. They are often used as indicator of solar activity which modulates the cosmic rays intensity or as tracers of atmospheric transport processes, and are also called cosmogenic radionuclides.

Coupled Model Intercomparison Project (CMIP)  A climate modelling activity from the World Climate
Research Programme (WCRP) which coordinates and archives climate model simulations based on shared model inputs by modelling groups from around the world. The CMIP3 multi-model data set includes projections using Special Report on Emissions Scenarios (SRES) scenarios. The CMIP5 data set includes projections using the Representative Concentration Pathways (RCP). The CMIP6 phase involves a suite of common model experiments as well as an ensemble of CMIP-endorsed Model Intercomparison Projects (MIPs).

Cryosphere  The components of the Earth System at and below the land and ocean surface that are frozen, including snow cover, glaciers, ice sheets, ice shelves, icebergs, sea ice, lake ice, river ice, permafrost and seasonally frozen ground.

Cumulative emissions  The total amount of emissions released over a specified period of time. See also Carbon budget and Transient climate response to cumulative CO₂ emissions (TCRE) (under Climate sensitivity).

Dansgaard-Oeschger events (D-O events)  Milennial-scale events first characterized in Greenland ice cores as abrupt warming from a cold stadial state to a warmer interstadial state, followed by a return to a cold stadial state (Dansgaard et al., 1993), and traced in the ocean via deposits of ice-rafted sand grains (Bond and Lotti, 1995). Named after Willi Dansgaard and Hans Oeschger by Bond and Lotti (1995). An example of a D-O event during the most recent deglacial transition is the Bolling-Allerød interstadial. Warm D-O events in Greenland are associated with cooling events in Antarctica (Blunier and Brook, 2001) through ocean thermohaline circulation (Stocker and Johnsen, 2003). See also Bipolar seesaw (also interhemispheric seesaw, interhemispheric asymmetry).

Data assimilation  Mathematical method used to combine different sources of information in order to produce the best possible estimate of the state of a system. This information usually consists of observations of the system and a numerical model of the system evolution. Data assimilation techniques are used to create initial conditions for weather forecast models, and to construct reanalyses describing the trajectory of the climate system over the time period covered by the observations.

Dead zones  Extremely hypoxic (i.e., low-oxygen) areas in oceans and lakes, caused by excessive nutrient input from human activities coupled with other factors that deplete the oxygen required to support many marine organisms in bottom and near-bottom water.

Decadal predictability  Decadal predictability refers to the notion of predictability of the climate system on a decadal time scale. See also Climate prediction, Predictability and Decadal prediction.

Decadal prediction  A decadal prediction is a climate prediction on decadal time scales.

Decadal variability  See Climate variability.

Deep uncertainty  See Uncertainty.

Deforestation  Conversion of forest to non-forest. [Note: For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and their 2019 Refinement, and information provided by the United Nations Framework Convention on Climate Change (IPCC, 2006, 2019, UNFCCC, 2021a, 2021b).]

See also Reducing Emissions from Deforestation and Forest Degradation (REDD+), Afforestation and Reforestation.

Deglacial or deglaciation or glacial termination  The period of transition from glacial conditions at the end of a glacial period to interglacial conditions characterized by a reduction in land ice volume. Gradual changes can be punctuated by abrupt changes linked to stadial / interstadial events and bipolar seesaw aspect. The last deglacial transition occurred between about 18,000 and 11,000 years ago. It encompasses...
rapid events such as Meltwater Pulse 1A (MWP-1A) and millennial-scale fluctuations such as the Younger Dryas. See also Glacial-interglacial cycles and Ice age.

Detection  Detection of change is defined as the process of demonstrating that climate or a system affected by climate has changed in some defined statistical sense, without providing a reason for that change. An identified change is detected in observations if its likelihood of occurrence by chance due to internal variability alone is determined to be small, for example, <10%.

Detection and attribution  See Detection and Attribution.

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

Dimensions of integration  In IPCC AR6, concepts used to synthesize the knowledge of climate change across not just the physical sciences, but also across impact and adaptation, and mitigation research. The concept of ‘dimensions of integration’ includes (i) emission and concentration scenarios underlying the climate change projections assessed in this report, (ii) levels of projected global mean temperature change and (iii) total amounts of cumulative carbon emissions for projections.

Direct (aerosol) effect  See Aerosol-radiation interaction.

Direct air capture (DAC)  Chemical process by which a pure carbon dioxide (CO₂) stream is produced by capturing CO₂ from the ambient air. See also Direct air carbon dioxide capture and storage (DACCSC), Anthropogenic removals and Carbon dioxide removal (CDR).

Direct emissions  Emissions that physically arise from activities within well-defined boundaries of, for instance, a region, an economic sector, a company, or a process. See also Indirect emissions.

Disaster  A ‘serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts’ (UNGA, 2016). See also Exposure, Hazard, Risk and Vulnerability.

Discharge (of ice)  See Mass balance / budget (of glaciers or ice sheets).

Dissolved inorganic carbon  The combined total of different types of non-organic carbon in (seawater) solution, comprising carbonate (CO₃²⁻), bicarbonate (HCO₃⁻), carbonic acid (H₂CO₃) and carbon dioxide (CO₂).

Diurnal temperature range (DTR)  The difference between the maximum and minimum temperature during a 24-hour period.

Dobson unit (DU)  A unit to measure the total amount of ozone in a vertical column above the Earth’s surface (total column ozone). The number of Dobson Units is the thickness in units of 10⁻³ 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 × 10³⁰ molecules per square metre. A typical value for the amount of ozone in a column of the Earth’s atmosphere, although very variable, is 300 DU.

Downscaling  A method that derives local- to regional-scale information from larger-scale models or data analyses. Two main methods exist: dynamical downscaling and empirical/statistical downscaling. The dynamical method uses the output of regional climate models, global models with variable spatial resolution, or high-resolution global models. The empirical/statistical methods are based on observations and 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 quality of the downscaled
information. The two methods can be combined, e.g., applying empirical/statistical downscaling to the
output of a regional climate model, consisting of a dynamical downscaling of a global climate model.

**Drought**  An exceptional period of water shortage for existing ecosystems and the human population (due
to low rainfall, high temperature, and/or wind). See also Plant evapotranspiration stress.

**Agricultural or ecological drought**  Agricultural or ecological drought (depending on the affected biome): a
period with abnormal soil moisture deficit, which results from combined shortage of precipitation and excess
evapotranspiration, and during the growing season impinges on crop production or ecosystem function in
general.

**Hydrological drought**  A period with large runoff and water deficits in rivers, lakes and reservoirs.

**Meteorological drought**  A period with an abnormal precipitation deficit.

**Dynamic global vegetation model (DGVM)**  A model that simulates vegetation development and
dynamics through space and time, as driven by climate and other environmental changes.

**Dynamical downscaling**  See Downscaling.

**Dynamical system**  A process or set of processes whose evolution in time is governed by a set of
deterministic physical laws. The climate system is a dynamical system.

**Early Eocene Climatic Optimum (EECO)**  The EECO is a period of geological time that occurred about
53 to 49 million years ago, during the Eocene Epoch. Continental positions at this time were somewhat
different to present due to tectonic plate movements. Geological data indicate that the EECO was a period of
relatively high atmospheric CO₂ concentrations (about 1150-2500 ppmv) and relative warmth (global mean
surface temperature was about 10-18 °C above the 1850-1900 reference), and polar ice sheets were absent.

**Earth system model (ESM)**  A coupled atmosphere–ocean general circulation model (AOGCM) in which
a representation of the carbon cycle is included, allowing for interactive calculation of atmospheric carbon
dioxide (CO₂) or compatible emissions. Additional components (e.g., atmospheric chemistry, ice sheets,
dynamic vegetation, nitrogen cycle, but also urban or crop models) may be included. See also Earth system
model of intermediate complexity (EMIC).

**Earth system model of intermediate complexity (EMIC)**  Earth system models of intermediate
complexity (EMIC) represent climate processes at a lower resolution or in a simpler, more idealised fashion
than an Earth system model (ESM).

**Earth’s energy budget**  For a given time period, Earth’s energy budget expresses the balance between total
earth system heating, the time-integrated effective radiative forcing and time-integrated Earth’s radiative
response. Units: Joules. See also Earth’s top of atmosphere energy budget, Earth’s energy imbalance, Earth’s
surface energy budget, Earth’s radiative response, Earth’s energy flows and Earth system heating.

**Earth’s energy flows**  The time-mean (or representative) energy exchanges within the climate system
(including energy energy exchanges at the surface and top-of-atmosphere). This also includes horizontal
ocean and atmospheric heat transports. See also Earth’s energy budget, Earth’s top of atmosphere energy
budget, Earth’s energy imbalance, Earth’s surface energy budget, Earth system heating and Earth’s radiative
response.

**Earth’s energy imbalance**  The persistent and positive (downward) net top of atmosphere energy flux
associated with greenhouse gas forcing of the climate system. See also Earth’s energy budget, Earth’s top of
atmosphere energy budget, Earth’s surface energy budget, Earth system heating, Earth’s radiative response
and Earth’s energy flows.
Earth's radiative response  The product of global mean surface air temperature (GSAT) change and the net feedback parameter (i.e. sum of all feedbacks), which determines the net top-of-atmosphere radiative flux that opposes a change in radiative forcing. Units: W m⁻². See also Earth's energy budget, Earth's top of atmosphere energy budget, Earth's energy imbalance, Earth's surface energy budget, Earth system heating and Earth's energy flows.

Earth's surface energy budget  Earth's surface energy budget comprises the exchanges of heat at the surface of the Earth associated with both radiative and non-radiative processes. See also Earth's energy budget, Earth's top of atmosphere energy budget, Earth's energy imbalance, Earth system heating, Earth's radiative response and Earth's energy flows.

Earth system sensitivity  See Climate sensitivity.

Earth's top of atmosphere energy budget  Earth's top of atmosphere energy budget comprises the energy fluxes associated with incoming solar radiation, reflected solar radiation and emitted thermal radiation. See also Earth's energy budget, Earth's energy imbalance, Earth's surface energy budget, Earth system heating, Earth's radiative response and Earth's energy flows.

East Antarctic ice sheet (EAIS)  See Ice sheet.

East Asian monsoon (EAsiaM)  See Global monsoon.

Eastern boundary upwelling systems (EBUS)  Eastern boundary upwelling system (EBUS) are located at the eastern (landward) edges of major ocean basins in both hemispheres, where equatorward winds drive upwelling currents that bring cool, nutrient-rich (and often oxygen-poor) waters from the deep ocean to the surface near the coast.


Economic potential  See Mitigation potential.

Ecosystem  A functional unit consisting of living organisms, their non-living environment and the interactions within and between them. The components included in a given ecosystem and its spatial boundaries depend on the purpose for which the ecosystem is defined: in some cases they are relatively sharp, while in others they are diffuse. Ecosystem boundaries can change over time. Ecosystems are nested within other ecosystems and their scale can range from very small to the entire biosphere. In the current era, most ecosystems either contain people as key organisms, or are influenced by the effects of human activities in their environment. See also Ecosystem services.

Effective radiative forcing (ERF)  See Radiative forcing, Aerosol effective radiative forcing (ERFari+aci) (under Aerosol-radiation interaction), Effective radiative forcing (or effect) due to aerosol-cloud interactions (ERFaci) (under Aerosol-cloud interaction) and Effective radiative forcing (or effect) due to aerosol-radiation interactions (ERFari) (under Aerosol-radiation interaction).

Ekman transport  The total transport resulting from a balance between the Coriolis force and the frictional stress due to the action of the wind on the ocean surface.


El Niño-Southern Oscillation (ENSO)  The term El Niño was initially used to describe a warm-water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. It has since become identified with warming of the tropical Pacific Ocean east of the dateline. This oceanic event is associated with a fluctuation of a global-scale tropical and subtropical surface pressure pattern called the Southern Oscillation. This coupled atmosphere–ocean phenomenon, with preferred time scales of two to about seven years, is known as the El Niño-Southern Oscillation (ENSO). The warm and cold phases of
ENSO are called El Niño and La Niña, respectively. ENSO is often measured by the surface pressure anomaly difference between Tahiti and Darwin and/or the sea surface temperatures in the central and eastern equatorial Pacific. This phenomenon has a great impact on the wind, sea surface temperature and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world through global teleconnections. See Section AIV.2.3 in Annex IV of the AR6 WGI report.

**Central Pacific El Niño** An El Niño event in which sea surface temperature anomalies are stronger in the central equatorial Pacific than in the east. Also known as a Modoki El Niño event.

**Eastern Pacific El Niño** An El Niño event in which sea surface temperature anomalies are largest in the eastern tropical Pacific.

**Electromagnetic spectrum** Wavelength, frequency or energy range of all electromagnetic radiation. In terms of solar radiation, the spectral irradiance is the power arriving at the Earth per unit area, per unit wavelength.

**Elevation-dependent warming (EDW)** Characteristic of many regions where mountains are located, in which past and/or future surface air temperature changes vary neither uniformly nor linearly with elevation. In many cases, warming is enhanced within or above a certain elevation range.

**Emergence (of the climate signal)** Emergence of a climate change signal or trend refers to when a change in climate (the ‘signal’) becomes larger than the amplitude of natural or internal variations (defining the ‘noise’). This concept is often expressed as a ‘signal-to-noise’ ratio and emergence occurs at a defined threshold of this ratio (e.g., S/N > 1 or 2). Emergence can refer to changes relative to a historical or modern baseline (usually at least 20 years long) and can also be expressed in terms of time (time of emergence) or in terms of a global warming level. Emergence is also used to refer to a time when we can expect to see a response of reducing greenhouse gas (GHG) emissions (emergence with respect to mitigation). Emergence can be estimated using observations and/or model simulations. See also Time of emergence (ToE).

**Emergent constraint** An attempt to reduce the uncertainty in climate projections, using an ensemble of ESMs to relate a specific feedback or future change to an observation of the past or current climate (typically some trend, variability or change in variability).

**Emission factor/Emissions intensity** A coefficient that quantifies the emissions or removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions.

**Emissions** See Indirect emissions, Negative CO₂ emissions, Production-based emissions, Scope 1, Scope 2, and Scope 3 emissions, Territorial emissions, Agricultural emissions, Cumulative emissions, Direct emissions, Embodied (embedded) [emissions, water, land], Anthropogenic emissions, Fossil fuel emissions, Non-CO₂ emissions and radiative forcing and Negative greenhouse gas emissions. See also Emissions scenario (under Scenario), Emission pathways and Emission trajectories.

**Emulation** Reproducing the behaviour of complex, process-based models (namely, Earth System Models, ESMs) via simpler approaches, using either emulators or simple climate models (SCMs). The computational efficiency of emulating approaches opens new analytical possibilities given that ESMs take a lot of computational resources for each simulation. See also Emulators and Simple climate model (SCM).

**Emulators** A broad class of heavily parametrized models (‘one-or-few-line climate models’), statistical methods like neural networks, genetic algorithms or other artificial intelligence approaches, designed to reproduce the responses of more complex, process-based Earth System Models (ESMs). The main application of emulators is to extrapolate insights from ESMs and observational constraints to a larger set of emission scenarios. See also Emulation and Simple climate model (SCM).
Energy balance  The difference between the total incoming and total outgoing energy. If this balance is positive, warming occurs; if it is negative, cooling occurs. Averaged over the globe and over long time periods, this balance must be zero. Because the climate system derives virtually all its energy from the Sun, zero balance implies that, globally, the absorbed solar radiation, that is, incoming solar radiation minus reflected solar radiation at the top of the atmosphere and outgoing longwave radiation emitted by the climate system are equal.

Energy balance model (EBM)  An energy balance model is a simplified model that analyses the energy budget of the Earth to compute changes in the climate. In its simplest form, there is no explicit spatial dimension and the model then provides an estimate of the changes in globally averaged temperature computed from the changes in radiation. This zero-dimensional energy balance model can be extended to a one-dimensional or two-dimensional model if changes to the energy budget with respect to latitude, or both latitude and longitude, are explicitly considered.

Energy budget (of the Earth)  The Earth is a physical system with an energy budget that includes all gains of incoming energy and all losses of outgoing energy. The Earth’s energy budget is determined by measuring how much energy comes into the Earth System from the Sun, how much energy is lost to space, and accounting for the remainder on Earth and its atmosphere. Solar radiation is the dominant source of energy into the Earth System. Incoming solar energy may be scattered and reflected by clouds and aerosols or absorbed in the atmosphere. The transmitted radiation is then either absorbed or reflected at the Earth’s surface. The average albedo of the Earth is about 0.3, which means that 30% of the incident solar energy is reflected into space, while 70% is absorbed by the Earth. Radiant solar or shortwave energy is transformed into sensible heat, latent energy (involving different water states), potential energy, and kinetic energy before being emitted as infrared radiation. With the average surface temperature of the Earth of about 15°C (288 K), the main outgoing energy flux is in the infrared part of the spectrum.

Enhanced weathering  A proposed method to increase the natural rate of removal of carbon dioxide (CO₂) from the atmosphere using silicate and carbonate rocks. The active surface area of these minerals is increased by grinding, before they are actively added to soil, beaches or the open ocean. See also Carbon dioxide removal (CDR) and Anthropogenic removals.

Ensemble  A collection of comparable datasets that reflect variations within the bounds of one or more sources of uncertainty, and that when averaged can provide a more robust estimate of underlying behaviour. Ensemble techniques are used by the observational, reanalysis and modelling communities. See also Climate simulation ensemble.

Equilibrium and transient climate experiment  An equilibrium climate experiment is a climate model experiment in which the 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 an experiment is called a transient climate experiment.

Equilibrium climate sensitivity (ECS)  See Climate sensitivity.

Equilibrium line  The spatially averaged boundary at a given moment, usually chosen as the seasonal mass budget minimum at the end of summer, between the region on a glacier where there is a net annual loss of ice mass (ablation area) and that where there is a net annual gain (accumulation area). The altitude of this boundary is referred to as equilibrium line altitude (ELA).

Equivalent carbon dioxide (CO₂) emission  See CO₂ equivalent (CO₂-eq) emission.

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 (or oxygen depletion) and harmful algal blooms.
Evaporation The physical process by which a liquid (e.g., water) becomes a gas (e.g., water vapour).

Evapotranspiration The combined processes through which water is transferred to the atmosphere from open water and ice surfaces, bare soil, and vegetation that make up the Earth’s surface.

Potential evapotranspiration The potential rate of water loss from wet soils and from plant surfaces, without any limits imposed by the water supply.

Evidence Data and information used in the scientific process to establish findings. In this report, the degree of evidence reflects the amount, quality and consistency of scientific/technical information on which the Lead Authors are basing their findings. See also Agreement, Confidence, Likelihood and Uncertainty.

Exposure The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.

Extended concentration pathways (ECPs) See Representative concentration pathways (RCPs) (under Pathways).

External forcing External forcing refers to a forcing agent outside the climate system causing a change in the climate system. Volcanic eruptions, solar variations and changes in Earth’s orbit, as well as anthropogenic changes in the composition of the atmosphere or in land use are external forcings. See also Orbital forcing.

Extratropical cyclone (ETC) Any cyclonic-scale storm that is not a tropical cyclone. Usually refers to a middle- or high-latitude migratory storm system formed in regions of large horizontal temperature variations. Sometimes called extratropical storm or extratropical low.

Extratropical jets Extratropical jets are wind maxima in the upper troposphere marking zones of baroclinic instability. Anomalies in the position of these jets are often associated with storms, blocking, and weather extremes.

Extreme climate event See Climate extreme (extreme weather or climate event).

Extreme coastal water level (ECWL) See Extreme sea level (ESL).

Extreme sea level (ESL) The occurrence of an exceptionally low or high local sea-surface height, arising from (a combination of) short term phenomena (e.g. storm surges, tides and waves). Relative sea-level changes affect extreme sea levels directly by shifting the mean water levels and indirectly by modulating the propagation of tides, waves and/or surges due to increased water depth. In addition, extreme sea levels can be influenced by changes in the frequency, tracks, or strength of weather systems and storms, or due to anthropogenically induced changes such as the modification of coastlines or dredging. In turn, changes in any or all of the contributions to extreme sea levels may lead to long term relative sea-level changes. Alternate expressions for ESL may be used depending on the processes resolved.

Extreme Still Water Level (ESWL) refers to the combined contribution of relative sea-level change, tides and storm surges. Wind-waves also contribute to coastal sea level via three processes: infragravity waves (lower frequency gravity waves generated by the wind waves); wave setup (time-mean sea-level elevation due to wave energy dissipation); and swash (vertical displacement up the shore-face induced by individual waves). Extreme Total Water Level (ETWL) is the ESWL plus wave setup. When considering coastal impacts, swash is also important, and Extreme Coastal Water Level (ECWL) is used. See also Storm surge and Sea level change (sea level rise/sea level fall).

Extreme still water level (ESWL) See Extreme sea level (ESL).
Extreme total water level (ETWL) See Extreme sea level (ESL).

Extreme weather event An event that is rare at a particular place and time of year. Definitions of ‘rare’ vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. See also Heatwave and Climate extreme weather event.

Extreme/heavy precipitation event An extreme/heavy precipitation event is an event that is of very high magnitude with a very rare occurrence at a particular place. Types of extreme precipitation may vary depending on its duration, hourly, daily or multi-days (e.g., 5 days), though all of them qualitatively represent high magnitude. The intensity of such events may be defined with block maxima approach such as annual maxima or with peak over threshold approach, such as rainfall above 95th or 99th percentile at a particular space.

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

Feedback See Climate feedback.

Fine-mode aerosol optical depth See Aerosol optical depth (AOD).

Fingerprint The climate response pattern in space and/or time to a specific forcing is commonly referred to as a fingerprint. The spatial patterns of sea level response to melting of glaciers or ice sheets (or other changes in surface loading) are also referred to as fingerprints. Fingerprints are used to detect the presence of this response in observations and are typically estimated using forced climate model simulations. See also Detection and attribution.

Fire weather Weather conditions conducive to triggering and sustaining wildfires, usually based on a set of indicators and combinations of indicators including temperature, soil moisture, humidity, and wind. Fire weather does not include the presence or absence of fuel load.

Firn Snow that has survived at least one ablation season but has not been transformed to glacier ice. Its pore space is at least partially interconnected, allowing air and water to circulate. Firn densities typically are 400–830 kg m$^{-3}$.

Fitness-for-purpose The suitability of a model (or other resource, such as a dataset or method) for a particular task, such as quantifying the contribution of increased greenhouse gas concentrations to recent changes in global mean surface temperature or projecting changes in drought frequency in a region under a given scenario. Assessment of a model’s fitness-for-purpose can be informed both by how the model represents relevant physical processes and by how it scores on relevant performance metrics.

Flaring Open air burning of waste gases and volatile liquids, through a chimney, at oil wells or rigs, in refineries or chemical plants, and at landfills.

Flood The overflowing of the normal confines of a stream or other water body, or the accumulation of water over areas that are not normally submerged. Floods can be caused by unusually heavy rain, for example during storms and cyclones. Floods include river (fluvial) floods, flash floods, urban floods, rain (pluvial) floods, sewer floods, coastal floods, and glacial lake outburst floods (GLOFs).

Flux A movement (a flow) of matter (e.g., water vapor, particles), heat or energy from one place to another, or from one medium (e.g., land surface) to another (e.g., atmosphere).

Foraminifera Single-celled, sand-sized marine organisms (protists) that possess a hard test mainly.
composed of agglutinated walls (detrital grains glued together with organic cement) or calcium carbonate
(predominantly calcite). They are used to reconstruct a range of (paleo)environmental variables such as
salinity, temperature, oxygenation, oxygen isotope composition, and organic and nutrient flux.

**Forcing** See Radiative forcing.

**Forest** A vegetation type dominated by trees. Many definitions of the term forest are in use throughout the
world, reflecting wide differences in biogeophysical conditions, social structure and economics. [Note: For a
discussion of the term forest in the context of National GHG inventories, see the 2006 IPCC Guidelines for
National GHG Inventories and their 2019 Refinement, and information provided by the United Nations
Framework Convention on Climate Change (IPCC, 2006, 2019, UNFCCC, 2021a, 2021b).] See also
Afforestation, Deforestation and Reforestation.

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

**Fossil fuels** Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas.

**Free atmosphere** The atmospheric layer that is negligibly affected by friction against the Earth’s surface,
and which is above the atmospheric boundary layer.

**Frozen ground** Soil or rock in which part or all of the pore water consists of ice. See also Active layer and
Permafrost.

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

**General circulation model (GCM)** A numerical representation of the atmosphere-ocean-sea ice system
based on the physical, chemical and biological properties of its components, their interactions and feedback
processes. General circulation models are used for weather forecasts, seasonal to decadal prediction, and
climate projections. They are the basis of the more complex Earth system models (ESMs). See also Climate
model.

**Geocentric sea-level change** See Sea level change (sea level rise/sea level fall).

**Geoid** The equipotential surface having the same geopotential at each latitude and longitude around the
world (geodesists denoting this potential \( W_0 \)) that best approximates the mean sea level. It is the surface of
reference for measurement of altitude. In practice, several variations of definitions of the geoid exist
depending on the way the permanent tide (the zero-frequency gravitational tide due to the Sun and Moon) is
considered in geodetic studies.

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

**Glacial isostatic adjustment (GIA)** The ongoing changes in gravity, rotation and viscoelastic solid Earth
def ormation (GRD) in response to past changes in the distribution of ice and water on Earth’s surface. On a
timescale of decades to tens of millennia following mass redistribution, Earth’s mantle flows viscously as it
evolves toward isostatic equilibrium, causing solid Earth movement and geoid changes, which can result in
regional to local sea-level variations. See also Sea level change (sea level rise/sea level fall).

**Glacial lake outburst flood (GLOF) / Glacier lake outburst** A sudden release of water from a glacier
lake, including any of the following types – a glacier-dammed lake, a pro-glacial moraine-dammed lake or
water that was stored within, under or on the glacier.
Glacial or glaciation  A period characterized by the establishment of expanded ice sheets and glaciers, and associated with global mean sea level (GMSL) substantially lower than present. Generally coincides with even-numbered marine isotope stages. Glacial intervals were interrupted by interglacial intervals. The Last Glacial Maximum (LGM) is a specific interval within the most recent glacialization, when ice sheets were near their global maximum volume (Clark et al., 2009; Gowan et al., 2021) and GMSL was near its most recent lowest stand (Lambeck et al., 2014; Yokoyama et al., 2018). Local or regional glacial maxima may be diachronous, for example ranging from about 29,000 years ago and 16,000 years ago. For purposes of global synthesis, IPCC AR6 adopts a practical chronostratigraphic definition of LGM of 23,000-19,000 years BP (before 1950; chronozone level 1 of Mix et al., 2001). For modeling purposes, LGM is defined by the model time step nearest to the center of this interval, 21,000 years ago (Kageyama et al., 2017). See also Deglacial or deglaciation or glacial termination, Glacial-interglacial cycles, Ice age and Interglacial or interglaciation.

Glacial termination  See Deglacial or deglaciation or glacial termination.

Glacial-interglacial cycles  Phase of the Earth’s history marked by large changes in continental ice volume and global sea level. See also Glacial or glaciation, Deglacial or deglaciation or glacial termination, Interglacial or interglaciation and Ice age.

Glaciated  State of a surface that was covered by glacier ice in the past, but not at present. See also Glacierised.

Glacier  A perennial mass of ice, and possibly firn and snow, originating on the land surface by accumulation and compaction of snow and showing evidence of past or present flow. A glacier typically gains mass by accumulation of snow, and loses mass by ablation. Land ice masses of continental size (>50,000 km$^2$) are referred to as ice sheets (Cogley et al., 2011).

Outlet glacier  A glacier, usually between rock walls, that is part of, and drains an ice sheet. See also Ice stream.

Glacierised  A surface that is currently covered by glacier ice. See also Glaciated.

Global carbon budget  See Carbon budget.

Global dimming  Global dimming refers to the observed widespread reduction in the amount of solar radiation received at the Earth’s surface from the 1950s to the 1980s, with an increase in anthropogenic aerosol emissions appearing to have contributed. This was followed by a partial recovery since the 1990s (“brightening”), particularly in industrialized areas, coincident with a reduction in anthropogenic aerosol emissions.

Global mean sea-level (GMSL) change  See Sea level change (sea level rise/sea level fall).

Global mean surface air temperature (GSAT)  Global average of near-surface air temperatures over land, oceans and sea ice. Changes in GSAT are often used as a measure of global temperature change in climate models. See also Global mean surface temperature (GMST).

Global mean surface temperature (GMST)  Estimated global average of near-surface air temperatures over land and sea ice, and sea surface temperature (SST) over ice-free ocean regions, with changes normally expressed as departures from a value over a specified reference period. See also Global mean surface air temperature (GSAT).

Global monsoon  The global monsoon (GM) is a global-scale solstitial mode that dominates the annual variation of tropical and sub-tropical precipitation and circulation. The GM domain is defined as the area where the annual range of precipitation (local summer minus winter mean precipitation rate) is greater than...
2.5 mm/day, following on from the definition as in Kitoh et al. (2013). Further details on how the GM is
defined, used and related to regional monsoons throughout the report is provided by Annex V.

Australian and Maritime Continent monsoon (AusMCM) The Australian-Maritime Continent monsoon
(AusMCM) occurs during December-January-February, with the large-scale shift of the Inter-Tropical
Convergence Zone into the Southern Hemisphere and covering northern Australia and the Maritime
Continent up to 10N. The AusMCM is characterized by the seasonal reversal of prevailing easterly winds to
westerly winds and the onset of periods of active convection and heavy rainfall. Over northern Australia, the
monsoon season generally lasts from December to March and is associated with west to northwesterly inflow
of moist winds, producing convection and heavy precipitation. Over the Maritime Continent, the main rainy
season south of the equator is centered on December to February with northwesterly monsoon flow at low
levels. Further details on how AusMCM is defined and used throughout the report is provided in the Annex
V.

East Asian monsoon (EAsiaM) The East Asian monsoon (EAsiaM) is the seasonal reversal in wind and
precipitation occurring over East Asia, including eastern China, Japan and the Korean peninsula. Differently
from the other monsoons it extends quite far north, out of the tropical belt, and it is largely influenced by
subtropical systems and by disturbances from the mid-latitudes. The EAsiaM manifests during boreal
summer with warm and wet southerly winds, but also during boreal winter with cold and dry northerly
winds. In late April/early May rainfall onsets in central Indochina Peninsula, and in mid-June the rainy
season arrives over East Asia with the formation of the Meiyu front along the Yangtze River valley,
Changma in Korea and Baiu in Japan. Lately in July, the monsoon advances up to North China, the Korean
peninsula and central Japan. During boreal winter, strong north westerlies manifest over north, northeast
China, Korea and Japan, while strong north easterlies arrive along the coast of East Asia. Further details on
how EAsiaM is defined and used throughout the report is provided in the Annex V.

North American monsoon (NAmerM) The North American monsoon (NAmerM) is a regional-scale
atmospheric circulation system with increase in summer precipitation over northwestern Mexico and
southwest United States. The monsoonal characteristics of the region include a pronounced annual maximum
of precipitation in boreal summer (June-July-August) accompanied by a surface low pressure system and an
upper-level anticyclone, although seasonal reversal of the surface winds is primarily limited to the northern
Gulf of California. Further details on how NAmerM is defined and used throughout the report is provided in
the Annex V.

South American monsoon (SAmerM) The South American monsoon (SAmerM) is a regional circulation
characterized by inflow of low-level winds from the Atlantic to South America, including Brazil, Peru’,
Bolivia and northern Argentina, associated with the development of surface pressure gradients (and intense
precipitation) during austral summer (December-January-February). During September-October-November
areas of intense convection migrate from northwestern South America to the south. Associated to this
regime, an upper-tropospheric anticyclone (a.k.a the Bolivian High) forms over the Altiplano region during
the monsoon onset. The SAmerM then retreats during March-April-May with a northeastward migration of
the convection. Further details on how SAmerM is defined and used throughout the report is provided in the
Annex V.

South and Southeast Asian monsoon (SAsiaM) The South and Southeast Asian monsoon (SAsiaM) is
characterized by pronounced seasonal reversals of wind and precipitation. The SAsiaM region extends across
vast geographical areas and several countries including India, Bangladesh, Nepal, Myanmar, Sri Lanka,
Pakistan, Thailand, Laos, Cambodia, Vietnam and Philippine. The SAsiaM starts in late May/early June and
progresses toward northeast, ending in late September/early October. During the core monsoon season,
maxima of SAsiaM precipitation are located over the west coast, northeast and central north India, Myanmar
and Bangladesh, whereas minima are located over northwest and southeastern India, western Pakistan,
southeastern and northern Sri Lanka. Further details on how SAsiaM is defined and used throughout the
report is provided in the Annex V.

West African monsoon (WAfriM) The West African monsoon (WAfriM) is a seasonal reversal in wind and
precipitation whose domain includes Benin, Burkina-Faso, northern Cameroon, Cape Verde, northern
Central African Republic, Chad, Gambia, Ghana, Guinea, Guinea Bissau, Ivory, Coast, Liberia, Mali,
Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. The WAfriM is characterized by the northward
progression from May to September of moist low-level south-westerlies from the Gulf of Guinea. In May
and June, rainfall essentially remains along the Guinean coast with a maximum occurring near 5°N, followed
by a sudden decrease of rainfall, marking the “short dry season” in the Guinean coast and the monsoon onset
in the Sahel. Then rainfall continues to progress northward up to about 18-20°N, with a maximum near 12°N
in late August/September, until it retreats starting from October towards the Guinean coast for a second
maximum. Further details on how WAfriM is defined and used throughout the report is provided in the
Annex V.

Global surface temperature  See Global mean surface temperature (GMST) and Global mean surface air
temperature (GSAT). See also Global warming.

Global warming  Global warming refers to the increase in global surface temperature relative to a baseline
reference period, averaging over a period sufficient to remove interannual variations (e.g., 20 or 30 years). A
common choice for the baseline is 1850-1900 (the earliest period of reliable observations with sufficient
geographic coverage), with more modern baselines used depending upon the application. See also Climate
change and Climate variability.

Global warming potential (GWP)  An index measuring the radiative forcing following an emission of a
unit mass of a given substance, accumulated over a chosen time horizon, relative to that of the reference
substance, carbon dioxide (CO₂). The GWP thus represents the combined effect of the differing times these
substances remain in the atmosphere and their effectiveness in causing radiative forcing. See also Lifetime
and Greenhouse gas emission metric.

Gravitational, rotational and deformational (GRD) effects  See Sea level change (sea level rise/sea level
fall).

Gravity Recovery And Climate Experiment (GRACE)  A pair of satellites to measure the Earth’s gravity
field anomalies from 2002 to 2017. These fields have been used, among other things, to study mass changes
of the polar ice sheets and glaciers.

Greenhouse effect  The infrared radiative effect of all infrared-absorbing constituents in the atmosphere.
Greenhouse gases (GHGs), clouds, and some aerosols absorb terrestrial radiation emitted by the Earth’s
surface and elsewhere in the atmosphere. These substances emit infrared radiation in all directions, but,
everything else being equal, the net amount emitted to space is normally less than would have been emitted
in the absence of these absorbers because of the decline of temperature with altitude in the troposphere and
the consequent weakening of emission. An increase in the concentration of GHGs increases the magnitude of
this effect; the difference is sometimes called the enhanced greenhouse effect. The change in a GHG
concentration because of anthropogenic emissions contributes to an instantaneous radiative forcing. Surface
temperature and troposphere warm in response to this forcing, gradually restoring the radiative balance at
the top of the atmosphere.

Greenhouse gas emission metric  A simplified relationship used to quantify the effect of emitting a unit
mass of a given greenhouse gas on a specified key measure of climate change. A relative GHG emission
metric expresses the effect from one gas relative to the effect of emitting a unit mass of a reference GHG on
the same measure of climate change. There are multiple emission metrics and the most appropriate metric
depends on the application. GHG emission metrics may differ with respect to (i) the key measure of climate
change they consider, (ii) whether they consider climate outcomes for a specified point in time or integrated
over a specified time horizon, (iii) the time horizon over which the metric is applied, (iv) whether they apply
to a single emission pulse, emissions sustained over a period of time, or a combination of both, and (v)
whether they consider the climate effect from an emission compared to the absence of that emission, or
compared to a reference emissions level or climate state.

Do Not Cite, Quote or Distribute  AVII-28
Notes: Most relative GHG emission metrics (such as the *Global Warming Potential* (GWP), Global Temperature change Potential (GTP), Global Damage Potential, and GWP*) use carbon dioxide as the reference gas. Emissions of non-CO₂ gases, when expressed using such metrics, are often referred to as “carbon dioxide equivalent” emissions. A metric that establishes equivalence regarding one key measure of the climate system response to emissions does not imply equivalence regarding other key measures. The choice of a metric, including its time horizon, should reflect the policy objectives for which the metric is applied.

**Greenhouse gas neutrality**  
Condition in which metric-weighted anthropogenic greenhouse gas (GHG) emissions associated with a subject are balanced by metric-weighted anthropogenic GHG removals. The subject can be an entity such as a country, an organisation, a district or a commodity, or an activity such as a service and an event. GHG neutrality is often assessed over the life cycle including indirect (“scope 3”) emissions, but can also be limited to the emissions and removals, over a specified period, for which the subject has direct control, as determined by the relevant scheme. The quantification of GHG emissions and removals depends on the GHG emission metric chosen to compare emissions and removals of different gases, as well as the time horizon chosen for that metric.

Note 1: GHG neutrality and net zero GHG emissions are overlapping concepts. The concepts can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms greenhouse gas neutrality and net zero greenhouse gas emissions are equivalent. At sub-global scales, net zero greenhouse gas emissions is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while greenhouse gas neutrality generally includes emissions and removals within and beyond the direct control or territorial responsibility of the reporting entity.

Accounting rules specified by GHG programmes or schemes can have a significant influence on the quantification of relevant emissions and removals.

Note 2. Under the Paris Rulebook [Decision 18/CMA.1, annex, paragraph 37], parties have agreed to use GWP100 values from the IPCC AR5 or GWP100 values from a subsequent IPCC Assessment Report to report aggregate emissions and removals of GHGs. In addition, parties may use other metrics to report supplemental information on aggregate emissions and removals of GHGs.

Note 3: In some cases, achieving greenhouse gas neutrality may rely on the supplementary use of offsets to balance emissions that remain after actions by the reporting entity are taken into account.] See also *Carbon neutrality*, *Greenhouse gas emission metric*, *Land use, land-use change and forestry (LULUCF)* and *Net zero greenhouse gas emissions*.

**Greenhouse gases (GHGs)**  
Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of radiation emitted by the Earth’s surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and ozone (O₃) are the primary GHGs in the Earth’s atmosphere. Human-made GHGs include *sulphur hexafluoride* (SF₆), *hydrofluorocarbons* (HFCs), *chlorofluorocarbons* (CFCs) and *perfluorocarbons* (PFCs); several of these are also O₃-depleting (and are regulated under the *Montreal Protocol*). See also *Well-mixed greenhouse gas*.

**Greenland ice sheet (GrIS)**  
See *Ice sheet*.

**Cross Primary Production (GPP)**  
See *Primary production*.

**Ground-level ozone**  
Atmospheric ozone (O₃) formed naturally or from human-emitted precursors near Earth’s surface, thus affecting human health, agriculture, and ecosystems. Ozone is a *greenhouse gas* (GHG), but ground-level ozone, unlike stratospheric ozone, also directly affects organisms at the surface. Ground-level ozone is sometimes referred to as tropospheric ozone, although much of the troposphere is well above the surface and thus does not directly expose organisms at the surface.

**Grounding line**  
The junction between a *glacier* or *ice sheet* and an *ice shelf*; the place where ice starts to float. This junction normally occurs over a zone, rather than at a line.
Gyre  Basin-scale ocean horizontal circulation pattern with slow flow circulating around the ocean basin, closed by a strong and narrow (100 to 200 km wide) boundary current on the western side. The subtropical gyres in each ocean are associated with high pressure in the centre of the gyres; the subpolar gyres are associated with low pressure.

Hadley cell  See Hadley circulation.

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

Halocarbons  A collective term for the group of partially halogenated organic species, which includes the chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), halons, methyl chloride and methyl bromide. Many of the halocarbons have large global warming potentials. The chlorine and bromine-containing halocarbons are also involved in the depletion of the ozone layer.

Halocline  A layer in the oceanic water column in which salinity changes rapidly with depth. Generally saltier water is denser and lies below less salty water. In some high latitude oceans the surface waters may be colder than the deep waters and the halocline is responsible for maintaining water column stability and isolating the surface waters from the deep waters.

Halosteric  See Sea level change (sea level rise/sea level fall).

Halosteric sea-level change  See Sea level change (sea level rise/sea level fall).

Hazard  The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. See also Impacts (consequences, outcomes) and Risk.

Heat index  A measure of how hot the air feels to the human body. The index is mainly based on surface air temperature and relative humidity, thus it reflects the combined effect of high temperature and humidity on human physiology and provides a relative indication of potential health risks.

Heat stress  A range of conditions in, e.g., terrestrial or aquatic organisms when the body absorbs excess heat during overexposure to high air or water temperatures or thermal radiation. In aquatic water breathing animals, hypoxia and acidification can exacerbate vulnerability to heat. Heat stress in mammals (including humans) and birds, both in air, is exacerbated by a detrimental combination of ambient heat, high humidity and low wind-speeds, causing regulation of body temperature to fail.

Heatwave  A period of abnormally hot weather often defined with reference to a relative temperature threshold, lasting from two days to months. Heatwaves and warm spells have various and, in some cases, overlapping definitions. See also Marine heatwave, Warm spell, Blocking, Heat index and Heat stress.

Heavy precipitation event  See Extreme/heavy precipitation event.

Heinrich event  Distinct layers of coarse-grained sediments comprised of ice-rafted debris identified across marine sediment cores in the North Atlantic. These sedimentary layers are closely associated with millennial-scale cooling events in the North Atlantic and a distinct pattern of global temperature and hydrological changes that are largely consistent with evidence for a slowdown, or even near-collapse, of the Atlantic meridional ocean circulation (AMOC) during these times.

Heterotrophic respiration  The conversion of organic matter to carbon dioxide by organisms other than
autotrophs.

**Hindcast or retrospective forecast**  A forecast made for a period in the past using only information available before the beginning of the forecast. A sequence of hindcasts can be used to calibrate the forecast system and/or provide a measure of the average skill that the forecast system has exhibited in the past as a guide to the skill that might be expected in the future.

**Holocene**  The current interglacial geological epoch, the second of two epochs within the Quaternary Period, the preceding being the Pleistocene. The International Commission on Stratigraphy (ICS) defines the start of the Holocene Epoch at 11,700 years before 2000 (ICS, 2018). It encompasses the mid-Holocene (MH), the 1000-year-long interval centered at 6000 years before 1950; a period of long-standing focus for modelling, with enhanced seasonality in the Northern Hemisphere and decreased seasonality in the Southern Hemisphere. The early part of the Holocene is marked by the late stages of deglaciation of Pleistocene land ice, and sea level rise, and the occurrence of warm phases that affected different regions at different times, often referred to as the “Holocene thermal maximum”. In addition, the epoch includes the post-glacial interval, which began approximately 7000 years ago when the fundamental features of the modern climate system were essentially in place, as the influence of remnant Pleistocene ice sheets waned. See also Anthropocene.

**Holocene Thermal Maximum (HTM)**  See Holocene.

**Human influence on the climate system**  Human-driven activities that lead to changes in the climate system due to perturbations of the Earth’s energy budget (also called anthropogenic forcing). Human influence results from emissions of greenhouse gases, aerosols, ozone-depleting substances (ODSs), and land-use change. See also Anthropogenic, Anthropogenic emissions and Anthropogenic removals.

**Human system**  Any system in which human organisations and institutions play a major role. Often, but not always, the term is synonymous with society or social system. Systems such as agricultural systems, urban systems, political systems, technological systems, and economic systems are all human systems in the sense applied in this report.

**Hurricane**  See Tropical cyclone.

**Hydroclimate**  Part of the climate pertaining to the hydrology of a region.

**Hydrofluorocarbons (HFCs)**  One of the seven types of greenhouse gases (GHGs) or groups of GHGs to be mitigated under the Kyoto Protocol. They are produced commercially as a substitute for chlorofluorocarbons (CFCs). HFCs largely are used in refrigeration and semiconductor manufacturing.

**Hydrological cycle**  The cycle in which water evaporates from the ocean and the land surface, is carried over the Earth in atmospheric circulation as water vapour, condenses to form clouds, precipitates over the ocean and land as rain or snow, which on land can be intercepted by trees and vegetation, potentially accumulating as snow or ice, provides runoff on the land surface, infiltrates into soils, recharges groundwater, discharges into streams, and ultimately, flows into the oceans as rivers, polar glaciers and ice sheets, from which it will eventually evaporate again. The various systems involved in the hydrological cycle are usually referred to as hydrological systems.

**Hydrological drought**  See Drought.

**Hydrological sensitivity (∇)**  The change in global-mean precipitation per degree Celsius of global mean temperature change when precipitation changes related to fast atmospheric and land surface adjustments to radiative forcings are removed. Units are % per °C although can also be calculated as W m⁻² per °C. See also Apparent hydrological sensitivity (∇a).

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

Hypoxic Conditions of low dissolved oxygen in shallow water ocean and freshwater environments. There is no universal threshold for hypoxia. A value around 60 \( \mu \text{mol kg}^{-1} \) has commonly been used for some estuarine systems, although this does not necessarily directly translate into biological impacts. Anoxic conditions occur where there is no oxygen present at all. See also Eutrophication.

Hypsometry The distribution of land or ice surface as a function of altitude.

Ice age An informal term for a geological period characterised by a long-term reduction in the temperature of the Earth's climate, resulting in the presence or expansion of ice sheets and glaciers. Among the Earth's ice ages is the current Quaternary Period, characterized by alternating glacial and interglacial intervals. See also Deglacial or deglaciation or glacial termination and Glacial-interglacial cycles.

Ice core A cylinder of ice drilled out of a glacier or ice sheet to determine the physical properties of the ice body, and to gain information on past changes in climate and composition of the atmosphere that are preserved in the ice or in air trapped in the ice.

Ice sheet An ice body originating on land that covers an area of continental size, generally defined as covering \( >50,000 \text{ km}^2 \), and that has formed over thousands of years through accumulation and compaction of snow. An ice sheet flows outward from a high central ice plateau with a small average slope. The margins usually slope more steeply, and most ice is discharged through fast-flowing ice streams or outlet glaciers, often 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. The latter is divided into the East Antarctic Ice Sheet (EAIS), the West Antarctic Ice Sheet (WAIS) and the Antarctic Peninsula ice sheet. During glacial periods, there were other ice sheets.

Ice shelf A floating slab of ice originating from land of considerable thickness extending from the coast (usually of great horizontal extent with a very gently sloping surface), resulting from the flow of ice sheets, initially formed by the accumulation of snow, and often filling embayments in the coastline of an ice sheet. Nearly all ice shelves are in Antarctica, where most of the ice discharged into the ocean flows via ice shelves.

Ice stream A stream of ice with strongly enhanced flow that is part of an ice sheet. It is often separated from surrounding ice by strongly sheared, crevassed margins.

Ice-albedo feedback A climate feedback involving changes in the Earth's surface albedo. Snow and ice have an albedo much higher (up to \( \sim 0.8 \)) than the average planetary albedo (\( \sim 0.3 \)). With increasing temperatures, it is anticipated that snow and ice extent will decrease, the Earth's overall albedo will decrease and more solar radiation will be absorbed, warming the Earth further.

Iceberg Large piece of freshwater ice broken off from a glacier or an ice shelf during calving and floating in open water (at least five metres height above sea level). Smaller pieces of floating ice known as 'bergy bits' (less than 5 metres above sea level) or 'growlers' (less than 2 metres above sea level) can originate from glaciers or ice shelves, or from the breaking up of a large iceberg. Icebergs can also be classified by shape, most commonly being either tabular (steep sides and a flat top) or non-tabular (varying shapes, with domes and spires) (NOAA, 2021). In lakes, icebergs can originate by breaking off shelf ice, which forms through freezing of a lake surface.

Impacts (consequences, outcomes) The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather / climate events), exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial. See also Adaptation, Exposure, Hazard, Loss and Damage, and losses and damages,
Vulnerability and Risk.

Incoming solar radiation  See Insolation.

Indian Ocean Basin (IOB) mode  A mode of interannual variability characterized by a temporal
alteration of basin-wide warming and cooling of the Indian Ocean sea surface. It mostly develops in
response to El Niño-Southern Oscillation (ENSO), but often persists after ENSO's equatorial eastern Pacific
signal has dissipated. The IOB affects atmospheric circulation, temperature, and precipitation in South,
Southeast, and East Asia as well as Africa, and modulates tropical cyclone activity in the Northwestern
Pacific. See Section AIV.2.4 in Annex IV of the AR6 WGI report. See also Modes of climate variability and
Indian Ocean Dipole (IOD).

Indian Ocean Dipole (IOD)  A mode of interannual variability that features an east-west dipole of sea
surface temperature anomalies in the tropical Indian Ocean. Its positive phase shows concurrent sea surface
cooling off Sumatra and Java and warming off Somalia in the west, combined with anomalous surface
easterlies along the equator, while the opposite anomalies are seen in the negative phase. The IOD typically
develops in boreal summer and matures in boreal autumn and controls part of the rainfall interannual
variability in Australia, South Eastern Asia and Eastern Africa. See Section AIV.2.4 in Annex IV of the AR6
WGI report. See also Indian Ocean Basin (IOB) mode.

Indirect aerosol effect  See Aerosol-cloud interaction.

Indirect land-use change (iLUC)  See Land-use change (LUC).

Industrial revolution  A period of rapid industrial growth with far-reaching social and economic
consequences, beginning in Britain during the second half of the 18th 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, initially coal, and hence emission of carbon dioxide (CO₂).

Infrared radiation  See Terrestrial radiation.

Initial condition ensemble (ICE)  See Model ensemble.

Insolation  The amount of solar radiation reaching the Earth by latitude and by season measured in W m⁻².
Usually insolation refers to the radiation arriving at the top of the atmosphere. Sometimes it is specified as
referring to the radiation arriving at the Earth’s surface. See also Orbital forcing and Total solar irradiance
(TSI).

Instantaneous radiative forcing (or effect) due to aerosol-cloud interactions (IRFaci)  See Aerosol-
cloud interaction.

Instantaneous radiative forcing (or effect) due to aerosol-radiation interactions (IRFari)  See Aerosol-
radiation interaction.

Integrated assessment model (IAM)  Models that integrate knowledge from two or more domains into a
single framework. They are one of the main tools for undertaking integrated assessments. One class of IAM
used in respect of climate change mitigation may include representations of: multiple sectors of the
economy, such as energy, land use and land use change; interactions between sectors; the economy as a
whole; associated greenhouse gas (GHG) emissions and sinks; and reduced representations of the climate
system. This class of model is used to assess linkages between economic, social and technological
development and the evolution of the climate system. Another class of IAM additionally includes
representations of the costs associated with climate change impacts, but includes less detailed representations
of economic systems. These can be used to assess impacts and mitigation in a cost-benefit framework and
have been used to estimate the social cost of carbon.

Do Not Cite, Quote or Distribute  AVII-33  Total pages: 65
Interdecadal Pacific Oscillation (IPO)  See Pacific Decadal Variability (PDV).

Inter-Tropical Convergence Zone (ITCZ) The Inter-Tropical Convergence Zone is an equatorial zonal belt of low pressure, strong convection and heavy precipitation near the equator where the northeast trade winds meet the southeast trade winds. This band moves seasonally. See also South Pacific Convergence Zone (SPCZ).

Interglacial or interglaciation A globally warm period lasting thousands of years between glacial periods within an ice age. Generally coincides with odd-numbered marine isotope stages (MIS) when mean sea level was close to present. The Last Interglacial (LIG) occurred between about 129 and 116 ka (thousand years) before present (defined as 1950) although the warm period started in some areas a few thousand years earlier. In terms of marine isotope stages (MIS), interglaciations are defined as the interval between the midpoint of the preceding termination and the onset of the next glaciation. The LIG coincides with MIS 5e. The present interglaciation, the Holocene, started at 11,700 years before 2000 CE, although global mean sea level did not approach its present position until roughly 7000 years ago. See also Deglacial or deglaciation or glacial termination, Glacial-interglacial cycles, Glacial or glaciation and Ice age.

Internal climate variability See Internal variability (under Climate variability).

Irreversibility A perturbed state of a dynamical system is defined as irreversible on a given timescale, if the recovery from this state due to natural processes takes substantially longer than the timescale of interest. See also Tipping point.

Isostatic or Isostasy Isostasy refers to the response of the earth to changes in surface load. It includes the deformational and gravitational response. This response is elastic on short time scales, as in the earth-ocean response to recent changes in mountain glaciation, or viscoelastic on longer time scales, as in the response to the last deglaciation following the Last Glacial Maximum.

Isotopes Atoms of the same chemical element that have the same the number of protons but differ in the number of neutrons. Some proton-neutron configurations are stable (stable isotopes), others are unstable undergoing spontaneous radioactive decay (radioisotopes). Most elements have more than one stable isotope. Isotopes can be used to trace transport processes or to study processes that change the isotopic ratio. Radioisotopes provide in addition time information that can be used for radiometric dating. See also $^{14}C$ and $^{13}C$.

Key climate indicators See Climate indicator.

Kriging Kriging is a method of interpolation (normally spatial interpolation when used with atmospheric or oceanographic data), in which the interpolated values are estimated using a Gaussian process governed by prior covariances.

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

Land The terrestrial portion of the biosphere that comprises the natural resources (soil, near-surface air, vegetation and other biota, and water), the ecological processes, topography, and human settlements and infrastructure that operate within that system (UNCCD, 1994; FAO, 2007).

Land cover The biophysical coverage of land (e.g., bare soil, rocks, forests, buildings and roads or lakes). Land cover is often categorised in broad land-cover classes (e.g., deciduous forest, coniferous forest, mixed forest, grassland, bare ground). [Note: In some literature, land cover and land use are used interchangeably, but the two represent distinct classification systems. For example, the land cover class woodland can be under various land uses such as livestock grazing, recreation, conservation, or wood harvest.]

Land cover change Change from one land cover class to another, due to change in land use or change in...
natural conditions (Pongratz et al., 2018). See also Land management change and Land-use change (LUC).

**Land surface air temperature (LSAT)**  The near-surface air temperature over land, typically measured at 1.25–2 m above the ground using standard meteorological equipment.

**Land use**  The total of arrangements, activities and inputs applied to a parcel of land. The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, conservation and city dwelling). In national GHG inventories, land use is classified according to the IPCC land use categories of forest land, cropland, grassland, wetlands, settlements, other lands (see the 2006 IPCC Guidelines for National GHG Inventories and their 2019 Refinement for details (IPCC, 2006, 2019)).

**Land water storage**  Land water storage (LWS) includes all surface water, soil moisture, groundwater storage and snow, but excludes water stored in glaciers and ice sheets. Changes in land water storage can be caused either by direct human intervention in the water cycle (e.g., storage of water in reservoirs by building dams in rivers, groundwater extraction from groundwater reservoirs for consumption and irrigation, or deforestation) or by climate variations (e.g., changes in the amount of water in endorheic lakes and wetlands, the canopy, the soil, the permafrost and the snowpack). Land water storage changes caused by climate variations may also be indirectly affected by anthropogenic influences. See also Sea level change (sea level rise/sea level fall).

**Land-use change (LUC)**  The change from one land use category to another. Note that in some scientific literature, land-use change encompasses changes in land-use categories as well as changes in land management. See also Afforestation, Agriculture, Forestry and Other Land Use (AFOLU), Deforestation, Land use, land-use change and forestry (LULUCF) and Reforestation.

Indirect land-use change (iLUC)  Land use change outside the area of focus, that occurs as a consequence of change in use or management of land within the area of focus, such as through market or policy drivers. For example, if agricultural land is diverted to biofuel production, forest clearance may occur elsewhere to replace the former agricultural production. See Land-use change (LUC).

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

**Large-scale**  The climate system involves process interactions from the micro- to the global-scale. Any threshold for defining “large-scale” is arbitrary. Understanding of large-scale climate variability and change requires knowledge of both the response to external forcings and the role of internal variability. Many external forcings have substantial hemispheric or continental scale variations. Modes of climate variability are driven by ocean basin scale processes. Thus we define large-scale to include ocean basin and continental scales as well as hemispheric and global scales.

**Last deglacial transition**  See Deglacial or deglaciation or glacial termination and Younger Dryas.

**Last Glacial Maximum (LGM)**  See Glacial or glaciation.

**Last Interglacial (LIG)**  See Interglacial or interglaciation.

**Last millennium**  The interval of the Common Era (CE) between 1001 and 2000 CE. Encompasses the Little Ice Age, a roughly defined period characterized by multiple expansions of mountain glaciers worldwide, the timing of which differs among regions, but generally occurred between 1400 CE and 1900 CE. The last millennium also mostly encompasses the Medieval Warm Period (also called the Medieval Climate Anomaly), a roughly defined period of relatively warm conditions or other climate excursions such as extensive drought, the timing and magnitude of which differ among regions, but generally occurred between 900 and 1400 CE. Transient climate model experiments by the Paleoclimate Modelling Intercomparison Project (PMIP) for the last millennium extend from 850-1849 CE.
Latent heat flux The turbulent flux of heat from the Earth's surface to the atmosphere that is associated with evaporation or condensation of water vapour at the surface; a component of the surface energy budget. See also Atmosphere and Flux.

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

Response time or adjustment time (Ta) Response time or adjustment time (T_a) is the time scale characterizing the decay of an instantaneous pulse input into the reservoir. The term adjustment time is also used to characterize 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 or adjustment 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_a = T. 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 the atmosphere and the ocean and terrestrial biota. However, a large part of that CO_2 is returned to the atmosphere within a few years. The adjustment time of CO_2 in the atmosphere is determined from the rates of removal of carbon by a range of processes with timescales from months to hundreds of thousands of years. As a result, 15 to 40% of an emitted CO_2 pulse will remain in the atmosphere longer than 1,000 years, 10 to 25% will remain about ten thousand years, and the rest will be removed over several hundred thousand years.

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 rate S is not proportional to its total mass M.

Turnover time (T) (also called global atmospheric lifetime) 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.

Light-absorbing particles Light-absorbing particles (LAP), e.g., black carbon, brown carbon, dust, are particles that absorb solar radiation and convert it into internal energy, thus raising the particle’s temperature and emitting thermal-infrared radiation that is selectively absorbed by the surrounding medium. LAP affect the energy balance of the atmosphere, clouds, and when deposited on snow and ice, they reduce snow/ice albedo, increasing heating and accelerating melting. These particles have a warming effect on climate.

Likelihood The chance of a specific outcome occurring, where this might be estimated probabilistically. Likelihood is expressed in this report using a standard terminology (Mastrandrea et al., 2010). See also Agreement, Confidence, Evidence and Uncertainty.

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.

Livelihood The resources used and the activities undertaken in order for people to live. Livelihoods are usually determined by the entitlements and assets to which people have access. Such assets can be
Local sea level change  See Sea level change (sea level rise/sea level fall).

Long-lived climate forcers (LLCFs)  A set of well-mixed greenhouse gases with long atmospheric lifetimes. This set of compounds includes carbon dioxide (\(\text{CO}_2\)) and nitrous oxide (\(\text{N}_2\text{O}\)), together with some fluorinated gases. They have a warming effect on climate. These compounds accumulate in the atmosphere at decadal to centennial timescales, and their effect on climate hence persists for decades to centuries after their emission. On timescales of decades to a century already emitted emissions of long-lived climate forcers can only be abated by greenhouse gas removal (GGR).

Low-likelihood, high impact events  Events whose probability of occurrence is low or not well known (as in the context of deep uncertainty) but whose potential impacts on society and ecosystems could be high. To better inform risk assessment and decision-making, such low-likelihood outcomes are considered if they are associated with very large consequences and may therefore constitute material risks, even though those consequences do not necessarily represent the most likely outcome.

Madden-Julian Oscillation (MJO)  The largest mode of tropical atmospheric intraseasonal variability with typical periods ranging from 20 to 90 days. The MJO corresponds to planetary-scale disturbances of pressure, wind and deep convection moving predominantly eastward along the equator. As it progresses, the MJO is associated with the temporal alternation of large-scale enhanced and suppressed rainfall, with maximum loading over the Indian and western Pacific oceans, although influences of the MJO can be tracked over the Atlantic/Africa in dynamical fields. See Section AIV.2.8 in Annex IV of the AR6 WGI report.

Maladaptive actions (Maladaptation)  Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas (GHG) emissions, increased vulnerability to climate change, or diminished welfare, now or in the future. Maladaptation is usually an unintended consequence.

Marine cloud brightening (MCB)  See Solar radiation modification (SRM).

Marine heatwave  A period during which water temperature is abnormally warm for the time of the year relative to historical temperatures with that extreme warmth persisting for days to months. The phenomenon can manifest in any place in the ocean and at scales of up to thousands of kilometres. See also Heatwave.

Marine ice cliff instability (MICI)  A hypothetic mechanism of an ice cliff failure. In case a marine-terminated ice sheet loses its buttressing ice shelf, an ice cliff can be exposed. If the exposed ice cliff is tall enough (about 800 m of the total height, or about 100 m of the above-water part), the stresses at the cliff face exceed the strength of the ice, and the cliff fails structurally in repeated calving events. See also Marine ice sheet instability (MISI).

Marine ice sheet instability (MISI)  A mechanism of irreversible (on the decadal to centennial time scale) retreat of a grounding line for the marine-terminating glaciers, in case the glacier bed slopes towards the ice sheet interior. See also Marine ice cliff instability (MICI).

Marine isotope stage (MIS)  Geological periods of alternating glacial and interglacial conditions, each typically lasting tens of thousands of years as inferred from the oxygen isotope composition of microfossils from deep sea sediment cores. MIS numbers increase back in time from the present, which is MIS 1. Even-numbered MISs coincide with glacial periods, and odd-numbered MISs are interglacials.

Marine-based ice sheet  An ice sheet containing a substantial region that rests on a bed lying below sea level and whose perimeter is in contact with the ocean. The best known example is the West Antarctic ice sheet.
Mass balance / budget (of glaciers or ice sheets)  Difference between the mass input (accumulation) and
the mass loss (ablation) of an ice body (e.g., a glacier or ice sheet) over a stated time period, which is often a
year or a season. Surface mass balance refers to the difference between surface accumulation and surface
ablation.

Ablation (of glaciers, ice sheets, or snow cover)  All processes that reduce the mass of a glacier, ice sheet,
or snow cover. The main processes are melting, and for glaciers also calving (or, when the glacier nourishes
an ice shelf, discharge of ice across the grounding line), but other processes such as sublimation and loss of
wind-blown snow can also contribute to ablation. Ablation also refers to the mass lost by any of these
processes.

Accumulation (of glaciers, ice sheets, or snow cover)  All processes that add to the mass of a glacier, an ice
sheet, or snow cover. The main process of accumulation is snowfall. Accumulation also includes deposition
of hoar, freezing rain, other types of solid precipitation, gain of wind-blown snow, avalanching, and basal
accumulation (often beneath floating ice).

Discharge (of ice)  Rate of the flow of ice through a vertical section of a glacier perpendicular to the
direction of the flow of ice. Often used to refer to the loss of mass at marine-terminating glacier fronts
(mostly calving of icebergs and submarine melt), or to mass flowing across the grounding line of a floating
ice shelf.

Mean sea level  The surface level of the ocean at a particular point averaged over an extended period of
time such as a month or year. Mean sea level is often used as a national datum to which heights on land are
referred.

Medieval Climate Anomaly (MCA)  See Medieval Warm Period (MWP).

Megacity  Urban agglomerations with 10 million inhabitants or more.

Meltwater Pulse 1A (MWP-1A)  A particular interval of rapid global sea level rise between about 14,700
and 14,300 years ago, associated with the end of the last ice age and attributed to freshwater flux to the
ocean from accelerated melting of ice sheets and glaciers. First defined based on oxygen isotope data
(Duplessy et al., 1981), and later shown to be reflected by high rates of sea-level rise (Fairbanks, 1989). See
also Deglacial or deglaciation or glacial termination.

Meridional overturning circulation (MOC)  Meridional (north-south) overturning circulation in the
ocean quantified by zonal (east-west) sums of mass transports in depth or density layers. In the North
Atlantic, away from the subpolar regions, the MOC (which is in principle an observable quantity) is often
identified with the thermohaline circulation (THC), which is a conceptual and incomplete interpretation. The
MOC 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.

Atlantic Meridional Overturning Circulation (AMOC)  The main current system in the South and North
Atlantic Oceans. AMOC transports warm upper-ocean water northwards, and cold, deep water southwards,
as part of the global ocean circulation system. Changes in the strength of AMOC can affect other
components of the climate system.

Meteorological drought  See Drought.

Methane (CH$_4$)  One of the seven greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol.
Methane is the major component of natural gas and associated with all hydrocarbon fuels. Significant
anthropogenic emissions also occur as a result of animal husbandry and paddy rice production. Methane is
also produced naturally where organic matter decays under anaerobic conditions, such as in wetlands.
future global warming, there is risk of increased methane emissions from thawing permafrost, coastal
wetlands and sub-sea gas hydrates. See also Short-lived climate forcers (SLCFs).

Microclimate  Local climate at or near the Earth's surface.

Microwave sounding unit (MSU)  A microwave sounder on National Oceanic and Atmospheric
Administration (NOAA) polar orbiter satellites, that estimates the temperature of thick layers of the
atmosphere by measuring the thermal emission of oxygen molecules from a complex of emission lines near
60 GHz. A series of nine MSUs began making this kind of measurement in late 1978. Beginning in mid-
1998, a follow-on series of instruments, the Advanced Microwave Sounding Units (AMSUs), began
operation.

Mid-Holocene (MH)  See Holocene.

Mid-Pliocene Warm Period (MPWP)  See Pliocene.

Mineralisation/Remineralisation  The conversion of an element from its organic form to an inorganic
form as a result of microbial decomposition. In nitrogen mineralisation, organic nitrogen from decaying plant
and animal residues (proteins, nucleic acids, amino sugars and urea) is converted to ammonia (NH$_3$) and
ammonium (NH$_4^+$) by biological activity.

Mitigation (of climate change)  A human intervention to reduce emissions or enhance the sinks of
greenhouse gases.

Mitigation potential  The quantity of net greenhouse gas emission reductions that can be achieved by a
given mitigation option relative to specified emission baselines. [Note: Net greenhouse gas emission
reductions is the sum of reduced emissions and/or enhanced sinks.] See also Sequestration potential.

Biogeophysical potential  The mitigation potential constrained by biological, geophysical and geochemical
limits and thermodynamics, without taking into account technical, social, economic, and/or environmental
considerations.

Economic potential  The portion of the technical potential for which the social benefits exceed the social
costs, taking into account a social discount rate and the value of externalities

Technical potential  The mitigation potential constrained by biogeophysical limits as well as availability of
technologies and practices. Quantification of technical potentials takes into account primarily technical
considerations, but social, economic and/or environmental considerations are occasionally also included, if
these represent strong barriers for the deployment of an option.

Mitigation scenario  See Scenario.

Mixing ratio  See Mole fraction or mixing ratio.

Model bias  See Biases.

Model drift  Since model climate differs to some extent from observed climate, climate forecasts will
typically 'drift' from the initial observation-based state towards the model's climate. This drift occurs at
different time scales for different variables, can obscure the initial-condition forecast information and is
usually removed a posteriori by an empirical, usually linear, adjustment.

Model initialization  A climate prediction typically proceeds by integrating a climate model forward in
time from an initial state that is intended to reflect the actual state of the climate system. Available
observations of the climate system are 'assimilated' into the model. Initialization is a complex process that is
limited by available observations, observational errors and, depending on the procedure used, may be
affected by uncertainty in the history of climate forcing. The initial conditions will contain errors that grow as the forecast progresses, thereby limiting the time for which the forecast will be useful.

Model spread  The range or spread in results from climate models, such as those assembled for Coupled Model Intercomparison Project Phase 6 (CMIP6). Does not necessarily provide an exhaustive and formal estimate of the uncertainty in feedbacks, forcing or projections even when expressed numerically, for example, by computing a standard deviation of the models’ responses. In order to quantify uncertainty, information from observations, physical constraints and expert judgement must be combined, using a statistical framework.

Modes of climate variability  Recurrent space-time structures of natural variability of the climate system with intrinsic spatial patterns, seasonality and time scales. Modes can arise through the dynamical characteristics of the atmospheric circulation but also through coupling between the ocean and the atmosphere, with some interactions with land surfaces and sea ice. Many modes of variability are driven by internal climate processes and are a critical potential source of climate predictability on sub-seasonal to decadal time scales. See Annex IV of the AR6 WGI report. See also Annular modes, Tropical Atlantic Variability (TAV), Indian Ocean Dipole (IOD), Indian Ocean Basin (IOB) mode, Pacific Decadal Variability (PDV), Pacific Decadal Oscillation (PDO) (under Pacific Decadal Variability (PDV)), El Niño-Southern Oscillation (ENSO), North Atlantic Oscillation (NAO), Northern Annular Mode (NAM) (under Annular modes), Southern Annular Mode (SAM) (under Annular modes), Atlantic Meridional Mode (AMM) (under Tropical Atlantic Variability (TAV)), Atlantic Zonal Mode (AZM) (under Tropical Atlantic Variability (TAV)), Madden-Julian Oscillation (MJO), Atlantic Multidecadal Variability (AMV) and Interdecadal Pacific Oscillation (IPO) (under Pacific Decadal Variability (PDV)).

Mole fraction or mixing ratio  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 well-mixed greenhouse gases are in the order of μmol mol\(^{-1}\) (parts per million: ppm), nmol mol\(^{-1}\) (parts per billion: ppb), and fmol mol\(^{-1}\) (parts per trillion: ppt). Mole fraction differs from volume mixing ratio, often expressed in ppmv etc., by the corrections for non-ideality of gases. This correction is significant relative to measurement precision for many greenhouse gases (Schwartz and Warneck, 1995).

Monsoon  See Global monsoon.

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 (O\(_3\)), such as chlorofluorocarbons (CFCs), methyl chloroform, carbon tetrachloride and many others.

Multi-model ensemble (MME)  See Climate simulation ensemble. See also Ensemble.

Narrative  See Storyline. See also Pathways.

Natural systems  The dynamic physical and biological components of the environment that would operate in the absence of human impacts. Most, if not all, natural systems are also now affected by human activities to some degree.

Natural variability  See Climate variability.

Near-surface permafrost  See Permafrost.

Negative greenhouse gas emissions  Removal of greenhouse gases (GHGs) from the atmosphere by deliberate human activities, i.e., in addition to the removal that would occur via natural carbon cycle or atmospheric chemistry processes. See also Carbon dioxide removal (CDR), Greenhouse gas removal (GGR).
Negative CO₂ emissions, Net negative greenhouse gas emissions, Net zero CO₂ emissions and Net zero greenhouse gas emissions.

**Net negative greenhouse gas emissions**  A situation of net negative greenhouse gas emissions is achieved when metric-weighted anthropogenic greenhouse gas (GHG) removals exceed metric-weighted anthropogenic GHG emissions. Where multiple GHG are involved, the quantification of net emissions depends on the metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon). See also Net zero CO₂ emissions, Net zero greenhouse gas emissions, Negative greenhouse gas emissions, Carbon dioxide removal (CDR), Greenhouse gas removal (GGR) and Greenhouse gas emission metric.

**Net primary production (NPP)**  See Primary production.

**Net zero CO₂ emissions**  Condition in which anthropogenic carbon dioxide (CO₂) emissions are balanced by anthropogenic CO₂ removals over a specified period. [Note: Carbon neutrality and net zero CO₂ emissions are overlapping concepts. The concept can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms carbon neutrality and net zero CO₂ emissions are equivalent. At sub-global scales, net zero CO₂ emissions is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while carbon neutrality generally includes emissions and removals within and beyond the direct control or territorial responsibility of the reporting entity. Accounting rules specified by GHG programmes or schemes can have a significant influence on the quantification of relevant CO₂ emissions and removals.] See also Net zero greenhouse gas emissions, Carbon neutrality and Land use, land-use change and forestry (LULUCF).

**Net zero greenhouse gas emissions**  Condition in which metric-weighted anthropogenic greenhouse gas (GHG) emissions are balanced by metric-weighted anthropogenic GHG removals over a specified period. The quantification of net zero GHG emissions depends on the GHG emission metric chosen to compare emissions and removals of different gases, as well as the time horizon chosen for that metric.

[Note 1: GHG neutrality and net zero GHG emissions are overlapping concepts. The concept of net zero GHG emissions can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms carbon neutrality and net zero GHG emissions are equivalent. At sub-global scales, net zero GHG emissions is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while GHG neutrality generally includes anthropogenic emissions and anthropogenic removals within and beyond the direct control or territorial responsibility of the reporting entity. Accounting rules specified by GHG programmes or schemes can have a significant influence on the quantification of relevant emissions and removals.]

Note 2. Under the Paris Rulebook [Decision 18/CMA.1, annex, paragraph 37], parties have agreed to use GWP100 values from the IPCC AR5 or GWP100 values from a subsequent IPCC Assessment Report to report aggregate emissions and removals of GHGs. In addition, parties may use other metrics to report supplemental information on aggregate emissions and removals of GHGs.

See also Net zero CO₂ emissions, Greenhouse gas emission metric, Greenhouse gas neutrality and Land use, land-use change and forestry (LULUCF).

**Nitrogen deposition**  Nitrogen deposition is defined as the nitrogen transferred from the atmosphere to the Earth’s surface by the processes of wet deposition and dry deposition.

**Nitrous oxide (N₂O)**  One of the seven greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol. The main anthropogenic source of N₂O is agriculture (soil and animal manure management), but important contributions also come from sewage treatment, fossil fuel combustion, and chemical industrial processes. N₂O is also produced naturally from a wide variety of biological sources in soil and water, particularly microbial action in wet tropical forests.
Non-CO\textsubscript{2} emissions and radiative forcing  Non-CO\textsubscript{2} emissions included in this report are all anthropogenic emissions other than CO\textsubscript{2} that result in radiative forcing. These include short-lived climate forcers, such as methane (CH\textsubscript{4}), some fluorinated gases, ozone (O\textsubscript{3}) precursors, aerosols or aerosol precursors, such as black carbon and sulphur dioxide, respectively, as well as long-lived greenhouse gases, such as nitrous oxide (N\textsubscript{2}O) or other fluorinated gases. The radiative forcing associated with non-CO\textsubscript{2} emissions and changes in surface albedo (e.g., resulting from land-use change) is referred to as non-CO\textsubscript{2} radiative forcing.

Non-methane volatile organic compounds (NMVOCs)  See Volatile organic compounds (VOCs).

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

North American monsoon (NAmerM)  See Global monsoon.

Northern Annular Mode (NAM)  See Annular modes.

North Atlantic Oscillation (NAO)  The leading mode of large-scale atmospheric variability in the North Atlantic basin characterized by alternating (see-saw) variations in sea level pressure or geopotential height between the Azores High in the sub tropics and the Icelandic Low in the mid- to high latitudes with some northward extension deep into the Arctic. It is associated with fluctuations in strength and latitudinal position of the main westerly winds across a vast North Atlantic-Europe domain, and thus with fluctuations in the embedded extratropical cyclones and associated frontal systems leading to strong teleconnection over the entire North Atlantic adjacent continents. The positive and negative phases of the NAO show similar characteristics described for the Northern Annular Mode (NAM). See Section AIV.2.1 in Annex IV of the AR6 WGI report.

Northern polar vortex  See Stratospheric polar vortex.

Ocean  The interconnected body of saline water that covers 71% of the Earth’s surface, contains 97% of the Earth’s water and provides 99% of the Earth’s biologically-habitable space. It includes the Arctic, Atlantic, Indian, Pacific and Southern Oceans, as well as their marginal seas and coastal waters.

Ocean acidification (OA)  A reduction in the pH of the ocean, accompanied by other chemical changes (primarily in the levels of carbonate and bicarbonate ions), over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO\textsubscript{2}) from the atmosphere, but can also be caused by other chemical additions or subtractions from the ocean. Anthropogenic OA refers to the component of pH reduction that is caused by human activity (IPCC, 2011, p. 37).

Ocean alkalinisation / Ocean alkalinity enhancement  A proposed carbon dioxide removal method that involves deposition of alkaline minerals or their dissociation products at the ocean surface. This increases surface total alkalinity, and may thus increase ocean CO\textsubscript{2} uptake and ameliorate surface ocean acidification. See also Anthropogenic removals and Carbon dioxide removal (CDR).

Ocean carbon cycle  The ocean carbon cycle is the set of processes that exchange carbon between various pools within the ocean, as well as between the atmosphere, Earth’s interior, cryosphere, and the seafloor. See also Carbon cycle.

Ocean deoxygenation  The loss of oxygen in the ocean. It results from ocean warming, which reduces oxygen solubility and increases oxygen consumption and stratification, thereby reducing the mixing of oxygen into the ocean interior. Deoxygenation can also be exacerbated by the addition of excess nutrients in the coastal zone.

Ocean dynamic sea level change  See Sea level change (sea level rise/sea level fall).
Ocean fertilisation  A proposed carbon dioxide removal method that relies on the deliberate increase of nutrient supply to the near-surface ocean with the aim of sequestering additional CO₂ from the atmosphere through biological production. Methods include direct addition of micro-nutrients or macro-nutrients. To be successful, the additional carbon needs to reach the deep ocean where it has the potential to be sequestered on climatically-relevant timescales. See also Anthropogenic removals and Carbon dioxide removal (CDR).

Ocean heat uptake efficiency  This is a measure (W m⁻² °C⁻¹) of the rate at which heat storage by the global ocean increases as global surface temperature rises. It is a useful parameter for climate change simulations in which the radiative forcing is changing monotonically, when it can be compared with the climate feedback parameter to gauge the relative importance of radiative response and ocean heat uptake in determining the rate of climate change. It can be estimated from such an experiment as the ratio of the rate of increase of ocean heat content to the surface temperature change.

Ocean stratification  See Stratification.

Orbital forcing  Orbital forcing is the influence of slow, systematic and predictable changes in orbital parameters (eccentricity, obliquity and precession of the equinox) on incoming solar radiation (insolation), especially its latitudinal and seasonal distribution. It is an external forcing and a key driver of glacial-interglacial cycles.

Organic aerosol  Component of the aerosol that consists of organic compounds, mainly carbon, hydrogen, oxygen and lesser amounts of other elements.

Outgoing longwave radiation  Net outgoing radiation in the infrared part of the spectrum at the top of the atmosphere.

Outlet glacier  See Glacier.

Oxygen minimum zone (OMZ)  The midwater layer (200–1000 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.

Ozone (O₃)  The triatomic form of oxygen, and a gaseous atmospheric constituent. In the troposphere, O₃ is created both naturally and by photochemical reactions involving gases resulting from human activities (e.g., smog). Tropospheric O₃ acts as a greenhouse gas (GHG). In the stratosphere, O₃ is created by the interaction between solar ultraviolet radiation and molecular oxygen (O₂). Stratospheric O₃ plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the ozone layer. See also Ground-level ozone, Ozone hole, Ozone layer, Ozone-depleting substances (ODSs), Ozonesonde and Short-lived climate forcers (SLCFs).

Ozone layer  The ozone layer is a layer of Earth's stratosphere that absorbs most of the Sun's ultraviolet radiation. It contains high concentrations of ozone (O₃) in relation to other parts of the atmosphere, although still small in relation to other gases in the stratosphere. The ozone layer contains less than 10 parts per million of ozone, while the average ozone concentration in Earth's atmosphere as a whole is about 0.3 parts per million. The ozone layer is mainly found in the lower portion of the stratosphere, from approximately 15 to 35 kilometres (9.3 to 21.7 miles) above Earth, although its thickness varies seasonally and geographically. See also Ozone hole and Ozone-depleting substances (ODSs).

Ozone-depleting substances (ODSs)  Ozone-depleting substances (ODSs) are man-made gases that destroy ozone (O₃) once they reach the ozone layer in the stratosphere. Ozone depleting substances include: halons, methyl bromide, carbon tetrachloride and methyl chloroform. They are used as refrigerants in commercial, home and vehicle air conditioners and refrigerators, foam blowing agents, components in...
electrical equipment, industrial solvents, solvents for cleaning (including dry cleaning), aerosol spray propellants and fumigants. See also Ozone layer, Ozone (O₃) and Stratospheric ozone.

Ozonesonde An ozonesonde is a radiosonde measuring ozone (O₃) concentrations. The radiosonde is usually carried on a weather balloon and transmits measured quantities by radio to a ground-based receiver.

Pacific Decadal Oscillation (PDO) See Pacific Decadal Variability (PDV).

Pacific Decadal Variability (PDV) Coupled decadal-to-interdecadal variability of the atmospheric circulation and underlying ocean that is typically observed over the entire Pacific Basin beyond the El Niño-Southern Oscillation (ENSO) timescale. In the AR6 WGI report, PDV encapsulates the Pacific Decadal Oscillation (PDO), the South Pacific Decadal Oscillation (SPDO), tropical Pacific decadal variability (also called decadal ENSO), and the Interdecadal Pacific Oscillation (IPO). Typically, the positive phase of the PDV is characterized by anomalously high sea surface temperatures in the central-eastern tropical Pacific that extend to the extratropical North and South Pacific along the American coasts, encircled to the west by cold sea surface anomalies in the mid-latitude North and South Pacific. The negative phase is accompanied by sea surface temperature anomalies in the opposite sign. Those sea surface temperature anomalies are linked to anomalies in atmospheric and oceanic circulation throughout the whole Pacific Basin. The PDV is associated with decadal modulations in the relative occurrence of El Niño and La Niña. See Section AIV.2.6 in Annex IV of the AR6 WGI report.

Interdecadal Pacific Oscillation (IPO) An equatorially symmetric pattern of sea surface temperature variability at decadal-to-interdecadal timescales. While the Pacific Decadal Oscillation (PDO) and its South Pacific counterpart, the South Pacific Decadal Oscillation (SPDO), are considered as physically distinct modes, the tropical Pacific decadal-interdecadal variability can drive both the PDO and SPDO, forming the IPO as a synchronized pan-Pacific variability. Its spatial pattern of sea surface temperature anomalies is similar to that of the El Niño-Southern Oscillation (ENSO), but with a broader meridional extent in the tropical signal and more weights in the extratropics compared to the tropics. In the AR6 WGI report, it is encapsulated within the definition and description of the Pacific Decadal Variability (PDV). See also Section AIV.2.6 in Annex IV of the AR6 WGI report.

Pacific Decadal Oscillation (PDO) The leading mode of variability obtained from decomposition in empirical orthogonal function of sea surface temperature over the North Pacific north of 20°N, and characterized by a strong decadal component. The positive phase of the PDO features a dipole of sea surface temperature anomalies in the North Pacific, with a cold lobe near the center of the basin and extending westward along the Kuroshio, encircled by warmer conditions along the coast of North America and in the subtropics. A positive PDO is accompanied by an intensified Aleutian Low and an associated cyclonic circulation enhancement leading to teleconnections over the continents adjacent to the North Pacific. In AR6 WGI report, the PDO is encapsulated within the definition and description of Pacific Decadal Variability (PDV). See also Section AIV.2.6 in Annex IV of the AR6 WGI report.

Pacific-North American (PNA) pattern An atmospheric large-scale wave pattern featuring a sequence of tropospheric high and low pressure anomalies stretching from the subtropical west Pacific to the east coast of North America. See also Pacific-South American (PSA) pattern.

Palaeocene-Eocene Thermal Maximum (PETM) The PETM is a transient event that occurred between 55.9 and 55.7 million years ago. Continental positions at this time were somewhat different to present due to tectonic plate movements. Geological data indicate that the PETM was characterised by a warming (global mean surface temperature rose to about 4-7 °C warmer than the preceding mean state), and an increase in atmospheric CO₂ (from about 900 to about 2000 ppmv). In addition, ocean pH and oxygen content decreased; many deep-sea species went extinct and tropical coral reefs diminished.

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

Do Not Cite, Quote or Distribute AVII-44
**Parameterisation**  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.

**Pathways**  The temporal evolution of natural and/or human systems towards a future state. Pathway concepts range from sets of quantitative and qualitative *scenarios* or *narratives* of potential futures to solution-oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic, and/or socio-behavioural trajectories and involve various dynamics, goals, and actors across different scales. See also *Scenario storyline* (under *Storyline*), *Mitigation scenario* (under *Scenario*), *Baseline scenario* (under *Scenario*) and *Stabilisation of GHG or CO₂-equivalent concentration*.

1.5°C pathway  A pathway of emissions of greenhouse gases and other climate forcers that provides an approximately one-in-two to two-in-three chance, given current knowledge of the climate response, of global warming either remaining below 1.5°C or returning to 1.5°C by around 2100 following an overshoot.

**Representative concentration pathways (RCPs)**  Scenarios that include time series of *emissions* and concentrations of the full suite of *greenhouse gases* (GHGs) and aerosols and chemically active gases, as well as *land use* and *land cover* (Moss et al., 2010). 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 emphasises that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome (Moss et al., 2010).

RCPs usually refer to the portion of the concentration pathway extending up to 2100, for which *Integrated assessment models* produced corresponding emission scenarios. Extended concentration pathways describe extensions of the RCPs from 2100 to 2300 that were calculated using simple rules generated by stakeholder consultations, and do not represent fully consistent scenarios. Four RCPs produced from Integrated assessment models were selected from the published literature and are used in the Fifth IPCC Assessment and also used in this Assessment for comparison, spanning the range from approximately below 2°C warming to high (>4°C) warming best-estimates by the end of the 21st century: RCP2.6, RCP4.5 and RCP6.0 and RCP8.5.

- **RCP2.6**: One pathway where radiative forcing peaks at approximately 3 W m⁻² and then declines to be limited at 2.6 W m⁻² in 2100 (the corresponding Extended Concentration Pathway, or ECP, has constant emissions after 2100).
- **RCP4.5 and RCP6.0**: Two intermediate stabilisation pathways in which radiative forcing is limited at approximately 4.5 W m⁻² and 6.0 W m⁻² in 2100 (the corresponding ECPs have constant concentrations after 2150).
- **RCP8.5**: One high pathway which leads to >8.5 W m⁻² in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250).

See also *Coupled Model Intercomparison Project (CMIP)* and *Shared socio-economic pathways (SSPs)* (under *Pathways*).

**Shared socio-economic pathways (SSPs)**  Shared socio-economic pathways (SSPs) have been developed to complement the *Representative concentration pathways (RCPs)*. By design, the RCP emission and concentration pathways were stripped of their association with a certain socio-economic development. Different levels of *emissions* and *climate change* along the dimension of the RCPs can hence be explored against the backdrop if different socio-economic development pathways (SSPs) on the other dimension in a matrix. This integrative SSP-RCP framework is now widely used in the climate *impact* and policy analysis literature, where *climate projections* obtained under the RCP scenarios are analysed against the backdrop of various SSPs. As several emission updates were due, a new set of emission scenarios was developed in conjunction with the SSPs. Hence, the abbreviation SSP is now used for two things: On the one hand SSP1, SSP2, ..., SSP5 is used to denote the five socio-economic scenario families. On the other hand, the
abbreviations SSP1-1.9, SSP1-2.6, ..., SSP5-8.5 are used to denote the newly developed emission scenarios that are the result of an SSP implementation within an integrated assessment model. Those SSP scenarios are bare of climate policy assumption, but in combination with so-called shared policy assumptions (SPAs), various approximate radiative forcing levels of 1.9, 2.6, ..., or 8.5 W m\(^{-2}\) are reached by the end of the century, respectively.

**Pattern scaling** Techniques used to represent the spatial variations in climate at a given increase in global mean surface air temperature (GSAT) are referred to as ‘pattern scaling’.

**Peat** Soft, porous or compressed, sedimentary deposit of which a substantial portion is partly decomposed plant material with high water content in the natural state (up to about 90%).

**Peatlands** Peatland is a land where soils are dominated by peat.

**Percentile** A partition value in a population distribution that a given percentage of the data values are below or equal to. The 50th percentile corresponds to the median of the population. Percentiles are often used to estimate the extremes of a distribution. For example, the 90th (10th) percentile may be used to refer to the threshold for the upper (lower) extremes.

**Permafrost** Ground (soil or rock, and included ice and organic material) that remains at or below 0°C for at least two consecutive years (Harris et al., 1988). Note that permafrost is defined via temperature rather than ice content and, in some instances, may be ice-free.

**Near-surface permafrost** Permafrost within \(\sim 3-4\) m of the ground surface. The depth is not precise, but describes what commonly is highly relevant for people and ecosystems. Deeper permafrost is often progressively less ice-rich and responds more slowly to warming than near-surface permafrost. Presence or absence of near-surface permafrost is not the only significant metric of permafrost change, and deeper permafrost may persist when near-surface permafrost is absent.

**Permafrost degradation** Decrease in the thickness and/or areal extent of permafrost.

**Permafrost thaw** Progressive loss of ground ice in permafrost, usually due to input of heat. Thaw can occur over decades to centuries over the entire depth of permafrost ground, with impacts occurring while thaw progresses. During thaw, temperature fluctuations are subdued because energy is transferred by phase change between ice and water. After the transition from permafrost to non-permafrost, ground can be described as thawed.

**Perturbed parameter ensemble** See Model ensemble.

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

**Phenology** The relationship between biological phenomena that recur periodically (e.g., development stages, migration) and climate and seasonal changes.

**Photosynthesis** The production of carbohydrates in plants, algae and some bacteria using the energy of light. Carbon dioxide (CO\(_2\)) is used as the carbon source.

**Physical climate storyline** See Storyline.

**Piacenzian warm period** See Pliocene.

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

**Plant evaporative stress**  Plant evaporative stress in both crops and natural vegetation can result from the combination of a high atmospheric evaporative demand and limited available water to supply this demand by means of evapotranspiration, further enhancing *agricultural or ecological drought.*

**Pleistocene**  The Pleistocene Epoch is the earlier of two epochs in the *Quaternary* System, extending from 2.59 Ma to the beginning of the *Holocene* at 11.65 ka.

**Pliocene**  The Pliocene Epoch is the more recent of two epochs of the Neogene Period within the *Cenozoic* Era. It extends from 5.33 Ma to the beginning of the *Pleistocene* Epoch at 2.59 Ma. The Neogene Period precedes the current geological period, the *Quaternary* Period, which is one of several ice ages that have occurred during Earth’s geological history. It encompasses the mid-Pliocene warm period (MPWP), also known as the Piacenzian warm period, which occurred approximately 3.3 to 3.0 Ma. The MPWP, in turn, encompasses the interglacial episode, marine isotope stage (MIS) KM5c, which peaked at 3.205 Ma, when orbital forcing was similar to modern (Haywood et al., 2016).

**Polar amplification**  Polar amplification describes the phenomenon where surface temperature change at high latitudes exceeds the global average surface temperature change. The terms Arctic Amplification or Antarctic Amplification are used when describing the phenomenon occurring at one of the poles.

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

**Post-glacial period**  See *Holocene*.

**Potential evapotranspiration**  See *Evapotranspiration*.

**Pre-industrial (period)**  The multi-century period prior to the onset of large-scale industrial activity around 1750. The *reference period* 1850–1900 is used to approximate pre-industrial *global mean surface temperature* (GMST). See also *Industrial revolution*.

**Precipitable water**  The total amount of atmospheric water vapour in a vertical column of unit cross-sectional area. It is commonly expressed in terms of the height of the water if completely condensed and collected in a vessel of the same unit cross section.

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

**Predictability**  The extent to which future states of a system may be predicted based on knowledge of current and past states of the system. Because knowledge of the climate system's past and current states is generally imperfect, as are the models that utilize this knowledge to produce a *climate prediction*, and because the *climate system* is inherently nonlinear and chaotic, predictability of the climate system is inherently limited. Even with arbitrarily accurate models and observations, there may still be limits to the predictability of such a nonlinear system (AMS, 2021).

**Prediction quality/skill**  Measures of the success of a prediction against observationally based information. No single measure can summarize all aspects of forecast quality and a suite of *metrics* is considered. Metrics will differ for forecasts given in deterministic and probabilistic form.

**Primary production**  The synthesis of organic compounds by plants and microbes, on land or in the ocean, primarily by photosynthesis using light and carbon dioxide (CO₂) as sources of energy and carbon respectively. It can also occur through chemosynthesis, using chemical energy, e.g., in deep sea vents.
Gross Primary Production (GPP)  The total amount of carbon fixed by photosynthesis over a specified time period.

Net primary production (NPP)  The amount of carbon fixed by photosynthesis minus the amount lost by respiration over a specified time period.

Probability density function (PDF)  A probability density function is a function that indicates the relative chances of occurrence of different outcomes of a variable. The function integrates to unity over the domain for which it is defined and has the property that the integral over a sub-domain equals the probability that the outcome of the variable lies within that sub-domain. For example, the probability that a temperature anomaly defined in a particular way is greater than zero is obtained from its PDF by integrating the PDF over all possible temperature anomalies greater than zero. Probability density functions that describe two or more variables simultaneously are similarly defined.

Process-based model  Theoretical concepts and computational methods that represent and simulate the behaviour of real-world systems derived from a set of functional components and their interactions with each other and the system environment, through physical and mechanistic processes occurring over time.

Projection  A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised. See also Climate projection, Pathways and Scenario.

Proxy  A proxy climate indicator is any biophysical property of materials formed during the past that is interpreted to represent some combination of climate-related variations back in time. Climate-related data derived in this way are referred to as proxy data and time series of proxy data are proxy records. Examples of proxy types include pollen assemblages, tree ring widths, speleothem and coral geochemistry, and various data derived from marine sediments and glacier ice. Proxy data can be calibrated to provide quantitative climate information.

Proxy records  See Proxy.

Quasi-Biennial Oscillation (QBO)  A near-periodic oscillation of the equatorial zonal wind between easterlies and westerlies in the tropical stratosphere with a mean period of around 28 months. The alternating wind maxima descend from the base of the mesosphere down to the tropopause, and are driven by wave energy that propagates up from the troposphere.

Quaternary The Quaternary Period is the last of three periods that make up the Cenozoic Era (66 Ma to present), extending from 2.58 Ma to the present, and includes the Pleistocene and Holocene Epochs.

Radiative effect  The impact on a radiation flux or heating rate (most commonly, on the downward flux at the top of the atmosphere) caused by the interaction of a particular constituent with either the infrared or solar radiation fields through absorption, scattering and emission, relative to an otherwise identical atmosphere free of that constituent. This quantifies the impact of the constituent on the climate system. Examples include the aerosol-radiation interactions, cloud radiative effect, and greenhouse effect. In this report, the portion of any top-of-atmosphere radiative effect that is due to anthropogenic or other external influences (e.g., volcanic eruptions or changes in the sun) is termed the instantaneous radiative forcing.

Radiative forcing  The change in the net, downward minus upward, radiative flux (expressed in W m$^{-2}$) due to a change in an external driver of climate change, such as a change in the concentration of carbon dioxide (CO$_2$), the concentration of volcanic aerosols or in the output of the Sun. The stratospherically adjusted radiative forcing is computed with all tropospheric properties held fixed at their unperturbed values, and after allowing for stratospheric temperatures, if perturbed, to readjust to radiative-dynamical equilibrium. Radiative forcing is called instantaneous if no change in stratospheric temperature is accounted for. The radiative forcing once both stratospheric and tropospheric adjustments are accounted for is termed
the effective radiative forcing.

Rapid adjustment  The response to an agent perturbing the *climate system* that is driven directly by the agent, independently of any change in the *global mean surface temperature*. For example, *carbon dioxide* and *aerosols*, by altering internal heating and cooling rates within the *atmosphere*, can each cause changes to cloud cover and other variables thereby producing a *radiative effect* even in the absence of any surface warming or cooling. Adjustments are rapid in the sense that they begin to occur right away, before *climate feedbacks* which are driven by warming (although some adjustments may still take significant time to proceed to completion, for example those involving vegetation or *ice sheets*). It is also called the rapid response or fast adjustment.

Rapid climate change  See *Abrupt change / abrupt climate change*.

Rapid dynamical change (of glaciers or ice sheets)  Changes in glacier or ice sheet mass controlled by changes in flow speed and discharge rather than by *accumulation* or ablation. This can result in a rate of mass change larger than that due to any imbalance between accumulation and ablation. Rapid dynamical change may be initiated by a climatic trigger, such as incursion of warm ocean water beneath an *ice shelf*, or thinning of a grounded tidewater terminus, which may lead to reactions within the glacier system, that may result in rapid ice loss.

Reanalysis  Reanalyses are created by processing past meteorological or oceanographic data using fixed state-of-the-art weather forecasting or ocean circulation models with *data assimilation* techniques. They are used to provide estimates of variables such as historical atmospheric temperature and wind or oceanographic temperature and currents, and other quantities. Using fixed data assimilation avoids effects from the changing analysis system that occur in operational analyses. Although continuity is improved, global reanalyses still suffer from changing coverage and biases in the observing systems.

Reasons for concern (RFCs)  Elements of a classification framework, first developed in the IPCC Third Assessment Report, which aims to facilitate judgments about what level of climate change may be dangerous (in the language of Article 2 of the UNFCCC) by aggregating risks from various sectors, considering hazards, exposures, vulnerabilities, capacities to adapt, and the resulting impacts.

Reconstruction (of climate variable)  Approach to reconstructing the past temporal and spatial characteristics of a *climate* variable from predictors. The predictors can be instrumental data if the reconstruction is used to infill missing data or *proxy* data if it is used to develop *paleoclimate* reconstructions. Various techniques have been developed for this purpose: linear multivariate regression based methods and nonlinear Bayesian and analogue methods.

Reference period  The period relative to which *anomalies* are computed. See also *Baseline/reference (period)*.

Baseline period  The period relative to which *anomalies* are computed. See also *Baseline/reference (period)*.

Reference scenario  See *Scenario*.

Reforestation  Conversion to forest of land that has previously contained forests but that has been converted to some other use. [Note: For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and their 2019 Refinement, and information provided by the United Nations Framework Convention on Climate Change (IPCC, 2006, 2019, UNFCCC, 2021a, 2021b).] See also *Afforestation*, *Deforestation*, *Reducing Emissions from Deforestation and Forest Degradation (REDD+)*, Anthropogenic removals and *Carbon dioxide removal* (CDR).

Region  *Land* and/or *ocean* area characterised by specific geographical and/or climatological features.
climate of a region emerges from a multiscale combination of its own features, remote influences from other regions, and global climate conditions.

Regional climate messages  Regional climate messages translate climate information synthesized from different lines of evidence into the context of a user vulnerable to climate at regional scales taking into account the values of both the producer and user (WGI Section 10.5).

Regional climate model (RCM)  A climate model at higher resolution over a limited area. Such models are used in downscaling global climate results over specific regional domains.

Regional climate scenario  A narrative used to describe how the future might unfold for a region (IPCC-TGICA, 2007). These are often used to guide impact understanding and adaptation efforts. They can include quantitative information based on scaled historical data or derived from GCM-based internally consistent future climates. See also Climate scenario.

Regional sea level change  See Sea level change (sea level rise/sea level fall).

Relative humidity  The relative humidity specifies the ratio of actual water vapour pressure to that at saturation with respect to liquid water or ice at the same temperature. See also Specific humidity.

Relative sea-level (RSL) change  See Sea level change (sea level rise/sea level fall).

Remaining carbon budget  See Carbon budget.

Representative concentration pathways (RCPs)  See Pathways.

Reservoir  A component or components of the climate system where a greenhouse gas (GHG) or a precursor of a greenhouse gas is stored (UNFCCC Article 1.7 (UNFCCC, 1992)).

Resilience  The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (Arctic Council, 2016). See also Hazard, Risk and Vulnerability.

Resolution  In climate models, this term refers to the physical distance (metres or degrees) between each point on the grid used to compute the equations. Temporal resolution refers to the time step or time elapsed between each model computation of the equations.

Respiration  The process whereby living organisms convert organic matter to carbon dioxide (CO₂), releasing energy and consuming molecular oxygen.

Response time or adjustment time  In the context of climate variations, 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 processes. It is very different for various components of the climate system. The response time of the troposphere is relatively short, from days to weeks, whereas the stratosphere reaches equilibrium on a time scale of typically a few months. Due to their large heat capacity, the oceans have a much longer response time: typically decades, but up to centuries or millennia. The response time of the strongly coupled surface-troposphere system is, therefore, slow compared to that of the stratosphere, and mainly determined by the oceans. The biosphere may respond quickly (e.g., to droughts), but also very slowly to imposed changes.

In the context of lifetimes, response time or adjustment time (T_a) is the time scale characterizing the decay of an instantaneous pulse input into the reservoir. See Response time or adjustment time (T_a) under Lifetime.

Return period  An estimate of the average time interval between occurrences of an event (e.g., flood or...
Return value  The highest (or, alternatively, lowest) value of a given variable, on average occurring once in a given period of time (e.g., in 10 years).

Risk  The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and well-being, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species.

In the context of climate change impacts, risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards. Hazards, exposure and vulnerability may each be subject to uncertainty in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making (see also risk management, adaptation and mitigation).

In the context of climate change responses, risks result from the potential for such responses not achieving the intended objective(s), or from potential trade-offs with, or negative side-effects on, other societal objectives, such as the Sustainable Development Goals (SDGs) (see also risk trade-off). Risks can arise for example from uncertainty in implementation, effectiveness or outcomes of climate policy, climate-related investments, technology development or adoption, and system transitions. See also Hazard and Impacts (consequences, outcomes).

Risk assessment  The qualitative and/or quantitative scientific estimation of risks. See also Risk management and Risk perception.

Risk framework  A common framework for describing and assessing risk across all three working groups is adopted to promote clear and consistent communication of risks and to better inform risk assessment and decision making related to climate change.

Risk management  Plans, actions, strategies or policies to reduce the likelihood and/or magnitude of adverse potential consequences, based on assessed or perceived risks. See also Risk assessment, Risk perception and Risk transfer.

Risk perception  The subjective judgment that people make about the characteristics and severity of a risk. See also Risk assessment, Risk management and Risk transfer.

Risk trade-off  The change in the portfolio of risks that occurs when a countervailing risk is generated (knowingly or inadvertently) by an intervention to reduce the target risk (Wiener and Graham, 2009).

River discharge  See Streamflow.

Rock glacier  A debris landform (mass of rock fragments and finer material that contains either an ice core or an ice-cemented matrix) generated by a former or current gravity-driven creep of permafrost in mountain slopes (Harris et al., 1988; Giardino et al., 2011; IPA-RG, 2020). It is detectable in the landscape due to the occurrence of (1) a steep slope delimiting the terminal part; (2) generally well-defined lateral margins in a continuation of the front; (3) transversal or longitudinal ridges and furrows (ridge and furrow topography). These are geomorphological indicators of the occurrence of permafrost conditions. Although it is an ice storage feature, it is not a type of glacier since it is not originated over the surface by the recrystallization of snow.

Runoff  The flow of water over the surface or through the subsurface, which typically originates from the part of liquid precipitation and/or snow/ice melt that does not evaporate, transpire or refreeze, and returns to water bodies.
Sampling uncertainty  See Uncertainty.

Scenario  A plausible description 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 (TC), prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions. See also Climate scenario and Regional climate scenario.

Baseline scenario  See Reference Scenario.

Concentrations scenario  A plausible representation of the future development of atmospheric concentrations of substances that are radiatively active (e.g., greenhouse gases (GHGs), aerosols, tropospheric ozone), plus human-induced land cover changes that can be radiatively active via albedo changes, and often used as input to a climate model to compute climate projections.

Emissions scenario  A plausible representation of the future development of emissions of substances that are radiatively active (e.g., greenhouse gases (GHGs) or aerosols), plus human-induced land cover changes that can be radiatively active via albedo changes, based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change, energy and land use) and their key relationships. Concentration scenarios, derived from emission scenarios, are often used as input to a climate model to compute climate projections. See also Representative concentration pathways (RCPs) (under Pathways) and Shared socio-economic pathways (SSPs) (under Pathways).

Mitigation scenario  A plausible description of the future that describes how the (studied) system responds to the implementation of mitigation policies and measures. See also Pathways, Socio-economic scenario (under Scenario) and Stabilisation (of GHG or CO₂-equivalent concentration).

Reference scenario  Scenario used as starting or reference point for a comparison between two or more scenarios.

[Note 1: In many types of climate change research, reference scenarios reflect specific assumptions about patterns of socio-economic development and may represent futures that assume no climate policies or specified climate policies, for example those in place or planned at the time a study is carried out. Reference scenarios may also represent futures with limited or no climate impacts or adaptation, to serve as a point of comparison for futures with impacts and adaptation. These are also referred to as baseline scenarios in the literature.

Note 2: Reference scenarios can also be climate policy or impact scenarios, which in that case are taken as a point of comparison to explore the implications of other features, e.g., of delay, technological options, policy design and strategy or to explore the effects of additional impacts and adaptation beyond those represented in the reference scenario.

Note 3: The term business as usual scenario has been used to describe a scenario that assumes no additional policies beyond those currently in place and that patterns of socio-economic development are consistent with recent trends. The term is now used less frequently than in the past.

Note 4: In climate change attribution or impact attribution research reference scenarios may refer to counterfactual historical scenarios assuming no anthropogenic greenhouse gas emissions (climate change attribution) or no climate change (impact attribution).]

Socio-economic scenario  A scenario that describes a plausible future in terms of population, gross domestic product (GDP), and other socio-economic factors relevant to understanding the implications of climate change. See also Baseline scenario (under Scenario), Mitigation scenario (under Scenario) and Pathways.
**Scenario storyline**  See *Storyline*.

**Sea ice**  Ice found at the sea surface that has originated from the freezing of seawater. Sea ice may be discontinuous pieces (ice floes) moved on the ocean surface by wind and currents (pack ice), or a motionless sheet attached to the coast (land-fast ice). Sea ice concentration is the fraction of the ocean covered by ice.

Sea ice less than one year old is called first-year ice. Perennial ice is sea ice that survives at least one summer. It may be subdivided into second-year ice and multi-year ice, where multiyear ice has survived at least two summers.

**Sea ice area (SIA)**  Sea ice area is the area covered by sea ice. In contrast to *sea ice extent*, it is a linear measure of sea ice coverage that does not depend on grid resolution.

**Sea ice concentration**  Sea ice concentration is the fraction of the ocean covered by ice.

**Sea ice extent (SIE)**  Sea ice extent is calculated for gridded data products as the total area of all grid cells with *sea ice concentration* above a given threshold, usually 15%. It hence is a grid-dependent, non-linear measure of sea ice coverage.

**Sea level change (sea level rise/sea level fall)**  Change to the height of sea level, both globally and locally (relative sea level change) at seasonal, annual, or longer time scales due to (1) a change in ocean volume as a result of a change in the mass of water in the ocean (e.g., due to melt of glaciers and ice sheets), (2) changes in ocean volume as a result of changes in ocean water density (e.g., expansion under warmer conditions), (3) changes in the shape of the ocean basins and changes in the Earth’s gravitational and rotational fields, and (4) local subsidence or uplift of the land. *Global mean sea level change* resulting from change in the mass of the ocean is called barystatic. The amount of barystatic sea level change due to the addition or removal of a mass of water is called its *sea level equivalent* (SLE). Sea level changes, both globally and locally, resulting from changes in water density are called steric. Density changes induced by temperature changes only are called thermosteric, while density changes induced by salinity changes are called halosteric. Barystatic and steric sea level changes do not include the effect of changes in the shape of ocean basins induced by the change in the ocean mass and its distribution. See also *Vertical land motion* (VLM), *Land water storage*, *Sea level commitment*, *Glacial isostatic adjustment* (GIA), *Extreme sea level* (ESL) and *Storm surge*.

**Geocentric sea-level change**  The change in local mean sea surface height with respect to the terrestrial reference frame, it is the sea-level change observed with instruments from space. See also *Altimetry*.

**Global mean sea-level (GMSL) change**  The increase or decrease in the volume of the ocean divided by the ocean surface area. It is the sum of changes in ocean density through temperature changes (global mean thermosteric sea-level change) and changes in the ocean mass as a result of changes in the cryosphere or land water storage (barystatic sea-level change). See also *Terrestrial water storage* (TWS).

**Gravitational, rotational and deformational (GRD) effects**  Changes in Earth Gravity, Earth Rotation and viscoelastic, solid Earth Deformation (GRD) result from the redistribution of mass between terrestrial ice and water reservoirs and the ocean. Contemporary terrestrial mass loss leads to elastic solid Earth uplift and a nearby relative sea level fall (for a single source of terrestrial mass loss this is within ~2000 km, for multiple sources the distance depends on the interaction of the different relative sea-level patterns). Farther away (more than ~7000 km for a single source of terrestrial mass loss), relative sea level rises more than the global average, due, to first order, to gravitational effects. Earth deformation associated with adding water to the oceans and a shift of the Earth’s rotation axis towards the source of terrestrial mass loss leads to second-order effects that increase spatial variability of the pattern globally. GRD effects due to the redistribution of ocean water within the ocean itself are referred to as self-atraction and loading effects.

**Halosteric sea-level change**  Halosteric sea-level change occurs as a result of salinity variations: higher salinity leads to higher density and decreases the volume per unit of mass. Although both processes can be relevant on regional to local scales, only thermosteric changes impact the *global mean sea-level change*, whereas the global mean halosteric change is negligible (Gregory et al., 2019).
Local sea level change  Change in sea level relative to a datum (such as present-day mean sea level) at spatial scales smaller than 10 km.

Ocean dynamic sea level change  Change in mean sea level relative to the geoid associated with circulation and density-driven changes in the ocean. Ocean dynamic sea-level change is regionally varying but by definition has a zero global mean and conventionally is inverse-barometer corrected (i.e., the effect of the hydrostatic depression of the sea surface by atmospheric pressure changes is removed). Changes in ocean currents occur due to variations in heating and cooling, variability in winds and changes in seasonally- to annually-averaged air temperature and humidity.

Regional sea level change  Change in sea level relative to a datum (such as present-day mean sea level) at spatial scales of about 100 km.

Relative sea-level (RSL) change  The change in local mean sea surface height (SSH) relative to the local solid surface, i.e. the sea floor, as measured by instruments that are fixed to the Earth’s surface, such as tide gauges. This reference frame is used when considering coastal impacts, hazards and adaptation needs.

Steric sea level change  Steric sea-level change is caused by changes in the ocean density and is composed of thermosteric sea-level change and halosteric sea-level change.

Thermosteric sea-level change  Thermosteric sea-level change (where thermosteric sea-level rise may also be referred to as thermal expansion) occurs as a result of changes in ocean temperature: increasing temperature reduces ocean density and increases the volume per unit of mass.

Sea level equivalent (SLE)  The SLE of a mass of water, ice, or water vapour is that mass, converted to a volume using a density of 1000 kg m⁻³, and divided by the present-day ocean surface area of 3.625 × 10⁰⁰ m². Thus, 362.5 Gt of water mass added to the ocean correspond to 1 mm of global mean sea level rise.

However, more accurate estimates of SLE must account for additional processes affecting mean sea level rise, such as shoreline migration, changes in ocean area, and for vertical land movements.

Sea level rise (SLR)  See Sea level change (sea level rise/sea level fall).

Sea surface temperature (SST)  The subsurface bulk temperature in the top few metres of the ocean, measured by ships, buoys, and drifters. From ships, measurements of water samples in buckets were mostly switched in the 1940s to samples from engine intake water. Satellite measurements of skin temperature (uppermost layer; a fraction of a millimetre thick) in the infrared or the top centimetre or so in the microwave are also used, but must be adjusted to be compatible with the bulk temperature.

Semi-direct (aerosol) effect  See Aerosol-radiation interaction.

Semi-empirical model  Model in which calculations are based on a combination of observed associations between variables and theoretical considerations relating variables through fundamental principles (e.g., conservation of energy). For example, in sea level studies, semi-empirical models refer specifically to transfer functions formulated to project future global mean sea level change, or contributions to it, from future global mean surface temperature change or radiative forcing.

Sensible heat flux  The turbulent or conductive flux of heat from the Earth's surface to the atmosphere that is not associated with phase changes of water; a component of the surface energy budget.

Sequestration  The process of storing carbon in a carbon pool. See also Uptake and Soil carbon sequestration (SCS).

Sequestration potential  The quantity of greenhouse gases that can be removed from the atmosphere by anthropogenic enhancement of sinks and stored in a pool. See Mitigation potential for different subcategories.
of sequestration potential. See also Pool, carbon and nitrogen, Sequestration and Sink.

**Shared policy assumptions (SPAs)** See Shared socio-economic pathways (SSPs) (under Pathways).

**Shared socio-economic pathways (SSPs)** See Pathways.

**Short-lived climate forcers (SLCFs)** A set of chemically reactive compounds with short (relative to CO₂) atmospheric lifetimes (from hours to decades) but characterised by different physiochemical properties and environmental effects. Their emission or formation has a significant effect on radiative forcing over a period determined by their respective atmospheric lifetimes. Changes in their emissions can also induce long-term climate effects via, in particular, their interactions with some biogeochemical cycles. SLCFs are classified as direct or indirect, with direct SLCFs exerting climate effects through their radiative forcing and indirect SLCFs being the precursors of other direct climate forcers. Direct SLCFs include methane (CH₄), ozone (O₃), primary aerosols and some halogenated species. Indirect SLCFs are precursors of ozone or secondary aerosols. SLCFs can be cooling or warming through interactions with radiation and clouds. They are also referred to as near-term climate forcers (NTCFs). Many SLCFs are also air pollutants. A subset of exclusively warming SLCFs is also referred to as short-lived climate pollutants (SLCPs), including methane, ozone, and black carbon.

**Short-lived climate pollutants (SLCP)** See Short-lived climate forcers (SLCFs).

**Shortwave radiation** See Solar radiation.

**Significant wave height** The average trough-to-crest height of the highest one-third of the wave heights (sea and swell) occurring in a particular time period.

**Simple climate model (SCM)** A broad class of lower-dimensional models of the energy balance, radiative transfer, carbon cycle, or a combination of such physical components. SCMs are also suitable for performing emulations of climate-mean variables of Earth system models (ESMs), given that their structural flexibility can capture both the parametric and structural uncertainties across process-oriented ESM responses. They can also be used to test consistency across multiple lines of evidence with regard to climate sensitivity ranges, transient climate responses (TCRs), transient climate response to cumulative emissions (TCREs) and carbon cycle feedbacks. See also Emulators and Earth system model of intermediate complexity (EMIC).

**Sink** Any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere (UNFCCC Article 1.8 (UNFCCC, 1992)). See also Source and Uptake.

**Small Island Developing States (SIDS)** Small Island Developing States (SIDS), as recognised by the United Nations OHRLLS (Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States), are a distinct group of developing countries facing specific social, economic and environmental vulnerabilities (UN-OHRLLS, 2011). They were recognized as a special case both for their environment and development at the Rio Earth Summit in Brazil in 1992. Fifty-eight countries and territories are presently classified as SIDS by the UN OHRLLS, with 38 being UN member states and 20 being Non-UN Members or Associate Members of the Regional Commissions (UN-OHRLLS, 2018).

**Snow cover** Snow cover refers to all the snow that has accumulated on the ground at a given time (UNESCO/IASH/WMO, 1970).

**Snow cover duration (SCD)** How long snow continuously remains on the land surface, or the period between snow-on and snow-off dates.

**Snow cover extent (SCE)** The areal extent of snow covered ground.

**Snow water equivalent (SWE)** The depth of liquid water that would result if a mass of snow melted
Socio-economic scenario  See Scenario.

Soil moisture  Water stored in the soil in liquid or frozen form. Root-zone soil moisture is of most relevance for plant activity.

Soil temperature  The temperature of the soil. This can be measured or modelled at multiple levels within the depth of the soil.

Solar activity  General term collectively describing a variety of magnetic phenomena on the Sun such as sunspots, faculae (bright areas), and flares (emission of high-energy particles). It varies on time scales from minutes to millions of years. The solar cycle, with an average duration of 11 years, is an example of a quasi-regular change in solar activity.

Solar cycle (11-year)  A quasi-regular modulation of solar activity with varying amplitude and a period of between 8 and 14 years.

Solar radiation  Electromagnetic radiation emitted by the Sun with a spectrum close to the one of a black body with a temperature of 5770 K. The radiation peaks in visible wavelengths. When compared to the terrestrial radiation it is often referred to as shortwave radiation. See also Insolation and Total solar irradiance (TSI).

Solar radiation modification (SRM)  Solar radiation modification (SRM) refers to a range of radiation modification measures not related to greenhouse gas (GHG) mitigation that seek to limit global warming. Most methods involve reducing the amount of incoming solar radiation reaching the surface, but others also act on the longwave radiation budget by reducing optical thickness and cloud lifetime.

Cirrus cloud thinning (CCT)  Cirrus cloud thinning is one of several radiation modification approaches to counter the warming caused by greenhouse gases. In the approach, it is proposed to reduce the amount of cirrus clouds by injecting ice nucleating substances in the upper troposphere. The reduction in cirrus clouds is expected to increase the amount of longwave cooling to space resulting in a planetary cooling. Although cirrus cloud thinning primarily affects the longwave radiation budget of our planet, it is often identified as one of the solar radiation modification (SRM) approaches in the literature.

Marine cloud brightening (MCB)  Marine cloud brightening is one of several solar radiation modification (SRM) approaches to increase the planetary albedo. In the approach, it is proposed to inject sea salt aerosols into the persistent marine low clouds. This is expected to increase the cloud droplet concentration of these clouds and their reflectivity.

Stratospheric aerosol injection (SAI)  Stratospheric aerosol injection is one of several solar radiation modification (SRM) approaches to increase the planetary albedo. In the approach, it is proposed to inject highly reflective aerosols such as sulphates into the lower stratosphere. This is expected to increase the fraction of solar radiation deflected to space resulting in a planetary cooling.

Solubility pump  A physicochemical process that transports dissolved inorganic carbon from the ocean’s surface to its interior. The solubility pump is primarily driven by the solubility of carbon dioxide ($CO_2$) (with more $CO_2$ dissolving in colder water) and the large-scale, thermohaline patterns of ocean circulation.

Source  Any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere (UNFCCC Article 1.9 (UNFCCC, 1992)). See also Sink.

South American monsoon (SAmM)  See Global monsoon.

South and Southeast Asian monsoon (SAsiaM)  See Global monsoon.
Southern Annular Mode (SAM)  See Annular modes.

South Pacific Convergence Zone (SPCZ)  A band of low-level convergence, cloudiness and precipitation ranging from the west Pacific warm pool south-eastwards towards French Polynesia, which is one of the most significant features of subtropical Southern Hemisphere climate. It shares some characteristics with the Inter-Tropical Convergence Zone (ITCZ), but is more extratropical in nature, especially east of the Dateline.

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

Specific humidity  The specific humidity specifies the ratio of the mass of water vapour to the total mass of moist air. See also Relative humidity.

Stadial  A period of North Atlantic cooling during the last glacial period, lasting anywhere from several centuries to millennia, as inferred from oxygen isotopes in Greenland ice cores. These episodes are often referred to as examples of “abrupt climate change events”, as they are often terminated by abrupt warming. They occur repeatedly during the last glacial period, and are associated with a distinct pattern of global temperature and hydrological variations recorded in paleoclimate records from this interval. See also Younger Dryas.

Statistical downscaling  See Downscaling.

Steric sea level change  See Sea level change (sea level rise/sea level fall).

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. See also Sea level change (sea level rise/sea level fall) and Extreme sea level (ESL).

Storm tracks  Originally, a term referring to the tracks of individual cyclonic weather systems, but now often generalized to refer to the main regions where the tracks of extratropical disturbances occur as sequences of low (cyclonic) and high (anticyclonic) pressure systems.

Storyline  A way of making sense of a situation or a series of events through the construction of a set of explanatory elements. Usually it is built on logical or causal reasoning. In climate research, the term storyline is used both in connection to scenarios as related to a future trajectory of the climate and human systems or to a weather or climate event. In this context, storylines can be used to describe plural, conditional possible futures or explanations of a current situation, in contrast to single, definitive futures or explanations.

Physical climate storyline  A self-consistent and plausible unfolding of a physical trajectory of the climate system, or a weather or climate event, on timescales from hours to multiple decades (Shepherd et al., 2018). Through this, storylines explore, illustrate and communicate uncertainties in the climate system response to forcing and in internal variability.

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.

Stratification  Process of forming of layers of (ocean) water with different properties such as salinity, density and temperature that act as barrier for water mixing. The strengthening of near-surface stratification generally results in warmer surface waters, decreased oxygen levels in deeper water, and intensification of ocean acidification (OA) in the upper ocean.

Stratosphere  The highly stratified region of the atmosphere above the tropopause, extending to about 50 km altitude. See also Troposphere.
Stratospheric aerosol injection (SAI)  See Solar radiation modification (SRM).

Stratosphere-troposphere exchange (STE)  Stratosphere-troposphere exchange (STE) is understood as the flux of air or trace constituents across the tropopause, including both directions: the stratosphere to troposphere transport (STT) and troposphere to stratosphere transport (TST). STE is one of the key factors controlling the budgets of ozone, water vapour and other substances in both the troposphere and the lower stratosphere.

Stratospheric ozone  Stratospheric ozone describes the ozone ($O_3$) that resides in the stratosphere, the region of the atmosphere which exists between 10 and 50 kilometres above the surface of the earth. Ninety percent of total-column ozone resides in the stratosphere. See Ozone layer and Ozone ($O_3$). See also Ozone-depleting substances (ODSs).

Stratospheric polar vortex  A large-scale region of cold air poleward of approximately 60 degrees that is contained by a strong westerly jet from the tropopause (8-10km) to the stratopause (50-60km) and that forms in each hemisphere during the winter half-year. Planetary waves can temporarily disrupt the vortex, producing easterly winds and rapid warming over polar regions in the stratosphere, and leading to substantial weakening or breakdown of the vortex.

Stratospheric sounding unit (SSU)  A three-channel infrared sounder on operational NOAA polar-orbiting satellites. The three channels are used to determine profiles of temperature in the stratosphere (AMS, 2020).

Streamflow  Water flow within a river channel, for example, expressed in m$^3$ s$^{-1}$. A synonym for river discharge.

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

Sudden stratospheric warming (SSW)  A phenomena of rapid warming in the stratosphere at high latitudes (sometimes more than 50°C in 1-2 days) that can cause breakdown of stratospheric polar vortices.

Sulphur hexafluoride (SF$_6$)  One of the seven types of greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol. SF$_6$ is largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems and semi-conductors.

Sunspots  Dark areas on the Sun where strong magnetic fields reduce the convection causing a temperature reduction of about 1500 K compared to the surrounding regions. The number of sunspots is higher during periods of higher solar activity, and varies in particular with the solar cycle.

Surface air temperature  See Land surface air temperature (LSAT) and Global mean surface air temperature (GSAT).

Surface mass balance (SMB)  See Mass balance / budget (of glaciers or ice sheets).

Surface temperature  See Global mean surface air temperature (GSAT), Global mean surface temperature (GMST), Land surface air temperature (LSAT) and Sea surface temperature (SST).

Surprises  A class of risk that can be defined as low-likelihood but well-understood events, and events that cannot be predicted with current understanding (see 1.4.4.3 in AR6 WGI Chapter 1). See also Unknown unknowns.
**Swash**  See Extreme sea level (ESL).

**Talik**  A layer or body of unfrozen ground in a permafrost area due to a local anomaly in thermal, hydrological, hydrogeological or hydrochemical conditions (IPA, 2005).

**Technical potential**  See Mitigation potential.

**Teleconnection**  Association between climate variables at widely separated, geographically fixed locations related to each other through physical processes and oceanic and/or atmospheric dynamical pathways. Teleconnections can be caused by several climate phenomena, such as Rossby wave-trains, mid-latitude jet and storm track displacements, fluctuations of the Atlantic Meridional Overturning Circulation, fluctuations of the Walker circulation, etc. They can be initiated by modes of climate variability thus providing the development of remote climate anomalies at various temporal lags.

**Teleconnection pattern**  A correlation map obtained by calculating the correlation between variables at different spatial locations and a climate index. It is the special case of a climate pattern obtained for standardized variables and a standardized climate index, that is, the variables and index are each centred and scaled to have zero mean and unit variance. One-point teleconnection maps are made by choosing a variable at one of the locations to be the climate index.

**Temperature overshoot**  Exceedance of a specified global warming level, followed by a decline to or below that level during a specified period of time (e.g., before 2100). Sometimes the magnitude and likelihood of the overshoot is also characterized. The overshoot duration can vary from one pathway to the next but in most overshoot pathways in the literature and referred to as overshoot pathways in the AR6, the overshoot occurs over a period of at least one and up to several decades. See also Pathways.

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

**Thermal expansion**  See Steric sea level change (under Sea level change (sea level rise/sea level fall)).

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

**Thermohaline circulation (THC)**  See Meridional overturning circulation (MOC).

**Thermokarst**  Process by which characteristic landforms result from thawing of ice-rich permafrost or melting of massive ice (IPA, 2005).

**Thermosteric**  See Sea level change (sea level rise/sea level fall).

**Tide gauge**  A device at a coastal or deep-sea location that continuously measures the level of the sea with respect to the adjacent land. Time averaging of the sea level so recorded gives the observed secular changes of the relative sea level.

**Time of emergence (ToE)**  Time when a specific anthropogenic signal related to climate change is statistically detected to emerge from the background noise of natural climate variability in a reference period, for a specific region (Hawkins and Sutton, 2012). See also Emergence (of the climate signal).
**Tipping element**  A component of the Earth System that is susceptible to a tipping point.

**Tipping point**  A critical threshold beyond which a system reorganizes, often abruptly and/or irreversibly. See also Tipping element, Irreversibility and Abrupt change.

**Total alkalinity**  Total Alkalinity (A_T) is a measurable parameter of the seawater acid-base system which, when expressed in micromoles per kilogram of seawater, is a conservative variable both on mixing, and for changes in temperature and/or pressure. Changes in total alkalinity in the oceans can result from a variety of biogeochemical processes that affect the acid-base composition of the seawater itself. However, its value is not affected by the exchange of carbon dioxide gas between seawater and the atmosphere. Measurements of total alkalinity can thus be used to help study these biogeochemical processes, and can also be used to help calculate the state of the seawater acid-base system. Total alkalinity is most commonly measured using an acidimetric titration technique, that determines how much acid is required to titrate a seawater sample to a specified equivalence point.

**Total carbon budget**  See Carbon budget.

**Total solar irradiance (TSI)**  The total amount of solar radiation in watts per square metre received outside the Earth’s atmosphere on a surface normal to the incident radiation, and at the Earth’s mean distance from the Sun. Reliable measurements of solar radiation can only be made from space and the precise record extends back only to 1978. It has recently been estimated to 1360.8 ± 0.5 W m² for the solar minimum of 2008. Variations of a few tenths of a percent are common, usually associated with the passage of sunspots across the solar disk. The solar cycle variation of TSI is of the order of 0.1% (AMS, 2000). See also Insolation.

**Total water level**  See Extreme sea level (ESL).

**Trace gas**  A minor constituent of the atmosphere, next to nitrogen and oxygen that together make up 99% of all volume. The most important trace gases contributing to the greenhouse effect are carbon dioxide (CO₂), ozone (O₃), methane (CH₄), nitrous oxide (N₂O), perfluorocarbons (PFCs), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF₆) and water vapour (H₂O).

**Transient climate response (TCR)**  See Climate sensitivity.

**Transient climate response to cumulative CO2 emissions (TCRE)**  See Climate sensitivity.

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

**Tropical Atlantic modes**  See Tropical Atlantic Variability (TAV).

**Tropical Atlantic Variability (TAV)**  A generic term to describe the climate variability of the tropical Atlantic which is dominated at interannual to decadal timescale by two main climate modes: the Atlantic Zonal Mode (AZM) and the Atlantic Meridional Mode (AMM). The Atlantic Zonal Mode, also commonly referred to as the Atlantic Niño or Atlantic equatorial mode, is associated with sea surface temperature anomalies near the equator, peaking in the eastern basin, while the Atlantic meridional mode is characterized by an inter-hemispheric gradient of sea surface temperature and wind anomalies. Both modes are associated with significant teleconnections over Africa and South America.

**Atlantic Meridional Mode (AMM)**  The Atlantic Meridional Mode (AMM) refers to the interannual to decadal variability of the cross-equatorial sea surface temperature gradients and surface wind anomalies in the tropical Atlantic. It modulates the strength and latitudinal shifts of the Inter-tropical Convergence Zone (ITCZ), which impacts regional rainfall over Northeast Brazil and Atlantic hurricane activity. See Section
Atlantic Zonal Mode (AZM)  An equatorial coupled mode in the Atlantic similar to El Niño-Southern Oscillation (ENSO) in the Pacific, and therefore sometimes referred to as “Atlantic Niño”. The AZM is associated with sea surface temperature anomalies near the equatorial Atlantic and rainfall disturbances over the African monsoon domain. Its variations are mostly observed in the interannual scale. It is called also Atlantic equatorial mode. See Section AIV.2.5 in Annex IV of the AR6 WGI report.

Tropical cyclone  The general term for a strong, cyclonic-scale disturbance that originates over tropical oceans. Distinguished from weaker systems (often named tropical disturbances or depressions) by exceeding a threshold wind speed. A tropical storm is a tropical cyclone with one-minute average surface winds between 18 and 32 m s⁻¹. Beyond 32 m s⁻¹, a tropical cyclone is called a hurricane, typhoon, or cyclone, depending on geographic location.

Tropopause  The boundary between the troposphere and the stratosphere. It ranges from 8-9 km at high latitudes to 15-16 km in the tropics.

Troposphere  The lowest part of the atmosphere, below the tropopause, where clouds and weather phenomena occur. In the troposphere, temperatures generally decrease with height. See also Stratosphere.

Tropospheric ozone  See Ozone (O₃) and Ground-level ozone.

Tundra  A treeless biome characteristic of polar and alpine regions.

Turnover time (T)  See Lifetime.

Typhoon  See Tropical cyclone.

Typological domains  See Typological regions.

Typological regions  Regions of the Earth that share one or more specific features (known as 'typologies'), such as geographic location (e.g., coastal), physical processes (e.g., monsoons), and biological (e.g., coral reefs, tropical forests), geological (e.g., mountains) or anthropogenic (e.g., megacities) formation, and for which it is useful to consider the common climate features. Typological regions are smaller than climatic zones (e.g., a mountain region) and can be discontinuous (e.g., a group of megacities affected by the urban heat island effect, or monsoon regions).

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, incomplete understanding of critical processes, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts) (see Moss and Schneider, 2000; IPCC, 2004; Mastrandrea et al., 2010). See also Confidence and Likelihood.

Deep uncertainty  A situation of deep uncertainty exists when experts or stakeholders do not know or cannot agree on: (1) appropriate conceptual models that describe relationships among key driving forces in a system; (2) the probability distributions used to represent uncertainty about key variables and parameters; and/or (3) how to weigh and value desirable alternative outcomes (Lempert et al., 2003).

Sampling uncertainty  Uncertainty arising from incomplete or uneven availability of measurements in either space or time or both.

United Nations Framework Convention on Climate Change (UNFCCC)  The UNFCCC was adopted in May 1992 and opened for signature at the 1992 Earth Summit in Rio de Janeiro. It entered into force in
March 1994 and as of September 2020 had 197 Parties (196 States and the European Union). The Convention’s 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’. The provisions of the Convention are pursued and implemented by two further treaties: the Kyoto Protocol and the Paris Agreement.

Uptake The transfer of substances (such as carbon) or energy (e.g., heat) from one compartment of a system to another; for example, in the Earth System from the atmosphere to the ocean or to the land. See also Sequestration.

Upwelling region A region of an ocean where cold, typically nutrient-rich waters well up from the deep ocean.

Urban heat island (UHI) 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.

Ventilation The exchange of ocean properties with the atmospheric surface layer such that property concentrations are brought closer to equilibrium values with the atmosphere (AMS, 2021), and the processes that propagate these properties into the ocean interior.

Vertical land motion (VLM) Vertical land motion (VLM) is the change in height of the land surface or the sea floor and can have several causes in addition to elastic deformation associated with contemporary changes in gravity, rotation and viscoelastic solid Earth deformation (GRD) and viscoelastic deformation associated with glacial isostatic adjustment (GIA). Subsidence (sinking of the land surface or sea floor) can, for instance, occur through compaction of alluvial sediments in deltaic regions, removal of fluids such as gas, oil, and water, or drainage of peatlands. Tectonic deformation of the Earth’s crust can occur as a result of earthquakes and volcanic eruptions. See also Sea level change (sea level rise/sea level fall).

Very short-lived halogenated substances (VSLSs) Very short-lived halogenated substances (VSLSs) are considered to include source gases (very short-lived halogenated substances present in the atmosphere in the form they were emitted from natural and anthropogenic sources), halogenated product gases arising from source gas degradation, and other sources of tropospheric inorganic halogens. VSLSs have tropospheric lifetimes of around 0.5 years or less.

Volatile organic compounds (VOCs) Important class of organic chemical air pollutants that are volatile at ambient air conditions. Other terms used to represent VOCs are hydrocarbons (HCs), reactive organic gases (ROGs) and non-methane volatile organic compounds (NMVOCs). NMVOCs are major contributors – together with nitrogen oxides (NOx), and carbon monoxide (CO) – to the formation of photochemical oxidants such as ozone (O3).

Biogenic volatile organic compounds (BVOCs) Organic gas-phase compounds emitted from terrestrial and aquatic ecosystems that are critical in ecology and plant physiology, from abiotic and biotic stress functions to integrated components of metabolism. BVOCs are important in atmospheric chemistry as precursors for ozone and secondary organic aerosol formation. Other terms used to represent BVOCs are hydrocarbons (HCs), reactive organic gases (ROGs) and non-methane volatile organic compounds (NMVOCs).

Vulnerability The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. See also Exposure, Hazard and Risk.

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

Warm days/warm nights Days where maximum temperature, or nights where minimum temperature, exceeds the 90th percentile, where the respective temperature distributions are generally defined with respect
to the 1961-1990 reference period.

**Warm spell** A period of abnormally warm weather. *Heatwaves* and warm spells have various and, in some cases, overlapping definitions.

**Water cycle** See *Hydrological cycle*.

**Water mass** A body of ocean water with identifiable properties (temperature, salinity, density, chemical tracers) resulting from its unique formation process. Water masses are often identified through a vertical or horizontal extremum of a property such as salinity. North Pacific Intermediate Water (NPIW) and Antarctic Intermediate Water (AAIW) are examples of water masses.

**Water security** ‘The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability’ (UN-Water, 2013).

**Wave run-up** See *Extreme sea level (ESL)*.

**Wave setup** See *Extreme sea level (ESL)*.

**Weathering** The gradual removal of atmospheric $\text{CO}_2$ through dissolution of silicate and carbonate rocks. Weathering may involve physical processes (mechanical weathering) or chemical activity (chemical weathering).

**Well-mixed greenhouse gas** A greenhouse gas that has an atmospheric lifetime long enough (> several years) to be homogeneously mixed in the *troposphere*, and as such the global average mixing ratio can be determined from a network of surface observations. For many well-mixed greenhouse gases, measurements made in remote regions differ from the global mean by < 15%.

**West African monsoon (WAfriM)** See *Global monsoon*.

**West Antarctic ice sheet (WAIS)** See *Ice sheet*.

**Wetland** Land that is covered or saturated by water for all or part of the year (e.g., *peatland*).

**Younger Dryas** A period 12.85 to 11.65 ka (thousand years before 1950), during the *last deglacial transition*, characterized by a temporary return to colder conditions in many locations, especially around the North Atlantic. See also *Stadial* and *Last deglacial transition*.

**Zero emissions commitment** See *Climate change commitment*. 
References


Harris, S.A. et al., 1988: Glossary of Permafrost and Related Ground-Ice Terms. Technical Memorandum No. 142, Permafrost Subcommittee, Associate Committee on Geotechnical Research, National Research Council of Canada, Ottawa, ON, Canada, 159 pp., doi: 10.4324/20386561


Mastrandrea, M.D. et al., 2010: Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties. Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, 6 pp.
Mix, A.C., W.F. Ruddiman, and A. McIntyre, 1986: Late Quaternary paleoceanography of the Tropical Atlantic, 1: Spatial variability of annual mean sea-surface temperatures, 0–20,000 years B.P. Paleoceanography, 1(1), 43–66, doi:10.1029/oa001i001p00043.
Türkeş, M., 1999: Vulnerability of Turkey to Desertification With Respect to Precipitation and Aridity Conditions. Turkish Journal of Engineering and Environmental Sciences, 23, 363–380.
UNESCO/IASH/WMO, 1970: Seasonal snow cover: a guide for measurement, compilation and assemblage of data.
UN- OHRLLS, 2011: Small Island Developing States: Small Islands Big(ger) Stakes. Office for the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS), New York, NY, USA, 32 pp.