

# Chapter 15

## Glossary of Terms

### A

**Adaptation** Action that helps cope with the effects of climate change - for example construction of barriers to protect against rising sea levels, or conversion to crops capable of surviving high temperatures and drought.

**Aerosols** Tiny liquid or solid particles of various composition that occur suspended in the atmosphere.

**Anomalies** Departures of temperature, precipitation, or other weather elements from long-term averages

**Anthropogenic climate change** Man-made climate change - climate change caused by human activity as opposed to natural processes.

**AR4** The Fourth Assessment Report produced by the Intergovernmental Panel on Climate Change (IPCC) published in 2007. The report assessed and summarised the climate change situation worldwide.

**AR5** The Fifth Assessment report from the Intergovernmental Panel on Climate Change (IPCC) was published over 2013 and 2014.

**AR6** The Sixth Assessment report from the Intergovernmental Panel on Climate Change (IPCC) was published over 2021 and 2022.

**Atmospheric aerosols** Microscopic particles suspended in the lower

atmosphere that reflect sunlight back to space. These generally have a cooling effect on the planet and can mask global warming. They play a key role in the formation of clouds, fog, precipitation and ozone depletion in the atmosphere.

### B

**Barystatic sea-level change** Global-mean sea-level change due to the addition of water that is formerly residing on land or atmosphere, or the removal of water from the oceans.

**Bias adjustment** of climate change projections. Correcting systematic model simulation errors using observed data.

**Business as usual (BAU)** A scenario used for projections of future emissions assuming no action, or no new action, is taken to mitigate the problem. Within IPCC AR6, the BAU scenario is the SSP585 scenario.

### C

**Carbon capture and storage** The collection and transport of concentrated carbon dioxide gas from large emission sources, such as power plants. The gases are then injected into deep underground reservoirs. Carbon capture is sometimes referred to as geological sequestration.

**Carbon dioxide (CO<sub>2</sub>)** Carbon dioxide is a gas in the Earth's atmosphere. It occurs

naturally and is also a by-product of human activities such as burning fossil fuels. It is the principal greenhouse gas produced by human activity.

**Carbon dioxide (CO<sub>2</sub>) equivalent** Six greenhouse gases are limited by the Kyoto Protocol and each has a different global warming potential. The overall warming effect of this cocktail of gases is often expressed in terms of carbon dioxide equivalent - the amount of CO<sub>2</sub> that would cause the same amount of warming.

**Carbon emissions or footprint** The amount of carbon emitted by an individual or organisation in a given period of time, or the amount of carbon emitted during the manufacture of a product.

**Carbon sink** Any process, activity or mechanism that removes carbon from the atmosphere. The biggest carbon sinks are the world's oceans and forests, which absorb large amounts of carbon dioxide from the Earth's atmosphere.

**CCRS** Centre for Climate Research Singapore and part of the Meteorological Service Singapore (MSS). It was officially launched in March 2013 and aims to advance scientific understanding of tropical climate variability and change and its associated weather systems affecting Singapore and the wider Southeast Asia Region, so that the knowledge and expertise can benefit decision makers and the community.

**Climate** The prevalent or characteristic weather conditions of a place or region over a period of years.

**Climate change** A pattern of change affecting global or regional climate, as measured by yardsticks such as average temperature and rainfall, or an alteration in frequency of extreme weather conditions. This variation may be caused by both natural processes and human activity. Global warming is one aspect of climate change.

**Climate Driver** Global and regional climate drivers influence weather patterns that occur over months and seasons. There are several important climate drivers that help to understand what the general weather pattern might look like (example: ENSO).

**CMIP (CMIP5, CMIP6)** Coupled Model Intercomparison Project – a global set of model experiments coordinated by the World Climate Research Program (WCRP) every ~7 years. The latest cycle is 'Phase 6', e.g. CMIP6.

**CO<sub>2</sub>** See carbon dioxide.

**Convection** - Vertical air circulation in which cool air sinks and forces warm air to rise.

**Contemporary Mass Redistribution (CMR) sea - level change** Satellite altimetry sea-level without stericodynamic and GIA-induced sea-level. Composed of barostatic sea-level change and GRD fingerprints.

**CORDEX** Coordinated Regional Climate Downscaling Experiment. One of the MIPs (Model Intercomparison Projects) forming part of the overall CMIP6 model experiments.

**Cyclone** A low pressure system with a cyclonic circulation. It is also called a depression and is generally associated with poor or stormy weather. The point of lowest atmospheric pressure marks the centre of the cyclone.

## D

**Dangerous climate change** A term referring to severe climate change that will have a negative effect on societies, economies, and the environment as a whole. The phrase was introduced by the 1992 UN Framework Convention on Climate Change, which aims to prevent "dangerous" human interference with the climate system.

**Deforestation** The permanent removal of standing forests that can lead to significant levels of carbon dioxide emissions.

**Dew Point** (also known as Dewpoint) The temperature to which air must be cooled in order to become saturated by the water vapour already present in the air.

**Divergence** - A wind pattern whereby there is a net outflow of air from some point.

**Dynamical Downscaling** of global climate models. Running a limited-domain climate model (regional climate model) forced at the domain boundaries by the global model to produce higher resolution climate simulations within the domain.

## E

**Easterly Wave** Also known as tropical wave, they are a type of atmospheric low-pressure trough, oriented north to south, which moves from east to west across the tropics, causing areas of cloudiness and thunderstorms. An easterly wave or tropical wave can develop into a tropical cyclone.

**ECS Equilibrium Climate Sensitivity** is the global and annual mean near-surface temperature rise that is expected to occur by doubling of CO<sub>2</sub> in the atmosphere.

**El Niño** El Niño can be distinguished when the surface waters in the eastern tropical Pacific extending westward from Ecuador become warmer than average. The changing pattern of the Pacific Ocean causes a shift in the atmospheric circulation, which then influences weather patterns across much of the earth, especially over the Maritima Continent. El Nino is like La Niña's brother, the totally opposite.

**ENSO** (El Niño/Southern Oscillation) - An episode of anomalously high sea-surface temperatures in the equatorial and tropical eastern Pacific; associated with large-scale swings in surface air pressure between the western and central tropical Pacific.

**Evaporation** The process by which water changes phase from a liquid to a vapor at a temperature below the boiling point of water.

**Evapotranspiration** Vaporization of water through direct evaporation from wet surfaces plus the release of water vapor by vegetation.

## F

**Feedback loop** In a feedback loop, rising temperatures on the Earth change the environment in ways that affect the rate of warming. Feedback loops can be positive (adding to the rate of warming), or negative (reducing it). The melting of Arctic ice provides an example of a positive feedback process. As the ice on the surface of the Arctic Ocean melts away, there is a smaller

area of white ice to reflect the Sun's heat back into space and more open, dark water to absorb it. The less ice there is, the more the water heats up, and the faster the remaining ice melts.

## G

**GCM** Global Climate Model (sometimes also called a General Circulation Model).

**GIA-induced sea-level change** GRD due to ongoing changes in the solid Earth caused by past changes in land ice (i.e., during the Last Glacial Maxima).

**Geocentric sea-level change** The change in local mean sea level with respect to the terrestrial reference frame. This does not include effects of vertical land movement.

**Glacier** Sea-ice terminology. Describes a mass of snow and ice that is continuously moving from higher to lower ground or, if afloat, continuously spreading.

**Global average temperature** The mean surface temperature of the Earth measured from three main sources: satellites, monthly readings from a network of over 3,000 surface temperature observation stations and sea surface temperature measurements taken mainly from the fleet of merchant ships, naval ships and data buoys.

**Global energy budget** The balance between the Earth's incoming and outgoing energy. The current global climate system must adjust to rising greenhouse gas levels and, in the very long term, the Earth must get rid of energy at the same rate at which it receives energy from the sun.

**Global-mean sea-level rise** Global-mean sea-level rise for the global mean of relative sea-level change, due to the change in the volume of the ocean.

**Global-mean thermosteric sea-level change** Global-mean sea-level change due to thermal expansion.

**Global warming** The steady rise in global average temperature in recent decades, which experts believe is largely caused by man-made greenhouse gas emissions. The long-term trend continues upwards, they suggest, even though the warmest year on record, according to the UK's Met Office, is 1998.

**Gravitational, Earth's Rotational, viscoelastic solid Earth Deformational (GRD) effects** Changes in gravitation and rotation alter the geopotential field and hence the geoid, while deformation of the solid Earth changes the sea floor topography through vertical land movement.

**Greenhouse gases (GHGs)** Natural and industrial gases that trap heat from the Earth and warm the surface. The Kyoto Protocol restricts emissions of six greenhouse gases: natural (carbon dioxide, nitrous oxide, and methane) and industrial (perfluorocarbons, hydrofluorocarbons, and sulphur hexafluoride).

**Greenhouse effect** The insulating effect of certain gases in the atmosphere, which allow solar radiation to warm the earth and then prevent some of the heat from escaping. See also Natural greenhouse effect.

## H

**Hadley cell** Thermally driven air circulation in tropical and subtropical latitudes of both hemispheres resembling a huge convective cell with rising air near the equator and sinking air in the subtropical anticyclones.

**Halosteric sea-level change** Steric sea-level change due to changes in salinity in the ocean.

**Humidity** (also called Relative Humidity) Humidity is the measure of water vapour content in the air. Relative humidity is usually expressed as a percentage of total possible moisture content.

## I

**Intertropical convergence zone** (ITCZ) Discontinuous belt of thunderstorms paralleling the equator and marking the convergence of the Northern and Southern Hemisphere surface trade winds. Associated with the monsoons.

**Inverse barometer effects on sea-level change** Sea-level change due to atmospheric pressure variations.

**IPCC** The Intergovernmental Panel on Climate Change is a scientific body established by the United Nations Environment Programme and the World Meteorological Organization. It reviews and assesses the most recent scientific, technical, and socio-economic work relevant to climate change, but does not carry out its own research. The IPCC was honoured with the 2007 Nobel Peace Prize.

**ISIMIP3** bias adjustment method in phase 3 of the Inter-Sectoral Impact Model Intercomparison Project

(ISIMIP3). This method was employed in V3 bias correction.

## J

**Jet Stream** Relatively strong winds, concentrated within a narrow band in the upper atmosphere.

## K

## L

**La Niña** An extensive cooling of the waters in the tropical central and eastern Pacific Ocean. It is the climatic opposite of the El Niño.

**Latent Heat** Heat that is stored in water vapour in the atmosphere. When water vapour rises, cools and condenses into liquid water, it releases this heat into the surrounding atmosphere. This is the driving mechanism for tropical cyclones.

**LULUCF** This refers to Land Use, Land-Use Change, and Forestry. Activities in LULUCF provide a method of offsetting emissions, either by increasing the removal of greenhouse gases from the atmosphere (i.e. by planting trees or managing forests), or by reducing emissions (i.e. by curbing deforestation and the associated burning of wood).

## M

**Manometric sea level** Change in the time-mean local mass of the ocean per unit area, assuming the density does not change

**Maritime Continent** A term commonly used by meteorologists, climatologists, and oceanographers to describe the region between the Indian and Pacific Oceans

including the archipelagos of Indonesia, Borneo, New Guinea, the Philippine Islands, the Malay Peninsula, and the surrounding seas.

**Mean sea level** The time-mean of the sea surface.

**Mesosphere** Region of the atmosphere, situated between the stratopause and the mesopause, in which the temperature generally decreases with height.

**MICI** Marine Ice Cliff Instability

**MISI** Marine Ice Sheet Instability

**Mitigation** Action that will reduce man-made climate change. This includes action to reduce greenhouse gas emissions or absorb greenhouse gases in the atmosphere.

**Monsoon** typically means the rainband associated with the seasonal reversal of winds and progression of the Inter-tropical Convergence Zone (ITCZ) across the equator.

**MSS** Meteorological Service Singapore. It is Singapore's national authority on the weather and climate. It is an operational pillar under the National Environment Agency (NEA).

## N

**Natural greenhouse effect** The natural level of greenhouse gases in our atmosphere, which keeps the planet about 30C warmer than it would otherwise be - essential for life as we know it. Water vapour is the most important component of the natural greenhouse effect.

**NCCS** National Climate Change Secretariat. It was established in 2010 under the Prime Minister's Office (PMO)

to develop and implement Singapore's domestic and international policies and strategies to tackle climate change.

**NEA** National Environment Agency is the leading public organisation responsible for ensuring a clean and sustainable environment for Singapore.

## O

**Ocean acidification** The ocean absorbs approximately one-fourth of man-made CO<sub>2</sub> from the atmosphere, which helps to reduce adverse climate change effects. However, when the CO<sub>2</sub> dissolves in seawater, carbonic acid is formed. Carbon emissions in the industrial era have already lowered the pH of seawater by 0.1. Ocean acidification can decrease the ability of marine organisms to build their shells and skeletal structures and kill off coral reefs, with serious effects for people who rely on them as fishing grounds.

**Ocean dynamic sea-level change** The local height of the sea surface above the geoid, with the inverse barometer correction applied.

## P

**ppm (350/450)** An abbreviation for parts per million, usually used as short for ppmv (parts per million by volume). The Intergovernmental Panel on Climate Change (IPCC) suggested in 2007 that the world should aim to stabilise greenhouse gas levels at 450 ppm CO<sub>2</sub> equivalent in order to avert dangerous climate change. Some scientists, and many of the countries most vulnerable to climate change, argue that the safe upper limit is 350ppm. Current levels of CO<sub>2</sub> only are about 380ppm.

### **Pre-industrial levels of carbon dioxide**

The levels of carbon dioxide in the atmosphere prior to the start of the Industrial Revolution. These levels are estimated to be about 280 parts per million (by volume). The current level is around 380ppm.

**Precipitation** Precipitation is a liquid or solid form of water falling from the atmosphere to the earth's surface. Examples include rain, freezing rain, hail, and snow.

## **Q**

## **R**

**Radiative Forcing** Radiative forcing is what happens when the amount of energy that enters the Earth's atmosphere is different from the amount of energy that leaves it.

**Relative Humidity** (also called Humidity) Relative humidity is the ratio of water vapour in the air at a given temperature, to the maximum amount which could exist at that temperature. It is usually expressed as a percentage.

**Relative sea-level change** The change in local mean sea level relative to the local solid surface, i.e., the sea floor. This includes effects of vertical land movement.

**Renewable energy** Renewable energy is energy created from sources that can be replenished in a short period of time. The five renewable sources used most often are: biomass (such as wood and biogas), the movement of water, geothermal (heat from within the earth), wind, and solar.

**RWG** Resilience Working Group (Singapore Government).

## **S**

**Sea level anomaly (SLA)** Deviations of sea surface height from a mean level (i.e., variations from mean sea level).

**SINGV, SINGV-RCM** The Singapore Variable Resolution weather model and its Regional Climate Model counterpart.

**SSP** Shared Socioeconomic Pathway. For example SSP126, SSP245, SSP585 are scenarios of future socio-economic pathways used for simulations of future climates in standardised ways.

**Steric sea-level change** Composed of thermosteric and halosteric sea-level change.

**Squall** An atmospheric phenomenon characterized by an abrupt and large increase of wind speed within a duration of minutes, that suddenly diminishes. Squalls are usually associated with thunderstorms, and as such are often accompanied by heavy showers, thunder, and lightning. Example: Sumatra Squall Line.

**Sterodynamic sea-level change** Composed of ocean dynamic sea level and global-mean thermosteric sea-level

**Storm Surge** The positive or negative difference in sea level from the predicted astronomical tide, due to the forces of the atmosphere. The two main atmospheric components that contribute to a storm surge are air pressure and wind.

**Stratosphere** The region of the atmosphere extending from the top of the troposphere (the tropopause), at height of 10-17 km to the base of the mesosphere

(the stratopause), at a height of roughly 50 km.

## T

**Teleconnection** A linkage between weather changes occurring in widely separated regions of the globe.

**Temperature Anomaly** The deviation of temperature in a given region over a specified period from the long-term average value for the same region.

**Thermal expansion** Thermal expansion happens when water gets warmer, which causes the volume of the water to increase.

**Thermosteric sea-level change** Steric sea-level change due to changes in ocean temperature.

**Thunderstorm** A local storm, usually produced by a cumulonimbus cloud, and always accompanied by thunder and lightning.

**Tide** Sea-level instability/movement in an approximately daily or twice daily period. The movement is caused by the difference of the gravitational attraction between celestial bodies and the centrifugal acceleration of their rotation and is periodic because it is related to the motion of the sun, earth, and moon.

**Tide gauge** Instrument measuring the sea level height.

**Tipping point** A tipping point is a threshold for change, which, when reached, results in a process that is difficult to reverse. Scientists say it is urgent that policy makers halve global carbon dioxide emissions over the next 50 years or risk triggering changes that could be irreversible.

**Trade Winds** (also called Tropical Easterlies) The belts of wind on either side of the equator, blowing from the northeast in the Northern Hemisphere, and from the southeast in the Southern Hemisphere. In both hemispheres the winds become more easterly the closer they are to the equator.

**Tropical Cyclone** The generic term for the class of tropical low-pressure systems, including tropical depressions, tropical storms, and hurricanes. Tropical cyclone systems typically last a week or more.

**Tropical Wave** (also called Easterly Wave) A type of atmospheric trough, oriented from north to south, which moves from east to west across the tropics causing areas of cloudiness and thunderstorms. A tropical wave can develop into a tropical cyclone.

## Troposphere

The lowermost layer of the atmosphere, in which air temperature falls steadily with increasing altitude. The troposphere begins at ground level and ranges in height from an average of 11 km (at the International Standard Atmosphere) at the poles to 17 km at the equator.

**Tsunami** A very large wave caused by a shallow submarine earthquake but can also be caused by submarine earth movement, subsidence, or volcanic eruption.

## U

**UNFCCC** The United Nations Framework Convention on Climate Change is one of a series of international agreements on global environmental issues adopted at the 1992 Earth Summit in Rio de Janeiro. The UNFCCC aims to prevent "dangerous" human interference with the climate system. It entered into force on 21 March



1994 and has been ratified by 192 countries.

## **V**

**VLM Vertical land movement** The change in the height of the sea floor or the land surface.

## **W**

**Weather** The state of the atmosphere with regard to temperature, cloudiness, rainfall, wind and other meteorological conditions. It is not the same as climate which is the average weather over a much longer period.

**Westerlies** The dominant west-to-east motion of the atmosphere, centered over the middle latitudes of both hemispheres. In the tropics, monsoon westerlies are a significant feature.

## **X**

## **Y**

## **Z**