Climate Modeling Text Glossary

For further reference, there are a number of online glossaries of climate terms. Much of the glossary here is based on these sources. In many cases, these glossaries trace back to the AMS Glossary.

1. Intergovernmental Panel on Climate Change (IPCC) Glossary: https://www.ipcc.ch/publications_and_data/publications_and_data_glossary.shtml

2. American Meteorological Society (AMS) Glossary: http://glossary.ametsoc.org/wiki/Main_Page

3. Skeptical Science Glossary: https://www.skepticalscience.com/glossary.php

Glossary Terms (Chapter in which term appears in parentheses).

Aerosol particles (5) small solid or liquid particles dispersed in some gas, usually air.

Albedo (2) the ratio of the reflected radiation to incident radiation on a surface. Shortwave albedo is the fraction of solar energy (shortwave radiation) reflected from the earth back into space. Albedo is a measure of the surface reflectivity of the earth. Ice and bright surfaces have a high albedo: Most sunlight hitting the surface bounces back toward space. The ocean has a low albedo: Most sunlight hitting the surface is absorbed.

Anthropogenic (3) human (*anthropo-*) caused (generated).

Anthroposphere (2) also called the anthrosphere; the part of the environment made or modified by humans for use in human activities and human habitats.

Aquifer (7) an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well.

Arable land (7) land capable of being plowed and used to grow crops.

Atmosphere (2) the gaseous envelope gravitationally bound to a celestial body (planet, satellite, or star).

Baythemetry (6) originally referred to the ocean's depth relative to sea level, although it has come to mean submarine (underwater) topography, or the depths and shapes of underwater terrain.

Biogeochemical cycles (7) natural pathways by which essential elements of living matter are circulated.

Biogeochemistry (7) the scientific discipline that involves the study of the biological, geological, chemical, and physical processes and reactions that govern the composition of the natural environment.

Biogeophysics (7) the study of water and heat (energy) flow through the soil and plants on the earth's surface.

Blocking events (10) the obstructing, on a large scale, of the normal west-to-east progress of migratory cyclones and anticyclones. This anomalous circulation pattern (the "block") typically remains nearly stationary or moves slowly westward, and persists for a week or more. Prolonged blocking in the Northern Hemisphere occurs most frequently in the spring over the eastern North Atlantic and eastern North Pacific regions.

Bottom water (6) the water mass at the deepest part of the water column. The densest water in the column.

Boundary layer (5) a layer near the edge of the ocean or atmosphere. The ocean boundary layer is right below the surface; the atmospheric boundary layer just above.

Brine pockets (6) pockets of salt water of high concentration in sea ice resulting from the rejection of salt on freezing of sea water into sea ice.

Bucket model (7) a representation of the field capacity (water-holding capacity) of soil, where the soil can hold a fixed amount of water before it overflows (runoff).

Buoyancy (6) the property of an object that enables it to float on the surface of a liquid, or ascend through and remain freely suspended in a compressible fluid such as the atmosphere. Also the upward force exerted on a parcel of fluid (or an object within the fluid) in a gravitational field because of the density difference between the parcel (or object) and that of the surrounding fluid.

Carbon cycle (7) the cycling of carbon through the earth system.

Carbon cycle feedback (7) the interaction of the land surface with climate. The feedback usually implies that increasing CO_2 will allow plants to grow more efficiently, taking up more CO_2 and reducing the CO_2 increase.

Carbon sink (7) a process that removes carbon from a reservoir.

Cell (4) a grid cell (the smallest unit that is resolved) in a model. A cell is one vertical part of a column.

Chlorofluorocarbons (7) also CFCs, organic compounds that contain carbon, chlorine, and fluorine; human-made compounds that are inert and nontoxic with long lifetimes in the atmosphere. They slowly release chlorine, which contributes to stratospheric ozone depletion.

Circulation patterns (2) the long-term patterns of the flow or motion of a fluid (air or water) in or through a given area or volume.

Classical physical mechanics (4) also Newtonian Mechanics; the laws of motion of physical objects.

Climate (1) the average or distribution of weather events, typically represented by averages over long periods of time (a month or more).

Climate forecasting (1) an estimate of the future state of the climate focusing on the distributions of temperature and precipitation over longer periods of time.

Climate interpreters (12) people with knowledge of the utility and use of climate models who are able to provide a link between climate-model science and applications.

Climate model (4) a model used to make forecasts and simulations of climate. Typically related to numerical weather-prediction models. Typically designed to be run (integrated) for many years.

Climate regimes (5) classification of climate into different types; regions with similar regimes have similar climates.

CO_2 fertilization (7) the enhancement of the growth of plants as a result of increase in the concentration of atmospheric CO_2. Higher CO_2 enables more efficient transfer of CO_2 into plant tissues for photosynthesis with less water loss.

Column (4) a vertical stack of grid cells in a model at a single horizontal location.

Compensating errors (5) errors that are hidden due to offsetting or cancellation. A positive bias combined with a negative bias leads to compensating errors.

Condensation (2) the transition from a gas to a liquid, the opposite of evaporation. Specifically the phase change of water from water vapor to liquid water.

Conservation of mass (4) the principle (in Newtonian mechanics) that states mass cannot be created or destroyed but only transferred from one volume to another.

Constraints (4) rules or laws that constrain or limit the behavior of different processes.

Convection (6) mass motions within a fluid resulting in transport and mixing of the properties of that fluid. Motions that are predominantly vertical and driven by buoyancy forces arising from density gradients with light air (or water) beneath denser air (or water).

Coriolis force (6) or Coriolis effect; an effect where a mass moving in a rotating system experiences an apparent force (the Coriolis force) acting perpendicular to the direction of motion and to the axis of the rotation. On the earth, the effect tends to deflect moving objects to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The Coriolis force is zero at the equator (since an object moves parallel to the axis of rotation), and a maximum at the poles.

Coupled climate system model (4) a class of climate model in which at least two different subsystems of earth's climate system are allowed to interact. A coupled model would typically couple the atmosphere, ocean, and land, sometimes also atmospheric chemistry so that different parts interact with each other.

Coupled Model Inter-comparison Project (CMIP) (11) a standard experimental protocol for studying the output of coupled atmosphere-ocean general circulation models. http://cmip-pcmdi.llnl.gov/.

Coupling (3) the interaction of two or more items, things, or processes.

Credibility (12) scientifically trusted or believable.

Cryosphere (2) the places on the earth where water is in solid form, frozen into ice or snow.

Deep ocean (6) the region of the ocean below the thermocline.

Deformable solid mechanics (7) the branch of continuum mechanics that studies the behavior of solid materials, especially their motion and deformation under the action of forces, temperature changes, phase changes, and other external or internal agents.

Disruptive innovation (10) innovation that helps create a new market and value network, and eventually disrupts an existing market and value network (over a few years or decades), displacing an earlier technology.

Domain (5) a specific and limited region.

Downscaling (5) method used to obtain local-scale weather and climate information, from regional-scale atmospheric variables that are provided by GCMs. Two main forms of downscaling technique exist. One form is dynamical downscaling, where large-scale model output (from the GCM) is used to drive a regional, numerical model at higher spatial resolution to simulate local conditions in greater detail. The other form is statistical downscaling, where a statistical relationship is established from observations between large-scale variables, like atmospheric surface pressure, and a local variable, like the wind speed at a

particular site. The relationship is then used subsequently on the GCM data to obtain the local variables from the GCM output.

Downwelling (11) downward motion of surface or subsurface water that removes excess mass brought into an area by convergent horizontal flow near the surface.

Drag (5) also called resistance; the frictional retarding force offered by air to the motion of bodies passing through it.

Dynamical core (5) the portion of a model that integrates the equations of motion. It usually determines the winds and the temperatures from a set of dynamical motion equations.

Dynamical downscaling (5) method by which large-scale model output (from the GCM) is used to drive a regional, numerical model at higher spatial resolution to simulate local conditions in greater detail.

Earth system models (4) a class of coupled climate model that is coupled to the biosphere on land and/or in the ocean.

Economic system models (7) models that simulate economic activity.

Ecosystem dynamics (7) the study of the response and evolution of ecosystems to disturbances.

Eddies (6) circular movements of air or water. In the ocean, a closed circulation system produced as an offshoot from an ocean current. Eddies are the common result of the turbulence of the ocean circulation. The corresponding features in the atmosphere are the wind currents around high and low pressure disturbances.

El Niño Southern Oscillation (ENSO) (8) a significant increase in sea surface temperature over the eastern and central equatorial Pacific that occurs at irregular intervals, generally ranging between 2 and 7 years. The Southern Oscillation refers to variations in the temperature of the surface of the tropical eastern Pacific Ocean, with warming known as El Niño and cooling known as La Niña, and in air surface pressure in the tropical western Pacific. The name for the warming comes from the Spanish word for Christ child because the warming usually occurs around Christmas.

Electromagnetic radiation (4) radiation consisting of electromagnetic waves, including radio waves, infrared, visible light, ultraviolet, X-rays, and gamma rays. Energy with the form of electromagnetic waves as well as the form of a stream of photons and traveling at the speed of light in a vacuum.

Emergent (4) a property which a collection or complex system has, but which the individual processes do not have.

Empirical model (13) a model based on observation, rather than theory. Sometimes called a statistical model.

Energy balance models (5) an idealized model focused on the energy balance, the balance between the net warming or cooling of a volume and all possible sources and sinks of energy. Energy is conserved, and energy balance models use this fact to help understand the different flows and exchanges of energy in the earth system.

Energy budget (7) the accounting for the energy balance, the balance between the net warming or cooling of a volume and all possible sources and sinks of energy.

Energy flows (2) the movement of energy in the earth system.

Ensembles (10) multiple model variations with slight changes. Ensembles of model simulations can be run with variations of initial conditions (often done for weather forecasting) to sample initial condition uncertainty, variations in scenarios for a single model to sample scenario uncertainty, or with different models to sample model or structural uncertainty.

Equilibrium (2) a state in which opposing forces or influences are balanced; a state of physical balance.

Evaluation (9) the process and practice of determining the quality and value of a model or forecast.

Evaporation (2) the transition between a liquid and a gas. Specifically the phase change of liquid water into water vapor.

Evaporative cooling (4) reduction in temperature resulting from the evaporation of a liquid, which removes latent heat from the surface from which evaporation takes place. This process is also the physical basis of why humans and other animals perspire.

Evapotranspiration (7) the sum of evaporation and plant transpiration of water from the earth's land and ocean surface to the atmosphere.

Extrapolate (9) or extrapolation; the process of estimating, beyond the original observation range, the value of a variable on the basis of its relationship with another variable.

Feedback (3) the modification or control of a process or system by its results or effects. A feedback alters the processes in the system by changing inputs depending on the output.

Field capacity (7) the maximum amount of water a soil can retain before runoff; the amount of soil moisture or water content held in the soil after excess water has drained away.

Finite element model (4) a model with dependent variables represented as a finite series of piecewise-developed polynomial basis functions (finite elements). The elements are often arrayed on a grid of points where each cell is an element.

Fixation (2) the process of making something firm or stable. In general terms for climate, making a gas into a more stable form, usually a solid.

Forcing (3) or external forcing; refers to a forcing agent outside the climate system causing a change in the climate system. Examples of forcing include volcanic eruptions, solar variations, and anthropogenic changes in the composition of the atmosphere.

Forecast (9) a prediction or estimate of the future.

Forecasting (1) an assessment of a future state of a system.

Fossil fuels (3) buried combustible geologic deposits of organic materials, formed from decayed plants and animals that are used for fuel; chiefly crude oil, coal, and natural gas (methane).

Gaia hypothesis (3) proposes that organisms interact with their inorganic surroundings on earth to form a self-regulating, complex system that contributes to maintaining the conditions for life on the planet. Originally put forward by James Lovelock.

General circulation model (GCM) (5) a global finite element model that integrates the equations of motion on a sphere to represent the circulation and weather patterns of the earth. GCMs are used for both climate and weather prediction.

Geostrophic balance (6) the balance that results from a fluid on a rotating sphere. A balance between the Coriolis and horizontal pressure-gradient forces.

Green ocean (7) a term sometimes ascribed to tropical rainforests like the Amazon, referring to the large evapotranspiration and precipitation that occurs over tropical rainforests, similar to an ocean of water.

Greenhouse gases (2) gases, such as water vapor (H_2O), carbon dioxide (CO_2), and methane (CH_4), that are mostly transparent to the short wavelengths of solar radiation but efficient at absorbing the longer wavelengths of the infrared radiation from the earth and atmosphere. They thus trap heat in the atmosphere.

Grid (4) the regular or irregular set of columns or points in a model.

Grid box (4) the same as a grid cell. The smallest unit that is resolved in a model, one part of a column.

Gross primary productivity (7) the amount of energy fixed by photosynthesis over a defined time period.

Gulf Stream (6) one of the western boundary currents of the North Atlantic and one of the swiftest ocean currents with one of the largest transports.

Gyre (6) a rotating ring-like system of mean or steady large ocean currents.

Hadley circulation (5) named after George Hadley, the Hadley circulation is a tropical atmospheric circulation that in the zonal (longitude) average features rising motion near the equator, poleward flow at high altitude above the surface, descending motion in the subtropics, and equatorward flow near the surface.

Halocline (6) a vertical salinity (salt) gradient in some layer of a body of water that is appreciably greater than the gradients above and below it; also a layer in which such a gradient occurs.

Heating or cooling degree day (12) a measure of each day that the daily average temperature deviates (colder for heating, higher for cooling) from a standard (usually around 65 °F or 18 °C); represents the cumulative energy demand for keeping buildings in a "comfortable" range.

Hindcasts (9) or hindcasting; analogous to forecasting, hindcasting is a way of testing a mathematical model. Forecasting the past. Observed inputs for past events are entered into a model to see how well the output matches the known results.

Human disturbances (7) perturbations or changes to an ecosystem that occur due to human activity, such as deforestation.

Hydrologic cycle (2) also called the water cycle, the hydrologic cycle describes the movement of water on (land), and above (atmosphere) and below (soil and ocean) the surface of the earth.

Hydrology (7) study of the movement, distribution, and quality of water on earth.

Ice core record (3) the record of a quantity (such as dust amount, or carbon dioxide trapped in air bubbles) found in an ice core; a core sample that is typically removed from an ice sheet or glacier.

Indicator or index (12) derived quantities that have a relationship to weather, such as the heat index (cumulative precipitation). Other climate indicators or indices include the state of El Niño expressed as a temperature anomaly in the Pacific Ocean.

Initial condition uncertainty (1) the uncertainty in a projection, prediction or forecast due to uncertainties in the initial input conditions of the state of the system.

Initialization (5) the process of starting up a model with a set of initial conditions before the model has been run.

Insolation (3) contraction from "incoming solar radiation". In general, solar radiation received at the earth's surface. Formally, isolation is the amount of direct solar radiation upon a unit horizontal surface.

Integrated assessment models (7) models of the earth and human system that generally include both physical and social science models that consider demographic, political, and economic variables that affect emissions of greenhouse gases as well as the physical climate system. Usually the physical system is simplified.

Intergovernmental Panel on Climate Change (IPCC) (11) the international scientific body that conducts assessments of climate change science, impacts, and policy. http://www.ipcc.ch/.

Intermediate complexity models (5) simplified models of the climate system (also know as earth system models of intermediate complexity). These models usually represent the climate by an energy balance over large regions (like an ocean basin or an entire continent) that are tied together. They are less complicated than full earth system models, but they do try to represent or specify feedbacks, so they are more complex than simple idealized models like energy balance models.

Isostatic rebound (8) the rise of land masses that were depressed by the huge weight of ice sheets during the last glacial period. *Isostatic* refers to the equilibrium of the earth's crust with the mantle underneath.

Isotopes (3) different forms of the same element that contain equal numbers of protons and electrons but different numbers of neutrons, and, hence, that differ in relative atomic mass but not in chemical properties.

Kinetic energy (4) the energy that a body possesses as a consequence of its motion, defined as one-half the product of its mass (m) and the square of its speed (v): $\frac{1}{2} mv^2$.

Latent heat (7) energy released or absorbed by changes of phases of water. Condensation and freezing release heat, while evaporation and melting require heat input.

Leads (6) open water that forms between patches of sea ice, usually due to divergence (separation of ice).

Legitimacy (12) valid, objective, fair, or free of bias.

Limited-area models (5) models that cover only a part of the earth and have lateral boundaries, such as regional climate models. Such models must be given lateral boundary conditions.

Longwave radiation (5) energy emitted at wavelengths longer than about 4 micrometers (millionths of a meter) in the infrared part of the spectrum, usually of terrestrial origin.

Mean (3) the arithmetic average of a set of numbers. Defined as the total sum of all values divided by the number of values.

Median (3) the middle value of a set of numbers listed in numerical (or algebraic) order. If an even number of values, then halfway between the middle terms.

Meridional overturning circulation (6) a system of surface and deep currents encompassing all ocean basins. It transports large amounts of water, heat, salt, carbon, nutrients, and other substances around the earth, and connects the surface ocean and atmosphere with the deep ocean.

Middle latitudes (5) or mid-latitudes; the region in both hemispheres between about 35° and 65°, usually marked by a band of westerly (eastward-blowing) winds.

Mixed layer (6) in oceanography, a turbulent region of nearly vertically uniform density that, in the case of the surface mixed layer, is bounded above by the air-sea interface and below by the transition layer or thermocline.

Mixed-layer ocean models (6) an ocean model that assumes a shallow ocean depth representative of the mixed layer (33–165 ft, 10–50 m). The models do not contain a deep ocean or its circulation.

Mode (1) the most frequent value in a distribution (highest probability).

Model (1) a representation of a process or object, by necessity simplified in some way from the original.

Model uncertainty (1) the uncertainty in a model formulation, also known as the structural uncertainty. In a numerical model, model uncertainty results from imperfect representations of different processes and their interactions.

Monsoon (8) a seasonal reversing wind accompanied by corresponding changes in precipitation, or more generally the seasonal changes in atmospheric circulation and precipitation associated with the asymmetric heating of land and sea.

Natural disturbances (7) perturbations or changes to an ecosystem that occur naturally, such as wildfires caused by lightning.

Natural forcing (3) a forcing agent that is not changed by humans. Examples include changes in the earth's orbit that affect the solar input, or volcanic eruptions.

Negative feedback (3) a feedback that dampens (decreases) the response to a perturbation on a system.

Nitrogen cycle (7) the cycling of nitrogen through the earth system.

Numerical weather prediction (NWP) models (1) a numerical model used to predict the future state of the atmosphere. More formally, NWP models integrate the hydrodynamical equations with numerical methods subject to specified initial conditions for a particular time.

Nutrient cycling (7) transformation of important chemicals used by plants for food from one state or one part of the climate system to another.

Observational uncertainty (9) the unknown difference between an observation and its "true" value.

Ocean circulation (6) the long-term patterns of the motion of seawater in the worlds' oceans. It includes several types of circulations at the surface (wind-driven gyres) as well as the circulations of the deep ocean (meridional overturning circulation and thermohaline circulation).

Ozone depletion (5) catalytic removal of stratospheric ozone by chlorine. In polar regions ozone depletion reactions are accelerated by the presence of polar stratospheric clouds leading to formation of a large region of ozone depletion in spring (the ozone hole), mostly in the Southern Hemisphere.

Paleoclimate (9) climate of the geological past.

Parameter (1) any quantity in a problem that is not an independent variable (the output of the model). Also used to distinguish fixed quantities in a model from the dependent variables (inputs) in a model. Usually a parameter is a fixed mathematical constant or function.

Parameterization (4) a mathematical representation of a physical process in terms of simplified parameters. Empirical parameterizations are a functional fit between observed inputs and desired outputs.

Parametric uncertainty (10) variations in model results that come from uncertainty of set parameters in a model. A given range of parameter choices will cause variations that define parametric uncertainty.

Persistent (11) lasting for a long time.

Phenology (7) the science dealing with the influence of climate on the recurrence of annual phenomena of animal and plant life such as budding and bird migrations.

Photochemical smog (5) haze produced from anthropogenic pollutants that react with sunlight. Photochemical smog of nitrogen oxides and hydrocarbons are emitted mainly by vehicle engines but can also contain particulates.

Plant functional types (7) a system that groups plants according to their characteristics; describing plant function in ecosystems and their use of resources (nutrients).

Point (4) a single location in a model, represented by a single grid cell.

Positive feedback (3) a feedback that amplifies (increases) the response to a perturbation on a system.

Prediction (9) a forecast; an estimate of some future outcome or state.

Probability distribution (1) a probability distribution assigns a probability to the occurrence of each subset of all the possible outcomes of a set of data. A probability distribution function represents a probability distribution as the

frequency of occurrence of any particular value of a set of data. A normalized distribution has the integral under the curve equal to 1 so that the probability of any value is represented by the vertical axis.

Process splitting (10) a method of model integration by which each process operates at the same time based on the same state in a model and then the results are combined.

Projection (9) an estimate of the future based on current trends, or based on assumptions in scenarios.

Proxy records (9) preserved physical characteristics of the past that stand in for direct measurements. For example, the isotopic ratio of different isotopes of oxygen can be used as a proxy for temperature of the formation of ice in ice cores.

Pycnocline (6) a vertical density gradient (determined by the vertical temperature and salinity gradients) in some layer of a body of water, which is appreciably greater than the gradients above and below it; also a layer in which such a gradient occurs.

Radiative forcing (3) measure of the influence a factor has in altering the balance of incoming and outgoing energy in the earth-atmosphere system and an index of the importance of the factor as a potential climate change mechanism.

Regional climate model (5) a numerical climate prediction model forced by specified lateral and ocean conditions. Boundary conditions can be from a general circulation model (GCM) or observation-based dataset. A regional climate model simulates atmospheric and land surface processes, while accounting for high-resolution topographical data, land-sea contrasts, surface characteristics, and other components of the Earth-system. The values at the boundaries (boundary conditions) of a regional climate model must be specified explicitly. Regional climate models can thus simulate climate variability with regional refinements, but are dependent on the boundary conditions.

Representative Concentration Pathways (RCPs) (10) four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014. The pathways are used for climate modeling and research. They describe four possible climate futures, all of which are considered possible depending on how much greenhouse gases are emitted in the years to come. The four RCPs—RCP2.6, RCP4.5, RCP6, and RCP8.5—are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5 Wm^{-2}, respectively). The RCPs describe a wide range of possible changes in future anthropogenic (i.e., human) greenhouse gas emissions.

Reservoirs (7) a supply of a substance, especially a reserve or extra supply, or a region that holds a supply of a compound or chemical in the earth system. A reservoir of water is a space capable of storing water.

Resistances (7) or impedances; retarding forces on flows of water or nutrients.

Resolution (4) the length of the finest-described scale in a model. Typically the horizontal scale (two dimensions in space) of a single grid box in a model.

Respiration (2) gas exchange between solid and gas forms. In the case of plants, consuming carbon dioxide and releasing oxygen. In the case of animals (and bugs, microbes), consuming oxygen and releasing carbon dioxide.

Rheology (6) the study of the flow of matter like liquids, or solids (like sea ice), under conditions in which they respond with plastic flow rather than deforming elastically in response to an applied force.

Ridging (6) regions of thicker ice that stick up above the surface due to compression or convergence of sea ice.

Salience (12) relevant, useful, having a prominent signal.

Salinity (6) salt content of water.

Sampling uncertainty (9) uncertainty or error introduced by having observations only at limited points and sparsely sampling an observed quantity (like temperature or precipitation).

Scenario uncertainty (1) the uncertainty in a projection or prediction of the future due to uncertainties in inputs (boundary conditions) to a model over time.

Scenarios (9) multiple, possible descriptions of what might happen in the future. Often used as inputs to models.

Sensitivity (5) the degree to which a system will respond to an input of given strength. Systems with larger positive feedbacks have higher sensitivity.

Shared Socioeconomic Pathways (SSPs) (10) a framework that combines climate forcing and socioeconomic conditions. These two dimensions describe situations in which mitigation, adaptation, and residual climate damage can be evaluated. The core is a limited set of five SSP narratives that describe the main characteristics of future human development pathways including population, urbanization, and economic development. SSPs are the starting point for the identification of internally consistent assumptions for the quantification of emissions (similar to RCPs). Different modeling tools can be used to develop quantifications of these storylines, including factors like population, economic development, land use, and energy use.

Shortwave radiation (5) energy in the ultraviolet or visible and near-visible portion of the electromagnetic spectrum (0.4–1.0 millionths of a meter, in wavelength). These are the wavelengths emitted by the sun, and *shortwave* is used to distinguish from radiation emitted by terrestrial (low-temperature sources).

Signal (10) the real portion of some observed relationship, the opposite of noise.

Simplified sea-ice models (6) also called thermodynamic ice models; sea-ice models that do not account for ice motion and deformation and instead just simulate a surface energy balance of ice.

Single-column model (5) a model that has a single, vertical dimension (a column).

Sink (5) a route by which a measurable quantity may exit a system, such as by accumulation (in a reservoir) or chemical conversion. A loss process.

Smog (5) a natural fog contaminated by industrial pollutants; a mixture of smoke and fog.

Soil moisture (7) the amount of water in the soil.

Spread (11) variation or variability across a sample, or ensemble.

Standard deviation (9) a quantity used to measures the amount of variation, or variability, in a data set. The standard deviation is the square root of the variance. It has the same unit as the data set. Variance is the average of the squared difference from the mean. Larger spread from the mean will give a larger variance and larger standard deviation.

State (4) or state variables; the basic variables that define the state of the grid cell in a model in the atmosphere, ocean, etc. For the atmosphere, the state is described by pressure, temperature, wind (kinetic energy), and concentrations or mass of trace species. The state vector is a set of these variables at every point (cell) in a model.

Statistical downscaling (5) method by which a statistical relationship is established from observations between large-scale variables, like atmospheric surface pressure, and a local variable, like the wind speed at a particular site. The relationship is then subsequently applied to GCM output to obtain the local variables from the GCM output.

Statistical models of climate (8) a climate model based on regression techniques that relate a climate response or impact to a state variable based on past observations. Sometimes called empirical models.

Storm surge (6) onshore surge of seawater due primarily to winds in a storm, and secondarily to the surface pressure drop near the storm center.

Stratosphere (5) from the Greek for "layered region." The region of the atmosphere above the tropopause that is stable with temperature increasing with height. The region where the ozone layer is found.

Stress (6) a surface force, induced for example by wind.

Structural uncertainty (10) the uncertainty in a model formulation, also known as the model uncertainty. In a numerical model, structural uncertainty results from imperfect representations of different processes and their interactions.

Subgrid variability (5) variability on scales that are less than the grid scale of a model.

Succession (7) the evolution of plant types in a region from one to another.

Surface fluxes (6) the flow of energy into or out of the surface due to net radiation, sensible heat, and latent heat.

Surface ocean (6) the region of the ocean above the thermocline.

Sverdrup balance (6) a theoretical relationship between the wind stress exerted on the surface of the open ocean and the vertically integrated meridional (north-south) transport of ocean water. The Sverdrup balance is a consistency relationship for flow that is dominated by the earth's rotation. Such flow will be characterized by weak rates of spin compared to that of the earth.

Terrestrial biosphere (2) the portion of the biosphere (the locations where life is present) that is found on the land surface of the earth.

Terrestrial system (7) the interacting set of processes that occur on the land surface of the earth.

Thermal energy (4) the heat content, heat energy.

Thermocline (6) a vertical temperature gradient, in some layer of a body of water, that is appreciably greater than the gradients above and below it; also a layer in which such a gradient occurs.

Thermodynamics (4) a branch of physics concerned with heat and temperature and their relation to energy and work. It is used to define internal energy, temperature, and pressure.

Thermohaline circulation (2) the buoyancy-driven part of the large-scale global ocean circulation. Different buoyancy (density) is created by the surface fluxes of heat (*thermo*) and salinity or salt (*haline*).

Tiling (7) a method for defining different fractional land-surface types where each type takes up only part of a grid box.

Time splitting (10) a method of model integration by which processes are split in time and each operates one after the other on updated model conditions from the previous process.

Time steps (4) discrete units of time that a model uses to integrate forward. Time steps are the time intervals for integration in a model.

Topography (7) the terrain or elevation of the earth's surface.

Transpiration (7) the process of evaporation of water from plant leaves. Formally, the process by which moisture is carried through plants from roots to small pores

on the underside of leaves, where it changes to vapor and is released to the atmosphere.

Transport (5) the movement of a substance or characteristic such as temperature.

Tropical cyclones (1) the general term for a cyclone or storm over the oceans. The term includes tropical depressions, tropical storms, hurricanes, and typhoons. Tropical cyclones are classified according to their intensity: (1) tropical depression, with winds up to 17 m/s (38 mph); (2) tropical storms, with winds of 18–32 m/s (39–72 mph); and (3) severe tropical cyclones, hurricanes, or typhoons, with winds greater than 33 m/s (74 mph).

Tropopause (5) the top of the troposphere. The boundary between the troposphere and the stratosphere.

Troposphere (5) from the Greek words meaning "changing region." The region of the atmosphere up to 40,000 ft (12 km) or so. The region where most weather and clouds occur. Temperature decreases with height in the troposphere, making it often unstable and prone to vertical motion.

Uncertainty (1) the noncorrectable or unknown part of the inaccuracy of an instrument, system, or model. Uncertainty represents the limit of measurement (or forecast) precision.

Unstructured grids (6) a grid with irregular connectivity between elements and often elements of variable size.

Upwelling (11) ascending motion of subsurface water from deeper layers brought into the surface layer and removed from the area of upwelling by divergent horizontal flow.

Validation (5) the determination of how well a task is performed.

Variance (1) in statistics, variance measures how much a set of numbers is spread out. Zero variance means all values are identical. Variance is always positive: A small variance indicates that data cluster close to the mean. A high variance means that the data points are spread out from the mean (and each other).

Water table (7) the level below which the ground is saturated with water.

Weather (1) the state of the atmosphere, typically referenced to the surface of the earth, and characterized by different types of weather phenomena.

Weather forecasting (1) an estimate of the future state of the atmosphere, or future weather, usually defined in terms of temperature, winds, clouds, and precipitation.

Weathering (2) breaking down by exposure to weather (rain, freezing, water).

Wind stress (6) a force exerted on the ocean by the motion of the wind over it.

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