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GLOSSARY OF TERMS

***Abstract*:** No, this is not the definition of abstract! There is still some confusion about meaning of some terms in the climate field. This "glossary of terms" chapter aims at reducing the level of uncertainty of these key terms.

Adaptation – (Mike C. lecture) types 1 to n (anticipatory/proactive, autonomous, planned, private, public, reactive.

Adaptive capacity – (Mike C. lecture)

Aridity – It is the continuous occurrence of rainfall below an arbitrary but very low threshold (aridity can be seasonal, e.g. northern Australian 'dry season').

Bias – Bias is a term which refers to how far the average statistic lies from the parameter it is estimating, that is, the error which arises when estimating a quantity. Errors from chance will cancel each other out in the long run, those from bias will not. [http://www.stats.gla.ac.uk/steps/glossary/]
From www.dictionary.com: A statistical sampling or testing error caused by systematically favoring some outcomes over others.

Calibration—The process whereby the magnitude of the output of a measuring instrument (e.g., the level of mercury in a thermometer or the detected backscatter power of a meteorological radar) is related to the magnitude of the input force (e.g., the temperature or radar reflectivity) actuating that instrument. [http://amsglossary.allenpress.com/glossary/]

Chaos – A property of certain systems to be highly sensitive to minute displacements at certain stages of their evolution. Chaotic behaviour originates when two or more 'large' forces acting upon a system produce an overall 'small' residual force, whose magnitude and direction can be sensitive to small changes in the 'large' forces. Any changes in the large forces can, in these

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circumstances, have a major impact on the future evolution of the system. For example, a freely-oscillating clock pendulum does not display chaotic behaviour because the forces acting on it, gravity and the tension in the support, are fixed and in balance. However, if a magnet is placed near the end of the swing of a pendulum with sufficient strength nearly to counterbalance the gravity, then the pendulum's swing can become chaotic, with minor changes in the pendulum's position determining the net force and thus when and how the pendulum will escape the magnet's influence; note that the pendulum's swing in the case remains predictable throughout except when under the influence of the magnet, when it may be possible to make predictions without impractical fine measurements of all forces involved. Planetary motion, as many other natural systems, exhibits chaotic behaviour, being entirely predictable except during rare occasions when two or more gravitational forces on a single body (e.g. planet) become closely balanced. In atmospheric and oceanographic sciences prediction on all time scales involves dealing with a chaotic system, in which changes in initial conditions well below any practical measurement accuracy can lead to significant differences in predictions – this issue is addressed through the use of ensembles. Note that many systems in addition to those of the atmosphere and oceans discussed in this book are chaotic – most geophysical systems, biological systems (including those affecting health), and social systems are all chaotic in nature.

Climate–The slowly varying aspects of the atmosphere-hydrosphere-land surface system. It is typically characterized in terms of suitable averages of the climate system over periods of a month or more, taking into consideration the variability in time of these averaged quantities. Climatic classifications include the spatial variation of these time-averaged variables. Beginning with the view of local climate as little more than the annual course of long-term averages of surface temperature and precipitation, the concept of climate has broadened and evolved in recent decades in response to the increased understanding of the underlying processes that determine climate and its variability. See also climate system, climatology, climate change, climatic classification. [http://amsglossary.allenpress.com/glossary/]

Climate Change – (Also called climatic change.) Any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer. Climate change may be due to natural external forcings, such as changes in solar emission or slow changes in the earth's orbital elements; natural internal processes of the climate system; or anthropogenic forcing. [http://amsglossary.allenpress.com/glossary/]

Climate Drift—The tendency for the solution of a numerical model integration to move away from its initial conditions and toward its own climate. Typically this new climate has some unrealistic features. Climate drift may be caused by various imbalances or errors in the model parameterizations. [http://amsglossary.allenpress.com/glossary/]

Climate Risk Management – It is the process of incorporating probabilistic risks of particular climate outcomes (e.g.) resource management decisions in advance of the events. It makes use of all information available on probable climate outcomes and the vulnerabilities to particular outcomes, in an adaptable decision-making process.

Climate Variability – It refers to the

Climatology - The description and scientific study of climate. Descriptive climatology deals with the observed geographic or temporal distribution of meteorological observations over a specified period of time. Scientific climatology addresses the nature and controls of the earth's climate and the causes of climate variability and change on all timescales. The modern treatment of the nature and theory of climate, as opposed to a purely descriptive account, must deal with the dynamics of the entire atmosphere-ocean-land surface climate system, in terms of its internal interactions and its response to external factors, for example, incoming solar radiation. Applied climatology addresses the climate factors involved in a broad range of problems relating to the planning, design, operations, and other decision-making activities of climate sensitive sectors of modern society. [http://amsglossary.allenpress.com/glossary/]

Coping range/strategies – (Mike C. lecture)

Coupled model (or coupled general circulation model) – It is a class of analytical or numerical time-dependent models in which at least two different subsystems of earth's climate system are allowed to interact. These subsystems may include the atmosphere, hydrosphere, cryosphere, and biosphere. This term is most commonly used for models of the evolution and interaction of earth's atmosphere and ocean. Coupled (two way) interaction between different subsystems can be contrasted with the class of models where the evolution of a subsystem A is affected by the present state of the subsystem B, but changes in A do not have feedback on the evolution of B itself. [http://amsglossary.allenpress.com/glossary/]

In the case of seasonal-to-interannual forecasting this normally refers to the coupling of an atmospheric model to an ocean model and possibly to other important component models such as a land model and a sea-ice model. In general, a coupled model is a model that best represents the various processes relevant to a specific problem.

Decision maker – This is ...

Decision taker – This is ...

Drought – It is a shortfall in rainfall for an extended period below an arbitrary threshold that is well below normal expectations.

El-Niño Southern Oscillation (ENSO) is a warming of the equatorial Pacific Ocean, which has significant and predictable influence on many local climates around the world. ENSO is the strongest climate 'signal' known, and is the basis of much seasonal forecasting. [Sustainable Development in Africa, IRI report]

Ensemble – In the climate prediction sense an ensemble refers to a set of predictions created using a numerical atmosphere and/or ocean model, each started (initialised) from a slightly different initial set of fields in such a way as to examine the effects of chaos on that particular prediction. Given a precisely defined ensemble then it is possible to define a pdf of future states providing a full set of the range of possibilities and their associated probabilities. Frequently climatologists also use more than a single model in their production of an ensemble – this is not only advantageous in spreading the high costs of running ensembles, but also benefits the predictions through accounting in part for the imperfect qualities of individual models.

Exposure – (Mike C. lecture)

Forecast – It is normally used interchangeably with the term *Prediction.* Strictly, however, *to forecast* and *to predict* have different meanings. *To forecast* means: to estimate or calculate in advance, especially to *predict* (weather/climate conditions) by analysis of meteorological data.

Forecast bias - The difference between the central locations of the forecasts and the observations (also known as overall bias, systematic bias, or unconditional bias). Most easily quantified using the Mean Error - the difference between the means of the forecasts and the observations. For

categorical forecasts, bias in marginal probabilities is estimated by the ratio of the total number of events forecast to the total number of events observed (i.e. (a. b) /(a. c) for binary categorical forecasts - see contingency table). From Glossary in "Forecast Verification", Editors: I.T. Jolliffe and D.B. Stephenson, Wiley and Sons Ltd., (2003)

Forecasting system – This is a relative term and caution should be paid in its interpretation (cf. definitions of *user* and *stakeholder*). It could be comprehensive in which case it has to be viewed as the integration of all the components of a forecast, from the generation of initial conditions of the dynamical models used for the forecasts, to the running of the coupled dynamical models, to the calibration and assessment of the model output, to the application of forecast products to specific users. But it could also be used to refer to contiguous parts of this comprehensive definition. The meaning should be clear by its context.

Marginal Climate – (e.g. from Glantz, 2003)

Millenium Development Goals (MDG) – A set of 8 Goals, originally agreed at the UN Millennium Summit in New York in 2000, that provide a time-bound (2015) coordination framework for development activities - see http://www.undp.org/mdg/. For all Goals there are certain quantifiable Targets, each with sets of Indicators.

Mitigation – (Mike C. lecture)

pdf – Probability Density Function – a mathematical description of the probabilities that events within a certain set might occur. For example, the climatological pdf of maximum temperature on a given day at a specific location indicates the frequencies with which different maximum temperatures have occurred on that same day in the past. The equivalent forecast pdf of maximum temperature, perhaps derived from an ensemble, illustrates the expected likelihood that individual maximum temperatures will occur on a specific day, a pdf that is likely to vary from the climatological pdf.

Predictability –The extent to which future states of a system may be predicted based on knowledge of current and past states of the system. Since knowledge of the system's past and current states is generally imperfect, as are the models that utilize this knowledge to produce a prediction, predictability is inherently limited. Even with arbitrarily accurate models and observations, there may still be limits to the predictability of a physical system.

Prediction – It is normally used interchangeably with the term *Forecast.* Strictly, however, *to predict* and *to forecast* have different meanings. *To predict* means: to state, tell about, or make known in advance, especially on the basis of special knowledge.

Prediction system – See definitions of *Prediction* and of *Forecasting system.*

Probability/uncertainty – (Mike C. lecture)

Producer – They are …

Random error—The inherent imprecision of a given process of measurement; the unpredictable component of repeated independent measurements on the same object under sensibly uniform conditions. It is found experimentally that, given sufficient refinement of reading, a series of independent measurements x_1, x_2, . . ., x_n will vary one from another even when conditions are most stringently controlled. [http://amsglossary.allenpress.com/glossary/]

Resilience – (Mike C. lecture)

Risk – (Mike C. lecture)

Seasonal Climate Prediction (or Seasonal-to-Interannual Forecast) – It makes use

Skill – A statistical evaluation of the accuracy of forecasts. Several simple formulations are commonly used in climatology. The skill score (SS) is useful for evaluating predictions of temperatures, pressures, or the numerical values of other parameters. It compares a forecaster's root-mean-squared or mean-absolute prediction errors, E_f, over a period of time, with those of a reference technique, E_{refr}, such as forecasts based entirely on climatology or persistence, which involve no analysis of synoptic weather conditions:

$$SS = 1 - (E_f / E_{refr})$$

If SS > 0, the forecaster or technique is deemed to possess some skill compared to the reference technique.
[http://amsglossary.allenpress.com/glossary/]

Stakeholders – This is a relative term and caution should be paid in its interpretation (cf. definitions of *user* and also *forecasting system*). A

stakeholder can be defined as anyone with a strong interest in outcomes related to their areas of professional and personal interest.

Supplier – See *Producer*

Sustainable Development – Probably the most controversial of the terms in this glossary. Here a few alternatives are given: pick your choose! In all these, "future generations" is the keyword.

Option 1 - Development that ensures that the use of resources and the environment today does not restrict their use by future generations.

www.grid.unep.ch/product/publication/freshwater_europe/glos.php

Option 2 - The management and conservation of the natural resources base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally viable and socially acceptable.

www.fao.org/DOCREP/003/X6896E/x6896e0e.htm

Option 3 - "Improving the quality of human life while living within the carrying capacity of supporting ecosystems" (Caring for the Earth, IUCN/WWF/UNEP, 1991)

www.interenvironment.org/wd1intro/glossary.htm

Option 3 - Within a country or region, gradual change characterized by economic growth, increased social equity, constructive modification of ecosystems, and maintenance of the natural resource base.

www.oas.org/usde/publications/Unit/oea03e/ch13.htm

Systematic error—That part of the inaccuracy of a measuring instrument, or statistical estimate of a parameter, that is due to a single cause or small number of causes having the same sign, and hence, in principle, is correctable; a bias or constant offset from the true value. In the absence of random errors, the true value is equal to the instrumental reading or statistical mean estimate minus the systematic error. [http://amsglossary.allenpress.com/glossary/]

User – This is a relative term and caution should be paid in its interpretation (cf. definitions of *stakeholder* and also *forecasting system*). A *user* is anyone that makes use of products available at any stage of the (comprehensive)

forecasting system. As a consequence, there are different levels of users: *intermediate* or *end/final* users.

Vulnerability – (Mike C. lecture)

From http://www.ccb.ucar.edu/elnino/glossary.html

Some scientists use El Niño and ENSO interchangeably. Others use the phrase "warm event" to describe a warming of the surface waters in the central and eastern equatorial Pacific, and "cold event" to denote the opposite phase of the Southern Oscillation. The glossary which follows is provided to help the reader sort out these concepts.

El Niño is a term originally used to describe the appearance of warm (surface) water from time to time in the eastern equatorial Pacific region along the coasts of Peru and Ecuador. It was once suggested that minor El Niño events occurred about every two to three years and major ones about every eight to 11 years. Today, scientists note that El Niño has a return period of four to five years. When an El Niño event occurs, it often lasts from 12 to 18 months.

La Niña refers to the appearance of colder-than-average sea surface temperatures (SSTs) in the central or eastern equatorial Pacific region (the opposite to conditions during El Niño). Many scientists do not like the use of the term and prefer to call it a cold event (described below).

A warm event refers to the anomalous warming of SSTs in the central and eastern equatorial Pacific. This term is being used to avoid confusion over the use of other terms like ENSO and El Niño. A warming in the regions mentioned is accompanied by a relative cooling in the western equatorial Pacific.

A cold event is one where the SSTs become anomalously colder compared to the long-term average for the central and eastern equatorial region. (It is the opposite of a warm event in that region.) It has been referred to in the past as anti-El Niño and, more recently, as La Niña. La Niña, however, unlike the restrictive view of El Niño, is applied to Pacific basinwide phenomena.

The Southern Oscillation is a see-saw of atmospheric mass (pressure) between the Pacific and Indo-Australian areas. For example, when the pressure is low in the South Pacific high pressure cell and high over Indonesia and Australia, the Pacific trade winds weaken, upwelling of cool water on the Pacific equator and along the Peruvian coast weakens or stops, and SSTs increase in these areas where the upwelling weakens.

The Southern Oscillation Index (SOI) has been developed to monitor the Southern Oscillation using the difference between sea level pressures at Darwin, Australia, and Tahiti, although other stations have sometimes been used. Large negative values of the SOI indicate a warm event, and large positive values indicate a cold event (also referred to as La Niña). It is important to note that there is not a one-to-one correspondence between the occurrence of Southern Oscillation events and El Niño events, using the spatially restrictive original definition of El Niño.

ENSO is the term currently used by scientists to describe the full range of the Southern Oscillation that includes both SST increases (a warming) as well as SST decreases (a cooling) when compared to a long-term average. It has sometimes been used by scientists to relate only to the broader view of El Niño or the warm events, the warming of SSTs in the central and eastern equatorial Pacific. The acronym, ENSO, is composed of El Niño-Southern Oscillation, where El Niño is the oceanic component and the Southern Oscillation is the atmospheric component of the phenomenon. The broader definition of El Niño has sometimes been used interchangeably with ENSO, because ENSO is less well known in the popular electronic and printed media.

Teleconnections can be defined as atmospheric interactions between widely separated regions. They have been identified through statistical correlations (in space and time). Some of these correlations have been used to generate hypotheses about geophysical processes related to teleconnections. Most countries in the world are, or should be, interested in this aspect of the Southern Oscillation. Some examples are provided in the following maps.