

Glossary

Adiabatic Process:

A process in which there is no diabatic heating and temperature changes arise solely from expansion and contraction.

Analogue:

A tropical cyclone from the climatological archive that has features similar to that of the cyclone under consideration.

Assimilation:

Any means of incorporating observations, or analyses into the prediction cycle of a numerical model.

Australian Tropical Cyclone Severity Scale:

Five categories indicating the damage potential of severe tropical cyclones.

Best Track:

A subjectively-smoothed representation of a tropical cyclone's location and intensity over its lifetime. The best track contains the cyclone's latitude, longitude, maximum sustained surface winds, and minimum sea-level pressure at 6-hourly intervals. Best track positions and intensities, which are based on a post-storm assessment of all available data, may differ from values contained in storm advisories. They also generally will not reflect the erratic motion implied by connecting individual center fix positions. (NHC Glossary)

Baroclinic:

Has vertical structure, in the form of variable density, temperature and winds. Baroclinic numerical models have a number of layers in the vertical in addition to a horizontal grid (Chapter 3, Section 3.3).

Barotropic:

Single level, with no vertical structure. Current numerical models tend to use either the barotropic vorticity equation (non-divergent models) or the shallow-water equations (free surface, allows divergence).

Basin:

Either an oceanic region with coherent features (eg, the north Indian Ocean Basin), or a set of bathymetric data for use in numerical models of storm surge.

Beaufort Number:

Categorization of wind speed based on visual state of the sea or land effects (see section 4 of this chapter).

Binary Tropical Cyclones:

Two tropical cyclones co-existing in sufficiently close proximity for each to effect the motion of the other (see also Fujiwhara effect).

Bogus Cyclone:

A preconstructed vortex inserted into analyses to provide a numerical model with a reasonable approximation of a tropical cyclone in data sparse areas.

Bogus Observation:

Any pseudo observation derived from indirect means, such as human interpretation, or empirical relationships with, for example, cloud fields. Used to provide additional information for analysis in data-void regions.

Boundary Conditions:

The means of specifying the forcing at boundaries of numerical models.

Central Dense Overcast:

The region of very high and cold cirrus cloud covering the core of a tropical cyclone (Dvorak, 1984).

Centre of a Tropical Cyclone:

Varies according to the analysis method; typically one of geometric centre of eye, minimum pressure, zero wind, or end of a spiral band.

Complex Extratropical Transition:

A tropical cyclone moves into high latitudes, merges with and intensifies a pre-existing baroclinic cyclone.

Compositing Forecast Technique:

A technique in which a tropical cyclone forecast track is constructed by averaging the tracks from different forecast models. The averaging scheme may treat each forecast model the same or may weight specific models according to their past performance under similar conditions.

Compound Extratropical Transition:

A tropical cyclone moves into high latitudes and induces a new development, such as waving on a frontal zone.

Cost-Loss:

An objective method of taking strike probability forecasts and calculating the ratio of expected cost of ameliorating action with the potential loss from taking no action; a ratio of less than one means that no ameliorating action should be taken on economical grounds alone.

Deep/Shallow Water:

Used in the context of gravity waves, water that is several wavelengths deep; thus greater than 100 m constitutes deep water for a ocean swell (wavelength tens of meters), but a storm surge (wavelength several tens of kilometres) is in shallow water anywhere on a continental shelf.

Diabatic Heating:

Externally imposed heating; for example solar radiation or latent heat release in a cloud.

Direct observation:

In situ measurements of meteorological elements at weather stations, from ships and aircraft, and with instrumented probes such as rawinsondes.

Doppler Effect:

Change in frequency of an electromagnetic or sound wave resulting from differential movement, for example, raindrops moving towards a Doppler radar will cause the reflected microwave beam to move towards higher frequency, enabling calculation of the raindrop speed.

Embedded Cloud Top:

Regions of very cold, overshooting cloud tops in a cirrus overcast.

Ensemble Forecasting:

Ensemble forecasting is a numerical prediction method that is used to generate a representative sample of the future states of a dynamical system, such as a tropical cyclone track. Ensemble forecasting is a form of Monte Carlo analysis, where multiple numerical predictions are conducted using slightly different initial conditions that are all plausible given the past and current set of observations, or measurements. Sometimes the ensemble of forecasts may use different forecast models or different formulations of a forecast model. (modified from *Wikipedia*)

Eulerian Coordinate System:

A coordinate system located on the earth surface.

Extratropical:

A term used in advisories and tropical summaries to indicate that a cyclone has lost its "tropical" characteristics. The term implies both poleward displacement of the cyclone and the conversion of the cyclone's primary energy source from the release of latent heat of condensation to baroclinic (the temperature contrast between warm and cold air masses) processes. It is important to note that cyclones can become extratropical and still retain winds of hurricane or tropical storm force. (NHC Glossary)

Extratropical Cyclone:

A synoptic scale low pressure system which derives its energy primarily from available potential energy in a pre-existing horizontal temperature gradient.

Eye:

The roughly circular area of comparatively light winds that encompasses the center of a severe tropical cyclone. The eye is either completely or partially surrounded by the eyewall cloud.

Eyewall / Wall Cloud:

An organized band or ring of cumulonimbus clouds that surround the eye, or light-wind center of a tropical cyclone. Eyewall and wall cloud are used synonymously. (NHC Glossary)

Fetch:

The area of sea, especially along the direction of the wind, over which winds are relatively constant and wave generation occurs.

Fujiwhara Effect:

Interaction of two binary cyclones in which both orbit cyclonically about their geometric centre; named after the pioneering laboratory experiments of Fujiwhara (1921).

Fully Developed Sea:

Sea in a quasi-steady state in which the energy gained by waves from the wind is approximately equal to that lost to wave breaking and other mechanisms.

Gravity Wave:

A perturbation along a vertical density discontinuity, or gradient, which has gravity as its restoring force; for example ocean waves, storm surges. In the atmosphere, gravity waves are generated whenever an imbalance between the mass and wind fields develops. This can be a major problem for the initial integration of numerical models.

Habitation Layer:

The thin layer of the atmospheric boundary layer in which humans live (Simpson and Riehl, 1981).

Hazard:

An event of occurrence that has the potential for causing injury to life or damage to property or the environment.

Hazard Risk Map:

Detailed demographic maps, including local community facilities, storm surge lines, etc, to provide a ready reference of people and facilities at risk when a tropical cyclone is threatening.

Hurricane / Typhoon:

A tropical cyclone in which the maximum sustained surface wind (using the U.S. 1-minute average) is 64 kt (74 mph or 119 km/hr) or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian. The term typhoon is used for Pacific tropical cyclones north of the Equator and west of the International Dateline. (NHC Glossary)

Indirect observation:

A remotely sensed but quantitative estimate of a meteorological element. The estimated variable is physically related to the observed quantity, though the estimate is often

made by statistical means in practice. Examples are retrievals of temperature and humidity from satellite sounders, estimates of winds made by tracking clouds in satellite imagery, and estimates of rainfall rates from radar or microwave radiometers.

Inferred estimate:

An estimate of a meteorological element based on remote observations of other quantities which are empirically related but not physically related in any direct sense. Tropical cyclone central pressure and wind speed estimated from satellite observed cloud top temperatures using the Dvorak method are examples of inferred estimates.

Intensity:

The maximum low-level sustained winds or the minimum sea level pressure of a tropical cyclone.

Inundation:

The flooding of normally dry land, primarily caused by severe weather events along the coasts, estuaries, and adjoining rivers. These storms, which include hurricanes and "winterstorms", bring strong winds and heavy rains. The winds drive large waves and storm surge on shore, and heavy rains raise rivers. (A tsunami - a giant wave caused by earthquakes or volcanic eruptions under the sea or landslides into the sea - is another kind of coastal inundation, but should not be confused with storm surge.) (NHC Glossary)

Inverted Barometer Effect:

The uplift of water in the centre of a tropical cyclone as a dynamic adjustment to the low air pressure there, roughly 1 cm sea level rise for every 1 hPa drop in sea level pressure, but substantial enhancement may occur from interactions with local bathymetry.

Isodrosotherm:

Line of constant specific humidity.

Lagrangian Coordinate System:

A coordinate system located on and moving with the feature of interest, for example centred on and moving with a tropical cyclone.

Landfall:

The intersection of the surface center of a tropical cyclone with a coastline. Because the strongest winds in a tropical cyclone are not located precisely at the center, it is possible for a cyclone's strongest winds to be experienced over land even if landfall does not

occur. Similarly, it is possible for a tropical cyclone to make landfall and have its strongest winds remain over the water. (NHC Glossary)

Leading Edge Band:

The first convective band on the front of a tropical cyclone.

Markov Chain:

Technique used to estimate the transition probabilities between various ranges or categories in a time series; for example the probability that a cyclone moving in the speed range 5-10 ms⁻¹ will accelerate to 15-20 ms⁻¹ in the next 12 hours (see Leslie et al., 1992).

Marsden Square:

Any region on earth with sides comprised of equal degrees of latitude and longitude.

Meander:

Quasi-oscillatory motion of a tropical cyclone centre about a longer-term mean track; see also trochoidal motion.

Mesoscale Convective System:

A small, long-lived cloud cluster, typically a few hundred kilometres in diameter.

Monte Carlo Method:

In the context of this volume, many forecasts made by a numerical model, each with a small change in the initial conditions; useful for indicating regions of rapid growth of errors in the initial conditions.

Multivariate Analysis:

Analysis utilising more than one variable in combination, for example maintaining the wind and pressure fields in balance.

Murphy's Law:

Anything that cannot possibly go wrong, will go wrong. There are two useful corollaries:

1. The chance of something going wrong is directly proportional to the amount of damage that will ensue;
2. Murphy was an optimist.

Outer Band Areas:

The edge of all outer convective cloud regions in a tropical cyclone.

Parameterisation:

A means of incorporating unresolved atmospheric features into numerical model forecasts. For example cumulus parameterisation incorporated the sub-grid forcing by convective clouds into a numerical model.

Partially Developed Sea:

Sea which has not reached a steady state for the imposed wind conditions and is still developing.

Poisson Distribution:

Used in the description of discrete cyclone occurrence in limited domains.

Potential Intensity:

The theoretical maximum possible intensity that can be sustained for the current environmental conditions; normally related to ocean temperature and tropopause height and temperature (Emanuel, 1986).

Radar:

Radio Direction And Ranging, a conical beam of pulsed electromagnetic energy in the microwave range transmitted outward from a rotating antenna. Backscattered energy from hydrometeors and other atmospheric scatterers, is collected by the same antenna and displayed either as a horizontal Plan Position Indicator (PPI) plot, or a vertical Range Height Indicator (RHI) slice. Some radar display systems also have the capacity to integrate volumetric data collected from several scans at different beam elevations. One such method is to display a Constant Altitude PPI (CAPPI).

Radius of Maximum Winds:

The radial distance from a cyclone centre to the mean position of the band of maximum winds.

Rankine Vortex:

A special type of vortex, which has zero vorticity outside the radius of maximum winds. Also called a potential vortex, or vortex patch. A modified Rankine vortex is sometimes used as an analytic approximation to tropical cyclones.

Repetitive Strain Injury:

Injury, generally sustained to wrists elbows and shoulders, arising from repetitive activities, such as keyboard operation.

Rapid Intensification:

An increase in the maximum sustained winds of a tropical cyclone of at least 30 kt in a 24-hour period. An earlier definition required a pressure fall of at least 42-hPa in a 24-hour period.

Relocated:

A term used in an advisory to indicate that a vector drawn from the preceding advisory position to the latest known position is not necessarily a reasonable representation of the cyclone's movement. (NHC Glossary)

Return Period:

The projected period of recurrence of a particular event, such as a tropical cyclone of a particular intensity, severe flooding, or a defined wind gust; derived using either empirical or Monte Carlo methods and assumed distributions of extreme events. Great care needs to be taken in interpretation this statistical result; in particular a return period of, say, 50 years does not mean that the next event will occur in 50 years, it could occur next year, albeit with a low probability.

Risk:

A probability that injury to life or damage to property and the environment will occur.

Rosby Number:

(also called Kibble Number in Russia); indicates the relative magnitude of centrifugal and Coriolis accelerations; an approximate breakdown of regimes is:

$R_o < 1$ Geostrophic Flow,
 $R_o > 1$ Gradient Flow,
 $R_o > 50$ Cyclostrophic Flow.

Rosby Radius of Deformation:

The ratio of the speed of the relevant gravity wave mode and the local vorticity, or, equivalently, the ratios of the Brunt Vaisala and inertial frequencies. This scale indicates the amount of energy that goes into gravity waves compared to inertial acceleration of the wind. For a local length scale, L , and Rossby Radius, L_R :

Relative Magnitude	Response to a Mass Perturbation	Response to a Wind Acceleration
$L \ll L_R$	Mostly gravity waves	Mass adjusts largely to the winds.
$L \geq L_R$	Inertial accelerations become dominant	Mass adjusts only partially to wind acceleration
$L \gg L_R$	Almost no gravity waves	Inertial oscillations with no mass adjustment.

Saffir/Simpson Hurricane Scale (Simpson 1974):

A Scale that defines five categories for indicating the damage potential of tropical cyclones. The Scale originally included storm surge estimates, but these estimates were removed from the scale circa 2010.

Saffir/Simpson Tropical Cyclone Scale (Guard & Lander 1999):

A Scale adapted from the Saffir/Simpson Hurricane Scale that defines two tropical storm categories and five typhoon categories for indicating the wind and storm surge damage potential of tropical cyclones. The Scale considers tropical building materials and practices, tropical plants, the weakening effects of salt spray, termites and wood rot, and the damaging potential of sub-hurricane force winds.

σ -coordinate:

A special vertical coordinate, used in numerical models, which "smooths out" variable topography by using surface pressure as the baseline.

Size:

The extent of the tropical cyclone's circulation, typically given by the extent of gale force winds, or ROCI, although this is arbitrary.

Spectral Function:

A means of representing a variable field, such as horizontal winds or a time-series of temperatures, as a series of sine waves or polynomials. A spectral model (Chapter 3, Section 3) holds the required atmospheric variables in the form of spectral functions.

Spherics:

Shortened from atmospheric, the crackle heard on radio from lightning discharges in the atmosphere.

Statistical Interpolation:

A method of analysing random observations onto a regular grid, using their known errors and spatial correlation characteristics in a statistically optimal way.

Steering Current:

Imprecise term used to designate the flow in which a tropical cyclone is embedded.

Storm Surge:

An abnormal rise of sea water associated with a tropical cyclone. It is described as the still water elevation above the local astronomical tide, uncontaminated by high frequency, short gravity wind waves.

Storm Tide:

The total ocean elevation, including the astronomical tide, above or below a standard datum resulting from the passage of a tropical cyclone.

Strike Probability:

The probability that a particular region will be directly affected by a current tropical cyclone; currently calculated from climatological and persistence forecasts, though Monte Carlo forecasts with numerical models now provide an alternative approach (see Cost-Loss).

Subtropical Cyclone:

A non-frontal low-pressure system that has characteristics of both tropical and extratropical cyclones. Like tropical cyclones, they are non-frontal, synoptic-scale cyclones that originate over tropical or subtropical waters, and have a closed surface wind circulation about a well-defined center. In addition, they have organized moderate to deep convection, but lack a central dense overcast. Unlike tropical cyclones, subtropical cyclones derive a significant proportion of their energy from baroclinic sources, and are generally cold-core in the upper troposphere, often being associated with an upper-level low or trough. In comparison to tropical cyclones, these systems generally have a radius of maximum winds occurring relatively far from the center (usually greater than 60 nm), and generally have a less symmetric wind field and distribution of convection. (NHC Glossary)

Subtropical Storm:

A subtropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) is 34 kt (39 mph or 63 km/hr) or more. (NHC Glossary)

Trochoidal Motion:

Short-term, oscillatory motion of a cyclone centre, which can be approximated by the equations for trochoidal motion.

Tropical Cyclone:

A warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere. In this they differ from extratropical cyclones, which derive their energy from horizontal temperature contrasts in the atmosphere (baroclinic effects). (NHC Glossary)

A synoptic-scale to meso-scale low pressure system which derives its energy primarily from: 1. evaporation from the sea in the presence of high winds and low surface pressure; and 2. condensation in convective clouds concentrated near its centre.

Tropical Depression:

A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) is 33 kt (38 mph or 62 km/hr) or less. (NHC Glossary)

Tropical Disturbance:

A discrete tropical weather system of apparently organized convection -- generally 100 to 300 nm in diameter -- originating in the tropics or subtropics, having a nonfrontal migratory character, and maintaining its identity for 24 hours or more. It may or may not be associated with a detectable perturbation of the wind field. (NHC Glossary)

Tropical Storm:

A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 kt (39 mph or 63 km/hr) to 63 kt (73 mph or 118 km/hr). (NHC Glossary)

Tropical Wave:

A trough or cyclonic curvature maximum in the trade-wind easterlies. The wave may reach maximum amplitude in the lower middle troposphere. (NHC Glossary)

Univariate Analysis:

Analysis of each variable, such as pressure or zonal wind component independently of all other variables.

Vulnerability:

A set of prevailing or consequential conditions composed of physical, geographic, demographic, socio-economic and/or political factors which increase a community's susceptibility to calamity, or which adversely affects its ability to respond to events.

Wall Cloud:

The region of deep cloud surrounding a mature cyclone eye.(Also see eyewall / wall cloud.)

Wave

Height: The vertical distance between a wave crest and trough;

Length: The horizontal distance between two wave crests;

Period: The time taken for two wave crests to pass a fixed point;

Set-Up: Water forced inshore by breaking waves;

Significant Wave Height/Period: The average height/period of the highest third of all waves in a sample of wind-waves;

Swell: Smooth, regularly spaced waves that have propagated long distances from their initial generation region;

Wind Waves: Choppy and chaotic waves generated locally by the wind.

Weibull Distribution:

Used in the estimation of extreme events, such as cyclone return periods.

Wind

Mean, Average or Sustained: Taken as the 10-min mean wind, except in the USA and North Atlantic, where 1-min means are used; conversion factor from 1 to 10-min mean is approximately 0.871;

Maximum Sustained: Highest mean wind in the tropical cyclone;

Gust:The highest wind burst, generally taken as the 1 s value.

Z-R Relationship:

Empirical relationship between the power of the reflected signal from a radar (Z), in units of dBZ, and rainfall at the ground (R); after Battan (1973); many relationships exist, depending on the degree of convection, presence of ice and assumed rain drop distribution.