

MAR110 Natural Hazards and the Oceans

Section #2 Glossary

- Albedo.** The degree to which short wave solar radiation is reflected from any surface or object.
- Blizzard.** Any wind event with velocities exceeding 60 km/hr, with temperatures below -6°C, and often with snow being blown within tens of meters of ground level.
- Bombs. (see East-Coast Lows).**
- Conductivity.** The ability of a fluid to conduct electrical currents. The conductivity increases with increased salt content. Salinity may be determined by measuring the conductance of seawater with an electronic device called a *salinometer*.
- Convection.** The upward transfer of heat through the movement of heated air or water parcels.
- Convective Instability.** A situation in which an air parcel, with a temperature greater than that of surrounding air (i.e. is less dense), rises upward - a process that is guaranteed when condensation leads to continued heating of the parcel.
- Conveyor Belt Circulation.** The thermohaline circulation mode of the ocean in which there is cooling-induced deep sinking of water in the polar zone, transport in a deep western boundary current to the Southern Ocean, where it is distributed to the Indian and Pacific Oceans, where it rises to the surface, is warmed and returned to the Atlantic.
- Coriolis Deflection.** The curvature of the trajectory of a freely moving water or air parcel to the right in the northern hemisphere (left in the southern hemisphere) as seen by an observer on a rotating Earth.
- Coriolis "Force".** An apparent "force" on moving particles resulting from the earth's rotation. It causes moving bodies to be deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The "force" is proportional to the speed and latitude of the moving object.
- Current.** The motion of water as it flows down a slope, pushed by wind stress or tidal forces. The velocity or speed of flow is usually expressed in centimeters per second, or for fast-moving currents in meters per second or kilometers per hour.
- Cyclogenesis.** The process forming an extra-tropical, mid-latitude cell or depression of low air pressure.
- Cyclonic circulation.** Wind circulation around a low-pressure weather cell. In the Northern Hemisphere, when viewed from above, cyclonic winds follow a counter-clockwise rotation pattern.
- Datum.** The reference level to which tide levels are compared. The datum planes commonly used are mean low water or mean lower low water, which are the average levels of low tides taken over a 19-year period. These are also the datum planes ("0" ft or "0" m) used in constructing bathymetric charts.
- Seawater Density.** The mass per unit volume of seawater; typically 1.0250 gm/cm³ compared to 1.000 gm/cm³ for fresh water.
- Density Anomaly.** The departure of seawater density from that of fresh water (1.000 gm/cm³) times 1000; which for a typical seawater density of 1.025 gm/cm³ is 25.
- Diurnal tides.** Tides occurring once daily, with one high and one low tide per lunar day.
- Downwelling.** A downward movement (sinking) of surface water caused by onshore Ekman transport, converging currents, or when a water mass becomes more dense than the surrounding water.
- Dynamic Topography.** The irregularities in the sea surface produced by wind or differences in density, usually expressed in dynamic meters or fractions thereof. This topography changes with time and the seasons.
- East-Coast Lows.** Very intense storms that develop over the seaward side of mid-latitude coasts on the eastern sides of continents. Such lows develop over warm ocean water and are dominated by intense convection, storm waves, and heavy rainfall. Such storms are called "bombs" when wind velocities exceed 100 km hr⁻¹ within a few hours.
- Easterly Wave.** Meanders in easterly wind flows with some rotation that can, once over warm water, can intensify into tropical cyclones.

Ekman Spiral. A theoretical representation of the effect of a wind blowing steadily over a large body of water, which causes the surface layer to drift at an angle of 45° to the right in the Northern Hemisphere. Water at successive depths drifts more and more to the right in a spiral fashion until at some depth, known as the *base* of the wind-driven current, motion is essentially zero. This depth depends on the duration and velocity of the wind but is approximately 100 meters.

Ekman Transport. Surface layer to drift to the right in the Northern Hemisphere in response to a wind blowing steadily for more than about one day over a large body of water.

Extra-Tropical Low (or Depression). A mid-latitude, low pressure cell with inwardly and upwardly spiraling winds. Unlike tropical cyclones, the cell can develop over land as well as water, usually in relation to the polar front and with a core of cold air.

Eye. The center of a tropical cyclone (or tornado), where air is descending, and marked by calm wind speeds; surrounded by a wall structure created by a sharp decline in pressure and characterized by intensely inwardly spiraling winds.

Feedback. The situation where one process reinforces (positive) or cancels (negative) the effect of another. For instance, a microphone placed close to an amplifier catches its own sound waves and rebroadcasts them louder. This is positive feedback.

Fetch. The length of an unobstructed open sea surface across which the wind can generate waves. The longer the fetch, the bigger the waves.

Flood. A large discharge of water flowing down - if not outside - any watercourse in a relatively short period compared to normal flows.

Friction. The force due to the resistance of one particle sliding over another because of a weight pressing irregularities on the surface of both particles together.

Friction Force. The force due to the mutual resistance due to surface irregularities of two particles sliding over one another.

Fully-Developed Sea. The class of surface waves that form when wind blows for enough time across the open ocean.

Geostrophic Current. A current defined by assuming an exact balance between the horizontal pressure gradient (density) and the Coriolis effect. The usual manner of deriving geostrophic currents is to prepare a chart of dynamic topography based upon observations of temperature and salinity for a number of oceanographic stations. The direction of the current is indicated by the contours of dynamic topography, and its speed by the spacing of the contours. Although the underlying assumptions are only approximately correct, the direction and speed computed by this method are very close to the direction and speed actually observed.

Hadley Cell. Heated air at the equator rises and moves poleward in the upper atmosphere. It cools through the loss of long wave radiation and begins to sink at about 20-30° north and south of the equator, whereupon part of the air returns to the equator. This forms a large, semi-permanent vertical cell on each side of the equator. Postulated by George Hadley in 1735.

Hectopascal. Standard international unit, abbreviated as hPa, measuring air pressure: 1 hPa = 1 millibar.

Hindcasting. The procedure whereby wave characteristics can be calculated from the wind direction, strength and duration derived from weather charts.

Hurricane. A tropical storm in the Atlantic Ocean, with cyclonic circulation and wind speeds greater than 118 kilometers/hour (74 miles/hour).

Hurricane Warning. Indicates that hurricane winds are expected in a designated coastal area within 24 hours.

Hurricane Watch. Indicates that hurricane winds are expected in a designated coastal area within 36 hours.

Hydrostatic. Describing pressure at a point in the water column due to the weight of water at higher levels.

Intertropical Convergence. Air in the tropics rises because of heating beneath the seasonal position of the sun. Winds flow from the north and south, and converge on this zone of heating, effectively producing a barrier to the exchange of air between hemispheres.

Inverted Barometer Effect. The height of sea level inversely relates to the pressure of the atmosphere above, such that a decrease of 1 hectopascal (hPa) in air pressure results in a rise in sea level locally of 1 cm.

Isobars. Lines plotted on a map joining points of equal pressure, usually at a fixed spacing of 4 hectopascals (hPa).

Isohaline. Line or contour connecting points of equal salinity in the oceans.

Isothermal. Having equal temperatures.

Isotherm. line or contour connecting points of equal temperature.

Landfall. The point where the eye of a tropical storm moves inland at a coastline.

Latent Heat. (1) of evaporation: each kilogram of water converted to water vapor at 26°C requires 2425 kilojoules of heat energy. Because this heat energy is not felt, it is termed 'latent'. (2) Of condensation: if this air is cooled and moisture condenses, the latent heat energy is released back to the atmosphere, warming the air.

Levee. When a river overflows its banks, there is an immediate decrease in velocity. This results in deposition of suspended mud, and eventually the build-up of an embankment that can contain the river above the elevation of its adjacent floodplain.

Longshore (Littoral) Current. Waves striking the shoreline at an angle generate a current running parallel to the beach that carries sand.

Longshore (Littoral) Drift. The movement of water and sediment within surf zones due to waves approaching shore at an angle.

Long Wave Radiation. Infrared radiation with wavelengths of about 50µm that is radiated by the earth to balance the global heat budget.

Meandering. The process whereby a flow of air or water tends to become unstable and travel in a winding path.

Meridional Flow. Movement of air or water in north-south directions.

Mixed Layer. The temperature zone of water above the thermocline where winds and currents mix the surface waters and convey heat downward.

Mixed tides. Complex tide curve, usually with two highs and lows of unequal height per lunar day.

Monsoon. Defines any region characterized by a distinct 180° change in wind direction between summer and winter, resulting in seasonal alternation of copious rain and aridity.

Neap tides. The tides of lowest range, occurring twice monthly when the moon is in quadrature with the sun (i.e., sun and moon are 90° apart).

Oceanic Section. A vertical cross-section of contoured ocean water properties.

Orthogonal. A line drawn perpendicular to wave crests so that refraction or bending can be visualized more clearly.

Polar Front. The relatively narrow intersection zone between cold, dense polar air and warmer, moister subtropical air.

Polar Jet Stream. A fast-moving flow of air at the top of the troposphere along the polar front.

Prevailing Westerlies. The average west to east winds in the subtropical zones that is frequented by alternating clockwise and counterclockwise rotating geostrophic wind zones.

Pycnocline. A zone of relatively rapid density change with depth (i.e. gradient) that in the ocean separates a relatively warm, less dense upper layer from very cold, dense deeper waters. The permanent oceanic pycnocline coincides with the permanent thermocline between the depths of about 200 meters and 1000 meters.

Resonance. A process involving air or water waves whose wavelength is equal to, or some harmonic of, the physical dimensions of a basin or embayment.

Rip Current. Concentrated, higher speed offshore current flows from the surf zone that return breaking wave run-up to deeper waters. The strength of the current is proportional to the height of the breakers striking the shoreline.

Rosby Waves. Any wave motion that develops with a long wavelength of hundreds or thousands of kilometers in a fluid moving parallel to the Earth's surface and controlled by Coriolis force. Generally restricted to the upper westerlies attached to the polar jet stream at mid-latitudes.

Run-Up. When any ocean wave reaches the shoreline, its momentum tends to carry a mass of water landward. The distance landward of the shoreline is the run-up distance, while the elevation above sea level is the run-up elevation.

Sea Surface Temperature (SST). The temperature of the upper surface of the ocean; sometimes detected by satellites.

Saffir-Simpson Scale. The standard for measuring hurricane strength, based on minimum *sustained* wind speeds.

Sahel. The subregion of Africa at the southern edge of the Sahara Desert, where hurricane-related easterly wave disturbances are formed.

Salinity. The concentration of salts in the water.

Santa Anna Wind. Air cools adiabatically at a slow rate of about 0.5°C per 100 m, when it rising on the

- windward side of a mountain, because it is warmed by condensation-related releases latent heat of evaporation. When this air then descends on the leeward side of the mountain, it tends to warm at the faster, dry adiabatic lapse rate of 1°C per 100 m and thus is much warmer and drier than on the windward side.
- Sea .** Local irregular waves of many periods and from many directions. A sea forms within storm areas or when local winds are blowing over the sea surface.
- Seiching.** Excitation of a regular oscillation of water waves within a basin or embayment - caused by an earthquake, the passage of an atmospheric pressure wave, or the occurrence of strong winds.
- Semidiurnal tides.** Tides occurring twice daily. There are two high and two low tides per lunar day.
- Set-Up.** The enhanced elevation of sea level at a coastline due mainly to the process of wave-breaking across a surf zone, but also aided by wind, shelf waves, Coriolis force, upwelling, and current impinging along a coast.
- Shear Stress.** The force applied to a body of material, which tends to move it parallel to the contact with another solid or fluid.
- Shearing.** A stress caused by two adjacent moving objects tending to slide past each other parallel to the plane of contact.
- Short Wave Radiation.** Solar radiation with wavelengths of about 5µm that is absorbed by the Earth and powers the combined atmospheric/oceanic heat transfer from the tropics to the polar region to balance the global heat budget.
- Spring tides.** The tides with largest range; occurring twice monthly when the lunar and solar forcings are in phase.
- Storm Surge.** A rise above normal water level on an open coast due to atmospheric pressure reduction and strong storm winds that "pile-up" water against the shore as the storm approaches land.
- Strain.** The deformation or movement caused by applying a force to material on a slope.
- Stratosphere.** That part of the atmosphere lying 12-60 km above the Earth, and characterized by stability and an increase in temperature with altitude.
- Surf Zone.** The nearshore zone in which shoreward propagating waves break.
- Surplus Heat.** Tropical regions have an excess of heat energy relative to the poles because incoming solar radiation exceeds outgoing long wave radiation.
- Surplus Heat Transport.** To maintain a heat balance over the Earth's surface, surplus tropical heat is transported by a combination of air and ocean currents to the polar regions.
- Swell.** Waves that have traveled a long distance from the generating area and have been sorted out by travel into long waves of the same approximate period.
- Thermocline.** A zone of relatively rapid temperature change (i.e. gradient) with depth in a body of water. The permanent thermocline in the oceans occurs between the levels of about 200 meters and 1000 meters, and separates a relatively uniform warm upper layer from very cold deeper waters.
- Tidal day (or lunar day).** The time between two successive transits or passages of the moon over a local meridian. It is derived from the rotation of the earth relative to the movement of the moon about the earth. As the earth rotates once on its axis (24 hours) the moon has advanced in its orbit about the earth about 50 minutes; therefore the tidal day is 24 hours and 50 minutes long.
- Tidal range.** The difference in height between successive high- and low-tide levels.
- Tidal Waves.** A misnomer applied to tsunami and storm surges because these phenomena sometimes produce a slow drop in sea level followed by a rapid rise, analogous to tides.
- Trade Winds.** Zonal easterly (east to west) winds in the tropical northern (NE trades) and tropical southern (SE trades) hemispheres. Their steadiness for three to four months of the year greatly benefited trading ships in the days of sail.
- Tropical Cyclone.** A large-scale vortex of rising air hundreds of kilometers in diameter that forms over the tropical oceans. It is characterized by copious rain and a central area of calm surrounded by rotating winds blowing at speeds in excess of 200-250 km hr⁻¹.
- Troposphere.** The lower part of the atmosphere, 10-12 km in altitude, characterized by cloud formation and a drop in temperature with elevation.
- Turbulence.** Flow - also called turbulent flow - in which individual particles or molecules travel unpredictable paths apparently unaffected by gravity.
- Typhoon.** A tropical storm in the Pacific Ocean, with cyclonic circulation and wind speeds greater than 118 kilometers/hour (74 miles/hour).
- Upwelling.** The process by which water rises from a lower to a higher depth, usually as a result of offshore water flow. It is most prominent where persistent wind blows parallel to a coastline, so that the resultant

Ekman transport moves surface water away from the coast.

Viscosity. The molecular-scale resistance of fluid to the motion.

Vortex. A spinning or swirling mass of air or water; sometimes reach considerable velocity, as in a tornado.

Wave Diffraction. The tendency for wave energy to spread out along the crest of a wave. Hence, when a wave passes through a narrow harbor entrance, the wave will tend to spread out and affect the entire coastline inside a harbor.

Wave Energy Coefficient; e is the ratio of the width of a pair of orthogonals at the shore to the width of the pair of orthogonals in the deep water.

Wave Height. The difference in elevation between the crest and trough of a wave.

Wave Length. The distance between equivalent points (e.g., crests or troughs) on waves.

Wave Period. The length of time, in seconds, required for a wave to pass a fixed point.

Wave Reflection. The process by which the energy of wave is returned seaward from a boundary

Wave Refraction. The process by which the direction of a wave moving in shallow water at an angle to the bottom contours is changed. The part of the wave moving shoreward in shallower water travels more slowly than that portion in deeper water, causing the wave to turn or bend to become parallel to the contours. Hence, a wave crest tends to wrap around headlands and to spread out into bays.

Wave-Rider Buoy. An instrument, consisting of sensitive accelerometers encased inside a buoy and floating on the ocean surface, used for measuring the height and energy of waves.

Wave Velocity. The wavelength divided by the wave period (in feet per second or meters per second).

Western Boundary Current. The high-speed western flow arm of the wind-driven circulation gyres. The Gulf Stream and Brazil Current are examples.

Wind-Driven Gyres. Large wind-driven rotating cells of ocean water that often completely occupy an ocean basin.

Wind setup. The vertical rise in the water level on the leeward or downwind side of a body of water due to strong winds. Wind setup is similar to storm surge but the term is usually applied to reservoirs and smaller bodies of water.

Wind Shear. The tendency for winds to move at different velocities at different elevations because of strong temperature differences. The wind, as a result, may accelerate in speed over short altitudes or even change direction - a particularly hazardous situation for airplanes landing or taking off.

Zonal Flow. Movement of air or water in east-west directions.