

GLOSSARY

3D Navier-Stokes Equations – describe the motion of fluid substances. These equations arise from applying Newton's second law to fluid motion, together with the assumption that the fluid stress is the sum of a diffusing viscous term (proportional to the gradient of velocity), plus a pressure term. These equations are fully three-dimensional such that vertical velocity gradients are important.

active layer – a “thin window” of sediment at the bed surface, in which sediment is exposed to hydrodynamic shear

adaption – refining of the finite element mesh such that elements are subdivided and more resolution is obtained.

adaption – the process by which the mesh can adapt in areas where more resolution is needed and then unrefine when necessary. The process during computations that allows the model automatically refine to provide accurate hydrodynamics and transport.

Additive Schwarz preconditioning - In mathematics, solves a boundary value problem for a partial differential equation approximately by splitting it into boundary value problems on smaller domains and adding the results.

AdH – Adaptive Hydraulics (AdH) is a modular, parallel, adaptive finite element model for one-, two-, and three-dimensional flow and transport. AdH simulates groundwater flow, internal flow, and open channel flow.

average stem density – the average density of the vegetation field

average stem diameter – the average diameter of the stems throughout the area

baroclinic transport – transport that includes the variation in density throughout the water body. This density consideration is important for salinity and temperature flows.

bathymetry – the bed elevations in water bodies

bed displacement – the change in the bed elevation over time due to the erosion and deposition of sediment. Positive values indicate deposition and negative values indicate erosion.

bed friction (bed roughness) – the roughness of the bed material generating an energy loss and effect on the flows

bed layer – a layer of bed material with specific properties used by AdH to accurately represent the various bed stratus and maintain the properties of sedimentation events during the model simulation.

bed layer thickness – the thickness of a bed layer

bed shear stress – The stress (or energy) that the flows generate on the bed. These stresses cause the erosion and deposition of the bed.

bedload – (1.) Sediment transport mode in which individual particles either roll or slide along the bed as a shallow, mobile layer a few particle diameters deep, the part of the load that is not continuously in suspension. (2.) The term bed load or bedload describes particles in a flowing fluid (usually water) that are transported along the bed.

bedload vector – the vector that describes the direction and magnitude of the bedload transport at a given location and time.

bendway correction – A method for correcting 2-dimensional models for the 3-dimensional effects of vorticity around bends.

boundary condition file – This file contains a series of one line control cards for your model (filename.bc).

boundary conditions – Environmental conditions, e.g. waves, currents, drifts, etc. used as boundary input to physical or numerical models. Water levels, flows, concentrations, stage/discharge relationships, etc., that are specified at the boundaries of the area being modeled. A specified tailwater elevation and incoming upstream discharge are typical boundary conditions.

boundary strings – connections of nodes or elements that define locations where boundary conditions will be applied

bulk density - Bulk density is a property of powders, granules and other "divided" solids, especially used in reference to soil. It is defined as the mass of many particles of the material divided by the total volume they occupy. The total volume includes particle volume, inter-particle void volume and internal pore volume.

cartesian coordinate system - A Cartesian coordinate system specifies each point uniquely in a plane by a pair of numerical coordinates, which are the signed distances from the point to two fixed perpendicular directed lines, measured in the same unit of length.

channel - (1.) A natural or artificial waterway of perceptible extent which either periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. (2.) The part of a body of water deep enough to be used for navigation through an area

otherwise too shallow for navigation. (3.) A large strait, as the English Channel. (4.) The deepest part of a stream, bay, or strait through which the main volume or current of water flows.

clay - A fine grained, plastic, sediment with a typical grain size less than 0.004 mm. Possesses electromagnetic properties which bind the grains together to give a bulk strength or cohesion.

coastal – The land and sea areas bordering the shoreline.

coastal wetlands – NOAA defines coastal wetlands as all wetlands in coastal watersheds—that is, watersheds that drain into the ocean or to an estuary or bay.

cohesionless sediment – (sand) grains larger than ~ 0.06 mm, the particles do not bind together through chemical processes.

cohesive sediment – (clay and/or silt) Sediment containing significant proportion of clays, the electromagnetic properties of which cause the sediment to bind together.

concentration - concentration is the measure of how much of a given substance there is mixed with another substance.

control volume - In fluid mechanics and thermodynamics, a control volume is a mathematical abstraction employed in the process of creating mathematical models of physical processes. In an inertial frame of reference, it is a fixed volume in space through which the fluid (gas or liquid) flows. The surface enclosing the control volume is referred to as the control surface.

converge, convergence - The process of obtaining a solution by way of an iterative solution technique, such as the Newton-Raphson method.

convergence tolerance –the maximum value accepted of the residual in order to proceed to the next time step.

coriolis force - A term in the relative hydrodynamic equations of motion that takes into account the effect of the Earth's rotation on moving objects (including air and water) when viewed with reference to a coordinate system attached to the rotating Earth. The horizontal component is directed 90° to the right (when looking in the direction of the motion) in the Northern Hemisphere and 90° to the left in the Southern. The horizontal component is zero along the Equator; also, when the object is at rest relative to the Earth.

critical shear stress for deposition – the shear stress that must not be exceeded such that a given grain size can deposit.

critical shear stress for erosion – the shear stress that must be exceeded for erosion to begin for a given grain size.

current - (1.) The flowing of water, or other liquid or gas. (2.) That portion of a stream of water which is moving with a velocity much greater than the average or in which the progress of the water is principally concentrated. (3.) Ocean currents can be classified in a number of different ways. Some important types include the following: (a) Periodic - due to the effect of the tides; such Currents may be rotating rather than having a simple back and forth motion. The currents accompanying tides are known as tidal currents (b) Temporary - due to seasonal winds (c) Permanent or ocean - constitute a part of the general ocean circulation. The term DRIFT CURRENT is often applied to a slow broad movement of the oceanic water Nearshore - caused principally by waves breaking along a shore.

density - The mass or quantity of a substance per unit volume.

depth - The vertical distance from a specified datum to the sea floor. Sometimes referred to as the overland head.

diffusion – a time-dependent process, constituted by random motion of given entities and causing the statistical distribution of these entities to spread in space.

dirichlet boundary condition – a directly specified boundary condition at a location; specifies the values a solution needs to take on the boundary of the domain.

DoD – The United States Department of Defense (USDOD, DOD or DoD) is the U.S. federal department charged with coordinating and supervising all agencies and functions of the government relating directly to national security and the United States armed forces.

domain – The extent of the numerical study area.

edge string – A list of element edges that form a common boundary. Natural or flux data are specified across edge strings. They can be also used to identify a wall, i.e. solid boundary.

element - A triangle shape composed of corner nodes. An element must be 'connected' to a neighboring element.

English units – The United States customary system (also called American system or, more rarely, "English units") is the most commonly used system of measurement in the United States. It is similar but not identical to the British Imperial units. The U.S. is the only industrialized nation that does not mainly use the metric system in its commercial and standards activities, although the International System of Units (SI, often referred to as "metric") is universally used in science, and increasingly in medicine, government, and many sectors of industry.

equilibrium transport boundary condition – A condition in which sediment is applied at the boundary such that equilibrium is satisfied and no sediment will erode or deposit.

equivalent roughness height – the height of the bed features that affect the friction generated by the bed.

erosion - The wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents, littoral currents, or by deflation is known as erosion.

erosion flux – the rate at which erosion is occurring at a location

estimated eddy viscosity – allow for AdH to compute the appropriate viscosity term depending on the depth and velocity magnitude at each location and time.

estuarine – Formed in an estuary. Found in estuaries which are the location where fresh water and salt water mix.

evaporation - Evaporation is a type of vaporization of a liquid, that occurs only on the surface of a liquid.

field data - Data which has been collected at an existing, physical site, used when verifying the simulation.

finite element - A method of solving the basic governing equations of a numerical model by dividing the spatial domain into elements in each of which the solution of the governing equations is approximated by some continuous function. This method lends itself well to the river/estuarine environments because of its diversity in computational mesh (element size, shape, orientation), flexibility of boundary conditions, and continuity of the solution over the area.

flow field - The domain in which the water flows. The spatial distribution of flows.

flume – An open channel constructed of wood, steel, or reinforced concrete and used to convey water for various purposes, including grade control.

flux – the amount that flows through a unit area per unit time

Froude number - A unitless mathematical expression used to describe a flow field. Froude numbers greater than or equal to 1 are supercritical, less than 1 are subcritical. The equation

for Froude number is $F = \frac{V}{\sqrt{gh}}$

geometry file – the file that contains the domain specific information defining the location of computation nodes and how they are connected.

GMS – Groundwater Modeling System, GMS integrates and simplifies the process of groundwater flow and transport modeling by bringing together all of the tools needed to complete a successful study. GMS provides a comprehensive graphical environment for numerical modeling, tools for site characterization, model conceptualization, mesh and grid generation, geostatistics, and sophisticated tools for graphical visualization.

grain class – the size class for specific grains

grain distribution – the ratio of the various grain sizes.

grain size – A linear dimension, usually designated as "diameter," used to characterize the size of a particle. The dimension may be determined by any of several different techniques, including sedimentation sieving, micrometric measurement, or direct measurement.

gravity – denoted g , the means by which objects with mass attract one another ($g = 9.81 \text{ m/s}^2 = 32.2 \text{ ft/s}^2$).

grid - Network of points covering the space or time-space domain of a numerical model. The points may be regularly or irregularly spaced.

groundwater - The water contained in interconnected pores located below the water table.

harmonic constituent - One of the harmonic elements in a mathematical expression for the tide-producing force and in corresponding formulas for the tide or tidal current. Each constituent represents a periodic change or variation in the relative positions of the Earth, Moon.

hotstart file - The hot start file is mandatory and contains initial conditions for each node of a mesh (filename.hot).

hydraulic conductivity - The rate at which water of a specified density and kinematic viscosity can move through a permeable medium.

hydraulic jump - A sudden turbulent rise in water level, such as often occurs at the foot of a spillway when the velocity of rapidly flowing water is instantaneously slowed.

hydrodynamics - Relates to the specific scientific principles that deal with the motion of fluids and the forces acting on solid bodies immersed in fluids, and in motion relative to them.

hydrograph - A time series recording of the measurement of flow across a river or stream.

ice string – A boundary string used to define an ice patch.

inflow – In hydrology, the inflow of a body of water is the source of the water in the body of water. It can also refer to the average volume of incoming water in unit time. It is contrasted with outflow. A boundary condition location at which flow enters the mesh. All bodies of water have multiple inflows, but often, one inflow may predominate and be the largest source of water. However, in many cases, no single inflow will predominate and there will be multiple primary inflows. For a lake, the inflow may be a river or stream that literally flows into the lake. Inflow may also be, strictly speaking, not flows, but rather precipitation, like rain.

initial conditions - The values of water levels, velocities, concentrations, etc., that are specified everywhere in the grid or mesh at the beginning of a model run. For iterative solutions, the initial conditions represent the first estimate of the variables the model is trying to compute.

interactive - Opposite of Batch mode. The program requires the user to respond to questions. If the program is running on a mainframe computer, the program is time sharing the CPU with other jobs, which can cause delays in some cases.

isotropic - having identical properties in all directions.

iteration - Repeating a sequence of instructions a specific number of times, changing parameters and obtaining a new solution each time, until a predetermined condition is met.

iteration parameters - control the iterative methods employed by the model.

kinematic eddy viscosity - The ratio of the dynamic viscosity of a fluid to its density

kinematic molecular viscosity – the transport of mass motion momentum solely by the random motions of individual molecules not moving together in coherent groups. Molecular viscosity is analogous in laminar flow to eddy viscosity in turbulent flow.

linear iterations – the iterations taken by the linear solver, which is solved for each nonlinear iteration.

linear solver – solves the system of linear equations.

logarithmic velocity profile – the velocity at the bed is zero due to friction and increases toward the water surface with a logarithmic ($y=e^x$) variation.

mangrove stands – An assemblage of mangrove trees which are mostly low trees noted for a copious development of interlacing adventitious roots above the ground. Mangrove stands provide significant flood protection in some coastal areas by protecting landward areas from wave impacts.

Manning's units constant – the constant used in the Manning's equation, 1.0 for SI units and 1.486 for English units.

material – a number assigned to elements in order to group them and then designate different parameters to them.

material string – These strings are used to designate a group of elements for Natural or flux data. They identify a surface area.

mesh – The network of computational points (nodes) linked together by finite element connection tables to form a digital representation of the modeled area's geometry.

mid string – A list of element edges such that there are elements on both sides of the string. Flow outputs internal to the domain are determined across mid-strings. They must begin and end on a mesh boundary and are created specifically for flow output.

mixed sediments – a mixture of sediment by grain size and therefore type: sand, silt, clay.

model - A representation of a physical process or thing that can be used to predict the process's or thing's behavior or state. Examples- A conceptual model, If I throw a rock harder, it will go faster. A mathematical model, $F = ma$. A hydraulic model, Columbia River physical model.

momentum - A measure of the motion of a body equal to the product of its mass and velocity.

natural boundary condition – a boundary condition that is built into the weak form of the finite element equation as an integral over the boundary.

Neumann boundary condition- see Natural Boundary Condition.

node - A point containing an x, y, and z coordinate which defines a location in space. Mid-side nodes (x, y, z) are linearly interpolated from adjacent corner nodes, unless the element side is curved.

node string – A list of nodes that form a common boundary. Dirichlet data are specified on node strings. These can be made up of boundary and/or interior nodes as the problem requires.

numerical approximation – solving a mathematical equation to represent nature where assumptions and boundary conditions are included that allow for an estimate of the real world.

numerical dissipation - In computational physics, a numerical dissipation is also known as "artificial dissipation" or "artificial diffusion" or "numerical diffusion". They all mean this: when the pure advection equation—which, by definition, is free of dissipation—is solved by a numerical approximation method that reduces the amplitude and changes the shape of the initial wave in a way analogous to a diffusional process, the method is said to contain 'dissipation'.

numerical scheme – the method used to set up and solve the finite element equations.

operation parameters - Control the operation of the code, the reserved memory space, type of problem being modeled, and the solver preconditioning arrangement. Operational parameter cards are identified by an "OP" in the first field. (An OP SW2 card is used to specify 2D Shallow Water flow modeling.

outflow - In hydrology, the outflow or discharge of a river is the volume of water transported by it in a certain amount of time.

outflow boundary condition – a boundary condition specifying a location where flow is allowed to leave the model. Used for supercritical boundary conditions.

output controls –define the times at which the output is saved for later analysis.

overland flow - Water flowing over the ground surface toward a channel; upon reaching the channel, it is called surface runoff.

parser – In computing, a parser is one of the components in an interpreter or compiler, which checks for correct syntax and builds a data structure (often some kind of parse tree, abstract syntax tree or other hierarchical structure) implicit in the input tokens.

phragmites – A large perennial grass found in wetlands throughout temperate and tropical regions of the world.

porosity – Percentage of the total volume of a soil sample not occupied by solid particles but by air and water, $n = V_v/V_T \times 100$. (ASTM D 653) the ratio, usually expressed as a percentage, of (1) the volume of voids of a given soil or rock mass, to (2) the total volume of the soil or rock mass.

post-processor - software that provides some final processing to data, such as formatting it for display or printing.

pre_adh – a setup program that reads the input files and checks to make sure they are consistent. Pre_adh also checks the geometry to make sure that the elements are properly formed.

preconditioner – In linear algebra and numerical analysis, a preconditioner P of a matrix A is a matrix such that $P^{-1}A$ has a smaller condition number than A . Preconditioners are useful when using an iterative method to solve a large, sparse linear system.

pre-processor - a program that processes its input data to produce output that is used as input to another program.

pseudo-transient continuation (PCT) – A method by which the timestep size can grow while providing accurate model results.

radiation stress - The flux of momentum, which is carried by the ocean waves. When these waves break, that momentum is transferred to the water column, forcing nearshore currents. Forcing due to these radiation stress gradients is commonly several orders of magnitude greater than forcing due to wind or other wave nonlinearities.

rectilinear domains – model domains defined by rectangular shaped elements.

refinement – the addition of more nodes and elements in a numerical model mesh.

refinement tolerance – the tolerance used to determine how an element can be divided within AdH.

residual error - The difference between the computed and observed value of a variable at a specific time and location.

salinity – Number of grams of salt per thousand grams of sea water, usually expressed in parts per thousand.

sand – Sediment particles, often largely composed of quartz, with a diameter of between 0.062 mm and 2 mm, generally classified as fine, medium, coarse or very coarse. Beach sand may sometimes be composed of organic sediments such as calcareous reef debris or shell fragments.

saturated groundwater – (saturated zone) The zone in which the voids in the rock or soil are filled with water at a pressure greater than atmospheric. The water table is the top of the saturated zone in an unconfined aquifer.

second order temporal scheme – additional time derivatives are included in the finite element equations to improve model accuracy.

sediment mass residual – the cumulative residual sediment mass. Here, residual is defined as the mass “left over” after summing up all of the cumulative sediment fluxes into and out of a control volume within the model domain.

sediment transport - The movement of solid particles (sediment) and the processes that govern their motion. Sediment transport is typically due to a combination of the force of gravity acting on the sediment, and/or the movement of the fluid in which the sediment is entrained.

settling velocity – the velocity as which a given particle will fall through the water column due to its weight.

shallow water - (1.) Commonly, water of such a depth that surface waves are noticeably affected by bottom topography. It is customary to consider water of depths less than one-half the surface wavelength as shallow water. (2.) More strictly, in hydrodynamics with regard to progressive gravity waves, water in which the depth is less than $1/25$ the wavelength.

Shallow Water Equations – (also called Saint Venant equations in its unidimensional form) are a set of hyperbolic partial differential equations that describe the flow below a pressure surface in a fluid. The equations are derived from depth-integrating the Navier-Stokes equations, in the case where the horizontal length scale is much greater than the vertical length scale. Under this condition, conservation of mass implies that the vertical velocity of the fluid is small. It can be shown from the momentum equation that vertical pressure gradients are nearly hydrostatic, and that horizontal pressure gradients are due to the displacement of the pressure surface, implying that the horizontal velocity field is constant throughout the depth of the fluid. Vertically integrating allows the vertical velocity to be removed from the equations. The shallow water equations are thus derived. These equations can be solved in two and three-dimensions.

shoreline – (1.) The line of demarcation between a shore and the water. May fluctuate periodically due to tide or winds. (2.) The intersection of the land with the water surface. The shoreline shown on charts represents the line of contact between the land and a selected water elevation. In areas affected by tidal fluctuations, this line of contact is the mean high water line. In confined coastal waters of diminished tidal influence, the mean water level line may be used. (3.) The intersection of a specified plane of water with the shore or beach (e.g., the high water shoreline would be the intersection of the plane of mean high water with the shore or beach). The line delineating the shoreline on National Ocean Service nautical charts and surveys approximates the mean high water line (United States).

SI units – System International (SI) Formally named in 1960 by an international general conference on weights and measures. This system provides exact definitions of the metric system units for the fields of science and industry.

sign convention - In physics, a sign convention is a choice of the signs (plus or minus) of a set of quantities, in a case where the choice of sign is arbitrary. "Arbitrary" here means that the same physical system can be correctly described using different choices for the signs, as long as one set of definitions is used consistently.

silt - (1.) Material passing the No. 200 (75- μ m) U.S. standard sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air-dried. (2.) Sediment particles with a grain size between 0.004 mm and 0.062 mm, i.e. coarser than clay particles but finer than sand.

simulation – Reproduction of the prototype behavior using a model.

skin friction – the friction of the fluid against the "skin" of the object that is moving through it. Skin friction arises from the interaction between the fluid and the skin of the body, and is directly related to the wetted surface, the area of the surface of the body that is in contact with the fluid.

SMS – Surface Water Modeling System, SMS officially replaced FastTABS in 1996. A computer program that provides a graphical, point and click means for performing pre- and post-processing for surface water numerical models. Developed at the Waterways Experiment Station and Brigham Young University. Corps of Engineers employees may contact the Engineer Research and Development Center, Coastal and Hydraulics Laboratory (ERDC-CHL) for more information. Or use e-mail at SMS@usace.army.mil.

solution controls - specify the initial/boundary conditions in the bc file.

spatial residual – the residual of the matrix equation based on the changes in the x and y directions.

specific gravity – Relative density, or specific gravity, is the ratio of the density (mass of a unit volume) of a substance to the density of a given reference material. Specific gravity usually means relative density with respect to water.

steady current field – the flow field does not change in time.

steady state – The flow field and boundary conditions do not change in time. Equivalent to running the model for infinity with a unique set of boundary conditions that do not change with time.

subcritical - The relationship of velocity to water depth such that the Froude number is less than one. The Froude number is defined as the fluid velocity divided by the square root of the product of gravity and water depth.

submerged aquatic vegetation – Vegetation that lives at or below the water surface; an important habitat for young fish and other aquatic organisms.

supercritical – A supercritical flow is when the flow velocity is larger than the wave velocity (Froude number > 1). Information travels at the wave velocity and surface disturbances will not travel upstream. It is only in supercritical flows that hydraulic jumps (bores) can occur.

suspended load – The term for the particles that settle slowly enough to be carried in flowing water (such as a stream or coastal area) either without touching the bed or while only intermittently touching it. These particles are generally of the fine sand, silt and clay size, although larger particles may be carried as well depending on the intensity of the flow.

suspension – the particles are moving within the water column rather than remaining on the bed, they are suspended in the fluid.

switched evolution relaxation (SER) strategy – Used in conjunction with PCT to allow for AdH to choose the appropriate time step size to maintain model accuracy and speed.

tailwater elevation – The elevation of the water surface at a downstream or exit boundary location.

tensor - Tensors are geometric entities introduced into mathematics and physics to extend the notion of scalars, (geometric) vectors, and matrices.

tetrahedral elements – These are three-dimensional elements with four, triangular shaped sides.

tide - The periodic variation in the surface level of the oceans and of bays, gulfs, inlets, and estuaries, caused by gravitational attraction and relative motions of the moon and sun. The types of tides are Diurnal tide, Mixed tide, Neap tide, Semidiurnal tide, and Spring tide.

time controls - specify the time to start, end, and time steps used to run the model.

time derivative - a derivative of a function with respect to time, usually interpreted as the rate of change of the value of the function. The variable denoting time is usually written as t .

time series – a sequential list of values that change with time and will be used to define some type of boundary condition.

time step - the amount of time between consecutive solves of the finite element matrix.

transport constituent – a transported quantity of some type.

transport quantities – quantities that are advected and diffused within the water body such as salinity, temperature, and sediment.

turbulence - In a turbulent motion, the true velocity and pressure vary in a disorderly manner. A turbulent motion is always unsteady, since at a given point the velocity changes continuously in a very irregular way.

turbulent diffusion - the transport of mass, heat, or momentum within a system due to random and chaotic time dependent motions.

two-dimensional (2D) element - A triangle (3 corners) shape which defines the geometry in two space coordinates and averages over the third space coordinate. In a two-dimensional *Horizontal* model, the averaging occurs over depth. In a two-dimensional *Vertical* model, the

averaging occurs over width. Several two-dimensional horizontal elements aligned side by side may accurately define the bottom elevation of a navigation channel.

undeflected stem height – the height of vegetation when erect.

unsaturated groundwater – (unsaturated zone) Also known as the zone of aeration and the vadose zone. The zone between the land surface and the water table. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched groundwater, may exist in the unsaturated zone.

unsubmerged rigid vegetation – vegetation that grows through the water column to heights greater than the depth and the stem structure is such that no bending occurs (tree trunks).

velocity - the rate of change of position (ft/sec or m/sec). Velocity is a vector consisting of a (u, v, z) component. In two dimensions, the z component is neglected.

vessel transport – the movement of a vessel through a water body.

viscosity - The degree to which a fluid resists flow under an applied force.

vorticity – Vorticity is a mathematical concept used in fluid dynamics. It can be related to the amount of "circulation" or "rotation" (or more strictly, the local angular rate of rotation) in a fluid. This is important in flow around bends (especially in rivers) in order to maintain the field behavior of higher flows along the outside of the bend and lower flows along the inside.

water surface elevation - A measure of the free water surface with respect to a given datum.

wave - A ridge, deformation, or undulation of the surface of a liquid.

where F = the Froude number, V = the fluid velocity, g = gravity, and h = fluid depth.

Updated 1-3-2012