Release Notes for January, 2002 SeaSoft Release [Version 4.32]

This release features several new often-requested features, many significant bug fixes and some important analytical and computational improvements.

The release notes for the previous full release (version 4.20) should be reviewed for additional recent update information. A cumulative list of recent release note files available from SeaSoft follows:

Release_Notes(April_01)	[v 4.20]
Release_Notes(June_00)	[v 4.14]
Release_Notes(Oct_99)	[v 4.07]

Release Highlights

- The new version number for all simulations is 4.32.
- There are several new features, including a comprehensive overhaul of user-specified wind and current environmental forces and irregular wave spectra, which overhaul provides a consistent framework for all user-specified input characteristics including RAOs, wave drift coefficients, wind and current coefficients, and irregular wave spectra.
- We found and eliminated several long-standing bugs, most notably bugs affecting Semisim, Sparsim and Slowsim, as documented further below.
- There are significant enhancements and modifications to recently developed simulations, particularly Sparsim, including a new spar/semisubmersible wave drift force model.
- There are significant improvements to the current-wave drift force interaction models for all vessel types; this impacts primarily simulations with large current speeds.

  If you have not checked out the web site, you should take an opportunity to do so. Free access to all simulations is available to anyone who requests an on-line account. This free access is intended to help us work out the kinks in the Internet-based delivery model and will naturally be limited in duration.

A selected listing of major enhancements, updates, modifications and bug fixes follows.

Significant Enhancements:

- Incorporated comprehensive units conversion routines; conversion of data files between English and metric units may now be carried out automatically; as is our custom, the primitive "legacy" units conversion option remains available alongside the new comprehensive option.
- An often-requested feature, namely a consistent treatment of user-specified tabular data input via externally supplied text files, has been implemented following the model already in use for wave drift forces (DRFTCOFS.txt) and RAOs (USERRAOS.txt). You may now specify wind coefficients (WINDCOFS.txt), current coefficients (CRNTCOFS.txt) and wave spectral data (WAVSPEC.txt) in a text-based format closely analogous to that of DRFTCOFS.txt and USERRAOS.txt. The "legacy" built-in mechanisms for wind and current (via the binary LOWDAT file), and for "Custom" irregular-wave spectra (previously stored in the binary *DAT files), will remain for backwards compatibility of data files. The new options are documented in on-line help notes, to which you should refer for guidance until the documentation makes its way into the manuals. Both DRFTCOFS.txt and USERRAOS.txt file specifications are described in detail in the Moorsim manual, to which reference can be made for additional guidance in preparing wind/current coefficient files or wave spectral files.

- Implemented a new drift force model for surface-piercing cylinders (called the "SeaSoft Spar" model); this was done primarily to improve the modeling of drift forces on caisson spars. However, both theoretically and in practice, it should produce good results for conventional semisubmersibles and TLPs as well. This model may ultimately prove to be more representative of semis than the existing "SeaSoft Semi" drift force model, which was developed using a hybrid of empirical and theoretical considerations. Both models are now, and will remain, available as user-selectable options. In heavy sea conditions, the new model typically produces somewhat smaller drift forces for both conventional semis and spars.

- Revisited and overhauled the treatment of the interaction between current and wave-drift coefficients. This change affects all comprehensive simulations that include both current and irregular waves (and/or swell) and will produce a small but noticeable change in all output values, particularly loads and low-frequency motions. These changes will also effect simulations with user-specified drift coefficients if the "Apply current correction to drift forces" flag is set (on the "Vessel Low-Frequency Dynamics Characteristics" editor page). Further, because the changes affect net mean forces and moments, they impact the equilibrium position and orientation determination and therefore will even slightly affect wave-frequency motions since those motions are dependent on vessel orientation.

  In most circumstances, particularly in deep water with aligned environmental conditions, numerical differences related to the new treatment will be only a few percent; further, in deep water the differences will always vanish in the limit of small current. In simulations with very large currents and/or very shallow water, which happen to be dynamically dominated by wave drift effects, or simulations with strongly crossed environments, the differences may in some circumstances be more profound. In testing to date, we have not seen changes in net loads or motions that go beyond the level of "noise", which for SeaSoft simulations we consider to be 5%-10%. One possible exception to this expectation: in highly crossed environmental conditions, where a cancellation of large opposing mean forces and moments conspires to produce a marginally stable equilibrium orientation, a small change in any of the environmental forces can produce a relatively large change in vessel orientation, which change can have profound effects on *any* motion or load variable.

  This revision was not undertaken lightly since the existing model has provided consistently good wave-basin comparisons for many years. However, the "legacy" model has some theoretical shortcomings and it was felt a re-visit was in order; we expect that the new model will be as least as effective in reproducing basin results as the legacy model, and hopefully will be more successful in modeling larger currents. This area will likely be the subject of further theoretical development, refinement and updates in future releases.

Minor Updates and Enhancements (partial list):

Note: The simulations group naturally into four classes: (1) Individual simulations such as Catsim, Moorsim, or Shipsim, (2) "Comprehensive simulations" that encompass statics, low- and wave-frequency dynamics (CALMsim, Moorsim,SALMsim, etc.), (3) wave-frequency vessel motion simulations (Shipsim, Discsim, Semisim), and (4) all the SeaSoft simulations as a family.

- Reorganized internal storage of important physical and mathematical constants for SeaSoft-wide consistency and to accommodate possible future upgrade to double-precision calculations. **(All simulations)**

- Small adjustments to English & metric gravity and air density constants were made to accommodate internal units conversion updates. This change, and the one described immediately above, will result in very slight numerical differences, of the order of normal round-off errors, in almost all output values. **(All simulations)**

- Added dimensional damping conversion factors to output on vessel summary pages. **(All simulations)**

- Updated **SALMsim** to accommodate aft-mounted yokes.

- Reworked semisubmersible and SALM member added mass calculations to minimize iteration failure and improve error reporting. **(Semisim, SALMsim)**

- Improved error processing on RAO iteration failures in **Semisim.**

- Improved precision of semisubmersible along-member square-law load integrations. **(Semisim)**

- Modified **Semisim** to accommodate zero GM (in roll center -> cg adjustment calculations), and to accommodate zero pitch and roll frequencies**.**

- Improved wave-drag handling for moored semisubmersibles. **(Semisim–Moorsim)**

- Changed the wave drift editor interface to accommodate new model types and to permit any model to be used with any vessel; although it should seldom be useful, you can now use tanker drift coefficients on a semi, or vice versa, should the mood strike you. **(Comprehensive simulations)**

- Improved modeling of drift forces on hockey puck-shaped buoys. **(Comprehensive simulations)**

- Increased the significant digits in reported RAOs and related irregular wave vessel motion variables. **(Wave-frequency simulations)**

- Incorporated warnings whenever a period of heave, pitch or roll lies outside the specified wave period array range on non-semisubmersible type vessels. **(Wave-frequency simulations)**

- Reworked low-frequency damping computations to provide more meaningful values for cross-damping coefficients (for example, sway damping estimates in surge-aligned environment conditions when there are no sway motions).

Bug Fixes (partial list):

Individual Simulations

- Eliminated a long-standing bug in the square-law drag moments computed in **Semisim**. The occasional iteration failures when using the "Full square-law driving force calculation" option should now occur less frequently. As a result of these changes, version 4.32 will in some circumstances produce noticeably different pitch and roll damping values for Semis, as well as somewhat different pitch and roll RAOs, particularly RAOs computed using either of the two square-law drag driving force options. Fortunately, because the contributions to semi motions from pitch and roll are generally quite small compared to heave, surge and sway, fixing this bug had relatively little impact on the calculation of net wave-frequency fairlead motions (or associated mooring line loads in comprehensive simulations). In other words, the fixing of this bug will noticeably affect your output stream, but will likely have few, if any, engineering consequences.

- Fixed some erroneous **Catsim** editor warnings that could occur when working with data files imported from another simulation.

- Fixed the formatting for selected run-time warnings in **SPMsim** and **CALMsim**.

- Fixed LOWDAT initialization for buoys in **CALMsim**.

- Eliminated a bug in the reporting of the vessel-yoke attachment point motions in **SALMsim**.

- Fixed a **Slowsim** bug that prevented LOWDAT-based user-specified drift coefficients from being displayed in the output stream.

- Fixed a **Slowsim** bug that resulted in an understatement of *regular* wave drift force coefficients in shallow water (but not in the integrated *irregular* wave drift forces); this bug did not affect drift force calculations in other comprehensive simulations. Since all waves in a finite depth of water become shallow water waves in the long-wave-period limit, in earlier versions this underestimate was most noticeable in the long wave period portion of the drift force output tables.

- Eliminated spurious "Current Angle Relative to Waves" output when current was off in **Slowsim**

- Fixed errors in Pitch/Roll damping & variance in **Sparsim**.

- Fixed roll-moment definition bug in **Sparsim**.

- Fixed Units format for clump weight & buoy in **Statmoor**.

Comprehensive Simulations

- Fixed a bug in SNAPOUT minimum line load output.

- Fixed a SNAPOUT bug that could sometimes cause the wrong phase to be used for peak line loads in the presence of simultaneous swell and irregular waves.

- Fixed a bug in the output format warnings of low-frequency dynamics routines.

- Fixed a minor bug in statics routines caused by nonzero heel/trim specification.

- Restored a bottom friction correction in LOWOUT lost during changes made for version 4.20.

- Fixed on-line documentation problems on low-frequency properties editor pages.

- Fixed trim/heel fatal termination situations caused by "zero lines in a line type" in mooring simulations**.**

All simulations

- Fixed a bug that caused empty SHIPRAN, SEMIRAN, etc. files to be produced when irregular waves were turned off.
- Fixed a long-standing bug causing inappropriate output in the SHIPIN, MOORIN, etc. input documentation files.
- Fixed an editor bug that could cause nonsensical low-frequency vessel properties to be displayed when transferring data files between simulations.
- Fixed incorrect error message for case of unequal wave periods & no random waves.
- Fixed spurious "data file corrupt" error messages occurring during import of certain data files.
- Fixed several minor bugs and improved error testing on Exits from the editor programs prior to program execution.

Patterns of Numerical Differences with version 4.20:

One of the most commonly asked question goes like:

"The output value of (some load, some motion, some position, ...) changed from version 4.14 to version 4.20; what caused that?"

Since it is in everybody's interest to understand, to the extent possible, what produces major numerical output changes from version to version, appended below is a brief discussion on the issue of version-to-version numerical differences and some specific comments on numerical changes associated with this release.

Generally speaking, isolated numerical output differences of less than 5% are considered "noise" and can be produced by any one (or a combination) of the multitude of code alterations associated with any release. In our own testing, we usually apply a filter with a 5% numerical tolerance so we don't even see version-to-version differences of less than 5%. Naturally, there remain many differences that exceed this 5% threshold, most often (but not exclusively) in numbers that are quite small to begin with (for example, an RAO phase change from 9 to 10 degrees is a 10% effect but is obviously of no consequence). In some circumstances, small code changes can produce profound output differences if they affect mean vessel orientation in a significant way (this happens most often when the vessel orientation equilibrium is "marginal" in the sense that a small change in any mean load component can produce a large change in mean orientation because of a circumstantial cancellation of large competing forces and moments; it is uncommon in aligned conditions in which the equilibrium is extremely robust.)

Some patterns in the differences from earlier versions associated with this release that can easily be explained by code changes described in the release notes are outlined below.

- **SNAPOUT**: large differences in some minimum line tensions; due to fixed SNAPOUT bug.

- **SALMsim**, **SPMsim** and **Moorsim**: differences (usually small) in mean orientation due to wave drift force modeling changes.

- **Semisim**: RAO differences due to square-law bug fix.

- **Slowsim**: drift coefficient differences due to (1) changes in the underlying current-drift force interaction model and (2) elimination of the Slowsim "shallow-water" bug identified above (which bug affected *only* the Slowsim drift coefficient tables, but *not* the integrated drift forces or drift force spectra). Additional details on these differences:

    - At very short periods, where shallow water corrections are irrelevant, any drift force differences are dominated by the revised current-drift force model, which produces drift forces that are somewhat smaller than the "legacy" model.

    - At long periods, where the shallow water correction becomes important and the current-drift force interaction is minimal, drift forces in the new code are somewhat larger than the legacy model.

      Obviously, for any specific simulation environment, these competing effects produce a crossover frequency at which the old & new drift force coefficients (pre- and post- v 4.32) are equal. For reasonable values of period, current, depth, etc. this crossover point is, serendipitously, smack in the band of interesting wave periods.

The Problem of Exponential Complexity

For users who have not seriously contemplated the magnitude of the "debugging" problem in the context of a complex computer code, there follows a brief discussion that will be incorporated into the SeaSoft FAQ. The discussion uses SeaSoft as an example, but the points made are of general applicability. It is very simple to understand why no complex code with a great many input options (such as the mission-critical code that guides our ICBMs and our laser-guided missiles) can ever be completely tested or made entirely bug-free.

Consider for a moment the exponential explosion in the number of unique paths through a complex computer code as we increase the number of input options.

To begin to understand this problem, we need a simple unit of branching complexity to use as a "ruler" for measuring complexity. A convenient choice is the "input toggle", of which many exist in each SeaSoft simulation (e.g., the English/metric units toggle or any of the input/output options toggles).

Each two-way toggle produces two distinct and unique paths through the code. Each toggle is in general independent of every other in that two toggles will produce four unique paths through the code.

However, most SeaSoft input variables are numeric: behind the scenes, a typical numeric input value (e.g., vessel draft or wind speed) also produces in general *at least* two distinct paths through the code (usually, *man*y more than just two), although the reason for the branches in each case can be hard to guess without intimate knowledge of the code. A simple "minimal" example: there is a test for a "zero" or "negative" or other nonphysical or unreasonable value for many numeric inputs. Some less trivial examples: there are branches depending on values of water depth, wave frequency, wave length, current speed, and even branches depending on the value of physical properties, such as vessel length or draft or mooring line weight or drag coefficient. In the end, assigning to each numeric input value the "path complexity" of a simple toggle is a conservative choice that will likely underestimate the number of unique paths through the simulation.

Therefore, we will (roughly) characterize the path complexity of a simulation by its total number of "equivalent toggles", which is defined as the simple sum of actual toggles plus the number of independent numeric input variables.

Comprehensive single-vessel SeaSoft simulations such as SPMsim have several hundred [toggles + numeric input values]; multi-vessel simulations such as CALMsim have substantially more. We will therefore adopt a value of 350 toggles as a path complexity estimate of a "typical" SeaSoft simulation.

The number of independent paths through the code for this hypothetical 350 toggle data file is 2^350, which translates to something like 10^105. As you can see, the number of paths through the code in this example is immense, easily exceeding the number of protons and neutrons in the universe (which is something like 10^80 give or take a few orders of magnitude, depending on who you ask).

Numbers of such stupendous immensity have been given a name (by a child, as it turns out): the "Googol" (which is 10^100). A Googol evidently provides a useful "unit of measure" of the number of independent paths through the more complex SeaSoft simulations. (Note that a GoogolPlex, or ten raised to the power of one Googol, would only be required to describe vastly more complex simulations than any yet to be contemplated by SeaSoft.)

Assuming we can carry out one hundred benchmark simulation tests per second, the puny amount of time available since the start of the Universe (less than 10^18 seconds), is only sufficient to test a fraction 10^[-85] of the available paths through our hypothetical simulation. So much work, so little time. This is why bugs keep surfacing and will continue to do so, forever. Still, we keep trying; such is the sorry lot of the software developer...