SwanOne User Manual
V1.3

April 2018

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1. Introduction

SwanOne is an easy to use program to transform offshore wave conditions to nearshore using the 1D-mode of the full SWAN model. It uses a Graphical User Interface to simplify the use of the SWAN model. The 1D-mode assumes that the offshore bathymetry can be represented by parallel bottom contours such that the bottom profile can be specified along one transect normal to the (average) coastline. The SWAN model represents the wave field in terms of the 2D-frequency-direction wave spectrum which then evolves towards the coast including effects of wind, current, water level, depth, shoaling and refraction effects. The initial conditions at the start of the transect can be specified in terms of wave parameters or in terms of an input spectrum.

To use the SwanOne model it is assumed that the user is familiar with basic knowledge of coastal waves theory and a basic understanding of numerical analysis. Detailed background information on SWAN can be found on the SWAN Technical and User Manuals that can be found on the homepage of the SWAN model: http://swan.tudelft.nl.

The SwanOne suite contains three programs:
- SpecGen, a program to make a (2D) input spectrum file based on 2 different Jonswap spectra. This can be used for example if conditions where simultaneously a wind waves and swell waves from different directions occur.
- SwanOne, the GUI for Swan to execute the Swan calculation and perform some post processing
- SwanOneSed, to calculate the sediment transport and its distribution along a coastline. This program uses the output of Swan to determine the wave conditions at any point of the profile and calculates the local sediment transport using the Van Rijn formula.

This manual covers the use of the SwanOne GUI only. The other two elements of the suite, SpecGen and SwanOneSed, are described elsewhere.

The current version at the time of writing of this manual is <u>SwanOne version 1.3</u>. This version was developed in April 2018. The main changes with respect to previous versions are as follows:
- A calculation error in shallow water wave height distribution (Battjes-Groenendijk) has been corrected.
- Users now have the option to override the default settings for 2D input spectrum (JONSWAP peak enhancement factor γ, directional spreading parameter m in $\cos^m\theta$ model).
- Output now also includes the significant wave height from the time domain ($H_{1/3}$) in shallow water (instead of H_{rms}).
- A consistent distinction in labelling is made between H_{m0} and $H_{1/3}$. The first is the 'spectral' significant wave height from frequency domain and follows directly from the SWAN calculations, the second is the time domain signifcant wave height and follows from a post-processing step using the shallow water wave height distribution model of Battjes-Groenendijk. The use of the potentially confusing label 'H_s' is avoided.
- General bugfixes and correction of minor errors in labelling and interface layout.
- SwanOne 1.3 works with SWAN version 41.20 (which is included in the SwanOne installation package)

2. Installation

SwanOne is developed in Matlab 2018a. It is available as a set of scripts (.m files). Alternatively, if you do not have access to Matlab, you can run SwanOne as a compiled, standalone executable file (in MS Windows). This executable file can only be run when the Matlab Component Runtime (MCR) is installed on your computer.

2.1. Installation of Matlab scripts version

You can download the required scripts in a .zip file from the SwanOne download page http://www.kennisbank-waterbouw.nl/Software/. The package contains the SwanOne .m files, as well

as some tutorial files (such as example bottom profiles) and this manual. Simply unpack the .zip file into a separate new directory somewhere on your computer. Open Matlab and make this new directory your Current Folder. Open SwanOne.m and run it. The start screen should now appear.

2.2.   Installation of standalone version

Installing the MCR

The required Matlab Component Runtime (MCR) does not come pre-installed in the SwanOne package and needs to be installed separately. SwanOne 1.3 works with MCR 2018a (version 9.4), which can be downloaded and installed from https://nl.mathworks.com/products/compiler/matlab-runtime.html. You can install this component into any location on your computer of your own convenience. You will most probably need aministrator rights on your computer to install this software. Installing the MCR may take some time.

Installing SwanOne.exe

You can download a packaged .zip file from the SwanOne download page http://www.kennisbank-waterbouw.nl/Software/. The package contains the SwanOne executable, as well as some tutorial files (such as example bottom profiles) and this manual.

Download and unpack this zip file. You can unpack it into any folder of your own convenience, but please make sure that you have full (read-write) permissions to this folder. SwanOne needs this permission for its local folder to write temporary files. Note that this is the case even if your project directory (see section 3.1) is elsewhere on your computer. In particular, make sure you do *not* unpack it into your 'program files' folder.

You can use the program immediately after unpacking, no further installation is required. The main executable is called SwanOne.exe. Run this executable to start SwanOne. The start screen should now appear. (On some systems, the the startup screen may disappear for a few seconds and then re-appear. This is normal behaviour).

The installation does not automatically create a shortcut to the main executable (e.g. in your start menu or on your desktop), so if you want such a shortcut you will have to make it manually.

3. Starting with SwanOne

3.1.   File – New

You may define any folder to be used as the SwanOne project directory. In this folder you should place your input data files and also your output data will be written into this folder. By default SwanOne will use the folder in which the program resides, but usually that is not a very handy place. If you want to place all SwanOne data in a dedicated folder, you have to create this folder; you may create this folder in SwanOne, but it is handier to create it on beforehand. As an example in this manual, the working directory is C:\SwanCases. In this folder a subfolder with the name C:\SwanCases\profiles has been created with the various input files.

Start SwanOne. Two windows will open. One window has a black background and is the Matlab log-file window. You do not have to pay any attention to that window. Do not click on this window, but let it it automatically disappear again. The other window is normal SwanOne window (see figure below). Only the tab "File" is active. Click on "new" (the other option is "exit", which is not relevant at this moment).
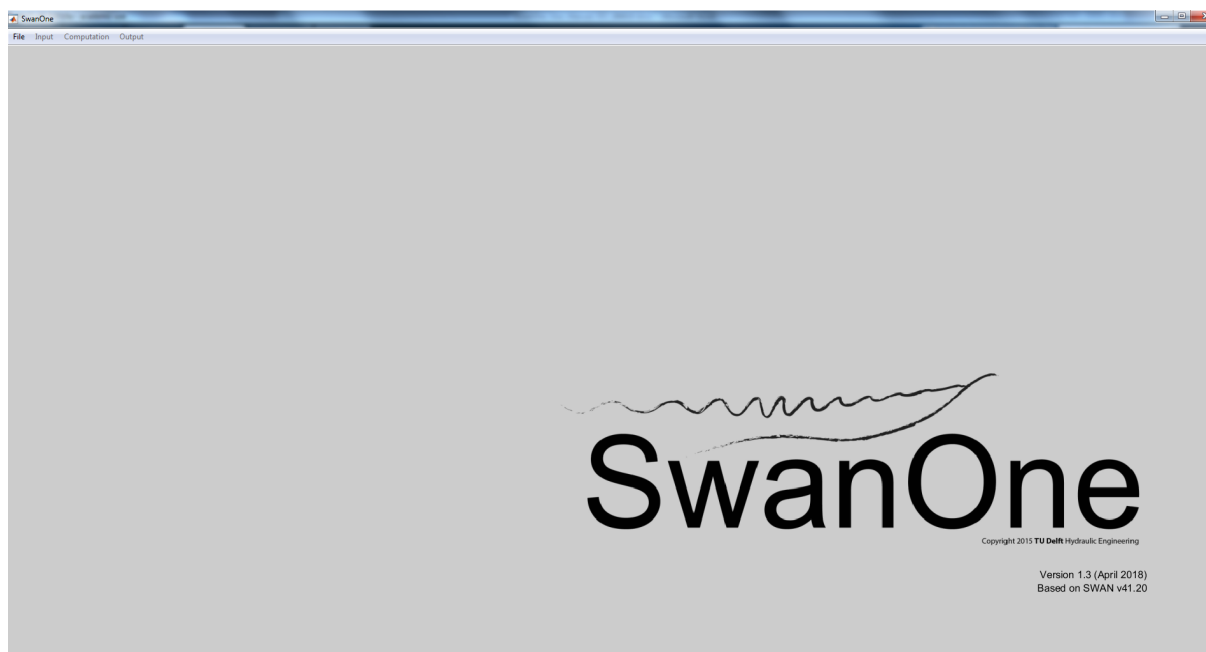
Now you get the "New Project" screen. In this version of SwanOne it is not yet possible to open existing files, so you start a new project. In the box "Folder Name" you type the name of the SwanOne data folder, or you select this folder with the "Browse"-button. Then you type in the box "Project Name" the name of your specific computation. The default name 'project_001' can be overruled. In the example below the case is called test. Some special characters are not allowed in your project name; in general your project name must follow the same restrictions as a normal Swan case name (in particular, it cannot contain any spaces).
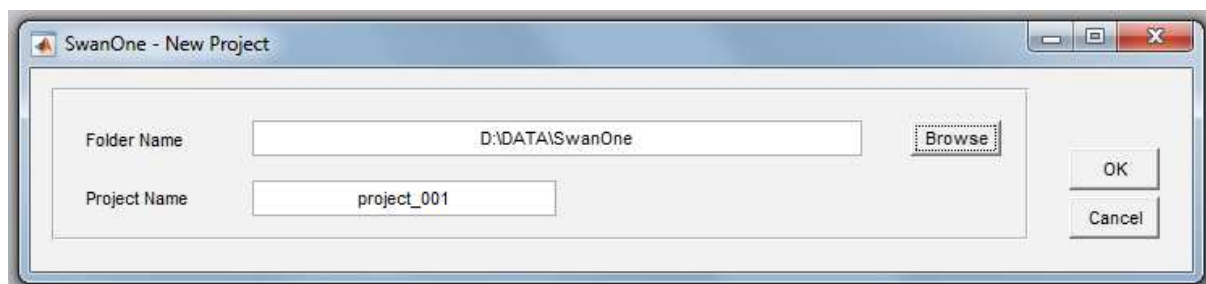

Continue via the "OK"-button.

4. Input data

4.1.   Input – Bottom Profile

SwanOne requires a bottom profile which is an TXT-file (e.g., made with Notepad or TextPad). In this file you place water depth information. The file should consist of two columns, separated by (at least) one space. In the first column the distance is given in m from your deep water starting point, in the second depth is given in m below a reference level (e.g. Chart Datum). Depth should be entered as a negative value. The distances are not necessarily equidistant; values can be entered as real values (use a point as decimal separator).

The origin (X = 0) is located at the offshore boundary of your model, so x values increase towards the coast.
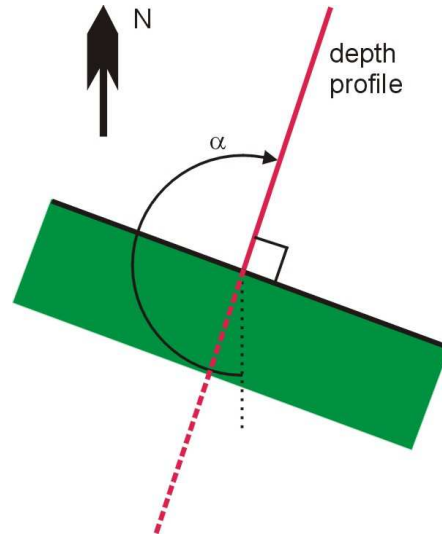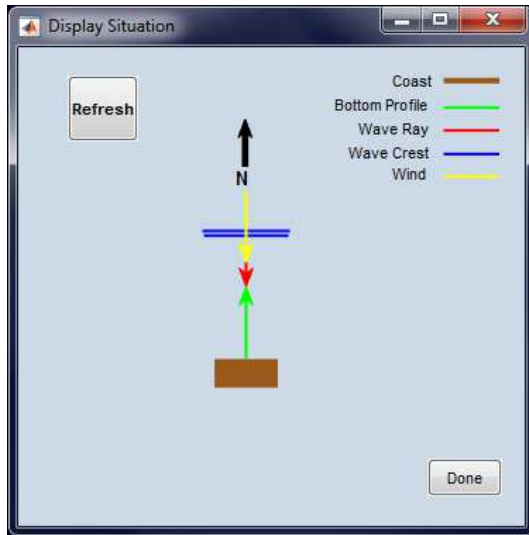
You have to place this depth file in a working folder. In this example all profiles are placed in the folder C:\SwanCases\profiles. You may have different files with bottom profiles in this folder. You may type in the folder name, or use the "Load File"-button to go to this file. The profile will be displayed in a small figure.
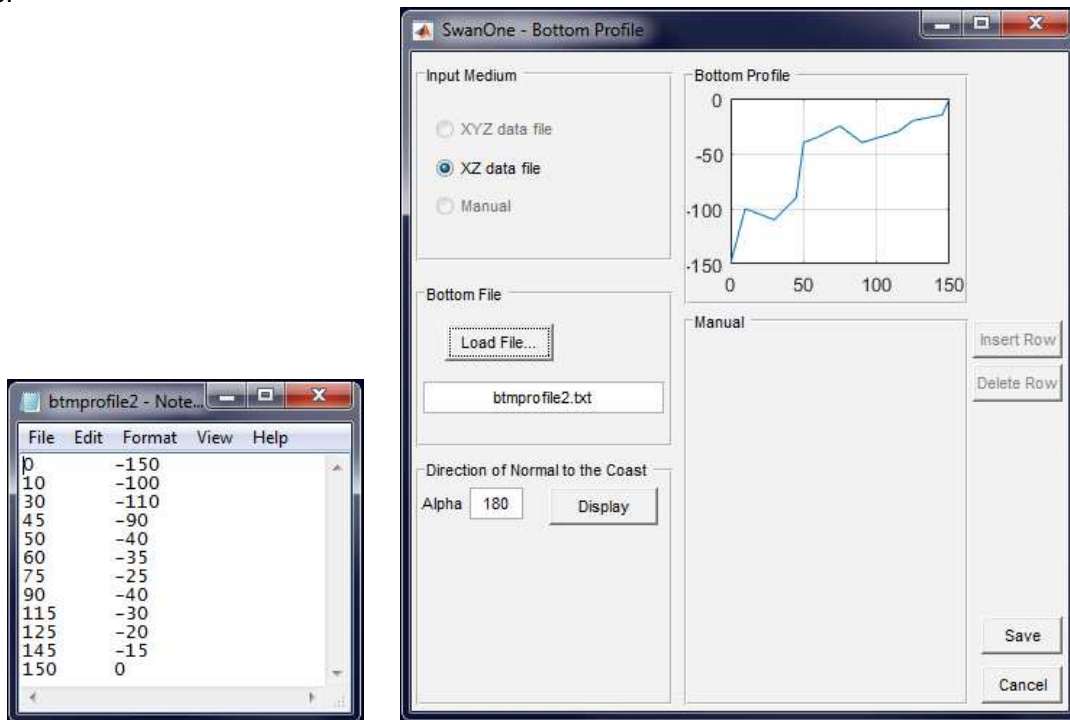
At this moment only input as an XZ file is possible. Also the option to edit the depth file in SwanOne is not yet operational. So editing of the depth file should be done outside SwanOne, e.g. with Notepad.
Also you have to enter the orientation of your coastline. The direction you should give here is the orientation with respect to the North, when looking from the sea to the land. The "Display"-button allows you to see your selected option. In this example a bottom profile of the Dutch coast near Petten is selected. Alpha is the direction of the profile with respect to a viewing direction from north. For this example, a value of alpha = 200°N has been selected. The depth profile has to be perpendicular to the coastline.

Save your settings by clicking on the "Save"-button. Saving the file with the "Save"-button will automatically close the screen. However, you can also close without saving by clicking on "close".
Note: when clicking on "save" without loading the bottom-file, the program will stop with a warning message.

4.2.   Input – Define Current

In case you do not want to include currents you have to select in this screen the option "No Current" and save. In case you do not select anything, SwanOne will not run.

When you want to include currents, you have to make a current input file. This file should consist of three columns, separated by at least one space. In the first column should be the distance as used in the depth profile. In the second column is the velocity perpendicular to the profile, in the third column is the velocity in the same direction (offshore direction) as the profile. The velocities are given in m/s. The distances between the points can be arbitrarily, because SwanOne will interpolate the magnitude of the currents linearly between these points. For the orientation is referred to the small sketch above.
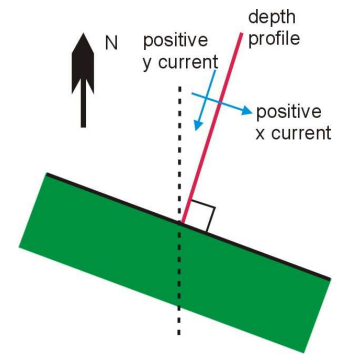
The data-file with currents should be an TXT-file and can be stored in the same folder as the depth profiles. Outside the defined areas the velocity is assumed to be zero.
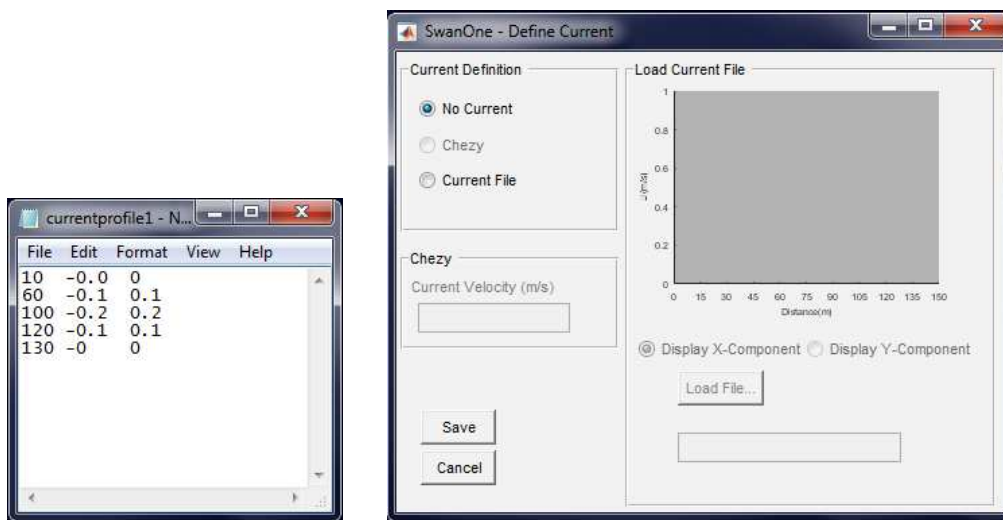
4.3.   Input – Boundary Conditions

In this screen the wave boundary conditions for the deep water edge are set. You may either define an arbitrary spectrum via a file or define input parameters manually.

For unexperienced users it is recommended to use the 'manual settings' option. In that case you may define your input spectrum via parameters by entering a deep water significant wave height (H_{m0}) and a deep water peak period (T_p). By default, SwanOne converts these data internally to a 2D JONSWAP spectrum with a peak enhancement factor γ = 3.3 and a $\cos^2(\theta)$ directional spreading. Starting from SwanOne v1.3, these default settings can be overruled by the user, with the following limitations:

- The spectral shape must remain a JONSWAP, but the peak enhancement factor can be adapted.
- The directional spreading must remain the $\cos^m(\theta)$ model, but the parameter *m* can be adapted.
- For more advanced modifications of the input spectrum (such as double-peaked spectra etc) the user has the option to define the complete 1D (S,f) or 2D (S, f, θ) spectrum at the boundary, see below.
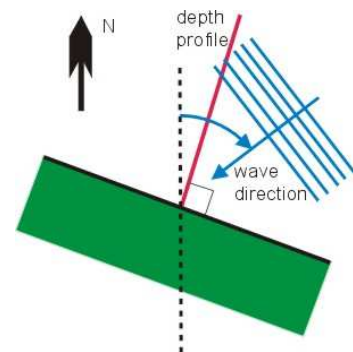
Also the wave direction should be set. Direction is with respect to North. In this example the wave direction is set to 30°.

Note: In fact you are not defining the wave height at the boundary, but you define the amount of wave energy entering your model. In the results you may see a deviation between the wave height defined by you and the calculated wave at the boundary. For further info, see Appendix 1 to this manual.

In a more advanced mode, you may define the input spectrum at the boundary. In that case select "SWAN 1-D Spectrum" or "SWAN 2-D Spectrum", load a spectrum file and save. The spectrum file has to have a specific format as described in Appendix D of the SWAN User Manual. The model SpecGen can be used to generate these files in which the characteristics of one or two design waves are converted to a spectrum. As input-file you may also use an output file of SwanOne or the full SWAN model. This allows you to nest models (e.g., overall 2D-grid models covering the coastal area and the (1D) SwanOne model) to transform these offshore wave conditions to the coastline. The output file with extension SP1 from the 2D-SWAN model can be used directly as input file for the SwanOne model. You may also make an input file yourself using Notepad. This has to be done quite accurate, because SwanOne does not tolerate (minor) typing errors. In Appendix 2 of this manual the SWAN spectrum file is discussed in more detail.

In this screen the water level with respect to the Reference Level (0 m in default setting) can be set. It is recommended to enter the 'Water Depth' in the bottom profile with respect to Chart Datum, so at this point you can set the water level with respect to Chart Datum. In the example a water level of CD+1 is selected. In the box you may also select if you want SwanOne to include a water level rise due to wave set-up.
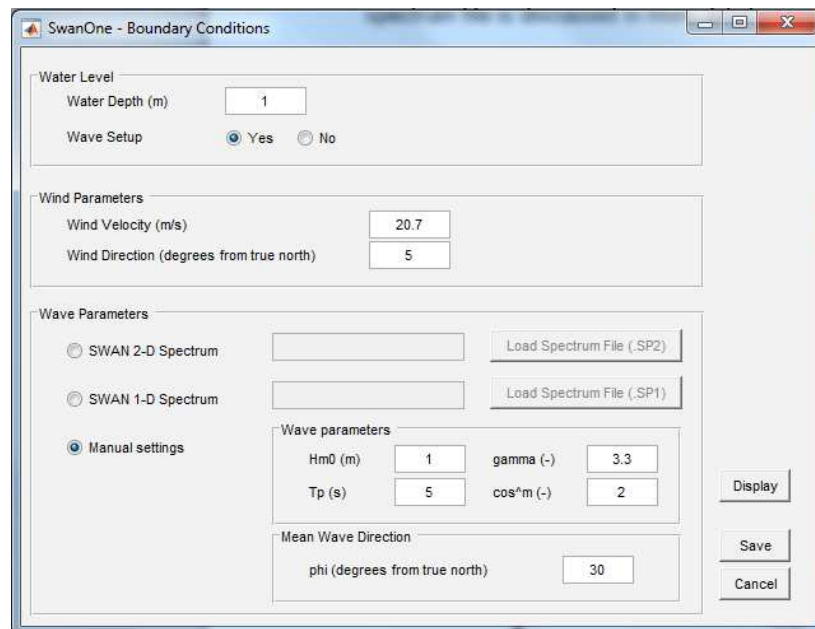
In this dialog screen you may set the wind speed and wind direction. Wind speed should be set in m/s, wind direction in degrees with respect to North. In this example the wind direction is 5°N A Table with wind speeds for various wind speed classes is given.

Beaufort	m/s	Beaufort	m/s
1	1.5	7	17.2
2	3.3	8	20.7
3	5.5	9	24.5
4	8.0	10	28.4
5	10.8	11	32.6
6	13.9	12	>33

With the "Display"-button you can visualise all input directions. Close this window after use. In case too many of these windows are open at the same moment, SwanOne will stop and provide an error message.
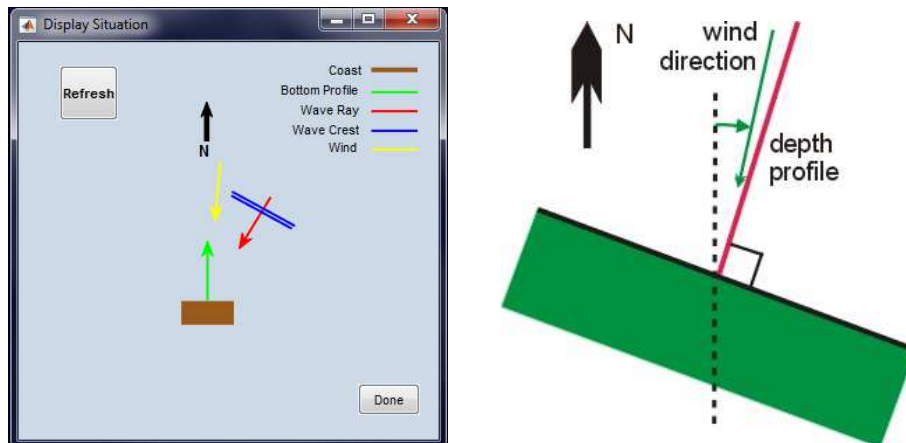

After entering your data you have to save the information by clicking the "Save"-button; the screen will be closed. You can close without saving by clicking on the "Cancel"-button.

4.4. *Input – Output Locations*

SwanOne provides a number of spectral parameters like the significant wave height or peak period at all grid points of the bottom profile. In this screen you may enter the x- and y coordinates of these locations in the 8 boxes. In this example a spectrum is selected at the offshore boundary (input spectrum), on the intermediate shelf and a number very close to the coast.

Save the data by clicking on the "Save"-button; the screen closes. You may also close without saving by clicking on the "Close"-button. The "Display"-button gives markers on the screen where the wave spectra are shown.
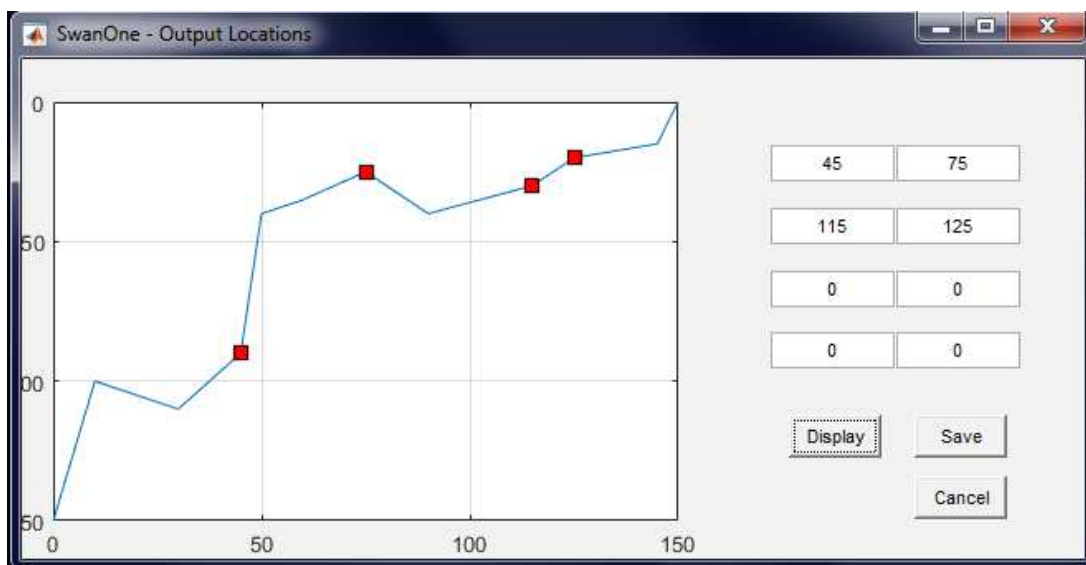

Note: You have to select at least one output location, otherwise the program terminates with an error message.

5. Computing

By clicking on the computing tab, the computation screen opens. It shows default value (1000) for the number steps and the associated step size which is computed by dividing the length of the bottom

profile by 1000. These values can be changed to make the computation more accurate (by increasing the number of steps) from a numerical point of view or by speeding up the computation by increasing the step size.

After changing one value (either the step size dx or Number of Steps) press "Edit" to compute the other value. Start the computation with the "Start"-button. At this moment SwanOne calls Swan.exe to make the computation. This may take some time, depending on the processor speed of your computer.
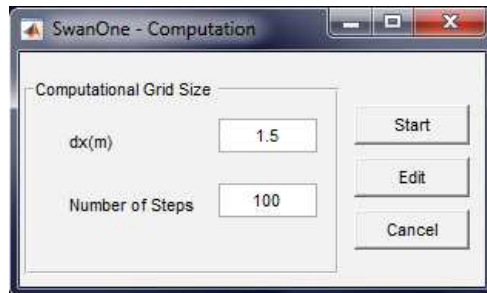
6. Creating Output

6.1.   General

The basic information is written in a subfolder of the SwanOne cases folder, in this example the name of the subfolder was defined as "test files" (see explanation in the chapter "Input"). This folder may contain the following files whose extensions are:
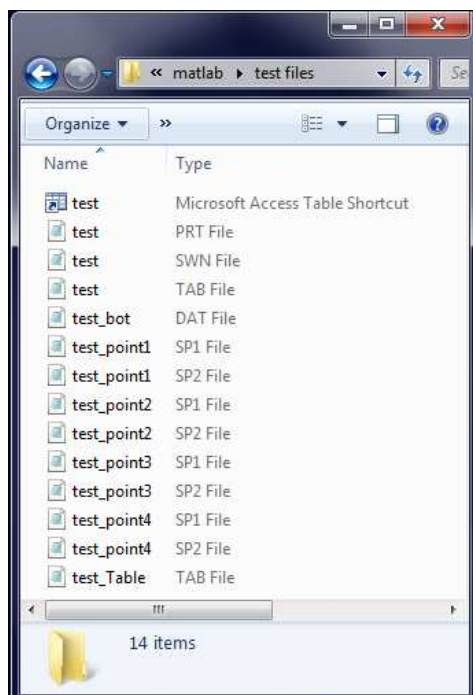
MAT	Binary Swan-file in Matlab format
PRT	Swan print file
SWN	Swan input file for the batch process
TAB	Standard outputfile of Swan
_bot.DAT	Expanded bottom profile file for internal use of Swan
_pointX.SP1	One dimensional spectrum file for output point X
_pointX.SP2	Two dimensional spectrum file for output point X
_Table.TAB	Output file as produced by the Table command of SwanOne

All files can be read with a TXT-file editor like Notepad or with Matlab. However, it might be useful to open files in Excel. In that case you have to change text to columns. Select column A in Excel and open "Text to Columns" in the "Data" tab of Excel. Select "delimited" and "space" as the delimiter.

Note: in case you have European settings for numbers (i.e. 0,23 instead of 0.23) in Excel, you first have to change all points in comma's. Do this with the "replace all" command in Excel, before you apply the "Text to columns" command

6.2.   Output – Rays Plot

After clicking on "Rays Plot" the ray plotting windows open. First you have to define the graphs with the spatial variation of a selected wave parameters along the full or part of the bottom profile. Click for that purpose on "define Graphs". The screen "define ray-plot" opens. You may select up to four graphs in one screen. View1 is default on Hm0. Mark one of the parameters. In case you want more plots, click on View2 and select your second parameter.

In this example the significant wave height Hm0, the spectral period Tm-1,0 the mean wave direction DIR and the depth d are selected for the views. After clicking on "Done", the basic screen is opened showing the requested graphs.
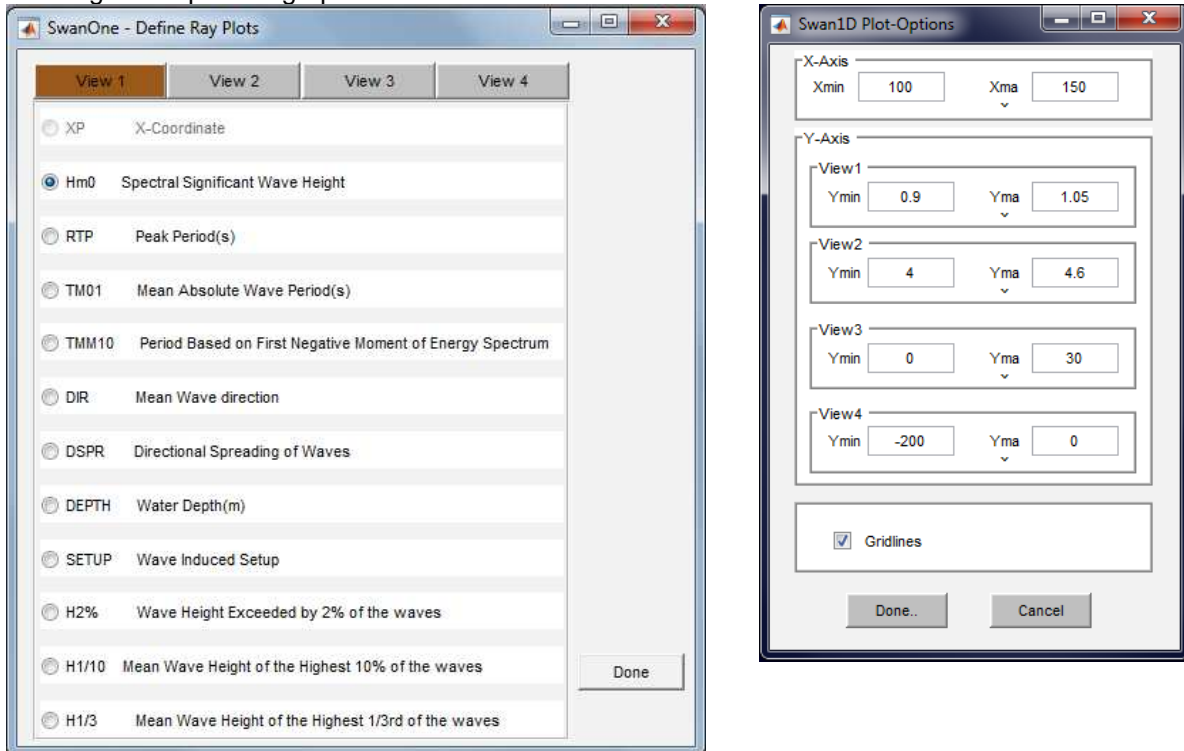
With the "Options"-button you may change the scales; for example to plot a detail of the last 50 m of the computation, set the horizontal scale from 100 to 150 m.
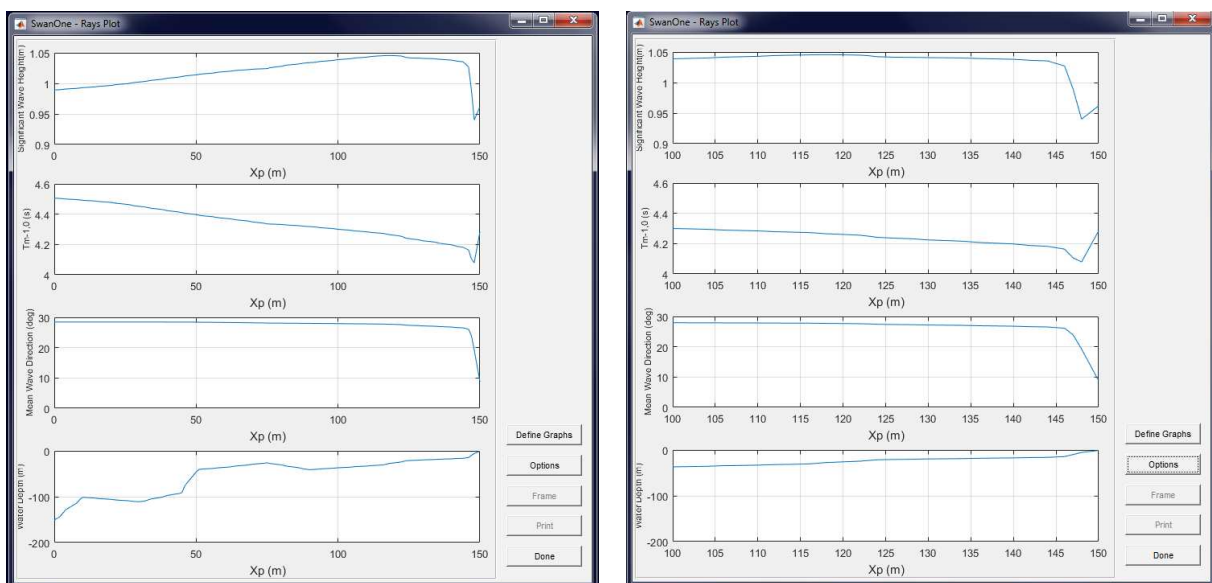
The options function is also very handy when comparing two parameters with the same unit, e.g. comparing Tm and Tm-1,0. Then the vertical scales can be made identical. See example.
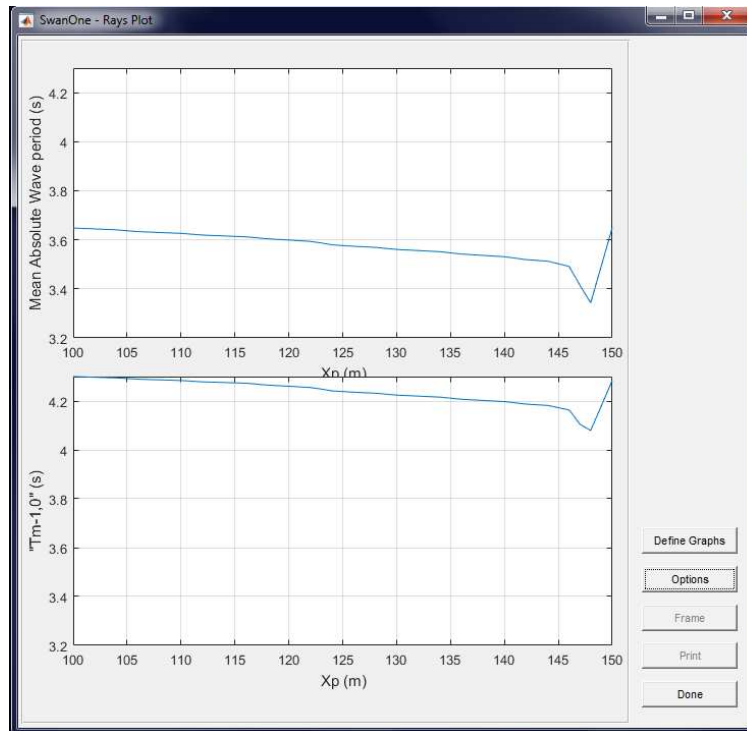
6.3. Output – Spectrum plots

Clicking on "Spectrum Plots" opens the spectrum plot window. Click on "Define Graphs" to select the spectra. At this moment only 1D spectra are possible. Up to 4 spectra can be plotted in one screen. The option not to plot gridlines is not active in this view.
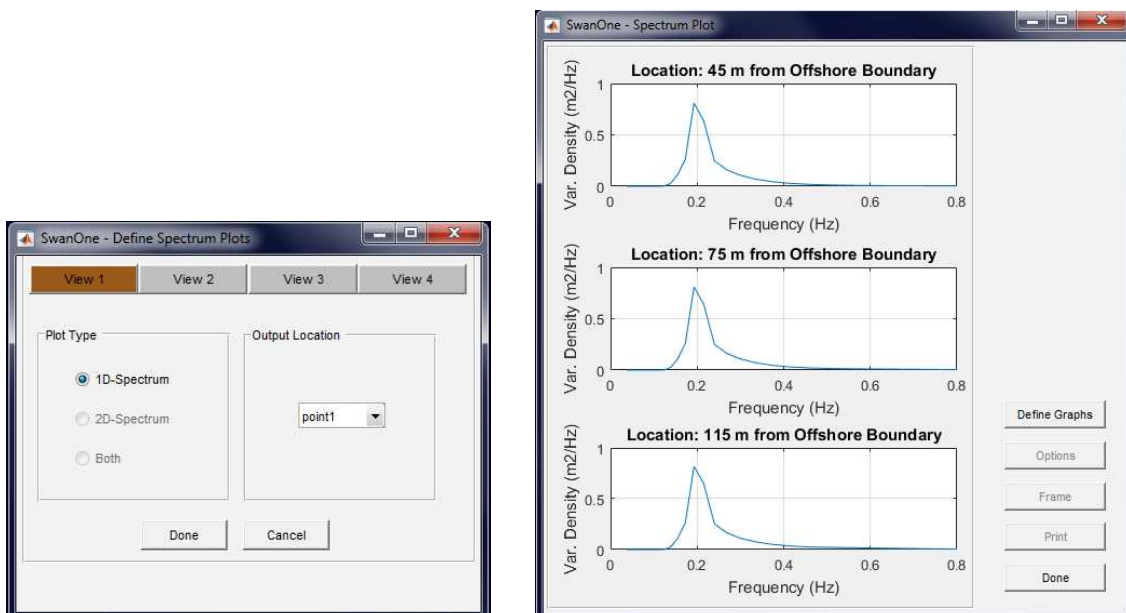
6.4. Output – Prints

The print tab opens a menu where you can select parameters to be printed in a table. When you select the option of printing to file, the file appears in the "test files"-folder (in this example matlab/test files; see also Output-General, above).

Printing direct to a printer is not possible.

For further info regarding the standard output-files of Swan is referred to the Swan documentation (http://www.swan.tudelft.nl/). The SP1-file gives the (one dimensional) variance density spectrum, while the SP2 file gives the frequency-direction spectrum.

7. Help

The help option is not yet implemented. Use this manual for help.

7.1.   About

In the "about" screen (which will be a subscreen of Help) you find information regarding the version of SwanOne and the embedded version of Swan. This manual is written for SwanOne version 0.02 and this version is using Swan 40.72.

SwanOne is developed by TU Delft, section Hydraulic Engineering. It is based on a Visual Basic package originally developed by Alkyon under contract for the Netherlands Ministry of Public works. SwanOne is written in Matlab by Sepehr Eslami Arab and Gerben Jan Vos under the guidance of Henk Jan Verhagen (section Hydraulic Engineering) and Gerbrant van Vledder (section Environmental Fluid Mechanics). The present version v1.3 was edited by Jeroen van den Bos (section Hydraulic Engineering).

7.2.   Liability

The computer program SwanOne has been initiated and written by Delft University of Technology. The program has been thoroughly checked in accordance with the latest developments in hydraulic engineering. Whilst every endeavour was made to ensure a program free of errors, the collaborators do not warrant, guarantee or make any representation regarding the use, availability, reliability, or the results of the use of the software. This includes the accuracy, correctness or completeness of any elements of SwanOne or of information provided within SwanOne.

By using this program, the user agrees and accepts the statements below:

Delft University of Technology and everyone who has collaborated with this program do not accept any liability in any event. This includes direct, indirect, special, punitive, incidental or consequential damages (such as loss of income, company breakdown, damage to reputation and missing orders) as a consequence of the use this program, amongst others by (but not limited to):

- *deficiencies or other limitations in the program, equipment and other software in relation to access to this program or the related website;*
- *use of the program;*
- *third party claims related to the use of the program.*

8. References

Battjes, J.A., Groenendijk, H.W. [2000] Wave height distribution on shallow foreshores. Coastal Engineering, Vol 40, No.3, pp.161-182.

Annex 1 Output Parameters

In the following equations spectral moments are defined as follows:

The zero-est order moment of the spectrum (i.e. the area of the variance density spectrum or the total wave variance of the spectrum (Note that the energy density spectrum can be obtained by multiplying the variance density spectrum with the factor $\rho_w g$ with ρ_w the density of water (kg/m^3) and g the gravitational acceleration (m/s^2):
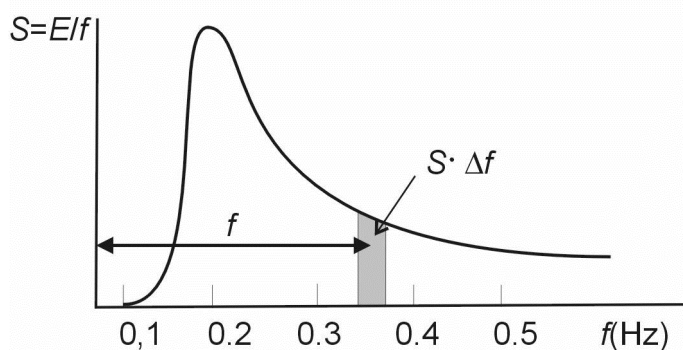
$$m_0 = \int E(f)\,df$$

The first order moment of the spectrum:

$$m_1 = \int f^1 E(f)\,df$$

The second order moment of the spectrum

$$m_1 = \int f^2 E(f)\,df$$

The first negative order moment of the spectrum:

$$m_1 = \int f^{-1} E(f)\,df$$

For simplicity the equations are given for one-dimensional spectra. Internally SWAN performs calculations with two-dimensional (frequency-direction) spectra, but that does not make any difference for the following equations.

SwanOne selects from Swan the following output parameters:

Hm0   significant wave height (in m) computed as from the total wave variance in the spectrum:

$$H_{m0} = 4\sqrt{m_0}$$

(*Note*: Swan calls this value HSIGN)

RTP   Peak period (s); the bin with the highest energy

TM01   Mean absolute period (in s)

$$T_{m1} = 2\pi \frac{m_0}{m_1}$$

TM02   Mean period (s)

$$T_{m02} = 2\pi \sqrt{\frac{m_0}{m_2}} \approx T_m$$

TMM10   "Shallow water" wave period (s)

$$T_{m-1,0} = 2\pi \frac{m_{-1}}{m_0}$$

DIR   Mean wave direction (in degrees with respect to North) in degrees.

DSPR   One-sided directional width of the spectrum (directional spreading or directional standard deviation, in degrees)

DEPTH   The computation water depth, depth below chart-datum+ water level rise + wave set-up

SwanOne also calculates the following values:

Hrms   The root-mean-square wave height. H_{rms} is a parameter from the time-domain, and is defined as:

$$H_{rms} = \frac{1}{N} \sum_{i=1}^{N} H_i^2$$

in which H_i is the wave heigth of an individual wave in the wave field. Because H_{rms} is a good representation of the energy, there is a fixed relation between H_{rms} and m_0:

$$H_{rms} = 2\sqrt{2m_0}$$

From the time-domain analysis (assuming a Rayleigh distribution) follows:

$$H_s = \sqrt{2}H_{rms}$$

And thus (but only for Rayleigh distributed waves, i.e. not in very shallow water):

$$H_s = H_{m0}$$

According to Battjes and Groenendijk (2000), the distribution in very shallow water is not according to Rayleigh, and therefore in very shallow water H_s is not equal any more to H_{m0}.

Hs   Calculated with the Battjes-Groenendijk method. Only in very shallow water this value is different from H_{m0}.

H2%   The wave-height exceeded by 2% of the waves in a wave field, calculated according to the method of Battjes-Groenendijk.
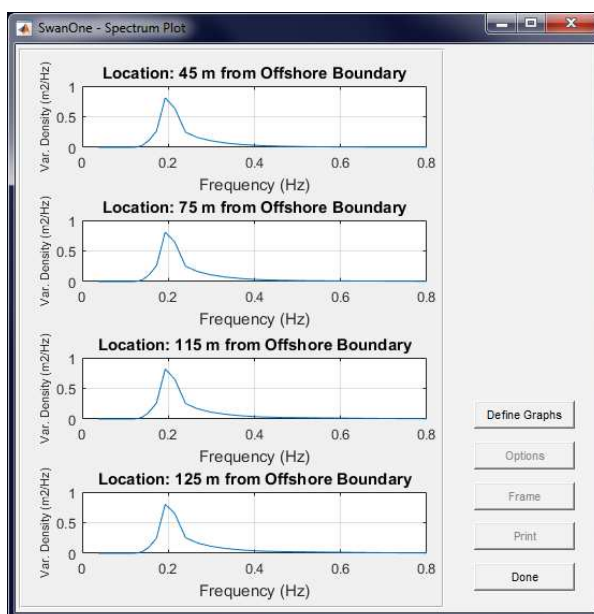
Annex 2 Swan Spectral File

SwanOne uses the same spectral output files as Swan. SP1 files are one-dimensional variance density spectra. However, you may define for each frequency band not only the wave variance, but also the average direction as well as the directional spreading.

As an example two files are given below. The left file is a simple uni-modal spectrum, from one direction with a constant directional spread of 30 degrees for all energy bands. In the first block is given that the spectrum consists of 31 energy bands, and the frequency of all bands is given. In the second block for each frequency band is given the wave variance, the mean direction and directional spread. The wave variance is given in m2/Hz. A plot of the input spectrum is given below (left).
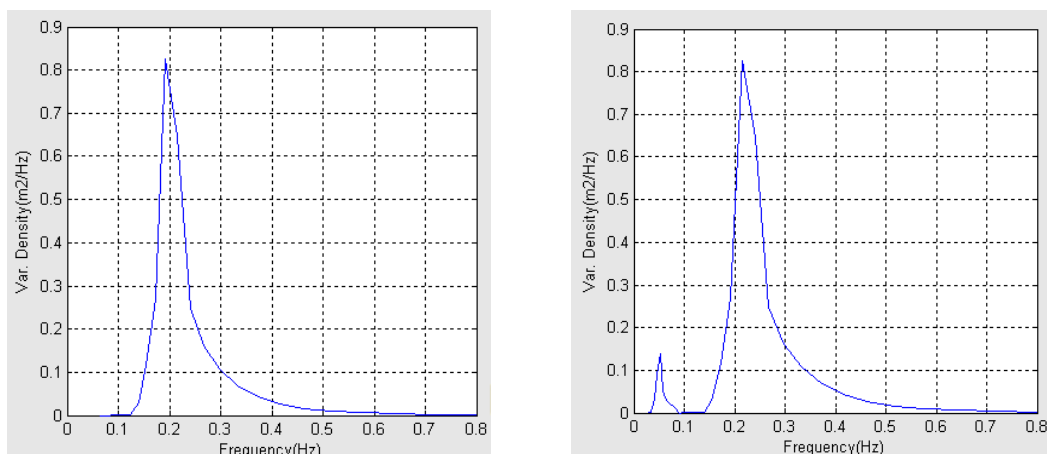
A similar file has been made, but now including a swell component with a peak of 20 seconds, and a slightly different direction. The input file is reproduced below. The spectrum plot is above right.

The plot below gives the various spectra at different distances from the coastline.

SWAN 1	Swan standard spectral file	SWAN 1	Swan standard spectral file
$ Most simple input file for SwanOne		$ Most simple input file for SwanOne	
$ Project: demo		$ Project: demo+swell	
LOCATIONS	locations in x-y-space	LOCATIONS	locations in x-y-space
1	number of locations	1	number of locations
1.0000 0.0000		1.0000 0.0000	
AFREQ	absolute frequencies in Hz	AFREQ	absolute frequencies in Hz
31	number of frequencies	31	number of frequencies
0.0300		0.0300	
0.0335		0.0335	
0.0373		0.0373	
0.0417		0.0417	
0.0465		0.0465	
0.0519		0.0519	
0.0579		0.0579	
0.0645		0.0645	
0.0720		0.0720	
0.0803		0.0803	
0.0896		0.0896	
0.1000		0.1000	
0.1116		0.1116	
0.1245		0.1245	
0.1389		0.1389	
0.1549		0.1549	
0.1728		0.1728	
0.1928		0.1928	
0.2151		0.2151	
0.2400		0.2400	
0.2678		0.2678	
0.2987		0.2987	
0.3333		0.3333	
0.3718		0.3718	
0.4149		0.4149	
0.4628		0.4628	
0.5164		0.5164	
0.5761		0.5761	
0.6427		0.6427	
0.7171		0.7171	
0.8000		0.8000	
QUANT		QUANT	
3	number of quantities in table	3	number of quantities in table
VaDens	variance densities in m2/Hz	VaDens	variance densities in m2/Hz
m2/Hz	unit	m2/Hz	unit
-0.9900E+02	exception value	-0.9900E+02	exception value
CDIR	average Cartesian direction in degr	CDIR	average Cartesian direction in degr
degr	unit	degr	unit
-0.9990E+03	exception value	-0.9990E+03	exception value
DSPRDEGR	directional spreading	DSPRDEGR	directional spreading
degr	unit	degr	unit
-0.9000E+01	exception value	-0.9000E+01	exception value
LOCATION 1		LOCATION 1	
-0.9900E+02 -999.0 -9.0		0.2433E-02 30.0 10	
-0.9900E+02 -999.0 -9.0		0.1282E-01 30.0 10	
-0.9900E+02 -999.0 -9.0		0.3299E-01 30.0 10	
-0.9900E+02 -999.0 -9.0		0.9169E-01 30.0 10	
-0.9900E+02 -999.0 -9.0		0.1400E+00 30.0 10	
-0.9900E+02 -999.0 -9.0		0.5148E-01 30.0 10	
-0.9900E+02 -999.0 -9.0		0.2958E-01 30.0 10	
0.2261E-34 0.0 30		0.1994E-01 30.0 10	
0.1614E-26 0.0 30		0.1278E-01 30.0 10	
0.1308E-20 0.0 30		0.1308E-20 0.0 30	
0.3482E-12 0.0 30		0.3482E-12 0.0 30	
0.3637E-09 0.0 30		0.3637E-09 0.0 30	
0.5523E-07 0.0 30		0.5523E-07 0.0 30	
0.2650E-02 0.0 30		0.2650E-02 0.0 30	
0.2941E-01 0.0 30		0.2941E-01 0.0 30	
0.1152E+00 0.0 30		0.1152E+00 0.0 30	
0.2717E+00 0.0 30		0.2717E+00 0.0 30	
0.8260E+00 0.0 30		0.8260E+00 0.0 30	
0.6476E+00 0.0 30		0.6476E+00 0.0 30	
0.2495E+00 0.0 30		0.2495E+00 0.0 30	
0.1619E+00 0.0 30		0.1619E+00 0.0 30	
0.1077E+00 0.0 30		0.1077E+00 0.0 30	
0.6866E-01 0.0 30		0.6866E-01 0.0 30	
0.4286E-01 0.0 30		0.4286E-01 0.0 30	
0.2651E-01 0.0 30		0.2651E-01 0.0 30	
0.1668E-01 0.0 30		0.1668E-01 0.0 30	
0.1056E-01 0.0 30		0.1056E-01 0.0 30	
0.6514E-02 0.0 30		0.6514E-02 0.0 30	
0.3959E-02 0.0 30		0.3959E-02 0.0 30	
0.2488E-02 0.0 30		0.2488E-02 0.0 30	
0.1492E-02 0.0 30		0.1492E-02 0.0 30	
Examples of a uni-modal wave spectrum in a SP1-file		Example of a more complicated spectrum, with sea and swell from different directions	