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OILTRANS: Oil Spill Modelling SoftwareApplication User Manual

Activity 4

Task 4.3: Drift and Pollutants Behaviour Predictions

ARCOPOL

The Atlantic Regions' Coastal Pollution Response

Version:	1.0
Last updated on:	04/07/2012
Author:	Alan Berry
Responsible partner:	IST
Involved partners:	Marine Institute

OILTRANS

Oil Spill Modelling Software Application

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Note: This document is to be read in conjunction with previous ARCOPOL report: "Development of OILTRANS model code"

Introduction

The OILTRANS modelling system was developed to provide a user-friendly link between the OILTRANS oil spill modelling computer code and a GIS, the latter providing facilities to create parameter files for OILTRANS simulations and the visualisation of simulation results. The system operates within the ArcView GIS developed by ERSI Inc of Redlands California and was developed through the ArcView 9.x programming language of VBA.

The OILTRANS oil spill modelling component provides an integrated oils database, three-dimensional hydrodynamic, meterological and particle transport mathematical model that that estimates the volume of oil remaining on the water surface, evaporated from the water surface, dispersed into the water column, emulsified into highly visous oil, or washed ashore.

The OILTRANS system may be applied to study any ocean or coastal system. The principle requirements are; bathymetric data, tidal current and wind fields, together with information on the location, quantity and constitution of spilled oil.

OILTRANS is operated through the selection of actions available through the "OILTRANS" toolbar which is integrated into the generic ArcView application

To date, only three functions are available to system users:

• **Run** model
(Captures parameters from the user through a series of forms to create an oil spill model simulation)

• **Edit** an existing model
(Edits parameters from a previous model simulation through a series of forms to create a new oil spill model simulation)

• **Delete Scenario**
(Allows the user to delete records of a previous run)

Interactively add new oil spill location

This section of the document explains the steps required to create a new model.

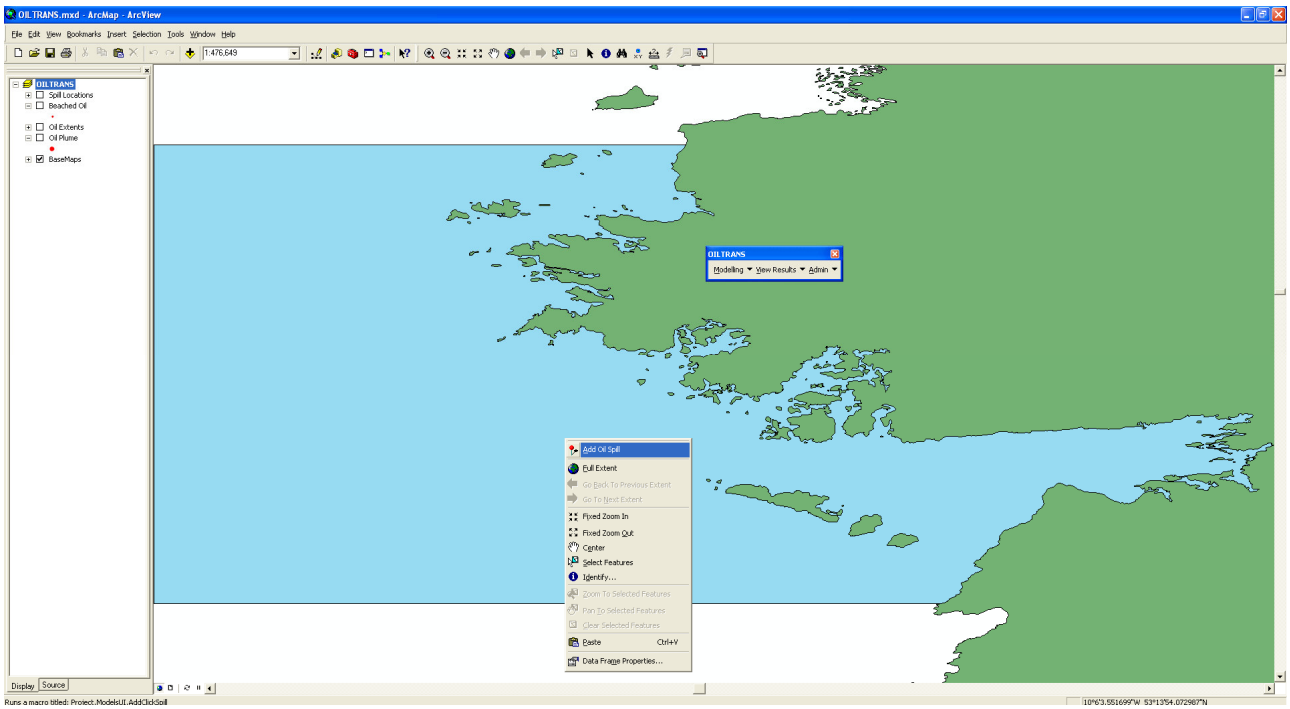
The first step is to determine whether a new oil spill location is to be included in the model through 'Point and Click' means.

'Point and Click' allows the user to click on a location on the map at which a oil spill is to be located. OILTRANS then determines the grid reference.

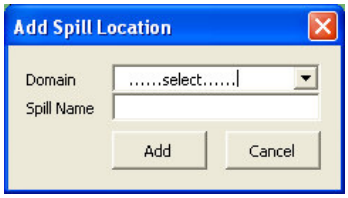
Alternatively, the user may enter coordinates for the site of a new oil spill location at any time during the model simulation creation process.

Right-click on the map at the location of the oil spill to be simulated.

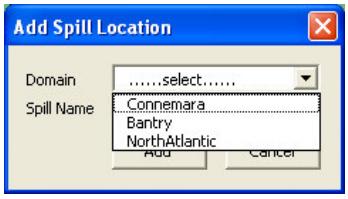
Select **Add Oil Spill**



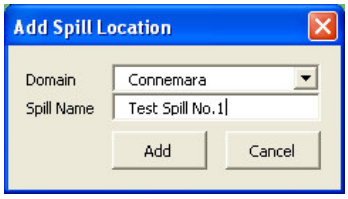
Select the model domain to which to apply the spill



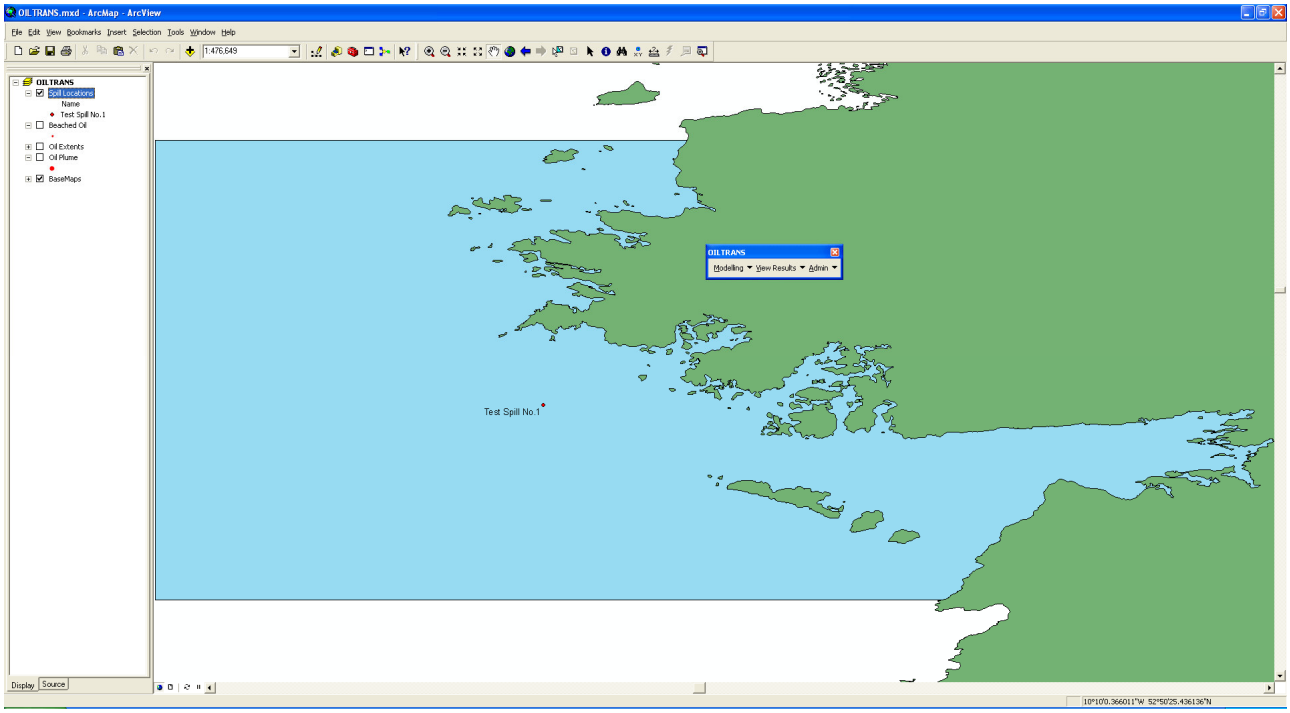
In this example of the OILTRANS system, we have three separate modelling domains to choose from.



For the current example, select "**Connemara**" and give the spill location a unique identifying name: "**Test Spill No.1**" for use later in the model simulation creation process.



Click "**Add**" and the oil spill location will be added to the map.

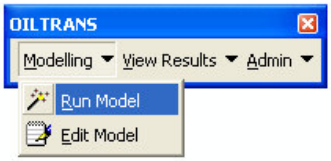


Once the user has determined whether or not a new oil spill incident is to be included in the new model, and if necessary, undertaken the required steps above, the user may then proceed to defining the new spill scenario.

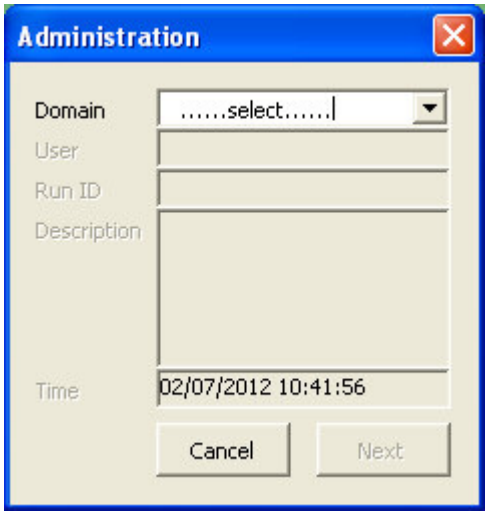
Modelling: Run Model

From the OILTRANS ArcView toolbar select "**Modelling**"

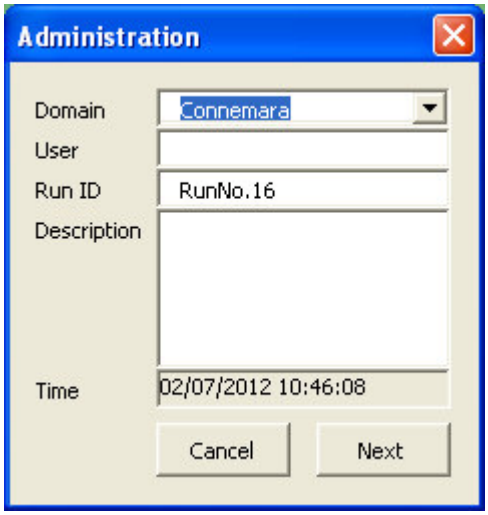
Then select "**Run Model**"



The user is presented with the following form.

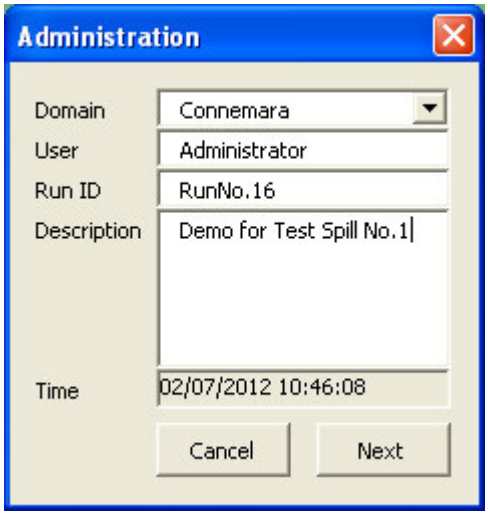


The user is requested to select the model domain in which to execute an oil spill modelling scenario. In this example the user selects "**Connemara**"



The user is then prompted to enter the following information; a username "**User**", and a description of the simulation being undertaken "**Description**".

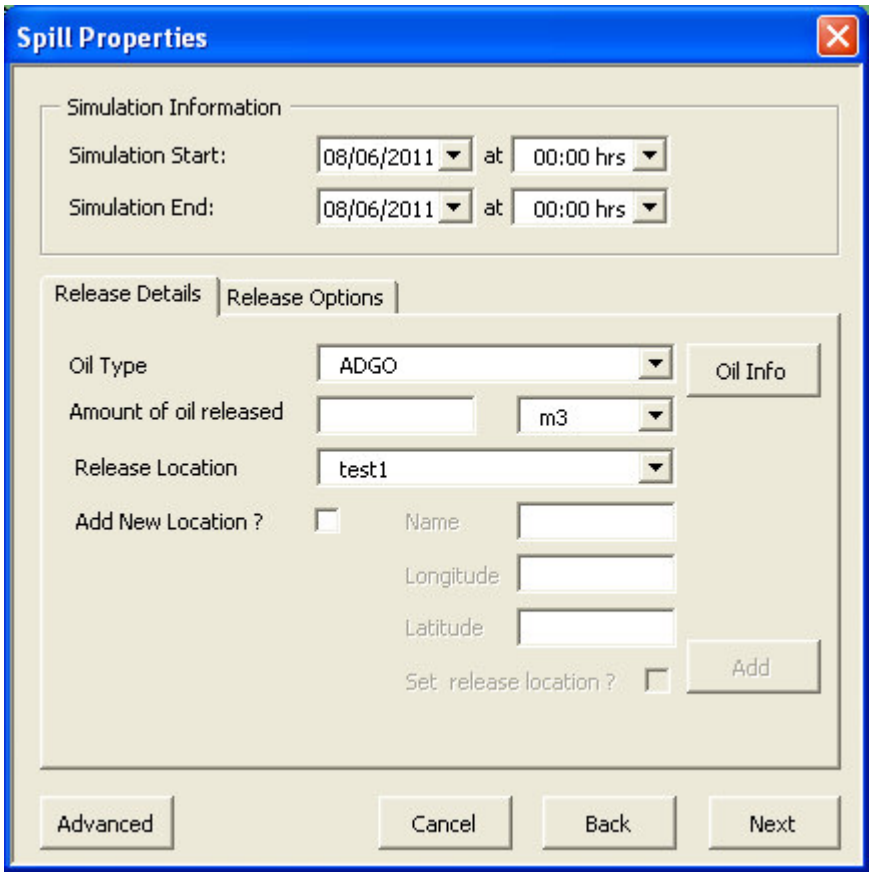
The "**Run ID**" field is populated internally within the application and acts as the unique simulation records identified within the internal OILTRANS database. Likewise, the "**Time**" field is populated internally within the application and acts as a unique timestamp record of simulation creation.



Once the user has populated the required fields, the user may select to "**Cancel**" the simulation at this stage or proceed to the "**Next**" step of the simulation creation process.

Note that when a user cancels the simulation creation process, no information is stored within the internal OILTRANS database.

In this example the user proceeds to the “Next” stage of the simulation creation process, where they are presented with the following form;



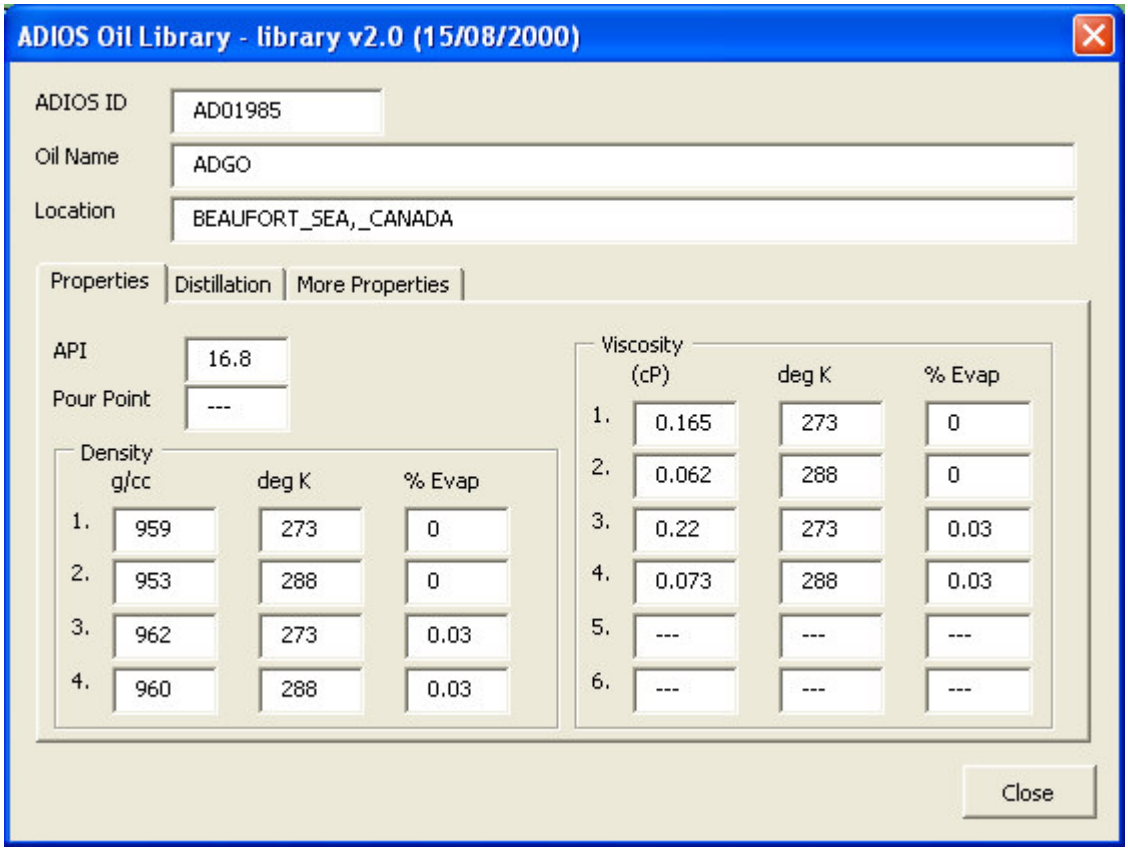
The top frame of the form deals with the temporal extent of the spill simulation that is being created. The user is required to enter the spill simulation starting date and time, and the spill simulation ending data and time.

The bottom part of the form characterises the spill incident.

The user is requested to select the “Oil Type” which constitutes the spill incident. The oil types are presented in alphabetical order. Almost 200 oil types may be simulated with the OILTRANS modelling ssytem.

The user may obtain information on any of the selected oil types be clicking the "**Oil Info**" button to the right of the selected oil type.

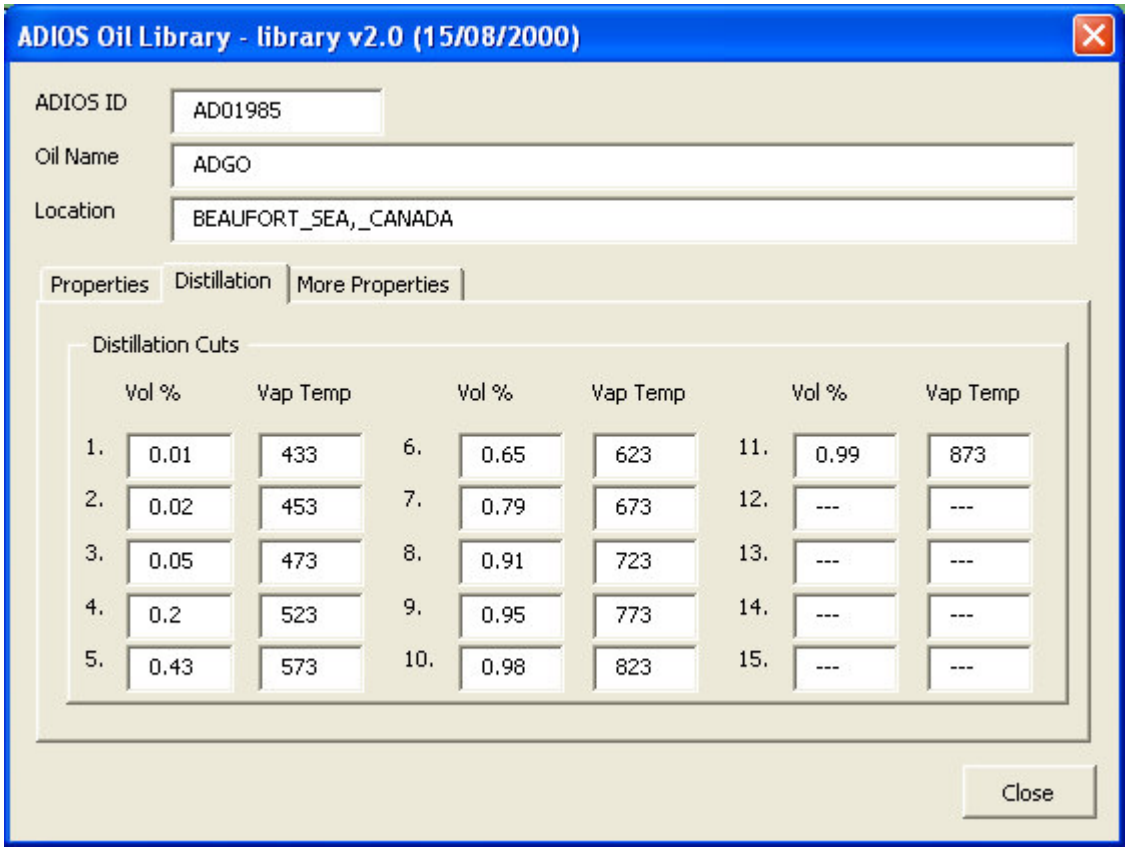
This will present the user with the following form;



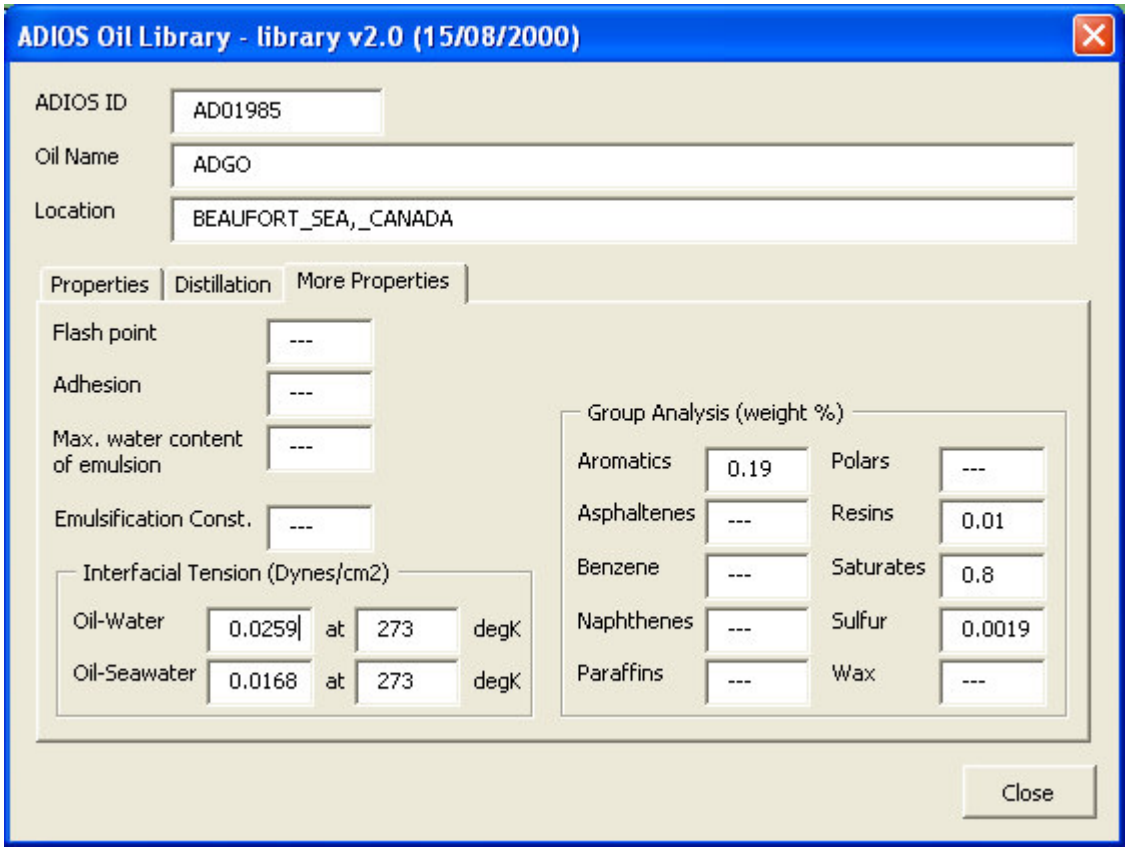
The physical and chemical properties of the selected oil type, in this case ADGO, are presented to the user. The oil properties are taken from the US NOAA ADIOS oil database.

Three pages of the form are accessible to the user. The first page (above) presents details on the oil density and viscosity.

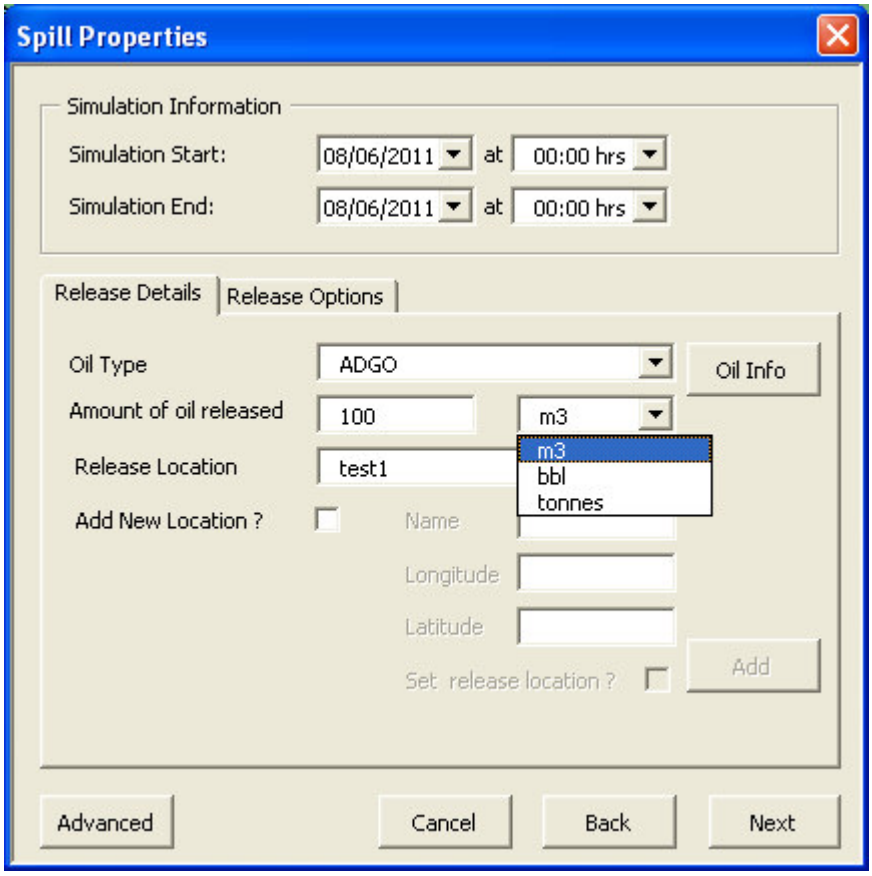
The second page presents details on the oil distillation properties.



Whilst the third page presented details on any other properties of the oil type which may be publically avaialable, such as the flash point, interfacial tensions, and group anaylsis of oil contituents such as wax, asphaltenes, resins, etc.



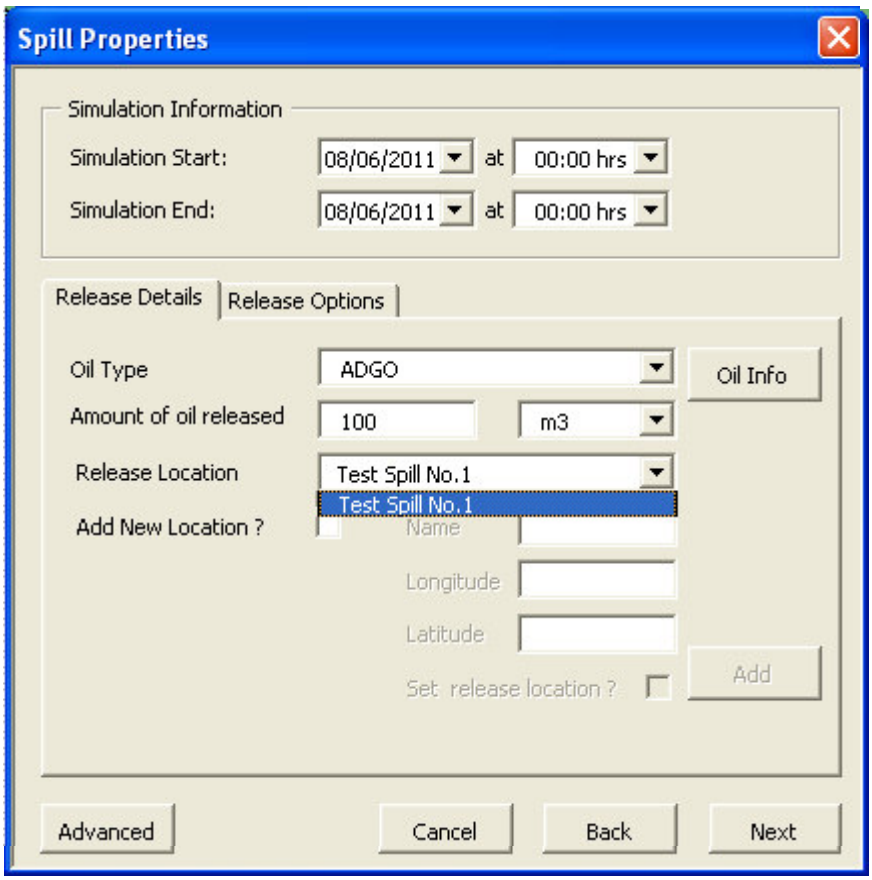
Once the user has determined that the properties of the selected oil are in accordance with the type of oil to be simulated the user can "**Close**" the form and will automatically be returned to the main spill properties form.



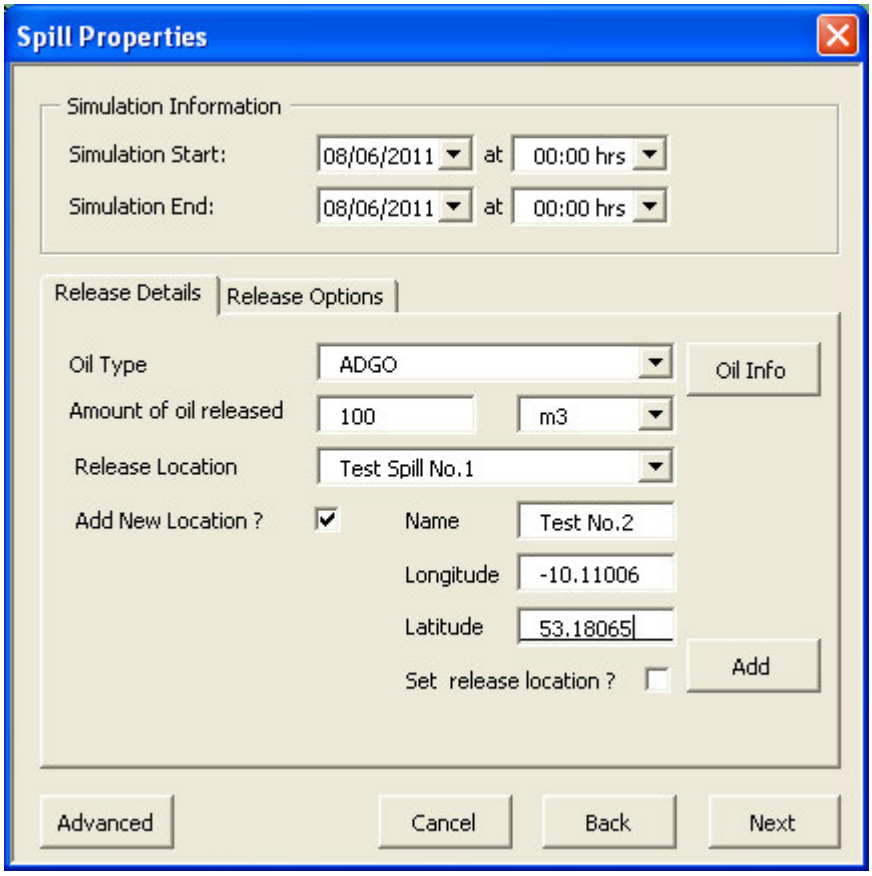
The user must define the "**Amount of oil released**" in units of "**m3**", US barrels "**bbl**", or metric tonnes "**tonnes**".

The user then selects the release location of the oil spill incident.

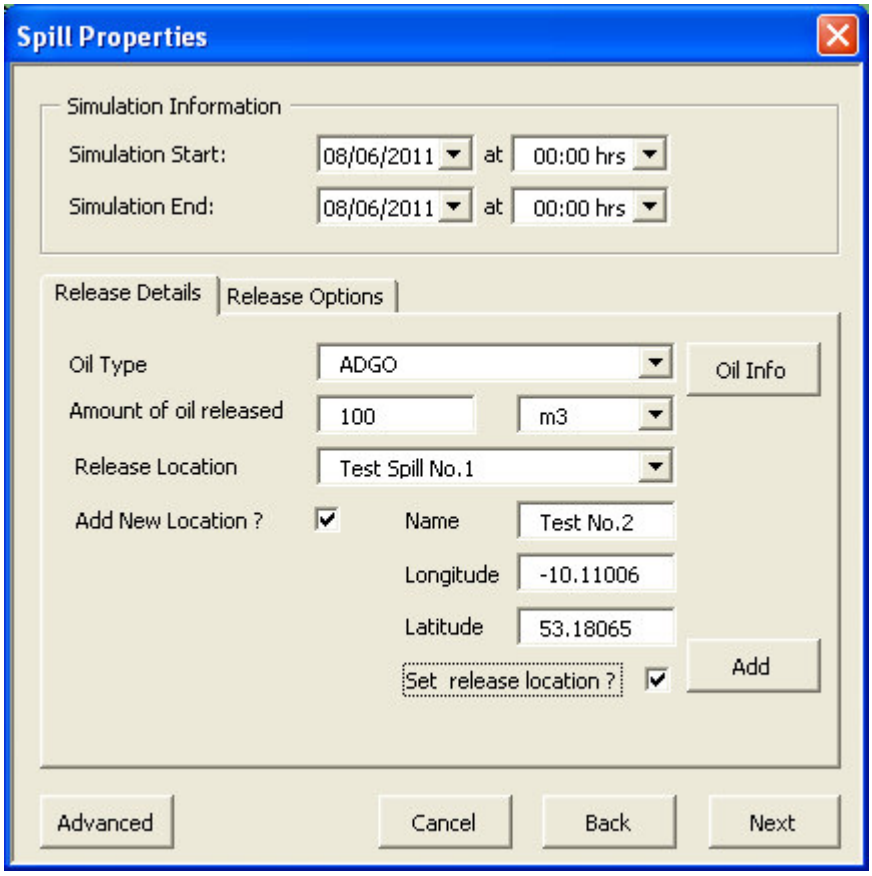
If the user added a spill location interactively through the GIS using the Point-and-Click method outlined in the previous section, then that spill location will be selectable via the drop down menu, as presented below.



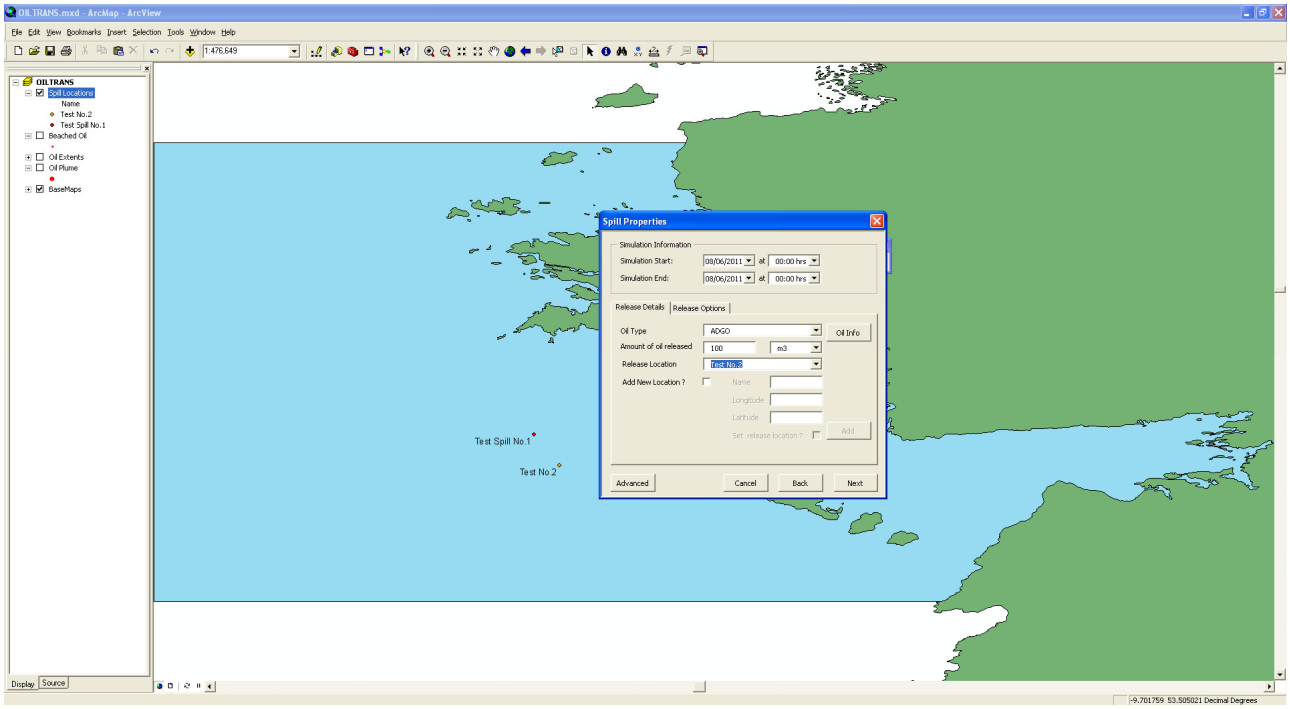
Optionally, the user has the option to "**Add New Location**" on the form by specifying a unique "**Name**" and the corresponding "**Longitude**" and "**Latitude**" coordinated of the spill location, as shown in the form below:



The user may then opt to "**Set release location**" to this newly added release location, and "**Add**" it to both the database and the GIS basemap.

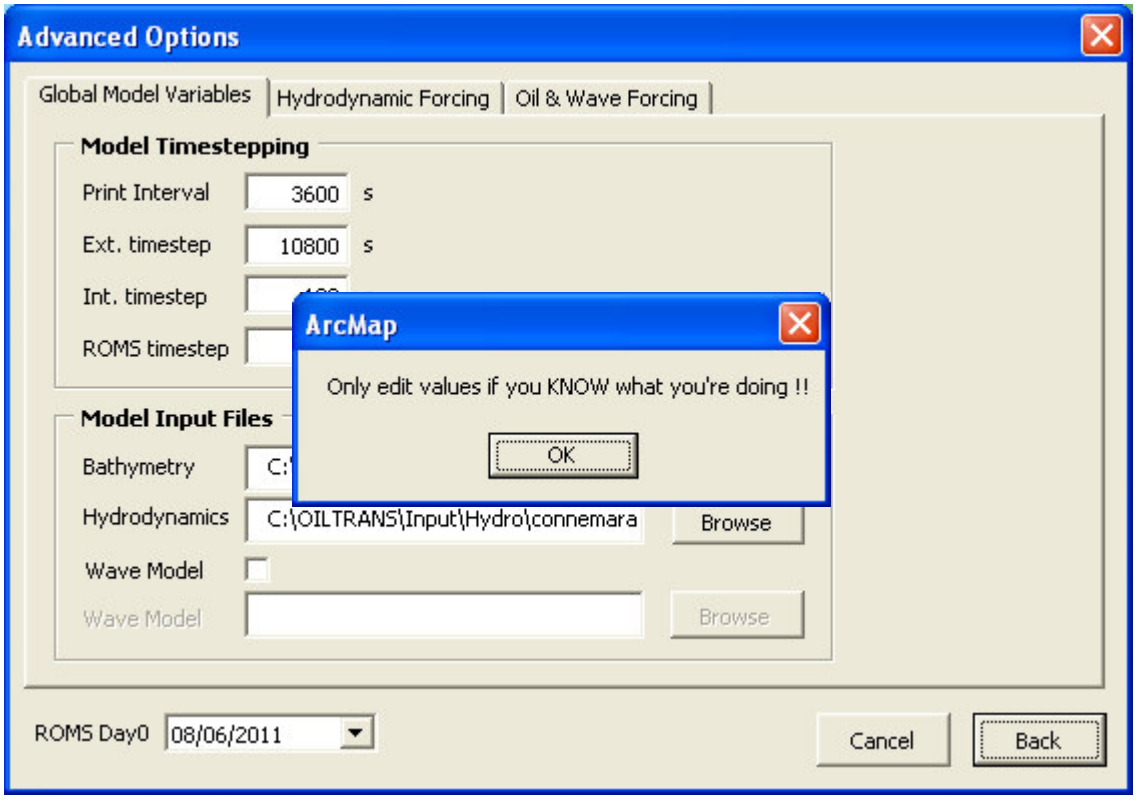


In which case the seelcted “Release Location” on the form is updated to reflect the users wishes and the new spilll location is added to the OILTRANS GIS application, as shown below.

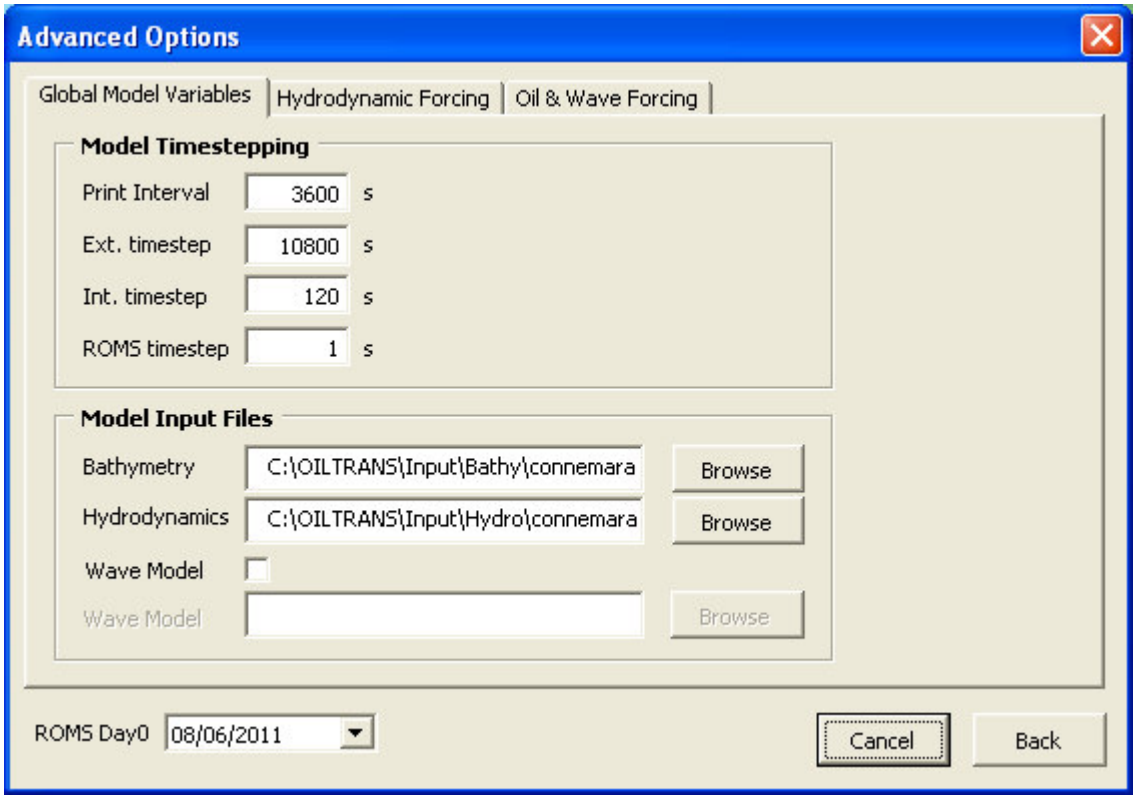


The Spill Properties form also has the option for "**Advanced**" settings, to allow the user flexibility in defining in more detail the exact nature of the simulation to be executed.

By selecting the "**Advanced**" button the user is presented with a warning message urging caution when modifying any of the variables presented.



Once the user has aknowledged the warning message, thus accepting responsibility for any modification which may be made, the form is ‘opened’ for the user to interact with.



The form is spread across three pages; "**Global Model Variables**", "**Hydrodynamic Forcing**" and "**Oil & Wave Forcing**", each of which will be dealt with in turn.

The "**Global Model Variables**" page presented above, allows the user to modfiy the "**Model Timestepping"** and "**Model Input Files**" options.

Global Model Variables :- Model Timestepping:

"**Print Interval**" at which the OILTRANS computer model creates output files for visualisation in the GIS viewer. The default for output generation is one hour (3600 seconds)

The "**Ext. timestep**" governs the timestep at which the archived hydrodynamic files are created. For the Marine Institute operational modelling system the default is 3 hours (10800 seconds).

The "**Int. timestep**" governs the timestep at which the OILTRANS computer model calculates and updates both the locations of oil particles, and their associated physical and chemical properties. The default for the internal timestep is set at two minutes (120 seconds)

The "**ROMS timestep**" governs the number of ROMS archived hydrodynamic timesteps (**Ext. timestep**) that are archived within each archived hydrodynamic file. The default value is 1, one set of 3 hourly archived hydrodynamics are contained within each archived file.

Global Model Variables :- Model Input Files

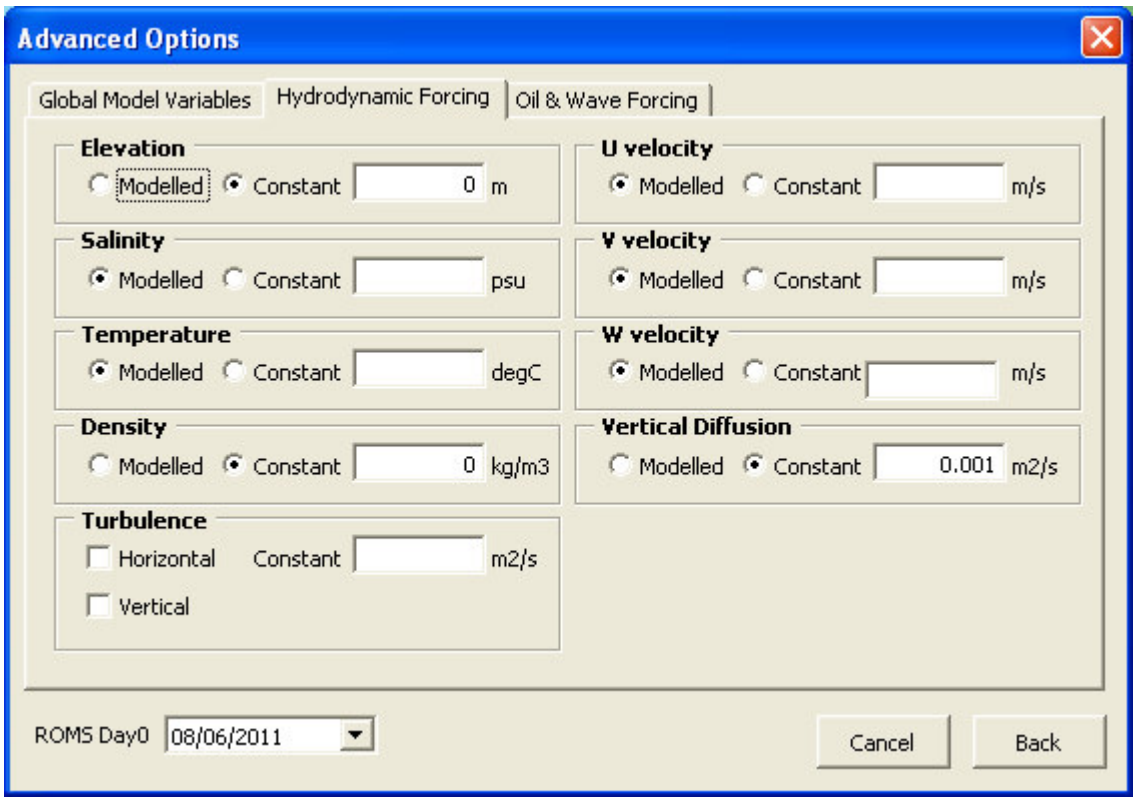
"Bathymetry" specifies the location of the NetCDF bathymetric file used by the ROMS oceanographic model in calculating the hydrodynamics of the region. It is recommended that this default is not changed.

"**Hydrodynamics**" specifies the location of the NetCDF archived hydrodynamic files created by the ROMS oceanographic model for the region in question. It is recommended that this default is not changed.

"**Wave Model**" allows the user to optionally specify the inclusion of archived wave field properties to the simulation. Note that the Wave model used in this current version of OILTRANS is SWAN, and further, the SWAN model grid and domain must exactly correspond to that of the ROMS oceanographic model domain.

"ROMS Day0" relates the day counter of the ROMS archived files to actual julian days. It is strongly recommended that this value is not changed as it links the temporal period of the simulation to the archived ROMS hydrodynamic files.

Hydrodynamic Forcing



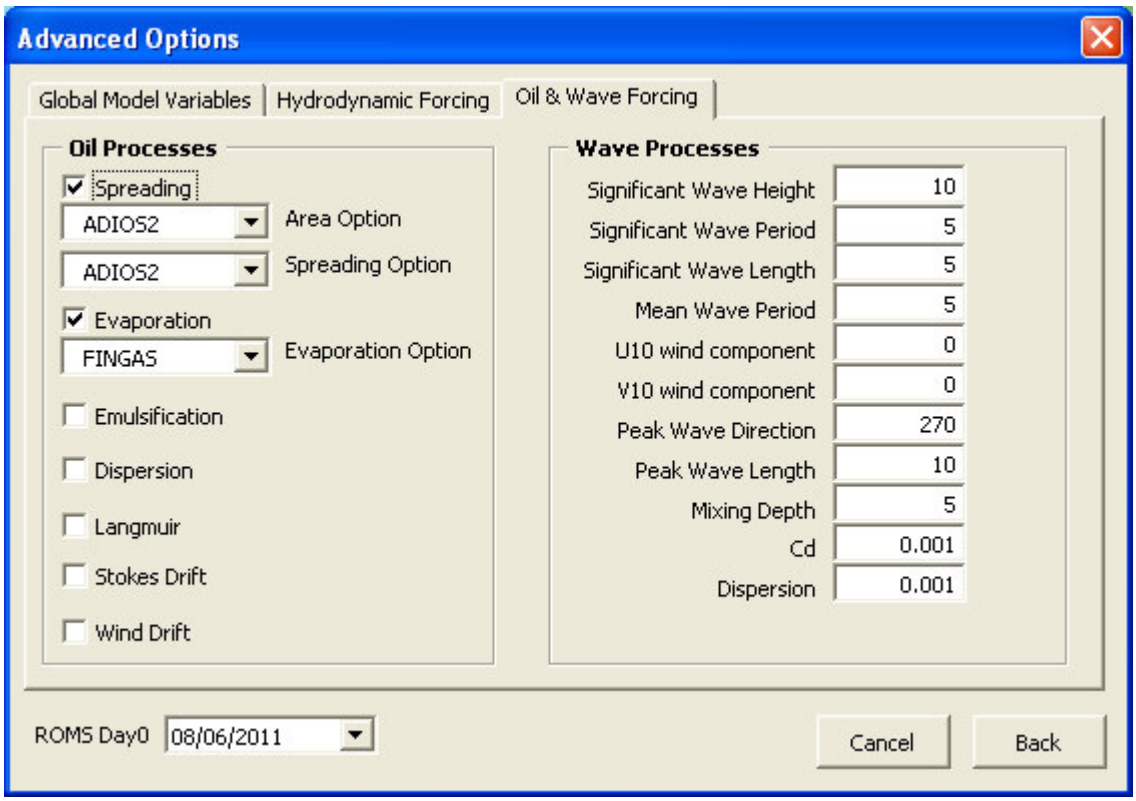
The options presented on the "**Hydrodynamic Forcing"** form allow the user to over-ride the archived hydrodynamics within the ROMS output files.

In the case a user wishes to define constant values for any parameter on the form, the user selects the "**Constant**" option and enters an appropriate value in the associated text box.

The user may toggle back to "**Modelled**" option before leaving the form.

Additional "**Turbulence**" may be included in the OILTRANS computer model as both a user defined "**Constant**" "**Horizontal**" value or as a calculated "**Vertical**" tubulent process.

Oil & Wave Forcing



The options presented on the "**Oil & Wave Forcing"** form allow the user to over-ride the default oil weathering/transport algorithms and override the archived wave forcing properties from the "**Wave Model**" option on the previous page.

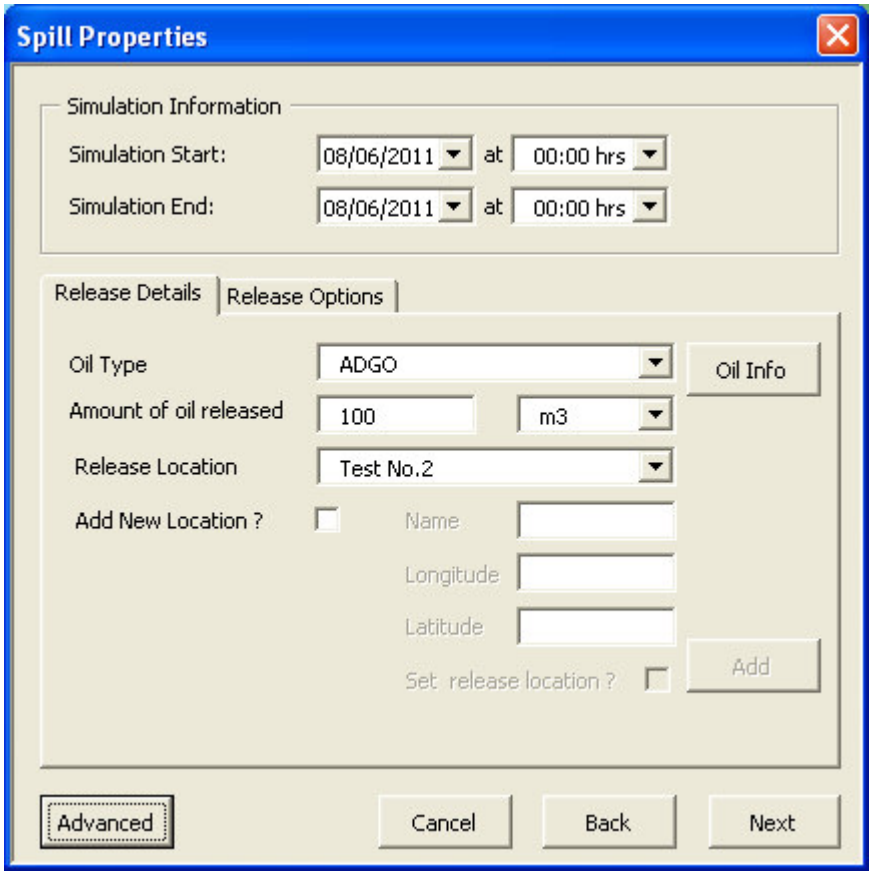
On the left hand side of the page, the user has the option to include (or not) the "**Spreading**" process of an oil slick and to select alternate algorithms for the oil "**Spreading**" process, both in terms of an initial predicted "**Area Option**" and the "**Spreading Option**" which controls the mechanical spreading of the oil slick.

The user has the option to include (or not) the "**Evaporation**" process of an oil slick and the ability to select alternate algorithms for the "**Evaporation Option**".

The user also has the ability to choose to include (or not) the processes of "**Emulsification"**, "**Dispersion"**, "**Langmuir circulation"**, "**Stokes Drift"** and "**Wind Drift"**.

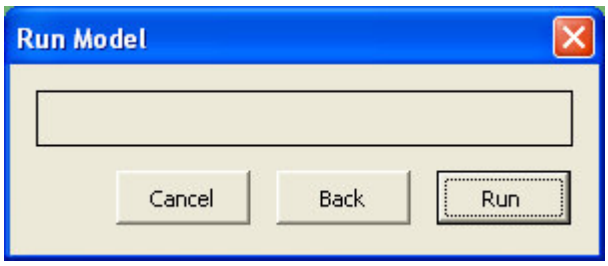
On the right hand side of the page, the user has the option to over-ride the the archived wave model predictions from the SWAN output files. These options only become valid if the "**WaveModel**" option has been chosen on the "**Global Model Variables**" page.

By pressing the "**Cancel**" button, the user returns to the previous form without any updates being made to the OILTRANS computer code. Pressing "**Back**" enforces the user selected changes to the OILTRANS computer code and returns the user to the previous form.



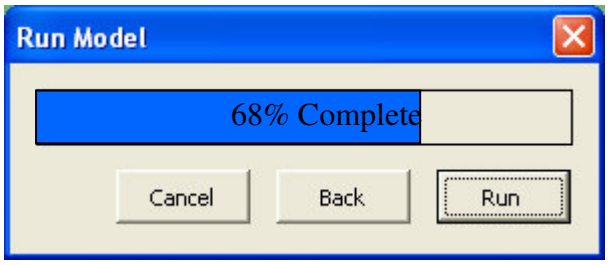
Upon returning to the Spill Properties form from the Advanced Options, the user may review the input parameters to date, or opt to move directly to the "**Next**" form in the process to launch the OILTRANS oil spill model simulation as defined.

The user is presented with the following form. Clicking "**Run**" will execute the OILTRANS oil spill model simulation. "**Cancel**" will cancel all input to the forms and return the user to the GIS viewer. "**Back**" will return the user to the previous form "**Spill Properties**"



Upon clicking run the OILTRANS oil spill model simulation will start.

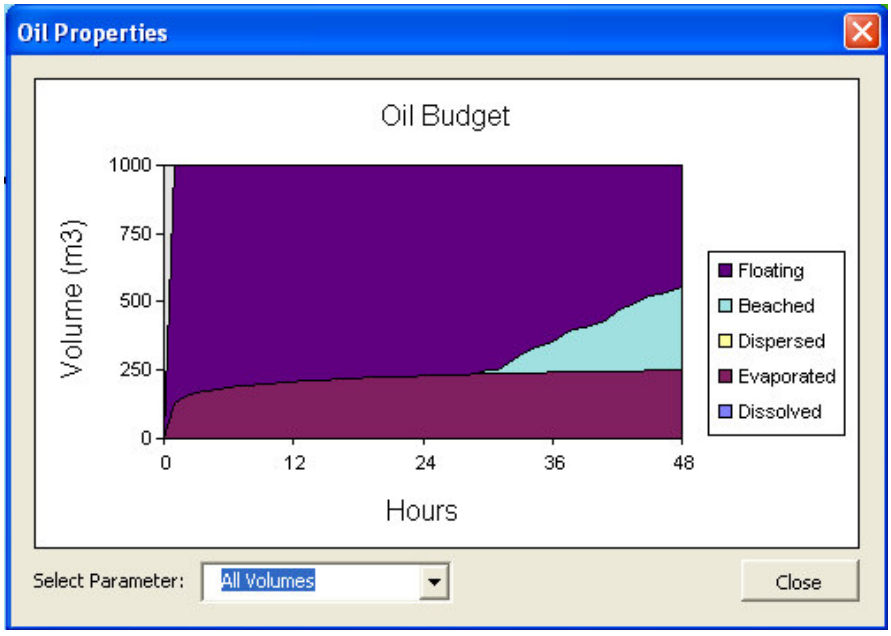
The progress bar at the top of the above form will start to gradually fill, denoting progress of the model simulation. In addition, the evolution of the oil slick will be updated in the GIS viewer at hourly intervals of the simulation, presenting the user with the path of the slick as the simulation progresses.

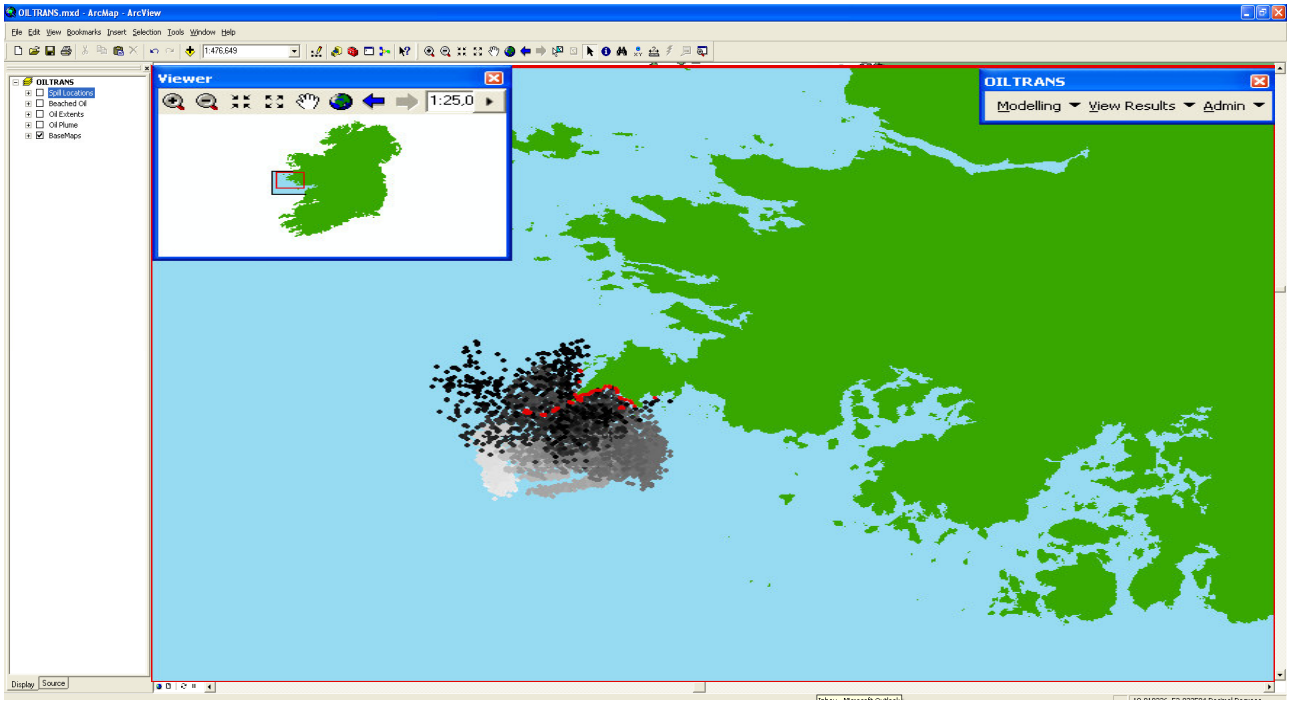


Once the simulation has been completed, the above form will disappear and be replaced by the oil mass balance graph, below, indicating the evolution of the volume of the spill over time.

The volume of oil is graphed in terms of volume of oil floating on the water column, volume beached, volume dispersed, volume evaporated and volume dissolved.

In addition, the swept path of the oil slick will also be presented in the GIS viewer, and any areas where the oil has beached will be presented as red dots.

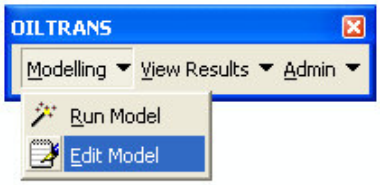

Oil Properties
Oil Budget
Volume (m3)
1000
750
500
250
0
0
12
24
36
48
Hours
Floating
Beached
Dispersed
Evaporated
Dissolved
Select Parameter:
All Volumes
Close


OILTRANS.mxd - ArcMap - ArcView
Viewer
OILTRANS
Modelling
View Results
Admin

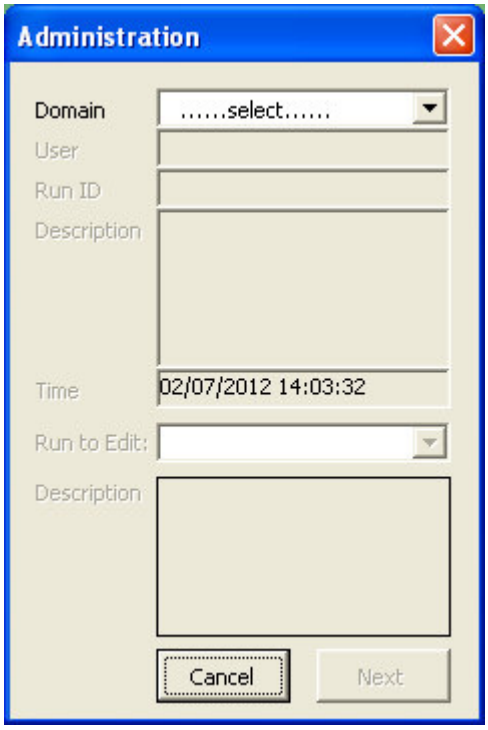
Modelling: Edit Model

From the OILTRANS ArcView toolbar select "**Modelling**"

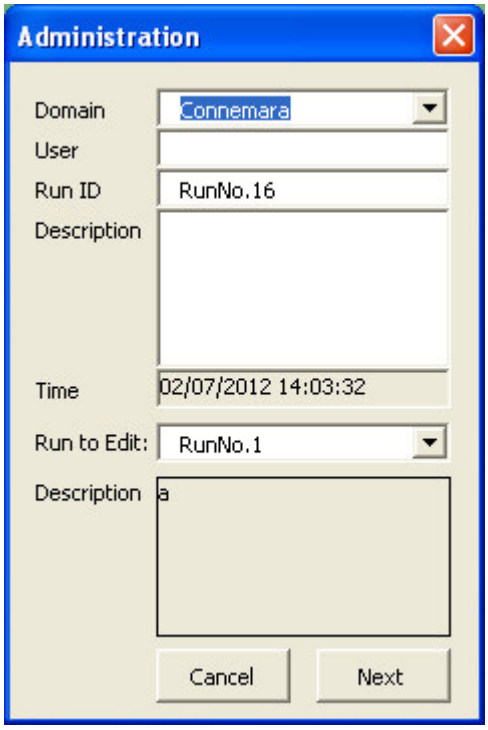
Then select "**Edit Model**"



The user is presented with the following form.

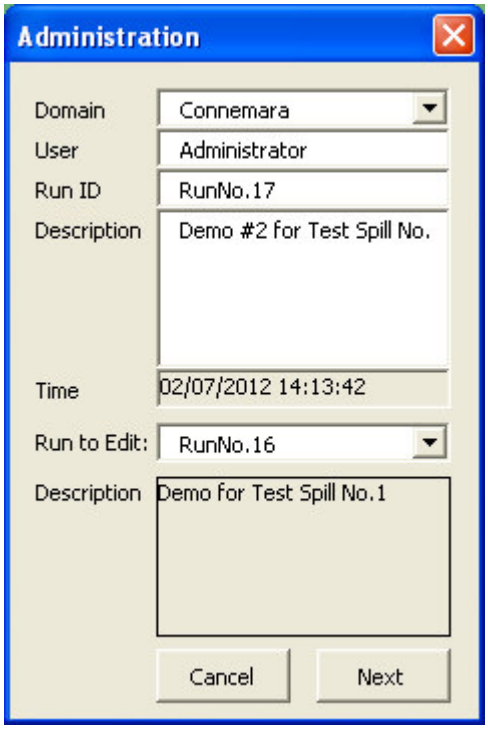


The user is requested to select the model domain in which to execute an oil spill modelling scenario. In this example the user selects "**Connemara**"



The user is then prompted to enter the following information; a username "**User**", and a description of the simulation being undertaken "**Description**". The user is also asked to select which previous "**Run to Edit**"

The "**Run ID**" field is populated internally within the application and acts as the unique simulation records identified within the internal OILTRANS database. Likewise, the "**Time**" field is populated internally within the application and acts as a unique timestamp record of simulation creation.

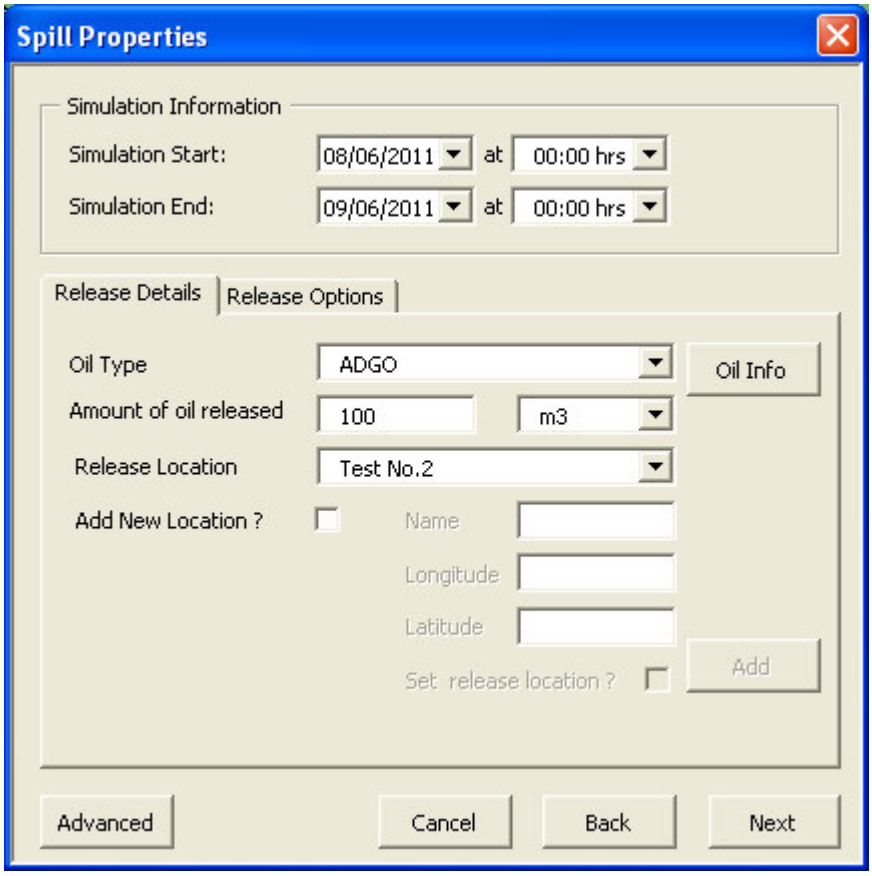


In this example the user has selected to edit Run No.16 (from **Run Model**, above).

Once the user has populated the required fields, the user may select to "**Cancel**" the simulation at this stage or proceed to the "**Next**" step of the simulation creation process.

Note that when a user cancels the simulation creation process, no information is stored within the internal OILTRANS database.

In this example the user proceeds to the "**Next**" stage of the simulation creation process, where they are presented with the following form;



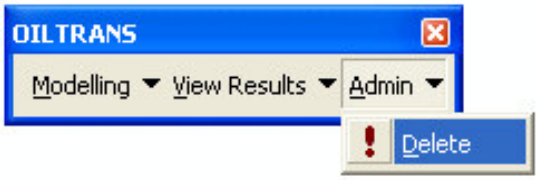
The form as been populated with the details retrieved from the OILTRANS system database for the Run No.16 simulation that the user has chosen to edit.

The user may now modify any of the parameters from the previous run and create a new instance of the simulation.

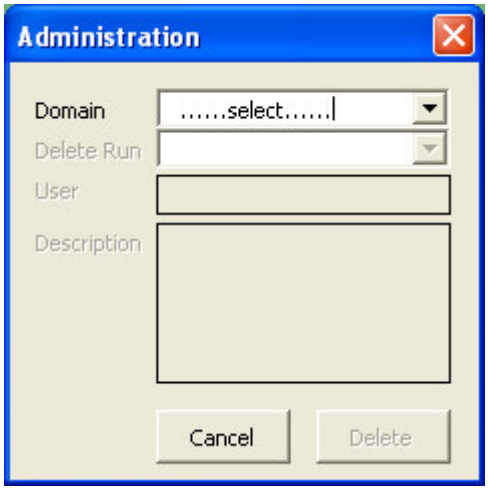
All other forms that are loaded contain the parameters from the OILTRANS database for the run that the user has chosen to edit.

Delete Scenario

Over time the user will create a large library of oil spill model simulations. Not all simulations will be required for future use and may therefore be deleted from the system. The user may choose from the OILTRANS toolbar the option "**Admin**", and the "**Delete**" option thereunder.



The user is then presented with the following form:



The user is requested to select the model domain from which the scenario is to be deleted, and the unique Run No. identifier for the run to be deleted.

In this example the user selects "**Connemara**" and "**Run No. 16**". From the presented description this can be seen to be the "**Demo for Test Spill No.1**" scenario, created earlier.

The user may choose to "**Cancel**" this operation or PERMANENTLY "**Delete**" all information pertaining to that scenario from the system databases.