MIKE 21/3 Oil Spill Module

Rectilinear Grid

Short Description

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MIKE213_OS_Short_Description.docx / IMNR/AJS / 2015-12-04

MIKE 21/3 Oil Spill Module

Accidental oil spills remind us of the dramatic impacts that oil can have on the environment. They also bring into focus, the importance of efficient emergency planning. Oil spills pose serious threats to the marine environment. They also put a lot of pressure on the entities that are responsible for the emergency response and clean-up operations, such as oil companies and national authorities.

This is the background for the Oil Spill Module. The module simulates the weathering and movement of oil represented by discrete particles in a flow field using a so-called Lagrangian approach. It may also simulate the spreading of dissolved oil using advection-dispersion calculations, which are based on the Eulerian approach.

The Oil Spill Module is a stand-alone model. The hydrodynamic basis is obtained from the hydrodynamic result files from the MIKE 21 HD Module or from the MIKE 3 HD Module.

Application Areas

The Oil Spill Module can be applied in the open sea, coastal areas, estuaries, rivers and lakes. It can be applied in two or three dimensions. However, when considering dissolved oil three dimensions are recommended.

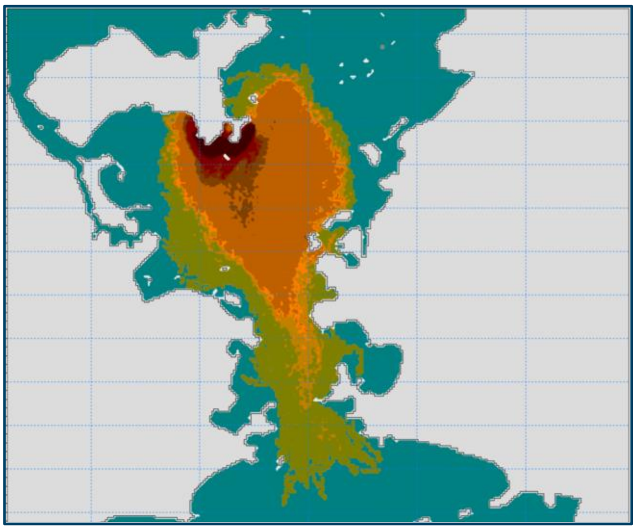
The Oil Spill Module can be applied in studies of e.g.

- environmental impact assessment
- single spill impacts
- clean-up operations
- emergency response systems
- assessment of required amounts of dispersants

Features

The MIKE 21/3 Oil Spill Module includes the following features:

- all weathering processes
- movement of the oil on the surface and in the water column
- the effects of dispersants
- stranding with the possibility of re-entering the water



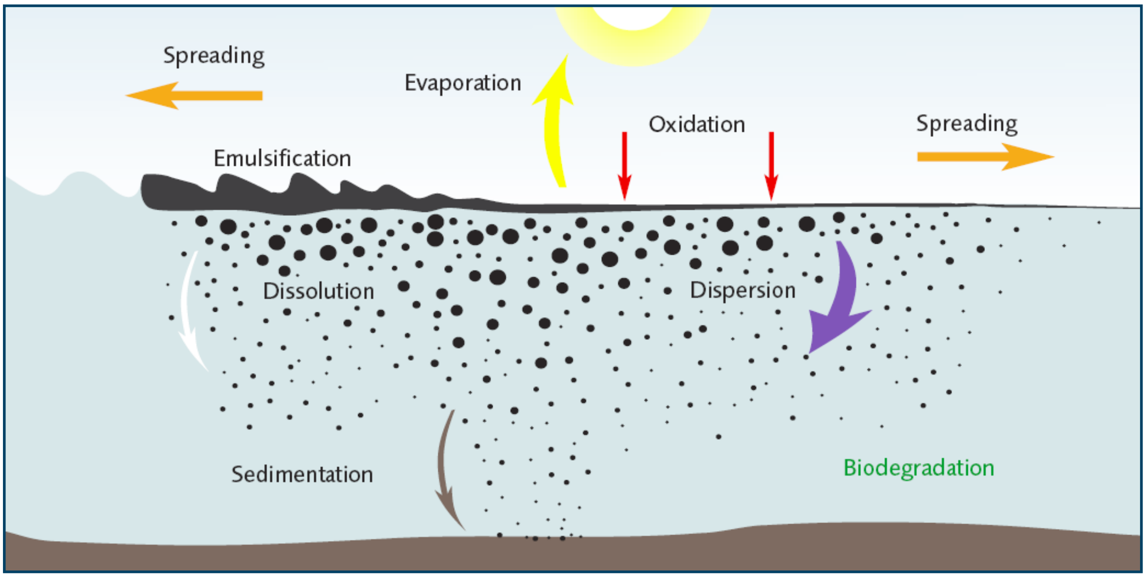
Oil spill scenario, Guanabara Bay, Brazil

Oil Characterisation

The different types of oil are characterised through a number of key parameters including e.g. density, viscosity, pour point and maximum water content. Additionally, the oil is divided into the following five fractions:

- heavy fraction
- volatile fraction
- wax
- asphaltene

Each of these is described through a number of key parameters and weathering constants.



Weathering processes (from Fate of Marine Oil Spills, 2002)

Weathering Processes

The following weathering processes are included in the Oil Spill Module:

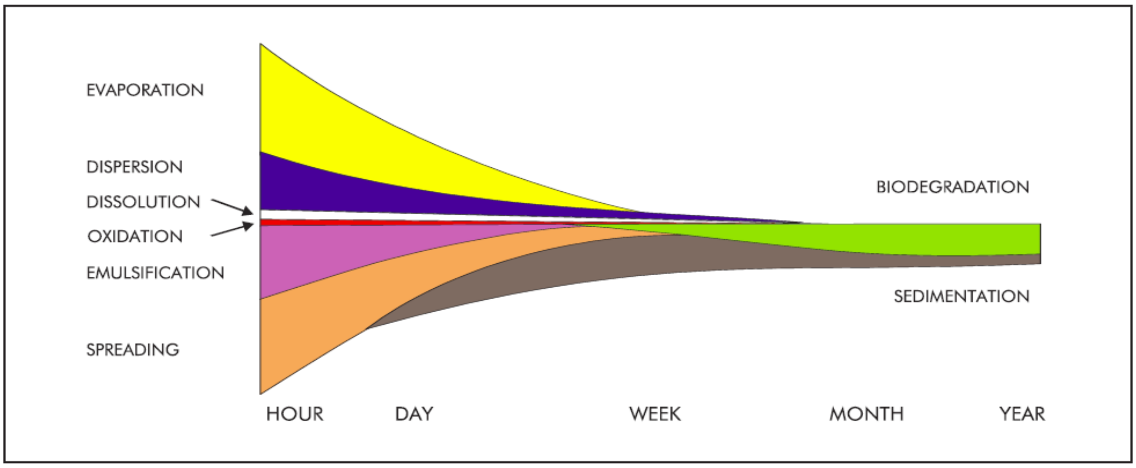
- spreading (viscous, gravity based)
- evaporation
- emulsification
- vertical dispersion (by waves)
- dissolution
- biodegradation
- photo-oxidation

All of these processes and the other features in the Oil Spill Module are handled by a MIKE ECO Lab template. This means that all processes/features may be inspected (and updated if so desired) using the ECO Lab editor (an ECO Lab license is required to use the ECO Lab editor). An illustration of the weathering processes and their time scales are shown above and below.

Environmental Data Requirements

The following environmental data are required for an oil spill simulation:

- Current data in 2D or 3D. These will be results from a MIKE 21 or MIKE 3 HD rectilinear grid simulation.
- Wind data. These are used for calculation of the surface layer drift and Stoke's drift. The wind data are also applied in e.g. the evaporation process.
- Wave data. These are used for the vertical dispersion of the oil. Note that when oil particles are dispersed into the water column no evaporation will take place. This may have an important effect on the amount of oil hitting e.g. a coast.



Time scales for weathering processes (from Fate of Marine Oil Spills, 2002)

Solution Technique

The oil spill simulation is executed using the MIKE ECO Lab engine and a MIKE ECO Lab oil spill template using Lagrangian particle tracking (including weathering processes).

An oil spill simulation using rectilinear grid is run in de-coupled mode, where flow data from a previous MIKE 21 or MIKE 3 HD simulation are used as input.

The spreading of an oil spill is calculated by dividing the oil spill into discrete parcels, termed particles.

The movements of the particles are given as a sum of a displacement determined by the hydrodynamic flow field (and optionally the wind) and a dispersive component as a result of random processes (e.g. turbulence in the water).

The movement of dissolved oil is calculated using an advective-dispersion formulation.

Input

Input data to the Oil Spill Module are divided into a number of groups:

- environmental data (currents, wind and wave)
- current profile specification near surface and bottom (optional)
- dispersion coefficients
- oil characteristics for the four fractions including weathering constants
- spill location, depth, duration and amount
- possibility of oil re-entering the water after being stranded (depending on type of coast, e.g. sandy beach or vertical rocks)
- initial conditions
- boundary conditions

The oil spill may be specified as an instantaneous spill (at the outset of the simulation) or as a spill continuing for some time. The location may be fixed or moving.

Output

A number of output types are available:

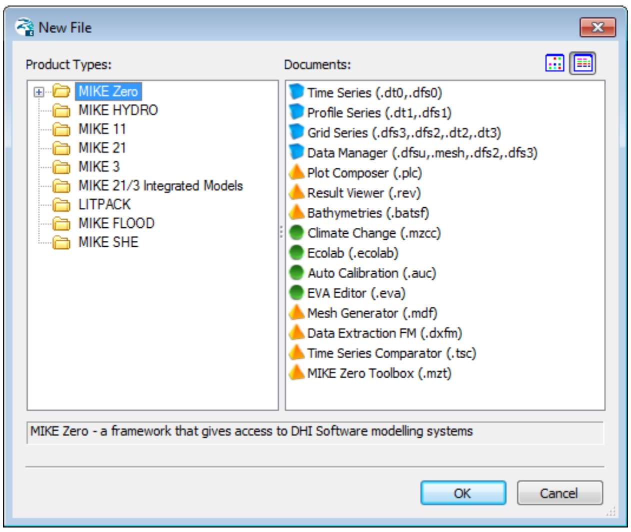
- 2D-maps or 3D maps (the latter only when running the Oil Spill Module in a 3D domain) containing the instantaneous value (as mass, area concentration of volume concentration) or the statistical value (min, mean, max, time average or cell average) of all oil parameters. These parameters include (among many):
    - total mass excluding water
    - total mass including water
    - oil slick thickness (2D only)
    - amount stranded incl. and excl. water (2D only)
    - time of first arrival (2D only)
- Particle tracks and particle properties. These are useful for illustrating the spreading of the oil spill. An example is shown below.

Visualisation of oil trajectories and current field on Google Earth background

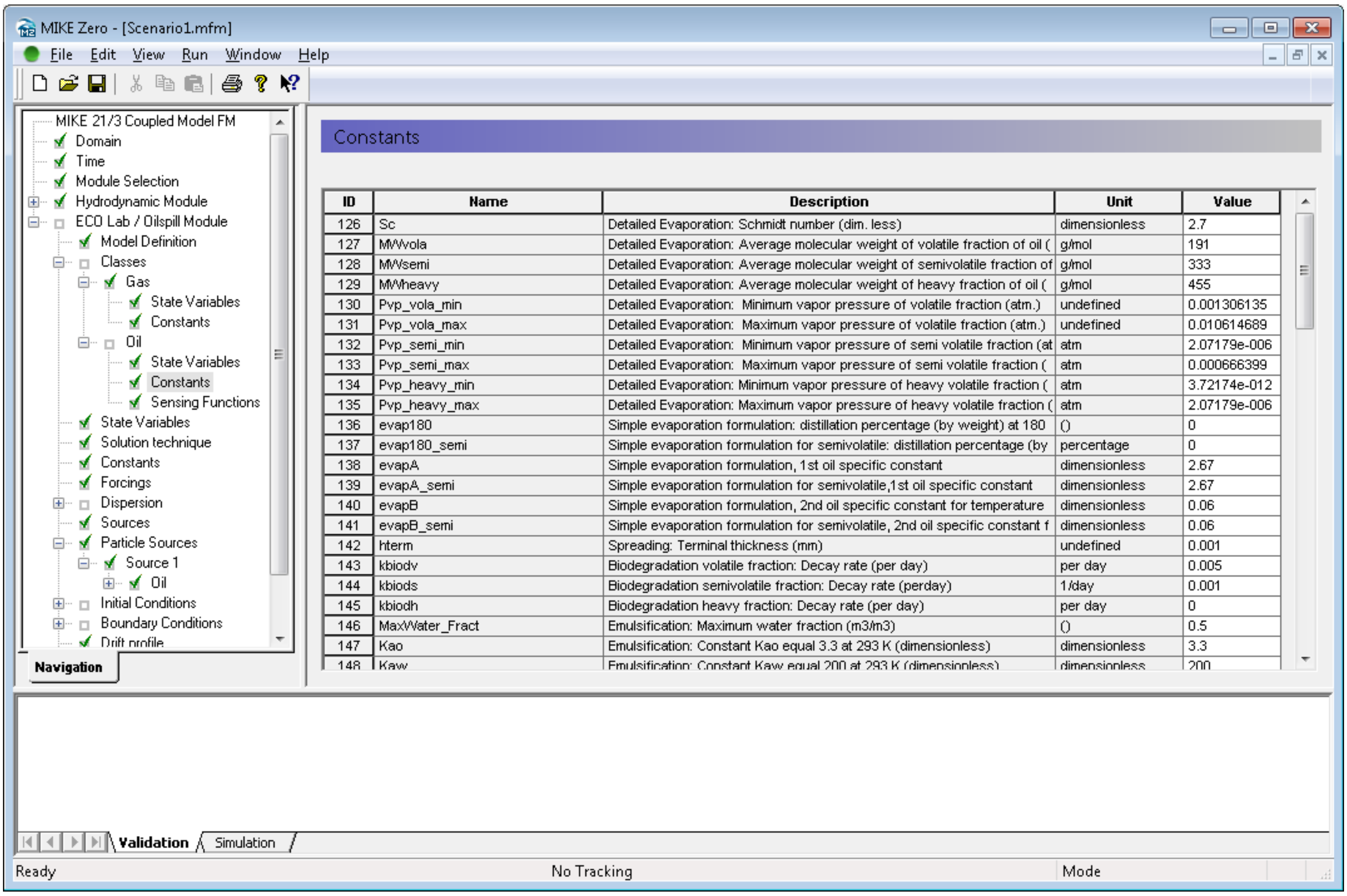
Graphical User interface

The MIKE 21/3 Oil Spill Module is operated through a fully Windows integrated Graphical User Interface (GUI) and is compiled as a true 64-bit application. Support is provided at each stage by an Online Help System. A screen shot of the GUI is shown on the next page.

The common MIKE Zero shell provides entries for common data file editors, plotting facilities and a toolbox with utilities as the Mesh Generator and Data Viewer.



Overview of the common MIKE Zero utilities



Graphical user interface of the Oil Spill Module showing weathering constants

Hardware and Operating System Requirements

The MIKE 21/3 Oil Spill Module supports Microsoft Windows 7 Professional Service Pack 1 (32 and 64 bit), Windows 8.1 Pro (64 bit), Windows 10 Pro (64 bit) and Windows Server 2012 R2 Standard (64 bit). Microsoft Internet Explorer 9.0 (or higher) is required for network license management as well as for accessing the Online Help.

The recommended minimum hardware requirements for executing the MIKE 21/3 Oil Spill Module are:

Processor:	3 GHz PC (or higher)
Memory (RAM):	4 GB (or higher)
Hard disk:	160 GB (or higher)
Monitor:	SVGA, resolution 1024x768
Graphic card:	64 MB RAM (256 MB RAM or higher is recommended)

Support

News about new features, applications, papers, updates, patches, etc. are available here:

www.mikepoweredbydhi.com/Download/DocumentsAndTools.aspx

For further information on MIKE 21 & MIKE 3 software, please contact your local DHI office or the support centre:

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Documentation

The MIKE 21 & MIKE 3 models are provided with comprehensive user guides, online help, scientific documentation, application examples and step-by-step training examples.

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