

ECO Lab

Exercise 1: Modelling E.coli bacteria

The expert in WATER ENVIRONMENTS



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1 Exercise 1: Modelling E.coli bacteria

Getting started

- 1. Locate the example folder: Explore the folder C:\Program Files (x86)\DHI.... and look for ...\MIKE Zero\Examples\MIKE_21\FlowModel_FM\HD\Oresund\Calibration_2
- 2. Open the file: oresund.m21fm
- 3. Save the file into a working folder and change the name of the setup file.

Template selection

- 4. In module selection, include ECO Lab.
- 5. In the model definition you open the 'From file ...' menu.

🔵 oresund_bacteria.m21fm - Modif	ied	- • ×
oresund_bacteria.m21fm - Modif MIKE 21 Flow Model FM M Domain M Time M Module Selection M Hydrodynamic Module K ECO Lab / Oilspill Module X Model Definition Dispersion Outputs	Model Definition Template Selection From File Summary O State Variables O State Variables O Constants O Processes O Forcings O Classes	
Navigation Model Definition: None or Invalid M	Integration Euler Update Frequency 1 Integration File Integration File	



🔵 oresund_bacteria.m21fm - Modif	ied		
MIKE 21 Flow Model FM Domain Time Module Selection Hydrodynamic Module COLab / Oilspill Module State Variables Solution technique Constants Forcings Initial Conditions Boundary Conditions Outputs	Model Definition Template Selection DHI Enterococci and E.coli Model C:\Program Files (x86)\DHI\2 Summary 2 State Variables 9 Constants 6 Forcings 0 Classes Solution Parameters Integration Luler Update Frequency	odel COLAD \Er \ COLAD \ COLAD \ER \ COLAD \	
Navigation	ion /		

6. Choose the DHI Enterococci and E.coli model.

7. Set the update frequency to 5.



State Variables, Solution Technique and Constants

8. For this exercise you do not change anything in the menus: State Variables, Solution Technique and Constants.

Forcings

9. In the 'Forcing menu you include the constants as stated in the power point.

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MIKE 21 Flow Model FM							
🗹 Domain	For	cings					
Time							
Module Selection							
🖶 🗹 Hydrodynamic Module	No.	Description	Туре	Va	lue	File Name	
ECO Lab / Oilspill Module	1	T, Temperature	Constant	20	degrees C		
Model Definition	2	S, Salinity	Constant	15	psu		
State Variables	3	lo, Surface solar irradiation	Constant	500	W/m2		
Solution technique	4	SD, Secchi depth	Constant	2	m		
Constants	5	depth, Total water depth	Built-in				
Forcings	6	dz, Water depth actual layer	Built-in				
Navigation							
Validation / Simulat	ion /						



Dispersion

10. For the Dispersion you include 'Scaled Eddy Viscosity Formulation' and keep the constant value at 1.

🔵 oresund_bacteria.m21fm - Modifi	ed		- • •
MIKE 21 Flow Model FM	Enterococci		Â
···· ✔ Time ···· ✔ Module Selection ··· ✔ Hydrodynamic Module	Formulation	Scaled eddy viscosity formulation	
ECO Lab / Oilspill Module	Scaled eddy viscosity	formulation	
State Variables	Format	Constant 💌	
Constants	Constant value	1	
■ Forcings	Data file and item	Select	
Horizontal Dispers		Item: View	=
	Dispersion coefficient Format Constant value Data file and item	formulation Constant 0.01 [m ² /s] Item: View	
Navigation			-
Validation / Simulatio	on /		



Sources specification

11. For the sources you first need to include one source in the 'Hydrodynamic section' – open the hydrodynamic module and enter the 'Source' folder.



12. Zoom in to a coastal area and double click where you would like to include the source.





oresund_bacteria.m21fm - Modified		
MIKE 21 Flow Model FM	ources	
I Domain IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	lources	
Module Selection Geo	eographic View List View	
Hydrodynamic Module	ími	
Solution Technique		
V Elood and Dry		
✓ Density =	018 New Source	
Eddy Viscosity		
Bed Resistance	Source name WWTP	
Wind Forcing	618 Position	
Ice Coverage	Map projection	
Tidal Potential		
Precipitation - Evapor	A Coordinate 349623.868923105 [m]	
Wave Radiation	Y coordinate 6182581.20050069 [m]	
€ Structures		
Initial Conditions	Layer	
Boundary Conditio	617 Value	
M Decoupling	OK Cancel	
ECO Lab / Oilspill Mod		
	Zoom in Zoom out Recenter	
∴ Navigation		
Validation Simulation		

13. You now have a source, and the location is shown on the map.





14. Enter the list view, press the 'go to' button and include a discharge as listed in the power point.

🔵 oresund_bacteria.m21fm - Modifie	1	- • •
MIKE 21 Flow Model FM	WWTP	Â
Module Selection	Location Map projection UTM-33	
Solution Technique	Type of vertical location	
Flood and Dry → Density → Eddy Viscosity	Easting: 349623.868923105 [m] Northing: 6182581.20050069 [m] Layer no: 1	
Bed Resistance	Source type Simple source Connected source	E
	Data	
Wave Radiation	Discharge 2 [m³/s] u-velocity 0 [m/s]	
WWTP	v-velocity 0 [m/s] Data file and items Select	
Initial Conditions Boundary Conditio	Item: View	
Outputs	Item:	
Navigation		-
Validation Simulation		

15. Close the 'Hydrodynamic section' and enter the 'Source' menu in the ECO Lab section.



16. Press the 'Go to' button and enter concentrations as listed in the power point. 300000 enterococci/100 ml and 1000000 E.coli/100 ml.

🔵 oresund_bacteria.m21fm - Modifier	d		- • ×
MIKE 21 Flow Model FM	Enterococci		· · ·
Module Selection Module Selection Hydrodynamic Module	Type of variable	Specified concentration	
COLAD / Oilspill Module Model Definition M State Variables M Solution technique M Constants M Forcings M Dispersion M Horizontal Dispers	Format Constant value Data file and item	Constant • 300000 [1/100 ml] Select Item: View	
f Enterococci f E. Coli Sources f F. Tetrococci f f. Tetrococci f f. Tetrococci f f. Coli f c.			
Navigation ►		View location	-
Validation & Simulation			
Validation Simulation	<u>, /</u>		



Initial Conditions and Boundary Conditions

17. Default values for the two bacteria are zero, why we do not need to change anything in the menus for 'Initial Conditions' and 'Boundary Conditions'.

Output specification

18. Enter the output menu and include two new outputs. Name them 2D and Point.

MIKE 21 Row Model FM Module Selection Module Selection Module Selection Module Selection Module Selection Module Selection Module Selection Module Selection Module Selection Marme Include Results Edit Module Selection Marme Selection Marm	
M Model Definition	
M Porcings M Dispersion M Hortzortal Dispers M Fraterococci M M M Ecoli E Initial Conditions E Boundary Conditions	
New output Delete output	
2D: File is not valid Output 2: File is not valid	



19. Create a 2D output file and a similar time series output as shown in the figures below.

🔵 oresund_bacteria.m21fm - Modifie	d	- • ×
MIKE 21 Flow Model FM	2D	
I Domain I Time	20	
Module Selection	Geographic View Output specification Output items	
🗄 🗹 Hydrodynamic Module		
ECO Lab / Oilspill Module	Data	
Model Definition	Field type 2D (horizontal)	
State Vanables	Output file 2D.dfsu	
Constants	Treatment of flood and Only real wet area	
Forcings	Unity real wet area	
🖃 🗹 Dispersion		
Horizontal Dispers	Time step	
Enterococci	First 0 Last 7020 Frequency 30	
🖮 🖌 WWTP		=
Enterococci		
E. Coli		
Boundary Conditions	Map projection UTM-33	
Outputs		
- ✓ 2D		
Point	Area series	
	Easting Northing Layer no. Name	
	1 322028.77431 6127731.4889	
	2 322028.77431 6224518.3037	
	3 378689.6147 6224518.3037	-
Navigation	14 1 3/0009 014/ 1 012//31 4009 1	
Point: File is not valid		
	1	

e oresund_bacteria.m21fm - Modified	
MIKE 21 Flow Model FM	
Module Selection Geographic View Output specification Output items	
ECO Lab / Oilspill Module	<u>^</u>
Model Definition Field type 2D (horizontal) Output format Point ser	ies 🔻
Solution technique Output file	TS.dfs0
Constants Treatment of flood and Only real wet area	-
□ Services	
Horizontal Dispers	
Section Secti	30
	E
E. Coli	
Boundary Conditions Map projection UTM-33	n file
□	
Point series	
	<u>↑</u>
Easting Northing z Name	
	-
Malan Wildebing Completion	



Model execution

20. Run the model. If the model does not start running, please remove the output from the 'Hydrodynamic selection' (the folder for the HD results might be 'read only').

Model results

21. When the model run is completed the model results can be viewed from the output menu, by pressing the 'view' button.

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🔵 oresund_bacteria.m21fm				
MIKE 21 Flow Model FM				
Minte 21110W Model I M				
v Domain v Dime				
Module Selection Output				
Hvdrodynamic Module t No. Name	Include Results Edr	t		
ECO Lab / Oilspill Mod 1 2D	View Go to			
Model Definition 2 Point	View Go to			
🖌 🖌 State Variables				
Solution technique				
Constants				
Forcings				
🖃 🗹 Dispersion				
🖻 🖌 Horizontal Disper				
Enteroco				
E. Coli				
	han an atomatic			
	te output			
Navigation				
,,				
====== Memory Usage =====				*
Peak memory usage (MB)	40.55			
Durfermon -				
Number of threads: 4				
100.0/				
100 %	1993-12-13 00:00:00	Time step: 7920	27045 0 se	conds
Validation Simulation				

22. The 2D results provide an overview of the transport and dilution of the bacteria source, whereas the point series show the results over time. The variance in the concentrations is governed by the current direction.







- 23. Applying the statistics from the 'tool' menu you can calculate the average concentration from the two bacteria: Enterococci and E.coli. For the example provided the average of the two are 379 enterococci/100 ml and 876 E.coli/100 ml.
- 24. Now try to change the Secchi depth in the 'Forcing' menu from 2 m to 5 m. Save the setup in a new name and repeat the model run.
- 25. The statistics from the model results now show 277 enterococci/100 ml and 575 E.coli/100 ml. Similar tests can be executed by changing temperature, salinity etc.
- 26. As stated in the power point, you can also try to do the same exercise by applying a 3D model setup. In this case include the source in the surface layer, but keep the remaining constants as in this 2D example.