

MIKE METOCEAN SIMULATOR







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1 Introduction

MIKE MetOcean Simulator (MIKE MS) is built on the MIKE Cloud Platform and leverages the power of MIKE Mesh Builder and MIKE Data Link in a simple web-based user interface. The MIKE MS web interface provides pre-defined templates and default settings for a quick setup. MIKE MS assists in high-resolution meshing of the model domain, provides long term boundary conditions for the created mesh, simulates selected events in the cloud and reconstructs a long term timeseries from the selected events. The resulting timeseries can be downloaded or published to DHI's MetOcean On Demand platform for further analysis.

MIKE MS is based in the MIKE Cloud Platform (Microsoft Azure based) and can be used online using browsers like Google Chrome and Microsoft Edge. It is developed using Agile processes, meaning that updates can take place when required, and consequently, we urge MIKE MS users to communicate questions, remarks and wishes to DHI, as we are improving our products based on your feedback.



2 Getting started

It only takes a few steps to get started with the MIKE MS application. The basic workflow processes are as listed below:

- 1. Access to MIKE Metocean Simulator is available only to users who have been invited to one of the MIKE Cloud Admin Sites. This can be done in one of the following ways:
 - a. Invitation by DHI Customer Care team, for the very first user of a newly created MIKE Cloud Admin Site.
 - b. Invitation by a MIKE Cloud Admin site owner, for and existing site.
- 2. Go to the MIKE MS home page: https://metoceansimulator.mike-cloud.com/
- 3. Log in to MIKE Cloud via the MIKE MS home page
- 4. Select an existing project by clicking on it or create a new project

+ Create folder

- Enter the selected or created project by clicking on the name NOTE: MIKE Metocean Simulator will not start from the root of MIKE Cloud. It is required to enter a project folder or subfolder.
- 6. Start the Metocean Simulator

Start Simulator

This will lead you to the initial starting screen:

ŵ 參 Metocean Simulator ▼
0 (2 (3 (4 (5 (6 _
Initial selection Mesh & Points Boundary Nodes selection Setup & run bathymetry conditions
Meshing options Select one of the below options
Use the assisted meshing option
By default coordinates are in EPSG code 4326, also known as WGS84 projection (LONG; LAT coordinates)
Coordinates are in Q Type at least 3 chars of code or name
Scenaro: Cosstal: Part of the external model boundary is closed by a shoreline. Offshore: There is no shoreline on any external model boundary. All external boundaries are open. Use your own mech
Next step

Figure 2.1 MIKE MS workspace with choice of meshing options

We will now describe the layout of the MIKE MS interface in general in chapter 3.



3 MetOcean Simulator User Interface

The user interface consists of the following main user interface components:

- Top bar
- Stepper
- Inputs panel
- Maps area
- Layer manager

The MIKE MS layout is presented in Figure 3.1 below, and the UI components are further described in the following sub sections.

If you want to get started immediately on using MIKE MS, refer to Section 4.



Figure 3.1 MIKE MS workspace with indication of main user interface components. The figure includes an example of a model mesh (blue polygon area) and output points.

3.1 Top bar

The application top bar includes generic functionality for DHI cloud applications including navigation between the Cloud applications as well as icons for help and user details.



The top bar has the following features:

• Home: Direct link to the DHI cloud admin home page. By clicking here, you leave the current (MIKE MS) application.



- App selector: A drop down list with the available Cloud applications are shown. If you
 click a new application, it opens the selected application in a new tab using the same
 project context.
- Navigation Breadcrumb: Click on a link to navigate between folders inside MIKE MS.
- Right side Icons for Notifications, Help & support and for logging out.

3.2 Stepper

The stepper highlights which step in the MIKE MS process flow is currently active.

1 —	2			5	
Initial selection	n Mesh & bathymetry	Points	Boundary conditions	Nodes selection	Setup & run
Figure 3.3	Metocean Simulator p	rocess stepper			

3.3 Inputs panel

The inputs panel provides inputs fields and figures depending on the step in the MIKE MS setup. More details of the specific input panels are shown later in Section 4.

3.4 Map area

The map area shows the following:

- A generic base map showing borders and labels for orientation of the user.
- Model domains, shorelines and areas of interest.
- Bathymetry data.
- Model meshes.
- Output points.

3.5 Layers manager

The Layers manager, shown in Figure 3.4, enables different visualisations on the map. These will only be visible once a mesh is uploaded or generated by the assisted meshing option.





Figure 3.4 Layers manager

The following are examples of layers that can be turned on or off:

- Auto mesh: The mesh file generated by the assisted meshing option
- User defined bathymetry files (In this case reduce_IRL.xyz)
- GEBCO Bathymetry: As extracted automatically for the generated mesh
- Shoreline: As drawn or uploaded by the user
- Area of interest: As drawn or uploaded by the user
- Domain: As drawn or uploaded by the user
- Central points: Centres of boundary sections
- Points of interest: As specified by the user
- Mesh: As generated or uploaded
- Boundaries: Lines along the boundaries.



4 Step-by-step setup guide

This step-by-step setup guide will take the user through pre-defined steps. Each step in the process, as shown in the stepper, is broken down into subtasks which a user should be able to follow to set up an example in MIKE MS.



The step-by-step guide shows the user how to proceed through the whole workflow for an example mesh on the north-west coast of Ireland.



Figure 4.1 Example mesh to be set up in the step-by-step guide. The location is off the north-west coast of Ireland.

4.1 Initial selection

The user interface for Step 1 (Initial Selection) is shown in Figure 4.2 below.

The initial selection provides the user with the choice of the following meshing options:

- 1. Use the assisted meshing option for generating either Coastal or Offshore meshes.
- 2. Use your own mesh.

Both options are described in subsections below.



0 —	2								
Initial selection	Mesh & bathymetry	Points	Boundary conditions	Quality control	Setup & run				
Meshing options Select one of the below	voptions								
 Use the assisted 	Use the assisted meshing option								
By default coordinat	es are in LONG; LAT (EPSC	6 4326)							
Coordinates are in Q Type at least 3	chars of code or name								
Scenario:									
Coastal 💌									
🔘 Use your own m	esh				~				
Figure 4.2 Ste	ep 1: Initial selection								

4.1.1 Assisted meshing

Computational meshes can be generated directly by MIKE MS. The meshing uses pre-defined meshing parameters and is therefore called assisted meshing. The user is still required to provide the domain, the shoreline and an area of interest. These can be defined by drawing on the map or by uploading the shapes into the project. The user also has the option to change some of the pre-defined meshing parameters.

For assisted meshing the user has the option to select the map projection system or to leave it default (Long; Lat EPSG 4326). In this example setup the default projection system is used.

Next the user must select between the **Coastal** and **Offshore** assisted meshing scenarios. In this example the Coastal scenario is used. The Offshore scenario is similar to the Coastal scenario, with the only difference being that a shoreline is not required for the Offshore scenario.

Click **Next step** to continue.

NOTE: Switching between meshing options will reset your workspace and all previous settings will be removed.

NOTE: The assisted meshing is intended for an assisted setup of a high-resolution mesh. There may be cases where the assisted meshing does not fulfil the needs of the user. For such cases the user must generate their own mesh, as described in the next section.

NOTE: The assisted meshing does not identify islands as areas excluded from the mesh, instead it will generate triangular mesh over any islands. These triangular mesh cells will eventually be interpolated to a level which is higher than the water level and will thus be treated by the simulator as dry land.



4.1.2 Use your own mesh

In cases where the user does not want to use the assisted mesh, the user can choose upload their own mesh. This can be done generating a mesh using MIKE Mesh Builder, using MIKE Mesh Generator or by reusing a mesh from a previous project.

The generated mesh can be copied from the MIKE Cloud Platform, or be uploaded from your computer.

🖪 Copy from Cloud Admin 🛛 + Upload File

NOTE: Switching between meshing options will reset your workspace and all previous settings will be removed.

By using your own mesh, the stepper omits the Mesh & bathymetry step and skips directly to the Points step (Section 4.3).



4.2 Mesh and Bathymetry

The Mesh & bathymetry step is used for uploading user inputs towards the generation of an assisted mesh. If the user uploads their own mesh, then this step is not available.

This section describes the workflow for creating a coastal mesh. The workflow for creating an offshore mesh is identical except that it's not necessary to define a coastline.

The inputs panel for the Mesh & bathymetry step is shown in Figure 4.3. The inputs panel show the required inputs from top to bottom.



~	2		(4)	(5)	6	
Initial selection	Mesh & bathymetry	Points	Boundary conditions	Nodes selection	Setup & run	
Mesh Create mesh input ge	eometries. User can c	Iraw on the map	or upload existing data	l.	6	
Туре	Edited on	Status				
Domain ()	NA		🎸 Draw 🕕	ტ Upload	
Shoreline G)	NA	ζ Suggest 🛈	🏹 Draw 🕕	ტ Upload	
Area of interest)	NA		🎸 Draw 🕕	ტ Upload	
Islands)	NA	🎸 Finish 🕕	🎸 Draw 🕕	쇼 Upload	
Bathymetry GEBCO bathymetry provided by Metocean Simulator. User can optionally upload additional bathymetry data						
Name	Edite	ed on	Status	Priority 🚺		
GEBCO bathymetry	0		NA			
				+ Add ba	thymetry 🚺	
				Baci	K Next step	

Figure 4.3 Inputs panel for the Mesh & bathymetry step.

The Mesh and bathymetry step consists of the following tasks, which are described in more detail in the sub sections below:

- Upload bathymetry (optional)
- Outline domain
- Define shoreline
- Define area of interest
- Define islands
- Error! Reference source not found. (optional)

4.2.1 Define islands

Islands can be defined by drawing or by uploading. It's also possible to use a combination of drawing and uploading. When finished adding islands, click on the Finish button. Islands are excluded for the resulting mesh.

- Create mesh
- Interpolate mesh to bathymetry



4.2.2 Outline domain

The domain can be created either by drawing in the map or by uploading. Uploading can be done from the desktop or from Cloud Admin.

✔ Draw 🛈 🚹 Upload

In this example a domain will be hand drawn on the map by taking the following steps:

 Under the Mesh header which is shown on the left, go to the *Domain* section and click on the ² Draw button:

Mesh Create mesh inp	ut geomet	ries. User can d	raw on the ma	p or upload existing data.			
Туре		Edited on	Status				
Domain	()		NA		🎸 Draw	0	🕁 Upload
Shoreline	()		NA	२ Suggest 🛈	🎸 Draw	0	ப் Upload
Area of interest	()		NA		🎸 Draw	0	ப் Upload
Islands	0		NA	🏹 Finish 🕕	🎸 Draw	0	🖞 Upload

2. Click the offshore boundary of the model, passing onto land to enclose the full marine area as well as the land behind the shoreline to be modelled.



Figure 4.4 Definition of the model domain by hand drawing on the map. The domain outline defines the offshore boundary and encloses the land behind the shoreline to be modelled.

WARNING: MIKE MS will provide a pop-up warning message if the **horizontal or vertical dimensions exceed 250km**. The user will be requested to reduce the domain size before the mesh can be created.



Domain exceeds extent limit of 250 km which could lead to invalid results. Please reduce OK the size of the domain before proceeding

WARNING: MIKE MS will provide a pop-up message if the **offshore boundary is too close to land**, and thereby not being able to extract boundary conditions from the DHI data providers. The user can still select to proceed if they choose to provide their own boundary conditions.

- If required, the domain can be deleted, after which a new domain can be created.
 Delete
- 4. The density of the mesh in the domain can be set by specifying a number of density points in the domain. Click on Parameter and adjust the default number of density points from 3000 to 6000 and submit the change. More information about the density points can

be found under the	e info 🔍	button.
Parameters	×	
Adapt default values		
Number of Density Points 3000	0	
Submit	change	

NOTE: As soon as the domain is created, MIKE MS will start to extract GEBCO bathymetry data which covers the full domain.

After extraction of the GEBCO data, it is displayed on the map. The GEBCO data can be hidden by opening the Layers panel on the top right and turning off the visibility of the GEBCO bathymetry layer.





Turned off GEBCO bathymetry layer:

GEBCO bathymetry

4.2.3 Define shoreline

The shoreline can be created using similar steps as for creating the domain. A "Suggest" option is available for retrieving a shoreline from OpenStreetMap. The Suggest option is activated once a domain is defined.



Draw a shoreline using the following steps:

- 1. Go to the Shoreline section on the left and click on the ^{V Draw} button
- 2. Start by clicking outside of the domain
- 3. Keep clicking shoreline points along the shoreline
- 4. End the shoreline outside of the domain by double clicking



Figure 4.6 Definition of the model shoreline by hand drawing on the map. The shoreline must start and end outside the domain.

WARNING: MIKE MS will provide a pop-up warning message if the shoreline **starts or ends inside the domain**. The user will be requested to redo the shoreline before the mesh can be created.



To extract a shoreline form OpenStreetMap, click on the Suggest button. The user is prompted to enter a simplication parameter that defines a tolerance for discarding vertices in the polyline extracted from OpenStreetMap. The tolerance is defined in units of meters, and values from 2 to 500 are allowed. The simplication parameter is a parameter of the Douglas-Peucker simplification algorithm (the distance parameter). For more information, see the reference below:



Douglas, David; Peucker, Thomas (1973). "Algorithms for the reduction of the number of points required to represent a digitized line or its caricature". Cartographica: The International Journal for Geographic Information and Geovisualization. 10 (2): 112–122. doi:10.3138/FM57-6770-U75U-7727.

If required, the shoreline can be deleted, after which a new shoreline can be uploaded or created.



4.2.4 Define area of interest

The area of interest is an area of higher resolution. It can be created by several options, similar to the domain and the shoreline:

In this example an area of interest will be drawn on the map by taking the following steps:

- 1. Go to the Area of Interest section and click on the ^{V Draw} button
- 2. Click a polygon.
- 3. End the Area of Interest by double clicking. The area of interest is allowed to overlap with the shoreline and/or the edge of the domain.



Figure 4.7 Definition of the area of interest by hand drawing on the map.

4. The area of interest can be deleted after which a new area of interest can be created or uploaded.



👕 Delete

5. The maximum edge length of the mesh in the area of interest can adjusted from the default. Click on **H** Parameter and adjust the maximum edge length from 300 to 500 and submit the change.

Parameters ×	
Adapt default values	
Maximum Edge Length at AOI 300	
Submit change	

4.2.5 Define islands

Islands can be defined by drawing or by uploading. It's also possible to use a combination of drawing and uploading. When finished adding islands, click on the Finish button. Islands are excluded for the resulting mesh.

4.2.6 Create mesh

The Create Mesh button will become active after the domain, GEBCO bathymetry, shoreline and area of interest has been uploaded, converted and shows a completed status \bigcirc . Pay attention to the status of these items.

Mesh Outline domain a	and area of inte	erest			
Туре		Edited on	Status		
Domain	()	21 Oct 2024	Ø	👭 Parameter	Delete
Shoreline	()	21 Oct 2024	Ø		Delete
Area of interest	0		3	🏷 Draw 🕕	ம் Upload

When all the statuses show completed, "Create mesh" can be clicked:

Create Mesh

The mesh is generated using a density function based on the seabed level from the GEBCO data. The density function placed higher resolution mesh in shallower water.

WARNING: If the shoreline is longer than the offshore boundary, then the mesh will be created on land. The user may have to invert the mesh.





Figure 4.8 Mesh incorrectly created on the land side. User must invert the mesh.

If the user selects "Invert mesh" and regenerates the mesh, then the correct mesh will be displayed.



Figure 4.9 Mesh incorrectly created on the land side. User must invert the mesh.

WARNING: If the mesh is created before the GEBCO bathymetry is available, then a pop-up message will warn the user to wait a bit longer before creating the mesh.

GEBCO data is missing

OK



4.2.7 Interpolate mesh to bathymetry

The mesh is interpolated to the bathymetry files when clicking Interpolate.

Interpolate

The user will see the interpolated mesh in the map as shown in Figure 4.10.



Figure 4.10 Mesh file interpolated to the bathymetry files

Click **Next step** to continue.

4.3 Points

In this step the user selects the output points from where the output will be derived.



	<u></u>	✓ — — 3		5	<u> </u>
Initia	al selection N	lesh & Points hymetry	Boundary conditions	Nodes selection	Setup & run
Outpo Click o	u t points on map to place a poin	t 🛈		+ Upl	oad points ()
P	pint	X coordinate	Y coordinate	Elevation [m]	Clear 前
0	Name	X coordinate	Y coordinate		~
0	Name Point1	X coordinate * 12.550919	Y coordinate * 55.88946	Elevation [m] -0.93	✓ ¹
0	Name Point2	X coordinate * 12.554681	Y coordinate * 55.885107	Elevation [m] -2.2	✓ [□]
0	Name Point3	X coordinate * 12.551711	Y coordinate * 55.879013	Elevation [m] 3.03	✓ 🗊
Down Down	load point coordinates load mesh as .mesh fi	s as xy file ile		Back	Next step

Figure 4.11 Step 3: Definition of output points

The user can upload a .xyz file with coordinates, click points in the interface or enter coordinates into the input fields.

In this example the user can choose to click some points on the map:

- One point in the centre of the offshore boundary (Useful for later validation)
- Points in the area of interest

Elevation points are extracted from the bathymetry by clicking on the elevation column heading. It's also possible to edit elevation point values.

The user can also select to create a comma delimited xyz file and upload it into the interface. The following coordinates can be copied into the xyz file:

Offshore point, -9.97488,54.83067 Approach point, -8.505645,54.576119 Entrance point, -8.445721,54.615373





Figure 4.12 Model mesh with output points selected in the domain. One point is selected on the offshore boundary while two more are selected in the area of interest.

4.4 Boundary conditions

Boundary conditions can be extracted from the DHI data providers, the user can provide their own boundary conditions, or a previous extraction/upload can be reused. The options are shown in Figure 4.13Figure 4.13 Three options for defining boundary conditions to the model

below.

Environmental data to use Confirm or select environmental data to extract	
 Extract data from one of our providers 	~
○ Or use your own environmental data	~
Or select from previous extractions/uploads	~

Figure 4.13 Three options for defining boundary conditions to the model

NOTE: The extraction from one of DHIs providers use spatially varying boundary conditions, while when the user uploads their own environmental data the inputs are defined to not be spatially varying.

The options will be described below in sub sections.

4.4.1 Extract data from one of our providers

The user interface for extracting data from one of the DHI providers are shown in Figure 4.14.



O Extract data from one of our providers							
Start date	End da	te					
02 Jan 1979		29 Jun 2024					
Water levels	Wind	Waves: Swell & Wind-sea					
DTU 10 Tide 👻	ERA5 👻	DHI GWM 2022 👻	Extract data				

Figure 4.14 User interface options for extraction of data from one of DHI's providers.

In this option the user can specify the start date and end date for which to extract data. By default, the full period is selected. It should take less than 15 minutes to extract the entire period for the mesh shown here.

For a faster demonstration, the user can select one year of data by setting the start date to 1 Jan 2021 and the end date to 31 Dec 2021. The extraction of one year of data should take about 1 minute.

There is currently one wind (ERA5), one Waves (DHI GWM 2022) and one water levels (DTU10) source which is provided with MIKE MS.

Click extract data to start the extraction to extract boundary and forcing conditions

The spatially varying boundary and forcing conditions has the following discretisation:

- Wave conditions along the offshore boundaries has three extraction points along each colour coded boundary section, as shown in Figure 4.15. There are about 144 dimensions to the wave boundary conditions, consisting of the following:
 - 12 wave boundary points.
 - 4 wave parameters (Significant wave height, Peak wave period, Mean wave
 - direction and directional standard deviation)
 - Total, sea and swell components.
- Wind conditions over the domain are extracted in a 0.25 degree grid, as shown in Figure 4.16. There are 184 wind dimensions, consisting of the following:
 - A grid of wind conditions (92 grid cells)
 - U and V wind velocity components
- Predicted tides over the domain are extracted in a 0.25 degree grid, as shown in Figure 4.17. There are 27 gridded predicted tide level conditions.

In total there are 355 dimensions to the metocean boundary conditions extracted in this example. The boundary conditions can be downloaded by the user by navigating to MIKE Cloud Admin and then downloading a zip file containing the boundary and forcing conditions.

Click the app selector next to the Metocean Simulator title:





Then open the project with MIKE Cloud Admin:

Open this project with				
K	Mesh Builder			
F	3D World			
	Data Link			
	Cloud Admin			
F	Mine			

In MIKE Cloud Admin the user can select and download the Extracted boundary conditions:



Extraction 20241021-1518.zip

The boundary conditions can be viewed in MIKE Zero software from the desktop computer, as shown below.



Figure 4.15 Wave boundary conditions along wave boundary 2, as viewed in MIKE Zero











4.4.2 Use your own environmental data

The user interface for user provided boundary conditions are shown in Figure 4.18.





Figure 4.18 User interface options for user provided boundary conditions.

If the user selects to upload their own data, it is important that the data is provided in the right format to MIKE MS.

Start by downloading the template file

The data in the template file can be edited and the number of rows can be extended, but the user must not change the headers or add additional columns to the file. Examples of the template file as seen in a Spreadsheet or in notepad++ is shown in Figure 4.19 and Figure 4.20 respectively.

	А	В	С	D	E	F	G	н	1	J	К	L	м	N	0	Ρ
1	Year (yyyy	Month (M	Day (dd)	Hour (HH)	Wind Spe	Wind Dire	Sign Wave	Peak Wav	Mean Way	Directiona	Sign Wave	Peak Wav	Mean Way	Directiona	Water leve	el [m]
2	1990	1	1	2	10	0	1	5	0	40	2	12	270	30	1	
3	1990	1	. 1	3	10	45	1	5	45	40	2	12	270	30	1	
4	1990	1	1	4	10	90	1	5	90	40	2	12	270	30	1	
5	1990	1	. 1	5	10	135	1	5	135	40	2	12	270	30	1	
6	1990	1	. 1	6	10	180	1	5	180	40	2	12	270	30	1	
7	1990	1	. 1	7	10	225	1	5	225	40	2	12	270	30	1	
8	1990	1	. 1	8	10	270	1	5	270	40	2	12	270	30	1	
9	1990	1	. 1	9	10	315	1	5	315	40	2	12	270	30	1	
10	1990	1	. 1	10	10	0	2	5	0	40	2	12	270	30	1	
11	1990	1	. 1	11	10	45	2	5	45	40	2	12	270	30	1	
12	1990	1	. 1	12	10	90	2	5	90	40	2	12	270	30	1	
13	1990	1	. 1	13	10	135	2	5	135	40	2	12	270	30	1	
14	1990	1	1	14	10	180	2	5	180	40	2	12	270	30	1	
15	1990	1	. 1	15	10	225	2	5	225	40	2	12	270	30	1	
16	1990	1	1	16	10	270	2	5	270	40	2	12	270	30	1	
17	1990	1	. 1	17	10	315	2	5	315	40	2	12	270	30	1	
18																

Figure 4.19 Example of the template file when viewed in as a spreadsheet. Be careful when editing the template in a spreadsheet, as the spreadsheet can add data in column P, change the number of decimals or change the delimiters.



🔚 Templa	ate_FWE_userdata.csv 🔀
1	Year (yyyy), Month (MM), Day (dd), Hour (HH), Wind Speed at 10m (WS), Wind Direct A
2	1990,1,1,2,10,0,1,5,0,40,2,12,270,30,1 🖼 🖬
3	1990,1,1,3,10,45,1,5,45,40,2,12,270,30,1 💽 🖬
4	1990,1,1,4,10,90,1,5,90,40,2,12,270,30,1 💽 🖬
5	1990,1,1,5,10,135,1,5,135,40,2,12,270,30,1 🖬 🖬
6	1990,1,1,6,10,180,1,5,180,40,2,12,270,30,1
7	1990,1,1,7,10,225,1,5,225,40,2,12,270,30,1 🖬 🖬
8	1990,1,1,8,10,270,1,5,270,40,2,12,270,30,1 💽 🗊
9	1990,1,1,9,10,315,1,5,315,40,2,12,270,30,1 🖬 🖬
10	1990,1,1,10,10,0,2,5,0,40,2,12,270,30,1 🖼 🖬
11	1990,1,1,11,10,45,2,5,45,40,2,12,270,30,1
12	1990,1,1,12,10,90,2,5,90,40,2,12,270,30,1
13	1990,1,1,13,10,135,2,5,135,40,2,12,270,30,1
14	1990,1,1,14,10,180,2,5,180,40,2,12,270,30,1
15	1990,1,1,15,10,225,2,5,225,40,2,12,270,30,1 🗟
16	1990,1,1,16,10,270,2,5,270,40,2,12,270,30,1
17	1990,1,1,17,10,315,2,5,315,40,2,12,270,30,1 CR 17

Figure 4.20 Example of the template file when viewed in notepad++

WARNING: When editing the file, the data must maintain equidistant timesteps at constant 1h intervals

Some warning messages has been built into MIKE MS to warn the user of unexpected inputs.

After the user had uploaded their boundary conditions, it is converted to a common format for use by MIKE Metocean Simulator. The converted data can be downloaded from MIKE Cloud Admin in the same way as described in Section 4.4.1.

4.5 Nodes selection



The quality control tab is used to select the events (defined here as nodes) which will be simulated and from which the long term timeseries will be reconstructed. It is also used to plot the selected events against the full timeseries.

The selection of events is done by first reducing the dimensionality of the data and then selecting the maximum dissimilar events. The dimensional reduction is required to reduce the high number of dimensions in the boundary and forcing data (355 as described in Section 4.4.1) to a more manageable format. This procedure is described in more detail in Section 5.

By default, 10 dimensions and 100 nodes is selected. After clicking "Apply settings" the user has to wait about 20 minutes for the dimensional reduction to complete (considering the long timeseries of data used in this example). At completion, the explained variance is shown in the interface (Figure 4.21). The explained variance depends on the number of dimensions selected, the duration of the timeseries and the resolution of the boundary conditions.



Dimensional reduction and number of model ru Specify number of dimensions used in pricipal compon algorithm	ns nent a	analysis and number of	nodes in I	maximum dissimilarity
Desired dimensions used in principal component analy Resulting dimensions 10 Variance 91 %	sis	Desired dimensions		0
Number of nodes selected from timeseries	Nu 10	mber of nodes)0	()	Apply settings

Figure 4.21 Default settings for dimensional reduction. The variance of 91% is shown after the "Apply settings" has been clicked. This process can take 20 minutes to complete.

The user should aim for an explained variance of above 98%. If the number of nodes is updated to 35 and the and "Apply settings" is rerun, then the explained variance increase up to 99%, as shown in Figure 4.22.

Dimensional reduction and number of model runs Specify number of dimensions used in pricipal component analysis and number of nodes in maximum dissimilarity algorithm					
Desired dimensions used in principal component analy Resulting dimensions 35 Variance 99 %	sis	Desired dimensions 35		0	
Number of nodes selected from timeseries	Nu 10	mber of nodes)0	()	Apply settings	

Figure 4.22 Updated settings for dimensional reduction showing an explained variance of 99%.

At the bottom of the page in the Nodes selection tab, the user can make timeseries and scatter plots of the boundary conditions data by changing the input fields. Thes plots show the selected nodes against the full timeseries. An example plot showing the Significant wave height for Boundary 4 is shown in Figure 4.23.





Figure 4.23 Selected nodes (red) from the timeseries data (blue) for the centre of Boundary 4.

Additional nodes can by manually added by clicking on the plot. Here it was decided to select any peaks where the significant wave height on boundary 4 is above 14m, as shown in Figure 4.24



Figure 4.24 Additional nodes selected by clicking on the chart. Peaks above 14m was selected.

Nodes can also be selected manually for the other wave boundaries, for the wind and for the predicted water level if required.

Example scatter plots of Significant wave height against peak wave period and mean wave direction is shown in Figure 4.25 and Figure 4.26 respectively. These plots can be used to identify any additional events that the user would like to add to the set of selected nodes.





Figure 4.25 Scatter plot of Significant wave against peak wave period.



Figure 4.26 Scatter plot of Significant wave against mean wave direction.

When completed, the user can click "Next step" to proceed.

4.6 Setup & run



The user can select a default template based on the seabed roughness, as shown in Figure 4.27



Setup selection Select pre configured setup or upload your own	+ Uploa	ad File
Offshore default r2	৶	~
Smooth nearshore r2	৶	~
O Rough seabed r2	৶	~
Fast low accuracy	৶	~

Figure 4.27 Pre-configured setup templates. More information about the template is available by expanding the accordion button

NOTE: The user also has the option to download $\stackrel{\bullet}{\checkmark}$ a template to make basic edits in the MIKE 21 SW desktop application and to re-upload $\stackrel{\bullet}{+}$ Upload File the file as a new template. This can be done if the user wants to adjust the solution technique.

The selected nodes are shown again at the bottom of the inputs panel. In this step the user can select a timestep for conducting a test run by clicking on the chart:

Selected for test run

Select Boundary 4 (Offshore) and click the highest wave event on the boundary for running the test.



Figure 4.28 Selection of a test run

Click the button for running the test.

Run Test

NOTE: Pay attention to the progress in the Top bar. Running the test will be pending for a minute or two while the computer is prepared in the cloud. Once the computer is prepared, the next simulation will have a shorter pending time.

When completed, the test result will be shown in a panel on the right as a table.



Result of test run			
Points	Approach_point	Entrance_point	Offshore_point
Mean Wave Direction (degree)	261.86	218.27	263.29
Mean Wave Direction S (degree)	1.92	164.15	60.02
Mean Wave Direction W (degree)	261.76	218.62	263.28
Peak Wave Direction (radian)	4.71	3.69	4.71
Peak Wave Direction S (radian)	0.1	2.88	0.79
Peak Wave Direction W (radian)	4.71	3.69	4.71
Peak Wave Period (second)	18.72	18.77	18.78
Peak Wave Period S (second)	18.77	18.86	10.79
Peak Wave Period W (second)	18.72	18.77	18.78
Sign. Wave Height (meter)	6.14	3.38	16.7
Sign. Wave Height S (meter)	0.28	0.28	0.38
Sign. Wave Height W (meter)	6.14	3.37	16.69
Wave Period T02 (second)	11.82	15.52	14.74
Wave Period T02 S (second)	16.06	17.21	8.78
Wave Period T02 W (second)	11.81	15.51	14.75

Figure 4.29 Test run results

Compare the inputs at the Boundary 4 to the results for the point at the boundary. The results should be close to the input values at the boundary.

Table 4.1Comparison of boundary conditions at Boundary 4 to the outputs from the test model run at
the same boundary.

Parameter	Boundary 4 centre	Offshore_point
Sign. wave height – Wind sea	16.9 m	16.7 m
Peak wave period – Wind sea	18.9 s	18.8 s
Mean wave direction – Wind sea	263 deg	263 deg

The test can be repeated to identify whether different templates affect the results at either the boundary, or close to the area of interest.

Test results are also available from the Cloud Admin folder for outputs. The user can navigate to MIKE Cloud admin by expanding the app selector next to the MIKE Metocean Simulator title



In MIKE Cloud Admin, the user must navigate to the output folder. The test results in Cloud Admin is a zip file which includes a spatial output in dfsu format.



It is recommended that the user download and inspect this results file using the desktop MIKE Zero interface. An example of such an output, called Area.dfsu is shown in Figure 4.30





The model runs will take some time to complete. The duration can be estimated by taking the time elapsed to complete the test run and multiplying it by the number of selected nodes. The time elapsed is available in the log file from the sw_testruns.zip file. In this case the test run took 34 seconds to complete, when using the "Fast low accuracy". The "Offshore default r2" template took about the same time and the results is not changed significantly in this case.

In this example, the total simulation is expected to take about 1h to complete running 100 nodes. Some additional time for timeseries reconstruction will also be required after the nodes have been simulated.

WARNING: There is a wall time of 24h on the model simulations. If the total simulation time is at risk of reaching 24h, the user should reconsider the mesh density, the number of nodes or the model template settings.

Press Run model to run the full set of simulations.



Figure 4.31 Notification at start of cloud execution.

The user can now click "Run model".



The user will soon see a progress notification in the top bar:

	0
Full model is running	Ō

On completion a notification pops up, as shown in Figure 4.32, indicating that the model results is ready for download or for publishing to MOOD.

Model results are ready	×
Model results can be downloaded as csv or or published to MetOcean On Demand (MO	as dfs0 OD)
Figure 4.32 Pop up notification indicating that	the model

Figure 4.32 Pop up notification indicating that the model results are ready. The pop us includes options to download data or to publish the results to MOOD.

The user can also log out of the browser and return sometime later to follow up on the model runs. In such case the notification in Figure 4.32 will not be shown. The user can see from the footer that the model results have been completed (on 22 Oct 2024 11:16:09 AM), as shown in Figure 4.34.

Download results from 22 Oct 2024 11:16:09 AM as csv or as dfs0			
or publish model results to MetOcean On Demand (MOOD)	Cancel job	Back	Run model

Figure 4.33 Footer which shown the last time that model runs have been completed.

When the simulation has completed, results can also be downloaded directly from the Setup & run tab by clicking the "as csv" or "as dfs0" text: as csv or as dfs0

The results are also available from the project's outputs folder in MIKE Cloud Admin.

The results can be published to MetOcean On Demand (MOOD) by clicking the provided button. The MIKE MS results will be called a Local Model in MOOD.

4.7 View and interact with the results in MOOD

After the MIKE Metocean Simulator outputs have been published to MOOD the user can interact with the data in MOOD.

Go to the MOOD site: https://www.metocean-on-demand.com/

DHI Metocean Data Portal



If you have logged off since running and publishing MIKE MS, sign in using the same user name and Tenant as you used for setting up the MIKE MS model.

In the layers panel on the left, you need to activate the local model area and the local model points, as shown in Figure 4.34



Figure 4.34 Layers panel in MOOD showing the toggle switches for displaying the local model

You should see your model domain and points in the map, as shown in Figure 4.35



Figure 4.35 Local model domain and points as indicated on the map in MOOD



Double click one of the points to see basic metadata of the MIKE MS point, as shown in Figure 4.36.

E	ntrance_point	×
L	ong -8.4457 Lat 54.6154	
F	older Name: MIKE MS step-by-step	
s	ee in MIKE MS	
	New point in this location	2
	0	

Figure 4.36 Information of the point displayed on double click.

Click "New point in this location" to define a new MOOD point at the location of the MIKE MS point.

In the points panel on the right, as shown in Figure 4.37, you can select a subset of the data. In this case the full timeseries (44 years) is selected.



Name	Longitude [°E]	Latitude [°N]	
P1	-8.445721	54.615373		Submit
Waves (Total, Wind-S	ea and Swell)			~
Model Data	Metadata	Start Date End Date		
FWE-Mesh-MIK	E MS step-by \vee	1979-01-02 2023-01-01 📋		
Water depth [mMSL]	Grid cell size [m]	Price[EUR]		
-	-	Parameters	0	Add to Cart
		2D Spectra	- [Download 🕹
(Water Level, o	Current, etc.)			>
مے Atmosph	ere			>

Figure 4.37 Points panel in MOOD. Here a subset of the data can be selected if required.

The data can be downloaded from MOOD by adding it to the cart and checking it out for free.

Click on the analytics button to make plots of the data:

🗠 Analytics

The analytics modal will pop up, from which several analytics can be generated. The timeseries, rose and scatter plots can be created without a MOOD subscription. Examples of these are shown below in Figure 4.38, Figure 4.39 and Figure 4.40 respectively.





P1 (-8.445721°E; 54.615373°N)

0.29

Download as JPG Update





36



Users subscribed to MOOD analytics can make additional analytics for the full datasets, including Scatter tables, Statistics plots, Exceedance plots, Histograms, Weather windows and



Extreme values. Users who are not subscribed to MOOD analytics can only use the last year of data using the additional analytics.



5 Scientific description

MIKE MS is a MIKE Cloud¹ application for modelling high-resolution nearshore and offshore wave conditions. MIKE MS applies statistical methods to get radically faster results than traditional modeling. It applies high-quality data from MIKE DataLink², removing effort for modelers. MIKE MS leverages cloud infrastructure to remove hardware investment, increasing cost-effectiveness. It is powered by recognized MIKE software (MIKE 21 SW³ – quasi stationary formulation).

MIKE MS follows the scientific basis defined by Camus et al (2013)⁴, and is implemented by DHI as shown in Figure 5.1. The diagram shows the sequence of obtaining boundary conditions and selecting a subset of the events by using principal component analysis (PCA) and maximum dissimilarity analysis (MDA). At completion of the modelling of the selected events the full timeseries is reconstructed using a radial basis function (RBF).





Data extracted along the boundaries of the model include significant wave height, peak wave period, mean wave direction and directional standard deviation for total, wind sea and swell wave components. Data extracted over the domain include directional wind vector components as well as predicted tides.

The event selection (PCA and MDA) makes use of all the extracted parameters along all boundaries and over the domain.

An example of a comparison between a MIKE MS model run using 100 events and a model run simulating all timesteps and using an instationary formulation is shown in Figure 5.2, for a location off the US west coast.

¹ https://www.mikepoweredbydhi.com/products/mike-cloud

² https://www.mikepoweredbydhi.com/products/mike-cloud/mike-data-link

³ https://manuals.mikepoweredbydhi.help/latest/Coast_and_Sea/M21SW_Scientific_Doc.pdf

⁴ Camus, P., Mendez, F. J., Medina, R., Tomas, A., & Izaguirre, C. (IH Cantabria 2013). High resolution downscaled ocean waves (DOW) reanalysis in coastal areas. Coastal Engineering, Volume 72, Pages 56-68.





Figure 5.2 Comparison of a MIKE MS run using 100 events against a detailed model run simulating all timesteps and using an instationary formulation. Comparison plots show significant wave height [m] (top) and peak wave period [s] (bottom) for a location off US west coast. Note this is a model to model comparison.