Getting Started with CPAS

This tutorial covers the following content:

- 1. Download the sample mesh zip file
- 2. Check the zip file
- 3. Import the mesh specification
- 4. View the resulting mesh
- 5. Download the mesh
- 6. Run a real simulation
- 7. Visualize the output of the simulation

Download the sample mesh zip file

1. Visit <u>https://cpas.earth/support/download</u> and download sample mesh if you haven't yet.

Check the zip file

1. You will find this tutorial and a mesh folder for the customized 128-to-5 km mesh (contains 43,580 horizontal grid cells) in the unzip folder.

Remarks: The algorithm for mesh generation might update from time to time, the mesh generated in later version might be different from the grid file in the unzip folder.

- 2. The mesh folder contains
 - a. Mesh specification file (HK_128-to-5km.json),
 - b. Grid file (HK_128-to-5km.grid.nc),
 - c. Model static file (HK_128-to-5km.static.nc),
 - d. Mesh connectivity file (HK_128-to-5km.graph.info),
 - e. Mesh partitionings (e.g. HK_128-to-5km.graph.info.part.96) and some figures.

Remarks: The model static file, mesh connectivity file and the partitionings are compatible with MPAS-A. Users may import these files to their environment to run real simulations using MPAS-A.

Import the mesh specification

- 1. Sign in CPAS online platform.
- 2. Click the import button and select *HK_128-to-5km.json*. The pre-generated mesh spec will be restored.

Remarks: The right panel shows the specified regions in an interactive map, and the left panel shows their corresponding specified resolutions.

CPAS CLARK REAL	My Specs	Visualization				😝 Sign Out
Mesh Specification						
New	v	Import ±				
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3. Save the file on the platform in the bottom left corner.



Last updated date: 10 Dec 2019

4. Click the **Preview** button in the bottom left corner to generate a mesh preview. *Remarks: It provides a quick check to examine the mesh transition by presenting the cells in* **Global** using a certain scale factor (1:31 in this case) and roughly a thousand smallest cells in **Zoom-in** using 1:1 scale. An approximate estimation of the total number of cells (35,516 in this case) will also be provided.



5. Click **Next** at the top right corner.

6. Enter the number of optimization iterations for generating the mesh (50 by default). *Remarks:*

- The maximum allowable number of iterations is 500.
- The 'Real Simulation' section will be available after the mesh is generated.

CPAS CLUSterTech	My Specs	Visualization			🕒 Sign Out
Order for Mesh Gene	ration / Real S	mulation			
Order for Mesh Gene	ration / Real S	mulation	Mesh Generation Number of optimization iterations 50 Real Simulation (Available after mesh gen job name job name Creating real-data initial condition Data source GFS ERA5 Episode start time mm//dd/yyyy 0 UTC Running the model Length of simulation (hours) 24 Creating Cancel	eration)	
			© 2019, ClusterTech Limited. All	rights reserved.	

- 7. Click **Order**.

Remarks:

- The mesh generation process will normally be completed in several minutes.
- You will receive a link in an email with title prefix "Successful CPAS job" ("Successful CPAS job HK_128-to-5km #50" in this case). It provides the main entry to other operations of the mesh in the future, such as real simulation and visualization.



View the resulting mesh

- 1. Open the link in the email "Successful CPAS job HK_128-to-5km #50".
- 2. The Mesh Generation Report shows the statistics of the resulting mesh. It contains 6 HTS levels (from 0 to 5) having resolution ranging from 3.548 km to 196.255 km.

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	Job name HK_128-to-5km #	50				
Oţ	otimization iterations #0 - #50					
Report						
nmary of this m Number of ce With 50 optin Mesh resolut	esh generation job: Ils generated: 43,580 nization iterations ion: 3.54789 km - 196.255 km					
lierarchica	I Time-Stepping by Clust	erTech				
Table Chart						
Level	Resolution	Time step	#Cell (%)	CPU core resource	Giga cell-step	Saving
0	145.792km - 170.845km	360.000s	17.961 (41.21%)	2.85%	0.00	96,47%
1	72.700km - 175.083km	180.000s	4,097 (9.40%)	3.20%	0.01	82.60%
2	34.034km - 168.732km	90.000s	1,649 (3.78%)	1.83%	0.00	75.33%
3	14.837km - 80.036km	45.000s	2,445 (5.61%)	5.14%	0.01	53.10%
4	7.105km - 39.334km	22.500s	8,488 (19.48%)	27.83%	0.05	26.89%
5	3.548km - 19.105km	11.250s	8,940 (20.51%)	59.15%	0.10	-47.52%
					Total	Overall
Quality me	easure of your customized	d mesh				
Enclosed ang	gle	Relative ler	ngth ratio	Number of ed	iges on cell	
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0 70- 60- 50- 50- 40- 30-		0 18 - 0 16 - 0 14 - 12 - 10 - 10 - 10 - 10 - 8 -	an de	0 00 - 0 00 - 00 - 00 - 00 - 00 - 00 -		
6. 20- 10- 5.00	45.00 85.00 125.00 1	65.00 L 0 4 - 2 - 0 0.00	0.40 0.80 1.20	1.60 2.00	5 6	7
	Enclosed angle (in degrees)		Relative length ratio		Number of edges on ce	
	Explanation	~	Explanation	·	Explanation	~
Refine Mesh S	pecification As New Run Real Simu	lation / More Optimizati	on Iterations			

- 3. Launch the Jupyter Notebook server by clicking **Visualization** on the top. Select **mesh-vis.ipynb** for visualizing the mesh.
- 4. Run the code cells one-by-one. First of all, run DO THIS FIRST: Select mesh, then
 - Select Data: My data
 - Select Project: HK_128-to-5km
 - Select Mesh: HK_128-to-5km #50

Remarks: You will see "Found diag.nc" if the mesh is ready, otherwise, you will see "[WARNING] Cannot open grid.nc for reading. Job not finished yet?".

📁 Jupyter mesh-vis (autosaved)	Logout Control Panel
File Edit View Insert Cell Kernel Widgets Help	Not Trusted Python 3 O
DO THIS FIRST: Select mesh	
<pre>In [1]: from cpas.ui import UI ui = UI().select_grid_ncfile()</pre>	
Select Data: My data Demo data	
Select Project: 2019-11-15 03:21:41Z HK_128-to-5km	
Select Mesh: 2019-11-15 03:21:42Z_HK_128-to-5km #50	
Found grid.nc Ready to do plot_mesh() and visualize_mesh().	
Plot mesh	
<pre>In []: ui.plot_mesh()</pre>	
Visualize mesh in interactive map	

- 5. Run the code cell **Plot mesh** to visualize the mesh in a static orthographic projection map. Before clicking **Plot Mesh**:
 - Enter the center of the region of interest (Center Latitude = 22 and Center Longitude = 114 in this case).
 - Tune the **Zoom size** to adjust the degree of magnification.



- 6. To show the mesh cells in an interactive map in Spherical Mercator projection, run the code cell **Visualize mesh in interactive map**:
 - Adjust the region of interest either by entering the center latitude and center longitude in **Center and Zoom** or zooming/panning in the interactive map.
 - In **Mesh Visualization Setting**, plot the mesh cells by setting the maximum number of cells in **Max #cell** (5000 by default). Click **Draw All Cells** to neglect the above options.

Remarks: The mesh cells will be drawn interactively on zooming/panning when **Draw** *is On. Click* **Pause** *will stop this function, and show only the mesh cells drawn last time.*



Download the mesh

- 1. Open the link in the email "Successful CPAS job HK_128-to-5km #50".
- 2. Tick the box after reading the Terms and Conditions at the bottom.
- 3. Click Download Mesh.

Run a real simulation

1. Open the link in the email "Successful CPAS job HK_128-to-5km #50".

- 2. Click Run Real Simulation / More Optimization Iterations at the bottom.
- 3. Select the **Data source** (GFS in this case) and **Episode start time** (11/11/2019 18 UTC in this case) of the initial condition.
- 4. Enter **Job name** (A string combining Mesh Name, **Data source** and **Episode start time** by default).
- 5. Enter the Length of simulation (hours) (48 hours in this case).

Remarks:

- The **Length of simulation (hours)** must be an integral multiple of the output interval, *i.e.* 3 hours.
- If one of the settings is invalid to carry out the simulation, you will receive an email shortly with title prefix "Failed CPAS job" stating the reason of failure.

CPAS ElusterTach	My Specs	Visualization		
Order for Mesh Gener	ration / Real S	imulation		
			Mesh Generation Number of additional optimization Iterations (based on the current #500 mesh) 50	
			Running the model Length of simulation (hours) 48 Order Cancel Note: Execution of computational jobs is subject to privileges and limitations of your (PAS subscription. 2019. Cluster Field Limited. All rights reserved.	

6. Click Order.

Remarks: The real simulation will complete in a few hours or a few days depending on the availability of computational resources as well as the settings, e.g. total no. of cells and length of simulation.



Visualize the output of the simulation

- 1. Open the link in the email "Successful CPAS job HK_128-to-5km GFS 2019-11-11T18:00:00Z".
- 2. Launch the Jupyter Notebook server by clicking **Visualization** on the top. Select **sim-vis.ipynb** for visualizing the output of real simulation.
- 3. Run the code cells one-by-one. First of all, run **DO THIS FIRST: Select simulation job**, then
 - Select Data: My data
 - Select Project: **HK_128-to-5km**
 - Select Mesh: HK_128-to-5km #50
 - Select Simulation: HK_128-to-5km GFS 2019-11-11T18:00:00Z

Remarks: You will see "Found diag.nc and mesh.nc" if the simulation result is ready, otherwise, you will see "[WARNING] No simulation found.".

💭 jupyter s	im-vis Last Checkpo	oint: Last Friday at 4:1	3 PM (unsaved chang	jes)		2	Logout Control Panel
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	Select Project: 201	9-11-15 03:21:41Z Hł	K_128-to-5km				
	Select Mesh: 2019	9-11-15 03:21:42Z HK	<_128-to-5km #50				
	Select Simulation:	2019-11-15 07:49:03	3Z HK_128-to-5km GF	S 2019-11-11T18:00	00Z		
	Found diag.n Ready to do	c and mesh.nc plotting of sim	ulation result.				

- 4. Run code cell **Contour plot** to visualize the output in a static orthographic projection map. Before clicking **Plot Contour**:
 - Select the time (UTC) and variable (2019-11-12_03:00:00 and t2m in this case).
 - Enter the center of the region of interest (Center Latitude = 22 and Center Longitude = 114 in this case).
 - Adjust the degree of magnification by tuning **Zoom size**.

Contour pl	ot						
In [2]: ui.plot_o	liag_contour()						
Select Time	(UTC): 2019-11-11 2019-11-11 2019-11-12 2019-11-12 2019-11-12 2019-11-12	18:00:00 21:00:00 00:00:00 03:00:00 06:00:00					
Select Varia	ble: u10 v10 q2 t2m mslp		*				
Center Latit	ide 22	Cent	ter Longitude: 114		Zoom size (1.	0 = global)	0.65
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Time: 201	.9-11-12_03:00:	00					
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		75°E 90°E	105°E	120°E	135°E	150°E	
		226.1 230.4 234.8 239.2 243.5	9 247.9 252.3 256.7 261 265.4	269.8 274.1 278.5 282.9 2	197.2 291.6 296 300.3	304.7 309.1 313.4	

- 5. To show the contour plot in an interactive map in Spherical Mercator projection, run the code cell **Visualize simulation results in interactive map**.
- 6. Similar to mesh-vis.ipynb:
 - Adjust the region of interest either by entering the center latitude and center longitude in **Center and Zoom** or zooming/panning in the interactive map.
 - In **Mesh Visualization Setting**, plot the mesh cells by setting the maximum number of cells in **Max #cell** (5000 by default). Click **Draw All Cells** to neglect the above options.

7. Select the time (UTC) and variable (2019-11-12_03:00:00 and t2m in this case). *Remarks: The contour will be drawn interactively on zooming/panning when* **Draw** *is On. Click* **Pause** *will stop this function, and show only the mesh cells drawn last time.*

✓ Center and	I Zoom				
Center Lati	29.026482	Center Lon	92.880403	Zoom le	vel: 4
✓ Mesh Visu	alization Setting				
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Visualize simulation results in interactive map