# Getting Started with CPAS

This tutorial covers the following content:

1. Download the sample mesh zip file
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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 https://cpas.earth/support/download 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.*

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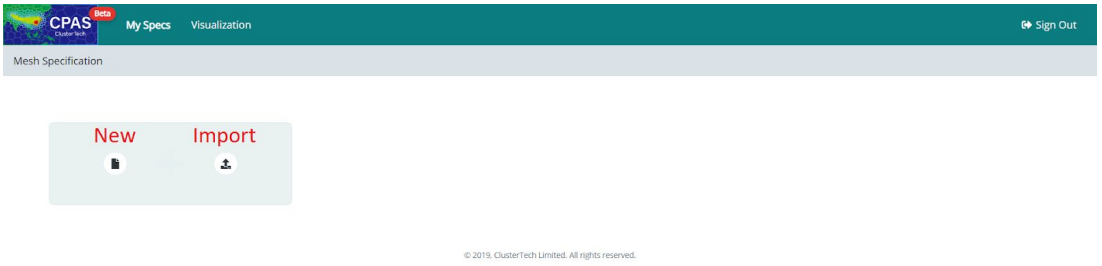
# Import the mesh specification

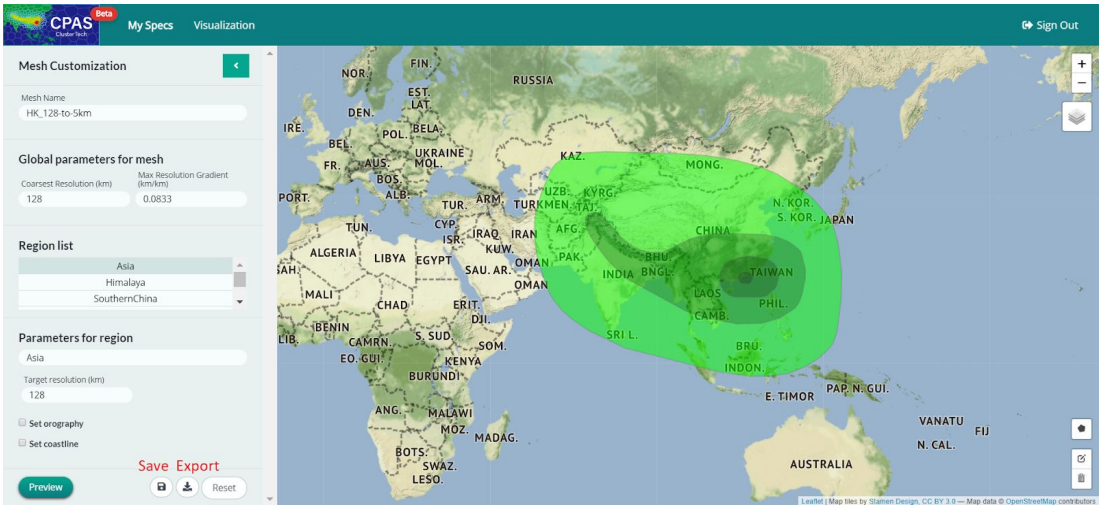
1. Sign in CPAS online platform.

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.*




3. Save the file on the platform in the bottom left corner.

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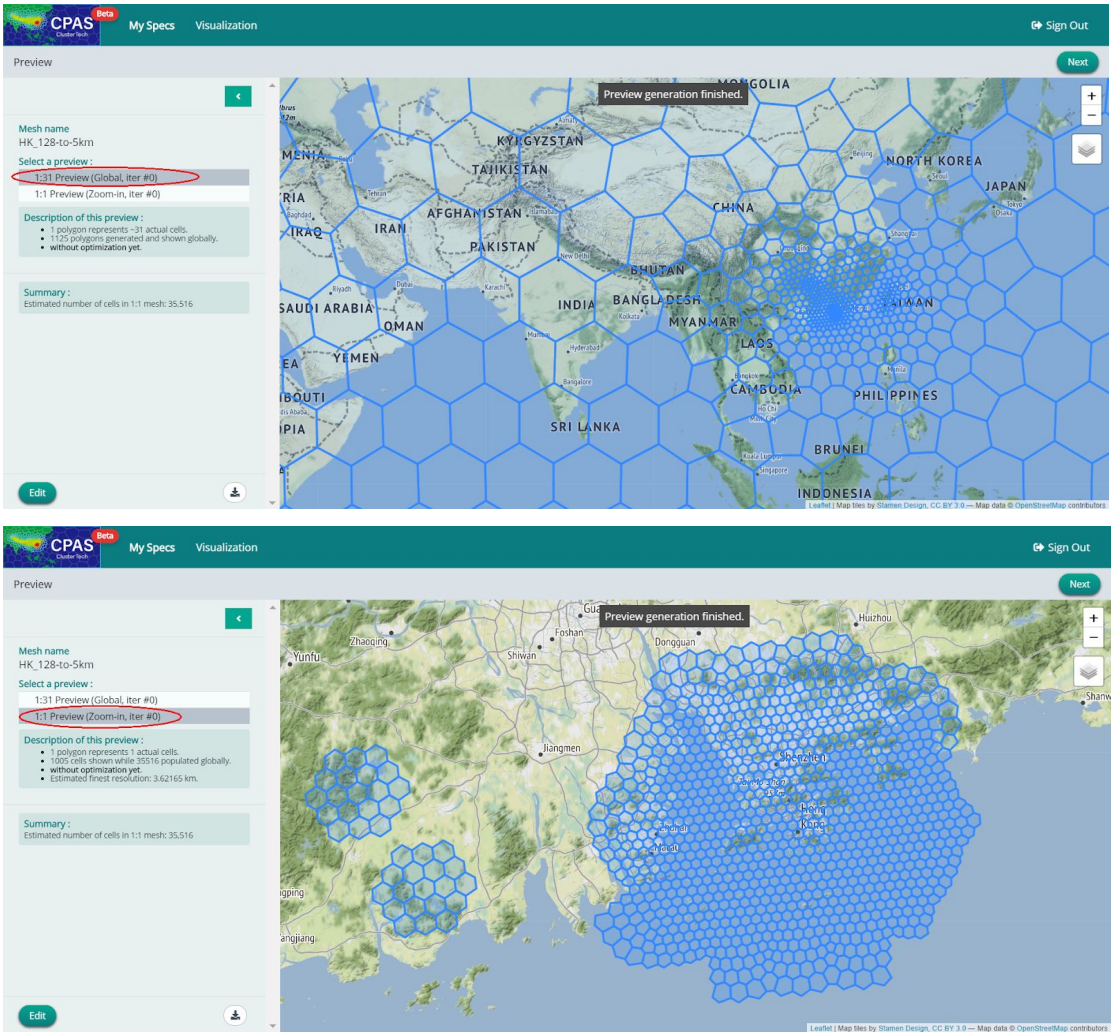
4. Click the **Preview** button in the bottom left corner to generate a mesh preview.
*Remarks: It provides a quick check to examine the mesh transition by presenting the cells in **Global** using a certain scale factor (1:31 in this case) and roughly a thousand smallest cells in **Zoom-in** using 1:1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



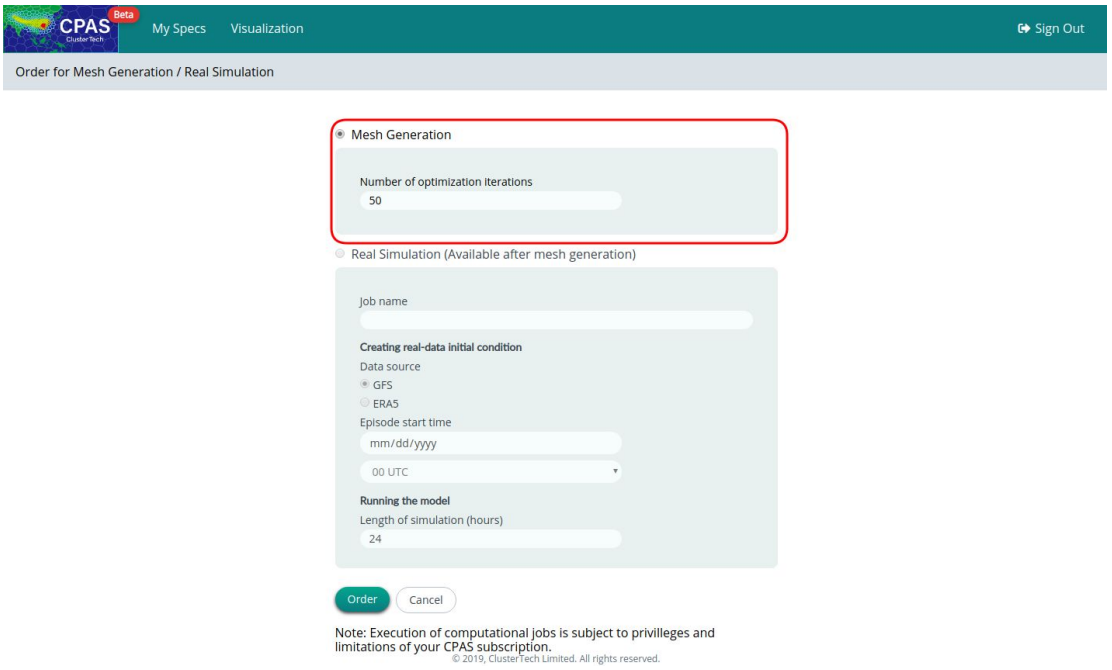




5. Click **Next** at the top right corner.

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

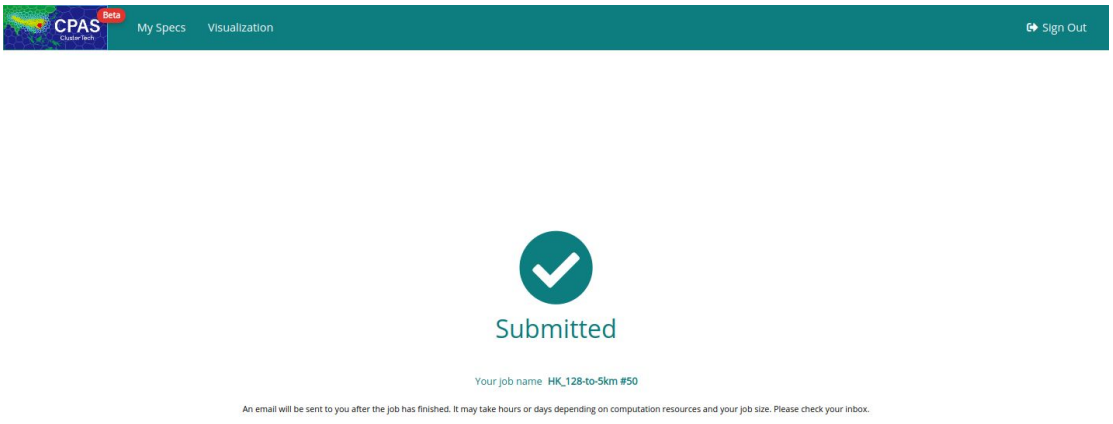
- *The maximum allowable number of iterations is 500.*
- *The 'Real Simulation' section will be available after the mesh is generated.*




7. Click **Order**.

*Remarks:*

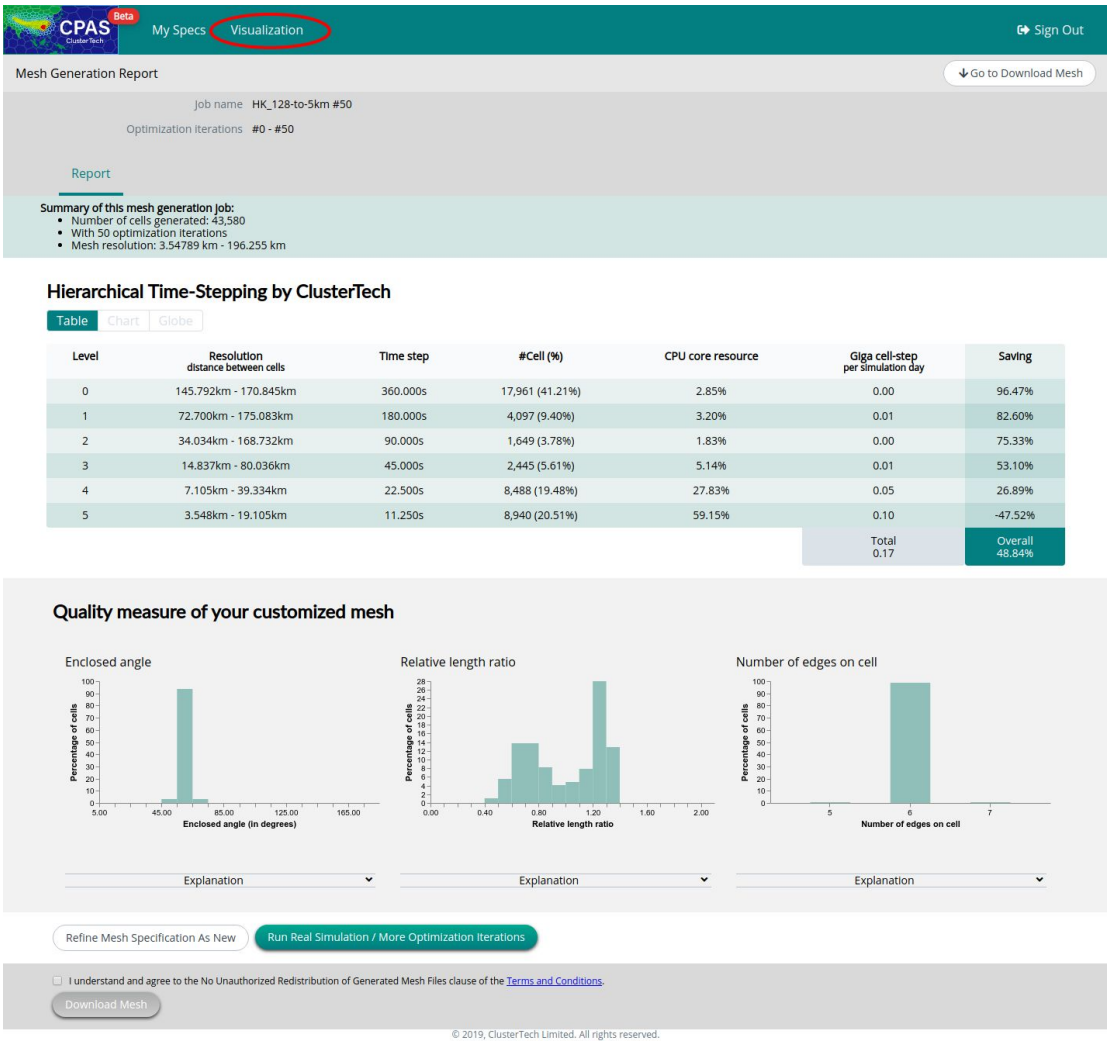
- *The mesh generation process will normally be completed in several minutes.*
- *You will receive a link in an email with title prefix "Successful CPAS job" ("Successful CPAS job HK_128-to-5km #50" in this case). It provides the main entry to other operations of the mesh in the future, such as real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




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?”.*

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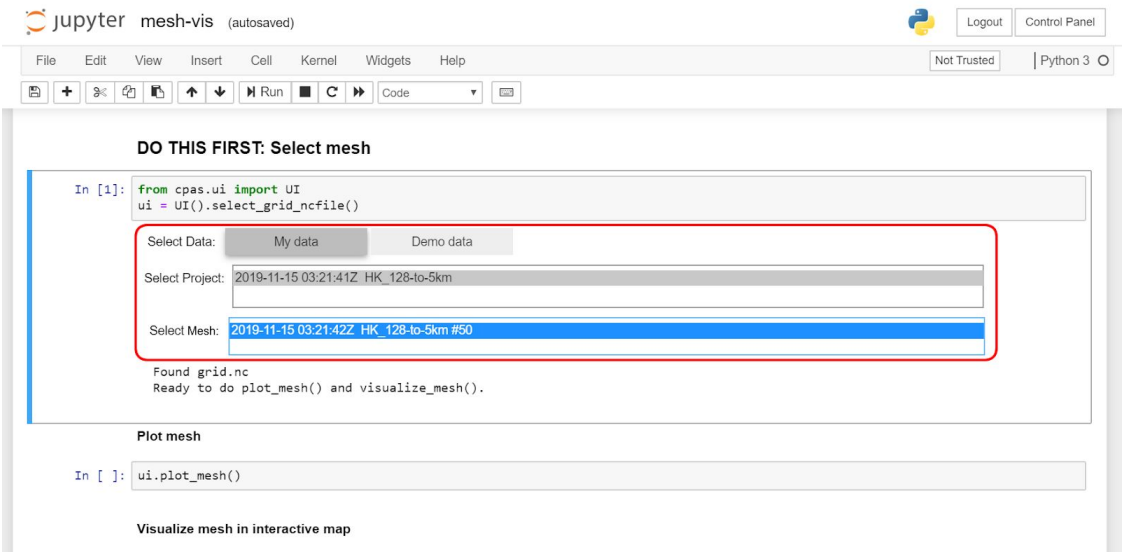
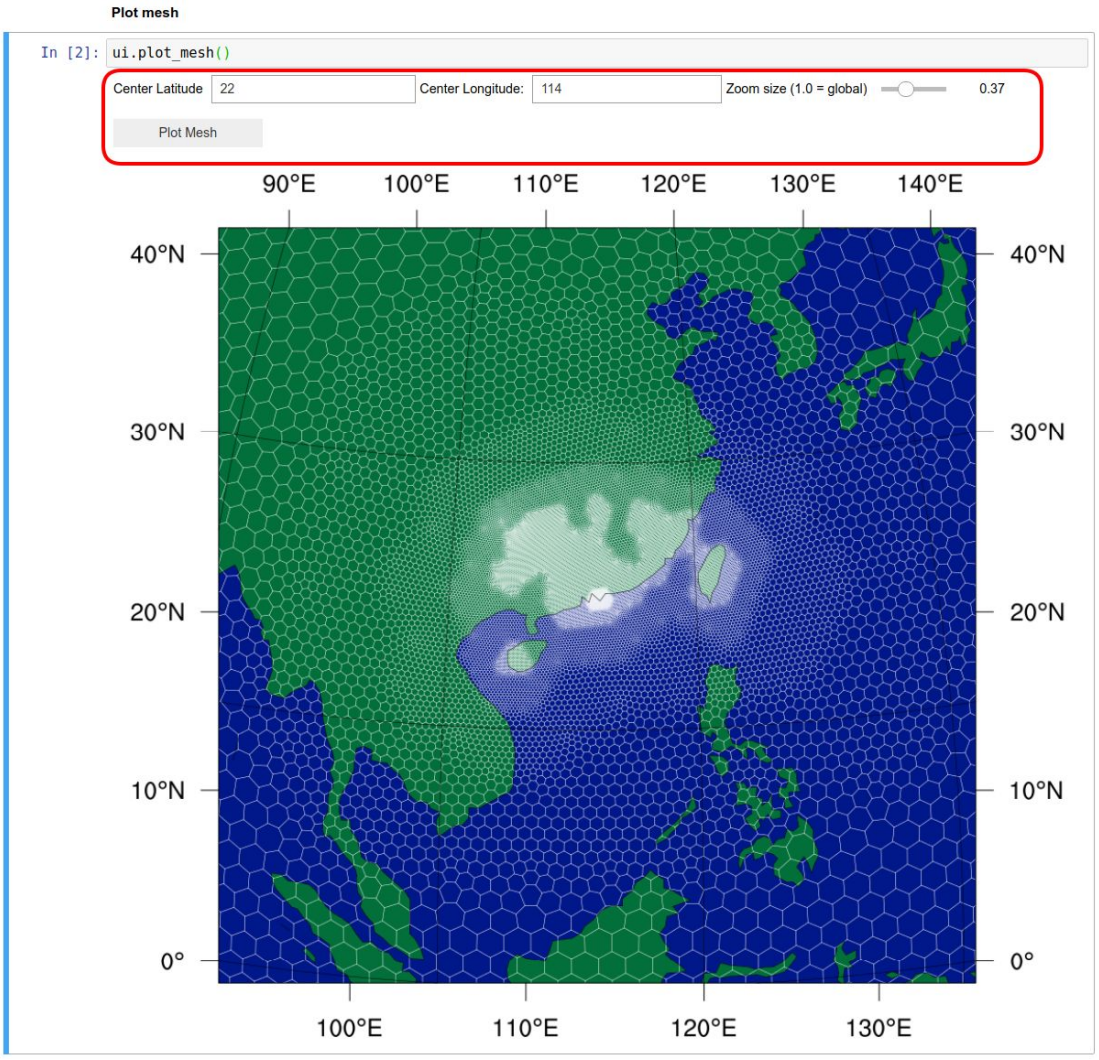
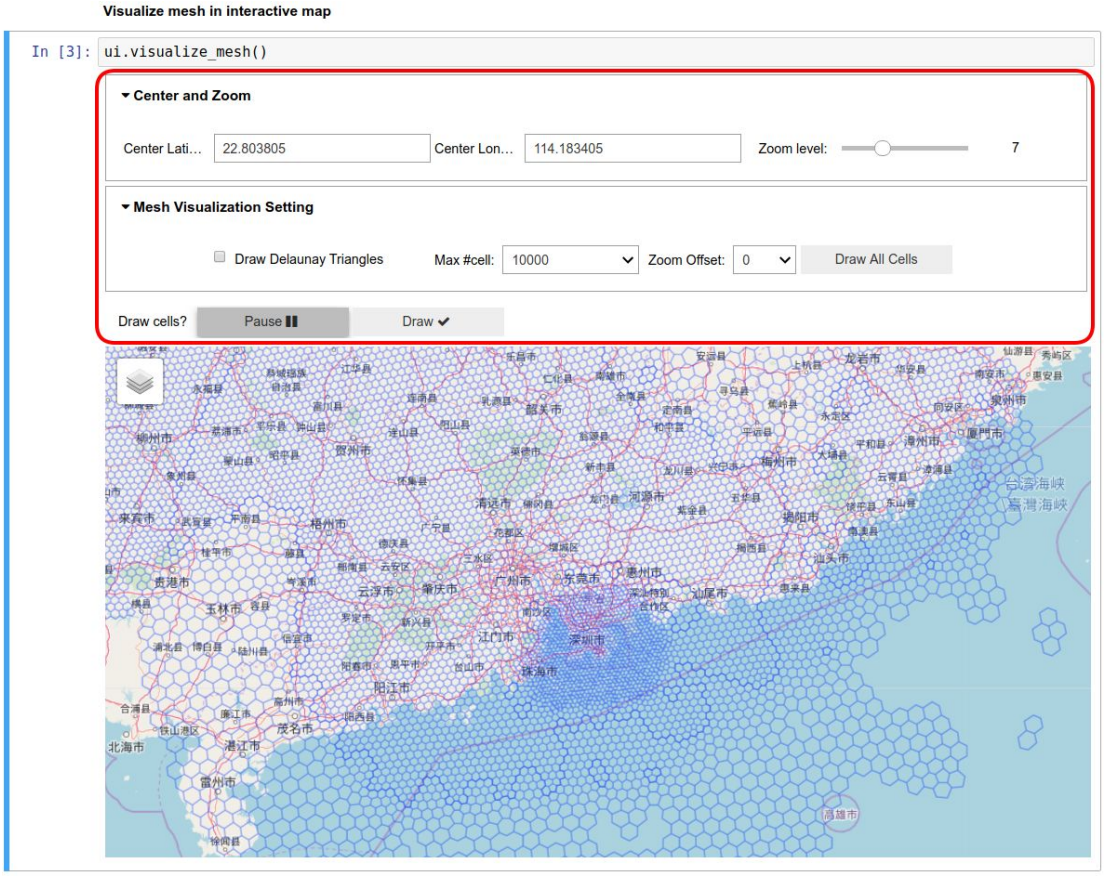



5. Run the code cell **Plot mesh** to visualize the mesh in a static orthographic projection map. Before clicking **Plot Mesh**:
   - Enter the center of the region of interest (Center Latitude = 22 and Center Longitude = 114 in this case).
   - Tune the **Zoom size** to adjust the degree of magnification.




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”.

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2. Click **Run Real Simulation / More Optimization Iterations** at the bottom.

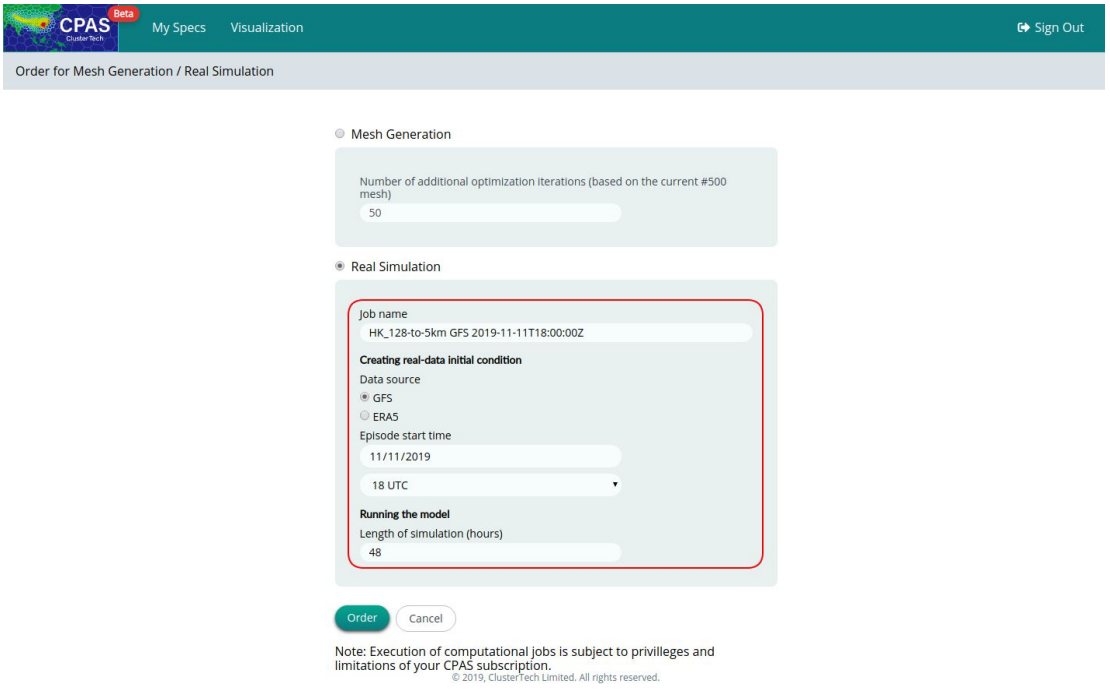
3. Select the **Data source** (GFS in this case) and **Episode start time** (11/11/2019 18 UTC in this case) of the initial condition.

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).

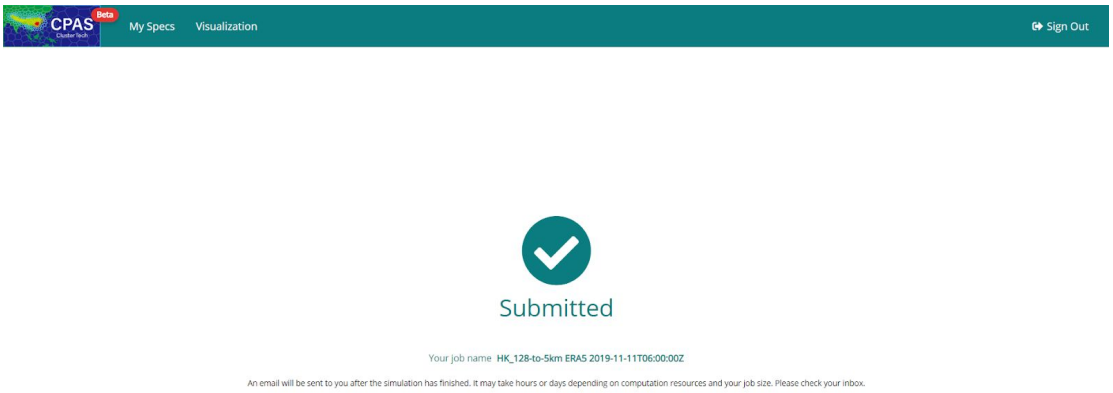
*Remarks:*

- *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.*




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.”.*

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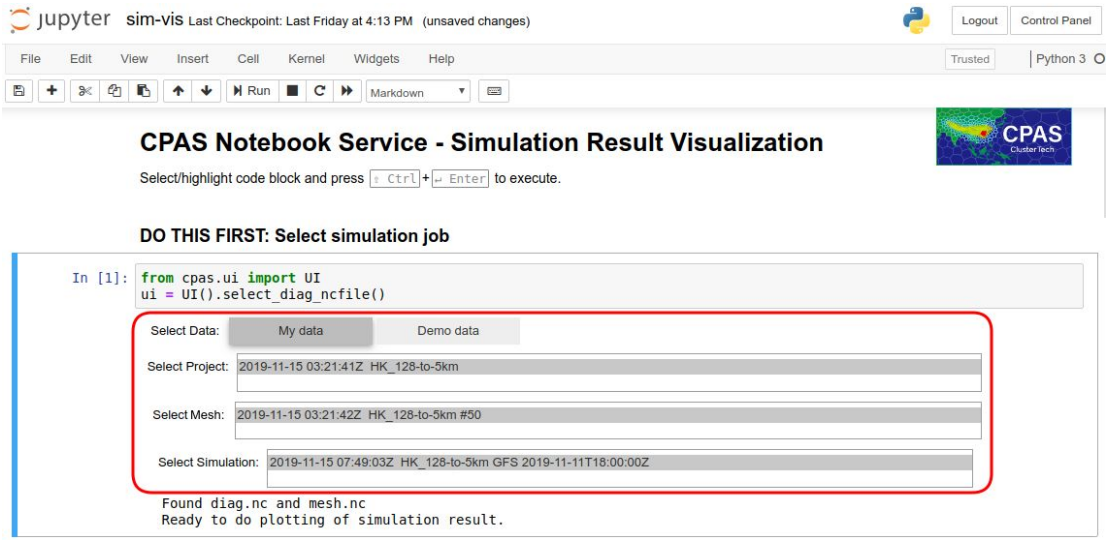
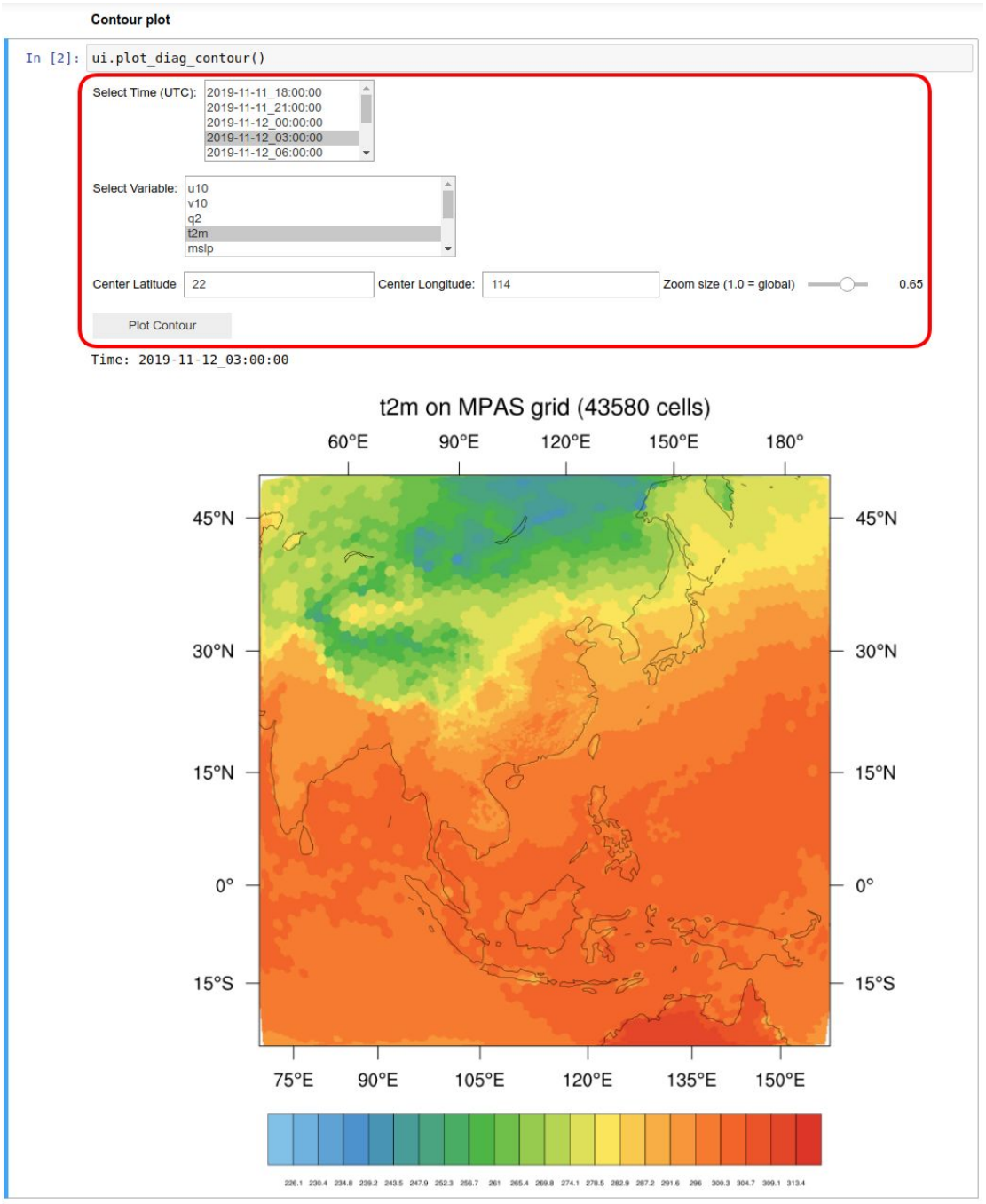



4. Run code cell **Contour plot** to visualize the output in a static orthographic projection map. Before clicking **Plot Contour**:
   - Select the time (UTC) and variable (2019-11-12_03:00:00 and t2m in this case).
   - Enter the center of the region of interest (Center Latitude = 22 and Center Longitude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




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.

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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.*