

# CPAS User Guide - Result Visualization

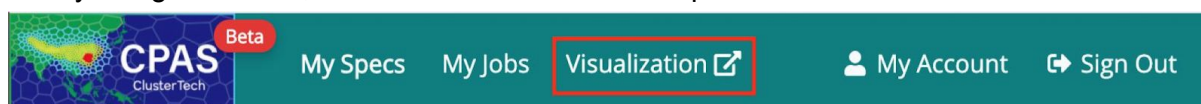
ClusterTech Limited

July 2020

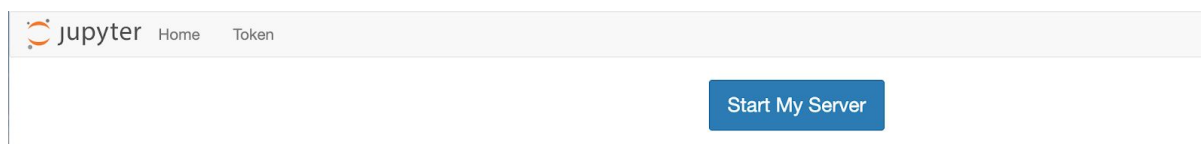
## 0. Before you start

### 0.1 Spawn your Jupyter server

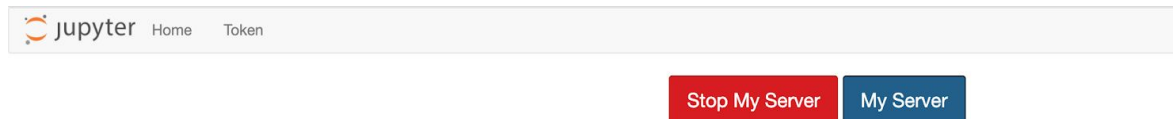
After you sign in CPAS, click “Visualization” on the top menu.



You shall see



or



*Note: If you see an error message like “401 Unauthorized”. Go back to console.cpas.earth (click the “Back” button in your browser), sign-in and try again.*

Click “Start My Server” or “My Server”, and wait a few seconds for the progress bar for spawning the server to complete, you will see:

Select items to perform actions on them.

Upload New ↕ ↻

<input type="checkbox"/>	0 ▾	📁 /	Name ▾	Last Modified	File size
<input type="checkbox"/>		📁	download	4 months ago	
<input type="checkbox"/>		📁	my_obs_data	5 days ago	
<input type="checkbox"/>		📁	output	3 minutes ago	
<input type="checkbox"/>		📁	plot	6 months ago	
<input type="checkbox"/>		📁	resource	6 months ago	
<input type="checkbox"/>		📁	template	7 days ago	
<input type="checkbox"/>		📄	cpas-vis.ipynb	an hour ago	82 kB
<input type="checkbox"/>		📄	VERSION.txt	6 months ago	9 B

Double click “cpas-vis.ipynb” to open it. You should see:

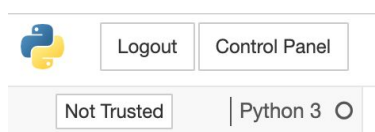
The screenshot shows the Jupyter Notebook interface for a file named 'cpas-vis'. The top bar includes the Jupyter logo, the file name, and a 'Last Checkpoint' timestamp. The menu bar contains 'File', 'Edit', 'View', 'Insert', 'Cell', 'Kernel', 'Navigate', 'Widgets', and 'Help'. The toolbar below the menu bar includes icons for file operations and a red-bordered icon for the Table of Contents. The main content area displays the notebook's title 'CPAS Jupyter Service - Result Visualization and Analysis' and a table of contents on the left. The table of contents lists sections: 1 DO THIS FIRST: Select job, 2 MESH, 3 REAL SIMULATION, 4 SHALLOW WATER TEST, 5 WRITE YOUR CODE, and 6 MISC SERVICE. The first section is expanded, showing code cells with Python code for importing UI and plotting a mesh.

If you cannot see the left Table of Contents, click the button on the toolbar.

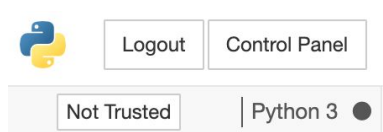
## 0.2 Tips on Jupyter system usage

### 0.2.1 Kernel busy

There is a circle beside the label “Python 3” near the top right corner. If the circle turns black, it means that the Python 3 kernel in the backend is processing the data. Just wait.



Kernel Idle

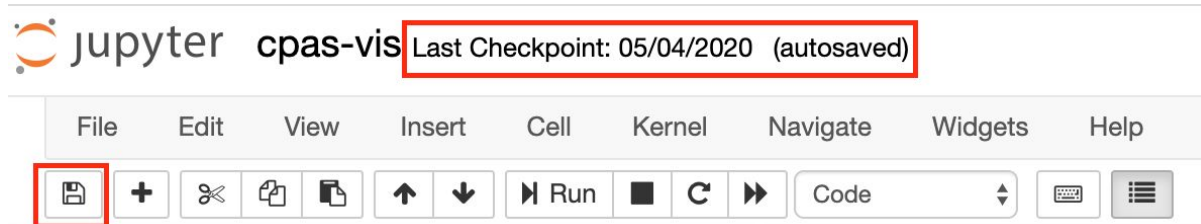


Kernel Busy

If you think the Jupyter system is not responsive, please kindly check whether the kernel in the backend is busy processing.

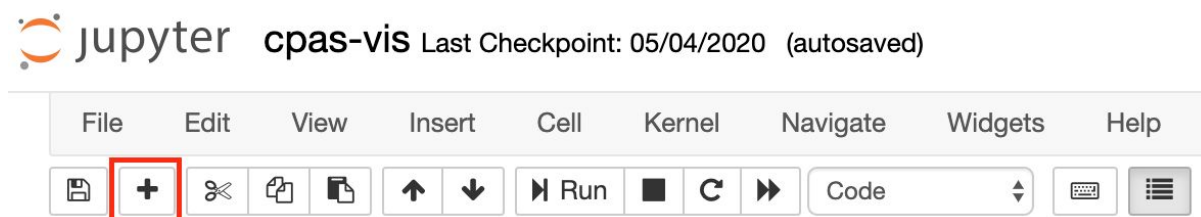
### 0.2.2 Save / Autosave

The content of your Notebook can be edited. Your edited content can be manually saved by clicking the “save” button, or autosaved by the system.



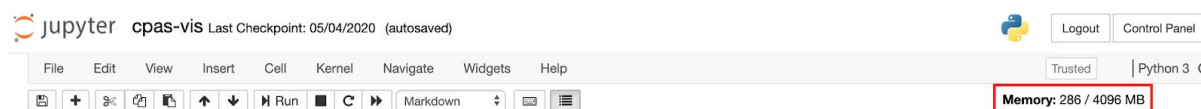
### 0.2.3 Add you code block

You are free to add your code block by clicking the “+” button.



### 0.2.4 Memory Usage

You may note your usage of memory and the limit (in accordance to your subscription level).



If you run out of memory, consider changing to a higher [subscription level](#). Your Jupyter server may be killed if your memory usage exceeds the limit. Restart the kernel in that case.

# 1. Select Job

Following the instructions on the notebook, highlight the code block with `select_job()` and press `Ctrl+Enter`. A set of widgets for selecting the jobs you previously ordered will be shown. You may select the Mesh Generation / Real Simulation / Shallow Water Test job you submitted (My data) or from public data available (Demo data).

## 1 DO THIS FIRST: Select job

```
In [1]: from cpas.ui import UI
        ui = UI().select_job()
```

Select Data:  My data  Demo data

Select Project: 2020-05-04 08:24:56Z EGU2020 HK\_128-to-1km (generated by experimental OLAM-based algorithm; customize  
2020-04-07 01:25:10Z Customized 160km-1km mesh for Hong Kong (generated by Lloyd algorithm; MPAS-A v5  
2020-04-07 01:24:13Z Standard 92km-25km mesh centered at Hong Kong (downloaded from MPAS-A; CPAS v0  
2020-04-07 01:22:41Z Standard 60km-3km mesh centered at Hong Kong (downloaded from MPAS-A; CPAS v0

Select Mesh: 2020-05-04 03:10:19Z HK\_128-to-1km #500 (experimental OLAM-based mesh generation algorithm)

Simulation  Shallow Water Test

Select Simulation: 2020-05-04 04:10:21Z 20180105 00Z Cold front (HTS)  
2020-05-04 04:10:16Z 20180105 00Z Cold front (nonHTS)  
2020-05-04 04:10:08Z 20180611 00Z Heavy rain (HTS)  
2020-05-04 04:10:02Z 20180611 00Z Heavy rain (nonHTS)  
2020-05-04 04:09:46Z 20180912 00Z Mangkhut (HTS)  
2020-05-04 04:09:22Z 20180912 00Z Mangkhut (nonHTS)

Found data files:  
grid.nc | static.nc | mesh.nc | diag.nc  
Ready to do `plot_mesh()` and `visualize_mesh()`.  
Ready to do `plot_diag_contour()` and `visualize_sim()`.

*Note: The "My data" tab would not appear until you have a successful job submission and the Server restarted to mount your result directory.*

*The demo data consists of some data from ClusterTech's R&D work presented on the [Publication and Public Presentations](#) page.*

## 2. Mesh visualization

### 2.1 Plot mesh

Highlight the code block with `plot_mesh()` and press `Ctrl+Enter`. A set of widgets will appear for you to specify the options on the scope to plot. Enter the latitude and longitude for the center and drag the slider to zoom.

#### 2 MESH

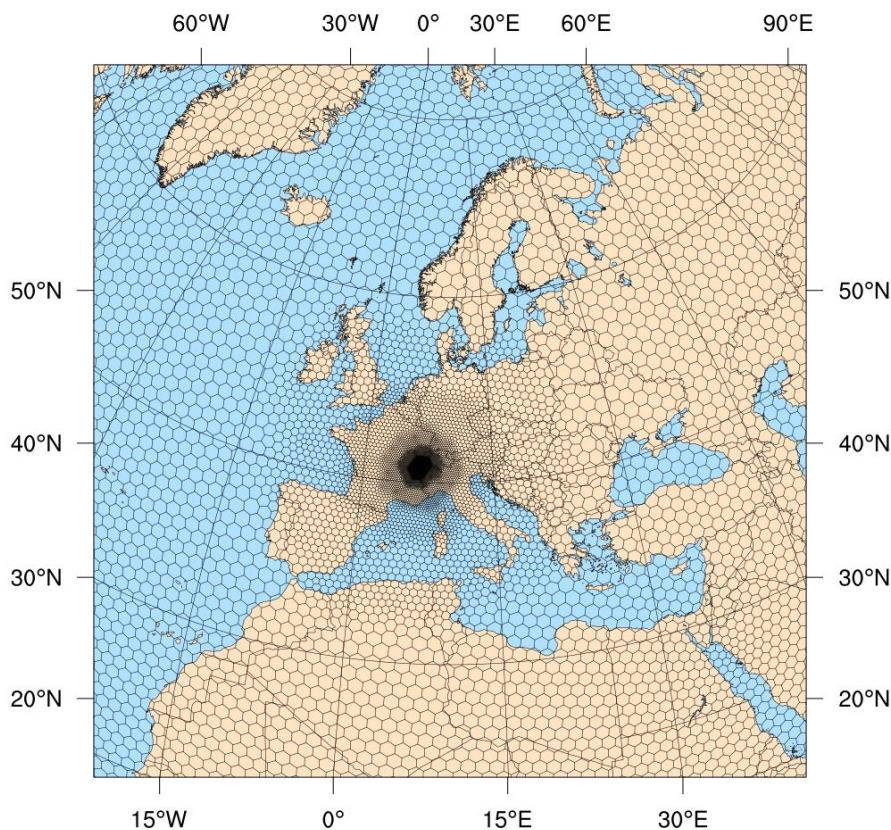
##### 2.1 Plot mesh

```
In [6]: ui.plot_mesh()
```

Center Latitude:  Center Longitude:  Zoom size (1.0 = global)

Draw Mesh...  Draw mesh only  Draw contour

Have “Draw mesh only” selected by default, click the “Plot Mesh” button. After a while, the plot will appear.



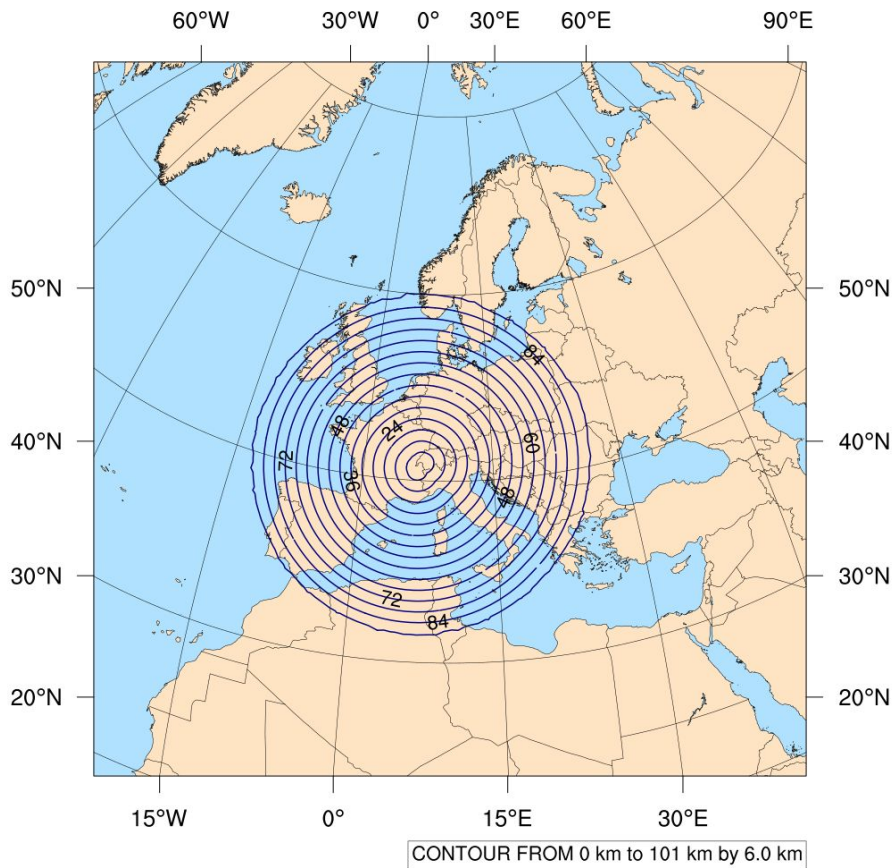
*For more details of geographical information, please use visualization of mesh in an interactive map.*

If you choose “Draw contour”, and click “Plot Mesh” again,

Center Latitude  Center Longitude:  Zoom size (1.0 = global)  0.50

Draw Mesh...

A plot with contours of resolution will appear soon.



## 2.2 Visualize mesh in interactive map

Highlight the code block with `visualize_mesh()` and press `Ctrl+Enter`. A progress bar on loading will appear, and after loading completes, you will see:

## 2.2 Interactive map visualization

```
In [8]: ui.visualize_mesh(height='500px')
```

Center and Zoom

**Mesh Visualization Setting**

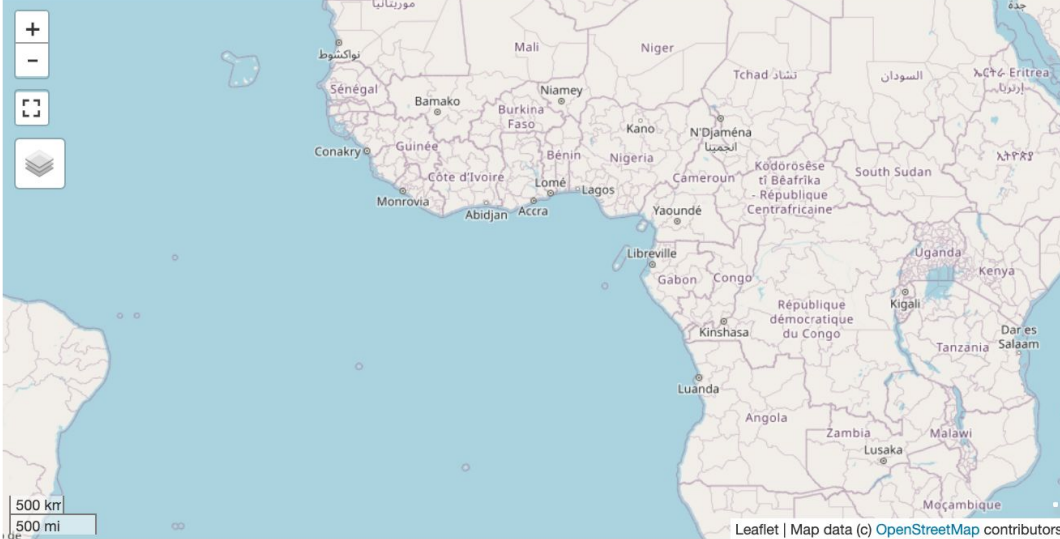
Draw Delaunay Triangles    Max #cell: 5000    Zoom Offset: 0    Draw All Cells

Draw cells?    Pause **||**    Draw **✓**

Draw mes...    Draw mesh only    Plot variables

Select variable: areaCell

Min: 0    Max: 0.0001    No. of intervals: 50    Apply Color Range    Auto Adjust Range



Leaflet | Map data (c) OpenStreetMap contributors

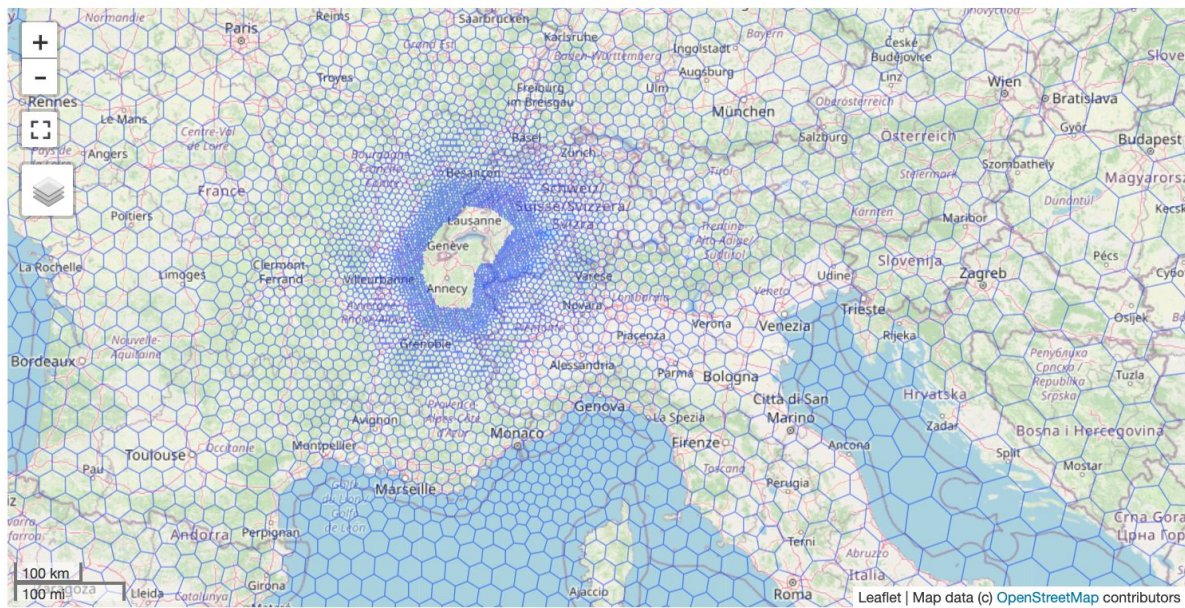
The interactive map is in Pause state. You are expected to drag and zoom in the map to the location you are interested. Then, click the Draw button to toggle to auto-redraw the state.

Draw cells?

Draw mesh...

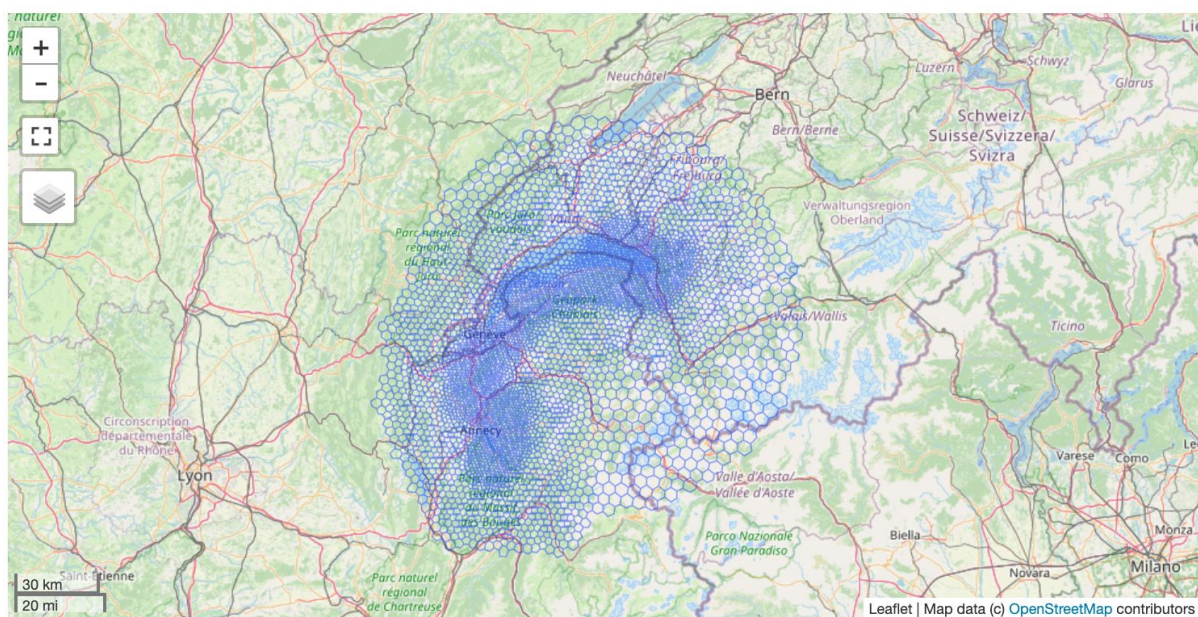
Select variable:

Min:  Max:  No. of intervals:



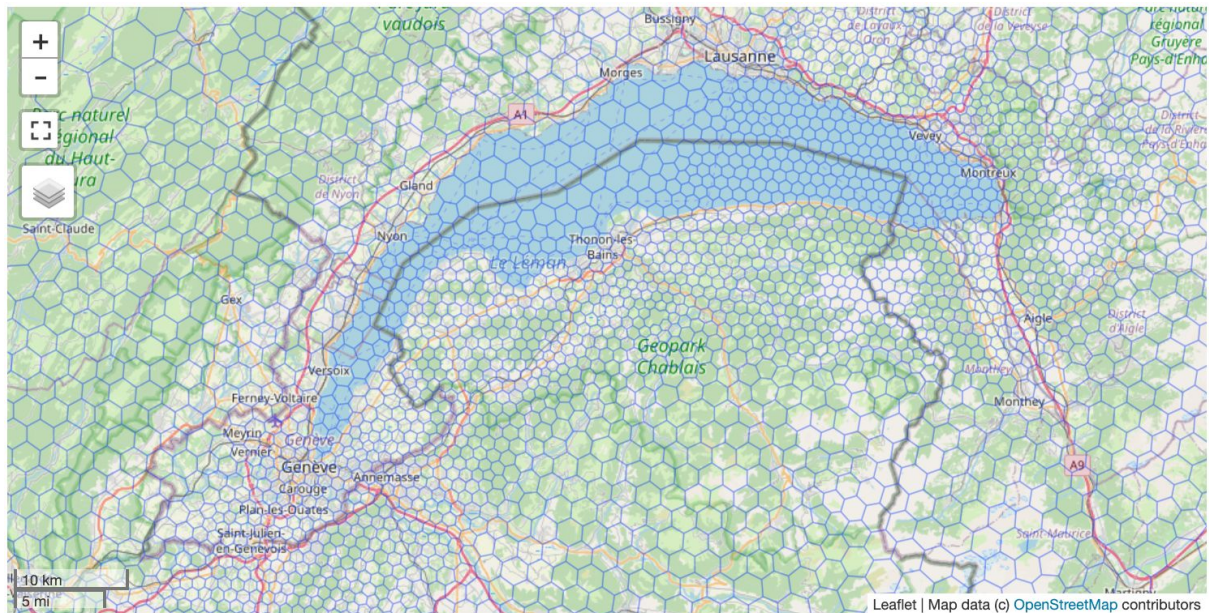
*With the initial default setting, drawing of the cells on the map may take a few seconds. However, if regions with no cells drawn appear, it's because we have set a limit on the maximum number of cells to draw in order to keep your browser responsive. The drawing algorithm selects cells of appropriate sizes to draw, and avoids drawing cells that stick together and form a patch.*

Zooming in, the system will take some time to redraw and you will see results similar to:





All cells of interest appear now, and you can continue to zoom in. You can also click the “Pause” button before zooming in in order to make the browser respond faster.



*(This is Geneva Switzerland! CPAS technology was firstly announced here at Meteorological Technology World EXPO 2019.)*

In case you would like to fine-tune the interaction behaviour, look into the “Mesh Visualization Setting” accordion. Max #cell is the limit mentioned earlier. Setting it to a larger value plots more cells but slows down browser response. “Zoom Offset” controls the choice of sizes of cells to appear. The “Draw All Cells” button disregards the limit on the number of cells, but will be very small if the number of cells is large. Last but not least, “Draw Delaunay Triangles” (light grey) helps you inspect the quality of the mesh (whether the triangles are close to equilateral, or if any obtuse triangle exists).

**▼ Mesh Visualization Setting**

Draw Delaunay Triangles    Max #cell: 20000    Zoom Offset: 0    Draw All Cells

Draw cells?    Pause ||    Draw ✓

Draw mesh...    Draw mesh only    Plot variables

Select variable: areaCell

Min: 0    Max: 0.0001    No. of intervals: 50    Apply Color Range    Auto Adjust Range

Leaflet | Map data (c) OpenStreetMap contributors

## 2.3 Visualize static data in interactive map

If you choose “Plot variables”, you may see

Draw cells?    Pause ||    Draw ✓

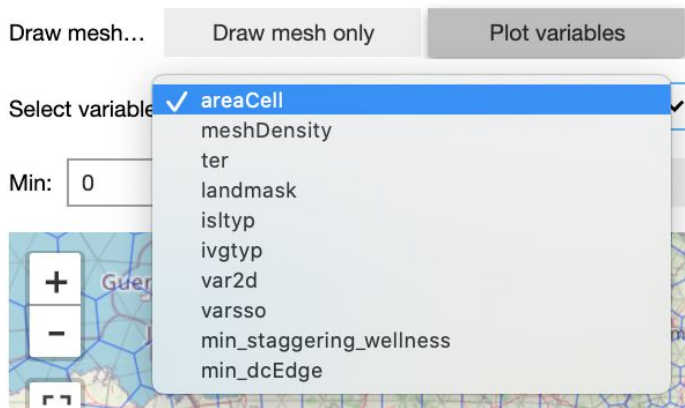
Draw mesh...    Draw mesh only    Plot variables

Select variable:
 

- ✓ areaCell
- meshDensity
- min\_staggering\_wellness
- min\_dcEdge

Min: 0

And if you have already executed a Real Simulation job with the mesh, you may see more variables:



Variable	Unit	Description	Reference
areaCell	km <sup>2</sup>	Area in square meters for a given cell of the primary mesh.	<a href="#">MPAS Mesh Specification</a>
meshDensity	unitless	The value of the generating density function at each cell center.	<a href="#">MPAS Mesh Specification</a>
ter	m	Terrain height	<a href="#">MPAS-Atmosphere Model User's Guide</a>
landmask	unitless	Land-ocean mask (1=land ; 0=ocean)	<a href="#">MPAS-Atmosphere Model User's Guide</a>
isltyp	unitless	Dominant soil category	<a href="#">MPAS-Atmosphere Model User's Guide</a>
ivgtyp	unitless	Dominant vegetation category	<a href="#">MPAS-Atmosphere Model User's Guide</a>
var2d	m <sup>2</sup>	Variance of orography	<a href="#">MPAS-Atmosphere Model User's Guide</a>
varsso (experimental)	m <sup>2</sup>	Variance of sub-grid-scale orography.	<a href="#">WPS V4 Geographical Static Data Downloads Page</a>
min_staggerin g_wellness	unitless	For each edge, the staggering wellness is defined as $1.0 - \frac{ dv1Edge - dv2Edge }{dvEdge}$ For a cell, min_staggering_wellness is the smallest staggering wellness among its edges. The range is from 0.0 to 1.0. 0.0 means ill staggering (obtuse or	Similar metrics are used in <a href="https://doi.org/10.1175/MWR-D-12-00236.1">https://doi.org/10.1175/MWR-D-12-00236.1</a> and <a href="https://doi.org/10.1016/j.jcp.2018.07.025">https://doi.org/10.1016/j.jcp.2018.07.025</a>

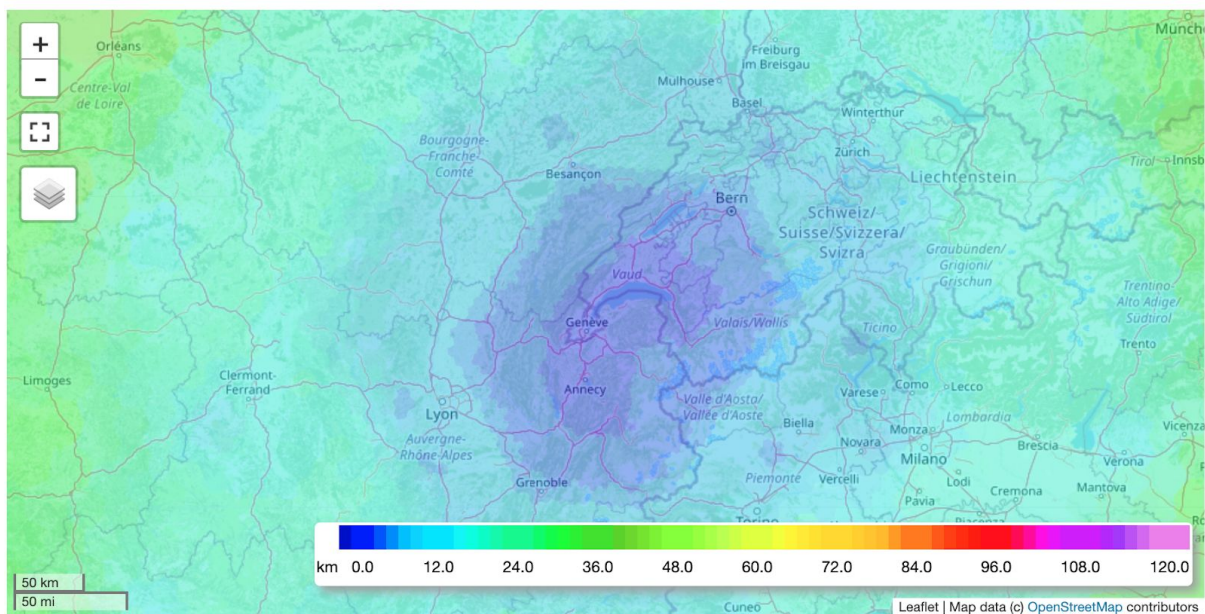
		right-angled Delaunay triangle occurs); 1.0 means perfect staggering.	
min_dcEdge	km	The shortest grid spacing with its neighbours, i.e. the smallest dcEdge associated with a cell.	<a href="#">MPAS Mesh Specification</a>

Table 1: Variables about mesh

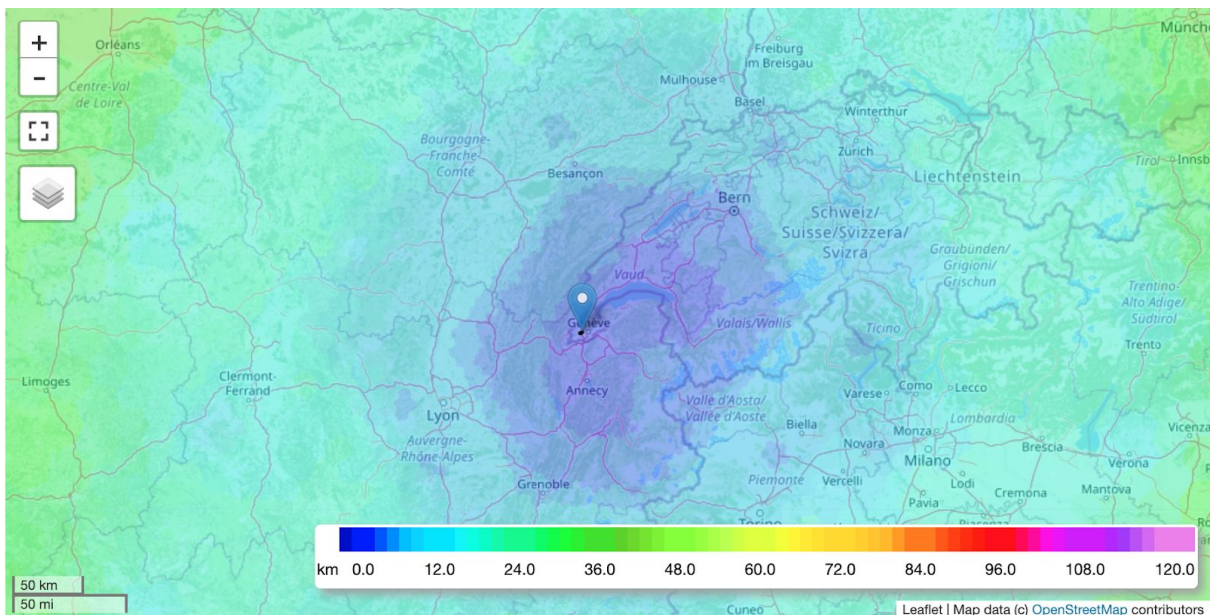
Take min\_dcEdge as an example,

Select variable:  ▼

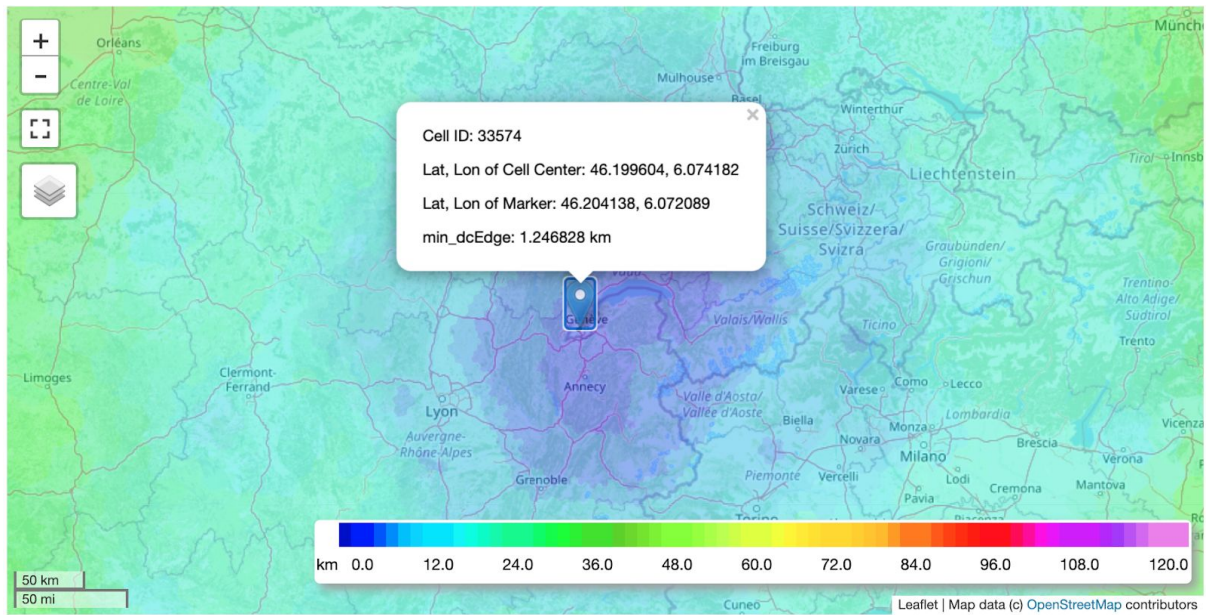
Min:  Max:  No. of intervals:



If you click on a position in a map panel, a marker will appear.



Click at the marker, detailed information would appear:



### 3. Simulation results visualization

The following list of variables may be available for plotting as contours or visualized in an interactive map.

Variable	Unit	Description	Reference
t2m	°C	2-meter temperature, converted to degree Celsius	<a href="#">MPAS-Atmosphere Model User's Guide</a>
q2	kg kg <sup>-1</sup>	2-meter specific humidity	<a href="#">MPAS-Atmosphere Model User's Guide</a>
u10	m s <sup>-1</sup>	10-meter zonal wind	<a href="#">MPAS-Atmosphere Model User's Guide</a>
v10	m s <sup>-1</sup>	10-meter meridional wind	<a href="#">MPAS-Atmosphere Model User's Guide</a>
wspd10	m s <sup>-1</sup>	10-meter wind speed, derived from u10 and v10 for CPAS users' convenience.	
mslp	hPa	Mean sea level pressure	<a href="#">core_atmosphere registry</a>
rainc	mm	Accumulated convective precipitation	<a href="#">MPAS-Atmosphere Model User's Guide</a>
rainnc	mm	Accumulated total grid-scale precipitation	<a href="#">MPAS-Atmosphere Model User's Guide</a>
temperature_<xxx>hPa	°C	Temperature at <xxx> hPa pressure level	<a href="#">core_atmosphere registry</a>
relhum_<xxx>hPa	%	Relative humidity at <xxx> hPa pressure level	<a href="#">core_atmosphere registry</a>
uzonal_<xxx>hPa	m s <sup>-1</sup>	Zonal wind at <xxx> hPa pressure level	<a href="#">core_atmosphere registry</a>
umeridional_<xxx>hPa	m s <sup>-1</sup>	Meridional wind at <xxx> hPa pressure level	<a href="#">core_atmosphere registry</a>
wspd_<xxx>hPa	m s <sup>-1</sup>	Wind speed at <xxx> hPa pressure level, derived from uzonal_<xxx>hPa and umeridional_<xxx>hPa for CPAS users' convenience.	

height_<xxx>hPa	m	Height at <xxx> hPa pressure level	<a href="#">core_atmosphere_registry</a>
w_500hPa	m s <sup>-1</sup>	Vertical wind at 500hPa. Good for visualizing convection.	<a href="#">core_atmosphere_registry</a>
delta_rainc	mm	Difference of rainc of this time slide from the previous time slide.	
delta_rainnc	mm	Difference of rainnc of this time slide from the previous time slide.	
rainsum	mm	rainc + rainnc	
delta_rainsum	mm	Difference of rainsum of this time slide from the previous time slide.	
olrtoa	W m <sup>-2</sup>	All-sky top-of-atmosphere outgoing longwave radiation flux	<a href="#">MPAS-Atmosphere Model User's Guide</a>
vorticity_500hPa	s <sup>-1</sup>	Relative vorticity at vertices	<a href="#">MPAS-Atmosphere Model User's Guide</a>

Table 2: Variables about real simulation.

For variables with <xxx>hPa suffix, usually the following pressure levels are available.

Pressure level	Typical analysis usage
850hPa	Low level thermal advection, vapour transport
500hPa	Vorticity, ridge and trough movement
200hPa	Jet stream, convergence and divergence

### 3.1 Plot contours

Highlight the code block with `plot_mesh()` and press Ctrl+Enter. A set of widgets will appear for you to specify the options on the scope to plot. Select the time slide to plot. Select up to 3 variables you may plot as color contour, line contour and wind vector. Enter the latitude and longitude for the center and drag the slider to zoom.

### 3 REAL SIMULATION

#### 3.1 Plot simulation result

```
In [9]: ui.plot_diag_contour()
```

Select Time (UTC):  
2019-06-05\_12:00:00  
2019-06-05\_15:00:00  
2019-06-05\_18:00:00  
2019-06-05\_21:00:00  
2019-06-06\_00:00:00

Select color contour: u10  
v10  
q2  
t2m  
mslp

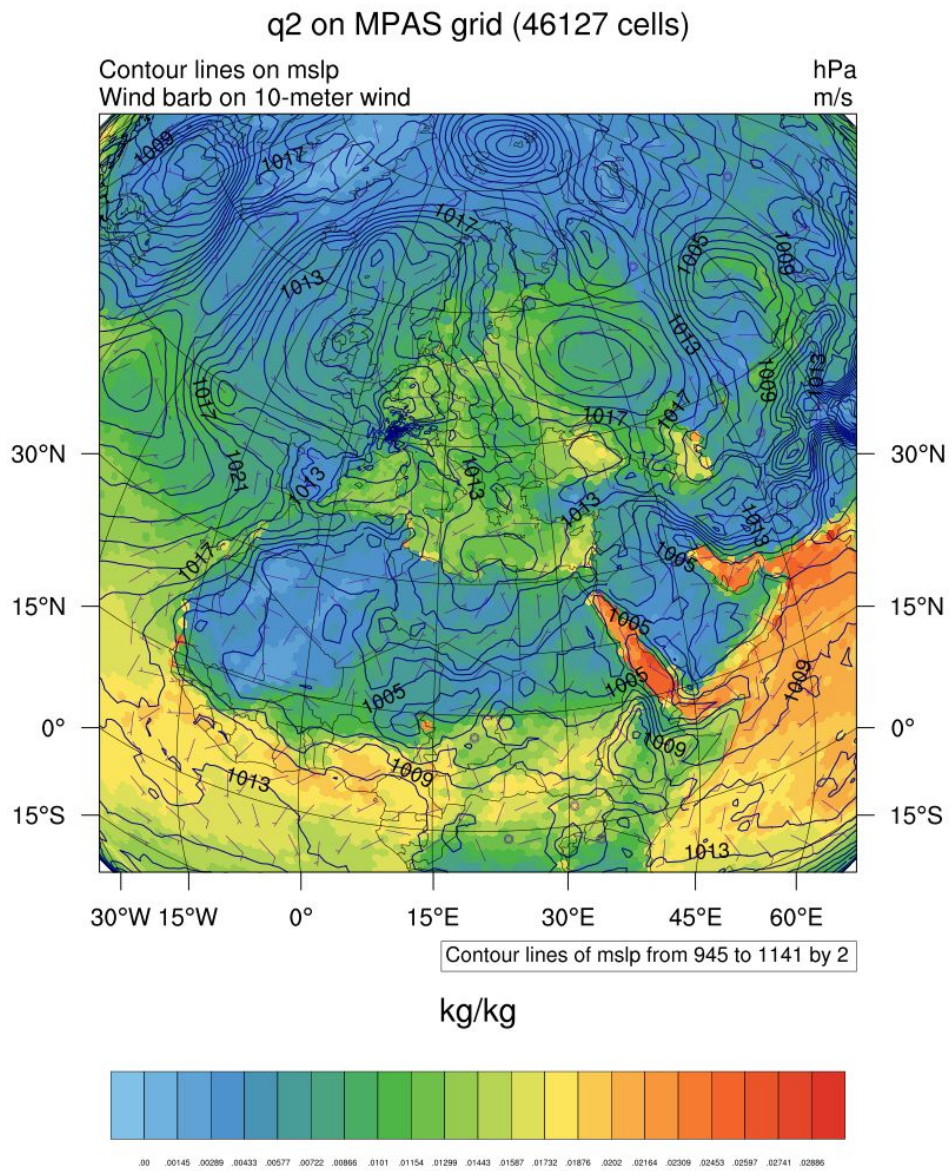
Select contour line: None  
mslp  
height\_850hPa  
height\_500hPa  
height\_200hPa

Select wind vector: None  
10-meter wind  
850hPa wind  
500hPa wind  
200hPa wind

Center Latitude: 0 Center Longitude: 0 Zoom size (1.0 = global) 1.00

Plot Contour

Then click the "Plot Mesh" button. The plot will appear soon.





### 3.2 Visualize simulation results in interactive map

Highlight the code block with visualize\_sim() and press Ctrl+Enter. A progress bar on loading will appear, and after loading completes, you will see:

#### 3.2 Interactive map visualization

In [6]: `ui.visualize_sim()`

Center and Zoom

Mesh Visualization Setting

Draw Delaunay Triangles    Max #cell: 5000    Zoom Offset: 0    Draw All Cells

Draw cells?    Pause    Draw

Select Time (UTC): 2019-06-05\_12:00:00

Select variable: t2m

Min: -20    Max: 40    No. of intervals: 50    Apply Color Range    Auto Adjust Range

500 km  
500 mi

Leaflet | Map data (c) OpenStreetMap contributors

Pulling down the “Select Time (UTC)” box, you will see time slides that your Real Simulation job outputs diagnostic data. Select the time slide you want to visualize.

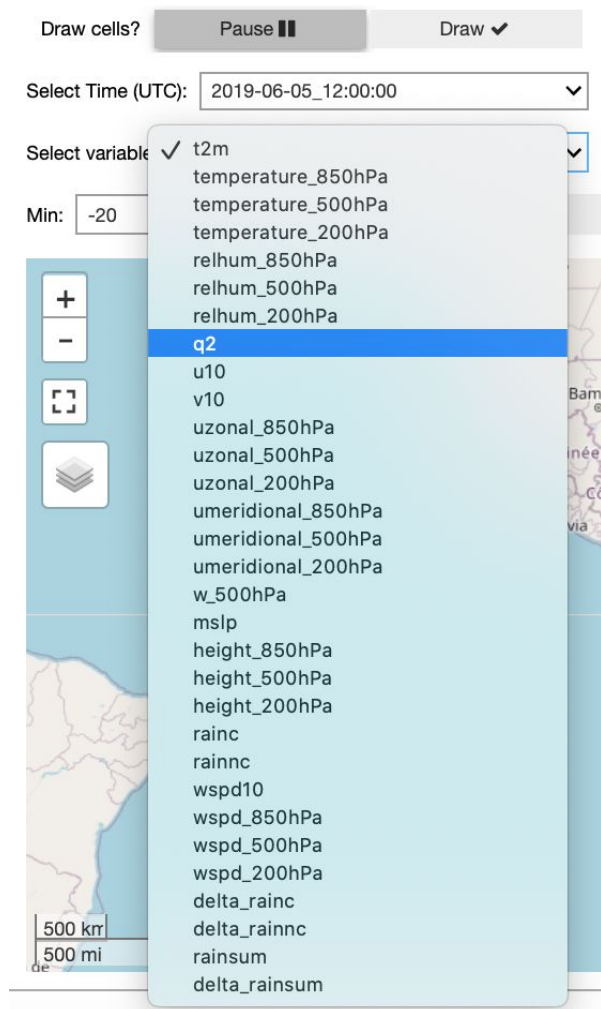
Draw cells?    Pause    Draw

Select Time (UTC) ✓ 2019-06-05\_12:00:00  
2019-06-05\_15:00:00  
2019-06-05\_18:00:00  
2019-06-05\_21:00:00  
2019-06-06\_00:00:00  
2019-06-06\_03:00:00  
2019-06-06\_06:00:00  
2019-06-06\_09:00:00  
2019-06-06\_12:00:00  
2019-06-06\_15:00:00  
2019-06-06\_18:00:00  
2019-06-06\_21:00:00

Select variable:

Min: -20

Pull down the “Select variable” pull down box. You will see a list of variable names that may be available to visualize. Select the variable (see Table 2) you want to visualize.



Other operations are similar to those for visualizing mesh. An example of visualizing t2m is below:

```
ui.visualize_sim()
```

Center and Zoom

Mesh Visualization Setting

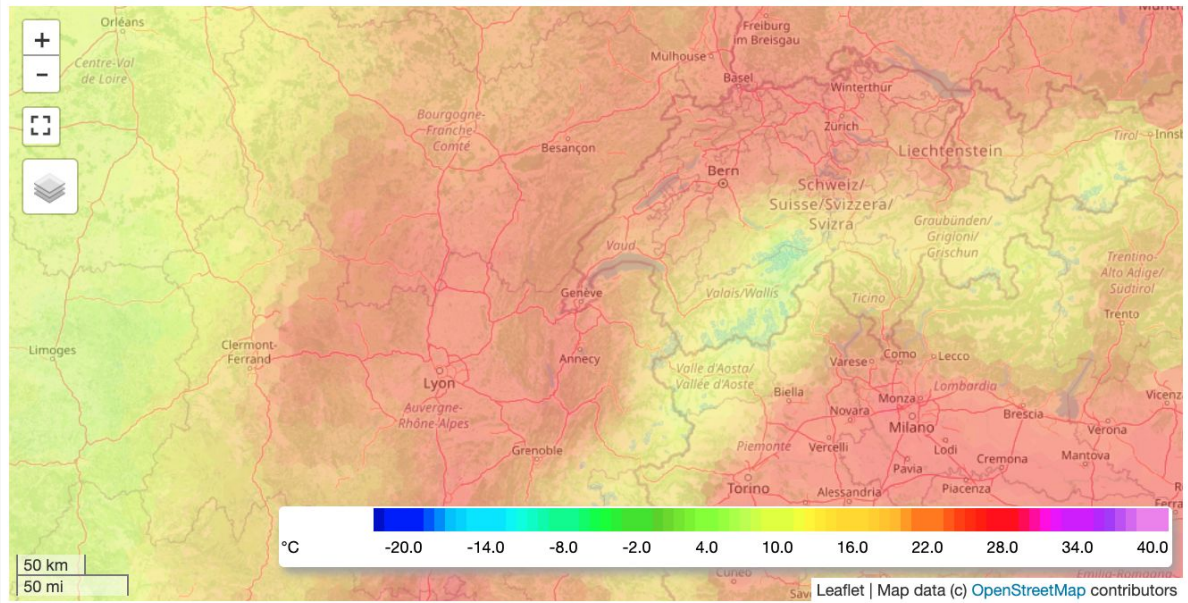
Draw Delaunay Triangles    Max #cell: 50000    Zoom Offset: 0    Draw All Cells

Draw cells?    Pause    Draw

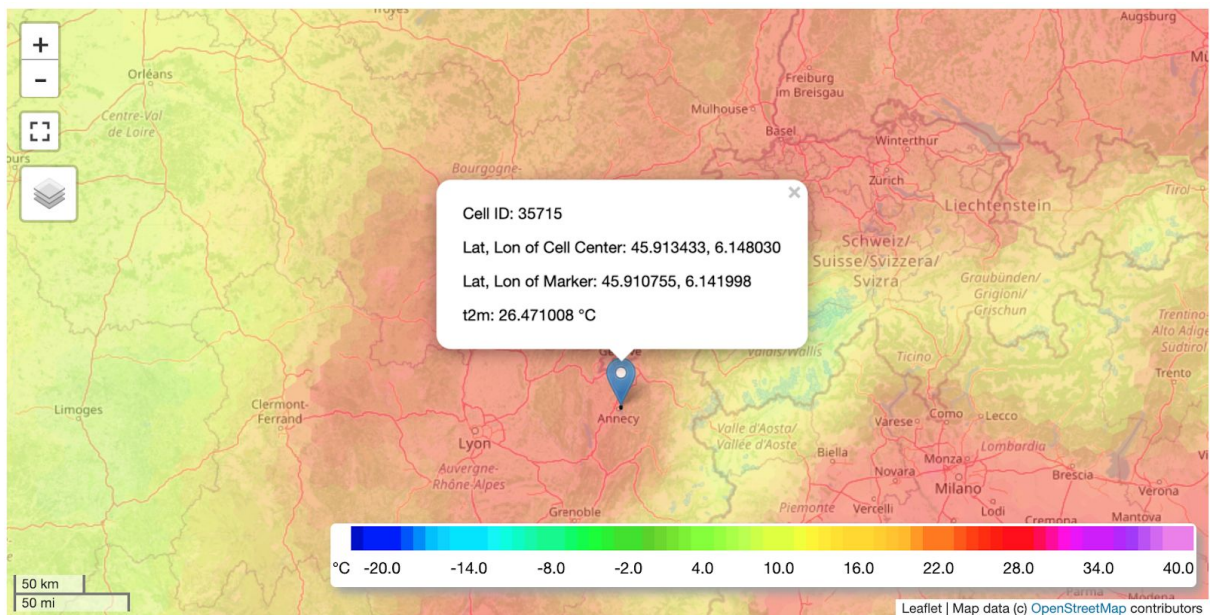
Select Time (UTC): 2019-06-05\_12:00:00

Select variable: t2m

Min: -20    Max: 40    No. of intervals: 50    Apply Color Range    Auto Adjust Range



Click on the map to position the marker, and display the detailed information:



## 3.3 Conversion to lat-lon grid

Many analysis and visualization tools are for lat-lon grid, for example, the pretty ipyleaflet Velocity package for visualizing wind with animation.

### 3.3.1 Regrid from unstructured grid

Read the code in the cell:

#### 3.3.1 Regrid from unstructured grid to lat-lon grid

This generates a separate nc file with listed variables in lat-lon grid.

```
In [10]: # Set configs for conversion (e.g. output filename, variables, target grid)
output_fname = 'output/diag_latlon.nc'
var_list = ['mslp', 't2m', 'q2', 'u10', 'v10',
            'uzonal_850hPa', 'umeridional_850hPa',
            'uzonal_500hPa', 'umeridional_500hPa',
            'uzonal_200hPa', 'umeridional_200hPa']

# Other available variables:
# 'height_850hPa', 'temperature_850hPa', 'relhum_850hPa',
# 'height_500hPa', 'temperature_500hPa', 'relhum_500hPa',
# 'height_200hPa', 'temperature_200hPa', 'relhum_200hPa',
# 'w_500hPa', 'rainc', 'rainnc'

ui.convert_mpas(output=output_fname,
                nlat=180, nlon=360,
                startlat=-90.0, startlon=-180.0,
                endlat=90.0, endlon=180.0,
                var=var_list)
```

Created the regridted nc file successfully: output/diag\_latlon.nc

It specifies the output file path, the list of variables that needs to be converted and the invocation of `convert_mpas()` with input arguments. After execution, a message would be printed.

### 3.3.2 Wind animation

Read the code in the cell:

### 3.3.2 Wind animation

```
In [12]: # This is a sample code block for wind animation
from cpas.wind import *

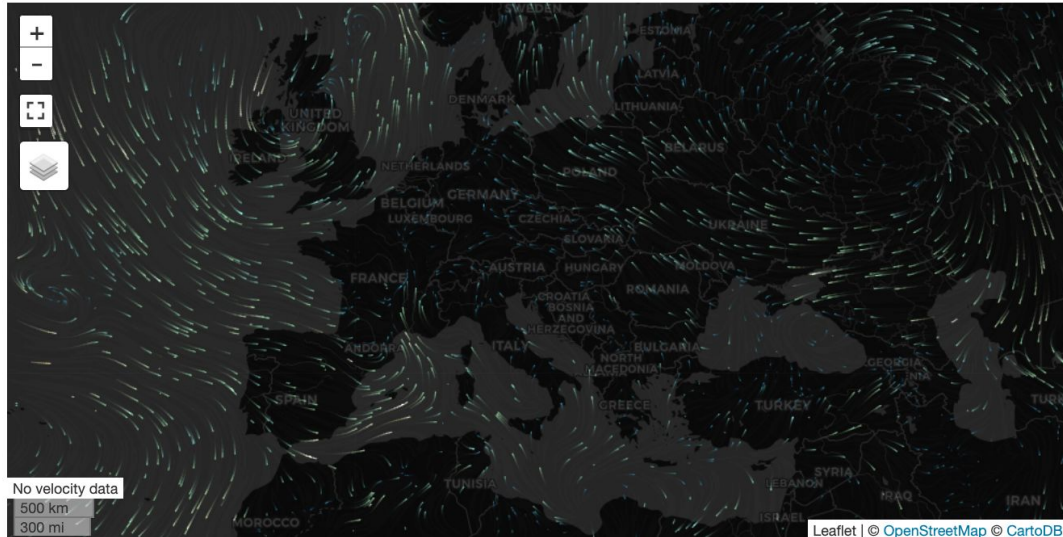
wind_field = WindMap(output_fname)
display(wind_field)
```

#### Center and Zoom

Center Lati...  Center Lo...  Zoom level:

Select time step:  0

Select vertical level:  surface



It assumes the wind data was converted into lat-lon grid data in the specified file path. Executing the code would produce the wind animation.

### 3.3.3 Plot the converted data

Have a look at the long piece of code and modify if necessary. Executing the code, some widgets and a plotting would appear. They should be self-explanatory to operate.

```
output = interactive_plot.children[-1]
interactive_plot
```

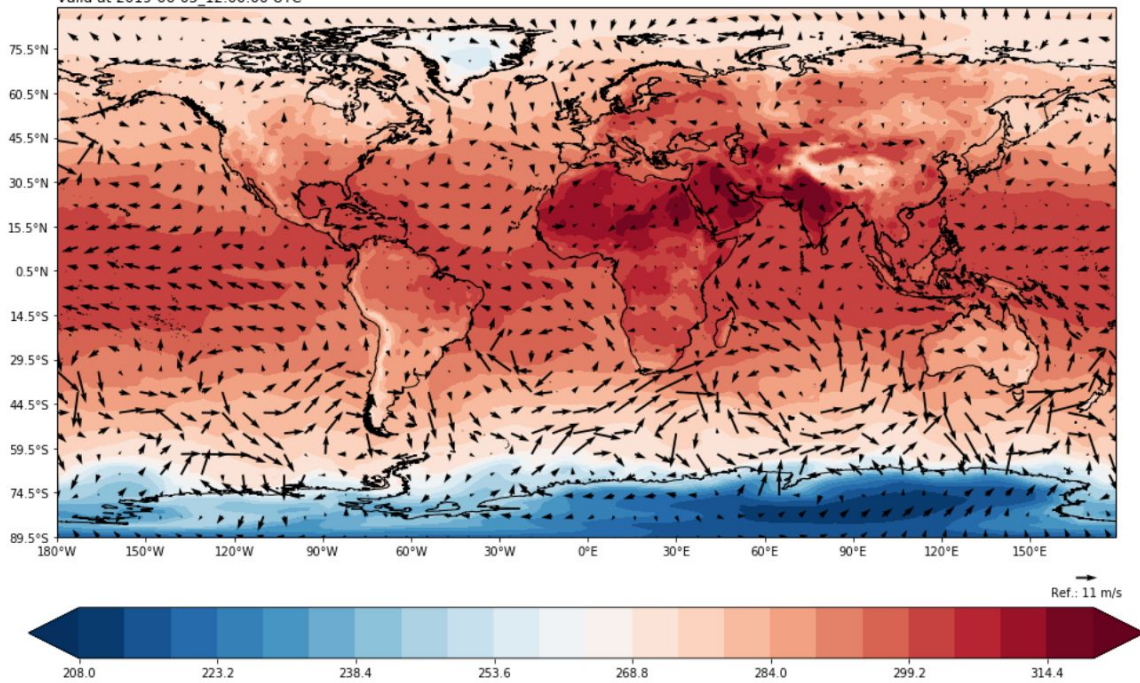
Contour:

X-component of vector:

Y-component of vector:

Time:

Contour:  
2-meter temperature (K);  
Vector:  
x-component: 10-meter zonal wind ( $\text{m s}^{-1}$ );  
y-component: 10-meter meridional wind ( $\text{m s}^{-1}$ );  
Initialized at 2019-06-05 12:00:00 UTC;  
Valid at 2019-06-05 12:00:00 UTC



## 4. Shallow water test result analysis

To verify validity of Atmospheric models, shallow water tests are often used. Researchers often publish shallow water test results in academic journals or presentations. MPAS-A bundles shallow water tests in [core\\_sw](#), which are also described in [Ringler et al \(2011\)](#) and [Williamson et al \(1992\)](#). The shallow water dynamic core, `core_sw`, can be configured to output global integrals into text files.

### 4.1 Plot global integrals

In the widgets shown by `select_job()`, select the "Shallow Water Test" tab.

## 1 DO THIS FIRST: Select job

```
In [5]: from cpas.ui import UI
ui = UI().select_job()
```

Select Data:  My data  Demo data

Select Project:

- 2020-05-04 08:24:56Z EGU2020 HK\_128-to-1km (generated by experimental OLAM-based algorithm; customized CPAS v0.4.0)
- 2020-04-07 01:25:10Z Customized 160km-1km mesh for Hong Kong (generated by Lloyd algorithm; MPAS-A v5.2 experiments)
- 2020-04-07 01:24:13Z Standard 92km-25km mesh centered at Hong Kong (downloaded from MPAS-A; CPAS v0.3.2 HTS experim
- 2020-04-07 01:22:41Z Standard 60km-3km mesh centered at Hong Kong (downloaded from MPAS-A; CPAS v0.3.2 HTS experim

Select Mesh:

- 2020-04-04 01:14:47Z Lloyd 160-to-1km
- 2020-04-04 02:02:05Z lloyd\_160km-1km\_dry\_mpas\_dynamical\_core
- 2020-04-08 02:19:18Z lloyd\_160km-1km\_shallow\_water\_solver

Simulation:  Simulation  Shallow Water Test

Select Shallow Water Test:

- 2020-04-07 01:08:48Z sw5
- 2020-04-07 01:08:47Z sw2

Found data files:  
grid.nc | GlobalIntegrals\*.txt  
Ready to do plot\_mesh() and visualize\_mesh().  
Ready to do plot\_shallow\_water\_global\_integrals().

The Demo data shown above contains some Shallow Water Test results. Note that the message tells GlobalIntegrals\*.txt are found.

Execute the code cell with plot\_shallow\_water\_global\_integrals().

## 4 SHALLOW WATER TEST

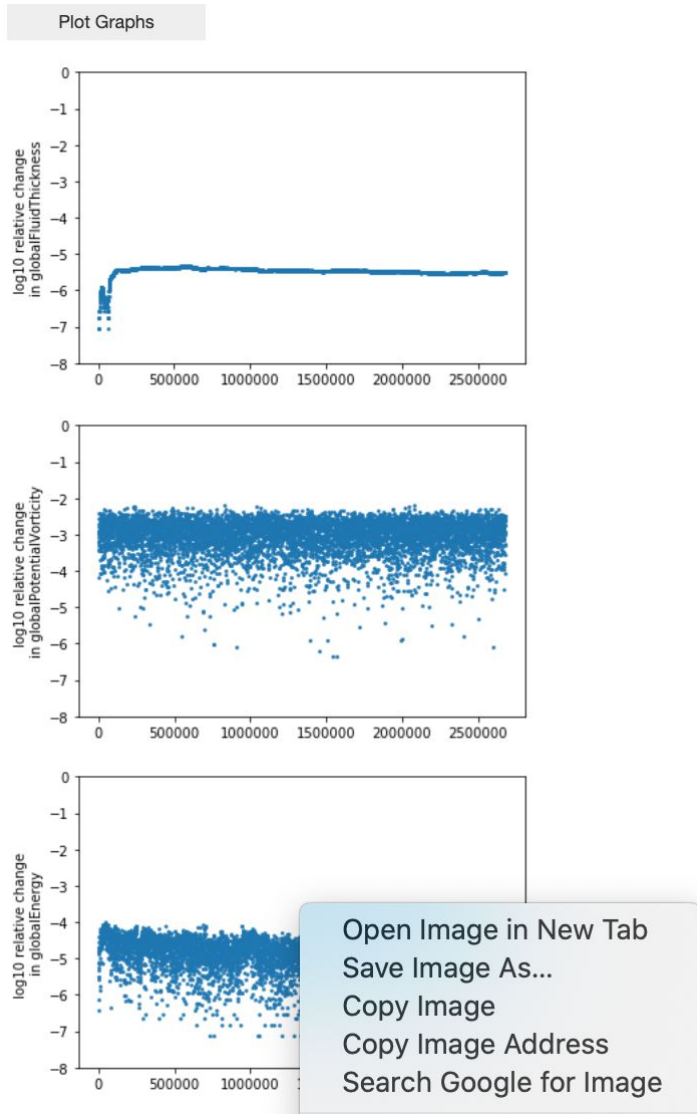
### 4.1 Plot global integrals

```
In [19]: ui.plot_shallow_water_global_integrals()
```

Select Variable:

- globalFluidThickness
- globalPotentialVorticity
- globalPotentialEnstrophy
- globalEnergy
- globalCoriolisEnergyTendency
- globalKineticEnergyTendency+globalPotentialEnergyTendency
- globalKineticEnergy
- globalPotentialEnergy

Select the variables you are interested in (multiple items allowed). Click the “Plot Graphs” button. Graphs would appear after a while.



For your convenience, you may right click on a graph and use “Save Image As...” to save it to your local computer.

## 5. Model evaluation against your observation data

The cpas Python package provides the ModelEvaluation class for your convenience of evaluating model predictions against observation data.

Your observation data needs to be uploaded to the Jupyter system first.



Select items to perform actions on them.

The screenshot shows the Jupyter file browser interface. At the top, there are tabs for 'Files', 'Running', 'Clusters', and 'Nbextensions'. Below the tabs, there's a header with 'Upload', 'New', and a refresh icon. A dropdown menu is open under 'New', showing options: 'Notebook: Python 3', 'Other: Text File', 'Folder', and 'Terminal'. The main area displays a file list with columns for Name, Last Modified, and File size.

Name	Last Modified	File size
download		
my_obs_data		
output		
plot		
resource		
template		
cpas-vis.ipynb	Running an hour ago	103 kB
VERSION.txt	7 months ago	9 B

Use “New”, “Folder” as shown above to create a folder on the Jupyter system. The “my\_obs\_data” has already been created in the above example. Use the “Upload” button to upload your observation data file.

Select items to perform actions on them.

The screenshot shows the Jupyter file browser interface with the 'my\_obs\_data' folder selected. The 'Upload' button is highlighted with a red box. The file list below shows several CSV files with their last modified dates and sizes.

Name	Last Modified	File size
..	seconds ago	
45007.03.02.2020.09.02.2020.1.0.0.cn.utf8.00000000.csv	3 months ago	17.7 kB
45007.04.01.2018.13.01.2018.1.0.0.en.utf8.00000000.csv	19 days ago	30.2 kB
47936.19.12.2019.25.12.2019.1.0.0.en.utf8.00000000.csv	3 months ago	42.2 kB
47936.20.12.2019.25.12.2019.1.0.0.en.utf8.00000000.csv	3 months ago	36.5 kB
ROAH.19.12.2019.25.12.2019.1.0.0.en.utf8.00000000.csv	3 months ago	64.1 kB

Here is an example of observation data in csv format:

```

1 # Weather station Hong Kong (airport), Hong Kong, WMO_ID=45007,selection from 04.01.2018 till 13.01.2018, all days
2 # Encoding: UTF-8
3 # The data is provided by the website "Reliable Prognosis", rp5.ru
4 # If you use the data, please indicate the name of the website.
5 # For meteorological parameters see the address http://rp5.ru/archive.php?wmo_id=45007&lang=en
6 #
7 "Local time in Hong Kong
(airport)";"T";"Po";"P";"Pa";"U";"DD";"Ff";"ff10";"ff3";"N";"WW";"W1";"W2";"Tn";"Tx";"Cl";"Nh";"H";"Cm";"Ch";"VV";"Td";"RRR";"tR";
"E";"Tg";"E";"sss"
8 "13.01.2018 23:00";"14.2";"768.7";"769.3";"0.6";"66";"Wind blowing from the east";"5";"";"10% or less, but not 0";"
";"";"";"";"Stratocumulus other than Stratocumulus cumulonimbus";"10% or less, but not 0";"600-1000";"No Altostratus,
Altostratus or Nimbostratus."; "No Cirrus, Cirrocumulus or Cirrostratus."; "17.0";"7.8";"";"";"";"";"";"";
9 "13.01.2018 20:00";"13.8";"768.1";"768.7";"0.9";"67";"Wind blowing from the east";"5";"";"no clouds";"
";"";"";"17.3";"";"";"";"16.0";"7.8";"No precipitation";"12";"";"";"";"";

```

Read the code in the code cell:

## 5.1 Model evaluation against your observation data (sample code)

Free free to change the code for your observation data upload. See this [blog article](#).

```
In [ ]: import numpy as np
import pandas as pd
from datetime import timedelta
from cpas.evaluation import ModelEvaluation, csv2df

(my_lat, my_lon) = (22+18.534/60, 113+54.84/60) # Hong Kong (airport)
local_time_header = 'Local time in Hong Kong (airport)' # Column header in CSV file
local_time_offset = 8
my_csv = 'my_obs_data/45007.04.01.2018.13.01.2018.1.0.0.en.utf8.00000000.csv'

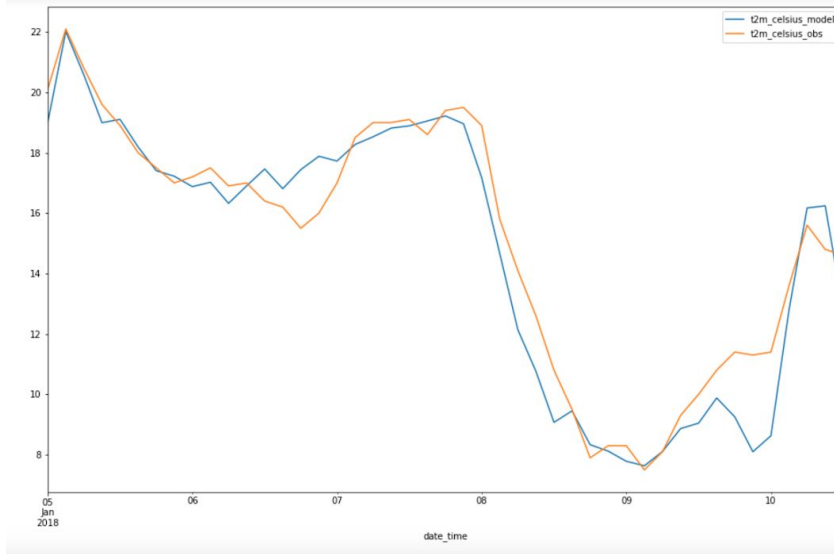
raw_obs_df = csv2df(my_csv, sep=';', comment='#', index_col=False)
obs_df = pd.DataFrame()
obs_df['date_time'] = pd.to_datetime(raw_obs_df[local_time_header], format='%d.%m.%Y %H:%M') + timedelta(hours=-local_time_offset)
(obs_df['lat'], obs_df['lon']) = (my_lat, my_lon)
obs_df['t2m_celsius'] = raw_obs_df['T']

me = ModelEvaluation(ui.mesh_ncfile, ui.diag_ncfile, obs_df)
me.met_combine()
comp = me.get_comparison()

mask = ~np.isnan(comp['t2m_celsius_model'])
filtered = comp[mask]
filtered.xs(my_lat, level='lat').xs(my_lon, level='lon').plot(y=['t2m_celsius_model', 't2m_celsius_obs'], figsize=(16,
```

You need to load your observation data into a pandas DataFrame. Beware of conversion between local time and UTC, as UTC is used in ModelEvaluation for matching time. If you reuse this piece of code, please remember to change the variables for specifying the lat, lon, header label and file path for your case.

Executing this piece of code, something like the following plotting would appear:



## 6. Download mesh

Run the cell of code with `download_mesh()`.

### 6 MISC SERVICE

#### 6.1 Download mesh

```
In [2]: ui.download_mesh()
```

```
Out[2]: By downloading the mesh, I agree to the No Unauthorized Redistribution of Generated Mesh Files clause of the Terms and Conditions.  
download/mesh.tar.gz
```

Read the Terms and Conditions. If you agree with it, you may click the link to download the file.

## 7 API documentation

You may use the question mark ( ? ) built-in magic of Jupyter's IPython kernel to check API documentation.

### 7 API Signature and Docstring

Put cursor after the dot, hit `→ Tab`, select method, hit `^ Ctrl` + `↵ Enter`

```
In [1]: from cpas.ui import UI
        ?UI.visualize_mesh
```

**Signature:** `UI.visualize_mesh(self, height='500px', width='100%', stroke_opacity=0.5)`

**Docstring:**

Use an interactive map and widgets to visualize the mesh

**Parameters**

`height` : str  
The height of the interactive map to display.

`width` : str  
The width of the interactive map to display.

`stroke_opacity` : float  
Opacity for drawing strokes of cell edges

**Returns**

none