How to visualize CPAS model data

ClusterTech Limited

July 2022

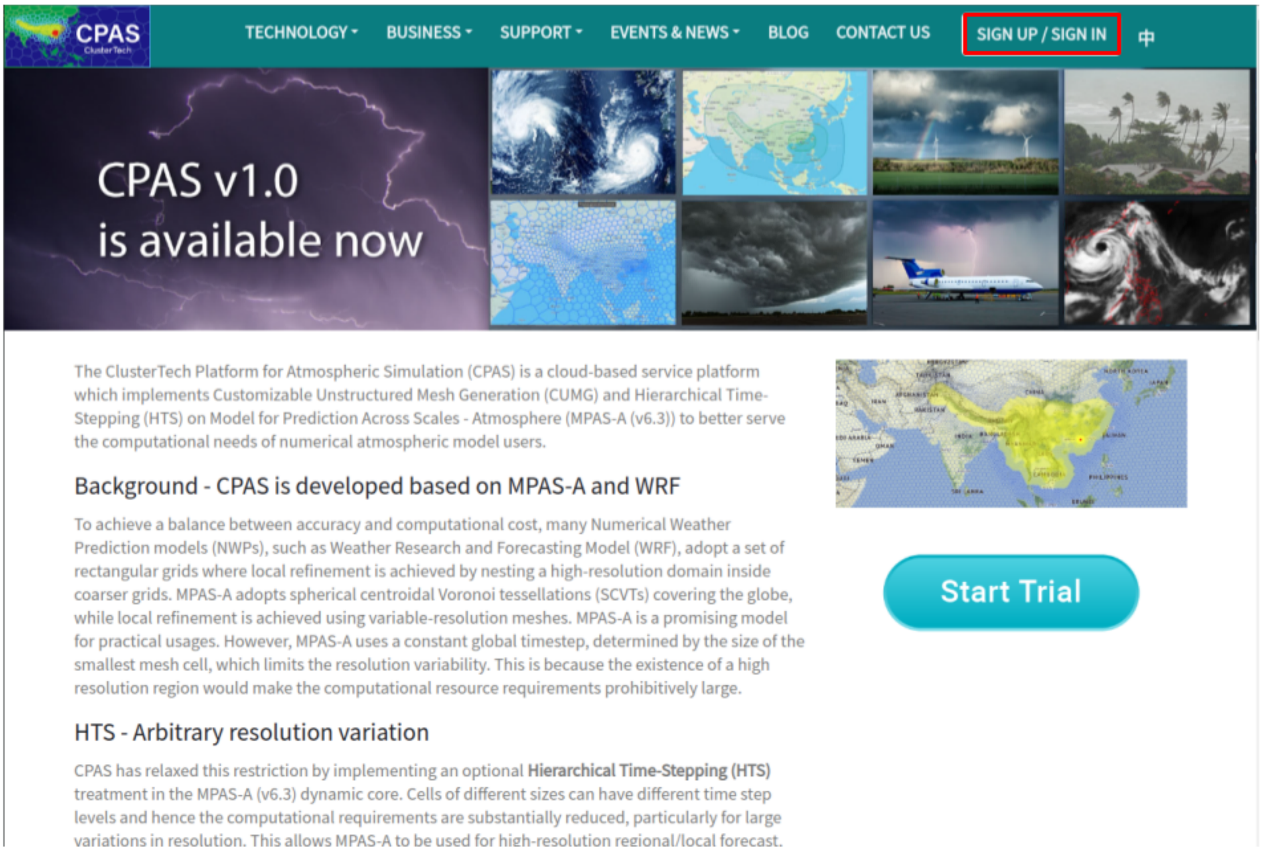
This document describes how to access CPAS model output data for the study "*Numerical weather prediction at 200m local resolution based on an unstructured grid global model*", and how to use the Jupyter tools to visualize and analyse the data on the cloud-based platform CPAS.

Step 1: Visit CPAS website.

https://cpas.earth/

Step 2: Sign up (so that you can run a Jupyter environment with your CPAS account).

From the top menu of the CPAS website, click "SIGN UP / SIGN IN" at the top right corner.



The ClusterTech Platform for Atmospheric Simulation (CPAS) is a cloud-based service platform which implements Customizable Unstructured Mesh Generation (CUMG) and Hierarchical Time-Stepping (HTS) on Model for Prediction Across Scales - Atmosphere (MPAS-A (v6.3)) to better serve the computational needs of numerical atmospheric model users.

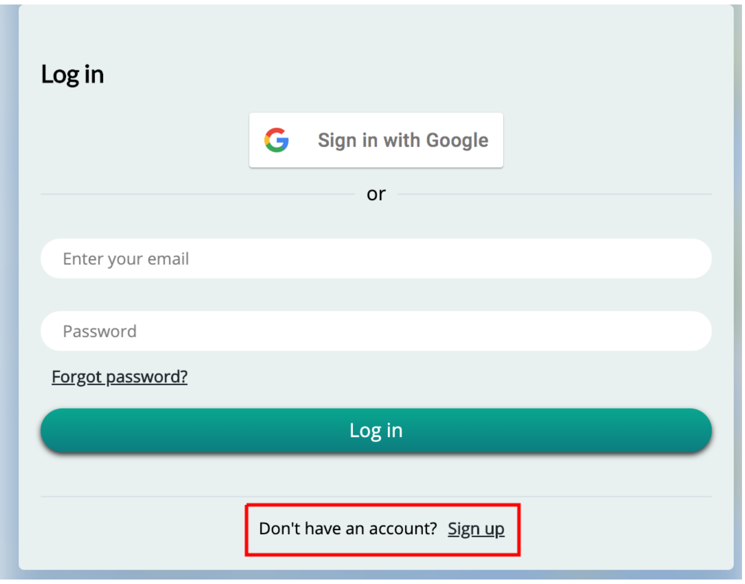
Background - CPAS is developed based on MPAS-A and WRF

To achieve a balance between accuracy and computational cost, many Numerical Weather Prediction models (NWPs), such as Weather Research and Forecasting Model (WRF), adopt a set of rectangular grids where local refinement is achieved by nesting a high-resolution domain inside coarser grids. MPAS-A adopts spherical centroidal Voronoi tessellations (SCVTs) covering the globe, while local refinement is achieved using variable-resolution meshes. MPAS-A is a promising model for practical usages. However, MPAS-A uses a constant global timestep, determined by the size of the smallest mesh cell, which limits the resolution variability. This is because the existence of a high resolution region would make the computational resource requirements prohibitively large.

HTS - Arbitrary resolution variation

CPAS has relaxed this restriction by implementing an optional **Hierarchical Time-Stepping (HTS)** treatment in the MPAS-A (v6.3) dynamic core. Cells of different sizes can have different time step levels and hence the computational requirements are substantially reduced, particularly for large variations in resolution. This allows MPAS-A to be used for high-resolution regional/local forecast.

The “Log in” window appears. Click “Sign up”.

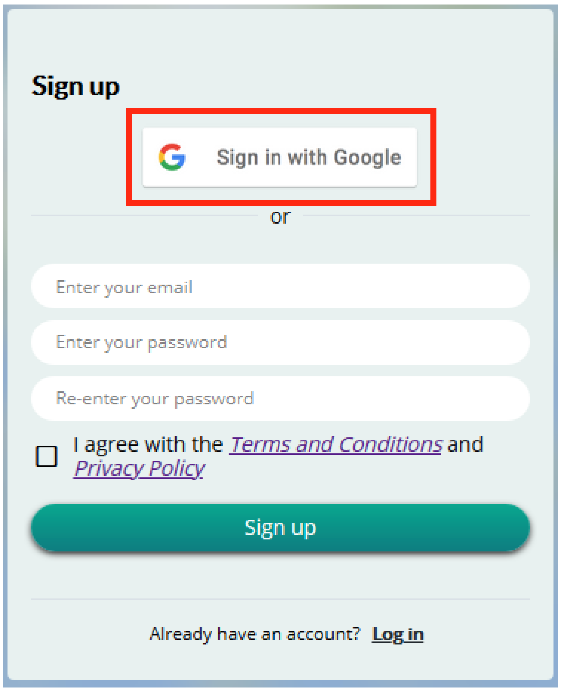


Don't have an account? Sign up

The “Sign up” window appears.

‣ Sign up with Google

Click “Sign in with Google”.

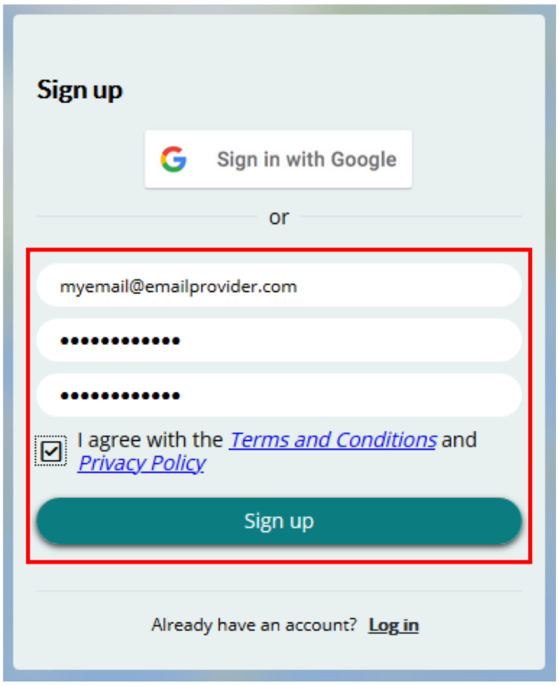


□ I agree with the *Terms and Conditions* and *Privacy Policy*

Already have an account? Log in

‣ Sign up with email registration

Enter your email address and your self-specified password for CPAS twice. Click “Sign up”.



myemail@emailprovider.com

••••••••••••

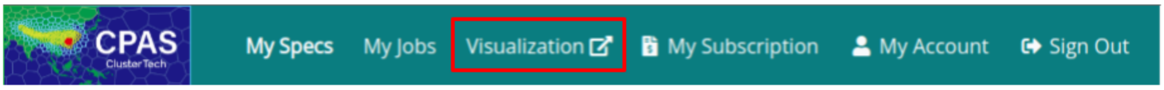
••••••••••••

☑ I agree with the *Terms and Conditions* and *Privacy Policy*

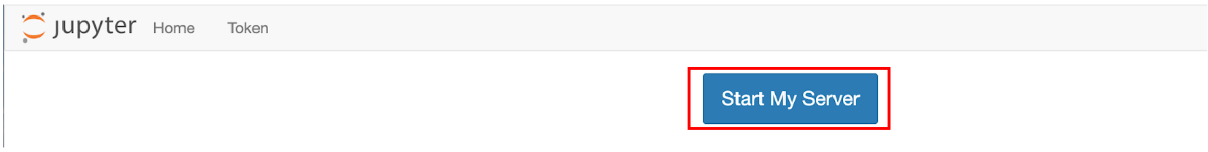
Already have an account? Log in

You will receive a verification email and follow instructions to confirm the registration.

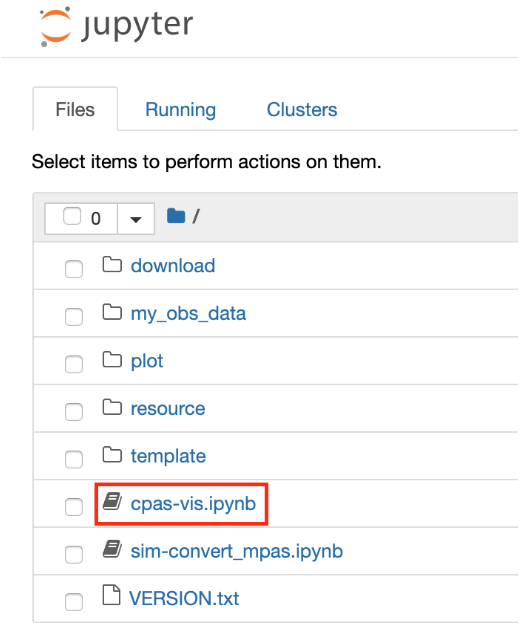
Step 3: Spawn your Jupyter notebook server.
From the top menu, click “Visualization”.



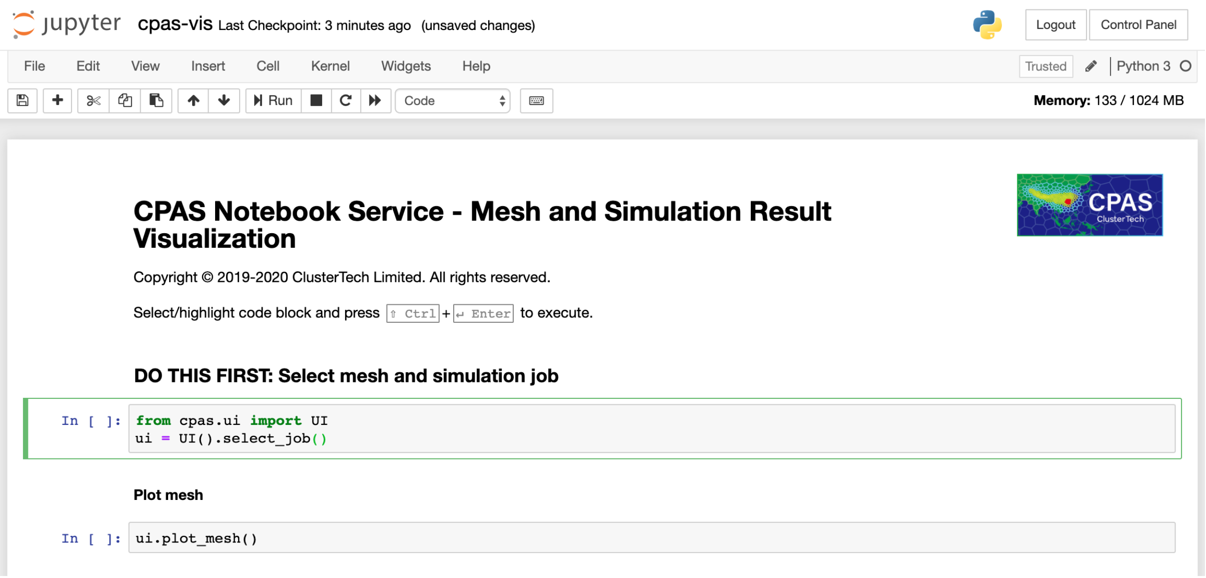
You will be directed to a new tab of Jupyter environment. Start the server by clicking the “Start My Server” button.



The files are listed after spawning the server:


Select items to perform actions on them.

Click “cpas-vis.ipynb” to run the notebook.



CPAS Notebook Service - Mesh and Simulation Result Visualization

Copyright © 2019-2020 ClusterTech Limited. All rights reserved.

Select/highlight code block and press ⇧ Ctrl + ↵ Enter to execute.

DO THIS FIRST: Select mesh and simulation job

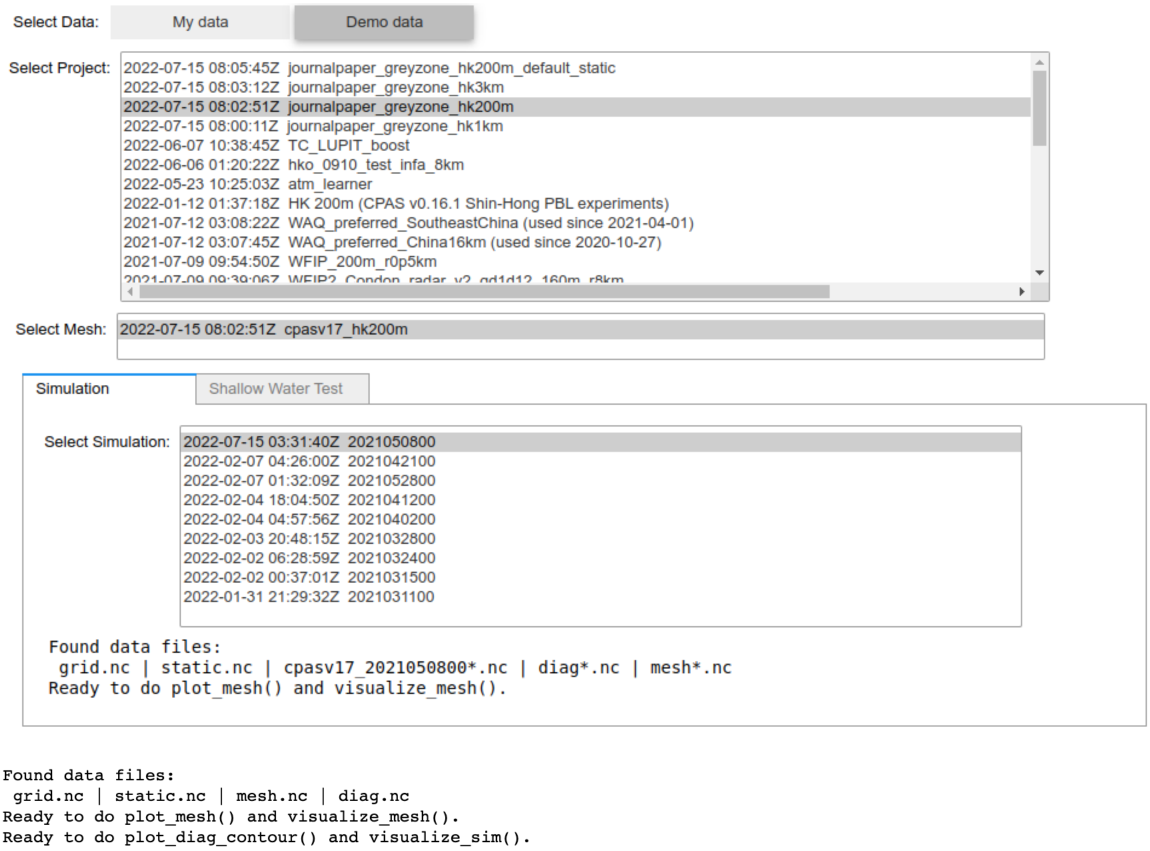
```
In [ ]: from cpas.ui import UI
        ui = UI().select_job()
```

Plot mesh

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

Step 4: Select the data for this study.

Select the code block under “DO THIS FIRST: Select mesh and simulation job” and press Ctrl+Enter to run it. Select “Demo data”. Something like the following would appear:



```
2022-07-15 08:05:45Z  journalpaper_greyzone_hk200m_default_static
2022-07-15 08:03:12Z  journalpaper_greyzone_hk3km
2022-07-15 08:02:51Z  journalpaper_greyzone_hk200m
2022-07-15 08:00:11Z  journalpaper_greyzone_hk1km
2022-06-07 10:38:45Z  TC_LUPIT_boost
2022-06-06 01:20:22Z  hko_0910_test_infa_8km
2022-05-23 10:25:03Z  atm_learner
2022-01-12 01:37:18Z  HK 200m (CPAS v0.16.1 Shin-Hong PBL experiments)
2021-07-12 03:08:22Z  WAQ_preferred_SoutheastChina (used since 2021-04-01)
2021-07-12 03:07:45Z  WAQ_preferred_China16km (used since 2020-10-27)
2021-07-09 09:54:50Z  WFIP_200m_r0p5km
2021-07-09 09:39:06Z  WFIP2_Condon_radar_v2_gd1d12_160m_r8km
```

```
2022-07-15 08:02:51Z  cpasv17_hk200m
```

```
2022-07-15 03:31:40Z  2021050800
2022-02-07 04:26:00Z  2021042100
2022-02-07 01:32:09Z  2021052800
2022-02-04 18:04:50Z  2021041200
2022-02-04 04:57:56Z  2021040200
2022-02-03 20:48:15Z  2021032800
2022-02-02 06:28:59Z  2021032400
2022-02-02 00:37:01Z  2021031500
2022-01-31 21:29:32Z  2021031100
```

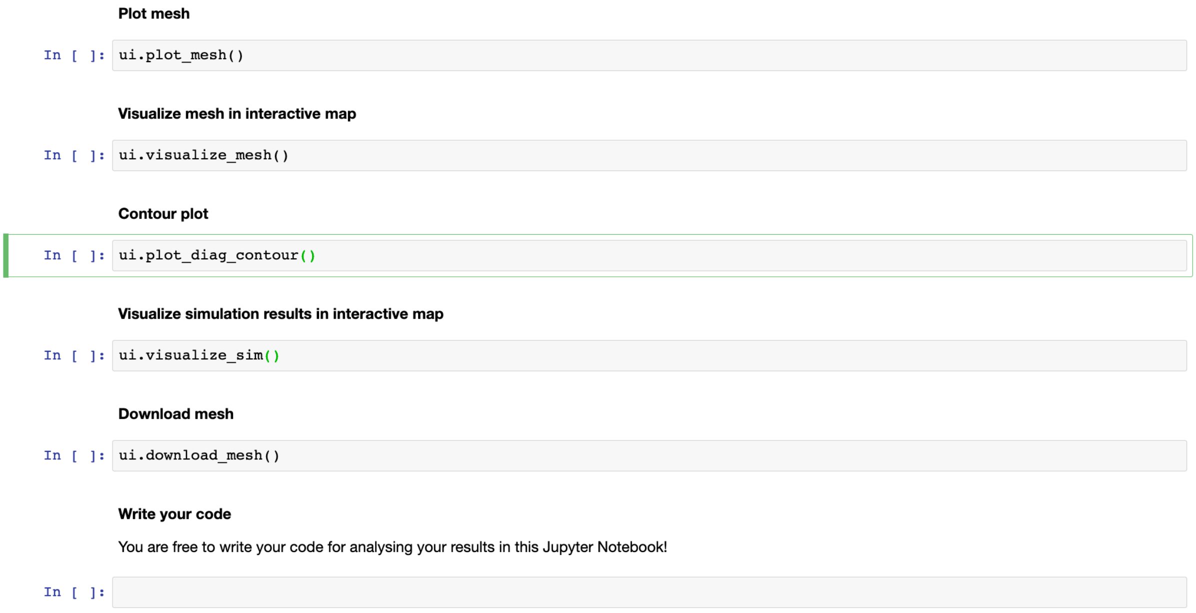
```
Found data files:
 grid.nc | static.nc | cpasv17_2021050800*.nc | diag*.nc | mesh*.nc
Ready to do plot_mesh() and visualize_mesh().
```

```
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().
```

In the Demo data collection, the project named “journalpaper_greyzone_*” contains the model simulations in the study “*Numerical weather prediction at 200m local resolution based on an unstructured grid global model*”.

Step 5: Visualize and analyse the data.

Take glance on the code blocks below. Select the code block you desire and run it. All operations hereafter are pretty self explanatory.



Plot mesh

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

Visualize mesh in interactive map

```
In [ ]: ui.visualize_mesh()
```

Contour plot

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

Visualize simulation results in interactive map

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

Download mesh

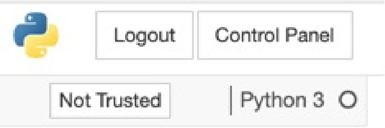
```
In [ ]: ui.download_mesh()
```

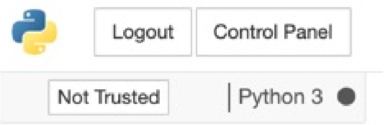
Write your code

You are free to write your code for analysing your results in this Jupyter Notebook!

```
In [ ]:
```

It takes time to load data. Hang on some minutes when you see the Jupyter backend is processing as indicated by the black dot at the top right corner.

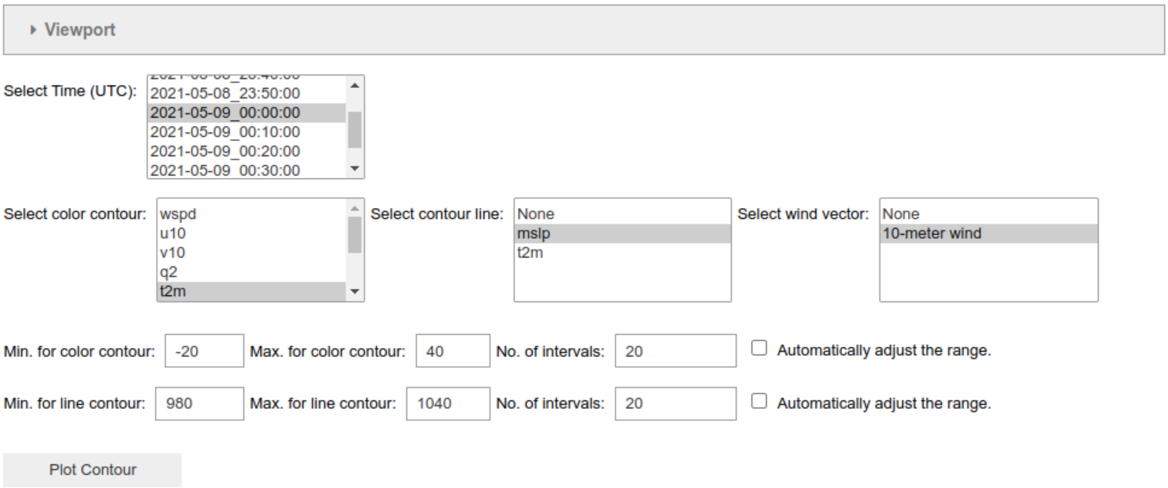




3.1.1 Plot single time step

```
ui.plot_diag_contour()
```

executed in 12.1s, finished 16:13:51 2022-07-15



▸ Viewport

Select Time (UTC): 2021-05-08_23:50:00 / **2021-05-09_00:00:00** / 2021-05-09_00:10:00 / 2021-05-09_00:20:00 / 2021-05-09_00:30:00

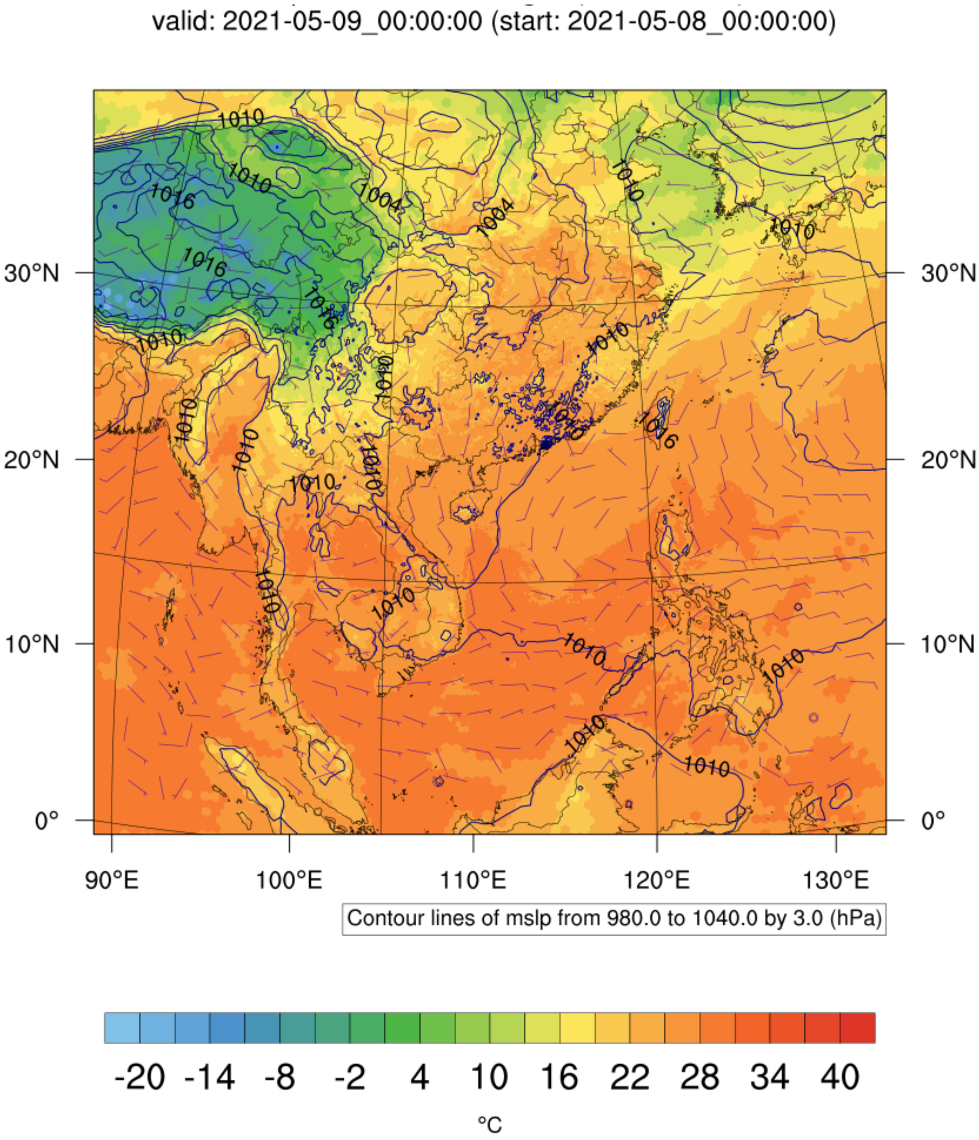
Select color contour: wspd / u10 / v10 / q2 / **t2m**

Select contour line: None / **mslp** / t2m

Select wind vector: None / **10-meter wind**

Min. for color contour: -20 Max. for color contour: 40 No. of intervals: 20 □ Automatically adjust the range.

Min. for line contour: 980 Max. for line contour: 1040 No. of intervals: 20 □ Automatically adjust the range.



valid: 2021-05-09_00:00:00 (start: 2021-05-08_00:00:00)
30°N
20°N
10°N
0°
90°E
100°E
110°E
120°E
130°E
1010
1016
1004
Contour lines of mslp from 980.0 to 1040.0 by 3.0 (hPa)
-20
-14
-8
-2
4
10
16
22
28
34
40
°C

You can also analyze the data using your own codes with common Python packages and Jupyter Notebook operation.

-- The End --