Student Group Projects

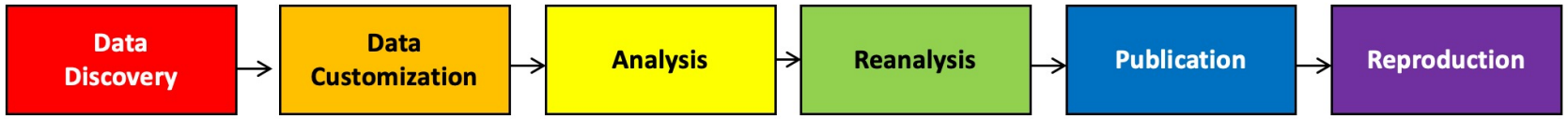
for 2022 NASA Summer School

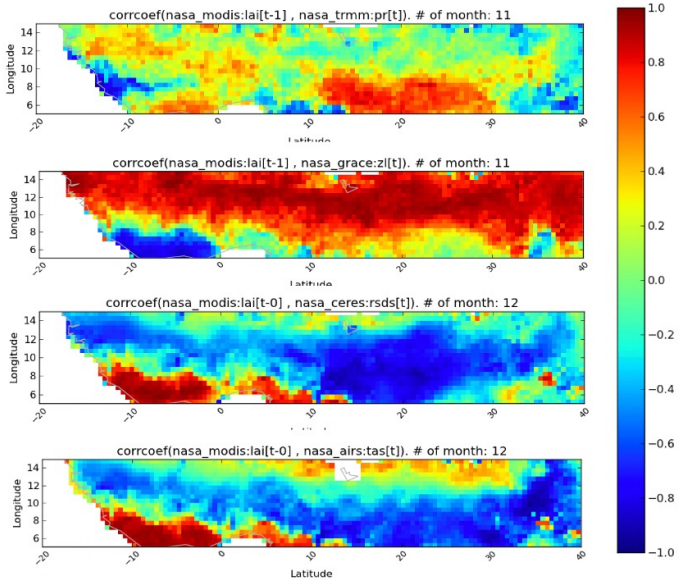
on Satellite Observations and Climate Models

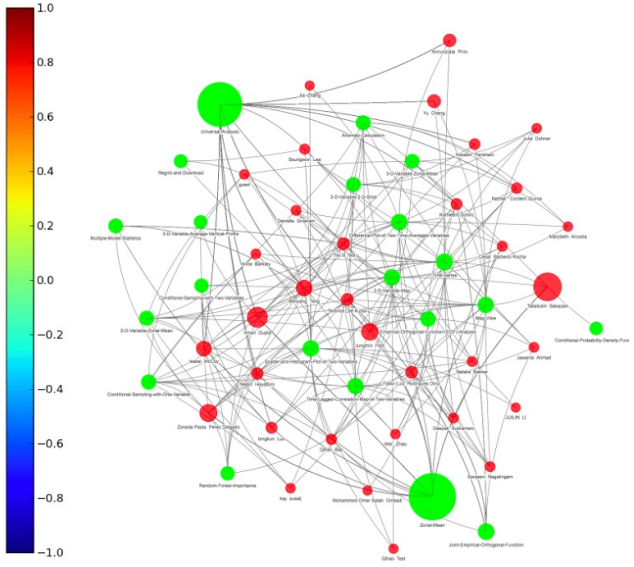
Lead: Seungwon Lee

Engineers: Alex Goodman, Benyang Tang

Scientists: Severine Fournier, Terry Kubar, Jonathan Jiang, JT Reager, Marcin Kurowski, Kyo Lee, Ruth Mooreman

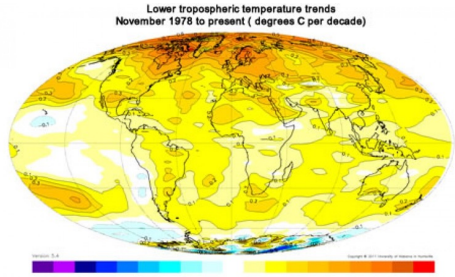


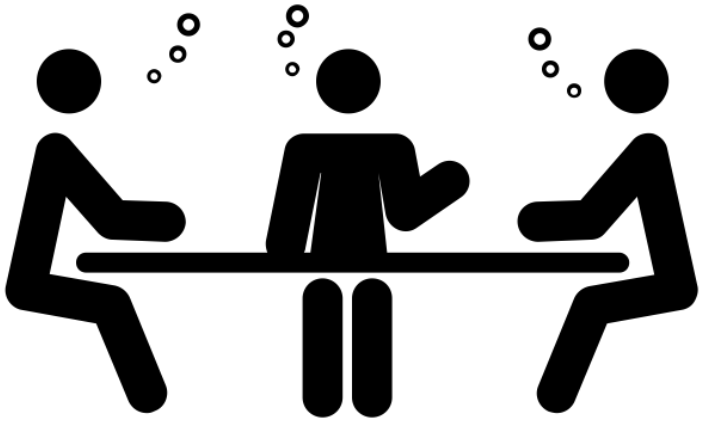




Student Group Projects

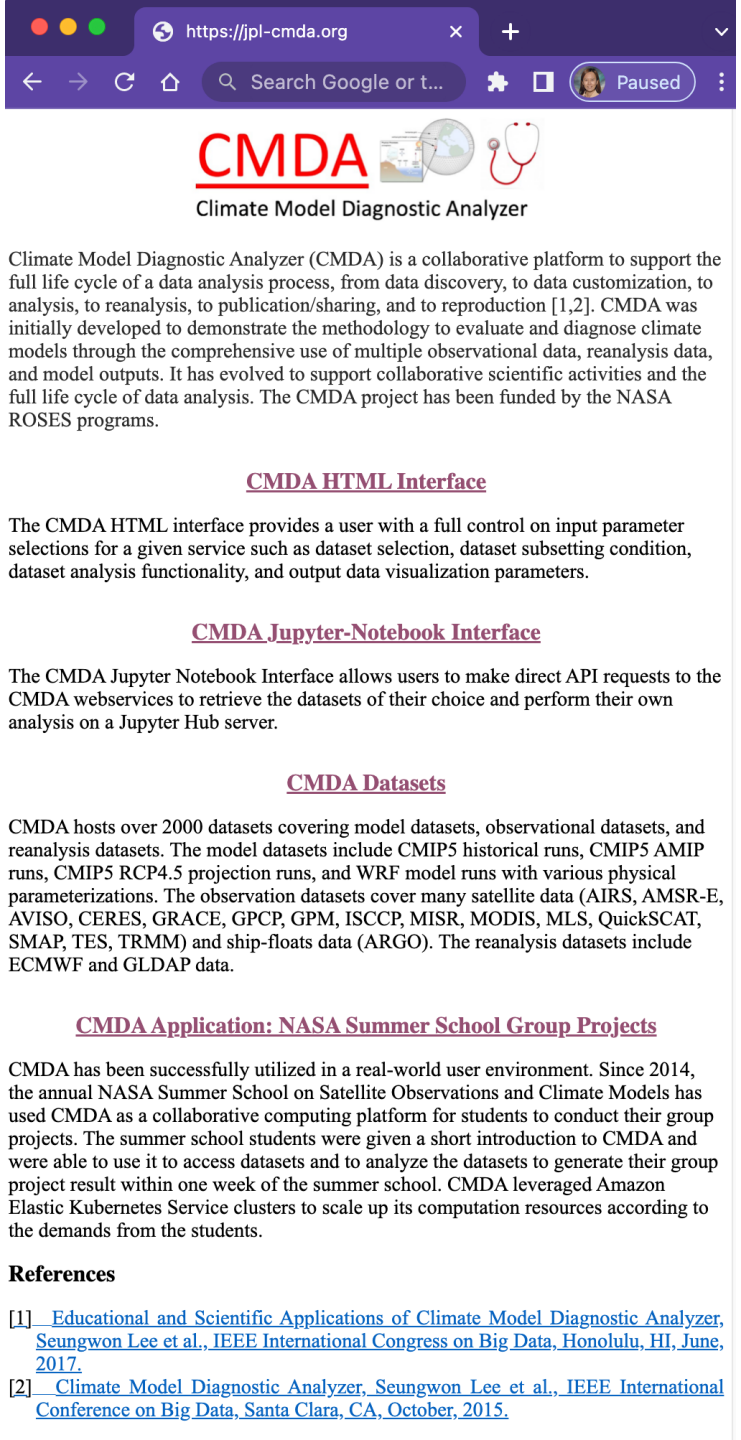
- Hands-on experience with climate science topics.
- Seven group research topics have been designed.
- Project information can be found in the project server: https://jpl-cmda.org.
- All the datasets and analysis tools needed are provided in the project server: https://jpl-cmda.org.
- The server has two interfaces: (1) Web HTML interface and (2) Jupyter Notebook interface.
- One introduction session now (datasets, tools, topics, group formation).
- Four practice sessions on 8/4, 8/8, 8/9, 8/11.
- Final presentation session on 8/11.

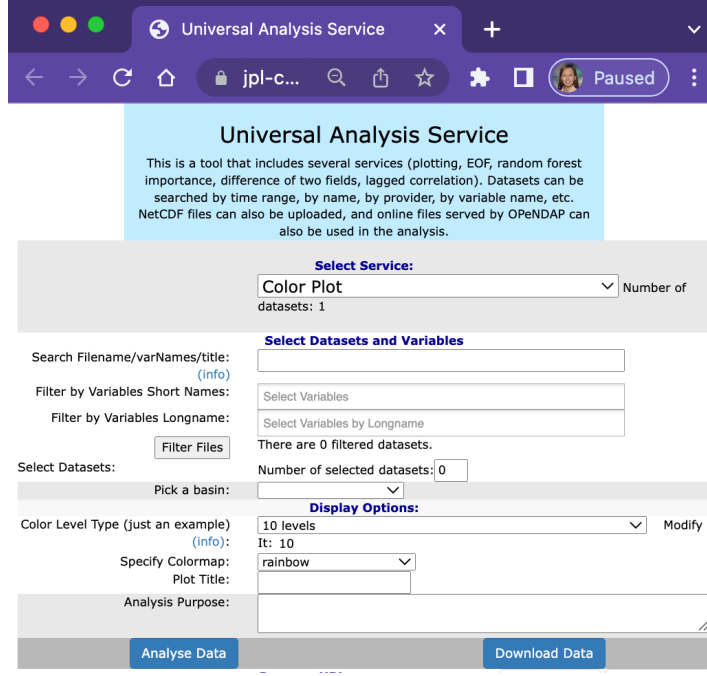


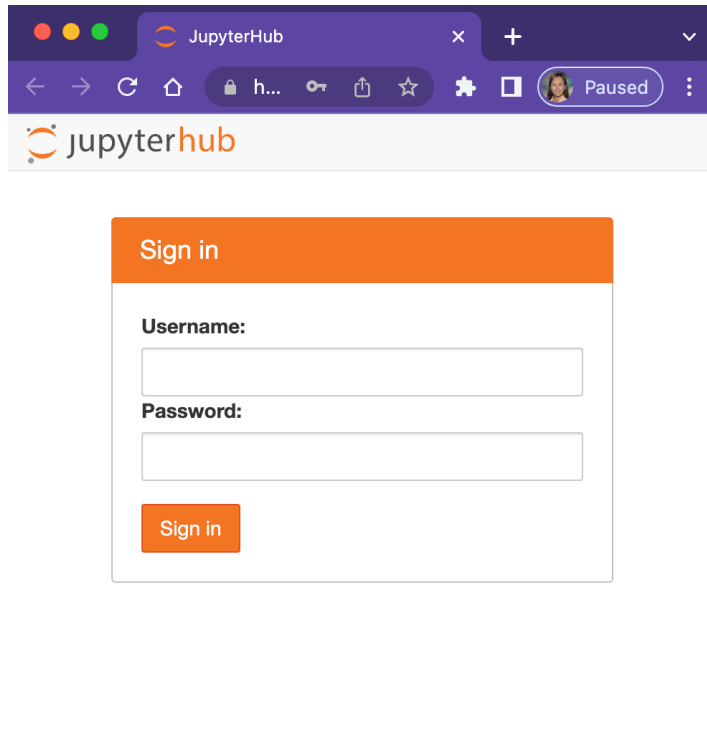


Group Project Server

- Server: https://jpl-cmda.org/
- Two interfaces:
  - Webservice HTML interface
  - Jupyter Notebook interface
- Jupyter Notebook Server Login information
  - Username: your email address
  - Password: nasa-ccs
- Jupyter Notebook Server Selection
  - CMDA: choose for Topics 1,2,3,4,5,7
  - RCMES: choose for Topic 6

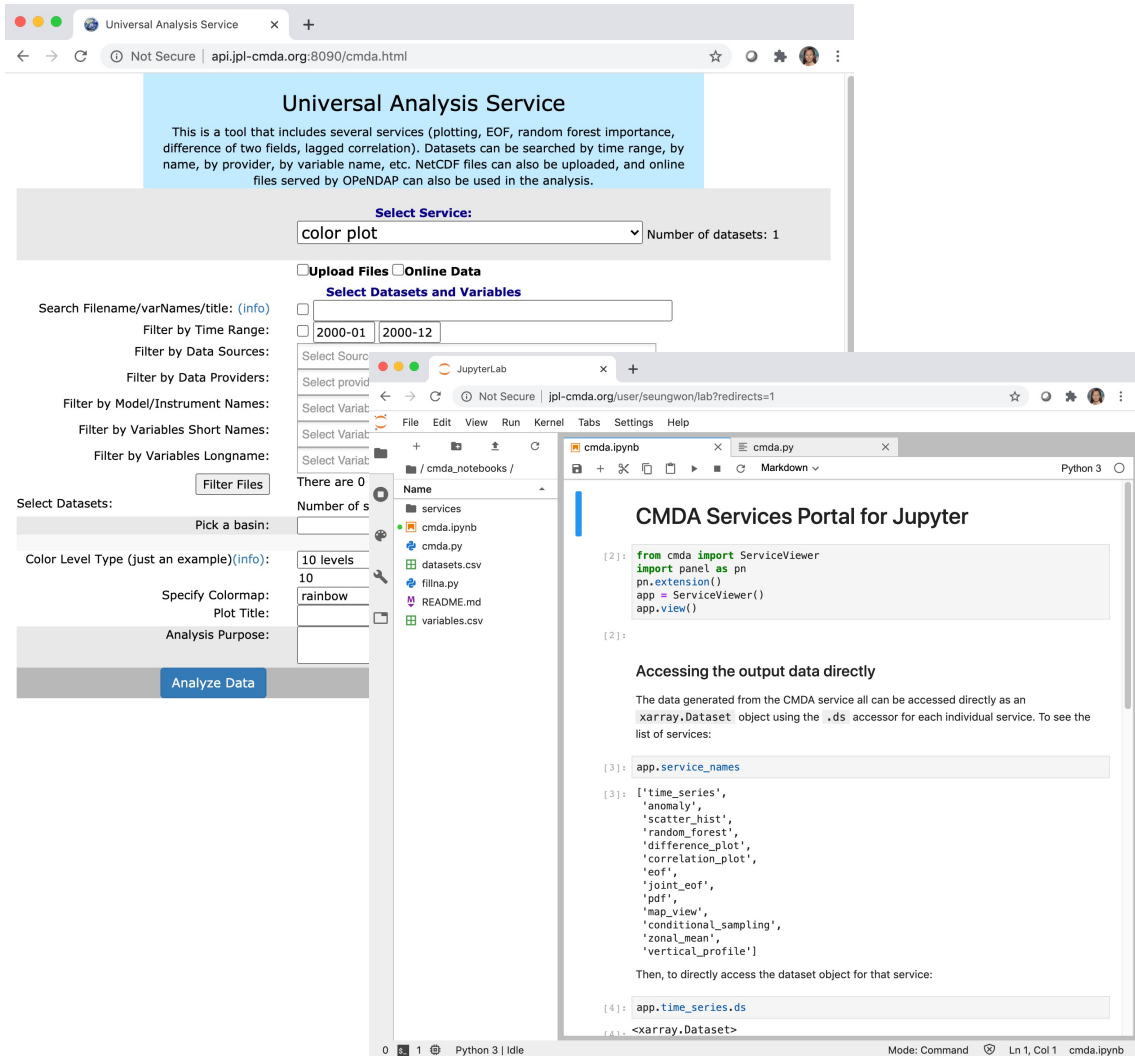






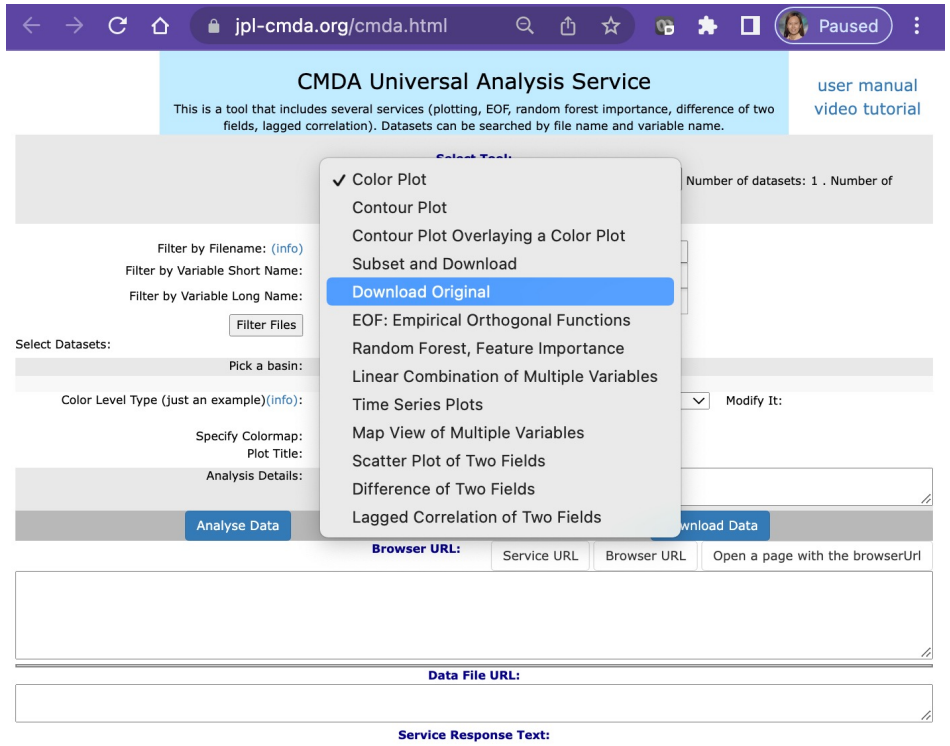
Climate Model Diagnostic Analyzer (CMDA)

- System designed to analyze climate datasets (monthly, lat-lon-press gridded datasets).
- Server running on Amazon cloud AWS.
- Datasets stored in AWS data storage S3.
- The only requirement from a user machine is a web browser with an internet connection.
- Provides datasets and analysis services.
- You can analyze the datasets using the services.
- You can download/access analyzed output datasets.
- You can download/access original input datasets.
- Provides two interfaces: HTML-web interface, Jupyter-notebook interface



CMDA Analysis Tools*

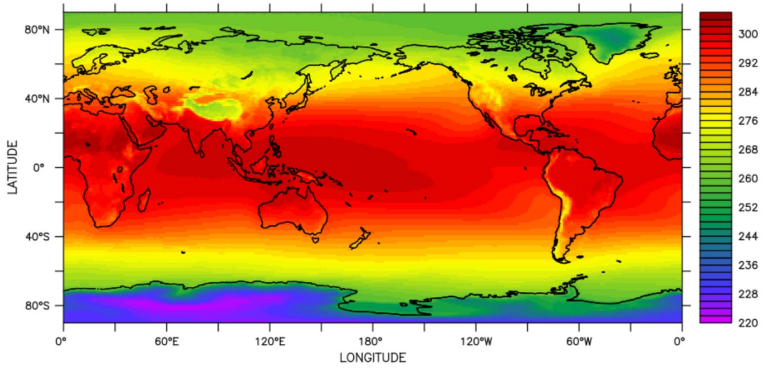
- Color Plot
- Contour Plot
- Contour Plot Overlaying a Color Plot
- Subset and Download
- Download Original
- Empirical Orthogonal Function
- Random Forest, Feature Importance
- Linear Combination of Multiple Variables
- Time Series Plot
- Map View of Multiple Variables
- Scatter Plot of Two Variables
- Difference of Two Variables
- Lagged Correlation of Two Variables

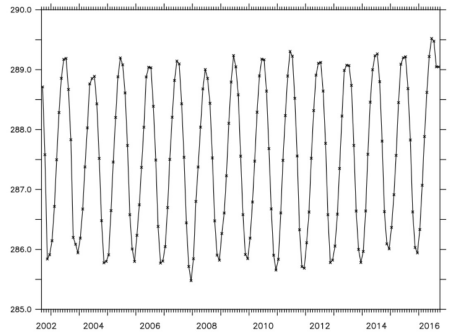


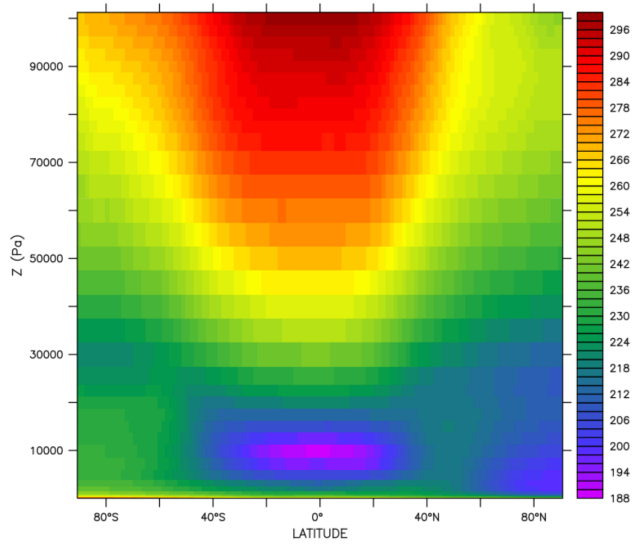
*Most tools have subsetting, averaging, and axis-selection options.

CMDA Datasets

- Data Structure: monthly, latitude-longitude-pressure gridded
- Temporal Resolution: monthly
- Temporal Range: various (10 years or longer)
- Spatial Resolution: various (1, 0.5, 0.25 degrees, etc)
- Geographic Range: global
- Dimensions: time, latitude, longitude, pressure
- File Format: NetCDF
- Types: model outputs, reanalysis datasets, observational datasets
- Variables: various ocean, atmosphere, and land variables
- Number of Datasets: 2,145 sets
- Total Data Volume: 2.15 TB
- Typical Data Size: 1 GB per dataset







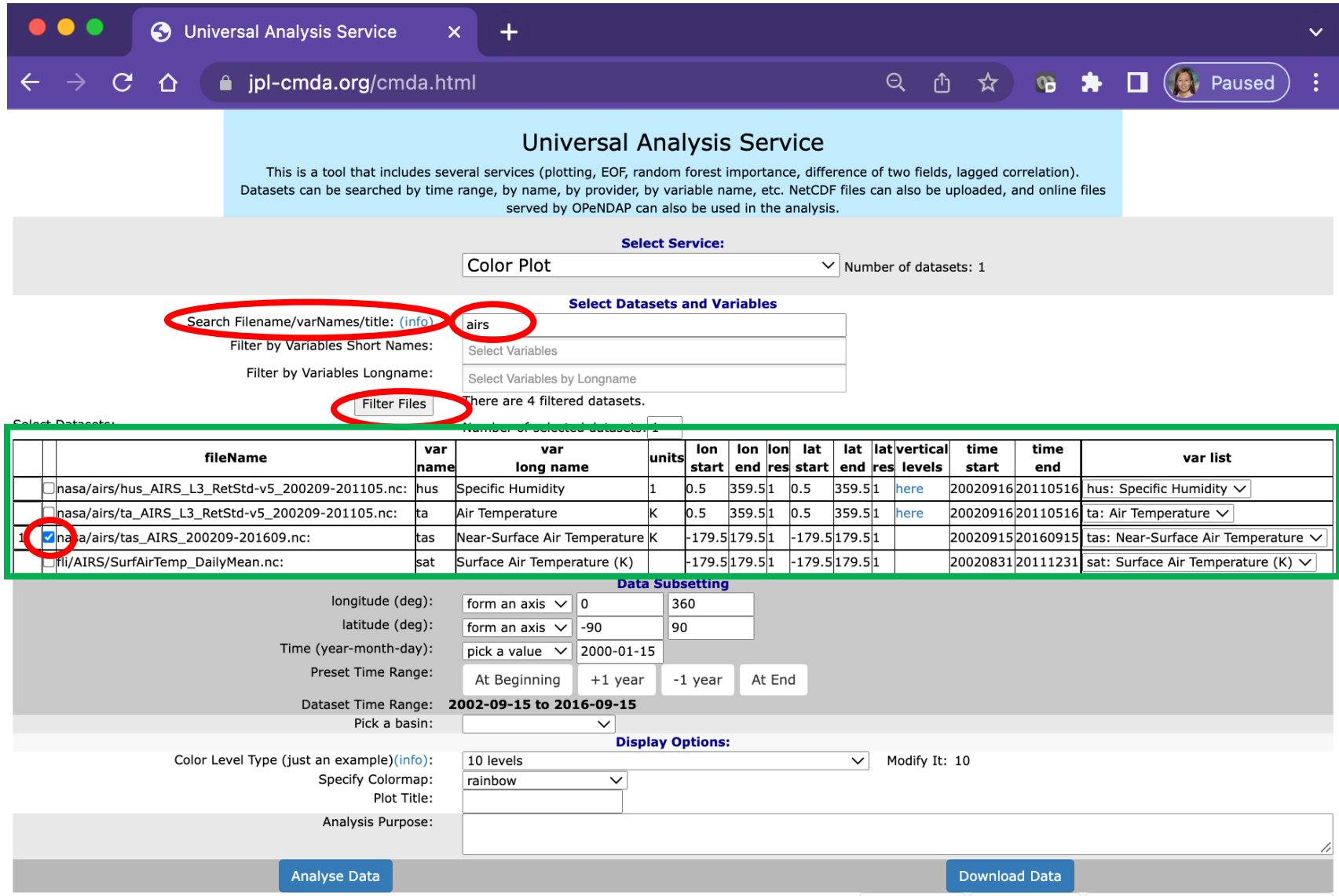
CMDA Datasets for Summer School

- The datasets used for topic 1,2,3,4,5,7 are listed in the attached document in the Project Server page.
- https://jpl-cmda.org/2022_dataset_list.pdf
- The document shows Topic Number, Data Name, Data Filename, Data Search Condition in the Universal Analysis Service, and Data Time Range.

Topic	Dataset (monthly, lat-lon gridded)	Data Filenames	Search Conditions in Universal Analysis Service	Time Range (YYYY-MM-YYYY-MM)
1	CERES TOA incident shortwave radiation	nasa/ceres/nasa_ceres_rsdt_200003-201812.nc:	ceres, rsdt, 2018	2000-03-2018-12
1	CERES TOA outgoing shortwave radiation	nasa/ceres/nasa_ceres_rsut_200003-201812.nc:	ceres, rsut, 2018	2000-03-2018-12
1	CERES TOA outgoing longwave radiation	nasa/ceres/nasa_ceres_rlut_200003-201812.nc:	ceres, rlut, 2018	2000-03-2018-12
1	ARGO ocean temperature	others/argo_temperature.nc (choose ARGO_TEMPERATURE_ANOMALY in the variable pull down)	argo	2004-01-2016-12
1	AMSR-E sea surface temperature	nasa/amsre/tos_AMSRE_L3_v7_200206-201012.nc	amsre	2002-06-2010-12
1	ECMWF sea surface temperature	others/tos_era5.nc	era5	1979-01-2021-04
1	ECMWF surface air temperature	others/tas_era5_1979-2018.nc	era5	1979-01-2018-12
2	ECMWF sea surface temperature	others/tos_era5.nc (choose sst in the variable pull down)	era5	1979-01-2021-04
2	ECMWF near surface winds	ecmwf/interim/sfcWind_Amon_ERA_interim_197901-201605.nc, users/tkubar/ecmwf_interim_near_sfc_wind_speed_1x1_monthly_*.nc	ecmwf, wind	1979-01-2016-05 2016-01-2019-05
2	ECMWF cloud fraction	ecmwf/interim/clt_Amon_ECMWF_interim_197901-201404.nc, users/tkubar/ecmwf_interim_total_cloud_fraction_pt75xpt75_monthly_*.nc	ecmwf, cloud	1979-01-2014-04 2014-01-2019-05
2	MODIS cloud top temperature	users/tkubar/output_monthly_modis_terra_l3_cloud_top_temp_day_2000_2019_v6pt1.nc	modis, tkubar, 2019	2000-02-2019-01
2	MODIS cloud optical depth	users/tkubar/output_monthly_modis_terra_l3_tau_combined_mean_2000_2019_v6pt1.nc	modis, tkubar, 2019	2000-02-2019-01
2	MODIS cirrus reflectance	users/tkubar/output_monthly_modis_terra_l3_cirrus_reflectance_mean_2000_2019_v6pt1.nc	modis, tkubar, 2019	2000-02-2019-01
2	MODIS ice cloud fraction	users/tkubar/output_monthly_modis_terra_l3_cf_ice_mean_2000_2019_v6pt1.nc	modis, tkubar, 2019	2000-02-2019-01
2	MISR cloud properties	users/tkubar/output_monthly_misr_terra_l3_cloud_top_height_dist_apr2002_jan2019.nc, many more	misr, tkubar	2002-04-2019-01
2	MISR TOA cloud albedo	users/tkubar/output_monthly_misr_terra_l3_toa_albedo_restrictive_clouds_only_apr2002_jan2019.nc	misr, tkubar	2002-04-2019-01
2	CERES TOA outgoing clear-sky longwave radiation	nasa/ceres/nasa_ceres_rlutcs_200003-201812.nc	ceres, rlucts, 2018	2000-03-2018-12
2	CERES TOA outgoing longwave radiation	nasa/ceres/nasa_ceres_rlut_200003-201812.nc:	ceres, rlut, 2018	2000-03-2018-12
2	AMIP simulations of the above variables	many model outputs for different models and variables	amip	various
3	CERES TOA outgoing clear-sky longwave radiation	nasa/ceres/nasa_ceres_rlutcs_200003-201812.nc	ceres, rlucts, 2018	2000-03-2018-12
3	CERES TOA outgoing longwave radiation	nasa/ceres/nasa_ceres_rlut_200003-201812.nc:	ceres, rlut, 2018	2000-03-2018-12
3	CERES TOA outgoing clear-sky shortwave radiation	nasa/ceres/nasa_ceres_rsutcs_200003-201812.nc	ceres, rsucts, 2018	2000-03-2018-12
3	CERES TOA outgoing shortwave radiation	nasa/ceres/nasa_ceres_rsut_200003-201812.nc:	ceres, rsut, 2018	2000-03-2018-12
3	MODIS cloud fraction (liquid + ice)	users/tkubar/output_monthly_modis_terra_l3_cf_day_mean_2000_2019_v6pt1.nc	modis, tkubar, cf, 2019	2000-02-2019-01
3	MODIS liquid cloud fraction	users/tkubar/output_monthly_modis_terra_l3_cf_liquid_mean_2000_2019_v6pt1.nc	modis, tkubar, cf, 2019	2000-02-2019-01
3	MODIS ice cloud fraction	users/tkubar/output_monthly_modis_terra_l3_cf_ice_mean_2000_2019_v6pt1.nc	modis, tkubar, cf, 2019	2000-02-2019-01
3	GCPC precipitation	nasa/gpcp/pr_GPCP-SG_L3_v2.2_*-*.nc	gpcp	1979-01-2011-06
3	TRMM precipitation	nasa/trmm/pr_TRMM_199801-201803.nc	trmm	1998-01-2018-04
3	GPM precipitation	others/pr_GPM_200006-202101.nc	gpm	2000-06-2021-01
3	AMSR-E sea surface temperature	nasa/amsre/tos_AMSRE_L3_v7_200206-201012.nc	amsre	2000-06-2021-01
3	ECMWF sea surface temperature	others/tos_era5.nc	era5	1979-01-2021-04
3	CMIP simulations of above variables	many model outputs for different models and variables	cmip5, historical (further filter with different model name and variable name, e.g. gfdl, clt)	various
4	GRACE water storage over land	others/nasa_grace_zl_a_200204-202105.nc	grace, others	2002-04-2021-05
4	GCPC precipitation	nasa/gpcp/pr_GPCP-SG_L3_v2.2_*-*.nc	gpcp	1979-01-2011-06
4	TRMM precipitation	nasa/trmm/pr_TRMM_199801-201803.nc	trmm	1998-01-2018-04
4	GPM precipitation	others/pr_GPM_200006-202101.nc	gpm	2000-06-2021-01
4	ECMWF surface air temperature	others/tas_era5_1979-2018.nc	era5	1979-01-2018-12
4	AIRS near-surface air temperature	nasa/airs/tas_AIRS_200209-201609.nc	airs, tas	2002-09-2016-09
4	GDLAS soil moisture	nasa/gldas/ncep_gldas_mrso1_*-*.nc nasa/gldas/ncep_gldas_mrso2_*-*.nc nasa/gldas/ncep_gldas_mrso3_*-*.nc	gldas	1979-01-2019-06
4	SMAP soil moisture	others/SMAP_L4_SM_201503-202105_reg_grid.nc	smap	2015-03-2021-05
5	WRF aqua-planet control simulations (8)	wrf/st/*.nc wrf/co-tie/*.nc wrf/co-kf/*.nc wrf/mp-wdm/*.nc wrf/mp-mor/*.nc wrf/pbl-nn2/*.nc wrf/pbl-ysu/*.nc wrf/ra-cam/*.nc	wrf	2004-01-2004-12 Year and month do not mean anything in this dataset.
5	WRF aqua-planet climate change simulations (8)	users/ksuselj/St_4K_v1.nc users/ksuselj/COtie_4K_v1.nc users/Ksuselj/COkf_4k_v1.nc users/ksuselj/MPwdm_4K_v1.nc users/ksuselj/MPmor_4K_v1.nc users/ksuselj/PBLnn2_4K_v1.nc users/ksuselj/PBLysu_4K_v1.nc users/ksuselj/RAcam_4K_v1.nc	ksuselj	2040-01-2004-12 Year and month do not mean anything in this dataset.

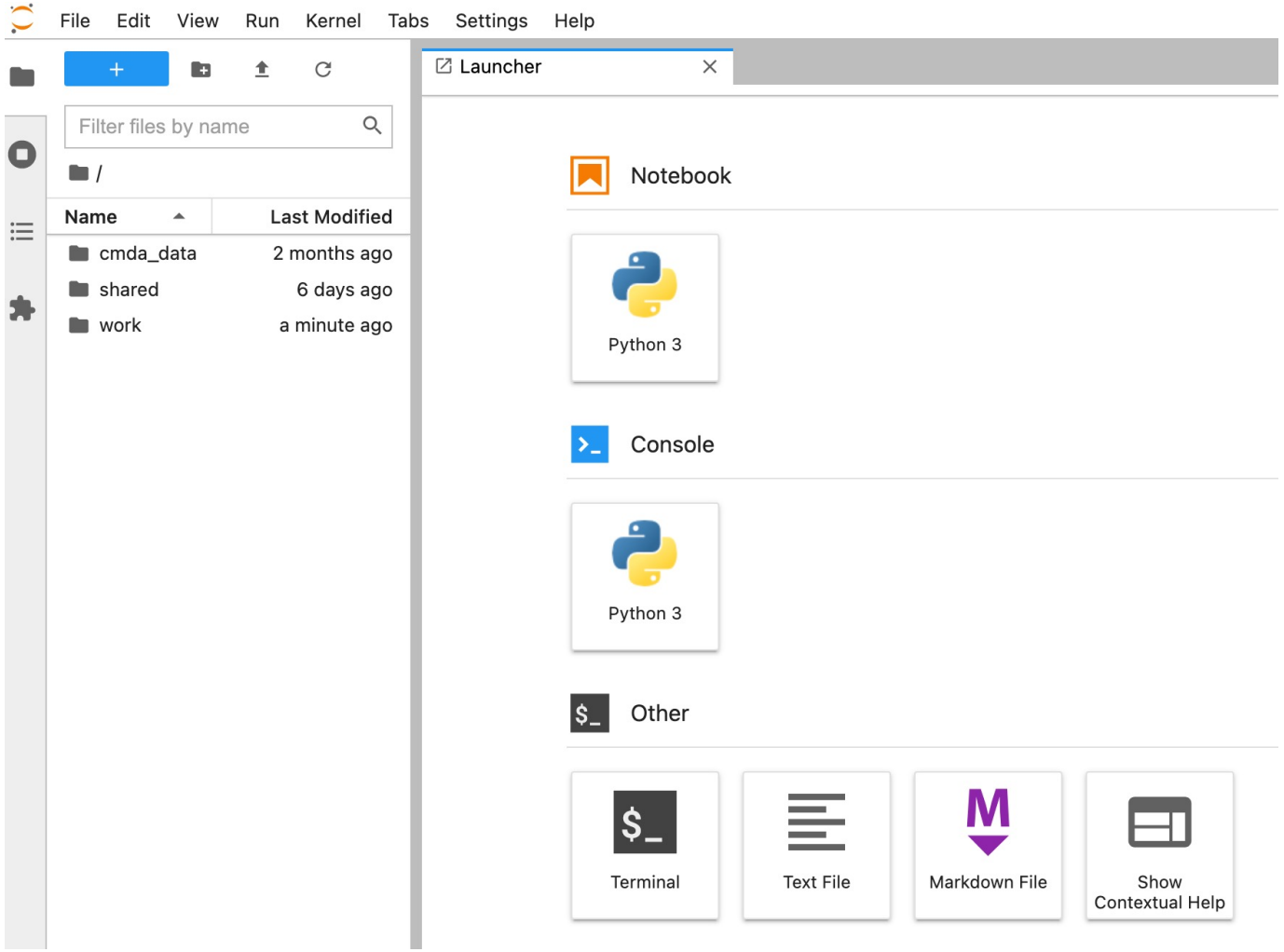
How to select CMDA Datasets

1. Use the Summer School Dataset List Document to see the datasets used in each topic and the search condition value of the dataset (column D).
2. Put the search condition value in “Search Filename/varNames/title” in the Universal Analysis Service.
3. Click the “Filter Files”.
4. The list of datasets that meet the search condition will show up below “Select Datasets”.
5. Choose a dataset that you want to use by clicking a box next to it.



Jupyter Notebook Server Directory

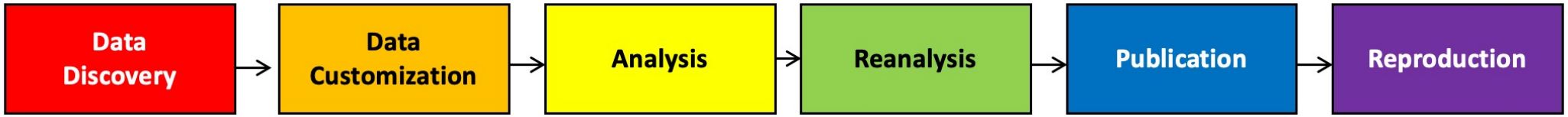
1. /cmda_data:
   - contains the subset of CMDA datasets. You can directly access them with the home directory path of /home/jovian.
   - Look at /work/read_data_example.ipynb for example.
2. /shared:
   - contains notebook examples and shared data
3. /shared/data/topic7-data
   - Contains datasets used in topic7.
4. /shared/notebook/Groups_2022
   - Please use the subfolder in this folder to share notebooks and files with your group (Group1, Group2, etc).
5. /work:
   - your main working directory. Contains all the topic example notebooks. This is your private directory. Other users cannot access this folder.



Project Server

- Project Server: https://jpl-cmda.org
- Group Project Page: https://jpl-cmda.org/ccs.html
- Webservice HTML interface: https://jpl-cmda.org/cmda.html
- Jupyter Notebook interface: https://hub.jpl-cmda.org

Project Approach



- Identify your datasets with the CMDA service (https://jpl-cmda.org/cmda.html).
- Explore your datasets with the CMDA service (https://jpl-cmda.org/cmda.html).
- Design your own CMDA webservice call (tool selection, input argument selection).
- Execute the webservice call in HTML and/or in Jupyter Notebook.
- Write code in Jupyter Notebook with the CMDA webservice call result (start with the example notebook).
- Share your code/results with your group using the Jupyter Server Shared Folder.
- Discuss the results.

CMDA Development Team

Please feel free to contact the team if you have any questions.

Seungwon Lee: seungwon.lee@jpl.nasa.gov (Project in General)

Alex Goodman: alexander.goodman@jpl.nasa.gov (Jupyter Notebooks)

Benyang Tang: benyang.tang@jpl.nasa.gov (HTML Webservices)

Group Research Project Topics

- Topic #1: Where is global warming?
- Topic #2: Tropical variability and analysis of ENSO forcing in observations and models
- Topic #3: Variability of clouds and precipitation
- Topic #4: Land water storage variability as a function of human and natural controls
- Topic #5: Sensitivity of equilibrium climate on physical parameterizations
- Topic #6: Added value of high-resolution downscaling
- Topic #7: Sea level rise from mass gain and thermal expansion

Group Research Project Scientists

- Topic #1: Dr. Severene Fournier (severine.Fournier@jpl.nasa.gov)
- Topic #2: Dr. Terry Kubar (terry.kubar@jpl.nasa.gov)
- Topic #3: Dr. Jonathan Jiang (jonathan.h.jiang@jpl.nasa.gov)
- Topic #4: Dr. JT Reager (john.reager@jpl.nasa.gov)
- Topic #5: Dr. Marcin Kurowski (marcin.j.kurowski@jpl.nasa.gov)
- Topic #6: Dr. Kyo Lee (huikyo.lee@jpl.nasa.gov)
- Topic #7: Ruth Mooreman (rmoorman@caltech.edu)

Group Project Topic Selection

Topic 1 Global Warming	Topic 2 ENSO	Topic 3 Clouds	Topic 4 Land Water	Topic 5 Physical Parameterization	Topic 6 High-resolution Downscaling	Topic 7 Sea-level Rise
	A link to a Google Document to select your topic will be given in the WebEx chat area.					