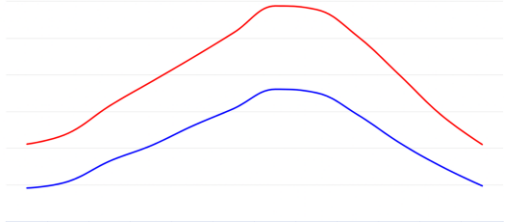
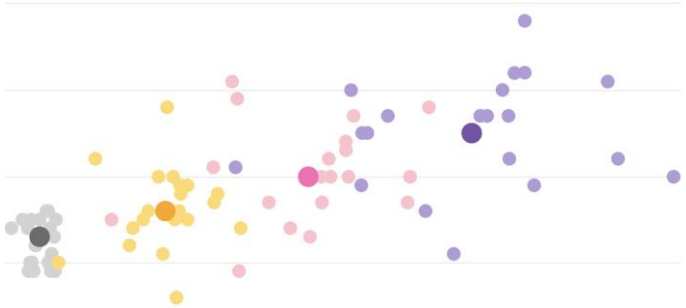
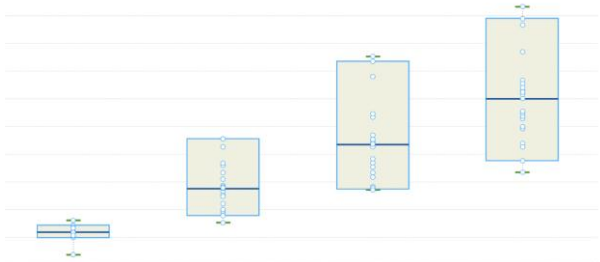
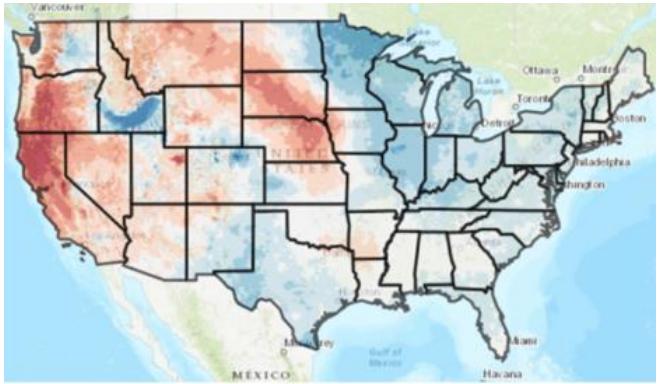


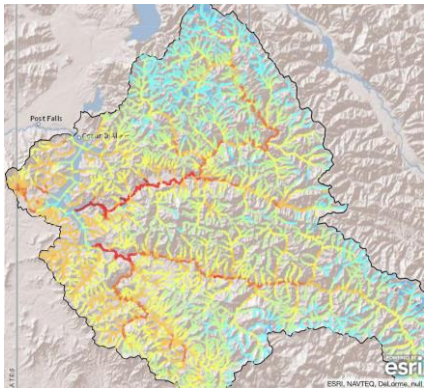


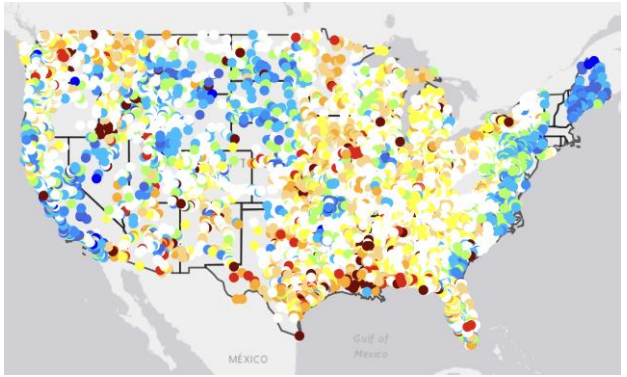


The Climate Toolbox

Katherine Hegewisch, UC Merced

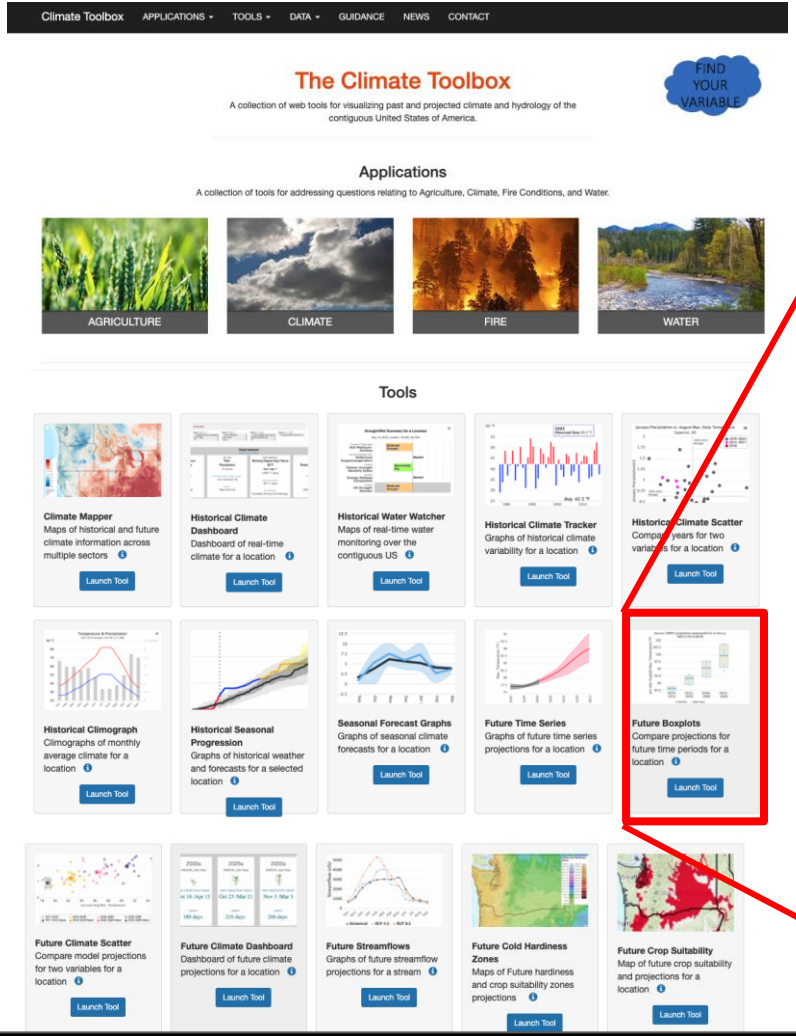


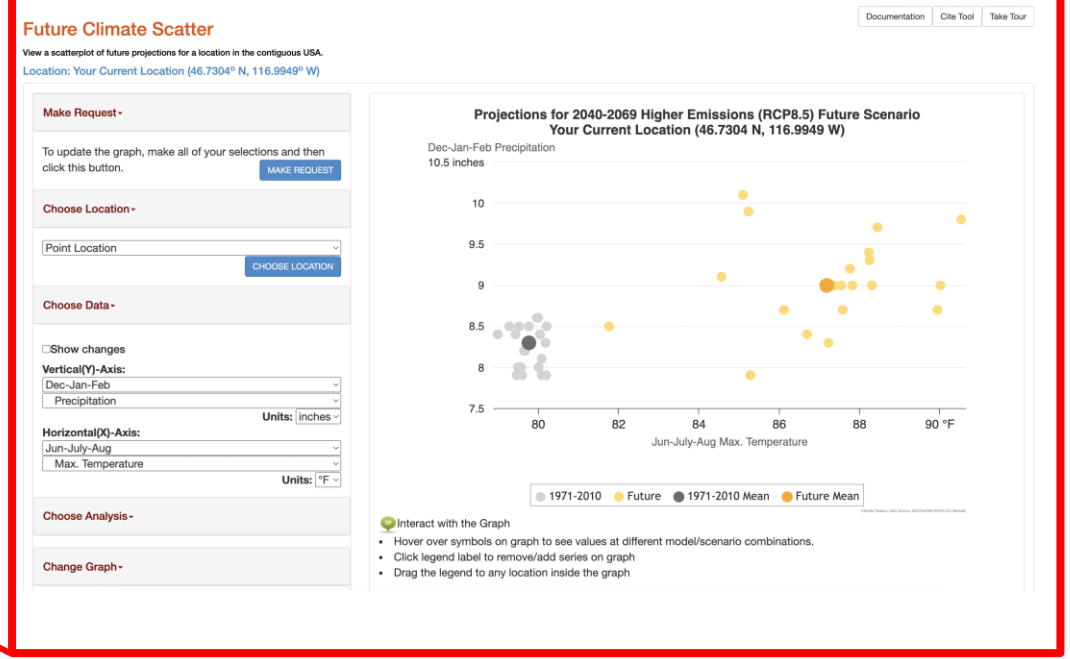




The Climate Toolbox

https://climateToolbox.org





Poll

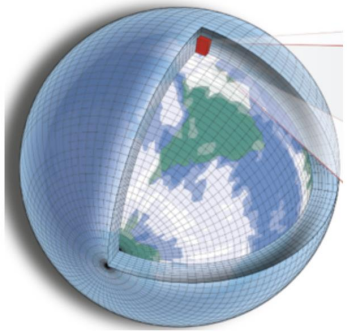
- Who have used the Climate Toolbox for their work?
- Who have looked at the Climate Toolbox since the virtual classroom?

What we did in the Virtual Class

Future Climate Projection Data

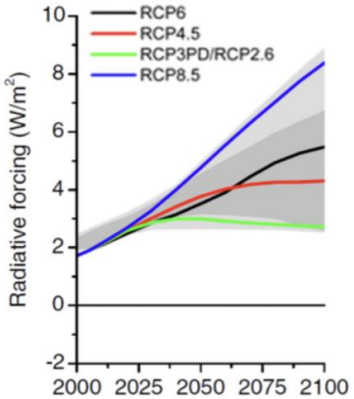
Future Climate Models

The 20 climate model projections utilized are from phase 5 of the Coupled Model Intercomparison Project(CMIP5) from the Intergovernmental Panel on Climate Change (IPCC) . These models are run by climate modeling agencies from different countries all over the world and represent the best science for climate modeling.



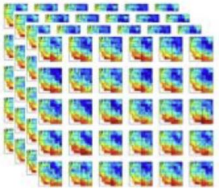
Future Climate Scenarios

The CMIP5 models ran future projections utilizing future scenarios in terms of Representative Concentration Pathways (RCPs). The "High Emissions Scenario (RCP 8.5)" represents a future pathway similar to a business-as-usual continuation of our emissions back in 2010. The "Low Emissions Scenario (RCP 4.5)" considers a curtailment in greenhouse gas emissions through greenhouse gas mitigation efforts.



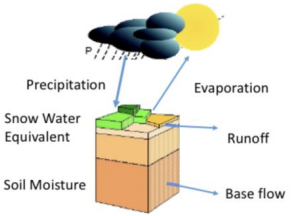
Statistical Downscaling

The CMIP5 model outputs were statistically downscaled using the Multivariate Adaptive Constructed Analogs (MACA) method version 2 with the gridMET training dataset. This method removes biases and increases the resolution of the model outputs.



Derived Metrics

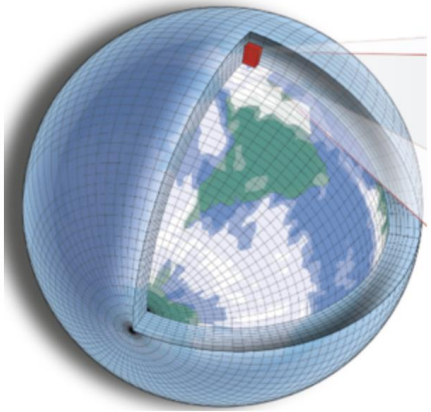
The downscaled CMIP6 data is run through other models or functions to create other metrics of interest to decision makers.



Future Climate Models

Future Climate Models

The 20 climate model projections utilized are from phase 5 of the Coupled Model Intercomparison Project(CMIP5) from the Intergovernmental Panel on Climate Change (IPCC) . These models are run by climate modeling agencies from different countries all over the world and represent the best science for climate modeling.



In the tools, you select a model.

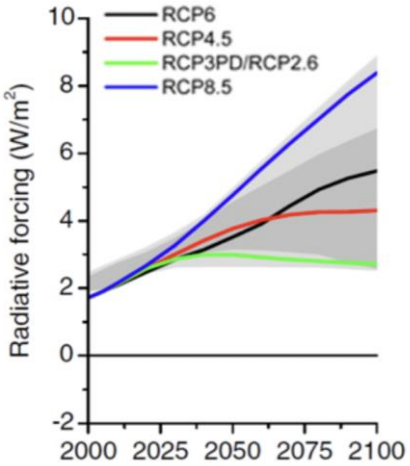
Individual Models

- bcc-csm1-1 (China)
- bcc-csm1-1-m (China)
- BNU-ESM (China)
- CanESM2 (Canada)
- CCSM4 (USA)
- CNRM-CM5 (France)
- CSIRO-Mk3-6-0 (Austrailia)
- GFDL-ESM2M (USA)
- GFDL-ESM2G (USA)
- HadGEM2-CC365 (United Kingdom)
- HadGEM2-ES365 (United Kingdom)
- inmcm4 (Russia)
- IPSL-CM5A-LR (France)
- IPSL-CM5A-MR (France)
- IPSL-CM5B-LR (France)
- MIROC5 (Japan)
- MIROC-ESM (Japan)
- MIROC-ESM-CHEM (Japan)
- MRI-CGCM3 (Japan)
- NorESM1-M (Norway)

Future Climate Scenarios

Future Climate Scenarios

The CMIP5 models ran future projections utilizing future scenarios in terms of Representative Concentration Pathways (RCPs). The "High Emissions Scenario (RCP 8.5)" represents a future pathway similar to a business-as-usual continuation of our emissions back in 2010. The "Low Emissions Scenario (RCP 4.5)" considers a curtailment in greenhouse gas emissions through greenhouse gas mitigation efforts.



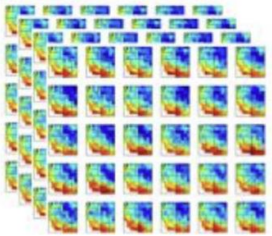
In the tools, you select a future scenario.

- ✓ RCP 4.5 (Reduced Emissions Scenario)
- RCP 8.5 (Business-as-Usual High Emissions Scenario)

Future Downscaled Data

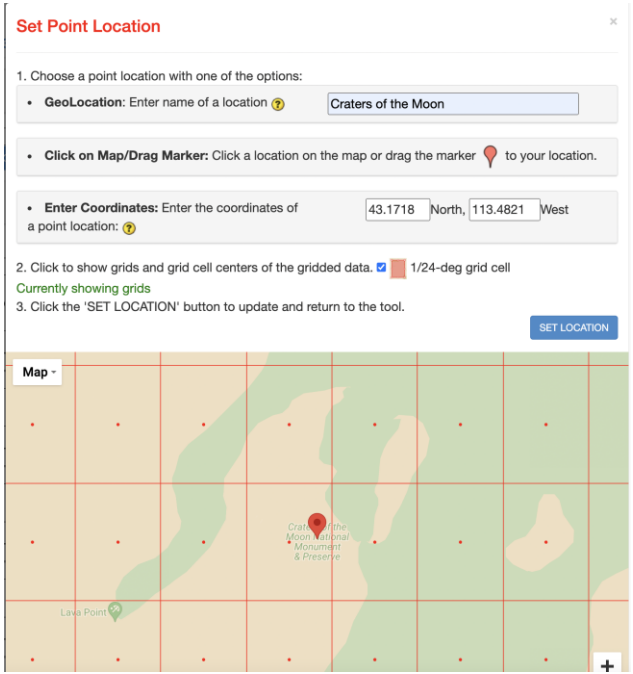
Statistical Downscaling

The CMIP5 model outputs were statistically downscaled using the Multivariate Adaptive Constructed Analogs (MACA) method version 2 with the gridMET training dataset. This method removes biases and increases the resolution of the model outputs.



In the tools…. you select a location.

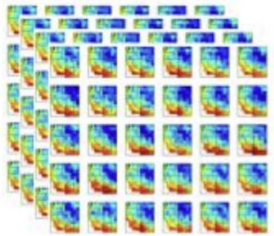
Data comes from 4-km (2.5 mile) grid cells



Future Downscaled Data

Statistical Downscaling

The CMIP5 model outputs were statistically downscaled using the Multivariate Adaptive Constructed Analogs (MACA) method version 2 with the gridMET training dataset. This method removes biases and increases the resolution of the model outputs.



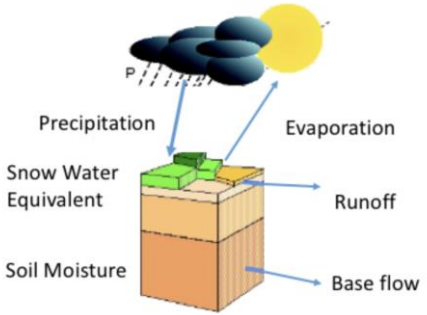
In the tools, you select a variable.

Downscaled variables:

- Min/max daily temperature
- Precipitation
- Min/max daily relative humidity
- Specific humidity
- Downward solar radiation
- Wind speed

Future Derived Metrics

Derived Metrics
The downscaled CMIP6 data is run through other models or functions to create other metrics of interest to decision makers.



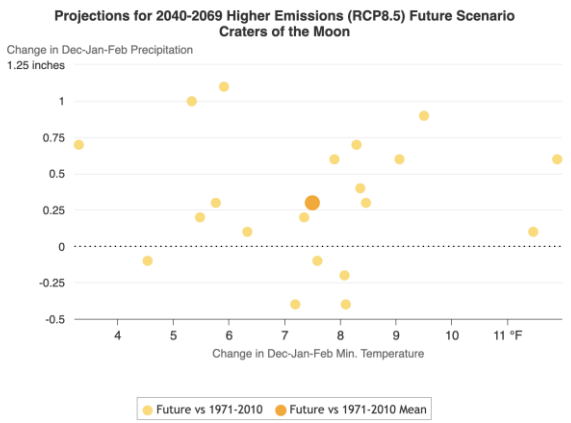
In the tools, you select a variable.

Derived Metrics:

- Snow water equiv., runoff, soil moisture
- Days of heat index > 90F
- Days with max temperature>86 F
- Coldest night temperature
- Day of first fall freeze, last spring freeze
- Growing degree days (32F, 40, 45, 50F)
- Number of ‘high’ fire danger days

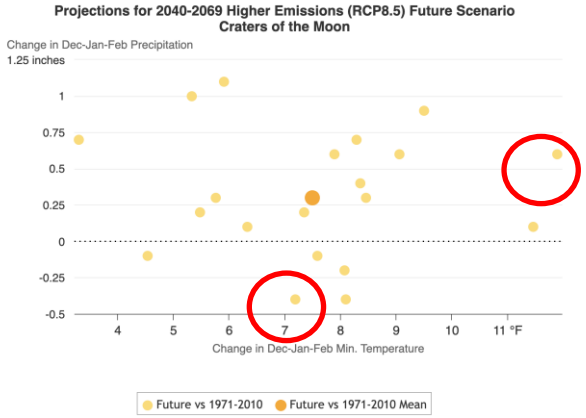
Process of Selecting a Future Scenario

Generate a scatter plot of model/scenario projections



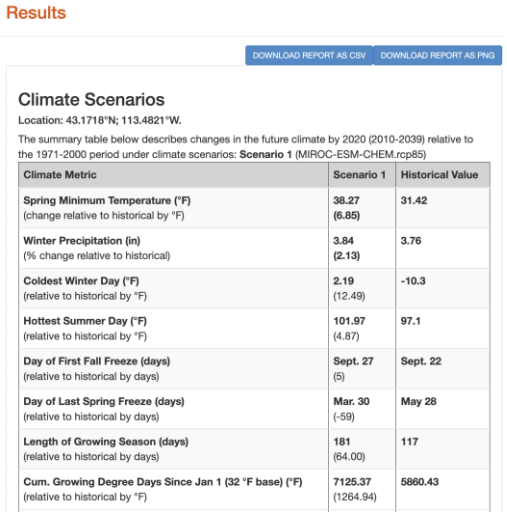
Future Climate Scatter

Identify models/scenarios that represent a particular climate vulnerability



Future Climate Scatter

Explore future metrics for chosen model/scenarios



Results

DOWNLOAD REPORT AS CSV | DOWNLOAD REPORT AS PNG

Climate Scenarios

Location: 43.1718°N; 113.4821°W.

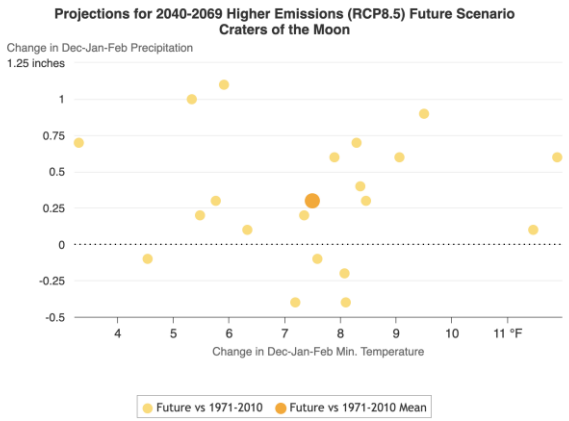
The summary table below describes changes in the future climate by 2020 (2010-2039) relative to the 1971-2000 period under climate scenarios: **Scenario 1** (MIROC-ESM-CHEM.rcp85)

Climate Metric	Scenario 1	Historical Value
Spring Minimum Temperature (°F) (change relative to historical by °F)	**38.27 (6.85)**	**31.42**
Winter Precipitation (in) (% change relative to historical)	**3.84 (2.13)**	**3.76**
Coldest Winter Day (°F) (relative to historical by °F)	**2.19** (12.49)	**-10.3**
Hottest Summer Day (°F) (relative to historical by °F)	**101.97** (4.87)	**97.1**
Day of First Fall Freeze (days) (relative to historical by days)	**Sept. 27** (5)	**Sept. 22**
Day of Last Spring Freeze (days) (relative to historical by days)	**Mar. 30** (-59)	**May 28**
Length of Growing Season (days) (relative to historical by days)	**181** (64.00)	**117**
Cum. Growing Degree Days Since Jan 1 (32 °F base) (°F) (relative to historical by °F)	**7125.37** (1264.94)	**5860.43**

Future Climate Scenarios

Generating a Scatterplot

Generate a scatter plot of model/scenario projections



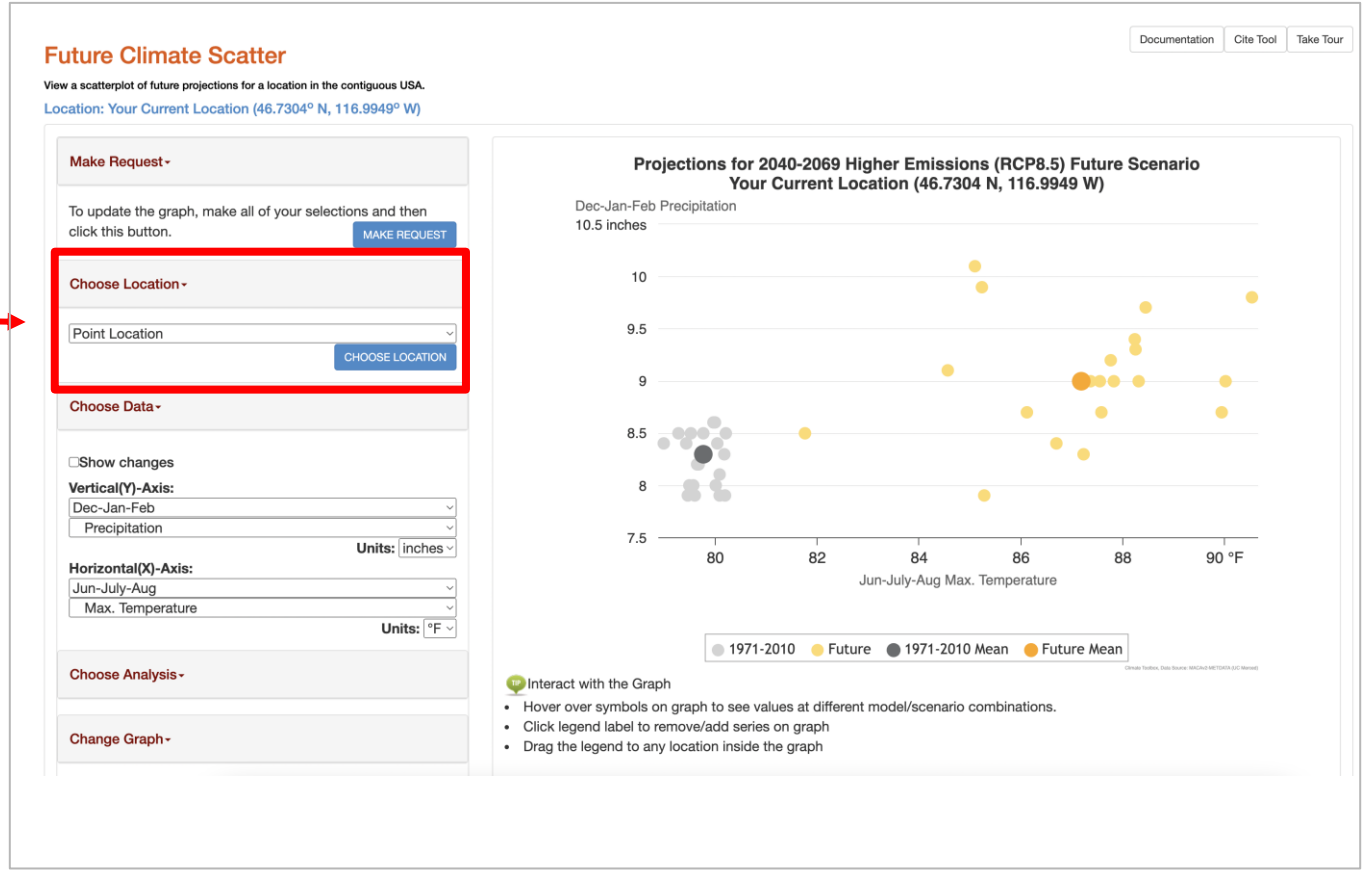
1. Go to Future Climate Scatter tool
2. Select a location

3. Select variables of interest for x,y axes
4. Select Future Scenario (RCP 8.5)
5. Select Future Time Period (2040-2069)
6. Click ‘Show Changes’

7. Click ‘Make Request’ button to update graph

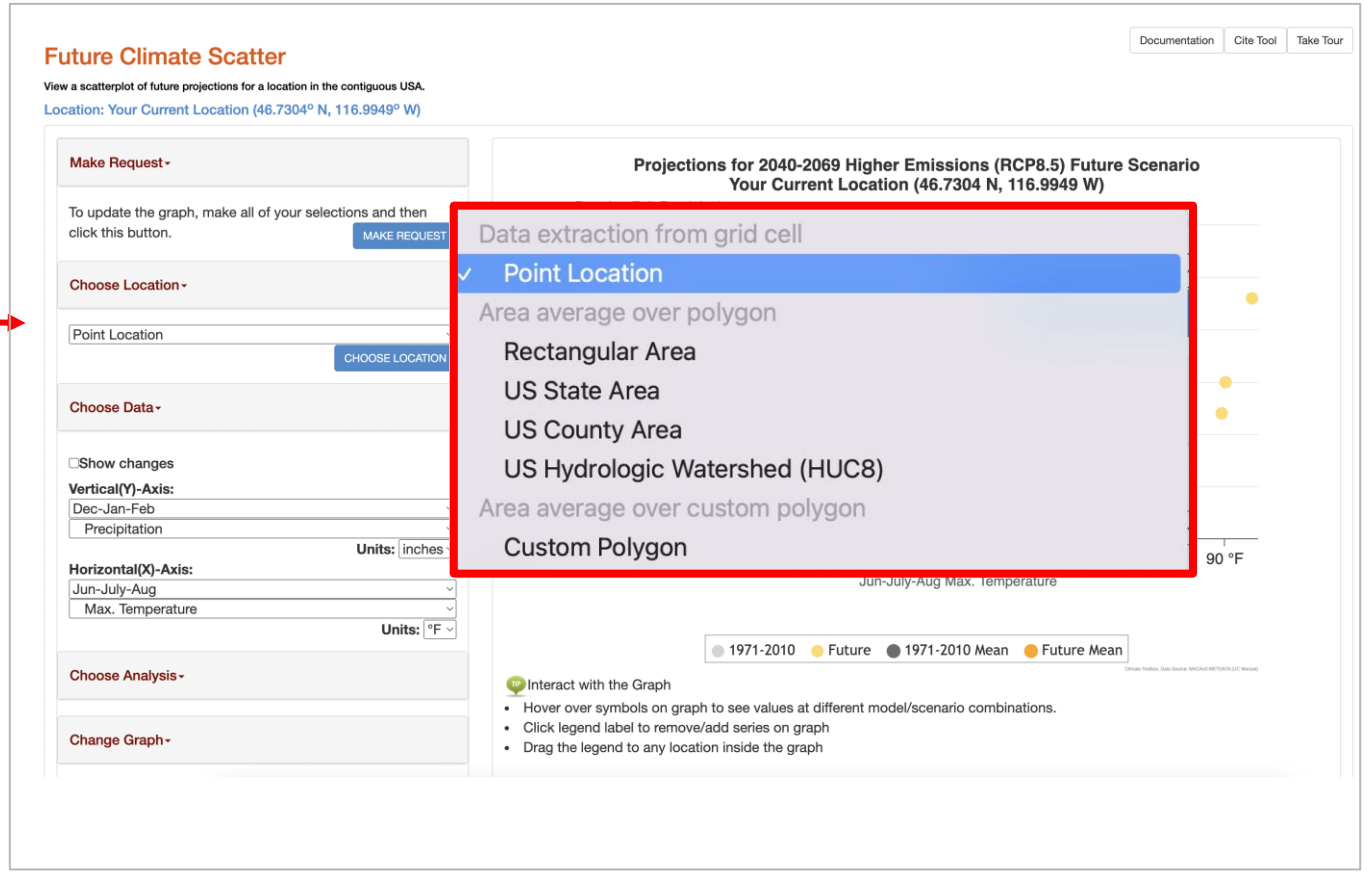
Generating Scatter Plot

Choose Location →



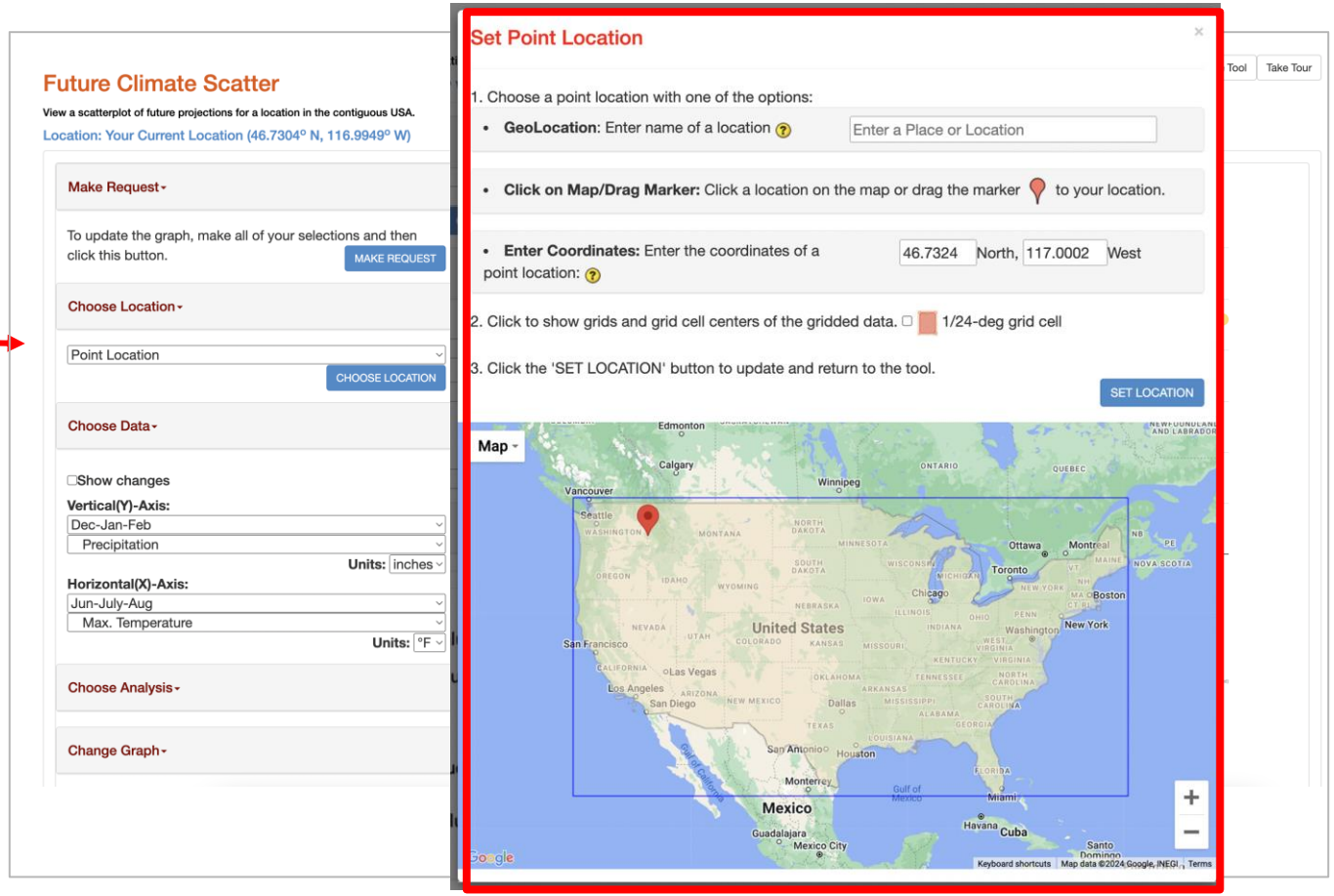
Generating Scatter Plot

Choose Location →



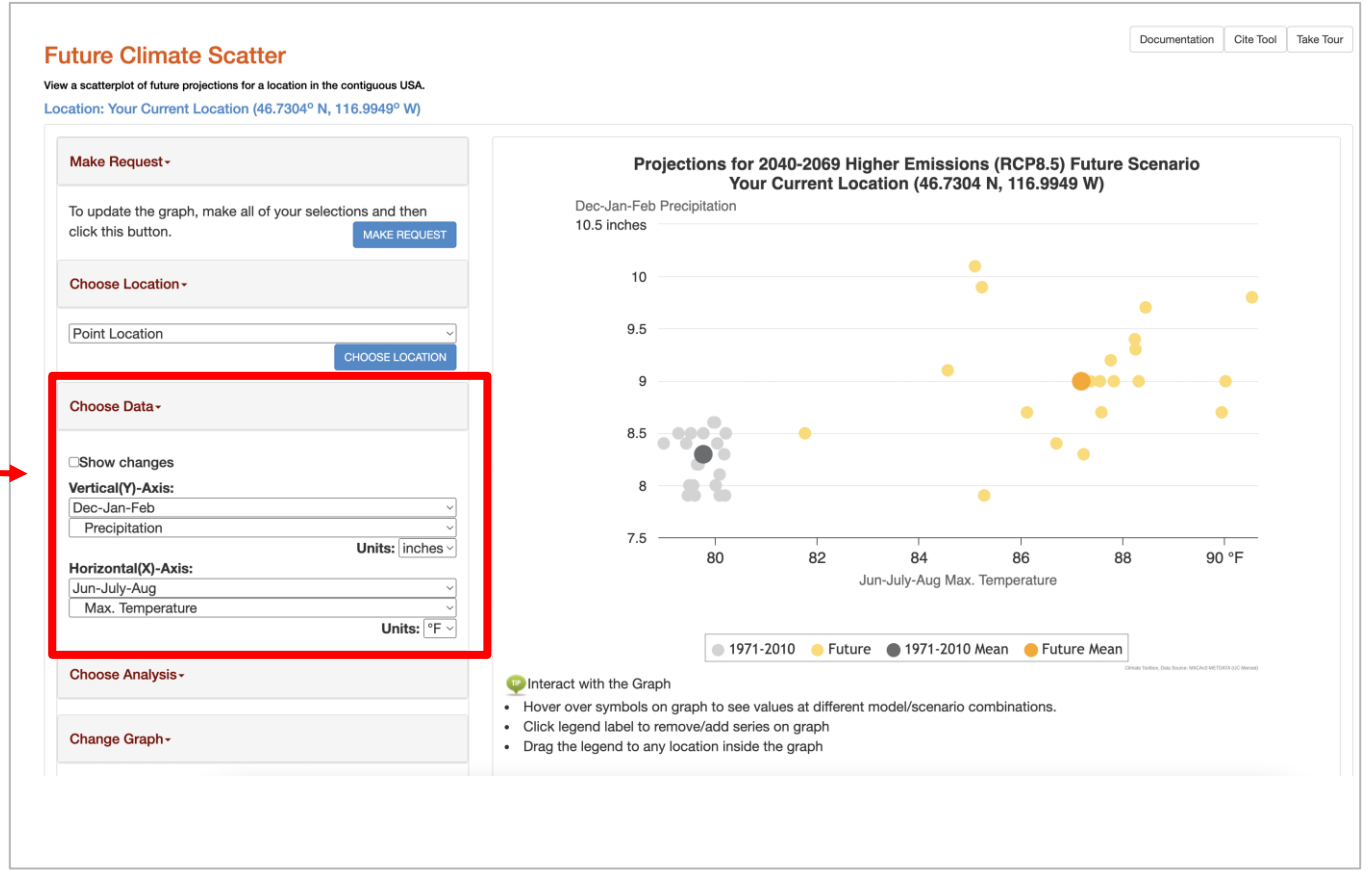
Generating Scatter Plot

Choose Location →



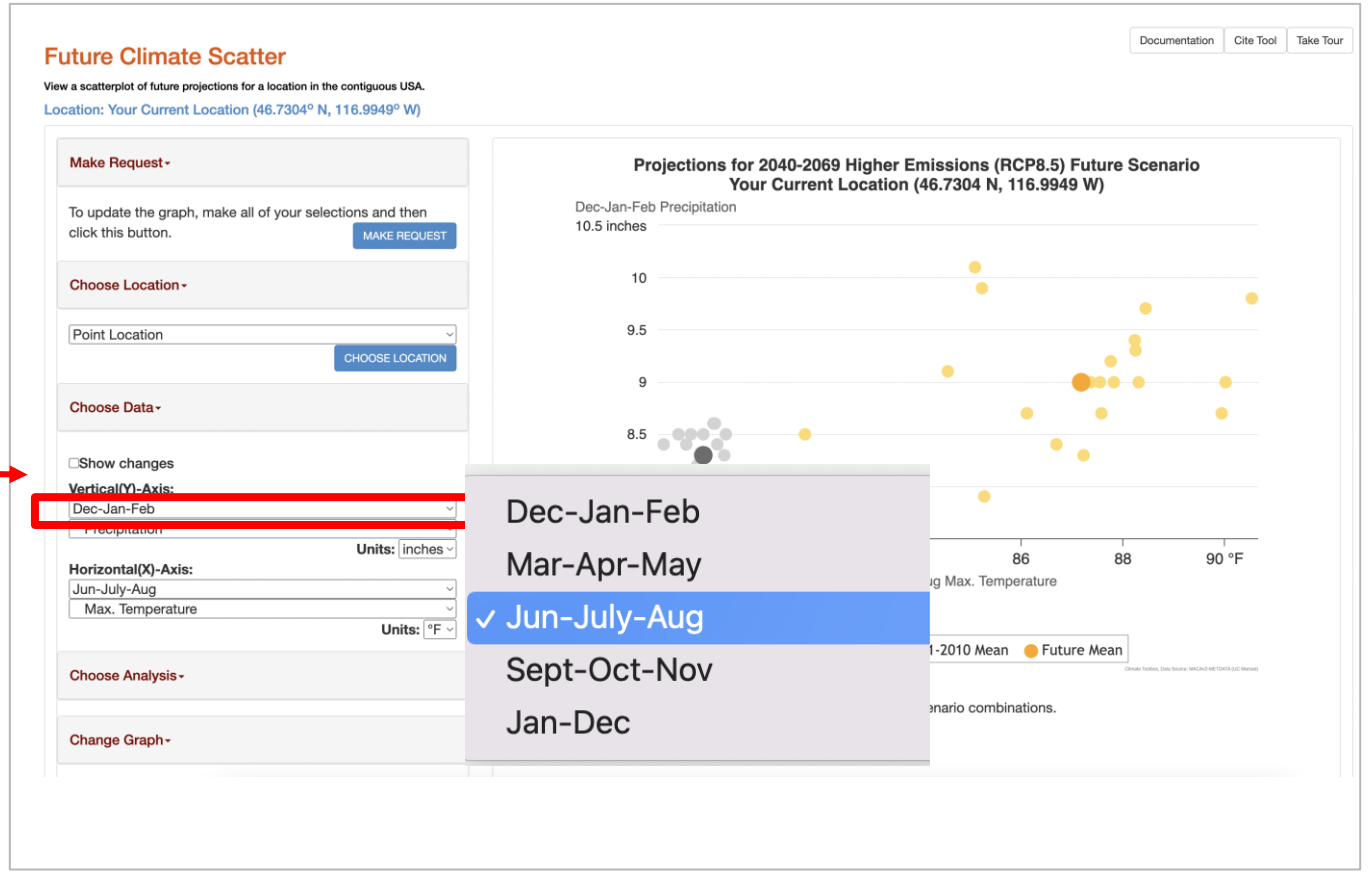
Generating Scatter Plot

Choose data for x,y axes



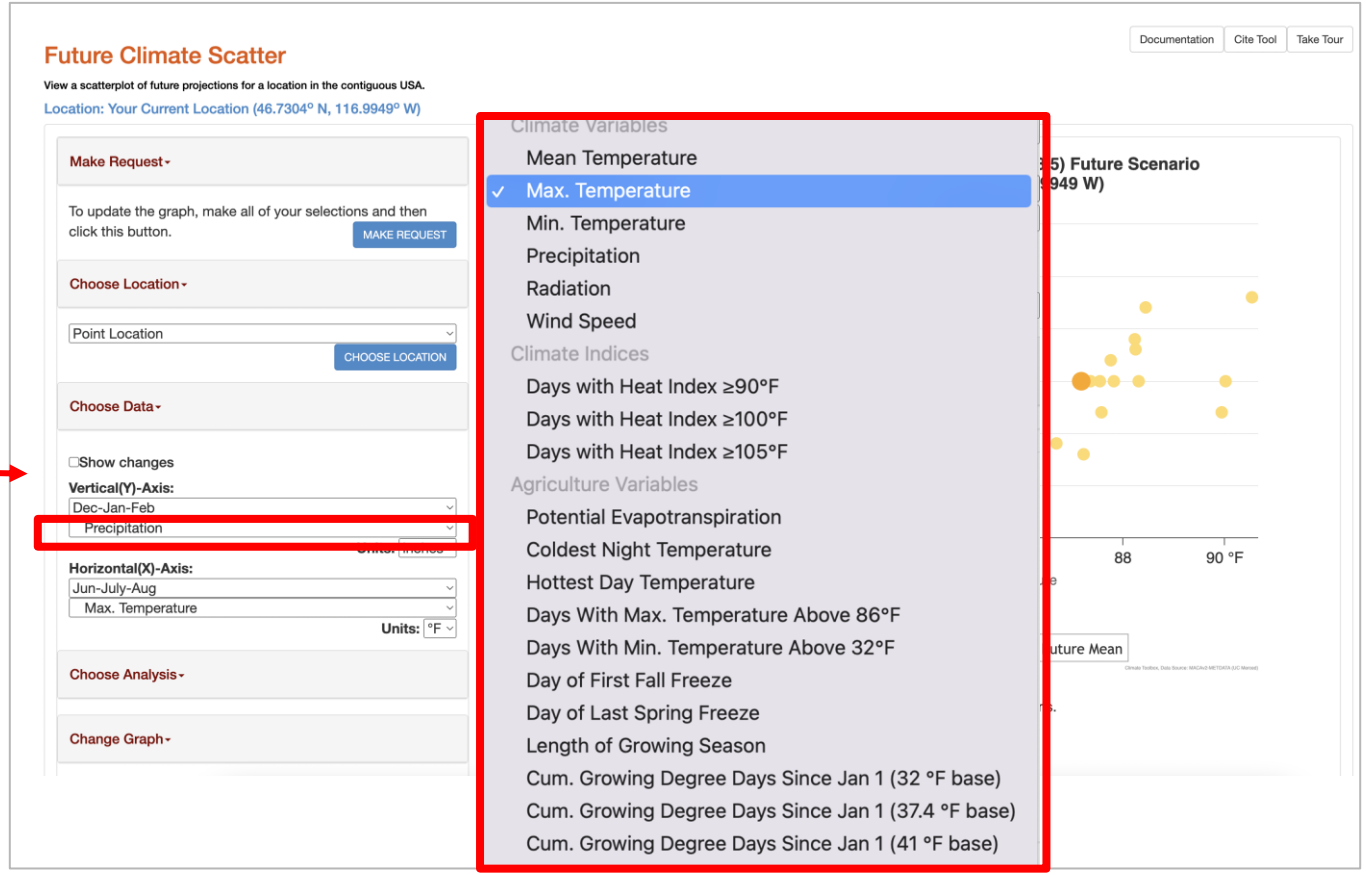
Generating Scatter Plot

Choose a season →



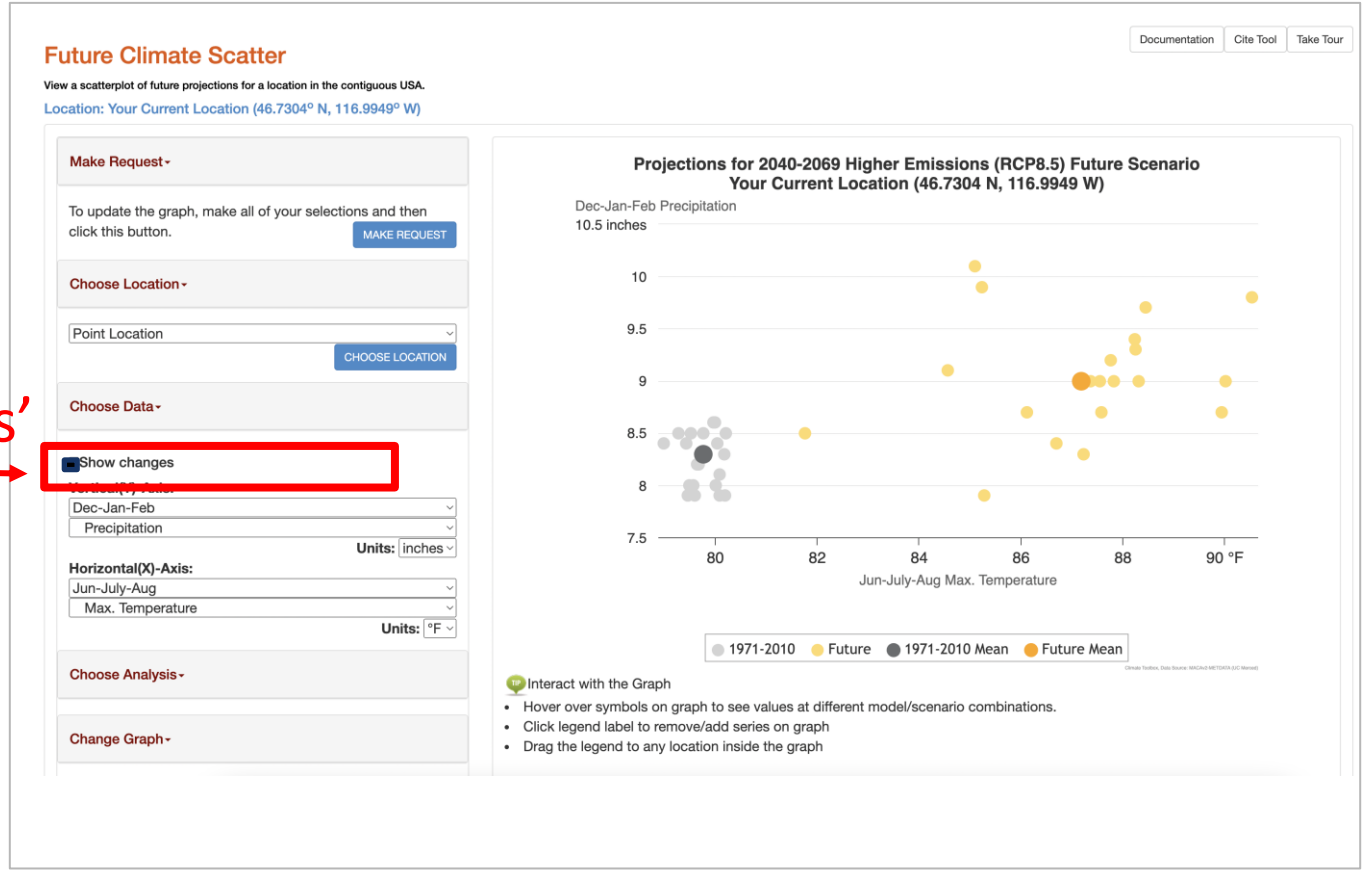
Generating Scatter Plot

Choose a variable



Generating Scatter Plot

Click ‘Show Changes’



Generating Scatter Plot

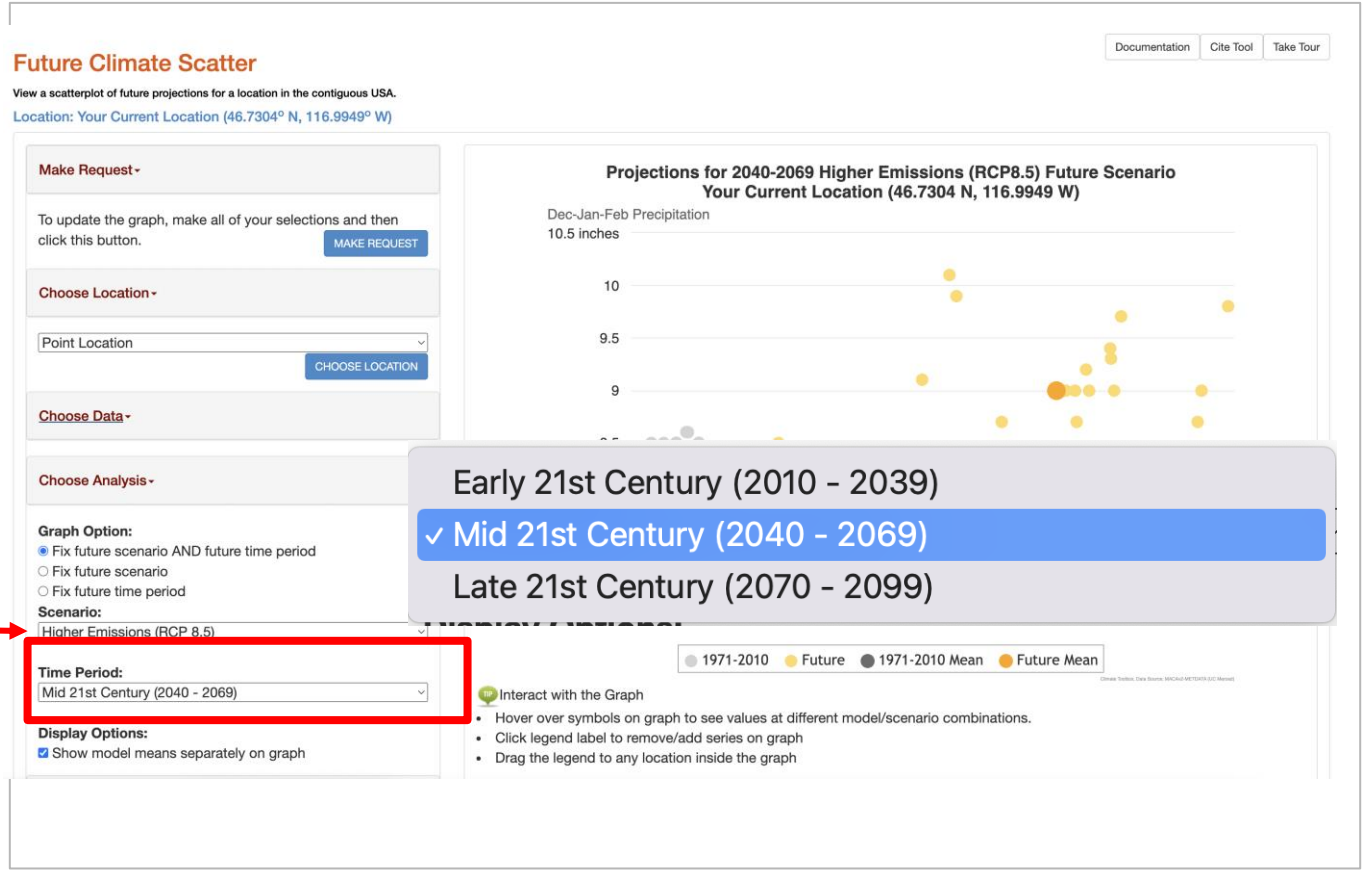
Open the Analysis Section →

Generating Scatter Plot

Choose a future scenario

Generating Scatter Plot

Choose a future time period



Generating Scatter Plot

Click ‘Make Request’ button to update graph

Generating Scatter Plot

Future Climate Scatter

View a scatterplot of future projections for a location in the contiguous USA.

Location: Craters of the Moon (43.1718° N, 113.4821° W)

Documentation | Cite Tool | Take Tour

Scatterplot from selections

Make Request

To update the graph, make all of your selections and then click this button.

MAKE REQUEST

Choose Location

Point Location

CHOOSE LOCATION

Choose Data

Show changes

Vertical(Y)-Axis:

Projected Change
Dec-Jan-Feb
Precipitation

Units: inches

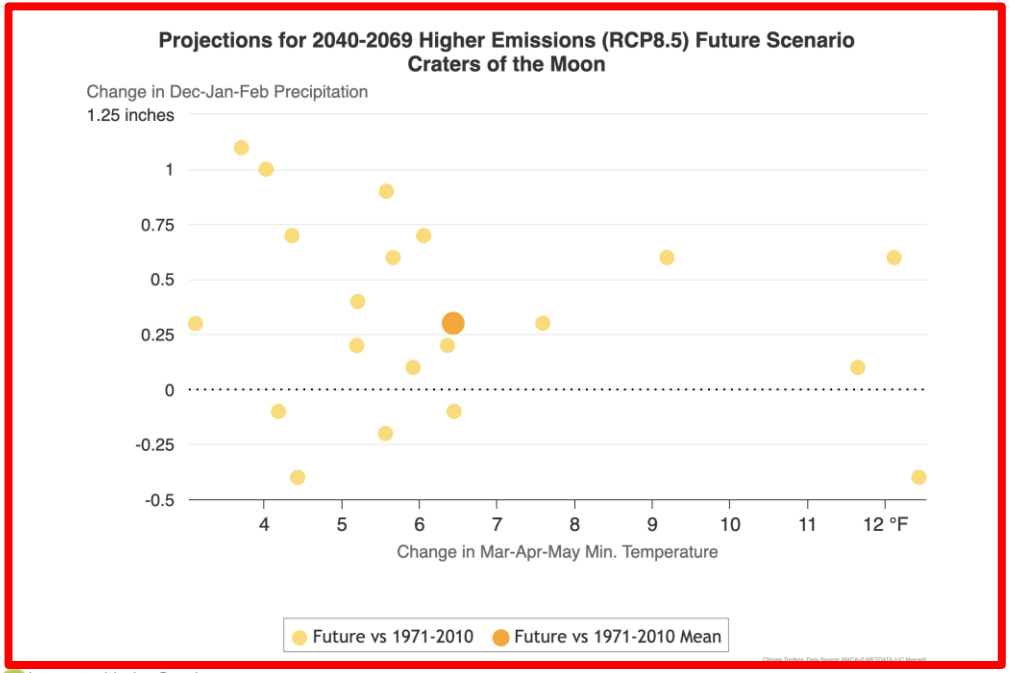
Horizontal(X)-Axis:

Projected Change
Mar-Apr-May
Min. Temperature

Units: °F

Choose Analysis

Graph Option:

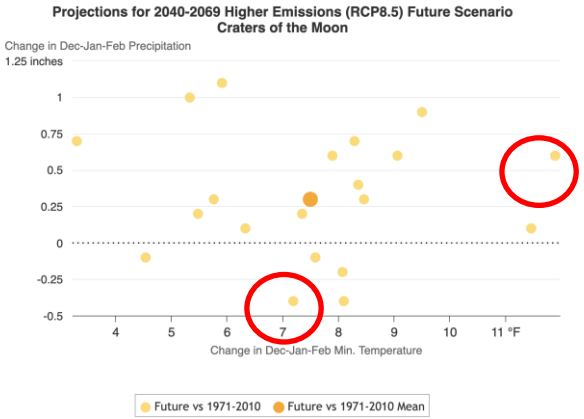


Interact with the Graph

- Hover over symbols on graph to see values at different model/scenario combinations.
- Click legend label to remove/add series on graph
- Drag the legend to any location inside the graph

Identifying Scenario

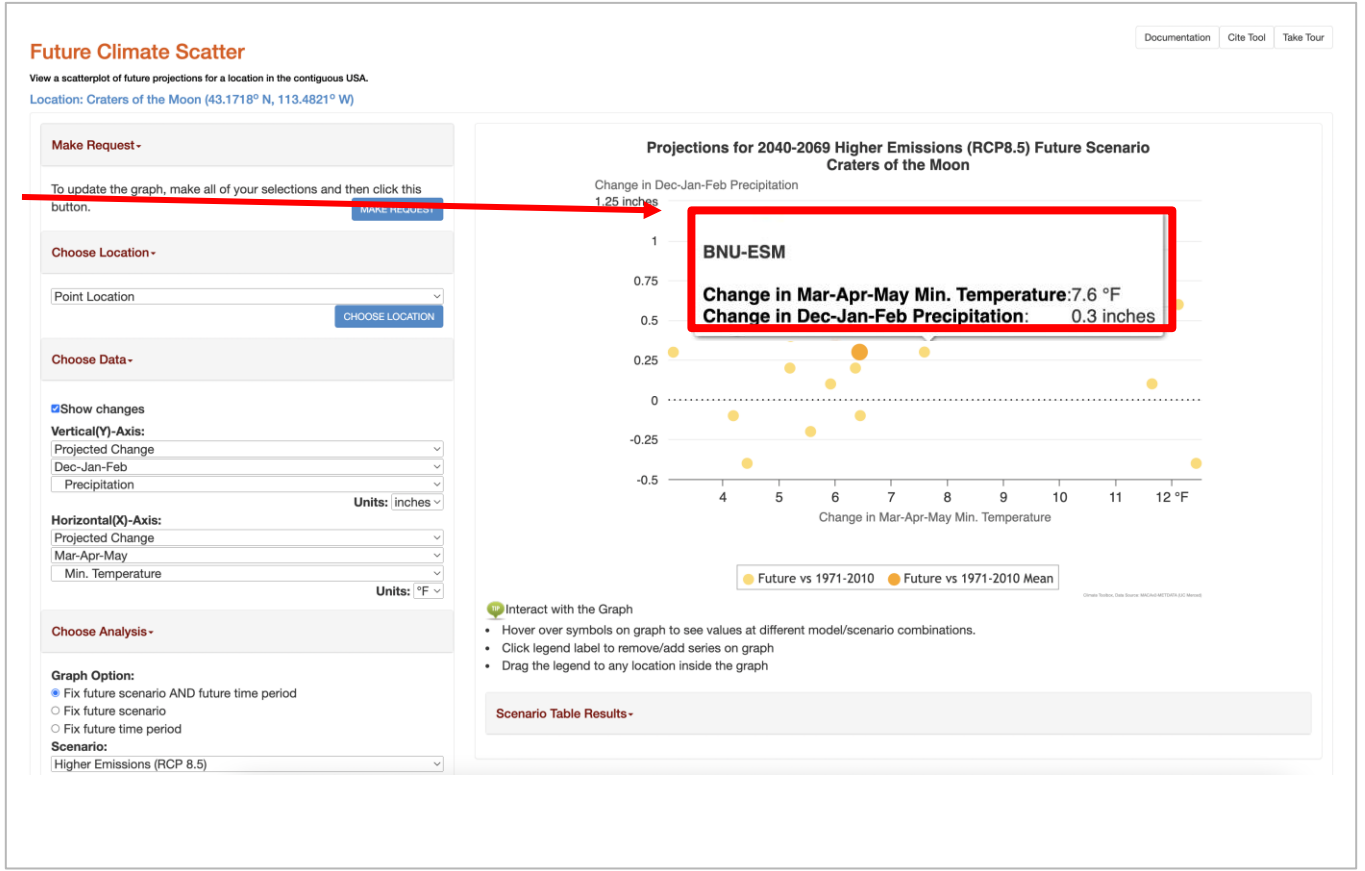
Identify models/scenarios that represent a particular climate vulnerability



1. Go to Future Climate Scatter tool
2. Generate Scatter plot
3. Hover over dots on graph to identify model and values
4. Choose a model representing an extreme (i.e. Hot wet, hot dry) of the projection space
5. Track selections in table
   - -In ‘Scenario Table Results’ section, turn tracking button ‘On’
   - -Click on dots to enter data into table

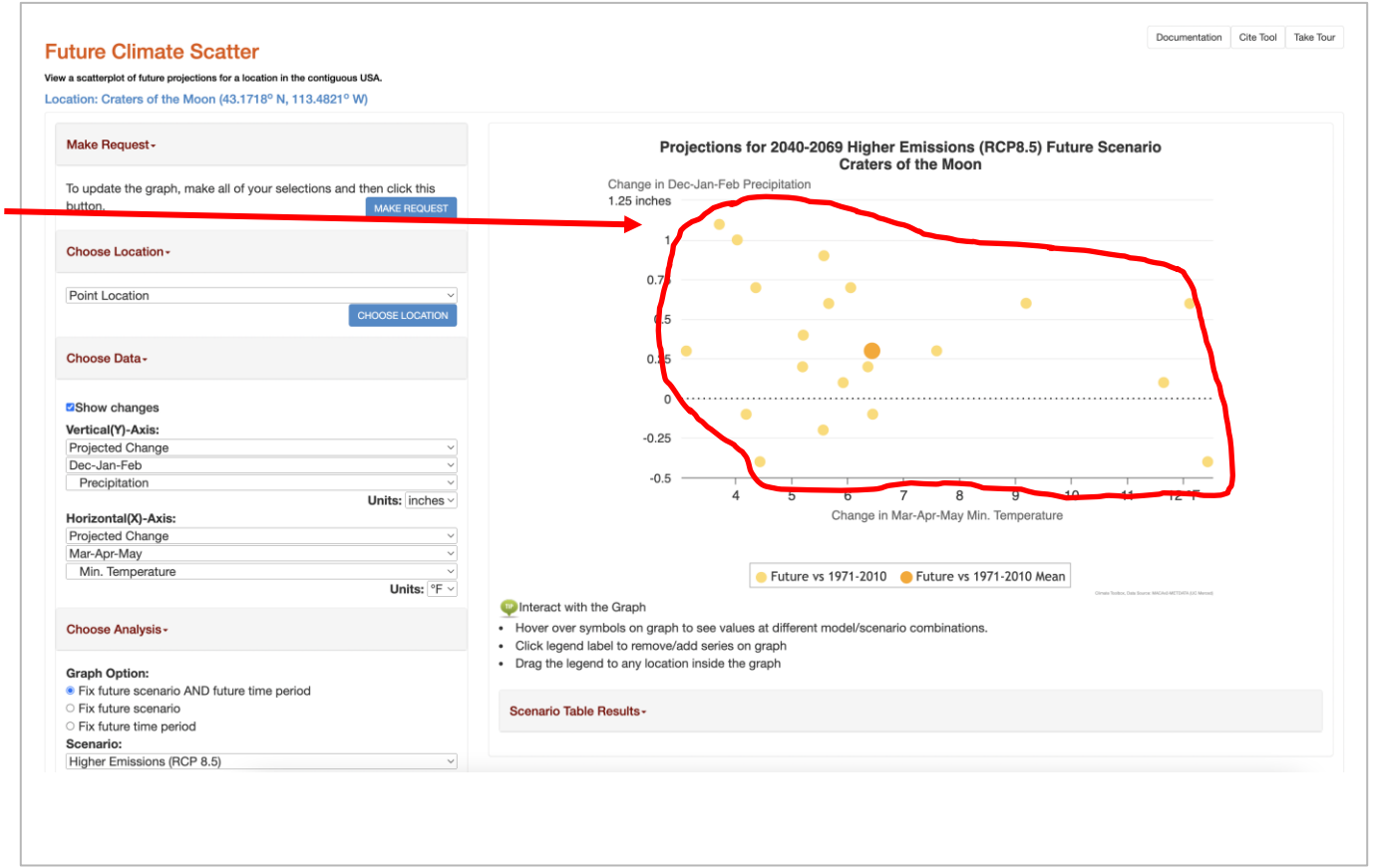
Identifying Scenarios

Hover over dots to display model information



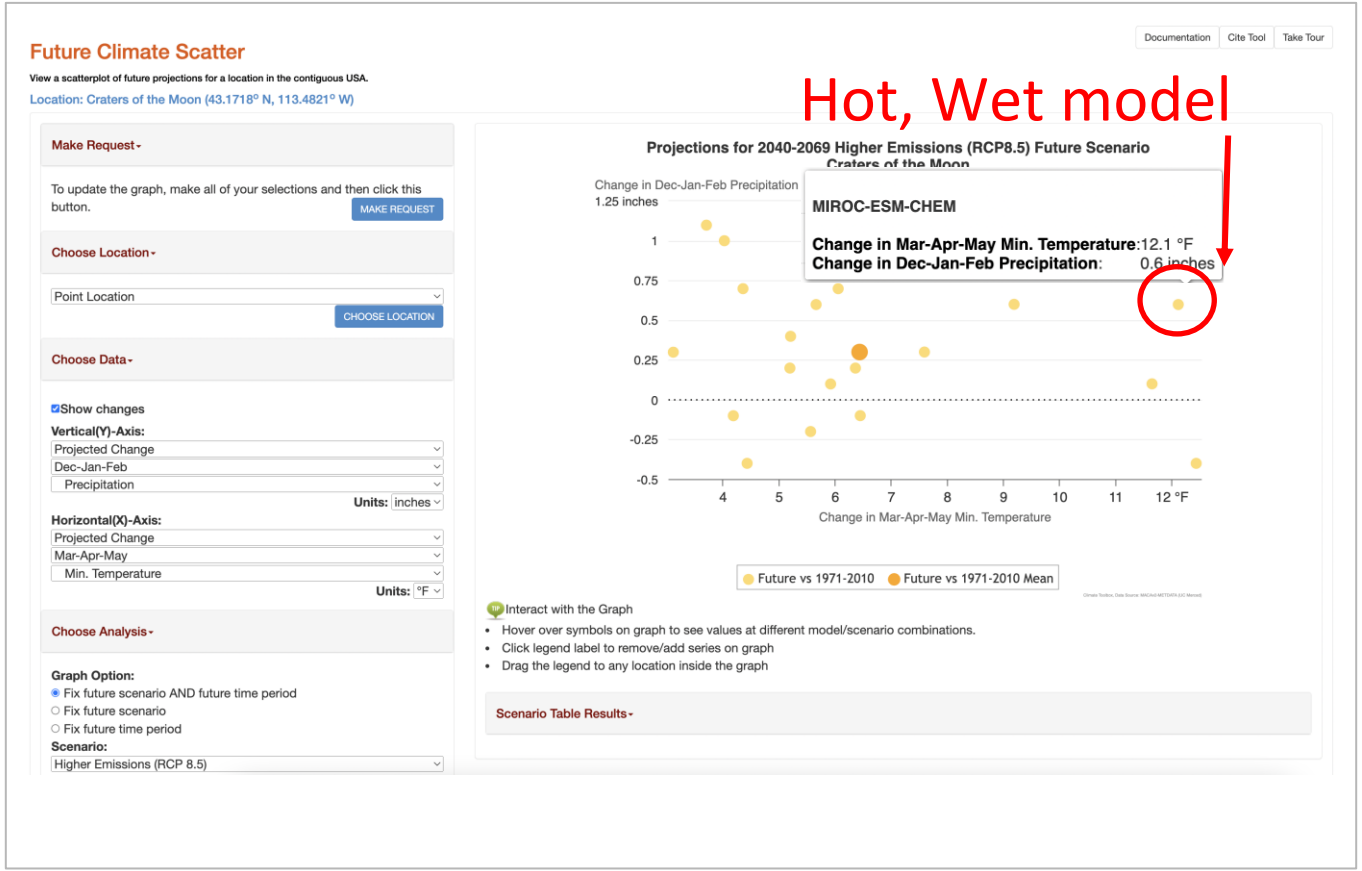
Identifying Scenarios

Projection space from models



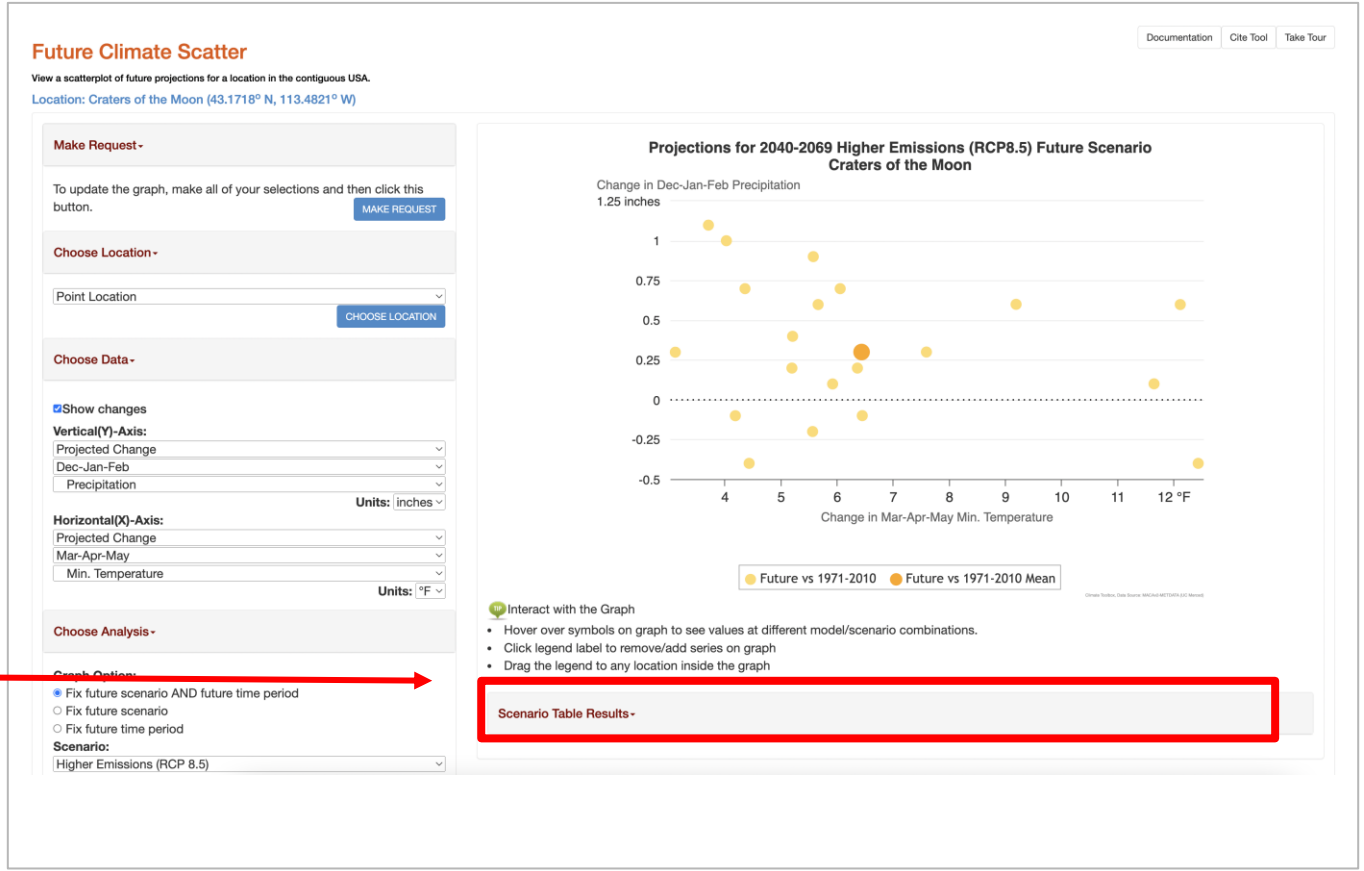
Identifying Scenarios

Choose a model representing an extreme of the projection space



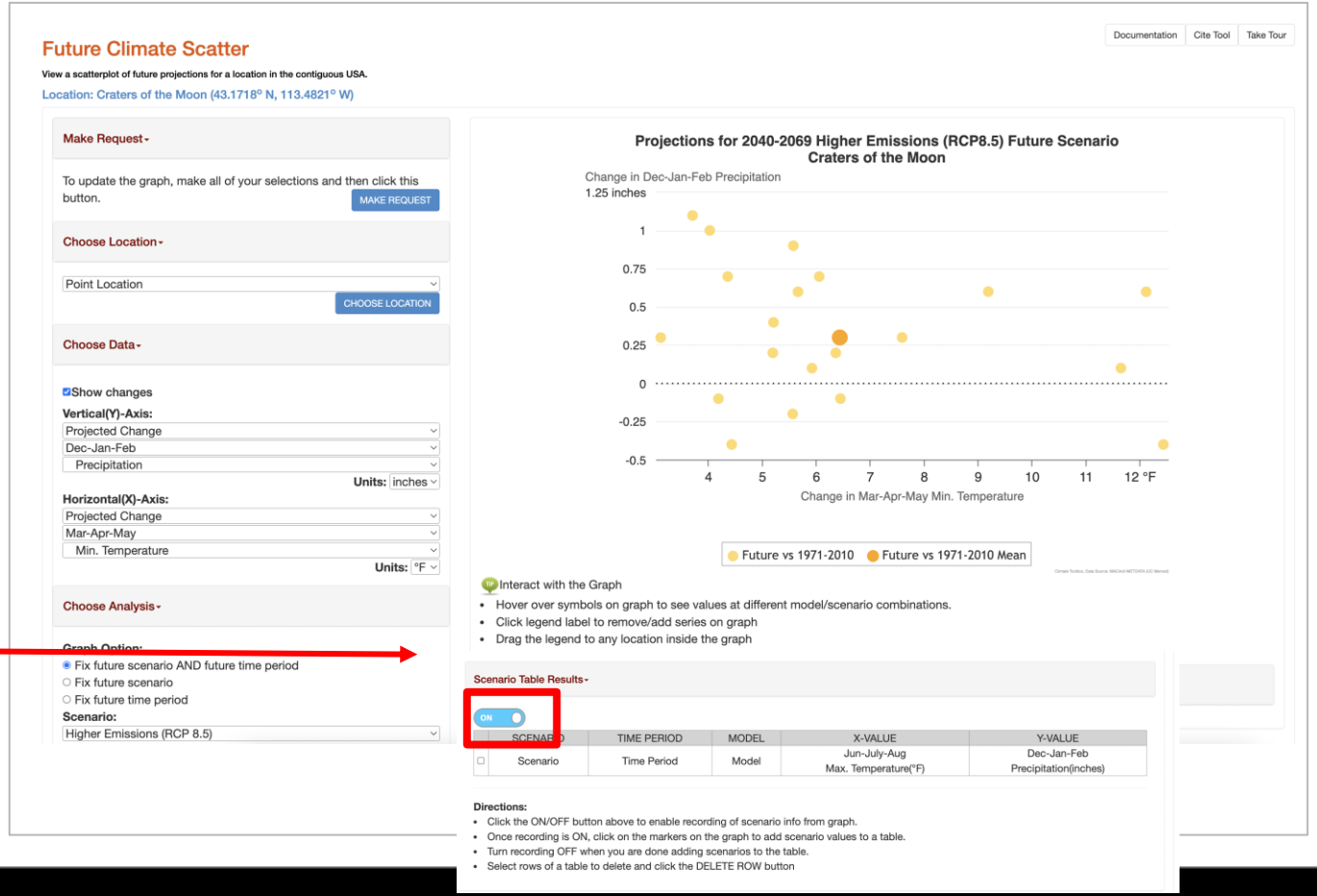
Identifying Scenarios

Open ‘Scenario Table Results’ section



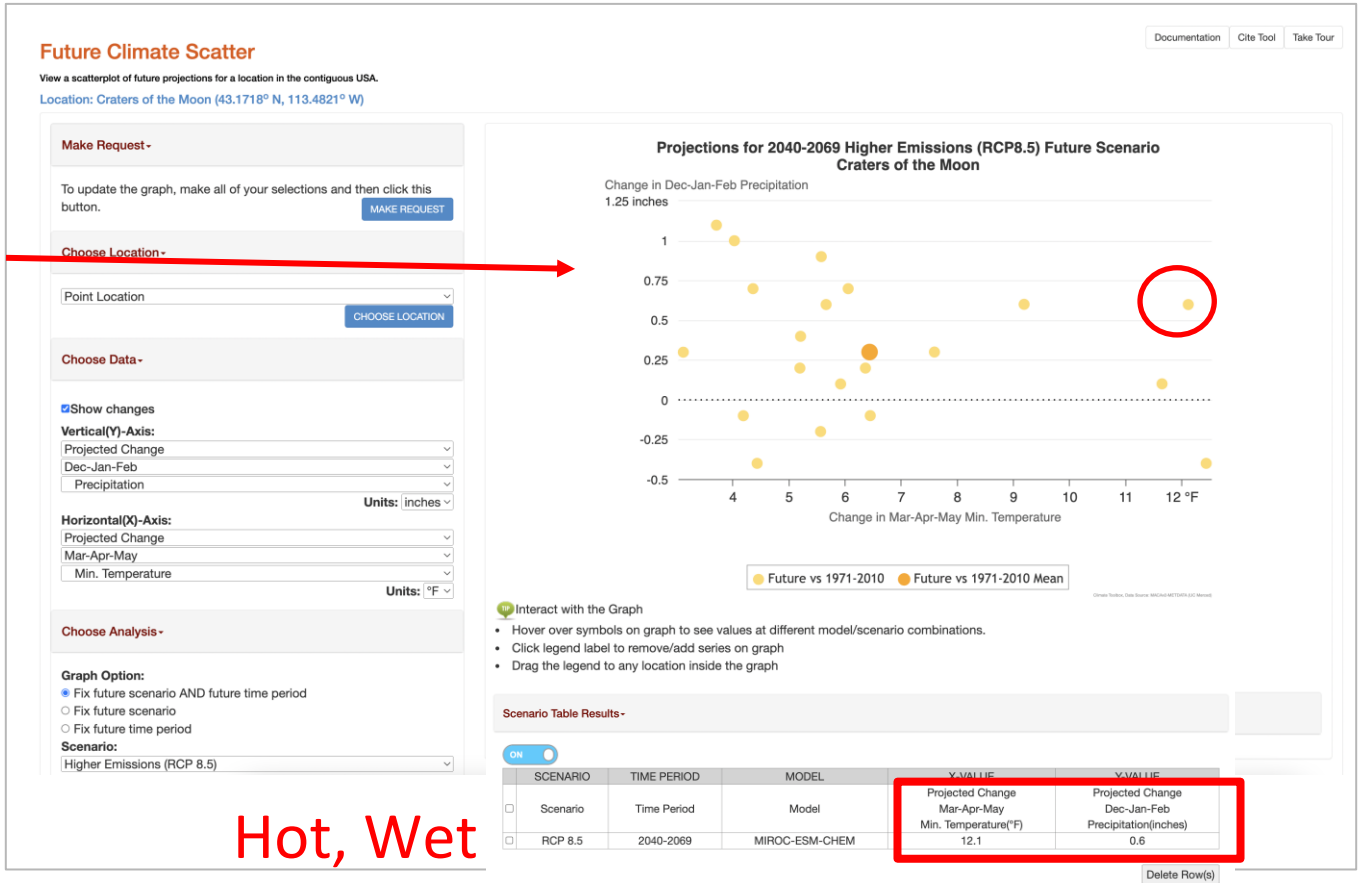
Identifying Scenarios

Toggle button
To 'On' to start
Recording data to
table



Identifying Scenarios

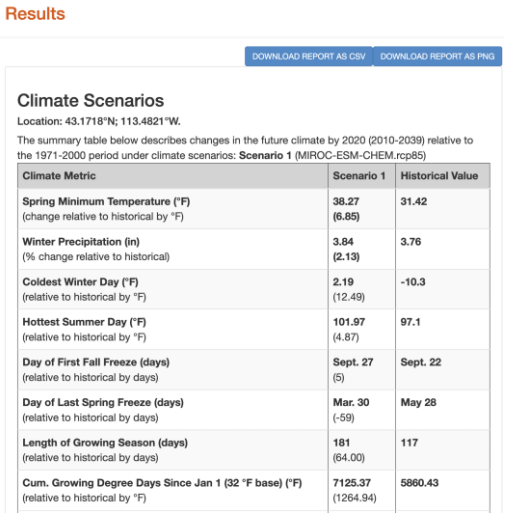
Click on a dot to record data in table.



Hot, Wet

Explore Future Metrics

Explore future metrics for chosen model/scenarios



Results

DOWNLOAD REPORT AS CSV | DOWNLOAD REPORT AS PNG

Climate Scenarios

Location: 43.1718°N; 113.4821°W.

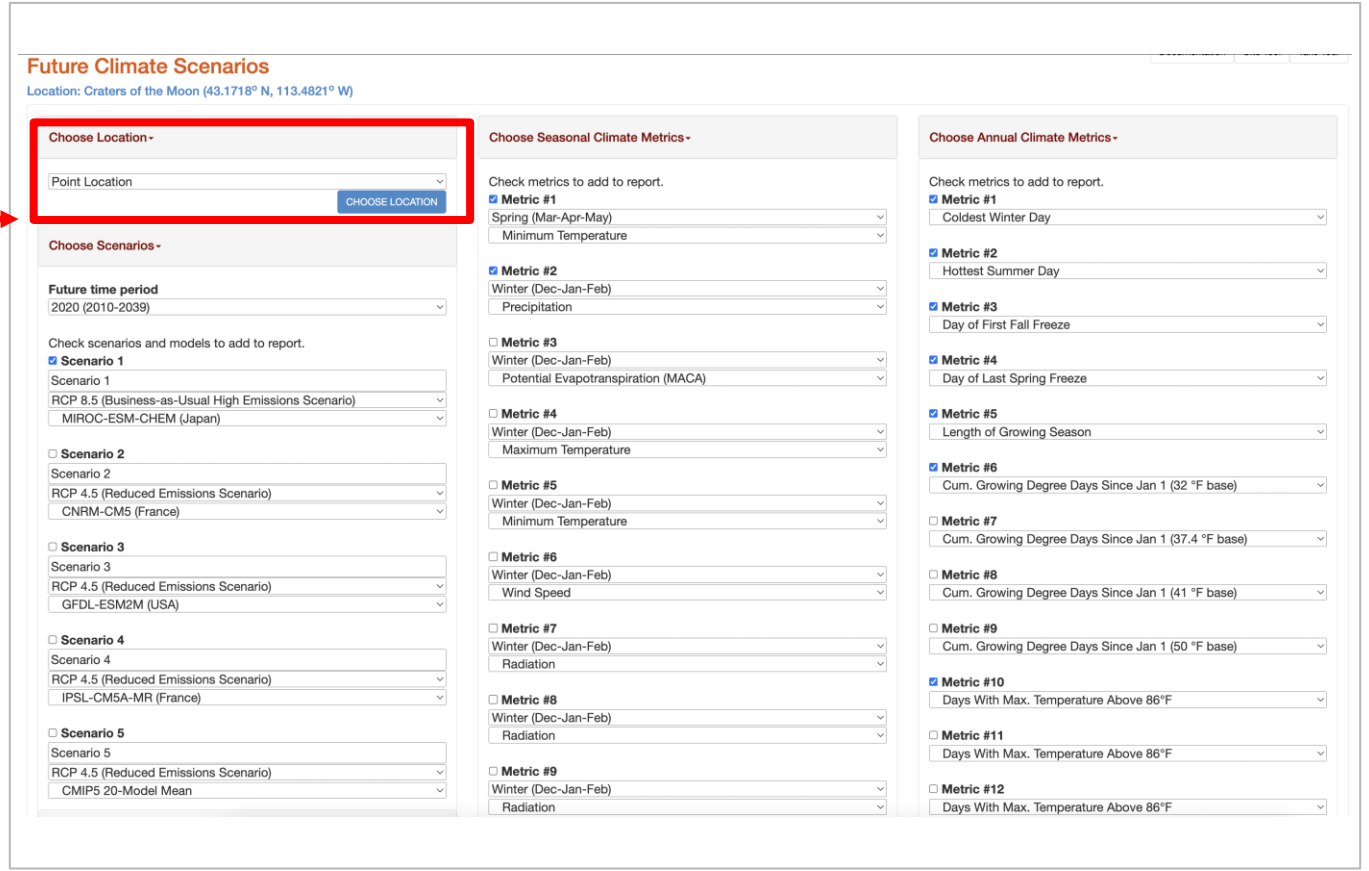
The summary table below describes changes in the future climate by 2020 (2010-2039) relative to the 1971-2000 period under climate scenarios: **Scenario 1** (MIROC-ESM-CHEM.rcp85)

Climate Metric	Scenario 1	Historical Value
Spring Minimum Temperature (°F) (change relative to historical by °F)	**38.27** **(6.85)**	**31.42**
Winter Precipitation (in) (% change relative to historical)	**3.84** **(2.13)**	**3.76**
Coldest Winter Day (°F) (relative to historical by °F)	**2.19** (12.49)	**-10.3**
Hottest Summer Day (°F) (relative to historical by °F)	**101.97** (4.87)	**97.1**
Day of First Fall Freeze (days) (relative to historical by days)	**Sept. 27** (5)	**Sept. 22**
Day of Last Spring Freeze (days) (relative to historical by days)	**Mar. 30** (-59)	**May 28**
Length of Growing Season (days) (relative to historical by days)	**181** (64.00)	**117**
Cum. Growing Degree Days Since Jan 1 (32 °F base) (°F) (relative to historical by °F)	**7125.37** (1264.94)	**5860.43**

1. Go to Future Climate Scenarios tool
2. Select Location
3. Enter in future time period
4. Enter in model/scenario
5. Select future metrics of interest
6. Generate a ‘Report’

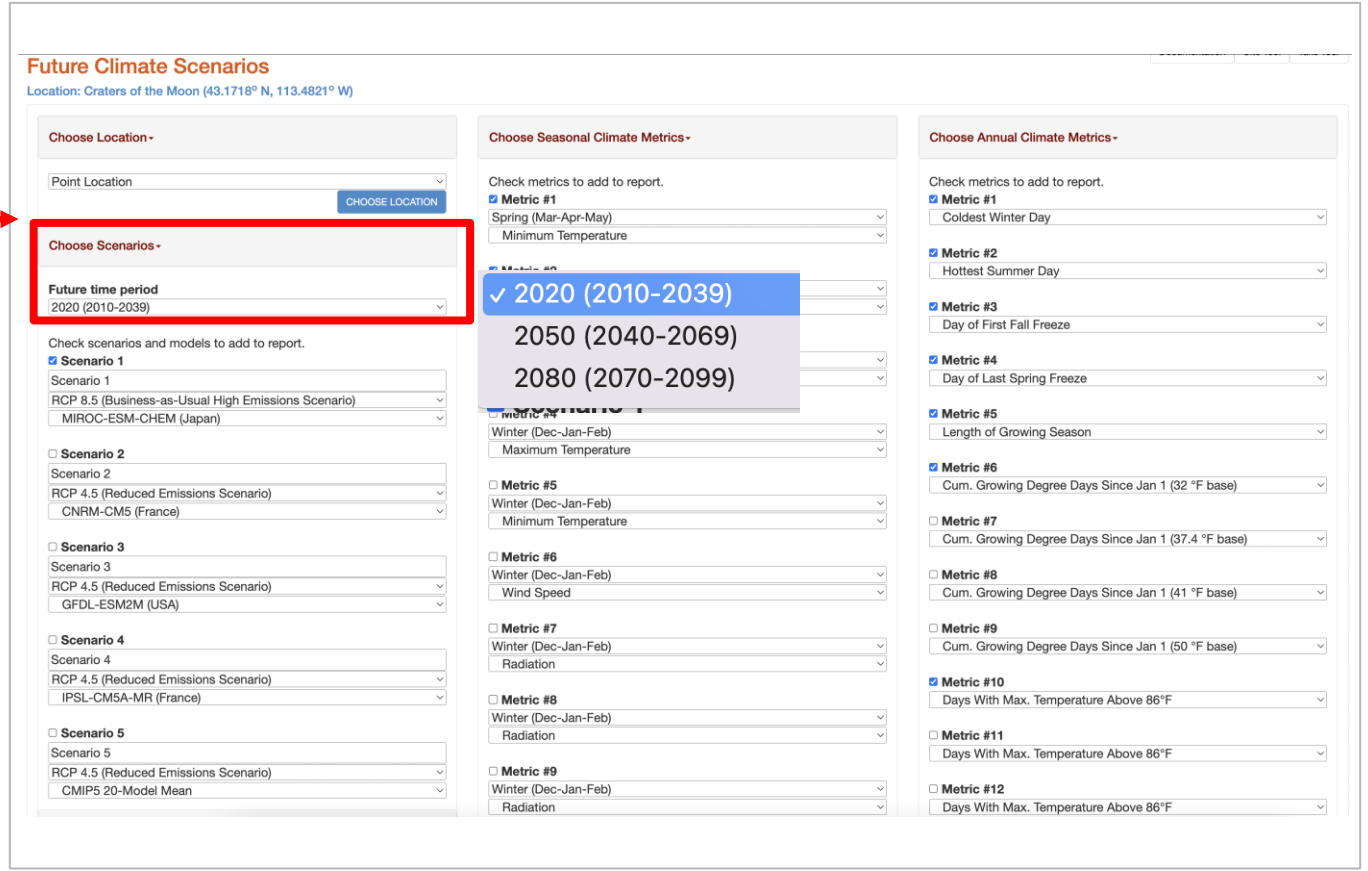
Explore Future Metrics

Select Location



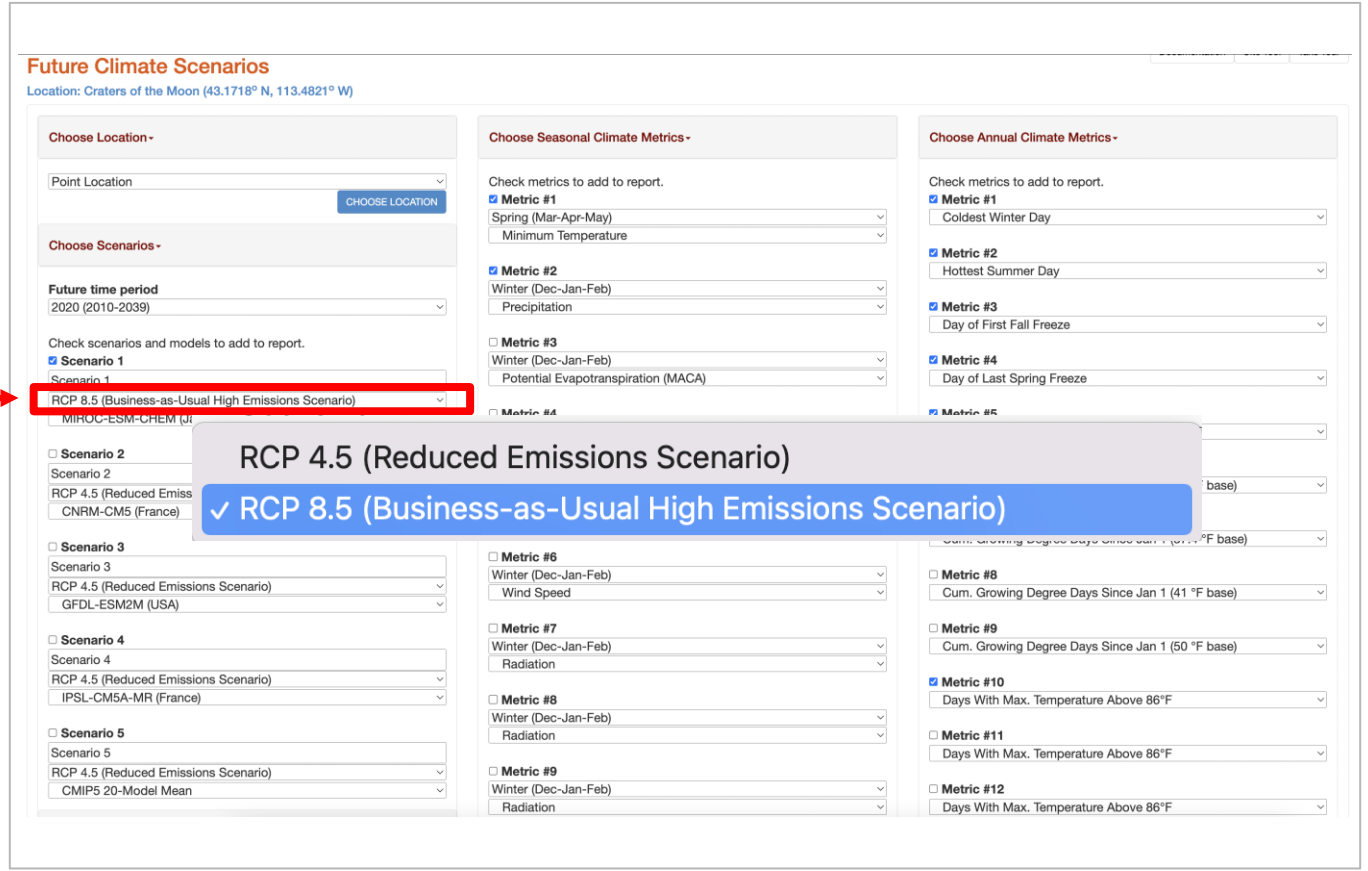
Explore Future Metrics

Select Future Time Period



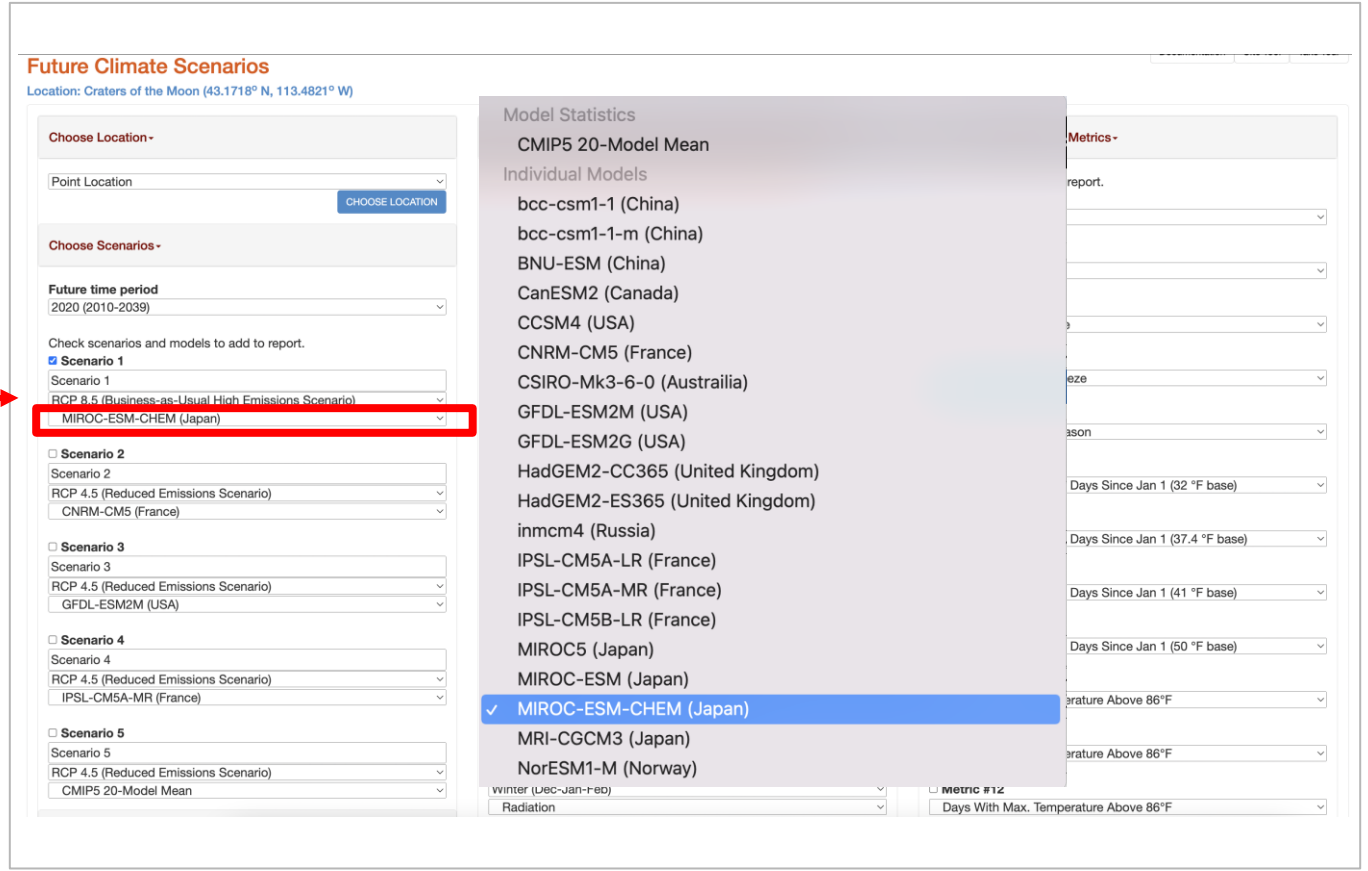
Explore Future Metrics

Select Future Scenario



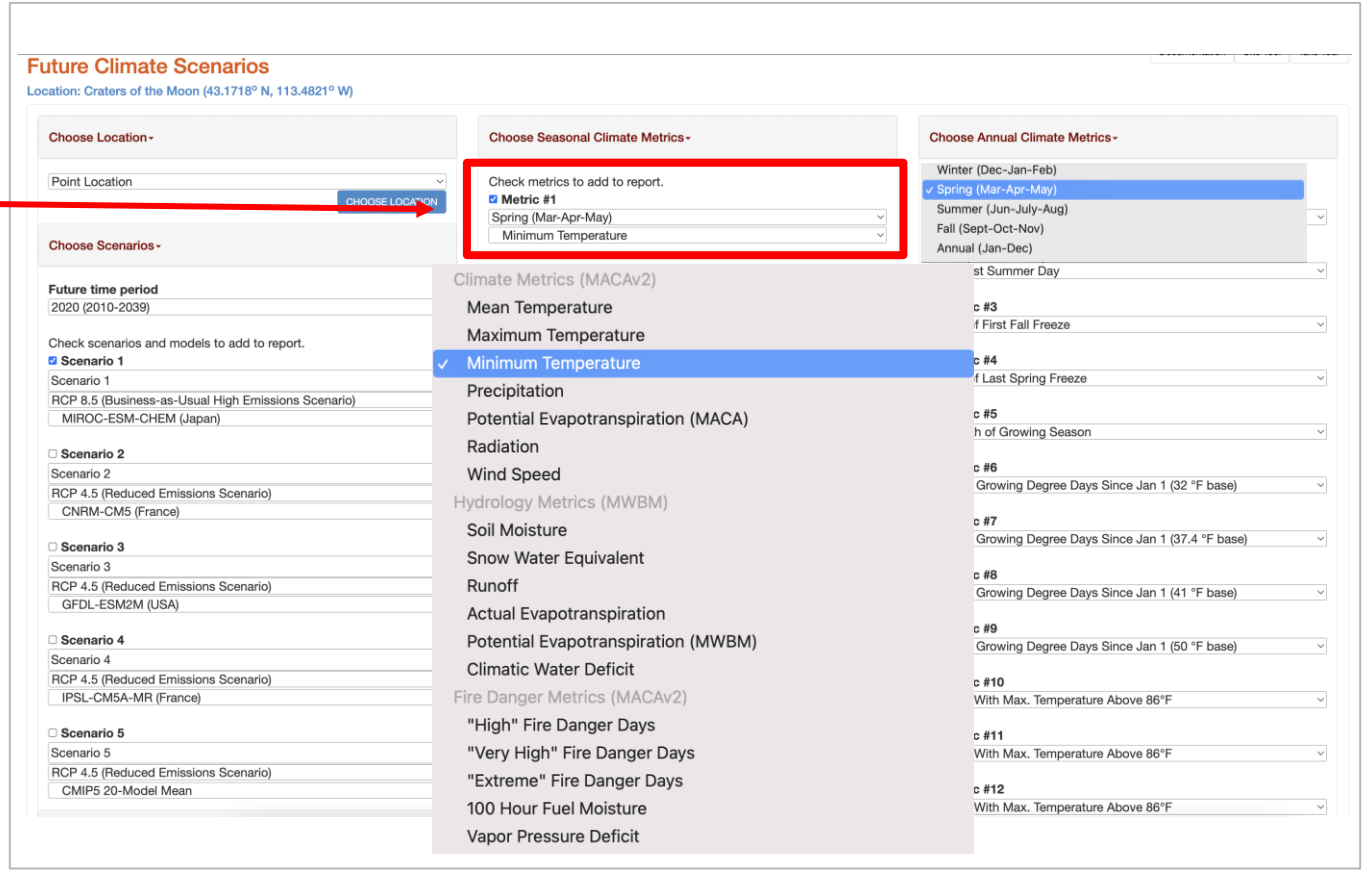
Explore Future Metrics

Select Model →



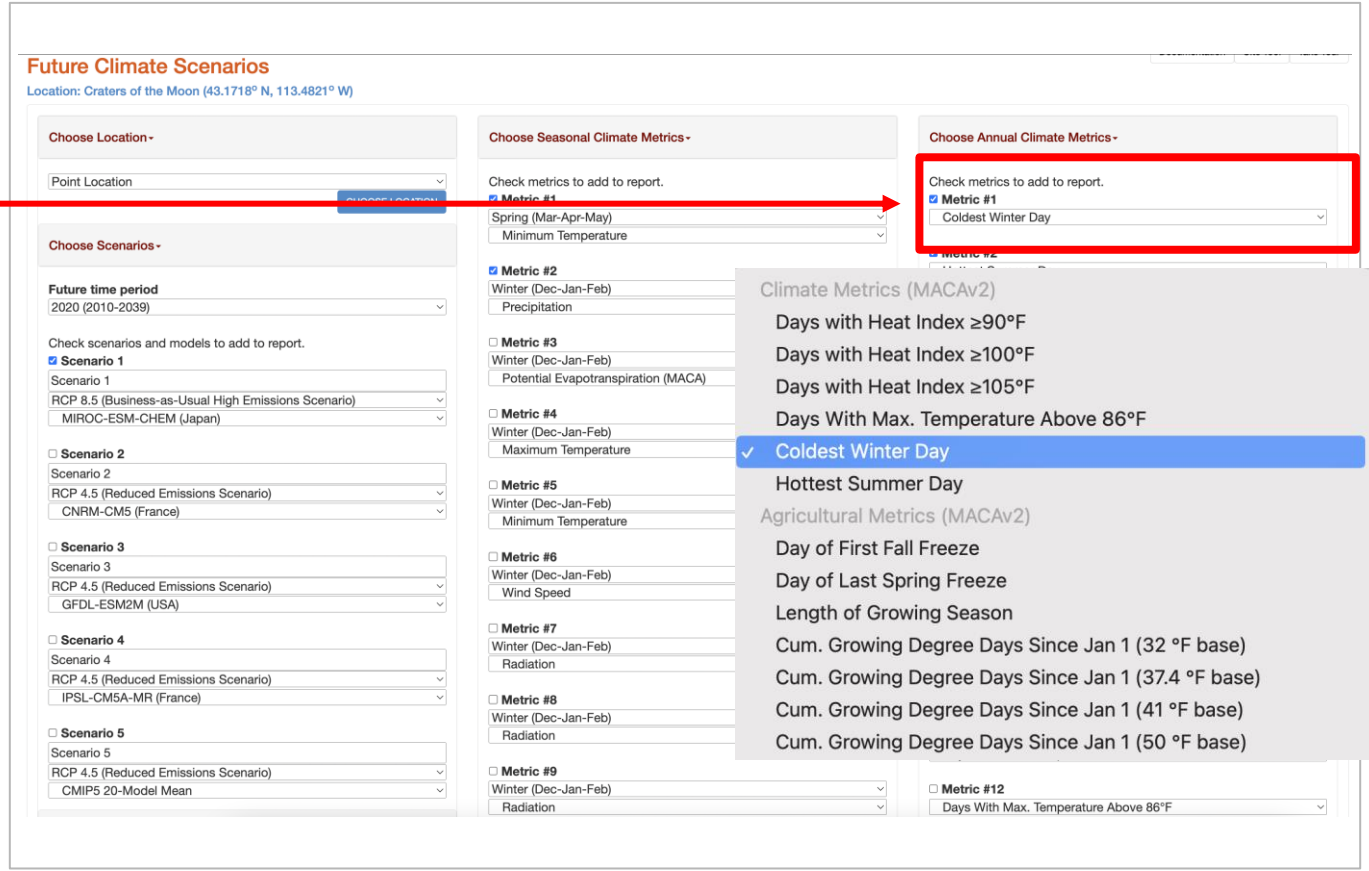
Explore Future Metrics

Select Seasonal Metrics
- metric
- season



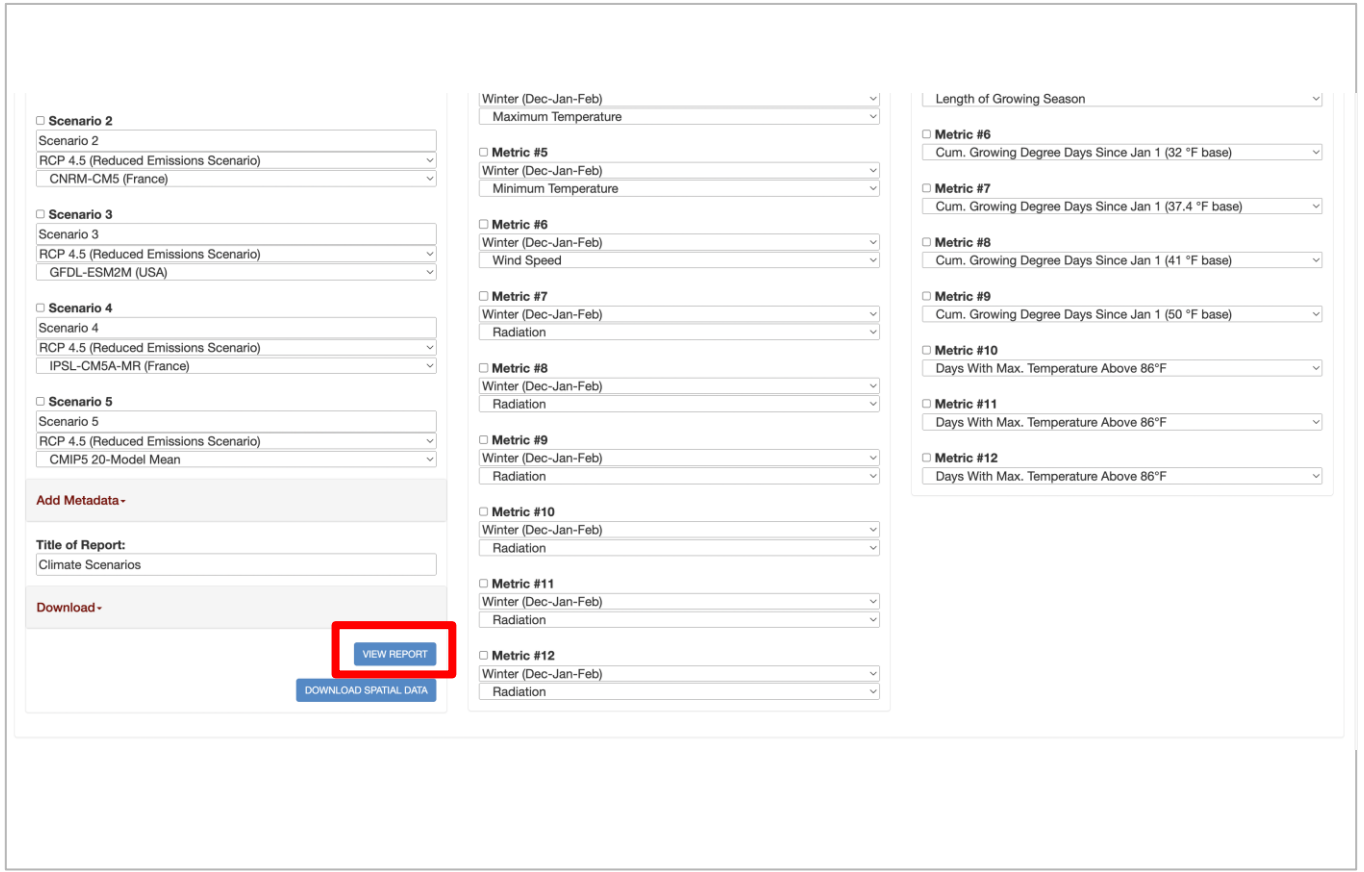
Explore Future Metrics

Select Annual Metrics



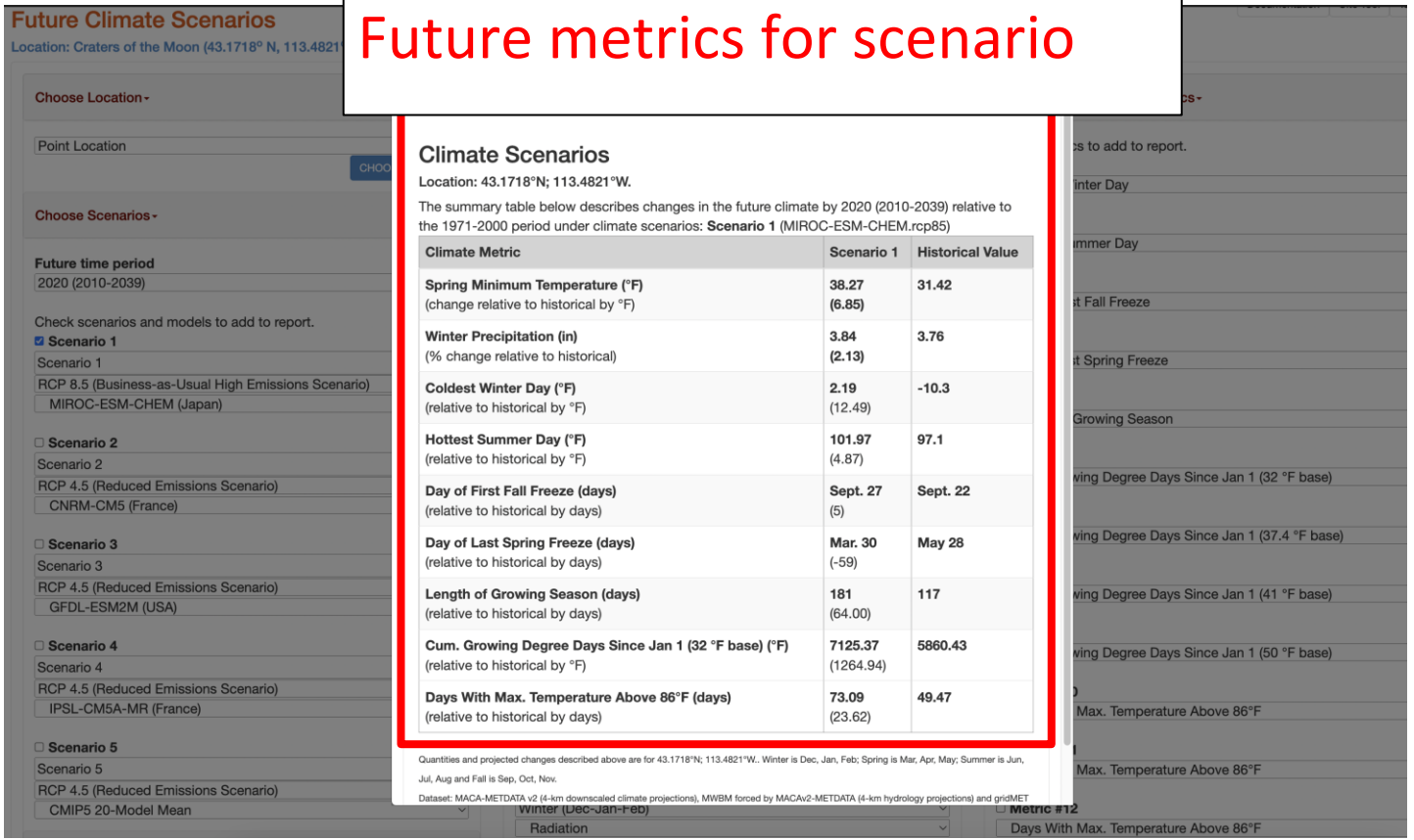
Explore Future Metrics

Scroll down and Click ‘View Report’



Explore Future Metrics

Future metrics for scenario



Climate Scenarios

Location: 43.1718°N; 113.4821°W.

The summary table below describes changes in the future climate by 2020 (2010-2039) relative to the 1971-2000 period under climate scenarios: **Scenario 1** (MIROC-ESM-CHEM.rcp85)

Climate Metric	Scenario 1	Historical Value
Spring Minimum Temperature (°F) (change relative to historical by °F)	**38.27** **(6.85)**	**31.42**
Winter Precipitation (in) (% change relative to historical)	**3.84** **(2.13)**	**3.76**
Coldest Winter Day (°F) (relative to historical by °F)	**2.19** (12.49)	**-10.3**
Hottest Summer Day (°F) (relative to historical by °F)	**101.97** (4.87)	**97.1**
Day of First Fall Freeze (days) (relative to historical by days)	**Sept. 27** (5)	**Sept. 22**
Day of Last Spring Freeze (days) (relative to historical by days)	**Mar. 30** (-59)	**May 28**
Length of Growing Season (days) (relative to historical by days)	**181** (64.00)	**117**
Cum. Growing Degree Days Since Jan 1 (32 °F base) (°F) (relative to historical by °F)	**7125.37** (1264.94)	**5860.43**
Days With Max. Temperature Above 86°F (days) (relative to historical by days)	**73.09** (23.62)	**49.47**

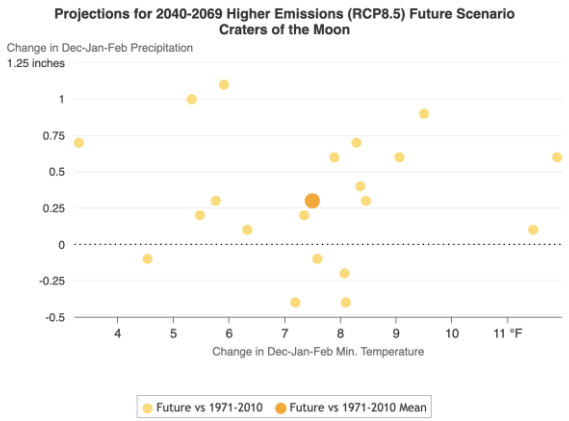
Quantities and projected changes described above are for 43.1718°N; 113.4821°W.. Winter is Dec, Jan, Feb; Spring is Mar, Apr, May; Summer is Jun, Jul, Aug and Fall is Sep, Oct, Nov.

Dataset: MACA-METDATA v2 (4-km downscaled climate projections), MWBM forced by MACAv2-METDATA (4-km hydrology projections) and gridMET

Up Next: explore future scenarios
In the activity

Generating a Scatterplot

Generate a scatter plot of model/scenario projections



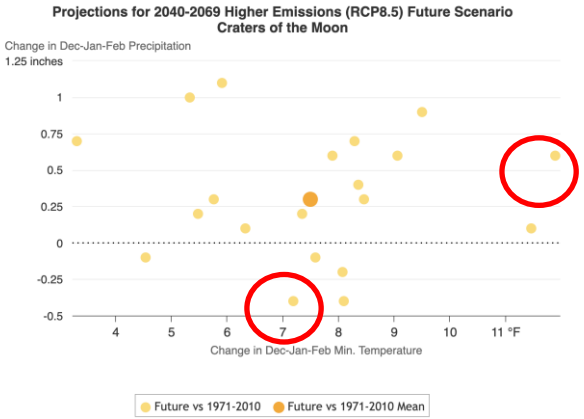
1. Go to Future Climate Scatter tool
2. Select a location

3. Select variables of interest for x,y axes
4. Select Future Scenario (RCP 8.5)
5. Select Future Time Period (2040-2069)
6. Click ‘Show Changes’

7. Click ‘Make Request’ button to update graph

Identifying Scenario

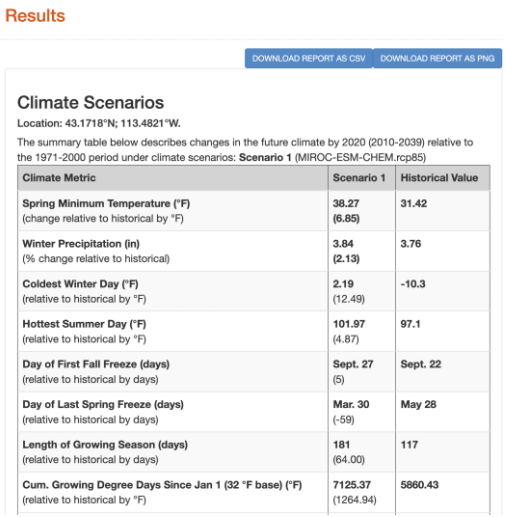
Identify models/scenarios that represent a particular climate vulnerability



1. Go to Future Climate Scatter tool
2. Generate Scatter plot
3. Hover over dots on graph to identify model and values
4. Choose a model representing an extreme (i.e. Hot wet, hot dry) of the projection space
5. Track selections in table
   - -In ‘Scenario Table Results’ section, turn tracking button ‘On’
   - -Click on dots to enter data into table

Explore Future Metrics

Explore future metrics for chosen model/scenarios



Results

DOWNLOAD REPORT AS CSV | DOWNLOAD REPORT AS PNG

Climate Scenarios

Location: 43.1718°N; 113.4821°W.

The summary table below describes changes in the future climate by 2020 (2010-2039) relative to the 1971-2000 period under climate scenarios: **Scenario 1** (MIROC-ESM-CHEM.rcp85)

Climate Metric	Scenario 1	Historical Value
Spring Minimum Temperature (°F) (change relative to historical by °F)	**38.27** **(6.85)**	**31.42**
Winter Precipitation (in) (% change relative to historical)	**3.84** **(2.13)**	**3.76**
Coldest Winter Day (°F) (relative to historical by °F)	**2.19** (12.49)	**-10.3**
Hottest Summer Day (°F) (relative to historical by °F)	**101.97** (4.87)	**97.1**
Day of First Fall Freeze (days) (relative to historical by days)	**Sept. 27** (5)	**Sept. 22**
Day of Last Spring Freeze (days) (relative to historical by days)	**Mar. 30** (-59)	**May 28**
Length of Growing Season (days) (relative to historical by days)	**181** (64.00)	**117**
Cum. Growing Degree Days Since Jan 1 (32 °F base) (°F) (relative to historical by °F)	**7125.37** (1264.94)	**5860.43**

1. Go to Future Climate Scenarios tool
2. Enter in future model/scenario/time period
3. Select future metrics of interest
4. Generate a ‘Report’