Spacetime Cube and Animation

a. Downloads the annual 30-Year Normals .bil files for precipitation from PRISM [2]

[2] PRISM website: https://prism.oregonstate.edu/normals/ (https://prism.oregonstate.edu/normals/)

```
In [7]:  import requests
         from ftplib import FTP
         from zipfile import ZipFile
         def FTPNormalsDownload(server_filename):

             ftp = FTP('prism.nacse.org')
             #enter credentials
             ftp.login(user = 'anonymous', passwd= 'and04671@umn.edu')
             #navigate directories
             ftp.cwd('normals_4km/ppt')
             #establish local_filename as inside the PRISM ZIP folder
             local_filename = open(server_filename, 'wb')
             ftp.retrbinary('RETR '+ server_filename, local_filename.write)
             #close the server and local_filename
             ftp.close()
             local_filename.close()

         for each in ['01','02','03','04','05','06','07','08','09','10','11','12']:
                 # the server file
                 desired_file = "PRISM_ppt_30yr_normal_4kmM2_"+each+"_bil.zip"
                 FTPNormalsDownload(desired_file)
                 with ZipFile(desired_file) as myzip:
                     myzip.extractall(path = 'PRISM_ZIPS')
```

MODEL VERSION

In [2]:
```python
import arcpy
Lab2_gdb = "C:\\Users\\Cole\\Documents\\GitHub\\GIS5572\\Lab2\\Lab2.gdb"
arcpy.env.workspace = "C:\\Users\\Cole\\Documents\\GitHub\\GIS5572\\Lab2"
PRISM_01_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_01_bil.bi
l")
PRISM_02_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_02_bil.bi
l")
PRISM_03_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_03_bil.bi
l")
PRISM_04_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_04_bil.bi
l")
PRISM_05_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_05_bil.bi
l")
PRISM_06_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_06_bil.bi
l")
PRISM_07_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_07_bil.bi
l")
PRISM_08_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_08_bil.bi
l")
PRISM_09_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_09_bil.bi
l")
PRISM_10_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_10_bil.bi
l")
PRISM_11_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_11_bil.bi
l")
PRISM_12_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_12_bil.bi
l")
```

In [20]:
```python
# Process: Create A Mosaic Dataset
TestMosaic3 = arcpy.management.CreateMosaicDataset(in_workspace=Lab2_gdb, in_m
osaicdataset_name="TestMosaic3",
coordinate_system="PROJCS['NAD_1983_UTM_Zone_15N',GEOGCS['GCS_North_American_1
983',DATUM['D_North_American_1983',SPHEROID['GRS_1980',6378137.0,298.25722210
1]],PRIMEM['Greenwich',0.0],UNIT['Degree',0.0174532925199433]],PROJECTION['Tra
nsverse_Mercator'],PARAMETER['False_Easting',500000.0],PARAMETER['False_Northi
ng',0.0],PARAMETER['Central_Meridian',-93.0],PARAMETER['Scale_Factor',0.9996],
PARAMETER['Latitude_Of_Origin',0.0],UNIT['Meter',1.0]]", num_bands=None, pixel
_type="", product_definition="NONE", product_band_definitions=[])[0]
```

In [17]:
```python
# Process: Convert Rasters to TIFF
arcpy.conversion.RasterToOtherFormat(Input_Rasters=[PRISM_01_bil, PRISM_02_bil
, PRISM_03_bil,

PRISM_04_bil, PRISM_05_bil, PRISM_06_bil,

PRISM_07_bil, PRISM_08_bil, PRISM_09_bil,

PRISM_10_bil, PRISM_11_bil, PRISM_12_bil],

Output_Workspace="Lab2.gdb",

Raster_Format="TIFF")
```

Out[17]:

Output

Messages

Start Time: Monday, March 1, 2021 6:08:33 PM

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_01

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_02

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_03

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_04

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_05

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_06

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_07

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_08

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_09

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_10

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_11

Successfully converted:

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\PRISM_ZIPS\PRISM_ppt_30yr_normal_4kmM2

To

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\PRISM_ppt_30yr_normal_4kmM2_12

Succeeded at Monday, March 1, 2021 6:08:45 PM (Elapsed Time: 11.59 seconds)

In [21]:
```python
#attempt at direct BIL to mosaic
for each in ['01','02','03','04','05','06','07','08','09','10','11','12']:
    desired_file = "Lab2.gdb\\PRISM_ppt_30yr_normal_4kmM2_"+each+"_bil"
    arcpy.AddRastersToMosaicDataset_management('Lab2.gdb/TestMosaic3','Raster Dataset', desired_file)


# Process: Add Rasters To Mosaic Dataset
#arcpy.management.AddRastersToMosaicDataset(in_mosaic_dataset=TestMosaic3, raster_type="Raster Dataset", input_path= [PRISM_01_tif, PRISM_02_tif, PRISM_03_tif, PRISM_04_tif, PRISM_05_tif,
#                                                                                                                                  PRISM_06_tif, PRISM_07_tif, PRISM_08_tif,
#                                                                                                                               PRISM_09_tif, PRISM_10_tif, PRISM_11_tif,
#                                                                                                                             PRISM_12_tif] )
```

In [22]:
```python
# Process: Calculate Variable Field
arcpy.management.CalculateField(in_table=Updated_Mosaic_Dataset,
                                                             field="Variable",
                                                             expression="\"precipitation\"",
                                                             expression_type="PYTHON3",
                                                             field_type="TEXT")
# Process: Calculate Timestamp Field (2)
arcpy.management.CalculateField(in_table=Updated_Mosaic_Dataset,
                                                             field="Timestamp",
                                                             expression ="DateAdd(Date(2010,0,1), $feature.OBJECTID-1, 'month')",
                                                             expression_type="ARCADE",
                                                             field_type="DATE")
```

Out[22]:

Output

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\TestMosaic3

Messages

Start Time: Monday, March 1, 2021 6:16:42 PM

Adding Timestamp to AMD_TestMosaic3_CAT...

Succeeded at Monday, March 1, 2021 6:16:43 PM (Elapsed Time: 1.41 seconds)

In [23]:
```python
# Process: Build Multidimensional Info
arcpy.md.BuildMultidimensionalInfo(in_mosaic_dataset=TestMosaic3,
                                   variable_field="Var
iable",
                                   dimension_fields=[[
"Timestamp", "", ""]],
                                   variable_desc_units
=[])
```

Out[23]:

Output
C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\TestMosaic3

Messages
Start Time: Monday, March 1, 2021 6:17:23 PM
Succeeded at Monday, March 1, 2021 6:17:25 PM (Elapsed Time: 1.87 seconds)

In [24]:
```python
# Process: Make Multidimensional Raster Layer
arcpy.md.MakeMultidimensionalRasterLayer(in_multidimensional_raster = TestMosa
ic3,
                                   out_multidimensional_raster_l
ayer="Lab2.gdb\\TestMosaic3_MultidimLayer",
                                   variables=["precipitation"],
dimension_def="ALL",
                                   dimension_ranges=[], dimensio
n_values=[],
                                   dimension="", start_of_first_
iteration="",
                                   end_of_first_iteration="", it
eration_step=None,
                                   iteration_unit="", template=
"DEFAULT",
                                   dimensionless="DIMENSIONS")
```

Out[24]:

Output
a Layer object

Messages
Start Time: Monday, March 1, 2021 6:17:30 PM
Succeeded at Monday, March 1, 2021 6:17:37 PM (Elapsed Time: 6.22 seconds)

```
In [26]:  # Process: Create Space Time Cube From Multidimensional Raster Layer
          TimeCube2_nc = "C:\\Users\\Cole\\Documents\\GitHub\\GIS5572\\Lab2\\TimeCube2.n
          c"
          arcpy.stpm.CreateSpaceTimeCubeMDRasterLayer(in_md_raster="Lab2.gdb\\TestMosaic
          3_MultidimLayer", output_cube=TimeCube2_nc, fill_empty_bins="ZEROS")
```

`Out[26]:`

Output

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\TimeCube2.nc

Messages

Start Time: Monday, March 1, 2021 6:21:04 PM
WARNING 110296: The Input Multidimensional Raster Layer contains irregular time intervals.
The data has been binned into regular intervals of 2419200 seconds.
WARNING 110013: The default Time Step Interval is 28 days.
The space time cube has aggregated 305309515 points into 964467 fishnet grid locations over
12 time step intervals. Each location is a 4638.31 meters by 4638.31 meters square. The entire
space time cube spans an area 6136486.93 meters west to east and 3381329.53 meters north
to south. Each of the time step intervals is 28 days in duration so the entire time period covered
by the space time cube is 336 days. Of the 964467 total locations, 384562 (39.87%) contain at
least one point for at least one time step interval. These 384562 locations comprise 4614744
space time bins of which 11573604 (250.80%) have point counts greater than zero. There is not
a statistically significant increase or decrease in point counts over time.

---------- Space Time Cube Characteristics -----------
Input feature time extent 2010-01-01 06:00:00
to 2010-12-01 06:00:00

Number of time steps 12
Time step interval 28 days
Time step alignment End

First time step temporal bias 7.14%
First time step interval after
2009-12-30 06:00:00
to on or before
2010-01-27 06:00:00

Last time step temporal bias 0.00%
Last time step interval after
2010-11-03 06:00:00
to on or before
2010-12-01 06:00:00

Cube extent across space (coordinates in meters)
Min X -2871587.5494
Min Y 2660354.4221
Max X 3264899.3806
Max Y 6041683.9549
Rows 729
Columns 1323
Total bins 11573604

--- Overall Data Trend - PRECIPITATION_NONE_ZEROS ----

Trend direction Not Significant

Trend statistic 0.0686

Trend p-value 0.9453

Succeeded at Monday, March 1, 2021 6:21:15 PM (Elapsed Time: 10.73 seconds)

In [30]:
```python
# Process: Visualize Space Time Cube in 3D
TimeCube2_VisualizeSpaceTimeCube3D = "C:\\Users\\Cole\\Documents\\GitHub\\GIS5
572\\Lab2\\Lab2.gdb\\TimeCube2_VisualizeSpaceTimeCube3D"
arcpy.stpm.VisualizeSpaceTimeCube3D(in_cube=TimeCube2_nc,
                                    cube_variable="PRECIPITATION_NONE_
ZEROS",
                                    display_theme="VALUE",
                                    output_features=TimeCube2_Visualiz
eSpaceTimeCube3D)
```

Out[30]:

Output
C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\TimeCube2_VisualizeSpaceTimeCube

Messages
Start Time: Monday, March 1, 2021 6:24:22 PM
WARNING 110044: The time it takes to render the cube in three dimensions may vary considerably based on the number of features and the graphics card associated with your CPU.
WARNING 110054: If some or all of your data is not drawing, it may fall outside of the Visibility Range limits, which can be cleared. If some or all of your data is underground, you may need to turn off Elevation Surfaces.
Succeeded at Monday, March 1, 2021 6:26:48 PM (Elapsed Time: 2 minutes 26 seconds)

In [ ]:
```
Export to Time Series
```