

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()
    # download and unzip for each normals file
    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]: 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.bil")
PRISM_02_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_02_bil.bil")
PRISM_03_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_03_bil.bil")
PRISM_04_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_04_bil.bil")
PRISM_05_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_05_bil.bil")
PRISM_06_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_06_bil.bil")
PRISM_07_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_07_bil.bil")
PRISM_08_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_08_bil.bil")
PRISM_09_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_09_bil.bil")
PRISM_10_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_10_bil.bil")
PRISM_11_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_11_bil.bil")
PRISM_12_bil = arcpy.Raster("PRISM_ZIPS\\PRISM_ppt_30yr_normal_4kmM2_12_bil.bil")
```

```
In [20]: # Process: Create A Mosaic Dataset
TestMosaic3 = arcpy.management.CreateMosaicDataset(in_workspace=Lab2_gdb, in_mosaicdataset_name="TestMosaic3",
coordinate_system="PROJCS['NAD_1983_UTM_Zone_15N',GEOGCS['GCS_North_American_1983',DATUM['D_North_American_1983',SPHEROID['GRS_1980',6378137.0,298.257222101]],PRIMEM['Greenwich',0.0],UNIT['Degree',0.0174532925199433]],PROJECTION['Transverse_Mercator'],PARAMETER['False_Easting',500000.0],PARAMETER['False_Northing',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]: # 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]: #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"

    #add to newly created mosaic
    arcpy.AddRastersToMosaicDataset_management('Lab2.gdb/TestMosaic3','Raster
Dataset', desired_file)
```

```
In [22]: # 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="ARCADY",
                                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]: # Process: Build Multidimensional Info
arcpy.md.BuildMultidimensionalInfo(in_mosaic_dataset=TestMosaic3,
                                   variable_field="Variable",
                                   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]: # Process: Make Multidimensional Raster Layer
#use precip for variable
arcpy.md.MakeMultidimensionalRasterLayer(in_multidimensional_raster = TestMosaic3,
                                         out_multidimensional_raster_layer=
"Lab2.gdb\\TestMosaic3_MultidimLayer",
                                         variables=["precipitation"],
                                         dimension_def="ALL",
                                         dimension_ranges=[],
                                         dimension_start_of_first_iteration=
"",
                                         iteration_unit="",
                                         iteration_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.nc"
arcpy.stpm.CreateSpaceTimeCubeMDRasterLayer(in_md_raster="Lab2.gdb\\TestMosaic3_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]: # Process: Visualize Space Time Cube in 3D
TimeCube2_VisualizeSpaceTimeCube3D = "C:\\Users\\Cole\\Documents\\GitHub\\GIS5572\\Lab2\\Lab2.gdb\\TimeCube2_VisualizeSpaceTimeCube3D"
arcpy.stpm.VisualizeSpaceTimeCube3D(in_cube=TimeCube2_nc,
                                     cube_variable="PRECIPITATION_NONE_ZEROS",
                                     display_theme="VALUE",
                                     output_features=TimeCube2_VisualizeSpaceTimeCube3D)
```

Out[30]:

Output

C:\Users\Cole\Documents\GitHub\GIS5572\Lab2\Lab2.gdb\TimeCube2_VisualizeSpaceTimeCube3D

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