

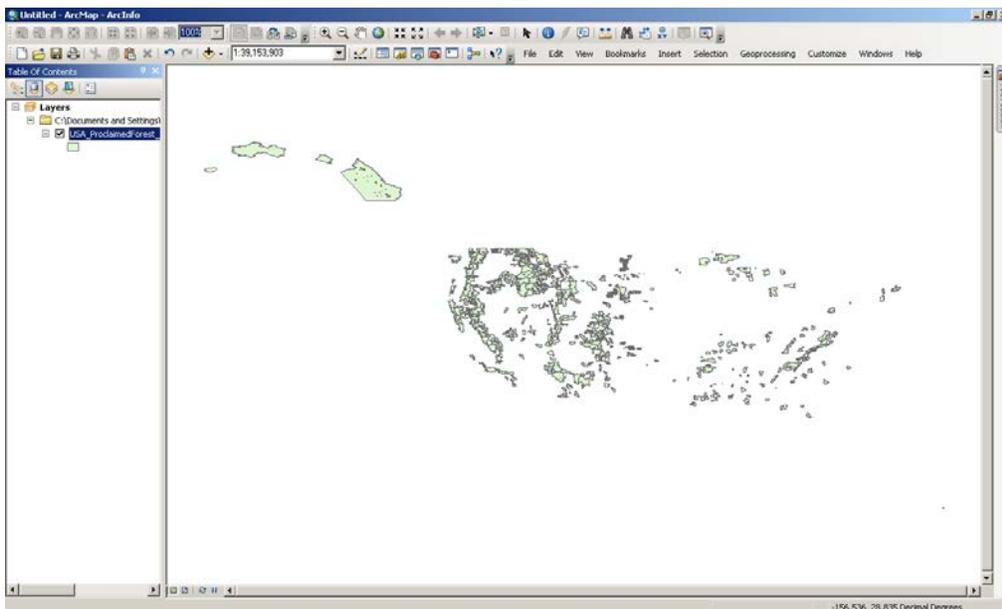
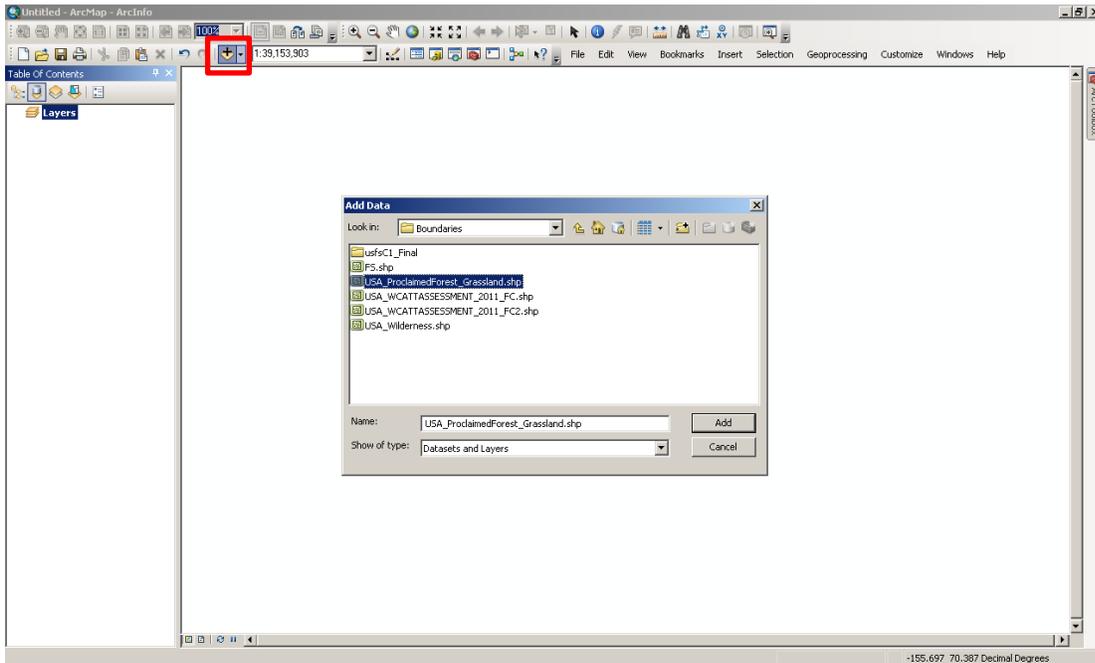
This documentation is outdated but shows our methodology before switching from CMAQ to TDEP for CL Exceedance Calculation. We are working to update this document, written: December 18, 2012

Critical Load Exceedance Calculation Documentation for Nationwide Critical Loads Efforts

Exceedance of Critical Loads of N for Mychorrized Fungi/Lichens/Herbaceous Plants and Shrubs/Forests/Nitrate Leaching on Forest Service Lands



1. Add Data : Boundaries→ USA_ProclaimedForest_Grassland.shp→Add
 - This layer displays NFS boundaries. Starting with this layer ensures that all future imported layers will be projected into the NAD 1983 projection.



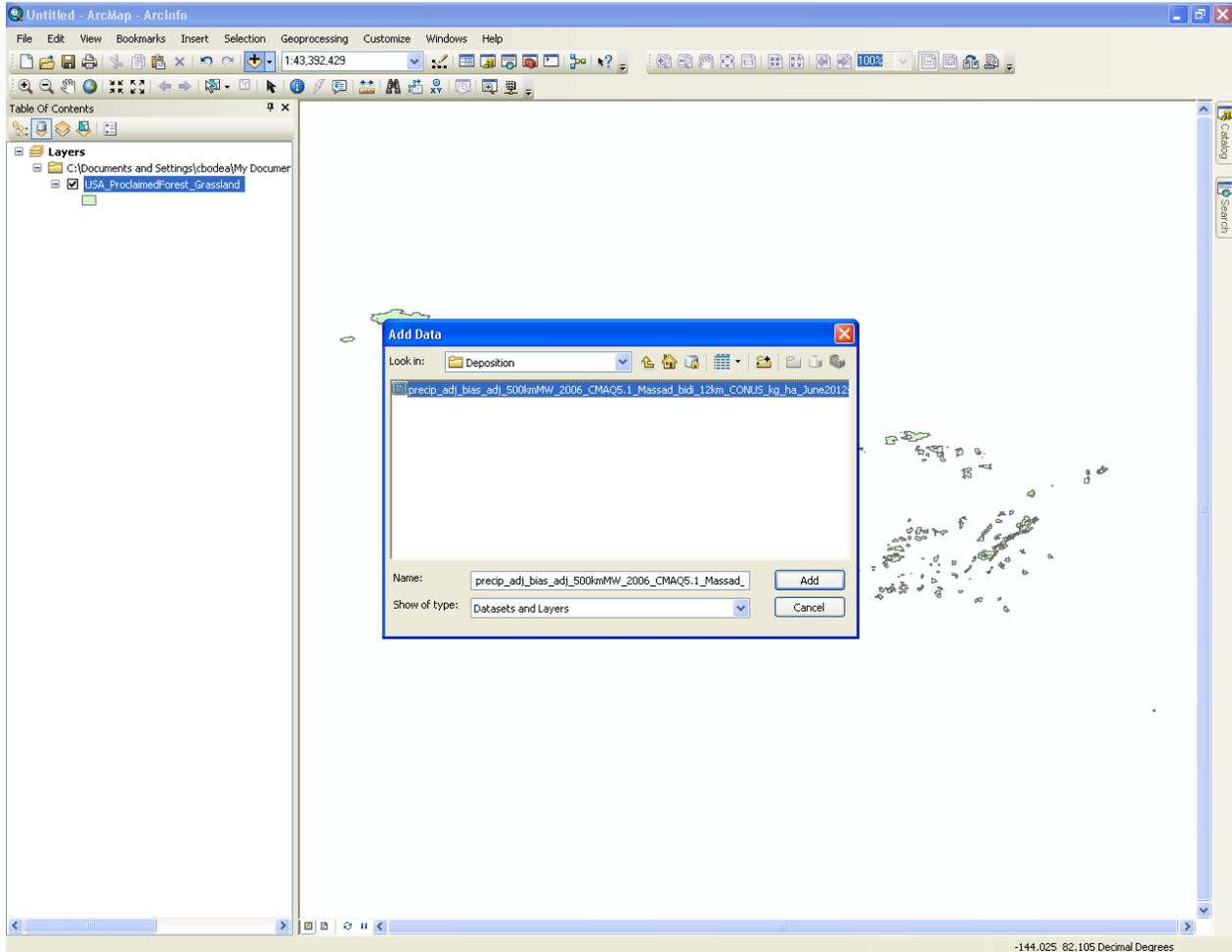
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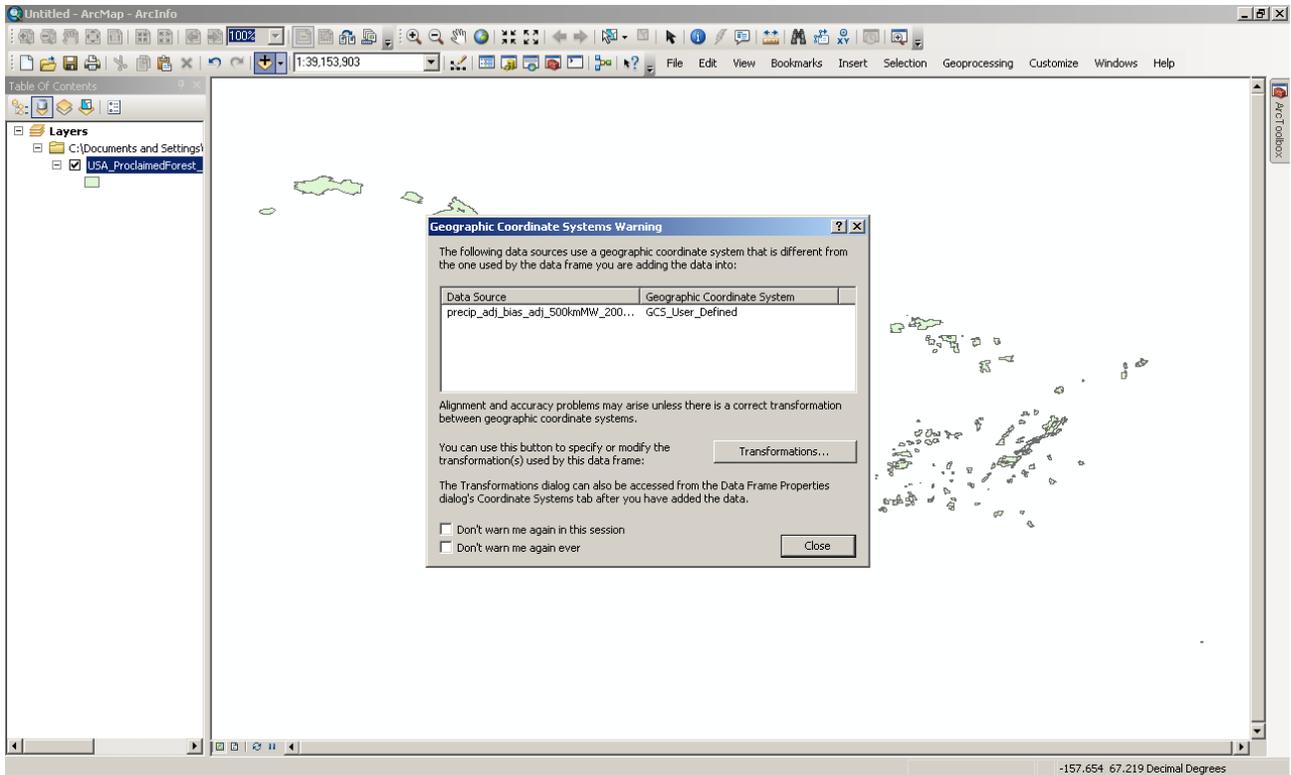
2. Add Data :

Deposition→US→precip_adj_bias_adj_500kmMW_2006_CMAQ5.1_Massad_bidi_12km_CONU
S_kg_ha_June2012sim.shp→Add

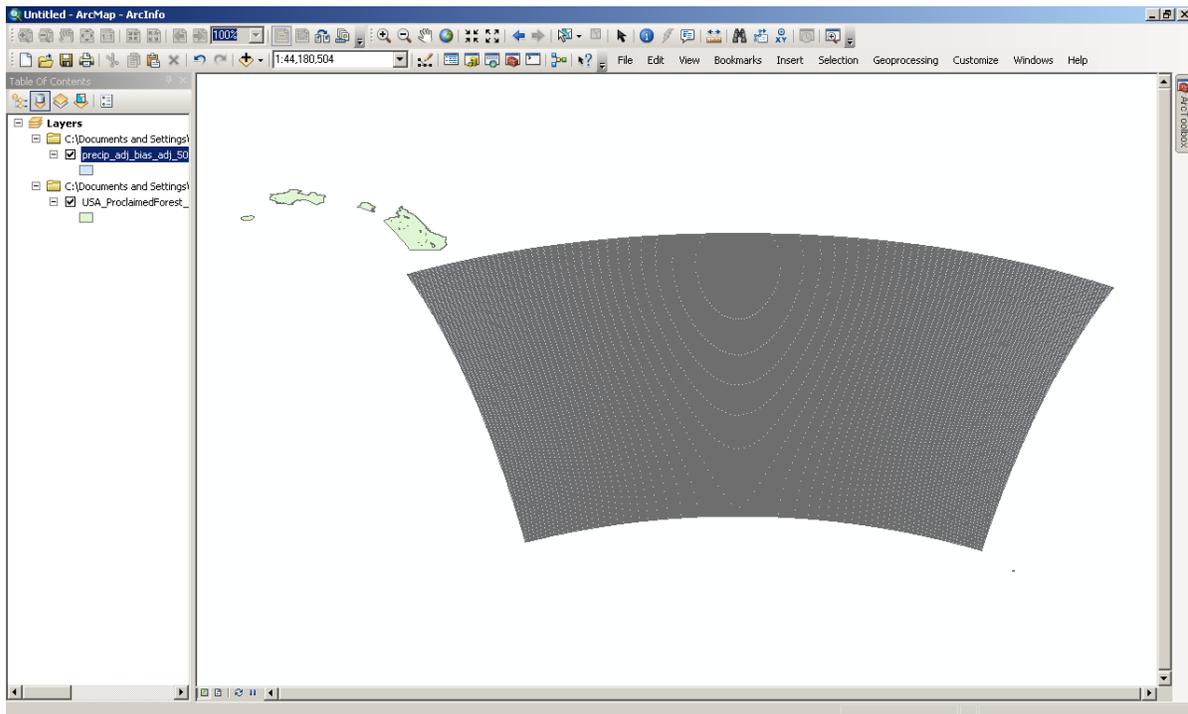
- This layer displays 2006 CMAQ deposition data.



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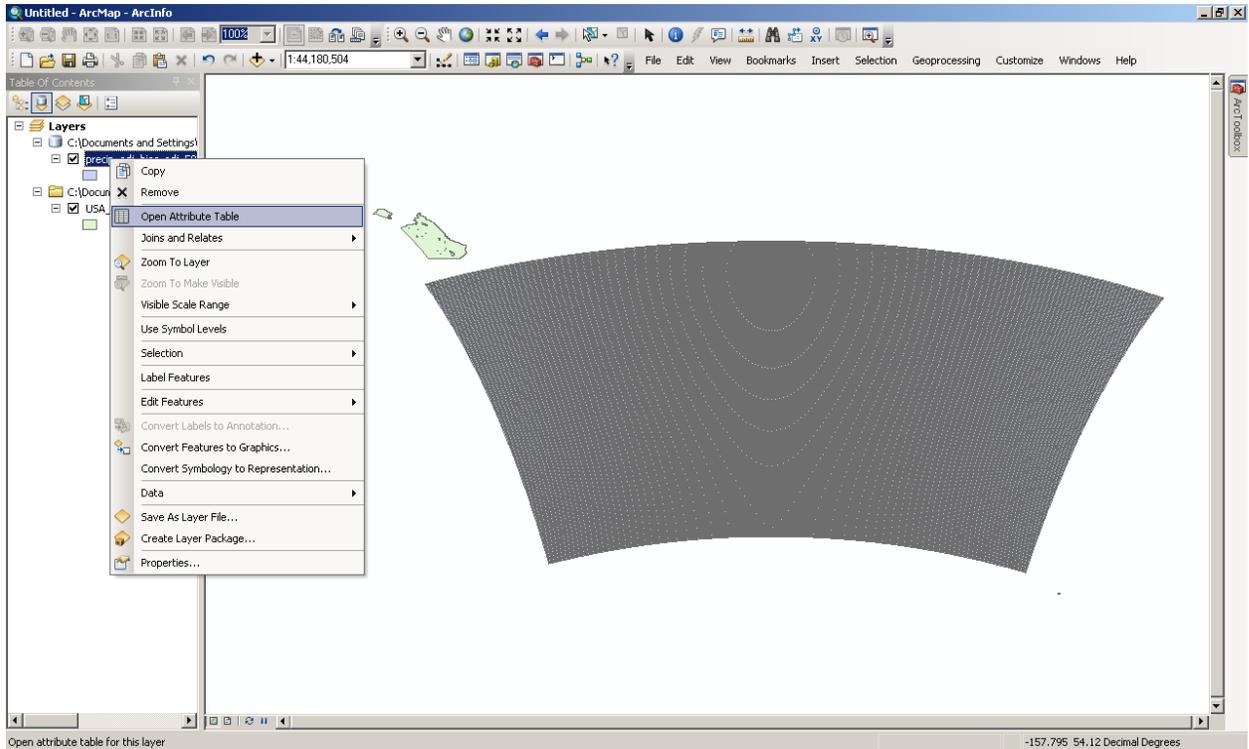


3. Close. **Note:** Other shapefiles added to this map will be reprojected on the fly to the projection defined by the first shapefile opened (NAD 1983 in this case). The shapefiles will line up in the viewer, but the projection of the shapefile itself will not change. For instructions on changing the projection of the file itself, see the end of this document (p. 20).



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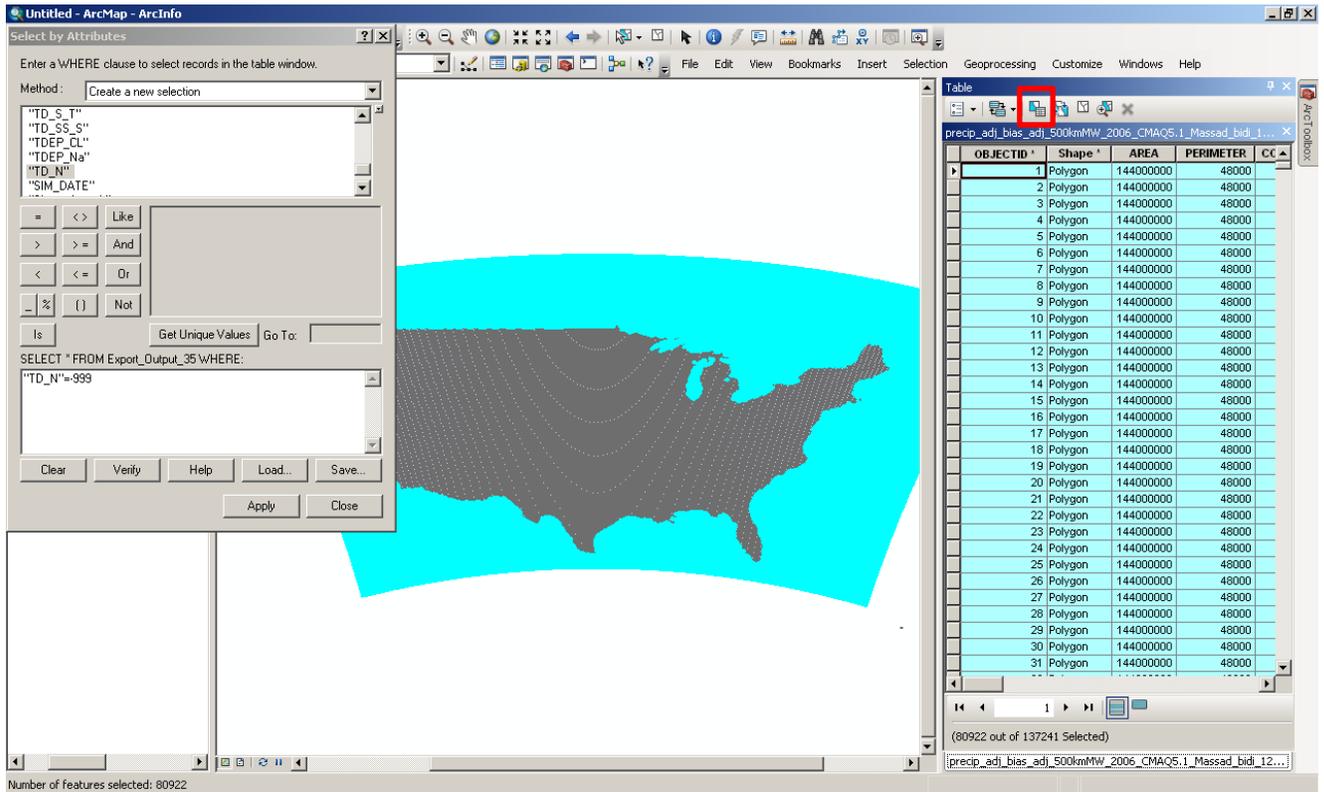
4. Right click on **precip_adj_bias_adj_500kmMW_2006_CMAQ5.1_Massad_bidi_12km_CONUS_kg_ha_June2012sim** in the Table of Contents and select “Open Attribute Table.”



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5. Click on “Select by Attributes” in the attribute table. The “Select by Attributes” window will appear. Double click on the variable “TD_N”. “TD_N” will appear in the “Select*From” dialog box. Double click the “=” sign and type “-999”. Click Apply. This procedure will select all the “no data” values. Close.



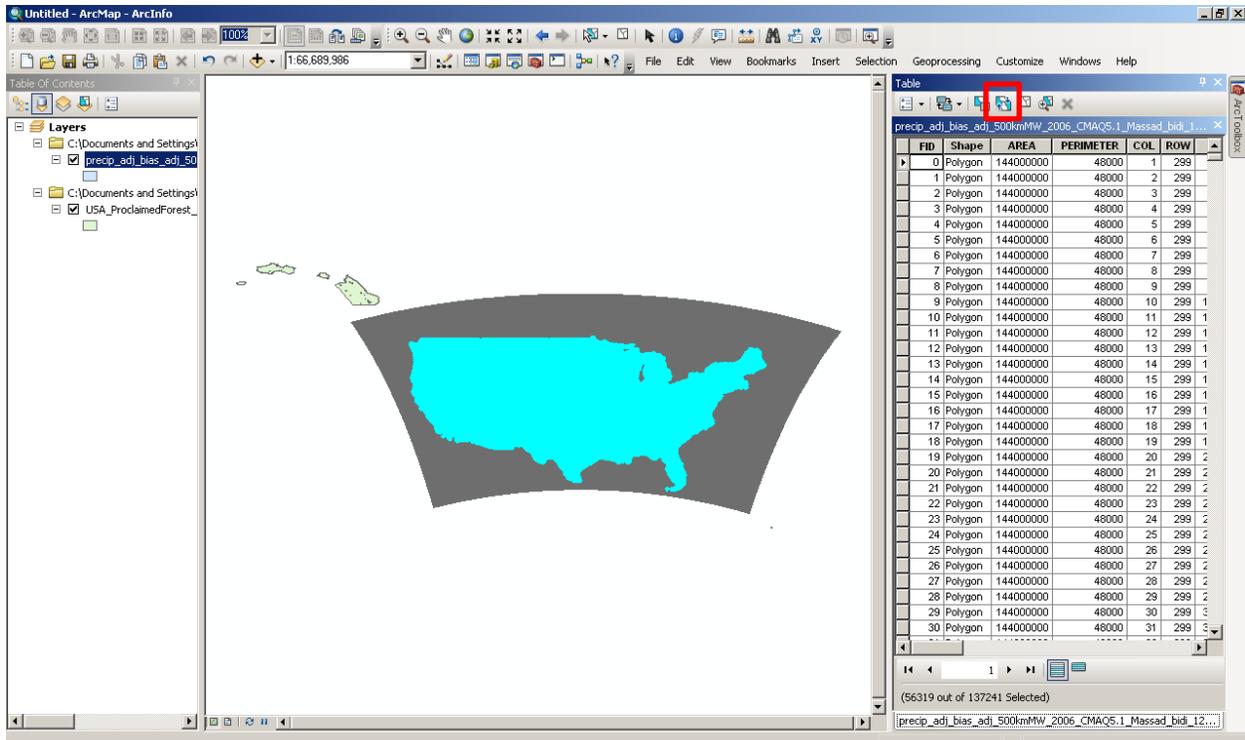
Number of features selected: 80922

OBJECTID	Shape	AREA	PERIMETER	CC
1	Polygon	144000000	48000	
2	Polygon	144000000	48000	
3	Polygon	144000000	48000	
4	Polygon	144000000	48000	
5	Polygon	144000000	48000	
6	Polygon	144000000	48000	
7	Polygon	144000000	48000	
8	Polygon	144000000	48000	
9	Polygon	144000000	48000	
10	Polygon	144000000	48000	
11	Polygon	144000000	48000	
12	Polygon	144000000	48000	
13	Polygon	144000000	48000	
14	Polygon	144000000	48000	
15	Polygon	144000000	48000	
16	Polygon	144000000	48000	
17	Polygon	144000000	48000	
18	Polygon	144000000	48000	
19	Polygon	144000000	48000	
20	Polygon	144000000	48000	
21	Polygon	144000000	48000	
22	Polygon	144000000	48000	
23	Polygon	144000000	48000	
24	Polygon	144000000	48000	
25	Polygon	144000000	48000	
26	Polygon	144000000	48000	
27	Polygon	144000000	48000	
28	Polygon	144000000	48000	
29	Polygon	144000000	48000	
30	Polygon	144000000	48000	
31	Polygon	144000000	48000	

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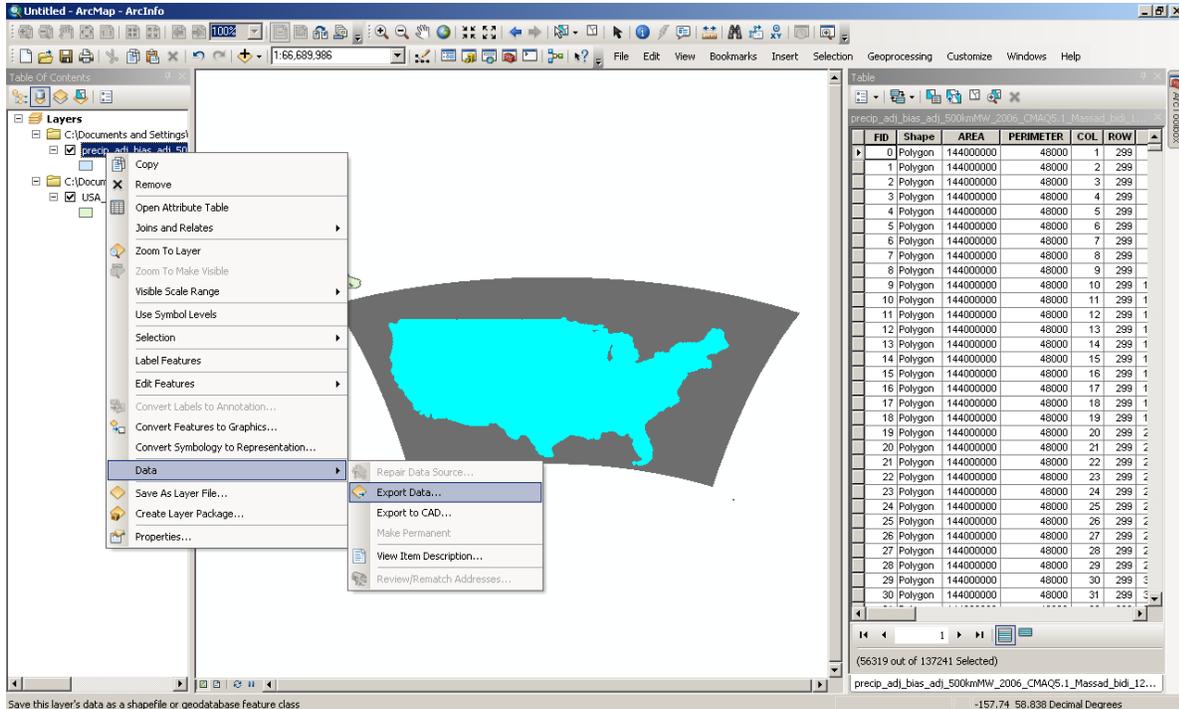


6. Click on “Switch Selection” in the attribute table. This procedure will select only the grid cells with values for the continental US.

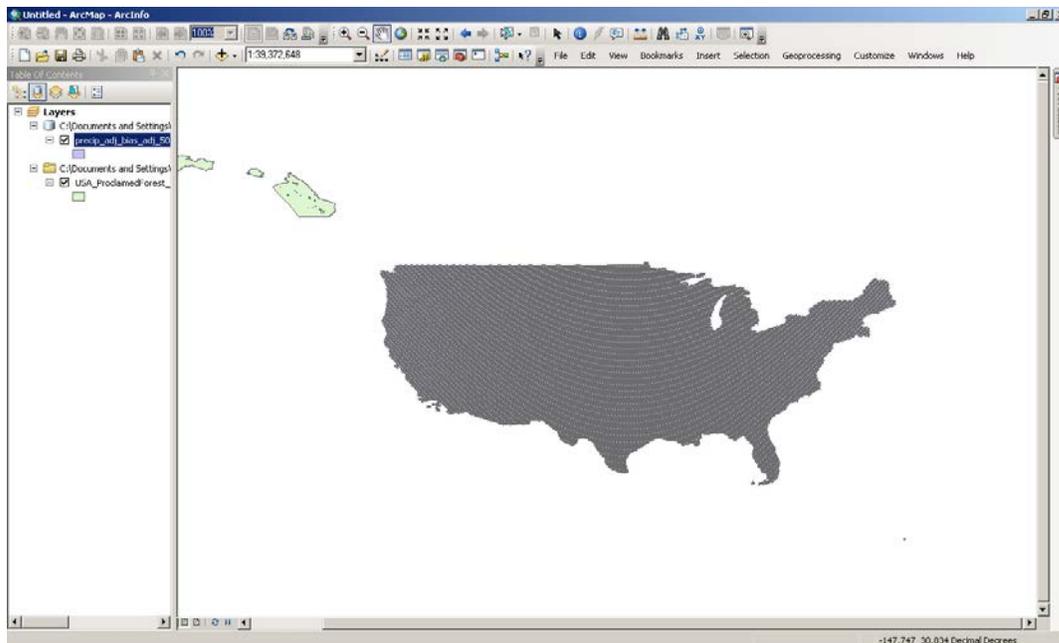


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7. Right click on the file name in the Table of Contents to export selected data (**precip_adj_bias_adj_500kmMW_2006_CMAQ5.1_Massad_bidi_12km_CONUS_kg_ha_June2012sim**). Select “Data” and “Export Data.” Click OK on Export Data window. A window will pop up and ask “Do you want to add the exported data to the maps as a layer?” Click Yes.



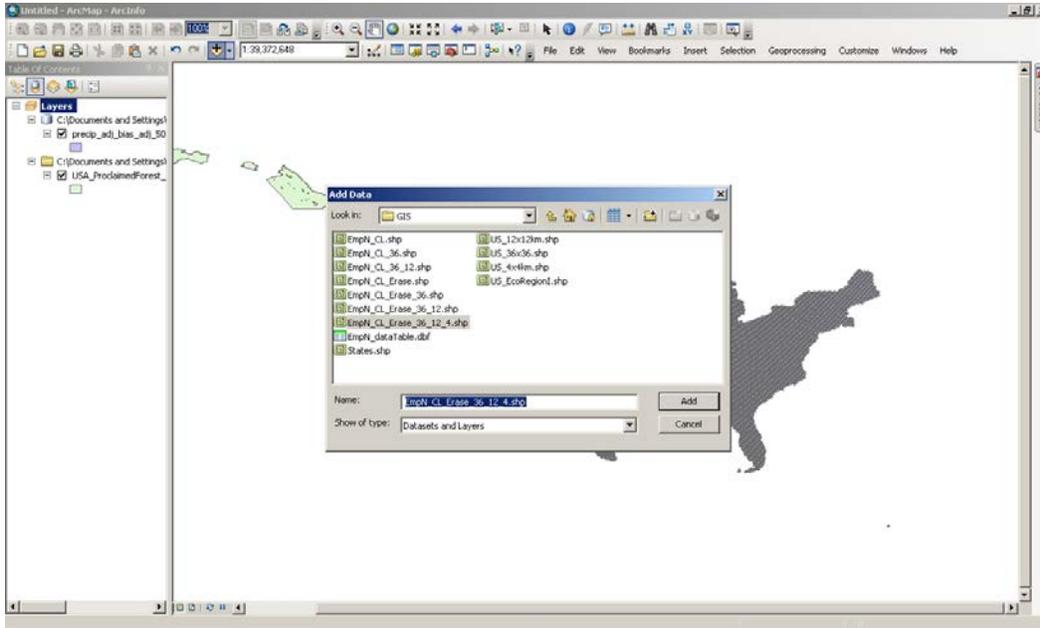
8. A new file will appear in the Table of Contents: **Export_Output_##**. This is the file with only the selected data for the continental US. You can remove the original file from the Table of Contents and rename the new file with the same name as the one that has just been removed.



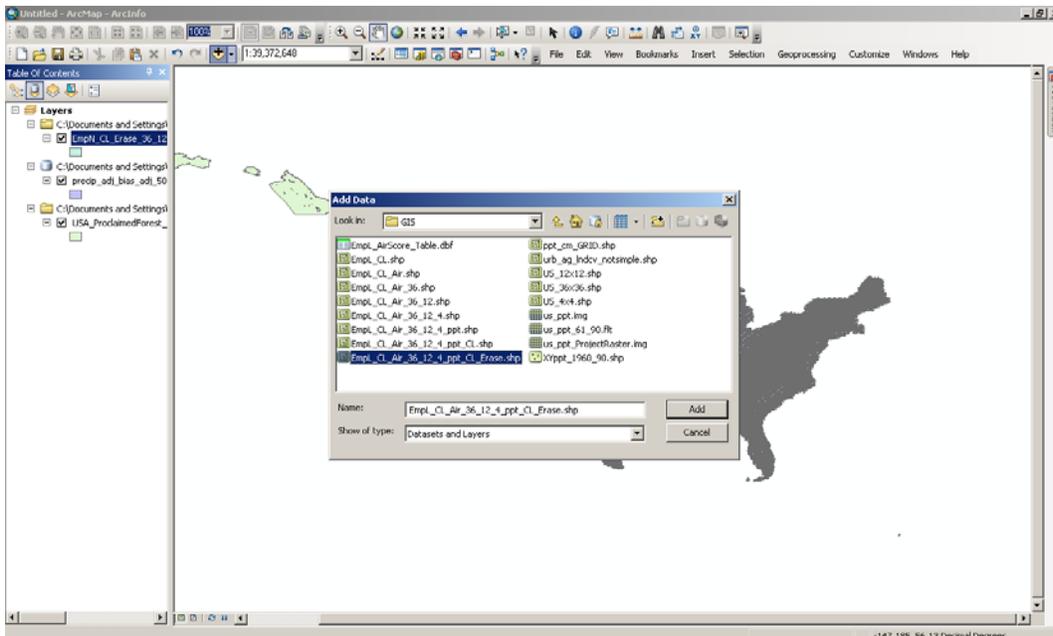
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9. Add Data : EmpiricalN → EmpN_CL_Erase_36_12_4.shp → Add. (Click Close when Geographical Coordinate System Warning appears because data will be reprojected on the fly.)
 - This layer displays empirical CLs for nutrient N for all receptors from GTR-80.

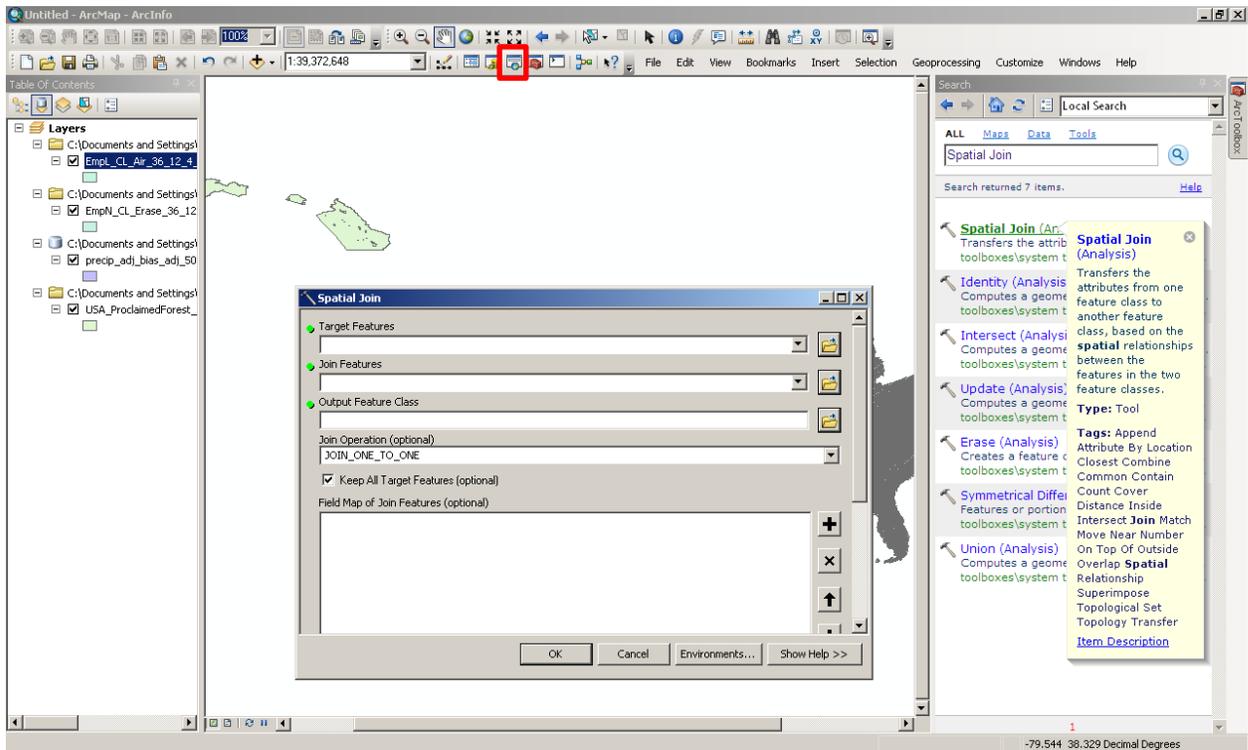


10. Add Data : EmpiricalL → EmpL_CL_Air_36_12_4_ppt_CL_Erase.shp → Add. (Click Close when Geographical Coordinate System Warning appears because data will be reprojected on the fly.)
 - This layer displays updated empirical CLs for nutrient N for lichens.



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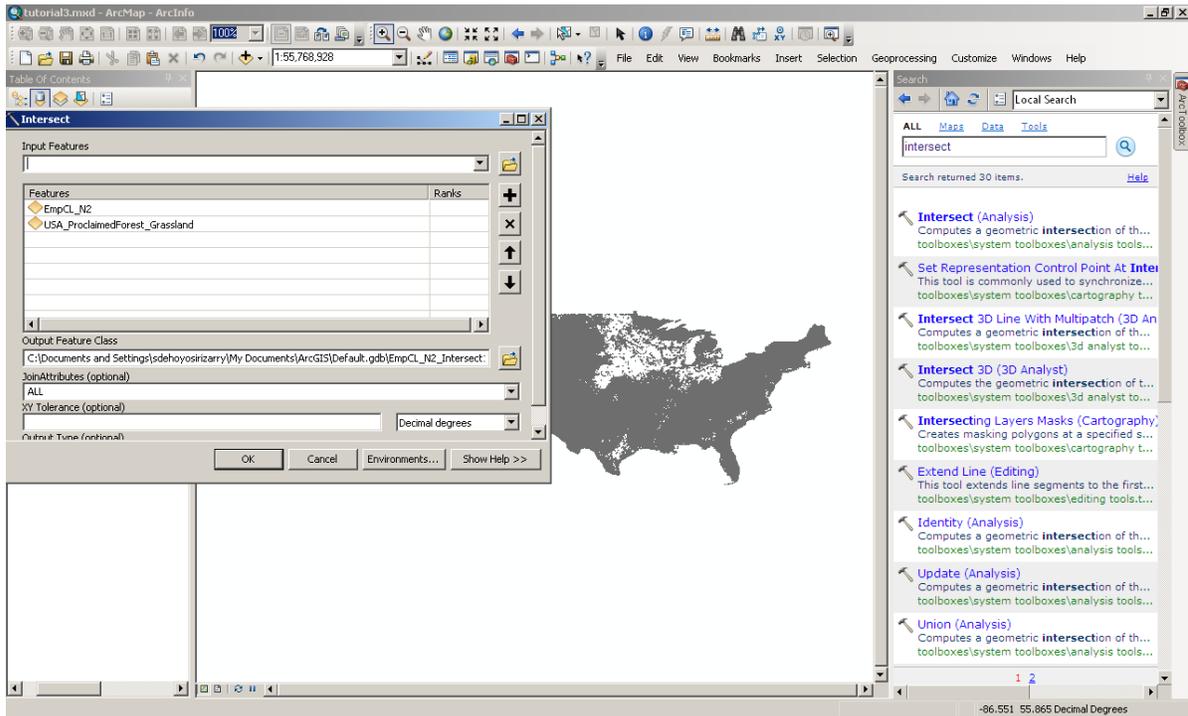
11. Search for “Spatial Join” to join the deposition data with the empirical CLs. Use the Search  to find any tool just by typing the name.



- Target Features: precip_adj_bias_adj_500kmMW_2006_CMAQ5.1_Massad_bidi_12km_CONUS_kg_ha_June2012sim
 - Join Features: EmpN_CL_Erase_36_12_4
 - Output Feature Class: Define a path for your output
 - OK
12. Perform another “Spatial Join” to merge the newly created layer with the updated CLs for lichens into one shapefile.
- Target Features: Output Feature from previous Spatial Join
 - Join Features: EmpL_CL_Air_36_12_4_ppt_CL_Erase
 - Output Feature Class: Define a path for your output
 - OK

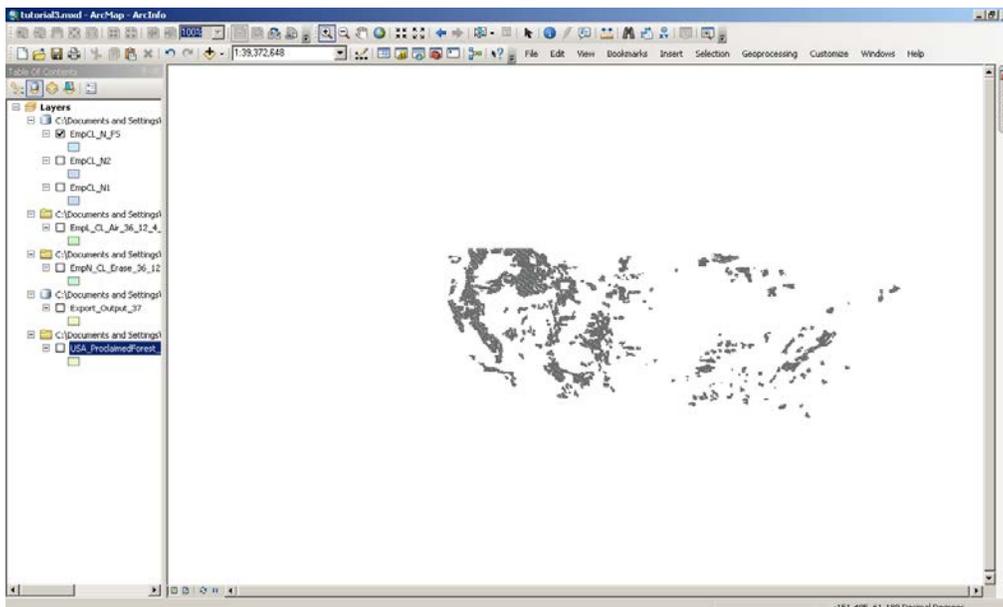
This documentation is outdated but shows our methodology before switching from CMAQ to TDEP for CL Exceedance Calculation. We are working to update this document, written: December 18, 2012

13. Search for "Intersect." You can use the Search  to find any tool just by typing the name.



- Input Features:
 - Output Feature from previous Spatial Join
 - USA_ProclaimedForest_Grassland
- Output Feature Class: Provide a name and path to the Output
- OK

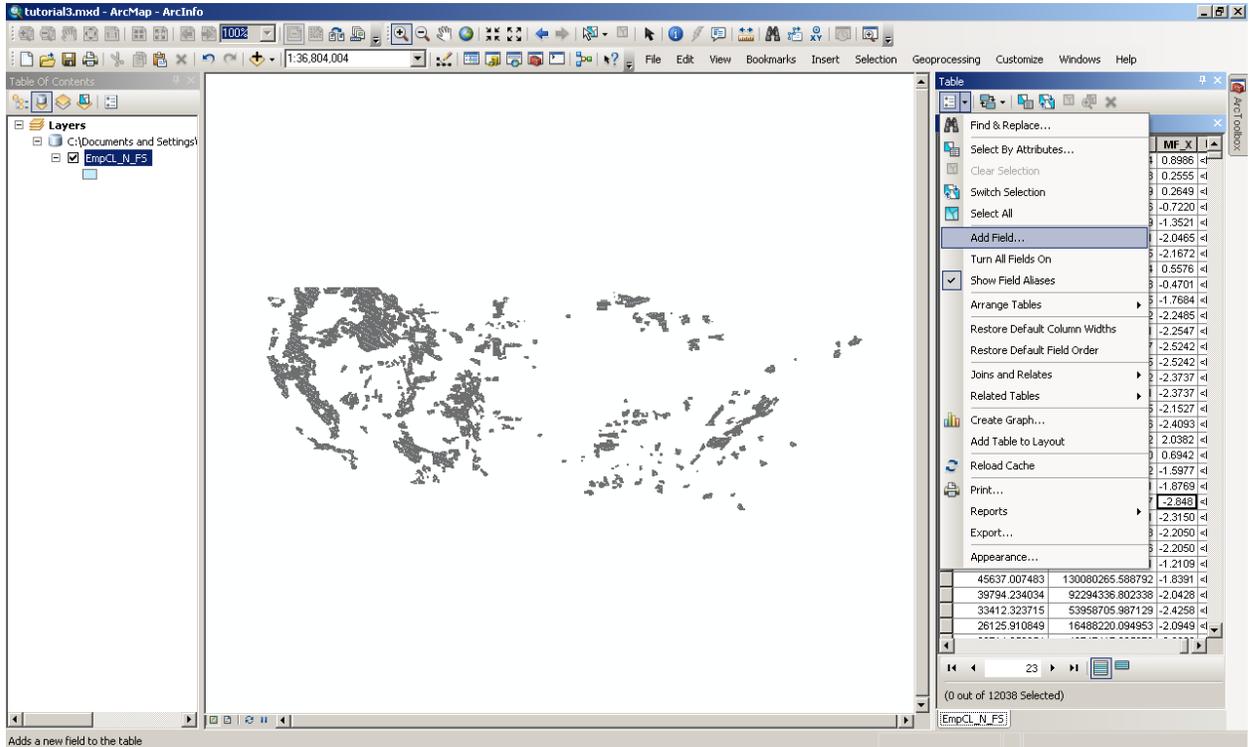
This step creates a new shapefile containing only CLs and deposition information within NFS boundaries.



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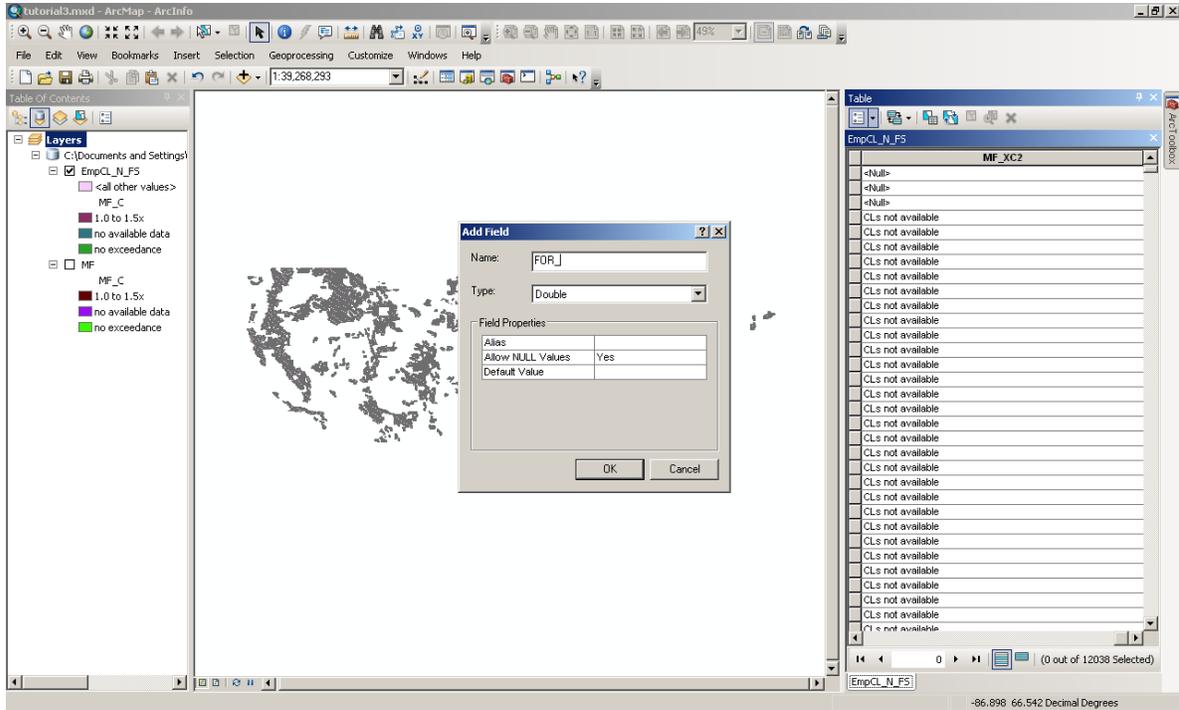
14. Remove all files from the Table of Contents leaving only your last Output.

15. Open the Attribute Table and open the Table Options menu . Select "Add Field".

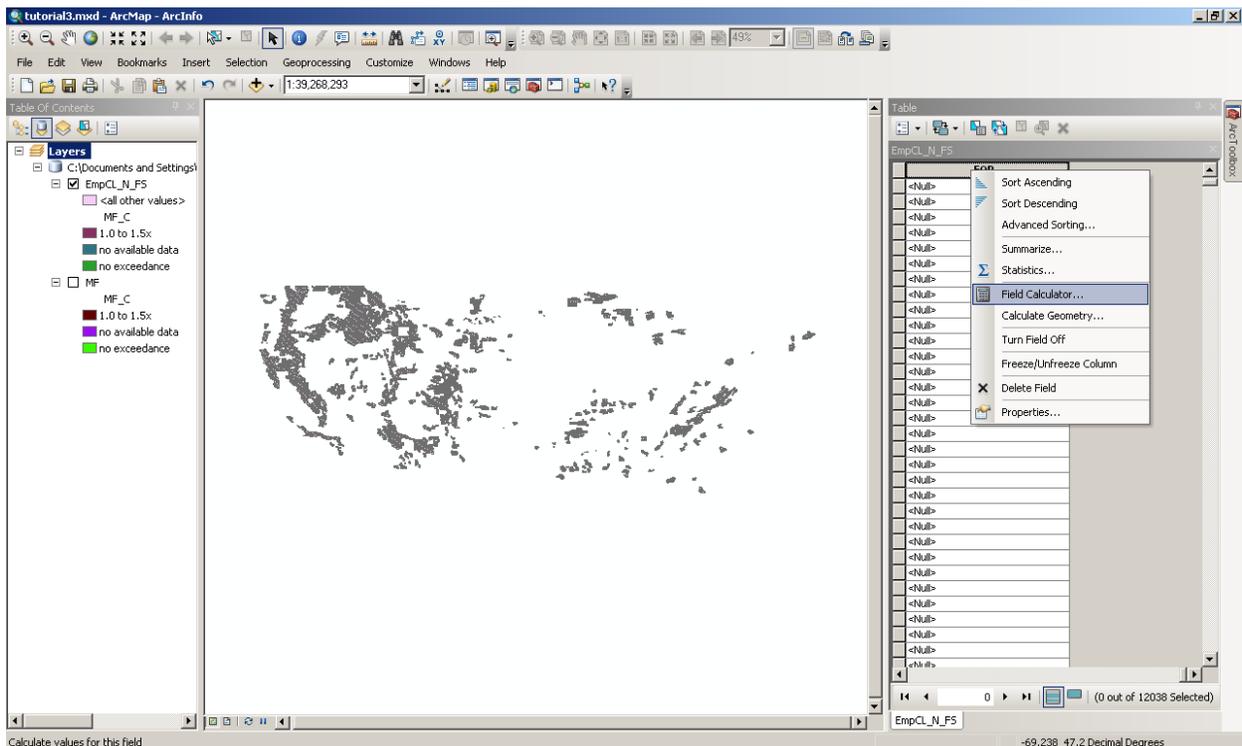


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16. Name the new field and select “Double” as the format for the result. We will name our field **FOR_** because our example calculates exceedances of the critical loads for forests. Click OK. A new column (field) will appear at the far right side of the attribute table. Use the scroll bar to navigate to the right if you don’t see the new field right away.



17. Right click on the field header and select “Field Calculator.”

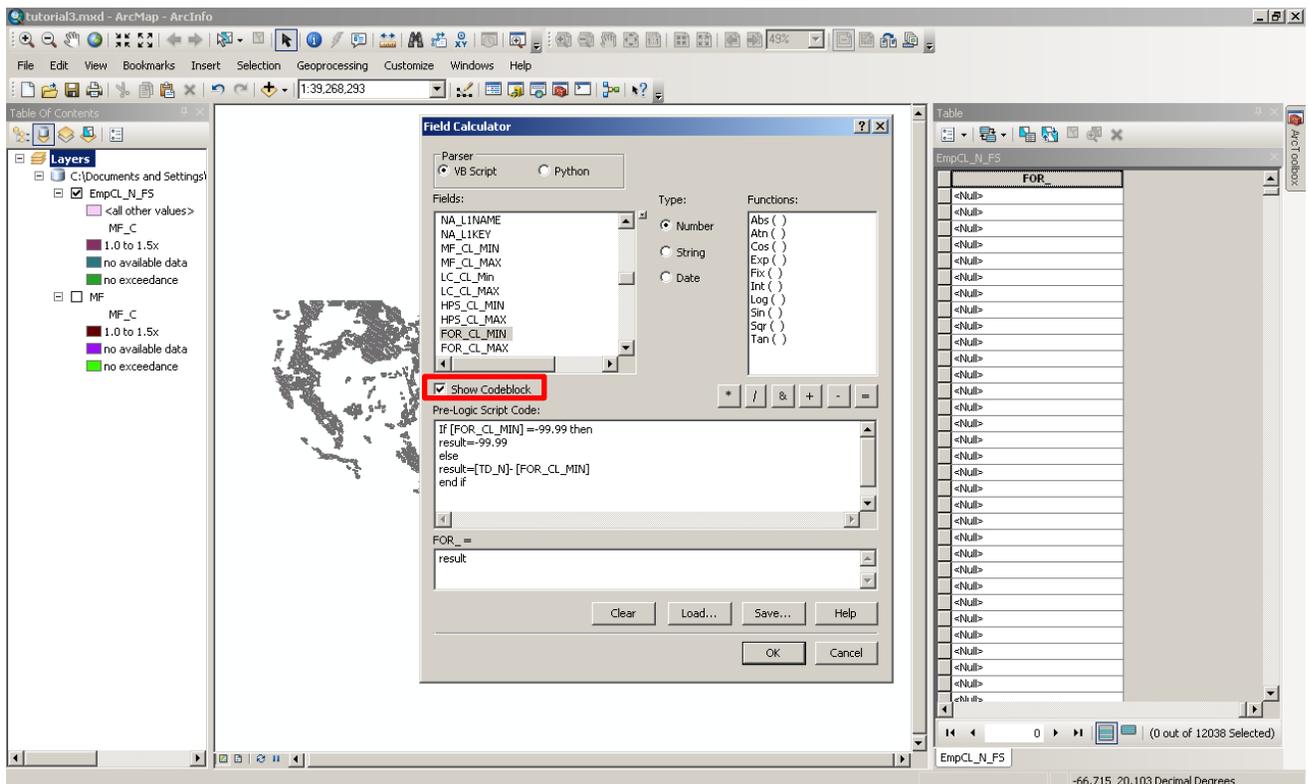


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18. Check on Show Codeblock. A “Pre-Logic Script Code” whitebox will appear. Paste the following code into the whitebox. Note that you will need to change the field in bold depending on the receptor for the CL exceedance you are calculating. Use the “Fields” selection box to select the corresponding field for your calculation. For this example we are using **Forests**. Type the word “result” in the whitebox at the bottom of the “Field Calculator” window. Click OK.

```
If [FOR_CL_MIN] =-99.99 then
result=-99.99
else
result=[TD_N]- [FOR_CL_MIN]
end if
```

This field calculates the CL exceedance for Forests by subtracting the minimum empirical critical load for forests (FOR_CL_MIN) from total nitrogen deposition (TD_N), leaving non-values as -99.99. We chose to calculate exceedances based on minimum critical loads to better protect sensitive receptors. If you decide to map CL exceedance values (rather than the exceedance classes calculated below), define exceedance values of -99.99 as “No CLs Available.”



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19. Add another field and select “Double” as the format for your result. We will name this field **FOR_C**.

20. Right click on the new field’s header and select “Field Calculator.” Repeat Step 18 using the following code:

```
If [FOR_CL_MIN] =-99.99 then
result=-99.99
else
result=[TD_N]/ [FOR_CL_MIN]
end if
```

This field calculates the proportion by which deposition exceeds the CL (rather than the amount). This value can be used to classify the CL exceedance into “Exceedance Classes.” This calculation again leaves non-values as -99.99.

21. Add another field. Name this field **FOR_XC**. This time select “Text” as the format for your output.

22. Right click on the new field’s header and select “Field Calculator.” Repeat Step 18 using the following code:

```
If [FOR_C] <1 then
result="No Exceedance"
elseif [FOR_C] >2.0 then
result="Over 2.0 Exceedance"
elseif [FOR_C] >=1.5 then
result="1.5 to 2.0 Exceedance"
elseif [FOR_C] >=1 then
result="1.0 to 1.5 Exceedance"
else
result="Null"
end if
```

This field classifies the exceedance proportions into the following exceedance classes (this in an interim step where missing data is incorrectly classified as “No Exceedance”):

- FOR_C < 1 → No Exceedance
- FOR_C between 1 and 1.5 → 1.0 to 1.5 Exceedance
- FOR_C between 1.5 and 2.0 → 1.5 to 2.0 Exceedance
- FOR_C > 2 → Over 2.0 Exceedance

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*Note: Use the following piece of VB code for the lichens receptor because exceedances are much higher:

```
If [LC_C] <1 then
result="No Exceedance"
elseif [LC_C] >50.0 then
result="Over 50.0 Exceedance"
elseif [LC_C] >=10.0 then
result="10.0 to 50.0 Exceedance"
elseif [LC_C] >=1 then
result="1.0 to 10.0 Exceedance"
else
result="Null"
end if
```

23. Add another field. We are naming this field **FOR_XC2**. This time select "Text" as the format for your output.
24. Right click on the new field's header and select "Field Calculator." Repeat Step 18 using the following code:

```
If [FOR_CL_MIN] =-99.99 then
result="CLs Not Available"
else
result= [FOR_XC]
end if
```

This new field is used to define non data values (-99.99) as "CLs Not Available," however there are still some "Null" values remaining. Other values for this field will be equal to the previous field value **FOR_XC**.

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25. Add another field. Name this field **FOR_Class**. Select "Text" as the format for your output.
26. Right click on the new field's header and select "Field Calculator." Repeat Step 18 using the following code:

```
If [FOR_XC2] ="Null"  
    result="CLs Not Available"  
else  
    result= [FOR_XC2]  
end if
```

This new field is used to define null values as "CLs Not Available." Other values for this field will be equal to the previous field value **FOR_XC2**. This is the field to use when mapping CL exceedance classes.

27. Add another field. Name this field **FOR_X**. Select "Text" as the format for your output.
28. Right click on the new field's header and select "Field Calculator." Repeat Step 18 using the following code:

```
If [FOR_C] <1 then  
    result="No Exceedance"  
else  
    result="Exceedance "  
end if
```

This field classifies the data into "Exceedance" versus "No Exceedance" instead of classifying exceedances into exceedance classes. This in an interim step where missing data is incorrectly classified as "No Exceedance."

29. Add another field. Name this field **FOR_X2**. Select "Text" as the format for your output.
30. Right click on the new field's header and select "Field Calculator." Repeat Step 18 using the following code:

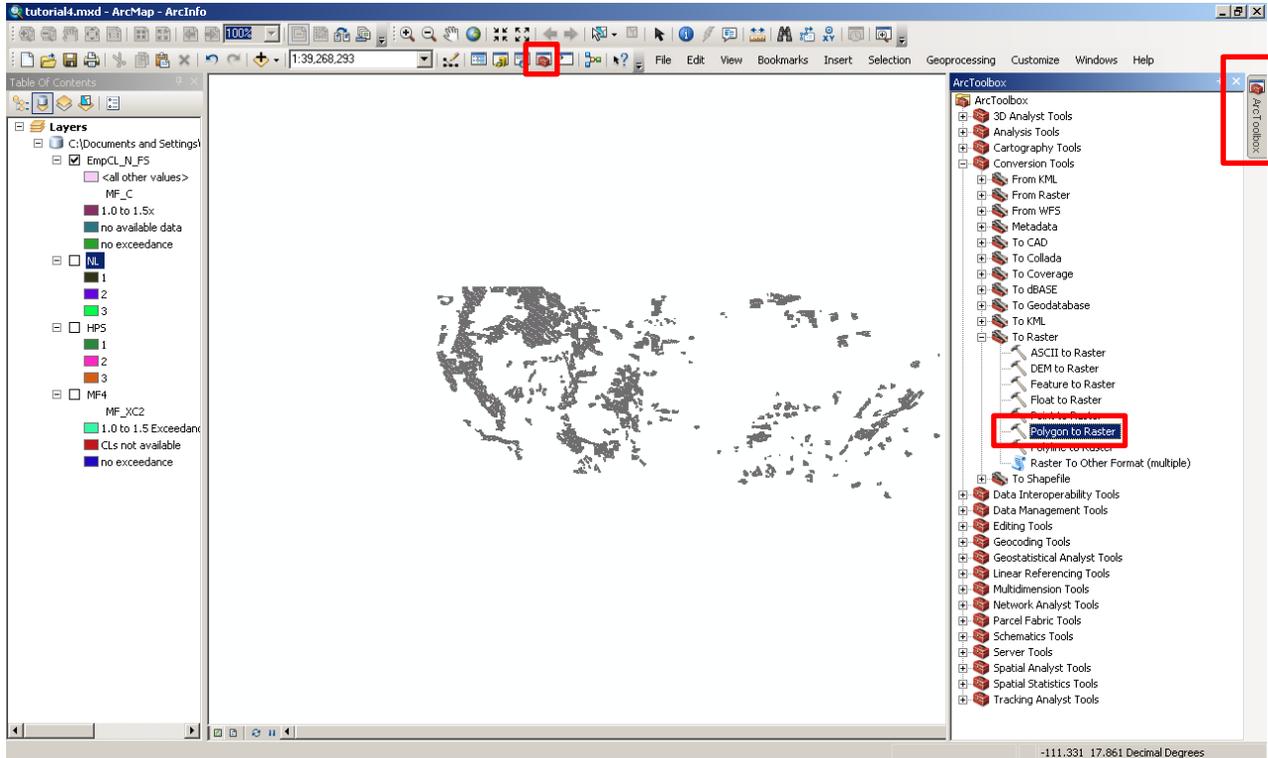
```
If [FOR_CL_MIN] =-99.99 then  
    result="CLs Not Available"  
else  
    result= [FOR_X]  
end if
```

This new field classifies the data into only three categories: exceedance, no exceedance, and CLs not available. This field is useful when mapping at the national scale, when exceedance versus no exceedance is a more useful distinction than highlighting levels of exceedance.

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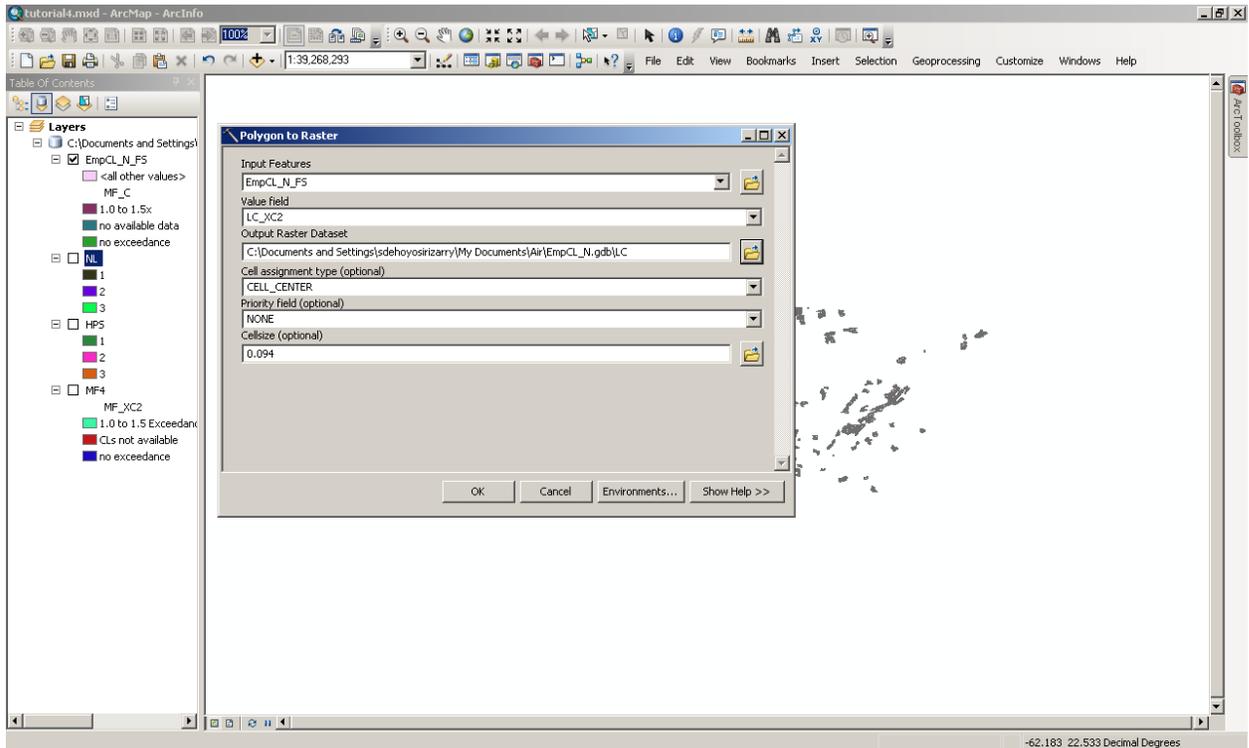


31. Select ArcToolbox . In order to create printable maps we need to convert from the current polygon feature format to a raster format. Select the “Polygon to Raster” tool.



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32. In the “Polygon to Raster” toolbox, select the input feature containing the fields you want to map. If previous instructions were followed exactly as stated, there should only be one option to choose because all of the other files were deleted. Select the field you want to map in the “Value field” dropdown box. Provide a path to your output in the “Output Raster Dataset” space. Leave the other options as they are. Click OK.



33. A new layer will appear in the Table of Contents with the requested raster map. See the [ArcGIS Mapping Protocols](#) for instructions on how to create a map to effectively display this data in shapefile or raster format.

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Exceedance of Critical Loads of Acidity for Surface Waters/Terrestrial Ecosystems on Forest Service
Lands

Surface Waters

1. Use "Add Data" to add the critical loads of acidity for surface water and NFS boundary datasets.
 - a. Add Data→CL_GIS_new→SW→GIS→ XYCLdatabase_SW.shp
2. Use the Intersect tool (as in Step 13 of previous section) to crop the CLs data to Forest Service Lands only. Use the following parameters:
 - a. Input Features: "XYCLdatabase_SW.shp" and "USA_ProclaimedForest_Grassland.shp"
 - b. Provide a path and name the Output Feature Class (SW_interFS)
3. Use Spatial Join (as in Step 11 of previous section) to merge the surface water data and the deposition data into the same shapefile. Use the following parameters:
 - a. Target Feature: SW_interFS
 - b. Join Features:
precip_adj_bias_adj_500kmMW_2006_CMAQ5.1_Massad_bidi_12km_CONUS_kg_ha_June2012sim
 - c. Provide a path and name the Output Feature Class (SW.shp)
4. Add a new field to the attribute table for the SW.shp layer. Name the field **TSD** (Total Sulfur Deposition) and select "Double" as the format for the values in the new field. Right click on the header of the new field and select "Field Calculator." Type the following expression in the white box: **[TD_S_T]*6.25**. This multiplication converts the values of total sulfur deposition from kg/ha to meq/m².
5. Add a new field to the attribute table. Name the field **SW_X** (surface water exceedance) and select "Double" as the format for the output values. Right click on the field header and select "Field Calculator". Type the following expression in the whitebox: **([TSD] + [Nleach]) - [CL_50]**. This equation calculates the critical load exceedance value.
6. Add another new field to the attribute table. Name the field **SW_XC** (surface water exceedance class) and select "Double" as the format for the output values. Right Click on the field header and select "Field Calculator". Type the following expression in the whitebox: **([TSD]+ [Nleach])/[CL_50]**. This equation calculates the proportion by which deposition exceeds the critical load (useful when creating exceedance classes).

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7. Add another new field to the attribute table. Name the field **SW_XProportion** and select "Double" as the format for the field values. Right click on the field header and select "Field Calculator." Check "Show Codeblock" and enter the following code:

```
If [CL_50] <0 then
result=1000
else
result= [SW_XC]
end if
```

This step replaces the CL exceedance proportions incorrectly labeled as negative because the CL was calculated as negative. A negative CL indicates that an ecosystem is so sensitive that impacts are occurring, even without deposition. We have therefore grouped all of these extremely sensitive ecosystems into one group at the highest end of the CL exceedance proportion range, setting them all equal to 1000. These areas will therefore fall into the highest exceedance classes in subsequent steps.

8. Add another new field to the attribute table. Name the field **SW_XC2** and select "Text" as the format for the field values. Right click on the field header and select "Field Calculator." Check "Show Codeblock" and enter the following code:

```
If [SW_XProportion] <1 then
result="No Exceedance"
elseif [SW_XProportion] >50.0 then
result="Over 50.0 Exceedance"
elseif [SW_XProportion] >=10.0 then
result="10.0 to 50.0 Exceedance"
elseif [SW_XProportion] >=1 then
result="1.0 to 10.0 Exceedance"
else
result="Null"
end if
```

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9. Add another field. Name this field **SW_X_1**. Select "Text" as the format for your output. This step creates a field displaying only exceedance and non exceedance. Right click on the new field's header and select "Field Calculator." Check "Show Codeblock" and enter the following code:

```
if [SW_XProportion] <1 then
  result="No Exceedance"
else
  result="Exceedance"
end if
```

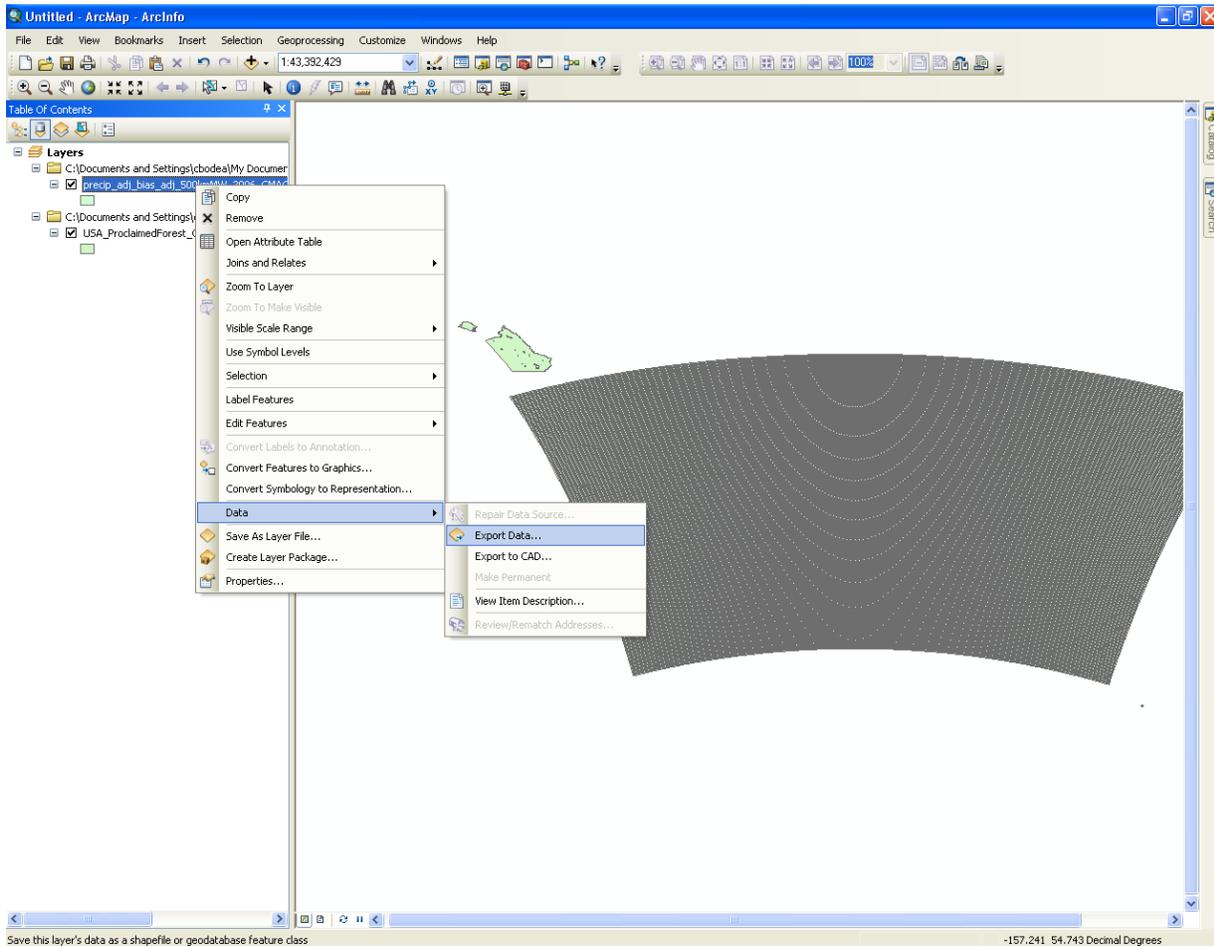
Forested Ecosystems (Terrestrial data)

1. CLs and CL Exceedances were calculated by [Steve McNulty](#). The data is available for download from the Portal, but we do not advocate altering the data in any way without consulting Steve McNulty or Erika Cohen. Instructions for mapping this data can be found in the [ArcGIS Mapping Protocols document](#).

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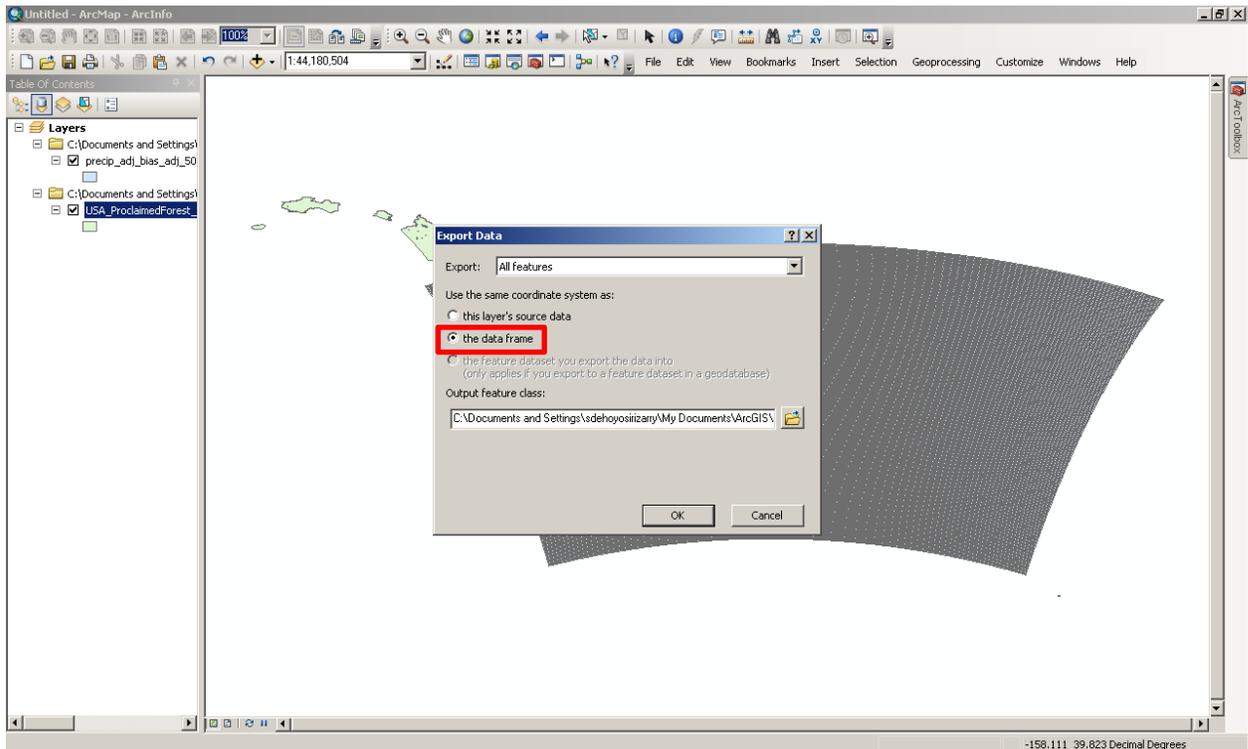
Reprojecting Shapefiles

1. Begin map by importing a file with the desired projection (for NAD 1983 we recommend the NF boundary file "USA_ProclaimedForest_Grassland.shp"). Then import the file that you want to reproject. Select "Close." Your file has been reprojected on the fly.
2. To change the projection of the file itself, right-click on the shapefile name in the Table of Contents, select "Data" from the menu, and select the "Export data" function.



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3. Make sure you select "the data frame" option for "Use same coordinate system as."



4. Click Ok on Export Data window. A window will pop up and ask: Do you want to add the exported data to the maps as a layer? Click Yes.
5. A new file will appear in the Table of Contents: **Export_Output_##**. This is the file with the altered projection. You can remove the original file from the Table of Contents and rename the new file with the same name as the one that has just been removed.