



THE WIND SPEED AND DIRECTION TOOL

By: Steven Archuleta

101793357



BACKGROUND

- I am an intern for the P50 Native Environmental Health Equity Research Center 2018 Pilot Project
- We are using surface wind data and point locations of abandoned uranium mines (AUMs) to understand the dispersal of radioactive pollutants through the air.
- I was in charge of finding reliable surface wind data and found it at the NOAA website.
- The study area is the 423 AUMs found in the Navajo Nation.



THE DATA

- Surface wind data is used to determine effects of plume dispersion and atmospheric pollution.
- The most reliable and abundant source of surface wind data is found on the NOAA website.
- This data comes in NetCDF files that contains a raster layer of data for each day of the year.
 - Similar to a workbook having individual worksheets in Excel.
- The data available is in U and V surface wind rasters ranging from 1948 – 2018.



RESEARCH QUESTION

How do you calculate windspeed and direction at multiple points from U and V wind data?



THE PROBLEM

- Individual rasters must be created from each U and V NetCDF file for specific dates.
- The U and V direction need to be calculated for the individual point locations.
- These U V values are used in equations to determine which direction and at what speed pollution is moving.
- There are four fields to be added and updated to the point shapefile with the new information.
- There are over 400 points to be recorded.

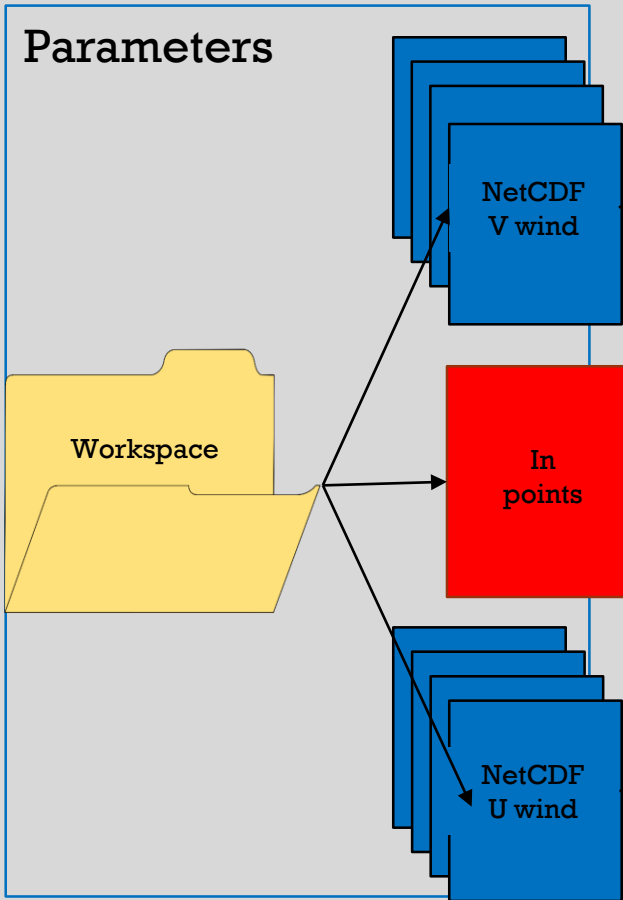
This is a time consuming and tedious process.



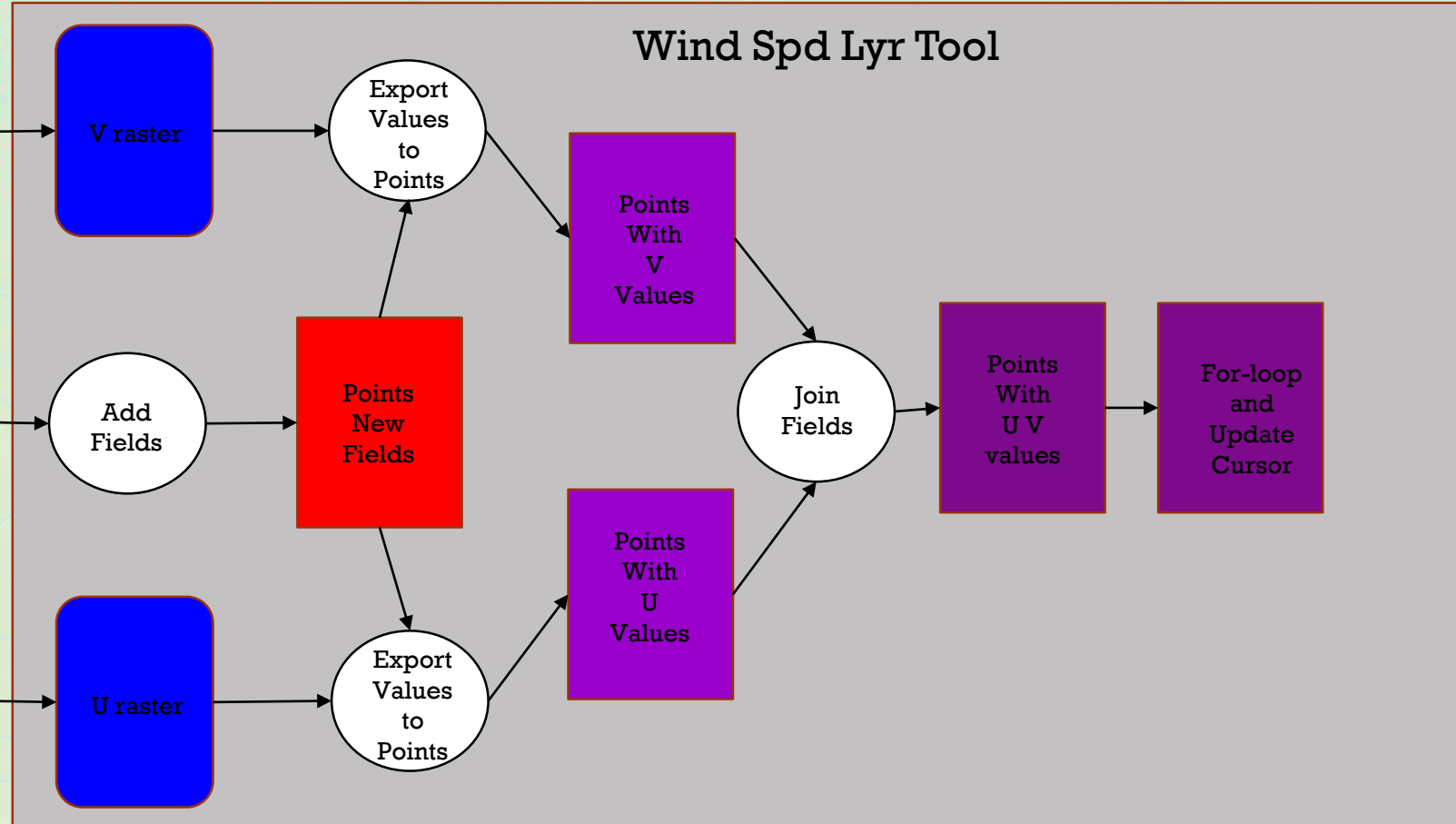
SOLUTION

Wind Speed and Direction Tool

Parameters



Wind Spd Lyr Tool



DESIGN

How to Determine Direction from U and V values.

- U values = (+)East / (-)West



- V values = (+)North / (-)South



- If you take the U and V values and place them tip to tail, you have a right triangle. This means the direction and speed can be determined with trigonometry.

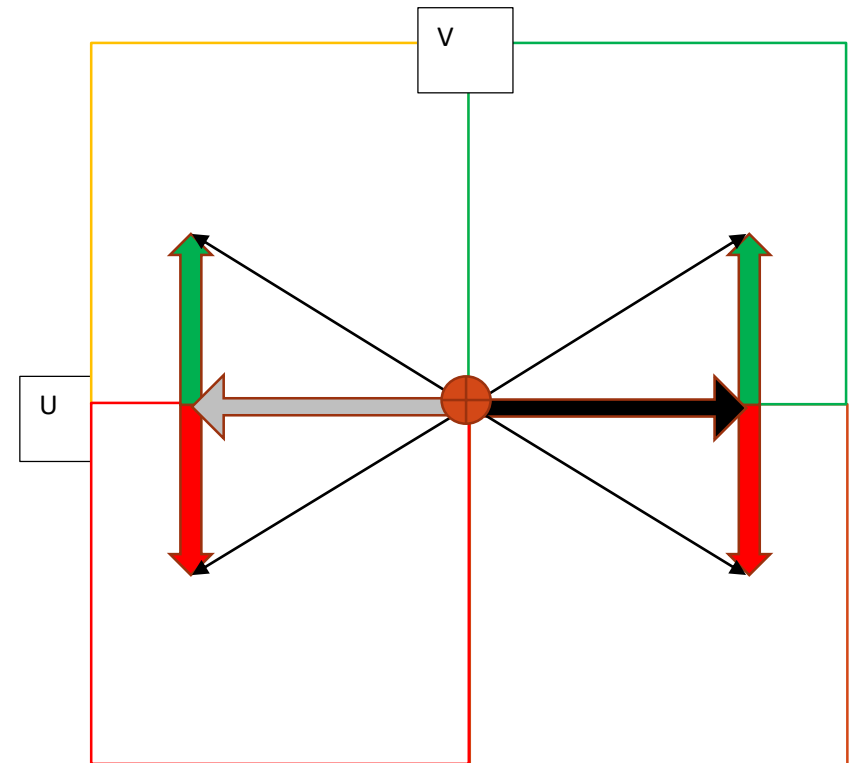
if row[0] > 0:

if row[1] > 0:

a = float(row[1])/float(row[0])

row[2] = math.degrees(math.atan(a))

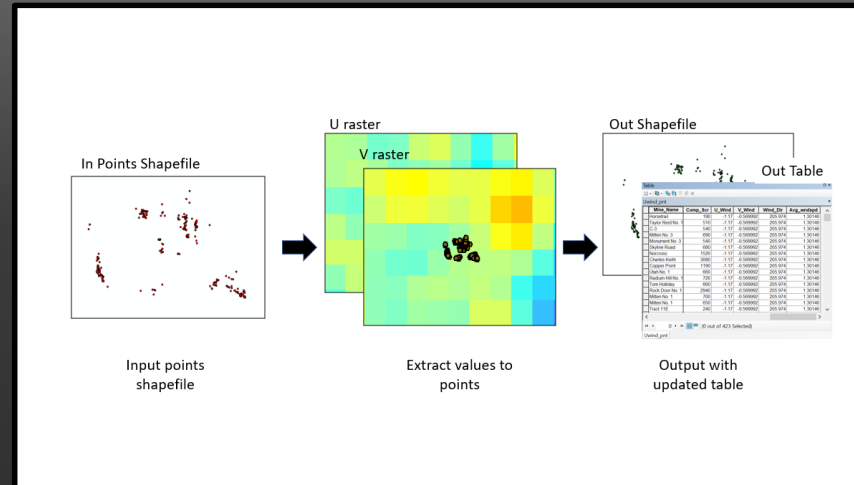
cursor.updateRow(row)



Tool #1 Code

- Wind Dir Spd
- # Import Arcpy and set Environment
- # Get Parameters
- # Make NetCDF Raster layers
- # Save Layers
- # Add Fields to point shapefile
- # Extract U and V values to points
- # Calculate U wind and V wind Fields
- # Join Field
- # Update Cursor and For-loop
 - # Get windspeed
 - # Get Direction
 - # Update

CODE DESIGN



Tool #2 Code

Wind Dir Lyr

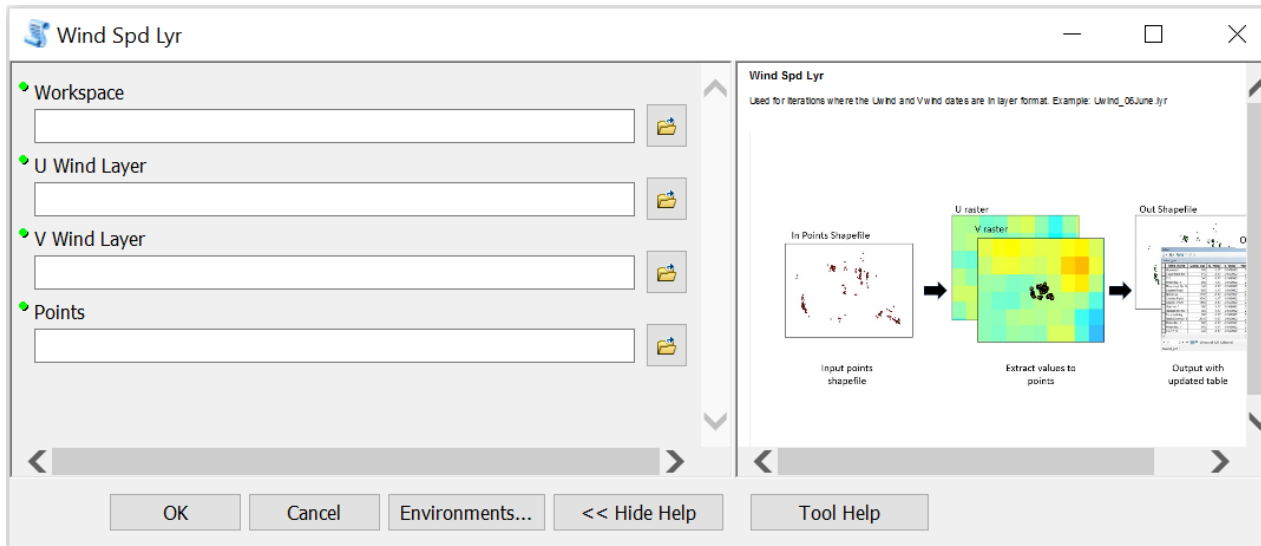
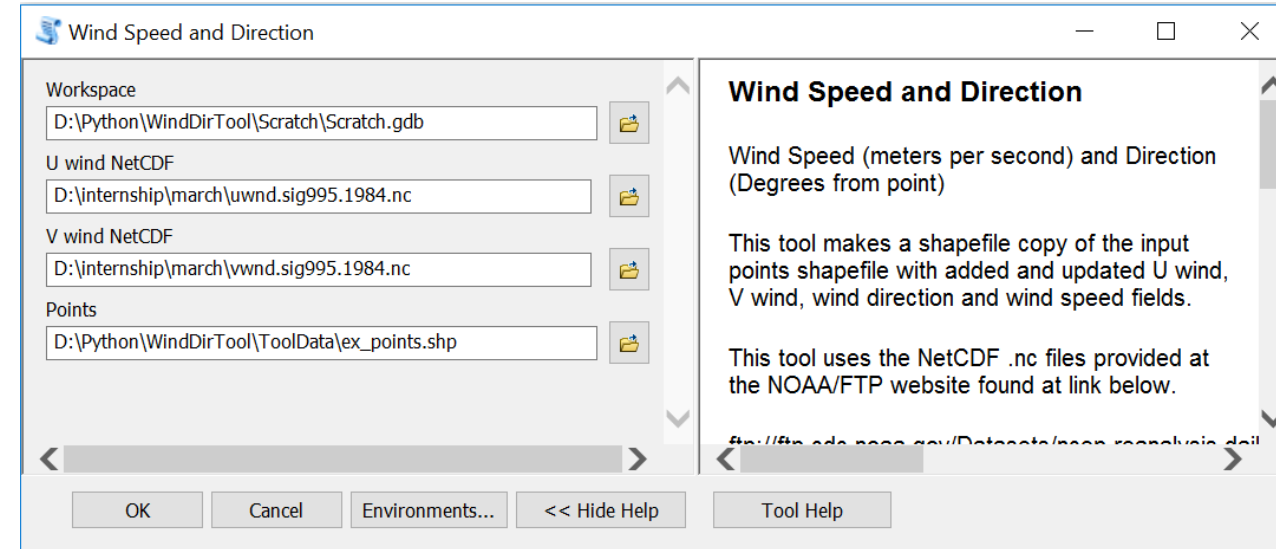
- # Import Arcpy and set Environment
- # Get Parameters
- # Add Fields to point shapefile
- # Extract U and V values to points
- # Calculate U wind and V wind Fields
- # Join Field
- # Update Cursor and For-loop
 - # Get windspeed
 - # Get Direction
 - # Update



TOOL INTERFACE

The tool has four parameters.

- The workspace is folder where the result layers will be saved.
- There are individual U and V wind NetCDF parameters.
- Last parameter is the points shapefile or feature class.



The auxiliary tool does not use NetCDF files because it works with the raster layers created by the first tool.

- A raster layer for a different time in the netCDF file can be created from the result raster layers of the first tool.

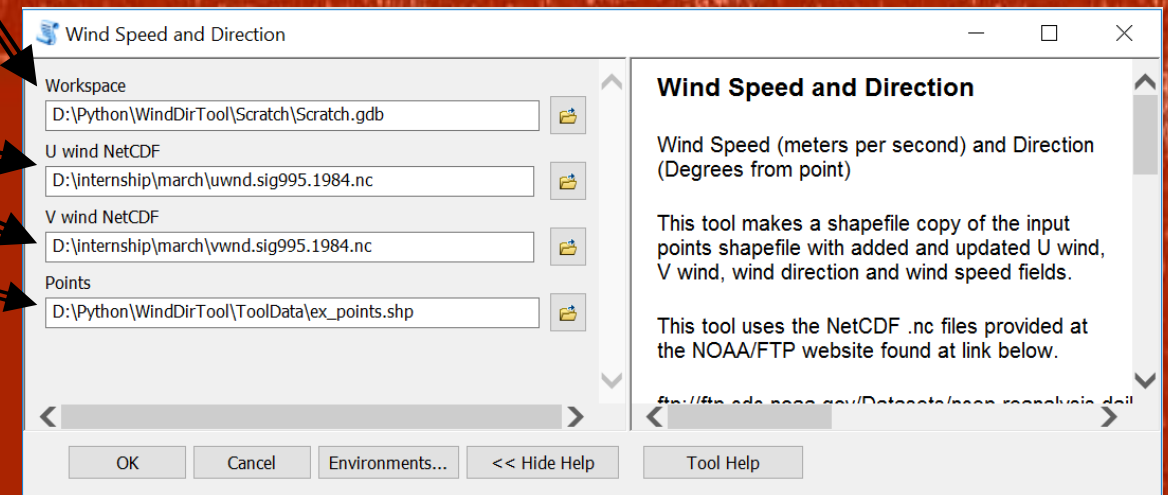
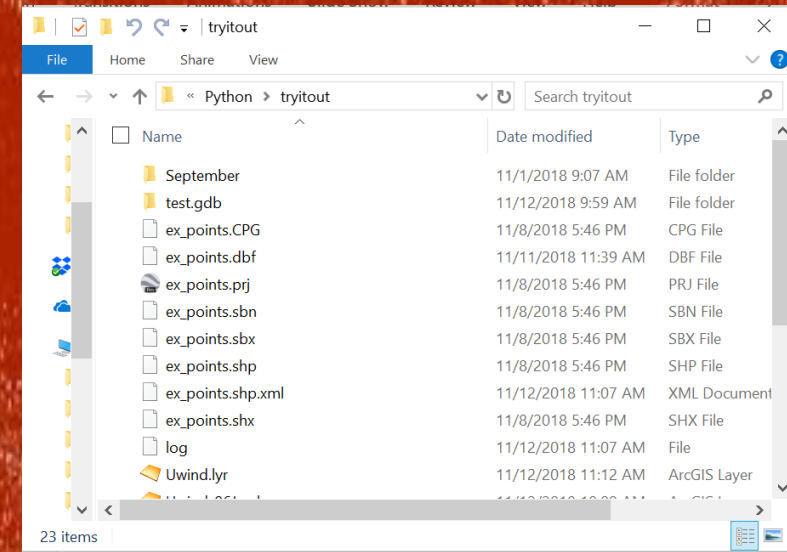
The tool parameters are the same but uses U and V raster layers.



DEMONSTRATION

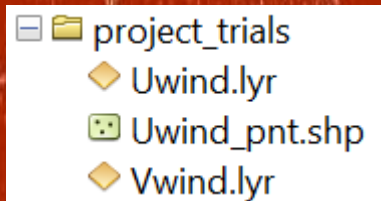
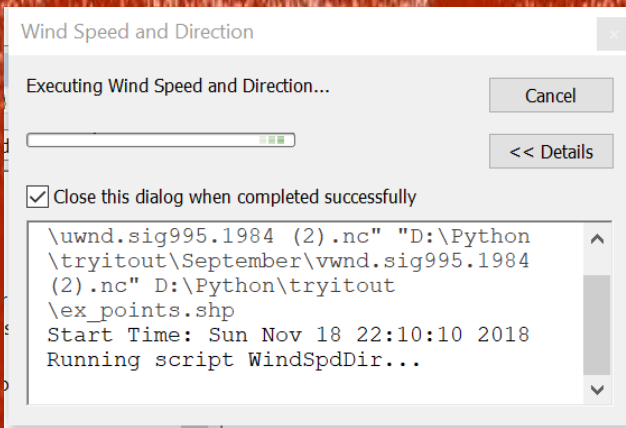
■ To use the Wind Speed and Direction tool:

1. Open ArcMap and Wind Speed and Direction Tool.
2. In Workspace, enter the folder where you would like the result layers to be saved.
3. Enter the U and V NetCDF files in their respective parameters.
4. Enter points shapefile into Points parameter.
5. Click OK to run the tool.



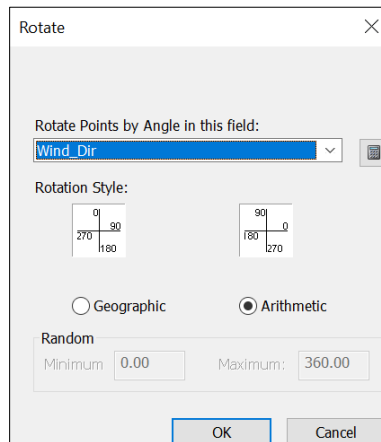
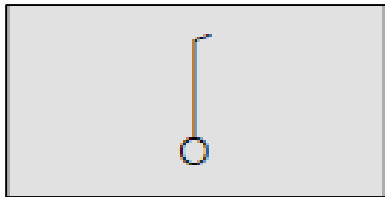
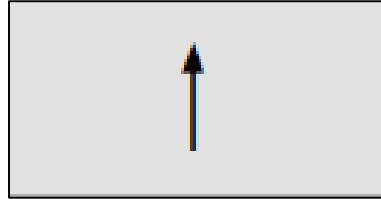
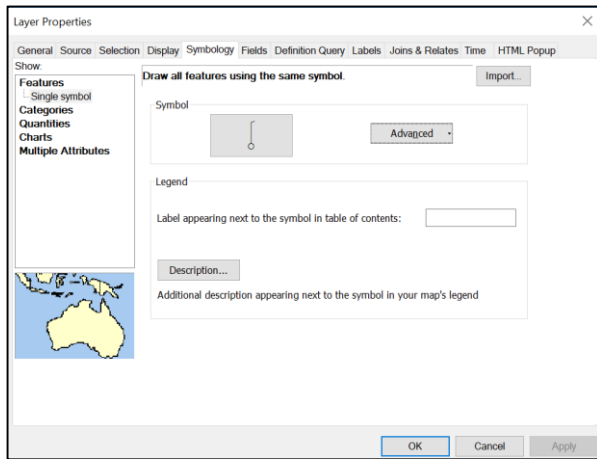
DEMONSTRATION CONT.

6. The tool will run and the progress will be shown in the messages of the tool window. (This takes roughly 2 minutes)
7. Locate the folder specified as the workspace to access the new result layers.
 - The Uwind_pnt.shp file is the file with the updated attribute table. This has the updated U wind, V wind, Wind direction and Wind Speed fields.
 - The Uwind.lyr and Vwind.lyr files are copies of the raster files used in the tool for additional analysis.
8. Add the new layers to the Table of Contents.
9. To view the points as directional arrows, open Uwind_pnt's properties.
10. Click the Symbology tab.



Mine_ID	Chapter	Region	Map	Map_J	GrndW	Soil	Air_Sc	Surf	Comp	U_Wind	V_Wind	Wind_Dir	Avg_wndspd
1039	HAYSTA	Eastern	0	E0	220	545	545	160	1470	0.25	-1.42	279.985	1.44184
1038	HAYSTA	Eastern	0	E0	290	510	510	160	1470	0.25	-1.42	279.985	1.44184
400	CHILCHI	Central	1	C1	110	135	135	160	540	-1.17	-0.569992	205.974	1.30146
309	CHURC	Eastern	1	E1	110	255	255	160	780	0.25	-1.42	279.985	1.44184
89	TEESTO	Southern	1	S1	320	150	150	160	780	-1.64	-1.49001	222.256	2.21579
294	Off Nava	Northern	1	N1	420	10	10	160	600	-1.17	-0.569992	205.974	1.30146
402	CHILCHI	Central	2	C2	110	135	135	160	540	-1.17	-0.569992	205.974	1.30146
308	CHURC	Eastern	2	E2	120	270	270	160	820	0.25	-1.42	279.985	1.44184
853	INDIAN	Southern	2	S2	210	380	380	160	1130	-1.64	-1.49001	222.256	2.21579
533	BODAW	Western	2	W2	50	120	120	160	450	-0.5	-2.89	260.184	2.93293
707	Off Nava	North Central	2	NC2	910	775	775	160	2620	-1.17	-0.569992	205.974	1.30146
388	OLJATO	North Central	3	NC3	10	10	10	160	190	-1.17	-0.569992	205.974	1.30146
112	ANETH	Northern	3	N3	620	60	60	160	900	-1.17	-0.569992	205.974	1.30146
75	CHILCHI	Central	3	C3	100	180	180	160	620	-1.17	-0.569992	205.974	1.30146
306	COYOT	Eastern	3	E3	510	140	140	160	950	0.25	-1.42	279.985	1.44184
291	INDIAN	Southern	3	S3	190	50	50	160	450	-1.64	-1.49001	222.256	2.21579
534	BODAW	Western	3	W3	50	40	40	160	290	-0.5	-2.89	260.184	2.93293
76	CHILCHI	Central	4	C4	100	180	180	160	620	-1.17	-0.569992	205.974	1.30146
305	COYOT	Eastern	4	E4	320	770	770	160	2020	0.25	-1.42	279.985	1.44184
851	INDIAN	Southern	4	S4	220	90	90	160	560	-1.64	-1.49001	222.256	2.21579
290	BODAW	Western	4	W4	190	10	10	160	370	-0.5	-2.89	260.184	2.93293
295	TEEC N	Northern	4	N4	210	70	70	160	510	-1.17	-0.569992	205.974	1.30146
190	RED ME	Northern	5	N5	40	80	80	160	360	-1.17	-0.569992	205.974	1.30146
801	CHILCHI	Central	5	C5	120	140	140	160	560	-1.17	-0.569992	205.974	1.30146
852	INDIAN	Southern	5	S5	230	165	165	160	720	-1.64	-1.49001	222.256	2.21579
303	NAHODI	Eastern	5	E5	350	520	520	160	1550	0.25	-1.42	279.985	1.44184
540	BODAW	Western	5	W5	140	400	400	160	1250	-0.5	-2.89	260.184	2.93293

DEMONSTRATION CONT.

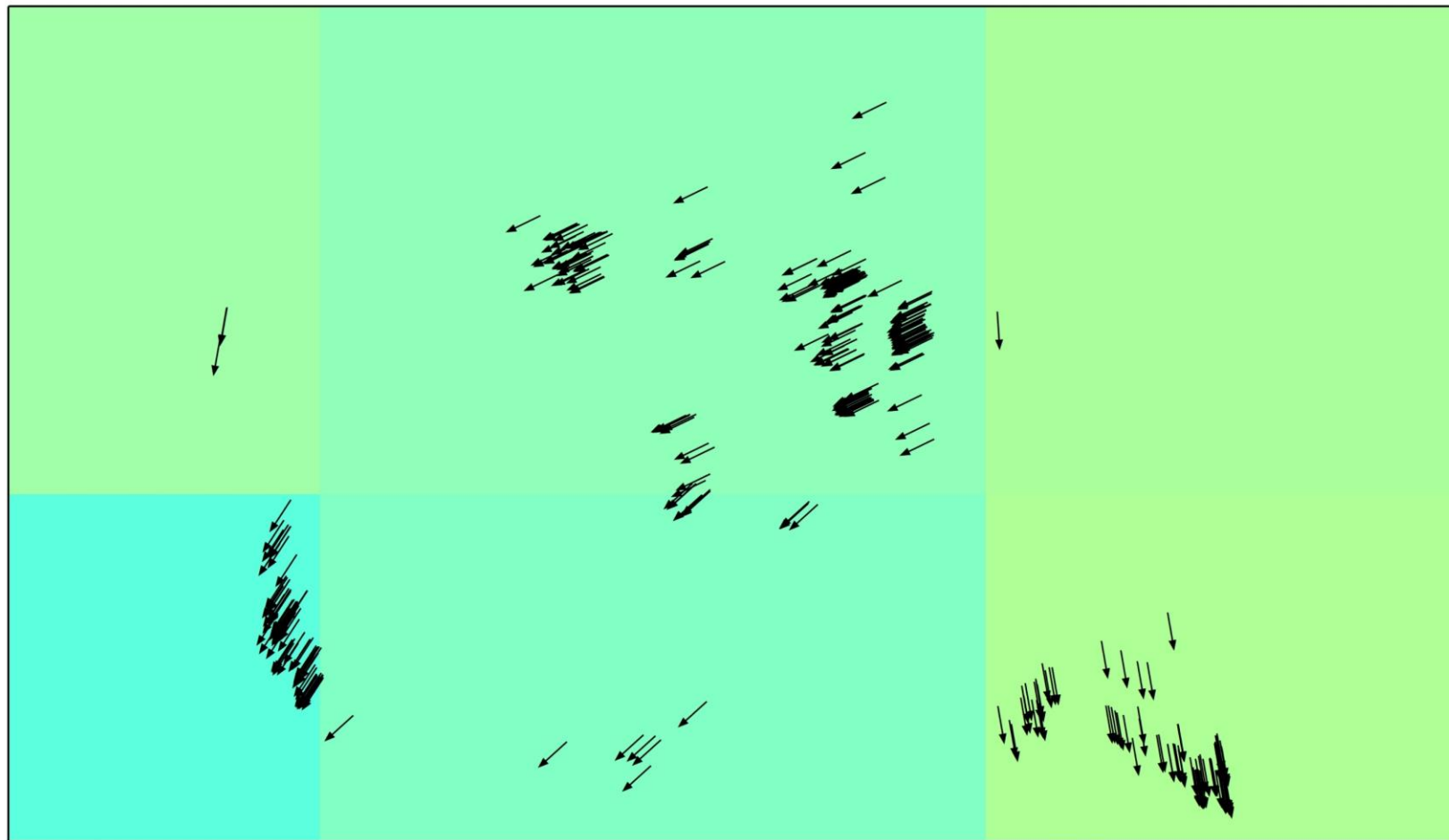


11. In the symbol area click the dropdown box and select Rotation.
12. In the new Rotate window choose the Wind_dir field for the angle to rotate the points.
13. Under the Dropdown button click the radio button for Arithmetic and click OK.
14. Select Symbol box inside of the symbol area and change to a directional Symbol. Be sure to Choose a symbol that is oriented upward.
15. Click OK.
16. Save the points, U and V layers as unique names to avoid overwriting data with the second tool.



Surface Wind Direction from AUMs in The Navajo Nation

01 January 1984



Legend

↑ Wind Direction

NOAA/FTP U wind

Value



High : 23.38

Low : -19.62

140 70 0 140 Kilometers

Coordinate System: WGS 1984 World Mercator

Projection: Mercator

Datum: WGS 1984

False Easting: 0.0000

False Northing: 0.0000

Central Meridian: 0.0000

Standard Parallel 1: 0.0000

Units: Meter

Author: Steven Archuleta

Date: 11/25/2018



Wind Direction Point data:

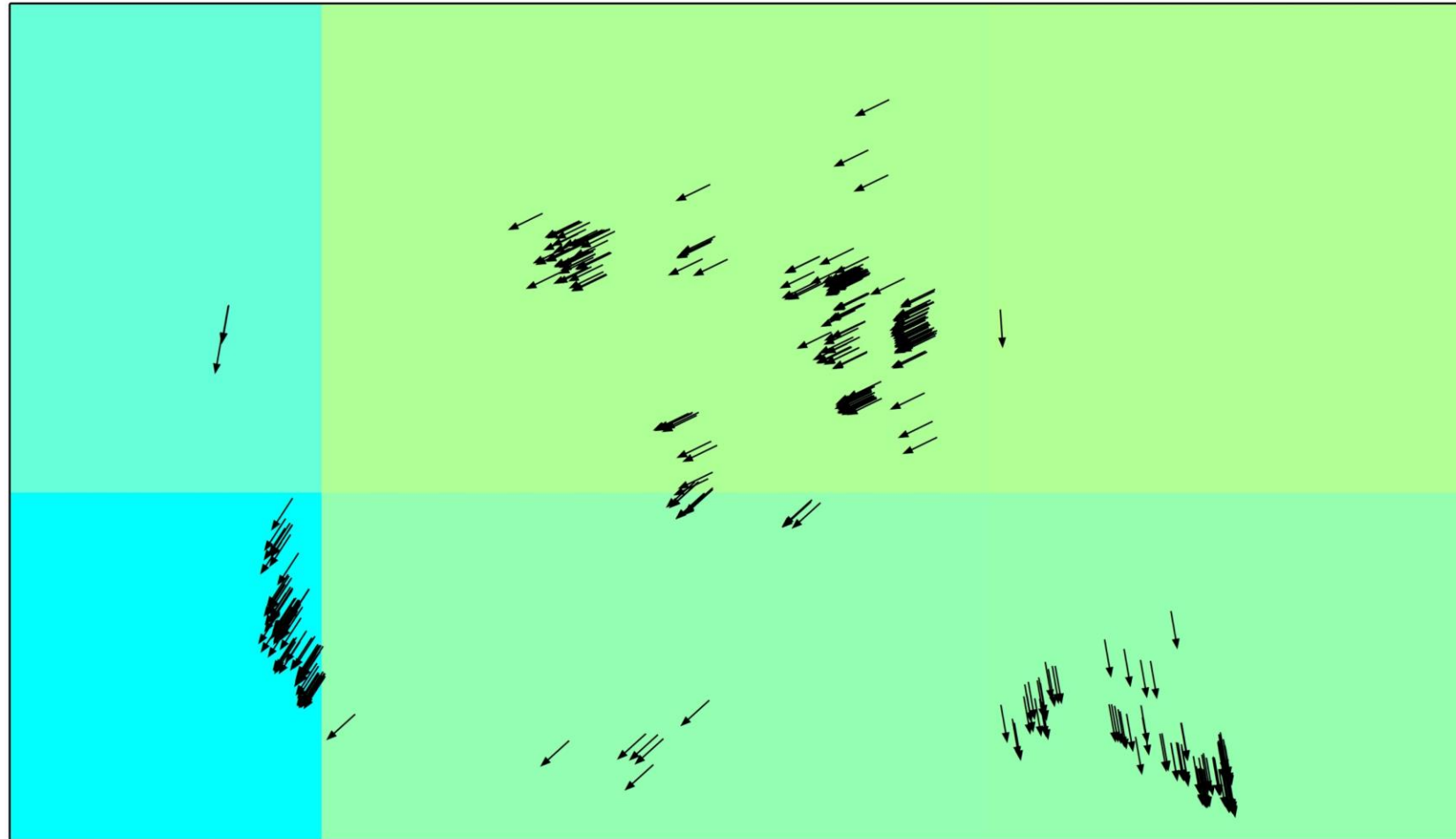
Larry Heard

NOAA / FTP Surface Wind data:

<ftp://ftp.cdc.noaa.gov/Datasets/ncep.reanalysis.dailyavgs/surface/>

Surface Wind Direction from AUMs in The Navajo Nation

01 January 1984



Legend

↑ Wind Direction

NOAA/FTP V wind

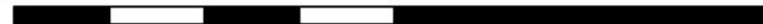
Value



High : 18.25

Low : -22.47

140 70 0 140 Kilometers



Coordinate System: WGS 1984 World Mercator

Projection: Mercator

Datum: WGS 1984

False Easting: 0.0000

False Northing: 0.0000

Central Meridian: 0.0000

Standard Parallel 1: 0.0000

Units: Meter

Author: Steven Archuleta

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Wind Direction Point data:

Larry Heard

NOAA / FTP Surface Wind data:

<ftp://ftp.cdc.noaa.gov/Datasets/ncep.reanalysis.dailyavgs/surface/>

Wind Direction

	Mine_I	Chapter	Region	Map	Map_I	GrndWtr	Soil_Scr	Air_Scr	SurfWtrS	Comp_Scr	U_Wind	V_Wind	Wind_Dir	Avg_wndspd
▶	388	OLJATO	North Central	3	NC3	10	10	10	160	190	-1.17	-0.569992	205.974	1.30146
	708	OLJATO	North Central	12	NC12	330	10	10	160	510	-1.17	-0.569992	205.974	1.30146
	516	OLJATO	North Central	13	NC13	340	20	20	160	540	-1.17	-0.569992	205.974	1.30146
	260	OLJATO	North Central	14	NC14	390	70	70	160	690	-1.17	-0.569992	205.974	1.30146
	226	OLJATO	North Central	25	NC25	240	70	70	160	540	-1.17	-0.569992	205.974	1.30146
	182	OLJATO	North Central	18	NC18	460	30	30	160	680	-1.17	-0.569992	205.974	1.30146
	224	OLJATO	North Central	17	NC17	460	450	450	160	1520	-1.17	-0.569992	205.974	1.30146
	225	OLJATO	North Central	15	NC15	710	1105	1105	160	3080	-1.17	-0.569992	205.974	1.30146
	389	OLJATO	North Central	16	NC16	570	230	230	160	1190	-1.17	-0.569992	205.974	1.30146
	259	OLJATO	North Central	26	NC26	460	20	20	160	660	-1.17	-0.569992	205.974	1.30146
	258	OLJATO	North Central	27	NC27	520	20	20	160	720	-1.17	-0.569992	205.974	1.30146
	517	OLJATO	North Central	19	NC19	440	30	30	160	660	-1.17	-0.569992	205.974	1.30146
	223	OLJATO	North Central	24	NC24	490	1145	1145	160	2940	-1.17	-0.569992	205.974	1.30146
	709	OLJATO	North Central	21	NC21	400	70	70	160	700	-1.17	-0.569992	205.974	1.30146
	255	OLJATO	North Central	20	NC20	410	40	40	160	650	-1.17	-0.569992	205.974	1.30146
	262	OLJATO	North Central	31	NC31	60	10	10	160	240	-1.17	-0.569992	205.974	1.30146
	263	OLJATO	North Central	30	NC30	30	10	10	160	210	-1.17	-0.569992	205.974	1.30146
	396	OLJATO	North Central	46	NC46	40	20	20	160	240	-1.17	-0.569992	205.974	1.30146
	391	OLJATO	North Central	33	NC33	280	80	80	160	600	-1.17	-0.569992	205.974	1.30146
	392	OLJATO	North Central	32	NC32	270	90	90	160	610	-1.17	-0.569992	205.974	1.30146
	180	OLJATO	North Central	35	NC35	540	10	10	160	720	-1.17	-0.569992	205.974	1.30146
	393	OLJATO	North Central	37	NC37	420	30	30	160	640	-1.17	-0.569992	205.974	1.30146
	253	OLJATO	North Central	36	NC36	530	150	150	160	990	-1.17	-0.569992	205.974	1.30146
	394	OLJATO	North Central	47	NC47	110	20	20	160	310	-1.17	-0.569992	205.974	1.30146
	252	OLJATO	North Central	48	NC48	130	20	20	160	330	-1.17	-0.569992	205.974	1.30146

CONCLUSION

- Positive:
 - The Wind Direction and Speed Tool is effective for visualizing wind direction from specific points. The tools main output is the updated fields in the attribute table.
 - It streamlines the tedious and time-consuming job of creating and updating four fields for over 400 point features.
- Room to Improve:
 - The tool could be improved by automatically changing the symbols to the arrows.
 - The code should be able to control the orientation of the symbols. I was unable to figure out how to change this using code.
- Final Conclusion:
 - The Wind Direction and Speed tool is limited to NetCDF files but the Wind Spd Lyr tool is able to use any raster for analysis. The combination of these tools will streamline the wind data acquisition for researchers.



REFERENCES

- “Novel Geospatial Modeling to Inform Risk Assessment for Metal Contamination Research on Tribal Lands”, National Institutes of Health (NIH) and Environmental Protection Agency (EPA) P50 (Native Environmental Health Equity Research Center 2018 Pilot Project), PI: Yan Lin
- NOAA/FTP Surface Wind Data

<https://www.ncdc.noaa.gov/societal-impacts/wind/overview>

