

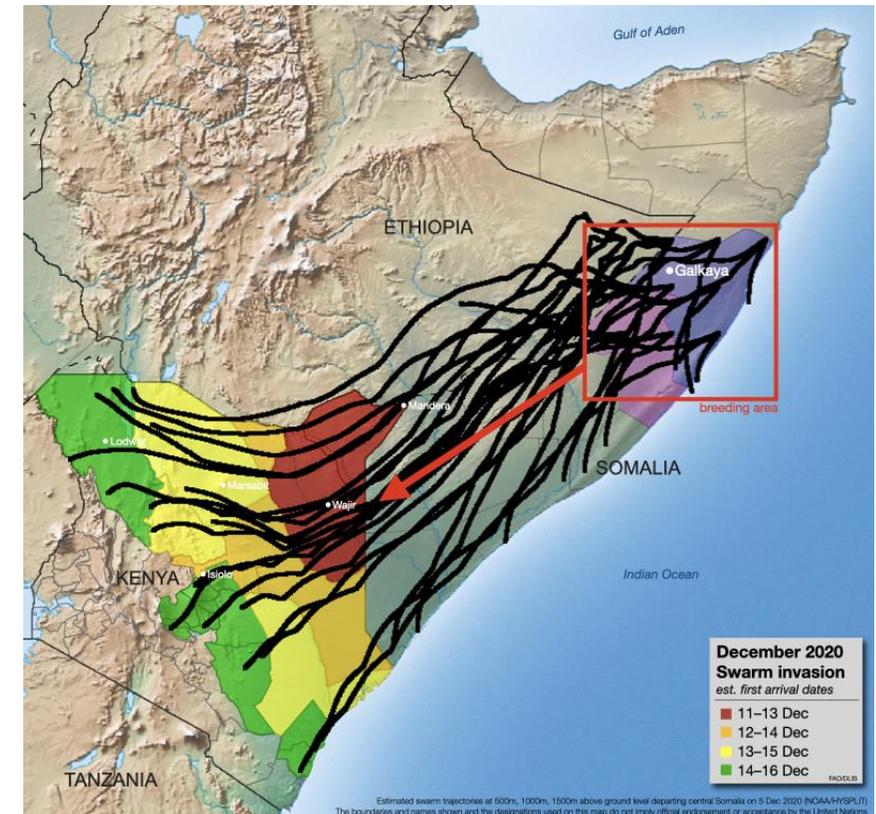
Overview of New Matrix and GIS Functionality in Locust Migration Application

Oct 31, 2021

Sonny Zinn and Mark Cohen

Locust Migration Tool: *Summary*

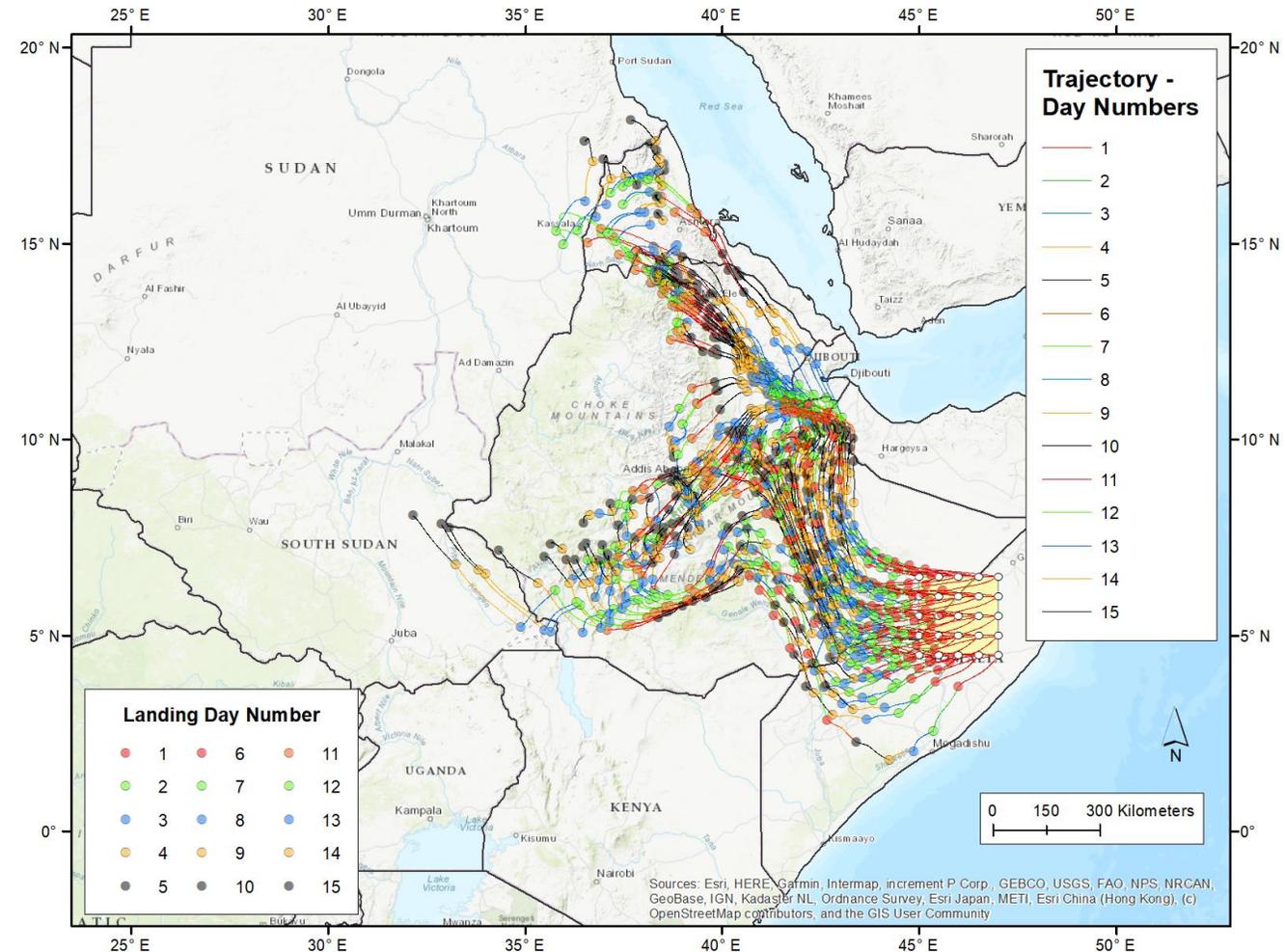
- **HYSPLIT** used, but daily takeoffs & landings difficult to implement
 - New locust functionality stops trajectory each day; starts next day
 - web application → users not required to download met data
- **Modes:** single swarm → batch → matrix → API
- **User Inputs:** start location and time; met data; number of days; flying height(s); graphics options; output options
- **Outputs:** trajectory endpoints, graphics, shapefiles, HYSPLIT files
- **Primary Partner:**
 - UN FAO's Chief Locust Forecaster Keith Cressman and his team
 - his knowledge of locust behavior has been critical
- **Other partners:** e.g., Plant Village (Penn State University)



From Keith Cressman, UN FAO

Locust Migration Tool: *New Matrix and GIS Features*

- Matrix functionality allows user to specify a grid of swarm source locations; simulations carried out for each source location in grid.
 - Lower left corner latitude and longitude specified
 - Grid spacing and number of grid points specified in each direction
- New Outputs:
 - Trajectories
 - Trajectory Frequency
 - Time of Arrival
 - Daily Take-off and Landing Locations
- GIS Shapefiles: extensive attributes now embedded so that more effective and efficient processing within GIS applications can be carried out



HYSPLIT Locust Forecast Matrix

Matrix user-input screen – all of the single-swarm and batch functionality, plus additional input and output specifications



Swarm name: for naming output files.

Start date and direction: Meteorological data GFS Model 1.0 degree [Information and grid domains of forecast datasets.](#)

Start date (UTC) Direction Forward Duration day(s)

First-day start time (UTC) First-day ending time (UTC)

Start location: The source matrix is specified by the start location, the spacings in latitude/longitude, and the number of points in the latitude/longitude directions. However, the total number of source locations **CANNOT EXCEED 125**, which is about a 11x11 lat/lon grid with a 1 degree spacing.

SW corner lat.	<input type="text" value="4.5"/>	deg	Lat. Spacing	<input type="text" value="0.5"/>	deg	Lat. Points	<input type="text" value="5"/>
SW corner long.	<input type="text" value="45"/>	deg	Long. Spacing	<input type="text" value="0.5"/>	deg	Long. Points	<input type="text" value="5"/>

Height m

Locust flight time: Fly without overnight stops

Time to take off after sunrise hr(s) Time to land before sunset hr(s)

Plot options: Map background STAMEN Terrain Plot radius km

GIS file: by day by height by each day-height all trajectories in one file use lines not points

Plot grid size deg Color Opacity %

Advanced: Vertical motion Sigma (4)

Lower left corner of source grid

Grid spacing

Number of grid points in each direction

Grid size for trajectory frequency statistics and graphics

GIS output options for trajectories

HYSPLIT Locust Model Results For Job 7129

Run-time screen – showing view once run is complete



Model Status

```
12:44:28.479 INFO - Creating matrix_7129_shapefiles_traj_freq.zip
12:44:28.491 INFO - Creating matrix_7129_toa_gis.zip
12:44:28.532 INFO - Creating file matrix_7129.zip for redistribution.
12:44:30.309 INFO - Finished generating graphics for matrix run 7129
12:44:30.310 INFO - The model and graphics are now complete.
12:44:30.310 INFO - 2021-04-12 12:44:30.310269
12:44:30.366 INFO - Posted status COMPLETED for matrix run 7129
```

Run-time messages scroll during simulations

Model Details

```
Run name: matrix_7129
Meteorological data: GFS
Start location: lat. 4.5000 deg, lon. 45.0000 deg, height(s) 500.0, 1000.0, 1500.0 m
Source matrix: spacing 0.5000, 0.5000 deg; number of points 5, 5
Start date: 2021-04-12
Simulation duration: 15.0 day(s)
Simulation direction: FORWARD
Locust flight time: takeoff after sunrise 2.0 hr(s), land before sunset 1.0 hr(s)
Vertical motion: Sigma
```

Run specification summary

Results

Click on text link or dropdown menu to view images. Please note that all input and output files will be deleted after 30 days they are created to conserve disk space. If it is desired, download the zip file for redistribution by clicking [here](#) before the files are deleted.

Name	Image	PostScript	PDF	Google Earth	Zipped GIS Shapefiles
Trajectory plots	PNG	PS	PDF		ZIP
Frequency plots	PNG	PS	PDF		ZIP
Grid plots	JPG	PS			
Time-of-arrival plots	PNG	PS	PDF		ZIP

Individual graphics and output collections

[Redraw the graphics](#)

[Start a new matrix run with the same input](#)

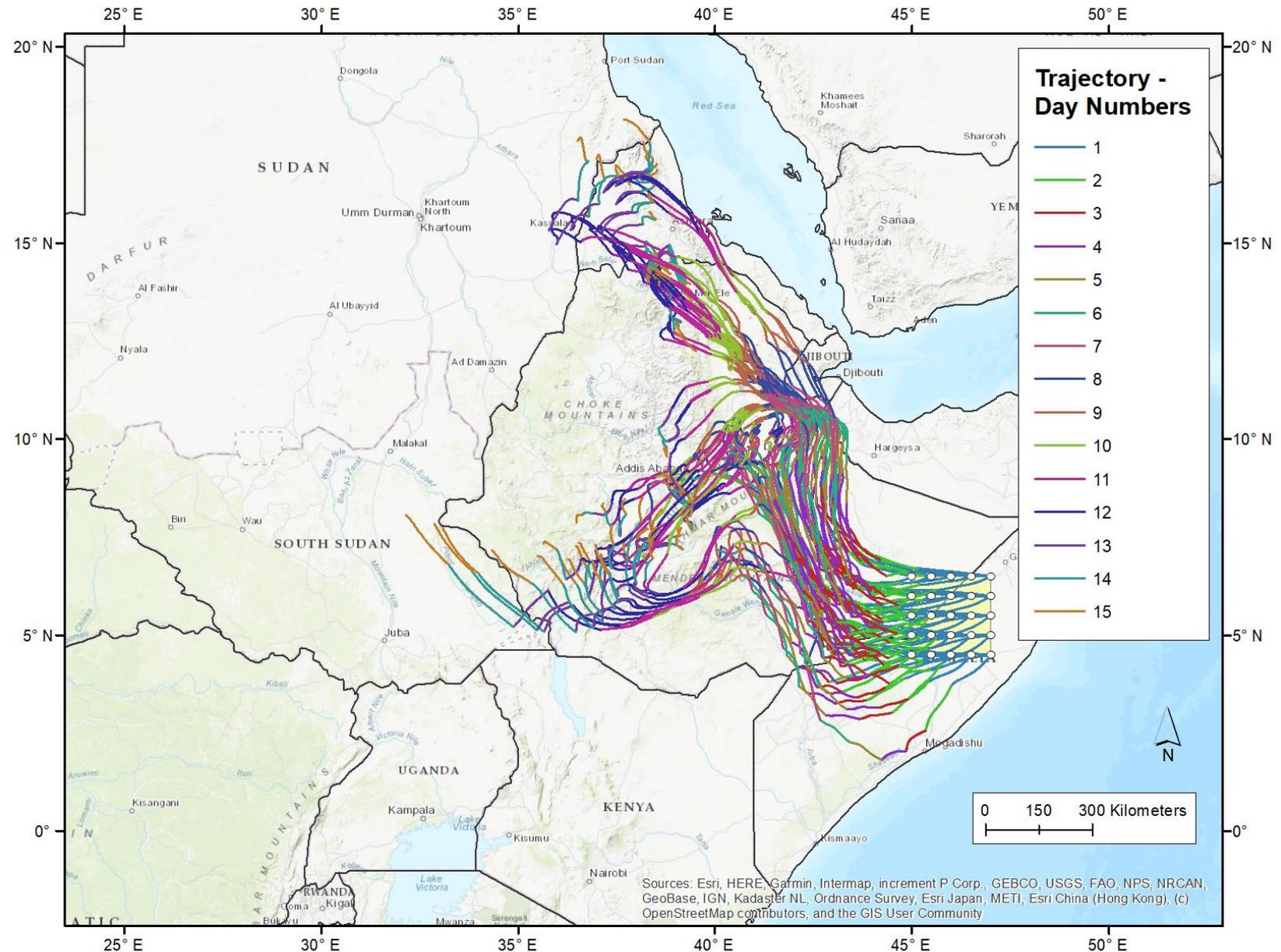
[Start a new matrix run](#)

Links

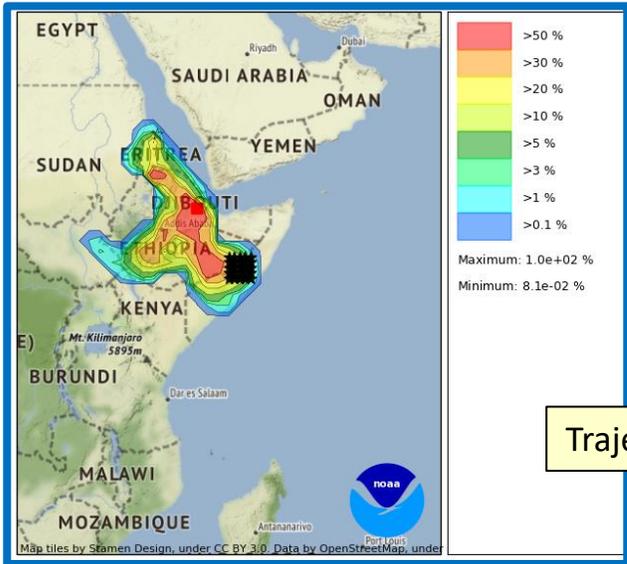
[Zipped file of all graphics and diagnostics \(for redistribution\)](#)

Zip file with all inputs and outputs

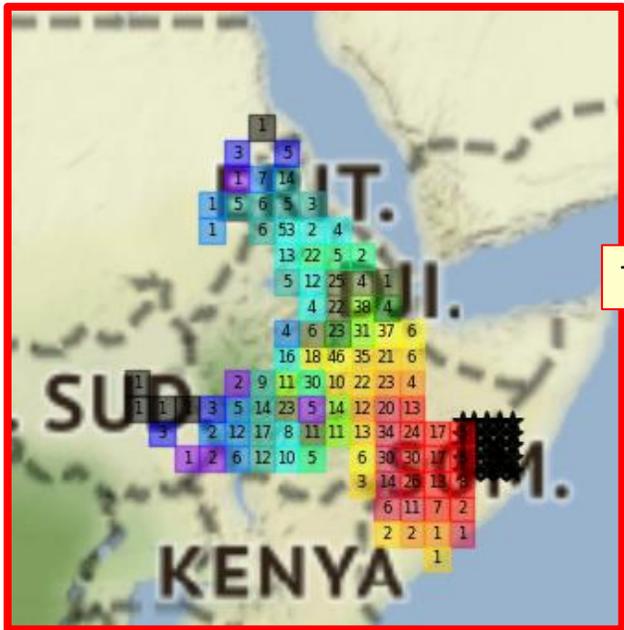
- In this example, we had 5 grid points in “longitude” and 5 grid points in “latitude”, so there was a total of 25 source locations
- And there were 3 heights chosen (500m, 1000m, and 1500m)
- So, there were a total of 75 trajectory-based migration paths simulated.
- And there were 15 days of simulation, so, each trajectory had 15 take-off locations and 15 landing locations.
- So, there are a total of 1125 trajectory paths simulated in this example



Files generated in this example, once zipped "redistribution" file is unzipped



Trajectory frequency graphics



Time of Arrival graphics

Trajectory frequency graphics via gridplot – a different HYSPLIT mapping program

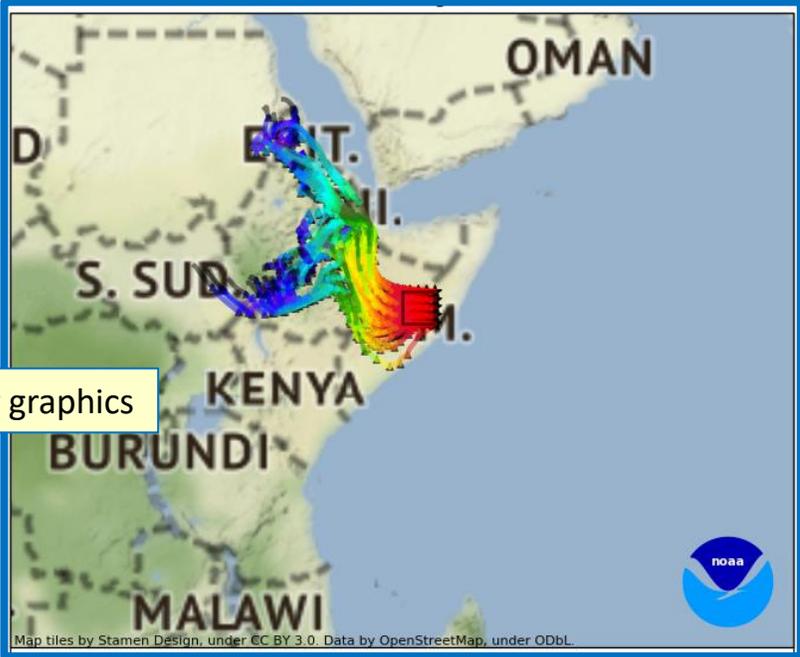
Name	Date	Type	Size
hysplit	4/12/2021 1:01 PM	File folder	
shapefiles_toa	4/12/2021 1:01 PM	File folder	
shapefiles_traj_aggregated	4/12/2021 1:01 PM	File folder	
shapefiles_traj_day	4/12/2021 1:01 PM	File folder	
shapefiles_traj_freq	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height_day	4/12/2021 1:01 PM	File folder	
LABELS.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
MAPTEXT.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
matrix_7129_freq.pdf	4/12/2021 1:01 PM	Adobe Acrobat D...	255 KB
matrix_7129_freq.png	4/12/2021 1:01 PM	PNG File	347 KB
matrix_7129_freq.ps	4/12/2021 1:01 PM	PostScript File	1,572 KB
matrix_7129_gridplot.jpg	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_gridplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_infile	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_MAPTEXT.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_progress.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_run_setup_summary.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trj_001.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trjfreq.bin	4/12/2021 1:01 PM	JPG File	454 KB

Folder with HYSPLIT Control and other model-specific files.

Folders with shapefiles associated with time of arrival (toa), trajectories, and trajectory frequencies. These can be imported into GIS applications (e.g. ArcGIS) and displayed – and processed further – according to the user’s needs

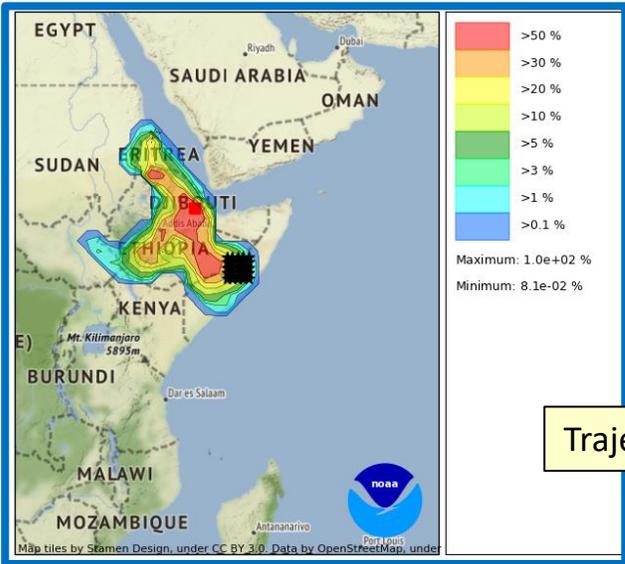
Summary files of inputs and outputs

Trajectory graphics

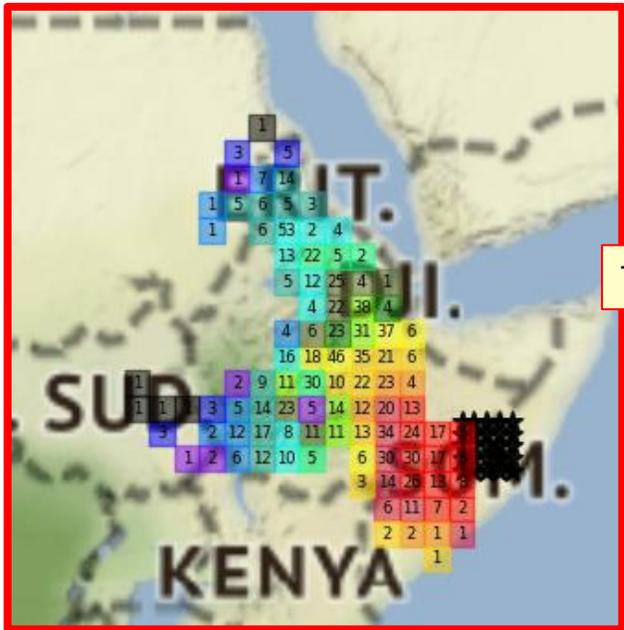


Trajectories

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Trajectory frequency graphics



Time of Arrival graphics

Trajectory frequency graphics via gridplot – a different HYSPLIT mapping program

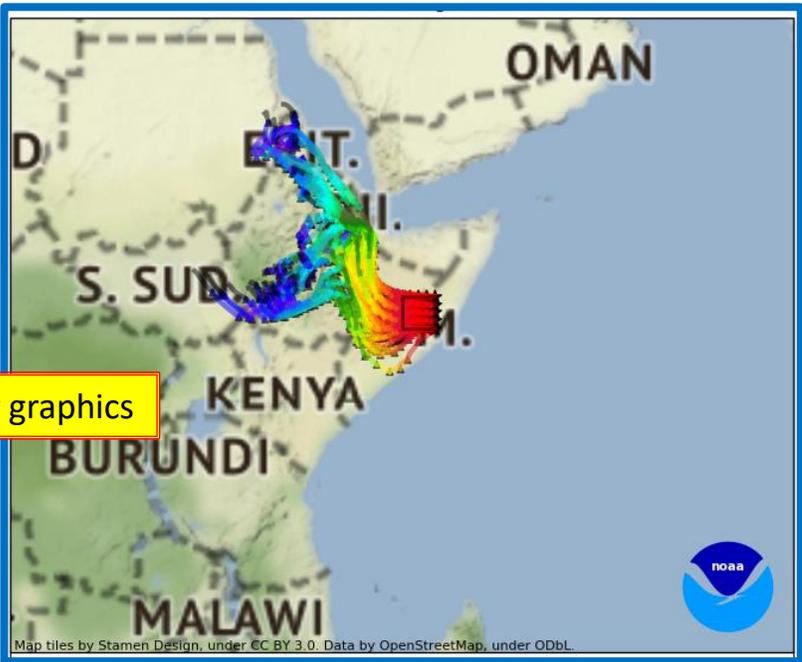
Name	Date	Type	Size
hysplit	4/12/2021 1:01 PM	File folder	
shapefiles_toa	4/12/2021 1:01 PM	File folder	
shapefiles_traj_aggregated	4/12/2021 1:01 PM	File folder	
shapefiles_traj_day	4/12/2021 1:01 PM	File folder	
shapefiles_traj_freq	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height_day	4/12/2021 1:01 PM	File folder	
LABELS.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
MAPTEXT.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
matrix_7129_freq.pdf	4/12/2021 12:56 PM	Adobe Acrobat D...	255 KB
matrix_7129_freq.png	4/12/2021 12:56 PM	PNG File	347 KB
matrix_7129_freq.ps	4/12/2021 12:56 PM	PostScript File	1,572 KB
matrix_7129_gridplot.jpg	4/12/2021 1:01 PM	JPG File	454 KB
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matrix_7129_toa.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.ps	4/12/2021 1:01 PM	JPG File	454 KB
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Folder with HYSPLIT Control and other model-specific files.

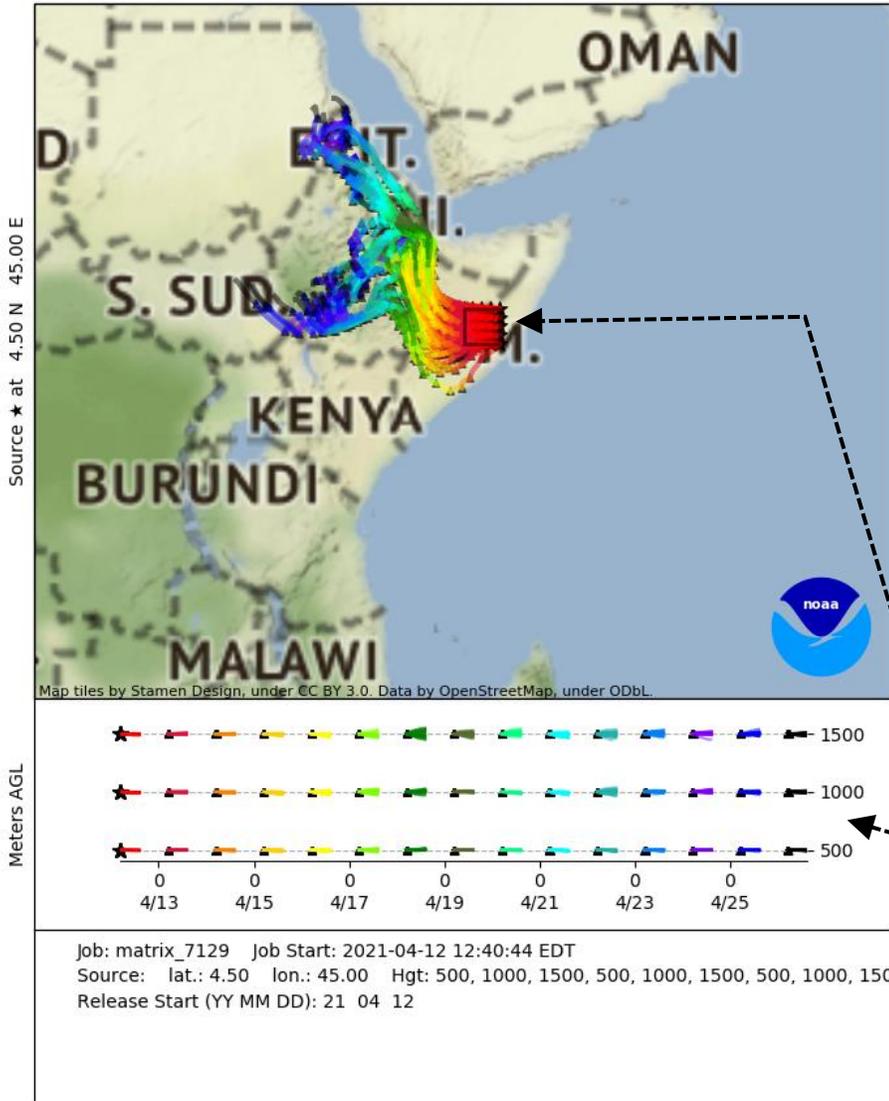
Folders with shapefiles associated with time of arrival (toa), trajectories, and trajectory frequencies. These can be imported into GIS applications (e.g. ArcGIS) and displayed – and processed further – according to the user’s needs

Summary files of inputs and outputs

Trajectory graphics



NOAA HYSPLIT MODEL
Forward trajectory starting at 0454 UTC 12 Apr 2021
GFSG Meteorological Data



Graphic output of trajectories using basic HYSPLIT graphics

- This is the output using basic HYSPLIT graphics.
- Some settings can be configured in matrix user-specification screen, including:
 - Map background
 - Map radius
- But for more advanced modifications, user can import shape files provided in output (see additional description of this functionality below)
- The source locations are shown with a bounding box
- In this output – example at left – each day’s trajectory is color-coded based on colors shown in bottom day-height panel of figure; and in this panel, you can also see the three flying heights chosen for this example

Trajectories
Aggregated

s > 2020 > Locusts > Time_of_Arrival > matrix_7129 > shapefiles_traj_aggregated

Name	Date modified	Type	Size
 matrix_7129_all_traj.satt	4/12/2021 1:01 PM	ATT File	108 KB
 matrix_7129_all_traj.dbf	4/12/2021 1:01 PM	DBF File	98 KB
 matrix_7129_all_traj.prj	4/12/2021 1:01 PM	PRJ File	1 KB
 matrix_7129_all_traj.shp	4/12/2021 1:01 PM	SHP File	2,060 KB
 matrix_7129_all_traj.shx	4/12/2021 1:01 PM	SHX File	9 KB
 matrix_7129_all_traj.txt	4/12/2021 1:01 PM	Text Document	2,528 KB

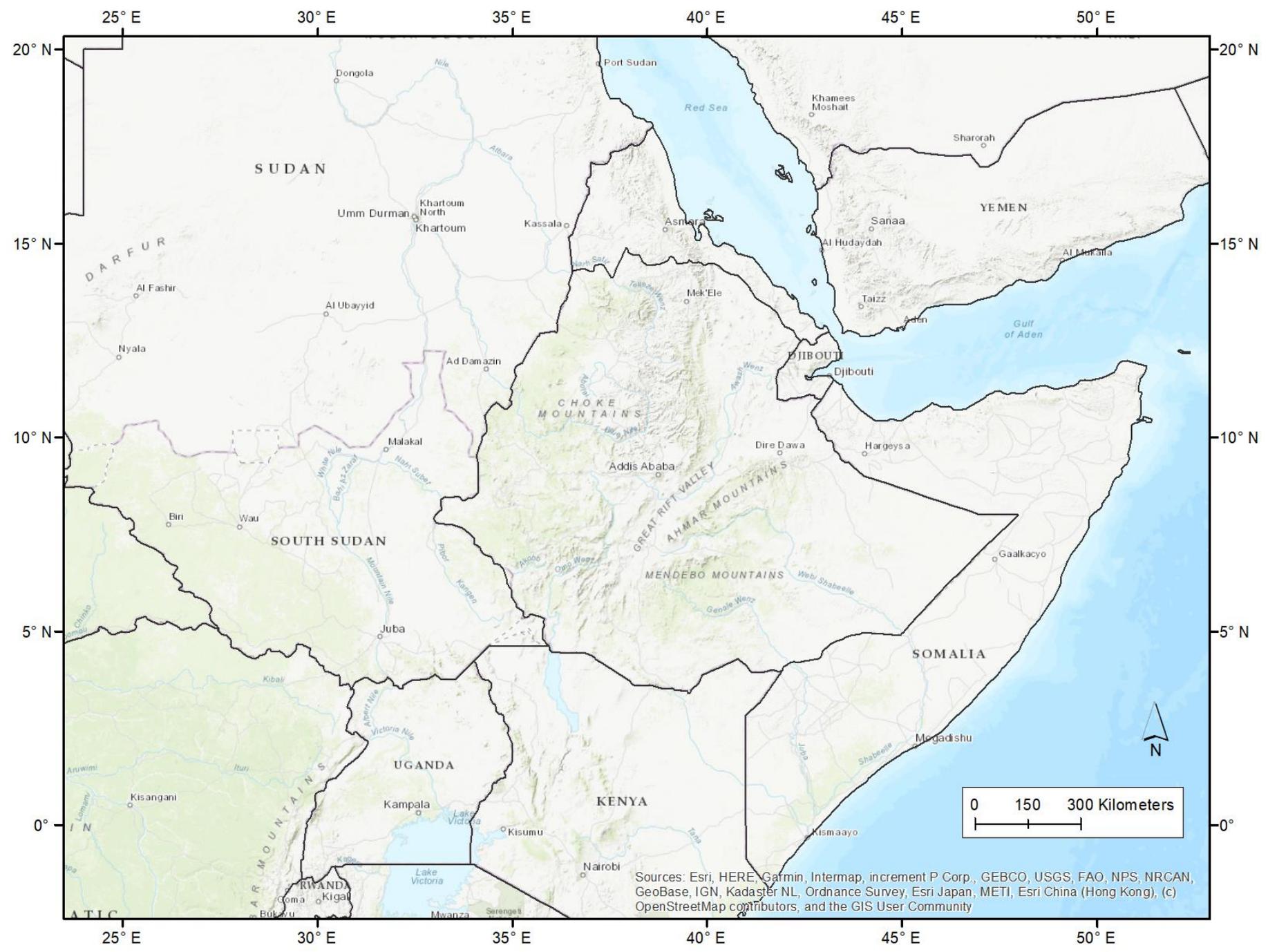
```
1, 45.0000, 4.5000
45.0000, 4.5000
44.9960, 4.5020
44.9790, 4.5100
44.9610, 4.5170
44.9440, 4.5250
44.9260, 4.5330
44.9090, 4.5400
44.8910, 4.5470
44.8740, 4.5550
44.8570, 4.5620
44.8390, 4.5690
44.8220, 4.5750
44.8050, 4.5820
44.7870, 4.5890
44.7700, 4.5950
44.7530, 4.6010
44.7360, 4.6080
44.7190, 4.6140
44.7010, 4.6200
44.6840, 4.6260
44.6670, 4.6310
44.6500, 4.6370
```

Folder: shapefiles_traj_aggregated

Has a shapefile – in this example: **matrix_7129_all_traj.shp** -- that can be imported into GIS applications. This shapefile has all of the trajectories in the analysis. Each trajectory has numerous identifying characteristics, however, and so, the user can select and display – or not display – trajectories based on their characteristics.

**GIS Processing:
Base Map**

Here is a base map before any of the locust app shapefiles have been added.



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

GIS Processing: Source matrix

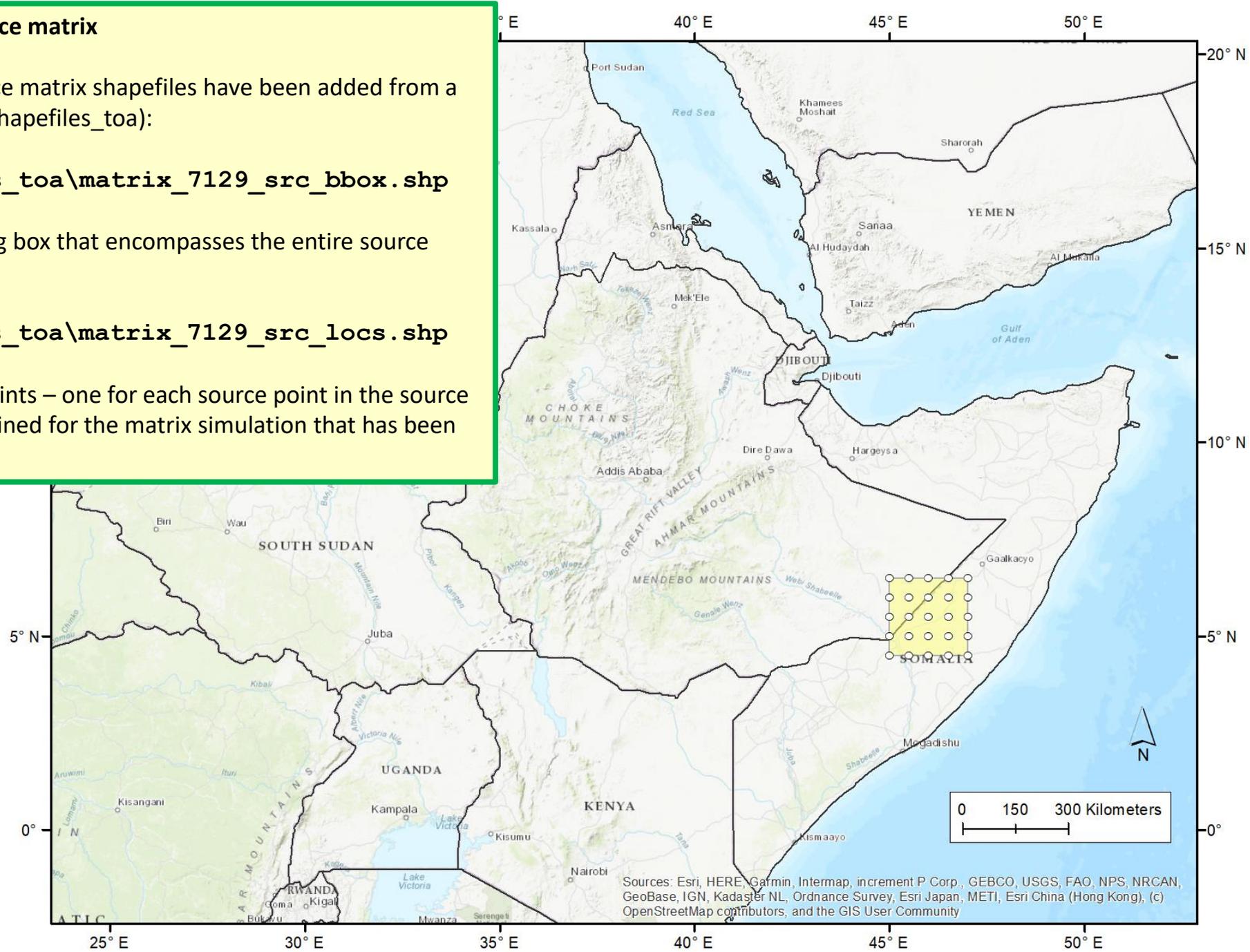
Two analogous source matrix shapefiles have been added from a different directory (shapefiles_toa):

- **shapefiles_toa\matrix_7129_src_bbox.shp**

a bounding box that encompasses the entire source matrix

- **shapefiles_toa\matrix_7129_src_locs.shp**

a set of points – one for each source point in the source matrix defined for the matrix simulation that has been conducted



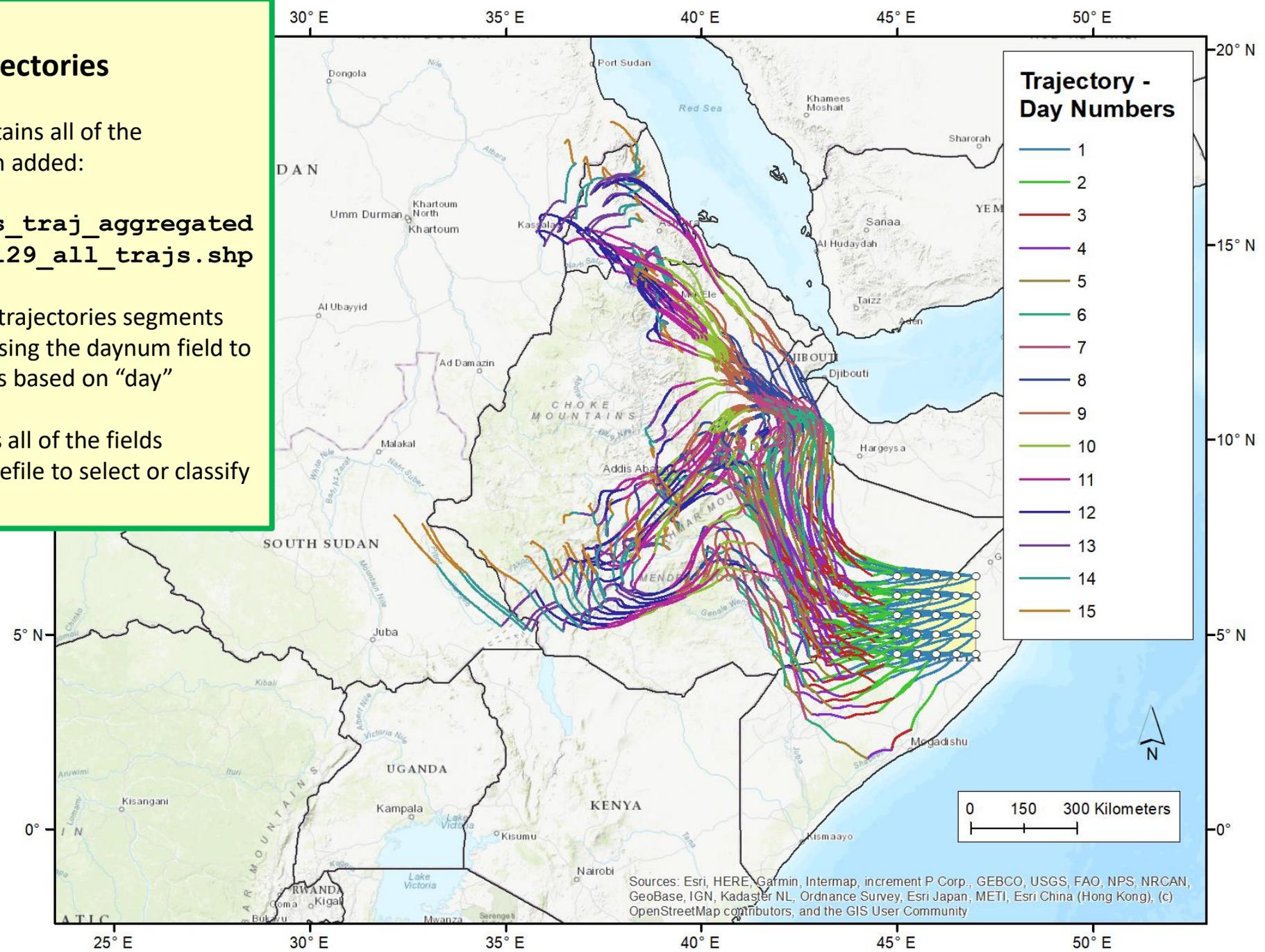
**GIS Processing:
Aggregated Trajectories**

A shapefile that contains all of the trajectories has been added:

- `shapefiles_traj_aggregated`
`\matrix_7129_all_trajs.shp`

In this example, the trajectories segments have been colored using the daynum field to show the trajectories based on “day”

The next slide shows all of the fields available in the shapefile to select or classify the trajectories



FID	Shape	TRAJNUM	YYYYMMDD	TIME	LEVEL	DAYNUM	SRCID	TRAJID	SLON	SLAT	ELON	ELAT
0	Polyline	1	20210412	454	500	1	1	1	45	4.5	43.417	4.621
1	Polyline	2	20210413	500	500	2	1	2	43.417	4.621	42.692	4.903
2	Polyline	3	20210414	502	500	3	1	3	42.692	4.903	42.214	5.751
3	Polyline	4	20210415	503	500	4	1	4	42.214	5.751	41.806	7.108
4	Polyline	5	20210416	503	500	5	1	5	41.806	7.108	40.861	8.646
5	Polyline	6	20210417	506	500	6	1	6	40.861	8.646	39.758	9.155
6	Polyline	7	20210418	509	500	7	1	7	39.758	9.155	39.816	9.406

GIS Processing: Aggregated Trajectories

Here are all of the attributes that are associated with each trajectory in the aggregated trajectory shapefile:

TRAJNUM: unique number for each trajectory for each day for each height – in this example, goes from 1 to 1125

YYYYMMDD: date of the trajectory

TIME: UTC start time of the trajectory

LEVEL: starting height (m-agl) – in this example, starting heights of 500, 1000, and 1500 meters above ground level were used

DAYNUM: day number – in this example, this goes from 1-15

SRCID: a unique number for each source location and height combination. In this example, there are 25 source locations and 3 heights, and so, the SRCID numbers go from 1 to 75. If one wants to remove a trajectory from the display, e.g., because it is deemed an unlikely path, such as a path going out over the ocean, then one can simply remove that overall migration path (all 15 days) by removing that SRCID from the display. Or if desired, one can remove just part of that path by further considering DAYNUM in the selection / de-selection of items to display

TRAJID: This is the same as TRAJNUM, and in this example, goes from 1 to 1125

SLON: Starting longitude for the trajectory

SLAT: Starting latitude for the trajectory

ELON: Ending longitude for the trajectory

ELAT: Ending latitude for the trajectory

GIS Processing: Selecting a specific SRCID (in ArcGIS)

Here is an example of selecting a specific SRCID – i.e., a specific starting location and height – in ArcGIS, a GIS application. There are 15 trajectory segments, one for each day, associated with this particular SRCID

Select by Attributes

Enter a WHERE clause to select records in the table window.

Method : Create a new selection

"DAYNUM"
"SRCID"
"TRAJID"
"SLON"
"SLAT"

= <> Like
> >= And
< <= Or
_ % () Not
Is In Null Get Unique Values Go To:

SELECT * FROM matrix_7129_all_trajs WHERE:
"SRCID"=15

Clear Verify Help Load... Save...
Apply Close



Table

matrix_7129_all_trajs

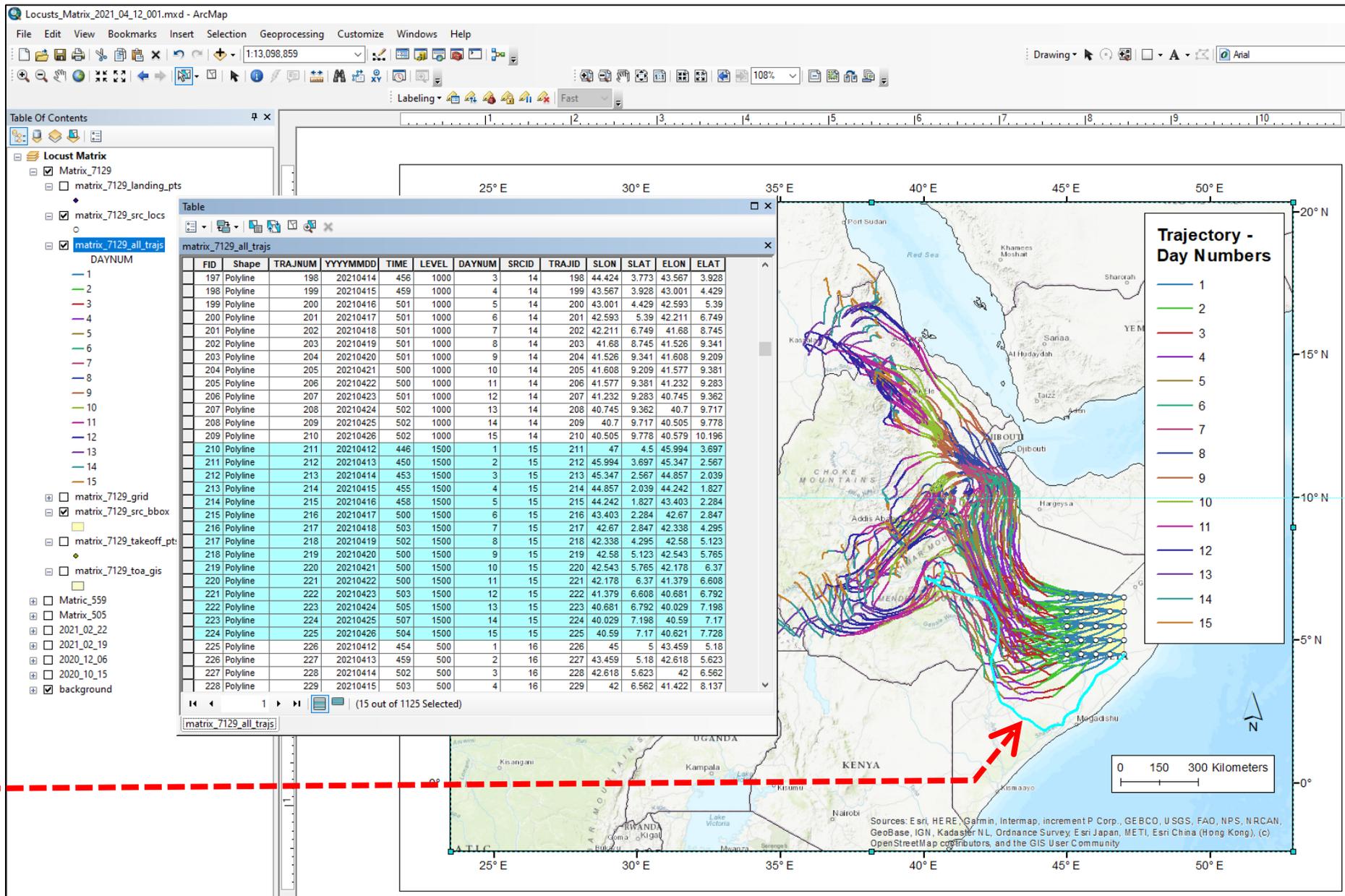
FID	Shape	TRAJNUM	YYYYMMDD	TIME	LEVEL	DAYNUM	SRCID	TRAJID	SLON	SLAT	ELON	ELAT
197	Polyline	198	20210414	456	1000	3	14	198	44.424	3.773	43.567	3.928
198	Polyline	199	20210415	459	1000	4	14	199	43.567	3.928	43.001	4.429
199	Polyline	200	20210416	501	1000	5	14	200	43.001	4.429	42.593	5.39
200	Polyline	201	20210417	501	1000	6	14	201	42.593	5.39	42.211	6.749
201	Polyline	202	20210418	501	1000	7	14	202	42.211	6.749	41.68	8.745
202	Polyline	203	20210419	501	1000	8	14	203	41.68	8.745	41.526	9.341
203	Polyline	204	20210420	501	1000	9	14	204	41.526	9.341	41.608	9.209
204	Polyline	205	20210421	500	1000	10	14	205	41.608	9.209	41.577	9.381
205	Polyline	206	20210422	500	1000	11	14	206	41.577	9.381	41.232	9.283
206	Polyline	207	20210423	501	1000	12	14	207	41.232	9.283	40.745	9.362
207	Polyline	208	20210424	502	1000	13	14	208	40.745	9.362	40.7	9.717
208	Polyline	209	20210425	502	1000	14	14	209	40.7	9.717	40.505	9.778
209	Polyline	210	20210426	502	1000	15	14	210	40.505	9.778	40.579	10.196
210	Polyline	211	20210412	446	1500	1	15	211	47	4.5	45.994	3.697
211	Polyline	212	20210413	450	1500	2	15	212	45.994	3.697	45.347	2.567
212	Polyline	213	20210414	453	1500	3	15	213	45.347	2.567	44.857	2.039
213	Polyline	214	20210415	455	1500	4	15	214	44.857	2.039	44.242	1.827
214	Polyline	215	20210416	458	1500	5	15	215	44.242	1.827	43.403	2.284
215	Polyline	216	20210417	500	1500	6	15	216	43.403	2.284	42.67	2.847
216	Polyline	217	20210418	503	1500	7	15	217	42.67	2.847	42.338	4.295
217	Polyline	218	20210419	502	1500	8	15	218	42.338	4.295	42.58	5.123
218	Polyline	219	20210420	500	1500	9	15	219	42.58	5.123	42.543	5.765
219	Polyline	220	20210421	500	1500	10	15	220	42.543	5.765	42.178	6.37
220	Polyline	221	20210422	500	1500	11	15	221	42.178	6.37	41.379	6.608
221	Polyline	222	20210423	503	1500	12	15	222	41.379	6.608	40.681	6.792
222	Polyline	223	20210424	505	1500	13	15	223	40.681	6.792	40.029	7.198
223	Polyline	224	20210425	507	1500	14	15	224	40.029	7.198	40.59	7.17
224	Polyline	225	20210426	504	1500	15	15	225	40.59	7.17	40.621	7.728
225	Polyline	226	20210412	454	500	1	16	226	45	5	43.459	5.18
226	Polyline	227	20210413	459	500	2	16	227	43.459	5.18	42.618	5.623
227	Polyline	228	20210414	502	500	3	16	228	42.618	5.623	42	6.562
228	Polyline	229	20210415	503	500	4	16	229	42	6.562	41.422	8.137

(15 out of 1125 Selected)

matrix_7129_all_trajs

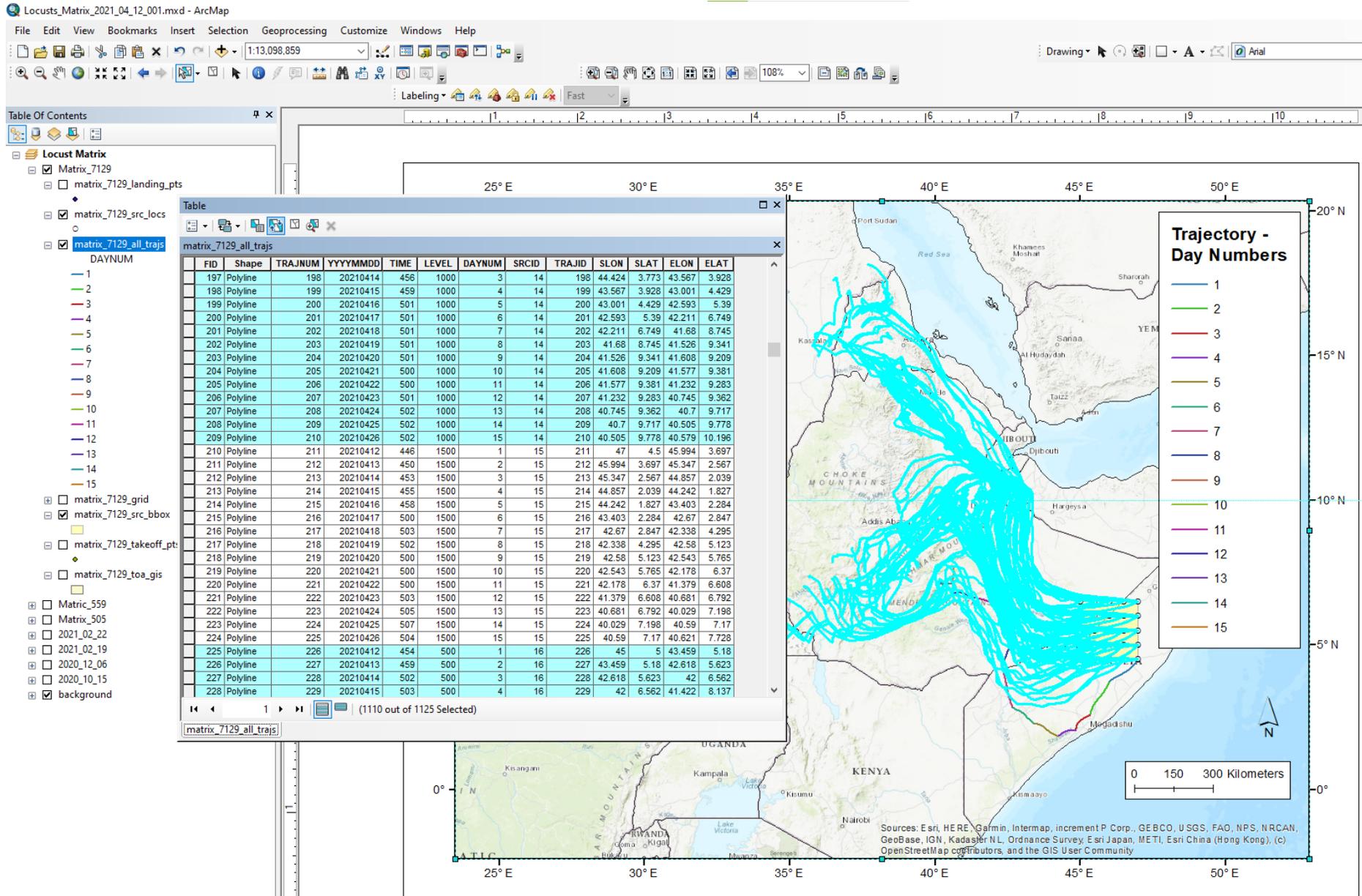
GIS Processing: Selecting a specific SRCID (in ArcGIS)

Here is an example of selecting a specific SRCID – i.e., a specific starting location and height – in ArcGIS, a GIS application. In this slide, you can see the entire selected trajectory outlined in light blue



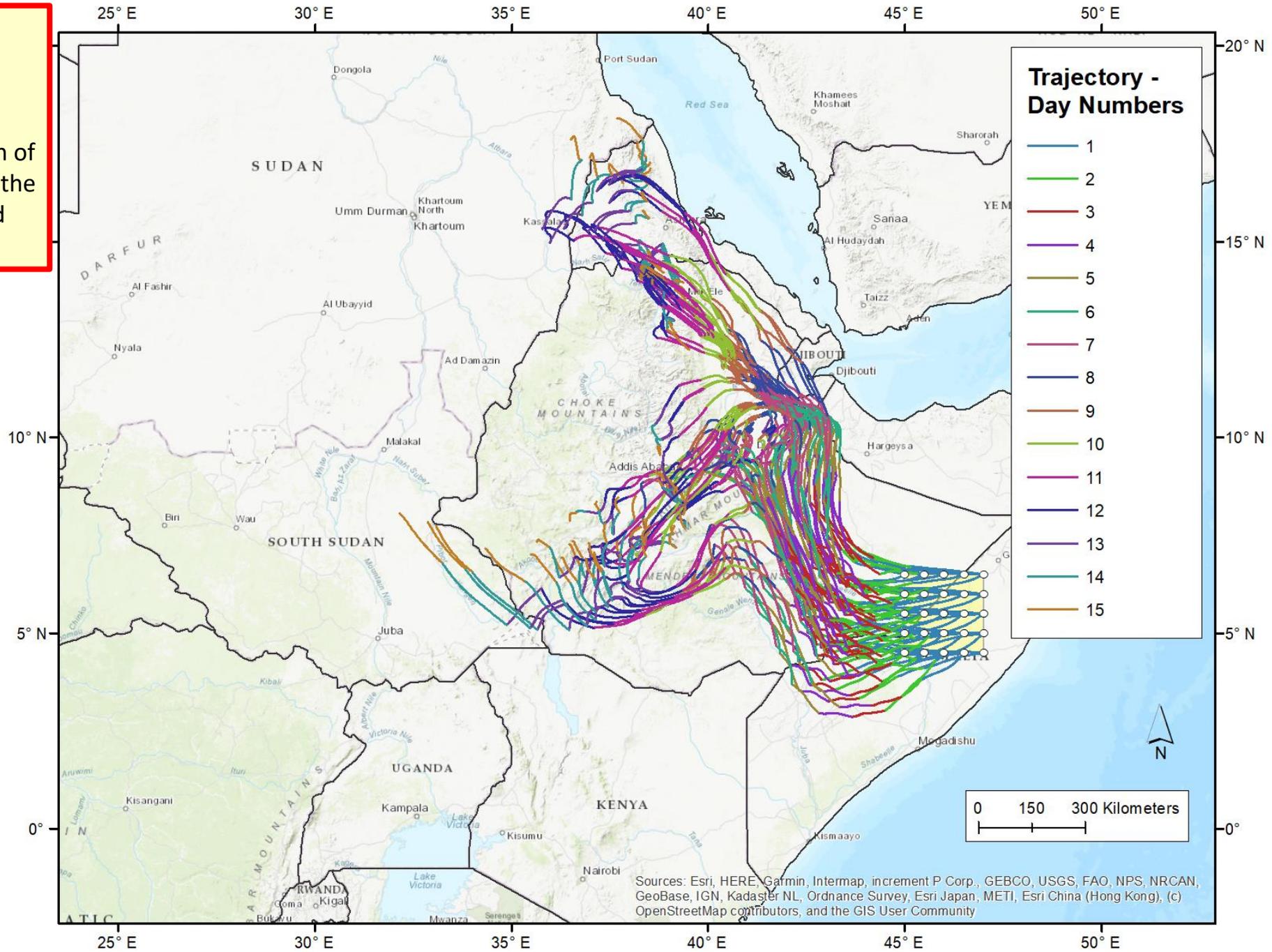
GIS Processing: Selecting a specific SRCID (in ArcGIS)

Here we have inverted the selection, to select all trajectories other than SRCID = 15. This is an example of what one might do to “remove” a given trajectory from the display, i.e., selecting all trajectories other than that one, and saving the resulting collection to a new shapefile.



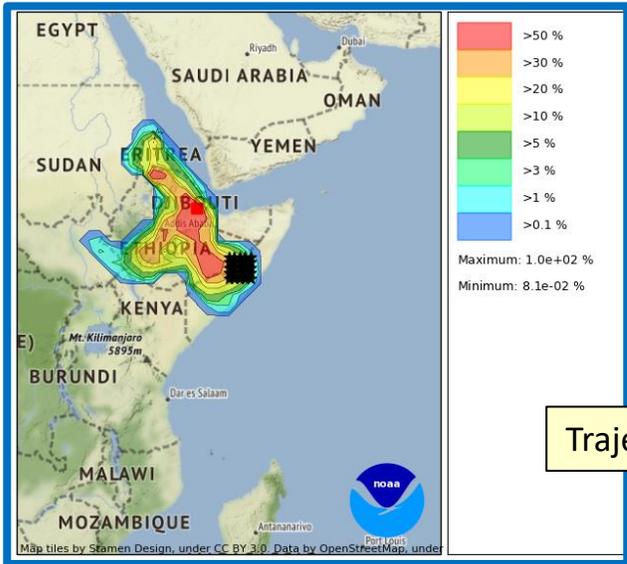
**GIS Processing:
Selecting a specific
SRCID (in ArcGIS)**

Here is the collection of
trajectories without the
trajectory associated
with SRCID = 15.

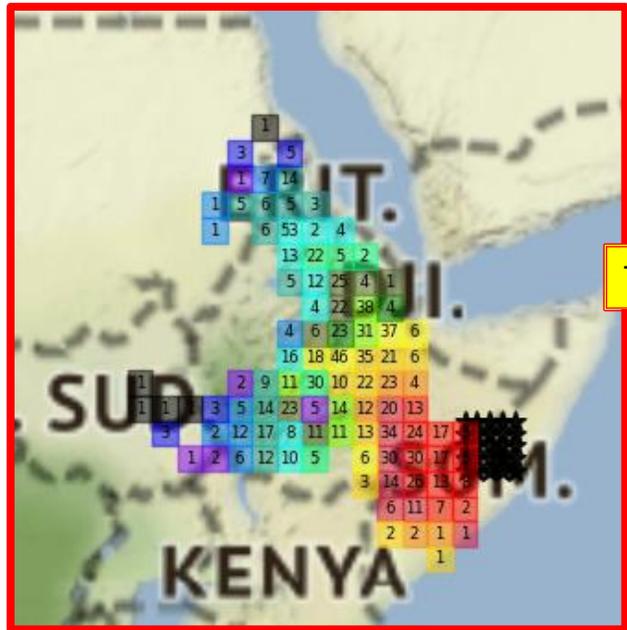


Time of Arrival

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Time of Arrival graphics

Trajectory frequency graphics via gridplot – a different HYSPLIT mapping program

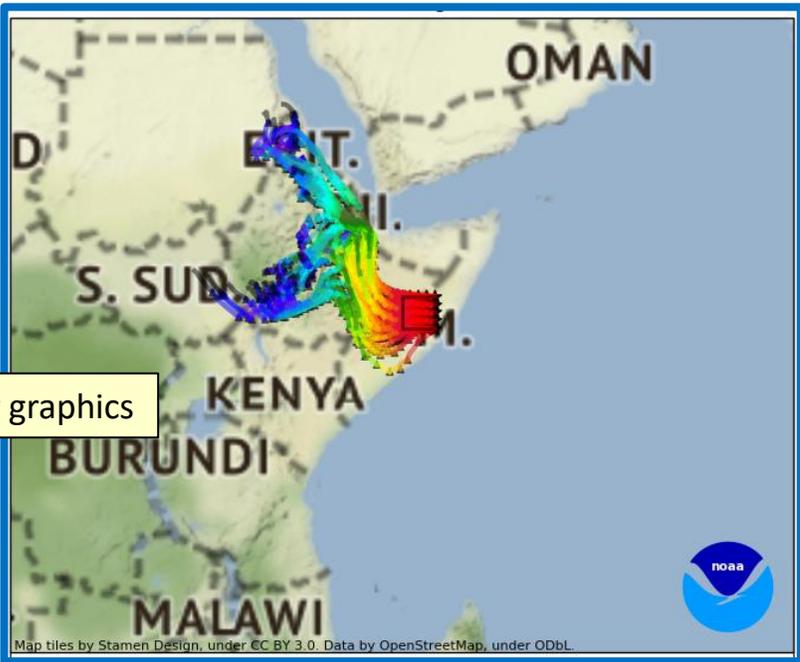
Name	Created	Type	Size
hysplit	4/12/2021 1:01 PM	File folder	
shapefiles_toa	4/12/2021 1:01 PM	File folder	
shapefiles_traj_aggregated	4/12/2021 1:01 PM	File folder	
shapefiles_traj_day	4/12/2021 1:01 PM	File folder	
shapefiles_traj_freq	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height_day	4/12/2021 1:01 PM	File folder	
LABELS.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
MAPTEXT.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
matrix_7129_freq.pdf	4/12/2021 1:01 PM	Adobe Acrobat D...	255 KB
matrix_7129_freq.png	4/12/2021 1:01 PM	PNG File	347 KB
matrix_7129_freq.ps	4/12/2021 1:01 PM	PostScript File	1,572 KB
matrix_7129_gridplot.jpg	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_gridplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_infile	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_MAPTEXT.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_progress.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_run_setup_summary.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trj_001.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trjfreq.bin	4/12/2021 1:01 PM	JPG File	454 KB

Folder with HYSPLIT Control and other model-specific files.

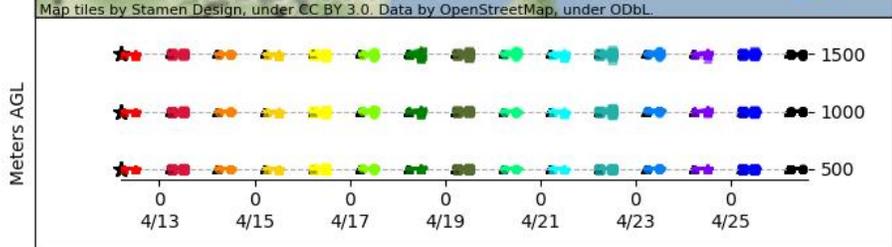
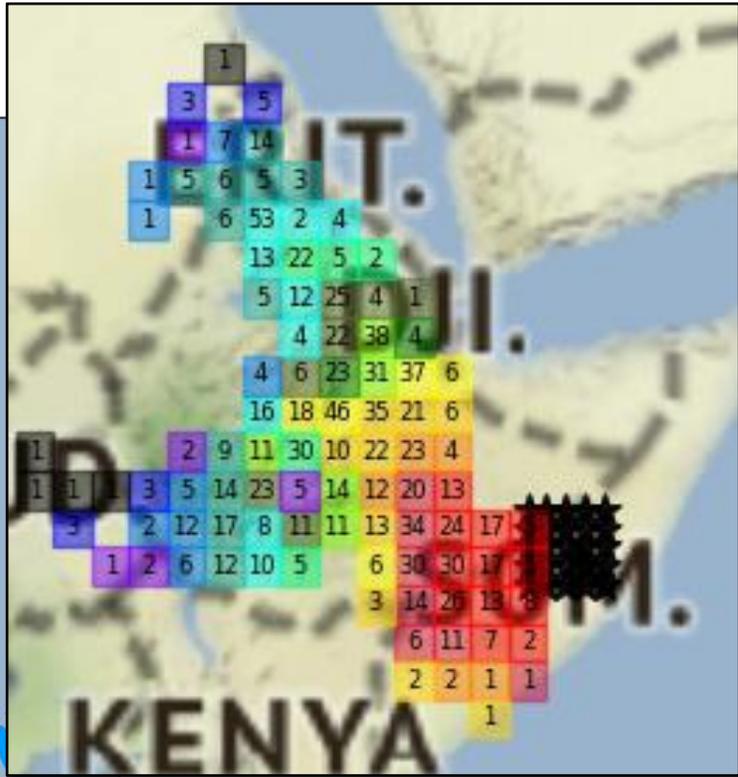
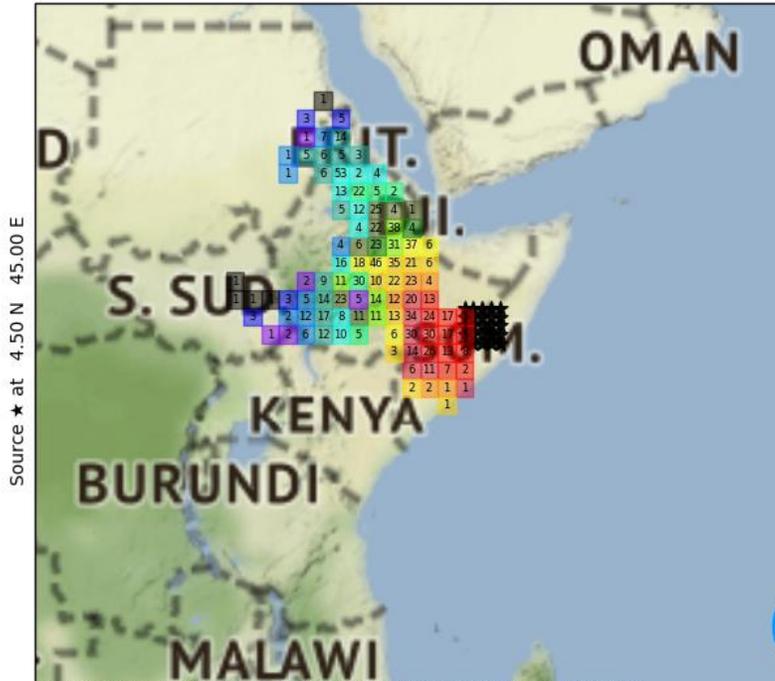
Folders with shapefiles associated with time of arrival (toa), trajectories, and trajectory frequencies. These can be imported into GIS applications (e.g. ArcGIS) and displayed – and processed further – according to the user’s needs

Summary files of inputs and outputs

Trajectory graphics



NOAA AIR RESOURCES LABORATORY
 Forward trajectory starting at 0454 UTC 12 Apr 2021
 GFSG Meteorological Data



TRAJECTORY ENDPOINT PERCENTAGE FREQUENCY MAP

-- run name: matrix_7129
 -- trajectory duration: 360 hours

There are 1125 landing points in this example, and the sum of all of the numbers displayed in this graphic add up to 1125

Graphic output of time-of-arrival information using basic HYSPLIT graphics

- This is generated by the App. For more advanced modifications, user can import shape files provided in output (see additional description of this functionality below)
- The source locations are shown with a matrix of stars
- The grid squares are color-coded with the same colors as the trajectories, and the color-coding is shown in the bottom panel of the figure for each day.
- And in the grid squares are the number of trajectory landing points. The color chosen for the grid square corresponds to the “day” with the most associated landing points in that grid square.

Time of Arrival:
Daily Landing Points

s > 2020 > Locusts > Time_of_Arrival > matrix_7129 > shapefiles_toa

Name	Date modified	Type	Size				
 matrix_7129_landing_pts.att	4/12/2021 1:01 PM	ATT File	48 KB	1,	43.4170,	4.6210,	496.
 matrix_7129_landing_pts.dbf	4/12/2021 1:01 PM	DBF File	44 KB	2,	42.6920,	4.9030,	500.
 matrix_7129_landing_pts.prj	4/12/2021 1:01 PM	PRJ File	1 KB	3,	42.2140,	5.7510,	495.
 matrix_7129_landing_pts.shp	4/12/2021 1:01 PM	SHP File	31 KB	4,	41.8060,	7.1080,	498.
 matrix_7129_landing_pts.shx	4/12/2021 1:01 PM	SHX File	9 KB	5,	40.8610,	8.6460,	485.
 matrix_7129_landing_pts.txt	4/12/2021 1:01 PM	Text Document	41 KB	6,	39.7580,	9.1550,	505.
 matrix_7129_src_bbox.dbf	4/12/2021 1:01 PM	DBF File	1 KB	7,	39.8160,	9.4060,	500.
 matrix_7129_src_bbox.prj	4/12/2021 1:01 PM	PRJ File	1 KB	8,	39.4930,	9.5910,	495.
 matrix_7129_src_bbox.shp	4/12/2021 1:01 PM	SHP File	1 KB	9,	39.1290,	9.1150,	490.
 matrix_7129_src_bbox.shx	4/12/2021 1:01 PM	SHX File	1 KB	10,	38.4700,	9.0090,	494.
 matrix_7129_src_bbox.txt	4/12/2021 1:01 PM	Text Document	1 KB	11,	37.7270,	8.6790,	502.
 matrix_7129_src_locs.att	4/12/2021 1:01 PM	ATT File	2 KB	12,	37.3790,	8.3540,	503.
 matrix_7129_src_locs.dbf	4/12/2021 1:01 PM	DBF File	2 KB	13,	36.8710,	8.1100,	502.
 matrix_7129_src_locs.prj	4/12/2021 1:01 PM	PRJ File	1 KB	14,	36.6370,	8.0640,	498.
 matrix_7129_src_locs.shp	4/12/2021 1:01 PM	SHP File	3 KB	15,	36.4780,	7.8620,	500.
 matrix_7129_src_locs.shx	4/12/2021 1:01 PM	SHX File	1 KB	16,	43.4610,	4.5110,	993.
 matrix_7129_src_locs.txt	4/12/2021 1:01 PM	Text Document	3 KB	17,	42.7580,	4.7170,	1001.
 matrix_7129_takeoff_pts.att	4/12/2021 1:01 PM	ATT File	48 KB	18,	42.3470,	5.3710,	997.
 matrix_7129_takeoff_pts.dbf	4/12/2021 1:01 PM	DBF File	44 KB	19,	41.9860,	6.4780,	990.
 matrix_7129_takeoff_pts.prj	4/12/2021 1:01 PM	PRJ File	1 KB	20,	41.2950,	8.0540,	984.
 matrix_7129_takeoff_pts.shp	4/12/2021 1:01 PM	SHP File	31 KB	21,	40.3040,	9.0470,	1000.
 matrix_7129_takeoff_pts.shx	4/12/2021 1:01 PM	SHX File	9 KB	22,	40.3120,	9.6170,	1003.
 matrix_7129_takeoff_pts.txt	4/12/2021 1:01 PM	Text Document	41 KB	23,	39.8860,	10.0890,	994.
 matrix_7129_toa_gis.att	4/12/2021 1:01 PM	ATT File	4 KB	24,	39.4550,	9.1820,	987.
 matrix_7129_toa_gis.dbf	4/12/2021 1:01 PM	DBF File	4 KB	25,	38.8270,	8.5400,	983.
 matrix_7129_toa_gis.prj	4/12/2021 1:01 PM	PRJ File	1 KB	26,	37.7150,	7.4580,	1004.
 matrix_7129_toa_gis.shp	4/12/2021 1:01 PM	SHP File	14 KB	27,	36.9630,	7.1610,	1007.
 matrix_7129_toa_gis.shx	4/12/2021 1:01 PM	SHX File	1 KB	28,	36.8860,	6.4050,	1015.
 matrix_7129_toa_gis.txt	4/12/2021 1:01 PM	Text Document	11 KB	29,	36.7940,	6.9350,	990.
				30,	36.5410,	7.3480,	997.
				31,	43.6800,	4.0720,	1489.
				32,	42.8800,	3.8110,	1506.
				33,	42.3480,	4.0940,	1503.
				34,	41.9360,	4.8350,	1498.
				35,	41.3370,	5.7810,	1474.
				36,	40.6930,	6.5320,	1475.
				37,	40.1500,	7.2650,	1450.
				38,	39.6970,	6.3840,	1525.
				39,	39.1210,	5.8810,	1514.
				40,	38.3720,	5.4500,	1504.
				41,	37.0830,	5.1430,	1530.
				42,	35.7540,	6.1470,	1507.
				43,	34.8820,	5.2120,	1505.
				44,	33.2240,	6.8130,	1508.
				45,	32.1430,	8.0660,	1500.
				46,	43.9320,	4.5830,	496.
				47,	42.9780,	4.7710,	500.
				48,	42.4730,	5.4210,	499.
				49,	42.1350,	6.7120,	497.
				50,	41.3990,	8.4460,	487.
				51,	40.7370,	9.3550,	501.
				52,	40.6590,	9.8230,	506.
				53,	40.5840,	9.9910,	501.

GIS Processing: Daily Landing Points

Here are the key attributes that are associated with the daily landing points shapefile in the **shapefiles_toa** subdirectory:

TRAJID: unique number for each trajectory for each day for each height – in this example, goes from 1 to 1125 (same as TRAJNUM in trajectory attributes)

YYYYMMDD: date of the trajectory

DAYNUM: day number – in this example, this goes from 1-15

SRCID: a unique number for each source location and height combination. In this example, there are 25 source locations and 3 heights, and so, the SRCID numbers go from 1 to 75. If one wants to remove a landing point of trajectory from the display, e.g., because it is deemed an unlikely path, such as a path going out over the ocean, then one can simply remove that overall migration path (all 15 days) by removing that SRCID from the display. Or if desired, one can remove just part of that path by further considering DAYNUM in the selection / de-selection of items to display

Table

matrix_7129_landing_pts

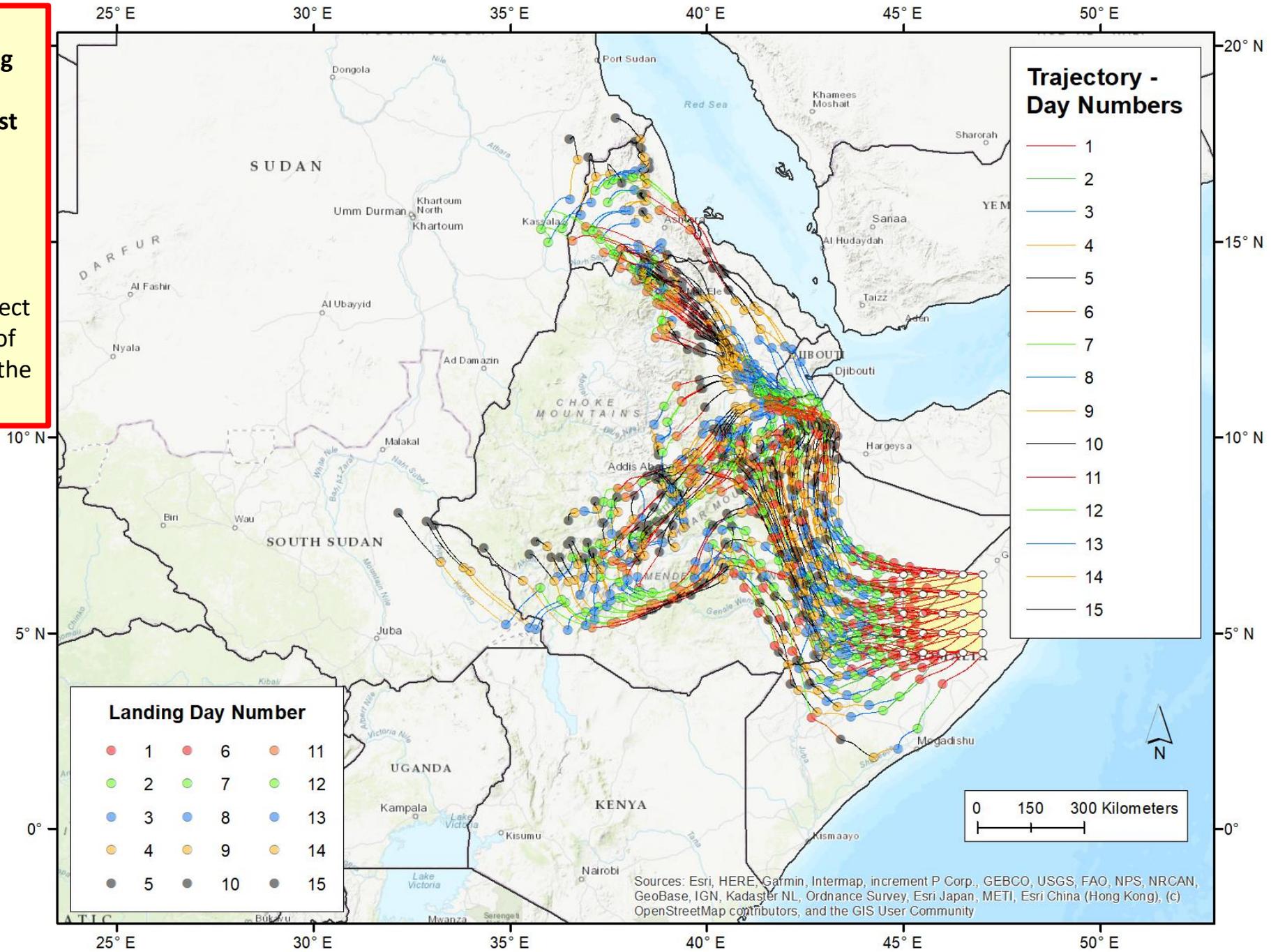
	FID	Shape	ID	YYYYMMDD	DAYNUM	SRCID	TRAJID
▶	0	Point	1	20210412	1	1	1
	1	Point	2	20210413	2	1	2
	2	Point	3	20210414	3	1	3
	3	Point	4	20210415	4	1	4
	4	Point	5	20210416	5	1	5
	5	Point	6	20210417	6	1	6
	6	Point	7	20210418	7	1	7
	7	Point	8	20210419	8	1	8
	8	Point	9	20210420	9	1	9
	9	Point	10	20210421	10	1	10
	10	Point	11	20210422	11	1	11
	11	Point	12	20210423	12	1	12
	12	Point	13	20210424	13	1	13
	13	Point	14	20210425	14	1	14
	14	Point	15	20210426	15	1	15
	15	Point	16	20210412	1	2	16
	16	Point	17	20210413	2	2	17
	17	Point	18	20210414	3	2	18
	18	Point	19	20210415	4	2	19
	19	Point	20	20210416	5	2	20
	20	Point	21	20210417	6	2	21
	21	Point	22	20210418	7	2	22
	22	Point	23	20210419	8	2	23
	23	Point	24	20210420	9	2	24
	24	Point	25	20210421	10	2	25
	25	Point	26	20210422	11	2	26
	26	Point	27	20210423	12	2	27
	27	Point	28	20210424	13	2	28
	28	Point	29	20210425	14	2	29
	29	Point	30	20210426	15	2	30
	30	Point	31	20210412	1	3	31
	31	Point	32	20210413	2	3	32

1 | (0 out of 1125 Selected)

matrix_7129_landing_pts

**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Here are all of the
landing points and
trajectories for this
example. We will select
and display subsets of
this complete set in the
following slides



**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Process for selecting
landing points for days
1 through 5

The screenshot shows the ArcGIS interface with the 'Select by Attributes' dialog box open. The dialog box is configured to create a new selection based on the 'DAYNUM' field, with the WHERE clause set to `"DAYNUM" <=5`. The background shows a map with a coordinate grid and a data table with columns MDD, DAYNUM, SRCID, and TRAJID. The table contains 32 rows of data, with the first 5 rows corresponding to the selected forecast days.

Select by Attributes Dialog:

- Method: Create a new selection
- Fields: "FID", "ID", "YYYYMMDD", "DAYNUM", "SRCID"
- Operator: =
- Field: "DAYNUM"
- Value: <=5
- SQL Statement: `SELECT * FROM matrix_7129_landing_pts WHERE: "DAYNUM" <=5`

Data Table:

MDD	DAYNUM	SRCID	TRAJID
0412	1	1	1
0413	2	1	2
0414	3	1	3
0415	4	1	4
0416	5	1	5
0417	6	1	6
0418	7	1	7
0419	8	1	8
0420	9	1	9
0421	10	1	10
0422	11	1	11
0423	12	1	12
0424	13	1	13
13	14	20210425	14
14	15	20210426	15
15	16	20210412	1
16	17	20210413	2
17	18	20210414	3
18	19	20210415	4
19	20	20210416	5
20	21	20210417	6
21	22	20210418	7
22	23	20210419	8
23	24	20210420	9
24	25	20210421	10
25	26	20210422	11
26	27	20210423	12
27	28	20210424	13
28	29	20210425	14
29	30	20210426	15
30	31	20210412	1
31	32	20210413	2

**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Process for selecting
landing points for days
1 through 5

Select by Attributes

Enter a WHERE clause to select records in the table window.

Method: Create a new selection

"FID"
"ID"
"YYYYMMDD"
"DAYNUM"
"SRCID"

= <> Like
> >= And
< <= Or
_ % () Not
Is In Null Get Unique

SELECT * FROM matrix_7129_landing_pts
"DAYNUM" <= 5

Clear Verify Help

matrix_7129_src_pts
matrix_7129_all_traj
DAYNUM
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
matrix_7129_src_bbox

Table

matrix_7129_landing_pts

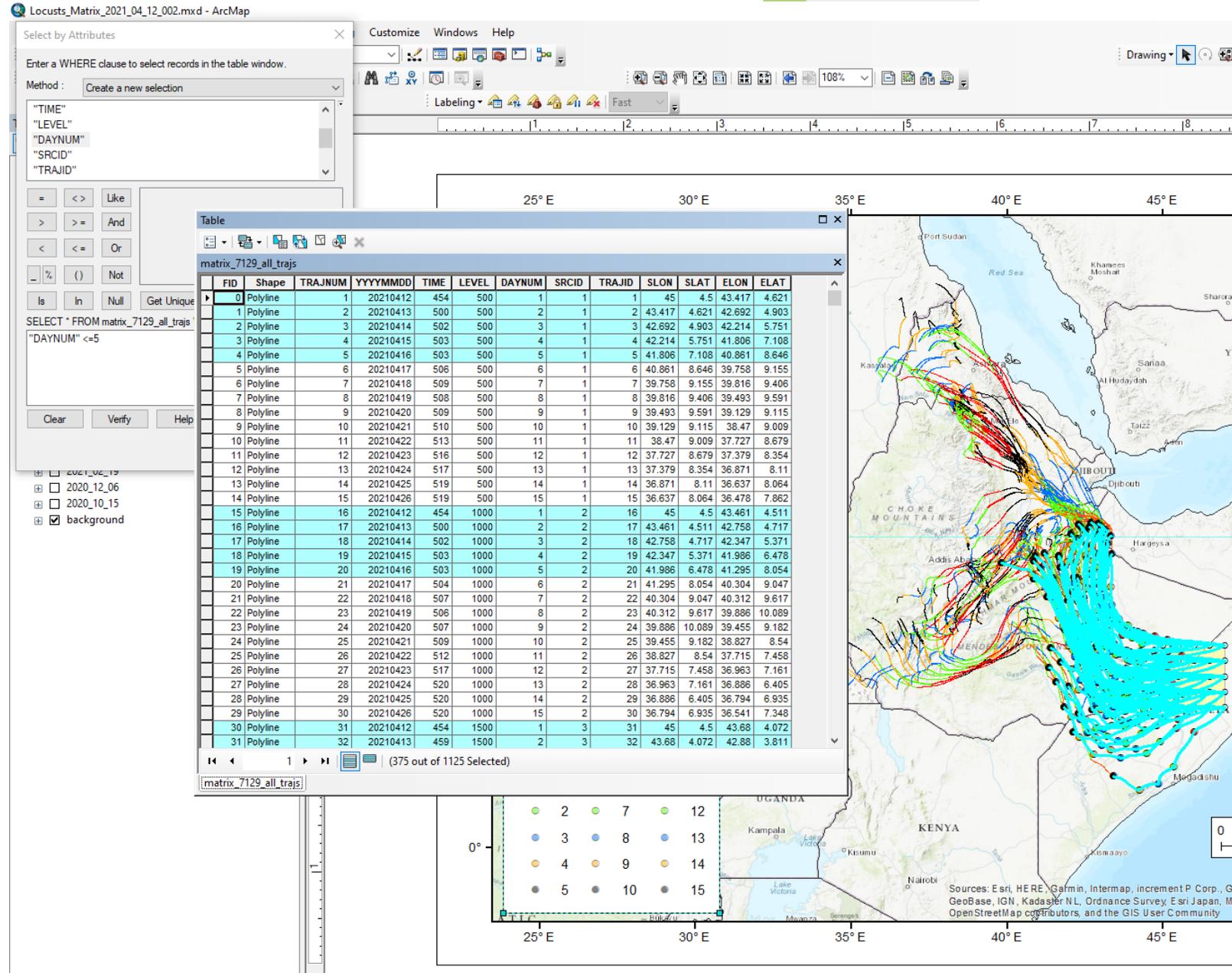
FID	Shape	ID	YYYYMMDD	DAYNUM	SRCID	TRAJID
0	Point	1	20210412	1	1	1
1	Point	2	20210413	2	1	2
2	Point	3	20210414	3	1	3
3	Point	4	20210415	4	1	4
4	Point	5	20210416	5	1	5
5	Point	6	20210417	6	1	6
6	Point	7	20210418	7	1	7
7	Point	8	20210419	8	1	8
8	Point	9	20210420	9	1	9
9	Point	10	20210421	10	1	10
10	Point	11	20210422	11	1	11
11	Point	12	20210423	12	1	12
12	Point	13	20210424	13	1	13
13	Point	14	20210425	14	1	14
14	Point	15	20210426	15	1	15
15	Point	16	20210412	1	2	16
16	Point	17	20210413	2	2	17
17	Point	18	20210414	3	2	18
18	Point	19	20210415	4	2	19
19	Point	20	20210416	5	2	20
20	Point	21	20210417	6	2	21
21	Point	22	20210418	7	2	22
22	Point	23	20210419	8	2	23
23	Point	24	20210420	9	2	24
24	Point	25	20210421	10	2	25
25	Point	26	20210422	11	2	26
26	Point	27	20210423	12	2	27
27	Point	28	20210424	13	2	28
28	Point	29	20210425	14	2	29
29	Point	30	20210426	15	2	30
30	Point	31	20210412	1	3	31
31	Point	32	20210413	2	3	32

(375 out of 1125 Selected)

matrix_7129_landing_pts

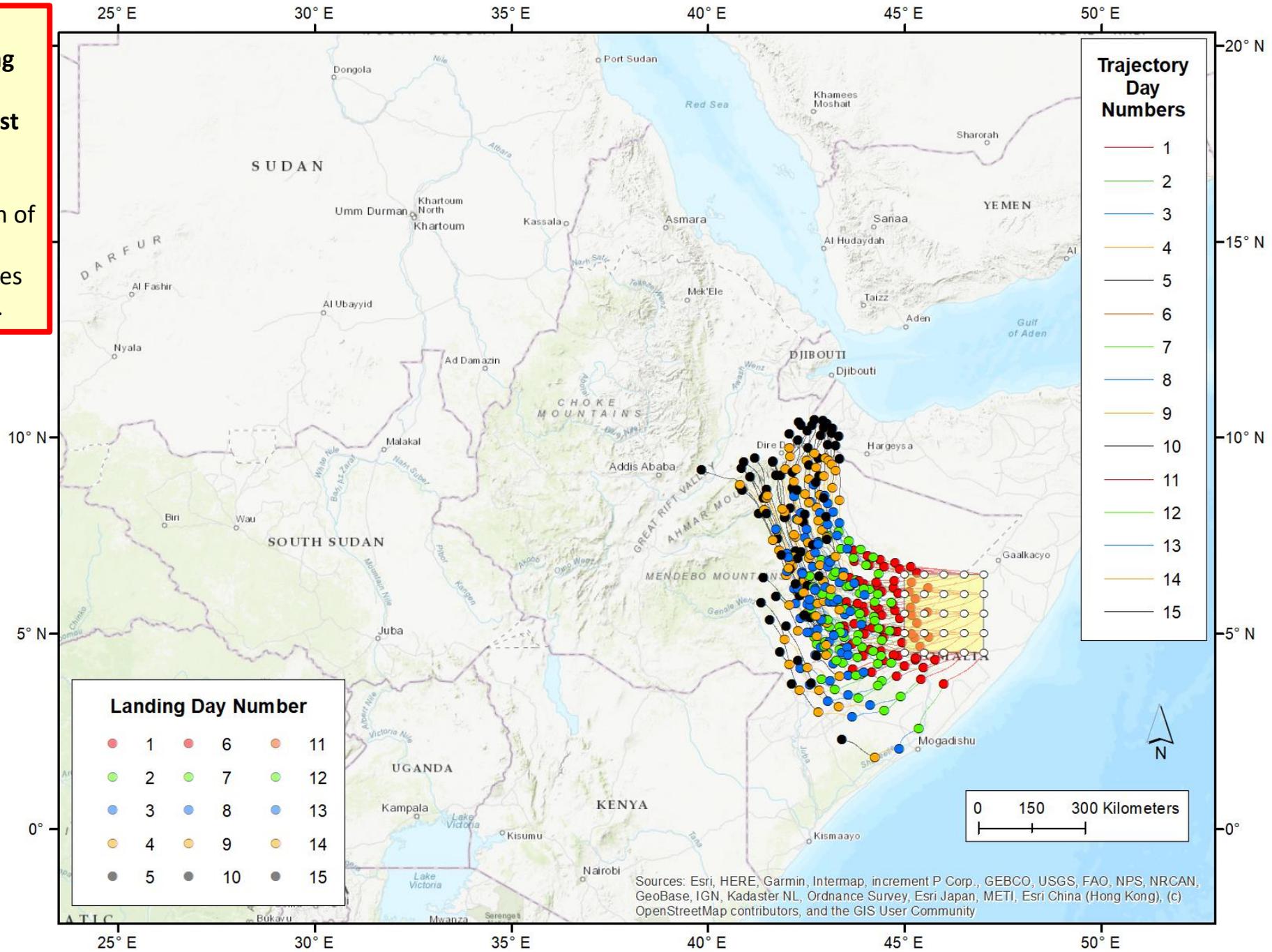
**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Process for selecting
trajectories for days 1
through 5



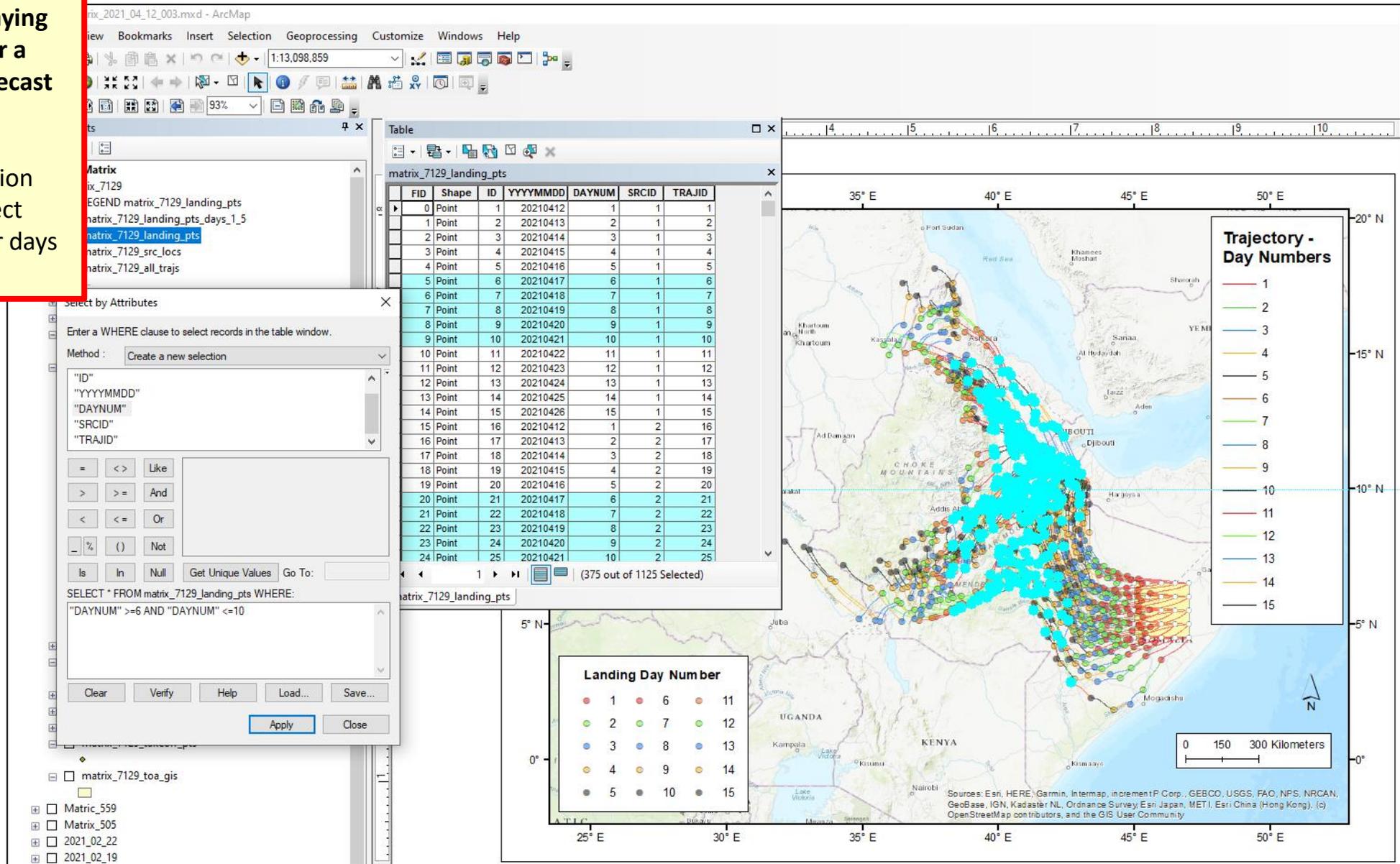
**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Here is the collection of
landing points and
associated trajectories
for days 1 through 5.



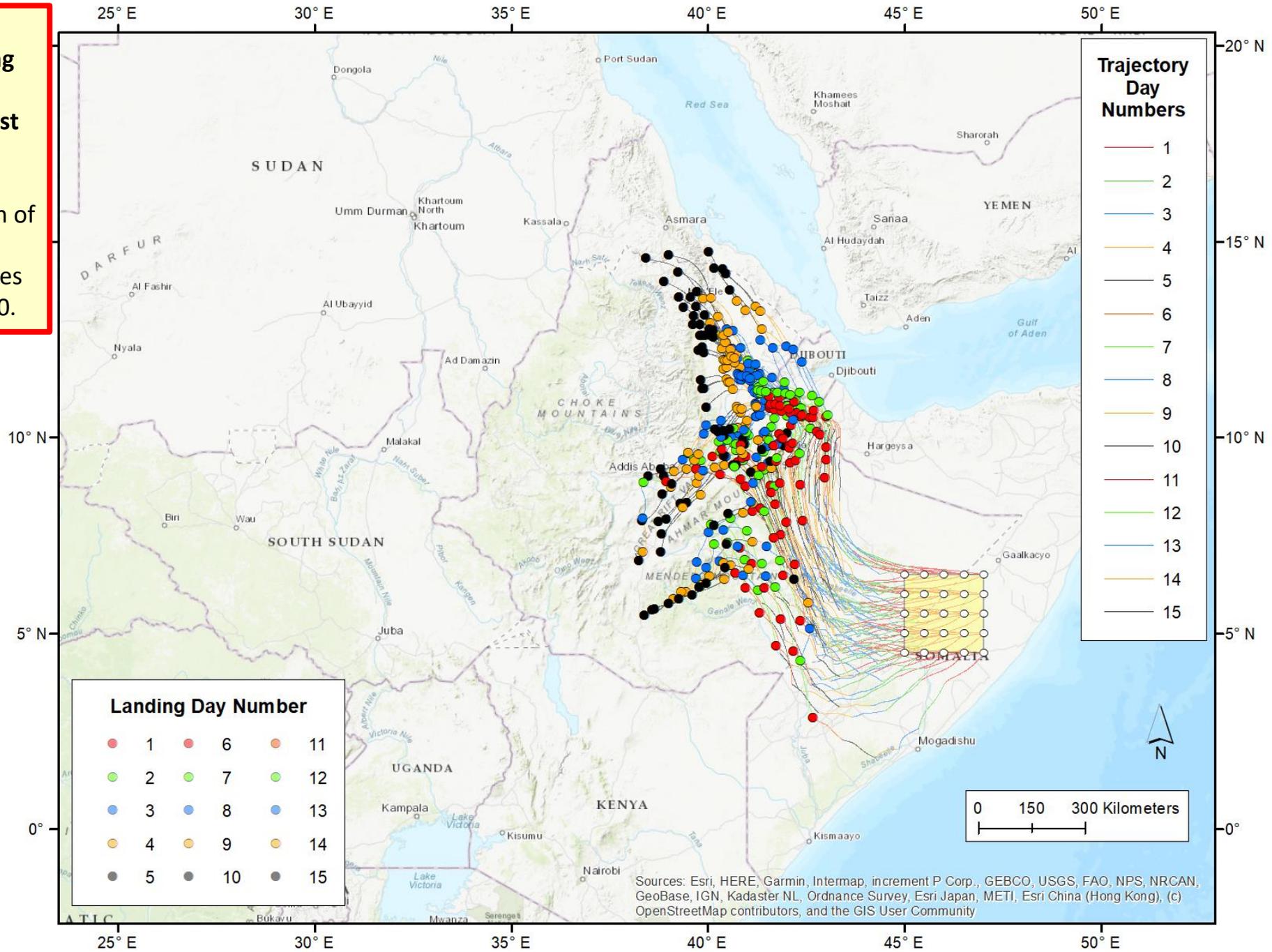
**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Here is the selection
procedure to select
landing points for days
6 through 10



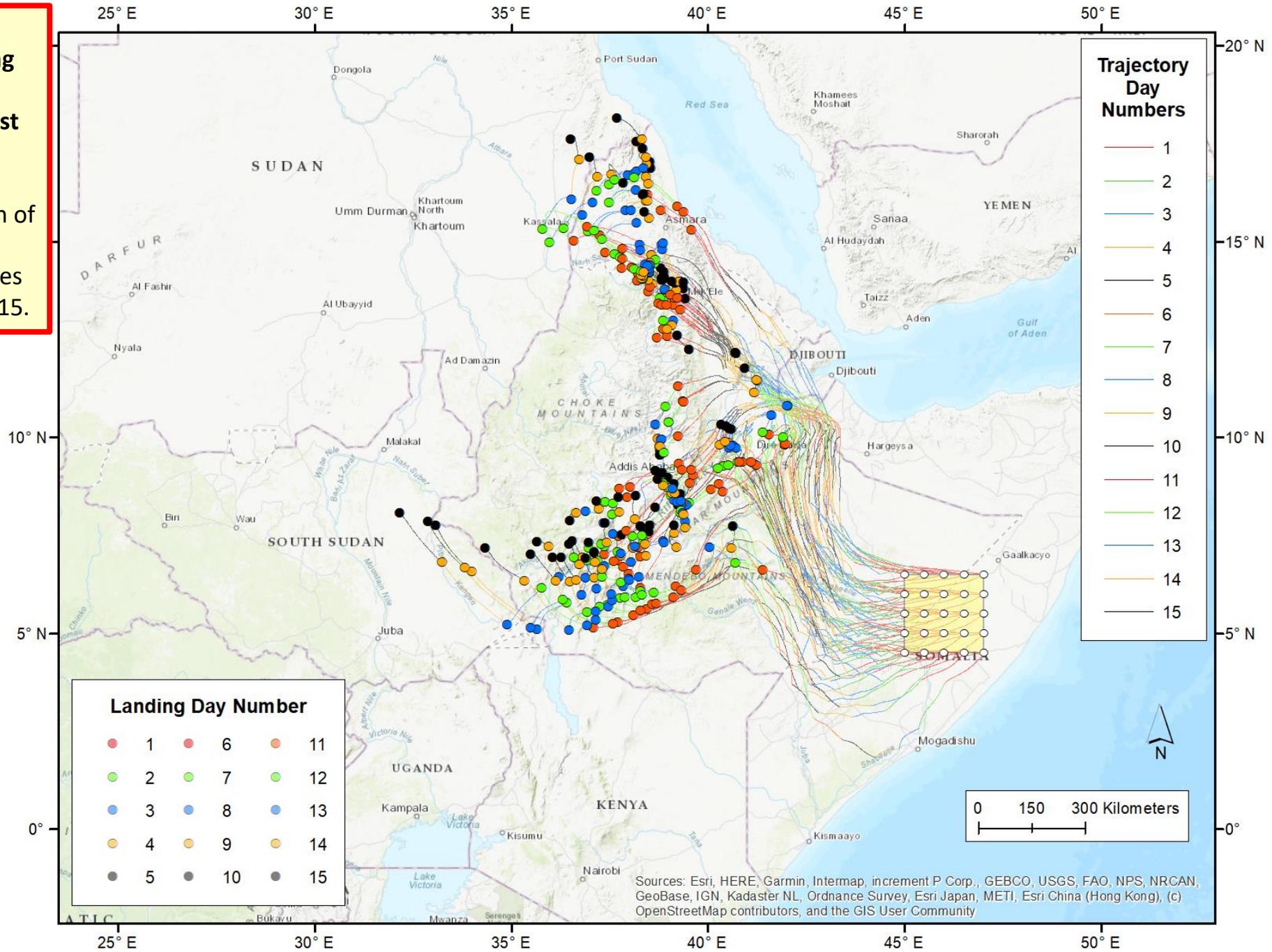
**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Here is the collection of
landing points and
associated trajectories
for days 6 through 10.



**GIS Processing:
Selecting / displaying
landing points for a
certain set of forecast
days (in ArcGIS)**

Here is the collection of
landing points and
associated trajectories
for days 11 through 15.



Other folders
with trajectory
shapefiles

s > 2020 > Locusts > Time_of_Arrival > matrix_7129 > shapefiles_traj_day

Name	Date modified	Type	Size
matrix_7129_day1.att	4/12/2021 1:01 PM	ATT File	8 KB
matrix_7129_day1.dbf	4/12/2021 1:01 PM	DBF File	7 KB
matrix_7129_day1.prj	4/12/2021 1:01 PM	PRJ File	1 KB
matrix_7129_day1.shp	4/12/2021 1:01 PM	SHP File	136 KB
matrix_7129_day1.shx	4/12/2021 1:01 PM	SHX File	1 KB
matrix_7129_day1.txt	4/12/2021 1:01 PM	Text Document	167 KB
matrix_7129_day2.att	4/12/2021 1:01 PM	ATT File	8 KB
matrix_7129_day2.dbf	4/12/2021 1:01 PM	DBF File	7 KB
matrix_7129_day2.prj	4/12/2021 1:01 PM	PRJ File	1 KB
matrix_7129_day2.shp	4/12/2021 1:01 PM	SHP File	136 KB
matrix_7129_day2.shx	4/12/2021 1:01 PM	SHX File	1 KB
matrix_7129_day2.txt	4/12/2021 1:01 PM	Text Document	167 KB
matrix_7129_day3.att	4/12/2021 1:01 PM	ATT File	8 KB
matrix_7129_day3.dbf	4/12/2021 1:01 PM	DBF File	7 KB
matrix_7129_day3.prj	4/12/2021 1:01 PM	PRJ File	1 KB
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matrix_7129_day4.att	4/12/2021 1:01 PM	ATT File	8 KB
matrix_7129_day4.dbf	4/12/2021 1:01 PM	DBF File	7 KB
matrix_7129_day4.prj	4/12/2021 1:01 PM	PRJ File	1 KB
matrix_7129_day4.shp	4/12/2021 1:01 PM	SHP File	136 KB
matrix_7129_day4.shx	4/12/2021 1:01 PM	SHX File	1 KB
matrix_7129_day4.txt	4/12/2021 1:01 PM	Text Document	167 KB
matrix_7129_day5.att	4/12/2021 1:01 PM	ATT File	8 KB
matrix_7129_day5.dbf	4/12/2021 1:01 PM	DBF File	7 KB
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matrix_7129_day5.shp	4/12/2021 1:01 PM	SHP File	137 KB
matrix_7129_day5.shx	4/12/2021 1:01 PM	SHX File	1 KB
matrix_7129_day5.txt	4/12/2021 1:01 PM	Text Document	168 KB
matrix_7129_day6.att	4/12/2021 1:01 PM	ATT File	8 KB
matrix_7129_day6.dbf	4/12/2021 1:01 PM	DBF File	7 KB
matrix_7129_day6.prj	4/12/2021 1:01 PM	PRJ File	1 KB
matrix_7129_day6.shp	4/12/2021 1:01 PM	SHP File	137 KB
matrix_7129_day6.shx	4/12/2021 1:01 PM	SHX File	1 KB
matrix_7129_day6.txt	4/12/2021 1:01 PM	Text Document	168 KB
matrix_7129_day7.att	4/12/2021 1:01 PM	ATT File	8 KB
matrix_7129_day7.dbf	4/12/2021 1:01 PM	DBF File	7 KB
matrix_7129_day7.prj	4/12/2021 1:01 PM	PRJ File	1 KB
matrix_7129_day7.shp	4/12/2021 1:01 PM	SHP File	138 KB
matrix_7129_day7.shx	4/12/2021 1:01 PM	SHX File	1 KB

1, 45.0000, 4.5000
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44.5990, 4.6530
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44.5660, 4.6640
44.5490, 4.6690
44.5330, 4.6740
44.5160, 4.6780
44.4990, 4.6830
44.4830, 4.6880
44.4670, 4.6920
44.4500, 4.6960
44.4340, 4.7000
44.4180, 4.7040
44.4020, 4.7080
44.3860, 4.7120
44.3700, 4.7160
44.3540, 4.7190
44.3380, 4.7230
44.3230, 4.7260
44.3070, 4.7290
44.2920, 4.7320
44.2760, 4.7350
44.2610, 4.7370
44.2460, 4.7400
44.2300, 4.7420
44.2150, 4.7440
44.2000, 4.7460
44.1850, 4.7480
44.1710, 4.7500
44.1560, 4.7520
44.1410, 4.7530
44.1260, 4.7540
44.1120, 4.7550
44.0970, 4.7560
44.0830, 4.7570
44.0680, 4.7570
44.0540, 4.7570
44.0390, 4.7570
44.0250, 4.7570
44.0110, 4.7570
43.9960, 4.7560
43.9820, 4.7550
43.9680, 4.7540
43.9540, 4.7530
43.9410, 4.7520

> 2020 > Locusts > Time_of_Arrival > matrix_7129 > shapefiles_traj_height

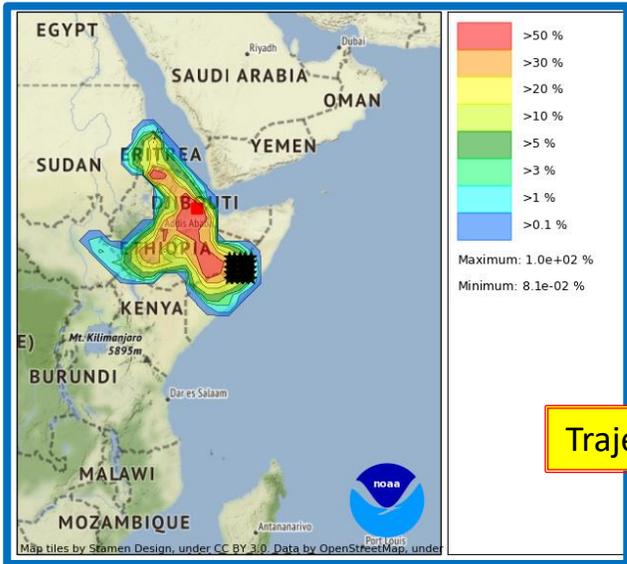
Name	Date modified	Type	Size	
 matrix_7129_0500m.att	4/12/2021 1:01 PM	ATT File	36 KB	1, 45.0000, 4.5000
 matrix_7129_0500m.dbf	4/12/2021 1:01 PM	DBF File	33 KB	44.9960, 4.5020
 matrix_7129_0500m.prj	4/12/2021 1:01 PM	PRJ File	1 KB	44.9790, 4.5100
 matrix_7129_0500m.shp	4/12/2021 1:01 PM	SHP File	688 KB	44.9610, 4.5170
 matrix_7129_0500m.shx	4/12/2021 1:01 PM	SHX File	4 KB	44.9440, 4.5250
 matrix_7129_0500m.txt	4/12/2021 1:01 PM	Text Document	844 KB	44.9260, 4.5330
 matrix_7129_1000m.att	4/12/2021 1:01 PM	ATT File	36 KB	44.9090, 4.5400
 matrix_7129_1000m.dbf	4/12/2021 1:01 PM	DBF File	33 KB	44.8910, 4.5470
 matrix_7129_1000m.prj	4/12/2021 1:01 PM	PRJ File	1 KB	44.8740, 4.5550
 matrix_7129_1000m.shp	4/12/2021 1:01 PM	SHP File	688 KB	44.8570, 4.5620
 matrix_7129_1000m.shx	4/12/2021 1:01 PM	SHX File	4 KB	44.8390, 4.5690
 matrix_7129_1000m.txt	4/12/2021 1:01 PM	Text Document	844 KB	44.8220, 4.5750
 matrix_7129_1500m.att	4/12/2021 1:01 PM	ATT File	36 KB	44.8050, 4.5820
 matrix_7129_1500m.dbf	4/12/2021 1:01 PM	DBF File	33 KB	44.7870, 4.5890
 matrix_7129_1500m.prj	4/12/2021 1:01 PM	PRJ File	1 KB	44.7700, 4.5950
 matrix_7129_1500m.shp	4/12/2021 1:01 PM	SHP File	685 KB	44.7530, 4.6010
 matrix_7129_1500m.shx	4/12/2021 1:01 PM	SHX File	4 KB	44.7360, 4.6080
 matrix_7129_1500m.txt	4/12/2021 1:01 PM	Text Document	841 KB	44.7190, 4.6140

s > 2020 > Locusts > Time_of_Arrival > matrix_7129 > shapefiles_traj_height_day

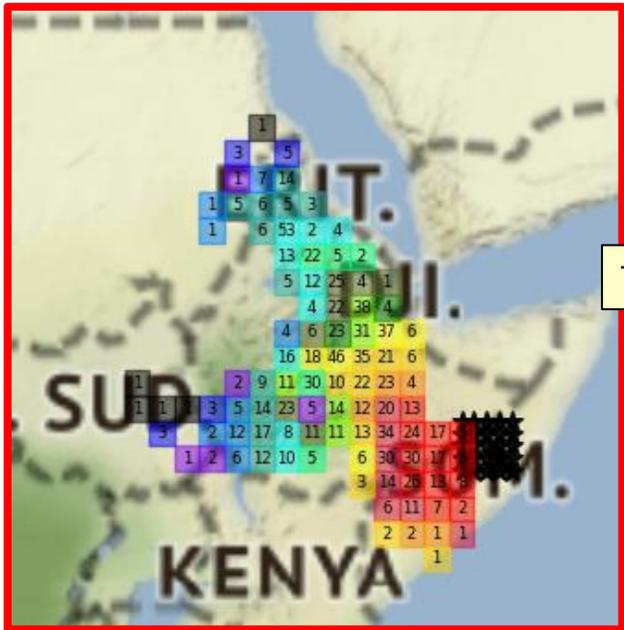
Name	Date modified	Type	Size	
 matrix_7129_0500m_day1.att	4/12/2021 1:01 PM	ATT File	3 KB	1, 45.0000, 4.5000
 matrix_7129_0500m_day1.dbf	4/12/2021 1:01 PM	DBF File	3 KB	45.0000, 4.5000
 matrix_7129_0500m_day1.prj	4/12/2021 1:01 PM	PRJ File	1 KB	44.9960, 4.5020
 matrix_7129_0500m_day1.shp	4/12/2021 1:01 PM	SHP File	46 KB	44.9790, 4.5100
 matrix_7129_0500m_day1.shx	4/12/2021 1:01 PM	SHX File	1 KB	44.9610, 4.5170
 matrix_7129_0500m_day1.txt	4/12/2021 1:01 PM	Text Document	56 KB	44.9440, 4.5250
 matrix_7129_0500m_day2.att	4/12/2021 1:01 PM	ATT File	3 KB	44.9260, 4.5330
 matrix_7129_0500m_day2.dbf	4/12/2021 1:01 PM	DBF File	3 KB	44.9090, 4.5400
 matrix_7129_0500m_day2.prj	4/12/2021 1:01 PM	PRJ File	1 KB	44.8910, 4.5470
 matrix_7129_0500m_day2.shp	4/12/2021 1:01 PM	SHP File	46 KB	44.8740, 4.5550
 matrix_7129_0500m_day2.shx	4/12/2021 1:01 PM	SHX File	1 KB	44.8570, 4.5620
 matrix_7129_0500m_day2.txt	4/12/2021 1:01 PM	Text Document	56 KB	44.8390, 4.5690
 matrix_7129_0500m_day3.att	4/12/2021 1:01 PM	ATT File	3 KB	44.8220, 4.5750
 matrix_7129_0500m_day3.dbf	4/12/2021 1:01 PM	DBF File	3 KB	44.8050, 4.5820
 matrix_7129_0500m_day3.prj	4/12/2021 1:01 PM	PRJ File	1 KB	44.7870, 4.5890
 matrix_7129_0500m_day3.shp	4/12/2021 1:01 PM	SHP File	46 KB	44.7700, 4.5950
 matrix_7129_0500m_day3.shx	4/12/2021 1:01 PM	SHX File	1 KB	44.7530, 4.6010
 matrix_7129_0500m_day3.txt	4/12/2021 1:01 PM	Text Document	56 KB	44.7360, 4.6080
 matrix_7129_0500m_day4.att	4/12/2021 1:01 PM	ATT File	3 KB	44.7190, 4.6140
 matrix_7129_0500m_day4.dbf	4/12/2021 1:01 PM	DBF File	3 KB	44.7010, 4.6200

Trajectory Frequencies

Files generated in this example, once zipped "redistribution" file is unzipped



Trajectory frequency graphics



Time of Arrival graphics

Trajectory frequency graphics via gridplot – a different HYSPLIT mapping program

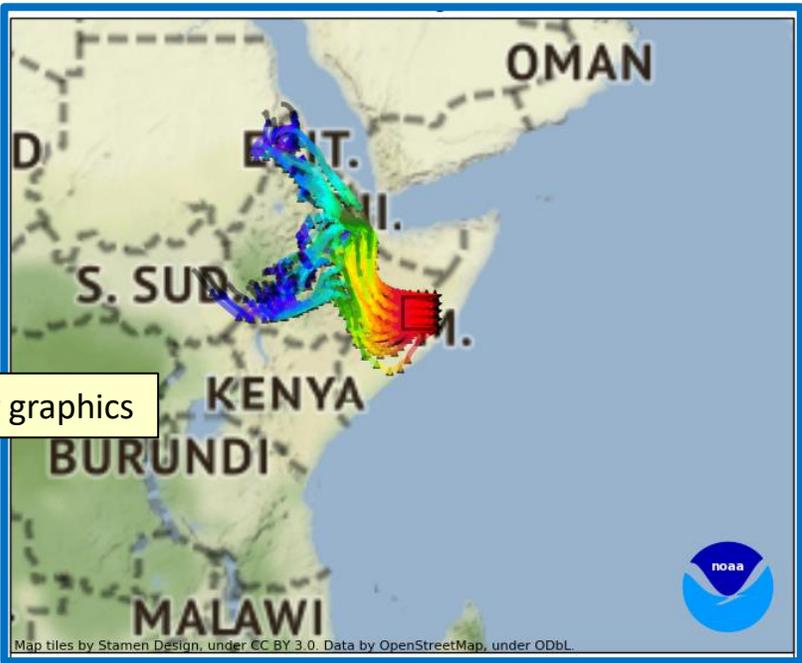
Name	Date	Type	Size
hysplit	4/12/2021 1:01 PM	File folder	
shapefiles_toa	4/12/2021 1:01 PM	File folder	
shapefiles_traj_aggregated	4/12/2021 1:01 PM	File folder	
shapefiles_traj_day	4/12/2021 1:01 PM	File folder	
shapefiles_traj_freq	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height_day	4/12/2021 1:01 PM	File folder	
LABELS.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
MAPTEXT.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
matrix_7129_freq.pdf	4/12/2021 1:01 PM	Adobe Acrobat D...	255 KB
matrix_7129_freq.png	4/12/2021 1:01 PM	PNG File	347 KB
matrix_7129_freq.ps	4/12/2021 1:01 PM	PostScript File	1,572 KB
matrix_7129_gridplot.jpg	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_gridplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_infile	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_MAPTEXT.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_progress.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_run_setup_summary.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trj_001.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trjfreq.bin	4/12/2021 1:01 PM	JPG File	454 KB

Folder with HYSPLIT Control and other model-specific files.

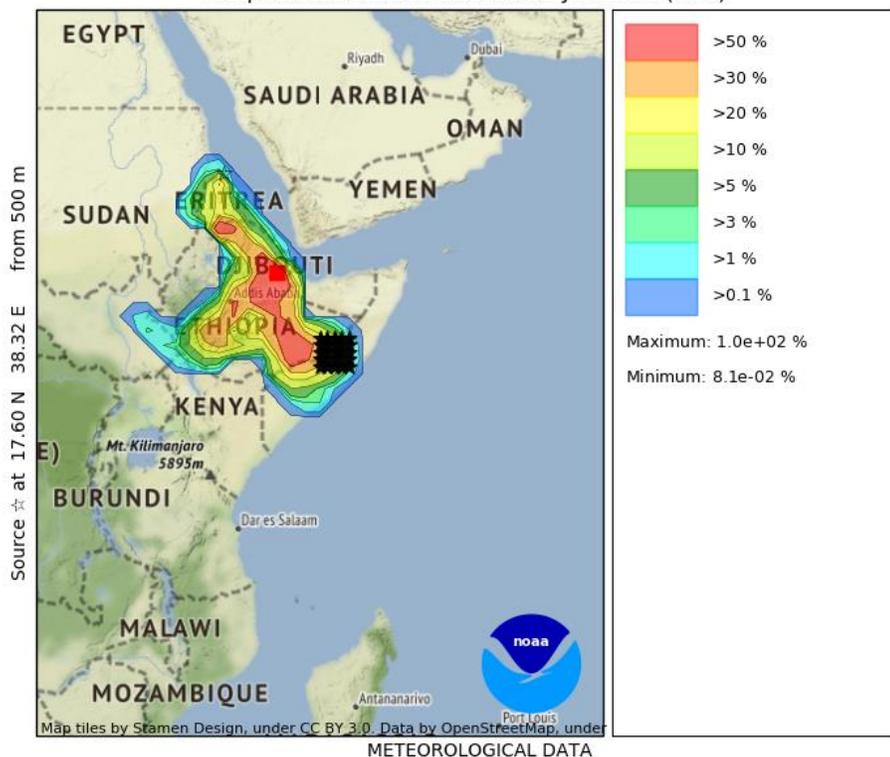
Folders with shapefiles associated with time of arrival (toa), trajectories, and trajectory frequencies. These can be imported into GIS applications (e.g. ArcGIS) and displayed – and processed further – according to the user’s needs

Summary files of inputs and outputs

Trajectory graphics



NOAA AIR RESOURCES LABORATORY
percent of maximum grid square endpoints (%) 0 m and 99999 m
Integrated from 0000 12 Apr to 0000 26 Apr 2021 (UTC)
Freq Release started at 0000 01 Jan 1970 (UTC)



TRAJECTORY ENDPOINT PERCENTAGE FREQUENCY MAP

-- run name: matrix_7129
-- run date: 2021-04-12 12:40:44 EDT
-- trajectory duration: 360 hours
-- endpt output frequency during trajectory simulations: 12 per hour
-- number of trajectories used for this calculation: 1125
-- grid size: 1.0 x 1.0 degrees

Graphic output of trajectory frequency information using basic HYSPLIT graphics

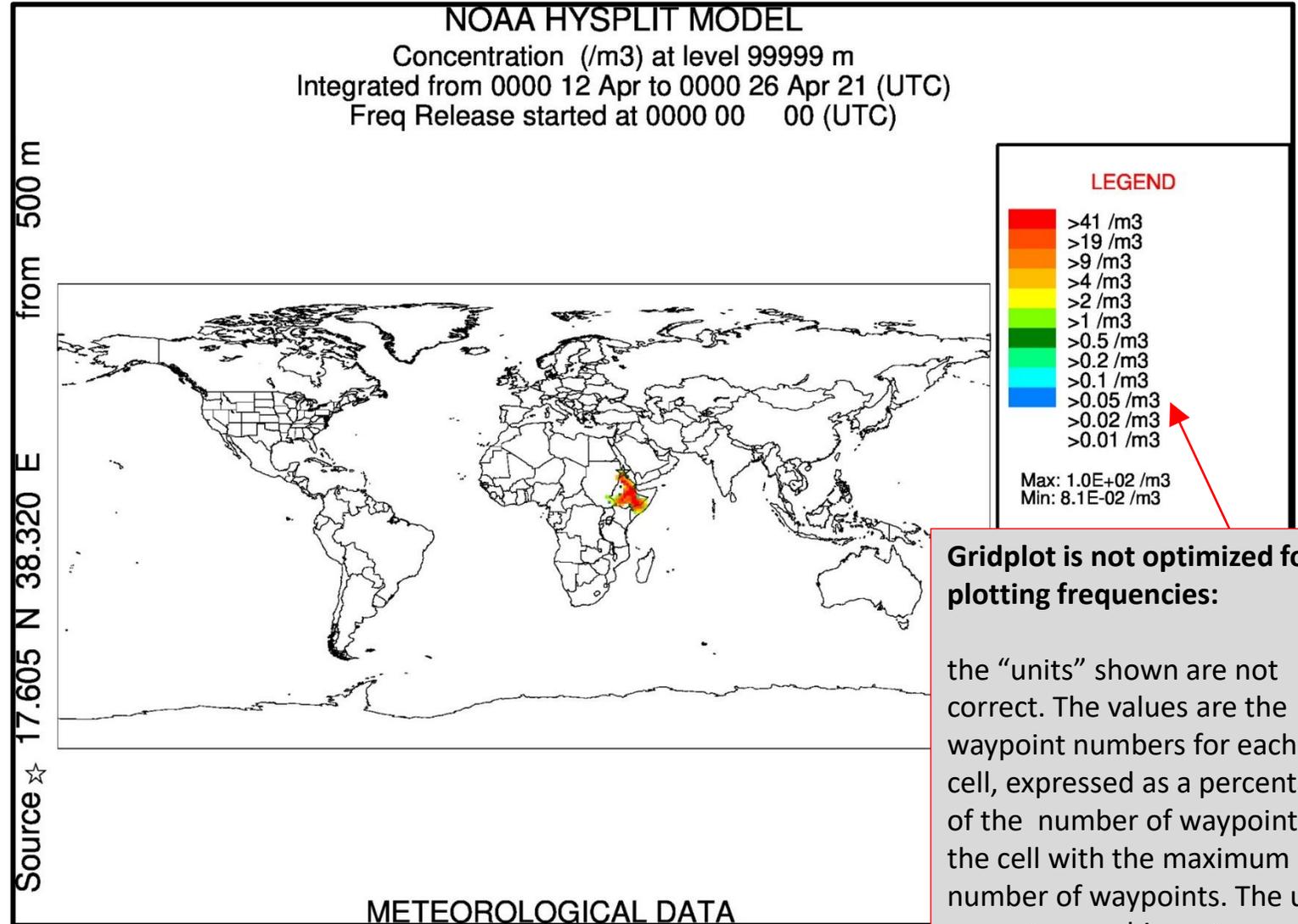
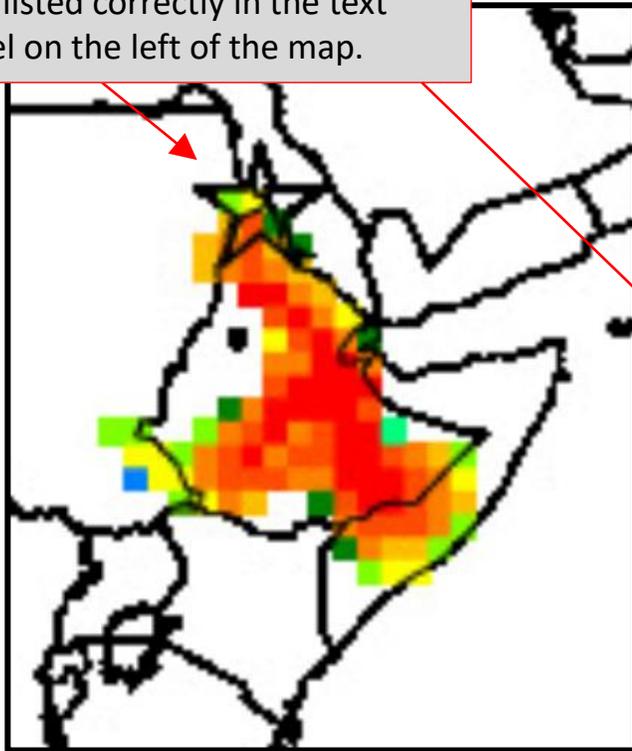
- This is generated by the App. For more advanced modifications, user can import shape files provided in output (see additional description of this functionality below)
- The source locations are shown with a matrix of stars
- A grid-size is defined during specifications of the run – in this example, it was 1 deg, and this is shown in the text in the bottom panel of the graphic – and then the trajectory waypoints (every 5 minutes) are summed up on this grid. The contours shown are the waypoints for each grid square expressed as the percent of waypoint in the grid square with the maximum number of waypoints.
- This graphic does not tell you anything about the time of arrival, but, does show you the overall geographical pattern of the forecasted migration from the specified source region over the forecast period.

HYSPLIT has a mapping program called "gridplot" :

the Locust Migration Application also creates a trajectory frequency map using this mapping program. Here is the output for this example (`matrix_7129_gridplot.jpg`)

Gridplot is not optimized for plotting multiple source locations:

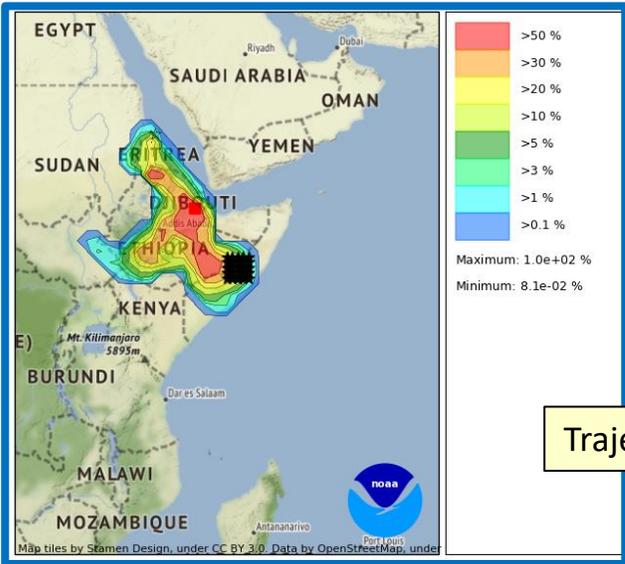
the "source" location is not shown correctly on the map – nor is a matrix of locations shown, which is the case in this matrix functionality – and it is not listed correctly in the text label on the left of the map.



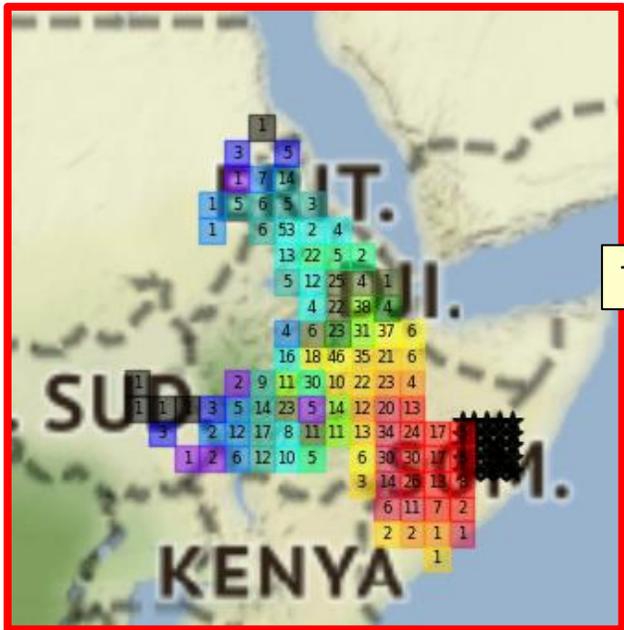
Gridplot is not optimized for plotting frequencies:

the "units" shown are not correct. The values are the waypoint numbers for each grid cell, expressed as a percentage of the number of waypoints in the cell with the maximum number of waypoints. The units are not per cubic meters.

Files generated in this example, once zipped "redistribution" file is unzipped



Trajectory frequency graphics



Time of Arrival graphics

Trajectory frequency graphics via gridplot – a different HYSPLIT mapping program

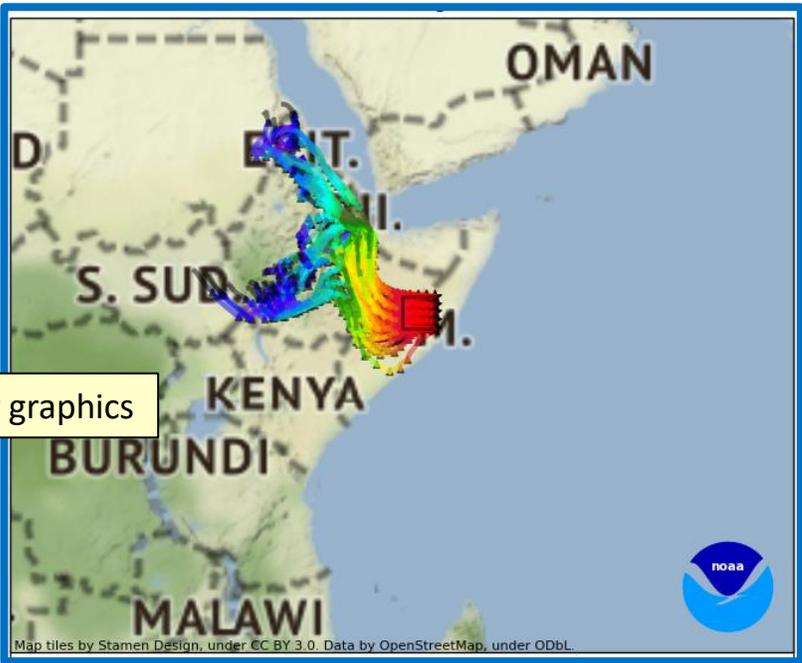
Name	Modified	Type	Size
hysplit	4/12/2021 1:01 PM	File folder	
shapefiles_toa	4/12/2021 1:01 PM	File folder	
shapefiles_traj_aggregated	4/12/2021 1:01 PM	File folder	
shapefiles_traj_day	4/12/2021 1:01 PM	File folder	
shapefiles_traj_freq	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height_day	4/12/2021 1:01 PM	File folder	
LABELS.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
MAPTEXT.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
matrix_7129_freq.pdf	4/12/2021 1:01 PM	Adobe Acrobat D...	255 KB
matrix_7129_freq.png	4/12/2021 1:01 PM	PNG File	347 KB
matrix_7129_freq.ps	4/12/2021 1:01 PM	PostScript File	1,572 KB
matrix_7129_gridplot.jpg	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_gridplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_infile	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_MAPTEXT.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_progress.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_run_setup_summary.txt	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_toa.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.pdf	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trajplot.ps	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trj_001.png	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_trjfreq.bin	4/12/2021 1:01 PM	JPG File	454 KB

Folder with HYSPLIT Control and other model-specific files.

Folders with shapefiles associated with time of arrival (toa), trajectories, and trajectory frequencies. These can be imported into GIS applications (e.g. ArcGIS) and displayed – and processed further – according to the user’s needs

Summary files of inputs and outputs

Trajectory graphics



2020 > Locusts > Time_of_Arrival > matrix_7129 > shapefiles_traj_freq

Name	Date modified	Type	Size
matrix_7129_frequencies.txt	4/12/2021 1:01 PM	Text Document	190 KB
matrix_7129_grid.dbf	4/12/2021 1:01 PM	DBF File	179 KB
matrix_7129_grid.prj	4/12/2021 1:01 PM	PRJ File	1 KB
matrix_7129_grid.shp	4/12/2021 1:01 PM	SHP File	487 KB
matrix_7129_grid.shx	4/12/2021 1:01 PM	SHX File	29 KB
matrix_7129_polygons.txt	4/12/2021 1:01 PM	Text Document	394 KB

```
"grid_id", "lat_centroid", "lng_centroid", "freq"  
1, -25.000000, 15.000000, 0.000000  
2, -25.000000, 16.000000, 0.000000  
3, -25.000000, 17.000000, 0.000000  
4, -25.000000, 18.000000, 0.000000  
5, -25.000000, 19.000000, 0.000000  
6, -25.000000, 20.000000, 0.000000  
7, -25.000000, 21.000000, 0.000000  
8, -25.000000, 22.000000, 0.000000  
9, -25.000000, 23.000000, 0.000000  
10, -25.000000, 24.000000, 0.000000  
11, -25.000000, 25.000000, 0.000000  
12, -25.000000, 26.000000, 0.000000  
13, -25.000000, 27.000000, 0.000000  
14, -25.000000, 28.000000, 0.000000
```

Folder: shapefiles_traj_freq

Has a shapefile – in this example: **matrix_7129_grid.shp** -- that can be imported into GIS applications, and also has a text file that can be imported into Excel or other data processing applications.

The “freq” field in the text file and in the shapefile is the number of trajectory waypoints in each grid cell, normalized by the maximum number of waypoints in any grid cell. The values are “percentages of the maximum”, so a frequency value of 30 means that that grid cell has 30% of the waypoints as the cell that has the maximum number of waypoints.

```
1907, 6.000000, 30.000000, 0.000000  
1908, 6.000000, 31.000000, 0.000000  
1909, 6.000000, 32.000000, 0.000000  
1910, 6.000000, 33.000000, 0.081400  
1911, 6.000000, 34.000000, 2.930403  
1912, 6.000000, 35.000000, 3.459503  
1913, 6.000000, 36.000000, 10.337811  
1914, 6.000000, 37.000000, 25.905577  
1915, 6.000000, 38.000000, 34.472935  
1916, 6.000000, 39.000000, 26.821327  
1917, 6.000000, 40.000000, 17.358568  
1918, 6.000000, 41.000000, 12.840863  
1919, 6.000000, 42.000000, 43.243793  
1920, 6.000000, 43.000000, 74.643875  
1921, 6.000000, 44.000000, 64.061867  
1922, 6.000000, 45.000000, 38.502239  
1923, 6.000000, 46.000000, 18.538868  
1924, 6.000000, 47.000000, 3.439153  
1925, 6.000000, 48.000000, 0.000000  
1926, 6.000000, 49.000000, 0.000000
```

This shapefile can be imported into a GIS application and mapped. The "freq" field can be used to color the grid squares according to a user preferences.

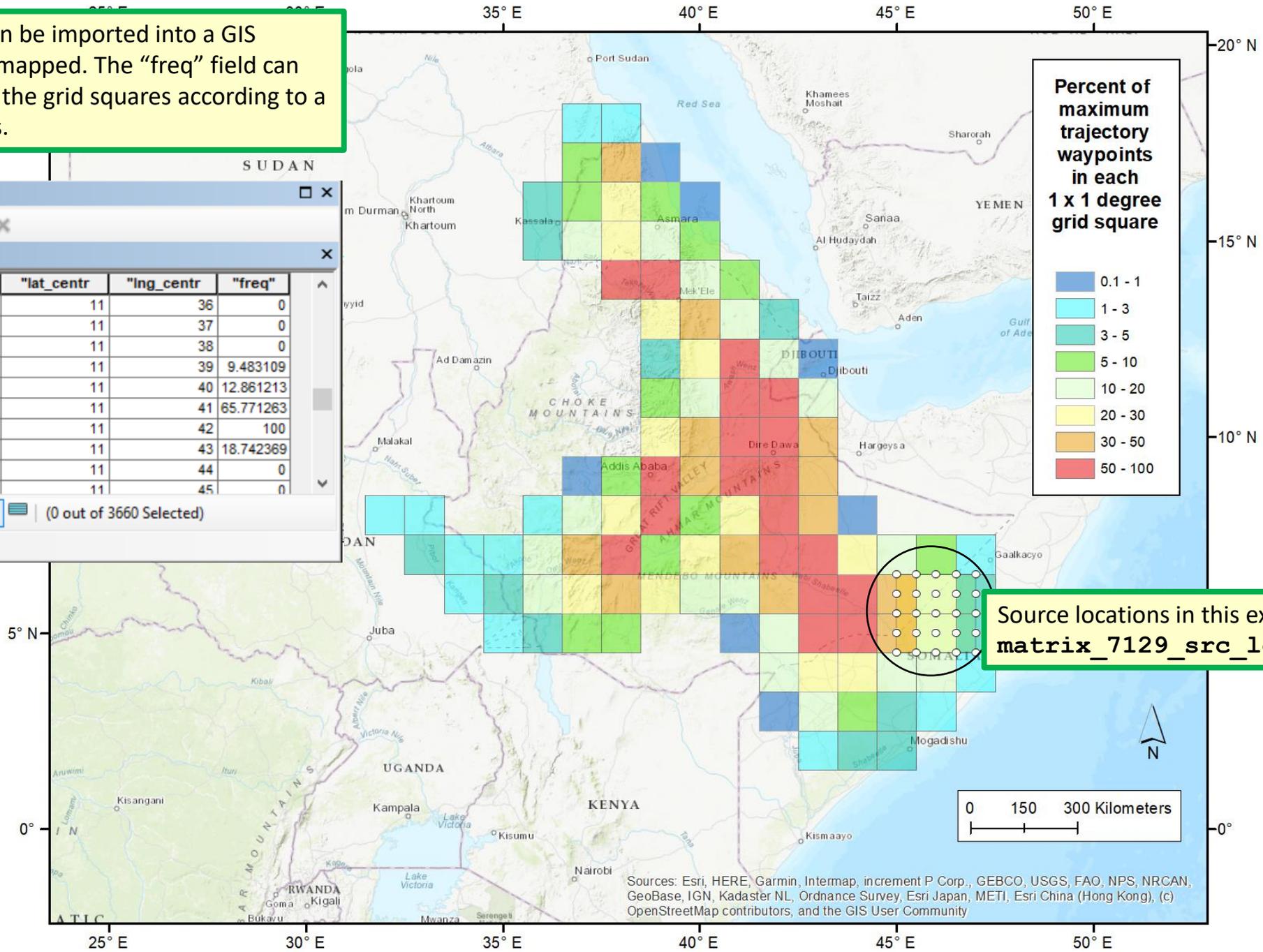
Table

matrix_7129_grid

FID	Shape	"grid_id"	"lat_centr"	"lng_centr"	"freq"
2217	Polygon	2218	11	36	0
2218	Polygon	2219	11	37	0
2219	Polygon	2220	11	38	0
2220	Polygon	2221	11	39	9.483109
2221	Polygon	2222	11	40	12.861213
2222	Polygon	2223	11	41	65.771263
2223	Polygon	2224	11	42	100
2224	Polygon	2225	11	43	18.742369
2225	Polygon	2226	11	44	0
2226	Polygon	2227	11	45	0

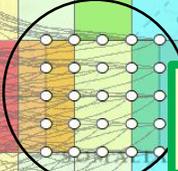
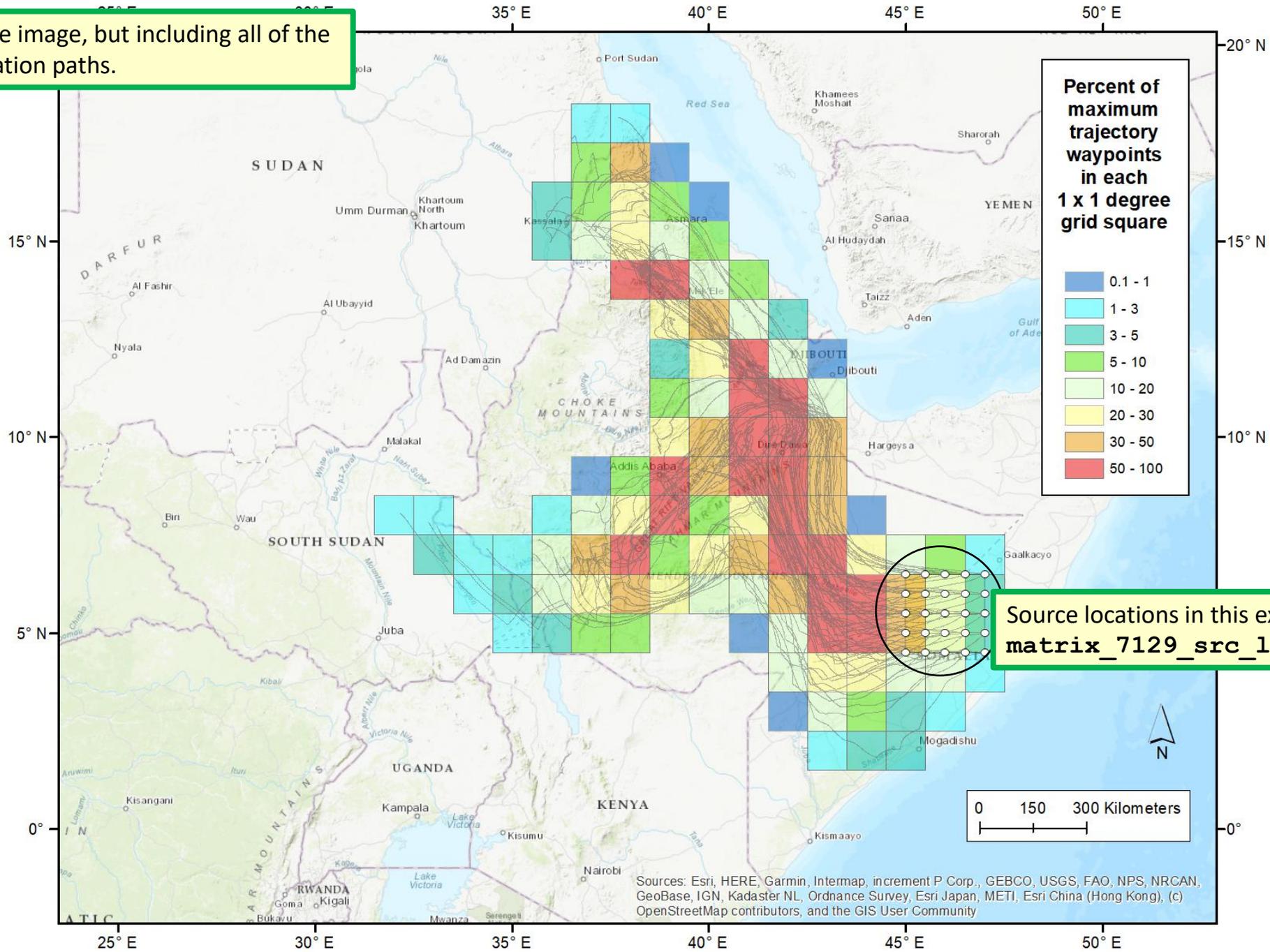
(0 out of 3660 Selected)

matrix_7129_grid



Source locations in this example: **matrix_7129_src_locs.shp**

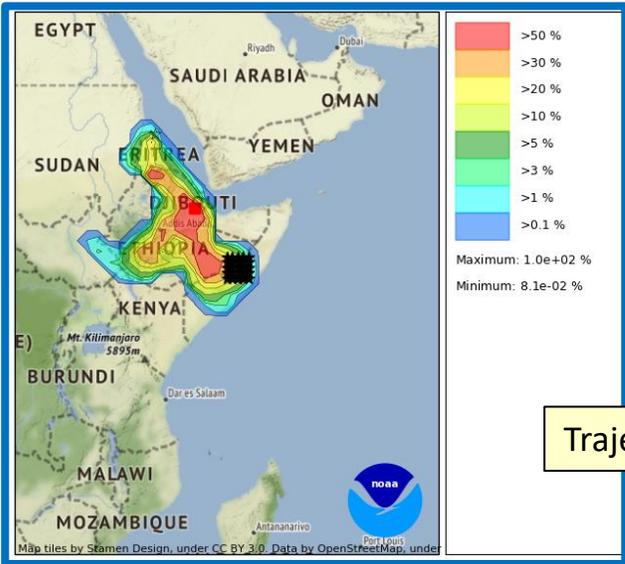
Here is the same image, but including all of the trajectory migration paths.



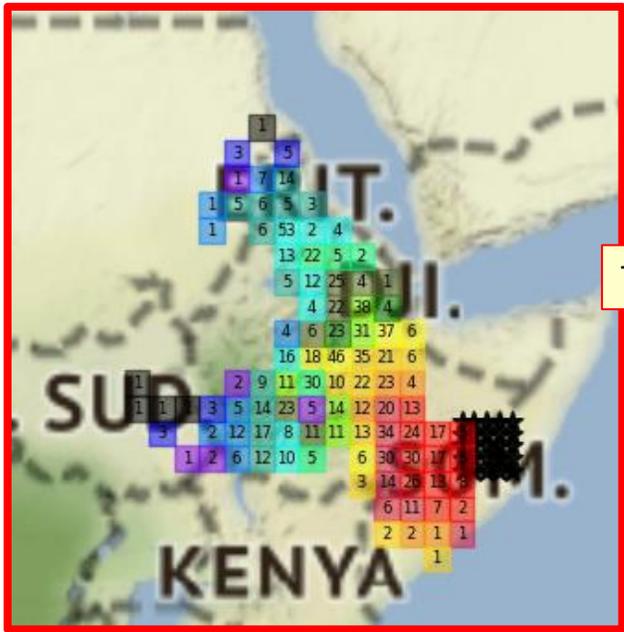
Source locations in this example: `matrix_7129_src_locs.shp`

HYSPLIT Folder

Files generated in this example, once zipped "redistribution" file is unzipped

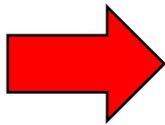


Trajectory frequency graphics



Time of Arrival graphics

Trajectory frequency graphics via gridplot – a different HYSPLIT mapping program



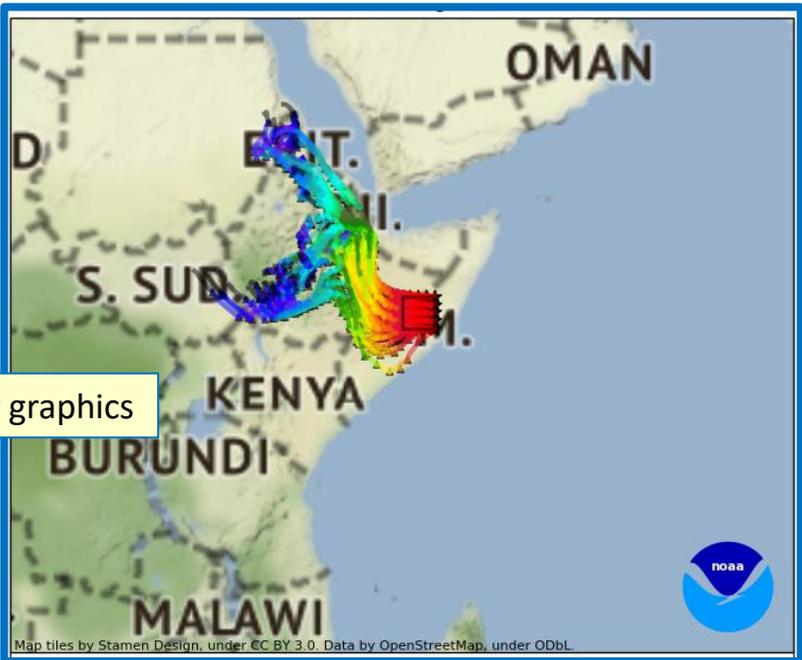
Name	Date	Type	Size
hysplit		File folder	
shapefiles_toa	4/12/2021 1:01 PM	File folder	
shapefiles_traj_aggregated	4/12/2021 1:01 PM	File folder	
shapefiles_traj_day	4/12/2021 1:01 PM	File folder	
shapefiles_traj_freq	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height	4/12/2021 1:01 PM	File folder	
shapefiles_traj_height_day	4/12/2021 1:01 PM	File folder	
LABELS.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
MAPTEXT.matrix_7129	4/12/2021 12:56 PM	MATRIX_7129 File	1 KB
matrix_7129_freq.pdf	4/12/2021 12:56 PM	Adobe Acrobat D...	255 KB
matrix_7129_freq.png	4/12/2021 12:56 PM	PNG File	347 KB
matrix_7129_freq.ps	4/12/2021 12:56 PM	PostScript File	1,572 KB
matrix_7129_gridplot.jpg	4/12/2021 1:01 PM	JPG File	454 KB
matrix_7129_gridplot.ps			
matrix_7129_infile			
matrix_7129_MAPTEXT.txt			
matrix_7129_progress.txt			
matrix_7129_run_setup_summary.txt			
matrix_7129_toa.pdf			
matrix_7129_toa.png			
matrix_7129_toa.ps			
matrix_7129_trajplot.pdf			
matrix_7129_trajplot.ps			
matrix_7129_trj_001.png			
matrix_7129_trjfreq.bin			

Folder with HYSPLIT Control and other model-specific files.

Folders with shapefiles associated with time of arrival (toa), trajectories, and trajectory frequencies. These can be imported into GIS applications (e.g. ArcGIS) and displayed – and processed further – according to the user's needs

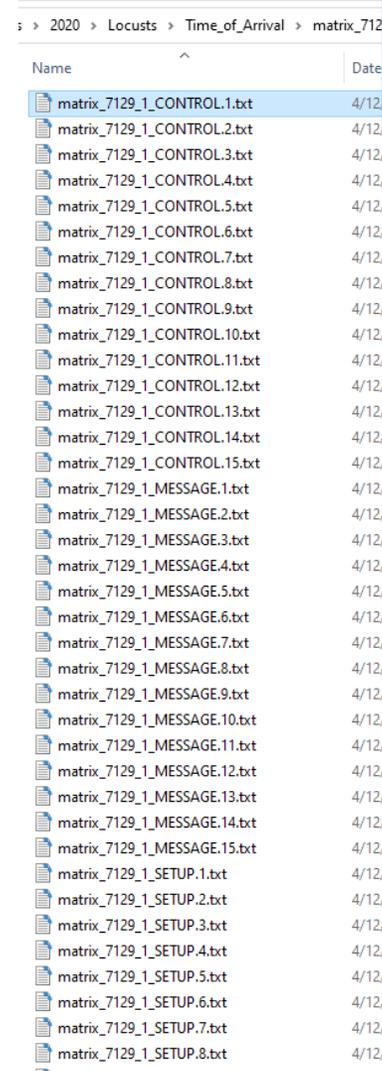
Summary files of inputs and outputs

Trajectory graphics



Folder with HYSPLIT Control, Message, and Setup files.

In this example, there are 25 source locations and three flying heights, so there are 75 migration paths. And for each path, there are 15 days of flights. Each flight day for each path has its own trajectory. So, there are 75 x 15 = 1125 trajectories. For each trajectory, there are the following files:



Name of file in this example for Job Name "Matrix_7129" for migration path number 5 (of 75 total), day number 14 (of 15 total)	HYSPLIT generic file name	notes
Matrix_7129_5_CONTROL.14.txt	CONTROL	The basic HYSPLIT input file for the run
Matrix_7129_5_SETUP.14.txt	SETUP.CFG	This file is another HYSPLIT input file with special settings
Matrix_7129_5_MESSAGE.14.txt	MESSAGE	A run-time file created during the simulation with diagnostic outputs (can be helpful for troubleshooting)
Matrix_7129_5_WARNING.14.txt	WARNING	A run-time file created during the simulation with warning outputs (can be helpful for troubleshooting)
Matrix_7129_5_tdump.14	TDUMP	The "trajectory dump" file with latitude, longitude and elevation data every five minutes for the entire day's flight
Matrix_7129_5_tdump.14.full	TDUMP	The trajectory is run longer than necessary, but then truncated based on the specified landing time. This is the tdump file before truncation.

```
32000.0 #TOP OF MODEL DOMAIN (m-agl)
2 #NUMBER nextfile mfile OF INPUT DATA GRIDS
/pub/forecast/20210412/
```