

An integrated example of using command line functionality of HYSPLIT and DOS Batch scripts to carry out various kinds of trajectory frequency analyses.

With Application to the Grand Bay Mercury Intensive

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## 1. Introduction / overview of example

- In this example, we will run 5-day back-trajectories from a single site, once every 30 minutes, for the entire period of two different aerosol samples at the OLF site in Pensacola.
- The period for the first sample was from 2:55 PM Aug 2, 2010 through 1:55 PM Aug 3, 2010, a total of 23 hours.
- The period for the 2<sup>nd</sup> sample was from 1:50 PM Aug 13, 2010 through 2:00 PM Aug 14, 2010, a total of about 24 hours.
- We will start a trajectory every 30 minutes (on the hour and on the half-hour) for every hour of the samples. So for the first sample, the first trajectory will start at 3:00 PM, the 2<sup>nd</sup> at 3:30 PM, and so on, till the last trajectory which will start at 2:00 PM on Aug 3. {Note, we included 2 PM even though the sample only went to 1:55}.
- So, a total of 47 trajectories will be run for this first sample.
- Analogously, a total of 49 trajectories will be run for the 2<sup>nd</sup> sample, starting at 2:00 PM on Aug 13 and the last trajectory starting at 2:00 PM Aug 14
- The starting point for the back-trajectories will be lat = 30.54997 long = -87.375155 (the Outlying Landing Field monitoring site near Pensacola)
- Then we will use TRAJFREQ and other programs to examine the spatial distribution of the back-trajectories
- We will also examine the difference between the gridded frequencies of trajectories for the two different sample periods
- The purpose of this exercise – GBI\_TRAJ\_example\_001 – is simply to demonstrate how one might carry out this type of analysis using command line and batch file functionalities of HYSPLIT.
- For this example, we will simply use EDAS 40 km and NCAR Global Reanalysis met data. For future work, we will try to use higher resolution data, e.g., the 4 km data generated by Dr. Fantine Ngan of NOAA ARL to support data analyses.
- These techniques can then be adapted to specific questions and situations of interest.



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## 2. Setting up the computational environment

(a) **Meteorological data:** we will use four different meteorological data files in this exercise, and these data must be downloaded and placed in an appropriate directory to be used by HYSPLIT.

- Two files are EDAS-40km: **edas.aug10.001**, **edas.jul10.002**

<ftp://arlftp.arlhq.noaa.gov/pub/archives/edas40/edas.aug10.001>

<ftp://arlftp.arlhq.noaa.gov/pub/archives/edas40/edas.july10.002>

- Two files are 2.5 degree NCAR Global Reanalysis data: **RP201008.gbl**, **RP201007.gbl**

<ftp://arlftp.arlhq.noaa.gov/pub/archives/reanalysis/RP201008.gbl>

<ftp://arlftp.arlhq.noaa.gov/pub/archives/reanalysis/RP201007.gbl>

- These files must be downloaded to your computer, if you want to carry out the simulations in this example yourself. You can put them anywhere you want, but you have to know where you put them so you can tell HYSPLIT where to look for them.

- If you want to do it exactly like I did, I put the EDAS-40km data into the following directory:

```
c:\_METDATA\EDAS40km\full_grid\
```

- And I put the global reanalysis data into the following directory:

```
c:\_METDATA\global_reanalysis\
```

- As mentioned above, you don't have to use these same directories, but you need to know what directory or directories you used for each file and these will be indicated in the TRAJSET batch file discussed below.

## 2. Setting up the computational environment ... *continued*

### (b) Batch files and Executables

- Download the following zip file to your computer (its about ~25 MB) from the GrandBay2010 dropbox:  
[http://www.arl.noaa.gov/documents/reports/extra\\_files\\_for\\_GBI\\_example\\_001.zip](http://www.arl.noaa.gov/documents/reports/extra_files_for_GBI_example_001.zip)
- Unzip the file; it contains three directories:
  - **working\_example\_001** [contains 11 files, incl. txt, bat, xlsx, and cfg]
  - **exec** [contains one file: freqdiff.exe]
  - **results** [contains one subdirectory – “**GBI\_example\_001\_from\_mark**” -- with many subdirectories]
- Copy (or move) these directories to the c:\hysplit4\ directory, i.e., into your PC HYSPLIT installation. The “working\_example\_001” and “results” directories are probably new, so they will probably be copied into the hysplit4 directory with no issues.
- HOWEVER, an “exec” directory already exists in c:\hysplit4\ and so Windows will ask you if you want to copy these files in... The executable – “freqdiff.exe” – is a new file that does not already exist in the c:\hysplit4\exec\ directory.

Ok, now, the computational environment has hopefully been set up to run the various simulations and computations in this example.

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### 3. Running HYSPLIT to create a set of trajectories for this example

#### (a) TRAJ\_SET\_GBI\_001.bat

- The batch file “TRAJ\_SET\_GBI\_001.bat” should reside in the working directory for the example, i.e., c:\hysplit4\working\_GBI\_example\_001\
  - This batch file is called by “TRAJ\_RUN\_GBI\_001.bat” to create each trajectory.
  - “TRAJ\_SET\_GBI\_001.bat” does the following:
    - ❑ Creates directories for the trajectory results, if they do not exist
    - ❑ Writes the CONTROL file that HYSPLIT uses, according to parameters set in the “TRAJ\_RUN...” batch file for a given run. Some of the parameters are “hardwired” and would have to be adjusted manually if one wanted to adjust them.
    - ❑ For example, if you put the meteorological data files being used in these runs in a different directory than I used, then these changes would have to be made in TRAJ\_SET\_GBI\_001.bat, as shown on the next slide.
    - ❑ Writes the SETUP.CFG file that HYSPLIT uses
    - ❑ Runs HYSPLIT to create one back-trajectory using the CONTROL and SETUP.CFG files created above
    - ❑ Makes a map of the results with TRAJPLOT, including the use of the STATIONPLOT.CFG functionality to put points on the map (in this case mercury emissions sources in the region)
    - ❑ Moves all the results for a given trajectory simulation to the “results” directories

If you put the meteorological data being used in this example in different directories than indicated here, then you need to edit these lines to indicate the directories that you used.

Some lines near the very beginning of TRAJ\_SET\_GBI\_001.bat:

```
rem *****
rem SET KEY DIRECTORIES
rem *****

rem *IF YOU HAVE YOUR EDAS MET DATA IN A DIFFERENT DIRECTORY than indicated here,
rem the following line must be changed to indicate the directory you have used...
SET EDAS_DIR=c:\_METDATA\EDAS40km\full_grid\

rem *IF YOU HAVE YOUR NCAR GLOBAL REANALYSIS MET DATA IN A DIFFERENT DIRECTORY
rem than indicated here, the following line must be changed to indicate the
rem directory you have used...
SET GBL_DIR=c:\_METDATA\global_reanalysis\
```

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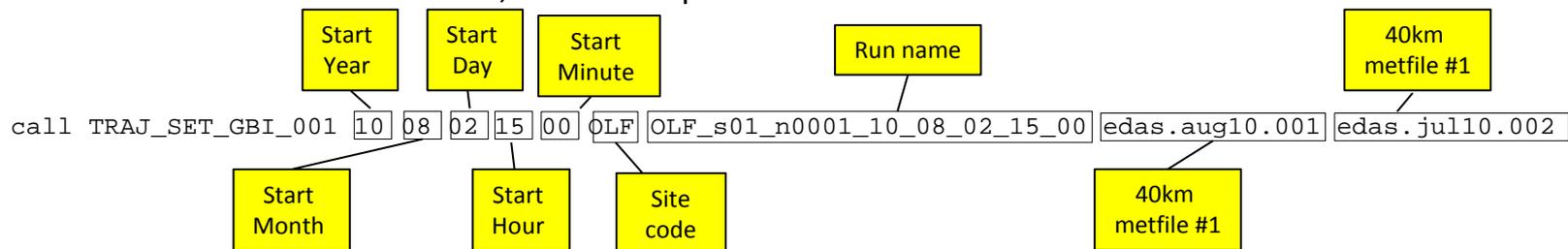
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### 3. Running HYSPLIT to create a set of trajectories for this example... *continued*

#### (b) TRAJ\_RUN\_GBI\_001.bat

- The batch file “TRAJ\_RUN\_GBI\_001.bat” should reside in the working directory for the example, i.e., c:\hysplit4\working\_GBI\_example\_001\
  - This batch calls “TRAJ\_SET\_GBI\_001.bat” to create each trajectory.
  - This TRAJ\_RUN batch file is relatively simple, and just contains one operational line per trajectory to be run... In this case there are 62 different trajectories, and so the file has 62 operational lines.
  - The TRAJ\_RUN batch file passes run-specific info to the TRAJ\_SET batch file using nine parameters:
    - parameter #1: **start year (UTC)**
    - parameter #2: **start month (UTC)**
    - parameter #3: **start day (UTC)**
    - parameter #4: **start hour (UTC)**
    - parameter #5: **start minute (UTC)**
    - parameter #6: **site code**
    - parameter #7: **run name**
    - parameter #8: **40\_km\_metfile\_1**
    - parameter #9: **40\_km\_metfile\_2**
- Here’s the first line of the file, as an example:



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#### (c) MS-Excel Run Generator

- The TRAJ\_RUN file discussed immediately above is a simple text file, and you can create it any way you want to. It could even be automated into a more complicated script that steps through each run.
- In general, once I have created one for a given case in a series of simulations, I just use search/replace to change things for another case. For example, in this case, if we were doing the analysis for another site, it would be easiest to just search/replace the text “ARL” with the site code for the new site. Or, if we were using a different TRAJ\_SET batch file, the name of the new batch file could be easily substituted for the name currently in the file.
- One way that I have found convenient in the past – at least to create the first batch file in a set of simulations -- is to create an MS-Excel worksheet that “creates” the line in the TRAJ\_RUN batch file
- An example of this type of file is included in the working directory for this example:

GBI\_example\_run\_generator\_001.xlsx

- A screen shot of the first few rows and first few columns of this file is shown on the next slide.
- This type of excel file can be useful further on in the analysis, as it can be used to create the name of each tdump file, which are used in any INFILE used as input to TRAJFREQ (discussed later)
- This type of excel file can also be used – by importing monitoring or other data into the sheet – to filter the data in order to create subsets of the tdump file list that meet certain criteria, e.g., that represent trajectories starting at times when the sample measurements were relatively high, or that occurred in a certain season, or whatever type of sub-set one wants to run a separate frequency analysis for.

# A screenshot of the first few rows and the first few columns of example\_run\_generator\_001.xlsx

The screenshot displays the Microsoft Excel interface for the file 'GBI\_example\_run\_generator\_001.xlsx'. The spreadsheet is divided into several sections:

- Parameters Section (Rows 8-13):**
  - Row 8: parameters --> local start year --> 2010
  - Row 9: parameters --> local start month --> 8
  - Row 10: parameters --> local start day --> 2
  - Row 11: parameters --> local start hour --> 15
  - Row 12: parameters --> local start minute --> 0
  - Row 13: parameters --> increment (minutes) --> 30
- Summary Section (Rows 14-19):**
  - Row 14: count -->
  - Row 15: sum -->
  - Row 16: avg -->
  - Row 17: min -->
  - Row 18: max -->
- Data Table Header (Row 21):**
  - Local: year, year 2000, month, day, hour, minute
  - UTC: date\_time, year, year 2000, month, day, hour, minute
  - site code
- Data Rows (Rows 22-36):**
  - Row 22: number, NOTES, date\_time
  - Row 23: 1, , 8/2/10 15:00
  - Row 24: 2, , 8/2/10 15:30
  - Row 25: 3, , 8/2/10 16:00
  - Row 26: 4, , 8/2/10 16:30
  - Row 27: 5, , 8/2/10 17:00
  - Row 28: 6, , 8/2/10 17:30
  - Row 29: 7, , 8/2/10 18:00
  - Row 30: 8, , 8/2/10 18:30
  - Row 31: 9, , 8/2/10 19:00
  - Row 32: 10, , 8/2/10 19:30
  - Row 33: 11, , 8/2/10 20:00
  - Row 34: 12, , 8/2/10 20:30
  - Row 35: 13, , 8/2/10 21:00

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#### (d) Issues around getting all the trajectories to finish

- Ok... go ahead and run the batch file "TRAJ\_RUN\_GBI\_001.bat" from the working directory. As in the normal fashion, to do this, you open up a DOS window, navigate to the working directory, type the name of the batch file, and then hit return.
- If everything is set up right, then a series of  $47 + 49 = 96$  trajectories should be created, with associated output files. All the output files will be created in the following directory:

```
..\results\GBI_example_001\
```

and there will be several subdirectories, including "tdp", "jpg", "ctl", and others.

- In each of these subdirectories, there should be 96 (or more) files. You can look at these files, e.g., examine the jpgs in the jpg directory to see the maps of each trajectory.
- It is crucial in this type of analysis to examine the "tdp" directory at this point, because these "tdp" files are going to be used in the subsequent frequency analyses.
- First – are there 96 tdp files present? If not, then there will be runs missing. Note which runs are missing and attempt to determine why the run failed. To do this you can look at the CONTROL file for that run, if it was created, in the "ctl" directory, and you can also look at the "MESSAGE" file for the run, if it was created, in the "msg" directory.
- Second – sort the tdp files by file size. Are all the tdp files the same size? They should be if all the trajectories went to their completion, which in this example, was 120 hours. If there are any "tdp" files that are smaller, then it means that that particular run terminated prematurely. In this example, each of the tdp files should be 132 KB.
- The significance of incomplete runs is that in the current frequency analysis programs in HYSPLIT (and also clustering programs), incomplete runs are not considered in the analysis! We may modify this aspect in the future, but for the time being, that is the way it is...

### 3. Running HYSPLIT to create a set of trajectories for this example... *continued*

#### (d) Issues around getting all the trajectories to finish... *continued*

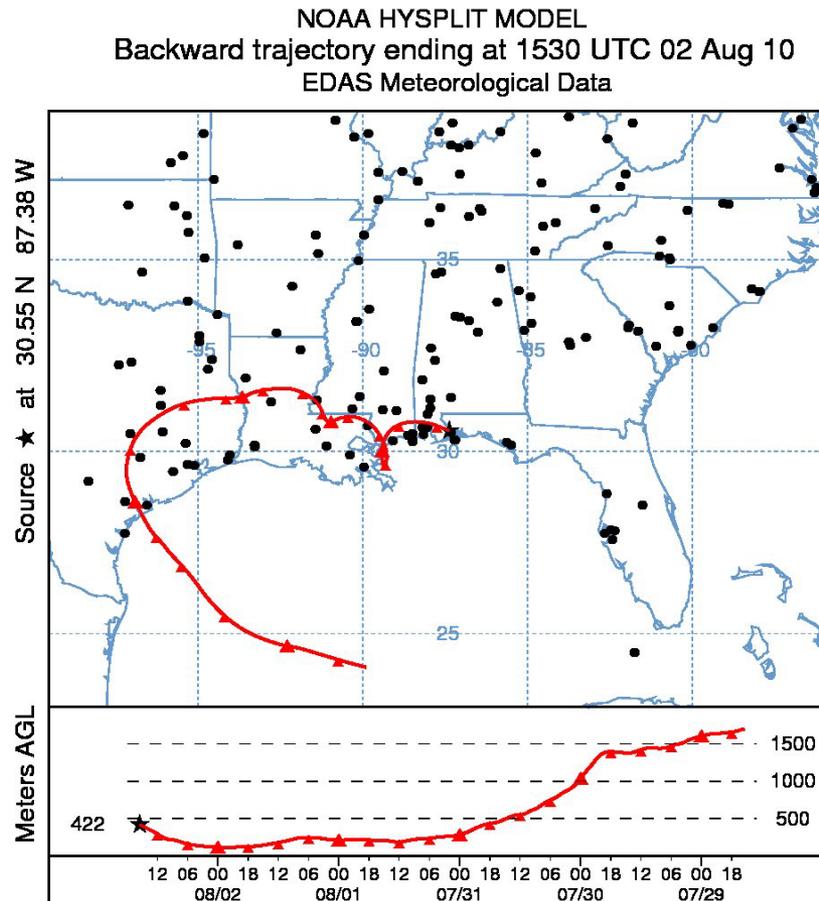
- In this example, all of the runs should have finished. However, there are a number of issues that can affect whether a trajectory finishes or not.
- One issue is the met data. If there is a problem with the met data, then the run can crash. The EDAS and GBL datasets are pretty robust, and should be ok, but sometimes glitches occur.
- Another met-data-related issue is that if you are using a regional grid only – liked EDAS which covers the Continental U.S. and surrounding region, then a given trajectory might leave the grid, and then be automatically terminated. This wouldn't be a problem doing short trajectories from the middle of the grid, e.g., 48-hr trajectories from somewhere in the lower mid-west, but could definitely be a problem if one were doing longer trajectories – e.g., in this example, we are doing 120-hr trajectories – and/or trajectories from nearer the edge of the grid. This is why I added the “global” met data files to the simulations in this example, so that if the trajectory left the EDAS grid, it would continue on the global met data grid.
- A different type of issue is the “MGMIN” issue. MGMIN is a parameter used in HYSPLIT to determine how large a met subgrid is loaded each time step to carry out the simulation. The default value is “10”. From the HYSPLIT users manual:

MGMIN (10) - is the minimum size in grid units of the meteorological sub-grid. The sub-grid is set dynamically during the calculation and depends upon the horizontal distribution of end-points and the wind speed. Larger sub-grids than necessary will slow down the calculation by forcing the processing of meteorological data in regions where no transport or dispersion calculations are being performed. In some situations, such as when the computation is between meteorological data files that have no temporal overlap or insufficient spatial overlap, the model may try to reload meteorological data with a new sub-grid. This will result in a fatal error. One solution to this error would be to increase the minimum grid size larger than the meteorological grid to force a full-grid data load.

- I found in preparing other related runs that MGMIN=10 did not work for all trajectories. I did some experimenting and found that if we set MGMIN=100, it works for a much higher percentage of trajectories, with not too much penalty in additional computational time. However, if some of the trajectories do not finish, you can try running them again with a higher value of MGMIN, e.g., you can set MGMIN = 9999. This is set in the SET batch file, and would just require you do edit one line in that file, changing 100 to 9999...
- In practice, one generally comments out the batch file lines for all the runs that worked, and experiments with the runs that did not work, hopefully getting these incomplete runs to finish. Of course, it may not be possible to get every run to finish, but this is the goal, and you can certainly try some of the diagnostic and other tactics discussed here – and others, if you can think of them – to get each of the runs that you want to do to finish.

Here is an example of one of the jpg outputs from the trajectories... Hopefully you were able to get the same results. A complete set of the results that I got is in the directory: [results\GBI\\_example\\_001\\_from\\_mark](#)

OLF\_s01\_n0001\_10\_08\_02\_15\_00\_tot.jpg



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## 4. Running TRAJFREQ to get the gridded frequency of a set of trajectories

### (a) Creating INFILES

- The fundamental input needed for the program TRAJFREQ to compute the gridded frequencies of a set of trajectories is an INFILE.
- An INFILE is an ascii text file that contains the names of the tdump files that one wants to include in that particular frequency analysis. An example of an INFILE is shown at the right. This infile is the first 21 lines of the INFILE that includes the tdump files for each of the 47 trajectories run for sample 01 in this example.
- You can create the INFILE(s) anyway you want. I have found it convenient to create them using the same MS-Excel run generator -- discussed above -- that was used to create the TRAJ\_RUN batch file. In the spreadsheet, you can easily create the tdump name, and you can then copy the column of those names directly to a text file.
- Note that if one invokes TRAJFREQ from the directory in which the tdump files reside, then only the file names are needed. However, if you invoke TRAJFREQ from another directory, you will need the absolute (or relative) path to the tdump directory, e.g.,

```
C:\hysplit4\results\GBI_example_001\tdp\ OLF_s01_n0001_10_08_02_15_00.tdp
```

- In this example, we will actually invoke TRAJFREQ from the tdp directory, so the path is not needed.

### An example of the structure of an INFILE

```
OLF_s01_n0001_10_08_02_15_00.tdp
OLF_s01_n0002_10_08_02_15_30.tdp
OLF_s01_n0003_10_08_02_16_00.tdp
OLF_s01_n0004_10_08_02_16_30.tdp
OLF_s01_n0005_10_08_02_17_00.tdp
OLF_s01_n0006_10_08_02_17_30.tdp
OLF_s01_n0007_10_08_02_18_00.tdp
OLF_s01_n0008_10_08_02_18_30.tdp
OLF_s01_n0009_10_08_02_19_00.tdp
OLF_s01_n0010_10_08_02_19_30.tdp
OLF_s01_n0011_10_08_02_20_00.tdp
OLF_s01_n0012_10_08_02_20_30.tdp
OLF_s01_n0013_10_08_02_21_00.tdp
OLF_s01_n0014_10_08_02_21_30.tdp
OLF_s01_n0015_10_08_02_22_00.tdp
OLF_s01_n0016_10_08_02_22_30.tdp
OLF_s01_n0017_10_08_02_23_00.tdp
OLF_s01_n0018_10_08_02_23_30.tdp
OLF_s01_n0019_10_08_03_00_00.tdp
OLF_s01_n0020_10_08_03_00_30.tdp
OLF_s01_n0021_10_08_03_01_00.tdp
.
.
.
```

## 4. Running TRAJFREQ to get the gridded frequency of a set of trajectories

### (a) Creating INFILES... *continued*

- Generally, one is carrying out an analysis in which one is comparing one set of trajectory frequencies with another.
- So, in each case, one assembles an INFILE that comprises the given subset of trajectories for each case and then one runs TRAJFREQ for each INFILE.
- As mentioned above, you might find it convenient to do this in the MS-Excel run generator, using existing or added columns to determine if a given tdp file belongs to a given subset or not. Or, you could create the files in some other way, e.g., from an automated script.
- In this example, we will use three different INFILE's and these have been created for you and placed in the working directory:
  - `OLF_sample_01_infile.txt` – contains the names of all 47 tdump files for this sample
  - `OLF_sample_2a_infile.txt` – contains the names of the 49 tdump files for this sample

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- b. Using output from FREQDIFF in GIS

## 4. Running TRAJFREQ to get the gridded frequency of a set of trajectories... *continued*

### (b) TRAJFREQ\_SET\_GBI\_001.bat

- We are now going to run TRAJFREQ, an auxiliary program in the HYSPLIT modeling suite that computes the frequency (percent) of trajectories that pass through each grid in a user-specified grid.
- The basic usage of TRAJFREQ is shown in the box at the right. You can see that the usage has similarities to other HYSPLIT programs, and, that some of the options are ones you may be familiar with if you used the GUI to run frequencies, e.g., the grid size in degrees.
- Since we are going to run TRAJFREQ three times in this example, and since in general one may run TRAJFREQ numerous times in a given analysis to compute the gridded frequencies of a number of different subsets of trajectories, we will employ a "SET" and "RUN" architecture like we did in the running the trajectories in the steps above.

```
-----  
C:\hysplit4\working_GBI_example_001>..\exec\trajfreq  
-----
```

```
Converts multiple trajectory input files into a  
concentration file that represents trajectory frequencies.
```

```
USAGE: trajfreq -[options (default)]  
-f[frequency file name (tfreq.bin)]  
-g[grid size in degrees (1.0)]  
-i[input file of file names (INFILE)]  
-r[residence time (0)=no 1=yes]  
-s[select bottom:top (0:99999) m AGL]  
-a[ascii2shp shapefile input file(0) or 1]  
-k[min longitude for ascii2shp shapefile input file]  
-l[max longitude for ascii2shp shapefile input file]  
-m[min latitude for ascii2shp shapefile input file]  
-n[max latitude for ascii2shp shapefile input file]
```

```
NOTE -- if shapefile input selected (-a) then:
```

- (1) k, l, m, n should be selected for region of interest (this does not affect regular bin output file, whose domain is always global)
  - (2) grid\_polygons.txt file is created
  - (3) create actual shapefile by running ascii2shp e.g., ascii2shp outfile polygons < grid\_polygons.txt
  - (4) grid\_frequencies.txt ascii csv file created containing: grid\_id, grid centroids, and frequencies for the shapefile subgrid
  - (5) this file can be imported into ArcView and "joined" to grid shapefile using the grid\_id field
  - (6) gridded frequencies can then be shown in ArcView
- ```
-----
```

## 4. Running TRAJFREQ to get the gridded frequency of a set of trajectories... *continued*

### (b) TRAJFREQ\_SET\_GBI\_001.bat...*continued*

- We are now going to run TRAJFREQ, an auxiliary program in the HYSPLIT modeling suite that computes the frequency (percent) of trajectories that pass through each grid in a user-specified grid.
- The basic usage of TRAJFREQ is shown in the box at the right. You can see that the usage has similarities to other HYSPLIT programs, and, that some of the options are ones you may be familiar with if you used the GUI to run frequencies, e.g., the grid size in degrees.
- Since we are going to run TRAJFREQ three times in this example, and since in general one may run TRAJFREQ numerous times in a given analysis to compute the gridded frequencies of a number of different subsets of trajectories, we will employ a “SET” and “RUN” architecture like we did in the running the trajectories in the steps above.
- The TRAJFREQ\_SET batch file, as used in this example, has 7 replaceable parameters:
  - parameter #1: name of run
  - parameter #2: directory for infile
  - parameter #3: name of infile
  - parameter #4: directory for tdumps
  - parameter #5: directory for trajfreq working
  - parameter #6: directory for trajfreq results
  - parameter #7: directory for exec
- In the following slides, the TRAJFREQ\_SET\_GBI\_001.bat DOS Batch file will be presented and explained.

# TRAJFREQ\_SET\_GBI\_001.bat

```
@echo off
rem BATCH file to SET TRAJFREQ for BV for 2008

rem parameters for TRAJFREQ_SET_001:
rem parameter #1: name of run
rem parameter #2: directory for infile
rem parameter #3: name of infile
rem parameter #4: directory for tdumps
rem parameter #5: directory for trajfreq working
rem parameter #6: directory for trajfreq results
rem parameter #7: directory for exec
```

These comments list the replaceable parameters, for reference

```
SET nrun=%1
SET dinf=%2
SET ninf=%3
SET dtdp=%4
SET dwrk=%5
SET dres=%6
SET dexe=%7
```

These lines create short-hand abbreviated variable names. We could use the %1, %2, %3... notation, but I introduced these variable names to make things a little more transparent. Now, for the name of the run, we can use %nrun% rather than %1.

```
IF NOT EXIST %dres% MKDIR %dres%
```

```
rem MOVE TO TDUMP DIRECTORY:
CD %dtdp%
```

```
rem first copy infile to tdump directory so that don't
rem have to have path-name for each tdump file
```

```
IF EXIST %ninf% DEL %ninf%
COPY %dinf%%ninf%
```

```
rem establish infile with standard name
```

```
IF EXIST infile.txt DEL infile.txt
COPY %ninf% infile.txt
```

```
IF EXIST grid_polygons.txt DEL grid_polygons.txt
IF EXIST grid_frequencies.txt DEL grid_frequencies.txt
IF EXIST %nrun%.bin DEL %nrun%.bin
```

Delete any pre-existing output files that might be present from previous runs. The reason why this is important, is that if the TRAJFREQ execution fails, e.g., the INFILE can't be found, then one wouldn't want to have these earlier files around to be mistakenly assigned the name of the current run!

# TRAJFREQ\_SET\_GBI\_001.bat (continued)

The binary output file of frequencies

The grid resolution for the normal global grid and the optional GIS grid.

The INFILE being used. We have made this a standardized name and copied the actual file to a file with this name

These command line parameters set the min/max longitude and min/max latitude of the GIS-compatible results output from the program.

```
rem RUN TRAJFREQ
%dexe%trajfreq -f%nruntime%.bin -g0.25 -iinfile.txt -a1 -k-110.0 -l-70.0 -m10.0 -n50.0
```

```
COPY grid_frequencies.txt %dres%%nruntime%_frequencies.txt
COPY grid_polygons.txt %dres%%nruntime%_polygons.txt
COPY infile.txt %dres%%nruntime%_infile.txt
```

Copying key output and input files for this run to save.

This "-a1" command line argument tells TRAJFREQ to output GIS-compatible results, and if this is set, the following parameters must also be set to specify the GIS grid.

```
rem -----
rem   CREATE the GRID SHAPEFILE for later GIS use
rem -----

rem C:\hysplit4\results\tcu>..\..\exec\ascii2shp
rem Usage: ascii2shp [options] outfile type < infile
rem reads stdin and creates outfile.shp,
rem outfile.shx and outfile.dbf
rem type must be: points lines or polygons
rem infile must be in 'generate' format
rem Options:
rem -i Place integer value id in .dbf file (default)
rem -d Place double precision id in .dbf file
rem -----
```

Creating a GIS shape-file using the program "ascii2shp" which is present in the normal HYSPLIT exec directory.

This shape-file has grid ID's for each grid polygon that match the grid ID's in the ascii-text file "grid\_frequencies.txt" that is output from TRAJFREQ when the -a1 command line parameter is set.

```
%dexe%ascii2shp %nruntime%_grid polygons < grid_polygons.txt
```

```
MOVE %nruntime%_grid.* %dres%
```

```
rem -----
rem   CREATE the LABELS.CFG file for CONCPLOT map
rem   to be made next
rem -----
```

CONCPLOT has not been optimized to make maps of TRAJFREQ contours, but, a few small adjustments to the labels here make things a little better, as far as the labeling goes... (but still not ideal...)

```
ECHO ^'TITLE^&^',^'NOAA AIR RESOURCES LABORATORY^&^' > LABELS.CFG
ECHO ^'MAPID^&^',^'percent of traj. thru each grid sq.^&^' >> LABELS.CFG
ECHO ^'LAYER^&^',^' ^&^' >> LABELS.CFG
ECHO ^'UNITS^&^',^' ^&^' >> LABELS.CFG
ECHO ^'VOLUM^&^',^' ^&^' >> LABELS.CFG
```

## TRAJFREQ\_SET\_GBI\_001.bat (continued)

```
rem -----
rem   CONCPLLOT INSTRUCTIONS
rem -----

rem C:\hysplit4\results\tcu_frequency>..\..\exec\concplot
rem USAGE: concplot -[options (default)]
rem   -a[Arcview GIS: 0-none 1-log10 2-value 3-GoogleEarth]
rem   -b[Bottom display level: (0) m]
rem   -c[Contours: (0)-dyn/exp 1-fix/exp 2-dyn/lin 3-fix/lin 4-set 50-0,interval 10 51-1,interval 10]
rem   -d[Display: (1)-by level, 2-levels averaged]
rem   -e[Exposure units flag: (0)-concentrations, 1-exposure, 2-threshold, 3-hypothetical volcanic ash]
rem   -f[Frames: (0)-all frames one file, 1-one frame per file]
rem   -g[Circle overlay: ( )-auto, #circ(4), #circ:dist_km]
rem   -h[Hold map at center lat-lon: (source point), lat:lon]
rem   -i[Input file name: (cdump)]
rem   -j[Graphics map background file name: (ar1map) or shapefiles.txt]
rem   -k[Kolor: 0-B&W, (1)-Color, 2-No Lines Color, 3-No Lines B&W]
rem   -l[Label options: ascii code, (73)-open star]
rem   -L[LatLonLabels: none=0 auto=(1) set=2:value(tenths)]
rem   -m[Map projection: (0)-Auto 1-Polar 2-Lamb 3-Merc 4-CylEqu]
rem   -n[Number of time periods: (0)-all, numb, min:max, -incr]
rem   -o[Output file name: (concplot.ps)]
rem   -p[Process file name suffix: (ps) or process ID]
rem   -q[Quick data plot: ( )-none, filename]
rem   -r[Removal: 0-none, (1)-each time, 2-sum, 3-total]
rem   -s[Species: 0-sum, (1)-select, #-multiple]
rem   -t[Top display level: (99999) m]
rem   -u[Units label for mass: (mass), see "labels.cfg" file]
rem   -v[Values[:labels (optional)] for fixed contours: val1:lab1+val2:lab2+val3:lab3+val4:lab4]
rem   -V[Values[:RRRGGGBBB (optional)] for fixed contours: val1:RGB+val2:RGB+val3:RGB+val4:RGB]
rem   -w[Grid point scan for contour smoothing (0)-none 1,2,3, grid points]
rem   -x[Concentration multiplier: (1.0)]
rem   -y[Deposition multiplier: (1.0)]
rem   -z[Zoom factor: 0-least zoom, (50), 100-most zoom]

rem NOTE: leave no space between option and value
```

## TRAJFREQ\_SET\_GBI\_001.bat (continued)

```
rem -----  
rem     CREATE some SIMPLE maps of results  
rem -----
```

```
IF EXIST CLRTBL.CFG DEL CLRTBL.CFG  
COPY %dwrk%CLRTBL.CFG
```

```
SET DIAM=0200
```

```
IF EXIST concplot.ps DEL concplot.ps  
%dexe%concplot -i%nrn%.bin -jc:\hysplit4\graphics\arlmmap -h -g0:%DIAM% -v40+30+20+10+7+5+3+2+1+0.5+0.1  
convert -density 300 concplot.ps %nrn%_%DIAM%.jpg  
MOVE %nrn%_%DIAM%.jpg %dres%
```

```
SET DIAM=1000
```

```
IF EXIST concplot.ps DEL concplot.ps  
%dexe%concplot -i%nrn%.bin -jc:\hysplit4\graphics\arlmmap -h -g0:%DIAM% -v40+30+20+10+7+5+3+2+1+0.5+0.1  
convert -density 300 concplot.ps %nrn%_%DIAM%.jpg  
MOVE %nrn%_%DIAM%.jpg %dres%
```

```
SET DIAM=2000
```

```
IF EXIST concplot.ps DEL concplot.ps  
%dexe%concplot -i%nrn%.bin -jc:\hysplit4\graphics\arlmmap h -g0:%DIAM% -v40+30+20+10+7+5+3+2+1+0.5+0.1  
convert -density 300 concplot.ps %nrn%_%DIAM%.jpg  
MOVE %nrn%_%DIAM%.jpg %dres%
```

```
SET DIAM=3000
```

```
IF EXIST concplot.ps DEL concplot.ps  
%dexe%concplot -i%nrn%.bin -jc:\hysplit4\graphics\arlmmap h -g0:%DIAM% -v40+30+20+10+7+5+3+2+1+0.5+0.1  
convert -density 300 concplot.ps %nrn%_%DIAM%.jpg  
MOVE %nrn%_%DIAM%.jpg %dres%
```

Here we make several maps using CONCPLOT.

Each map is drawn to a different scale by using a different value of the an internal variable defined as "DIAM". The meaning of this variable is the diameter in km of a circle that would be drawn around the starting point of the back-trajectory. Actually, by setting the "-g0:%DIAM%" command line argument, we are not actually drawing the circle, but make the map as if we had drawn the circle. This is a way to make a map's scale be "reproducible", if one wants to compare a number of different cases. If we wanted the circle to be drawn, we could use "-g1:%DIAM%"

The contour levels chosen [-v40+30+20+10+7+5+3+2+1+0.5+0.1] are just ones that I thought might work for this situation. You can experiment with changing them or adding (or subtracting) levels.

## TRAJFREQ\_SET\_example\_001.bat (continued)

Finally we copy the final files that we want to save to the results directory and clean up the TDP directory where we have been doing the work. We want to just leave tdp files in that tdp directory.

Note that we have created a “log” file that saves the command line execution output from running this batch file. So, if there are any errors – or if you want to check on some of the screen output from the program(s) – you can see them.

```
IF EXIST %dres%%nrun%.log DEL %dres%%nrun%.log
IF EXIST %dwrk%%nrun%.log COPY %dwrk%%nrun%.log %dres%
IF EXIST %nrun%.bin MOVE %nrun%.bin %dres%

rem clean up TDP directory
IF EXIST concplot.ps DEL concplot.ps
IF EXIST LABELS.CFG DEL LABELS.CFG
IF EXIST grid_polygons.txt DEL grid_polygons.txt
IF EXIST grid_frequencies.txt DEL grid_frequencies.txt
IF EXIST infile.txt DEL infile.txt
IF EXIST %nrun%_infile.txt DEL %nrun%_infile.txt
IF EXIST CLRTBL.CFG DEL CLRTBL.CFG

rem when done, go back to working directory
CD %dwrk%
```

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- d. Issues around getting all the trajectories to finish

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- a. Creating INFILES
- b. TRAJFREQ\_SET.bat
- c. TRAJFREQ\_RUN.bat
- d. CONCLOT maps of results
- e. Other output from TRAJFREQ
- f. Using output from TRAJFREQ in GIS



## **5. Using FREQDIFF to get differences between two frequency runs**

- a. FREQDIFF\_RUN.bat
- b. Using output from FREQDIFF in GIS

# TRAJFREQ\_RUN\_example\_001.bat

```
@echo off
rem BATCH file to RUN TRAJFREQ for EXAMPLE_001
```

```
rem parameters for TRAJFREQ_SET_001:
```

```
rem parameter #1: name of run
rem parameter #2: directory for infile
rem parameter #3: name of infile
rem parameter #4: directory for tdumps
rem parameter #5: directory for trajfreq working
rem parameter #6: directory for trajfreq results
rem parameter #7: directory for exec
rem parameter #8:
rem parameter #9:
```

These are the parameters that we pass to the TRAJFREQ\_SET batch file that we have been discussing immediately above.

```
rem -----
rem   set directories for all runs:
rem -----
```

```
rem directory for trajfreq infile:
SET dinf=C:\hysplit4\working_example_001\
rem directory for tdump files:
SET dtdp=C:\hysplit4\results\example_001\tdp\
rem directory for trajfreq working
SET dwrk=C:\hysplit4\working_example_001\
rem directory for trajfreq results
SET dres=C:\hysplit4\results\example_001\freq\
rem directory for trajfreq executable
SET dexe=C:\hysplit4\exec\
```

Some of the key parameters are directories, and these will be set here, using local variables. We will then use these in the "calling" statements below.

And then we carry out three different runs, one for ALL 62 of the trajectories, one for just the 31 DAY trajectories and a third one for just the 31 NIGHT trajectories.

Note that when you run TRAJFREQ\_RUN\_example\_001.bat, there will be no output on the screen, as we are directing all the output to a log file. When the execution ends, you will be returned to the DOS Prompt. The three runs will take several minutes to complete. You can follow the progress by looking in the results\example\_001\freq\ directory to see the files being created.

```
SET RUN_NAME=ARL_ALL
call TRAJFREQ_SET_example_001 %RUN_NAME% %dinf% %RUN_NAME%\infile.txt %dtdp% %dwrk% %dres% %dexe% > %RUN_NAME%.log
```

```
SET RUN_NAME=ARL_DAY
call TRAJFREQ_SET_example_001 %RUN_NAME% %dinf% %RUN_NAME%\infile.txt %dtdp% %dwrk% %dres% %dexe% > %RUN_NAME%.log
```

```
SET RUN_NAME=ARL_NIGHT
call TRAJFREQ_SET_example_001 %RUN_NAME% %dinf% %RUN_NAME%\infile.txt %dtdp% %dwrk% %dres% %dexe% > %RUN_NAME%.log
```



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## **4. Running TRAJFREQ to get the gridded frequency of a set of trajectories**

- a. Creating INFILES
- b. TRAJFREQ\_SET.bat
- c. TRAJFREQ\_RUN.bat
- d. CONCLOT maps of results
- e. Other output from TRAJFREQ
- f. Using output from TRAJFREQ in GIS

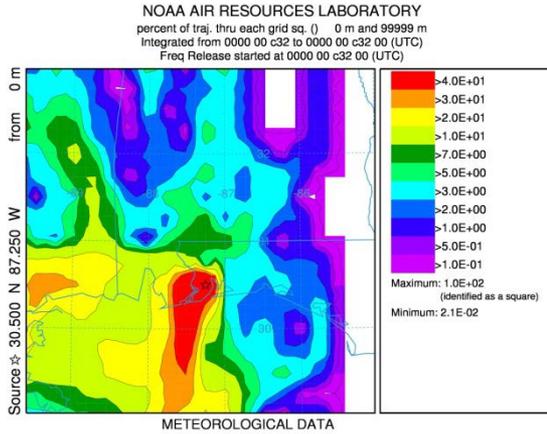


## **5. Using FREQDIFF to get differences between two frequency runs**

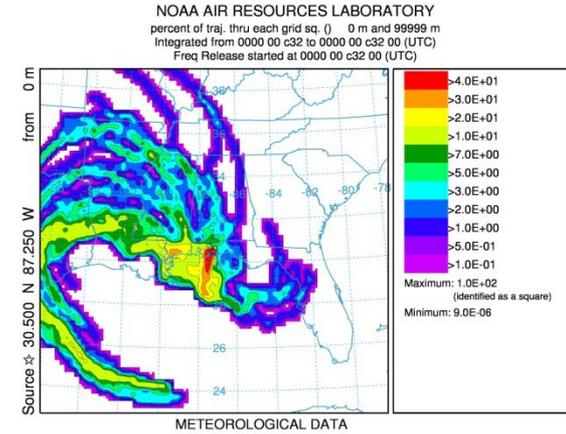
- a. FREQDIFF\_RUN.bat
- b. Using output from FREQDIFF in GIS

Here are the four CONCPLOT figures produced for the sample\_01 run, for all 47 trajectories. You can see that the domain gets bigger and bigger as the DIAM parameter increases. Because we have so few trajectories and the grid size (0.25 deg) is relatively small, the large-scale maps (1000, 2000, and 3000) all show individual trajectories in the display of the gridded data. Don't pay too much attention to the text above and below the figure, as the CONCPLOT program has not really been optimized for making these frequency maps. For now, if I want to display these CONCPLOT-produced maps, I usually crop out the text at the top and bottom... Larger versions of the 200km maps – for each of the two samples – are shown on the next two slides. And usually, these CONCPLOT maps are not the final product, as one generally imports the results into GIS to display them with more control and also to display them with other information, like the locations of emissions sources.

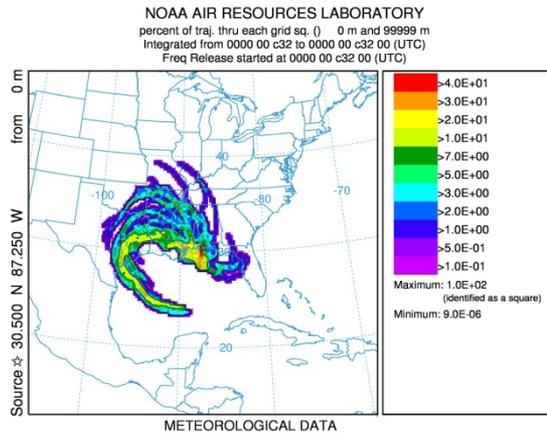
OLF\_Sample\_01\_0200.jpg



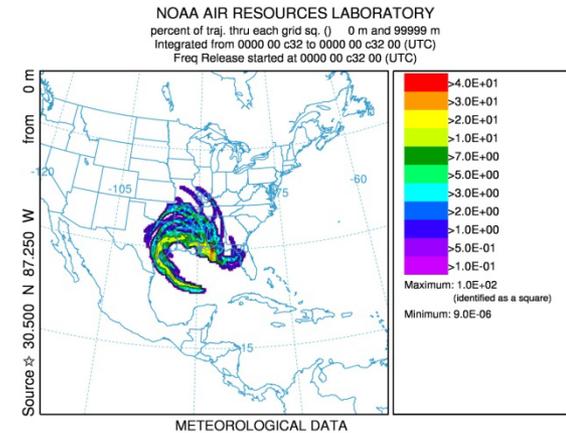
OLF\_Sample\_01\_1000.jpg



OLF\_Sample\_01\_2000.jpg



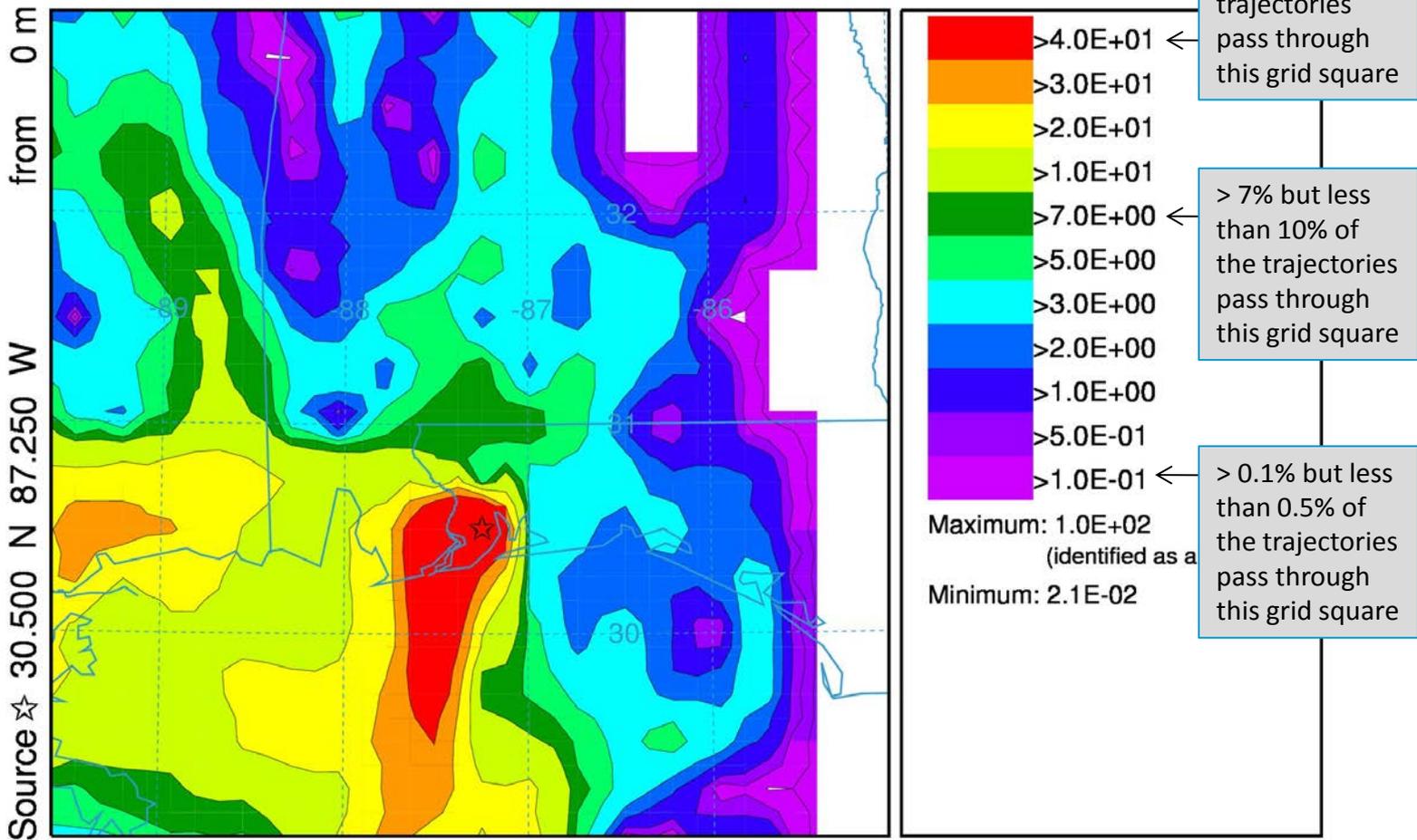
OLF\_Sample\_01\_3000.jpg



# OLF\_sample\_01\_0200.jpg

## NOAA AIR RESOURCES LABORATORY

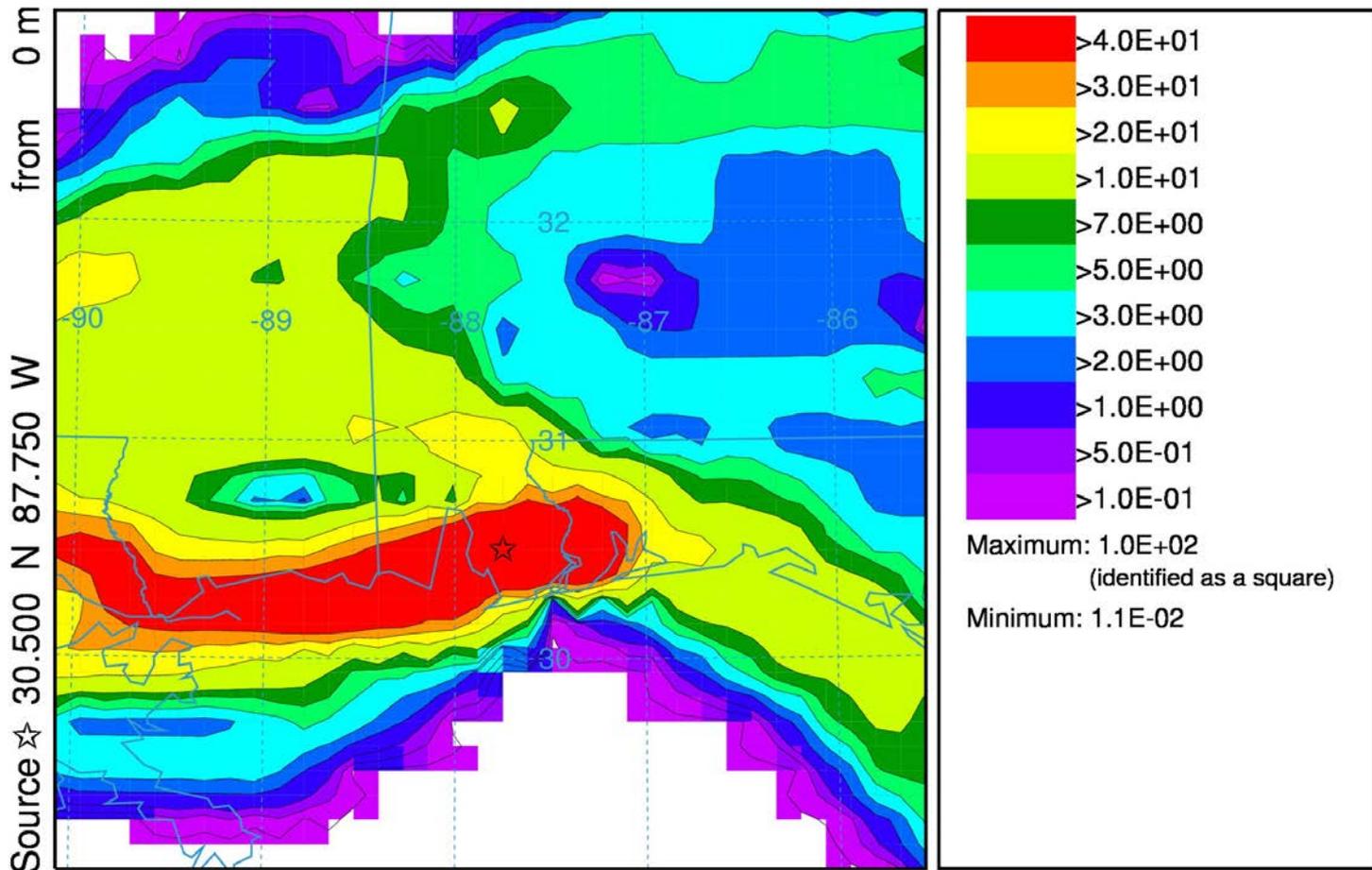
percent of traj. thru each grid sq. ( ) 0 m and 99999 m  
 Integrated from 0000 00 c32 to 0000 00 c32 00 (UTC)  
 Freq Release started at 0000 00 c32 00 (UTC)



METEOROLOGICAL DATA

# OLF\_sample\_2a\_0200.jpg

NOAA AIR RESOURCES LABORATORY  
percent of traj. thru each grid sq. ( ) 0 m and 99999 m  
Integrated from 0000 00 c32 to 0000 00 c32 00 (UTC)  
Freq Release started at 0000 00 c32 00 (UTC)



METEOROLOGICAL DATA

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- d. Issues around getting all the trajectories to finish

## **4. Running TRAJFREQ to get the gridded frequency of a set of trajectories**

- a. Creating INFILES
- b. TRAJFREQ\_SET.bat
- c. TRAJFREQ\_RUN.bat
- d. CONCPLOT maps of results
- e. Other output from TRAJFREQ
- f. Using output from TRAJFREQ in GIS



## **5. Using FREQDIFF to get differences between two frequency runs**

- a. FREQDIFF\_RUN.bat
- b. Using output from FREQDIFF in GIS

One of the main files that comes out of TRAJFREQ – when the –a1 command line parameter is set – is the file “grid\_frequencies.txt”, an ascii-text file that contains the percentages for each of the grid squares as defined in the call to TRAJFREQ. This file only contains the grid to the extent specified by the command line parameters –k, –l, –m, and –n.

This file is renamed according to the run-name, and is then copied to the results directory. At the right are excerpts from another example “ARL\_ALL\_frequencies.txt”, the grid\_frequencies.txt file from the ARL\_ALL example run. The first and last 10 lines are shown, along with an excerpt from the middle, just as an example.

This is the file that can be imported into a GIS program and linked with the shapefile that was also created for this run.



| "grid_id" | "lat_centroid" | "lng_centroid" | "freq"   |
|-----------|----------------|----------------|----------|
| 1,        | 25.000000,     | -100.000000,   | 0.000000 |
| 2,        | 25.000000,     | -99.750000,    | 0.000000 |
| 3,        | 25.000000,     | -99.500000,    | 0.000000 |
| 4,        | 25.000000,     | -99.250000,    | 0.000000 |
| 5,        | 25.000000,     | -99.000000,    | 0.000000 |
| 6,        | 25.000000,     | -98.750000,    | 0.000000 |
| 7,        | 25.000000,     | -98.500000,    | 0.000000 |
| 8,        | 25.000000,     | -98.250000,    | 0.000000 |
| 9,        | 25.000000,     | -98.000000,    | 0.000000 |
| 10,       | 25.000000,     | -97.750000,    | 0.000000 |

•  
•  
•

|       |            |             |          |
|-------|------------|-------------|----------|
| 7330, | 36.250000, | -79.000000, | 1.612903 |
| 7331, | 36.250000, | -78.750000, | 1.612903 |
| 7332, | 36.250000, | -78.500000, | 0.000000 |
| 7333, | 36.250000, | -78.250000, | 1.612903 |
| 7334, | 36.250000, | -78.000000, | 1.612903 |
| 7335, | 36.250000, | -77.750000, | 3.225806 |
| 7336, | 36.250000, | -77.500000, | 4.838710 |
| 7337, | 36.250000, | -77.250000, | 3.225806 |
| 7338, | 36.250000, | -77.000000, | 1.612903 |
| 7339, | 36.250000, | -76.750000, | 1.612903 |

•  
•  
•

|        |            |             |          |
|--------|------------|-------------|----------|
| 16252, | 50.000000, | -62.250000, | 1.612903 |
| 16253, | 50.000000, | -62.000000, | 0.000000 |
| 16254, | 50.000000, | -61.750000, | 0.000000 |
| 16255, | 50.000000, | -61.500000, | 0.000000 |
| 16256, | 50.000000, | -61.250000, | 0.000000 |
| 16257, | 50.000000, | -61.000000, | 0.000000 |
| 16258, | 50.000000, | -60.750000, | 0.000000 |
| 16259, | 50.000000, | -60.500000, | 0.000000 |
| 16260, | 50.000000, | -60.250000, | 0.000000 |
| 16261, | 50.000000, | -60.000000, | 0.000000 |

In addition to this “grid\_frequencies.txt” file, the file “grid\_polygons.txt” file is created. This is a related file that is in the ESRI-generate format that is used as input to the ascii2shp program to create the GIS-ready shape-file of the grid defined by –g, –k, –l, –m, and –n.

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## **4. Running TRAJFREQ to get the gridded frequency of a set of trajectories**

- a. Creating INFILES
- b. TRAJFREQ\_SET.bat
- c. TRAJFREQ\_RUN.bat
- d. CONCLOT maps of results
- e. Other output from TRAJFREQ
- f. Using output from TRAJFREQ in GIS

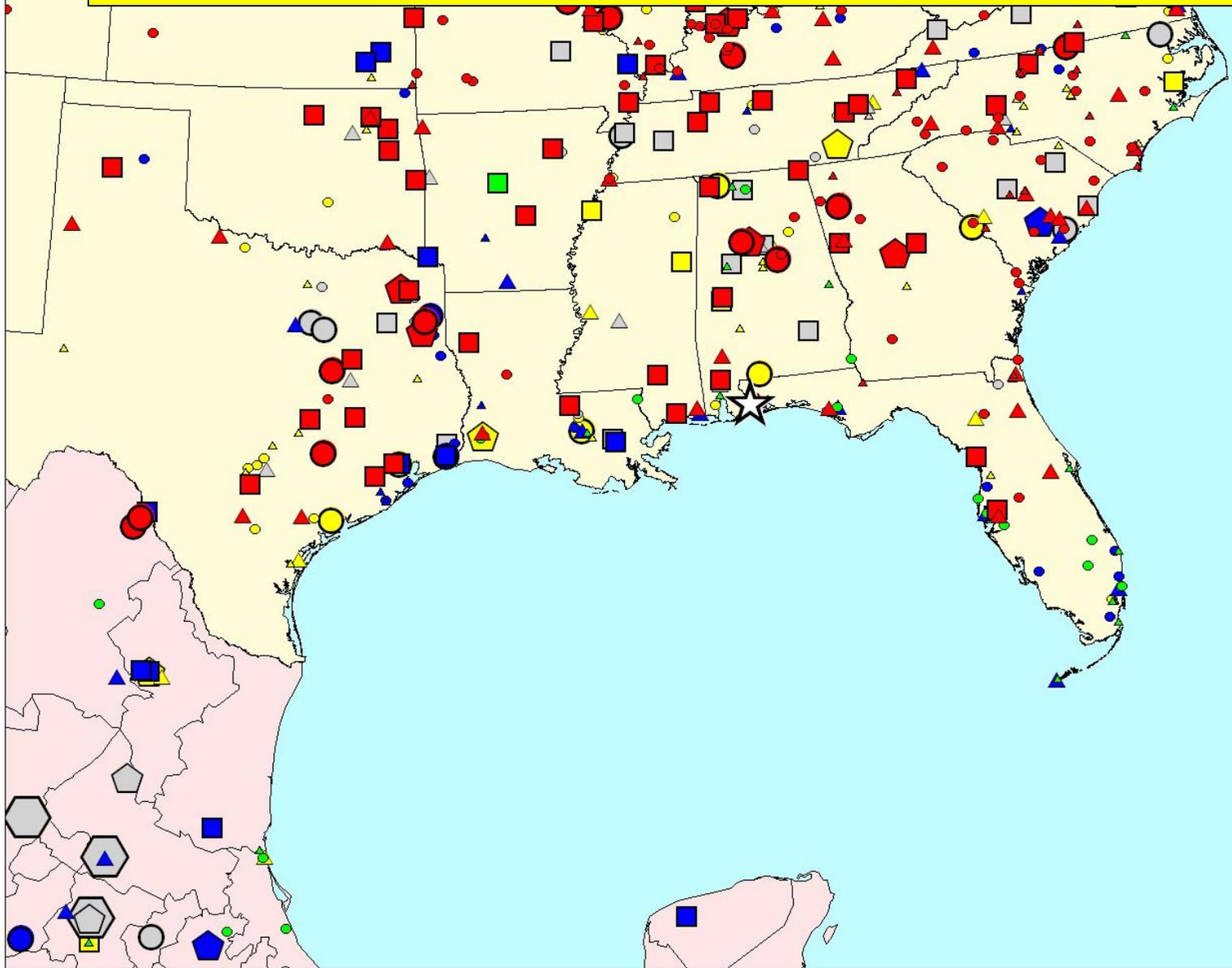


## **5. Using FREQDIFF to get differences between two frequency runs**

- a. FREQDIFF\_RUN.bat
- b. Using output from FREQDIFF in GIS

- ❑ I used ArcView to create the following GIS maps. Other GIS programs or version should also work, as all we are doing is importing a shapefile of the grid and linking a text file with frequencies to the grid, using a common ID field.
- ❑ *One key issue is the interaction of the grid resolution and the trajectory output frequency. When we ran the trajectories, we used a value of the TOUT parameter equal to 6 minutes, so, the endpoints were output every 6 minutes (rather than the default of one hour). The reason why we did this was so we could use the endpoints with a relatively fine grid, say, down to 0.1 degree or even smaller. If one uses a TOUT that is too long for the grid resolution being used, a given trajectory can “leap-frog” a grid square. That is, even though the trajectory passed through the grid square, it is not recorded as such because the TRAJFREQ program is simply considering the endpoints written to the TDUMP file and is not doing any sort of interpolation.*
- ❑ *To determine what TOUT is needed, consider the maximum wind speed that would be tolerated. For a TOUT of 6 minutes, if the wind speed was 100 km/hr, then the trajectory would move 10 km in 6 minutes. And so, in that case, a grid resolution of 0.1 deg (~10 km) would probably be ok, i.e., would not be subject to much if any leap-frogging issues. In this example, we used a grid of 0.25 deg, so we almost certainly did not have any leap-frogging issues.*
- ❑ *The advantage of using a relatively small TOUT is that you would then be able to use the TDUMP files with a relatively small grid if you eventually choose to do so.*
- ❑ *The disadvantage of using a relatively small TOUT is that the resulting TDUMP files – created for each trajectory – are relatively large. If one is running a lot of trajectories, this can mean that a significant amount of disk space is taken up.*
- ❑ The following GIS maps also include source information... In this case, its just some mercury emissions source information that I happened to have readily available in my GIS project. In general, once you import into GIS, you can add whatever source or other information that you want to add...

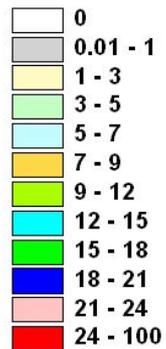
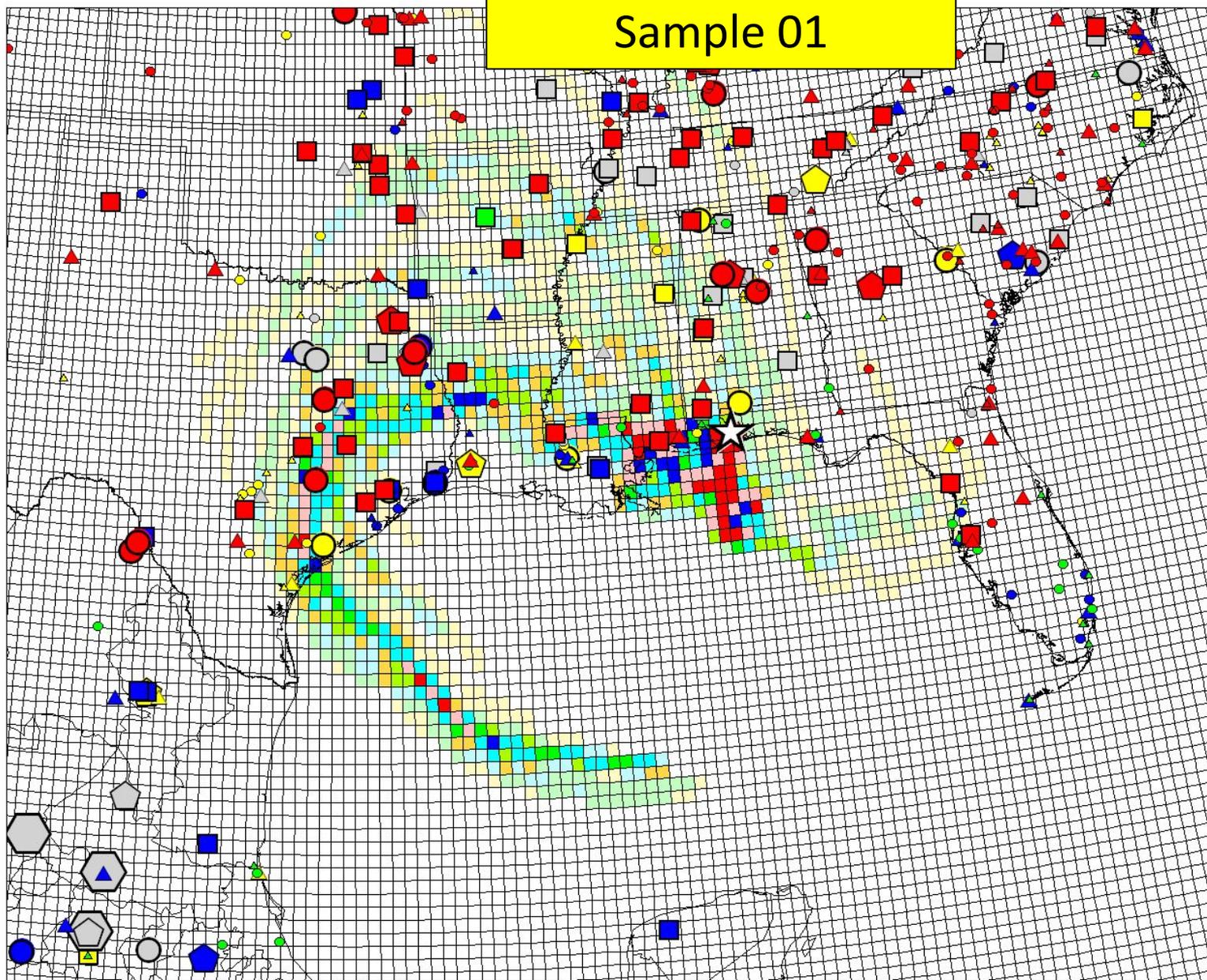
# Just the mercury emissions



200 0 200 400 600 800 1000 Kilometers



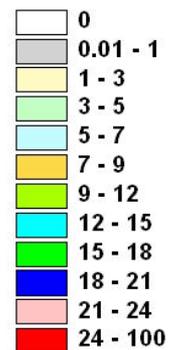
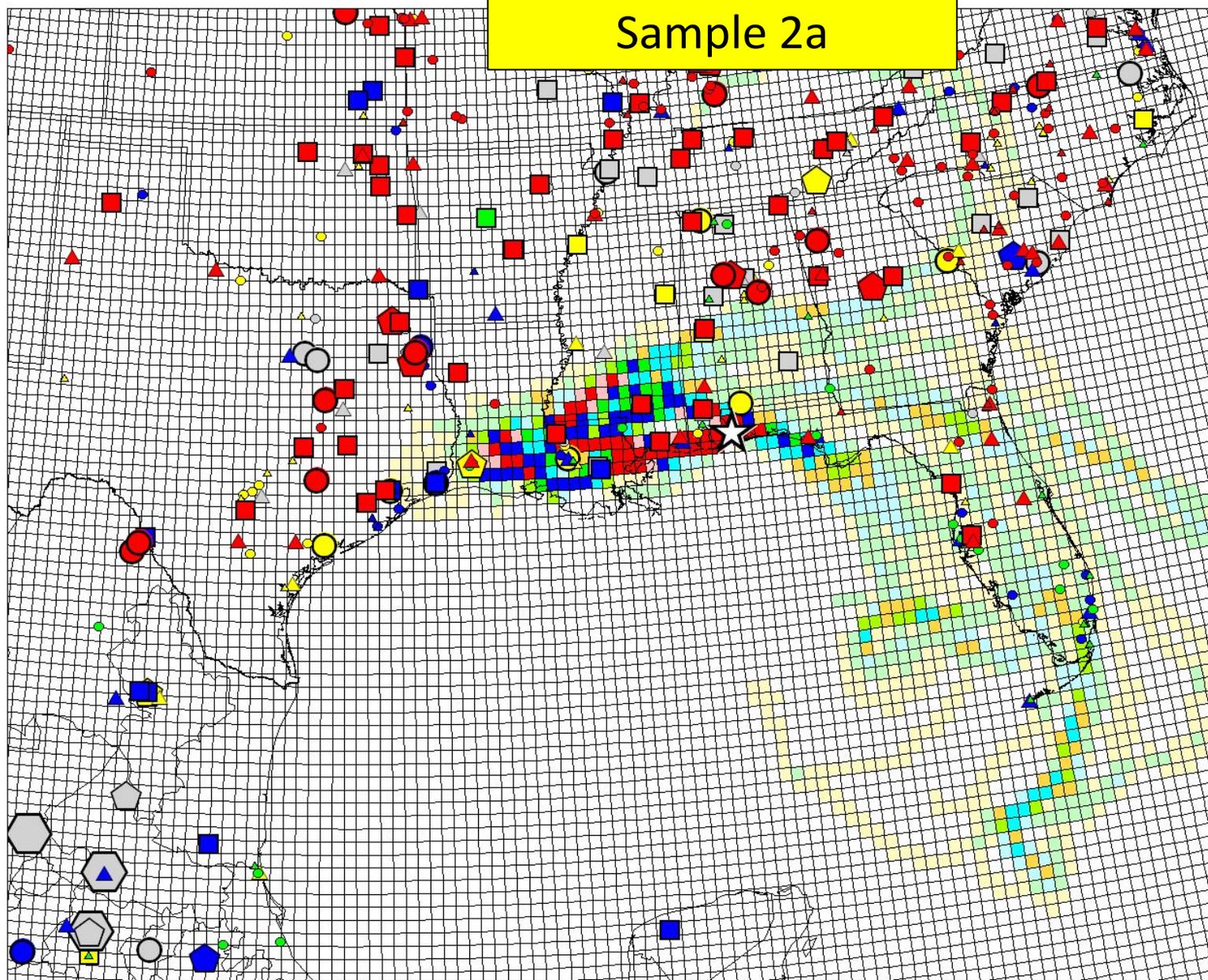
# Sample 01



200 0 200 400 600 800 1000 Kilometers



# Sample 2a



## **1. Introduction / overview of example**

## **2. Setting up the computational environment**

- a. Met data
- b. Batch Files and Executables

## **3. Running HYSPLIT to create a set of trajectories for this example**

- a. Set batch file
- b. Run batch file
- c. MS-Excel run generator
- d. Issues around getting all the trajectories to finish

## **4. Running TRAJFREQ to get the gridded frequency of a set of trajectories**

- a. Creating INFILES
- b. TRAJFREQ\_SET.bat
- c. TRAJFREQ\_RUN.bat
- d. CONCLOT maps of results
- e. Other output from TRAJFREQ
- f. Using output from TRAJFREQ in GIS

## **5. Using FREQDIFF to get differences between two frequency runs**



- a. FREQDIFF\_RUN.bat
- b. Using output from FREQDIFF in GIS

*Instead of mapping trajectory frequencies for a given set of trajectories, it can be helpful and potentially more informative to consider the **difference** between two sets of trajectory frequencies. In this example, we will compute and map the **difference** between the DAY and NIGHT subsets of trajectories.*

## FREQDIFF\_RUN\_example\_001.bat

```
@echo off

rem -----
rem C:\hysplit4\working_GBI_example_001>..\exec\freqdiff
rem Computes difference in trajectory frequency results between a
rem BASE case and a SPECIFIC case and writes results to a RESULTS file

rem INPUT FILES are the ascii GIS-compatible grid_frequency files
rem from TRAJFREQ, obtained from command line argument -a1

rem USAGE: freqdiff -[options (default)]
rem -b[base case (base.freq)]
rem -s[specific case (specific.freq)]
rem -r[results file (results.freq)]
rem -----

SET BASE=C:\hysplit4\results\GBI_example_001\freq\OLF_sample_01

SET SPECIFIC=C:\hysplit4\results\GBI_example_001\freq\OLF_sample_2a

SET RESULTS=C:\hysplit4\results\GBI_example_001\freq\OLF_sample_01_vs_2a

C:\hysplit4\exec\freqdiff -b%BASE%_frequencies.txt -s%SPECIFIC%_frequencies.txt -r%RESULTS%_frequencies.txt

copy %BASE%_grid.* %RESULTS%_grid.*
```

Instructions for command line arguments for the program FREQDIFF. This is a simple program that I created recently to take two grid\_frequency.txt files – output from TRAJFREQ, when the -a1 option is set – and create a file that contains each of the frequencies and the difference between the two frequencies. This output file can then be joined to the same grid as discussed before and displayed in GIS. Currently, the calculation is all done with ascii-text files, and so is not compatible with CONCPLOT (which requires binary files).

The “base” and “specific” case files MUST be exactly the same structure, i.e., must have the same grid spacing and same grid extent. That is, they must be “identical” and complementary runs of TRAJFREQ, the only difference being which subset of trajectories are used. If the files are not matched, then the program will exit with an error message. If they are the same, it will tell you that they are the same that the calculation will be done.

Setting the BASE, SPECIFIC and RESULTS locations and names.

Note that the way this batch file is structured, the actual names of the input grid\_frequency.txt files are created in the calling statement command-line arguments with the “+\_frequencies.txt” ending, as we have created them in this example earlier. You can use whatever way you want to tell FREQDIFF what the input files are, as long as you give the program the name of the file (with path if necessary).

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- a. Creating INFILES
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## **5. Using FREQDIFF to get differences between two frequency runs**

- a. FREQDIFF\_RUN.bat
- b. Using output from FREQDIFF in GIS

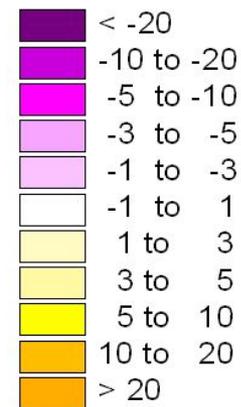
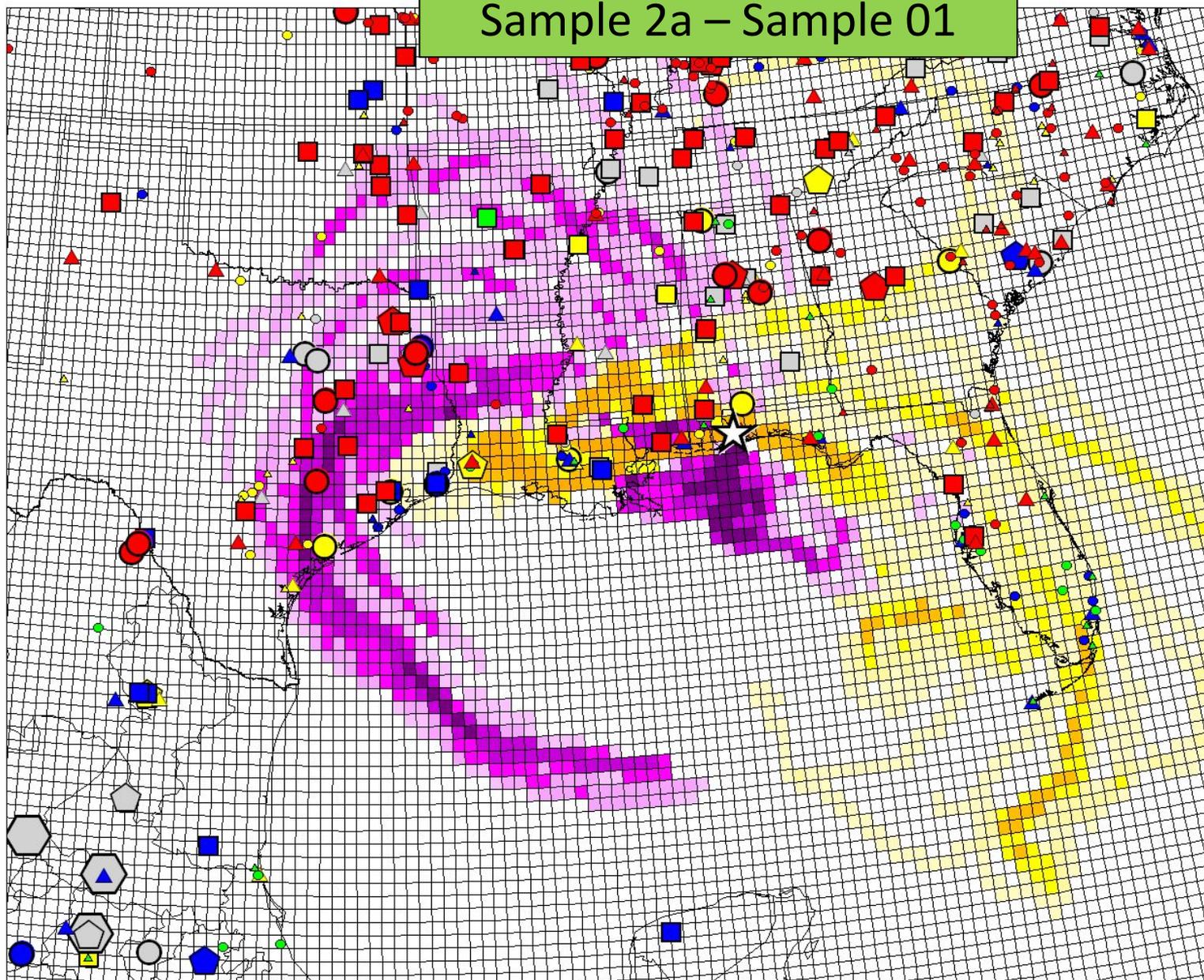


- I used ArcView to create the following GIS map.*
- Other GIS programs or version should also work, as all we are doing is importing a shapefile of the grid and linking a text file with frequencies to the grid, using a common ID field.*
- In this case we have linked the “difference” field between the day and night frequencies to the same grid that we have been using.*
- When you do this, you get positive and negative numbers, depending on which case has a higher (or lower) frequency compared to the other.*
- So, for example, if the BASE case has a frequency of 12% for a given grid square, and the SPECIFIC case has a frequency of 18% for that same grid square, the difference output from FREQDIFF will be  $12\% - 18\% = -6\%$*
- Note that the file output from FREQDIFF also includes the base and specific frequencies for each grid point, for convenience and for reference.*
- The following GIS map also includes source information... In this case, its just some mercury emissions source information that I happened to have readily available in my GIS project.*
- In general, once you import into GIS, you can add whatever source or other information that you want to add...*

# Sample 2a – Sample 01

Purple means higher frequency during sample 01 than sample 2a

Yellow means higher frequency during sample 2a than sample 01



200 0 200 400 600 800 1000 Kilometers

