Appendix A- Lye Brook Supplement

Trajectory analysis results at Lye Brook Wilderness Area.

Equations for Different Metrics

Everyday Residence-time Probability

$$EP = \left(n_{ij} \middle/ N \right)$$

n_{ij} = total endpoints passing through grid cell i, j

N = total endpoints passing through all grid cells from all trajectories

Incremental Probability

$$IP = HP - EP$$

High Day Residence-time Probability

$$HP = \left(m_{ij} \middle/ M \right)$$

m_{ij} = total high day endpoints passing through grid cell i, j

M = total high day endpoints passing through all grid cells from high day trajectories

Cluster-Weighted Probability

$$CWP = \frac{1}{\overline{C}} \left(\sum_{i=1}^{L} (\overline{C})_i \cdot RP_i - \overline{C} \cdot EP \right)$$

L = total number of clusters calculated

$(\overline{C})_i$ = Average pollutant concentration (based on observations associated with cluster i)

$\overline{C}$ = Average pollutant concentration (based on all days)

Description of Figures

- Central Trajectory (CT)- Trajectory with the largest number of nearest neighbors in the dataset.
- Frequency Based Clusters- These clusters are formed by finding the “central” trajectory which has the greatest number of neighboring trajectories within a subjectively selected radius of proximity (R). These trajectories are then removed from the dataset and the process is applied to the remaining trajectories.
- Proximity Based Clusters- Clustering relies on the frequency-based cluster groups, but forms trajectory groups based on proximity rather than frequency. In the first step, the frequency-based approach is used to identify the central trajectories that represent the most populated frequency-based clusters (approximately 10 clusters typically contain at least 98% of the trajectories in the dataset using R=12 and 120 hour back-trajectory (BT) time). These 10 central trajectories are then used to develop 10 proximity-based clusters by assigning every trajectory in the dataset to its nearest central trajectories (calculated back to 72 hours).
- Incremental Probability- Difference between the everyday probability (probability derived from all the trajectories in the dataset) and high day probability (probability derived from trajectories arriving at the site on the subset of high pollution days).
- Cluster Weighted Probability- Each PATH-derived cluster’s residence-time probability is weighted by the average sulfate (or other pollutant) value for any measurements corresponding to a trajectory which is a member of that cluster. The weighted residence-time probability is summed over *all* clusters calculated for a site. The everyday probability is subtracted from the sum of cluster-weighted probabilities to identify areas of increased (or in the case of negative values, decreased) probability of being associated with a meteorological pathway for pollutant transport.

Lye Brook All Trajectories 00-04, Top 10 Clusters

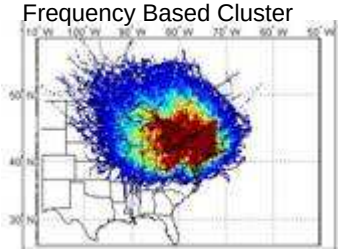
Modes defined at: R=12, 120hr BT, 500m Start ht, 6282 Valid Trajectories, 8041 Invalid

Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories

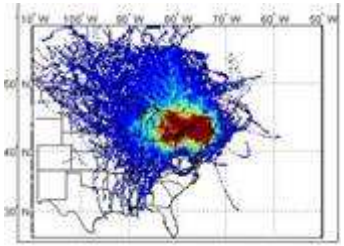
Cluster 1

Central Trajectory

Frequency Based Cluster



Proximity Based Cluster

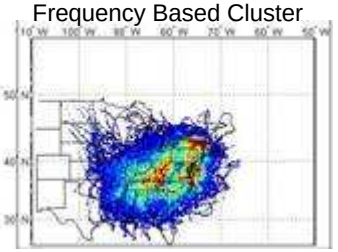


	Frequency	Proximity
Sulfate	2.47	3.14
Bext	46.2	56.48
PM	6.26	7.69
OC	1.4	1.75
# Trajs	4505	896
# Trajs w. Pol	1226	196

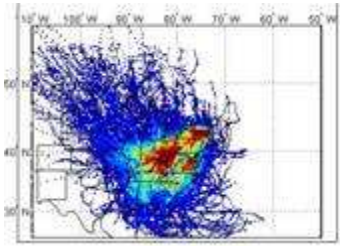
Cluster 2

Central Trajectory

Frequency Based Cluster



Proximity Based Cluster

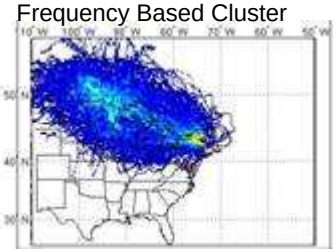


	Frequency	Proximity
Sulfate	4.14	3.67
Bext	68.71	66.52
PM	9.56	8.79
OC	1.76	1.63
# Trajs	1229	802
# Trajs w. Pol	355	246

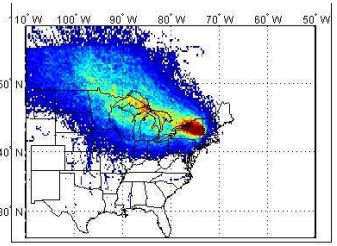
Cluster 3

Central Trajectory

Frequency Based Cluster



Proximity Based Cluster

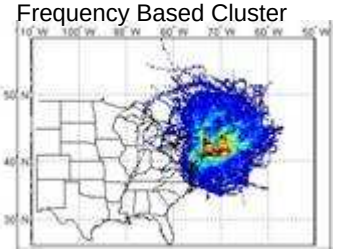


	Frequency	Proximity
Sulfate	1.79	1.43
Bext	35.8	30.80
PM	4.82	4.00
OC	1.13	0.99
# Trajs	986	1623
# Trajs w. Pol	284	358

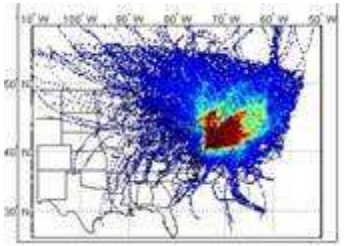
Cluster 4

Central Trajectory

Frequency Based Cluster



Proximity Based Cluster

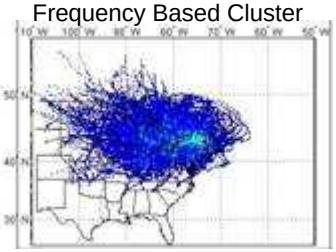


	Frequency	Proximity
Sulfate	1.7	1.56
Bext	30.48	29.28
PM	4.22	4.07
OC	0.88	0.91
# Trajs	636	929
# Trajs w. Pol	194	254

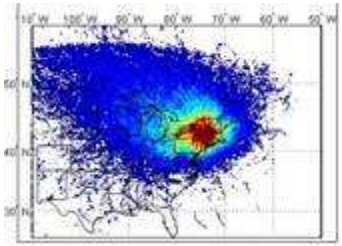
Cluster 5

Central Trajectory

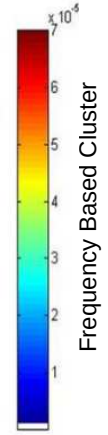
Frequency Based Cluster

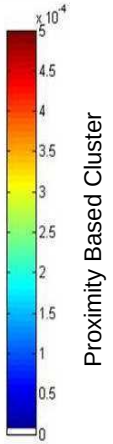


Proximity Based Cluster



	Frequency	Proximity
Sulfate	2.07	2.87
Bext	36.91	50.45
PM	5.57	7.08
OC	1.43	1.55
# Trajs	427	1775
# Trajs w. Pol	115	478





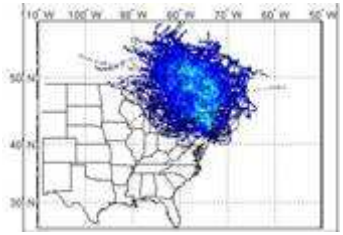
Lye Brook All Trajectories 00-04, Top 10 Clusters

Modes defined at: R=12, 120hr BT, 500m Start ht, 6282 Valid Trajectories, 8041 Invalid
Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories

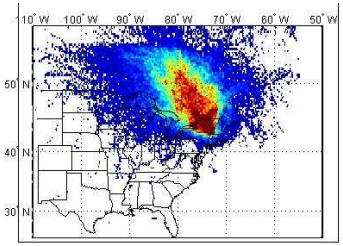
Cluster 6

Central Trajectory

Frequency Based Cluster



Proximity Based Cluster



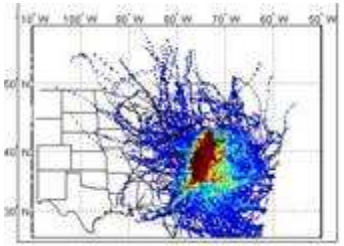
	Frequency	Proximity
Sulfate	3.58	1.16
Bext	62.5	24.77
PM	8.73	3.70
OC	1.78	1.07
# Trajs	360	1592
# Trajs w. Pol	94	361

Cluster 7

Central Trajectory

Frequency Based Cluster

Proximity Based Cluster

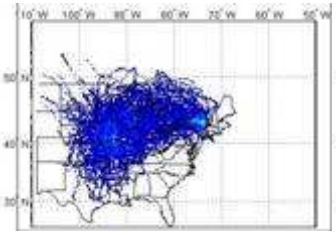


	Frequency	Proximity
Sulfate	0.93	3.75
Bext	19.79	57.79
PM	2.74	7.81
OC	0.7	1.07
# Trajs	301	500
# Trajs w. Pol	68	131

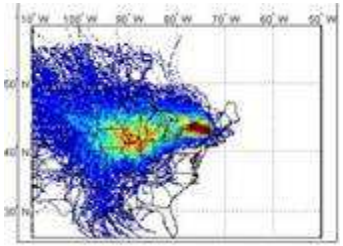
Cluster 8

Central Trajectory

Frequency Based Cluster



Proximity Based Cluster

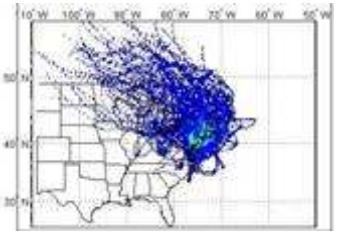


	Frequency	Proximity
Sulfate	2.36	2.76
Bext	44.72	50.56
PM	6.09	6.79
OC	1.45	1.37
# Trajs	218	656
# Trajs w. Pol	62	193

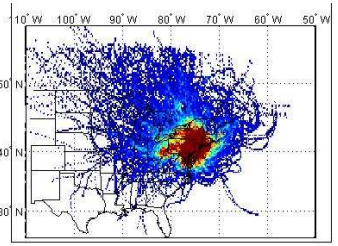
Cluster 9

Central Trajectory

Frequency Based Cluster



Proximity Based Cluster

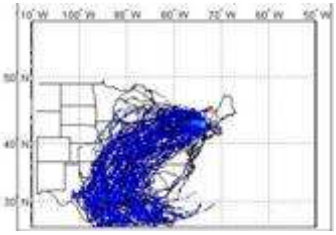


	Frequency	Proximity
Sulfate	5.83	3.97
Bext	90.51	67.64
PM	12.95	9.13
OC	2.22	1.73
# Trajs	157	586
# Trajs w. Pol	47	192

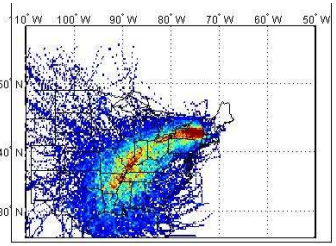
Cluster 10

Central Trajectory

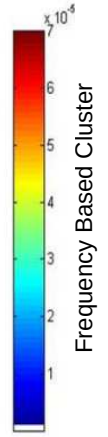
Frequency Based Cluster

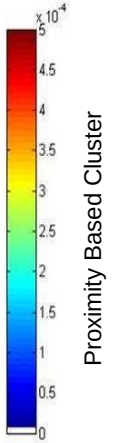


Proximity Based Cluster



	Frequency	Proximity
Sulfate	0.87	4.56
Bext	17.41	72.69
PM	2.09	10.89
OC	0.39	2.27
# Trajs	129	492
# Trajs w. Pol	36	130





Lye Brook All Trajectories 00-04, Best/Worst Sulfate

Modes defined at: R=12, 120hr BT, 500m Start ht, 6282 Valid Trajectories, 8041 Invalid
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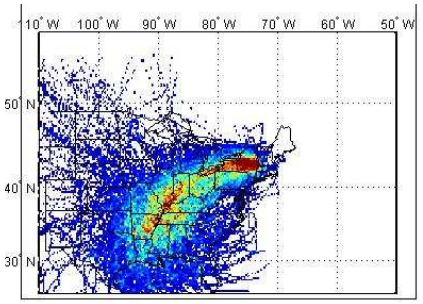
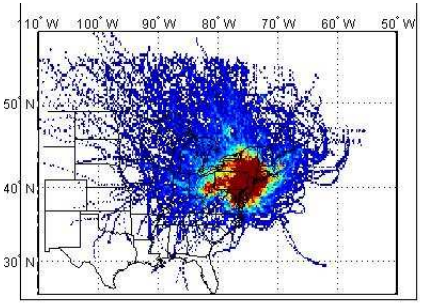
Highest Sulfate (Proximity)

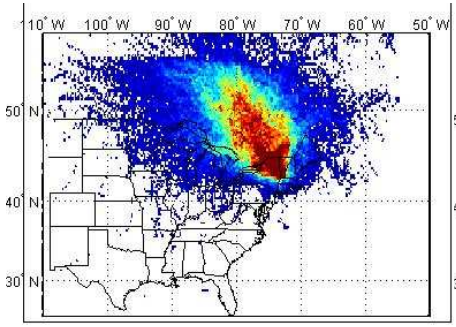


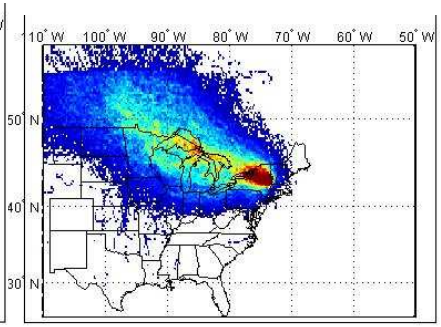


	Frequency	Proximity
Sulfate	0.87	4.56
Bext	17.41	72.69
PM	2.09	10.89
OC	0.39	2.27
# Trajs	129	492
# Trajs w. Pol	36	130

	Frequency	Proximity
Sulfate	5.83	3.97
Bext	90.51	67.64
PM	12.95	9.13
OC	2.22	1.73
# Trajs	157	586
# Trajs w. Pol	47	192

Lowest Sulfate (Proximity)





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PM	8.73	3.70
OC	1.78	1.07
# Trajs	360	1592
# Trajs w. Pol	94	361

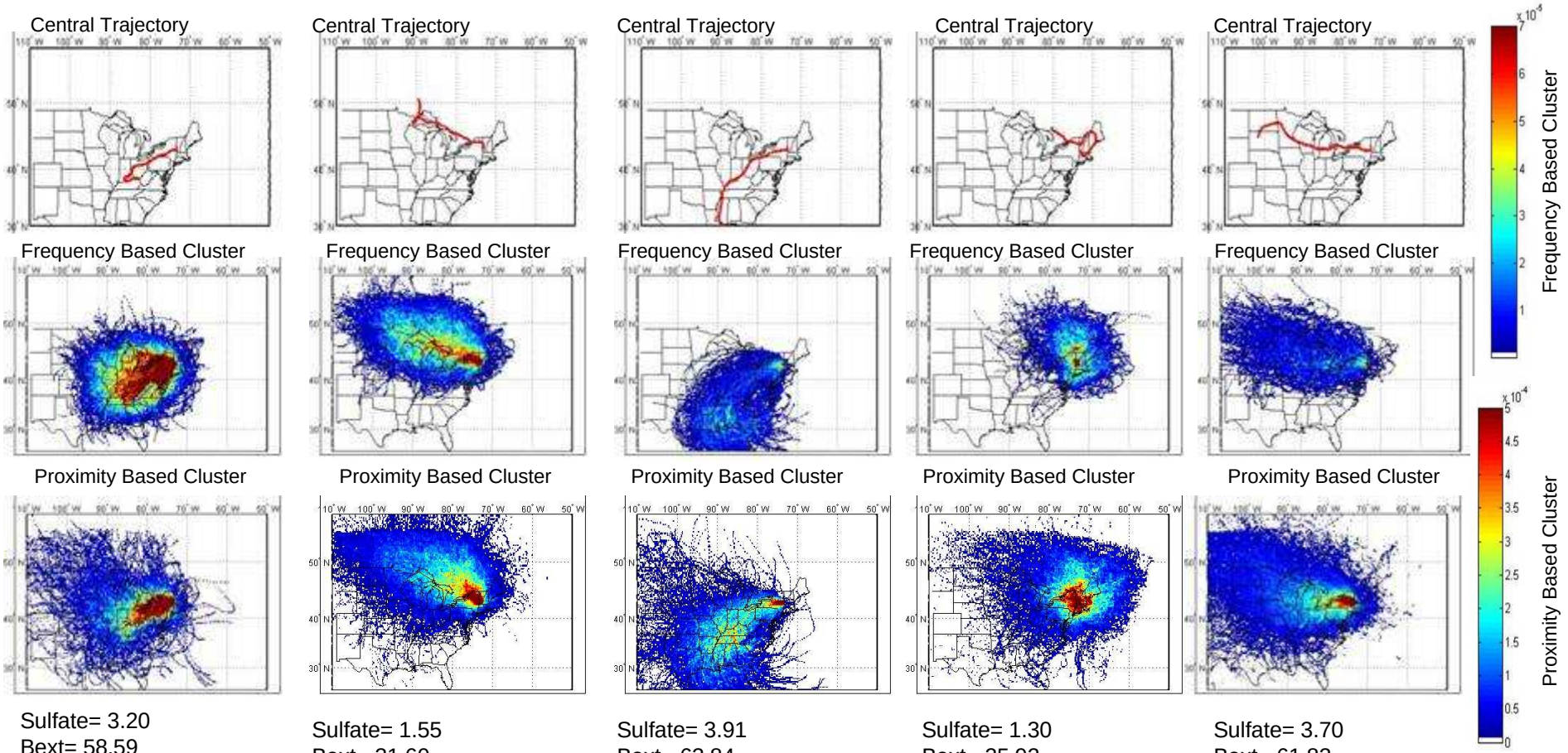
	Frequency	Proximity
Sulfate	1.79	1.43
Bext	35.8	30.80
PM	4.82	4.00
OC	1.13	0.99
# Trajs	986	1623
# Trajs w. Pol	284	358

Sulfate- Sulfate ion Conc. (ug/m3)
Bext- Extinction (Mm-1)
PM- Particulate Matter Conc. (ug/m3)
OC- Organic Carbon Conc. (ug/m3)
Num Trajs- Number of trajectories in cluster
Num Trajs w. Poll- Number of trajectories in cluster with associated pollution measurement (Based on number of IMPROVE samples taken during the 2000-2004 period).

Lye Brook All Trajectories 00-04, Top 10 Clusters

Modes defined at: R=12, 120hr BT, 1000m Start ht, 6282 Valid Trajectories, 8041 Invalid
Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories
Proximity Based Cluster Statistics Shown

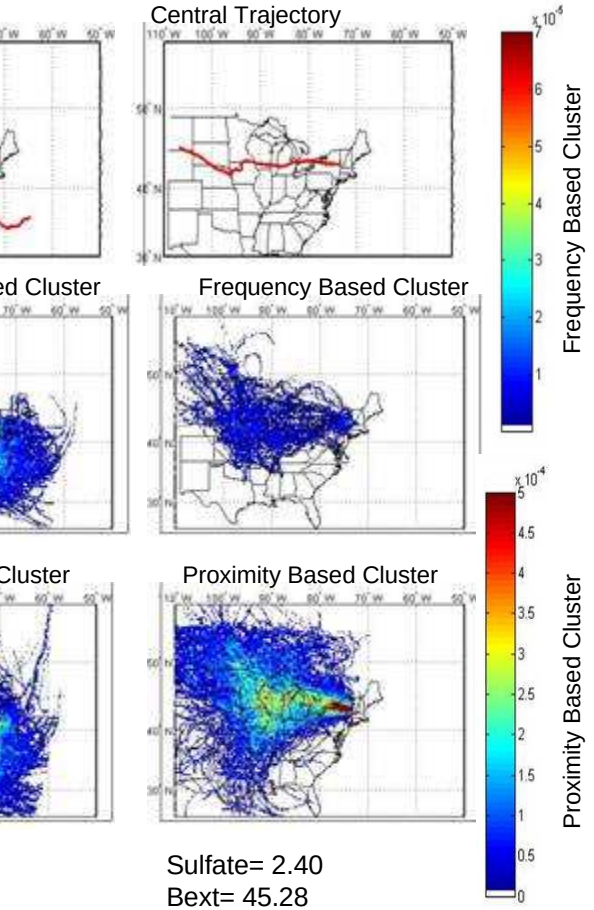
Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory
Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster
Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster
Sulfate= 3.20 Bext= 58.59 PM =7.60 OC = 1.47 Num trajs = 633 Num Trajs w. Poll = 171	Sulfate= 1.55 Bext= 31.60 PM =4.52 OC = 1.22 Num trajs = 2154 Num Trajs w. Poll = 538	Sulfate= 3.91 Bext= 63.84 PM =9.29 OC =1.93 Num trajs = 796 Num Trajs w. Poll = 223	Sulfate= 1.30 Bext= 25.92 PM =3.62 OC = 0.90 Num trajs = 1367 Num Trajs w. Poll = 384	Sulfate= 3.70 Bext= 61.83 PM =8.67 OC = 1.73 Num trajs = 1722 Num Trajs w. Poll = 469



Lye Brook All Trajectories 00-04, Top 10 Clusters

Modes defined at: R=12, 120hr BT, 1000m Start ht, 6282 Valid Trajectories, 8041 Invalid
Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories
Proximity Based Cluster Statistics Shown

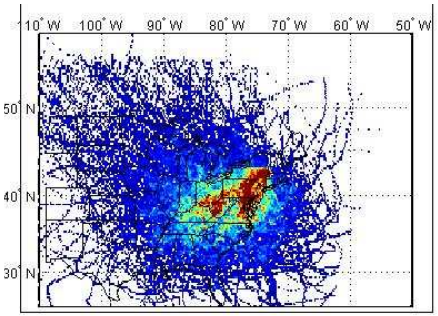
Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory
Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster
Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster
Sulfate= 2.07 Bext= 41.31 PM =5.12 OC = 1.03 Num trajs = 289 Num Trajs w. Poll = 75	Sulfate= 3.92 Bext= 68.67 PM =9.11 OC = 1.72 Num trajs = 633 Num Trajs w. Poll = 191	Sulfate= 1.74 Bext= 35.57 PM =4.62 OC =1.07 Num trajs = 656 Num Trajs w. Poll = 192	Sulfate= 3.39 Bext= 56.78 PM =7.78 OC = 1.32 Num trajs = 736 Num Trajs w. Poll = 200	Sulfate= 2.40 Bext= 45.28 PM =5.90 OC = 1.17 Num trajs = 663 Num Trajs w. Poll = 167



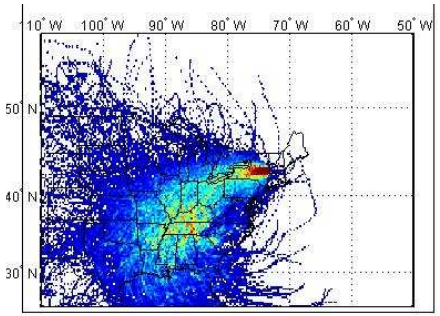
Lye Brook All Trajectories 00-04, Best/Worst Sulfate

Modes defined at: R=12, 120hr BT, 1000m Start ht, 6282 Valid Trajectories, 8041 Invalid
Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories

Highest Sulfate (Proximity)

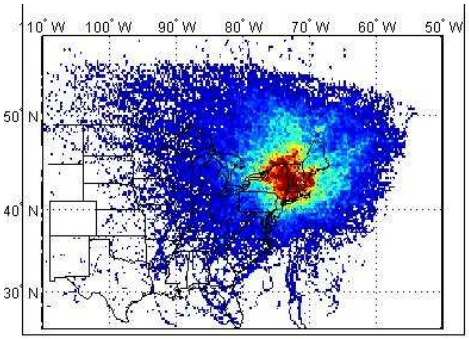


Sulfate= 3.92
Bext= 68.67
PM =9.11
OC = 1.72
Num trajs = 633
Num Trajs w. Poll = 191

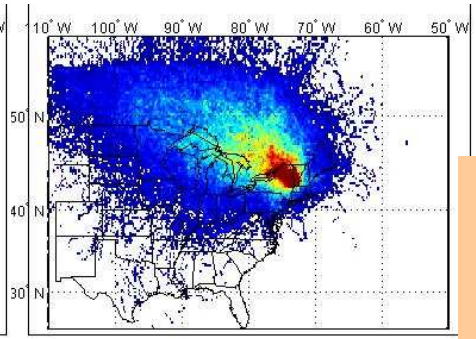


Sulfate= 3.91
Bext= 63.84
PM =9.29
OC =1.93
Num trajs = 796
Num Trajs w. Poll = 223

Lowest Sulfate (Proximity)



Sulfate= 1.30
Bext= 25.92
PM =3.62
OC = 0.90
Num trajs = 1367
Num Trajs w. Poll = 384



Sulfate= 1.55
Bext= 31.60
PM =4.52
OC = 1.22
Num trajs = 2154
Num Trajs w. Poll = 538

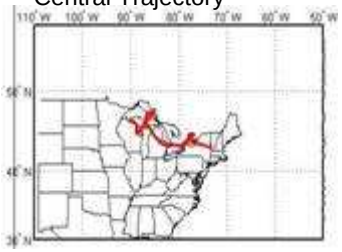
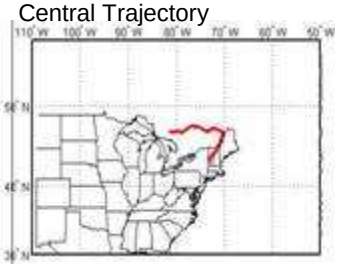
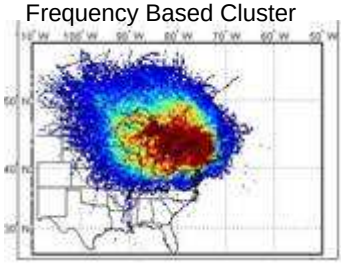
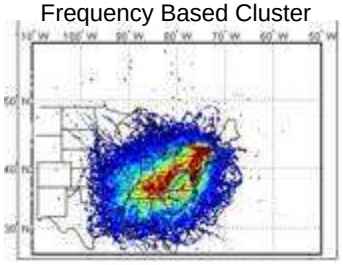
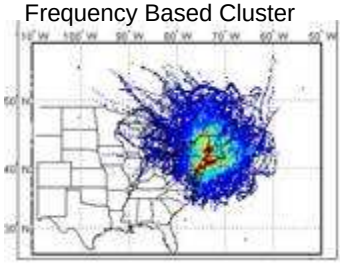
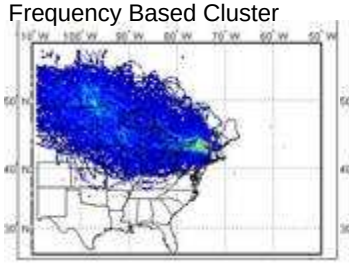
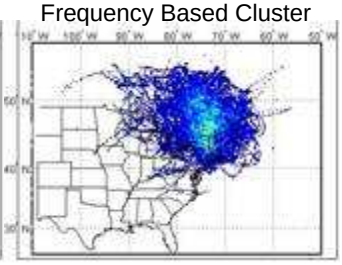
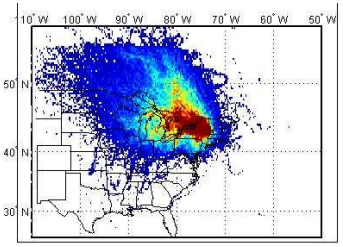
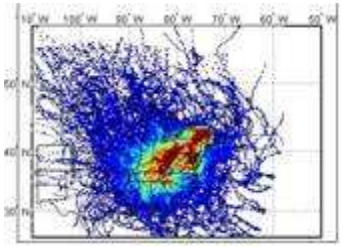
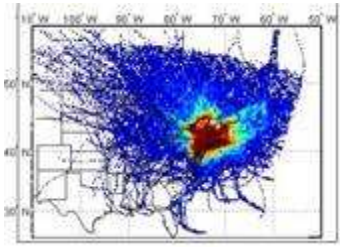
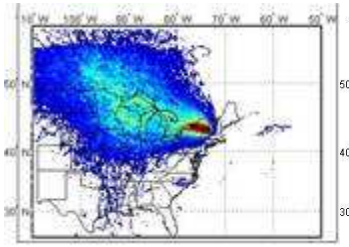
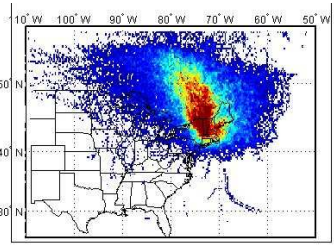
Sulfate- Sulfate ion Conc. (ug/m3)
Bext- Extinction (Mm-1)
PM- Particulate Matter Conc. (ug/m3)
OC- Organic Carbon Conc. (ug/m3)
Num Trajs- Number of trajectories in cluster
Num Trajs w. Poll- Number of trajectories in cluster with associated pollution measurement (Based on number of IMPROVE samples taken during the 2000-2004 period).

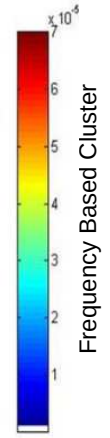
Lye Brook All Trajectories 00-04, Top 10 Clusters

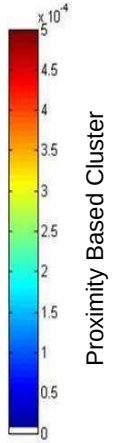
Modes defined at: R=12, 120hr BT, 500m(winter)-1000m(summer) Start ht

Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories 10 Bins

Proximity Based Cluster Statistics Shown

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory
				
Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster
				
Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster
				
Sulfate= 1.74 Bext= 35.04 PM =4.65 OC = 1.10 Num trajs = 1498 Num Trajs w. Poll = 422	Sulfate= 3.62 Bext= 63.93 PM =8.64 OC = 1.64 Num trajs = 828 Num Trajs w. Poll = 223	Sulfate= 2.37 Bext= 41.55 PM =5.52 OC =1.03 Num trajs = 969 Num Trajs w. Poll = 297	Sulfate= 1.89 Bext= 39.62 PM =5.19 OC = 1.17 Num trajs = 1442 Num Trajs w. Poll = 363	Sulfate= 1.27 Bext= 26.64 PM =3.97 OC = 1.16 Num trajs = 1352 Num Trajs w. Poll = 329





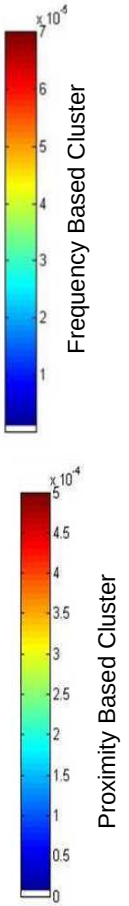
Lye Brook All Trajectories 00-04, Top 10 Clusters

Modes defined at: R=12, 120hr BT, 500m(winter)-1000m(summer) Start ht

Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories 10 Bins

Proximity Based Cluster Statistics Shown

Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory	Central Trajectory
Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster	Frequency Based Cluster
Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster	Proximity Based Cluster
Sulfate= 4.44 Bext= 70.63 PM =10.42 OC = 2.12 Num trajs = 509 Num Trajs w. Poll = 140	Sulfate= 3.91 Bext= 67.74 PM =9.07 OC = 1.63 Num trajs = 664 Num Trajs w. Poll = 192	Sulfate= 3.58 Bext= 59.50 PM =8.35 OC =1.68 Num trajs = 1455 Num Trajs w. Poll = 402	Sulfate= 2.34 Bext= 42.33 PM =5.84 OC = 1.17 Num trajs = 467 Num Trajs w. Poll = 124	Sulfate= 2.52 Bext= 45.99 PM =6.60 OC = 1.52 Num trajs = 465 Num Trajs w. Poll = 128

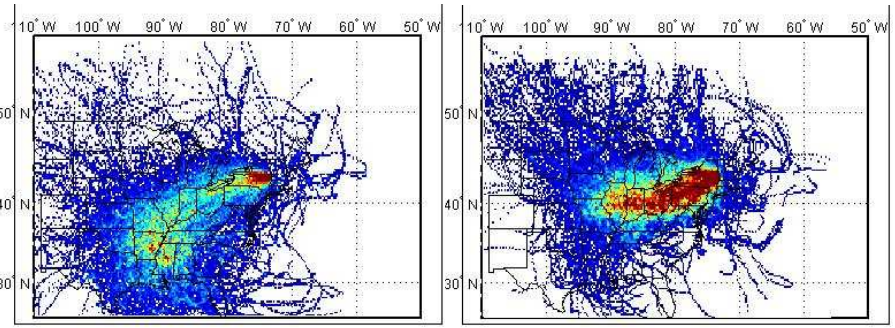


Lye Brook All Trajectories 00-04, Best/Worst Sulfate

Modes defined at: R=12, 120hr BT, 500m(winter)-1000m(summer) Start ht

Reassigned Trajectories Based on 72hr BT, 500m Start Ht, 9859 Valid Trajectories 10 Bins

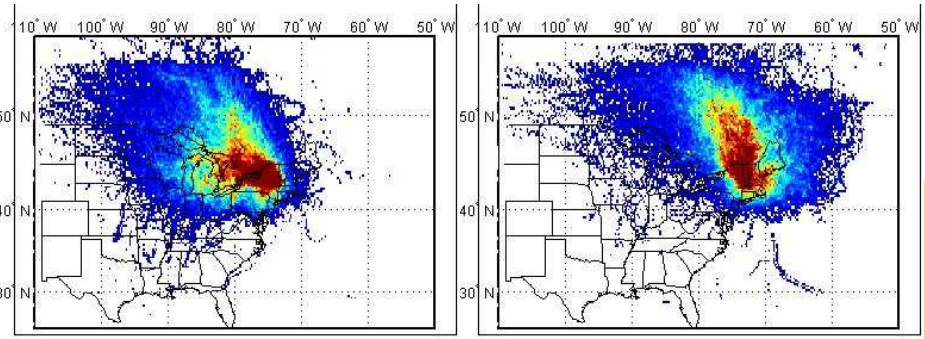
Highest Sulfate (Proximity)



Sulfate= 4.44
Bext= 70.63
PM =10.42
OC = 2.12
Num trajs = 509
Num Trajs w. Poll = 140

Sulfate= 3.91
Bext= 67.74
PM =9.07
OC = 1.63
Num trajs = 664
Num Trajs w. Poll = 192

Lowest Sulfate (Proximity)



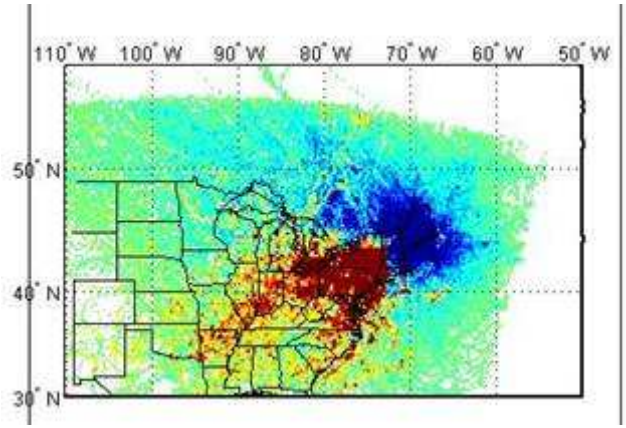
Sulfate= 1.74
Bext= 35.04
PM =4.65
OC = 1.10
Num trajs = 1498
Num Trajs w. Poll = 422

Sulfate= 1.27
Bext= 26.64
PM =3.97
OC = 1.16
Num trajs = 1352
Num Trajs w. Poll = 329

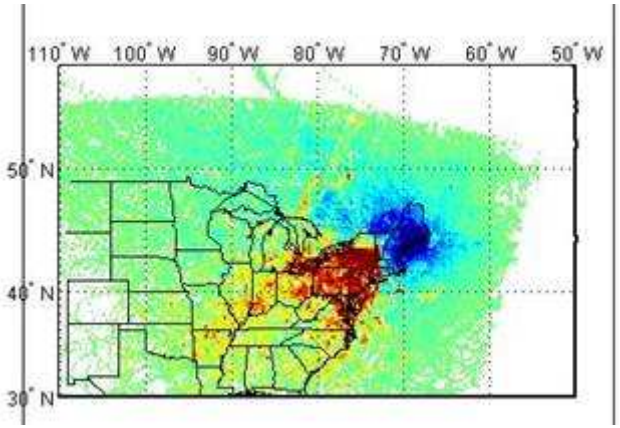
Sulfate- Sulfate ion Conc. (ug/m3)
Bext- Extinction (Mm-1)
PM- Particulate Matter Conc. (ug/m3)
OC- Organic Carbon Conc. (ug/m3)
Num Trajs- Number of trajectories in cluster
Num Trajs w. Poll- Number of trajectories in cluster with associated pollution measurement (Based on number of IMPROVE samples taken during the 2000-2004 period).

Lye Brook All Trajectories 00-04, Incremental Probability

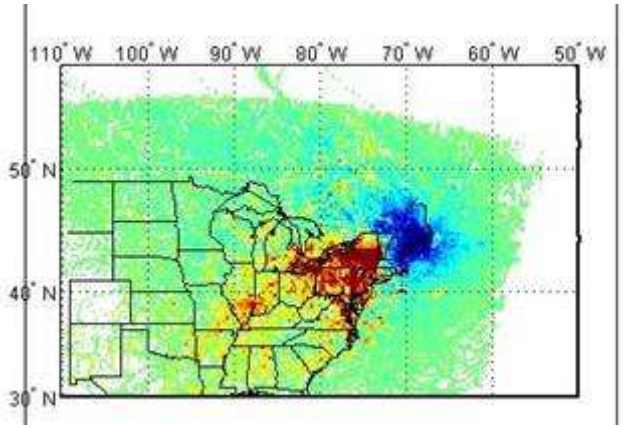
IP Based on Top10%, 500m



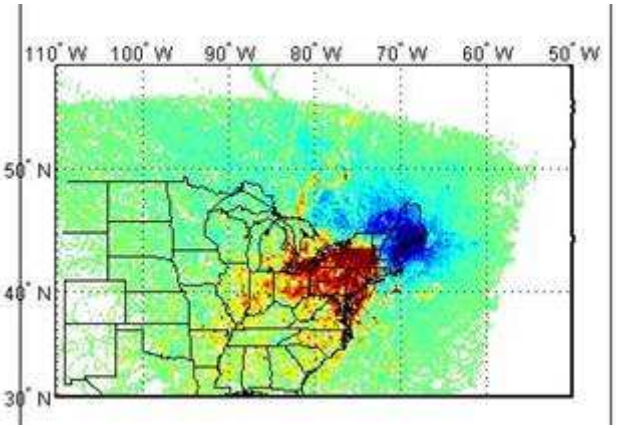
Sulfate



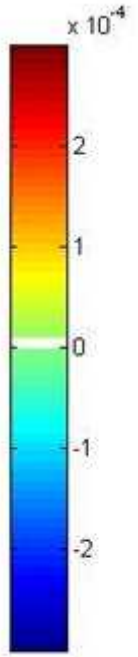
PM



OC

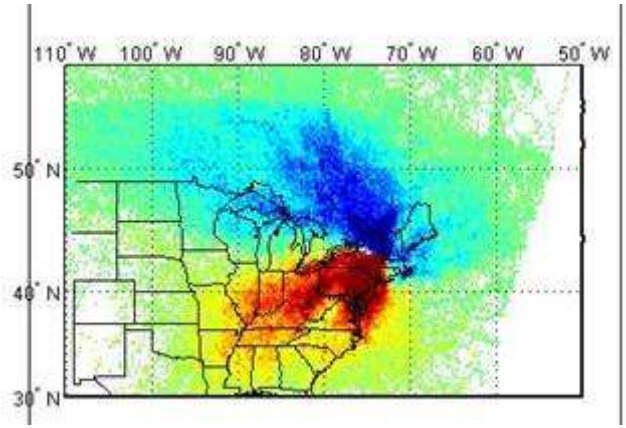


B-ext



Lye Brook All Trajectories 00-04, Cluster Weighted Probability

Calculated using Proximity Based Clusters, 500m



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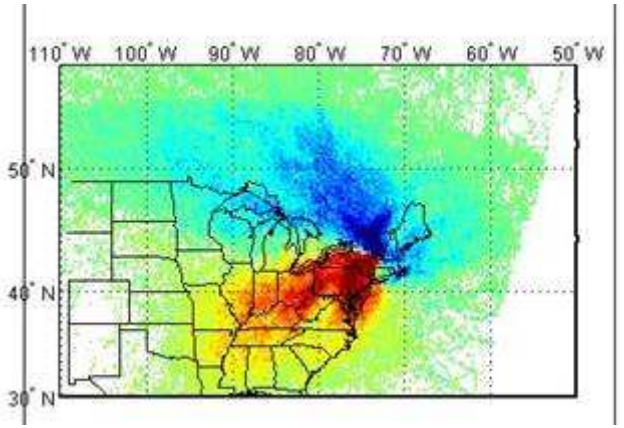
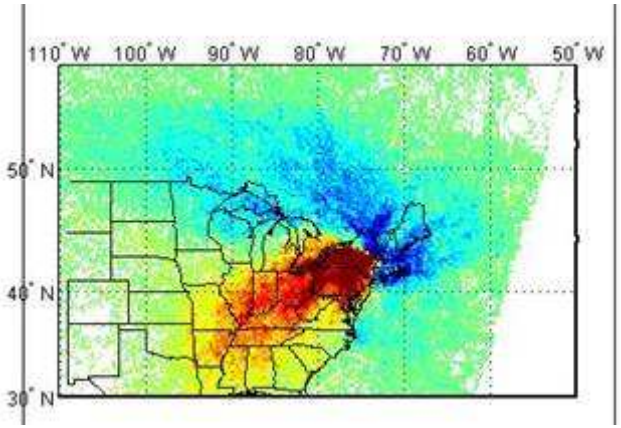
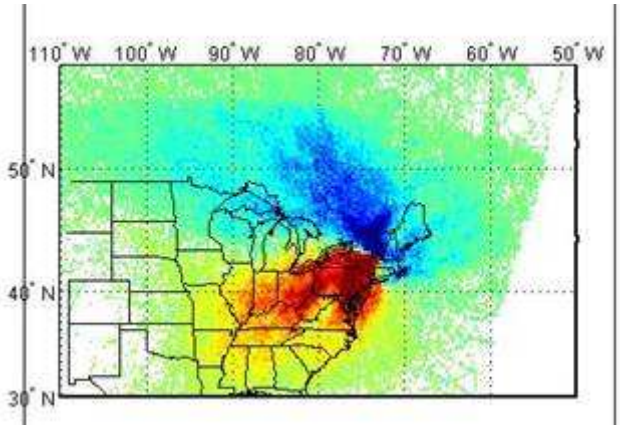


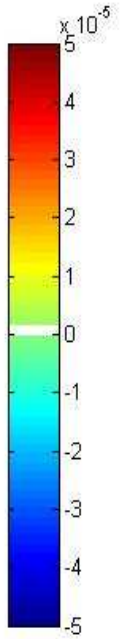
PM



OC

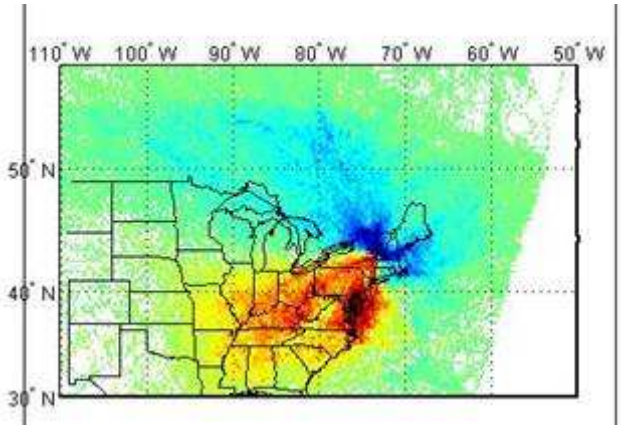


B-ext

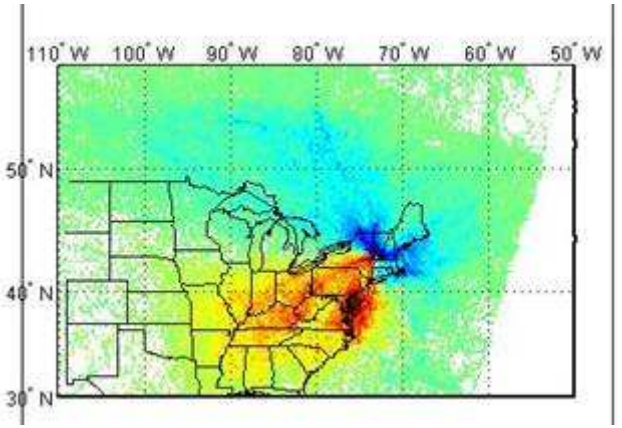


Lye Brook All Trajectories 00-04, Cluster Weighted Probability

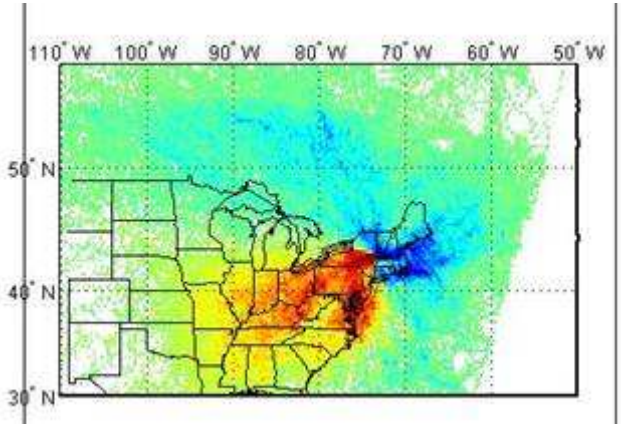
Calculated using Frequency Based Clusters, 500m



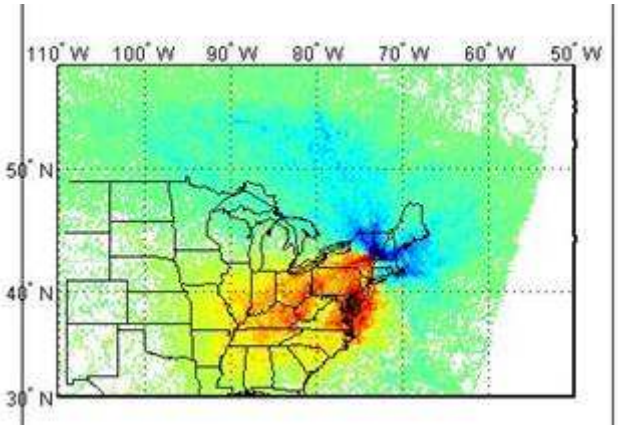
Sulfate



PM



OC



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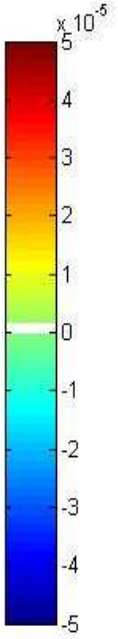
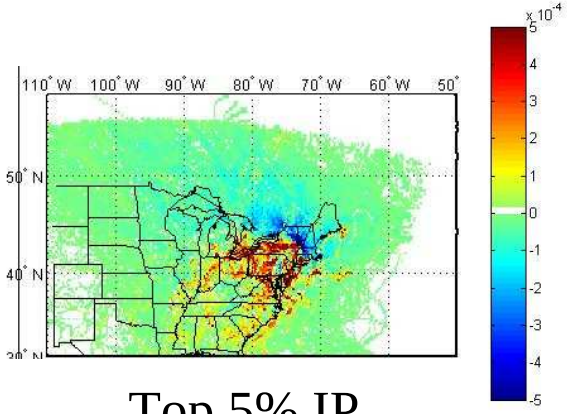
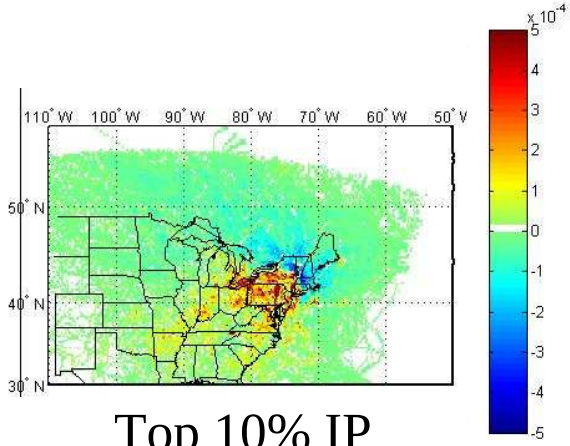


Lye Brook All Trajectories 00-04, Incremental Probability

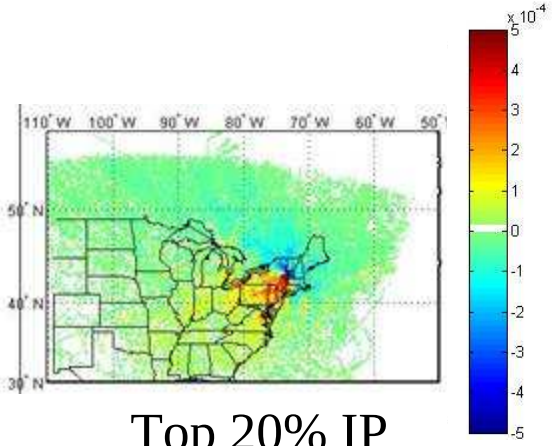
IP at 500m



Top 5% IP



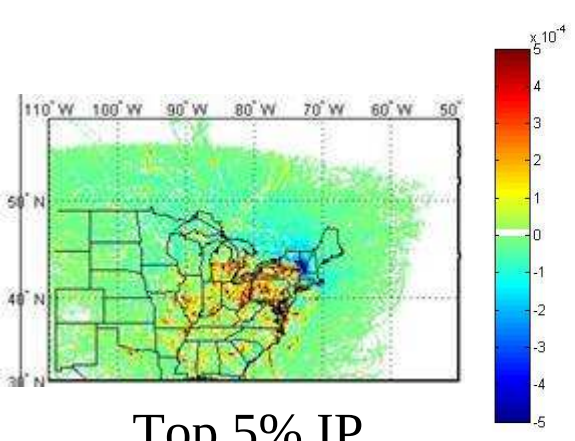
Top 10% IP



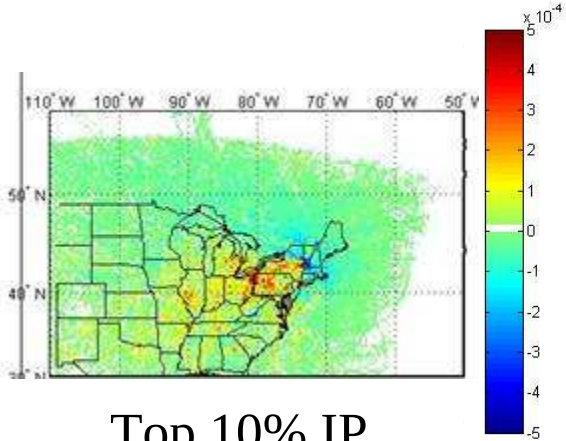
Top 20% IP

Lye Brook All Trajectories 00-04, Incremental Probability

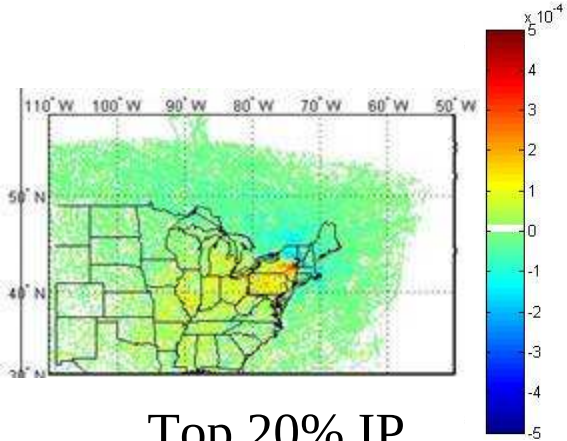
IP at 1000m



Top 5% IP



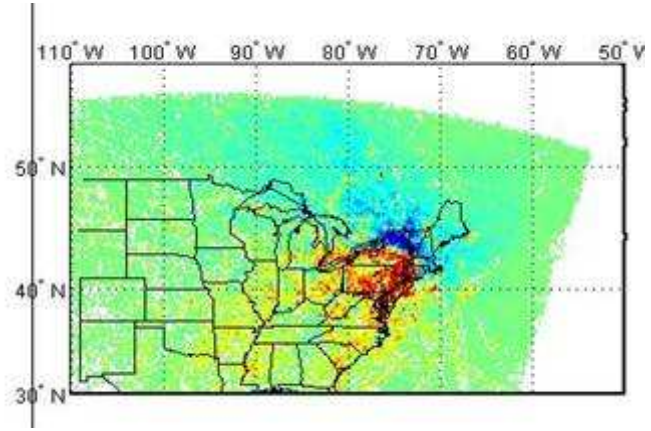
Top 10% IP



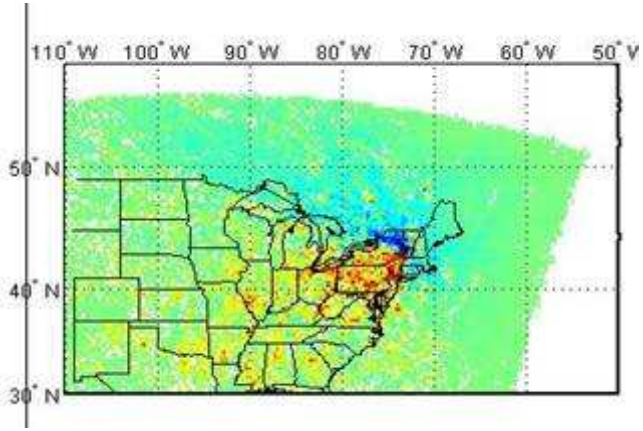
Top 20% IP

Lye Brook Top 20% Sulfate Incremental Probability

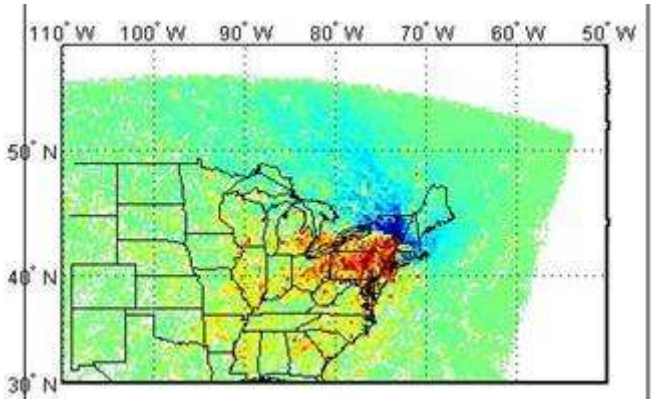
1998-2002, Calculated at 500m, 1000m, and an average using the two heights



500 meters



1000 meters



Mixed Height

Mixed Height Calculation:
All Day Weighted Average = (((500m Sept thru May Allday_Prob)*1365)+(1000m Jun thru Aug Allday Prob)*460)))/(1365+460)
High Day Weighted Average = (((500m Sept thru May Hiday_Prob)*1365)+(1000m Jun thru Aug Hiday Prob)*460)))/(1365+460)

IncProb_mixed_ht = High Day Weighted Average – All Day Weighted Average

1365 = Number of days Sept – May
460 = Number of days Jun - Aug