Appendix A- Moosehorn Supplement

Trajectory analysis results at Moosehorn National Wildlife Refuge.

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

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

Incremental Probability

$$IP = HP - EP$$

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.

Moosehorn All Trajectories 00-04, Top 10 Clusters

Modes defined at: R= 12, 120hr BT, 500m start height, 4804 valid trajectories, 9562 invalid
Reassign Trajectories Based on 72hr BT, 500m start height,7894 Valid Trajectories

Cluster 1   Cluster 2   Cluster 3   Cluster 4   Cluster 5

Cluster 1
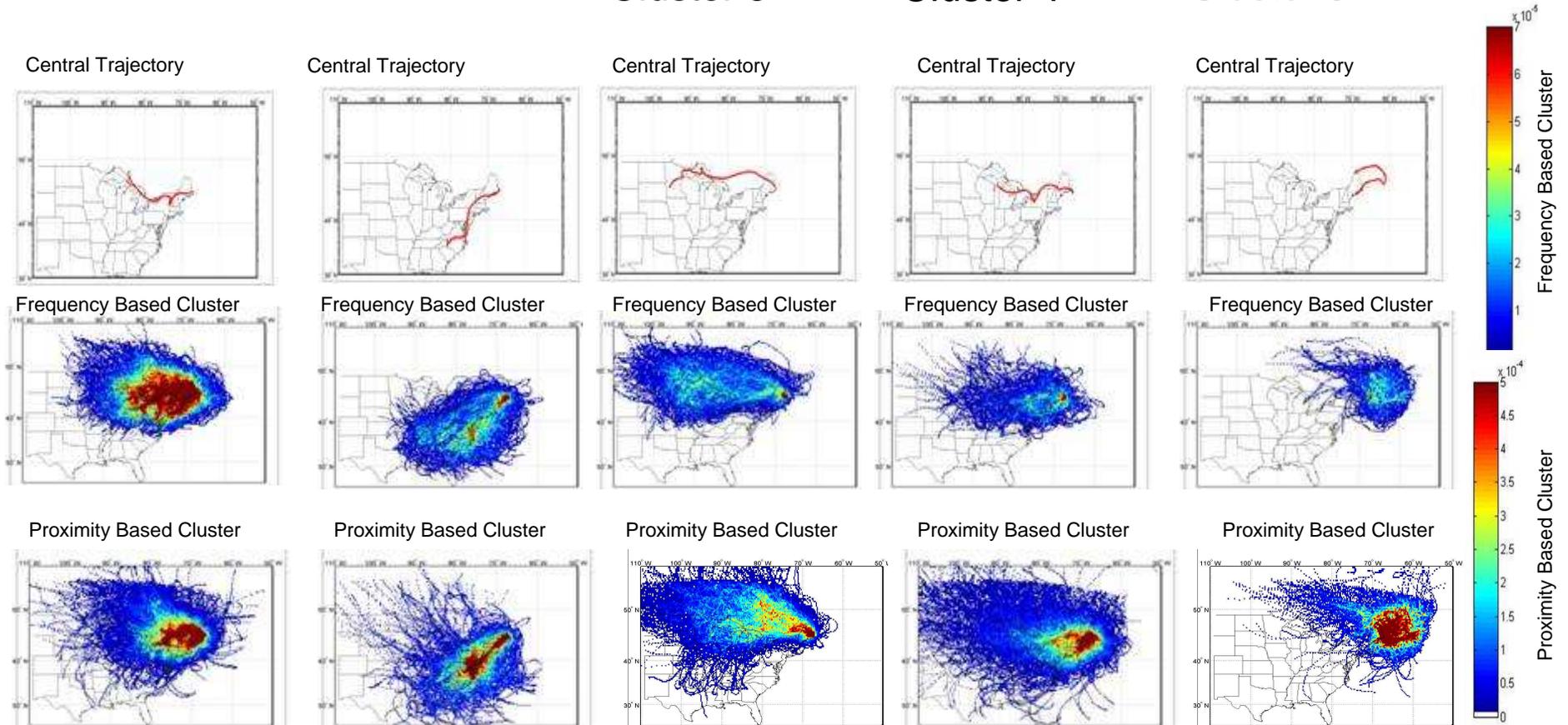
	Frequency	Proximity
Sulfate	2.47	2.55
Bext	51.08	53.59
PM	6.87	7.21
OC	1.98	2.13
# Trajs	3666	1106
# Trajs w. Poll	1141	299

Cluster 2

	Frequency	Proximity
Sulfate	1.67	3.30
Bext	37.55	64.22
PM	5.22	8.29
OC	1.79	1.73
# Trajs	974	434
# Trajs w. Poll	273	109

Cluster 3

	Frequency	Proximity
Sulfate	2.86	1.42
Bext	55.21	34.94
PM	7.05	4.71
OC	1.59	1.69
# Trajs	742	1052
# Trajs w. Poll	208	313

Cluster 4

	Frequency	Proximity
Sulfate	1.63	2.83
Bext	36.00	54.84
PM	5.15	7.38
OC	1.68	1.95
# Trajs	508	1382
# Trajs w. Poll	166	332

Cluster 5

	Frequency	Proximity
Sulfate	1.26	1.28
Bext	26.61	27.63
PM	3.70	3.91
OC	1.20	1.25
# Trajs	378	492
# Trajs w. Poll	121	142

Moosehorn All Trajectories 00-04, Top 10 Clusters

Modes defined at: R= 12, 120hr BT, 500m start height, 4804 valid trajectories, 9562 invalid
Reassign Trajectories Based on 72hr BT, 500m start height,7894 Valid Trajectories

Cluster 6   ## Cluster 7   ## Cluster 8   ## Cluster 9   ## Cluster 10

Central Trajectory | Central Trajectory | Central Trajectory | Central Trajectory | Central Trajectory
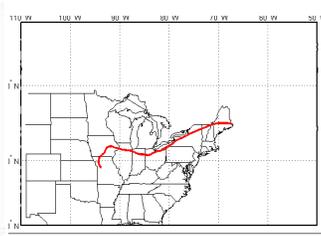
Frequency Based Cluster | Frequency Based Cluster | Frequency Based Cluster | Frequency Based Cluster | Frequency Based Cluster
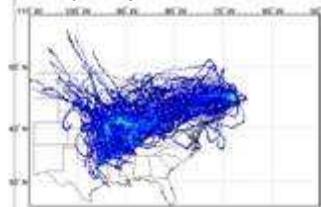
Proximity Based Cluster | Proximity Based Cluster | Proximity Based Cluster | Proximity Based Cluster | Proximity Based Cluster

Cluster 6
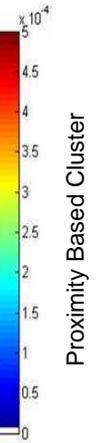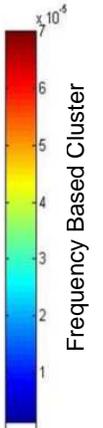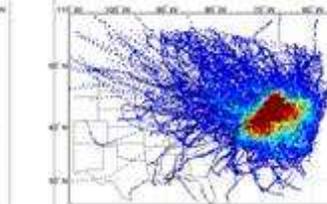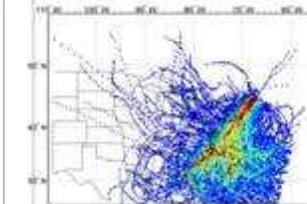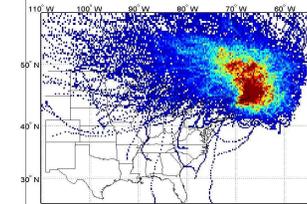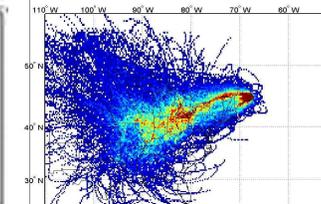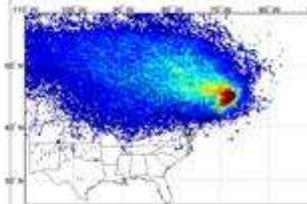
	Frequency	Proximity
Sulfate	2.91	1.85
Bext	58.09	40.18
PM	7.65	5.59
OC	1.90	1.82
# Trajs	301	1547
# Trajs w. Poll	88	410

Cluster 7

	Frequency	Proximity
Sulfate	1.12	3.68
Bext	27.26	68.86
PM	3.74	8.95
OC	1.48	2.08
# Trajs	257	485
# Trajs w. Poll	67	167

Cluster 8

	Frequency	Proximity
Sulfate	0.95	3.32
Bext	24.11	64.52
PM	3.33	8.44
OC	1.31	2.18
# Trajs	147	781
# Trajs w. Poll	28	243

Cluster 9

	Frequency	Proximity
Sulfate	1.94	2.07
Bext	43.02	37.93
PM	5.98	5.31
OC	1.78	1.04
# Trajs	120	318
# Trajs w. Poll	39	87

Cluster 10

	Frequency	Proximity
Sulfate	1.86	2.21
Bext	34.52	43.64
PM	4.94	5.72
OC	1.02	1.55
# Trajs	118	528
# Trajs w. Poll	36	140

Frequency Based Cluster

Proximity Based Cluster

Moosehorn All Trajectories 00-04, Top 10 Clusters

Modes defined at: R= 12, 120hr BT, 500m start height, 4804 valid trajectories, 9562 invalid
Reassign Trajectories Based on 72hr BT, 500m start height, 7894 Valid Trajectories
Best and Worst Days

Highest Sulfate (Proximity)
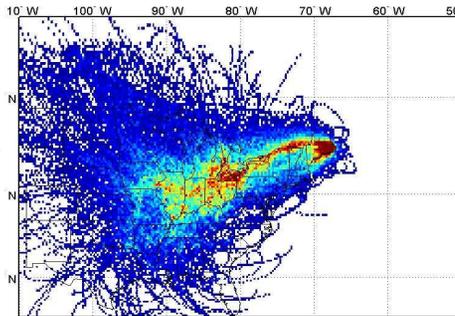
	Frequency	Proximity
Sulfate	1.12	3.68
Bext	27.26	68.86
PM	3.74	8.95
OC	1.48	2.08
# Trajs	257	485
# Trajs w. Poll	67	167
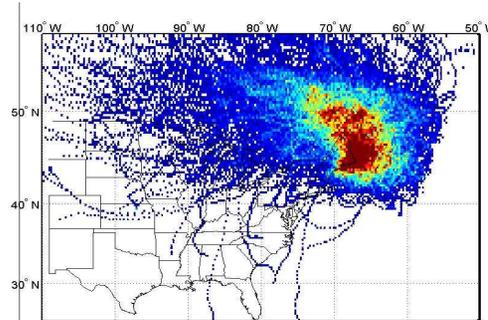
	Frequency	Proximity
Sulfate	0.95	3.32
Bext	24.11	64.52
PM	3.33	8.44
OC	1.31	2.18
# Trajs	147	781
# Trajs w. Poll	28	243

Lowest Sulfate (Proximity)
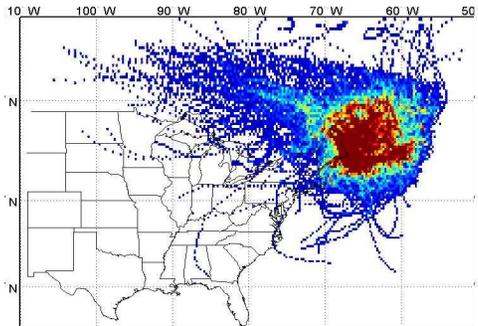
	Frequency	Proximity
Sulfate	1.26	1.28
Bext	26.61	27.63
PM	3.70	3.91
OC	1.20	1.25
# Trajs	378	492
# Trajs w. Poll	121	142
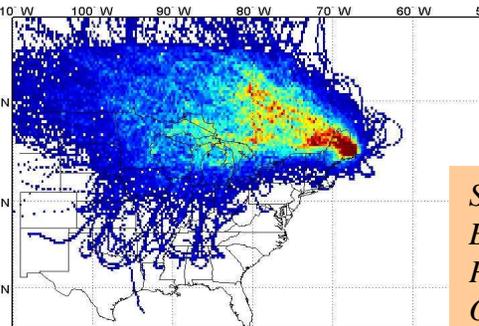
	Frequency	Proximity
Sulfate	2.86	1.42
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PM	7.05	4.71
OC	1.59	1.69
# Trajs	742	1052
# Trajs w. Poll	208	313

*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).

Moosehorn All Trajectories 00-04, Incremental Probability
IP Based on Top10%, 500m
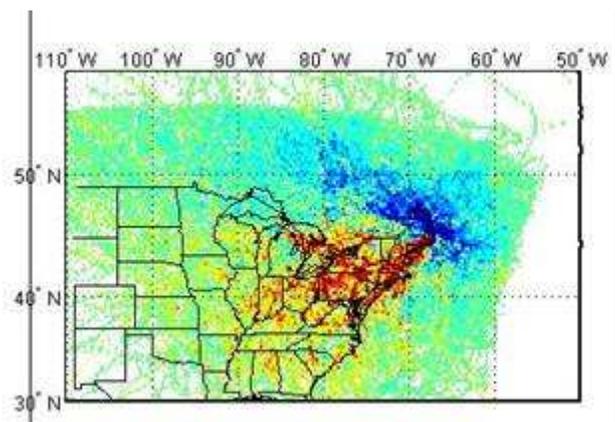
Sulfate
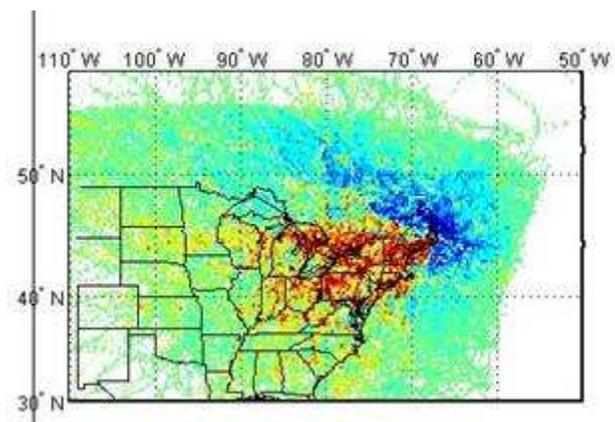
PM

OC
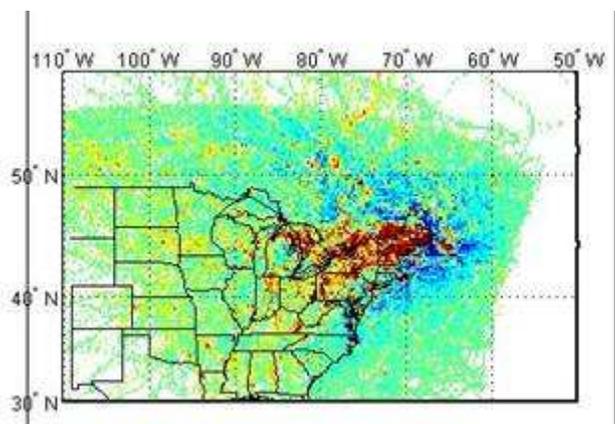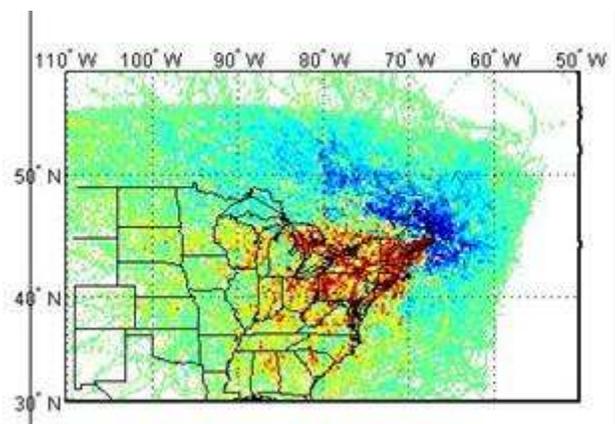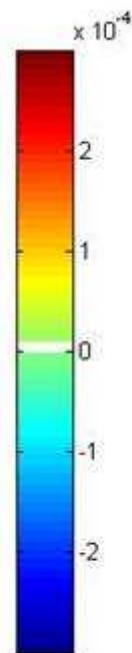
B-ext

Moosehorn All Trajectories 00-04, Cluster Weighted Probability

Calculated using Proximity Based Clusters, 500m
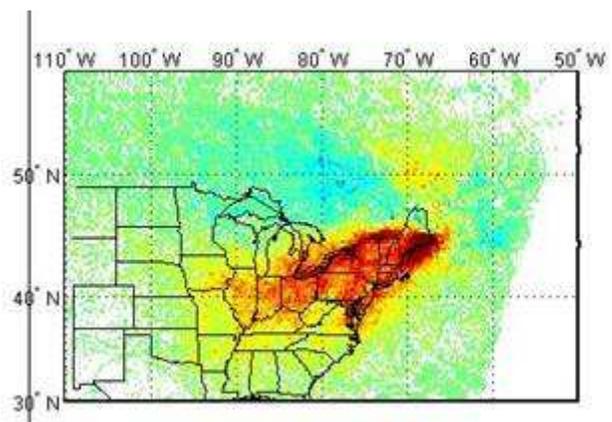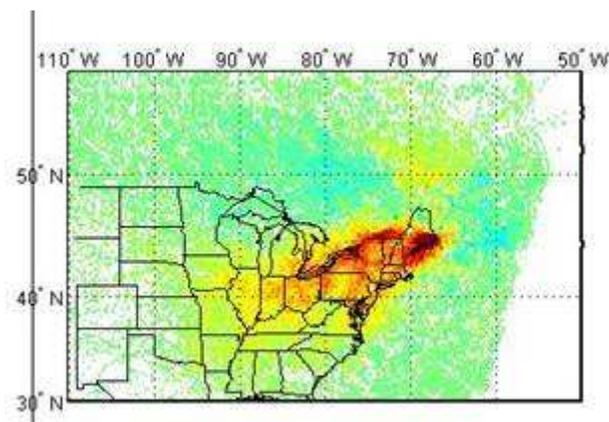
Sulfate

PM

OC
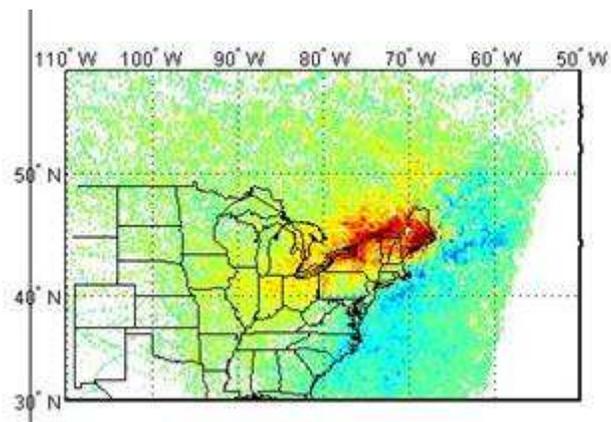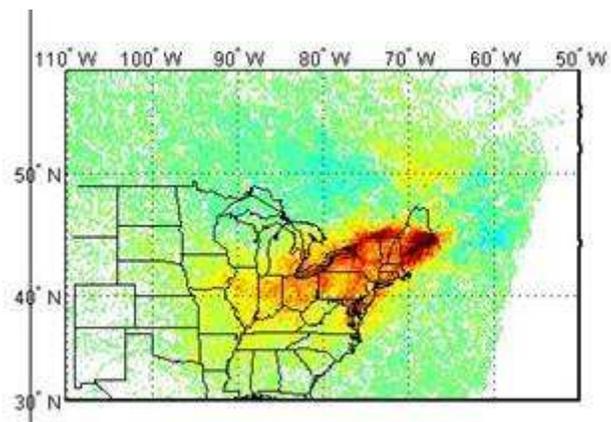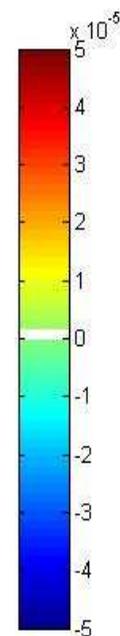
B-ext

Moosehorn All Trajectories 00-04, Cluster Weighted Probability
Calculated using Frequency Based Clusters, 500m

Sulfate

PM

OC

B-ext