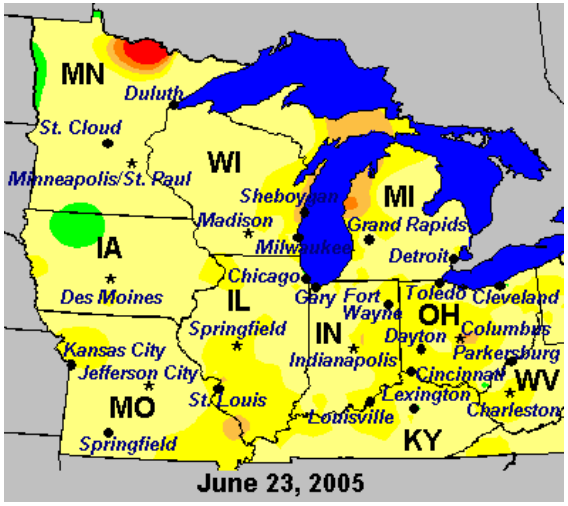
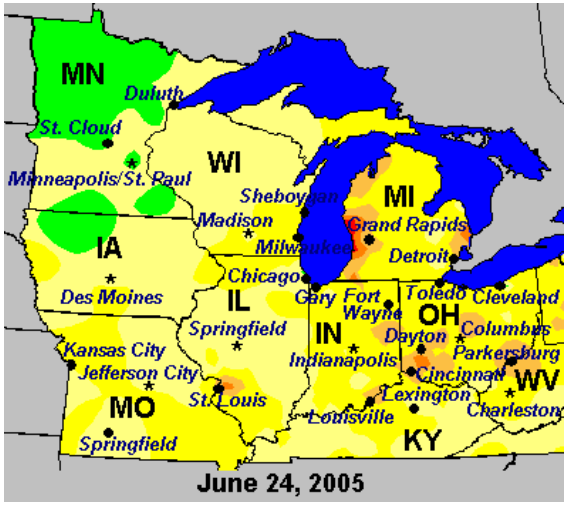
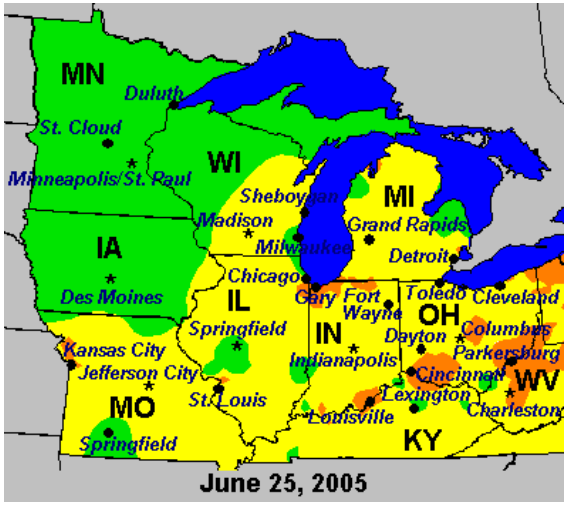
Comparison of OSAT and DDM

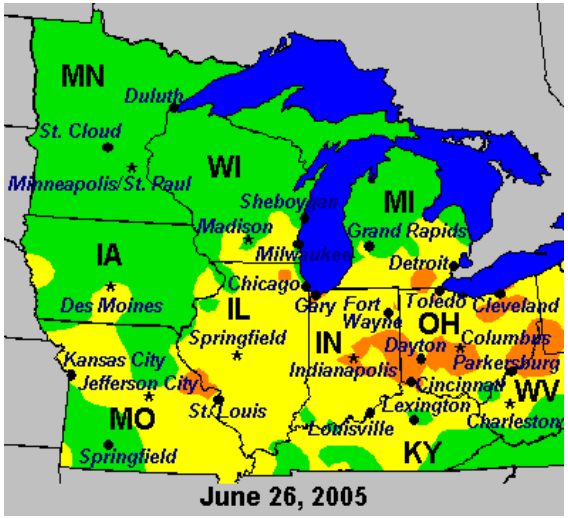
Analysis of June 2005 ozone episode

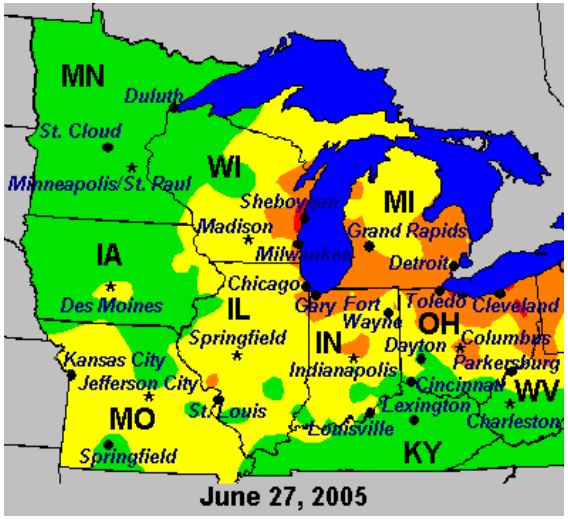
Late June 2005 Episode had lots of ozone

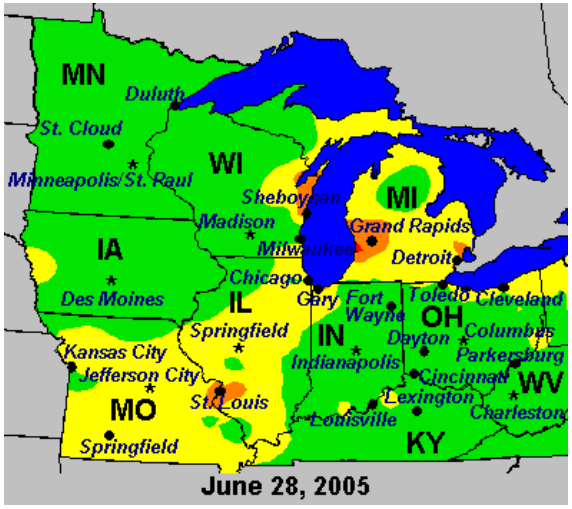












Illinois 8-hour Ozone Readings - June 2005 Episode

ILLINOIS 8-hour Ozone (ppm)			June 23	June 24	June 25	June 26	June 27
Site	**Site Address**	**Site ID**	**8-hour**	**8-hour**	**8-hour**	**8-hour**	**8-hour**
Alsip	4500 W. 123rd St.	170310001	0.073	0.073	**0.102**	0.078	**0.089**
Chicago	3300 E. Cheltenham Pl.	170310032	0.071	0.070	0.058	0.065	0.087
Chicago	Wacker At Adams	170310042	0.059	0.058	**0.103**	0.085	0.074
Chicago	5720 S. Ellis Ave.	170310064	0.070	0.071	0.063	0.074	**0.086**
Chicago	1000 E. Ohio	170310072	0.068	0.065	0.056	0.055	**0.096**
Chicago	7801 Lawndale	170310076	0.071	0.071	0.085	0.083	**0.086**
Chicago	6545 W. Hurlbut St.	170311003	0.073	0.072	0.071	0.084	0.084
Lemont	729 Houston	170311601	0.077	0.069	0.082	0.075	**0.087**
Cicero	1820 S. 51st Ave.	170314002	0.067	0.065	0.066	0.075	0.078
	9511 W. Harrison St.	170314007	0.071	0.068	0.065	0.075	0.082
Northbrook	750 Dundee Road	170314201	0.074	0.072	0.056	0.064	**0.086**
Evanston	531 E. Lincoln	170317002	0.050	0.051			**0.104**
Waukegan	Golf & Jackson St.	170971002	0.070	0.072	0.048	0.056	0.081
Zion	Illinois Beach State Park	170971007	0.079	0.080	0.055	0.059	0.084

Indiana 8-hour Ozone Readings - June 2005 Episode

INDIANA 8-hour Ozone (ppm)			June 23	June 24	June 25	June 26	June 27
Site	**Site Address**	**Site ID**	**8-hour**	**8-hour**	**8-hour**	**8-hour**	**8-hour**
Gary	IITRI	180890022	0.072	0.075	**0.102**	0.089	**0.089**
Whiting	Whiting H.S.	180890030	0.082	0.081	0.072	0.080	**0.092**
Hammond	1300 141st St.	180892008	0.077	0.075	**0.095**	**0.089**	**0.088**
Michigan City	NIPSCO	180910005	0.074	0.075	**0.097**	0.082	**0.091**
LaPorte	2011 E. Lincolnway	180910010	0.077	0.076	**0.090**	0.078	**0.089**
Ogden Dunes	Water Treatment Plant	181270024	0.074	0.073	**0.110**	**0.091**	**0.088**
Valparaiso	Valparaiso Water Dept.	181270026	0.073	0.071	0.076	0.074	**0.087**

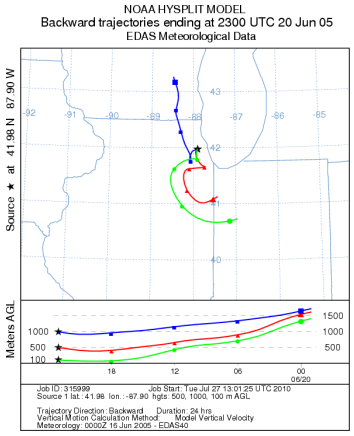
Michigan 8-hour Ozone Readings - June 2005 Episode

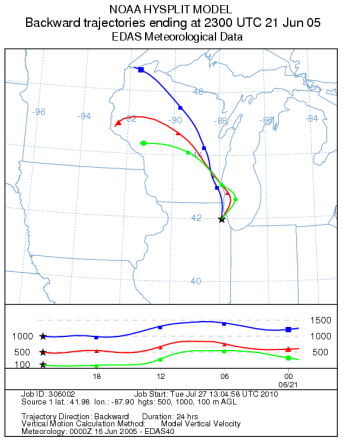
MICHIGAN 8-hour Ozone (ppm)			June 23	June 24	June 25	June 26	June 27
Site	**Site Address**	**Site ID**	**8-hour**	**8-hour**	**8-hour**	**8-hour**	**8-hour**
Holland	966 W. 32nd	260050003	0.083	**0.114**	0.063	0.063	**0.095**
Coloma	4689 Defield Rd.	260210014	0.076	**0.096**	0.074	0.068	**0.094**
Scottville	525 W US 10	261050007	**0.100**	**0.096**	0.041	0.042	0.085
Muskegon	1340 Green Creek Road	261210039	**0.090**	**0.114**	0.062	0.064	**0.091**
Jenison	6981 28th Ave.	261390005	0.072	**0.099**	0.075	0.066	**0.091**

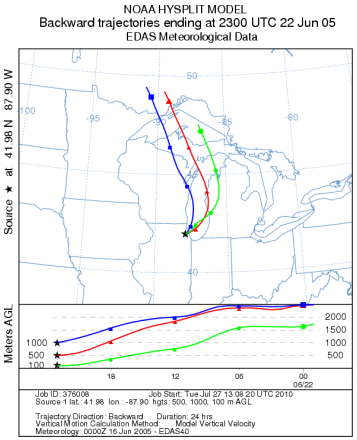
Wisconsin 8-hour Ozone Readings - June 2005 Episode

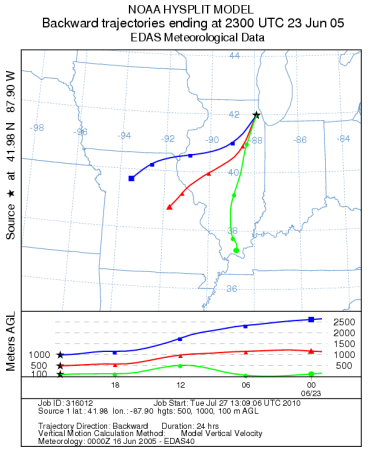
WISCONSIN 8-hour Ozone (ppm)			June 23	June 24	June 25	June 26	June 27
Site	**Site Address**	**Site ID**	**8-hour**	**8-hour**	**8-hour**	**8-hour**	**8-hour**
Door Co.	Newport State Park	550290004	**0.101**	0.074	0.036	0.051	**0.106**
Pleasant Prairie	Chiwaukee Prairie	550590019	**0.089**	0.085	0.060	0.066	**0.103**
Kewaunee	Kewaunee	550610002	0.085	0.074	0.042	0.055	**0.103**
Two Rivers	Manitowoc	550710007	**0.096**	0.081	0.041	0.051	**0.108**
Milwaukee	Health Center	550790010	0.071	0.080	0.042	0.058	**0.097**
Milwaukee	DNR Headquarters	550790026	0.066	0.076	0.052	0.069	**0.096**
Milwaukee	UWM North Campus	550790041	0.073	0.084	0.051	0.067	**0.097**
Milwaukee	7528 W. Appleton Ave.	550790044	0.075	0.085	0.054	0.071	**0.099**
Bayside	601 E. Ellsworth Lane	550790085	0.078	0.085	0.050	0.069	**0.104**
Grafton	Grafton	550890008	0.076	0.080	0.041	0.067	**0.105**
Ozaukee Co.	Harrington Beach State Park	550890009	**0.087**	0.085	0.045	0.063	**0.107**
Racine	1519 Washington Ave.	551010017	0.073	0.083	0.053	0.066	**0.098**
Sheboygan Co.	Kohler Andre Park	551170006	**0.097**	0.085	0.049	0.055	**0.111**

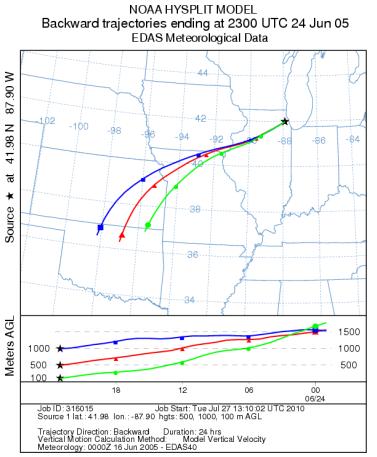
Back trajectories from ozone episode

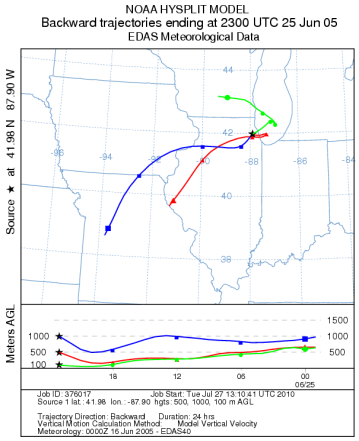


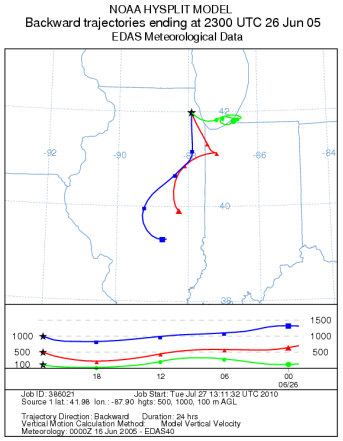


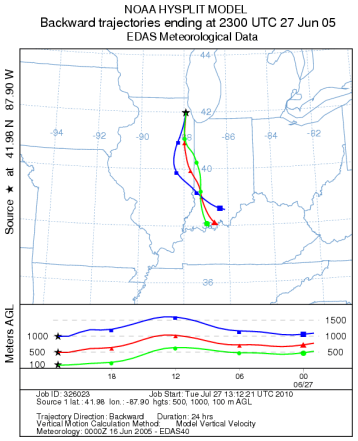


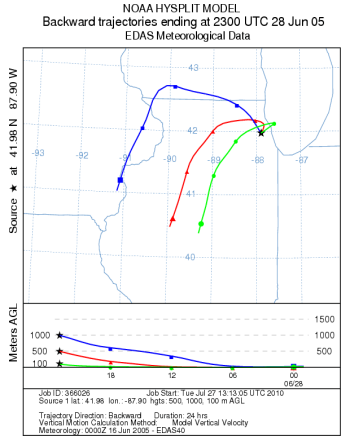


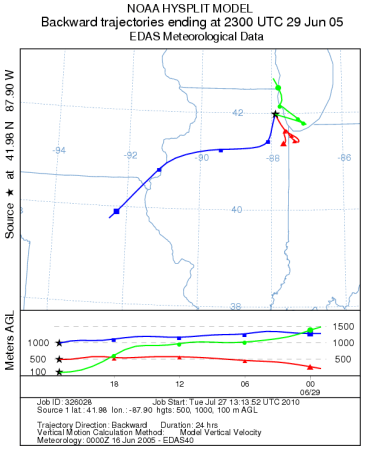




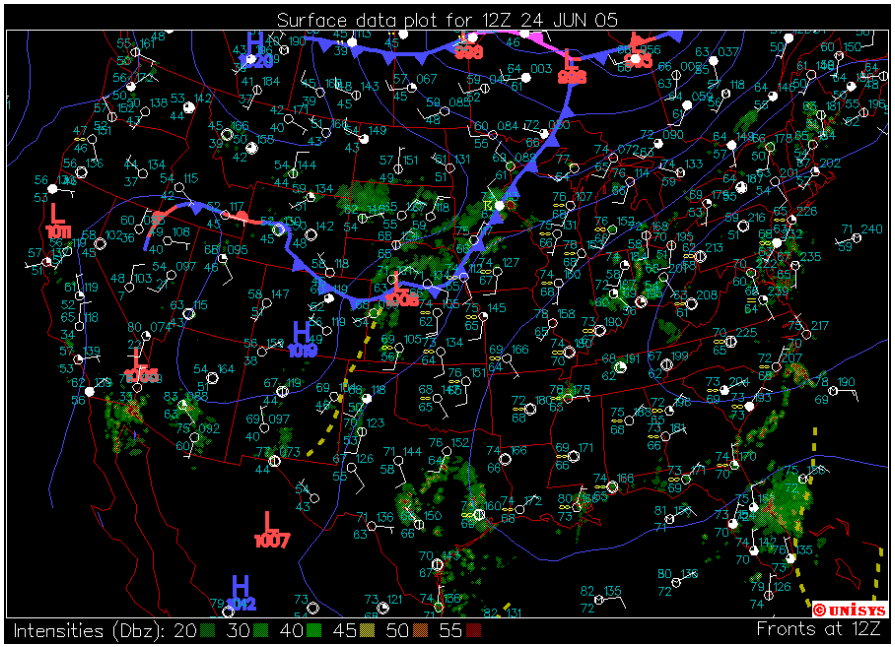


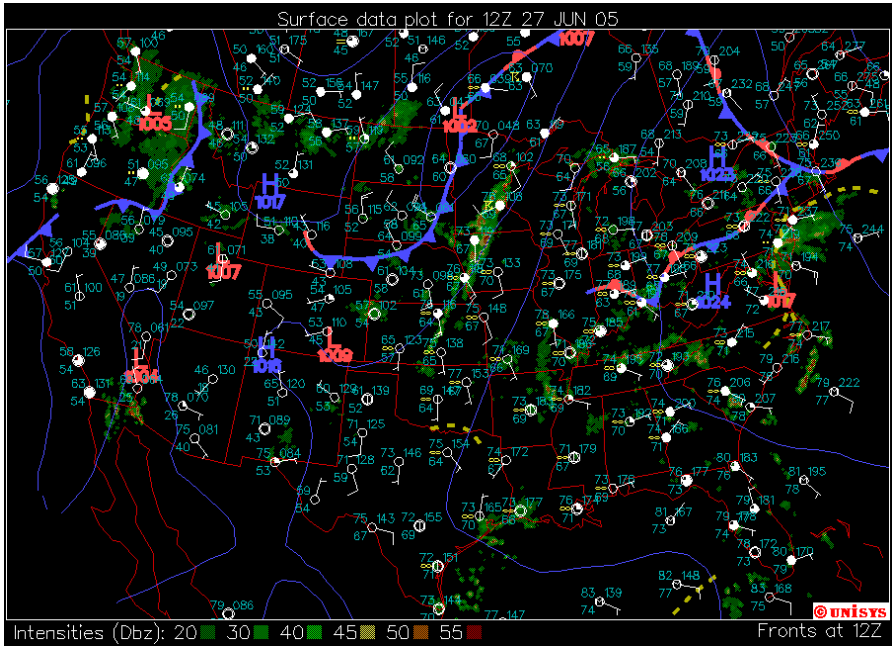






Synoptic Analysis of Ozone Episode





DDM Input Section

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&DDM_Control
 DDM_File_Root             = '$OUT/$stdate.$CGRID.$CRES.$NZ.$CCASE.ld.$MODEL',
 DDM_Master_Sfc_Output      = .true.,
 DDM_Nested_Sfc_Output      = .true.,
 DDM_Stratify_Boundary      = .false.,
 DDM_Number_of_Source_Regions  = 1,
 DDM_Number_of_Source_Groups   = 5,
 Number_of_IC_Species_Groups  = 0,
 IC_Species_Groups(1)       = ' ',
 Number_of_BC_Species_Groups  = 0,
 BC_Species_Groups(1)       = '',
 Number_of_EM_Species_Groups  = 2,
 Emis_Species_Groups(1)     = 'NOX',
 Emis_Species_Groups(2)     = 'VOC',
 Number_of_Rate_Const_Groups  = 0,
 Rate_Const_Groups(1)       = ' ',
 Number_of_HDDM_Sens_Groups   = 9,
 HDDM_parameters(1,1)       = 'EM0201NOX_',
 HDDM_parameters(1,2)       = 'EM0201VOC_',
 HDDM_parameters(2,1)       = 'EM0201NOX_',
 HDDM_parameters(2,2)       = 'EM0201NOX_',
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 HDDM_parameters(3,2)       = 'EM0201VOC_',
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 HDDM_parameters(9,2)       = 'EM0501VOC_',
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Number of the source regions and groups to be modeled

Initial Conditions species to be modeled

Boundary Conditions species to be modeled

Emission species to be tracked

Reaction rate sensitivity groups to be tracked

High Decoupled Direct Method sensitivity groups to be tracked

DDM Input Section

```
DDM_Receptor_Definitions     = '$HOME/osat/osat.monitors.ld.txt',
DDM_Source_Area_Map(1)       = '$HOME/osat/osat.36.uniform.txt',
DDM_Source_Area_Map(2)       = '$HOME/osat/osat.12.uniform.txt',
DDM_Calc_Grid(1)             = .true.,
DDM_Calc_Grid(2)             = .true.,
DDM_Master_Restart           = '$OUT2/$yesterday.$CGRID.$CRES.$NZ.$CCASE.ld.$MODEL.sa.inst',
DDM_Nested_Restart           = '$OUT2/$yesterday.$CGRID.$CRES.$NZ.$CCASE.ld.$MODEL.sa.finst',

DDM_Points_Group(2)          = '$PTSRDIR/ptsr.$stdate.$PGRID.NR.baseM_ddm.ld.camx',

DDM_Emiss_Group_Grid(1,1) = '$ESAT2/lamb.$stdate.4rpos.36.2005Mnh3+meganv2proxy.ld.camx',
DDM_Emiss_Group_Grid(1,2) = '$ESAT2/lamb.$stdate.upmw.12.2005Mnh3+meganv2proxy.ld.camx',
DDM_Emiss_Group_Grid(2,1) = '$ESAT/lamb.$stdate.4rpos.36.M_noneguLOWP+canada.ld.camx',
DDM_Emiss_Group_Grid(2,2) = '$ESAT/lamb.$stdate.upmw.12.M_noneguLOWP+canada.ld.camx',
DDM_Emiss_Group_Grid(3,1) = '$ESAT/lamb.$stdate.4rpos.36.M_nonroad+mar.ld.camx',
DDM_Emiss_Group_Grid(3,2) = '$ESAT/lamb.$stdate.upmw.12.M_nonroad+mar.ld.camx',
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DDM_Emiss_Group_Grid(5,2) = '$ESAT/area.$stdate.upmw.12.other_baseM.ld.camx',
```

Source area maps for receptors for 36 km and 12 km grids

DDM restart files For 36 km and 12 km grids

Point sources group

NH3 and biogenic groups

Non-egu groups

Nonroad and mar groups

Motv groups

Area groups

HDDM Sensitivity Groups for DDM Model Run

- Group – Looks at the sensitivity to emissions domain-wide.
  - Emissions species modeled were NOx and VOC
  - Emissions groups were motor vehicle, non-EGU, point, area and nonroad

- Region – Looks at the emissions from the Chicago area, Illinois and remaining domain.
  - Emissions species modeled were NOx and VOC
  - Emissions groups were anthropogenic and boundary condition

Challenges Encountered Running DDM

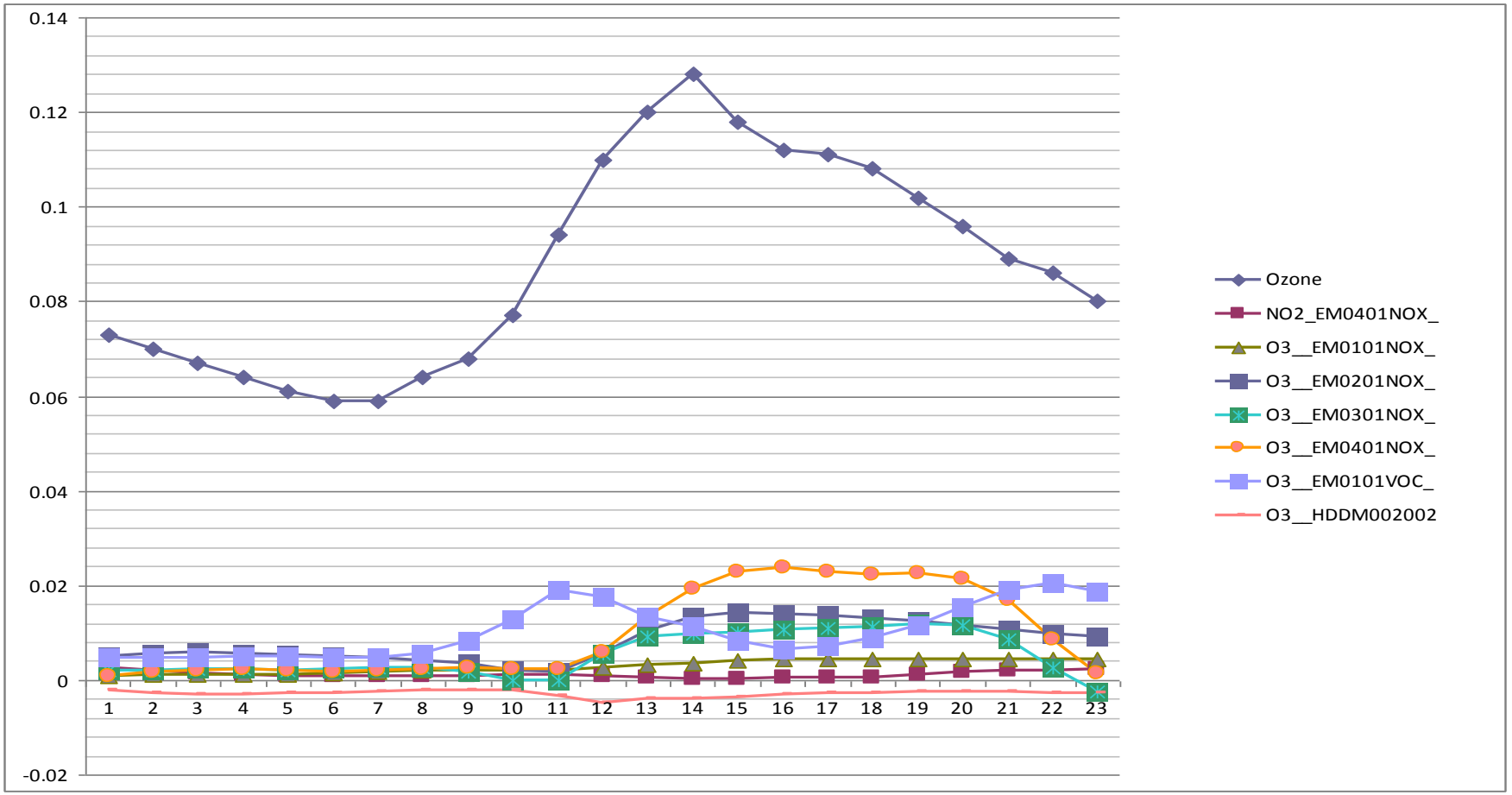
- Develop new Control input section
- New restart files for regular CAMx and DDM portions of the run
- Receptor Definition files/Source area maps recognition by model
- Recompiled version of source code for CAMx
- Determination of sensitivity groups and species to model
- Computing speed
- Post-processing programs

Diagnostic File for DDM

- Number of IC groups : 0
- No IC species modeled.
- Number of BC groups : 0
- No BC species modeled.
- Number of EM groups : 2
- 1: NOX
- 2: VOC
- Number of rate const groups: 0
- No rate constant sens modeled.
- Number of HDDM sens groups : 9
- 1: EM0201NOX_, EM0201VOC_
- 2: EM0201NOX_, EM0201NOX_
- 3: EM0201VOC_, EM0201VOC_
- 4: EM0401NOX_, EM0401VOC_
- 5: EM0401NOX_, EM0401NOX_
- 6: EM0401VOC_, EM0401VOC_
- 7: EM0501NOX_, EM0501VOC_
- 8: EM0501NOX_, EM0501NOX_
- 9: EM0501VOC_, EM0501VOC_
- DDM turn-off flags are shown below after the nested-grid maps.
- Average species 1 O3 mapped to modeled species 5 O3
- Average species 2 NO mapped to modeled species 3 NO
- Average species 3 NO2 mapped to modeled species 4 NO2
-

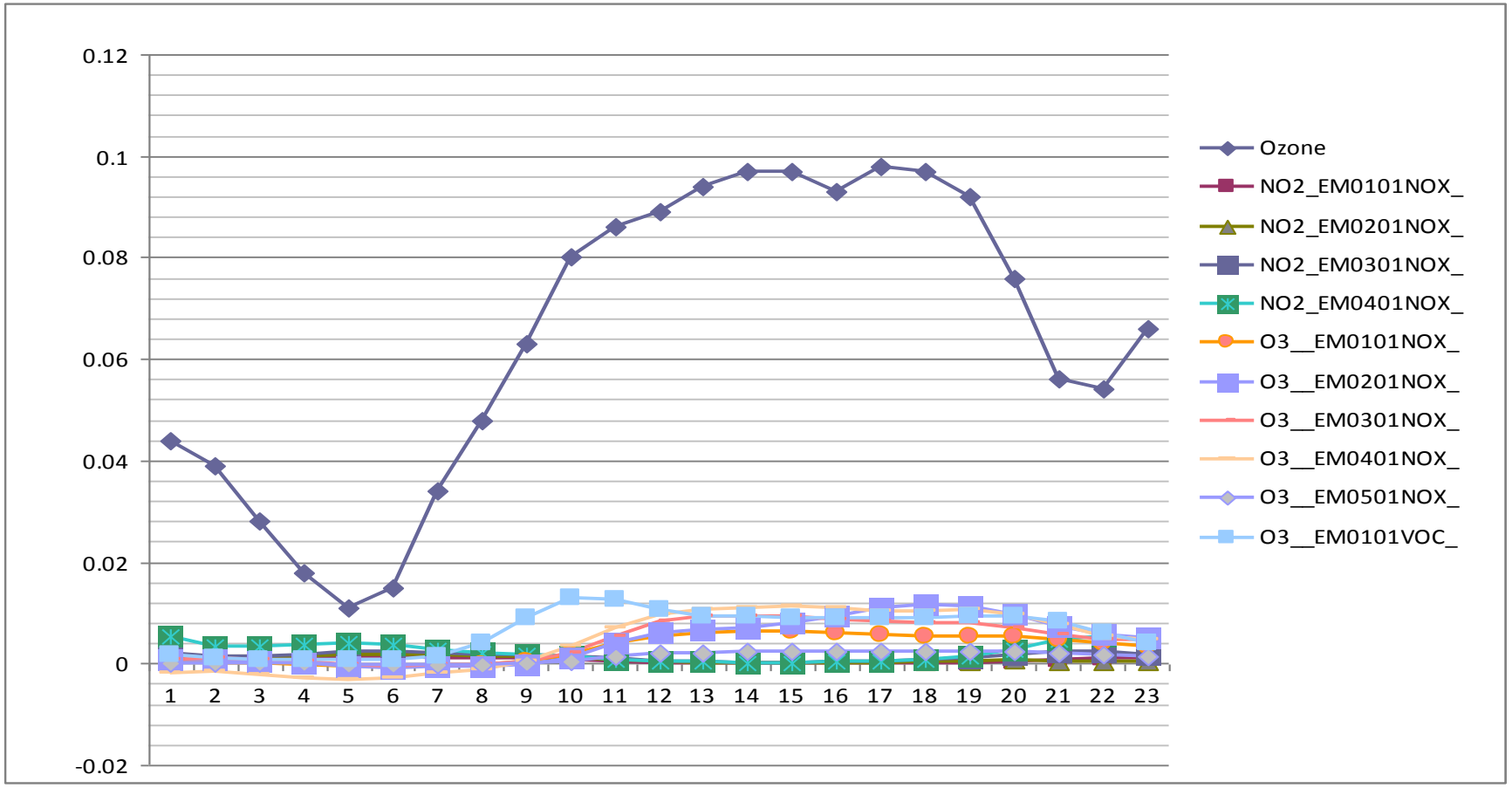
Affected Species	Influencing Species	Source Type	Group	Long Region	Name	Short Name
O3	NOX	EM	1	1	O3__EM0101NOX_	05E0101NOX
O3	NOX	EM	2	1	O3__EM0201NOX_	05E0201NOX
O3	NOX	EM	3	1	O3__EM0301NOX_	05E0301NOX
O3	NOX	EM	4	1	O3__EM0401NOX_	05E0401NOX
O3	NOX	EM	5	1	O3__EM0501NOX_	05E0501NOX
O3	VOC	EM	1	1	O3__EM0101VOC_	05E0101VOC
O3	VOC	EM	2	1	O3__EM0201VOC_	05E0201VOC
O3	VOC	EM	3	1	O3__EM0301VOC_	05E0301VOC
O3	VOC	EM	4	1	O3__EM0401VOC_	05E0401VOC
O3	VOC	EM	5	1	O3__EM0501VOC_	05E0501VOC
O3	EM0201NOX_ & EM0201VOC_				O3__HDDM002007	05HDDM0207
O3	EM0201NOX_ & EM0201NOX_				O3__HDDM002002	05HDDM0202
O3	EM0201VOC_ & EM0201VOC_				O3__HDDM007007	05HDDM0707
O3	EM0401NOX_ & EM0401VOC_				O3__HDDM004009	05HDDM0409
O3	EM0401NOX_ & EM0401NOX_				O3__HDDM004004	05HDDM0404
O3	EM0401VOC_ & EM0401VOC_				O3__HDDM009009	05HDDM0909
O3	EM0501NOX_ & EM0501VOC_				O3__HDDM005010	05HDDM0510
O3	EM0501NOX_ & EM0501NOX_				O3__HDDM005005	05HDDM0505
O3	EM0501VOC_ & EM0501VOC_				O3__HDDM010010	05HDDM1010

DDM (Group) Results for Holland, Michigan
June 24, 2005



Maximum 8-Hour Reading for Holland was 0.114 ppm
Biggest NOx contributors were non-EGU and Motor Vehicle
Biggest VOC contributors were Biogenics

DDM (Group) Results for Holland, Michigan
June 27, 2005

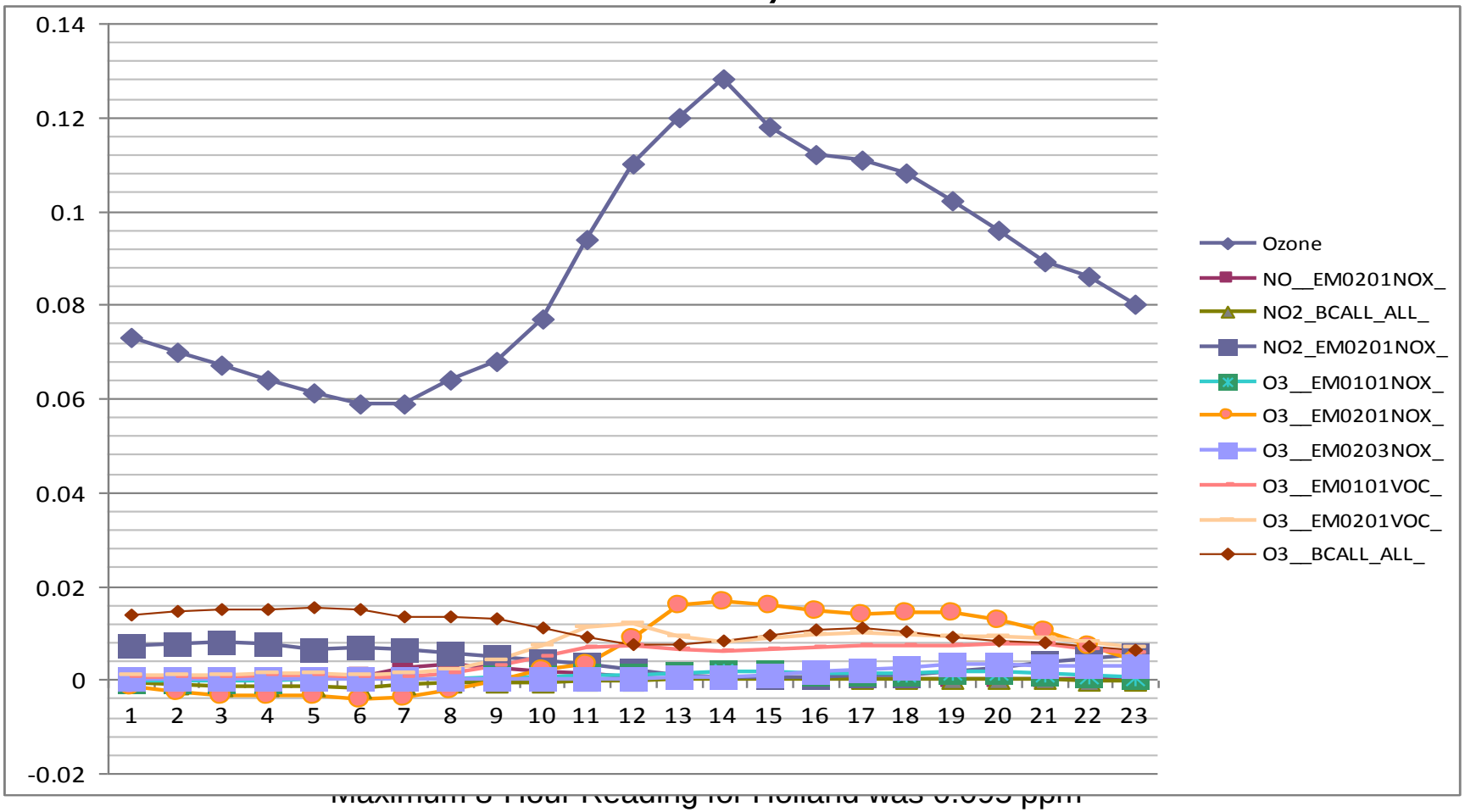


Maximum 8-Hour Reading for Holland was 0.095 ppm

Biggest Nox contributors were non-EGU and motor vehicle

Biggest VOC contributors were biogenics

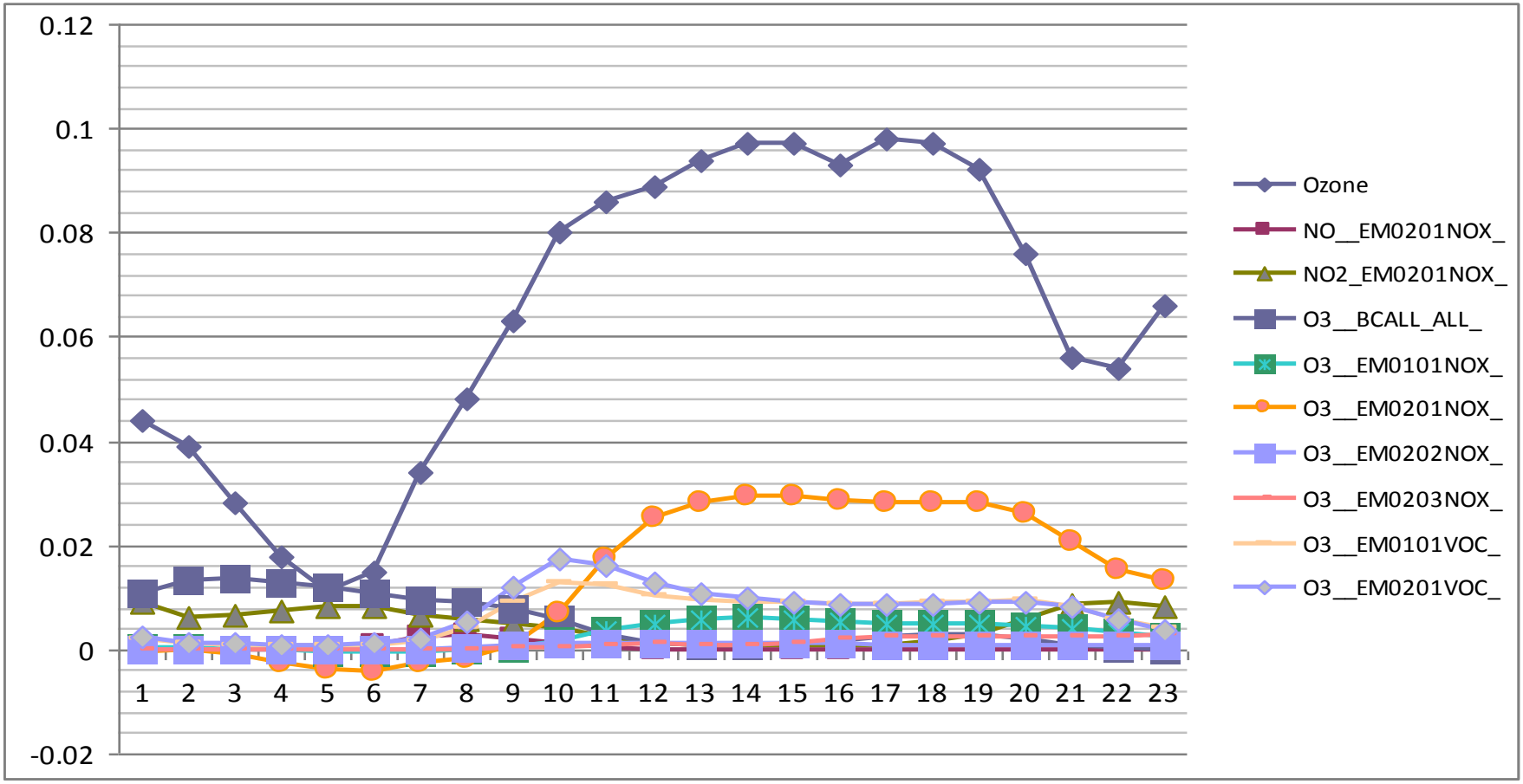
DDM (Region) Results for Holland, Michigan
June 24, 2005



Maximum 8 Hour Reading for Holland was 0.095 ppm

Biggest NOx contributors were anthropogenic emission from domain (minus Chicago/Illinois)
Biggest VOC contributors were Boundary Conditions in morning and anthropogenic emission from domain (minus Chicago/Illinois)

DDM (Region) Results for Holland, Michigan
June 27, 2005



Maximum 8-Hour Reading for Holland was 0.095 ppm

Biggest NOx contributors were anthropogenic emission from domain (minus Chicago/Illinois) with anthropogenic emissions from Illinois then anthropogenic emissions from Chicago

Biggest VOC contributors were anthropogenic emission from domain (minus Chicago/Illinois)

Summary of Results of DDM analysis

- 8-hour ozone averages were determined based on the sensitivities and regions modeled
- Results for Holland during high ozone days showed domain-wide emissions were large contributors as expected.
  - Boundary Conditions dominate early morning concentrations
  - NOx and VOC emission had higher impacts in the afternoon
  - Non-EGU and motor vehicle emissions had the highest impacts at Holland during this ozone episode
- More results and post-processing need to be conducted on results

Special Acknowledgments for DDM analysis

- Abby Fontaine – LADCO
- Chris Emery – Environ
- Bonyoung Koo – Environ
- Jeremiah Johnson - Environ