

TSD-1b

**Processing of Biogenic Emissions for OTC / MANE-VU
Modeling**

**Bureau of Air Quality Analysis and Research
Division of Air Resources
New York State Department of Environmental Conservation
Albany, NY 12233**

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Biogenic emissions for the time period from January 1, 2002 – December 31, 2002 were calculated by NYSDEC using the Biogenic Emissions Inventory System (BEIS) version 3.12 integrated within SMOKE2.1. General information about BEIS is available at <http://www.epa.gov/AMD/biogen.html> while documentation about biogenic emissions processing within SMOKE2.1 is available at <http://cf.unc.edu/cep/empd/products/smoke/version2.1/html/ch06s10.html> and <http://cf.unc.edu/cep/empd/products/smoke/version2.1/html/ch06s17.html>. Note that the SMOKE documentation refers to BEIS3.09 and has not yet been updated for BEIS3.12. This affects the number of species modeled as well as the use of different speciation profiles. However, the general processing approach has not changed from BEIS3.09 to BEIS3.12. In short, this processing approach is as follows and was utilized by NYSDEC for its biogenic emission processing for 8-hr ozone and PM_{2.5} modeling:

1. **Normbeis3** reads gridded land use data and emissions factors and produces gridded normalized biogenic emissions for 34 species/compounds. The gridded land use includes 230 different land use types. Both summer and winter emissions factors for each species/compound are provided for each of the 230 land use types. On output, **Normbeis3** generates a file B3GRD which contains gridded summer and winter emission fluxes for the modeling domain that are normalized to 30 °C and a photosynthetic active radiation (PAR) of 1000 μmol/m²s. In addition, gridded summer and winter leaf area indices (LAI) are also written to B3GRD.
2. **Tmpbeis3** reads the gridded, normalized emissions file B3GRD and meteorological data from the MCIP-processed MM5 meteorological fields generated by the University of Maryland for MANE-VU/OTC modeling. Specifically, the following MM5/MCIP meteorological variables are used by **Tmpbeis3** to compute hour-specific, gridded biogenic emissions from the normalized emission fluxes contained in B3GRD: layer-1 air temperature (“TA”), layer-1 pressure (“PRES”), total incoming solar radiation at the surface (“RGRND”), and convective (“RC”) and non-convective (“RN”) rainfall. Additionally, the emissions for the 34 species/compounds modeled by BEIS3.12 are converted to CO, NO, and the CB-IV

VOC species utilized in CMAQ via the use of the BEIS3.12-CB-IV speciation profile. In addition, an optional seasonal switch file, `BIOSEASON`, was utilized to decide whether to use summer or winter emissions factors for any given grid cell on any given day. This file was generated by the SMOKE2.1 utility **Metscan** based on MM5 layer-1 air temperatures to determine the date of the last spring frost and first fall frost at each grid cell. Summer emission factors are used by **Tmpbeis3** for the time period between the last spring frost and first fall frost at any given grid cell, and winter emission factors are used for the remaining time period. Documentation for the **Metscan** utility is available at

<http://cf.unc.edu/cep/empd/products/smoke/version2.1/html/ch05s07.html> . An animated GIF file showing the `BIOSEASON` file used by NYSDEC can be found at ftp://ftp.dec.state.ny.us/dar/air_research/chogrefe/biog_reports/b3season_movie.gif

3. For reporting purposes, the hourly, speciated, gridded emissions were aggregated to the county level for each day. For any given grid cell, emissions are distributed among the counties intersecting this grid cell in proportion to the area of each of these counties within the grid cell. The area gridding surrogates needed for this aggregation are based on a file obtained from EPA via http://www.epa.gov/ttn/chief/emch/spatial/new/bgpro.12km_041604.us.gz followed by windowing for the MANE-VU/OTC modeling domain.

Table 1 County and State totals of estimated biogenic emissions (tpy)

State	FIPS	County	NO [TPY]	CO [TPY]	VOC [TPY]
Connecticut	009001	Fairfield	52	894	7150
	009003	Hartford	88	915	8537
	009005	Litchfield	98	1261	12221
	009007	Middlesex	54	615	5587
	009009	New Haven	80	876	7544
	009011	New London	74	906	8960
	009013	Tolland	55	651	5999
	009015	Windham	60	772	8019
Connecticut		TOTAL	560	6889	64017
Deleware	010001	Kent	308	1354	15912
	010003	New Castle	143	875	8834
	010005	Sussex	539	2045	21595
Deleware		TOTAL	990	4274	46342
DC	011001	Washington	30	150	1726
DC		TOTAL	30	150	1726
Maine	023001	Androscoggin	35	885	8204
	023003	Aroostook	741	15531	140877
	023005	Cumberland	49	1298	11528
	023007	Franklin	72	3269	32111
	023009	Hancock	66	2950	27090
	023011	Kennebec	73	1425	12849
	023013	Knox	30	689	6680
	023015	Lincoln	32	849	8072
	023017	Oxford	79	3224	34189
	023019	Penobscot	211	7249	63128
	023021	Piscataquis	146	8638	80748
	023023	Sagadahoc	37	526	4504
	023025	Somerset	173	8413	77850
	023027	Waldo	57	1833	18125
	023029	Washington	144	6459	58678
023031	York	73	1698	15571	
Maine		TOTAL	2018	64936	600203
Maryland	024001	Allegany	63	661	8664
	024003	Anne Arundel	79	945	12786
	024005	Baltimore	166	847	8102
	024009	Calvert	59	798	10048
	024011	Caroline	202	648	7907

	024013 Carroll	189	822	7853
	024015 Cecil	86	654	10093
	024017 Charles	78	1079	15042
	024019 Dorchester	134	829	10337
	024021 Frederick	204	1123	10964
	024023 Garrett	102	930	11391
	024025 Harford	141	911	9053
	024027 Howard	75	562	4460
	024029 Kent	177	498	4761
	024031 Montgomery	134	813	6786
	024033 Prince Georges	87	732	10214
	024035 Queen Annes	222	684	7146
	024037 St Marys	99	886	10793
	024039 Somerset	58	498	5796
	024041 Talbot	131	495	5225
	024043 Washington	112	781	7538
	024045 Wicomico	124	796	10304
	024047 Worcester	158	1121	13079
	024510 Baltimore	54	235	1762
Maryland	TOTAL	2934	18350	210104
Massachusetts	025001 Barnstable	261	668	5905
	025003 Berkshire	73	1182	11029
	025005 Bristol	107	753	7142
	025007 Dukes	115	252	1728
	025009 Essex	55	794	7128
	025011 Franklin	61	1031	9424
	025013 Hampden	51	904	9201
	025015 Hampshire	61	820	7056
	025017 Middlesex	68	1085	11630
	025019 Nantucket	56	159	1362
	025021 Norfolk	49	615	5513
	025023 Plymouth	170	1197	11876
	025025 Suffolk	26	177	1351
	025027 Worcester	103	1955	23612
Massachusetts	TOTAL	1257	11594	113957
New Hampshire	033001 Belknap	25	693	6915
	033003 Carroll	40	1512	14981
	033005 Cheshire	49	1019	10099
	033007 Coos	72	3239	33668
	033009 Grafton	91	2442	23151
	033011 Hillsborough	48	1337	14503
	033013 Merrimack	48	1314	13566
	033015 Rockingham	39	1120	10080
	033017 Strafford	25	686	6617
	033019 Sullivan	45	943	8314
New Hampshire	TOTAL	482	14306	141894

New Jersey	034001 Atlantic	135	1225	18890
	034003 Bergen	37	239	2455
	034005 Burlington	151	1827	25255
	034007 Camden	68	491	7751
	034009 Cape May	90	566	7763
	034011 Cumberland	122	773	10699
	034013 Essex	57	199	1831
	034015 Gloucester	119	556	8444
	034017 Hudson	26	125	701
	034019 Hunterdon	81	706	5743
	034021 Mercer	85	475	4889
	034023 Middlesex	98	456	5267
	034025 Monmouth	125	1152	15423
	034027 Morris	63	604	7288
	034029 Ocean	128	1871	27063
	034031 Passaic	41	339	3841
	034033 Salem	123	535	8304
	034035 Somerset	49	518	5548
	034037 Sussex	67	718	7768
	034039 Union	21	168	2191
	034041 Warren	125	517	4505
New Jersey	TOTAL	1813	14058	181618

New York	036001 Albany	59	730	6253
	036003 Allegany	129	1218	9526
	036005 Bronx	25	100	657
	036007 Broome	107	879	7861
	036009 Cattaraugus	148	1654	13540
	036011 Cayuga	227	986	7928
	036013 Chautauqua	202	1260	8144
	036015 Chemung	88	521	3911
	036017 Chenango	149	1120	7833
	036019 Clinton	138	1631	13341
	036021 Columbia	96	896	8484
	036023 Cortland	101	616	4280
	036025 Delaware	133	1672	13435
	036027 Dutchess	90	1096	10288
	036029 Erie	165	1127	6898
	036031 Essex	94	2547	20888
	036033 Franklin	228	2337	17197
	036035 Fulton	90	764	5275
	036037 Genesee	201	645	3993
	036039 Greene	47	886	8182
	036041 Hamilton	78	2092	16056
	036043 Herkimer	175	1783	12846
	036045 Jefferson	251	1754	12503
	036047 Kings	15	60	309

036049 Lewis	154	1693	12116	
036051 Livingston	222	888	6048	
036053 Madison	149	1049	7528	
036055 Monroe	223	990	6237	
036057 Montgomery	106	579	4715	
036059 Nassau	81	408	2859	
036061 New York	16	76	473	
036063 Niagara	335	940	5182	
036065 Oneida	214	1515	10021	
036067 Onondaga	171	929	6259	
036069 Ontario	178	767	6024	
036071 Orange	110	1065	13024	
036073 Orleans	195	635	3314	
036075 Oswego	119	1277	7911	
036077 Otsego	157	1190	7958	
036079 Putnam	32	473	5243	
036081 Queens	20	105	543	
036083 Rensselaer	96	894	7316	
036085 Richmond	47	173	1292	
036087 Rockland	26	300	4006	
036089 St. Lawrence	376	3876	28960	
036091 Saratoga	76	1125	9010	
036093 Schenectady	39	377	3032	
036095 Schoharie	95	737	5496	
036097 Schuyler	87	438	3193	
036099 Seneca	127	438	3305	
036101 Steuben	267	1475	12085	
036103 Suffolk	368	1328	12886	
036105 Sullivan	76	1325	12538	
036107 Tioga	102	730	5400	
036109 Tompkins	96	576	4128	
036111 Ulster	82	1493	15714	
036113 Warren	46	1396	11568	
036115 Washington	183	1109	8355	
036117 Wayne	270	920	5940	
036119 Westchester	35	549	5347	
036121 Wyoming	194	720	3813	
036123 Yates	107	507	4017	
New York	TOTAL	8313	63436	492483
Pennsylvania	042001 Adams	186	892	8926
	042003 Allegheny	182	948	6727
	042005 Armstrong	108	940	9955
	042007 Beaver	69	600	4895
	042009 Bedford	128	1249	14127
	042011 Berks	280	1377	14146
	042013 Blair	91	729	7579
	042015 Bradford	224	1265	9423

042017 Bucks	144	954	8399
042019 Butler	149	1032	8602
042021 Cambria	128	805	6545
042023 Cameron	25	627	7563
042025 Carbon	53	585	8121
042027 Centre	158	1344	16886
042029 Chester	264	1176	10474
042031 Clarion	85	848	10743
042033 Clearfield	149	1368	13267
042035 Clinton	71	1230	18191
042037 Columbia	106	802	9080
042039 Crawford	204	1297	10839
042041 Cumberland	193	816	9505
042043 Dauphin	116	799	8502
042045 Delaware	35	410	3250
042047 Elk	49	949	8921
042049 Erie	199	1107	8273
042051 Fayette	156	1087	9277
042053 Forest	26	577	7122
042055 Franklin	271	1057	10296
042057 Fulton	93	744	9341
042059 Greene	91	830	6966
042061 Huntingdon	135	1093	12606
042063 Indiana	144	1078	9156
042065 Jefferson	101	865	7362
042067 Juniata	79	588	8263
042069 Lackawanna	58	586	5569
042071 Lancaster	464	1299	9565
042073 Lawrence	114	503	3755
042075 Lebanon	155	623	5827
042077 Lehigh	149	594	6040
042079 Luzerne	75	1013	13215
042081 Lycoming	152	1457	16633
042083 Mc Kean	57	1044	7113
042085 Mercer	175	865	7114
042087 Mifflin	107	620	7508
042089 Monroe	75	773	8856
042091 Montgomery	106	812	6736
042093 Montour	85	321	3306
042095 Northampton	144	506	4416
042097 Northumberland	92	570	6340
042099 Perry	113	804	10216
042101 Philadelphia	29	194	1420
042103 Pike	37	757	9946
042105 Potter	89	1129	9027
042107 Schuylkill	123	1050	15001
042109 Snyder	88	538	6373
042111 Somerset	221	1251	11228

	042113 Sullivan	45	684	5112
	042115 Susquehanna	126	978	6448
	042117 Tioga	176	1313	10942
	042119 Union	71	541	6435
	042121 Venango	72	855	9086
	042123 Warren	76	1031	7352
	042125 Washington	166	1068	7429
	042127 Wayne	89	862	5954
	042129 Westmoreland	199	1297	10589
	042131 Wyoming	60	551	4634
	042133 York	366	1393	12758
Pennsylvania	TOTAL	8645	59945	585271
Rhode Island	044001 Bristol	40	90	441
	044003 Kent	41	328	3471
	044005 Newport	37	183	1646
	044007 Providence	39	591	6901
	044009 Washington	54	572	6775
Rhode Island	TOTAL	211	1764	19233
Vermont	050001 Addison	186	922	6274
	050003 Bennington	43	896	7349
	050005 Caledonia	58	1149	10239
	050007 Chittenden	74	606	3633
	050009 Essex	61	1315	11795
	050011 Franklin	208	971	5927
	050013 Grand Isle	50	490	3506
	050015 Lamoille	36	727	5627
	050017 Orange	57	1182	10120
	050019 Orleans	120	1570	12842
	050021 Rutland	102	1257	9867
	050023 Washington	47	1099	9502
	050025 Windham	42	1232	10898
	050027 Windsor	57	1330	10796
Vermont	TOTAL	1142	14745	118376
Virginia	051001 Accomack	187	959	9472
	051003 Albemarle	140	1246	12533
	051005 Alleghany	35	522	7369
	051007 Amelia	70	915	10717
	051009 Amherst	80	905	10823
	051011 Appomattox	76	830	10447
	051013 Arlington	17	64	531
	051015 Augusta	135	1049	13291
	051017 Bath	46	771	11636
	051019 Bedford	189	1279	13052
	051021 Bland	41	515	7097
	051023 Botetourt	74	780	10211

051025 Brunswick	98	1458	18254
051027 Buchanan	32	722	9557
051029 Buckingham	76	1287	18830
051031 Campbell	112	1078	12933
051033 Caroline	73	1173	16020
051035 Carroll	132	634	6885
051036 Charles City	93	415	4711
051037 Charlotte	84	1219	14277
051041 Chesterfield	69	802	10686
051043 Clarke	56	369	4009
051045 Craig	39	538	7314
051047 Culpeper	105	894	10720
051049 Cumberland	56	814	10677
051051 Dickenson	20	550	6910
051053 Dinwiddie	82	1207	16511
051057 Essex	58	671	7403
051059 Fairfax	111	533	5538
051061 Fauquier	150	1166	14084
051063 Floyd	47	593	6493
051065 Fluvanna	54	775	10756
051067 Franklin	119	1297	15933
051069 Frederick	64	588	8798
051071 Giles	38	508	4918
051073 Gloucester	32	510	5945
051075 Goochland	47	670	10392
051077 Grayson	60	627	8260
051079 Greene	57	434	5727
051081 Greensville	63	735	9009
051083 Halifax	201	1852	22730
051085 Hanover	91	950	12493
051087 Henri	81	427	5468
051089 Henry	59	805	9772
051091 Highland	44	608	8579
051093 Isle Of Wight	178	813	8049
051095 James City	41	314	3989
051097 King And Queen	77	673	7615
051099 King George	62	540	6111
051101 King William	102	712	7846
051103 Lancaster	33	311	3669
051105 Lee	97	680	7221
051107 Loudoun	137	942	8999
051109 Louisa	78	1142	16780
051111 Lunenburg	88	1108	13611
051113 Madison	70	598	7305
051115 Mathews	27	367	4025
051117 Mecklenburg	145	1478	18507
051119 Middlesex	42	480	5561
051121 Montgomery	70	501	5366

051125 Nelson	67	979	12465
051127 New Kent	35	600	8240
051131 Northampton	90	263	2019
051133 Northumberland	88	778	9298
051135 Nottoway	74	894	10670
051137 Orange	98	759	8265
051139 Page	77	540	6705
051141 Patrick	75	884	10255
051143 Pittsylvania	203	1806	22102
051145 Powhatan	47	675	10194
051147 Prince Edward	69	942	12042
051149 Prince George	73	572	6484
051153 Prince William	38	718	10979
051155 Pulaski	61	450	6510
051157 Rappahannock	61	521	7141
051159 Richmond	63	383	4548
051161 Roanoke	63	427	5278
051163 Rockbridge	101	813	9710
051165 Rockingham	189	1020	12959
051167 Russell	56	703	7975
051169 Scott	95	753	9943
051171 Shenandoah	117	757	10570
051173 Smyth	78	603	7159
051175 Southampton	177	1306	15588
051177 Spotsylvania	46	911	12575
051179 Stafford	27	637	8344
051181 Surry	85	784	10024
051183 Sussex	102	1267	16362
051185 Tazewell	77	639	7477
051187 Warren	44	438	6310
051191 Washington	142	632	6822
051193 Westmoreland	101	777	9357
051195 Wise	35	462	5685
051197 Wythe	109	596	7803
051199 York	35	271	3423
051510 Alexandria	38	145	1065
051515 Bedford	22	101	604
051520 Bristol	37	135	1220
051530 Buena Vista	6	43	381
051540 Charlottesville	18	98	528
051550 Chesapeake	71	666	8477
051560 Clifton Forge	27	61	436
051570 Colonial Heights	35	88	662
051580 Covington	24	114	1605
051590 Danville	55	343	3405
051595 Emporia	19	234	3300
051600 Fairfax	18	96	1518
051610 Falls Church	16	98	1120

	051620 Franklin	66	142	1041
	051630 Fredericksburg	14	250	3012
	051640 Galax	45	94	519
	051650 Hampton	24	127	1112
	051660 Harrisonburg	73	143	746
	051670 Hopewell	26	79	711
	051678 Lexington	8	62	620
	051680 Lynchburg	45	250	2135
	051683 Manassas	17	86	743
	051685 Manassas Park	17	50	268
	051690 Martinsville	19	190	1625
	051700 Newport News	63	231	2187
	051710 Norfolk	42	197	2692
	051720 Norton	13	120	1305
	051730 Petersburg	58	171	1419
	051735 Poquoson	17	122	1351
	051740 Portsmouth	34	285	3215
	051750 Radford	27	76	609
	051760 Richmond	29	239	3517
	051770 Roanoke	33	91	770
	051775 Salem	14	61	568
	051790 Staunton	69	205	1550
	051800 Suffolk	118	964	11269
	051810 Virginia Beach	186	924	8724
	051820 Waynesboro	43	120	895
	051830 Williamsburg	3	38	446
	051840 Winchester	42	117	772
Virginia	TOTAL	9267	80615	981848