



**UNC**  
INSTITUTE FOR  
THE ENVIRONMENT

**MARAMA** Mid-Atlantic Regional Air  
Management Association, Inc.

# Temporal Allocation Module Development in EMF

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MARAMA



# Why Do We Need TA?

- Inventory time step varies by sector: hourly, daily, month-specific average day, annual
- States need to be able to create State Implementation Plan (SIP) inventories with a consistent time step across inventory sectors: e.g., weekday/weekend, ozone season
- Currently use SMOKE modeling system and/or other post-processing scripts to develop weekday/weekend/ozone season inventories
- Need a tool for states to apply the time step of their choice to any inventory



# What is Temporal Allocation?





# How to Convert Emissions?

- **Convert a finer resolution to a coarser one**
  - Daily totals → monthly totals or episodic average day
  - Sum emissions for appropriate days, divide by number of days for average day value
  
- **Convert a coarser resolution to a finer one**
  - Annual totals → monthly totals or daily totals
  - Need to estimate how the emissions will vary through time

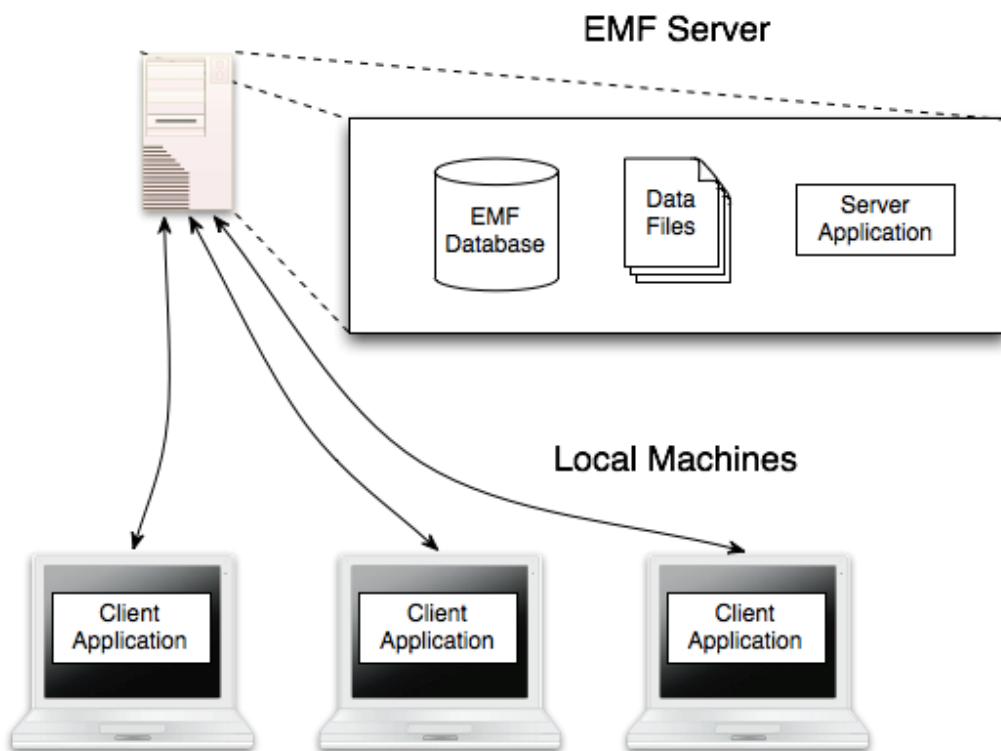


# What is EMF?

- **Emissions modeling**
  - Emissions inventories → hourly, gridded, chemically speciated emissions estimates
  - Create input for air quality models (CMAQ and CAMx)
- **Software system designed specifically to help with the process of emissions modeling**
  - Manage emissions data files
  - Organize data files and track changes to data
  - Create summaries and comparisons of inventories
  - Share with other users
  - Developed by OAQPS US EPA



# How the EMF works



- The EMF client application runs on your local computer
- The client application communicates with the remote EMF server
- The remote EMF server stores the emissions data and does the number crunching
- MARAMA installed the EMF server on Amazon Web Service (AWS)



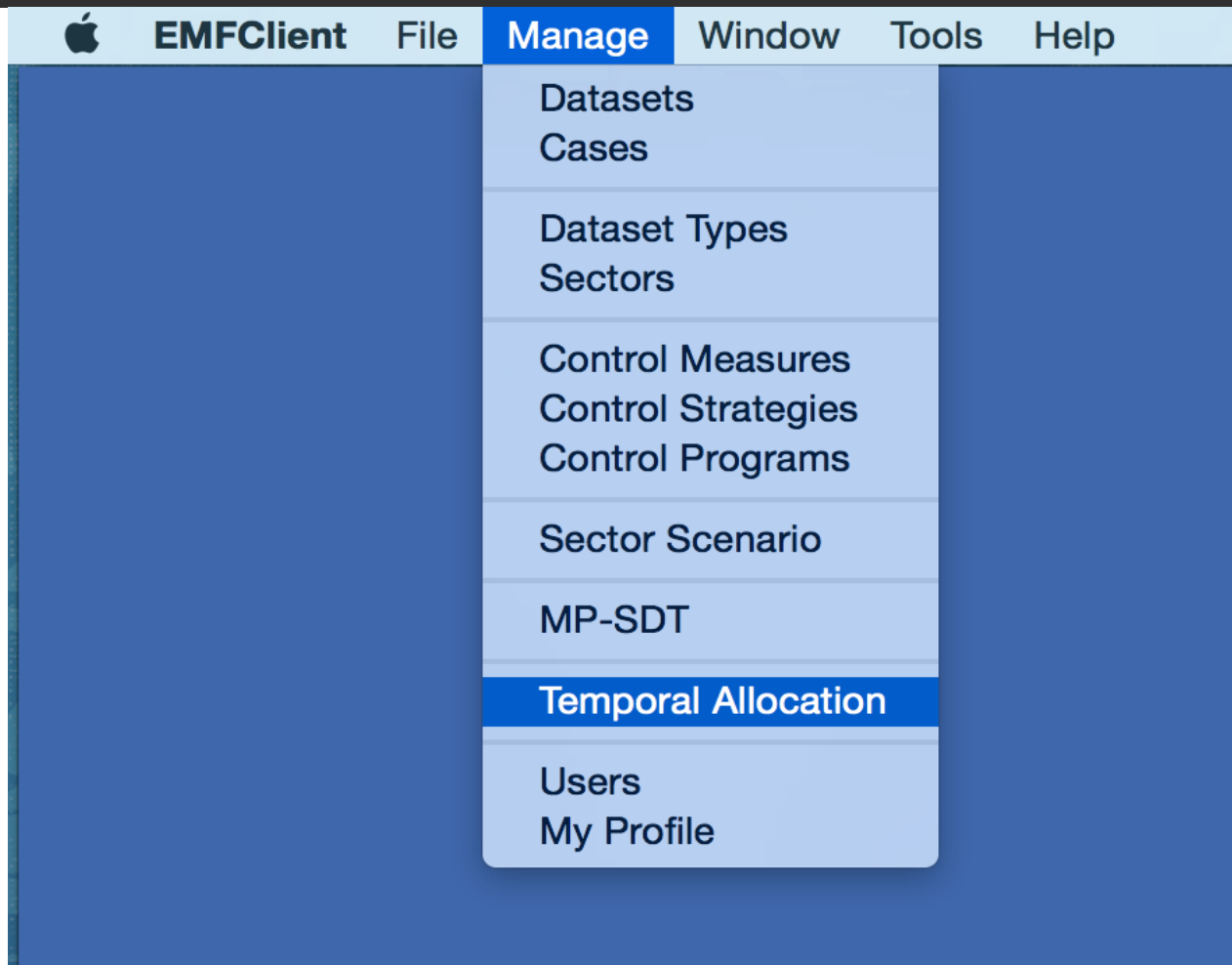
# EMF GUI

EMF Username

EMF Password



# EMF Managers







# EMF GUI

The screenshot displays the EMF GUI interface. The main window is titled "Temporal Allocation Manager" and contains a table with the following data:

#	Select	Name	Resolution
1	<input type="checkbox"/>	2011OzoneNonroadPA	Summer Weekday ave
2	<input type="checkbox"/>	2011NonpointOzonePA	Summer Weekday ave
3	<input type="checkbox"/>	2011PointOzoneWorkdayPA	Summer Weekday ave
4	<input type="checkbox"/>	S	
5	<input type="checkbox"/>	st	
6	<input type="checkbox"/>	2	
7	<input type="checkbox"/>	2	
8	<input type="checkbox"/>	P	
9	<input type="checkbox"/>	2	
10	<input type="checkbox"/>	S	

Below the table, it shows "10 rows : 8 colu" and a "View" button.

An "Edit Temporal Allocation: 2011/07 weekend - NC Wake" window is open, showing the following details:

- Name: 2011/07 weekend - NC Wake
- Description: Average-day values for weekend in July. Focusing on Wake Co. in North Carolina

A second "Edit Temporal Allocation: 2011/07 weekend - NC Wake" window is also open, displaying a table with the following data:

#	Select	Result Type	Record Count	Result Dataset
1	<input type="checkbox"/>	Temporal Allocation Monthly Result	609	Temp_Alloc_Monthly_000445793
2	<input type="checkbox"/>	Temporal Allocation Daily Result	5,278	Temp_Alloc_Daily_000445852
3	<input type="checkbox"/>	Temporal Allocation Episodic Result	203	Temp_Alloc_Episodic_000445900

At the bottom of this window, it shows "3 rows : 4 columns: 0 Selected [Filter: None, Sort: None]" and buttons for "View Properties", "View Data", and "Summarize".

Other visible buttons include "Refresh", "Save", "Run", and "Close".



# Temporal Allocation Module

- Designed to help with analysis of inventory emissions
- Convert your inventory data to various temporal resolution periods:
  - Estimate monthly, daily, or episodic totals from annual values
  - Sum up or daily totals for different periods throughout the year
- Same Temporal Allocation Method used in SMOKE modeling system
- Comparable results between EMF TA and SMOKE
- More Flexible Summing/Averaging Methods than SMOKE



# Temporal Allocation Manager

Temporal Allocation Manager

Refresh

Home Refresh Eye \$0.00 Navigation Window

#	Select	Name	Resolution	Start Day	End Day	Last Modified	Run Status	Name
1	<input type="checkbox"/>	2011OzoneNonroadPA	Summer Weekday average (tons/day)	04/29/2011	09/28/2011	2014/11/25 15:18	Finished	Carrie E
2	<input type="checkbox"/>	2011NonpointOzonePA	Summer Weekday average (tons/day)	04/29/2011	09/28/2011	2014/11/24 13:15	Finished	Carrie E
3	<input type="checkbox"/>	2011PointOzoneWorkdayPA	Summer Weekday average (tons/day)	04/30/2011	09/29/2011	2014/11/21 14:07	Finished	Carrie E
4	<input type="checkbox"/>	Susan M - 2011 ozone season test for PA...	Ozone season average (tons/day)	04/26/2011	09/26/2011	2014/11/03 14:40	Finished	Susan M
5	<input type="checkbox"/>	susan nonroad test	Episodic average (tons/day)	04/29/2011	09/28/2011	2014/11/03 12:13	Running	Susan M
6	<input type="checkbox"/>	2011Nonroadfiltered	Episodic average (tons/day)	04/30/2011	09/29/2011	2014/11/03 11:29	Finished	Carrie E
7	<input type="checkbox"/>	2011 PA ozone season tons/day point	Ozone season average (tons/day)	04/27/2011	09/26/2011	2014/10/22 14:03	Finished	Carrie E
8	<input type="checkbox"/>	PA ozone season tons/day nonpoint	Ozone season average (tons/day)	04/30/2011	09/29/2011	2014/10/08 09:56	Finished	Carrie E
9	<input type="checkbox"/>	2011/07 weekend - NC Wake - ptnonipm	Summer Weekend average (tons/day)	05/30/2011	08/29/2011	2014/09/18 13:51	Finished	Susan M
10	<input type="checkbox"/>	sample temporal allocation	Daily total (tons/day)	06/29/2011	06/29/2011	2014/09/08 11:30	Finished	Catherin

10 rows : 8 columns: 0 Selected [Filter: None, Sort: Last Modified(-)]

View Edit **New** Remove Copy Close



# Summary Tab

The screenshot shows a software window titled "Edit Temporal Allocation: \*". The window has a tabbed interface with the following tabs: Summary, Inventories, Time Period, Profiles, and Output. The "Summary" tab is currently selected. The form contains the following fields and information:

- Name:** August 2011 ptegu analysis - cas
- Description:** Calculate average day VOC emissions for weekends in the first half of August 2011 for the ptegu sector
- Project:** (Empty dropdown menu)
- Last Modified Date:** 12/07/2014 16:32
- Creator:** Catherine Seppanen
- Results:**
  - Run Status: Not started
  - Start Date: Not started
  - Completion Date: Not started

At the bottom of the window, there are four buttons: Save, Run, Refresh, and Close.



# Inventory Tab

Summary Inventories Time Period Profiles Output

Inventories to Process

#	Select	Type	Dataset	Version	# of Records
1	<input checked="" type="checkbox"/>	Flat File 2010 Point	2011NEIv2_POINT_ptegu_20141007_07oct2014_v0.csv	0	214,312

1 rows : 5 columns: 1 Selected [Filter: None, Sort: None]

Add Set Version Remove View Properties View Data

Filters  
Inventory Filter:

Save Run Refresh Close



# Inventory Input Resolution

- Inventory contains emissions data at different temporal resolutions
  - Annual Total (tons/year)
  - Monthly total (tons/month)
  - Monthly Average Day: Monthly total divided by the number of day in the month
  - Daily Totals
  - Hourly Totals (not supported by the Temporal allocation module)
  
- Supporting FF10 and ORL formats only



# Inventory Tab: View Data

The screenshot shows the 'Edit Temporal Allocation' application window. The 'Inventories' tab is active, displaying a table of 'Inventories to Process'. The table has five columns: '#', 'Select', 'Type', 'Dataset', 'Version', and '# of Records'. The first row is selected, with a checkmark in the 'Select' column. Below the table, a status bar indicates '1 rows : 5 columns: 1 Selected [Filter: None, Sort: None]'. A row of buttons includes 'Add', 'Set Version', 'Remove', 'View Properties', and 'View Data', with the 'View Data' button circled in red. At the bottom, there are buttons for 'Save', 'Run', 'Refresh', and 'Close'.

#	Select	Type	Dataset	Version	# of Records
1	<input checked="" type="checkbox"/>	Flat File 2010 Point	2011NElv2_POINT_ptegu_20141007_07oct2014_v0.csv	0	214,312



# Inventory Tab

Data Viewer [Dataset:2011NElv2\_POINT\_ptegu\_20141007\_07oct2014\_v0.csv, Version: Initial Version, Table: DS\_2011NElv2\_POINT\_ptegu\_20...]

Sort Order:  Apply

Row Filter:

Decimal Places: 4  Show Commas Format  Reset View

Current: 1 - 100 Filtered: 214312 of 214312

COUNTRY_CD String(4)	REGION_CD String(6)	TRIBAL_CODE String(3)	FACILITY_ID String(20)	UNIT_ID String(20)	REL_POINT_ID String(20)	PROCESS_ID String(20)	AGY_FACILITY_ID String(20)	AGY_UNIT_ID String(20)	AGY_REL Strir
US	01001		10583111	52263713	50910612	71808614	0010	X001A	001A
US	01001		10583111	52263813	50940312	71809514	0010	X001B	001B
US	01001		10583111	52263913	50941612	71809914	0010	X001C	001C
US	01001		10583111	52264013	50942712	71810214	0010	X001D	001D
US	01001		10583111	52263713	50910612	71808614	0010	X001A	001A
US	01001		10583111	52263813	50940312	71809514	0010	X001B	001B
US	01001		10583111	52263913	50941612	71809914	0010	X001C	001C
US	01001		10583111	52264013	50942712	71810214	0010	X001D	001D
US	01001		10583111	52263713	50910612	71808614	0010	X001A	001A
US	01001		10583111	52263813	50940312	71809514	0010	X001B	001B
US	01001		10583111	52263913	50941612	71809914	0010	X001C	001C
US	01001		10583111	52264013	50942712	71810214	0010	X001D	001D
US	01001		10583111	52263713	50910612	71808614	0010	X001A	001A
US	01001		10583111	52263813	50940312	71809514	0010	X001B	001B
US	01001		10583111	52263913	50941612	71809914	0010	X001C	001C
US	01001		10583111	52264013	50942712	71810214	0010	X001D	001D
US	01001		10583111	52263713	50910612	71808614	0010	X001A	001A

Add Note Close





# Temporal Resolution

Edit Temporal Allocation: 2011/07 weekend - NC Wake

Running temporal allocation. Monitor the status window for progress.

Summary Inventories Time Period Profiles Output

Resolution: Episodic weekend average (tons/day) ▼

Time Period Start: 06/01/2011

Time Period End: 08/31/2011

Save Run Refresh Close



# Temporal Output Options

The screenshot shows a software window titled "Edit Temporal Allocation: 2011/07 weekend - NC Wake \*". The window has a tabbed interface with four tabs: "Summary", "Inventories", "Time Period" (which is the active tab), and "Output".

Under the "Time Period" tab, there are three main sections:

- Resolution:** A dropdown menu is open, showing the following options:
  - Choose an output resolution (highlighted)
  - Daily total (tons/day)
- Time Period Start:** A dropdown menu with the following options:
  - Episodic average (tons/day)
  - Episodic total (tons/episode)
- Time Period End:** A dropdown menu with the following options:
  - Episodic weekday average (tons/day)
  - Episodic weekend average (tons/day)
  - Monthly average (tons/day)
  - Monthly total (tons/month)

At the bottom of the window, there are five buttons: "Save", "Run", "Refresh", "Stop", and "Close".



# Profile Tab

Edit Temporal Allocation: \*

Summary Inventories Time Period Profiles Output

Cross-Reference Dataset

Dataset: Not selected

Version: View Properties View Data

Year-to-Month Profile Dataset

Dataset: Not selected

Version: View Properties View Data

Week-to-Day Profile Dataset

Dataset: Not selected

Version: View Properties View Data

Month-to-Day Profile Dataset

Dataset: Not selected

Version: View Properties View Data

Save Run Refresh Close

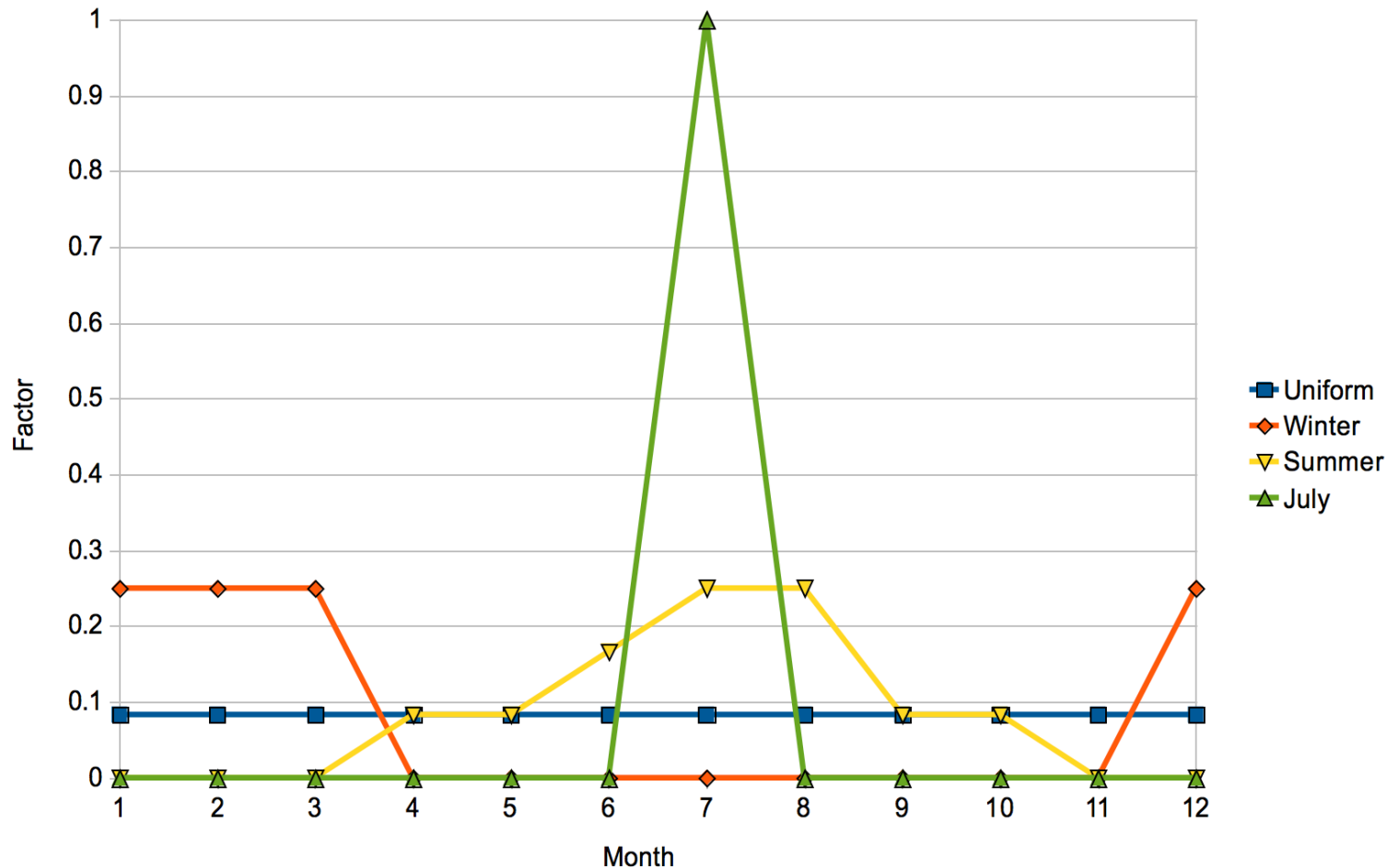


# Temporal Profiles

- Temporal Profiles are estimates of how emissions vary for different time periods
- Consider a year-to-month temporal profile
  - 12 factors (between 0 and 1) indicating how much of the annual total to allocate to each month
  - If each factor is 0.0833 (1/12), then the emissions will be evenly distributed to each month
  - If July factor = 1.0 and all other = 0.0, then all emissions allocated to July



# Example Monthly Profiles





# Types of Temporal Profiles

- Monthly estimates use
  - **Year-to-Month** profiles: 12 factors per year
- Daily estimates can use either:
  - **Month-to-Day** profiles: 31 factors per month
  - **Week-to-Day** profiles: 7 factors per week

Dataset Type	Description	# of Datasets Currently Loaded in MARAMA EMF
Temporal Profile Monthly (CSV)	Year-to-month factors	1 (2011 EPA modeling platform)
Temporal Profile Weekly (CSV)	Week-to-day factors	1 (2011 EPA modeling platform)
Temporal Profile Daily (CSV)	Month-to-day factors	0



# Profile Data Viewer

Data Viewer [Dataset:amptpro\_for\_2011\_platform\_with\_carb\_mobile\_2011CEM\_moves\_13aug2013\_v0\_tpro\_monthly.csv, Version: Initial Version, Table: DS\_bile\_201...]

Sort Order:  **Apply**

Row Filter:

Decimal Places:   Show Commas **Format**  Reset View

Current: 2901 - 3000 Filtered: 3080 of 3080

Navigation:

PROFILE_ID String(15)	JANUARY Double	FEBRUARY Double	MARCH Double	APRIL Double	MAY Double	JUNE Double	JULY Double	AUGUST Double	SEPTEMBER Double	OCTOBER Double	NOVEMBER Double	DECEMBER Double	COM Str
51323	.1208	.1208	.1208	.0369	.0369	.0369	.0648	.0700	.0321	.1300	.1000	.1300	
51324	.1225	.1033	.1148	.1017	.1058	.0674	.0484	.0453	.0479	.0629	.0761	.1039	
51325	.1290	.1500	.1400	.1030	.0750	.0160	.0190	.0160	.0240	.0820	.1090	.1370	
51326	.1300	.1100	.1200	.1100	.0700	.0500	.0400	.0400	.0400	.0500	.1100	.1300	
51327	.1300	.1200	.1200	.0800	.0600	.0300	.0300	.0300	.0400	.1000	.1200	.1400	
51328	.1378	.1378	.1378	.0647	.0646	.0646	.0212	.0212	.0212	.1097	.1097	.1097	
51329	.1400	.1300	.1200	.1000	.0350	.0300	.0350	.0400	.0500	.0800	.1000	.1400	
51330	.1500	.1100	.1600	.1100	.0600	.0100	.0100	.0100	.0300	.0700	.1100	.1700	
51331	.1500	.1500	.1000	.1000	.0500	.0500	.0500	.0500	.0500	.0500	.1000	.1000	
51332	.1500	.1500	.1000	.0500	.0300	.0300	.0200	.0200	.0500	.1000	.1500	.1500	
51333	.1500	.1500	.1000	.0500	.0500	.0500	.0500	.0500	.1000	.1000	.1000	.0500	
51334	.1500	.1500	.1200	.0600	.0100	.0100	.0100	.0100	.0900	.1000	.1400	.1500	
51335	.1500	.1500	.1500	.1000	.1000	.1000	.0167	.0167	.0167	.0667	.0666	.0666	
51336	.1518	.1479	.1351	.1400	.0660	.0443	.0184	.0159	.0142	.0230	.1030	.1404	

**Add Note** **Close**



# Temporal Profiles Assignments

- ❑ Different sources will use different temporal profiles based on the source's activity or location
- ❑ Temporal profiles assigned to sources via a **cross-reference dataset**
- ❑ Cross-reference dataset allows
  - ❑ Geographic region (FIPS code)
  - ❑ Source type (SCC)
  - ❑ Pollutant
  - ❑ Point-source characteristics (facility ID, emission unit ID,,)





# X-Reference Data Viewer

Data Viewer [Dataset:Gentpro\_TREF\_HOURLY\_BASH\_NH3\_agNH3\_bash\_2011ea\_11f\_newgent\_emf\_txt\_06sep2013\_nf\_v4\_tref.csv, Version: ...]

Sort Order:  Apply

Row Filter:

Decimal Places: 4  Show Commas   Reset View

Current: 1 - 100 Filtered: 961551 of 961551

SCC String(20)	FIPS String(12)	PLANTID String(20)	POINTID String(20)	STACKID String(20)	PROCESSID String(20)	POLL String(20)	PROFILE_TYPE String(10)	PROFILE_ID String(15)	COMMENT String(*)	COMME String
2805001100	001001					NH3	MONTHLY	1560		
2805001100	001001					NH3	WEEKLY	7		
2805001100	001001					NH3	HOURLY	1001		
2805001100	001001					NH3	ALLDAY	26		
2805001100	001003					NH3	MONTHLY	1560		
2805001100	001003					NH3	WEEKLY	7		
2805001100	001003					NH3	HOURLY	1003		
2805001100	001003					NH3	ALLDAY	26		
2805001100	001005					NH3	MONTHLY	1560		
2805001100	001005					NH3	WEEKLY	7		
2805001100	001005					NH3	HOURLY	1005		
2805001100	001005					NH3	ALLDAY	26		
2805001100	001007					NH3	MONTHLY	1560		
2805001100	001007					NH3	WEEKLY	7		
2805001100	001007					NH3	HOURLY	1007		
2805001100	001007					NH3	ALLDAY	26		
2805001100	001009					NH3	MONTHLY	1560		



# Execution

Edit Temporal Allocation: \*

Summary Inventories Time Period Profiles Output

Cross-Reference Dataset

Dataset: Gentpro\_TREF\_HOURLY\_BASH\_NH3\_agNH3\_bash\_2011ea\_11f\_newgent\_emf\_txt... ▼

Version: 0 (Initial Version) ▼ View Properties View Data

Year-to-Month Profile Dataset

Dataset: amptpro\_for\_2011\_platform\_with\_carb\_mobile\_2011CEM\_moves\_13aug2013\_v0... ▼

Version: 0 (Initial Version) ▼ View Properties View Data

Week-to-Day Profile Dataset

Dataset: amptpro\_for\_2011\_platform\_with\_carb\_mobile\_2011CEM\_moves\_13aug2013\_v0... ▼

Version: 0 (Initial Version) ▼ View Properties View Data

Month-to-Day Profile Dataset

Dataset: Not selected ▼

Version: ▼ View Properties View Data

Save Run Refresh Close



# Types of Outputs

- A run creates up to three output datasets
  - Monthly results, daily results, and episodic results
- EMF Dataset Types
  - Temporal Allocation Monthly Result
    - Total and average day emissions for each source, pollutant, and month
  - Temporal Allocation Daily Result
    - Total emissions for each source, pollutant, and day
  - Temporal Allocation Episodic Result
    - Total and average day emissions for each source and pollutant across the episode



# Output Files

The screenshot shows the 'Edit Temporal Allocation' window with the 'Output' tab selected. A table lists three result types, with the first row selected. The 'View Data' button is highlighted with a red circle.

#	select	Result Type	Record Count	Result Dataset
1	<input checked="" type="checkbox"/>	Temporal Allocation Monthly Result	7,757	Temp_Alloc_Monthly_220706789
2	<input type="checkbox"/>	Temporal Allocation Daily Result	31,028	Temp_Alloc_Daily_220706883
3	<input type="checkbox"/>	Temporal Allocation Episodic Result	7,757	Temp_Alloc_Episodic_220706961

3 rows : 4 columns: 1 Selected [Filter: None, Sort: None]

View Properties View Data Summarize

Save Run Refresh Close



# Output Files

Data Viewer [Dataset:Temp\_Alloc\_Monthly\_220706789, Version: Initial Version, Table: ds\_Temp\_Alloc\_Monthly\_220706789\_201412072...]

Sort Order:  Apply

Row Filter:

Current: 1 - 100 Filtered: 7757 of 7757

Decimal Places 4  Show Commas   Reset View

SCC String(20)	FIPS String(12)	PLANTID String(20)	POINTID String(20)	STACKID String(20)	PROCESSID String(20)	POLL String(20)	PROFILE_ID String(15)	FRACTION Double	MONTH Integer	TOTAL_EMIS Double	DAY
20100201	01001	10583111	52263713	50910612	71808614	VOC	38	.0908	8	1.3150	
20100201	01001	10583111	52263813	50940312	71809514	VOC	38	.0908	8	.4432	
20100201	01001	10583111	52263913	50941612	71809914	VOC	38	.0908	8	.8673	
20100201	01001	10583111	52264013	50942712	71810214	VOC	38	.0908	8	2.9816	
20100201	01001	10708711	58649613	54327012	76997514	VOC	38	.0908	8	.1727	
20100201	01001	10708711	58649713	54373012	76997614	VOC	38	.0908	8	.1085	
20100201	01001	10708711	58649813	54466712	76997714	VOC	38	.0908	8	.1562	
20100201	01001	560011	48133813	45686112	61566714	VOC	38	.0908	8	.1331	
20100201	01001	560011	48133913	45686212	61566614	VOC	38	.0908	8	.1555	
20100201	01001	560011	48134013	45686012	61566514	VOC	38	.0908	8	.1461	
20100201	01015	10569911	52269913	50938712	71808714	VOC	38	.0908	8	.0001	
20100201	01015	10569911	52270013	50940912	71809614	VOC	38	.0908	8	.0001	
20100201	01015	10569911	52270113	50941912	71810014	VOC	38	.0908	8	.0162	
20100201	01015	10569911	52270213	50942912	71810314	VOC	38	.0908	8	.0101	
20100101	01033	7212811	10817213	10769412	61093014	VOC	443	.0721	8	.0009	
10100202	01033	7212811	10817313	10769812	61092914	VOC	262	.0833	8	.5208	
20100101	01033	7212811	10817413	10769312	61092814	VOC	443	.0721	8	.0009	



# Resources

- EMF User's Guide:  
<http://www.cmascenter.org/emf/internal/guide.html>
- CoST User's Guide:  
[http://www.cmascenter.org/help/model\\_docs/emf\\_cost/2.5.1/CoST\\_UsersGuide\\_2012-08-01\\_Final.pdf](http://www.cmascenter.org/help/model_docs/emf_cost/2.5.1/CoST_UsersGuide_2012-08-01_Final.pdf)
- TA User's Guide:  
[https://www.cmascenter.org/emf/internal/temporal\\_allocation.html](https://www.cmascenter.org/emf/internal/temporal_allocation.html)
- **MARAMA EMF/CoST/TA Webinars:**  
<http://www.marama.org/73-about-us-sp-480/general/477-emf-webinar-training>



# MARAMA's EMF/CoST/TA Webinars



## **EMF Webinar Training**

### **Advanced SQL for EMF (February 2015)**

[Presentation](#)

### **How to Grow and Control Inventories (January 2015)**

[Presentation](#)

[Inventory Projection User's Guide](#)

[Inventory Projection Tutorial](#)

### **EMF Temporalization Tool (December 2014)**

Video of Webinar (YouTube video) \*Will be posted at a later date.

[Presentation](#)

[Tutorial](#)

[Temporalization Tool Users Guide](#)

### **SQL for EMF (November 2014)**

[Webinar presentation](#)

[Tutorial](#)

[SQL Reference Guide](#)

### **EMF Basics - Part 2 (October 2014)**

Video of Webinar (YouTube video) \*Will be posted at a later date.

[Presentation](#)

[Tutorial](#)

[Example Queries](#)

### **EMF Basics - Part 1 (September 2014)**

Video of Webinar (YouTube video) \*Will be posted at a later date.



# Ongoing Project

- Enabling the “Case Manager” module that allows users to run SMOKE modeling system as a main goal of Emission Modeling support
- Setting up the MOVES2014 runs on AWS and executing SMOKE-MOVES2014 Integration tool run through the EMF server on AWS





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Catherine Seppenen and B.H. Baek



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# Why Do We Need TA Module?

- An Episode is a user-defined time period
  - Could represent ozone season, summer, winter, etc.
  - You specify the start and end date
- Within an episode, you can consider all days, weekdays, or weekends only
  - Weekend average: calculate average day emissions for each weekend day within the episode
- Currently use SMOKE modeling system or other post-processing scripts to develop daily/hourly inventories based on annual/monthly Inventories



# Temporal Output Options

- Temporal Resolution
  - Daily total (tons/day)
  - Episodic average (tons/day)
  - Episodic total (tons/episode)
  - Episodic weekday average (tons/day)
  - Episodic weekend average (tons/day)
  - Monthly average (tons/day)
  - Monthly total (tons/month)
  
- Period Start and End Date and Time