

DUSTRAN—A GIS-based Dispersion Modeling System

Jeremy Rishel
Pacific Northwest
National Laboratory
SCAPA 2007 Annual Meeting



DUSTRAN Development Background

- A multi-year research project that started in January 2001.
- Purpose was to develop a fully-tested and documented atmospheric dispersion modeling system to assist the U.S. Department of Defense in addressing particulate air quality issues at military training/testing ranges.
- Result: DUSTRAN—DUST TRANsport
- Investigators and contributors:
Jerry Allwine (Lead), Elaine Chapman, Brad Fritz, Bonnie Hoopes, Jeremy Rishel, Fred Rutz, Will Shaw, Tim Seiple

DUSTRAN Components

- The basic approach in formulating DUSTRAN was to construct the system from widely-used, industry-standard components:
 - Graphical User Interface (GUI): ArcMap GIS (Version 9.x)
 - Dispersion Models:
 - CALPUFF (Scire et al. 2000a)—EPA regulatory Lagrangian puff dispersion model
 - CALGRID (Scire et al. 1989)—widely used Eulerian dispersion model
 - Meteorological Model:
 - CALMET (Scire et al. 2000b)—diagnostic meteorological model that uses surface and upper-air observations to construct 3-D fields
- Emissions Model (source-term specification):
 - Currently, DUSTRAN includes dust emission modules for creating source-term factors from both wind-blown dust generation and wheeled military vehicle activities.
 - DUSTRAN's componentized architecture lends to the development and integration of other source-term models, including source-terms for emergency response.

EXPECT THE UNEXPECTED

DUSTRAN Interface:

The screenshot displays the ArcMap interface with the DUSTAN extension. The map shows a geographical area with various layers including roads, water, and land use. The DUSTAN console on the right provides configuration options for simulation scenarios, including domain name, size, release period, and simulation type. The console also includes a graphical source and domain creation tool.

Standard ArcMap Interface and Toolbar

DUSTAN Scenario Development Console

Organized Model Layers

Graphical Source and Domain Creation

Layers

- Appgms
- Contours
- Domains
- US_Sonde
- US_Metar
- Topography
- buildings_local
- US_Hwys
- roads_local
- fence_local
- US_Rivers
- water_local
- US_Lakes
- owe14d (vegetation)
- srrtxt (soils)
- Hanford_bndy
- US_Counties
- US_States
- PointSources
- AreaSources
- LineSources

DUSTAN Console

Add Site **Select Site...**
File **Run Simulation**
Clean Site **Help** **Refresh**

Domain:
Name: tester
Size (km): 100
UTM Zone: 11

Release Period: Synchronize
Start Time: 04:00 AM
Release Duration: 02:00 hr

Simulation Scenario:
Simulation Type: Source Emissio
Time Zone: PST
Start Date: May 06, 2007
Start Time: 04:00 AM
Run Duration: 04:00 hr
Averaging Interval (hour): N/A

Display Options | Scenarios | Species
Sources | Meteorology | Contours

Point Sources
 tester (TEMP)
 Line Sources
 Area Sources

332073.98 5211766.87 Meters

DUSTRAN Scenario Development:

- Intuitive model interfaces allows for quick scenario development:
 - Select site (created from *Add Site* utility...more on this later)
 - Graphically create:
 - Model domain (20-400 km)
 - Source types:
 - Point
 - Area
 - Line
 - Enter simulation, release, and averaging time information through descriptive text and list-box entries.

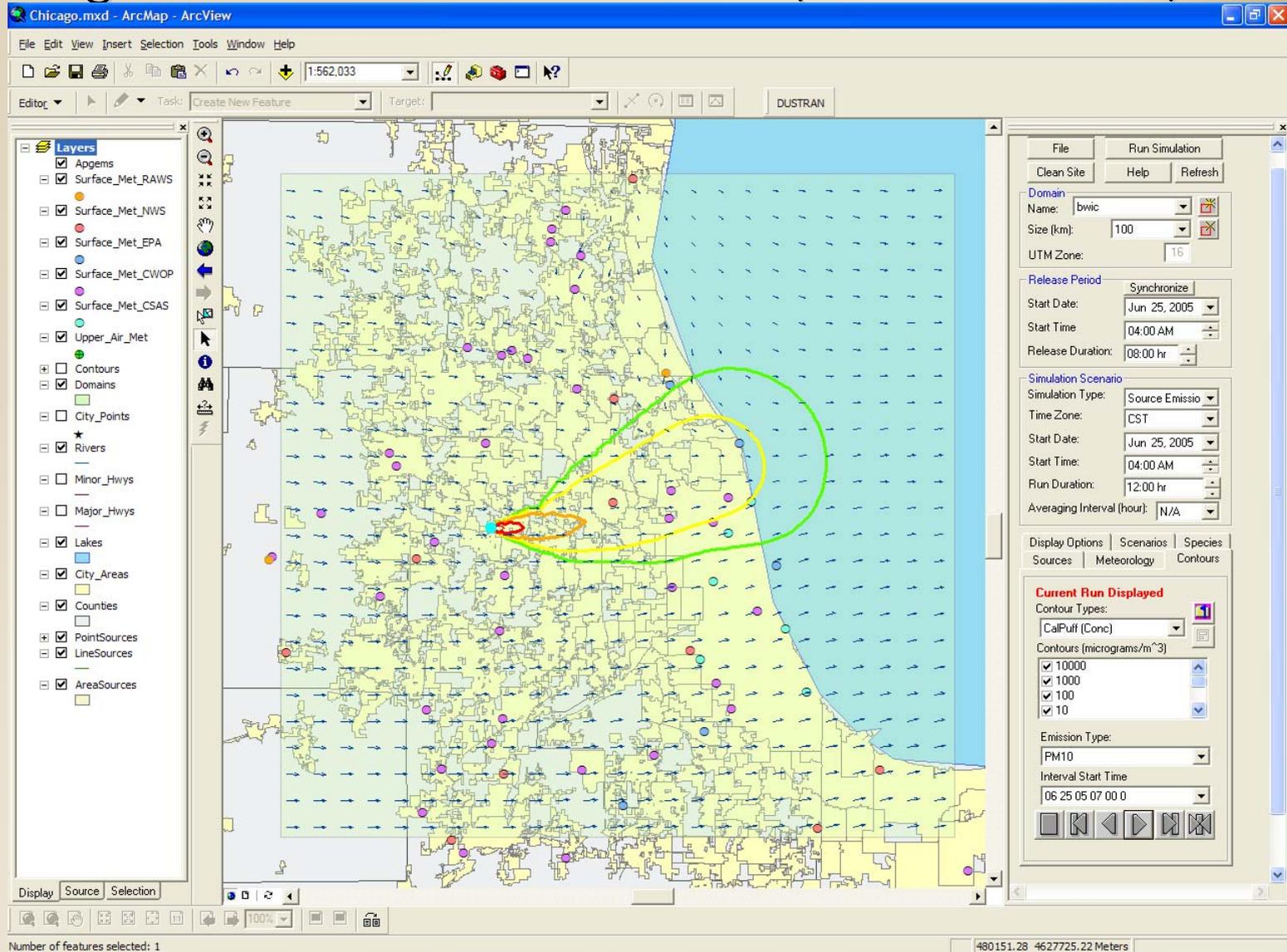
Sample DUSTRAN Simulation:

- Lake Breeze Event: Chicago IL, June 25, 2005 (7:00 a.m.-6:00 p.m. CST).
- Complex wind pattern develops as lake breeze moves inland throughout mid-morning to early evening.
- DUSTRAN is able to capture and simulate the spatial variability of the wind-field and its affect on a material release.

EMERGENCY MANAGEMENT ROUNDUP

Chicago Lake Breeze: 06/05/05 (7:00 a.m. LST):

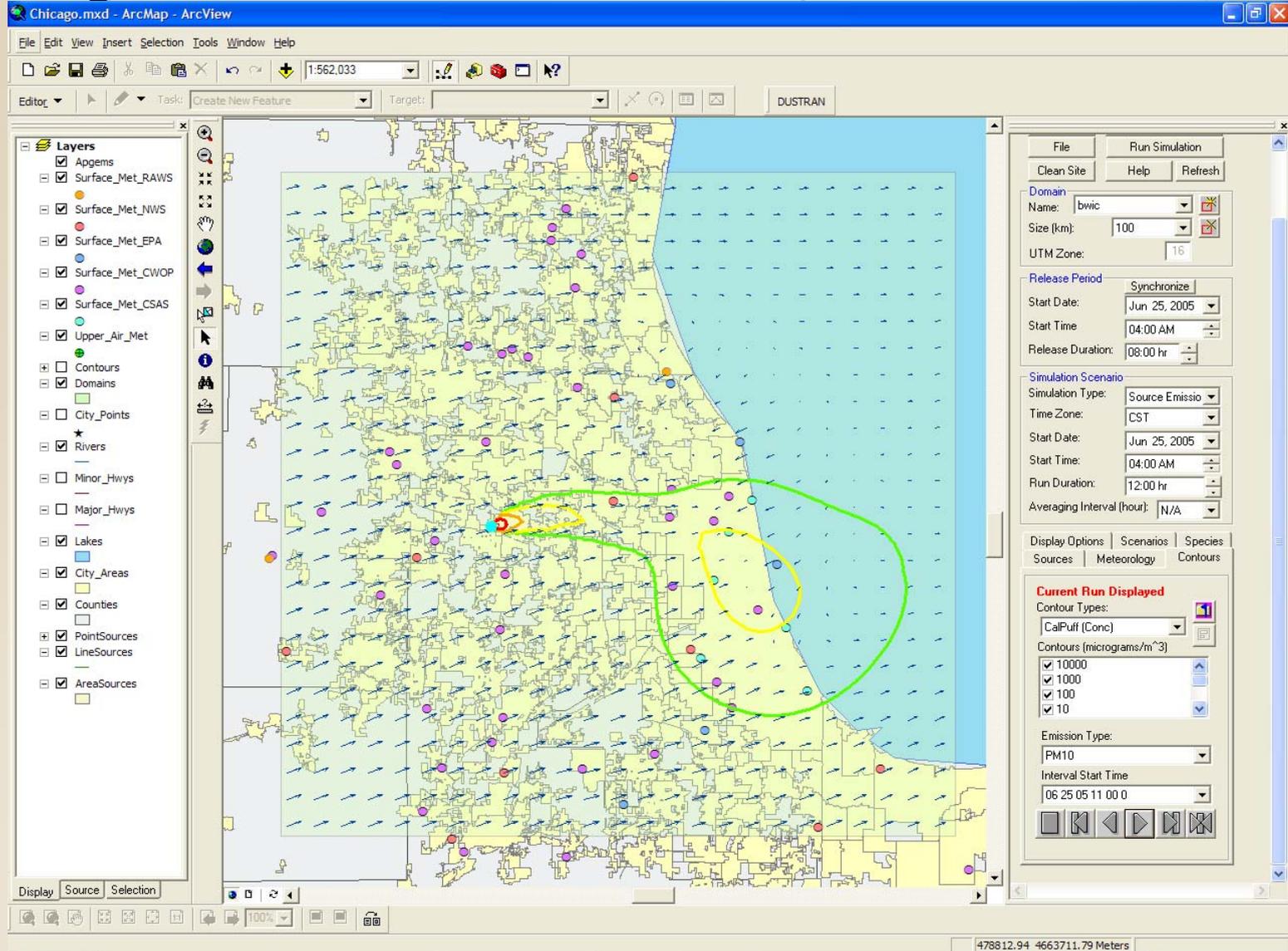
EXPECT THE UNEXPECTED



EMERGENCY MANAGEMENT ROUNDUP

Chicago Lake Breeze: 06/05/05 (11:00 a.m. LST):

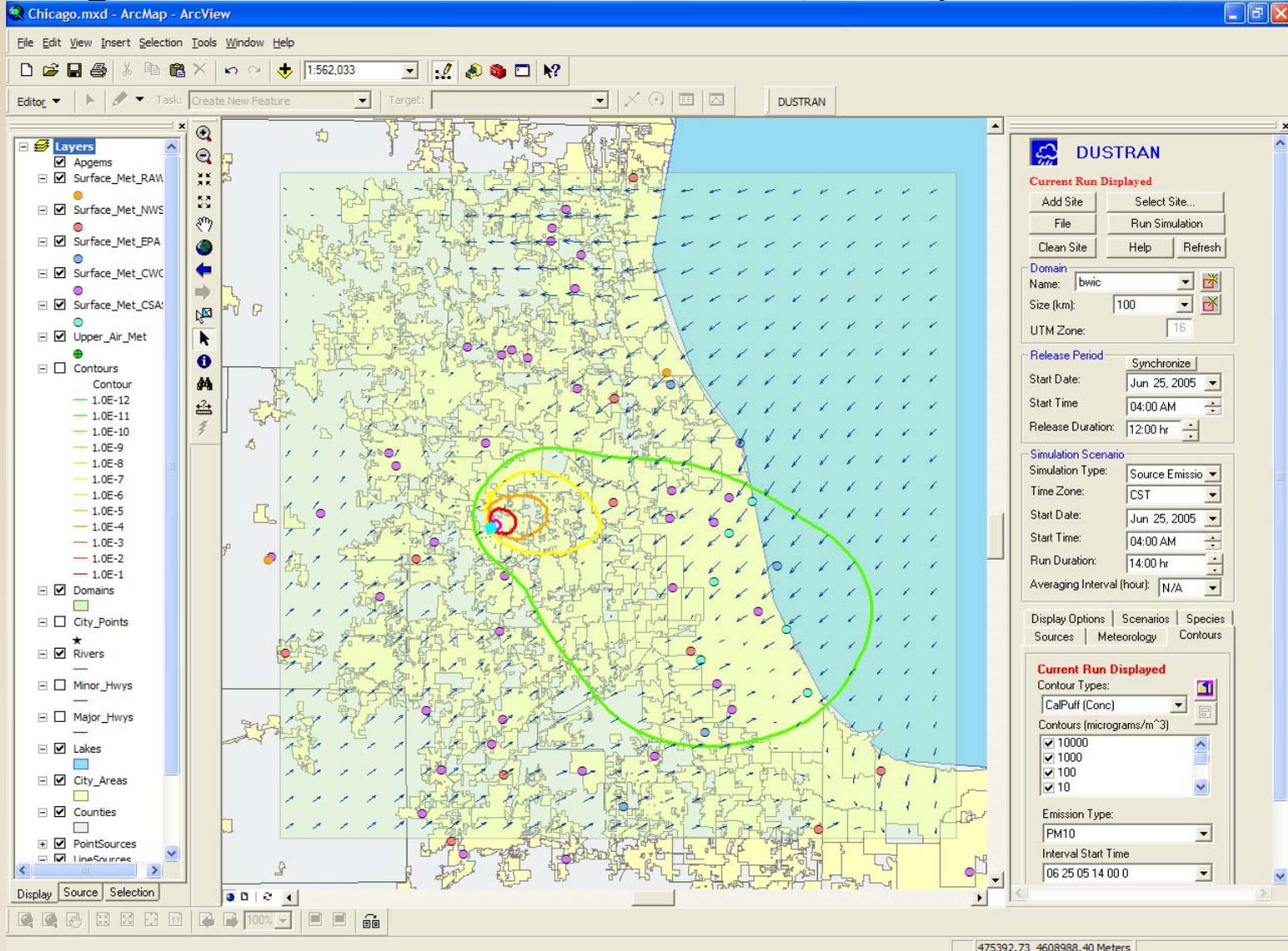
EXPECT THE UNEXPECTED



EMERGENCY MANAGEMENT ROUNDUP

EXPECT THE UNEXPECTED

Chicago Lake Breeze: 06/05/05 (2:00 p.m. LST):



EMERGENCY MANAGEMENT ROUNDUP

EXPECT THE UNEXPECTED

Chicago Lake Breeze: 06/05/05 (4:00 p.m. LST):

The screenshot shows the ArcMap interface with a map of Chicago. The map displays a lake breeze simulation with wind vectors and concentration contours. The Dustran interface on the right shows simulation parameters for a run on June 25, 2005, at 04:00 AM.

Layers Panel:

- Appgms
- Surface_Met_RAW
- Surface_Met_NWS
- Surface_Met_EPA
- Surface_Met_CWC
- Surface_Met_CSA
- Upper_Air_Met
- Contours
 - 1.0E-12
 - 1.0E-11
 - 1.0E-10
 - 1.0E-9
 - 1.0E-8
 - 1.0E-7
 - 1.0E-6
 - 1.0E-5
 - 1.0E-4
 - 1.0E-3
 - 1.0E-2
 - 1.0E-1
- Domains
- City_Points
- Rivers
- Minor_Hwys
- Major_Hwys
- Lakes
- City_Areas
- Counties
- PointSources
- LineSources

Dustran Panel:

Current Run Displayed

Add Site Select Site...
File Run Simulation
Clean Site Help Refresh

Domain Name: bwic
Size (km): 100
UTM Zone: 16

Release Period Synchronize
Start Date: Jun 25, 2005
Start Time: 04:00 AM
Release Duration: 12:00 hr

Simulation Scenario
Simulation Type: Source Emissio
Time Zone: CST
Start Date: Jun 25, 2005
Start Time: 04:00 AM
Run Duration: 14:00 hr
Averaging Interval (hour): N/A

Display Options | Scenarios | Species
Sources | Meteorology | Contours

Current Run Displayed

Contour Types: CalPuff (Conc)
Contours (micrograms/m³):
 10000
 1000
 100
 10

Emission Type: PM10
Interval Start Time: 06 25 05 16 00 0

Number of features selected: 1
478961.65 4644677.57 Meters

EMERGENCY MANAGEMENT ROUNDUP

EXPECT THE UNEXPECTED

Chicago Lake Breeze: 06/05/05 (6:00 p.m. LST):

The screenshot displays the ArcMap interface with a map of Chicago and Lake Michigan. The map shows a grid of blue arrows representing wind direction and speed, with a prominent green contour line indicating a specific concentration level. The Dustran control panel on the right is active, showing the following settings:

- Current Run Displayed**
- Buttons: Add Site, Select Site..., File, Run Simulation, Clean Site, Help, Refresh
- Domain: Name: bwic, Size (km): 100, UTM Zone: 16
- Release Period: Synchronize, Start Date: Jun 25, 2005, Start Time: 04:00 AM, Release Duration: 12:00 hr
- Simulation Scenario: Simulation Type: Source Emissio, Time Zone: CST, Start Date: Jun 25, 2005, Start Time: 04:00 AM, Run Duration: 18:00 hr, Averaging Interval (hour): N/A
- Display Options: Sources, Meteorology, Contours
- Current Run Displayed**
- Contour Types: CalPuff (Conc), Contours (micrograms/m³): 10000, 1000, 100, 10
- Emission Type: PM10, Interval Start Time: 06 25 05 18 00 0

At the bottom of the window, the status bar shows "Number of features selected: 1" and coordinates "478069.42 4635309.16 Meters".

Other DUSTRAN Productivity Tools:

- *Add-Site Utility*: companion tool that allows for the creation of a model-ready site, including all standard GIS layers, for direct use in a DUSTRAN simulation.
- *Met-Archiver*: archives meteorological observations from the National Weather Service (NWS) and NOAA's MADIS archiving system. Archived data is available for direct use in a DUSTRAN simulation.

Future DUSTRAN Development:

- A possible name change...since DUSTRAN is extensible to modeling other source types and scenarios.
- Incorporation of the recently-released sub-hourly CALPUFF/CALMET models.
- A website which describes the modeling system in greater detail and how to obtain the software.

Questions?

- Dr. Jerry Allwine:
 - Email: jerry.allwine@pnl.gov
 - Phone: 509-375-6741
- Jeremy Rishel:
 - Email: jeremy.rishel@pnl.gov
 - Phone: 509-375-6974