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The Application of WinMACCS to Multiple Source Terms and Output Post-Processing

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Overview

- WinMACCS
- Application of WinMACCS to PRA-like Analyses
- MACCS Output File Structure
- MACCS Output File Post-Processing
- Example Analysis
- Lessons Learned
- Potential Improvements
- WinMACCS 3.11 Features

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WinMACCS

- WinMACCS is used to create and execute MACCS calculations of the off-site consequences attributed to radionuclide releases
  - Each model can define a unique emergency plan attributed to a particular source term
  - MACCS is capable of generating large amounts of data
- PRA applications require the creation of a unique MACCS model for each release category
  - Models may have differing numbers of cohorts, event timings, etc.
- WinMACCS can sequentially create and execute unique models using cyclic files
  - Cyclic files cannot be used to make some changes, such as add or remove cohorts
- WinMACCS can import files which define changes to the model to aid in model updates

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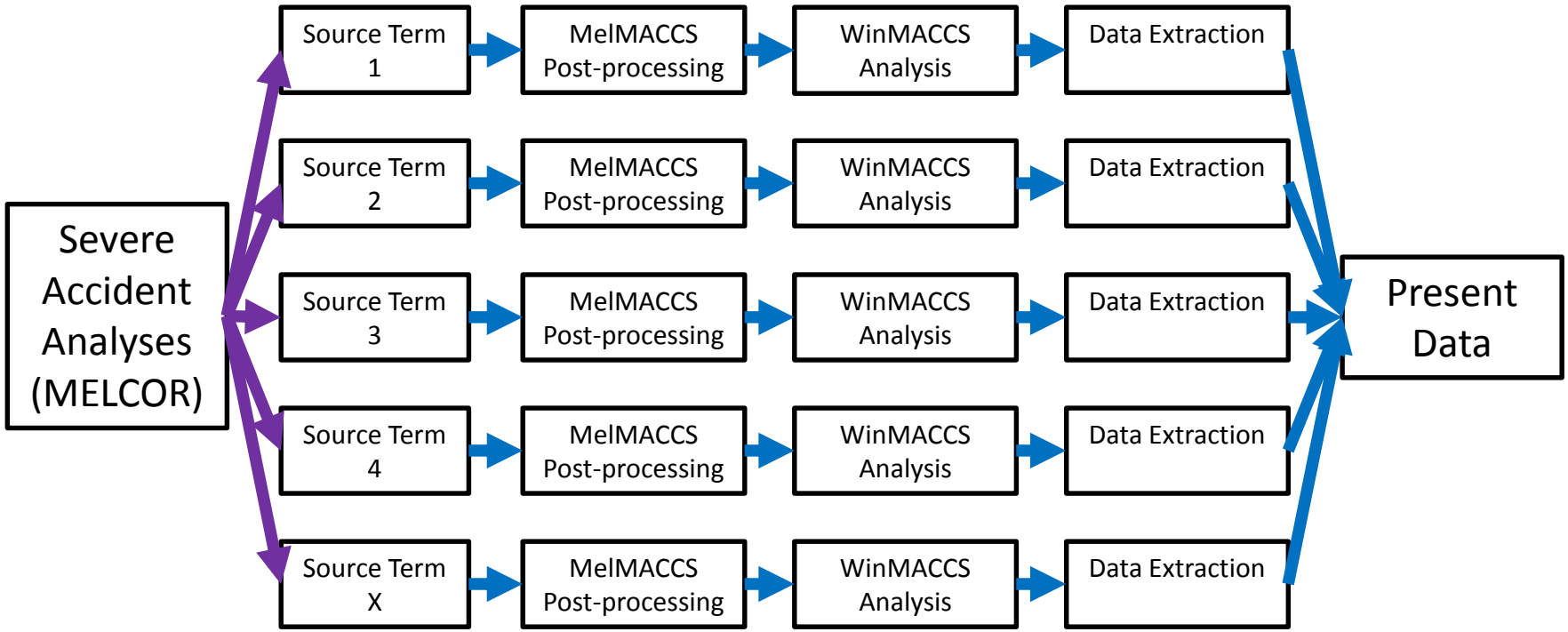
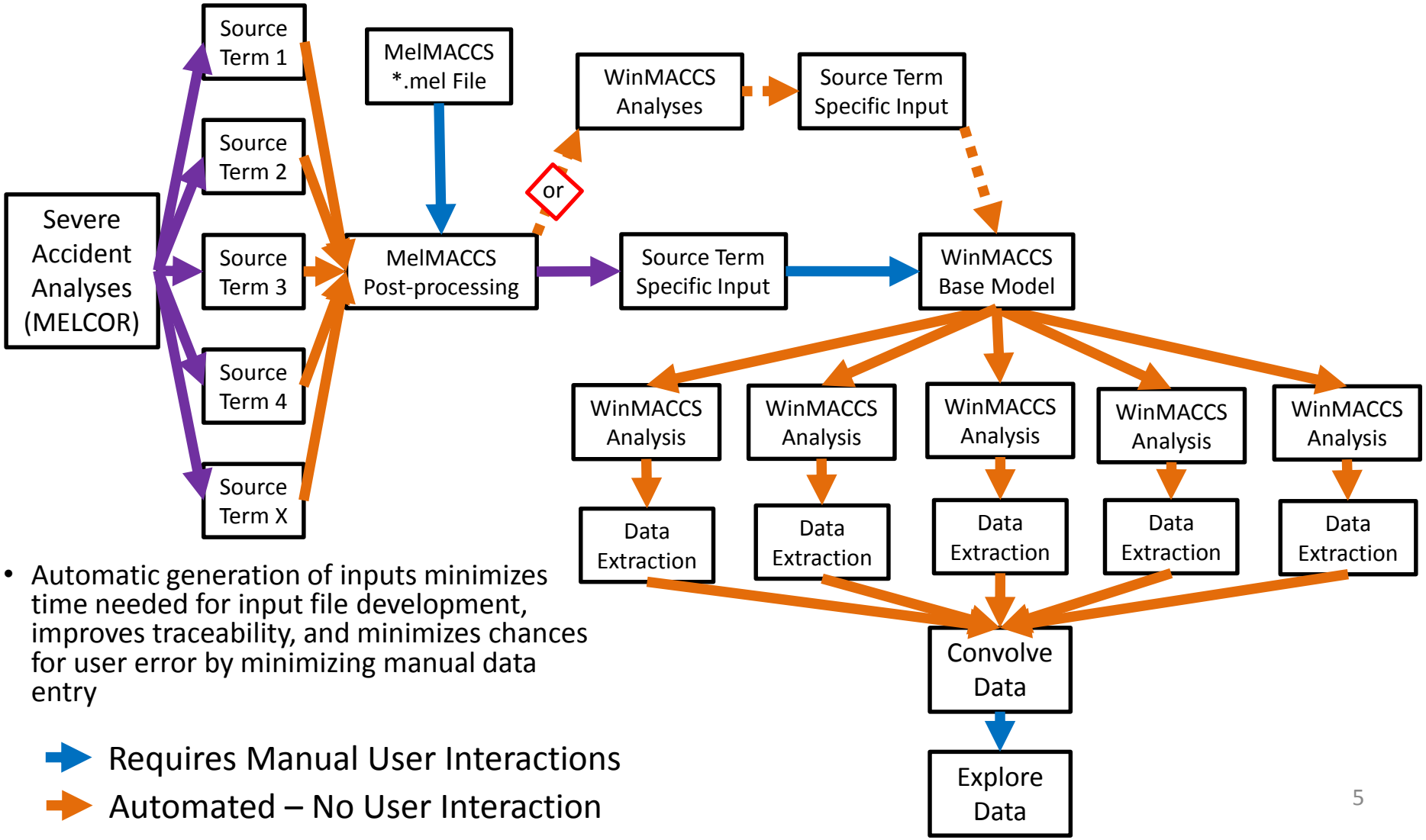
Application of WinMACCS to PRA-like Analyses



Requires Manual User Interactions

Application of WinMACCS to PRA-like Analyses



- Automatic generation of inputs minimizes time needed for input file development, improves traceability, and minimizes chances for user error by minimizing manual data entry

Requires Manual User Interactions

Automated – No User Interaction

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MACCS Output File Structure

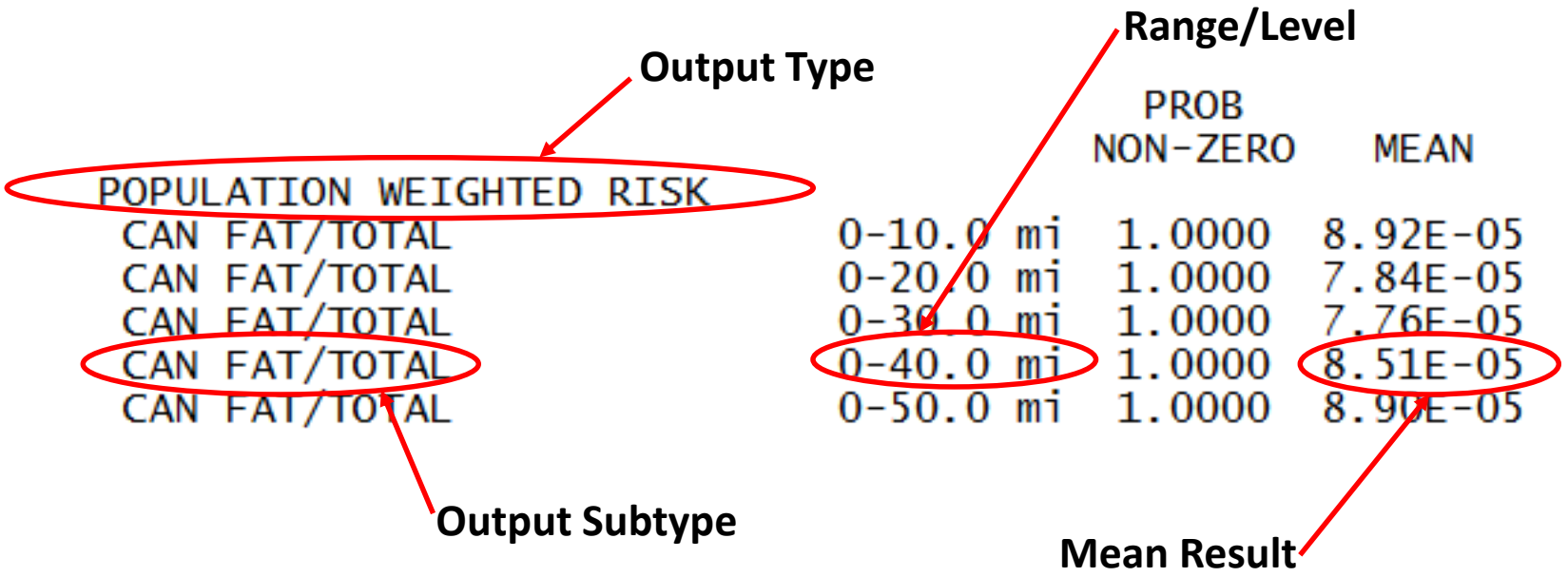
- Echo of Input
- List of Calculation Trials
- ATMOS Output
- Consequence Output
  - Overall results
  - Cohort results for early phase
  - Long-term results
  - CCDF results (Over weather trials)
  - RISCAT results

MACCS produces results which can be uniquely defined by four categories:

1. Cohort
2. Output Type
3. Output Subtype
4. Range or Level

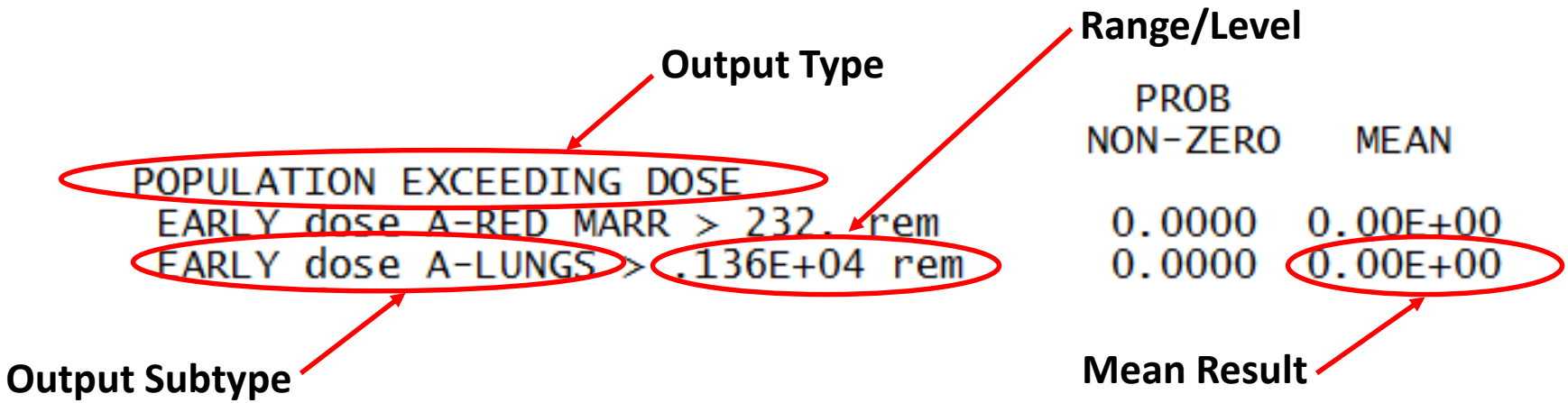
MACCS Output File Structure

Cohort: Overall



MACCS Output File Structure

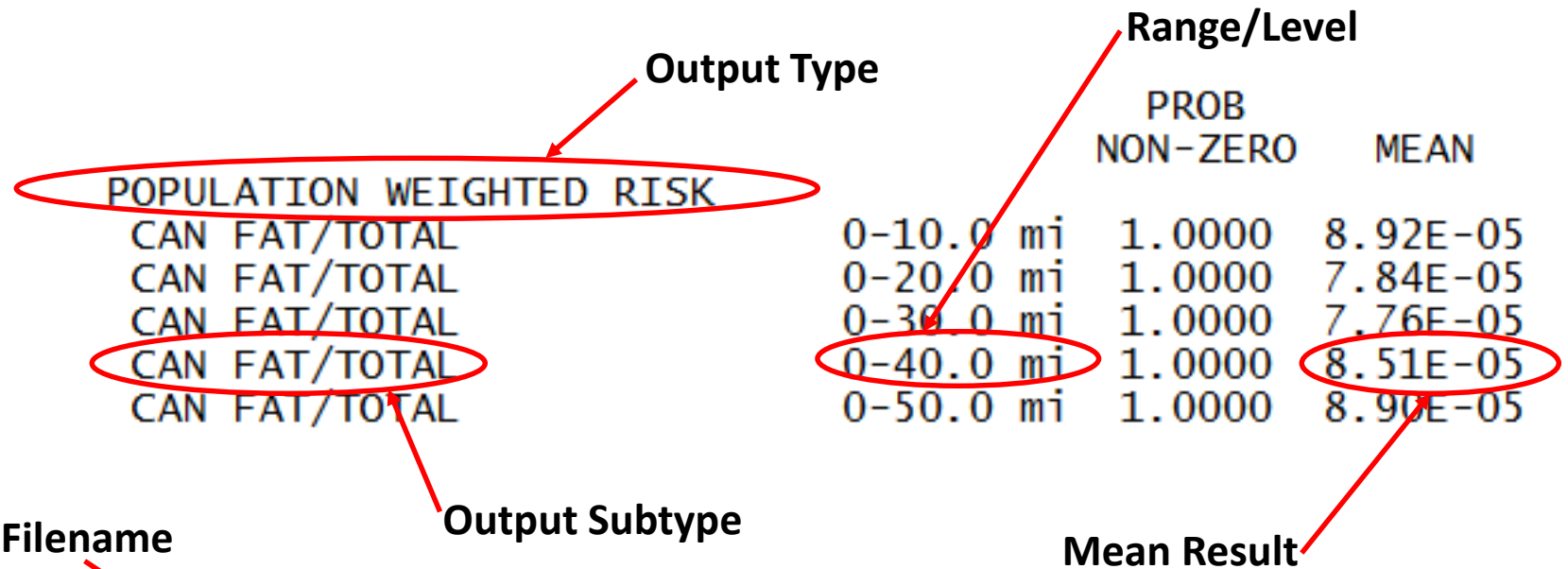
Cohort: Overall



MACCS Output File Post-Processing

- Post-processing results converts the verbose WinMACCS output into a structured array

Cohort: Overall




```
H:\IMUG_DEMO_RLZ232_v3.11.2\Output\model1.out  OVERALL POPULATION WEIGHTED RISK  CAN FAT/TOTAL  0-10.0 mi  1.0000  8.92E-05
H:\IMUG_DEMO_RLZ232_v3.11.2\Output\model1.out  OVERALL POPULATION WEIGHTED RISK  CAN FAT/TOTAL  0-20.0 mi  1.0000  7.84E-05
H:\IMUG_DEMO_RLZ232_v3.11.2\Output\model1.out  OVERALL POPULATION WEIGHTED RISK  CAN FAT/TOTAL  0-30.0 mi  1.0000  7.76E-05
H:\IMUG_DEMO_RLZ232_v3.11.2\Output\model1.out  OVERALL POPULATION WEIGHTED RISK  CAN FAT/TOTAL  0-40.0 mi  1.0000  8.51E-05
H:\IMUG_DEMO_RLZ232_v3.11.2\Output\model1.out  OVERALL POPULATION WEIGHTED RISK  CAN FAT/TOTAL  0-50.0 mi  1.0000  8.90E-05
```

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MACCS Output File Post-Processing

- A script was generated to post-process the model1.out files and convert them into a database format
- Post-processed files for each source term are concatenated into one file
  - Enables quick parsing of the data
- Scripts were written to automatically create plots based on user input
  - User supplies the Cohort, Output Type, Output Subtype, and Range/Level to define a specific plot
  - A graphical user interface was also constructed to enable the selection of data available

```
H:\IMUG_DEMO_RLZ232_v3.11.2\Output\model1.out  OVERALL POPULATION WEIGHTED RISK  CAN FAT/TOTAL   0-10.0 mi   1.0000  8.92E-05
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```

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Example Analysis

- **Disclaimer: The following results are for demonstration purposes only**
  - They are presented to demonstrate data output exploration
  - These results do not reflect a PRA analysis
- Nine source terms were selected from the SOARCA Sequoyah analysis at different times in cycle (BOC, MOC, or EOC), safety valve functionality (failed or not failed), and the time of containment failure (early or late)
  - These calculations simulated the first 72 hours of a short-term station blackout event
- A probability of the state occurring was used to weight an assumed contribution to core damage frequency of 2×10^{-6} yr^{-1}
- Each source term used the same WinMACCS model

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Example Analysis

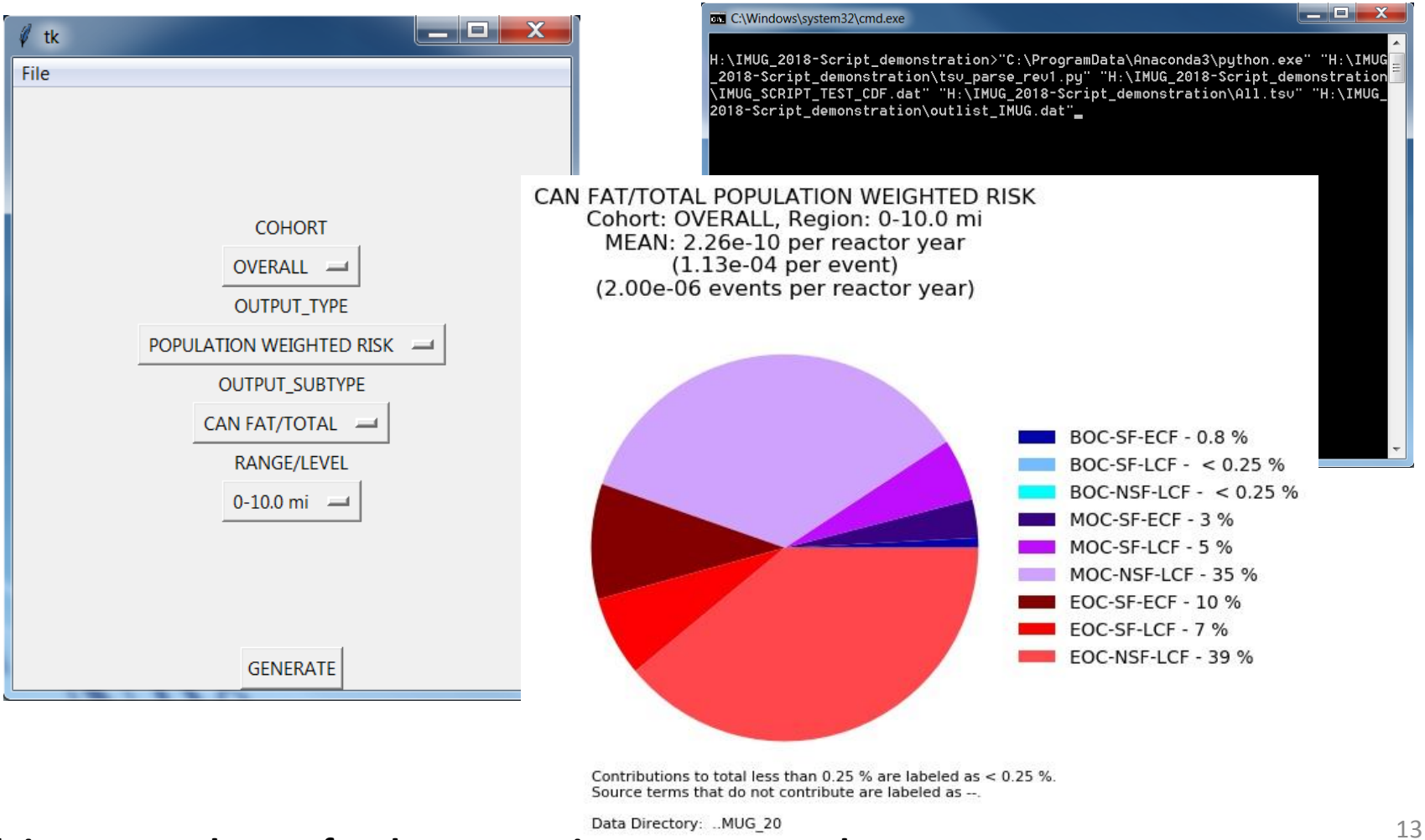
Label	Description	Frequency	Percentage
BOC-SF-ECF	Beginning-of-cycle with failed pressurizer safety valve and early containment failure	3.6×10^{-9}	0.2%
BOC-SF-LCF	Beginning-of-cycle with failed pressurizer safety valve and late containment failure	2.1×10^{-8}	1.0%
BOC-NSF-LCF	Beginning-of-cycle with no failed pressurizer safety valve and late containment failure	2.0×10^{-7}	10.0%
MOC-SF-ECF	Middle-of-cycle with failed pressurizer safety valve and early containment failure	1.6×10^{-8}	0.8%
MOC-SF-LCF	Middle-of-cycle with failed pressurizer safety valve and late containment failure	8.6×10^{-8}	4.3%
MOC-NSF-LCF	Middle-of-cycle with no failed pressurizer safety valve and late containment failure	9.0×10^{-7}	45.0%
EOC-SF-ECF	End-of-cycle with failed pressurizer safety valve and early containment failure	2.2×10^{-8}	1.1%
EOC-SF-LCF	End-of-cycle with failed pressurizer safety valve and late containment failure	9.2×10^{-8}	4.6%
EOC-NSF-LCF	End-of-cycle with no failed pressurizer safety valve and late containment failure	6.6×10^{-7}	33.0%
	Total	2.0×10^{-6}	100%

NOTE: No source terms were available which had the combination of no pressurizer safety valve failure and early containment failure

Disclaimer: Results are for demonstration purposes only

Example Analysis

- Example: Pie chart showing contributions of source terms to mean value



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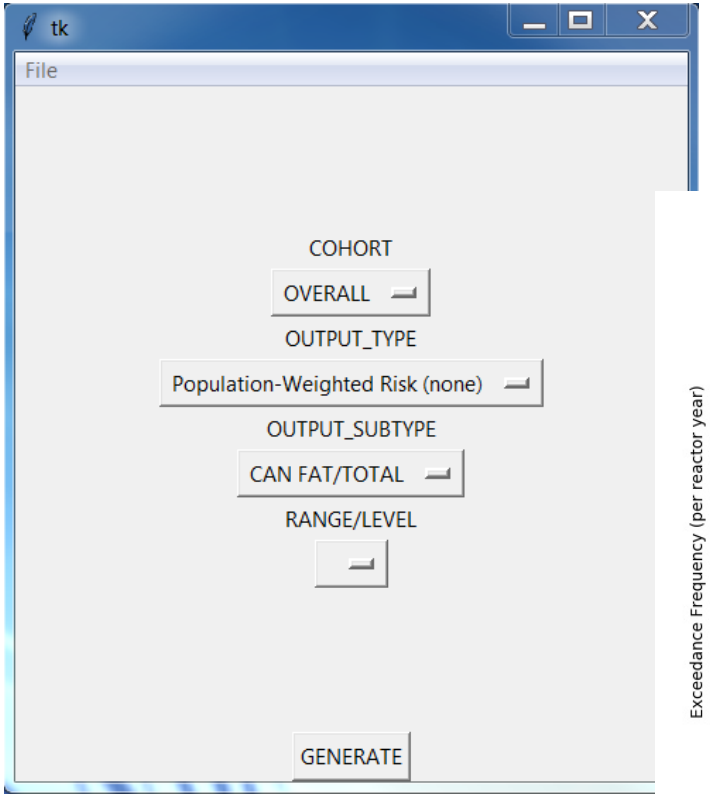
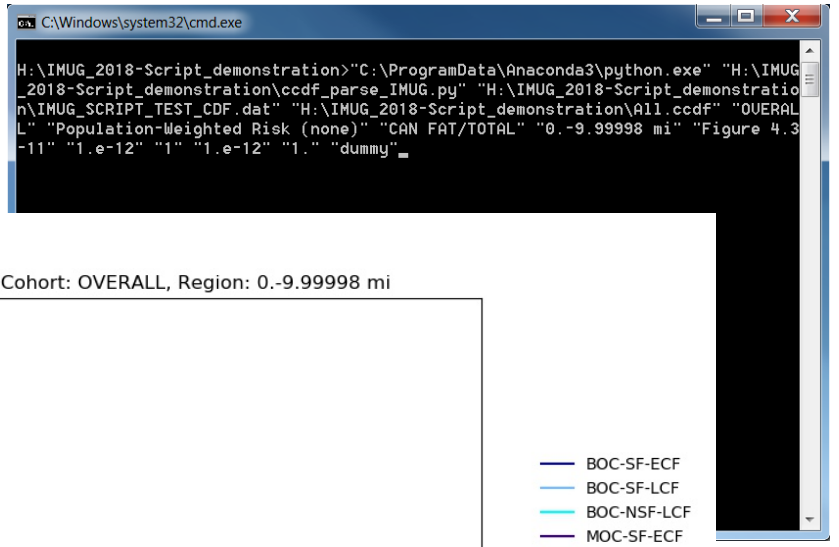
Example Analysis

- Example: Contributions of source terms to overall CCDF
- CCDF results reflect the probability of exceeding a consequence threshold due to variability in the weather



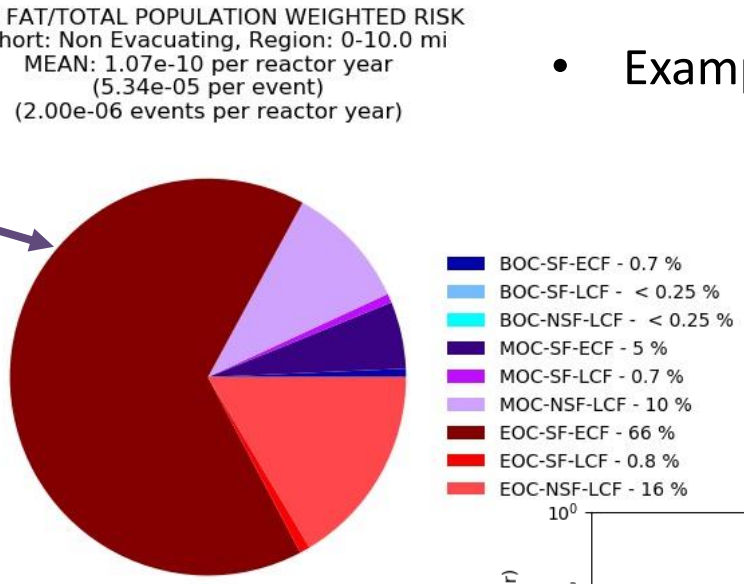


Disclaimer: Results are for demonstration purposes only

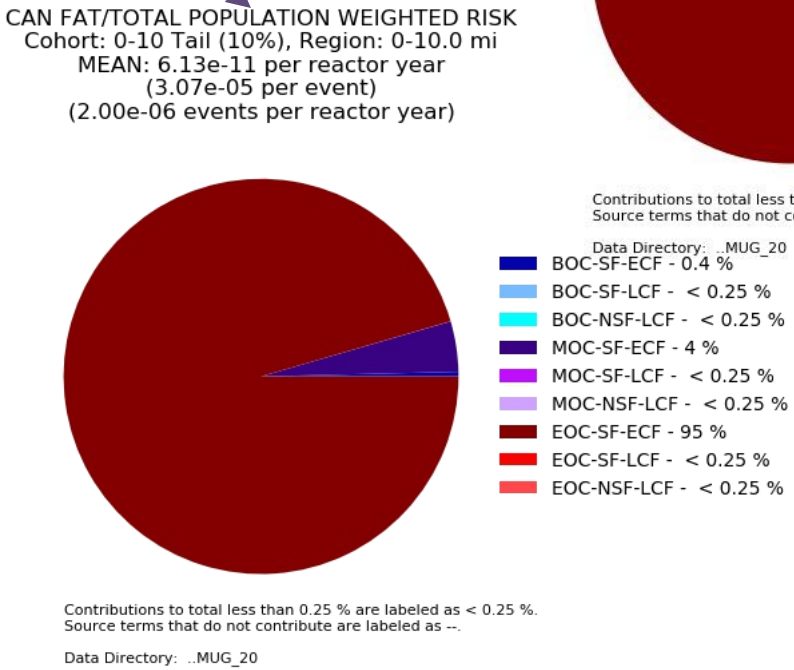
Example Analysis

- Example: Data Exploration

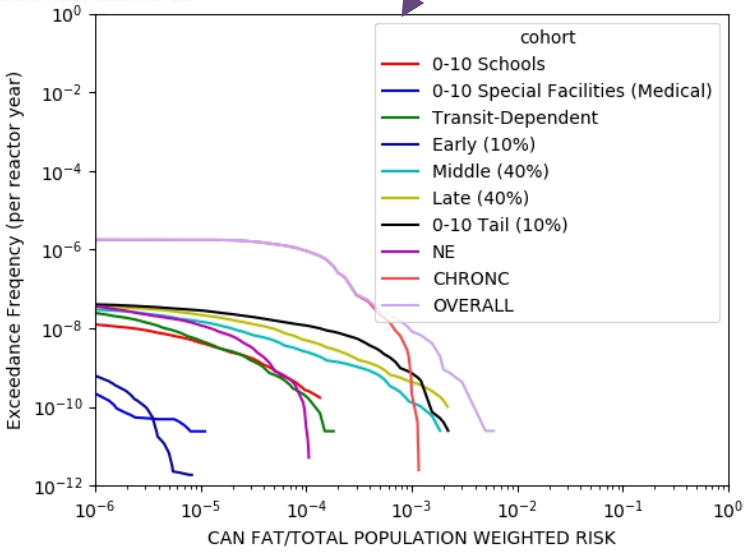
Contribution of source terms to mean value for non-evacuating cohort



Contribution of source terms to mean value for evacuation tail cohort



Contribution of cohorts to overall ccdf



NOTE: When examining ccdf results in this manner, care must be taken to ensure enough trials are run to get good statistics on the individual ccdf curves at lower exceedance frequencies

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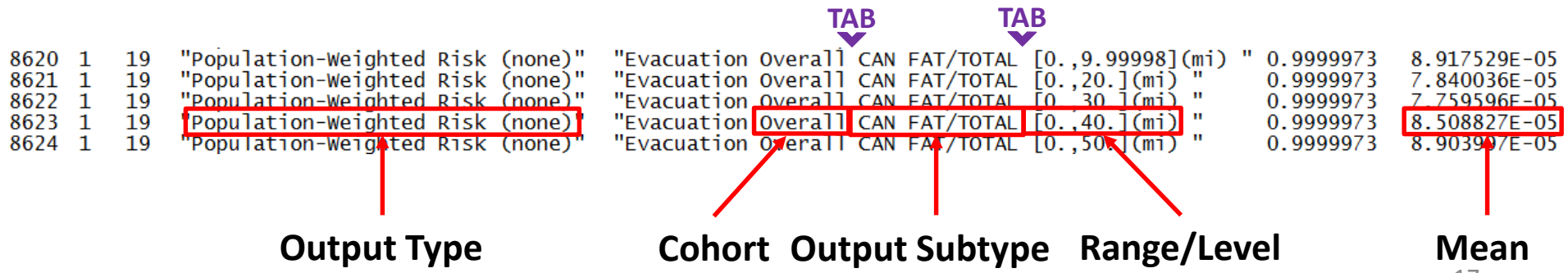
Potential Improvements

- Ability to import MACCS import files through command line input could increase calculation efficiency
- Format all WinMACCS output so that each result is uniquely defined by a set of categories
- Allow the definition of output file names through user input
  - This would aid in the use of cyclic files by providing a unique name

WinMACCS 3.11 Features

- WinMACCS 3.11 can output results to tab delimited text file
  - Change `DEBUG_BIN_RESULTS` flag in WinMACCS.ini file to `TRUE`
    - Binary file contents saved as text file in RESULTS_DB folder
    - `tbl_outStat.txt` and `tbl_outCCDF.txt`



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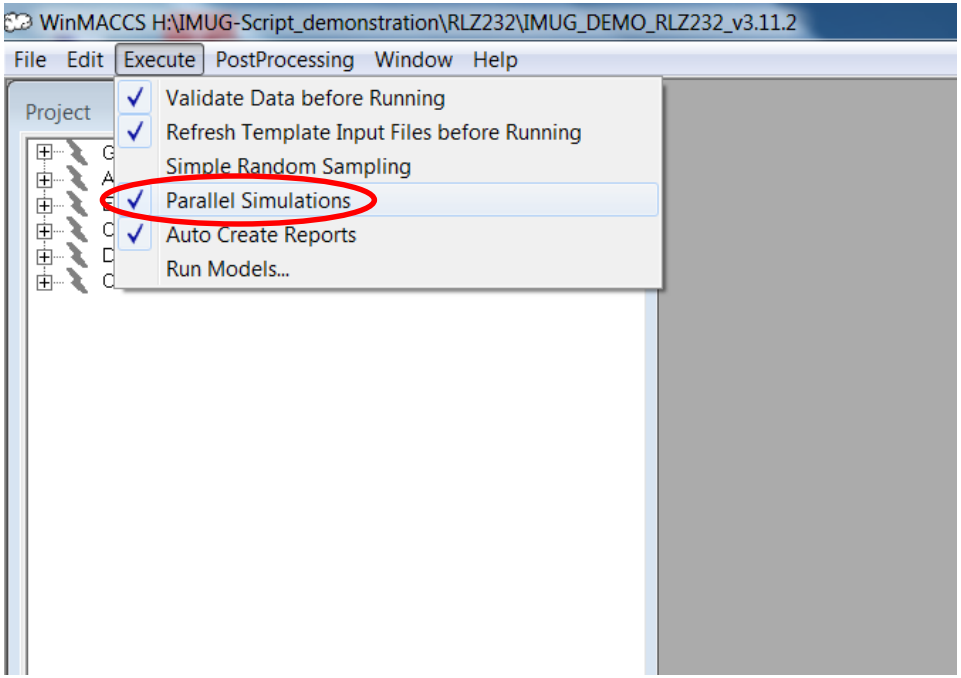
WinMACCS 3.11 Features

- WinMACCS 3.11 can automatically distribute cyclic files across a computer's available processors
  - Increases calculation efficiency by performing multiple jobs in parallel



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Lessons Learned

- Performing MelMACCS calculations in batch mode allows for data traceability in analyses and increases calculation efficiency
- Importing files which apply source term specific input to a base WinMACCS model increases analysis traceability and minimizes potential user error when constructing multiple models
- WinMACCS output results can be uniquely defined by 4 categories
- Using scripting for data-analysis allows for easy data exploration and the construction of consistent figures

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Questions?