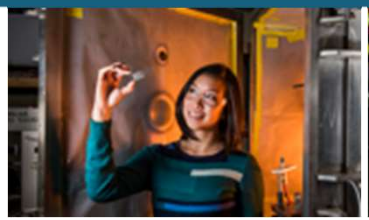
Overview of MACCS
Status and Development



PRESENTED BY

J. E. Leute

Sandia National Laboratories

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Contents

- Current versions
- MACCS background
- MACCS 4.1 updates
- Advanced reactor initiatives
- MACCS modernization
- FogBugz demonstration
- Summary

Current Versions

- MACCS/WinMACCS
  - Latest version is v4.1.0
  - Currently working on v4.2.0
- SecPop
  - Current version is v4.3.0
  - Plan in progress to update with new US census data
- MelMACCS
  - Current version is v2.0.1
  - Currently testing MelMACCS v4.0.0
- AniMACCS
  - Current version is v1.3

Purpose for MACCS

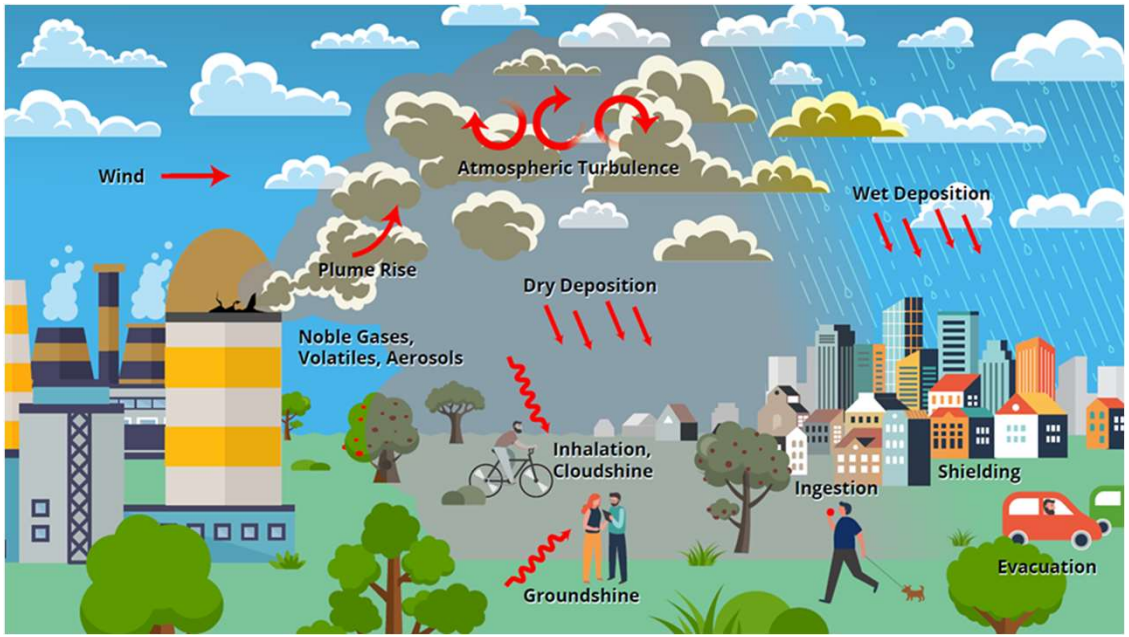
- Created by Sandia to support NRC research and regulatory applications
  - Origins go back to the mid-1970s
- Typically used for prospective analyses, e.g.,
  - Probabilistic risk assessments (NUREG-1150 and NRC's Level 3 PRA)
  - Probabilistic consequence assessments (SOARCA)
  - Cost/benefit analyses (required for environmental analyses in licensing)
- Very versatile with a large set of user inputs
- Intended to run rapidly for PRA applications
  - Large set of weather trials (hundreds or thousands)
  - Significant set of source term categories (ten or twenty) plus additional sensitivity studies

MACCS Lineage

- Calculation of Reactor Accident Consequences (CRAC) Code (1975)
  - Developed for the Reactor Safety Study (WASH-1400)
- CRAC2 (1982)
  - Primarily used in 1982 siting study (NUREG/CR-2239)
- MACCS (MELCOR Accident Consequence Code System) (1990)
  - Primarily used in NUREG-1150
- MACCS2 (1998)
  - Developed to support DOE documented safety analyses of nuclear facilities
- WinMACCS/MACCS (2011)
  - Enhance user friendliness
  - Reduce likelihood of user errors
  - Enable routine examination of uncertainty

Phenomena Treated by MACCS

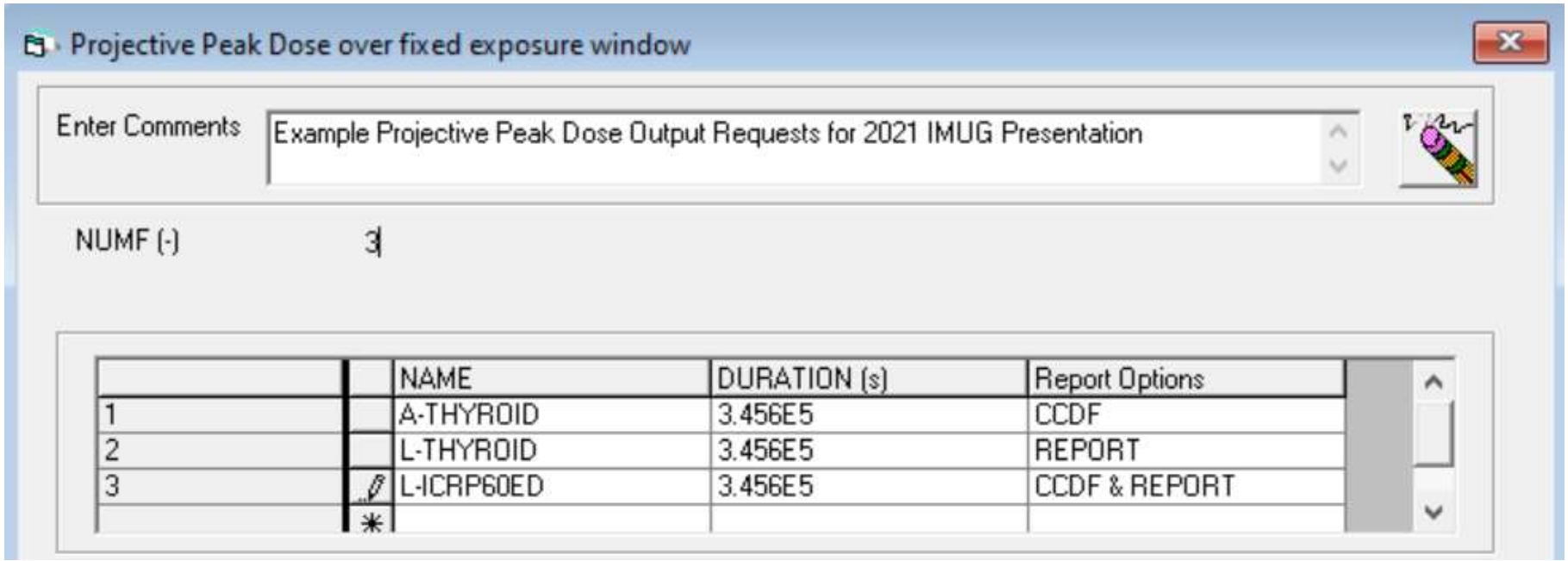
- Representation of source term
- Atmospheric transport and dispersion
  - Statistical sampling of archived weather data
- Wet and dry deposition
- Exposure pathways to humans
  - Inhalation
  - Cloudshine
  - Groundshine
  - Resuspension
  - Ingestion



- Emergency actions
  - Sheltering
  - Evacuation
  - KI ingestion
  - Relocation
- Long-term remedial actions
  - Decontamination
  - Temporary or permanent interdiction of property
  - Crop disposal
- Economic losses
  - Evacuation and relocation per diem costs
  - Long-term relocation cost
  - Decontamination costs
  - Loss of property use
  - Depreciation during interdiction
  - Property value for permanent interdiction

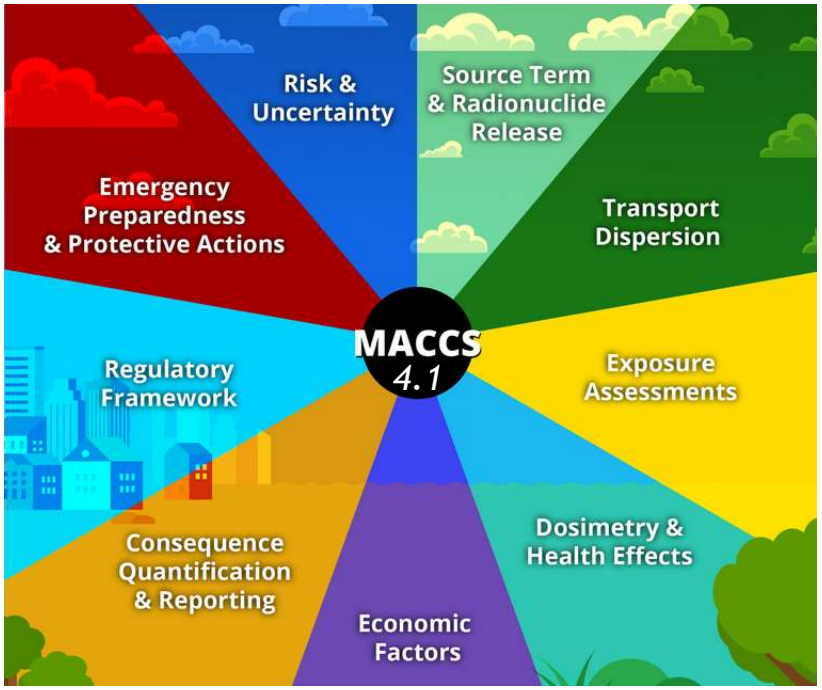
MACCS 4.1 – Released on 30 July 2021!

- Near-field modeling improvements
- New projective peak dose output option
- Documentation added to help menu in WinMACCS
- Updates to the RDEIM economic model
- Mixing layer information for each time period
- Time synchronization
- Pop-up window for converting previous version
- Linux version released in September 2021



Advanced Reactor Initiatives

- Modeling near-field dispersion
  - Release of MACCS 4.1
  - Potential update for HYSPLIT
- Radionuclide screening
  - Preliminary assessment of potentially released radionuclides from HTGRs, MSRs, FHRs, and LMRs
  - Next step to evaluate gaps and priorities for consequence analysis
- MelMACCS update in process:
  - More flexibility for advanced reactor source terms
  - Linux compatibility
  - Incorporating new plume of maximum risk algorithm



MACCS 4.1 was released on 30 July 2021

MACCS Modernization

- Working collaboratively with the US NRC to determine the future vision for MACCS
- Effectively tackle the consequence analysis challenges of the future
  - Incorporate modern programming languages and techniques
  - Be compatible with modern computing platforms
  - Increased flexibly and modularity
  - Support advanced reactor consequence analysis and future model updates

FogBugz Demonstration

- Bug tracking and recommendations for updates
- User account login information to be emailed

New Case

Case Status

Wiki

J.L. Community User

Case List for MACCS Issues and Recommendations

RELEASE MACCS/WINMACCS 4.2 - PLANNED SEPT 2022

Case	Area	Title	Correspondent	Priority	Status
4119	WinMACCS	Fix typo for Keyhole Definition Window		Medium	Resolved

RELEASE MACCS/WINMACCS 4.1 - RELEASED JULY 2021

Case	Area	Title	Correspondent	Priority	Status
4133	WinMACCS	CCDF Plots incorrectly showing (0,0)		Medium	Closed
4132	WinMACCS	Linux Compatability		High	Closed
4131	WinMACCS	Cloudshine Factor Table Updates		High	Closed
4130	WinMACCS	MACCS using incorrect windspeed after reaching boundary weather in creation of AniMACCS files		Low	Closed
4134	WinMACCS	New output for projective peak dose		Medium	Closed
4135	WinMACCS	Crop disposal costs added into RDEIM		Medium	Closed
4039	WinMACCS	Near Field Modeling Updates		High	Closed

RELEASE MACCS/WINMACCS 4.0 - RELEASED JUNE 2020

Case	Area	Title	Correspondent	Priority	Status
4036	MACCS	Multi-source term offset does not properly calculate decay in subsequent source terms		Medium	Closed
4030	MACCS	Potential bug in statistical summary results for 50th, 90th, 95th, 99th, and 99.5th percentile values		High	Closed
4034	MACCS	WINSP2 lower bound does not match WinMACCS interface or draft WinMACCS manual		Pending	Closed
4029	MACCS	Adjusted Source, Q (Ci) percentile values appear incorrect		High	Closed
4028	MACCS	Implement using actual requested values per trial to generate percentile values		High	Closed
4035	MACCS	MNDIST lower bound does not match WinMACCS user interface or		Medium	Closed

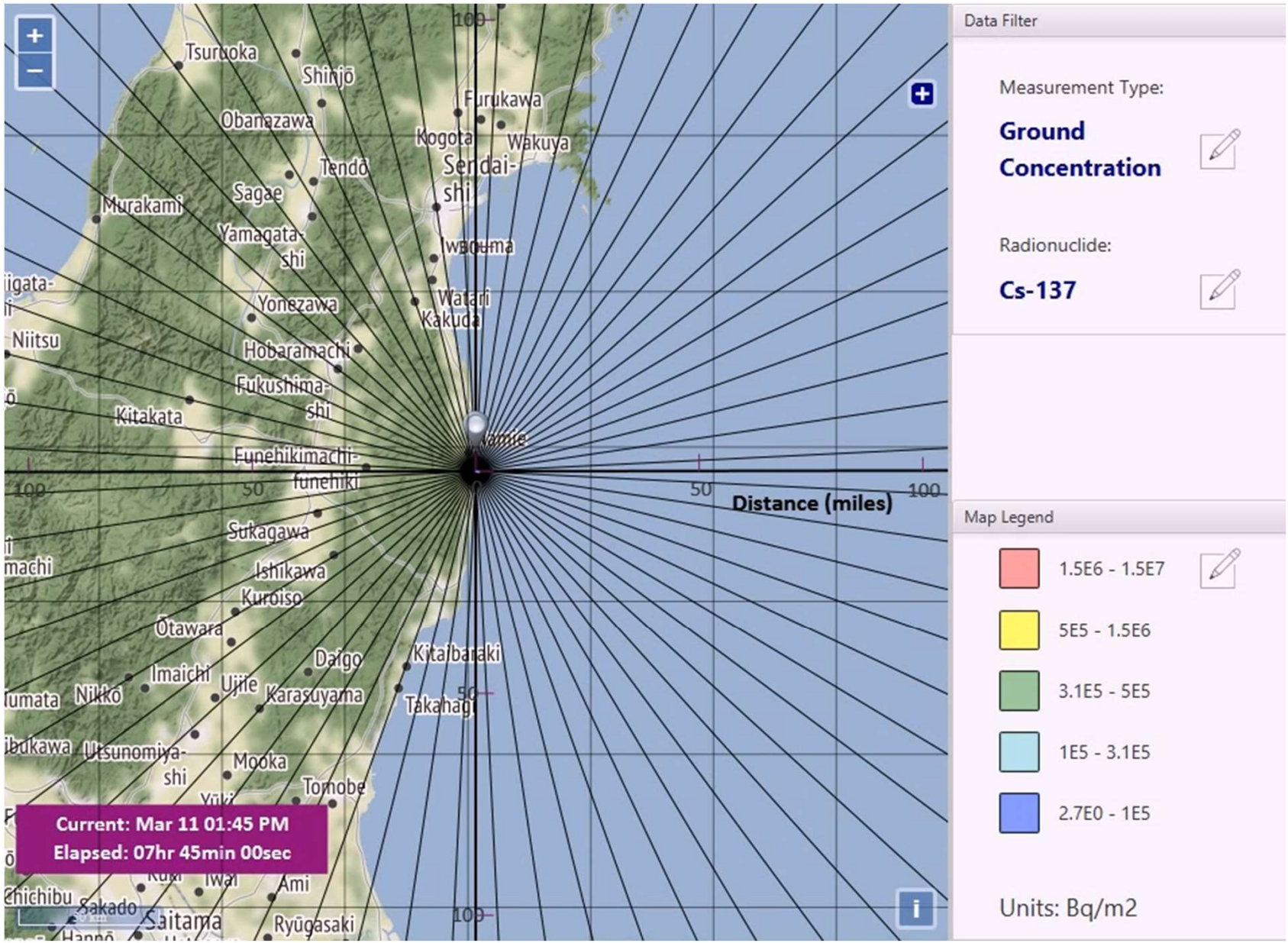
Summary

- MACCS performs prospective consequence analysis of potential atmospheric releases of nuclear materials
- MACCS 4.1 released in July 2021, Linux version released in September 2021
- Several initiatives in progress:
  - MACCS 4.2.0
  - MelMACCS 4.0.0
  - MACCS Modernization
  - FogBugz for bug tracking and update recommendations

List of Acronyms

ATD	Atmospheric Transport and Dispersion
CRAC	Calculation of Reactor Accident Consequences
DCF	Dose Conversion Factor
DOE	Department of Energy
FGR	Federal Guidance Report
GDP	Gross Domestic Product
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory
LNT	Linear No-Threshold
MACCS	MELCOR Accident Consequence Code System
NOAA	National Oceanographic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
PRA	Probabilistic Risk Assessment
RBE	Relative Biological Effectiveness
RDEIM	Regional Disruption Economic Impact Model
SOARCA	State-of-the-Art Reactor Consequence Analyses

Example Application - Fukushima

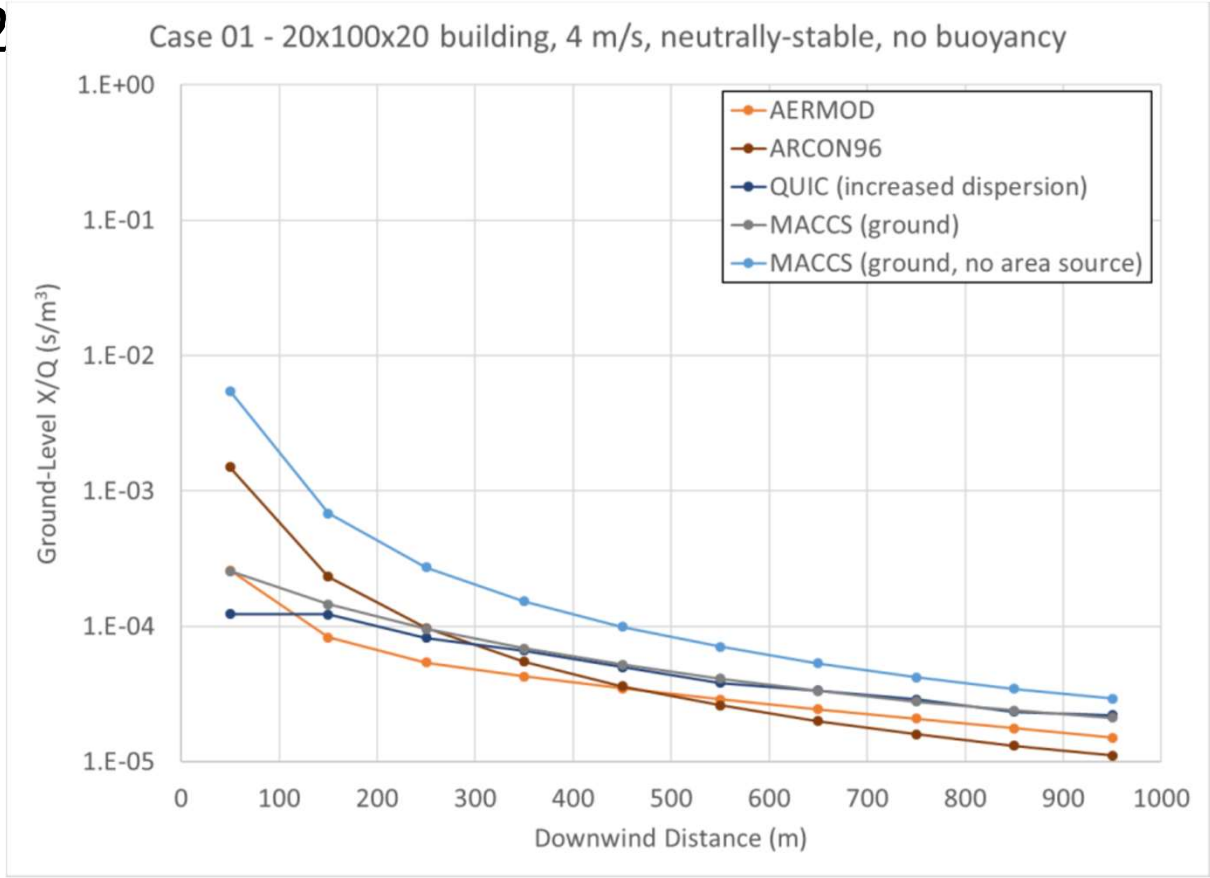


MACCS Code Modules

- ATMOS
  - Calculates transient air and ground concentrations
- EARLY
  - Treats emergency phase (up to 40 days, usually one week)
  - Models emergency response actions
  - Estimates doses from exposure pathways
  - Estimates health effects
- CHRONC
  - Treats intermediate phase (up to 30 years, usually one year)
  - Treats long-term phase (up to >300 years, usually 50 years)
  - Estimates long-term doses from exposure pathways
  - Estimates health effects
  - Calculates economic losses

Nearfield Background

- Previous MACCS User Guide did not recommend MACCS for within 500 meters of the source term
- SAND2020-2609 compared MACCS v3.11.6 to several near-field atmospheric transport and dispersion codes including QUIC, ARCON96, and AERMOD2
- Concluded MACCS provides a conservatively bounding assessment in the nearfield given the proper parameterization

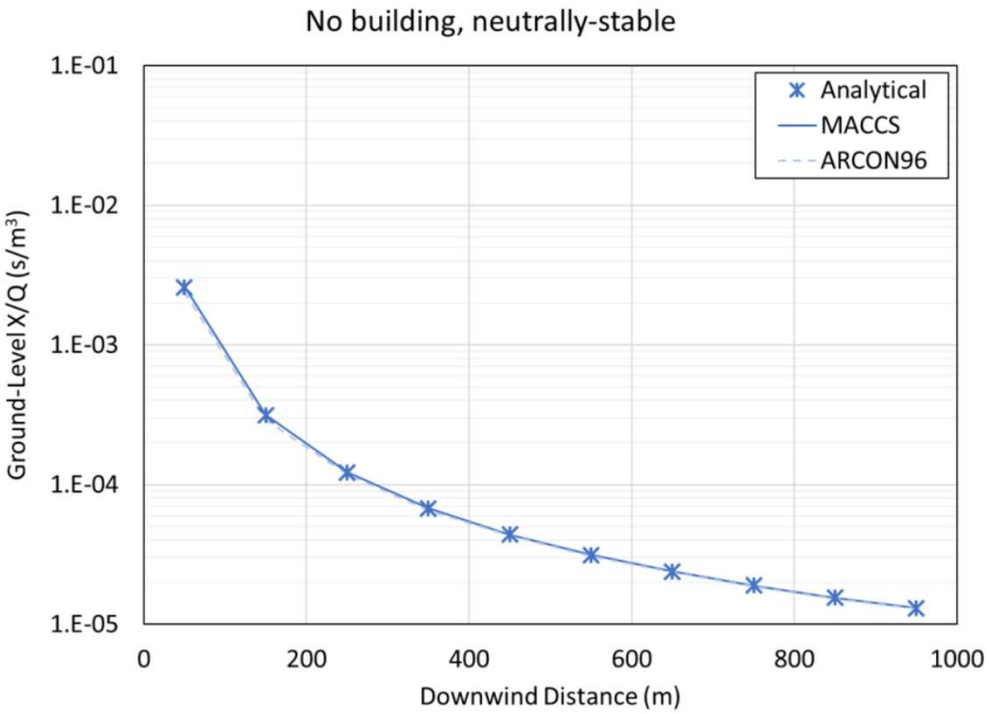


Model Comparison (SAND2020-2609)

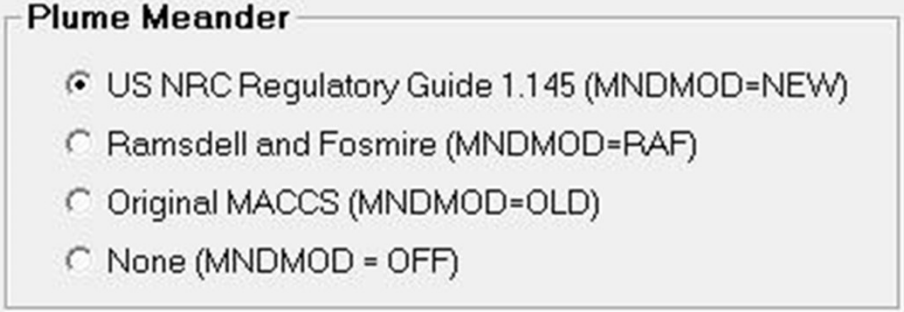
Nearfield Updates

MACCS v4.1 enhancements added for plume meander and trapping and downwash to simulate or bound nearfield assessments of other codes:

- Ramsdell and Fosmire meander model used in ARCON96
  - Accounts for both building wake effects and low wind speed plume meander
- US NRC Regulatory Guide 1.145 meander model as implemented in PAVAN



Model Verification (SAND2021-6924)



Projective Peak Dose

- Peak dose over a fixed exposure window
- Helpful for comparison to emergency response guidelines
- Calculated from the time a plume arrives at a grid element to the end of the given time period
- Maximum of the sum of the different plume releases
- User defines the organ, duration, and report options