URS | URS Safety Management Solutions

# Deposition Velocity Estimation with the GENII v2 Software

# DV Estimation with the GENII v2 Software

- Background on Plume modeling and deposition velocity
- General instruction for using GENII v2 to calculate deposition velocity
- Examination of parameters of concern to deposition velocity
- Comparison of $\chi$/Q calculated using GENII v2 to other software suites

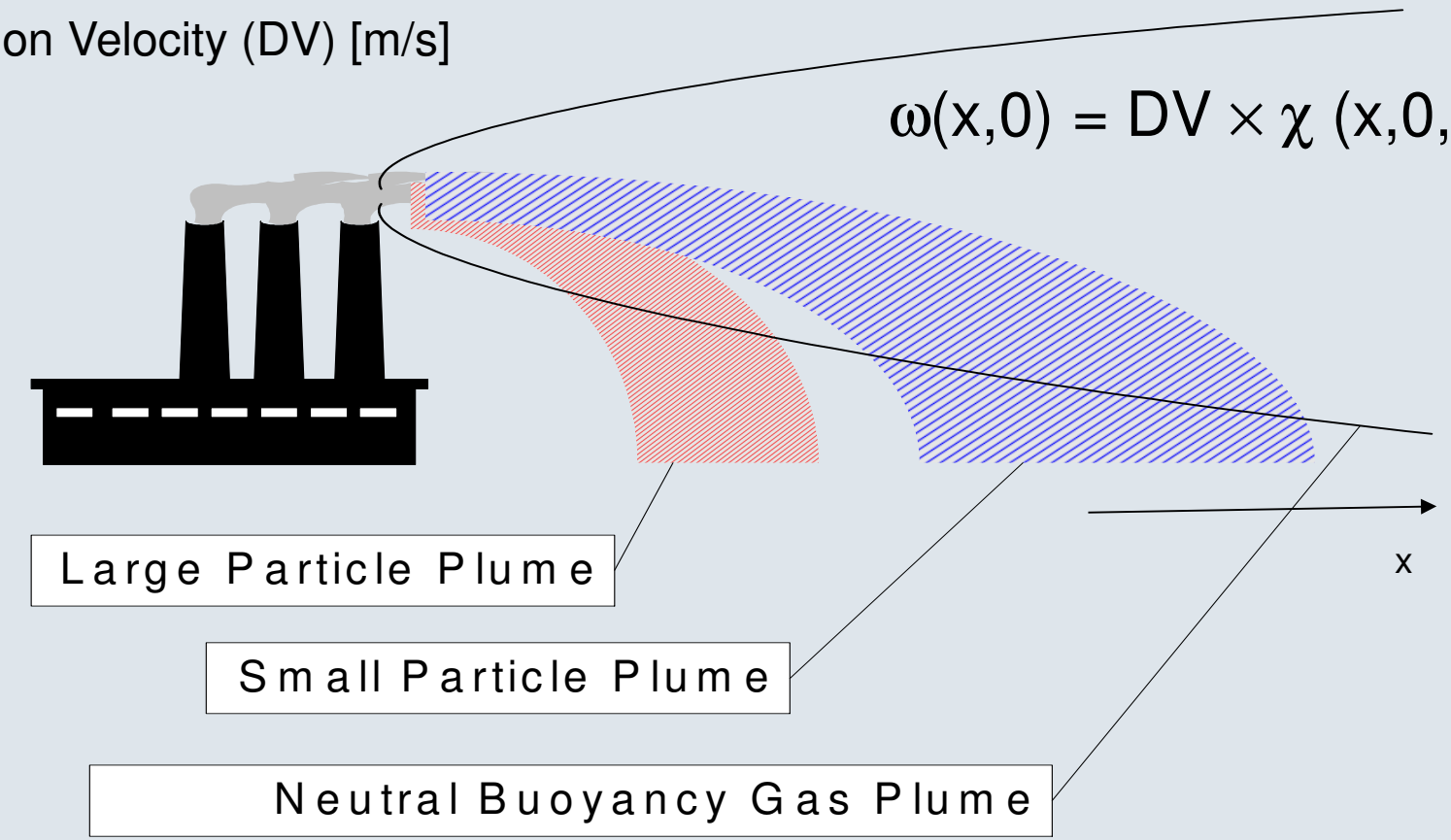
# Plume Modeling - General

Time-integrated Ground Flux ($\omega$) [Ci/m$^2$]

Time-integrated Air Concentration at Ground ($\chi$) [Ci-s/m$^3$]

Deposition Velocity (DV) [m/s]

$$\omega(x,0) = DV \times \chi\,(x,0,0)$$

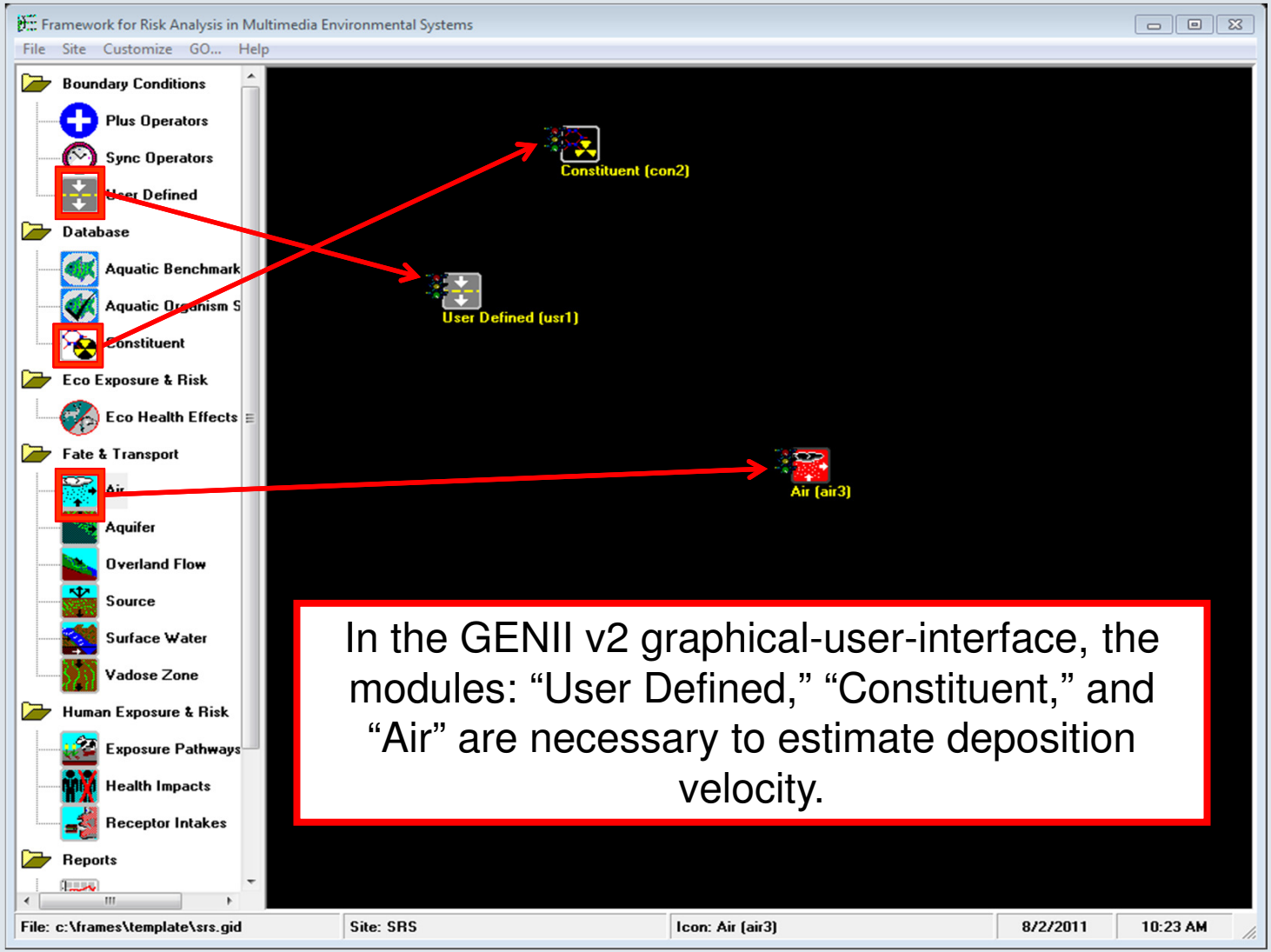


# Background

- **Deposition Velocity (DV) is a Key Input to Atmospheric Transport and Dispersion (ATD) Models (including MACCS2)**
- **Office of Health, Safety and Security (HSS) of the Department of Energy (DOE) Issued Guidance on DV in May 2011**
- **DV, Unfiltered/Unmitigated Release:**
  - Historically, DV = 1.0 cm/s was considered to be reasonably conservative.
  - Option 1: New Default Value: DV = 0.1 cm/s
  - Option 2: Calculate site-specific DV values using GENII v2.10 (GENII2)
  - Option 3: Use more sophisticated code than MACCS2 for ATD analysis

# Option 2: Using GENII v2.10 to Calculate Deposition Velocity

# The GENII v2 GUI




In the GENII v2 graphical-user-interface, the modules: “User Defined,” “Constituent,” and “Air” are necessary to estimate deposition velocity.

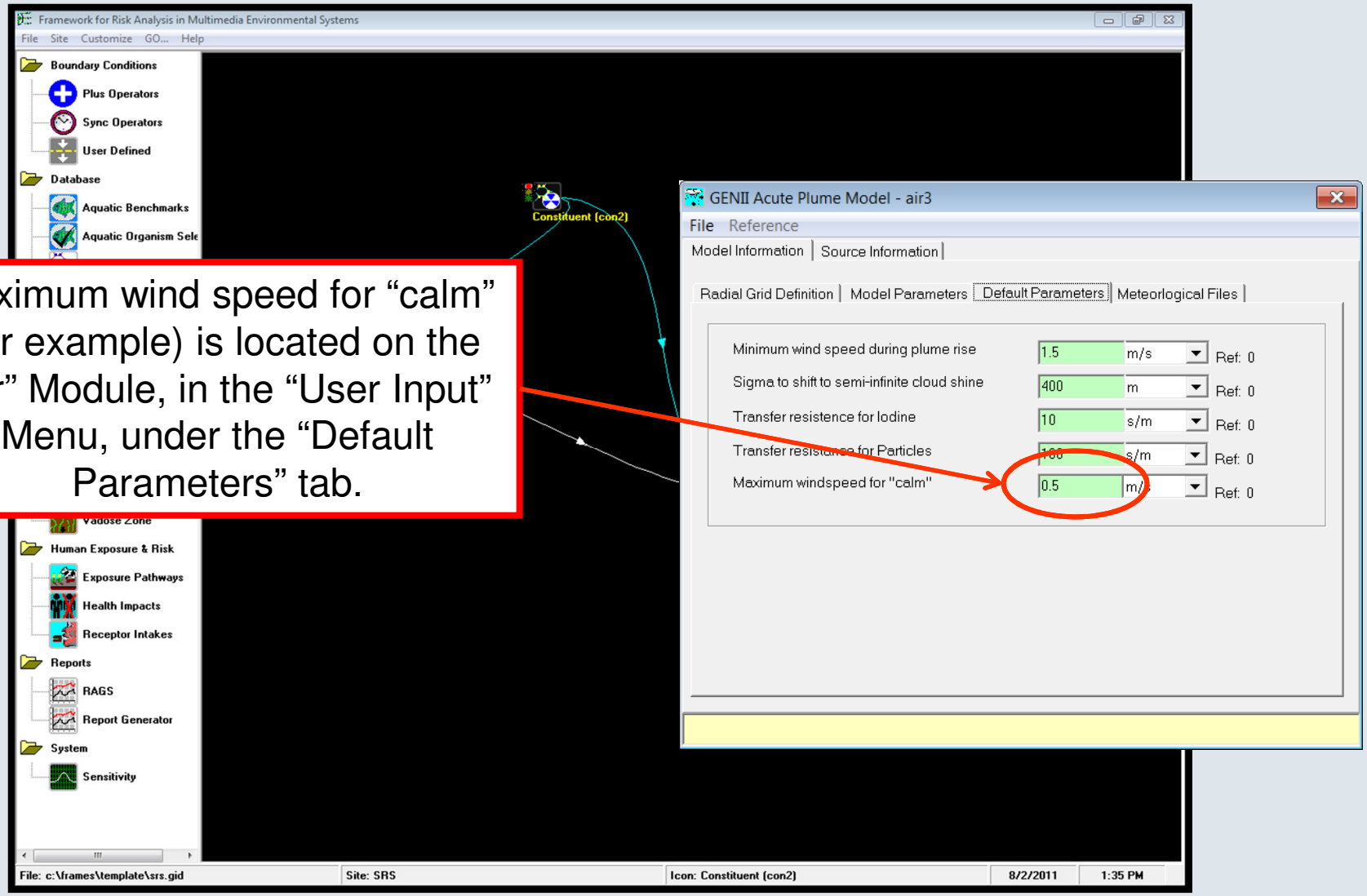
# GENII v2 Data Input

The modules are connected to one another and calculational parameters are entered into each module.

Complete instruction for using GENII v2 are included in the user's guide (PNNL-14583) and "Getting Started with GENII Version 2 FULL Edition" (PNNL-14993).

# GENII v2 Data Input

Maximum wind speed for “calm” (for example) is located on the “Air” Module, in the “User Input” Menu, under the “Default Parameters” tab.



# GENII Meteorological Data

- **The First line of the GENII meteorological input (.met) file provides the surface roughness [m] and the wind speed reference height [m]**
- **Each subsequent line is hourly weather data (separated with spaces) in the format:**

| year | month | day | hour | SC | Flow Vector (deg) | WS (m/s) | dry bulb T (K) | mixing height (m) | precip type | precip Rate (mm/h) | Weighting factor |
|---|---|---|---|---|---|---|---|---|---|---|---|

WIPPofficial05-10 - Notepad

File Edit Format View Help

```
0.10, 10.0
1       1       1       1       5       315     4       300     300     0       0       1
1       1       1       2       6       315     3.3     300     300     0       0       1
1       1       1       3       7       315     3.8     300     300     0       0       1
1       1       1       4       7       292.5   3.1     300     300     0       0       1
1       1       1       5       7       315     2.5     300     300     0       0       1
1       1       1       6       6       0       2.2     300     300     0       0       1
1       1       1       7       6       337.5   1.4     300     300     0       0       1
1       1       1       8       6       315     1.5     300     300     0       0       1
1       1       1       9       6       337.5   2.5     300     300     0       0       1
```

# Excel File with Total Deposition and Air Exposure Output

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ========== | | | | | | | | | | |
| GENII Acute 95% Plume Model Version 2.10 | | | | | | | | | | |
| Run Performed: 13/10/2011 13:31:34. 5 | | | | | | | | | | |
| Output Filename: | | | | | | | | | | |
| Meteorological File used: C:\FRAMES\WIPP_met_2005-2010_10-13-11new.met | | | | | | | | | | |
| ========== | | | | | | | | | | |
| 1 | | | | | | | | | | |
| 1 | air3 | | | | | | | | | |
| All 1 | 1.5 | um | 1 | g/cm^3 | | | | | | |
| acute | polar | grid | 1 | 2005 | 1 | 1 | 1 | 0 | | |
| Plutonium-239 | PU239 | 1 | 0 | | | | | | | |
| 1 | yr | 4 | | | | | | | | |
| Air Exposure | All 1 | | (Bq-s)/m^3 | 10 | m | 16 | deg | | | |
| | 100 | 500 | 900 | 1200 | 1500 | 1800 | 2100 | 2400 | 2700 | 3000 |
| 22.5 | 9.35E+08 | 6.68E+07 | 2.37E+07 | 1.44E+07 | 9.79E+06 | 7.23E+06 | 5.62E+06 | 4.53E+06 | 3.76E+06 | 3.18E+06 |
| 45 | 8.02E+08 | 5.52E+07 | 1.95E+07 | 1.16E+07 | 7.92E+06 | 5.86E+06 | 4.56E+06 | 3.69E+06 | 3.06E+06 | 2.59E+06 |
| 67.5 | 7.68E+08 | 5.35E+07 | 1.91E+07 | 1.14E+07 | 7.79E+06 | 5.68E+06 | 4.43E+06 | 3.52E+06 | 2.90E+06 | 2.45E+06 |
| 90 | 6.72E+08 | 4.47E+07 | 1.60E+07 | 9.74E+06 | 6.62E+06 | 4.87E+06 | 3.78E+06 | 3.04E+06 | 2.51E+06 | 2.12E+06 |
| 112.5 | 9.35E+08 | 6.68E+07 | 2.37E+07 | 1.44E+07 | 9.79E+06 | 7.23E+06 | 5.62E+06 | 4.53E+06 | 3.76E+06 | 3.18E+06 |
| 135 | 1.03E+09 | 6.75E+07 | 2.37E+07 | 1.44E+07 | 9.79E+06 | 7.23E+06 | 5.62E+06 | 4.53E+06 | 3.76E+06 | 3.18E+06 |
| 157.5 | 1.08E+09 | 6.97E+07 | 2.48E+07 | 1.50E+07 | 1.02E+07 | 7.53E+06 | 5.85E+06 | 4.72E+06 | 3.91E+06 | 3.31E+06 |
| 180 | 1.08E+09 | 7.28E+07 | 2.59E+07 | 1.56E+07 | 1.06E+07 | 7.85E+06 | 6.10E+06 | 4.92E+06 | 4.08E+06 | 3.45E+06 |
| 202.5 | 1.19E+09 | 8.44E+07 | 2.99E+07 | 1.80E+07 | 1.23E+07 | 9.04E+06 | 7.02E+06 | 5.66E+06 | 4.68E+06 | 3.96E+06 |
| 225 | 1.19E+09 | 8.02E+07 | 2.84E+07 | 1.71E+07 | 1.17E+07 | 8.61E+06 | 6.69E+06 | 5.39E+06 | 4.46E+06 | 3.77E+06 |
| 247.5 | 1.19E+09 | 8.02E+07 | 2.84E+07 | 1.71E+07 | 1.17E+07 | 8.61E+06 | 6.69E+06 | 5.39E+06 | 4.46E+06 | 3.77E+06 |
| 270 | 1.13E+09 | 7.90E+07 | 2.71E+07 | 1.63E+07 | 1.11E+07 | 8.21E+06 | 6.38E+06 | 5.14E+06 | 4.26E+06 | 3.60E+06 |
| 292.5 | 1.03E+09 | 7.28E+07 | 2.59E+07 | 1.56E+07 | 1.06E+07 | 7.85E+06 | 6.10E+06 | 4.92E+06 | 4.08E+06 | 3.45E+06 |
| 315 | 9.77E+08 | 6.97E+07 | 2.48E+07 | 1.50E+07 | 1.02E+07 | 7.53E+06 | 5.85E+06 | 4.72E+06 | 3.91E+06 | 3.31E+06 |
| 337.5 | 1.02E+09 | 6.97E+07 | 2.48E+07 | 1.50E+07 | 1.02E+07 | 7.53E+06 | 5.85E+06 | 4.72E+06 | 3.91E+06 | 3.31E+06 |
| 360 | 1.14E+09 | 8.02E+07 | 2.84E+07 | 1.71E+07 | 1.17E+07 | 8.61E+06 | 6.69E+06 | 5.39E+06 | 4.46E+06 | 3.77E+06 |
| Total Deposition | All 1 | dry | Bq/m^2 | 10 | m | 16 | deg | | | |
| 100 | 500 | 900 | 1200 | 1500 | 1800 | 2100 | 2400 | 2700 | 3000 | |
| 22.5 | 2.72E+06 | 1.95E+05 | 6.92E+04 | 4.18E+04 | 2.85E+04 | 2.11E+04 | 1.64E+04 | 1.32E+04 | 1.10E+04 | 9.27E+03 |
| 45 | 2.54E+06 | 1.56E+05 | 5.41E+04 | 3.95E+04 | 2.70E+04 | 2.00E+04 | 1.56E+04 | 1.26E+04 | 1.04E+04 | 8.84E+03 |
| 67.5 | 2.56E+06 | 1.82E+05 | 6.52E+04 | 3.20E+04 | 2.17E+04 | 1.98E+04 | 1.54E+04 | 5.77E+03 | 8.18E+03 | 6.89E+03 |
| 90 | 2.44E+06 | 1.72E+05 | 6.16E+04 | 3.74E+04 | 2.10E+04 | 1.54E+04 | 1.20E+04 | 9.62E+03 | 7.94E+03 | 6.70E+03 |
| 112.5 | 2.72E+06 | 1.95E+05 | 6.92E+04 | 4.18E+04 | 2.85E+04 | 2.11E+04 | 1.64E+04 | 1.32E+04 | 1.10E+04 | 9.27E+03 |
| 135 | 2.70E+06 | 1.56E+05 | 6.92E+04 | 4.18E+04 | 2.85E+04 | 2.11E+04 | 1.64E+04 | 1.32E+04 | 1.10E+04 | 9.27E+03 |
| 157.5 | 2.84E+06 | 1.97E+05 | 6.99E+04 | 4.22E+04 | 2.88E+04 | 2.13E+04 | 1.65E+04 | 1.33E+04 | 1.10E+04 | 9.34E+03 |
| 180 | 2.84E+06 | 1.99E+05 | 7.07E+04 | 4.27E+04 | 2.91E+04 | 2.15E+04 | 1.67E+04 | 1.35E+04 | 1.11E+04 | 9.42E+03 |
| 202.5 | 2.92E+06 | 2.06E+05 | 7.30E+04 | 4.40E+04 | 3.00E+04 | 2.21E+04 | 1.72E+04 | 1.38E+04 | 1.14E+04 | 9.66E+03 |
| 225 | 2.92E+06 | 2.04E+05 | 7.22E+04 | 4.35E+04 | 2.97E+04 | 2.19E+04 | 1.70E+04 | 1.37E+04 | 1.13E+04 | 9.58E+03 |
| 247.5 | 2.92E+06 | 2.04E+05 | 7.22E+04 | 4.35E+04 | 2.97E+04 | 2.19E+04 | 1.70E+04 | 1.37E+04 | 1.13E+04 | 9.58E+03 |
| 270 | 2.87E+06 | 1.93E+05 | 7.14E+04 | 4.31E+04 | 2.94E+04 | 2.17E+04 | 1.68E+04 | 1.36E+04 | 1.12E+04 | 9.50E+03 |
| 292.5 | 2.70E+06 | 1.99E+05 | 7.07E+04 | 4.27E+04 | 2.91E+04 | 2.15E+04 | 1.67E+04 | 1.35E+04 | 1.11E+04 | 9.42E+03 |
| 315 | 2.76E+06 | 1.97E+05 | 6.99E+04 | 4.22E+04 | 2.88E+04 | 2.13E+04 | 1.65E+04 | 1.33E+04 | 1.10E+04 | 9.34E+03 |
| 337.5 | 2.80E+06 | 1.97E+05 | 6.99E+04 | 4.22E+04 | 2.88E+04 | 2.13E+04 | 1.65E+04 | 1.33E+04 | 1.10E+04 | 9.34E+03 |
| 360 | 2.63E+06 | 2.04E+05 | 7.22E+04 | 4.35E+04 | 2.97E+04 | 2.19E+04 | 1.70E+04 | 1.37E+04 | 1.13E+04 | 9.58E+03 |

DV = 95th percentile time-integrated ground flux ("Total Deposition," $\omega$) divided by the 95th percentile time-integrated air concentration ("Air Exposure," $\chi$) for each defined distance and compass sector.

$$\omega = DV \times \chi$$

$$DV = \frac{\omega}{\chi}$$

# Parameters of Importance to Deposition Velocity

# Parametric Study Inputs

**Parameters examined in this study are determined by the geographical and meteorological conditions of the location for which dose assessment is to be performed.**

**Deposition Velocity could also be impacted by the particle size and density (which was not examined in this study). The HSS safety bulletin recommends 2-4 µm.**

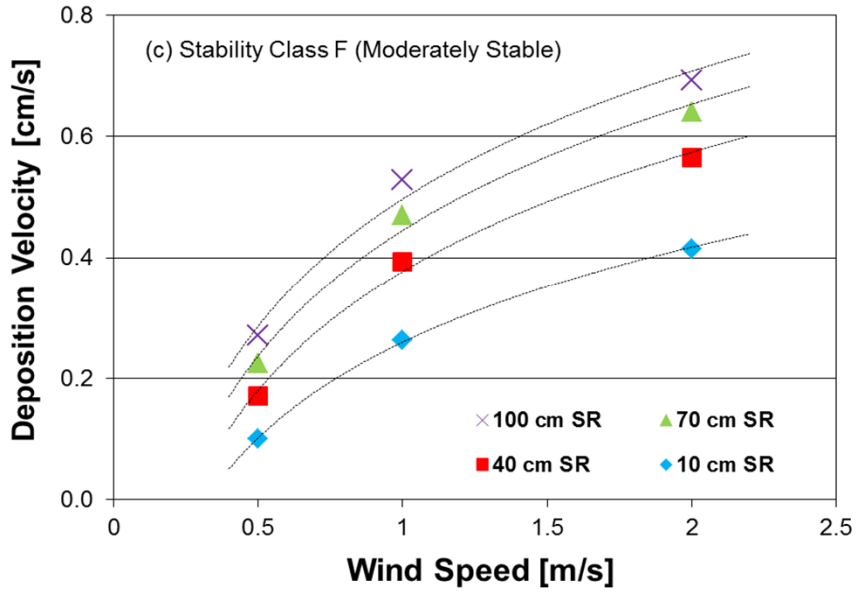
| Input # | Parameter (units) | Value |
|---|---|---|
| 1 | Wind Speed (m/s) | 0.5, 1.0, 2.0 |
| 2 | Stability Class | D (neutrally stable), E (slightly stable), F (moderately stable) |
| 3 | Surface Roughness Length (m) | 0.1, 0.4, 0.7, 1.0 |

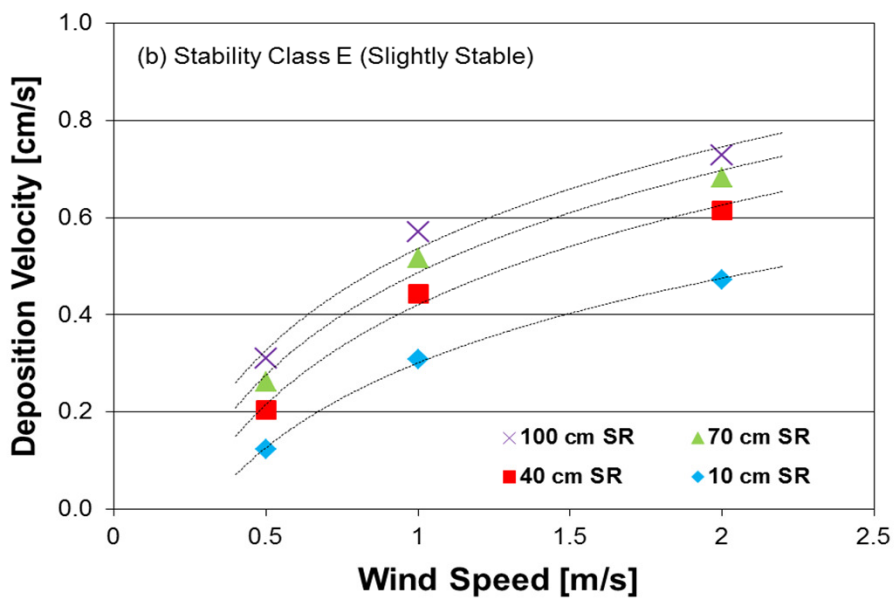
# Parametric Study Results

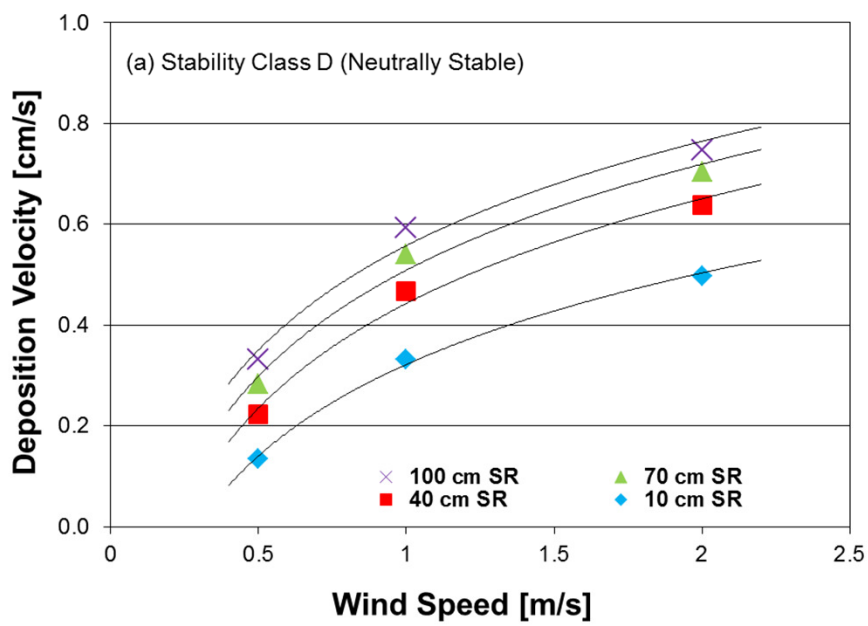
**DV** is observed to **increase slightly** with respect to **stability class**

**DV** is observed to **increase moderately** with respect to **surface roughness**

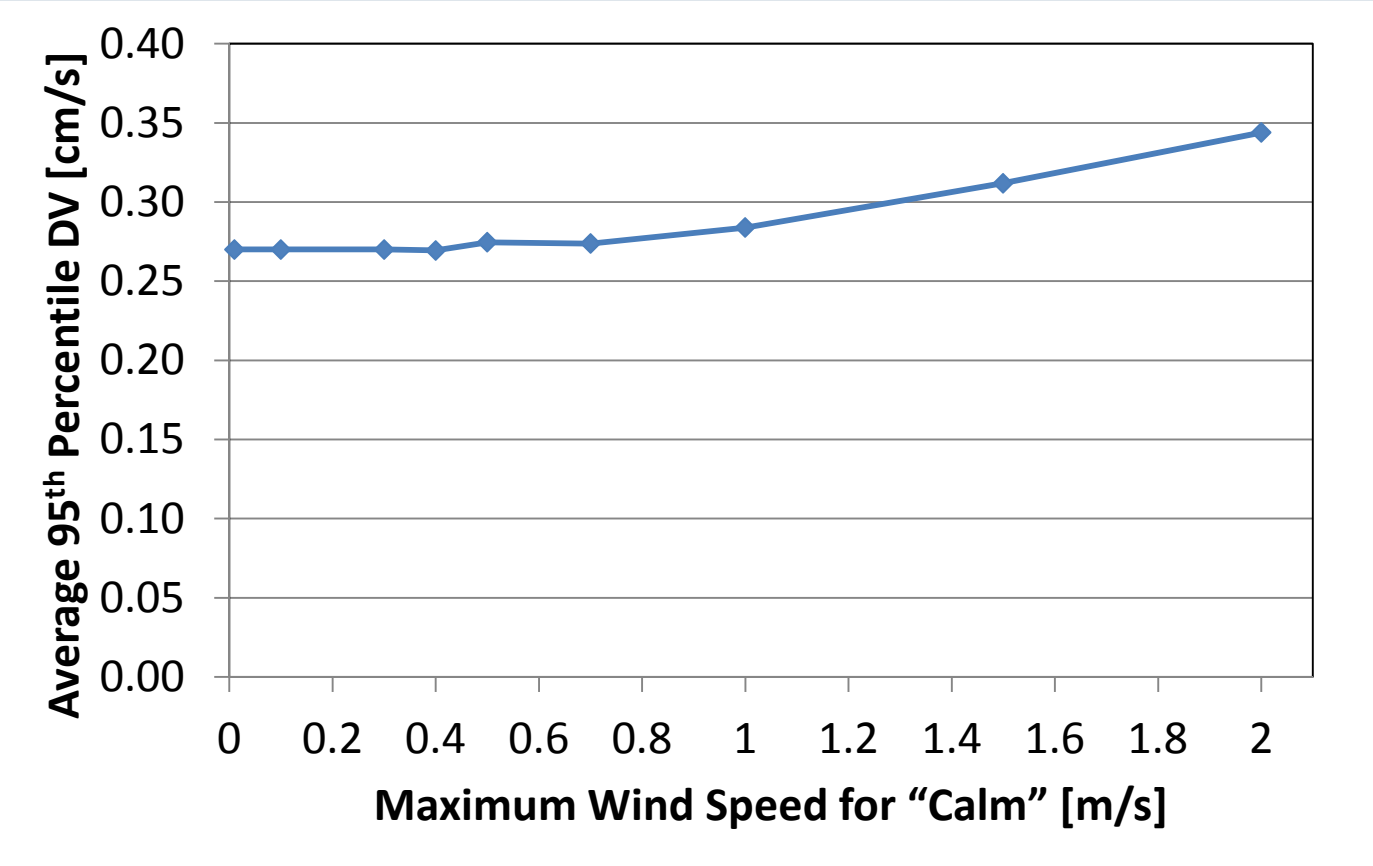
**DV** is observed to **increase greatly** with respect to **wind speed**



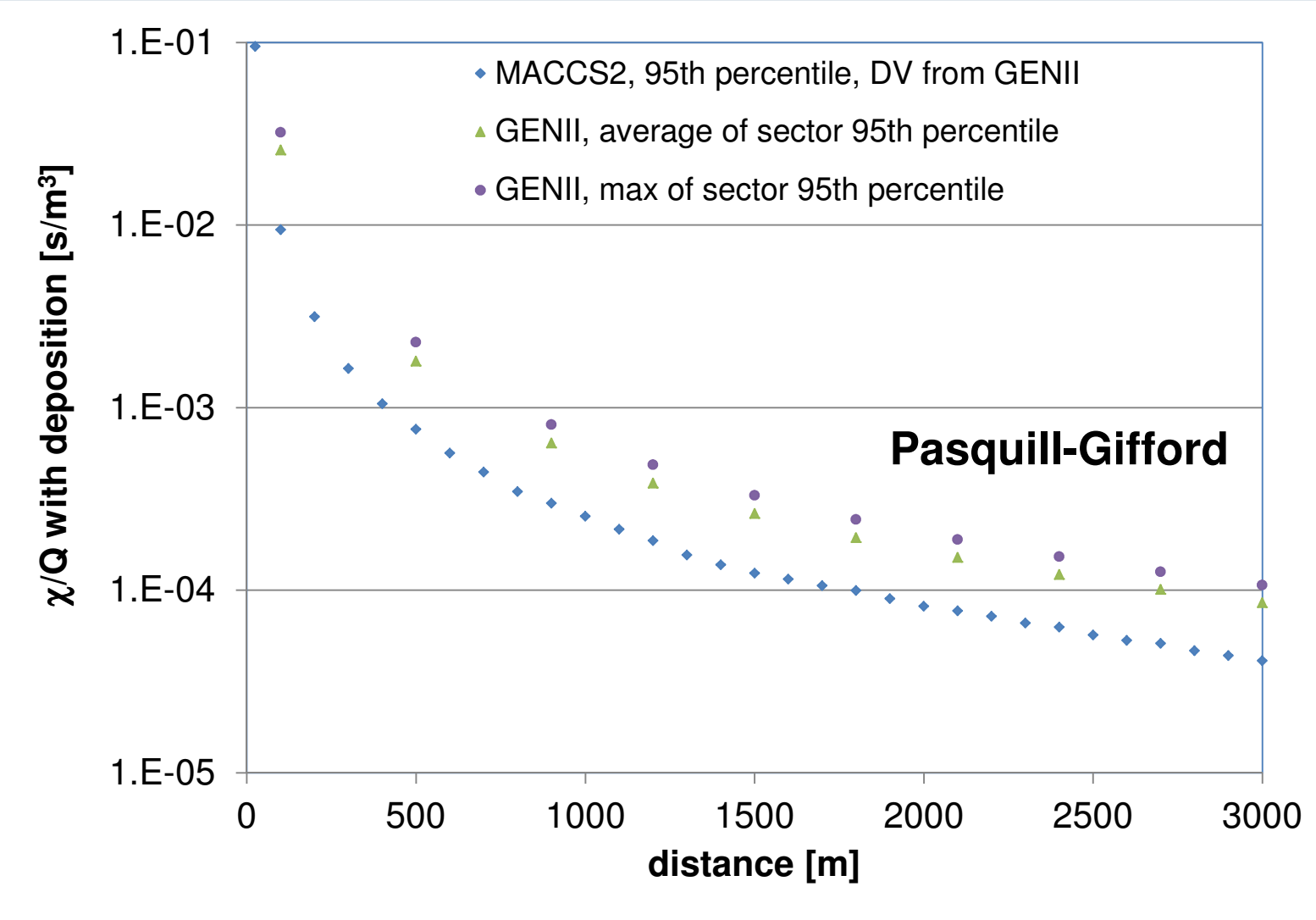
# Sensitivity of DV to Maximum Wind Speed for Calm



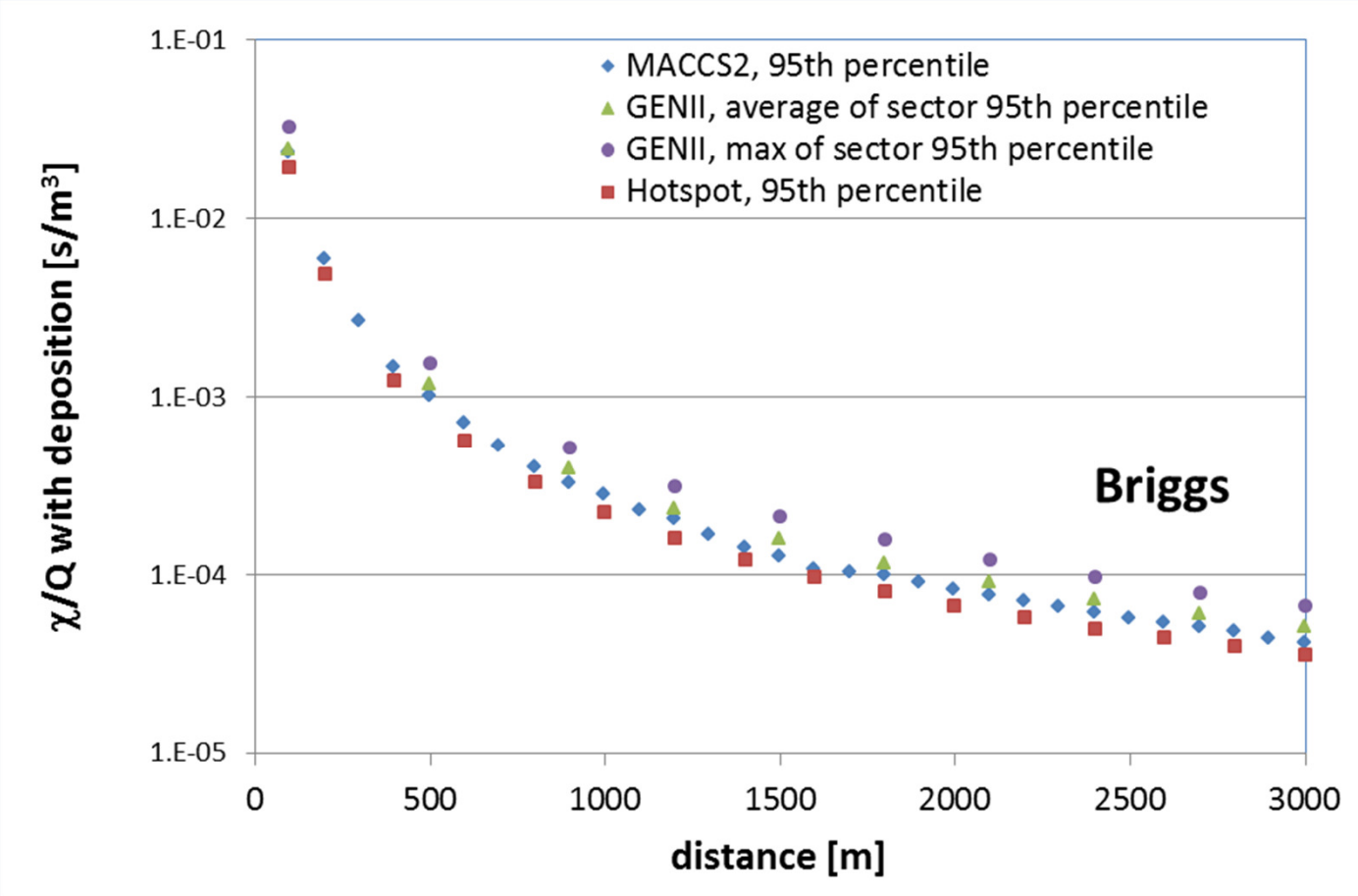

**Sensitivity of DV to the maximum wind speed under calm conditions will vary depending on the meteorological data and surface roughness data. It is observed to be relatively low in this instance.**

# Comparison of $\chi$/Q calculated using GENII v2 to other software suites

# Comparison of Results



# Comparison of MACCS2, GENII and Hotspot




**Briggs dispersion coefficients and 3 cm surface roughness were used to compare 3 software suites. Doses calculated using hotspot were converted to χ/Q values.**

# Conclusions

- **The DV results of the parametric study ranged from 0.1 cm/s to 0.75 cm/s.**
  - These values are based on a range of surface roughness lengths (10 cm to 100 cm) representative of most DOE sites, and on a range of meteorological conditions that likely reflect 95$^{th}$ percentile conditions for the sites.
  - The lower bound of the sensitivity study coincides with the conservative 0.1 cm/s value associated with "Option 1."
- **When estimated with GENII v2, deposition velocity is most sensitive to wind speed and surface roughness length.**
- **Greater disparity between $\chi$/Q values calculated by GENII v2 and other software suites was observed when Pasquill-Gifford dispersion coefficients were used.**

# References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- DOE-STD-3009-94. *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, Change Notice 3, March 2006, U.S. Department of Energy, Washington, DC.
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