Table A 1. Complete list of field studies for field estimated1,3-D flux submitted to DPR between 1992 - 2015.

Reference number	Study	Experiment	Application date	Location	Application			Duration (day)	Tarp type	Tarp cutting (day)
					Type	Depth (in)	Rate (lbs/ac)			
1	Knuteson, et al. 1992a	1	Feb-91	Imperial, CA	Broadcast	18	68.19	8	NA	NA
2		2	Feb-91	Imperial, CA	Broadcast	18	120.13	8	NA	NA
3	Knuteson, et al. 1992b	1	Sep-91	Salinas, CA	Broadcast	18	121.21	14	NA	NA
4	Knuteson, et al. 1995	1	May-93	Firebaugh, CA	Bed	21	119.24	21	NA	NA
5	Gillis and Dowling, 1999	1	Oct-95	Salinas, CA	Broadcast	14	121.51	14	NA	NA
6		2	Nov-95	Salinas, CA	Bed	12	67.41	14	NA	NA
7	van Wesenbeeck and Philips, 2000	1	Dec-98	Douglas, GA	Drip	0	67.23	14	PE	No cut
8	Knuteson and Dolder, 2000	1	Oct-98	Salinas, CA	Drip	0	127.97	19	VIF	No cut
9		2	Oct-98	Salinas, CA	Drip	0	127.97	19	VIF	No cut
10	van Wesenbeeck, et al., 2001	1	Jan-98	Rio Grande, TX	Drip	5	39.33	14	NA	NA
11	Ajwa, et al., 2011a	1	Jan-09	Duette, FL	Bed	8	126.60	9	MP	No cut
12		2	Jan-09	Duette, FL	Bed	8	129.40	9	VIF	No cut
13	Ajwa, et al., 2011b	1	Oct-09	Salinas, CA	Drip	5	374.40	6	NA	NA
14		2	Oct-09	Salinas, CA	Drip	0	374.40	6	LDPE	5
15	Ajwa and Sullivan, 2012a	1	Jun-11	Lost Hills, CA	Broadcast	12	230.80	18	TIF	16
16		2	Jun-11	Lost Hills, CA	Broadcast	12	221.00	12	TIF	10
17		3	Jun-11	Lost Hills, CA	Broadcast	12	239.80	7	TIF	5
18		4	Jun-11	Lost Hills, CA	Broadcast	12	241.00	7	TIF	5
19	Ajwa and Sullivan, 2012b	1	Sep-09	Oxnard, CA	Broadcast	12	122.80	14	PE	6
20		2	Sep-09	Oxnard, CA	Broadcast	12	126.39	14	TIF	6
21	Ajwa, et al., 2012	1	Nov-09	Fort Pierce, FL	Broadcast	8	153.50	10	HDPE	No cut
22		2	Nov-09	Fort Pierce, FL	Broadcast	8	146.25	10	HDPE	No cut
23	Ajwa, 2015	1	Sep-14	Salinas, CA	Drip	0	173.11	13	TIF	No cut

Table B-1. Input variables required for HYDRUS simulations and their data source.

HYDRUS Input		Source
Dimension of simulation domain		Simulated study
Duration of study		
Application depth		
Application start time and duration		
Amount of applied fumigant		
Amount of applied water and fumigant concentration (chemigation)		
Atmospheric evaporative demand		
Soil textural properties		
$T_z(0)$ (C)	soil initial temperature as a function of depth	
$T_0(t)$ (C)	soil surface temperature as a function of time *t*	
θ_i (-)	initial water content	
ρ_b	soil bulk density	
θ_s (-)	saturated water content	ROSETTA
θ_r (-)	residual water content	
α (cm^{-1})	VG retention model parameter	
n (-)	VG retention model parameter	
K_s ($cm\ h^{-1}$)	saturated hydraulic conductivity	
OC ($g_{OC}\ g_{soil}^{-1}$)	soil organic carbon mass fraction	Brown (2018)
C_n ($J\ cm^3\ K^{-1}$)	volumetric solid phase heat capacity	
λ_L, b_1, b_2, b_3	soil thermal conductivity parameters	
D_g ($cm^2\ h^{-1}$)	gas phase diffusion coefficient	
D_gE_a ($J\ mol^{-1}$)	D_g activation energy	
D_w ($cm^2\ h^{-1}$)	aqueous phase diffusion coefficient	
D_wE_a ($J\ mol^{-1}$)	D_w activation energy	
K_h (-)	Henry's law constant	
K_hE_a (-)	K_h activation energy	
k_1 (h^{-1})	first-order degradation rate constant	
k_1E_a ($J\ mol^{-1}$)	k_1 activation energy	
K_d ($cm^3\ g^{-1}$)	soil partition coefficient	
d (cm)	tarp boundary layer depth	
λ_w (cm)	longitudinal dispersivity	

Concentration of fumigant at injection time

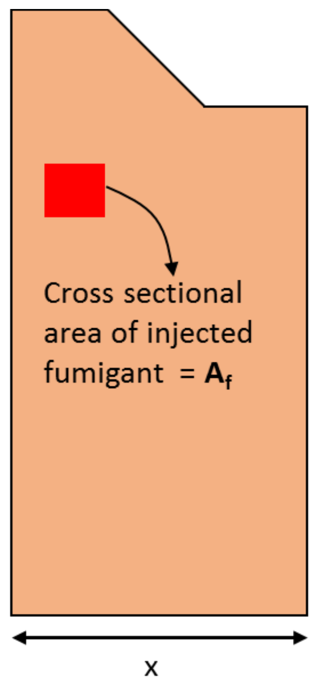

Figure 1. An exmple of HYDRUS domain for bed application.

The fumigant application rate, R_f, is usually given in units of either lbs/ac or kg/ha. In order to determine the amount of fumigant applied to the area represented in HYDRUS model, A, the application rate should be multiplied by the area represented in HYDRUS model, A.

Assuming that the length unit used in HYDRUS is cm, the area represented in HYDRUS model can be calculated as follow:

$$A\ (cm^2) = x\ (cm) \times 1(cm) \quad (1)$$

It should be noted that the thickness of the HYDRUS domain (in plannar type domain) is equal to unit length (= 1).

Therefore, the amount of fumigant applied to the HYDRUS simulated domain, M_f, can be calculated as follow:

$$M_f(g) = R_f(kg/ha) \times 10^{-6}\ (ha/cm^2) \times A(cm^2) \times 10^3(g/kg) \quad (2)$$

The next step is to determine the concentration of fumigant at the injection time. The information about the application equipment and the dimension of injector (e.g., knife, shank, chisel, etc) and observation (if possible) should be used to determine the cross-sectional area of soil that is directly sprayed by injector, A_f.

The concentration of fumigant at the injection time can be calculated as follow:

$$C\ (g/cm^3) = \frac{M_f(g)}{A_f\ (cm^2) \times 1\ (cm)}$$

Statistical indicators

Mean Error (ME):

$$ME = \frac{1}{N}\sum_{i=1}^{N}(M_i - S_i)$$

Mean Absolute Error (MAE):

$$MAE = \frac{1}{N}\sum_{i=1}^{N}|M_i - S_i|$$

Root Mean Square Error (RMSE):

$$RMSE = \sqrt[2]{\frac{1}{N}\sum_{i=1}^{N}(M_i - S_i)^2}$$

Efficiency (E):

$$E = 1 - \frac{\sum_{i=1}^{N}(M_i - S_i)^2}{\sum_{i=1}^{N}(M_i - \bar{M})^2}$$

Index of Agreement (IA):

$$IA = 1 - \frac{\sum_{i=1}^{N}(M_i - S_i)^2}{\sum_{i=1}^{N}(|S_i - \bar{M}| + |M_i - \bar{M}|)^2}$$

where N is total number of data point, M is measured value, and S is simulated value, $\bar{M}$ is the average of measured values.

Emission Ratio

Result of linear regression analysis:

```
Residuals:
     Min       1Q   Median       3Q      Max 
-0.08503 -0.06499 -0.04957  0.05474  0.17021 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  0.09325    0.05017   1.859     0.09 .  
Fild_ER      0.71748    0.12100   5.930 9.88e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08977 on 11 degrees of freedom
Multiple R-squared:  0.7617,	Adjusted R-squared:   0.74 
F-statistic: 35.16 on 1 and 11 DF,  p-value: 9.877e-05
```

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS

```
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05 

Call:
 gvlma(x = Ew) 

                      Value p-value                Decision
Global Stat        4.239820  0.3745 Assumptions acceptable.
Skewness           1.490573  0.2221 Assumptions acceptable.
Kurtosis           0.369964  0.5430 Assumptions acceptable.
Link Function      2.376959  0.1231 Assumptions acceptable.
Heteroscedasticity 0.002324  0.9615 Assumptions acceptable.
```

24-hour pick flux

RESULT OF LINEAR REGRESSION ANALYSIS

```
Residuals:
   Min     1Q Median     3Q    Max 
-6.484 -3.784 -1.763  2.048 11.232 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)   4.2783     3.0695   1.394    0.191    
Fild_24       0.8309     0.1362   6.101 7.73e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5.962 on 11 degrees of freedom
Multiple R-squared:  0.7719,	Adjusted R-squared:  0.7511 
F-statistic: 37.22 on 1 and 11 DF,  p-value: 7.73e-05
```

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS

```
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05 


                      Value p-value                Decision
Global Stat        3.087451  0.5433 Assumptions acceptable.
Skewness           2.409789  0.1206 Assumptions acceptable.
Kurtosis           0.001304  0.9712 Assumptions acceptable.
Link Function      0.554185  0.4566 Assumptions acceptable.
Heteroscedasticity 0.122173  0.7267 Assumptions acceptable.
```

72-hour pick flux

RESULT OF LINEAR REGRESSION ANALYSIS

```
Residuals:
   Min     1Q Median     3Q    Max
-4.199 -1.860 -1.019  2.078  6.315

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.7320     1.6990   1.608    0.136
Fild_72       0.8305     0.1112   7.468 1.25e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.311 on 11 degrees of freedom
Multiple R-squared:  0.8353,  Adjusted R-squared:  0.8203
F-statistic: 55.78 on 1 and 11 DF,  p-value: 1.248e-05
```

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS

```
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05


                    Value p-value                Decision
Global Stat        3.2855  0.5112 Assumptions acceptable.
Skewness           1.3114  0.2522 Assumptions acceptable.
Kurtosis           0.2013  0.6537 Assumptions acceptable.
Link Function      1.6436  0.1998 Assumptions acceptable.
Heteroscedasticity 0.1292  0.7192 Assumptions acceptable.
```