Table of Contents

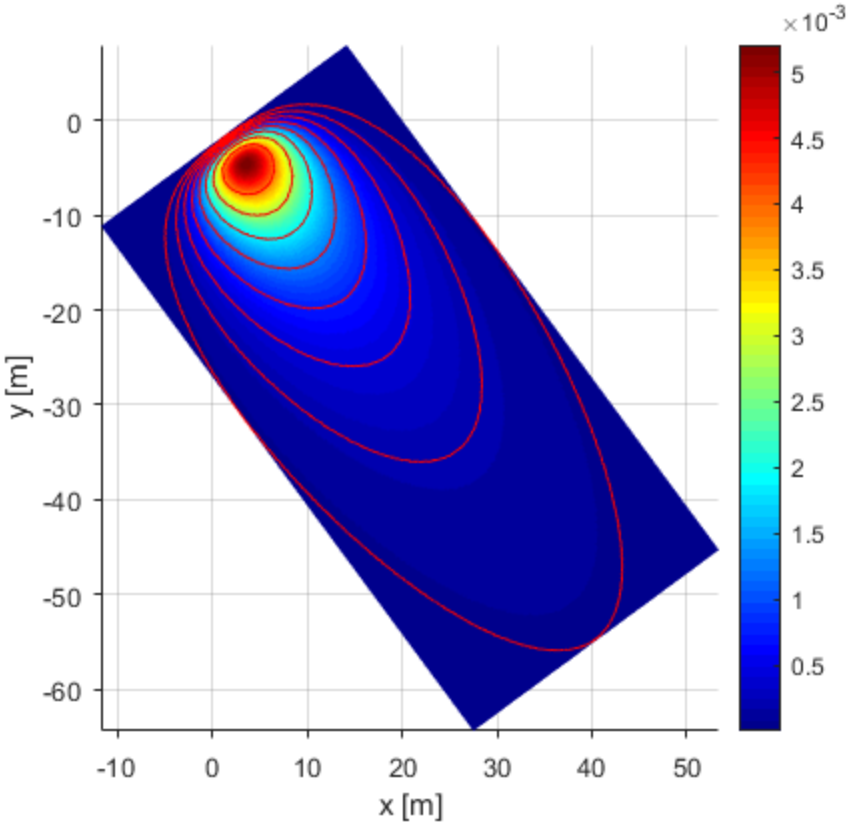
Flux Footprint Prediction

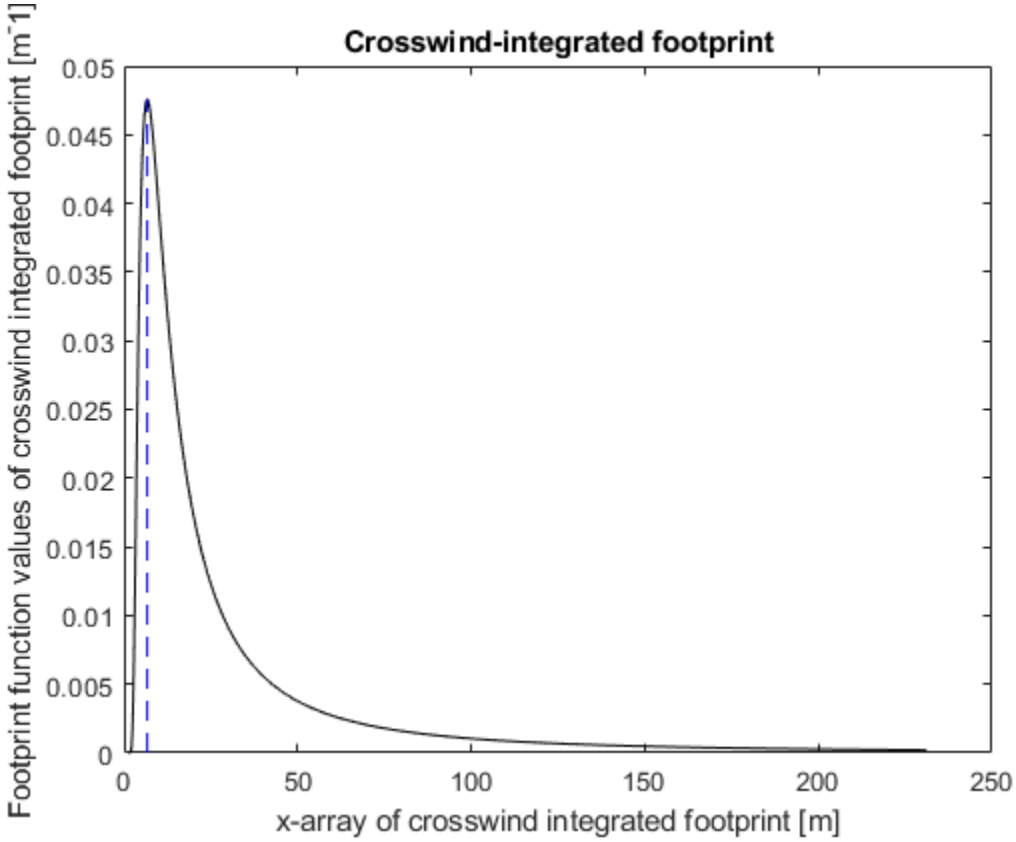
Kelley Drechsler

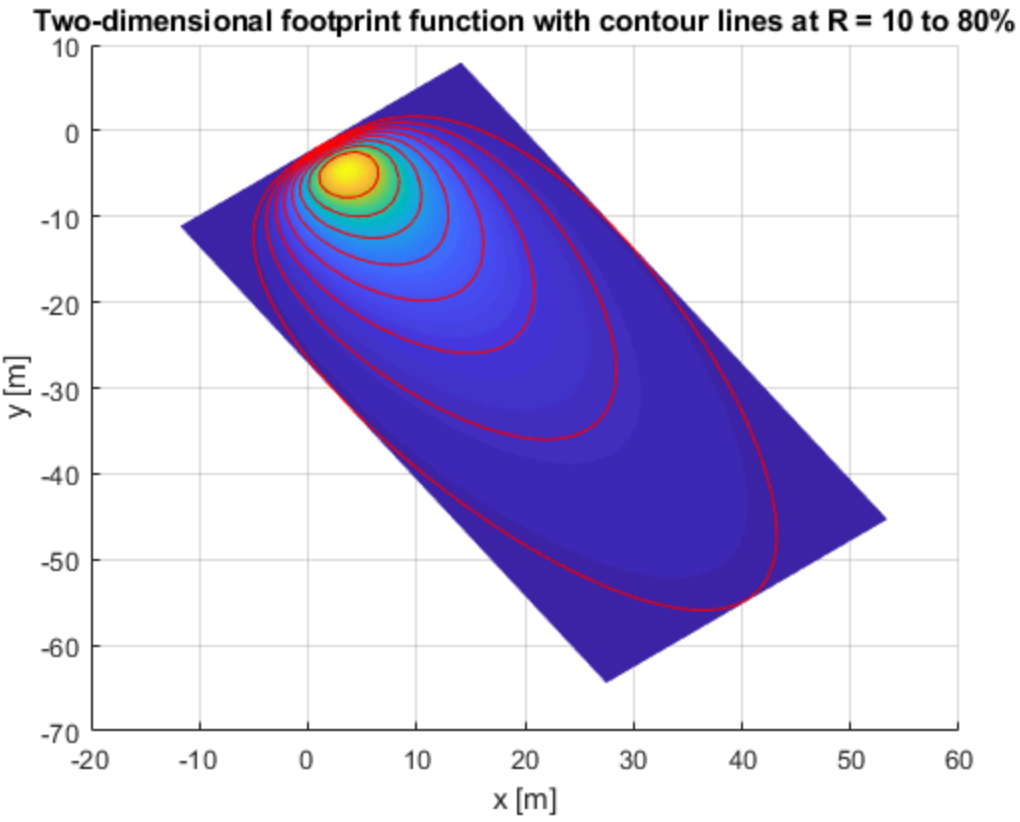
```
clear
close all
```

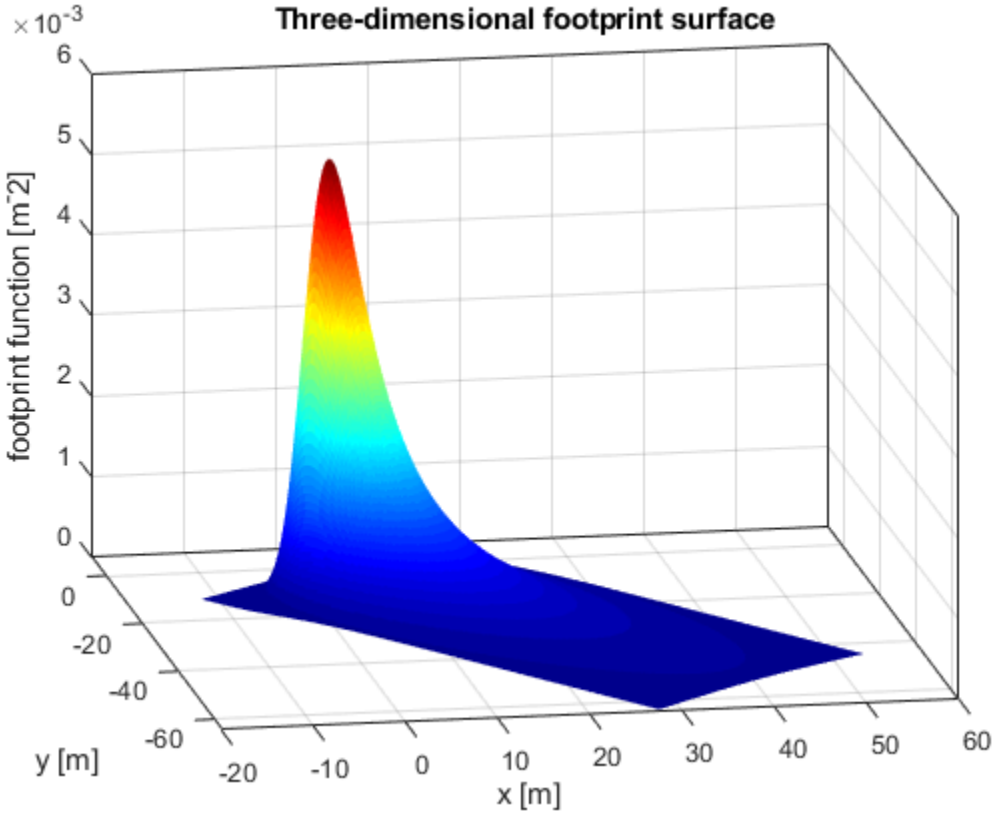
Almonds 1 on 7/1/19

```
xstation = 574287.972; % x-coordinate of station [m]
ystation = 4422836.305; % y-coordinate of station [m]
zm = 3; % measurement height [m]
umean = 2.5; % measured [m s-1]
sigmav = 0.7; %
ustar = 0.39; % measured [m s-1]
wind_dir = 143.6; % measured [deg]
Ta = 29.1; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 11.0; % vapor pressure [mb]
LE = 372; % station latent heat flux [W m-2]
H = 236; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_1_FFP_07-01-19.txt',M,'precision',11)
dlmwrite('Almonds_1_FFP_07-01-19_contour.txt',Mcontour,'precision',11)
```


×10-3
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-10
-20
-30
-40
-50
-60
y [m]
-10
0
10
20
30
40
50
x [m]


Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m-1]
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
x-array of crosswind integrated footprint [m]

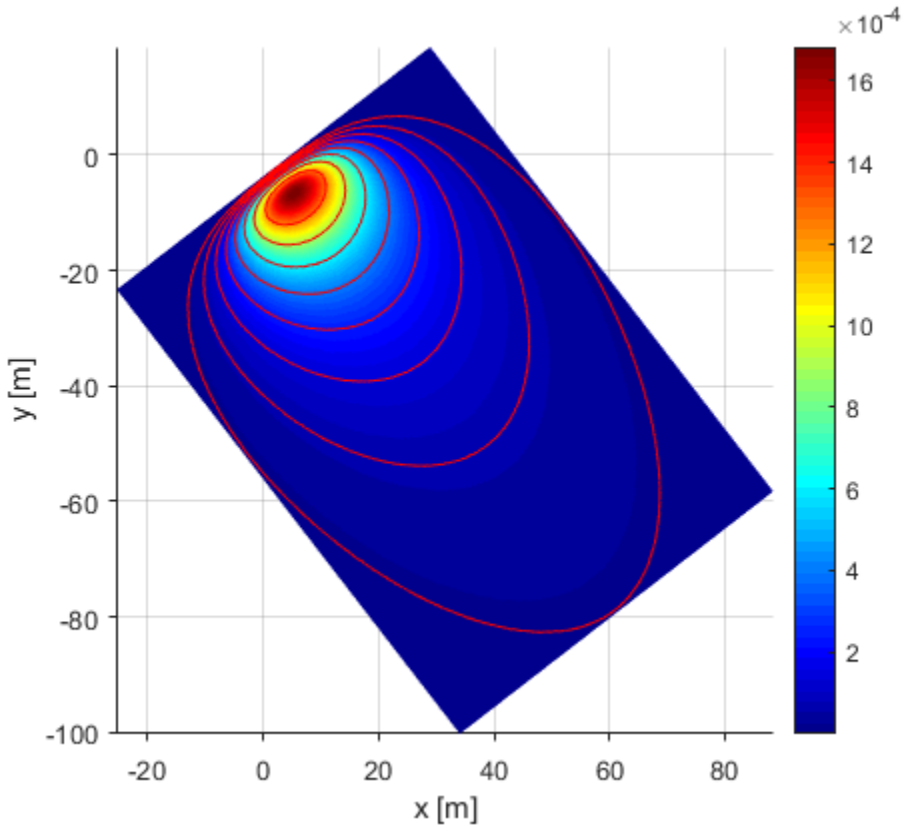

Two-dimensional footprint function with contour lines at R = 10 to 80%
y [m]
x [m]

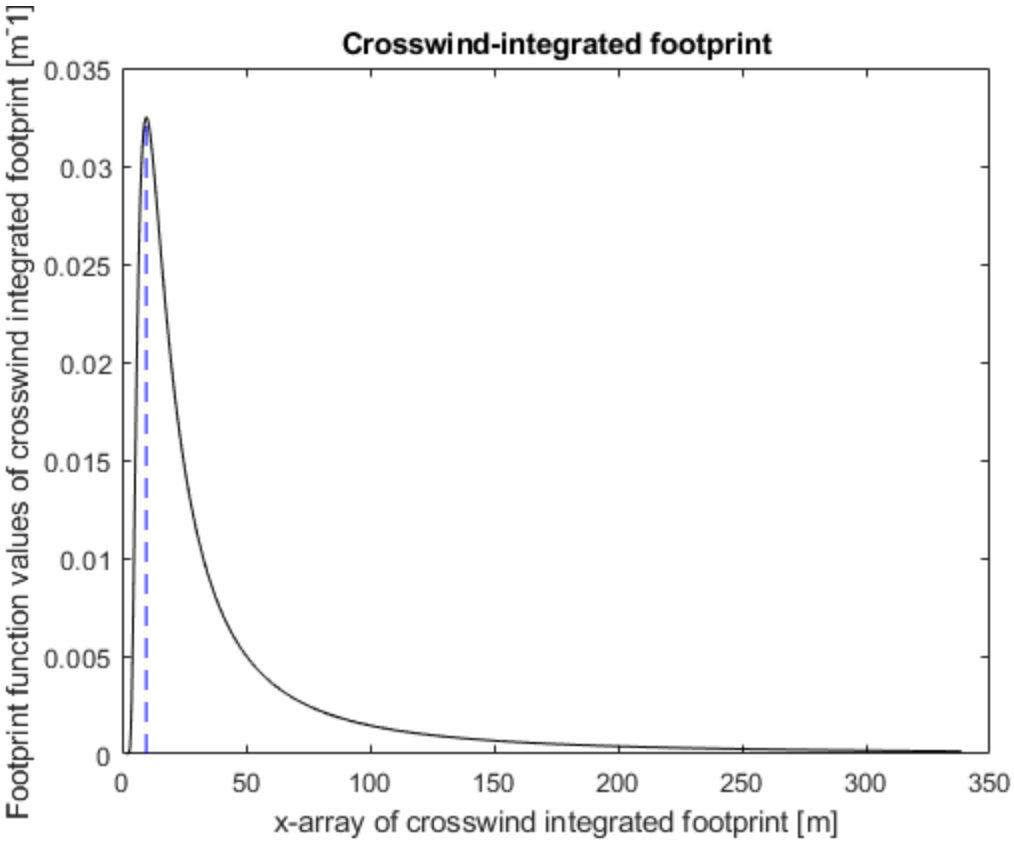

Three-dimensional footprint surface
footprint function [m^-2]
y [m]
x [m]

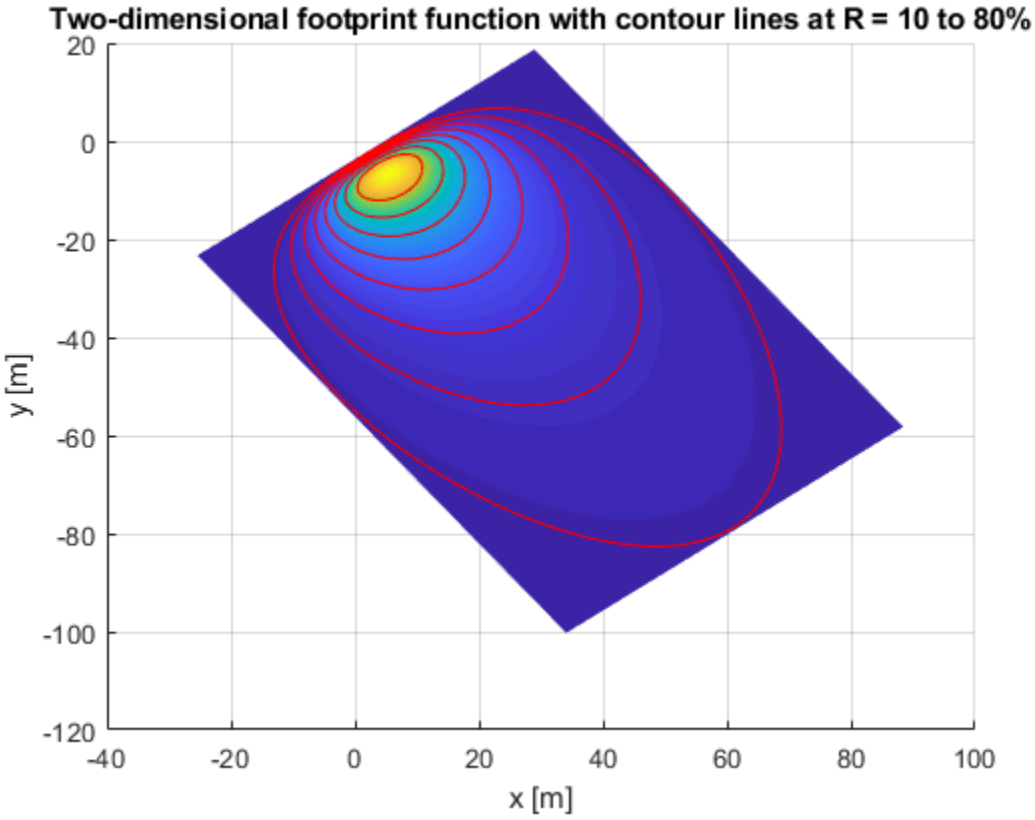
Almonds 2 on 7/1/19

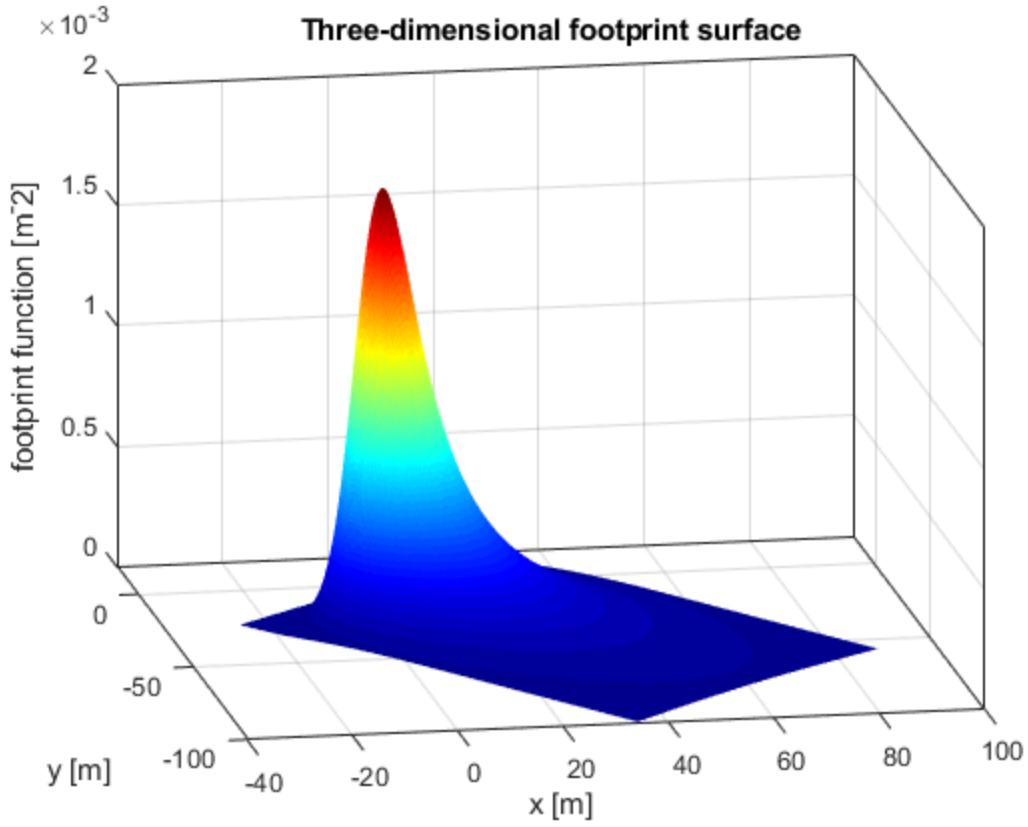
```
xstation = 574057.44; % x-coordinate of station [m]
ystation = 4422582.887; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 1.73; % measured [m s-1]
sigmav = 0.7; %
ustar = 0.4; % measured [m s-1]
wind_dir = 142.3; % measured [deg]
Ta = 28.8; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 12.2; % vapor pressure [mb]
LE = 553; % station latent heat flux [W m-2]
H = 111; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_2_FFP_07-01-19.txt',M,'precision',11)
dlmwrite('Almonds_2_FFP_07-01-19_contour.txt',Mcontour,'precision',11)
```

Done!



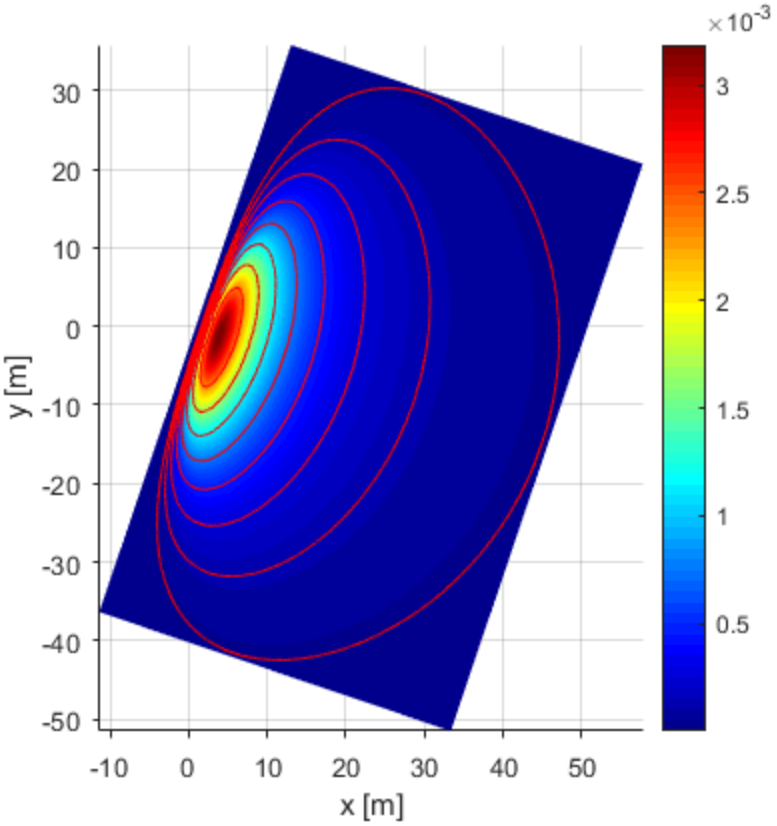

Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m^-1]
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
350
x-array of crosswind integrated footprint [m]

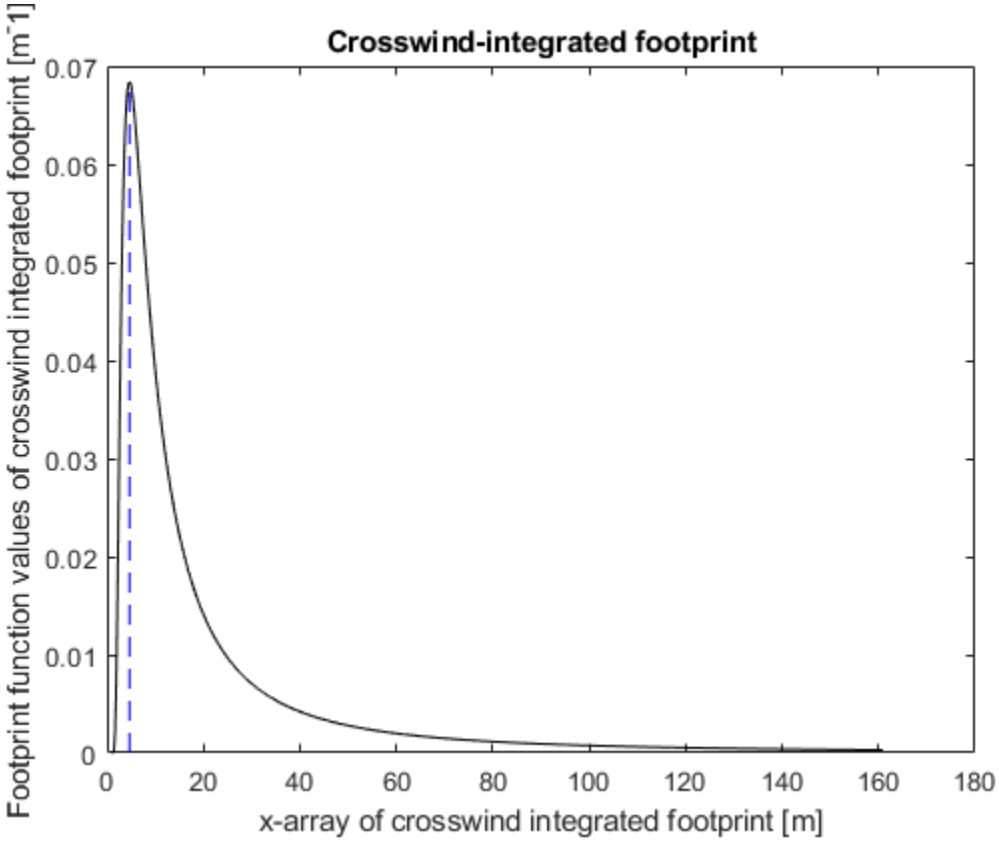

Two-dimensional footprint function with contour lines at R = 10 to 80%
20
0
-20
-40
-60
-80
-100
-120
y [m]
-40
-20
0
20
40
60
80
100
x [m]

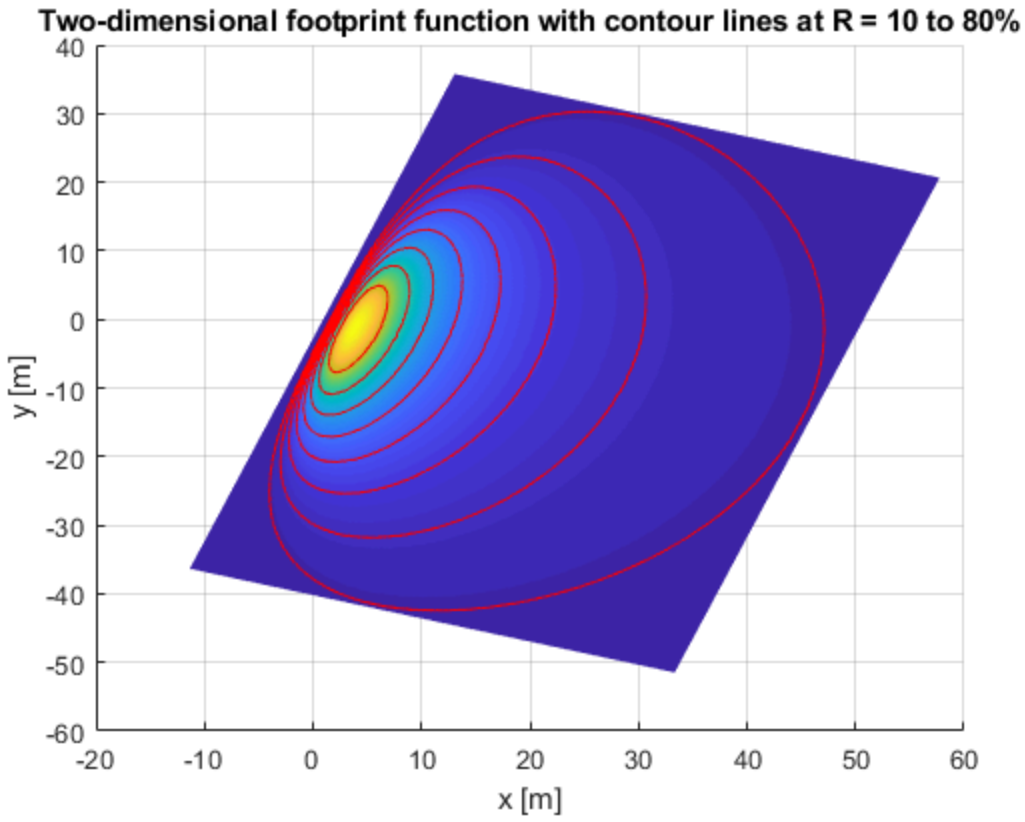


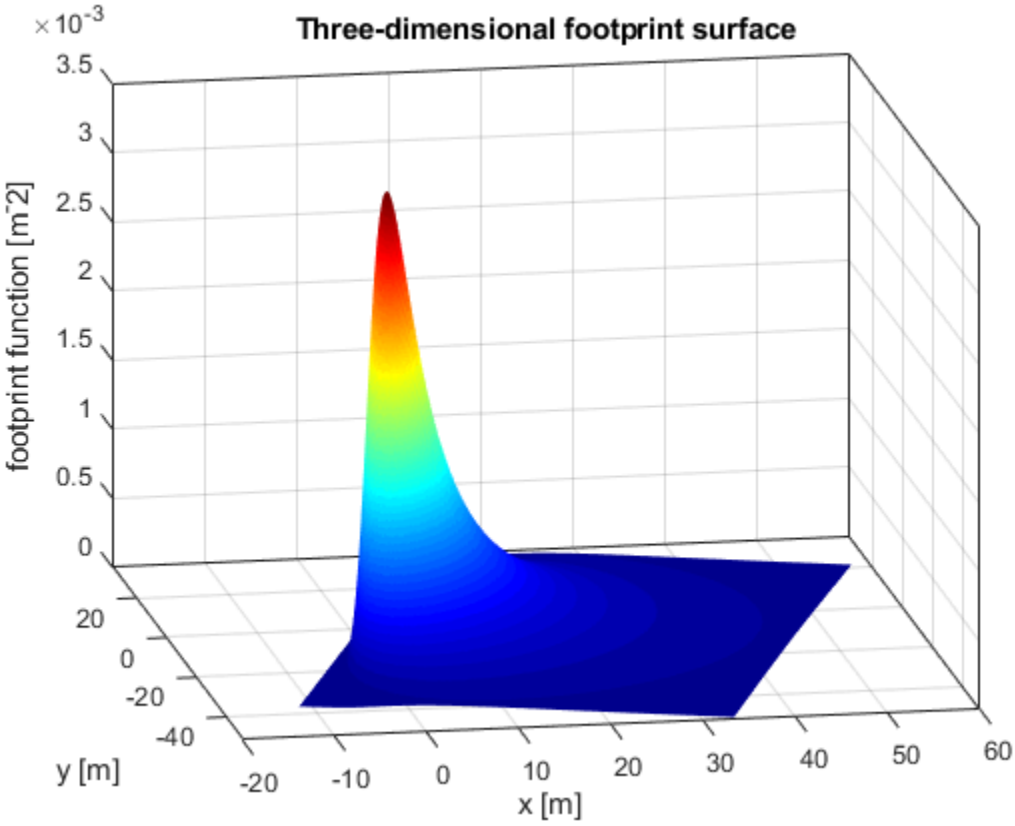
Almonds 3 on 7/1/19

```
xstation = 574822.323; % x-coordinate of station [m]
ystation = 4422508.481; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 0.74; % measured [m s-1]
sigmav = 0.7; %
ustar = 0.36; % measured [m s-1]
wind_dir = 108.7; % measured [deg]
Ta = 28.1; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 12.2; % vapor pressure [mb]
LE = 501; % station latent heat flux [W m-2]
H = 107; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_3_FFP_07-01-19.txt',M,'precision',11)
dlmwrite('Almonds_3_FFP_07-01-19_contour.txt',Mcontour,'precision',11)

Done!
```


×10^-3
3
2.5
2
1.5
1
0.5
30
20
10
0
-10
-20
-30
-40
-50
y [m]
-10
0
10
20
30
40
50
x [m]


Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m^-1]
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
120
140
160
180
x-array of crosswind integrated footprint [m]

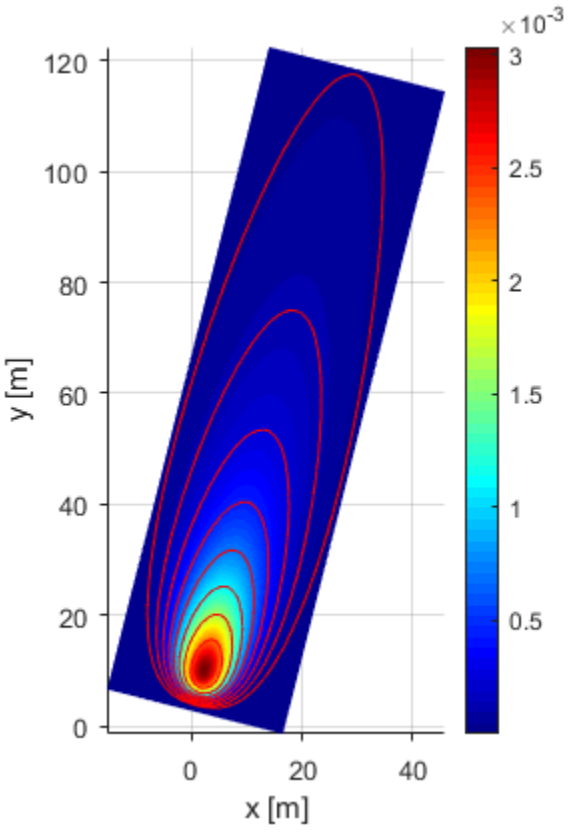

Two-dimensional footprint function with contour lines at R = 10 to 80%
y [m]
x [m]

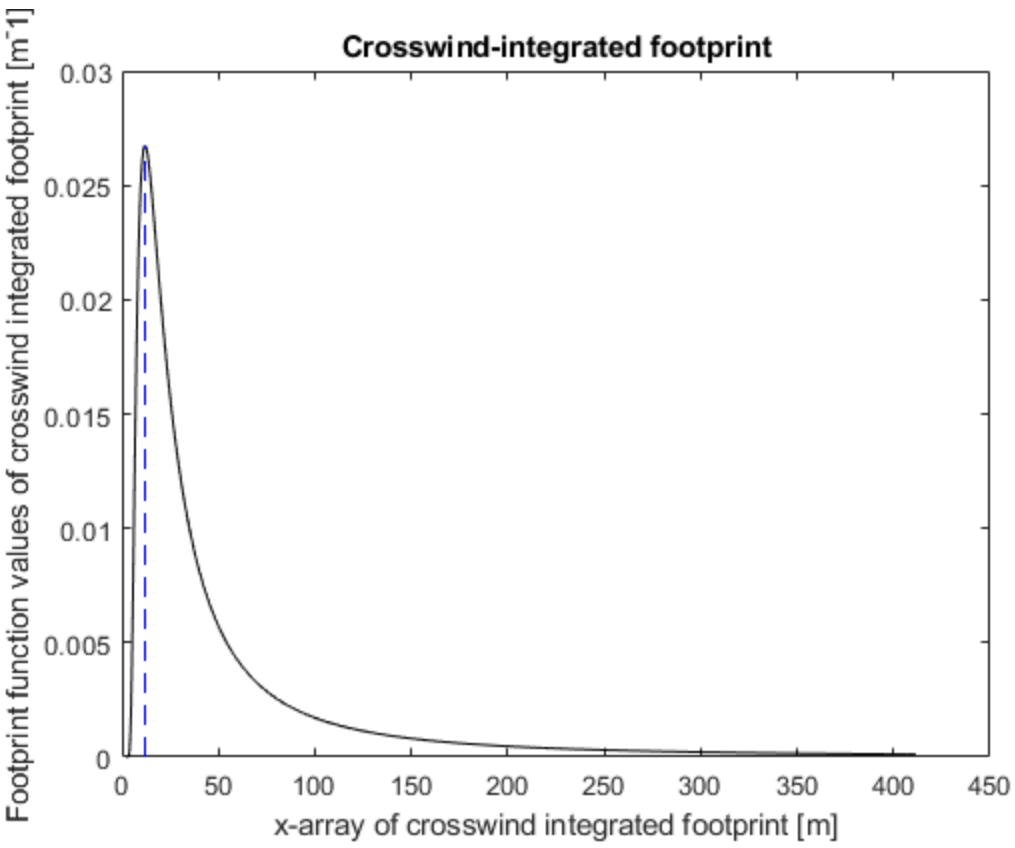

Three-dimensional footprint surface
×10^-3
footprint function [m^-2]
y [m]
x [m]

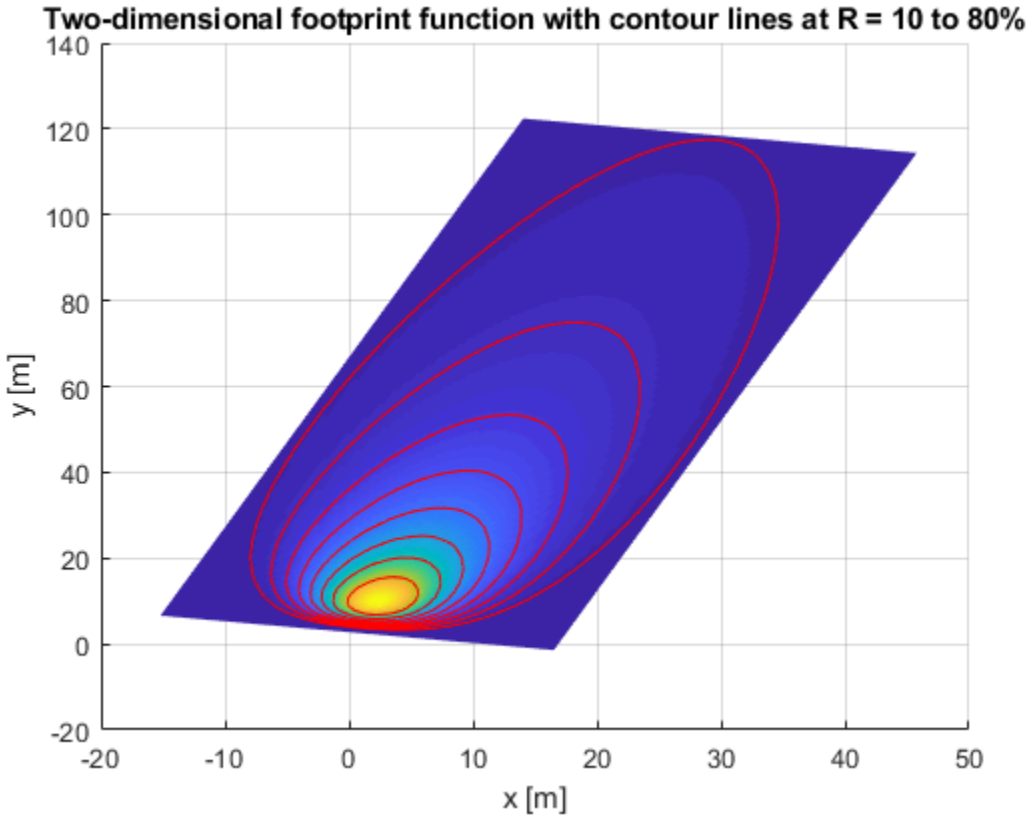
Almonds 1 on 9/24/19

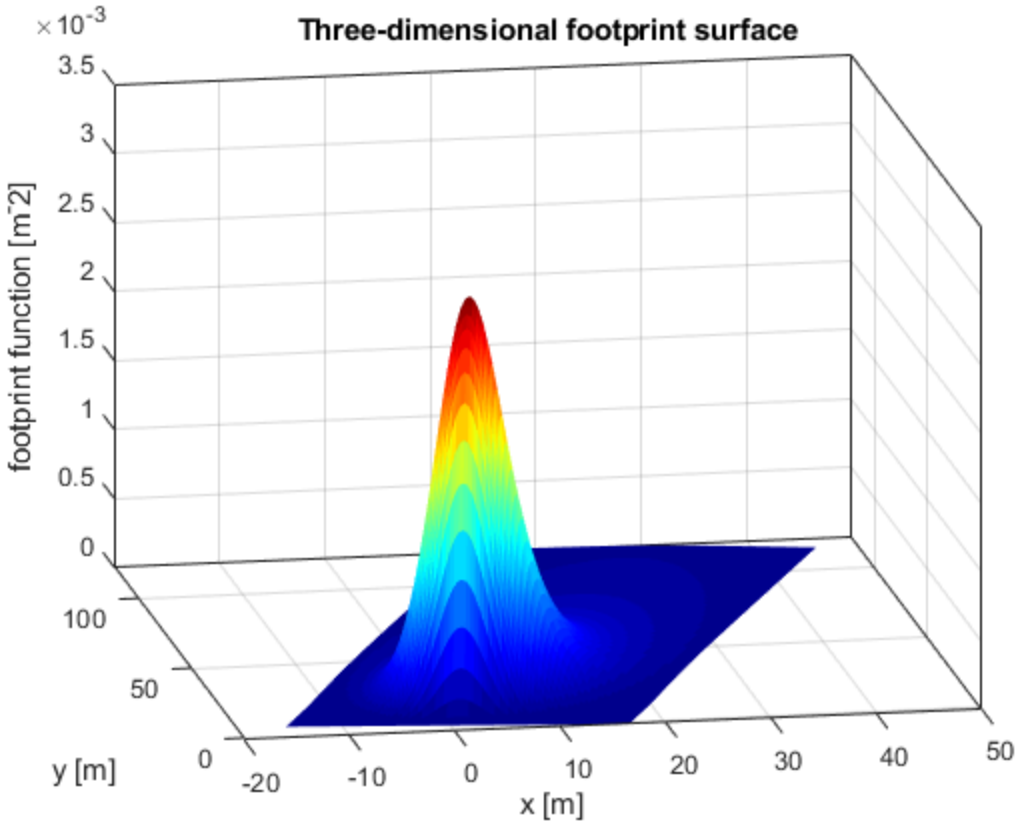
```
xstation = 574287.972; % x-coordinate of station [m]
ystation = 4422836.305; % y-coordinate of station [m]
zm = 4.6; % measurement height [m]
umean = 4.61; % measured [m s-1]
sigmav = 0.7; %
ustar = 0.62; % measured [m s-1]
wind_dir = 14.18; % measured [deg]
Ta = 33.7; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 11.5; % vapor pressure [mb]
LE = 93; % station latent heat flux [W m-2]
H = 146; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_1_FFP_09-24-19.txt',M,'precision',11)
dlmwrite('Almonds_1_FFP_09-24-19_contour.txt',Mcontour,'precision',11)
```

Done!



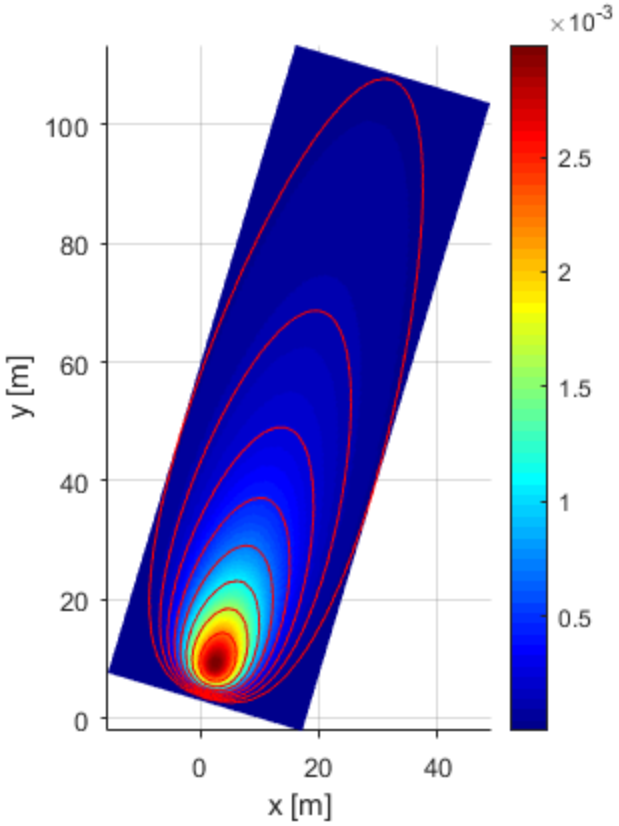

Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m^-1]
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
350
400
450
x-array of crosswind integrated footprint [m]

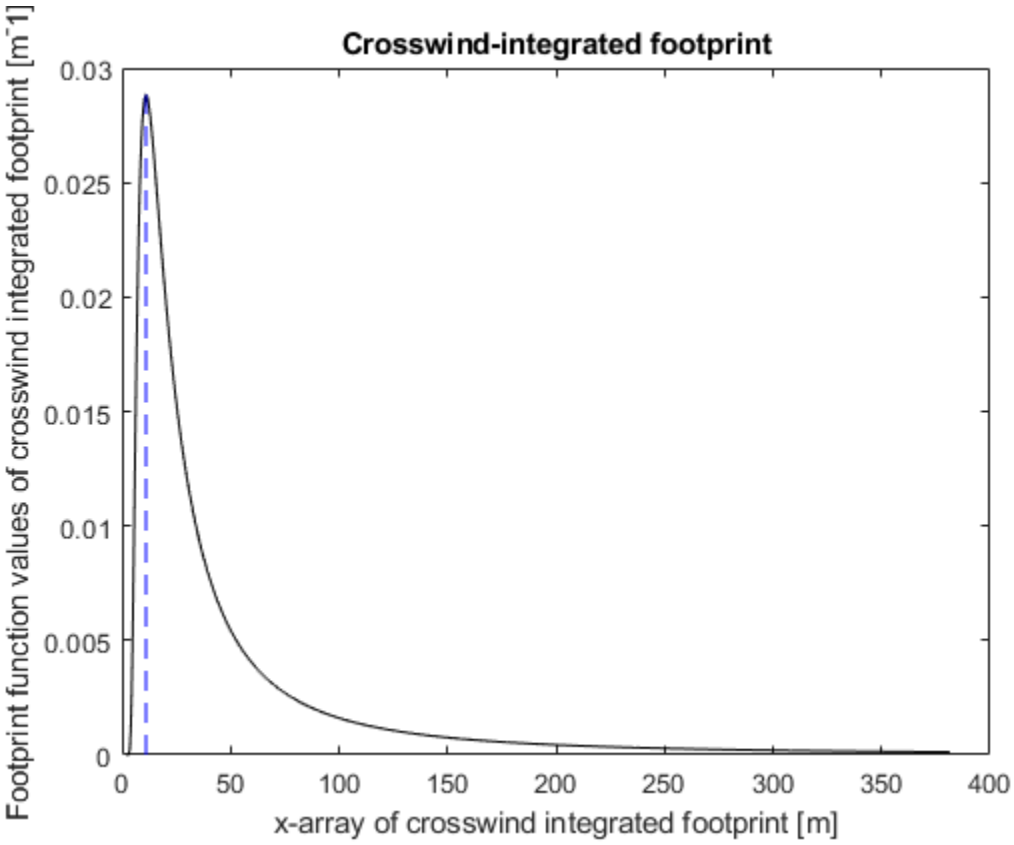

Two-dimensional footprint function with contour lines at R = 10 to 80%
140
120
100
80
60
40
20
0
-20
y [m]
-20
-10
0
10
20
30
40
50
x [m]

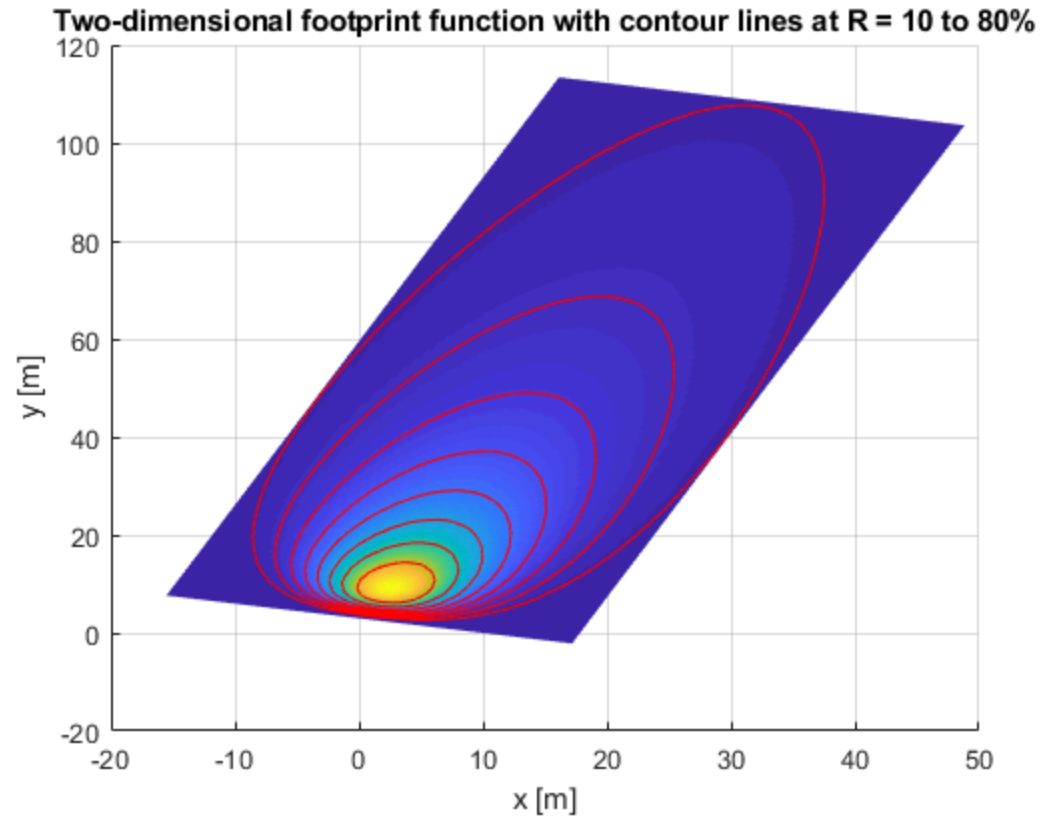


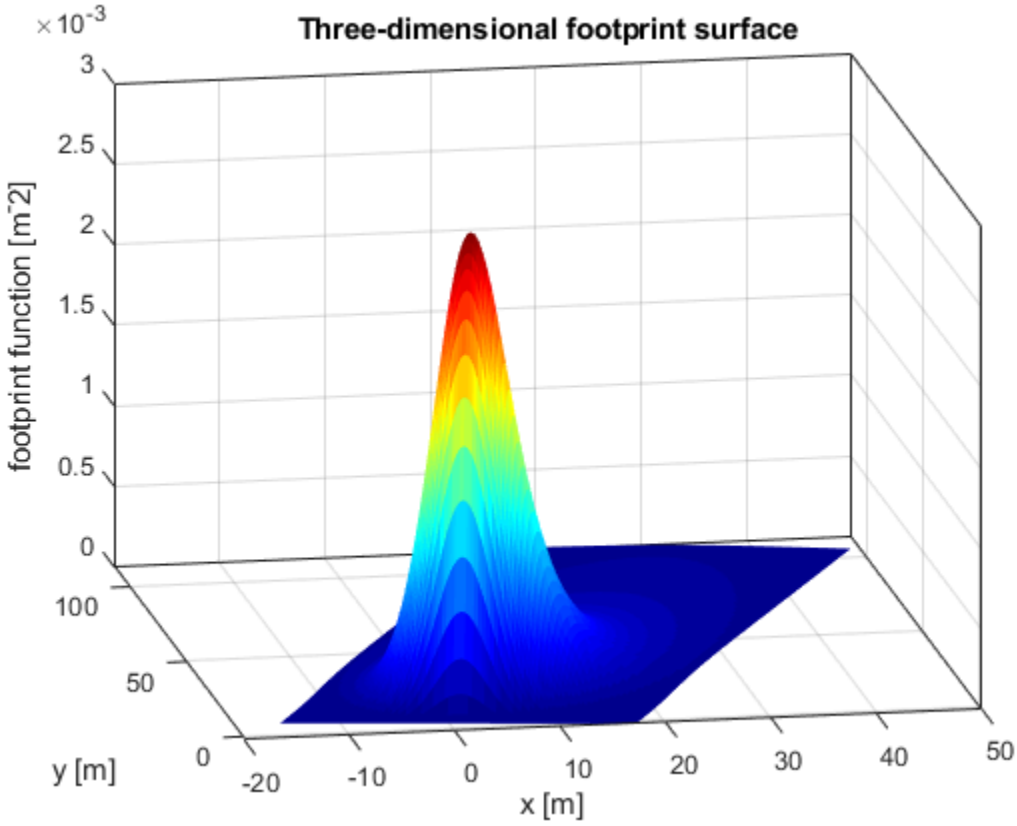
Almonds 2 on 9/24/19

```
xstation = 574057.44; % x-coordinate of station [m]
ystation = 4422582.887; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 3.9; % measured [m s-1]
sigmav = 0.7; %
ustar = 0.8; % measured [m s-1]
wind_dir = 16.66; % measured [deg]
Ta = 33.8; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 11.7; % vapor pressure [mb]
LE = 229; % station latent heat flux [W m-2]
H = 94; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_2_FFP_09-24-19.txt',M,'precision',11)
dlmwrite('Almonds_2_FFP_09-24-19_contour.txt',Mcontour,'precision',11)

Done!
```


×10^-3
2.5
2
1.5
1
0.5
100
80
60
40
20
0
y [m]
0
20
40
x [m]


Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m-1]
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
350
400
x-array of crosswind integrated footprint [m]

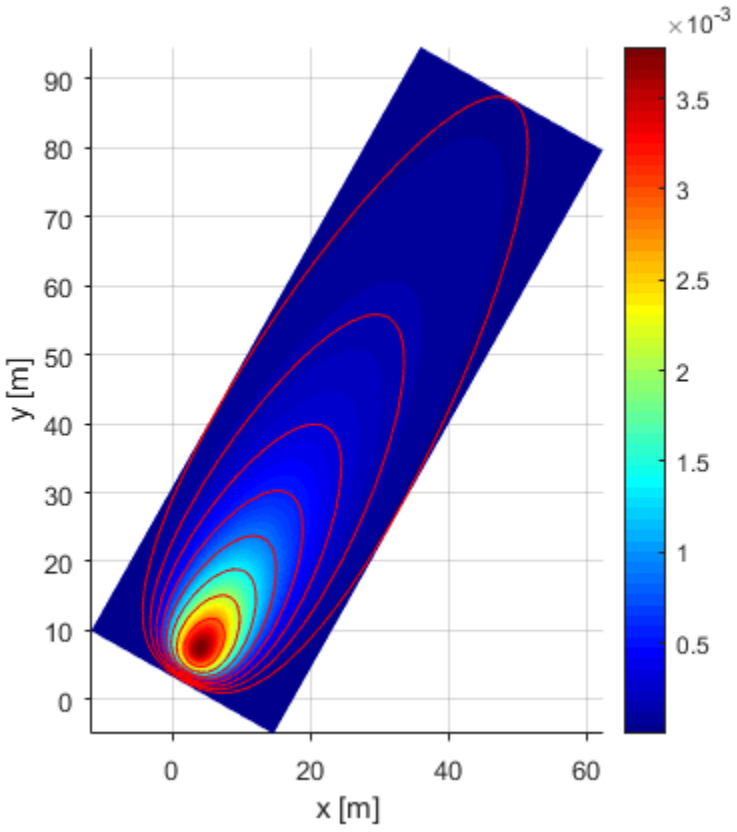

Two-dimensional footprint function with contour lines at R = 10 to 80%
y [m]
x [m]

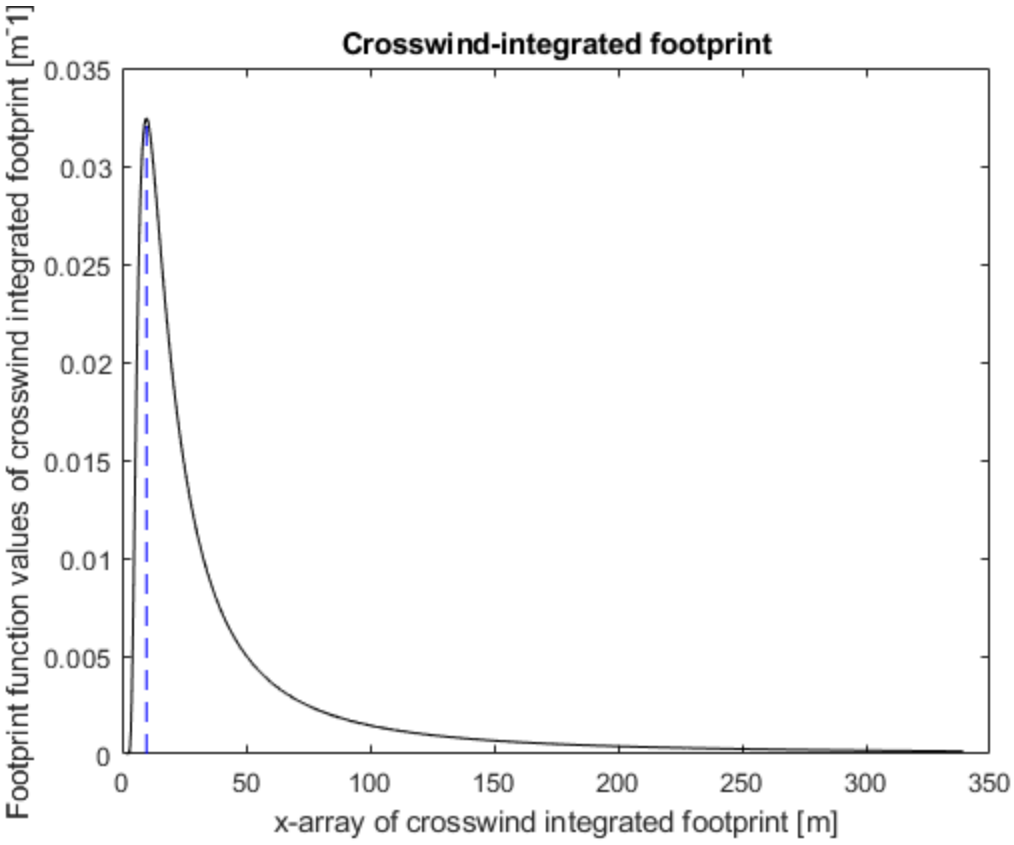

Three-dimensional footprint surface
×10-3
footprint function [m-2]
y [m]
x [m]

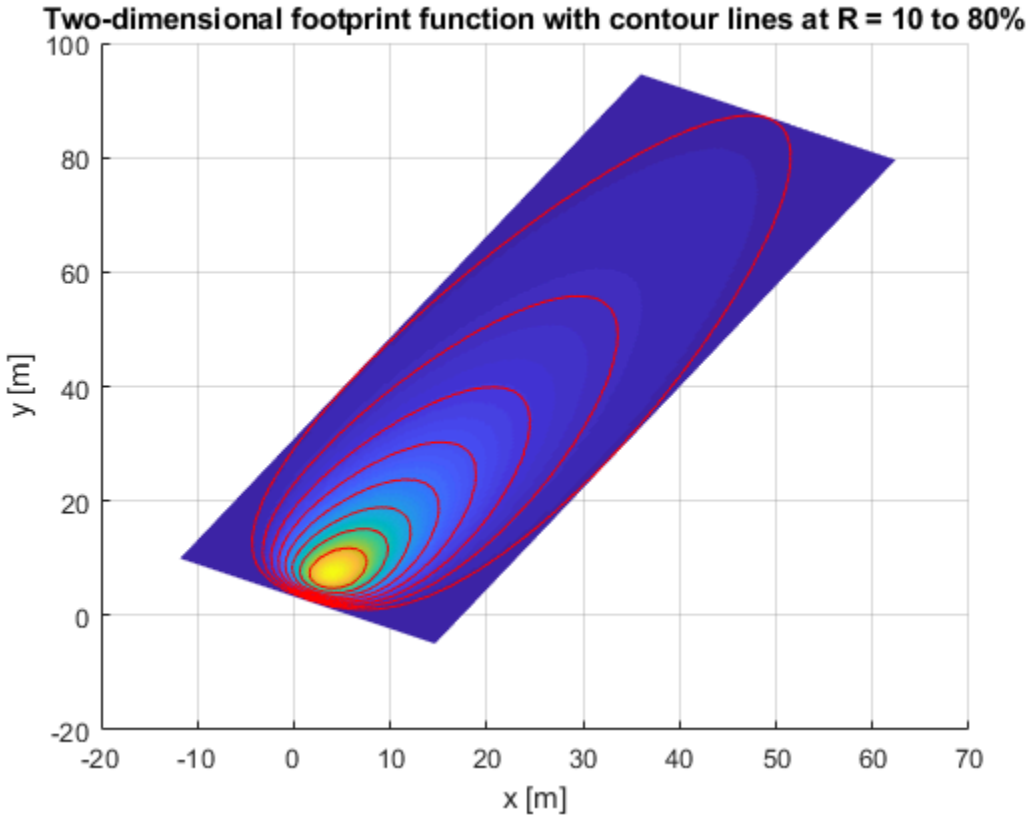
Almonds 3 on 9/24/19

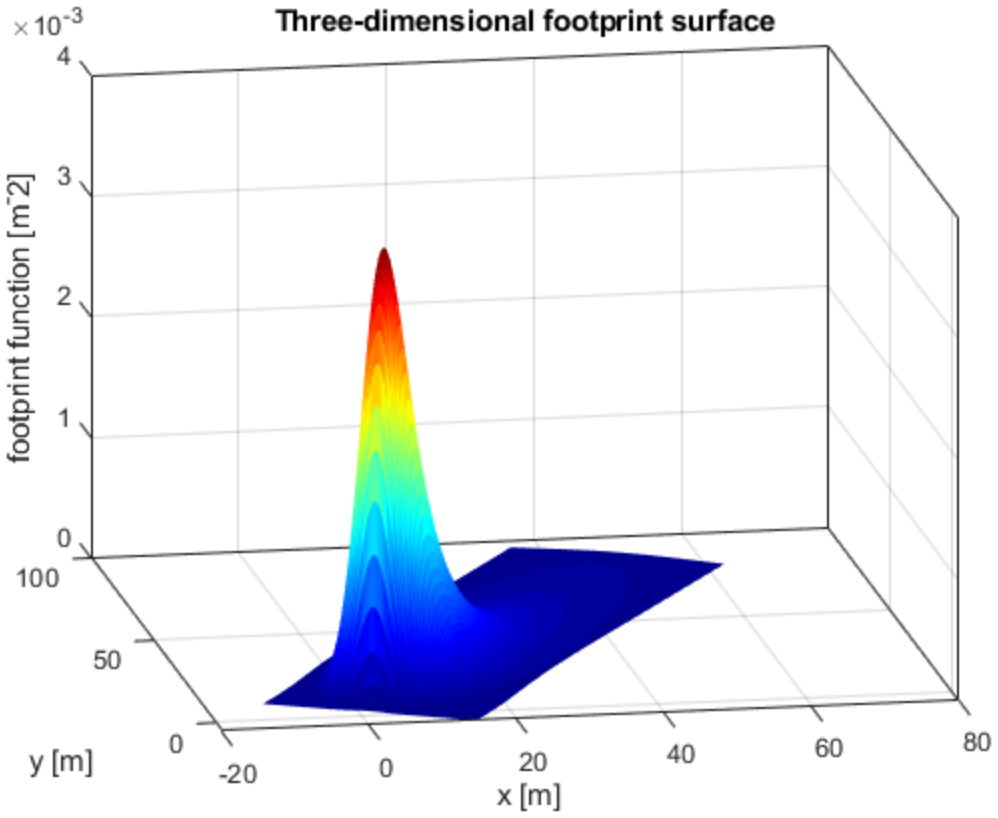
```
xstation = 574822.323; % x-coordinate of station [m]
ystation = 4422508.481; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 3.9; % measured [m s-1]
sigmav = 0.7; %
ustar = 0.9; % measured [m s-1]
wind_dir = 29.46; % measured [deg]
Ta = 33.1; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 10.2; % vapor pressure [mb]
LE = 260; % station latent heat flux [W m-2]
H = 173; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_3_FFP_09-24-19.txt',M,'precision',11)
dlmwrite('Almonds_3_FFP_09-24-19_contour.txt',Mcontour,'precision',11)
```

Done!



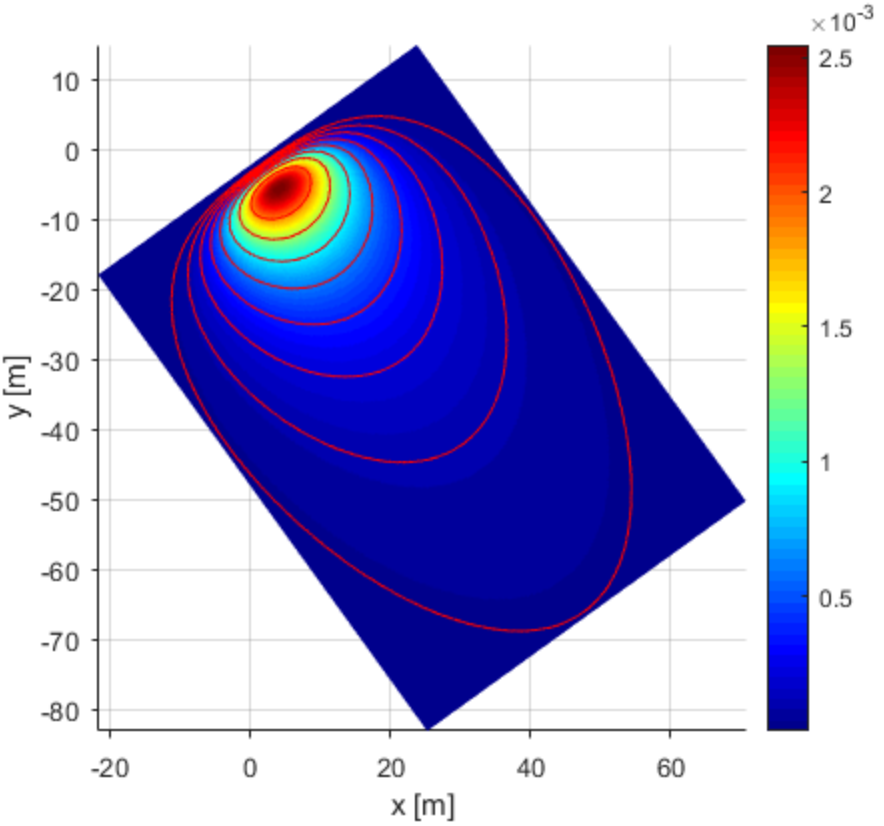

Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m^-1]
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
350
x-array of crosswind integrated footprint [m]

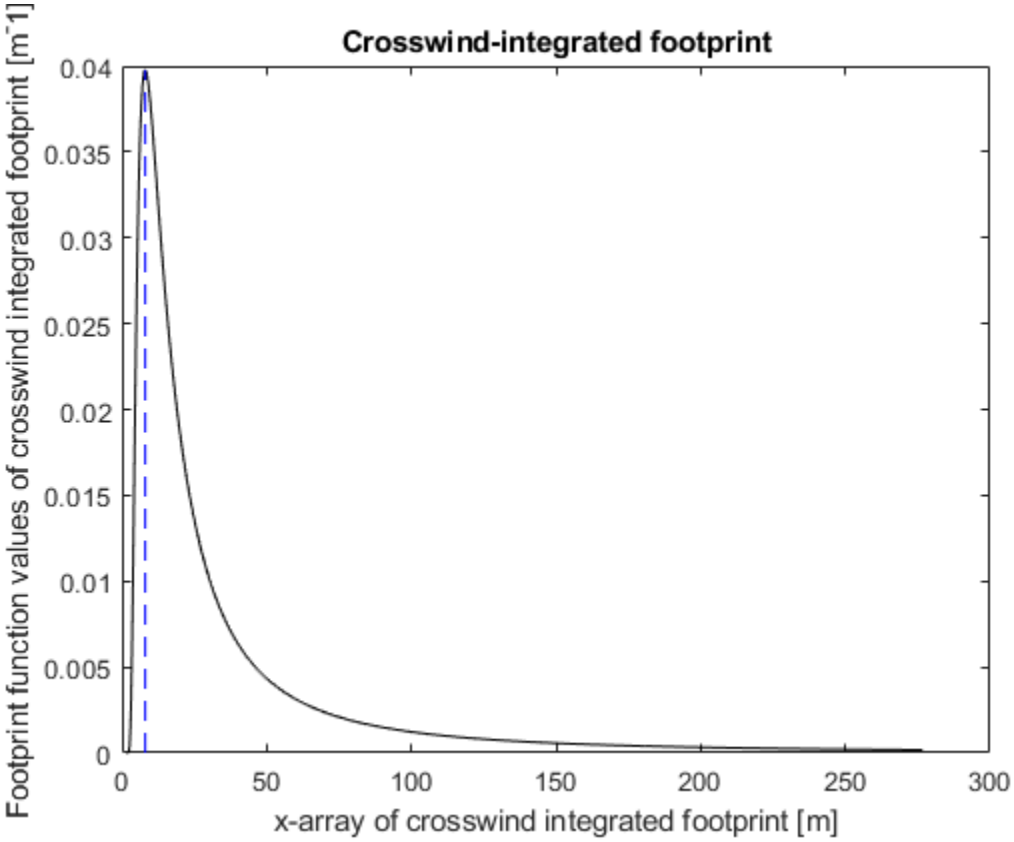

Two-dimensional footprint function with contour lines at R = 10 to 80%
100
80
60
40
20
0
-20
y [m]
-20
-10
0
10
20
30
40
50
60
70
x [m]

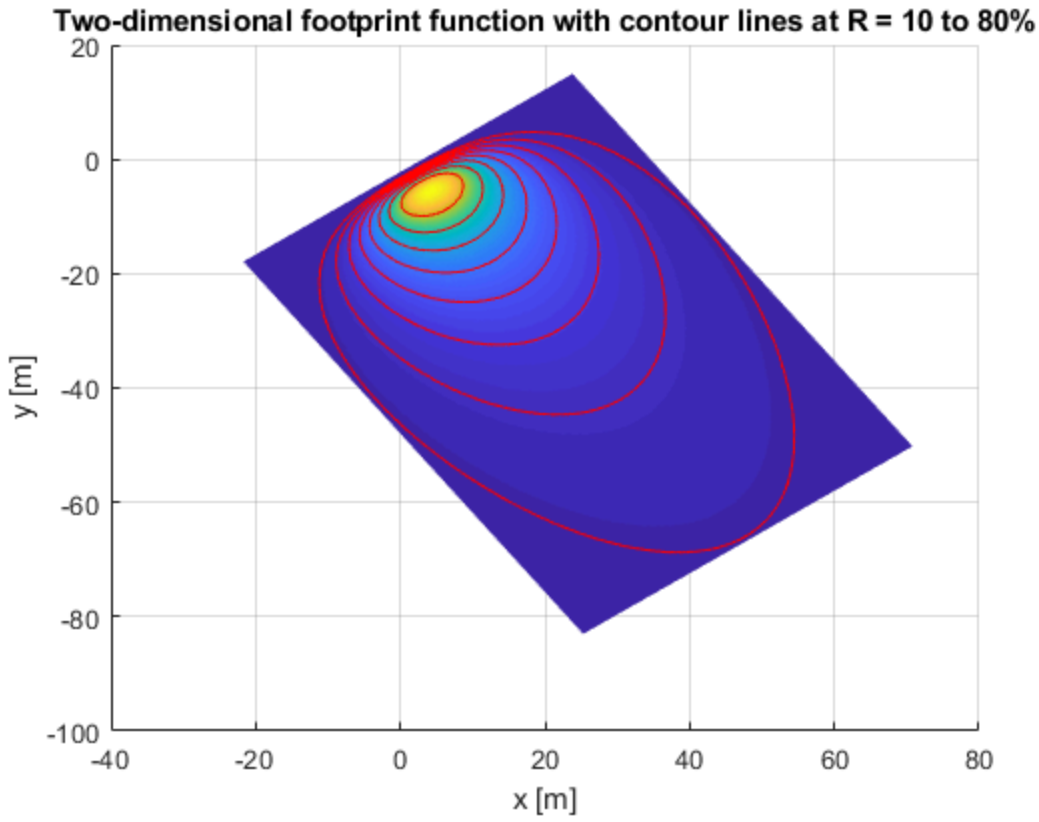


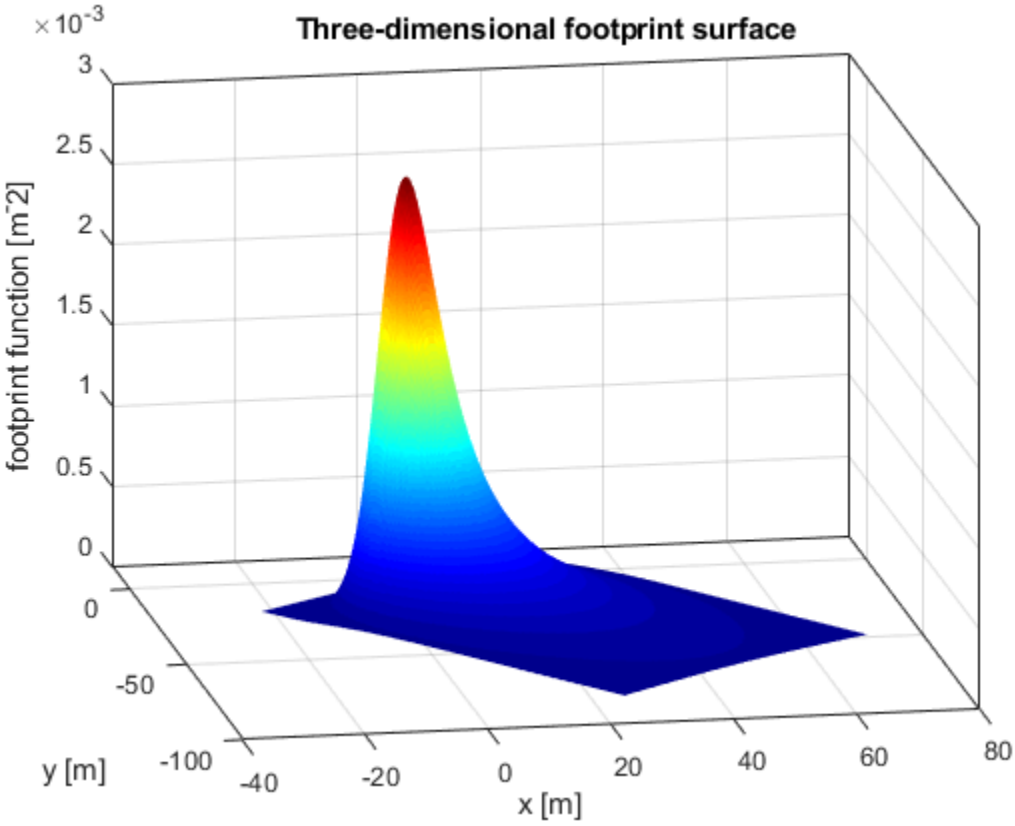
Almonds 1 on 6/19/20

```
xstation = 574287.972; % x-coordinate of station [m]
ystation = 4422836.305; % y-coordinate of station [m]
zm = 4.6; % measurement height [m]
umean = 2.0; % measured [m s-1]
sigmav = 0.8; %
ustar = 0.4; % measured [m s-1]
wind_dir = 144.2; % measured [deg]
Ta = 33.2; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 11.5; % vapor pressure [mb]
LE = 518; % station latent heat flux [W m-2]
H = 37; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_1_FFP_06-19-20.txt',M,'precision',11)
dlmwrite('Almonds_1_FFP_06-19-20_contour.txt',Mcontour,'precision',11)

Done!
```


×10^-3
2.5
2
1.5
1
0.5
10
0
-10
-20
-30
-40
-50
-60
-70
-80
y [m]
-20
0
20
40
60
x [m]


Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m-1]
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
x-array of crosswind integrated footprint [m]

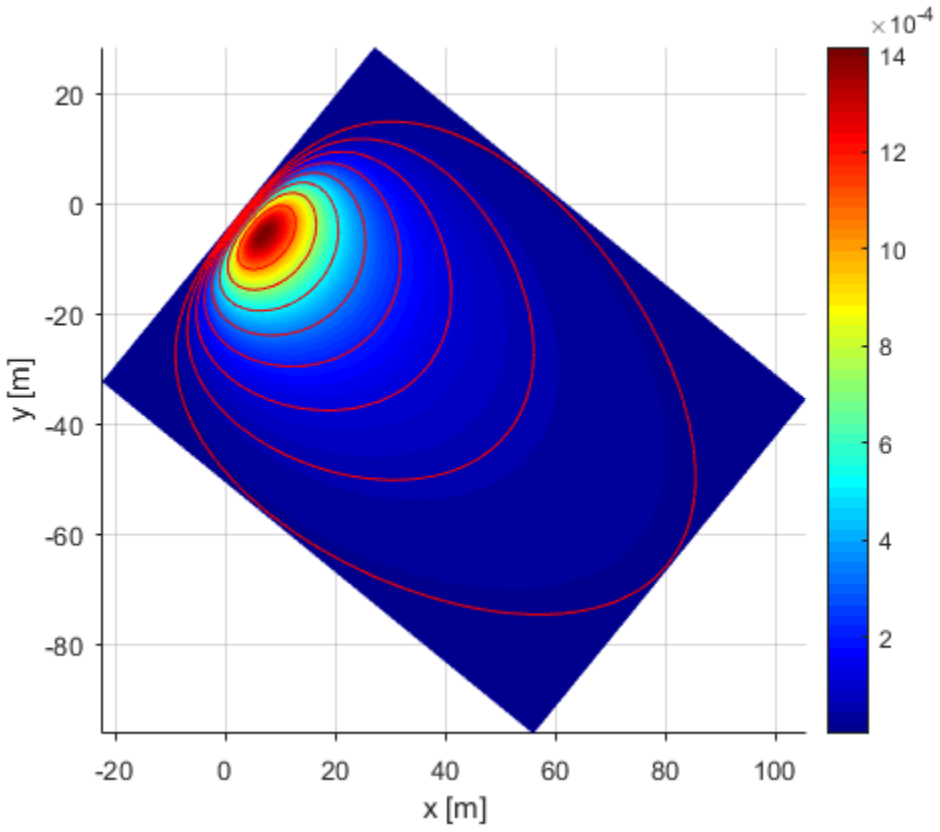

Two-dimensional footprint function with contour lines at R = 10 to 80%
20
0
-20
-40
-60
-80
-100
y [m]
-40
-20
0
20
40
60
80
x [m]

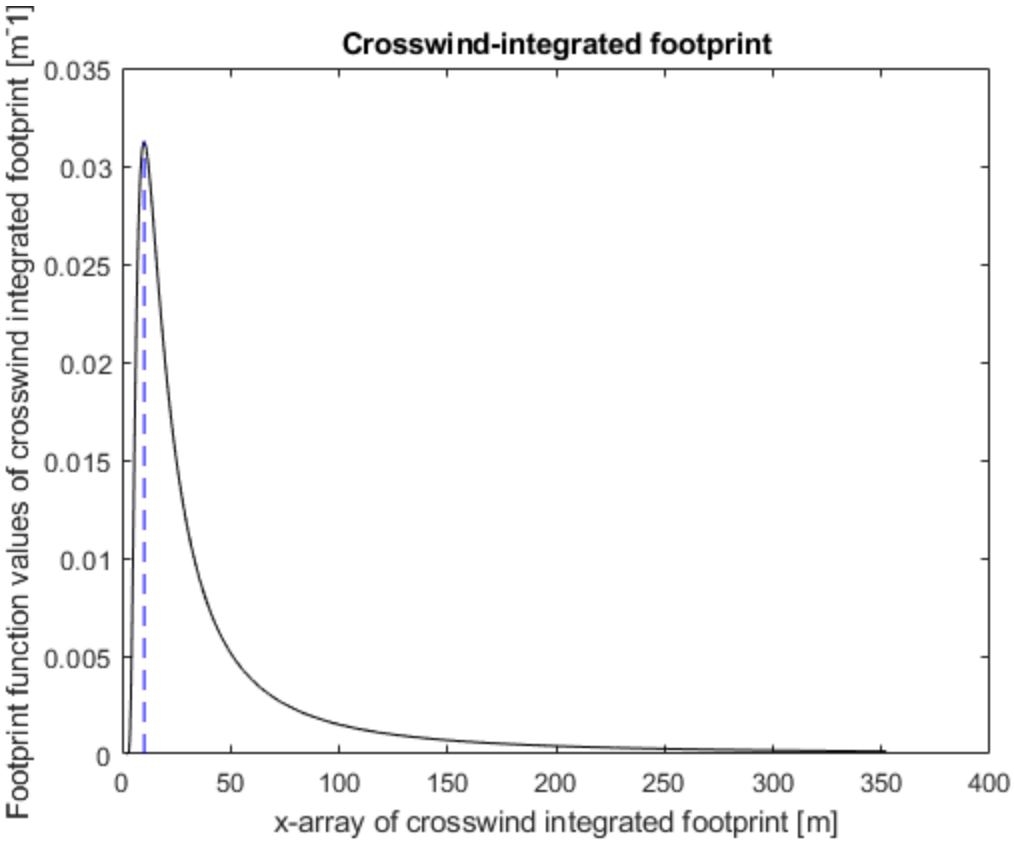

Three-dimensional footprint surface
×10^-3
3
2.5
2
1.5
1
0.5
0
footprint function [m^-2]
0
-50
-100
y [m]
-40
-20
0
20
40
60
80
x [m]

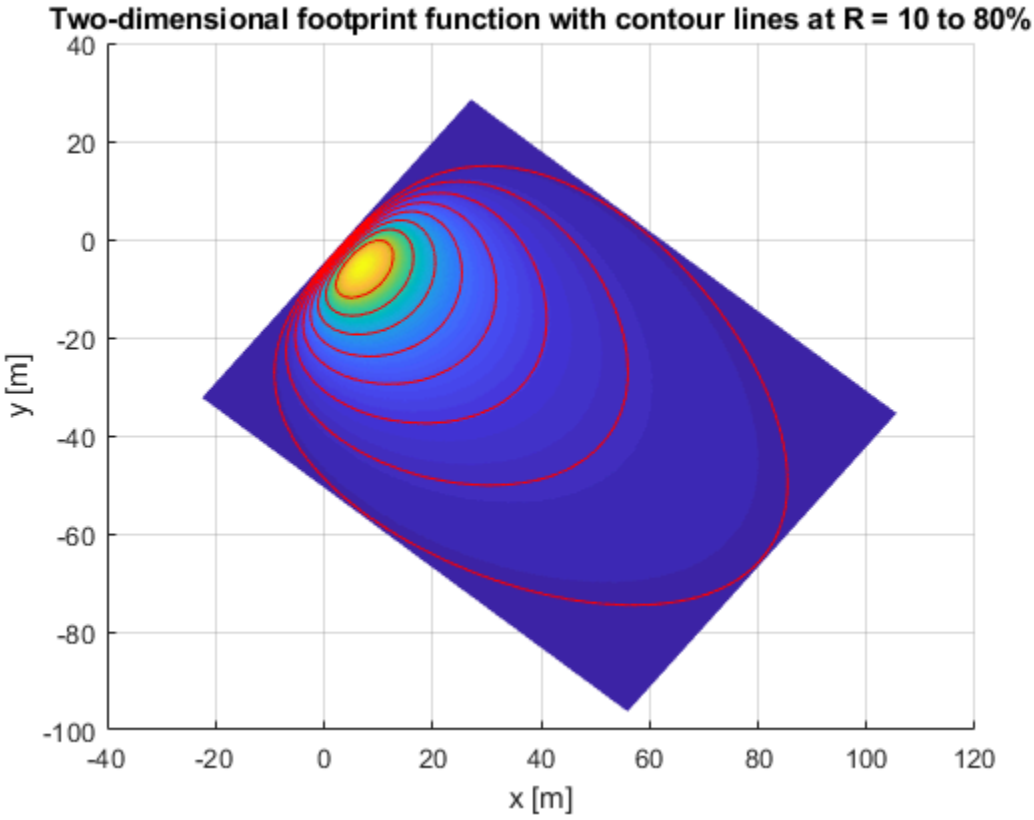
Almonds 2 on 6/19/20

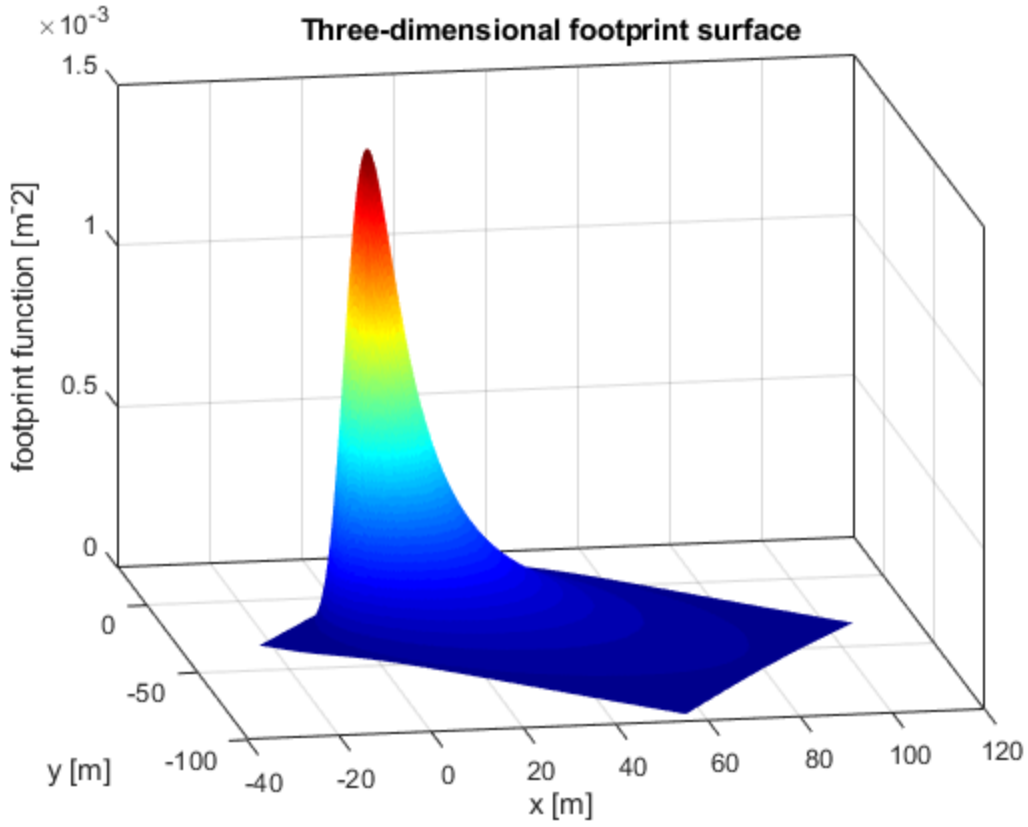
```
xstation = 574057.44; % x-coordinate of station [m]
ystation = 4422582.887; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 1.8; % measured [m s-1]
sigmav = 0.8; %
ustar = 0.4; % measured [m s-1]
wind_dir = 129.2; % measured [deg]
Ta = 33.0; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 11.6; % vapor pressure [mb]
LE = 681; % station latent heat flux [W m-2]
H = -39; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_2_FFP_06-19-20.txt',M,'precision',11)
dlmwrite('Almonds_2_FFP_06-19-20_contour.txt',Mcontour,'precision',11)
```

Done!




Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m^-1]
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
350
400
x-array of crosswind integrated footprint [m]

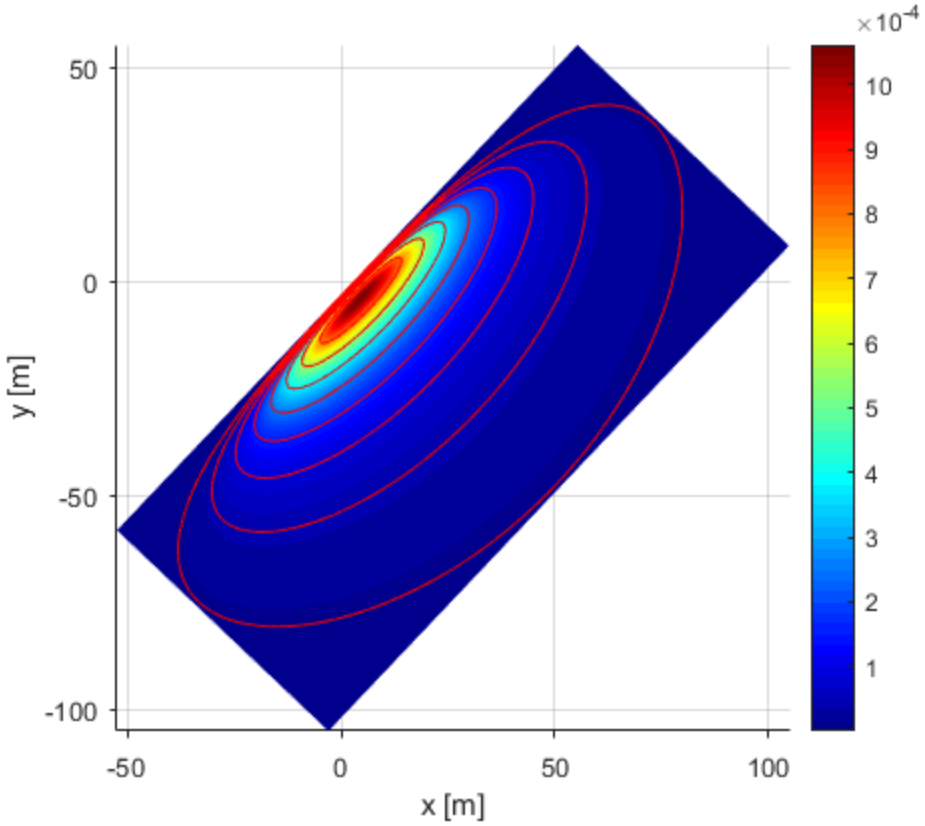

Two-dimensional footprint function with contour lines at R = 10 to 80%
40
20
0
-20
-40
-60
-80
-100
y [m]
-40
-20
0
20
40
60
80
100
120
x [m]

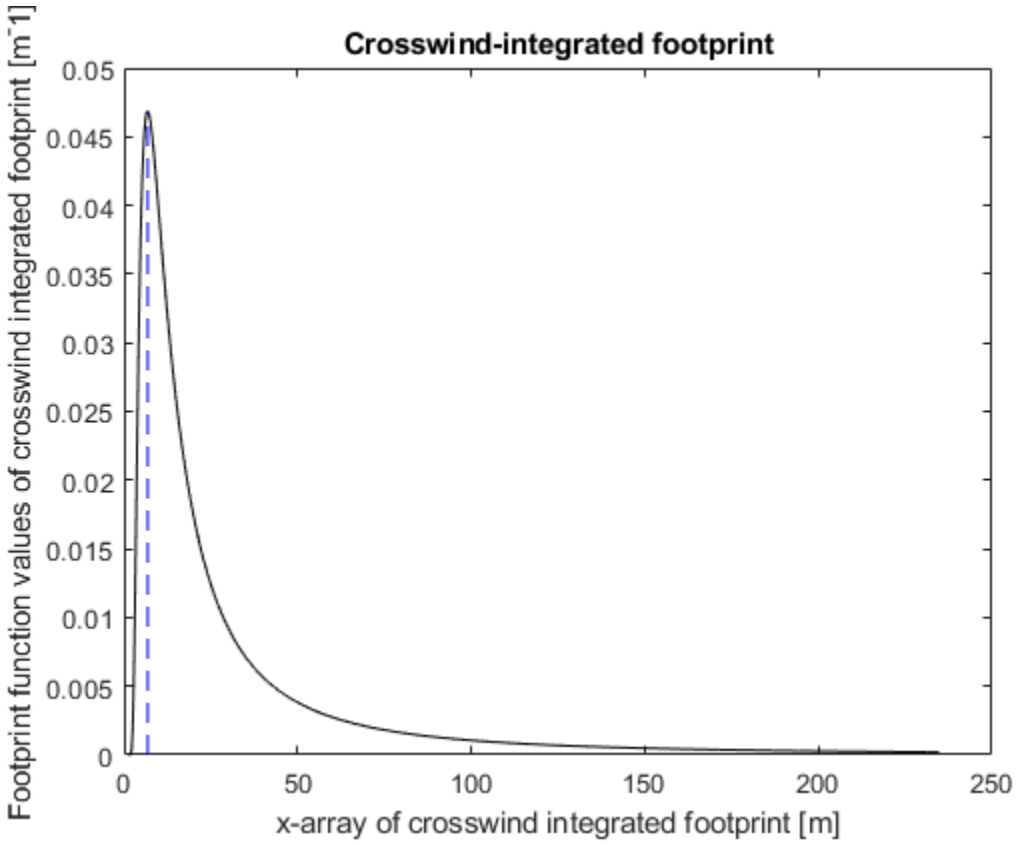


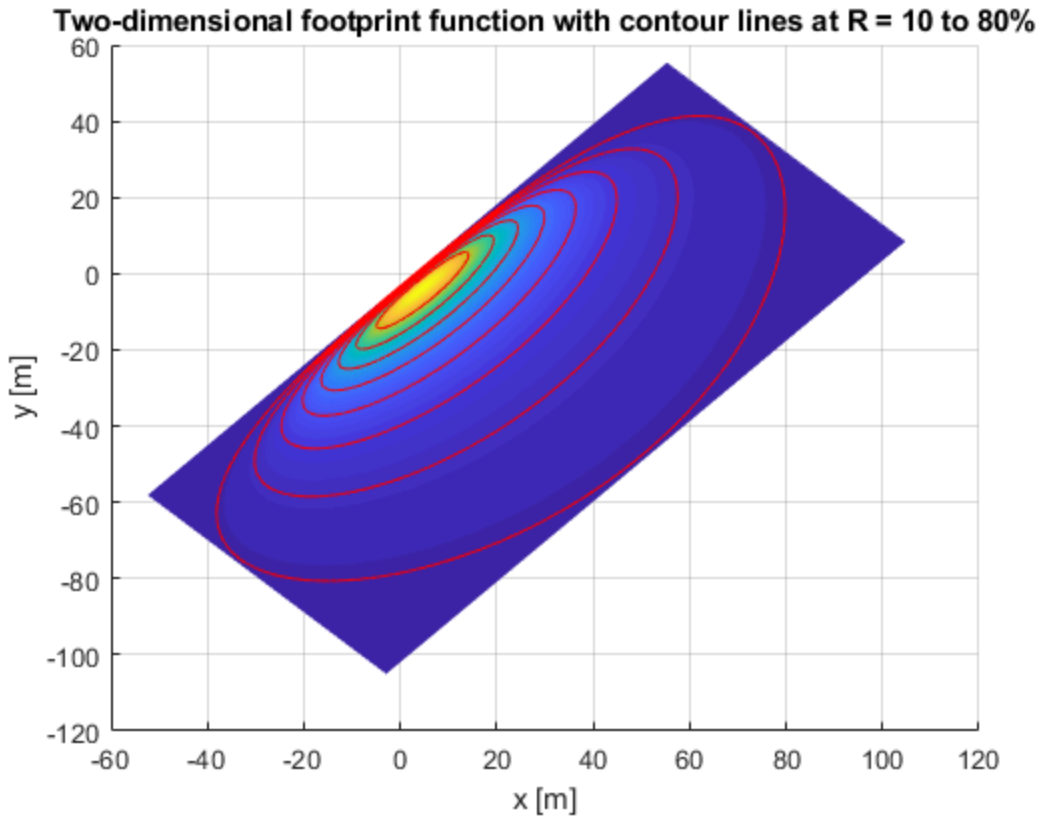
Almonds 3 on 6/19/20

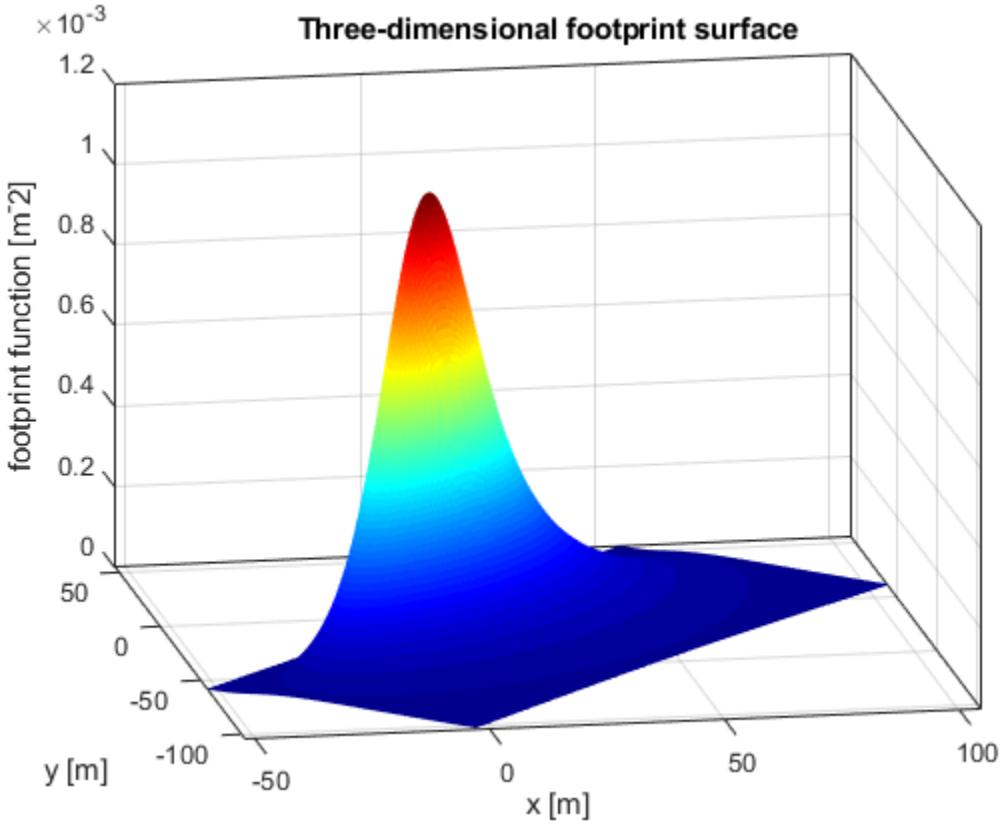
```
xstation = 574822.323; % x-coordinate of station [m]
ystation = 4422508.481; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 0.6; % measured [m s-1]
sigmav = 0.8; %
ustar = 0.2; %
wind_dir = 133.5; % measured [deg]
Ta = 30.7; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 13.4; % vapor pressure [mb]
LE = 383; % station latent heat flux [W m-2]
H = 6; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_3_FFP_06-19-20.txt',M,'precision',11)
dlmwrite('Almonds_3_FFP_06-19-20_contour.txt',Mcontour,'precision',11)
```

Done!


×10^-4
10
9
8
7
6
5
4
3
2
1
50
0
-50
-100
y [m]
-50
0
50
100
x [m]


Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m-1]
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
x-array of crosswind integrated footprint [m]

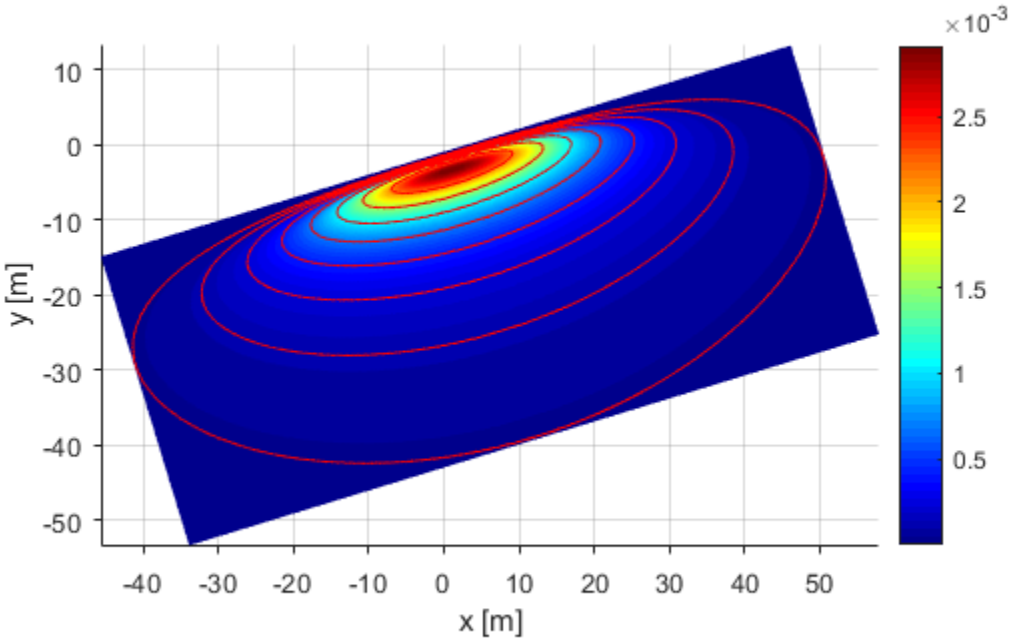

Two-dimensional footprint function with contour lines at R = 10 to 80%
y [m]
x [m]
60
40
20
0
-20
-40
-60
-80
-100
-120
-60
-40
-20
0
20
40
60
80
100
120

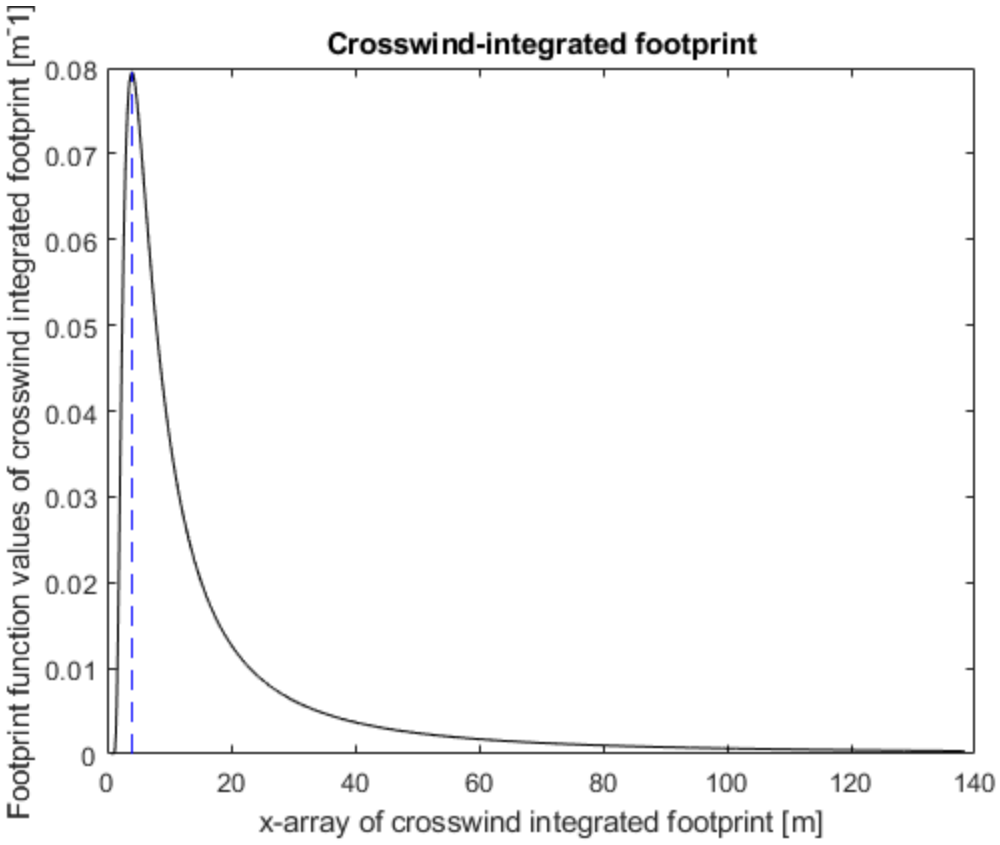

Three-dimensional footprint surface
×10^-3
footprint function [m^-2]
1.2
1
0.8
0.6
0.4
0.2
0
y [m]
50
0
-50
-100
x [m]
-50
0
50
100

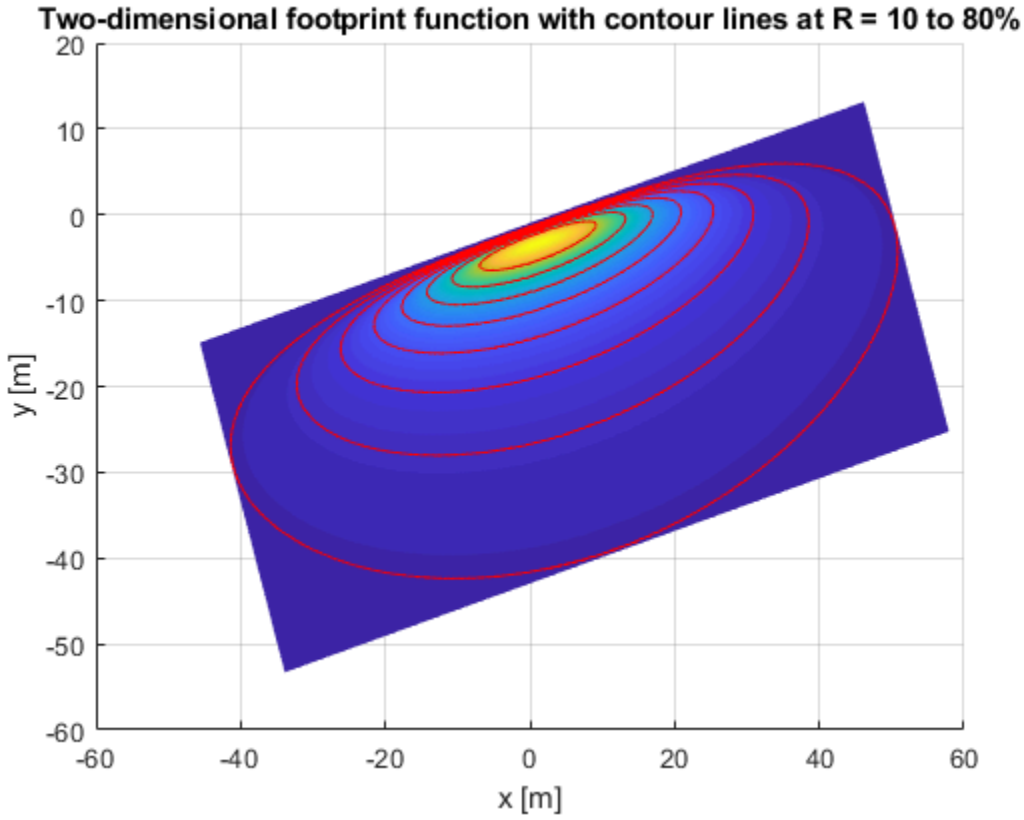
Almonds 1 on 8/9/20

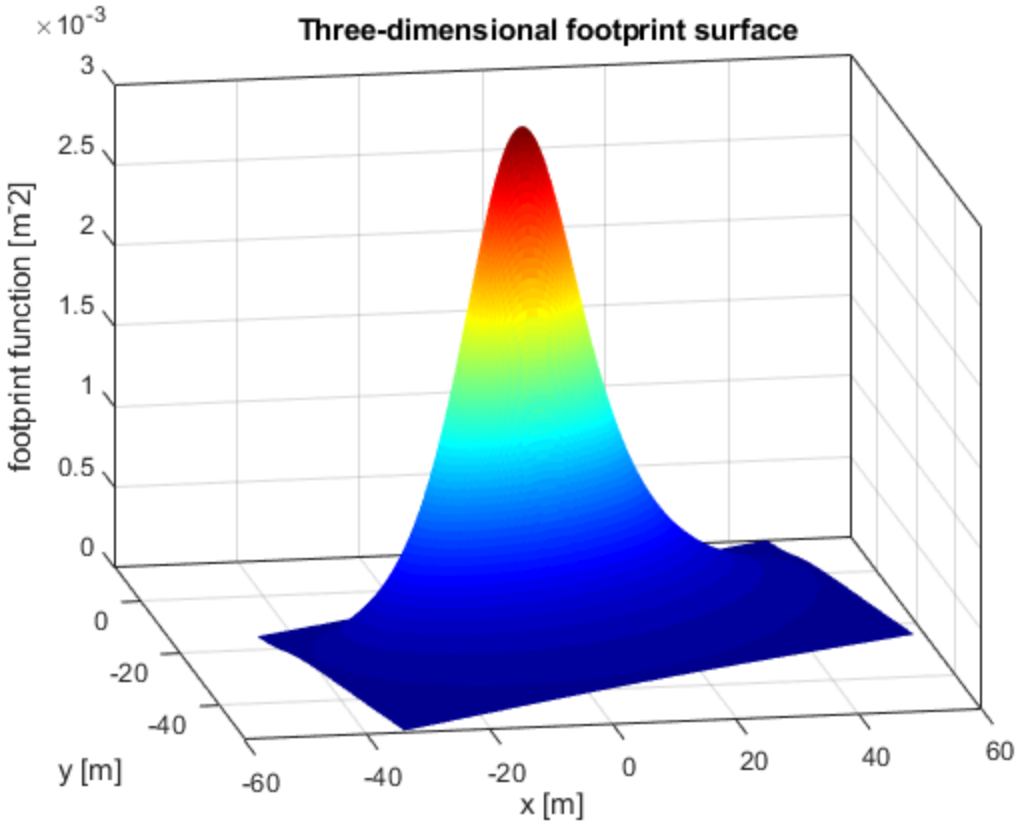
```
xstation = 574287.972; % x-coordinate of station [m]
ystation = 4422836.305; % y-coordinate of station [m]
zm = 4.6; % measurement height [m]
umean = 0.5; % measured [m s-1]
sigmav = 0.7; '
ustar = 0.2; % measured [m s-1]
wind_dir = 163; % measured [deg]
Ta = 36.7; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 14.7; % vapor pressure [mb]
LE = 543; % station latent heat flux [W m-2]
H = 13; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_1_FFP_08-09-20.txt',M,'precision',11)
dlmwrite('Almonds_1_FFP_08-09-20_contour.txt',Mcontour,'precision',11)
```

Done!



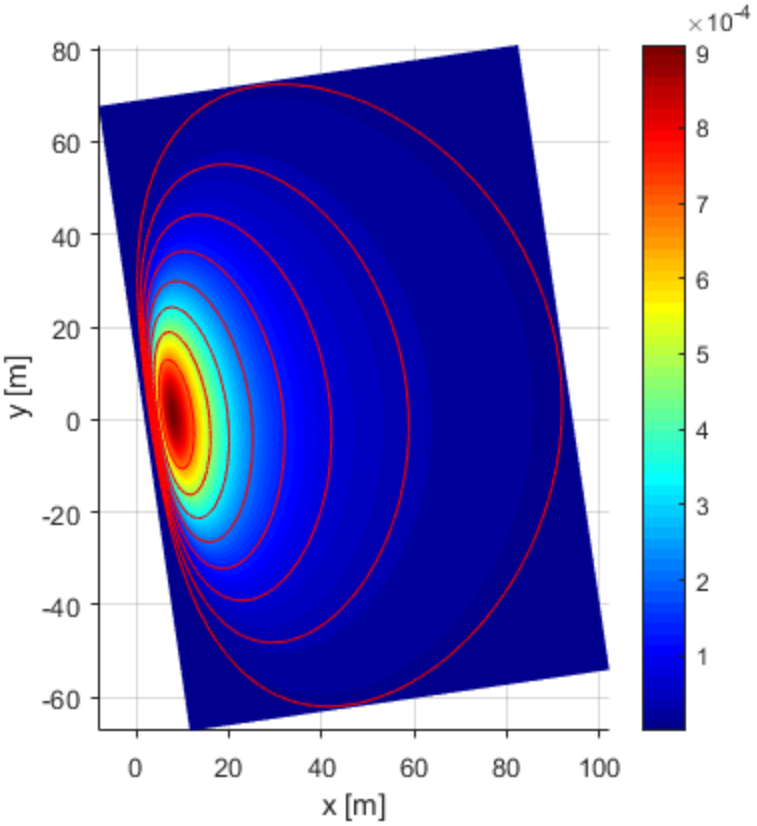

Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m^-1]
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
120
140
x-array of crosswind integrated footprint [m]

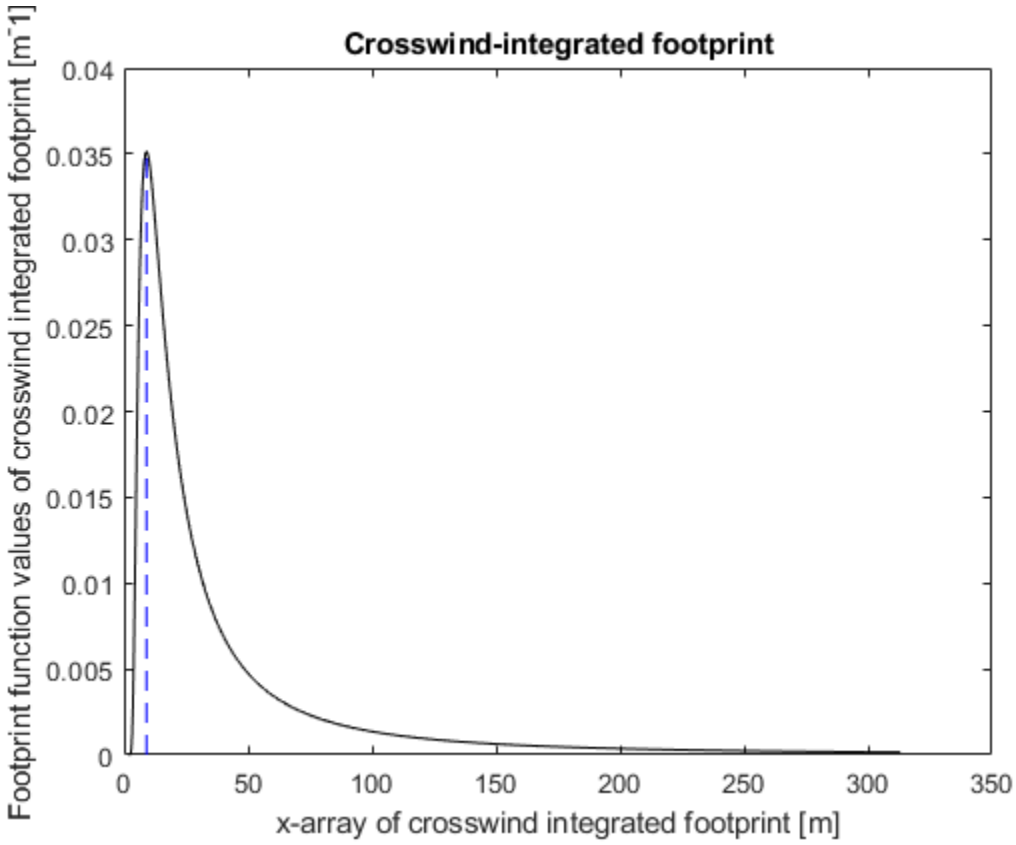

Two-dimensional footprint function with contour lines at R = 10 to 80%
20
10
0
-10
-20
-30
-40
-50
-60
y [m]
-60
-40
-20
0
20
40
60
x [m]

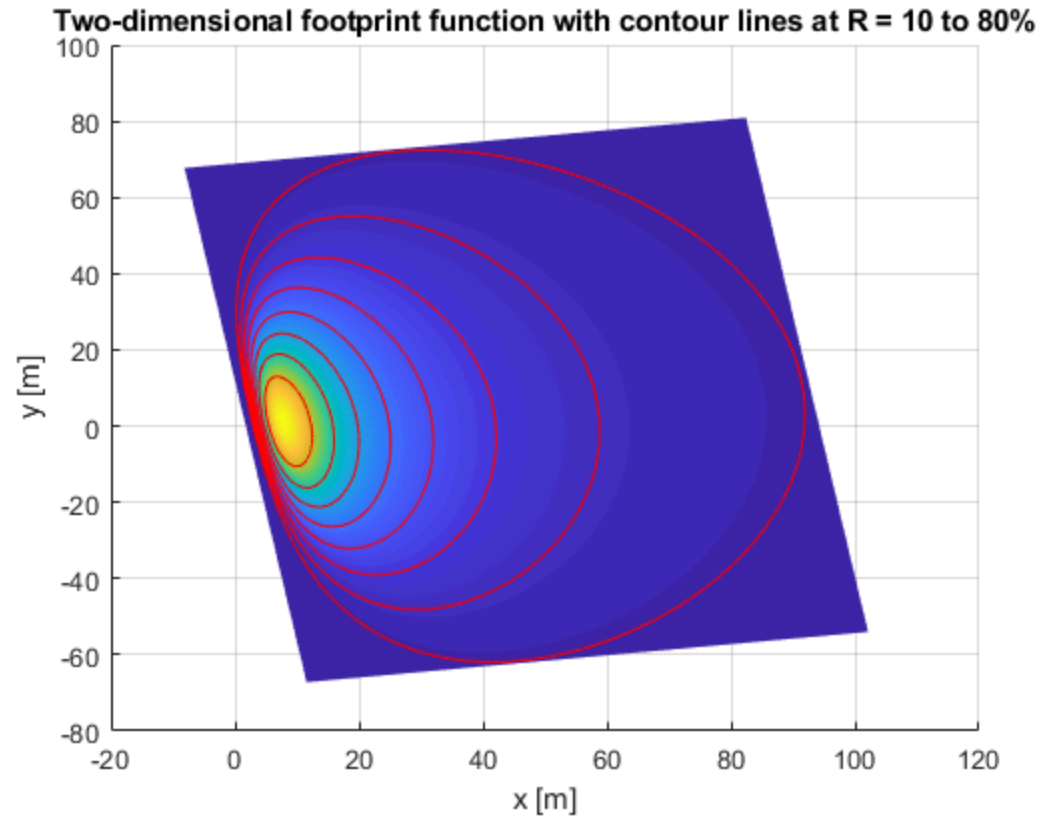


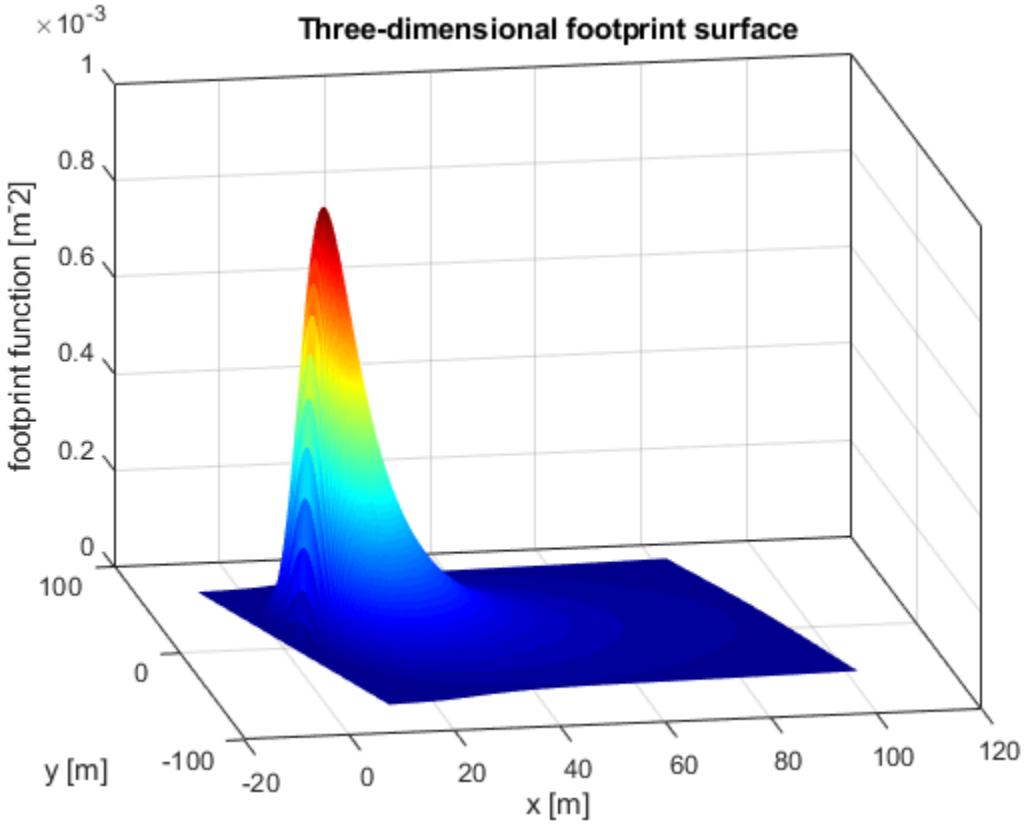
Almonds 2 on 8/9/20

```
xstation = 574057.44; % x-coordinate of station [m]
ystation = 4422582.887; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 0.8; % measured [m s-1]
sigmav = 0.7; % ***
ustar = 0.2; % measured [m s-1]
wind_dir = 81.7; % measured [deg]
Ta = 35.9; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 17.7; % vapor pressure [mb]
LE = 542; % station latent heat flux [W m-2]
H = -22; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_2_FFP_08-09-20.txt',M,'precision',11)
dlmwrite('Almonds_2_FFP_08-09-20_contour.txt',Mcontour,'precision',11)

Done!
```


×10^-4
9
8
7
6
5
4
3
2
1
80
60
40
20
0
-20
-40
-60
y [m]
0
20
40
60
80
100
x [m]


Crosswind-integrated footprint
Footprint function values of crosswind integrated footprint [m-1]
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
350
x-array of crosswind integrated footprint [m]


Two-dimensional footprint function with contour lines at R = 10 to 80%
y [m]
x [m]
100
80
60
40
20
0
-20
-40
-60
-80
-20
0
20
40
60
80
100
120


Three-dimensional footprint surface
×10^-3
footprint function [m^-2]
1
0.8
0.6
0.4
0.2
0
y [m]
100
0
-100
x [m]
-20
0
20
40
60
80
100
120

Almonds 3 on 8/9/20

```
xstation = 574822.323; % x-coordinate of station [m]
ystation = 4422508.481; % y-coordinate of station [m]
zm = 6.5; % measurement height [m]
umean = 0.6; % measured [m s-1]
sigmav = 0.7; %
ustar = 0.2; % measured [m s-1]
wind_dir = 55.58; % measured [deg]
Ta = 35.2; % air temperature [C]
z = 84; % elevation [m], https://en.wikipedia.org/wiki/
Corning,_California
e = 18.3; % vapor pressure [mb]
LE = 547; % station latent heat flux [W m-2]
H = 4; % station sensible heat flux [W m-2]

% Run FFP Function
[ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H);

% save array
dlmwrite('Almonds_3_FFP_08-09-20.txt',M,'precision',11)
dlmwrite('Almonds_3_FFP_08-09-20_contour.txt',Mcontour,'precision',11)
```

Functions

```
function [ M, Mcontour ] =
 FFPprogram(xstation,ystation,zm,umean,sigmav,ustar,wind_dir,Ta,z,e,LE,H)
    % Citation of FFP function: Kljun, N., P. Calanca, M.W. Rotach,
 H.P. Schmid,
    % 2015: A simple two?dimensional parameterisation for Flux
 Footprint Prediction
    % (FFP). Geosci. Model Dev., 8, 3695?3713. doi:10.5194/gmd?8?3695?
2015.

    % Resources for calculating the Monin-Obukhov length:
    % https://www.weather.gov/epz/wxcalc_stationpressure
    % https://www.weather.gov/epz/wxcalc_mixingratio
    % https://www.shodor.org/os411/courses/_master/tools/calculators/
virtualtemp/tv1calc.html
    % https://www.shodor.org/os411/courses/_master/tools/calculators/
moninobukhov/index.html

    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%

    % Inputs
    %FFP Input
    %All inputs as scalars
    %zm = Measurement height above displacement height (i.e. z?d) [m]
    %z0 = Roughness length [m] ? enter [None] if not known
    %umean = Mean wind speed at zm [ms?1] ? enter [None] if not known
```

```
    %h = Boundary layer height [m]
    %ol = Obukhov length [m]
    %sigmav = Standard deviation of lateral velocity fluctuations [ms?
1]
    %ustar = Friction velocity [ms?1]

    gravity = 9.8; % acceleration of gravity [m s-2]
    k = 0.4; % von Karman's constant [dimensionless]
    R_d = 287.04; % gas constant for dry air, J/(kg*degK)

    % guess
    z0 = NaN; % unknown, either z0 or umean is required.
    h = 2000; % guess [m]

    % settings
    rs = 10:10:80; % percentage of source area
    fig = 1; % show plots
    %crop = 1; % crop output area to size of the footprint

    % meteorological inputs
    epsilon = 0.622; % ratio of the molecular weight of water vapor to
 dry air
    c_pd = 1003.5; % heat capacity of dry air at constant pressure [J
 kg-1 K-1]
    c_pv = 1865; % heat capacity of water vapour at constant pressure
 [J kg-1 K-1]

    % meterological calculations
    p = 1013.25 * (1.0 - 2.225577e-5 * z)^5.25588; % barometric
 pressure above sea level [mb]
    ea = 6.112 * exp((17.67 * Ta) / (Ta + 243.5)); % saturation water
 vapor pressure [mb]
    %mr = epsilon * ea / (p - ea); %8.2; % actual mixing ratio, g/kg
 [https://www.weather.gov/epz/wxcalc_mixingratio]
    q = epsilon * ea / (p + (epsilon - 1.0) * ea); % specific humidity
    cp = (1.0 - q) * c_pd + q * c_pv; % heat capacity of moist air
    rho = ((p * 100.0) / (R_d * (Ta+273.15))) * (1.0 - (1.0 - epsilon)
* ea / p); % density of air [kg m-3]

    % Monin-Obukhov length calculation
    Lambda = 1E6 *(2.501 - (2.361e-3 * Ta)); % latent heat of
 vaporization [J kg-1]
    E = LE/Lambda; % rate of surface evaporation (kg m-2 s-1)
    Hv = H + (0.61 * (Ta+273.15) * cp * E); % virtual sensible heat
 flux
    Lconst = k*gravity/(Ta+273.15);
    ol = -ustar^3 / (Lconst * (Hv / (rho * cp))); % Monin-Obukhov
 length [m]

    % FIX
    % % Calculate the mixing ratio
    % w = 621.97*(e/(p-e)); % actual mixing ratio, g/kg
    % ws = 621.97*(es/(p-es)); % saturated mixing ratio, g/kg
    % rh = w/ws; % relative humidity
```

```
   % Main function for flux footprint prediction
   [FFP,flag_err] = calc_footprint_FFP(zm,...
                                       z0,...
                                       umean,...
                                       h,...
                                       ol,...
                                       sigmav,...
                                       ustar,...
                                       'wind_dir',wind_dir,...
                                       'r',rs,...
                                       'fig',fig,...
                                       'crop',1);

   % Crosswind?integrated footprint
   figure()
   plot(FFP(1).x_ci, FFP(1).f_ci,'k-',[ FFP(1).x_ci_max
FFP(1).x_ci_max],...
       [0 max(FFP(1).f_ci)],'b--')
   title('Crosswind-integrated footprint')
   xlabel('x-array of crosswind integrated footprint [m]')
   ylabel('Footprint function values of crosswind integrated
footprint [m^-1]')

   % Two?dimensional footprint with contour lines at R = 10 to 80%
   figure()
   surf(FFP(1).x_2d, FFP(1).y_2d, FFP(1).f_2d);
   shading flat;
   view(2);
   title('Two-dimensional footprint function with contour lines at R
= 10 to 80%')
   xlabel('x [m]')
   ylabel('y [m]')
   hold all;

   for i=1:8
   z = FFP(i).fr.*10.*ones(size(FFP(i).yr));
   plot3(FFP(i).xr,FFP(i).yr,z,'r')
   end

   % Three?dimensional footprint surface
   figure()
   surf(FFP(1).x_2d, FFP(1).y_2d, FFP(1).f_2d);
   shading flat;
   view(-10,20);
   box on;
   colormap jet
   title('Three-dimensional footprint surface')
   xlabel('x [m]')
   ylabel('y [m]')
   zlabel('footprint function [m^-2]')

   % reshape array for saving
   x_2d_flat = reshape(FFP(1).x_2d,[numel(FFP(1).x_2d),1]);
```

```
    y_2d_flat = reshape(FFP(1).y_2d,[numel(FFP(1).y_2d),1]);
    f_2d_flat = reshape(FFP(1).f_2d,[numel(FFP(1).f_2d),1]);
    x_2d_flat = x_2d_flat + xstation; % corrected for absolute station
location
    y_2d_flat = y_2d_flat + ystation; % corrected for absolute station
location
    dim = 2; % dimension along which to concatenate
    M = cat(dim,x_2d_flat,y_2d_flat,f_2d_flat); % concatenate

    % x_c_flat = reshape(FFP(1).x_ci,[numel(FFP(1).x_ci),1]);
    % y_c_flat = reshape(FFP(1).y_ci,[numel(FFP(1).y_ci),1]);
    % f_c_flat = reshape(FFP(1).f_ci,[numel(FFP(1).f_ci),1]);
    % x_c_flat = x_c_flat + xstation; % corrected for absolute station
location
    % y_c_flat = y_c_flat + ystation; % corrected for absolute station
location
    % dim = 2; % dimension along which to concatenate
    % M_contour = cat(dim,x_c_flat,y_c_flat,f_c_flat); % concatenate

    x = transpose(FFP(8).xr) + xstation;
    y = transpose(FFP(8).yr) + ystation;
    z = FFP(8).fr.*10.*ones(size(y));
    xyz = cat(2,x,y,z);
    Mcontour = xyz(2:end,:); % delete first row with NaNs

    disp('Done!')

end
```

```
Done!
```

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