Observations of Urban-Derived Water Vapor during WINTER

Olivia Salmon
Purdue University

Purdue-UMD Flight Dates

February 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

March 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Purdue

Purdue-UMD

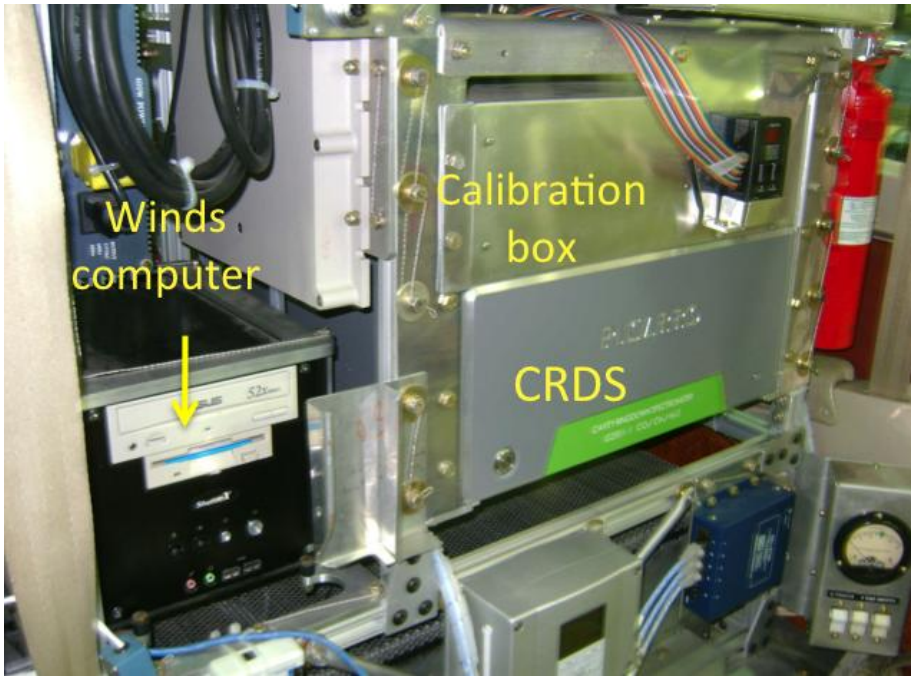
UMD

Purdue-UMD Hangar Cross Calibration

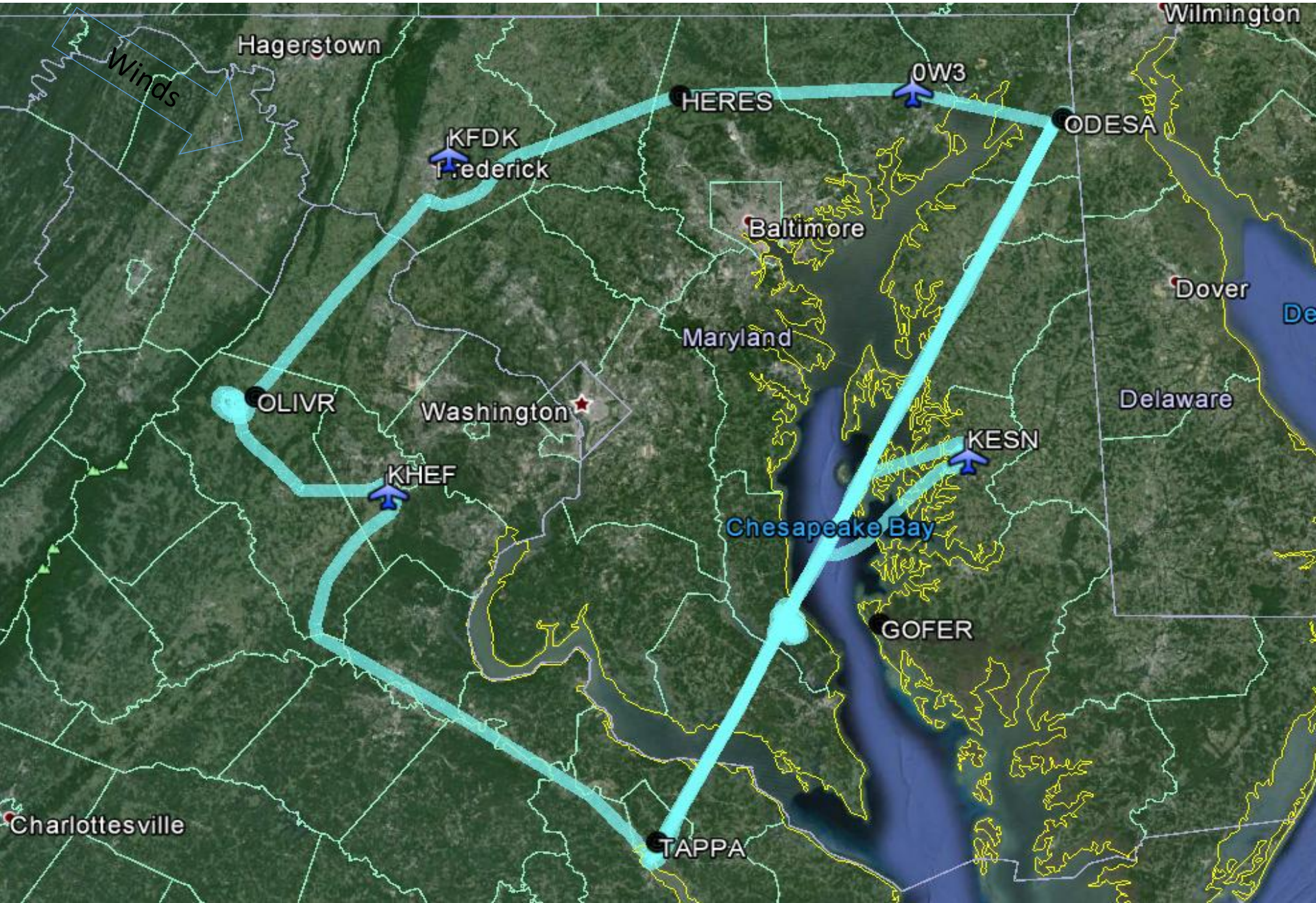
Purdue-C130 Intercomparison

Airborne Laboratory for Atmospheric Research

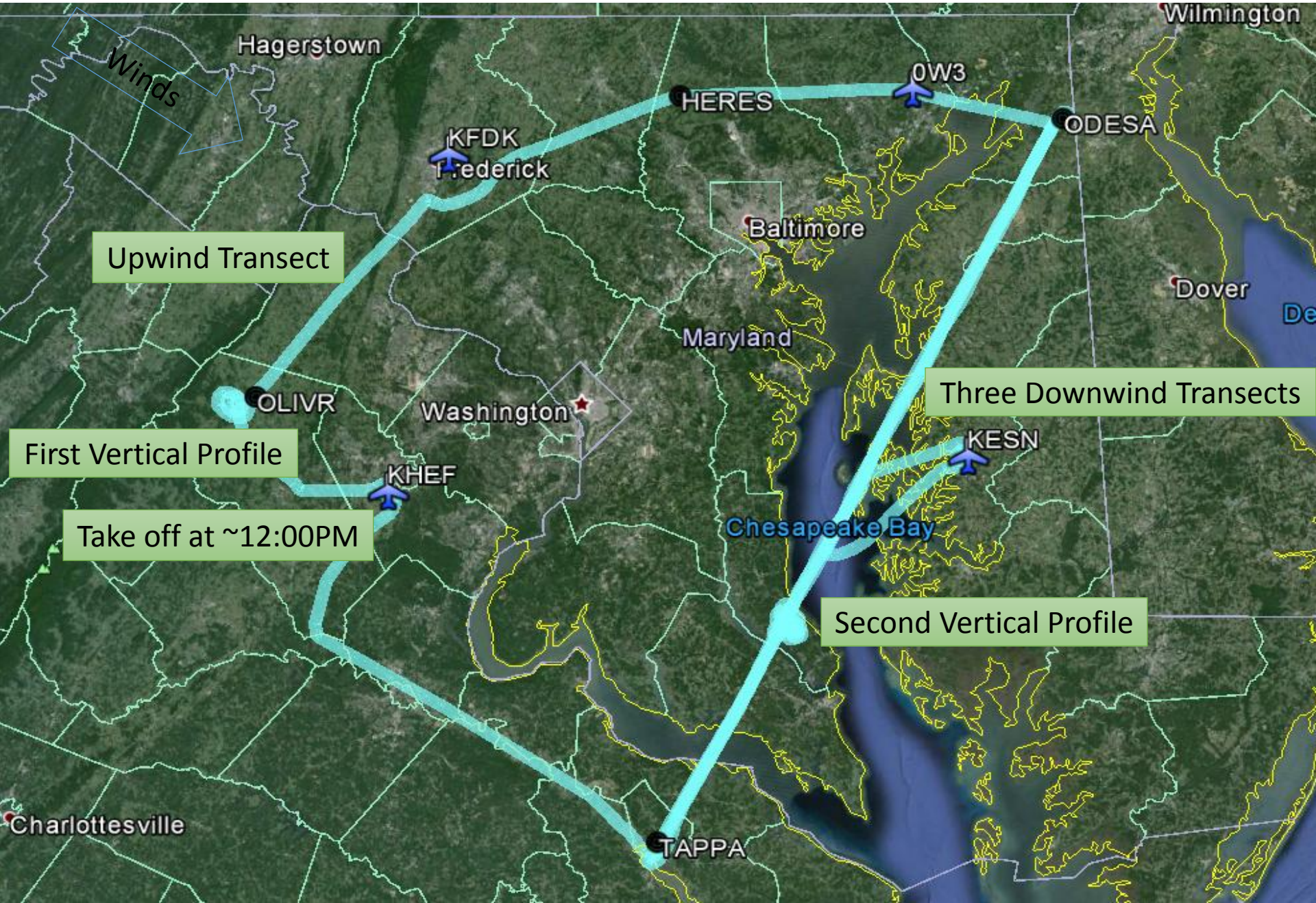
- BAT Probe (50 Hz Winds)
- GPS/INS System
- Picarro CRDS $CO_2/CH_4/H_2O$
- LGR CRDS NO_2
- 2B O_3 Monitor
- Grimm Aerosol Spectrometer



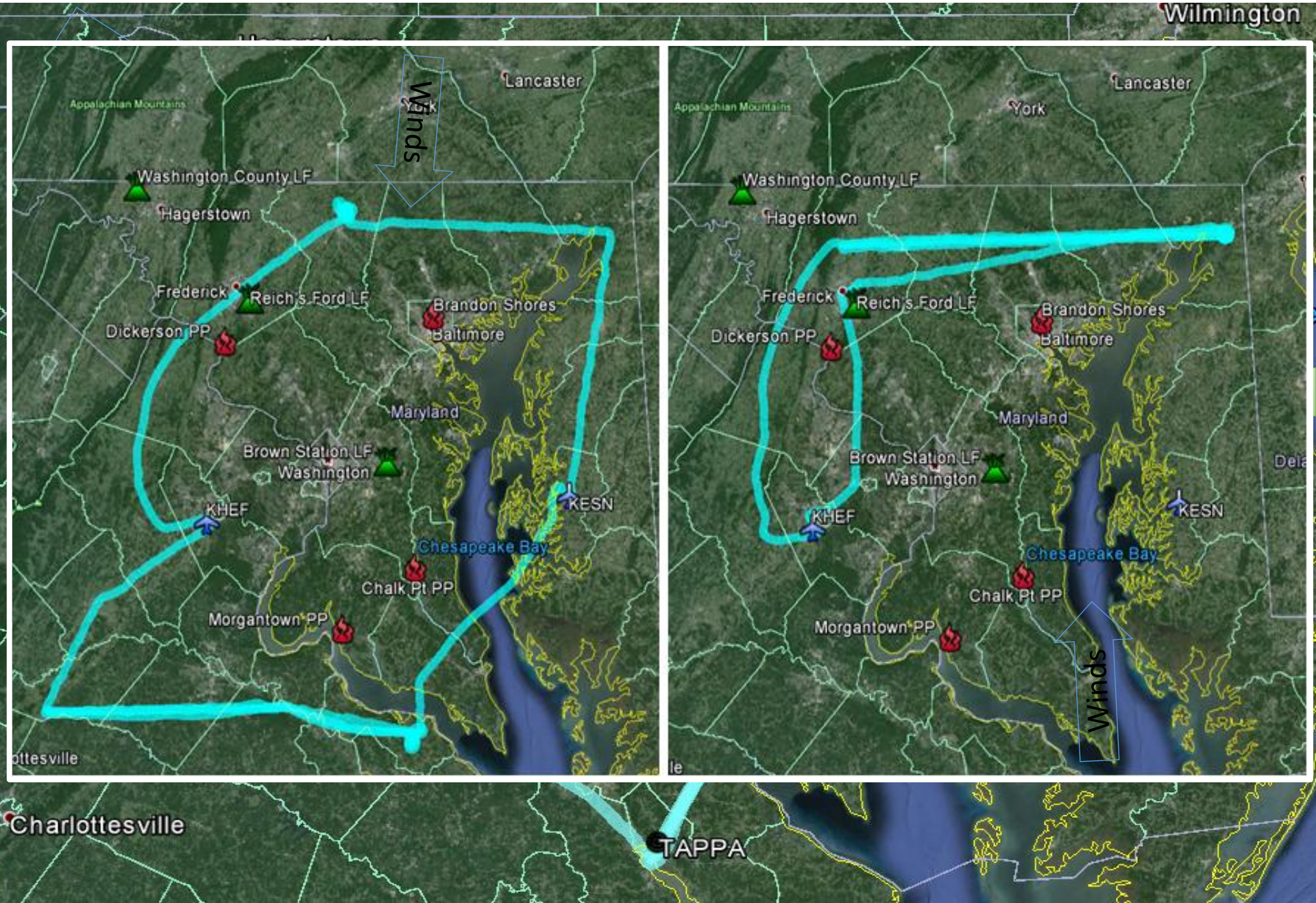
Typical Mass Balance Flight Design



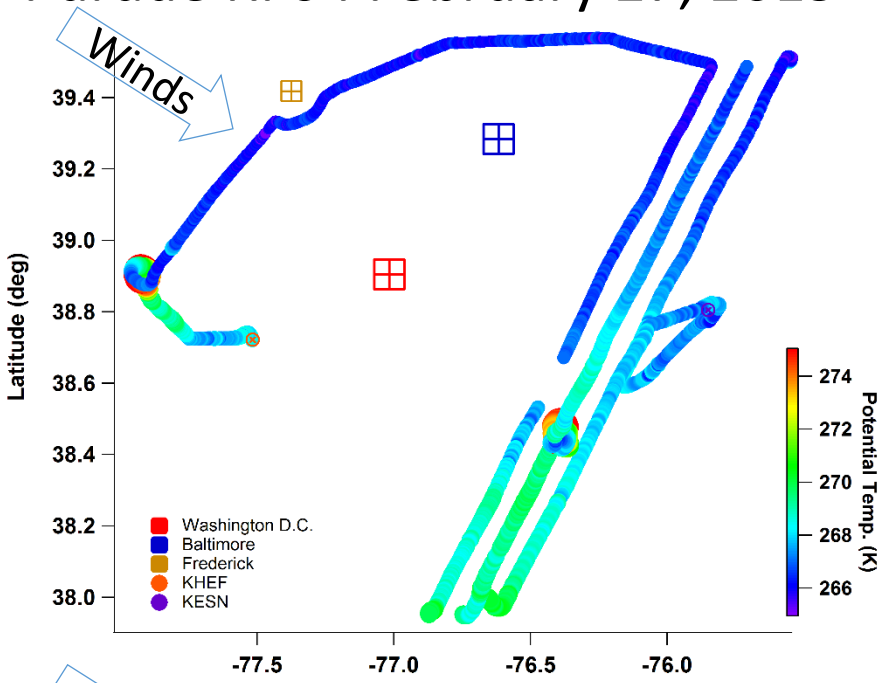
Typical Mass Balance Flight Design

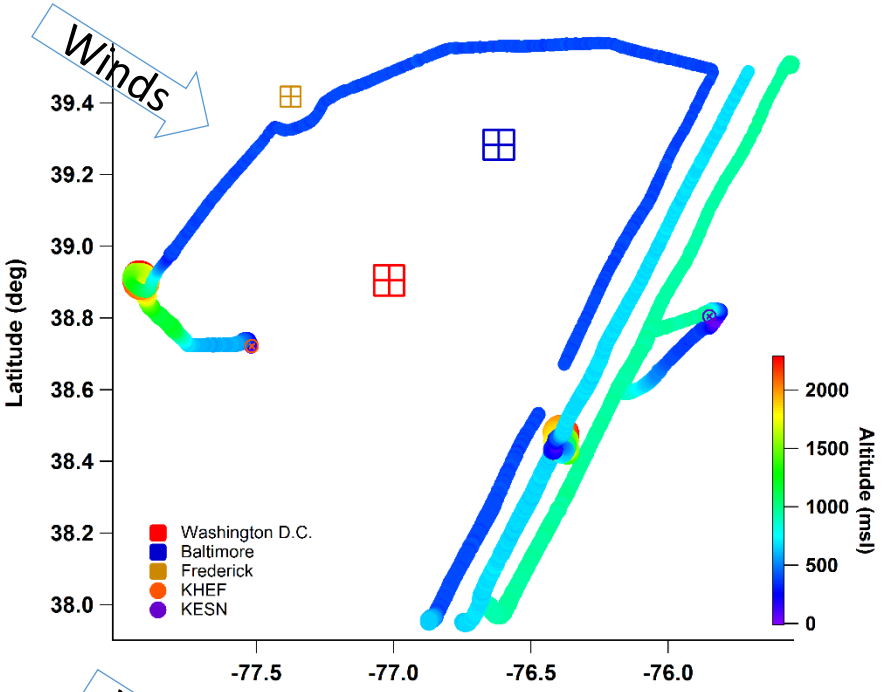


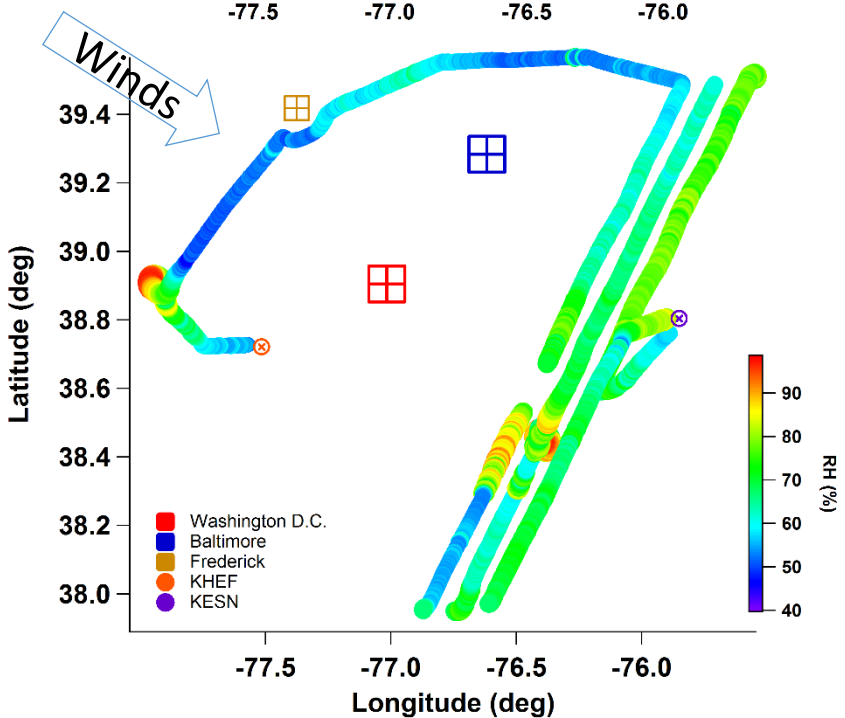
Typical Mass Balance Flight Design

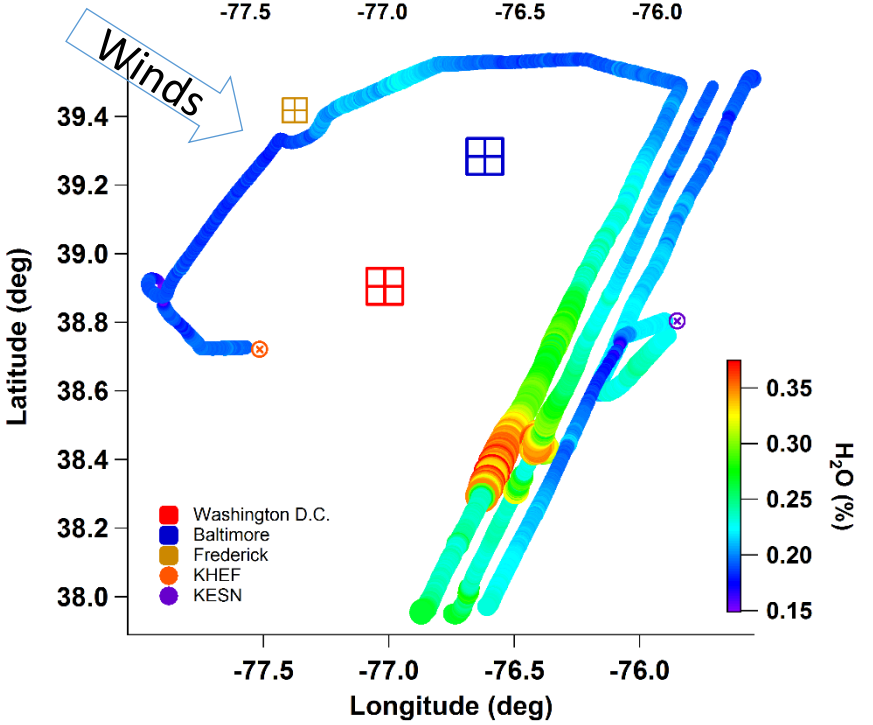


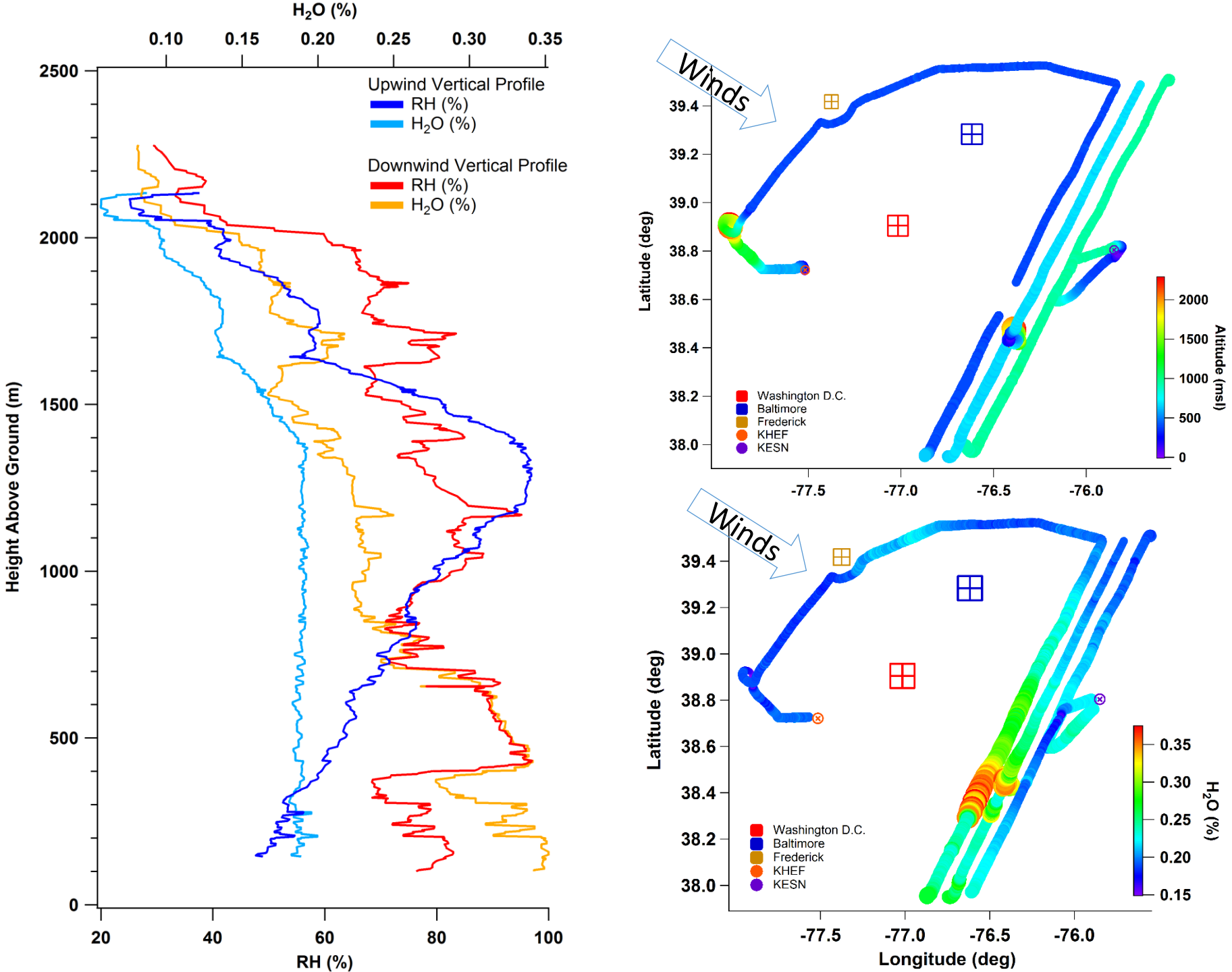
Purdue RF04 February 27, 2015



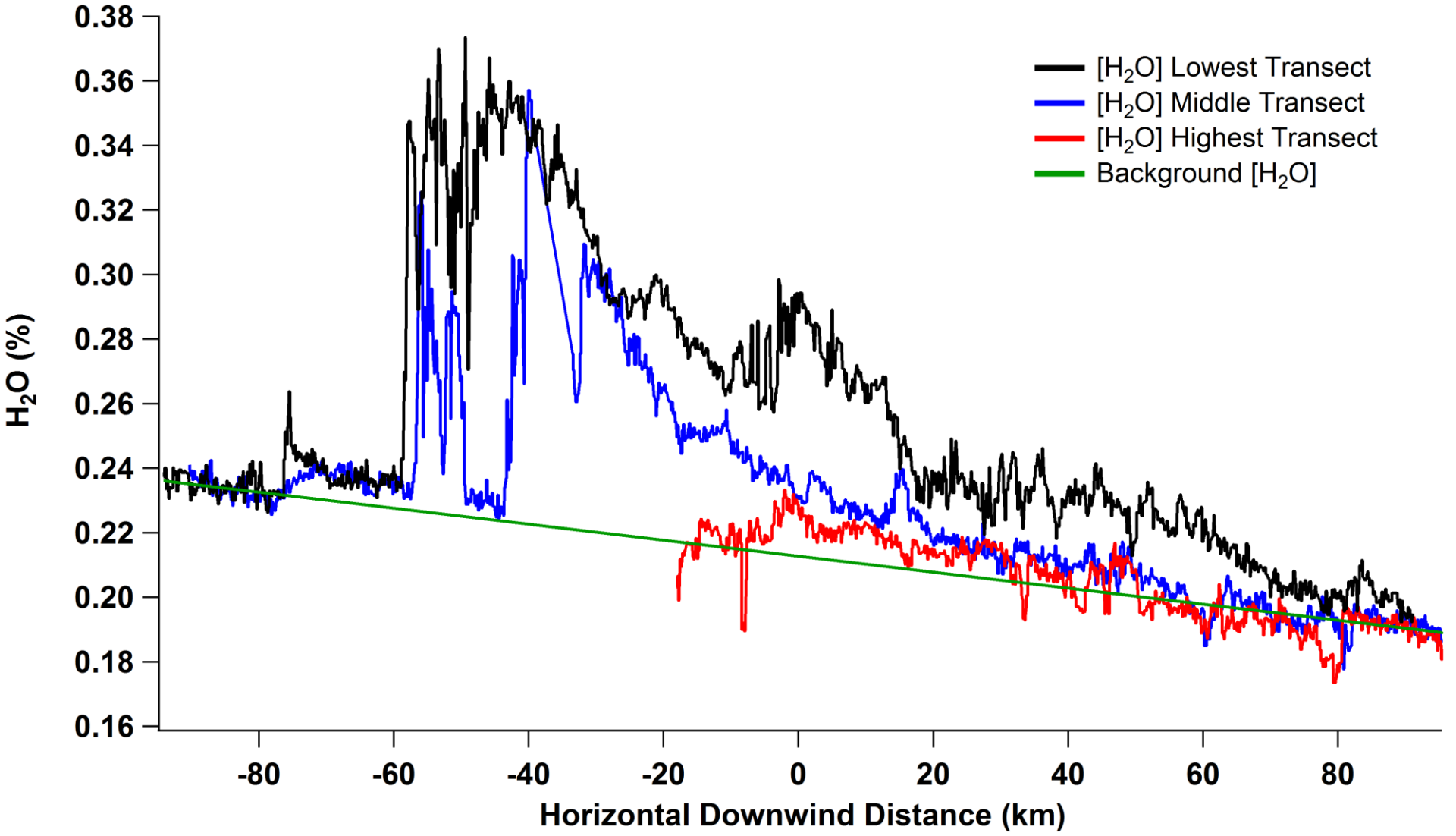




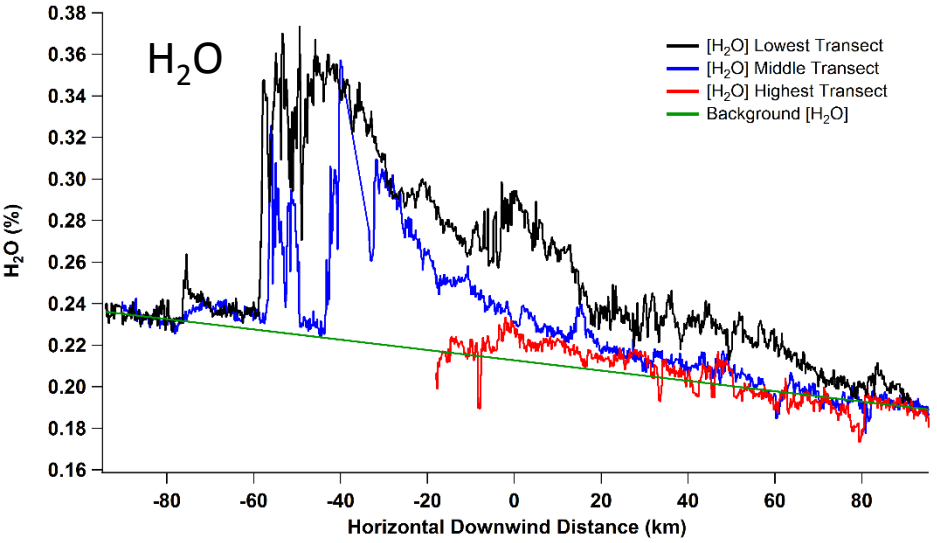


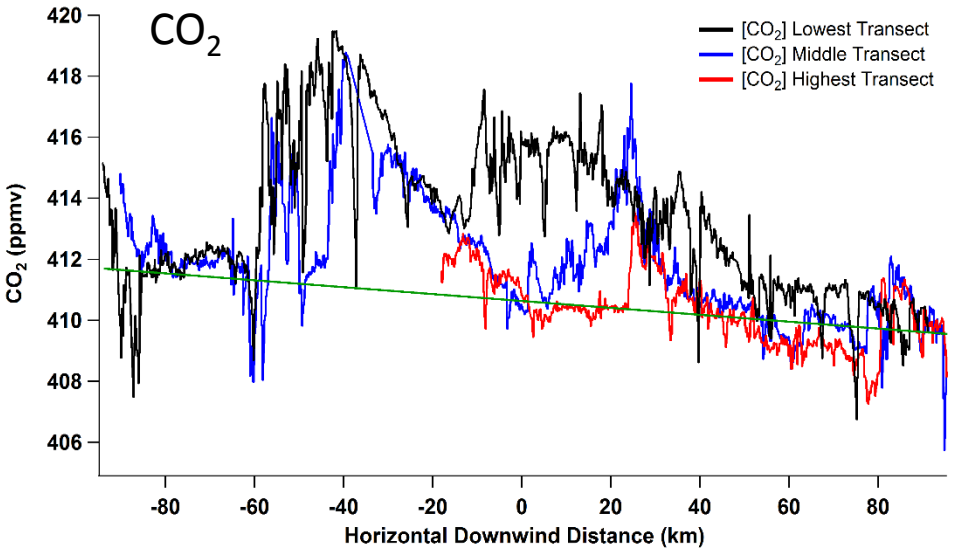

H2O (%)
0.10
0.15
0.20
0.25
0.30
0.35
Upwind Vertical Profile
RH (%)
H2O (%)
Downwind Vertical Profile
RH (%)
H2O (%)
Height Above Ground (m)
2500
2000
1500
1000
500
0
20
40
60
80
100
RH (%)
Winds
Latitude (deg)
39.4
39.2
39.0
38.8
38.6
38.4
38.2
38.0
Washington D.C.
Baltimore
Frederick
KHEF
KESN
-77.5
-77.0
-76.5
-76.0
Altitude (msl)
2000
1500
1000
500
0
Winds
Latitude (deg)
Longitude (deg)
H2O (%)
0.35
0.30
0.25
0.20
0.15

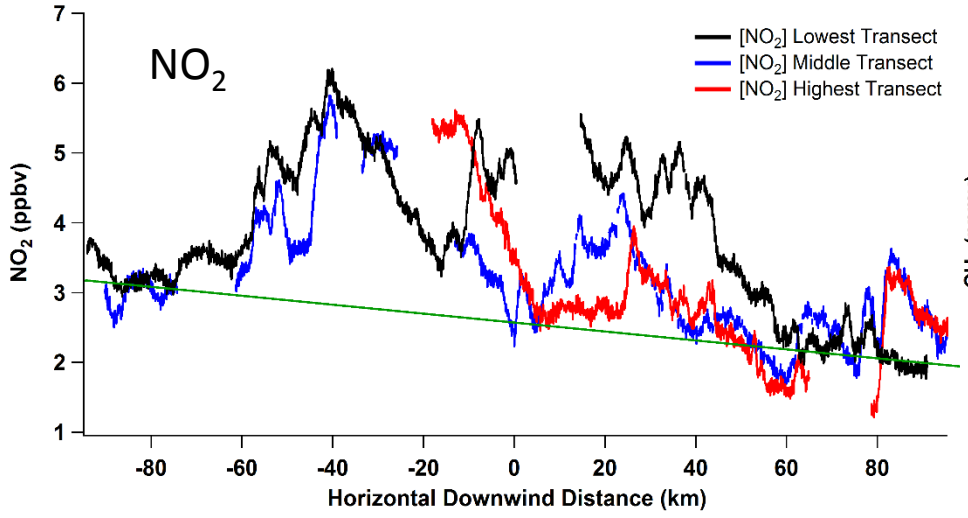
H_2O Profile Along Downwind Transects

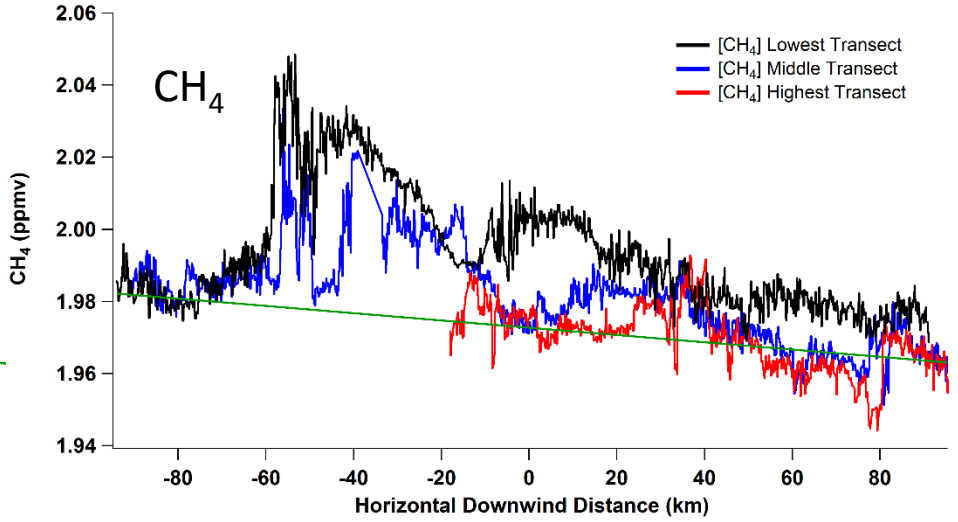


H_2O and other GHGs Track Similar Downwind Profile

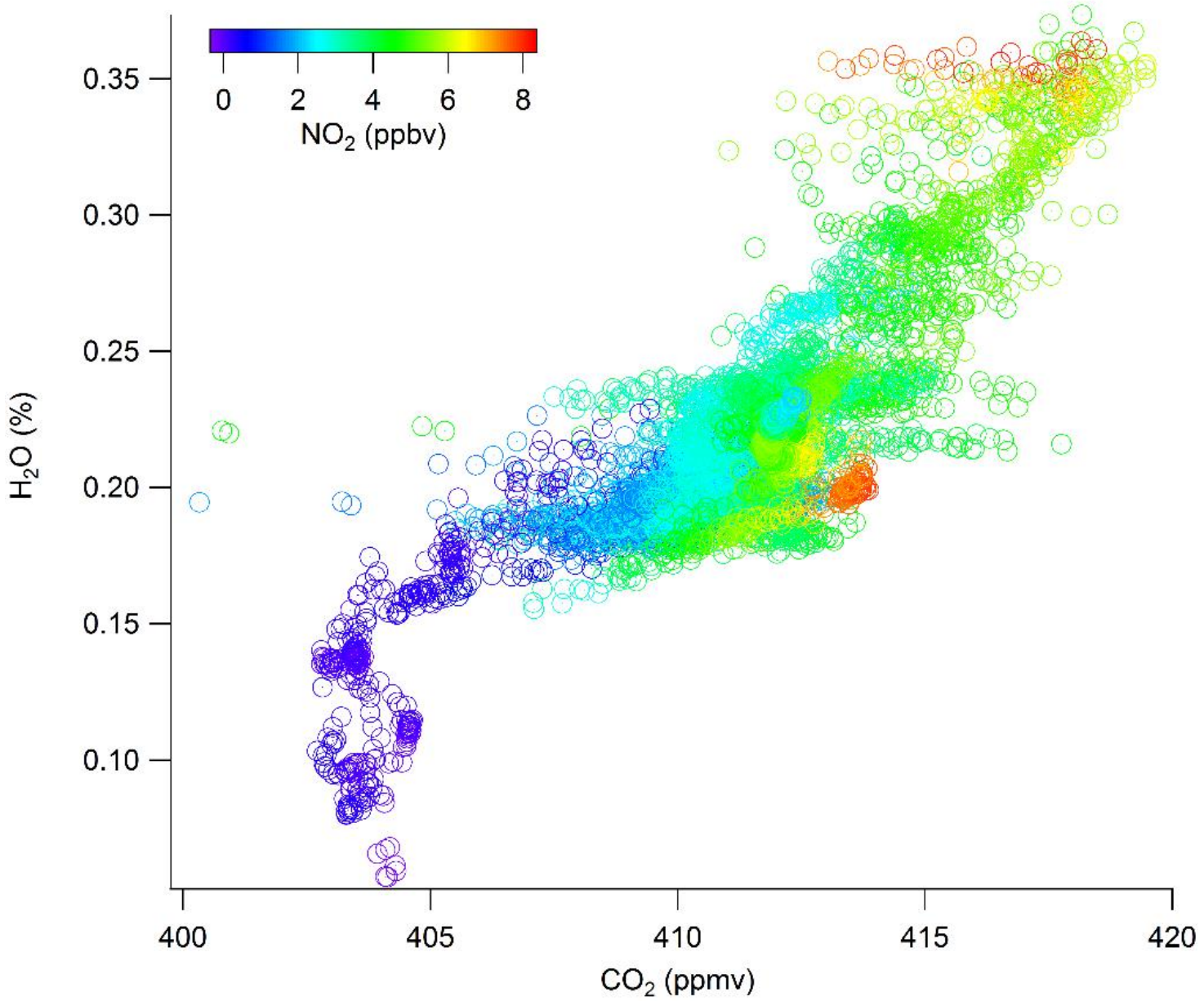




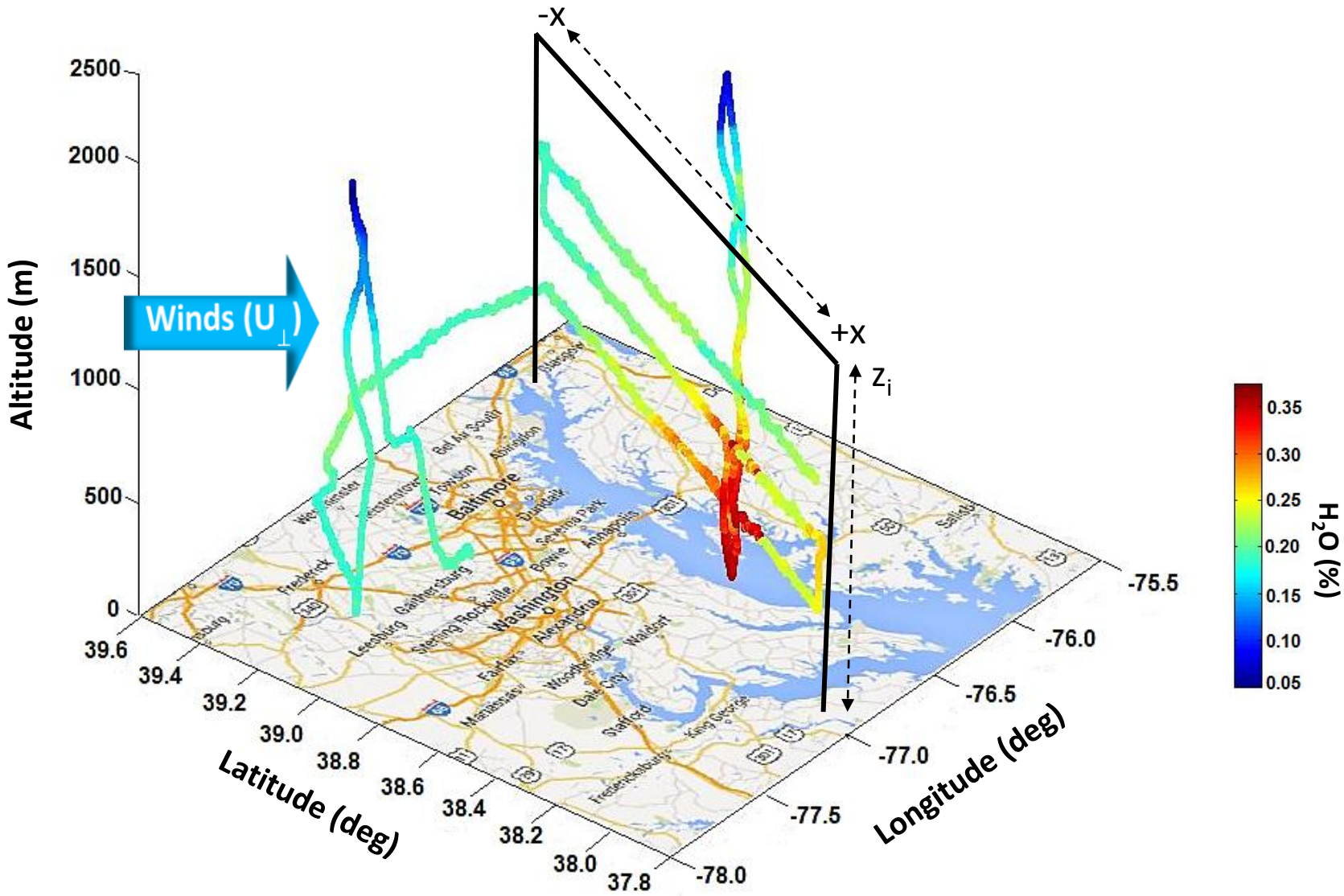




Atmospheric Correlation of H_2O, CO_2, and NO_2

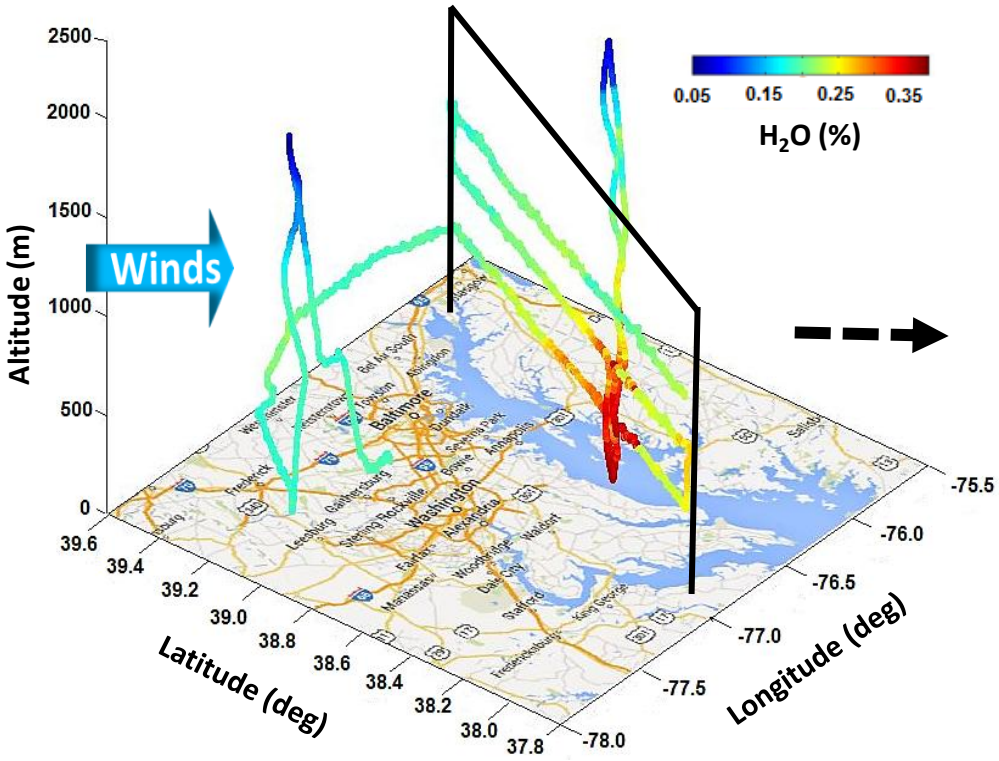


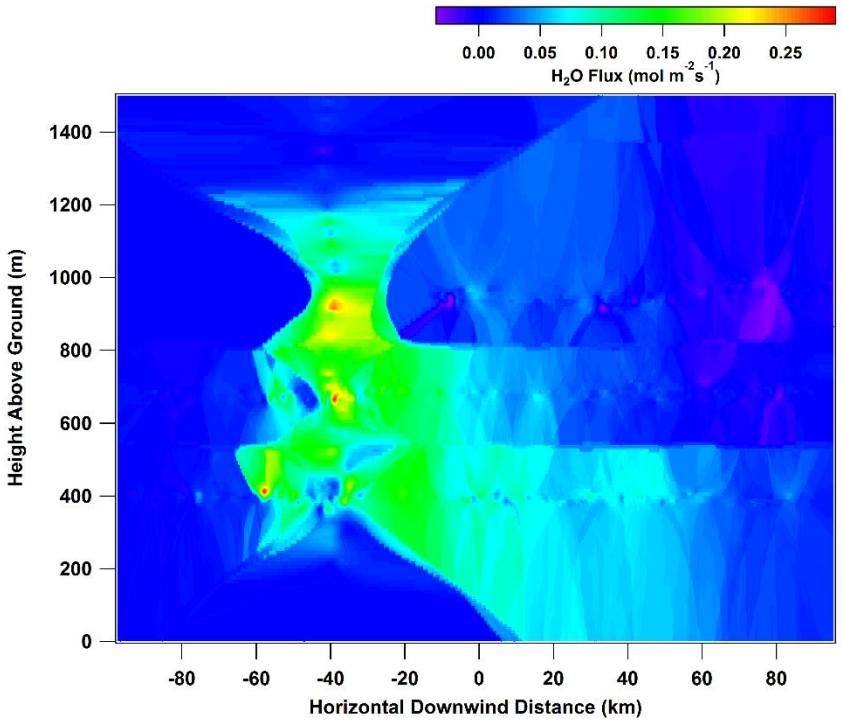
GHG Emission Rate Calculation



$$ER_C = \int_0^{z_i} \int_{-x}^{+x} \left([C]_{downwind} - [C]_{background}\right) x\, U_\perp dx\, dz$$

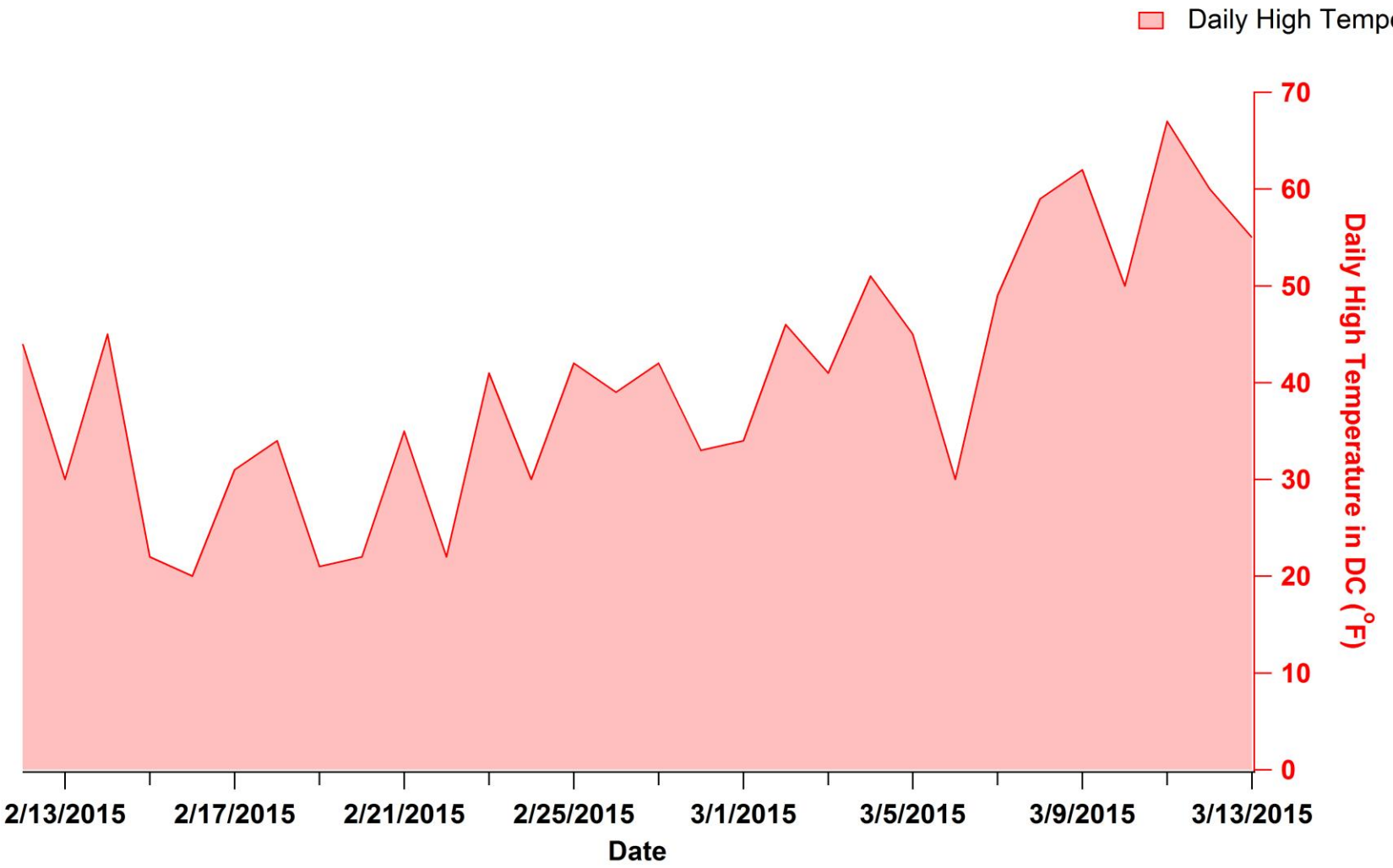
GHG Emission Rate Calculation





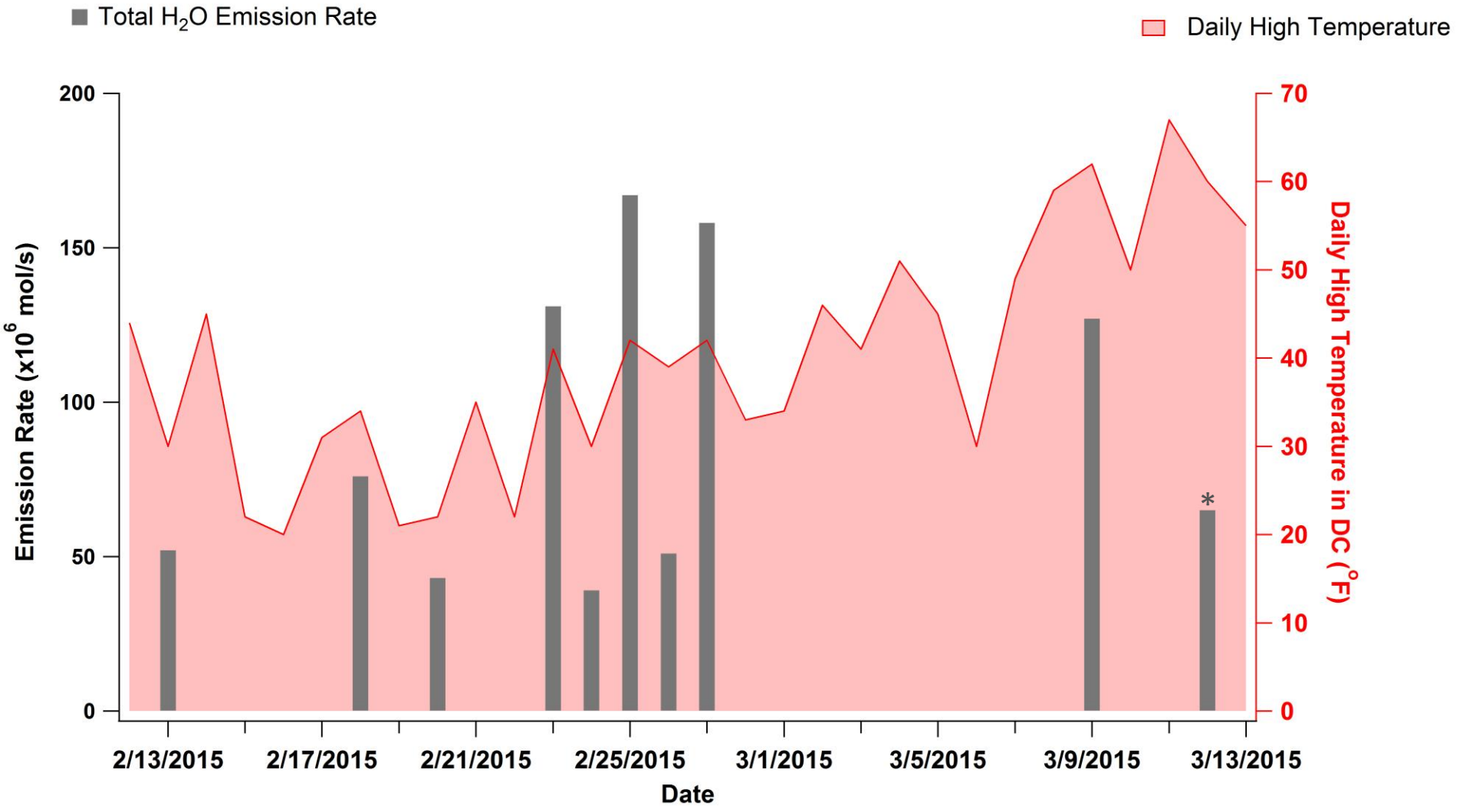
$$ER_C = \int_0^{z_i} \int_{-x}^{+x} \left([C]_{downwind} - [C]_{background}\right) x\, U_{\perp} dx\, dz$$

Daily High Temperatures in Washington, D.C.

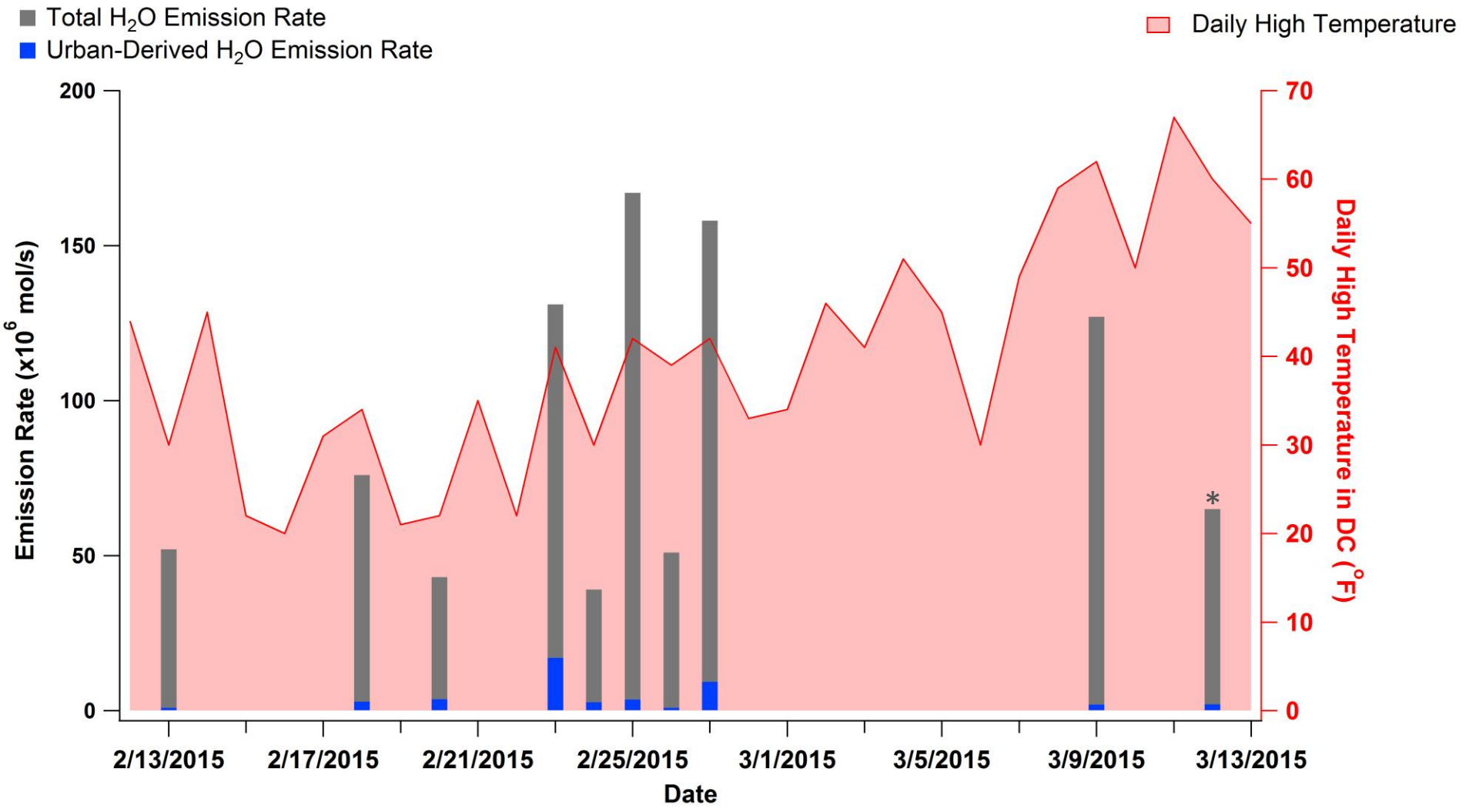


Total H_2O Vapor Emission Rates

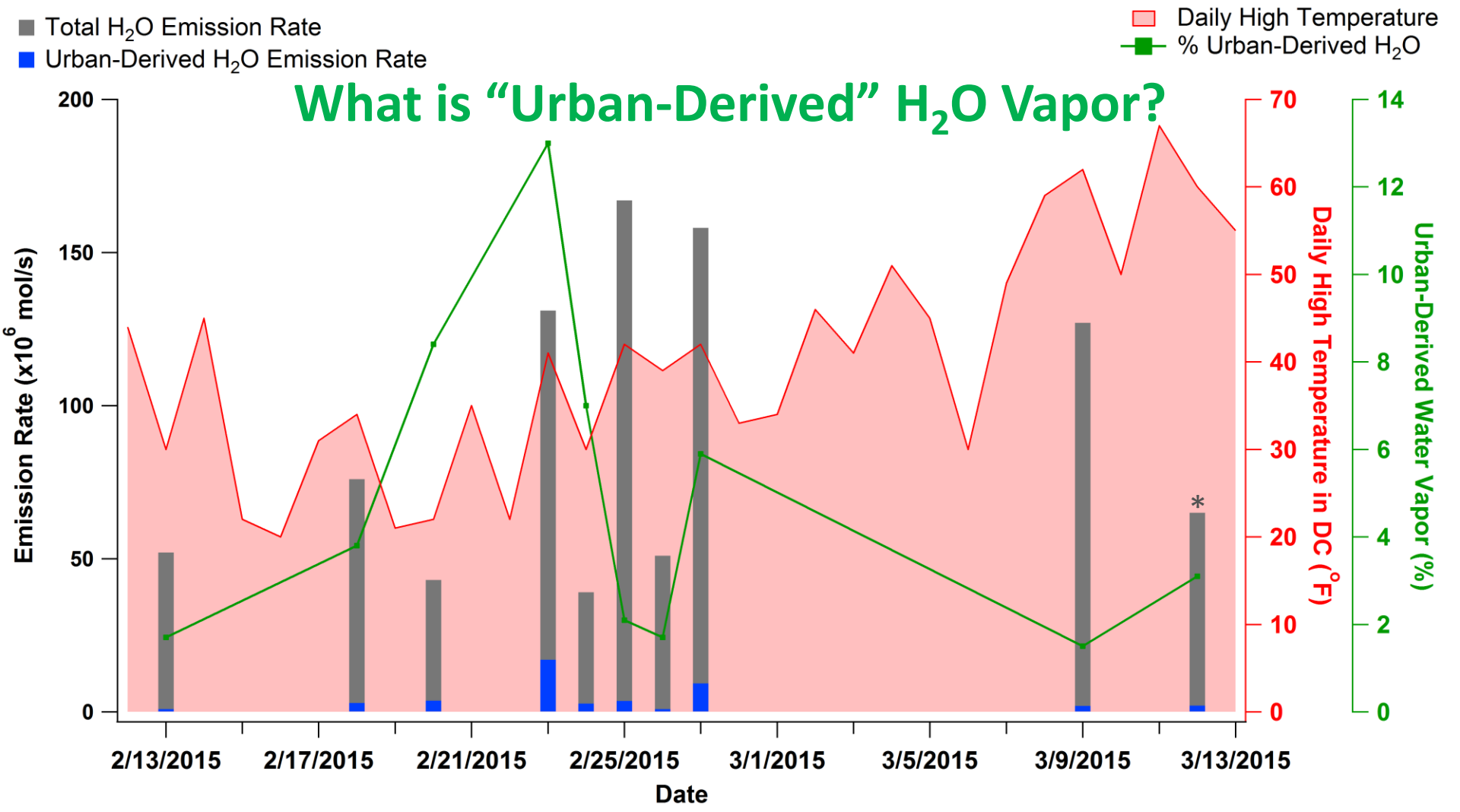
Total = Background + Urban-Derived



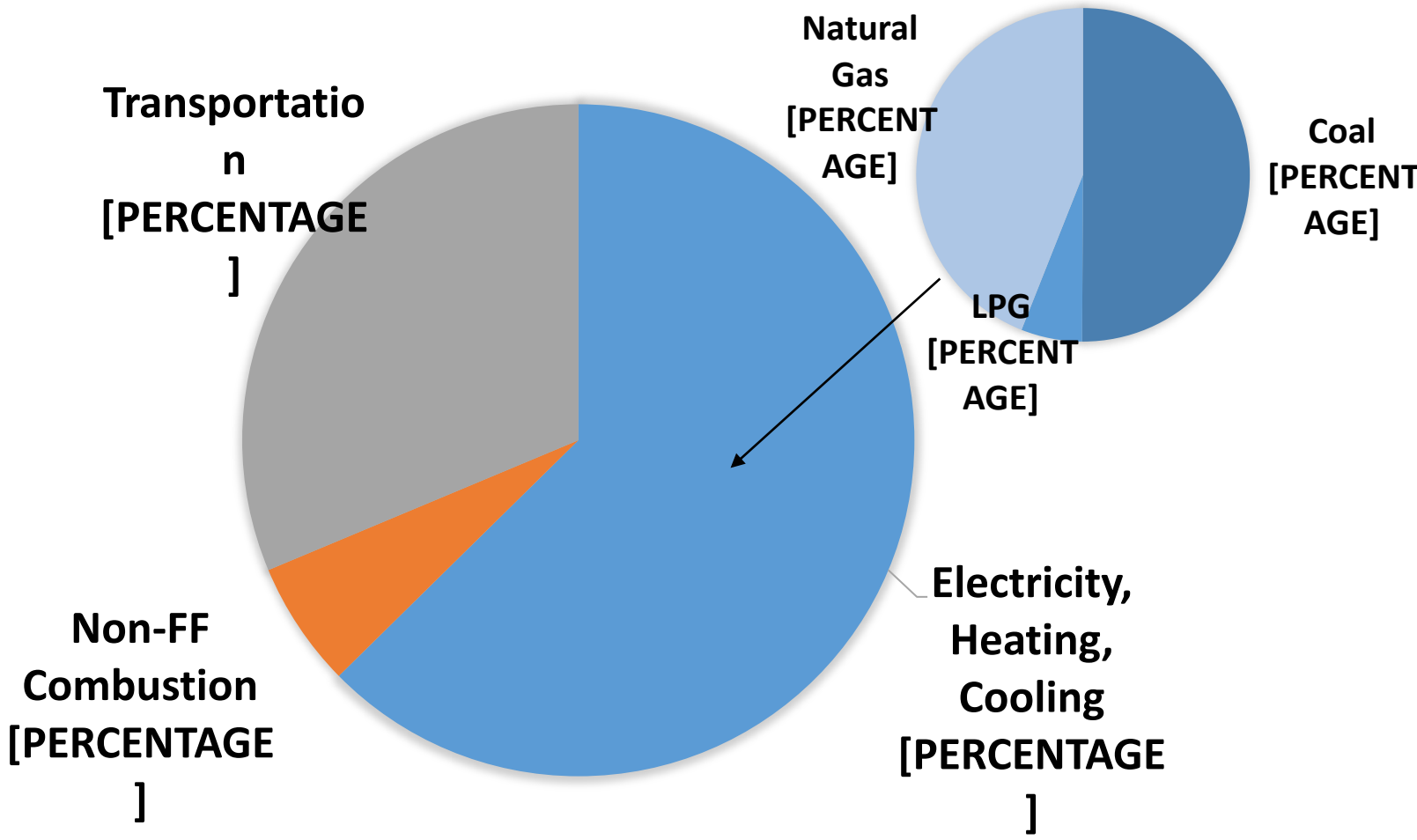
Urban-Derived and Total H_2O Vapor Emission Rates



% Urban Contribution to Total H_2O Vapor



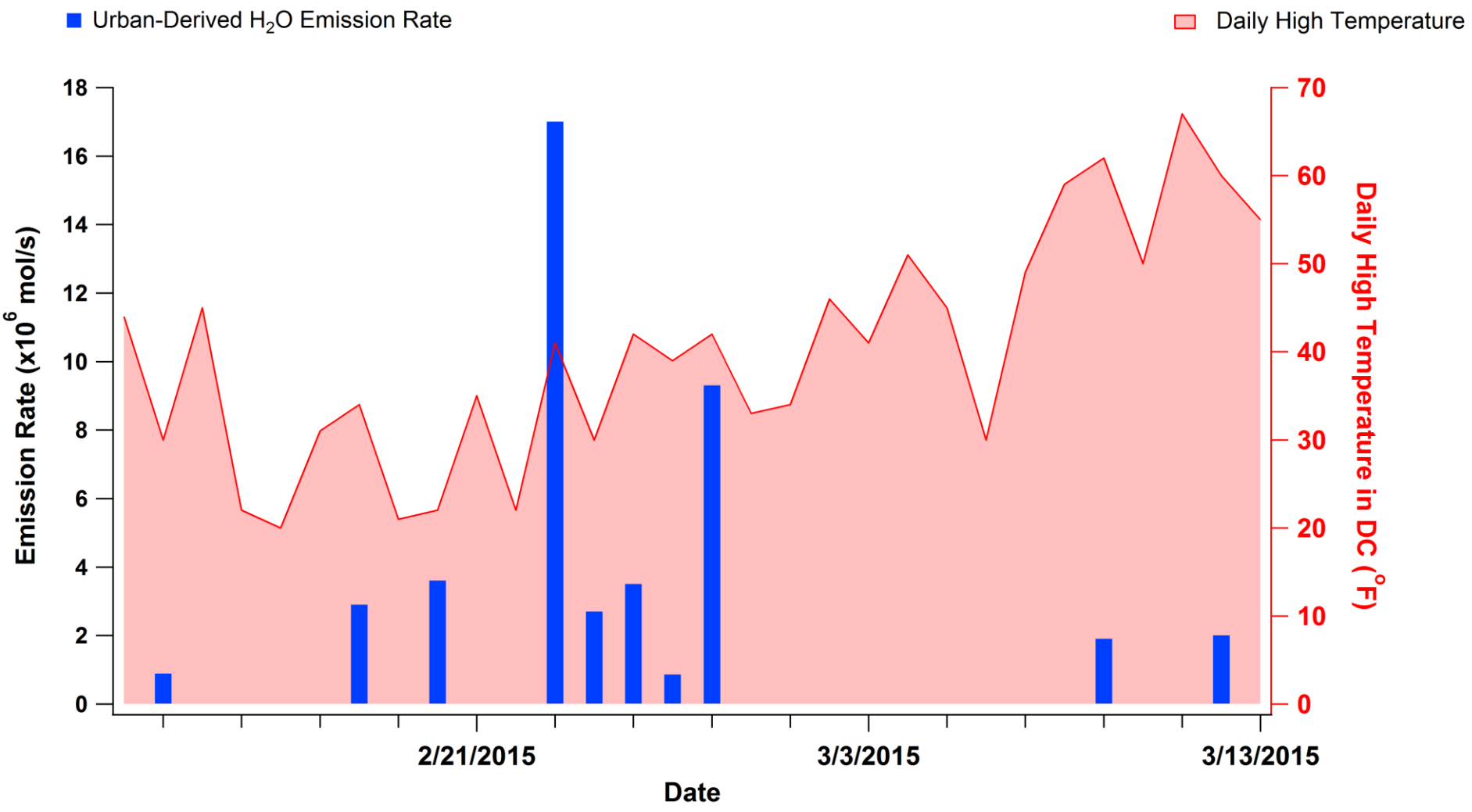
CO_2 Emissions By Combustion Source



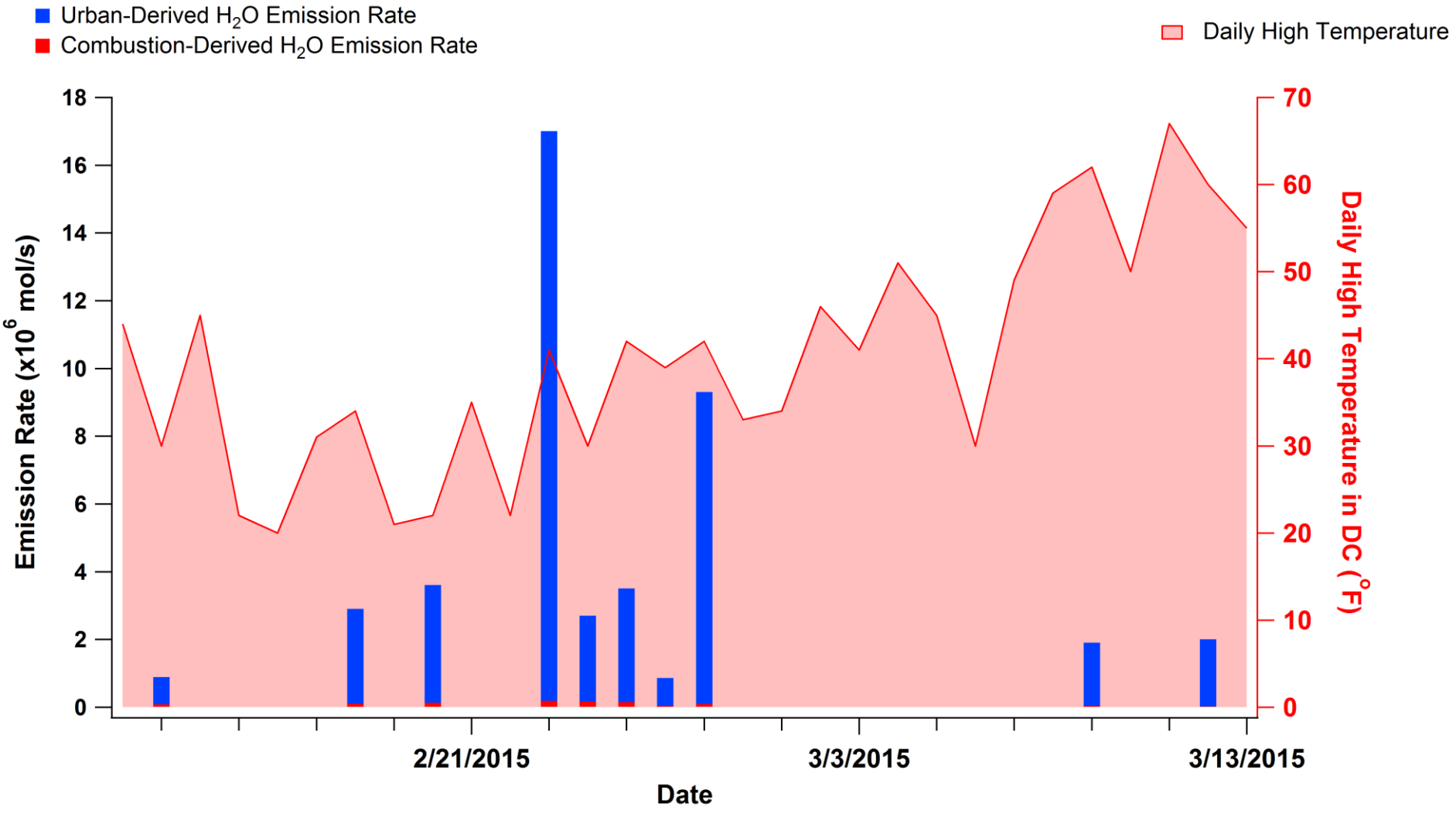
Weighted H_2O:CO_2 Emission Ratio from Combustion Sources: 1.20

EPA GHG Emissions, U.S.
EIA Electricity Data, South Atlantic

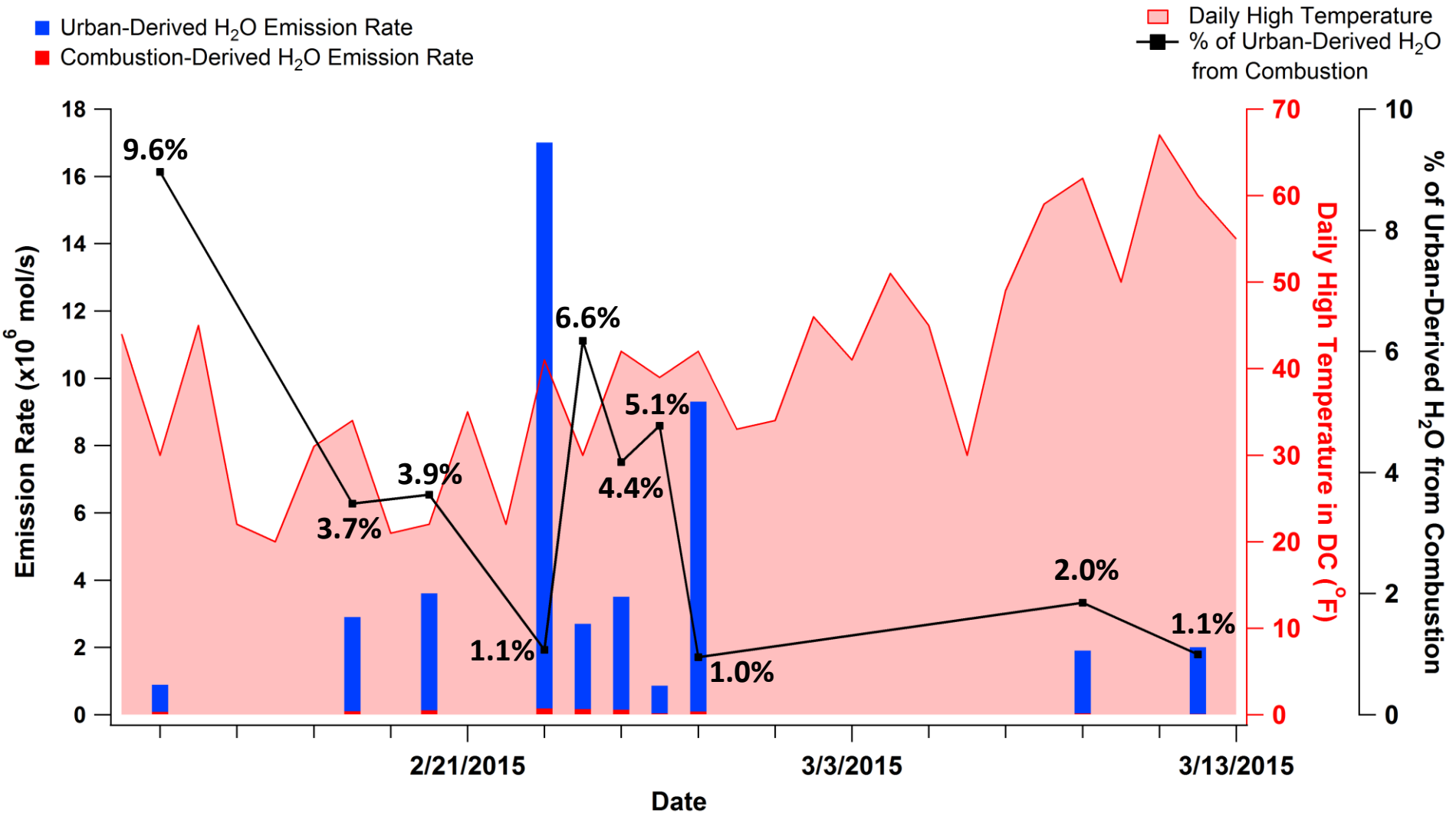
Urban-Derived H_2O Vapor Emission Rates



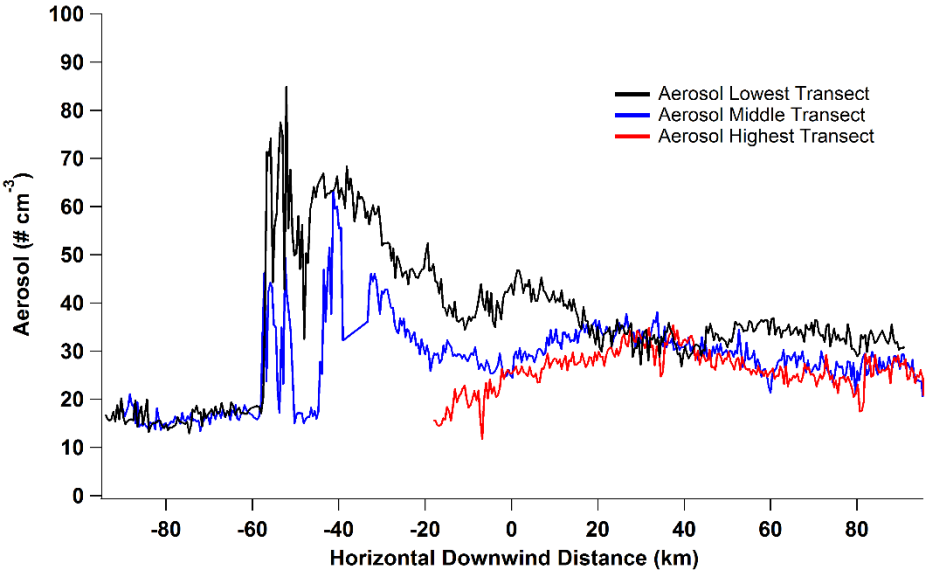
Combustion and Urban-Derived H_2O Vapor Emission Rates

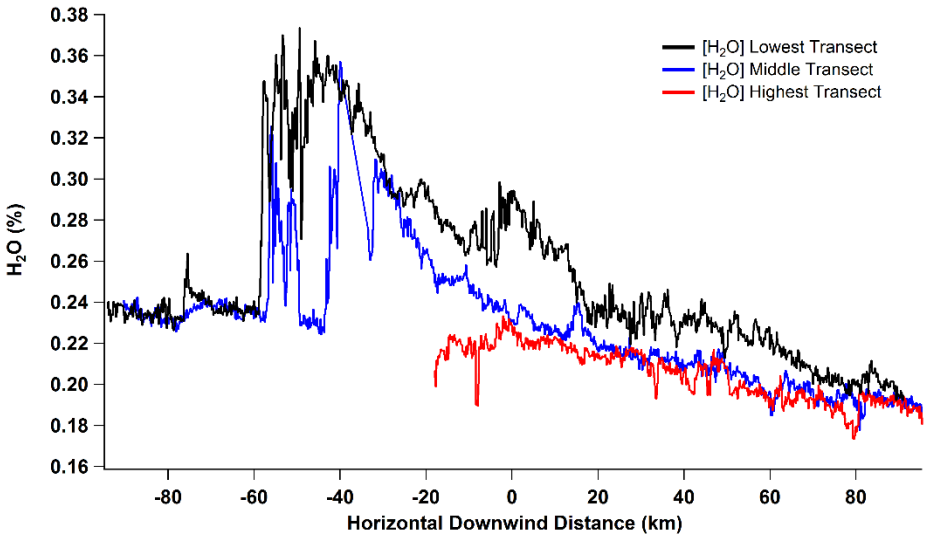


% Combustion Contribution to Urban-Derived H_2O Vapor



Modification of Weather Downwind of Urban Area?





High aerosol emissions are thought to spin down the hydrological cycle

- Smaller and more numerous cloud droplets
- Longer time to reach precipitation size (fixed H_2O content)
- Precipitation delayed & cloud cover increased

However, if aerosol emissions and urban water vapor emissions are collocated, does the urban environment invigorate precipitation?