Radiosonde Observation Representativeness for Air Dispersion Potential in Complex Terrain - Preliminary Findings

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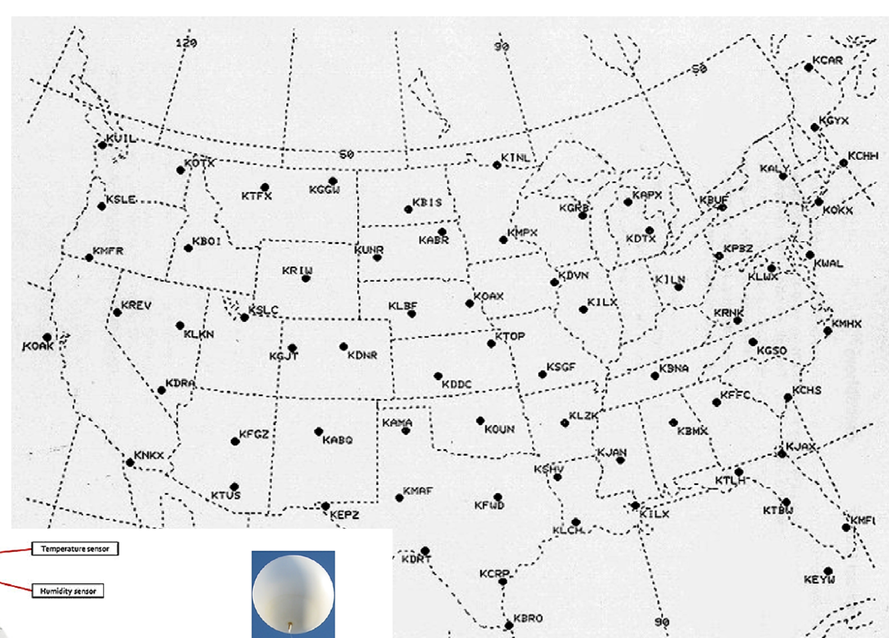
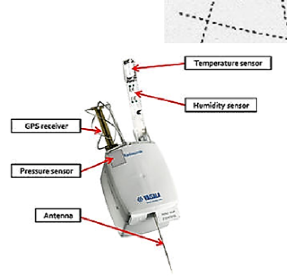
Radiosonde and Launch Sites



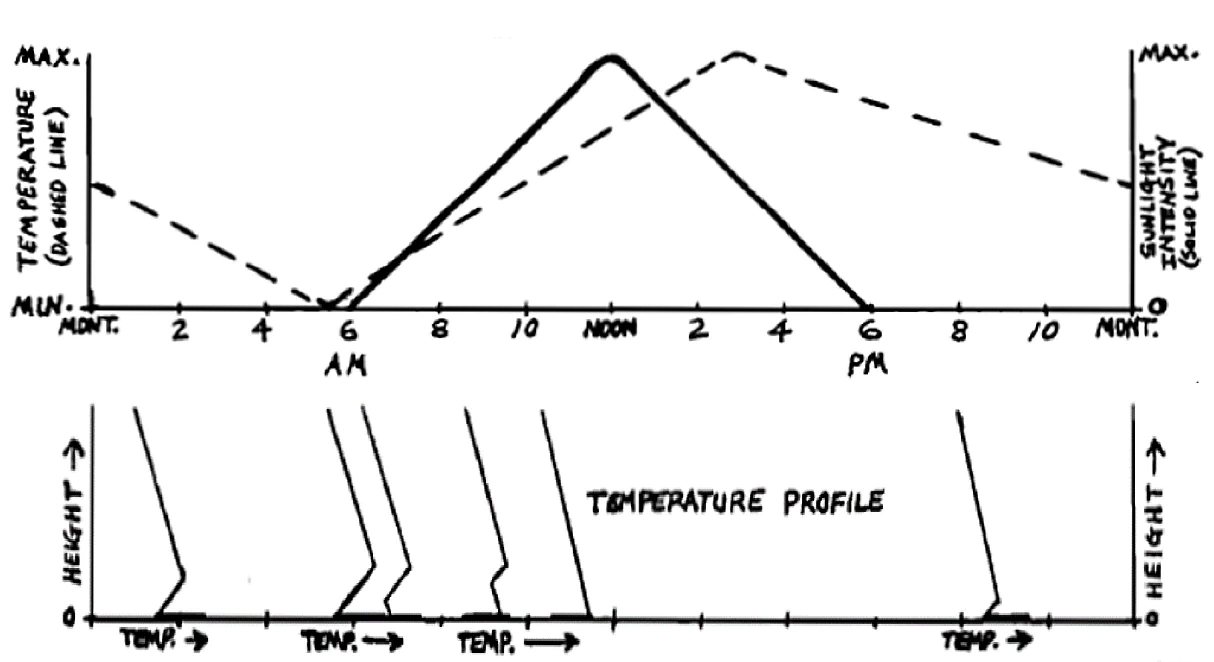
Source: http://web.gps.caltech.edu/~bordoni/ese132/docs/April2612.pdf



(Photo and description from Plymouth State University, 2014.)

(Photo from Radiosonde Museum of North America, 2013.)

Diurnal Variation of Surface Temperature, Sunlight, and Vertical Temperature Profile



Determining Representativeness

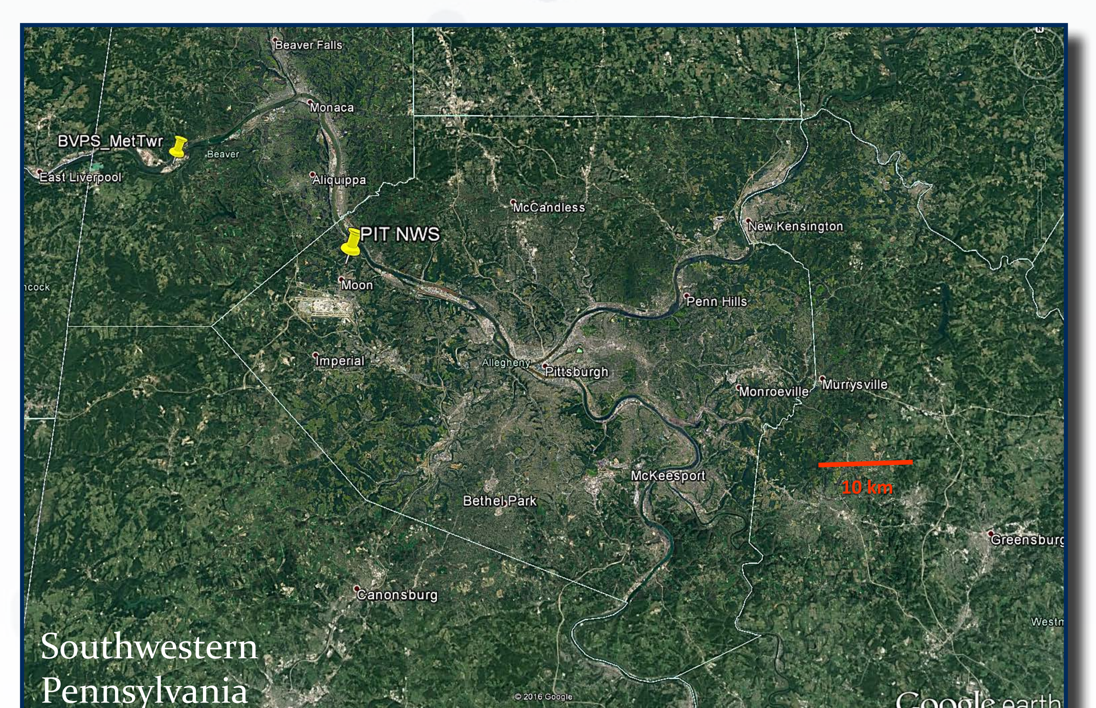
The actual times radiosondes are launched from PIT NWS for the 7 am EST and 7 pm EST reports are typically about 6:15 am EST and 6:15 pm EST, respectively. The ascent of the sensors takes about 45 min to complete. The resulting data represents the 12Z (7 am EST) and 00Z (7 pm EST) rather well; however, conditions can change quickly with advancing fronts, precipitation, wind shifts, et al.

Key issues of concern are related to spatial and temporal representativeness of the radiosonde data:

1) **Spatial Representativeness:** concerns whether sounding data collected at PIT properly represents dispersion potential of all of Allegheny County, parts of which are as far away from the radiosonde launch site as 50 km and much of which is below the elevation of the site; and,

1) **Temporal Representativeness:** involves whether measurements made typically only twice a day, at 12-hour intervals, are adequate to represent dispersion potential throughout the remaining 22 hours of the day.

PIT NWS Location in Allegheny County with Nearby BVPS Met Tower



Numerous river valleys exist in Allegheny County.

Within valleys or low lying areas, inversions can form first and/or be more intense than at elevated locations.

Pittsburgh National Weather Service (PIT NWS) is at an elevation of nearly 360 m MSL. River levels can be as low as 216 m MSL.

The figure presents a relief map of Allegheny County showing the location of PIT NWS and terrain within the county. Also shown is the location of the Beaver Valley Power Station (BVPS) meteorological tower at ~220 m MSL from which data was compared with PIT NWS readings.

Total **12Z** Low-level Inversions: **2011-2015**, From PIT **NWS** Soundings cp. **BVPS** Tower

Month	2011 NWS	2011 BVPS	2011 (NWS-BVPS)	2012 NWS	2012 BVPS	2012 (NWS-BVPS)	2013 NWS	2013 BVPS	2013 (NWS-BVPS)	2014 NWS	2014 BVPS	2014 (NWS-BVPS)	2015 NWS	2015 BVPS	2015 (NWS-BVPS)	2011-2015 NWS	2011-2015 BVPS	5 Yr. (NWS-BVPS)
JAN	6 (19)	3 (10)	3	11 (35)	8 (26)	3	9 (29)	12 (39)	-3	8 (27)	8 (26)	0	9 (29)	5 (16)	4	43 (28)	36 (23)	7
FEB	10 (36)	9 (32)	1	13 (46)	11 (38)	2	6 (21)	6 (21)	0	11 (39)	10 (36)	1	11 (39)	5 (18)	6	51 (36)	41 (29)	10
MAR	10 (32)	11 (35)	-1	15 (48)	16 (52)	-1	6 (19)	7 (23)	-1	12 (43)	11 (35)	1	15 (48)	17 (55)	-2	58 (38)	62 (40)	-4
APR	10 (33)	9 (30)	1	14 (47)	17 (57)	-3	17 (57)	22 (73)	-5	14 (47)	17 (57)	-3	15 (50)	18 (60)	-3	70 (47)	83 (55)	-13
MAY	13 (43)	19 (61)	-6	14 (45)	21 (68)	-7	9 (29)	22 (71)	-13	15 (48)	18 (58)	-3	22 (71)	21 (68)	1	73 (47)	101(65)	-28
JUN	9 (31)	18 (27)	-9	14 (47)	20 (67)	-6	14 (47)	14 (47)	0	13 (43)	15 (50)	-2	16 (53)	19 (63)	-3	66 (44)	86 (57)	-20
JUL	22 (73)	24 (77)	-2	15 (48)	20 (65)	-5	11 (35)	18 (58)	-7	11 (37)	15 (48)	-4	21 (68)	18 (58)	3	80 (52)	95 (61)	-15
AUG	21 (68)	17 (55)	4	19 (61)	23 (74)	-4	19 (61)	17 (55)	2	17 (55)	17 (55)	0	25 (81)	23 (74)	2	101(65)	97 (63)	4
SEP	12 (40)	10 (33)	2	16 (53)	19 (63)	-3	15 (50)	16 (53)	-1	20 (67)	17 (57)	3	22 (73)	22 (73)	0	85 (57)	84 (56)	1
OCT	12 (39)	15 (48)	-3	15 (48)	19 (61)	-4	20 (65)	21 (68)	-1	13 (42)	9 (29)	4	18 (58)	14 (45)	4	78 (50)	78 (50)	0
NOV	15 (50)	14 (47)	1	18 (60)	18 (60)	0	14 (47)	12 (40)	2	10 (33)	6 (20)	4	18 (60)	16 (53)	2	75 (50)	66 (44)	9
DEC	11 (35)	10 (32)	1	11 (35)	15 (48)	-4	10 (33)	9 (29)	1	8 (26)	7 (23)	1	17 (55)	11 (35)	6	57 (37)	52 (34)	5
Annual	151(42)	159(44)	-8	175(48)	207(57)	-32	150(41)	176(48)	-26	152(42)	150(41)	2	209(57)	189(52)	20	837(46)	881(48)	-44

* **For 12Z (morning) surface inversions of at least 0.2°C in strength and 0.5°C per 100m** (shallow isothermal and/or unstable conditions may also be present below or within ground inversion). Percent based on available days of data is given in parenthesis.

** **For 6 am EST low-level stable (inversion) conditions based on NRC Guide 1.23, Table 1** (shallow isothermal and/or unstable conditions may also be present below or within low-level inversion). Percent based on available days of data is given in parenthesis.

NWS data compilations/evaluations by A.J. Sadar, A. Holt, and Q. Lin, ACHD/AQP, January-April 2014; and, A.J. Sadar, Jan-Feb 2016.
NWS/BVPS data compilations/evaluations by A.J. Sadar and A. Holt, Jan 2017.

Total **00Z** Low-level Inversions: **2011-2015**, From PIT **NWS** Soundings cp. **BVPS** Tower

Month	2011 NWS	2011 BVPS	2011 (NWS-BVPS)	2012 NWS	2012 BVPS	2012 (NWS-BVPS)	2013 NWS	2013 BVPS	2013 (NWS-BVPS)	2014 NWS	2014 BVPS	2014 (NWS-BVPS)	2015 NWS	2015 BVPS	2015 (NWS-BVPS)	2011-2015 NWS	2011-2015 BVPS	5-Yr. (NWS-BVPS)
JAN	5 (16)	3 (10)	2	4 (13)	7 (23)	-3	6 (19)	10 (32)	-4	7 (23)	5 (16)	2	6 (19)	6 (19)	0	28 (18)	31 (20)	-3
FEB	5 (18)	6 (21)	-1	2 (7)	7 (25)	-5	2 (7)	2 (7)	0	5 (18)	4 (14)	1	2 (7)	2 (7)	0	16 (11)	21 (15)	-5
MAR	2 (6)	4 (13)	-2	2 (6)	0 (0)	2	0 (0)	0 (0)	0	2 (6)	2 (6)	0	5 (16)	2 (6)	3	11 (7)	8 (5)	3
APR	1 (3)	1 (3)	0	1 (3)	0 (0)	1	1 (3)	1 (3)	0	0 (0)	0 (0)	0	3 (10)	1 (3)	2	6 (4)	3 (2)	3
MAY	1 (3)	3 (10)	-2	2 (6)	0 (0)	2	0 (0)	1 (3)	-1	4 (13)	1 (3)	3	0 (0)	1 (3)	-1	7 (5)	6 (4)	1
JUN	0 (0)	0 (0)	0	0 (0)	1 (3)	-1	1 (3)	1 (3)	0	6 (20)	2 (7)	4	6 (20)	1 (3)	5	13 (9)	5 (3)	8
JUL	3 (10)	2 (6)	1	0 (0)	0 (0)	0	3 (10)	1 (3)	2	1 (3)	1 (3)	0	3 (10)	3 (10)	0	10 (6)	7 (5)	3
AUG	2 (6)	1 (3)	1	1 (3)	1 (3)	0	0 (0)	1 (3)	-1	1 (3)	1 (3)	0	1 (3)	0 (0)	1	5 (3)	4 (3)	1
SEP	4 (13)	3 (10)	1	3 (10)	2 (7)	1	4 (13)	2 (7)	2	1 (3)	0 (0)	1	8 (27)	0 (0)	8	20 (13)	7 (5)	13
OCT	9 (29)	9 (29)	0	6 (19)	6 (19)	0	14 (45)	5 (16)	9	10 (32)	2 (6)	8	13 (42)	5 (16)	8	52 (34)	27 (17)	25
NOV	8 (27)	14 (47)	-6	13 (43)	20 (67)	-7	8 (27)	6 (20)	2	5 (17)	7 (23)	-2	13 (43)	16 (53)	-3	47 (31)	63 (42)	-16
DEC	7 (23)	11 (35)	-4	5 (16)	15 (48)	-10	11 (35)	8 (26)	3	6 (19)	8 (26)	-2	14 (45)	15 (48)	-1	43(28)	57 (37)	-14
Annual	47 (13)	57 (16)	-10	39 (11)	59 (16)	-20	50 (14)	38 (10)	12	48 (13)	33 (9)	15	74 (20)	52 (14)	22	258(14)	239(13)	19

* **For 00Z (evening) surface inversions of at least 0.2°C in strength and 0.5°C per 100m** (shallow isothermal and/or unstable conditions may also be present below or within ground inversion). Percent based on available days of data is given in parenthesis.

** **For 6 pm EST low-level stable (inversion) conditions based on NRC Guide 1.23, Table 1** (shallow isothermal and/or unstable conditions may also be present below or within low-level inversion). Percent based on available days of data is given in parenthesis.

NWS data compilations/evaluations by A.J. Sadar, A. Holt, and Q. Lin, ACHD/AQP, January-April 2014; and, A.J. Sadar, Jan-Feb 2016.
NWS/BVPS data compilations/evaluations by A.J. Sadar and A. Holt, Jan 2017.

Preliminary Conclusions

Data analysis continues on this project; however, based on initial comparisons of 2011-2015 total days per month during which substantial low-level inversions occurred at two closely located measurement sites, we tentatively conclude:

- Low-level inversions, whether measured in or out of the valley, are quite frequent in Allegheny County.
- Seasonally, there appears to be a tendency toward more measured low-level inversions in the valley during the late spring through mid-summer mornings.

For improved understanding of air-dispersion characteristics and consequences, it is important to model with upper-air data that properly represents--both spatially and temporally--all locations within the modeling domain.

References

- Enz, J.W., Hofman, V., and Thostenson, A. (2014, April). "Air Temperature Inversions: Causes, Characteristics and Potential Effects on Pesticide Spray Drift." Report No. AE1705. North Dakota State University Extension Service.
- U.S. Nuclear Regulatory Commission (2007, March). "Regulatory Guide 1.23: Meteorological Monitoring Programs for Nuclear Power Plants." Revision 1. Office of Nuclear Regulatory Research, Washington, D.C.

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