UrbaNet

Building a Public-Private Mesonet Partnership for Forecasting in Urban Areas

NOAA/OAR/ARL

May 7, 2007

UrbaNet Discussion

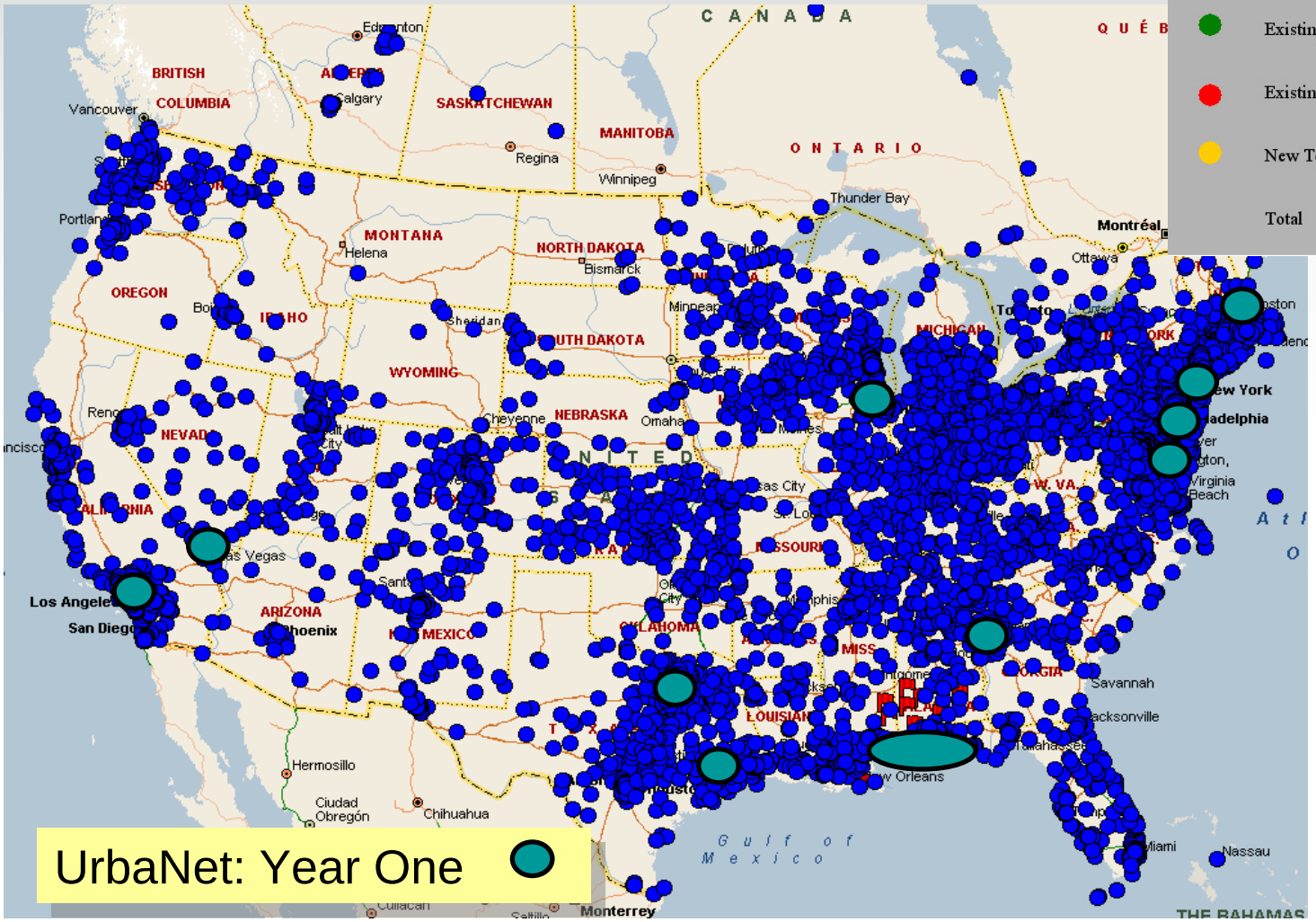
- AWS Partnership
  - Phase 1: 10 City Development
  - Site Qualification Process
  - Documentation
  - Assessment
- ARL Research Programs
  - Data assimilation
  - Forecast Nudging: MOS
  - Testbeds
  - Data qualification

UrbaNet Program
AWS Partnership

AWS Urbanet 2006 Development

UrbaNet
11 Metro Areas / 1125 Sensors
SITE BREAKDOWN ESTIMATE

Icon	Type	Count
	Existing - Up	683
	Existing – Down	227
	New To Install	214
	Total	1124



Atlanta
Chicago
National Capital
Dallas
Houston
Los Angeles
Boston
Las Vegas
Gulf Coast
New York
Philadelphia

National Capital Area

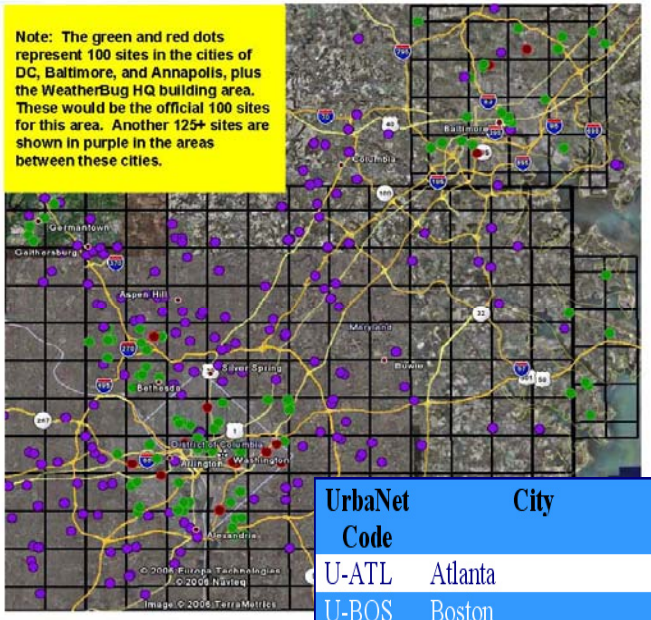
SITE BREAKDOWN ESTIMATE

Icon	Type	Count
●	Existing – Up	87
●	Existing – Down	13
	Total	100
●	Additional Available Sites Between Cities	125+

AREA DIMENSIONS

5 km grid defining city area based on 50 miles wide 50 miles tall

Note: The green and red dots represent 100 sites in the cities of DC, Baltimore, and Annapolis, plus the WeatherBug HQ building area. These would be the official 100 sites for this area. Another 125+ sites are shown in purple in the areas between these cities.



UrbaNet Code	City	New Stations Needed	New Stations Installed	% Installed	Total Stations	Funnel	UrbaNet Qualified	% Qualified
U-ATL	Atlanta	78	5	6%	27	3	24	24%
U-BOS	Boston	23	15	65%	92	3	78	78%
U-CAP	National Capital Area	0		100%	100	0	100	100%
C-CHI	Chicago	1	1	38%	100	0	100	100%
U-DAL	Dallas	8	3	100%	45	5	42	84%
U-HOU	Houston	6	6		50	5	48	96%
U-LAX	Los Angeles	9		17%	91	10	39	39%
U-LVG	Las Vegas	23	4	100%	81	3	80	80%
U-NGC	Northern Gulf Coast	13	13		100	1	100	100%
U-NYC	New York	0			100	0	100	100%
U-PHL	Philadelphia	0			100	3	100	100%
	Totals	**160**	**47**	**29%**	**886**	**33**	**811**	**81%**
	Total UrbaNet Sites: 1000							

AWS Deployment

Status February, 2007

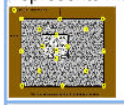
AWS Site Qualification

AWS Metadata/Qualification web site:
http://www.aws.com/urbanet/Status.asp

State	Station ID	Station Name	Address	City	Zip Code	Qualification Status	Site Visits	Site Data/Photos
VA	AGTON	Carlin Springs School	5995 5th Road South	Arlington	22204	Qualified	7/26/2006 11:17:29 PM	Site Data
VA	ALXAN	Jefferson-Houston ES	1501 Cameron Street	Alexandria	22314	Qualified	8/3/2006 8:40:08 AM	Site Data
VA	ALXD1	NOVA Alexandria Campus	3001 North Beauregard Street	Alexandria	22311	Qualified	7/26/2006 10:05:51 PM 7/7/2006 5:16:56 PM	Site Data
VA	ALXD2	George Mason ES	2601 Cameron Mills Road	Alexandria	22302	Qualified	8/29/2006 9:05:41 AM	Site Data
VA	ALXDV	John Adams ES	5651 Rayburn Ave.	Alexandria	22311	Qualified	7/14/2006 9:09:39 AM	Site Data
VA	ALXGE	Grace Episcopal School	3601 Russell Road	Alexandria	22305	Qualified	8/29/2006 9:37:56 AM	Site Data
VA	ALXIA	Green Spring Gardens	4603 Green Springs Road	Alexandria	22312	Qualified	8/29/2006 9:46:56 AM	Site Data
VA	ALXMD	James K. Polk ES	5000 Polk Ave	Alexandria	22304	Qualified	7/14/2006 9:56:18 AM	Site Data
VA	ANDLE	Edgar Allen Poe MS	7000 Cindy Lane	Annandale	22003	Qualified	7/14/2006 9:47:37 AM	Site Data
MD	ANNAP	St. Anne's Day School	3112 Arundel on the Bay Rd	Annapolis	21403	Qualified	8/10/2006 10:56:38 AM	Site Data
MD	ANNAS	St. Marys ES	111 Duke of Gloucester Street	Annapolis	21401	Qualified	9/8/2006 9:53:28 AM 8/10/2006 11:53:39 AM 7/11/2006 2:42:36 PM	Site Data
MD	ANPHS	The Harbour School	1277 Green Holly Drive	Annapolis	21409	Qualified	8/10/2006 11:10:56 AM	Site Data
VA	ARLIN	Arlington Science Focus School	1501 North Lincoln Street	Arlington	22201	Qualified	8/4/2006 10:03:26 AM	Site Data
VA	ARLIO	St. Anges School	2024 N. Randolph Street	Arlington	22207	Qualified	8/4/2006 8:52:10 AM	Site Data
VA	ARLNN	Hoffman-Boston ES	1415 S. Queen Street	Arlington	22204	Qualified	7/26/2006 10:40:42 PM	Site Data
VA	ARLNV	Zachary Taylor ES	2600 N Stuart Street	Arlington	22207	Qualified	8/4/2006 9:52:08 AM 7/11/2006 4:03:26 PM	Site Data

AWS Site Qualification MetaData

UrbaNet Qualification
Station ID
ALXAN

Attribute	
1. Logo Photo:	
2. Looking Up Photo:	
3. Looking Up Photo II:	
4. Mount Type:	
5. Direction of Northeast Ext. Wall:	
6. Mast is mounted:	
7. Number that best represents mast location:	
8. Wall Material:	
9: Wall Color:	

10. Master Base Photo:		Green ○ Yellow ○ Red ◉
11. Roof Material:	Asphalt	Green ◉ Yellow ○ Red ○
12. Roof Color:		
13. Roof Height:		
14: Temperature Sensor Height:		
14b: Total Temperature Sensor Height:		
15. Wind Sensor Height:		
15b: Total Wind Sensor Height:		
16. Wind Sensor Type:		
17: Wind Sensor Direction:		
18. Wind Sensor Direction Fixed:	My Wind S pl	
19. North Photo:		
20: South Photo		
21. West Photo		
22. East Photo		
Sit		

23. Distance to North Obstruction:	40
Closest North Obstruction:	Trees
24. Distance to South Obstruction:	2
Closest South Obstruction:	Porch
25. Distance to West Obstruction:	0
Closest West Obstruction	Blank Wall
26. Distance to East Obstruction:	60
Closest East Obstruction:	Playground
27. Distance to Heat Source:	0
Closest Heat Source:	
28. Two Photos on the Roof:	
Photo9 is looking:	Please Select A Direction
Photo9 shows:	
Photo10 is looking:	Please Select A Direction
Photo10 shows:	
29: Camera Direction:	West
30. Extra Photos	
Photo11 is looking:	West
Photo11 shows:	Masonic
31. Rain Gauge Status:	My Rain Gauge does NOT appear to be clogged. I did not test the Rain Gauge but knowthat is has been recording rainfall.

32. Mast Prone to Sway.	My mast is secure and shakes/says very little.	Green ◉ Yellow ○ Red ○
Inside Equipment Update		
33. MCU/DL Location:	Room 68. e have been waiting for it to be moved to room 69. We are in need of a rain sensor as the building had a rehaul last year & the station isn't running as it should.	Green ◉ Yellow ○ Red ○
MCU/DL Serial #:	SW01679	
Remote Serial # Listed on Bottom Label:	3454	
34. Modem or Internet?:	Internet	Green ◉ Yellow ○ Red ○
35. Power/Connection Policies:	Station remains powered and connected.	Green ◉ Yellow ○ Red ○
36. Ownership Pledge:	Do my best to keep the weather station functioning.	Green ◉ Yellow ○ Red ○
37. PC Passwords.	The WeatherNet PC does not require a password or I will remove the existing username/password.	Green ◉ Yellow ○ Red ○
38. Additional Info:	The camera is operating and we are able to capture an image however we need some advide on how to reconnect to obtain data.	Green ◉ Yellow ○ Red ○
Site Location and OB History Update		
40. Coordinate/Elevation	**38° 48** min **29** s **77° 3** min **18** s **36** ft.	Green ◉ Yellow ○ Red ○
41. Ob Data History:	% of Historical Obs: 41.36% First Ob Date: 11/11/1993 12:00:01 AM Last Ob Date: 1/31/2007 8:57:43 AM	Green ◉ Yellow ○ Red ○
UrbaNet Qualified Status Update		
42. Weather Data Certification Status: Weather Data Certification Tool	Certified.	Green ◉ Yellow ○ Red ○
43. Overall UrbaNet Qualified Status:	Certified.	Green ◉ Yellow ○ Red ○
44. AWS Review Notes:	Certified 8/30/06 by Bryan – Site data/photos submitted by UrbaNet Tech. Site has been down since 7/2002. Called and left msg for Sonia 6/25.	
45. Review Notes to Communicate to Site:	Certified 8/3/06 by Bryan – Site data/photos submitted by UrbaNet Tech. Site has been down since 7/2002. Called and left msg for Sonia 6/25.	
Update		
Save Changes and Go to Next Site	Cancel Changes and Go to Next Site	

AWS Measurement

Network Documentation

User's Guide rev. 2
User's Guide rev. 3 (02/2007)
Appendix A – Installation, Operations, and Maintenance
Appendix B – Quick Installation Guide and Tools Required
Appendix C – Metadata Collection Form
Appendix D – UrbaNet Site Evaluation Form
QA/QC rev. 1 (11/2006)
QA/QC rev. 2 (1/2007)

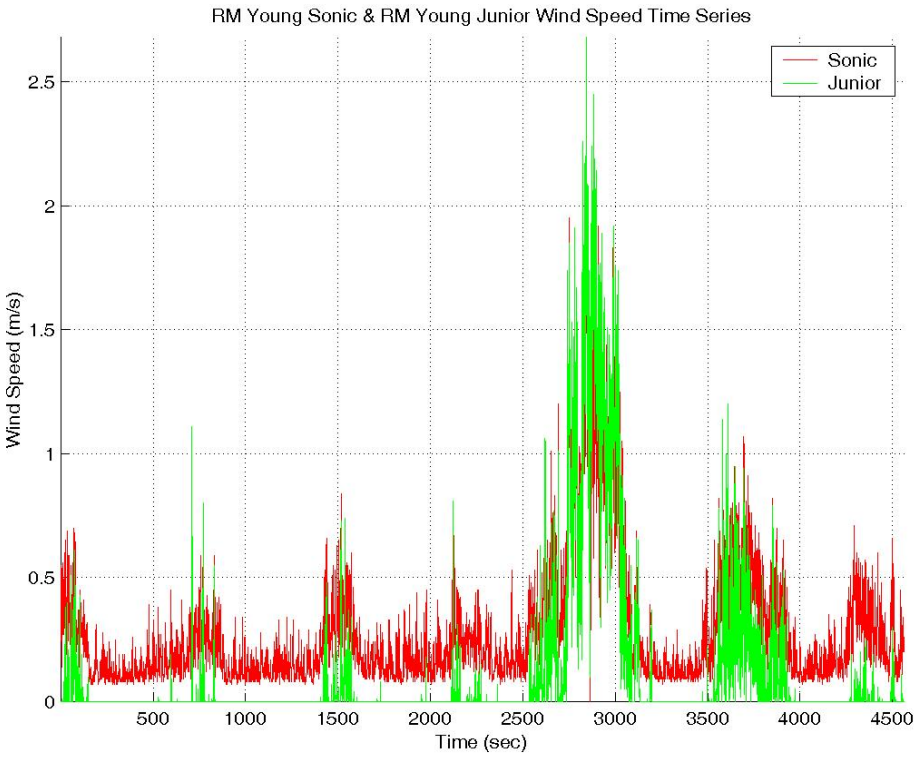
Item	WeatherBug Weather Station			NOAA ASOS		
	Sensor Type	Sensor Range	Accuracy	Sensor Type	Sensor Range	Accuracy
Temperature	Semicon-ductor Thermistor	-13 °F to +150 °F -31 °F to –13 °F -58 °F to –31 °F	+/- 1 °F + 2 °F + 3 °F	Resistive Temp-erature Device (RTD)	-80 °F to +130 °F	RMS: 0.9 °F to 1.8 °F dependent on operating range
Relative Humidity (RH) Dew point calculation from Temp. and RH	Electrical Capaci-tance	0 to 100%	+/- 2%	Dew Point mea-sured by Chilled Mirror	-30 °F to +86 °F with plans to change lower limit to -80 °F	RMS: 1.1 °F to 7.9 °F dependent on operating range
Rainfall	Tipping Bucket	Unlimited	+/- 1% @ 1"/hour	Heated Tipping Bucket	0 to 10"/hour	+/- 0.02" or 4% of hourly total (whichever is greater)
Wind Speed	Propeller anemo-meter	0 to 130 mph (0 to 113 knots) with 220 mph gust survivability	+/- 2 mph with 2.2 mph threshold sensitivity	Cup anemo-meter	0 to 125 knots (0 to 144 mph)	+/- 2 knots or 5% whichever is greater (+/- 2.3 mph or 5% whichever is greater)
Wind Direction	Vane	0 to 352 deg. electrical & 0 to 360 deg.mech	+/- 3 deg. with 3.8mph threshold sensitivity	Vane	0 to 359 deg.	+/- 5 deg. (when speed > 5 knots or speed > 5.75 mph)
Barometric Pressure	Electrical Piezoresis-tive Transducer	28.0"Hg to 32.0"Hg	+/- 0.05"Hg	Redun-dant Pressure Cells	16.9"Hg to 31.5"Hg	+/- 0.02"Hg

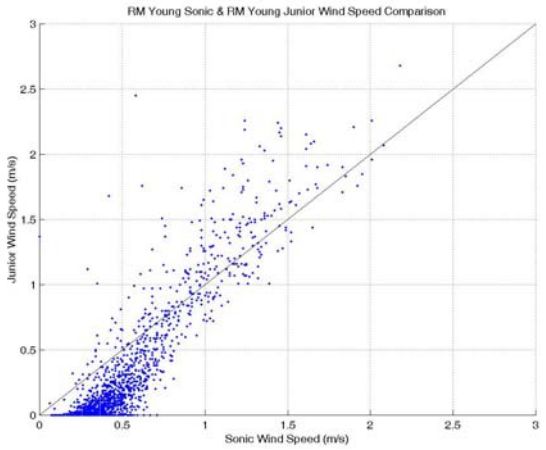
ARL Research

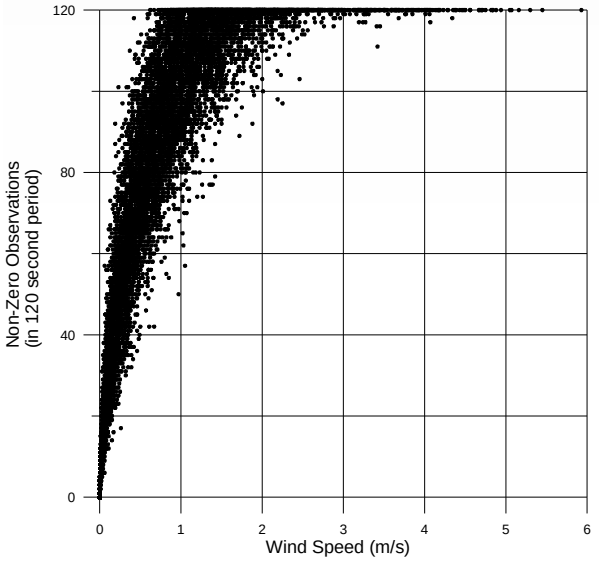
Evaluating Measurement Technologies

Wind Speed threshold 2.2 mph

Wind Direction threshold 3.8 mph







ARL Research

Evaluating
Measurement
Technologies

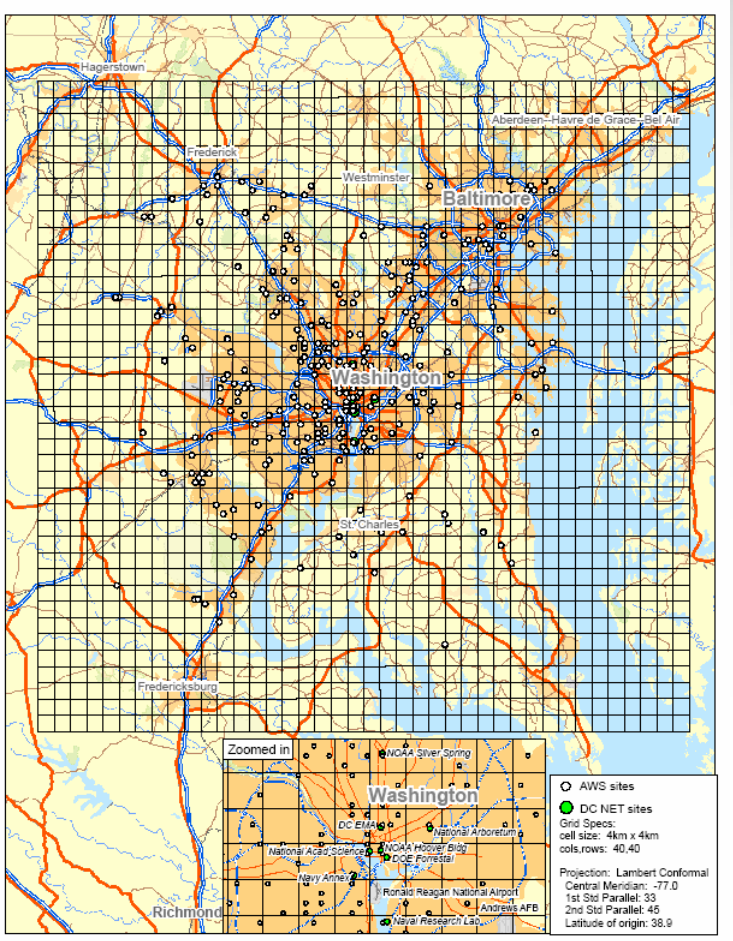
NOAA/ARL Research Programs

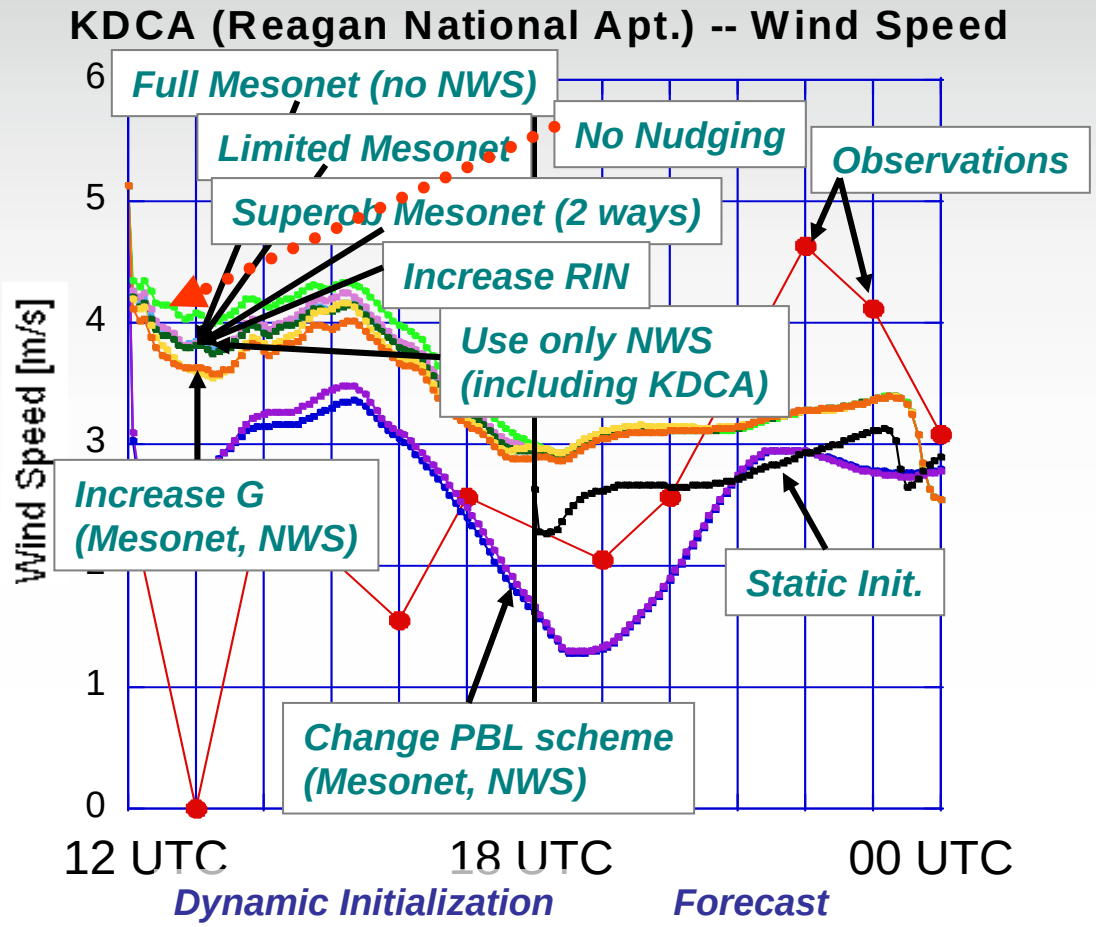
ARL Research

Data Assimilation

Try to improve dispersion forecasting for Washington, D.C. by:

- Using AWS ("WeatherBug") data *as available in MADIS* to determine if value can be added in the short-term forecast process
- Using MM5 to assimilate mesonet observations in pre-forecast dynamic initialization period
- Providing MM5 forecast fields to HYSPLIT for trajectory analysis
  - 4-km horizontal grid
  - Over 350 AWS sites
  - 8 ARL DCNet sites





ARL Research

Impact of Nudging

All 12 UTC initializations converge shortly after forecast start, regardless of DI strategy or network of surface observations.

Changing PBL scheme makes bigger difference.

ARL Research

Impact of Nudging

Sensitivities for one case study suggest:

- Obs nudging toward surface observations only (i.e., wind) for dynamic initialization (DI) does not impact the forecast significantly
- Small gains in skill are shown during DI in wind speed, but very little change in wind direction
- Using dense surface mesonet observations for DI made no discernable difference compared with using standard NWS observations. Although changes are seen in wind speed during DI, the following had virtually no impact on forecast:
  - Using all ~325 active mesonet observations as is
  - Limiting mesonet observations to one per cell
  - Superobbing mesonet within each cell
  - Superobbing mesonet in 2x2-cell clusters
  - Using only (up to 16) NWS observations
  - Observation nudging radius of influence (24, 48 km)
  - Observation nudging strength (0, 4x10-4, 8x10-4, 1.2x10-3 s-1)

These conclusion come as no surprise!

ARL Research

Nowcast nudging: MOS

$$y_i = \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots \beta_k x_{ik} + \varepsilon_i$$

or

$$y = X\beta + \varepsilon$$

"Model Output Statistics" (MOS)

- Dynamic model's uncertainties implicitly included in estimated error
- Generally higher forecast scores
- Thirty-year history in weather forecasting
- Tied to specific dynamic-model version
- Shorter history from which to form equations

Current experience favors MOS except for "rare" events

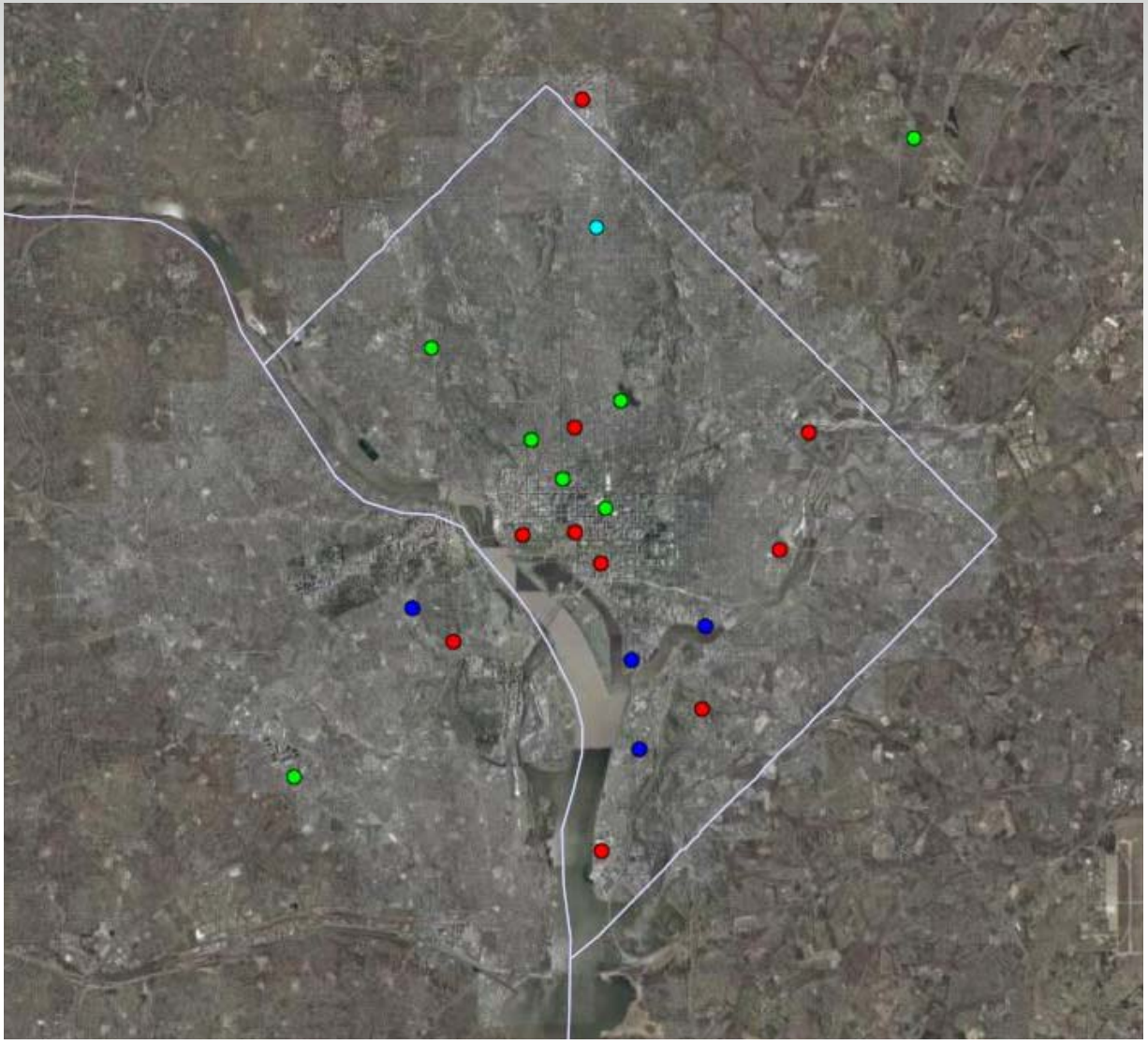
ARL Research

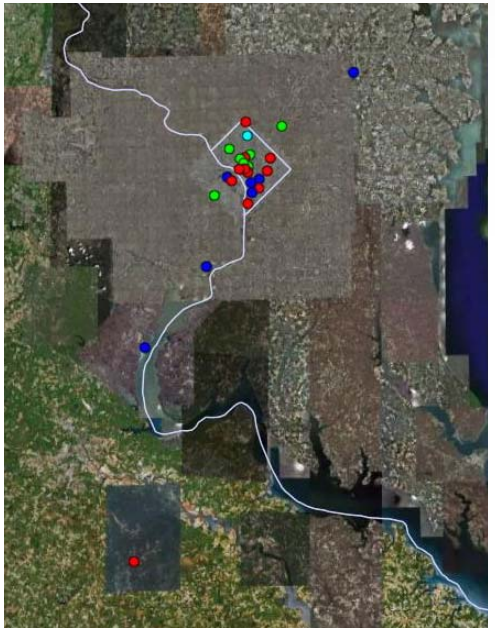
NCR Testbed

- Current UrbaNet Sites

DC001	NOAA Hoover Bldg	DC009	Navy Annex
DC003	National Acad Science	DC011	Naval Research Lab
DC004	NOAA Silver Spring	DC012	DC EMA 2
DC005	National Arboretum	DC013	RFK Stadium
DC006	DOE Forrestal	DC014	Ft. A. P. Hill
DC008	DC EMA		

- Potential Military Sites
- Potential AWS Collocation Sites
- Potential Tall Tower Site





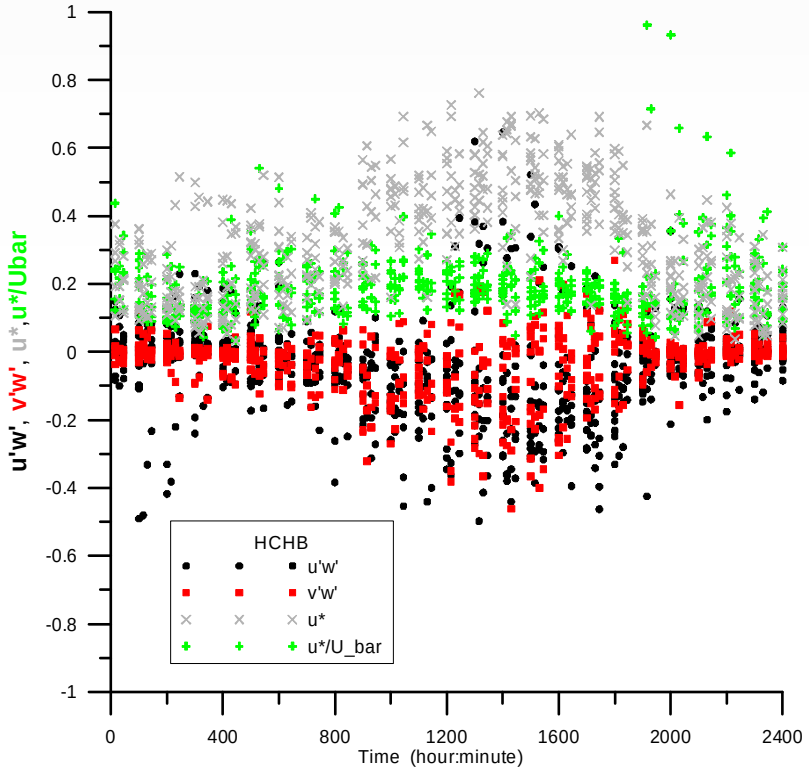
ARL Research

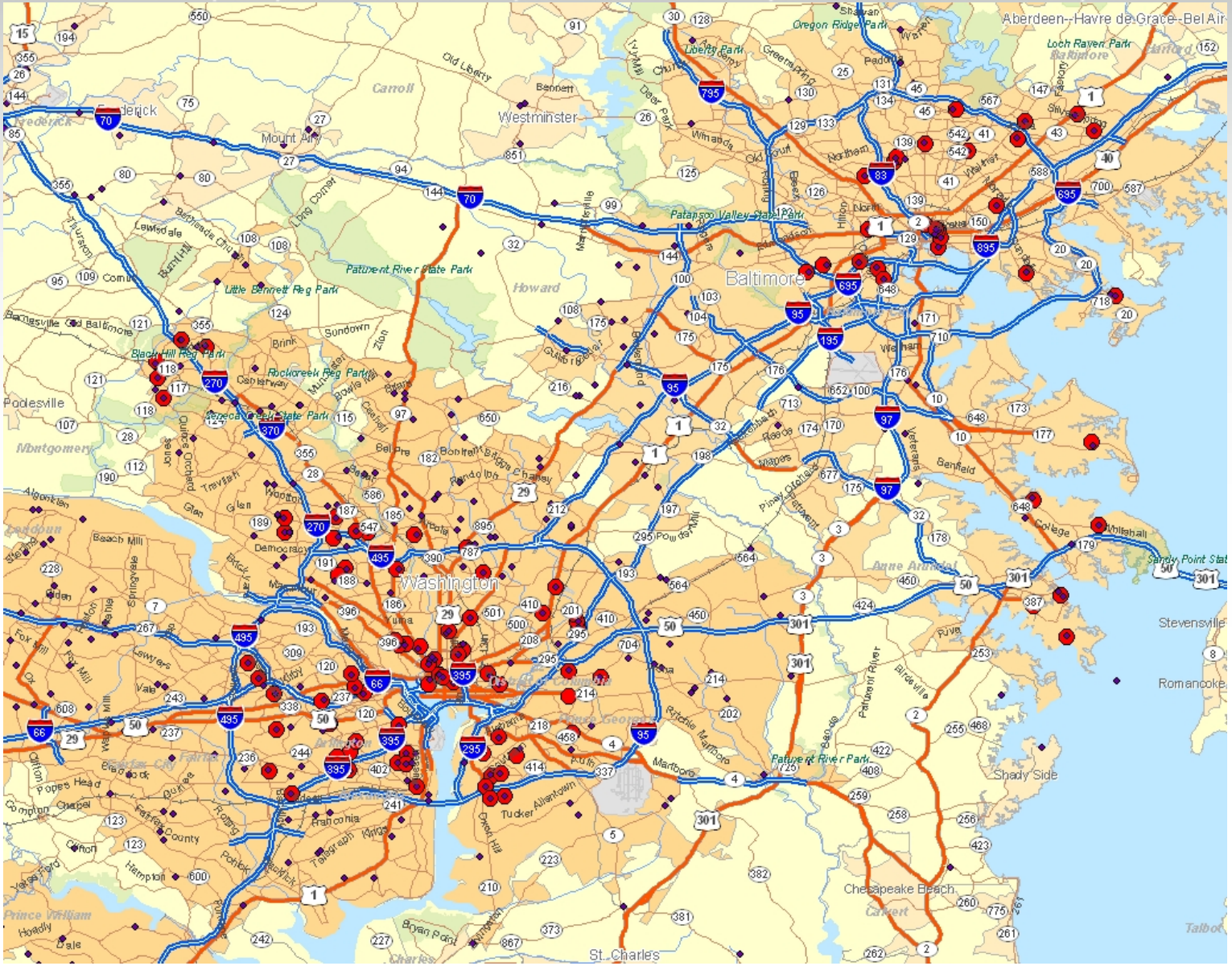
NCR Testbed

DC Network

NOAA

Silver Spring





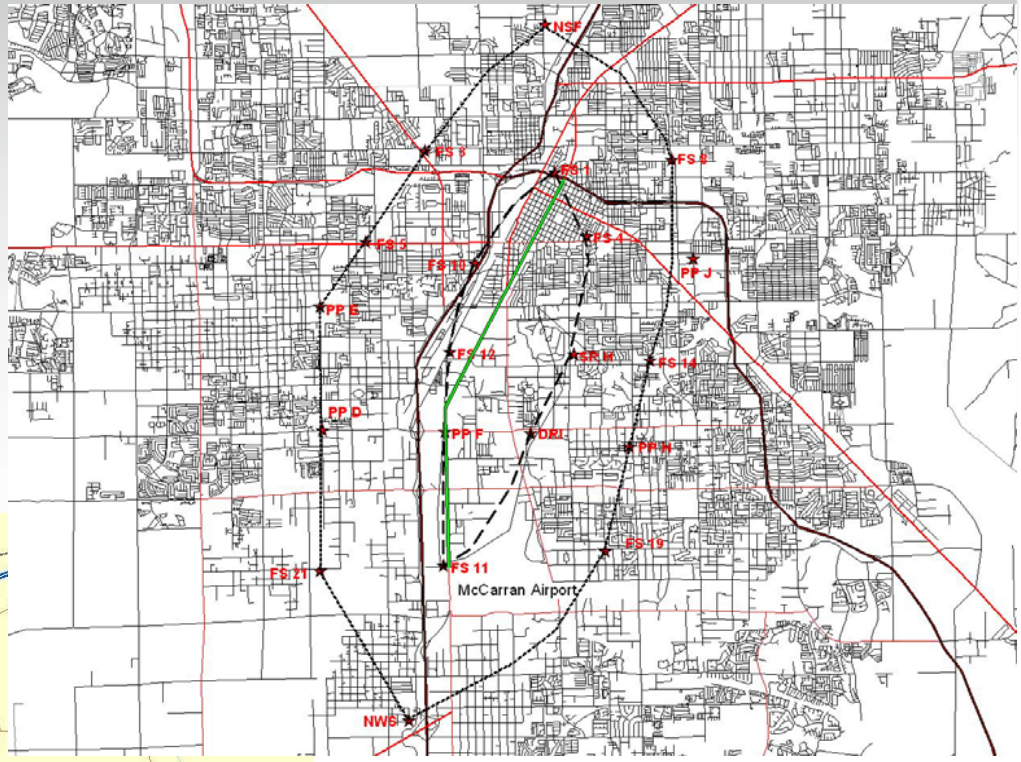
ARL Research

NCR Testbed

AWS/ARL Monitoring Stations

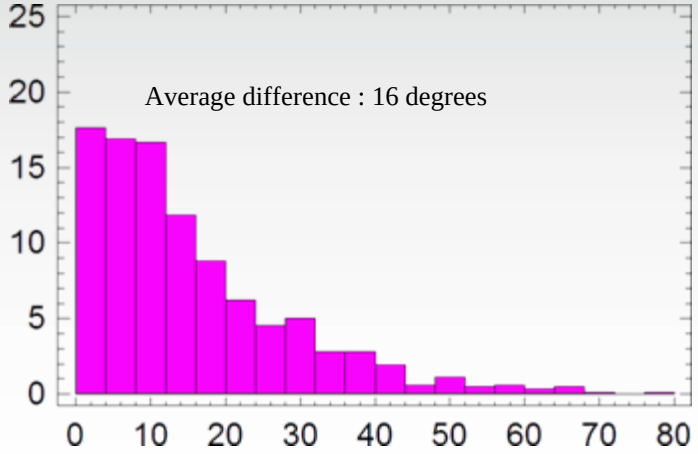
ARL
Research

Proposed
Las Vegas
Testbed

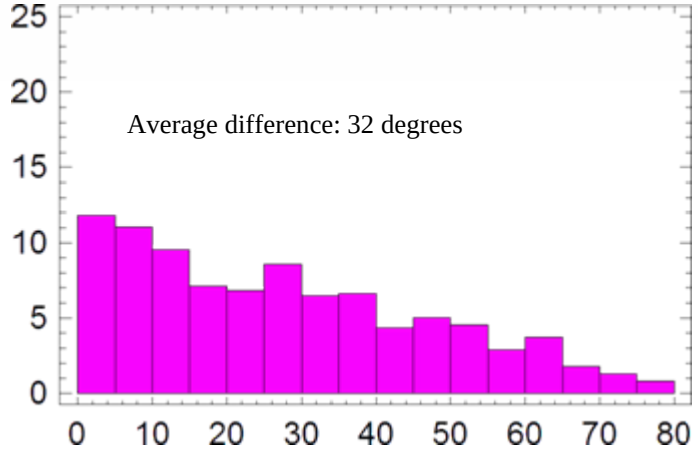


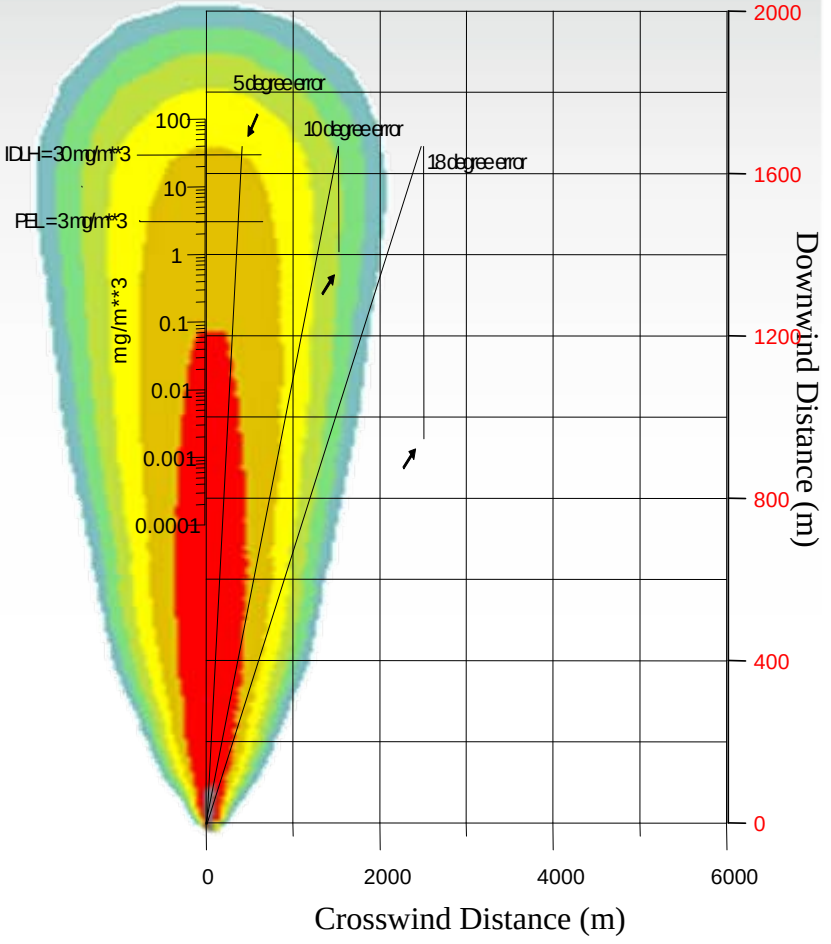
ARL Research

Direction difference between HCHB and NAS



Direction difference between HCHB and DCA

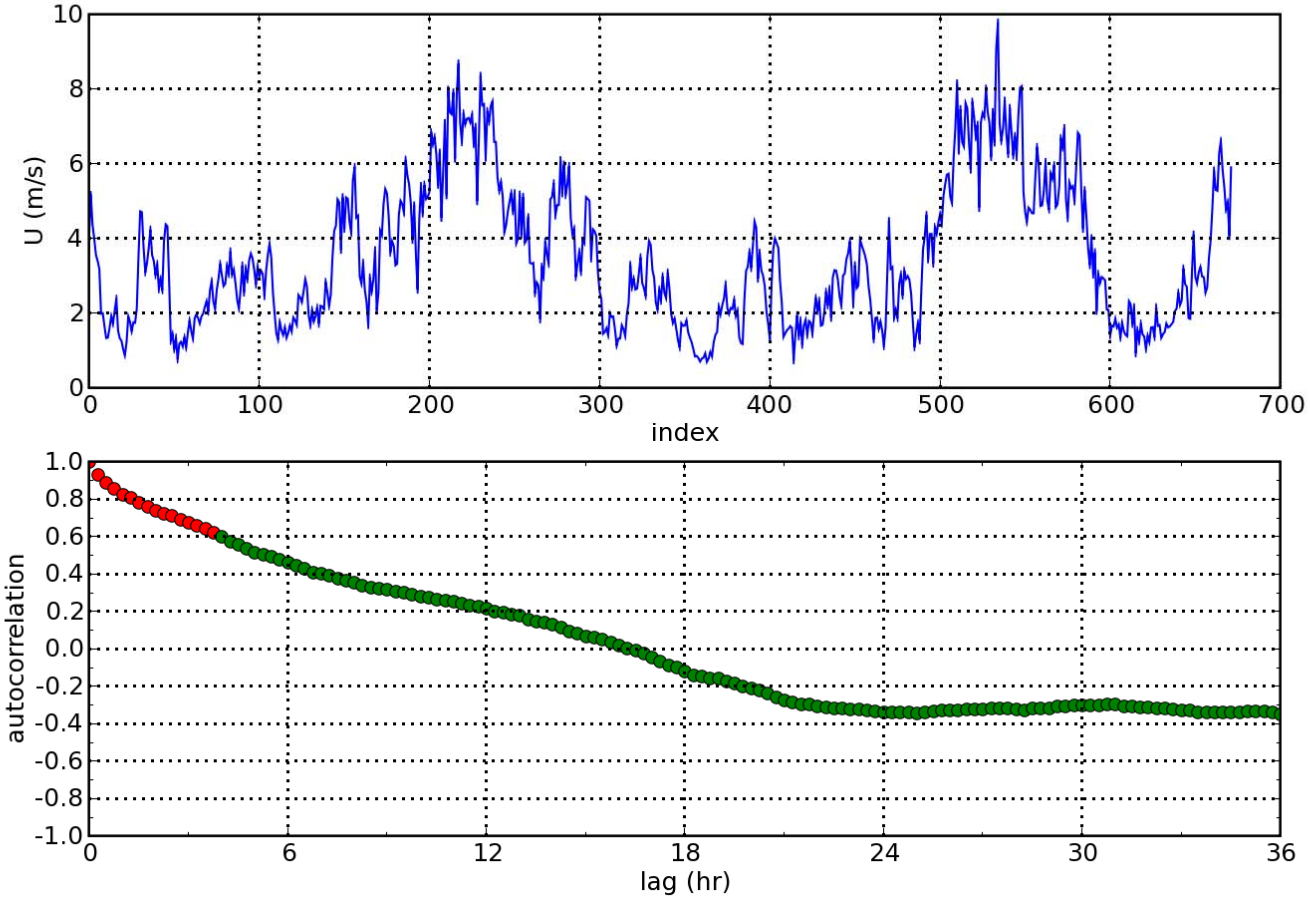




ARL Research

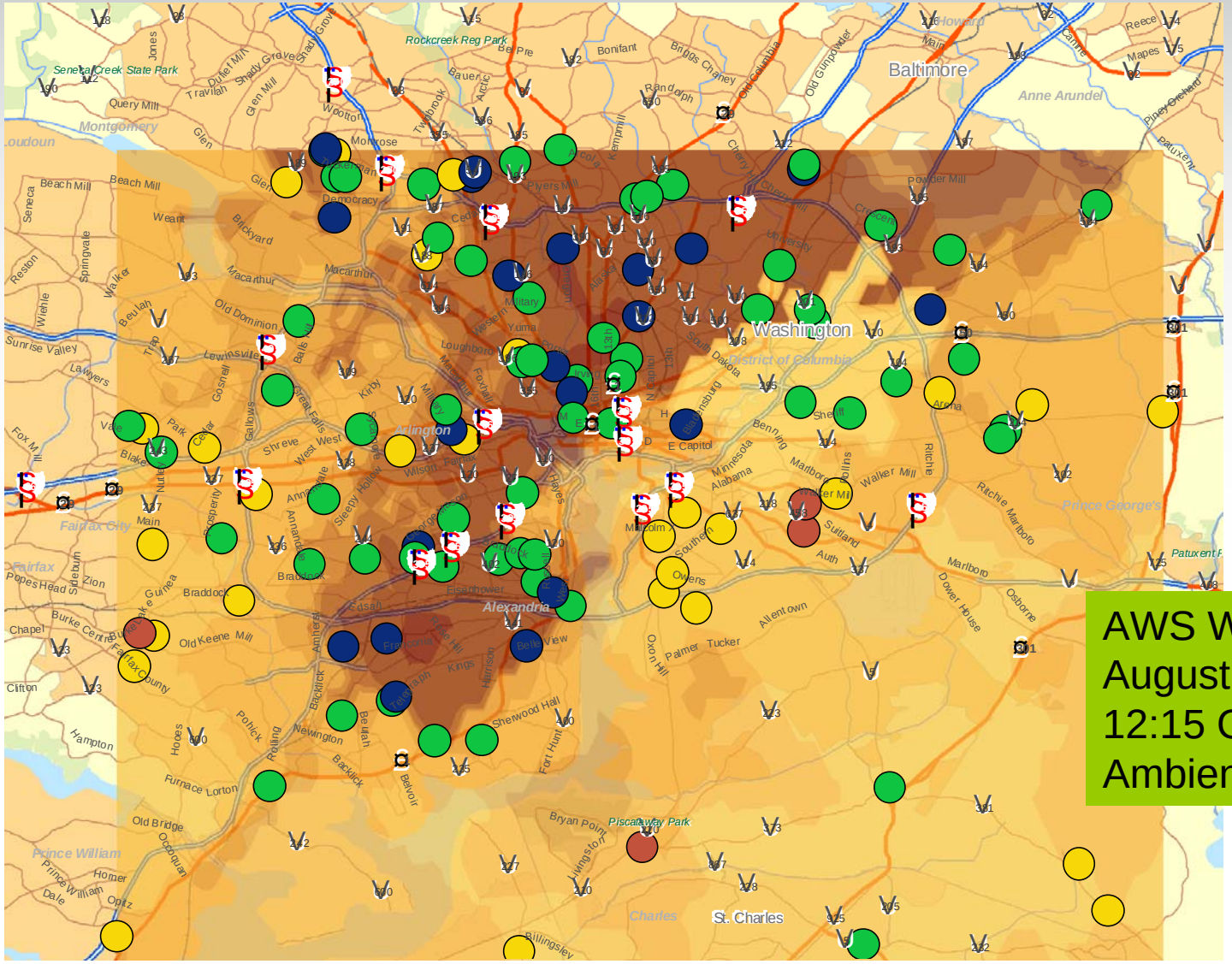
NCR Testbed

Wind Speed Persistence Analysis Hoover Building 2007-01-23 1415 to 2007-01-30 1400



At a 95% confidence level, an autocorrelation analysis indicates persistence is a valid forecast for 2-3 hours.

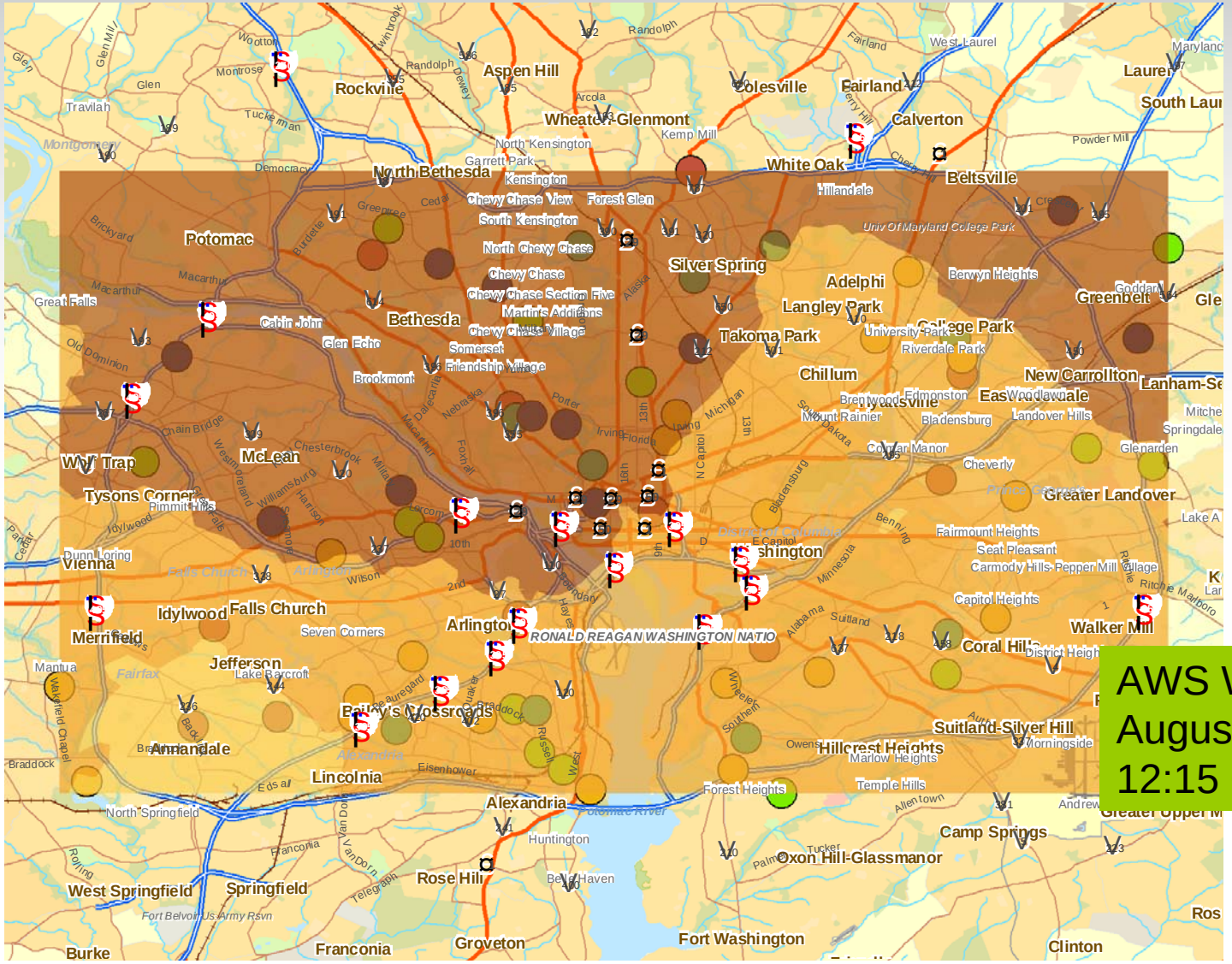
UrbaNet (AWS+ARL) Applications



ARL Research

NCR Heat Island

AWS Weather Stations
August 15, 2006
12:15 GMT
Ambient Temperature



ARL Research

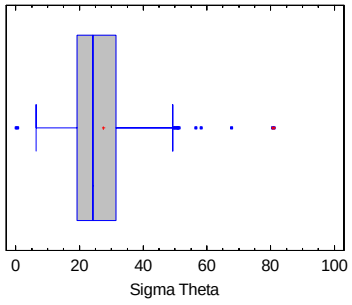
NCR Sigma Theta (Dispersion) Field

AWS Weather Stations
August 15, 2006
12:15 GMT

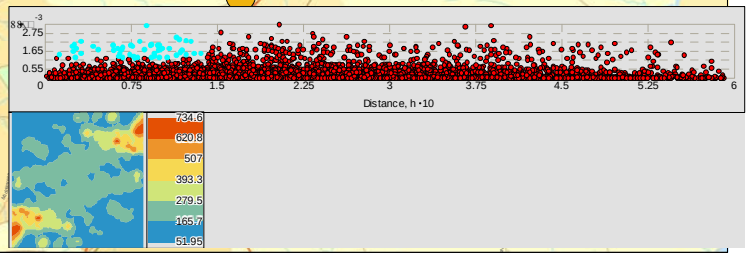
ARL Research

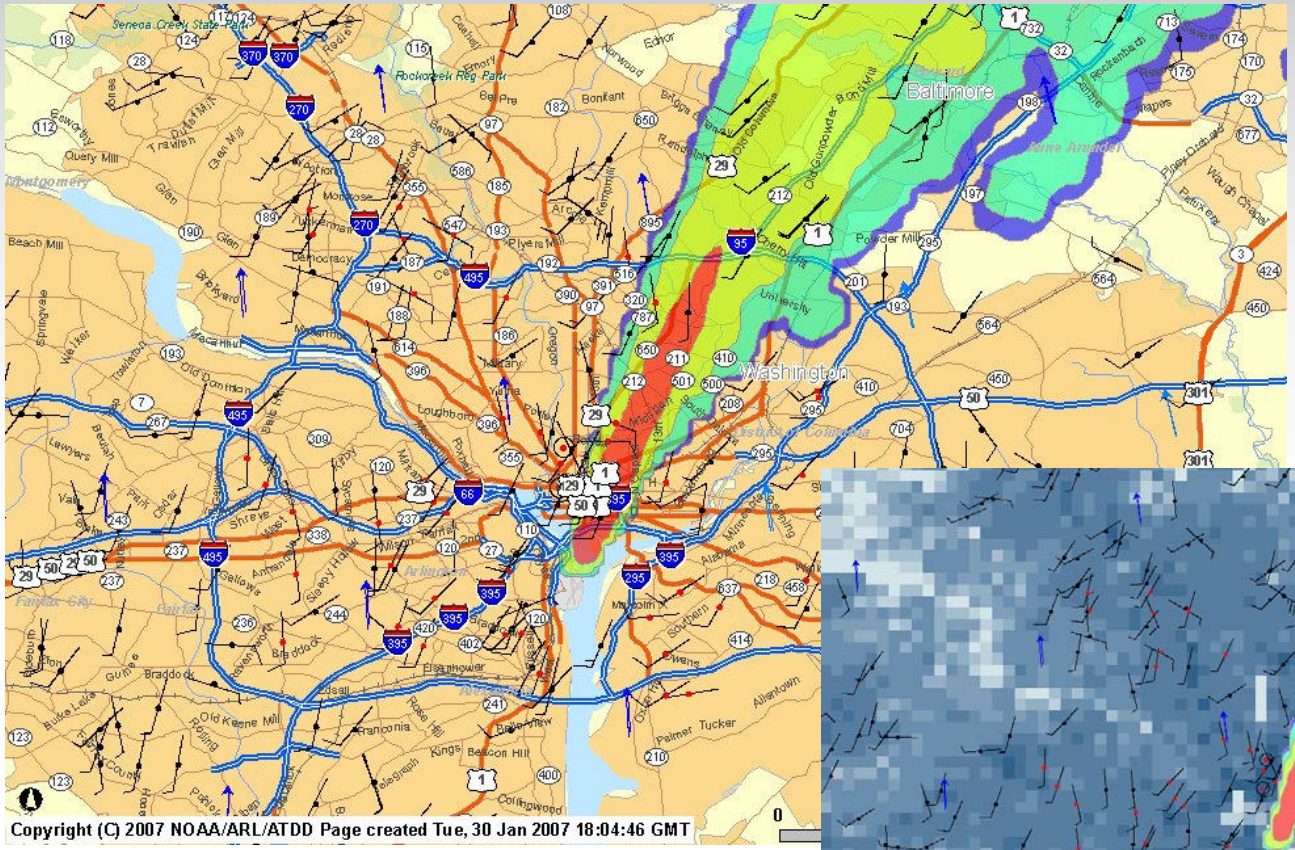
NCR Testbed

Sigma Theta Outliers?



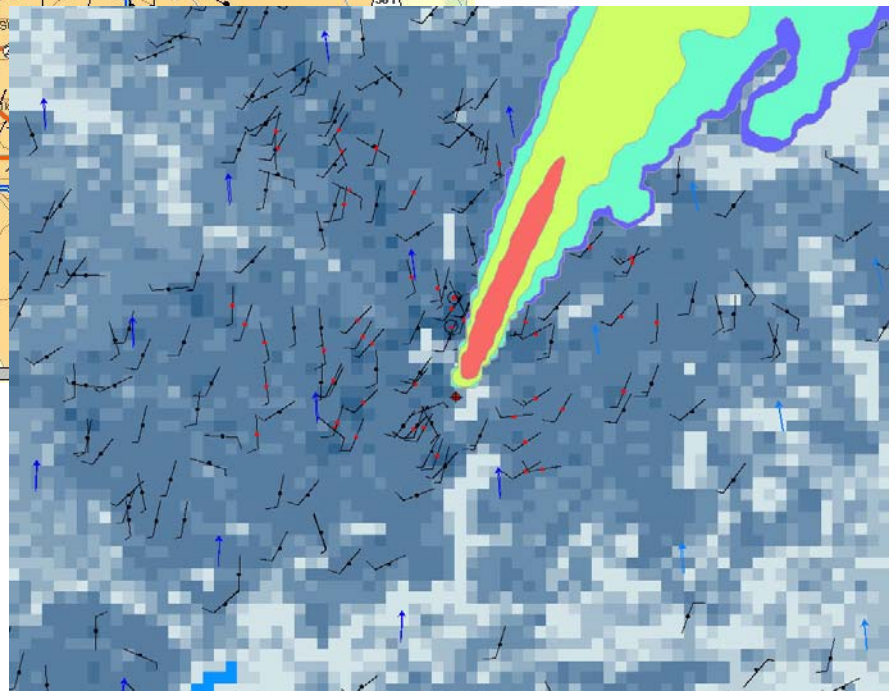
Semi variogram Sigma Theta





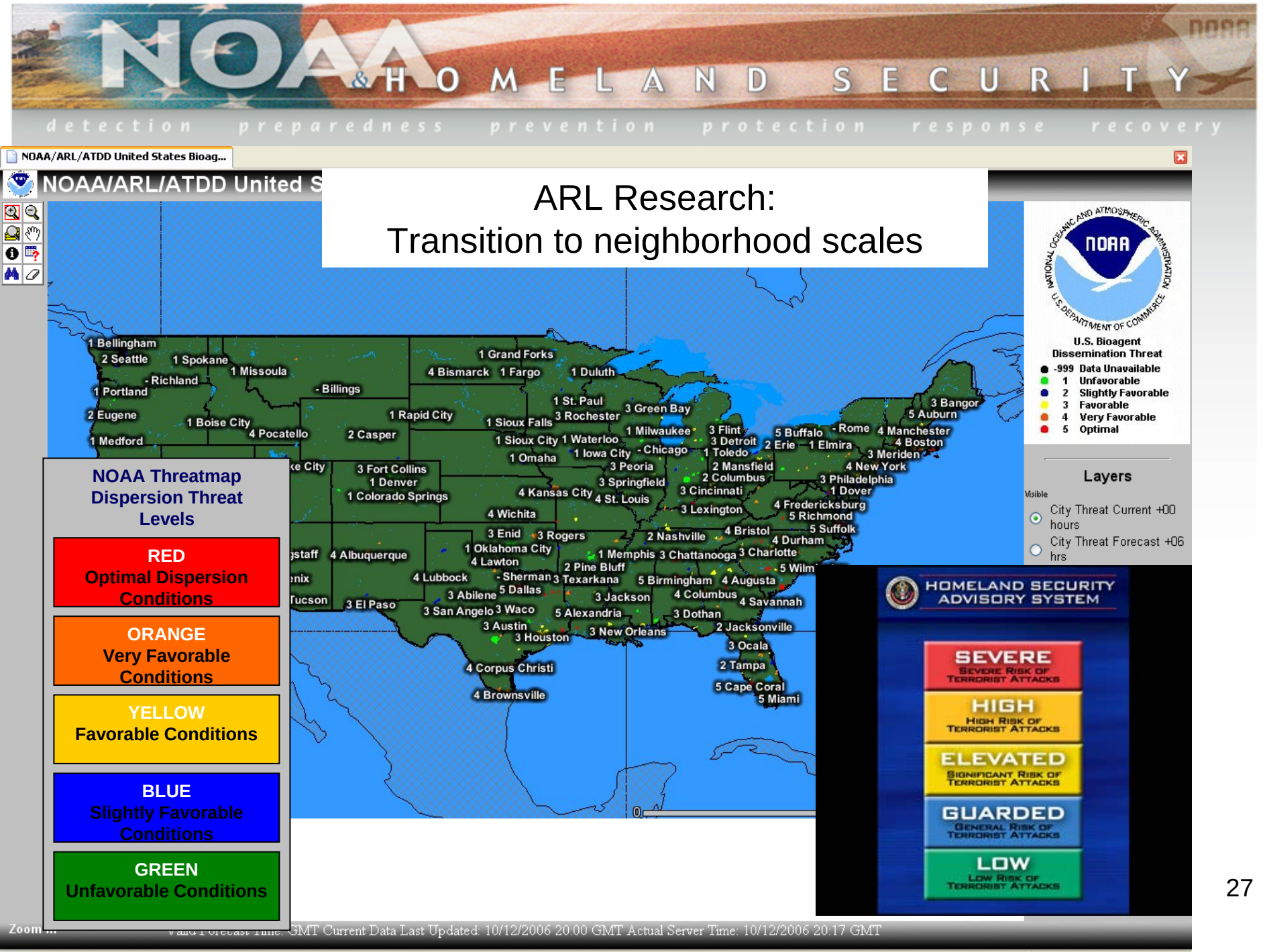
ARL Research

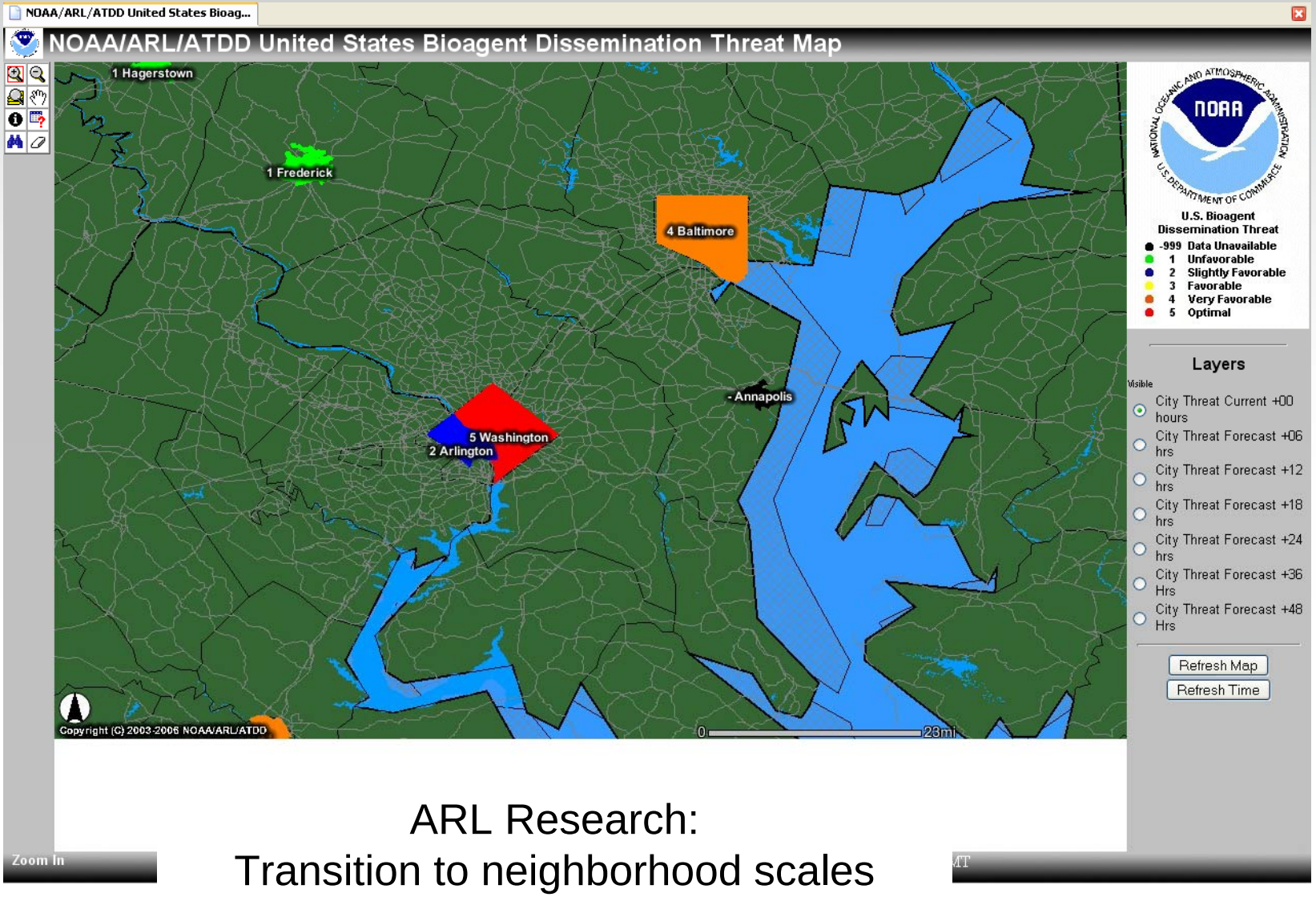
NCR Testbed



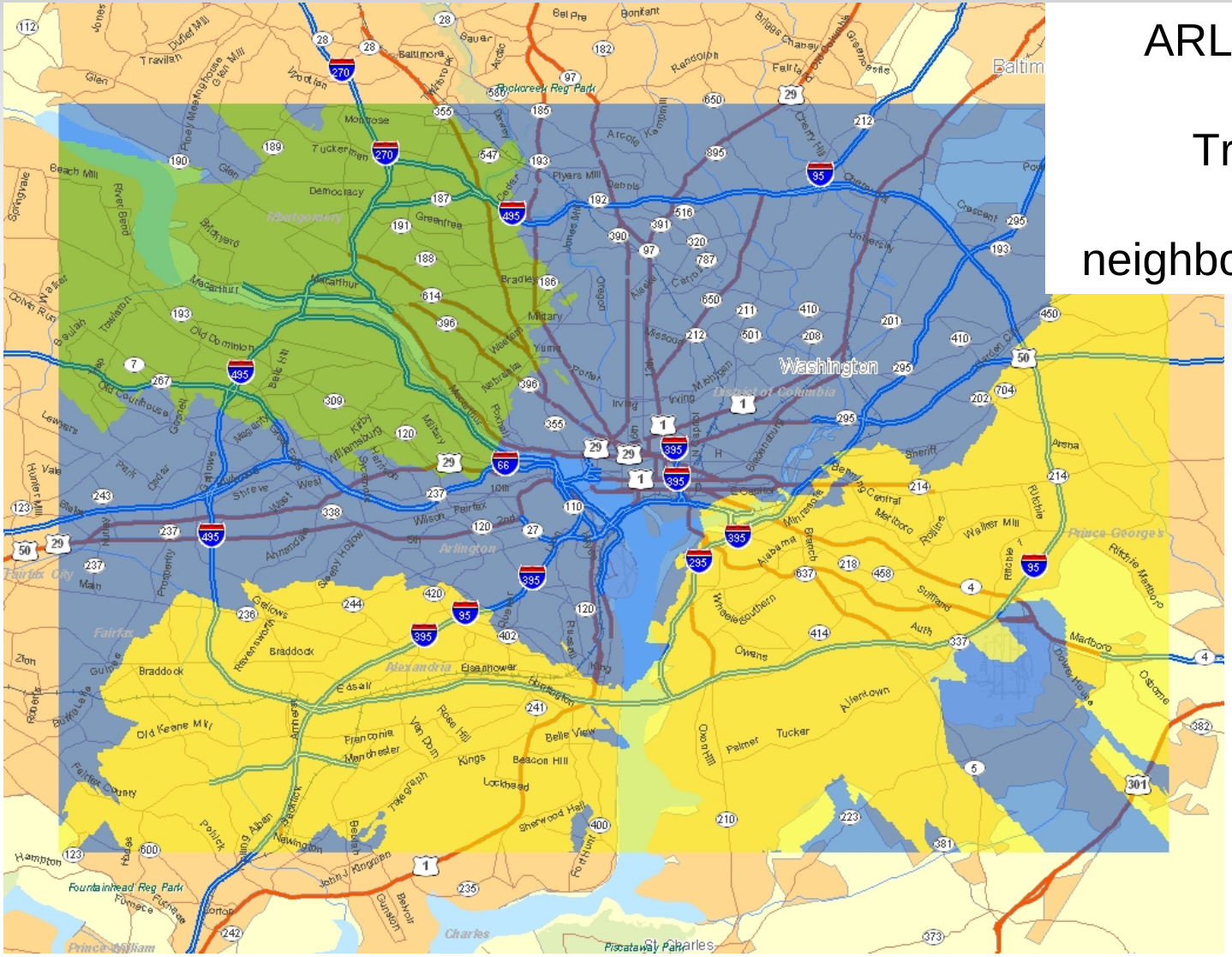
Hysplit Model Output

Population Overlay


NOAA & HOMELAND SECURITY
detection preparedness prevention protection response recovery
NOAA/ARL/ATDD United States Bioag...
NOAA/ARL/ATDD United S
ARL Research:
Transition to neighborhood scales
NOAA Threatmap
Dispersion Threat
Levels
RED
Optimal Dispersion
Conditions
ORANGE
Very Favorable
Conditions
YELLOW
Favorable Conditions
BLUE
Slightly Favorable
Conditions
GREEN
Unfavorable Conditions
U.S. Bioagent
Dissemination Threat
-999 Data Unavailable
1 Unfavorable
2 Slightly Favorable
3 Favorable
4 Very Favorable
5 Optimal
Layers
City Threat Current +00 hours
City Threat Forecast +06 hrs
HOMELAND SECURITY ADVISORY SYSTEM
SEVERE
Severe Risk of Terrorist Attacks
HIGH
High Risk of Terrorist Attacks
ELEVATED
Significant Risk of Terrorist Attacks
GUARDED
General Risk of Terrorist Attacks
LOW
Low Risk of Terrorist Attacks
Zoom ...
GMT Current Data Last Updated: 10/12/2006 20:00 GMT Actual Server Time: 10/12/2006 20:17 GMT



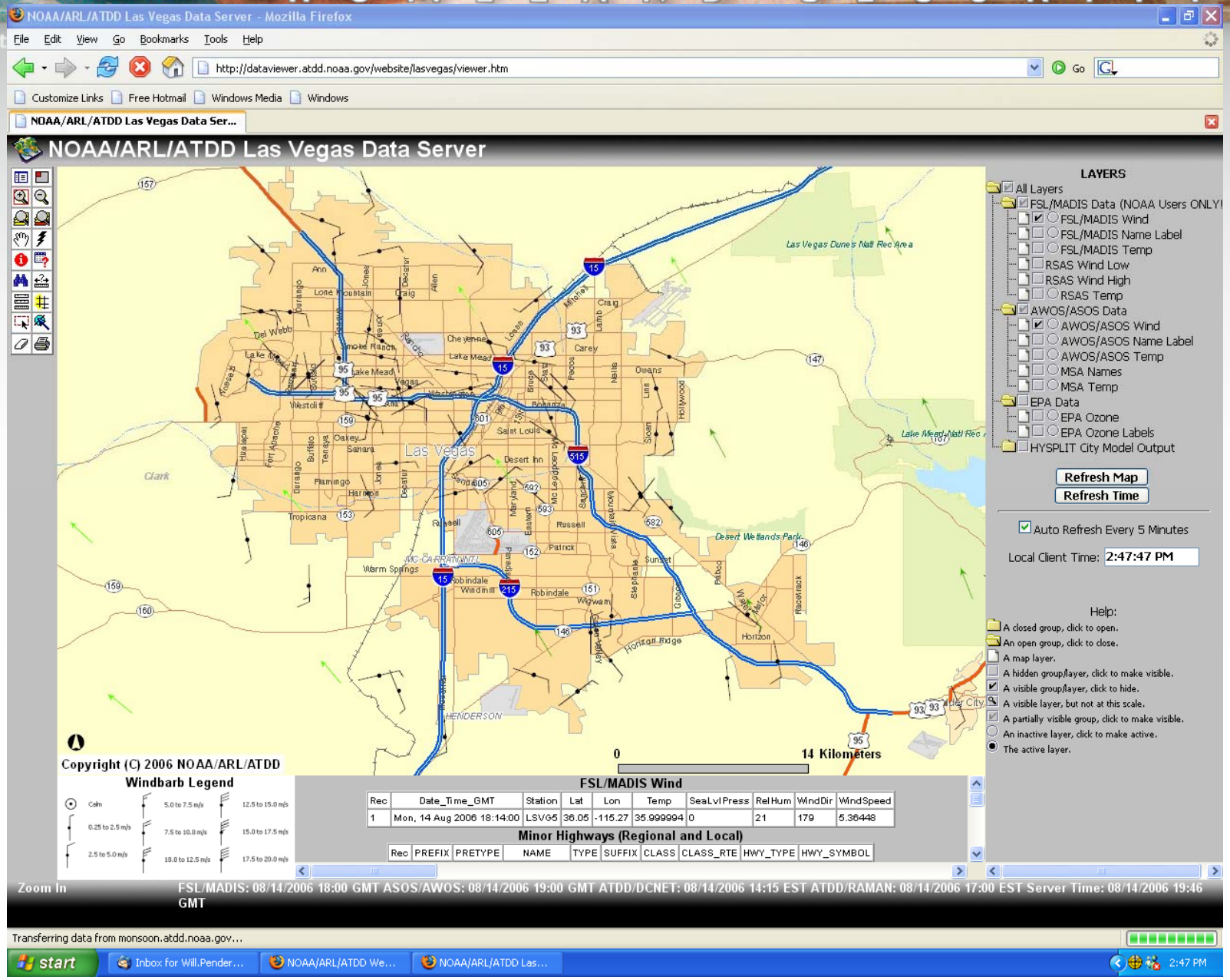
ARL Research:
Transition to neighborhood scales

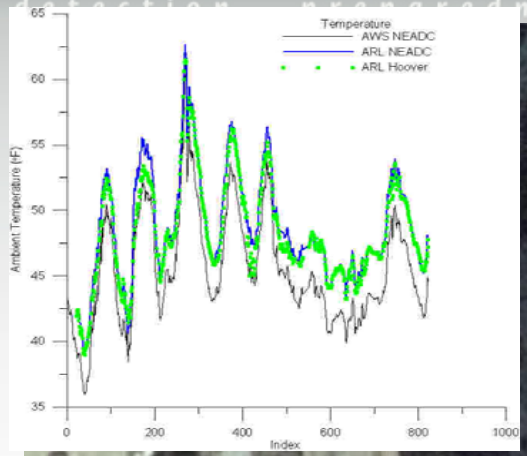


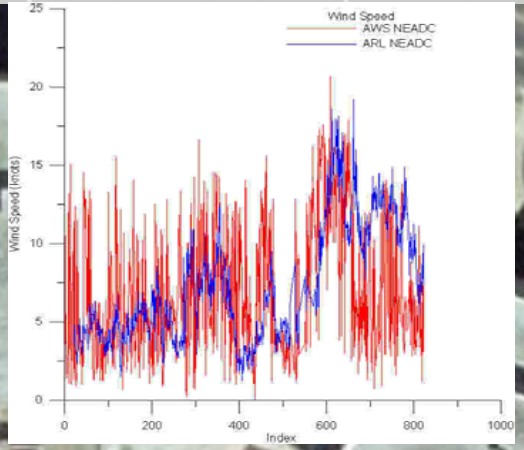
ARL Research

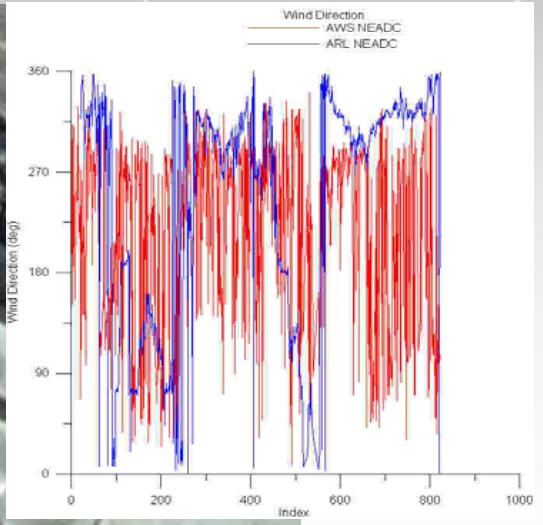
Transition
to
neighborhood scales

Dataviewer
http://dataviewer.atdd.noaa.gov

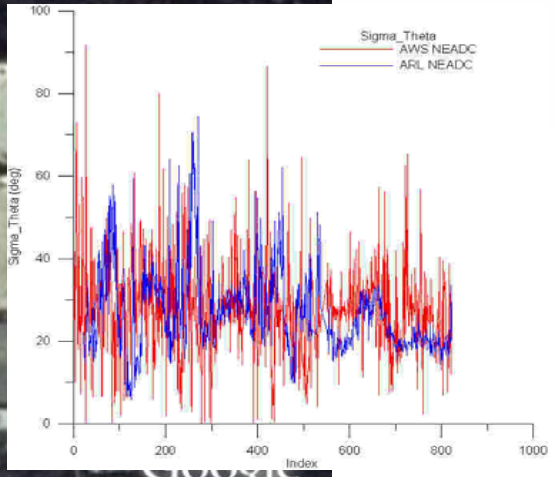


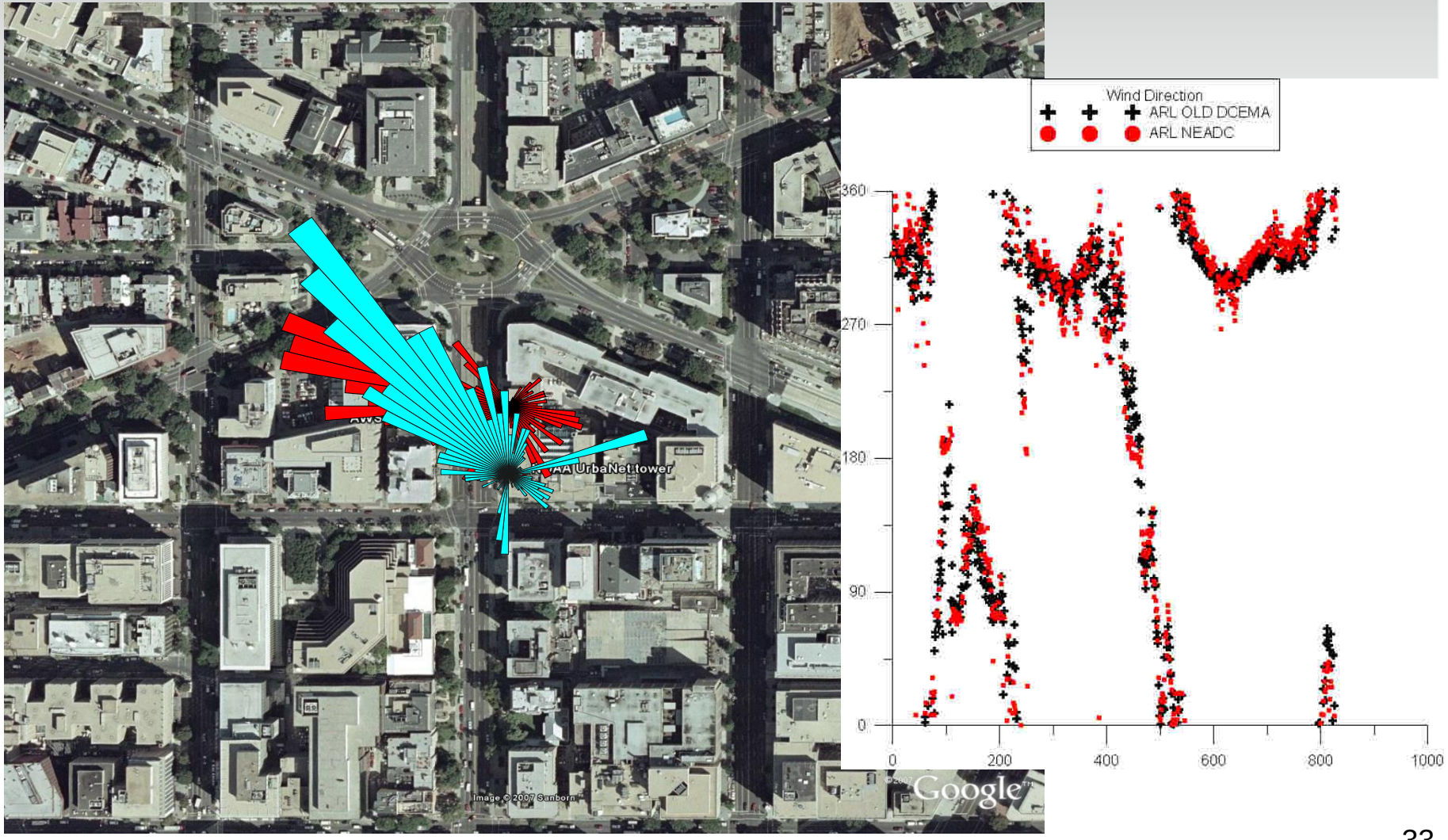

Temperature
AWS NEADC
ARL NEADC
ARL Hoover
Ambient Temperature (F)
Index


Wind Speed
AWS NEADC
ARL NEADC
Wind Speed (knots)
Index


Wind Direction
AWS NEADC
ARL NEADC
Wind Direction (deg)
Index


AWS WeatherBug mast
NOAA UrbaNet tower
Image © 2007 Sanborn

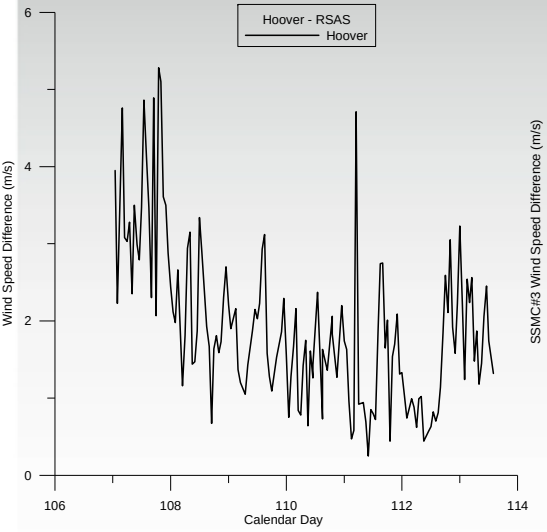

Sigma_Theta
AWS NEADC
ARL NEADC
Sigma_Theta (deg)
Index

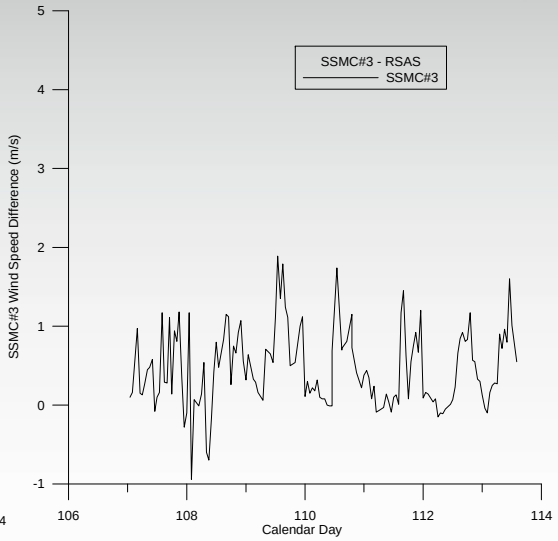

Wind Direction
ARL OLD DCEMA
ARL NEADC
360
270
180
90
0
0
200
400
600
800
1000
NOAA UrbaNet tower
Image © 2007 Sanborn
Google

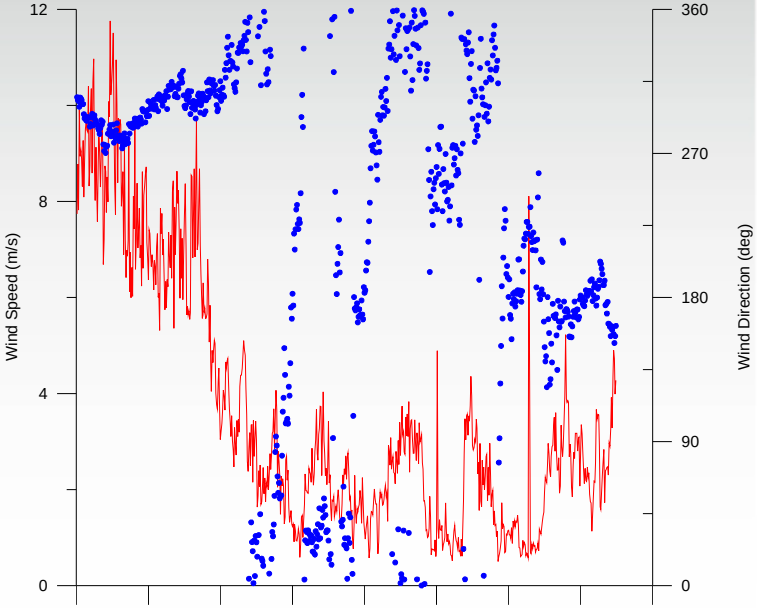
20070423141500

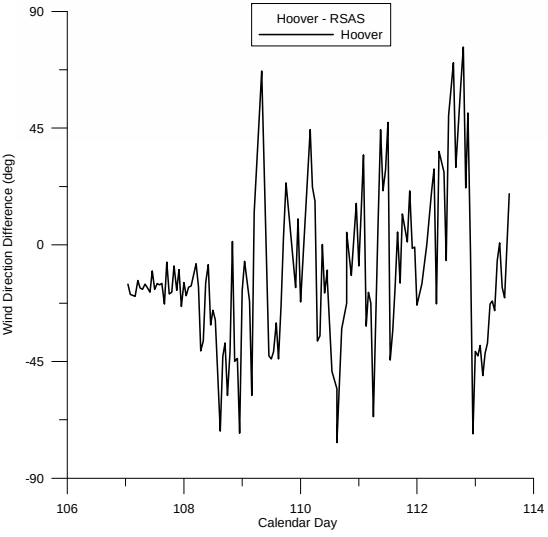
Reporting Date: Download this data as CSV file

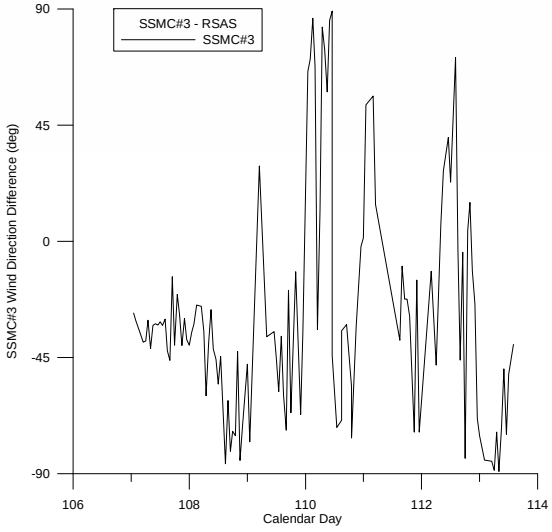
Grouping	Total Obs	WS<= 2.2 MPH	WS<= 3.8 MPH	ST>= 40	ST>=40.8 & WS>=6.0	TRate > 3	TRate > 5	WS > 20 MPH	WS > 30 MPH
Urbanet all	4378	763	1596	414	36	1534	539	6	0
Urbanet Qualified	723	87	260	75	6	246	63	2	0
Washington	78	15	54	13	0	70	22	0	0
Las Vegas	73	21	32	5	0	0	0	0	0



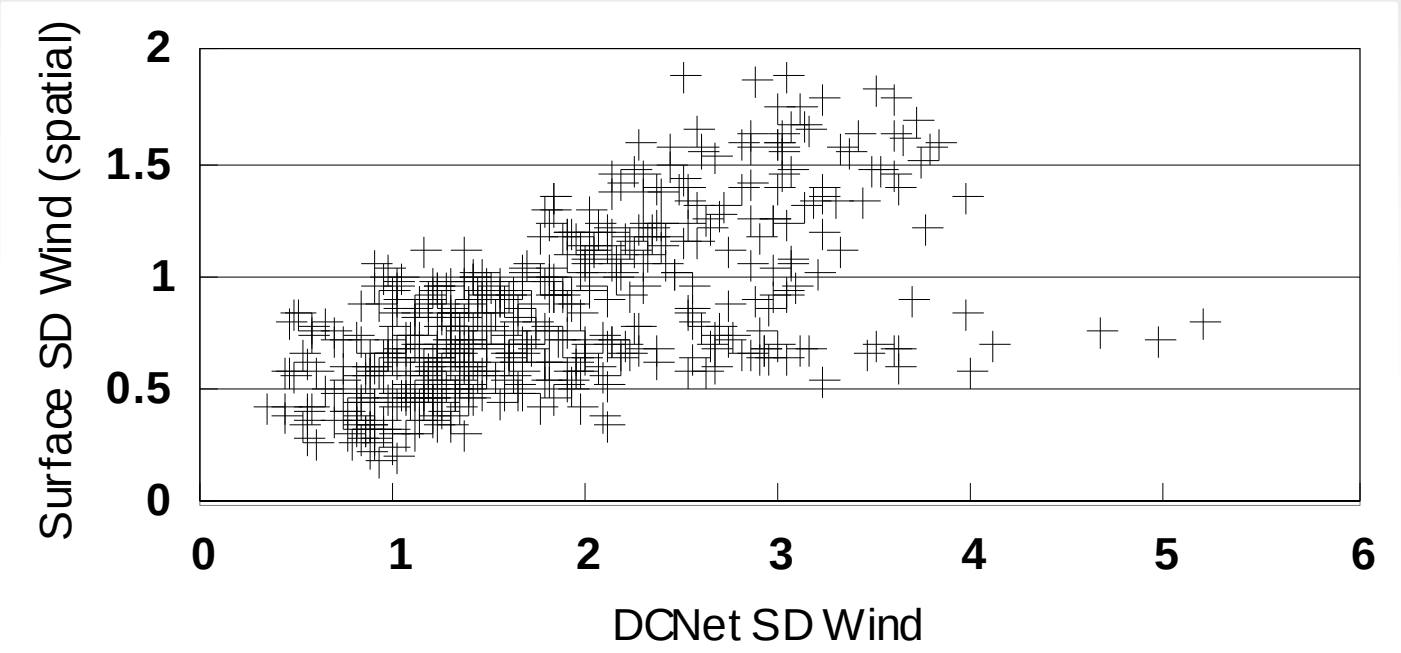








Mesoscale Model Comparison



R-square = 0.386 # pts = 531

y = 0.369 + 0.259x