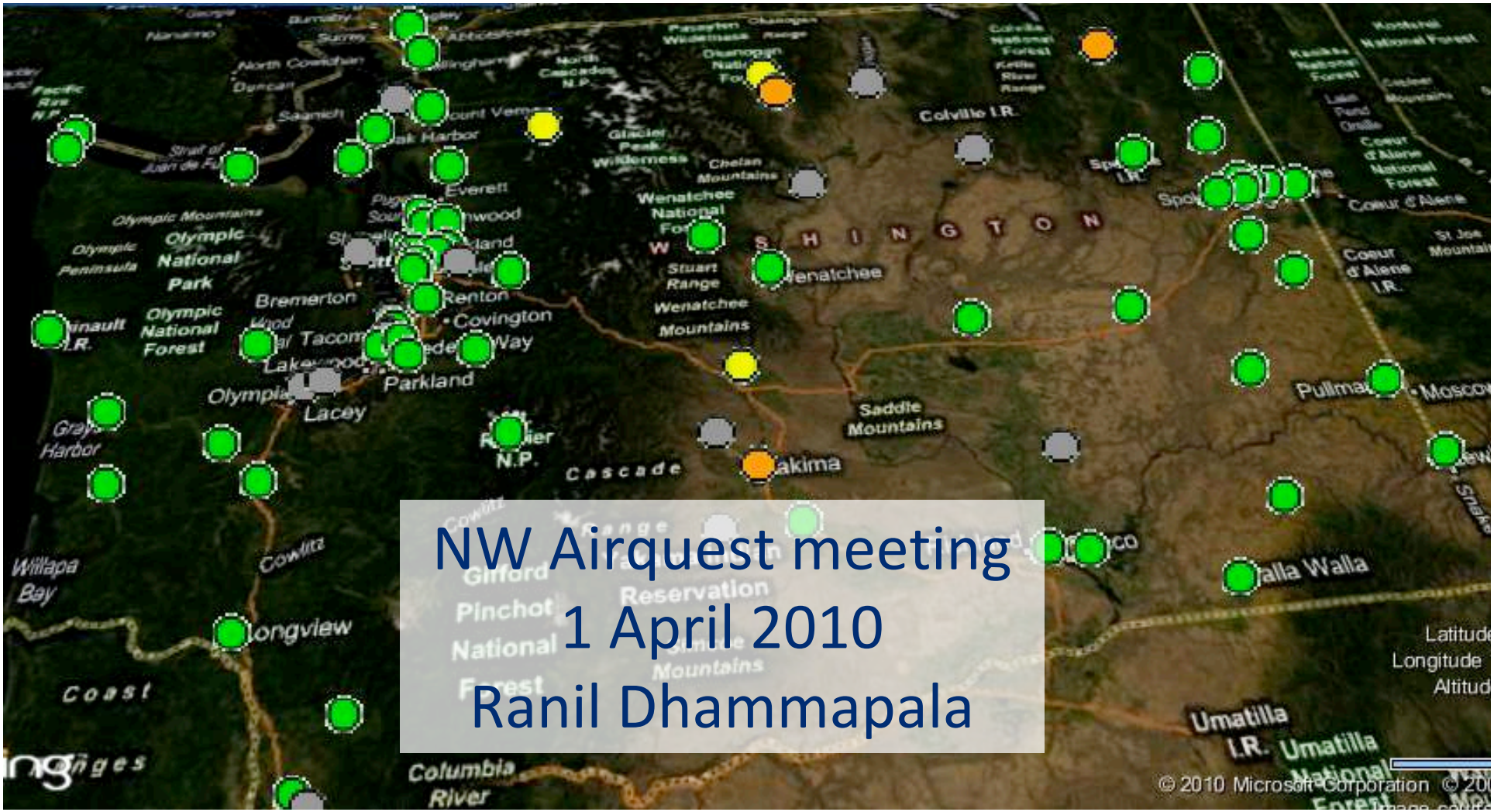
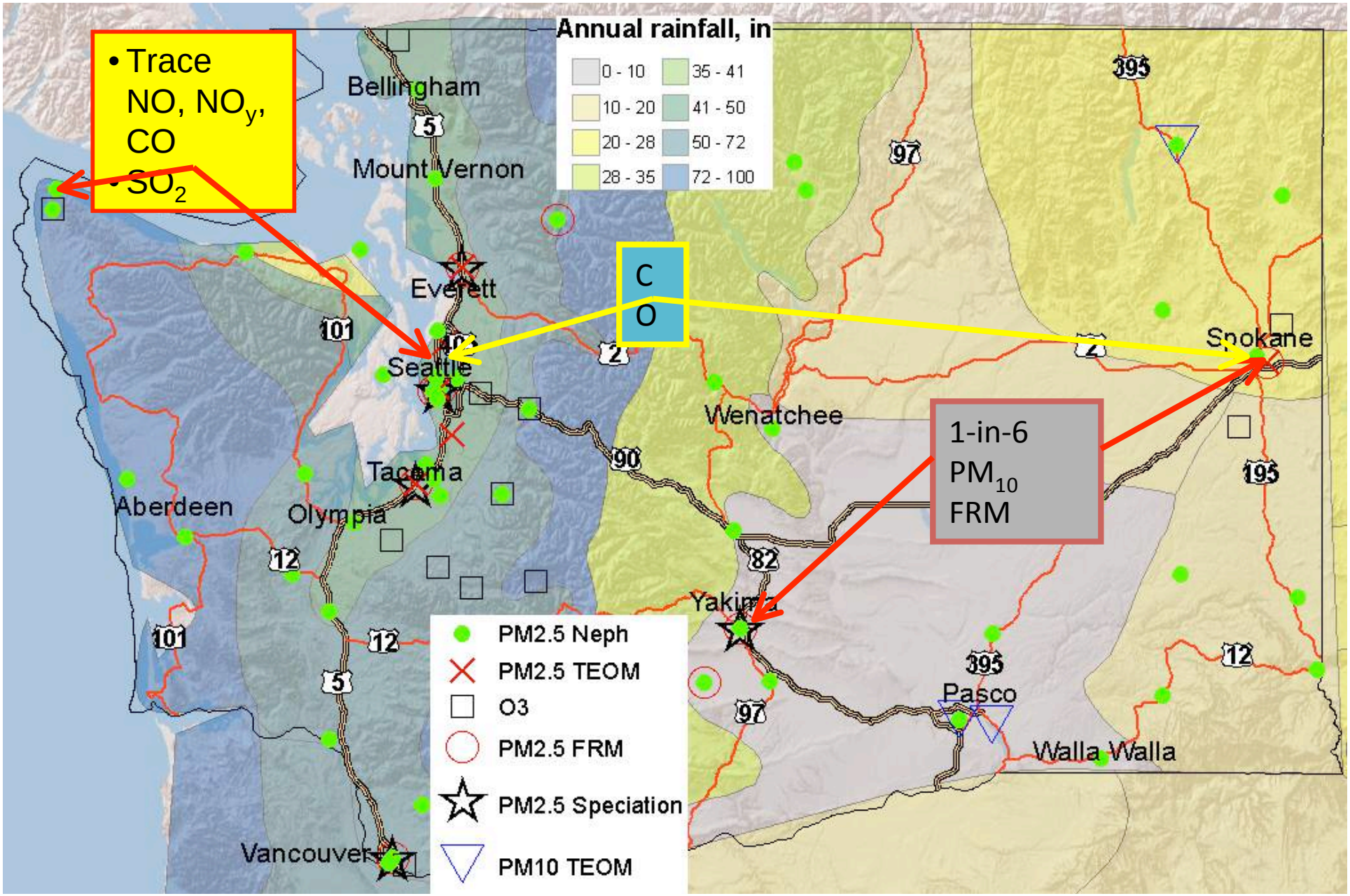
Washington 2010 monitoring network assessment
Some preliminary results

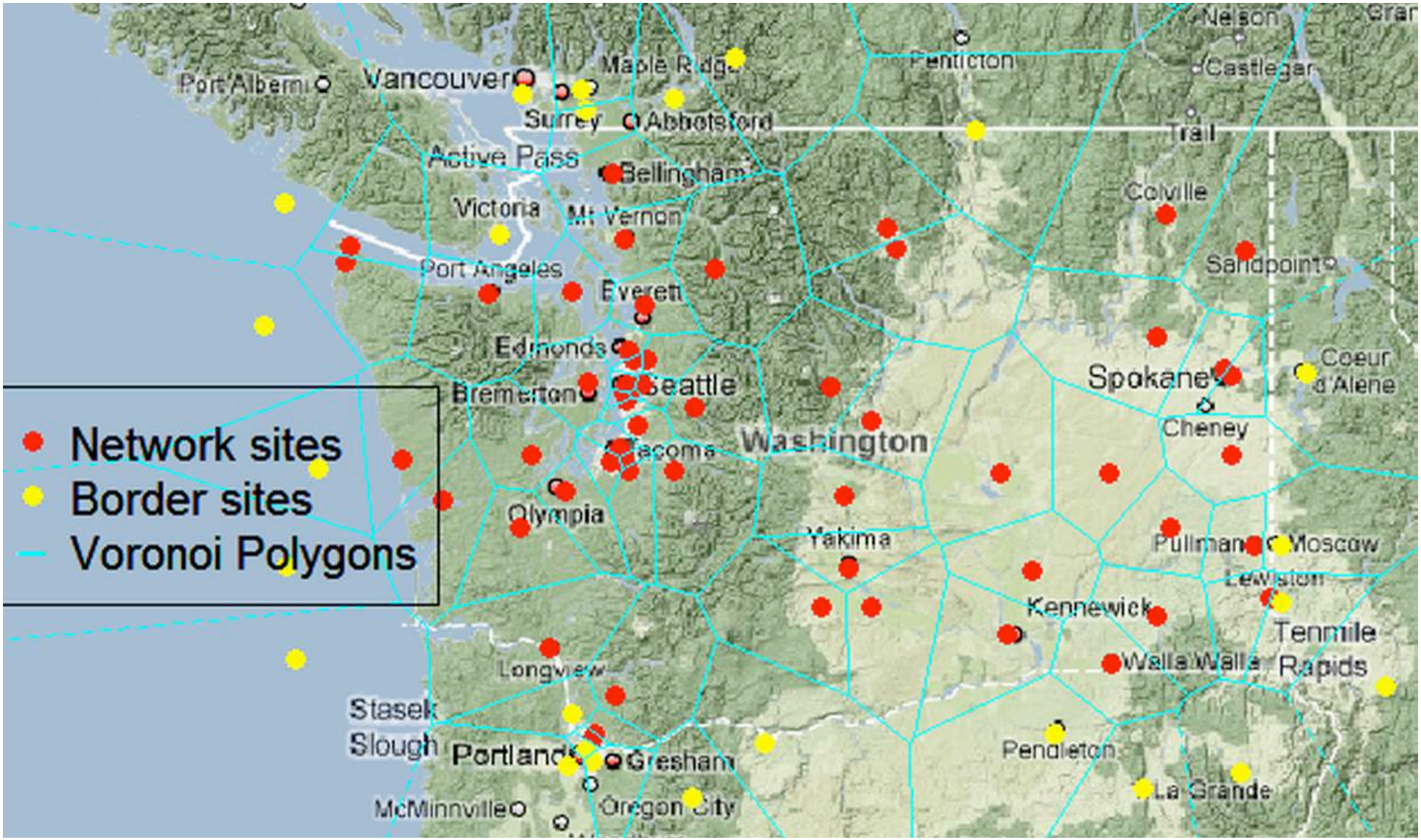


Existing sites – only those supported by ECY



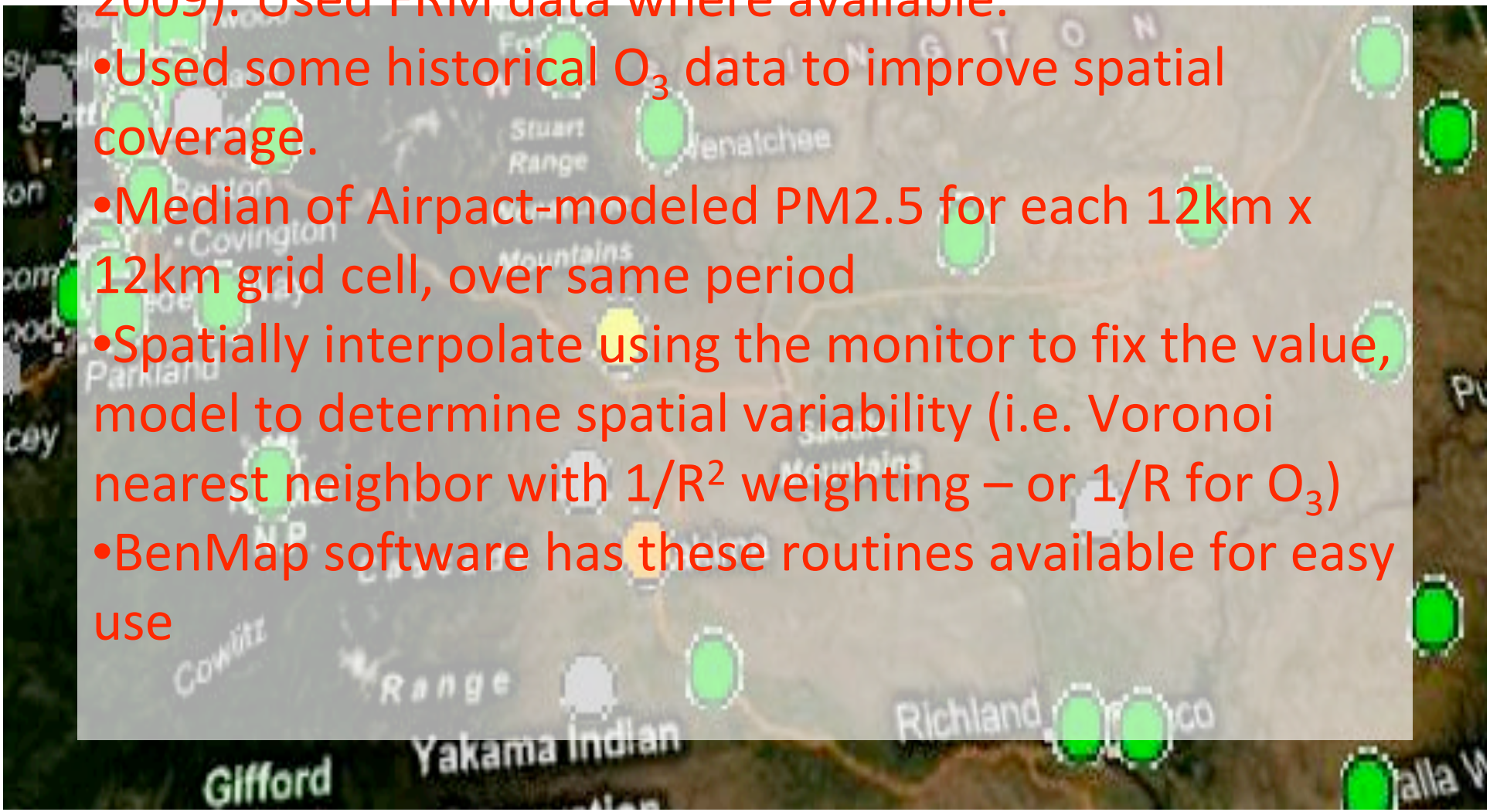
$PM_{2.5}$ site ranking criteria	O_3 site ranking criteria
2009 "Design value" (24-hour), normalized to max	2009 "Design value" (8-hour, Primary Standard), normalized to max
24-hr NAAQS Exceedances (2007-2009)	8-hour NAAQS Exceedances (2007-2009)
Ecology Air Quality Program goal (20 µg/m^3) exceedances (2007-2009)	8-hour Excursions Above .060 ppm (2007-2009)
Number of non-Good Days (WAQA $PM_{2.5}$ scale)	
Tribal Monitor	
USFS Monitor	
Agricultural Burning Monitor	
Sole monitor in Airshed	
Sole Continuous Onsite $PM_{2.5}$ Monitor	
Population Exposure by City	
% of Individuals below Federal Poverty Level	
Population Trend	
Pollution Trend; Forecasting/Curtailment/ Action day need; NCORE/Potential NCORE site; Length of Historical Record; Number of Collocated Network Parameters	

EPA proposed method for determining areas served by each continuous $PM_{2.5}$ monitor

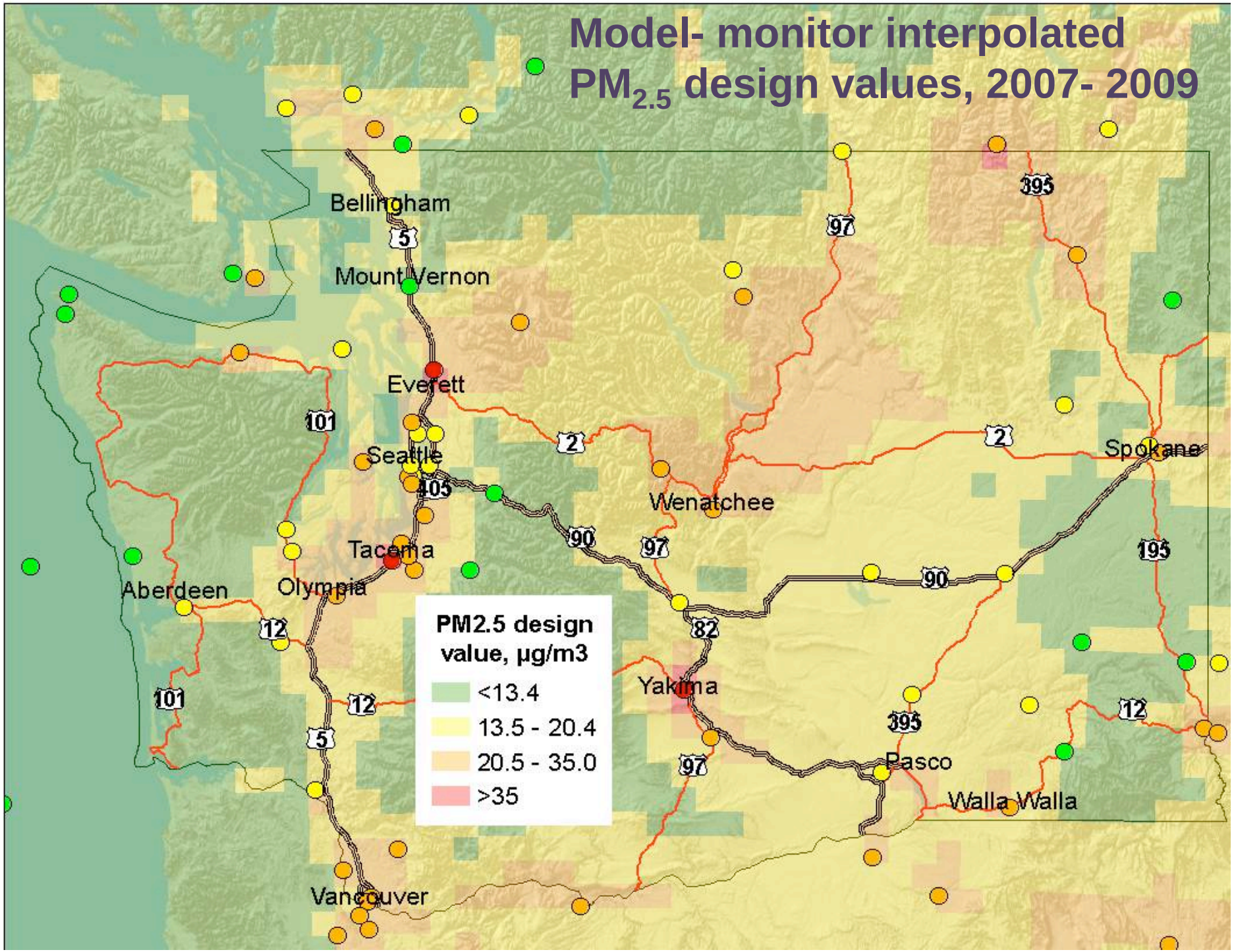


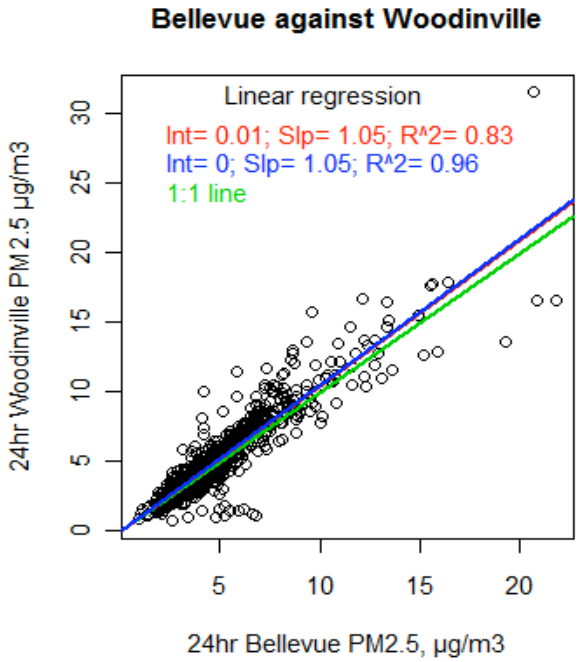
To surmount these limitations and determine spatial variability of $PM_{2.5}$ and O_3:

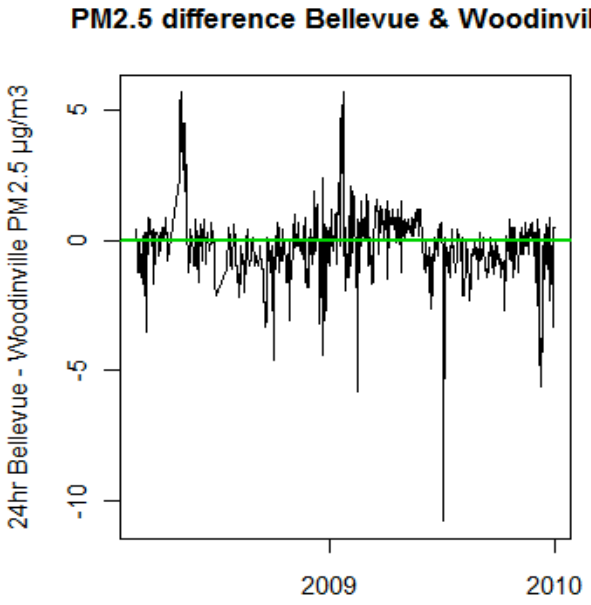
- Used current design values from each monitor (2007-2009). Used FRM data where available.
- Used some historical O_3 data to improve spatial coverage.
- Median of Airpact-modeled PM2.5 for each 12km x 12km grid cell, over same period
- Spatially interpolate using the monitor to fix the value, model to determine spatial variability (i.e. Voronoi nearest neighbor with $1/R^2$ weighting – or $1/R$ for O_3)
- BenMap software has these routines available for easy use

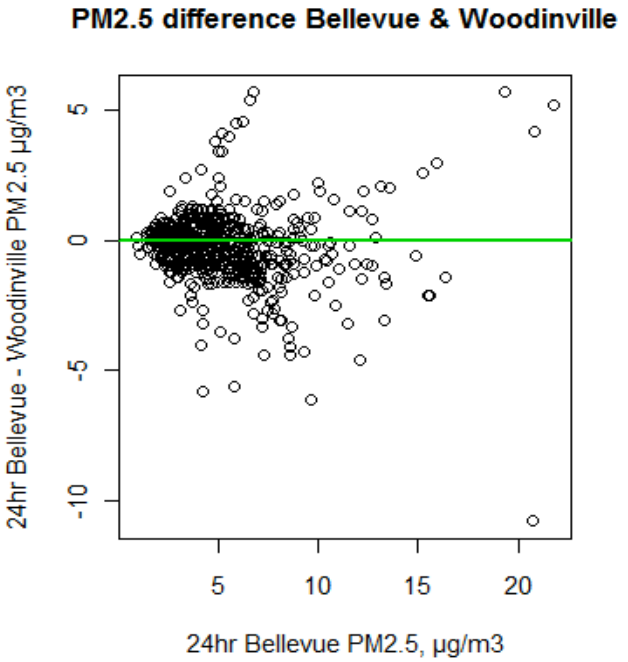


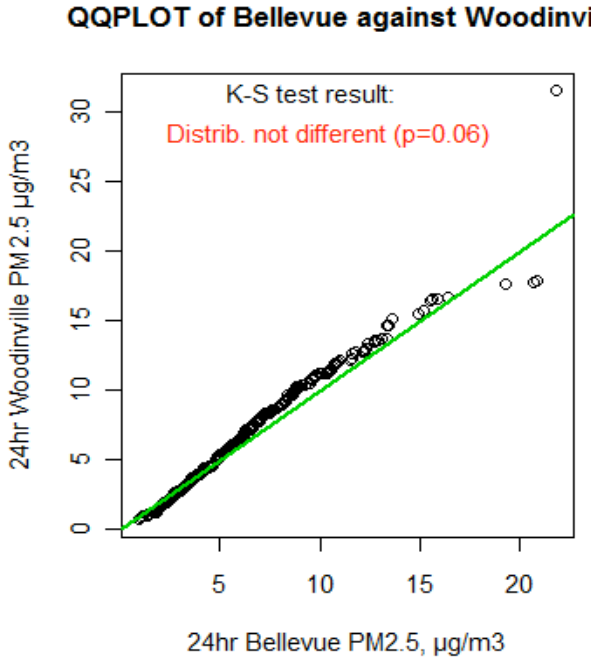
Model- monitor interpolated $PM_{2.5}$ design values, 2007- 2009

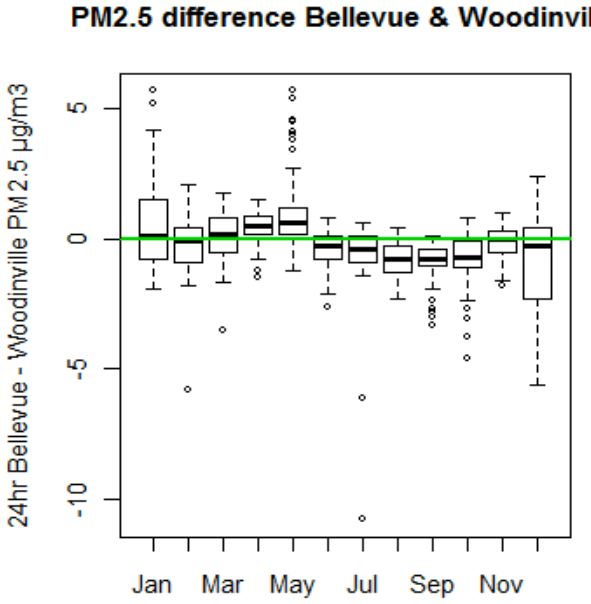


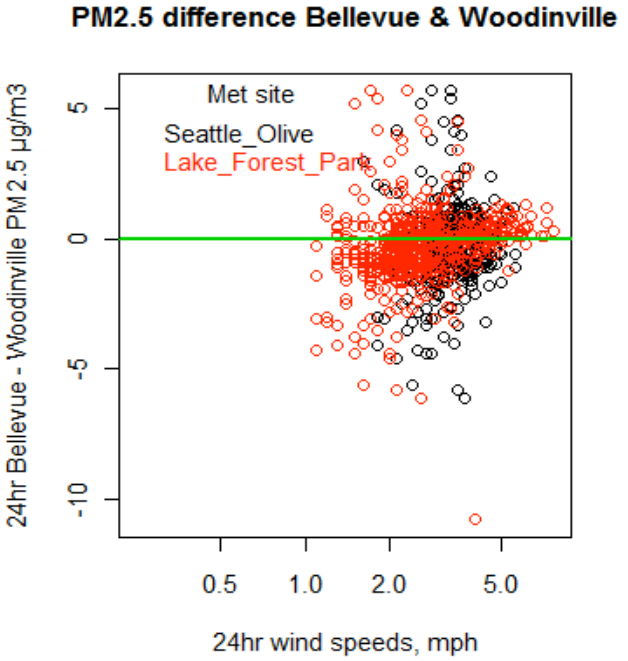

Bellevue against Woodinville
Linear regression
Int= 0.01; Slp= 1.05; R^2= 0.83
Int= 0; Slp= 1.05; R^2= 0.96
1:1 line
24hr Woodinville PM2.5 µg/m3
24hr Bellevue PM2.5, µg/m3

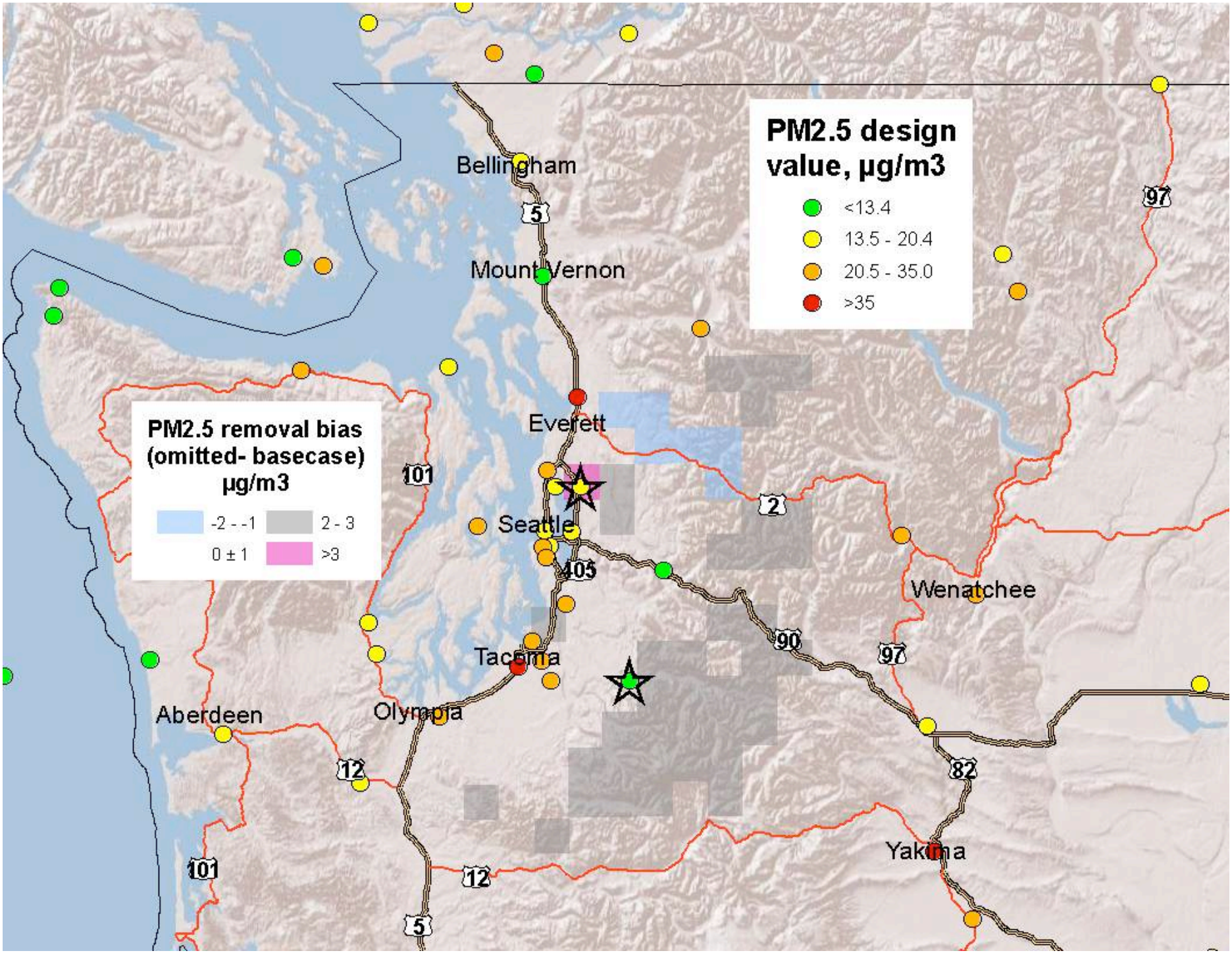

PM2.5 difference Bellevue & Woodinville
24hr Bellevue - Woodinville PM2.5 µg/m3
2009
2010

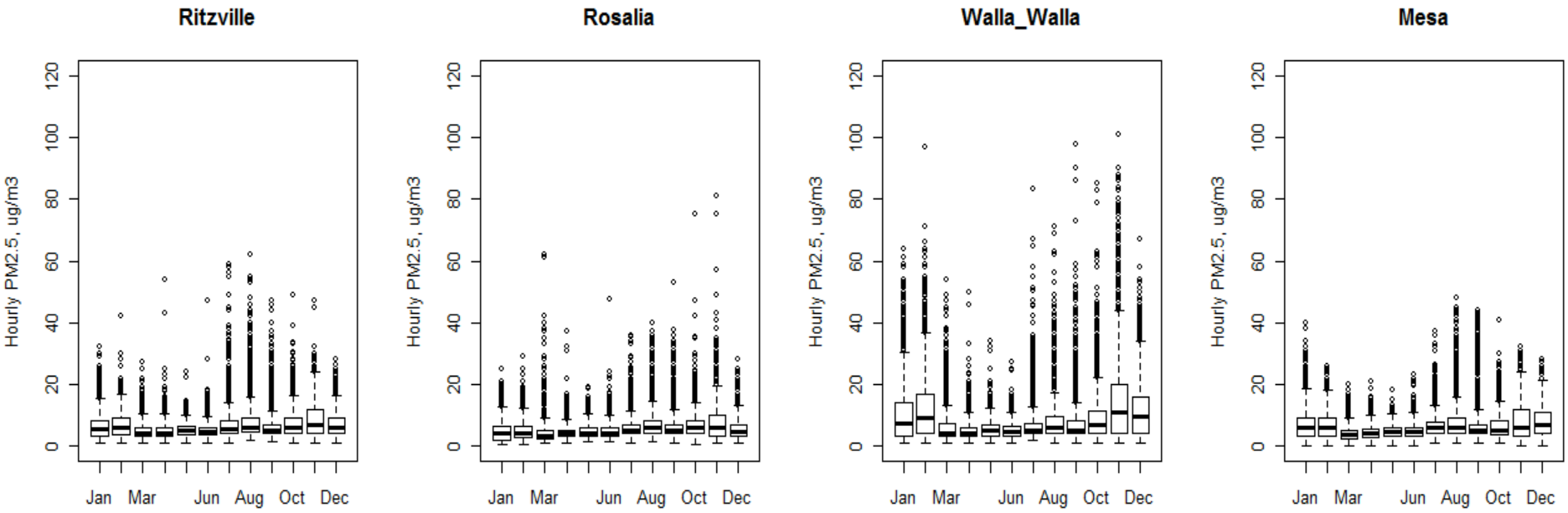

PM2.5 difference Bellevue & Woodinville
24hr Bellevue - Woodinville PM2.5 µg/m3
24hr Bellevue PM2.5, µg/m3


QQPLOT of Bellevue against Woodinville
K-S test result:
Distrib. not different (p=0.06)
24hr Woodinville PM2.5 µg/m3
24hr Bellevue PM2.5, µg/m3

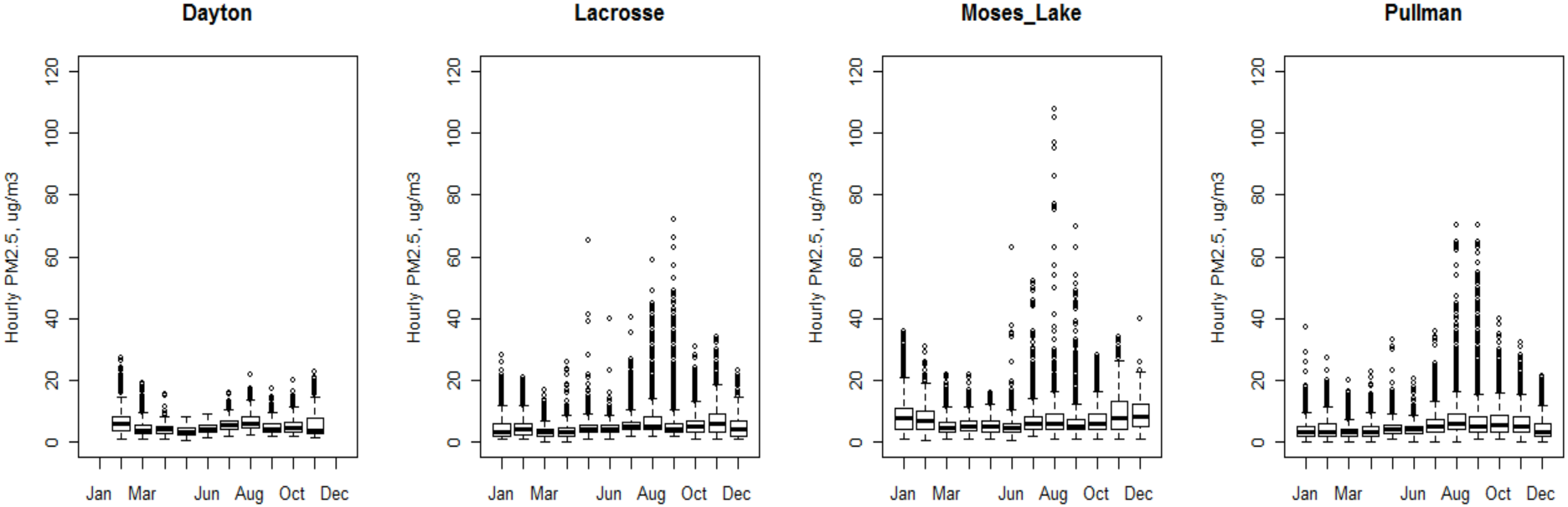

PM2.5 difference Bellevue & Woodinville
24hr Bellevue - Woodinville PM2.5 µg/m3
Jan
Mar
May
Jul
Sep
Nov

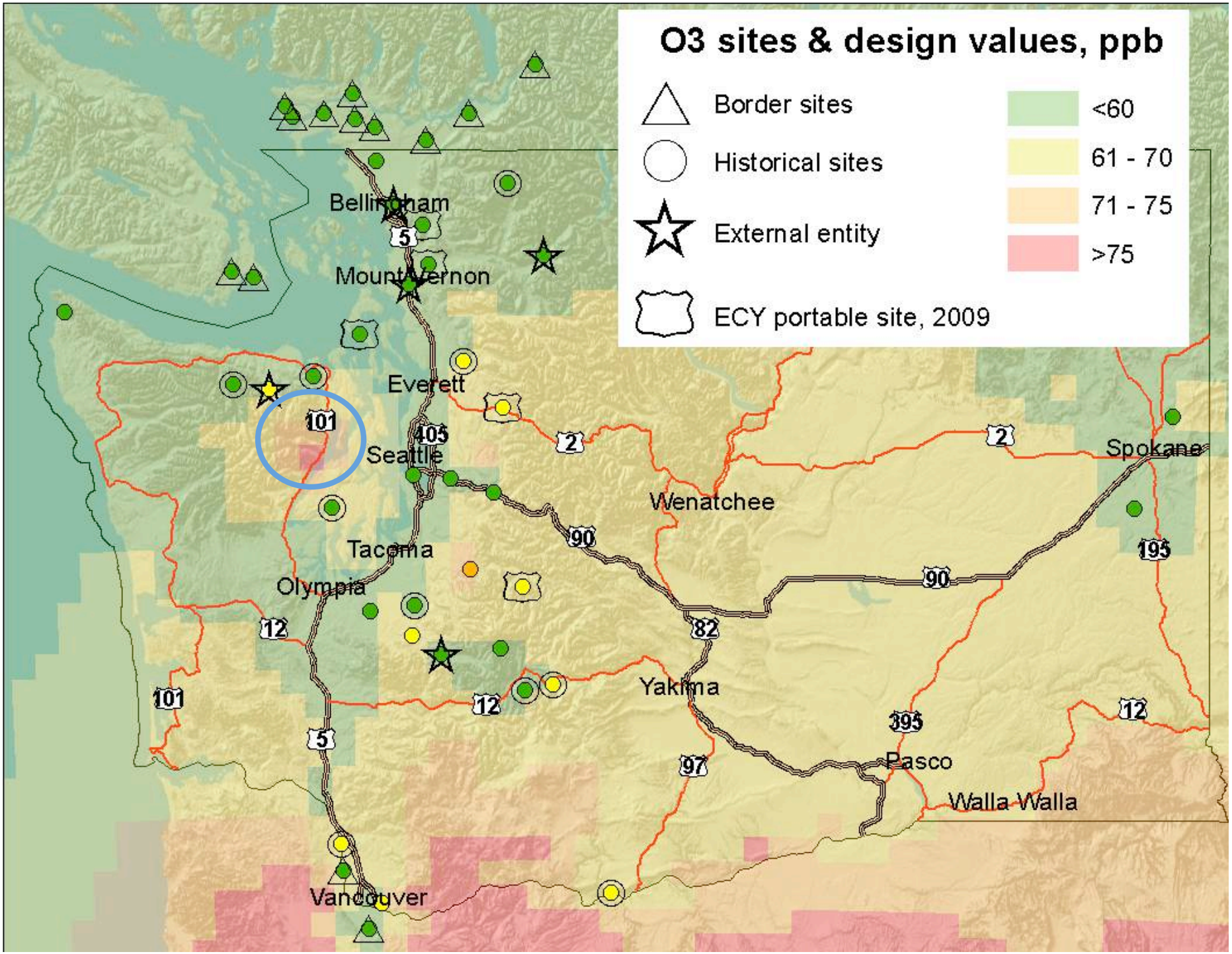

PM2.5 difference Bellevue & Woodinville
Met site
Seattle_Olive
Lake_Forest_Park
24hr Bellevue - Woodinville PM2.5 µg/m3
24hr wind speeds, mph

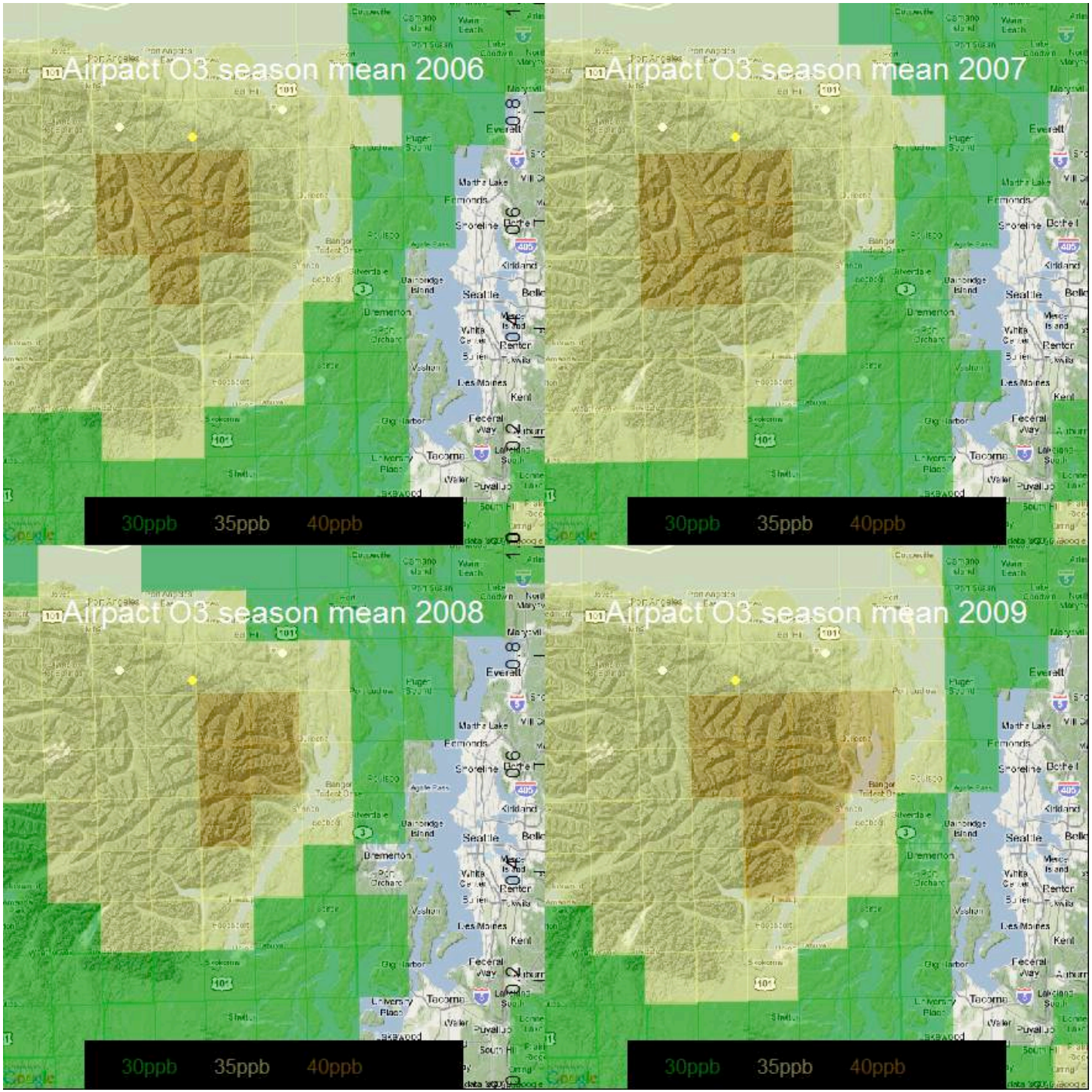

PM2.5 design value, µg/m3
<13.4
13.5 - 20.4
20.5 - 35.0
>35
PM2.5 removal bias (omitted- basecase) µg/m3
-2 - -1
2 - 3
0 ± 1
>3
Bellingham
Mount Vernon
Everett
Seattle
Tacoma
Olympia
Aberdeen
Wenatchee
Yakima
5
97
101
2
405
90
12
82



Smokenet sites, hourly data



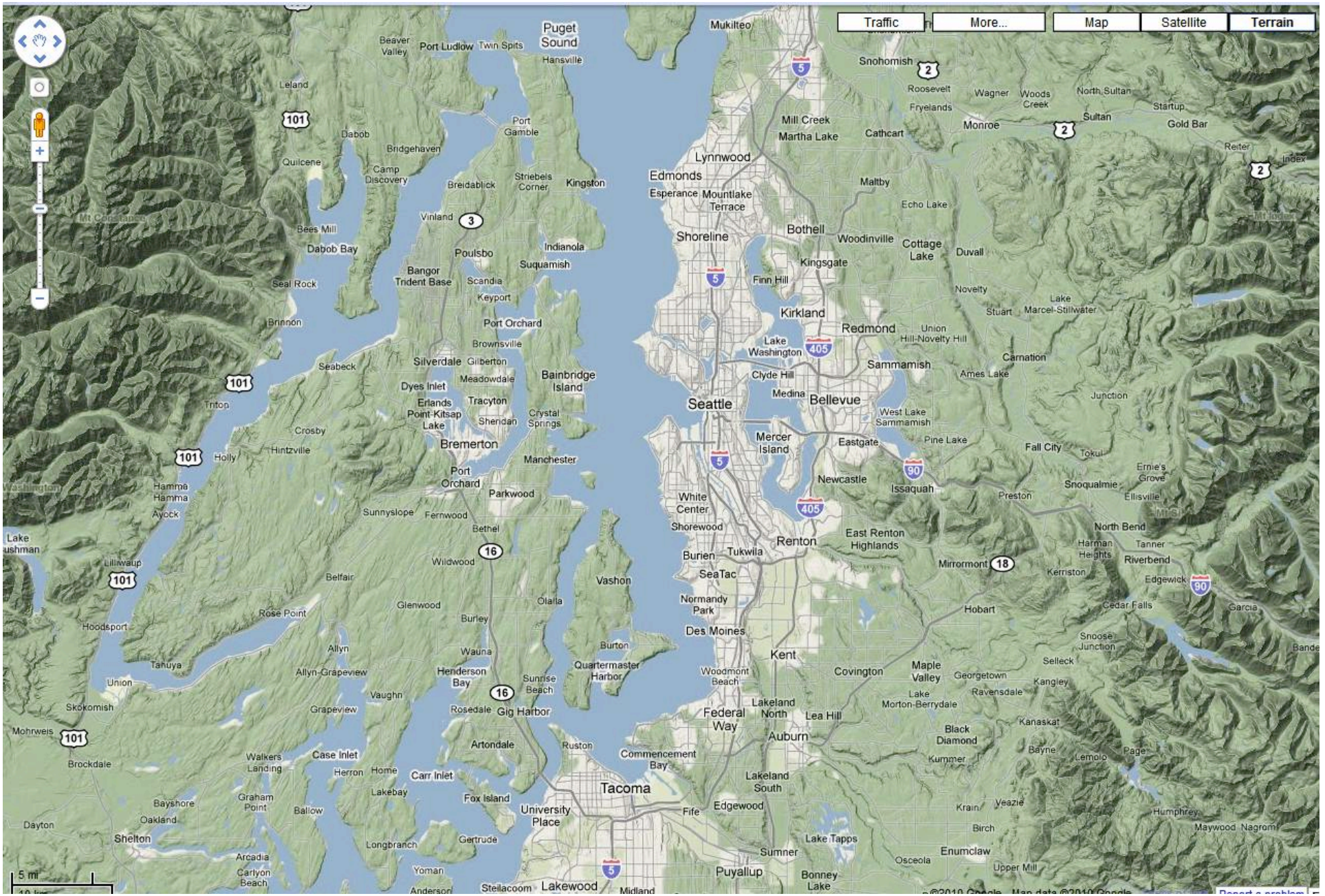

O3 sites & design values, ppb
Border sites
Historical sites
External entity
ECY portable site, 2009
<60
61 - 70
71 - 75
>75
Bellingham
Mount Vernon
Everett
Seattle
Tacoma
Olympia
Vancouver
Wenatchee
Yakima
Pasco
Walla Walla
Spokane
5
101
405
2
90
12
82
395
97
195

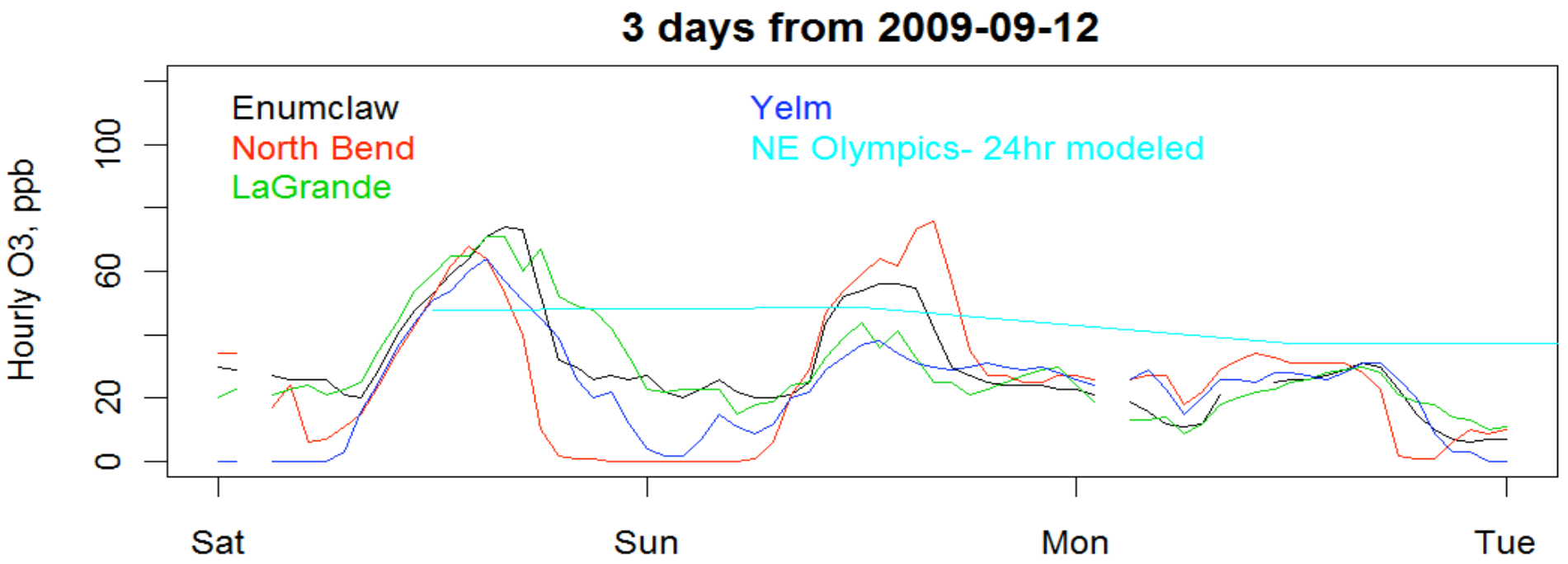


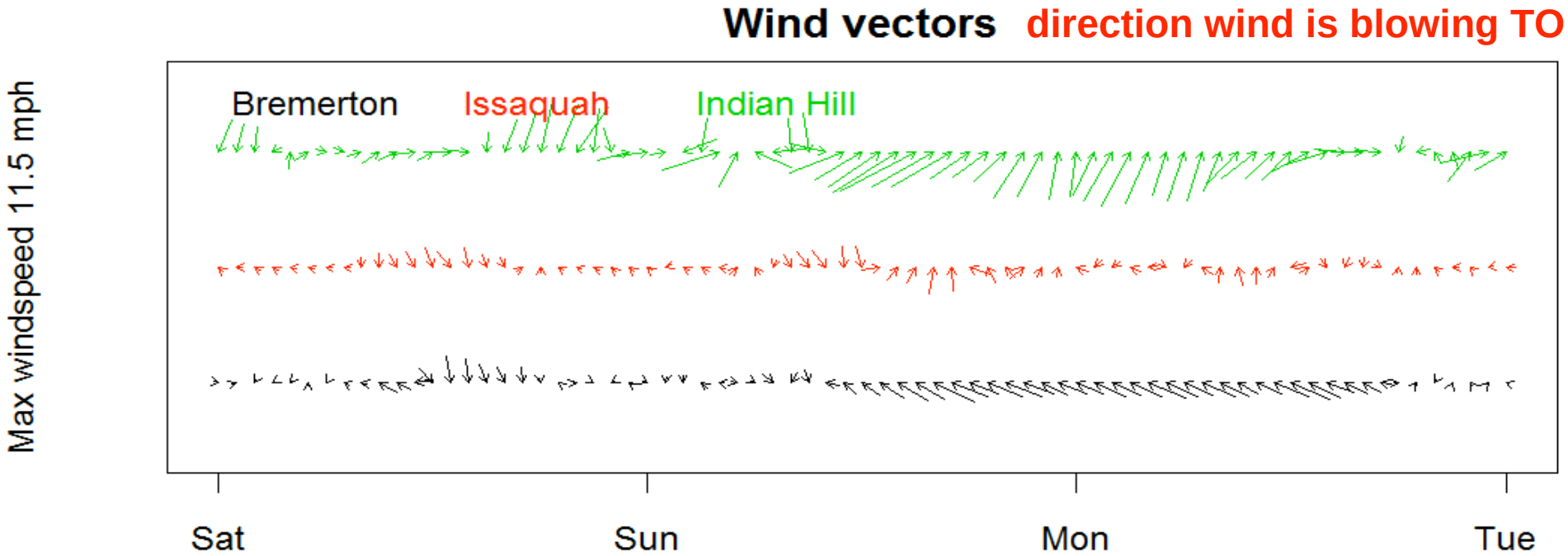
Close up of NE Olympics-

Seasonal means of **modeled** O_3, by year.

Not interpolated with monitors.

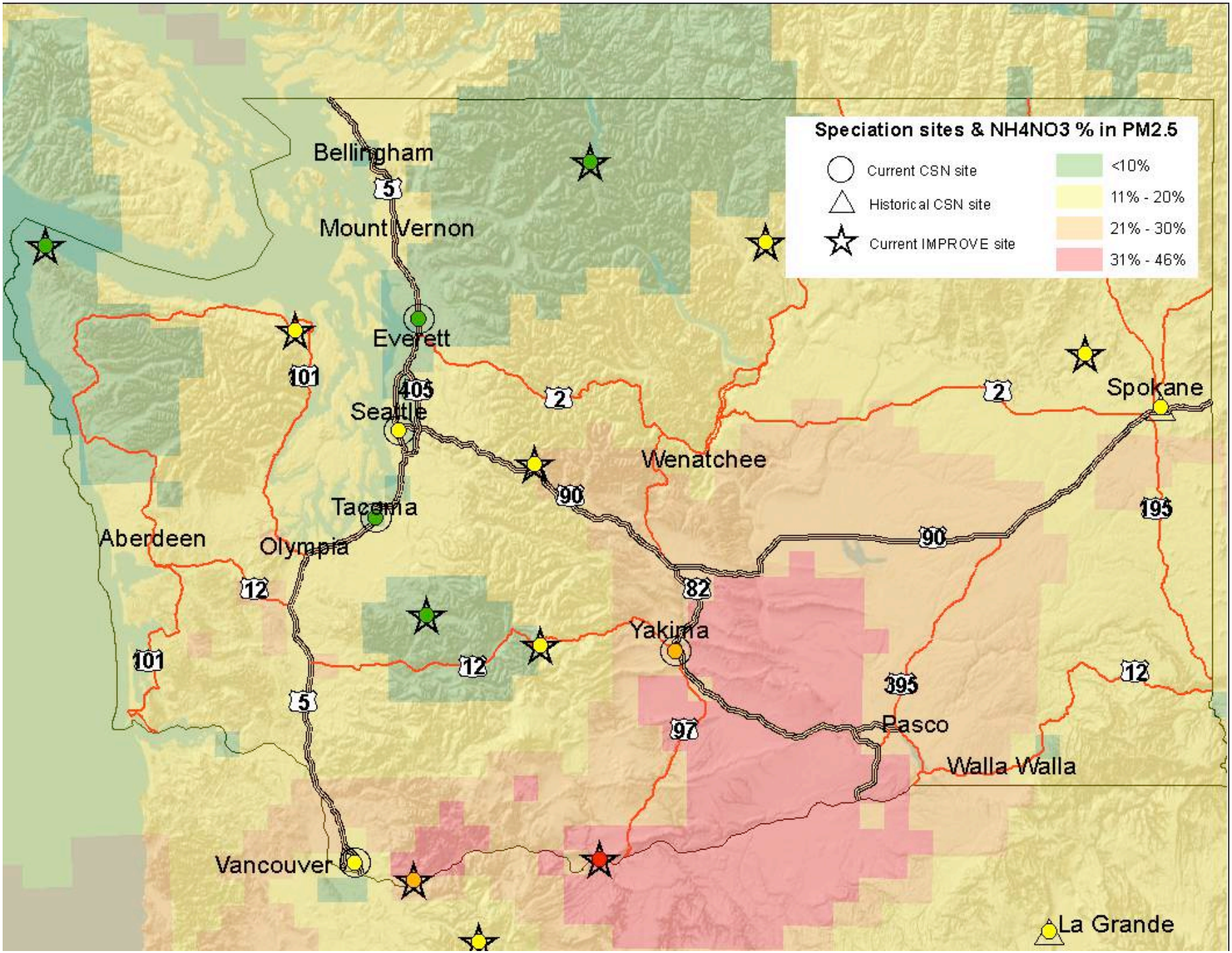

Traffic
More...
Map
Satellite
Terrain
Puget Sound
Mukilteo
Snohomish
Beaver Valley
Port Ludlow
Twin Spits
Hansville
Leland
Port Gamble
Dabob
Bridgehaven
Quilcene
Camp Discovery
Breidablick
Striebels Corner
Kingston
Vinland
Bees Mill
Dabob Bay
Poulsbo
Indianola
Suquamish
Bangor Trident Base
Scandia
Keyport
Seal Rock
Brinnon
Port Orchard
Brownsville
Silverdale
Gilberton
Meadowdale
Seabeck
Dyes Inlet
Bainbridge Island
Triton
Erlands Point-Kitsap Lake
Tracyton
Sheridan
Crystal Springs
Crosby
Hintzville
Holly
Bremerton
Manchester
Port Orchard
Parkwood
Hamma Hamma
Ayock
Sunnyslope
Fernwood
Bethel
Wildwood
Lilliwaup
Belfair
Vashon
Olalla
Glenwood
Rose Point
Burley
Hoodsport
Allyn
Wauna
Burton
Quartermaster Harbor
Tahuya
Allyn-Grapeview
Henderson Bay
Sunrise Beach
Union
Vaughn
Rosedale
Gig Harbor
Skokomish
Grapeview
Mohrweis
Artondale
Ruston
Brockdale
Walkers Landing
Case Inlet
Herron
Home
Carr Inlet
Commencement Bay
Tacoma
Lakebay
Fox Island
Graham Point
Ballow
Bayshore
Oakland
Dayton
Shelton
University Place
Fife
Edgewood
Longbranch
Gertrude
Arcadia
Carlyon Beach
Yoman
Anderson
Steilacoom
Lakewood
Midland
Puyallup
Sumner
Lake Tapps
Enumclaw
Osceola
Upper Mill
Bonney Lake
Lynnwood
Edmonds
Esperance
Mountlake Terrace
Shoreline
Mill Creek
Martha Lake
Cathcart
Maltby
Echo Lake
Bothell
Woodinville
Cottage Lake
Duvall
Kingsgate
Finn Hill
Kirkland
Redmond
Lake Washington
Union Hill-Novelty Hill
Novelty
Stuart
Lake Marcel-Stillwater
Carnation
Sammamish
Ames Lake
Clyde Hill
Medina
Bellevue
Seattle
West Lake Sammamish
Mercer Island
Eastgate
Pine Lake
Fall City
Tokul
Newcastle
Issaquah
Snoqualmie
Ernie's Grove
Preston
Ellisville
White Center
Shorewood
Renton
East Renton Highlands
North Bend
Harman Heights
Tanner
Riverbend
Burien
Tukwila
SeaTac
Mirrormont
Kerriston
Edgewick
Normandy Park
Des Moines
Hobart
Cedar Falls
Garcia
Snoose Junction
Kent
Selleck
Covington
Maple Valley
Georgetown
Kangley
Woodmont Beach
Lake Morton-Berrydale
Ravensdale
Lakeland North
Federal Way
Lea Hill
Auburn
Kanaskat
Black Diamond
Kummer
Bayne
Lemolo
Page
Lakeland South
Krain
Veazie
Humphrey
Maywood
Nagrom
Birch
Monroe
Sultan
Gold Bar
Startup
North Sultan
Woods Creek
Wagner
Fryelands
Roosevelt
Reiter
Index
Mt Constance
Mt Index
5 mi

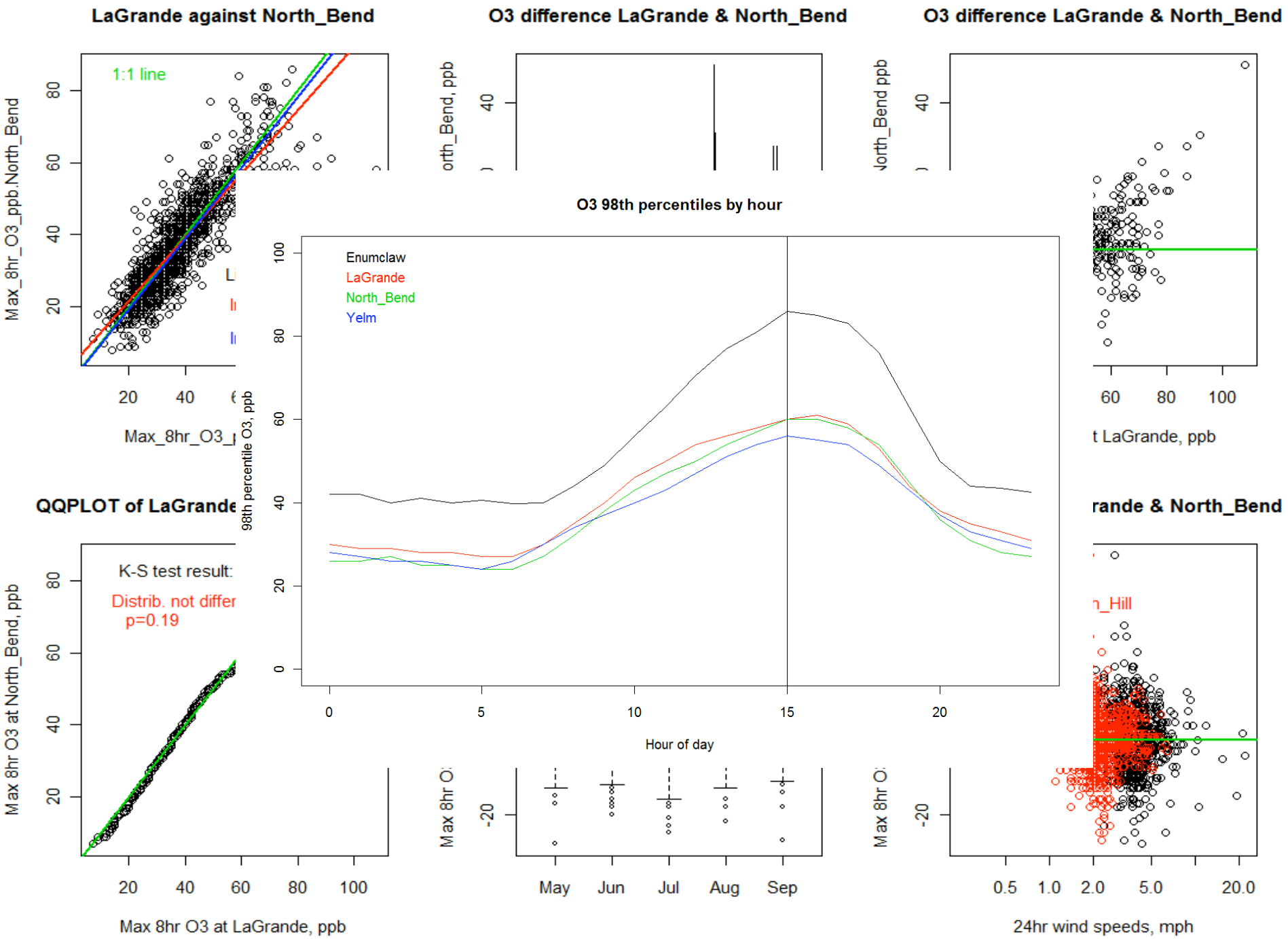

3 days from 2009-09-12
Enumclaw
North Bend
LaGrande
Yelm
NE Olympics- 24hr modeled
Hourly O3, ppb
0
20
60
100
Sat
Sun
Mon
Tue


Wind vectors
direction wind is blowing TO
Bremerton
Issaquah
Indian Hill
Max windspeed 11.5 mph
Sat
Sun
Mon
Tue

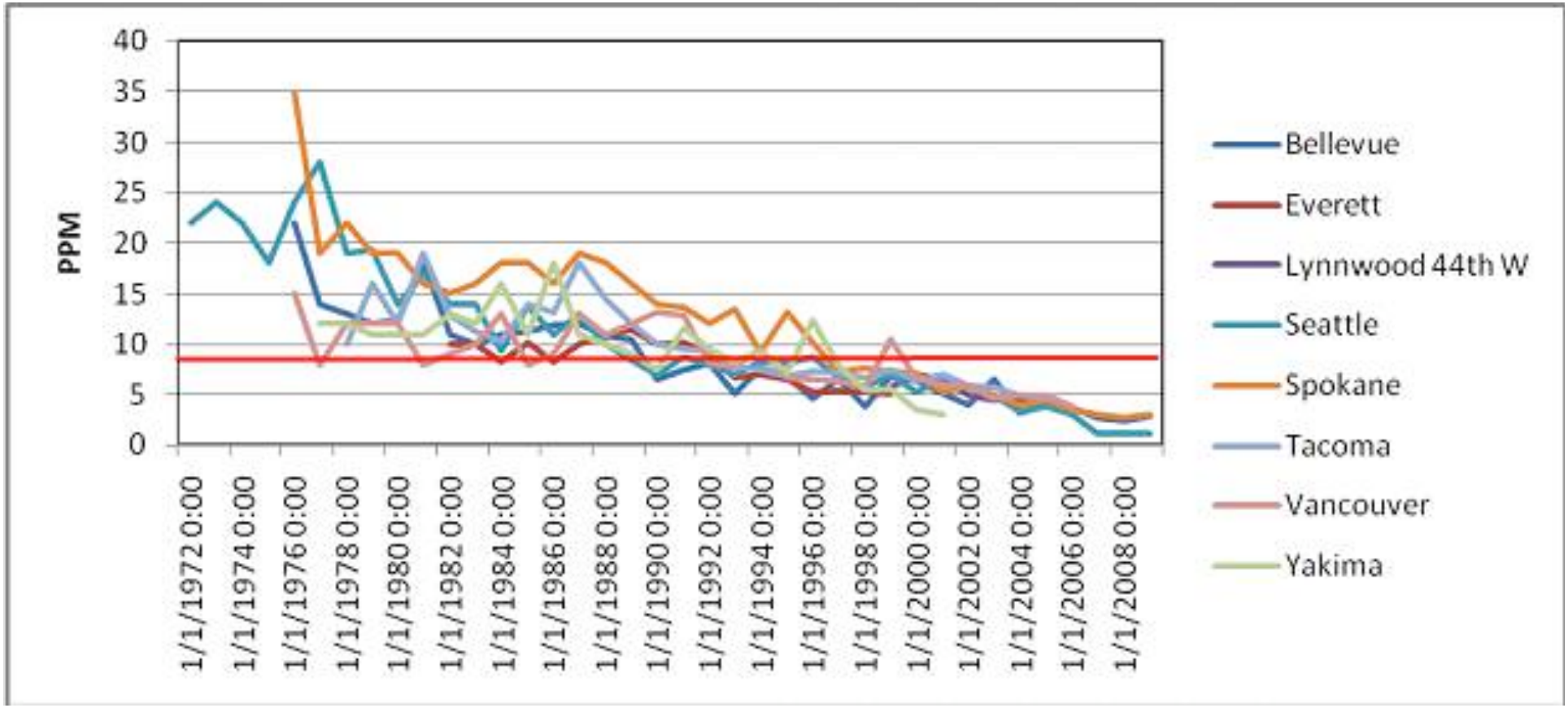
Preliminary conclusions

- Recommend shutting down Bellevue CO and Woodinville $PM_{2.5}$ sites
- Consolidate Burbank (PM_{10} and met) and Kennewick ($PM_{2.5}$ and PM_{10}) sites?
- Shut down La Grande/ Pack Forest standalone O_3 site?
- Shut down Yakima PM_{10} FRM
- O_3 monitoring in NE Olympics
- Speciation monitor and/ or detailed modeling study in Columbia basin

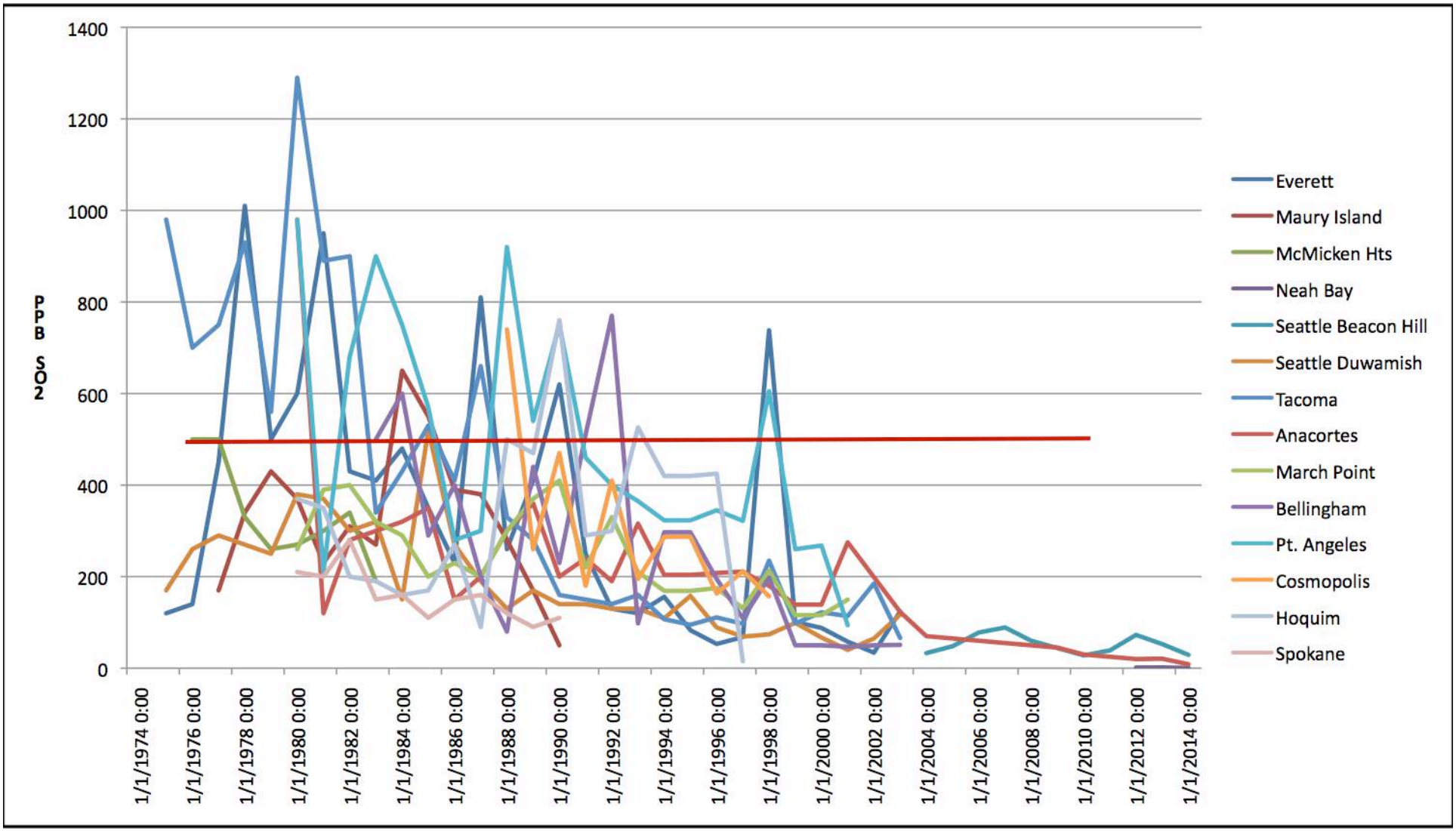

Speciation sites & NH4NO3 % in PM2.5
Current CSN site
Historical CSN site
Current IMPROVE site
<10%
11% - 20%
21% - 30%
31% - 46%
Bellingham
Mount Vernon
Everett
Seattle
Tacoma
Olympia
Aberdeen
Wenatchee
Yakima
Spokane
Pasco
Walla Walla
Vancouver
La Grande
5
101
405
2
90
82
12
395
97
195

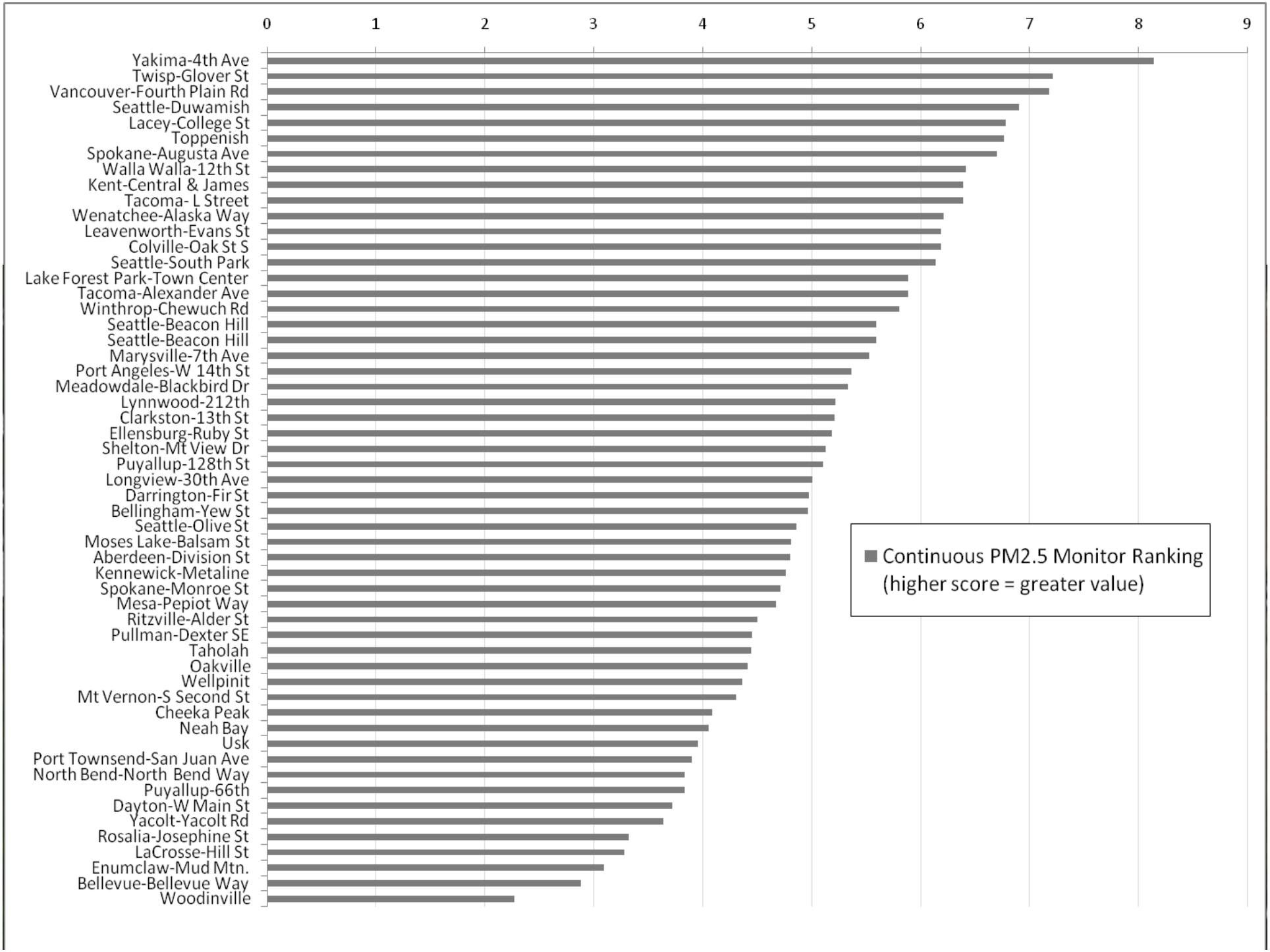

LaGrande against North_Bend
1:1 line
Max_8hr_O3_ppb.North_Bend
Max_8hr_O3_
O3 difference LaGrande & North_Bend
orth_Bend, ppb
O3 difference LaGrande & North_Bend
North_Bend ppb
t LaGrande, ppb
O3 98th percentiles by hour
Enumclaw
LaGrande
North_Bend
Yelm
98th percentile O3, ppb
Hour of day
QQPLOT of LaGrande
rande & North_Bend
K-S test result:
Distrib. not differ
p=0.19
Max 8hr O3 at North_Bend, ppb
Max 8hr O3 at LaGrande, ppb
Max 8hr O
May
Jun
Jul
Aug
Sep
n_Hill
24hr wind speeds, mph

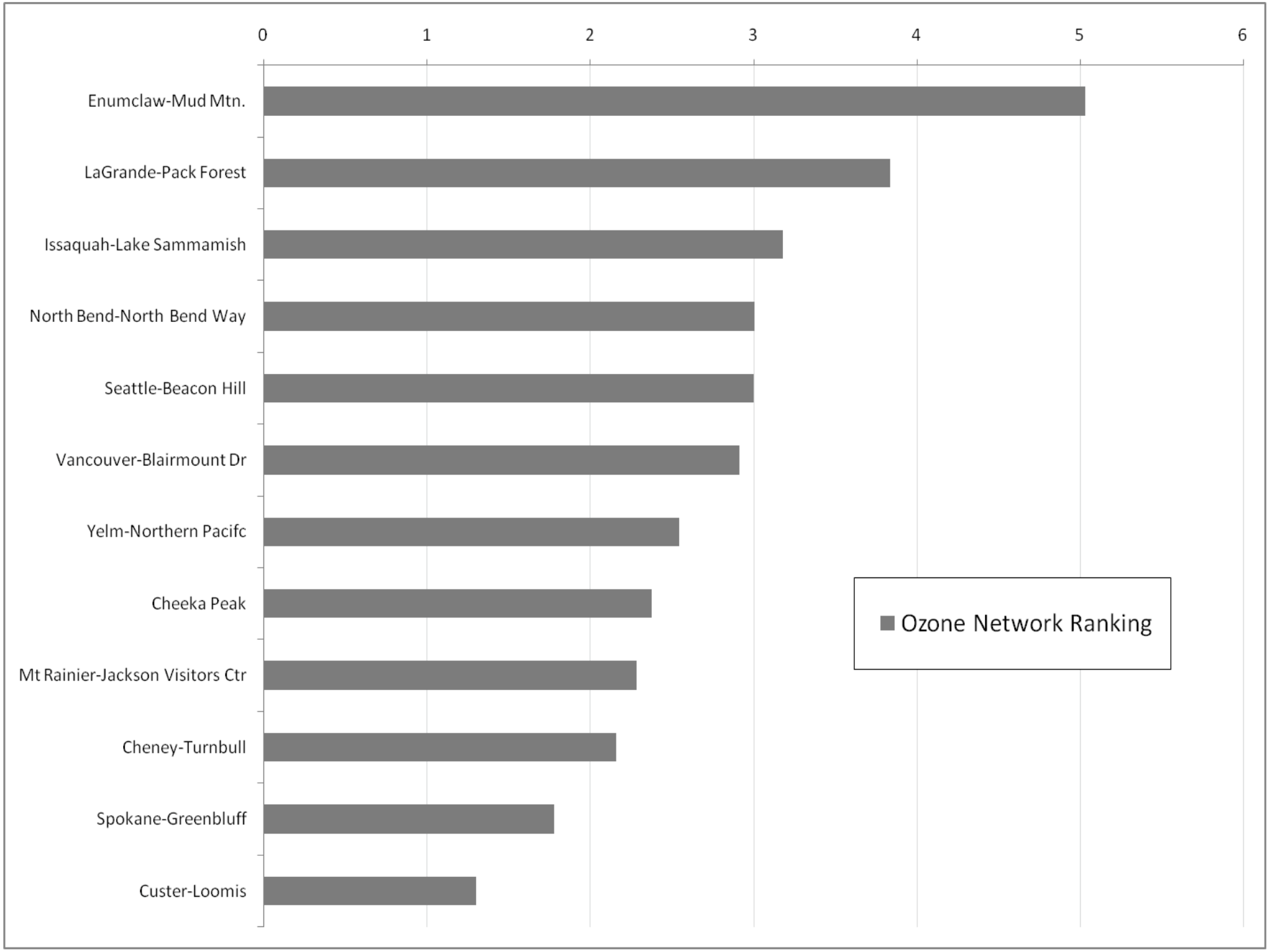
Annual max 8 Hour CO



Annual max 1hr SO_2




0
1
2
3
4
5
6
7
8
9
Yakima-4th Ave
Twisp-Glover St
Vancouver-Fourth Plain Rd
Seattle-Duwamish
Lacey-College St
Toppenish
Spokane-Augusta Ave
Walla Walla-12th St
Kent-Central & James
Tacoma- L Street
Wenatchee-Alaska Way
Leavenworth-Evans St
Colville-Oak St S
Seattle-South Park
Lake Forest Park-Town Center
Tacoma-Alexander Ave
Winthrop-Chewuch Rd
Seattle-Beacon Hill
Seattle-Beacon Hill
Marysville-7th Ave
Port Angeles-W 14th St
Meadowdale-Blackbird Dr
Lynnwood-212th
Clarkston-13th St
Ellensburg-Ruby St
Shelton-Mt View Dr
Puyallup-128th St
Longview-30th Ave
Darrington-Fir St
Bellingham-Yew St
Seattle-Olive St
Moses Lake-Balsam St
Aberdeen-Division St
Kennewick-Metaline
Spokane-Monroe St
Mesa-Pepiot Way
Ritzville-Alder St
Pullman-Dexter SE
Taholah
Oakville
Wellpinit
Mt Vernon-S Second St
Cheeka Peak
Neah Bay
Usk
Port Townsend-San Juan Ave
North Bend-North Bend Way
Puyallup-66th
Dayton-W Main St
Yacolt-Yacolt Rd
Rosalia-Josephine St
LaCrosse-Hill St
Enumclaw-Mud Mtn.
Bellevue-Bellevue Way
Woodinville
Continuous PM2.5 Monitor Ranking
(higher score = greater value)


0
1
2
3
4
5
6
Enumclaw-Mud Mtn.
LaGrande-Pack Forest
Issaquah-Lake Sammamish
North Bend-North Bend Way
Seattle-Beacon Hill
Vancouver-Blairmount Dr
Yelm-Northern Pacifc
Cheeka Peak
Mt Rainier-Jackson Visitors Ctr
Cheney-Turnbull
Spokane-Greenbluff
Custer-Loomis
Ozone Network Ranking