Four Corners Region Aerometric Data Web Site

GIS Data Mapping, Access and Analysis

Four Corners Air Quality Interagency Task Force

May 9, 2006
Farmington, NM

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Atmospheric Sciences
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Argonne National Laboratory is managed by The University of Chicago for the U.S. Department of Energy

Overview

- Objectives
- Summary of Aerometric Measurements
  - Region of Interest
  - Measurement Networks/Maps
  - AQVD-Met Monitors/Site Database/Web Links
  - Sample of Data Analysis
- Tour of GIS Mapping/Aerometric Database Features
- Public Site ⇔ End-User feedback
- Path Forward

Four Corners Air Quality Task Force

Science & Technical Support

Support Area 1

- **Air Monitoring: Inventory and Map Existing Four Corners Regional Air Quality, Visibility, and Weather Station Sites**

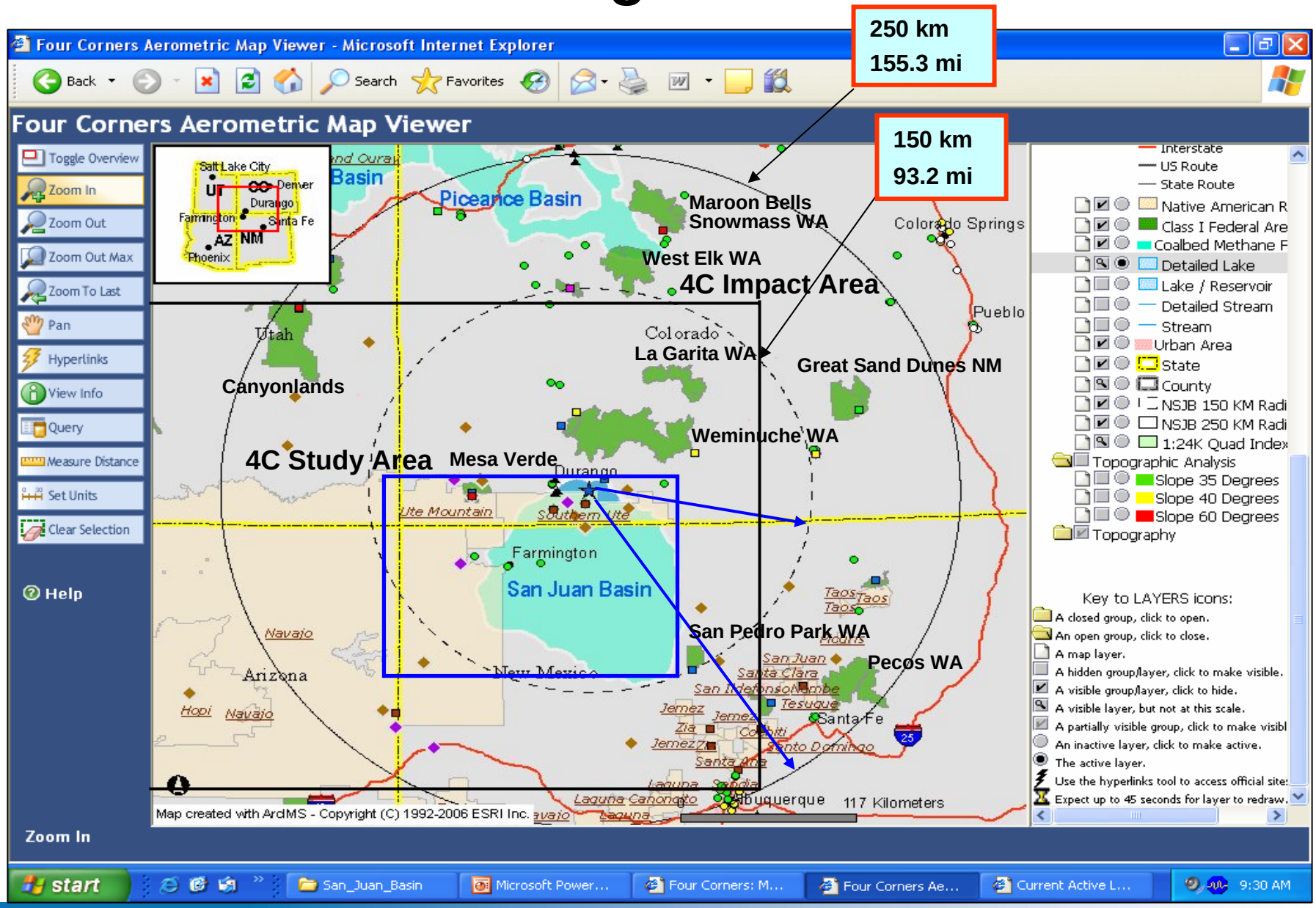
Objective(s):

- Survey/map current and historical air quality and visibility measurement sites within the Four Corners Region
- Data made readily accessible to Task Force members through a interactive GIS Aerometric Web Site

Goals

- Map existing coverage,
- Provide for data access & analysis,
- Identifying data gaps and additional monitoring needs

Identification of Region of Interest

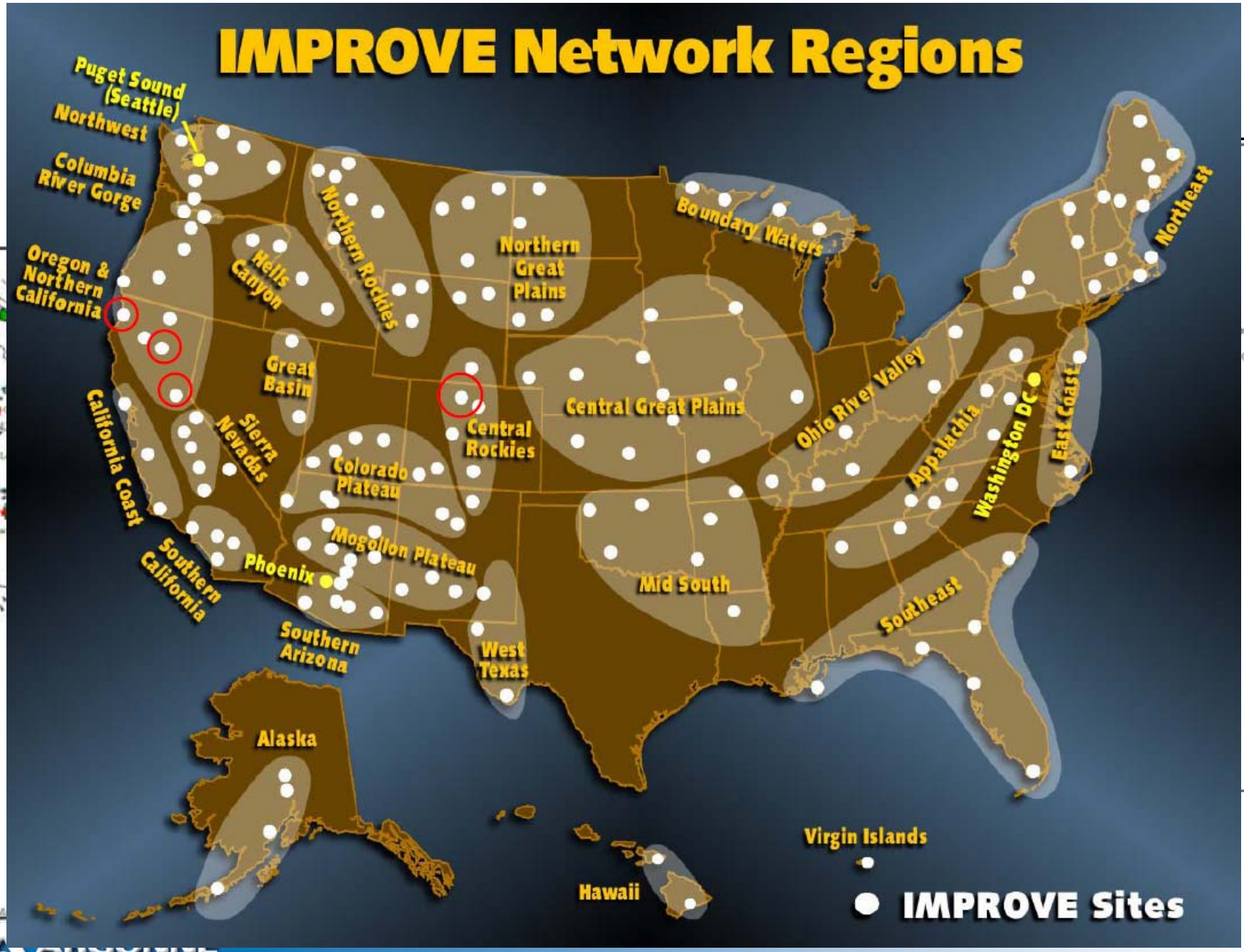


Major Aerometric - AQVD Monitors Measurement Networks

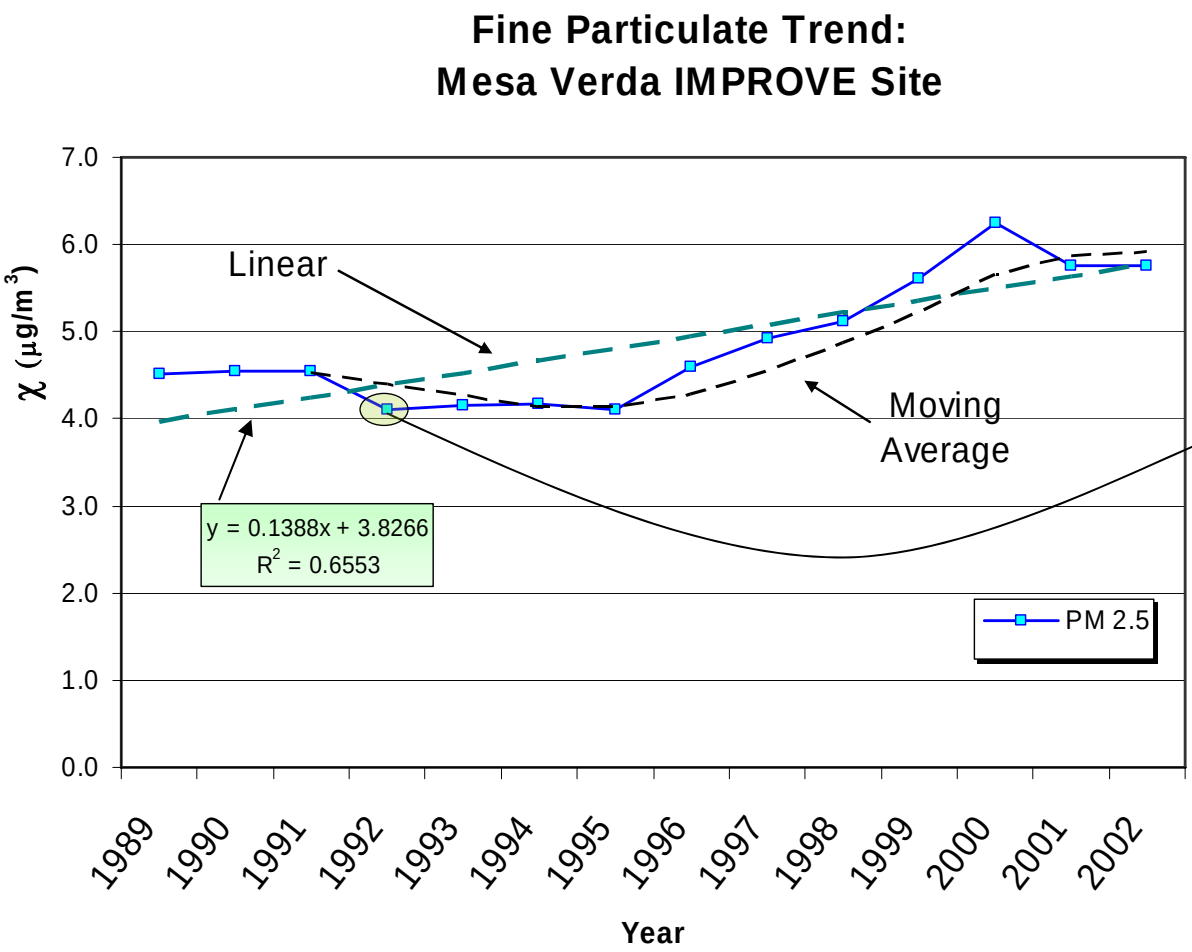
Nephelometer at IMPROVE Site

Air Quality/Visibility/Deposition: 129 Sites

Name	Parameters		Sites	Agencies
IMPROVE/ STN	Aerosols (course, fine, *speciated*)/ Visibility, T_a, RH, Gas (SO_2)	➔	15 sites 0 site(s)	Federal (NPS/USFS)
NADP/NTN NADP/MDN	Precip Chemistry Wet Hg Deposition	➔ ➔	8 sites 1 site(s)	Federal (NPS/USFS)
CASTNET	Dry Deposition (PDD/GDD)/O_3/Met {SO_4, NO_3, NH_4, SO_2, HNO_3, O_3, $NHNO_3$}	➔	9 sites	Federal (USEPA/NPS)
POMS/GPMP Special Purpose Sites	O_3, GDD, u, σ_θ σ_φ, w T_a, P_a, PM_{10}	➔ ➔	1/2 sites 31 sites	NPS-State/Other Agency Other/Industrial
TRIBAL	O_3, NO_X, $PM_{2.5}$/PM_{10} u, w, T_a, RH, Q_{SR}, Precip.	➔	18 sites	Tribal (Utes, …)
SLAMS/NAMS	O_3, NO_2, PM_{10}, $PM_{2.5}$	➔	44 sites	State/Local/USEPA


IMPROVE Network Regions
Puget Sound (Seattle)
Northwest
Columbia River Gorge
Oregon & Northern California
Hells Canyon
Northern Rockies
Northern Great Plains
Boundary Waters
Northeast
Great Basin
Sierra Nevadas
California Coast
Central Rockies
Central Great Plains
Ohio River Valley
Appalachia
Washington DC
East Coast
Colorado Plateau
Mogollon Plateau
Southern California
Phoenix
Southern Arizona
West Texas
Mid South
Southeast
Alaska
Hawaii
Virgin Islands
IMPROVE Sites

Fine Aerosol Trends

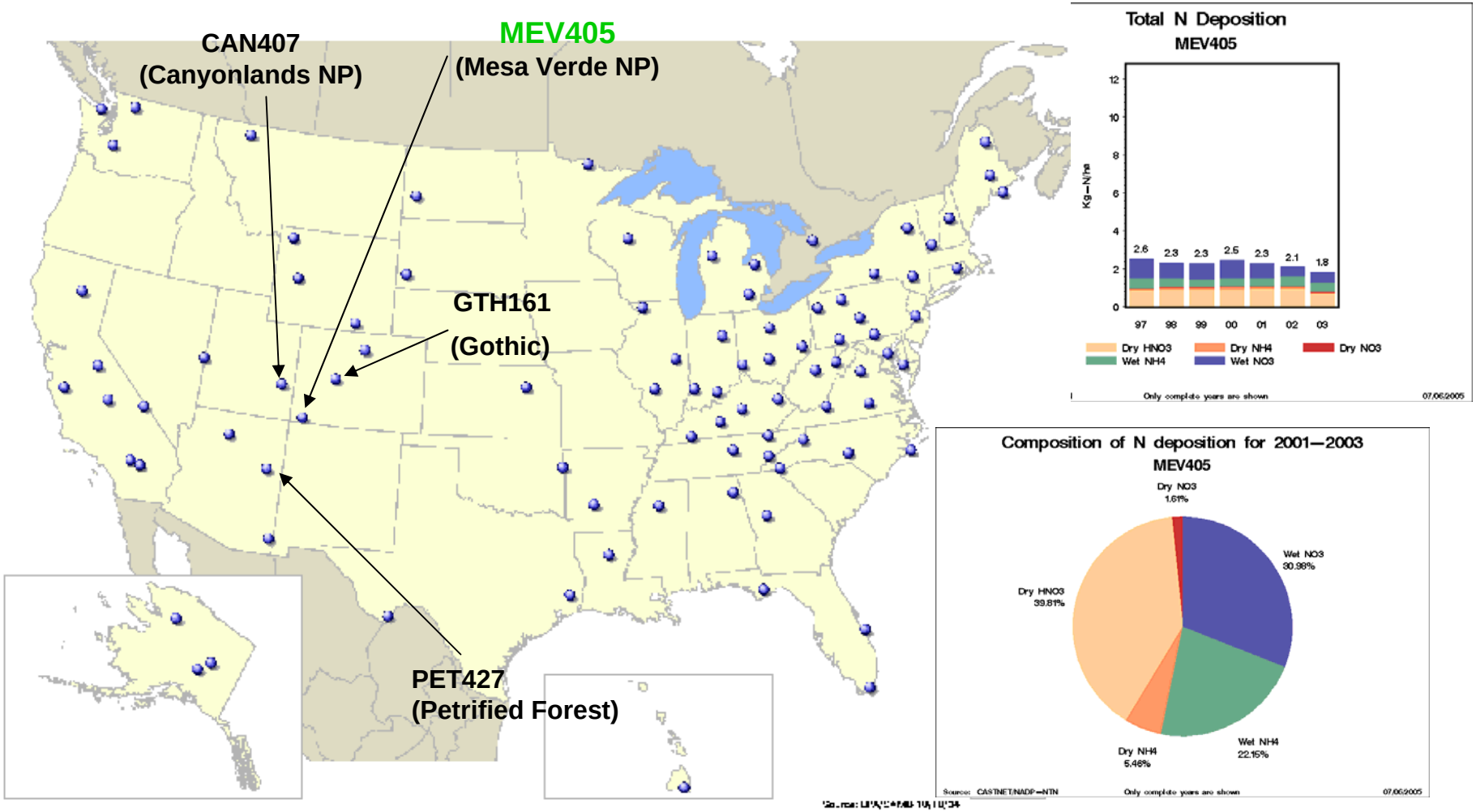


Mesa Verde Haze Episode
Dec. 10–12, 1992

$PM_{2.5}$ = 18.4 ug/m^3

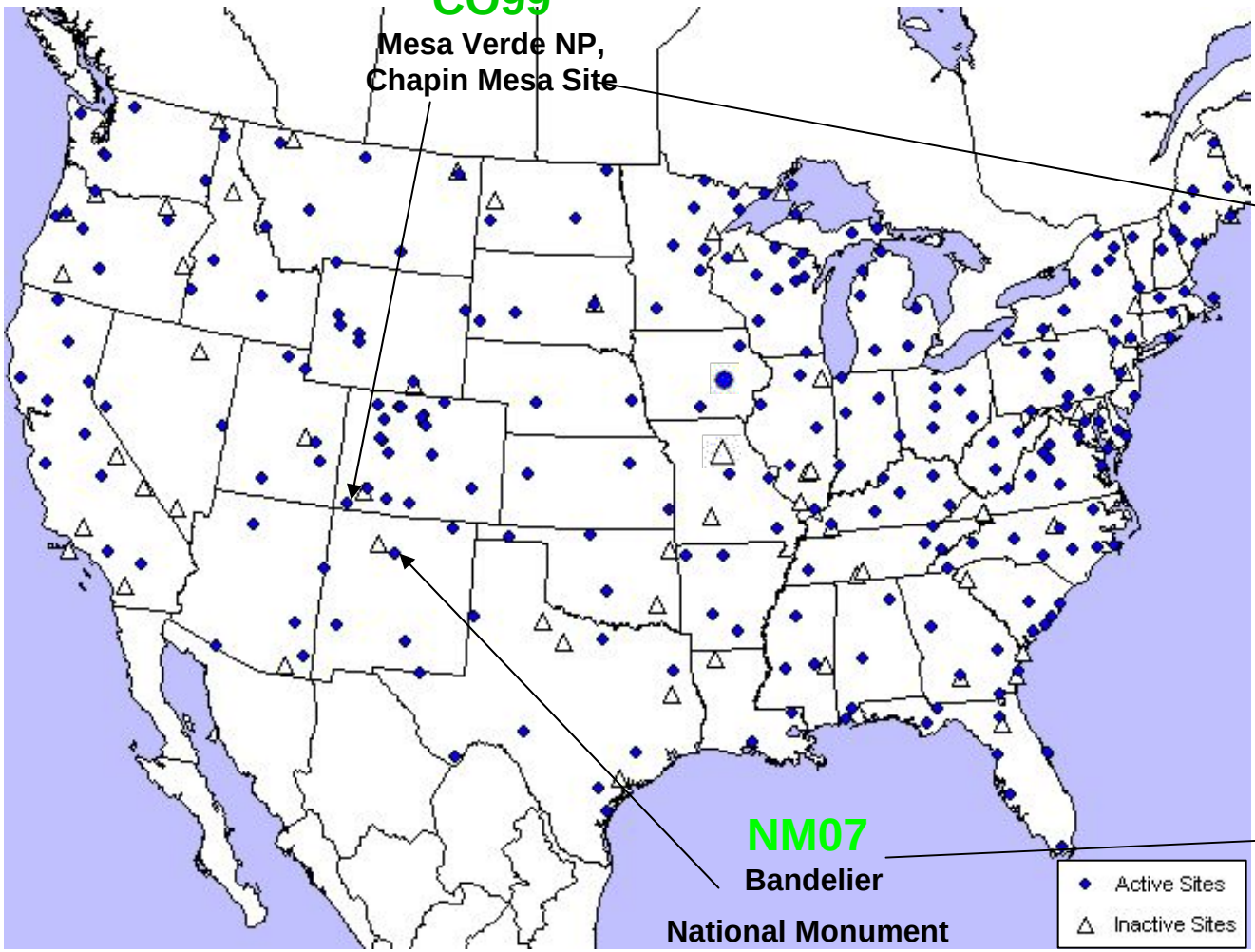
b_{ext} = 98 Mm-1

CASTNET - Dry Deposition Sites

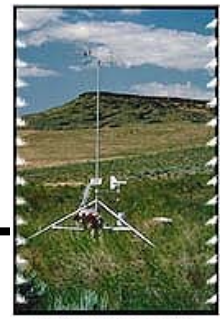


Adapted from: http://www.epa.gov/castnet/site.html

NADP/NTN – Wet Deposition Sites



Aerometric - MET Monitors Measurement Networks

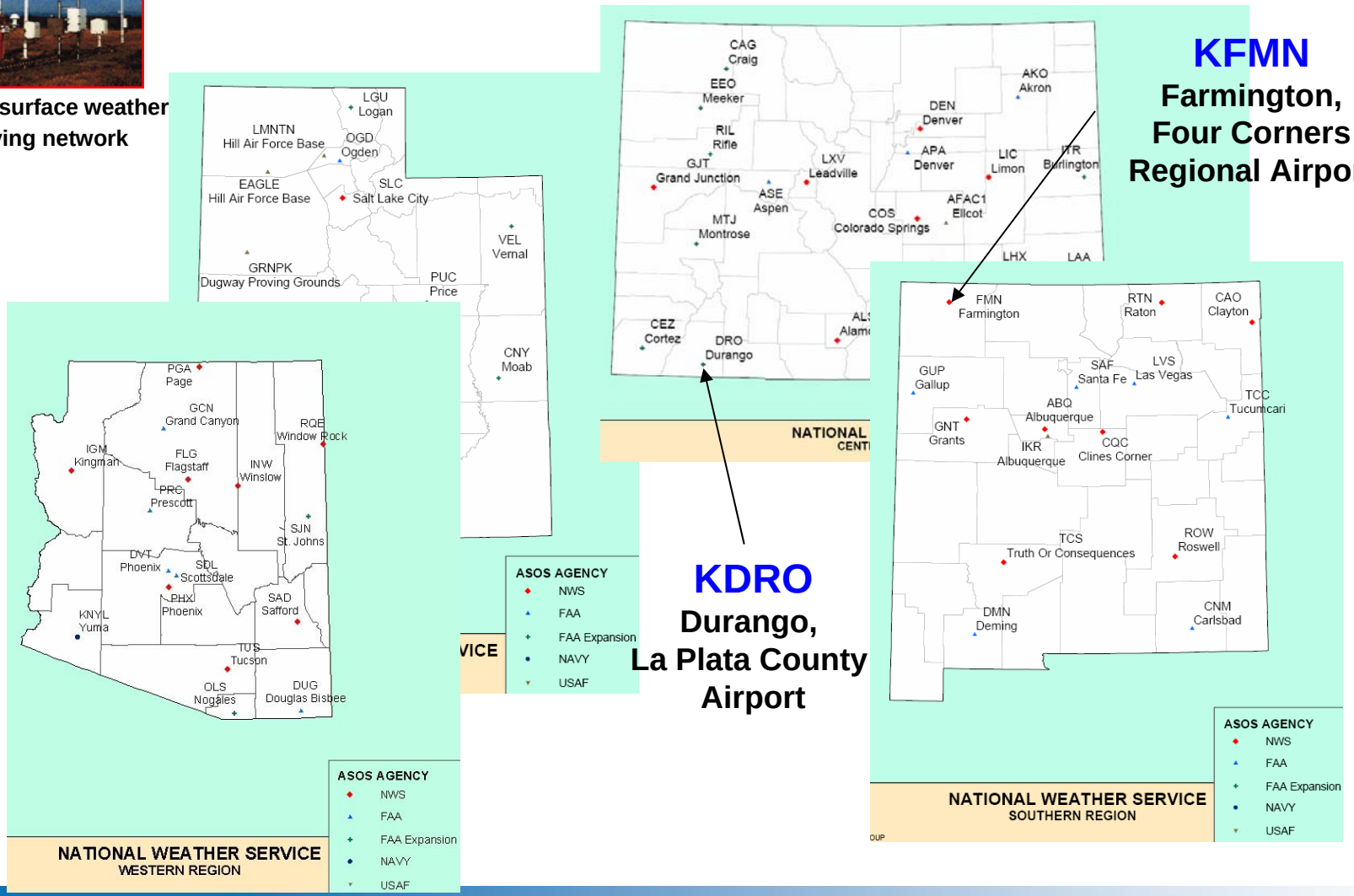

RAWS in a meadow collecting weather data.

Meteorology [surface, UA, profiler] (57 Sites)

Name	Parameters	Sites	Agency
RAWS	Precip. type/rate u, T, RH, soil moisture	➔ 25 Sites	BLM, NPS, USFS
ASOS/AWOS AWSS	Rainfall, u, T, RH P, T_{dp}, SkyC, fog, haze	➔ 8 Sites	NWS-FAA
AWDN	u, Ta, Ts, Precip, SR, RH	➔ [4 Sites] (CO sites)	HPRCC (NOAA)
CASTNET	u. RH, Ta, SR, Precip.	➔ 6 Sites	USEPA
GSD-ESRL	u, T, RH, P, u(z)	➔ 1 Sites	NOAA/NCAR
Tribal	u, T, RH, w, θ	➔ 3 Sites	Tribal
GPMP	RH, T, Precip, u	➔ 3 sites	NPS
POMS	RH, T, u, solar radiation	➔ 3 sites	NPS
AERONET (Hazemeter Net)	Direct solar irradiance (e.g., aerosol optical depths (AOT) and size, b_{ext})	➔ 2 sites	NASA/ DOE/LANL-USGS

ASOS/AWOS/AWSS Surface Weather Stations

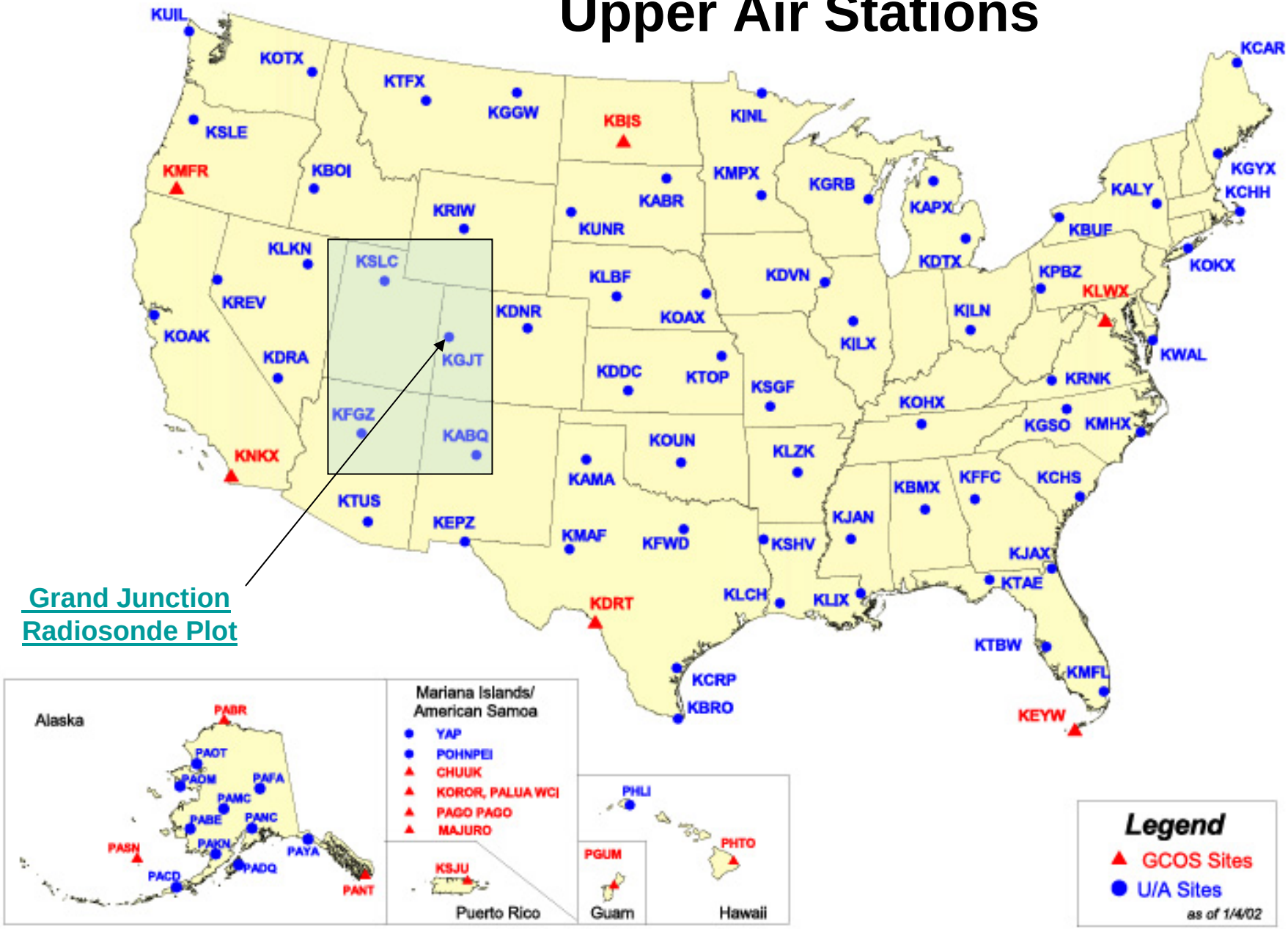
ASOS surface weather observing network



KFMN
Farmington, Four Corners Regional Airport

KDRO
Durango, La Plata County Airport

RAOBS (NCAR/NWS)
Upper Air Stations



Grand Junction Radiosonde Plot

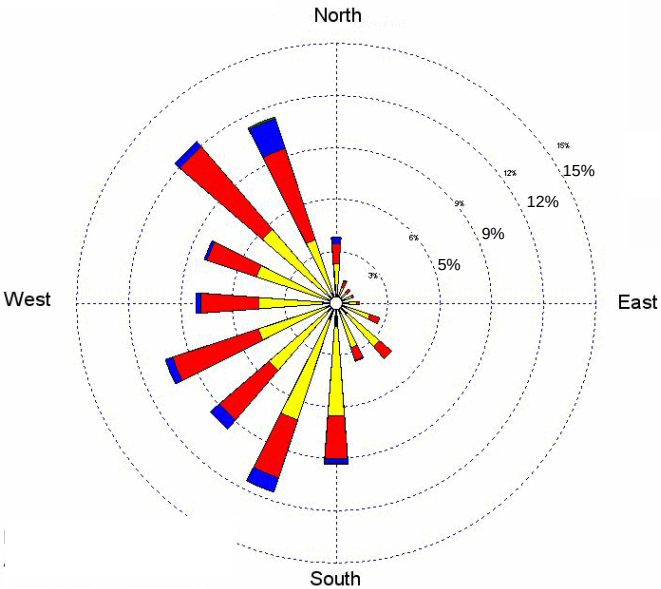
Mesa Verde NP: Annual Wind Roses

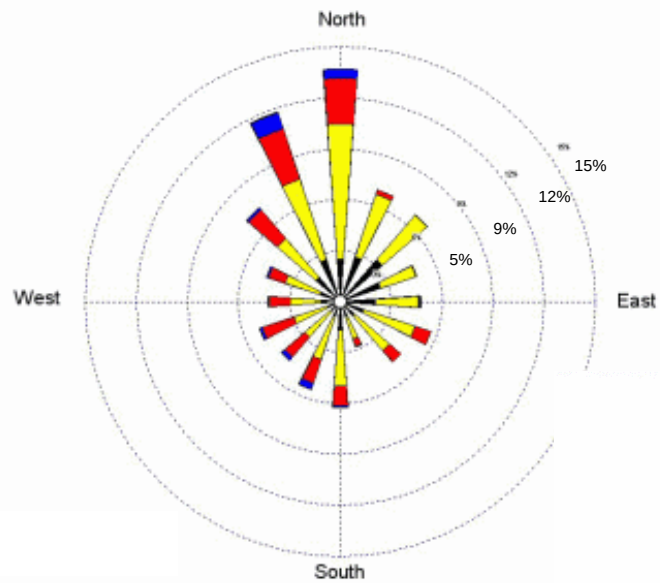
County	Montezuma
Latitude	37.1983
Longitude	-108.4903
Elevation	2165
Operating Agency	NPS

CASTNET Site: MEV405 (Mesa Verde NP)

Annual

Day:
1300-1600





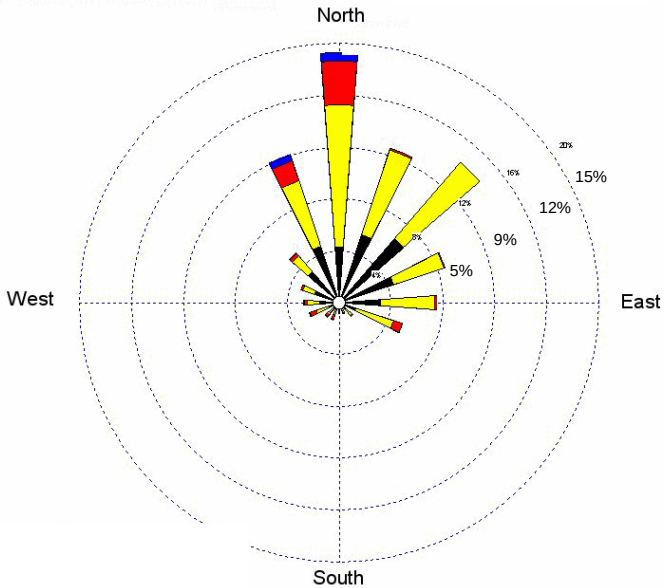
Annual

Day/Night

1995 – 2001

Annual

Night:
0100-0600

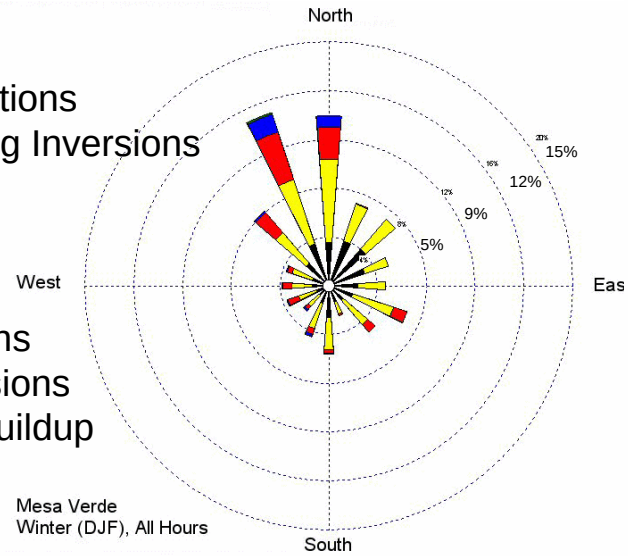


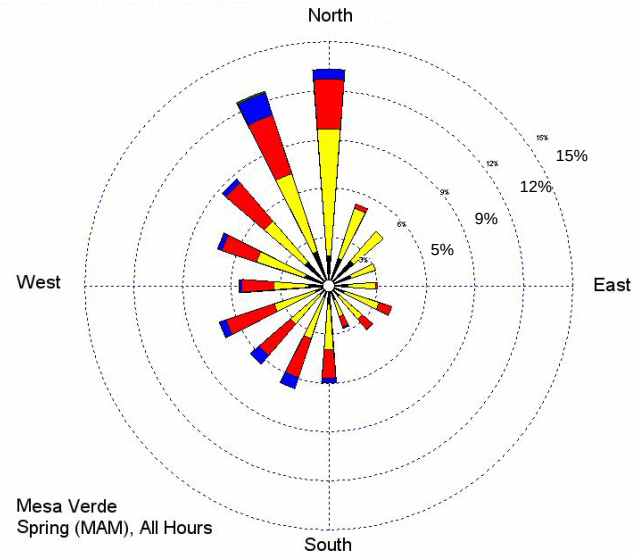
Source: Adapted from Mesa Verde CASTNET site, MEV405

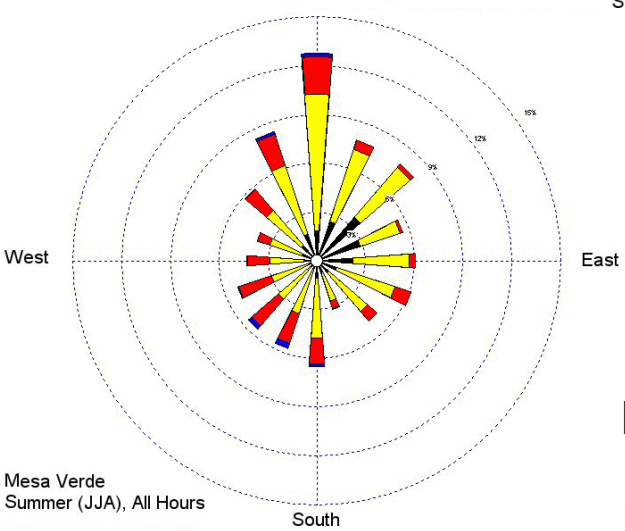
Mesa Verde: Seasonal Wind Roses

Lower Park Elevations
Radiation Trapping Inversions
Fall and Winter

Mesa Top Locations
Subsidence Inversions
➔ Stagnation & Buildup
Summer months

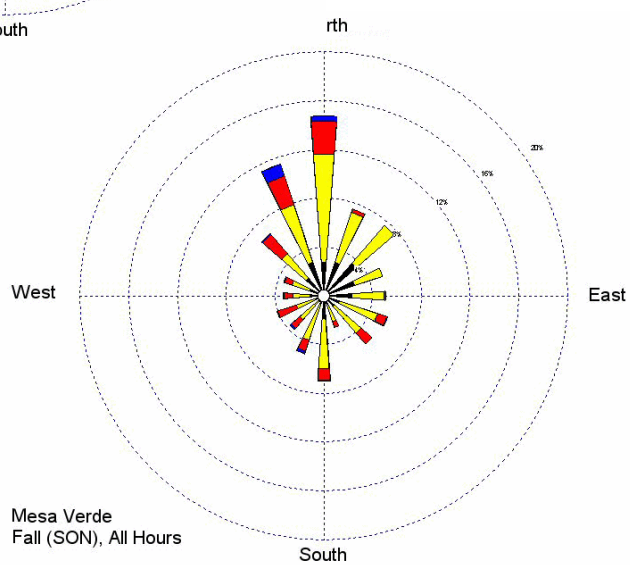




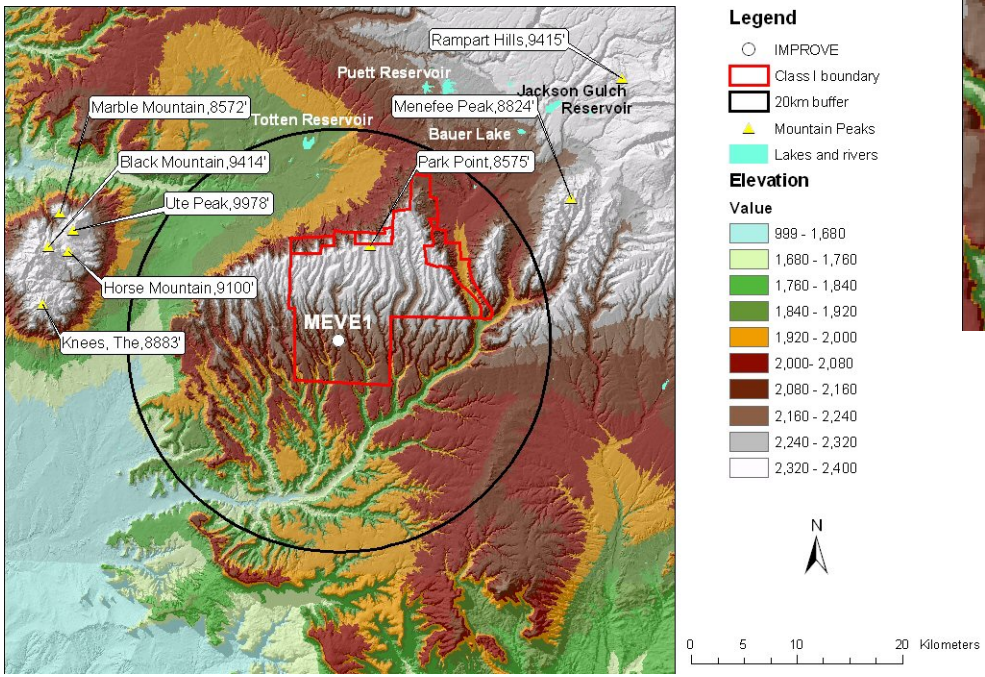


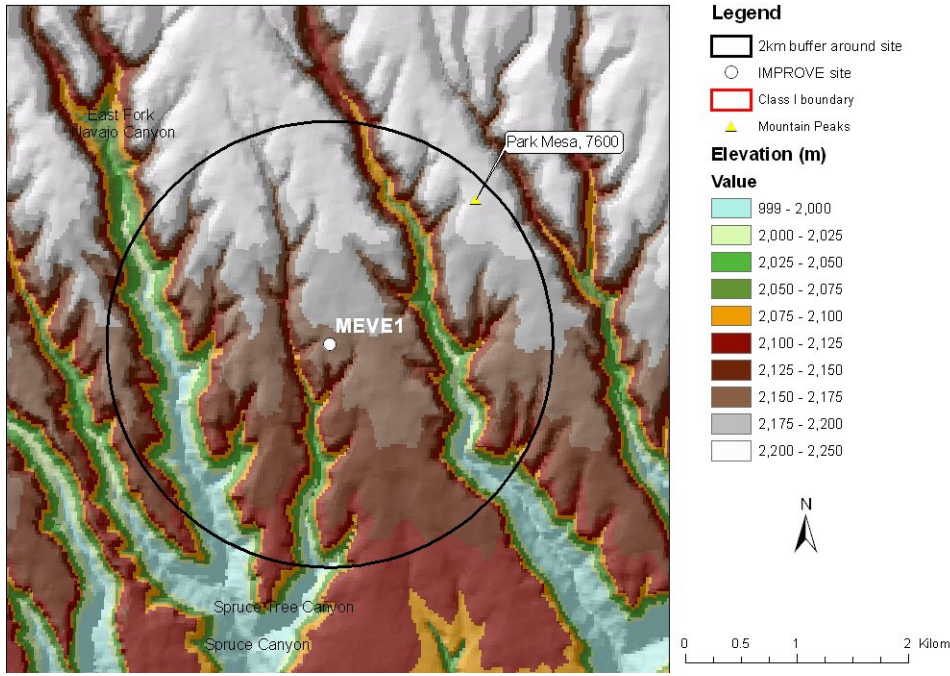
1995 – 2001

CASTNET Site:
MEV405 (Mesa Verde NP)
Representative of exposed locations at higher elevations.



Local Terrain Wind Influences

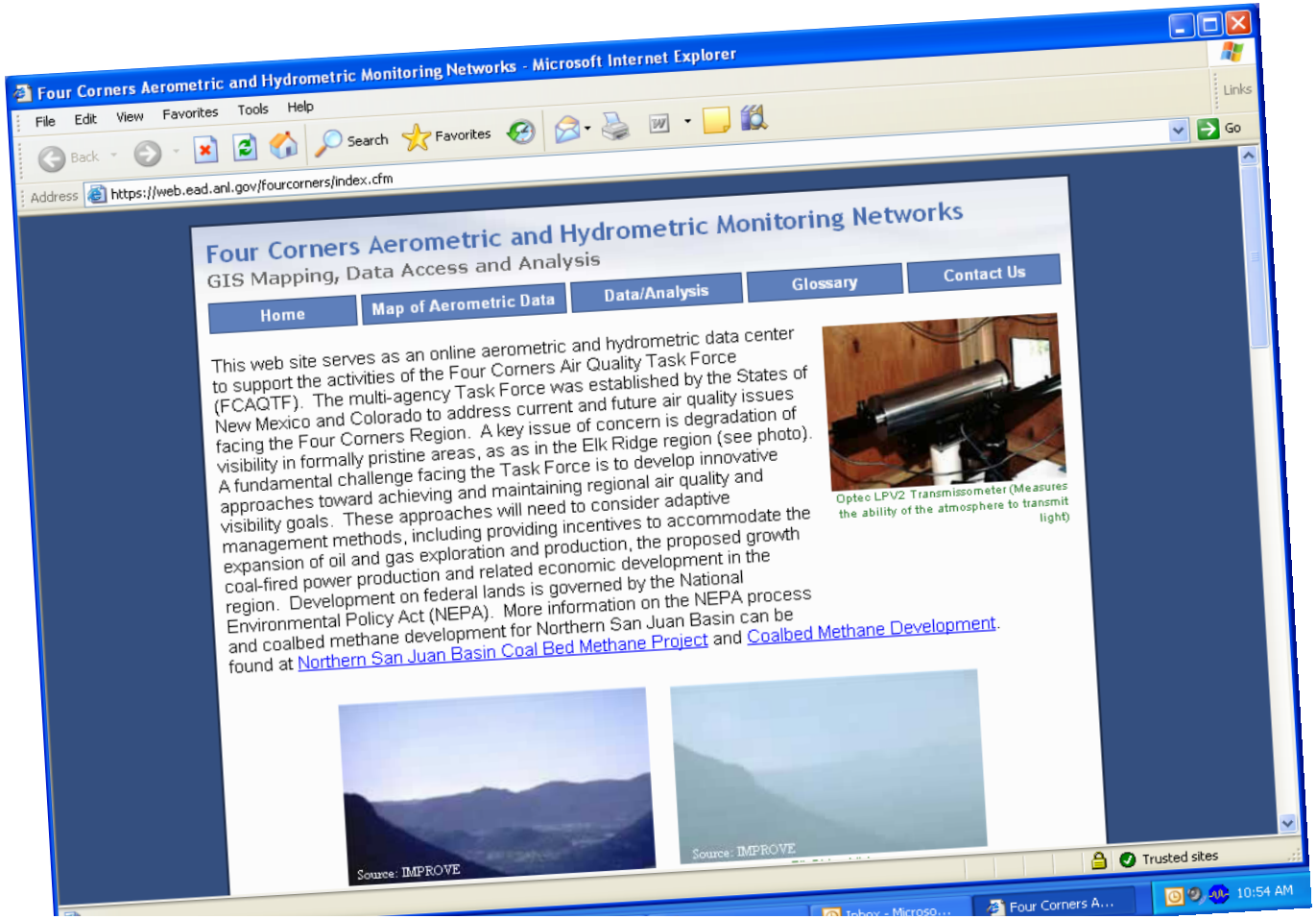




Meta Data Sample used on the Four Corners Aerometric GIS Web Site

ID	Site Name	Site Code	ST	County	Elevat.	Long	Lat	Network Name	Agency	X	Parameters Measured	Start Date	Opor
	Air Quality/Visibility Measurements									km			(yrs)
1 AQ	**Weminuche, Class I Wilderness Area**	WEMI1	CO	La Plata	2750	-107.8	37.6594	**IMPROVE** (Interagency Monitoring of Protected Visual Environments)	USFS	51.5	$PM_{2.5}$, PM_{10}, Scene monitoring, b_{abs}	3/2/88	17.6
18 AQ/ WDEP	Mesa Verde NP – Chapin Mesa	CO99	CO	Montezuma	2172	-108.49	37.1981	NADP/NTN	NPS	80.1	Precipitation Chemistry (mg/L of 9 ions + pH), wet deposition (kg/ha, 9 ions), Hg deposition (kg/ha)	4/28/81	24.4
2a AQ	**Mesa Verde Class I National Park**	MEVE1	CO	Montezuma	2177	-108.491	37.1984	**IMPROVE** (Interagency Monitoring of Protected Visual Environments)	NPS	80.1	$PM_{2.5}$, PM_{10}, Scene monitoring, b_{abs}	3/5/88	17.6
2b AQ	Mesa Verde NP – Mesa Rim	MEVE1	CO	Montezuma	2245	-108.493	37.2186	IMPROVE	NPS	80.3	b_{abs}, b_{scat}	9/15/88	17.0

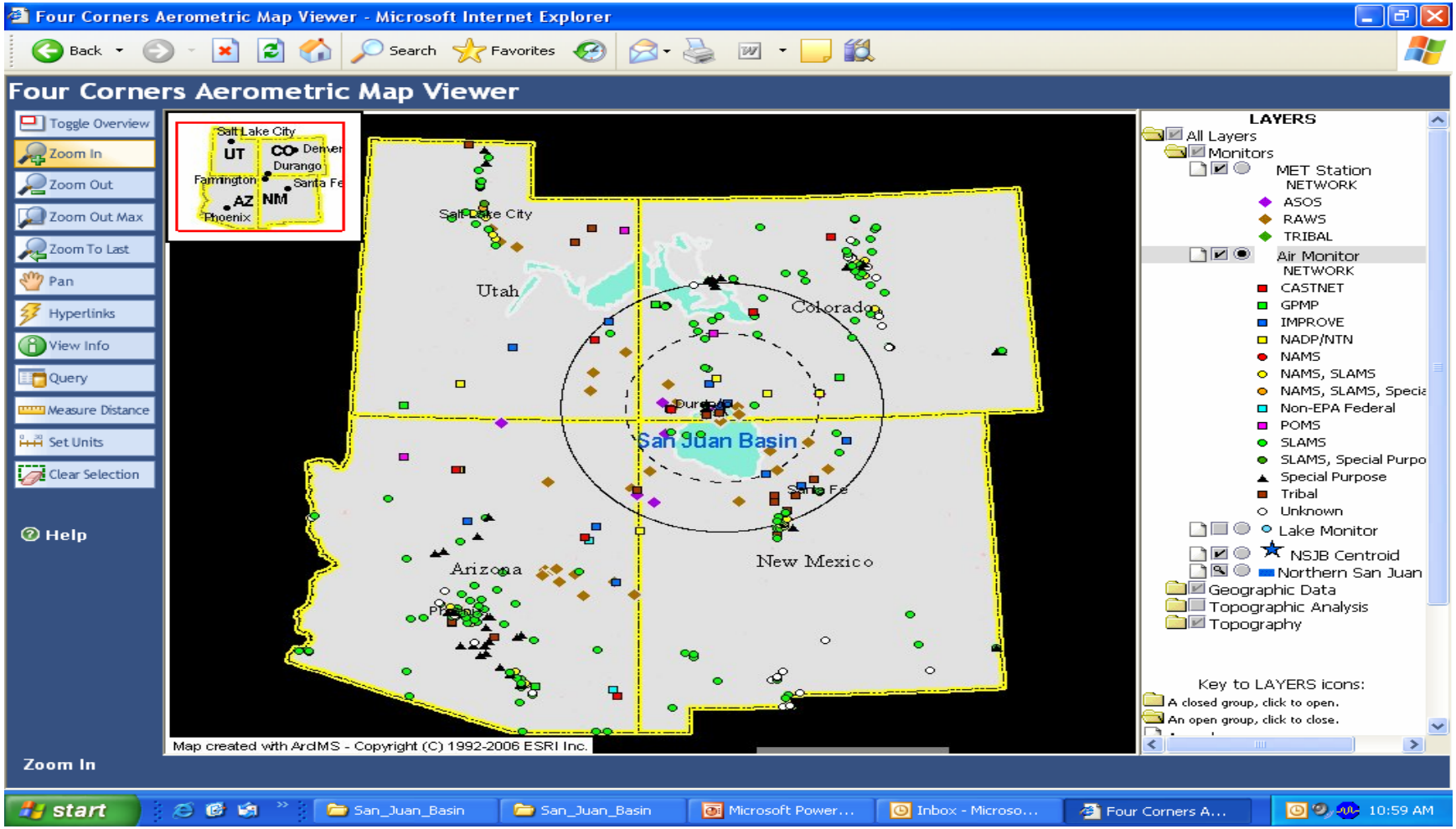
San Juan Basin Aerometric Web-GIS Data Management Site



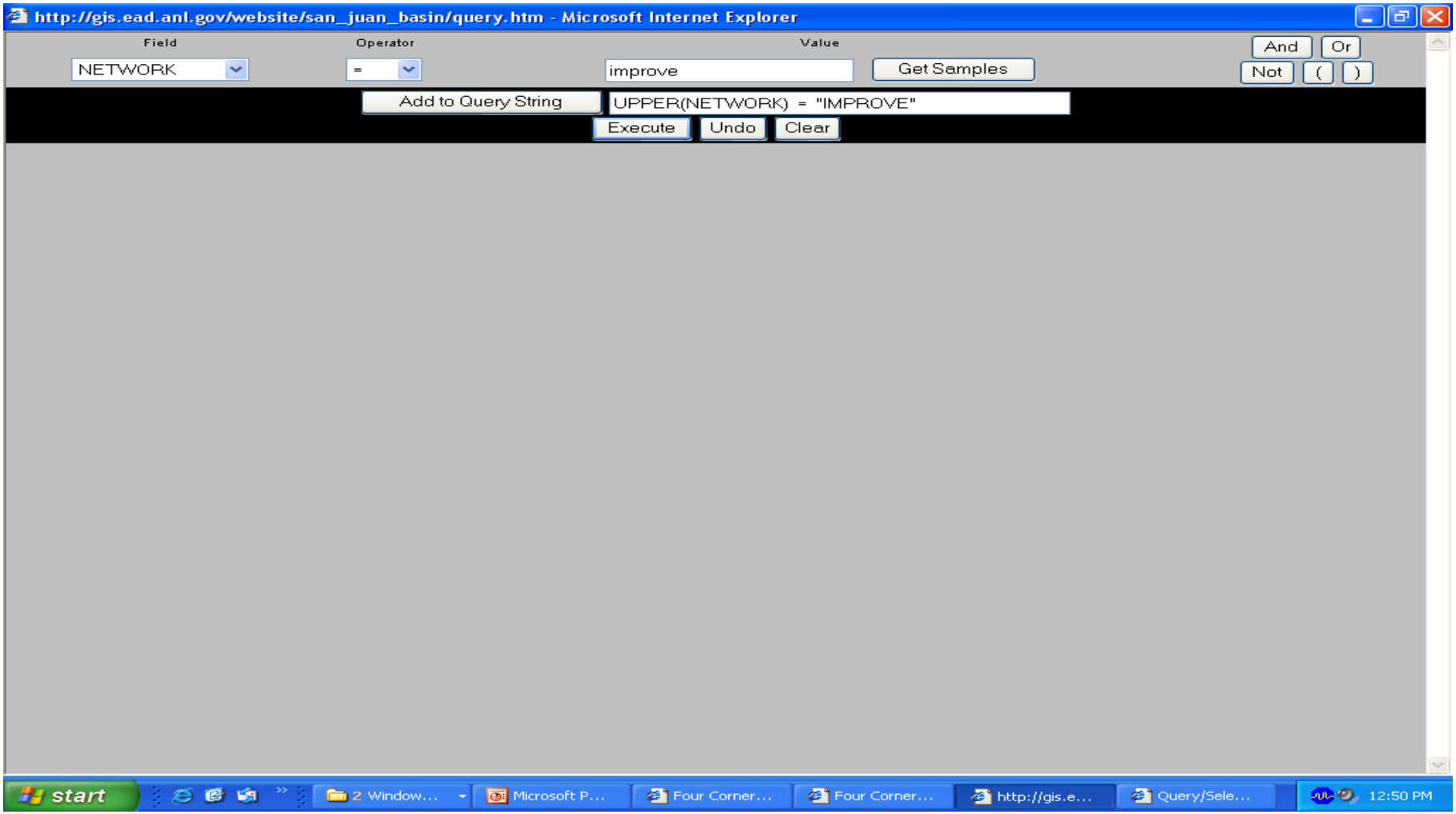
http://www.nmenv.state.nm.us/aqb/4C/monitoring_workgroup.html

https://web.ead.anl.gov/fourcorners/index.cfm

GIS Website


Four Corners Aerometric Map Viewer - Microsoft Internet Explorer
Back
Search
Favorites
Four Corners Aerometric Map Viewer
Toggle Overview
Zoom In
Zoom Out
Zoom Out Max
Zoom To Last
Pan
Hyperlinks
View Info
Query
Measure Distance
Set Units
Clear Selection
Help
Zoom In
Salt Lake City
UT
CO
Denver
Durango
Farmington
Santa Fe
AZ
NM
Phoenix
Utah
Colorado
San Juan Basin
Santa Fe
Arizona
New Mexico
Map created with ArcIMS - Copyright (C) 1992-2006 ESRI Inc.
LAYERS
All Layers
Monitors
MET Station NETWORK
ASOS
RAWS
TRIBAL
Air Monitor NETWORK
CASTNET
GPMP
IMPROVE
NADP/NTN
NAMS
NAMS, SLAMS
NAMS, SLAMS, Specia
Non-EPA Federal
POMS
SLAMS
SLAMS, Special Purpo
Special Purpose
Tribal
Unknown
Lake Monitor
NSJB Centroid
Northern San Juan
Geographic Data
Topographic Analysis
Topography
Key to LAYERS icons:
A closed group, click to open.
An open group, click to close.
start
San_Juan_Basin
San_Juan_Basin
Microsoft Power...
Inbox - Microso...
Four Corners A...
10:59 AM

San Juan Basin Aerometric Data Query



Query/Selection Results - Microsoft Internet Explorer

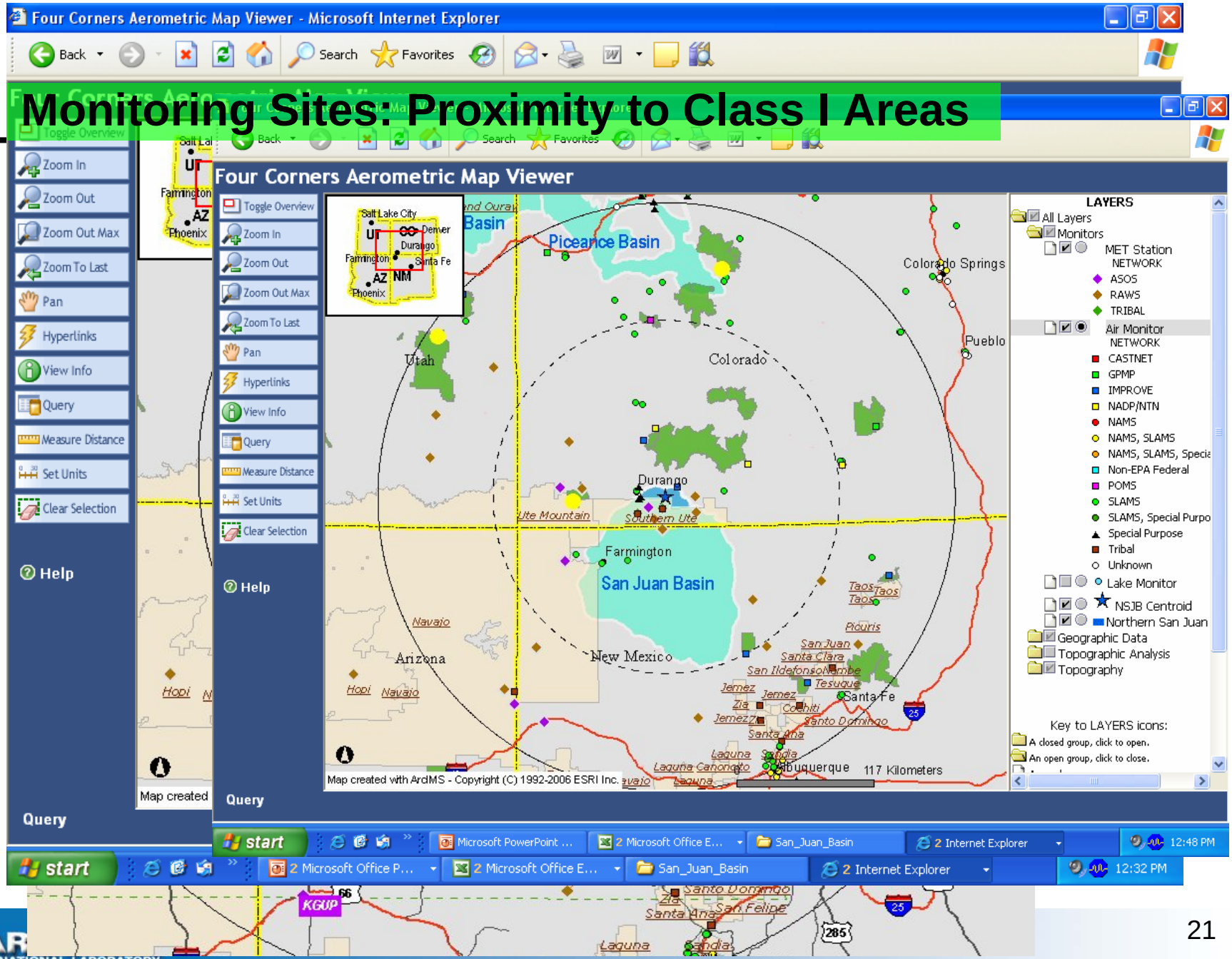
Air Monitor

Rec	ID	ST	COUNTY	CITY	LATITUDE	LONGITUDE	SITENAME	SITECODE	ELEVATION	DISTANCE	NETWORK	AGENCY	MONITORING	FREQUENCY
1	AD0287	CO	La Plata		37.6594	-107.7998	Weminuche, WA	WEMI1	2765	51.84826	IMPROVE	USFS	PM2.5, PM10, Scene monitoring,?abs	Every Third Day, 2
2	AD0288	CO	Montezuma		37.1984	-108.4907	Mesa Verde NP	MEVE1	2177	79.32320	IMPROVE	USNPS	PM2.5, PM10, Scene monitoring,babs	Every Third Day 2
3	AD0289	CO	Montezuma		37.2186	-108.4933	Mesa Verde NP ? Mesa Rim	MEVE1	2245	79.48155	IMPROVE	USNPS	babs, bscat	Every Third Day 2
4	AD0290	NM	Taos		36.5855	-105.4513	Wheeler Peak	WHPE1	3372	201.92960	IMPROVE	USFS	PM2.5, PM10,babs	Every Third Day 2
5	AD0291	CO	Saguache		37.7249	-105.5186	Great Sand Dunes	GRSA1	2504	189.75743	IMPROVE	USNPS	PM2.5, PM10,babs	Every Third Day 2
6	AD0292	NM	Rio Arriba		36.014	-106.8446	San Pedro Parks	SAPE1	2918.9	151.06107	IMPROVE	USFS	PM2.5, PM10,babs	Every Third Day 2
7	AD0293	NM	Los Alamos		35.7797	-106.2664	Bandelier	BAND1	1987	200.16113	IMPROVE	USNPS	PM2.5, PM10,babs	Every Third Day 2
8	AD0294	UT	Grand		38.7833	-109.5833	Arches NP	ARCH1	1722	245.96947	IMPROVE	USNPS		Every Third Day 2
9	AD0295	UT	San Juan		38.4587	-109.8209	Canyonlands NP	CANY1	1799	238.52577	IMPROVE	USNPS	PM2.5, PM10,babs	Every Third Day 2
10	AD0296	AZ	Navajo		35.0781	-109.7683	Petrified Forest NP	PEFO1	1767.4	309.28827	IMPROVE	USNPS	PM2.5, PM10,babs, bscat	Every Third Day 2
11	AD0297	AZ	Coconino		35.1406	-111.9694	Sycamore Canyon	SYCA1	2039.6	454.90912	IMPROVE	USFS	PM2.5, PM10,?abs, ?scat	Every Third Day 2
12	AD0298	UT	Wayne		38.3022	-111.2926	Capitol Reef NP	CAPI1	1890	344.86829	IMPROVE	USNPS	PM2.5, PM10,?abs	Every Third Day 2
13	AD0299	UT	Garfield		37.6184	-112.1736	Bryce Canyon NP	BRCA1	2477	404.23126	IMPROVE	USNPS	PM2.5, PM10,?abs	Every Third Day 2
14	AD0300	AZ	Coconino		36.0776	-112.129	Indian Gardens	INGA1	1166	422.16873	IMPROVE	USNPS	?abs, ?scat	Every Third Day 2
15	AD0301	AZ			34.0667	-109.433333	Greer Arizona	GRER1	2513	390.56354	IMPROVE		?abs, ?scat	Every Third Day 2
16	AD0302	CO	La Plata		37.3038	-107.4842	Shamrock Site	SHMI1	2351	12.60368	IMPROVE	BLM/USFS	NOx, O3, and u, T, RH, SR, Precip	Hourly

Zoom to these records

start | San_Juan_Basin | Microsoft Power... | Inbox - Microso... | 4 Internet Ex... | Microsoft Excel ... | 11:09 AM

Monitoring Sites: Proximity to Class I Areas



Lake Chemistry Data

Data-collection platform

Probe to measure water-quality

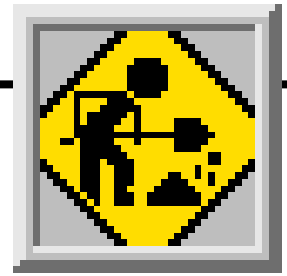
Lake Guage Equipment

Microsoft Excel - FourCornersLakeData-2005-12-02

Colorado and Utah: Lake Chemistry Data, July 1981 - October 2003

#	Location	Station ID	LatDD (degrees)	LongDD (degrees)	CaDis (LAB) (mg/L)	Cat/An (LAB) (None)	Clarity (FLD) (meters)	ClDis (LAB) (mg/L)	CO3 (LAB) (mg/L)	Color (FLDL) (PCUs)	Con (FLD (uS/c
1	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	6.35			0.139			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.03			0.17			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	6			0.205			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.69			0.147			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.56			0.154			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	8.26			0.146			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	5.87			0.185			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	6.76			0.112			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	6.76			0.111			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.56			0.127			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	4.9			0.135			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	5			0.175			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	8.03			0.353			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.57			0.201			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.57			0.271			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	9.53			0.281			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	9.6			0.279			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.25			0.254			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	7.03			0.697			
	CRATER LAKE (SANGRE DE CRISTO)	1054950375758	37.57583	-105.495	10.7			0.354			
	CRATER LAKE (SANGRE DE CRISTO)										
2	UPPER LITTLE SAND CREEK LAKE	1055355379038	37.90389	-105.536	6.35			0.119			
	UPPER LITTLE SAND CREEK LAKE	1055355379038	37.90389	-105.536	6.33			0.134			
	UPPER LITTLE SAND CREEK LAKE	1055355379038	37.90389	-105.536	6.05			0.157			
	UPPER LITTLE SAND CREEK LAKE	1055355379038	37.90389	-105.536	5.37			0.204			
	UPPER LITTLE SAND CREEK LAKE	1055355379038	37.90389	-105.536	2.91			0.074			
	UPPER LITTLE SAND CREEK LAKE	1055355379038	37.90389	-105.536	3.03			0.073			

Path Forward

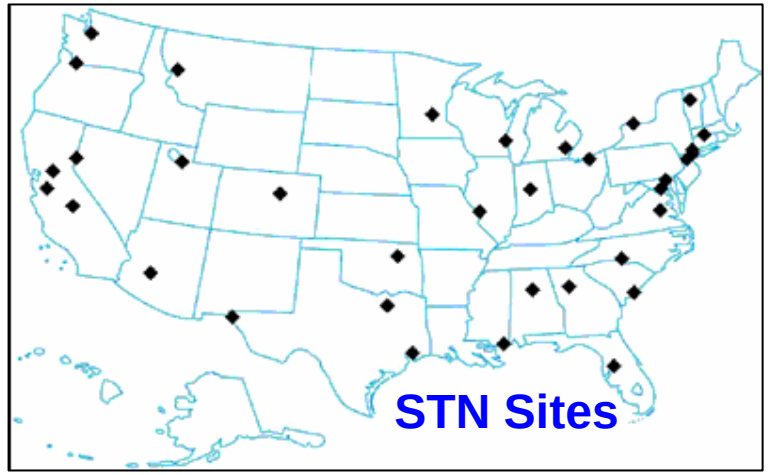


- End-user input
  - Two Prototype demos
  - Direct hands-on use experience – Currently ongoing
  - Work Group Feedback ➔ Finalize 4CAMoN-GIS Web Site ➔ **4CAQTF**
- Other Monitoring Workgroup Needs?
- **Data Analysis ➔ Monitoring Data Gaps ➔ Support to Emissions and Cumulative Assessment WG**
  - Objective analysis of the spatial distribution of existing AQ and met samplers and topographic features
  - ➔ Fingerprinting aerosol sample
  - ➔ Identify wind field patterns using mesoscale met model
  - Map prevalent low-dilution zones - $\sigma_\theta \sigma_\varphi u$ (deg^2-m/s) or $\sigma_v \sigma_w / u$ (m/s)

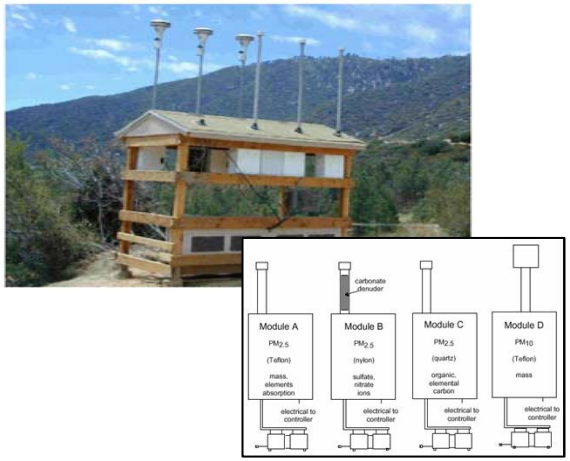
Current PM Speciation

IMPROVE Sites

Fingerprint Attribution



STN Sites



Filter	Analysis Methods	Measured variables
Teflon	gravimetric	$PM_{2.5}$ mass
	• XRF or EDXRF (Energy Dispersive X-Ray Fluorescence) • PIXE (Proton induced x-ray emission)	major elements (S, Al, Si, K, Ca, Ti, Fe, Na, Cl) trace elements (Zn, Se, Pb, Br, V, Mn, Ni, Cu, Zr)
	proton elastic scattering	elemental H
nylon	Ion Chromatography	NO_3^-, $SO_4^=$, Cl^-, NH_4^+
quartz	TOT (thermal/optical reflection)	organic and elemental carbon (8 fractions)

Data from the Speciation Trends Network (STN) or analysis from Interagency Monitoring of PROtected Visual Environment (IMPROVE) data

Aerosol Chemical Speciation for Source Attribution Studies

- Aerosol samples will be collected over 2 hr periods and analyzed for trace metals and nonmetals by total reflection x-ray spectrometry.
  - Trace metals and nonmetals will be used as markers of inorganic aerosol from biogenic and anthropogenic sources.
- A 30-min aerosol sample will be collected (from every 2 hr and analyzed for organic species by on-line supercritical fluid extraction (SFE) with two-dimensional gas chromatography/ time-of-flight mass spectrometry (2DGC-TOFMS).
  - Distributions of <u>inorganic species</u> and <u>organic compounds</u> will be used as markers of <u>primary and secondary organic aerosol</u> from anthropogenic and biogenic sources.

SFE/2DGC-TOFMS

at Argonne Lab

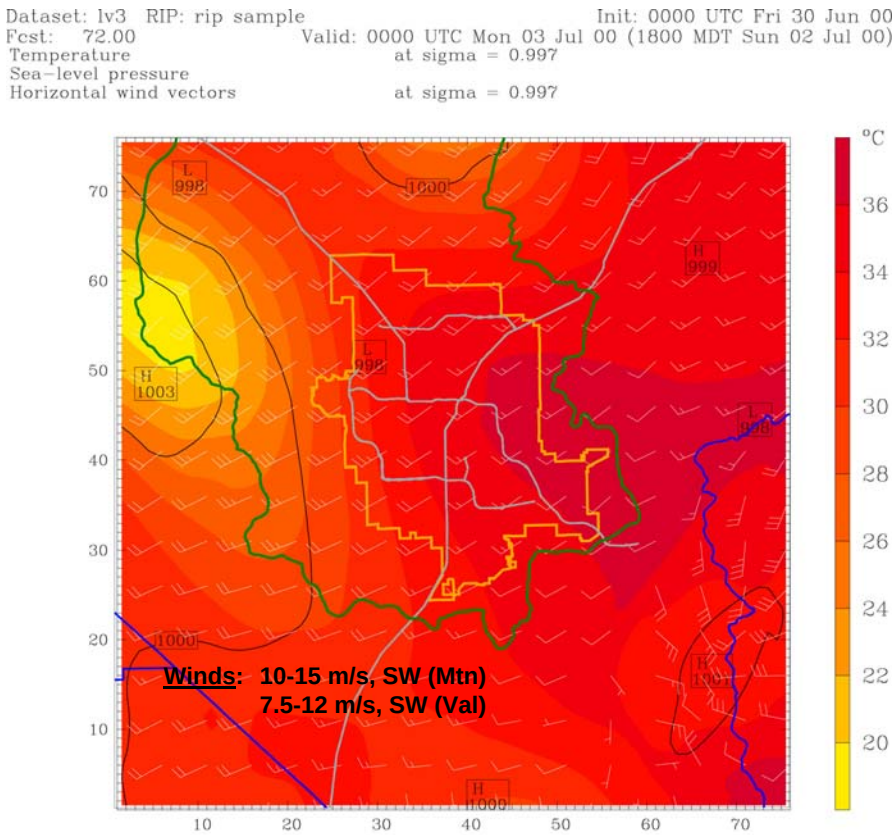
Selected Inorganic Species for Source Attribution Studies

Inorganic Aerosol Species	Source
Sulfur	Fossil fuel and coal combustion.
Potassium	Biogenic emissions, biomass burning.
Calcium	Soil, cement production.
Titanium	Soil, metal production.
Vanadium	Fossil fuel combustion.
Chromium	Metal processing and production.
Manganese	Metal processing and production.
Iron	Soil, metal processing and production.
Nickel	Fossil fuel combustion, metal processing and production.
Copper	Metal processing and production.
Zinc	Soil, metal processing and production.
Bromine	Fossil fuel combustion.
Lead	Various sources.

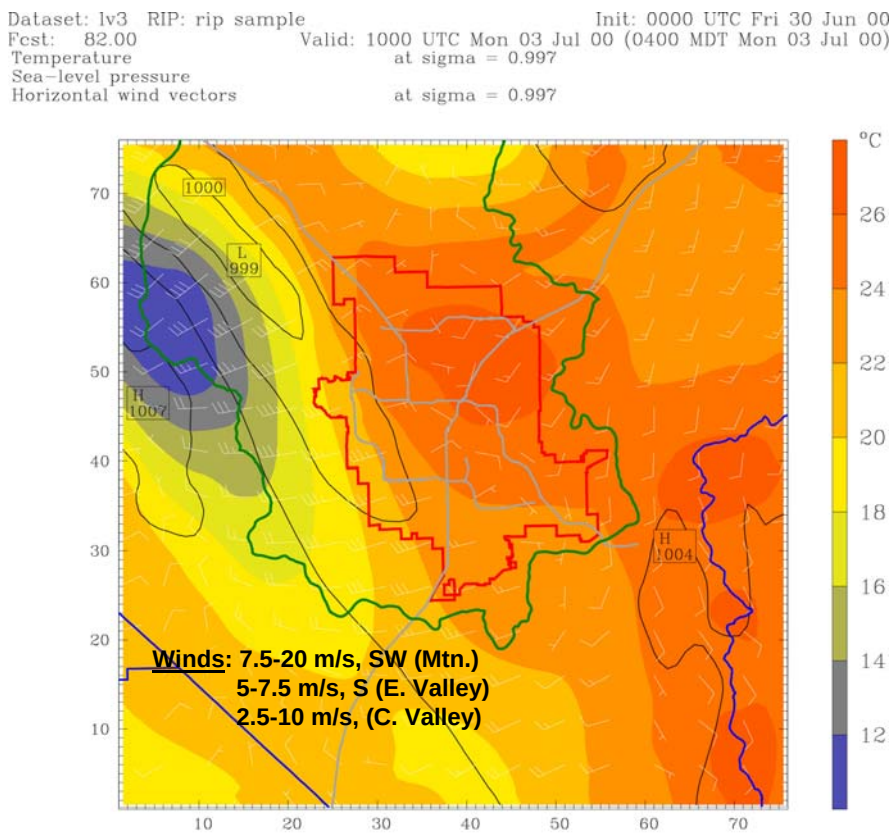
Selected Organic Species for Source Attribution Studies

Organic Aerosol Species	Source
Primary	
Alkanes, Alkanoic acids	Biogenic and anthropogenic emissions.
PAHs, Levoglucosan	Vehicle exhaust and biomass burning, respectively.
Secondary	
2-Methyltetrols	Isoprene emissions from deciduous vegetation.
Pinic acid, Pinonic acid	Monoterpene emissions from coniferous vegetation.
Furandiones	Monoaromatic hydrocarbon emissions from vehicle exhaust.
Dicarboxylic acids	Biogenic and anthropogenic emissions.

MM5 Generated Surface Wind, Temperature and Pressure Fields - Diurnal Pattern



MM5-Generated Surface Wind Fields and Pressure and Temperature Contours on a Summer Afternoon (July 2, 2000, at 4:00 p.m. local or Pacific standard time) for the Local to Urban Valley Grid, 1.3-km-Resolution Inner Domain (The colors represent temperatures shown on the color scale next to the figure, and the contours represent surface pressure. Each full wind barb represents a velocity of 5 m/s.)



MM5-Generated Surface Wind Fields and Pressure and Temperature Contours on an Early Summer Morning (July 3, 2000, at 2:00 a.m. local or Pacific standard time) for the Local to Urban Valley Grid, 1.3-km-Resolution Inner Domain (The colors represent temperatures shown on the color scale next to the figure, and the contours represent surface pressure. Each full wind barb represents a velocity of 5 m/s.)

Further Questions, Issues, Needs, Desires, Recommendations …. other ?

Well, was it the Hg, nitric acid, NH_3 or just heredity?

4CAMoN-GIS: Data Mapping

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Aerometric Data GIS Web Site:

https://web.ead.anl.gov/fourcorners/map/index.cfm

DOE Sponsor:

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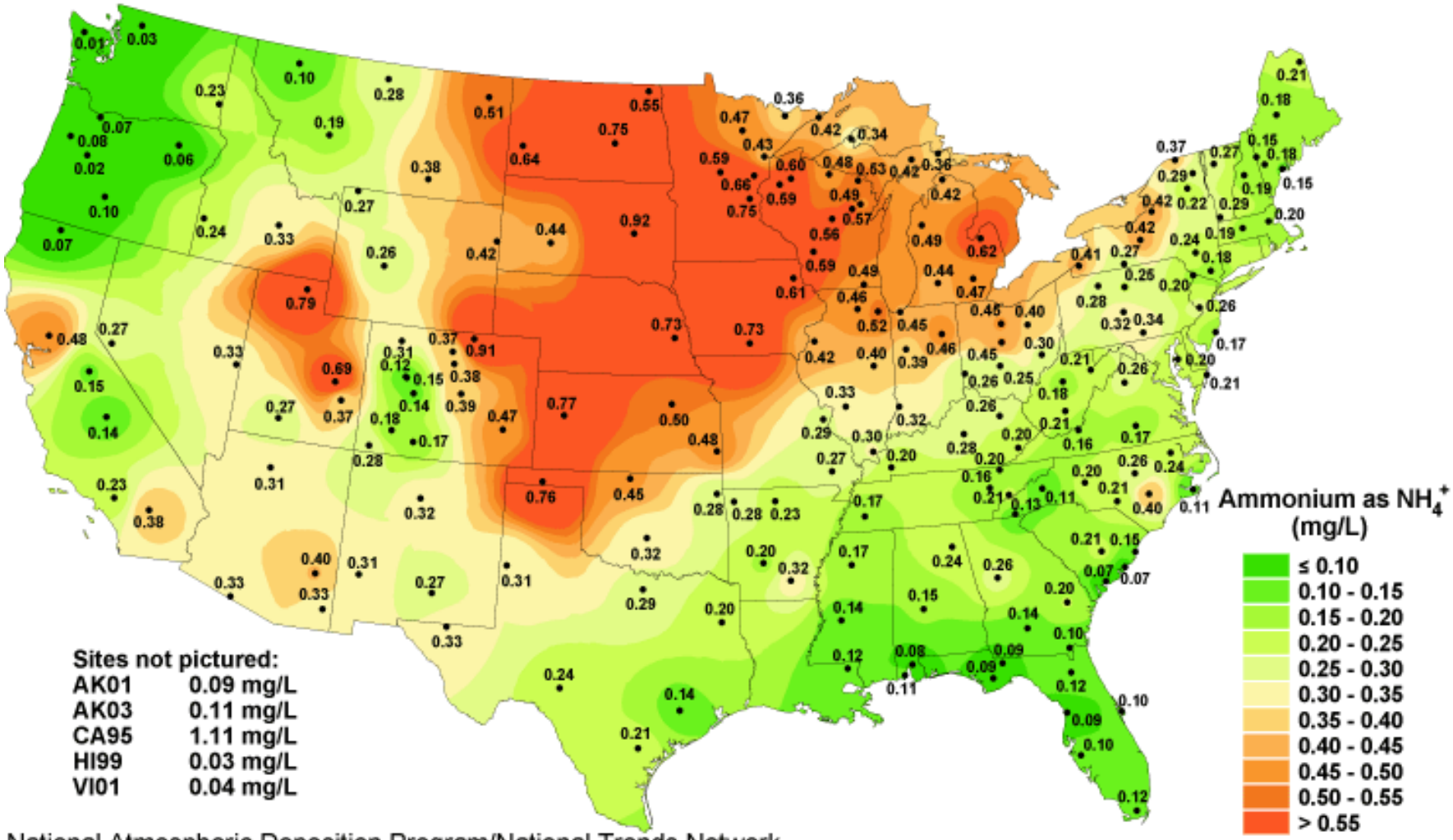
4CAMoN-GISWeb - Four Corners Aerometric Monitoring – GIS-Web

Ammonium ion concentration, 2002



Sites not pictured:

AK01	0.09 mg/L
AK03	0.11 mg/L
CA95	1.11 mg/L
HI99	0.03 mg/L
VI01	0.04 mg/L

National Atmospheric Deposition Program/National Trends Network
http://nadp.sws.uiuc.edu