

Using Real-time Air Quality WebCams to Increase Public Awareness

Presented by Jim Renfro
Air Resource Specialist
Great Smoky Mountains NP

*U.S. EPA's 2004 National
Air Quality Conference
Baltimore, MD*

February 24, 2004





Air Quality in National Parks: Relevant Mandates

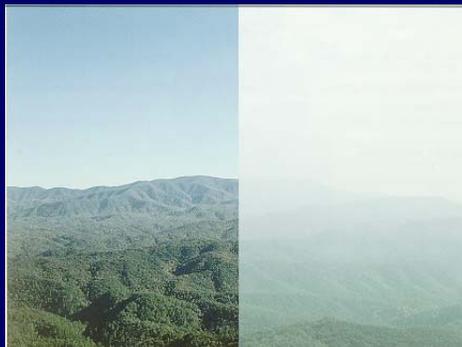
“...conserve the scenery and the natural and historic objects and wild life therein...as will **leave them unimpaired** for the enjoyment of future generations.” (NPS Organic Act, 1916)



Great Smoky Mountains National Park was established “for the **benefit and enjoyment of the people**”.
(Park’s Enabling Legislation in 1926)

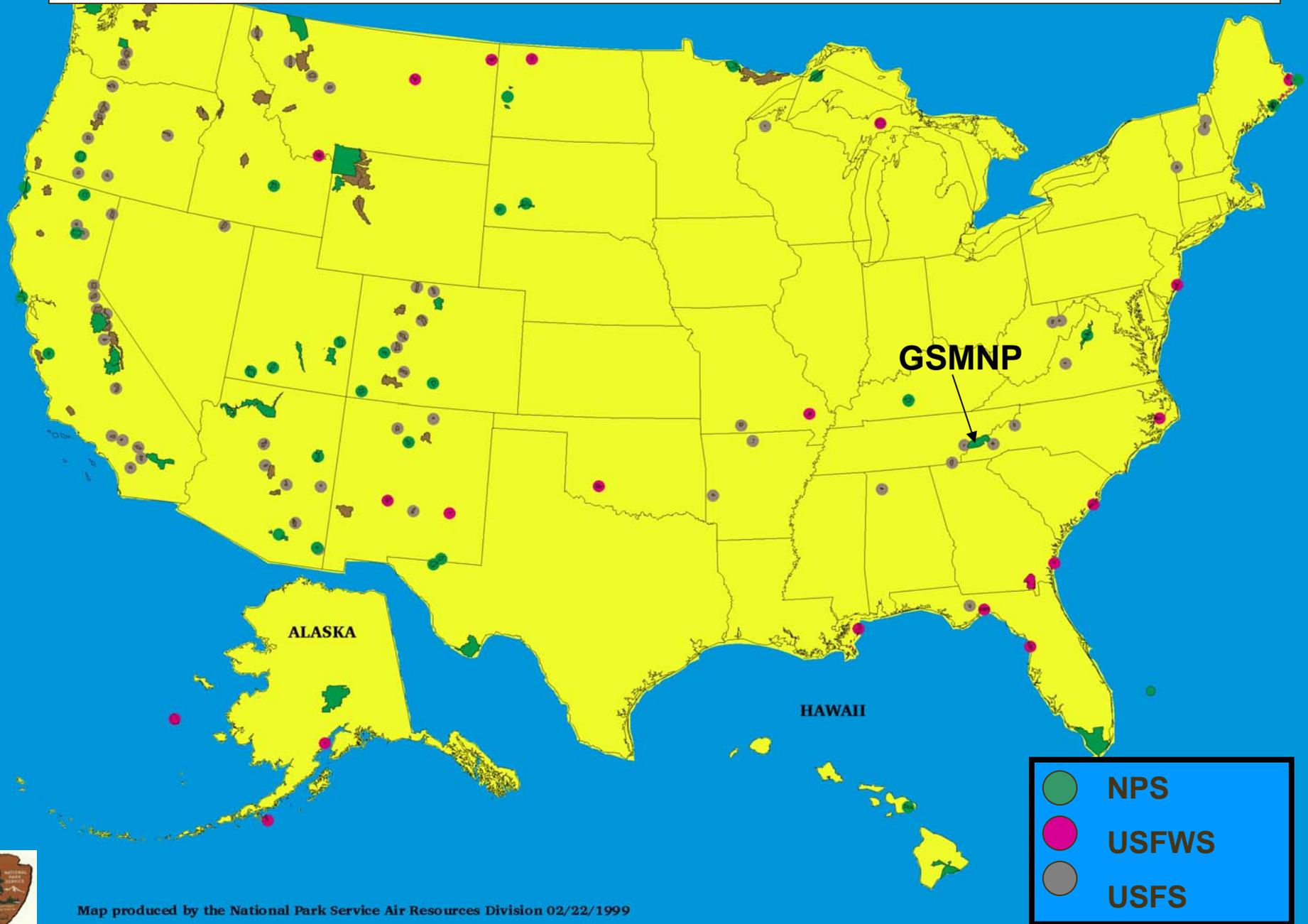


“...**preserve, protect and enhance the air quality** in national parks,...and other areas of special national or regional natural, recreational, scenic, or historic value.”
(Clean Air Act as amended in 1977)



“...Congress declares as a national goal the **prevention of any future, and the remedying of any existing, impairment of visibility** in mandatory class I Federal areas which impairment results from manmade air pollution.”
(Clean Air Act as amended in 1977 & Regional Haze Rule in 1999)

156 Federal Class I Areas Designated under the Clean Air Act (1977)



Map produced by the National Park Service Air Resources Division 02/22/1999

Class I Area Designation

- The Clean Air Act affords greatest degree of protection to Class I Areas (National Parks > 6,000 acres in size).
- Requires protection of “air quality-related values”.
 - Park should be one of the cleanest area in the U.S.
 - Federal Land Managers have “affirmative responsibility” to take “active role”, and “err on the side of protection”;
 - Preserve resources “*unimpaired*” for future generations;
 - Park is expected to know the condition of the resources.



Air Pollutants of Concern

- **Primary Emissions**
 - SO₂, NO_x, NH₃, C, Hg
- **Secondary Pollutants**
 - SO₄, **O₃**, NO₃, NH₄, **PM_{2.5}**
- **Effects**
 - Haze, acid rain, ozone
 - Impacts public health and natural resources (e.g. streams, soils, vegetation, **visibility**)

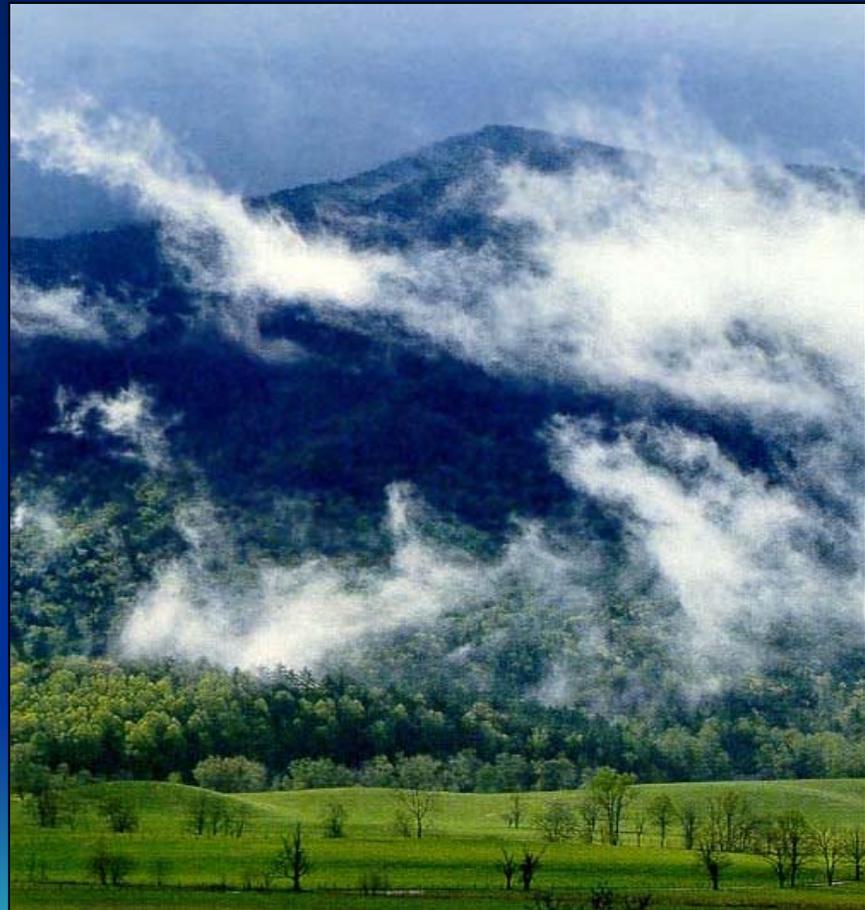


Visibility

Concerns with Fine Particles and Haze

“Shaconage”

...Cherokee word for
“Land of blue smoke
and mist-like clouds”,
...not regional haze.



Typical Regional Haze

(“View” of Tennessee Valley from the Park)



12 1:42 PM



Viewing scenery is #1 reason the 10 million visitors come to the Park annually and generate over \$1 billion in revenues



Unfortunately, vistas are obscured with haze 90% of the time.

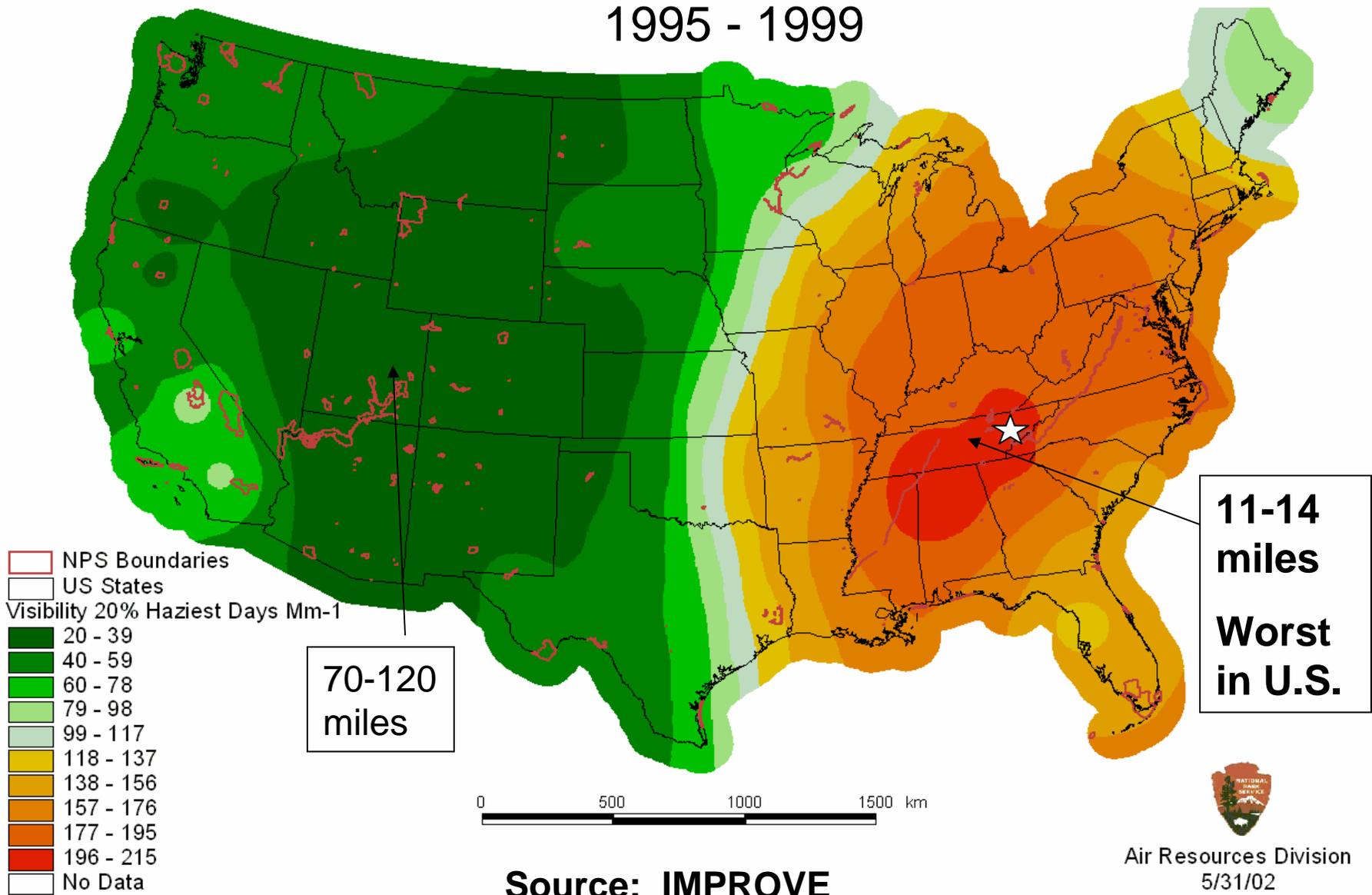
Visibility Monitoring Methods

- **Scene (real-time)**
 - Cameras
- **Optical (real-time)**
 - Nephelometer - point
 - Transmissometer - path
- **Particle (filter-based)**
 - Calculate reconstructed light extinction from speciated particle concentrations (IMPROVE)



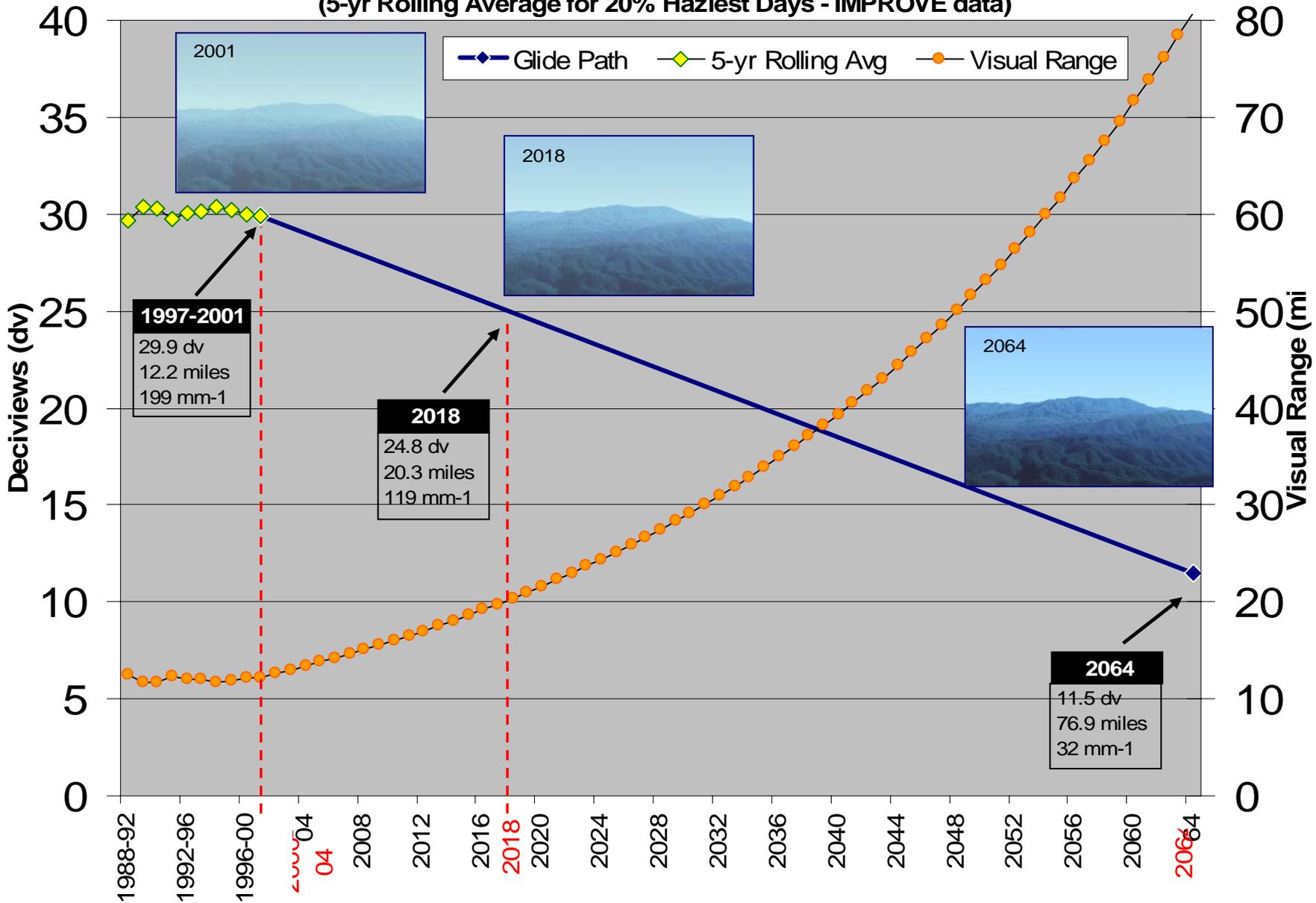
Visibility on the 20% Haziest Days

1995 - 1999

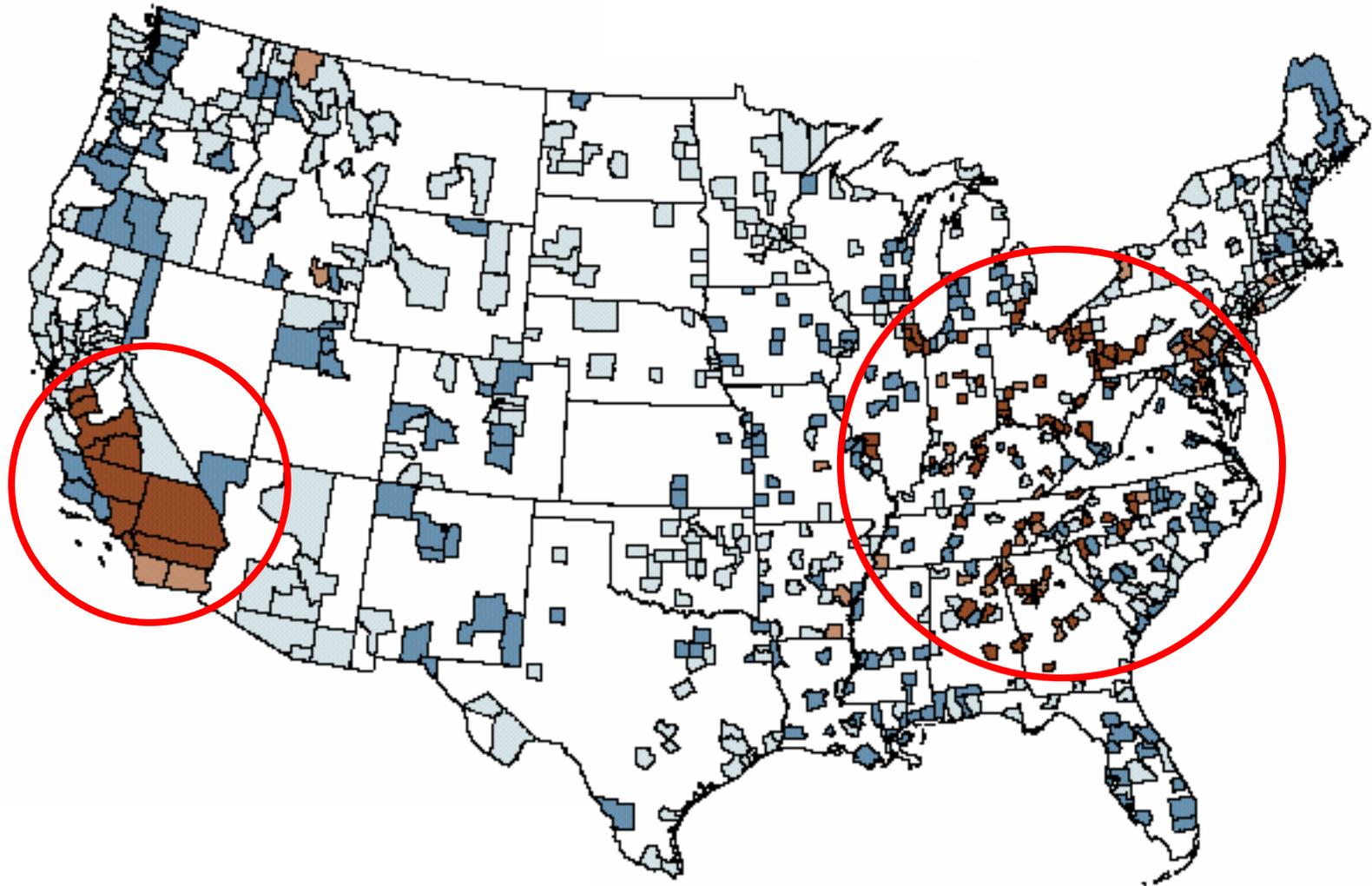


Glide Path to Natural Conditions at GRSM (1988-2064)

(5-yr Rolling Average for 20% Hazyest Days - IMPROVE data)

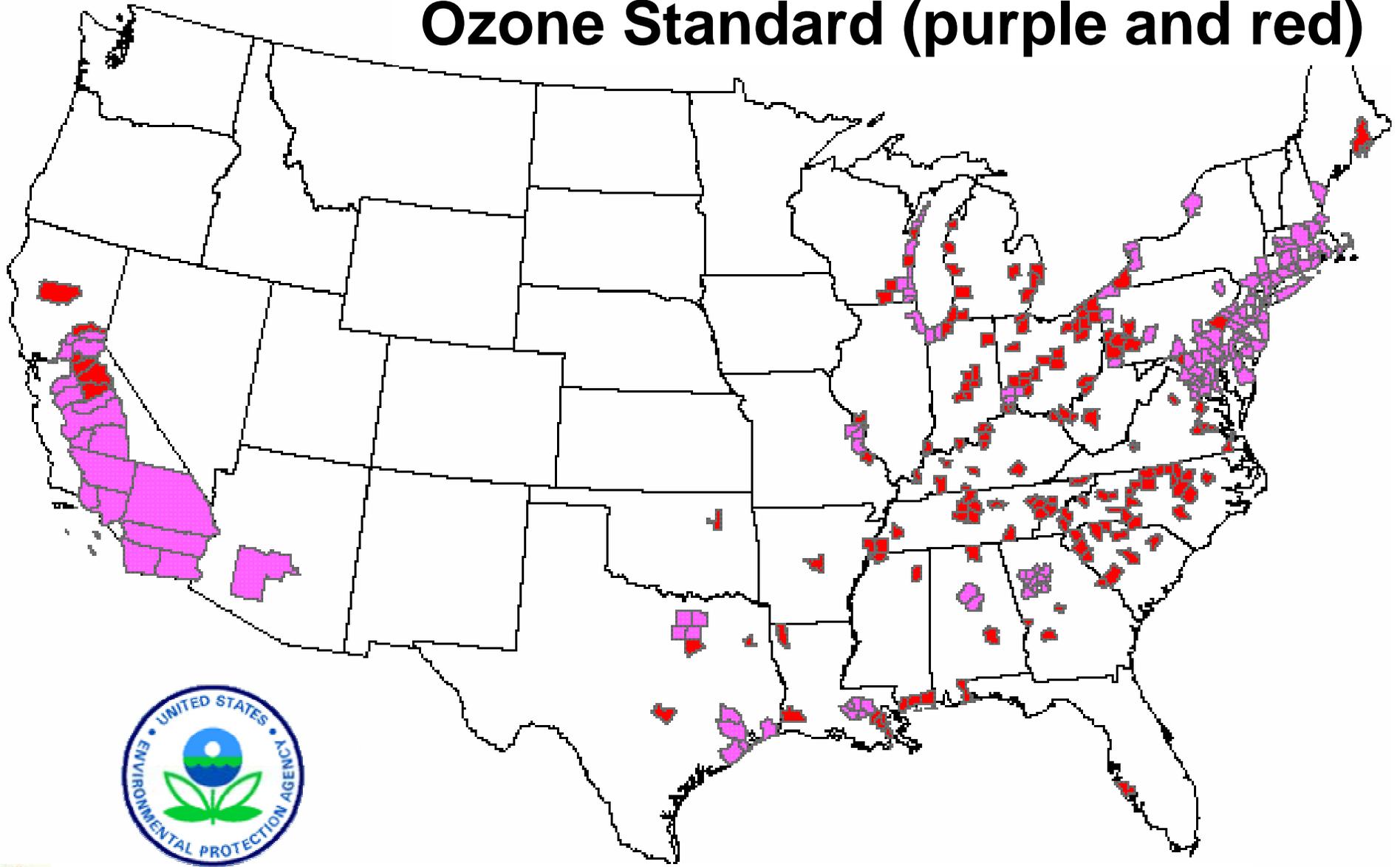


Counties not meeting PM_{2.5} Annual Standard (based on 2000-2002 data)

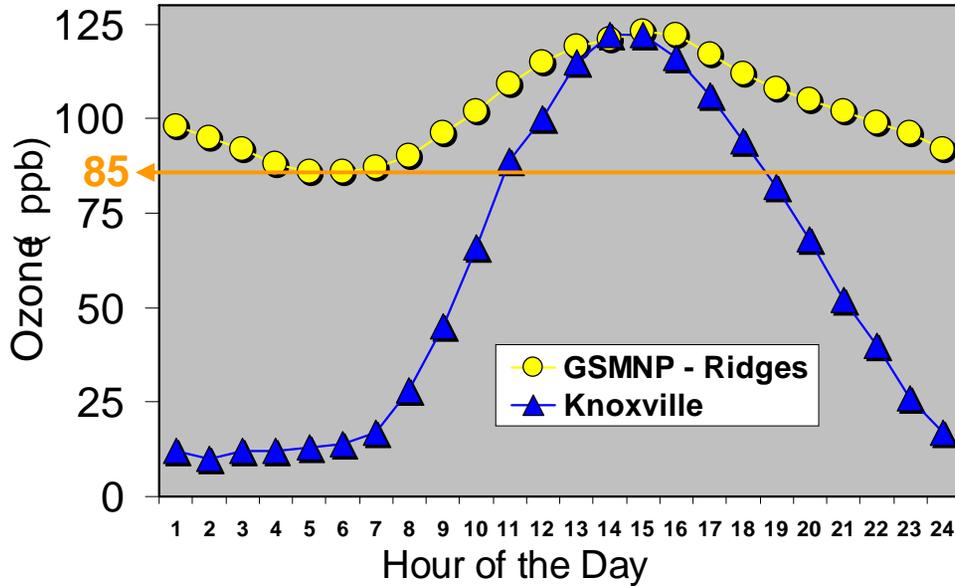


Source: EPA Apr 2003. 2002 data has not been QA and flagged data has not been excluded

Counties Violating the 8-Hour Ozone Standard (purple and red)

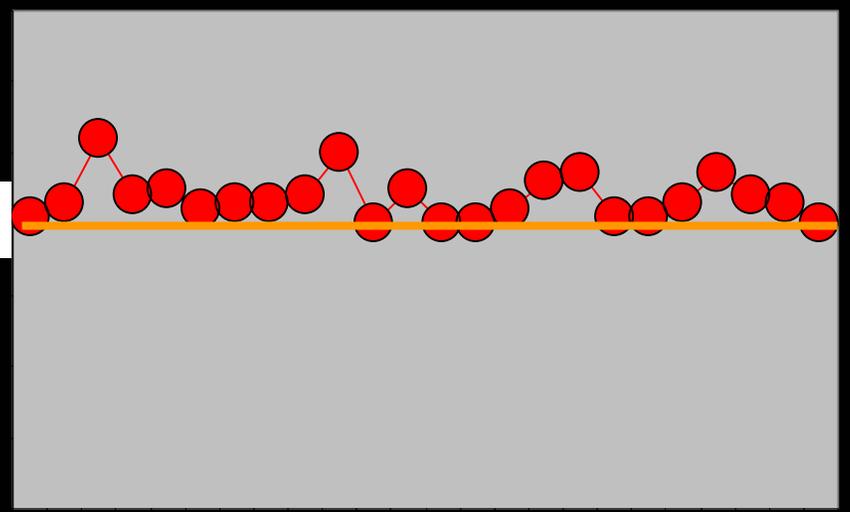


Typical Daily Pattern of an Unhealthy for Sensitive Groups Ozone Day

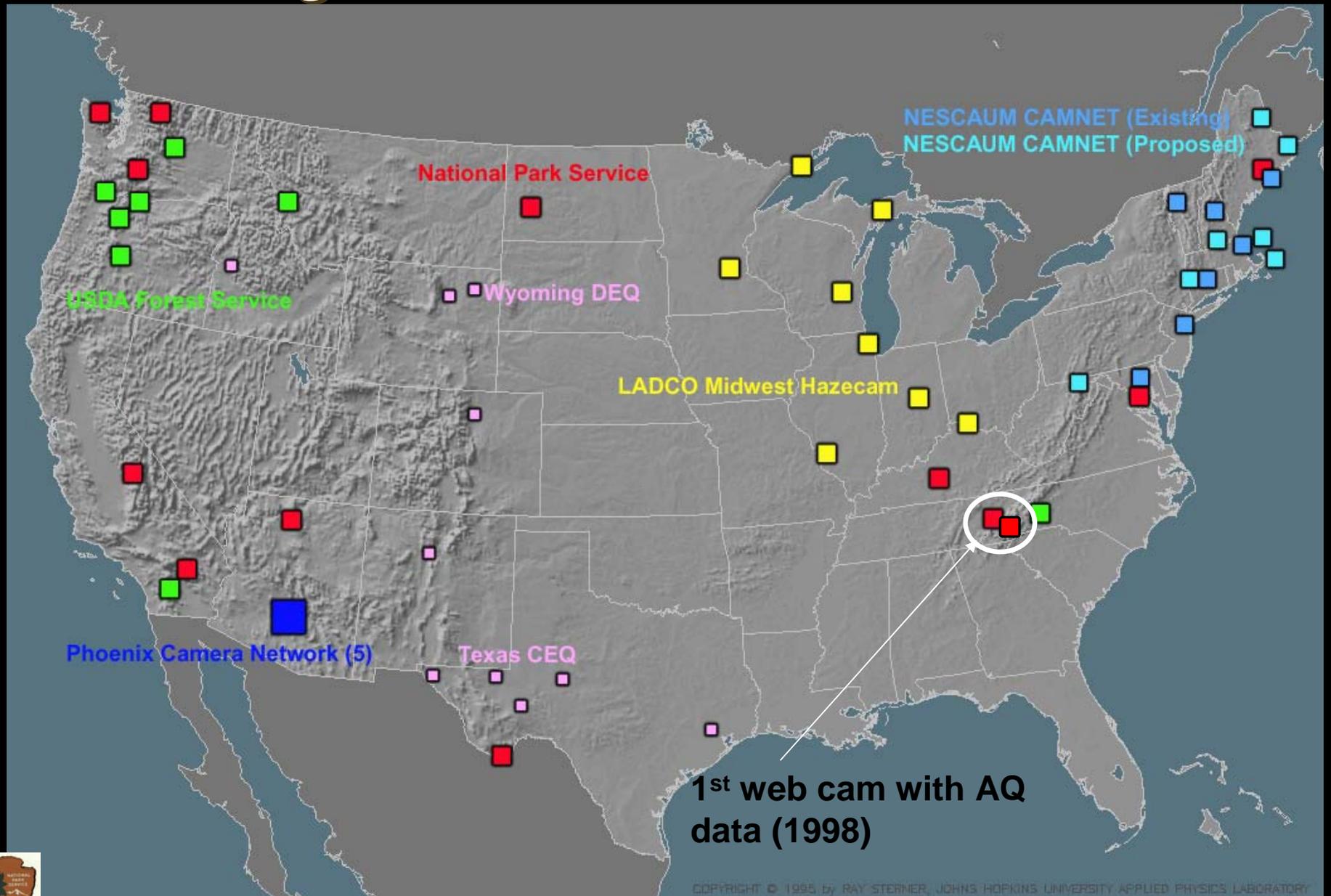


Hourly/Daily Patterns of O₃ and PM_{2.5} are Important

40



Digital Camera Networks

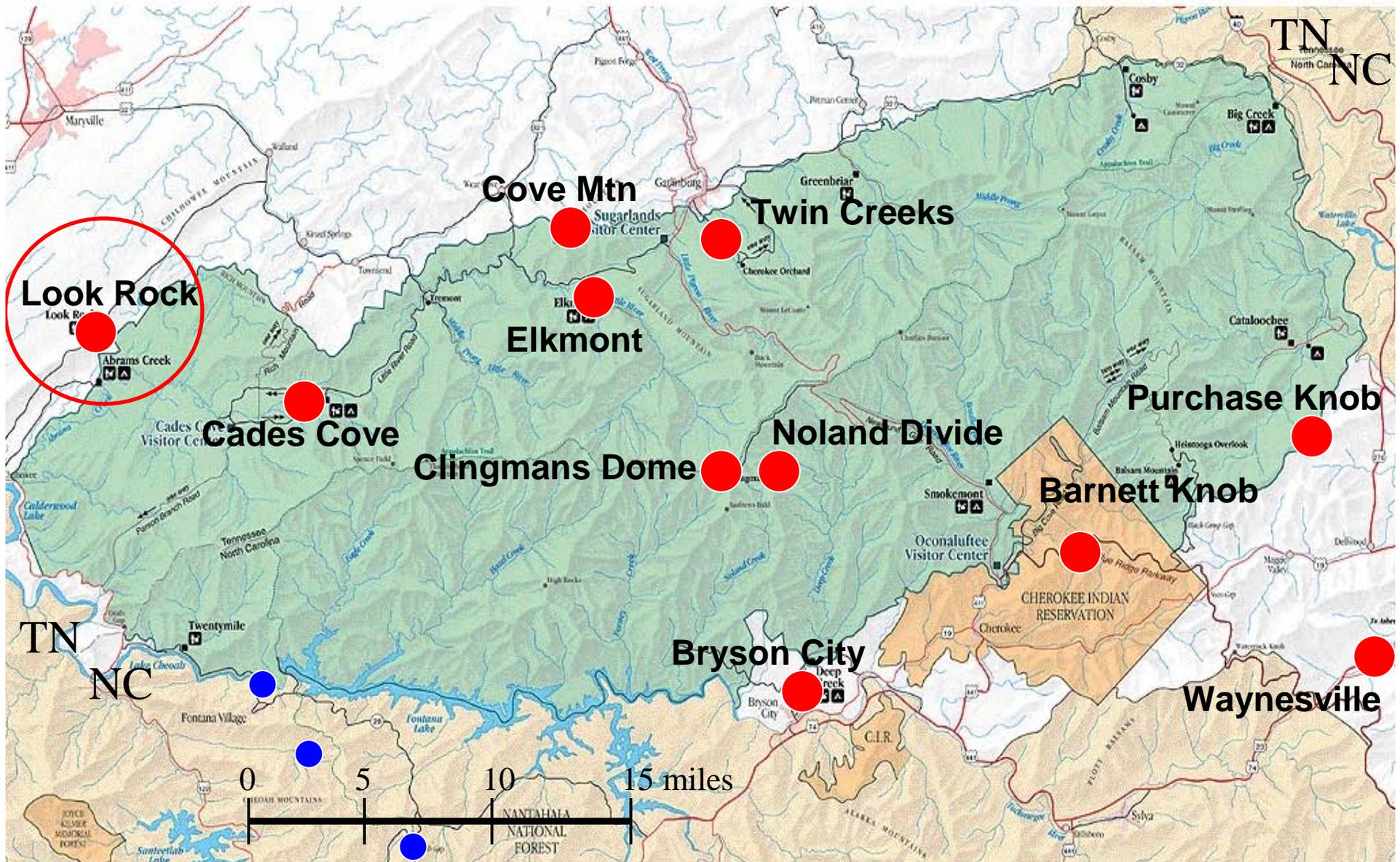


Air Quality Webcam Network Goals

- Display near real time images, visual range, and associated air quality (O_3 , SO_2 , $PM_{2.5}$) and meteorology on the web;
- Capture high quality images usable for print media and future analysis for regional haze;
- Increase public awareness of air quality issues through public outreach and education.



Air Quality Monitoring Sites at GSMNP



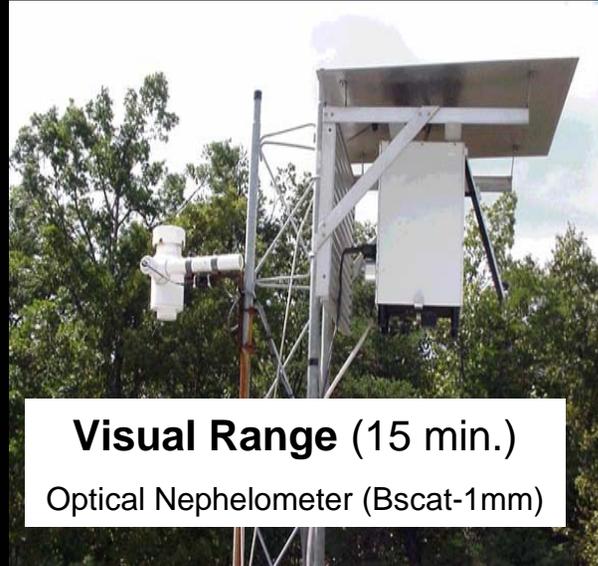
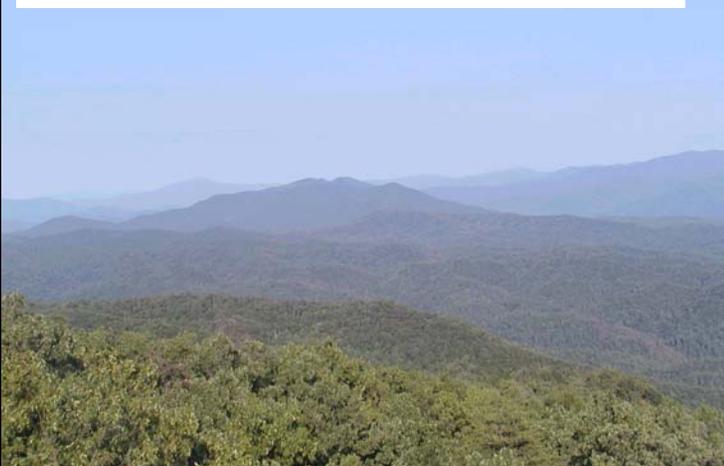
Look Rock Air Quality Station and Observation Tower



Parameters Monitored and Displayed on Real-time Air Quality Web Site

<http://www2.nature.nps.gov/air/WebCams/parks/grsmcam/grsmcam.htm>

View (15 min.) Scene/digital camera



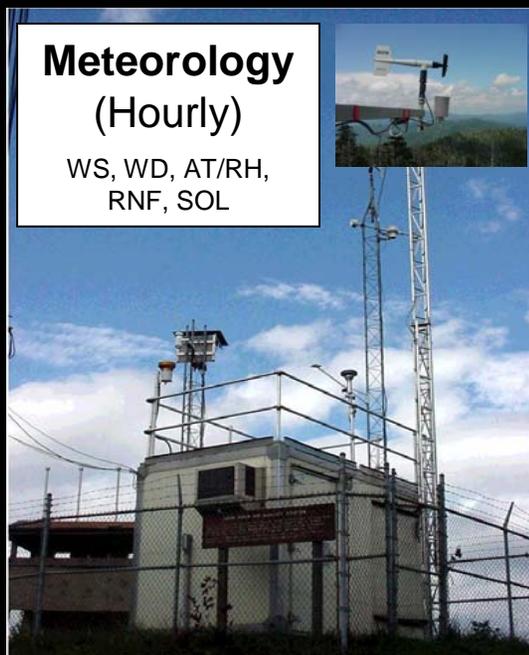
Visual Range (15 min.)
Optical Nephelometer (Bscat-1mm)

Ozone (Hourly)
ppb

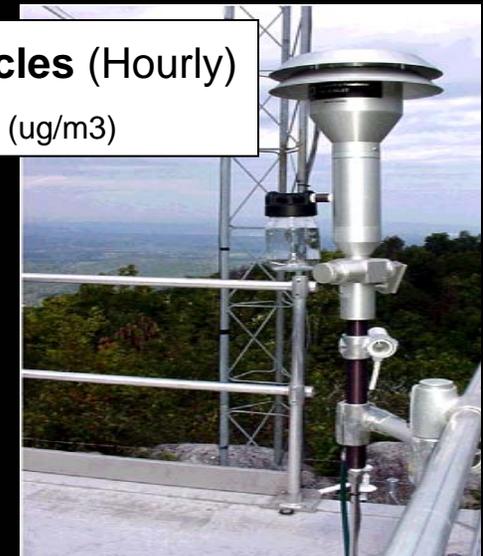


Meteorology
(Hourly)

WS, WD, AT/RH,
RNF, SOL



Fine Particles (Hourly)
TEOM ($\mu\text{g}/\text{m}^3$)



Operated 35mm Camera from 1980-2000 (20,000 slide archive)

9 a.m.



12 p.m.



3 p.m.



DIGITAL CAMERAS

Kodak DC120
(April 1998- May, 2002)



Olympus C2100
(May 2002 – October 2003)



Olympus C730
(October 2003 - Present)



Great Smoky Mountains National Park – Look Rock

- Original digital camera system (with supporting air quality) in 1998 funded by NPS, EPA, and GSMNHA.
- **Camera** - camera in tower linked to PC in shelter using 900 feet of buried fiber optic line or RS485 signal cable. A USB fiber driver or optically isolated line driver at each end protects the camera and PC from electrical surges.
- **Dataloggers** - a CR21X datalogger operates in parallel with the NPS ESC8816 datalogger and the nephelometer datalogger.
- **PCs** - the camera PC controls the camera, interfaces with the 21X and ESC8816 to get data, and uploads the image and data to a temporary FTP site every 15 minutes via a local dial-up ISP connection.
- **End Products** - NPS and the visitor center software get the image and data from the FTP site (dial-up or fiber). The visitor center software dynamically updates the kiosk screens.



Look Rock Observation Tower and Webcam





**Purchase Knob Air
Quality Station
(NPS, NC, NOAA)**

**Digital Camera, ozone,
meteorology and
sound monitoring**



Purchase Knob Webcam



Look Rock PC



Purchase Knob Laptop



“DigiCam” Program (developed by Scott Cismoski w/ARS, Inc.)

My Computer: ARS DIGICAM

My Documents

Internet Explorer

Recycle Bin

msn

Setup MSN Internet A...

My Briefcase

Gateway Business...

DigiCam [2.010202] Camera Interface [Kodak DC260/265 1.121701]

Manual Operation

09:25:25 Automatic Operation Upload Enabled Ready Quit

Camera #1

- ✓ Configuring camera(s)
- ✓ Configuring camera #1
- ✓ Taking image #1
- ✓ Processing image #1

Disk Information:

Disk space available for image storage:
18253 (91%) out of 19994 MB

There is enough disk space available for:
36505 images (380 days)

Recent Activity:

Last image: **01/10/2002 09:24**

Last upload:

Click the 'Log' tab to see detailed information.

Start | DigiCam [2.010202] ... | 9:25 AM



View From Look Rock, Great Smoky Mountains National Park



Visual range is approximately 82 miles

Picture Last Updated: 10/2/2003 12:15 PM EDT

Current Conditions

as of 10/2/2003 12:00 PM EDT

OZONE

Current 8-hour average ozone concentration (ppb) **42**



* At or above 85ppb for 8 hours, children, the elderly, and people with respiratory problems should reduce outdoor activity.

** At or above 105ppb for 8 hours, all people should reduce outdoor activity.

Current 1-hour average ozone concentration (ppb) 41

Today's maximum 8-hour average ozone concentration (ppb) 44

Today's maximum 1-hour average ozone concentration 46

Yesterday's maximum 8-hour average ozone concentration (ppb) 38

Yesterday's maximum 1-hour average ozone concentration 46

PARTICULATE MATTER

Current 24-hour average PM-2.5 concentration (ug/m3) **8.6**



View From Purchase Knob Great Smoky Mountains National Park



Picture Last Updated: 1/20/2004 8:30 AM EST

- [Landmarks Visible Within View From Purchase Knob](#)
- [Park Map Showing Camera Field of View](#)
- [Display Archived Views of Great Smoky Mountains National Park](#)
- [Example of Good and Bad Visibility Days](#)
- [Data Disclaimer](#)



Current Conditions

OZONE

as of 1/20/2004 8:00 AM EST

Current 8-hour average ozone concentration (ppb)

42



* At or above 85ppb for 8 hours, children, the elderly, and people with respiratory problems should reduce outdoor activity.

** At or above 105ppb for 8 hours, all people should reduce outdoor activity.

Current 1-hour average ozone concentration (ppb) 53

Today's maximum 8-hour average ozone concentration (ppb) 42

Today's maximum 1-hour average ozone concentration 53

Yesterday's maximum 8-hour average ozone concentration (ppb) 26

Yesterday's maximum 1-hour average ozone concentration 31

WEATHER

as of 1/20/2004 8:00 AM EST

Current temperature (F) 23

Yesterday's minimum temperature (F) 10

Yesterday's maximum temperature (F) 19

Current relative humidity (%) 15

Yesterday's minimum relative humidity (%) 94

Current wind speed (mph) 4.7



Example of Good and Bad Visibility at Look Rock Air Quality Monitoring Station

The Great Smoky Mountains National Park Look Rock Tower houses a digital camera which takes high resolution pictures of the view every fifteen minutes. Below are examples of good and bad visibility days. The visual range is calculated from data provided by the nephelometer housed at the same location.



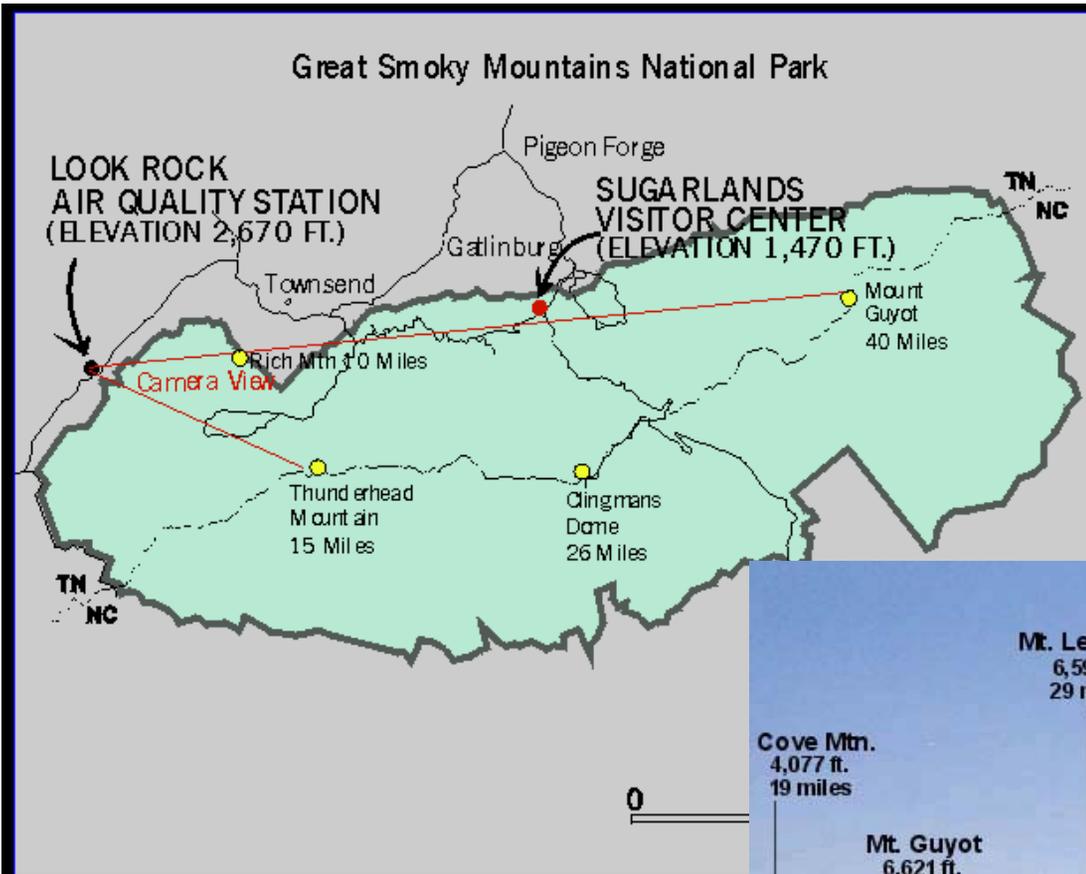
Good Visibility Day
Visual Range: 100 miles



Bad Visibility Day
Visual Range: 20 miles

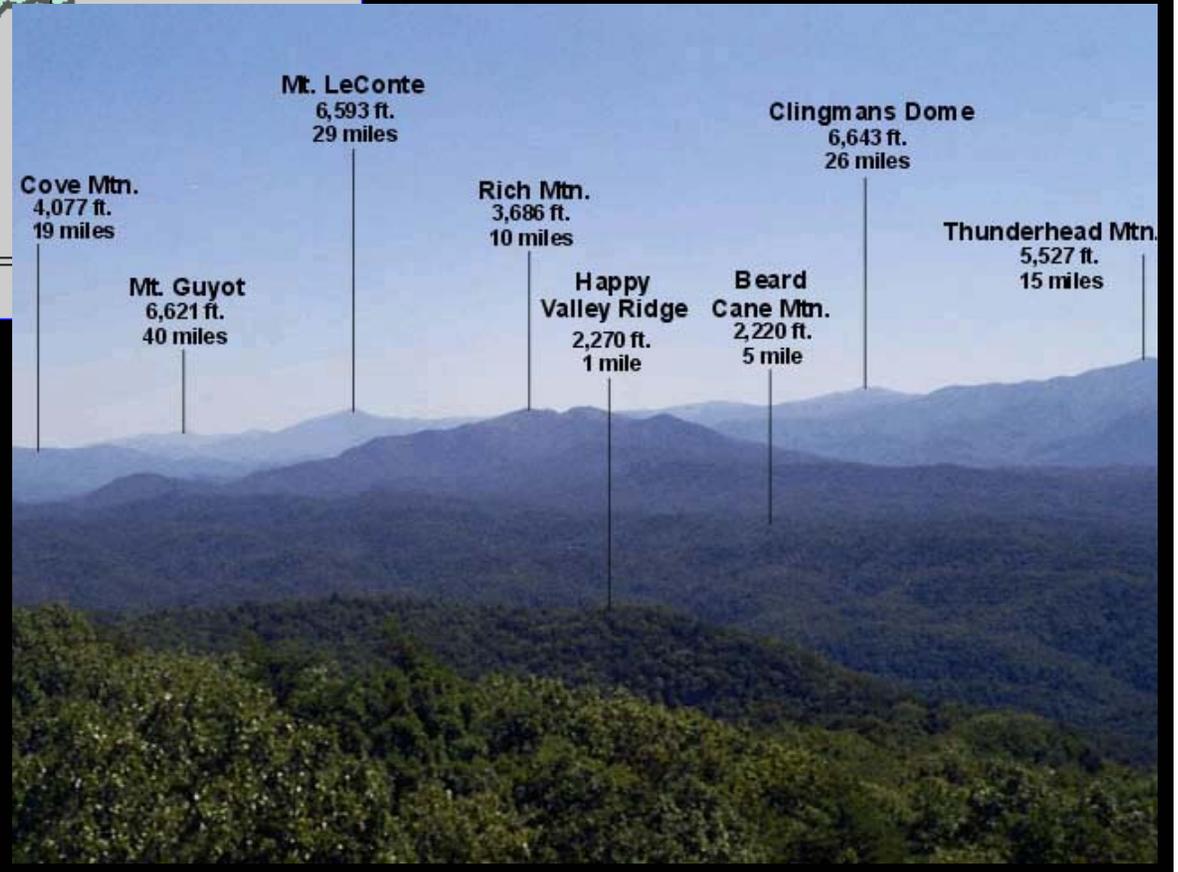
Last Update 08/06/1998

[Back to Sugarlands Air Quality Exhibit](#)



Links to Map Field of View and Significant Landscape Features

“What are we looking at?”



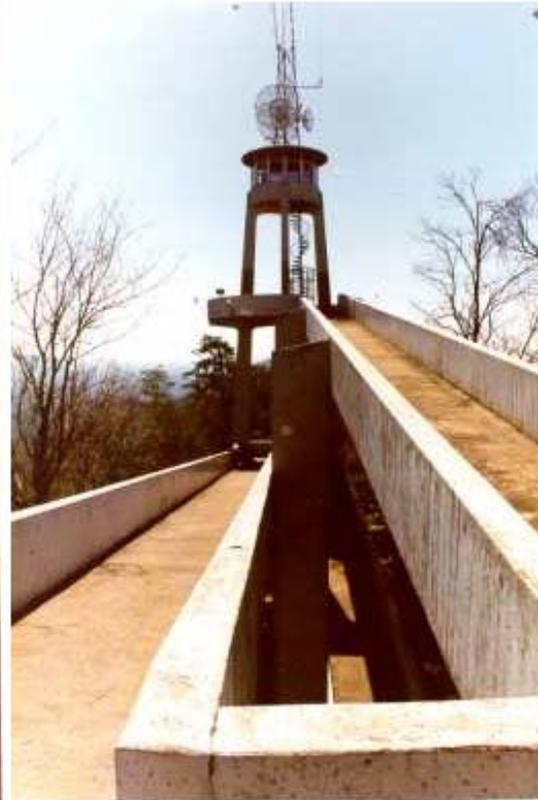


Sugarlands Air Quality Exhibit and Look Rock Observation Tower

The Great Smoky Mountains National Park Sugarlands Visitor Center has an exhibit which displays current air quality and meteorological information currently monitored at the Look Rock air quality station in the park. The NPS maintains an active visibility and gaseous pollutant monitoring site at Look Rock and the data collected is updated at the visitor center display and at this web site every 15 minutes. This project was cofunded by the Great Smoky Mountains Natural Association, the Environmental Protection Agency, and the National Park Service.



Sugarlands Visitor Center Display



Look Rock Observation Tower



Look Rock Air Quality Monitoring Station



Sugarlands Visitor Center Real-time Air quality Exhibit

Nearly 1 million people visit
the exhibit annually.



Ozone Pollution at Look Rock



Health scale for 8-hour ozone average

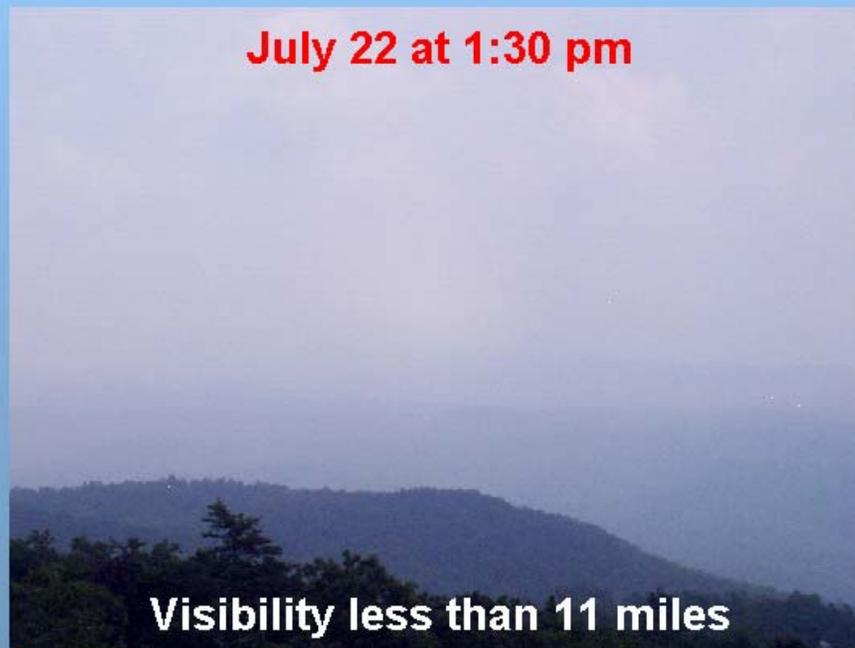


* At or above 85 ppb for 8 hours, people with respiratory problems should reduce outdoor activity.

** At or above 105 ppb for 8 hours, all people should reduce outdoor activity.



Current Visibility Conditions from Look Rock



Compare





Air & Radiation

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- Basic Information
- Indoor Air
- Transportation/Fuels
- Nonroad Equipment
- Acid Rain
- Ozone Depletion
- Climate Change
- Visibility**
- Toxic Air Pollutants
- Radiation
- Grants & Funding
- Publications
- What You Can Do
- Tools & Technical Info
 - AIRNow
 - Emissions Trading
 - Air Data & Maps
 - Green Vehicles
 - TTN - Technology Transfer Network
- Air Homepage

Visibility

This site describes visibility impairment caused by air pollution in the United States. One of the most basic forms of air pollution - haze - degrades visibility in many American cities and scenic areas.



What is Visibility Impairment?



EPA's Regional Haze Program



Regional Planning Organizations



Visibility in Parks & Wilderness Areas

Great Smoky Mountains National Park



Clear Day



Hazy Day



Real Time Image Last 15 Minutes.

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[EPA Home](#) > [Air & Radiation](#) > [Air Quality Planning & Standards](#) > [AIRNow](#) > Tomorrow's Air Quality Forecast

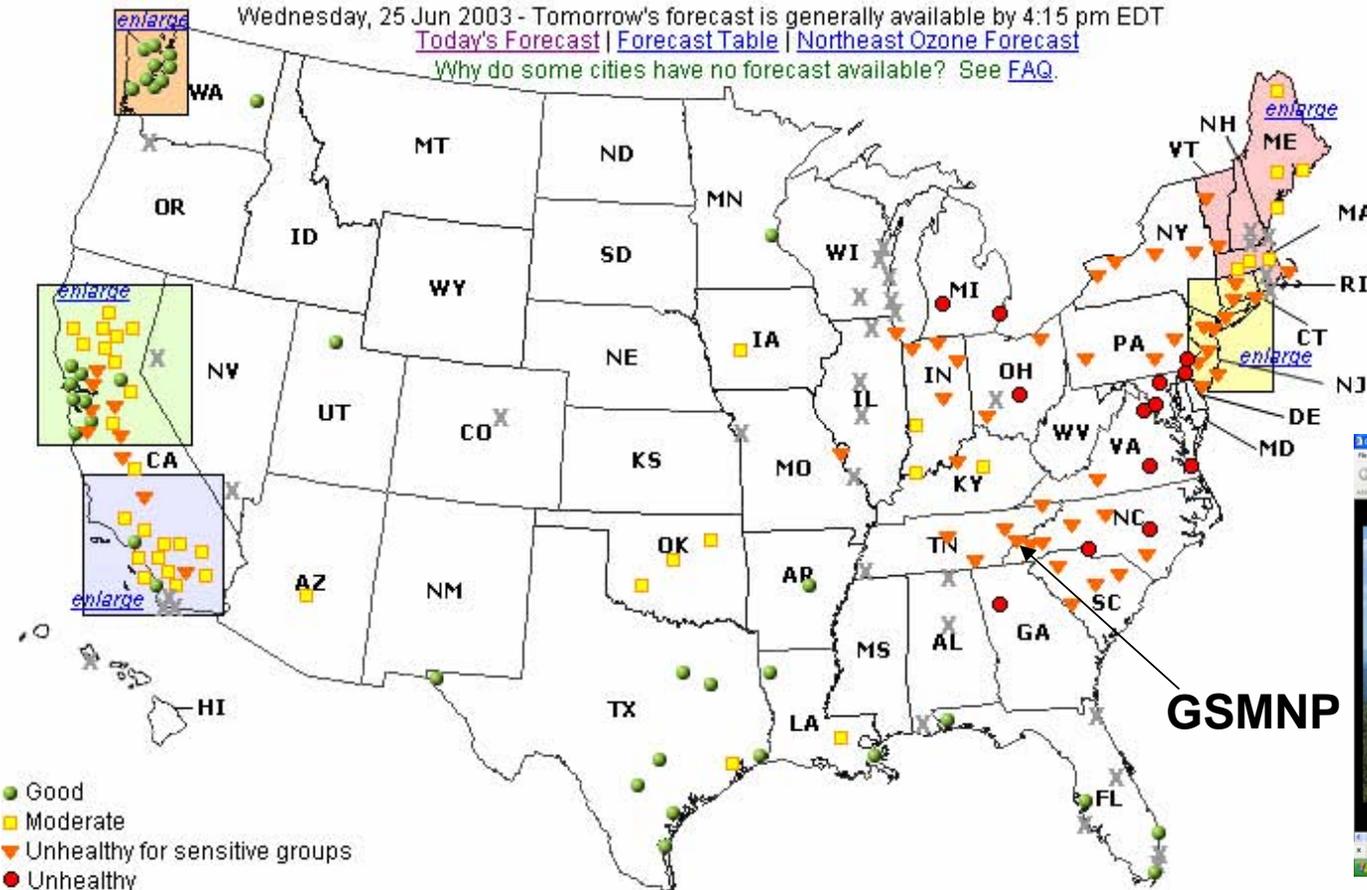
Tomorrow's Air Quality Forecast



Wednesday, 25 Jun 2003 - Tomorrow's forecast is generally available by 4:15 pm EDT

[Today's Forecast](#) | [Forecast Table](#) | [Northeast Ozone Forecast](#)

Why do some cities have no forecast available? See [FAQ](#).

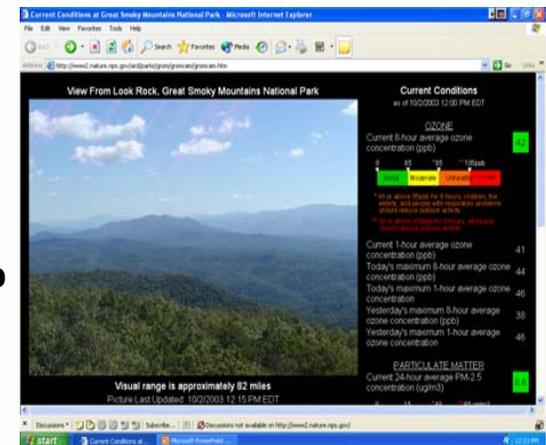


- Good
 - Moderate
 - ▲ Unhealthy for sensitive groups
 - Unhealthy
 - ◆ Very unhealthy
 - ! Hazardous
 - X No forecast available
- Placement of cities on this map is approximate.

[EXIT disclaimer](#)

Air Quality forecasts are provided by State and local agencies, using EPA's Air Quality Index (AQI), a uniform index that provides general information to the public about air quality and associated health effects.

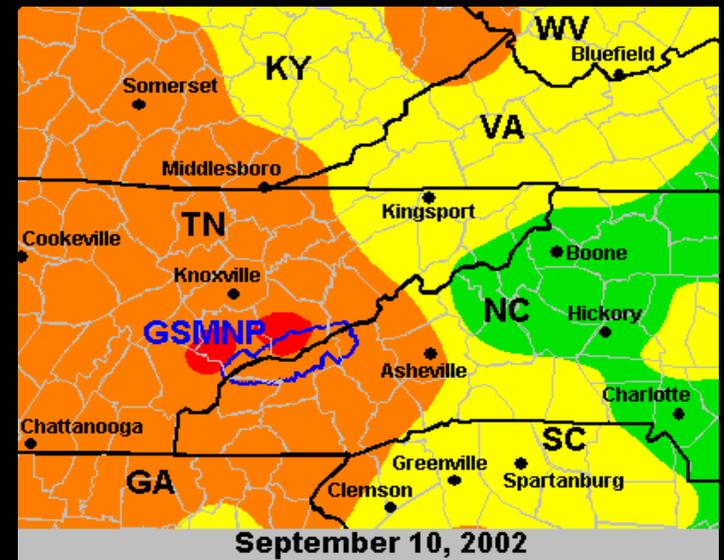
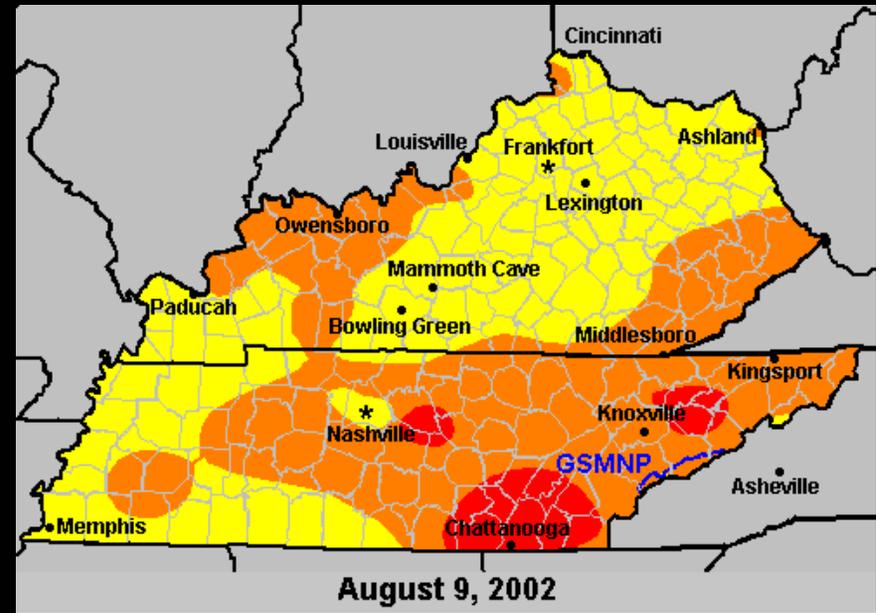
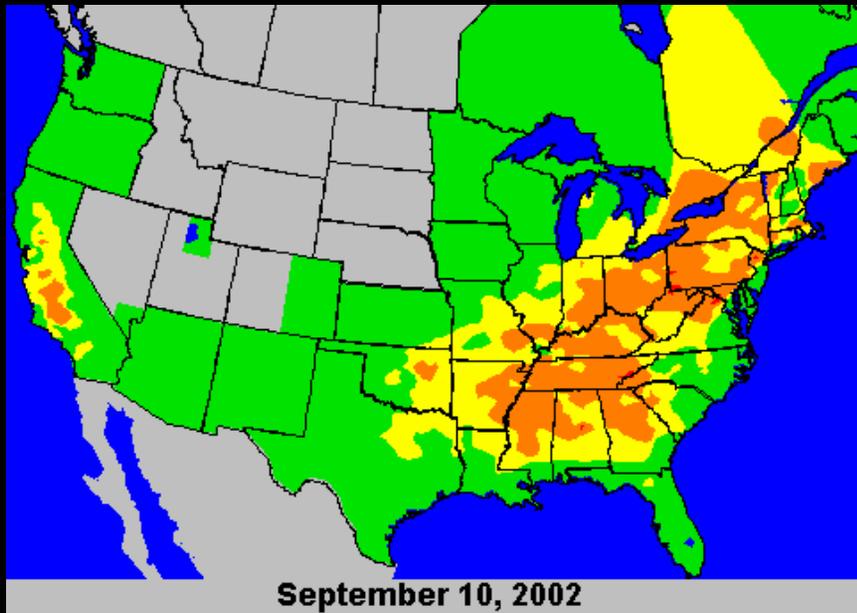
Cities which have web sites with information about air pollution in their location have links associated with their spot on the map. A more [detailed forecast](#) is also available.



NOTE: Most links on this page are pointers to other hosts and locations in the Internet. This information is provided as a service; however the U.S. Environmental Protection Agency does not endorse, approve or otherwise support these sites.



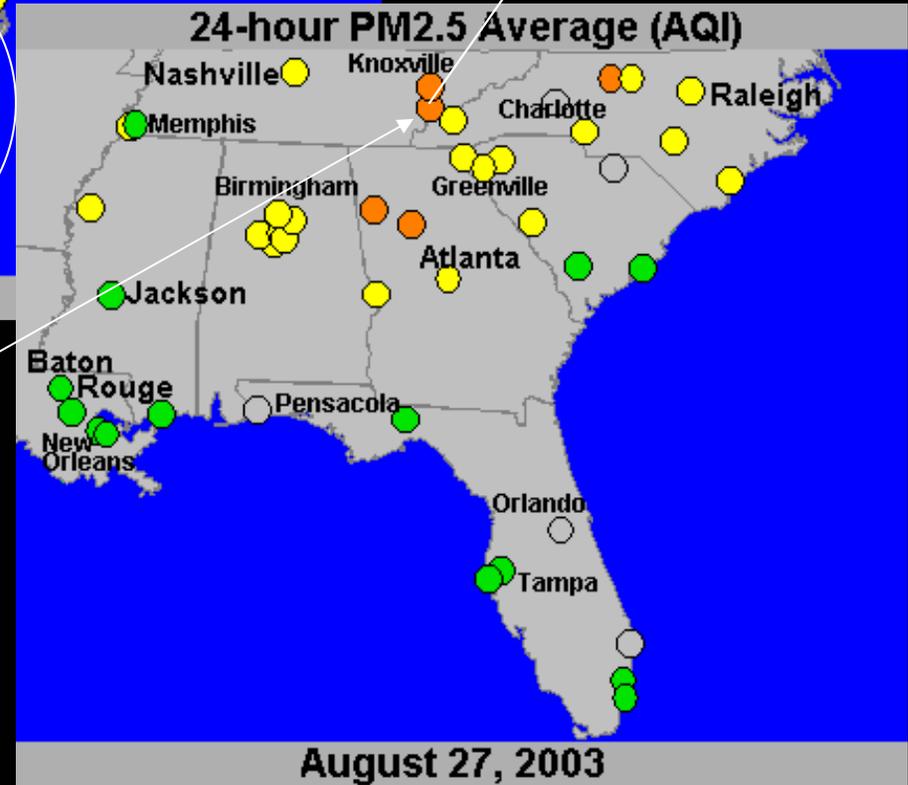
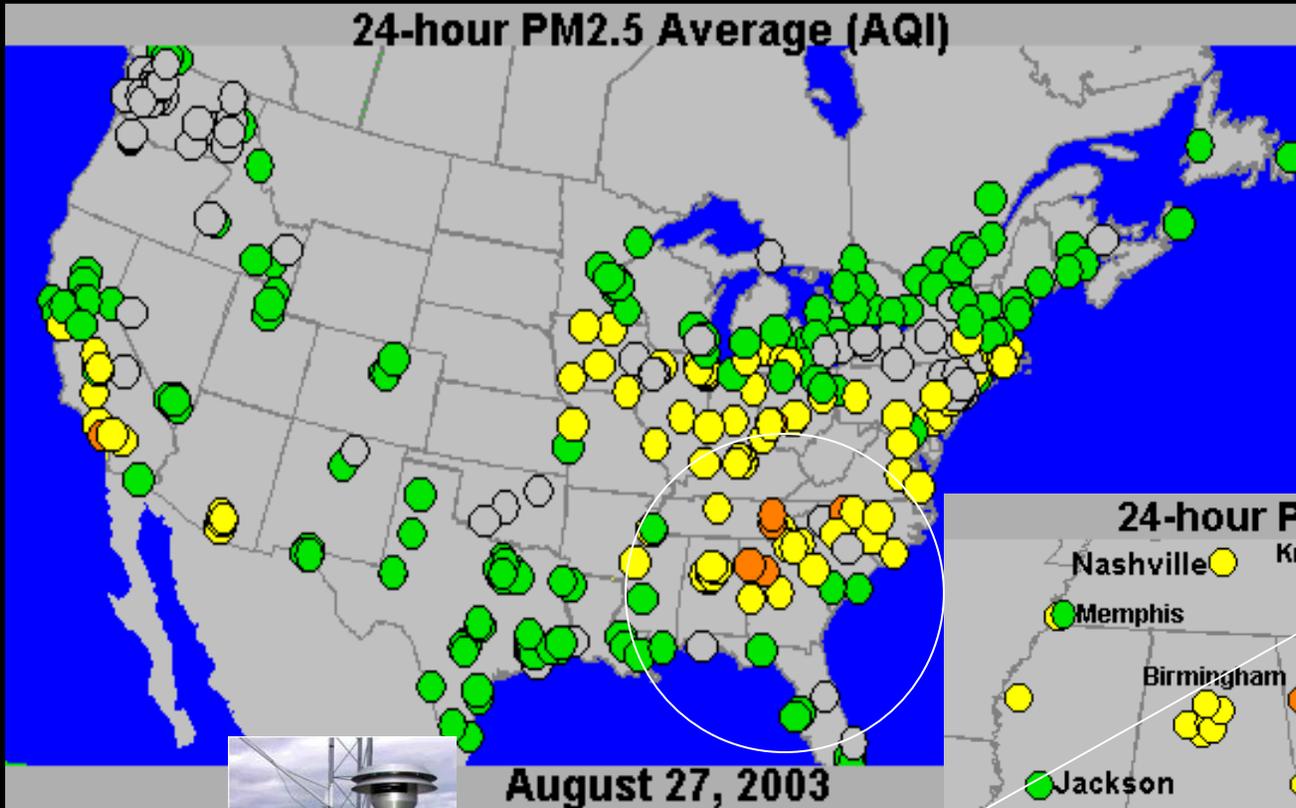
O₃ Mapping (U.S., State, NPs, and GSMNP Domains)



PM_{2.5} Mapping (U.S. & Regional)



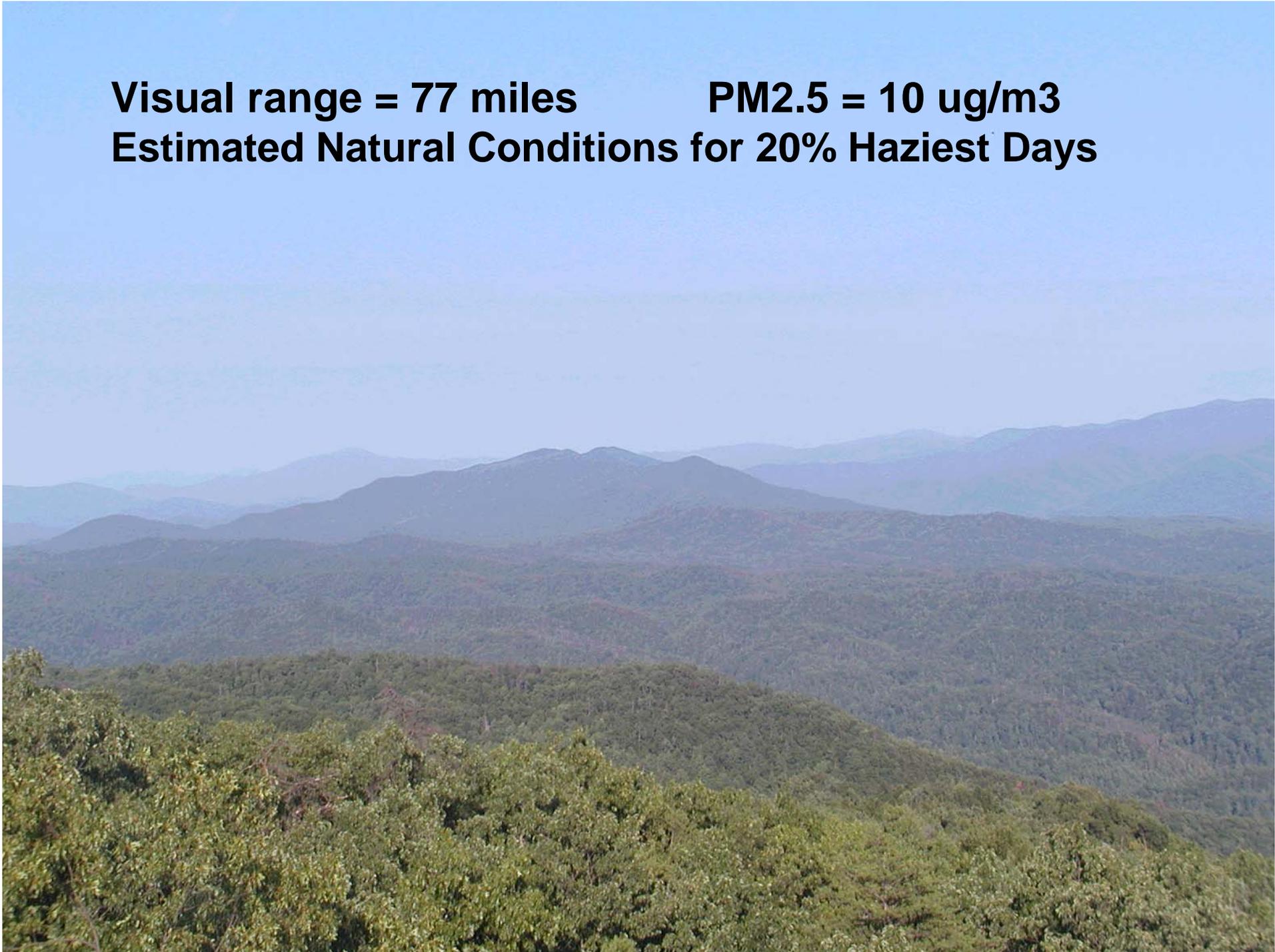
Visual Range = 5 miles
PM_{2.5} = 50 ug/m³







Visual range = 77 miles **PM2.5 = 10 ug/m³**
Estimated Natural Conditions for 20% Hazy Days





Visual range > 200 miles

PM2.5 = 2 ug/m³

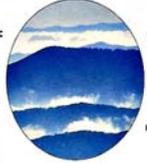


Brochures and reports available to the Public on the real-time webcam page

GREAT SMOKY MOUNTAINS NATIONAL PARK MANAGEMENT FOLIO #2

AIR QUALITY

AIR POLLUTION IS SHRINKING SCENIC VIEWS, DAMAGING PLANTS, AND DEGRADING HIGH ELEVATION STREAMS AND SOILS IN THE GREAT SMOKY MOUNTAINS.



EVEN HUMAN HEALTH IS AT RISK. MOST POLLUTION ORIGINATES OUTSIDE THE PARK AND IS CREATED BY POWER PLANTS, INDUSTRY, AND AUTOMOBILES.

RESEARCH and monitoring conducted in Great Smoky Mountains National Park has shown that airborne pollutants emitted from mostly outside the Smokies are degrading park resources and visitor enjoyment. The burning of fossil fuels—coal, oil, and gas—causes most of the pollution. Inadequate pollution control equipment in power plants, factories, and automobiles is the primary problem.

Wind currents moving toward the southern Appalachians transport pollutants from urban areas, industrial sites, and power plants located both near and far. The height and physical structure of the mountains, combined with predominant weather patterns, tend to trap and concentrate human-made pollutants in and around the national park.

SHRINKING VIEWS
Views from scenic overlooks at Great Smoky Mountains National Park have been seriously degraded over the last 50 years by human-made

pollution. Since 1948, based on regional airport records, average visibility in the southern Appalachians has decreased 40% in winter and 80% in summer. These degradations in visibility not only affect how far one can see from a scenic overlook, they also reduce how well one can see. Pollution causes colors to appear washed out and obscures landscape features. Pollution typically appears as a uniform whitish haze, different from the natural mist-like clouds for which the Smokies were named.

The burning of fossil fuels produces tiny airborne sulfate particles which scatter light and degrade visibility. Increasingly, visitors no longer see distant mountain ridges because of this haze. Annual average visibility at Great Smoky Mountains National Park is 25 miles, compared to natural conditions of 93 miles. During severe haze episodes, visibility has been reduced to under one mile.

Air pollution travels here from as far away as Ohio and Louisiana and stagnates in the mountains.



Air pollution travels here from as far away as Ohio and Louisiana and stagnates in the mountains.

77% Power Plants
12% Factories
3% Other
8% Vehicles

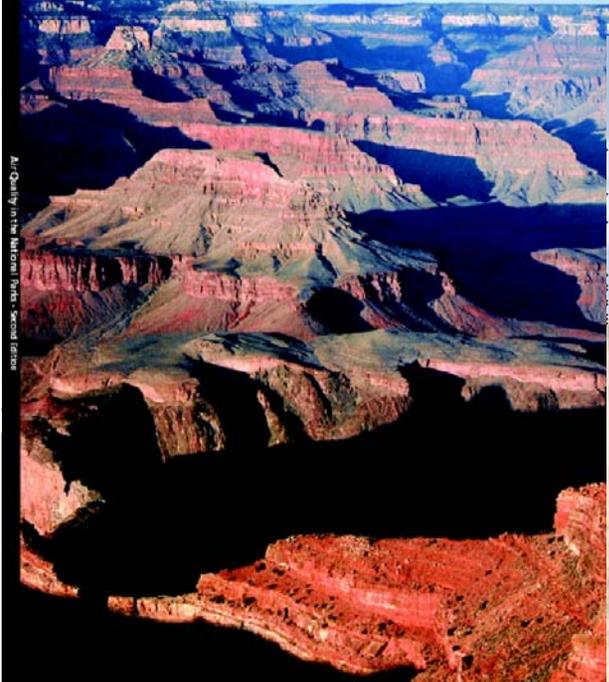
Source of sulfur dioxide in the Smokies.

73% Sulfates
19% Carbon
2% Nitrogen
6% Sulfates

Types of particles which contribute to summer haze.

National Park Service
U.S. Department of the Interior
Air Resources Division

Air Quality in National Parks



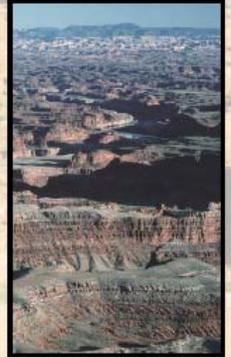
Air Quality in the National Parks - Second Edition



Introduction to Visibility

William C. Malm





CIRA
ISSN 0737-5352-40

Colorado State
Laboratory

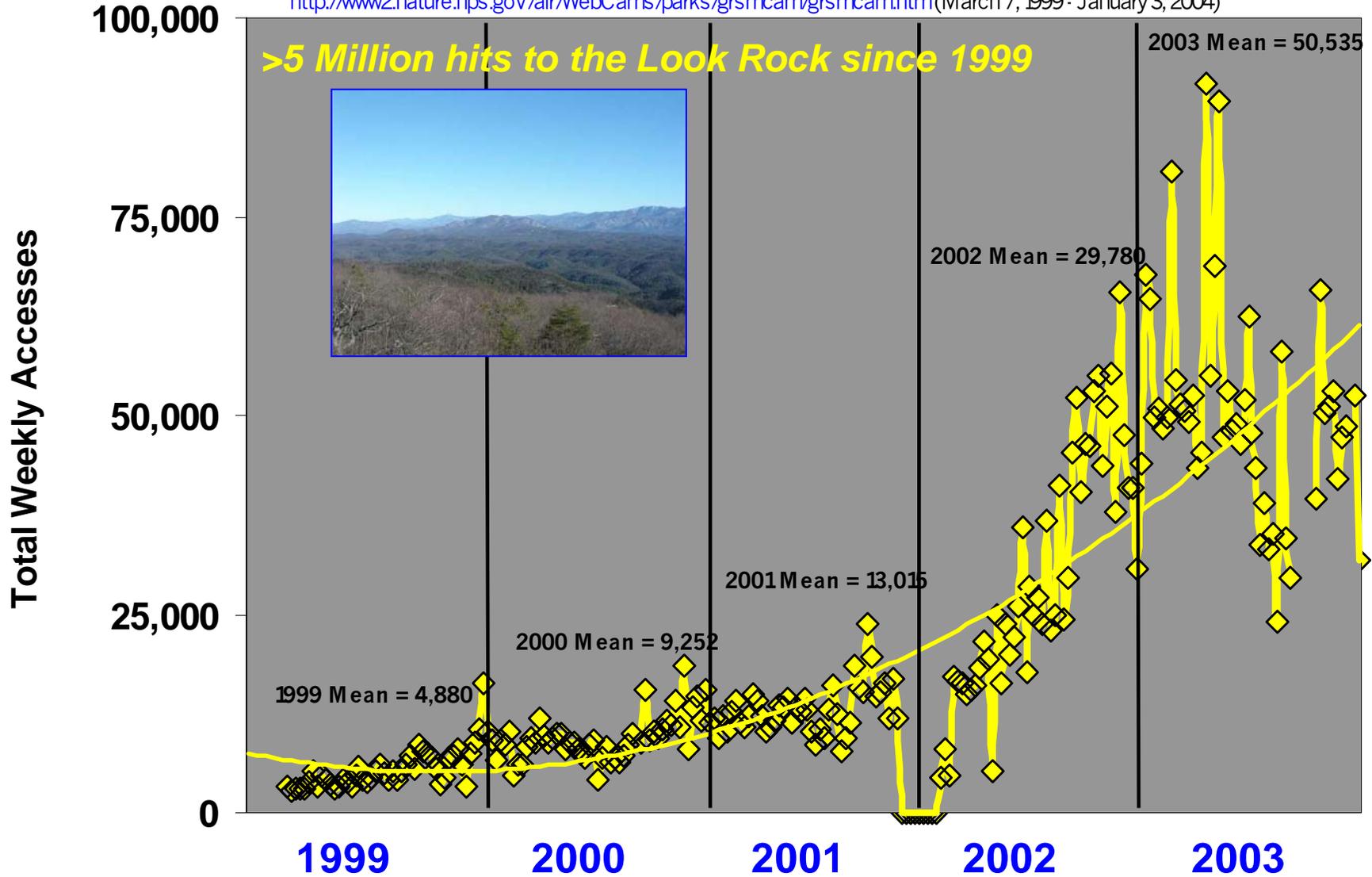
Hosting Numerous Field Trips Touring the Sites



Number of Weekly Accesses

Great Smoky Mtns NP Real-time Air Quality Website

<http://www2.nature.nps.gov/air/WebCams/parks/grsmcam/grsmcam.htm> (March 7, 1999 - January 3, 2004)



NATURAL SOUNDS PROGRAM

Programs

- ▶ **Current Issues**
- ▶ **Laws & Policies**
- ▶ **Overview**
- ▶ **Publications**
- ▶ **RM 47 -coming soon!**

In Depth

- ▶ **About Natural Sounds**
- ▶ **Organization**
- ▶ **Personnel/Contacts**
- ▶ **Sound Glossary**

Definition of Natural Soundscapes

A natural soundscape is an area characterized by certain ambient acoustical and sound level qualities. In a national park setting, a natural soundscape is composed of a variety of both natural ambient sounds and human caused sounds, where many visitors have an expectation of seeing, hearing and experiencing phenomena associated with a specific natural or cultural environment. In some parks sounds of man can be appropriate to the cultural or historic setting of the park.

Sounds from the national parks units. Mouse over an image and listen.



“How great are the advantages of solitude! How sublime is the silence of nature's ever-acting energies! There is something in the very name of wilderness, which charms the ear and soothes the spirit of man.”

Estwick Evans, 1818

***Great Smoky Mountains NP is the first park to install and monitor natural sound (on-line 11/18/03 at Purchase Knob/APHI Learning Center)**









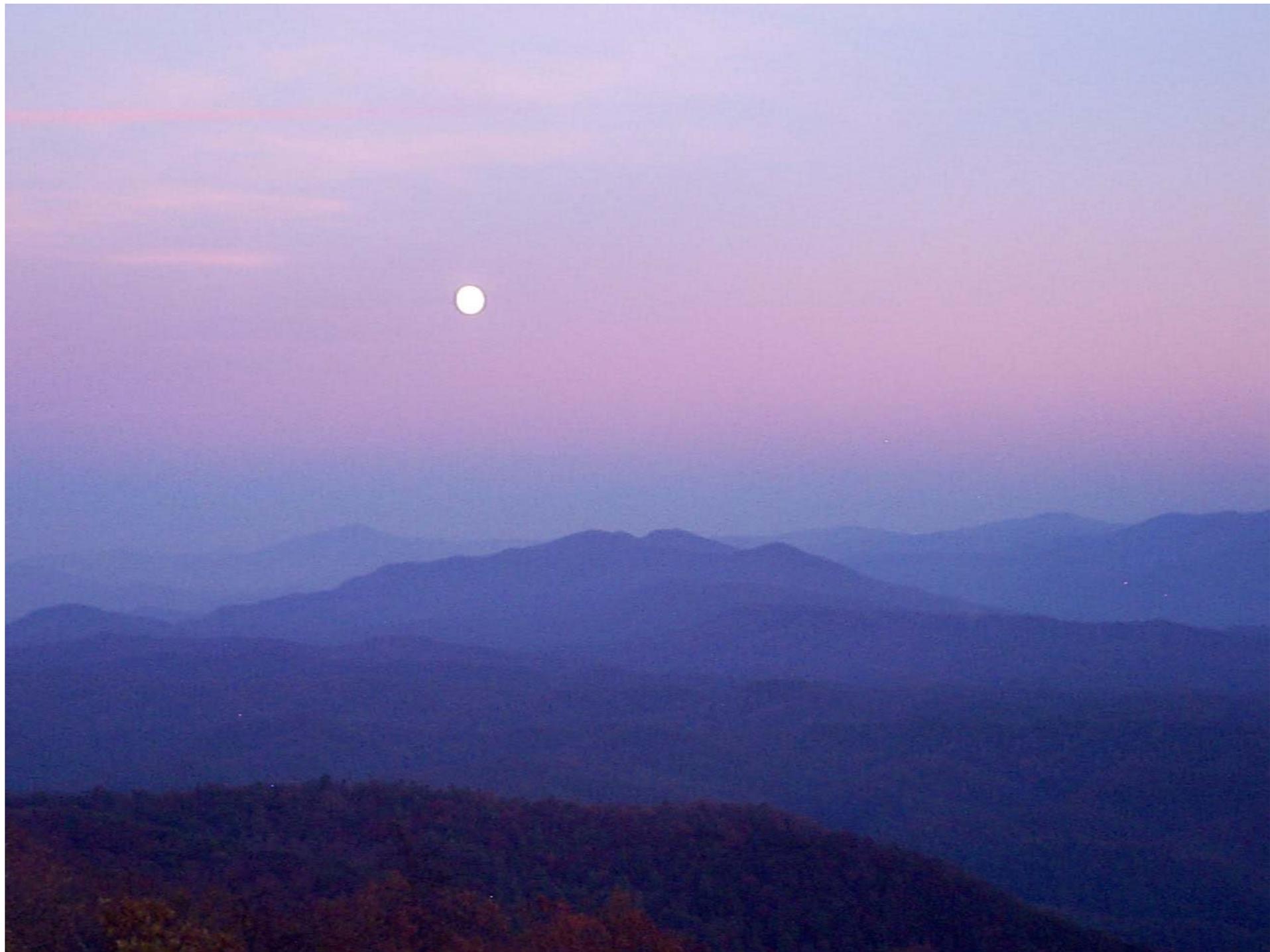












Example Uses of AQ Webcam

- Relate visual image w/associated ambient AQ
- Regional Haze planning (20% best & worst days)
- See weather in the “high country” (temp, cloud level, precip)
- See air pollution levels (ozone, PM_{2.5})
- Trip activity planning (hikes, health, media, roads)
- Episode selection for atmospheric modeling
- Time-lapse or time-series
- Track fall color “peak”
- Prescribed fire monitoring (spread, plume rise)
- Military aircraft trip planning (cloud type, height)
- Boundary layer, inversion (forecasting)
- School science projects
- View sunrises, sunsets, moonrises

“A Picture is Worth a Thousand Words” (or data points)



Questions?
Comments?

