INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS

IMPROVE

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IMPROVE MONITORING UPDATE

Preliminary data collection statistics for the Winter 1994 season (December 1993 - February 1994) are:

Data Type	Collection Percentage
Aerosol Data	96%
Optical (transmissometer) Data	90%
Scene (photographic) Data	84%

Figure 1 is a map of the current IMPROVE and IMPROVE Protocol sites. The CASTNet program has adopted IMPROVE optical and scene monitoring protocols, but is using different aerosol monitoring techniques.

Network changes in the last quarter included the installation of an IMPROVE sampler (stage A only) at Sawtooth National Forest, Idaho.

The USFS is expanding its IMPROVE Protocol monitoring network. Three sites, Gila, Shining Rock, and Great Gulf Wildernesses, will be reconfigured to include IMPROVE aerosol samplers, nephelometers, and cameras.

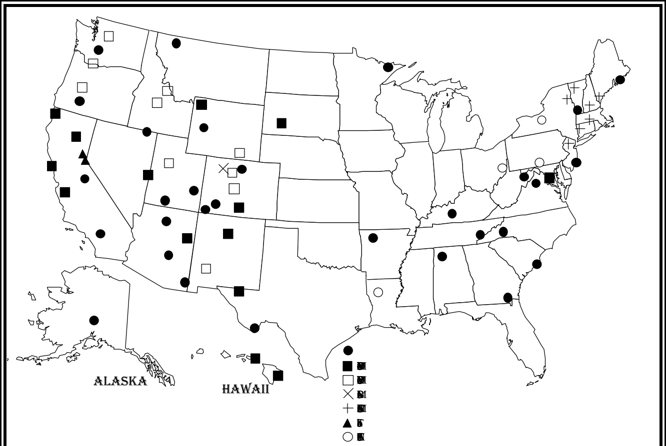

Figure 1. IMPROVE and IMPROVE Protocol Sites April 1994

Aerosol data for the Summer 1993 season are complete and seasonal summaries have been submitted to the NPS. Analyses of Fall 1993 data are underway.

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Feature Article

THE EVOLVING IMPORTANCE OF PHOTOGRAPHIC VISIBILITY MONITORING

IMPROVE monitoring protocols describe three primary monitoring components: scene, optical, and aerosol. Scene monitoring refers to photography that is representative of the visual air quality in the area of interest. 35mm color slides are taken daily at every IMPROVE and IMPROVE Protocol site. Although generally taken at 0900, 1200, and 1500 local time, slides can be taken at any time of day to capture visually sensitive events. Time-lapse movies (generally super 8mm film or time-lapse video) have also been used at selected sites and during special studies to document the visual dynamics of a scene or source.

The combination of scene, optical and aerosol measurements addresses the primary visibility monitoring needs of the scientist, decision-maker, and the public. Each monitoring component provides unique information:

Scene The photographic record documents the appearance of a scene. Scene characteristics include color, texture, contrast, clarity, observer visual range, and other terms. Photography is uniquely suited for identifying ground-based or elevated layers or plumes that are below, above, or some distance away from aerosol or optical monitoring sites.

Optical The ability of the atmosphere to scatter or absorb light passing through it is measured by optical instrumentation. The physical properties of the atmosphere are described by extinction, scattering, and absorption coefficients, plus an angular dependence of the scattering known as the normalized phase function. Optical characteristics integrate the effects of atmospheric aerosols and gases.

Aerosol The physical properties of ambient atmospheric particles and gases include chemical composition, size, shape, concentration, temporal and spatial distribution, and other physical properties. Aerosol monitoring is principally conducted to characterize the causes of visibility impairment.

PRESENT ROLE OF PHOTOGRAPHIC MONITORING

The role of photographic monitoring is evolving due in large part to technological advances in both photography and other monitoring equipment. Today the varied uses, advantages, and limitations of photographic visibility monitoring can be summarized as follows.

Essential and/or Advantageous Roles of Photography

Document how vistas appear under various air quality, meteorological and seasonal conditions. Photographs can be used to translate the visual significance of measured aerosol and optical values and are the only

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EVOLVING (continued from page 1)

way to identify layers, plumes, and other visual events that can not be measured by ground-based measurements (e.g., an elevated, distant plume.)

Record the frequency with which various visual air quality conditions occur (e.g., incidence of uniform haze, layered haze, plumes or weather events). Similar to airport observations, compiling a frequency distribution of how often selected features at known distances can be seen in a photographic record can yield an understanding of the visual conditions of an area.

Record the visual sensitivity of views to variations in ambient air quality:

videntify local sources (industrial, fire, dirt roads, etc.).

videntify potential areas of impairment.

Document the visual dynamics of a source or scene:

vTime-lapse photography of source emissions can be used in source attribution studies and to support air quality modeling particularly in complex terrain or where complex meteorological patterns exist (e.g., time-lapse surveillance of a source's plume to verify or enhance plume transport and dispersion modeling, particularly under conditions where atmospheric stability, wind speed, and wind direction vary dramatically with height).

vTime-lapse photography is particularly useful for documenting dynamic visibility events. At locations such as large urban areas where visibility changes rapidly, time-lapse images can provide valuable insights and lead to a clearer understanding of events.

Visually support presentations of program goals, objectives, and results to decision makers and the public. Photographs dramatically and effectively support:

v displays
v video productions
v presentations
v community forums
v seminars
v scientific visualization
v hearings

Support human perception research.

Automatic 35mm Camera Enclosure at Tonto National Monument

Provide a basis for digital image modeling. Pristine slides of a scene can be digitized and used as the primary image for computer image simulation modeling of visibility impairment.

Limited or Inappropriate Uses of Photography

(including some uses that were formerly significant)

Cannot provide quantitative information on the cause and effect of visibility impairment unless a specific source and plume are visible in a scene. Aerosol and optical measurements are required to understand the chemical and physical properties of the aerosols and their resulting optical effects.

Cannot provide accurate estimates of the atmospheric extinction coefficient (b_{ext}). Although used in the past as a technique to estimate extinction, the uncertainty of slide-based estimates of b_{ext} is now considered to be too high when compared to currently available optical instruments such as transmissometers and nephelometers.

vSlide-derived b_{ext} estimates of seasonal visibility were generally based on a maximum of 270 slides (90 day x 3 photographs a day). However, at many sites, weather conditions and other circumstances limit the slides usable for contrast measurements to 100 to 200 slides. Transmissometers and nephelometers are now able to provide continuous hourly averages of b_{ext} or b_{scat}. Slide-based seasonal cumulative frequency distributions, based on a maximum of three instantaneous measurements per day during daylight hours, do not compare well with transmissometer or nephelometer-based distributions derived from hourly averages.

vTo estimate b_{ext} from slide contrast measurements, numerous assumptions about the atmospheric conditions, target conditions, film exposure and film processing are required. Ideal conditions include: uniform dark target, clear sky, uniform air quality within the sight path, uniform sight path illumination, exact target distances, and perfect film exposure. Due to naturally occurring variations, these ideal conditions are seldom realized and result in individual slide b_{ext} uncertainties of between 50% and 200%. Optical instruments that are now available, such as the transmissometer and ambient nephelometer, make direct, continuous, quantitative measurements of the optical properties of the ambient atmosphere with precision approaching 10%.

vCaution must be applied when using b_{ext} values derived from slides. The use of b_{ext} estimates from individual slides is not appropriate because of the wide range of probable uncertainty. For ideal monitoring sites, calculated seasonal values average the uncertainty of individual measurements so that seasonal medians may appear to be fairly representative of median visibility. The uncertainty of b_{ext} estimates increases as you move away from the median toward the tails of the cumulative frequency distribution.

Urban Installation Of A Video Time-Lapse Camera

- Bias can also exist in the data depending on the ability to effectively determine and account for:
  - target inherent contrast
  - film exposures
  - target distances
  - frequency of occurrence of target obscuring haze and weather events
  - other parameters

Cannot be considered a permanent archive. Photographs age (fade) with time and use. Current digital technology, however, can be used to digitize slides and to archive the images on a more permanent media.

THE FUTURE OF PHOTOGRAPHIC TECHNOLOGY

Advances in video technology and digital imaging continue. Video and digital single frame and time-lapse systems now exist, but are still expensive and have limitations. Although film will likely be around for a long time, the application of video and digital imagery is evolving rapidly and may soon replace film for a number of applications. For example, time-lapse video systems have become the preferred alternative for long-term time-lapse monitoring where power is available and sites are secure, such as urban monitoring from secure rooftops. The IMPROVE program is watching these developing technologies closely.

At present, 35mm slides remain the primary format of the IMPROVE photographic strategy with 8mm time-lapse film used for selected special studies. 35mm slides and 8mm movie film make up the national visibility archive. IMPROVE archives are kept at room temperature and low relative humidity in file cabinets. Under these conditions, the film products age slowly. However, film products do have a limited life. The contrast and color of these photographs can be expected to fade with age. Film also fades rapidly when exposed to the intense light of a projector. Slides or other film products used to present visibility issues to the public must be replaced often. Projecting a slide for as little as 10 minutes can cause noticeable degradation.

Technical advances and commercialization of digital image products, primarily Kodak Photo CD, have made the digitization of high resolution slides practical and affordable. The advantages of the Photo CD are its extended life and the ability to make exact duplicates of the digital image without degradation from the original. Transferring slides from a photographic archive to Photo CD provides insurance that a long term record of current events will be available well into the future. Photo CD display systems for TV and computers are becoming common. As digital technologies advance, the information on a Photo CD could be transferred to other media.

Although 8mm time-lapse film can be easily transferred to video tape, video tapes also have a limited life. The quality of the magnetic signals on the tapes will degrade as the tape ages. Quality is also lost with every generation of video reproduction. Digitization of time-lapse film, however, is not yet available at practical commercial rates.

CONCLUSION

No matter what numerical data is captured by optical and aerosol samplers, photography has the unique ability to relate what the numbers mean to decision makers and the public. Photographs are the link between science and the present and future public.

VISIBILITY NEWS.....

AEROSOLS AND ATMOSPHERIC OPTICS SPECIALTY CONFERENCE

Make reservations now for the AWMA/AGU International Specialty Conference:

Aerosols and Atmospheric Optics:
Radiation Balance and Visual Air Quality
Snowbird, UT
September 25-30, 1994

The conference program chairmen have received an exceptional collection of abstracts from scientists world-wide; the selection process will be challenging. The response to the call for papers was beyond expectations and everyone associated with the conference is excited and enthusiastic about this event.

For more information and to be included on the conference mailing list, call 801-378-5474

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525

TO:

First Class Mail

IMPROVE STEERING COMMITTEE

IMPROVE Steering Committee members represent their respective agencies and meet periodically to establish and evaluate program goals and actions. IMPROVE-related questions within agencies should be directed to the agency's Steering Committee representative. Steering Committee representatives are:

U.S. EPA
Marc Pitchford
Environmental Monitoring Systems Lab
P.O. Box 93478
Las Vegas, NV 89193-3478
702/895-0432 (Phone)
702/895-0496 (Fax)

U.S. EPA
Joe Elkins
MD-14
OAQPS
Research Triangle Park, NC 27711
919/541-5653 (Phone)
919/541-2357 (Fax)

NPS
William Malm
NPS-AIR
Colorado State University
CIRA - Foothills Campus
Fort Collins, CO 80523
303/491-8292 (Phone)
303/491-8598 (Fax)

BLM
Scott Archer
Service Center (SC-212A)
P.O. Box 25047
Denver, CO 80225-0047
303/236-6400 (Phone)
303/236-3508 (Fax)

USFS
Rich Fisher
Air Specialist, Wash. Office
Rocky Mtn. Experiment Sta.
240 W. Prospect
Fort Collins, CO 80526
303/498-1232 (Phone)
303/498-1010 (Fax)

FWS
Sandra Silva
Fish and Wildlife Service
P.O. Box 25287
Denver, CO 80225
303/969-2814 (Phone)
303/969-2822 (Fax)

NESCAUM
Rich Poirot
VT Agency of Nat. Res.
103 South Main Street
Building 3 South
Waterbury, VT 05676
802/241-3840 (Phone)
802/244-5141 (Fax)

STAPPA
Dan Ely
Colorado Dept. of Health
Air Pollution Control Div.
4300 Cherry Creek Drive S.
Denver, CO 80222-1530
303/692-3228 (Phone)
303/782-5493 (Fax)

WESTAR
John Core
Executive Director
1001 S.W. 5th Ave., Suite 1100
Portland, OR 97204
503/220-1660 (Phone)
503/220-1651 (Fax)

PREVIEW OF UPCOMING ISSUE . . .

The next IMPROVE Newsletter will be published in July 1994, and will include:

- Network Status for the Spring 1994 Season.
- **FEATURE ARTICLE:** Aerosol Monitoring and Analysis Update

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Suite E
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For more information, address corrections, or to receive the IMPROVE Newsletter, contact:

Air Resource Specialists, Inc.
303/484-7941 Phone
303/484-3423 Fax

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