

Interagency Monitoring of Protected Visual Environments (IMPROVE)

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IMPROVE Program Goals and ARL's Role

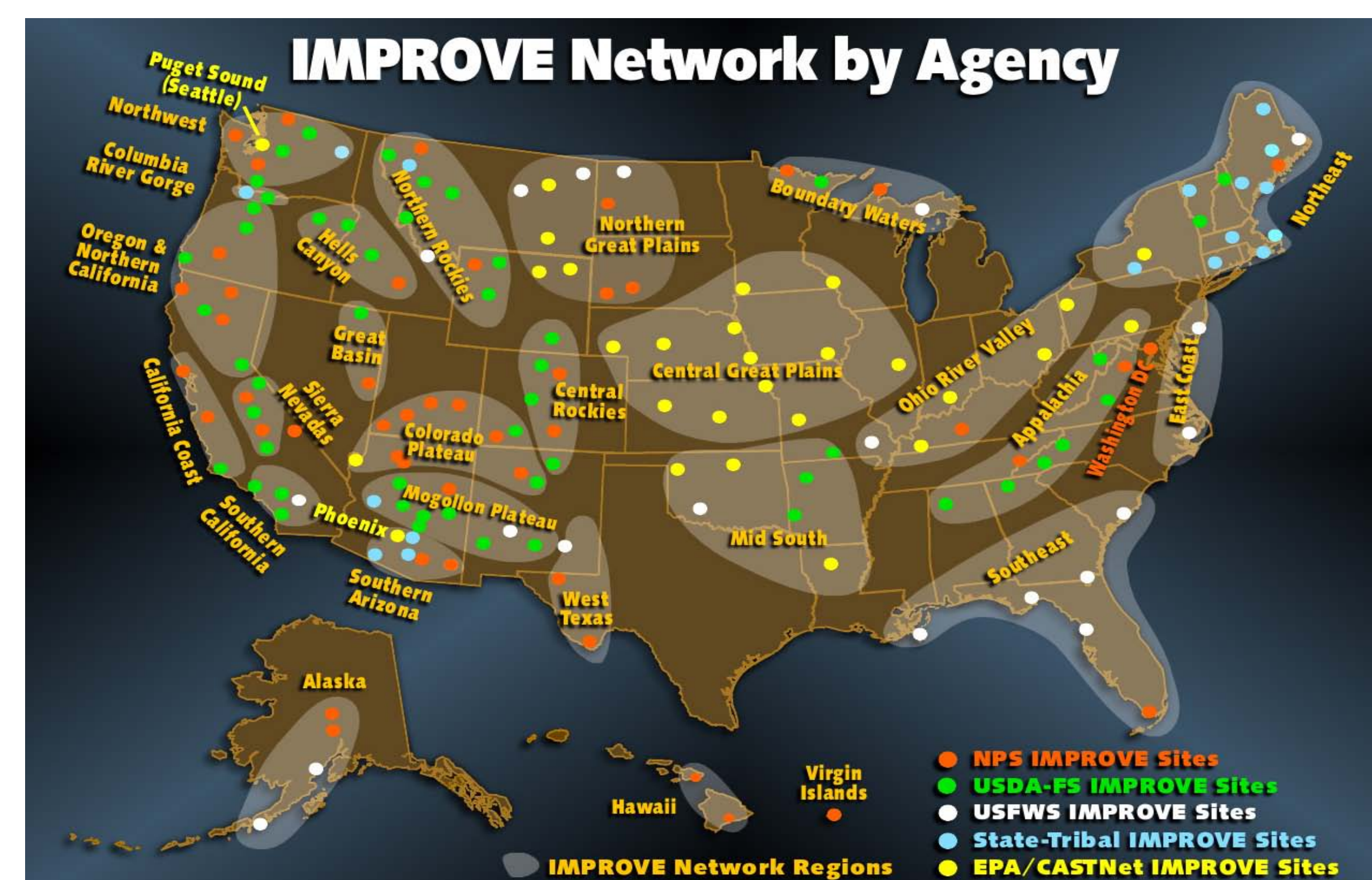
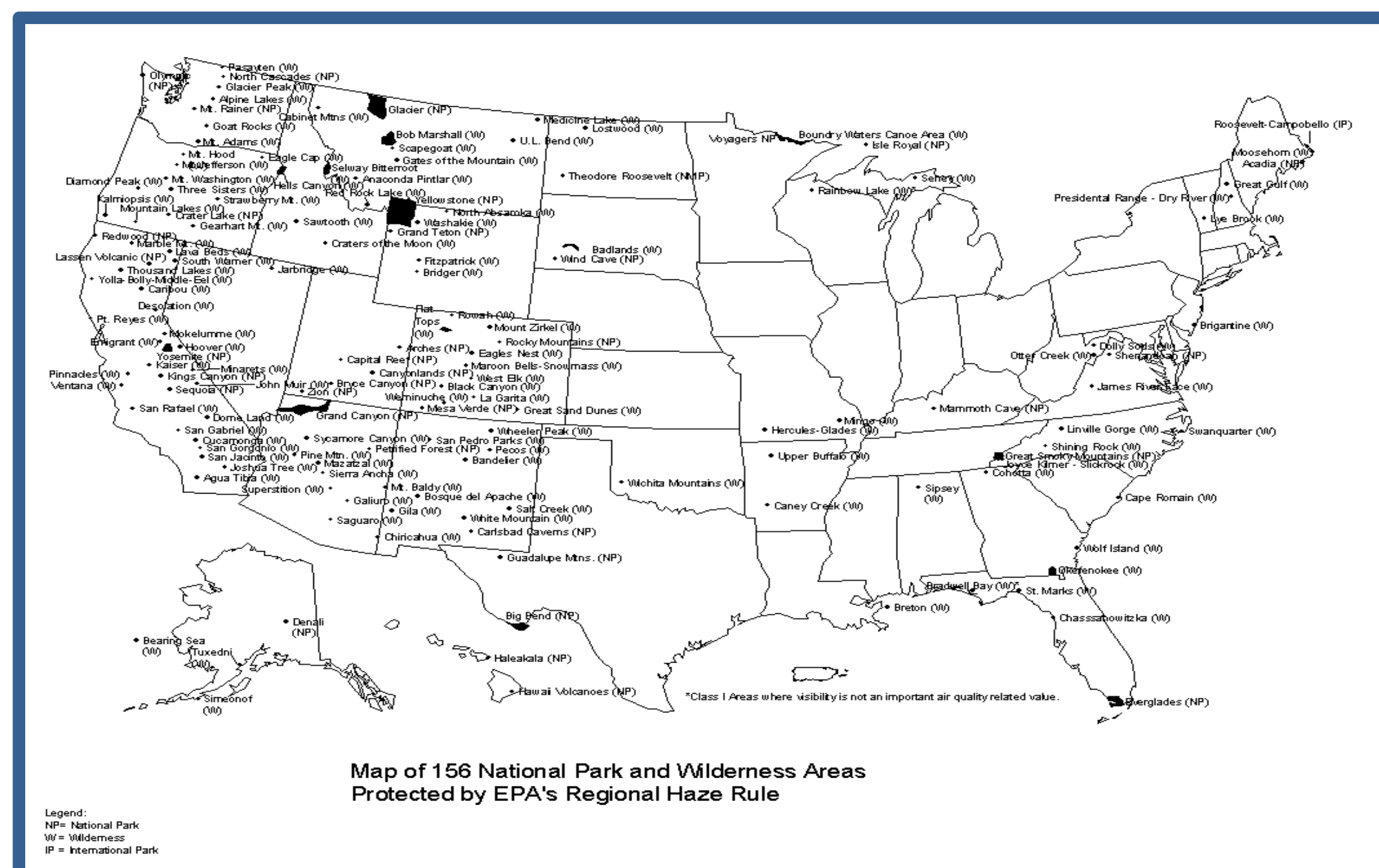
Goals: to meet the monitoring requirements associated with the visibility protection provisions of the Clean Air Act (as amended in 1977)

- Monitoring representative of 156 large National Parks and Wilderness Areas (see map below)
- Monitoring is required to determine visibility levels, track impairment trends and to develop source attribution relationships

ARL's Role: assist EPA, states and federal land managers who have the primary responsibility for federal visibility protection by

- Developing the initial monitoring plan and national network design
- Leading the multi-agency steering committee
- Providing continued technical support as the network evolved over the last 25 years¹

1. Started with 20 sites in 1987, currently over 160 sites including 50 sites not representative of protected areas.



Collaborators

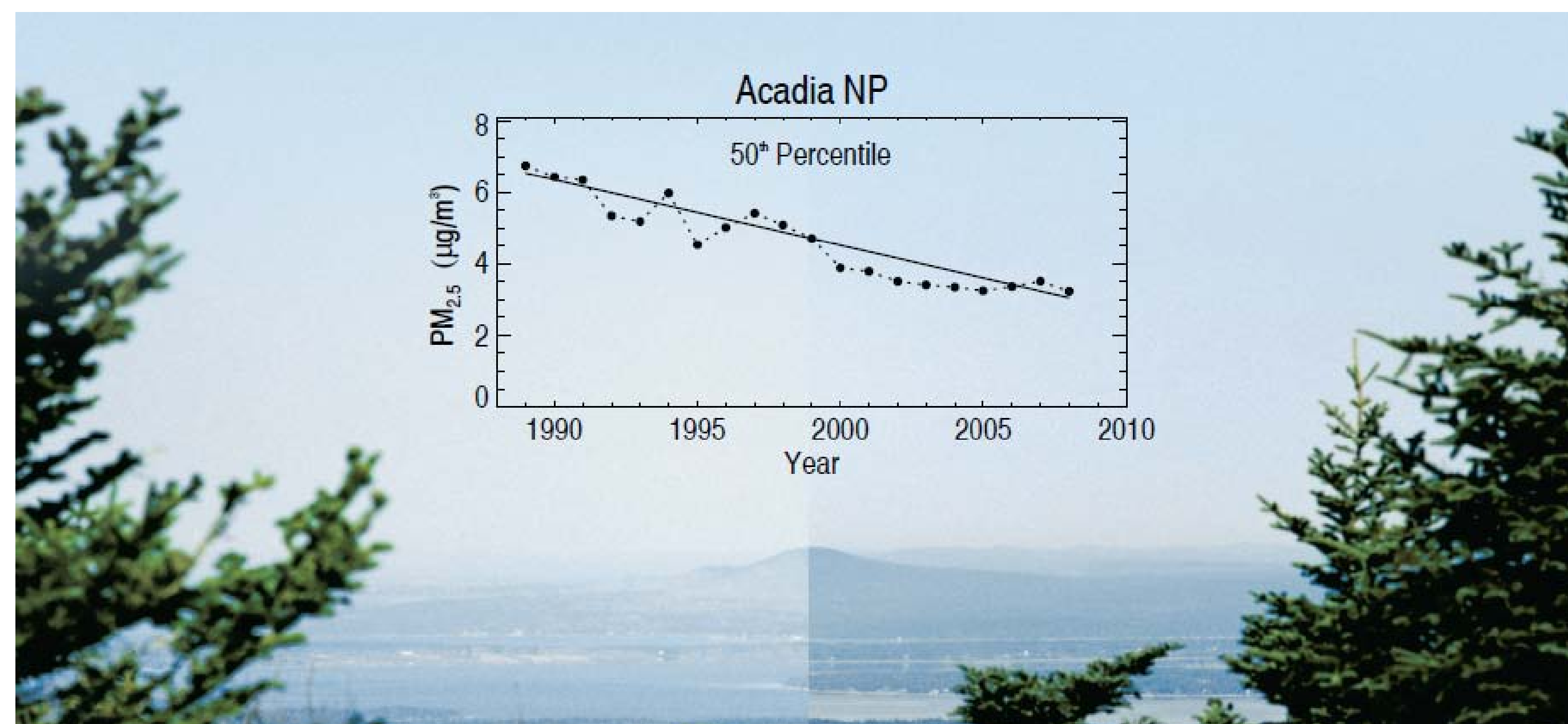
Federal

State

University/Nonprofit



Split-Photo Display of IMPROVE Measured 20-Year Trend



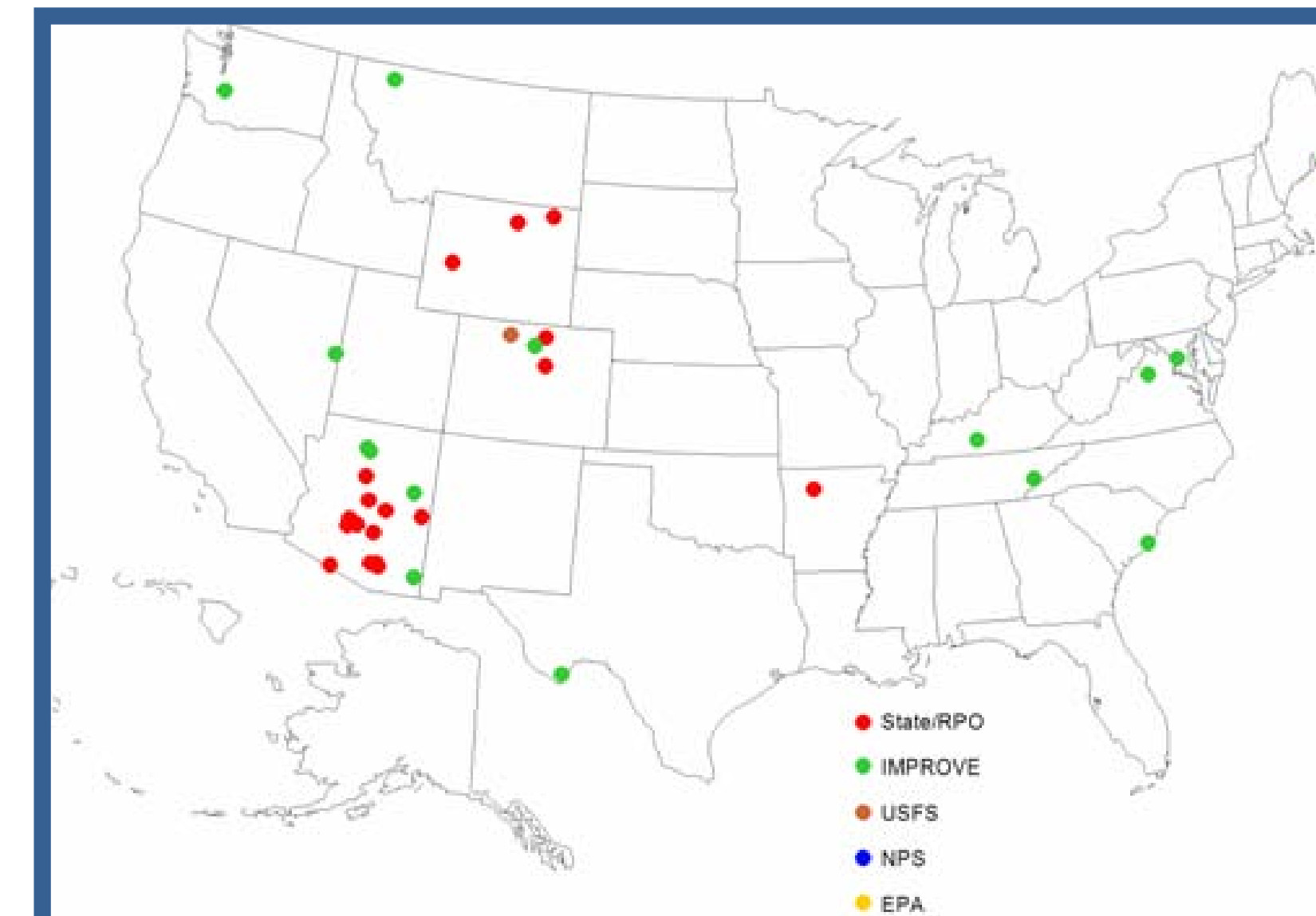
Monitoring Approach

Aerosol monitoring conducted at all sites:

- 24-hour duration sampling every third day
- PM_{2.5} samples collected by three sampling modules on filter substrate compatible with subsequent mass and composition analysis
 - PM_{2.5} and PM₁₀ mass concentration on Teflon filters
 - PM_{2.5} elements by XRF on Teflon filters
 - PM_{2.5} ions by IC on nylon filters behind a carbonate denuder to scrub HNO₃
 - PM_{2.5} organic and elemental carbon by thermal-optical analysis on quartz filters
- Collocated sampling conducted to determine data precision for mass and composition data

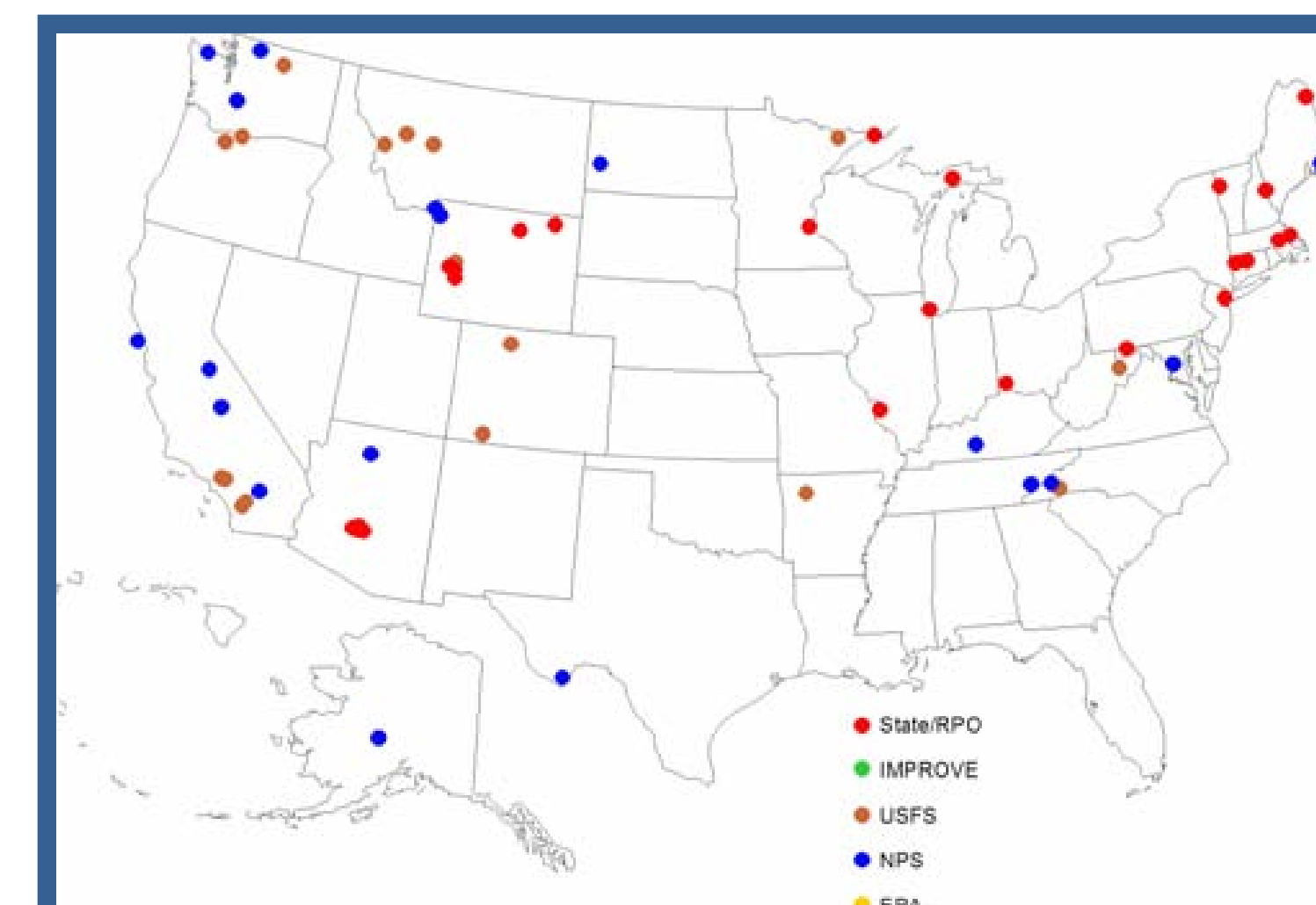
Optical monitoring conducted at some sites (see map below):

- Continuous particle light scattering (b_{sp}), plus temperature and relative humidity measurements
- Performs auto zero calibrations (6-hrs)
- Requires manual span (7-14 days)



Scene monitoring conducted at some sites (see map below)

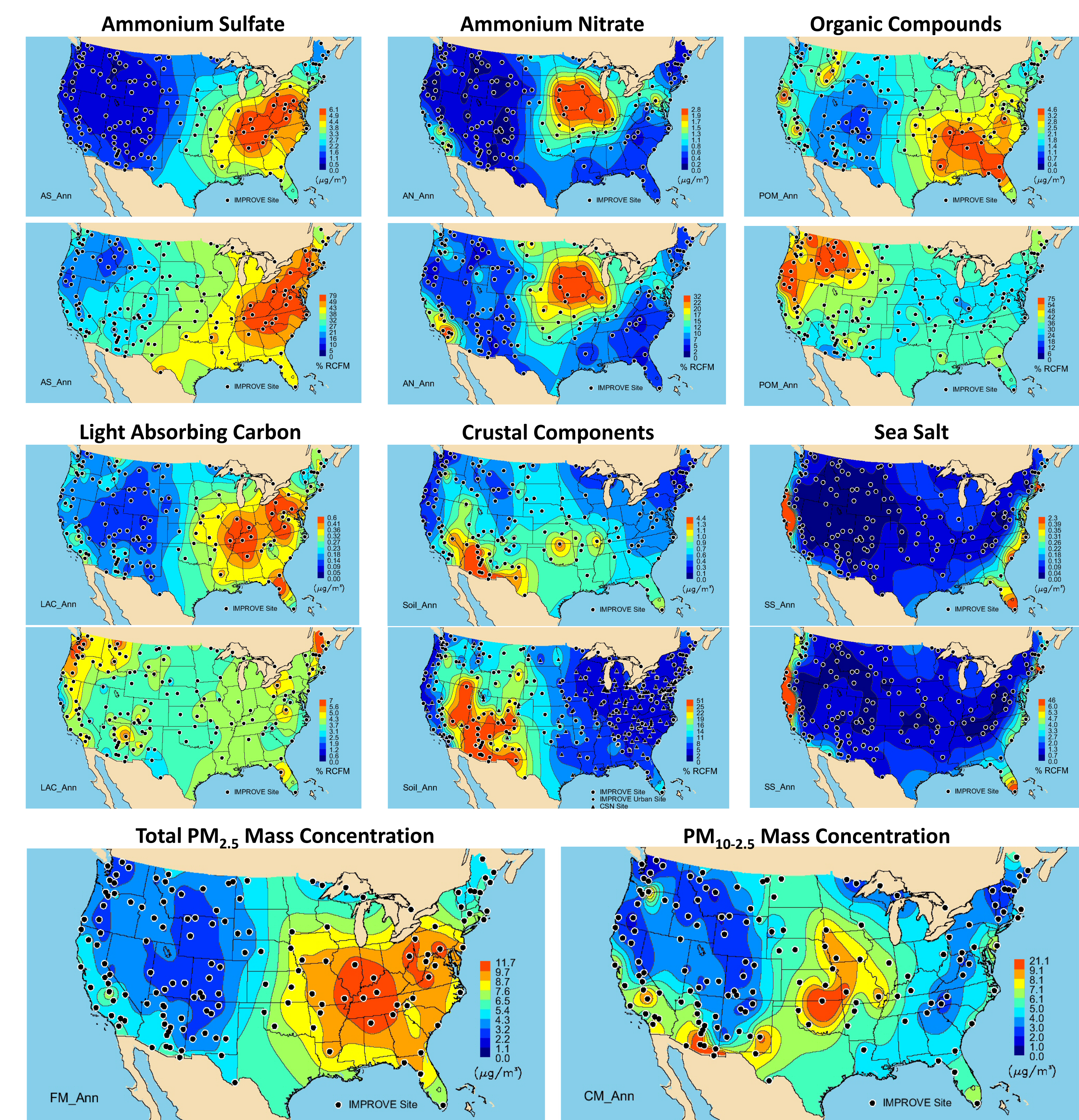
- Visibility camera sites today use high resolution digital cameras
- Most active visibility cameras feed an agency web site
- Before the introduction of digital cameras and other optical monitoring equipment, 35mm slide film was used to capture images for analysis



Indicators of Success

- Consistently greater than 90% data-recovery by calendar quarter over the 25-year data record
- IMPROVE visibility and aerosol composition data used by EPA in the last three reviews of the PM_{2.5} federal standards (1997, 2006, and 2011)
- 1999 Regional Haze Rule requires IMPROVE data (or equivalent) for progress tracking
 - Five-year baseline (2000 to 2004) mean values for visibility-protected areas – used to establish current conditions for every states' Regional Haze Rule State Implementation Plans
 - Second 5-year (2005 to 2009) mean values – currently available for state assessments of progress in meeting Regional Haze Rule
- Data have been used in hundreds of papers, journal articles and reports for
 - Spatial and temporal trends assessment
 - Air quality model verification
 - Episode analysis
 - Source attribution assessment
 - Providing spatial and temporal context for air quality special studies
 - International air pollution transport analysis
 - Black carbon's role as a short-term climate change forcing agent

Four-Year Mean (2004 – 2008) Aerosol Composition Maps ($\mu\text{g}/\text{m}^3$ and % of PM_{2.5})



Information and Data Availability

- IMPROVE website includes background, management, and technical information and data <http://vista.cira.colostate.edu/IMPROVE>
- Quarterly news letter beginning from March 1992
- Fifth IMPROVE Summary Report available Spring 2011