

ROLE OF AMMONIA/AMMONIUM IN VISIBILITY ASSESSMENTS

Nitrate, nitrate, where is the nitrate?

ACKNOWLEDGMENTS

- Dr. Jeffrey Collett, Colorado State University
- IMPROVE and VIEWS Websites

VISIBILITY FOCUS

- Only consider visibility impairment associated with SO_2 and NO_x emissions
- Only consider that portion of those emissions that convert to sulfuric acid (p) and nitric acid (g)
- Discuss role of ammonia in neutralizing those acids
- Discuss the resulting effect on visibility

Causes of Visibility Impairment

- In General
 - Scattering and absorption of light by particles
 - Scattering and absorption of light by gases
- This discussion
 - Emphasis on scattering of light by particles

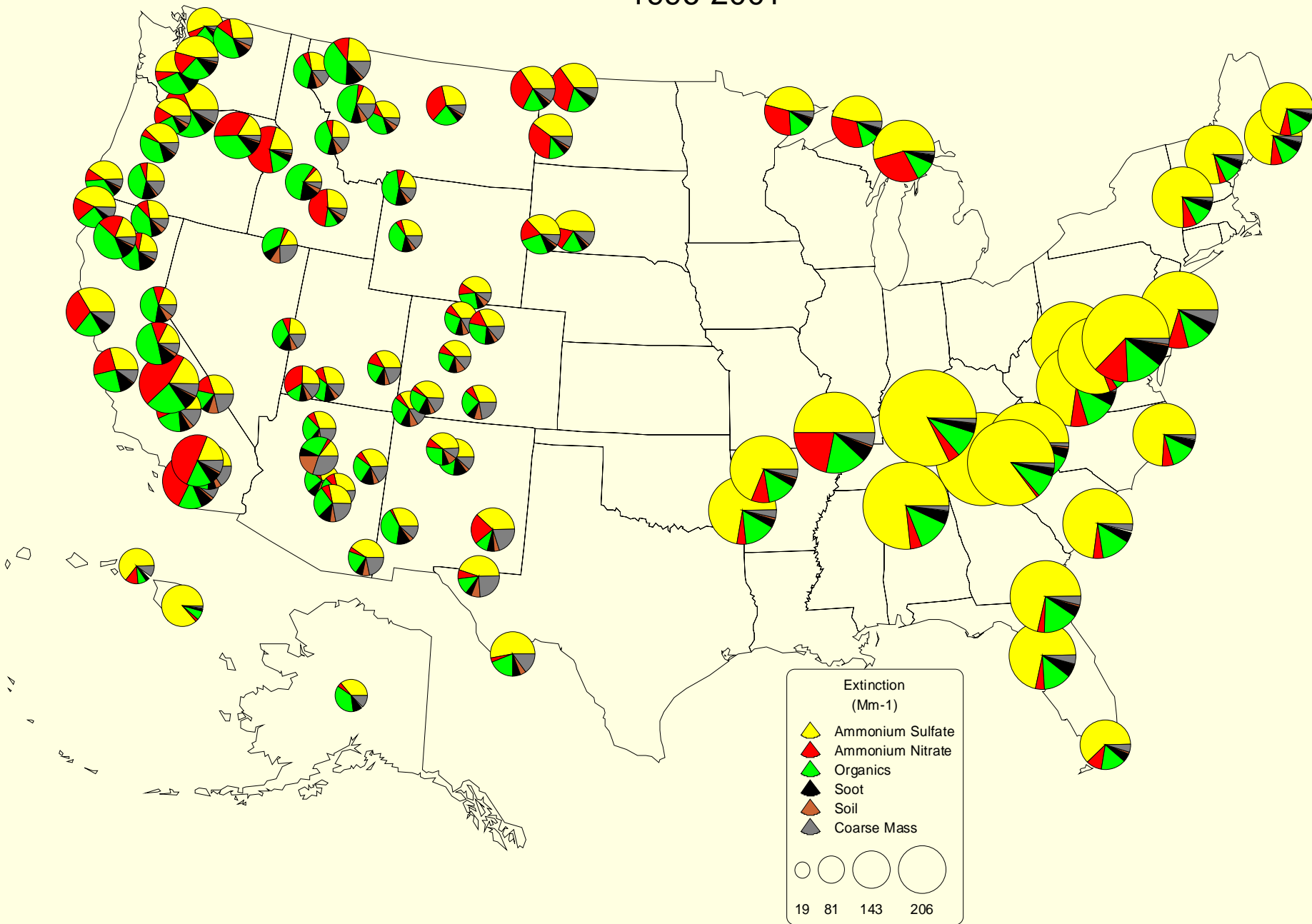
IMPROVE Sampling

- 160+ sites in 2003
- Particle sampling
 - 24-hour samples every third day
- PM_{2.5} mass
 - Elemental analysis
 - Ions
 - Carbonaceous material
- PM₁₀ Mass

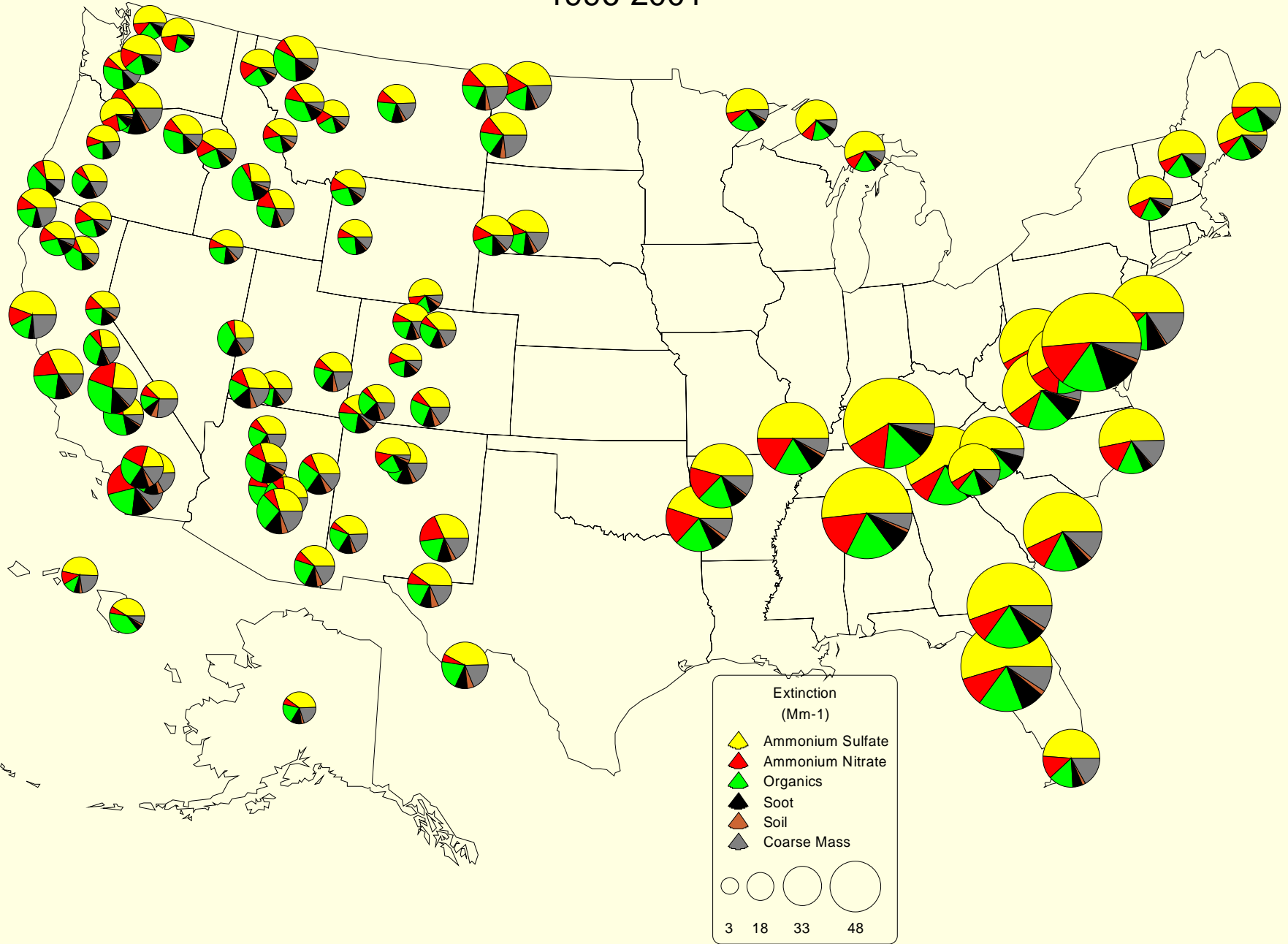
IMPROVE Reporting

- Fine mass
 - Ammonium sulfate
 - Ammonium nitrate
 - Organic carbon
 - Elemental Carbon
 - Fine soil
- Undifferentiated Coarse mass
- “Reconstruct” Extinction

Mean Extinction Budgets on Hazyest Days 1996-2001



Mean Extinction Budgets on Clearest Days 1996-2001



So what can we notice?

- Particle extinction much greater in the eastern U.S.
- Sulfate (as ammonium sulfate) typically dominates the extinction in the east and is a major constituent elsewhere
- Nitrate (as ammonium nitrate) is a major contributor in central and southern California, the northernmost tier of States
- We need to fill in the gaps, but indications are the central U.S. may also experience high nitrate contributions

Why do we care about ammonia?

- Free ammonia will tend to preferentially neutralize the sulfuric acid
- The degree of neutralization may not be too important since ammonium sulfate, ammonium bisulfate, and letovacite all have similar hygroscopic properties.
- However, sulfuric acid has a greater effect on visibility because of its enhanced hygroscopic properties
- In some locations, particulate nitrate may replace “controlled” sulfate since “freed” ammonia may become available when the temperature régime is favorable

Confounding Issues

- Aerosol chemistry uncertainties
 - Assumption of fully neutralized sulfate is not correct for all sample days
 - Assumption of ammonium nitrate may not always be correct
 - IMPROVE configuration may not be suitable to determine ammonium concentrations

Nitrate Issues

- Nitrate may be present in both the fine and coarse modes
 - Usually ammonium nitrate in fine mode
 - In some locations, fine fraction may actually be tail of coarse fraction
 - Sodium nitrate in coarse mode

Nitrate Summary

- Eastern U.S.
 - Model studies show potential for aerosol mass increase as nitrate replaces sulfate in response to declining sulfate concentrations
- Western U.S.
 - Little known about potential for nitrate replacement of sulfate
 - Large uncertainties in current aerosol composition