FLM ISSUES
for
R/S/L 2006

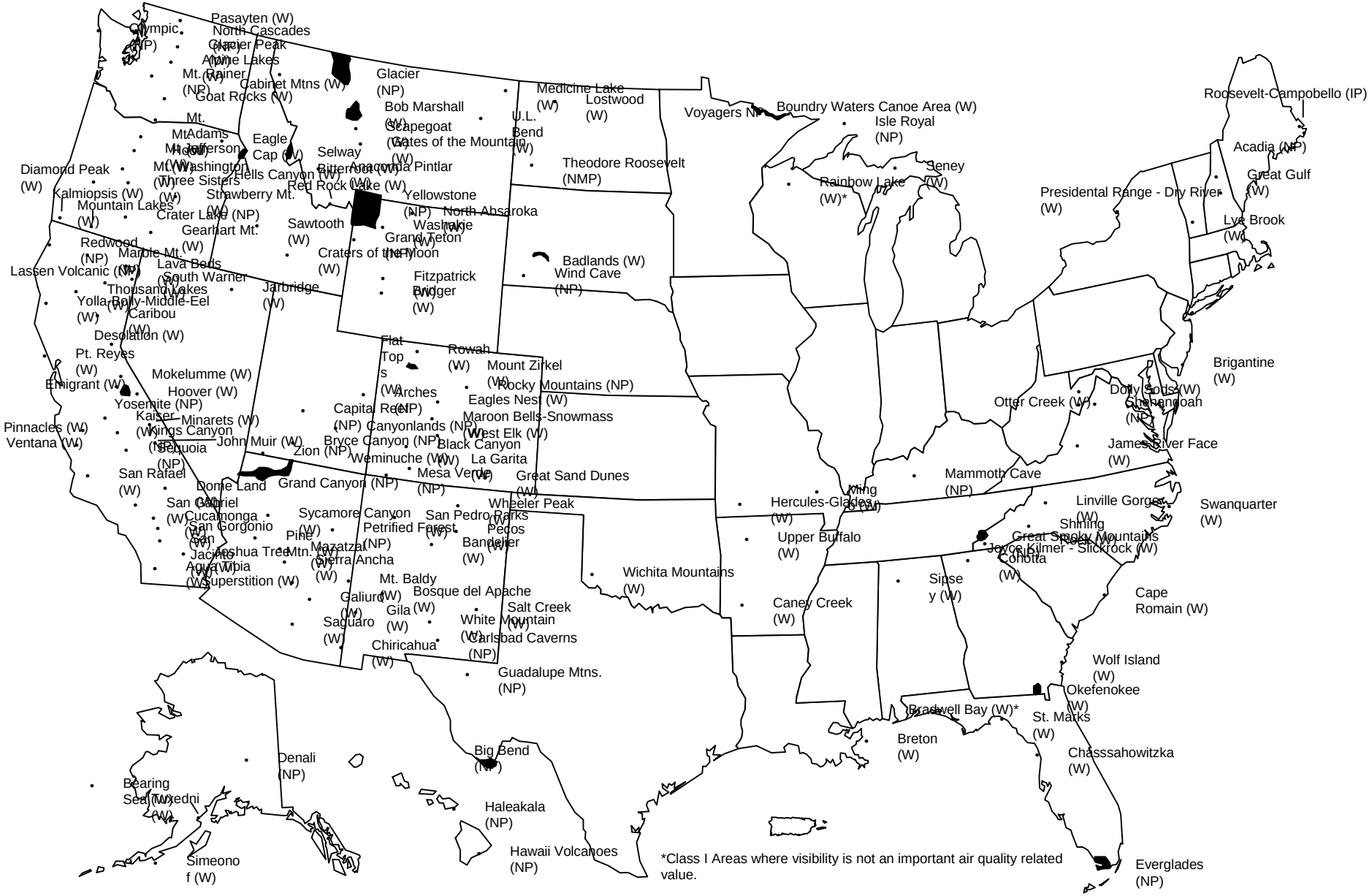
FLAG REVISIONS

Disclaimer

- The following presentation represents the current views and ideas of the federal land management agencies' staff and does not necessarily represent the official position of the Department of the Interior, the Department of Agriculture, or the agencies or bureaus of these departments.
- Editorial comments are those of the presenter and do not necessarily reflect the views or opinions of anyone else.

Why FLAG?

- Let applicant know what Federal Land Management Agencies expect in an air quality analysis (primarily for PSD)
- Provide consistent approach when impacts span more than one agency jurisdiction
  - Assist Agencies and permit applicants to determine if impacts would be negligible.
  - Not a bright-line test that allows one to determine if a source would cause or contribute to an adverse impact.
  - FLMs, as delegated by Congress, make the project-specific decision, on whether or not the source make an adverse impact.



*Class I Areas where visibility is not an important air quality related value.

Legend:
NP= National Park
W = Wilderness
IP = International Park

Map of Mandatory Federal Class I Areas

Process for Revisions

- Revisions at staff level (present step)
- Seeking input from professional groups
- Consult with states
- Take up management chain
- Public comments
- Federal Register notice
- FLAG is Guidance NOT Regulation
- Maybe at the end of 2006 at the earliest

"…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)

"Wilderness areas…shall be administered for the use of the American people in such a manner as will **leave them unimpaired** for future use and enjoyment as wilderness…" (Wilderness Act of 1964)

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

"…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)

CAA165 (d)(2)(B)

The Federal Land Manager and the Federal official charged with direct responsibility for management of such lands shall have an ***affirmative responsibility*** to protect the air quality related values (including visibility) of any such lands within a class I area and to consider, in consultation with the Administrator, whether a proposed major emitting facility will have an adverse impact on such values.

Err on the Side of Protection*

- The Senate committee wrote,"[i]n the case of doubt, . . . [to] err on the side of protecting the air quality related values for future generations."
- Focus is on the resource
- Does not mean make everything in the AQRV analysis conservative
- Does mean to weigh the credibility of the analysis and interpret the uncertainty of the result in favor of the resource

*Presenter's editorial opinion

FLAG Challenge

- FLAG Level I is a screening tool that attempts to include positive and negative biases to arrive at conservative estimates of a source's impact on AQRVs (24-hour average for visible haze)
- FLMs are generally comfortable with specifying when there is not a problem
- How to take a rather uncertain "hazy" set of decision criteria and pin down a specific methodology
- More difficult to know when there is a problem – particularly with incomplete analysis techniques

Things affecting AQRVs in FLAG

- Visibility
  - Plumes < 50 km from Class I areas
  - Layered and uniform hazes > 50 km from Class I areas
- Atmospheric Deposition (DAT newer)~2002
  - Nitrogen
  - Sulfur
  - Mercury (in progress)
- Ozone

Existing FLAG Haze-like Analysis

- Run CALPUFF (3 years MM data)
- No longer accepting CALPUFF-lite
- Concentrations of SO_4 , NO_3, & PM speciated
- Calculate a visibility index – b_{ext}
  - 24-hour average
  - Hour-by-hour b_{ext} using hourly f(RH) concentration (98% rollback)
- Compare change in b_{ext} against average natural conditions (very similar to average annual conditions in BART)
- < 5% change – ok
- > 5% < 10% change cumulative analysis
  - If cumulative > 10% and source > 0.4% likely to object
- > 10% likely to object

Some FLAG Adaptations to Level I Visibility Screening Analysis

- Maximum 95% f(RH) rollback vs. 98%
- Revised f(RH) curves
- Ammonia limiting so as not to overestimate particulate nitrate formation
- Speciation of PM emissions to more accurately calculate visibility impacts

FLMs do ***NOT*** Accept Method 7 or 7' or 2'

- Method 7 accounts for change to natural background visibility due to precipitation and fog events
- Method 7' is a variation that responds to FLM concerns that a single weather event hour can substantially change the daily calculation results for Method 7, as FLAG computes the ratio
- Method 7' & Method 2' takes *hourly* ratios, so the effect of one hour is isolated to 1/24 of the total daily average extinction change - which reduces the affect of a couple of high impact hours

Not Changing These in the Level I Screening Analysis

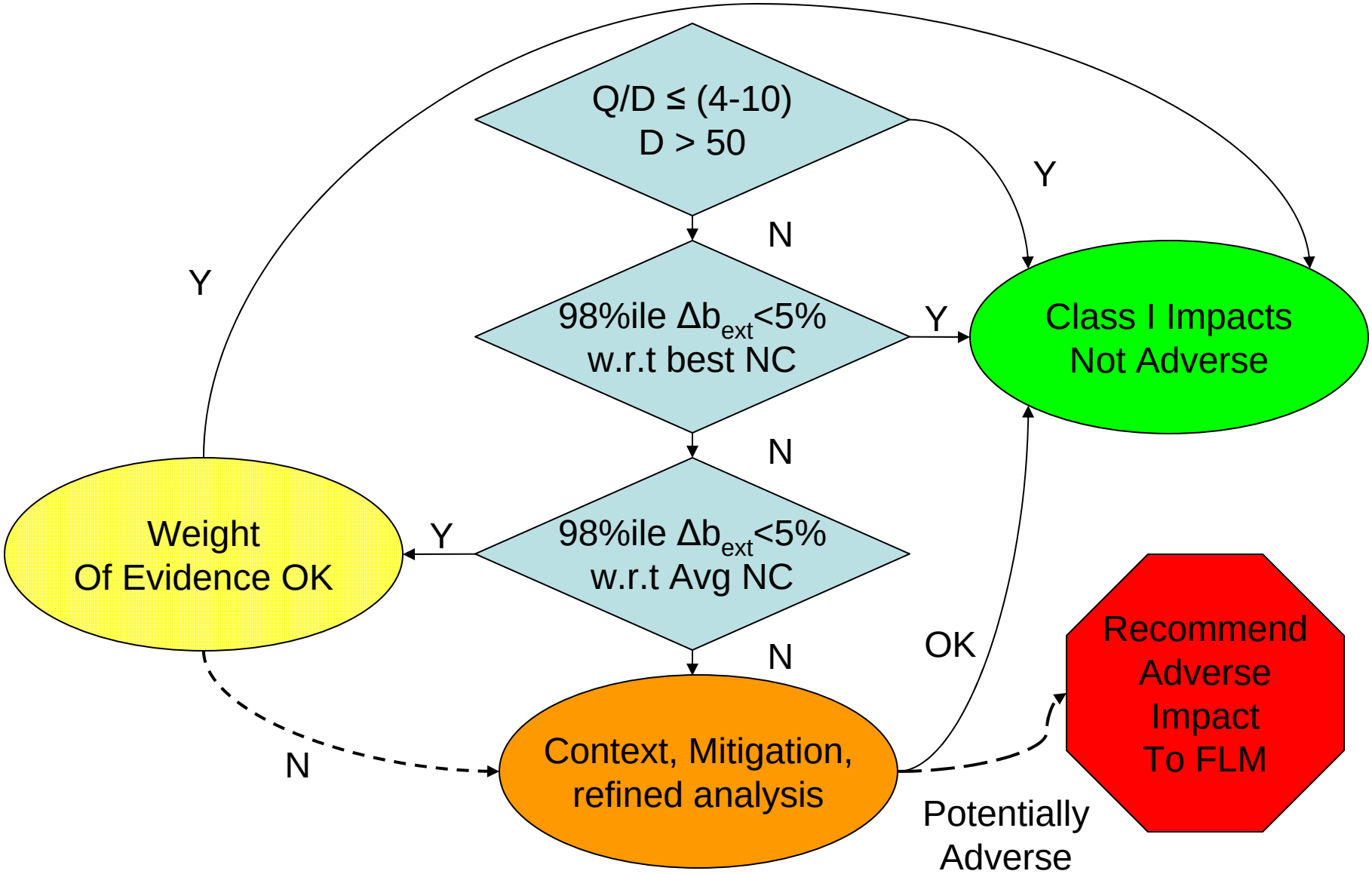
- Minimum 3 years preferred, but eventually 5 years MM5 data
- CALPUFF runs the same
  - Dependent on future EPA guidance
- Considering maximum receptor in Class I area as maximum for that day
- Level-one screening analysis is still a 24-hour average
- Use the *existing* extinction equation (the “new” extinction equation is intended only for analyzing the IMPROVE monitored data)

Potential FLAG Changes to the Level I Screening Analysis

- Monthly average f(RH) (MVISBK=6) (like in BART) This removes weather events from Level I Screening Analysis
- 98th percentile 5% Δb_{ext} (i.e. 8th high)
  - Any 1 year fails test (these are ***CLEAN NEW*** sources)
- Two tiered visibility test
  - Against 20% best natural conditions
  - &
  - Against annual average natural conditions
- If fail test look at context and mitigation

Class I areas are large and weather events may not occur everywhere in it, & obscure all views

New FLAG Flow Chart



Weight Of Evidence is OK

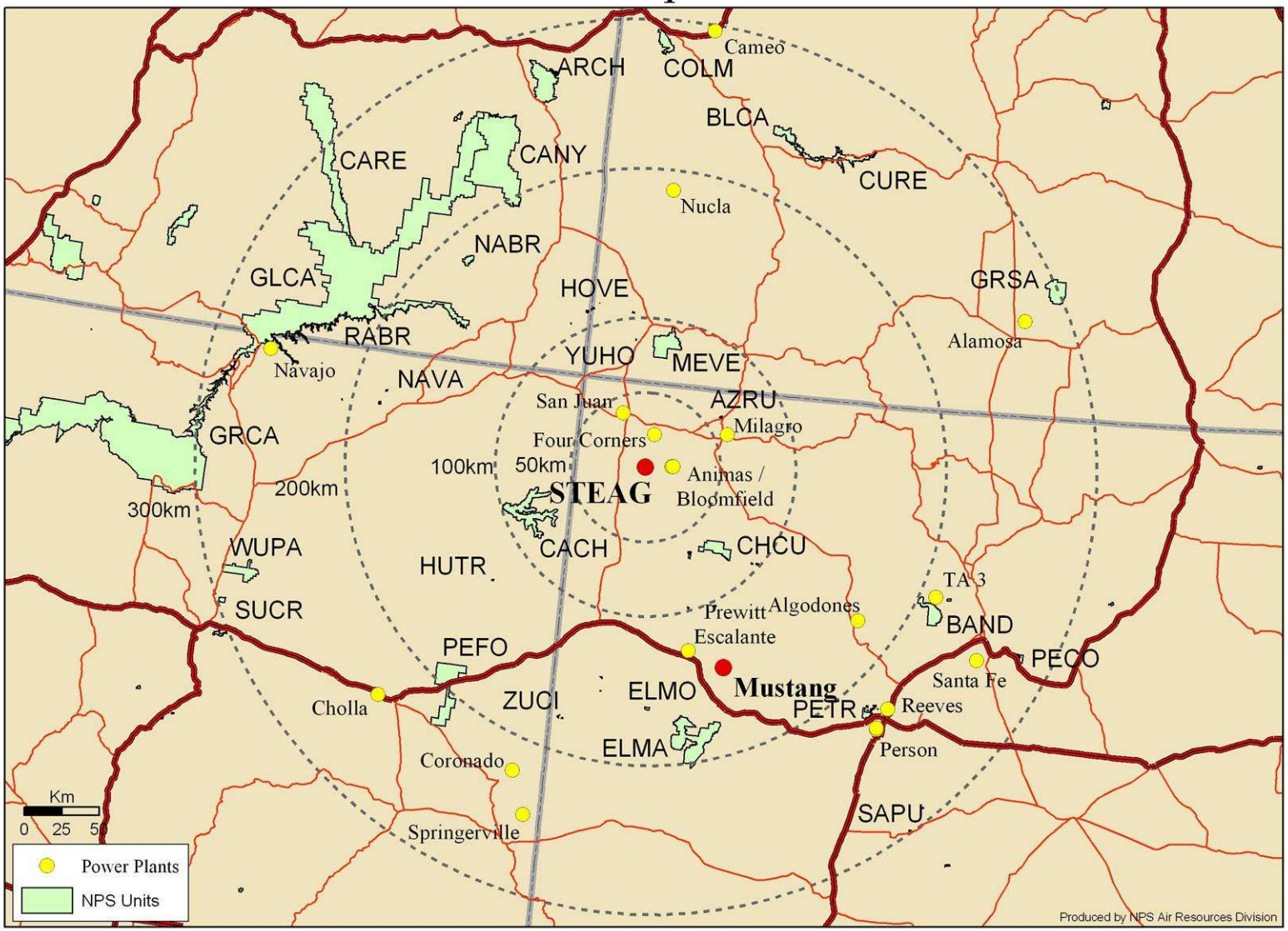
- So what does this mean?
- What is the difference between this and

Context, Mitigation, refined analysis

So what does this mean?

- If here you have failed the 20% best days natural condition test but passed the annual natural condition test
- If BACT in question or **multiple** Class I areas impacted may jump to context, mitigation, further analysis
- Most cases, with resolution of BACT, probably pass without further analysis

STEAG Impact Area



What is the difference?

- Subtle difference
  - First scenario fairly routine examination
  - Second scenario really triggers our concern threshold – further considerations
    - Very tight BACT examination
    - Examine the air quality context
      - Trends, projected emission reductions, severity of AQRV problem, status of visibility SIP
      - Frequency, magnitude, extent…
    - May seek mitigation
    - Option of performing REFINED analysis

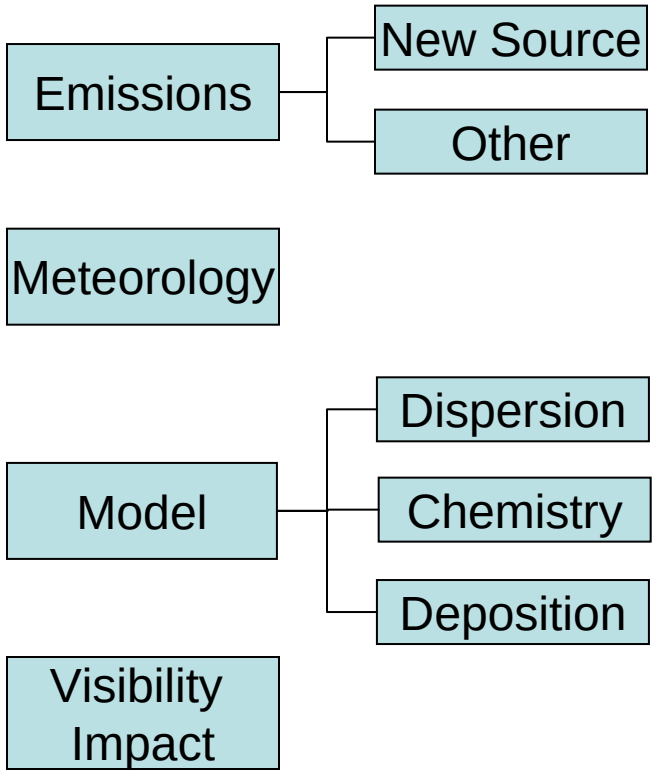
Further Considerations

- Regulatory Factors
  - Geographic extent, intensity, duration, frequency, time of visitor use, natural conditions that affect visibility
- Context
  - Expected source life
  - Stringency of BACT
  - Ancillary environmental benefits proposed by applicant
  - Current status and trends of AQRV impacts in Class I area
  - Cumulative impact
  - Regional Haze SIP provisions on new source growth
  - Enforceable emissions reductions in area
  - Comments from public and other agencies

Further Considerations (cont)

- Mitigation strategies
  - Emission offsets
  - Emission rate reductions
  - Monitoring/special studies leading to future permit revisions/re-openers (monitoring alone NOT a mitigation strategy)
- If no mitigation, agencies likely to recommend adverse impact to FLM
- Or can do a REFINED analysis

FLAG Modeling Information Gaps



Uncertainty	Best Available Information
Low	Yes
Low (SO_2) - High (NH_3)	Yes
Medium (winds, temp) - High (Clouds, Precipitation)	Yes-No
Medium (No puff splitting)	Yes-No
High	**No**
Medium to High	Yes-No
High for some scenarios	**No**

CAMx, A Level II Screening Option?

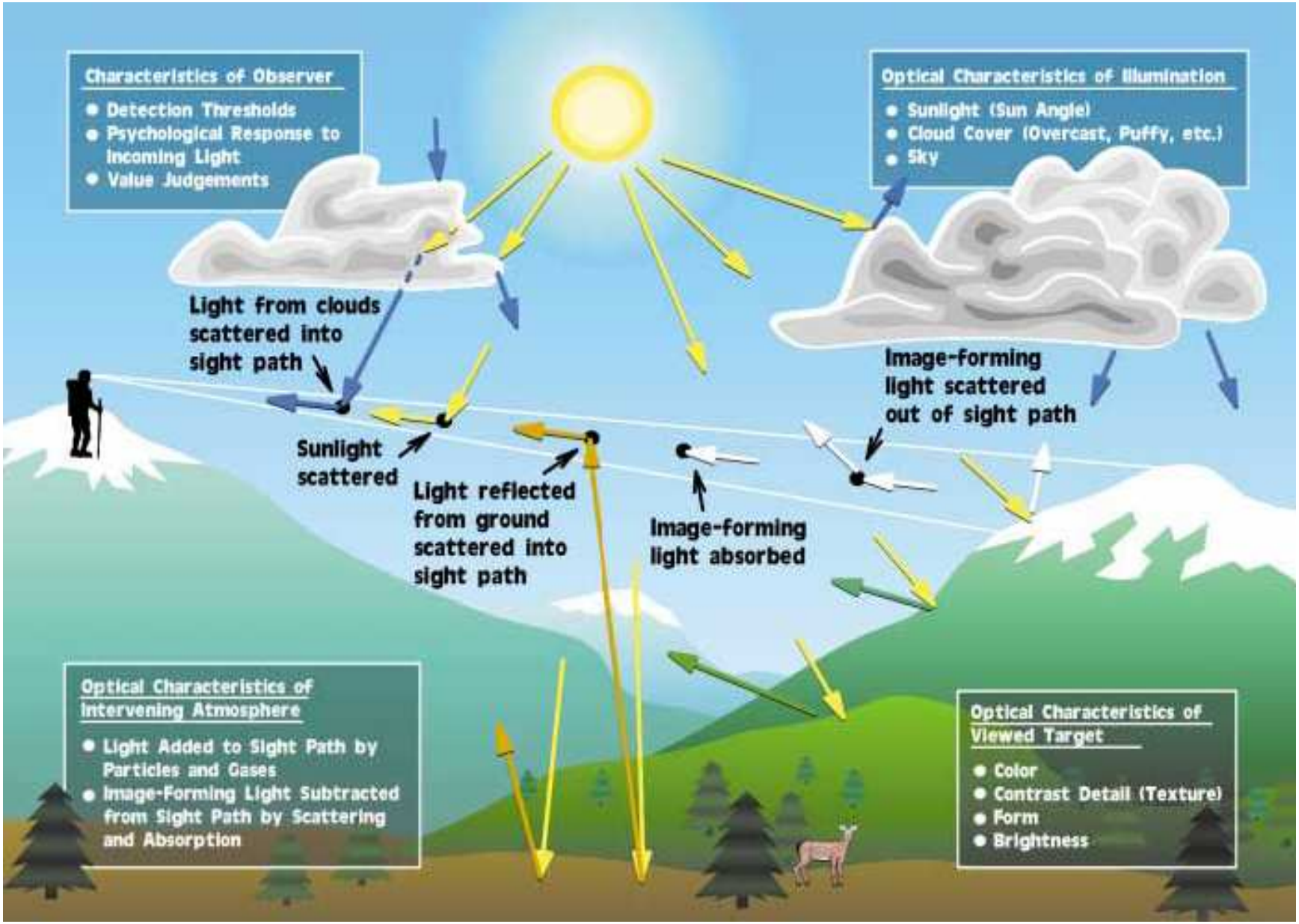
- Plume-in-Grid (PiG) module for sub-grid treatment of selected point sources
- Multiple gas phase chemistry mechanism options (CB-IV, SAPRC99)
- Wet & dry deposition of gases and particles
- Two-way/Flexi Nesting
- Ozone impacts
- States know how to run it
- Available RPO MM data can run it

Proposed FLAG Level II and III Visibility Assessment

Bret A. Schichtel, John Molenar, William C. Malm, Michael Barna, and Marco Rodriguez

Presented at the AWMA Specialty Conference - Guideline on Air Quality Models: Applications and FLAG Developments

April 26-28, 2006, Denver, CO


Characteristics of Observer
Detection Thresholds
Psychological Response to Incoming Light
Value Judgements
Optical Characteristics of Illumination
Sunlight (Sun Angle)
Cloud Cover (Overcast, Puffy, etc.)
Sky
Light from clouds scattered into sight path
Image-forming light scattered out of sight path
Sunlight scattered
Light reflected from ground scattered into sight path
Image-forming light absorbed
Optical Characteristics of Intervening Atmosphere
Light Added to Sight Path by Particles and Gases
Image-Forming Light Subtracted from Sight Path by Scattering and Absorption
Optical Characteristics of Viewed Target
Color
Contrast Detail (Texture)
Form
Brightness

Refinement Expectations

- Refine/advance the science
- Consider all relevant phenomena
  - (e.g. both cloud obscuration and enhanced aqueous phase conversion)
- Only consider time periods relevant for case-by-case visibility analysis (≤ 1-hour)
- Refinements applied to all daylight time periods in analysis, not just failed Level I screening conditions
- Don’t imply that Level I screening analysis has all conservative assumptions – that’s what makes it a Level I analysis

Refined Analysis Needs

- End product – estimate of visibility, not visibility index (the index serves us well in level-one)
  - Consideration of scenic elements
  - Lighting
  - Pollutant spatial distribution
  - Particle size distribution
  - Instantaneous time scale (≤ 1-hour)
  - All daylight time periods

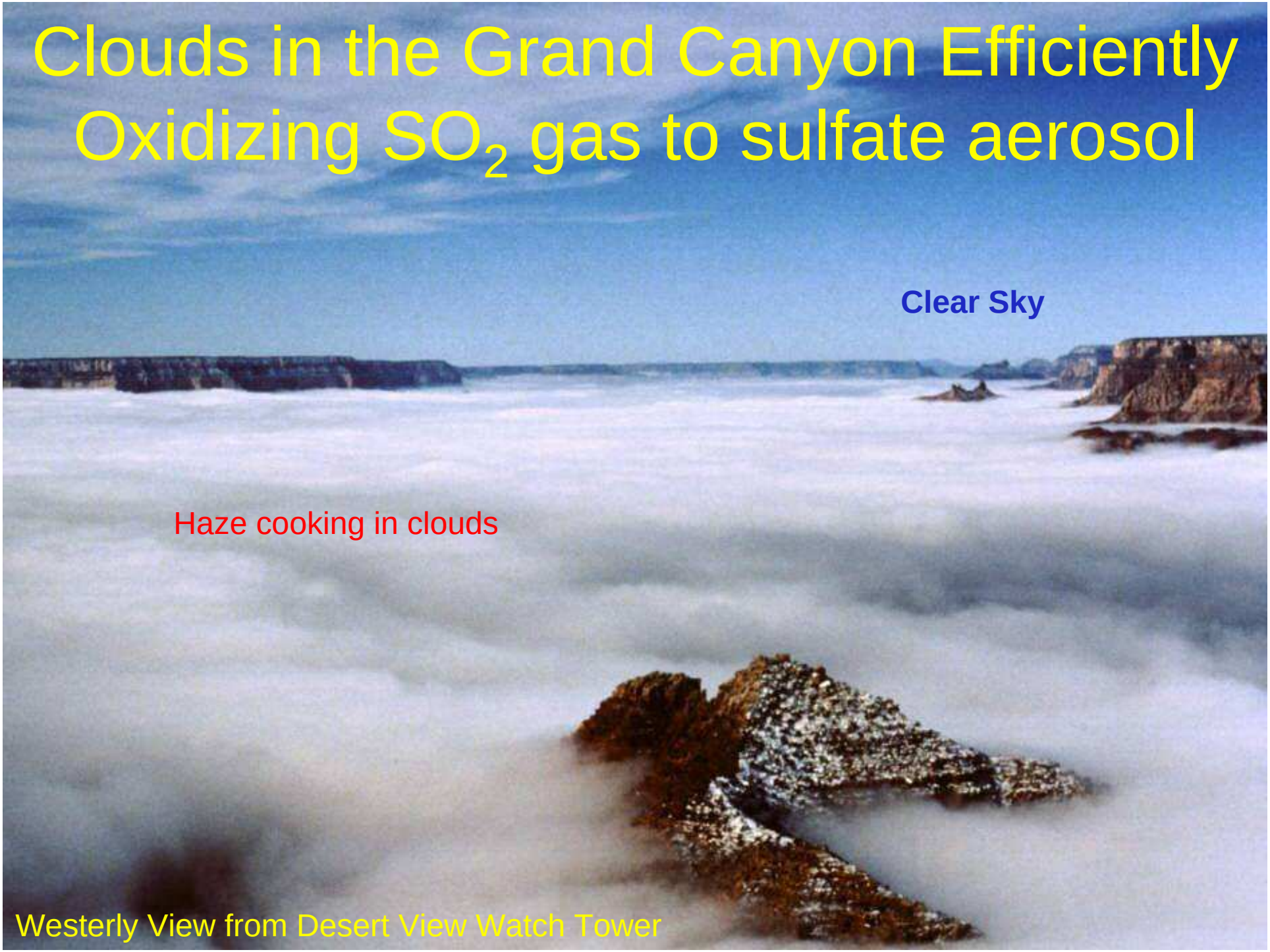
Refined Analysis Needs (cont)

- Air pollutant concentration estimates
  - Appropriate dispersion scale (channeling, stagnation, recirculation)
  - Treatment of relevant chemical transformation
    - Aqueous phase chemistry
    - Dry phase chemistry
    - Background pollutants
- Meteorological fields
  - Resolution to capture appropriate flow
  - Clouds/precipitation in the right place and right time

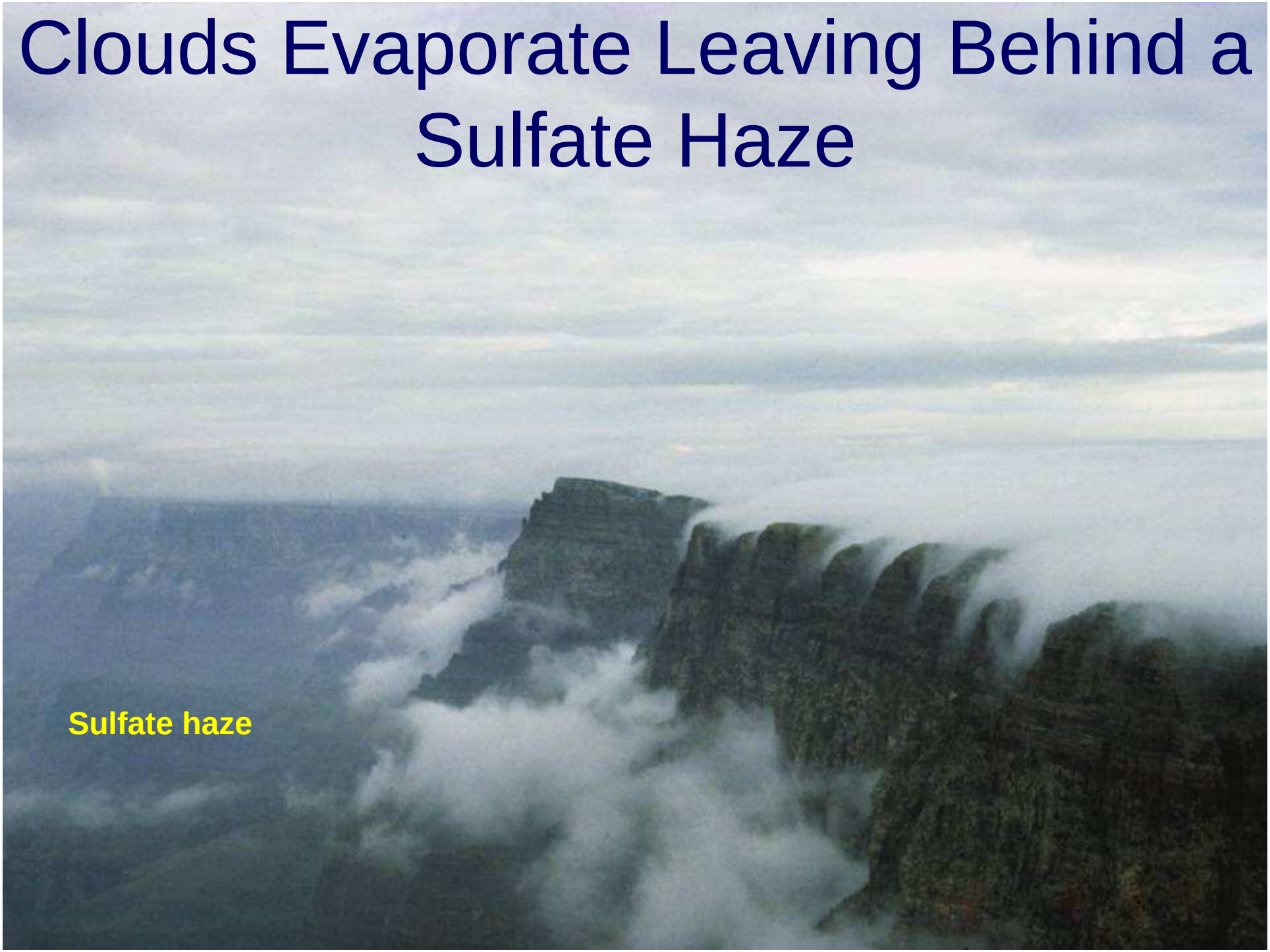
Grand Canyon Filling Up With Clouds

Easterly View of Grand Canyon from Desert View Watch Tower

Clouds in the Grand Canyon Efficiently Oxidizing SO_2 gas to sulfate aerosol



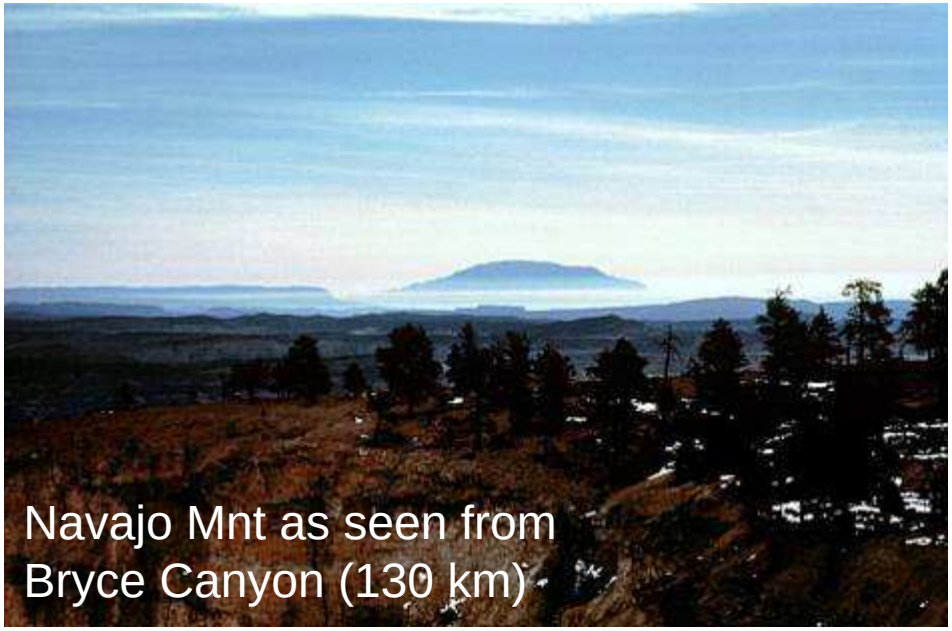
Clouds Evaporate Leaving Behind a Sulfate Haze

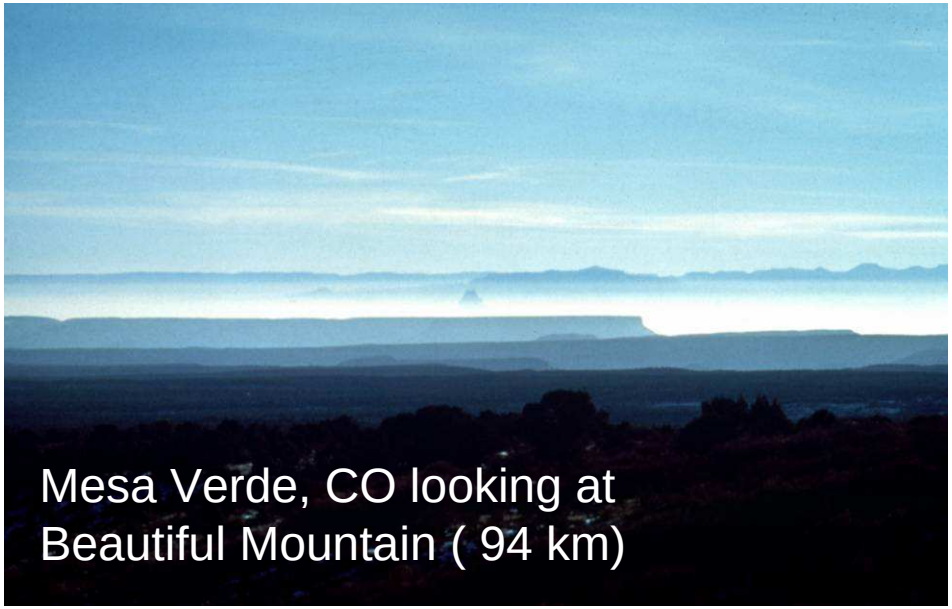


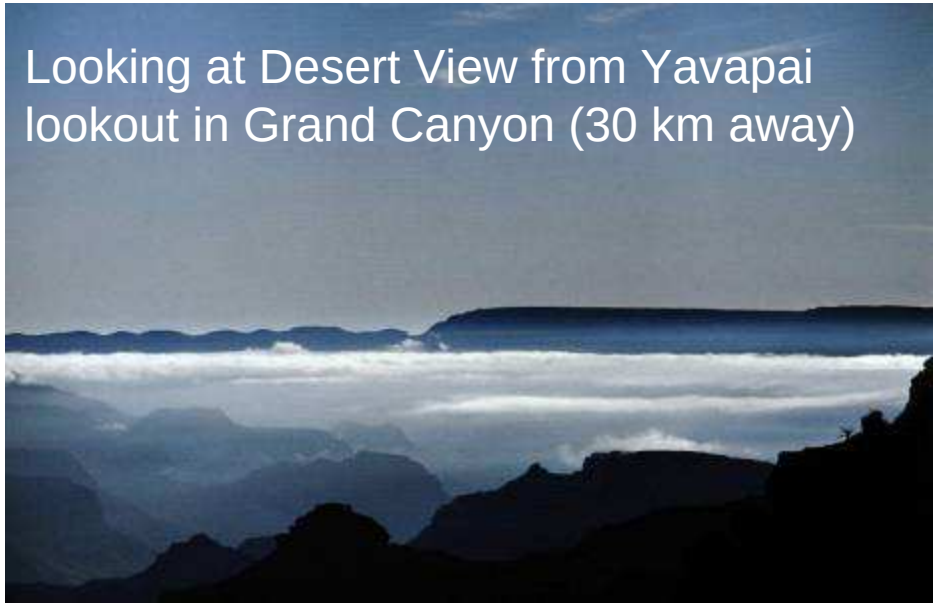
Clouds Evaporated Leaving Sulfate Haze

Next Day After Haze is Blown Out

Seeing the Haze - Layered Haze

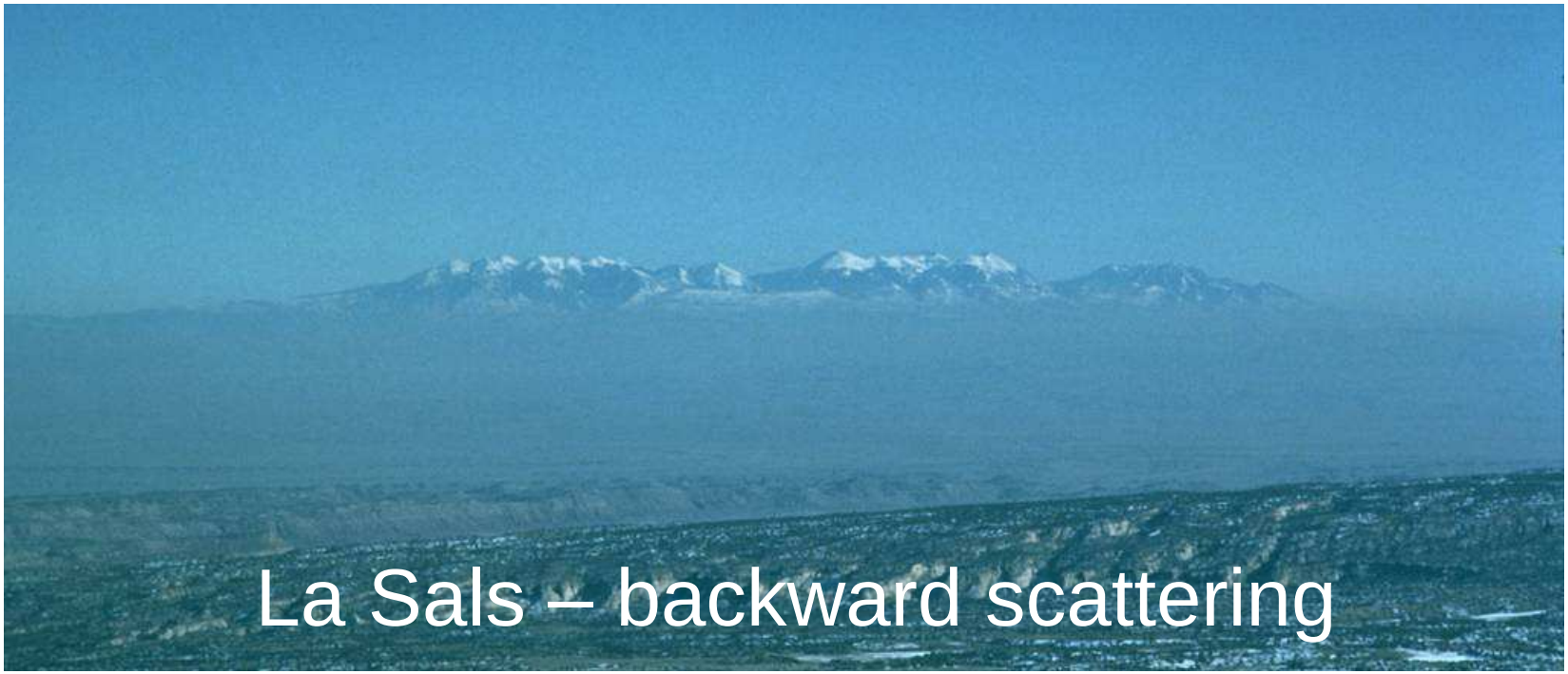






Dependence on Illumination

La Sals – forward scattering



La Sals – backward scattering

Process Needed to Reproduce to Assess Visibility Impairment

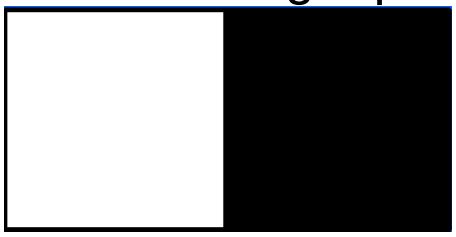
- Influence of complex terrain on source dispersion
- Cloud processing of pollutants
- Visibility is a nearly instantaneous event that can change from moment to moment dependent on:
  - Observer vantage point
  - Landscape features
  - 3-D distribution of haze at high time resolution
  - Illumination of the scene.

FLAG Refined Assessment Recommendations

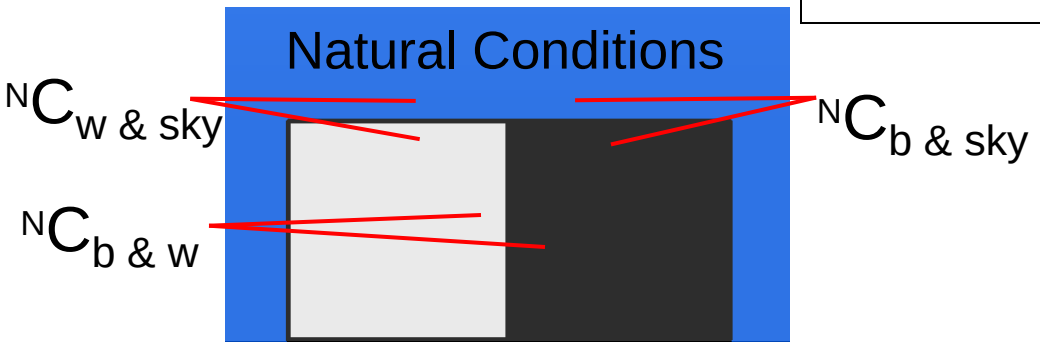
- Define one or more sight paths important to the visitor experience at each class I area of interest
- Calculate hourly 3-D concentration and RH fields over the sight paths
  - High resolution meteorological data that can reproduce clouds and precipitation and terrain forcing on dispersion
  - Chemical mechanisms capable of simulating cloud processing of pollutants
  - May require bounding calculations, e.g., assume 100% conversion of SO_2 to particulate sulfate
- Use a radiative transfer model to estimate the impact of the source on each sight path accounting for varying:
  - Landscape features
  - Illumination (forward and backward scattering)
  - Observer vantage point – uniform and layered haze

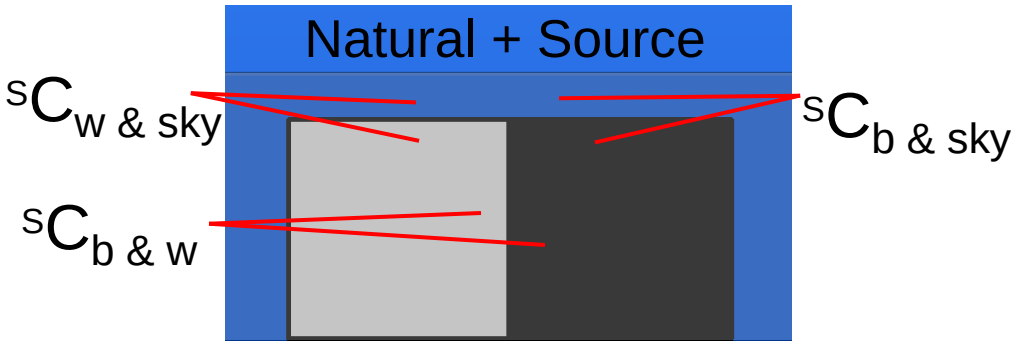
REFINED Level II Visibility Assessment Uniform Haze with standardized targets

Black & white targets at the end of sight path



- Using a radiative transfer model calculate the change in contrast (**Δ Contrast**) from natural conditions and natural + source haze
  - –white and black target
  - –white target and sky
  - –black target and sky
- forward and backward illumination.



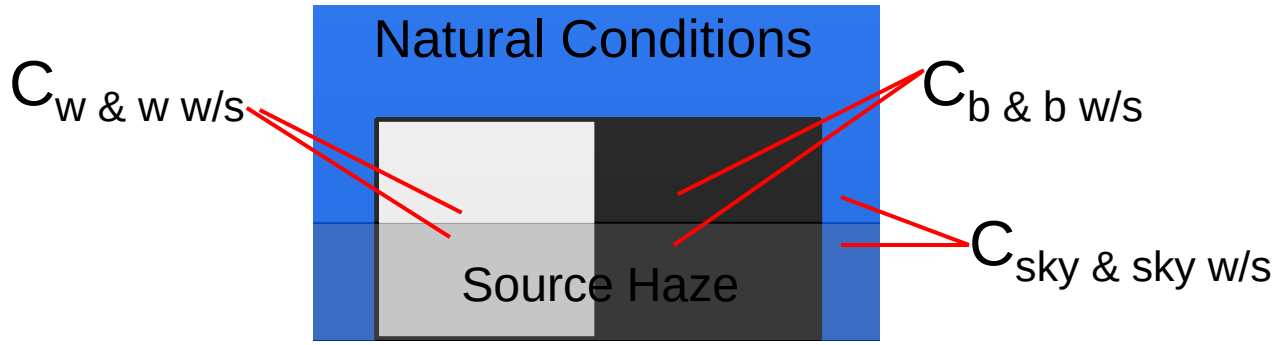


$$\Delta C_{b\&w} = {}^{S}C_{b\ \&\ sky} - {}^{N}C_{b\ \&\ sky}$$

$$\Delta C_{b\&\ sky} = {}^{S}C_{b\ \&\ sky} - {}^{N}C_{b\ \&\ sky}$$

$$\Delta C_{w\&\ sky} = {}^{S}C_{b\ \&\ sky} - {}^{N}C_{b\ \&\ sky}$$

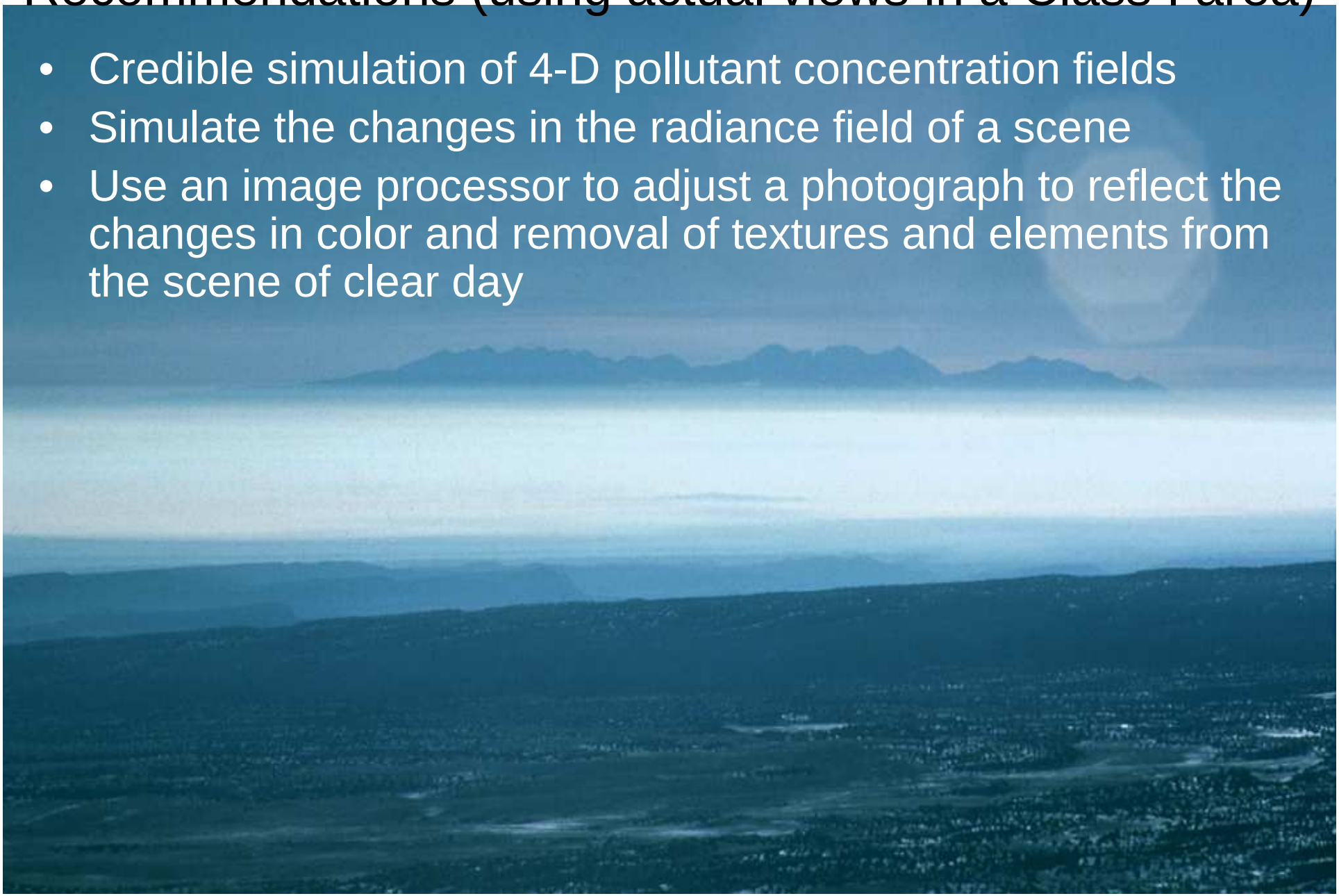
REFINED Level II Visibility Assessment Layered Haze



$C_{w \& w\ w/s}$ = contrast of white target w/ & w/o source haze
$C_{b \& b\ w/s}$ = contrast of black target w/ & w/o source haze
$C_{sky \& sky\ w/s}$ = contrast of sky w/ & w/o source haze

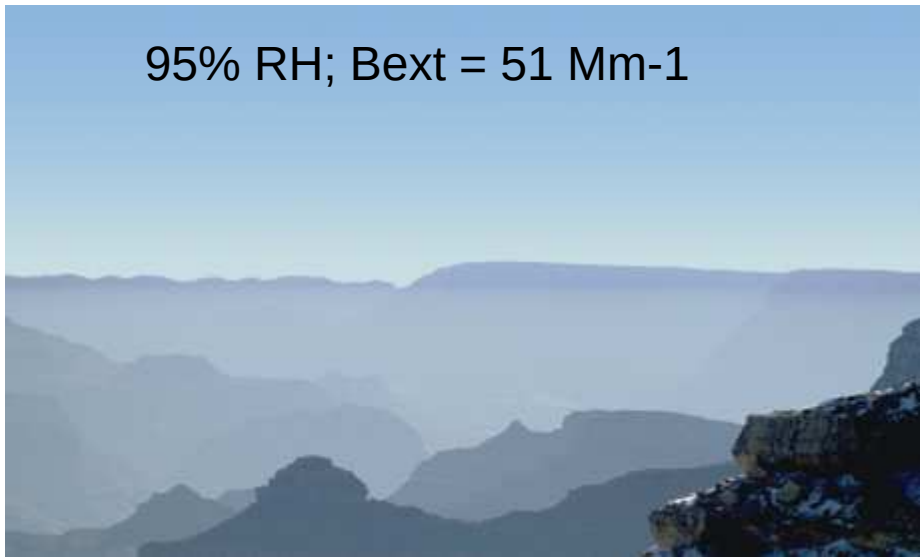
Contrasts are calculated for both forward and backward scattering illumination

REFINED FLAG Level III Assessment Recommendations (using actual views in a Class I area)



- Credible simulation of 4-D pollutant concentration fields
- Simulate the changes in the radiance field of a scene
- Use an image processor to adjust a photograph to reflect the changes in color and removal of textures and elements from the scene of clear day

REFINED Level III Visibility Assessment: Simulation of Grand Canyon Layered Haze



Looking at Desert View from Hopi Point at 9 AM through 1 μg/m^3 of ammonium sulfate

Summary

- Four Dimensional Concentration fields of source impact on class I area and associated RH Fields
  - Dispersion: credibly account for influences of terrain
  - Chemistry: credibly account for influence of precipitation and cloud chemistry
  - Upper bound calculation when large uncertainties in concentration fields exist
- REFINED Level II Visibility Assessment
  - Define one or more sight paths in the class I areas
  - Calculate the Δ contrast of synthetic landscape features and sky under natural conditions and natural + source haze
    - Between white and black targets
    - Targets and sky
  - Calculate the contrast for a layered haze over
    - Black and white target
    - Sky
- REFINED Level III Visibility Assessment
  - Simulate the impact of the source on an actual view within the class I areas


Finished