

Addendum 1: SCENES review of the initial rough draft of the
WHITEX report.

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REVIEW OF THE WHITEX DRAFT REPORT

GENERAL ISSUES

- The report is a very rough draft. There are numerous technical concerns. The analyses and results are currently being modified.
- The review is a technical critique of the report, as is, and an assessment of the likely validity of the conclusions. The review is not an assessment as to whether the data analysis plan was followed.

STRUCTURE OF REVIEW:

BY CHAPTER

CONTENTS: *

CONCLUSIONS: *

COMMENTS AND PROBLEMS: ● Significant
●● Very Important

AN INITIAL GENERAL COMMENT

- The nomenclature, units, dates, data sets, data adjustments, and statistical outputs need to be standardized throughout the report.

CHAPTER 2: AIR QUALITY CLIMATOLOGY

CONTENTS:

- * Presentation of synoptic classification scheme for wintertime in Southwest US.
- * Qualitative evaluation of the climatological representativeness of the WHITEX period.

CONCLUSIONS:

- * Wind conditions and persistence of synoptic stagnations during WHITEX were not unusual.

COMMENTS AND PROBLEMS:

- The evaluation of climatological representativeness could be made much more specific and quantitative.
- There are questions as to whether WHITEX was unusual in having fewer stagnations, high relative humidity, different wind directions, etc. compared to climatological norms.

CHAPTER 3: ACCURACY OF EXTINCTION MEASUREMENTS

CONTENTS:

- * Tutorial on instrumentation theory, design, and advantages/disadvantages.
- * Discussion of previous intercomparison studies.

CONCLUSIONS:

- * Transmissometer measurements accurate to within at least 10-15%.

COMMENTS AND PROBLEMS:

- Precision should be addressed as well as accuracy.
- There should be a summary of the accuracy/precision of all the extinction related methods using consistently applied definitions of accuracy and precision.
- The WHITEX extinction measurements entail two unresolved accuracy problems:
 - The correct absorption/elemental carbon values have not been determined.
 - There is no discussion of the slight but consistent effect that the sum of extinction components exceeds teleradiometer extinction.

CHAPTER 4: AEROSOL AND SO₂ MEASUREMENTS

CONTENTS:

- * Description of sampling and analysis methods for aerosols and SO₂.
- * Presentation of data and calculations pertinent to precision and accuracy.
- * Intercomparison of samplers (e.g. IMPROVE versus SCISAS).

CONCLUSIONS:

- * Some data sets are of very good quality, but others are highly uncertain.

COMMENTS AND PROBLEMS:

- This document should be made into an appendix and replaced by a ten page chapter that presents the following:
 - o Condensed descriptions of the measurement methods and the general precision/accuracy methodology.
 - o A table of consistently defined precisions for all the measurements.
 - o Brief discussions of the data sets that are evidently of good quality.
 - o Expanded discussions, including reconciliation and resolution, of the data sets with known inaccuracies (e.g. organic carbon, elemental carbon, absorption, nitrates, and certain soil elements).

CHAPTER 5: LIGHT EXTINCTION BUDGET

CONTENTS:

- * Discussion of assumptions and techniques for the extinction budget analysis.
- * Justification of data sets chosen with respect to extinction, elemental carbon, and nitrates.
- * Derivation of extinction budgets for Page, Canyonlands, and Hopi Point based on two methods: (1) RESOLVE "consensus" extinction efficiencies, and (2) multiple linear regression.

CONCLUSIONS:

- * The extinction budget analysis should be based on teleradiometer data alone (rather than nephelometer data), IMPROVE elemental carbon data (rather than SCISAS data), and denuder/nylon nitrate data (rather than Teflon data).
- * Averaged over WHITEX period, sulfates accounted for 26-29% of total extinction (43-55% of non-Rayleigh extinction) at Page, Canyonlands, and Hopi Point. On February 12 episode day, sulfates accounted for 41-74% of total extinction (73-86% of non-Rayleigh extinction).

COMMENTS AND PROBLEMS:

- The extinction type budget should be redone based on the following considerations:
 - o There needs to be a better reconciliation of the severe discrepancies in the absorption/elemental carbon data. (The current rationale for using IMPROVE elemental carbon is not justifiable.)
 - o The analysis should make use of nephelometer scattering data (rather than only reconstructed scattering).
 - o The contribution of NO₂ should be included (especially when different methods are used to estimate particle absorption).

CHAPTER 5: LIGHT EXTINCTION BUDGET
COMMENTS AND PROBLEMS (continued)

- The extinction species budget should be redone using "WHITEX consensus" extinction efficiencies that are based on the following:
 - o Revised literature review. (The current results involve misinterpretations of the RESOLVE literature review.)
 - o Mie theory calculations with WHITEX data for sulfur size distributions (not done yet).
 - o Insights from multiple structural regression. ("Insights" only because the current results show that multiple regression basically fails as a method with WHITEX data.)
- Potential errors in the extinction budget should be calculated by applying error propagation methods to judgmental estimates of the major uncertainties (i.e. in scattering efficiencies, elemental carbon concentrations, and nitrate concentrations).
- The extinction budget calculations are inherently limited by problems in the organic and elemental carbon data. However, a fairly reliable answer should still be possible regarding the extinction contribution of sulfates..
- Actual visibility effects should be estimated by calculating the modulation transfer function, contrast changes, and/or number of detectable changes for given scenes.

CHAPTER 6: VISIBILITY IMPAIRMENT ATTRIBUTION

CONTENTS:

- * Theoretical discussion of chemical mass balance (CMB), differential material balance (DMB), and univariate tracer mass balance regression (TMBR).
- * Description of CD4 injection procedures, CD4 data, and CD4 scaling factors (scaled per megawatt and by a factor of 0.3 for Unit 3 releases).
- * Calculations of upper bounds for NGS sulfur contributions at Page and Hopi Point based on CD4 data, and estimation of NGS extinction contributions based on regressions of sulfate versus CD4 (and RH).
- * Use of routine CMB to allocated PM-2.5 with respect to secondary aerosols and primary sulfate categories.

CONCLUSIONS:

- * The CD4 tracer data suggest that upper bound NGS sulfur contributions are generally a factor of two greater than observed ambient sulfur at Page and a factor of eight greater than observed ambient sulfur at Hopi Point.
- * Tracer regression analyses indicate that ambient sulfates at Page and Hopi Point are predominately from NGS, especially during the February 12 high sulfate episode. Approximately 40% of non-Rayleigh extinction is allocated to NGS sulfate at both sites.

COMMENTS AND PROBLEMS:

- The tracer injection data from NGS should be reanalyzed based on the following considerations:
 - o The emission ratio and stack ratio for S/CD4 should be examined as well as the two plume flight ratios.
 - o An exhaustive investigation should be made regarding the cause of the 0.3 factor for Unit 3.
 - o Time-lagged scaling factors should be tried based on estimated plume ages (from Latimer's work).
 - o The same CD4 scaling factors should be used for all sites and for all chapters.

CHAPTER 6: VISIBILITY IMPAIRMENT ATTRIBUTION
COMMENTS AND PROBLEMS (continued)

- The extinction source apportionment should be split into two parts: (1) sulfate (and nitrate) source apportionment, and (2) extinction/aerosol relationships. Part 2 should be derived in a straight forward way from the extinction budget. The main focus of Chapter 6 should be Part 1. All analyses and data pertinent to Part 1 should be considered including:
 - o Multivariate, structural, free intercept regressions of sulfates versus CD4 and aerosol tracers. These regressions might include RH terms in physically meaningful functional forms and time-lagged CD4 scaling.
 - o Differential material balance calculations (i.e. Latimer's work).
 - o Examination of sulfate levels at background sites far from local sources.
 - o Deterministic mesoscale models.
- A general comparison and interpretation should be performed regarding the various source apportionment methods. The uncertainties in each method and overall uncertainties need to be evaluated.
- The representativeness problem introduced by the CD4 sample selection process should be analyzed and discussed.
- At present, the source apportionment techniques are inherently limited by uncertainties in the CD4 data. However, because NGS contributions at Page and Hopi Point may be predominant, a reliable apportionment for sulfate may be possible.

CHAPTER 7: CLIMATOLOGY OF EXTREME SULFATE EPISODES

CONTENTS:

- * Qualitative meteorological descriptions of sulfate episodes at Hopi Point during WHITEX.
- * Qualitative meteorological descriptions of winter sulfate episodes at Hopi Point from 1982 to 1987.

CONCLUSIONS:

- * Out of ten sulfate episodes at Hopi Point, 8-9 cases involve synoptic flow mechanisms that are consistent with NGS being the source. The other 1-2 cases appear to involve transport from distant sources.

COMMENTS AND PROBLEMS:

- Until Chapter 6 is made more definitive, unequivocal conclusions should not be made regarding CD4 source attribution at Hopi Point.
- The section can be made more quantitative by comparing averages (of wind roses, relative humidity, cloudiness, etc.) for episode conditions versus non-episode conditions.
- An attempt should be made to estimate the frequency of occurrence of various levels of visibility degradation by NGS.

DIFFERENTIAL MATERIAL BALANCE

CONTENTS:

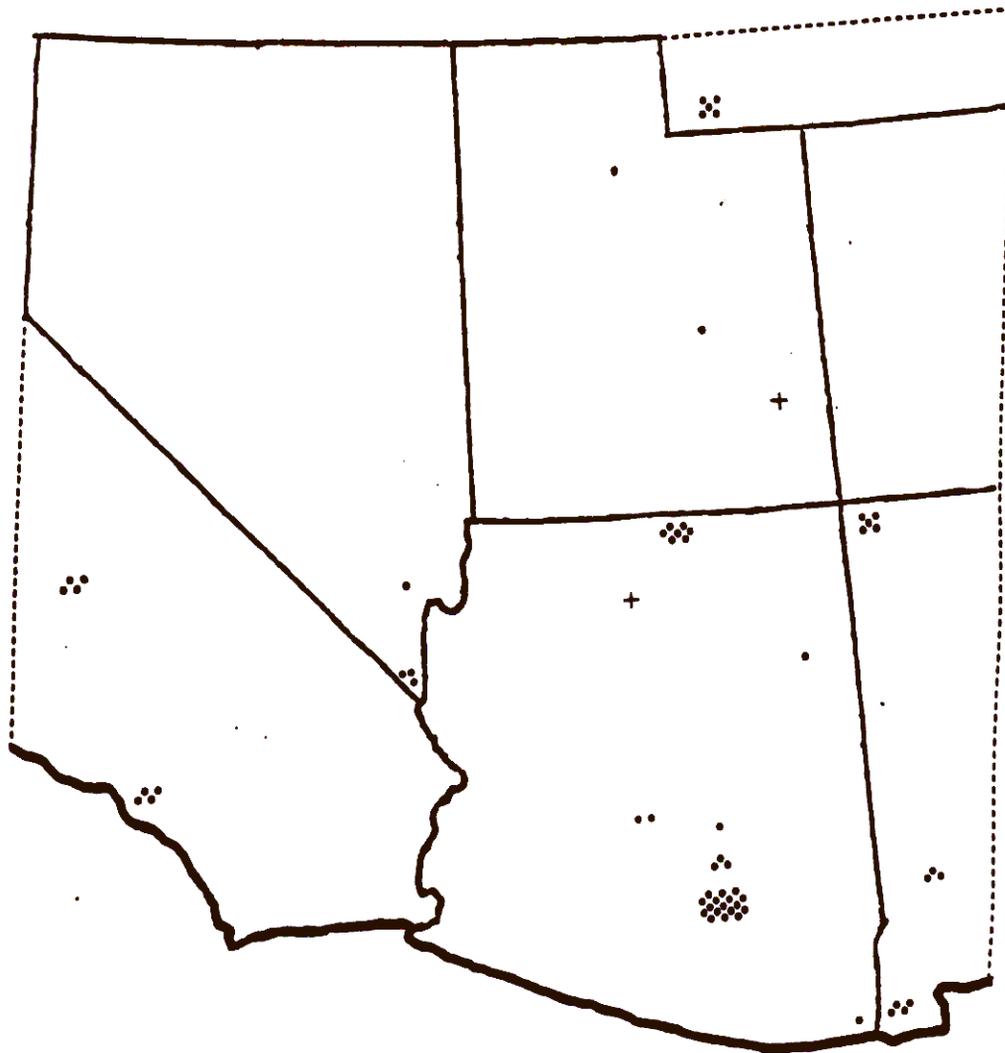
- * Presentation of data (SO_x/NO_x emissions, CD_4 concentrations, plume trajectories, air parcel ages, etc.) and parameters (oxidation rates and deposition rates) for DMB calculations.
- * Interpretation of spatial/temporal patterns in sulfates and nitrates based on trajectories and mass balance calculations.
- * Use of CD_4 data with DMB techniques to estimate sulfate and nitrate contributions from NGS.
- * Comparison of results with prior regional modeling.

CONCLUSIONS:

- * Wintertime sulfate episodes in the WHITEX region are mostly of a local nature (as opposed to long-range transport).
- * Liquid- or particle-phase oxidation may be a major sulfate function mechanism.
- * There are qualitative correlations between sulfate episodes at WHITEX sites and transport from NGS.
- * The "best estimate" is that NGS contributes 75% of average ambient sulfur at Page. During the February 11-12 episode, best estimates of sulfur contributions from NGS are 78% at Page, 100% at Hopi Point, 15% at Bullfrog, and 4% at Canyonlands.
- * The estimated NGS contribution to average nitrogen levels at Page is only 4%.
- * RIVAD modeling results support the conclusion regarding NGS sulfate impacts but contradict the conclusion regarding NGS nitrate impacts.

COMMENTS AND PROBLEMS:

- The DMB analysis needs to be redone using the same CD_4 data as in Chapter 6.
- A reconciliation needs to be made of the paradox in the DMB results that NGS contributes nearly all the sulfur at Page but basically none of the nitrogen.
- There should be a more extensive discussion and justification for the trajectory calculations and the transformation/deposition parameters.



● = 10,000 tons/year SO_x

APPROXIMATE SO_x EMISSIONS FROM MAJOR POINT SOURCES AND URBAN
AREAS IN THE SOUTHWEST UNITED STATES FOR 1987.

