

## 1.0 INTRODUCTION

This report is designed as a gateway to the detailed information integrated into Phase I of the Attribution of Haze (AoH) project. Most of this information resides on the Western Regional Air Partnership (WRAP) Web site (<http://wrapair.org/index.html>) and with WRAP data centers. The major sections of the report include:

- Section 1.0, Introduction – This section steps through the AoH project background and goals, and provides context for the project results.
- Section 2.0, Analytical Approach – This section describes the data sets and methods used to determine attribution of haze.
- Section 3.0, Attribution of Haze Web Site Description – This section introduces the data summary and analysis products available on the AoH Web site.
- Section 4.0, Regional Attributions and Assessments – This section presents the sulfate and nitrate attribution results, and summarizes other mass and visibility impact assessments that were performed.
- Section 5.0, Recommendations for Phase II – This section presents the recommendations for future AoH work.

## 1.1 BACKGROUND

The Western Regional Air Partnership is comprised of representatives from cooperating western states, tribes, and federal agencies. The WRAP was primarily established to implement the recommendations of the Grand Canyon Visibility Transport Commission (GCVTC) and to develop technical and policy tools to assist western states and tribes to comply with the U.S. Environmental Protection Agency's (EPA) Regional Haze Rule (RHR). The WRAP carries out its responsibilities through a network of committees and forums, composed of members and stakeholders who represent a wide range of viewpoints.

The WRAP Strategic Plan for 2003 – 2008 outlines a two-phased approach for developing state and tribal implementation plans (SIPs and TIPs) in accordance with the RHR (see: [http://wrapair.org/WRAP/meetings/031014board/Tab\\_4\\_Strategic\\_Plan\\_Final.doc](http://wrapair.org/WRAP/meetings/031014board/Tab_4_Strategic_Plan_Final.doc)). Phase I is intended as a trial run for Phase II. With Phase I the WRAP hopes to gain insight into which strategies are successful in meeting its goals, where data sets and other information are incomplete and need revision, and how to refine its approach to meet the needs of states and tribes in Phase II.

## 1.2 ATTRIBUTION OF HAZE PROJECT

The Attribution of Haze Workgroup was established to prepare a policy-level report describing the emission source categories and geographic source regions presently contributing to visibility impairment at each of the over 100 tribal and mandatory federal Class I areas in the WRAP region. A broad representation of technical and policy representatives were selected for the workgroup and an open meeting format was established to foster additional input. Most meetings were attended by a mix of industry, government, tribal and environmental groups.

The AoH Workgroup understands the importance of the guidance contained in the WRAP Tribal Template document (<http://wrapair.org/WRAP/reports/Gen-Tribe-Temp.pdf>). Tribes, along with states and federal agencies, are full partners in the WRAP, having equal representation on the WRAP Board as states. Whether Board members or not, all tribes are governments, as distinguished from the “stakeholders” (private interest) which participate on Forums and Committees but are not eligible for the Board. Despite this equality of representation on the Board, tribes are very differently situated than states. There are over four hundred federally recognized tribes in the WRAP region, including Alaska. The sheer number of tribes makes full participation impossible. Moreover, many tribes are faced with pressing environmental, economic, and social issues, and do not have the resources to participate in an effort such as the WRAP, however important its goals may be. These factors necessarily limit the level of tribal input into and endorsement of WRAP products. The tribal participants in the WRAP make their best effort to ensure that WRAP products are in the best interest of the tribes, the environment, and the public. One interest is to ensure that WRAP policies, as implemented by states and tribes, will not constrain the future options of tribes who are not involved in the WRAP. With these considerations and limitations in mind, the tribal participants have joined the state, federal, and private stakeholder interests in approving this report as a consensus document.

The specific goals of Phase I of the AoH project are:

- To provide state and tribal air regulators with an initial, regional assessment of the attribution of haze in their Class I areas;
- To provide an initial assessment of how and to what extent natural and anthropogenic emissions from each state affect western Class I areas; and
- Ultimately, to provide air regulators with the information and tools they need to prepare state and tribal implementation plans (SIPs and TIPs) under the RHR.

The attribution results from Phase I are designed neither to explicitly single out individual sources nor to identify the amount of reduction needed by a given source or group of sources in order to meet the RHR goals. Phase II of the project will build upon the experiences, results, and recommendations of Phase I. Important additional steps in Phase II will be the modeling of future pollution levels based on emissions control strategies defined by WRAP forums, an assessment of the impact from WRAP states to nearby Class I areas in the Central Regional Air Planning Association (CENRAP), and the development of Web-based analytical tools. A tentative schedule for Phase II and recommendations for Phase II are presented in Section 5.0.

### 1.3 ANALYSIS METHODS

The term “Attribution” used in this report refers to an assessment of the natural and anthropogenic emission from geographic source regions that contribute to aerosol concentration and extinction measured or estimated at a Class I area. It was not the intent or design of the AoH project to perform original research. Rather, the project was designed to pull together existing information from various analyses and use that data to determine the source types and source areas impacting each of the WRAP Class I areas. The three major sources of data for this project include:

- Emissions inventories (EIs) – While in some cases uncertain or incomplete, the EIs defined geographic source regions and provided estimates of emissions magnitudes.
- Monitoring data – Light extinction calculated from measured speciated fine mass and total coarse mass define the scope of visibility impacts in or near Class I areas.
- Modeling results – Atmospheric chemistry and transport models were used to make the connection between emissions from geographic source regions and fine mass collected in or near Class I areas.

A weight of evidence approach was used to evaluate and describe source attribution. The methodology consisted of reviewing emissions inventories, monitoring data, and modeling results, for the 2002 calendar year. One or two independent source apportionment methods were applied to each Class I area, results were compared, and supporting data and information were used to corroborate or question apportionment results.

The WRAP Regional Modeling Center (RMC) performed modeling runs for 2002 using the EPA Models-3/Community Multiscale Air Quality (CMAQ) model. The RMC developed a new algorithm in CMAQ to tag emissions inputs from particular source categories and source regions and then track the chemical transformations and transport of those emissions. Due to the complexity of the modeling technique, this Tagged Species Source Apportionment (TSSA) method was used to track only sulfate ( $\text{SO}_4$ ) and nitrate ( $\text{NO}_3$ ) associated with point and mobile sources from broad source regions. The point and mobile source categories were chosen because together these represent approximately 80% of the WRAP sulfur dioxide ( $\text{SO}_2$ ) and oxides of nitrogen ( $\text{NO}_x$ ) emissions. Together, sulfate and nitrate compounds account for 25 – 70% of the visibility impairment at Class I areas in the WRAP region.

The WRAP Causes of Haze Assessment (COHA) contractor, Desert Research Institute (DRI), performed meteorological back trajectory analyses for all Class I area monitoring locations within WRAP using the National Oceanic and Atmospheric Administration (NOAA) Hybrid-Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model. Using back trajectory results and monitoring data, DRI was able to perform a Trajectory Regression Analysis (TRA) for each monitoring location. This analysis relates the amount of time air spends over a source region (determined by a compilation of many back trajectories) to the aerosol species measured at a receptor site. This method was applied to sulfate and aerosol extinction only. DRI also generated many other back trajectory products in support of the AoH project.

The TSSA method fosters an understanding of source-receptor relationship, including emissions, chemistry, and transport. The TRA method does not incorporate emissions or chemistry, and thus treats all potential source regions similarly. Given these differences, comparisons between TSSA and TRA results are encouraging. The major contributing source regions identified by both methods are generally the same, though there is often some disagreement in the magnitude of each region's impact. Often the major differences between methods occur in the attribution results associated with Canada, Mexico, and the Pacific Ocean. The TSSA method shows only minor contributions from Canada and Mexico in border states where international impacts would be expected to be important. Since the emissions inventories used for Canada and Mexico were older than U.S. EIs (from 1995 and 1999, respectively) and are believed to be incomplete, the modeled impacts from these regions, based on the TSSA method, are more uncertain than modeled impacts from WRAP states. The TSSA method includes a wide band of the Pacific Ocean in its designation of coastal states as source regions, so impacts from coastal shipping is not reported as separate from coastal states. Emissions inventories for the Pacific region are far from complete. The TRA method identifies a Pacific Coast region close to shore independent from the rest of the Pacific Ocean. The TRA method can indicate a significant (>10%) contribution from the Pacific that is not explicitly indicated by the TSSA method.

While these differences are important, the attribution from WRAP states was considered the highest priority during Phase I. States and tribes will look to control the contributions from within WRAP in their efforts to reduce regional haze. States and tribes must cooperatively determine how best to use the attribution results. AoH has not defined a minimum threshold below which attribution results should be ignored. It may be more beneficial for states and tribes to review and understand source categories than to stipulate these minimum values.

State and regional emissions inventories, and other analyses of back trajectories were compared to source attribution results, and often added confidence to the attribution findings. Not all emissions types were tracked by TSSA and not all species were analyzed by TRA, so attribution results are not available for all species. Other methods were used to determine the regional affects of fire, carbon, and wind blown dust within the WRAP.

Class I areas were assigned to clusters based on the similarity of their attribution results. A total of twenty distinct clusters were identified. The motivation for grouping sites by species attribution was to understand if specific source regions might impact a group of Class I areas in a similar way, thus allowing those Class I areas to be treated together in Phase II. A closer review of these clusters is also anticipated in Phase II.

Table 1-1 presents an overview of the approaches used to determine and support the attribution of each aerosol species.

Table 1-1  
Approaches Used to Determine and Support Source Attribution by Species

Species	Attribution/Assessment Methods			Supporting Analyses and Data		
	CIA		Regional	Back Trajectories	Emissions	Monitoring Data
	TSSA	TRA	Modeling			
Sulfate	x	x		x	x <sup>1</sup>	x
Nitrate	x			x	x <sup>1</sup>	x
Organic Carbon			x	x	x <sup>1</sup>	x
Elem. Carbon			x	x	x	x
Soil			x	x	x	x
Coarse Mass			x	x	x	x
Extinction		x		x		x

<sup>1</sup> Species defined in Table 1 are not necessarily emitted as primary particles, but may be result of chemical transformation of direct emissions.

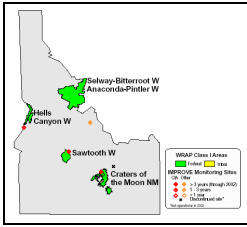
#### 1.4 PHASE I DATA SUMMARY PRODUCTS

Analysis results for the AoH project cover a broad region of the country, with some results focusing on individual Class I areas and others on the entire modeling domain. This report outlines some of the major data summary products and results generated as part of Phase I of the AoH project. The regional, state, tribal, and individual Class I area products themselves are too numerous to include here, but are available on the project Web site at: <http://wrapair.org/forums/aoh/index.html>. Section 3.0 describes what products are available on this Web site and how to find them. A summary of the major products with sample Web links is provided in Table 1-2.

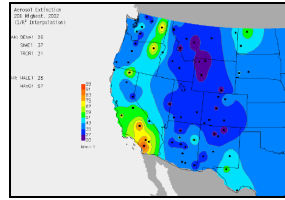
Table 1-2  
Summary of AoH Major Data Products

**State and Regional Reports**

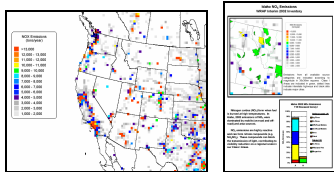
Sample Link: <http://www.wrapair.org/forums/aoh/ars1/states/Idaho.html>



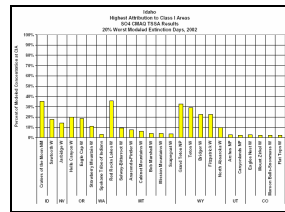
State maps showing the locations of visibility monitors in and near Class I areas



Regional maps showing 2002 visibility in WRAP, as measured in and near the Class I areas



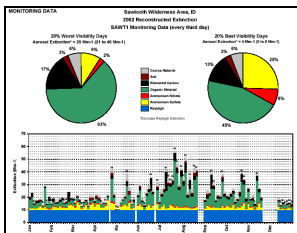
Regional and state maps showing gridded emissions data used for the 2002 AoH modeling



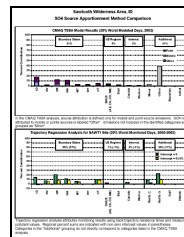
Summaries of individual state impacts on all Class I areas

**Individual Federal and Tribal Class I areas Reports**

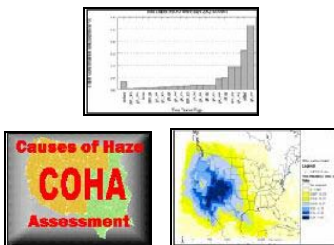
Sample link: <http://www.wrapair.org/forums/aoh/ars1/classone/idaho/SAWT1.html>



2002 monitored and modeled visibility summaries



2002 attribution results by TSSA and TRA methods



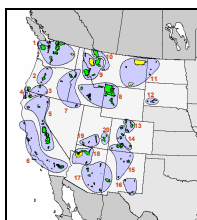
Links to more detailed supporting data (RMC and DRI raw results, back trajectory maps)



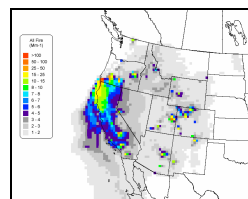
Links to VIEWS Web site and WRAP EDMS

**Other Products**

(Section 4.0 of this report)



Identification of clusters of Class I areas which have similar attribution results



Regional assessments of fire, carbon, and wind blown dust