



NASA Proposal Title: **Evaluation and Application of ACAST Products and Knowledge in Western U.S. Air Quality Planning and Management**

NASA Solicitation: [NNH13ZDA001N-HEALTH: Earth Science Applications: Health and Air Quality](#)

Submitting Organization: Western Regional Air Partnership (WRAP) / Western States Air Resources Council (WESTAR)

April 24, 2014

Proposal Summary

The WRAP and WESTAR will utilize their Technical Steering Committee resources of state, tribal, local and federal agencies' air quality management staff with additional subject matter experts from across its member agencies and collaborators to assist NASA in understanding when and how completely ACAST products and knowledge, and by extension Earth Observations more broadly, can be applied to real-world, well-established CAA-required assessment, evaluation, and analysis efforts, as well as the associated planning procedures and activities. WRAP will conduct this project to address CAA air quality standards protecting both health and ecosystem welfare - topics that are multi-jurisdictional and broadly regional in nature. WRAP will interview ACAST Tiger Teams to evaluate their work products and deliverables. The results of this process is to determine specific test applications where Earth observations and related tools and data products can be integrated into western regional photochemical modeling activities at various time and space scales, for various air quality health and welfare standards and goals, to evaluate ACAST work products and their applicability to western U.S. air quality planning and management situations in ongoing western regional analyses. The implementation of ACAST work products and Earth Observations data will be the Western Regional Modeling Framework (WRMF). The WRMF is in development to support western regional air quality analysis and planning on an ongoing basis, to be operational later in 2014. It will consist of ground-based ambient air quality data, regulatory and scientific emissions inventories for all sectors, the transformation and analysis of the inventories to modeled emission fields, meteorological and other atmospheric data for modeling, and full-capacity regional photochemical models to provide one-atmosphere simulations of present and future air quality.

Decision-making Activity

The Western Regional Air Partnership (WRAP, <http://www.wrapair2.org/>) is a regional air quality membership organization founded in 1997, which has conducted extensive regional technical and planning analyses for the western U.S., including Alaska and Hawaii. The WRAP is administered by WESTAR (<http://www.westar.org/>) and the organizations share the same geographic boundaries and many of the same member air pollution control agencies. WRAP/WESTAR has been quite active in efforts to improve understanding of the sources, formation, and transport of air pollution and the effects of that pollution on air quality and associated natural resources across the West, in the context of emissions control and air management programs to achieve health and welfare standards for residents and visitors to the region. WRAP includes membership, participation, and support of 15 state air pollution control agencies, tribal nations in the West, over 30 local air quality management agencies at the county or district level – all as individual regulatory authorities implementing air pollution control programs working with the U.S. EPA

at the regional and national level under the Clean Air Act (CAA) through the CAA's "cooperative federalism" approach. The EPA and the federal land management agencies with mandatory CAA air quality protection duties - (NPS, USFS, FWS, and BLM) are also active members of the WRAP/WESTAR – forming a fully integrated western regional air quality analysis and planning membership organization. WRAP studies collaborate actively with other federal agencies, as well as academic, industry and environmental organizations.

The WRAPⁱ and WESTARⁱⁱ will utilize their Technical Steering Committee resources of state, tribal, local and federal agencies' air quality management staff with additional subject matter experts from across its member agencies and collaborators to assist NASA in understanding when and how completely ACAST products and knowledge, and by extension Earth Observations more broadly, can be applied to real-world, well-established CAA-required assessment, evaluation, and analysis efforts, as well as the associated planning procedures and activities. WRAP will interview ACAST Tiger Teams to evaluate their work products and deliverables. The results of this process is to determine specific test applications where Earth observations and related tools and data products can be integrated into western regional photochemical modeling activities at various time and space scales, for various air quality health and welfare standards and goals, to evaluate ACAST work products and their applicability to western U.S. air quality planning and management situation in ongoing western regional analyses.

Under the federal Clean Air Act, as amended, air pollution control and air quality management agencies have specific responsibilities have individual and joint regulatory responsibilities with their neighboring jurisdictions, U.S EPA, and numerous other federal agencies. These individual agency and regional analysis, planning, and regulatory requirements are well developed and documentedⁱⁱⁱ over the past 40+ years^{iv,v,vi,vii,viii,ix,x,xi,xii,xiii,xiv,xv}, since 1970. These processes and analyses cannot be adequately described in the space available in this document, but are among the principle functions of the WRAP member agencies.

WRAP will conduct this project to address CAA air quality standards protecting both health and ecosystem welfare - topics that are multi-jurisdictional and broadly regional in nature. The kinds of air management decisions to be made under CAA requirements will include, for example:

1. the range of air quality standards that are being considered for adoption;
2. geographic areas which could be defined as being "in violation";
3. assessments of international and interstate transport of air pollutants;
4. quantification of emissions source sectors that contribute to local and regional air pollution; and
5. regional assessments of air quality responses to emission change scenarios.

These topics affect one or more WRAP member jurisdictions on an individual basis, one or more multi-jurisdictional sub-region areas in the WRAP/WESTAR region, and in some cases, may fully encompass the entire 15-state area, affecting air quality control and management agencies.

WRAP will define possible outcomes from the interview and collaboration process with ACAST by developing hypotheses to test with applications of ACAST products and knowledge to western U.S. air quality analysis and planning. The primary objective of this project is to identify and pilot test ACAST data products so that time- and resource-constrained air managers have real-world applications to reference for compliance with CAA planning requirements. Successful applications of data, tools, and knowledge would be integrated into ongoing WRAP regional air quality analyses.

The implementation of ACAST work products and Earth Observations data will be the Western Regional Modeling Framework (WRMF). The WRMF is in development to support western regional air quality analysis and planning on an ongoing basis, to be operational later in 2014. It will consist of ground-based

ambient air quality data, regulatory and scientific emissions inventories for all sectors, the transformation and analysis of the inventories to modeled emission fields, meteorological and other atmospheric data for modeling, and full-capacity regional photochemical models (CAMx^{xvi} and CMAQ^{xvii}) to provide one-atmosphere simulations of present and future air quality.

The WRMF will provide a regionally consistent, comprehensive, and transparent/well-documented technical nexus for testing and incorporating AQAST products and Earth Observation data into regional air quality studies, supporting all WRAP/WESTAR member agencies. The WRAP is currently developing a comprehensive regional integrated work plan across multiple agencies, funders, and projects for 2014-18, to be finalized by September 2014. A number of already-funded air quality studies at the WRAP during the time period of this proposed project for NASA will be linked through the WRMF and in the Work Plan. This NASA project proposal will be part of the WRAP Integrated Work Plan development process.

Earth Observations

Applying Earth Observations in the well-established CAA analysis and planning structure requires broad agreement about the utility of the specific Earth Observation resources in the CAA planning timelines and technical evolution requirements. Examples of the challenges are shown in Figure 1.

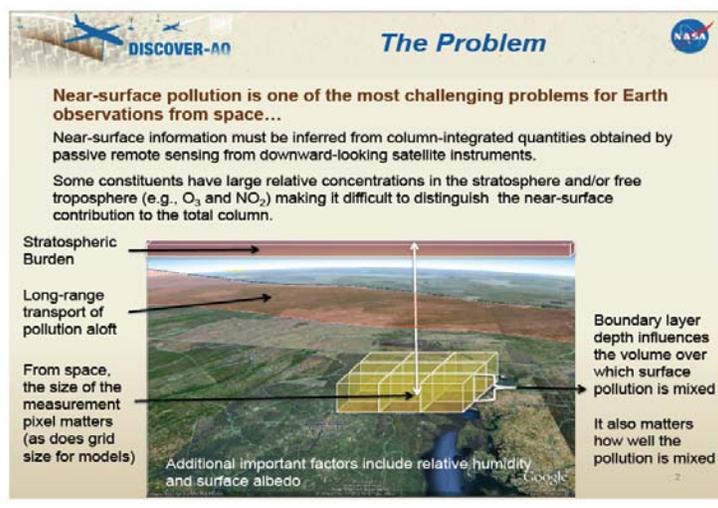


Figure 1. Near-surface pollution is a challenging problem for Earth Observations from space.^{xviii}

The CAA monitoring, emissions, and photochemical modeling data collection and analysis methodologies are well-established processes. With several kinds of resource limitations for these historic approaches – budget, temporal, spatial, ground-based observations, chemical composition information, et cetera – it is desirable to begin to routinely integrate Earth Observations in air quality analysis and planning for CAA requirements. Careful assessment and evaluation, with an eye to better Earth Observation instruments on future NASA missions, needs to be done systematically with a diverse group of users with a variety of air pollution problems at various levels of severity and human health exposure. WRAP intends to evaluate and assess Earth Observations using the federal air quality standards and goals as the measure of human health and welfare impacts. For these reasons, we have identified the AQAST effort and its products, as well as associated products and tools from the Earth Observations community as our menu of options to evaluate the use of Earth Observations in routine air quality analysis and planning under the CAA. AQAST topic areas are shown in Figure 2.

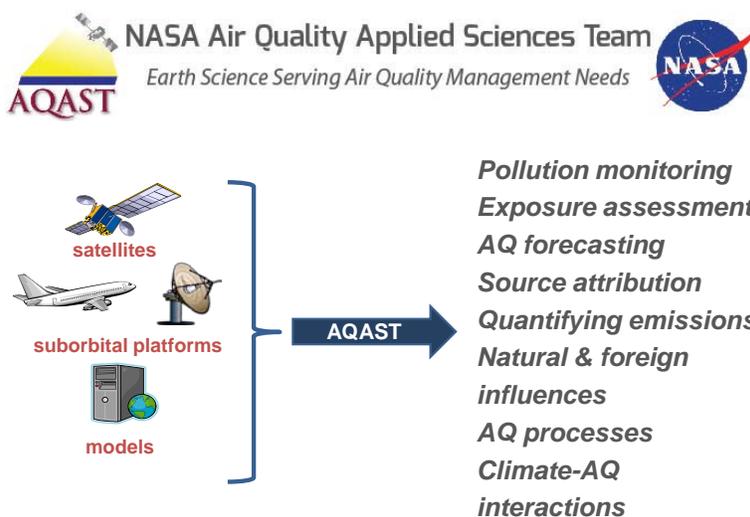


Figure 2. NASA Air Quality Applied Sciences Team topic areas.^{xix}

WRAP will draw principally upon these topics in this evaluation and assessment effort.

- Pollution Monitoring
- Source Attribution
- Quantifying Emissions
- Influence of Natural and Foreign Sources on western U.S. air quality
- Air Quality Processes
- Climate Change Interactions and Impacts on present and future western U.S. Air Quality

Technical/Scientific/Management

WRAP will define possible outcomes from the collaboration process with AQAST by developing hypotheses to test with applications of AQAST products and knowledge to western U.S. air quality analysis and planning. The primary objective of this project is to identify and pilot test AQAST data products so that time- and resource-constrained air managers have real-world applications to reference for compliance with CAA planning requirements. Successful applications of data, tools, and knowledge would be integrated into ongoing WRAP regional air quality analyses, through the WRMF technical capability.

WRAP proposes to evaluate and identify specific applications of NASA Air Quality Applied Science Team (AQAST) products and knowledge as AQAST completes their current phase of work. WRAP also plans to apply Earth Observations associated with AQAST products. WRAP will conduct this project at time-space-chemistry data and analysis scales appropriate to AQAST projects, to address CAA air quality standards protecting both health and ecosystem welfare - topics that are multi-jurisdictional and broadly regional in nature.

The technical and scientific efforts will focus on evaluating and assessing AQAST products and Earth Observations for five key topics:

1. The range of air quality standards that are being considered for adoption.

U.S. EPA is currently evaluating a range of 60 to 70 ppb for the primary (health) Ozone air quality standard, as well as growing-season/time-weighted secondary (welfare) Ozone standard to protect ecosystems. Planning for both the primary and secondary standards would require emissions reductions strategies to be fully evaluated. Analysis of historic monitoring data and future modeling studies shows that large regions of the West would exceed the Ozone standard if it is set below 70 ppb. WRAP would evaluate ACAST products and Earth Observations across the range of the levels of the proposed standards with our current analysis tools in the WRMF, and as these products add resolution, completeness, and additional detail - combine them into routine analyses. WRAP sees the organizational, technical capacity, and composition of ACAST as ideal for this kind of analysis and evaluation activity, see Figure 3 for ACAST attributes.

Why is ACAST Unique?

- All ACAST projects **connect** Earth Science and air quality management:
 - Pursue science to support air quality management
 - Collaborate with partners in air quality management
 - Expand relationships through meetings, online tools, newsletters
- ACAST has **flexibility** in how it allocates its resources
 - Members can adjust work plans to meet evolving air quality needs
 - Multi-member "Tiger Teams" compete for funding to address strategic problems requiring coordinated activity
 - ACAST is self-organizing and can respond **quickly** to demands
- ACAST supports two types of projects:
 - **Investigator Projects** – core funding to individual members
 - **Tiger Team Projects** – collaborations between ACAST members with supplementary funding to address urgent air quality management needs

**Quick, collaborative, flexible,
responsive to the needs of the AQ
community**




www.aqast.org & www.aqast-media.org

Figure 3. Attributes of NASA Air Quality Applied Sciences Team^{xx}.

2. Geographic areas which could be defined as being “in violation”.

ACAST has reached out over the past two years to air quality management agencies across the nation, including some WRAP/WESTAR member agencies. Figure 4 illustrates the connections and relationships between ACAST Projects, Themes, and Air Quality Management Agencies. These connections and relationships would be better evaluated and assessed with a larger sample size of air quality management agencies with specific concerns about scenarios of Ozone nonattainment under the CAA. WRAP plans to use the individual and collective knowledge of its members to anticipate future geographic areas which may “violate” a more stringent Ozone standard(s) and evaluate and assess the utility of ACAST products and Earth Observations to reduce uncertainty and increase technical precision in the CAA “area designation” processes. The effect is not only to define the geographic area of concern more accurately, but to identify chemical and temporal signals from ACAST products and Earth Observations that better enable the air quality management agencies to evaluate their own programs, rules and permits – with an eye on future regulatory strategies.

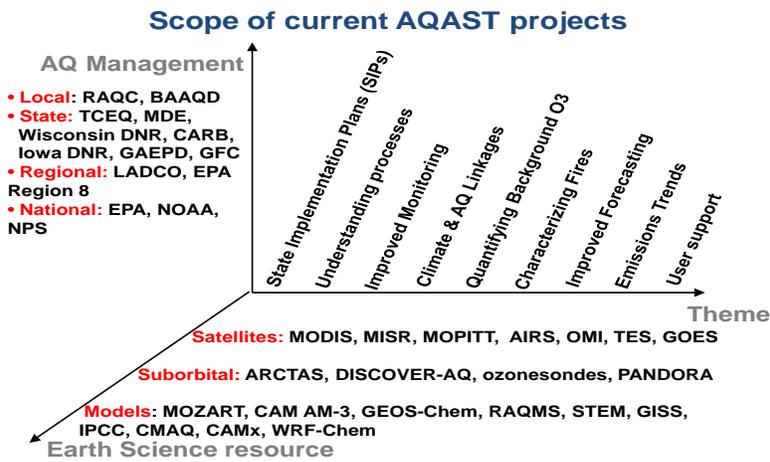


Figure 4. Relationships of AQAST Projects, Themes, and Air Quality Management Agencies.^{xxi}

3. Assessments of international and interstate transport of air pollutants.

WRAP seeks to work with the AQAST as the most expert panel on Earth Observations for air quality purposes, to constrain and more precisely determine the transport of air pollution into and across the western U.S. Numerous satellite platforms and instruments are providing Earth Observation data as shown in Figure 5. These platforms and instruments have different and relative degrees of coverage, accuracy, frequency, and lifespan, among other characteristics. CAA planning has a nominal 10-year time horizon and international transport is likely to continue to be important to sort out across that time frame. Through this evaluation and assessment, using the WRMF technical capacity, WRAP specifically intends to be able to apply the Earth Observations across the spectrum of information and data from satellites, sub-orbital platforms, and global models to more fully analyze transport in an efficient manner, in terms of computational resources and staff time at air quality management agencies.

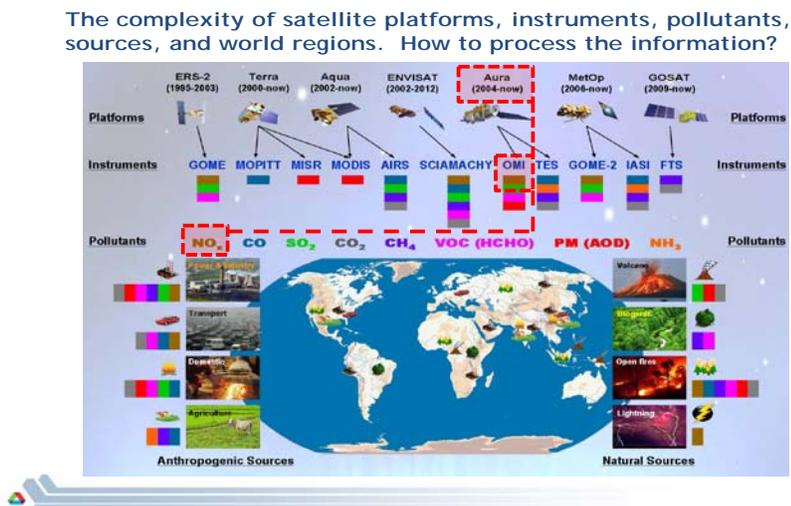


Figure 5. Complexity of Satellite Platforms, Instruments, and Source Regions.^{xxii}

4. Quantification of emissions source sectors that contribute to local and regional air pollution.

Under the CAA, air quality management agencies develop and implement plans and control programs to reduce emissions to improve air quality. In this portion of the proposed project, WRAP seeks to, as fully as possible, leverage and integrate the knowledge and capability of AQA and Earth Observations to better understand emissions rates, chemistry, spatial and temporal patterns, and the source strengths and characteristics of emissions outside the U.S. Example work by David Streets and colleagues, and Bryan Duncan, among others from AQA would be an enormous resource to the large cross-section of air quality management agencies in the WRAP/WESTAR region.

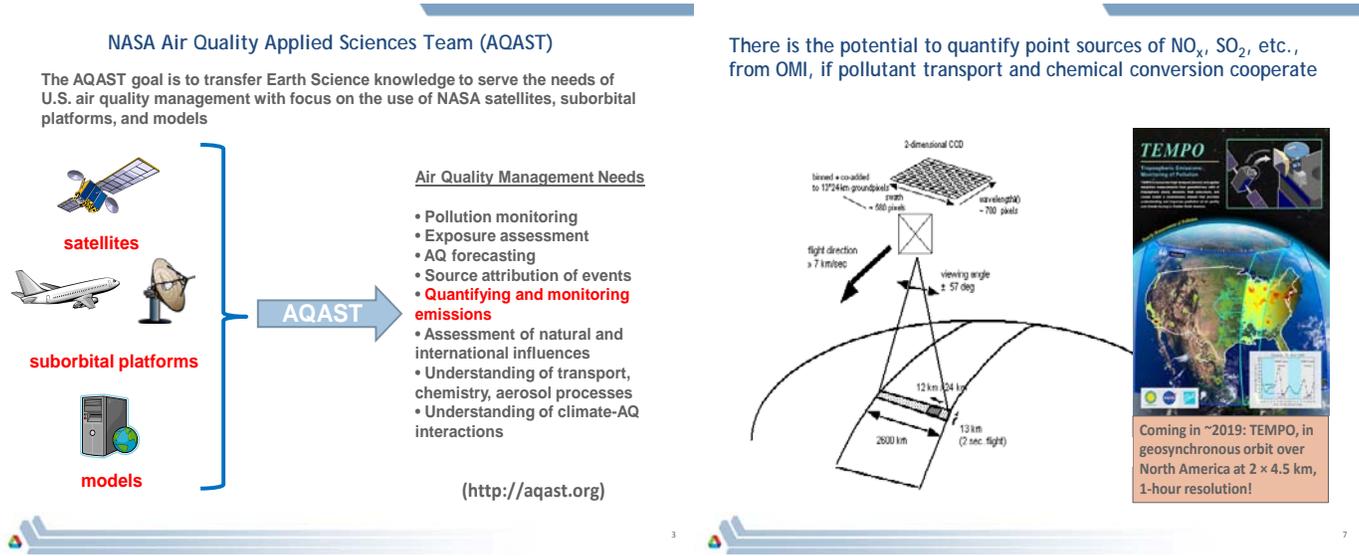


Figure 5. Applications of Earth Observations to Evaluate, Assess, and Improve Emissions Estimates^{.xxiii, xxiv, xxv,xxvi}

5. Regional assessments of air quality responses to emission change scenarios.

Air quality planning under the CAA requires evaluation and selection of emissions reductions that improve air quality in the future by a specified date. These emissions changes are adopted by air quality management agencies and ultimately are approved and made federally-enforceable by U.S. EPA action. It is desirable to apply additional tools, data, and methods that will track changes in the emissions into the future in the “top-down” manner of Earth Observations. In order to determine if Earth Observations can be used to assist in demonstrating successful implementation of control programs, evaluation and assessment of AQA products and Earth Observations must be done with current results. Figure 6 illustrates some of the current products and results that would be evaluated for use in regional air quality analysis and planning by air quality management agencies in the western U.S.

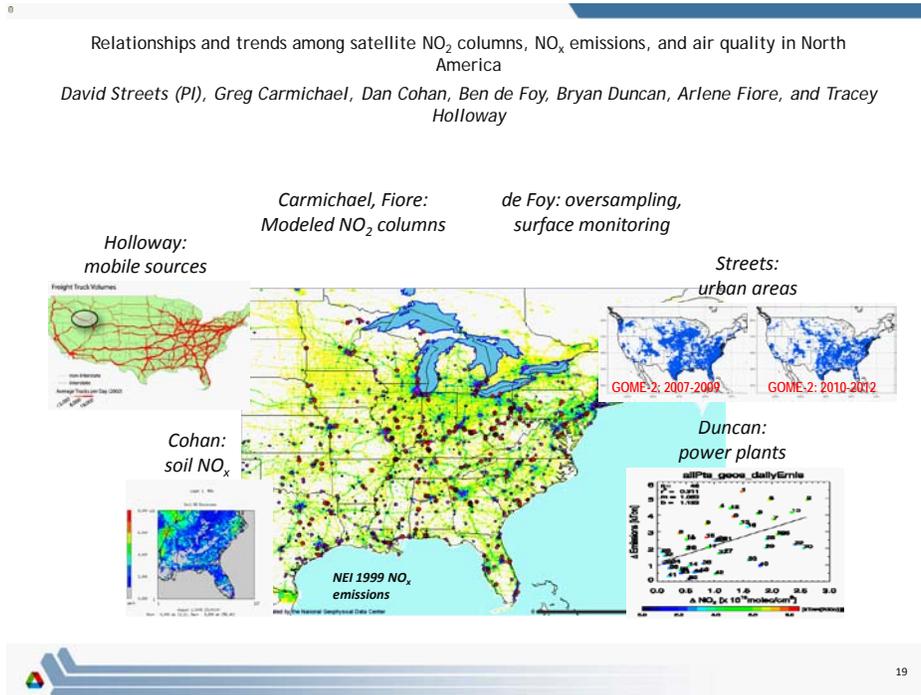


Figure 6. Examples of ACAST Products for Evaluation and Assessment, for subsequent application in the Western Regional Modeling Framework.^{xxvii}

Methods Proposed to Accomplish the Technical/Scientific Activities

As noted, the WRAP will utilize its Technical Steering Committee with additional subject matter experts from across its member agencies and collaborators to assist NASA in understanding when and how completely ACAST products and knowledge, and by extension Earth observations more broadly, can be applied to real-world, well-established CAA-required assessment, evaluation, analysis, and planning procedures and activities. WRAP will interview ACAST Tiger Teams to determine specific test applications where Earth observations and related tools and data products can be integrated, and then evaluate ACAST work products and their applicability to western U.S. air quality planning and management situation in ongoing western regional analyses.

WRAP will use the hypotheses, and the planning needs and collective knowledge of WRAP/WESTAR member agencies to shape the assessment of the ACAST products and Earth Observations datasets identified in the process. These products and data will then be applied in the tools and evaluation methods used in the Western Regional Modeling Framework, and the results of those tests evaluated for the changes in results for planning purposes – increased accuracy, completeness, precision. The test results will also identify where, when and how uncertainty is reduced and additional, new information and data can be used in air quality planning.

For the five key topics, assuming that each topic will return at least one ACAST product and/or Earth Observations that are beneficial to air quality planning activities, WRAP expects the five topic areas to rise to the following Application Readiness Levels during the two-year period of this project.

1. The range of air quality standards that are being considered for adoption.

WRAP expects the ARL to progress from a 5 to a level 8 over the time frame of this project.

2. Geographic areas which could be defined as being “in violation”;

WRAP expects the ARL to progress from a level 5 to a level 7 over the time frame of this project.

3. Assessments of international and interstate transport of air pollutants;

WRAP expects the ARL to progress from a level 6 to a level 9 over the time frame of this project.

4. Quantification of emissions source sectors that contribute to local and regional air pollution

WRAP expects the ARL to progress from a level 3 to a level 7 over the time frame of this project.

5. Regional assessments of air quality responses to emission change scenarios

WRAP expects the ARL to progress from a level 2-3 to a level 5-6 over the time frame of this project.

Three of the five topics are targeted for integration as “decision-support” into the Western Regional Modeling Framework during the period of this project, and the remaining two topics would be moving from testing and validation into the lower end of application for “decision-support”.

Performance Measures

The metrics and measures for determining the outcomes, value, and results for this project are dependent upon sufficient participation and engagement by the ACAST members and WRAP/WESTAR member agencies. Good working relationships between WRAP/WESTAR and several ACAST members are in place, and WRAP/WESTAR staff has been participating in the ACAST activities. Also, several WRAP/WESTAR member agency staff has been engaged in ACAST Tiger Team projects, as well as other projects with scientists from the Earth Observations community.

Figure 7 illustrates a proposed approach from the ACAST Deputy Leader, Tracey Holloway.

Deliverables & Expected AQ outcomes

1. Establishment of a stakeholder advisory committee (set priorities)
 - Build broader engagement between ACAST and state-level AQMs
2. For each episode, generate reports with technical details of approach in appendices (“the recipe” for the analysis)
 - New info / approaches to support SIP development
 - Build capacity by providing case studies for future analyses
3. Develop website archive of reports, and links to related ACAST resources, including coordination with RSIG TT activity, other web tools
 - Broader dissemination of approaches & findings
4. Online interactive graphics to facilitate exploration of model and satellite data
 - Developing user-friendly space-based and model products to provide information on contributions from transported pollution

Figure 7. ACAST-proposed Deliverables and Expected Air Quality Outcomes.^{xxviii}

WRAP will prepare a consensus report with Technical Steering Committee and other WRAP/WESTAR participants as co-authors, at the end of the project, to document the collaboration process and specifying the AQAST products and Earth Observations status in the Western Regional Modeling Framework and their use in western air quality planning activities. We will also include the ARL status of products and data at that time.

Anticipated Results/Improvements

The activities and work outlined in this proposal by WRAP address NASA Strategic Goals and a NASA Earth Science Area Objective, in addition to the practical applied integration of AQAST products and Earth Observations into the WRAP/WESTAR Western Regional Modeling Framework. The NASA Goals and Objectives addressed directly by this proposed project are listed next for reference.^{xxix}

NASA Strategic Goals

- Advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet
- NASA is working to understand the mechanisms and possible actions Federal, state, and local agencies and organizations and communities can take to minimize the impacts of environmental change.

NASA Earth Science Area Objective

1. Understand and improve predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.

Transition and Sustainability

CAA analysis and planning requirements, and the unique challenges of western U.S. air quality management, will require the ongoing support and operation of the Western Regional Modeling Framework. This proposed project is a serendipitous activity for WRAP/WESTAR and NASA Applied Sciences. The success of applying AQAST products and ongoing use of Earth Observations means the WRMF will be more robust, efficient, and effective in accomplishing analyses for regional air quality planning support. The success and enhancement of the WRMF means NASA will be able to refer to the WRMF as a practical and ongoing application of Earth Observations and take credit for the foresight to assemble and complete the current AQAST phase of work. As mentioned above, three of the five topics are targeted for integration as “decision-support” into the Western Regional Modeling Framework during the period of this project, and the remaining two topics would be moving from testing and validation into the lower end of application for “decision-support”. This level of success is the WRAP/WESTAR measure of a transition to sustainability.

Project Management and Schedule

Project management will be handled by Tom Moore, the WRAP Air Quality Program Manager for WESTAR and Principal Investigator on this proposed project. He will supervise a full-time staff person to be hired. The likely profile of this new staff would be a post-doctoral researcher with interests and training in regional air quality analysis using Earth Observations. Alternatively, a well-qualified state or federal employee may be employed through an Inter-Personnel Agreement arrangement. In either case, s/he would likely be based at CIRA at Colorado State University with Mr. Moore. S/he would handle the detailed scientific and technical interactions between AQAST members and WRAP Technical Steering Committee members. In addition to a

AQAST meeting presentation during the project, six (6) in-person meetings are proposed in this effort, at western U.S. venues, and would be open to the western air quality agency community and the Earth Observations community, as the project seeks broad input and review of the work of AQAST and WRAP. WRAP would align, to the degree possible, the meetings with AQAST and western regional air quality meetings. The periods between the in-person meetings would utilize webinar/video and telephone conferencing to work on specific assessments and evaluations. Deliverables in addition to the final project report and the integration of the AQAST products and Earth Observations into the Western Regional Modeling Framework are noted in the schedule.

Activity	Milestone Timeframe	Deliverable
Project kick-off meeting	Within 3 months of project award	Develop schedule and action items for project activities
Conference calls / webinars	One each in months 2, 3, and 4 after kickoff meeting	Plan for assessments Format for AQAST interviews
Project meeting	Month 5 after kickoff meeting	Discuss, refine, and finalize hypotheses.
Conference calls / webinars	One each in months 6, 7, and 8 after kickoff meeting	Begin assessments and AQAST interviews
Project meeting	Month 9 after kickoff meeting	Identify initial findings Begin scoping to test in WRMF
Conference calls / webinars	One each in months 10, 11, and 12 after kickoff meeting	2 nd round of assessments and AQAST interviews
Project meeting	Month 13 after kickoff meeting	Review and finalize mid-project progress report Determine schedule & evaluation methods for testing in WRMF
Conference calls / webinars	One each in months 14, 15, and 16 after kickoff meeting	Conduct WRMF testing and evaluate results – round 1
Project meeting	Month 17 after kickoff meeting	Review documentation of WRMF Round 1 testing results Determine schedule for Round 2 WRMF testing
Conference calls / webinars	One each in months 18, 19, and 20 after kickoff meeting	Conduct WRMF testing and evaluate results – round 2
AQAST meeting	Month 21 after kickoff meeting (approximately)	Report interim results with WRAP/WESTAR member agencies' staff to AQAST and NASA Report on WRMF activities and future plans
Conference calls / webinars	One each in months 22 and 23 after kickoff meeting	Review documentation of WRMF Round 2 testing results Review draft of project report
Project WRAP-up meeting	Month 24 after kickoff meeting	Adopt consensus project report with Technical Steering Committee and other WRAP/WESTAR participants as co-authors Review lessons learned Finalize WRMF activities / future plans after this project

Participation by end-users in this project will be organized and coordinated by WRAP/WESTAR staff. WRAP/WESTAR staff regularly and routinely gathers member agencies' representatives for periodic as well as special purpose meetings. Members of the WRAP Technical Steering Committee reviewed and contributed to the Notice of Intent sent by WRAP for this proposal, and their input informs the details of this proposal. If this proposal is funded, WRAP/WESTAR expects significant and steady participation of our member agencies, given the linkage to the Western Regional Modeling Framework and other WRAP projects.

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