

Four Corners Air Quality Group Four Corners Area Current Studies

November 2021

Ozone Studies

- The Colorado Department of Public Health and Environment conducted a summer 2019 ozone study in southwest Colorado to help determine if monitoring in the area is appropriate. One short-term site was added to the north of Cortez and five were added in the Animas Valley around Durango. A report will be developed in the next year.
- The Intermountain West Data Warehouse - Western Air Quality Study (IWDW-WAQS) has produced an updated air quality model platform for year 2011 ([2011b](#)) for use by interested parties (see further description below under Multiple Pollutant Studies).
- The [Southern New Mexico Ozone Study \(SNMOS\)](#) was completed in early November 2016. The SNMOS assessed 2011 base year and future projection year ozone impacts and contributing source categories/regions in and around Doña Ana County, NM.
- 2014 Uinta Basin Winter Ozone Study final report is available here: <https://deq.utah.gov/legacy/destinations/u/uintah-basin/ozone/strategies/studies/2014.htm>.
- WESTAR/WRAP worked with Dr. Dan Jaffe and a team of federal and university scientists to publish a paper in the scientific journal *Elementa* on the state of the science of background ozone in the U.S.: http://www.wrapair2.org/pdf/BOSA_O3_Elementa2018_Jaffe_et_al.pdf.
- WESTAR/WRAP staff had a paper published in *AWMA Environmental Manager* September 2018 issue on the topic of addressing background ozone and transport: <http://www.wrapair2.org/pdf/moore.pdf>.
- The Ute Mountain Ute Tribe (UMUT) Air Quality program deployed an ozone field monitoring system at Tribal Lands north of Kirkland, NM and began data collection in July, 2021. Monitoring will be ongoing on that site until November 2021. The UMUT monitors ozone at Towaoc, CO which meets regulatory requirements. Data since 2019 has been uploaded into EPA's Air Quality System Database. Staff posts current daily AQI via email and social media.
- National Park Service (NPS) and Colorado State University researchers measured volatile organic compounds (VOCs) which are known ozone precursors at four national parks in the southwestern United States: Carlsbad Caverns (CAVE), Great Basin (GRBA), Grand Canyon (GRCA), and Joshua Tree (JOTR), for five months in 2017. CAVE had the highest levels of light alkanes by approximately an order of magnitude. At the other three Parks, VOC concentrations were similar to each other. Measurements in and around CAVE showed an oil and gas influence: <https://www.sciencedirect.com/science/article/abs/pii/S135223102030515X>.
- NPS and State University of New York researchers examined decadal (2005- 2015) ozone trends for 13 rural & remote sites in the Intermountain West. No trends were observed at two reference sites while widely varying trends were observed at the other 11 sites. Decreasing trends

were observed at Mesa Verde and Canyonlands National Parks, attributed to a 37% decrease in natural gas production in the San Juan Basin and 25% emission reductions in coal-fired electricity generation, respectively. Findings suggest that emissions from oil and natural gas extraction likely played a significant role in shaping long-term ozone trends near or within oil and gas basins and warrant consideration in designing efficient ozone mitigation strategies for the Intermountain West: <https://acp.copernicus.org/preprints/acp-2019-164/>

- In 2016, NPS researchers conducted assessments of ozone foliar injury at Arches, Canyonlands, Mesa Verde National Parks and Colorado and Dinosaur National Monuments. The levels of ozone in 2016 were low during this time and prevented the development of foliar injury on bioindicator species in spite of moderate to high levels of precipitation in some parks. More research is needed: <https://irma.nps.gov/DataStore/DownloadFile/640216>

Mercury Studies

- Two years of follow-up gaseous oxidized mercury (GOM) dry deposition measurements in the Four Corners Area 2017-2019 completed in August, 2019. Results published in journal Atmospheric Pollution Research at the following link: <https://doi.org/10.1016/j.apr.2020.08.030>
- Mark E. Sather, Shaibal Mukerjee, Kara L. Allen, Luther Smith, Johnson Mathew, Clarence Jackson, Ryan Callison, Larry Scrapper, April Hathcoat, Jacque Adam, Danielle Keese, Philip Ketcher, Robert Brunette, Jason Karlstrom, and Gerard Van der Jagt, "Gaseous Oxidized Mercury Dry Deposition Measurements in the Southwestern USA: A Comparison between Texas, Eastern Oklahoma, and the Four Corners Area," The Scientific World Journal, vol. 2014, Article ID 580723, 14 pages, 2014. Doi:10.1155/2014/580723. The article can be accessed at the following link: <http://www.hindawi.com/journals/tswj/2014/580723/> .
- Sather, M.E., Mukerjee, S., Smith, L., Mathew, J., Jackson, C., Callison, R., Scrapper, L., Hathcoat, A., Adam, J., Keese, D., Ketcher, P., Brunette, R., Karlstrom, J., Van der Jagt, G., 2013. Gaseous oxidized mercury dry deposition measurements in the Four Corners Area and Eastern Oklahoma, U.S.A. Atmospheric Pollution Research, doi: 10.5094/APR.2013.017. <https://www.sciencedirect.com/science/article/pii/S130910421530386X>
- The Mesa Verde NPS Mercury Deposition Network (MDN) monitor. NADP-MDN website <http://nadp.sws.uiuc.edu/mdn/> includes a temporal trend graph for mercury. Total Hg in wet deposition has been monitored at Mesa Verde NP since 2002.
- As a surrogate for mercury (Hg) risk, dragonfly larvae have been collected and analyzed for total Hg concentrations from NPS units in the Four Corners region including Valles Caldera National Preserve (Jemez Springs, NM) and Glen Canyon National Recreation Area (Page, AZ). Samples were collected from nine unique sites in these two parks across three years (2015, 2018-2019); 27% of the dragonfly Hg data fall into the moderate (100-300 ng/g dw) and 36% fall into the high or severe (>300 ng/g dw) impairment categories for potential Hg risk. An index of moderate impairment or higher suggests some fish species may exceed the US EPA benchmark for protection of human health. There are also recent dragonfly Hg data from other NPS units that fall close to the Four Corners region including those in UT (Capitol Reef NP, Zion NP), CO (Colorado NM, Great Sand Dunes NP&P), and AZ (Grand Canyon NP, Montezuma Castle NM, Tuzigoot NM). New dragonfly Hg data are expected from parks in the Four Corners that sampled over the 2021 field season, including Yucca House NM

(Cortez, CO) and nearby FWS refuges Valle de Oro (Albuquerque, NM) and Bosque del Apache (San Antonio, NM). Those data are anticipated in spring 2022. References below:

- *Eagles-Smith, C.A., J.J. Willacker, S.J. Nelson, C.M. Flanagan Pritz, D.P. Krabbenhoft, C.Y. Chen, J.T. Ackerman, E.H. Campbell Grant, and D.S. Pilliod. 2020a. Dragonflies as biosentinels of mercury availability in aquatic food webs of national parks throughout the United States. Environmental Science and Technology 54(14):8779-8790. <https://doi.org/10.1021/acs.est.0c01255>*
- *Eagles-Smith, C.A., J.J. Willacker Jr., S.J. Nelson, C.M. Flanagan Pritz, C.S. Emery, B.L. Johnson, K. Ko, D.P. Krabbenhoft, C.Y. Chen, J.T. Ackerman, E.H. Grant, and D.S. Pilliod. 2020b. The Dragonfly Mercury Project- A citizen science framework for monitoring mercury pollution in US national parks using dragonfly larvae as biosentinels. USGS Story Map. <https://doi.org/10.5066/P9SUMI7P>*
- *Eagles-Smith, C.A., S.J. Nelson., C.M. Flanagan Pritz, J.J. Willacker Jr., and A. Klemmer. 2018. Total Mercury Concentrations in Dragonfly Larvae from U.S. National Parks (ver. 6.0, June 2021): U.S. Geological Survey data release. <https://doi.org/10.5066/P9TK6NPT>*
- *Johnson, B., C.A. Eagles-Smith, J. Willacker, C. Emery, C. Flanagan Pritz, K. Ko, and S. Nelson. Dragonfly Mercury Project Data Visualization Dashboard. In Review.*

Methane Studies

- EPA will be conducting a special Methane Study at the NMED Air Quality Bureau's monitoring site located in Carlsbad, New Mexico. This is to commence either the summer of 2020 or 2021 depending on budget availability. The study will consist of a continuous monitor along with summa-canister sampling. The continuous monitor will be solar powered to measure for Methane while the summa-canisters will be used to capture VOC's (grab samples). A contractor will be hired by EPA to set-up the equipment. AQB's responsibility will be solely to set-up and collect the summa canisters and ship them to the respective laboratory for analysis. This study is to last for 4 months in duration.
- Riley Duren (University of Arizona/NASA-JPL) conducted methane overflights during August 2020. Data for detections are available at <https://carbonmapperdata.org/>.
- Smith, Mackenzie L., Alexander Gvakharia, Eric A. Kort, Colm Sweeney, Stephen A. Conley, Ian Faloona, Tim Newberger, Russell Schnell, Stefan Schwietzke, Sonja Wolter, 2017. Airborne Quantification of Methane Emissions over the Four Corners Region. Environmental Science & Technology. Abstract at: <http://pubs.acs.org/doi/abs/10.1021/acs.est.6b06107>.
- Frankenburg, Christian, Andrew K. Thorpe, David R. Thompson, Glynn Hulley, Eric Adam Kort, Nick Vance, Jakob Borchardt, Thomas Krings, Konstantin Gerilowski, Colm Sweeney, Stephen Conley, Brian D. Bue, Andrew D. Aubrey, Simon Hook, Robert O. Gree, 2016. Airborne methane remote measurements reveal heavy-tail flux distribution in Four Corners region. Proceedings of the National Academy of Sciences of the United States of America. <http://www.pnas.org/content/113/35/9734.full>

- Kort, Eric A., Christian Frankenburg, Keeley R. Costigan, Rodica Lindenmaier, Manvendra K. Dubey, Debra Wunch, 2014. Four Corners: The largest US methane anomaly viewed from space. Geophysical Research Letters, an AGU Journal.
<http://onlinelibrary.wiley.com/doi/10.1002/2014GL061503/full>

Multiple Pollutant and Other Deposition Studies

- Colorado 2019 Final Report: [Human Health Risk Assessment for Oil & Gas Operations in Colorado](#). This includes both HHRA's for Denver-Metro North Front Range and Garfield County.
- The Western Regional Air Partnership (WRAP) has a 2018-19 workplan led by the Technical Steering Committee in place and has continued operation of five technical work groups on key western issues: Regional Technical Operations; Oil and Gas; Fire and Smoke; Regional Haze Planning; and Tribal Data. Each work group is implementing tasks under the workplan and all work groups have contractor analysis support activities underway. The WRAP workplan can be found at: <https://www.wrapair2.org/TSC.aspx> along with related materials and progress reports.
- The Intermountain West Data Warehouse - Western Air Quality Study (IWDW-WAQS), sponsored by EPA Region 8, NPS, USFS, BLM, and the States of CO, NM, UT, and WY have completed approval of the Cooperator workplan in September 2018 for the next three years of activities related to monitoring, emissions, and air quality modeling. The next regional modeling platform will be for the calendar year 2014 based on the NEIv2, with projections to 2023 and 2028 for use in regional air quality planning studies by the Cooperators while also supporting Regional Haze planning described in the WRAP 2018-19 Workplan. Work on the 2014 platform will include detailed model performance evaluation for year-round ozone, PM_{2.5}, nitrogen deposition, and visibility. The IWDW data are accessible at: <http://views.cira.colostate.edu/tsdw/>. The IWDW-WAQS provides air quality data and analysis tools to support regulatory, research, and academic applications. Available datasets include emissions inventories, meteorological data, monitoring data, and air quality modeling platforms. Modeling platforms available through the IWDW support consistent AQ/AQRV photochemical grid modeling (PGM) for NEPA projects and other modeling studies.
- 2014 BLM Drill Rig NO₂ Impacts Study: Effort to better predict 1-hour NO₂ impacts from drill rigs through a field study. Monitoring NO₂ concentrations at multiple locations near operating drill rights combined with stack testing and modeling. Data analysis, model evaluation and reporting happened in late 2016. Project website: <http://www.wrapair2.org/DrillRig.aspx>.
- BLM released a photochemical modeling analysis termed the Colorado Air Resource Management and Modeling Study (CARMMS) 1.5 in March 2016, with updated Mancos Shale modeling in northwestern New Mexico. The CARMMS predicts impacts from future federal and non-federal energy development in Colorado and parts of New Mexico.
- Western Regional Air Partnership (WRAP) Oil and Gas Phase III inventory for the San Juan Basin was completed in 2009. <http://www.wrapair2.org/PhaseIII.aspx>. An update to this inventory for the year 2014 was completed in September 2018. The new project also updates the Permian Basin emissions in west TX and southeast NM. The project website is at: <http://www.wrapair2.org/SanJuanPermian.aspx>.

- NPS and University of Colorado Denver researchers found that lichen species richness has improved at Chaco Culture National Historical Park, Curecanti National Recreation Area, and Black Canyon of the Gunnison National Park while conditions have deteriorated at Nez Perce National Historical Park. The rate of species richness loss attributed to N deposition decreased for 88% of national parks between 2001 and 2016, and yet in 2016 89% of CONUS I&M National Park Service units (149 national parks) remained above the critical load of N for a decline in species richness (CLN-SR) of 3.5 kg-N ha⁻¹ yr⁻¹. The total forested area in the 168 parks that was in exceedance of the CLN-SR decreased from 2001 to 2016, indicating that the health of forests is improving (McCoy et. al. 2021): <https://irma.nps.gov/DataStore/DownloadFile/663435>
- The study “Muted Responses to Chronic Experimental Nitrogen Deposition on the Colorado Plateau” found that simulated nitrogen deposition did not affect plant diversity or increase an invasive annual grass (*Bromus tectorum*). More work is needed to determine nitrogen critical load thresholds for plant community and biocrust dynamics in semi-arid systems: <https://link.springer.com/article/10.1007/s00442-020-04841-3>
- Southern Ute Indian Tribe Air Quality Program
 - Operates two State and Local Air Monitoring Stations (SLAMS) and a mobile monitoring station (MMS) within the exterior boundaries of the Reservation. The SLAMS and MMS are configured and operated consistent with EPA requirements and report to the EPA Air Quality Systems and AirNow databases. Real time air quality data, meteorological data and AirNow health forecasts for the Reservation are available for SLAMS on the Tribe’s Website at: <https://www.southernutensn.gov/justice-and-regulatory/epd/air-quality/ambient-monitoring/>.
 - Operates Thermo 55i analyzers at the Ute 3 SLAMS and MMS to measure ambient concentrations of methane and non-methane hydrocarbons.
 - Conducting a study using vehicle-mounted mobile methane detection equipment. The study objectives include evaluating the accuracy, reliability, and practicality of the equipment, measuring average ambient methane concentrations on the Reservation, determining the effectiveness of the system for locating large methane leaks, and evaluating if the equipment could be used as a good screening tool for determining when leaks are occurring at natural gas production facilities, prompting identification of leaks with optical gas imaging cameras and repair. The Tribe’s Air Quality Program has shared the technology with the Tribe’s Department of Energy to expand the benefits of the technology to the Reservation.
- UMUT Air Quality Program maintains an air quality station at White Mesa, UT. In the past, total suspended particulate (TSP) monitoring occurred, which was analyzed for radioactive HAPs. A new TSP monitor is currently being installed and monitoring is planned to be resumed.