Adjusting the URP Glidepath Accounting for International Anthropogenic Emissions and Wildland Prescribed Fires using the WRAP-WAQS 2014/2028 Modeling Platform Results

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RECOMMENDATION (to be added)

The recommended approach to be added will be from Table 1 shown at the end of this document that lists the four preferred candidate approaches for developing contributions of international emissions and Rx fire. The recommended approach will be implemented on the appropriate tools on the WRAP Technical Support System.

INTRODUCTION

The ultimate goal of the Regional Haze Rule (RHR) is no perceptible manmade impairment at Class I Areas (CIAs) by 2064. To determine whether a CIA is on a path toward this goal, a linear Uniform Rate of Progress (URP) Glidepath is constructed (in deciviews, dv) for the 20% most anthropogenically impaired days (MID) using observations from the IMPROVE monitoring site representing a CIA. The URP Glidepath starts with the IMPROVE MID for the 2000-2004 5-year baseline and draws a straight line (in deciview, dv) to estimated natural conditions in 2064. State Implementation Plans (SIPs) are due from all 50 states on a decadal schedule that set Reasonable Progress Goals in dv for the milestone future years of 2018, 2028, 2038, et cetera. For the second Regional Haze planning period, recent historic emissions are projected to the 2028 future year and a photochemical grid model (PGM) is used to assess changes in visibility-impairing species for controllable U.S. sources while holding uncontrollable natural and most[1] international sources constant, and visibility conditions in 2028 are estimated. Model results are compared to the URP Glidepath value for MID in 2028. WRAP is modeling several 2028 emission scenarios and states will choose which scenario to report as the Reasonable Progress Goal (RPG) in their RHR SIP. EPA allows adjustments to be made to the URP Glidepath to account for contributions from international anthropogenic emissions ("international emissions") and wildland prescribed fires ("Rx fire") that are added to the 2064 natural conditions end-point to create an adjusted Glidepath.

Purpose

This document outlines the approaches that will be evaluated for adjusting the URP Glidepath for the 112 CIAs in the contiguous WESTAR-WRAP region to account for international emissions and Rx Fires using the WRAP 2014/2028 modeling platform.

[1] Currently, the 2028 emissions scenarios use Boundary Conditions (BCs), which represent the contributions of most international emissions as well as natural sources, based on 2014 GEOS-Chem global model simulation, although projected 2028 emissions from the EPA 2016v1 modeling platform are used for the portions of Mexico and Canada within the regional model North American domain.

EPA Guidance for Tracking Progress and Adjusting URP Glidepaths

In December 2018, building on the options specified in the January 2017 changes to the Regional Haze Rule, EPA released "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program" (EPA, 2018[2]) that, among other things, provided recommendations for adjusting the URP Glidepath to account for international emissions and Rx fire contributions. The URP Glidepath adjustment is made by adding the contribution of international emissions (and/or Rx fire) to the 2064 natural conditions end-point thereby decreasing the slope of the Glidepath. EPA guidance recommends using Chemical Transport Models (CTMs) to estimate the contributions of international emissions to visibility and makes recommendations on the year to be modeled and how to quantify the international emission contributions as follows (EPA, 2018, pp.18-22).

Year Selected for Estimating International Contribution: EPA postulates that modeling a current (e.g., base) year, implementation period end year (e.g., 2028) or 2064 end-point year could be used for estimating the contribution of international emissions. EPA notes that projecting international emissions to 2064 may be speculative and somewhat uncertain so believes modeling a more recent year is more appropriate: "Therefore for the second implementation period, EPA recommends estimating international impacts in a recent year…" and goes on to suggest that using recently developed modeling platforms for 2011, 2014 or 2016 would be appropriate (EPA, 2018, pp. 19). EPA also suggests that modeling the 2028 implementation period end year may also be appropriate if high-quality international emission projections are available.

Estimating Anthropogenic International Visibility Impacts: EPA guidance recommends two approaches for quantifying the contributions of international emissions to visibility impairment on the MID: (1) use of brute force international emissions zero-out simulations (ZROW, Zero-Out Rest of World); or (2) use of source apportionment to track the contributions of international emissions. Both approaches require coordinated modeling using both global and regional CTMs. EPA guidance recommends that the international emissions contribution modeling be consistent with the approach used to project 2028 MID for comparison against the URP Glidepath (i.e., use of the relative changes in modeling results to scale observed IMPROVE MID).

Whether using current, i.e., recent historic base year, or high quality 2028 milestone year projection modeling results, adjusting the 2064 end point requires adding results from current modeling results or 2028 projections based on current modeling results to the 2064 estimated natural conditions. There is no connection in science between the statistically-estimated natural conditions estimates and modeling results for international anthropogenic and/or Rx fire contributions. Those modeled contributions are the relative amounts for the timeframe modeled and are unrelated to the statistically-estimated natural conditions.

[2] https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

EPA's Updated 2028 National Regional Haze Modeling

On September 19, 2019, EPA released updated 2028 national regional haze modeling (EPA, 2019[3]) that included 2016 base and 2028 future year CAMx 36/12-km modeling with 2028 visibility projections compared against the URP Glidepath. The Software for the Modeled Attainment Test (SMAT[4]) was used to project the observed IMPROVE MID data from 2014-2017 period to 2028 using the relative changes in the CAMx 2016 to 2028 modeling results following EPA's ozone, fine particulate and regional haze SIP modeling guidance (EPA, 2018[5]).

EPA's updated regional haze modeling also included adjustments to the URP Glidepath to account for the contributions of international emissions. EPA's default adjusted URP Glidepaths only accounted for the contributions of international emissions and did not include the effects of Rx fire. EPA was concerned about the uncertainties with the representation of Rx fire using only one year to represent them and that the contribution from Rx fire may be double counted as they may also be included in the natural conditions used as the 2064 end-point, although there is no explicit term for Rx fire contributions in the 2064 end-point. EPA also noted that the contributions of Rx fire (~0 to 5 Mm^{-1}) were relatively small compared to the international emission impacts (~3 to 19 Mm^{-1}).

EPA conducted 2028 CAMx PM source apportionment modeling that obtained separate contributions of international emissions for several Source Groups, including:

- BC_{Intl} = International anthropogenic emissions contributions through the lateral boundaries of the CAMx modeling domain that was based on two Hemispheric CMAQ 2016 simulations, a base case and a no international emissions case (ZROW).
- Mex = anthropogenic emissions from Mexico.
- Can = anthropogenic emissions from Canada.
- CMV_{200} = emissions from Commercial Marine Vessels more than 200 nautical miles from the U.S. coast and off the coast of non-U.S. countries.

The contributions of international anthropogenic emissions from outside of the CAMx modeling domain (i.e., BC_{Intl}) were held constant in the 2028 future projection for the historic timeframe they represented, as well as not being the same time period as the U.S. emissions inventory used in the EPA modeling. WRAP modeling has the same limitations. As U.S. anthropogenic emissions decline in the future, the 2028 milestone year, the constant emissions have a greater proportional impact on future visibility.

EPA developed a default contribution of international emissions that was consistent with their 2018 guidance:

- Use the CAMx modeling results in a relative sense using SMAT to project 2028 visibility base case conditions and 2028 conditions without contributions of international emissions [i.e., 2028 CAMx minus the source apportionment contributions from the BC_{Intl}, Mex, Can and CMV_{200} Source Groups] and take the difference between the two 2028 MID visibility projections to obtain the international emissions contribution.

[3] https://www.epa.gov/sites/production/files/2019-10/documents/updated_2028_regional_haze_modeling-tsd-2019_0.pdf

[4] https://www.epa.gov/scram/photochemical-modeling-tools

[5] https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf

- Use of ambient air quality based default Natural Conditions for the 2064 end-point.

EPA notes that there are inconsistencies in combining the relative modeling results of international emissions with the ambient based Natural Conditions in 2064 that produces results that are "obviously incorrect" at some sites. Thus, EPA calculated the adjusted URP Glidepath with an adjusted 2064 end-point five different ways using relative (i.e., using SMAT to project 2028 visibility for the MID) and absolute (i.e., CAMx concentration estimates on the IMPROVE MID) contributions of international emissions as well as the ambient data derived Natural Conditions and modeled natural conditions as the 2064 end-point:

1. [**Default**] Relative international anthropogenic model contributions + ambient natural conditions.
2. Absolute international anthropogenic model contributions + ambient natural conditions.
3. Relative international anthropogenic and prescribed fire model contributions + relative modeled natural conditions.
4. Absolute international anthropogenic and prescribed fire model contributions + absolute modeled natural conditions.
5. Relative international anthropogenic and prescribed fire model contributions + ambient natural conditions

In EPA's documentation, the adjusted URP Glidepath was presented as a shaded range of the five methods given above with the default approach presented as a dotted line. Figure 1 below shows an example of EPA's URP Glidepath for Canyonlands IMPROVE site with the shaded range of adjusted URP Glidepaths.

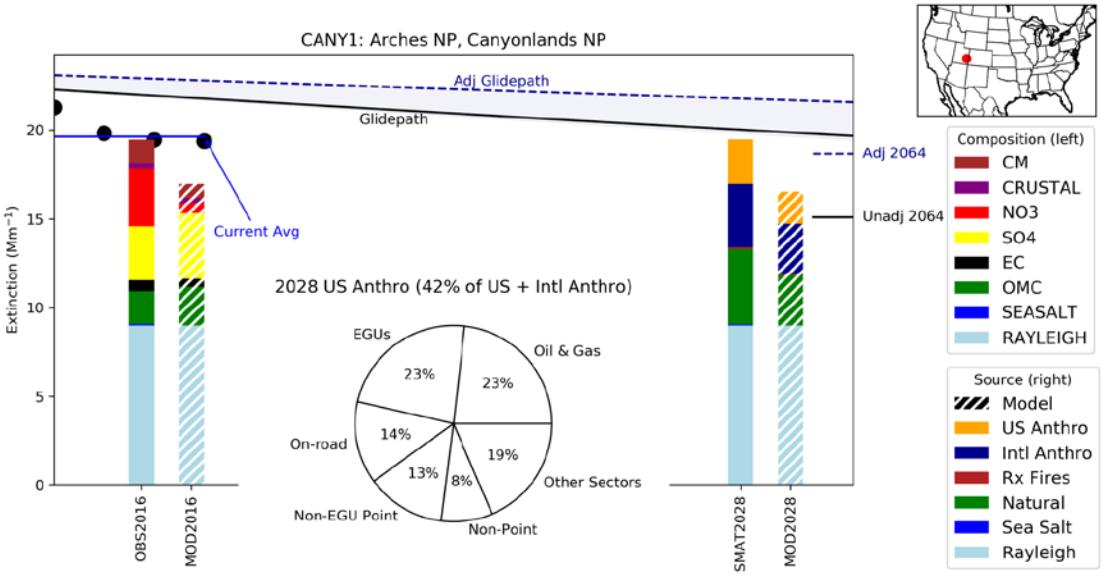

Figure 17: 2014-2017 IMPROVE observations, 2016 CAMx model predictions, 2028 modeled projection, and 2028 sector contributions at CANY1. Used for Class I areas: Arches NP, Canyonlands NP.

Figure 1. Example of EPA's URP Glidepath for Canyonlands showing range of adjusted Glidepath using the five methods as well as default adjusted Glidepath (Source, EPA, 2019).

APPROACHES FOR ADJUSTING GLIDEPATHS USING THE WRAP MODELING RESULTS

WRAP has developed a 2014 36/12-km CAMx modeling platform and conducted 2014v2 base case, Representative Baseline (RepBase, emissions representative of 2014-2018) and 2028 future year modeling. They are also conducting a 2002 Dynamic Evaluation CAMx simulation.

WRAP Modeling Data Available for International Emissions, Rx Fire and Natural Conditions

There are several ways WRAP could obtain the contributions of international emissions and Rx fire:

- WRAP has conducted RepBase CAMx source apportionment (SA) modeling and, like EPA's 2028 CAMx SA modeling, obtained separate contributions of BC_{Intl}, Mex, Can, CMV_{200} and Rx fire. The RepBase SA run can be processed in a relative sense (i.e., using SMAT to scale the 2014-2018 IMPROVE MID data) or in an absolute fashion (e.g., use 2014 IMPROVE MID data or modeled MID) to get the current year (e.g., 2014-2018) contributions of international emissions and Rx fire to impairment on the MID.
    - There are also plans to conduct a similar CAMx 2028OTBa2 SA simulation from which relative and absolute contributions of international emissions and Rx fire can be obtained whose results should be available in August 2020. The 2028

simulation international emissions differ from RepBase in that they use projected Mex, Can and CMV_{200} emissions.
    - Similar source apportionment modeling is being conducted for the 2002 U.S. anthropogenic emissions scenario, but use of the RepBase or 2028OTBa SA modeling results would be more appropriate that using 2002 SA results for adjusting the URP Glidepath.
- WRAP also conducted linked GEOS-Chem/CAMx international anthropogenic emissions zero-out (ZROW) modeling that could be used to obtain the international emission contributions. The GEOS-Chem ZROW modeling was used for the CAMx RepBase and 2028OTBa SA BC inputs to allow the separate tracking of BC_{Intl}.

We recommend the use of the results from the CAMx 2028OTBa2 SA run to obtain international emissions and Rx fire contributions, so they are calculated in an internally consistent fashion to the 2028 projections, rather than using the ZROW international emissions zero-out modeling.

The sources for the natural conditions 2064 endpoint are as follows:

- The recommended Natural Conditions based on 2000 through 2014 ambient data used as the default 2064 end-point.[6]
- The RepBase and/or 2028OTBa2 SA runs can be used to obtain the natural conditions contribution. The natural conditions SA Source Group include biogenic VOC and NOx, lightning NOx (LNOx), oceanic sea spray aerosol (SSA) and dimethyl sulfide (DMS), windblown dust (WBD) and Canada and Mexico fires (for RepBase SA but not for planned 2028OTBa2 SA).
    - Biogenic soil NOx does include anthropogenic components from fertilizer application and atmospheric nitrogen deposition.
    - The inclusion of the Mexico and Canada fires in the RepBase Natural Source Group may result in overstated natural conditions at U.S. border CIAs.
- WRAP also conducted a zero-out all anthropogenic emissions GEOS-Chem/CAMx natural (NAT) simulation that could also be used to obtain to obtain an estimate of Natural Conditions.
    - One advantage of using the WRAP NAT zero-out run is that its biogenic NOx emissions eliminated the contributions of soil NOx emissions due to fertilizer application and anthropogenic nitrogen deposition.
    - A big disadvantage of using the WRAP RepBase NAT zero-out run is that it includes wildfire (WF) emissions that will affect the natural conditions 2064 end-point at some sites.

Relative Versus Absolute Modeling Results

EPA's 2028 national regional haze modeling used five techniques to develop adjusted URP Glidepaths that used both relative and absolute modeling results. The EPA default visibility projection approach is to use EPA's relative approach that involves running SMAT for the 2028

[6] https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

scenario and the 2028 scenario with the international emissions contribution removed using source apportionment.

WRAP also evaluated several different alternative visibility projection approaches to the EPA default approach to account for the contribution of fire emissions.[7] WRAP found that the relative response factors (RRFs using the EPA default approach based on IMPROVE 2014 MID were influenced by emissions from fires even though one of the premises of the MID was to limit the influence of fire contributions in the MID. Thus, WRAP has three different approaches for projecting 2028 MID visibility:

- EPA: The EPA default approach where relative response factors (RRFs) used to project the observed 2014-2018 IMPROVE MID are based on CAMx RepBase and 2028OTBa concentrations averaged across the 2014 IMPROVE MID.
- EPAwoF: Uses RRFs based on the IMPROVE 2014 MID (as used in the EPA default projection approach) only eliminating the contributions of fires through source apportionment.
- ModMID: Use of the RepBase source apportionment results to identify the modeled 20% days that are the most impaired by U.S. anthropogenic emissions and basing RRFs on those days and not using contributions of fires in the RRFs (as in EPAwoF).

Separately, WRAP has recommended that the EPAwoF projection method be the default approach for 2028 future visibility conditions that would be used to inform selection of Reasonable Progress Goals by states in their Regional Haze SIPs for the 112 ClAs in the contiguous WESTAR-WRAP region.

Recommended Approach for Adjusting the URP Glidepath

Like EPA's national regional haze modeling, it is difficult to tell a priori which approach for adjusting the URP Glidepath to account for contributions of international emissions and Rx fire will work best in all cases. As reported in EPA's regional haze modeling technical support document (EPA, 2019), EPA's default guidance (EPA, 2018) approach produced results for some sites that EPA found were "obviously incorrect."

Table 1 below lists the four candidate approaches for developing contributions of international emissions and Rx fire as well as the 2064 end-point natural conditions that can be used to adjust the URP Glidepaths in the WRAP regional haze modeling.

1. The first method is the EPA guidance (EPA, 2018) approach (called Default in EPA's national modeling). SMAT is run twice to project the observed 2014-2018 IMPROVE MID to 2028 using RepBase current year and two future year emission scenarios: 2028OTBa and 2028OTBa with the contributions of international emissions removed using the 2028OTBa source apportionment results. The difference in the two 2028 SMAT projections are the relative contributions of international emissions.
2. The second method is like the first only accounting for international emissions and Rx fire. EPA was concerned that the Rx fire may also be present in the Natural Conditions so did not include Rx fire in their adjusted Glidepaths to avoid double counting.

[7] https://www.wrapair2.org/pdf/VisProj_Alt-EPAwoF-ModMID_RTOWG_2020-07-16v1.pptx

3. The third method uses internally consistent SA absolute modeling results for both international emission and Rx fire Source Groups as well as the natural Source Group Source Group for the 2064 natural conditions.
4. The fourth method uses the relative approach to represent international emissions and Rx fire (as in method 2). And uses the relative approach for the 2064 natural conditions as well (i.e., running SMAT using RepBase and CAMx NAT run).

In evaluating these methods, issues may be raised as EPA found in their evaluation that will be addressed at that time.

Table 1. Potential methods using WRAP modeling results for developing adjusted URP Glidepaths to account for international emissions and/or Rx fire.

Method	Intl Emiss/Rx Fire	2064 Nat Cond	Comment
1	Relative SA Intl	Natural Conditions	EPA Default & WRAP Selected
2	Relative SA Intl+Rx	Natural Conditions	EPA Default & WRAP Selected
3	Absolute SA Intl+Rx	Absolute SA Nat	Absolute model view of world
4	Relative SA Intl+Rx	Relative SA Nat	Relative model view of world

Figure 2. Mock-up of WRAP Technical Support System display.