OFFICE OF AIR QUALITY PLANNING AND STANDARDS
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RECOMMENDATIONS FOR THE HALE1-HACR1 IMPROVE MONITORING SITE COMBINATION AND VOLCANO ADJUSTMENT FOR SITES REPRESENTING HAWAI'I CLASS I AREAS FOR THE REGIONAL HAZE RULE

In the 2017 update to the Regional Haze Rule[1] and associated 2018 Technical Guidance[2], the EPA described a recommended metric for tracking visibility progress that focused on the 20% Most Anthropogenically Impaired Days rather than the 20% Haziest Days that had been used for visibility tracking in the First Implementation Period. A June 2020 Memo[3] further clarified recommendations on ambient data completeness criteria and which years are to be used for the baseline period. This white paper builds upon the recommendations in the 2018 Technical Guidance and June 2020 Memo with additional recommendations for combining visibility data for Interagency Monitoring of Protected Visual Environments (IMPROVE) sites representing the Haleakalā National Park Class I area and an adjustment of visibility data at sites representing Haleakalā National Park and Hawai'i Volcanoes National Park Class I areas (on the Islands of Maui and Hawai'i, respectively) to account for episodic volcanic events. Due to the unique circumstances of the visibility data for the Hawai'i Class I areas, these recommendations are limited to those areas and are not intended for other IMPROVE sites representing Class I areas across the United States.

Combining visibility data for sites representing the Haleakalā National Park

In the vicinity of the Haleakalā National Park Class I area, the Haleakalā NP (HALE1) IMPROVE site began operation in 1990 and was joined by a higher elevation IMPROVE site called Haleakalā Crater (HACR1) in 2007 (see Figure 1). During the overlap period when both HALE1 and HACR1 were in operation (2007-2011), the Western Regional Air Partnership (WRAP), in consultation with the State of Hawaii Department of Health – Clean Air Branch, National Park Service, and U.S. EPA Region 9, determined that the HACR1 IMPROVE site was more representative of visibility conditions within Haleakalā National Park and the HALE1 site closed in 2012. Using ambient visibility data from both sites during the first 3 years (2007-2009) of the overlap period, the Hawai'i State Department of Health's 5-Year Regional Haze Progress Report created an estimate of the 2000-2004 baseline period deciview value at the HACR1 site for 20% Clearest and 20% Haziest Days. These estimates were based on ratios of the extinction for each chemical component during the overlap period.

In the default recommended EPA methodology, several of the calculations for determining the 20% Most Anthropogenically Impaired Days are based on visibility data from the entire 2000-2014 period. This suggests a need for an alternative approach to estimate the 2000-2004 baseline

[1] https://www.govinfo.gov/content/pkg/FR-2017-01-10/pdf/2017-00268.pdf
[2] https://www.epa.gov/sites/default/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf
[3] https://www.epa.gov/sites/default/files/2020-06/documents/memo_data_for_regional_haze_0.pdf

period deciview value at the HACR1 site on the 20% Most Anthropogenically Impaired Days that differs from both the Hawai'i State Department of Health's approach in the 5-Year Regional Haze Progress Report and the unadjusted site combination used in the 2018 Technical Guidance and June 2020 Memo (see Figure 2 which displays IMPROVE data for the HALE1 site in 2000-2007 and for the HACR1 site in 2008-2018). EPA's recommended approach is to use the complete HALE1 and HACR1 overlap period to combine the two sites into one data stream and then calculate the 20% Most Anthropogenically Impaired Days for the combined site record. EPA's approach is similar to the ratio-based approach from the Hawai'i State Department of Health's 5-Year Regional Haze Progress Report with the following modifications:

- ratios were calculated between the two sites for the same time period rather than for the same site over two time periods
- monitoring data was utilized for all years where both sites were complete during the overlap period (2007-2011)
- monitoring data was limited to days where both sites had concentration measurements for all chemical components
- medians rather than averages were used for calculating the ratios between sites

Table 1 shows the extinction values for each chemical component based on this approach. These ratios were applied to the daily extinction value of each chemical component at the HALE1 site from 2000-2007 to help estimate a single combined site record. The recommended HALE1-HACR1 combined site values shown in Table 2 and Figure 3 reflect these ratioed HALE1 values through 2007 and the unadjusted HACR1 values starting in 2008.

Volcanic adjustment for Haleakalā National Park and Hawai'i Volcanoes National Park

The Hawai'i State Department of Health reported a majority of the visibility impairment at both Hawai'i Volcanoes National Park and Haleakalā National Park being associated with SO_2 emissions from the Kīlauea Volcano (located in Hawai'i Volcanoes National Park on the Big Island of Hawai'i). Hawai'i's 5-Year Regional Haze Progress Report cited previous source apportionment assessments from the Technical Support Document for Hawai'i's Regional Haze FIP. In the 2018 Technical Guidance and June 2020 Memo, ammonium sulfate extinction (presumably associated with the Kīlauea Volcano) was the dominant component of the extinction for the 20% Most Anthropogenically Impaired Days throughout the 2000-2018 period at both Class I areas.

To account for the impacts of episodic volcanic events on extinction during the 20% Most Anthropogenically Impaired Days, we recommend an adjustment approach similar to that of wildfire smoke and dust storms described in the 2018 Technical Guidance. For the combined HALE1-HACR1 site and the Hawai'i Volcanoes NP (HAVO1) site, we've identified the 95th percentile 24-hour ammonium sulfate extinction value for each year between 2000 and 2014 and selected the year with the lowest value. This selected year presumably represents the year with the lowest episodic volcanic impacts on visibility during the 15-year period. The lowest 95th percentile ammonium sulfate extinction value then serves as a threshold value above which daily ammonium sulfate extinction is considered episodic natural extinction for the impairment calculations. The extinction budget and glidepath calculated before and after this adjustment are shown in Figures 4-5 and Figures 5-6 for the combined HALE1-HACR1 site and the HAVO1

site, respectively. At both sites, the extinction budget and visibility on the 20% Most Anthropogenically Impaired Days are more consistent throughout the 2000-2018 period due to the reduced variability of the year-to-year ammonium sulfate extinction. The overall reduction in the ammonium sulfate extinction on these days is modest for the combined HALE1-HACR1 site, but for HAVO1 the reduction is substantial (particularly for the 2008-2010 time period).

Even with these reductions, ammonium sulfate extinction remains relatively high at both sites (especially HAVO1) and the dominant component of the overall extinction on the 20% Most Anthropogenically Impaired Days. This result is not consistent with relatively low SO_2 emissions inventory in the State and very low anthropogenic sulfate concentrations predicted for these sites in the EPA's 2028 Regional Haze modeling for Hawai'i.[4] For this reason, EPA suggests that Hawai'i start tracking visibility progress of the HALE1-HACR1 and HAVO1 sites with the monitoring site combinations and volcano adjustments described within this document and supplement this process with any additional analyses of ambient data and/or source apportionment modeling that may be necessary to better characterize and differentiate anthropogenic sulfate impacts from those of routine natural sulfate sources such as the ongoing eruptions and venting of SO_2 from the Kīlauea Volcano.

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

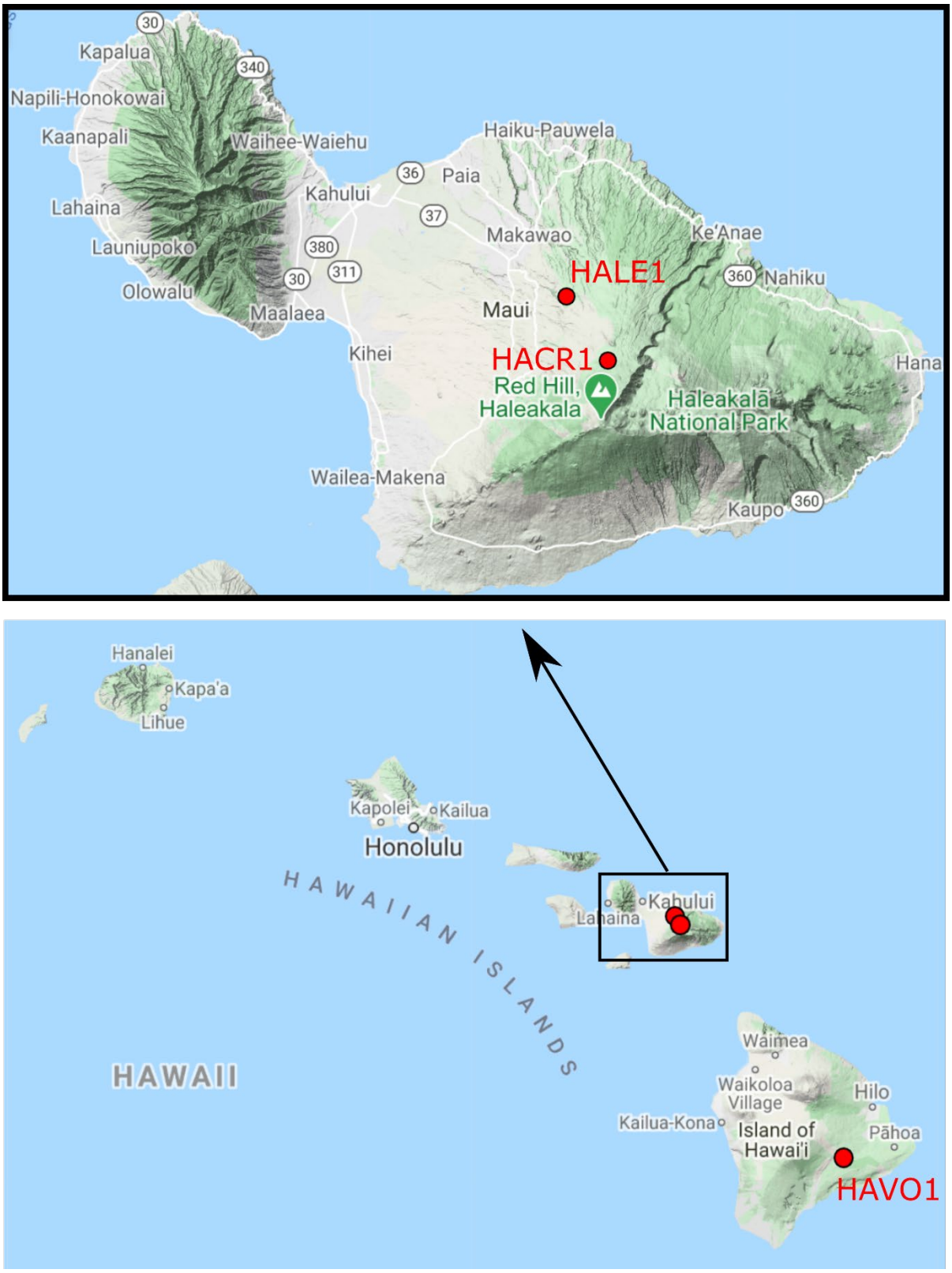
Table 1: Median light extinction values from the HALE1 and HACR1 IMPROVE sites during the 2007-2011 overlap period used to create a combined HALE1-HACR1 site record.

Species	2007-2011 Median Extinction Value		
	HALE1	HACR1	HACR1/ HALE1 Ratio
Ammonium Sulfate	5.4019	3.0723	0.57
Ammonium Nitrate	1.1021	0.4957	0.45
Organic Mass by Carbon	1.1342	0.1786	0.16
Light Absorbing Carbon	0.3920	0.1320	0.34
Fine Soil	0.1461	0.1070	0.73
Sea Salt	1.8580	0.5036	0.27
Coarse Matter	1.4728	0.6609	0.45

Table 2: Updated estimates (in deciviews) of the baseline, most recent, natural visibility conditions on the 20% clearest and 20% most impaired days as well as the episodic event thresholds for IMPROVE site representing Hawai'i Class I areas. The HALE_RHTS* denotes the combined HALE1-HACR1 site record and the *VADJ denotes the volcano adjustment.

Site	20% Clearest Days			20% Most Impaired Days			e3 (Mm^{-1})		
	Baseline Visibility Condition (2000-2004)	Most Recent Visibility Condition (2014-2018)	Natural Conditions (20% Clearest Days)	Baseline Visibility Condition (2000-2004)	Most Recent Visibility Condition (2014-2018)	Natural Conditions (20% Most Impaired Days)	carbon	dust	sulfate
HALE_RHTS	2.18	0.48	-0.12	8.31	8.60	3.50	0.94	1.66	NA
HALE_RHTS_VADJ	2.18	0.48	-0.12	7.84	7.27	4.22	0.94	1.66	9.58
HAVO_VADJ	4.06	3.50	2.20	15.60	16.31	6.62	1.56	1.93	44.87

Figure 1. Map of the Hawai'i IMPROVE sites representing Class I areas including an inset showing the HALE1 and HACR1 sites representing Haleakalā National Park



Visibility Figures. Light extinction by component for days classified as the 20 percent most impaired in 2018 unless otherwise noted (Left), average light extinction by component for days classified as the 20 percent most impaired from 2000-2018 (Middle), and annual average, 5-year average, and glidepath of the visibility index (in deciviews) on the 20 percent most impaired days from 2000 to 2018 (Right). For all extinction budget figures, the following color scale applies: ammonium sulfate (yellow), ammonium nitrate (red), OMC (teal), LAC (black), FS (tan), CM (brown), and sea salt (blue). For all visibility index figures, the blue points are annual average values; red points are 5-year averages and the orange line is the glidepath between 2000-2004 and 2060-2064.

Figure 2. Haleakala National Park, HI (unadjusted combination of HALE1 and HACR1 starting 01/01/2008 used in the 2018 Technical Guidance and June 2020 Memo)

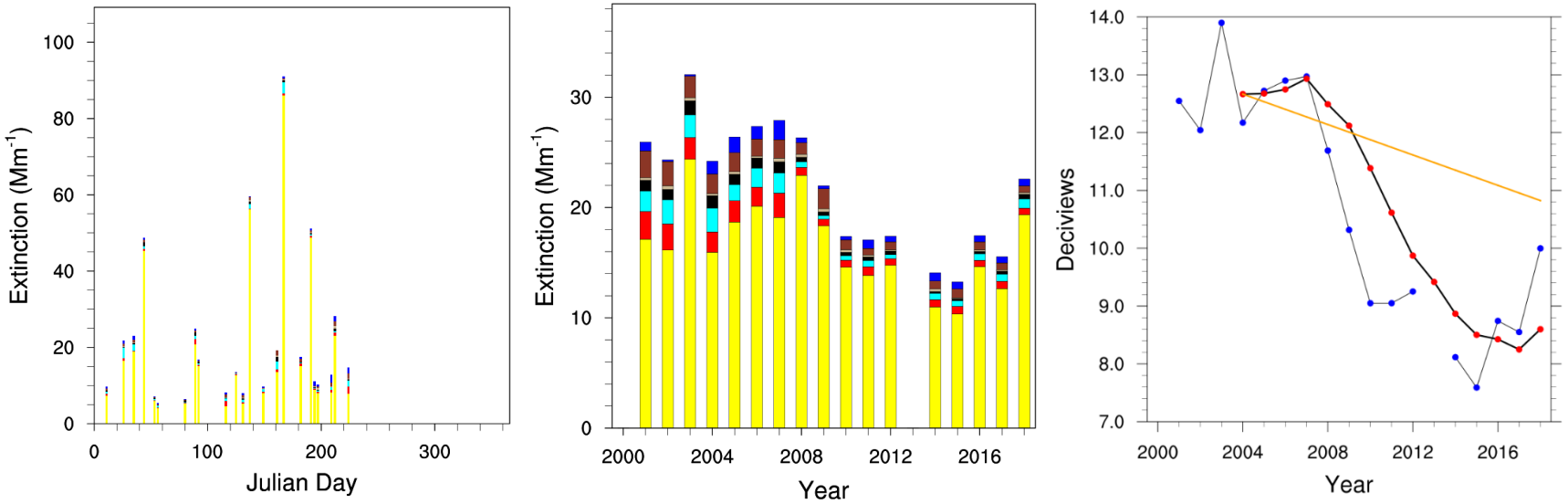


Figure 3. Haleakalā National Park, HI (updated combination of HALE1 and HACR1 starting 01/01/2008)

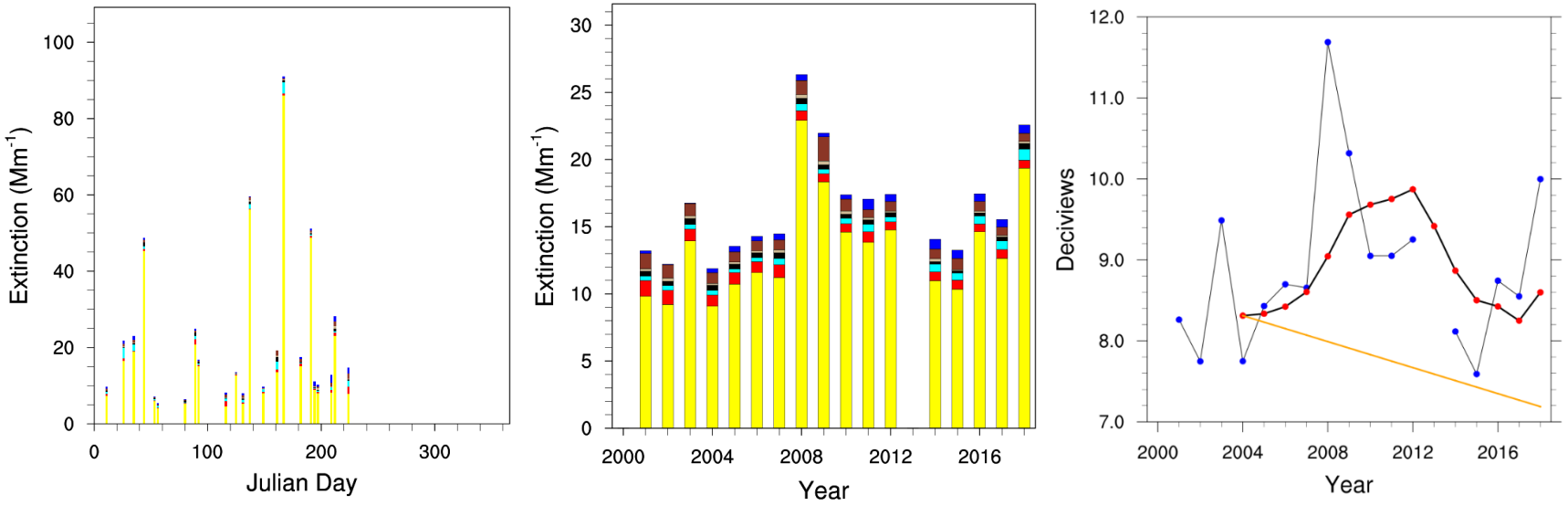


Figure 4. Haleakalā National Park, HI (updated combination of HALE1 and HACR1 starting 01/01/2008 with volcano adjustment)

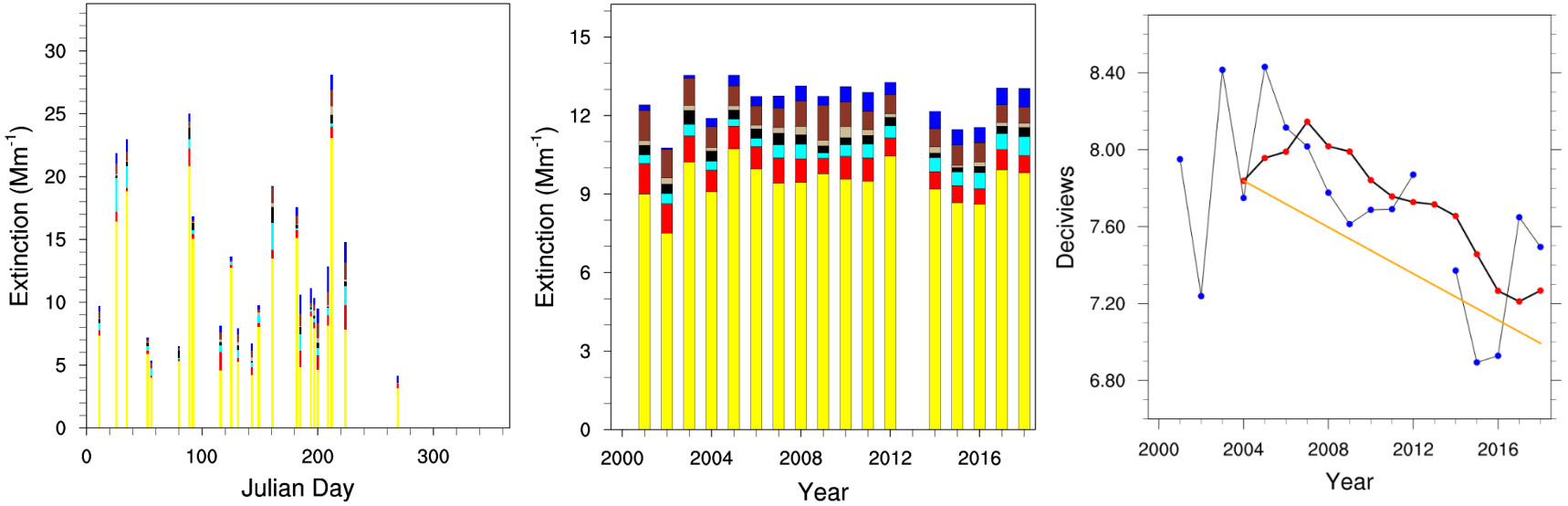


Figure 5. Hawai'i Volcanoes National Park, HI (2017 data shown in figure to the left)

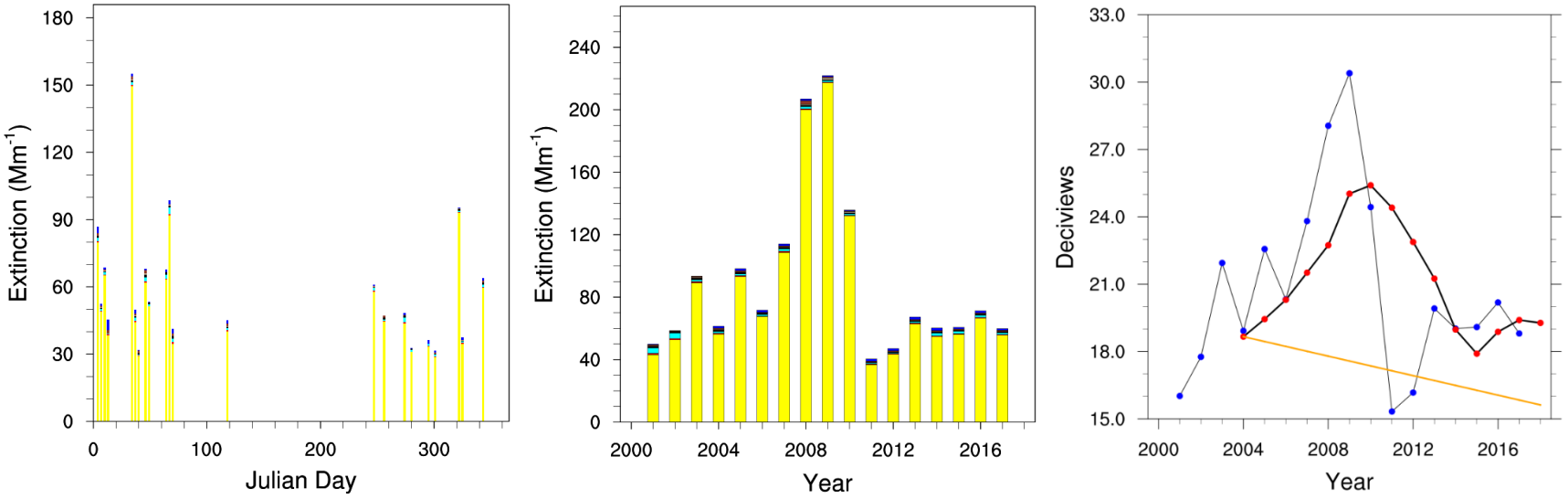


Figure 6. Hawai'i Volcanoes National Park, HI (with volcano adjustment; 2017 data shown in figure to the left)