UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

DEC 2 0 2018

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program

FROM: Richard A. Wayland, Division Director
Air Quality Assessment Division

TO: Regional Air Division Directors, Regions 1 – 10

Through this memorandum, the U.S. Environmental Protection Agency (EPA) is communicating the availability of its technical guidance on tracking visibility progress for the second implementation period of the regional haze program. This guidance document includes EPA's final recommendations on 1) methods for selecting the 20 percent most impaired days to track visibility and determining natural visibility conditions; and 2) methods for accounting for total international impacts to adjust the uniform rate of progress (i.e., the URP glidepath) for the second implementation period. EPA committed to releasing this guidance document in the September 11, 2018, Regional Haze Reform Roadmap.[1]

The purpose of this guidance document is to support states with some of the technical aspects of developing regional haze state implementation plans (SIPs) to protect visibility in mandatory Class I Federal areas, in particular the SIPs that are due to be submitted to EPA by July 31, 2021, for the second implementation period.

This guidance describes EPA's recommended methods on two technical aspects of regional haze SIP development: 1) the visibility tracking metrics and 2) estimating international anthropogenic impacts and optional adjustment to the URP glidepath. EPA's recommended visibility tracking metrics and methodology will help states determine baseline, current, and natural visibility conditions. EPA's recommended methods for estimating international anthropogenic impacts will serve as a useful guide to states that choose to propose an adjustment to the URP glidepath endpoint to account for international anthropogenic source contributions.

This document is not a substitute for provisions or requirements of the Clean Air Act (CAA), nor is it a regulation itself. As the term "guidance" suggests, it provides recommendations on how to

[1] *See* https://www.epa.gov/sites/production/files/2018-09/documents/regional_haze_reform_roadmap_memo_09-11-2018.pdf

implement regional haze rule visibility tracking metrics. Thus, it does not impose binding, enforceable requirements on any party, nor does it assure that EPA will approve all instances of its application, as the guidance may not apply to a particular situation based upon the circumstances. Final decisions by EPA regarding a particular SIP demonstration will only be made based on the statute and applicable regulations and will only be made following a final submission by air agencies and after notice and opportunity for public review and comment.

Visibility Tracking Metrics

The 2017 Regional Haze Rule revisions[2] require a revised approach to tracking visibility improvements over time within the URP glidepath framework.[3] Under these rule revisions, in the second and future implementation periods, states must select the "20 percent most impaired days" each year at each Class I area based on daily anthropogenic impairment.[4] This guidance document describes a recommended methodology to develop the required 20 percent most impaired and 20 percent clearest days metrics. In June 2016, EPA sought public comment on this approach which was included in the 2016 draft regional haze SIP development guidance document.[5] After considering public comments received on that draft and more recent discussions with states about the draft recommended method, EPA is now finalizing the portion of that guidance specific to the recommended visibility tracking metrics for the second implementation period. Note that while the rule requires states to track visibility progress for the 20 percent (most anthropogenically) impaired days, it does not require states to follow EPA's recommended methodology for how to select the set of days. We recommend states work closely with their Regional Offices if they intend to pursue an alternative methodology for selecting the most impaired days for one or more Class I areas.

Estimating International Anthropogenic Impacts and Optional Adjustment to the URP/Glidepath

The 2017 Regional Haze Rule includes a provision that allows states to propose an optional adjustment to the URP glidepath to account for impacts from anthropogenic sources outside the United States, if the adjustment has been developed through scientifically valid data and methods. This guidance document describes recommended tools and methods to develop optional adjustments to the URP glidepath endpoint to account for international anthropogenic emissions impacts. Note that this guidance does not provide numerical estimates of international anthropogenic source impacts.

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[2] Final Rule: Protection of Visibility: Amendments to Requirements for State Plans, 82 FR 3078, January 10, 2017.
[3] The URP glidepath framework refers to the interrelated Regional Haze Rule requirements regarding the quantification of historical and projected visibility conditions using specific metrics, the quantification of natural conditions, the quantification of the uniform progress that would achieve natural visibility conditions for the 20 percent most anthropogenically impaired days in 2064, the URP glidepath, the setting of RPGs for the end of the implementation period, and the comparison of the RPG for the 20 percent most anthropogenically impaired days to the URP glidepath.
[4] Previously, states and EPA tracked visibility progress on the 20% *worst* visibility days.
[5] Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for the Regional Haze State Implementation Plans for the Second Implementation Period, June 30, 2016.

Next Steps

EPA is continuing to develop the other implementation tools outlined in the September 2018 roadmap, including producing and documenting updated 2028 visibility modeling results and estimating U.S. and international source contributions for individual Class I areas. These results, specifically the numerical estimates of international anthropogenic source contributions, may be useful for states that wish to propose an adjustment to the URP glidepath to account for international anthropogenic visibility impacts. This updated modeling is expected to be released in Spring/Summer 2019. In the roadmap, EPA also committed to providing updated natural visibility conditions estimates, if necessary. This effort will be done in parallel with the visibility modeling and will be released in Spring 2019.

EPA understands the unique and valuable role that states and multi-jurisdictional organizations can provide to enhance the quality of the modeling inputs and results. EPA's regional haze modeling will use emissions inventory inputs developed from the ongoing inventory collaborative partnership[6] between EPA, state emissions inventory staff, multi-jurisdictional organizations, and federal land managers. In addition, EPA will seek further cooperation with states on model inputs and methods as we further refine the 2028 visibility modeling over the next several months. We also encourage states to continue to work closely with their Regional offices as they develop their regional haze SIPs.

EPA is also continuing to develop updated guidance on regional haze SIP development for the second implementation period. This guidance will be a final version of the remaining portions of the 2016 draft guidance. This guidance will focus on issues raised by states as needed for work on second planning period SIPs and will be consistent with the Administration's key principles for implementing the regional haze program moving forward as laid out in the roadmap.

For convenience, this technical guidance document is available electronically on EPA's visibility website, https://www.epa.gov/visibility/visibility-guidance-documents. Questions or comments should be electronically submitted to Brett Gantt (gantt.brett@epa.gov) or Brian Timin (timin.brian@epa.gov) of EPA's Air Quality Assessment Division.

[6] See the inventory collaborative partnership wiki at: http://views.cira.colostate.edu/wiki/wiki/9169.

United States Environmental Protection Agency

Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program

EPA-454/R-18-010
December 2018

Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, North Carolina

Table of Contents

1.0 Purpose of this guidance

The purpose of this guidance document is to support states in the development of regional haze state implementation plans (SIPs) to protect visibility in certain national parks and wilderness areas, known as mandatory Class I Federal areas,[1] in particular the SIPs that are due to be submitted to the Environmental Protection Agency (EPA) by July 31, 2021, for the second implementation period. The required content of these SIPs is specified in 40 CFR 51.308(f), which was revised in 2017.[2] As called for in the agency's "Regional Haze Reform Roadmap" (September 11, 2018), this guidance document describes EPA's recommended methods on two aspects of the regional haze program:

1) **Visibility Tracking Metrics:** The 2017 Regional Haze Rule revisions require a revised approach to tracking visibility improvements over time within the Uniform Rate of Progress (URP) framework.[3] Under these 2017 Regional Haze Rule revisions, in the second and future implementation periods, states must select the "20 percent most impaired days" each year at each Class I area based on daily anthropogenic impairment.[4] This guidance document describes a recommended methodology to develop the baseline and current visibility conditions, and natural conditions on the most impaired and clearest days.

2) **International Emissions:** The 2017 Regional Haze Rule includes a provision that allows states to propose an adjustment to the URP to account for impacts from anthropogenic sources outside the United States, if the adjustment has been developed through scientifically valid data and methods. This guidance document describes recommended tools and methods to develop optional adjustments to the URP endpoint to account for international anthropogenic emissions impacts.

This document provides recommendations on these two aspects of SIP development under the Regional Haze Rule and is for use by states in developing SIP submissions and for EPA Regional offices in acting on them. This document does not substitute for provisions or requirements of the Clean Air Act (CAA), nor is it a rule itself. Thus, it does not impose binding, enforceable requirements on any party. States retain the discretion to develop regional haze SIP revisions that differ from this guidance so long as they are consistent with the CAA and the implementing regulations – a core principle of cooperative federalism.

[1]For brevity, mandatory Class I Federal areas will often be referred to as "Class I areas" in the remainder of this document.
[2]Final Rule: Protection of Visibility: Amendments to Requirements for State Plans, 82 FR 3078, January 10, 2017.
[3]"URP framework" refers to the interrelated Regional Haze Rule requirements regarding the quantification of historical and projected visibility conditions using specific metrics, the quantification of natural conditions, the quantification of the uniform progress that would achieve natural visibility conditions for the 20 percent most anthropogenically impaired days in 2064, the URP glidepath, the setting of reasonable progress goals (RPGs) for the end of the implementation period, and the comparison of the RPG for the 20 percent most anthropogenically impaired days to the URP glidepath.
[4]Previously, states and EPA tracked visibility progress on the 20 percent *worst* visibility days.

EPA generally expects that SIPs which follow this guidance are likely to meet the related applicable statutory and regulatory requirements. Final decisions by EPA to approve a particular SIP revision can only be made based on the requirements of the statute and the Regional Haze Rule, and on whether the SIP submission is the product of reasoned decision making. In addition, final EPA decisions can only be made following a state's final submission of the SIP revision to EPA in accordance with all applicable requirements, including appropriate notice and opportunity for public review and comment. Only final actions taken to approve or disapprove SIP submissions would be final actions for purposes of CAA section 307(b). Therefore, this guidance is not judicially reviewable. This guidance does not change or substitute for any law, regulation, or other legally binding requirement and is not legally enforceable. Due to case-specific circumstances, following the recommendations in this document does not ensure that the related aspects of a SIP will be approvable in all instances, as this guidance may not apply to the facts and circumstances underlying a particular SIP.

We encourage states to discuss with their EPA Regional office early in their SIP development the approach they anticipate taking and how the interpretations and recommendations in this guidance may relate to their SIPs.

1.1 Regional Haze Background

Consistent with the CAA, "regional haze" is defined at 40 CFR 51.300 as "visibility impairment that is caused by the emission of air pollutants from numerous anthropogenic sources located over a wide geographic area. Such sources include, but are not limited to, major and minor stationary sources, mobile sources, and area sources." This visibility impairment is a result of anthropogenic particles and gases in the atmosphere that scatter and absorb (i.e., extinguish) light, thus acting to reduce overall visibility. The primary cause of regional haze is light extinction by particulate matter (PM). For purposes of the Regional Haze Rule, light extinction is estimated from measurements of PM and its chemical components (sulfate, nitrate, organic mass by carbon (OMC), light absorbing carbon (LAC), fine soil (FS), sea salt, and coarse material (CM)), assumptions about relative humidity at the monitoring site, and the use of a commonly accepted algorithm (Pitchford, et al., 2007). These estimates of light extinction are logarithmically transformed to deciview units. The Regional Haze Rule established the deciview haze index as the principal metric for expressing visibility on any particular day. The deciview haze index is calculated from light extinction values and expresses uniform changes in the degree of haze in terms of common increments across the entire range of visibility conditions, from pristine to extremely hazy.

The PM measurements used in the regional haze program are collected by the IMPROVE (Interagency Monitoring for PROtected Visual Environments) monitoring network. The Regional Haze Rule requires states to submit a series of SIPs to protect visibility in Class I areas.

1.2 Statutory Provisions and Regulatory Requirements

In section 169A of the 1977 Amendments to the CAA, Congress established a program for protecting and restoring visibility in certain national parks, wilderness areas, and other Class I areas due to their “great scenic importance.”[5] This section of the CAA establishes as a national goal the “prevention of any future, and the remedying of any existing, impairment of visibility in Class I areas which impairment results from manmade air pollution.” This section also required EPA to issue regulations requiring states to adopt implementation plans containing emission limits as may be necessary to make reasonable progress towards meeting this goal.

In 2017, EPA issued a final rule revising portions of the visibility protection rule promulgated in 1980 and the Regional Haze Rule promulgated in 1999.[6] The revised rule covers EPA’s review of periodic SIPs developed for the second and subsequent implementation periods, among other requirements.

The Regional Haze Rule established the concept of state-set reasonable progress goals (RPG) for the 20 percent most anthropogenically impaired days as a regulatory construct promulgated to implement the statutory requirements for visibility protection. These RPGs reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of its own and other states’ long-term strategies, as well as the implementation of other requirements of the CAA.

The 2017 Regional Haze Rule requires states to determine the baseline (2000-2004) visibility condition for the 20 percent most impaired days and requires that the long-term strategy and RPG must provide for improvement in visibility for the most impaired days, relative to the baseline period. Specifically, states must determine the rate of improvement in visibility that would need to be maintained during each implementation period in order to reach natural conditions by 2064 for the 20 percent most impaired days, given the starting point of the 2000-2004 baseline visibility condition.[7] The “glidepath,” or URP, is the amount of visibility improvement that would be needed to stay on a linear path from the baseline period to natural conditions.

The URP is calculated according to the following formula:

$$URP = [(\text{2000-2004 visibility})_{\textit{20\% most impaired}} - (\text{natural visibility})_{\textit{20\% most impaired}}]/60 \qquad \text{(Eqn. 1)}$$

An example diagram of the URP (in this case for GRSM1 in Great Smoky Mountains National Park) for the entire 2000-2064 period is shown in Figure 1. In this diagram, the URP (orange line) connects the 2000-2004 baseline period with the 2064 endpoint at the estimate of natural visibility conditions.

[5]H.R. Rep. No. 294, 95th Cong. 1st Sess. at 205 (1977).
[6]45 FR 80084 (December 2, 1980) and 64 FR 35714 (July 1, 1999)
[7]See 40 CFR 51.308(f)(1).

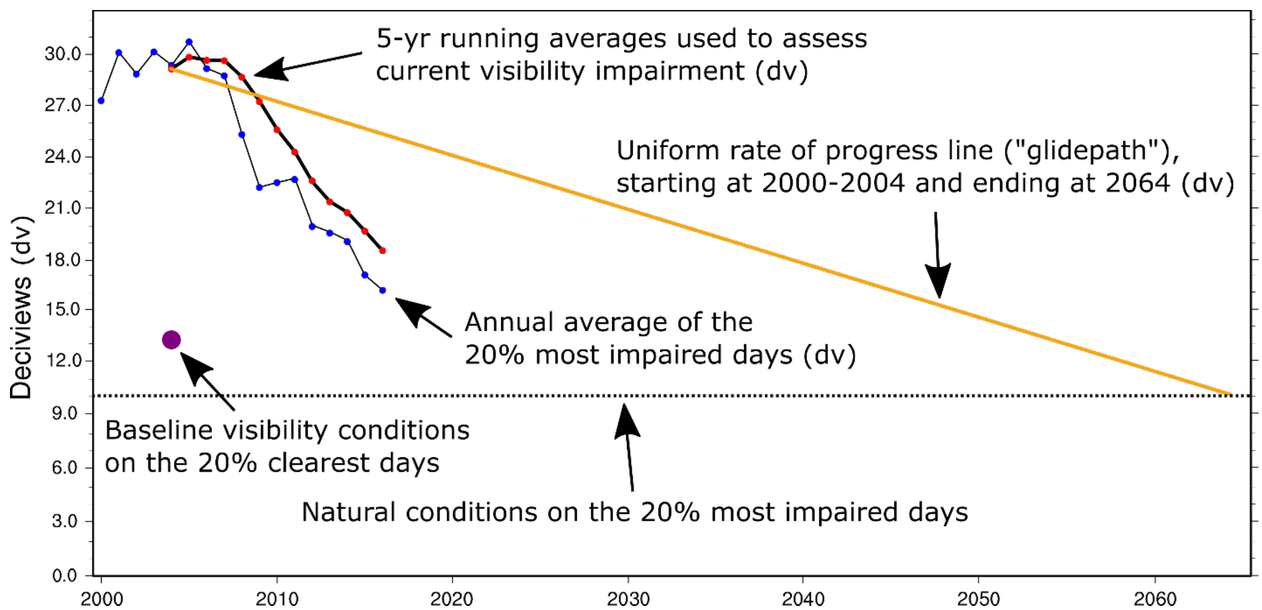

Figure 1. Example diagram showing the important parameters used to calculate the visibility metrics for the Regional Haze Rule

The 2017 Regional Haze Rule also requires states to determine the baseline (2000-2004) visibility condition for the 20 percent clearest days and requires that the long-term strategy and RPG ensure no degradation in visibility for the clearest days since the baseline period.

2.0 Ambient Data Analysis

Among the requirements described in 40 CFR 51.308(f)(1)(i)-(vi), states must calculate the following tracking metrics using available ambient monitoring data (states typically use data collected by the IMPROVE monitoring program):

- Baseline, current, and natural visibility conditions for the 20 percent most anthropogenically impaired and 20 percent clearest days. These six conditions must be quantified in deciviews.
- The URP between the baseline visibility condition for the most impaired days and the natural visibility condition for the most impaired days. The URP must be quantified as the visibility improvement (in deciviews per year) that would need to be maintained during each implementation period in order to attain natural visibility conditions by 2064. The rule also allows states to propose an optional adjustment to the URP to account for impacts from anthropogenic sources outside the U.S. and from certain wildland prescribed fires.

The 1999 rule text defined “most impaired days” and “least impaired days” by referring to highest and lowest levels of “visibility impairment” caused by manmade air pollution. The 1999 final rule preamble stated that the least and most impaired days were to be selected as the monitored days with the lowest and highest actual deciview levels, respectively, without distinguishing between the natural and anthropogenic contributions to reduced visibility.[8] In 2003, EPA issued guidance describing in detail the steps for selecting and calculating light extinction on the "worst" and "best" visibility days (EPA, 2003a). Consistent with the 1999 final rule preamble, the 2003 guidance recommended that states determine the most and least impaired days based on which days had the highest and lowest overall deciview values, rather than determining and selecting the days with the highest and lowest anthropogenic impairment. However, because natural haze due to wildfires or dust storms can be larger than anthropogenic impairment for some Class I areas (particularly in the western U.S.), this approach resulted in some days with large natural sources of haze being included in the 20 percent most impaired days metric.

The 2017 Regional Haze Rule defines *visibility impairment* or *anthropogenic visibility impairment* as "any humanly perceptible difference due to air pollution from anthropogenic sources between actual visibility and natural visibility on one or more days. Because natural visibility can only be estimated or inferred, visibility impairment also is estimated or inferred rather than directly measured."[9] In this definition, the Regional Haze Rule's definition of *visibility impairment* is synonymous with anthropogenic impairment. A metric that reflects both the fraction of the actual light extinction that is above natural levels (in Mm^{-1}) as well as the logarithmic relationship between light extinction and perceived visibility is, thus, a logical basis for selecting the 20 percent most anthropogenically impaired days. One such metric is the difference (the "delta deciviews") between the total deciview value that exists (or is projected to exist) and the deciview value that would have existed if there were only natural sources causing reduced visibility. This is the metric that EPA recommends be used. We recommend that states use Equation 2 to calculate anthropogenic visibility impairment:

$$\Delta\, dv_{\text{anthropogenic visibility impairment}} = dv_{total} - dv_{natural} \qquad \text{(Eqn. 2)}$$

where dv_{total} is the overall deciview value for a day, and $dv_{natural}$ is the natural portion of the deciview value for a day The Regional Haze Rule does not specify how dv_{total} and $dv_{natural}$ are to be determined; that is the subject of some of EPA's recommendations in this document.

2.1 Recommendations for estimating daily natural and anthropogenic visibility fractions and light extinction budgets and calculating the 20% most impaired and 20% clearest days

The first step in determining $dv_{natural}$ is to split the daily light extinction into natural and anthropogenic fractions. Because these are not directly measured, a statistical or computational method must be used to estimate these fractions. This guidance document presents EPA's current recommendation for estimating these fractions; data for this recommended approach, as well as the results of applying the recommended approach,[10] will

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[8] *See* 64 FR 35728.
[9] *See* 40 CFR 51.301.
[10] A state that wishes to follow the EPA-recommended approach may download these completed results and will not have to itself execute the 7 steps discussed in this section. These completed results are available at http://vista.cira.colostate.edu/Improve/rhr-summary-data.

be provided by the IMPROVE program to states for their use on an annual basis. EPA may provide refinements to this method or additional recommended methods through additional guidance as such methods become available.

In general, the recommended approach to splitting daily light extinction into natural and anthropogenic fractions is to estimate the natural contribution to daily light extinction and then attribute the remaining light extinction to anthropogenic sources. The natural contributions are grouped into two types – "episodic" and "routine." Episodic natural contributions are those that occur relatively infrequently. These may differ in number and size from year to year and likely result from extreme events. Routine natural contributions are those that occur on all or most days in a year or season and are more consistent from year to year. Large wildfires and strong dust storms are examples of episodic natural contributions from extreme events, while biogenic secondary aerosol is an example of a routine natural contribution.[11] It is useful to make this distinction because the values used by most states in the first implementation period to represent natural visibility conditions, the "NC-II" estimates,[12] are generally recognized as representing long-term averages influenced by routine natural sources but not episodic natural sources (EPA, 2003b). As explained below, the annual average NC-II estimates are used in the recommended method described in this section, but in a manner that is consistent with the premise that they represent only the influences of routine natural sources.

The recommended steps (1 through 7) to estimate natural and anthropogenic light extinction and the 20 percent most impaired days for the year are detailed below, using an example for Mesa Verde National Park (MEVE1). Note that the values throughout this example are unique to MEVE1 and have been included for illustrative purposes only. Each Class I area is treated individually, and these values do not apply to any site other than MEVE1. A flow chart summarizing these steps is shown in Figure 2.

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[11] The EPA recognizes that natural emissions can also include volcanic emissions. The approach described in this guidance document does not attempt to account for haze formed from natural volcanic emissions. We encourage states with Class I areas affected by volcanic emissions to work with their EPA Regional office to determine an appropriate approach for determining which days are the 20 percent most anthropogenically impaired days.

[12] "NC-II" refers to a set of estimates of natural conditions for each Class I area contained in Regional Haze Rule Natural Level Estimates Using the Revised IMPROVE Aerosol Reconstructed Light Extinction Algorithm, available at http://vista.cira.colostate.edu/improve/publications/graylit/032_NaturalCondIIpaper/Copeland_etal_NaturalConditionsII_Description.pdf. As called for in the agency's "Regional Haze Reform Roadmap" (September 11, 2018, the agency may be updating the natural visibility conditions estimates in spring 2019, as necessary.

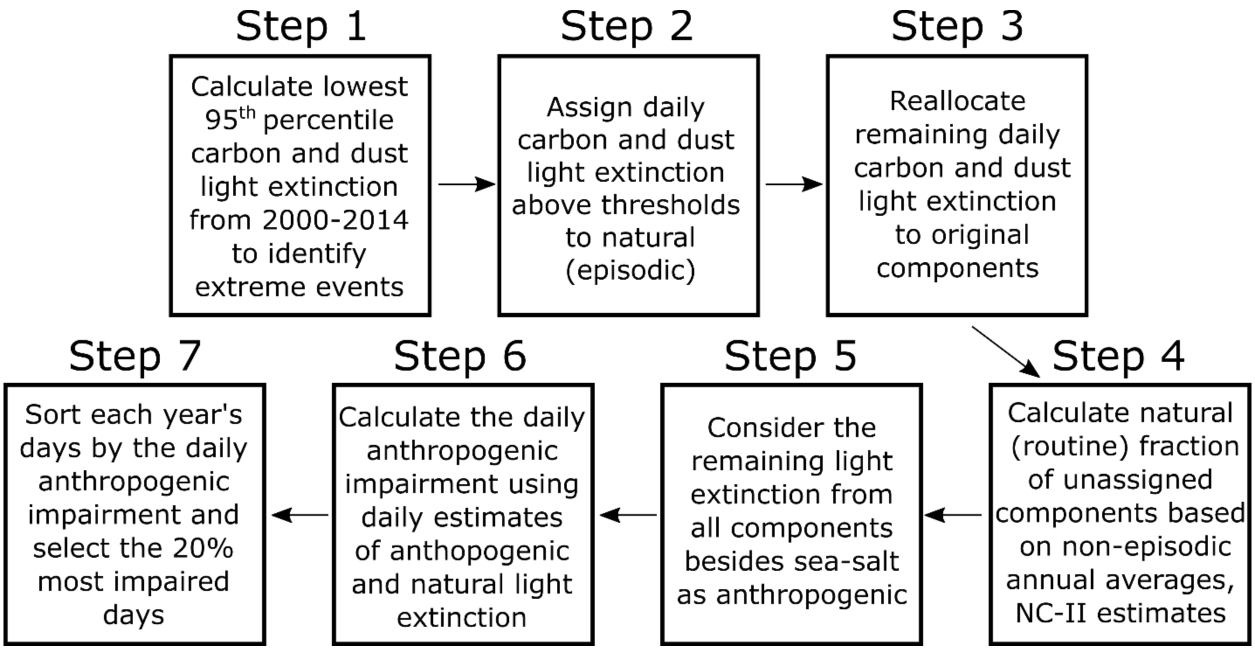

Figure 2. Flow chart of the 7 steps involved in calculating the 20% most impaired days.

Step 1: Establish light extinction thresholds to identify extreme events

Analysis from the first implementation period showed that smoke from wildfires (mainly composed of OMC and LAC) and dust storms (mainly composed of CM and FS) are major contributors to light extinction at many Class I areas (Tombach, 2008). For each Class I area, using data from the IMPROVE monitor associated with the area, identify for each year the 95th percentile 24-hour carbon (OMC + LAC) light extinction (Spracklen, et al., 2007) (Jaffe, et al., 2008). Choose the year between 2000 and 2014 with the lowest such value. This year represents the "low wildfire" year of this period. Also, choose the year with the lowest 95th percentile 24-hour dust (CM + FS) light extinction. This year represents the "low dust storm" year of this period. The 95th percentile carbon and dust values for these years will serve as the threshold values used to identify impacts on carbon and dust light extinction from extreme episodic events in that year and other years. At Class I areas where episodic influences vary significantly from year to year, it will not be unusual for more than five percent of the monitored days to be affected by extreme episodic events in years other than the "low wildfire" and "low dust storm" years. Thus, this approach allows a different number of high carbon days or high dust days in different years to be identified as ones with extreme episodic impacts, but all the days that are identified will have carbon or dust concentrations at least as high as the respective threshold. EPA believes this method for calculating threshold values for identifying episodic light extinction is reasonable and practical to apply to the large set of IMPROVE data, and our investigations have indicated that the results (i.e., the days selected as the 20 percent most impaired) would not be substantially different if slightly different percentile values were used for this purpose. However, some areas with a high frequency of episodic wildfire smoke or dust impacts even in the "low wildfire" or "low dust storm year" could use a lower percentile value. At other sites, the year representing the lowest wildfire or dust storm thresholds may have no episodic impacts and such sites could use a higher percentile value. States may use other reasonable thresholds for determining impacts from extreme natural events if they explain why another method is appropriate for their individual Class I areas.

The 95th percentile value will be the 0.95×n measured value sorted from lowest to highest. If 0.95×n is not an integer value, the 95th percentile value is the monitored value such that it and all lower values are more than 95 percent of the sample. For MEVE1 in 2003, there were 105 complete values for carbon. For MEVE1 in 2003, 0.95×105 is 99.75, so the 95th percentile value would be the 100th value counting up from the lowest value, out of 105 (the sixth value counting down from the highest value). In 2003, the 100th highest carbon value is 25.36 Mm^{-1}. Repeat this process to get a 95th percentile value for each year from 2000 to 2014 for carbon and dust. The results for each of these years for MEVE1 are shown in Table 1.

Table 1. 95th percentile values for carbon and dust light extinction (in units of Mm^{-1}) from 2000-2014 at MEVE1.

Year	Annual 95th percentile carbon light extinction	Annual 95th percentile dust light extinction
2000	12.68	7.732
2001	7.002	6.686
2002	16.14	19.60
2003	25.36	16.45
2004	5.937	5.498
2005	9.640	5.658
2006	7.813	5.326 (lowest)
2007	11.72	5.685
2008	7.545	9.257
2009	10.55	10.35
2010	7.109	13.30
2011	5.289	9.726
2012	10.66	8.930
2013	5.396	8.223
2014	5.054 (lowest)	9.281

The years 2014 and 2006 have the lowest carbon and dust 95th percentile values for MEVE1, respectively. The year 2014 was in this sense the "low wildfire" year at MEVE1, such that the 95th percentile value for carbon in 2014 becomes the threshold for identifying extreme wildfire-affected days in any year, with the same concept applying to dust from natural sources and the year 2006. The 95th percentile value of carbon in 2014 was 5.054 Mm^{-1}, and the 95th percentile value of dust in 2006 was 5.326 Mm^{-1}. National maps of the light extinction thresholds to identify extreme carbon and dust events are shown in Figures 3 and 4.

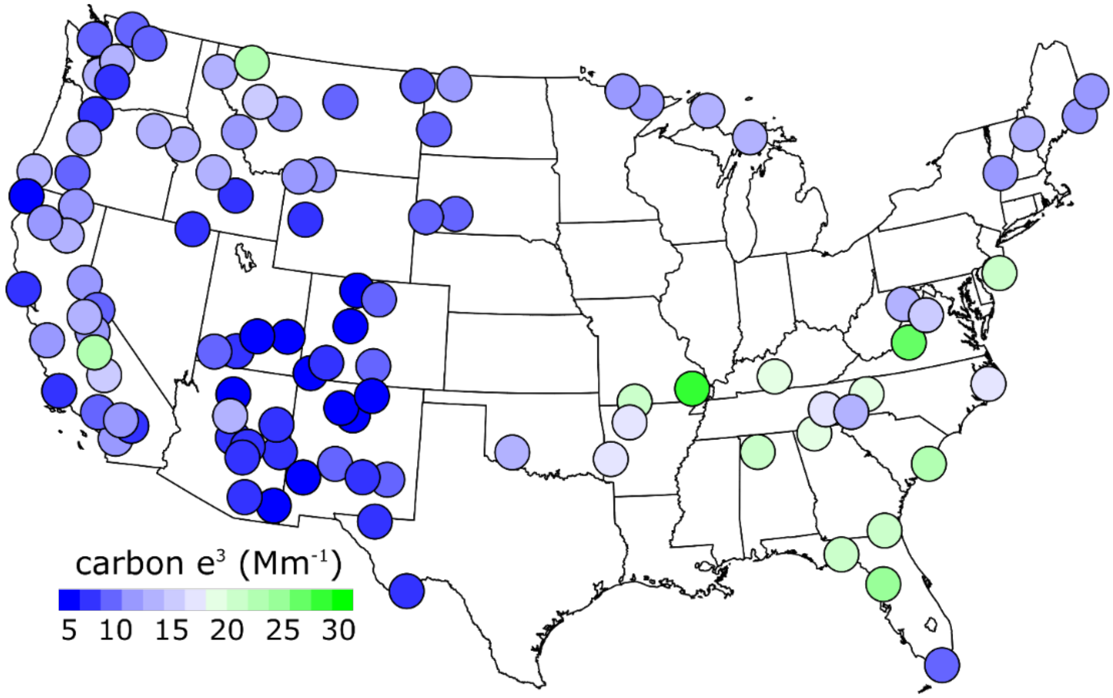

Figure 3. Site-specific extinction thresholds of carbon from extreme episodic events

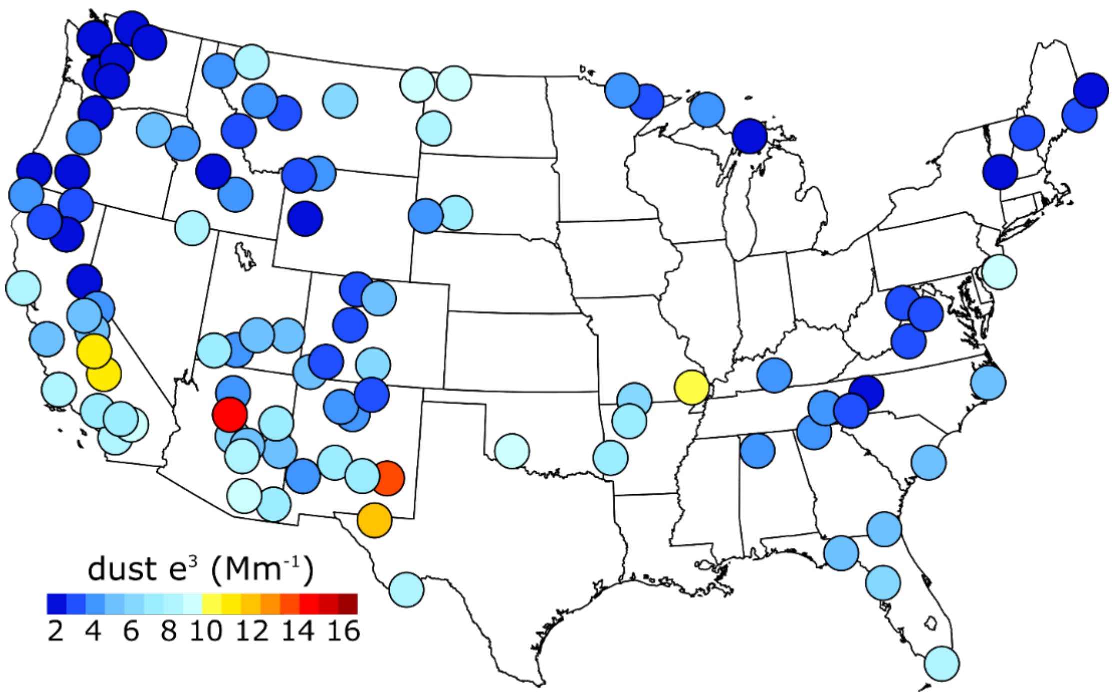

Figure 4. Site-specific extinction thresholds of dust from extreme episodic events

Step 2: Assign the portions of daily carbon and dust light extinction that are in excess of these thresholds to "natural (episodic)"

The IMPROVE light extinction data for a specific day (May 12, 2003) at MEVE1 are shown in Table 2. The light extinction from carbon (25.36 Mm^{-1}) on this day is greater than the threshold of 5.054 Mm^{-1}. Therefore, 25.36 minus 5.054 or 20.31 Mm^{-1} is assigned to natural (episodic). Carbon light extinction in the amount of 5.054 Mm^{-1} remains to be split between natural (routine) and anthropogenic in Step 4 below, after the combined value of carbon is reallocated to OMC and LAC (Step 3). The dust-related light extinction of 2.699 Mm^{-1} is less than the threshold value of 5.326 Mm^{-1}, therefore no dust-related light extinction is assigned to natural (episodic). However, the 2.699 Mm^{-1} value for dust-related light extinction does need to be split between natural (routine) and anthropogenic in Step 4 below, after the combined value of dust is reallocated to FS and CM (Step 3). A summary of the episodic thresholds and the light extinction assigned to natural (episodic) is shown in Table 2.

Step 3: Reallocate the daily combined carbon and dust light extinction remaining after assigning values over the threshold values to "natural (episodic)" into OMC, LAC, FS, and CM.

Separate the combined carbon back into OMC and LAC and separate the combined dust back into FS and CM based on the original percentages of the individual PM species to the grouped light extinction. For example, at MEVE1 on May 12, 2003, the total carbon light extinction was 25.36 Mm^{-1}, with OMC light extinction of 21.78 and LAC Mm^{-1} light extinction of 3.576 Mm^{-1}. The total dust light extinction was 2.699 Mm^{-1} with 1.141 Mm^{-1} from FS and 1.558 Mm^{-1} from CM. Therefore, on May 12, 2003, carbon light extinction was 85.88 percent from OMC and 14.10 percent from LAC; dust light extinction was 42.27 percent from FS and 57.72 percent from CM. Separate the estimates of natural (episodic) and the remaining light extinction from carbon back into OMC and LAC and the remaining light extinction from dust back into FS and CM, using these percentages. Table 2 shows the results of these calculations for this example day at MEVE1. For example, of the 20.31 Mm^{-1} of carbon assigned to natural (episodic), 17.44 Mm^{-1} (or 85.88 percent) is reallocated to OMC and 2.864 Mm^{-1} (14.10 percent) is reallocated to LAC. States may use other approaches than the one recommended here.

Table 2. Total and speciated light extinction (in units of Mm^{-1}) for an example day (May 12, 2003) at MEVE1

PM Species	Total Light Extinction	Threshold	Light extinction associated with natural (episodic)	Light extinction remaining after episodic treatment
Sulfate	2.963	NA	0	2.963
Nitrate	0.8055	NA	0	0.8055
Carbon (OMC + LAC)	25.36 (21.78 + 3.576)	5.054	20.31 (17.44 + 2.864)	5.054 (4.340 + 0.7126)
Dust (FS + CM)	2.699 (1.141 +1.558)	5.326	0	2.699 (1.141 +1.558)
Sea salt	0.001469	NA	0	0.001469
Rayleigh	9.0	NA	0	9.0
TOTAL	40.83	NA	20.31	20.52

Step 4: Split the remaining components of light extinction into natural (routine) and anthropogenic based in part on the NC-II estimates (Copeland, et al., 2008)***.***

In order to split the remaining components of light extinction into natural (routine) and anthropogenic components, we recommend allowing the natural (routine) to vary daily based on the NC-II estimates weighted by the ratio of the light extinction remaining after removing episodic contributions to the non-episodic annual average extinction. At most Class I areas, the use of this ratio results in higher natural (routine) values in the summer and lower values in the winter.

Starting with the daily results from Step 3 for all days with complete data in a year, calculate the annual average light extinction values for each PM species, excluding light extinction already attributed to episodic events. The non-episodic annual averages for 2003 at MEVE1 are shown in Table 3.

For all PM species except sea salt (which is treated as entirely natural (routine)), use the existing NC-II annual average natural light extinction values (which are distinct from the "p90" values), the daily light extinction values, and the annual averages for the site (for both, excluding the light extinction already attributed to episodic events) to calculate a daily estimate of natural (routine). These three input values appear in Table 3 for the May 12, 2003, MEVE1 example. (Table 3 is not intended to show a calculation using these values. The way these input values are used to complete the calculation of anthropogenic versus natural light extinction for a given day is described below the table.)

Table 3. The remaining light extinction at MEVE1 on May 12, 2003 (in units of Mm^{-1}), after applying thresholds to allocate some light extinction to natural (episodic). The NC-II average light extinction estimates and the 2003 annual average light extinction excluding the episodic light extinction are also shown.

PM species	Light extinction remaining after episodic treatment (Step 3)	NC-II average natural light extinction	2003 annual average non-episodic light extinction	Natural (routine) light extinction (Step 4)	Anthropogenic light extinction (Step 5)
Sulfate	2.963	0.5741	4.103	0.4146	2.548
Nitrate	0.8055	0.5829	1.599	0.2936	0.5119
OMC	4.340	1.831	3.194	2.489	1.851
LAC	0.7126	0.2	0.8624	0.1653	0.5467
FS	1.141	0.5	0.8793	0.6490	0.492
CM	1.558	1.726	2.351	1.144	0.4140
Sea salt	0.001469	0.01822	0.02806	0.001469	0
Rayleigh	9.000	9.000	9.000	9.000	0
TOTAL	NA	NA	NA	14.16	6.36

The calculation formula in Step 4 using daily and annual average inputs like those shown in Table 3 depends on whether, for a given PM species, the annual average light extinction value (excluding episodic events) for the particular year is greater than or less than the NC-II estimate of annual average natural light extinction. For a site and PM species with an annual average light extinction value (excluding episodic events) less than the NC-II estimate, all of the daily light extinction is assigned to natural (routine). This results in the natural (routine) light extinction being different each day, with the annual average being less than the NC-II estimate. For a site and PM species with an annual average light extinction value (excluding episodic events) greater than the NC-II estimate, the daily estimates of natural (routine) light extinction are calculated by multiplying the total daily light extinction for each species by the ratio of the NC-II annual average estimates and the annual average non-episodic light extinction. This results in the natural (routine) light extinction being different each day and the annual average of the daily estimates of natural (routine) light extinction equaling the NC-II annual average value. The daily contributions to natural (routine) are calculated according to Equation 3:

$$\text{natural(routine)} = \frac{\text{daily extinction} \times \text{NC-II estimate}}{\text{non-episodic annual average}} \qquad \text{(Eqn. 3)}$$

An example for the OMC light extinction on May 12, 2003, at MEVE1, using extinction values from Table 3, is shown below.

$$\text{natural(routine)}_{OMC} = \frac{4.340 \times 1.831}{3.194} = 2.489\ Mm^{-1}$$

Repeat this calculation for LAC, FS, CM, sulfate, and nitrate light extinction (not shown here). States may use other reasonable methods for estimating routine natural and anthropogenic fractions if they explain why another method is appropriate for their individual Class I areas.

Step 5: Consider the remaining light extinction from sulfate, nitrate, OMC, LAC, FS, and CM as "anthropogenic."

Starting with the daily total light extinction measured on each day, subtract the daily natural (episodic) and daily natural (routine) to find the daily anthropogenic light extinction attributable to each PM species and overall, i.e., the light extinction budget. For the May 12, 2003, MEVE1 example, the daily total light extinction was 40.83 Mm^{-1}, daily natural light extinction was 34.46 Mm^{-1} (20.31 episodic + 14.16 routine), and daily anthropogenic light extinction was 6.36 Mm^{-1} (see Tables 2 and 3).

Step 6: Calculate anthropogenic impairment for each day using the daily estimates of natural and anthropogenic light extinction, according to Equation 2.

For each day at the Class I area of interest, convert the daily total and natural light extinction to deciviews and calculate anthropogenic impairment according to Equation 2. At MEVE1, for May 12, 2003, the anthropogenic impairment is calculated as:

$$\Delta\ dv_{\text{anthropogenic visibility impairment}} = 10 \times \ln\frac{40.83}{10} - 10 \times \ln\frac{34.46}{10} = 1.695\ \text{dv}$$

Step 7: Sort each year's days with complete data by the anthropogenic impairment value and choose the 20 percent most impaired days based on this value.

Perform these calculations for each day at the Class I area of interest, then rank the days within each year from high to low by anthropogenic impairment where a rank of 1 is the most impaired day (*i.e.*, the day with the highest anthropogenic impairment value). At MEVE1, this day, May 12, 2003, with an anthropogenic impairment value of 1.695 deciviews, is a relatively low impairment day and was ranked 99 out of 105 total days with complete observations. Therefore, based on anthropogenic impairment, this day is *not* one of the 20 percent most impaired days for 2003.[13] Average the deciviews of total haze on the 20 percent most impaired days for each year to obtain a single value for the associated visibility condition for each year (for MEVE1 in 2003, which had 105 complete observations, 21 days will be in the 20 percent most impaired).

States may choose alternative approaches for estimating natural and anthropogenic contributions to light extinction, but the Regional Haze Rule requires states to choose the 20 percent most impaired days based on anthropogenic impairment. In other words, while Steps 1 through 6 described above are EPA recommendations and states are not precluded from using other approaches to determine the anthropogenic impairment on each day, the Regional Haze Rule requires states to follow Step 7 as it is described here.

The 2017 Regional Haze Rule revisions introduced a new term for describing the days with the lowest light extinction and deciview values: *clearest days*. These days are *not* to be selected

[13] In contrast, if ranking this day based on either total light extinction or overall visibility conditions (the ranking would be the same with these two metrics), as the EPA's guidance for the first implementation period recommended, this day would be ranked 14 out of 105 days with complete observations and would be one of the 20 percent of days with the haziest visibility conditions.

based on the lowest anthropogenic impairment (as referring to them as the 20 percent least impaired days as in the 1999 Regional Haze Rule would suggest). These will be the days with the lowest values of the deciview index. It is unnecessary to split the data into “natural” and “anthropogenic” fractions. Rather, the days are to be sorted for each year by total deciviews, and the 20 percent of days with the lowest deciviews are the 20 percent clearest days. When 0.2 multiplied by the number of monitored days in a year with complete data is not an integer, an “extra” day should not be included in the set of clearest days, which means that the percentage of days in this set may be a value somewhat below 20 percent.

2.2 Calculating the baseline, current, and natural visibility conditions

The 2017 Regional Haze Rule continues to define the period for establishing baseline visibility conditions as 2000 to 2004 for the second and future implementation periods.[14] Visibility conditions averaged over these 5 baseline years are the starting point for calculating the URP and drawing the URP line for all implementation periods of the Regional Haze Rule. It is important to note that in the 2017 Regional Haze Rule, the term “most impaired days” has a different meaning than EPA and states gave to that term in the first implementation period. The “baseline visibility condition (in deciviews) for the 20 percent most impaired days” in a state’s SIP submission for the second implementation period will likely have a different value than the baseline values used in SIPs for the first implementation period, even if there have been no revisions to the IMPROVE data for the 2000-2004 period. The differences will be largest at Class I areas impacted by fire and dust events in the baseline period. If a state chooses an alternative approach for estimating natural and anthropogenic contributions to light extinction, it is likely that the baseline visibility condition will have a different value than with the recommended approach.

The period for calculating current visibility conditions in the 2017 Regional Haze Rule is the 5-year period ending with the most recently available data. Due to the laboratory, data analysis, and quality assurance procedures of the IMPROVE program, there is some delay between the date of the filter collection and the date the data are ready for use in analyses. Current visibility conditions must be calculated based on the annual average level of visibility impairment for the 20 percent most impaired and the 20 percent clearest days. The current visibility condition for each set of days is the average of the valid annual values from the 5-year period ending with the most recently available data set as expressed in deciviews. Five years are averaged to account for variability in meteorology and emissions. Data completeness requirements for valid years are described in the 2003 Regional Haze Rule visibility tracking guidance (EPA, 2003a). Incomplete or missing data from some IMPROVE sites may require the combination or substitution of data from multiple IMPROVE sites for the ongoing visibility tracking of the Regional Haze Rule. The appropriate EPA Regional office should be consulted when data completeness issues arise.

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[14]It is recommended that the data for the 2000-2004 baseline period be refreshed prior to analysis due to periodic revisions in the methods for calculating ambient concentrations from measurements made on filters and for filling in missing or invalidated data.

The URP framework requires states to determine a single value for the "natural visibility condition" for the 20 percent most impaired days. Given the inherent day-to-day variability of natural processes (e.g., windblown dust, fire, volcanic activity, biogenic emissions, etc.), it follows that even if there were no anthropogenic sources, visibility would not be constant and would vary day-to-day. Also, visibility due only to natural sources has never occurred in modern times and, therefore, has never been directly measured nor could it be directly measured. It must be estimated. Even if past natural conditions could be known with certainty, future natural conditions may be different. The steps for estimating natural and anthropogenic fractions of light extinction recommended in this guidance are based on estimates of natural visibility conditions for each monitored day in the past, with a given past day having the potential for both routine and episodic contributions to natural conditions. An additional step is needed to get the single value for the "*natural visibility condition*." Under the Regional Haze Rule, the single value of the natural visibility condition for the 20 percent most impaired days is used in several ways:

1. The value of the natural visibility condition is to be compared to the "current visibility condition," i.e., the most recent 5-year average of actual visibility for the 20 percent most impaired days. (51.308(f)(1)(v)).
2. The URP can be calculated as the difference between the 2000-2004 baseline visibility condition and the natural visibility condition for the 20 percent most impaired days, divided by 60 years. In other words, the "glidepath" can end at the natural visibility condition in 2064. (51.308(f)(1)(vi)).[15]
3. The future year (2028 for the second implementation period) RPG for the 20 percent most impaired days is compared to its value on the URP line, which can use the natural visibility condition estimate as its endpoint. (51.308(f)(1)(vi)).

We are recommending that states set the single value of the natural visibility condition for the 20 percent most impaired days to be equal to the average of the new estimates of daily natural visibility conditions estimated for the particular days that have been identified as the 20 percent most impaired days from 2000-2014. This method takes advantage of the already calculated daily "natural (episodic)" and "natural (routine)" estimates of light extinction produced in steps 1 through 3. These revised natural visibility conditions are consistently lower in magnitude than the "p90" NC-II haze estimates (representing the average conditions for days between the 80^{th} percentile and the 100^{th} percentile) and generally more similar in magnitude to the annual average NC-II haze estimates. (Gantt, et al., 2018) describes in greater detail the methodology, seasonality, composition, and trends in the natural visibility conditions, and a summary of the natural visibility condition estimates for each IMPROVE site can be found in Appendix A.

When following the recommended approach to select the 20 percent most impaired days based on anthropogenic impairment, days with large impacts from extreme, episodic natural events such as fires and dust storms are no longer selected. Therefore, these extreme impacts

[15]If an adjustment is made to the URP for impacts from international anthropogenic emissions or wildland prescribed fires, the glidepath would not end at the natural visibility condition.

generally will not be included in estimates of natural visibility conditions that will be compared with the most impaired days. This addresses past feedback from the first implementation period that the natural and current visibility conditions were inconsistent because 1) the "p90" NC-II Natural Haze estimates developed by the Natural Haze Levels II Committee in 2007 failed to include effects from large episodic natural events (Tombach, 2008) and 2) the 20 percent of days with the worst overall visibility included these extreme episodic natural influences. In addition to avoiding selecting historical days dominated by extreme natural events when calculating the single value of the natural visibility condition that will be used in calculating the URP, it is important to recognize that the 20 percent most impaired days will be distributed across seasons of the year differently than the 20 percent haziest days used for the first implementation period (Gantt, et al., 2018). Because the revised national visibility condition value is calculated from estimates of daily natural contributions on the most impaired days, this recommended natural visibility condition value is more consistent within the framework.

At most Class I areas, these updates to the baseline and natural visibility conditions in recommended approach result in a time series that is less influenced by natural events and reflects the substantial visibility improvements that have occurred in many areas of the United States between 2000 and 2016 (see Figure 5).

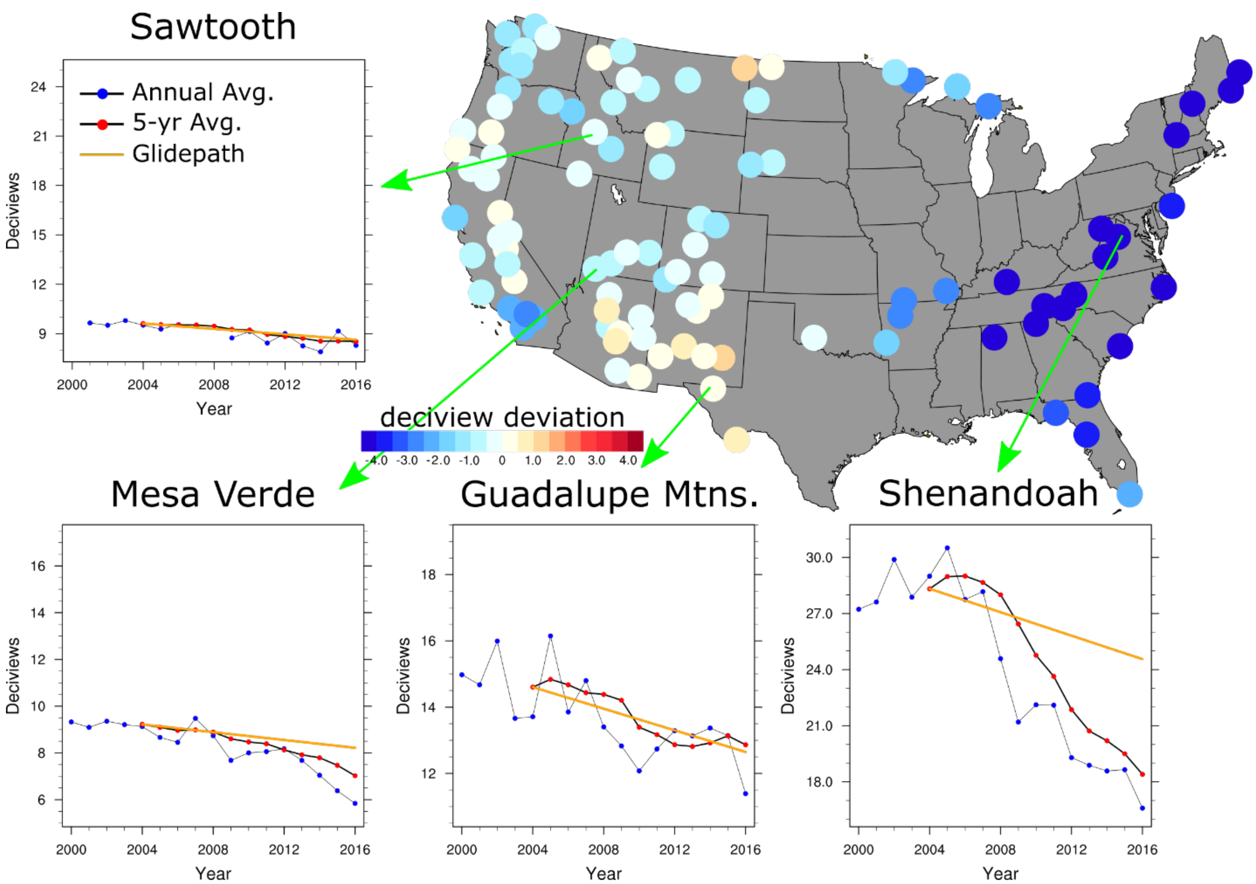

Figure 5. National map of current visibility conditions relative to the URP in 2012-2016 based on the 20 percent most impaired days (recommended approach).

3.0 Adjustment of the Uniform Rate of Progress for Impacts from International Anthropogenic Emissions

Visibility at Class I areas is impacted not only by natural and anthropogenic emissions from within the U.S., but also by natural and anthropogenic *international* emissions. Due to the fact that international anthropogenic emissions are beyond the control of states preparing regional haze SIPs, the Regional Haze Rule allows states to propose an adjustment of the 2064 URP to account for international anthropogenic impacts, if the adjustment has been developed using scientifically valid data and methods. The URP can be adjusted by adding an estimate of the visibility impact of international anthropogenic sources to the value of natural visibility condition to get an adjusted 2064 endpoint.[16]

The optional adjustment to the URP for international anthropogenic emissions is in addition to another optional adjustment relating to certain prescribed fires. Specifically, the rule also allows states to include an adjustment of the URP to account for impacts from certain wildland prescribed fires. The information and procedures for prescribed fire adjustments are expected in practice to be similar to the recommended international anthropogenic adjustment procedure provided in this guidance. Therefore, this section of the guidance document may be useful in either case. Note that preliminary EPA regional haze modeling (based on 2011 fire emissions) (EPA, 2017) indicates that prescribed fire impacts on the 20 percent most impaired days at most Class I areas are likely to be small and, thus, any adjustment to the URP would also be small. This section focuses on anthropogenic international emissions and their impacts.

3.1 URP Adjustment in the Regional Haze Rule

The relevant international anthropogenic URP adjustment language in the Regional Haze Rule is at 40 CFR 51.308(f)(1)(vi):

> (B) As part of its implementation plan submission, the State may propose (1) an adjustment to the uniform rate of progress for a mandatory Class I Federal area to account for impacts from anthropogenic sources outside the United States and/or (2) an adjustment to the uniform rate of progress for the mandatory Class I Federal area to account for impacts from wildland prescribed fires that were conducted with the objective to establish, restore, and/or maintain sustainable and resilient wildland ecosystems, to reduce the risk of catastrophic wildfires, and/or to preserve endangered or threatened species during which appropriate basic smoke management practices were applied. To calculate the proposed adjustment(s), the State must add the estimated impact(s) to the natural visibility condition and compare the baseline visibility

[16] The EPA expects that the revised approach of selecting the most anthropogenically impaired days for purposes of defining RPGs and tracking progress, which focuses progress tracking on days not affected by large episodic natural events such as dust storms and wildfires, will also largely resolve any concerns stemming from the same types of natural emission sources in other countries. Because the recommended method for identifying the most anthropogenically impaired days is based entirely on information from IMPROVE monitoring sites, it can be executed without detailed information on the emissions from natural sources outside the U.S.

> condition for the most impaired days to the resulting sum. If the Administrator determines that the State has estimated the impact(s) from anthropogenic sources outside the United States and/or wildland prescribed fires using scientifically valid data and methods, the Administrator may approve the proposed adjustment(s) to the uniform rate of progress.

The URP is based on 1) PM species measurements that do not distinguish between PM due to natural, U.S. anthropogenic, and international anthropogenic emissions, and 2) the "natural visibility condition" endpoint that should not include any anthropogenic contribution (see Figure 1). The natural visibility condition endpoint, therefore, assumes no anthropogenic international contribution in 2064 and the default URP slope reflects a hypothetical uniform decrease in both U.S. and international anthropogenic haze contributions. The rule provision that allows states to include an international adjustment allows for the modification of the URP slope to account for international anthropogenic contributions that states cannot control.

The Regional Haze Rule allows for an adjusted URP but does not prescribe a particular adjustment methodology. To inform this adjustment to the URP, EPA recommends the use of chemical transport models (CTMs) as the most broadly applicable method for attributing pollutant concentrations to emissions sources. Two key issues with using CTMs for this purpose are addressed below: what year should be used to estimate international anthropogenic impacts, and how to apply the models to quantify international anthropogenic impacts.

3.2 Year Selection for Estimating International Contribution

Estimating international anthropogenic visibility impact is a function of transport patterns and emissions. Both meteorology and emissions are year-specific, so the first choice in photochemical modeling is determining what year to simulate. For example, the estimation could be based on a current or recent year, the implementation period end year (e.g., 2028, 2038, etc.), or the URP endpoint (2064).

To illustrate the potential impacts of international emissions, Figure 6 shows hypothetical effects of adjusting the 2064 endpoint to account for international emissions at a hypothetical Class I area. The URP lines in Figure 6 illustrate how the URP slope is impacted by different estimates of international impacts. The URP represented by the orange line shows an unadjusted URP that assumes both U.S. and international anthropogenic impacts will decrease uniformly to zero in 2064. The black URP line represents an adjusted URP, assuming constant international anthropogenic impacts over time. In both URP series, the U.S. anthropogenic contribution is uniformly decreasing in each period.[17]

[17]In the example figure, the U.S. visibility impairment improvement is calculated as a fixed percentage in each implementation period. However, consistent with the Regional Haze Rule, there is no regulatory requirement to achieve "uniform progress." The actual improvement in visibility impairment during each implementation period may vary.

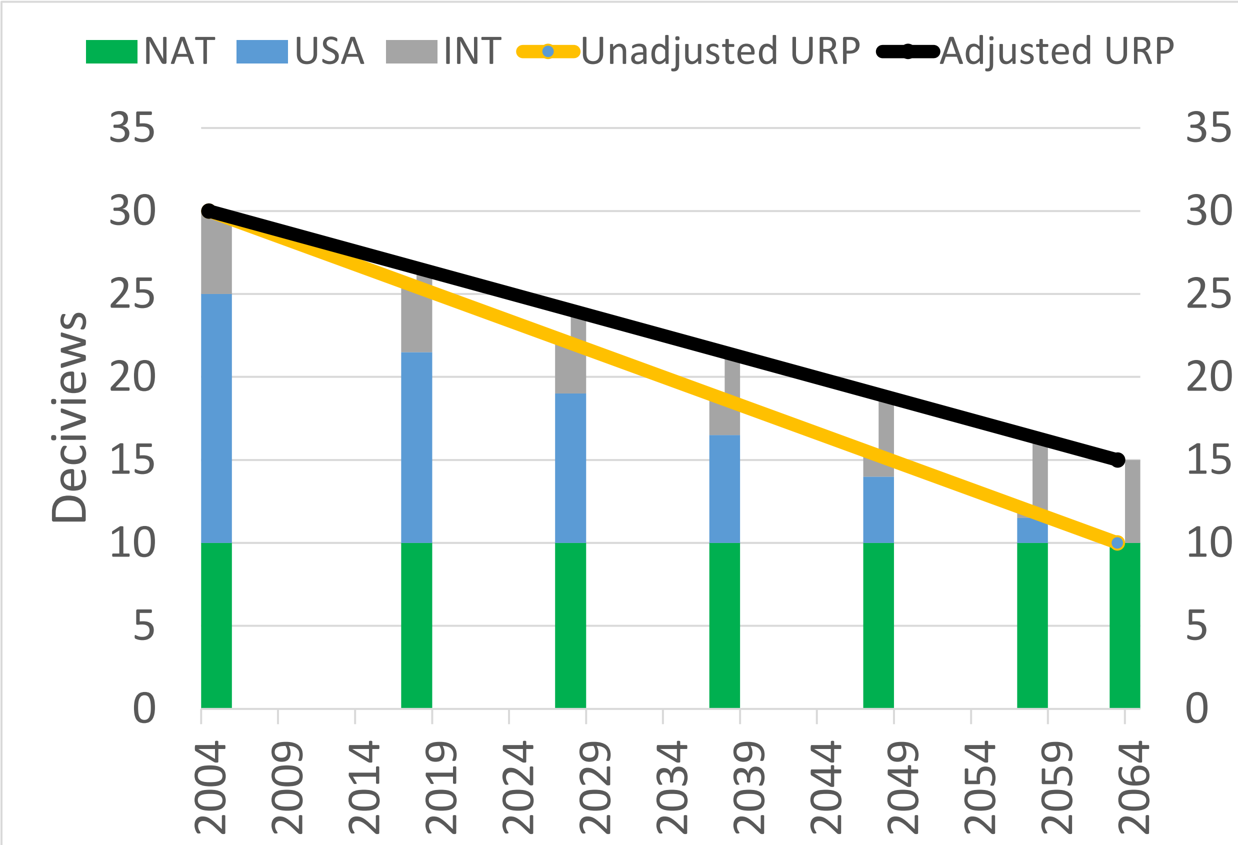

Figure 6. URP lines based on alternate international projections. For each year except 2004, there are two bars representing two different possibilities (1st: decreasing international (INT); 2nd: constant international). Note that both realizations have the same decreasing U.S. anthropogenic (USA) contribution and same constant natural conditions (NAT).

Projecting international emissions to 2064 may be speculative and somewhat uncertain. EPA therefore believes that recent year estimates of visibility impacts are most appropriate to use in estimating international adjustments. There are existing recent estimates of global PM and PM precursor emissions that have been used in various modeling studies (Galmarini, et al., 2016; Janssens-Maenhout, et al., 2015; Li, et al., 2015; Hoesly, et al., 2018). Therefore, for the second implementation period, EPA recommends estimating international impacts in a recent year, with more recent years being best able to reflect current international emissions and trends. In choosing the analysis year, additional practical considerations, such as the availability of emission information or modeling results may constrain a state's options. For example, it may only be practical to use 2011, 2014, or 2016 base year international emissions to calculate the adjustment because only that information is readily available.

In some cases, additional data on emissions trends may be used to estimate future year international impacts, if future changes are well known. This is especially relevant for North American emissions sources (generally within the regional modeling domain), where future trends in some non-U.S. emissions sectors (e.g., on-road mobile sources and commercial ships) may be relatively well characterized in existing inventories. Since 2028 is the end of the second implementation period, it is the most likely future modeling analysis year. To the extent that high-quality international emissions projections are available, it may be appropriate to calculate international anthropogenic adjustments based on 2028 emissions.

Since international anthropogenic visibility impacts are likely to change in the future, in subsequent planning periods, a new international adjustment can be made for each implementation period. In this way, an iterative process over time allows the glidepath to be periodically adjusted to reflect future trends in international anthropogenic emissions. Eventually, as we get closer in time to the URP endpoint, the international anthropogenic visibility impact will become less uncertain.

3.3 Estimating the Anthropogenic International Visibility Impacts

The methods to quantify international visibility impacts are largely independent of the chosen year. The Regional Haze Rule requires that a state's approach be based on scientifically valid data and methods. Due to long-range transport and secondary PM components involved in international transport, photochemical chemical transport modeling (CTM) is the preferred approach for quantifying international contributions to visibility. Detailed guidance on performing CTM simulations is available in EPA's photochemical modeling guidance for ozone, $PM_{2.5}$, and regional haze (EPA, 2018).

Using CTMs, there are several potential ways to quantify international anthropogenic impacts in Class I areas:

1) The simplest approach is to perform brute force "zero-out" model runs, which involves at least two model runs: one "base case" run with all emissions, and one with anthropogenic emissions from outside of the U.S. removed from the original base case simulation. The difference between these simulations provides an estimate of the air quality impact due to the international anthropogenic emissions.

2) An alternative approach to isolating international anthropogenic impacts in photochemical grid models is "photochemical source apportionment." Some photochemical models have been developed with a photochemical source apportionment capability, which tracks emissions from specific sources or groups of sources and/or source regions through chemical transformation, transport, and deposition processes to estimate the apportionment of predicted $PM_{2.5}$ species concentrations (Kwok, et al., 2013; Kwok, et al., 2015; Ramboll, 2018). Source apportionment can be used to track PM formed from international anthropogenic emissions sources.

From the CTM runs, whether based on brute-force or source apportionment (or a combination of both), PM species concentration increments due to international anthropogenic emissions can be calculated for each of the 20 percent most impaired days (for each Class I area). The PM concentration increments on the 20 percent most impaired days are then converted to extinction and averaged. The “delta deciview” adjustment factor associated with the international anthropogenic impact can then be calculated as follows[18]:

$$\Delta dv = 10 \ln\left(bext_{natural\ conditions} + bext_{international\ anthropogenic}\right) / bext_{natural\ conditions} \qquad \text{(Eqn. 4)}$$

The Class I area-specific adjustment factor (in deciviews) is added to the natural conditions value for each Class I area to get the adjusted URP.[19] In this process, the following issues should be given appropriate treatment:

The air quality model (or combination of models) that is used.

The modeling system typically includes a global/hemispheric modeling simulation and a regional photochemical modeling simulation. The global component is often used to supply “boundary” conditions to the regional simulation. To the extent practical, the modeling platforms with the two scales should be consistent using the same (or similar) meteorology, vertical resolution, emissions, and representation of chemical species. This is particularly true for the international emissions but is also true for gas-phase and aerosol modeling components. The consistency is particularly important when performing anthropogenic zero-out and/or source apportionment simulations that cross horizontal grid scales (going from a lower resolution global/hemispheric model to a higher resolution nested regional model).[20]

The validity of the estimates of both international and U.S emissions.

Before estimating source contributions, the “*basecase*” simulation, both for global and regional models, should be able to reasonably reproduce historical PM measurements and calculated visibility values. Thus, model performance evaluation and diagnostic evaluation should both play a role as described in the photochemical modeling guidance (EPA, 2018) (Simon, et al., 2012). This will provide confidence that both U.S. and international emissions and visibility impacts are reasonably well represented.

After the *basecase* has been evaluated and shown capable of representing historical PM and visibility, then the models can be used to quantify international impacts. Quantifying the international sources, as previously stated, may be done using zero-out (sensitivity) or source apportionment model runs, or a combination of both.[21] Unless the international impacts are primarily from the portions of North America included in the smaller scale (regional) modeling simulation, the modeling will likely require coordinated efforts between a global/hemispheric and regional CTM simulation. When this is the case, it is especially important to understand the

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[18]There may be multiple ways this aggregation across days might be done, keeping in mind that the URP line is in units of deciviews, so the adjustment must also be in units of deciviews.

[19]Note that the Regional Haze Rule does not allow a state to subtract an estimate of the impacts of international anthropogenic sources when projecting the RPGs for the end of the implementation period, as an alternative to adding international anthropogenic impacts to the 2064 endpoint of the URP glidepath.

[20]The boundary between the global and regional models should be sufficiently far removed from U.S. emissions sources and/or the Class I areas being considered.

[21]For example, zero-out modeling could be used in the global or hemispheric model to feed boundary conditions to the regional model. Then source apportionment technology could be used to track international anthropogenic emissions within the regional model. The available options depend on the source apportionment capability of the chosen global, hemispheric, and/or regional CTMs.

harmony of inventories at the different scales. Regardless of the technology used for quantification of source contributions (sensitivity or source apportionment), the most important aspect is appropriate selection of source sectors and domains over which they apply.

Previous studies provide guidance on which inventories need to be considered in international contribution analysis. The majority of studies have focused on ozone because of its long-range transport capability (Zhang, et al., 2011; Emery, et al., 2012). Estimating international contribution continues to evolve and applications should review all emission sectors and consider the appropriate divisions between natural, international anthropogenic, and domestic anthropogenic sources.

When the emissions inventory coverages cross scales (global to regional), the emissions should be consistent between the two scales and the sensitivity (zero-out) or source apportionment should also be consistent between the two scales. Emissions that cross scales include aircraft and international shipping. These inventories require special consideration if they are used in estimating international contributions. The assignment of domestic versus foreign emissions depends on the jurisdiction of the waters and/or air space. Where the assignment is unclear, the appropriate EPA Regional office should be consulted. For brute force modeling, the "boundary conditions" for the regional perturbation simulation would be provided by a consistent perturbation in the global model.

Model contributions will vary, and a range of estimates should be considered and discussed to provide context. Particularly for sensitivity modeling, the sequential order of emission perturbations influences the result (zeroing the international source or the local source give different answers). Thus, two estimates of international source contribution can be developed and used to characterize a range of possible results. This is particularly important for haze that is strongly influenced by secondary organic aerosol and/or nitrate. For example, nitrate concentrations can increase when removing international sulfate due to chemical displacement. Estimates of all species should be characterized and the realism of the estimate considered before simply adding to natural conditions.

Because the adjustment factor will be added to the endpoint of the URP and ultimately used to calculate an adjusted URP for comparison with the RPG, it is important that the modeling be consistent across the URP framework (e.g., the same or similar model, domain, meteorology, and emissions should be used in both the RPG modeling and in the modeling used to adjust the endpoint).

3.4 EPA Review of an International URP Adjustment

EPA's approval for a URP adjustment will be part of EPA's review of the full SIP submission for the second implementation period, and not a separate action in advance of SIP submission. In this way, EPA's decision to approve or not approve the adjustment will be made in the context of the complete SIP submission, with public notice and an opportunity to comment. States are encouraged to consult with their EPA Regional office during the development of any proposed adjustment approach. Any proposed adjustment must be adequately documented to allow public comment and EPA review. An adequate explanation of the adjustment will necessarily show the unadjusted and adjusted values for the 2064 endpoint and for the URP.

Whether and what adjustment should be made to the URP to account for impacts from international anthropogenic emissions will be a new issue for the SIP for each implementation period. EPA's approval of an adjustment approach included in the SIP revision due in 2021 does not mean that the same adjustment will be automatically approved if included in the SIP revision due in 2028, for example.

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APPENDIX A.

Site	First Implementation Period Approach			Recommended Approach			e3 (Mm[-1])	
	Baseline Visibility Condition for 20% Haziest Days (2000-2004)	Current Visibility Condition for Most Impaired Days (2012-2016)	NC-II P90 (2064)	Baseline Visibility Condition for 20% Most Impaired Days (2000-2004)	Current Visibility Condition for 20% Most Impaired Days (2012-2016)	Derived-NC (2064)	carbon	dust
ACAD1	23.21	16.50	12.43	22.01	15.28	10.39	10.44	3.11
AGTI1	23.50	17.65	7.64	21.62	16.73	7.63	10.85	8.86
BADL1	17.14	14.71	8.06	14.98	12.56	6.09	9.17	7.49
BALD1	11.51	10.19	6.24	8.64	7.55	4.04	6.65	5.42
BAND1	12.23	10.71	6.26	9.70	8.88	4.59	5.60	4.36
BIBE1	17.30	15.29	7.16	15.57	14.25	5.33	7.60	8.59
BLIS1	12.63	12.64	6.05	10.06	9.39	4.91	11.14	2.84
BOAP1	13.80	14.06	6.73	11.61	10.98	5.36	9.38	7.83
BOWA1	19.99	16.51	11.61	18.94	14.58	9.11	11.11	3.16
BRCA1	11.65	9.29	6.80	8.42	6.88	4.08	6.13	4.26
BRID1	11.12	10.84	6.45	7.96	6.58	3.90	7.75	2.83
BRIG1	29.01	21.62	12.24	27.43	20.44	10.69	20.15	9.07
BRIS1[a]		21.29	11.93		19.67	9.28	18.10	9.12
CABI1	14.09	14.27	7.52	10.73	9.97	5.65	13.14	4.13
CACR1	26.36	20.68	11.58	23.99	19.22	9.47	16.84	7.80
CANY1	11.25	9.91	6.43	8.79	7.36	4.11	5.53	5.02
CAPI1	9.97	9.97	6.03	8.62	7.27	4.13	5.07	5.14
CHAS1	26.10	19.96	11.03	24.62	18.12	8.97	24.69	6.68
CHIR1	13.43	11.94	7.20	10.50	9.78	4.93	4.81	7.87
COHU1	30.30	20.15	10.78	28.83	18.59	9.52	18.17	4.44
CRLA1	13.74	12.96	7.62	9.36	8.64	5.22	8.67	2.37
CRMO1	14.00	14.08	7.53	11.91	9.28	4.97	7.26	4.72
DENA1	9.86	9.25	7.31	7.06	6.97	4.79	3.58	1.60
DOME1	19.43	17.95	7.46	17.20	15.42	6.18	14.13	11.58
DOSO1	29.05	19.96	10.39	28.29	18.88	8.92	13.57	3.40
EVER1	22.31	18.06	12.15	19.54	15.33	8.34	10.00	7.90
GAMO1	11.29	10.97	6.38	8.95	7.50	4.66	10.17	3.03
GICL1	13.11	11.11	6.66	8.93	8.02	4.22	5.73	4.40
GLAC1	20.47	16.91	9.18	16.19	13.69	6.99	22.24	7.50
GRCA2	11.66	9.56	7.04	7.94	6.95	4.18	5.97	4.74
GRGU1	22.82	15.20	11.99	21.93	13.92	9.78	12.07	3.23
GRSA1	12.78	10.63	6.66	9.66	8.28	4.45	8.01	6.69
GRSM1	30.28	19.66	11.24	29.16	18.42	10.05	16.09	4.48
GUMO1	17.19	14.93	6.65	14.60	12.86	4.83	6.25	12.95
HACR1[b]	13.33	9.16	7.43	12.67	8.37	4.78	1.24	2.01
HAVO1	18.86	19.01	7.17	18.66	18.82	5.64	1.65	1.93
HECA1	18.55	17.17	8.32	16.51	13.09	6.57	13.88	5.00
HEGL1	26.75	20.73	11.30	25.17	19.32	9.30	20.30	6.84
HOOV1	12.87	11.84	7.71	8.97	7.91	4.91	8.92	4.00
IKBA1	13.35	11.80	6.68	11.19	9.52	5.22	6.78	6.14
ISLE1	20.74	17.46	12.37	19.53	16.03	10.15	12.05	4.22
JARB1	12.07	12.85	7.87	8.73	7.82	5.23	7.45	8.00
JARI1	29.12	20.18	11.13	28.08	18.70	9.48	26.27	3.13
JOSH1	19.62	14.97	7.19	17.74	13.15	6.09	7.82	9.81
KAIS1	14.75	15.45	7.12	12.67	11.45	5.98	11.16	5.19
KALM1	15.51	14.40	9.44	13.35	12.12	7.80	12.46	2.43
KPBO1[c]	14.11	12.94	11.31	10.47	10.48	6.96	3.39	2.32
LABE1	15.05	15.03	7.85	11.29	9.92	6.16	10.38	3.81
LAVO1	14.15	12.69	7.31	11.50	9.97	6.14	12.36	2.59
LIGO1	28.77	19.15	11.22	28.05	17.36	9.70	18.22	2.83
LOST1	19.57	18.37	8.00	18.27	15.89	5.88	10.17	9.28
LYEB1[d]	24.45	17.11	11.73	23.57	16.07	10.23	11.44	2.75
MACA1	31.37	23.04	11.08	29.83	22.03	9.79	19.44	4.28
MELA1	17.72	17.75	7.89	16.63	15.50	5.95	9.14	9.09
MEVE1	13.03	9.88	6.81	9.22	7.03	4.20	5.05	5.33
MING1	29.54	22.34	11.62	26.65	20.70	9.28	28.55	10.81
MOHO1	14.86	13.14	8.43	12.10	9.74	6.60	7.75	2.74
MONT1	14.48	15.15	7.73	10.84	9.61	5.43	14.92	4.89
MOOS1	21.72	15.64	12.01	20.66	14.07	9.97	11.13	2.54

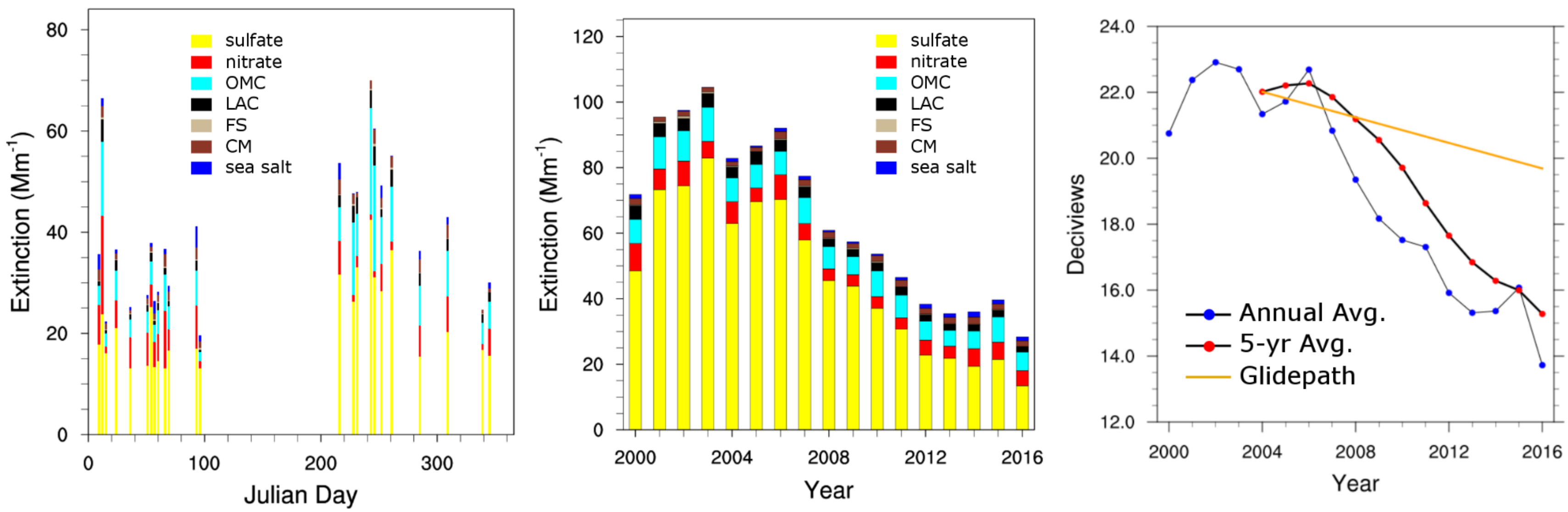
Site	First Implementation Period Approach			Recommended Approach			e3 (Mm^{-1})	
	Baseline Visibility Condition for 20% Haziest Days (2000-2004)	Current Visibility Condition for Most Impaired Days (2012-2016)	NC-II P90 (2064)	Baseline Visibility Condition for 20% Most Impaired Days (2000-2004)	Current Visibility Condition for 20% Most Impaired Days (2012-2016)	Derived-NC (2064)	carbon	dust
MORA1	18.25	14.93	8.54	16.53	13.35	7.66	13.33	2.53
MOZI1	10.52	9.16	6.08	7.29	5.63	3.16	5.70	3.23
NOAB1	11.46	11.30	6.83	8.78	7.17	4.54	10.18	4.23
NOCA1	13.96	12.65	8.39	12.57	10.42	6.79	8.20	1.97
OKEF1	27.13	20.47	11.44	25.34	18.73	9.47	20.65	5.50
OLYM1	16.74	13.38	8.44	14.93	12.24	6.88	8.78	1.76
PASA1	15.23	13.94	8.25	10.41	9.17	5.97	9.42	2.58
PEFO1	13.21	10.73	6.49	9.82	8.49	4.21	6.75	7.84
PINN1	18.46	16.03	7.99	17.02	14.35	6.96	11.33	5.88
PORE1	22.81	19.98	15.77	19.38	15.94	9.75	6.78	8.23
RAFA1	18.86	16.08	7.57	17.00	14.14	6.85	7.65	8.20
REDW1	18.45	17.88	13.91	13.64	12.70	8.54	5.86	4.44
ROMA1	26.48	20.21	12.12	25.25	18.32	9.79	23.38	5.35
ROMO1	13.83	11.54	7.15	11.12	8.66	4.93	8.54	5.32
SACR1	18.03	17.33	6.81	16.54	15.36	5.50	9.01	14.44
SAGA1	19.94	14.83	6.99	17.89	13.63	6.12	8.49	7.11
SAGO1	22.17	15.98	7.30	20.43	14.80	6.19	11.94	7.77
SAGU1	14.83	12.69	6.46	12.64	10.96	5.16	6.15	9.62
SAMA1	26.03	20.64	11.67	24.30	18.17	9.19	21.26	5.22
SAPE1	10.17	9.13	5.72	7.66	6.66	3.36	5.66	4.53
SAWT1	13.78	17.12	6.42	9.62	8.52	4.67	12.35	2.57
SENE1	24.16	19.20	12.65	23.62	18.41	11.11	13.67	2.52
SEQU1	24.62	21.10	7.70	23.23	19.20	6.29	23.11	11.47
SHEN1	29.31	19.71	11.35	28.32	18.40	9.52	15.06	3.92
SHRO1	27.89	18.65	11.47	27.32	16.87	10.01	13.99	3.09
SIAN1	13.67		6.59	10.76		5.14	6.77	5.91
SIME1	18.56	16.97	15.60	13.67	13.69	8.49	3.42	4.63
SIPS1	29.03	20.95	10.99	27.71	19.77	9.55	21.66	4.79
SNPA1	17.84	15.54	8.43	15.37	13.07	7.25	12.33	1.79
STAR1	18.57	14.54	8.92	14.53	11.53	6.59	13.10	5.66
SULA1	13.41	15.55	7.43	10.06	8.53	5.48	11.78	3.22
SWAN1	25.49	19.06	11.55	24.40	17.44	9.79	16.47	5.01
SYCA2[e]	15.26	14.59	6.65	12.16	11.45	4.68	13.12	15.93
THRO1	17.74	15.97	7.80	16.35	13.70	5.96	9.87	8.71
THSI1	15.34	15.28	8.79	12.80	11.48	7.30	12.62	4.01
TONT1	13.94	12.47	6.54	11.34	10.63	5.06	7.14	8.76
TRCR1	11.61	10.03	8.40	9.16	8.85	6.38	5.11	2.38
TRIN1	16.32	16.02	7.90	11.97	10.45	6.24	10.36	3.61
ULBE1	15.14	14.31	8.16	12.76	10.79	5.87	9.82	6.17
UPBU1	26.27	20.57	11.57	24.25	18.85	9.43	17.22	7.72
VIIS1	17.02	18.49	10.68	14.29	15.60	8.53	2.60	21.54
VOYA2	19.27	17.08	12.06	17.75	15.04	9.38	11.48	4.14
WEMI1	10.33	9.17	6.21	7.81	6.74	3.98	6.51	3.93
WHIT1	13.70	13.21	6.80	11.31	10.41	4.89	7.16	7.13
WHPA1	12.76	12.02	8.35	10.48	8.51	6.15	6.89	2.41
WHPE1	10.41	9.11	6.08	7.35	7.02	3.53	5.13	3.50
WHRI1	9.61	7.93	6.06	6.30	5.18	3.02	4.92	3.56
WICA1	15.84	13.55	7.71	13.09	10.63	5.64	8.02	4.62
WIMO1	23.81	19.53	7.53	22.15	18.79	6.92	13.95	9.94
YELL2	11.76	12.26	6.44	8.30	7.65	3.98	10.08	3.06
YOSE1	17.63	15.84	7.64	13.52	11.89	6.29	13.14	5.19
ZICA1[f]	12.97	10.32	6.70	10.72	8.66	5.08	5.54	6.90

[a]Site data combined with BRET1 starting 01-01-08
[b]Site data combined with HALE1 starting 01-01-08
[c]Site data combined with TUXE1 starting 01-01-15
[d]Site data combined with LYBR1 starting 01-01-12
[e]Site data combined with SYCA1 starting 01-01-16
[f]Site data combined with ZION1 starting 01-01-04

APPENDIX B

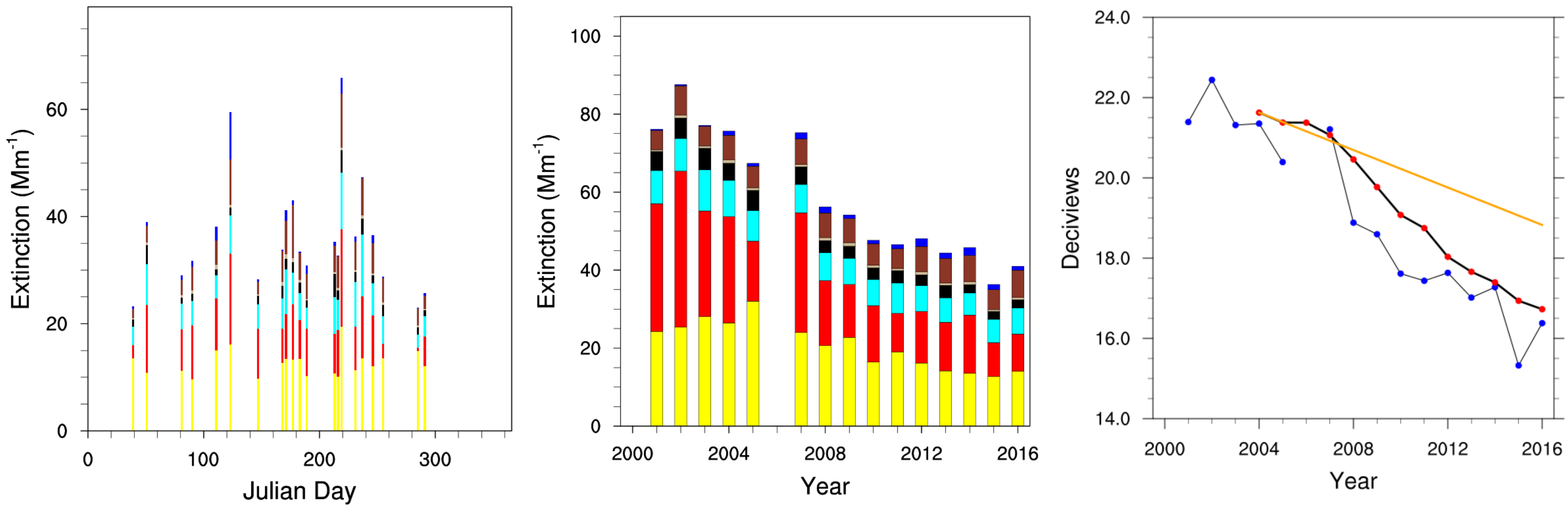
For each of the following sites, the left column gives the total extinction budget for days classified as the 20 percent most impaired in 2015 (or 2013 when noted), middle column gives the time series from 2000-2016 of the annual average total extinction budget for days classified as the 20 percent most impaired , and right column shows the visibility conditions on the 20 percent most impaired days from 2000 to 2016. For all extinction budget figures, the following color scale applies: sulfate (yellow), nitrate (red), OMC (teal), LAC (black), FS (tan), CM (brown), and sea salt (blue). For all visibility conditions 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 2064.[22]

Acadia National Park, ME

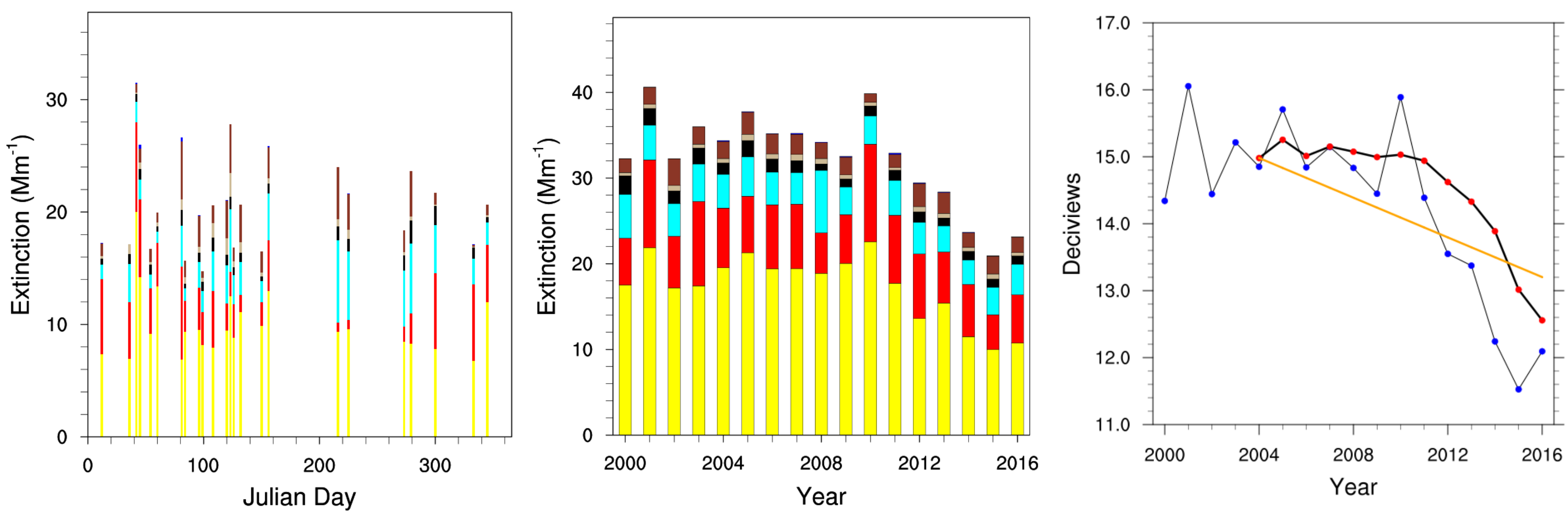


[22]Updated site-specific graphics summarizing visibility status and trends following the Regional Haze Rule metrics can be found at http://views.cira.colostate.edu/fed/SiteBrowser/Default.aspx?appkey=SBCF_VisSum.

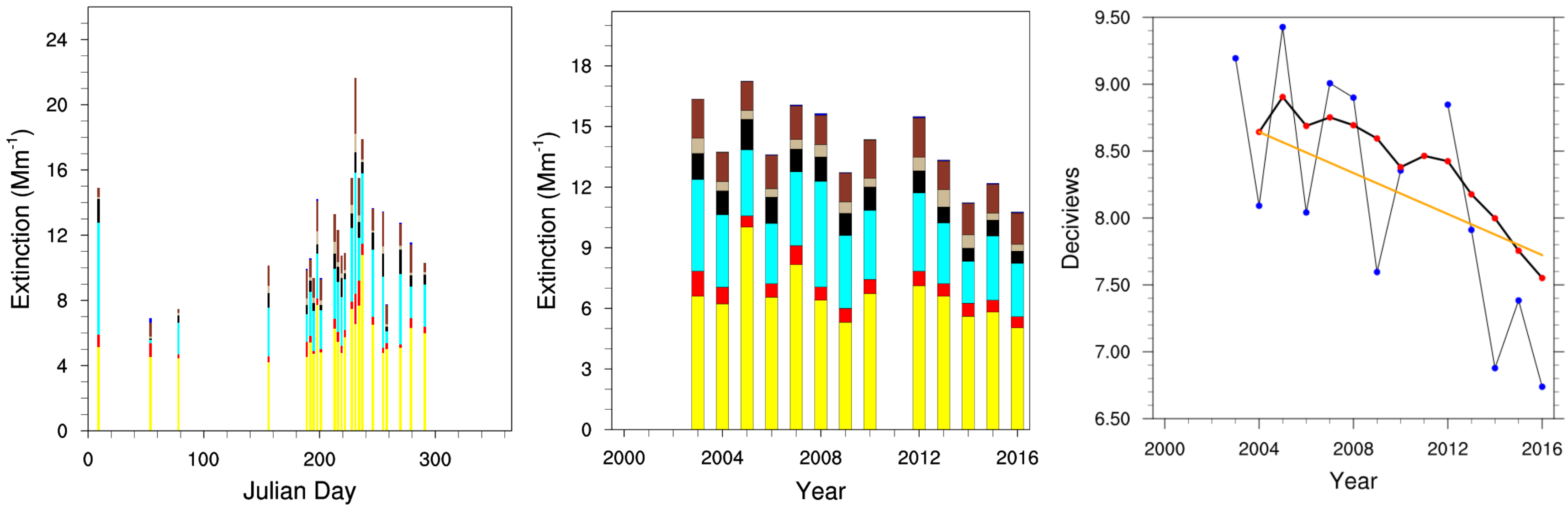
Agua Tibia, CA



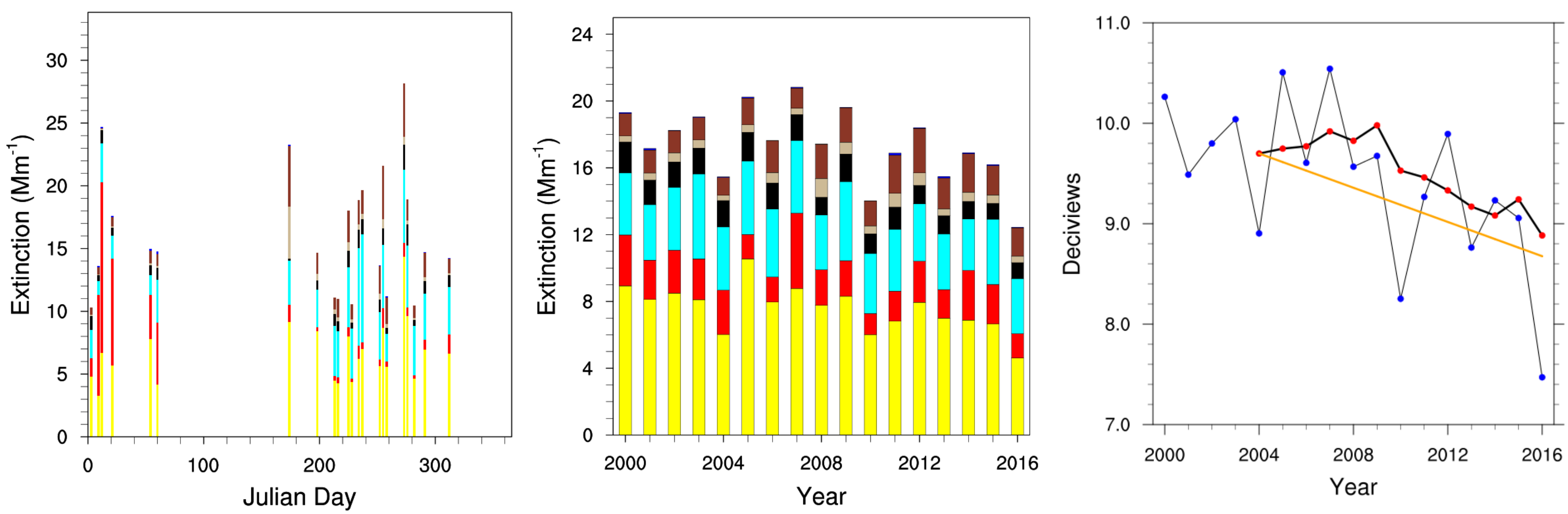
Badlands National Park, SD



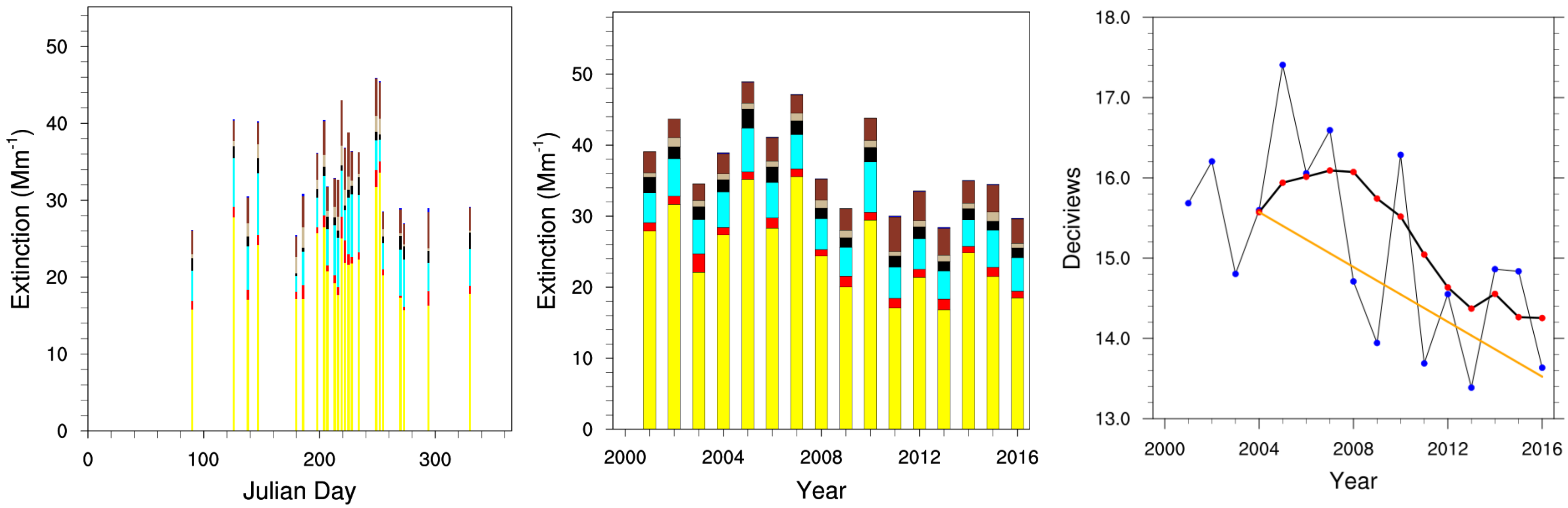
Mount Baldy, AZ



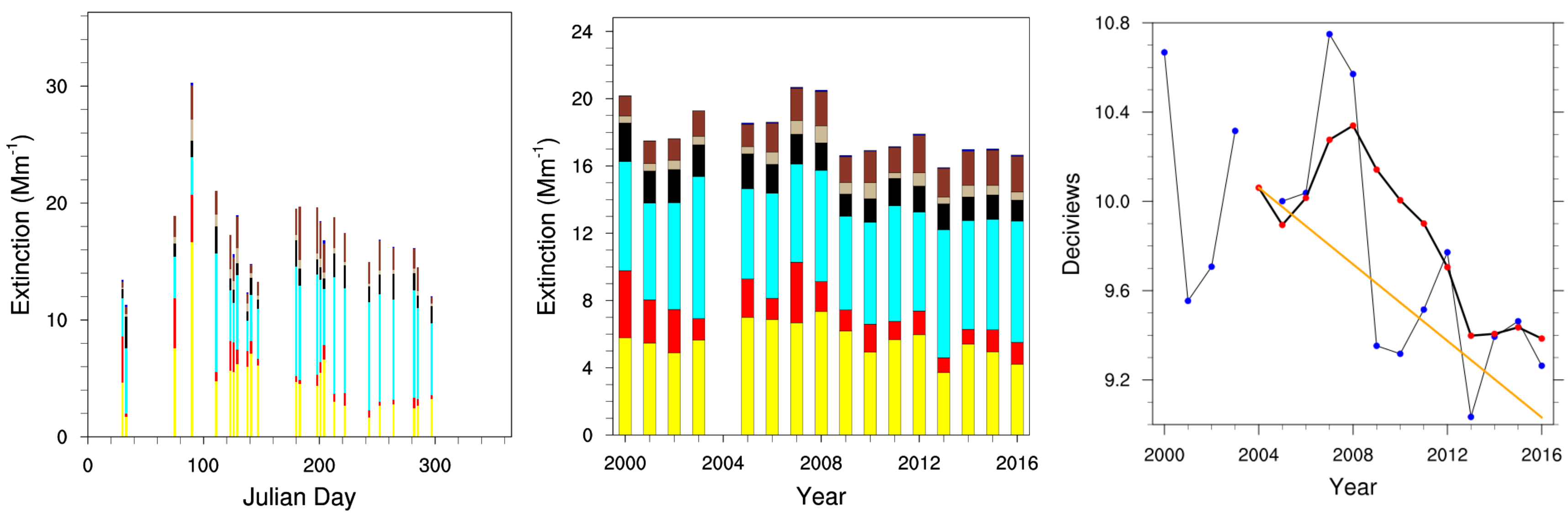
Bandelier National Monument, NM



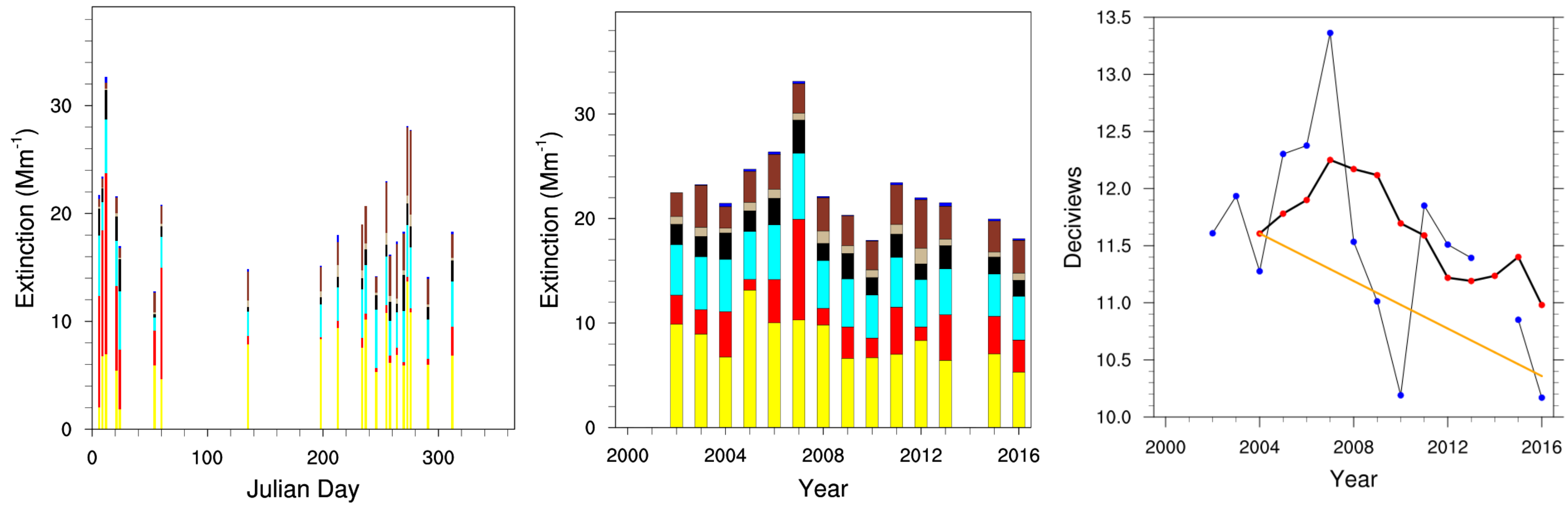
Big Bend National Park, TX



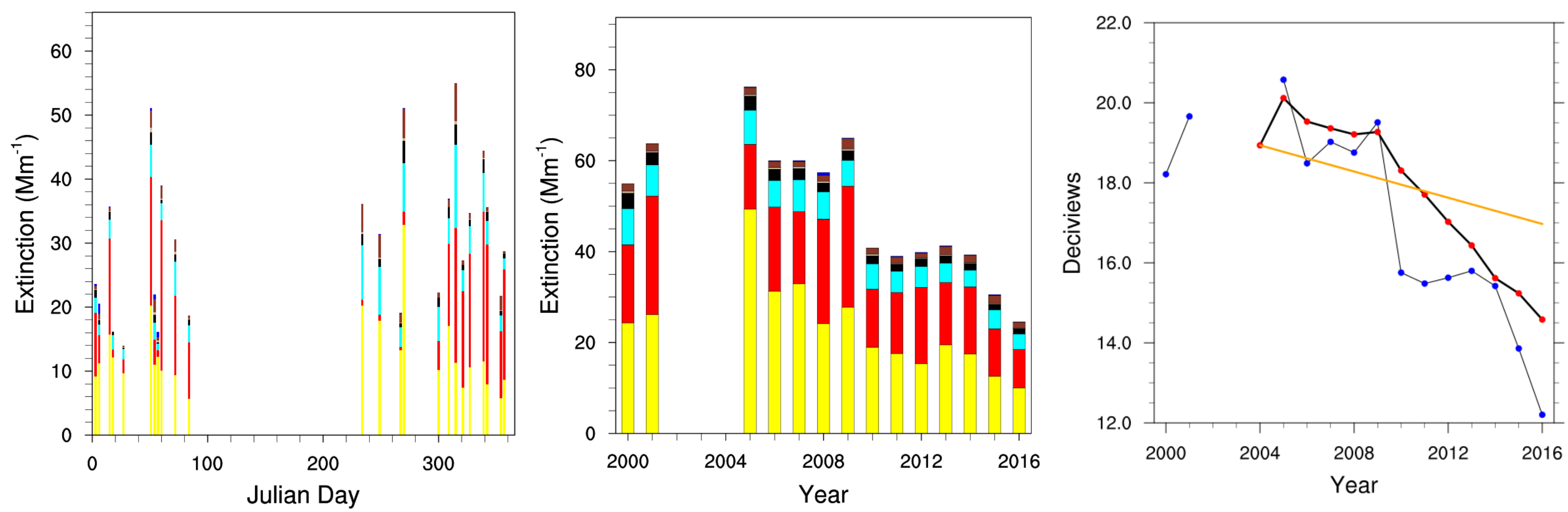
Bliss State Park, CA



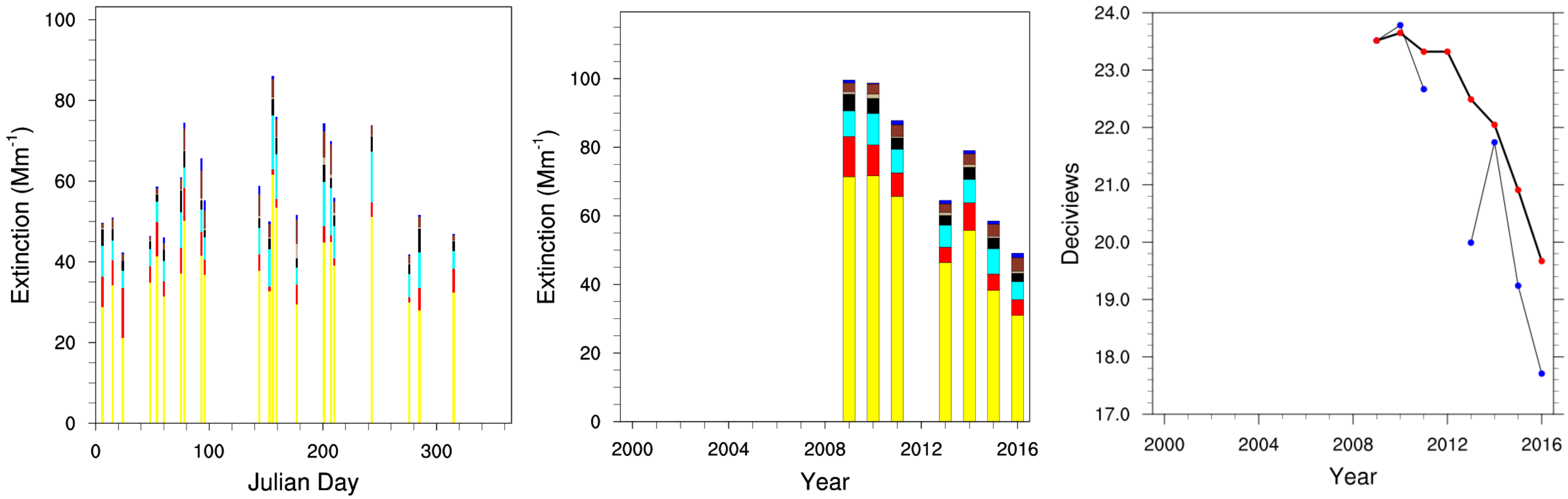
Bosque del Apache, NM



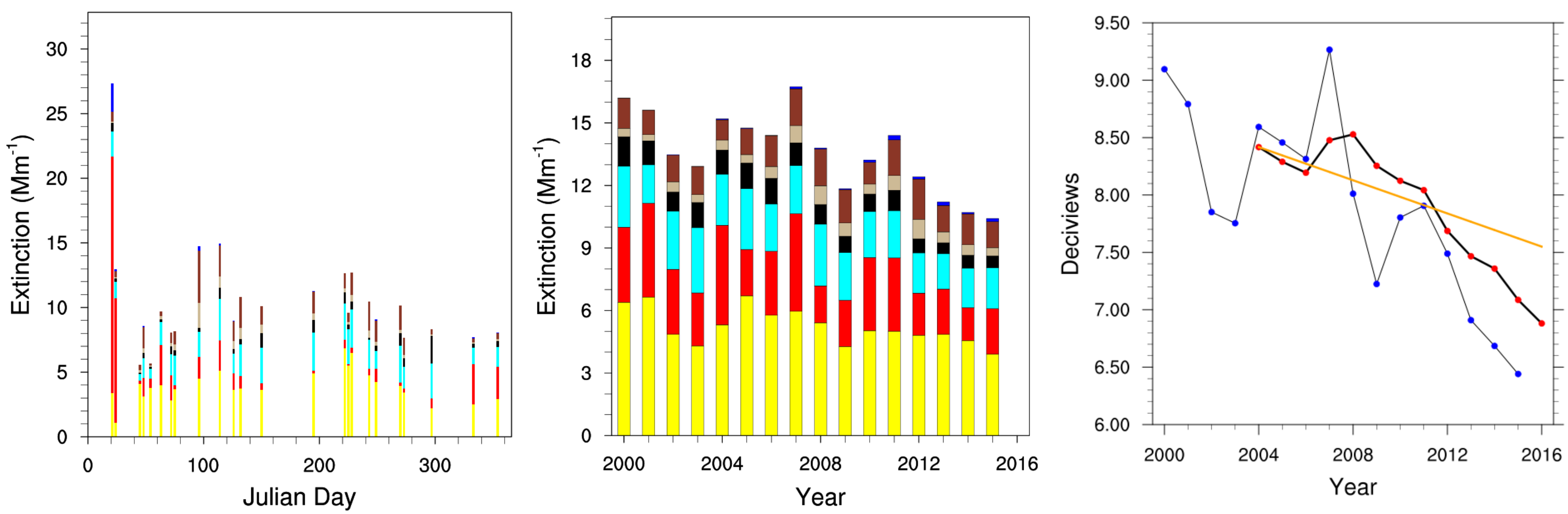
Boundary Waters Canoe Area, MN



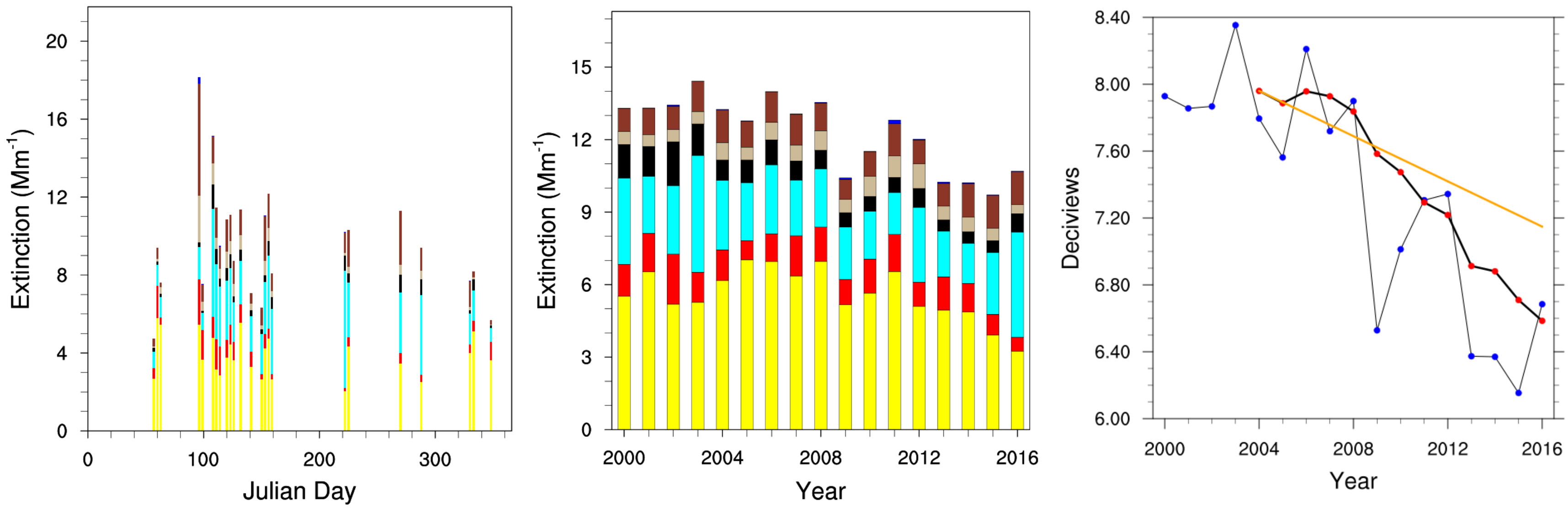
Breton Island, LA



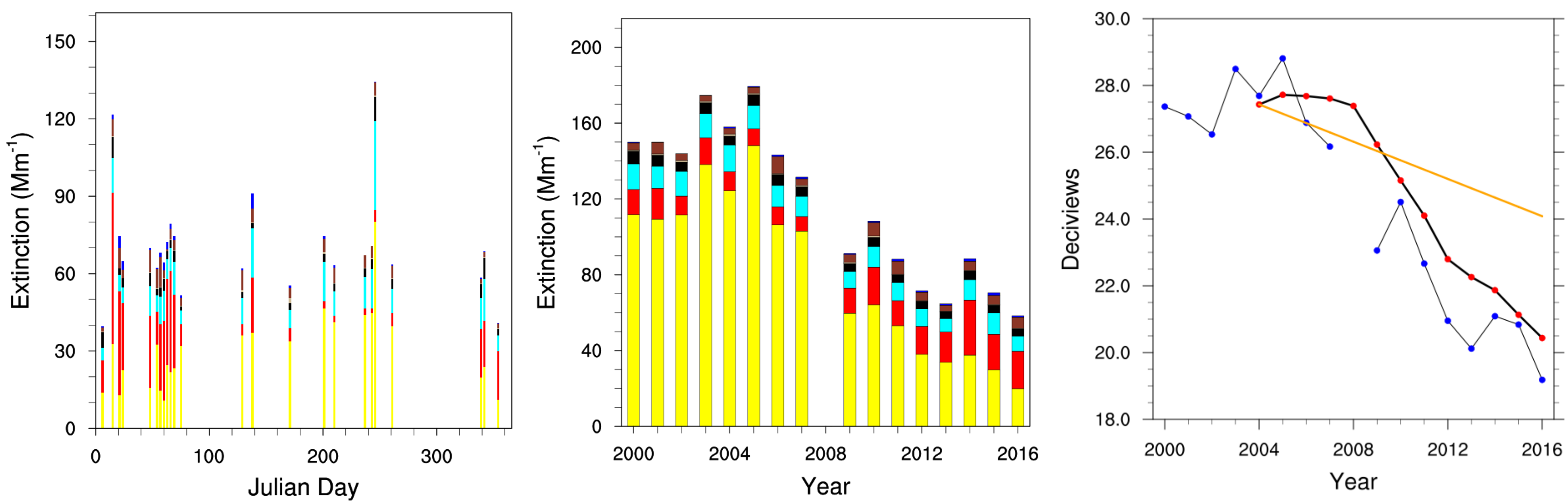
Bryce Canyon National Park, UT



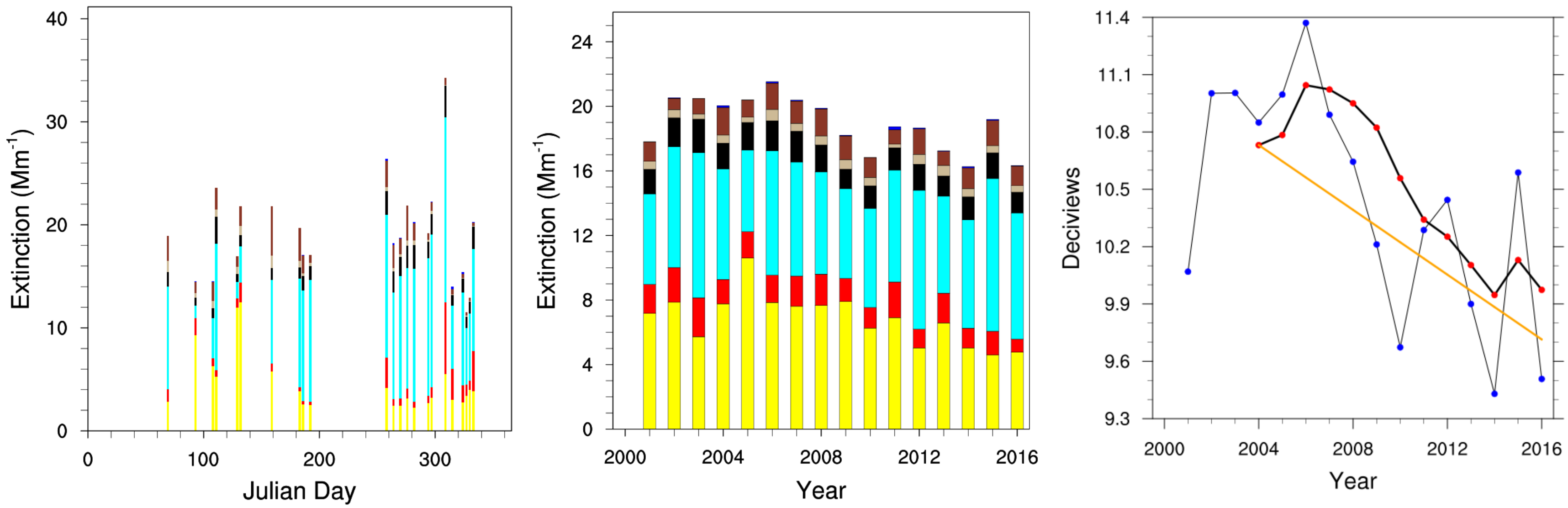
Bridger Wilderness, WY



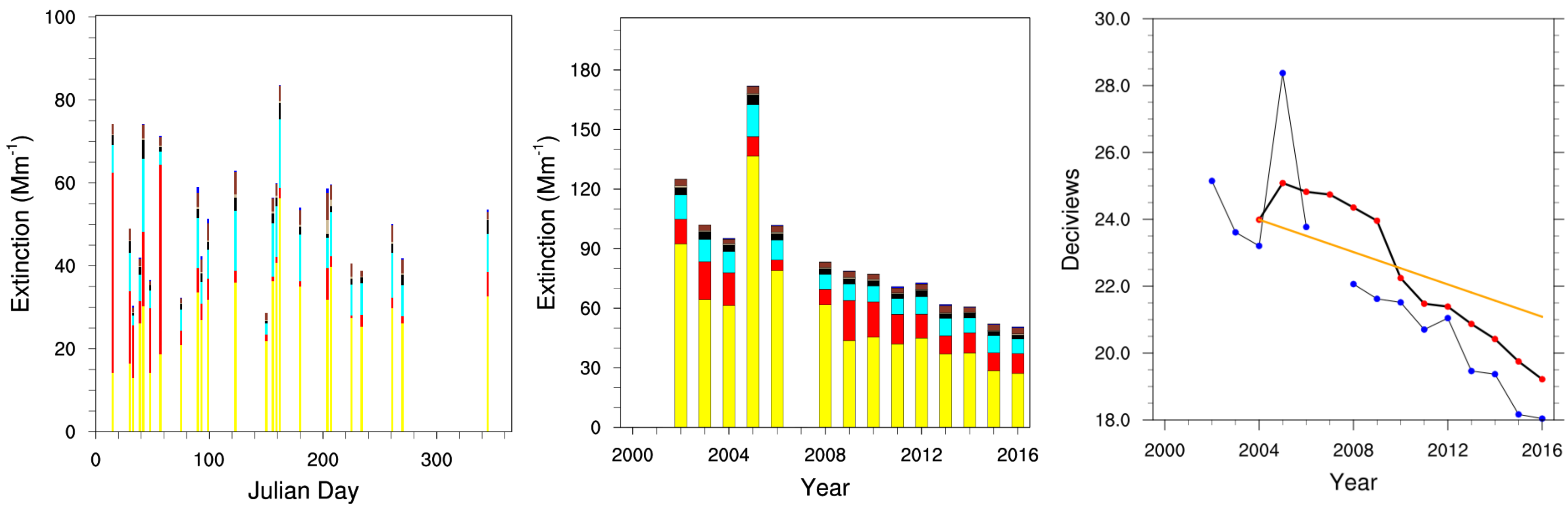
Brigantine National Wildlife Refuge, NJ



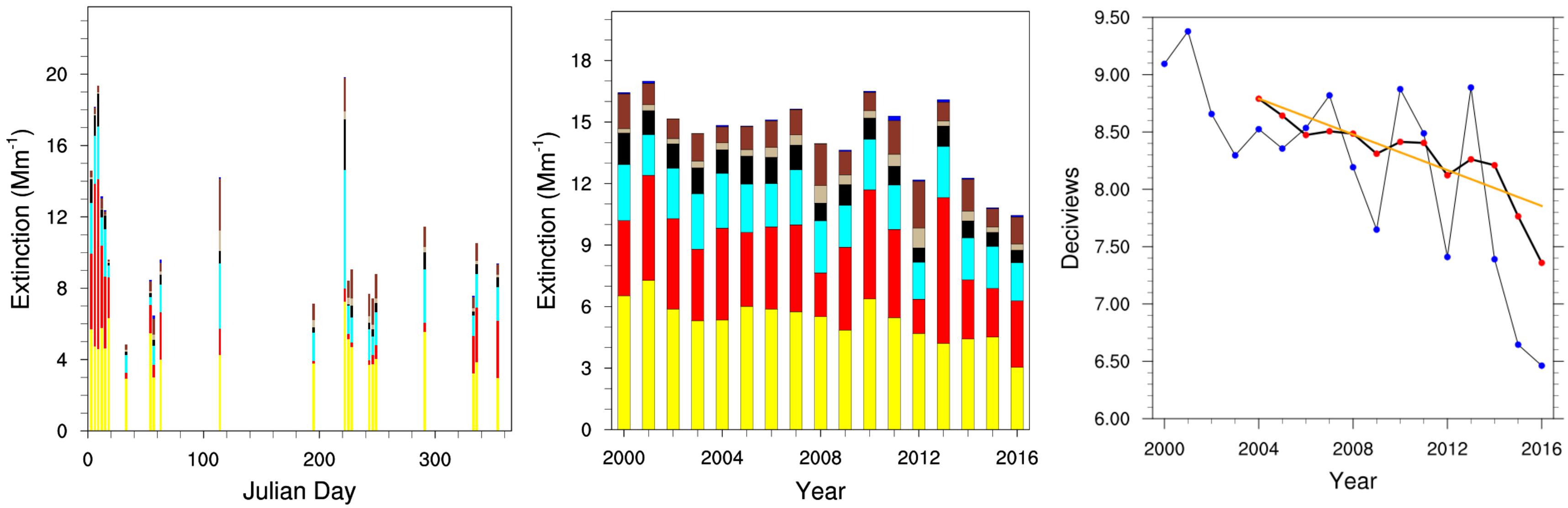
Cabinet Mountains, MT



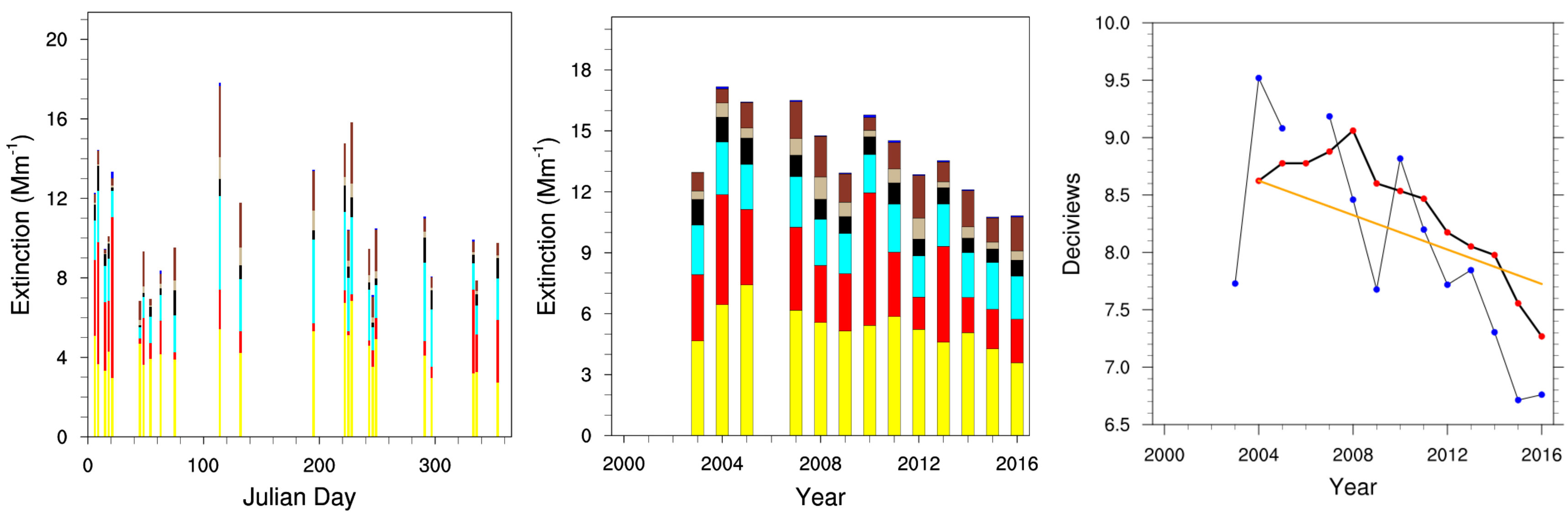
Caney Creek, AR



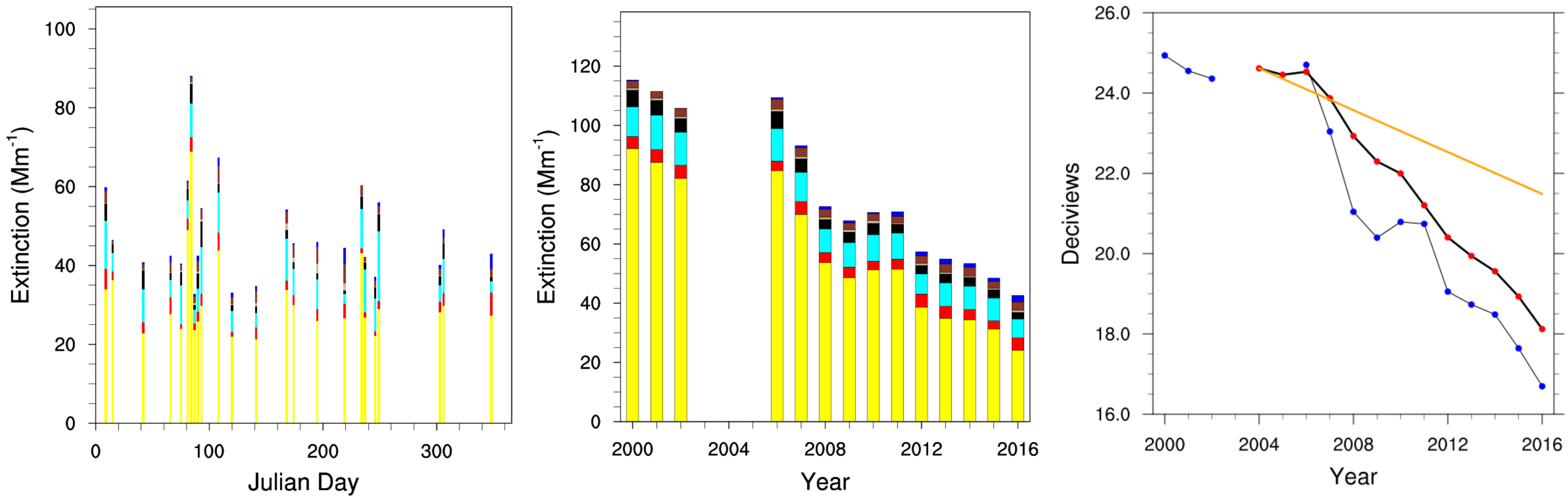
Canyonlands National Park, UT



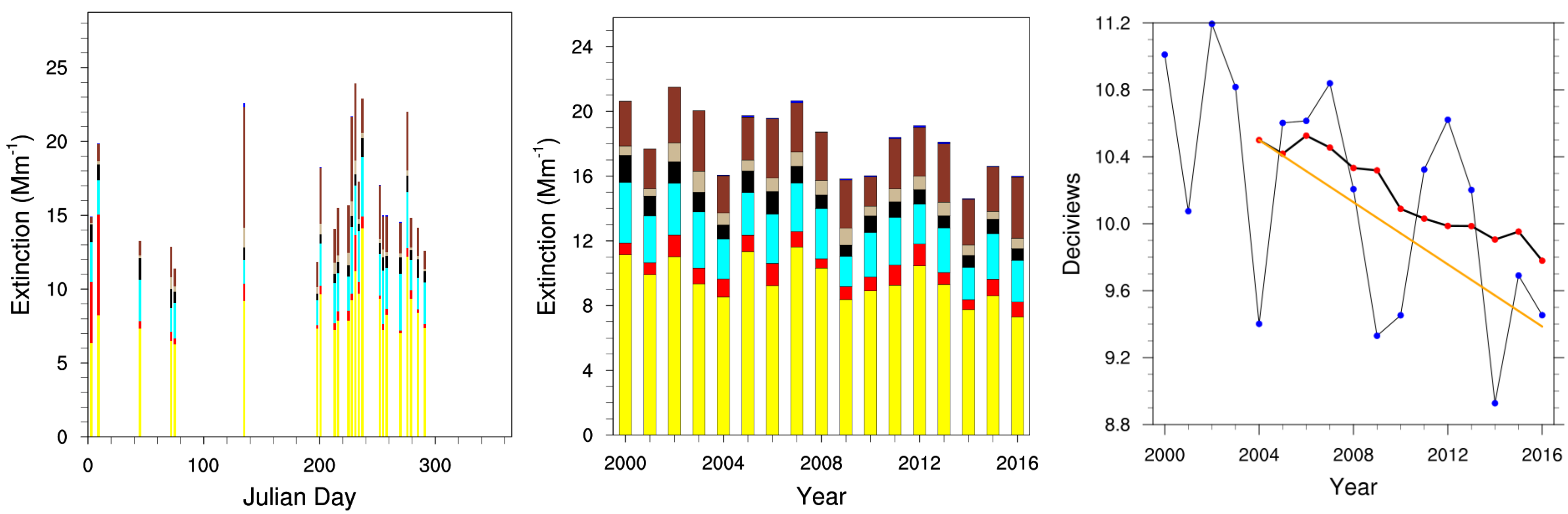
Capitol Reef National Park, UT



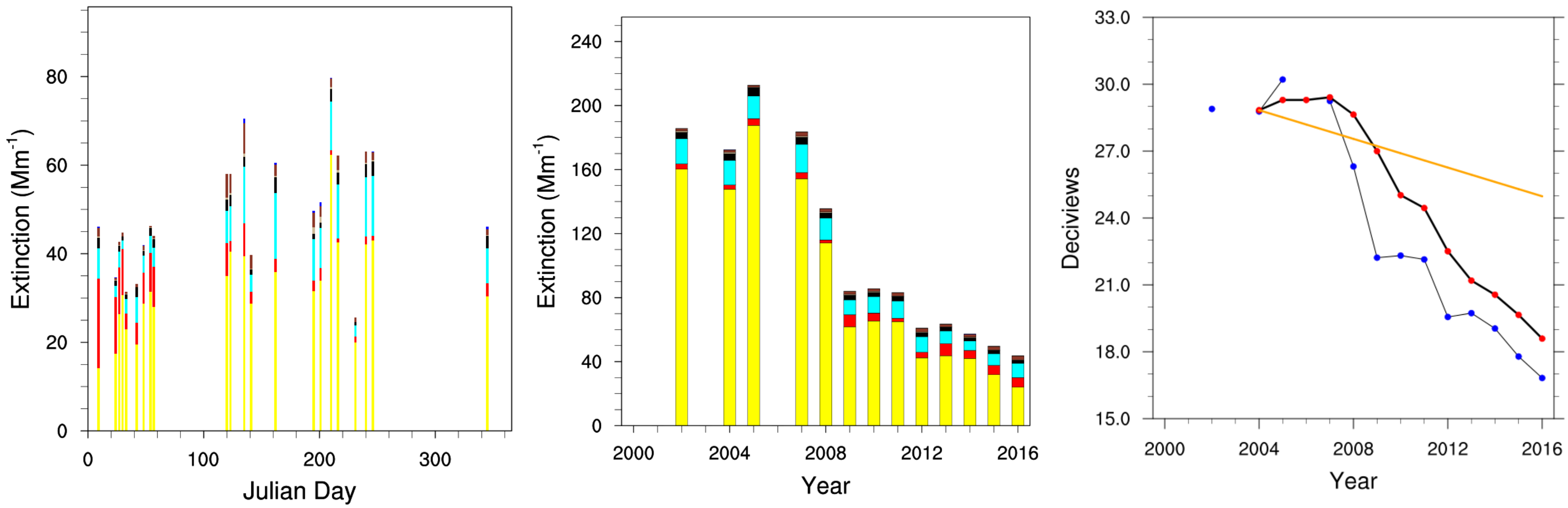
Chassahowitzka National Wildlife Refuge, FL



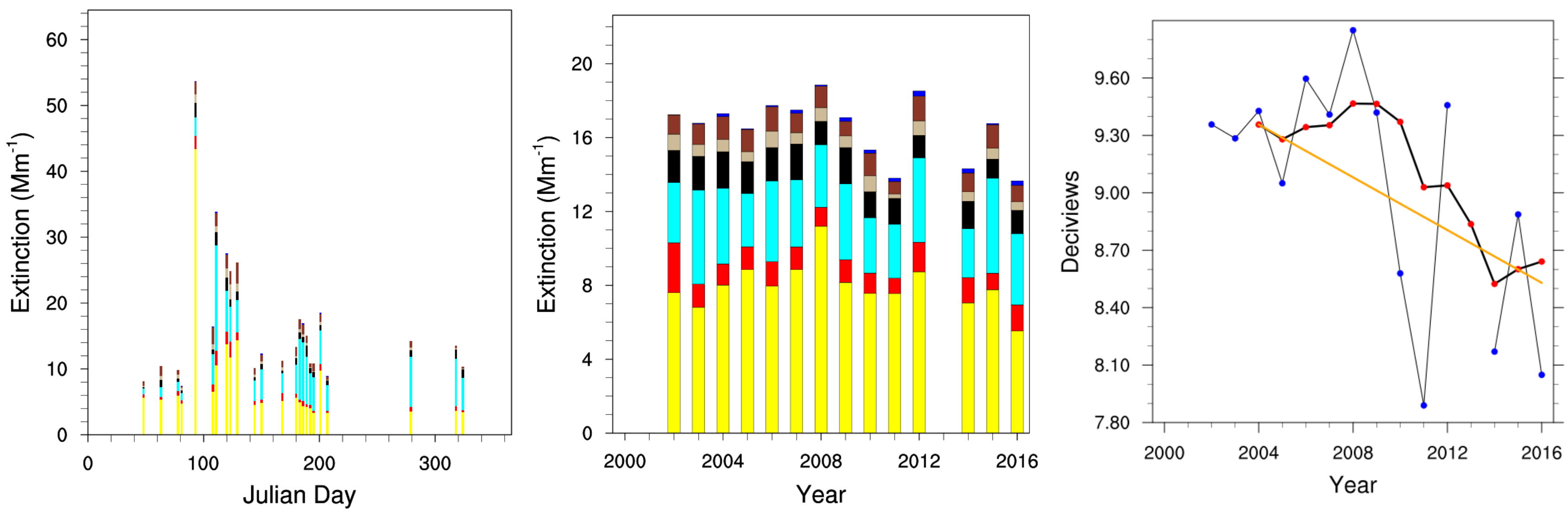
Chiricahua National Monument, AZ



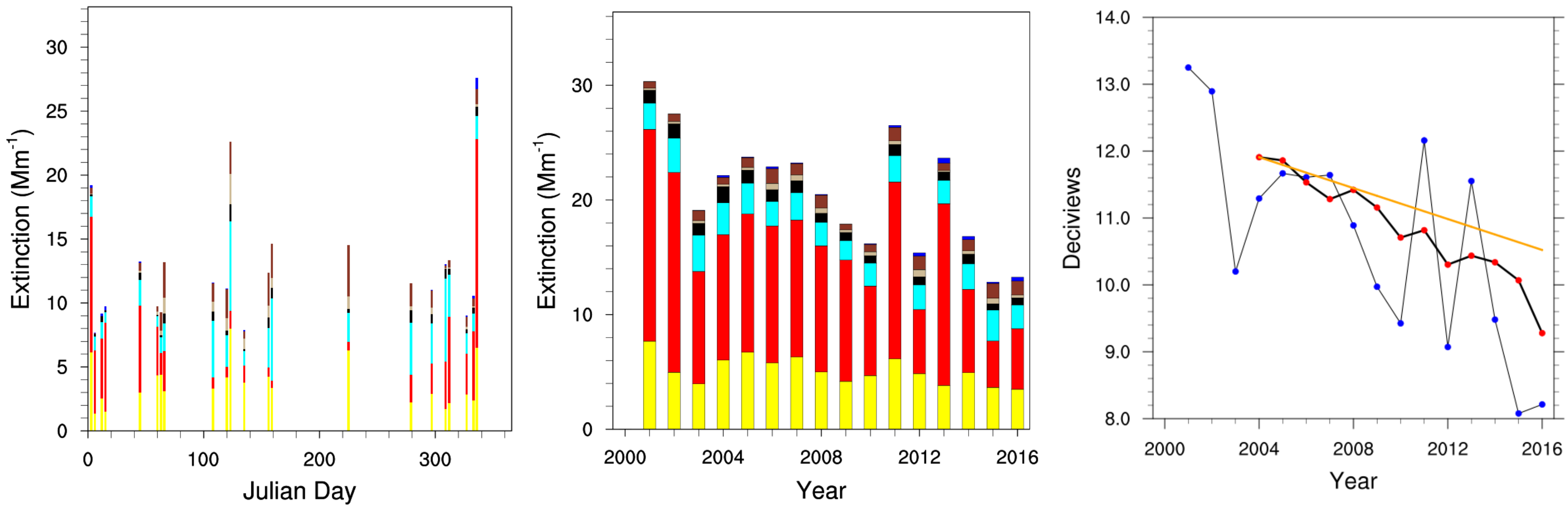
Cohutta, GA



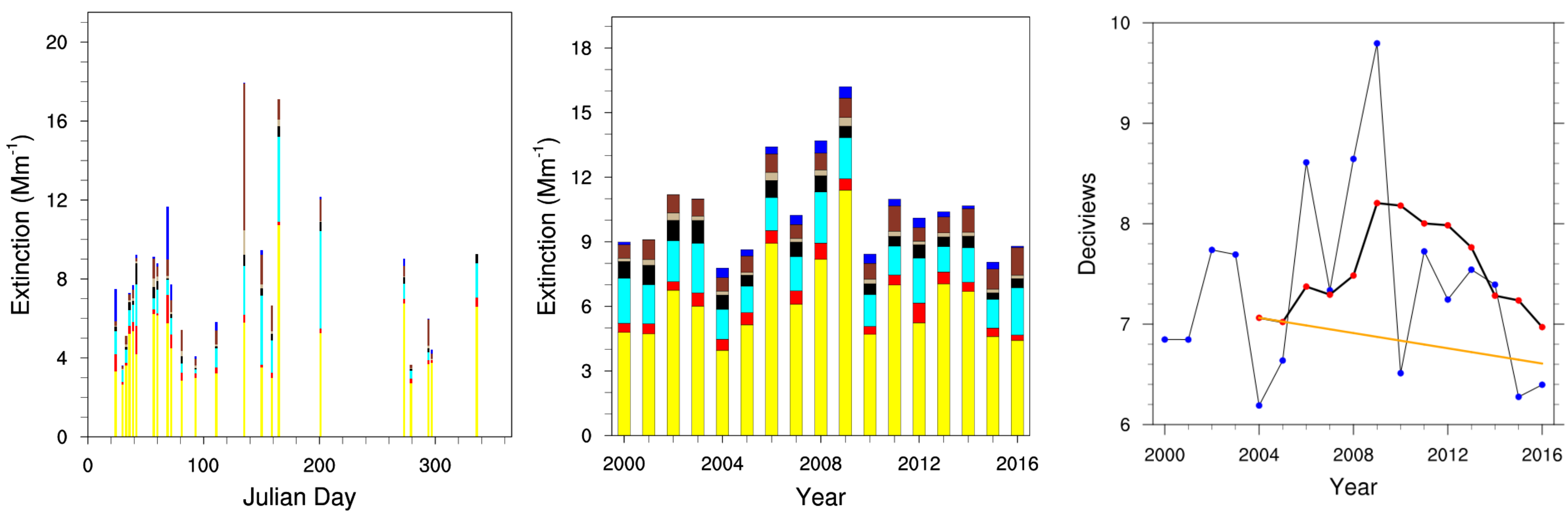
Crater Lake National Park, OR



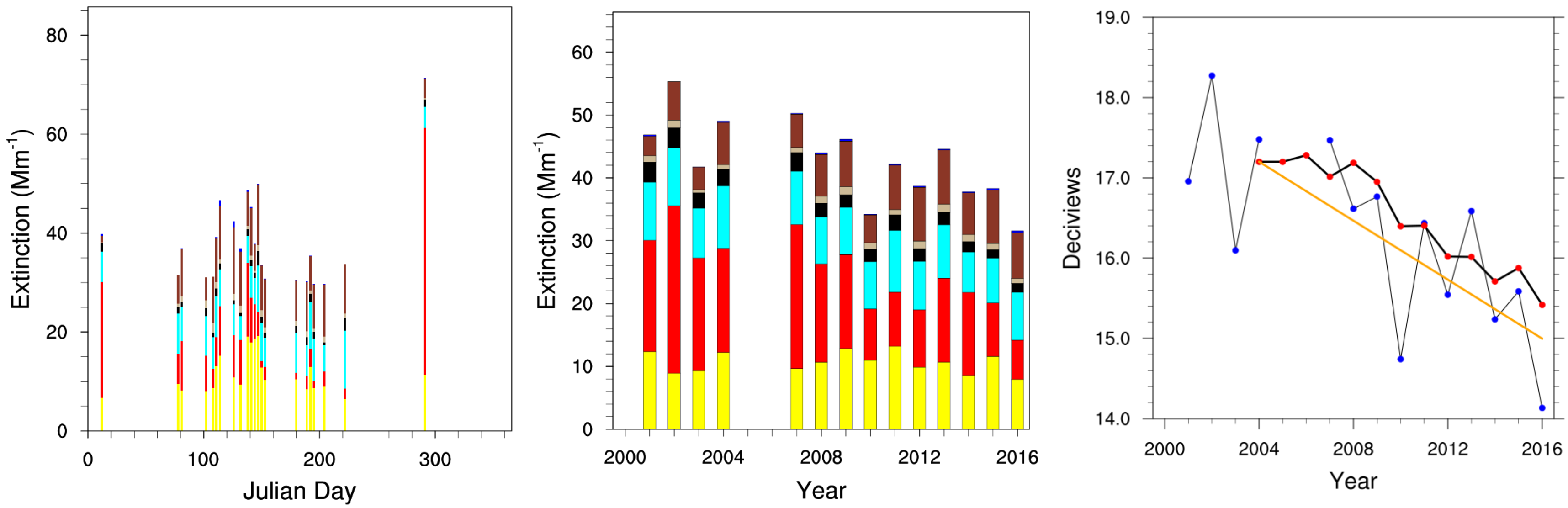
Craters of the Moon National Monument, ID



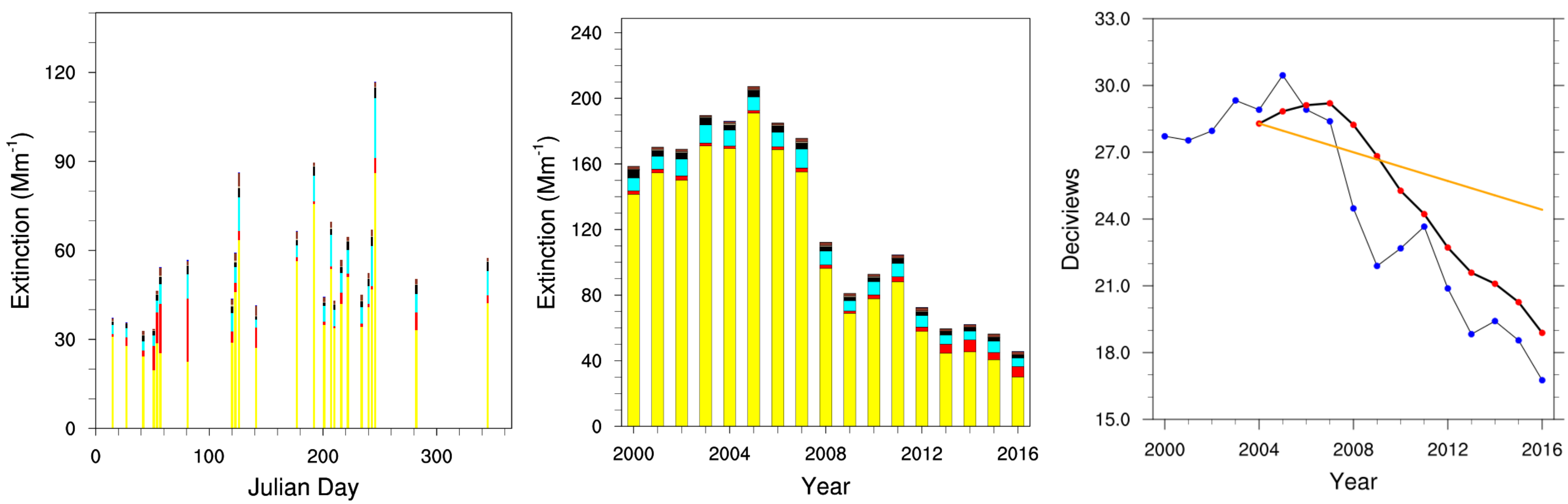
Denali National Park, AK



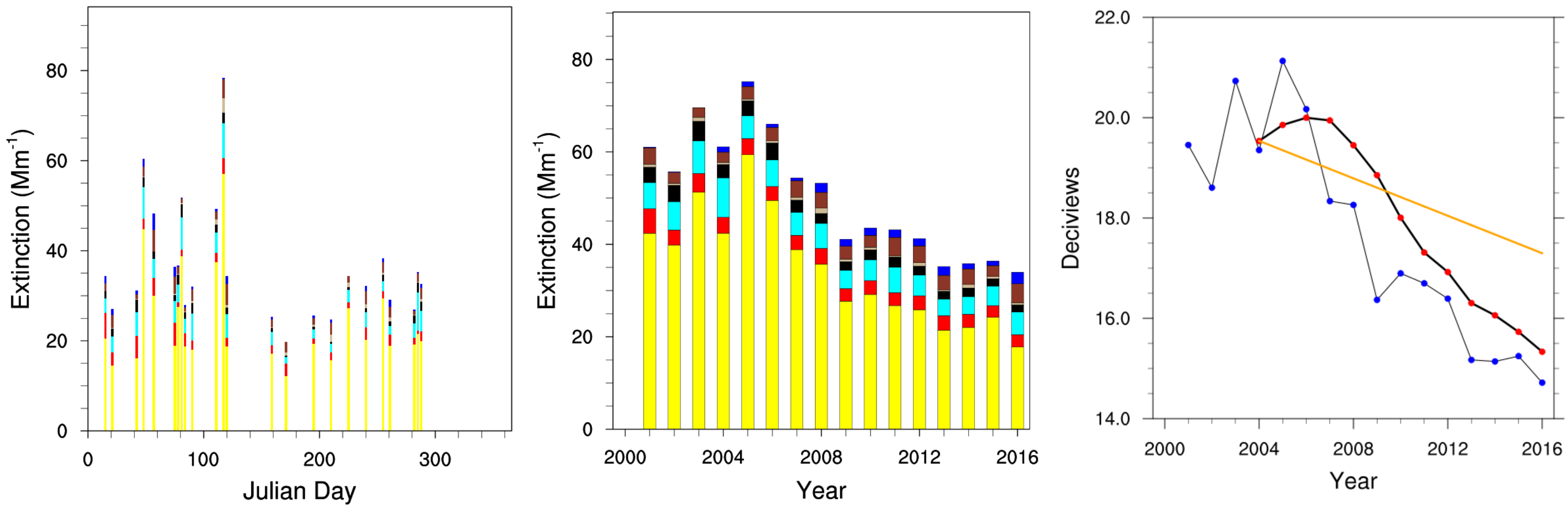
Dome Lands Wilderness, CA



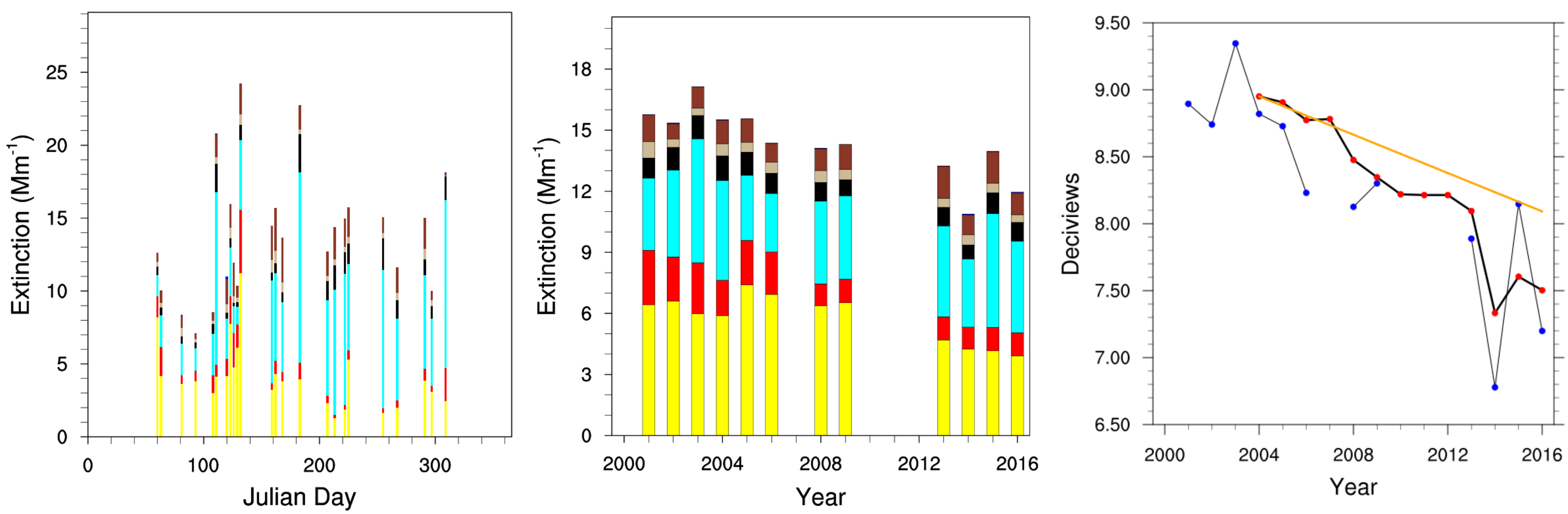
Dolly Sods Wilderness, WV



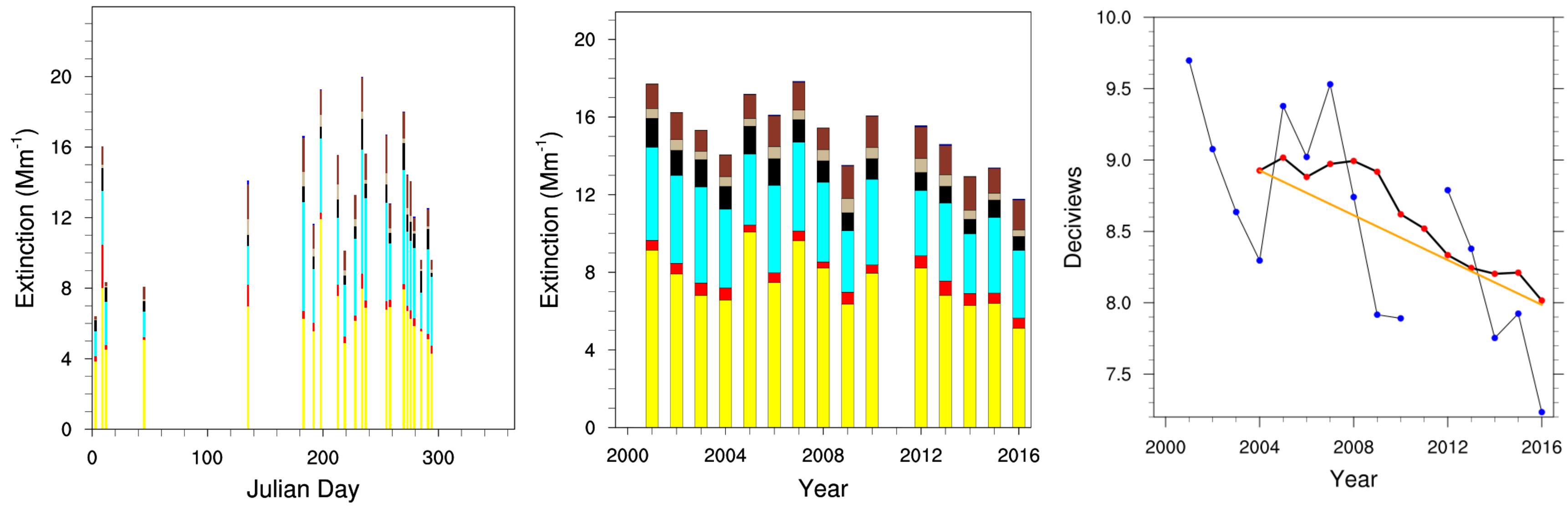
Everglades National Park, FL



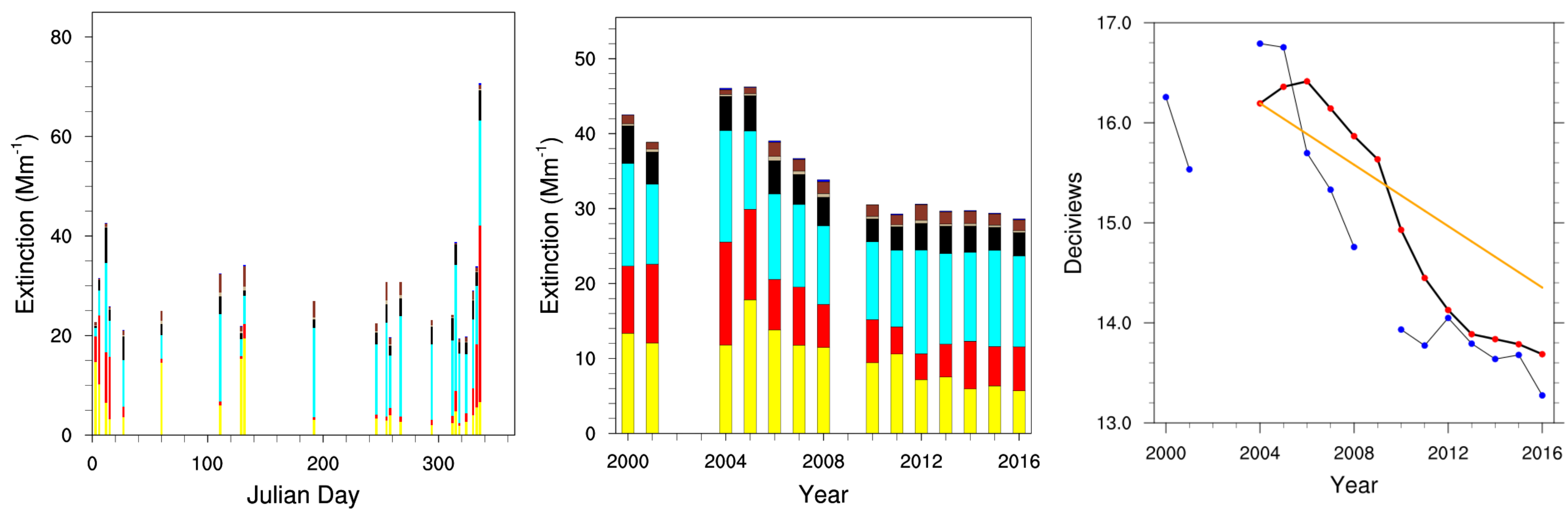
Gates of the Mountains, MT



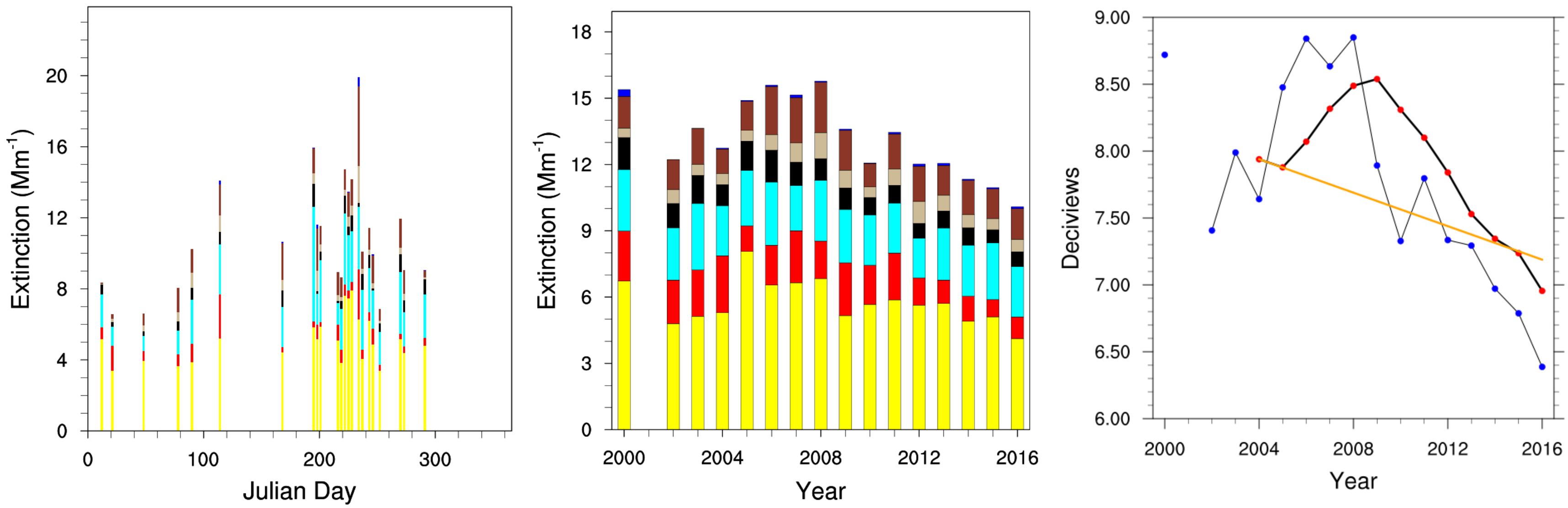
Gila Wilderness, NM



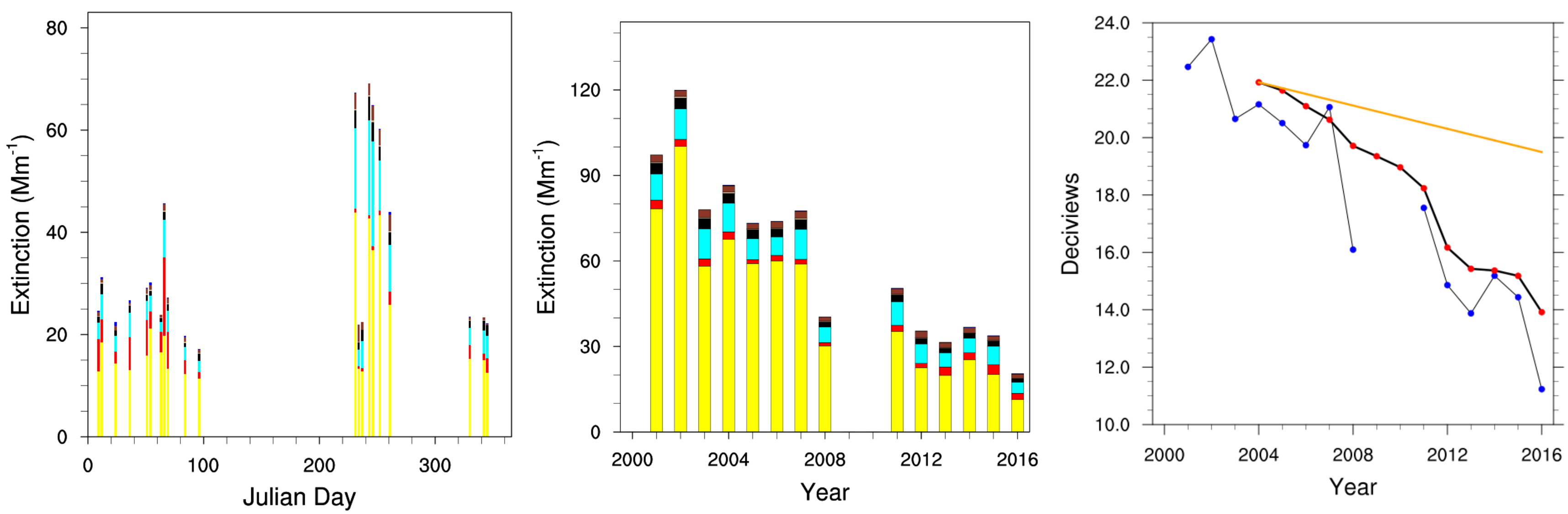
Glacier National Park, MT



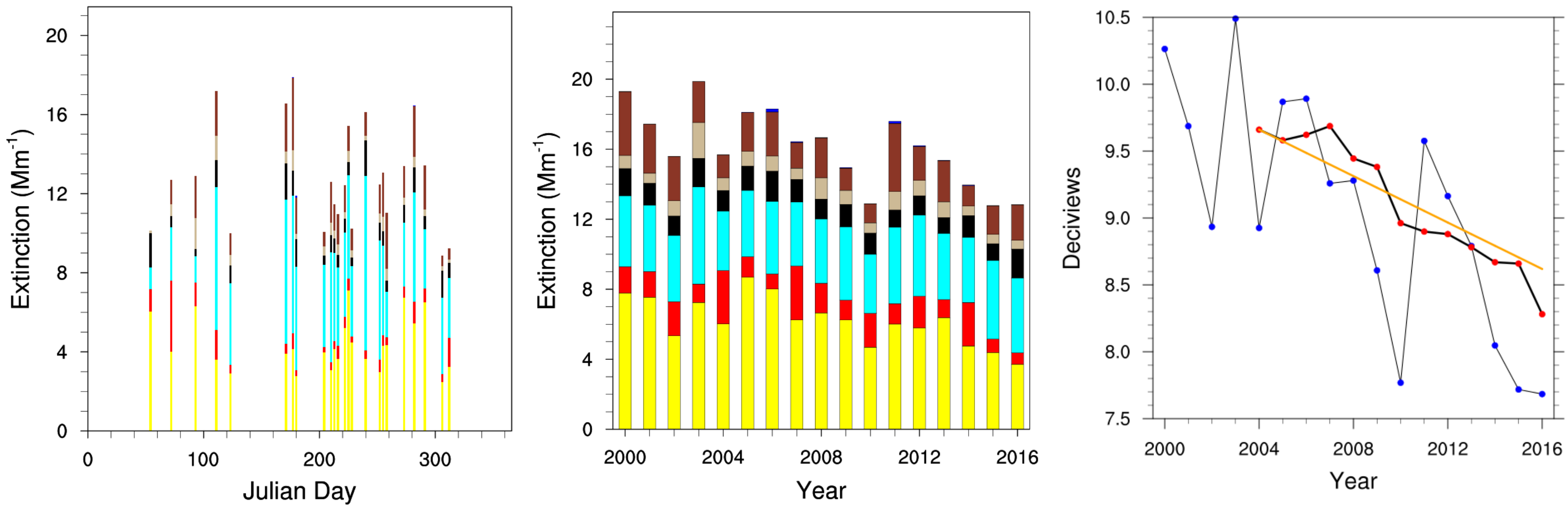
Grand Canyon National Park, AZ



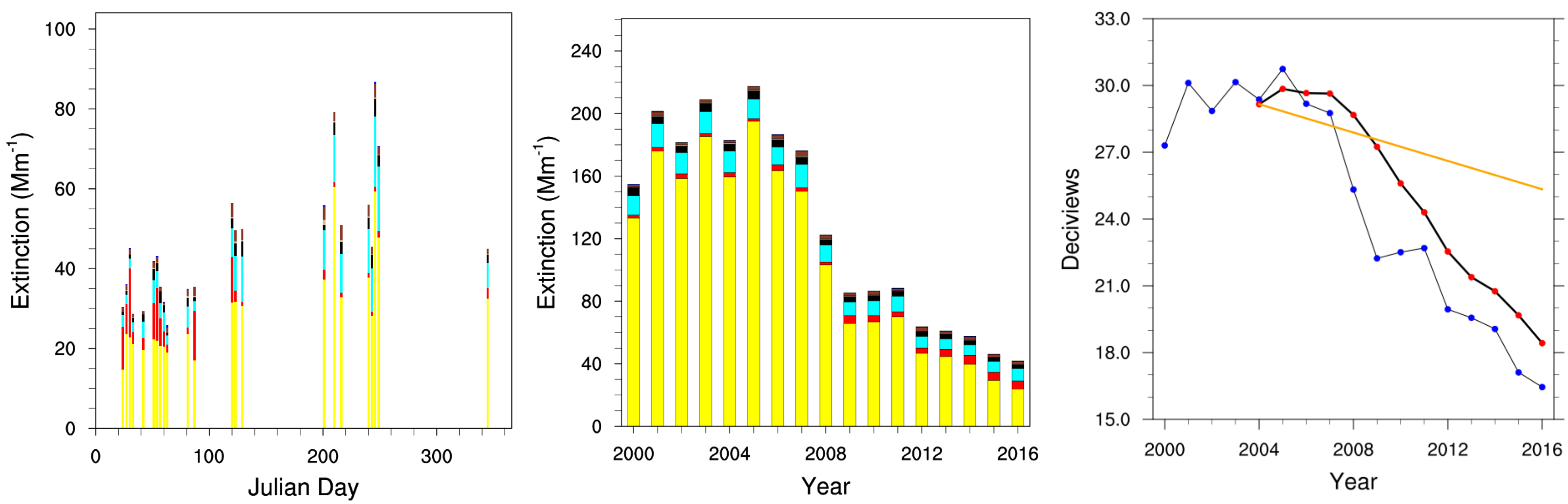
Great Gulf Wilderness, NH



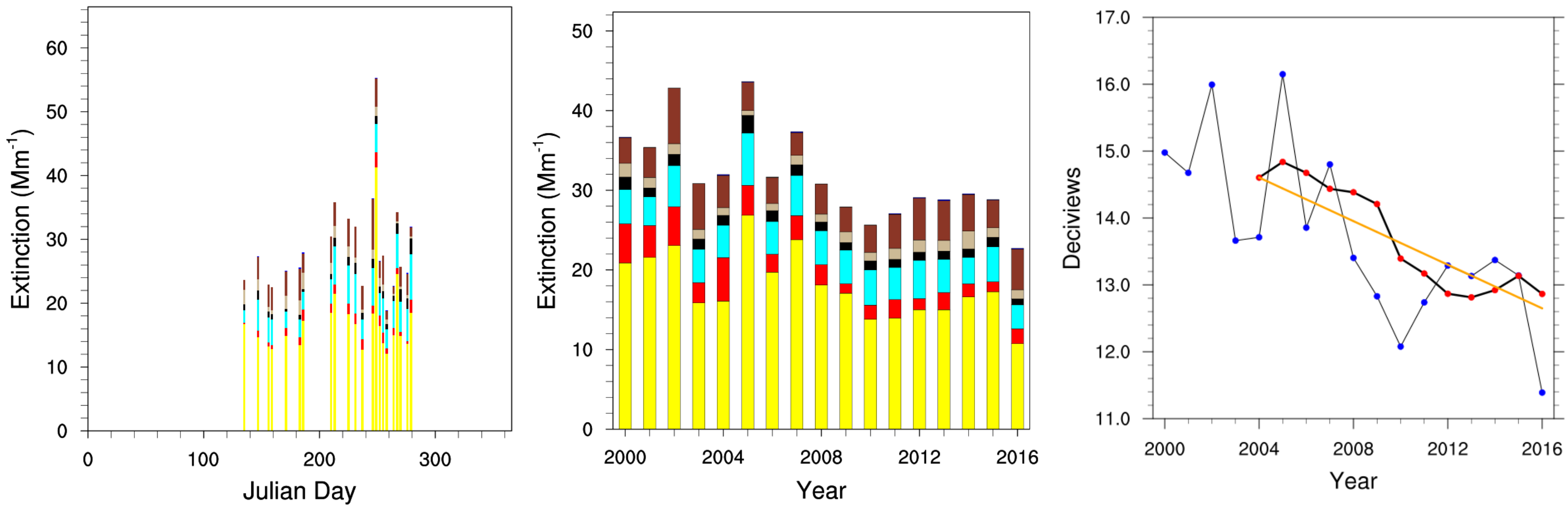
Great Sand Dunes National Monument, CO



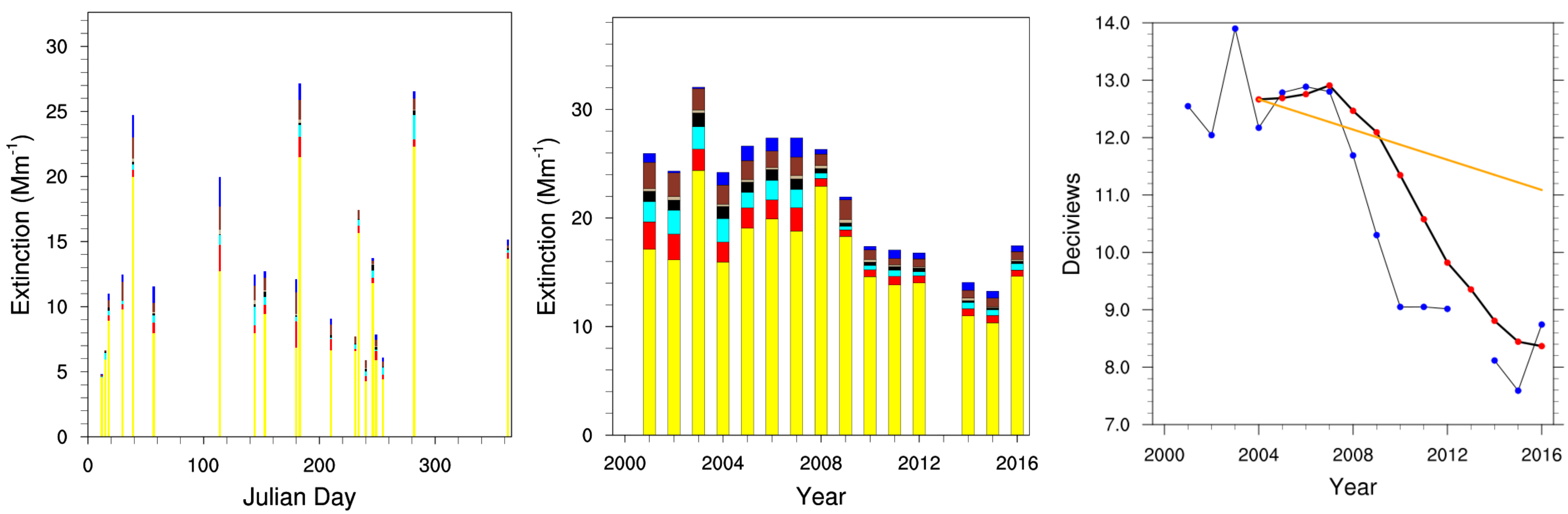
Great Smoky Mountains National Park, TN



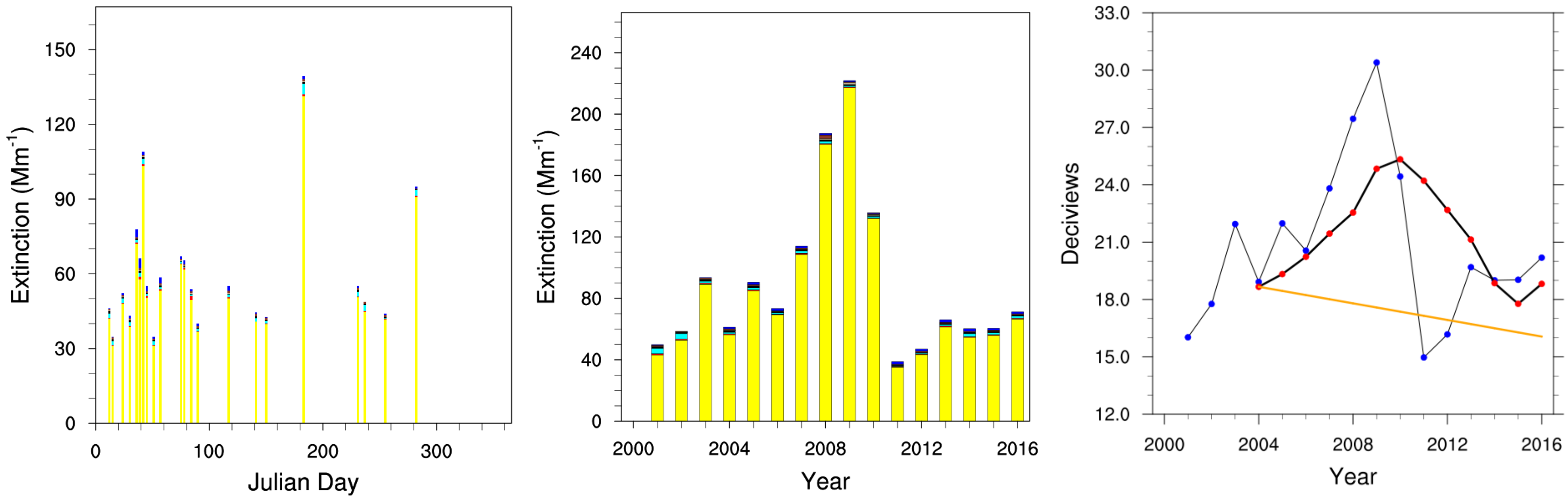
Guadalupe Mountains National Park, TX



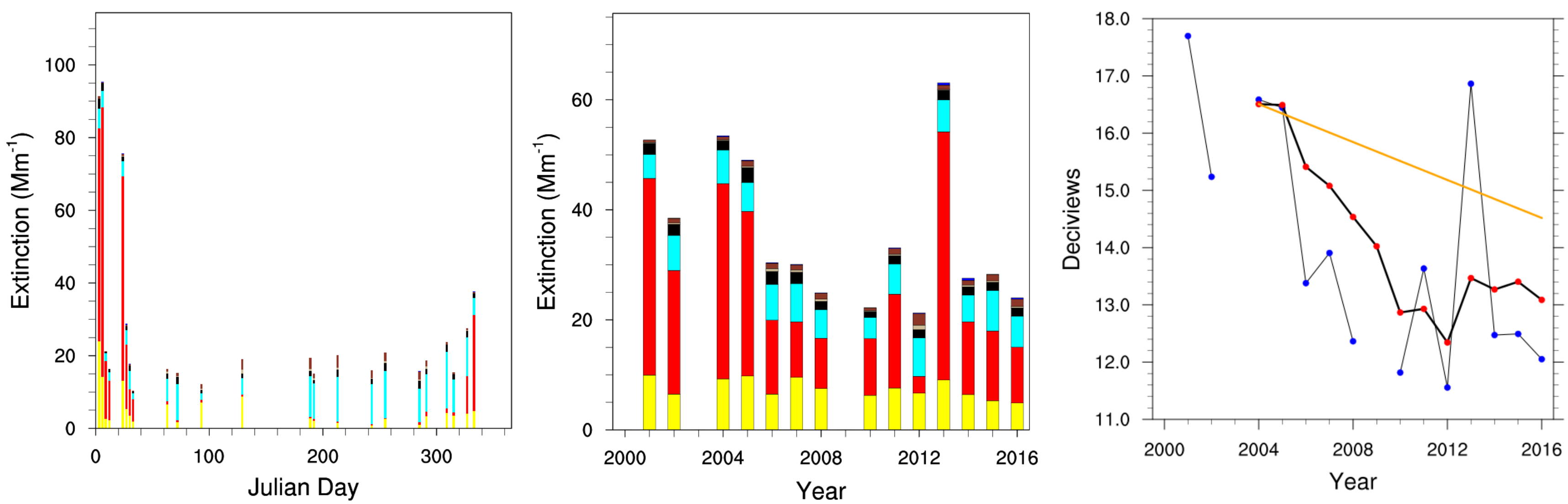
Haleakala National Park, HI (combined HALE1 and HACR1 starting 01/01/2007)



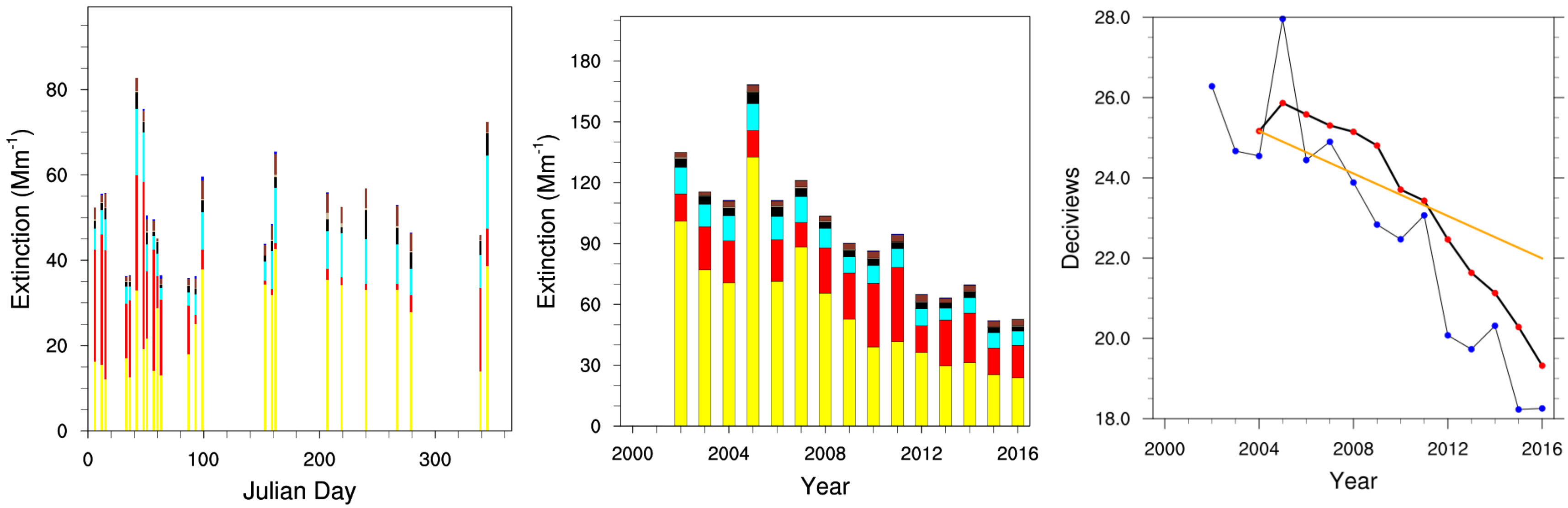
Hawaii Volcanoes National Park, HI



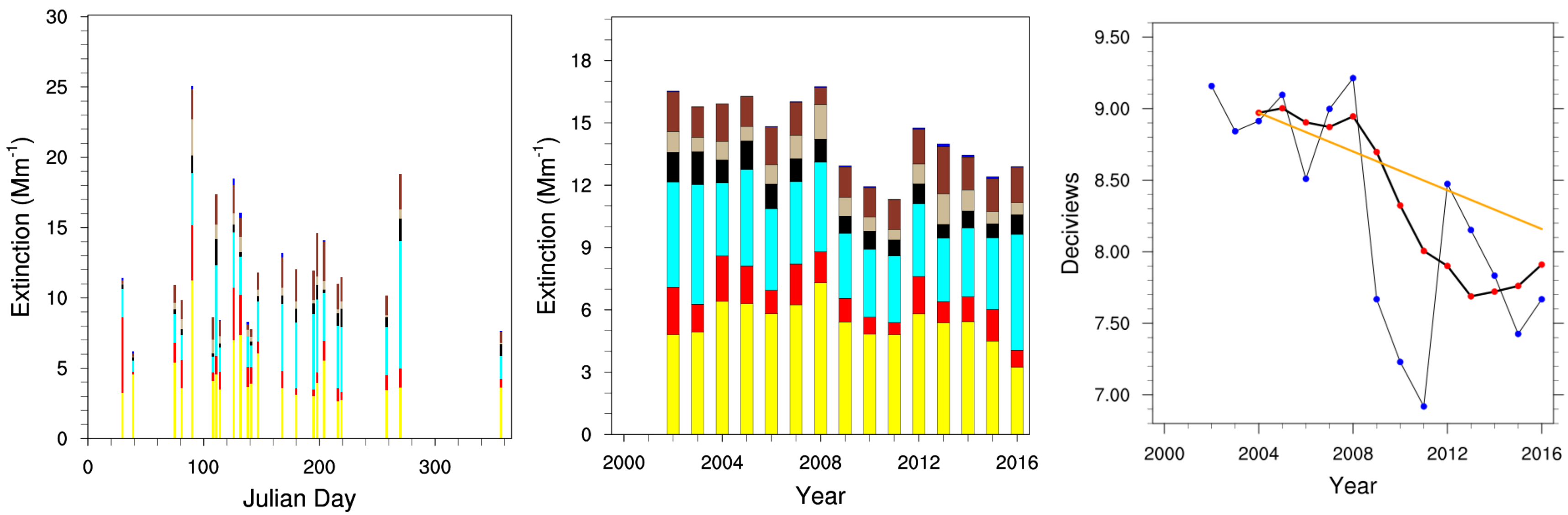
Hells Canyon, OR



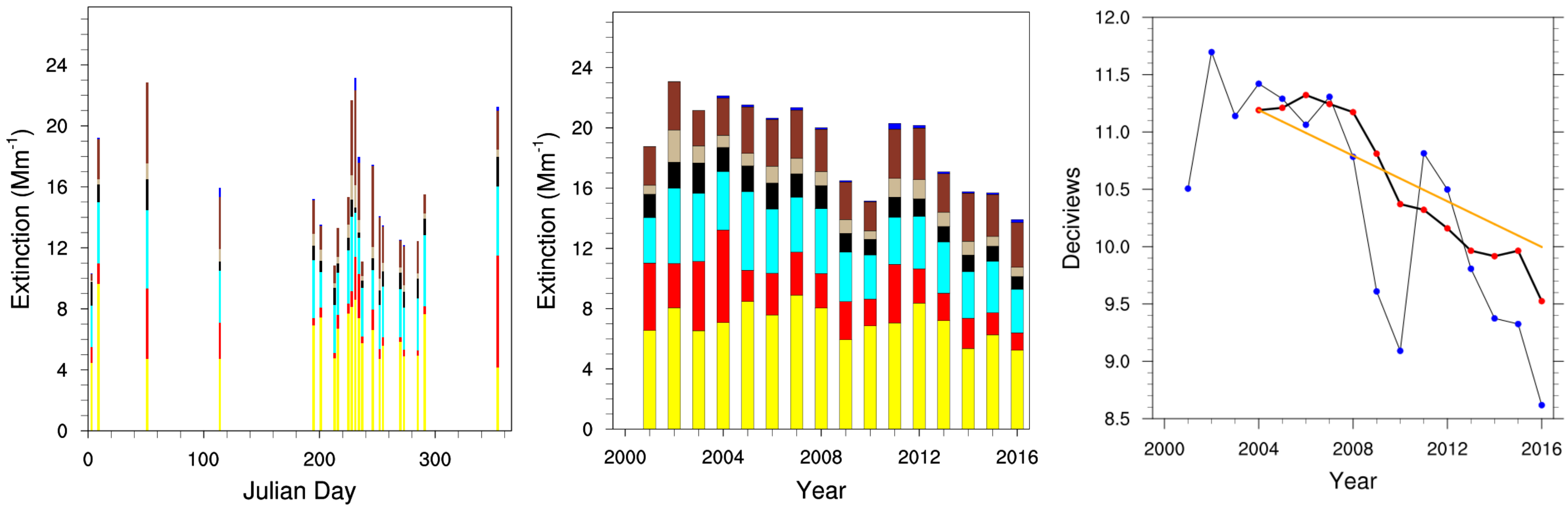
Hercules-Glades, MO



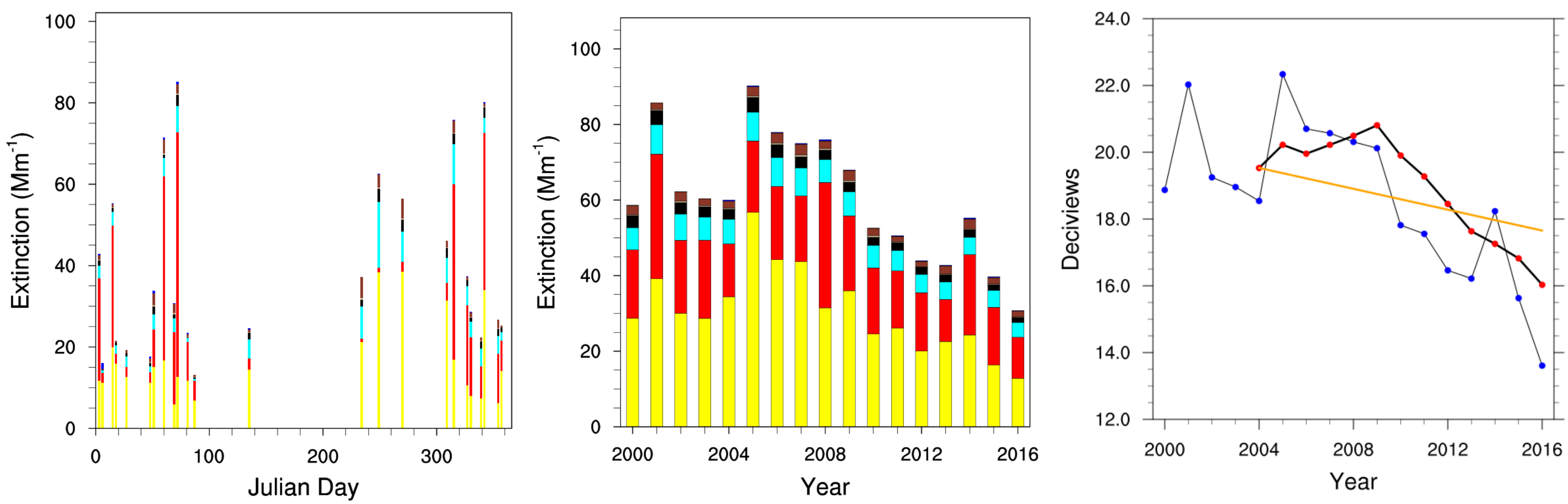
Hoover, CA



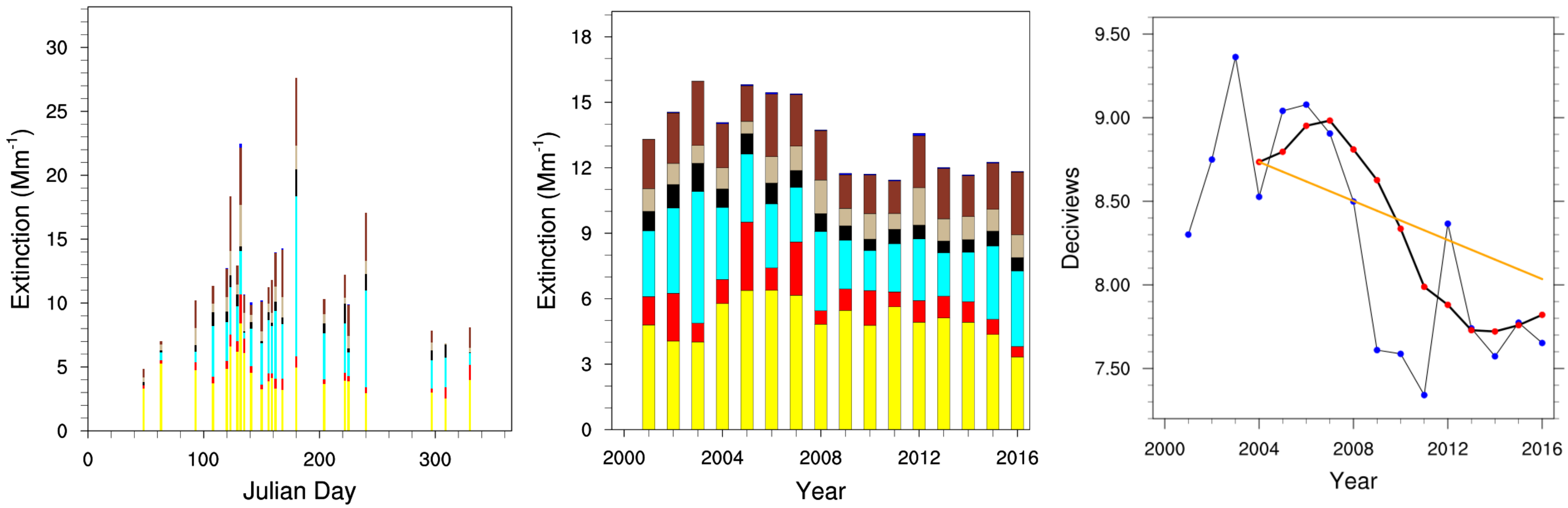
Ike's Backbone, AZ



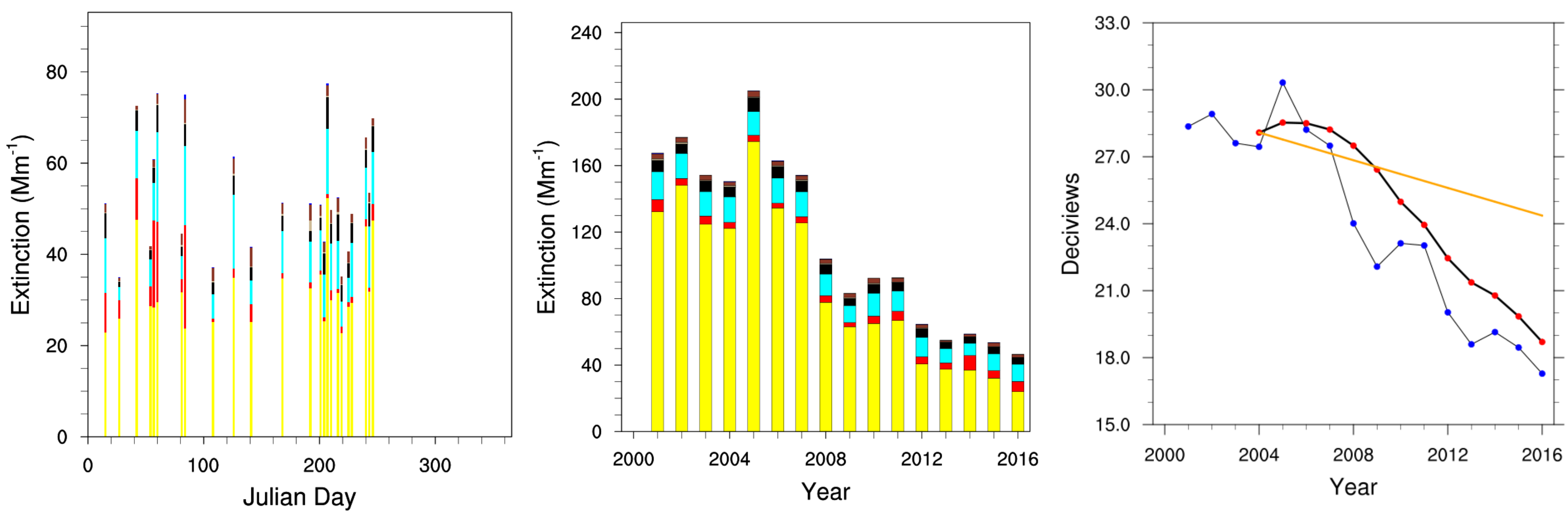
Isle Royale National Park, MI



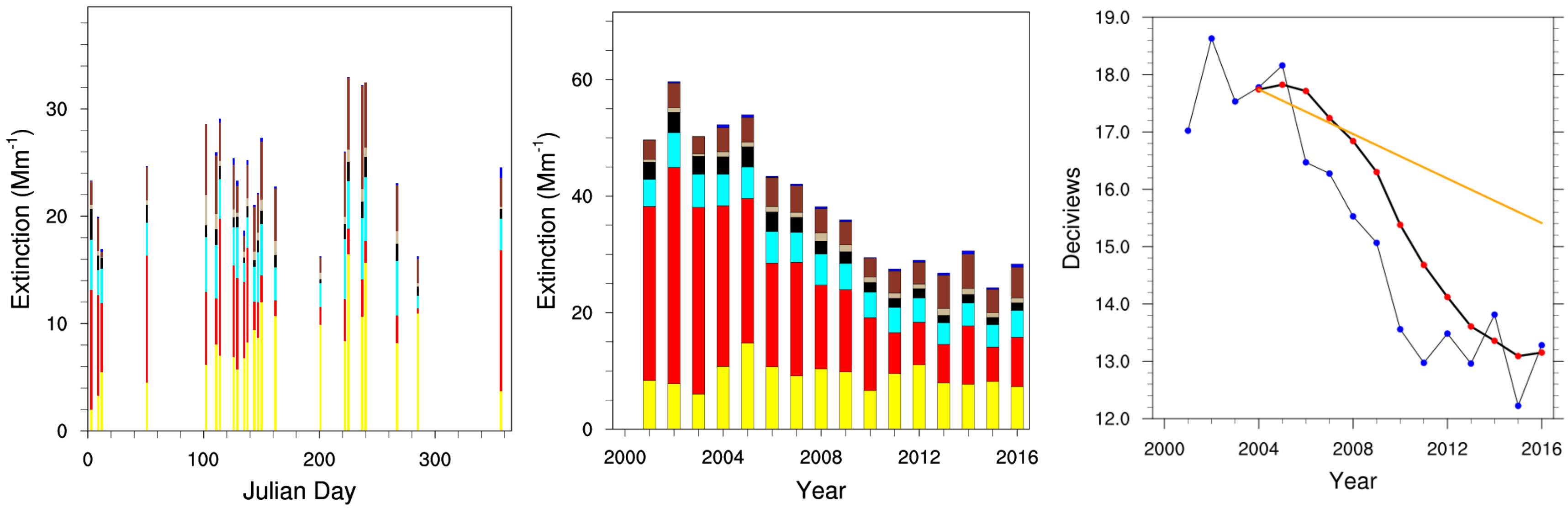
Jarbidge Wilderness, NV



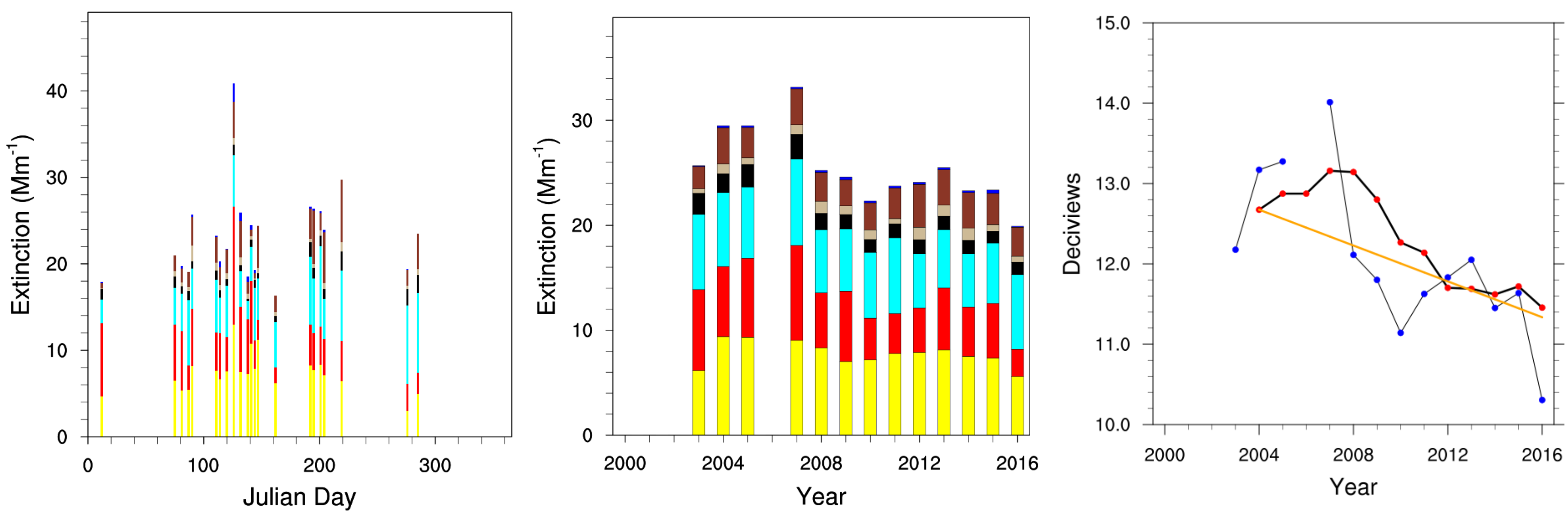
James River Face Wilderness, VA



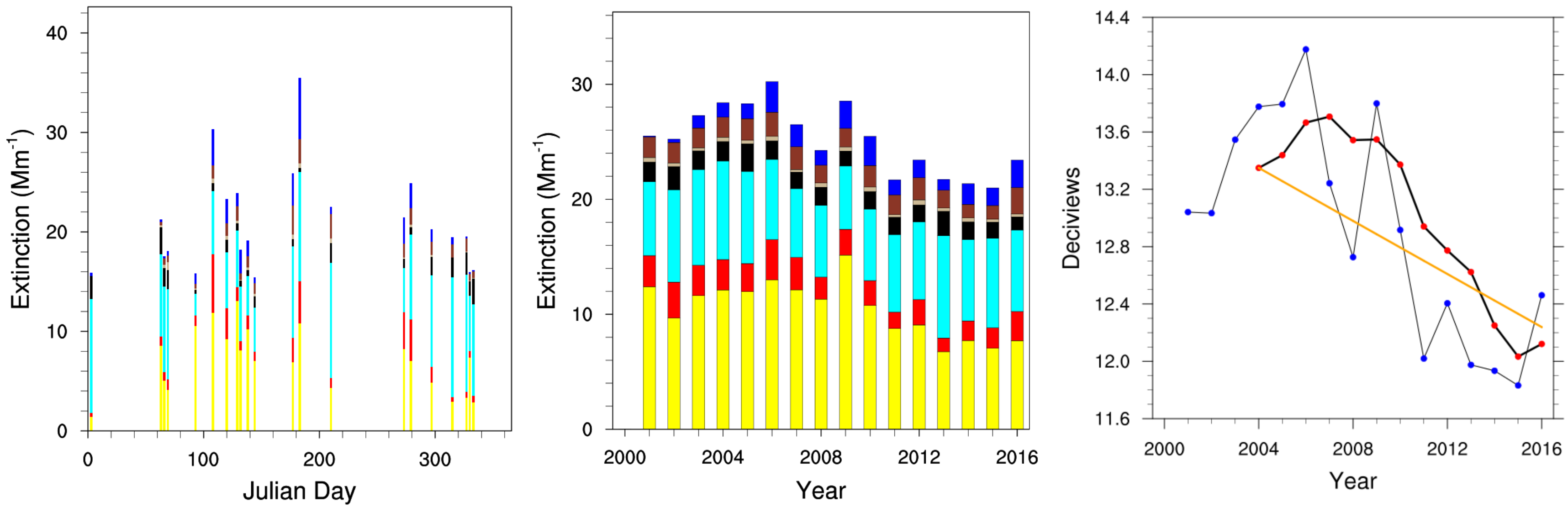
Joshua Tree National Park, CA



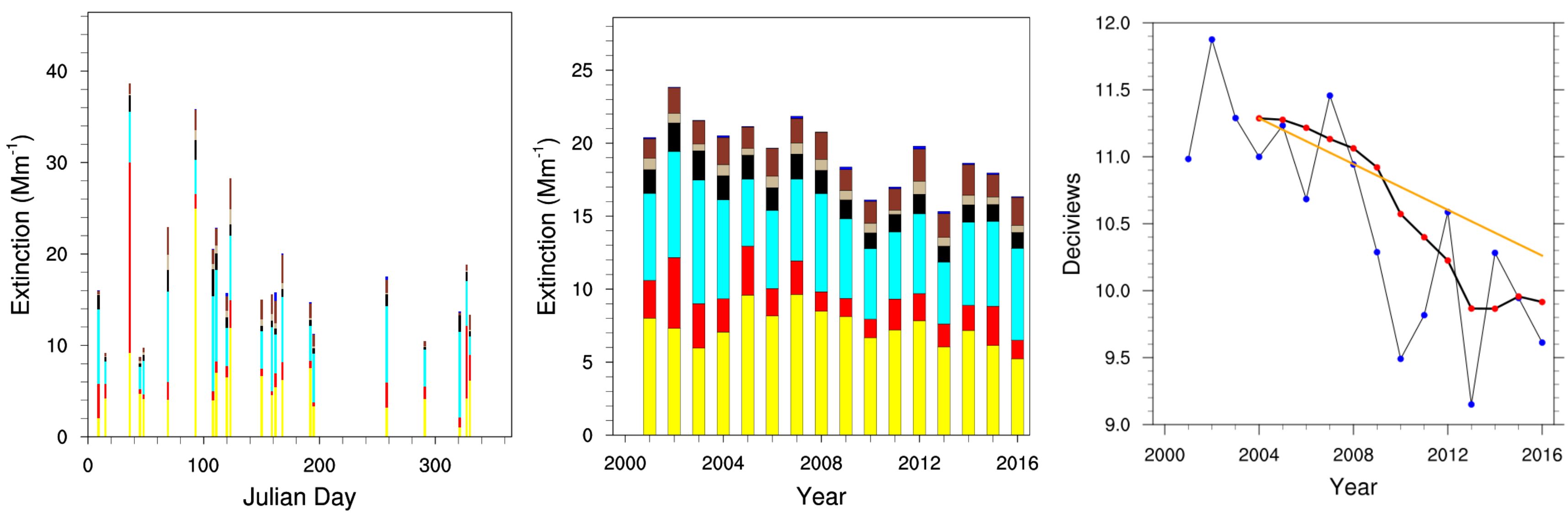
Kaiser, CA



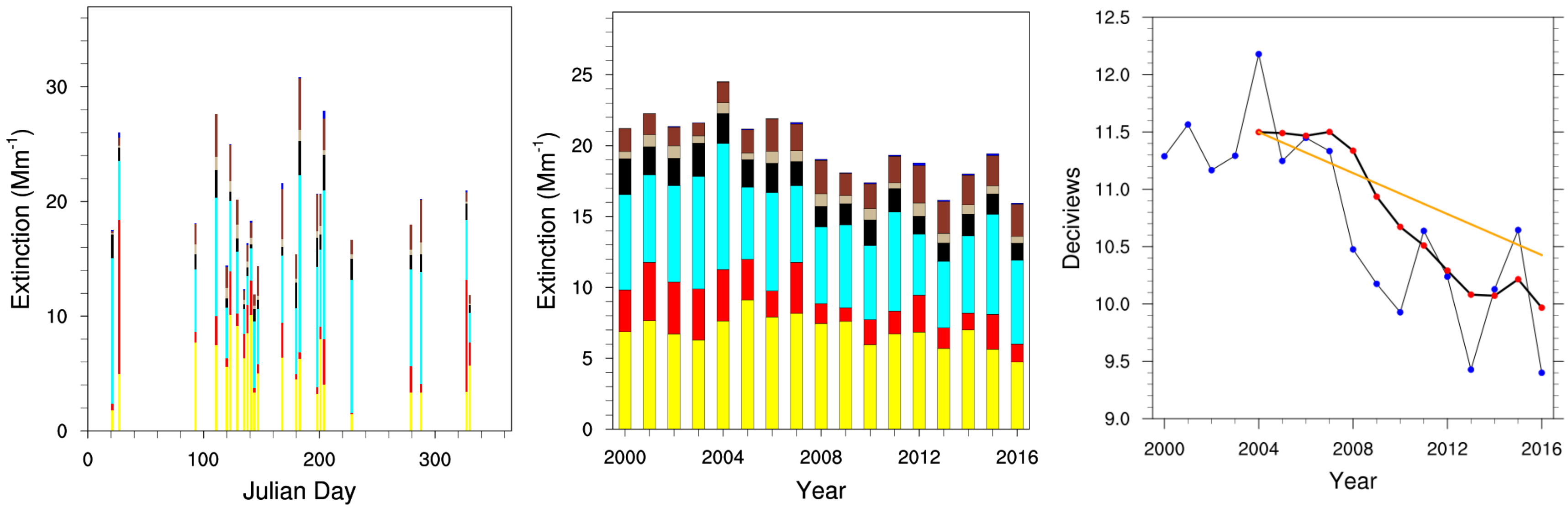
Kalmiopsis, OR



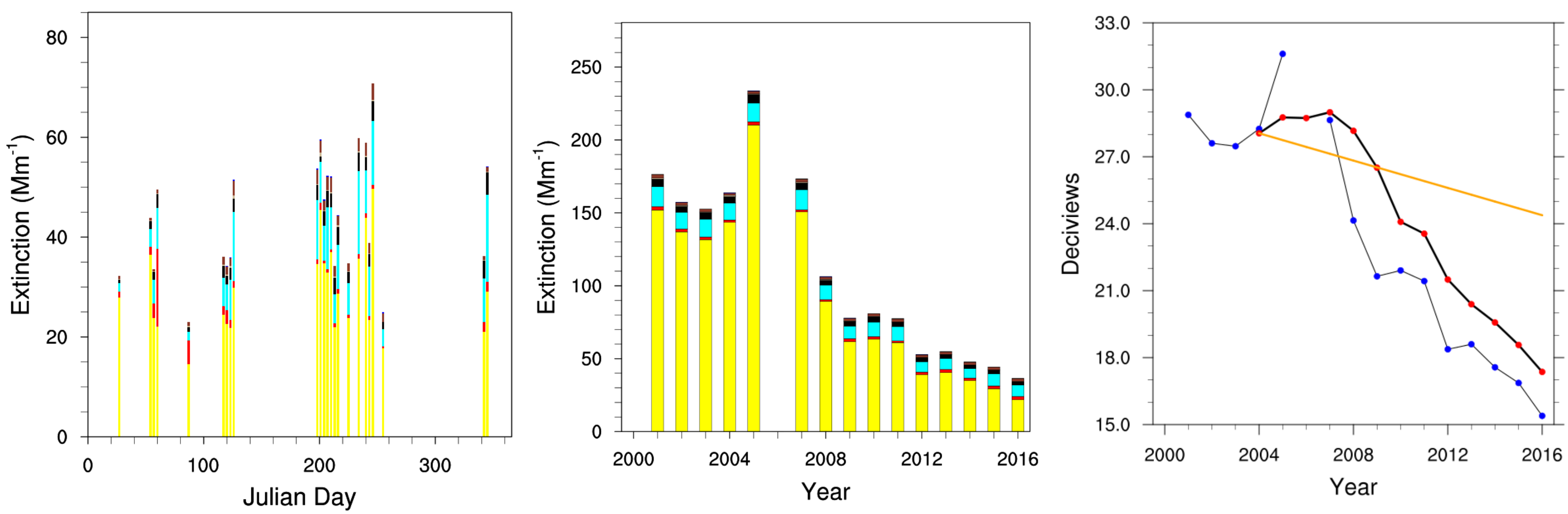
Lava Beds National Monument, CA



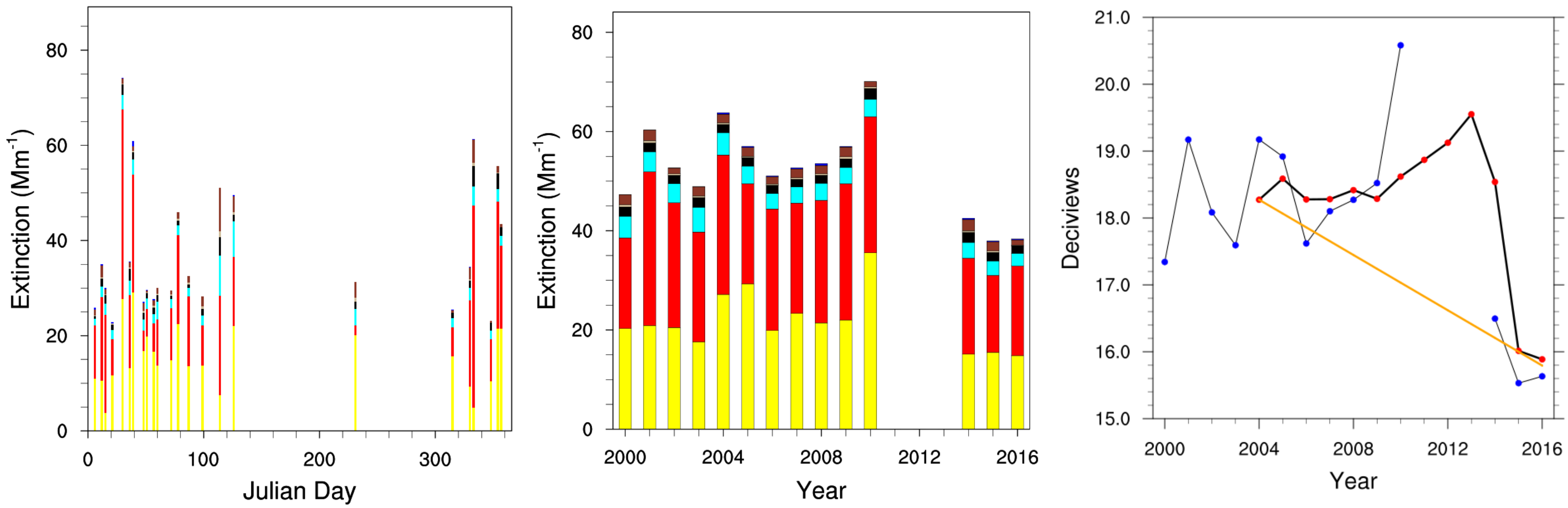
Lassen Volcanic National Park, CA



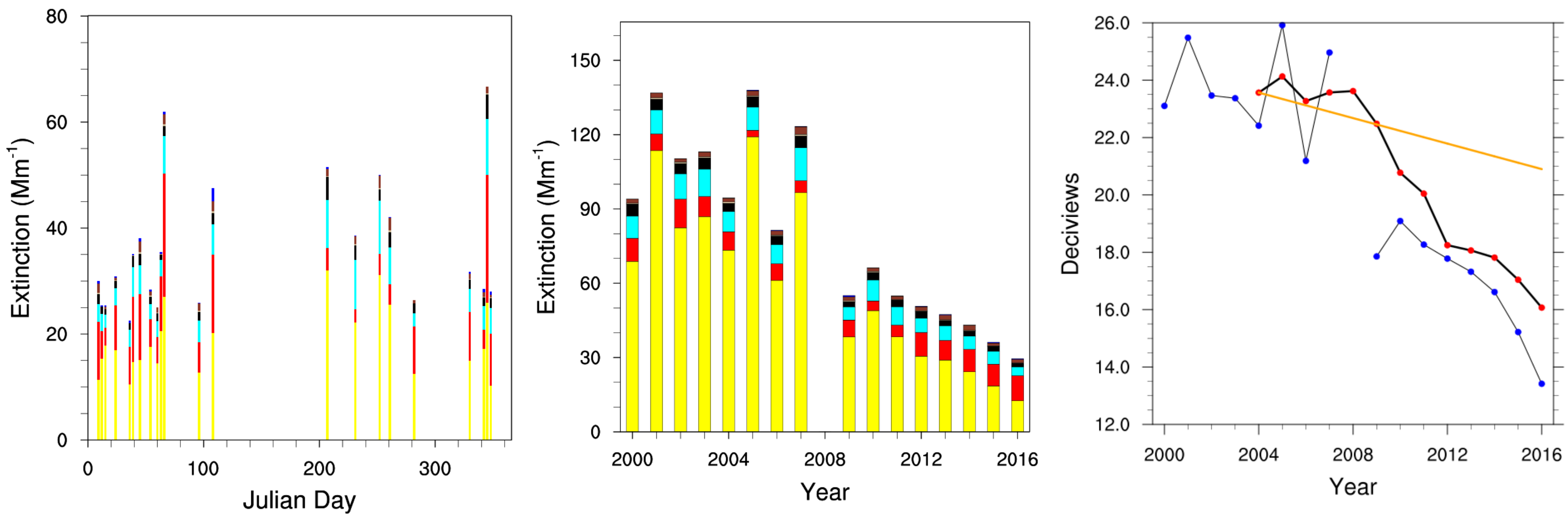
Linville Gorge, NC



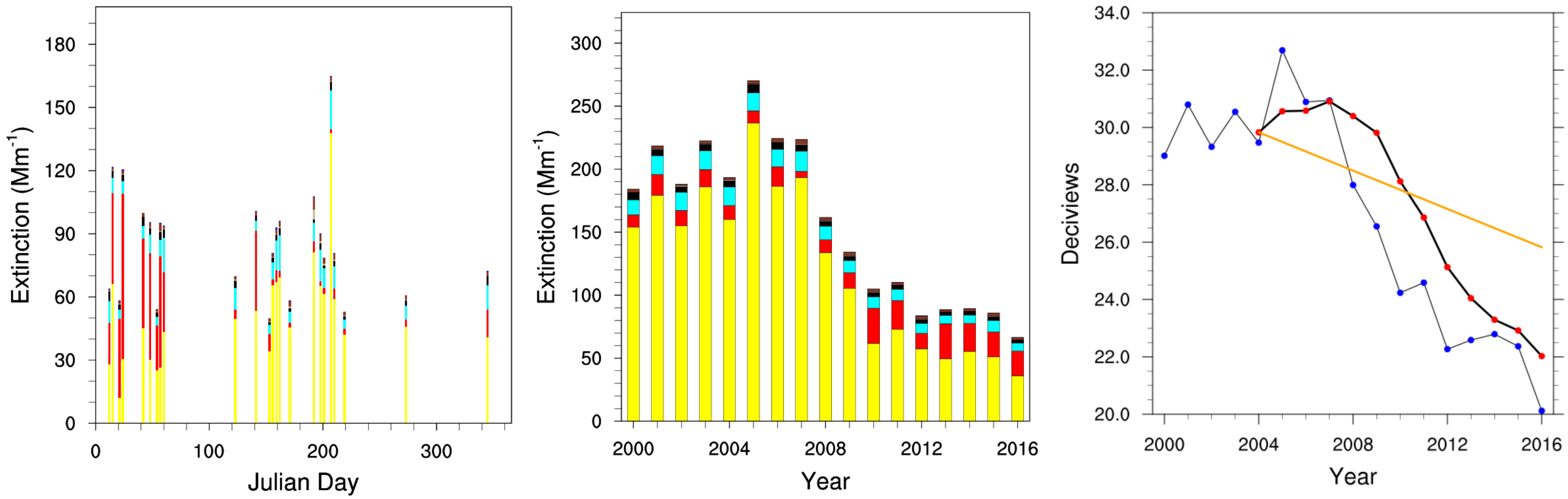
Lostwood, ND



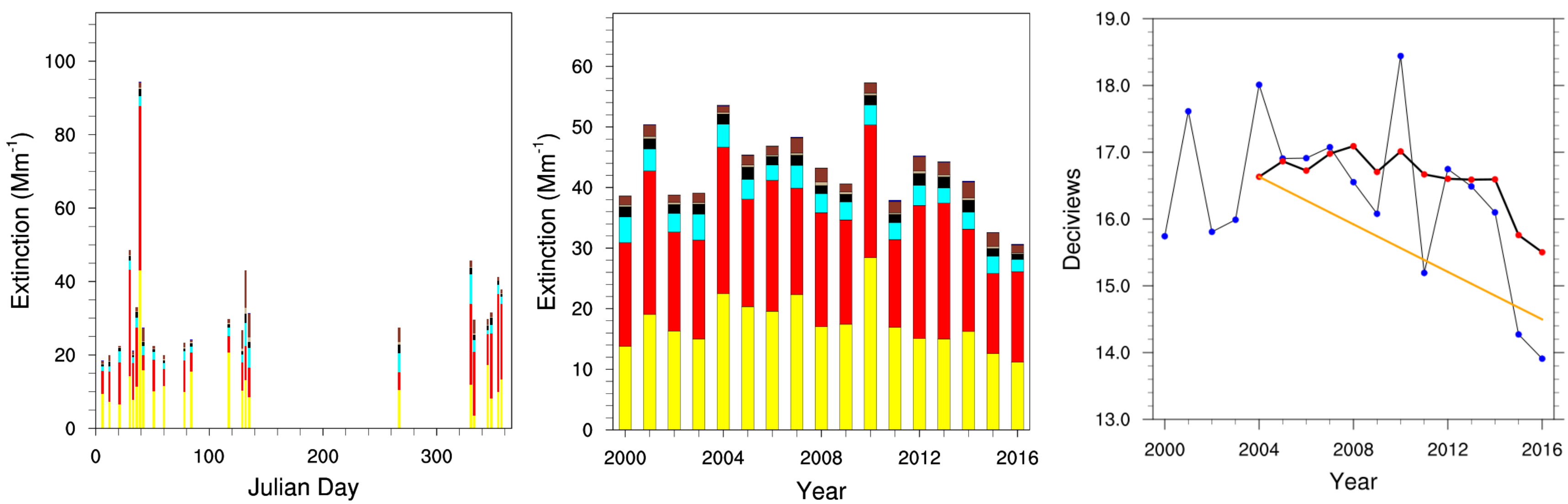
Lye Brook Wilderness, VT (combined LYBR1 and LYEB1 starting 01/01/2012)



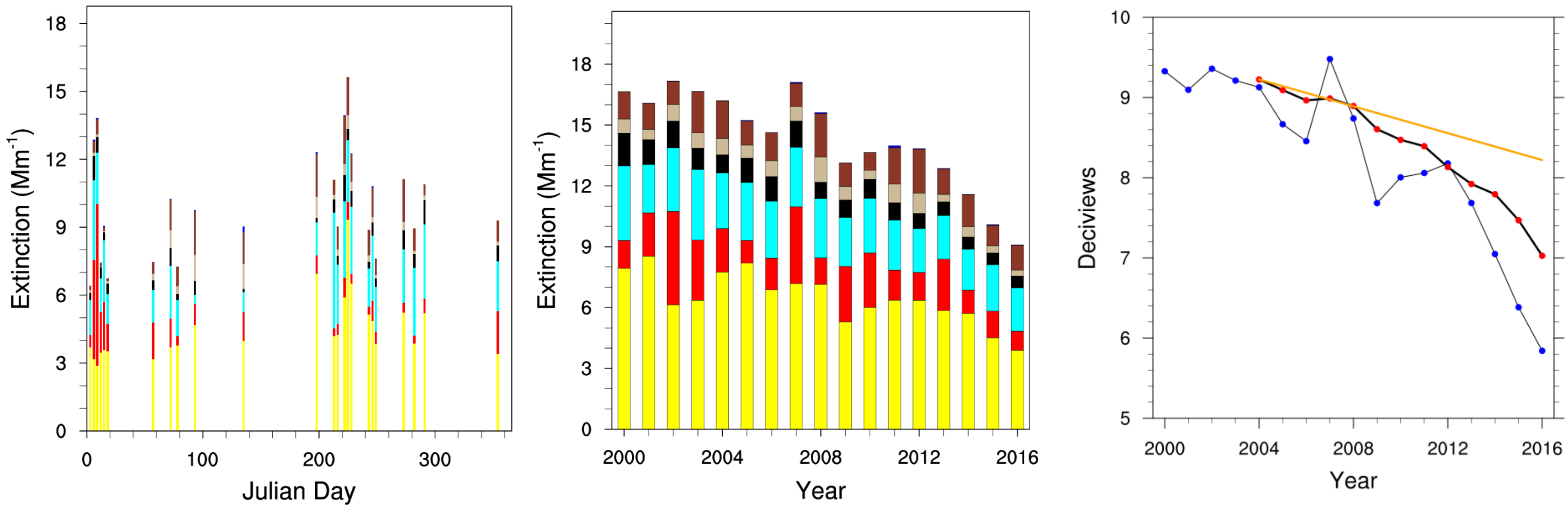
Mammoth Cave National Park, KY



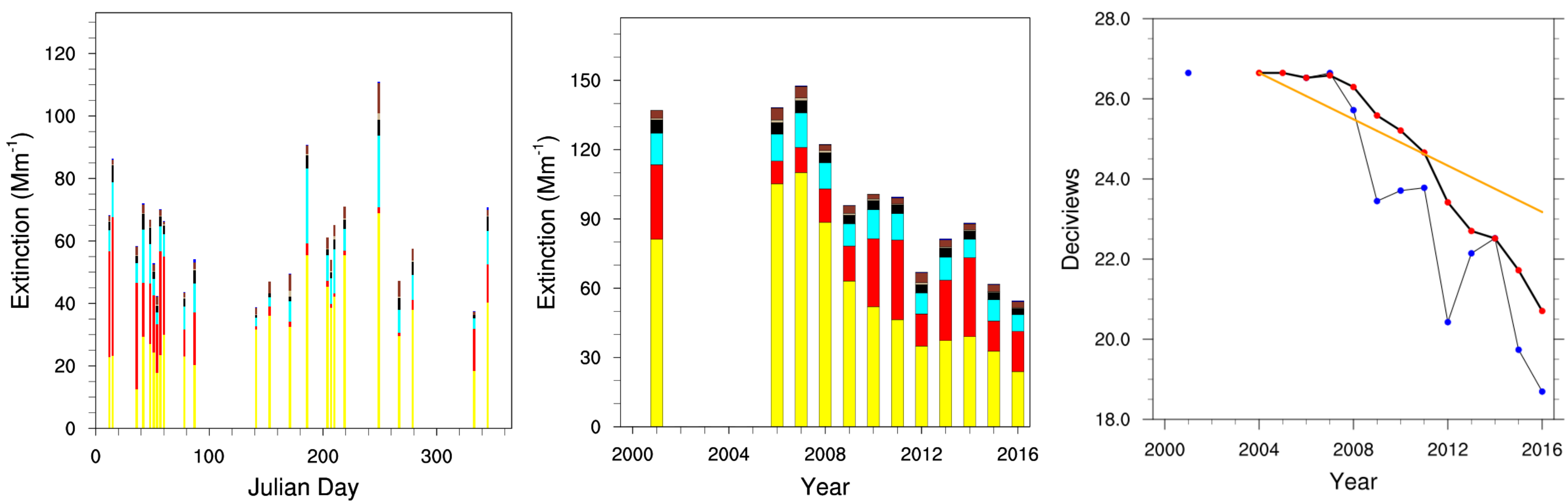
Medicine Lake, MT



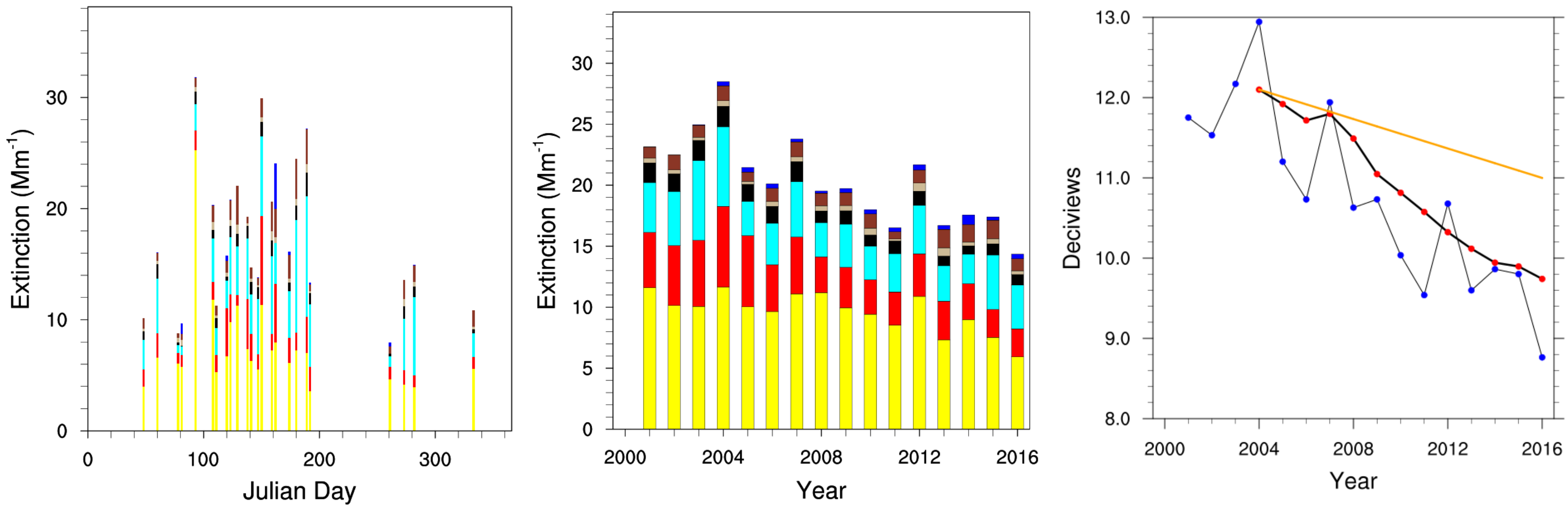
Mesa Verde National Park, CO



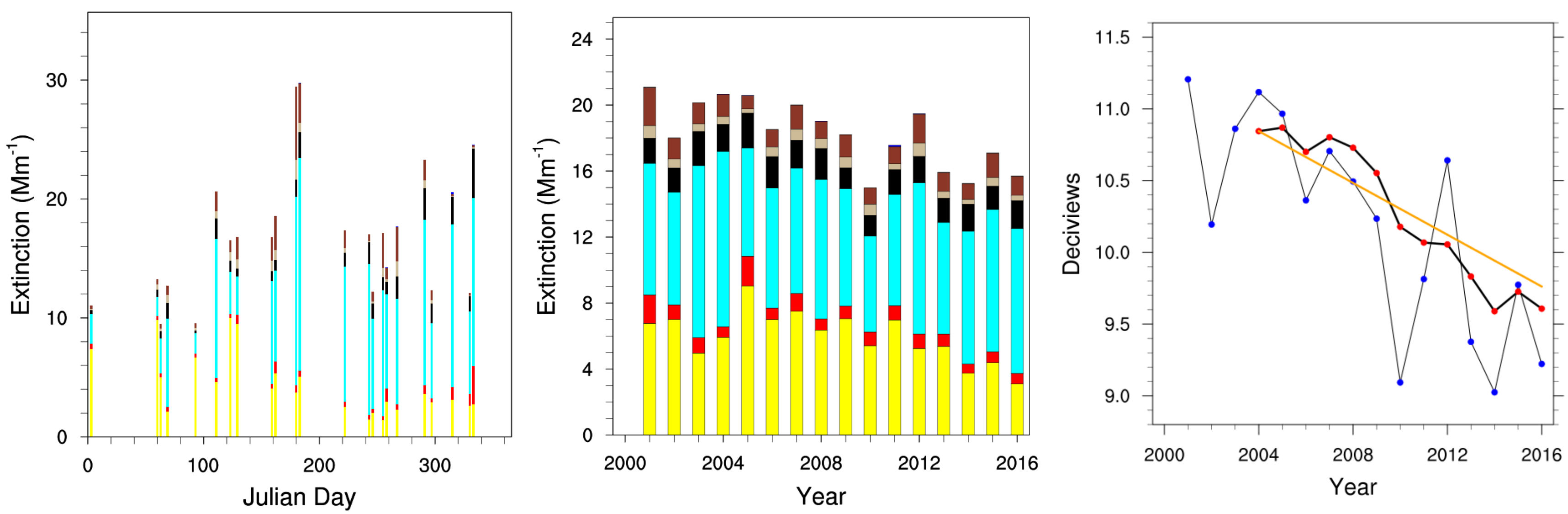
Mingo, MO



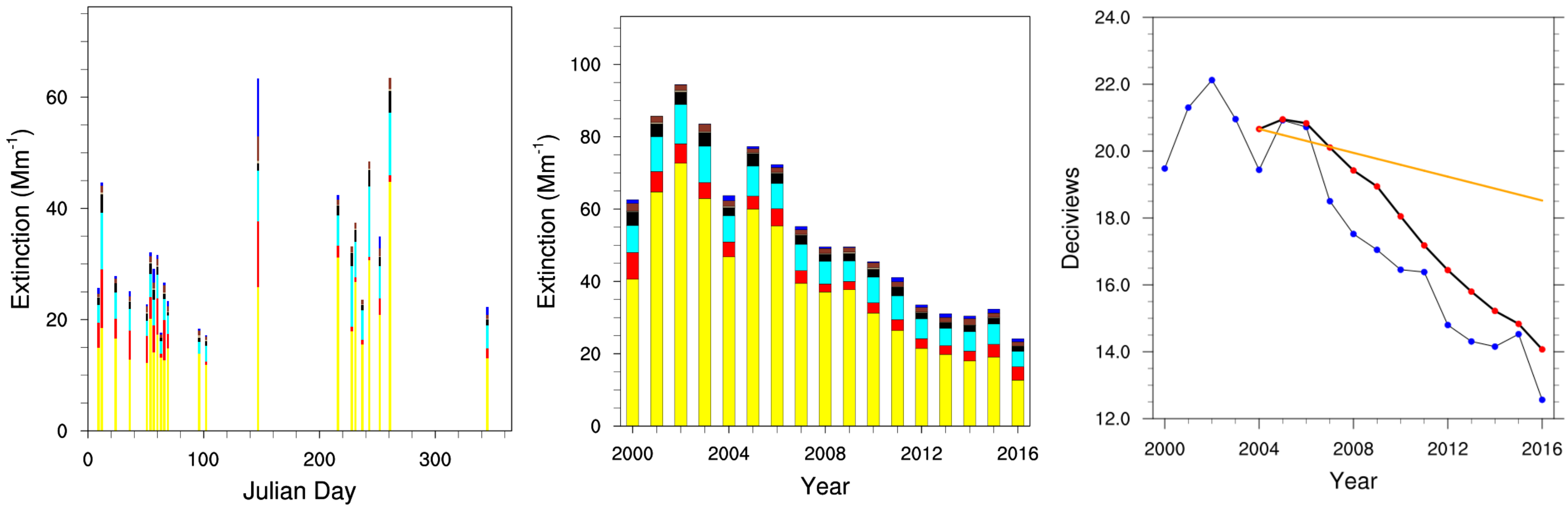
Mount Hood, OR



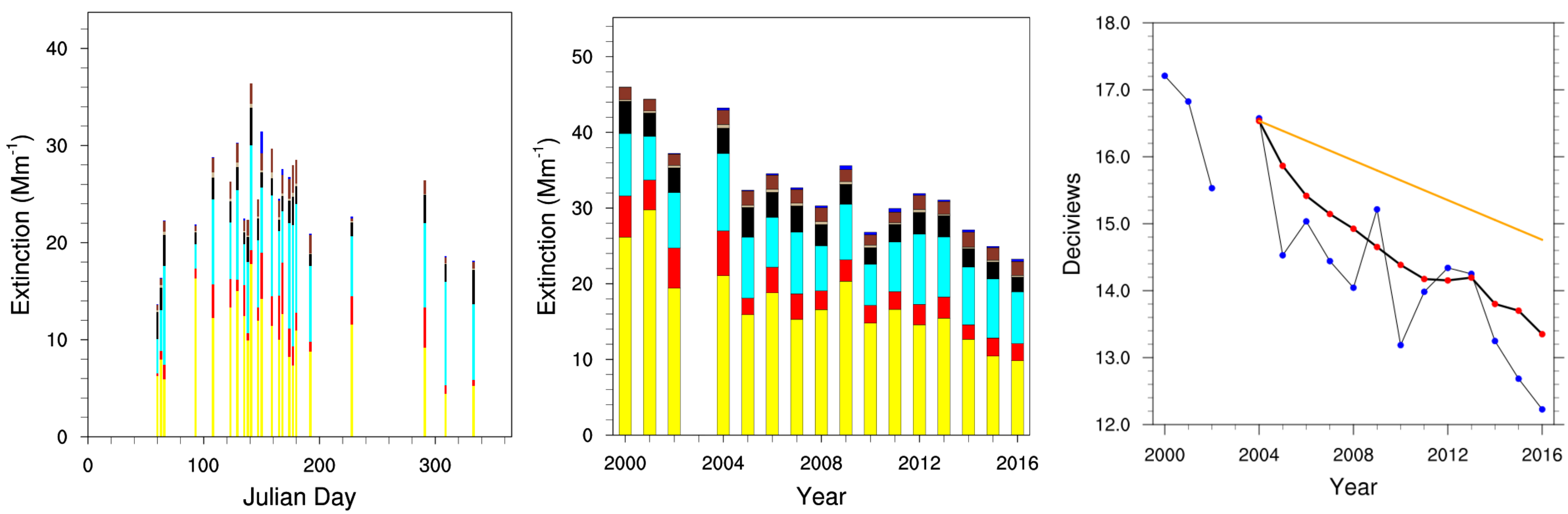
Monture, MT



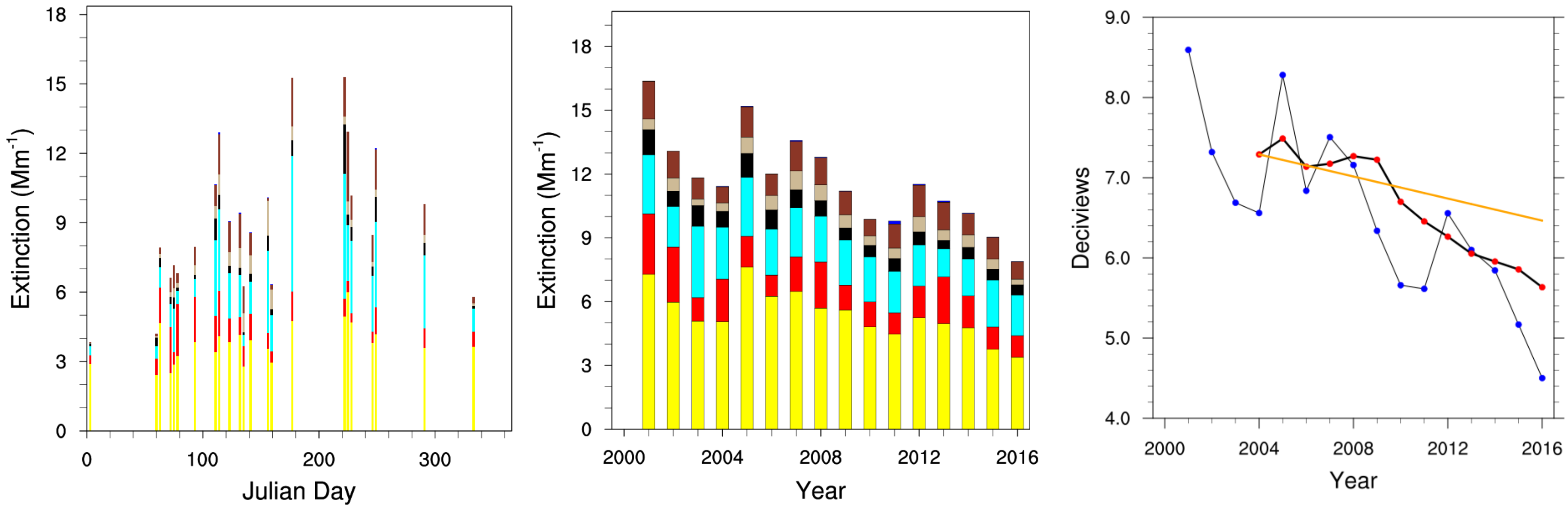
Moosehorn National Wildlife Refuge, ME



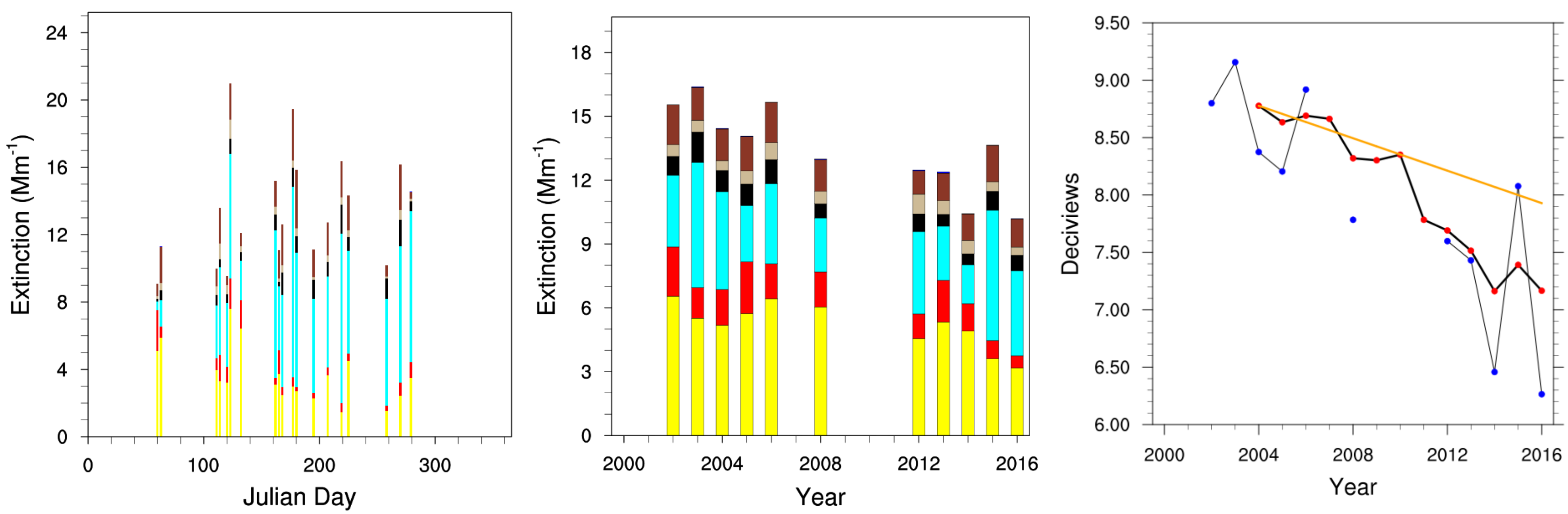
Mount Rainier National Park, WA



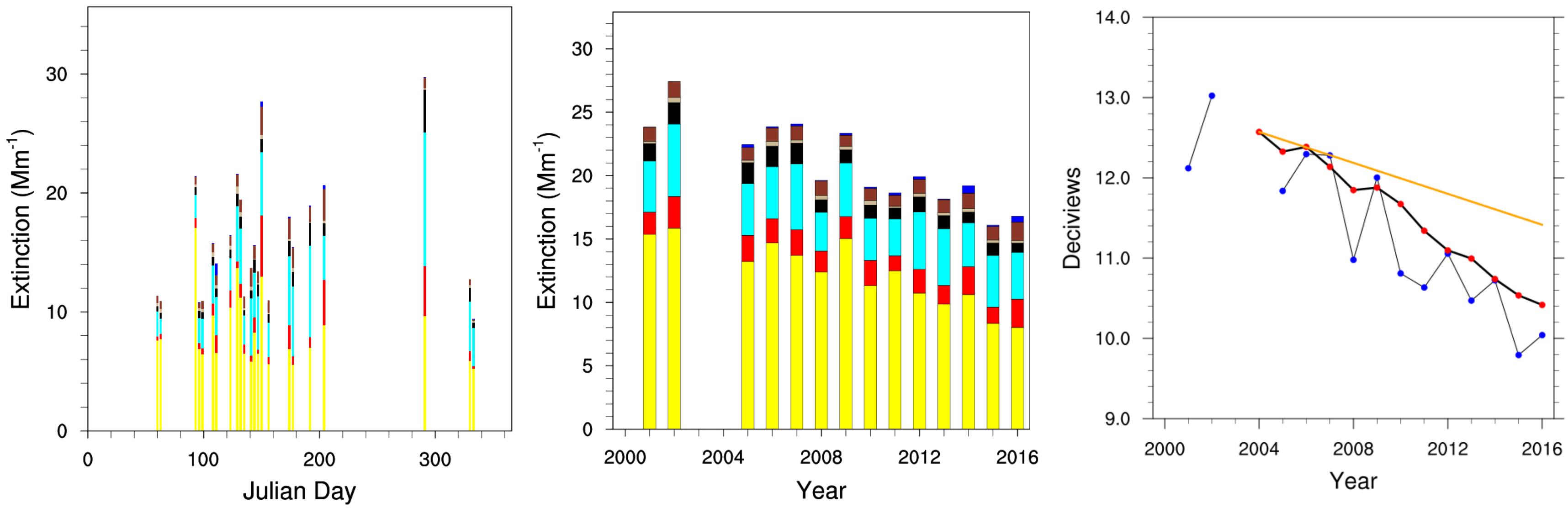
Mount Zirkel Wilderness, CO



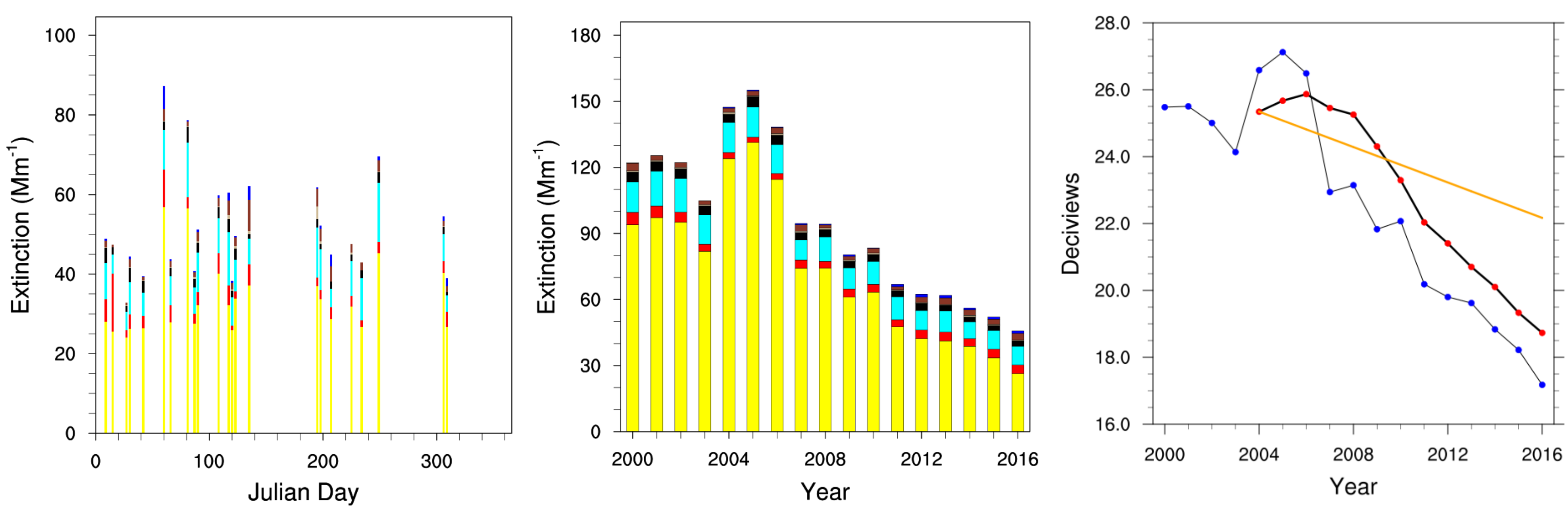
North Absaroka, WY



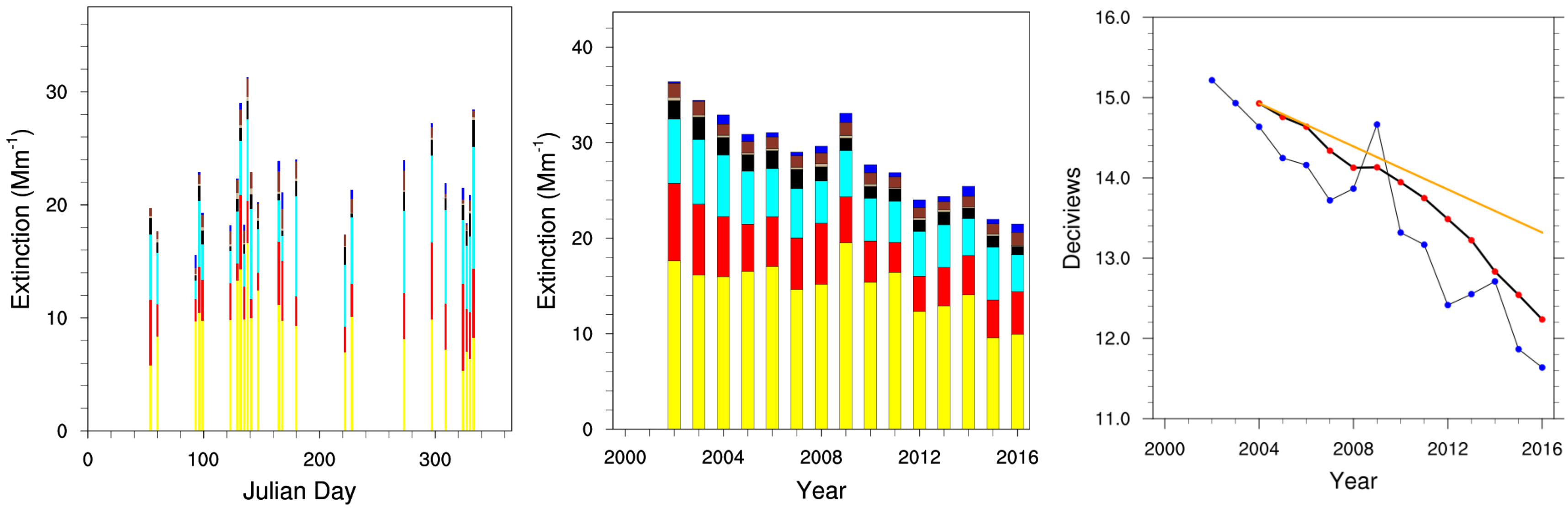
North Cascades National Park, WA



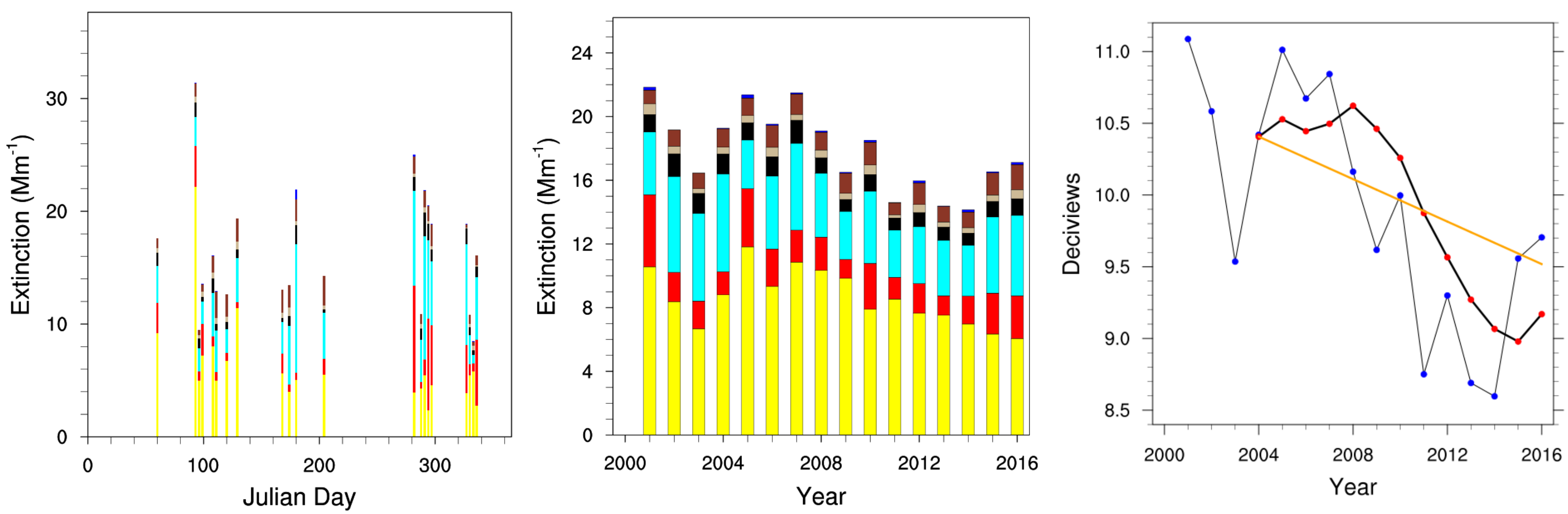
Okefenokee National Wildlife Refuge, GA



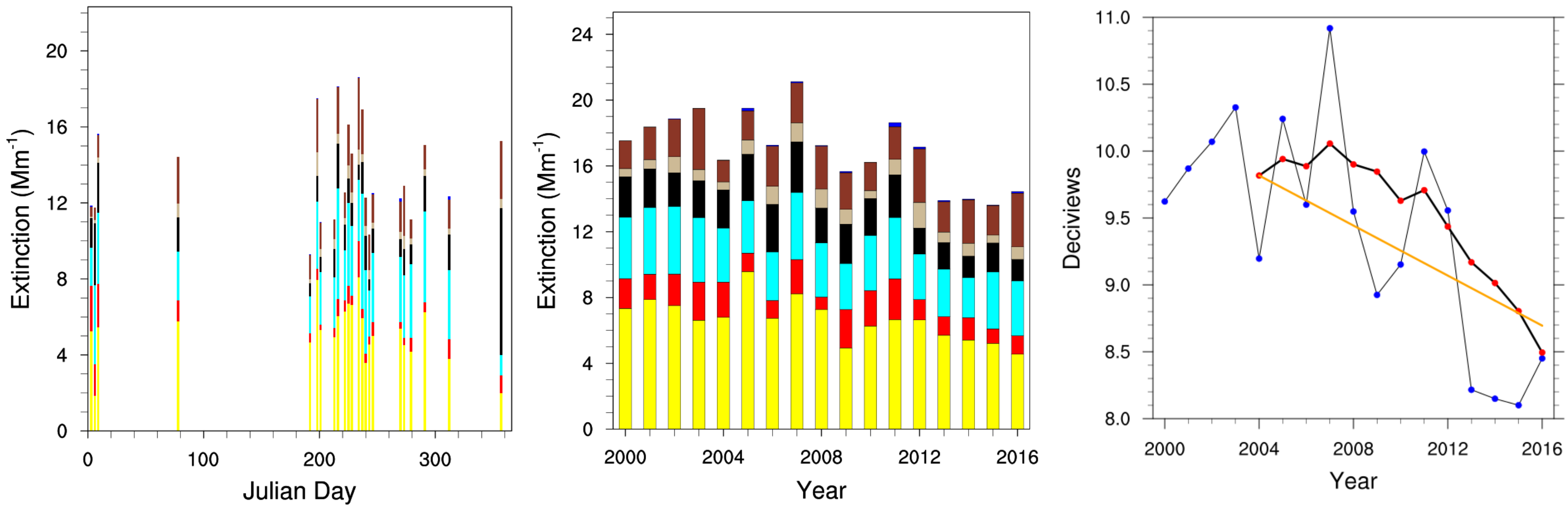
Olympic National Park, WA



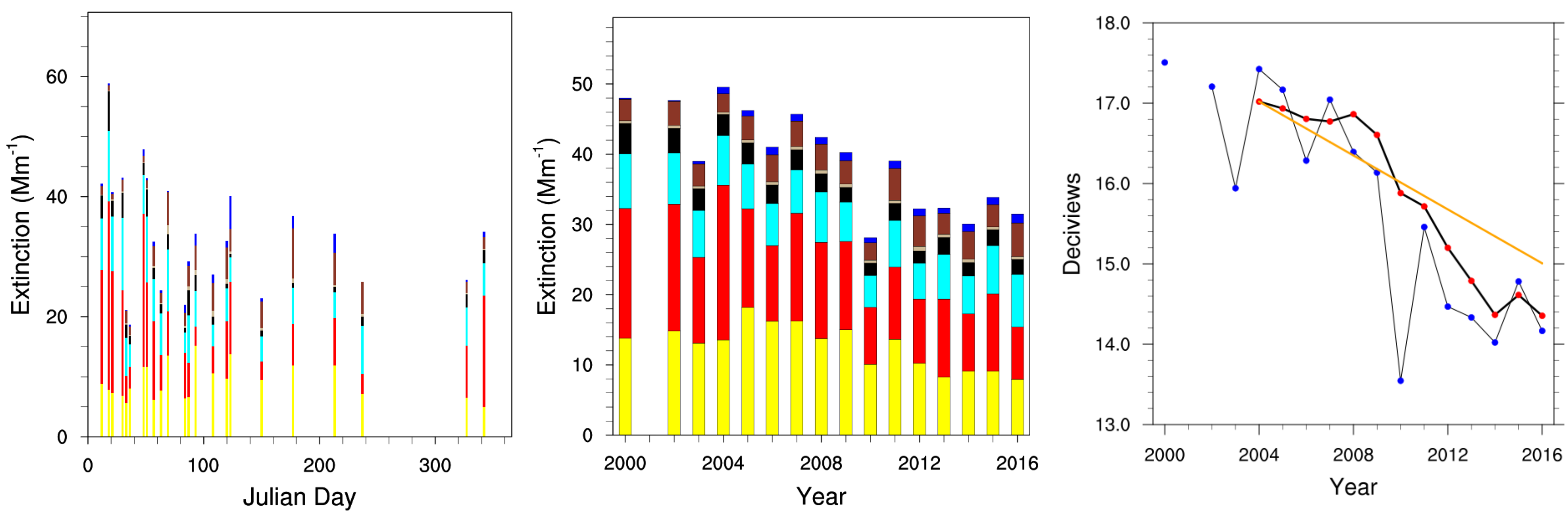
Pasayten, WA



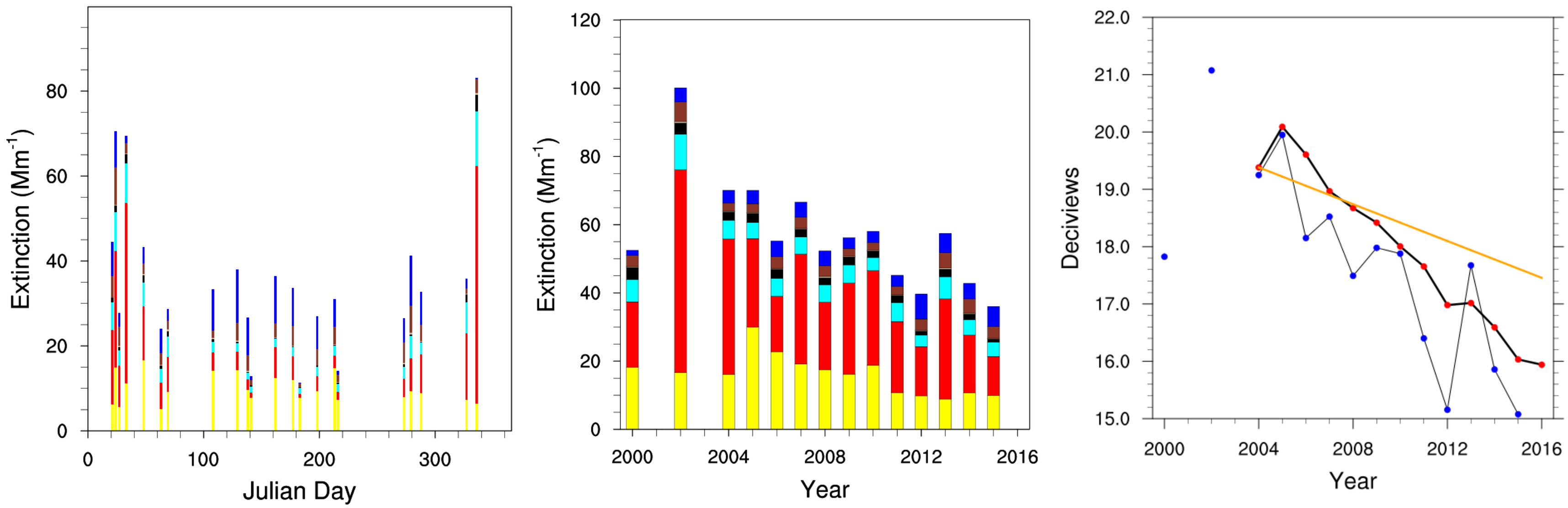
Petrified Forest National Park, AZ



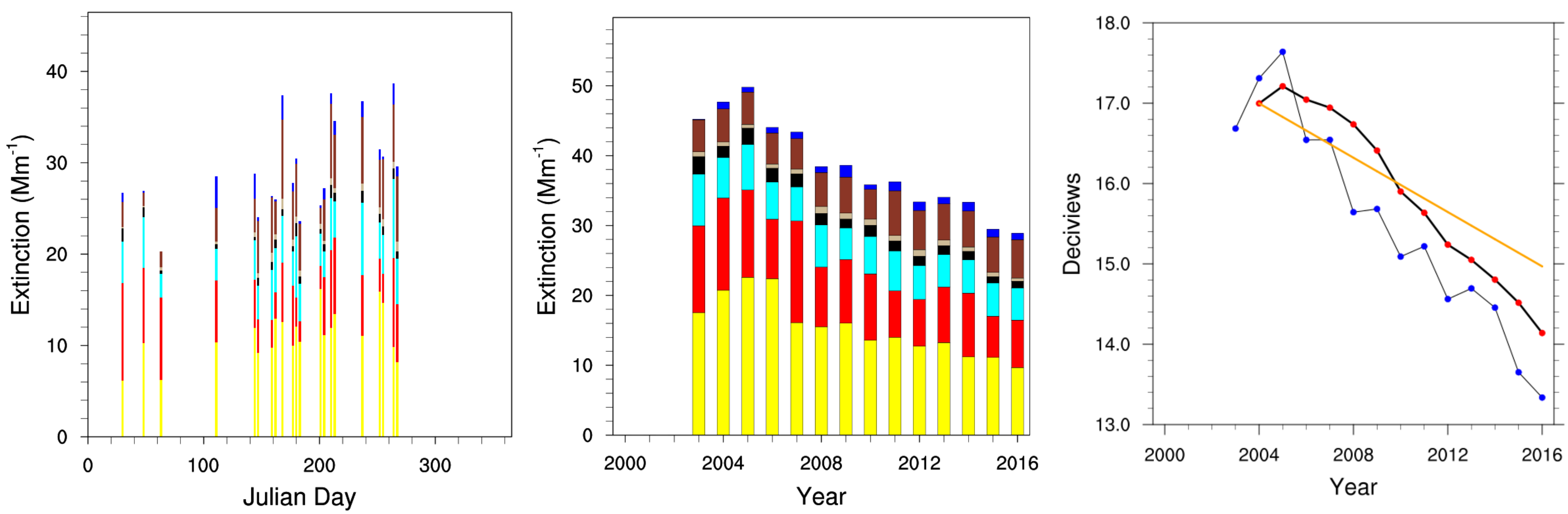
Pinnacles National Monument, CA



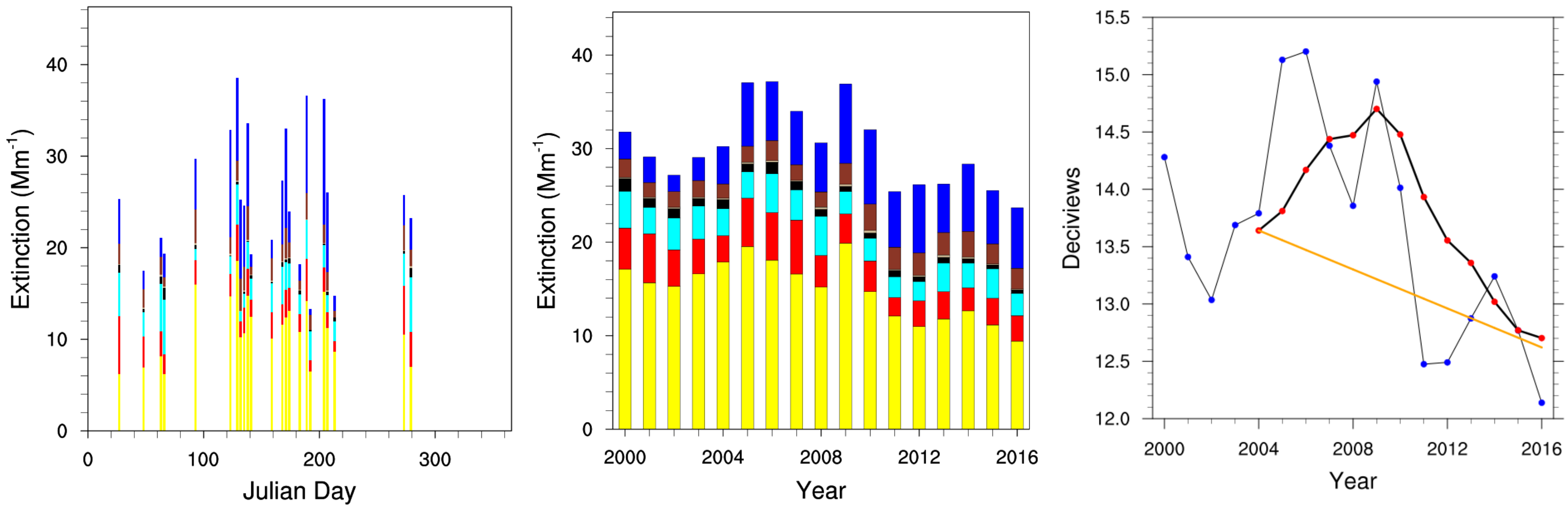
Point Reyes National Seashore, CA



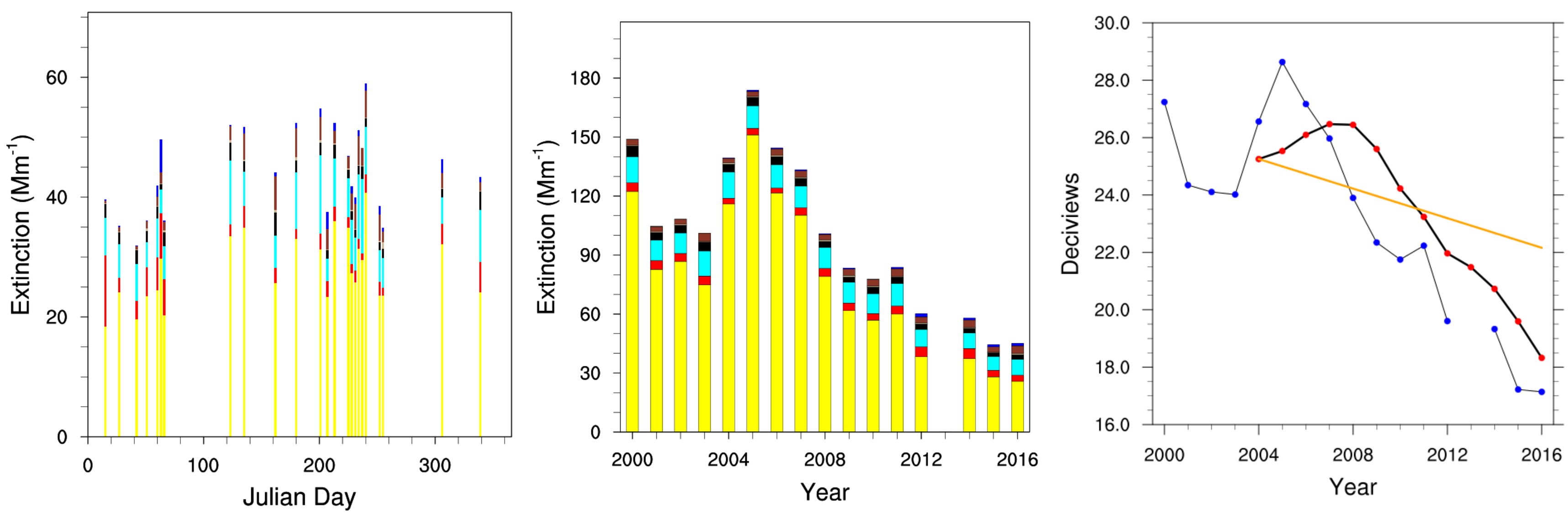
San Rafael, CA



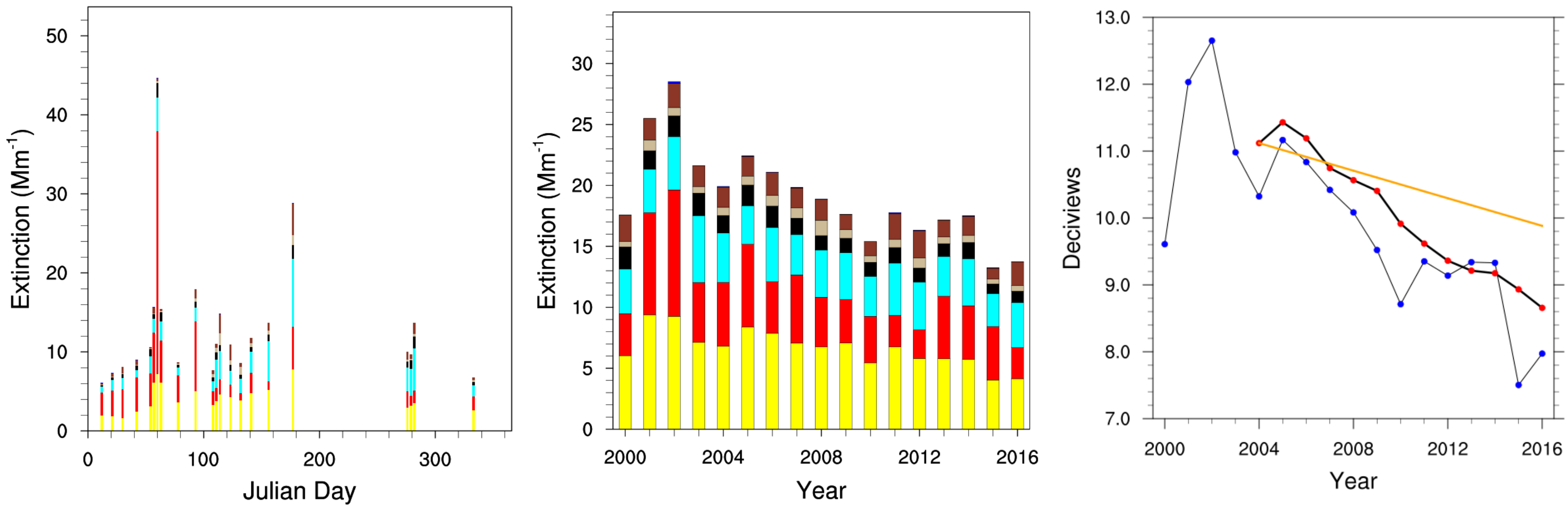
Redwood National Park, CA



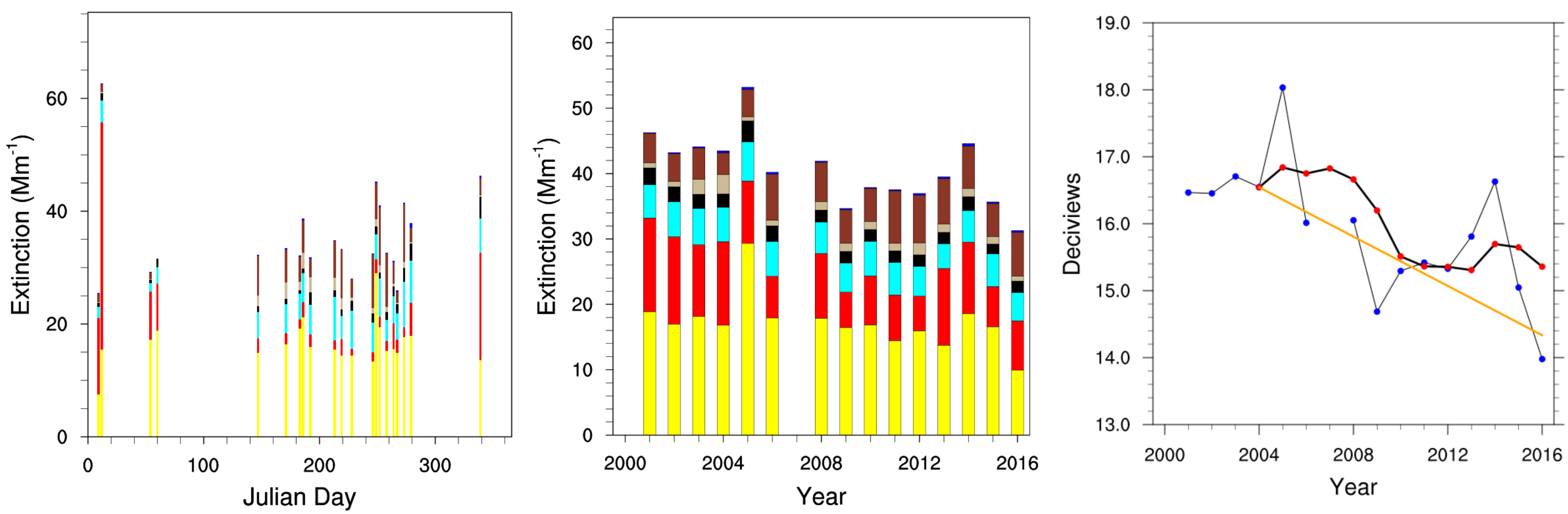
Cape Romain National Wildlife Refuge, SC



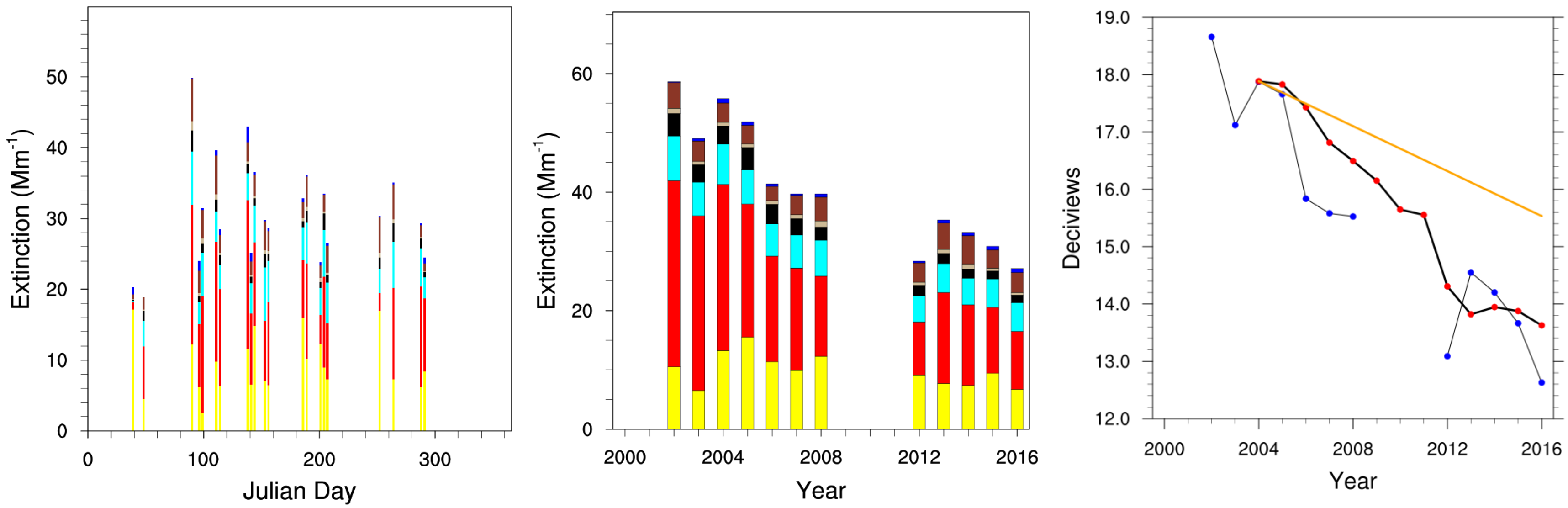
Rocky Mountain National Park, CO



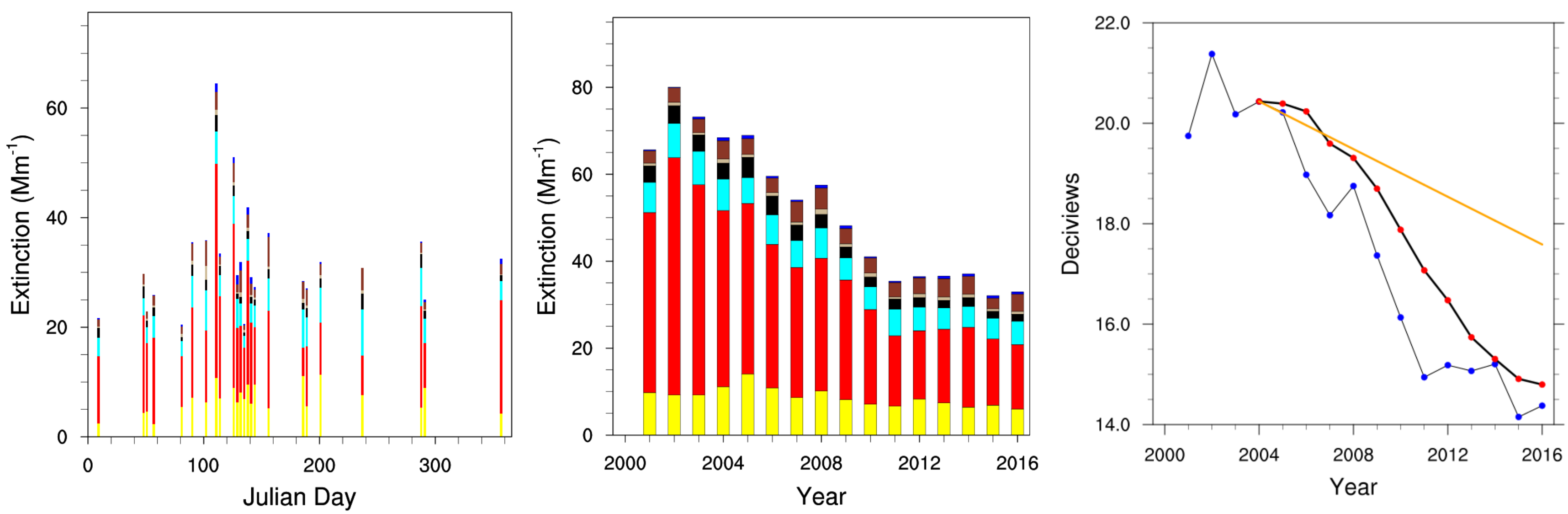
Salt Creek, NM



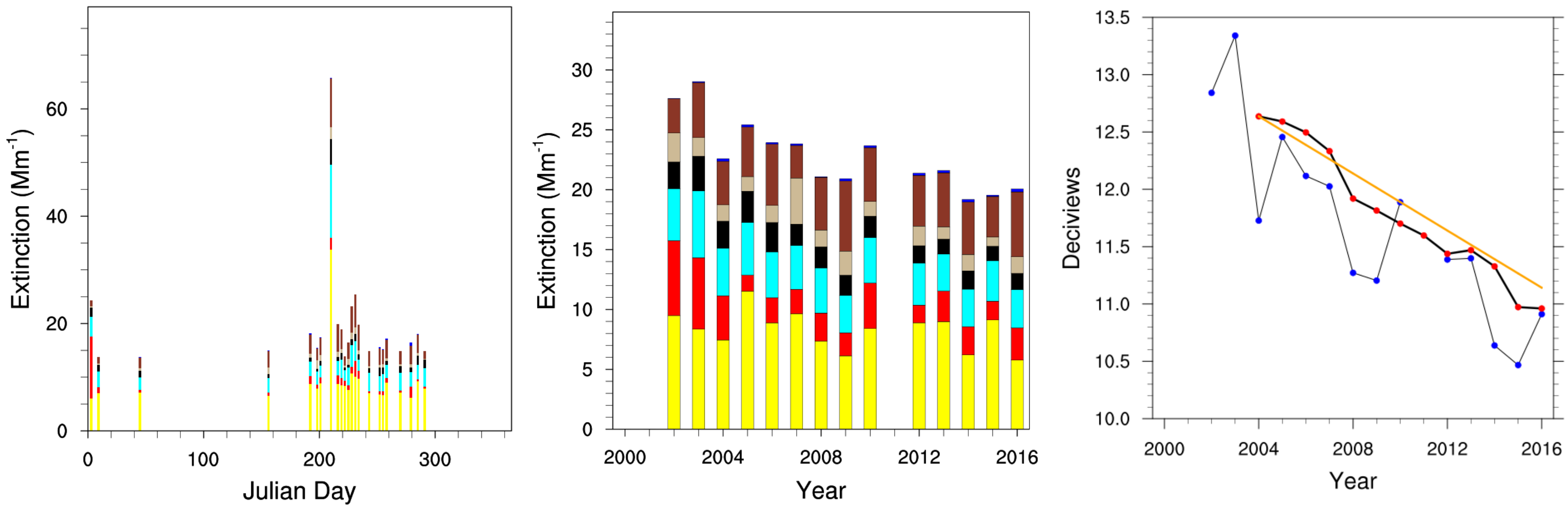
San Gabriel, CA



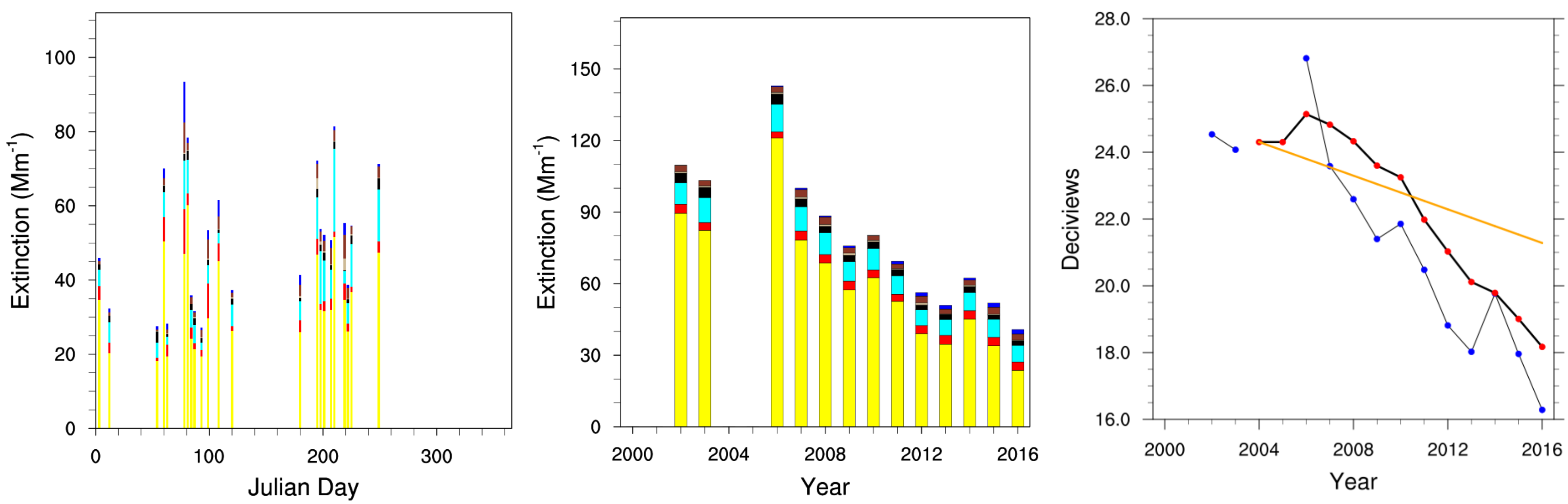
San Gorgonio Wilderness, CA



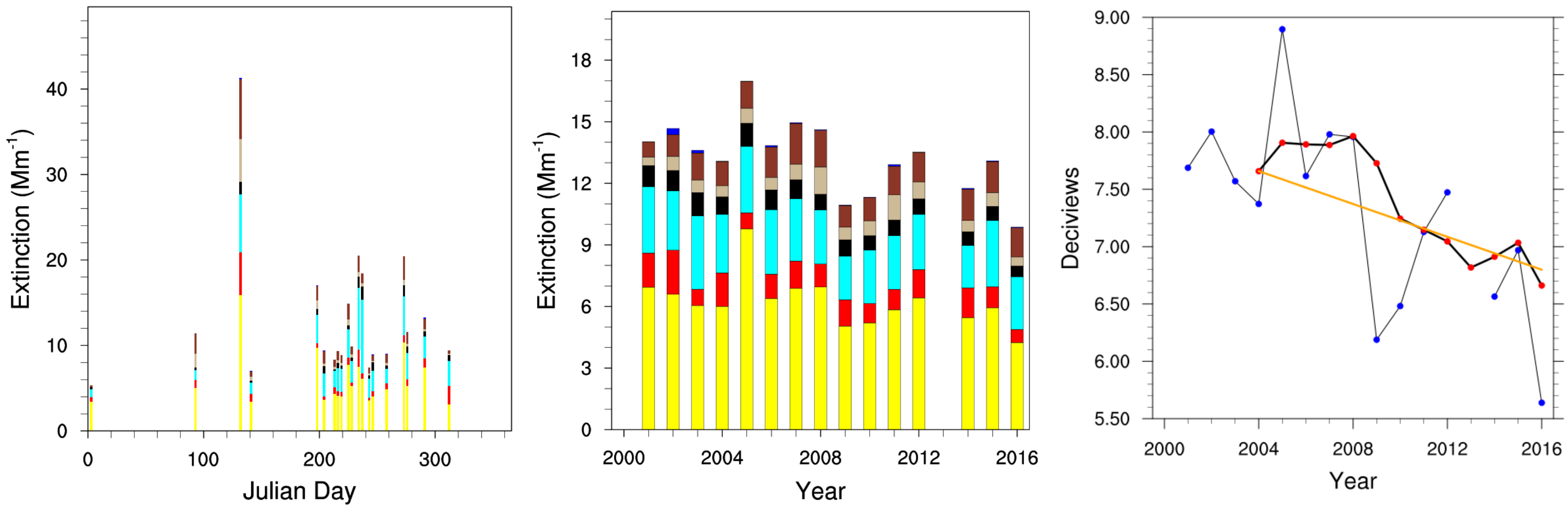
Saguaro National Monument, AZ



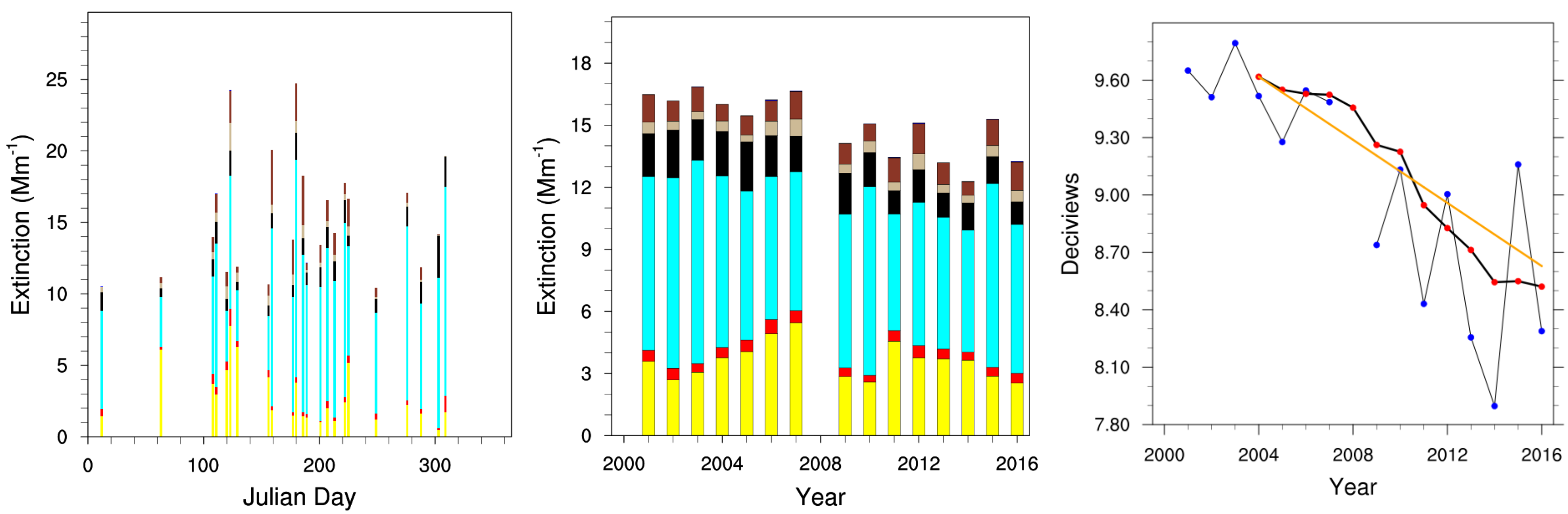
St. Marks, FL



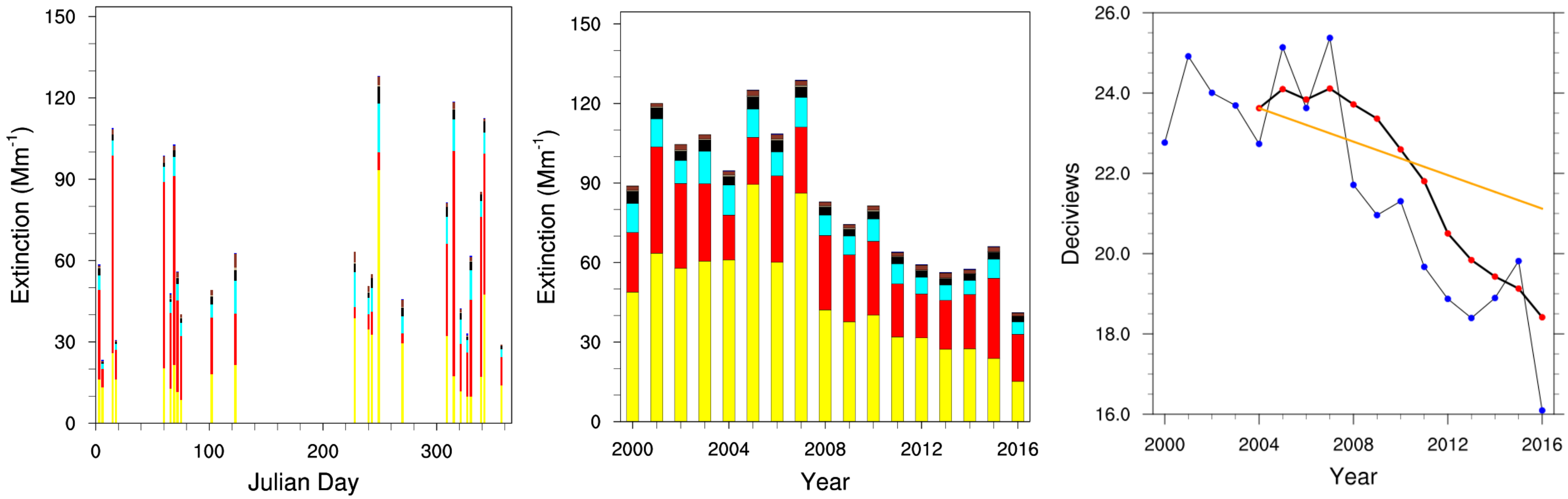
San Pedro Parks, NM



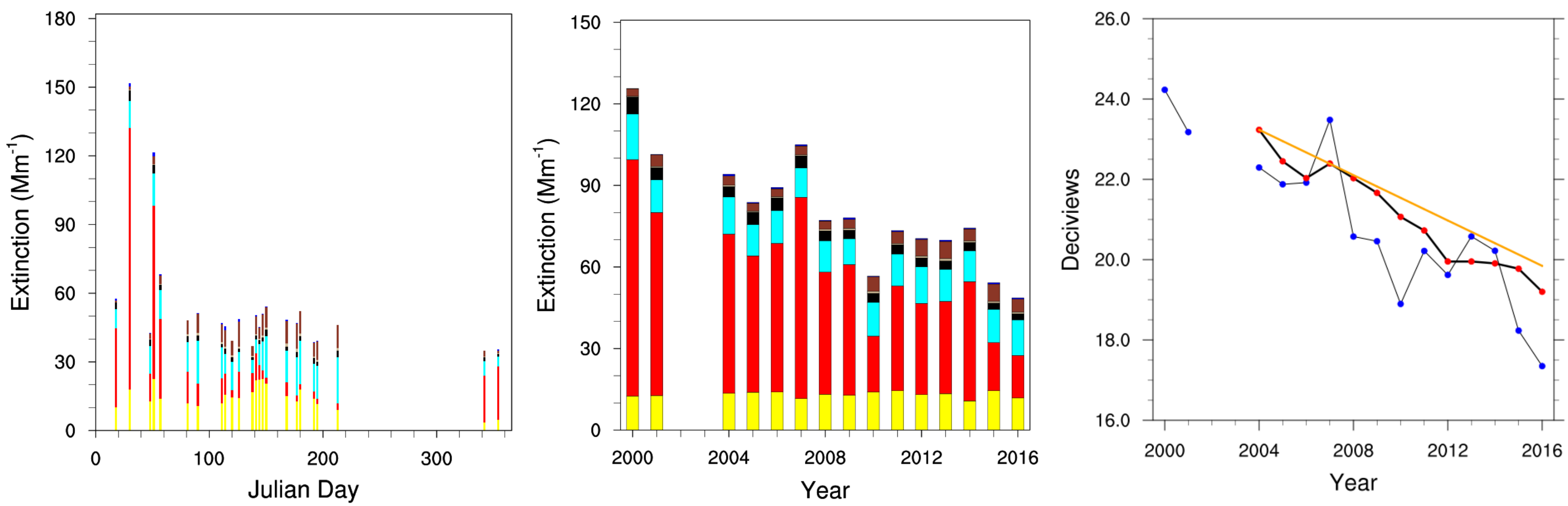
Sawtooth National Forest, ID



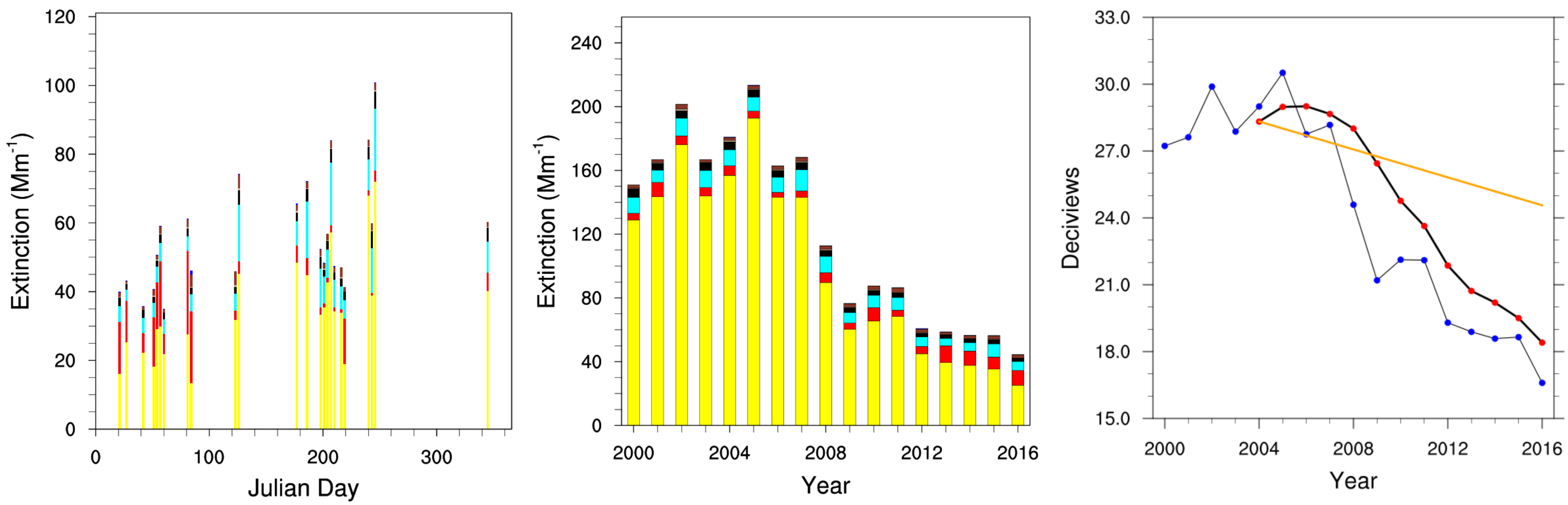
Seney, MI



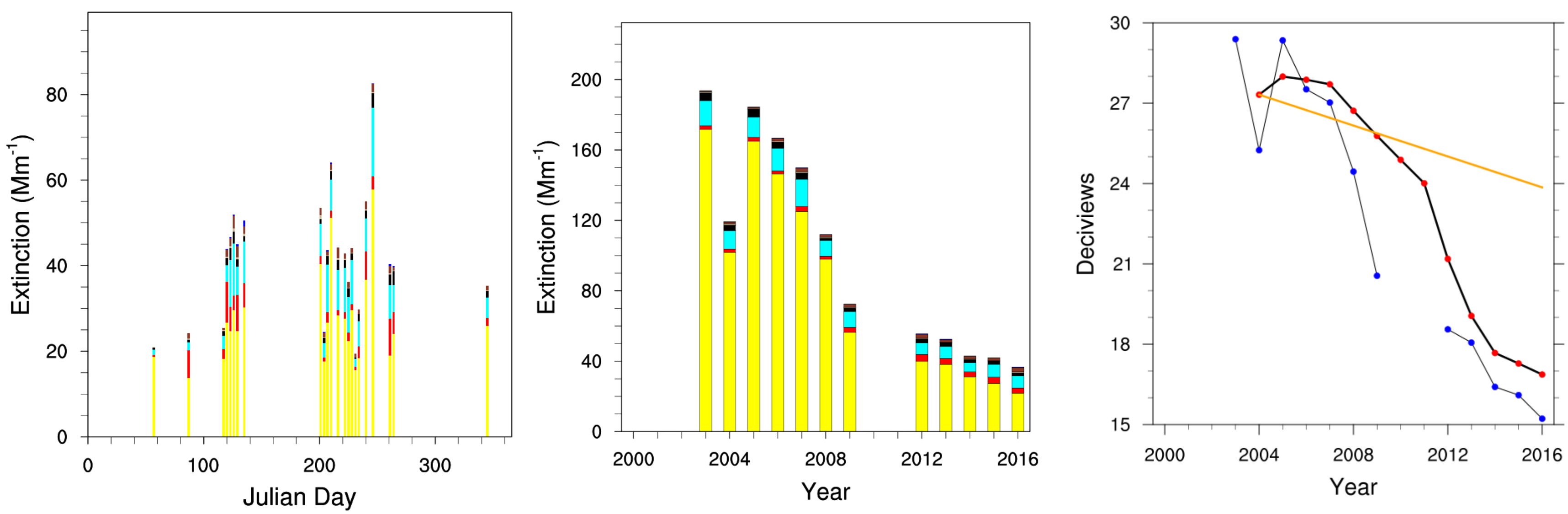
Sequoia National Park, CA



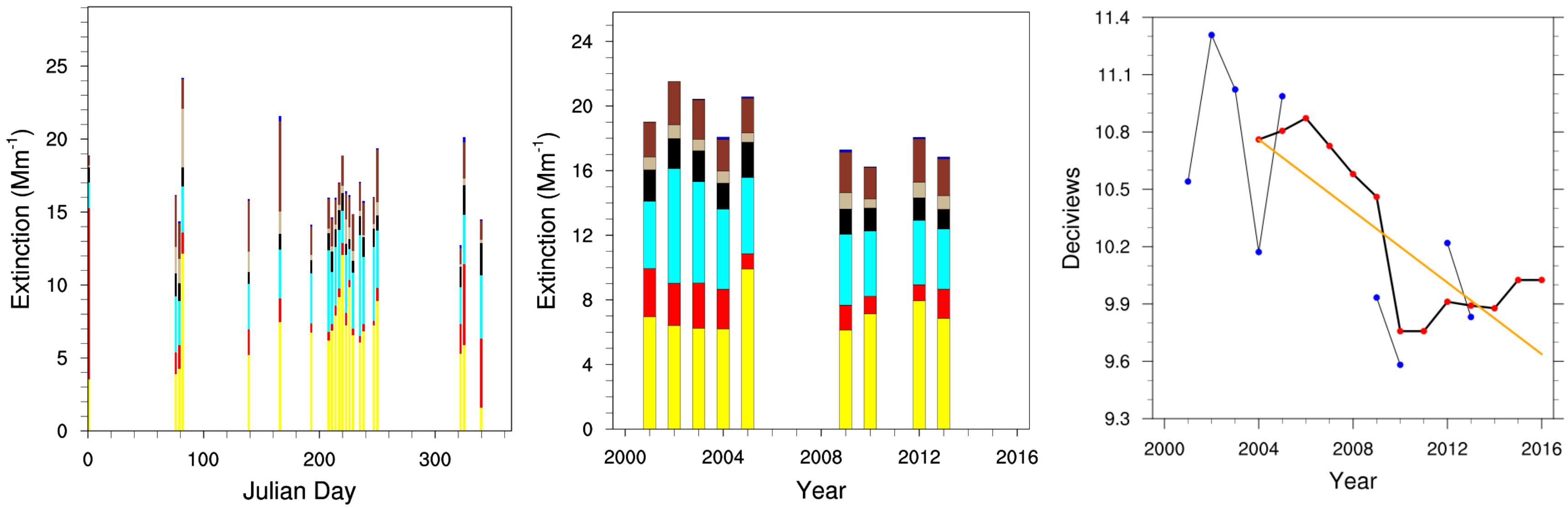
Shenandoah National Park, VA



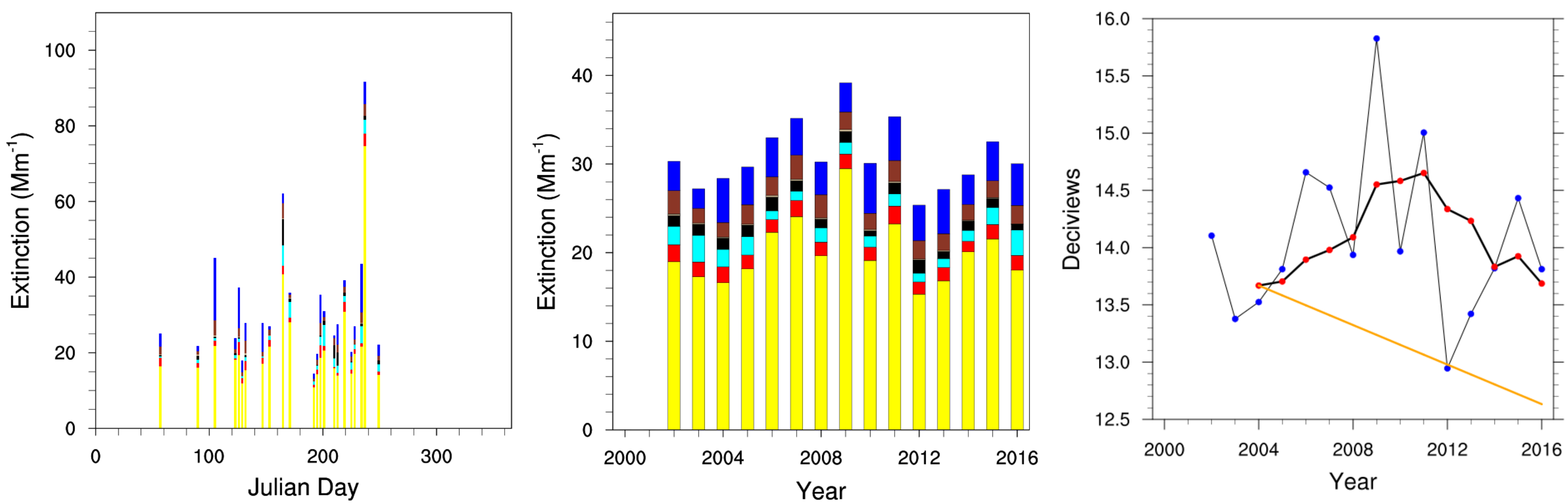
Shining Rock Wilderness, NC



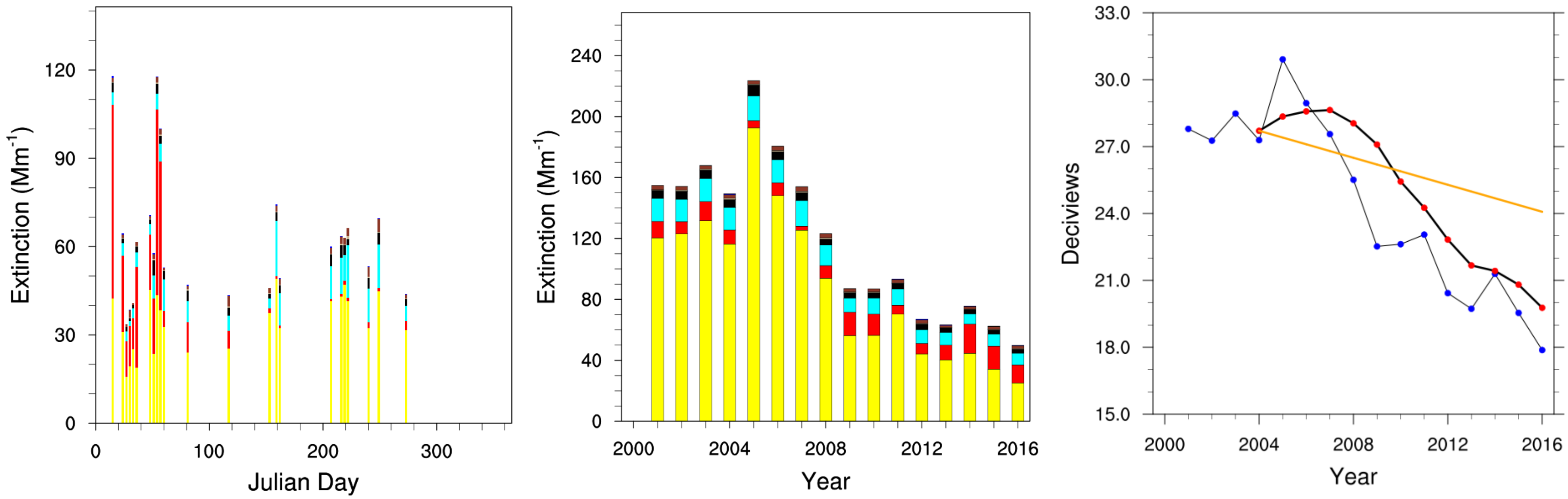
Sierra Ancha, AZ (2013 data shown on figures in left column)



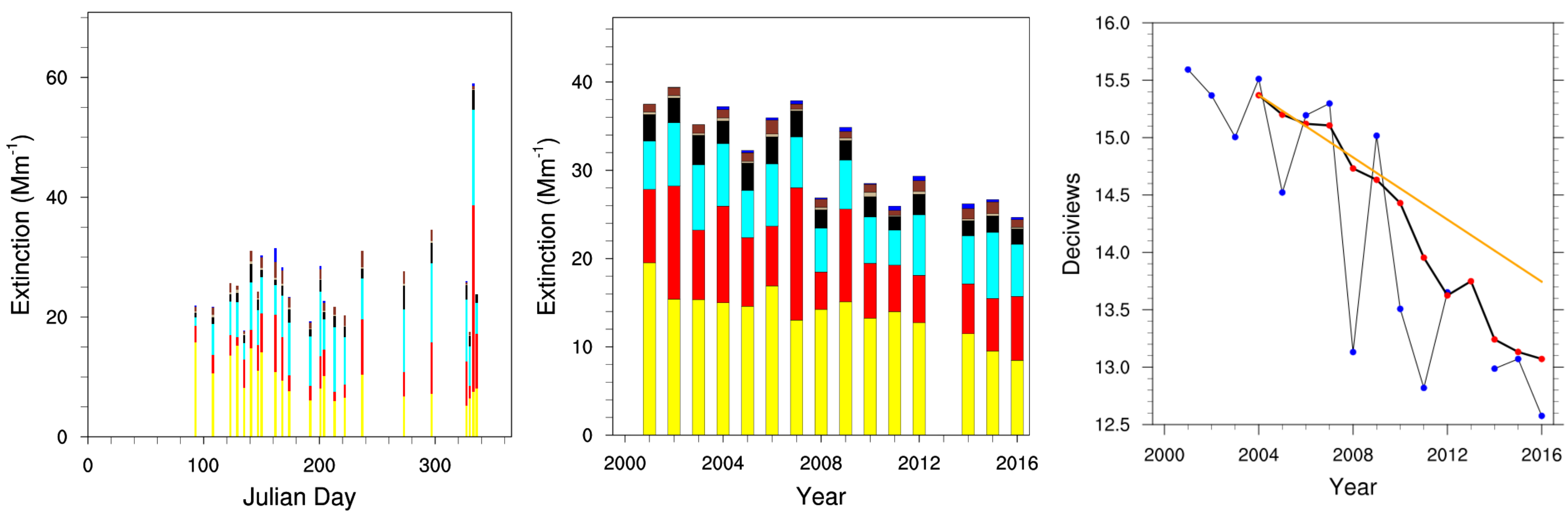
Simeonof, AK



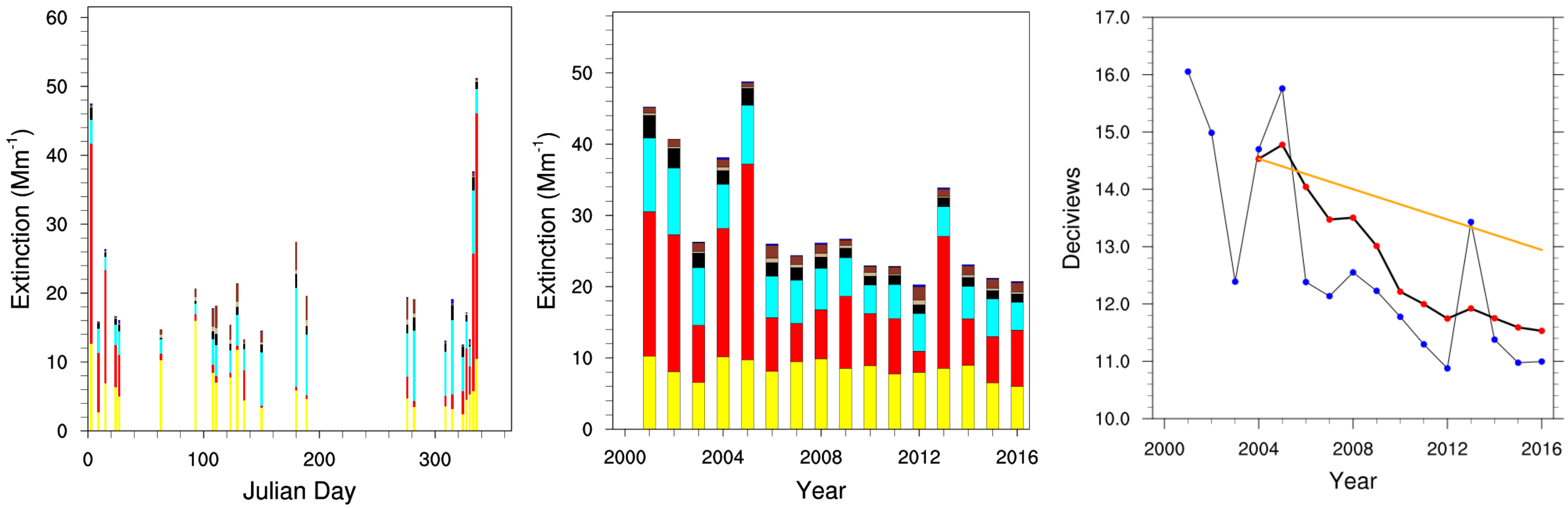
Sipsey Wilderness, AL



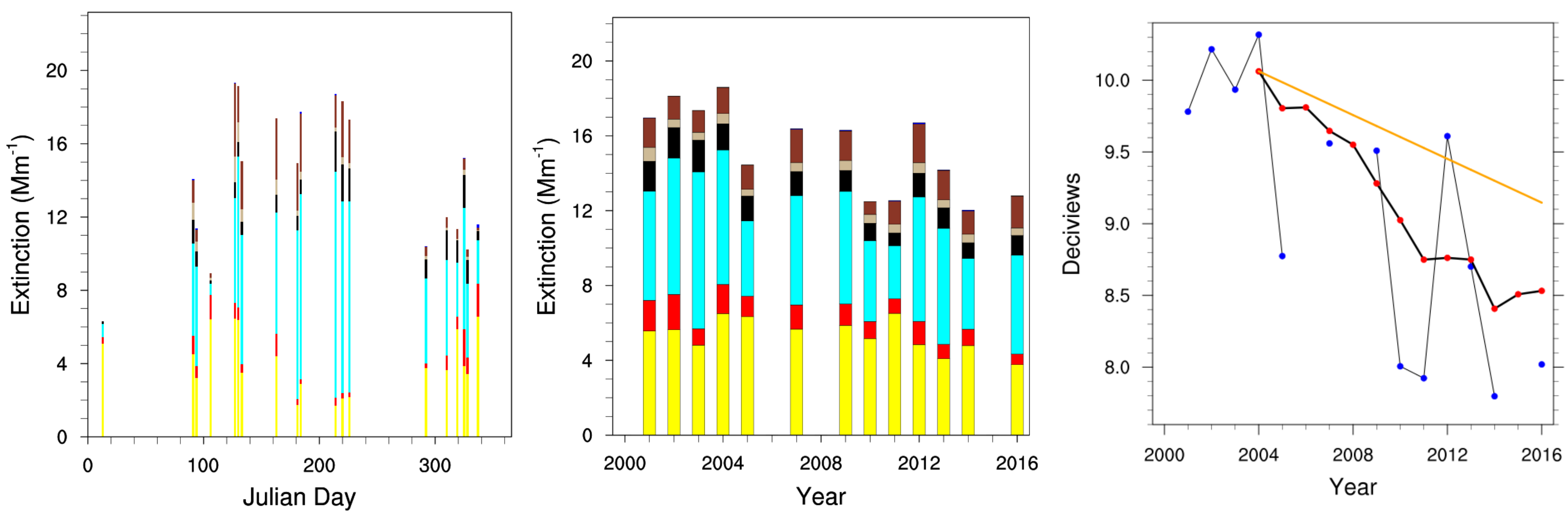
Snoqualmie Pass, WA



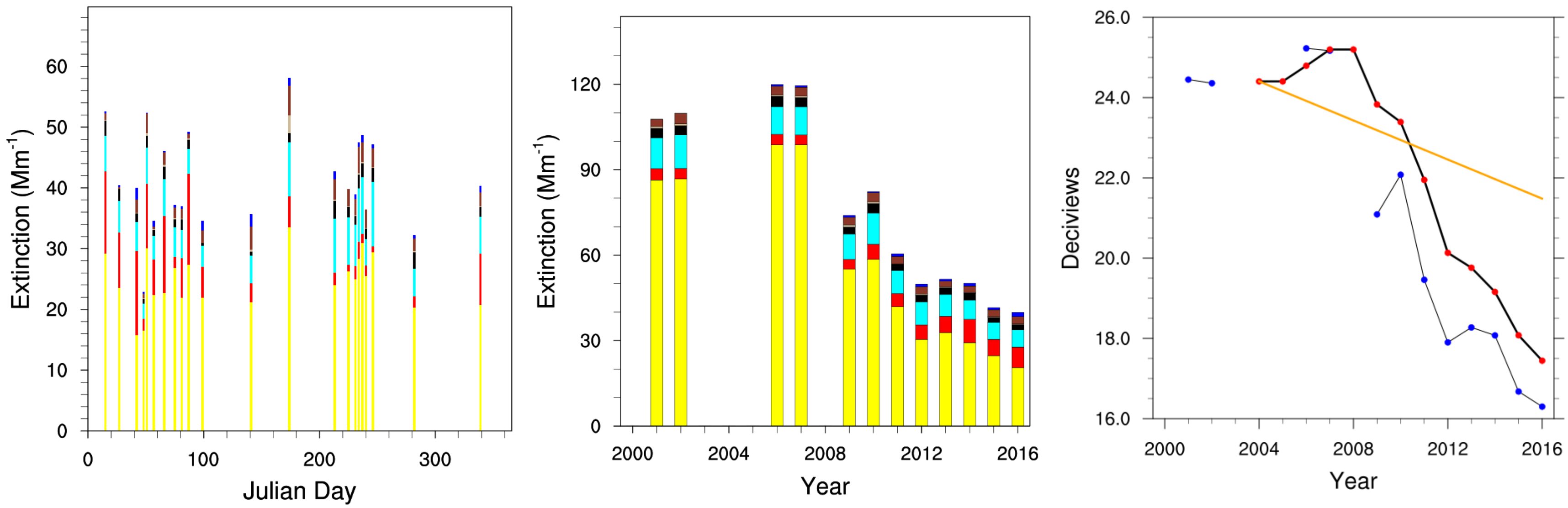
Starkey, OR



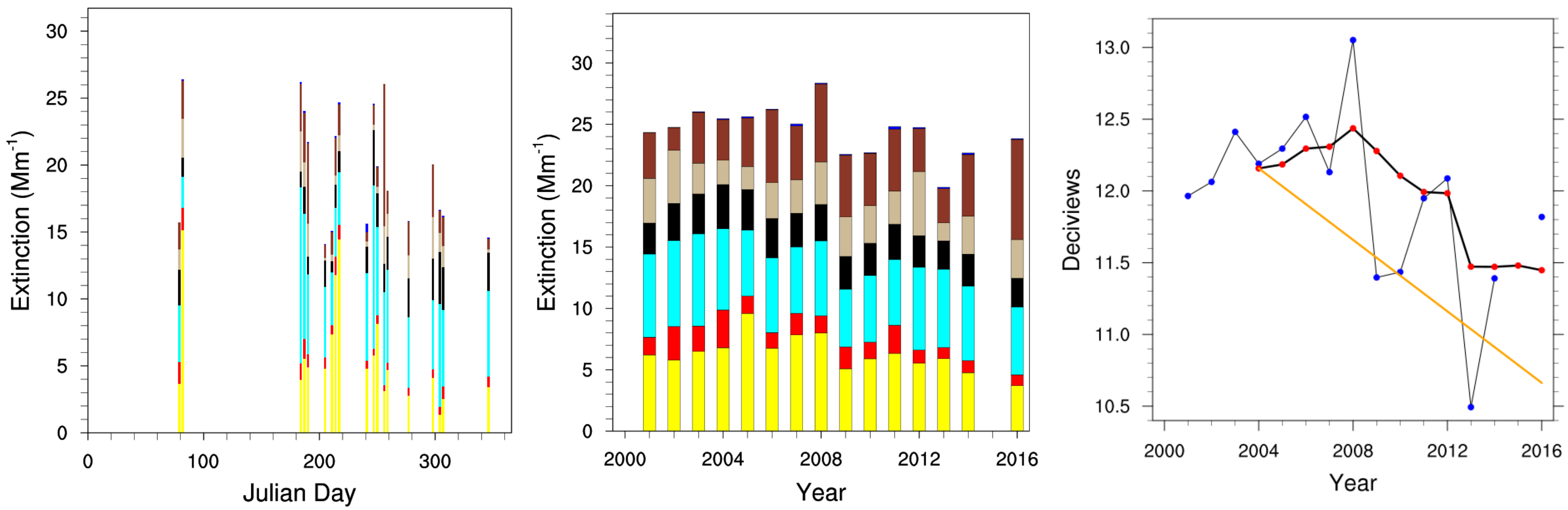
Sula Peak, MT (2013 data shown for figures in right column)



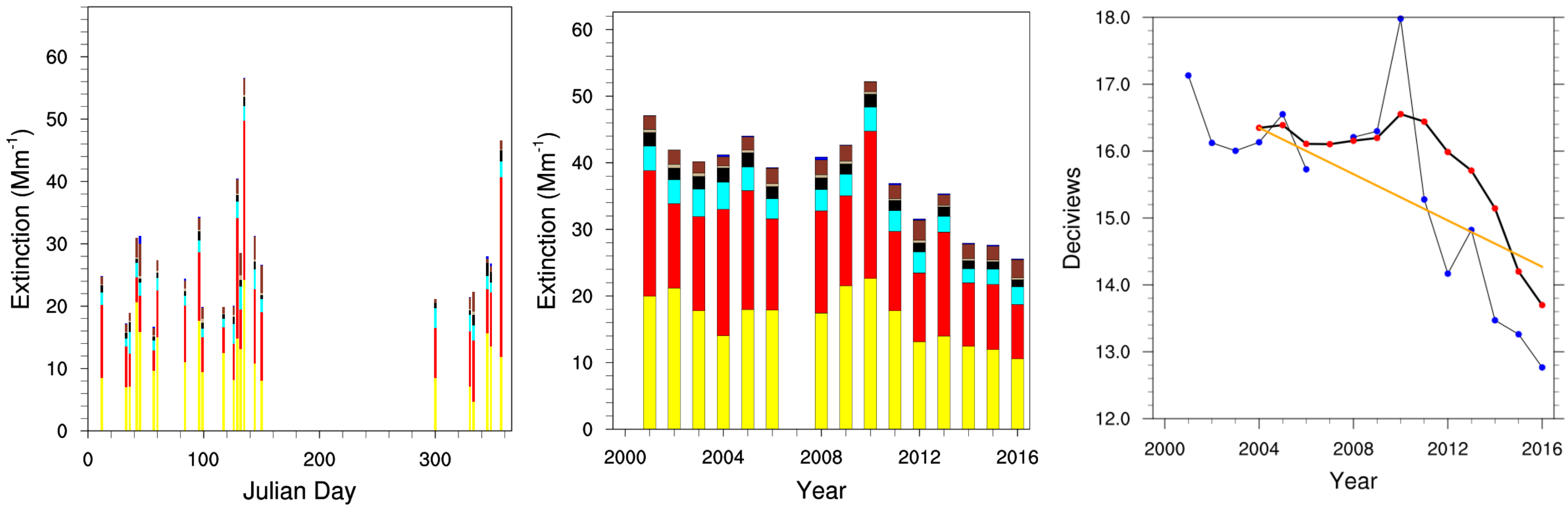
Swanquarter, NC



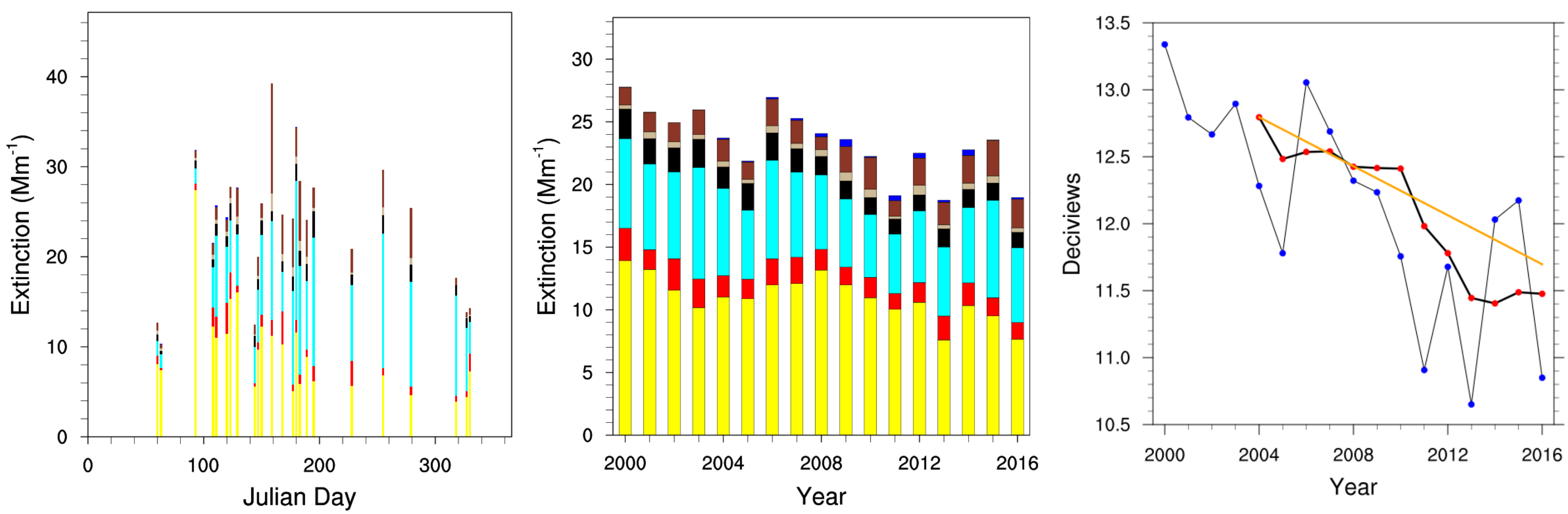
Sycamore Canyon, AZ (2013 data shown for figures in right column)



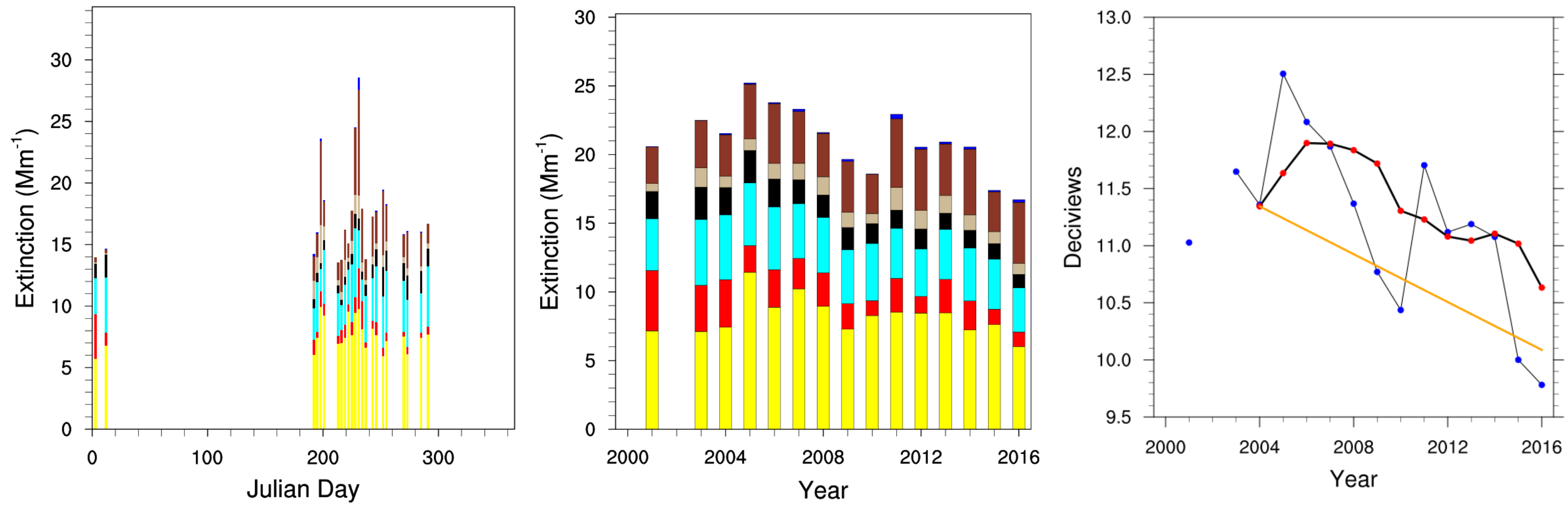
Theodore Roosevelt, ND



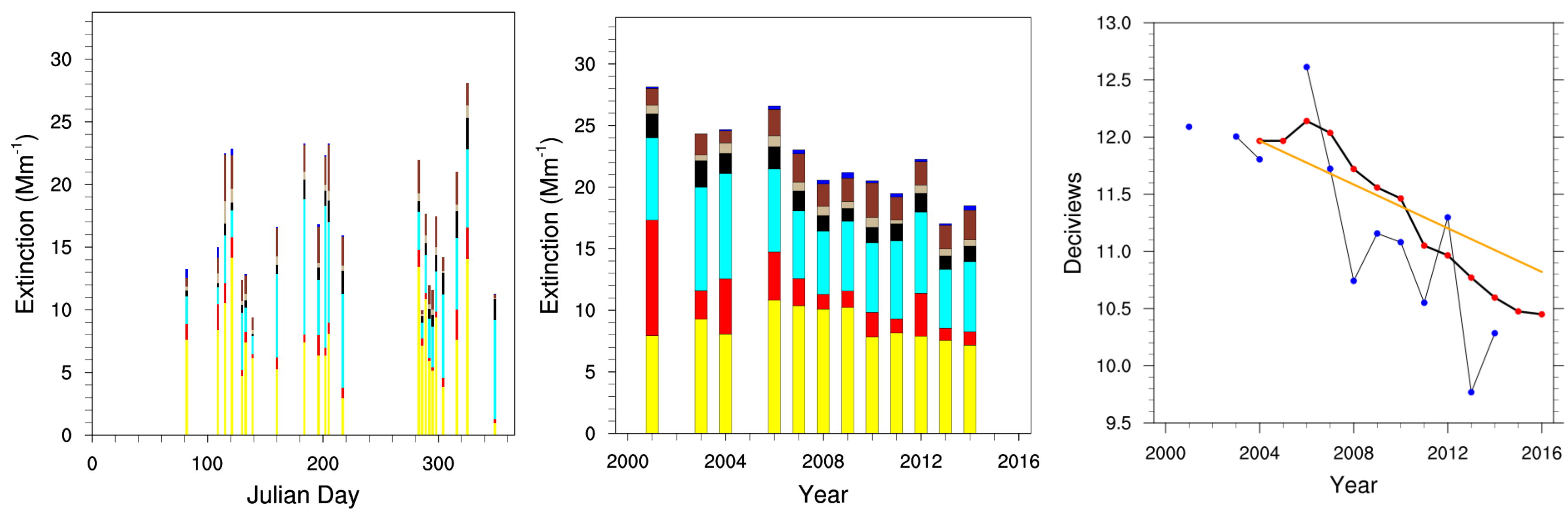
Three Sisters Wilderness, OR



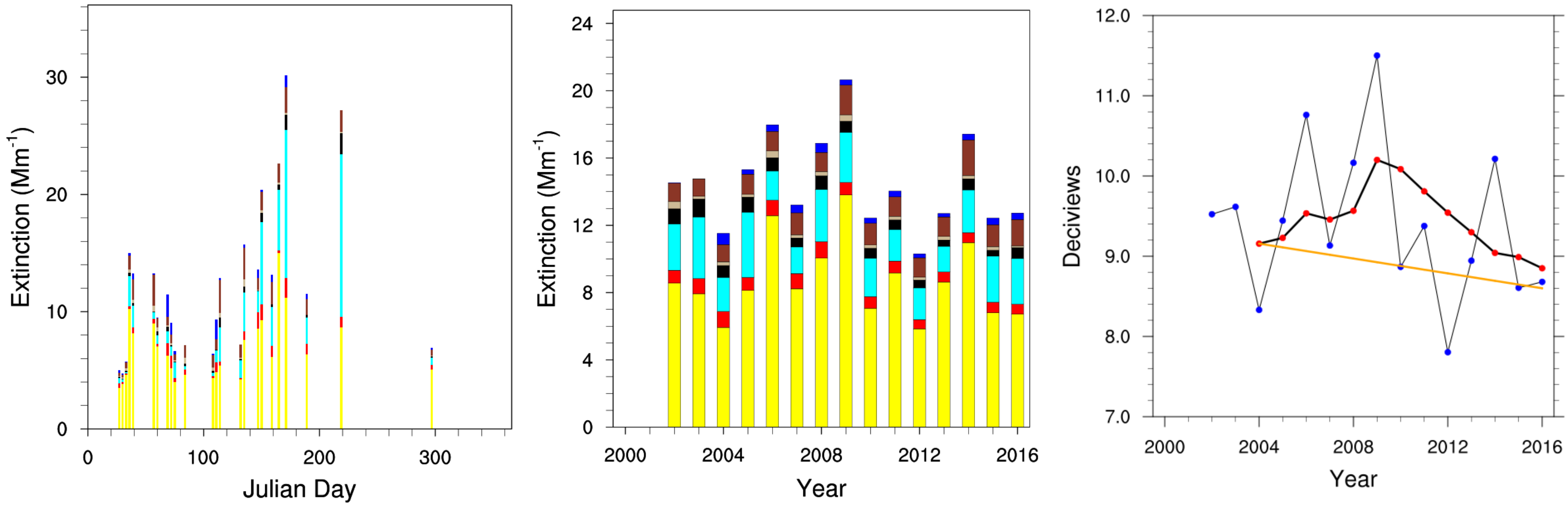
Tonto National Monument, AZ



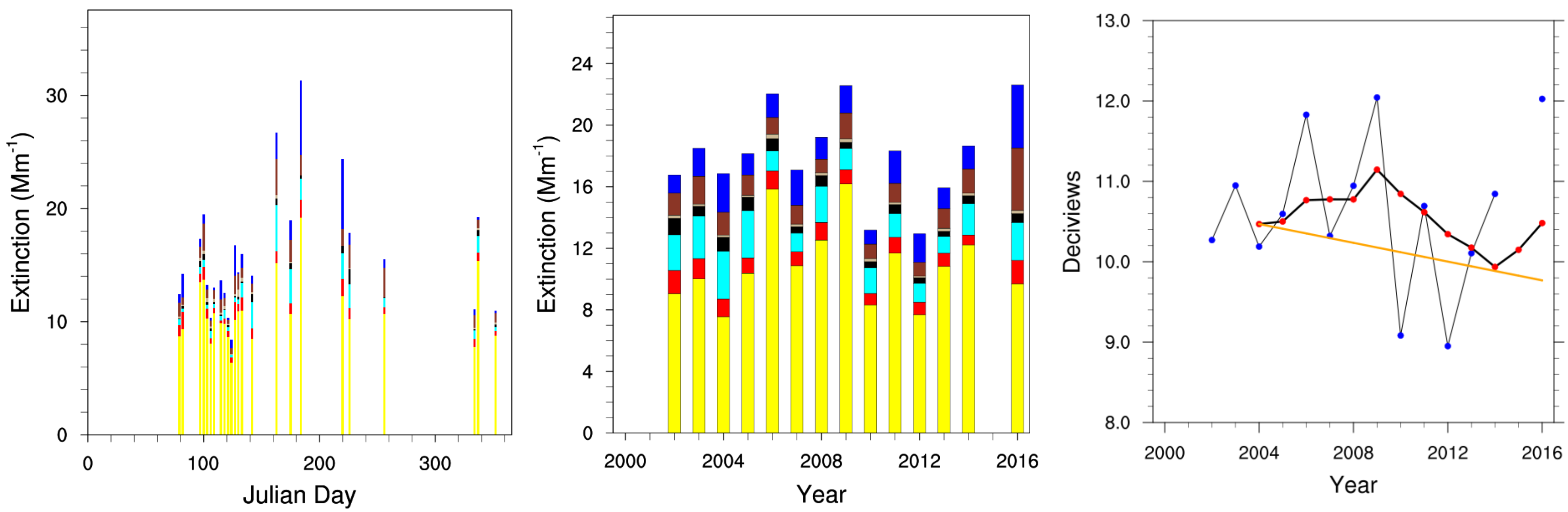
Trinity, CA (2013 data shown for figures in right column)



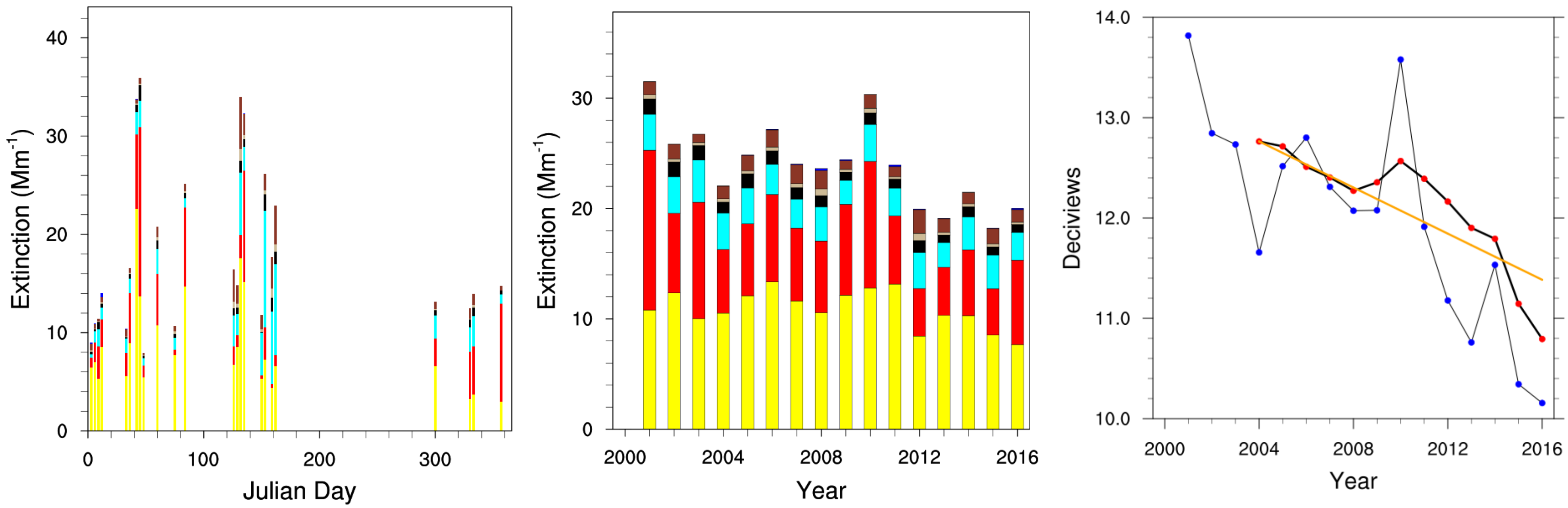
Trapper Creek, AK



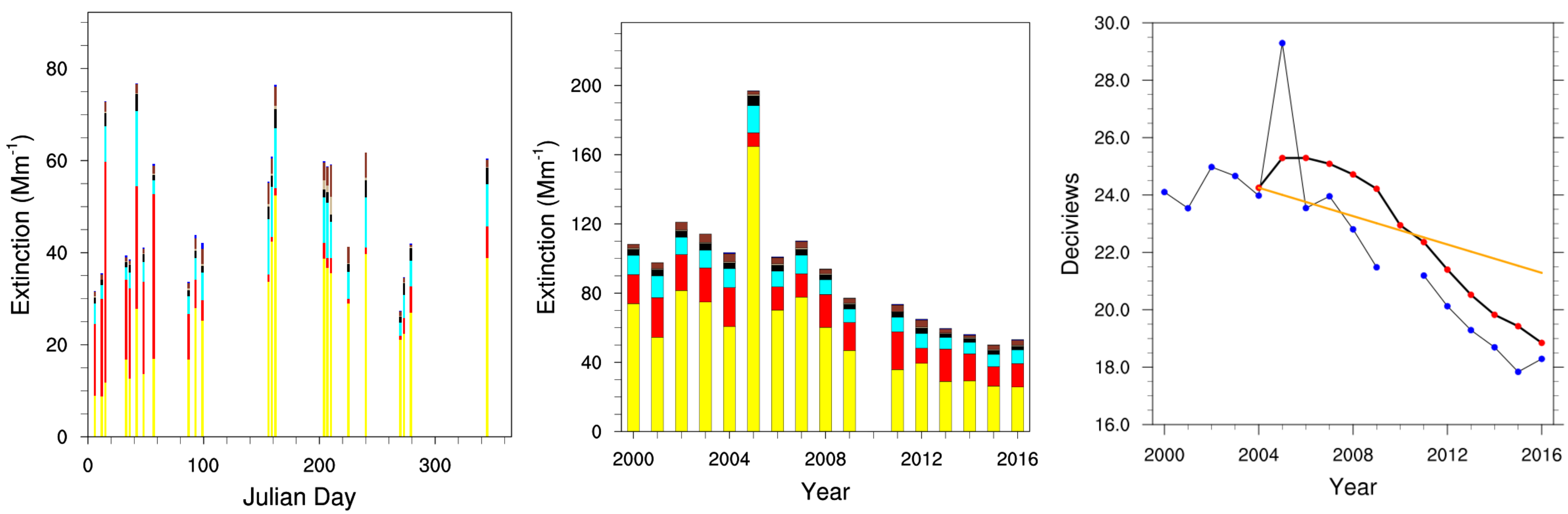
Tuxedni, AK (2013 data shown for figures in right column)



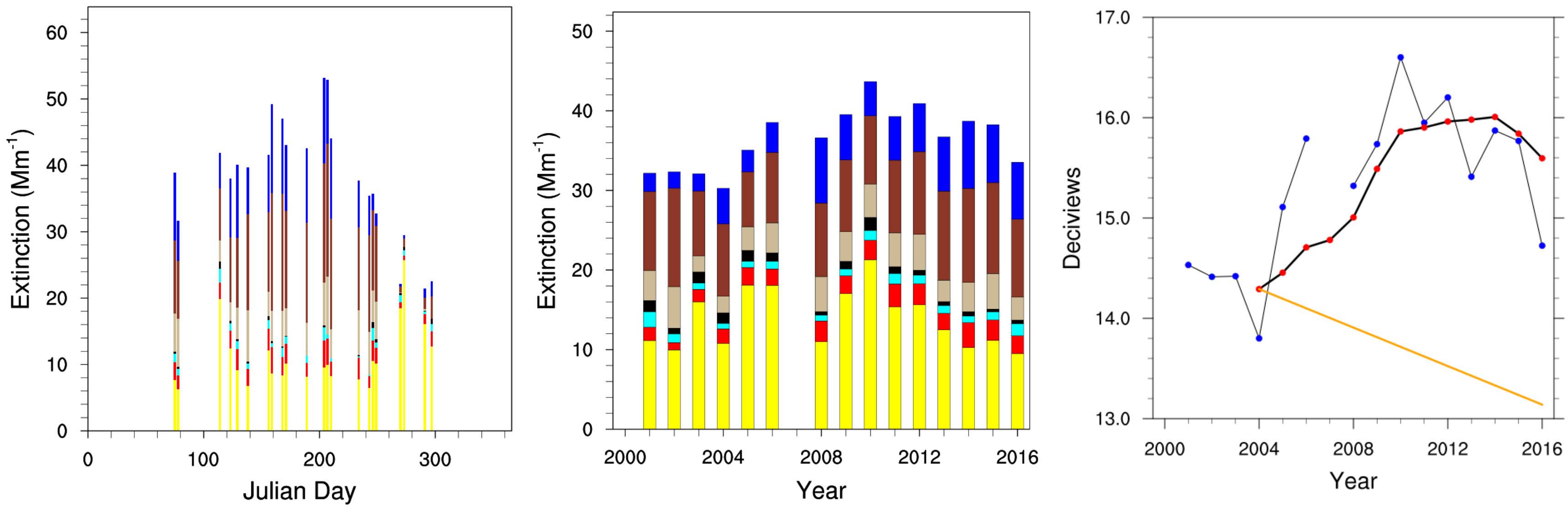
UL Bend, MT



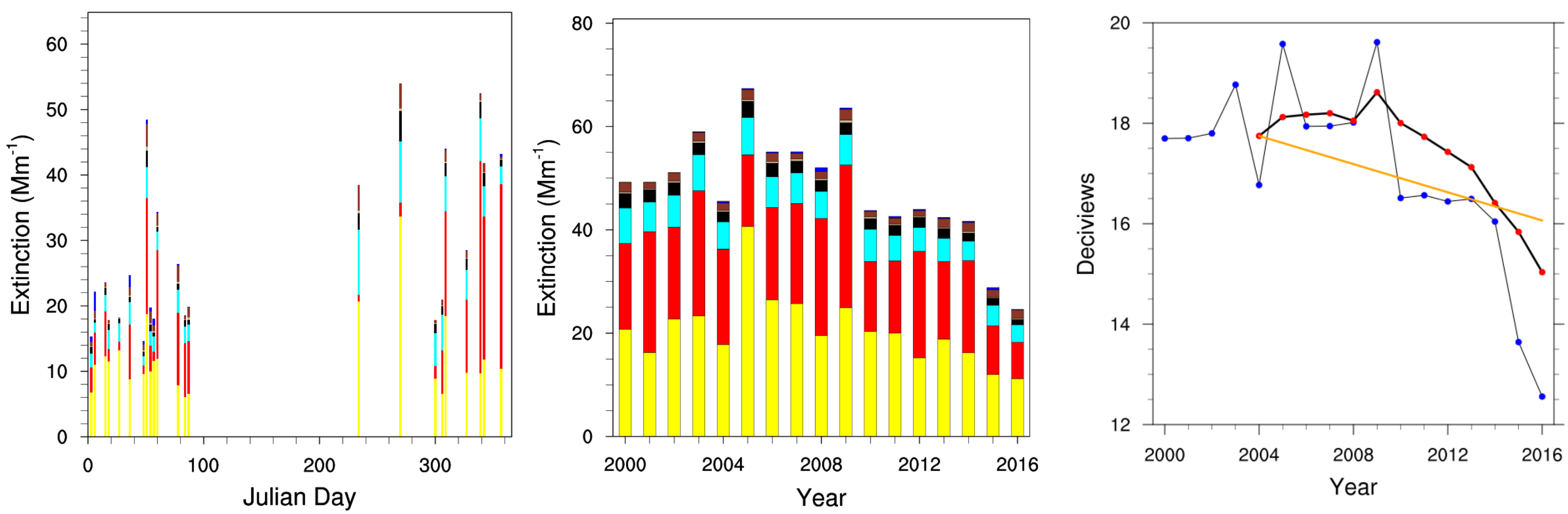
Upper Buffalo Wilderness, AR



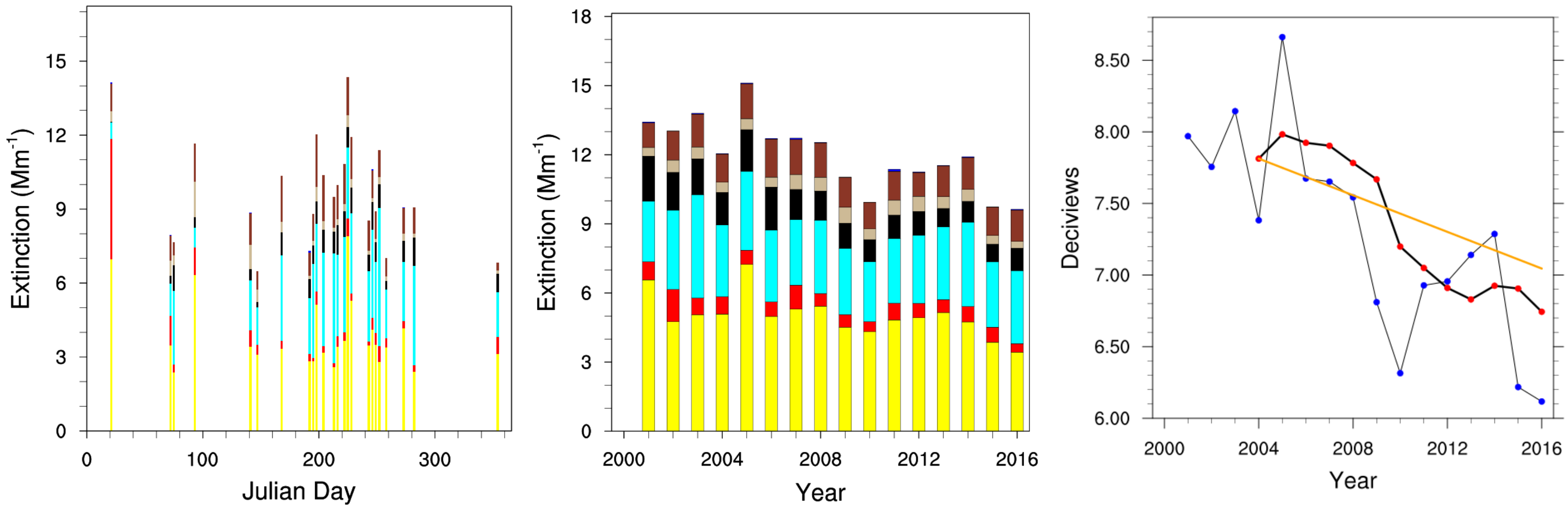
Virgin Islands National Park, VI



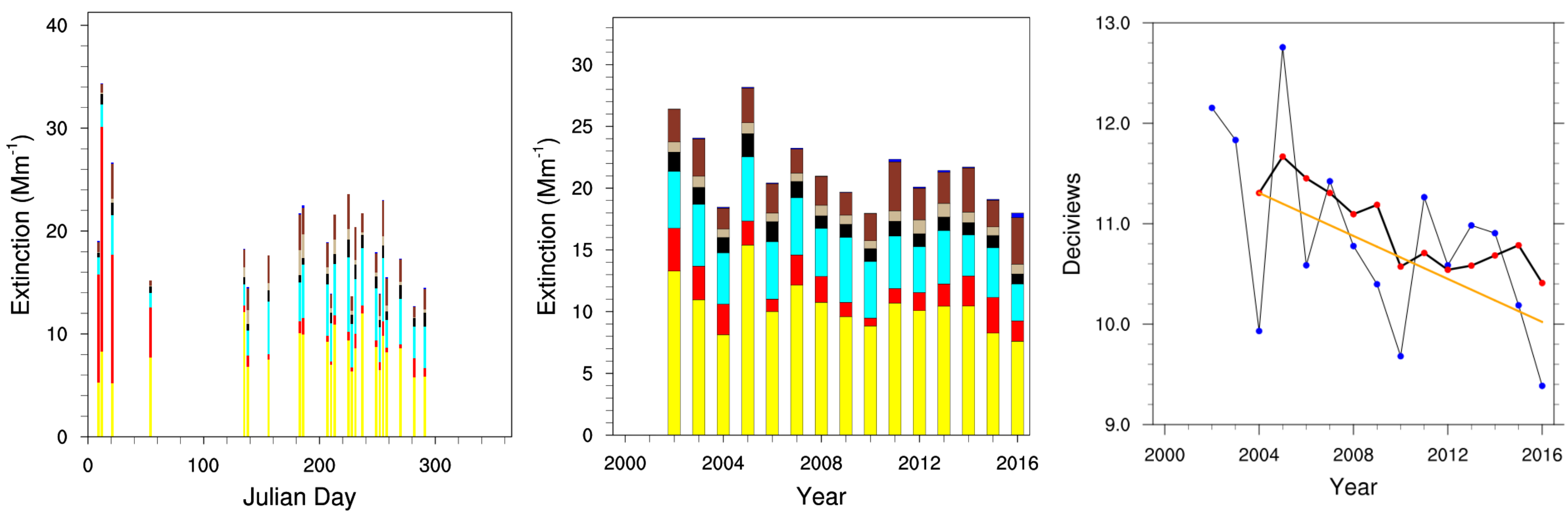
Voyageurs National Park, MN



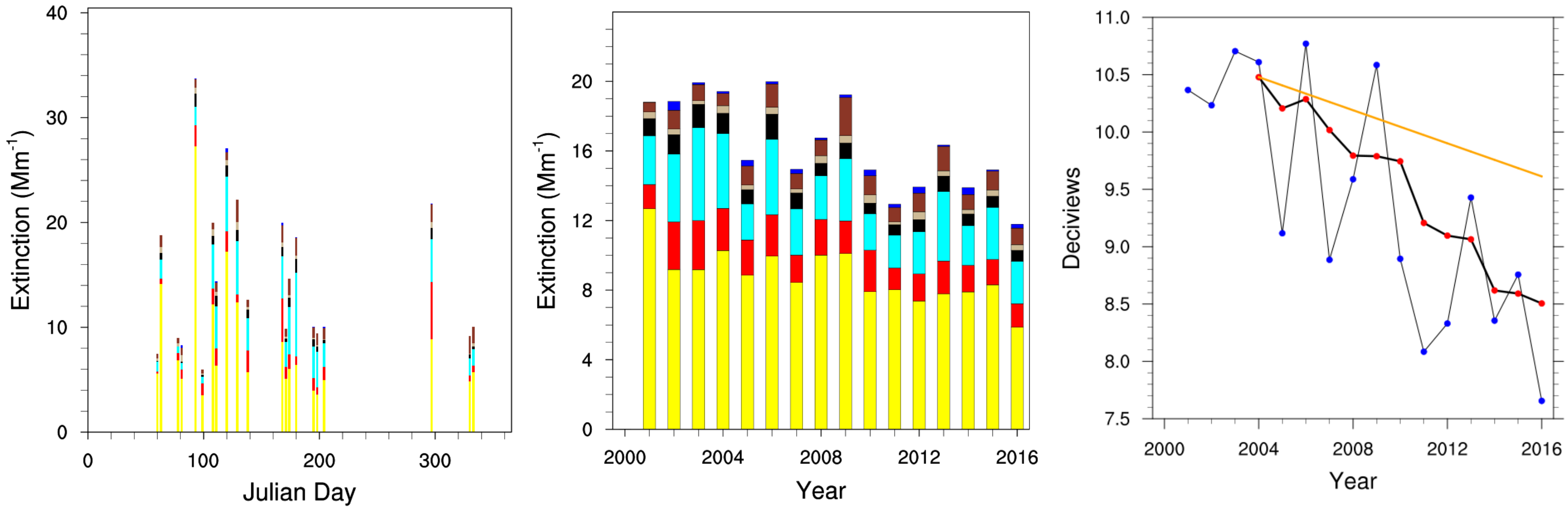
Weminuche Wilderness, CO



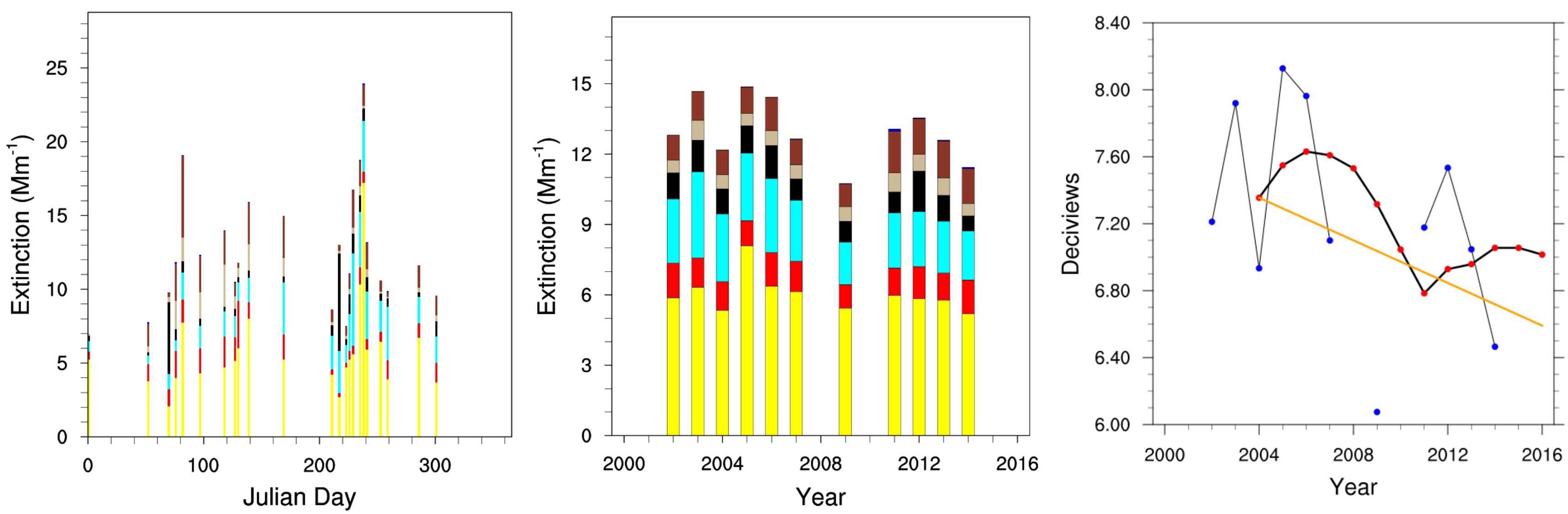
White Mountain, NM



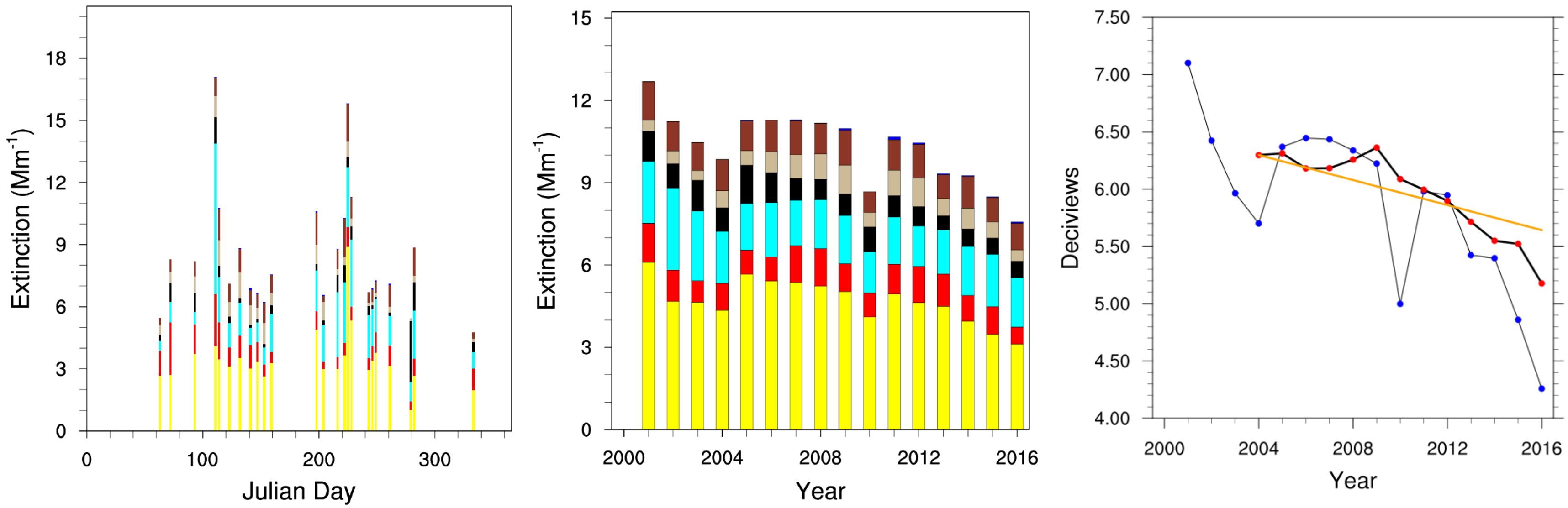
White Pass, WA



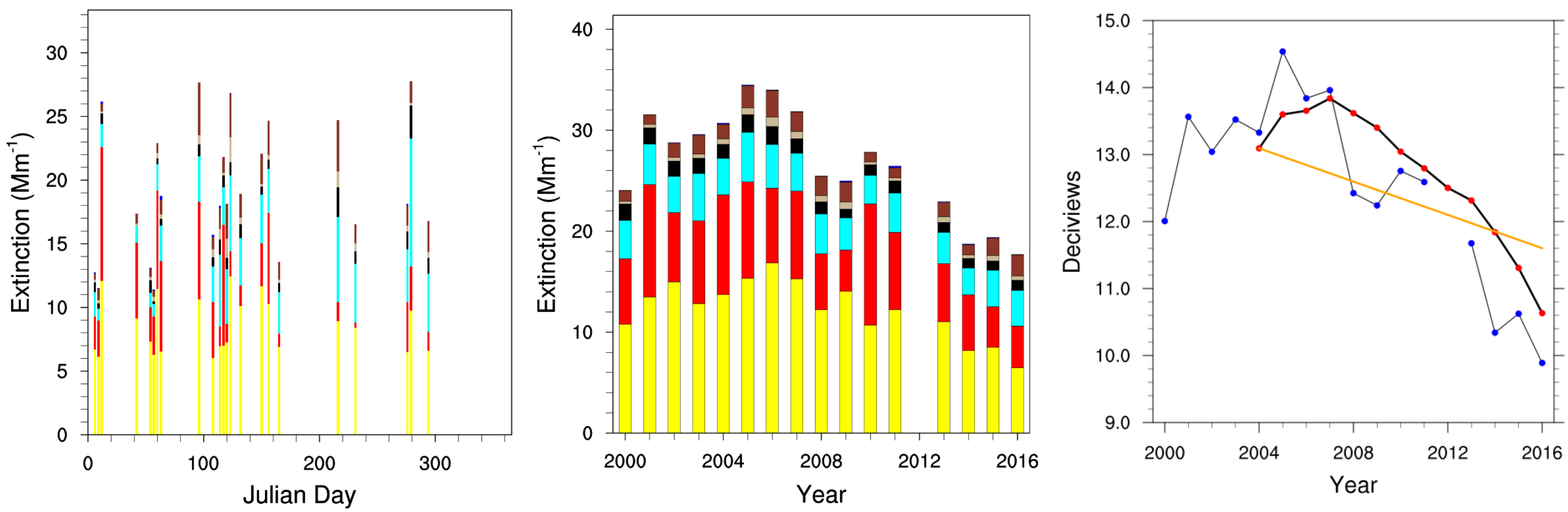
Wheeler Peak, NM (2013 data shown for figures in right column)



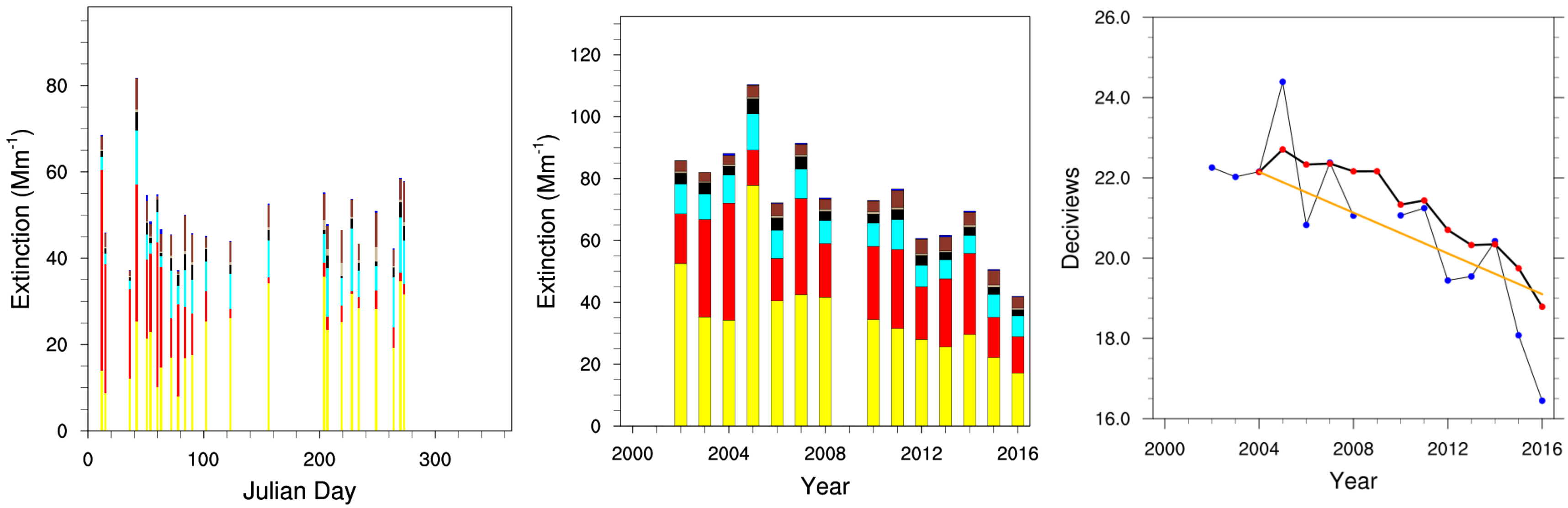
White River National Forest, CO



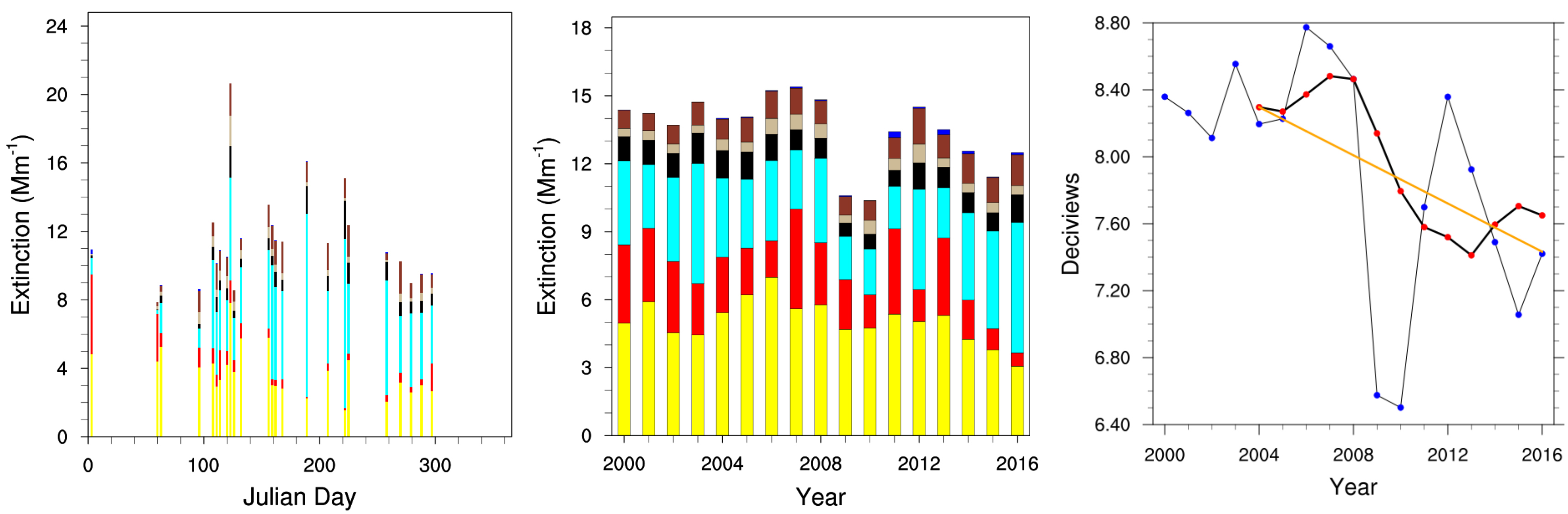
Wind Cave, SD



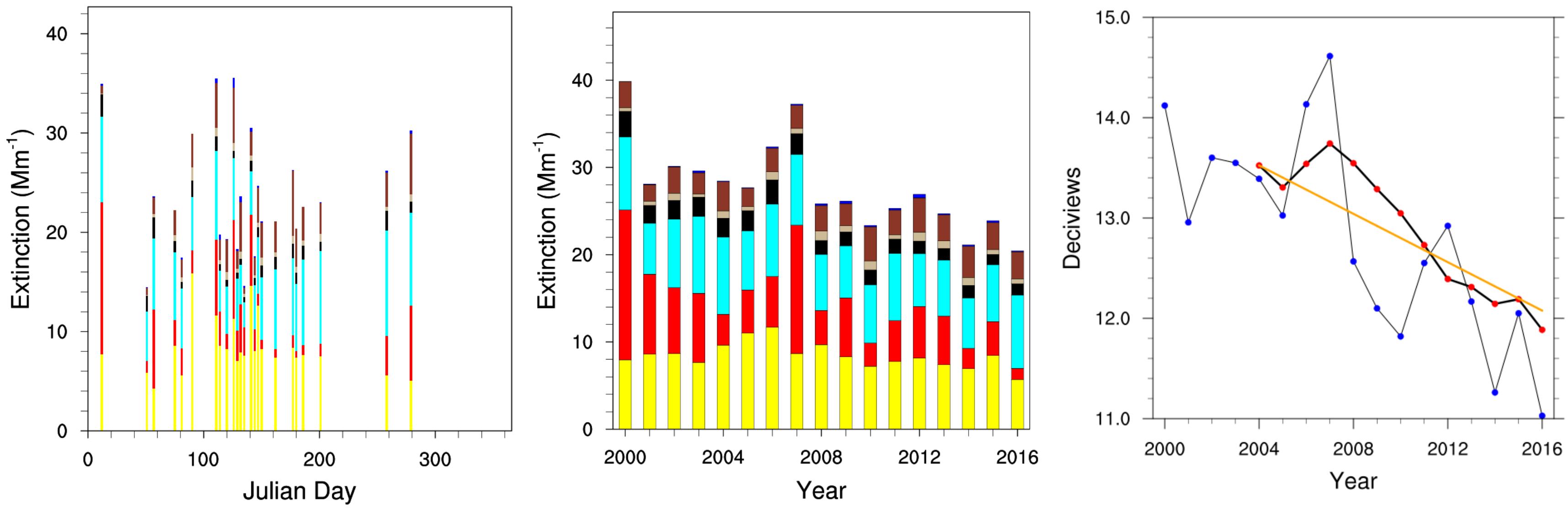
Wichita Mountains, OK



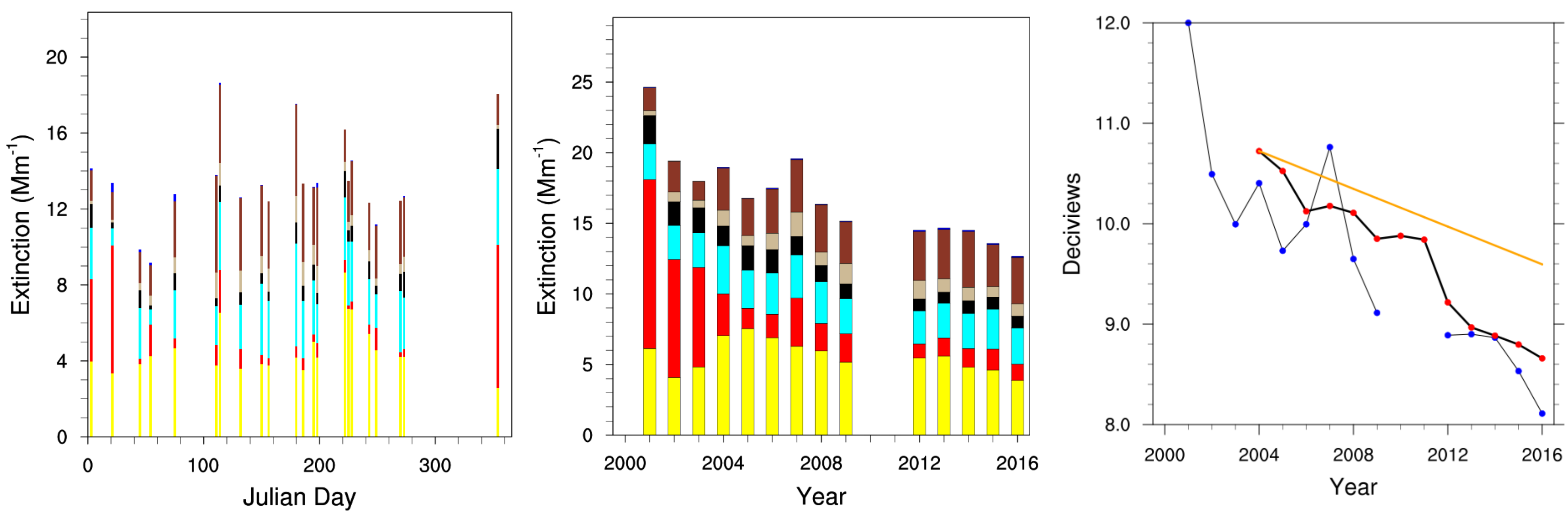
Yellowstone National Park, WY



Yosemite National Park, CA



Zion National Park, UT (combined ZION1 and ZICA1 starting 1/1/04)



United States Environmental Protection Agency	Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC	Publication No. EPA-454/R-18-010 December 2018