

# **Special Considerations for RRFs in the Western US – The WRAP Experience**

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*UCR*; and Tom Moore, *WRAP***

**RPO National Technical Meeting  
Adams Mark Hotel  
Denver, Colorado  
June 10, 2005**

# Content – WRAP Vis Projections

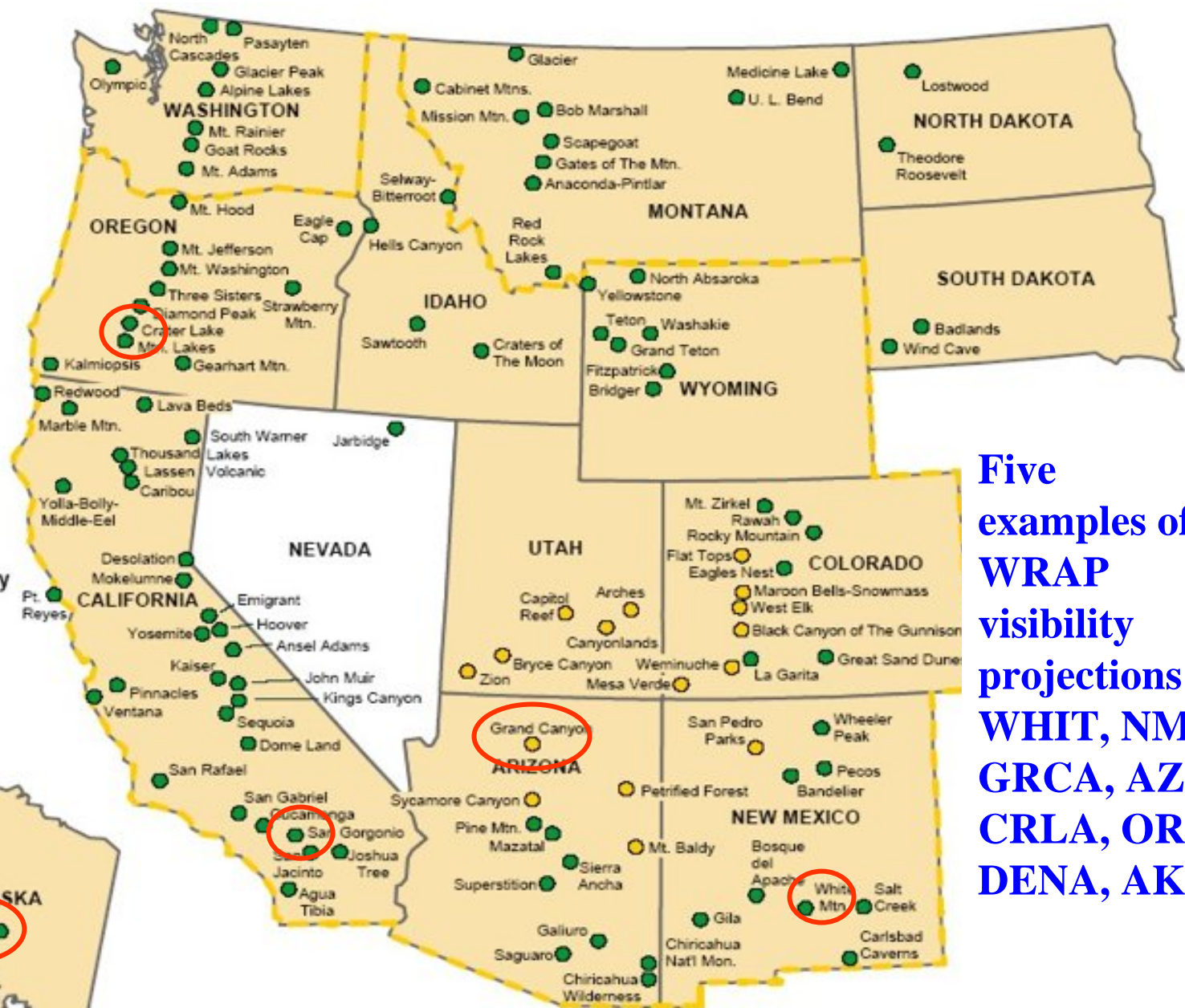
- Background
  - Why demonstrating reasonable progress will be difficult in WRAP region
- Characterization of WRAP Visibility
  - Causes of Haze (COHA) Study
    - <http://www.coha.dri.edu/>
  - Attribution of Haze (AOH) Study
    - <http://www.wrapair.org/forums/aoh/>
- Example Class I areas
  - Causes of visibility impairment (all and Worst 20%)
  - Example 2018 visibility projections using VISTAS modeling
    - Important caveat: data of opportunity, VISTAS data not designed for WRAP projections, for example does not include Section 309 SO2 Annex controls
- Conclusions
  - WOE reasonable progress demonstration likely necessary

# WRAP RRF Considerations

- Worst days not always dominated by SO<sub>4</sub>; OMC, NO<sub>3</sub> and/or CM can be more important than SO<sub>4</sub> at many sites
  - California NO<sub>3</sub> issue
  - Southwestern Desert dust (CM)
  - Fires, Fires, Fires, Fires
- Posses unique and special conditions for modeling visibility projections
- May be more difficult to model visibility goals
  - Many sites dominated by fires for Worst 20% days and assumed to remain unchanged from 2002 to 2018
  - Don't CAIR states
  - Point source SO<sub>2</sub> and NO<sub>x</sub> controls much less effective at reducing visibility in west compared to east

# Western Regional Air Partnership

-  State Member
-  Grand Canyon Visibility Transport Region
-  Class I Area \*
-  Class I Area (Colorado Plateau) \*\*



Five examples of WRAP visibility projections: WHIT, NM GRCA, AZ CRLA, OR DENA, AK

**Notes:**

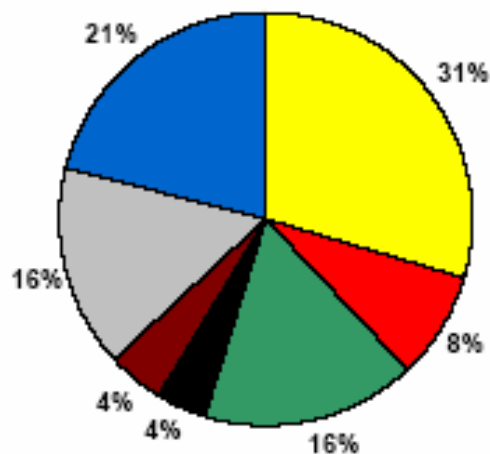
\* Class I areas: Mandatory Federal Class I Areas as published in 40 CFR Subpart D, Section 81.401 through 81.437.

\*\* Those areas above for which states in the Grand Canyon Visibility Transport Region may submit regional haze SIPs in 2003 implementing the recommendations of the Grand Canyon Visibility Transport Commission and therefore satisfying the states' requirement to demonstrate reasonable progress under the Clean Air Act.

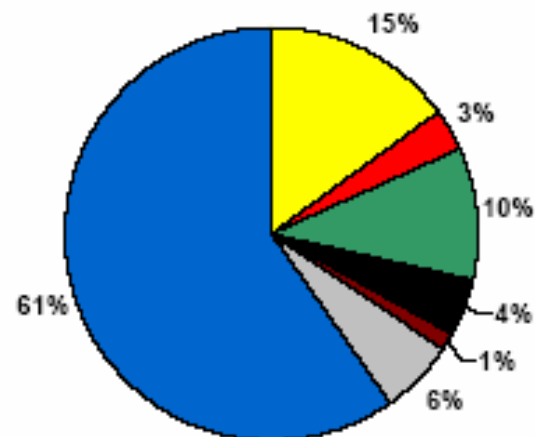
MONITORING DATA

White Mountain Wilderness Area, NM  
 2002 Reconstructed Extinction  
 WHIT1 Monitoring Data (every third day)

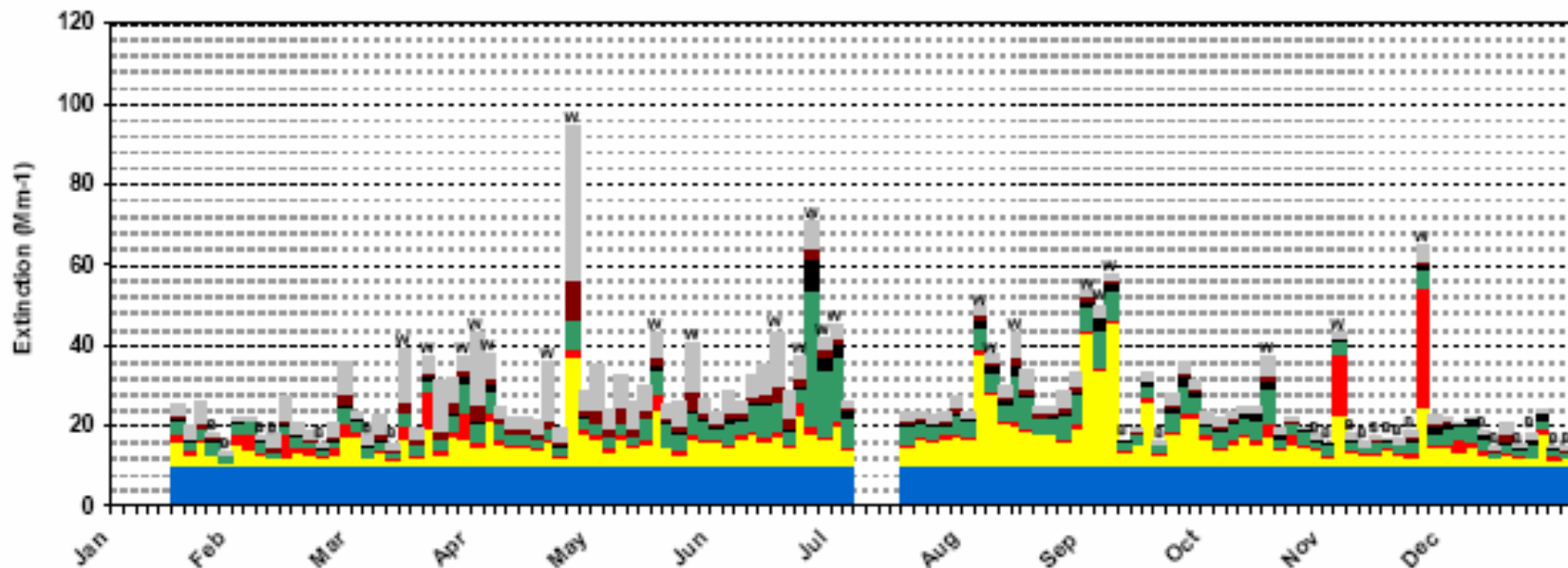
20% Worst Visibility Days  
 Total Extinction = 47 Mm-1 (36 to 94 Mm-1)



20% Best Visibility Days  
 Total Extinction = 17 Mm-1 (13 to 19 Mm-1)



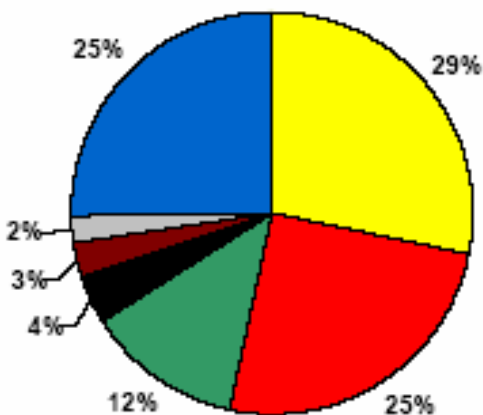
- Coarse Material
- Soil
- Elemental Carbon
- Organic Material
- Ammonium Nitrate
- Ammonium Sulfate
- Rayleigh



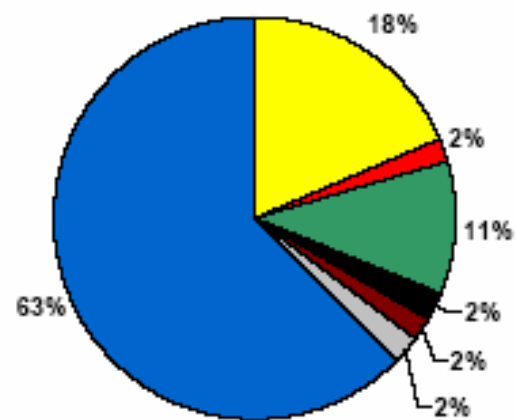
MODEL RESULTS

White Mountain Wilderness Area, NM  
2002 Reconstructed Extinction  
CMAQ Model Results (every day)

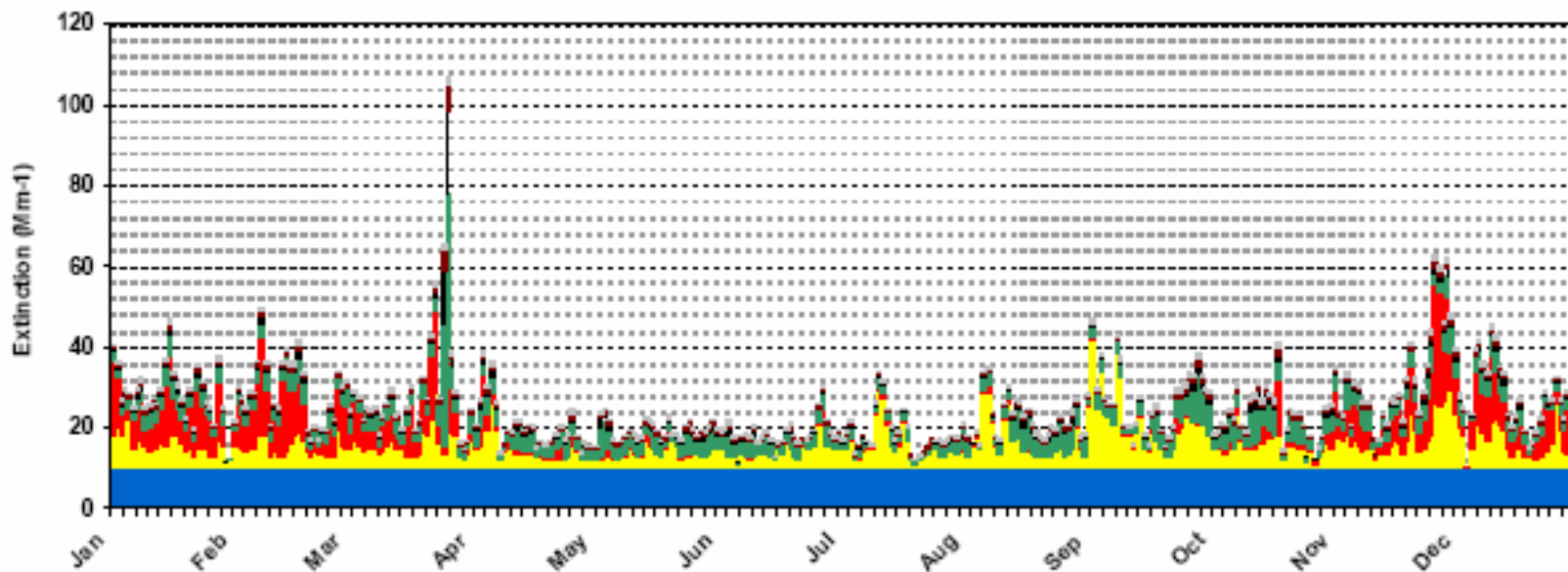
20% Worst Visibility Days  
Total Extinction = 39 Mm-1 (31 to 107 Mm-1)



20% Best Visibility Days  
Total Extinction = 16 Mm-1 (11 to 18 Mm-1)



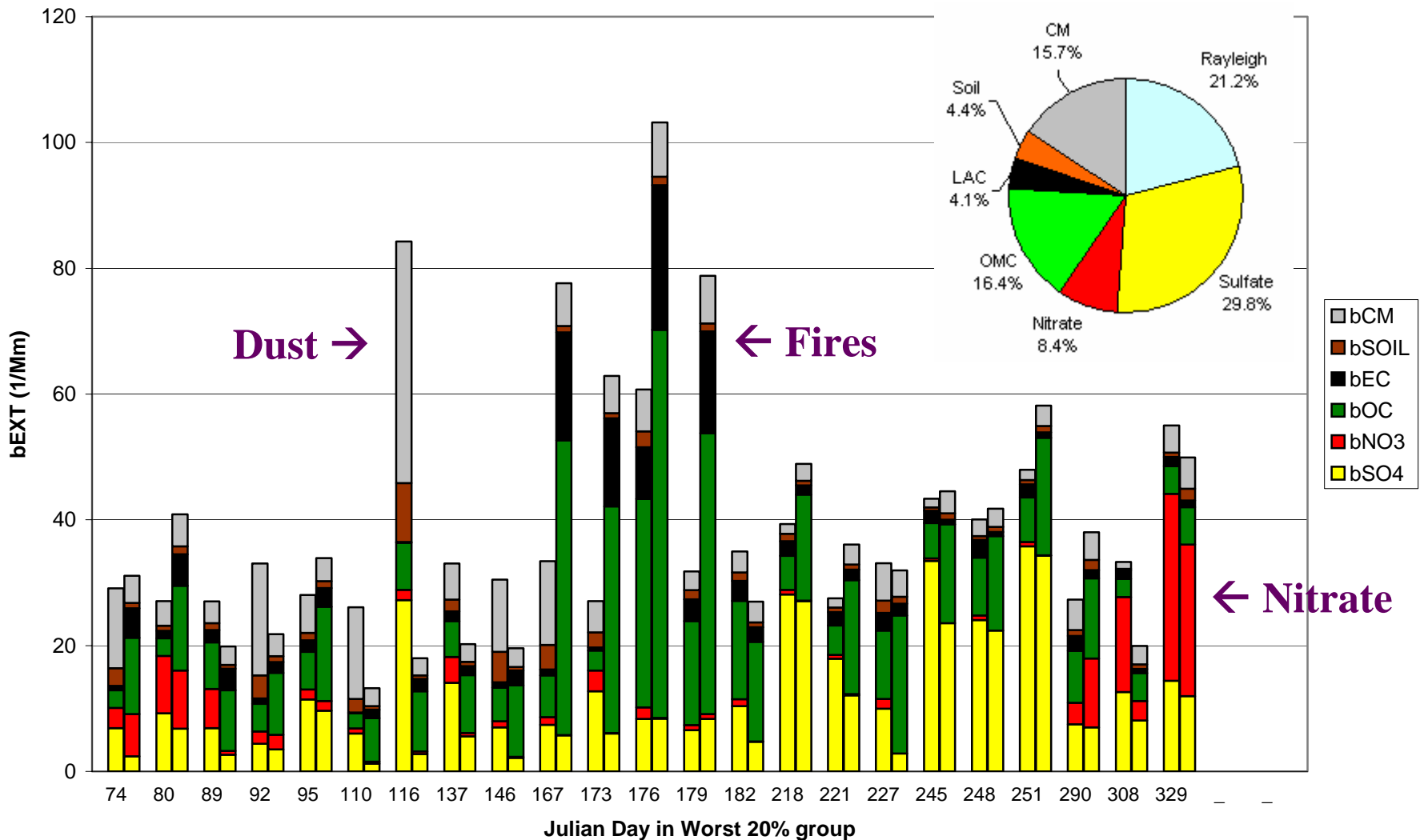
- Coarse Material
- Soil
- Elemental Carbon
- Organic Material
- Ammonium Nitrate
- Ammonium Sulfate
- Rayleigh



# White Mountain, NM – Worst 20% Days in 2002

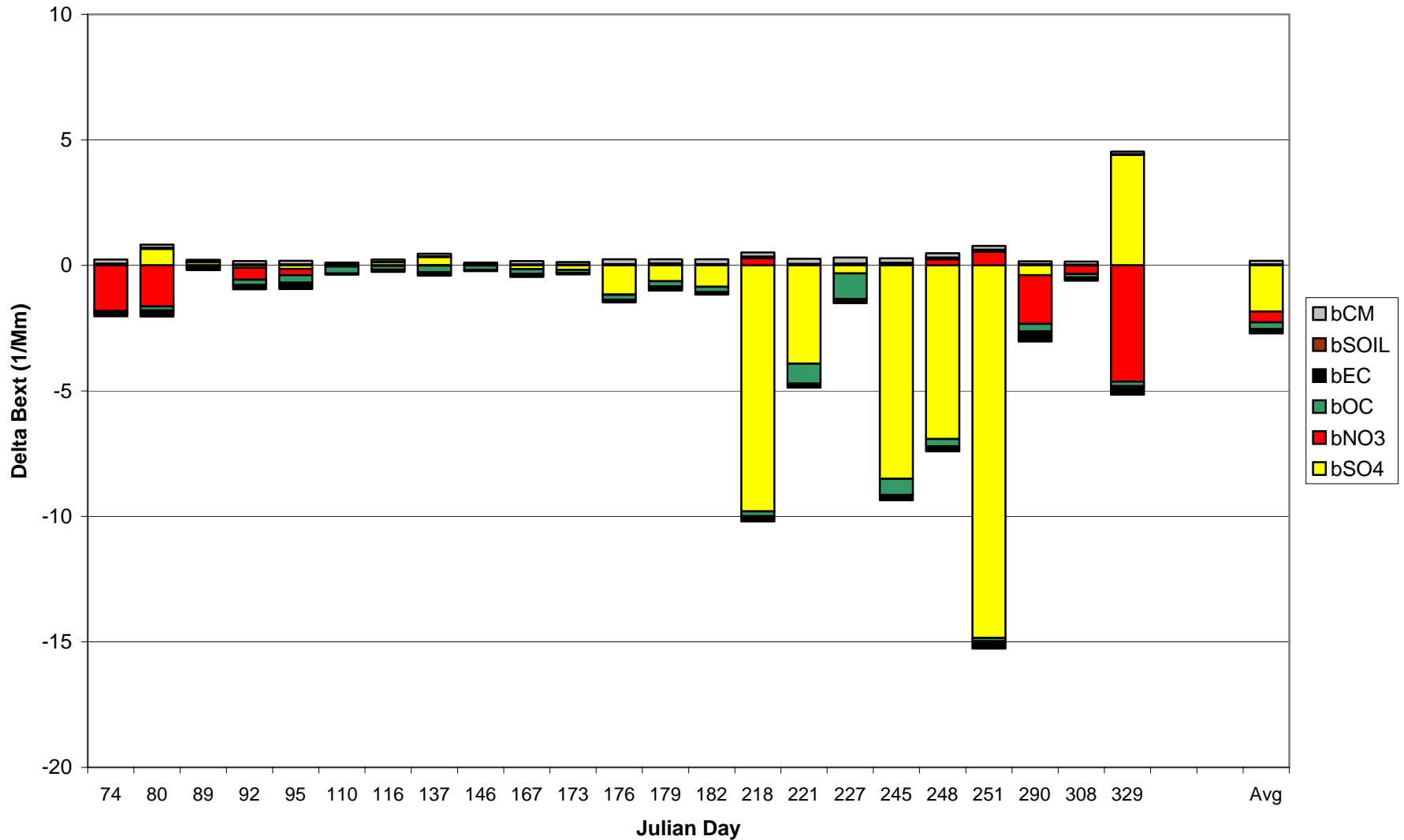
## Observations vs. Predictions

Worst 20% Obs & CMAQ Actual baseE at WHIT1



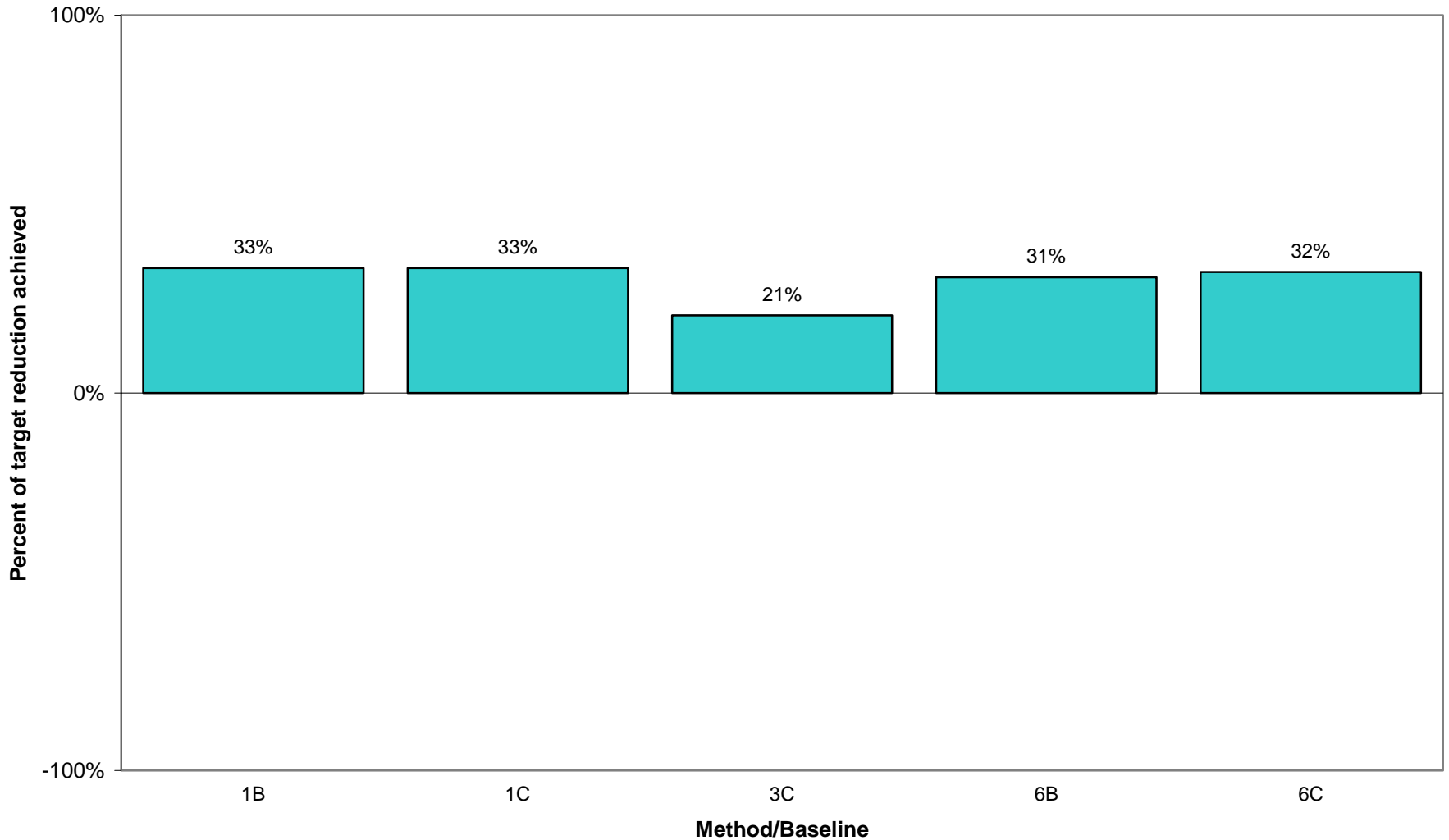
# White Mountain, NM: 2018 – 2002 for Worst Days

Bext Response (OTWd-Typical) at WHIT1 on Worst 20% Days



# 2018 Visibility Projections Percent of Reasonable Progress Goal for White Mountain, New Mexico (RPG = 1.82 dv)

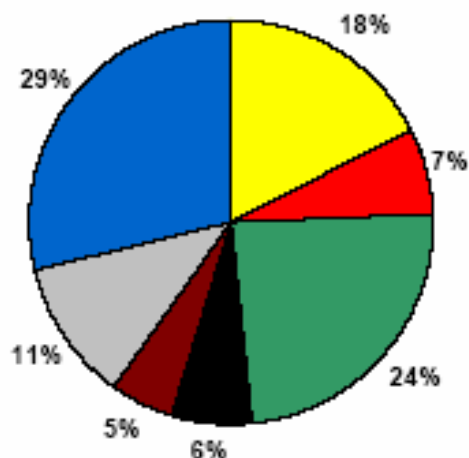
Predictions of various methods for achieving target reduction in HI OTWd for Worst 20% of days at WHIT1



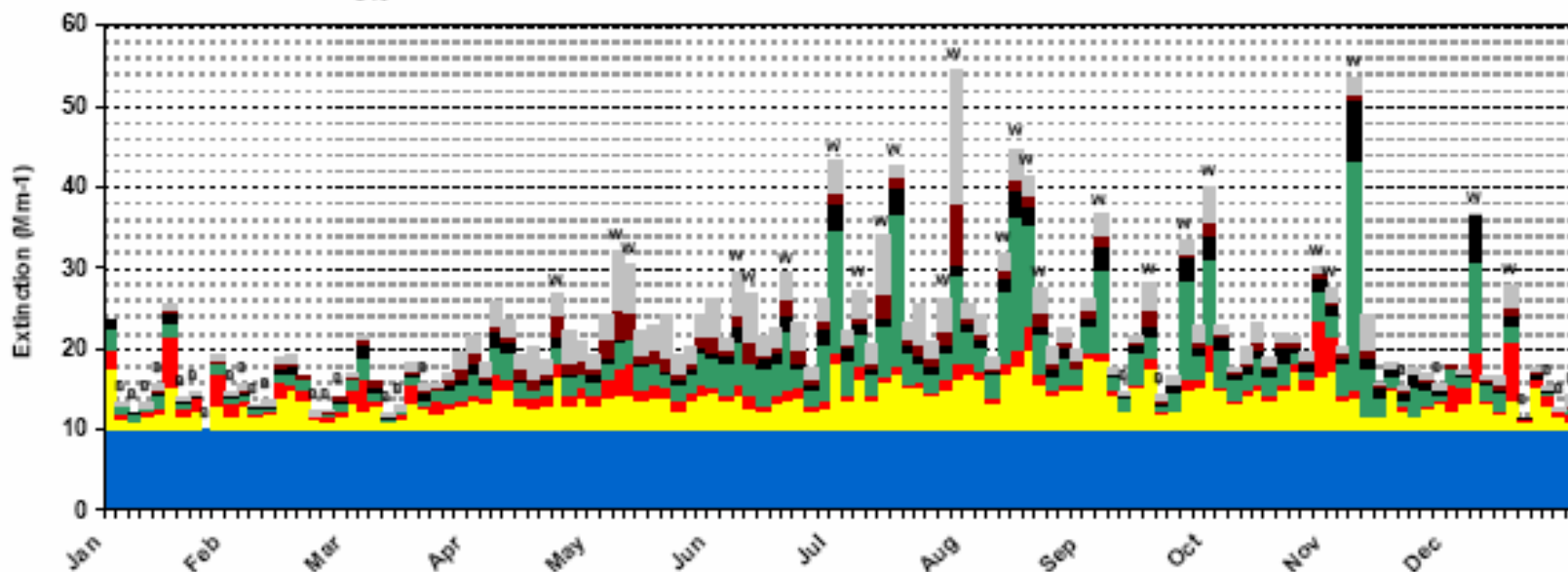
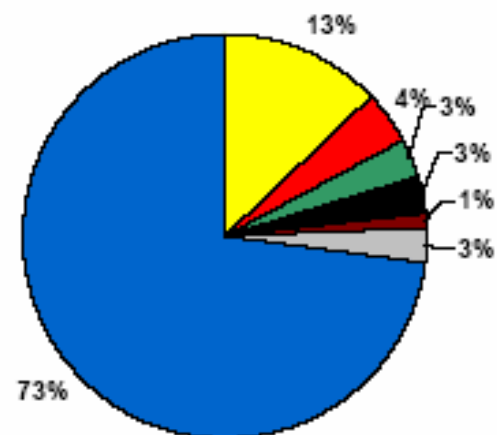
MONITORING DATA

Grand Canyon National Park, AZ  
 2002 Reconstructed Extinction  
 GRCA2 Monitoring Data (every third day)

20% Worst Visibility Days  
 Total Extinction = 34 Mm-1 (26 to 55 Mm-1)



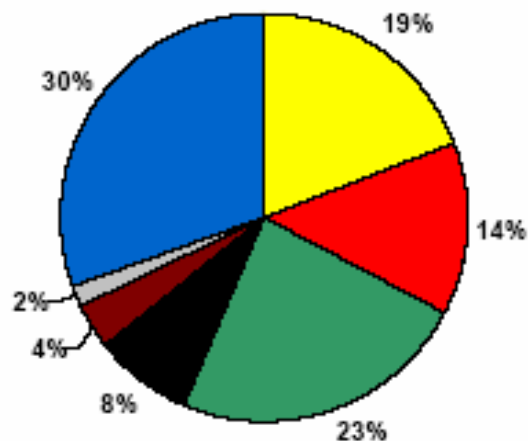
20% Best Visibility Days  
 Total Extinction = 14 Mm-1 (10 to 16 Mm-1)



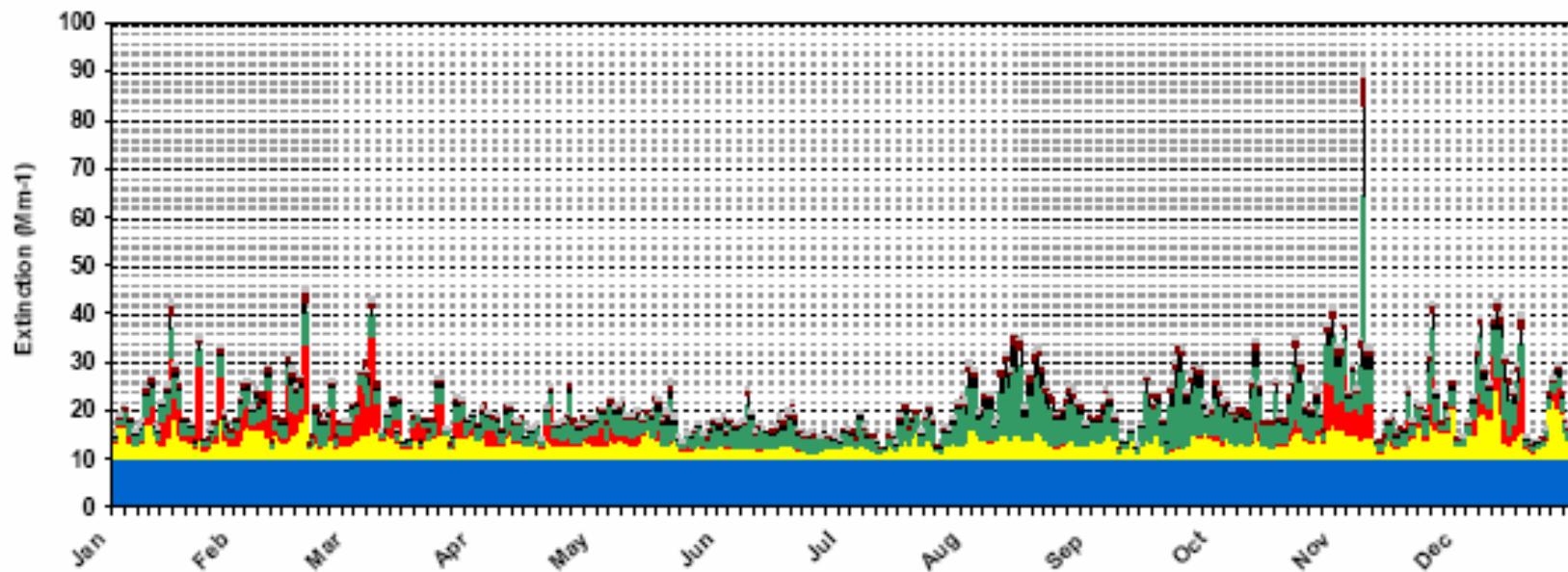
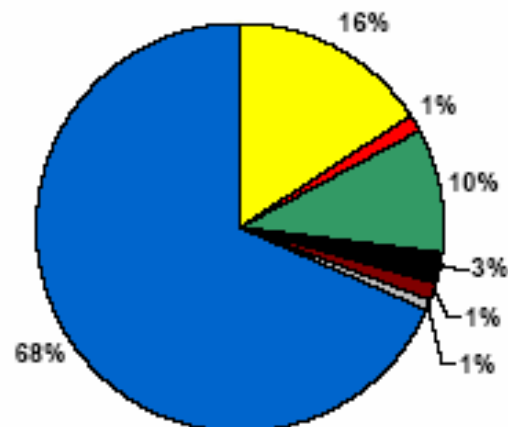
# MODEL RESULTS

## Grand Canyon National Park, AZ 2002 Reconstructed Extinction CMAQ Model Results (every day)

20% Worst Visibility Days  
Total Extinction = 33 Mm-1 (26 to 91 Mm-1)

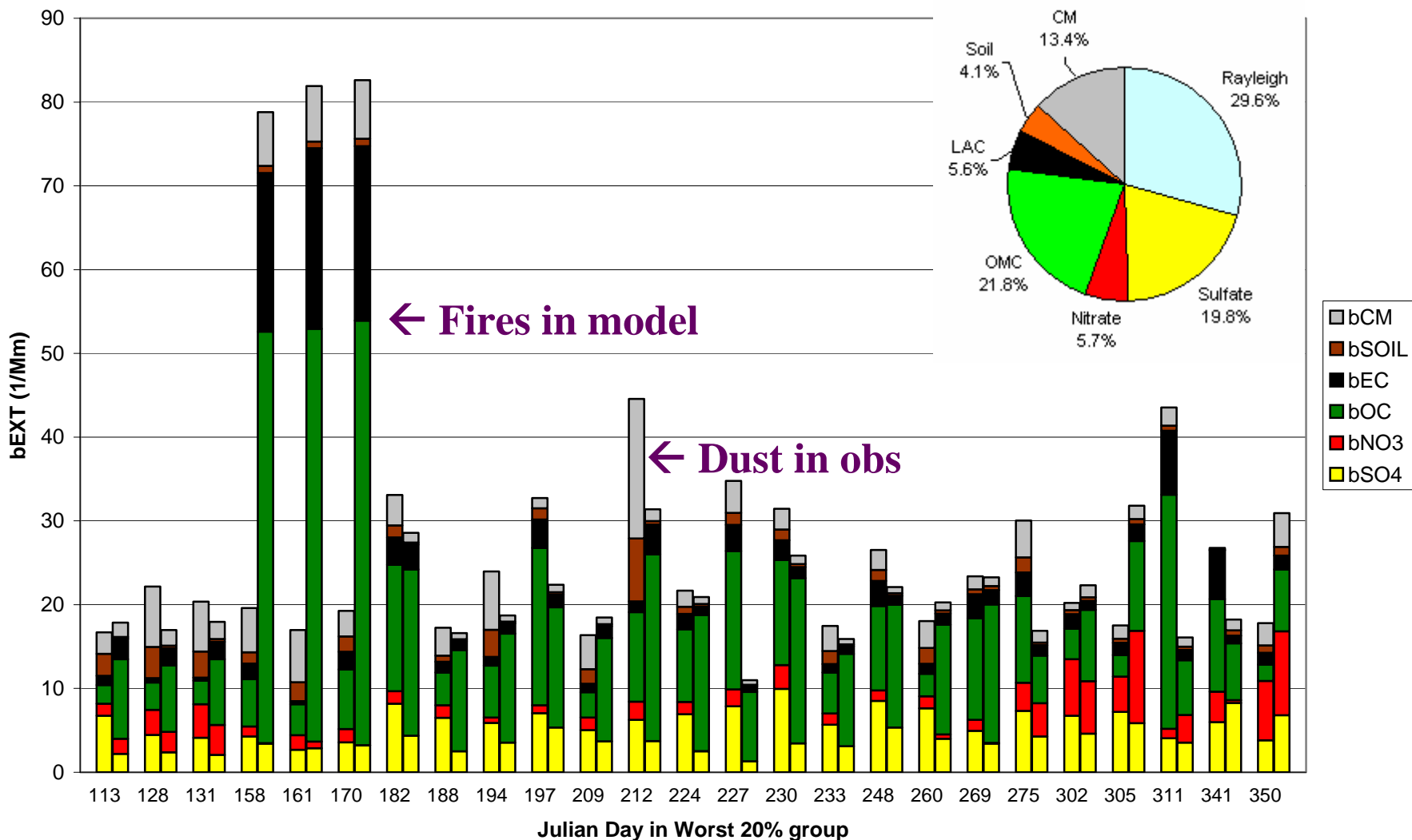


20% Best Visibility Days  
Total Extinction = 15 Mm-1 (11 to 16 Mm-1)



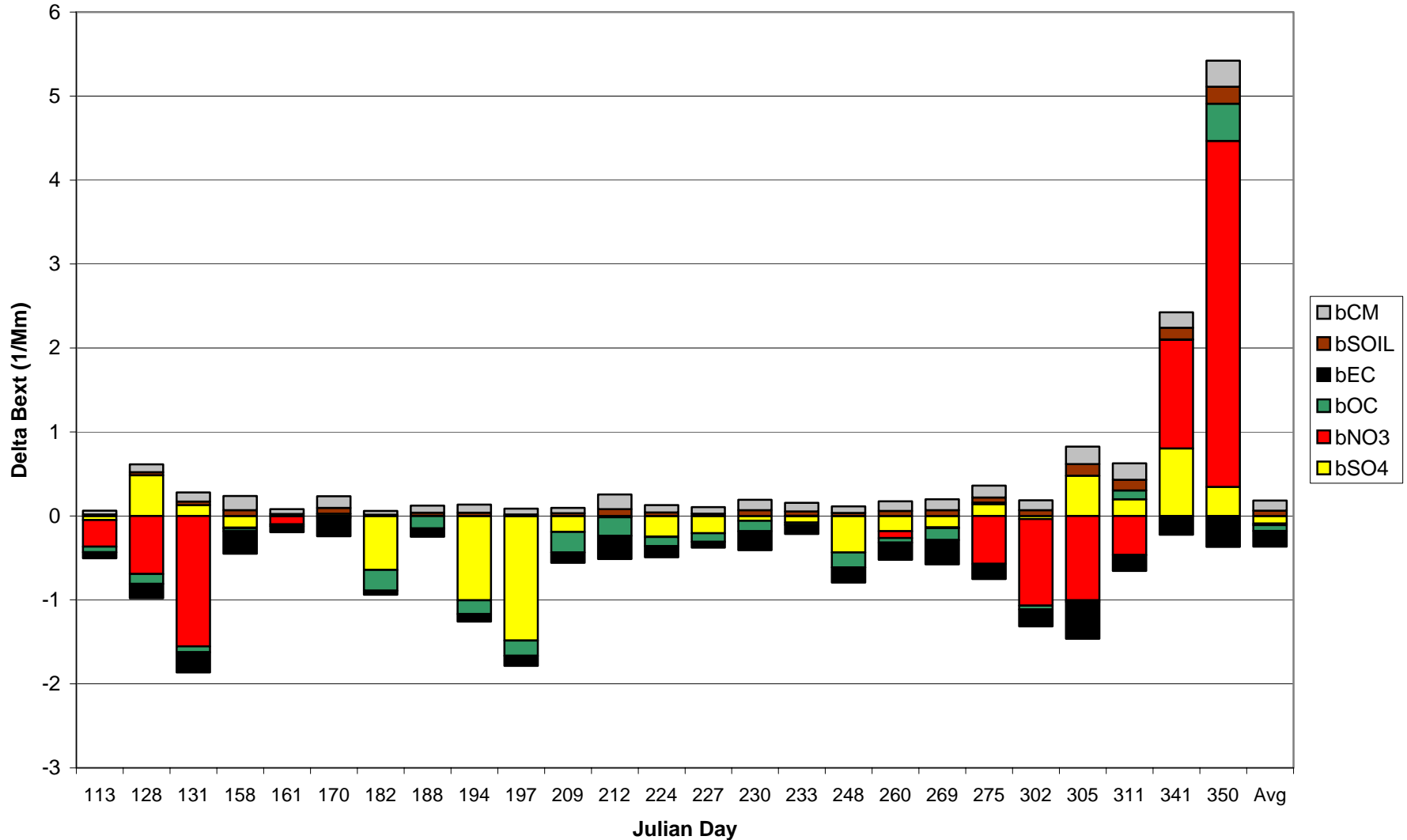
# Grand Canyon, AZ – Worst 20% Days in 2002

## Observations vs. Predictions Worst 20% Obs & CMAQ Actual baseE at GRCA2



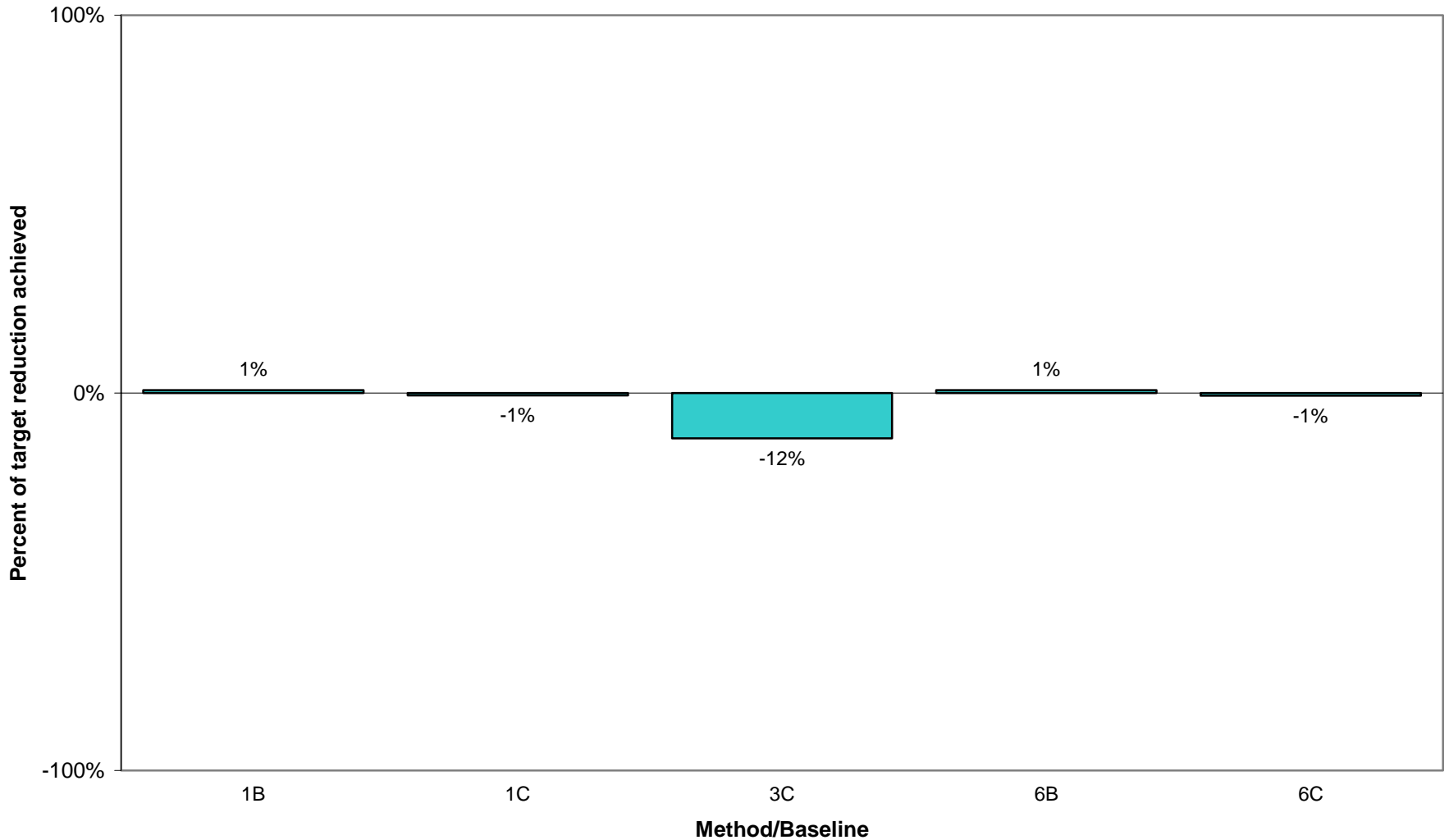
# Grand Canyon, AZ: 2018 – 2002 for Worst Days

Bext Response (OTWd-Typical) at GRCA2 on Worst 20% Days



# 2018 Visibility Projections Percent of Reasonable Progress Goal for Grand Canyon, Arizona (RPG = 1.26 dv)

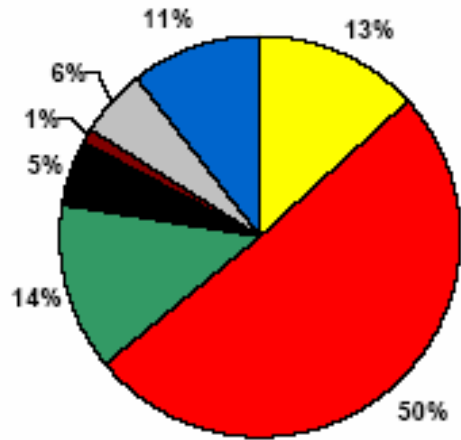
Predictions of various methods for achieving target reduction in HI  
OTWd for Worst 20% of days at GRCA2



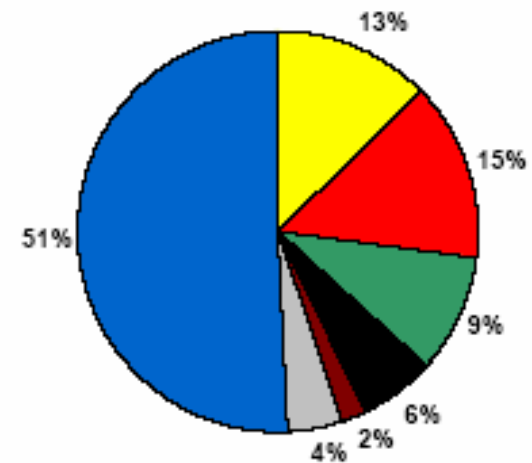
MONITORING DATA

San Geronio Wilderness Area, CA  
 2002 Reconstructed Extinction  
 SAGO1 Monitoring Data (every third day)

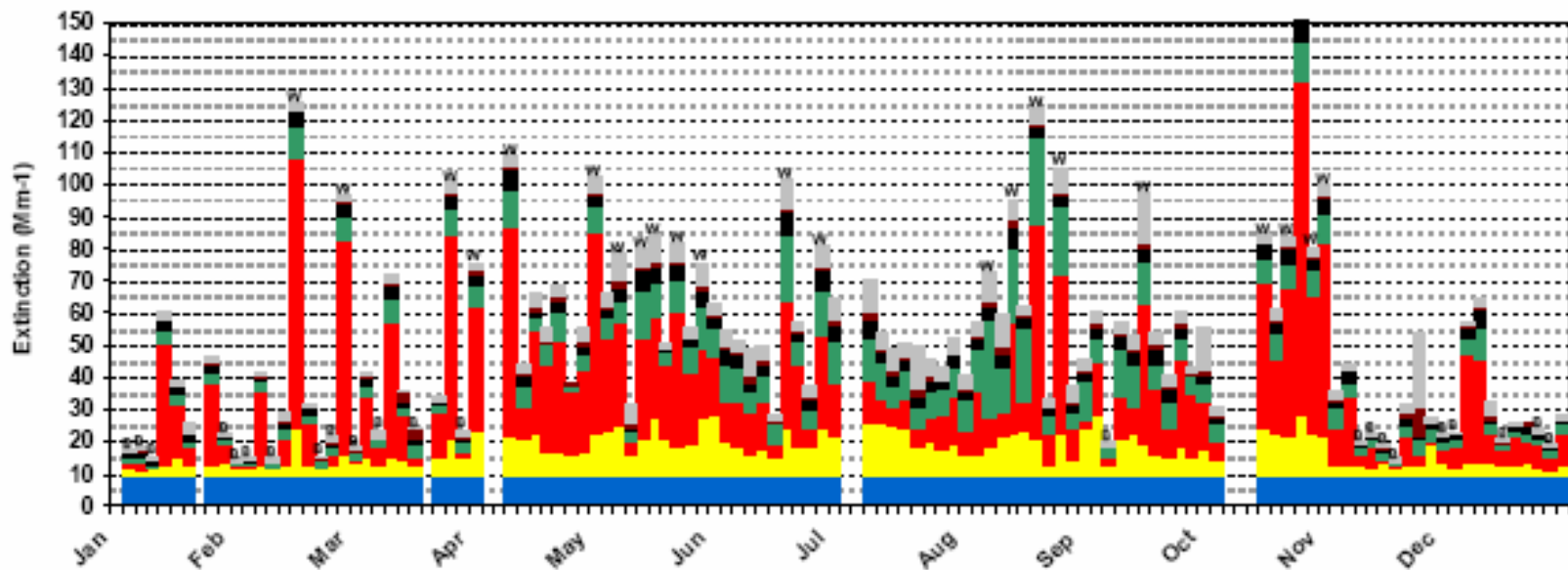
20% Worst Visibility Days  
 Total Extinction = 95 Mm<sup>-1</sup> (73 to 154 Mm<sup>-1</sup>)



20% Best Visibility Days  
 Total Extinction = 20 Mm<sup>-1</sup> (14 to 24 Mm<sup>-1</sup>)



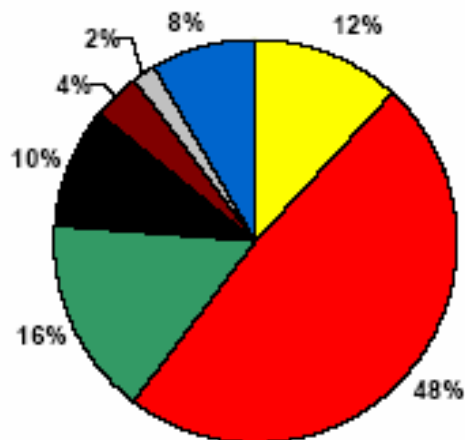
- Coarse Material
- Soil
- Elemental Carbon
- Organic Material
- Ammonium Nitrate
- Ammonium Sulfate
- Rayleigh



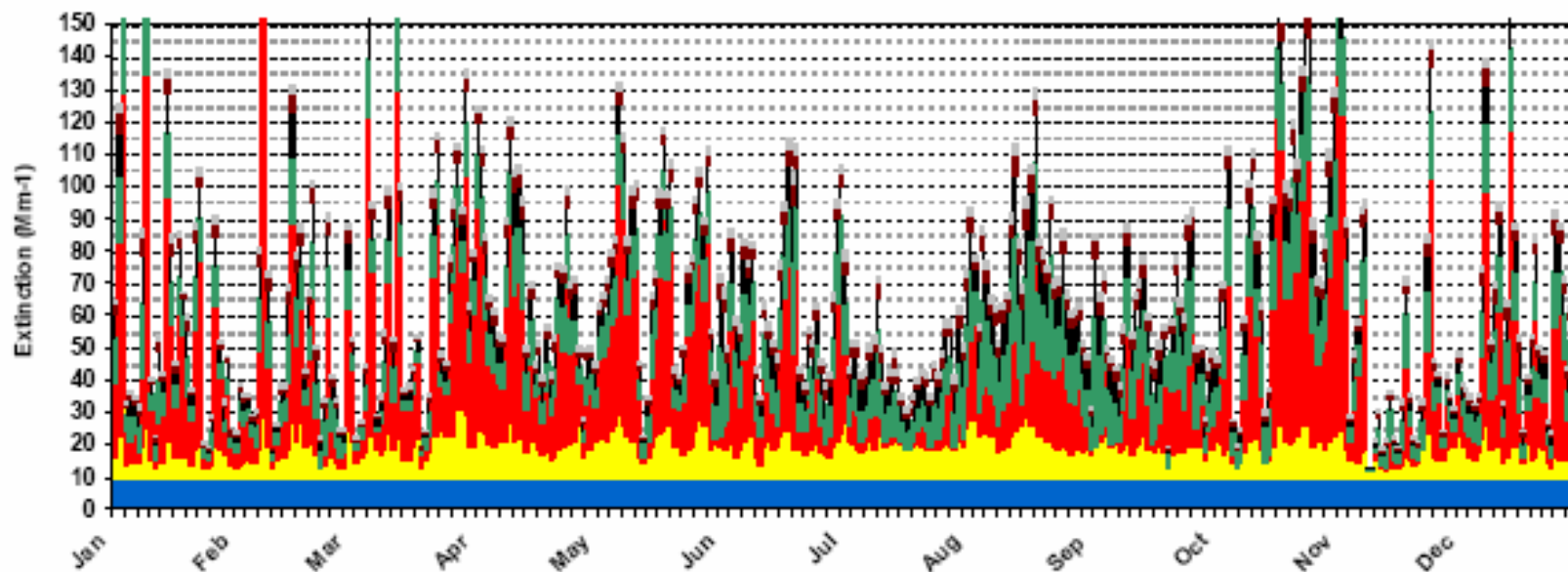
# MODEL RESULTS

## San Geronio Wilderness Area, CA 2002 Reconstructed Extinction CMAQ Model Results (every day)

20% Worst Visibility Days  
Total Extinction = 120 Mm-1 (93 to 223 Mm-1)



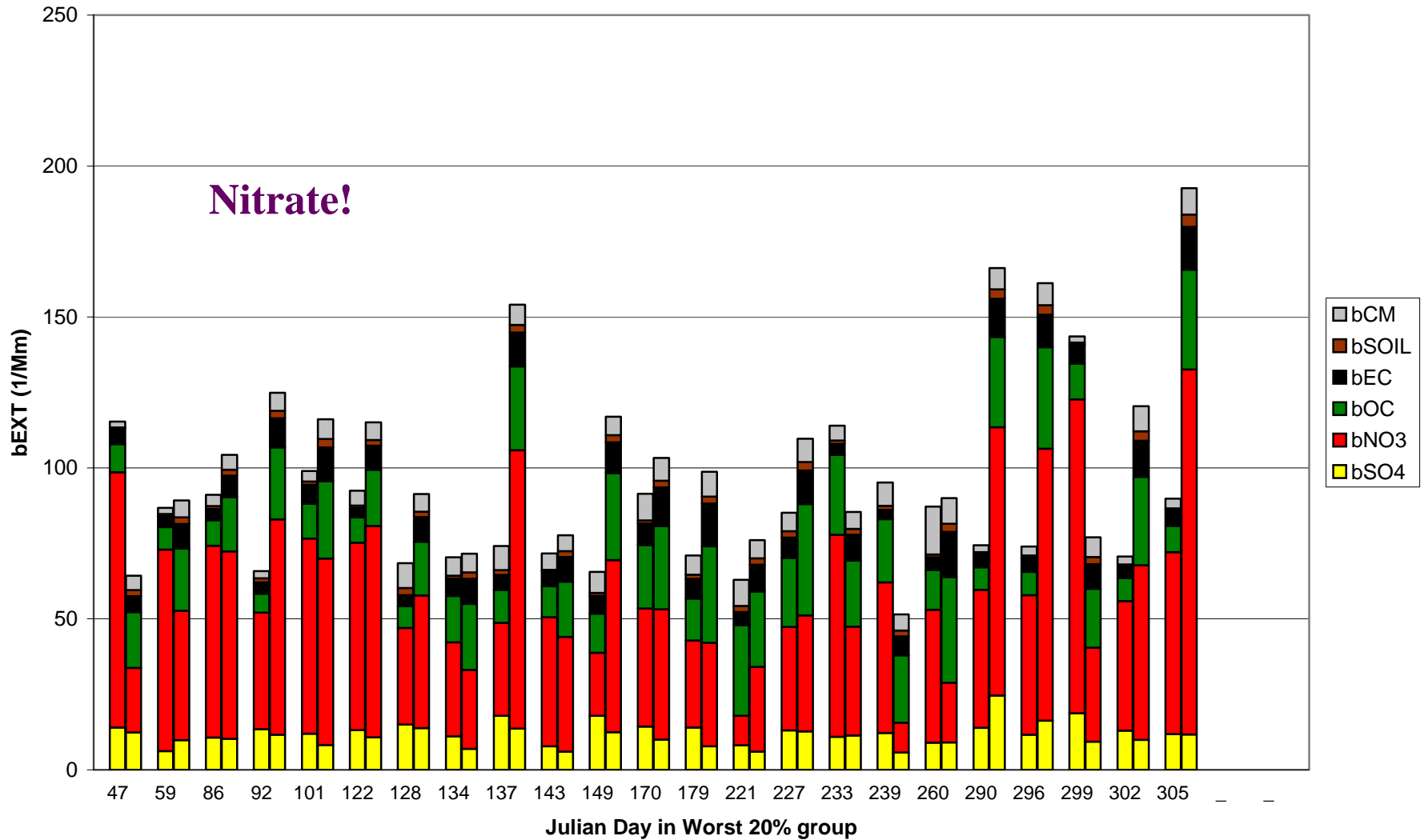
20% Best Visibility Days  
Total Extinction = 29 Mm-1 (13 to 38 Mm-1)



# San Gorgonio, CA – Worst 20% Days in 2002

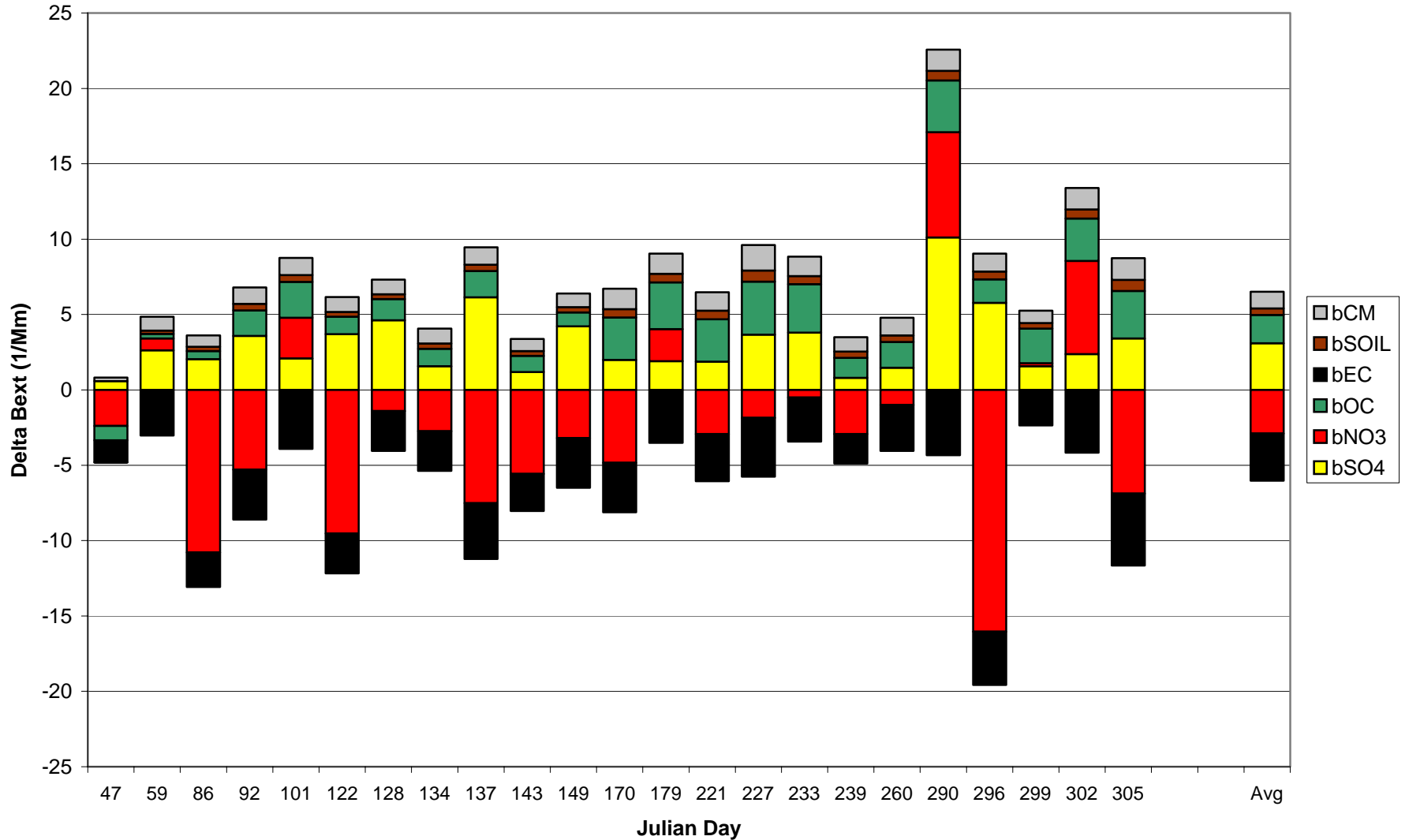
## Observations vs. Predictions

Worst 20% Obs & CMAQ Actual baseE at SAGO1



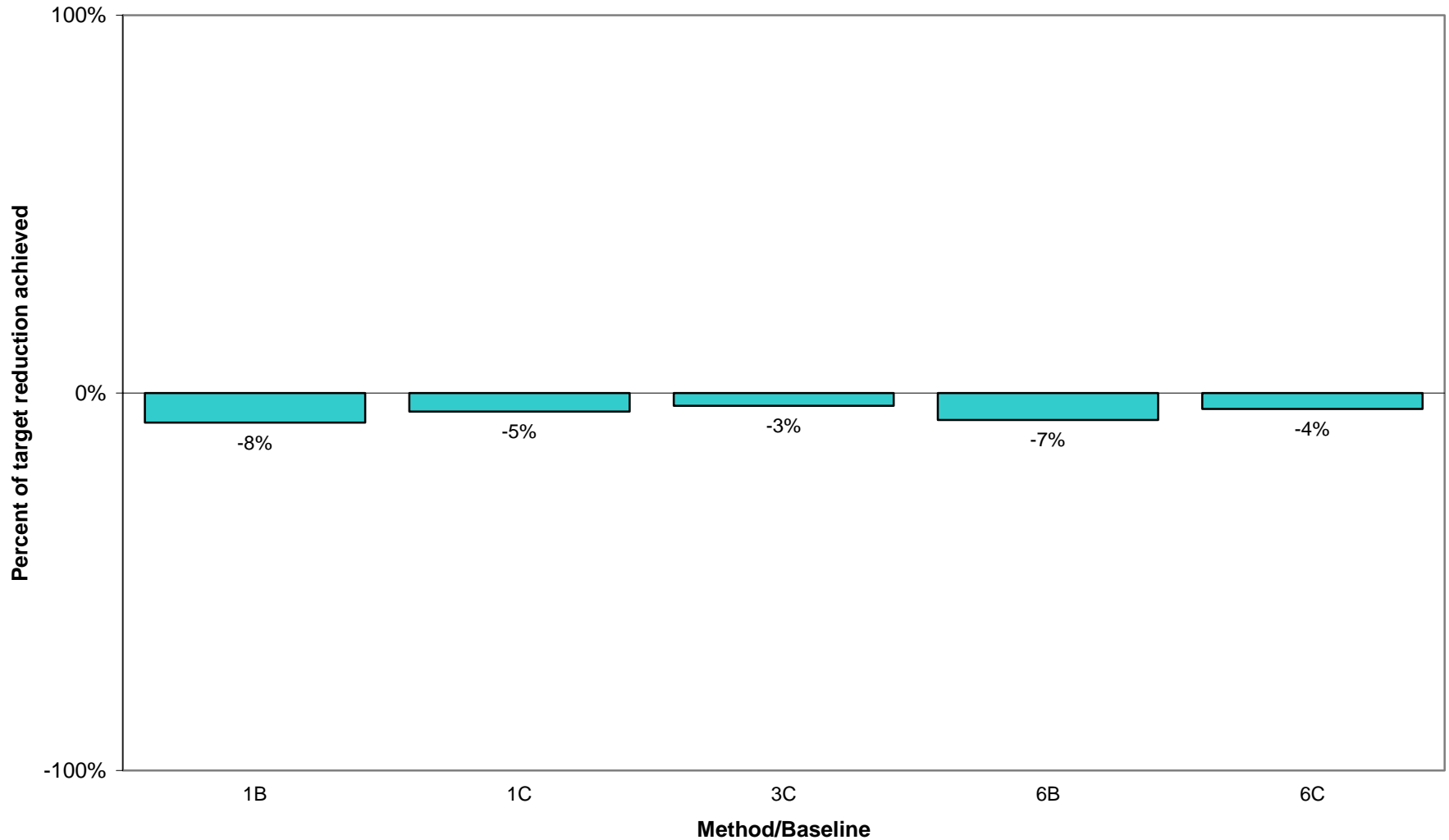
# San Gorgonio, CA: 2018 – 2002 for Worst Days

Bext Response (OTWd-Typical) at SAGO1 on Worst 20% Days



# 2018 Visibility Projections Percent of Reasonable Progress Goal for San Geronio, California (RPG = 3.38 dv)

Predictions of various methods for achieving target reduction in HI OTWd for Worst 20% of days at SAGO1

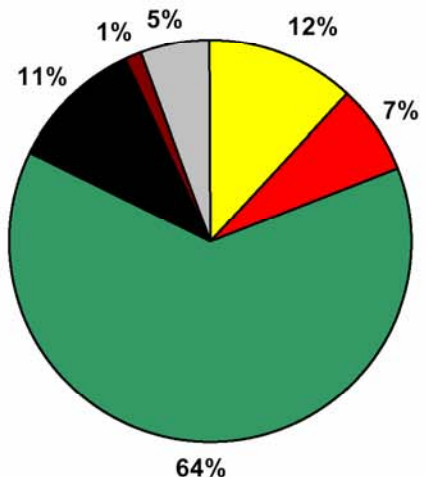


# CRLA Data Following RHR Guidelines

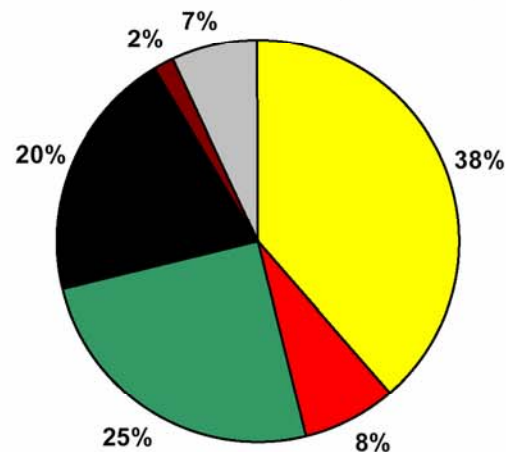
## MONITORING DATA

Crater Lake National Park, OR  
 2002 Reconstructed Extinction  
 CRLA1 Monitoring Data (every third day)

20% Worst Visibility Days  
 Aerosol Extinction\* = 68 Mm<sup>-1</sup> (22 to 217 Mm<sup>-1</sup>)

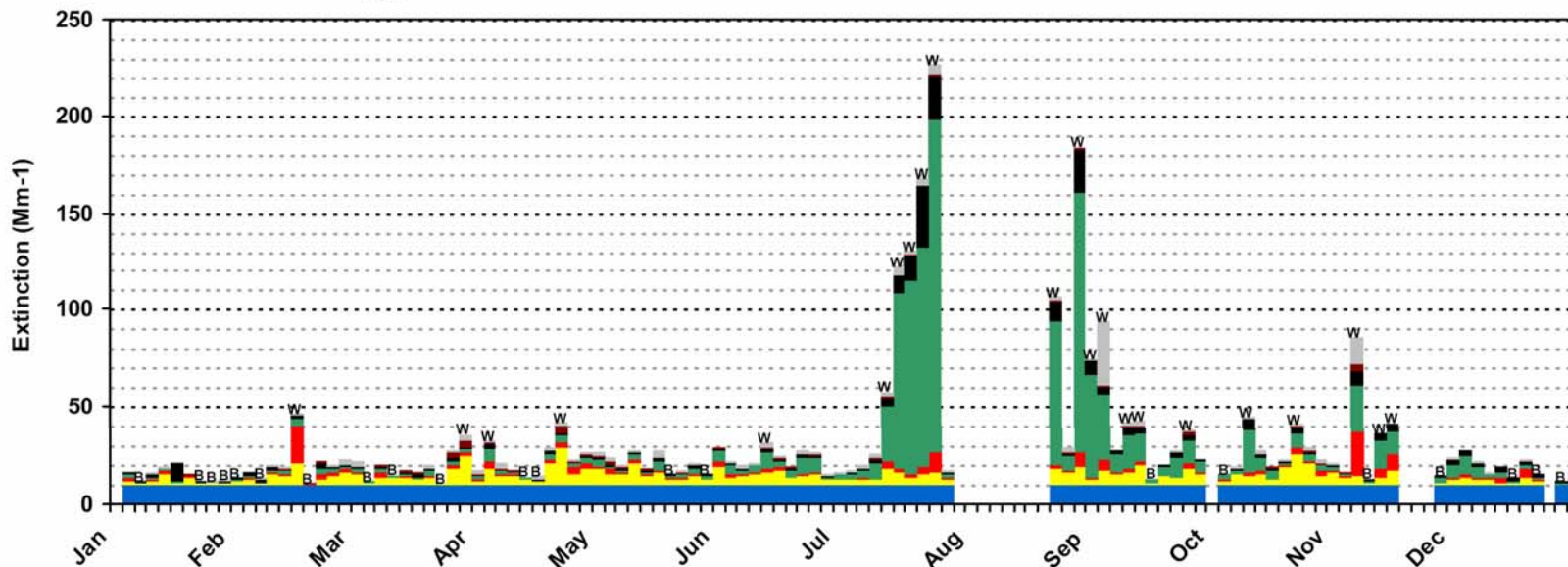


20% Best Visibility Days  
 Aerosol Extinction\* = 3 Mm<sup>-1</sup> (1 to 6 Mm<sup>-1</sup>)



Coarse Material  
 Soil  
 Elemental Carbon  
 Organic Material  
 Ammonium Nitrate  
 Ammonium Sulfate  
 Rayleigh

\*Excludes Rayleigh Extinction



# CRLA Data Including Clogged Filter Days

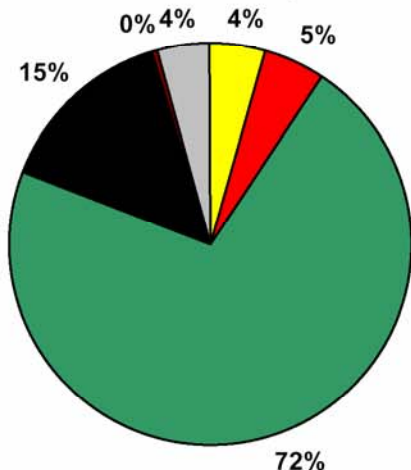
## MONITORING DATA

Crater Lake National Park, OR  
 2002 Reconstructed Extinction  
 CRLA1 Monitoring Data (every third day)

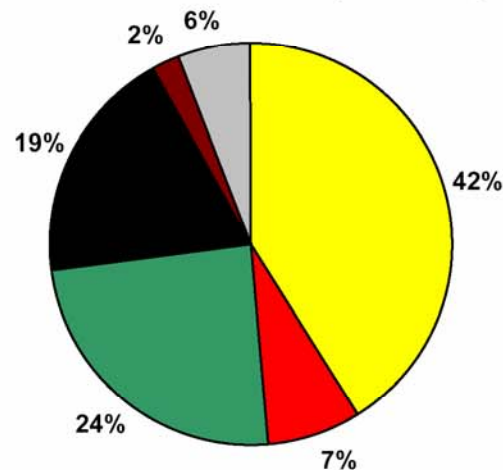
## "RAW" DATA

- No RHR data substitutions
- Includes available data from days with clogged filters

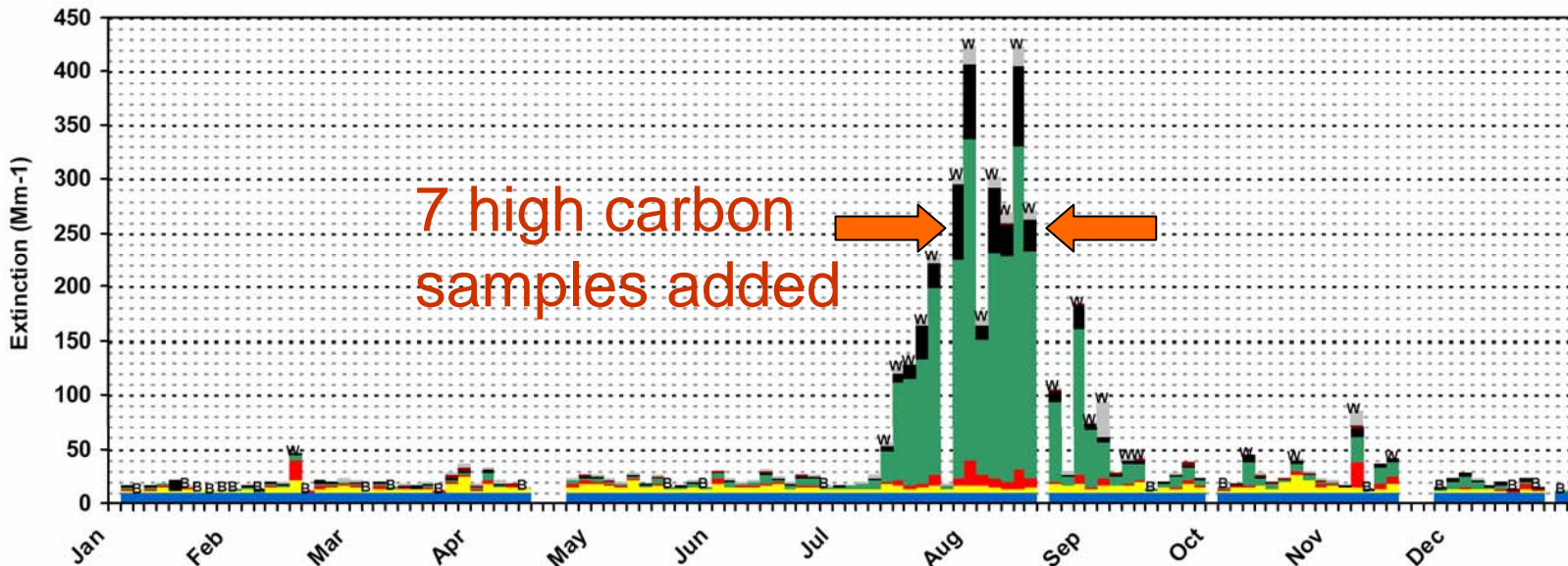
20% Worst Visibility Days  
 Aerosol Extinction\* = 149 Mm<sup>-1</sup> (31 to 414 Mm<sup>-1</sup>)



20% Best Visibility Days  
 Aerosol Extinction\* = 3 Mm<sup>-1</sup> (1 to 6 Mm<sup>-1</sup>)



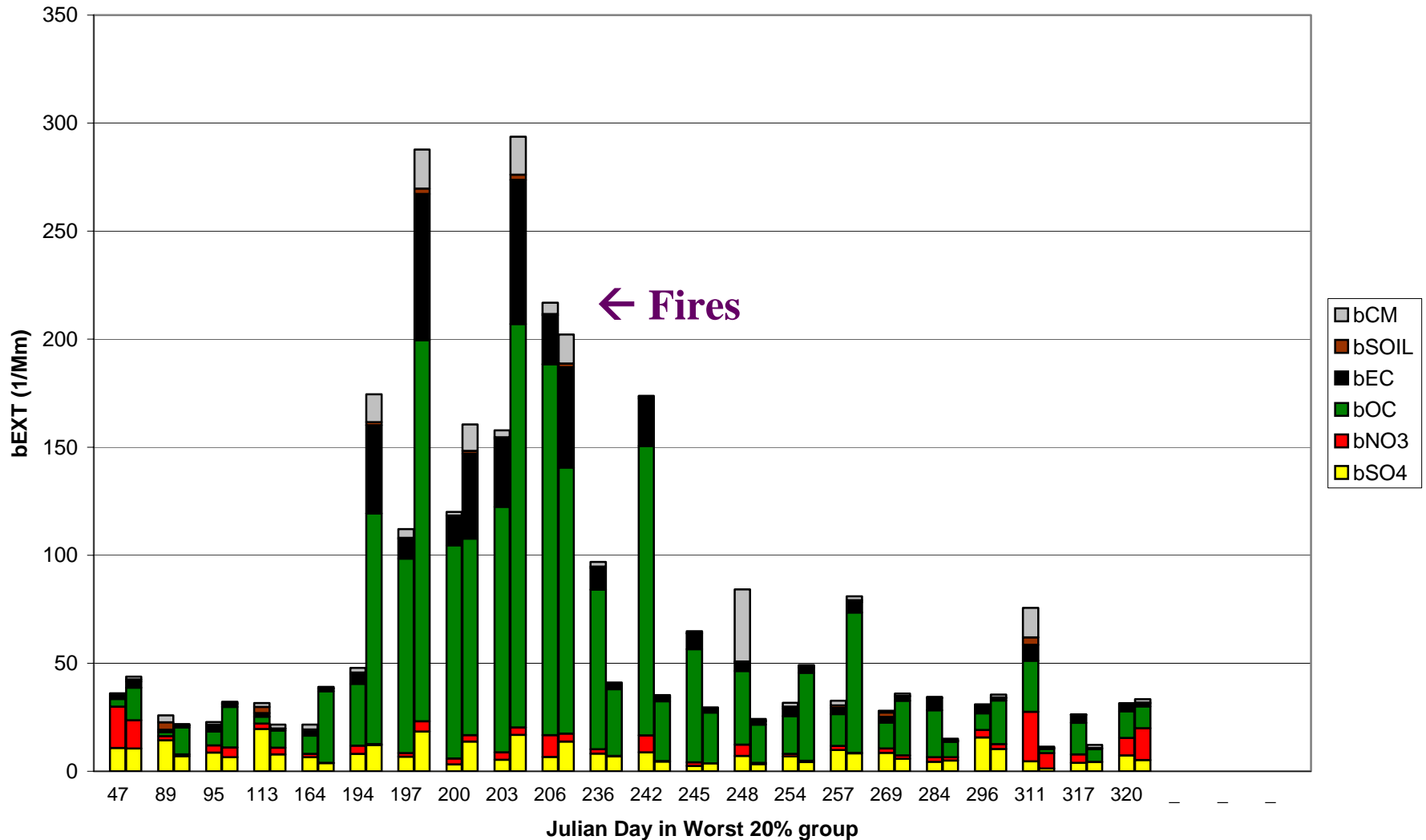
- Coarse Material
  - Soil
  - Elemental Carbon
  - Organic Material
  - Ammonium Nitrate
  - Ammonium Sulfate
  - Rayleigh
- \*Excludes Rayleigh Extinction



# Crater Lake, OR – Worst 20% Days in 2002

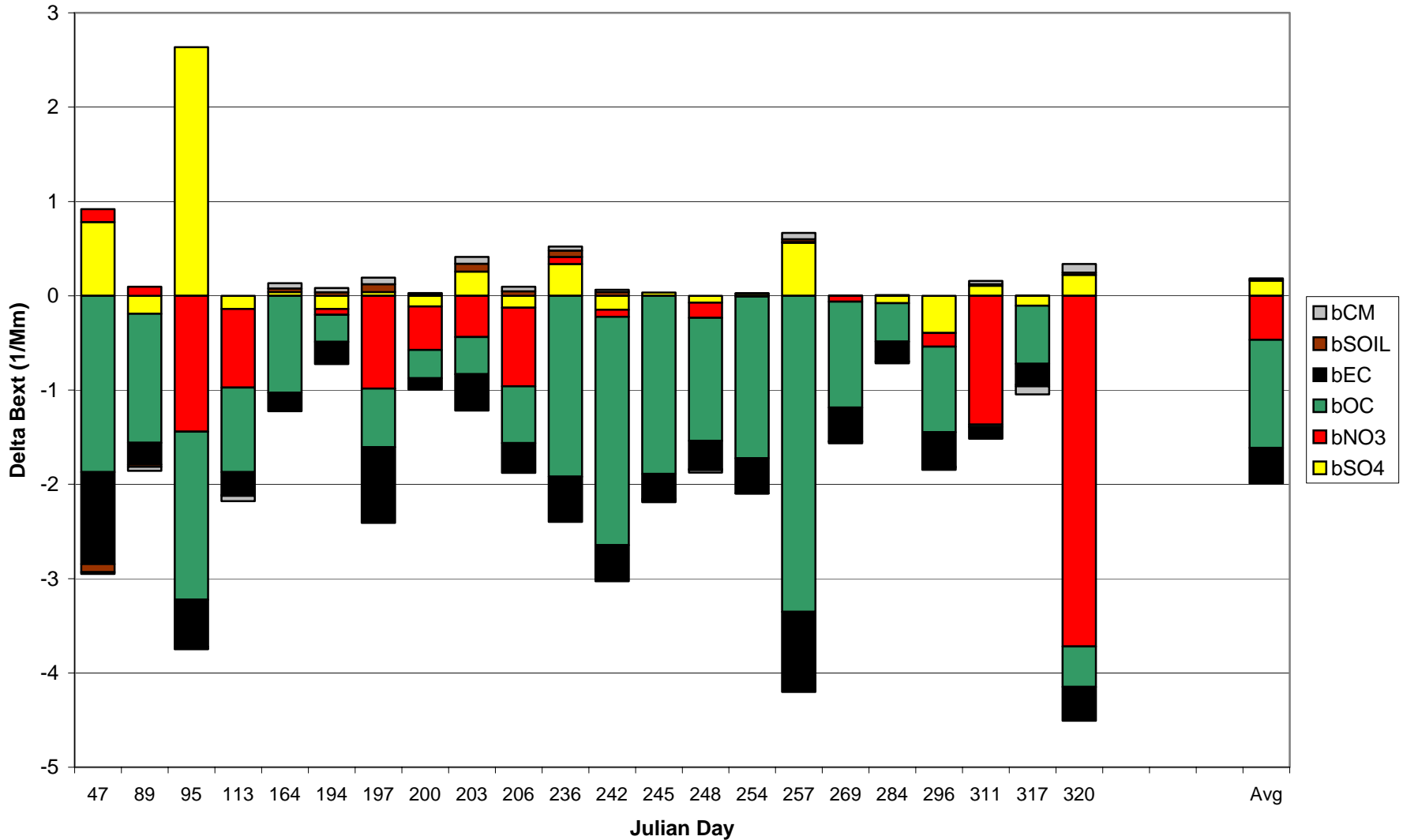
## Observations vs. Predictions

Worst 20% Obs & CMAQ Actual baseE at CRLA1



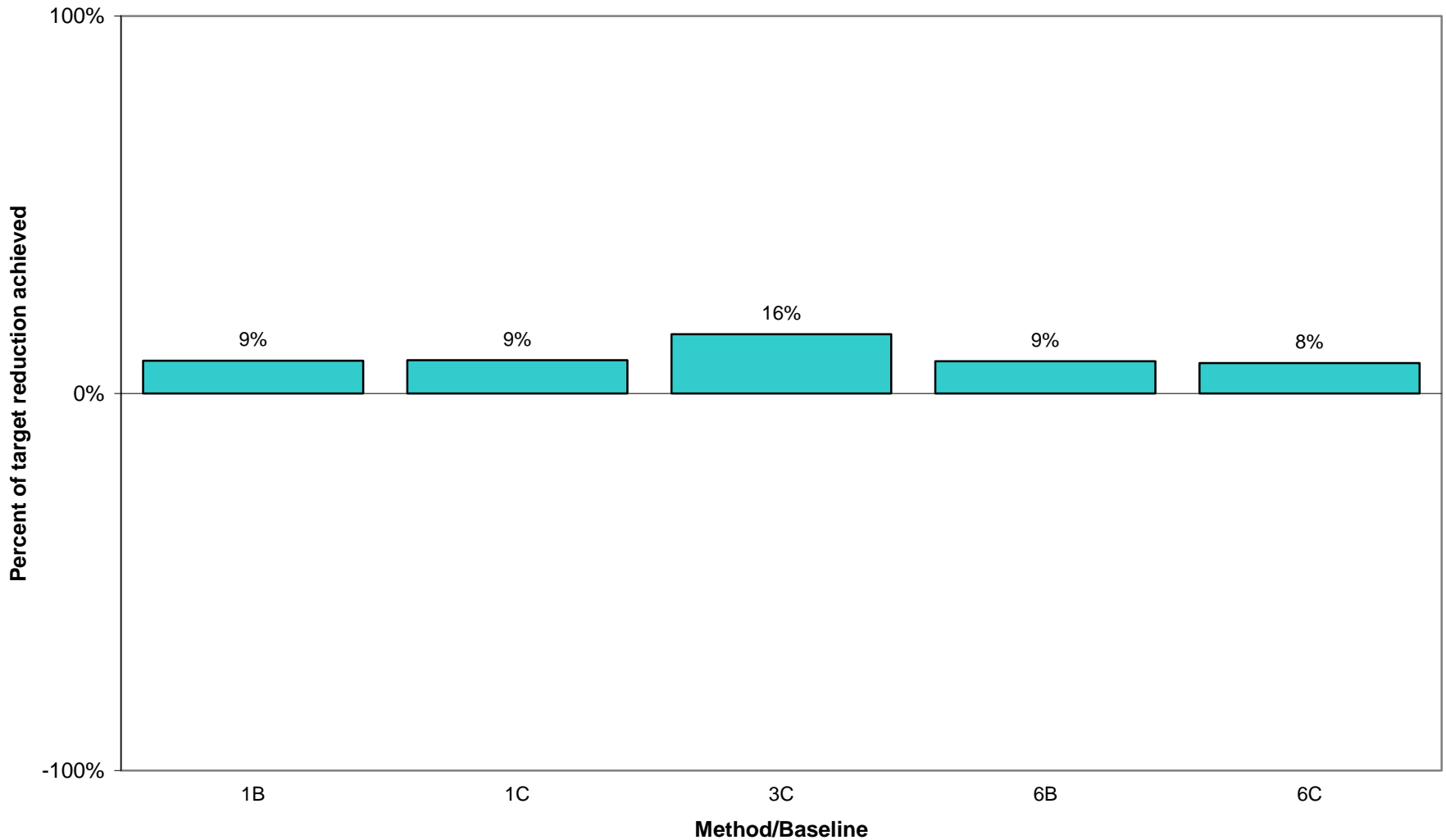
# Crater Lake, OR: 2018 – 2002 for Worst Days

Bext Response (OTWd-Typical) at CRLA1 on Worst 20% Days



# 2018 Visibility Projections Percent of Reasonable Progress Goal for Crater Lake, Oregon (RPG = 1.98 dv)

Predictions of various methods for achieving target reduction in HI OTWd for Worst 20% of days at CRLA1



# Denali, AK – 2002 IMPROVE Extinction

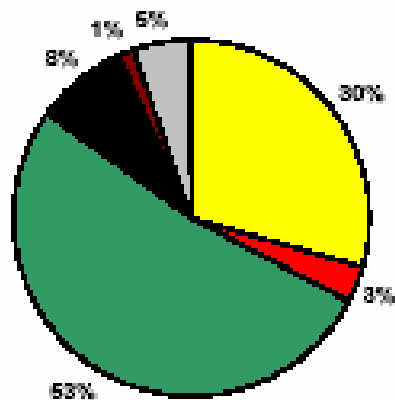
## MONITORING DATA

Denali National Park and Preserve, AK

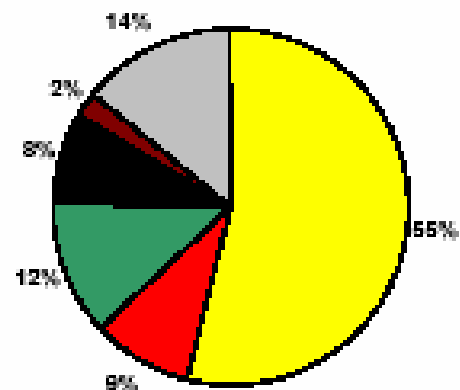
2002 Reconstructed Extinction

DENA1 Monitoring Data (every third day)

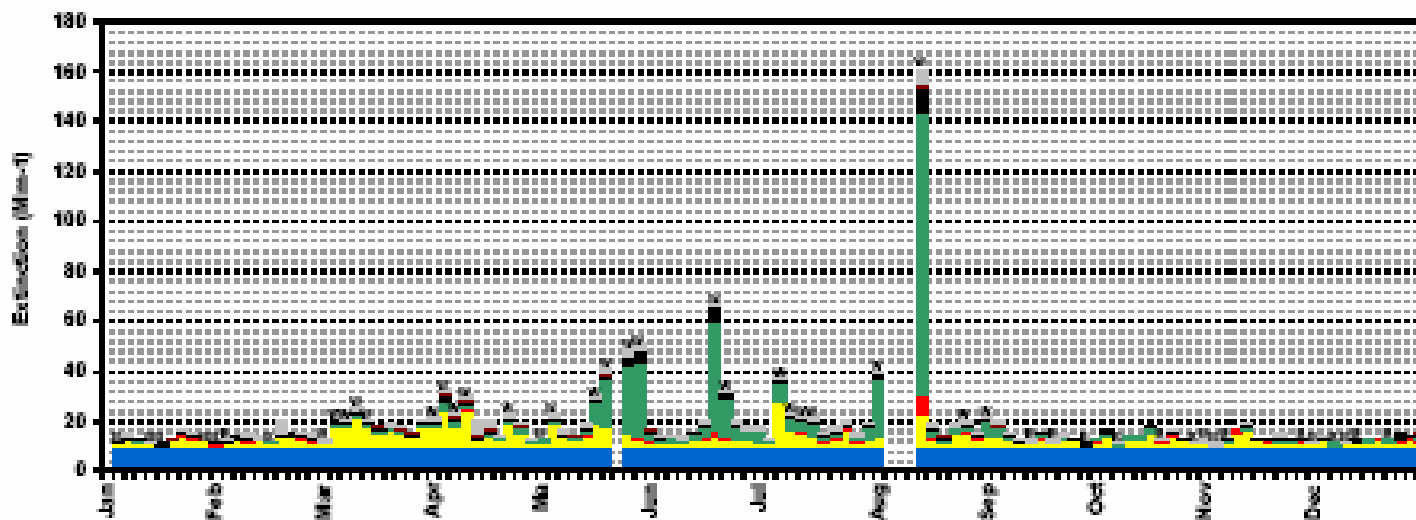
20% Worst Visibility Days  
Aerosol Extinction\* = 26 Mm<sup>-1</sup> (10 to 151 Mm<sup>-1</sup>)



20% Best Visibility Days  
Aerosol Extinction\* = 2 Mm<sup>-1</sup> (1 to 3 Mm<sup>-1</sup>)

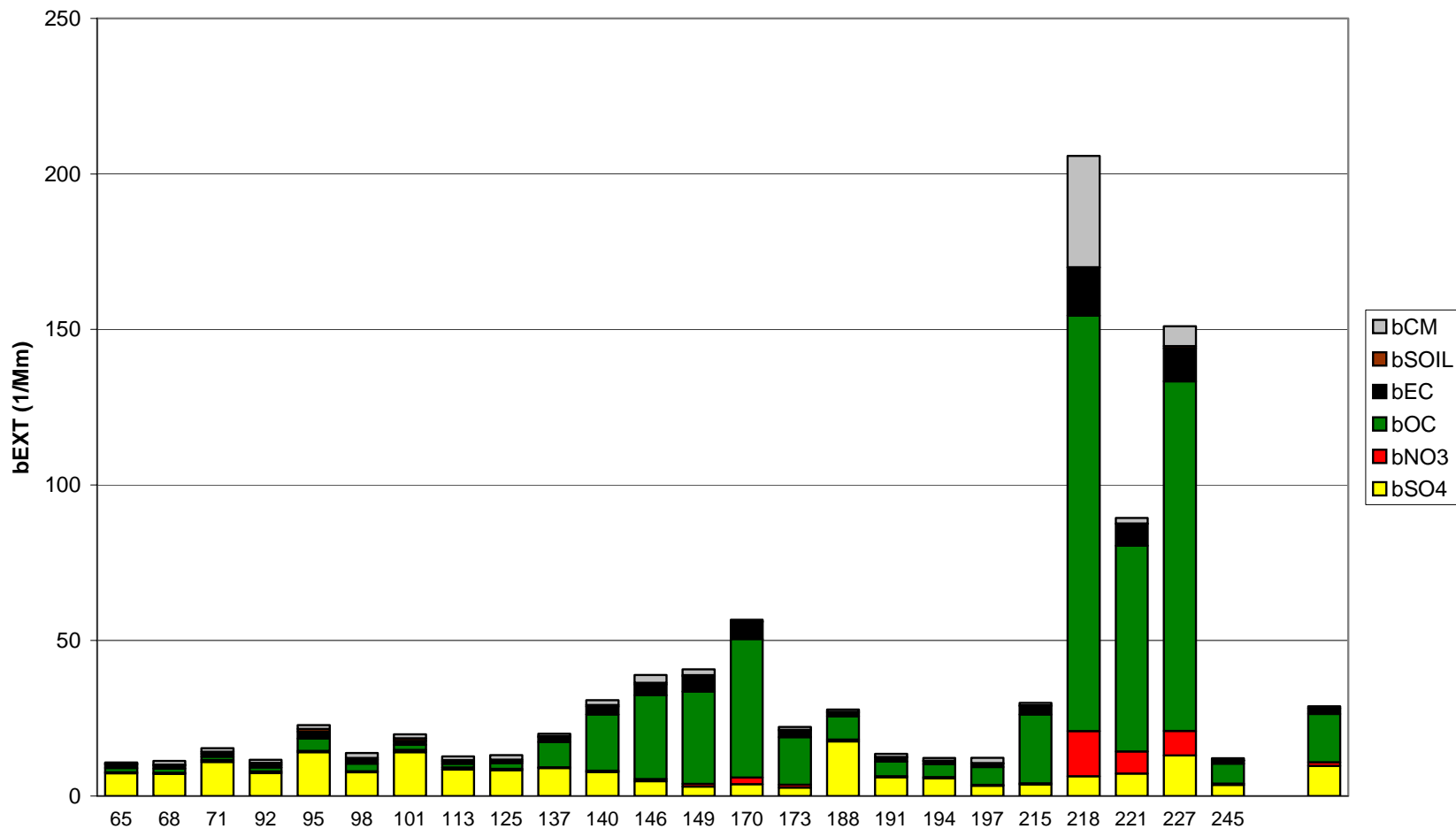


\*Excludes Rayleigh Extinction



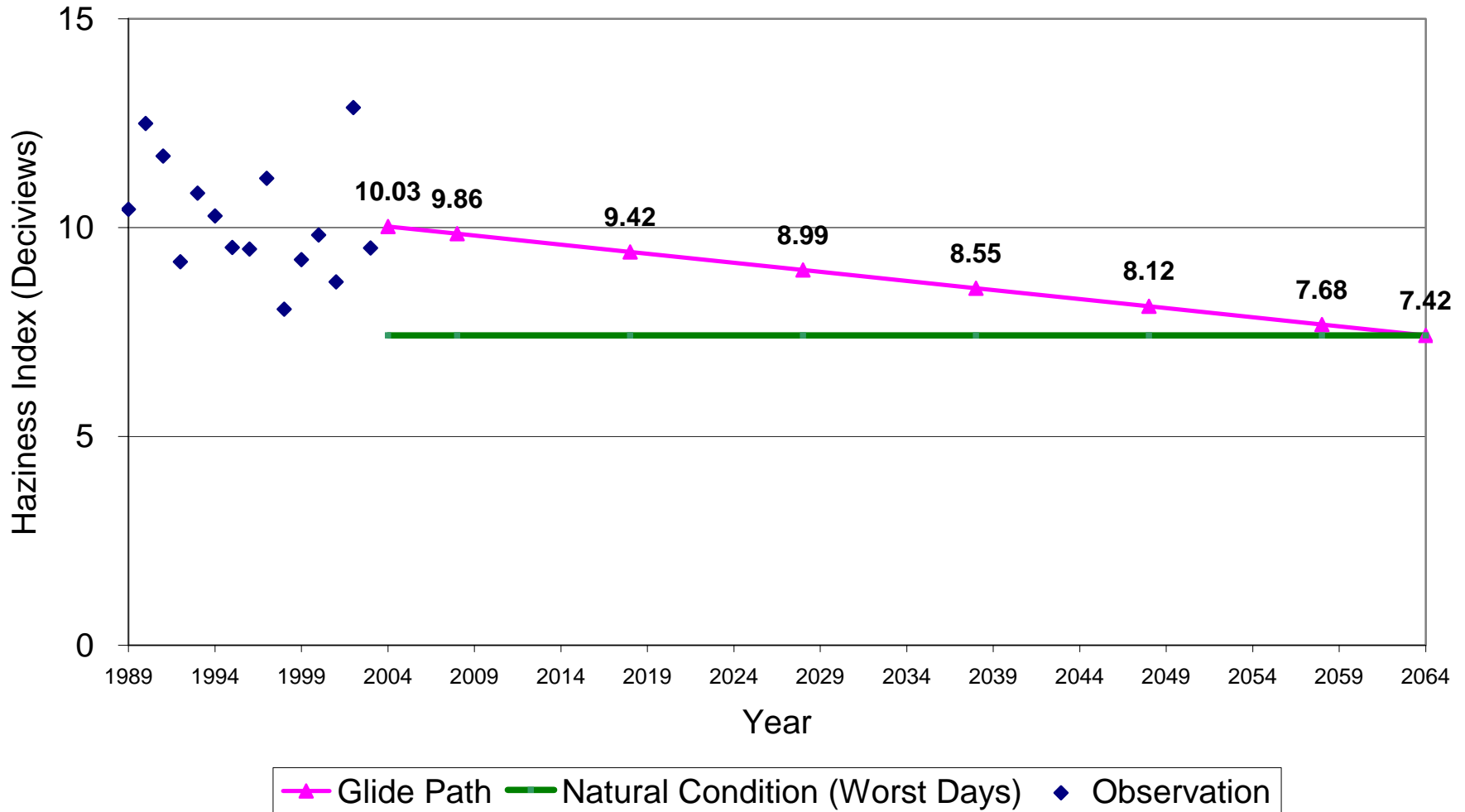
# Denali, AK – Worst 20% Days in 2002 Observations

Worst 20% Obs during 2002 at DENA1



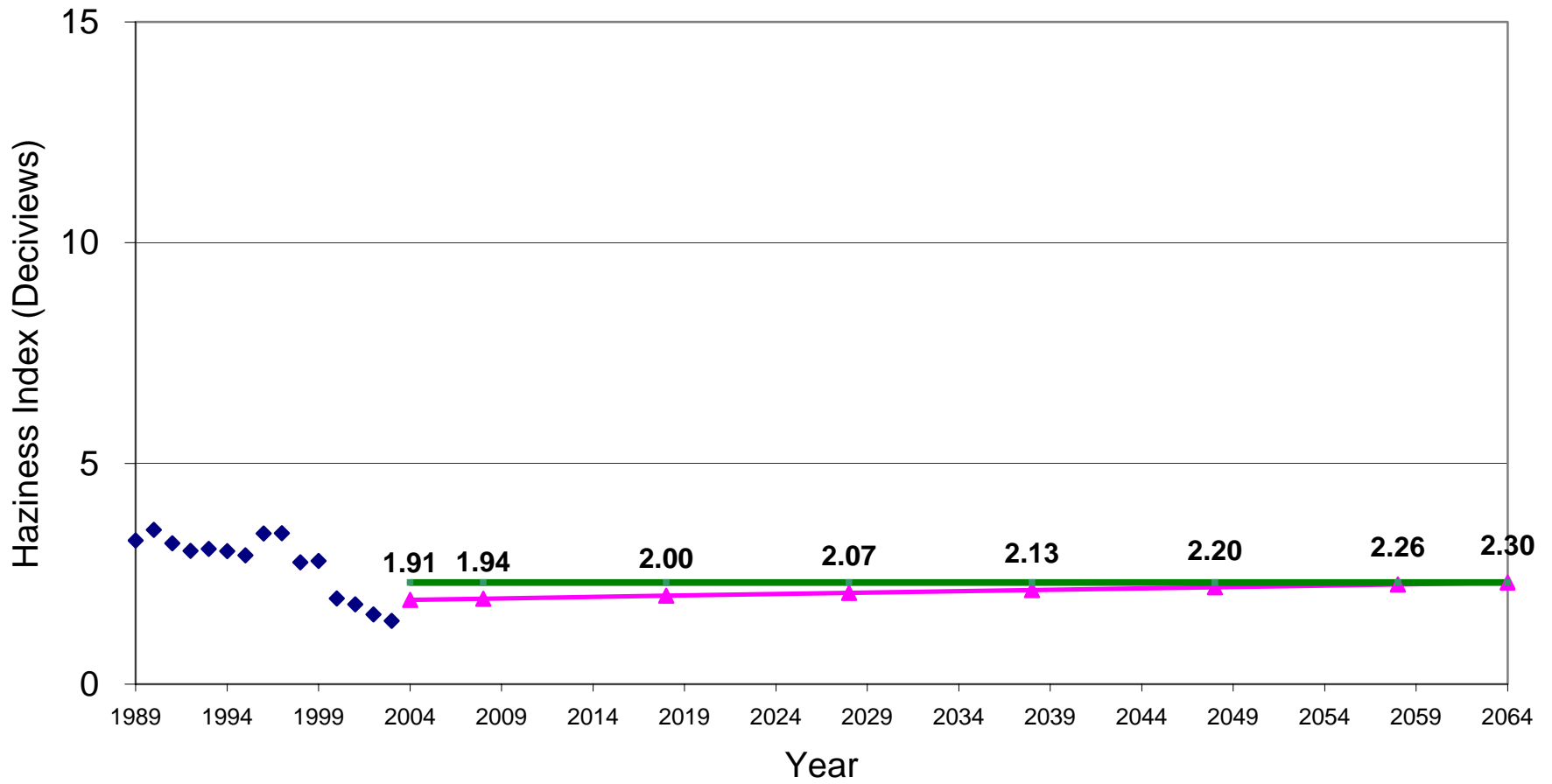
# Denali Glide Path to Natural Conditions, Baseline for Current Worst Days (10 dv) > 2064 Natural Conditions for many eastern Class I areas (e.g., GRSM @ 11 dv)

Denali 2018 RPG Reduction = 0.61 dv



# Denali National Park Best 20% Days (B20)

Current 5-Year Average for B20 Days (1.91 dv) lower than EPA default natural conditions for best days (2.30 dv)



◆ Observation    ▲ Glide Path    — Natural Condition (Best Days)



# Conclusions – WRAP Vis Projections (1)

- Much more diverse PM mixture in western US on Worst 20% days than in the east
- Fires and wind blown dust much more important – little opportunity to control
  - Focus reasonable progress on days with high anthropogenic contributions?
  - Incorporate fires and dust in Natural Conditions endpoint?
- Mexico, Canada and global transport can have large influence at some Class I areas

# Conclusions – WRAP Vis Projections (2)

- Need to start developing strategy for demonstrating reasonable progress for WRAP
  - Modeled 2018 RPG demonstration not likely for many Class I areas in western US
  - Mex/Can/International large influences
  - Weight of Evidence (WOE) RPG demo needed
    - Enforceable emission reductions
    - Treatment of extreme events (fires/dust/international)
    - Visibility improvements on days due to US anthro sources
      - Examine extinction improvements by species?
    - Smoke management plan
    - Modeled visibility changes just one element of RPG demonstration