WRAP/RMC Fire Sensitivity Modeling Project

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Fire Sensitivity Modeling Project Status

- Today's Presentation
  - Project Objectives
  - Sensitivity Parameters
  - Metrics used in Evaluation
  - Description of scenarios
  - Summary of S1 Emissions
  - S2 analysis results

Acknowledgments

- Tom Moore and FEJF – project design
- Air Sciences - Emissions Inventory
- Zac Adelman UNC & Mohammad Omary UCR - Emissions Processing.
- Chao-Jung Chien and Mohammad Omary UCR – preparation of plots.

Fire Sensitivity Modeling Project Objectives

- *Prioritize Data Collection Efforts* - the Regional Haze Rule identifies many forms of data collection pertaining to fire emissions. Examples include:
  - Emission inventories for modeling analyses (in support of regional haze implementation plans);
  - Emission tracking systems for regional haze plan compliance; and
  - Tracking/quantifying "credit" for applications of emission reduction techniques.
- *Prioritize Long-Term Research Needs* - the FEJF has acknowledged the uncertainty and imprecision of the information and tools available to estimate fire emissions.
- *Improve Smoke Management Decisions* - States and Tribes may need to make real-time decisions with regard to issuing permits and requiring emission reduction and/or smoke management techniques.

Fire Sensitivity Modeling Parameters

- ***Spatial extent of the sensitivity runs*** – use the entire modeling domain. Depending on the nature of the runs and the protocols developed to analyze and interpret the data, smaller geographic areas of sources or a limited number of receptors in Class I areas may then become the focus of the analyses.
- ***Temporal extent of the sensitivity runs*** - for runs made with the 2002 wildfire inventory, limiting the model runs to a 3- or 4-month period of high wildfire incidence (June–September, for example) should be adequate. For interpreting the results from modeling runs already performed, analyzing the entire year's of data is preferred.
- ***Emissions from Other Source Categories*** - for the Fire Sensitivity Runs, use a constant set of other source categories' emissions data.
- ***Use RMC modeling framework to determine the sensitivity of the model to changes in the physical environment***, rather than to determine the best physical representation of fire.

Fire Sensitivity Modeling Metrics

- Use PAVE module to analyze emission outputs (from SMOKE) and modeled extinction (from CMAQ)
- Metrics:
  - Sensitivity of the model results to proximity of fire events may lead to result of “extinction/concentration is inversely proportional to distance.”
  - For plume characteristics may lead to “75% of impact is due to emissions fumigated into the first vertical layer”.
  - Possible general rules-of-thumb could result, to describe the sensitivity of the model to changes in specific parameters. For example:
    - “Fires less than 25 acres do not contribute significantly”, or
    - “Fires greater than 1,000 acres in size may have a significant impact on Class I areas in a 500 km radius.”
- The FEJF places high importance on the development of protocols to direct the analysis and interpretation of the results of the modeling sensitivity study. These protocols will be developed as the study is being defined.

Fire Sensitivity Modeling Scenarios

- **S1** – Quantify/characterize the contribution to extinction due to:
  - (a) all fire sources contributing in combination
  - (b) each type of fire source contributing individually (agricultural burning (2018 Base), prescribed burning (2002), and wildfire (2002)).
- Analysis should include:
  - Does any type of fire contribute to any of the 20% worst days;
  - What is the magnitude of the contribution; and
  - What is the relationship of the contribution to the emissions (is it mass? proximity? fire size?).

Fire Sensitivity Modeling Scenarios (cont)

- **S2** – Quantify/characterize the effect of Optimal Smoke Management (OSM) on extinction levels. Compare results of existing §309 2018 OSM to 2018 Base model runs. Attempt to use model results to characterize predicted benefits to regional haze with less aggressive OSM reductions. FEJF is interested in quantifying the effect of:
  - (a) OSM applied to prescribed fire and agricultural burning;
  - (b) OSM applied to prescribed fire; and
  - (c) OSM applied to agricultural burning.
- Analyze using PAVE on a grid scale to quantify the effect on net change in emissions and net change in extinction.
- Analysis S2(a) is presented later in this presentation, and S2(b) and S2(c) are deferred.

Fire Sensitivity Modeling Scenarios (cont)

S3 – Effects of small fires:

a. Generate new 2002 scenario. This will be the same as Pre02c except replacing the Rx and wild fires by new inputs in which some of the small size fires were zeroed.

b. Do comparison analysis with scenario Pre02c.

Fire Sensitivity Scenarios (cont)

S4 – investigate sensitivity to mass in Layer 1.

a. Generate new 2002 scenario. This will be Pre02b and the Ag fires, as Pre02b_AGF(2018) in S1(b), where the emissions in the first layer are split. The ratio 38/80 of the emissions (LAY1F) will be replaced in the first layer and the rest (42/80) will be placed in the subsequent layers.

b. Do comparison analysis with scenario

Pre02b+AGF(2018) (see S1(b))

Fire Sensitivity Modeling Scenarios

- **S5** – Quantify / characterize the contribution to extinction due to smaller fire events (between 10 acres and 100 acres).
- Subsets (representing only fires larger than specified size cut points) of the 2002 emission inventory (wildfire and prescribed burning) will be provided by the FEJF to the RMC.
- Air Sciences can provide a proposed methodology and cost estimate for preparing emission inventory at various size cut-points.
  - This can be accomplished easily by adding a filter to remove emissions from fire in all grid cells for which the emissions exceed a certain cut point.

Fire Sensitivity Modeling Scenarios

- **S7 –** Quantify/characterize the effect on extinction levels of physical plume characteristics provided for each fire event, using the 2002 wildfire emission inventory.
- FEJF to provide modified plume profile data to RMC.
  - FEJF to provide RMC with 2018 Ag base emission inventory with emissions fumigated to the first vertical layer (LAY1F) adjusted by 38/80 to account for the RMC vs. FEJF discrepancy in the assumed height of the first vertical layer.
  - This can be accomplished by modifying the SMOKE fire output file to change the vertical profile. Alternatively, if a new plume rise algorithm is proposed, it would be better to run SMOKE again with the new algorithm.

S1 Results

Seasonal Plots comparing Emissions for:

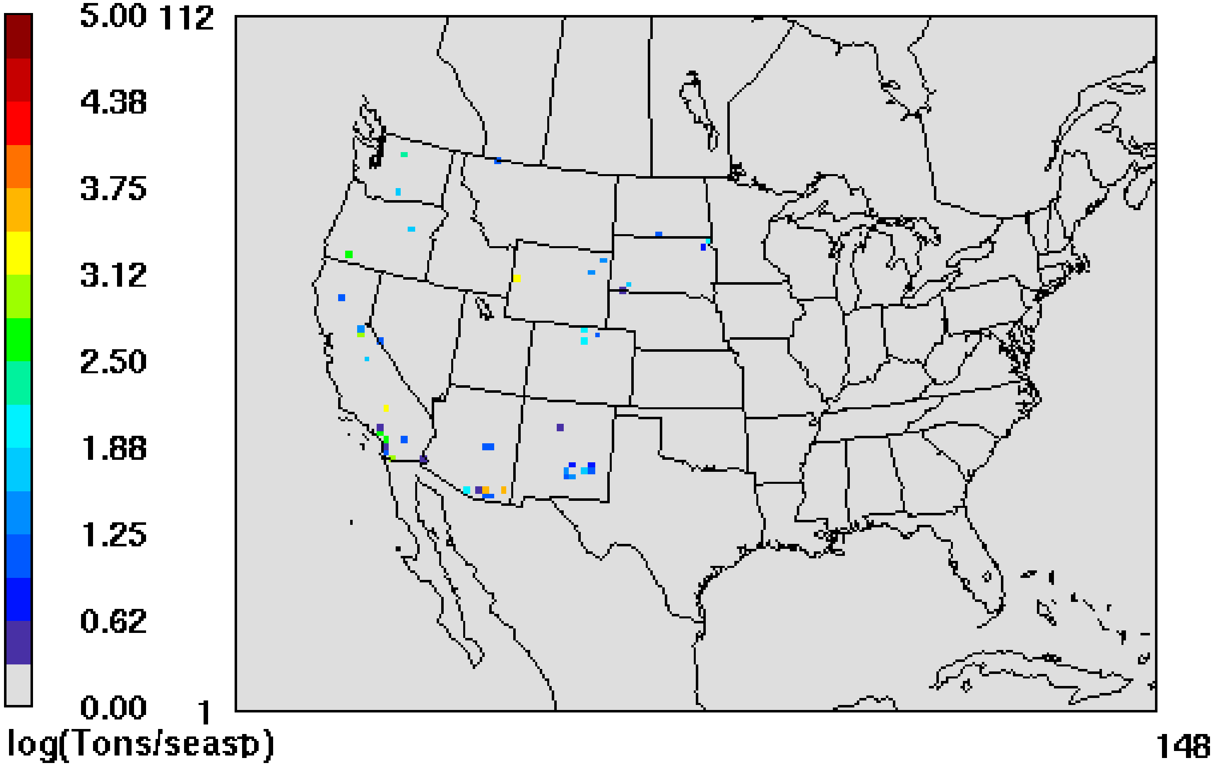
- Agricultural Burning (Ag)
- Prescribed Burning (Rx)
- Wild Fires

Redo of CMAQ Cases to be complete **9/31/04**:

- Pre02b – no wild fire emissions
- Pre02c – includes 2002 wild fire and Rx
- Pre02b plus Ag burning only
- Pre02b plus Rx only
- Pre02b plus wildfires only

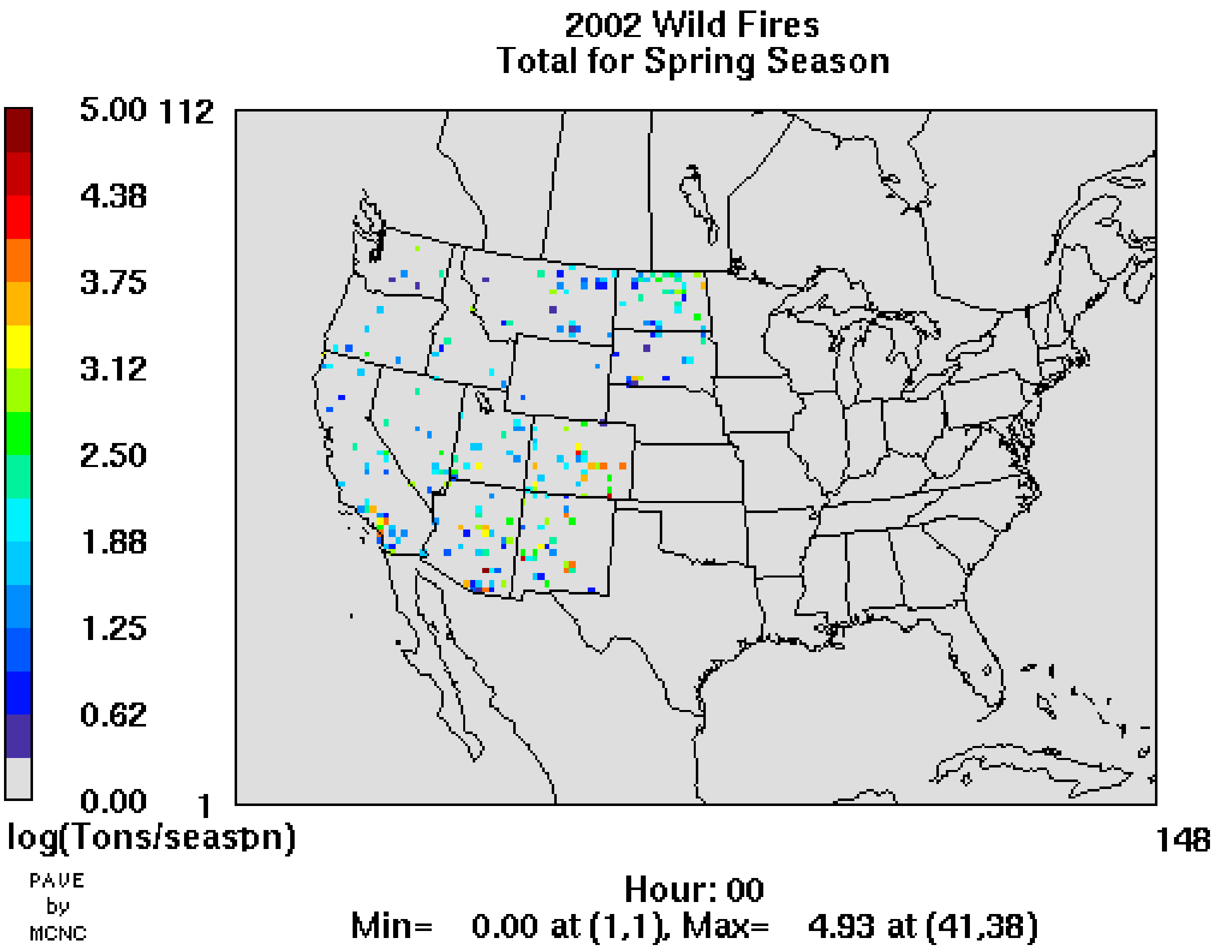
CO

2002 Wild Fires
Total for Winter Season



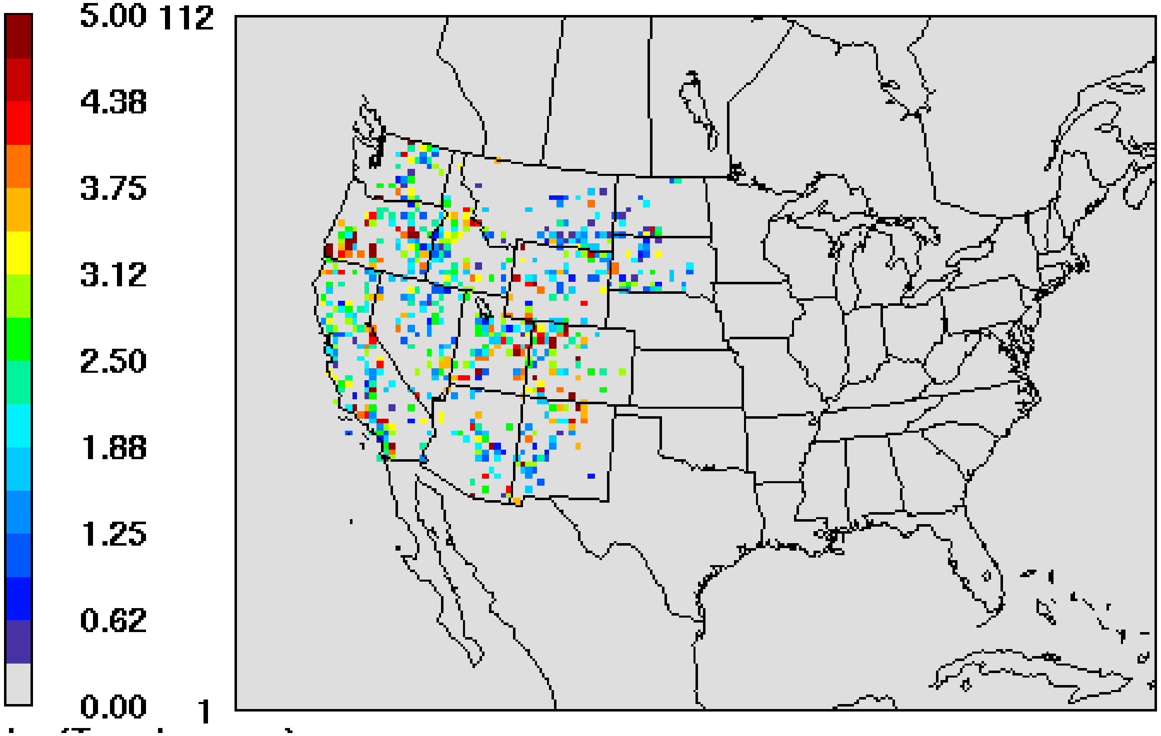
Hour: 00
Min= 0.00 at (1,1), Max= 3.75 at (41,36)

CO


2002 Wild Fires
Total for Spring Season
5.00
4.38
3.75
3.12
2.50
1.88
1.25
0.62
0.00
log(Tons/season)
112
1
148
PAVE
by
MCNC
Hour: 00
Min= 0.00 at (1,1), Max= 4.93 at (41,38)

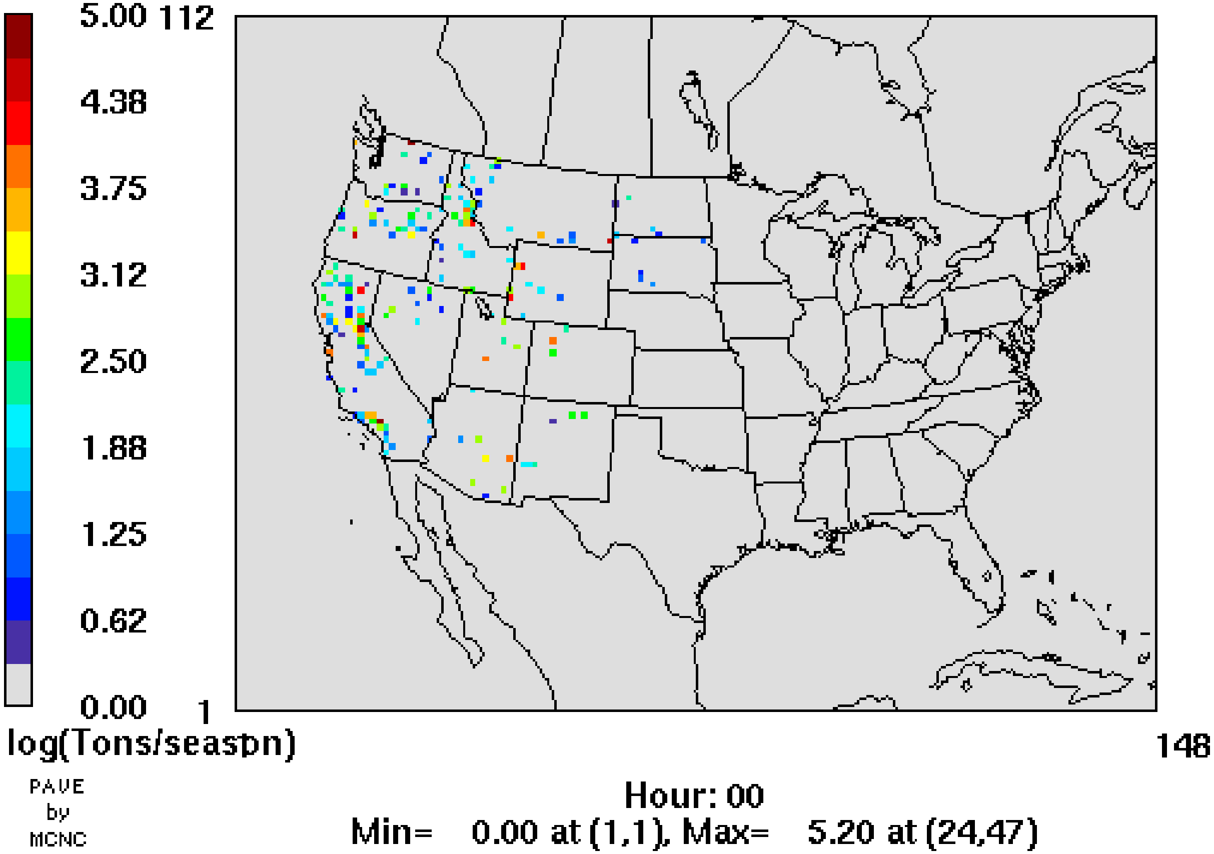
CO

2002 Wild Fires
Total for Summer Season



CO

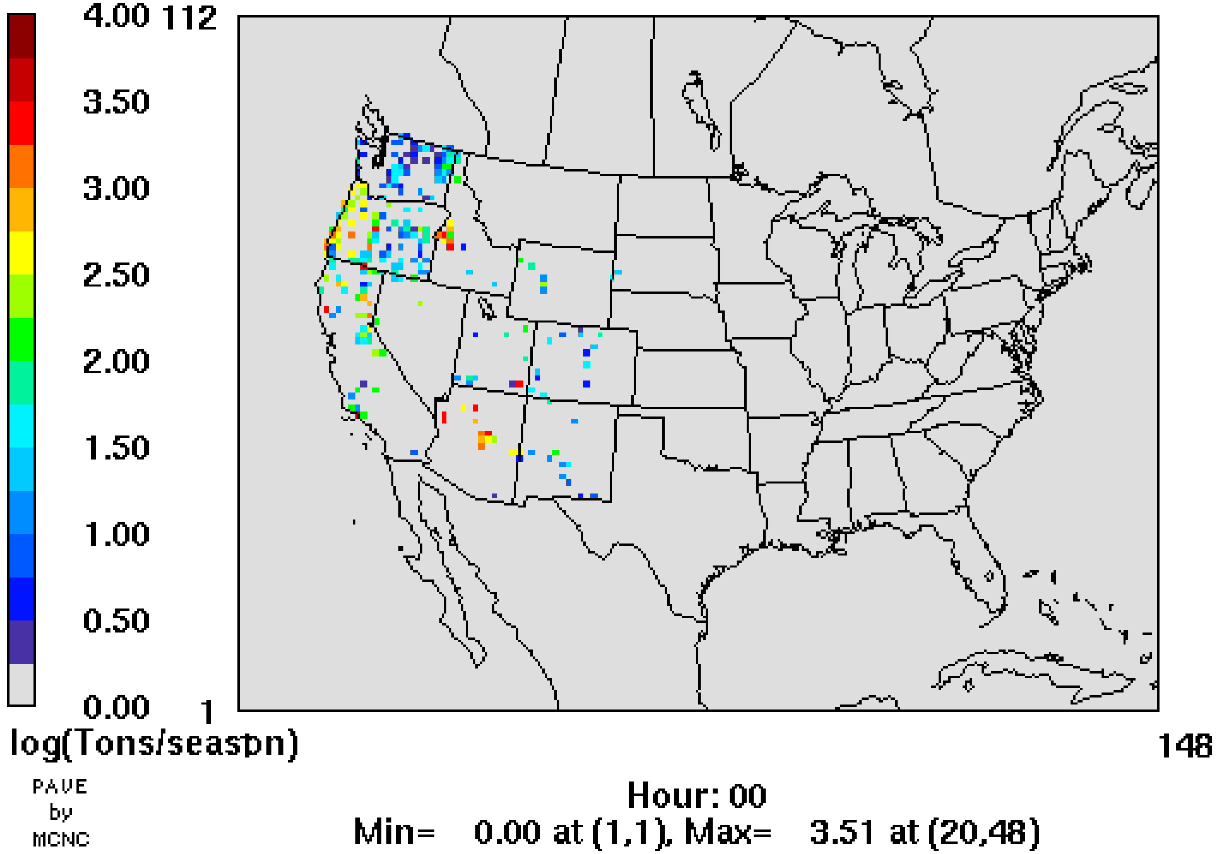
2002 Wild Fires
Total for Fall Season



Hour: 00
Min= 0.00 at (1,1), Max= 5.20 at (24,47)

CO

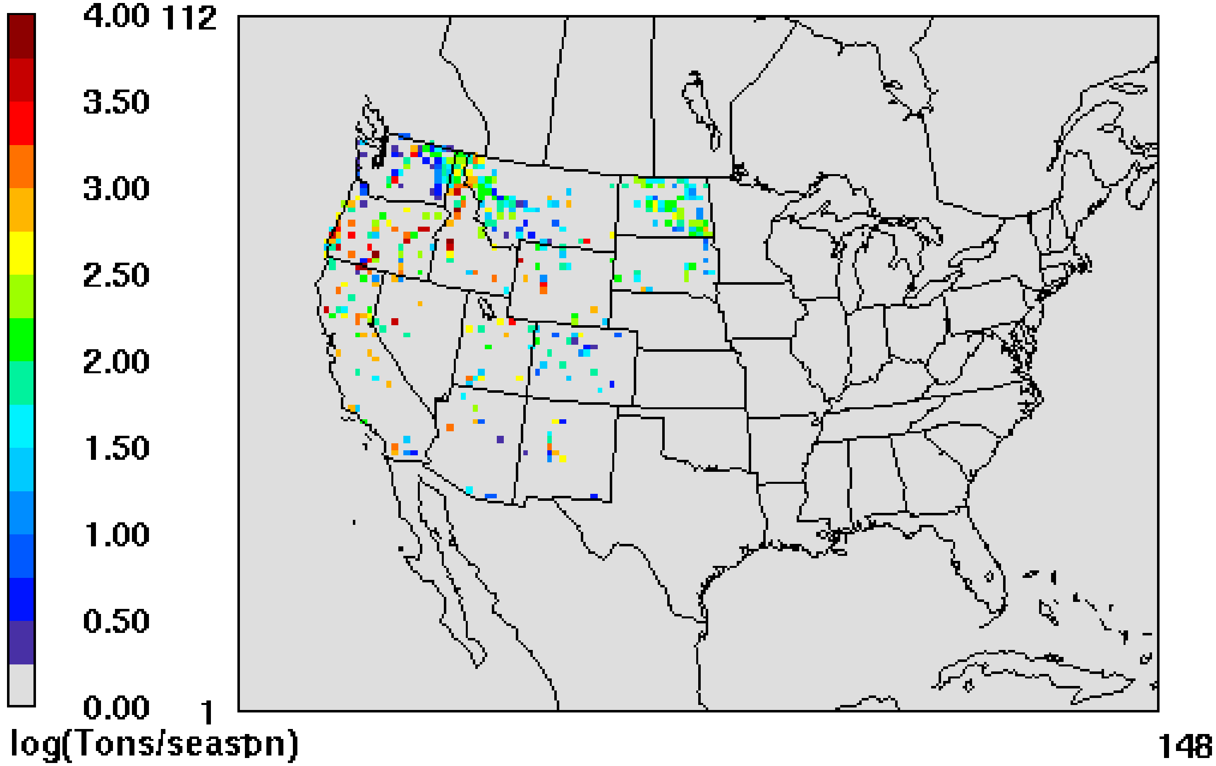
2002 Rx Fires
Total for Winter Season



Hour: 00
Min= 0.00 at (1,1), Max= 3.51 at (20,48)

CO

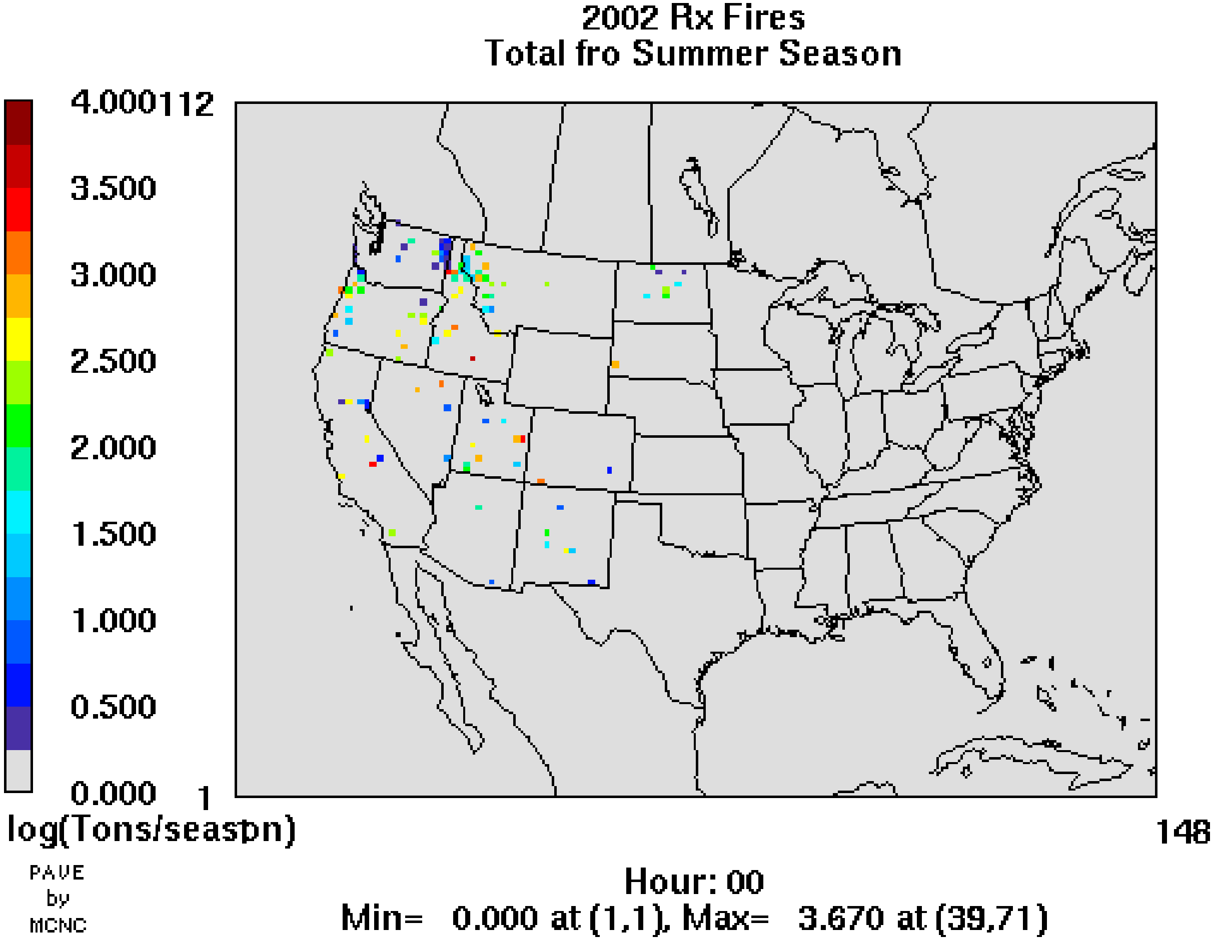
2002 Rx Fires
Total for Spring Season



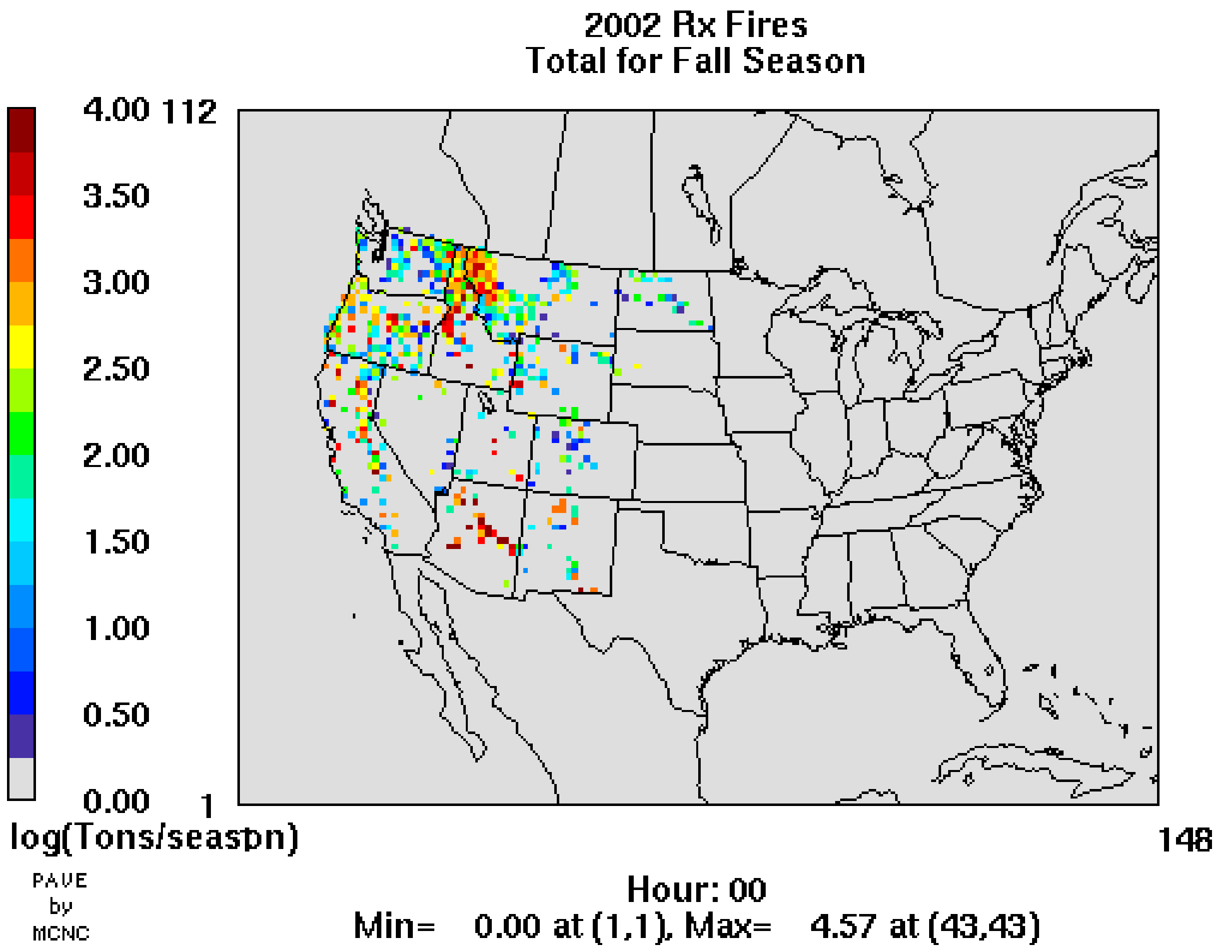
PAVE
by
MCNC

Hour: 00
Min= 0.00 at (1,1), Max= 4.13 at (21,72)

CO

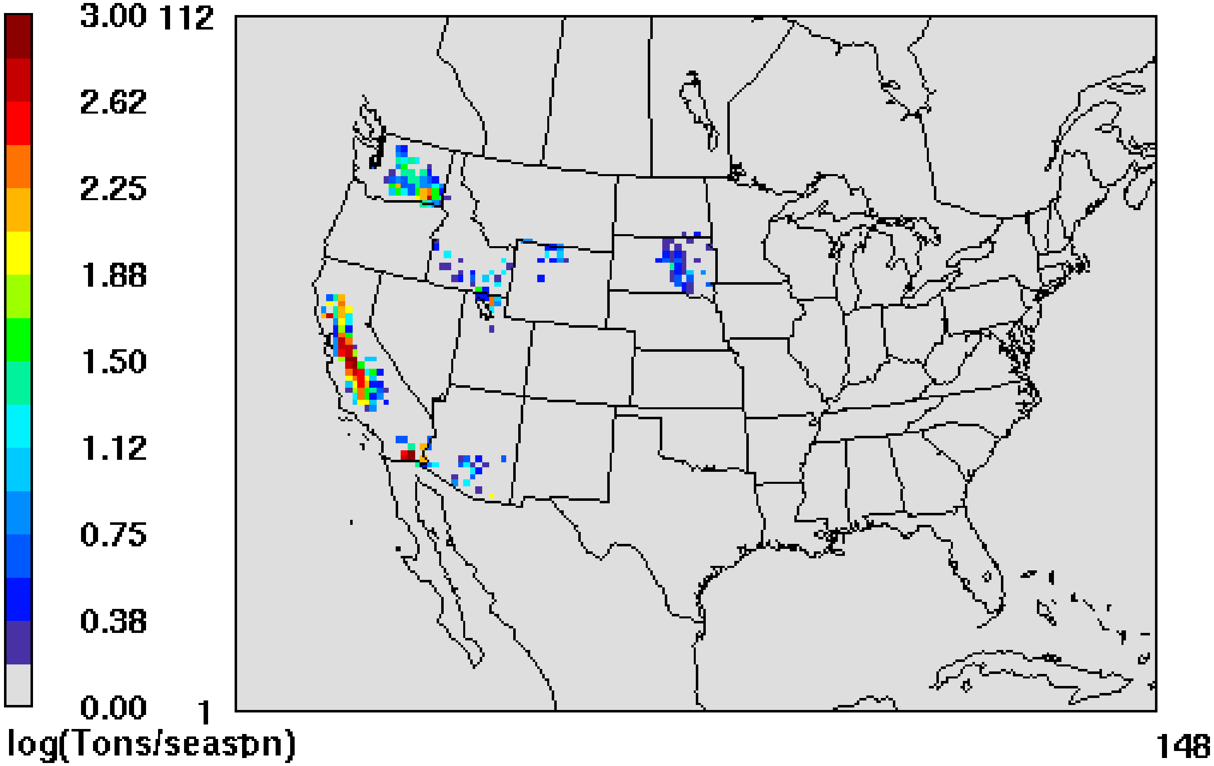

2002 Rx Fires
Total fro Summer Season
4.000112
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
1
log(Tons/season)
148
PAVE
by
MCNC
Hour: 00
Min= 0.000 at (1,1), Max= 3.670 at (39,71)

CO


2002 Rx Fires
Total for Fall Season
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
112
1
148
log(Tons/season)
PAVE
by
MCNC
Hour: 00
Min= 0.00 at (1,1), Max= 4.57 at (43,43)

CO

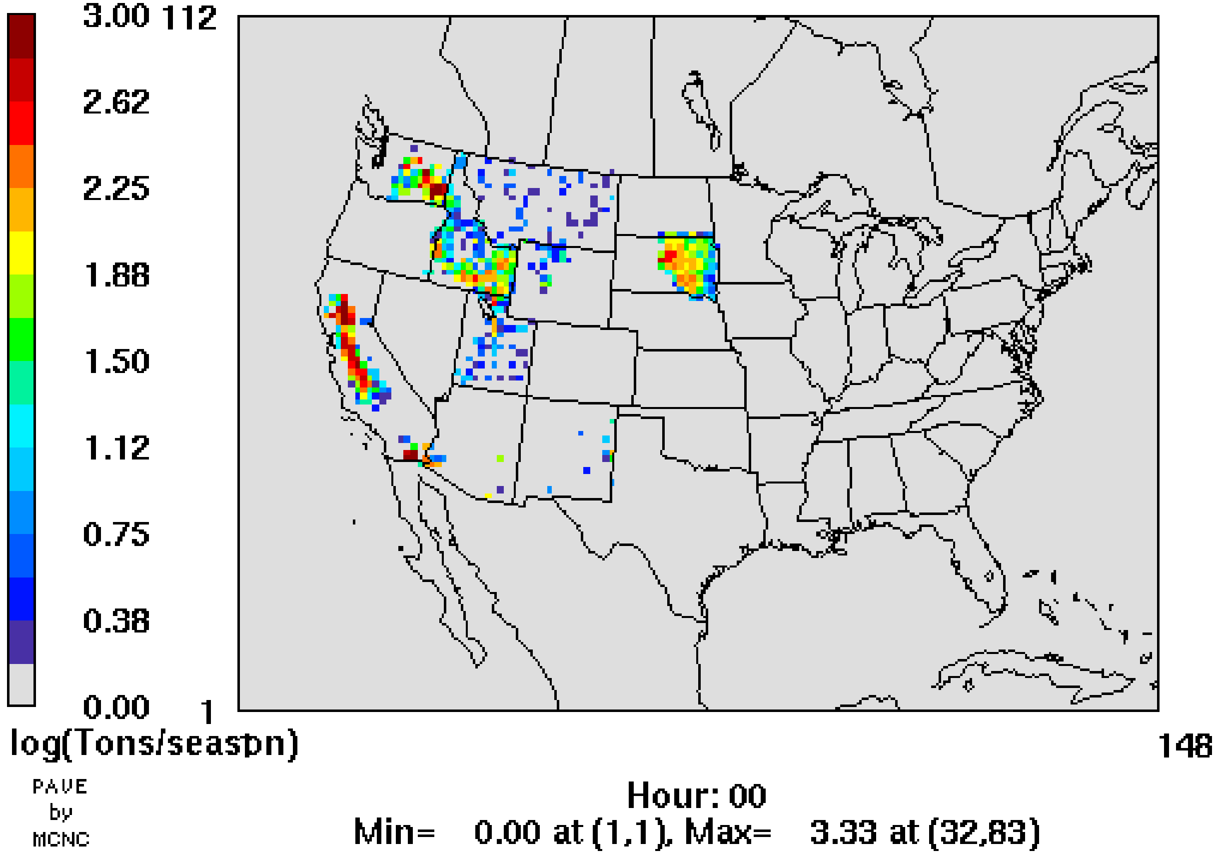
2018 Ag Fires
Total for Winters Season



Hour: 00
Min= 0.00 at (1,1), Max= 3.05 at (29,41)

CO

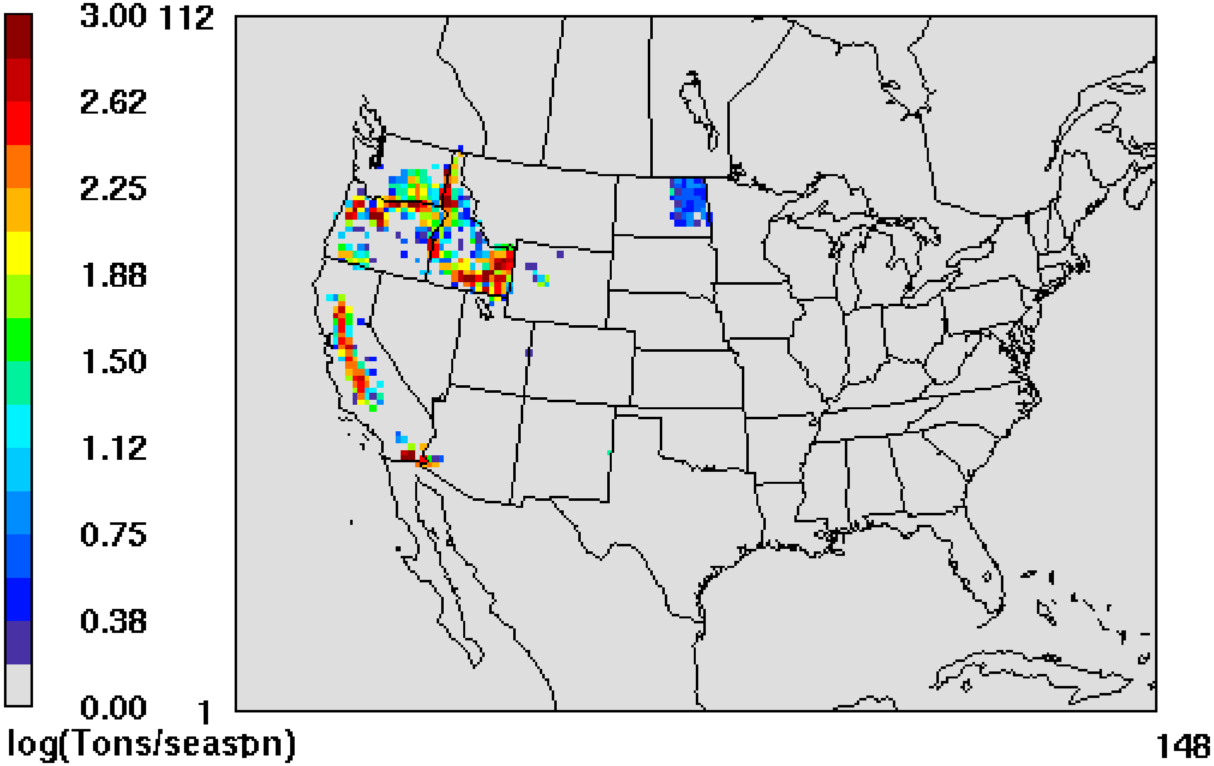
2018 Ag Fires
Total for Spring Season



Hour: 00
Min= 0.00 at (1,1), Max= 3.33 at (32,83)

CO

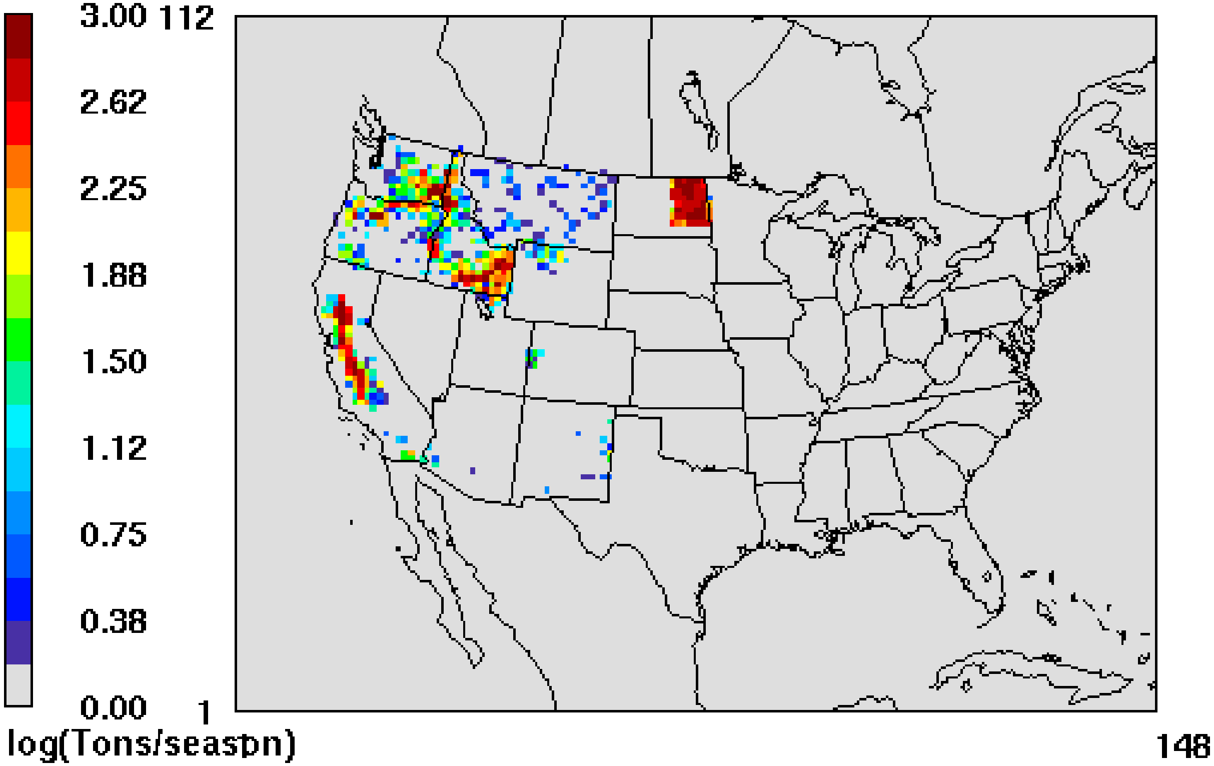
2018 Ag Fires
Totlal for Summer Season



Hour: 00
Min= 0.00 at (1,1), Max= 3.43 at (24,80)

CO

2018 Ag Fires
Total for Fall Season



Hour: 00
Min= 0.00 at (1,1), Max= 3.20 at (33,85)

S2 Results

Seasonal Plots comparing changes in Emissions, Visibility and PM Species for:

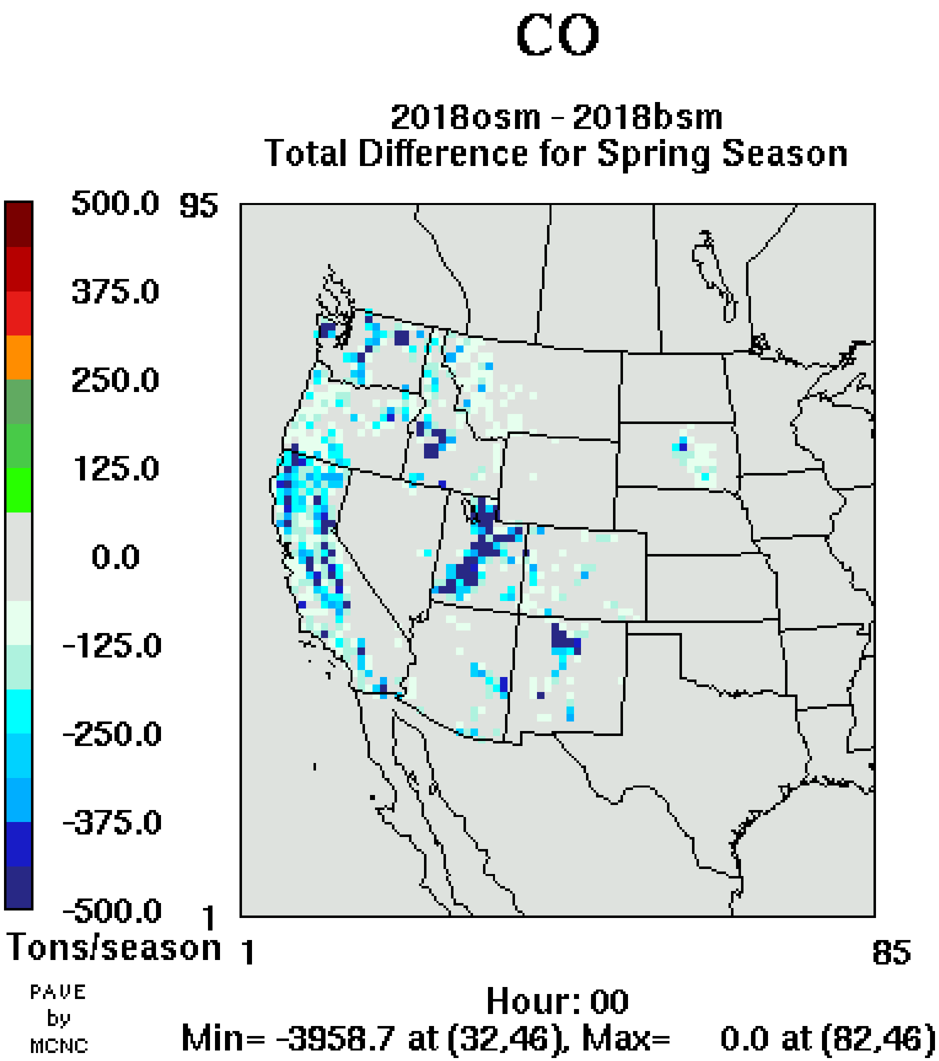
- Base Smoke Management (BSM)
- Optimal Smoke Management (OSM)

Calculated as (OSM-BSM), where “Blue” indicates reductions in OSM compared to BSM.

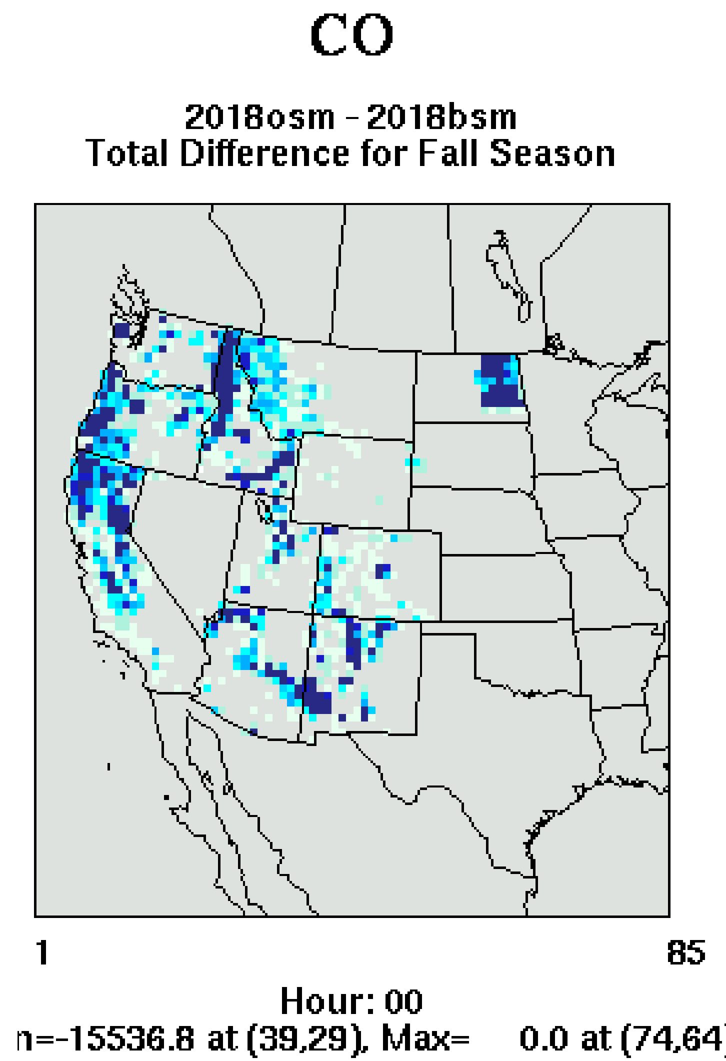
Spring = March/April/May Summer = June/July/Aug

Fall = Sept/Oct/Nov Winter = Dec/Jan/Feb

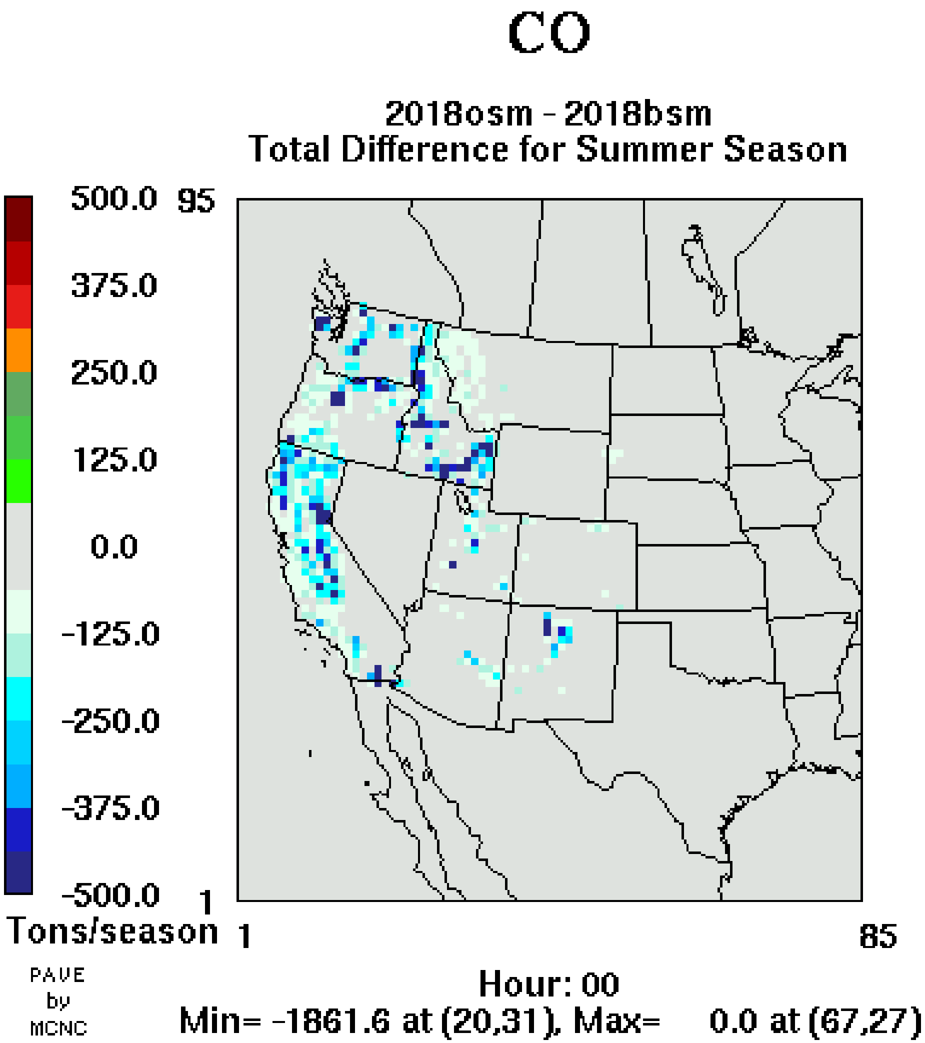
Spring CO Emissions



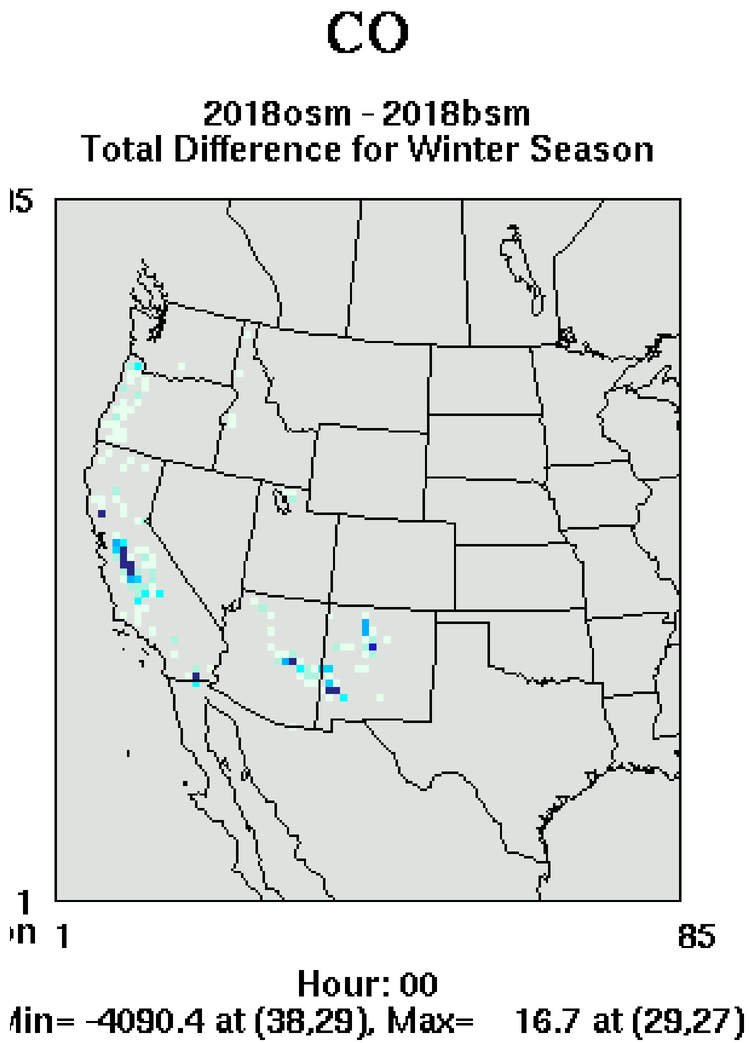
Fall CO Emissions



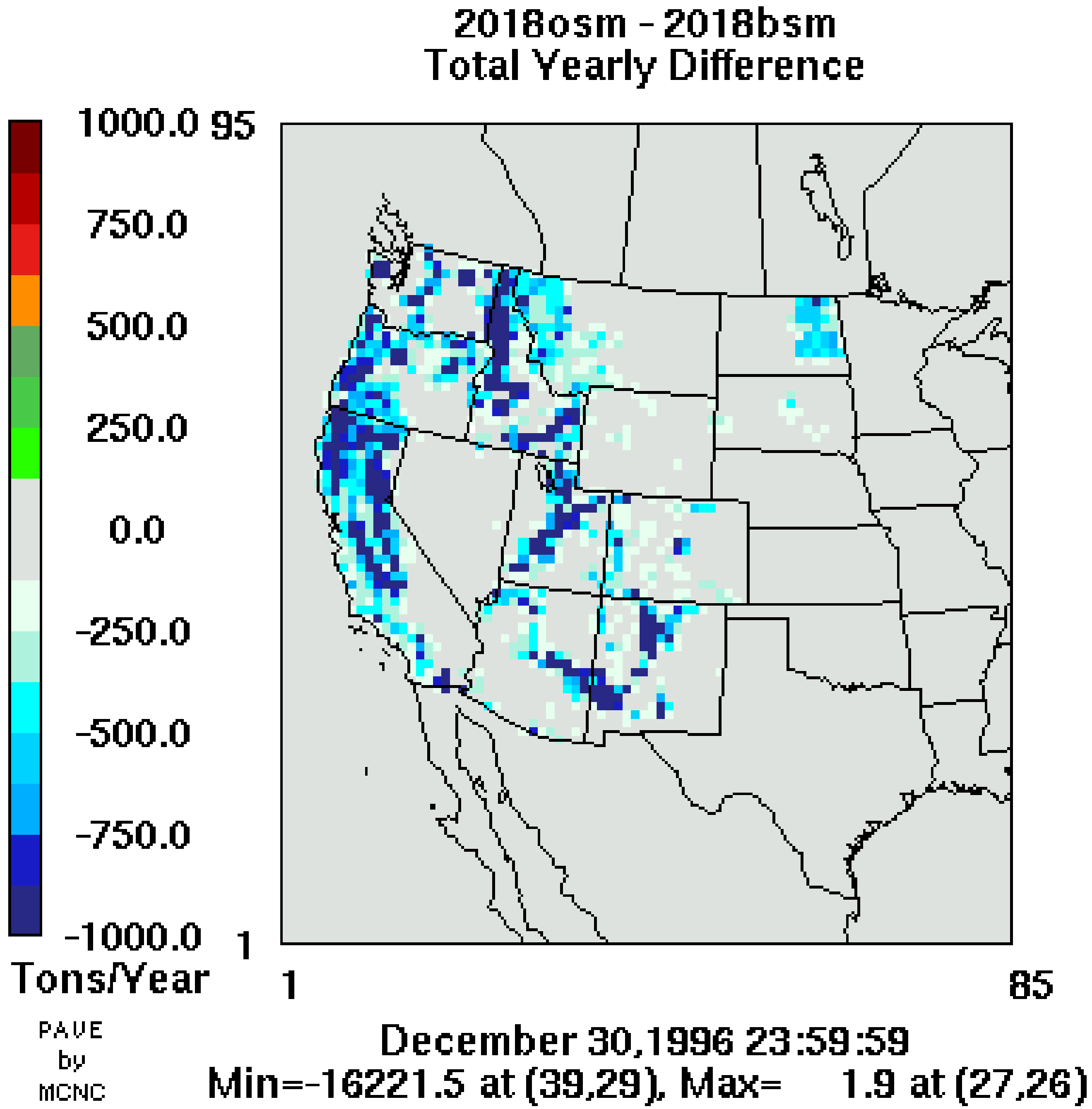
Summer CO Emissions



Winter CO Emissions



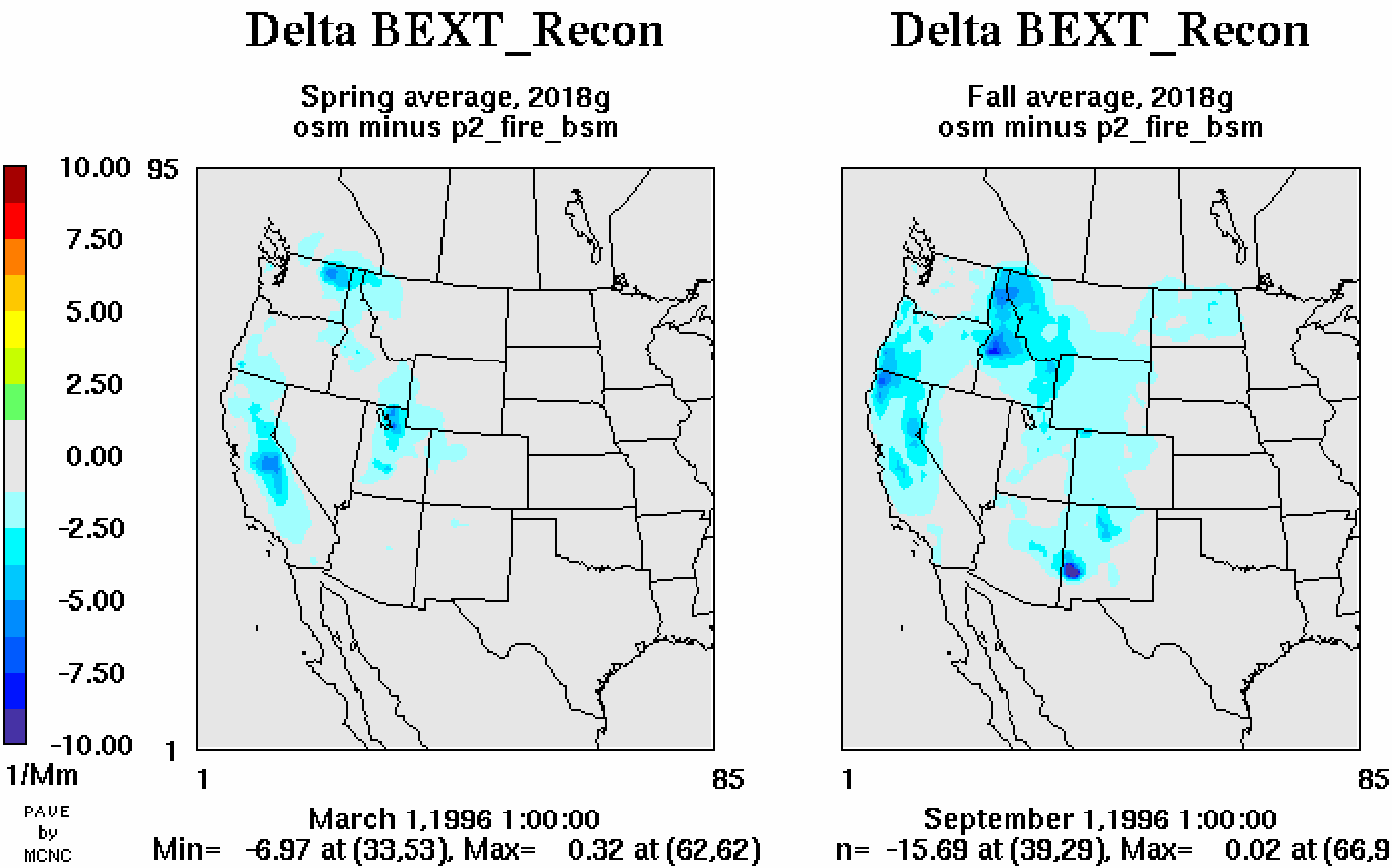
Annual Total Change in CO Emissions

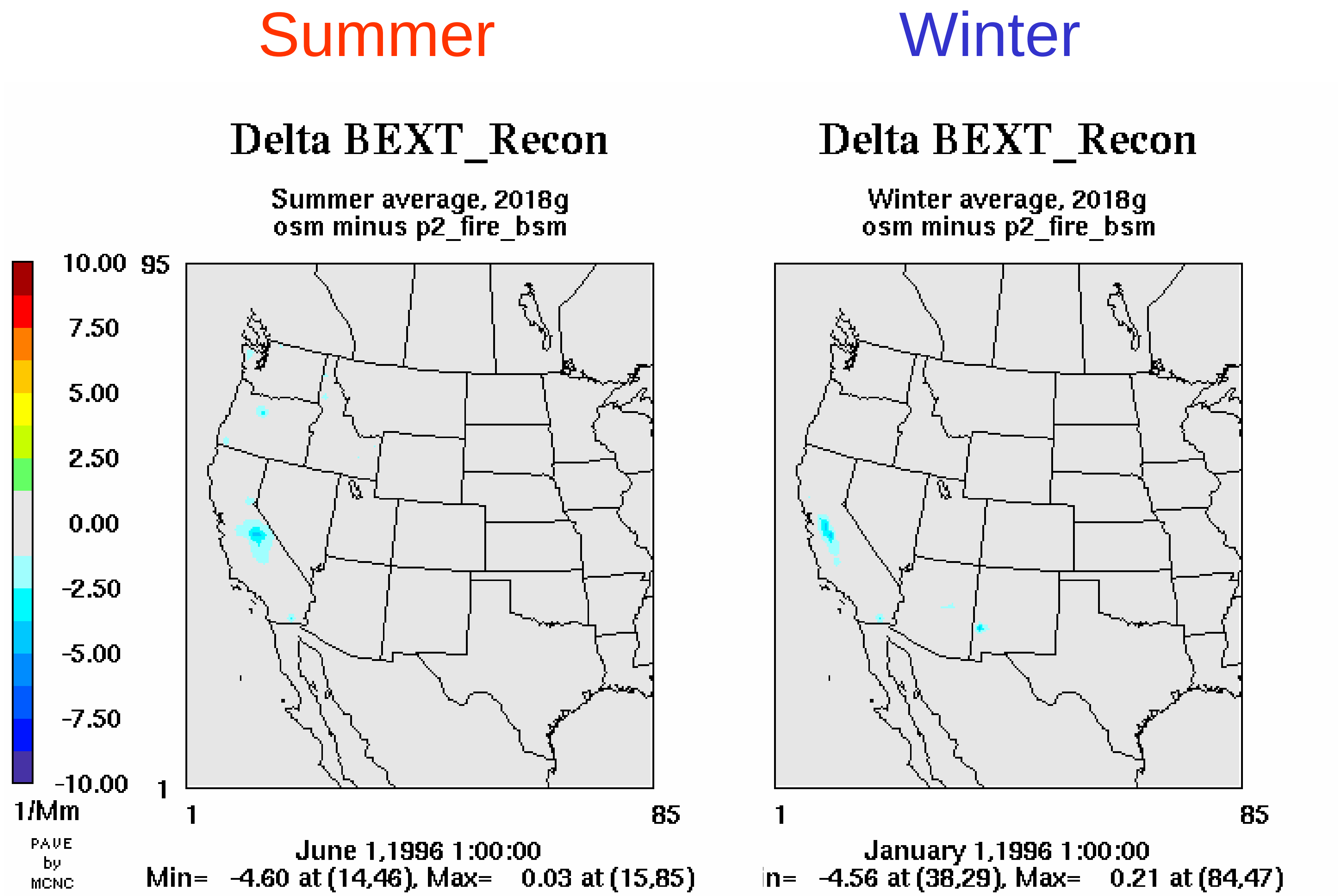


Change in Visibility

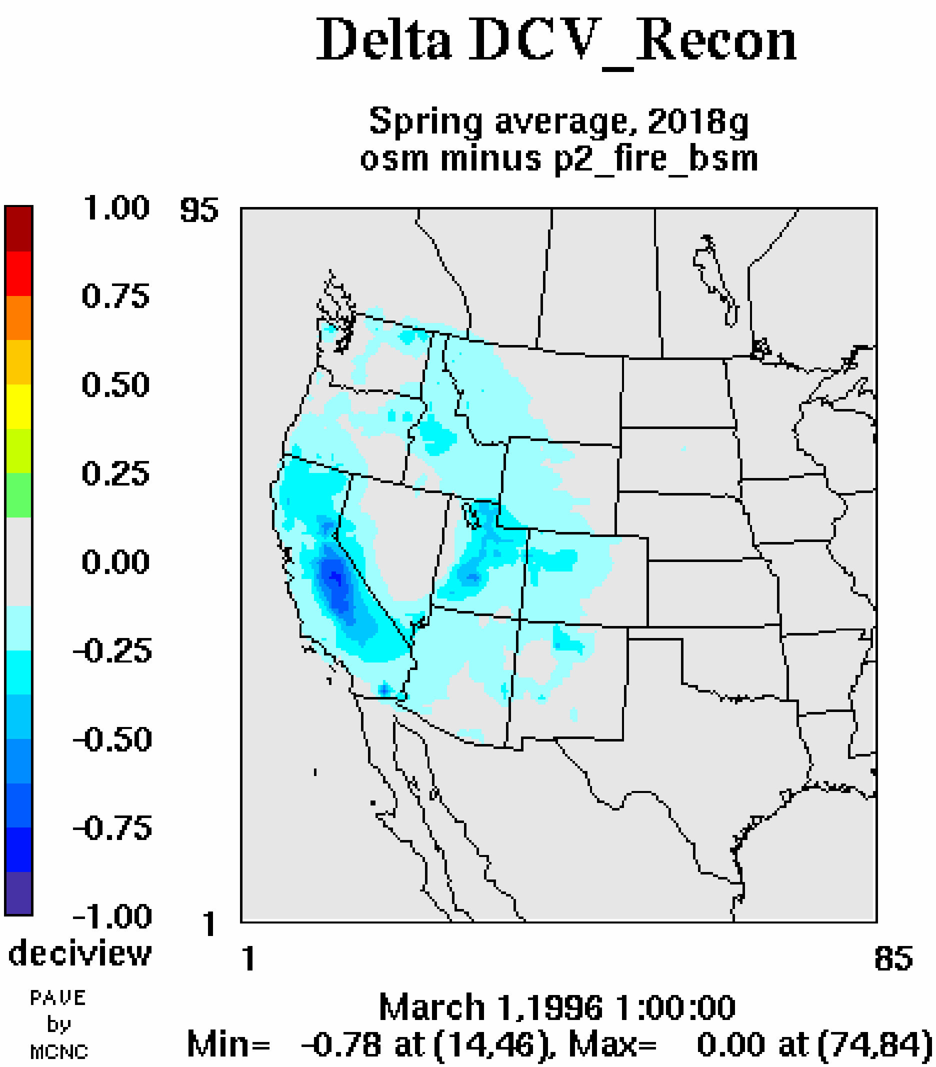
- Effects will depend on both the change in emissions and seasonal differences in meteorology.

Spring   Fall

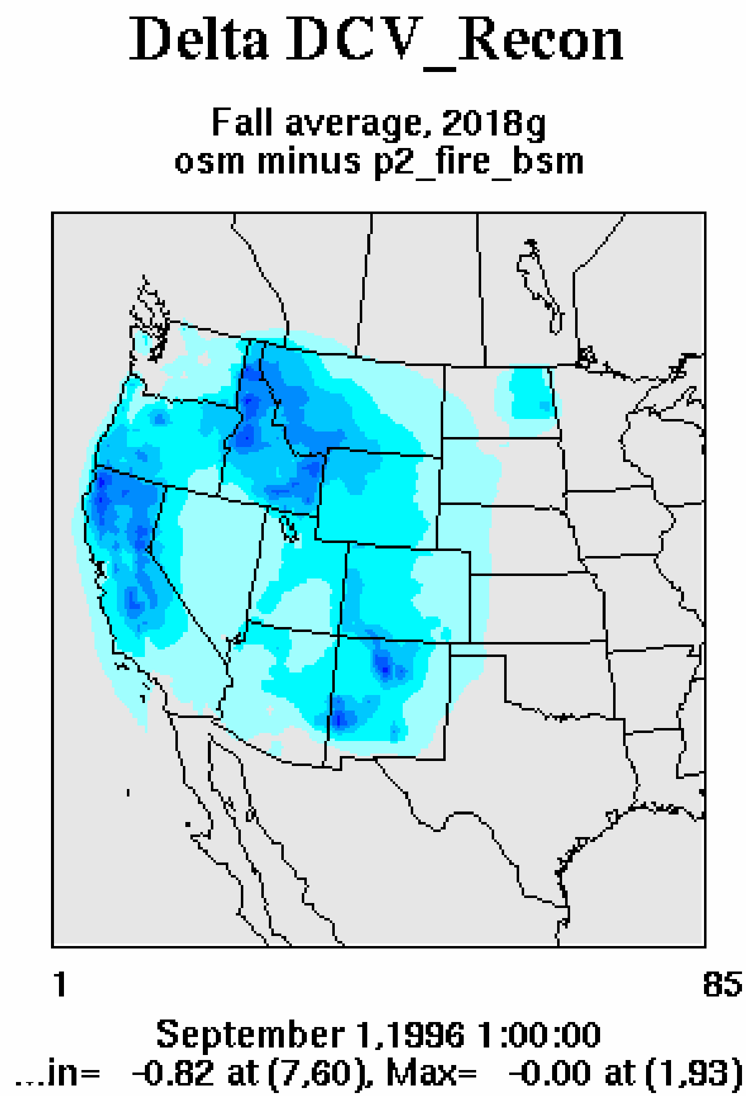

Delta BEXT_Recon
Spring average, 2018g
osm minus p2_fire_bsm
10.00
7.50
5.00
2.50
0.00
-2.50
-5.00
-7.50
-10.00
1/Mm
PAVE
by
MCNC
95
1
1
85
March 1,1996 1:00:00
Min= -6.97 at (33,53), Max= 0.32 at (62,62)
Delta BEXT_Recon
Fall average, 2018g
osm minus p2_fire_bsm
1
85
September 1,1996 1:00:00
n= -15.69 at (39,29), Max= 0.02 at (66,9)


Summer
Winter
Delta BEXT_Recon
Summer average, 2018g
osm minus p2_fire_bsm
Delta BEXT_Recon
Winter average, 2018g
osm minus p2_fire_bsm
10.00
7.50
5.00
2.50
0.00
-2.50
-5.00
-7.50
-10.00
1/Mm
PAVE
by
MCNC
95
1
1
85
1
85
June 1,1996 1:00:00
Min= -4.60 at (14,46), Max= 0.03 at (15,85)
January 1,1996 1:00:00
in= -4.56 at (38,29), Max= 0.21 at (84,47)

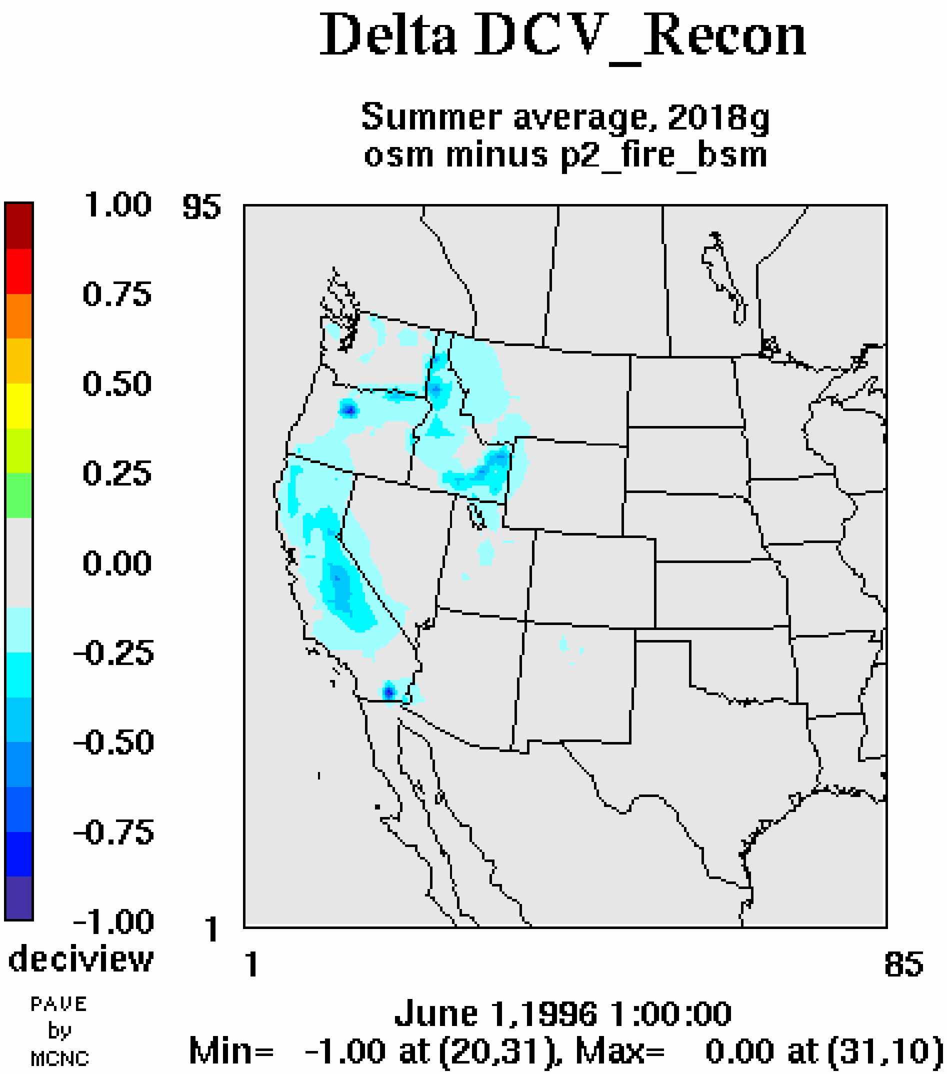
Spring


Delta DCV_Recon
Spring average, 2018g
osm minus p2_fire_bsm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
deciview
PAVE
by
MCNC
95
1
1
85
March 1,1996 1:00:00
Min= -0.78 at (14,46), Max= 0.00 at (74,84)

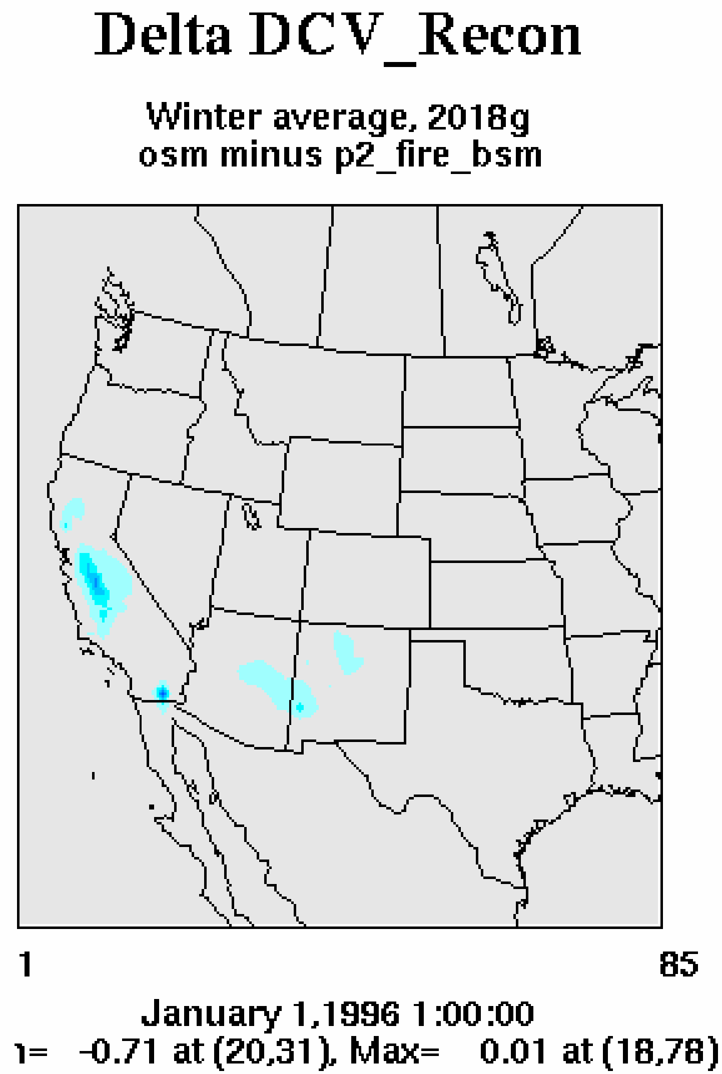
Fall


Delta DCV_Recon
Fall average, 2018g
osm minus p2_fire_bsm
1
85
September 1,1996 1:00:00
...in= -0.82 at (7,60), Max= -0.00 at (1,93)

Summer



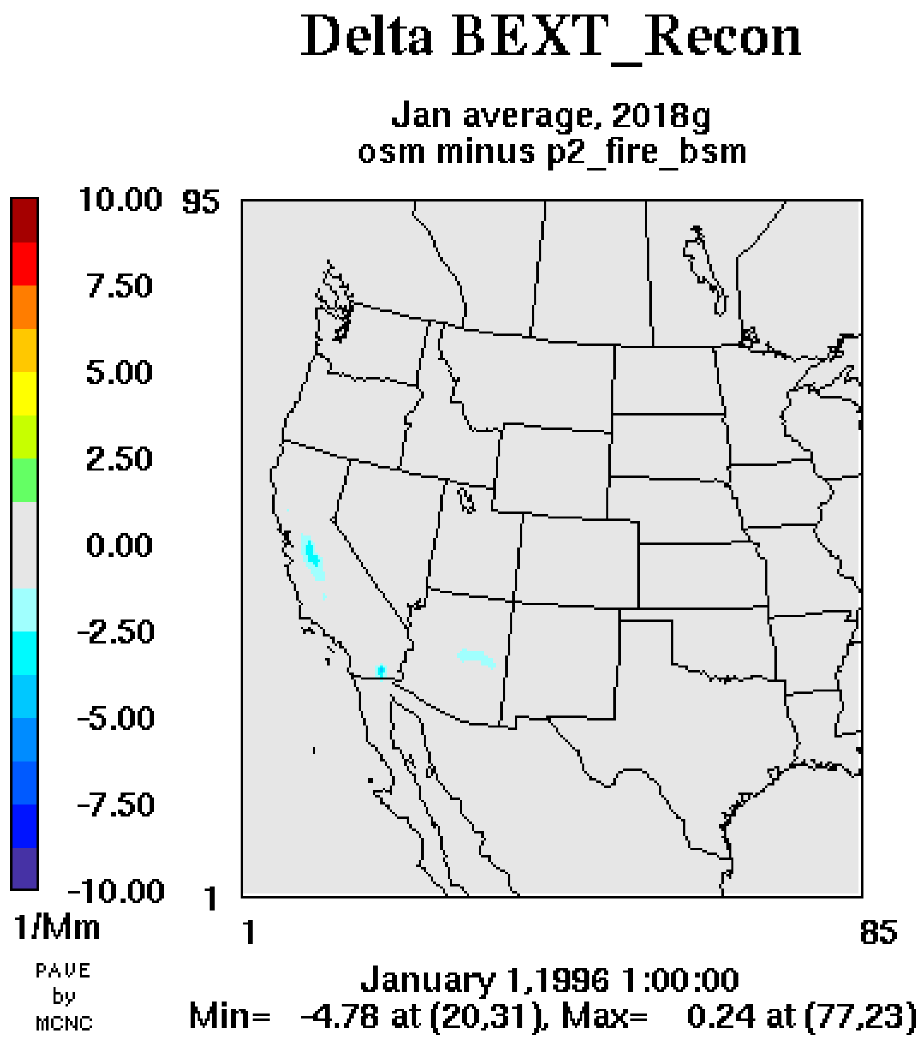
Winter



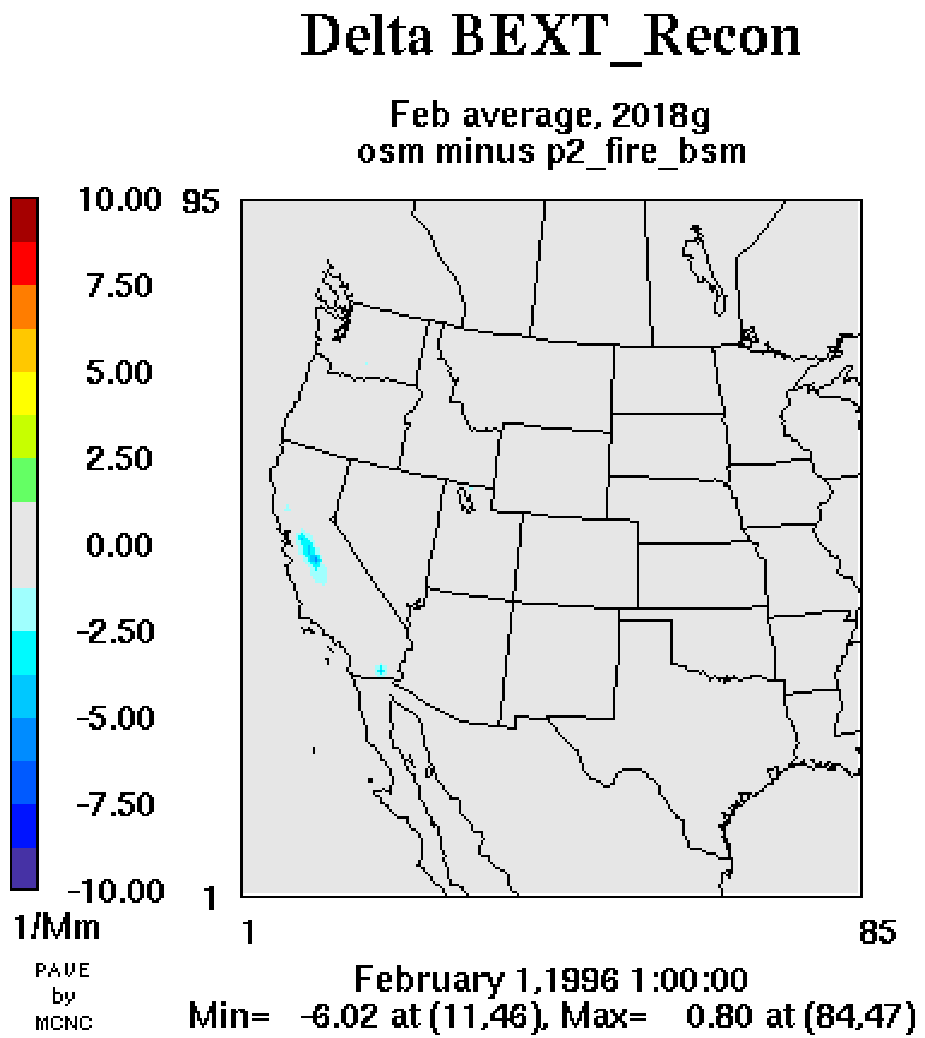
Monthly Results for OSM - BSM

Beta Extinction

Jan


Delta BEXT_Recon
Jan average, 2018g
osm minus p2_fire_bsm
10.00
7.50
5.00
2.50
0.00
-2.50
-5.00
-7.50
-10.00
1/Mm
95
1
1
85
PAVE
by
MCNC
January 1,1996 1:00:00
Min= -4.78 at (20,31), Max= 0.24 at (77,23)

Feb

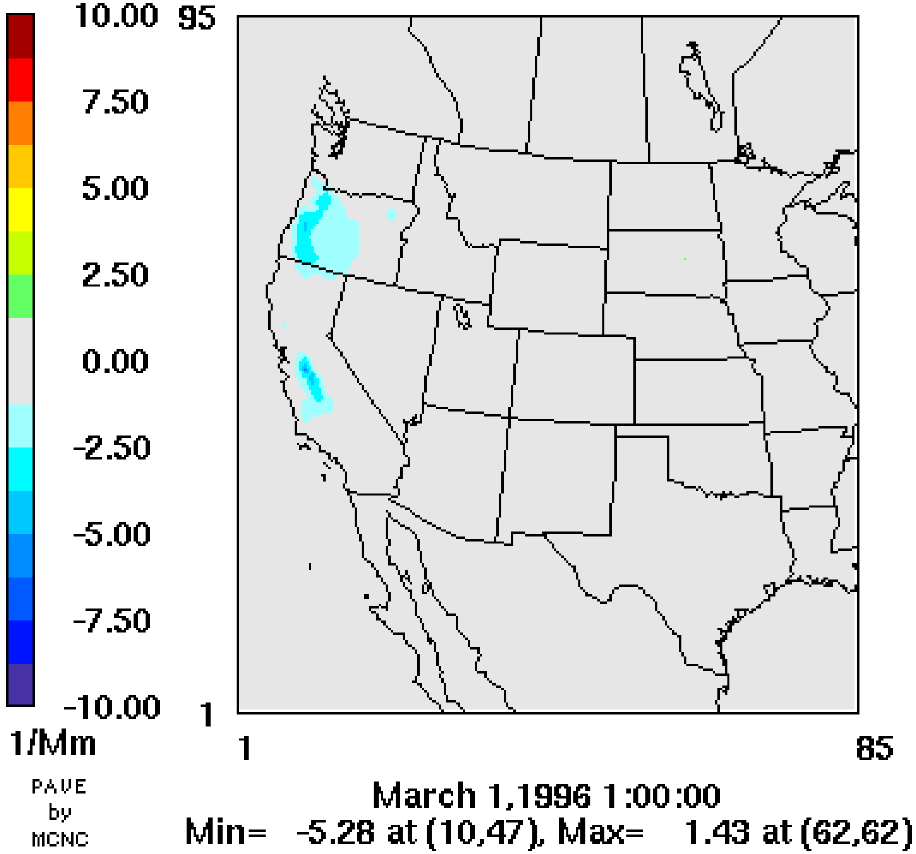


Delta BEXT_Recon
Feb average, 2018g
osm minus p2_fire_bsm
10.00
7.50
5.00
2.50
0.00
-2.50
-5.00
-7.50
-10.00
1/Mm
95
1
1
85
PAVE
by
MCNC
February 1,1996 1:00:00
Min= -6.02 at (11,46), Max= 0.80 at (84,47)

Mar

Delta BEXT_Recon

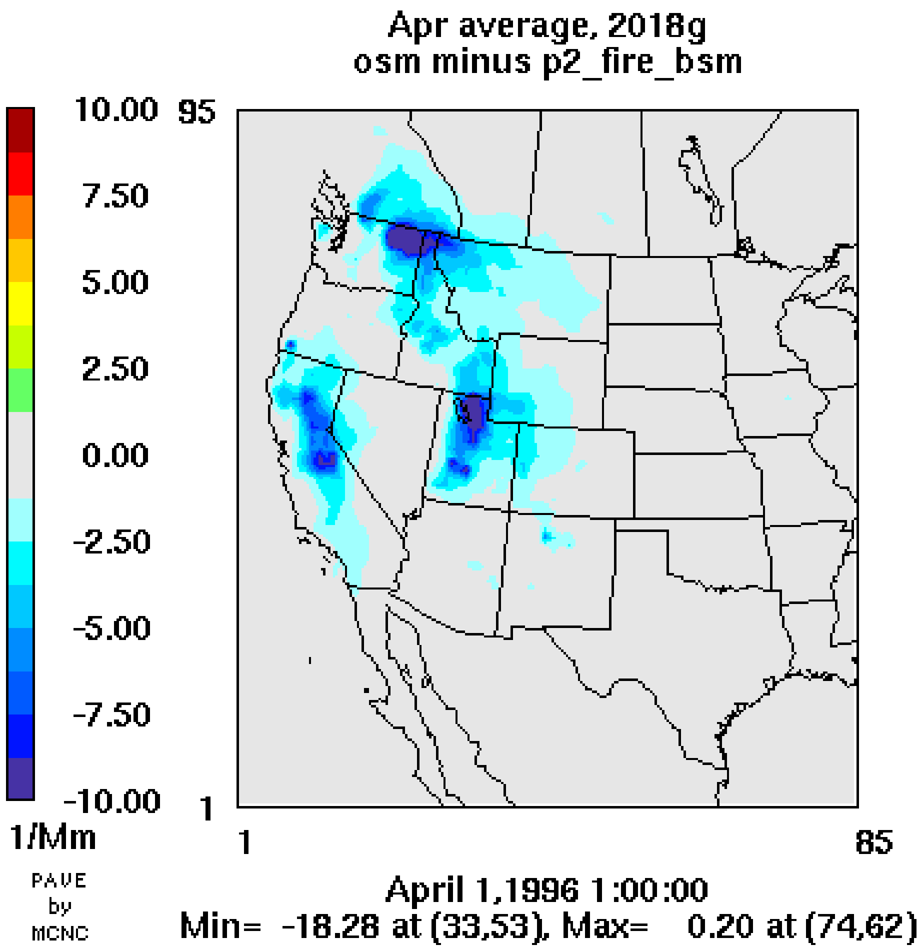
Mar average, 2018g
osm minus p2_fire_bsm



March 1,1996 1:00:00
Min= -5.28 at (10,47), Max= 1.43 at (62,62)

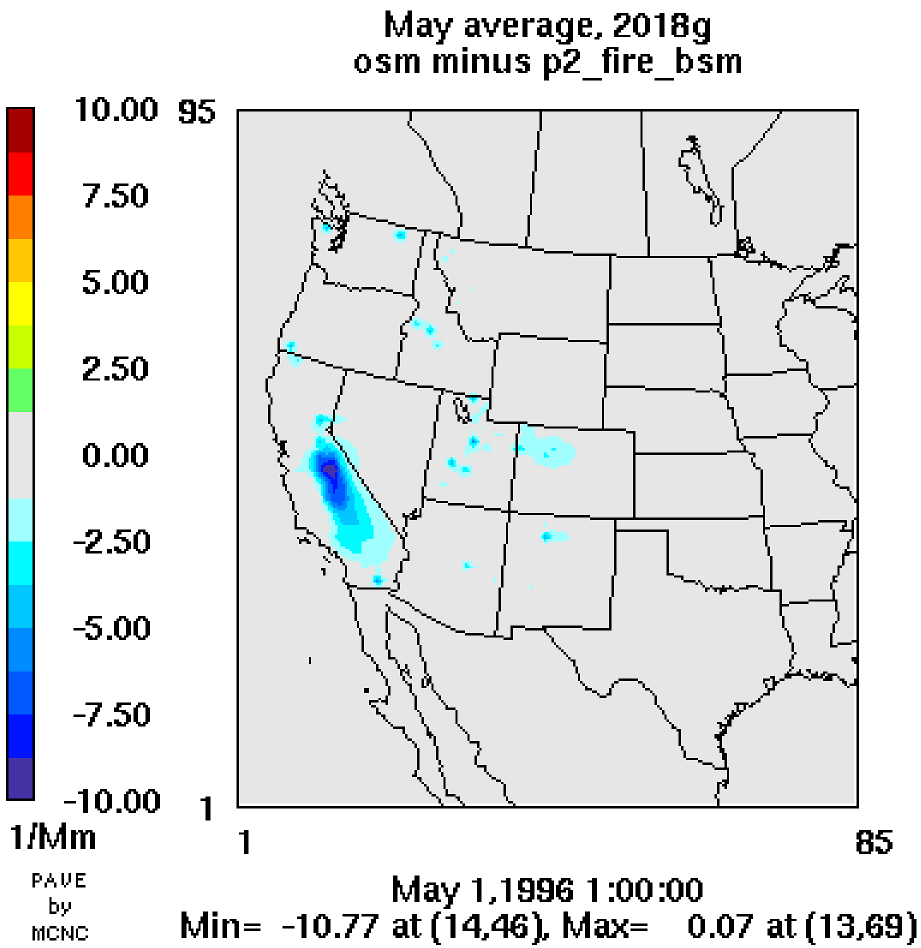
April

Delta BEXT_Recon

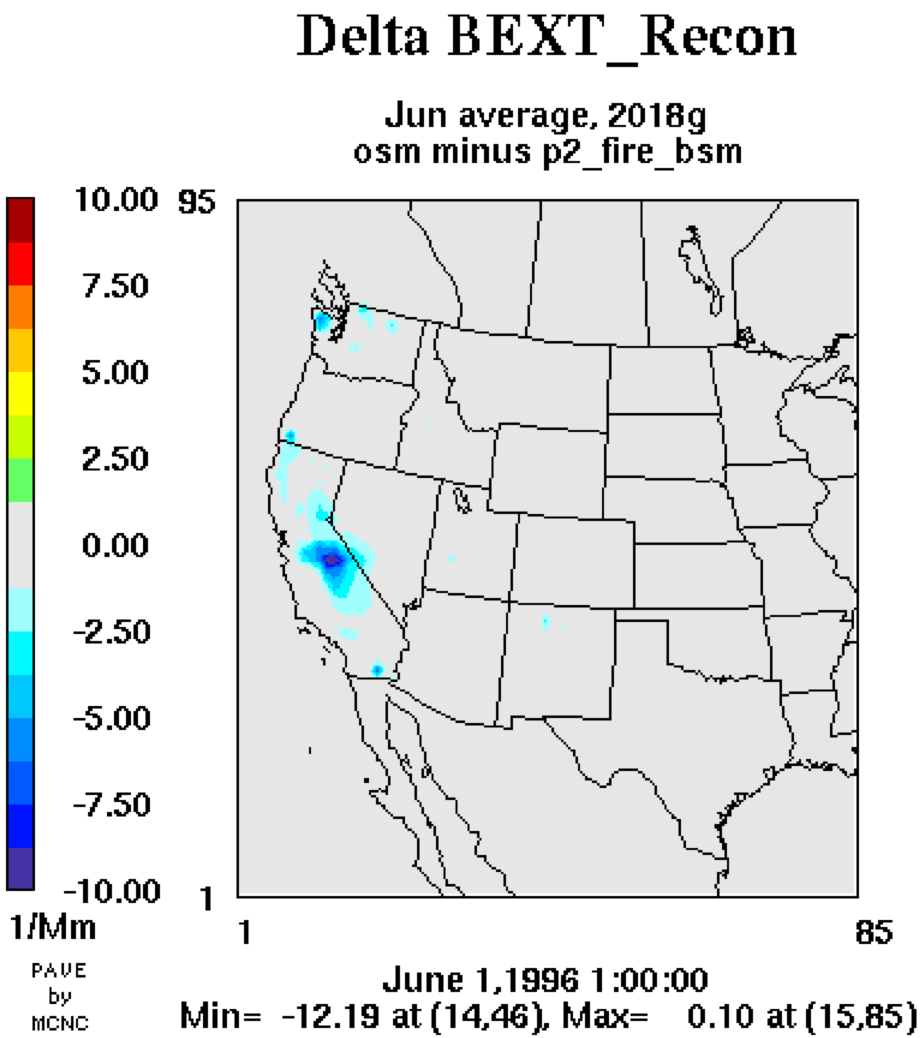


May

Delta BEXT_Recon



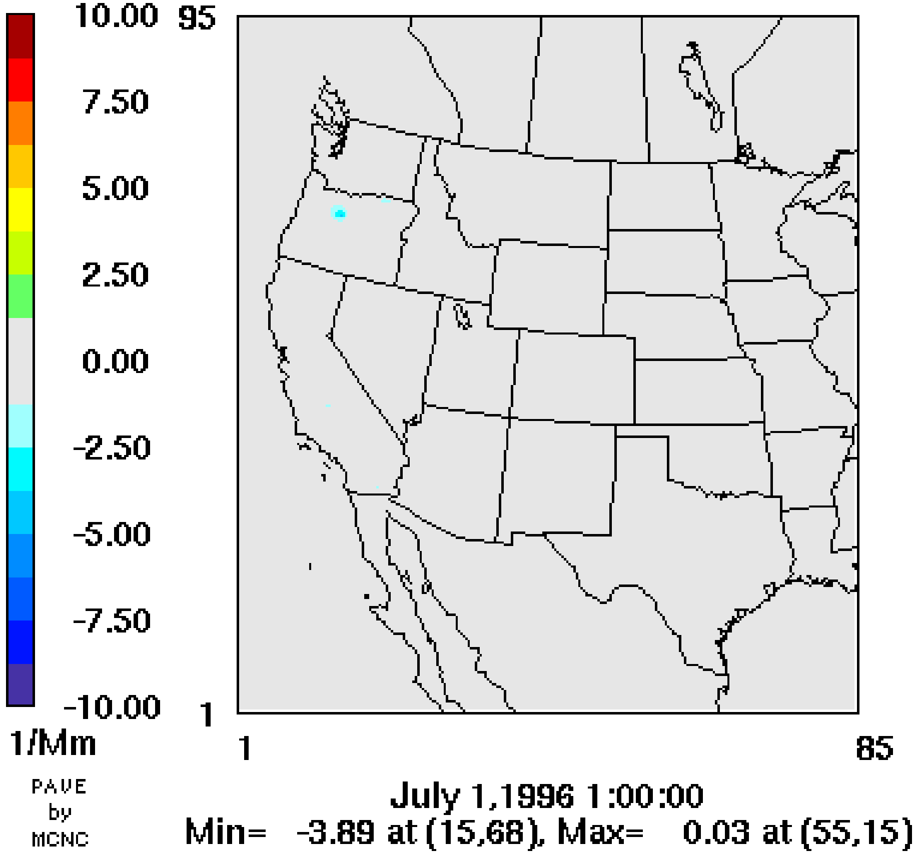
June


Delta BEXT_Recon
Jun average, 2018g
osm minus p2_fire_bsm
10.00
7.50
5.00
2.50
0.00
-2.50
-5.00
-7.50
-10.00
1/Mm
95
1
1
85
PAVE
by
MCNC
June 1,1996 1:00:00
Min= -12.19 at (14,46), Max= 0.10 at (15,85)

July

Delta BEXT_Recon

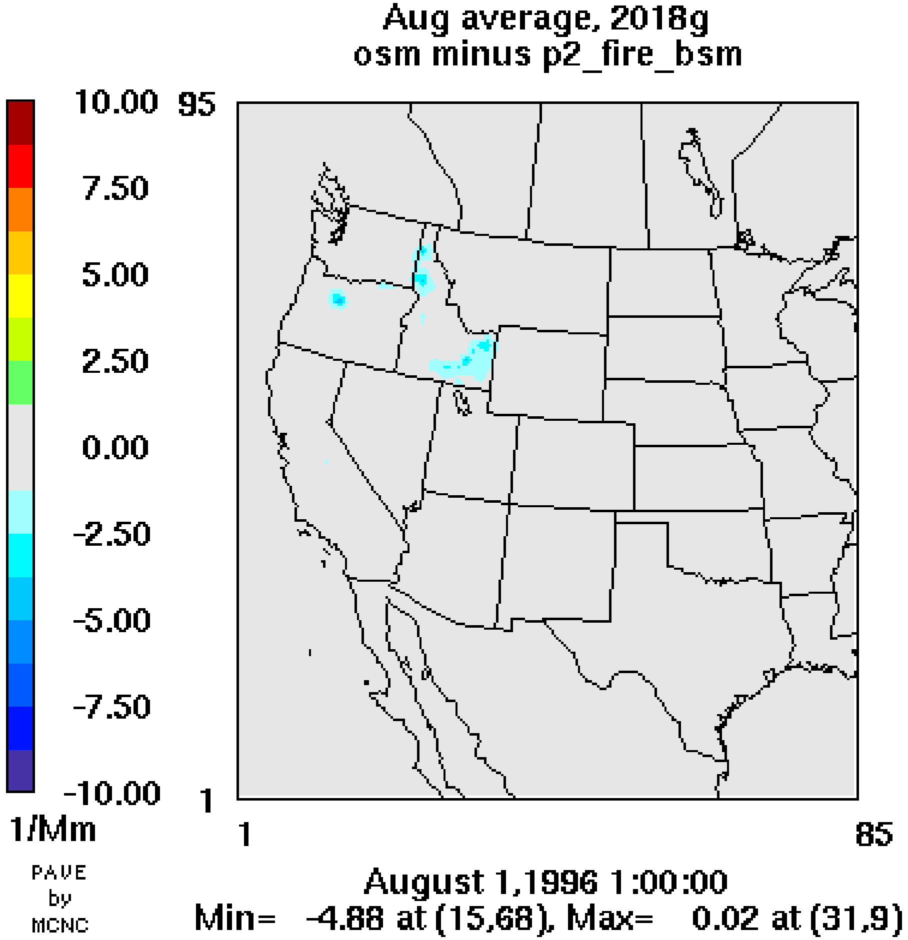
Jul average, 2018g
osm minus p2_fire_bsm



July 1,1996 1:00:00
Min= -3.89 at (15,68), Max= 0.03 at (55,15)

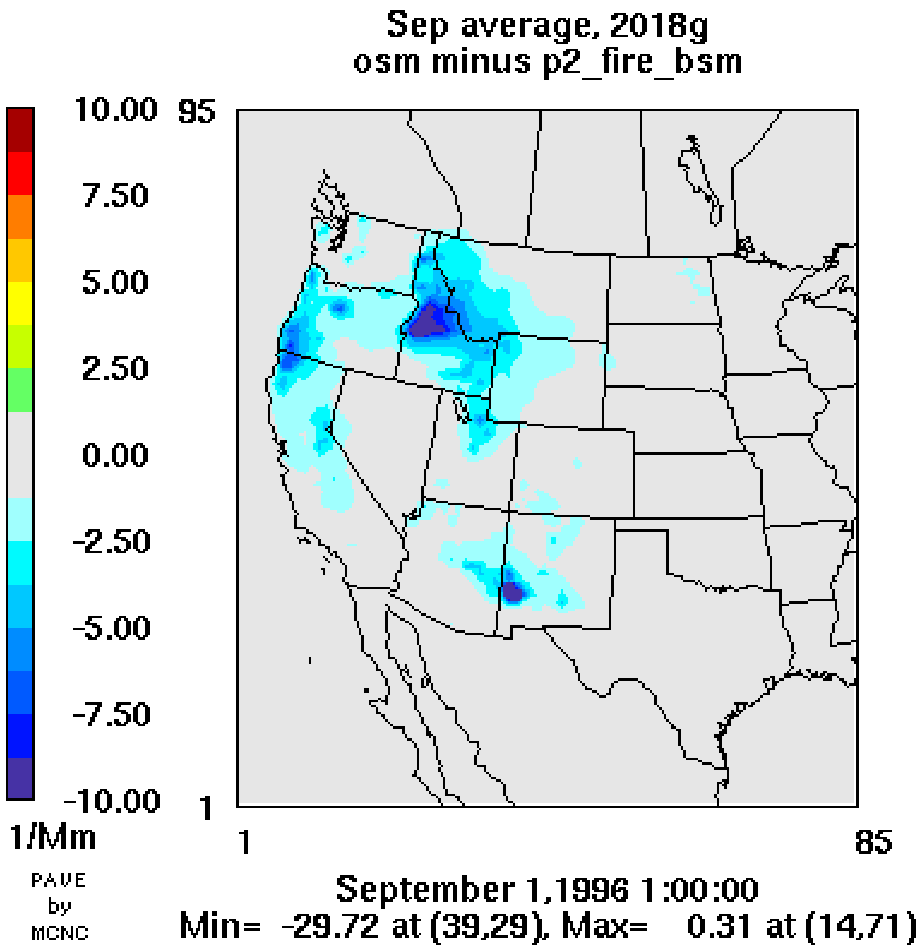
Aug

Delta BEXT_Recon



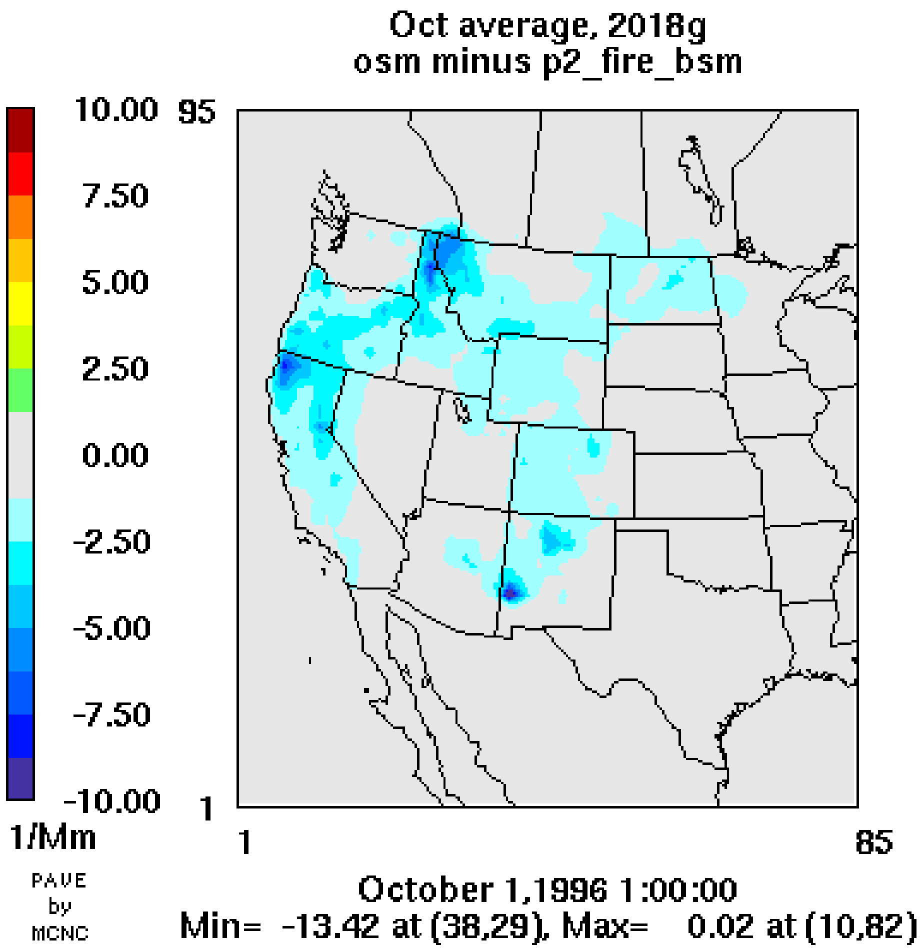
Sept

Delta BEXT_Recon

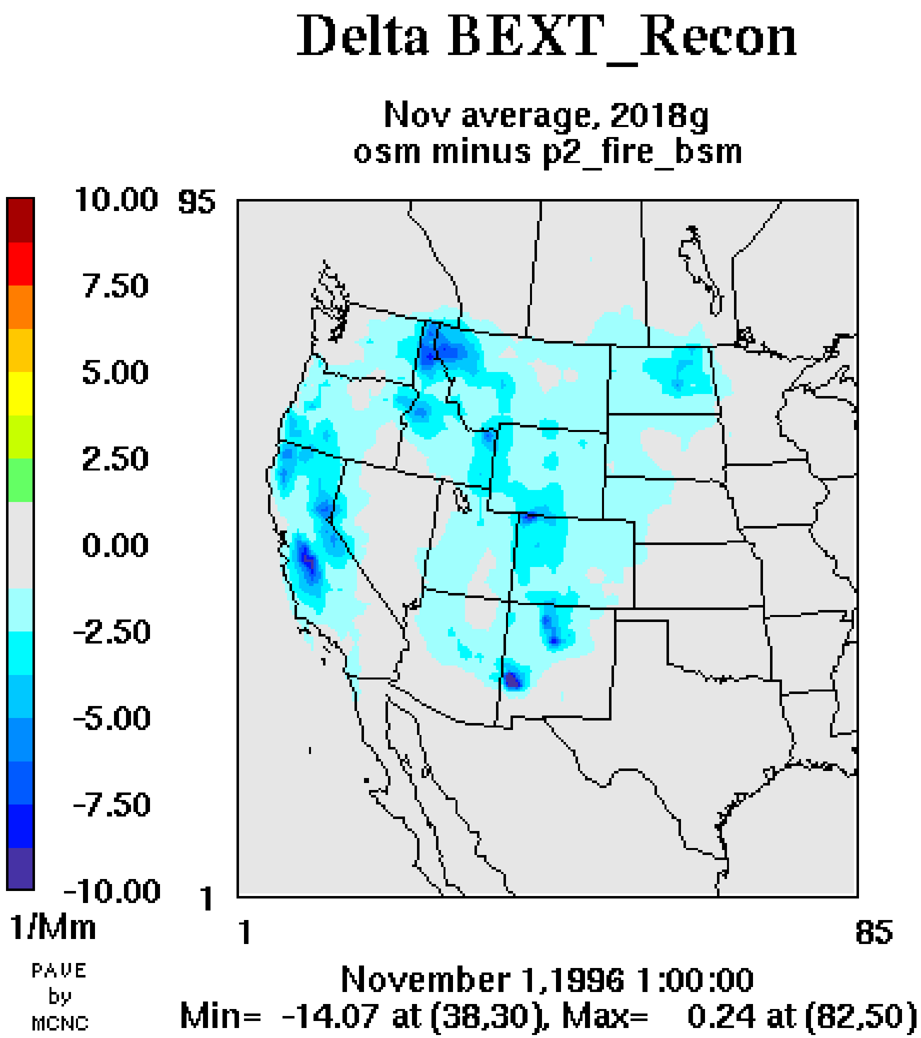


Oct

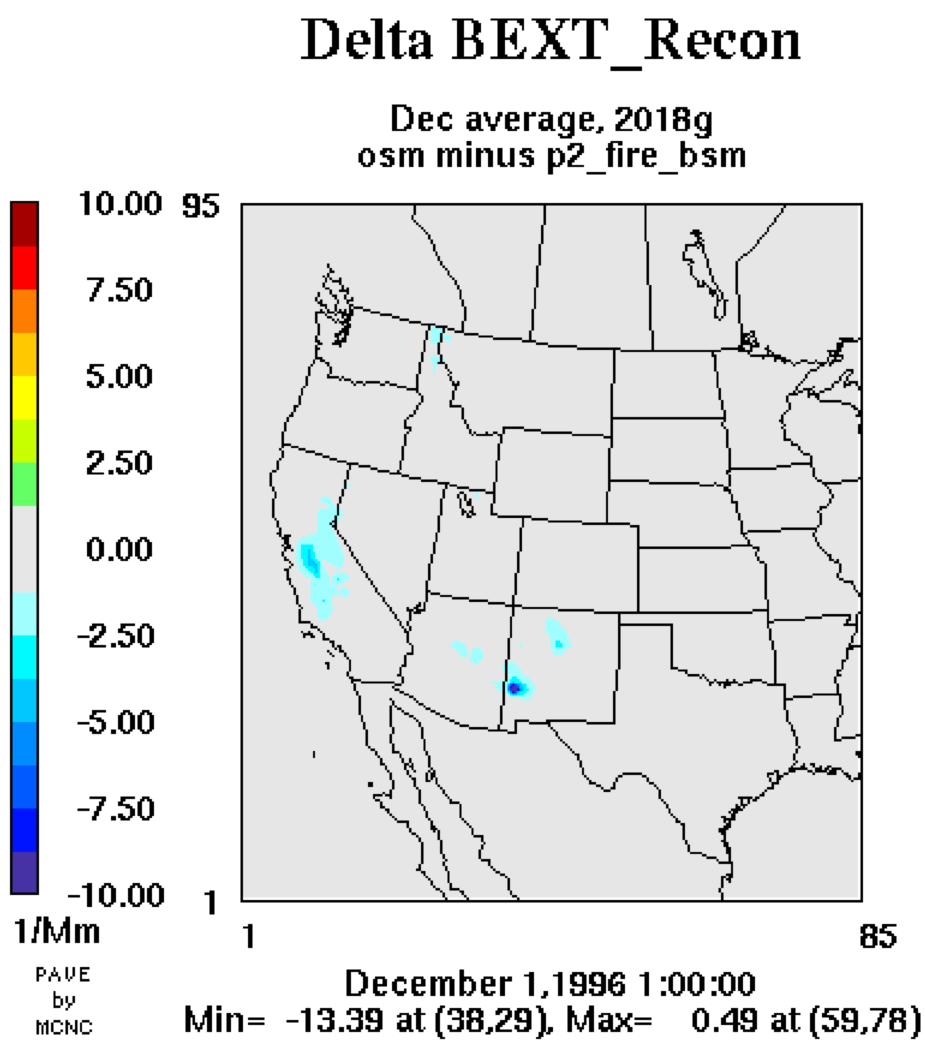
Delta BEXT_Recon



Nov


Delta BEXT_Recon
Nov average, 2018g
osm minus p2_fire_bsm
10.00
7.50
5.00
2.50
0.00
-2.50
-5.00
-7.50
-10.00
1/Mm
95
1
1
85
PAVE
by
MCNC
November 1,1996 1:00:00
Min= -14.07 at (38,30), Max= 0.24 at (82,50)

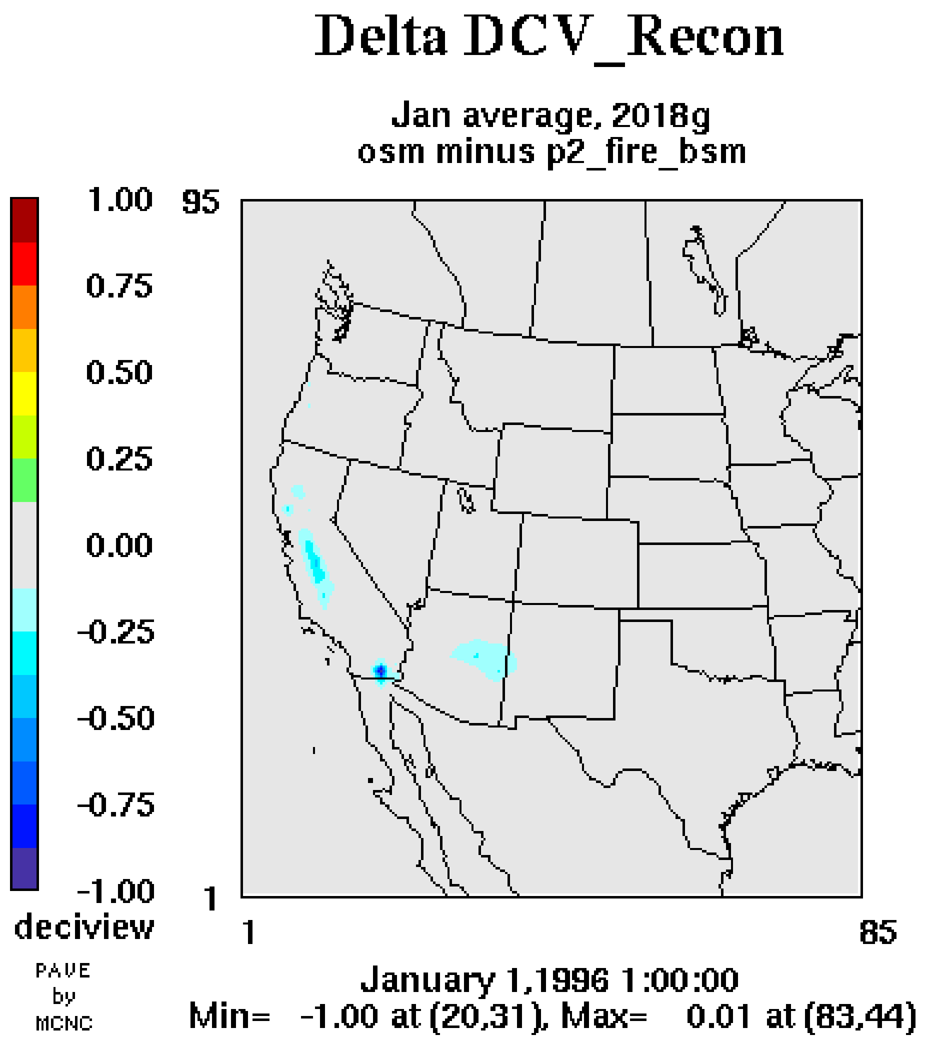
Dec


Delta BEXT_Recon
Dec average, 2018g
osm minus p2_fire_bsm
10.00
7.50
5.00
2.50
0.00
-2.50
-5.00
-7.50
-10.00
1/Mm
PAVE
by
MCNC
95
1
1
85
December 1,1996 1:00:00
Min= -13.39 at (38,29), Max= 0.49 at (59,78)

Monthly Results for OSM - BSM

Deciviews

Jan

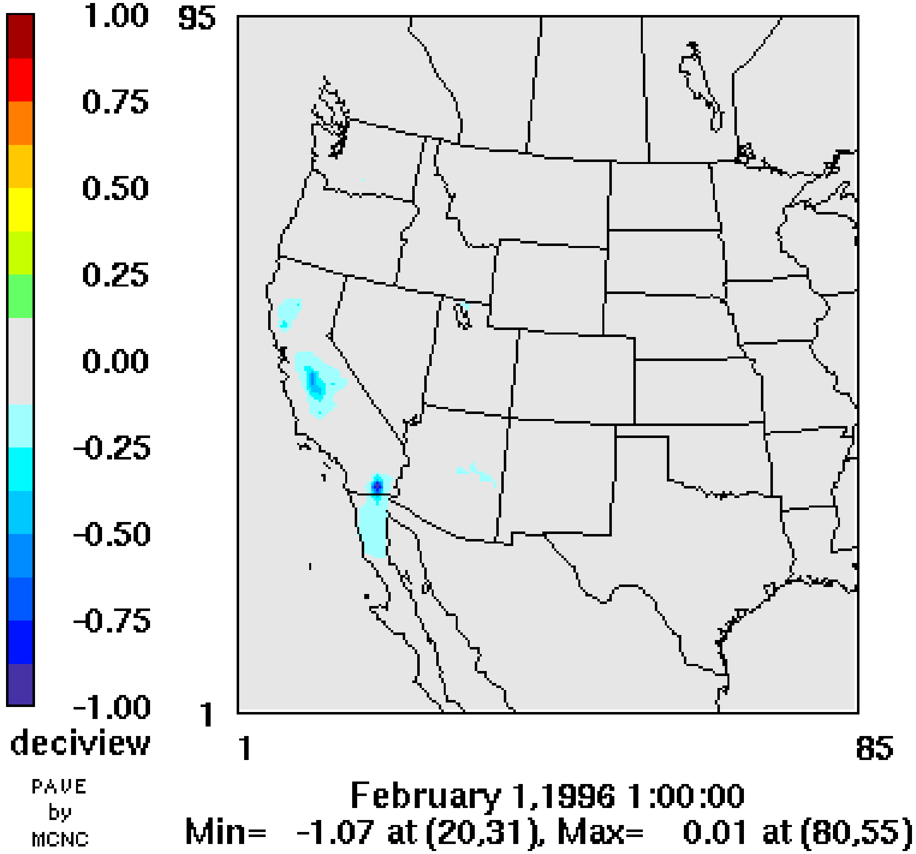


Delta DCV_Recon
Jan average, 2018g
osm minus p2_fire_bsm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
deciview
95
1
1
85
PAVE
by
MCNC
January 1,1996 1:00:00
Min= -1.00 at (20,31), Max= 0.01 at (83,44)

Feb

Delta DCV_Recon

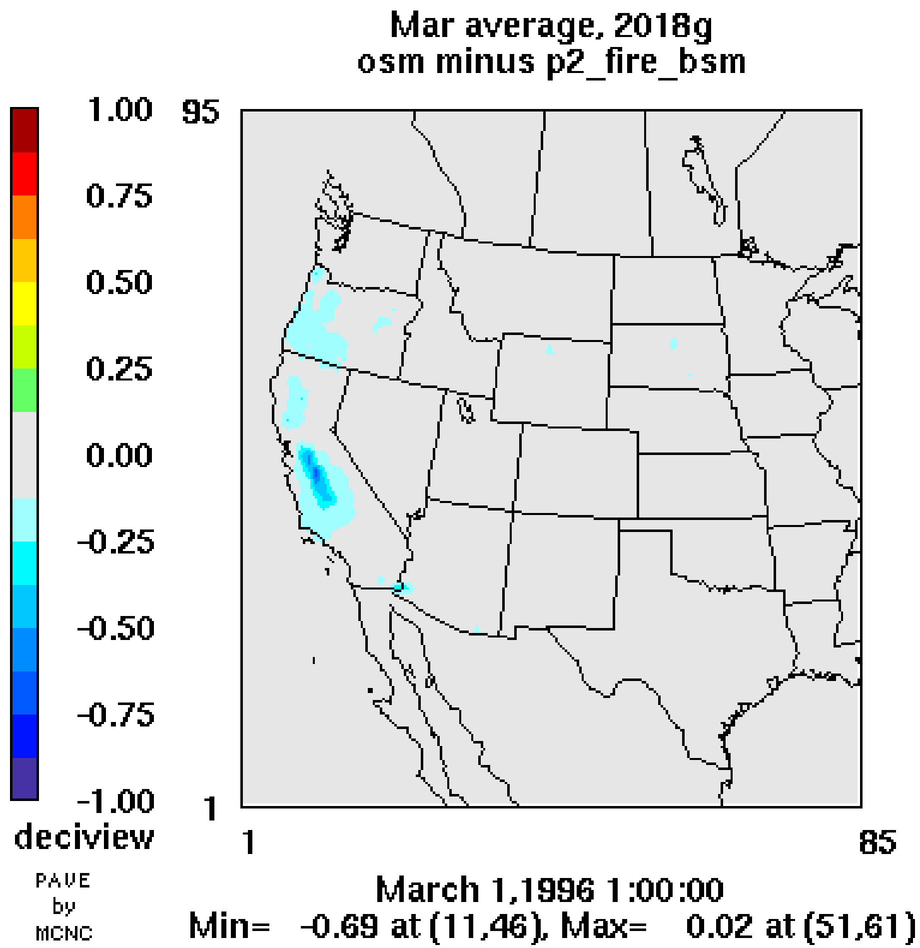
Feb average, 2018g
osm minus p2_fire_bsm



February 1,1996 1:00:00
Min= -1.07 at (20,31), Max= 0.01 at (80,55)

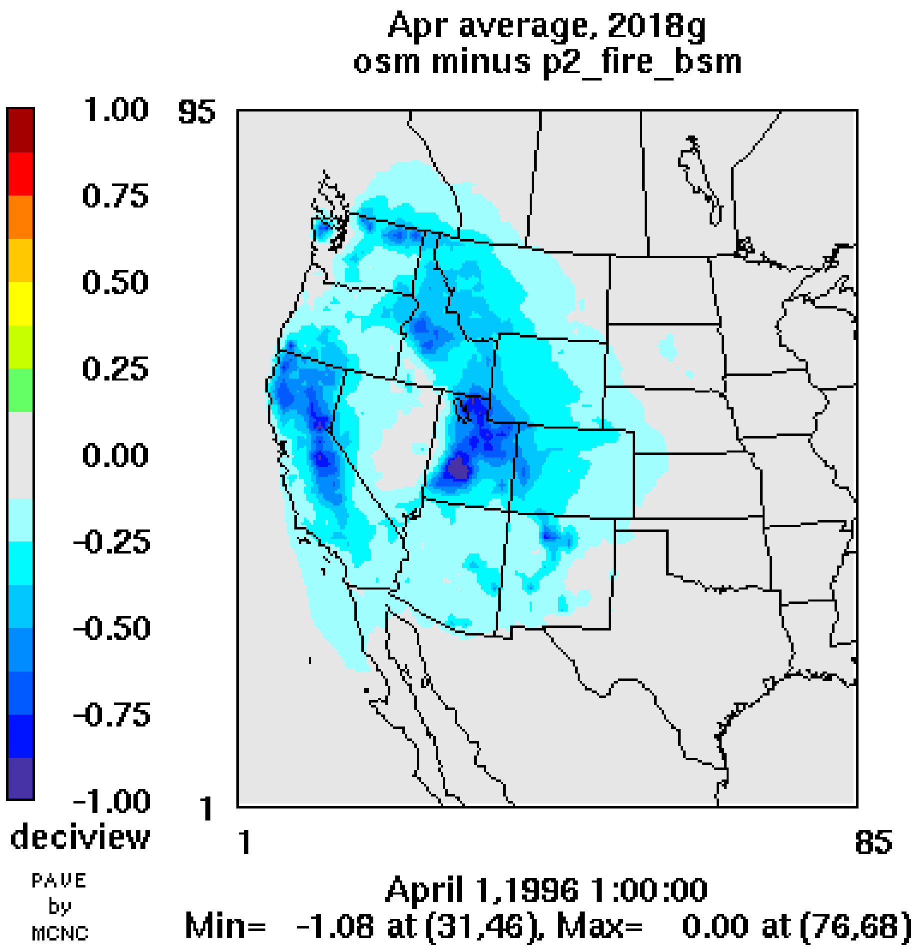
March

Delta DCV_Recon

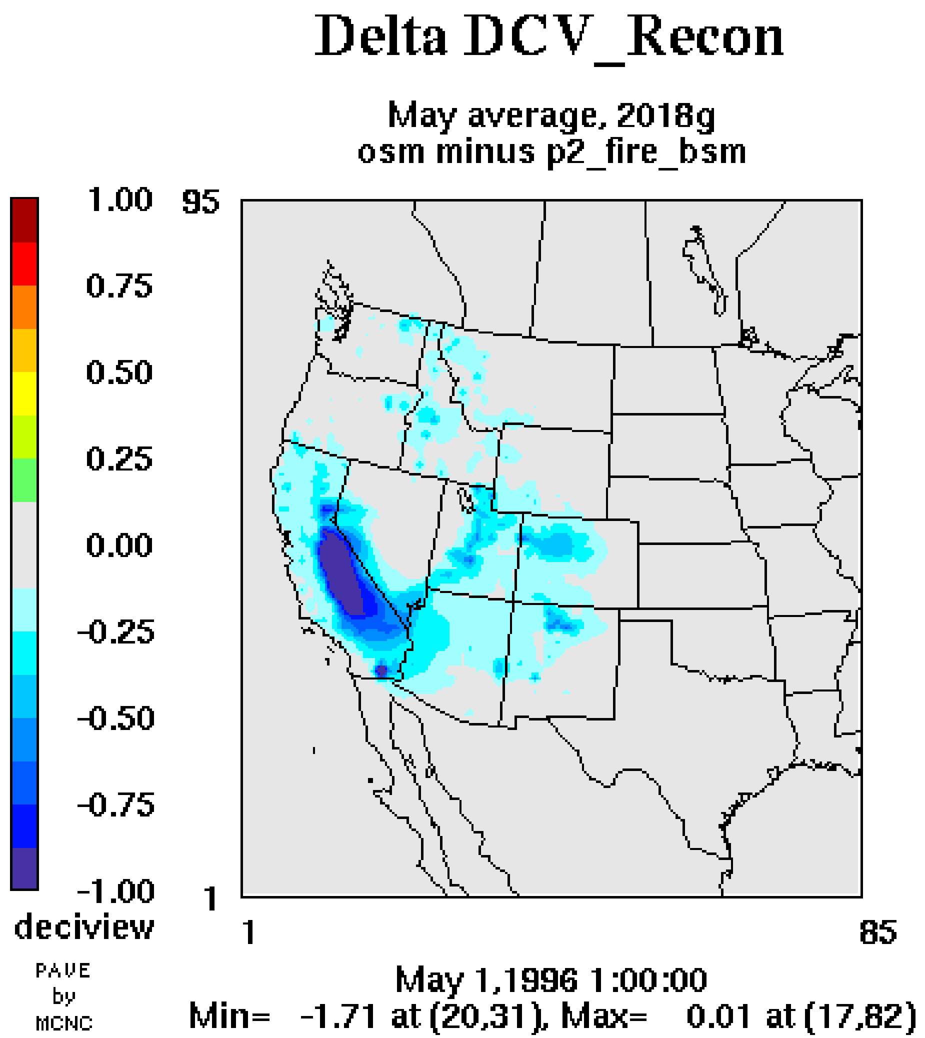


April

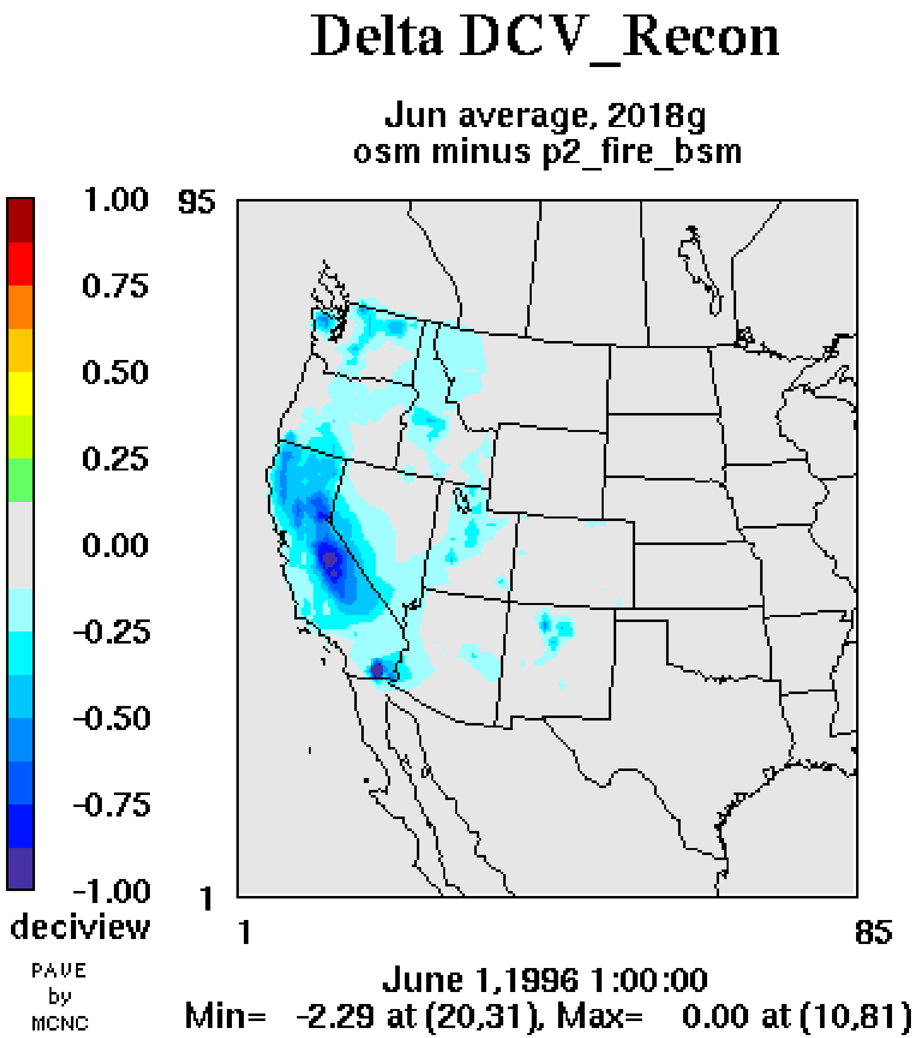
Delta DCV_Recon



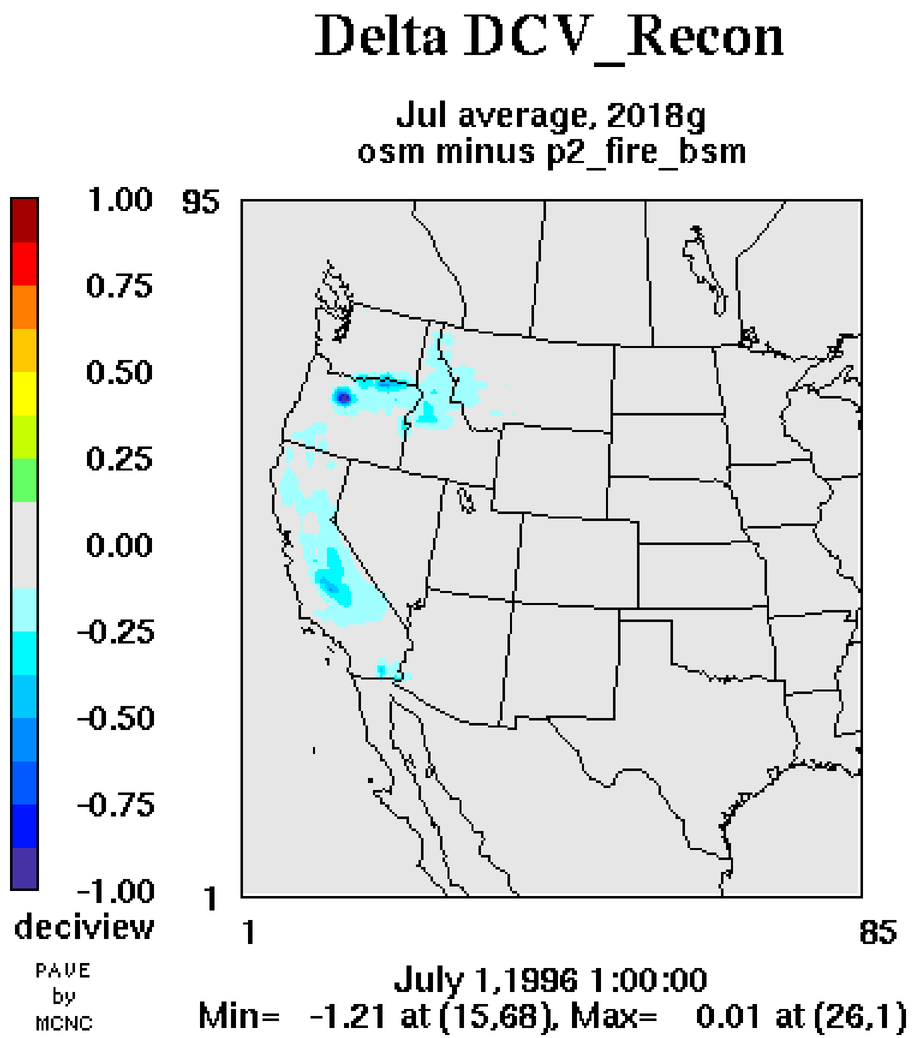
May


Delta DCV_Recon
May average, 2018g
osm minus p2_fire_bsm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
deciview
95
1
1
85
PAVE
by
MCNC
May 1,1996 1:00:00
Min= -1.71 at (20,31), Max= 0.01 at (17,82)

June

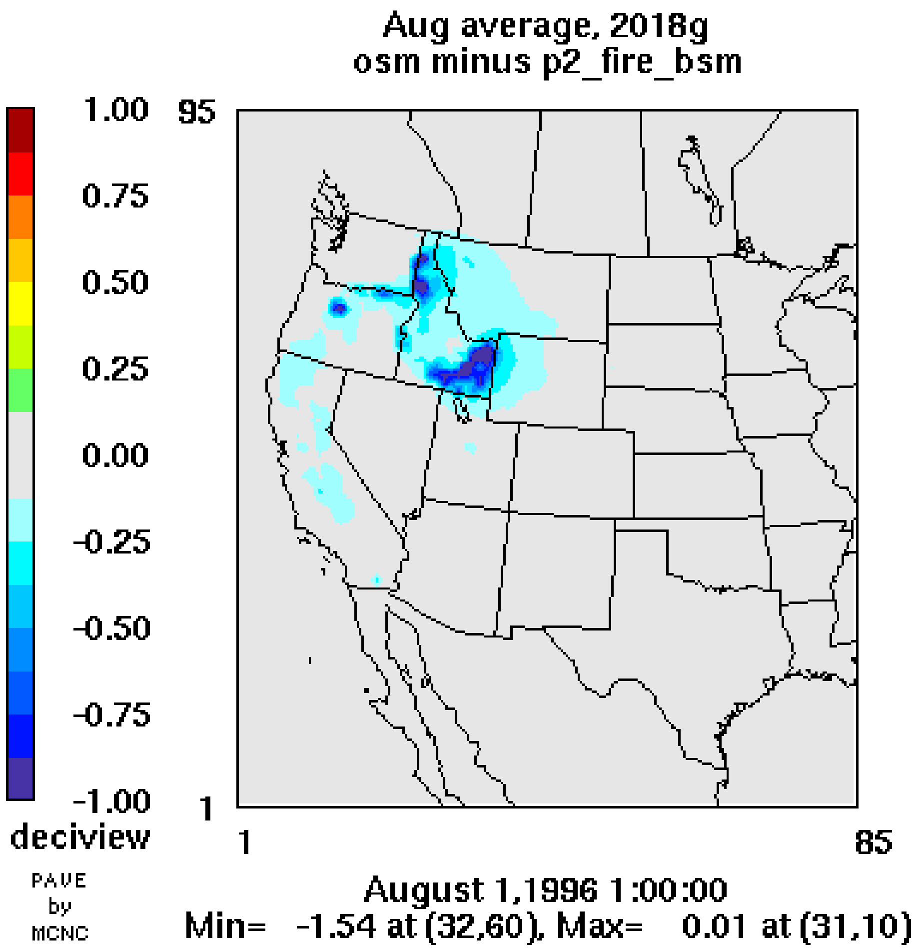

Delta DCV_Recon
Jun average, 2018g
osm minus p2_fire_bsm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
deciview
PAVE
by
MCNC
95
1
1
85
June 1,1996 1:00:00
Min= -2.29 at (20,31), Max= 0.00 at (10,81)

July


Delta DCV_Recon
Jul average, 2018g
osm minus p2_fire_bsm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
deciview
95
1
1
85
PAVE
by
MCNC
July 1,1996 1:00:00
Min= -1.21 at (15,68), Max= 0.01 at (26,1)

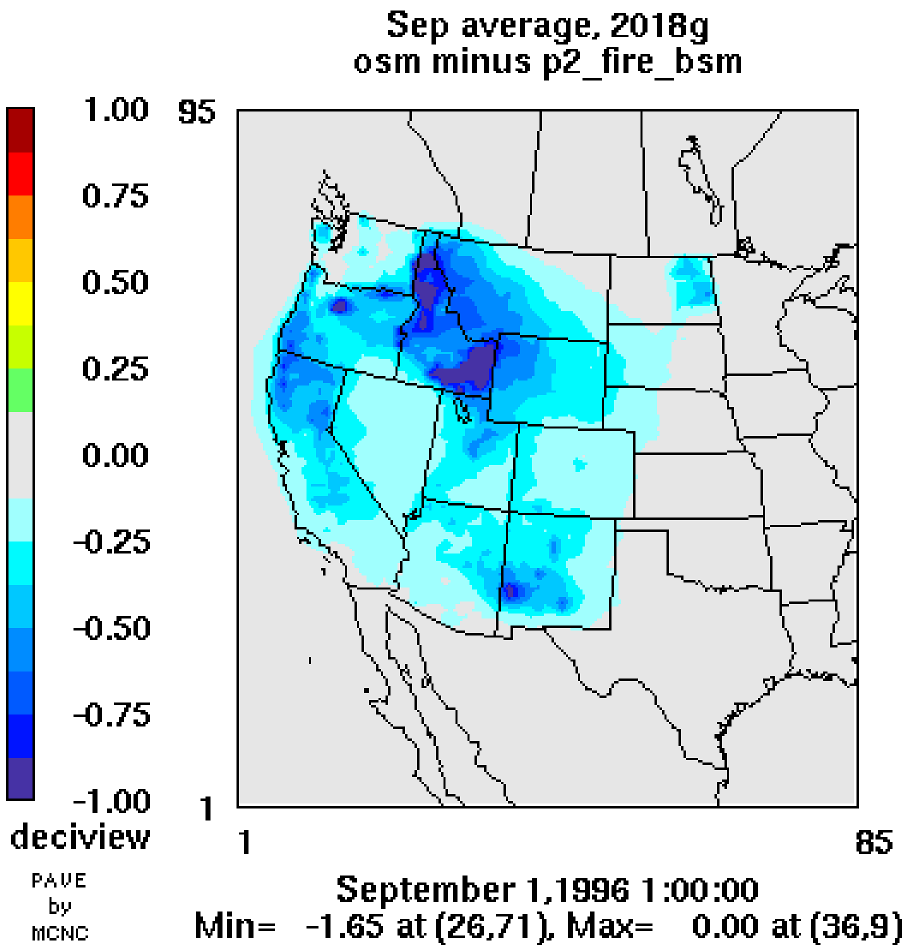
Aug

Delta DCV_Recon

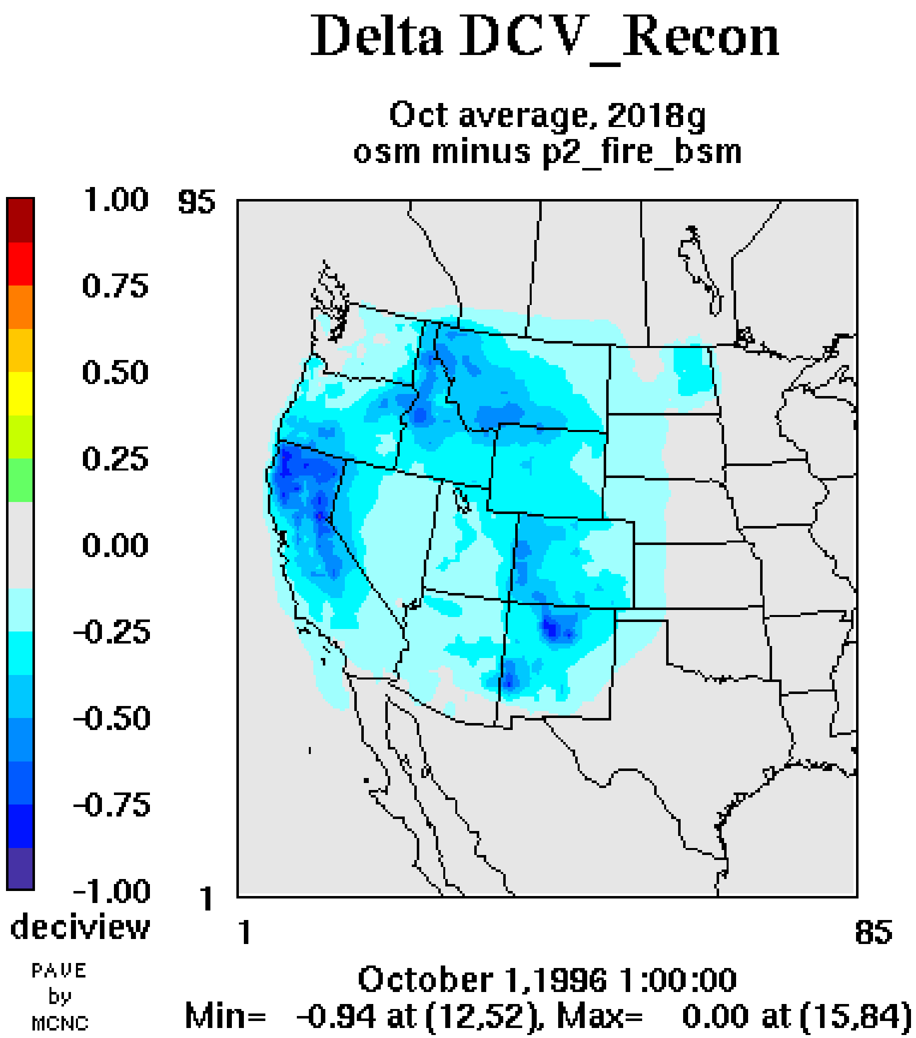


Sept

Delta DCV_Recon



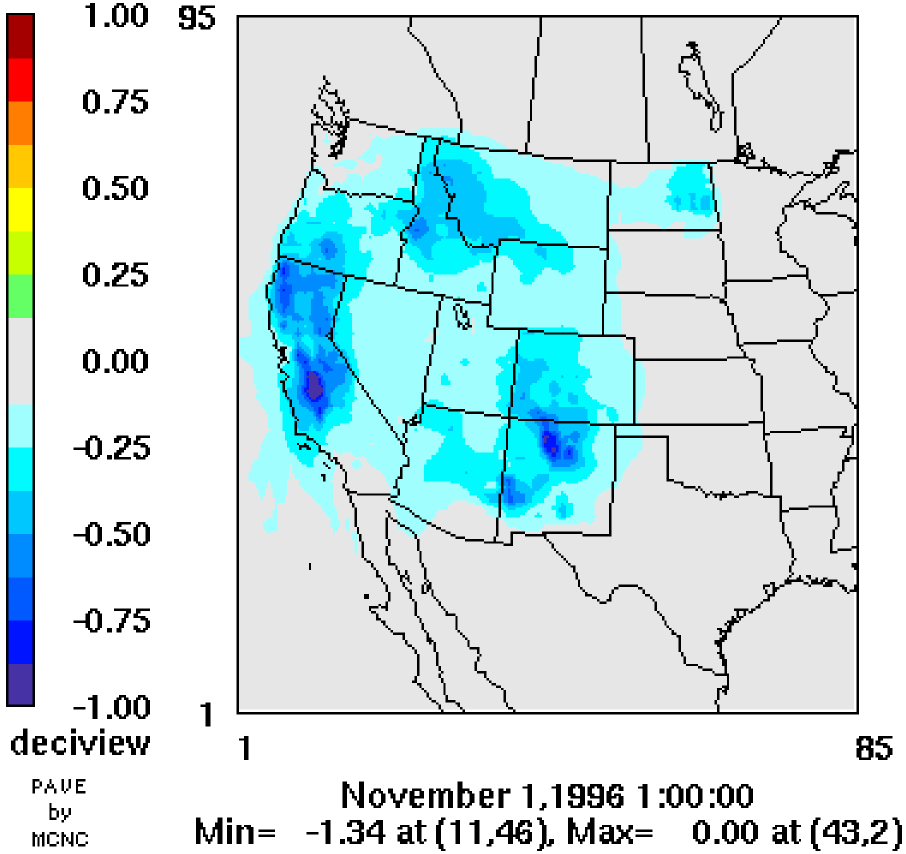
Oct


Delta DCV_Recon
Oct average, 2018g
osm minus p2_fire_bsm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
deciview
95
1
1
85
PAVE
by
MCNC
October 1,1996 1:00:00
Min= -0.94 at (12,52), Max= 0.00 at (15,84)

Nov

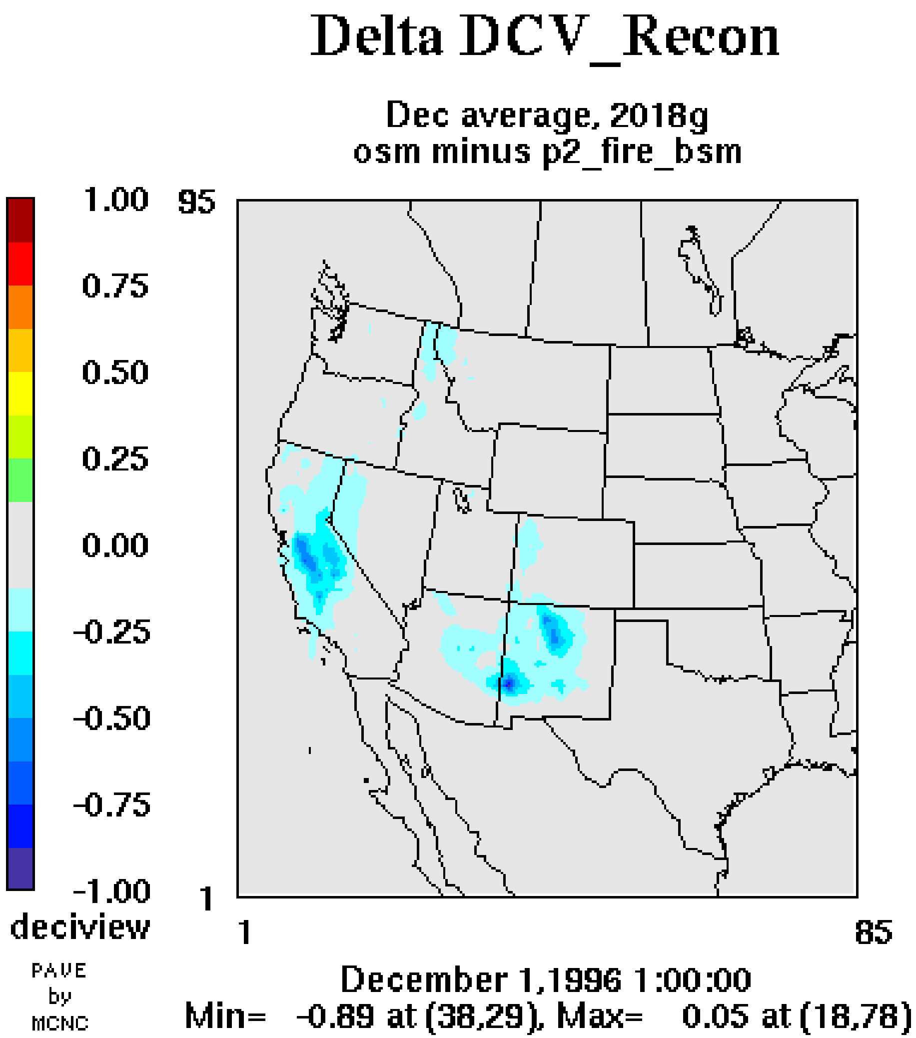
Delta DCV_Recon

Nov average, 2018g
osm minus p2_fire_bsm



November 1,1996 1:00:00
Min= -1.34 at (11,46), Max= 0.00 at (43,2)

Dec


Delta DCV_Recon
Dec average, 2018g
osm minus p2_fire_bsm
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
deciview
95
1
1
85
PAVE
by
MCNC
December 1,1996 1:00:00
Min= -0.89 at (38,29), Max= 0.05 at (18,78)

Next Steps

- Evaluate Individual Fire Contributions at each site on each day using:
  - Change in DCV and Beta_extinction
  - Bar plots of component PM contributions?
- Schedule:
  - Plan to complete all model runs and evaluation by December 2004.
  - S1 results by end of September.