Intended for

U.S. Bureau of Land Management
and
Environmental Management and Planning Solutions, Inc. (EMPSi)

Prepared by

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BLM WESTERN US PHOTOCHEMICAL AIR QUALITY MODELING FOR 2032

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1. INTRODUCTION

The United States Department of the Interior, Bureau of Land Management (BLM) has developed a photochemical modeling platform to assess the impacts of oil and gas development and coal production and other cumulative sources on air quality and air quality related values (AQRV) in BLM-administered lands. The modeling platform developed for circa 2032 provides vital information to guide the management of public lands and interests in the US intermountain west states. The modeling results will inform BLM decisions that may impact key features related to air resources in BLM-administered lands and have special air quality protections under federal law. These include national parks and wilderness areas designated as the mandatory federal Class I areas under the federal Clean Air Act (CAA) and other areas re-designated as Class I at the request of a state or Indian Tribe.

Regional air quality is assessed by comparing the concentrations of air pollutants in the atmosphere to regulatory standards and other nonregulatory thresholds that are protective of human health and the environment. In addition to criteria pollutants, this study discloses impacts to AQRV (visibility and atmospheric deposition), considered important by federal Land Managers. The potential impacts are estimated using the Comprehensive Air Quality Model with Extensions (CAMx, 2022), a well-established photochemical grid model. CAMx is a state-of-the-science photochemical grid model with a "one-atmosphere" treatment of tropospheric air pollution (ozone, particulates, and precursors) over spatial scales ranging from neighborhoods to continents. CAMx has been used to analyze air quality impacts in other modeling studies in the U.S., including State Implementation Plans (SIPs) and other actions related to EISs by BLM and other agencies under NEPA and programmatic NEPA assessments, and by the U.S. Environmental Protection Agency (EPA) to support federal rulemaking. CAMx also implements Ozone and Particulate Source Apportionment Technology (OSAT/PSAT) which efficiently allows the model to track emission contributions to predicted ozone and particulate matter (PM) species concentrations by source region and category.

The photochemical modeling was conducted using a scenario that included coal, oil and gas development, natural and other anthropogenic emissions, representative of the cumulative sources around the year 2032. The modeling builds upon a previously vetted modeling database developed by the United States Environmental Protection Agency. Details of the modeling setup and emissions are provided in Sections 3 and 4.

1.1 Air Quality Standards and Air Quality Related Values

The EPA has defined National Ambient Air Quality Standards (NAAQS) for six Criteria Air Pollutants (CAPs): particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), and lead (Pb) (40 CFR 50). The NAAQS for PM are defined separately for coarse particles (diameters less than 10 micrometers [PM_{10}]) and fine particles (diameters less than 2.5 micrometers [$PM_{2.5}$]). The standard for NO_2 is designed to account for both nitric oxide (NO) and NO_2, which are referred to collectively as nitrogen oxides (NOx) (EPA 2011). The NAAQS include primary standards that are protective of public health, including the health of sensitive segments of the population, and secondary standards that are protective of public welfare, such as protection against visibility impairment and damage to animals, vegetation, crops, and buildings. As shown in Table 1.1-1, the NAAQS averaging period for several pollutants is based on measurements over 3 years; since photochemical modeling is performed in this study for one year, the modeling analysis provides an approximate representation of NAAQS impacts based on best available science and data.

Table 1.1-1. National ambient air quality standards.

Pollutant	Averaging Period	National Ambient Air Quality Standards[1]
O_3	8 hours	0.70 ppm[2]
NO_2	1 hour	100 ppb[3]
NO_2	Annual	53 ppb
$PM_{2.5}$	24 hours	35[4] µg/m^3
$PM_{2.5}$	Annual	12.0[5] µg/m^3
PM_{10}	24 hours	150[6] µg/m^3
SO_2	1 hour	75 ppb[7]
SO_2	3 hours	0.5 ppm[8]
CO	1 hour	35 ppm[8]
CO	8 hours	9 ppm[8]
Pb	3 months	0.15[9] µg/m^3

Source: 40 CFR 50; NDCC 33.1-15-02

[1]µg/m3 = micrograms per cubic meter of air; ppb = parts per billion by volume; ppm = parts per million by volume; N/A = not applicable

[2]Annual 4th highest daily maximum 8-hour average concentration, averaged over 3 years

[3]98th percentile (8th highest) of 1-hour daily maximum concentrations, averaged over 3 years

[4]98th percentile, averaged over 3 years.

[5]Annual mean, averaged over 3 years.

[6]Not to be exceeded more than once per year on average over 3 years

[7]99th percentile (4th highest) of 1-hour daily maximum concentrations, averaged over 3 years

[8]Not to be exceeded more than once per year.

[9]Maximum 3-month rolling arithmetic mean within a 3-year period

AQRVs are resources that may be adversely affected by changes in air quality. Federal land managers are responsible for protecting AQRVs in Class I areas. FLAG provided recommendations for evaluating the effects of air emissions from new or modified sources on AQRVs (FLAG 2010). The FLAG guidance is primarily meant to evaluate the impacts of individual projects and using it for this study is for information purposes only and does not have a regulatory implication. The condition of AQRVs in Class I areas is an indicator of local and long-range air quality impacts in this study because these areas could be affected by local and distant emission sources.

Visibility is the “degree of perceived clarity when viewing objects at a distance” (42 CFR 51.301). Visibility impairment is caused by the absorption or scattering of light by small particles or gases emitted from both natural and human sources. Atmospheric deposition is the process by which air pollutants are removed from the atmosphere and transferred to the earth’s surface on, for example, buildings, waterbodies, soil, and vegetation. Deposition can occur both in the presence and absence of precipitation (referred to as wet deposition and dry deposition). It has widespread impacts that can occur far from the source of pollutants. There are no federal standards for deposition, but critical loads are often used as indicators of potential cumulative impacts from atmospheric deposition at Class I areas. Critical loads represent the total level of atmospheric deposition below which no harmful effects on an ecosystem are expected.

1.2 Document Outline

Section 2 describes the regional photochemical modeling approach including the modeling configuration and inputs to the model. Section 3 describes the emissions modeled for each source sector. Section 4 provides the photochemical modeling approach and the source apportionment methodology. The photochemical modeling results including the estimated impacts for air quality and air quality related values for the circa 2032 modeling are presented in Section 5.

2. PHOTOCHEMICAL MODELING OVERVIEW

The BLM circa 2032 photochemical modeling used an available dataset developed by the EPA as the basis for this study (EPA2016v2[1,2]). The EPA2016v2 modeling platform was developed by the EPA and has been used extensively to support the Good Neighbor Plan for 2015 Ozone NAAQS[3] by EPA as well as other state and federal agencies for conducting several air quality analyses. The platform is supplemented with additional oil and gas development and coal mining data provided by the BLM. The following sections give more detail on how the modeling configuration, ancillary inputs, and emission inputs were adapted from the EPA modeling platform for this study.

2.1 Modeling Domains

2.1.1 Horizontal Domain

The BLM circa 2032 modeling was performed using a single modeling l domain with a horizontal resolution of 12 km. An ancillary simulation was performed using the EPA 36US3 36 km modeling domain to provide lateral boundary concentrations to the BLM 12 km domain. The 36 km resolution domain covers the continental United States (CONUS) and is typically used by Regional Planning Organizations (RPOs) to set national boundary conditions for regional modeling. These domains are based on a Lambert Conic Conformal (LCC) map projection with parameters specified in Table 2.1-1 and Table 2.1-2. Figure 2.1-1 shows the spatial extent of the standalone 12km modeling l domain used for the BLM circa 2032 modeling. Several subsets of the 12km domain were defined as analysis areas and they are presented in further detail in Section 2.5.

Table 2.1-1. Projection parameters for the modeling domains.

Parameter	Value
Projection	Lambert-Conformal Conic
1st True Latitude	33 degrees N
2nd True Latitude	45 degrees N
Central Longitude	97 degrees W
Central Latitude	40 degrees N

Table 2.1-2. Grid definitions for modeling domains.

Grid	Origin (Southwest) (km)*	Number of grid cells in X direction (NX)	Number of grid cells in Y direction (NY)
36 km (36US3)	(-2952, -2772)	172	148
12 km Western US	(-2376, -1224)	225	213

*Coordinates shown are relative to the central longitude and latitude in Table 2.1-1

[1] EPA 2016v2 Modeling platform. Accessed in June 2023: https://www.epa.gov/air-emissions-modeling/2016v2-platform
[2] EPA 2016v2 Technical Support Document. Accessed in June 2023: https://www.epa.gov/air-emissions-modeling/2016-version-2-technical-support-document
[3] EPA Good Neighbor Plan for 2015 ozone NAAQS. Accessed in June 2023: https://www.epa.gov/csapr/good-neighbor-plan-2015-ozone-naaqs

Figure 2.1-1. Western US 12 km horizontal resolution modeling domain used in the BLM circa 2032 photochemical modeling.

2.1.2 Vertical Domain

The vertical layer structure is identical to the EPA 2016v2 modeling platform. The CAMx modeling is performed with all 35 vertical layers in the meteorological model with no layer collapsing. Table 2.2-1 shows this vertical domain structure.

2.2 Model Inputs

This section describes the model inputs except for the emission inputs which are described in Chapter 3.

2.2.1 Meteorology

The meteorological inputs to CAMx were previously developed by the EPA for the 2016v2 modeling platform[4] using the Weather Research and Forecasting model (WRF) version 3.8 (Skamarock et al., 2008). EPA developed meteorological data for the year 2016 for both a 36 km and 12 km modeling domains. This meteorological data has been used extensively in support of EPA's Good Neighbor Plan for 2015 Ozone NAAQS. Ramboll requested and obtained from the EPA a copy of the WRF dataset used in this study.

[4] Air Quality Modeling for the 2016v2 Emissions Platform TSD. Accessed on June 2023: https://gaftp.epa.gov/Air/aqmg/2016v2_Platform_Modeling_Data/AQ%20Modeling%20TSD_2016v2%20Platform_rev_2022_0119a.pdf

Table 2.2-1. Vertical domain definition of the 35 layers shared by the WRF and CAMx models.

WRF/CAMx Model Layer Structure				
Layer	**Sigma**	**Pressure (mb)**	**Height (m)**	**Thickness (m)**
35	0.0000	50.00	20576	4279
34	0.0500	98.16	16297	2532
33	0.1000	146.33	13766	1804
32	0.1500	194.49	11961	1406
31	0.2000	242.65	10555	1184
30	0.2500	290.81	9372	1034
29	0.3000	338.98	8337	921
28	0.3500	387.14	7416	833
27	0.4000	435.30	6583	761
26	0.4500	483.46	5822	702
25	0.5000	531.62	5120	652
24	0.5500	579.79	4467	610
23	0.6000	627.95	3857	573
22	0.6500	676.11	3284	541
21	0.7000	724.27	2743	412
20	0.7400	762.80	2331	298
19	0.7700	791.70	2033	290
18	0.8000	820.60	1744	189
17	0.8200	839.86	1555	185
16	0.8400	859.13	1370	182
15	0.8600	878.40	1188	178
14	0.8800	897.66	1010	175
13	0.9000	916.92	835	87
12	0.9100	926.56	748	86
11	0.9200	936.19	662	85
10	0.9300	945.82	577	84
9	0.9400	955.46	493	84
8	0.9500	965.09	409	83
7	0.9600	974.72	326	82
6	0.9700	984.35	243	82
5	0.9800	993.99	162	41
4	0.9850	998.80	121	41
3	0.9900	1003.62	81	40
2	0.9950	1008.43	40	20
1	0.9975	1010.84	20	20
Surface	1.0000	1013.25	0	

2.2.2 Initial and Boundary Conditions

EPA also developed lateral boundary and initial concentrations for the 36 km modeling domain as part of the 2016v2 modeling platform. These boundary conditions (BC) and initial conditions (IC) were derived from the Hemispheric version of the Community Multi-scale Air Quality Model (H-CMAQ) version 3.1.1—a three-dimensional global atmospheric chemistry model. The BC derived from H-CMAQ were used to generate three-dimensional concentrations for the ancillary one-way 36 km CAMx simulation. These air quality concentrations provide the boundary and initial concentrations for the Western US 12km simulations. CAMx was initialized for ten days (spin-up period) to remove the effects of the initial concentrations.

2.2.3 Ancillary Inputs

Additional data used in the air quality modeling include ozone column data from the Ozone Monitoring Instrument (OMI) which continues the Total Ozone Mapping Spectrometer (TOMS) record for total ozone and other atmospheric parameters related to ozone chemistry (OMI officially replaced the TOMS ozone column satellite data on January 1, 2006). OMI data are available every 24-hours and are obtained from the TOMS ftp site. The CAMx O3MAPprogram reads the OMI ozone column text file data, interpolates to fill gaps and generates daily gridded ozone column input data. The OMI data were also used in the CAMx (TUV) radiation models to calculate photolysis rates.

2.3 Photochemical Modeling Configuration

The CAMx photochemical grid model configuration and science options used were based on the EPA 2016v2 modeling platform setup and summarized in Table 2.3-1. The bi-directional flux for in-line deposition was turned off in the BLM circa 2032 modeling because EPA noted that using bi-directional flux and a value of 1 for rescaling led to substantial nitrate over-predictions. EPA turned off bi-directional flux in the 2016 modeling platform.[5]

[5] EPA comments on the BLM 2032 regional modeling protocol

Table 2.3-1. CAMx modeling configuration.

Science Options	CAMx	Comment
Model Version	CAMx v7.20	
Horizontal Grid Mesh	36 and 12 km	
36 km grid	172 x 148 cells	EPA 2016v2 36US3 domain
12 km grid	225 x 213 cells	12 km Western US
Vertical Grid Mesh	35 vertical layers, defined by meteorological model	Layer 1 thickness 20 m. Model top at ~20 km above ground level
Grid Interaction	One-way grid nesting	
Initial Conditions	10-day model spin-up	
Boundary Conditions	H-CMAQ for 36 km domain 36 km CAMx 3D for 12 km domain	36km BC same as 2016v2 modeling platform
Sub-grid-scale Plumes	No Plume-in-Grid (PiG)	Large source apportionment applications cannot support added computational burden of PiG
Gas Phase Chemistry	Carbon Bond 6 mechanism release 5 (CB6r5)	Yarwood et al., (2010) chemical reactions and kinetic rates with halogen chemistry
Meteorological Processor	WRFCAMx	Converts WRF meteorology to CAMx-ready inputs
Horizontal Diffusion	Spatially varying	K-theory with K_h grid size dependence
Vertical Diffusion	CMAQ-like diffusivity (K_z)	Minimum K_z 0.1 to 1.0 m^2/s
Diffusivity Lower Limit	K_z min = 0.1 to 1.0 m^2/s or 2.0 m^2/s	Depends on urban land use fraction
Deposition Schemes		
Dry Deposition	Zhang dry deposition scheme	Zhang et. al, 2001; 2003
Bidirectional model	Turned off	Same as EPA 2016v2 modeling platform
Wet Deposition	CAMx-specific formulation	Rain, snow and graupel
Numerical Methods		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI)	EBI fast and accurate solver
Vertical Advection Scheme	Implicit scheme with vertical velocity update	Emery et al., (2011)
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	Colella and Woodward (1984)
Integration Time Step	Wind speed dependent	5 min (12 km), 5-15 min (36 km)

2.4 Model Performance Evaluation

The CAMx modeling system in this study has been previously evaluated for a 2016 base case simulation as part of EPA's Good Neighbor ozone rule. Results for this model performance evaluation are available as an appendix to the 2016v2 technical support document[6].

2.5 Analysis Areas

Air quality modeling results are disclosed in separate analysis areas, each including the state of interest and an additional area within approximately 60 kilometers (km) of the state. The analysis areas are defined as subdomains of the 12 km modeling domain and shown in Figure 2.5-1.

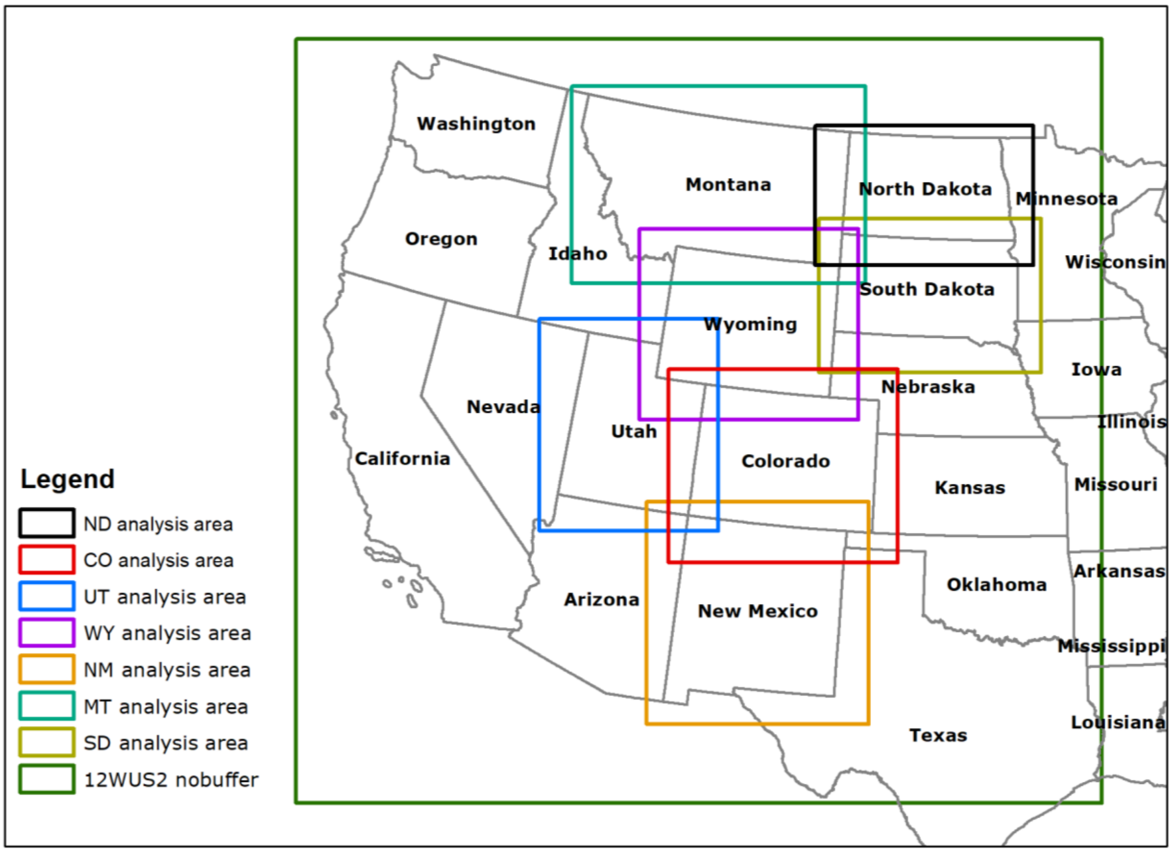


Figure 2.5-1. Overview of all air quality analysis areas

The maximum impacts to the NAAQS are assessed over each analysis areas and reported accordingly. Additionally, this assessment considers potential impacts to the lands with special air quality protections under federal law. These include national parks and wilderness areas designated as mandatory federal Class I areas under the federal Clean Air Act (CAA) and other areas re-designated as Class I at the request of a state or Indian Tribe. Tribal Class I areas are authorized in CAA Section 164(c) (EPA 2013). Federal Class I areas are listed in 40 CFR 81.400–81.437 and tribal Class I areas are listed by the National Park Service (NPS 2018). Individual sensitive areas for each state are listed below.

[6] Air Quality Modeling for the 2016v2 Emissions Platform TSD. Accessed on June 2023: https://gaftp.epa.gov/Air/aqmg/2016v2_Platform_Modeling_Data/AQ%20Modeling%20TSD_2016v2%20Platform_rev_2022_0119a.pdf

2.5.1 Colorado Analysis Area

Colorado's analysis area is presented in Figure 2.5-2 and the Class I areas selected for impact analysis are listed in Table 2.5-1.

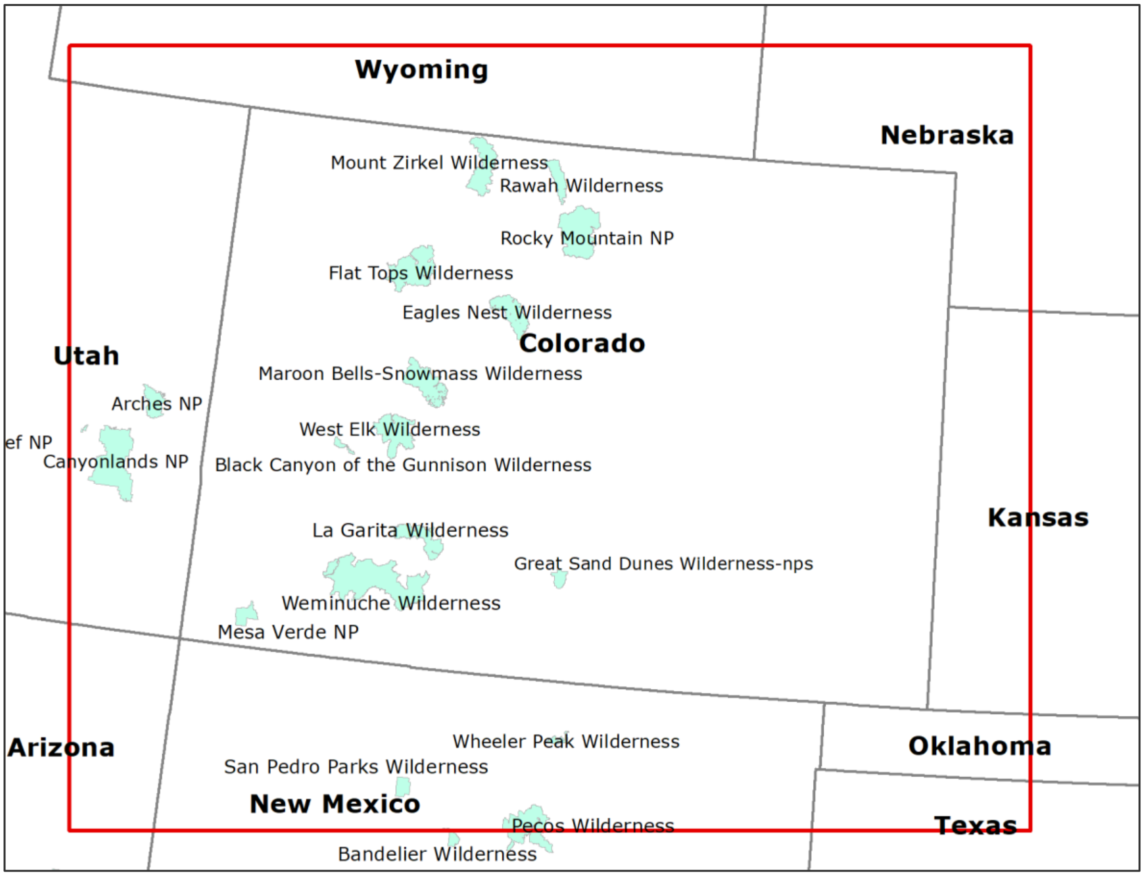


Figure 2.5-2. Colorado analysis area for air quality impact analysis

Table 2.5-1. List of Class I areas selected for impact analysis in CO analysis area.

Class I Area Name	Agency
Arches NP	NPS
Black Canyon of the Gunnison Wilderness	NPS
Canyonlands NP	NPS
Eagles Nest Wilderness	USFS
Flat Tops Wilderness	USFS
Great Sand Dunes Wilderness	NPS
La Garita Wilderness	USFS
Maroon Bells-Snowmass Wilderness	USFS
Mesa Verde NP	NPS
Mount Zirkel Wilderness	USFS
Rawah Wilderness	USFS

Class I Area Name	Agency
Rocky Mountain NP	NPS
San Pedro Parks Wilderness	USFS
Weminuche Wilderness	USFS
West Elk Wilderness	USFS
Wheeler Peak Wilderness	USFS

2.5.2 Montana Analysis Area

Montana’s analysis area is presented in Figure 2.5-3 and the Class I areas selected for impact analysis are listed in Table 2.5-2.

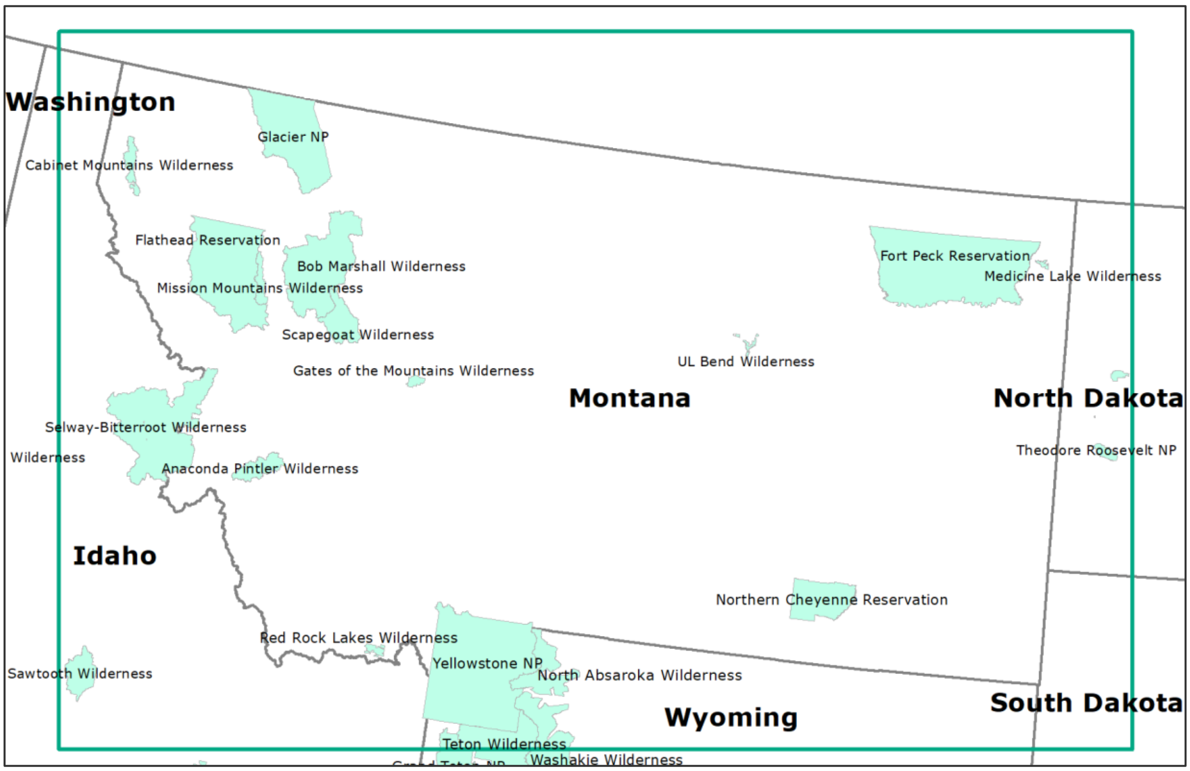


Figure 2.5-3. Montana analysis area for air quality impact analysis

Table 2.5-2. List of Class I areas selected for impact analysis in MT analysis area.

Class I Area Name	Agency
Anaconda Pintler Wilderness	USFS
Bob Marshall Wilderness	USFS
Cabinet Mountains Wilderness	USFS
Gates of the Mountains Wilderness	USFS
Glacier NP	NPS
Medicine Lake Wilderness	USFS
Mission Mountains Wilderness	USFS

Class I Area Name	Agency
North Absaroka Wilderness	USFS
Red Rock Lakes Wilderness	USFS
Sawtooth Wilderness	USFS
Scapegoat Wilderness	USFS
Selway-Bitterroot Wilderness	USFS
Theodore Roosevelt NP	NPS
UL Bend Wilderness	USFS
Yellowstone NP	NPS
Fort Peck Reservation	USFS
Northern Cheyenne Reservation	n/a
Flathead Reservation	n/a

2.5.3 New Mexico Analysis Area

New Mexico's analysis area is presented in Figure 2.5-4 and the Class I areas selected for impact analysis are listed in Table 2.5-3.

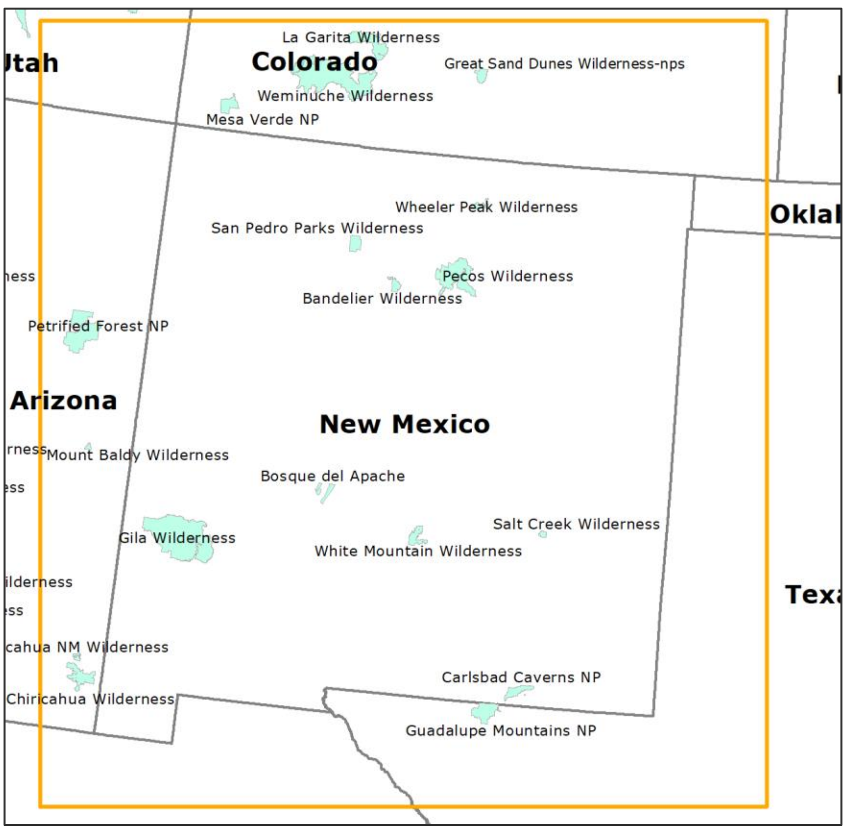


Figure 2.5-4. New Mexico analysis area for air quality impact analysis

Table 2.5-3. List of Class I areas selected for impact analysis in NM analysis area.

Class I Area Name	Agency
Bandelier Wilderness	NPS
Bosque del Apache (Chupadera Unit)	USFWS
Bosque del Apache (Indian Well Unit)	USFWS
Bosque del Apache (Little San Pascual Unit)	USFS
Carlsbad Caverns NP	NPS
Chiricahua NM Wilderness-Designated Wilderness	NPS
Chiricahua Wilderness	USFS
Gila Wilderness	USFS
Great Sand Dunes Wilderness-nps	USFS
Guadalupe Mountains NP	NPS
La Garita Wilderness	USFS
Mesa Verde NP	NPS
Mount Baldy Wilderness	USFS
Pecos Wilderness	USFS
Petrified Forest NP	NPS
Salt Creek Wilderness	USFWS
San Pedro Parks Wilderness	USFS
Weminuche Wilderness	USFS
Wheeler Peak Wilderness	USFS
White Mountain Wilderness	USFS

2.5.4 North Dakota Analysis Area

North Dakota's analysis area is presented in Figure 2.5-5 and the Class I areas selected for impact analysis are listed in Table 2.5-4.

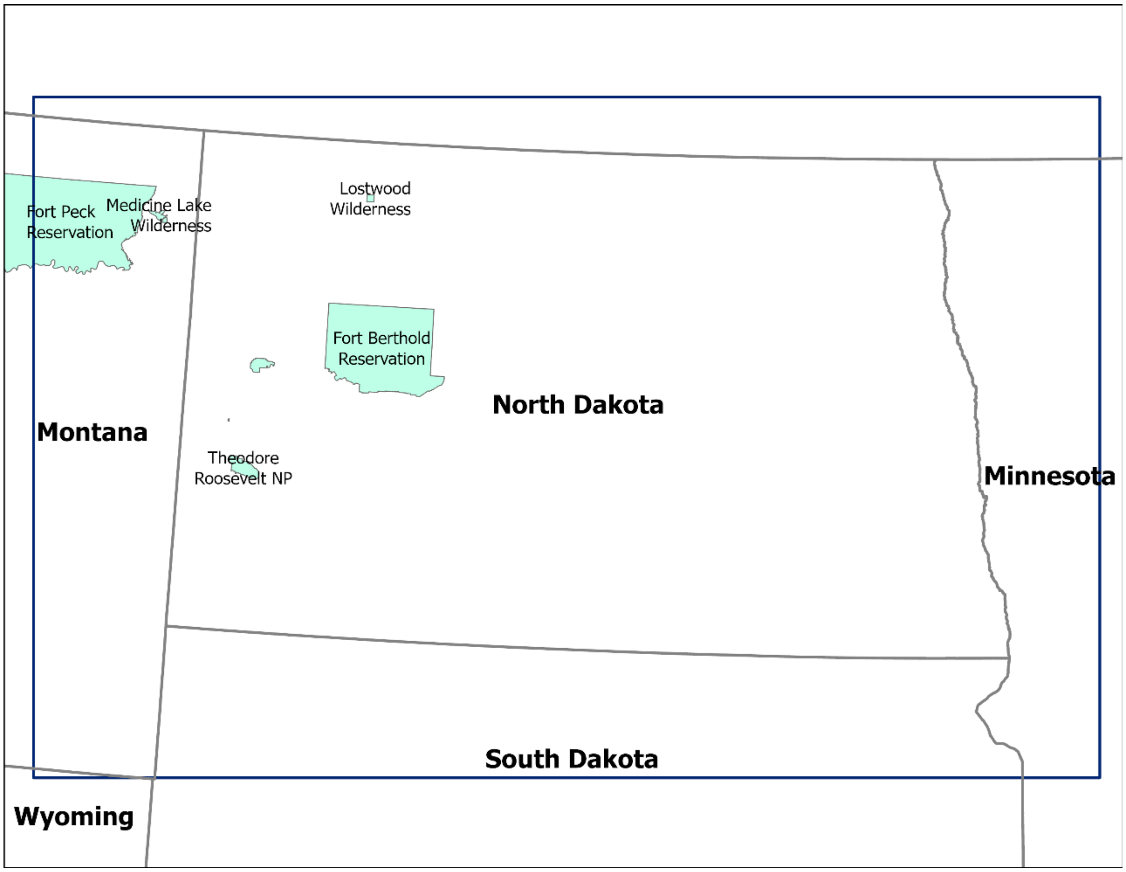


Figure 2.5-5. North Dakota analysis area for air quality impact analysis

Table 2.5-4. List of Class I areas selected for impact analysis in ND analysis area.

Class I Area Name	Agency
Fort Berthold Reservation	n/a
Fort Peck Reservation	n/a
Lostwood Wilderness	USFWS
Medicine Lake Wilderness	USFWS
Theodore Roosevelt NP	NPS

2.5.5 South Dakota Analysis Area

South Dakota's analysis area is presented in Figure 2.5-6 and the Class I areas selected for impact analysis are listed in Table 2.5-5.

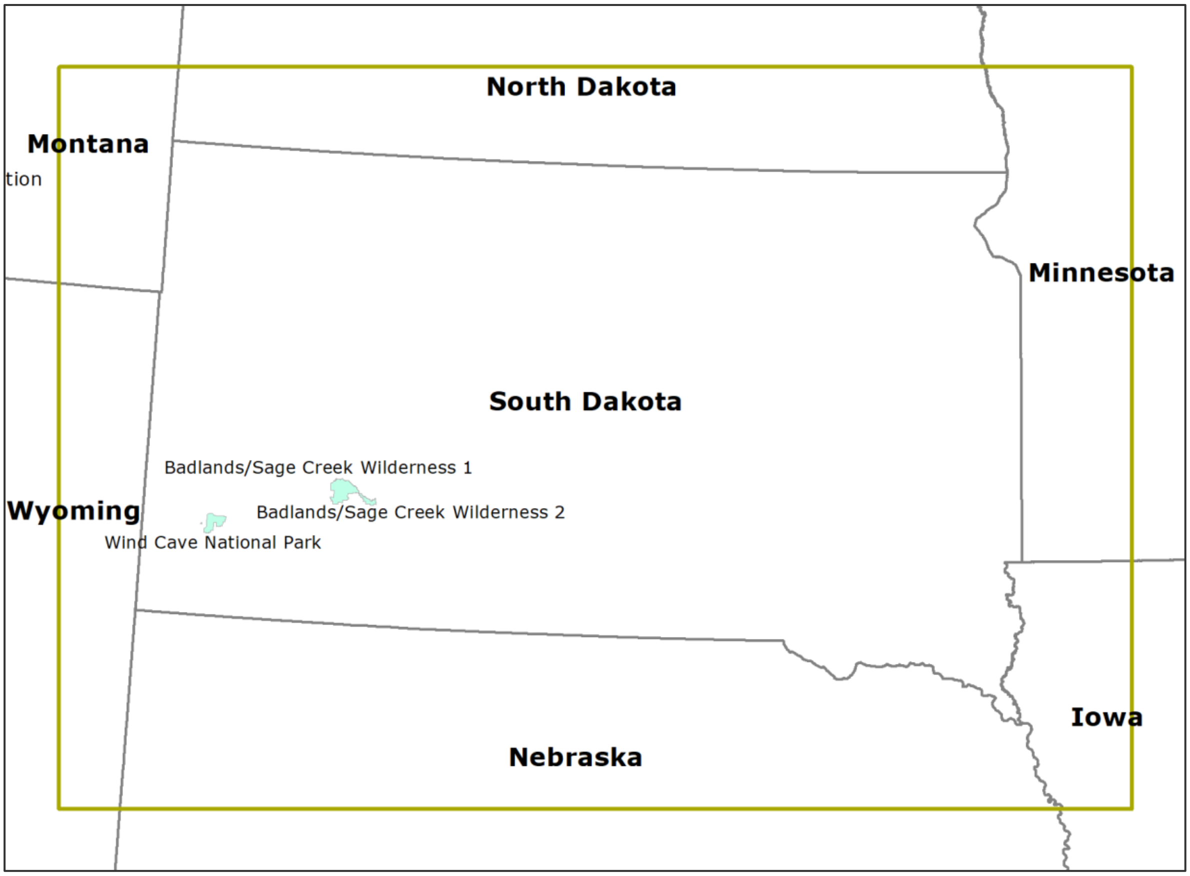


Figure 2.5-6. South Dakota analysis area for air quality impact analysis

Table 2.5-5. List of Class I areas selected for impact analysis in SD analysis area.

Class I Area Name	Agency
Badlands/Sage Creek Wilderness 1	NPS
Badlands/Sage Creek Wilderness 2	NPS
Wind Cave National Park	NPS

2.5.6 Utah Analysis Area

Utah's analysis area is presented in Figure 2.5-7 and the Class I areas selected for impact analysis are listed in Table 2.5-6.

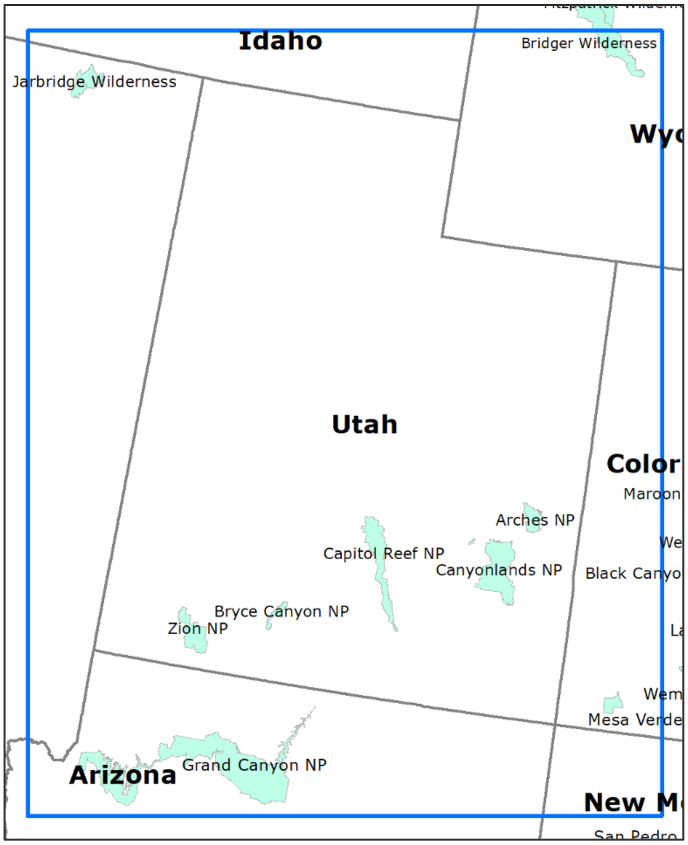


Figure 2.5-7. Utah analysis area for air quality impact analysis

Table 2.5-6. List of Class I areas selected for impact analysis in UT analysis area.

Class I Area Name	Agency
Arches NP	NPS
Bryce Canyon NP	NPS
Canyonlands NP	NPS
Capitol Reef NP	NPS
Grand Canyon NP	NPS
Jarbidge Wilderness	USFS
Zion NP	NPS

2.5.7 Wyoming Analysis Area

Wyoming's analysis area is presented in Figure 2.5-8 and the Class I areas selected for impact analysis are listed in Table 2.5-7.

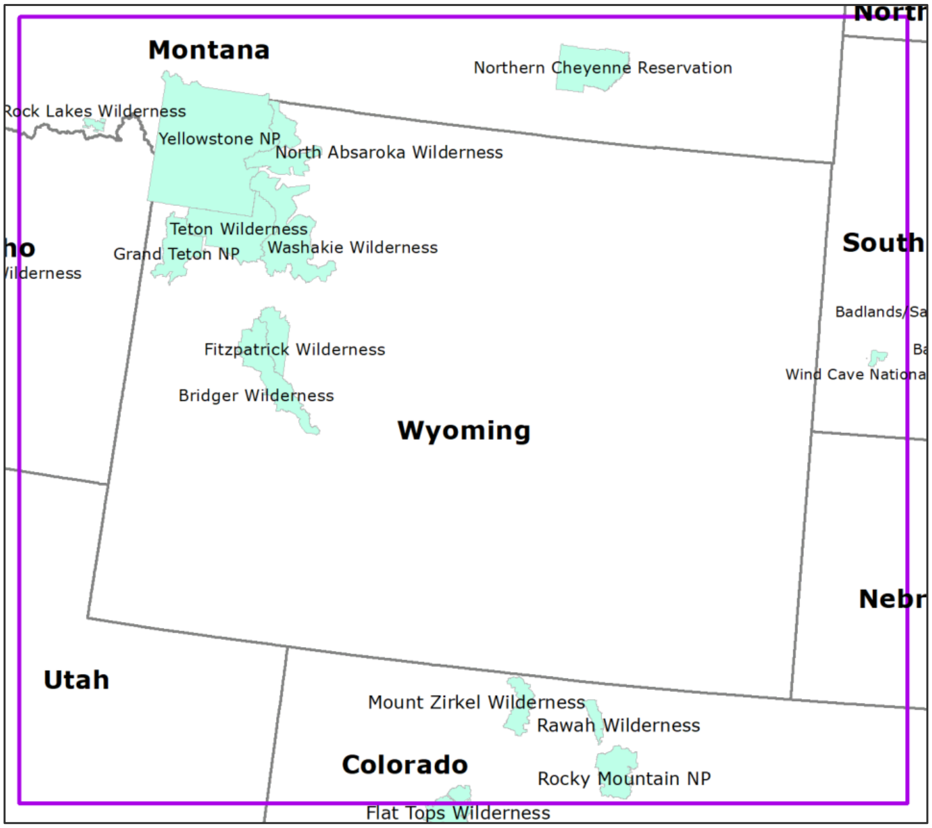


Figure 2.5-8. Wyoming analysis area for air quality impact analysis

Table 2.5-7. List of Class I areas selected for impact analysis in WY analysis area.

Class I Area Name	Agency
Bridger Wilderness	USFS
Fitzpatrick Wilderness	USFS
Grand Teton NP	NPS
Mount Zirkel Wilderness	USFS
North Absaroka Wilderness	USFS
Rawah Wilderness	USFS
Red Rock Lakes Wilderness	USFS
Rocky Mountain NP	USFS
Teton Wilderness	USFS
Washakie Wilderness	USFS
Wind Cave National Park	NPS
Yellowstone NP	NPS
Northern Cheyenne Reservation	n/a

3. EMISSIONS APPLIED IN PHOTOCHEMICAL MODELING

This section describes the emission inputs for the source apportionment modeling performed for the BLM circa 2032 Air Quality Modeling.

3.1 Coal Mining Emissions Inventory

Emissions inventories of criteria air pollutants and precursors (NOx, CO, $PM_{2.5}$, PM_{10}, SO_2, and VOC) were prepared for coal mining that included emissions from stationary sources, non-road equipment and blasting, fugitive dust emissions from earth moving, coal processing and vehicle travel on unpaved roads.

Estimates of historical emissions of criteria air pollutants and precursors were compiled for each mine from previous NEPA studies (e.g., Environmental Assessments) and air quality permitting databases.[7] Using these historical data as appropriate, emissions intensities were estimated for each mine (tons emissions of pollutant per ton of coal) for all modeled pollutants. In the absence of an existing emissions inventory for a given mine, the maximum emissions intensities for all mines of the same type (e.g., surface mine) in that state were used. The mine-specific emission intensities were then multiplied by the projected coal production rate at each mine to estimate emissions for the future year modeling scenario. Forecasts of coal production at each mine were provided by the BLM. The forecasts of coal production are uncertain and therefore the projected emissions inventory is uncertain as well and would vary with actual coal production rates in the future.

The modeled production rates at each mine are discussed below; the detailed emissions inventories for these mines are available separately in spreadsheets.

3.1.1.1 Coal Mining Emissions in North Dakota

There are currently four operating coal mines that produce thermal coal in North Dakota: BNI Center Mine, Coyote Creek Mine, Falkirk Mine, and Freedom Mine. All are surface mines that produce lignite and are located within three contiguous counties (i.e., Mercer, McLean, and Oliver) (BLM, 2022). Beulah Mine ceased mining coal in February 2022 and is undergoing reclamation (BLM, 2022), thus, it was not included in the modeling. The other four mines were included in the modeling.

Federal and non-federal coal production projections for North Dakota mines for circa 2032 used in the modeling were provided by the BLM Montana/Dakotas State Office. The projected production rates for North Dakota coal mines are provided in Table 3.1-1. The total federal and non-federal production rates are aligned with the BLM Reasonably Foreseeable Development (RFD) scenario of the BLM North Dakota Draft RMP/EIS (BLM 2022, 2023b) for the year 2032.

[7] For example, the Wyoming Department of Environmental Quality's IMPACT and Open Air System (https://deq.wyoming.gov/aqd/impact-and-open-air/)

Table 3.1-1. List of coal mines in North Dakota included in modeling and projected federal, non-federal, and total coal production in circa 2032.

Mine	Mine Type	Federal Production (tons/year)	Non-federal Production (tons/year)	Total Production (tons/year)
BNI Center Mine	Surface	1,575,000	2,748,000	4,323,000
Coyote Creek Mine	Surface	259,000	2,241,000	2,500,000
Falkirk Mine	Surface	427,000	7,373,000	7,800,000
Freedom Mine	Surface	3,731,000	8,259,000	11,990,000
	Total	5,992,000	20,621,000	26,613,000

Notes: Projected production rates for 2032 were provided by the BLM Montana/Dakotas State Office (email from J. Zeise of BLM on June 13, 2022). Note that this table contains only mines that are expected to be operational in 2032 per the information provided by BLM.

3.1.1.2 Coal Mining Emissions in Montana and Wyoming

Historical emissions and coal production rates for mines in Montana and Wyoming were obtained from annual emissions inventory reports from the Montana Department of Environmental Quality (MT DEQ) and the Wyoming Department of Environmental Quality's IMPACT/Open Air System (https://openair.wyo.gov/), respectively. These emissions inventory reports do not include tailpipe emissions from nonroad equipment, and so mobile source emissions data from permit applications and NEPA studies was used, where available.

The federal and non-federal coal production projections used to develop the emissions inventories for Montana and Wyoming for 2032 were obtained from the BLM Montana/Dakotas State Office and BLM Wyoming High Plains District Office, respectively. The federal and non-federal coal mine production rates modeled for Montana and Wyoming in the modeling are provided in Table 3.1-2 and Table 3.1-3, respectively.

Table 3.1-2. List of coal mines in Montana included in modeling and projected federal, non-federal, and total coal production in circa 2032.

Mine	Mine Type	Federal Production (tons/year)	Non-federal Production (tons/year)	Total Production (tons/year)
Bull Mountains Mine	Underground	1,500,000	5,500,000	7,000,000
Rosebud Mine	Surface	3,500,000	3,500,000	7,000,000
Spring Creek Coal Company	Surface	8,400,000	3,600,000	12,000,000
	Total	13,400,000	12,600,000	26,000,000

Notes: Projected production rates for 2032 were provided by the BLM Montana/Dakotas State Office (email from J. Zeise of BLM on June 13, 2022). Note that this table contains only mines that are expected to be operational in 2032 per the information provided by BLM.

Table 3.1-3. List of coal mines in Wyoming included in modeling and projected federal, non-federal, and total coal production in circa 2032.

Mine	Mine Type	Federal Production (tons/year)	Non-federal Production (tons/year)	Total Production (tons/year)
Antelope Coal Mine	Surface	16,200,000	1,800,000	18,000,000
Black Butte and Leucite Hills	Surface	200,000	800,000	1,000,000
Black Thunder	Surface	22,770,000	2,530,000	25,300,000
Buckskin Mine	Surface	9,000,000	1,000,000	10,000,000
Caballo Mine	Surface	11,700,000	1,300,000	13,000,000
Coal Creek Mine	Surface	2,500,000	0	2,500,000
Cordero Rojo Mine	Surface	14,000,000	0	14,000,000
Dry Fork Mine	Surface	2,700,000	300,000	3,000,000
Eagle Butte Mine	Surface	18,000,000	0	18,000,000
Jim Bridger Mine	Surface	850,000	850,000	1,700,000
Kemmerer Mine	Surface	500,000	2,000,000	2,500,000
North Antelope Rochelle Mine	Surface	61,500,000	2,400,000	63,900,000
Rawhide Mine	Surface	8,800,000	0	8,800,000
Wyodak Mine	Surface	3,240,000	360,000	3,600,000
	Total	171,960,000	13,340,000	185,300,000

Notes: Projected production rates for 2032 were provided by the BLM High Plains District Office (email from E. Vernon of BLM on May 9, 2022). Note that this table contains only mines that are expected to be operational in 2032 per the information provided by BLM.

3.1.1.3 Coal Mining Emissions in Colorado, New Mexico, and Utah

Emissions from coal mining activities in Colorado, New Mexico, and Utah were estimated using previous NEPA studies (e.g., Environmental Assessments), air quality permitting databases, and prior BLM studies.

Emissions for Colorado mines were developed using decadal forecasts of total coal production from Stantec (2020) and additional data on active mines from BLM. These projections were provided for several multi-year periods starting in 2020, and the period 2030-2035 was used for Colorado. Updates were made by BLM to account for closures that were announced after the publication of the Stantec report. The emissions at each mine were allocated between federal and non-federal fractions using the federal fraction of production at each mine in 2019. This was estimated using the ratio of the federal production reported by the Office of Natural Resources Revenue (ONRR) and the total production (federal + non-federal) reported by the MSHA.

BLM provided the 2032 federal and non-federal coal production projections for the mines in New Mexico and Utah. Production from tribal estate in NM (specifically the Navajo Mine) is included under the federal category for modeling.

The federal and non-federal coal mine production rates modeled for Colorado, Utah, and New Mexico are shown in Table 3.1-4, Table 3.1-5, and Table 3.1-6, respectively.

Table 3.1-4. List of coal mines in Colorado included in modeling and projected federal, non-federal, and total coal production in circa 2032.

Mine	Mine Type	Federal Production (tons/year)	Non-federal Production (tons/year)	Total Production (tons/year)
King II Mine	Underground	585,304	39,696	625,000
	Total	585,304	39,696	625,000

Notes: The production rates for 2032 are based on projections for 2030 to 2035 from Stantec (2020) with updates on more recent closures provided by BLM (emails from F. Cook of BLM on May 27, 2022, and July 7, 2022)

Table 3.1-5. List of coal mines in New Mexico included in modeling and projected federal, non-federal, and total coal production in circa 2032.

Mine	Mine Type	Federal Production (tons/year)	Non-federal Production (tons/year)	Total Production (tons/year)
Navajo Mine	Surface	3,800,000	0	3,800,000
El Segundo Mine	Surface	0	2,588,411	2,588,411
	Total	3,800,000	2,588,411	6,388,411

Notes: The production rates for 2032 are based on projections for 2030 to 2035 from Stantec (2020) with updates on more recent closures provided by BLM (email from E. Vernon of BLM on May 9, 2022). Production from Tribal estate is included under federal.

Table 3.1-6. List of coal mines in Utah included in modeling and projected federal, non-federal, and total coal production in circa 2032.

Mine	Mine Type	Federal Production (tons/year)	Non-federal Production (tons/year)	Total Production (tons/year)
Sufco	Underground	3,000,000	0	3,000,000
Skyline	Underground	1,260,000	2,000,000	3,260,000
Emery	Underground	0	750,000	750,000
Lila Canyon	Underground	150,000	2,500,000	2,650,000
Castle Valley	Underground	500,000	500,000	1,000,000
Fossil Rock	Underground	0	1,000,000	1,000,000
	Total	4,910,000	6,750,000	11,660,000

Notes: The production rates for 2032 are based on projections for 2030 to 2035 from Stantec (2020) with updates on more recent closures provided by BLM (email from E. Vernon of BLM on May 10, 2022)

3.2 Coal-fired EGU Emissions Inventory

The coal-fired Electric Generating Units (EGUs) included in the circa 2032 modeling were selected following directions from BLM, other stakeholder inputs, and a literature review. The coal-fired EGU list from EPA's 2032 inventory was used as a starting point. This list was updated by first removing EGUs that had already retired in circa 2028 modeling, followed by incorporating stakeholder inputs, and reflecting changes based on a literature review. Table 3.2-1 provides the list of the coal-fired EGUs to be modeled in the circa 2032 scenario in the following western U.S. states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. Criteria air pollutant emissions for 2032 EGUs were obtained from the EPA 2032 inventory. EPA prepared the 2032 EGU inventory using the output of the Integrated Planning Model (IPM) model. The IPM model is a linear model that accounts for variables and information such as energy demand, planned unit retirements, and planned rules to forecast unit-level energy production and configurations.

Table 3.2-1. List of Coal-fired Electrical Generating Units included in the 2032 modeling.

State	Facility Name	Boilers
Arizona	CORONADO GENERATING PLANT	U1B, U2B
Arizona	TUCSON ELECTRIC POWER CO - SPRINGERVILLE	2, 4, TS3
California	Argus Cogen Plant	BLR25, BLR26
Montana	COLSTRIP STEAM ELECTRIC STATION	3, 4
Montana	ROCKY MOUNTAIN POWER	U1
Nevada	TS POWER PLANT	1
New Mexico	Four Corners Power Plant	4, 5
North Dakota	Antelope Valley Station	B1, B2
North Dakota	Coyote Station	B1
North Dakota	Leland Olds Station	2
North Dakota	Milton R. Young Station	B1, B2
North Dakota	Spiritwood Station	1
South Dakota	Otter Tail Power Company	1
Utah	PacifiCorp- Hunter Power Plant	1, 2, 3
Utah	PacifiCorp- Huntington Power Plant	1, 2
Utah	Sunnyside Cogeneration Associates- Sunnyside Cogeneration Facility	1
Wyoming	Dry Fork Station	1
Wyoming	Jim Bridger Plant	BW73, BW74
Wyoming	Laramie River Station	1, 2, 3
Wyoming	Neil Simpson Two	1
Wyoming	WYGEN II	1
Wyoming	WYGEN III	1
Wyoming	WYGEN Station I	1
Wyoming	Wyodak Plant	BW91

Emissions from Coal Combustion Sources other than EGUs

Emissions from coal combustion sources other than coal-fired EGUs for the 2032 modeling were obtained from the EPA 2032 inventory. These sources were identified by the source classification codes (SCC) listed in Table 0-1 and extracted from the 2016v2 2032 non-EGU stationary point source inventory.

Table 0-1. Source classification codes for coal combustion sources other than EGUs included in the "Other Coal Combustion" source apportionment group for modeling.

Source classification codes (SCC) Description	SCC
Cement Manufacturing (Dry Process) Coal Kiln Feed Units	30500621
Cement Manufacturing (Wet Process) Coal Kiln Feed Units	30500721
Sodium Carbonate Manufacturing - Rotary Ore Calciner: Coal-fired	30102105
Iron Ore Processing Coal-fired Furnace	30302314, 30302357-62
Municipal Waste Incineration - Coal	50100115, 50100120, 50100135, 50100140, 50100158
Solid Waste Disposal - Industrial - Coal	50300137-43
Coal-fired External Combustion Boilers - Industrial	10200101, 10200104, 10200107, 10200117, 10200201-06, 10200210,10200212-13, 10200217-19, 10200221-26, 10200229, 10200300-07
Coal-fired External Combustion Boilers - Commercial/Institutional	10300101-03, 10300203, 10300205-09, 10300211, 10300214, 10300216-18, 10300221-26, 10300300, 10300305-09
Cement Manufacturing (Dry Process) Coal Kiln Feed Units	30500621
Cement Manufacturing (Wet Process) Coal Kiln Feed Units	30500721
Sodium Carbonate Manufacturing - Rotary Ore Calciner: Coal-fired	30102105
Iron Ore Processing Coal-fired Furnace	30302314, 30302357-62
Municipal Waste Incineration - Coal	50100115, 50100120, 50100135, 50100140, 50100158
Solid Waste Disposal - Industrial - Coal	50300137-43
Coal-fired External Combustion Boilers - Industrial	10200101, 10200104, 10200107, 10200117, 10200201-06, 10200210,10200212-13, 10200217-19, 10200221-26, 10200229, 10200300-07
Coal-fired External Combustion Boilers - Commercial/Institutional	10300101-03, 10300203, 10300205-09, 10300211, 10300214, 10300216-18, 10300221-26, 10300300, 10300305-09
Cement Manufacturing (Dry Process) Coal Kiln Feed Units	30500621
Cement Manufacturing (Wet Process) Coal Kiln Feed Units	30500721

3.3 Oil and Gas Development Emissions

A circa 2032 forecast oil and gas (O&G) emission inventory was developed for several Intermountain West states. The basis of the forecast oil and gas emission inventory for nonpoint sources is (i) circa 2032 oil and gas activity estimates, and (ii) nonpoint well-site emissions and emission per unit of oil and gas activity from the future year WRAP Oil and Gas Working Group (OGWG) emission inventory (Grant et al., 2020)[8] or New Mexico Ozone Attainment Initiative Photochemical Modeling Study – Draft Final Air Quality Technical Support Document[9]. Point source emissions were taken from EPA's 2016v2 Modeling Platform[10] point sources emissions.

3.3.1 Geographical Area and Temporal Scale

Emissions were estimated by county, and mineral estate (federal [excluding Tribal], Tribal, and non-federal) for Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming.

Annual O&G emissions were compiled for a circa 2032 future year.

3.3.2 Sources and Pollutants

Emissions were estimated by County, and mineral estate (federal [excluding tribal], tribal, and non-federal). The emissions inventory includes criteria air pollutants, volatile organic compounds (VOCs), hazardous air pollutants (HAPs) and greenhouse gases (GHGs). Inventoried criteria air pollutants include nitrogen oxides (NOx), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter less than or equal to 10 microns (PM_{10}) and particulate matter less than or equal to 2.5 microns ($PM_{2.5}$). Emissions of volatile organic compounds (VOC) are also included for use in photochemical grid modeling. Inventoried HAPs include those commonly included in oil and gas development studies, i.e., benzene, toluene, ethylbenzene, xylenes, n-hexane and formaldehyde. The GHGs inventoried include carbon dioxide, methane, and nitrous oxide. Annual oil and gas emissions were compiled for a circa 2032 future year.

The emission inventory documented herein includes wellsite, gathering, and processing subsectors. Emissions from well-site sources are classified as nonpoint sources and include exploration and production phase sources. The gathering and processing subsectors are collectively referred to as "midstream" sources; emissions from midstream sources are classified as point sources. The classification of well-site emissions as nonpoint and midstream emissions as point sources is consistent with oil and gas emission inventory classifications used in prior BLM studies such as the Colorado Air Resource Management Modeling Study (CARMMS)[11].

3.3.3 Approach

The circa 2032 oil and gas emission inventory was developed for nonpoint sources based on oil and gas activity and emissions per unit of oil and gas activity and for point sources based on 2016v2 2032 emissions for criteria air pollutants and GHGs. Speciation factors were applied to criteria air pollutant emission for HAPs. Circa 2032 nonpoint (well-site) source criteria air pollutant and GHG emissions were estimated as the product of 1) circa 2032 oil and gas activity forecasts and 2) future year WRAP/WAQS emission rates (i.e., emission factors). Circa 2032 nonpoint source HAPs emissions were estimated as the product of the 1) HAP to VOC weight ratio from the WRAP/WAQS modeling platform

[8] Grant, J., R. Parikh, A. Bar-Ilan, 2020. "Revised Final Report: 2028 Future Year Oil and Gas Emission Inventory for WESTAR-WRAP States - Scenario #1: Continuation of Historical Trends". Prepared for the Western Regional Air Partnership Oil and Gas Working Group. Prepared by Ramboll. October.

[9] https://www-archive.env.nm.gov/air-quality/wp-content/uploads/sites/2/2021/06/NM_OAI_2028_AQTSD_v8.pdf

[10] https://www.epa.gov/air-emissions-modeling/2016v2-platform

[11] https://www.blm.gov/documents/colorado/public-room/data

speciation profile associated with each SCC and 2) SCC-level VOC emissions. Circa 2032 point source criteria air pollutant and GHG emissions were assumed unchanged from EPA 2016v2 Modeling Platform estimates for 2032. Circa 2032 point source HAPs emissions were estimated by multiplying the 1) HAP to VOC weight ratio from the WRAP/WAQS modeling platform speciation profile associated with each SCC by 2) SCC-level VOC emissions.

Oil and Gas Activity

Oil and gas activity estimates were developed for Colorado, Montana, New Mexico, South Dakota, Utah, Wyoming (except the Newcastle Field Office) as described below.

1. EIA 2022 Annual Energy Outlook (AEO2022)[12] oil and gas production estimates were disaggregated to state, basin, and well type based on 2032 oil and gas activity estimates from Ramboll (Ramboll, 2023)[13].

2. Per BLM input[14] [15] [16] [17], for each state, basin, and well type combination, oil and gas production were set at 1) an EIA AEO2022 forecast (e.g., reference, high or low) for circa 2032 or 2) at a production level specified by BLM.

3. Oil and gas production estimates were disaggregated to county and mineral designation based on Ramboll (2023) 2032 oil and gas production fractions.

4. Existing active well counts were based on circa-2020 historical data and were unchanged from Ramboll (2023) estimates; BLM determined new active well counts based on the number of new wells required to achieve the selected 2032 oil and gas production levels[18].

5. Drilling estimates were based on the average annual drilling rate required to achieve the new active well count estimate in #4 above.

For North Dakota, RMP/EIS[19] Alternative A oil and gas activity for 2032 was used.

For the Newcastle Field Office, which includes Crook, Niobrara and Weston counties, the Newcastle FO RMP/EIS reasonably foreseeable development scenario[20,21] for 2032 was used.

Appendix A shows circa 2032 state total oil and gas activity estimates by mineral designation (Table 1) and circa 2032 state total oil and gas activity estimates for federal existing and new activities (Table 2). Appendix A (Figure 1 to Figure 9) also shows maps of county-level circa 2032 O&G activity by well type and mineral designation for oil production, gas production, active well count, and spuds (drilled wells) in the seven Intermountain West states.

[12] https://www.eia.gov/outlooks/archive/aeo22/
[13] Ramboll (2023). “BLM Western US Photochemical Air Quality Modeling for 2028”. Prepared for EMPSi and BLM. March
[14] Email communication from BLM Staff (Erik Vernon) to Ramboll (John Grant). May 17, 2022.
[15] Email communication from BLM Staff (Erik Vernon) to Ramboll (John Grant). May 19, 2022.
[16] Email communication from BLM Staff (Erik Vernon) to Ramboll (John Grant). May 23, 2022.
[17] Email communication from BLM Staff (Erik Vernon) to Ramboll (John Grant). May 24, 2022.
[18] Email communication from BLM Staff (Forrest Cook) to Ramboll (John Grant). June 29, 2022.
[19] Email communication from EMPSi Staff (Francis Craig) to Ramboll (John Grant). May 23, 2022.
[20] Email communication from BLM Staff (Ryan McCammon) to Ramboll (Krish Vijayaraghavan). November 24, 2020.
[21] Email communication from BLM Staff (David Chase) to Ramboll (Krish Vijayaraghavan). December 1, 2020.

Nonpoint Source Criteria Air Pollutant and GHG Emission Rates

Nonpoint source circa 2032 oil and gas emissions per unit of oil and gas activity were estimated from the future year WRAP/WAQS oil and gas emissions inventory (Grant et al., 2020). The WRAP/WAQS oil and gas emission inventory includes criteria air pollutant and GHG emissions by County and source classification code (SCC) for nonpoint (well-site) sources and by SCC, facility, and unit for point sources. The 2032 WRAP/WAQS oil and gas emission inventory accounts for emission reductions resulting from on-the-books regulations as of August 2020. Controls per the federal Oil and Gas New Source Performance Standard (NSPS) were developed prior to August 2020 Final Policy and Technical Amendments[22].

The WRAP/WAQS oil and gas emission inventory includes emissions by well type for most gas production-, oil production- and active well count-related source categories and across all well types for spud-related source categories. Therefore, estimates of emissions per unit of oil and gas activity were developed by well type for gas production, oil production and active well count-related source categories, and aggregated across well types for spud-related categories. The oil and gas activity emissions forecast parameter associated with each nonpoint (well-site) emission source category is shown in Appendix A Table 3.

In the 2017 Utah Air Agencies Uinta Basin Emission Inventory (version 1.86), wastewater (primarily produced water) pond emissions were estimated to be 4,901 tons per year VOC in Duchesne County and 72,057 tons per year in Uinta County. These 2017 wastewater pond emissions are much higher than wastewater pond emissions included in the WRAP O&G emission inventory. Wastewater pond emission rates for Uinta and Duchesne counties were estimated based on the ratio of 2017 Utah Air Agencies Uinta Basin Emission Inventory (version 1.86) values to 2017 oil production in each county. Colorado GHG emissions were not included in the future year WRAP O&G emission inventory. Colorado GHG emissions were added based on SCC specific ratios of criteria air pollutant to GHG emission rate ratios applied to SCC-level emissions.

3.3.4 Results

The circa 2032 emission inventory estimates are summarized in Appendix A (Table 4 – Table 7) by state and mineral designation and by new and existing activity[23] for federal emissions. In Colorado, Montana, North Dakota, and South Dakota, emissions from non-federal activities were the largest source of emissions. In New Mexico, Utah, and Wyoming emissions from federal (excluding Tribal) mineral estate were the largest source of emissions. Emissions from Tribal mineral estate were smaller than federal and non-federal emissions in all states except Utah where emissions from Tribal mineral estate were higher than emissions from Non-federal mineral estate. For federal (including Tribal) mineral estate, emissions from existing wells were higher than emissions from new wells in Colorado, New Mexico, and Utah; emissions from new wells were higher in Montana, North Dakota, South Dakota, and Wyoming.

[22] https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-industry/epa-issues-final-policy-and-technical

[23] "New" activity here refers to wells drilled from 2020+ for all regions except Crook, Niobrara, and Weston counties in Wyoming where "new" activity refers to wells drilled from 2024 per discussions with BLM Wyoming. "Existing" refers to wells drilled prior to new activity.

3.4 Other Anthropogenic Emissions

The EPA 2016v2 modeling platform 2032fj emissions were the primary source of the 2032 future year anthropogenic emission inputs except for oil and gas and coal-related sources; the EPA 2016v2 modeling platform was the most current EPA database available at the time of initiation of this study. The modeling platform includes a full suite of the base and future year inventories, ancillary emissions data, and scripts and software for preparing emissions for air quality modeling. The 2016v2 platform updates emissions from the 2016v1 platform that incorporates emissions based on MOtor Vehicle Emission Simulator (MOVES3) model, the 2017 National Emissions Inventory (NEI) nonpoint inventory (both anthropogenic and biogenic), the Western Regional Air Partnership (WRAP) oil and gas inventory, and updated inventories for Canada and Mexico.

Prescribed burns and agricultural burning were included as part of the other anthropogenic source category and held constant at the 2016 levels. The 2016 prescribed burning and agricultural fire emissions were obtained from the EPA 2016v2 platform.

3.5 Natural Emissions

Natural source categories were held constant at the 2016 level and obtained from the EPA 2016v2 platform. EPA developed pre-merged emission files for each source category in CMAQ-ready format, except for oceanic emissions. Oceanic emissions were generated using a CAMx preprocessor in CAMx-ready format. 2016v2 CMAQ-ready emissions for other categories were converted into CAMx format using the CMAQ2CAMX processor and the BLM 12 km domain data were extracted. Natural source categories included in the modeling are listed below.

- Biogenic: In the 2016v2 platform, biogenic emissions for the entire year 2016 were developed using the Biogenic Emission Inventory System version 3.7 (BEIS3.7) within SMOKE. BEIS3.7 used the Biogenic Emissions Landuse Dataset (BELD) version 5 as its landuse input.
- Ocean Sea Salt and DMS emissions: Sea-salt emissions were developed using an emissions processor that integrates published sea spray flux algorithms to estimate sea salt PM emissions for input to CAMx. The gridded input data for the sea salt emissions model is a land-water mask file that identifies each modeling domain grid cell as open ocean, surf zone, or land. Additional details on the development and evaluation of the sea salt emissions processor are available in the WestJumpAQMS Sea Salt memo (Morris et al., 2012). The CAMx sea salt emissions processor was used with the 2016 WRF data to generate sea salt emissions by EPA.
- 2016 emissions from open land fires (wildfires, prescribed burns, and agricultural burning) were obtained from the EPA 2016v2 platform. The 2016v2 fire emissions for Mexico and Canada were used without any changes.

3.6 Development of CAMx-ready Emission Inputs

The SMOKE modeling system was used to prepare 36 and 12 km domain CAMx-ready emissions for oil and gas, coal mining and coal EGUs, and other coal combustion sources. Note that, the latest version of SMOKE at the time of initiation of this study, namely 4.8.1, was used for emissions processing. Oil and gas emissions were processed using gridding surrogates for federal and non-federal mineral designation provided by BLM. GIS software was used to calculate the fraction of geospatial indicator coverage in each CAMx model grid cell. The county-specific gridding surrogates were developed from the data provided by BLM, and chemical speciation profiles were obtained from the WRAP/WAQS RH study for oil and gas emissions processing. The conventional gas (CG) and CBM gas speciation profile were assigned to source categories associated with the respective well type. Gridding surrogates were developed for spatial allocation for each well type (i.e., conventional, CBM) and land type (federal, non-federal) combination. Ancillary data for the other source categories were obtained from the WRAP/WAQS RH study through the Intermountain West Data Warehouse (IWDW). SMOKE was used to allocate O&G, mining, industrial coal combustion sources, and EGU annual emissions to months and across diurnal cycle to account for seasonal, day-of-week, and hour-of-day effects.

EGUs were separated into coal and other EGUs for modeling to evaluate the indirect effects of coal . The EGU processing was performed using 2016v2 2032 hourly emissions for NOx and SO_2 and hourly heat inputs for other pollutants. Ramboll created a separate source apportionment category for other coal combustion by extracting data for specific SCCs related to coal combustion (see Table 0-1) from the EPA 2032 inventory. The modeling inventories were harmonized, so there is no double counting of emissions between area and point sources.

The modeled emissions inventory included the following pollutants: CO, NOx, VOC, NH3, SO_2, PM_{10}, and $PM_{2.5}$. Ramboll used SMOKE to convert inventoried VOC emissions into the CB6r4 mechanism-specific model species used in CAMx. Chemical speciation profiles were assigned to inventory sources using cross-referencing data that matched the speciation profiles and inventory sources using country/state/county (FIPS) and SCC. Ramboll used VOC and PM speciation profiles from the WRAP/WAQS RH study. Emission inputs also include the CB6r4 chemistry modeled local excess methane (ECH4) above background concentrations. SMOKE was used to apply source-specific speciation profiles to convert inventoried NOx emissions to NO, NO2, and HONO components. PM emissions were also speciated to model species, namely primary organic aerosol (POA), primary elemental carbon (PEC), primary nitrate (PNO3), primary sulfate (PSO4), primary other PM (FPRM), elemental metals, and coarse PM (CPRM or PM10-2.5). Similar to the WRAP/WAQS RH study, fugitive dust emissions (including fugitive dust emissions associated with oil and gas activities and coal mining) were adjusted after SMOKE processing to account for fugitive dust correction factors (also called fugitive dust transport factors, FDTF) that were derived from the Biogenic Emission Landuse Database version 4 (BELD4). The correction factors account for dust removal due to local vegetation scavenging and ensure that dust emissions are not transported downwind. These correction factors have typically been applied in prior photochemical modeling exercises.

3.6.1 Processing of Emissions for the 36 km CONUS and 12 km Domain

Emission inventories for oil and gas, coal mining, and coal combustion sources were processed through SMOKE to generate 12-km resolution emission inputs for the 12-km domain. For all other source categories in the 12-km domain, 2032 model-ready emissions from EPA's 2016v2 platform were usedafter processing them into CAMx format using the CMAQ2CAMx processor. Emission data outside the 12 km domain and within the 36 km domain were obtained from the EPA 2016v2 modeling platform CMAQ-ready emission inputs for 2032 that were also processed through the CMAQ2CAMX processor. Each source category, for which separate ozone and particulate matter contribution is needed, was processed in a separate SMOKE processing stream.

Separate Quality Assurance (QA) and Quality Control (QC) were performed for each stream of emissions processing and processing step. SMOKE includes advanced quality assurance features, including error logs when emissions are dropped or added. SMOKE log files were carefully reviewed for error messages to ensure that appropriate source profiles are used. SMOKE input and output emissions were compared to verify that no emissions were lost or gained in the SMOKE processing. In addition, visual displays were used for QA/QC including:

- Spatial plots of emissions for each major species (e.g., NOX, VOC, SO_2, NH_3, PM and CO)
- Summary tables of criteria air pollutant emissions by major source category

To prepare the final CAMx-ready emission inputs, emission files were merged for the biogenic, on-road, non-road, area, and low-level point sources for coal mining, coal combustion, oil and gas, and other sources. The point source and fire emissions were processed into the day-specific hourly speciated emissions in CAMx point source format.

4. PHOTOCHEMICAL MODELING APPROACH

The CAMx source apportionment tools (probing tools) were applied during the modeling. The following sections describe the proposed source apportionment modeling and the analysis approach.

4.1 Source Apportionment Modeling Approach and Source Groups/Regions

The CAMx Anthropogenic Precursor Culpability Assessment (APCA) version of the Ozone Source Apportionment Technology (OSAT) tool and the Particulate Source Apportionment Technology (PSAT) tool were used to get separate air quality and AQRV contributions for specified source apportionment groups within specific regions.

4.1.1 Overview of CAMx Source Apportionment Tools

The CAMx OSAT/APCA ozone and PSAT PM source apportionment tools use reactive tracers that are released for each source group of interest. These reactive tracers operate in parallel to the host photochemical grid model accessing the model's transport, dispersion, chemistry, and deposition algorithms. For example, the OSAT/APCA ozone source apportionment tools represent each source group's ozone contributions using four reactive tracers that represent VOC emissions (V), NO_X emissions (N) and ozone attributed to the source group formed under more VOC-limited (O3V) and NO_X-limited (O3N) conditions. At each time step and grid cell, ozone formed is allocated to the source groups based on their relative contribution of VOC or more NO_X emissions to the total VOC or NO_X concentrations after determination of whether ozone formation is more VOC-limited or more NO_X-limited. The APCA ozone source apportionment tool differs from OSAT in that it recognizes that some precursor emissions are not controllable, redirecting ozone formed from the uncontrollable to the controllable source group. For example, when ozone is formed under VOC-limited conditions due to the interaction between biogenic VOC and anthropogenic NO_X emissions, a case OSAT would assign the ozone formed to the biogenic emissions source group, APCA redirects the ozone formed to the anthropogenic emissions source group recognizing that biogenic VOC emissions are not controllable and without the anthropogenic NO_X the ozone would not have been generated. In a CAMx APCA source apportionment run, the first source category specified in the run is assumed to be the uncontrollable source group (typically natural emissions) and ozone is allocated only to natural emissions when it is due to natural VOC and NO_X emissions interacting with each other (e.g., ozone formed due to reactions between biogenic VOC and biogenic NOx). The modeled natural emissions source group typically includes biogenic emissions, fires (wildfires, prescribed burns, and agricultural burning), lightning, windblown dust and sea salt emissions. Emissions from wildfires usually dominate the fire emissions within the 12 km domain.

The CAMx PSAT PM source apportionment tool considers several families of PM source apportionment tracers that can track different components of PM. Each of these families has a different number of reactive tracers to track the pathway from the PM precursor emissions to the ultimate PM compounds. The five different families of PSAT source apportionment are (number of tracers in parenthesis): Sulfate-SO4 (2); Nitrate/Ammonium-NO3/NH4 (7); Primary PM (6); Secondary Organic Aerosol-SOA (20) and Mercury-Hg (3). For this study we use the SO_4, NO_3/NH_4 and Primary PM PSAT families of tracers so that 15 total reactive tracers are needed to track PM contribution for each source group. There are six SOA precursors treated in CAMx: benzene, toluene, and xylene (aromatics), isoprene, terpene and sesquiterpene with biogenic sources typically contributing over 50% of the SOA. Coal mining and oil and gas VOC emissions are dominated by light VOCs that do not form much SOA. Adding the SOA PSAT family more than doubles the number of tracers and hence significantly increases the computational time. Therefore, SOA is not included in the $PM_{2.5}$ and visibility impacts associated with the source groups based on the PSAT source apportionment modeling results. However, SOA is included in the $PM_{2.5}$ and visibility impacts due to total emissions.

4.1.2 Source Apportionment Groups and Regions

The APCA version of the OSAT and the SO_4, NO_3/NH_4 and Primary PM families of PSAT source apportionment are used to track the contributions of the emission groups defined in Table 4.1-1. The groups are defined to understand the impacts on AQ and AQRV due to federal and non-federal coal and oil and gas sectors and other remaining source groups in each of the states analyzed in this document. The regions reported in each area analysis for each state are shown in Figure 4.1-1.

Table 4.1-1. CAMx source apportionment groups.

Group	ID	Description
1	Natural	Natural emissions (biogenic, lightning, sea salt, windblown dust)
2	Wildfire	Wildfire emissions
3	OilGas_ExistFed State[a]	Existing federal oil and gas development in individual region of a state
4	OilGas_NewFed State[a]	New federal oil and gas development in individual region of a state
5	OilGas_Fed_Other_States	Existing and New federal oil and gas development outside the state
6	OilGas_NonFed	Non-federal oil and gas development
7	OilGas_ExisTribal	Existing tribal oil and gas development
8	OilGas_NewTribal	New tribal oil and gas development
9	Coal_Fed	federal coal mining
10	Coal_NonFed	Non-federal coal mining
11	Coal_EGU WRAP states	Coal electric generating units in WRAP states (including individual state and others)
12	Coal_Comb WRAP states	Other (non-EGU) coal combustion sources in WRAP states (including individual state and others)
13	Other_EGU	All other EGU facilities (non-coal in WRAP states and non-WRAP EGU)
14	Anthro_Rest	Other anthropogenic sources inside and outside individual state

[a] State: Results are reported for the emissions group at individual regions within each state: CO, MT, ND, NM, SD, UT or WY

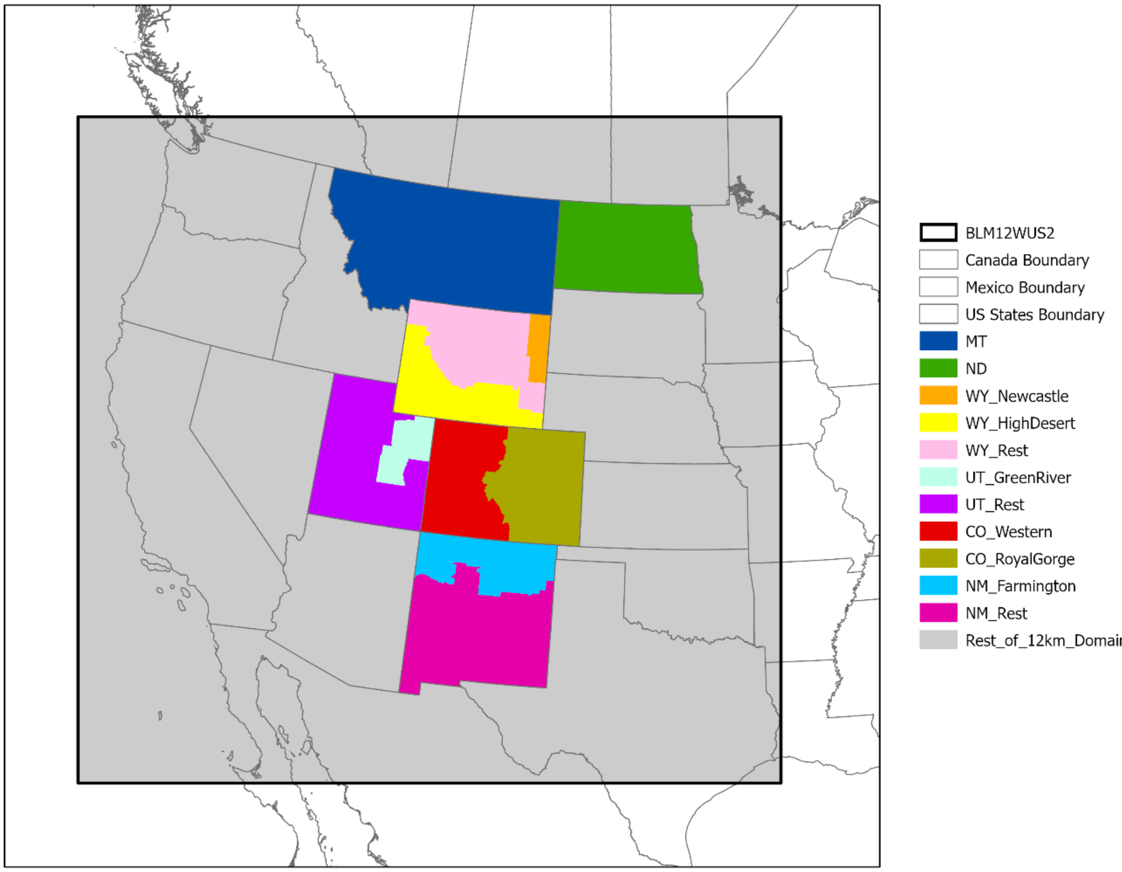


Figure 4.1-1. Source Apportionment regions reported in analysis

4.2 Comparison of Modeled Concentrations to Ambient Air Standards

The CAMx modeling results are processed and evaluated against standards and thresholds to determine impacts AQ and AQRVs. The total (absolute or cumulative) concentrations predicted by CAMx for criteria air pollutants are compared to the National Ambient Air Quality Standards (NAAQS) listed in Table 1.1-1. The APCA and PSAT source apportionment results are used to analyze the contribution of emissions from each of the source groups listed in Table 4.1-1.

4.3 Analysis at Class I Areas and other Areas

Air quality and AQRV impacts due to federal and non-federal and other cumulative contributions are estimated and reported at the Class I areas and Indian reservations shown in Figure 2.5-2 to Figure 2.5-8 and listed in Table 2.5-1 to Table 2.5-7.

4.4 Visibility Analysis

Particulate matter concentrations in the atmosphere contribute to visibility degradation by both scattering and absorption of visible light. The combined effect of scattered and absorbed light is called light extinction. This study estimated the contributions to the light extinction from the groups defined in Section 2.5 at the Class I areas for each analysis area described in Section 4.1.2. The visibility metric used in this analysis is called the Haze Index (HI), which is measured in deciview (dv) units and is defined as follows:

$$HI = 10 \times \ln [b_{ext}/10]$$

Where b_{ext} is the atmospheric light extinction measured in inverse megameters (Mm^{-1}) and is calculated primarily from atmospheric concentrations of particulates.

For this analysis, cumulative visibility design values were assessed using the Software for Model Attainment Test- Community Edition (SMAT-CE) version 2.1. SMAT-CE provides model-adjusted visibility design values that are consistent with the EPA's "Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze" (EPA 2018). Photochemical models are affected by biases (i.e., model results are a simplification of natural phenomena and tend to over- or underestimate particulate matter concentrations). Using SMAT-CE mitigates model bias for visibility calculations by pairing model estimates with reconstructed light extinction from measured concentrations.

SMAT-CE calculates baseline and future-year visibility levels for both the 20 percent best days and the anthropogenic most impaired days (MID) for each of the Class I areas in the US. SMAT-CE adjusts the modeled ambient concentrations based on measured concentrations to account for possible model bias using the relative response factor approach described below. Within SMAT-CE, model-predicted concentrations of chemical compounds that scatter or absorb light are converted to estimates of light extinction using the IMPROVE equation (Hand and Malm, 2006). The IMPROVE equation reflects empirical relationships derived between measured mass of PM components and measurements of light extinction at IMPROVE monitoring sites in Class I areas. The IMPROVE equation calculates light extinction as a function of relative humidity for large and small particulate matter. As a final step in SMAT-CE, light extinction values are converted into dv, a measure for describing the ability for the human eye to perceive changes in visibility.

The EPA guidance for estimating future-year visibility levels recommends using the photochemical grid model results in a relative sense to scale the visibility current design values (DVC). The visibility DVCs are based on a 5-year average of monitored IMPROVE data centered on the typical modeling year. For this analysis, the 5-year period centered on 2016 is 2014 through 2018.

Scaling factors, called relative response factors (RRFs), are calculated from the modeling results. RRFs are applied to the DVC to predict future-year design values (DVF) at a given IMPROVE monitor location using the following equation:

$$DVF = DVC \times RRF$$

RRFs are the ratio between the model-predicted concentrations in the future-year modeling scenario and the typical year modeling scenario. RRFs are calculated for each individual chemical component that contributes to light extinction based on the model grid cells surrounding a monitoring site.

SMAT-CE depends on IMPROVE monitors to assess visibility impacts.

The contributions for the source groups defined in Section 2.5 to the DVF estimated by SMAT-CE were obtained from absolute modeling results. For each source group, the reconstructed daily light extinction using the IMPROVE equation was derived using the speciated PM model concentrations from PSAT. For each Class I area PM concentrations were extracted at the grid cell that represents the location of the corresponding IMPROVE monitor. For areas with no monitor, concentrations were extracted from a centroid grid cell, and IMPROVE equation parameters of the monitor that SMAT-CE used to map areas with missing monitors were used. The daily light extinctions were averaged over the 20 percent best days and MID, specific to each IMPROVE monitor. A percentage contribution was then calculated using the model-derived average light extinction values and applied to the DVF (light extinction only) provided by SMAT-CE. For each sensitive area, the light extinction contributions for both the 20 percent best and the most impaired days are reported here.

4.5 Sulfur and Nitrogen Deposition Analysis

Hourly wet and dry deposition fluxes of sulfur- and nitrogen-containing modeled species are processed to estimate total annual sulfur (S) and nitrogen (N) deposition values at each federal Class I area and other areas of interest. The maximum annual S and N deposition values at any grid cell within the area of interest are also used to represent deposition for that area in addition to the average annual deposition values over the entire area. Maximum and average predicted S and N deposition impacts for all the groups listed in Table 4.1-1 are estimated separately for each area of interest.

Nitrogen deposition impacts account for all the nitrogen containing species modeled in CAMx, including reactive gaseous nitrate species, RGN (NO, NO_2, NO_3 radical, HONO, N_2O_5), TPN (PAN, PANX, PNA), organic nitrates (NTR), particulate nitrate formed from primary emissions plus secondarily formed particulate nitrate (NO_3), gaseous nitric acid (HNO_3), gaseous ammonia (NH_3) and particulate ammonium (NH_4). CAMx species used in the sulfur deposition calculation are primarily sulfur dioxide emissions (SO_2) and particulate sulfate ion from primary emissions plus secondarily formed sulfate (SO_4).

FLAG (2010) recommends that applicable sources assess impacts of nitrogen and sulfur deposition at Class I areas. This guidance recognizes the importance of establishing critical deposition loading values or simply “critical loads” (CL). Critical loads are a level of atmospheric pollutant deposition below which negative ecosystem effects are not likely to occur. Here, annual nitrogen and sulfur deposition are compared against critical loads to assess total deposition impacts.

FLAG (2010) guidance does not include any critical loads for specific Class I areas and refers to site-specific critical load information on FLM websites for each area of concern. The guidance recommends the use of deposition analysis thresholds (DATs) as Project-level thresholds; these are not relevant for this study. Critical loads were obtained from the EPA Critical Load Mapper Tool[24] which provides access to critical loads for terrestrial and aquatic ecosystems from the National Atmospheric Deposition Program’s National Critical Loads Database[25]. There are a total of six critical loads in the Mapper Tool: forest and aquatic acidification from nitrogen and sulfur and empirical critical loads of nitrogen for forest ecosystems, herbaceous plants and shrubs, mycorrhizal fungi, and herbaceous species richness. Critical loads vary for each ecosystem and are different for each Class I area. Table 4.5-1 presents a single critical load for each Class I area, chosen to be the lowest value among all ecosystems. In general, the lowest critical load corresponds to the “herbaceous plants and shrubs” ecosystem, but exceptions are indicated in the table’s notes.

[24] USEPA, 2021. Critical Load Mapper Tool. US Environmental Protection Agency, USDA Forest Service, and National Park Service, Washington, DC. CL Mapper ver. 2.2. https://clmapper.epa.gov/. Downloaded 9/2021

[25] https://nadp.slh.wisc.edu/clad-national-critical-load-database/

For total sulfur deposition, the 5 kg/ha-yr threshold published by Fox et al. (Fox 1989) is used as critical load for each area of interest.

Table 4.5-1. Nitrogen deposition critical loads (CL) at areas of interest. All critical loads values are for the herbaceous plants and shrubs ecosystem except those noted in the footnotes.

State	Analysis Area	Lowest Critical Load for the Analysis Area (kg N/ha-yr)
AZ	Chiricahua National Monument	n/a
	Chiricahua Wilderness	n/a
	Grand Canyon National Park	3
	Mount Baldy Wilderness[1]	7.54
	Petrified Forest National Park	3
CO	Black Canyon of the Gunnison	3
	Eagles Nest Wilderness	4
	Flat Tops Wilderness	4
	Great Sand Dunes National Park	3.18
	La Garita Wilderness	4
	Maroon Bells-Snowmass Wilderness	4
	Mesa Verde National Park	3
	Mount Zirkel Wilderness	4
	Rawah Wilderness	3.97
	Rocky Mountain NP	4
	Weminuche Wilderness	4
	West Elk Wilderness	4
ID	Sawtooth Wilderness	4
	Selway-Bitterroot Wilderness	4
MT	Anaconda Pintler Wilderness	4
	Bob Marshall Wilderness	4
	Cabinet Mountains Wilderness	4
	Flathead Indian Reservation	4
	Fort Peck Indian Reservation	5
	Gates of the Mountains Wilderness[2]	4
	Glacier National Park	4
	Medicine Lake National Wildlife Refuge	5
	Mission Mountains Wilderness	4
	Northern Cheyenne Indian Reservation	5
	Red Rock Lakes National Wildlife Refuge	4
	Scapegoat Wilderness	4
	UL Bend National Wildlife Refuge	5
ND	Fort Berthold Reservation	5
	Fort Peck Reservation	5
	Lostwood Wilderness	5

State	Analysis Area	Lowest Critical Load for the Analysis Area (kg N/ha-yr)
	Medicine Lake Wilderness	5
	Theodore Roosevelt National Park	5
NM	Bandelier National Monument	3.89
	Bosque Del Apache National Wildlife Refuge	3
	Carlsbad Caverns National Park	3
	Gila Wilderness[1]	7.54
	Pecos Wilderness	4
	Salt Creek Wilderness	3
	San Pedro Parks Wilderness	4
	White Mountain Wilderness[1]	7.54
	Wheeler Peak Wilderness	4
NV	Jarbidge Wilderness	3
SD	Badlands National Park	5
	Wind Cave National Park	4
TX	Guadalupe Mountains National Park	3
UT	Arches National Park	3
	Bryce Canyon National Park	3.45
	Canyonlands National Park	3
	Capitol Reef National Park	3.01
	Zion National Park	3.02
WY	Bridger Wilderness	3.99
	Fitzpatrick Wilderness	3.99
	Grand Teton National Park	4
	North Absaroka Wilderness	4
	Teton Wilderness	4
	Washakie Wilderness	3.99
	Yellowstone National Park	4

[1] Critical load applied to Herb Species Richness – open canopy (Ecoregion)
[2] Critical load applied to Empirical Forest (minimum)
Source: USEPA, 2021

5. MODELING RESULTS FOR COLORADO

This Chapter discloses the potential impacts to AQ and AQRVs estimated with the photochemical modeling system for each analysis area. All figures mentioned below are provided under separate cover as part of Appendix B.

5.1 Colorado

The CAMx source apportionment absolute modeling results for the future year (circa 2032) simulations for the state of Colorado (CO) are analyzed and compared to the relevant thresholds in this section.

5.1.1 Ambient Air Quality Estimates from Photochemical Modeling

5.1.1.1 Ozone NAAQS Analysis

The ozone NAAQS is defined as the three-year average of the 4th highest daily maximum 8-hour (DMAX8) ozone concentration. Since in this study, we use only one year of modeling results, the modeled 4th highest DMAX8 ozone concentration is used as a representative value for comparison with the NAAQS[26]. The contributions of each source group to ozone are examined for the 4th highest DMAX8 ozone concentration in the circa 2032 future year modeling.

<u>Cumulative Concentrations</u>

Figure 5.1-1 (also shown in Figure CO.O3.1 in Appendix B) below shows a spatial isopleth of the 4th highest DMAX8 ozone centered in Colorado for the future year (circa 2032) simulation. The modeled results show that cumulative concentrations over this region will not lead to any ozone NAAQS exceedances. The highest ozone concentration of 69.3 ppb occurs in the Jefferson County and Denver area. Figure 5.1-1 shows there is generally a west to east gradient with larger ozone concentrations usually in the western and central parts of Colorado. Figures CO.O3.2 to CO.O3.17 (Appendix B) show spatial maps of the contributions from each source group to the cumulative 4th highest DMAX8 ozone concentrations. The figures follow the order of the source groups presented in Table 5.1-1. In general, the largest contributions to ozone are due to the modeled “rest anthropogenic” group (i.e., sources other than oil, gas, or coal source groups) followed by the natural source group. Non-federal oil and gas source is the largest contributor to ozone in northwestern Colorado among the oil and gas groups. The largest coal related contributions are from the EGU combustion sector followed by the combined WRAP states coal sources. At the location of peak (68.8 ppb), the ozone impacts due to federal oil and gas and coal production are 0.5 ppb or less. The impacts from each source group are discussed below.

[26] Other pollutants are modeled for one year as well.

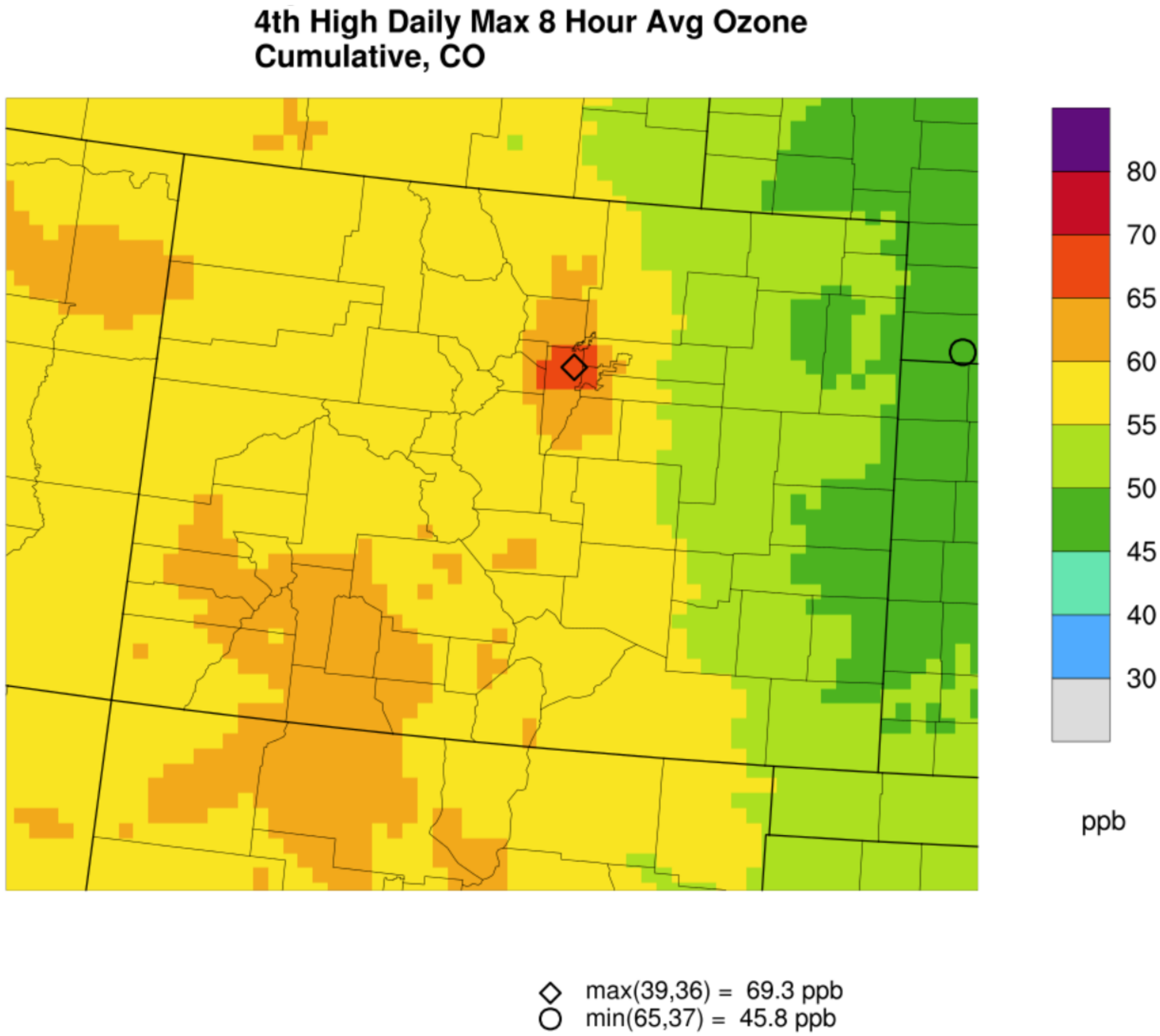


Figure 5.1-1. Modeled cumulative 4th highest daily maximum 8-hour ozone in Colorado

Natural and Wildfire Source Groups

Figure CO.O3.2 presents the contributions from natural sources within Colorado which range between 0.3 and 7.8 ppb.

Oil and Gas Source Groups

Figures CO.O3.4 to CO.O3.7 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado. The figures show varying spatial patterns with higher contributions from new and existing sources in Western than sources in Royal Gorge Colorado. The contributions from federal sources in Royal Gorge Colorado confine on the eastern side of the state whereas impacts from sources in Western Colorado spread across entire the state. The maximum contribution from existing federal oil and gas sources in Western Colorado (3.1 ppb in La Plata County/New Mexico's border) is slightly larger than the maximum contribution from the new federal sources (0.8 ppb in Garfield County). Other than a few grid cells both source groups have contributions that are below 2 ppb with the typical range between 0.1 and 1 ppb. Federal oil and gas sources in other states (Figures CO.O3.8) show highest impacts on ozone in the northwest and southwest areas of Colorado adjacent to Utah and New Mexico, respectively.

Figures CO.O3.9, CO.O3.10 and CO.O3.11 show the contributions from non-federal oil and gas development, existing tribal and new tribal, respectively. The non-federal oil and gas show impacts throughout the state with contributions that range between 0.1 and 7.4 ppb, with the peaks modeled in Larimer and Weld counties. The new tribal contributions are lower than the existing tribal oil and gas sources. Both existing and new tribal contributions peak close to the border between Colorado (La Plata County) and New Mexico (Rio Arriba County) at 3.4ppb and 1.3ppb, respectively. Within Colorado, the new and existing tribal oil and gas sources show impacts ranging between 0.1 and 1 ppb.

Coal Source Groups

Figures CO.O3.12 to CO.O3.16 show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. The largest contribution is due to non-coal in WRAP states and non-WRAP EGU combustion, with impacts between 0.1 and 2.5 ppb (the maximum contribution grid cell is in Jefferson County). The contributions from both federal coal mining in Colorado and non-federal coal mining are small with impacts below 0.1 ppb.

Other Anthropogenic Sources

Figure CO.O3.17 shows the contributions from other anthropogenic activity both within and outside Colorado. Other anthropogenic sources have a large contribution to ozone in Colorado with impacts between 1.2 and 17.2 ppb. The largest impacts occur in Jefferson and its surrounding counties in Colorado with concentrations as large as 15 to 20 ppb.

Impacts at Class I and other areas in Colorado

Table 5.1-1 summarizes the maximum cumulative values at each of the areas of interest and the state of Colorado. The table also shows the contributions from each of the source emissions groups that correspond to these maximum cumulative values; therefore, the values within a single area represent the same location. In contrast, Table 5.1-2 shows the maximum possible concentrations from each source group across each area of interest, therefore these values need not be co-located.

The maximum cumulative value indicates there are no exceedances to the ozone NAAQS at any of the areas of interest. The contribution from the boundary conditions is very large and usually represents between 71% and 95% of the cumulative concentrations depending on the area of interest. The other anthropogenic sources represent between 3% to 11% of the peak ozone values. The other source groups generally represent individually less than 2% of the ozone peak values, except that oil and gas sources from other states contribute about 4% in San Pedro Parks Wilderness and Wheeler Peak Wilderness.

The two source groups most relevant to BLM authorizations (new federal oil and gas development and federal coal development) are shown in bold font in these and other tables.

Table 5.1-1. Modeled maximum 8-hour ozone cumulative concentrations and corresponding contributions by emissions group at areas of interest in 2032 (standard = 70 ppb).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	69.3	59.8	59.3	59.2	58.4	59.5	62.8	59.4	62.3	60.0	61.4	58.0	58.0	59.5	58.1	58.6	58.5
Natural	1.2	1.5	2.2	2.2	1.6	1.6	2.0	1.0	2.3	1.6	2.0	0.9	3.1	3.2	1.8	1.2	2.9
Wildfire	0.3	0.1	0.1	0.1	0.4	0.1	1.3	0.1	0.1	0.2	0.1	0.1	0.6	1.9	0.0	0.2	0.2
OilGas_ExistFed_WesternCO	0.1	0.2	0.0	0.1	0.0	0.1	0.3	0.4	0.3	0.5	0.0	0.0	0.2	0.0	0.0	0.2	0.5
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.1	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.3	0.0	0.0	0.1	0.2
OilGas_NewFed_RoyalGorge	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
OilGas_Fed_Other_States	0.5	0.7	0.1	0.3	0.3	0.5	2.2	2.4	0.2	0.6	0.1	0.0	0.9	0.5	0.1	0.2	1.3
OilGas_NonFed	1.1	0.4	0.1	0.3	0.1	0.3	0.6	0.8	0.6	0.7	0.1	0.0	0.7	3.6	0.0	0.3	0.9
OilGas_ExistTribal	0.0	0.3	0.0	0.1	0.1	0.1	0.7	0.8	0.2	0.5	0.0	0.0	0.2	0.1	0.0	0.2	0.6
OilGas_NewTribal	0.0	0.1	0.0	0.0	0.0	0.1	0.3	0.3	0.1	0.2	0.0	0.0	0.1	0.0	0.0	0.1	0.3
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.2	1.0	0.6	0.1	1.0	0.3	0.1	0.8	0.1	0.5	0.0	0.2	0.1	0.0	0.0	1.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0
Other_EGU	0.6	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1	0.1	0.1
Anthro_Rest	12.2	3.6	3.3	2.9	3.5	3.2	6.0	2.0	3.7	2.9	2.8	6.2	2.4	6.8	1.5	3.2	3.3
Boundary Conditions	52.8	52.3	52.3	52.2	52.0	52.3	48.7	51.4	53.7	52.5	55.6	50.5	48.9	42.3	54.4	52.9	47.1

Table 5.1-2. Modeled maximum 8-hour ozone concentrations across areas of interest for each emissions group in 2032 (standard = 70 ppb).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	69.3	59.8	59.3	59.2	58.4	59.5	62.8	59.4	62.3	60.0	61.4	58.0	58.0	59.5	58.1	58.6	58.5
Natural	6.7	2.8	2.4	2.5	2.1	2.1	2.9	2.8	2.9	2.7	2.1	3.3	3.1	3.5	3.9	3.3	2.9
Wildfire	14.7	0.3	0.1	0.1	0.4	0.4	1.4	0.5	10.7	0.4	0.1	4.0	0.6	3.0	4.6	4.9	0.2
OilGas_ExistFed_WesternCO	1.7	0.2	0.0	0.2	0.1	0.1	0.4	0.4	1.1	0.5	0.4	0.2	0.2	0.2	0.0	0.2	0.5
OilGas_ExistFed_RoyalGorge	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.8	0.1	0.0	0.4	0.2	0.2	0.1	0.1	0.3	0.1	0.1	0.2	0.3	0.1	0.0	0.1	0.2
OilGas_NewFed_RoyalGorge	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
OilGas_Fed_Other_States	3.7	0.7	0.1	0.3	0.3	1.3	2.8	2.4	1.4	0.6	1.0	1.2	1.0	0.5	0.5	0.4	1.3
OilGas_NonFed	7.4	0.4	0.1	0.5	0.5	0.5	1.0	0.8	2.0	0.8	0.8	0.5	0.7	3.6	0.5	0.5	0.9
OilGas_ExistTribal	2.4	0.4	0.0	0.1	0.1	0.4	1.0	0.8	1.1	0.5	0.5	0.3	0.3	0.2	0.1	0.2	0.6
OilGas_NewTribal	1.0	0.1	0.0	0.0	0.0	0.2	0.4	0.3	0.5	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.3
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	1.3	0.3	1.0	0.7	0.4	1.0	0.3	0.1	0.8	0.1	0.5	2.0	1.1	0.8	0.4	0.2	1.1
Coal_Comb WRAP states	0.8	0.1	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.2	0.0
Other_EGU	2.1	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.3	0.1	0.7	0.2	0.2	0.1
Anthro_Rest	16.7	3.7	4.2	3.1	3.5	4.2	6.1	3.9	5.2	2.9	3.9	6.2	2.8	7.3	3.9	3.9	3.3
Boundary Conditions	58.5	54.3	52.3	54.6	54.2	54.2	48.7	51.3	56.9	52.5	58.3	52.5	51.4	54.4	54.4	54.0	47.3

5.1.1.2 NO_2 NAAQS Analysis

There are two forms of the NO_2 NAAQS; the daily one is expressed as the 98th percentile of a 1-hour daily maximum concentrations averaged over 3 years. With a complete year of modeling results, the 98th percentile corresponds to the 8th highest 1-hour daily maximum. The other form of the NAAQS is expressed as an annual mean. In general, the analysis and spatial distributions of impacts observed for the annual form of the NO_2 NAAQS are like the 1-hour form described in this section. Additional figures for the annual average NO_2 are included in Appendix B.

<u>Cumulative Concentrations</u>

Figure 5.1-2 below shows a spatial isopleth of the 98th percentile daily maximum 1-hour NO_2 concentrations centered in Colorado for the future year (circa 2032) simulation. The figure indicates that cumulative concentrations over this region will not lead to any exceedances for the 1-hour NO_2 form of the NAAQS. It shows concentration peak at 60.0 ppb in La Plata/NM border with additional hotspots in Denver and Garfield/Mesa counties. Figures CO.NO2.1h.2 to CO.NO2.1h.17 show spatial maps of the contributions from each source group to the 98th percentile daily maximum 1-hour NO_2 concentrations. The figures follow the order of the source groups presented in Table 5.1-3. In general, the largest contributions to 1-hour NO_2 are the other anthropogenic source group followed by the non-federal oil and gas development sources. Both these sources have their peaks located in the same region as the cumulative 1-hour NO_2 peak. Impacts for each source group are discussed below.

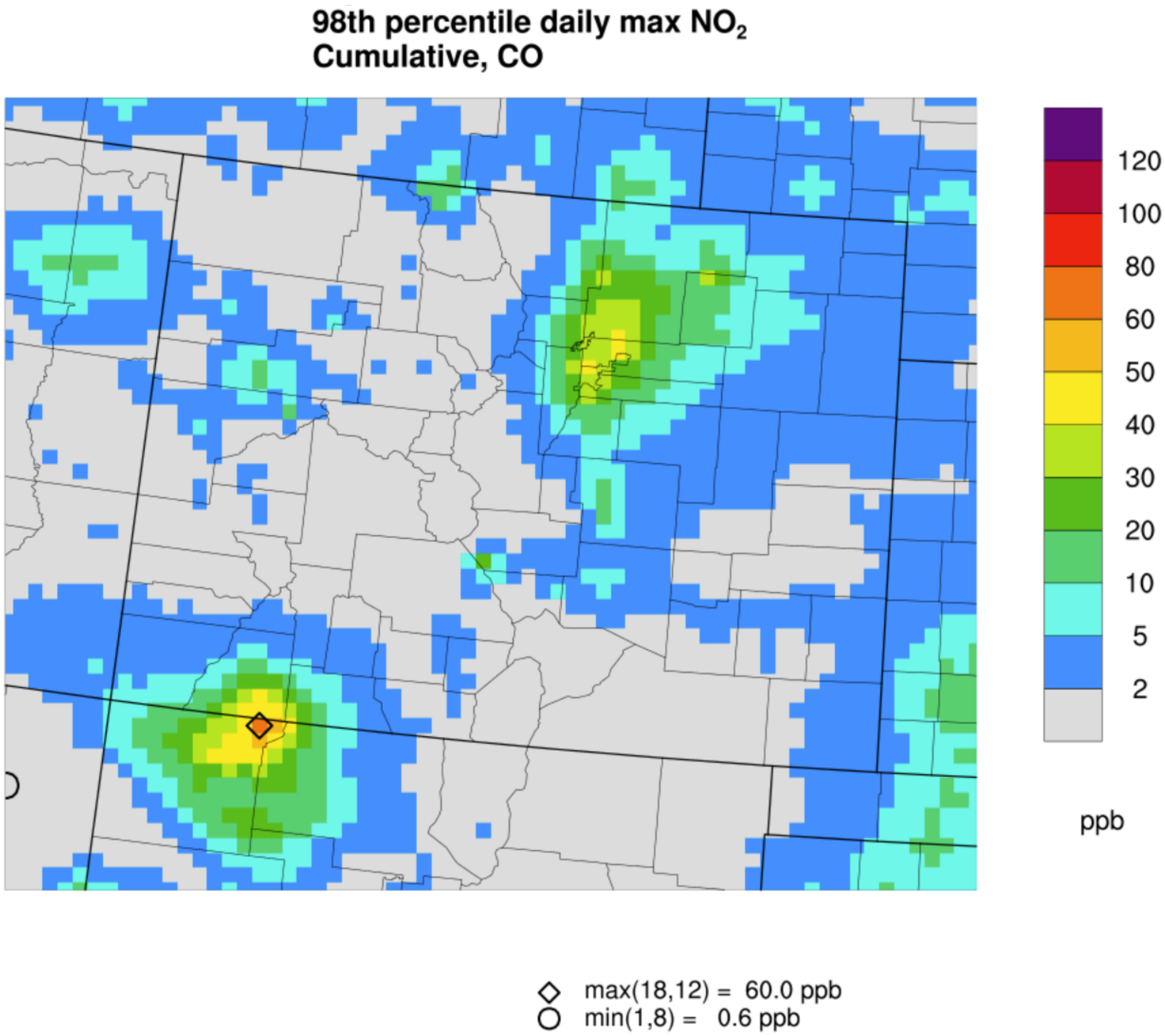


Figure 5.1-2. Modeled cumulative 8th highest daily maximum NO2 concentrations in Colorado

Natural and Wildfire Source Groups

Figure CO.NO2.1h.2 shows contributions from natural sources are between 0.1 and 4.6 ppb and relatively higher in the eastern part of the state.

Oil and Gas Source Groups

Figures CO.NO2.1h.4 to CO.NO2.1h.7 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado. The figures show peak concentrations in La Plata County (10.1 ppb) and Mesa (10.6 ppb) due to Western Colorado existing and new oil and gas sources, respectively. Oil and gas in Royal Gorge Colorado area show much smaller impacts that are peak in Weld County. Other than these peak grid cells, both new and existing federal oil and gas contributions show contributions between 0.1 and 4 ppb. Federal oil and gas sources in other states (Figures CO.NO2.1h.8) show highest impacts on NO_2 in the northwest and southwest areas of Colorado adjacent to Utah and New Mexico, respectively.

Figures CO.NO2.1h.9, CO.NO2.1h.10 and CO.NO2.1h.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. The existing and new tribal exhibit a similar spatial distribution. The new tribal oil and gas sources show impacts between 0.1 and 4.6 ppb while existing tribal oil and gas sources show impacts between 0.1 and 10.4 ppb. The non-federal oil and gas group shows the largest contribution of 34 ppb in the northern part of the state as shown in Figure 5.1-3.

Coal Source Groups

Figures CO.NO2.1h.12 to CO.NO2.1h.16 show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. The largest contribution is due to non-coal in WRAP states and non-WRAP EGU combustion, with impacts between 0.1 and 1.5 ppb (the maximum contribution grid cell is in Jefferson County). The contributions from other coal source groups are small with impacts below 0.1 ppb.

Other Anthropogenic Sources

Figure CO.NO2.1h.17 shows that the contributions of other anthropogenic emissions are between 0.1 and 42.8 ppb. The highest concentrations correspond with the location of urban areas and populated areas such as Denver, Aurora, Grand Junction and Colorado Springs.

Impacts at Class I and other areas in Colorado

Table 5.1-3 summarizes the maximum cumulative values at each of the areas of interest and the state of Colorado. The table also shows the contributions from each of the source emissions groups that correspond to these maximum cumulative values, therefore the values within a single area represent the same location. Table 5.1-4 shows the maximum possible concentrations from each source group across each area of interest, therefore all these values need not be at the same location.

The maximum cumulative value indicates there are no exceedances to the 1-hour NO_2 NAAQS at any of the areas of interest including the entire state of Colorado. The other anthropogenic source group represents 1% to 96% of peak NO_2 concentrations depending on the area of interest and is the largest contributor overall followed by natural source group (up to 80%) contributions. New and existing federal oil-gas in Colorado contributions range between 0% to 19%. Federal oil and gas in other states contribute up to 50% of the peak NO_2 values in San Pedro Parks Wilderness. Other oil and gas contributions range between 0 to 25%. The coal source contributions range from 1% up to 7%.

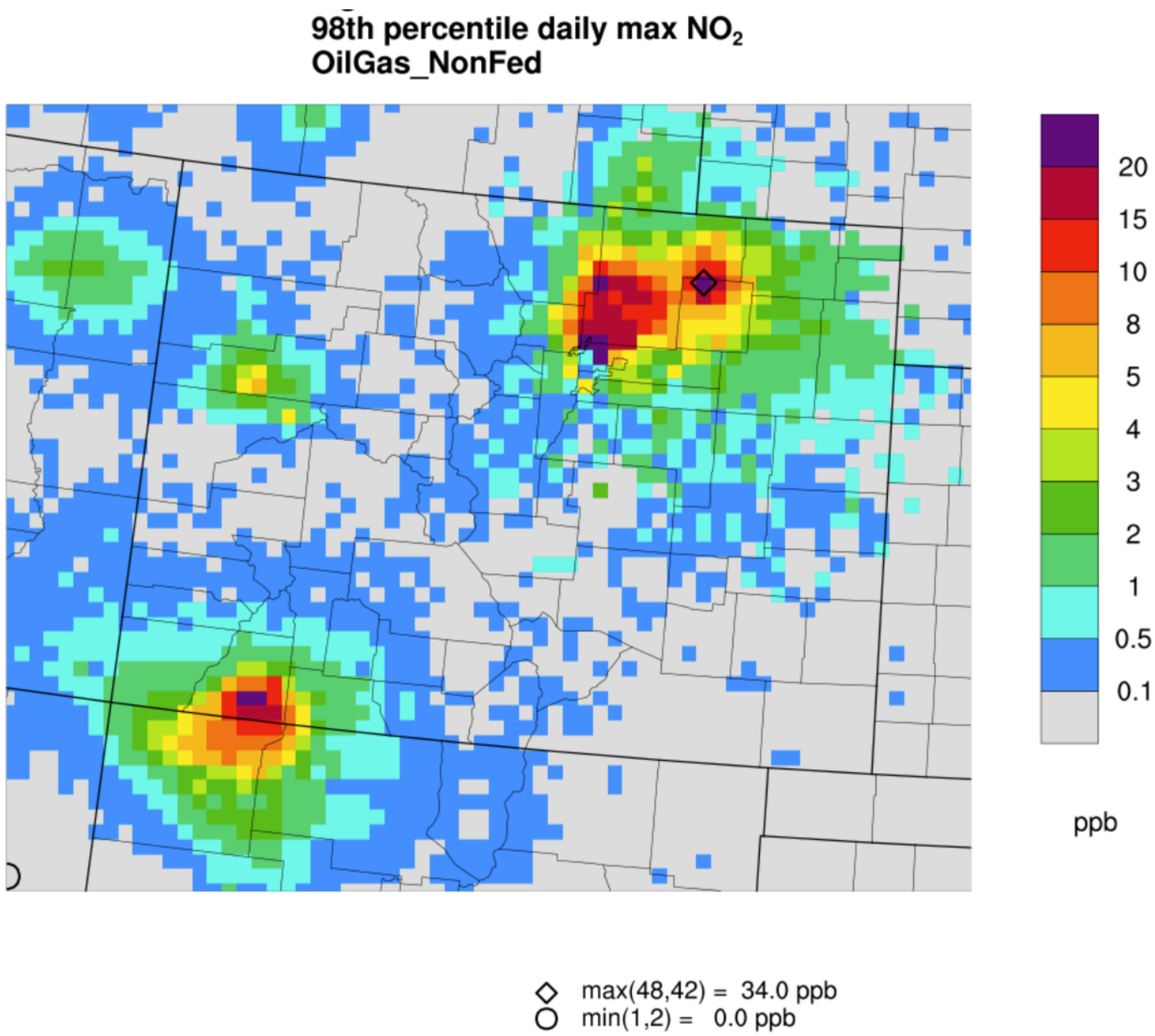


Figure 5.1-3. Modeled 8th highest daily maximum NO_2 contribution from non-federal oil and gas development in Colorado.

Table 5.1-3. Maximum 8th highest daily NO_2 cumulative concentrations and corresponding contributions by emissions group at areas of interest (standard = 100 ppb).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	48.3	0.8	1.0	1.9	2.3	7.8	3.2	1.0	7.9	1.0	1.9	1.7	2.6	2.9	12.6	1.5	5.9
Natural	0.2	0.1	0.3	0.5	0.0	0.3	0.1	0.1	0.2	0.8	0.1	0.1	0.5	0.2	0.3	0.5	0.8
Wildfire	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	0.9	0.0
OilGas_ExistFed_WesternCO	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.1	1.5	0.0	0.2	0.2	0.0	0.0	0.0	0.0	1.1
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3
OilGas_NewFed_RoyalGorge	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.2	0.0	0.0	0.0	0.0	1.6	0.4	1.5	0.0	0.5	0.4	0.2	0.0	0.0	0.0	1.2
OilGas_NonFed	6.1	0.1	0.0	0.0	0.0	0.0	0.4	0.2	2.5	0.0	0.4	0.3	0.0	0.3	0.0	0.0	1.5
OilGas_ExistTribal	0.0	0.1	0.0	0.0	0.0	0.0	0.6	0.2	1.5	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.8
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.5	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.3
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Anthro_Rest	41.4	0.2	0.7	1.4	2.3	0.0	0.2	0.1	0.3	0.1	0.2	0.2	1.9	2.2	0.1	0.1	0.2
Boundary Conditions	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Numbers may not add exactly due to rounding.

Table 5.1-4. Maximum 8th highest daily NO_2 cumulative concentrations across areas of interest for each emissions group (standard = 100 ppb)

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	48.3	0.8	1.0	1.9	2.3	7.8	3.2	1.0	7.9	1.0	1.9	1.7	2.6	2.9	12.6	1.5	5.9
Natural	3.1	0.6	0.8	0.7	0.2	0.4	0.2	0.1	0.3	0.8	0.3	1.0	0.7	0.2	0.4	0.5	0.8
Wildfire	24.3	0.0	0.0	0.1	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	0.9	0.0
OilGas_ExistFed_WesternCO	6.9	0.1	0.0	0.0	0.0	0.1	0.3	0.1	1.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0	1.1
OilGas_ExistFed_RoyalGorge	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	10.6	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.3
OilGas_NewFed_RoyalGorge	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
OilGas_Fed_Other_States	5.4	0.2	0.0	0.1	0.0	0.0	1.6	0.4	1.5	0.1	0.5	0.8	0.3	0.0	0.0	0.1	1.2
OilGas_NonFed	34.0	0.2	0.0	0.2	0.2	0.2	0.5	0.2	2.5	0.1	0.4	0.4	0.2	0.9	0.1	0.5	1.7
OilGas_ExistTribal	10.4	0.1	0.0	0.0	0.0	0.0	0.6	0.2	1.5	0.0	0.3	0.4	0.1	0.0	0.0	0.0	1.1
OilGas_NewTribal	4.6	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.5	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.4
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.5	0.2	0.0	0.0	0.4	0.0
Coal_Comb WRAP states	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	1.5	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.0	0.1	0.0
Anthro_Rest	42.8	0.4	0.7	1.4	2.3	0.7	0.2	0.1	2.6	0.6	0.6	0.6	1.9	2.2	0.2	0.8	0.6
Boundary Conditions	0.2	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0

5.1.1.3 $PM_{2.5}$ NAAQS Analysis

There are two $PM_{2.5}$ NAAQS, one for a 24-hour averaging time that is expressed as a three-year average of the 98th percentile value in a year with a standard of 35 μg/m^3 and an annual average over three-years with a standard of 12 μg/m^3. We note that EPA proposes to strengthen the standard to a value between 9-10 μg/m^3. With a complete year of modeling results, the 98th percentile corresponds to the 8th highest daily $PM_{2.5}$ concentration in a year.

<u>24-hour $PM_{2.5}$ NAAQS Analysis</u>

<u>Cumulative Concentrations</u>

Figure 5.1-4. Modeled cumulative 8th highest daily $PM_{2.5}$ in Colorado and corresponding contribution from wildfire emissions.Figure 5.1-4 below shows a spatial isopleth of the 8th highest daily average $PM_{2.5}$ concentration centered in Colorado for the future year (circa 2032) simulation and the spatial-temporal corresponding contributions from wildfire emissions. The figures indicates that cumulative concentrations over this region do not lead to any $PM_{2.5}$ NAAQS exceedances in Colorado except for isolated hotspots in Jackson, Rio Blanco, Fremont, and Custer Counties caused by wildfire emissions. The largest cumulative daily average $PM_{2.5}$ concentration of 123.3 μg/m^3 occurs in an isolated grid cell in Fremont County from wildfires Excluding wildfires, the maximum cumulative daily average $PM_{2.5}$ concentration of 20 μg/m^3 occur in and around Denver County. Figures CO.PM25.dly.2 to CO.PM25.dly.17 show spatial maps of the contributions from each source group to the cumulative 8th highest daily average $PM_{2.5}$ concentrations. The figures follow the order of the source groups presented in Table 4.1.1. Besides wildfires, the largest contributors to $PM_{2.5}$ are the other anthropogenic sectors that are not oil and gas and coal combustions. Impacts for each source group are discussed below.

<u>Natural and Wildfire Source Groups</u>

Figure CO.PM25.dly.2 shows the contributions from natural sources are very small with maximum contributions up to 0.1 mg/m3. Figure 5.1-4 (also shown in Figure CO.PM25.dly.3) shows contributions from wildfires, the highest contributors to PM2.5 concentrations leading to several isolated PM2.5 NAAQS exceedances in Colorado. The highest impacts of wildfires are seen in Jackson, Rio Blanco, Fremont, and Custer Counties.

<u>Oil and Gas Source Groups</u>

Figures CO.PM25.dly.4 to CO.PM25.dly.7 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado. All groups have contributions that are at most 0.3 μg/m^3. CO.PM25.dly.8 show maximum contributions up to 1 μg/m^3 from federal oil and gas development in other states.

Figures CO.PM25.dly.9, CO.PM25.dly.10 and CO.PM25.dly.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. The largest contributor to $PM_{2.5}$ is the non-federal oil and gas group with concentrations between 0.1 and 2.9 μg/m^3 with peak concentrations in Weld County. The new and existing tribal oil and gas sources show concentrations between less than 0.1 μg/m^3.

<u>Coal Source Groups</u>

Figures CO.PM25.dly.12 to CO.PM25.dly.16 show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. The largest contribution is due to non-coal in WRAP states and non-WRAP EGU combustion, with impacts between 0.1 and 2.0 $\mu g/m^3$. The contributions from other coal source groups are small with impacts below 0.8 $\mu g/m^3$.

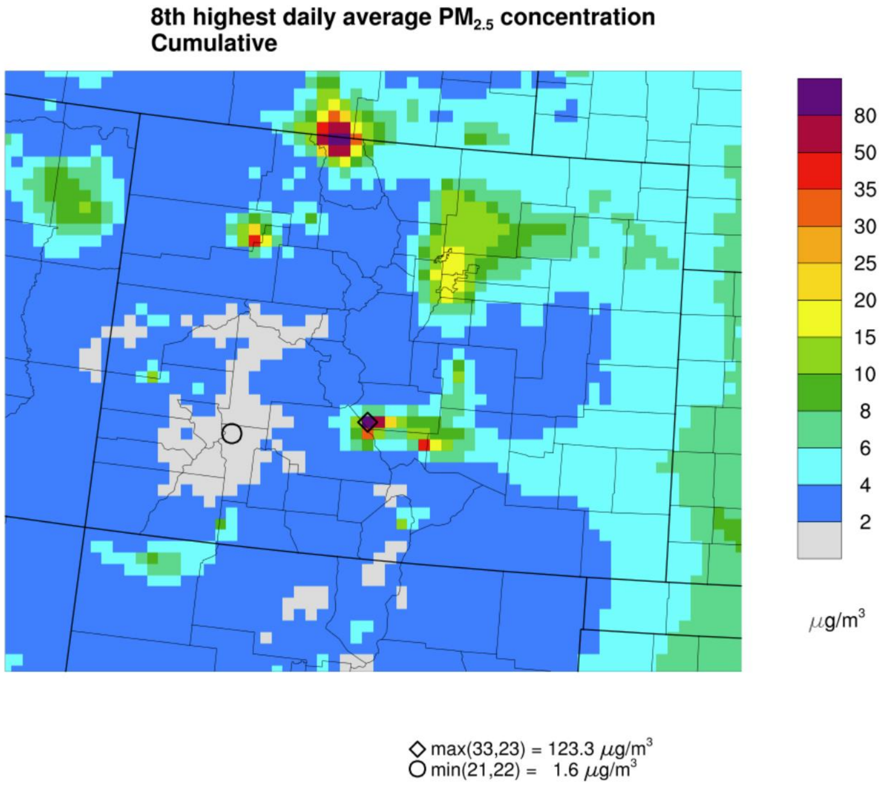
Other Anthropogenic Sources

Figure CO.PM25.dly.17 shows concentrations from other anthropogenic sources ranging between 0.1 and 17.1 $\mu g/m^3$ in Colorado. The largest impacts are in the Denver region.

Impacts at Class I and other areas in Colorado

As in the case of the other pollutants discussed above, Table 5.1-5 summarizes the maximum cumulative values at each of the areas of interest and the state of Colorado as well as contributions from each of the source emissions groups that correspond to these maximum cumulative values. Table 5.1-6 shows the maximum possible concentrations from each source group across each area of interest.

The maximum cumulative value indicates that when wildfire contributions are excluded, there are no exceedances to the 24-hour primary or secondary $PM_{2.5}$ NAAQS at any of the areas of interest including the entire state of Colorado. The other anthropogenic sources represent 11% to 48% of the peak $PM_{2.5}$ values across Colorado, the largest contribution from all source groups. Federal oil and gas in other states' contributions are up 11% of cumulative $PM_{2.5}$ peak in Canyonlands National Park. The rest of oil and gas sectors' contributions are less than 5% of cumulative $PM_{2.5}$ peaks. The contributions from all coal sectors are less than 8% of peak cumulative values.



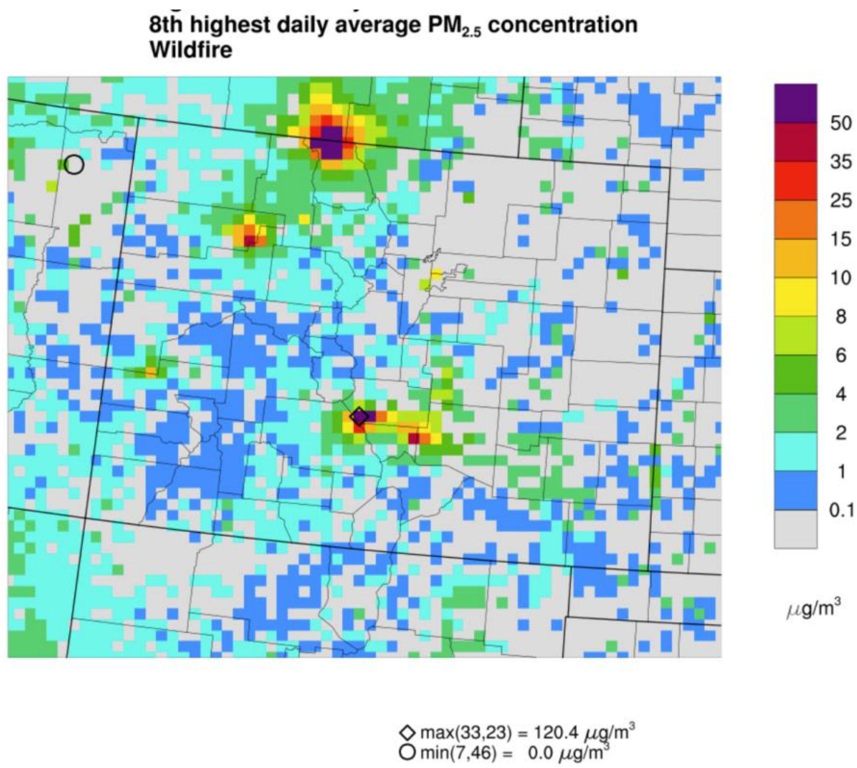


Figure 5.1-4. Modeled cumulative 8th highest daily $PM_{2.5}$ in Colorado and corresponding contribution from wildfire emissions.

Table 5.1-5. Maximum 8th highest daily $PM_{2.5}$ cumulative concentrations and corresponding contributions by emissions group at areas of interest (standard = 35 $\mu g/m^3$).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	123.3	2.4	2.2	2.4	2.6	48.9	2.2	2.1	3.0	2.2	2.3	2.6	3.0	3.8	61.7	7.2	3.0
Natural	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	120.4	1.2	0.0	0.0	1.2	47.4	1.0	0.0	1.3	1.3	1.4	1.7	0.9	1.3	59.8	6.1	1.4
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.2	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	0.4	0.3	2.0	1.1	0.6	0.5	0.4	1.0	0.4	0.3	0.1	0.3	1.0	0.9	0.3	0.2	0.6
Boundary Conditions	2.4	0.8	0.2	0.9	0.8	1.0	0.7	0.7	1.1	0.5	0.7	0.5	1.0	1.5	1.6	0.9	0.9

Numbers may not add exactly due to rounding.

Table 5.1-6. Maximum 8th highest daily $PM_{2.5}$ concentrations across areas of interest for each emissions group (standard = 35 $\mu g/m^3$).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	123.3	2.4	2.2	2.4	2.6	48.9	2.2	2.1	3.0	2.2	2.3	2.6	3.0	3.8	61.7	7.2	3.0
Natural	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Wildfire	120.4	1.2	1.0	0.9	1.6	47.4	1.0	0.0	1.6	1.6	1.4	1.7	1.1	2.7	59.8	6.1	1.4
OilGas_ExistFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.3	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1
OilGas_NonFed	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.0
OilGas_ExistTribal	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.8	0.1	0.0	0.2	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.2	0.1	0.3	0.0	0.0	0.2
Coal_Comb WRAP states	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Other_EGU	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.2	0.1	0.0	0.0
Anthro_Rest	17.1	1.0	2.0	1.3	0.6	0.5	1.4	1.1	2.6	1.2	2.1	1.7	1.0	2.3	0.4	0.5	1.0
Boundary Conditions	1.2	0.1	0.1	0.1	0.0	0.2	0.2	0.2	0.2	0.3	0.1	0.3	0.3	0.2	0.1	0.0	0.1

Annual $PM_{2.5}$ NAAQS Analysis

Cumulative Concentrations

Figure CO.PM25.ann.1 shows a spatial isopleth of the annual average $PM_{2.5}$ concentration centered in Colorado for the future year (circa 2032) simulation. The figure indicates that cumulative concentrations over this region does not lead to any $PM_{2.5}$ NAAQS exceedances in Colorado except at a grid cell in Denver which shows concentrations less than 10 $\mu g/m^3$. Regions around Denver shows concentrations between 4 to 10 $\mu g/m^3$. Figures CO.PM25.ann.2 to CO.PM25.ann.17 show isopleths with the contributions from each source group to the cumulative annual average $PM_{2.5}$ concentrations. Besides wildfires, the largest contributors to $PM_{2.5}$ are the other anthropogenic. The largest oil and gas contributions are from the non-federal and other states' federal sources. The contributions from the coal sector are very small. Impacts for each source group are discussed below.

Natural and Wildfire Source Groups

Figure CO.PM25.ann.2 shows the contributions from natural sources to be negligible (e.g., less than 0.1 $\mu g/m^3$).

Oil and Gas Source Groups

Figures CO.PM25.ann.4 to CO.PM25.ann.7 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado. All groups have contributions that are at most 0.1 $\mu g/m^3$. CO.PM25.ann.8 show negligible contributions from federal oil and gas development in other states.

Figures CO.PM25.ann.9, CO.PM25.ann.10 and CO.PM25.ann.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. The largest contributor to $PM_{2.5}$ is the non-federal oil and gas group with concentrations between 0.1 and 0.7 $\mu g/m^3$ with peak concentrations in Weld County. The new and existing tribal oil and gas sources show concentrations between less than 0.1 $\mu g/m^3$.

Coal Source Groups

Figures CO.PM25.ann.12 to CO.PM25.ann.16 show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. The largest contribution is due to non-coal in WRAP states and non-WRAP EGU combustion, with impacts between 0.1 and 0.4 $\mu g/m^3$. The contributions from other coal source groups are small with impacts below 0.1 $\mu g/m^3$.

Other Anthropogenic Sources

Figure CO. PM25.ann.17 shows concentrations from other anthropogenic sources ranging between 0.1 and 8.0 $\mu g/m^3$ in Colorado. The largest impacts are in the Denver region.

Impacts at Class I and other areas in Colorado

Table 5.1-7 and Table 5.1-8 summarize the maximum concentrations for annual $PM_{2.5}$ similar to the other pollutants described above.

The maximum cumulative value indicates there are no exceedances to the annual primary or secondary $PM_{2.5}$ NAAQS at any of the areas of interest. The peak $PM_{2.5}$ cumulative concentration of 10.1 $\mu g/m^3$ corresponds to location of a large contribution (89%) from wildfire emissions. The other anthropogenic sources represent 3% to 57% of the peak $PM_{2.5}$ values across Colorado, the largest contribution from all source groups followed by boundary contributions. The contributions from all oil and gas and coal sectors are negligible (less than 0.1%) of peak $PM_{2.5}$ cumulative values.

Table 5.1-7. Maximum annual $PM_{2.5}$ cumulative concentrations and corresponding contributions by emissions group at areas of interest (standard = 12 $\mu g/m^3$).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	10.1	0.8	0.9	1.0	1.1	5.3	0.9	0.9	1.0	0.8	0.8	1.0	1.4	1.4	5.9	1.3	1.3
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	9.0	0.1	0.1	0.1	0.1	4.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	5.0	0.4	0.1
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	0.3	0.3	0.4	0.5	0.5	0.2	0.3	0.4	0.4	0.3	0.4	0.4	0.8	0.5	0.3	0.4	0.7
Boundary Conditions	0.6	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.4

Numbers may not add exactly due to rounding.

Table 5.1-8. Maximum annual $PM_{2.5}$ concentrations across areas of interest for each emissions group (standard = 12 $\mu g/m^3$).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	10.1	0.8	0.9	1.0	1.1	5.3	0.9	0.9	1.0	0.8	0.8	1.0	1.4	1.4	5.9	1.3	1.3
Natural	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	9.0	0.1	0.1	0.1	0.1	4.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	5.0	0.4	0.1
OilGas_ExistFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	8.0	0.3	0.4	0.5	0.5	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.8	0.5	0.4	0.4	0.7
Boundary Conditions	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

5.1.1.4 PM_{10} NAAQS Analysis

The primary form of the PM_{10} NAAQS is expressed as a 24-hour average value not to be exceeded more than once per year on average over 3 years. With a complete year of modeling results, this corresponds to the second highest daily PM_{10} concentration in a year reported below. Annual average PM_{10} NAAQS results are provided in Figures CO.PM10.ann.1 to CO.PM10.ann.17 but are not discussed in this section.

Cumulative Concentrations

Figure 5.1-5 and Figure 5.1-6 show spatial isopleth of the 2^{nd} highest daily average PM_{10} concentration centered in Colorado for the future year (circa 2032) simulation and the spatial-temporal corresponding contributions from wildfire emissions respectively. The figures indicates that cumulative concentrations over this region do not lead to any PM_{10} NAAQS exceedances in Colorado except for isolated hotspots in Jackson, Rio Blanco, Fremont, and Custer Counties caused by wildfire emissions. The largest cumulative daily average PM_{10} concentration of 390.2 0 $\mu g/m^3$ occurs in an isolated grid cell in Fremont County due to wildfires. Excluding wildfires, the maximum cumulative daily average PM_{10} concentration of 50 $\mu g/m^3$ occur in and around Denver County. Figures CO.PM10.dly.2 to CO.PM10.dly.17 show spatial maps of the contributions from each source group from each source group to the cumulative PM_{10} concentrations. Besides wildfires, the largest contributors to $PM_{2.5}$ are the other anthropogenic sectors that are not oil and gas and coal combustions. Impacts for each source group are discussed below.

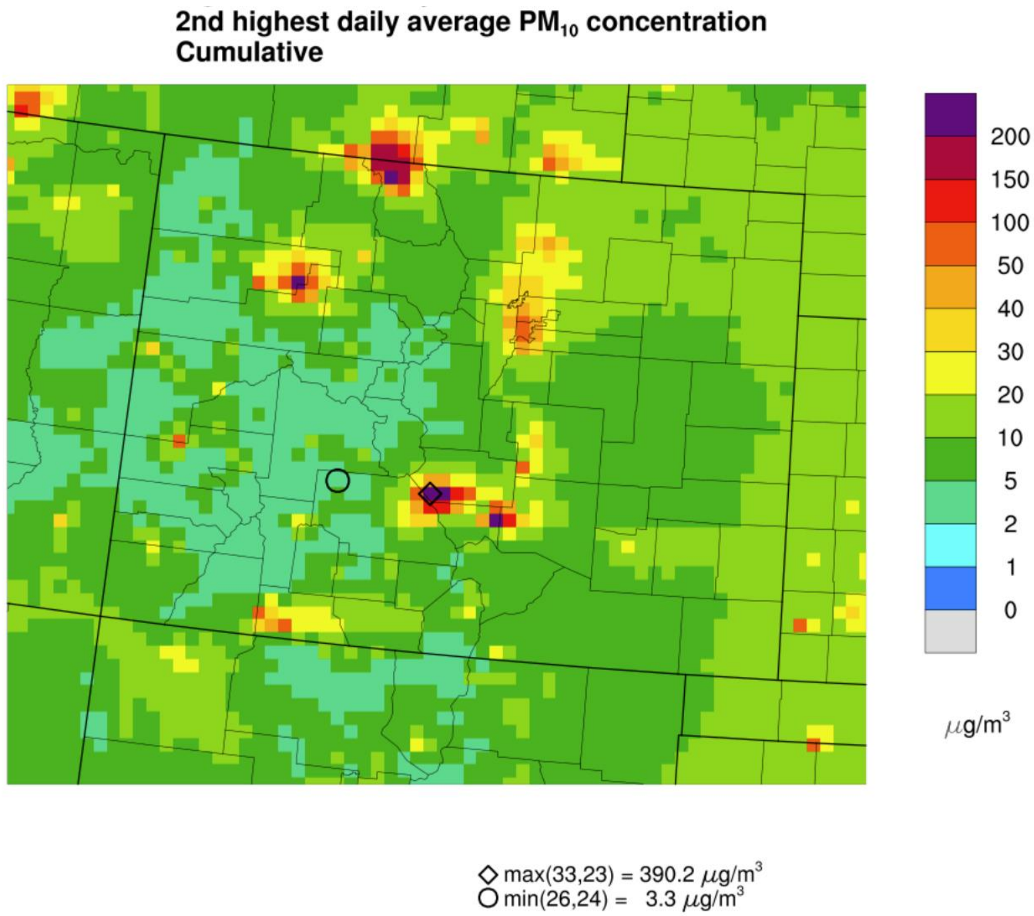


Figure 5.1-5. Modeled cumulative 2nd highest daily PM_{10} concentrations in Colorado

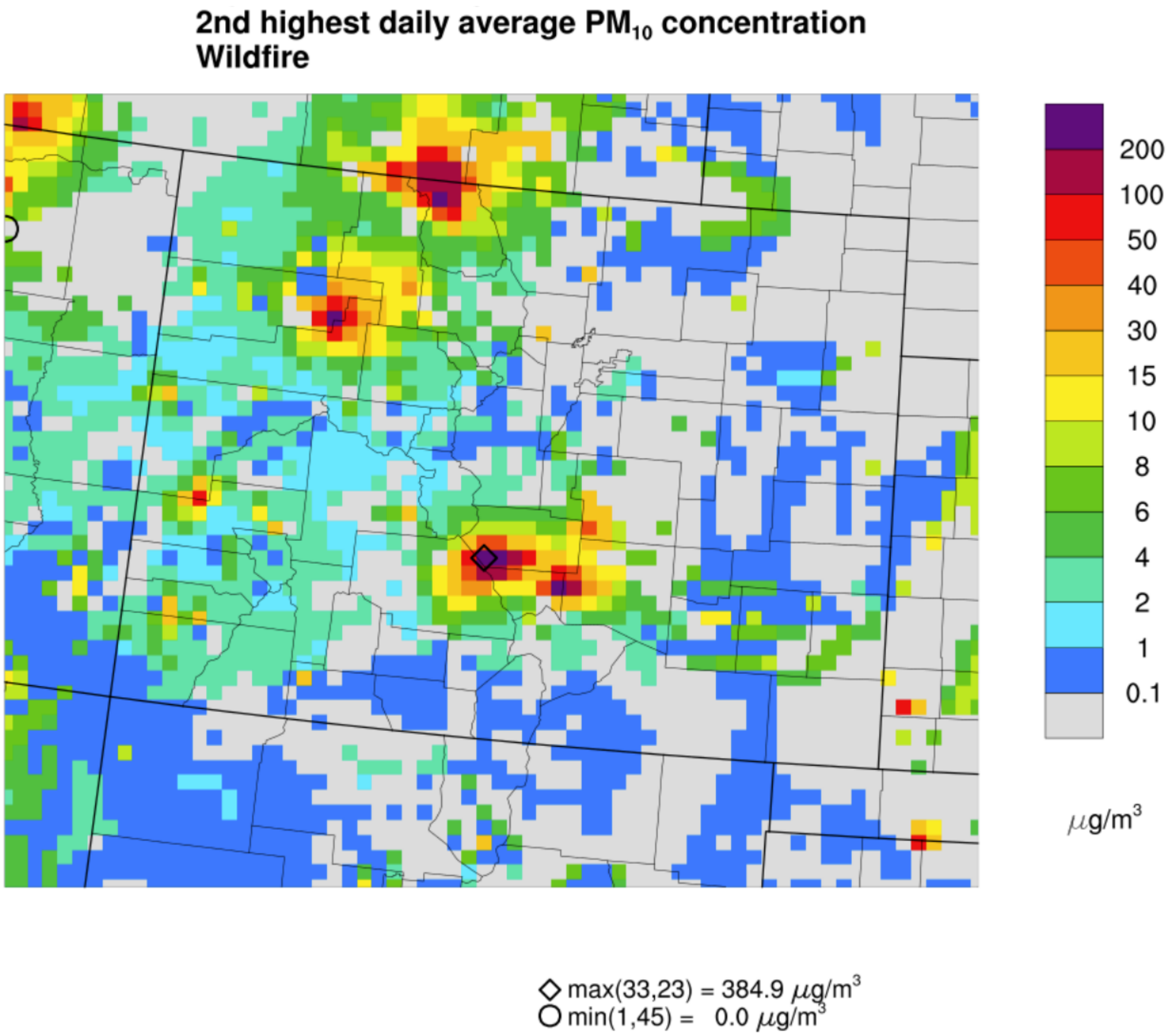


Figure 5.1-6. Modeled 2nd highest daily average PM_{10} contribution from natural sources in Colorado.

Natural and Wildfire Source Groups

Figure CO.PM10.dly.2 shows concentrations from the modeled natural source within Colorado range between 0.1 to 0.9 $\mu g/m^3$ that are higher on the eastern side of the state. Figure 5.1-6 (also shown in Figure CO.PM10.dly.3) shows concentrations from wildfires with the maximum of 384.9 $\mu g/m^3$ with hotspots coincide with PM_{10} exceedance locations. Thus, the modeled PM_{10} exceedances in Colorado are due to the wildfire group.

Oil and Gas Source Groups

Figures CO.PM10.dly.4 to CO.PM10.dly.7 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado. All groups have contributions that are at most 0.3 $\mu g/m^3$. CO.PM25.dly.8 show maximum contributions up to 1 $\mu g/m^3$ from federal oil and gas development in other states.

Figures CO.PM10.dly.9, CO.PM10.dly.10 and CO.PM10.dly.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. The largest contributor to $PM_{2.5}$ is the non-federal oil and gas group with concentrations between 0.1 and 4.8 $\mu g/m^3$ with peak concentrations in Weld County as shown in Figure 5.1-7. The new and existing tribal oil and gas sources show concentrations between less than 0.1 $\mu g/m^3$.

Coal Source Groups

Figures CO.PM10.dly.12 to CO.PM10.dly.16 show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. The largest contribution is due to non-coal in WRAP states and non-WRAP EGU combustion, with impacts between 0.1 and 2.4 $\mu g/m^3$. The contributions from other coal source groups are small with impacts below 0.6 $\mu g/m^3$.

Other Anthropogenic Sources

Figure CO.PM10.dly.17 shows concentrations from other anthropogenic sources ranging between 0.2 and 97.5 $\mu g/m^3$ in Colorado. The largest impacts are in the Rio Blanco County.

Impacts at Class I and other areas in Colorado

Table 5.1-9 and Table 5.1-10 summarize the spatial maximum daily PM10 concentrations (in the form of the NAAQS) in Colorado similar to the other pollutants described above.

The maximum cumulative value indicates that when wildfire contributions are excluded, there are no exceedances to the 24-hour primary or secondary PM_{10} NAAQS at any of the areas of interest including the entire state of Colorado. The other anthropogenic sources represent 5% to 96% of the peak $PM_{2.5}$ values across Colorado, the largest contribution from all source groups. All oil and gas and coal sectors' contributions are less than 4% of cumulative $PM_{2.5}$ peaks.

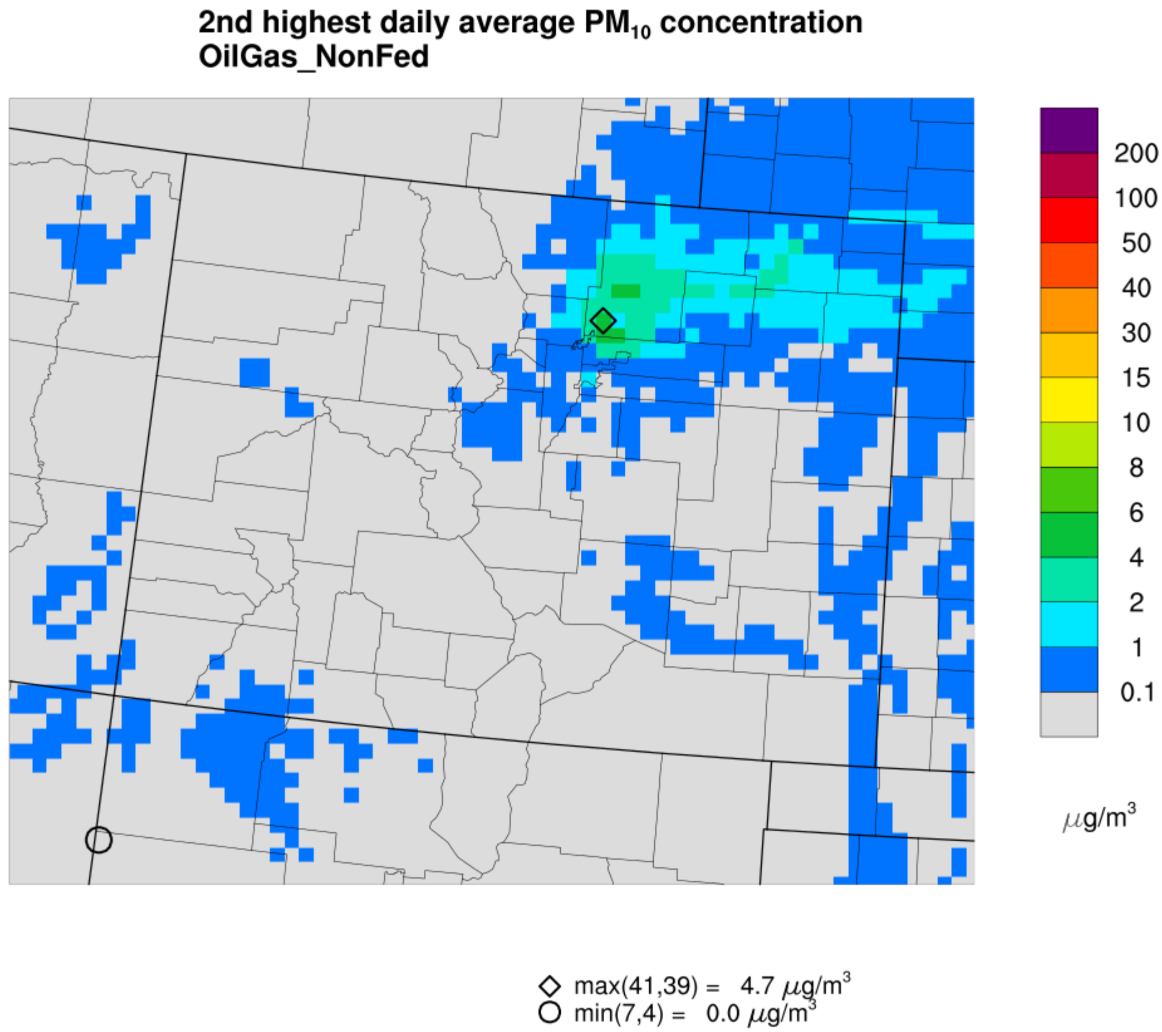


Figure 5.1-7. Modeled 2[nd] highest daily average PM_{10} contribution from non-federal oil and gas source in Colorado.

Table 5.1-9. Maximum 2nd highest daily PM_{10} cumulative concentrations and corresponding contributions by emissions group at areas of interest (standard = 150 $\mu g/m^3$).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	390.2	11.7	4.4	9.0	7.6	262.9	7.0	8.6	7.3	5.0	20.4	7.4	10.6	8.4	241.0	12.8	7.9
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Wildfire	384.9	0.0	2.0	0.0	5.9	259.2	0.6	0.0	0.0	3.5	0.0	6.3	0.0	0.0	236.4	9.6	5.3
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Anthro_Rest	1.1	11.2	1.4	8.4	0.9	1.0	4.4	8.0	6.1	0.5	20.1	0.6	10.1	6.7	1.2	1.8	1.6
Boundary Conditions	4.1	0.4	1.0	0.5	0.8	2.7	1.3	0.5	1.1	1.0	0.3	0.4	0.4	1.0	3.2	1.3	0.8

Numbers may not add exactly due to rounding

Table 5.1-10. Maximum 2nd highest daily PM_{10} concentrations across areas of interest for each emissions group (standard = 150 $\mu g/m^3$).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	390.2	11.7	4.4	9.0	7.6	262.9	7.0	8.6	7.3	5.0	20.4	7.4	10.6	8.4	241.0	12.8	7.9
Natural	0.9	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0
Wildfire	384.9	2.1	2.4	6.7	5.9	259.2	0.6	0.0	2.6	3.5	2.2	6.3	2.4	4.6	236.4	9.6	5.3
OilGas_ExistFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.4	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
OilGas_NonFed	4.8	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.0
OilGas_ExistTribal	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.6	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0
Coal_Comb WRAP states	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	1.5	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.0	0.1	0.0
Anthro_Rest	97.5	11.2	1.4	8.4	6.0	1.1	5.6	8.0	6.1	0.6	20.1	3.5	10.1	6.7	12.8	1.8	1.6
Boundary Conditions	0.9	0.5	0.1	0.1	0.1	0.2	0.6	0.1	0.2	0.1	0.2	0.4	0.1	0.2	0.1	0.0	0.1

5.1.1.5 SO_2 NAAQS Analysis

The primary SO_2 NAAQS is expressed as the 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years. With one year of modeling that is presented here as the 4th highest 1-hour daily maximum concentrations. The secondary SO_2 NAAQS is expressed as 3-hour averages not to be exceeded more than once per year. With one year of modeling that is presented here as the 2nd highest 3-hour average modeled concentration. Both primary and secondary NAAQS are described here.

1-hour SO_2 NAAQS Analysis

Cumulative Concentrations

Figure CO.SO2.1hr.1 shows a spatial isopleth of the 4th highest 1-hour daily maximum SO_2 concentrations centered in Colorado for the future year (circa 2032) simulation. The figure indicates that cumulative concentrations over this region will not lead to any SO_2 NAAQS exceedances. Figure CO.SO2.1hr.1 shows concentrations over the state are at most 5 ppb, except in few locations where wildfire contributions shown by source apportionment (discussed below) are high (Figure CO.SO2.1hr.3). Figures CO.SO2.1hr.2 to CO.SO2.1hr.17 show spatial maps of the contributions from each source group to the 1-hour daily maximum SO_2 concentrations. Besides wildfires, the larger contributions are from non-coal in WRAP states and non-WRAP EGU combustion followed by other anthropogenic sources, whereas contributions from the rest of source groups are small. Impacts for each source group are discussed below.

Natural and Wildfire Source Groups

Figure CO.SO2.1hr.2 and CO.SO2.1hr.3 present the contributions from natural sources and wildfires respectively. Concentrations from natural sources are negligible (~ zero ppb) whereas wildfires contributed to more than 95% of SO_2 cumulative hotspots.

Oil and Gas Source Groups

Figures CO.SO2.1hr.4 and CO.SO2.1hr.8 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado as well as federal oil and gas sources in other states. All figures show that concentrations from these sources are very low and generally less than 0.1 ppb.

Figures CO.SO2.1hr.9, CO.SO2.1hr.10 and CO.SO2.1hr.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. Like the other oil and gas source groups described above, their contributions are very low and generally less than 0.1 ppb.

Coal Source Groups

Figures CO.SO2.1hr.12 to CO.SO2.1hr.16 show the contributions show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. The largest contribution is due to non-coal in WRAP states and non-WRAP EGU combustion, with impacts between 0.1 and 7.9 ppb SO_2. Other coal sources yield very small contributions that are less than 1 ppb.

Other Anthropogenic Sources

Figure CO.SO2.1hr.17 shows that the contributions other anthropogenic emissions are between 0.1 and 6.4 ppb. The highest concentrations correspond with the location of urban areas such as Denver and its surrounding counties.

Impacts at Class I and other areas in Colorado

Table 5.1-11 and Table 5.1-12 summarize the spatial maximum 1-hour SO_2 concentrations (in the form of the NAAQS) in Colorado similar to the other pollutants described above.

The maximum cumulative value indicates there are no exceedances to the 1-hour primary SO_2 NAAQS at any of the areas of interest in the state of Colorado. All areas of interest within Colorado experienced very small impacts from all anthropogenic source groups with cumulative SO_2 concentrations less than 1 ppb.

Table 5.1-11. Maximum 1-hour SO_2 cumulative concentrations and corresponding contributions by emissions group at areas of interest (standard = 75 ppb).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	25.7	0.3	0.2	0.4	0.4	13.8	0.4	0.3	0.5	0.5	0.8	0.5	0.3	0.5	12.6	1.1	0.4
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	25.7	0.2	0.0	0.3	0.0	13.7	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.4	12.6	1.0	0.0
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.4
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.5	0.0	0.8	0.5	0.0	0.0	0.0	0.0	0.0
Boundary Conditions	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Numbers may not add exactly due to rounding

Table 5.1-12. Maximum 1-hour SO_2 cumulative concentrations across areas of interest for each emissions group (standard = 75 ppb).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	25.7	0.3	0.2	0.4	0.4	13.8	0.4	0.3	0.5	0.5	0.8	0.5	0.3	0.5	12.6	1.1	0.4
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	25.7	0.2	0.0	0.3	0.0	13.7	0.0	0.0	0.2	0.4	0.3	0.3	0.0	0.4	12.6	1.0	0.0
OilGas_ExistFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.7	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.4
Coal_Comb WRAP states	0.7	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0
Other_EGU	2.4	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Anthro_Rest	6.4	0.1	0.0	0.1	0.2	0.0	0.1	0.1	0.5	0.0	0.8	0.5	0.3	0.1	1.4	0.5	0.0
Boundary Conditions	0.5	0.2	0.0	0.2	0.2	0.0	0.2	0.2	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0

3-Hour SO2 NAAQS Analysis

Cumulative Concentrations

Figure CO.SO2.3hr.1 shows a spatial isopleth of the 2nd highest 3-hour average SO_2 concentrations centered in Colorado for the future year (circa 2032) simulation. The figure indicates that cumulative concentrations over this region will not lead to any SO_2 NAAQS exceedances. Figure CO.SO2.3hr.1 shows most of the state has concentrations below 5 ppb, except in few locations where wildfire contributions shown by source apportionment (discussed below) are high (Figure CO.SO2.3hr.3). Figures CO.SO2.3hr.2 to CO.SO2.3hr.17 show spatial maps of the contributions from each source group to the 1-hour daily maximum SO_2 concentrations. Besides wildfires, the larger contributions are from non-coal in WRAP states and non-WRAP EGU combustion followed by other anthropogenic sources, whereas contributions from the rest of source groups are small. Impacts for each source group are discussed below.

Natural and Wildfire Source Groups

Figure CO.SO2.3hr.2 and CO.SO2.3hr.3 present the contributions from natural sources and wildfires respectively. Concentrations from natural sources are negligible (~ zero ppb) whereas wildfires contributed to more than 95% of SO_2 cumulative hotspots.

Oil and Gas Source Groups

Figures CO.SO2.3hr.4 and CO.SO2.3hr.8 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado as well as federal oil and gas sources in other states. All figures show that concentrations from these sources are very low and generally less than 0.1 ppb.

Figures CO.SO2.3hr.9, CO.SO2.3hr.10 and CO.SO2.3hr.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. Like the other oil and gas source groups described above, their contributions are very low and generally less than 0.1 ppb.

Coal Source Groups

Figures CO.SO2.3hr.12 to CO.SO2.3hr.16 show the contributions show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. The largest contribution is due to non-coal in WRAP states and non-WRAP EGU combustion, with impacts between 0.1 and 7.3 ppb SO_2. Other coal sources yield very small contributions that are less than 1 ppb.

Other Anthropogenic Sources

Figure CO.SO2.3hr.17 shows that the contributions other anthropogenic emissions are between 0.1 and 14.7 ppb. The highest concentrations are in Archuleta County followed by areas near Denver.

Impacts at Class I and other areas in Colorado

Table 5.1-13 and Table 5.1-14 summarize the spatial maximum 3-hour SO_2 concentrations (in the form of the NAAQS) in Colorado similar to the other pollutants described above.

The maximum cumulative value indicates there are no exceedances to the 3-hour primary SO_2 NAAQS at any of the areas of interest in the state of Colorado. All areas of interest within Colorado experienced very small impacts from all source groups with cumulative SO_2 concentrations less than 2.2 ppb.

Table 5.1-13. Maximum 3-Hour SO_2 cumulative concentrations and corresponding contributions by emissions group at areas of interest (standard = 0.5 ppm). Values shown are in ppb.

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	37.9	1.6	0.3	1.4	0.9	29.8	0.4	0.6	2.0	0.4	2.2	0.5	0.3	0.8	18.0	1.0	0.5
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	37.7	0.0	0.0	0.0	0.0	29.8	0.0	0.0	0.0	0.4	0.0	0.5	0.0	0.7	18.0	1.0	0.4
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	0.0	1.5	0.2	1.4	0.9	0.0	0.1	0.5	2.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0
Boundary Conditions	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0

Numbers may not add exactly due to rounding.

Table 5.1-14. Maximum 3-Hour SO_2 cumulative concentrations across areas of interest for each emissions group (standard = 0.5 ppm). Values shown are in ppb.

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative	37.9	1.6	0.3	1.4	0.9	29.8	0.4	0.6	2.0	0.4	2.2	0.5	0.3	0.8	18.0	1.0	0.5
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	37.7	0.4	0.0	0.2	0.5	29.8	0.0	0.0	0.4	0.4	0.0	0.5	0.0	0.7	18.0	1.0	0.4
OilGas_ExistFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0
OilGas_ExistTribal	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.2	0.0	0.0	0.4
Coal_Comb WRAP states	0.6	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0
Other_EGU	2.5	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Anthro_Rest	14.7	1.5	0.2	1.4	0.9	0.1	0.4	0.5	2.0	0.0	2.2	0.4	0.0	0.4	0.0	0.9	0.0
Boundary Conditions	0.6	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0

5.1.1.6 CO NAAQS Analysis

The primary standard of the CO NAAQS is expressed in two forms: a daily maximum of the 1-hour and 8-hour average concentrations, both not to be exceeded more than once a year. Figure CO.CO.1hr.1 shows the cumulative concentrations in the form of the 1-hour standard while Figure CO.CO.8hr.1 presents the cumulative concentrations in the form of the 8-hour standard. Source apportionment for CO is not implemented in the model and therefore is not reported as part of this analysis. Figures CO.CO.1hr.1 and CO.CO.8hr.1 show that there are no exceedances to the CO NAAQS in Colorado except for few isolated locations coinciding with wildfire spots as identified in the source apportionment analysis for other pollutants (discussed above) where 8-hour average concentration exceeds 9 ppm.

Impacts at Class I and other areas in Colorado

Table 5.1-15 summarizes the maximum cumulative values at each of the areas of interest and the state of Colorado for both the 1-hour and the 8-hour forms of the NAAQS. The maximum cumulative value indicates there are no exceedances to the CO NAAQS at any area of interests across the entire state of Colorado.

Table 5.1-15. Maximum CO cumulative concentrations at areas of interest(ppm).

	Colorado	West Elk Wilderness	Black Canyon of the Gunnison Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Flat Tops Wilderness	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Great Sand Dunes Wilderness-National Parkss	La Garita Wilderness	Canyonlands National park	Arches National Park	Rocky Mountain National Park	Mount Zirkel Wilderness	Rawah Wilderness	Mesa Verde National Park
Cumulative 1-hour daily maximum (standard = 35 ppm)	17.3	0.6	0.2	0.5	0.3	13.8	0.2	0.2	0.4	0.3	1.2	0.2	0.2	0.3	8.4	0.6	0.3
Cumulative 8-hour average (standard = 9 ppm)	9.4	0.4	0.1	0.5	0.3	7.6	0.2	0.2	0.5	0.1	0.5	0.2	0.1	0.2	5.0	0.3	0.2

5.1.2 Atmospheric Deposition Estimates from Photochemical Modeling

5.1.2.1 Nitrogen Deposition

Cumulative Deposition

Figure 5.1-8 (also shown in Figure CO.NDEP.1) shows a spatial isopleth of annual nitrogen deposition centered in Colorado for the future year (circa 2032) simulation. Cumulative annual deposition over Colorado varies between 1 and 8 kg N/ha with the eastern side of the state showing higher deposition than the western side. Figures CO.NDEP.2 to CO.NDEP.17 show spatial distribution of the nitrogen deposition contributions from each source group to the cumulative deposition. In general, the largest contributors to nitrogen deposition are the non-fossil anthropogenic sources. Impacts for each source group are discussed below.

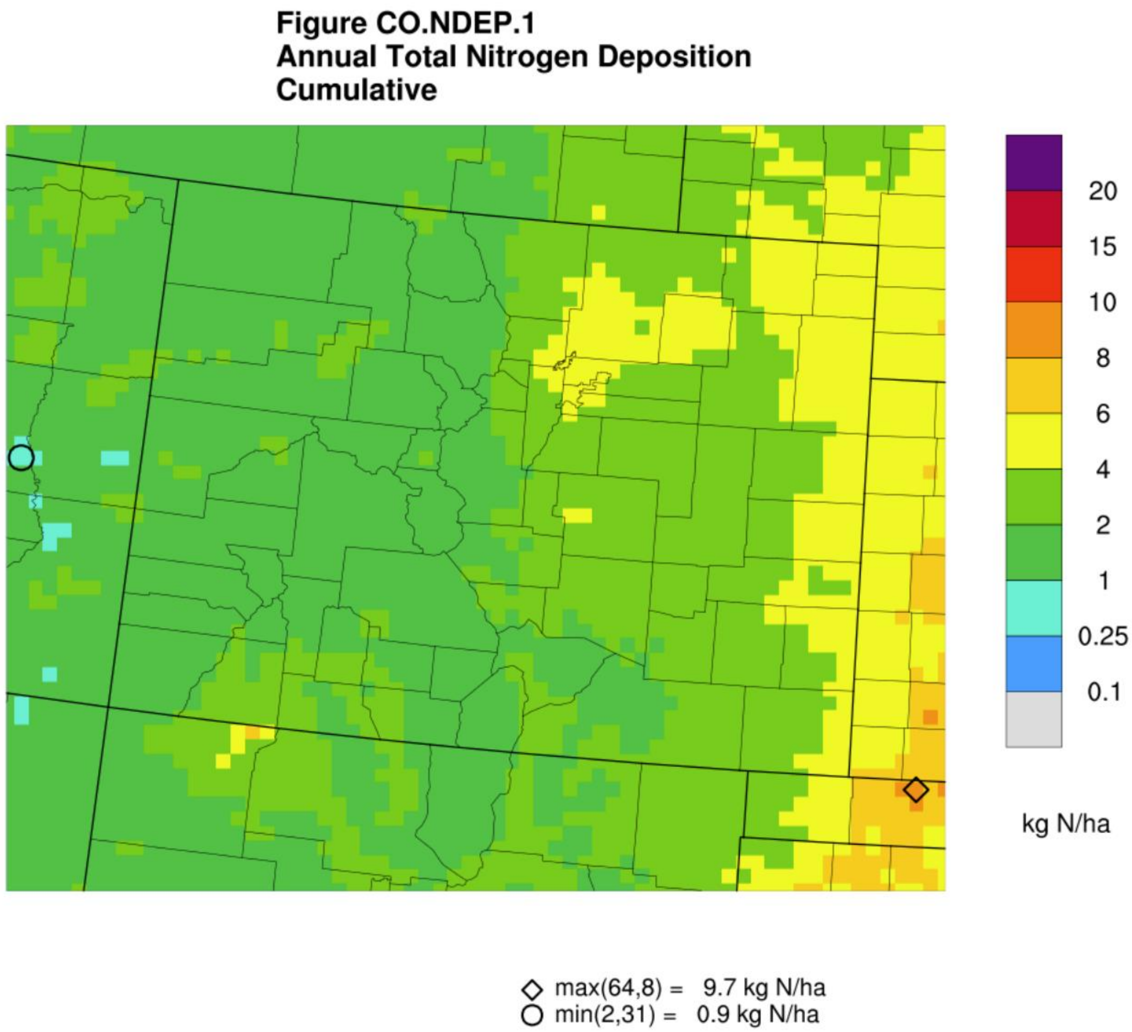


Figure 5.1-8. Modeled cumulative annual nitrogen deposition (kg N/ha-yr) in Colorado

Natural and Wildfire Source Groups

Figure CO.NDEP.2 presents the annual contributions from natural sources ranging between 0.0 and 0.1 kg N/ha. Figure CO.NDEP.3 presents the contributions from wildfires ranging from 0.0 to 0.5 kg N/ha.

Oil and Gas Source Groups

Figures CO.NDEP.4 to CO.NDEP.8 show the impacts on nitrogen deposition from existing and new federal oil and gas development in Western and Royal Gorge Colorado as well as federal oil and gas sources in other states. The annual contributions from these sources are less than 0.7 kg N/ha.

Figures CO.NDEP.9, CO.NDEP.10 and CO.NDEP.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. Of these three, the largest contributor to annual nitrogen deposition within Colorado is the non-federal oil and gas group with values of up to 1.7 kg N/ha. The maximum value occurs in the border of Morgan and Weld County. La Plata County also has values above 1.0 kg N/ha. The new and existing tribal oil and gas sources show smaller deposition rates of less than 0.5 kg N/ha inside Colorado.

Coal Source Groups

Figures CO.NDEP.12 to CO.NDEP.16 show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. Annual impacts from all four coal source groups are less than 0.25 kg N/ha throughout Colorado. The non-coal in WRAP states and non-WRAP EGU combustion impacts are greater than 0.25 kg N/ha on one grid cell in Jefferson County. The contributions from federal coal sources show zero contributions in Colorado.

Other Anthropogenic Sources

Figure CO.NDEP.17 shows the nitrogen deposition from other anthropogenic sources; these represent a large fraction of the cumulative deposition and ranges between 0.4 and 5.0 kg N/ha with higher values in the eastern side of the state. The largest impact of 8.1 kg N/ha is simulated outside Colorado. Inside Colorado, the largest impacts between 4 and 5 kg N/ha are modeled in Adams County and Denver County.

Impacts at Class I and other areas in Colorado

Table 5.1-16 summarizes the average nitrogen deposition over each area of interest and shows the contributions from each source emissions group that corresponds to the average deposition over the area. Table 5.1-17 shows similar information but the values are reported for the maximum nitrogen deposition in each area.

Critical loads for the Class I areas in the Colorado analysis area range from 3.0 to 4.0 kg N/ha as shown in Section 4.5.

As shown in Table 5.1-16, none of the cumulative average nitrogen deposition in the Class I areas exceeds the critical loads. The highest cumulative average deposition is 2.1 kg N/ha at Flat Tops Wilderness and the critical load at that location is 4.0 kg N/ha. The non-fossil anthropogenic sources account for up to 52% of total deposition at this studied area. Contributions from federal new oil and gas sectors to nitrogen deposition at all areas of interest are zero whereas existing oil and gas sectors in Western Colorado show maximum impacts of 0.1 kg N/ha at Weminuche Wilderness and Mesa Verde NP. Tribal and other state-federal oil and gas sectors show a maximum contribution of 0.1 to 0.2% of the total deposition, respectively. Contributions from all coal combustion and EGU sectors are negligibly small.

As shown in Table 5.1-17, none of the maximum cumulative nitrogen deposition exceeds the critical loads in all Class I areas. The highest cumulative maximum deposition is 2.9 kg N/ha at Rocky Mountain NP where the critical load is 4.0 kg N/ha and the lowest cumulative maximum deposition is 1.2 kg N/ha at Arches NP for which the critical load is 3.0 kg N/ha. Non-fossil anthropogenic sources are the major contributors to cumulative nitrogen deposition at all areas of interest (e.g., account for 35% to 52% of total deposition). Coal and oil and gas sector contributions are much smaller than those from other anthropogenic sources.

Table 5.1-16. Modeled average annual nitrogen deposition (kg N/ha-yr) and corresponding contributions by emissions group at areas of interest.

	Arches NP	Black Canyon of the Gunnison Wilderness	Canyonlands NP	Eagles Nest Wilderness	Flat Tops Wilderness	Great Sand Dunes Wilderness-nps	La Garita Wilderness	Maroon Bells-Snowmass Wilderness	Mesa Verde NP	Mount Zirkel Wilderness	Rawah Wilderness	Rocky Mountain NP	San Pedro Parks Wilderness	Weminuche Wilderness	West Elk Wilderness	Wheeler Peak Wilderness
Cumulative	1.1	1.3	1.2	1.6	2.1	1.4	1.7	1.7	1.6	1.8	1.6	2.0	2.1	2.0	1.7	1.9
Natural	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Wildfire	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.1
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.1
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	0.6	0.7	0.6	0.9	1.1	0.7	1.0	1.0	0.7	1.0	0.9	1.2	1.1	1.1	0.9	1.1
Boundary Conditions	0.3	0.3	0.3	0.4	0.5	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.5	0.4	0.4	0.5

Numbers may not add up exactly due to rounding.

Table 5.1-17. Modeled maximum annual nitrogen deposition (kg N/ha-yr) and corresponding contributions by emissions group at areas of interest.

	Rocky Mountain NP	Flat Tops Wilderness	Weminuche Wilderness	San Pedro Parks Wilderness	Mount Zirkel Wilderness	La Garita Wilderness	Canyonlands NP	Wheeler Peak Wilderness	West Elk Wilderness	Maroon Bells-Snowmass Wilderness	Eagles Nest Wilderness	Rawah Wilderness	Mesa Verde NP	Great Sand Dunes Wilderness-nps	Black Canyon of the Gunnison Wilderness	Arches NP
Cumulative	2.9	2.4	2.4	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.7	1.6	1.3	1.2
Natural	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Wildfire	0.2	0.4	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0
OilGas_ExistFed_WesternCO	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.1	0.2	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
OilGas_NonFed	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	1.7	1.1	1.3	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.0	1.0	0.6	0.9	0.7	0.7
Boundary Conditions	0.6	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3

5.1.2.2 Sulfur Deposition

<u>Cumulative Deposition</u>

Figure 5.1-9 (also shown in Figure CO.SDEP.1) presents a spatial isopleth of annual sulfur deposition centered in Colorado for the future year (circa 2032) simulation. Cumulative annual deposition over most of Colorado varies between 0.1 and 1.0 kg S/ha. The eastern side of the state shows a region of high sulfur deposition with values between 0.25 and 1.0 kg S/ha; the maximum of 1.3 kg S/ha occurs outside Colorado. This maximum corresponds with maximum of the "rest of the anthropogenic" source group. Figures CO.SDEP.2 to CO.SDEP.17 show spatial maps of the sulfur deposition contributions from each source group to the cumulative deposition. In general, the largest contributors to sulfur deposition in Colorado are the non-fossil anthropogenic sources. Remaining sources have a smaller impact on sulfur deposition in Colorado. Impacts for each source group are discussed below.

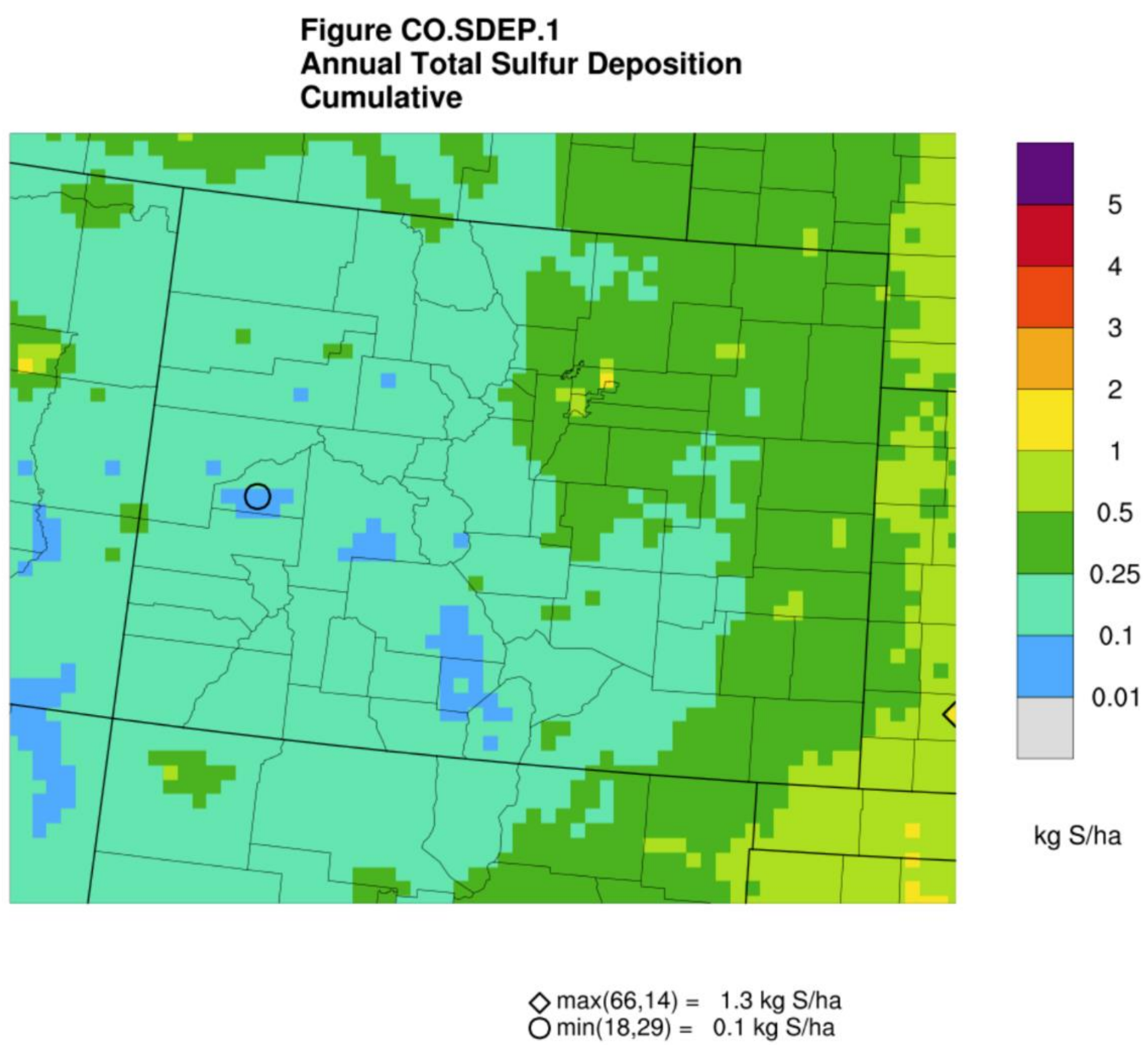


Figure 5.1-9. Modeled cumulative annual sulfur deposition (kg S/ha-yr) in Colorado.

Natural and Wildfire Source Groups

Figures CO.SDEP.2 presents the annual contributions from natural sources. As expected, these sources have negligible contributions to sulfur deposition. Figure CO.SDEP.3 presents the contributions from wildfires ranging from 0.0 to 0.2 kg S/ha

Oil and Gas Source Groups

Figures CO.SDEP.4 to CO.SDEP.8 show the contributions from existing and new federal oil and gas development in Western and Royal Gorge Colorado as well as federal oil and gas sources in other states. The contributions from these sources are low with impacts less than 0.1 kg S/ha.

Figures CO.SDEP.9, CO.SDEP.10 and CO.SDEP.11 show the contributions from non-federal, existing tribal and new tribal oil and gas development, respectively. Among these, the largest contributor to sulfur deposition is the non-federal oil and gas group with values below 0.25 kg S/ha throughout Colorado. Both the new and existing tribal oil and gas sources show negligible impacts.

Coal Source Groups

Figures CO.SDEP.12 to CO.SDEP.16 show the contributions from federal coal, non-federal coal in CO, WRAP states' EGU coal combustion, WRAP states' other coal combustion and all other EGU coal combustion (e.g., non-coal in WRAP states and non-WRAP EGU), respectively. Annual impacts from all four coal source groups are less than 0.25 kg S/ha throughout Colorado. The non-coal in WRAP states and non-WRAP EGU combustion impacts are greater than 0.25 kg S/ha on one grid cell in Jefferson County. The contributions from federal coal sources show zero contributions in Colorado.

Other Anthropogenic Sources

Figure CO.SDEP.17 shows the sulfur deposition from other anthropogenic sources; these represent a large fraction of the cumulative deposition and ranges between 0.01 and 0.90 kg S/ha. The maximum impact of 0.9 kg S/ha occurs outside Colorado in northwestern Texas. Inside Colorado, the largest impacts are modeled in Adams County and Denver County.

Impacts at Class I and other areas in Colorado

Table 5.1-18 summarizes the average sulfur deposition over all areas of interest and shows the contribution for each source emissions group that corresponds to the average deposition. Table 5.1-19 shows similar information, but the values are reported for the maximum sulfur deposition in each area.

The cumulative average and maximum deposition values for all analysis areas do not exceed the 5 kg S/ha threshold. Federal fossil fuel development contributed from zero to 0.1 S/ha to average and maximum sulfur deposition for all areas. The non-fossil anthropogenic sources are the main contributors to both average and maximum sulfur deposition at all areas of interest (e.g., account for 52% to 60% of total deposition). All coal sources show zero contributions sulfur deposition at all areas.

Table 5.1-18. Modeled average annual sulfur deposition (kg S/ha-yr) and corresponding contributions by emissions group at areas of interest.

	Arches NP	Black Canyon of the Gunnison Wilderness	Canyonlands NP	Eagles Nest Wilderness	Flat Tops Wilderness	Great Sand Dunes Wilderness-nps	La Garita Wilderness	Maroon Bells-Snowmass Wilderness	Mesa Verde NP	Mount Zirkel Wilderness	Rawah Wilderness	Rocky Mountain NP	San Pedro Parks Wilderness	Weminuche Wilderness	West Elk Wilderness	Wheeler Peak Wilderness
Cumulative	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boundary Conditions	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1

Numbers may not add up exactly due to rounding.

Table 5.1-19. Modeled maximum annual sulfur deposition (kg S/ha-yr) and corresponding contributions by emissions group at areas of interest.

	Mount Zirkel Wilderness	Flat Tops Wilderness	Rocky Mountain NP	San Pedro Parks Wilderness	Wheeler Peak Wilderness	Weminuche Wilderness	Rawah Wilderness	Maroon Bells-Snowmass Wilderness	Canyonlands NP	West Elk Wilderness	La Garita Wilderness	Eagles Nest Wilderness	Mesa Verde NP	Great Sand Dunes Wilderness-nps	Arches NP	Black Canyon of the Gunnison Wilderness
Cumulative	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Natural	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wildfire	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_WesternCO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewFed_RoyalGorge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_Fed_Other_States	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_ExistTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OilGas_NewTribal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_Fed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_NonFed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal_EGU WRAP states	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Coal_Comb WRAP states	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other_EGU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthro_Rest	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boundary Conditions	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0

5.1.3 Visibility Impacts Estimates from Photochemical Modeling

This section presents the visibility impacts at the areas of interest in the Colorado analysis area. Table 5.1-20 shows the cumulative visibility design values calculated by SMAT-CE following the approach described in Section 4.4. The table only shows the future year design values (DVF) for both haze index (in deciview) and the corresponding light extinction (in inverse megameters). These values are provided for both the 20 percent clearest days and most impaired days (MID). Areas with the highest cumulative values in circa 2032 for the MID are Rocky Mountain NP, Arches NP, Canyonlands NP and Mesa Verde NP. However, all these areas have visibility design values for the most impaired days that are projected below the uniform rate of progress toward the 2064 visibility goals.

Table 5.1-20. Future (circa 2032) cumulative visibility impacts to the 20 percent clearest and most impaired days in deciview and corresponding light extinction.

Assessment Area	20 Percent Clearest Days		20 Percent Most Impaired Days	
	Haze Index (dv)	Light Extinction (Mm^{-1})	Haze Index (dv)	Light Extinction (Mm^{-1})
Black Canyon of the Gunnison Wilderness	0.01	10.01	3.62	14.48
Mesa Verde NP	0.56	10.58	4.10	15.21
Mount Zirkel Wilderness	-0.89	9.16	2.38	12.83
Rawah Wilderness	-0.89	9.16	2.38	12.83
Rocky Mountain NP	0.03	10.04	5.74	18.20
San Pedro Parks Wilderness	-0.98	9.07	3.97	15.22
West Elk Wilderness	-1.41	8.69	1.55	11.77
Arches NP	0.22	10.23	4.24	15.44
Canyonlands NP	0.22	10.23	4.24	15.44
Eagles Nest Wilderness	-1.41	8.69	1.55	11.77
Flat Tops Wilderness	-1.41	8.69	1.55	11.77
Great Sand Dunes Wilderness NP	1.00	11.07	5.22	17.03
La Garita Wilderness	0.01	10.01	3.62	14.48
Maroon Bells-Snowmass Wilderness	-1.41	8.69	1.55	11.77
Weminuche Wilderness	0.01	10.01	3.62	14.48
Wheeler Peak Wilderness	-1.14	8.93	2.86	13.45

Table 5.1-21 and Table 5.1-22 provide the contribution from each group reported. to the cumulative design value (as light extinction) for both the 20 percent best and most impaired days respectively. During MID, the contributions of natural sources are small, while wildfires' contributions range between 2% and 16%. The maximum impacts are observed at Flat Tops Wilderness and Black Canyon of the Gunnison NP. The contributions from oil and gas sectors to visibility impacts are negligible with the contributions from states outside Colorado showing the largest impacts (2%) at Canyonlands NP and Mesa Verde NP. Existing federal oil and gas contributions from Western Colorado have a maximum impact of 1% at Mesa Verde NP. Among the coal source groups, coal EGUs affect Class I areas the most, with contributions between 2 and 5%. Impacts from other anthropogenic sources (both inside and outside the state) have significant impacts between 7 and 28%. This is not unexpected given the large number of urban and industrial emissions typically associated with this group. The maximum impact from this sector occurs at Rocky Mountain NP.

Table 5.1-21. Modeled cumulative light extinction (Mm^{-1}) and corresponding contributions by emissions group at areas of interest for the 20 percent clearest days.

	Black Canyon of the Gunnison Wilderness	Mesa Verde NP	Mount Zirkel Wilderness	Rawah Wilderness	Rocky Mountain NP	San Pedro Parks Wilderness	West Elk Wilderness	Arches NP	Canyonlands NP	Eagles Nest Wilderness	Flat Tops Wilderness	Great Sand Dunes Wilderness NP	La Garita Wilderness	Maroon Bells-Snowmass Wilderness	Weminuche Wilderness	Wheeler Peak Wilderness	Black Canyon of the Gunnison Wilderness
Cumulative	10.01	10.58	9.16	9.16	10.04	9.07	8.69	10.23	10.23	8.69	8.69	11.07	10.01	8.69	10.01	8.93	10.01
Natural	0.03	0.04	0.04	0.03	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.06	0.05	0.03	0.04	0.03	0.03
Wildfire	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
OilGas_ExistFed_WesternCO	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
OilGas_ExistFed_RoyalGorge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OilGas_NewFed_WesternCO	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
OilGas_NewFed_RoyalGorge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OilGas_Fed_Other_States	0.03	0.06	0.06	0.04	0.03	0.08	0.03	0.03	0.04	0.02	0.03	0.07	0.04	0.02	0.04	0.06	0.03
OilGas_NonFed	0.02	0.04	0.03	0.03	0.02	0.03	0.02	0.01	0.02	0.02	0.02	0.08	0.04	0.02	0.03	0.03	0.02
OilGas_ExistTribal	0.01	0.03	0.01	0.01	0.00	0.03	0.01	0.00	0.01	0.00	0.01	0.02	0.01	0.01	0.02	0.02	0.01
OilGas_NewTribal	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00
Coal_Fed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal_NonFed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal_EGU WRAP states	0.08	0.15	0.11	0.10	0.06	0.16	0.06	0.11	0.17	0.05	0.06	0.16	0.11	0.06	0.12	0.10	0.08
Coal_Comb WRAP states	0.02	0.01	0.05	0.04	0.04	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.01	0.02
Other_EGU	0.02	0.03	0.04	0.03	0.03	0.01	0.02	0.02	0.03	0.02	0.02	0.06	0.02	0.02	0.02	0.02	0.02
Anthro_Rest	0.61	0.90	0.50	0.62	0.54	0.52	0.31	0.86	0.68	0.36	0.31	1.08	0.44	0.32	0.46	0.48	0.61
Boundary Conditions	0.15	0.27	0.28	0.24	0.27	0.19	0.18	0.15	0.23	0.15	0.15	0.45	0.26	0.18	0.23	0.17	0.15
Rayleigh	9.00	9.00	8.00	8.00	9.00	8.00	8.00	9.00	9.00	8.00	8.00	9.00	9.00	8.00	9.00	8.00	9.00

Table 5.1-22. Modeled cumulative light extinction (Mm^{-1}) and corresponding contributions by emissions group at areas of interest for the 20 most impaired days.

	Black Canyon of the Gunnison Wilderness	Mesa Verde NP	Mount Zirkel Wilderness	Rawah Wilderness	Rocky Mountain NP	San Pedro Parks Wilderness	West Elk Wilderness	Arches NP	Canyonlands NP	Eagles Nest Wilderness	Flat Tops Wilderness	Great Sand Dunes Wilderness NP	La Garita Wilderness	Maroon Bells-Snowmass Wilderness	Weminuche Wilderness	Wheeler Peak Wilderness	Black Canyon of the Gunnison Wilderness
Cumulative	14.48	15.21	12.83	12.83	18.20	15.22	11.77	15.44	15.44	11.77	11.77	17.03	14.48	11.77	14.48	13.45	14.48
Natural	0.09	0.12	0.15	0.15	0.25	0.14	0.14	0.09	0.12	0.13	0.07	0.13	0.15	0.14	0.13	0.15	0.09
Wildfire	1.47	0.53	0.29	0.28	0.95	1.19	0.45	0.13	0.21	0.36	1.93	1.32	0.86	0.41	0.88	0.37	1.47
OilGas_ExistFed_WesternCO	0.01	0.09	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.03	0.02	0.04	0.01	0.01
OilGas_ExistFed_RoyalGorge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OilGas_NewFed_WesternCO	0.00	0.02	0.01	0.01	0.00	0.00	0.01	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
OilGas_NewFed_RoyalGorge	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OilGas_Fed_Other_States	0.07	0.26	0.16	0.13	0.10	0.19	0.08	0.21	0.31	0.07	0.05	0.19	0.11	0.08	0.12	0.15	0.07
OilGas_NonFed	0.04	0.20	0.11	0.17	0.59	0.12	0.07	0.11	0.17	0.07	0.04	0.15	0.08	0.07	0.09	0.11	0.04
OilGas_ExistTribal	0.02	0.10	0.02	0.02	0.01	0.02	0.02	0.05	0.07	0.01	0.01	0.03	0.04	0.02	0.05	0.02	0.02
OilGas_NewTribal	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.00	0.01	0.02	0.01	0.02	0.01	0.01
Coal_Fed	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Coal_NonFed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal_EGU WRAP states	0.41	0.54	0.27	0.26	0.26	0.28	0.27	0.61	0.83	0.20	0.15	0.45	0.51	0.22	0.46	0.23	0.41
Coal_Comb WRAP states	0.04	0.06	0.20	0.12	0.06	0.05	0.04	0.08	0.10	0.04	0.05	0.09	0.03	0.03	0.02	0.03	0.04
Other_EGU	0.07	0.13	0.18	0.17	0.55	0.17	0.08	0.09	0.11	0.08	0.08	0.19	0.08	0.07	0.07	0.16	0.07
Anthro_Rest	2.20	3.07	2.33	2.32	5.18	3.24	1.48	4.00	3.06	1.75	0.80	3.45	1.89	1.52	2.02	2.59	2.20
Boundary Conditions	1.05	1.03	1.08	1.16	1.19	1.79	1.12	1.00	1.37	1.03	0.57	1.98	1.67	1.15	1.55	1.63	1.05
Rayleigh	9.00	9.00	8.00	8.00	9.00	8.00	8.00	9.00	9.00	8.00	8.00	9.00	9.00	8.00	9.00	8.00	9.00

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APPENDIX A: OIL AND GAS EMISSIONS INVENTORY SUPPORTING INFORMATION

Appendix A - Table 1. Modeled oil and gas activity by mineral designation for each state: circa 2032

State	Mineral Designation			
	Federal	Non-Federal	Tribal	Total
Oil production (MMBbl/yr)				
CO	21	203	0	224
MT	20	30	2	51
ND	56	708	65	829
NM	133	123	3	259
SD	1	1	0	2
UT	17	7	8	32
WY	107	35	1	143
Gas production (BCF/yr)				
CO	478	1,094	80	1,651
MT	26	32	4	63
ND	115	1,458	134	1,707
NM	903	425	112	1,440
SD	1	1	0	2
UT	140	48	65	254
WY	1,404	393	53	1,850
Well Count (number of wells)				
CO	14,812	52,996	1,877	69,685
MT	5,902	8,286	1,185	15,372
ND	2,688	34,151	3,144	39,983
NM	46,682	23,891	6,162	76,736
SD	140	184	-	324
UT	11,541	3,534	4,867	19,942
WY	37,777	11,372	749	49,897
Spud Count (number of spuds)				
CO	223	829	22	1,074
MT	153	182	16	351
ND	150	1893	174	2,217
NM	1,001	325	238	1,564
SD	2	3	0	6
UT	214	92	113	420
WY	627	189	14	829

Appendix A - Table 2. Modeled federal existing and new oil and gas activity for each state: circa 2032.

State	Federal Existing	Federal New
Oil production (MMBbl/yr)		
CO	4	17
MT	4	16
ND	12	43
NM	38	96
SD	0	1
UT	2	15
WY	18	89
Gas production (BCF/yr)		
CO	210	267
MT	9	17
ND	26	89
NM	661	241
SD	1	0
UT	106	35
WY	668	736
Well Count (number of wells)		
CO	11,918	2,894
MT	3,908	1,993
ND	1,247	1,441
NM	33,663	13,019
SD	110	30
UT	8,757	2,784
WY	28,729	9,047
Spud Count (number of spuds)		
CO	-	223
MT	-	153
ND	-	150
NM	-	1,001
SD	-	2
UT	-	214
WY	-	627

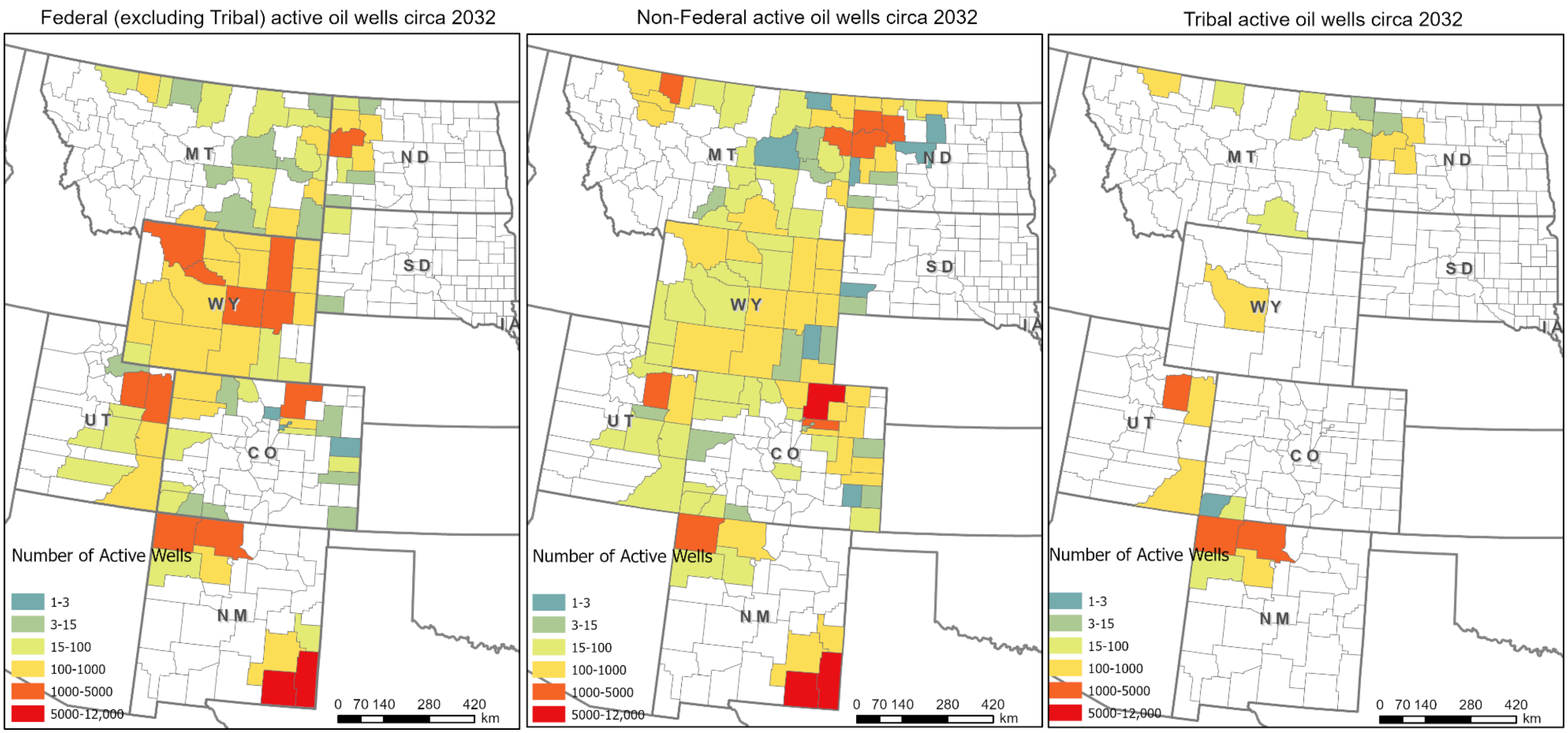
Appendix A - Table 3. Scaling parameter for nonpoint oil and gas source categories.

O&G Activity Scaling Parameter	Emission Source Category
Active Well Count	Refracing
	Water Pump Engines
	Well Venting
	Wellhead Engines (e.g., compressors, artificial lift)
	Workover rigs
	Blowdowns
	Heaters
	Fugitive Leaks
	Pneumatic Devices
	Pneumatic Pumps
	Well Venting
	Recompletions
Gas Production (i.e., total, primary, associated, Coalbed Methane (CBM)	Midstream Sources
	Produced Water Tanks
	Dehydrators
	Casinghead Gas
Liquid Hydrocarbon Production (i.e., oil, condensate)	Oil Tanks
	Condensate Tanks
	Tank Truck/Railcar Loading
Spud Count	Completions
	Drill Rigs
	Hydraulic Fracturing Engines
	Mud Degassing

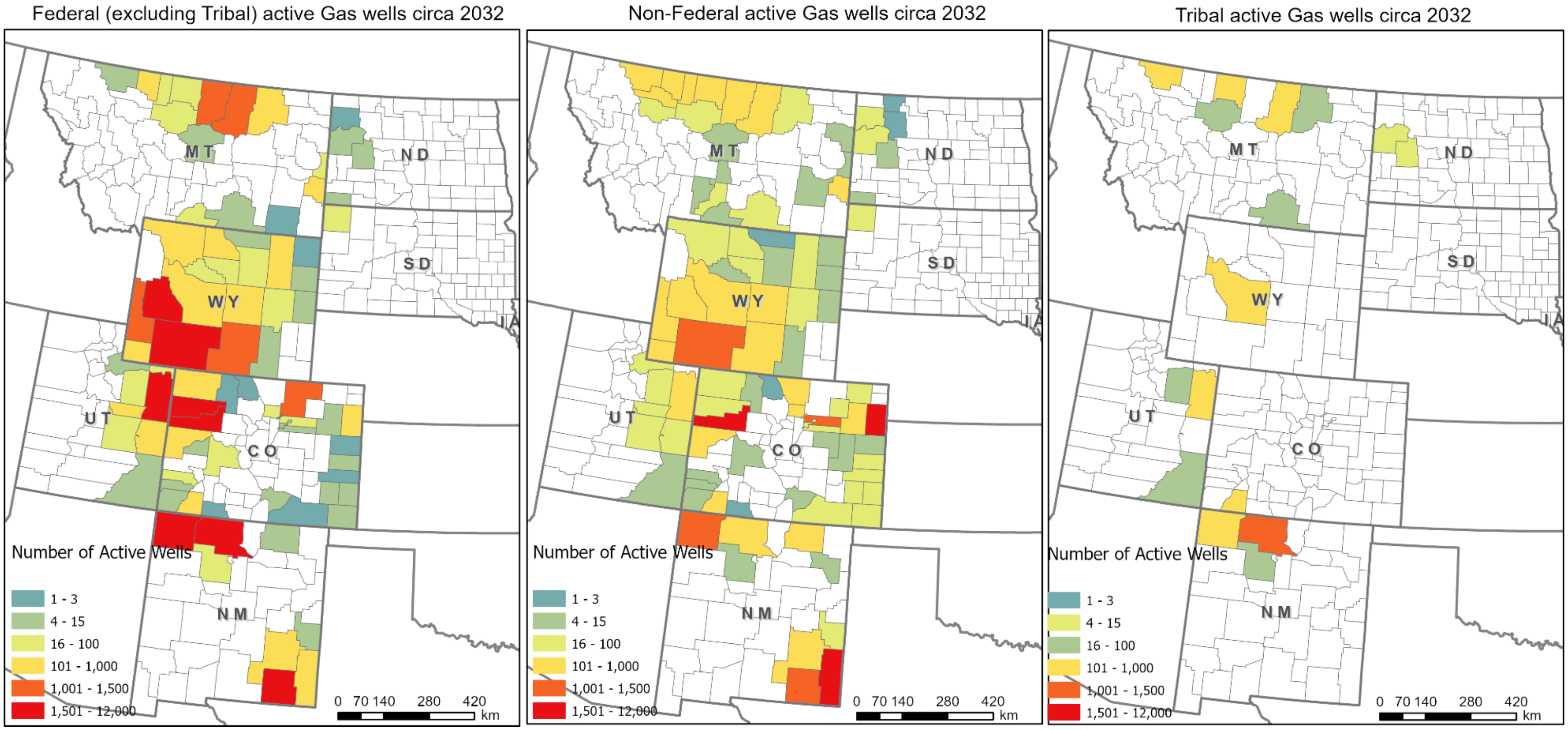
Appendix A - Table 4. Colorado (CO) modeled oil and gas emissions (short tons/year) in circa 2032 by mineral designation.

Pollutants	New federal	New + existing federal	New tribal	New + existing tribal	New + existing non-federal	Total (federal + tribal + non-federal)	New federal + new tribal
NO_x	4,734	10,150	1,865	8,339	28,363	46,851	6,598
VOC	25,215	36,565	292	1,035	68,325	105,925	25,508
CO	3,701	8,456	1,509	6,863	28,615	43,934	5,210
SO_2	103	199	4	15	290	504	108
$PM_{2.5}$	150	246	22	82	835	1,164	172
PM_{10}	152	250	23	87	863	1,200	175
CO_2	887,431	1,661,290	164,717	637,098	5,486,150	7,784,538	1,052,149
CH_4	30,084	119,080	69,168	337,885	345,519	802,484	99,251
N_2O	30	103	53	269	322	694	83
CO_2e (20-yr GWP)	3,422,375	11,691,170	5,988,817	29,090,444	34,594,826	75,376,440	9,411,193
CO_2e (100-yr GWP)	1,737,718	5,022,798	2,115,475	10,169,148	15,246,059	30,438,004	3,853,193
Total HAPs	1,402	2,084	29	82	4,009	6,175	1,431

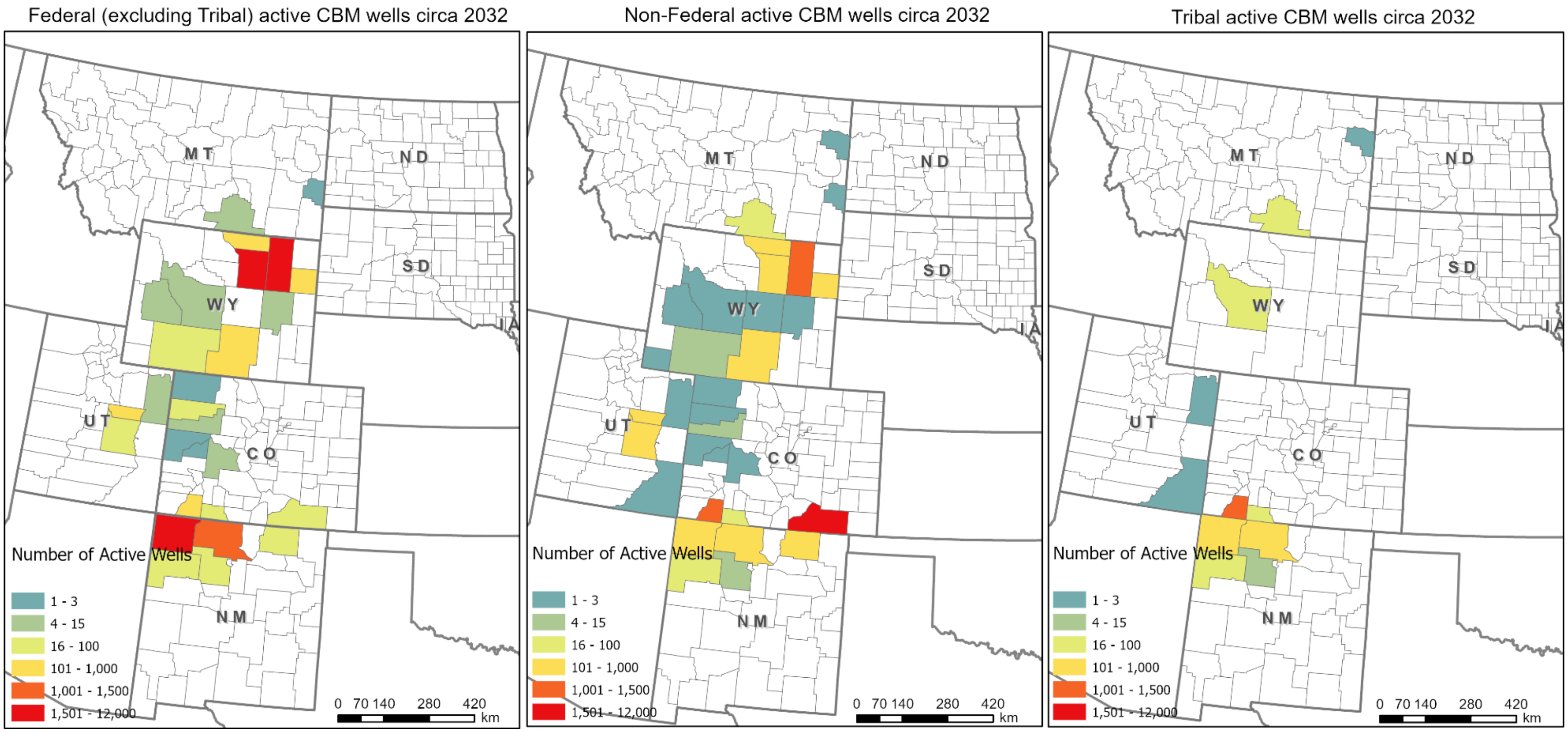
Spatial Maps of Modeled Oil and Gas Activity



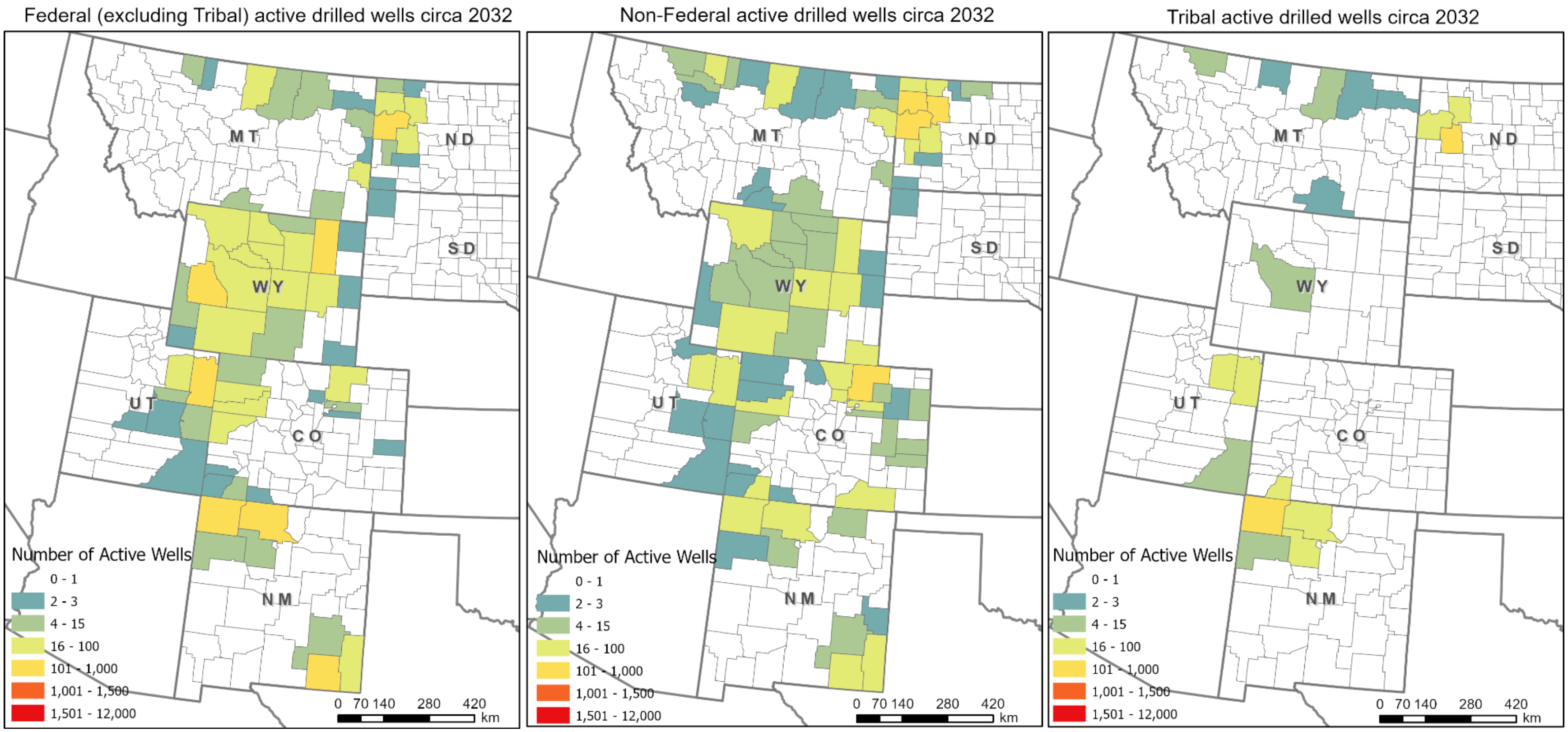
Appendix A - Figure 10. Modeled circa 2032 active oil wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).



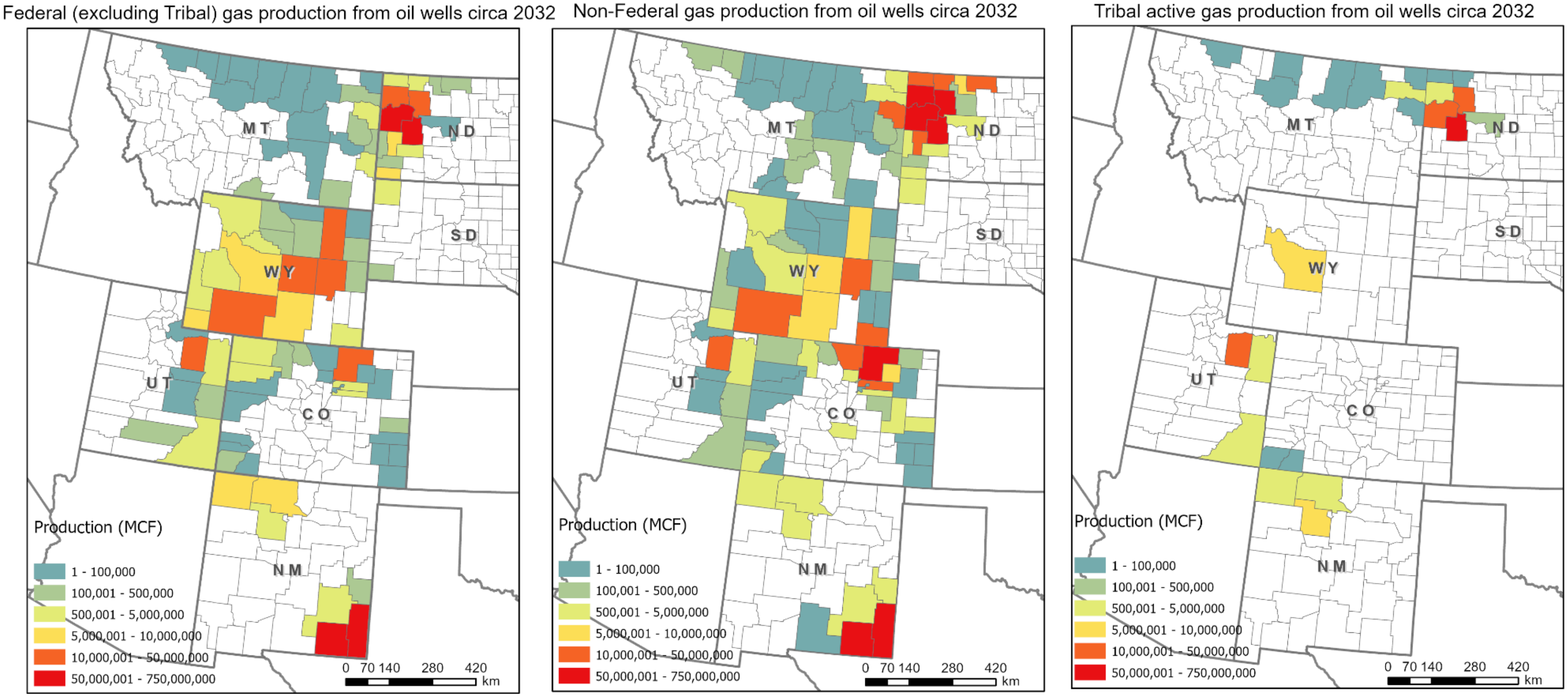
Appendix A - Figure 11. Modeled circa 2032 active gas wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).



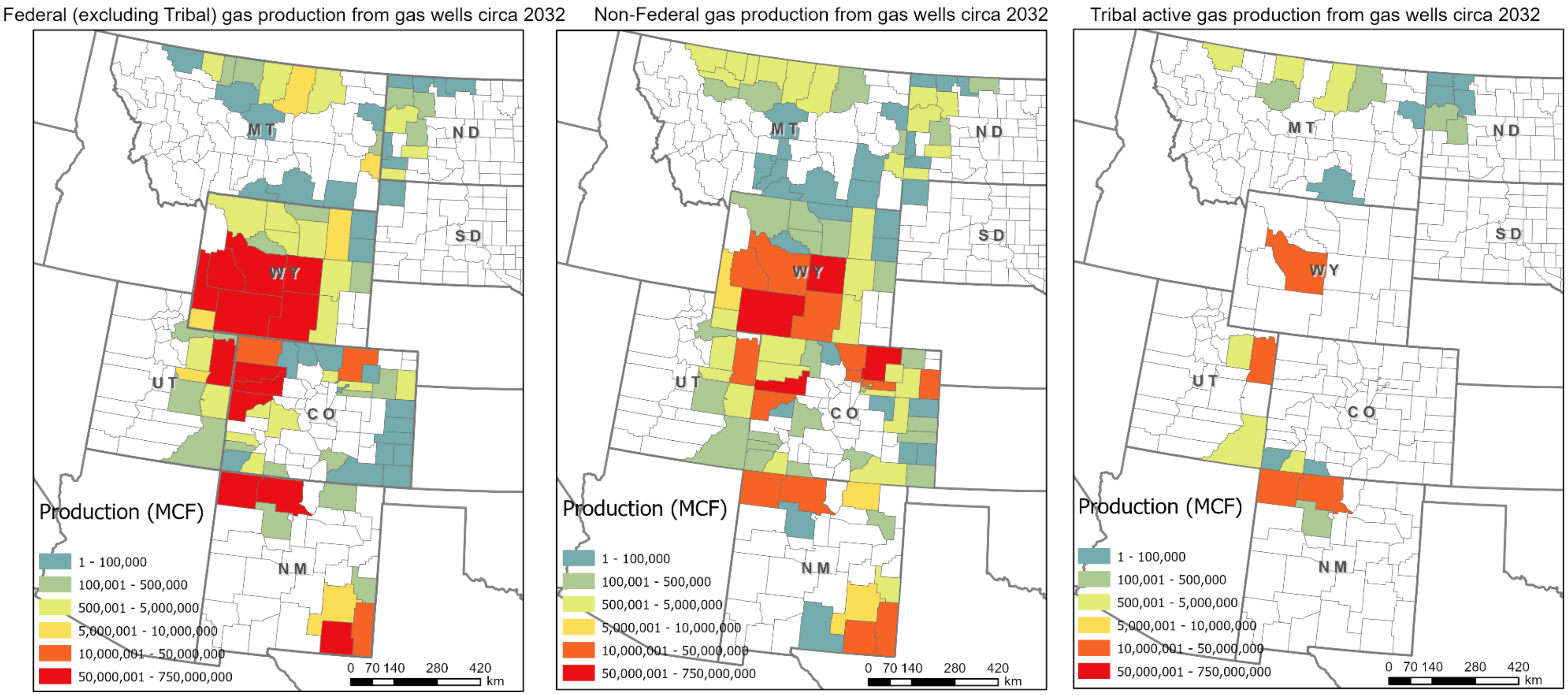
Appendix A - Figure 12. Modeled circa 2032 active CBM wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).



Appendix A - Figure 13. Modeled circa 2032 drilled wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).

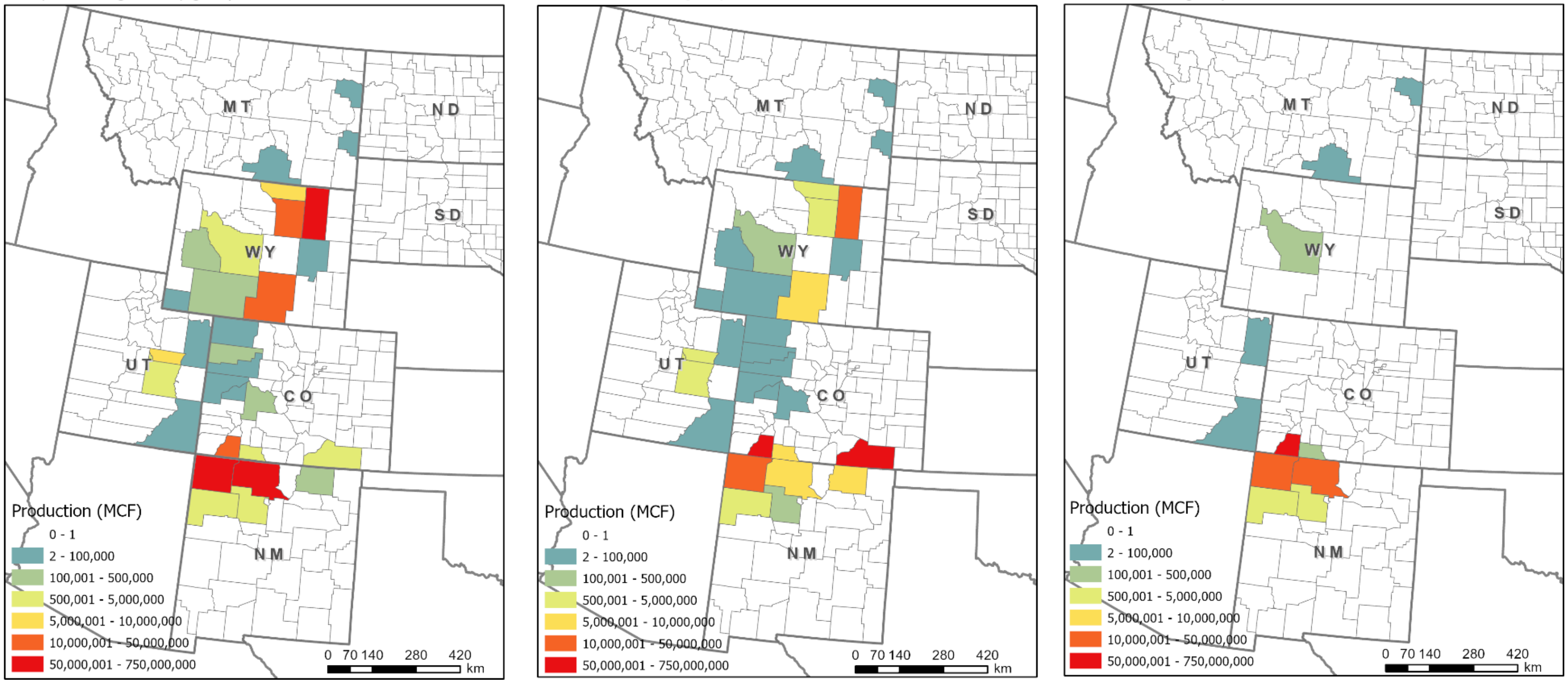


Appendix A - Figure 14. Modeled circa 2032 gas production from oil wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).

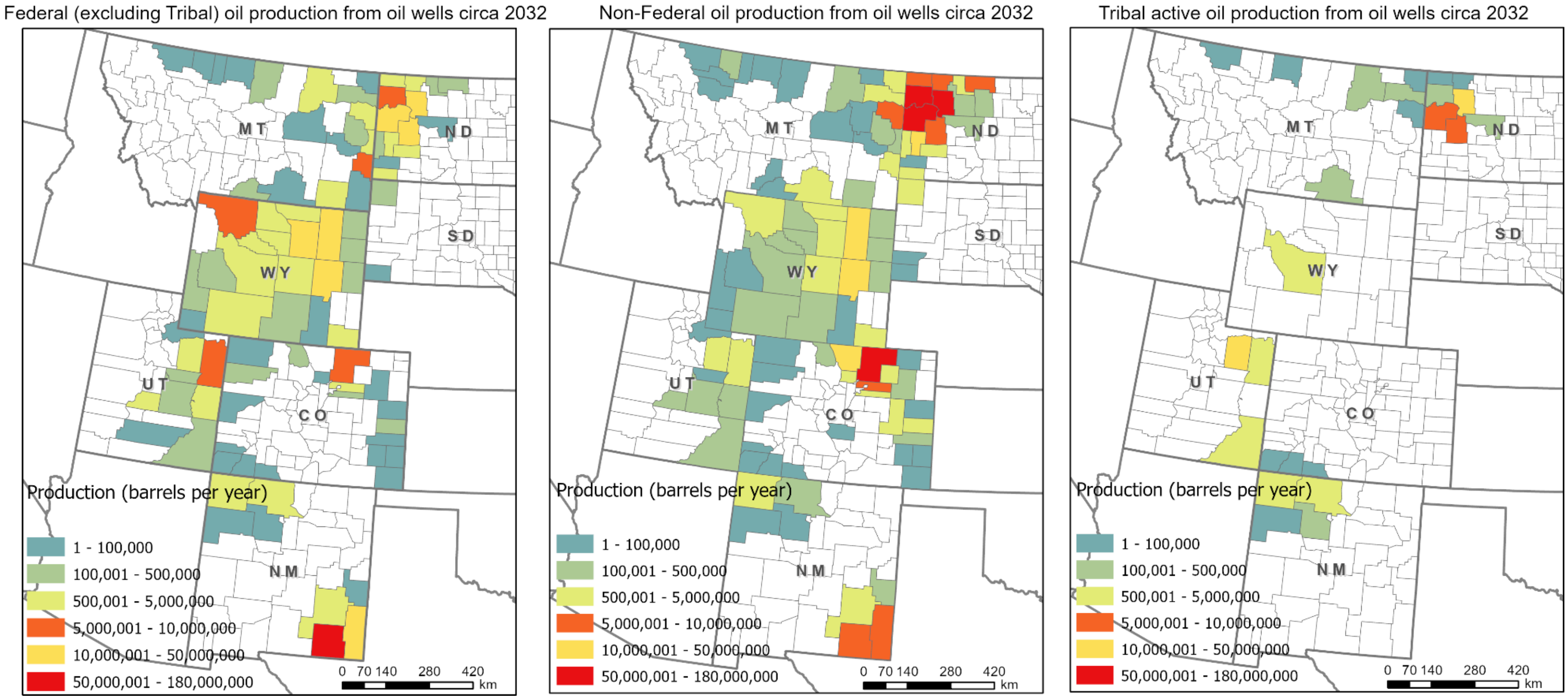


Appendix A - Figure 15. Modeled circa 2032 gas production from gas wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).

Federal (excluding Tribal) gas production from CBM wells circa 2032 Non-Federal gas production from CBM wells circa 2032 Tribal active gas production from CBM wells circa 2032

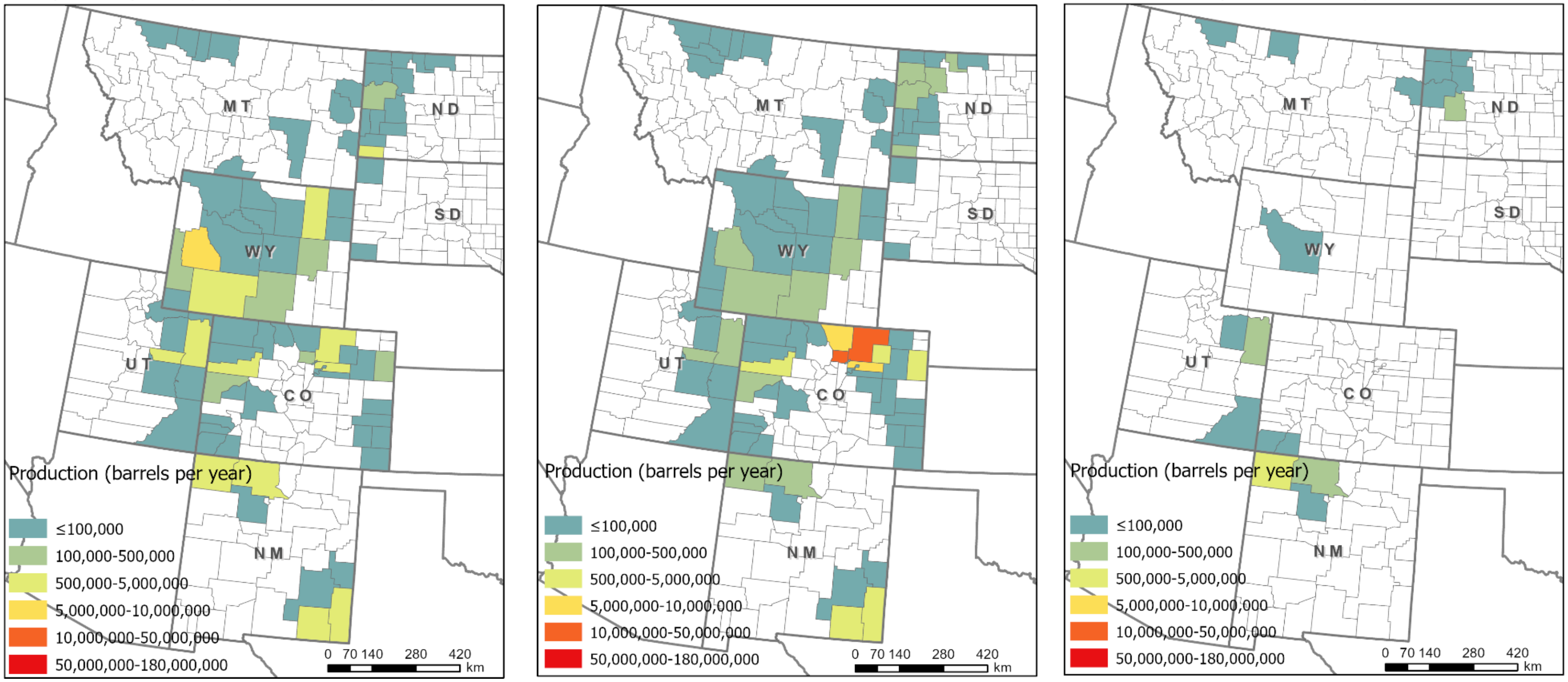


Appendix A - Figure 16. Modeled circa 2032 gas production from CBM wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).



Appendix A - Figure 17. Modeled circa 2032 oil production from oil wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).

Federal (excluding Tribal) oil production from gas wells circa 2032 Non-Federal oil production from gas wells circa 2032 Tribal active oil production from gas wells circa 2032



Appendix A - Figure 18. Modeled circa 2032 oil production from gas wells in the selected states for Federal (excluding Tribal; left), Non-Federal (middle), and Tribal (right) mineral estate (Source: Data from BLM).

Appendix A - Table 5. Modeled circa 2032 (new plus existing) oil and gas emissions by state and mineral designation.

State	Criteria Air Pollutant Emissions (short tons/year)						Greenhouse Gas Emissions (short tons/year)					Total HAPs (short tons/yr)
	NOx	VOC	CO	SO_2	$PM_{2.5}$	PM_{10}	CO_2	CH_4	N_2O	CO_2e (20-yr GWP)[1]	CO_2e (100-yr GWP)[2]	
Federal (excluding Tribal)												
CO	10,150	36,565	8,456	199	246	250	1,661,290	119,080	103	11,691,178	5,022,801	2,084
MT	3,592	15,952	4,688	269	87	87	899,199	49,000	16	5,019,413	2,275,429	829
ND	13,580	34,843	15,398	10,129	1,435	1,586	6,637,115	54,576	73	11,240,781	8,184,599	3,696
NM	52,216	94,069	119,401	19,118	2,353	2,380	9,340,025	215,007	183	27,448,888	15,408,679	6,087
SD	282	1,273	204	7	21	21	244,811	1,609	5	381,159	291,059	83
UT	10,113	117,584	9,540	288	489	489	4,599,808	607,165	80	55,622,872	21,621,712	7,227
WY	27,956	148,617	14,149	4,598	1,139	1,139	8,707,579	176,659	182	23,594,948	13,702,225	5,325
Tribal												
CO	8,339	1,035	6,863	15	82	87	637,098	337,885	269	29,090,436	10,169,145	82
MT	639	2,343	836	23	12	12	102,501	19,993	2	1,782,362	662,756	118
ND	8,177	38,035	12,793	3,217	258	278	5,680,255	58,999	39	10,646,468	7,342,563	3,956
NM	5,528	13,646	16,972	44	279	285	1,721,383	42,195	28	5,273,225	2,910,333	749
SD	23	1	8	0	2	2	26,147	40	1	29,646	27,406	0
UT	5,449	26,535	5,670	185	267	267	1,929,303	109,336	33	11,122,122	4,999,338	1,673
WY	269	1,370	254	464	12	12	107,919	4,821	2	513,404	243,430	69
Non-federal												
CO	28,363	68,325	28,615	290	835	863	5,486,150	345,519	322	34,594,788	15,246,046	4,009
MT	5,250	25,733	6,708	418	100	100	1,233,114	106,292	18	10,166,456	4,214,122	1,442
ND	85,737	412,034	136,940	31,448	2,232	2,383	60,861,462	638,865	405	114,633,089	78,857,054	42,824
NM	33,790	46,998	50,228	18,898	1,201	1,214	5,440,422	75,518	768	11,986,782	7,758,543	3,386
SD	390	1,792	269	10	53	53	338,313	2,094	7	515,994	398,736	119
UT	3,763	30,953	3,651	156	189	189	1,519,283	156,468	27	14,669,676	5,907,495	1,985
WY	8,870	46,817	4,730	1,419	408	408	3,965,065	50,437	76	8,221,768	5,397,372	1,741
Total												
CO	46,851	105,925	43,934	504	1,164	1,200	7,784,538	802,484	694	75,376,402	30,437,992	6,175
MT	9,482	44,027	12,232	711	199	199	2,234,813	175,286	36	16,968,231	7,152,307	2,389
ND	107,494	484,912	165,131	44,794	3,925	4,247	73,178,832	752,439	517	136,520,338	94,384,216	50,477
NM	91,533	154,713	186,601	38,059	3,833	3,880	16,501,831	332,720	979	44,708,896	26,077,555	10,222
SD	695	3,066	482	18	77	77	609,271	3,744	12	926,798	717,202	203
UT	19,325	175,071	18,861	629	944	944	8,048,394	872,969	140	81,414,669	32,528,545	10,885
WY	37,096	196,804	19,133	6,481	1,559	1,559	12,780,563	231,917	260	32,330,119	19,343,027	7,136

[1] 20-year time horizon global warming potentials (GWPs) applied are: CO_2 = 1; CH_4 = 84; N_2O = 264 from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).

[2] 100-year time horizon global warming potentials (GWPs) applied are: CO_2 = 1; CH_4 = 28; N_2O = 265 from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).

Appendix A - Table 6. Modeled circa 2032 "new" oil and gas emissions: federal (excluding Tribal), Tribal, and combined.

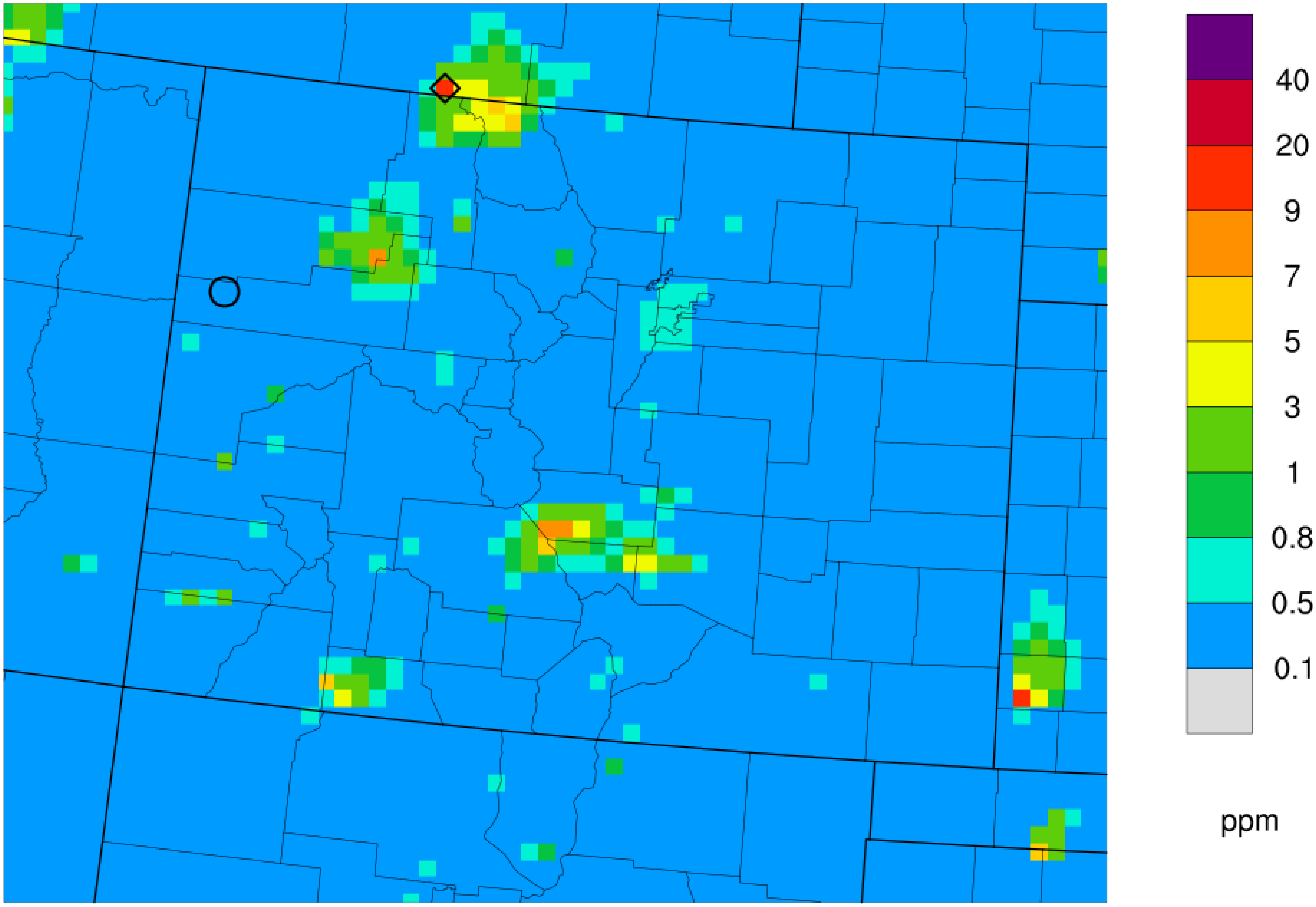
State	Criteria Air Pollutant Emissions (short tons/year)						Greenhouse Gas Emissions (short tons/year)					Total HAPs (short tons/year)
	NOx	VOC	CO	SO_2	$PM_{2.5}$	PM_{10}	CO_2	CH_4	N_2O	CO_2e (20-yr GWP)[1]	CO_2e (100-yr GWP)[2]	
Federal (excluding Tribal)												
CO	4,734	25,215	3,701	103	150	152	887,431	30,084	30	3,422,375	1,737,718	1,402
MT	2,328	8,055	3,071	160	55	55	565,214	20,359	12	2,278,494	1,138,382	479
ND	8,705	24,805	11,250	6,447	912	1,008	4,238,179	36,247	51	7,296,384	5,266,597	2,727
NM	13,922	35,214	26,608	4,028	492	499	3,634,180	83,067	83	10,633,777	5,982,092	2,184
SD	169	491	84	4	13	13	143,104	438	3	180,691	156,140	37
UT	2,420	71,667	1,995	28	121	121	1,373,715	329,506	26	29,059,069	10,606,752	5,113
WY	19,331	118,696	7,417	3,208	584	584	4,215,406	57,993	100	9,113,299	5,865,776	4,055
Tribal												
CO	1,865	292	1,509	4	22	23	164,717	69,168	53	5,988,817	2,115,475	29
MT	208	765	329	11	5	5	46,065	3,866	1	371,052	154,569	44
ND	5,260	27,248	9,813	2,036	161	173	3,624,473	39,267	30	6,930,785	4,731,874	2,953
NM	2,305	6,975	5,477	20	78	80	1,014,104	24,320	15	3,060,846	1,698,925	326
SD	14	0	5	0	1	1	16,431	25	0	18,635	17,224	0
UT	1,904	15,803	1,925	34	90	90	665,361	65,132	12	6,139,485	2,492,122	1,137
WY	149	421	139	288	7	7	52,241	1,615	1	188,170	97,722	24
Combined federal (including Tribal)												
CO	6,598	25,508	5,210	108	172	175	1,052,149	99,251	83	9,411,193	3,853,193	1,431
MT	2,536	8,819	3,400	172	60	60	611,279	24,225	13	2,649,546	1,292,951	523
ND	13,965	52,053	21,063	8,483	1,073	1,181	7,862,652	75,514	81	14,227,169	9,998,471	5,680
NM	16,227	42,190	32,084	4,048	569	579	4,648,284	107,388	98	13,694,622	7,681,016	2,510
SD	183	491	90	4	15	15	159,535	464	3	199,326	173,364	38
UT	4,324	87,470	3,920	62	212	212	2,039,076	394,638	38	35,198,554	13,098,874	6,249
WY	19,480	119,117	7,557	3,496	591	591	4,267,648	59,608	101	9,301,469	5,963,498	4,079

[1] 20-year time horizon global warming potentials (GWPs) applied are: CO2 = 1; CH4 = 84; N2O = 264 from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).

[2] 100-year time horizon global warming potentials (GWPs) applied are: CO2 = 1; CH4 = 28; N2O = 265 from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5)

APPENDIX B: MODELING RESULTS SPATIAL PLOTS

Figure CO.CO.8hr.1
2nd highest 8-hr daily max CO
Cumulative



◇ max(27,49) = 9.4 ppm
○ min(14,37) = 0.1 ppm

Figure CO.NO2.1h.1
98th percentile daily max NO_2
Cumulative, CO

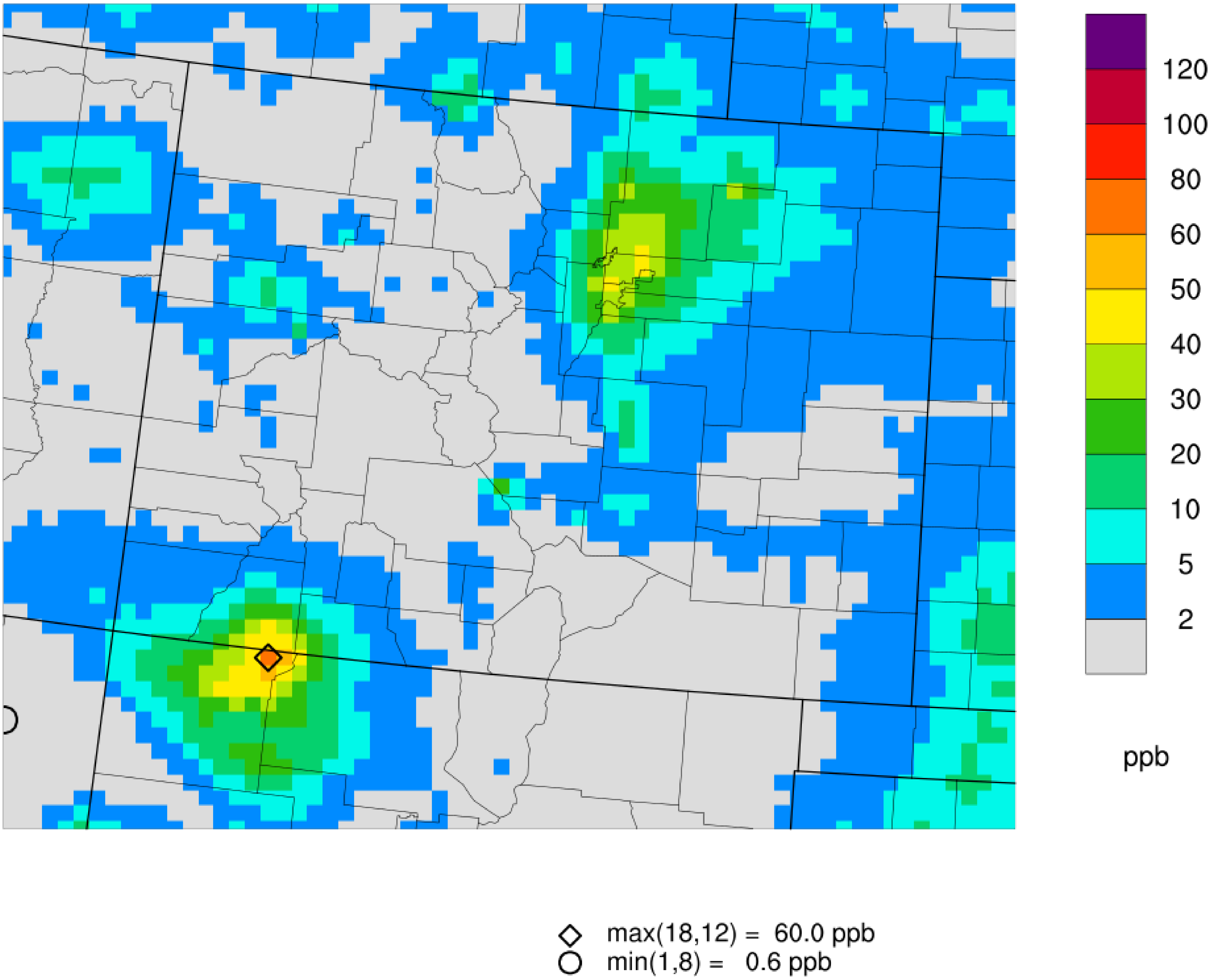
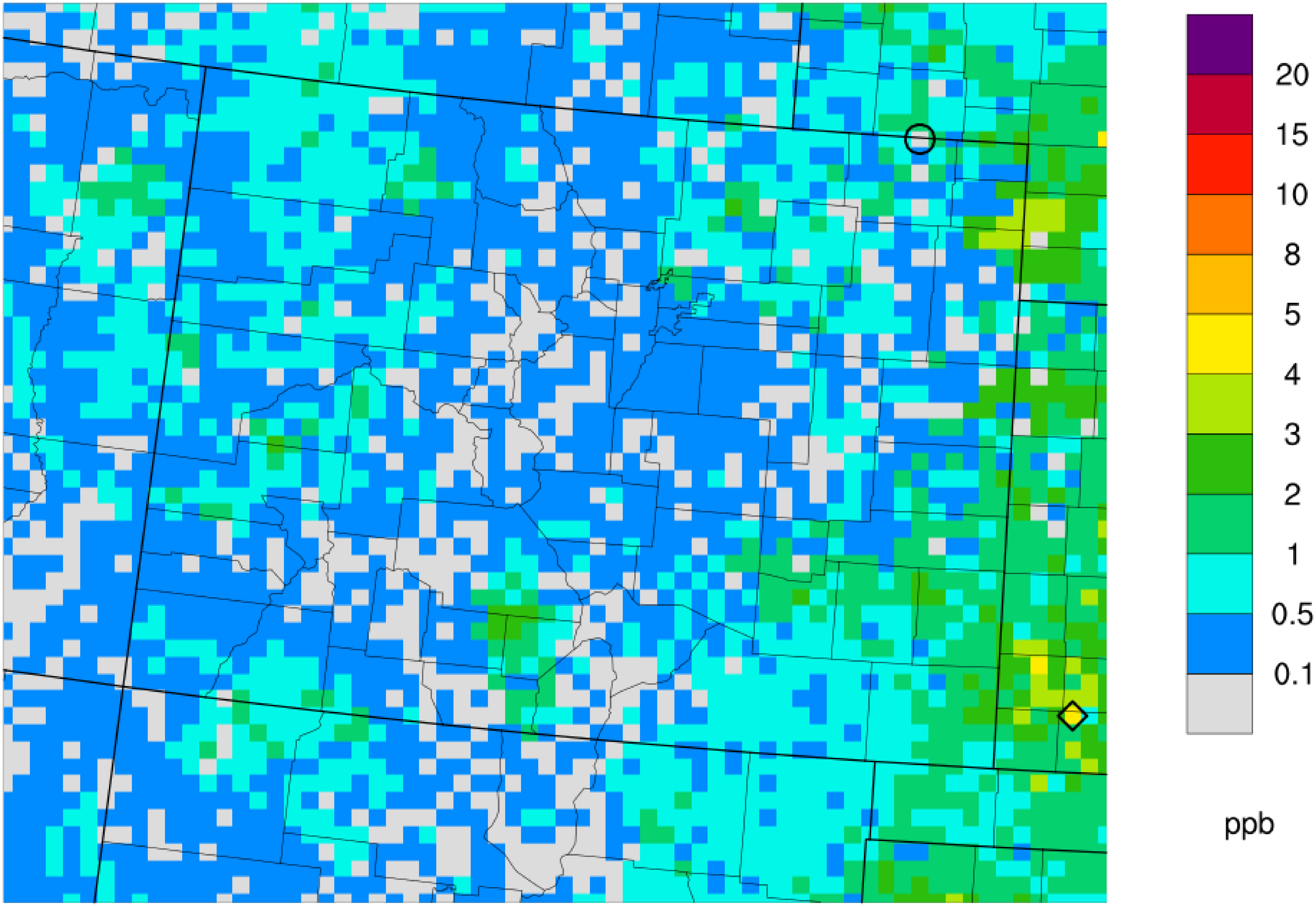


Figure CO.NO2.1h.2
98th percentile daily max NO_2
Natural



max(64,12) = 4.6 ppb
min(55,46) = 0.0 ppb

Figure CO.NO2.1h.3
98th percentile daily max NO_2
Wildfire

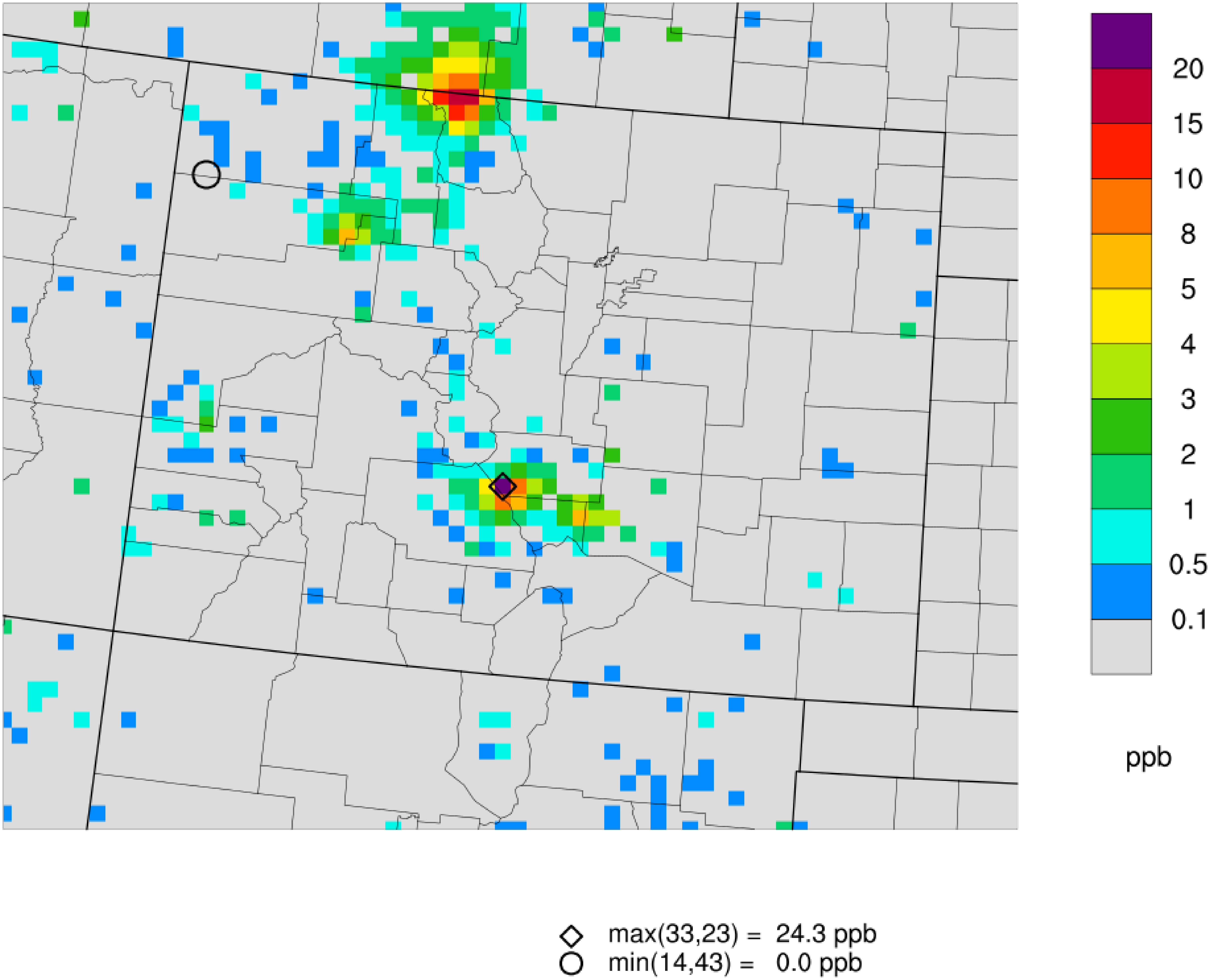


Figure CO.NO2.1h.4
98th percentile daily max NO_2
OilGas_ExistFed_WesternCO

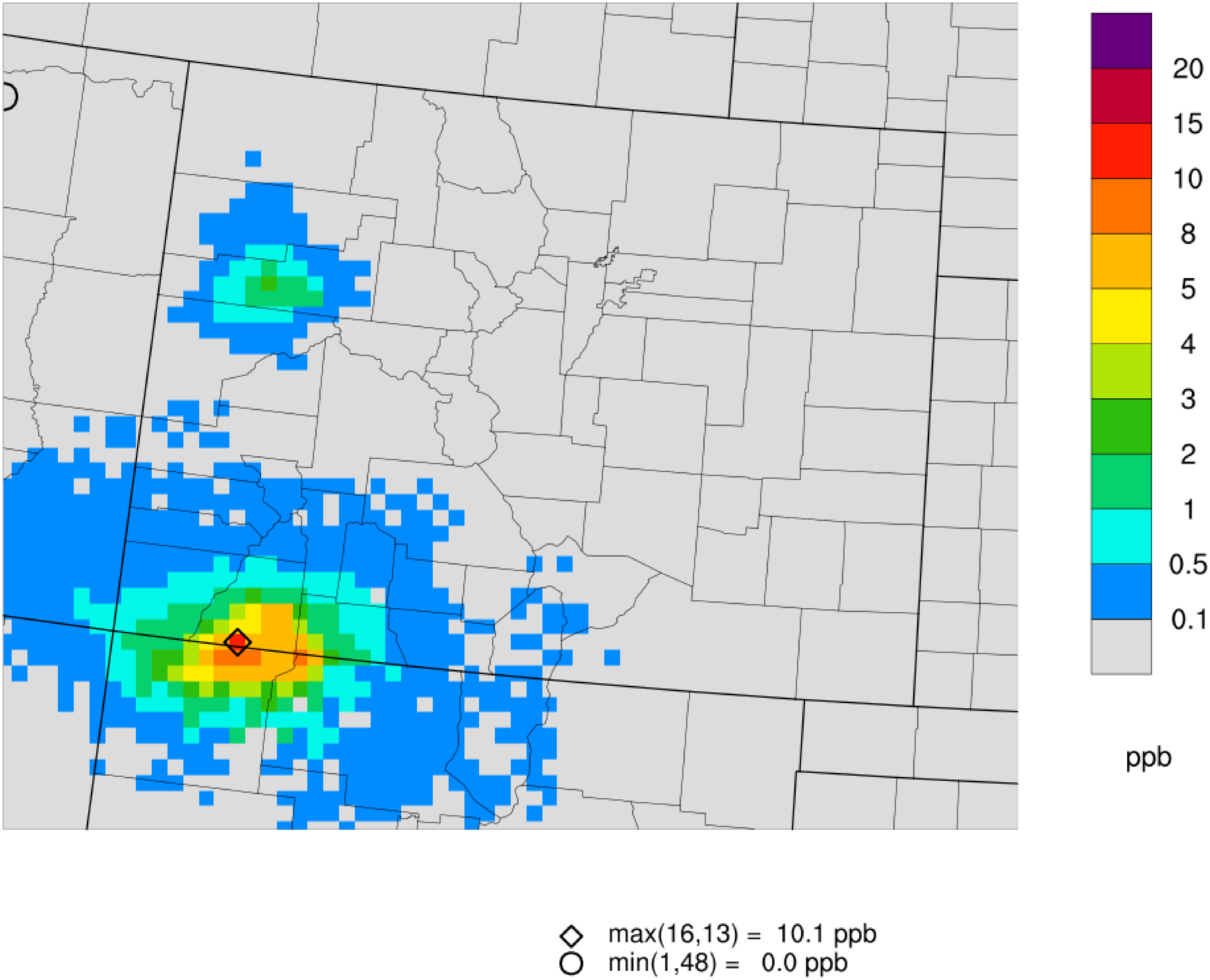
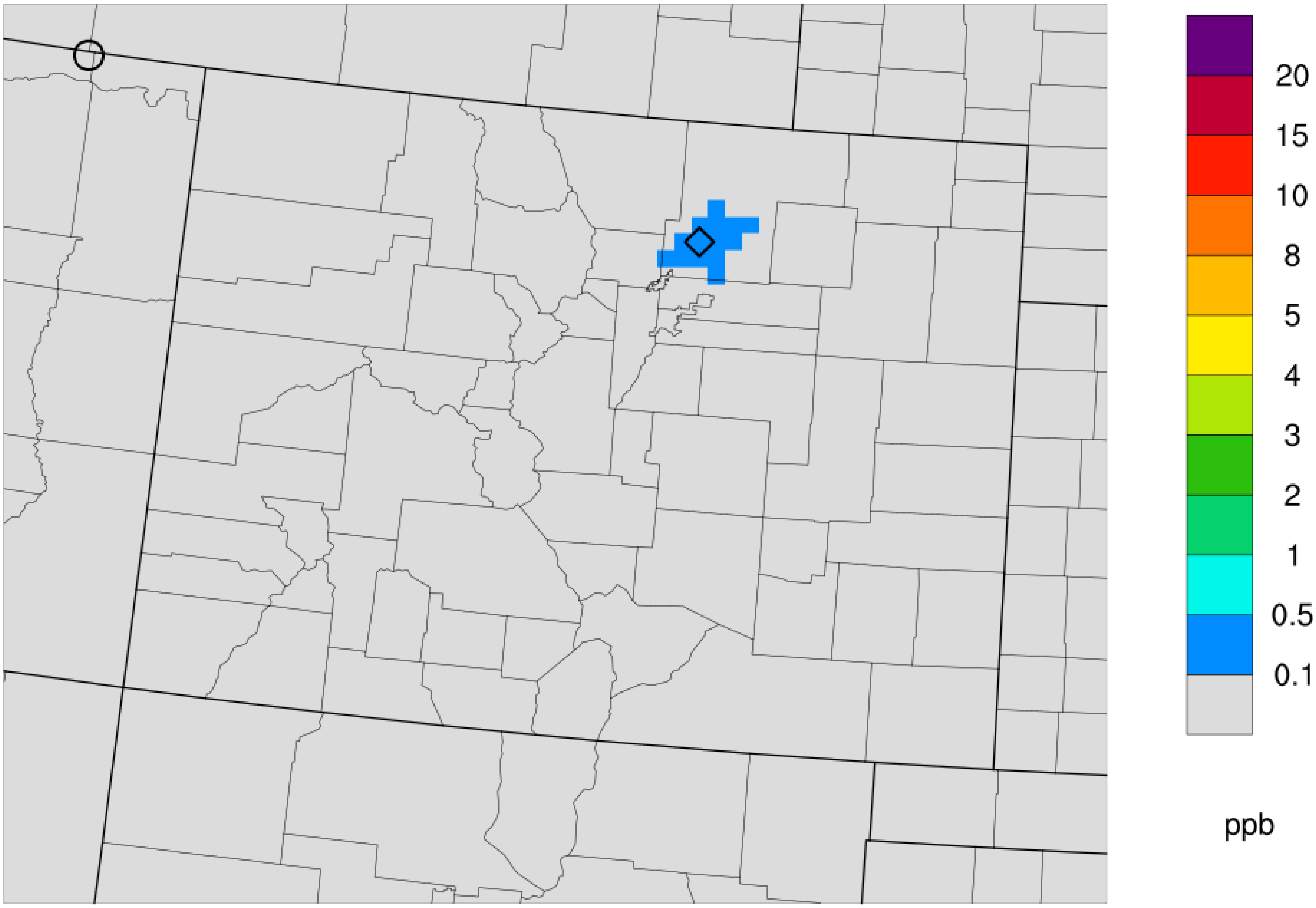
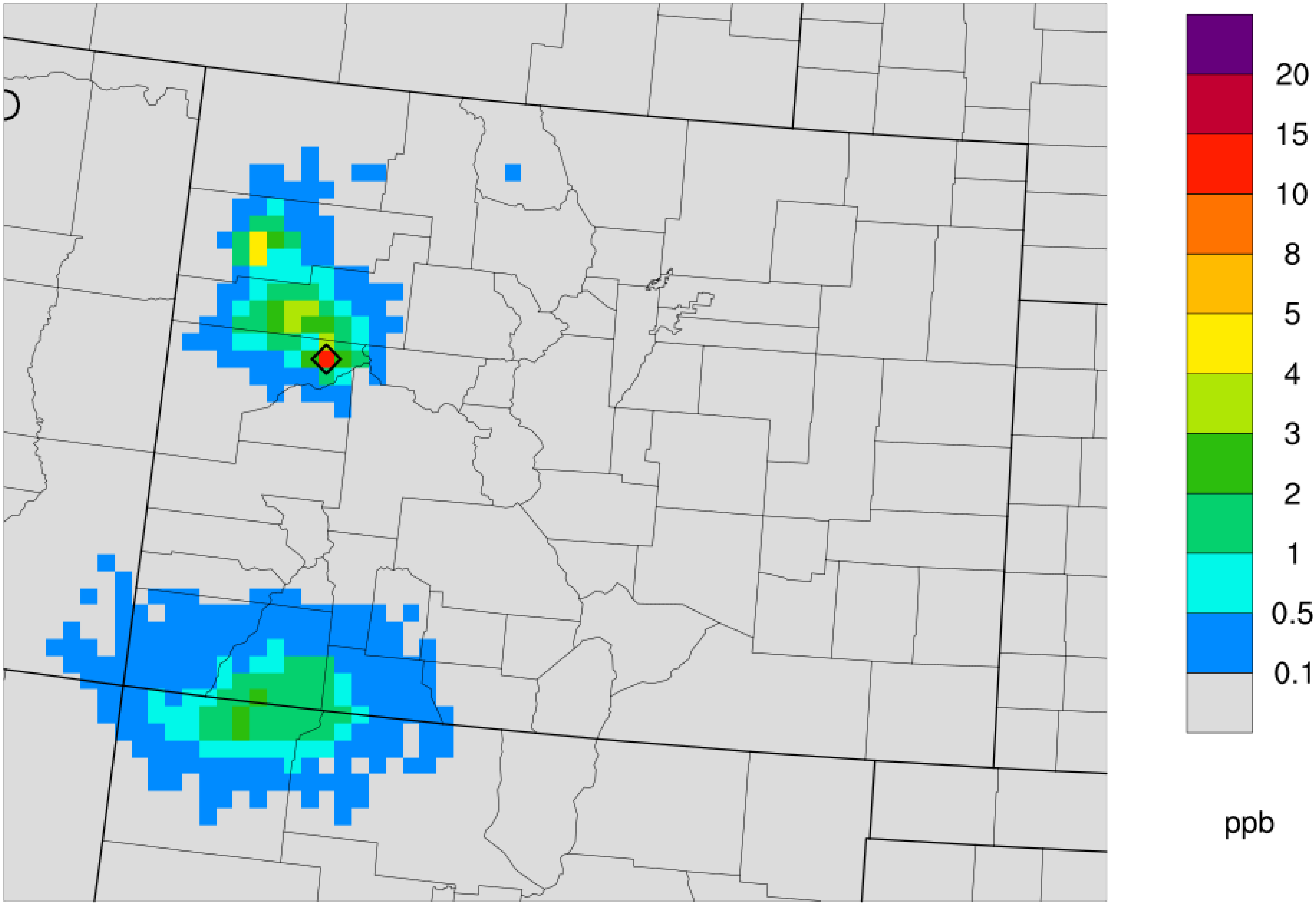


Figure CO.NO2.1h.5
98th percentile daily max NO_2
OilGas_ExistFed_RoyalGorge



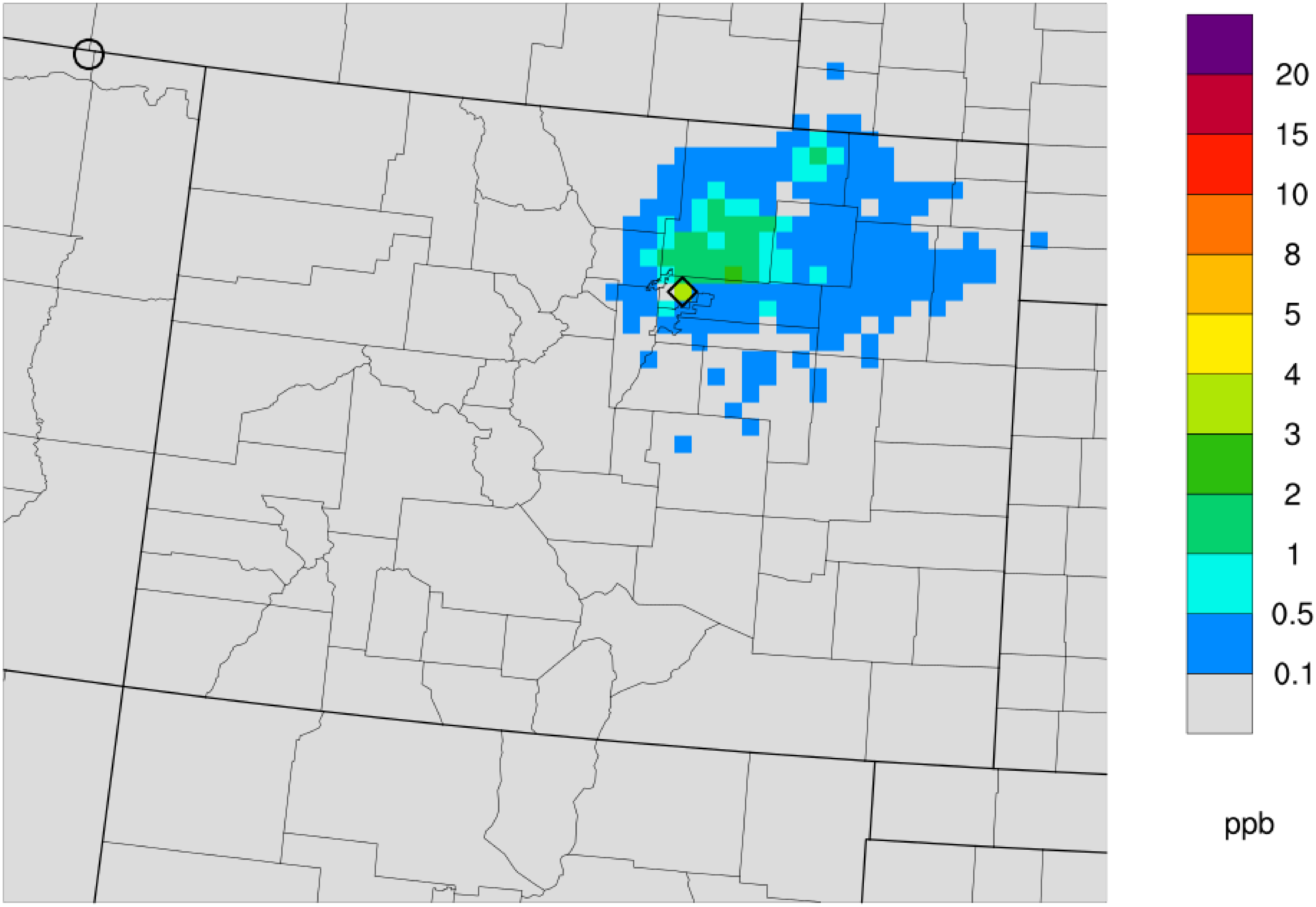
◇ max(42,40) = 0.2 ppb
○ min(6,51) = 0.0 ppb

Figure CO.NO2.1h.6
98th percentile daily max NO_2
OilGas_NewFed_WesternCO



◇ max(20,33) = 10.6 ppb
○ min(1,48) = 0.0 ppb

Figure CO.NO2.1h.7
98th percentile daily max NO_2
OilGas_NewFed_RoyalGorge



◇ max(41,37) = 3.6 ppb
○ min(6,51) = 0.0 ppb

Figure CO.NO2.1h.8
98th percentile daily max NO_2
OilGas_Fed_Other_States

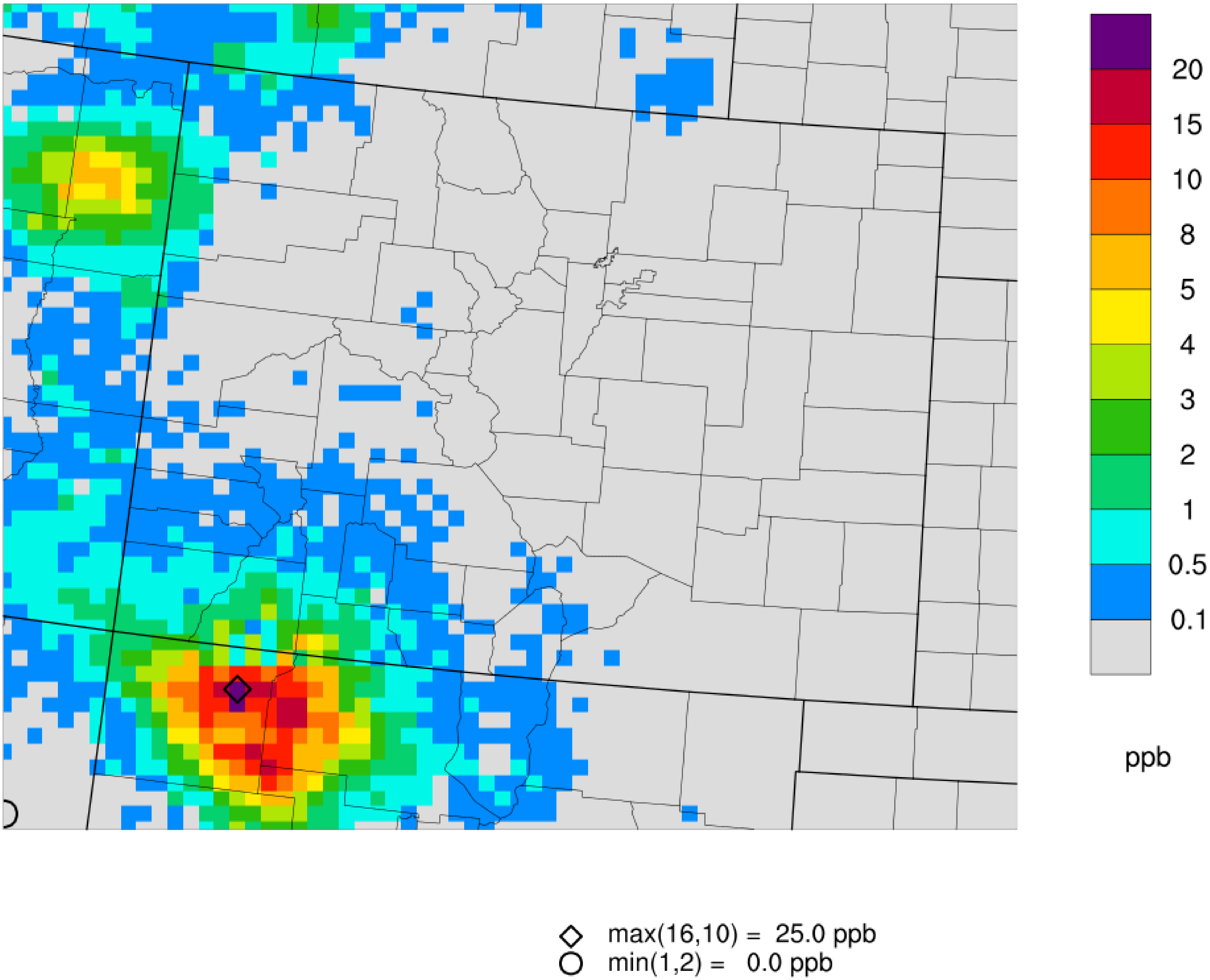


Figure CO.NO2.1h.9
98th percentile daily max NO_2
OilGas_NonFed

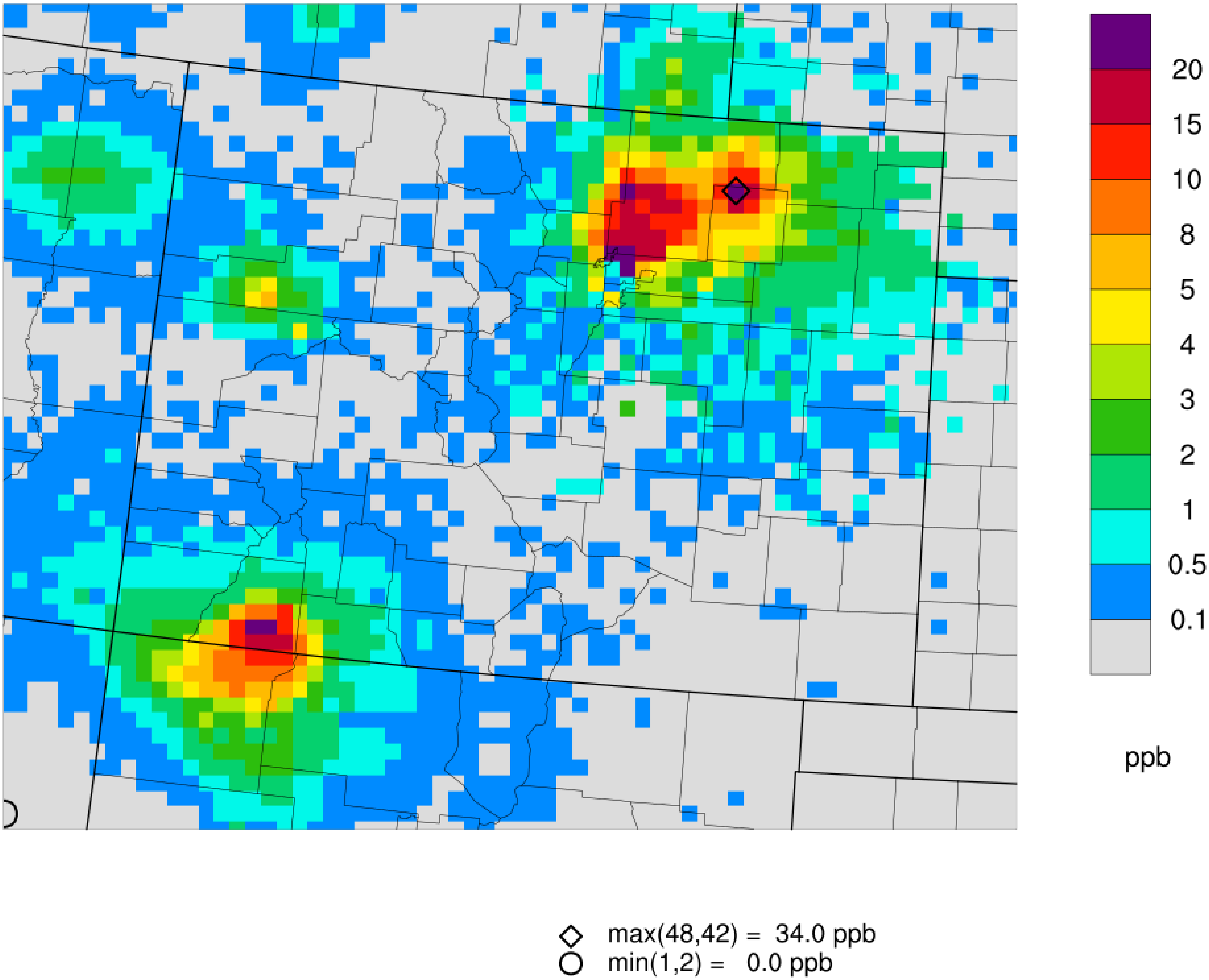


Figure CO.NO2.1h.10
98th percentile daily max NO_2
OilGas_ExistTribal

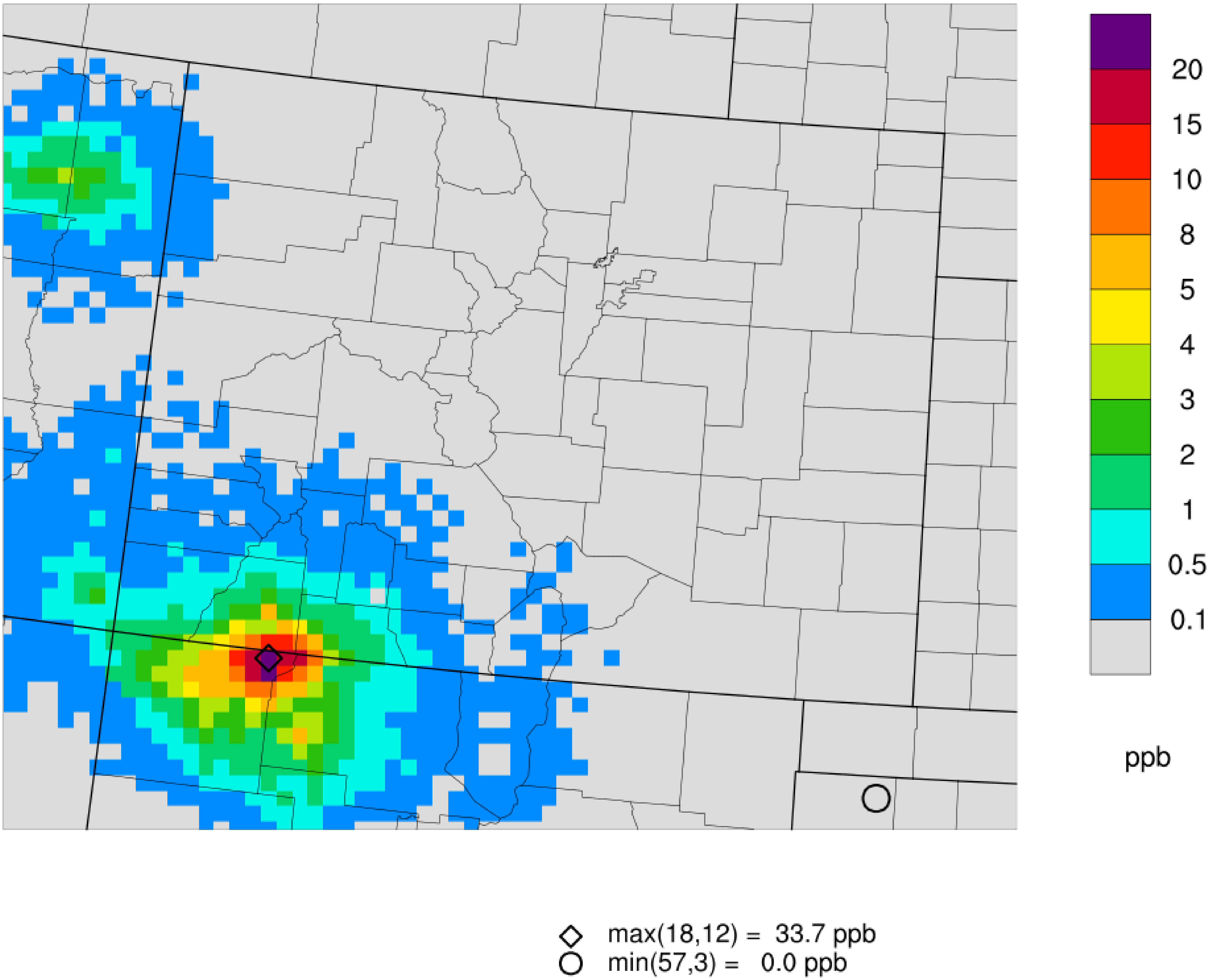


Figure CO.NO2.1h.11
98th percentile daily max NO_2
OilGas_NewTribal

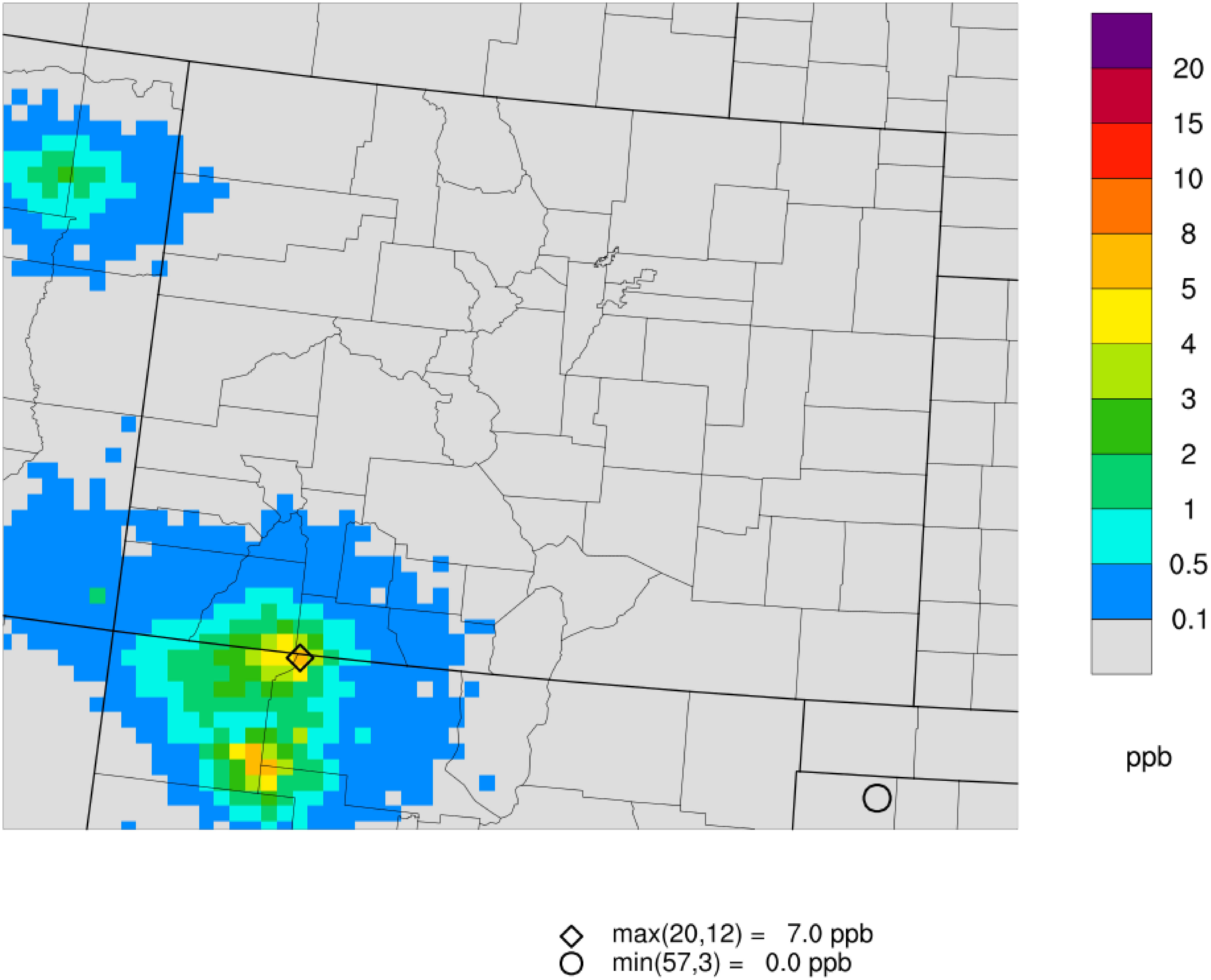
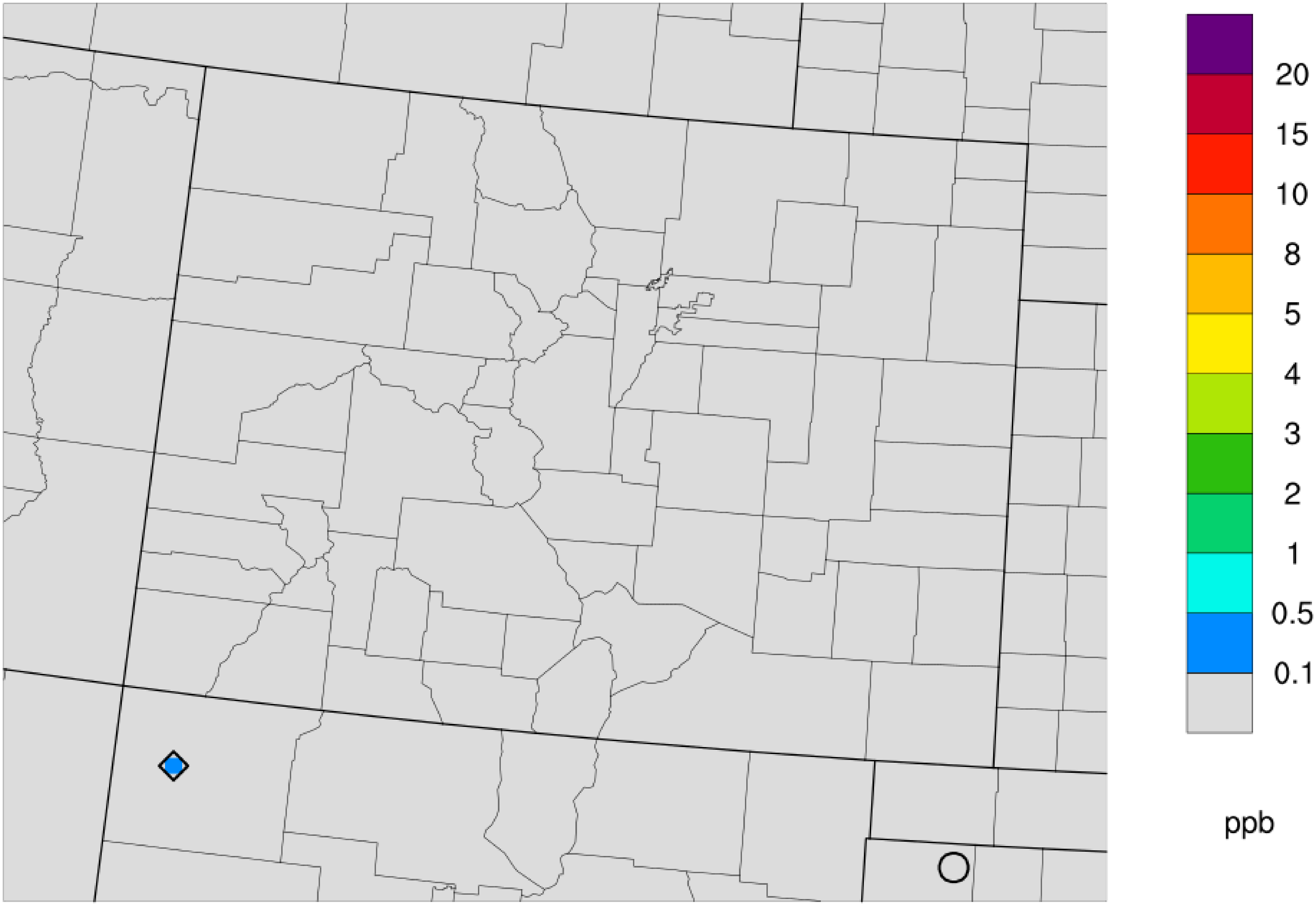
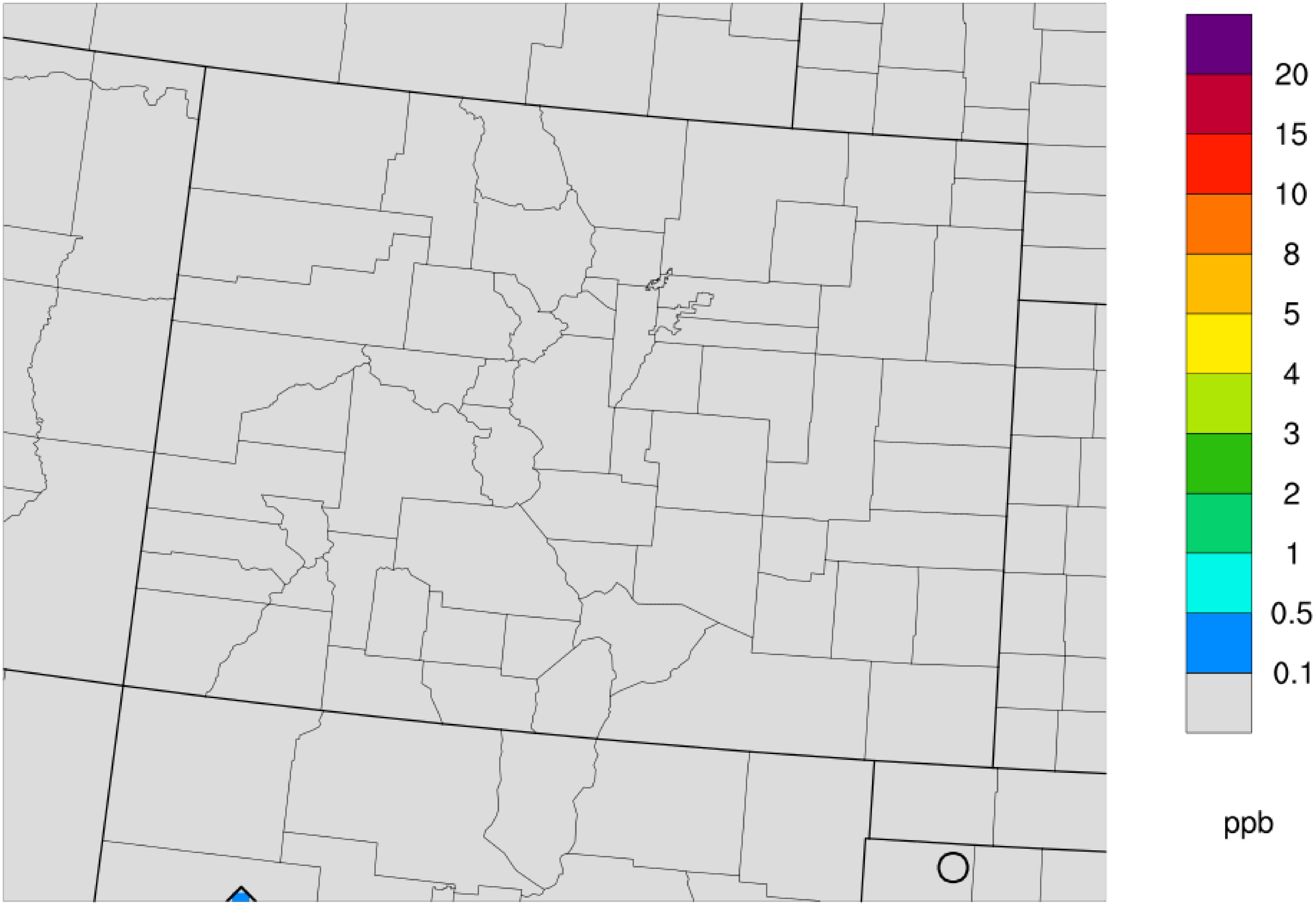


Figure CO.NO2.1h.12
98th percentile daily max NO_2
Coal_Fed



max(11,9) = 0.1 ppb
min(57,3) = 0.0 ppb

Figure CO.NO2.1h.13
98th percentile daily max NO_2
Coal_NonFed



◇ max(15,1) = 0.1 ppb
○ min(57,3) = 0.0 ppb

Figure CO.NO2.1h.14
98th percentile daily max NO_2
Coal_EGU WRAP states

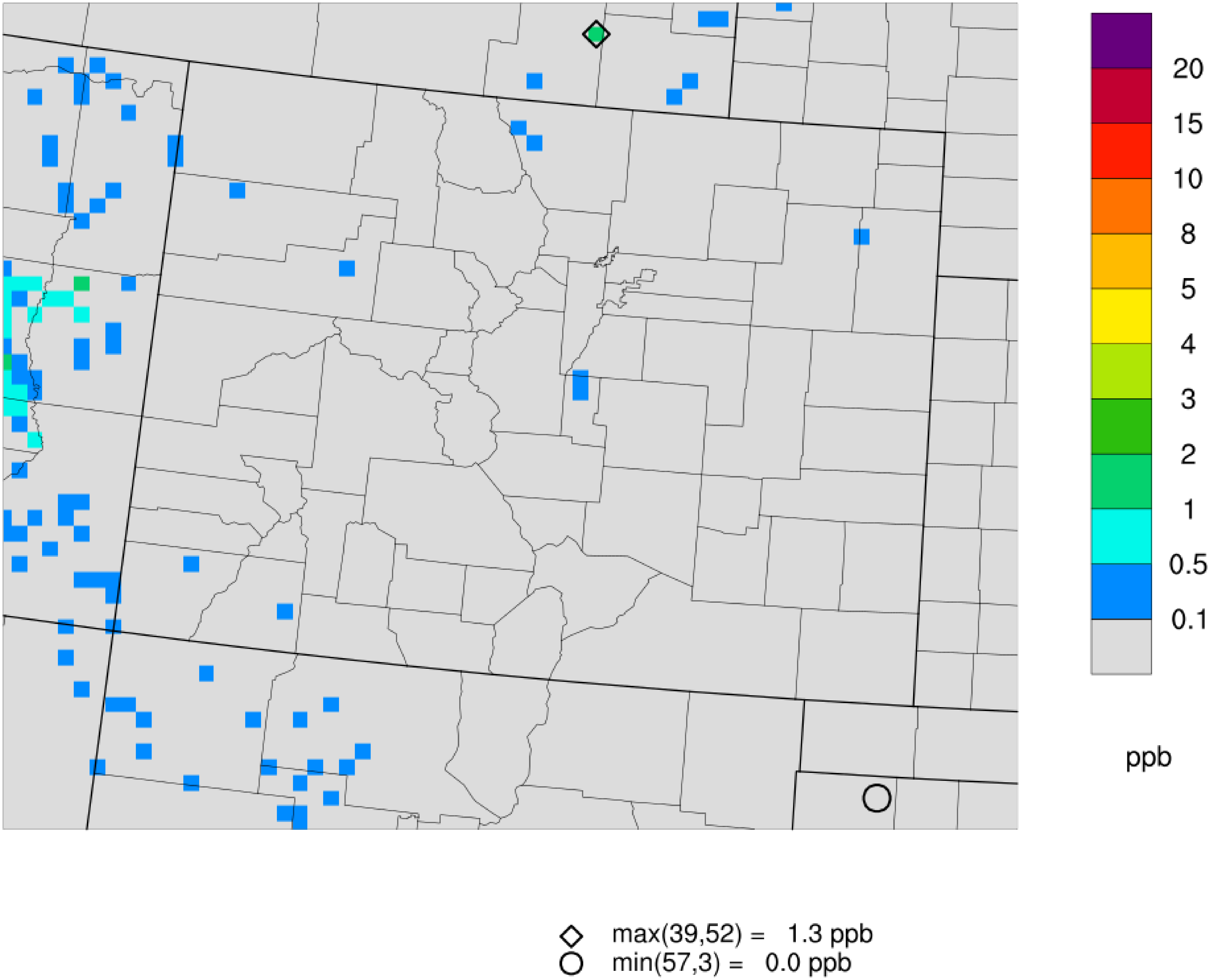


Figure CO.NO2.1h.15
98th percentile daily max NO_2
Coal_Comb WRAP states

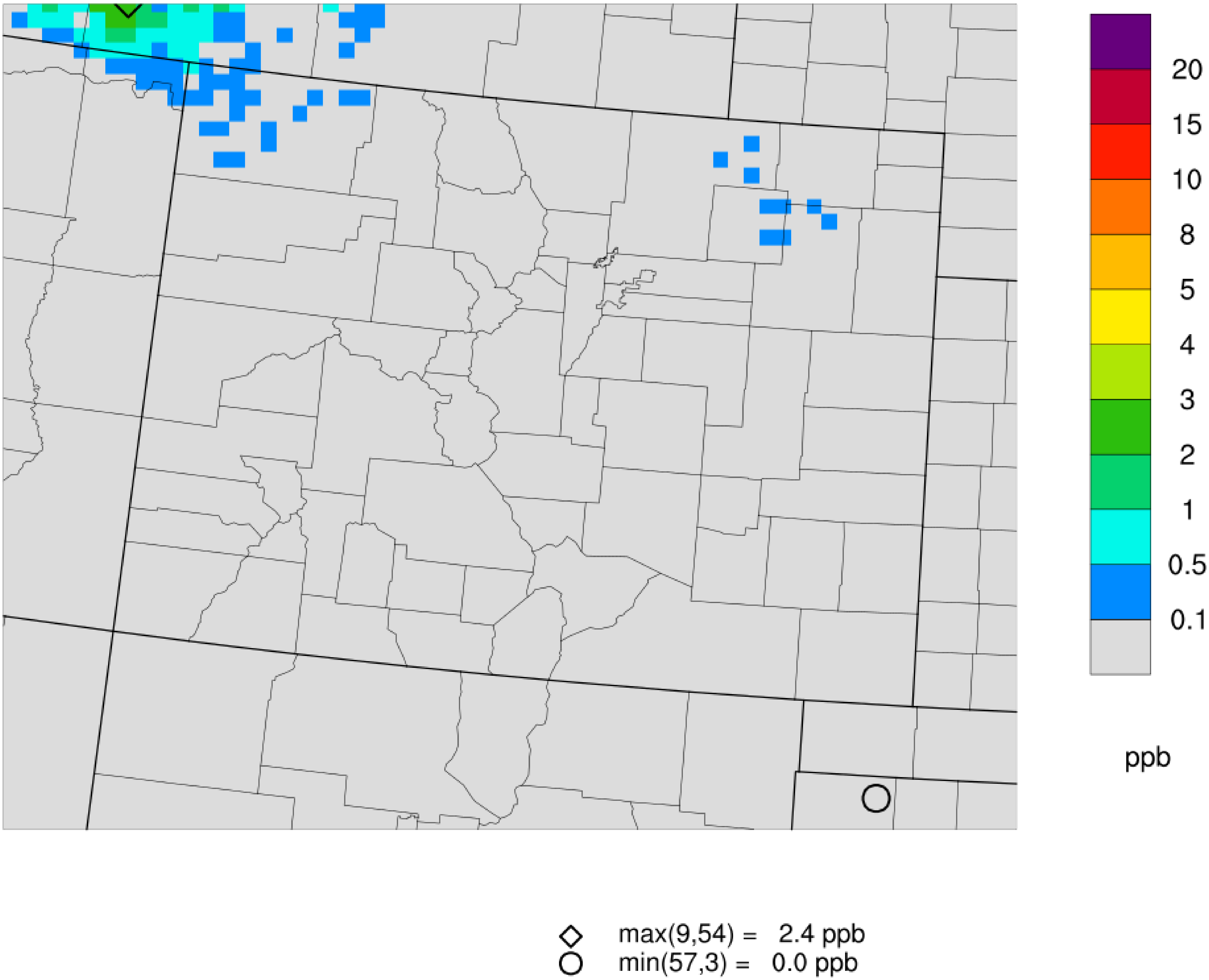


Figure CO.NO2.1h.16
98th percentile daily max NO_2
OtherEGU

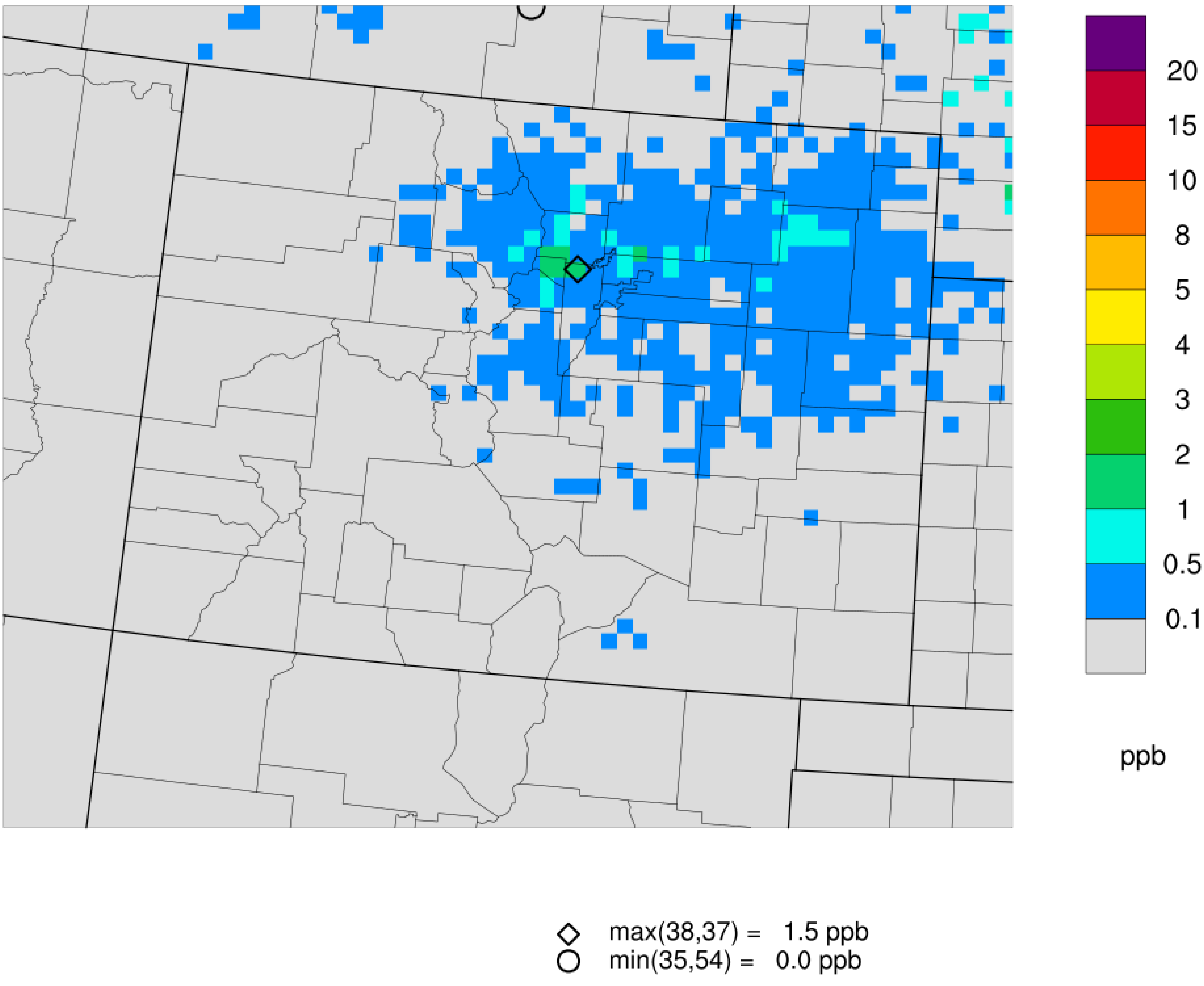
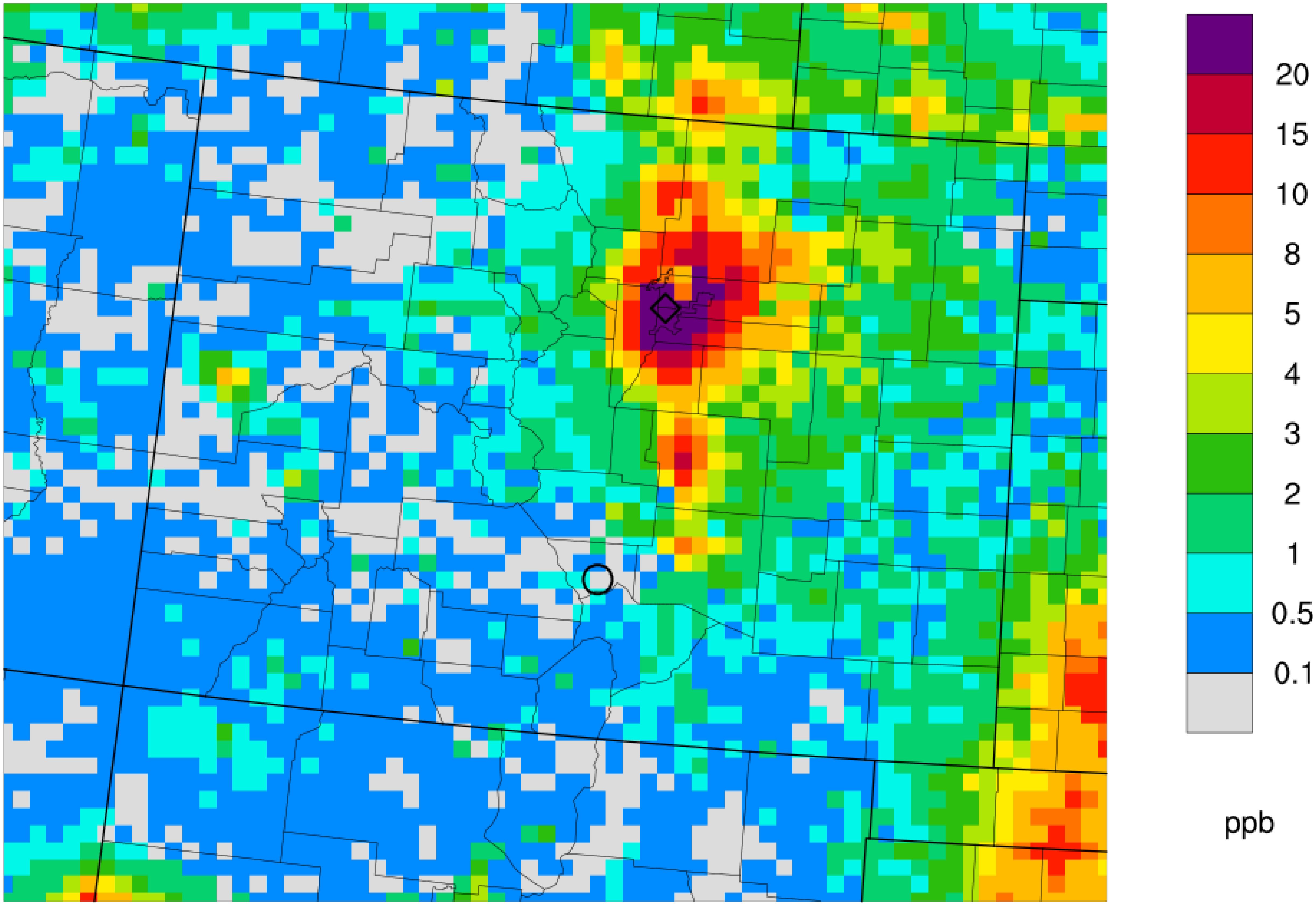
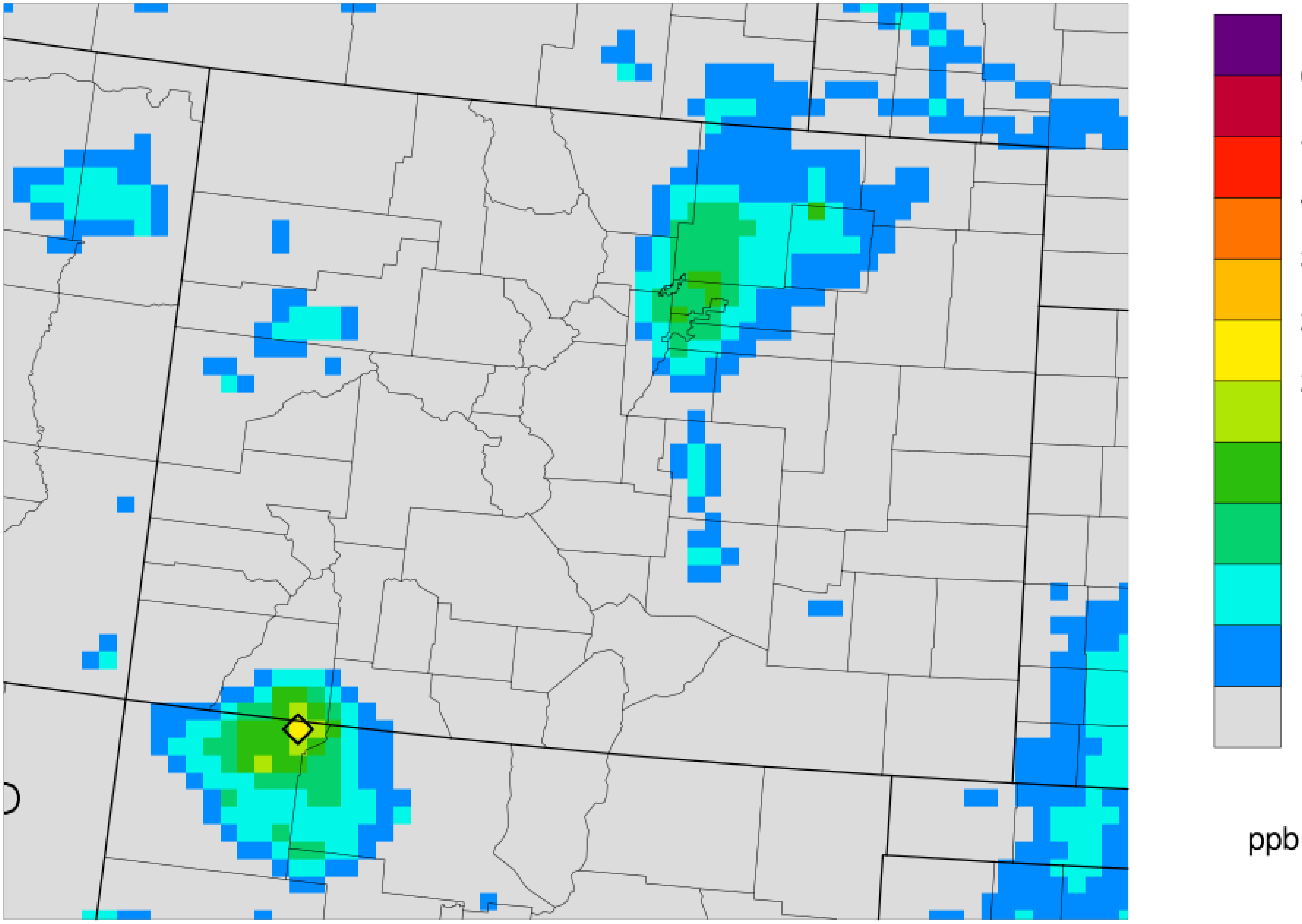


Figure CO.NO2.1h.17
98th percentile daily max NO_2
Anthro_Rest



◇ max(40,36) = 42.8 ppb
○ min(36,20) = 0.0 ppb

Figure CO.NO2.ann.1
Annual Average NO_2
Cumulative, CO



◇ max(18,12) = 23.9 ppb
○ min(1,8) = 0.1 ppb

Figure CO.NO2.ann.2
Annual Average NO_2
Natural

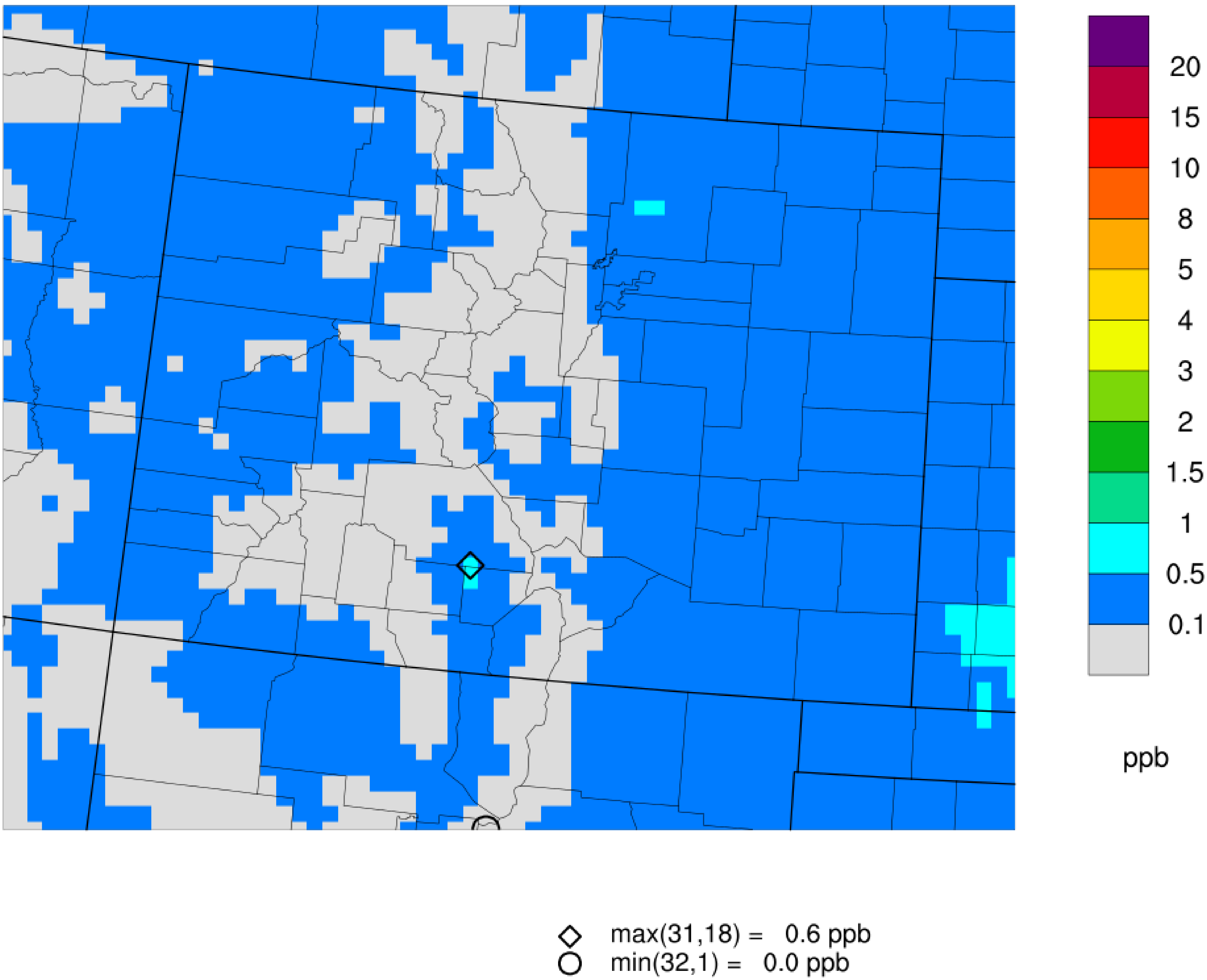


Figure CO.NO2.ann.3
Annual Average NO_2
Wildfire

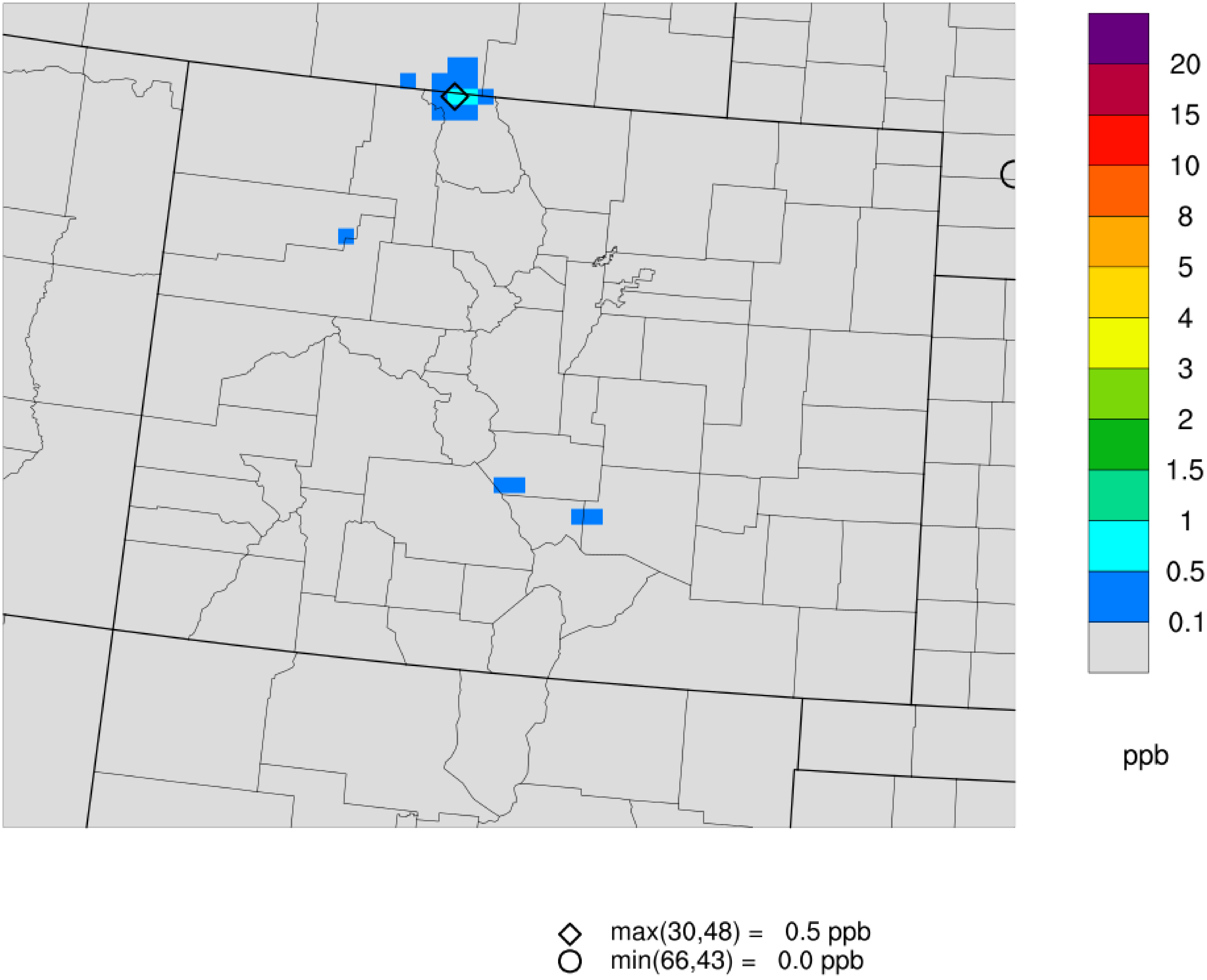


Figure CO.NO2.ann.4
Annual Average NO_2
OilGas_ExistFed_WesternCO

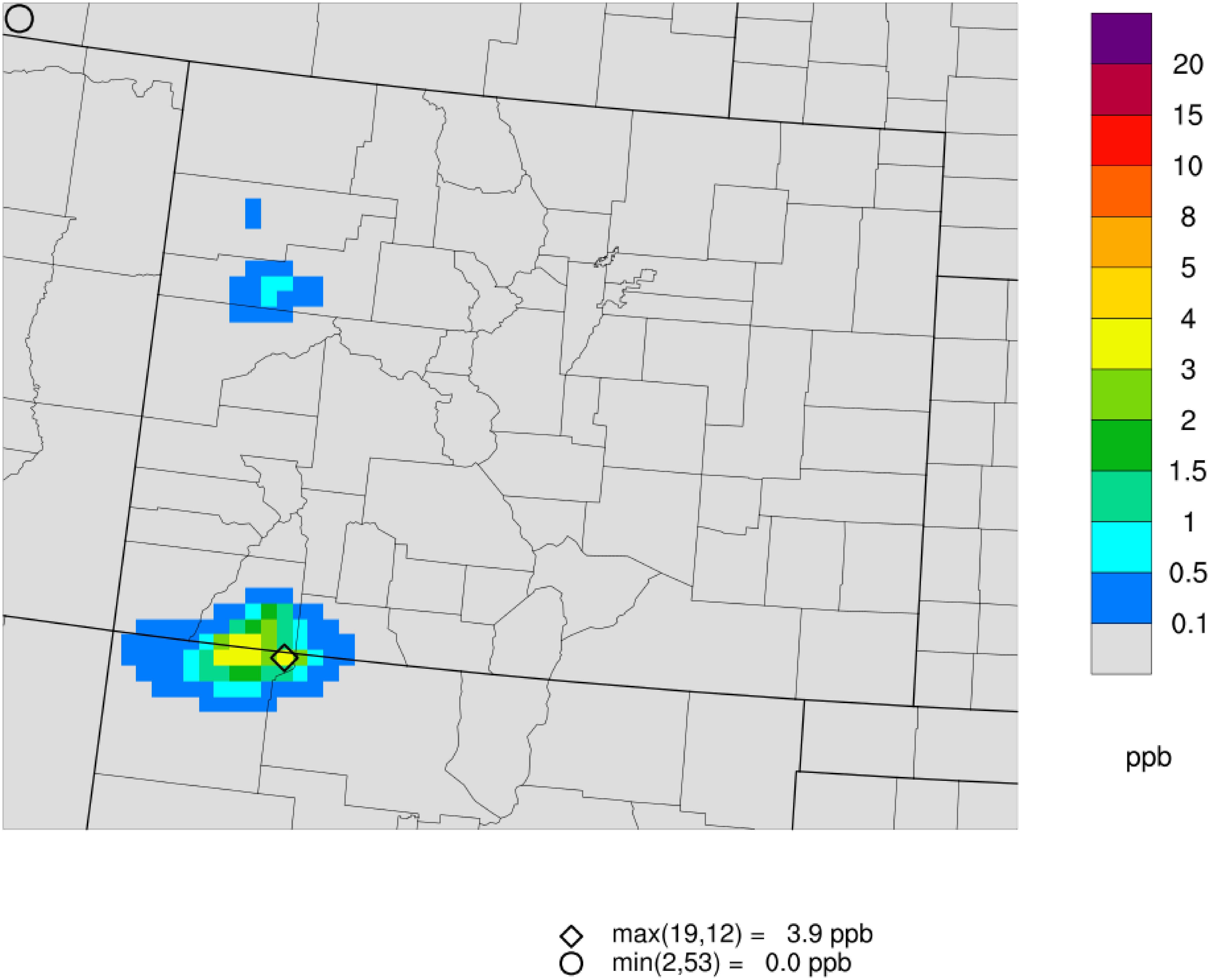
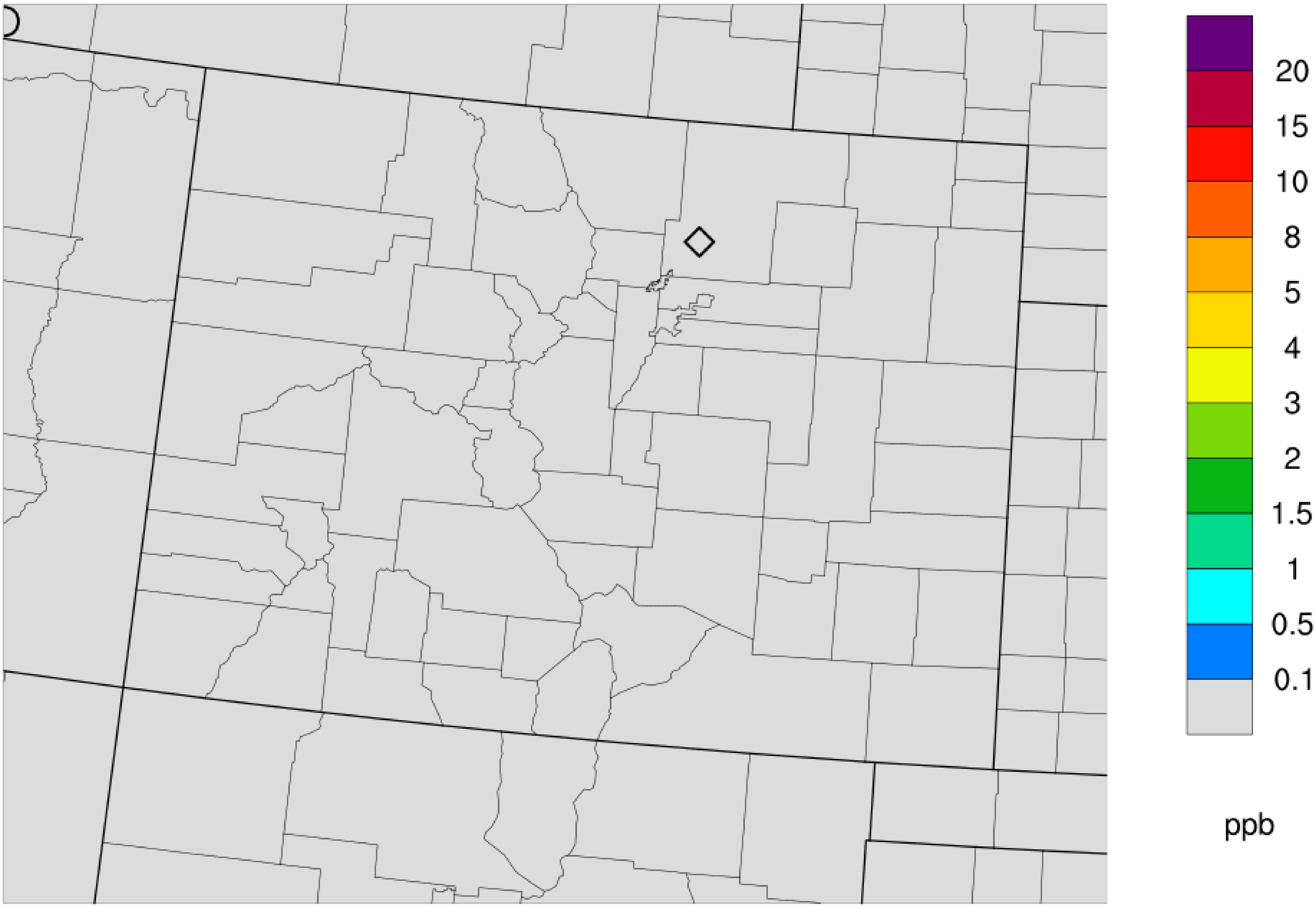


Figure CO.NO2.ann.5
Annual Average NO_2
OilGas_ExistFed_RoyalGorge



◇ max(42,40) = 0.1 ppb
○ min(1,53) = 0.0 ppb

Figure CO.NO2.ann.6
Annual Average NO_2
OilGas_NewFed_WesternCO

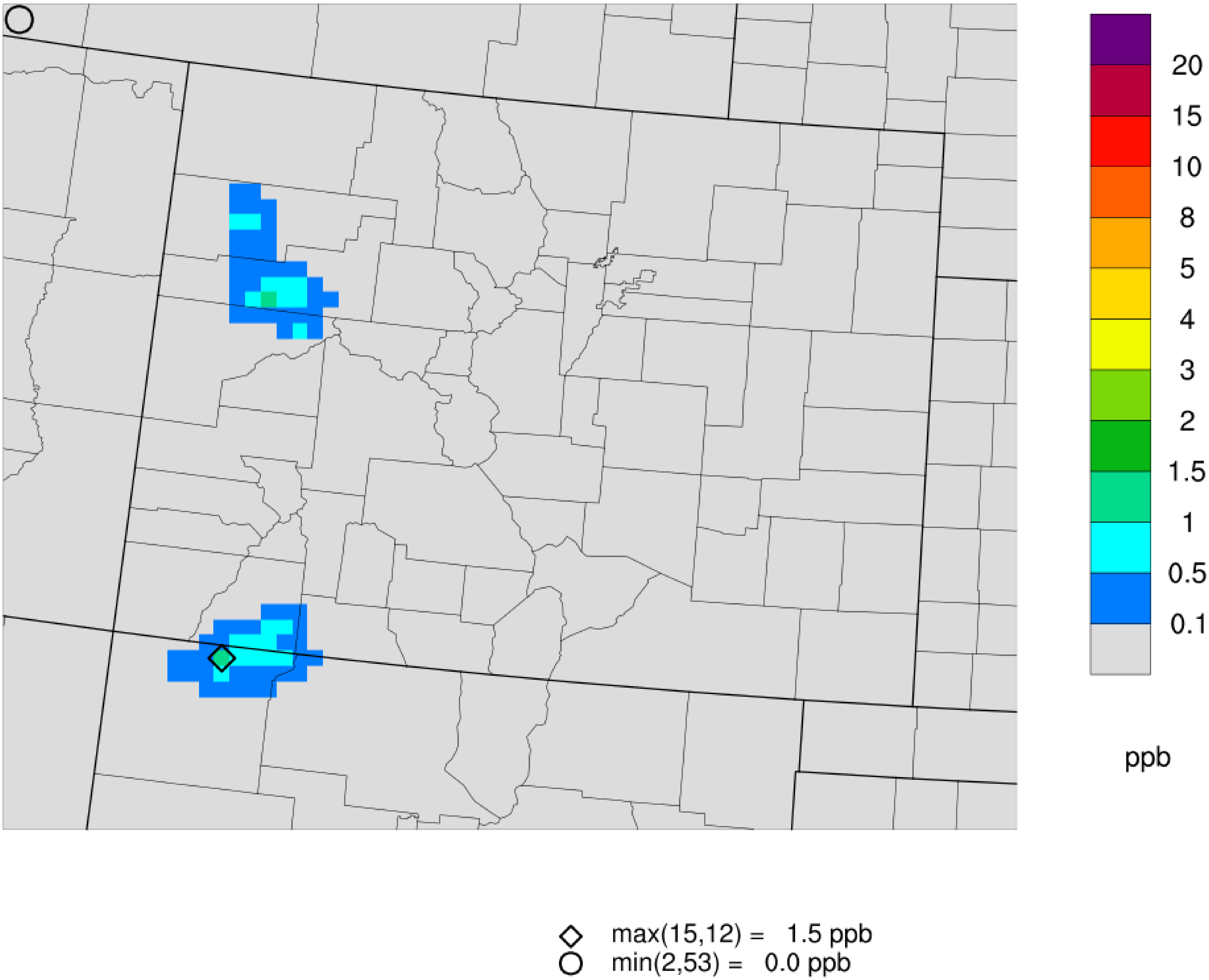
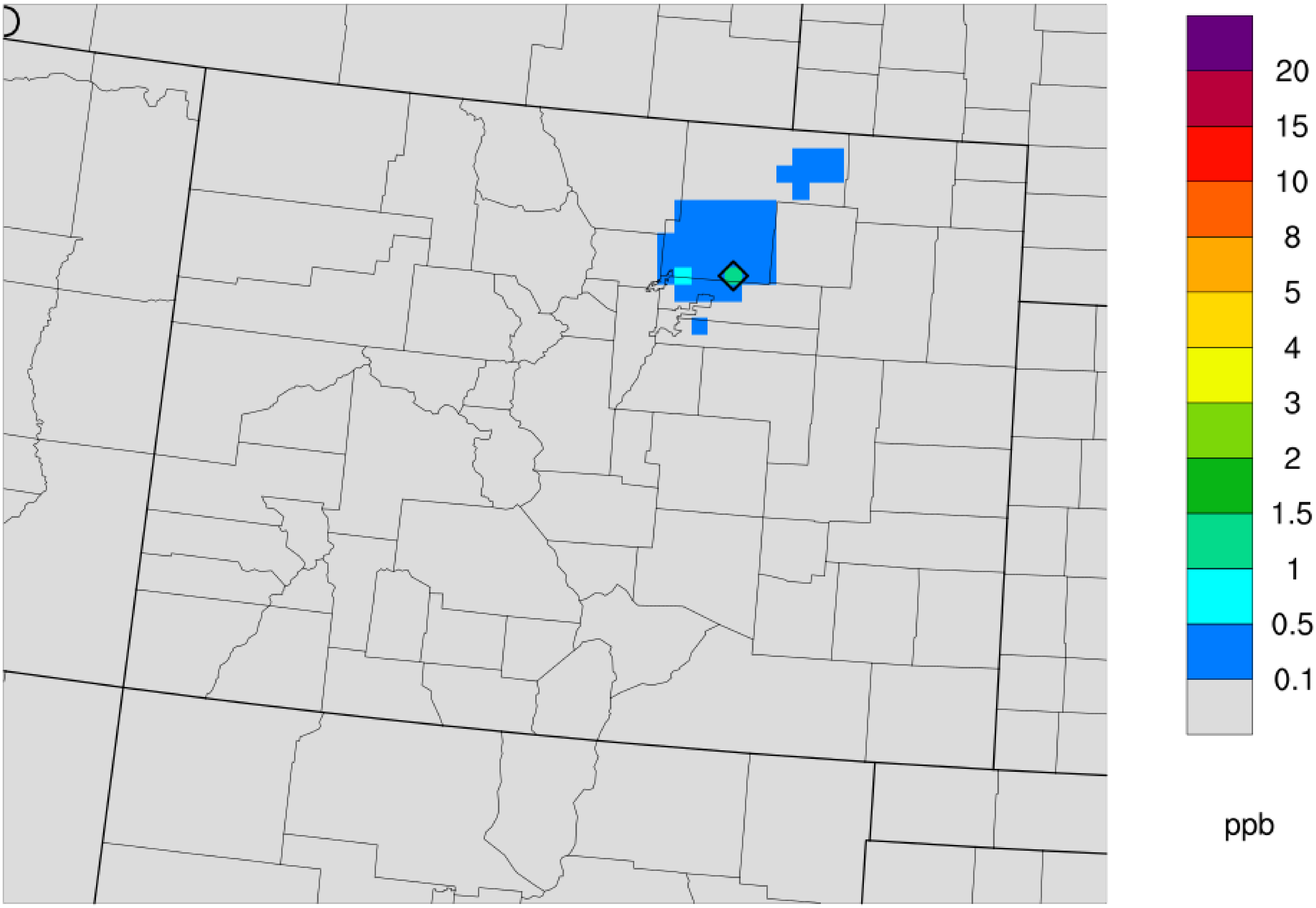


Figure CO.NO2.ann.7
Annual Average NO_2
OilGas_NewFed_RoyalGorge



max(44,38) = 1.3 ppb
min(1,53) = 0.0 ppb

Figure CO.NO2.ann.8
Annual Average NO_2
OilGas_Fed_Other_States

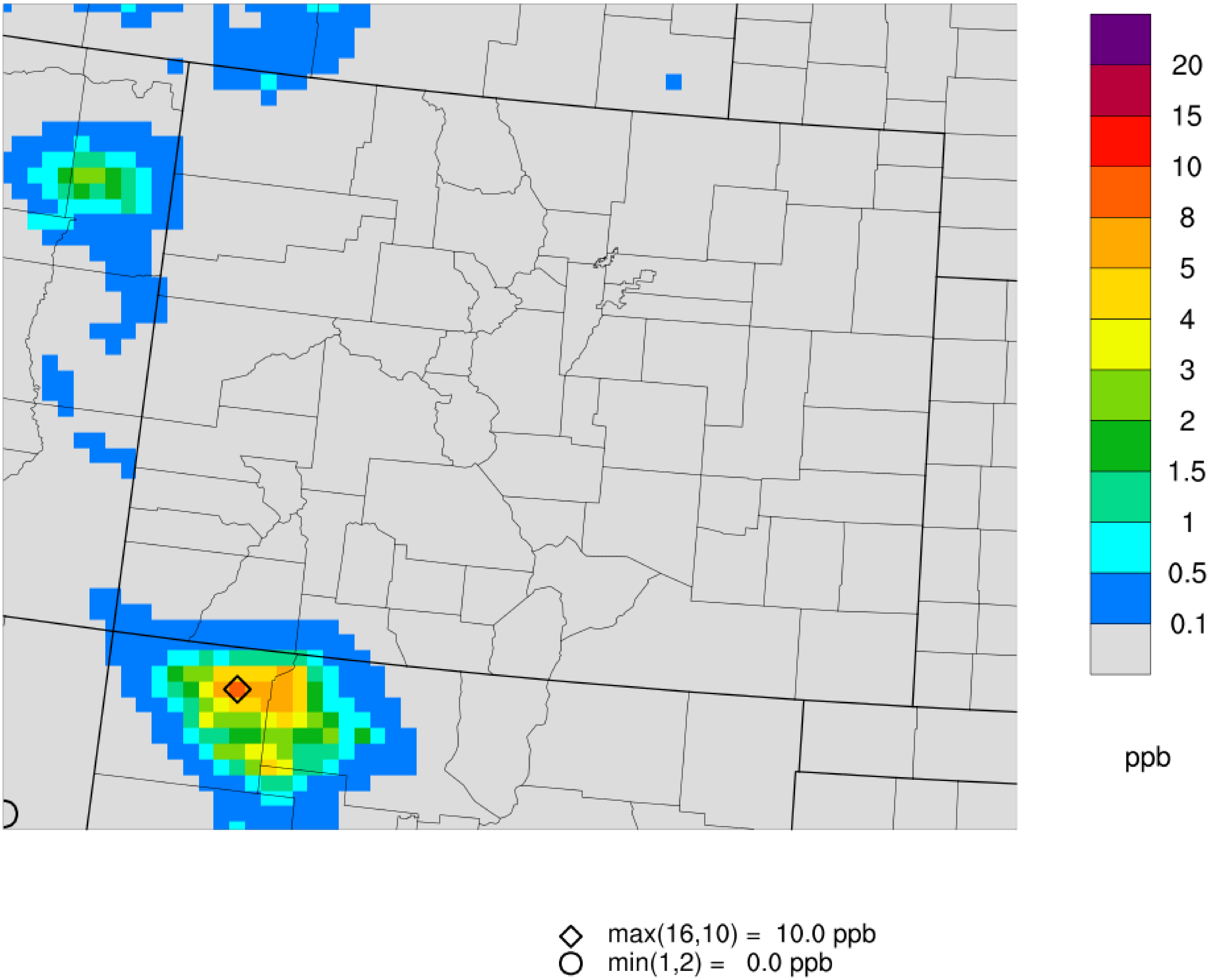


Figure CO.NO2.ann.9
Annual Average NO_2
OilGas_NonFed

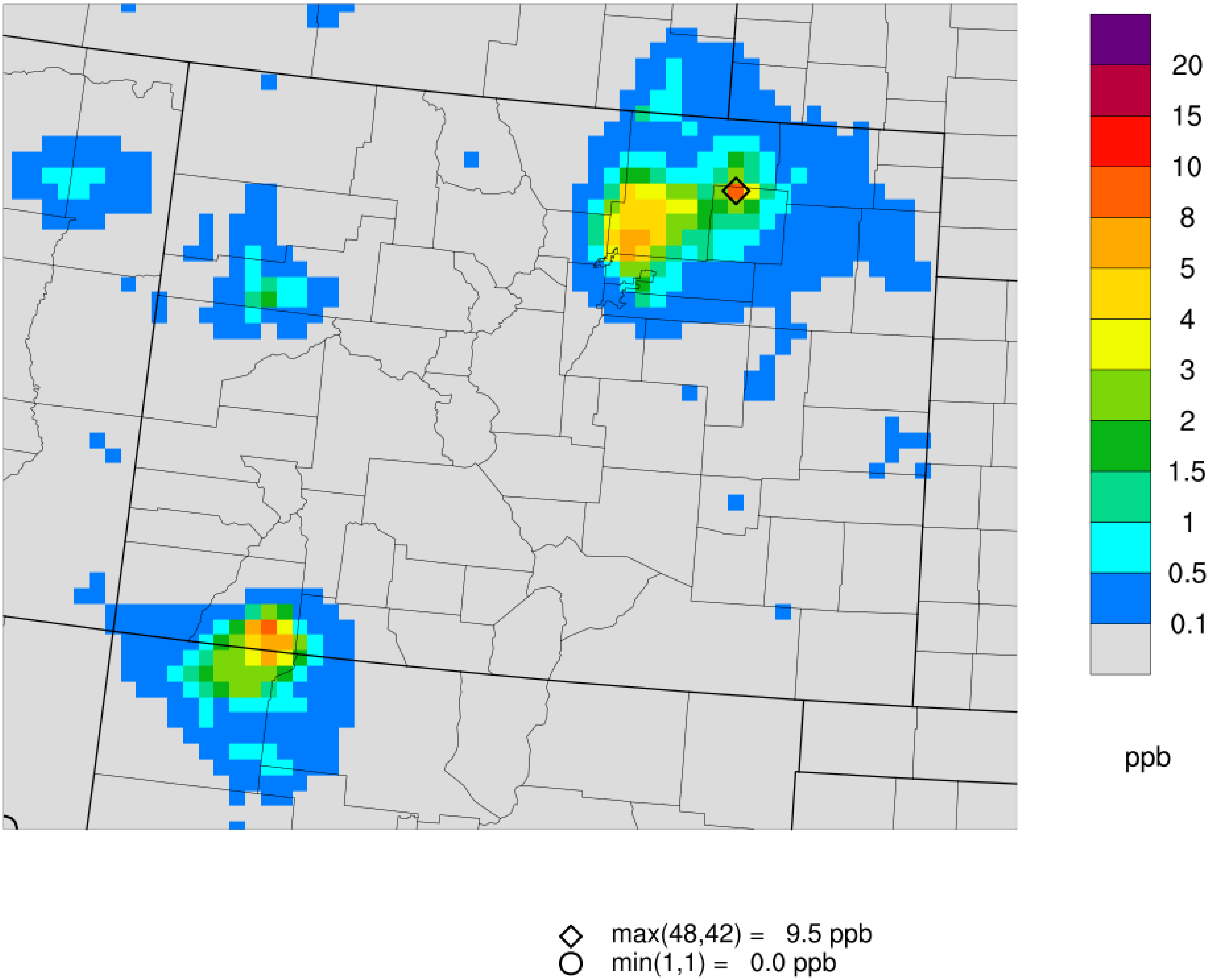
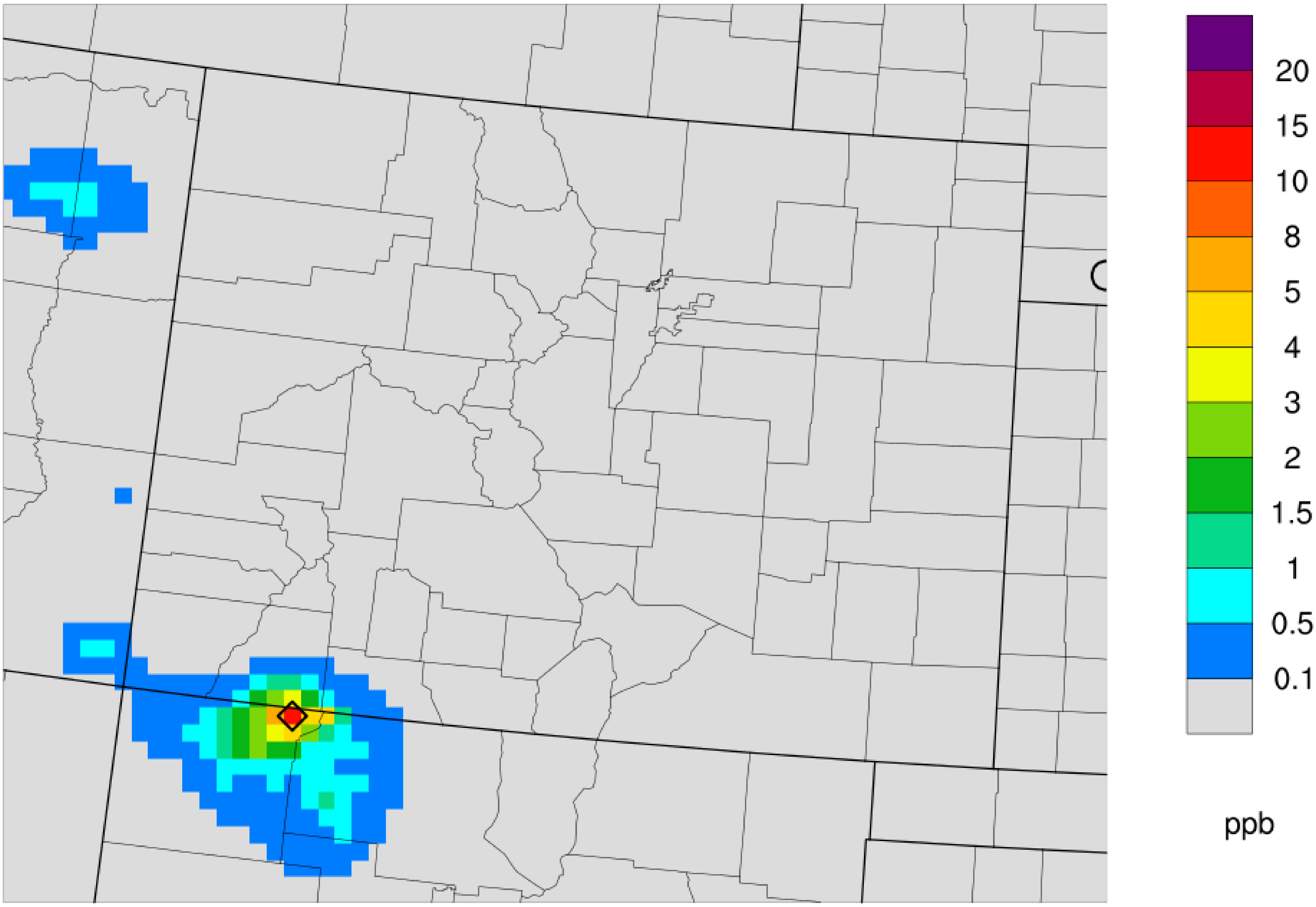
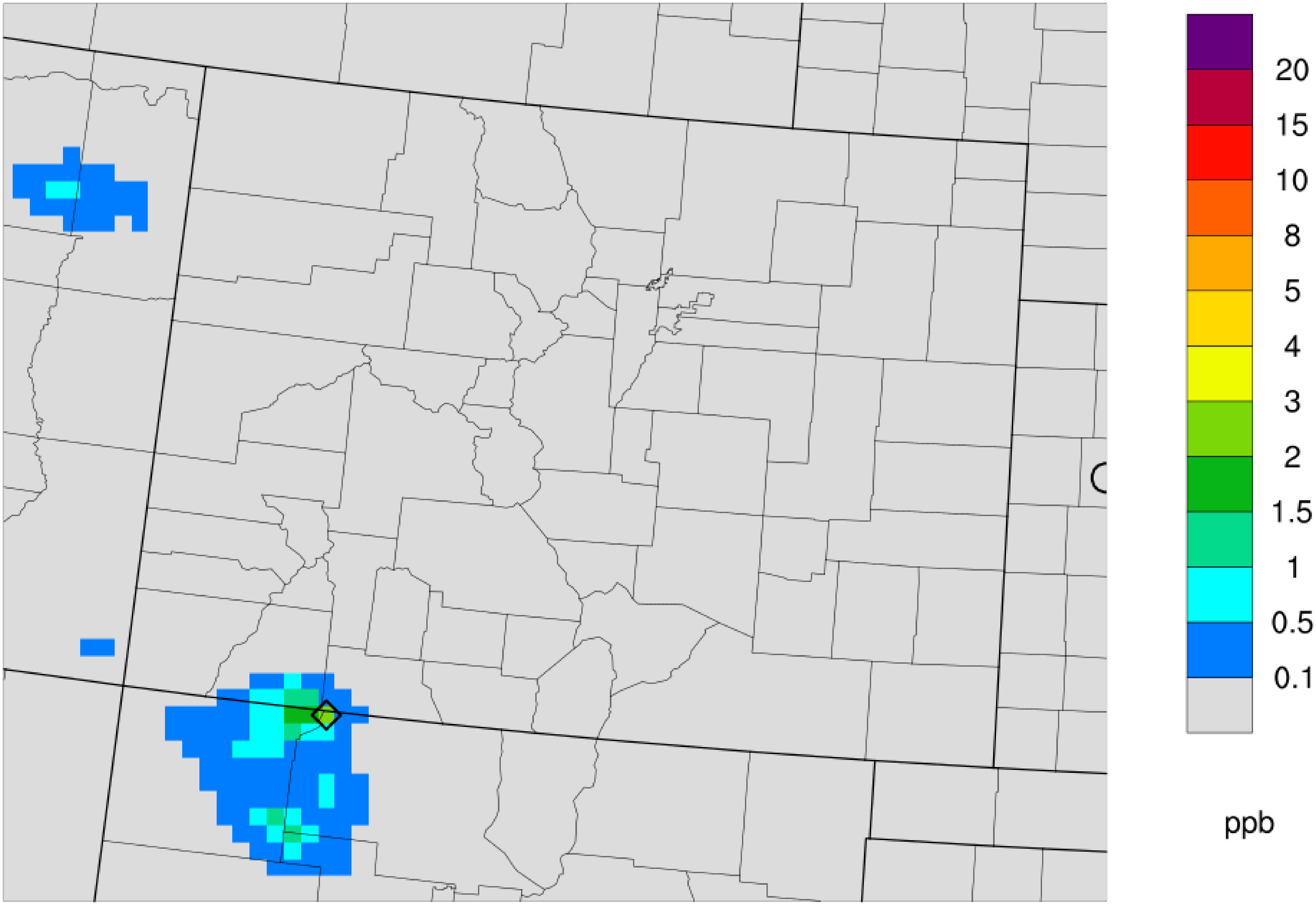


Figure CO.NO2.ann.10
Annual Average NO_2
OilGas_ExistTribal



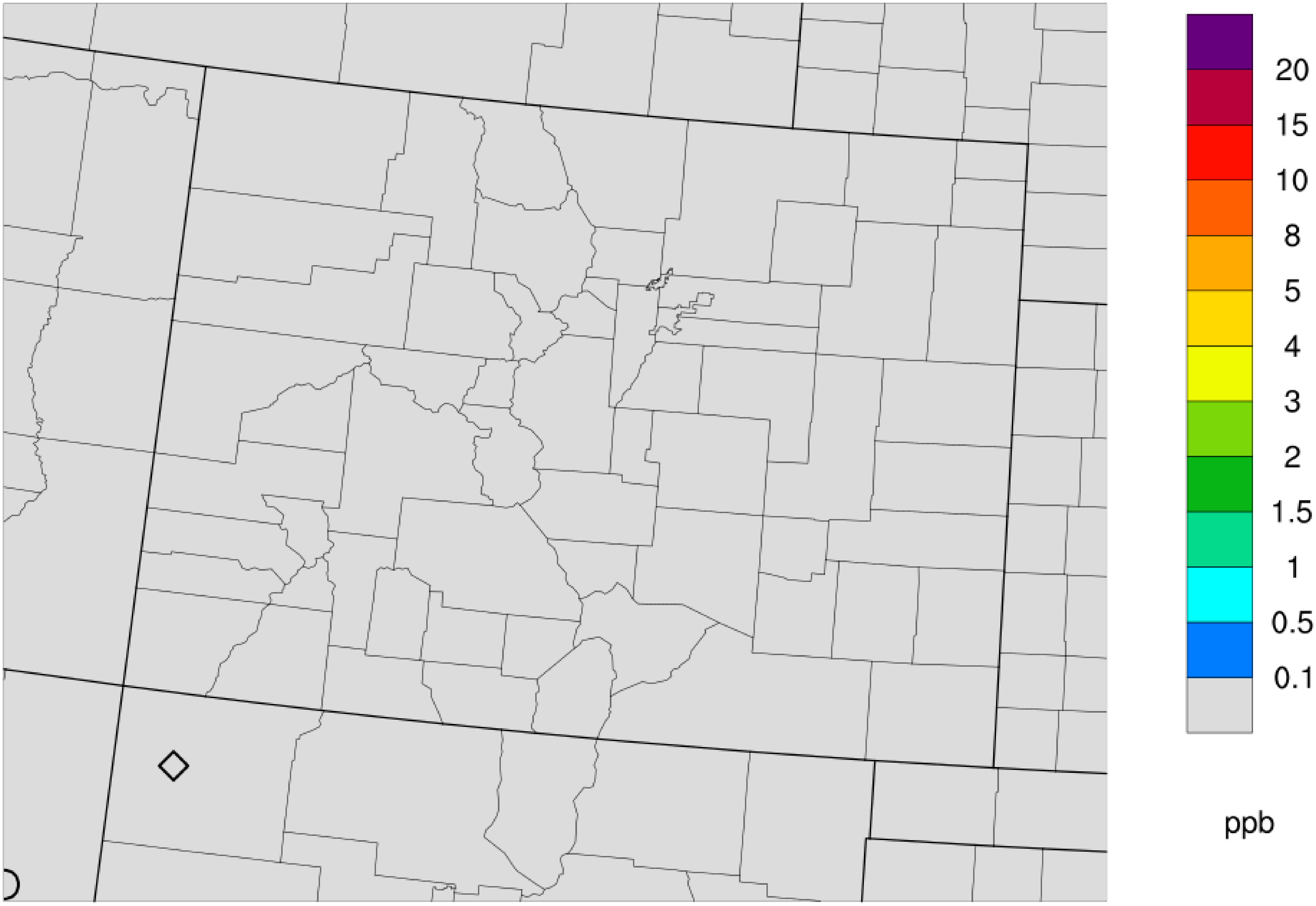
◇ max(18,12) = 11.9 ppb
○ min(66,38) = 0.0 ppb

Figure CO.NO2.ann.11
Annual Average NO_2
OilGas_NewTribal



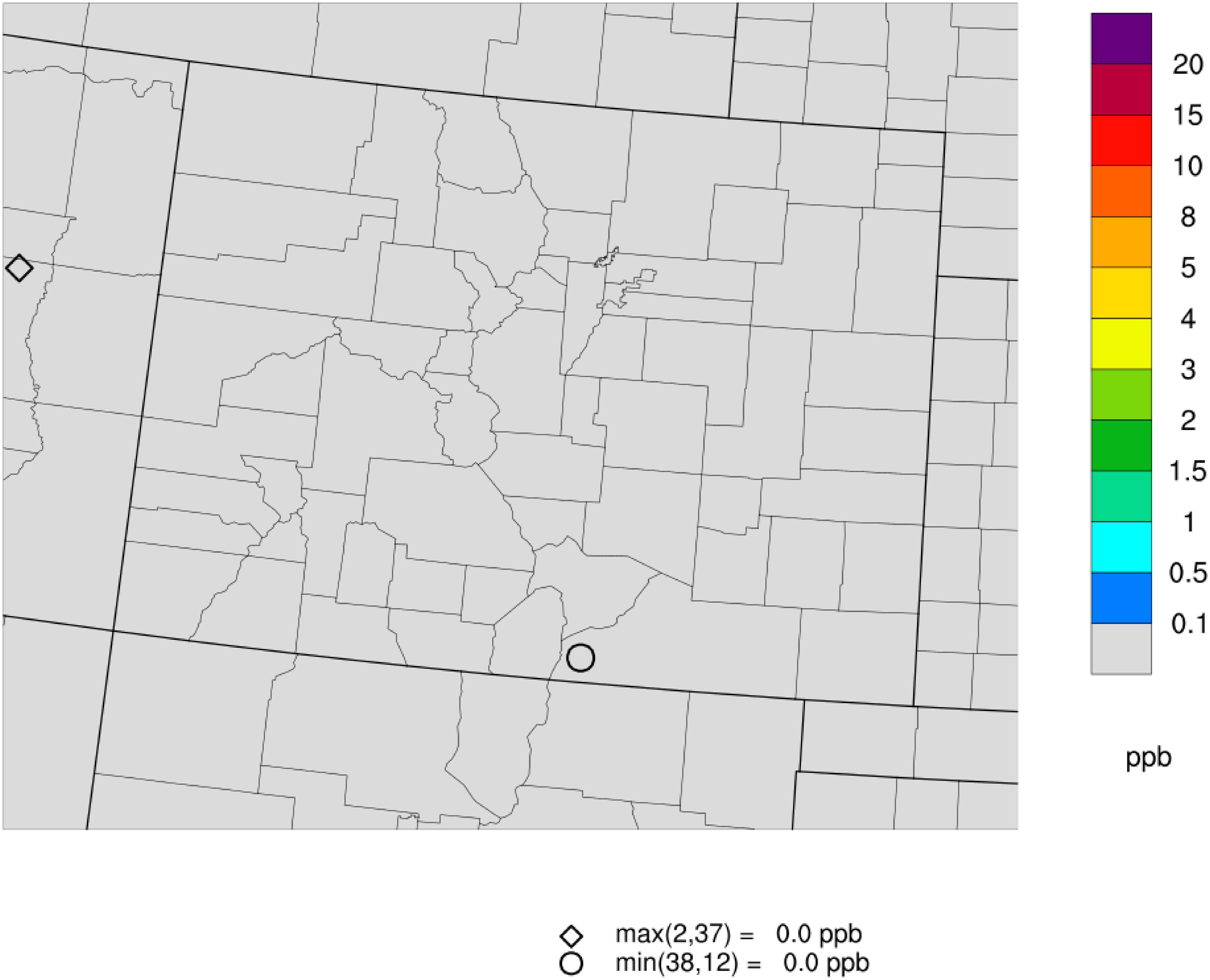
◇ max(20,12) = 2.6 ppb
○ min(66,26) = 0.0 ppb

Figure CO.NO2.ann.12
Annual Average NO_2
Coal_Fed



◇ max(11,9) = 0.1 ppb
○ min(1,2) = 0.0 ppb

Figure CO.NO2.ann.13
Annual Average NO_2
Coal_NonFed



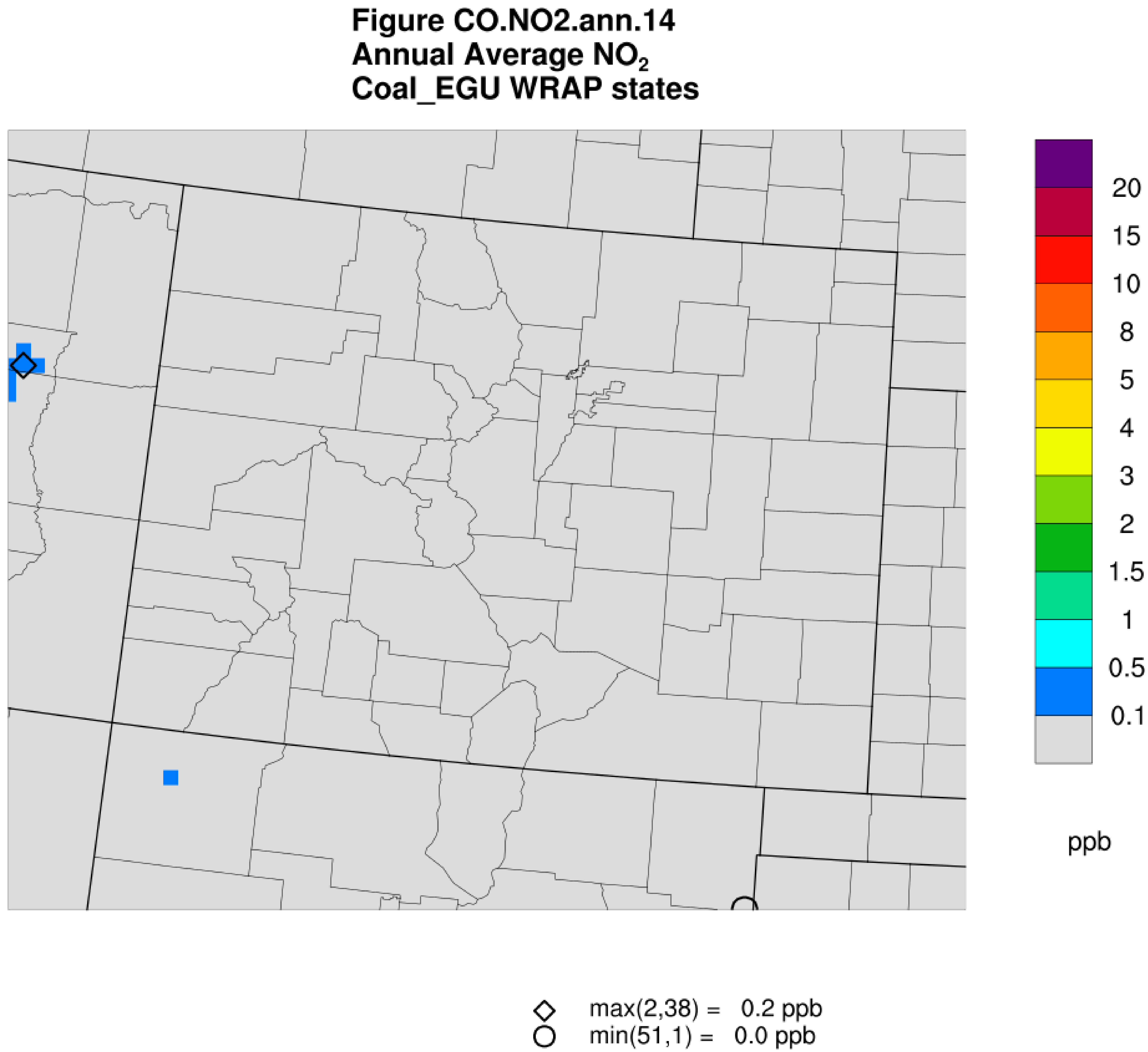


Figure CO.NO2.ann.14
Annual Average NO_2
Coal_EGU WRAP states
20
15
10
8
5
4
3
2
1.5
1
0.5
0.1
ppb
max(2,38) = 0.2 ppb
min(51,1) = 0.0 ppb

Figure CO.NO2.ann.15
Annual Average NO_2
Coal_Comb WRAP states

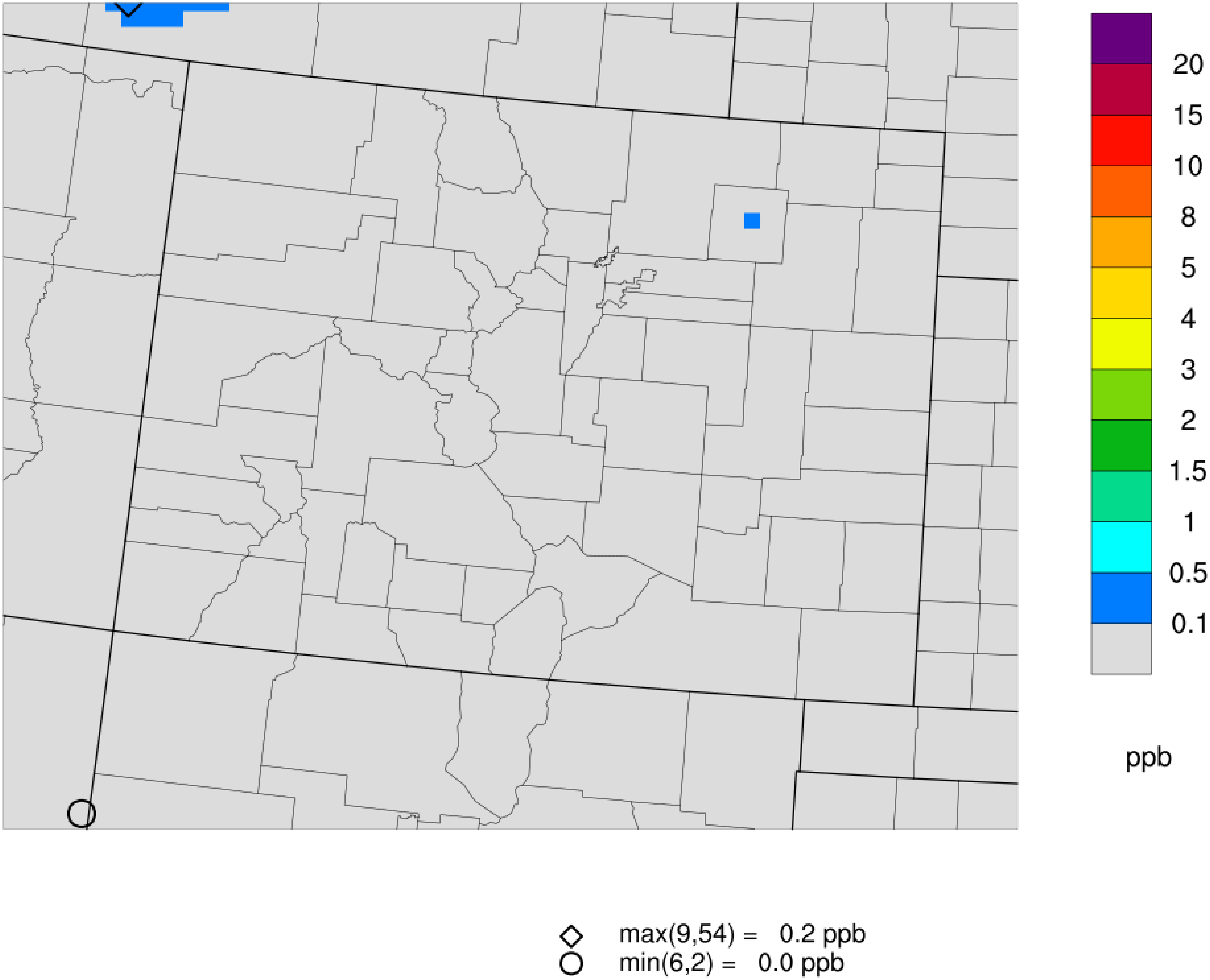
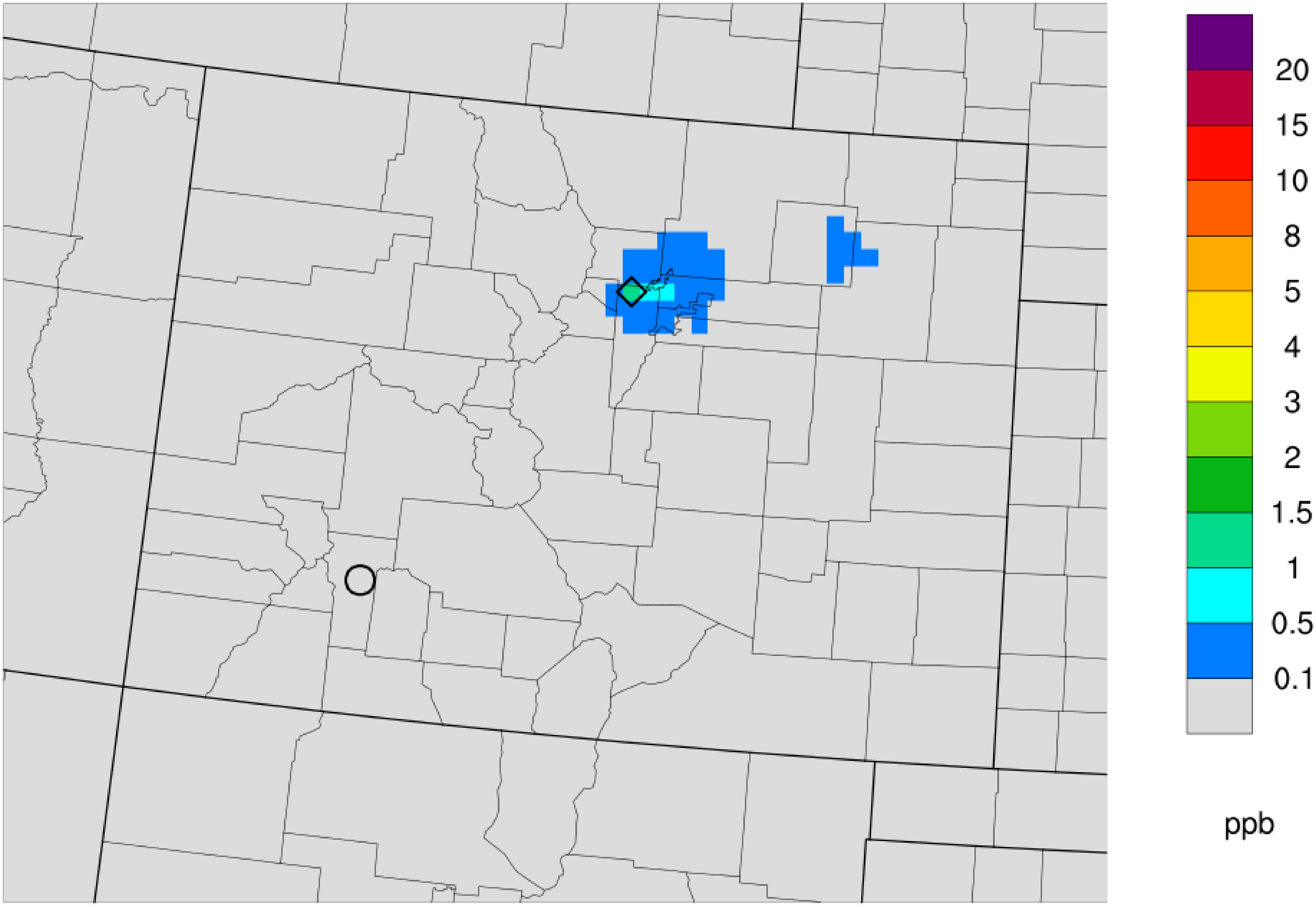


Figure CO.NO2.ann.16
Annual Average NO_2
OtherEGU



max(38,37) = 1.1 ppb
min(22,20) = 0.0 ppb

Figure CO.NO2.ann.17
Annual Average NO_2
Anthro_Rest

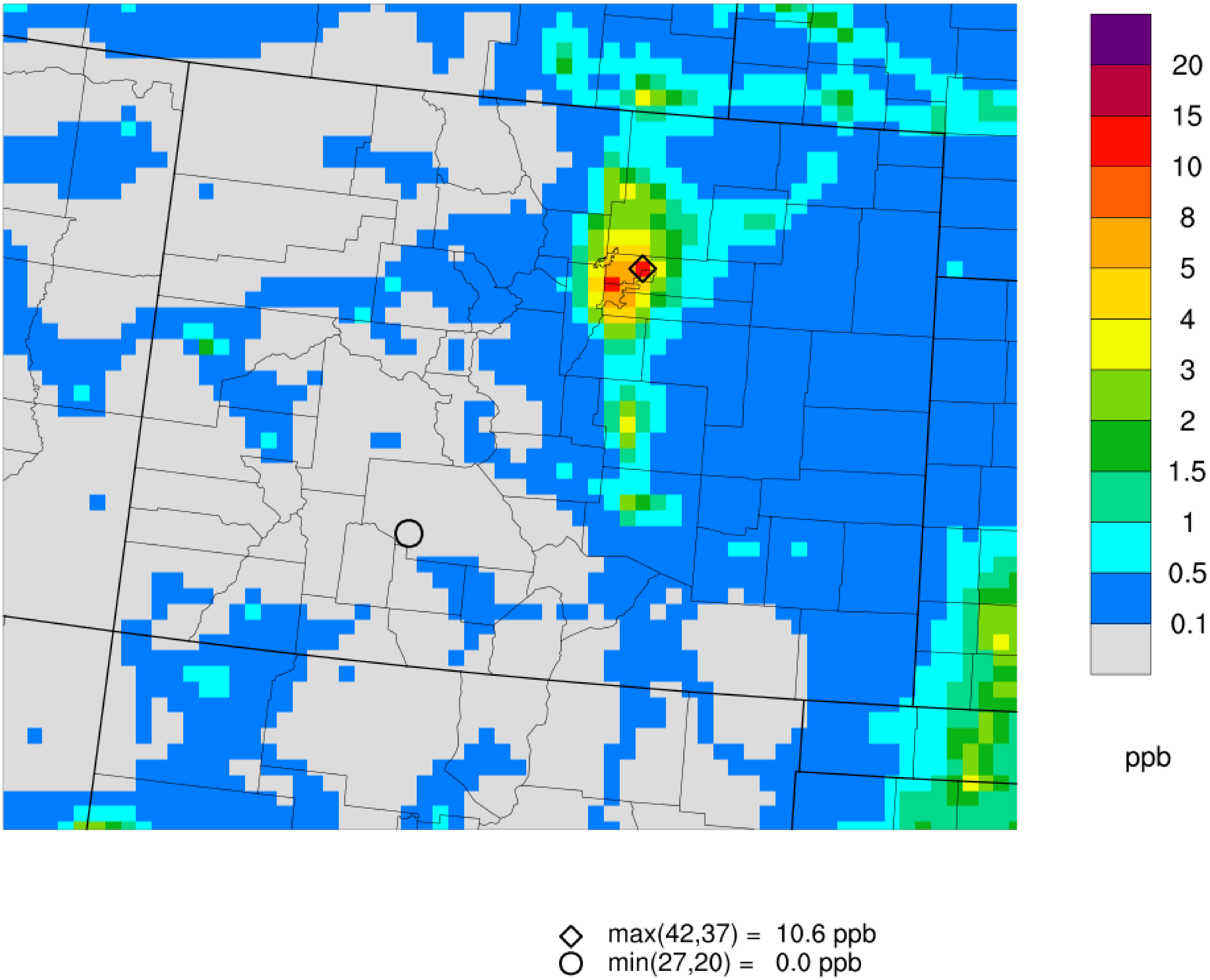


Figure CO.O3.1
4th High Daily Max 8 Hour Avg Ozone
Cumulative, CO

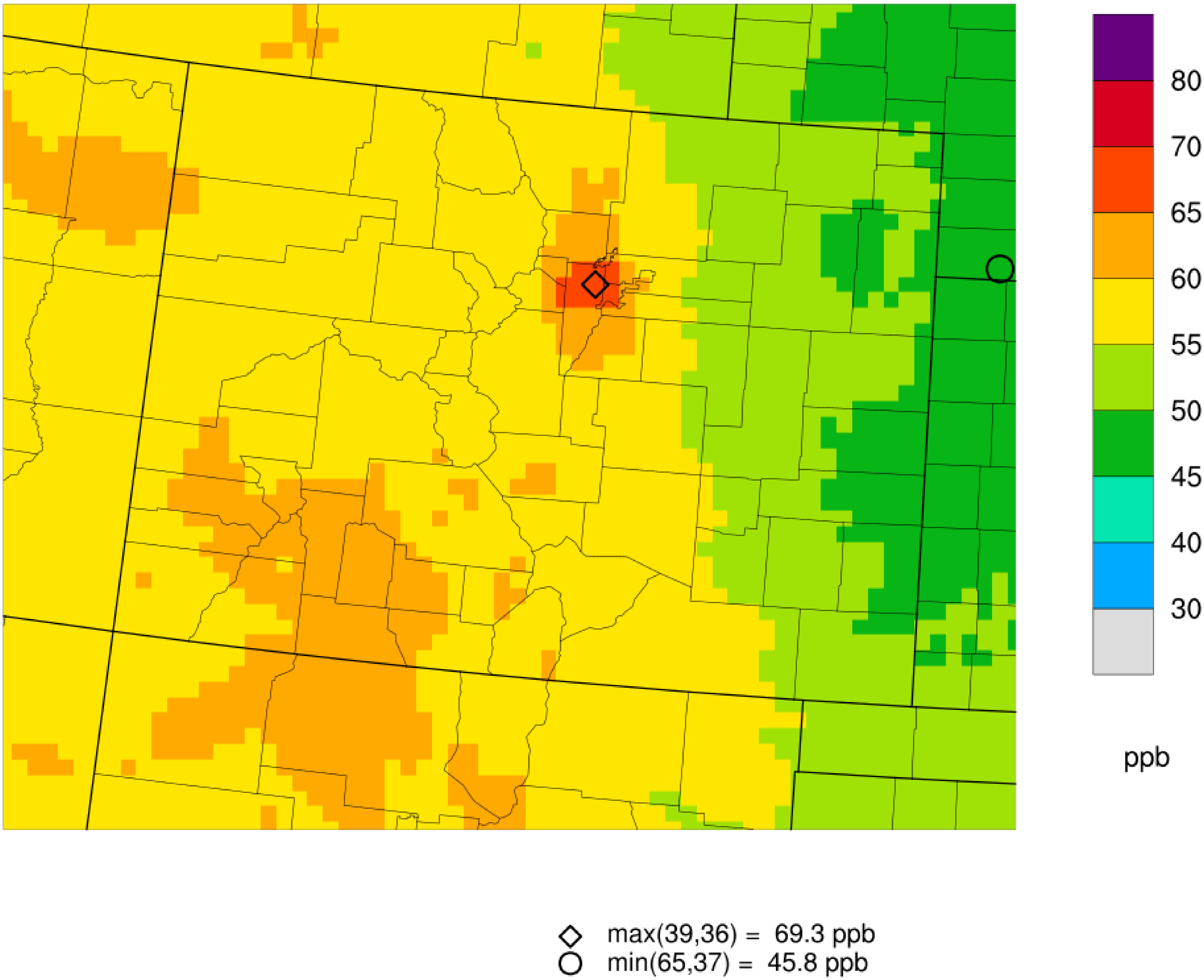


Figure CO.O3.2
4th High Daily Max 8 Hour Avg Ozone
Natural

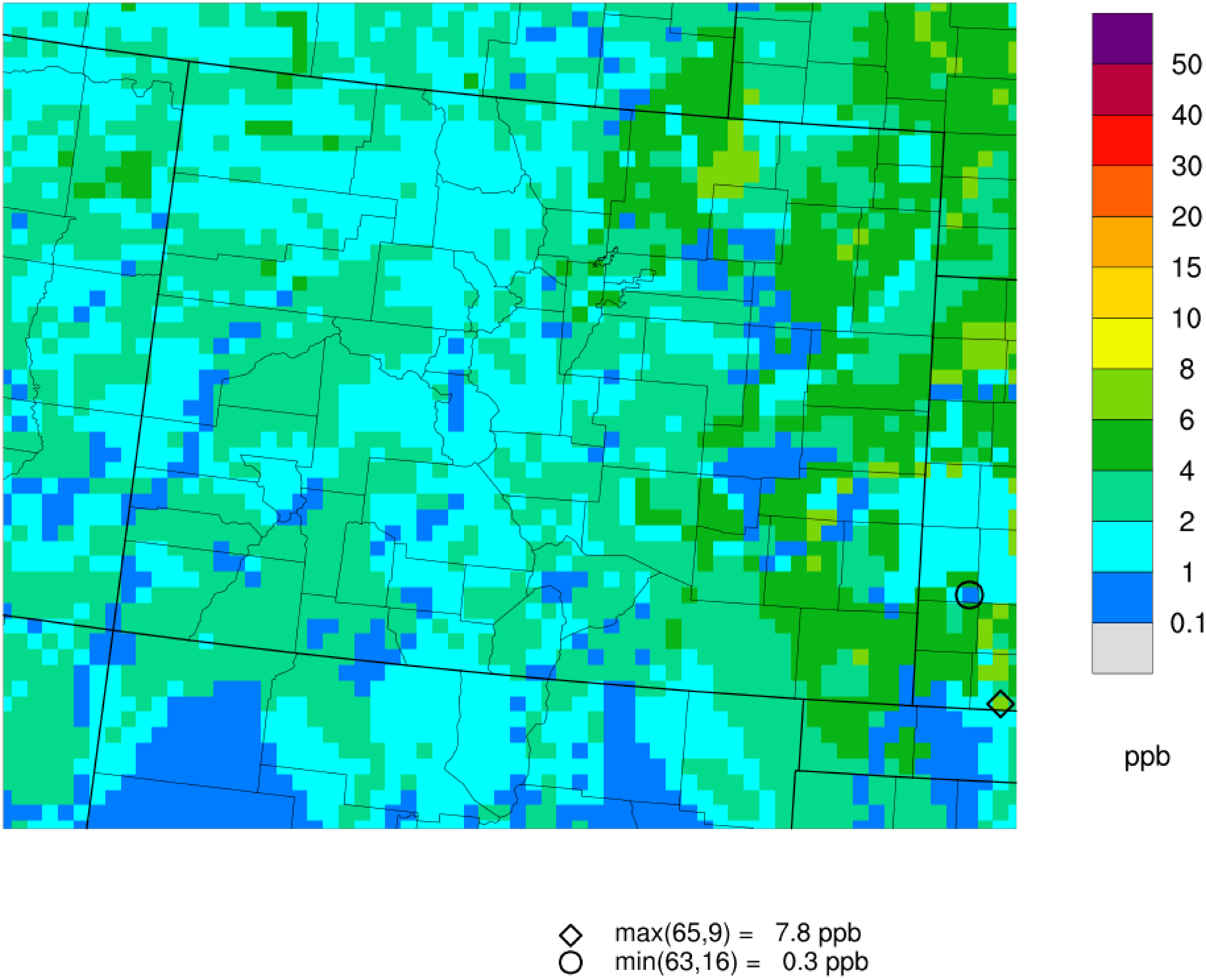
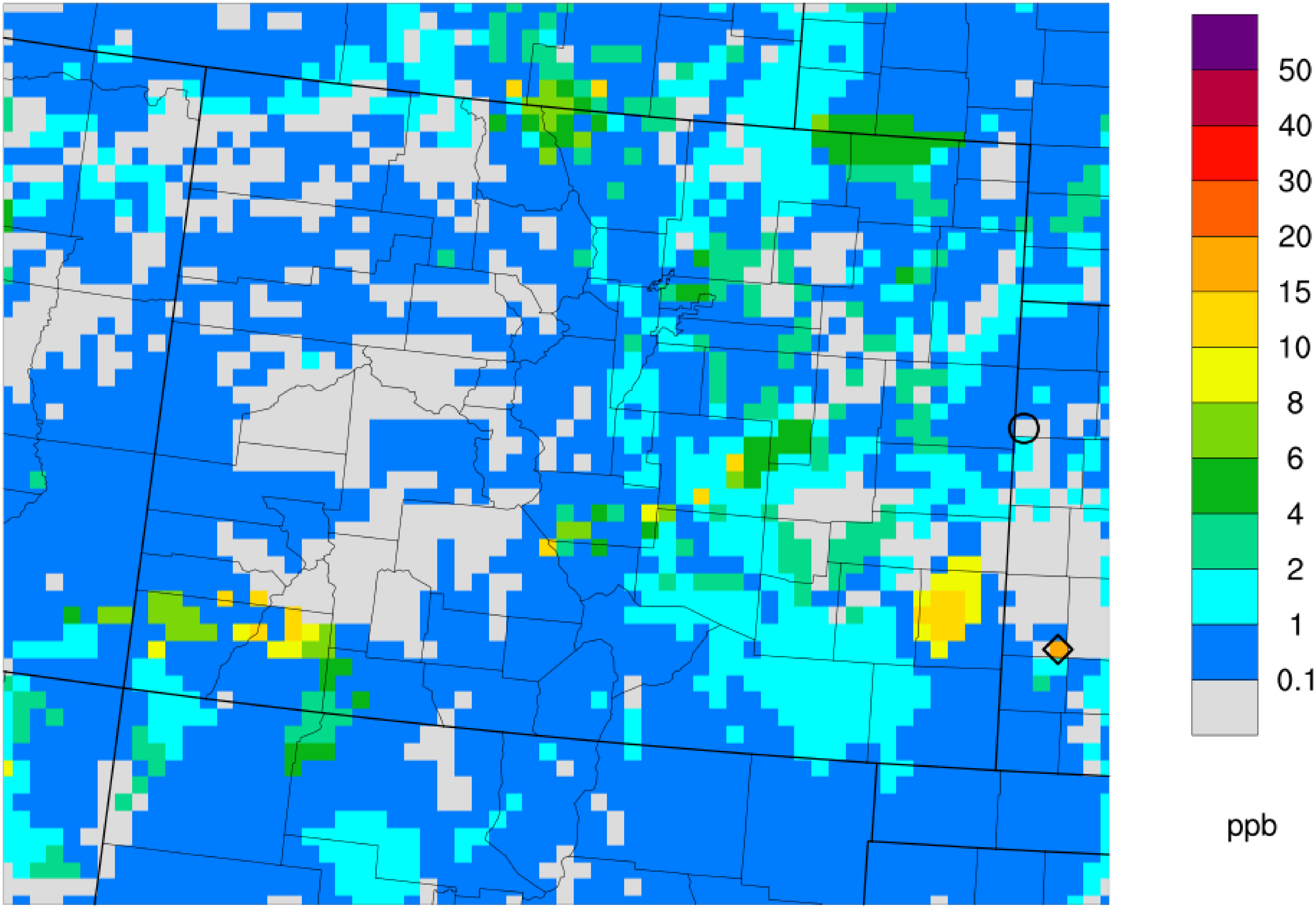


Figure CO.O3.3
4th High Daily Max 8 Hour Avg Ozone
Wildfire



max(63,16) = 19.3 ppb
min(61,29) = 0.0 ppb

Figure CO.O3.4
4th High Daily Max 8 Hour Avg Ozone
OilGas_ExistFed_WesternCO

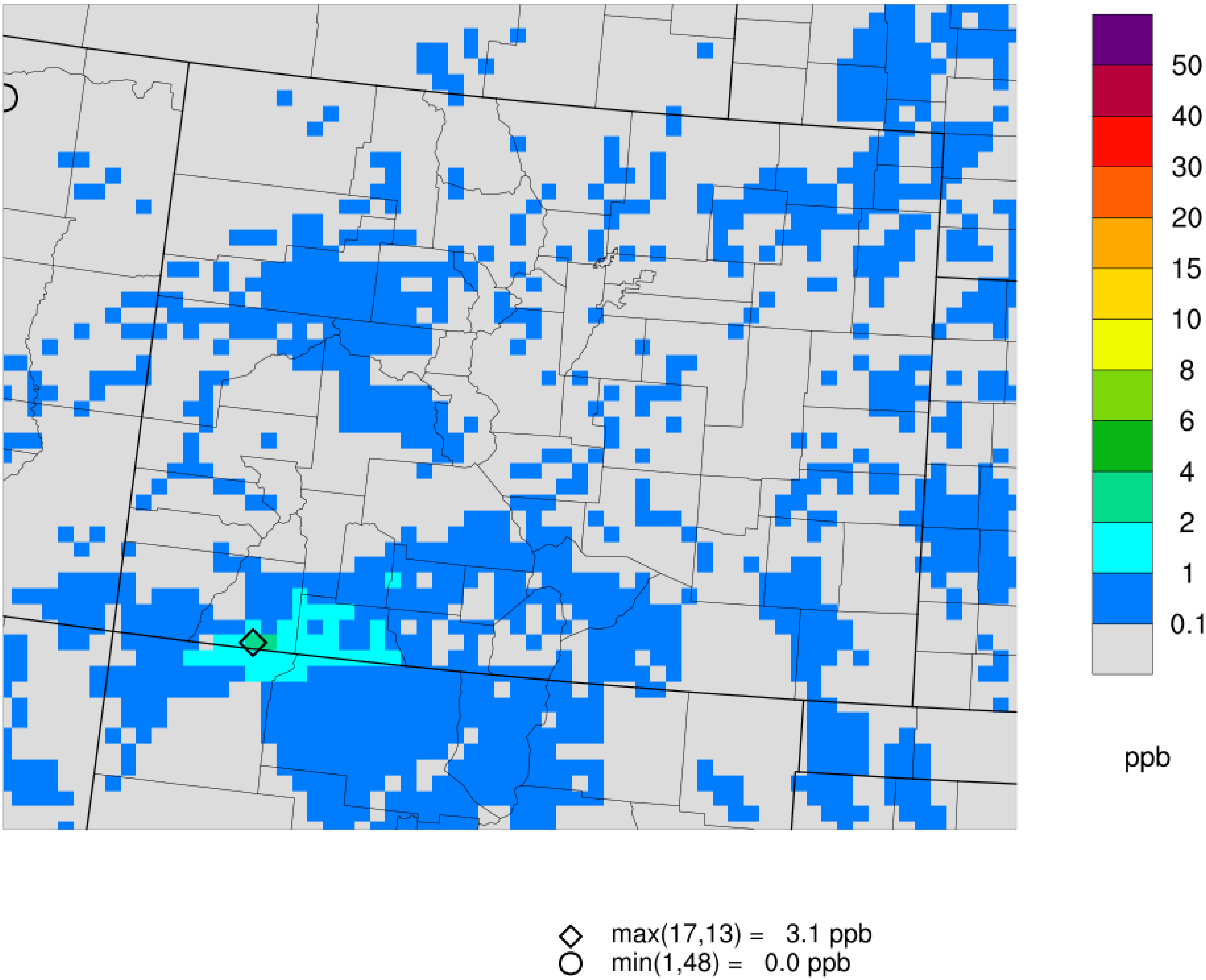


Figure CO.O3.5
4th High Daily Max 8 Hour Avg Ozone
OilGas_ExistFed_RoyalGorge

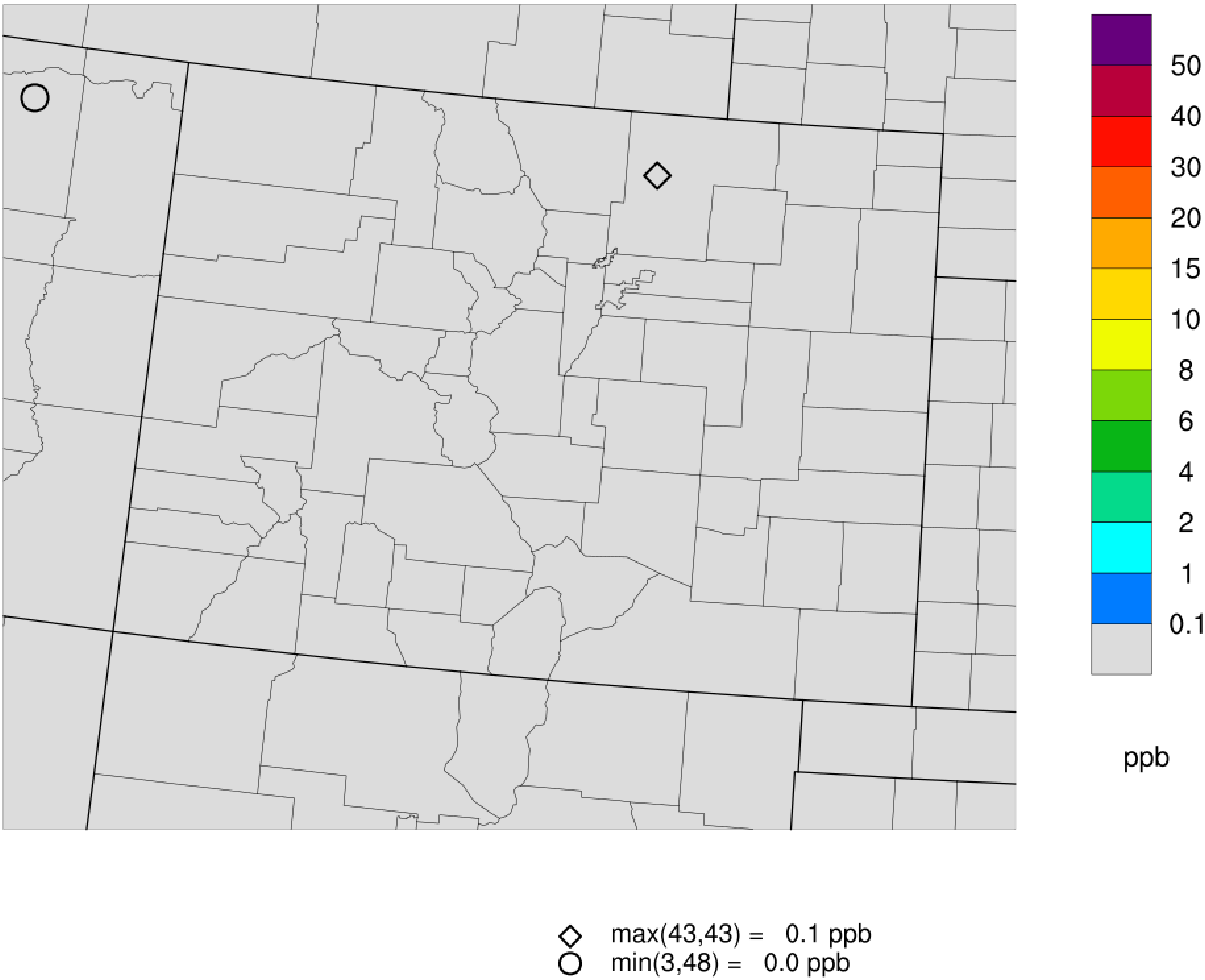


Figure CO.O3.6
4th High Daily Max 8 Hour Avg Ozone
OilGas_NewFed_WesternCO

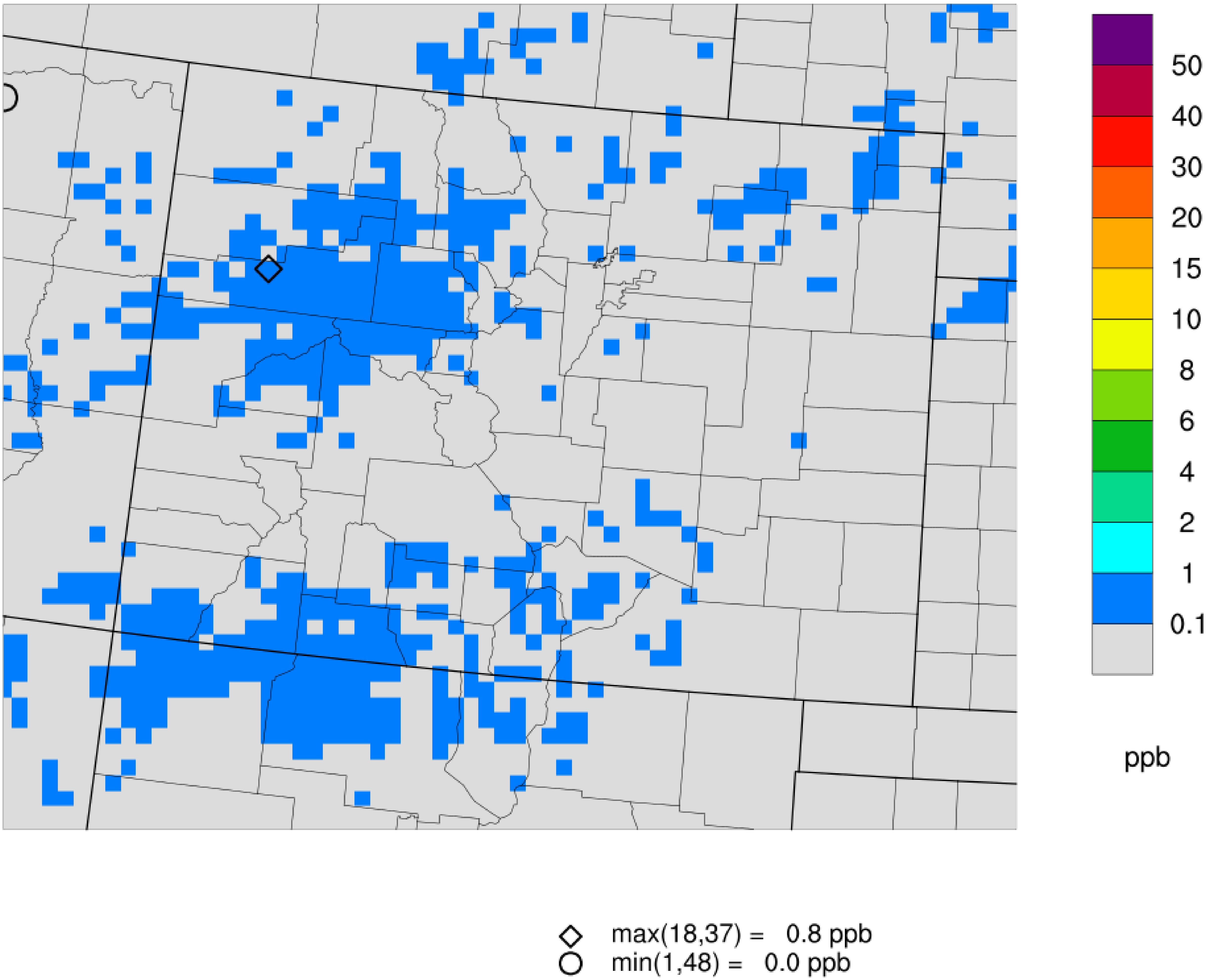
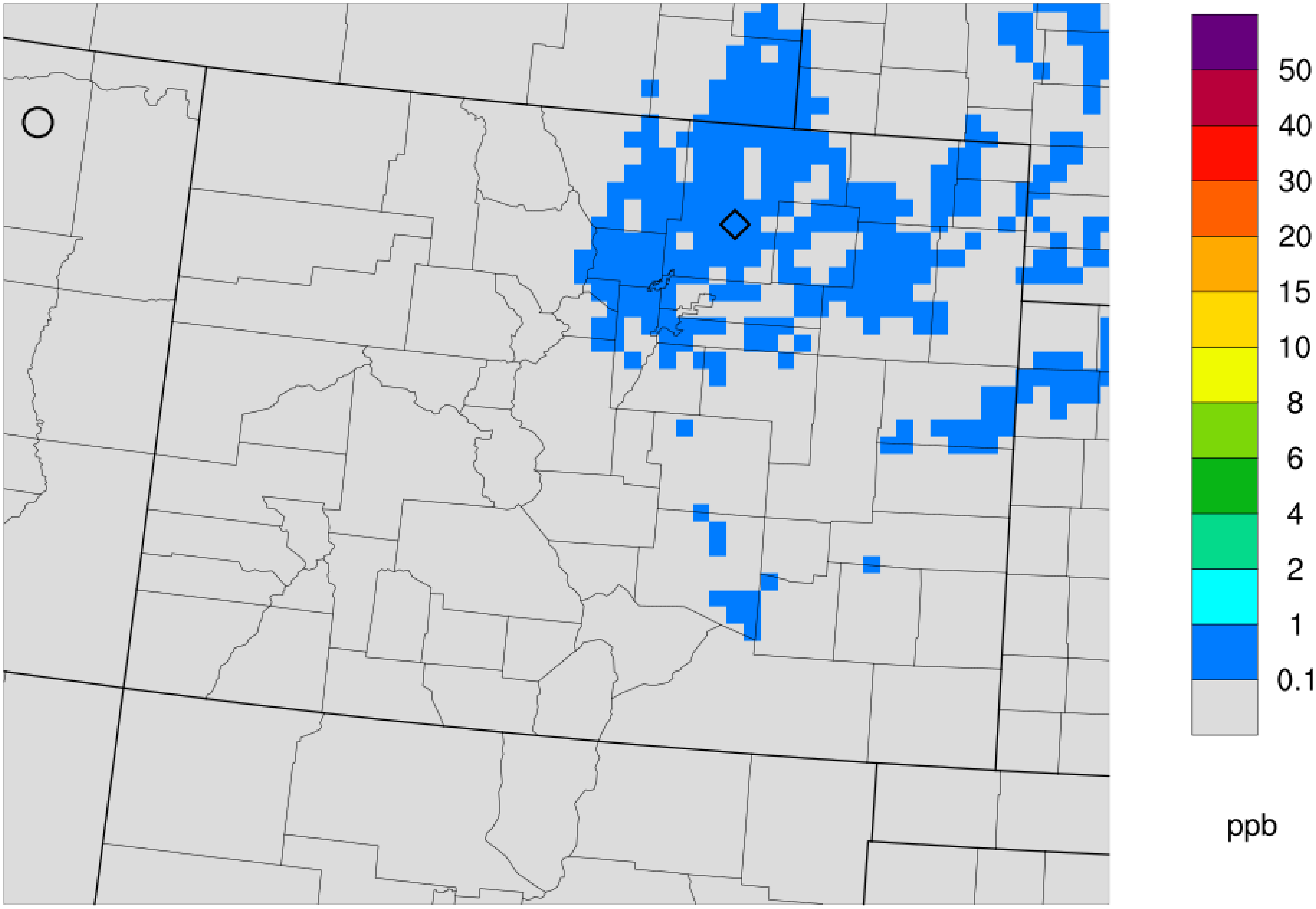


Figure CO.O3.7
4th High Daily Max 8 Hour Avg Ozone
OilGas_NewFed_RoyalGorge



max(44,41) = 0.5 ppb
min(3,47) = 0.0 ppb

Figure CO.O3.8
4th High Daily Max 8 Hour Avg Ozone
OilGas_Fed_Other_States

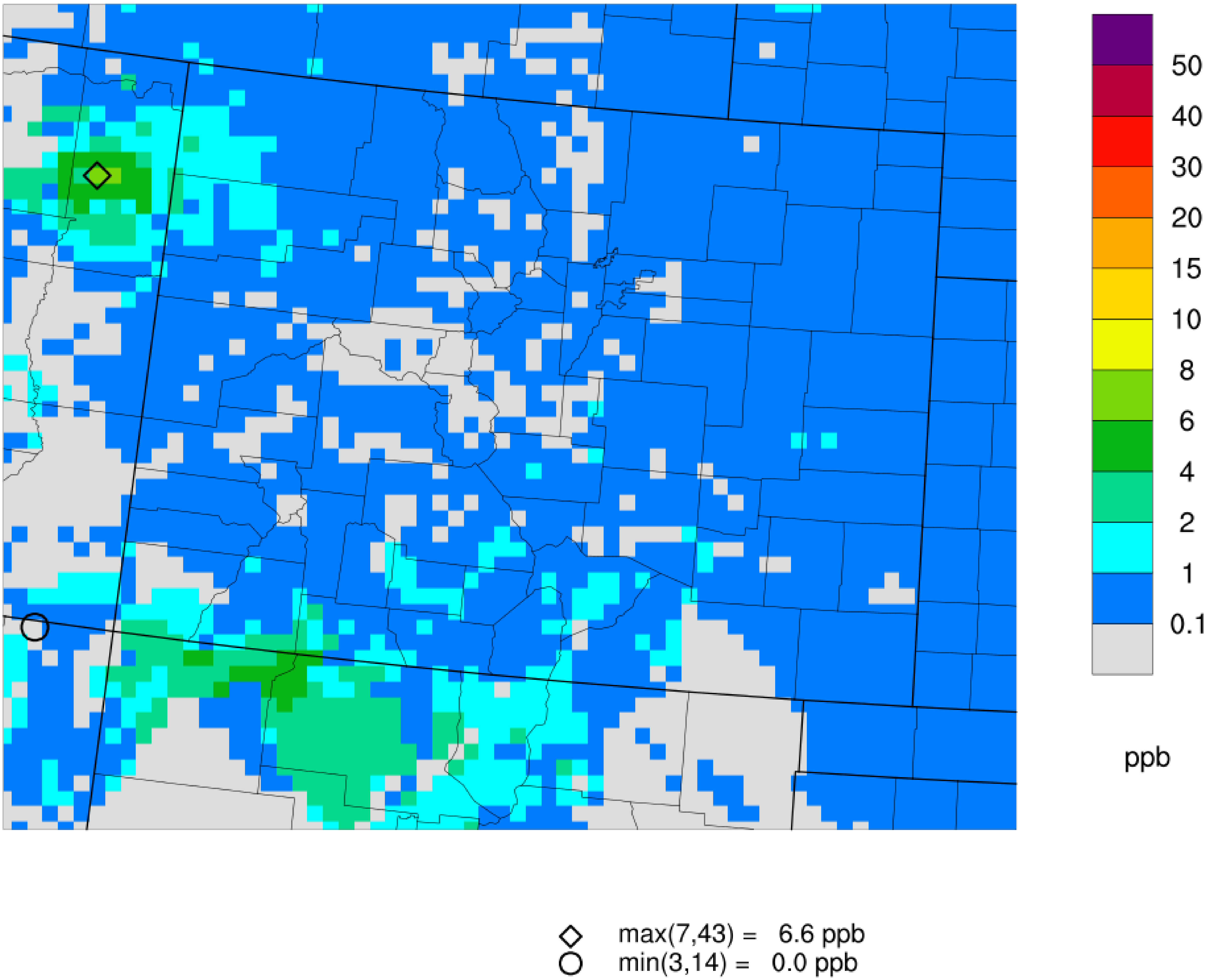


Figure CO.O3.9
4th High Daily Max 8 Hour Avg Ozone
OilGas_NonFed

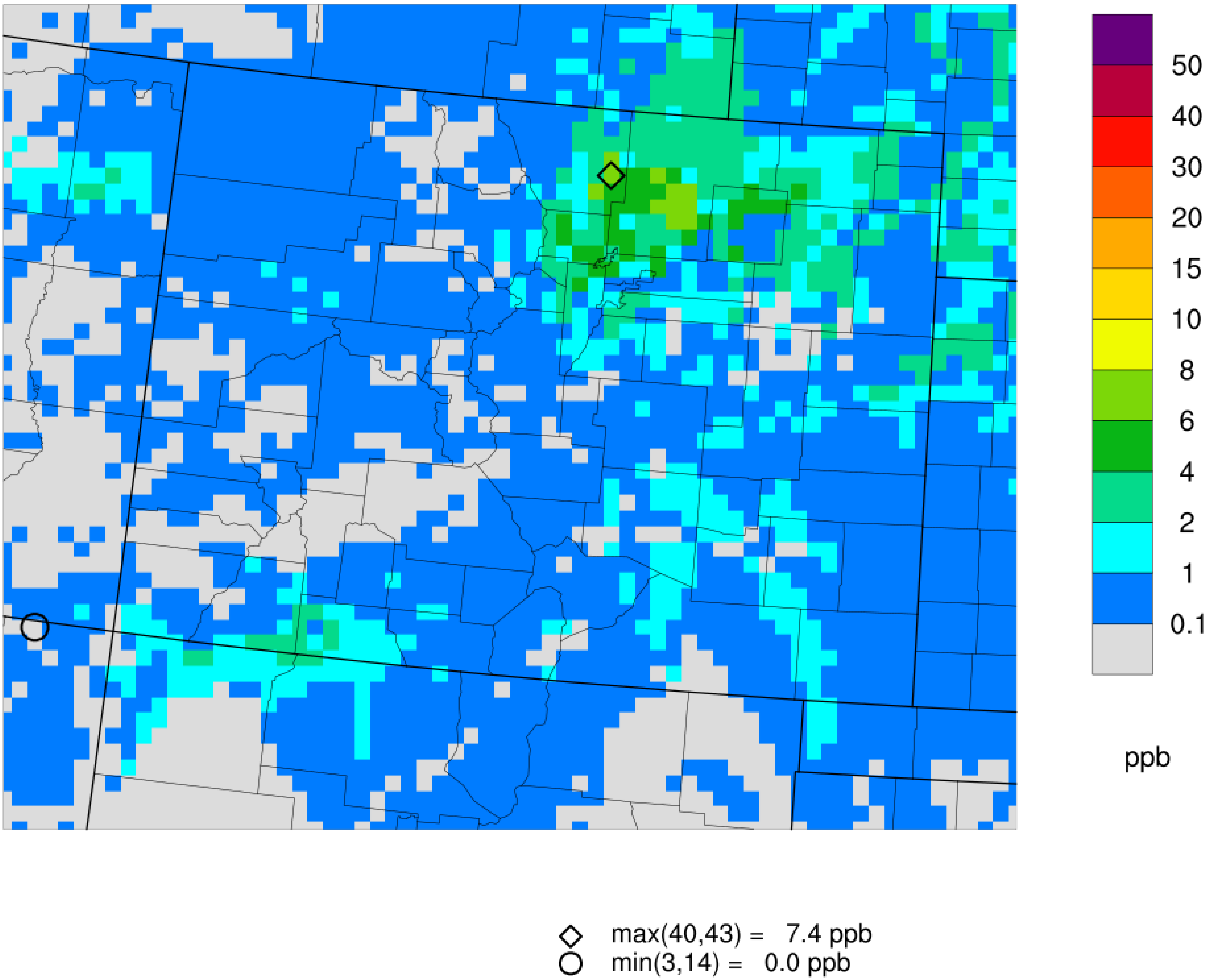


Figure CO.O3.10
4th High Daily Max 8 Hour Avg Ozone
OilGas_ExistTribal

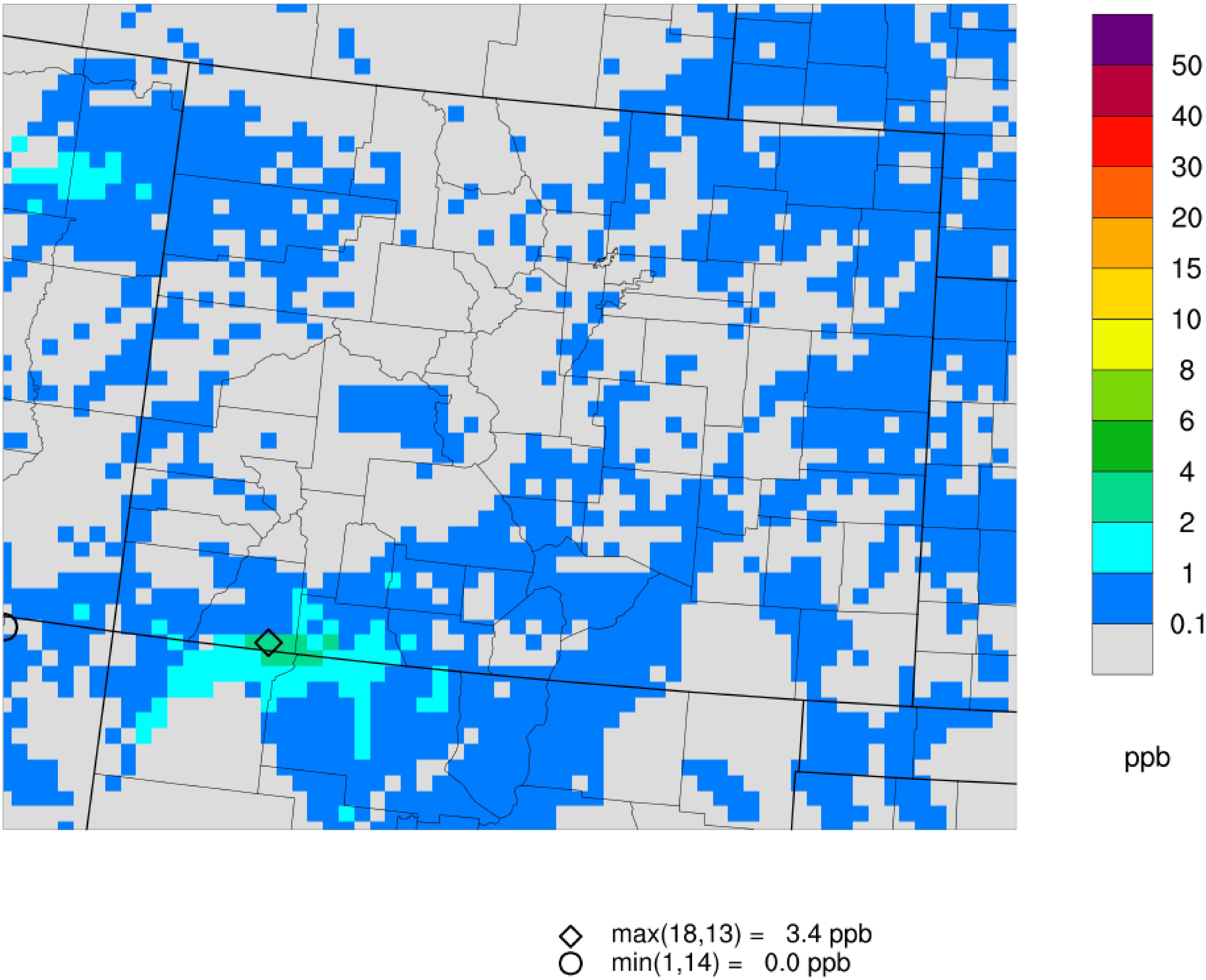


Figure CO.O3.11
4th High Daily Max 8 Hour Avg Ozone
OilGas_NewTribal

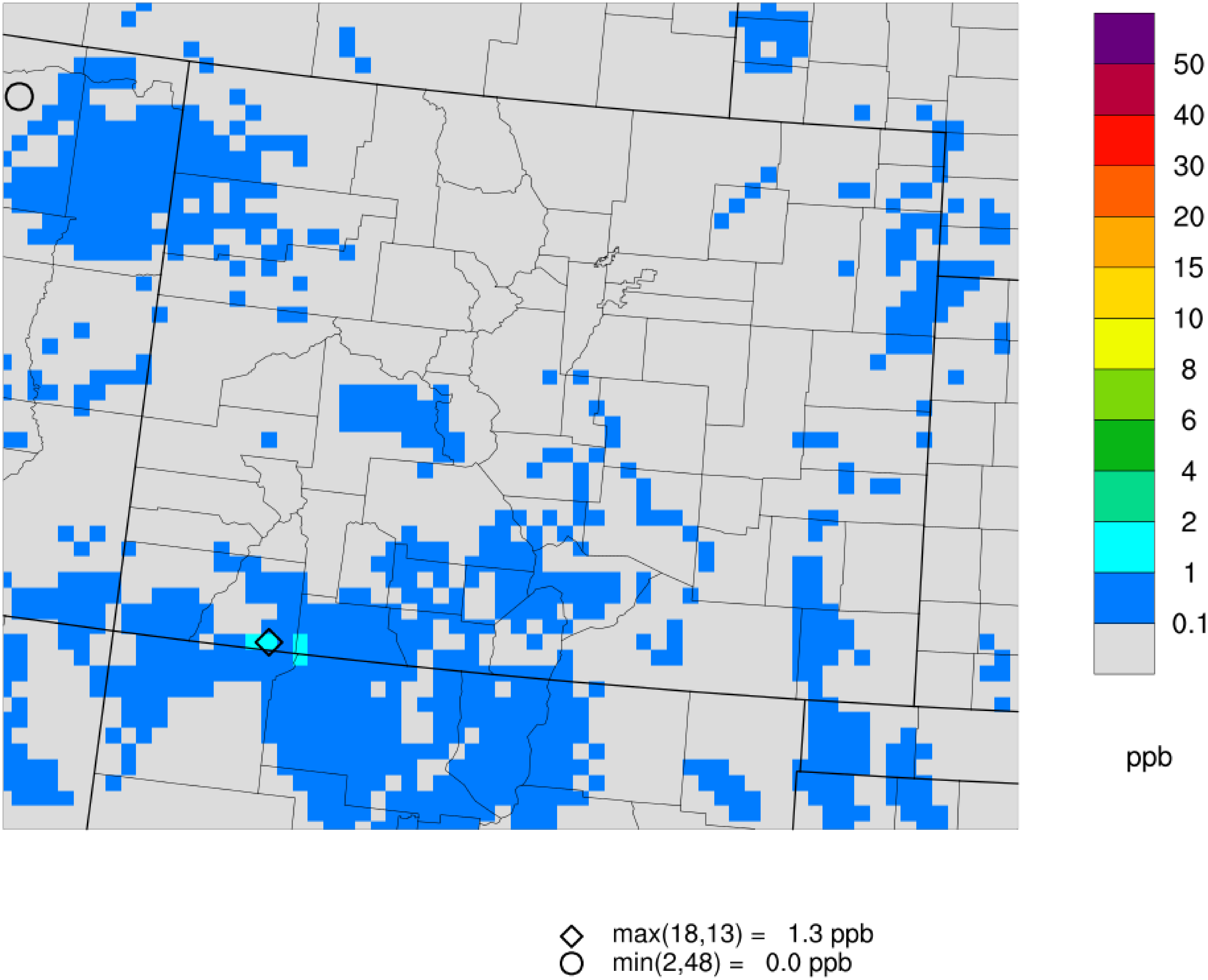


Figure CO.O3.12
4th High Daily Max 8 Hour Avg Ozone
Coal_Fed

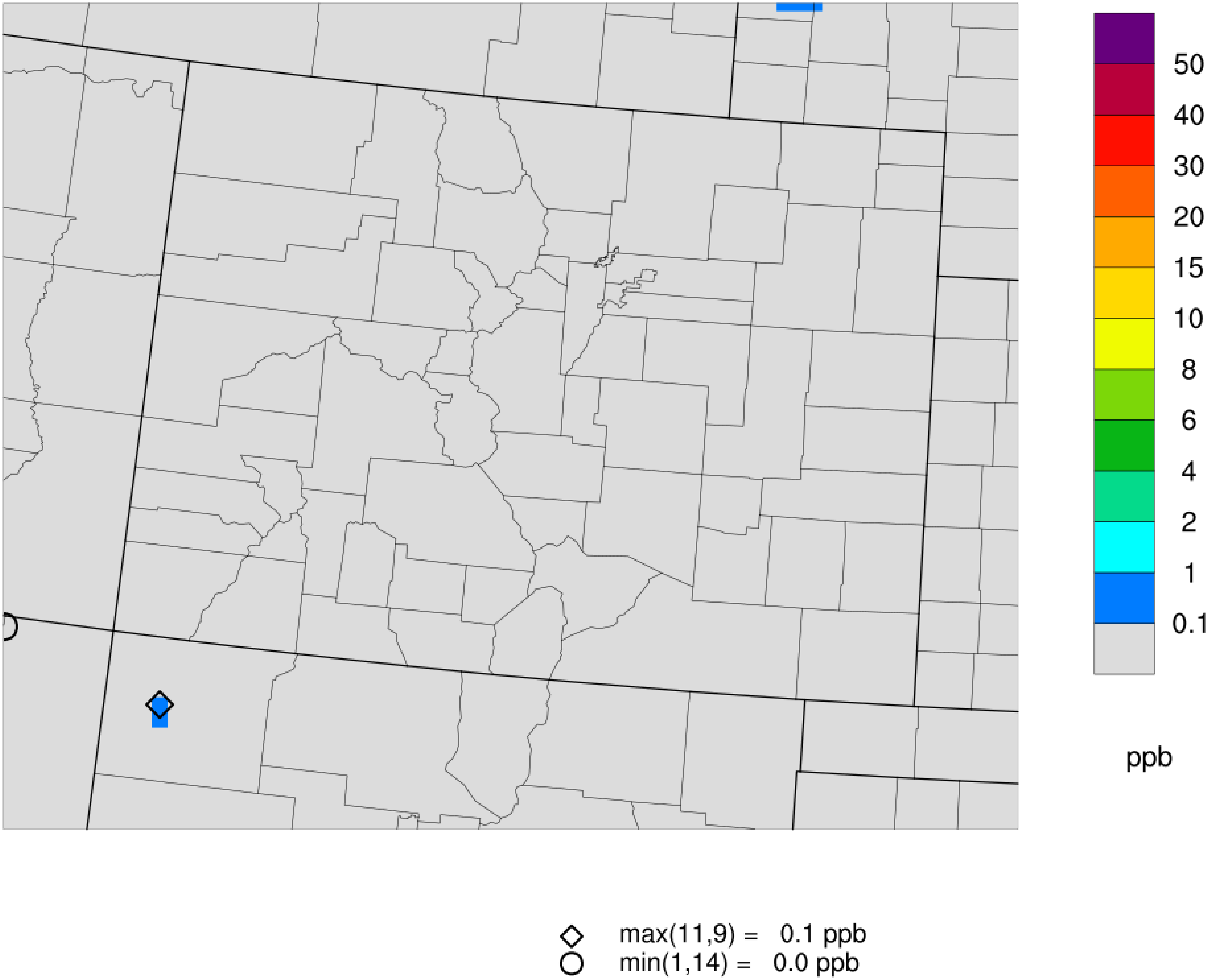
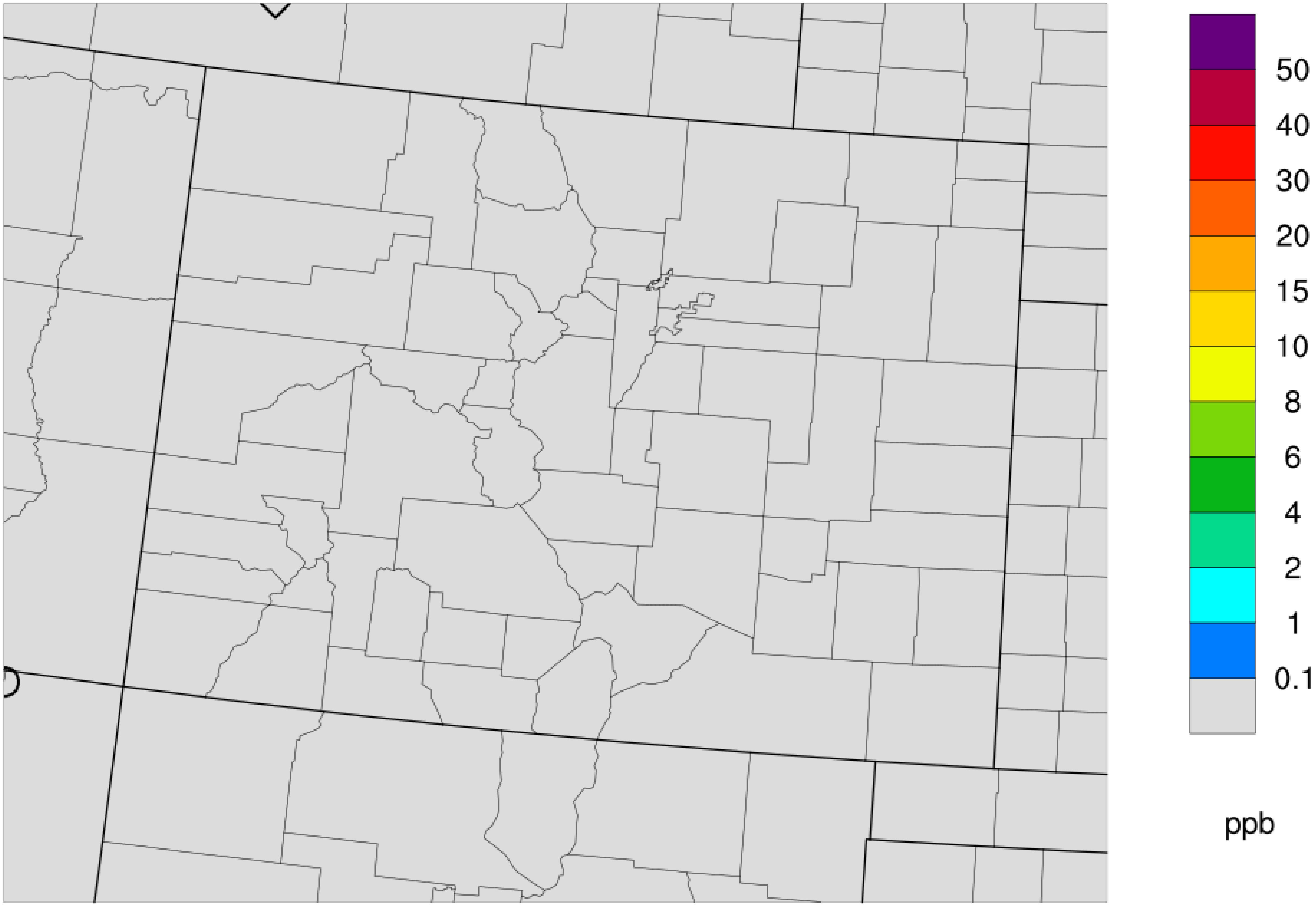


Figure CO.O3.13
4th High Daily Max 8 Hour Avg Ozone
Coal_NonFed



max(17,54) = 0.1 ppb
min(1,14) = 0.0 ppb

Figure CO.O3.14
4th High Daily Max 8 Hour Avg Ozone
Coal_EGU WRAP states

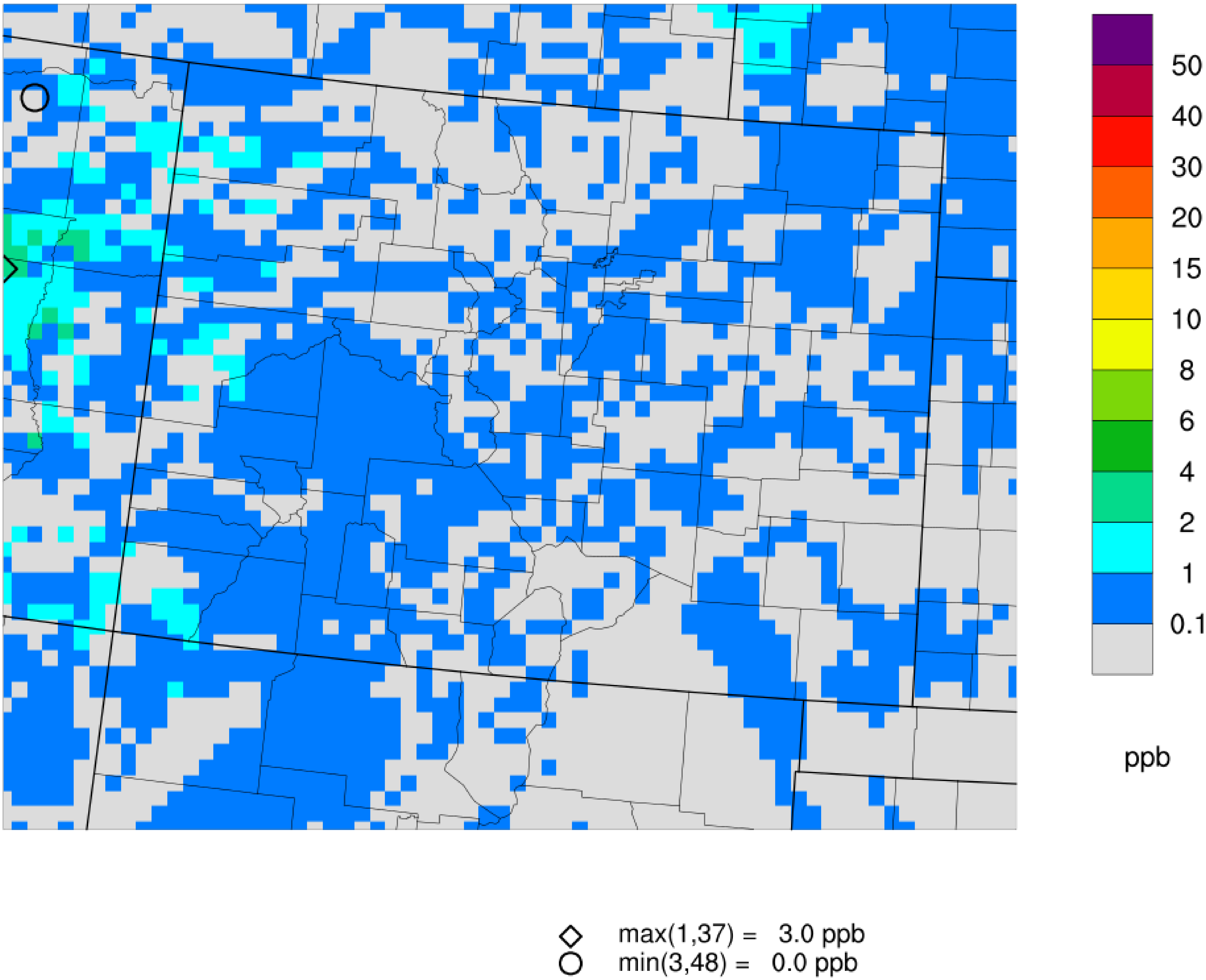


Figure CO.O3.15
4th High Daily Max 8 Hour Avg Ozone
Coal_Comb WRAP states

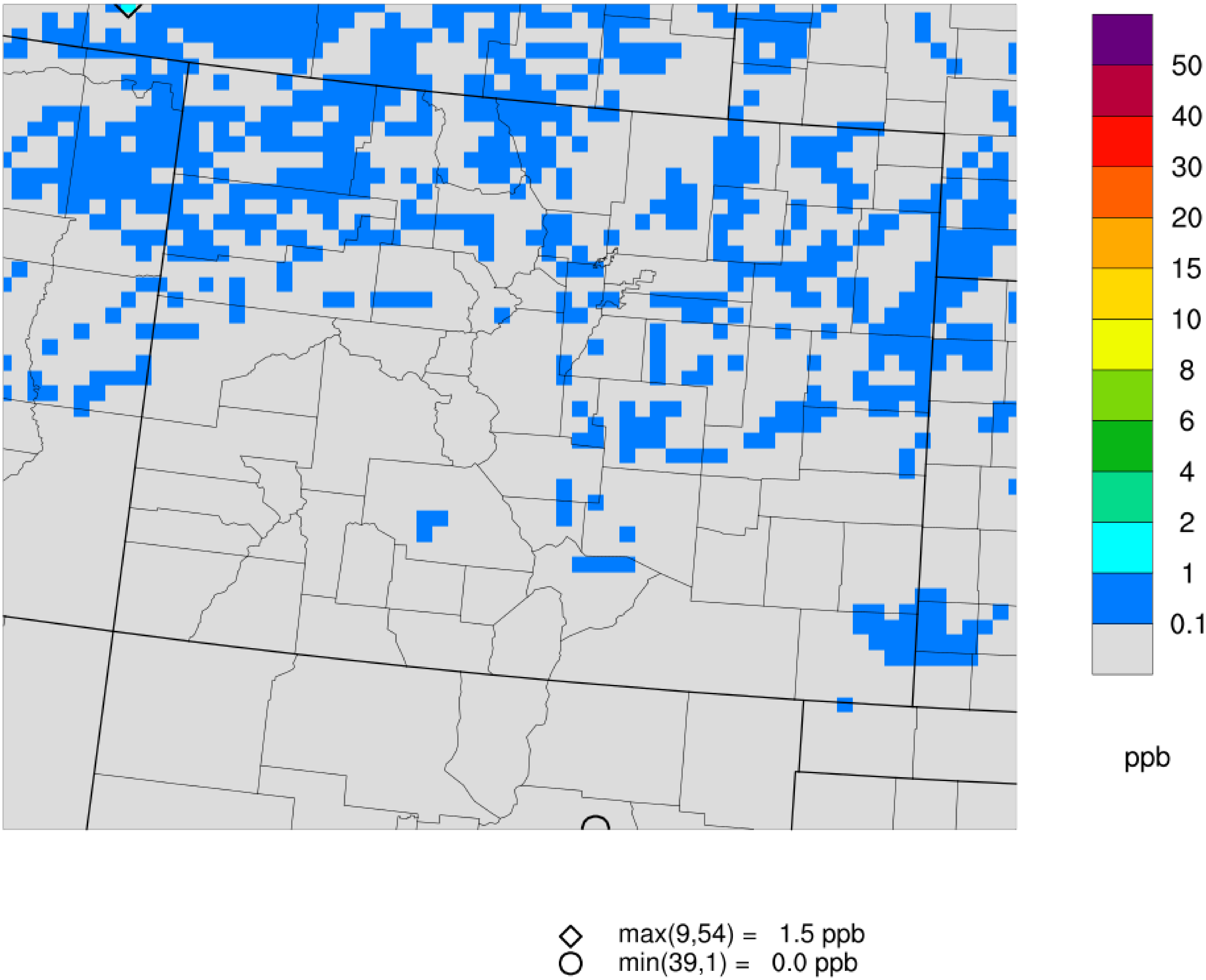


Figure CO.O3.16
4th High Daily Max 8 Hour Avg Ozone
OtherEGU

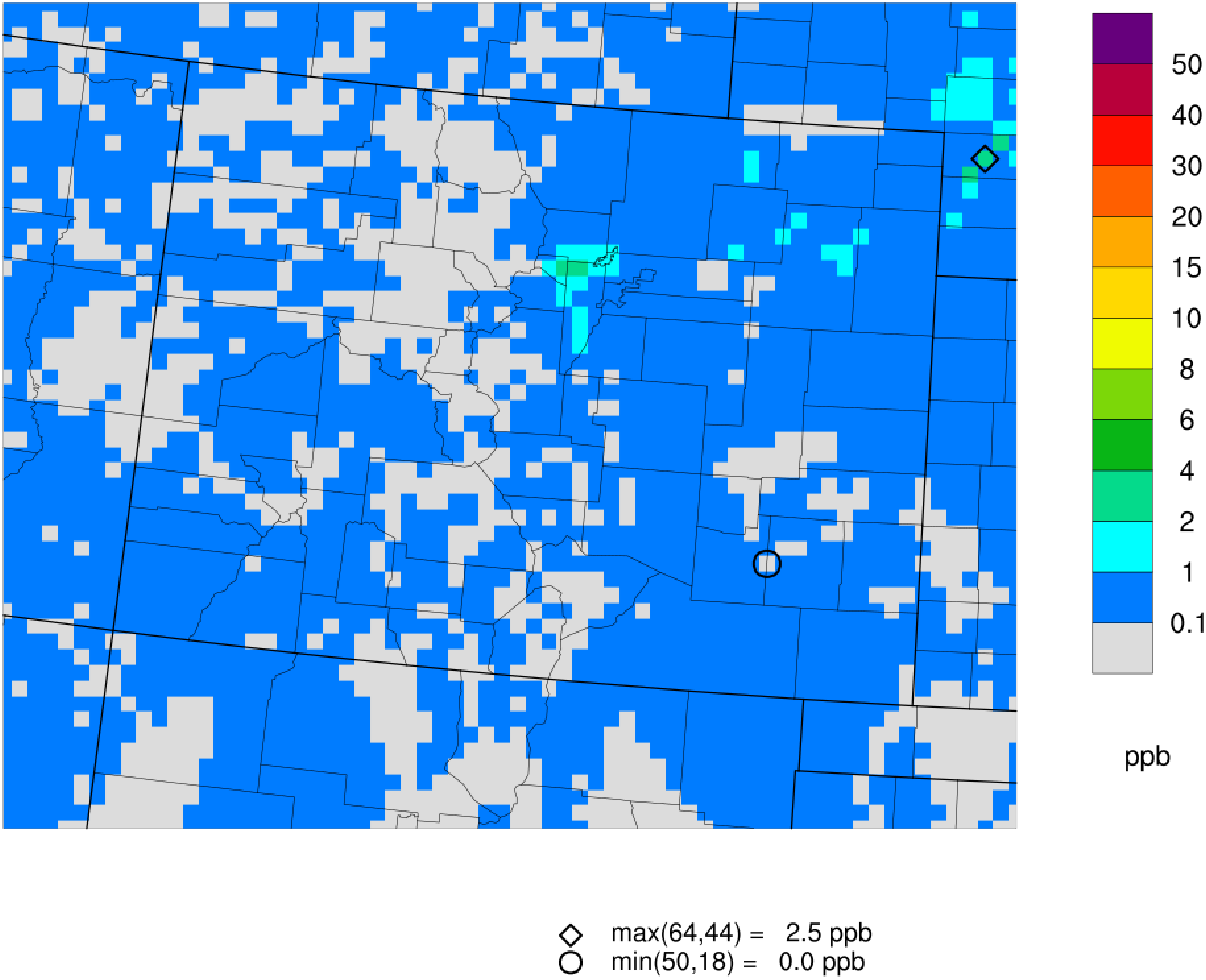


Figure CO.O3.17
4th High Daily Max 8 Hour Avg Ozone
Anthro_Rest

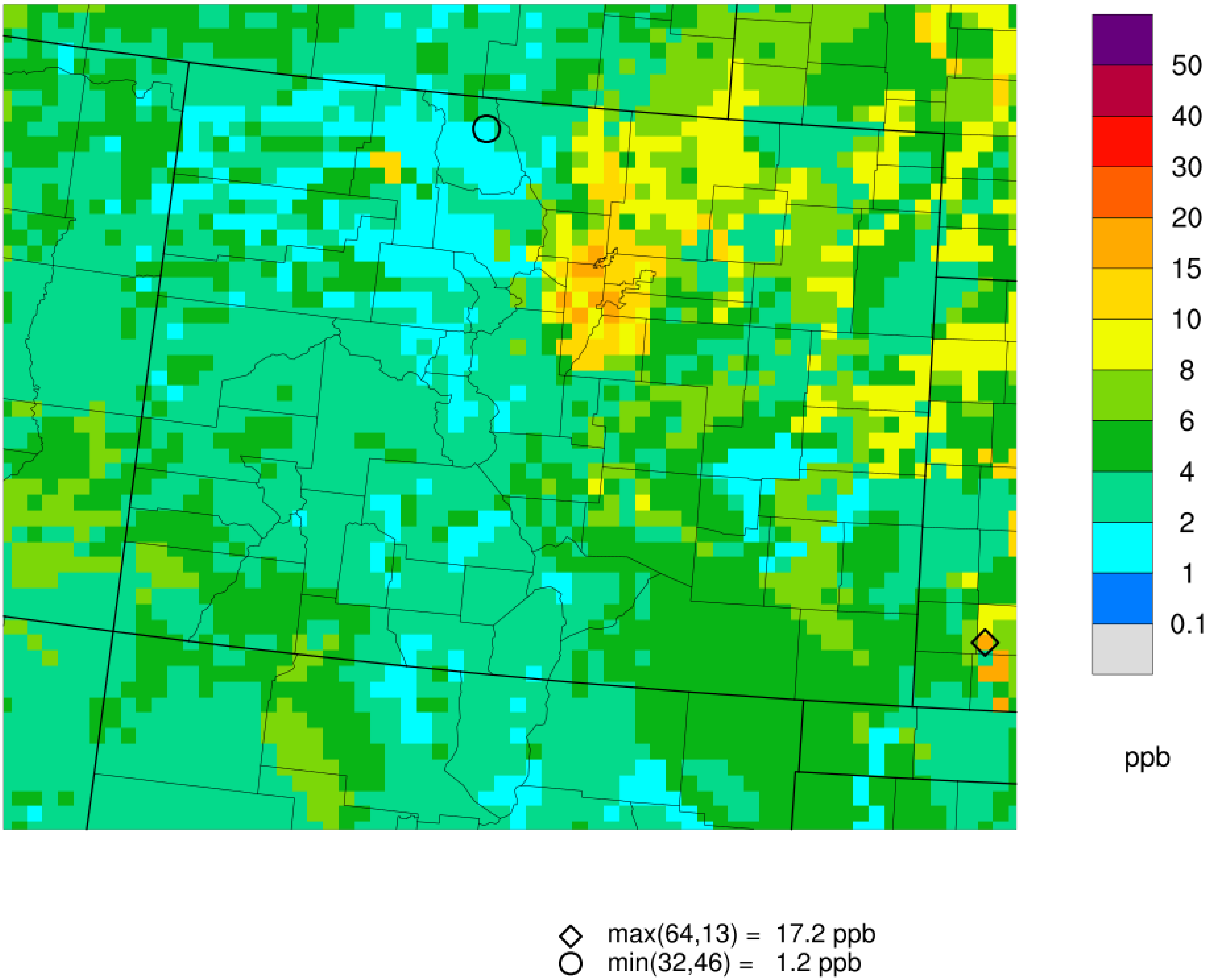
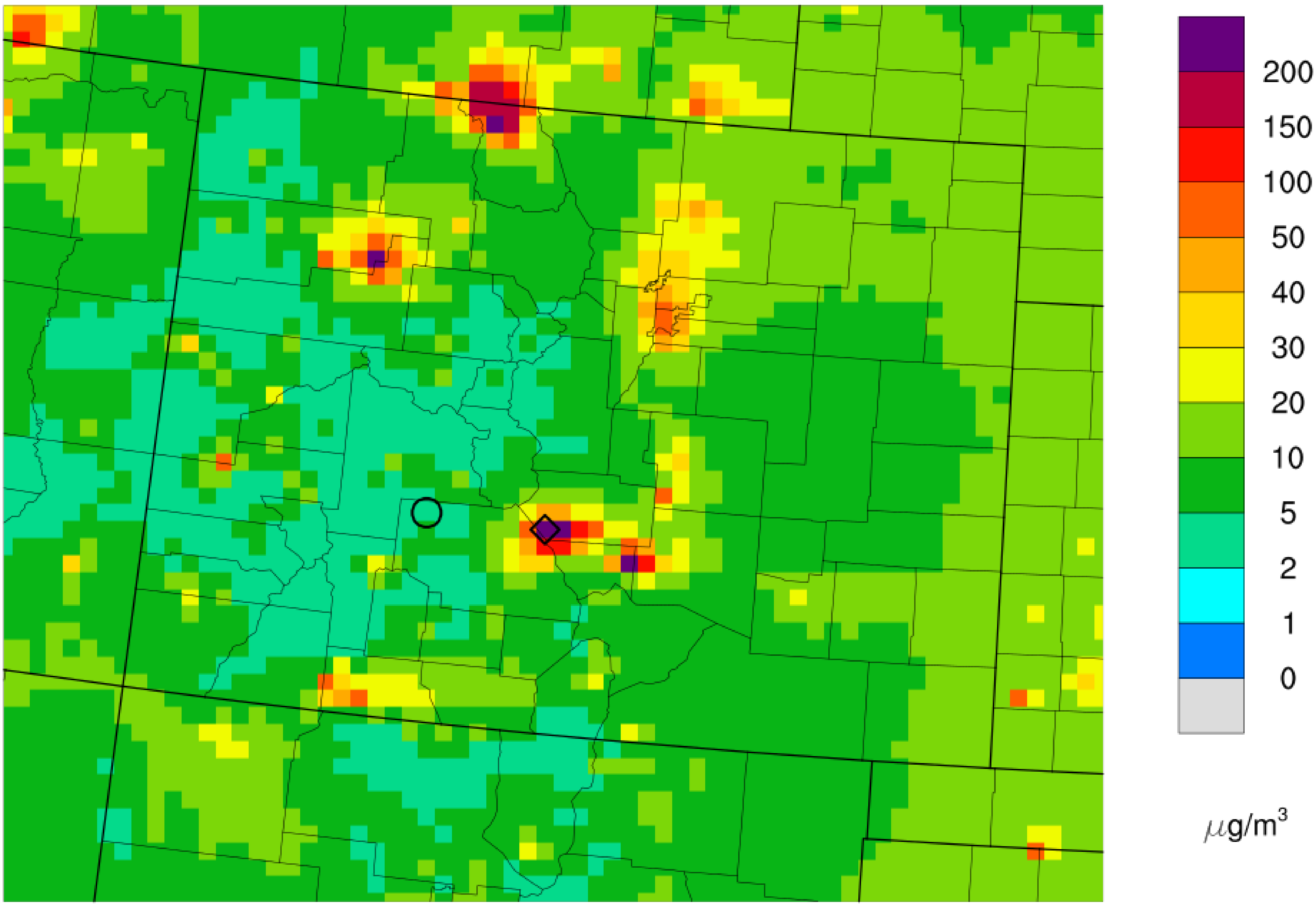
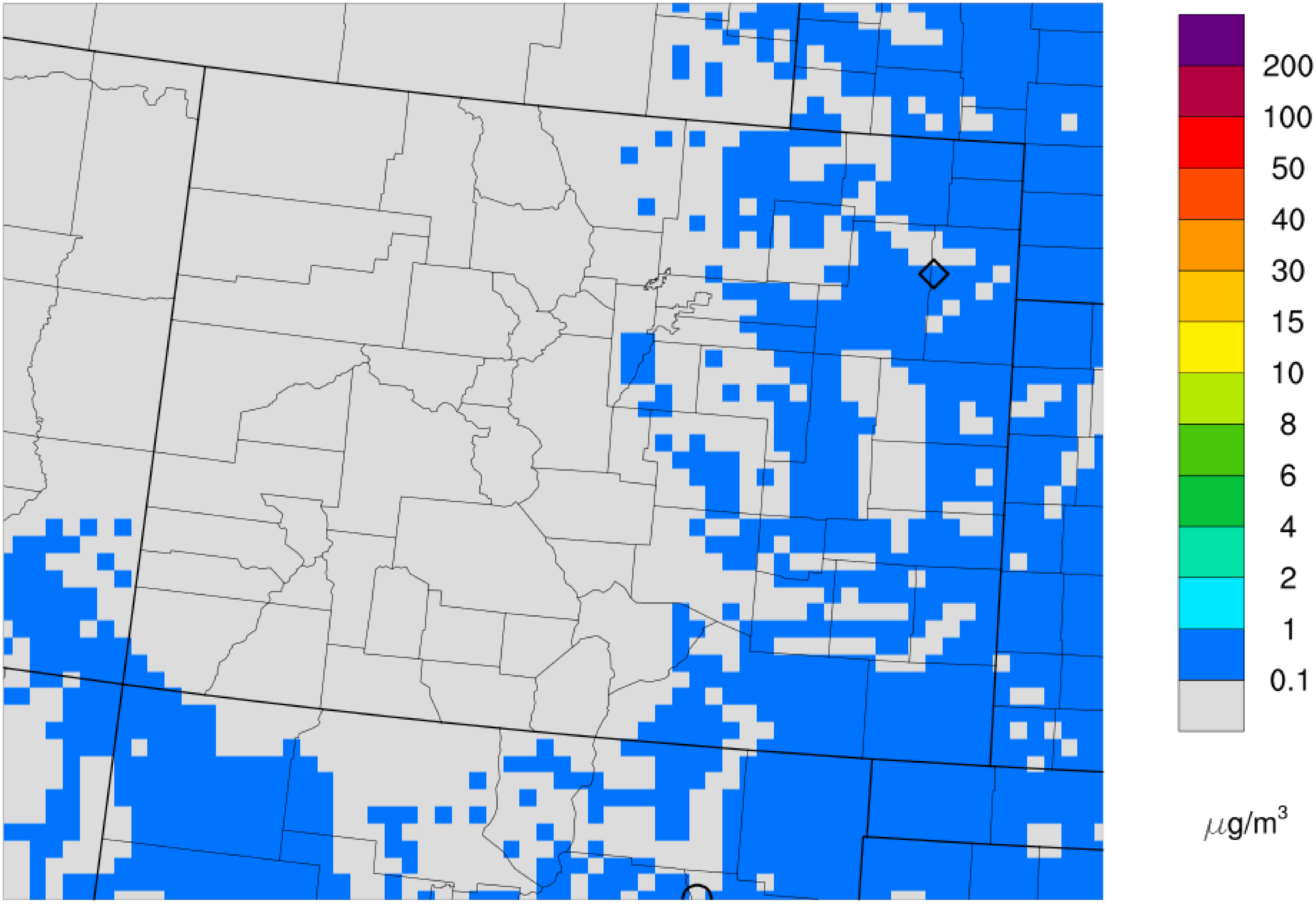


Figure CO.PM10.dly.1
2nd highest daily average PM_{10} concentration
Cumulative



◇ max(33,23) = 390.2 $\mu g/m^3$
○ min(26,24) = 3.3 $\mu g/m^3$

Figure CO.PM10.dly.2
2nd highest daily average PM_{10} concentration
Natural



◇ max(56,38) = 0.9 $\mu g/m^3$
○ min(42,1) = 0.0 $\mu g/m^3$

Figure CO.PM10.dly.3
2nd highest daily average PM_{10} concentration
Wildfire

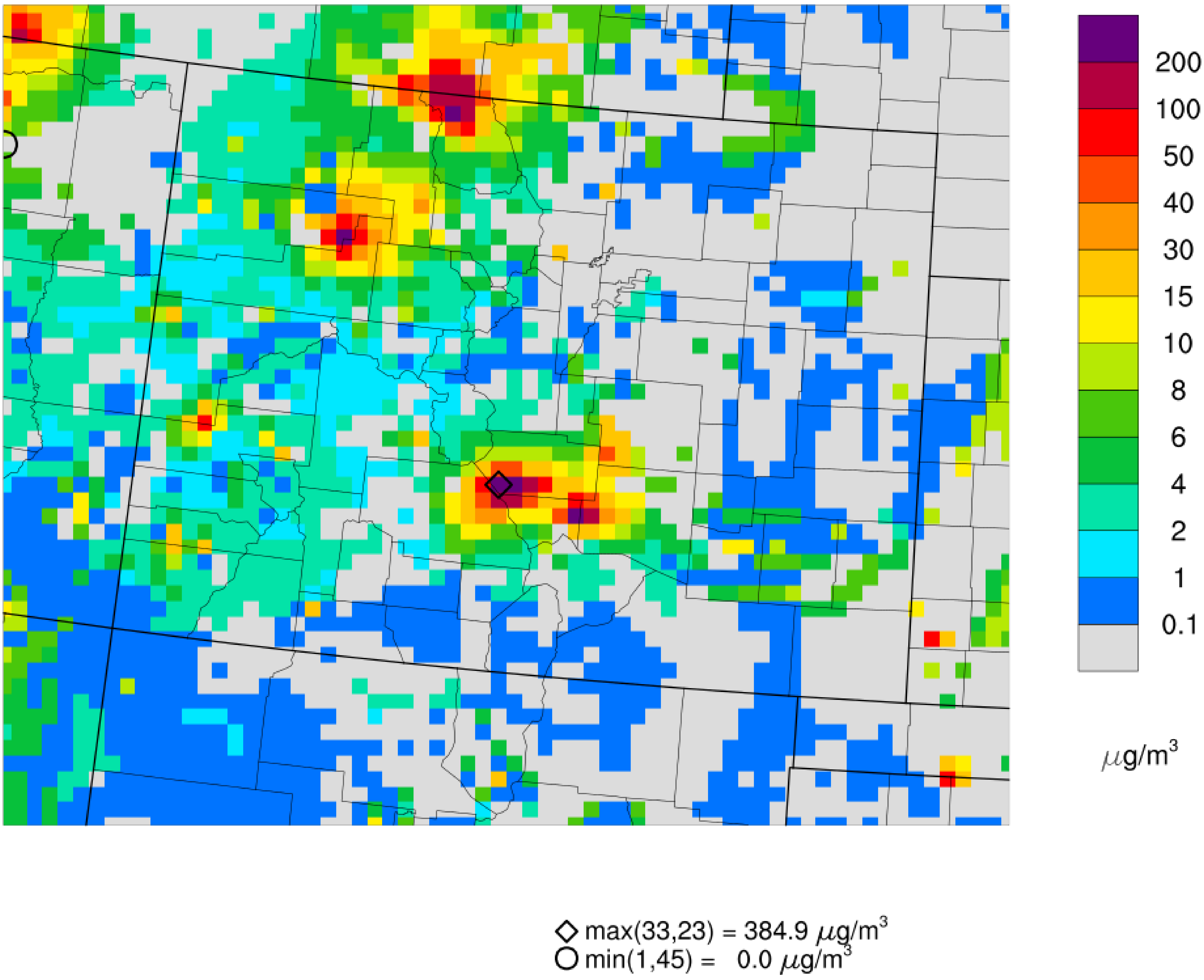
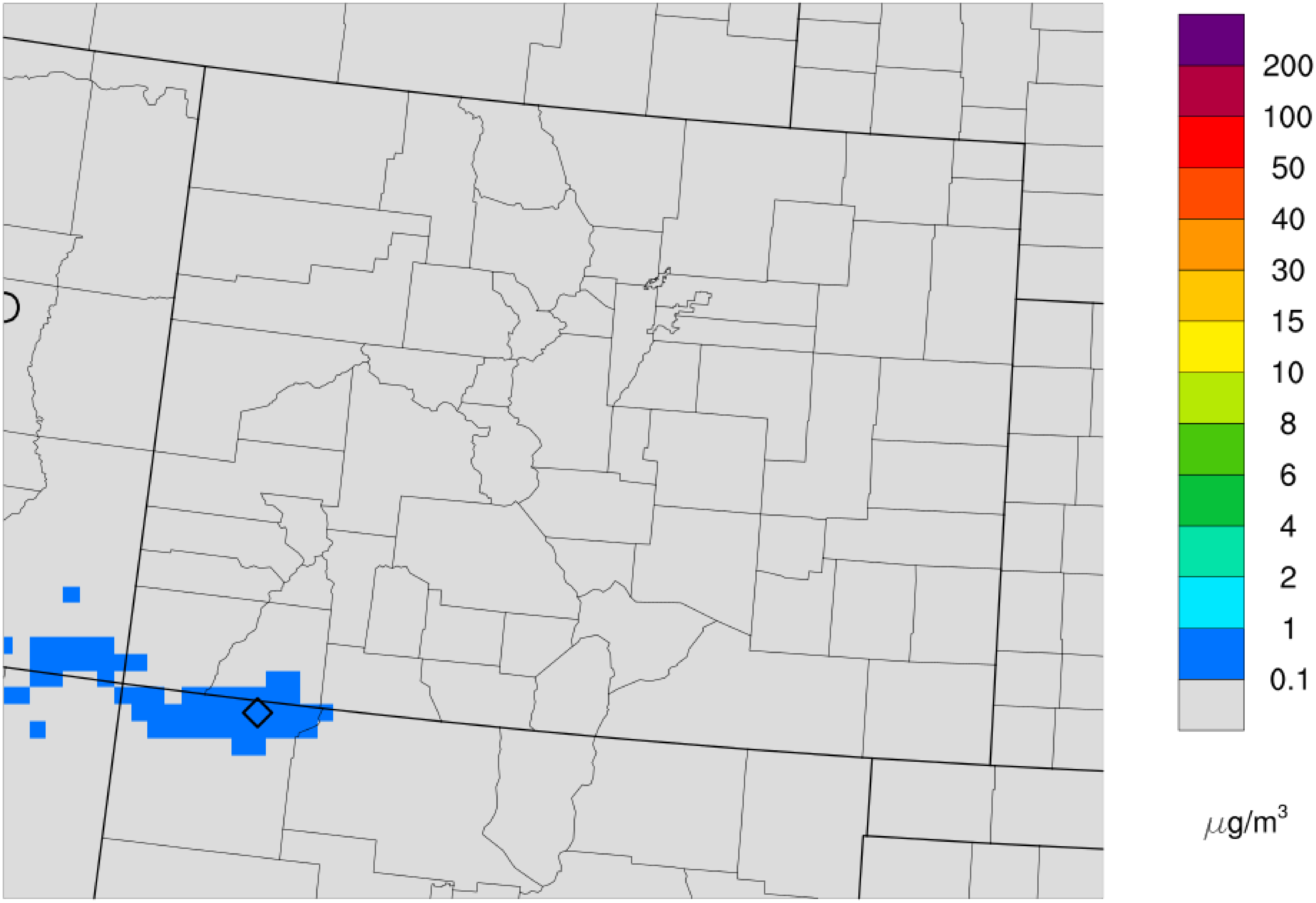


Figure CO.PM10.dly.4
2nd highest daily average PM_{10} concentration
OilGas_ExistFed_WesternCO



max(16,12) = 0.6 $\mu g/m^3$
min(1,36) = 0.0 $\mu g/m^3$

Figure CO.PM10.dly.5
2nd highest daily average PM_{10} concentration
OilGas_ExistFed_RoyalGorge

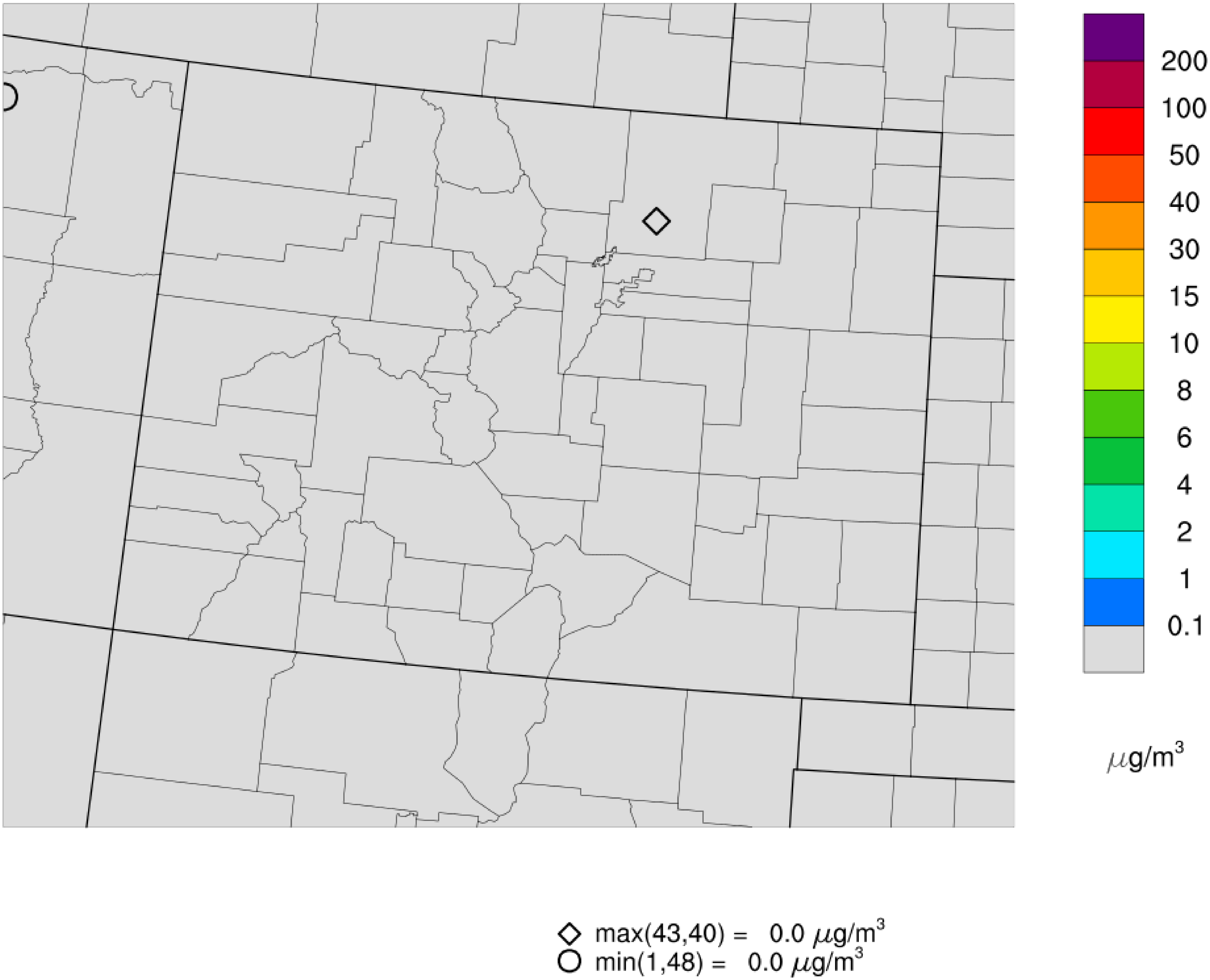


Figure CO.PM10.dly.6
2nd highest daily average PM_{10} concentration
OilGas_NewFed_WesternCO

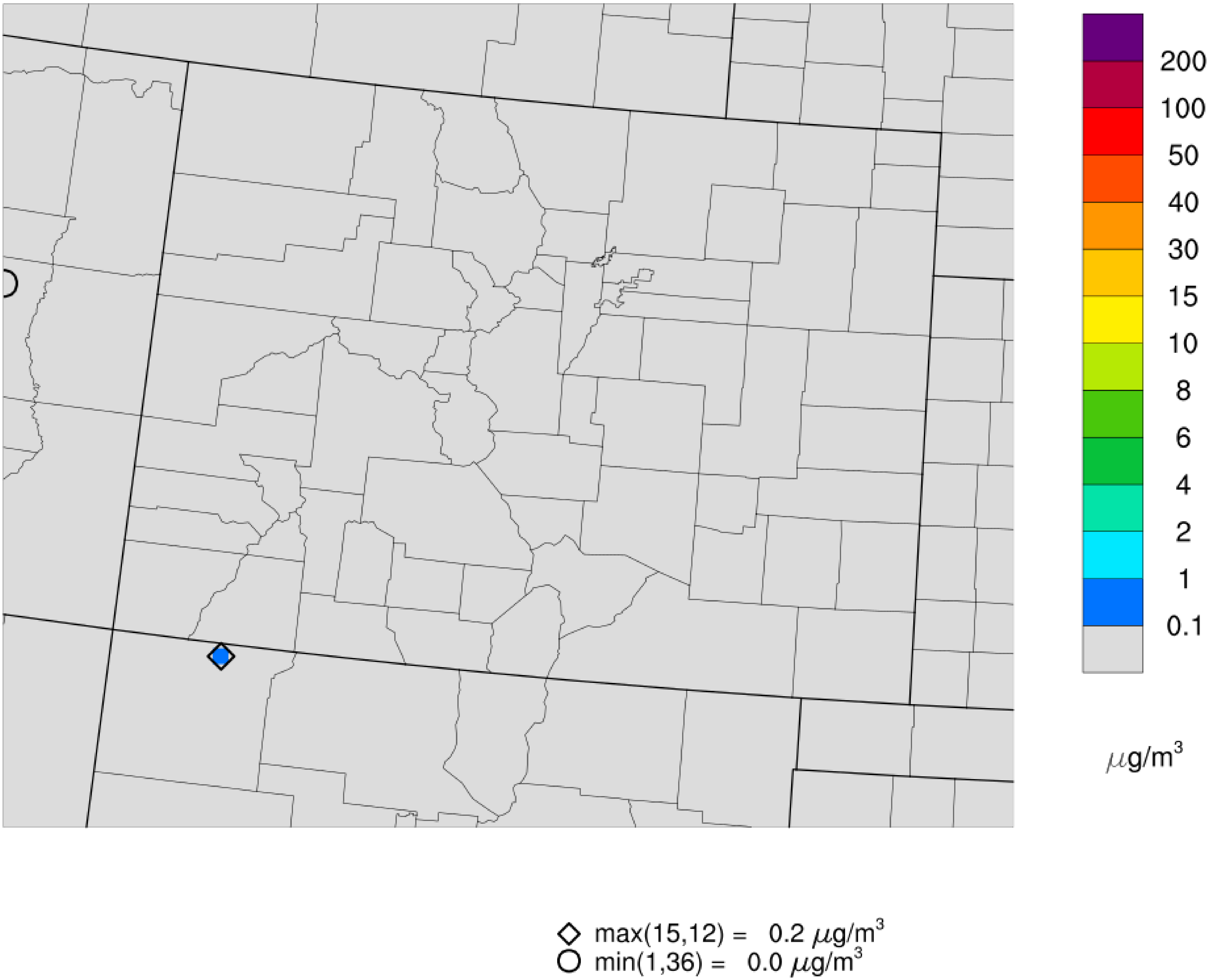
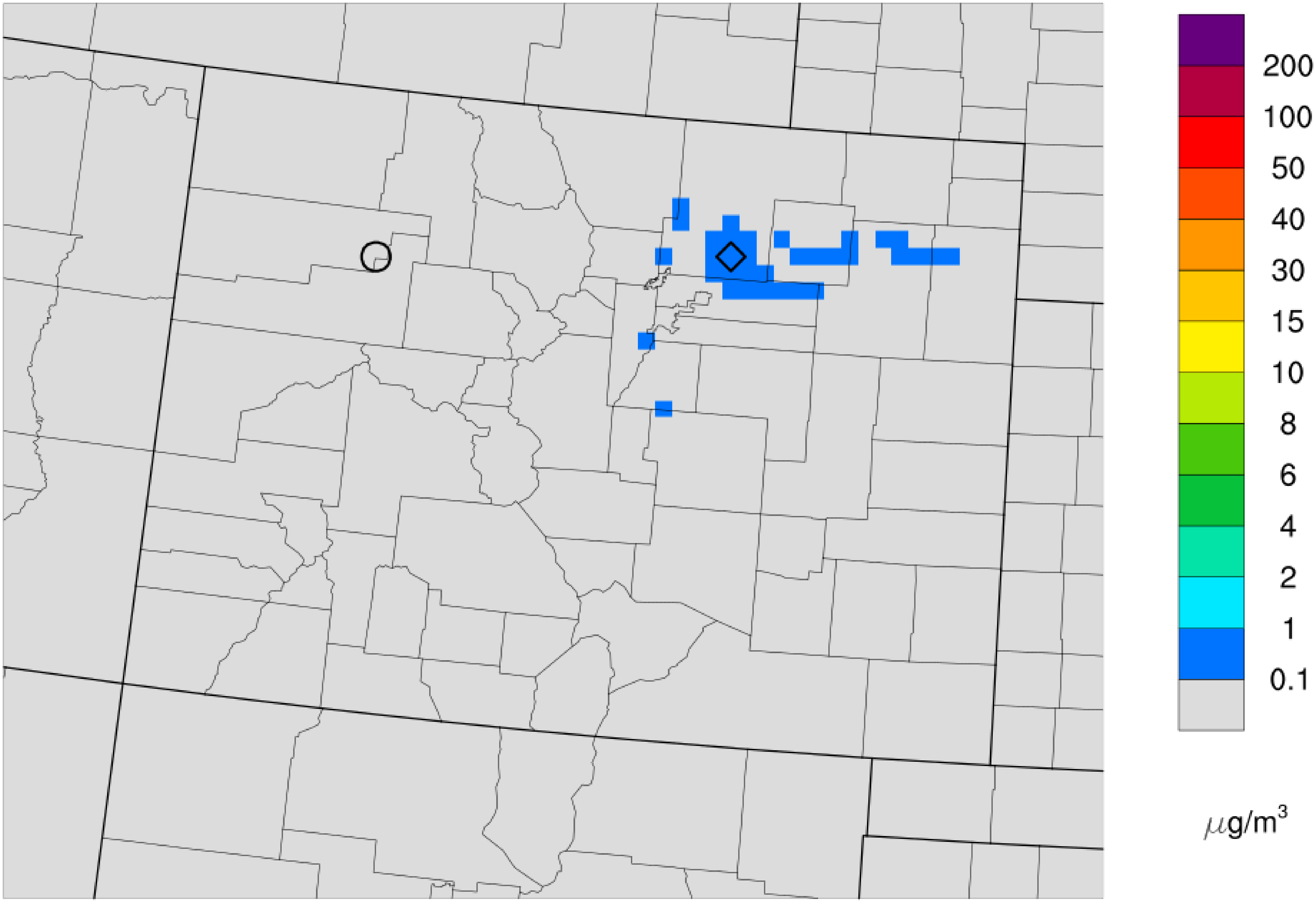


Figure CO.PM10.dly.7
2nd highest daily average PM_{10} concentration
OilGas_NewFed_RoyalGorge



◇ max(44,39) = 0.3 $\mu g/m^3$
○ min(23,39) = 0.0 $\mu g/m^3$

Figure CO.PM10.dly.8
2nd highest daily average PM_{10} concentration
OilGas_Fed_Other_States

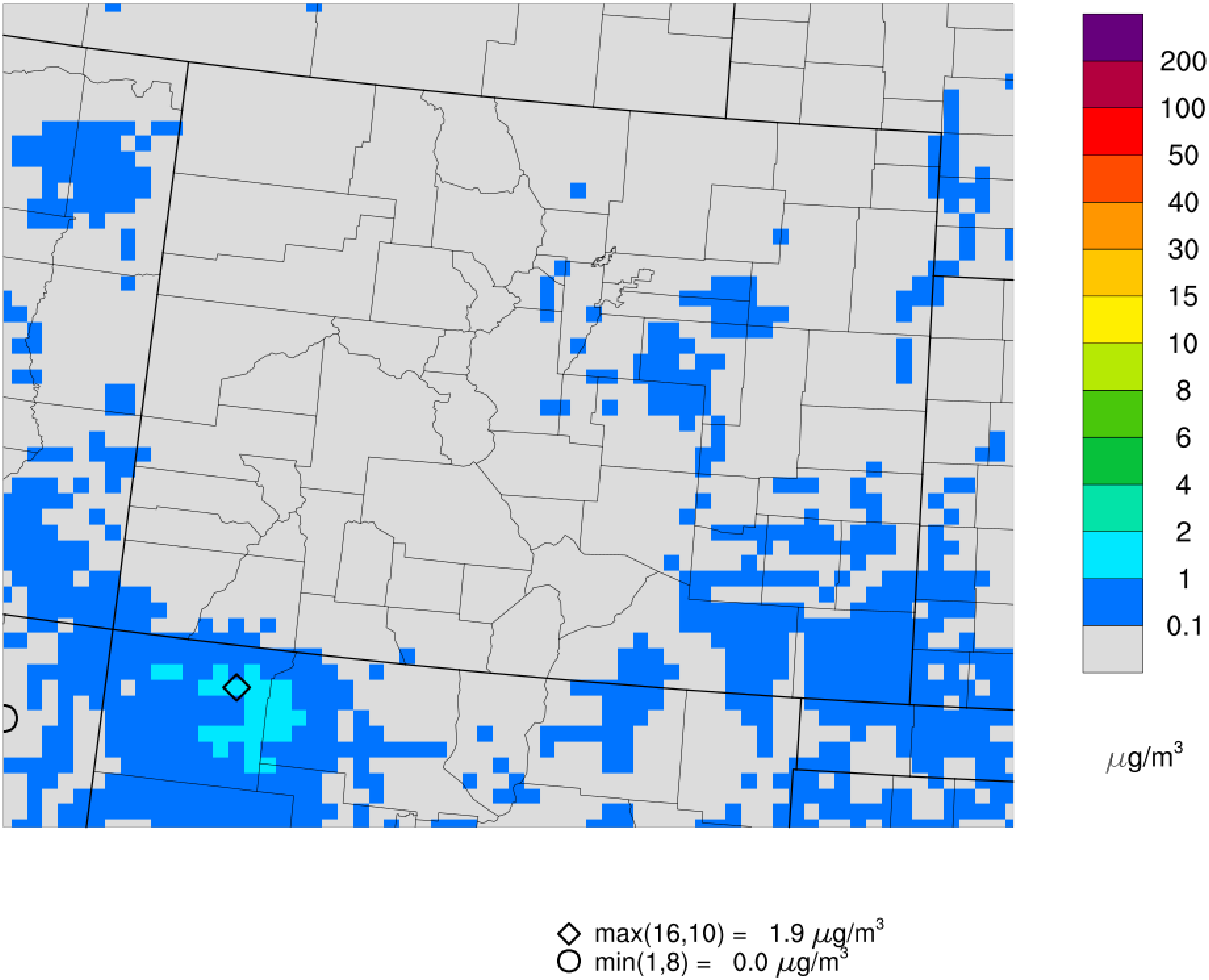


Figure CO.PM10.dly.9
2nd highest daily average PM_{10} concentration
OilGas_NonFed

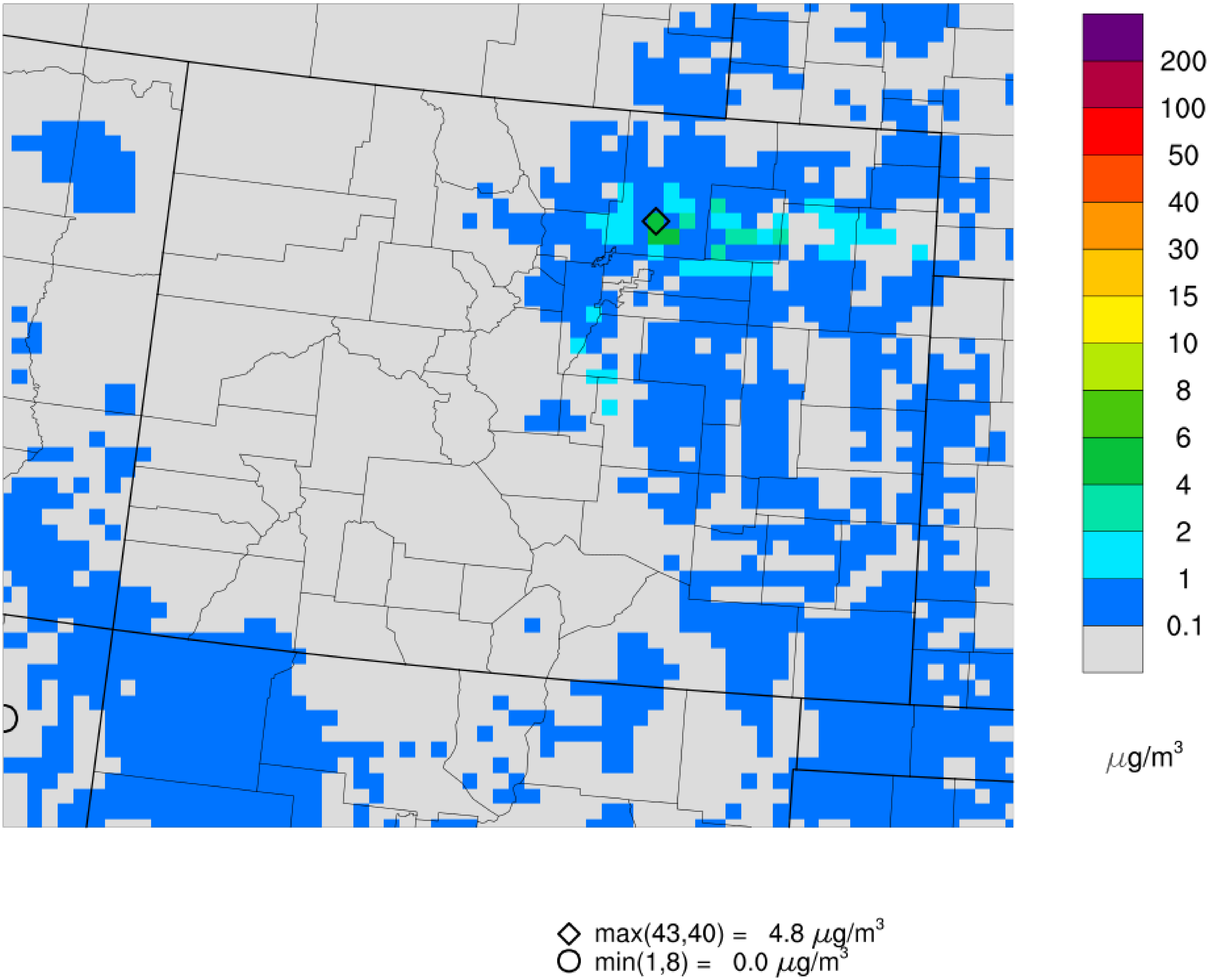


Figure CO.PM10.dly.10
2nd highest daily average PM_{10} concentration
OilGas_ExistTribal

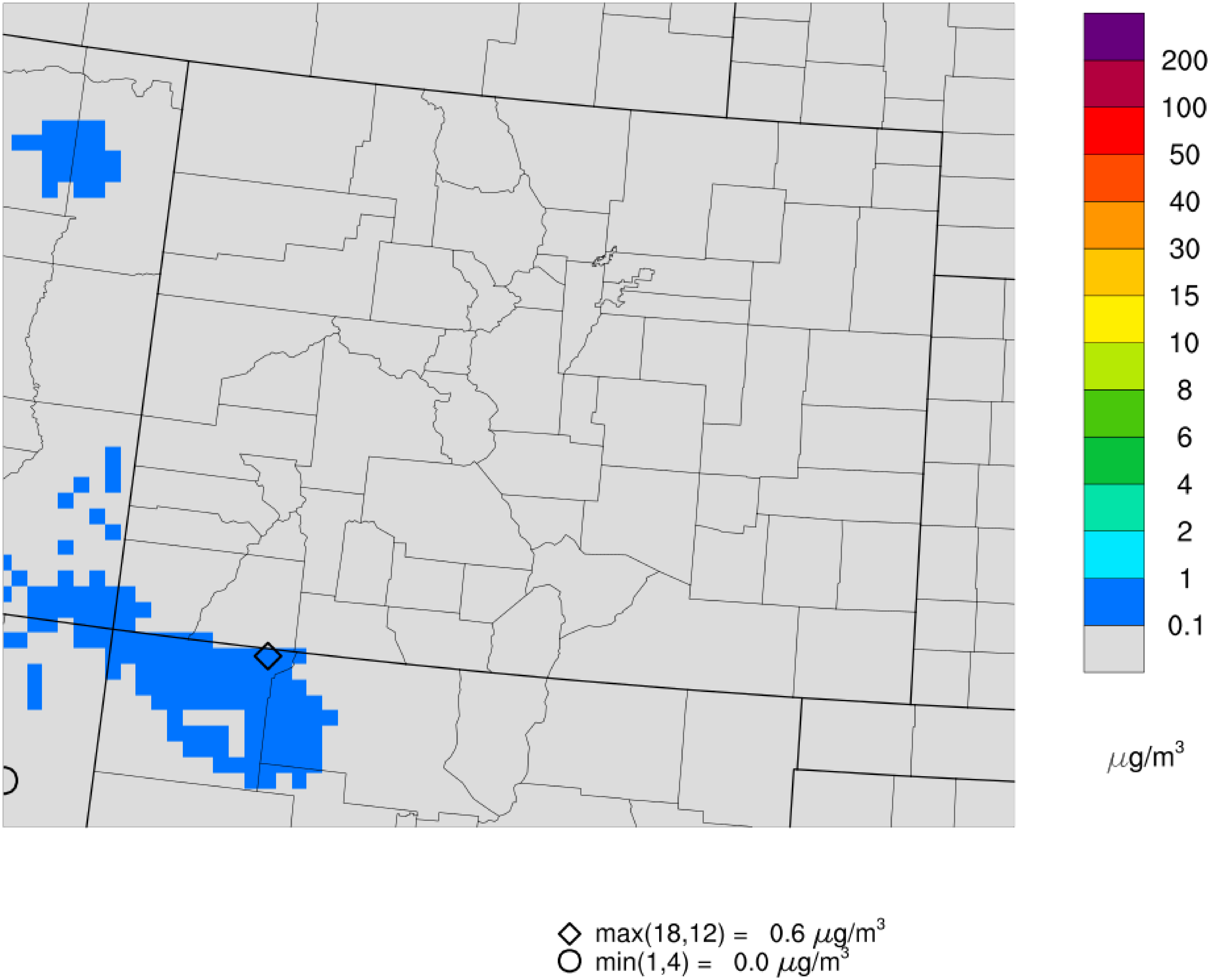


Figure CO.PM10.dly.11
2nd highest daily average PM_{10} concentration
OilGas_NewTribal

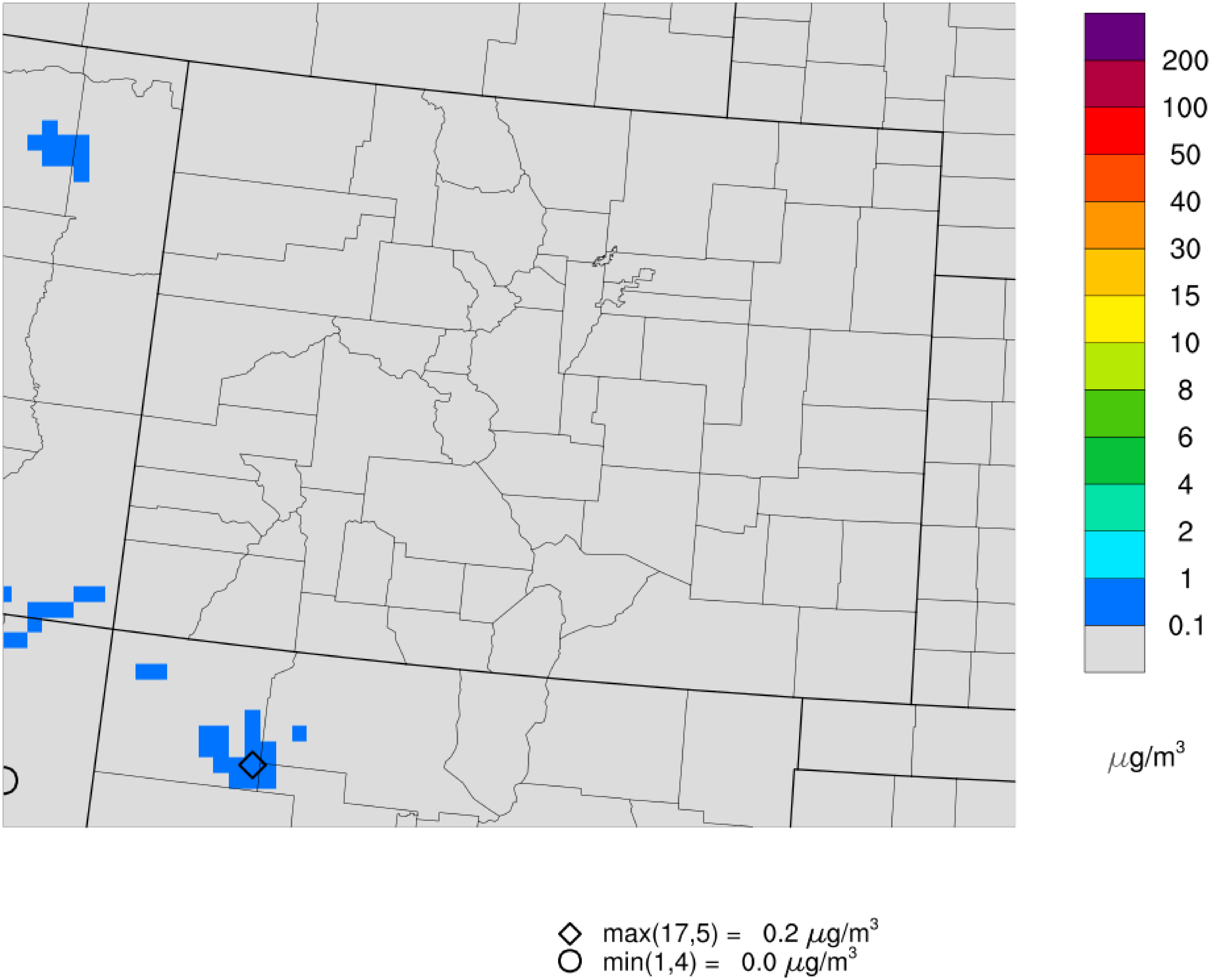
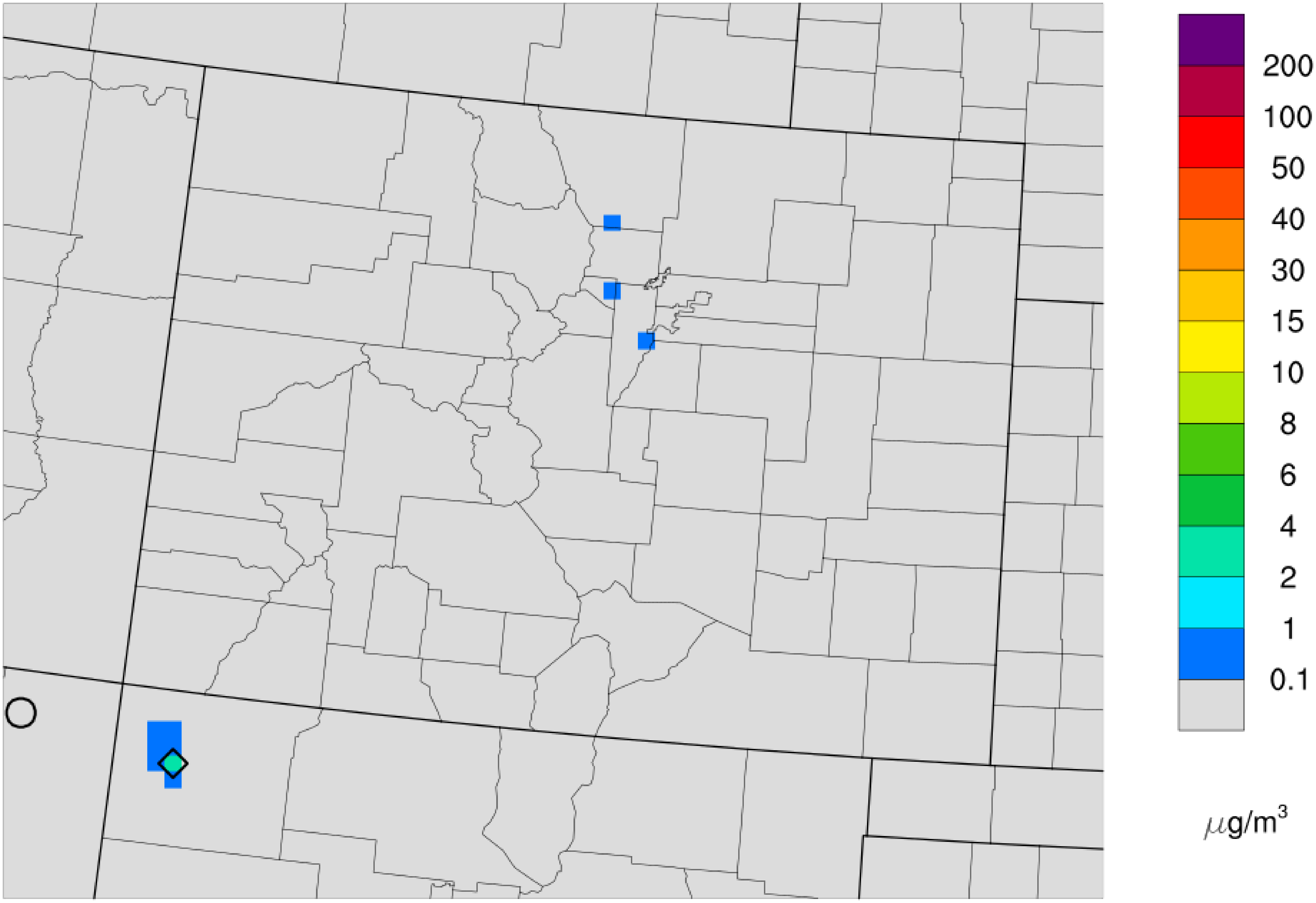


Figure CO.PM10.dly.12
2nd highest daily average PM_{10} concentration
Coal_Fed



◇ max(11,9) = 2.1 $\mu g/m^3$
○ min(2,12) = 0.0 $\mu g/m^3$

Figure CO.PM10.dly.13
2nd highest daily average PM_{10} concentration
Coal_NonFed

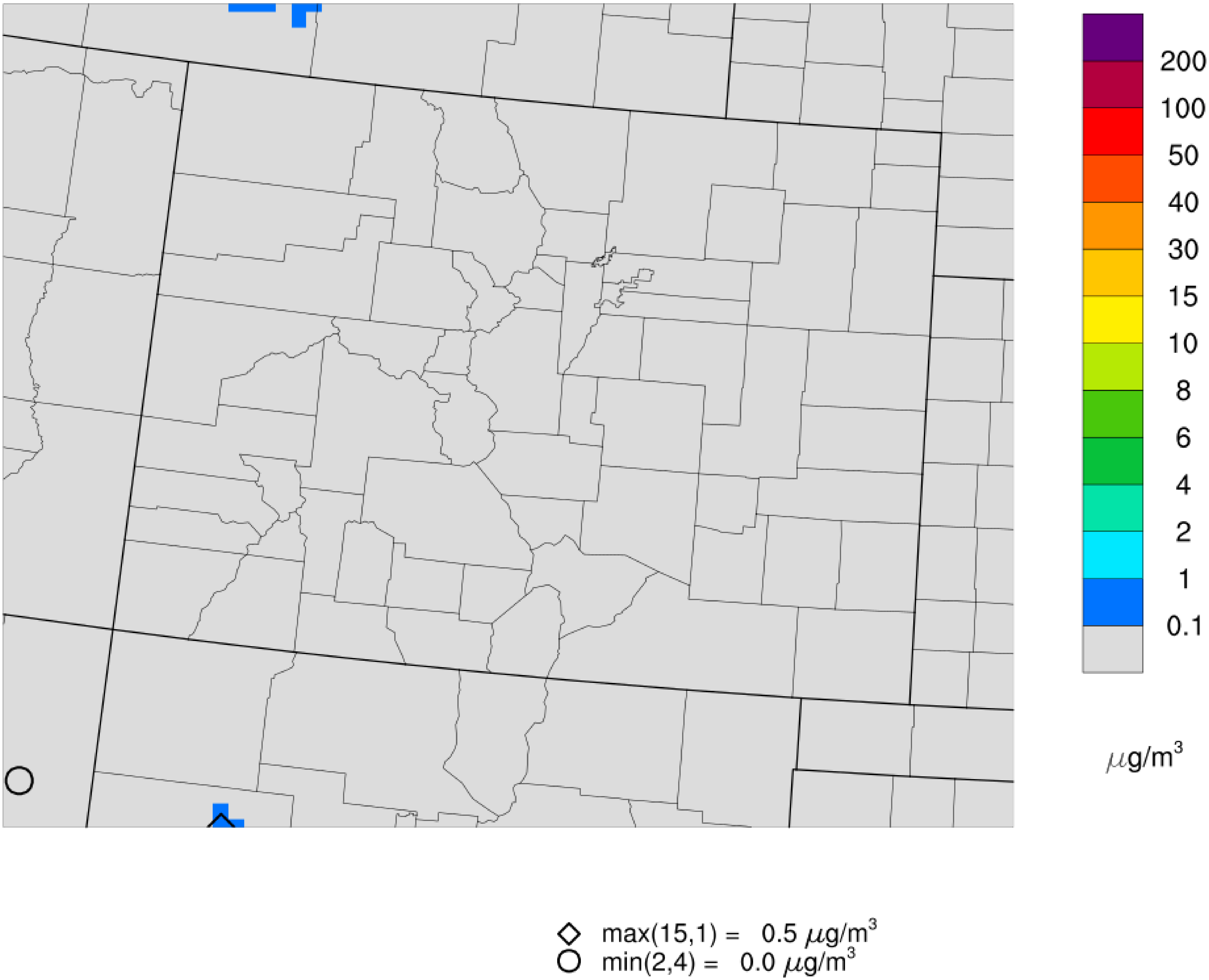
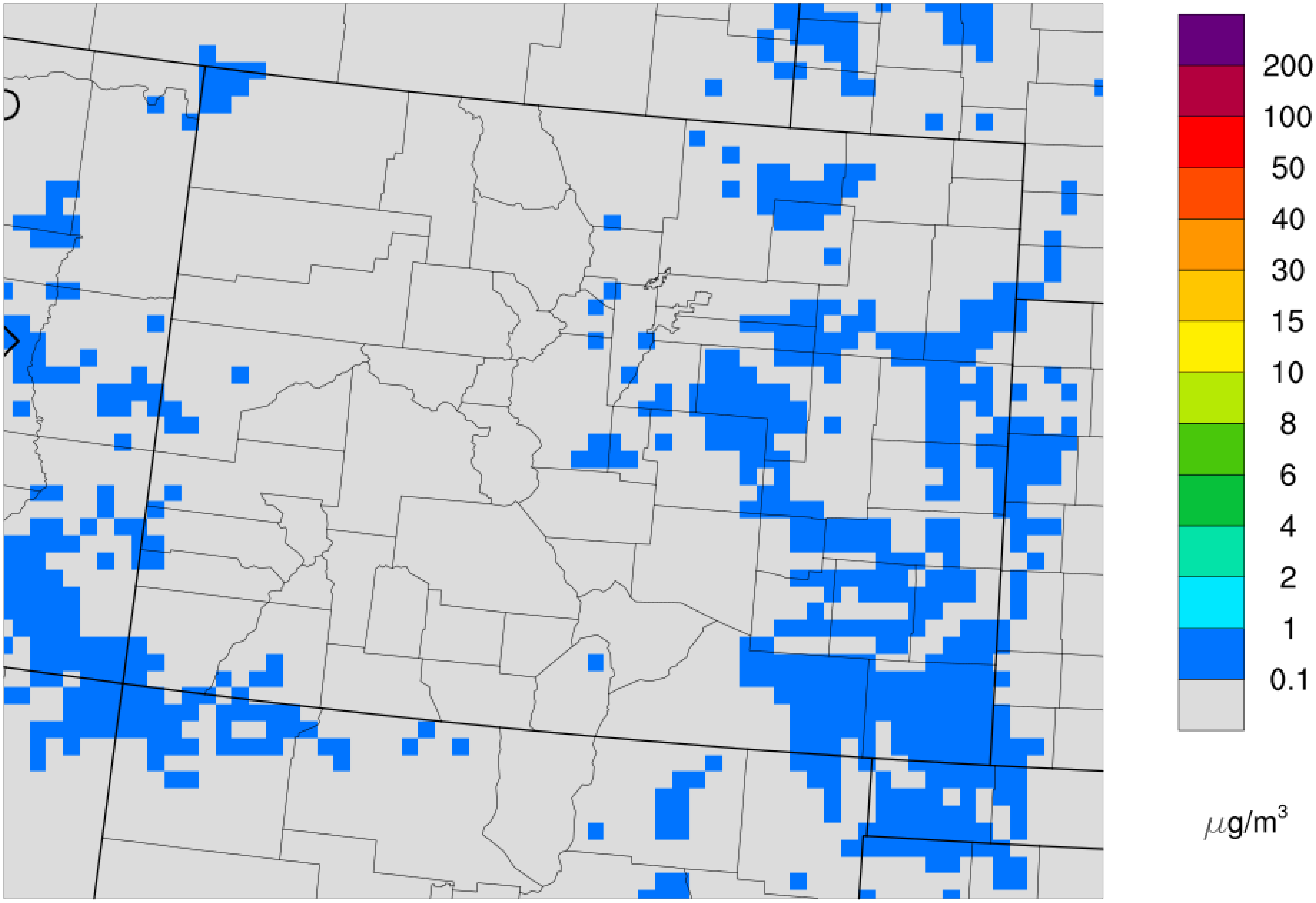


Figure CO.PM10.dly.14
2nd highest daily average PM_{10} concentration
Coal_EGU WRAP states



◇ max(1,34) = 0.6 $\mu g/m^3$
○ min(1,48) = 0.0 $\mu g/m^3$

Figure CO.PM10.dly.15
2nd highest daily average PM_{10} concentration
Coal_Comb WRAP states

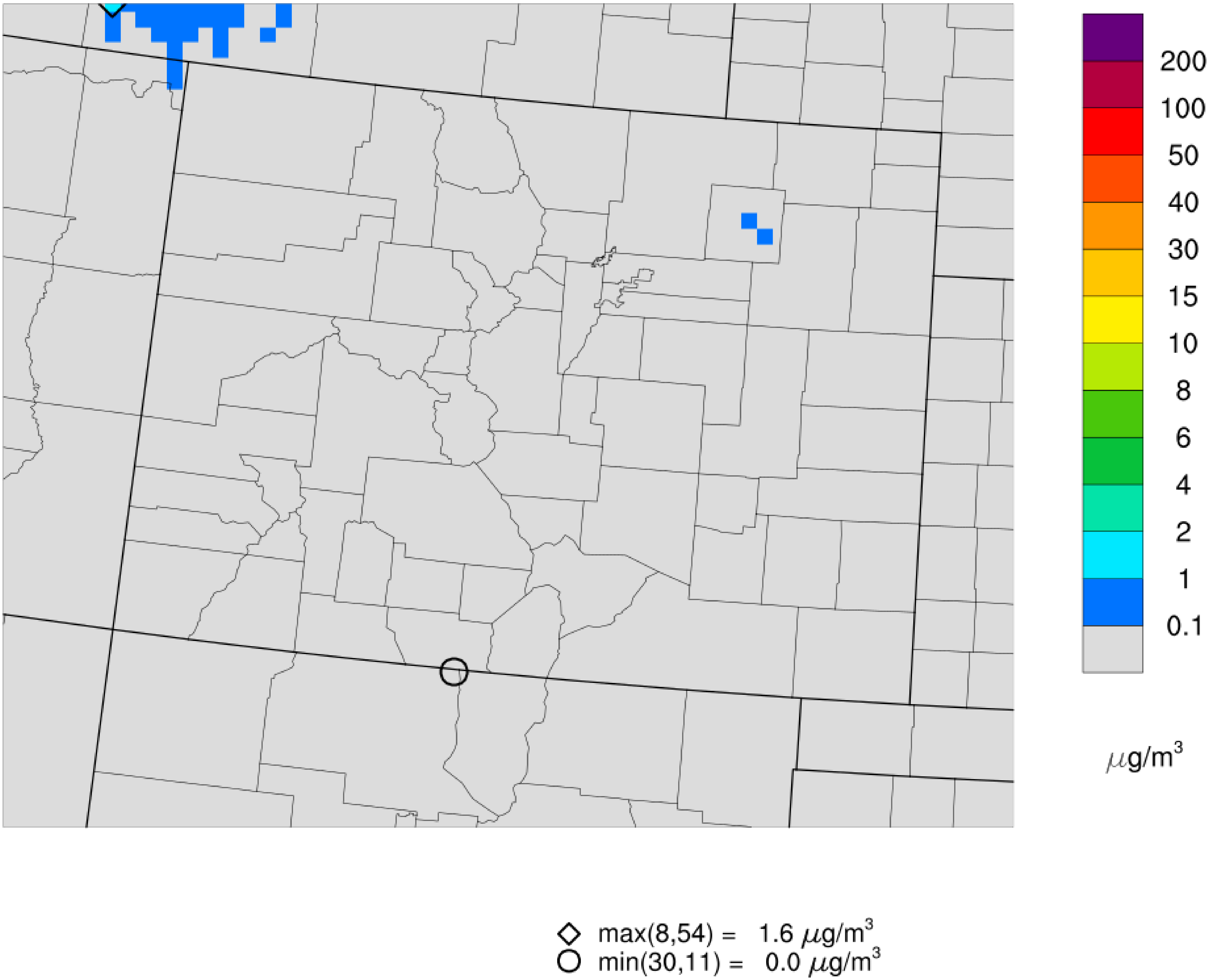
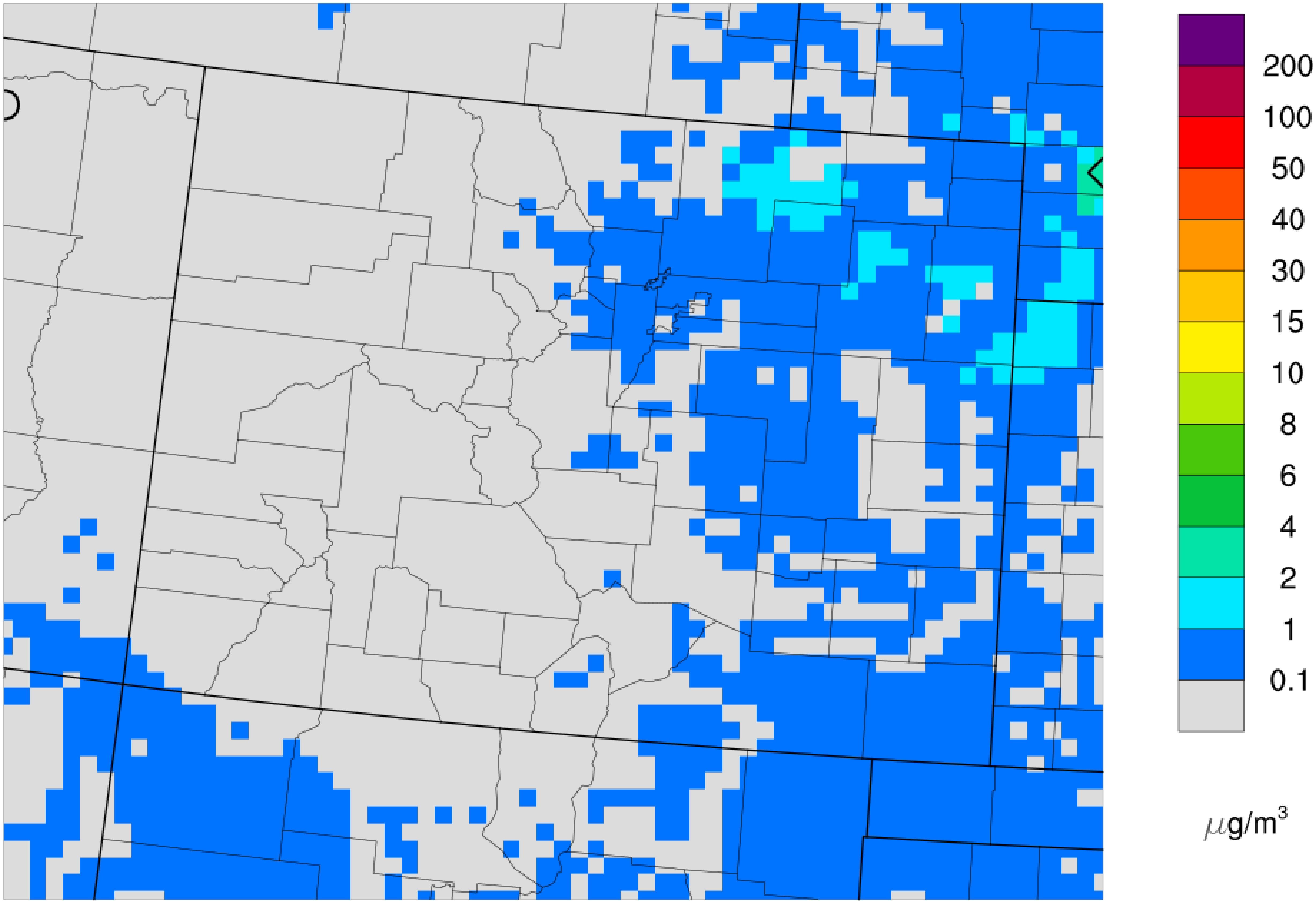
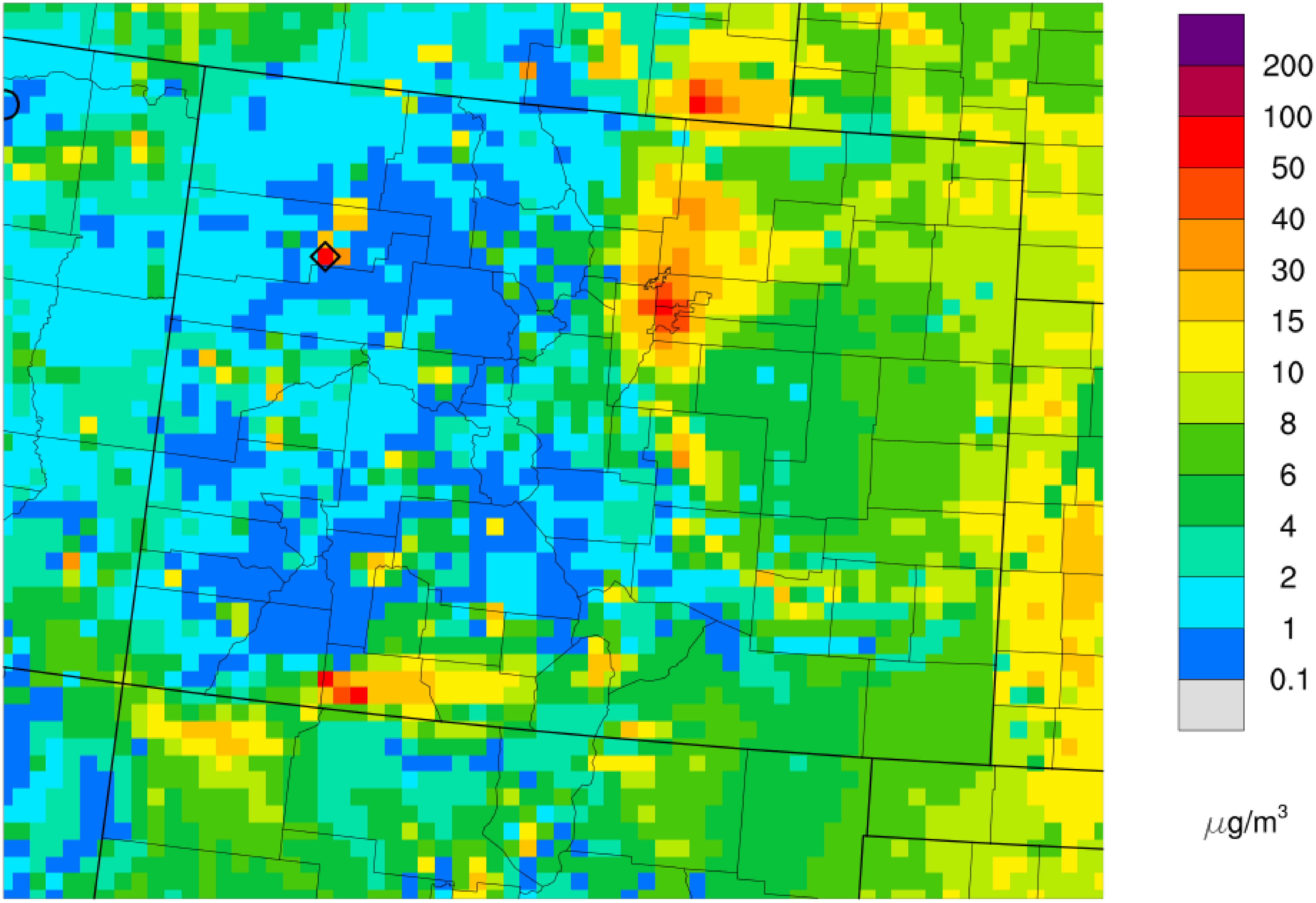


Figure CO.PM10.dly.16
2nd highest daily average PM_{10} concentration
OtherEGU



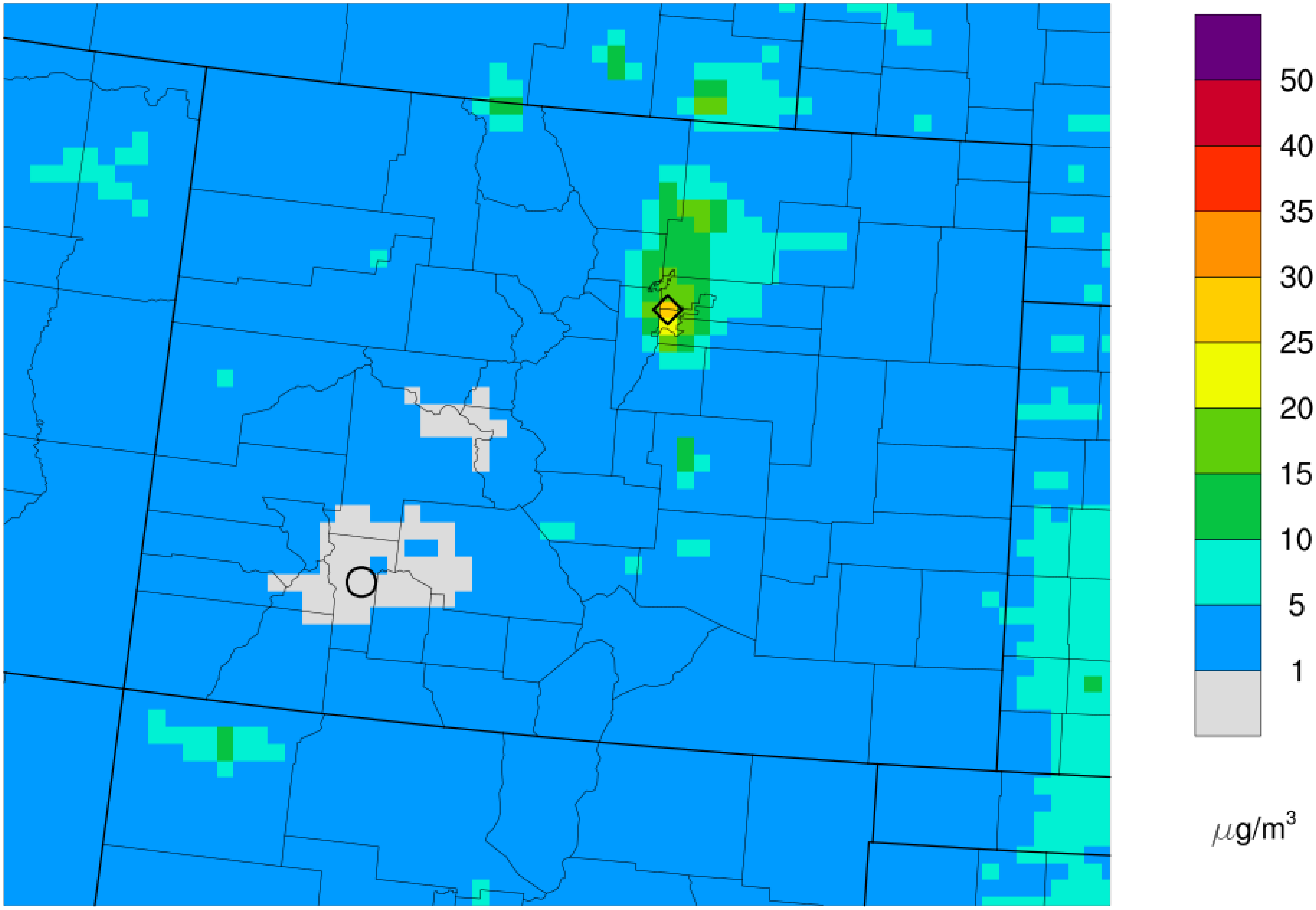
◇ max(66,44) = 2.4 $\mu g/m^3$
○ min(1,48) = 0.0 $\mu g/m^3$

Figure CO.PM10.dly.17
2nd highest daily average PM_{10} concentration
Anthro_Rest



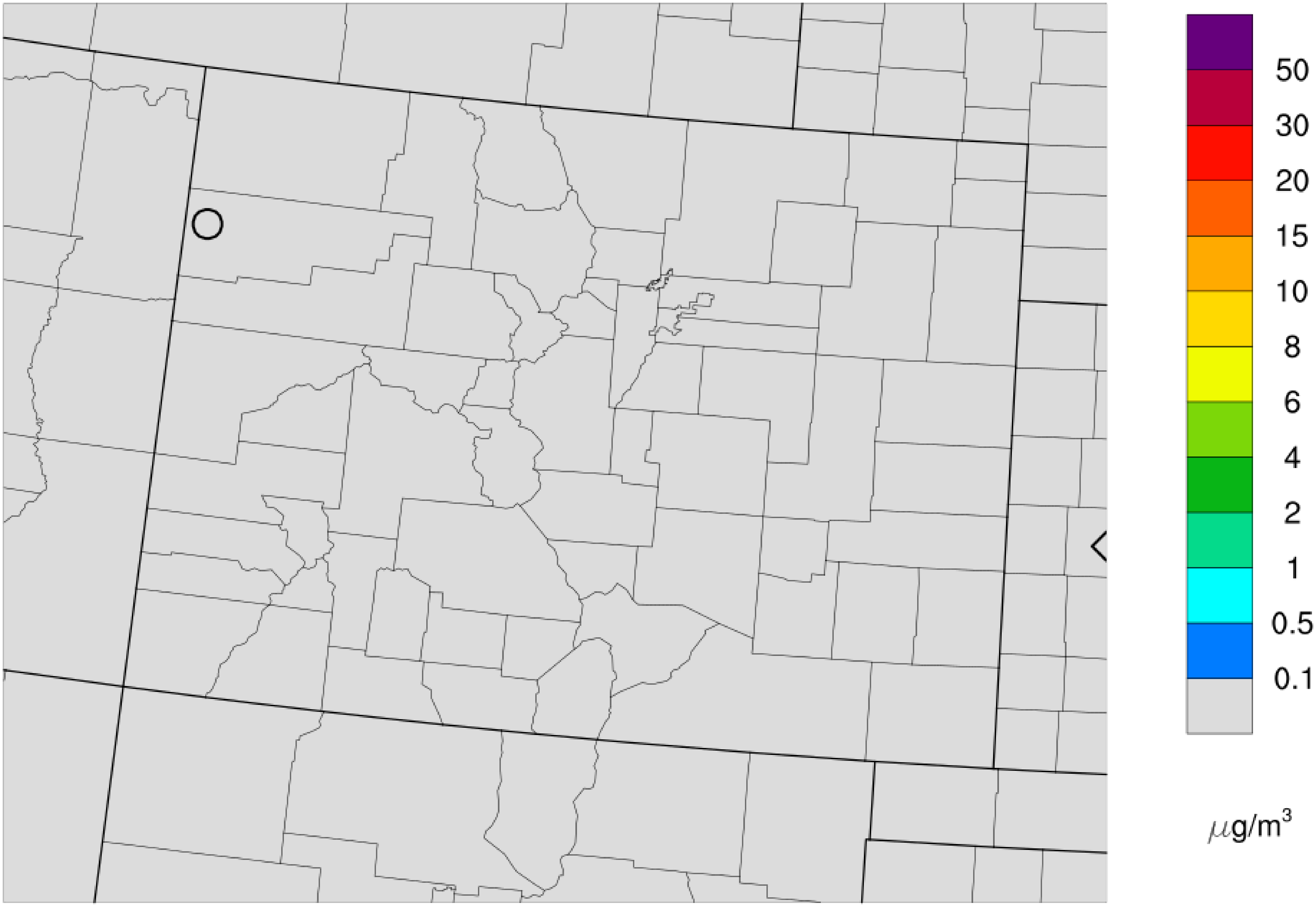
◇ max(20,39) = 97.5 $\mu g/m^3$
○ min(1,48) = 0.2 $\mu g/m^3$

Figure CO.PM10.ann.1
Annual average PM_{10} concentration
Cumulative



◇ max(40,36) = 25.1 $\mu g/m^3$
○ min(22,20) = 0.9 $\mu g/m^3$

Figure CO.PM10.ann.2
Annual average PM_{10} concentration
Natural



◇ max(66,22) = 0.1 $\mu g/m^3$
○ min(13,41) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.3
Annual average PM_{10} concentration
Wildfire

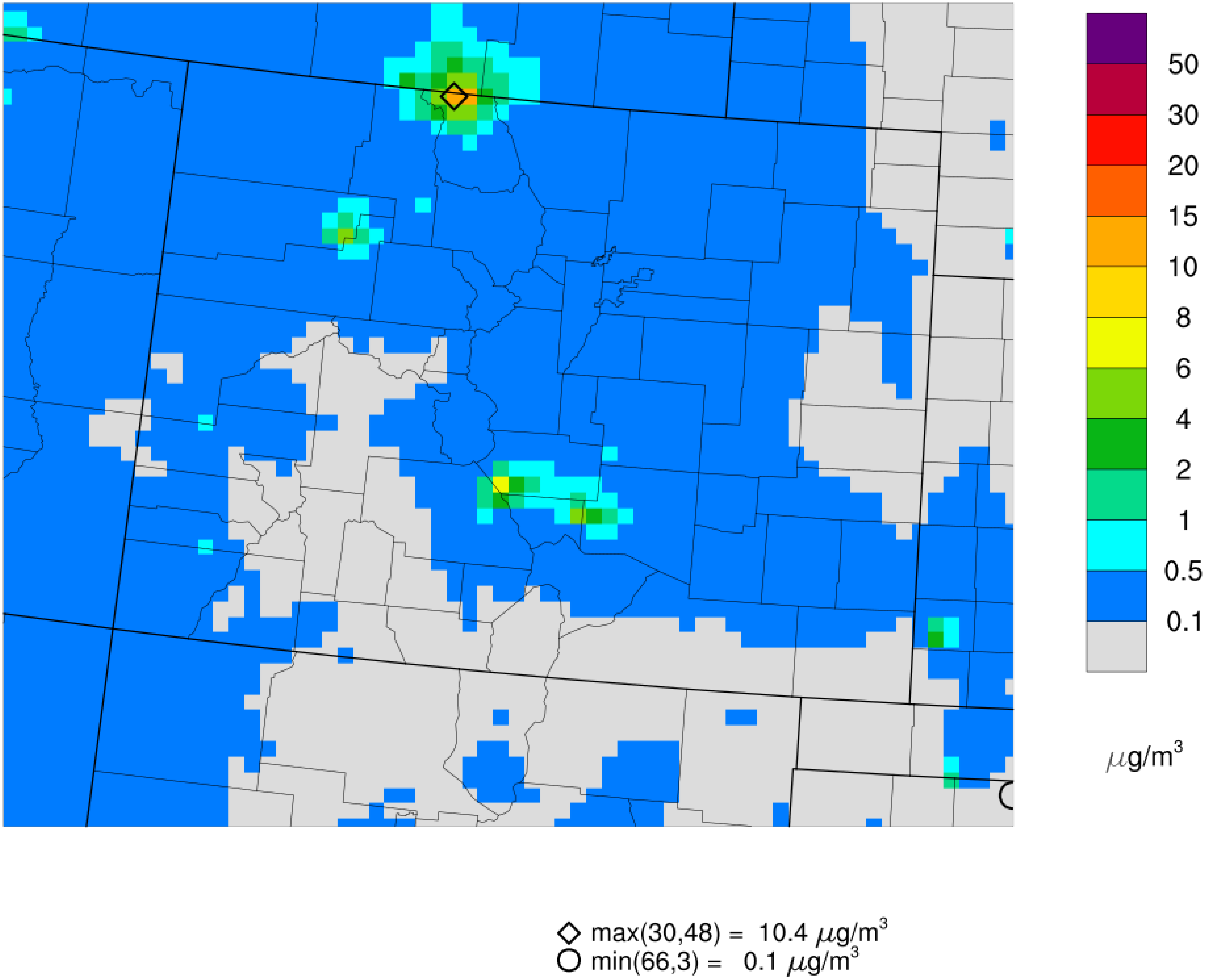
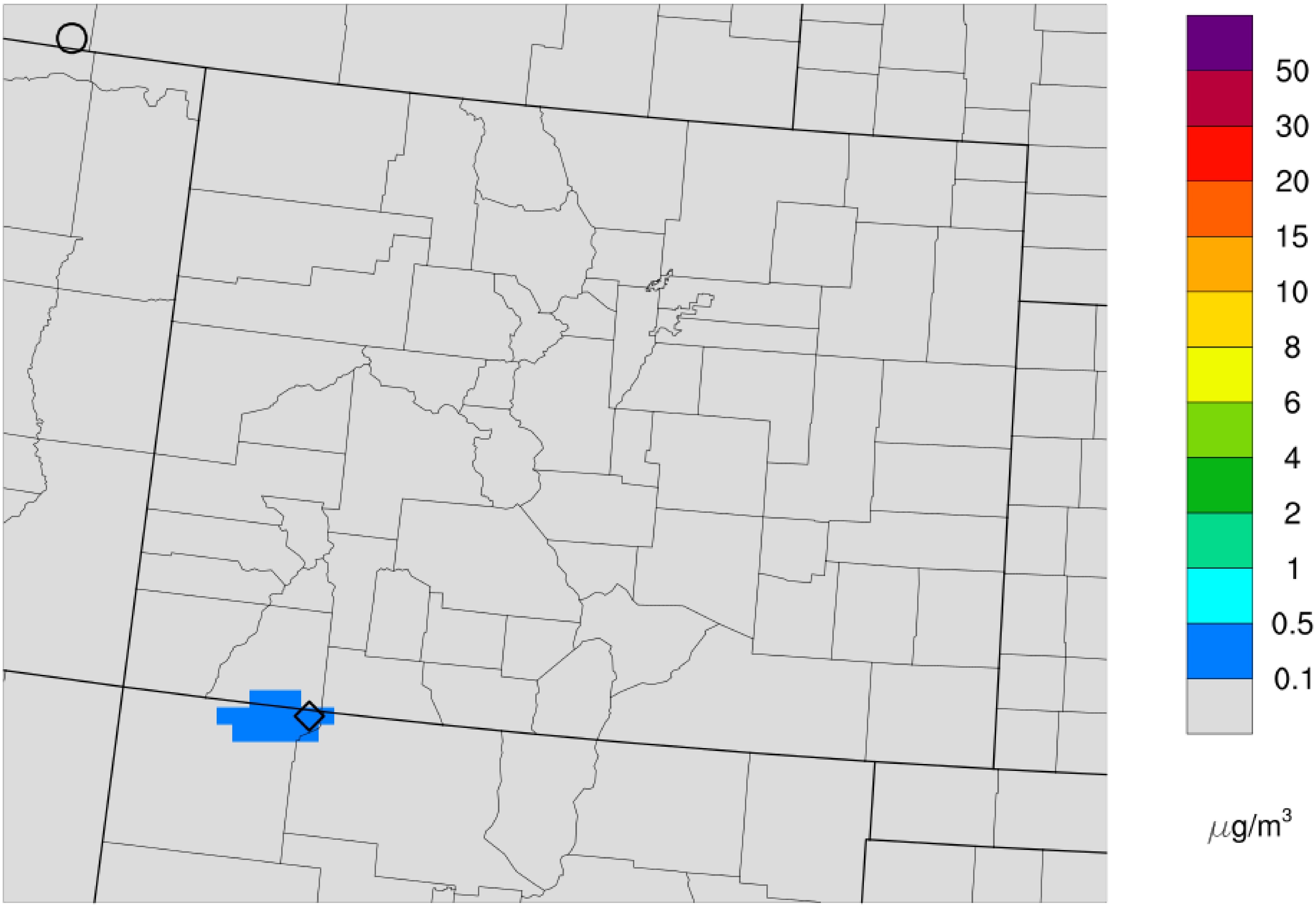


Figure CO.PM10.ann.4
Annual average PM_{10} concentration
OilGas_ExistFed_WesternCO



max(19,12) = 0.4 $\mu g/m^3$
min(5,52) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.5
Annual average PM_{10} concentration
OilGas_ExistFed_RoyalGorge

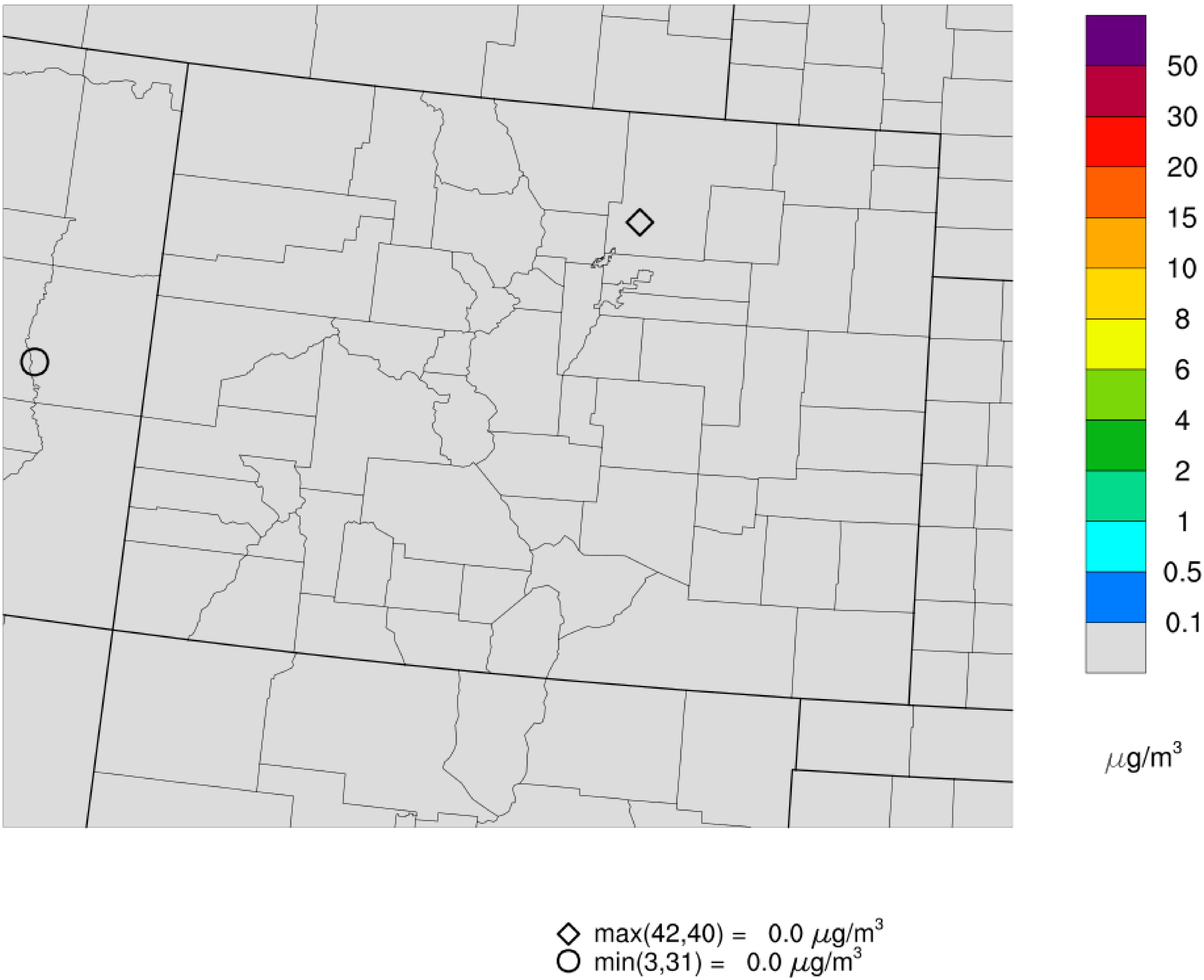
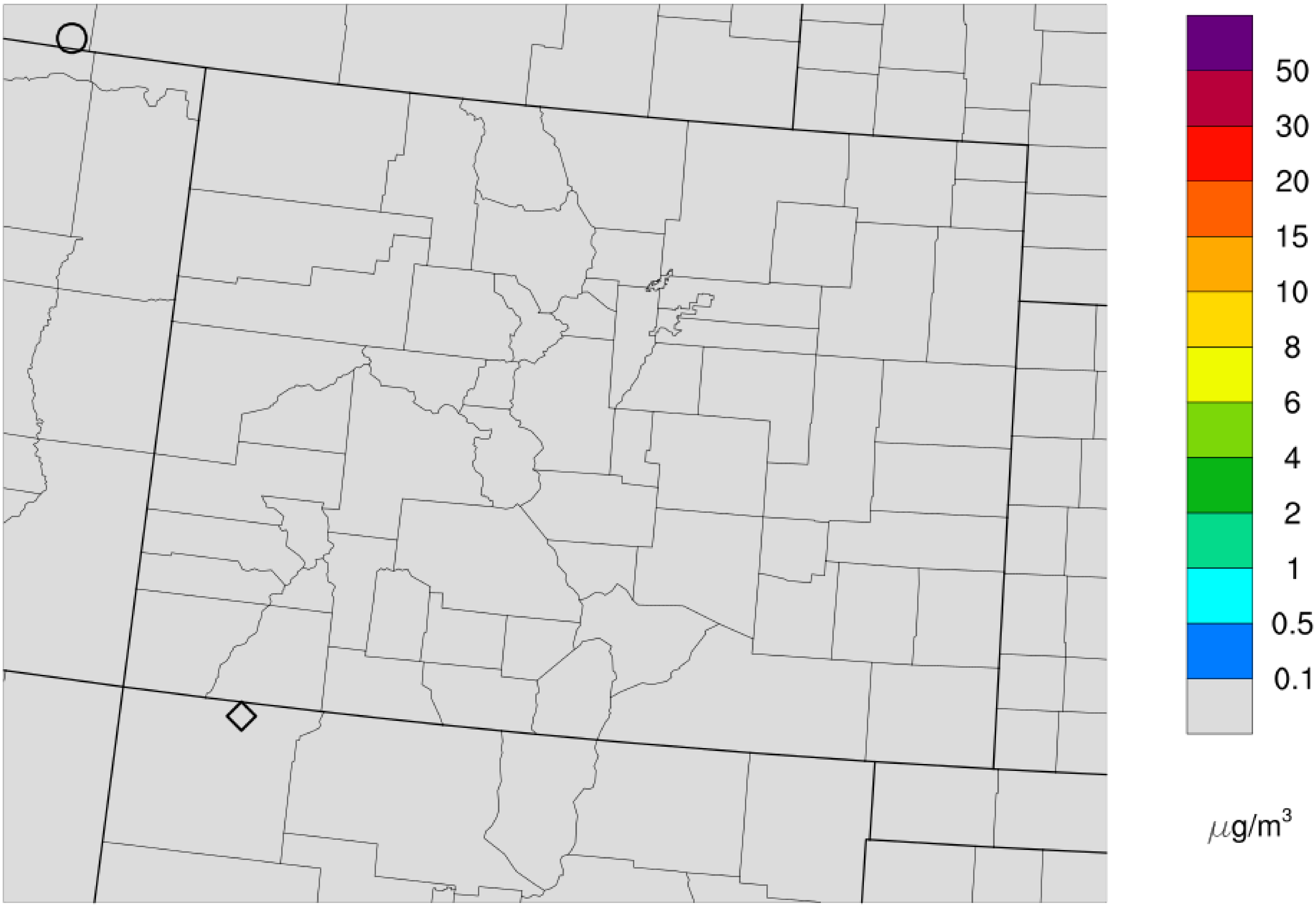


Figure CO.PM10.ann.6
Annual average PM_{10} concentration
OilGas_NewFed_WesternCO



◇ max(15,12) = 0.1 $\mu g/m^3$
○ min(5,52) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.7
Annual average PM_{10} concentration
OilGas_NewFed_RoyalGorge

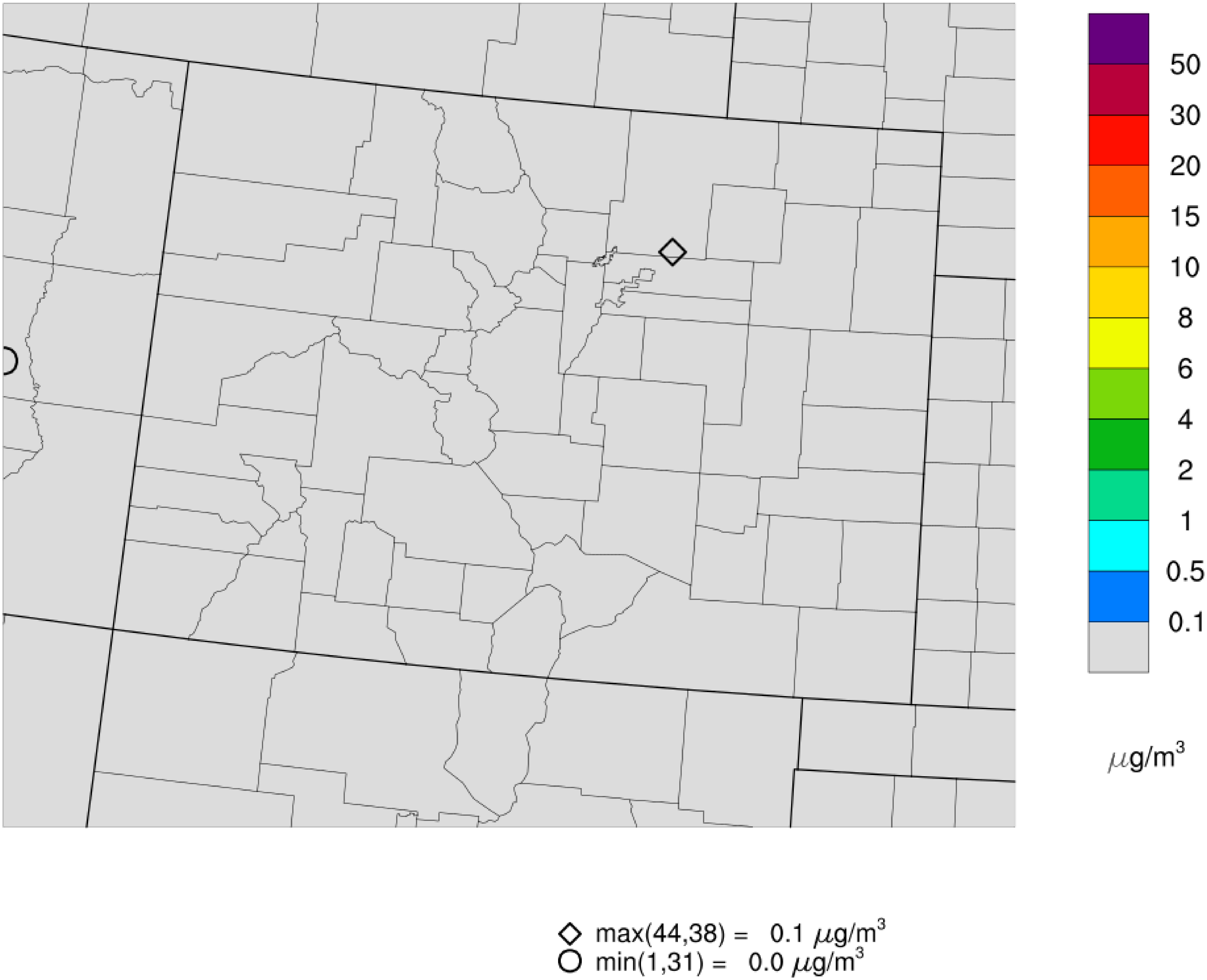
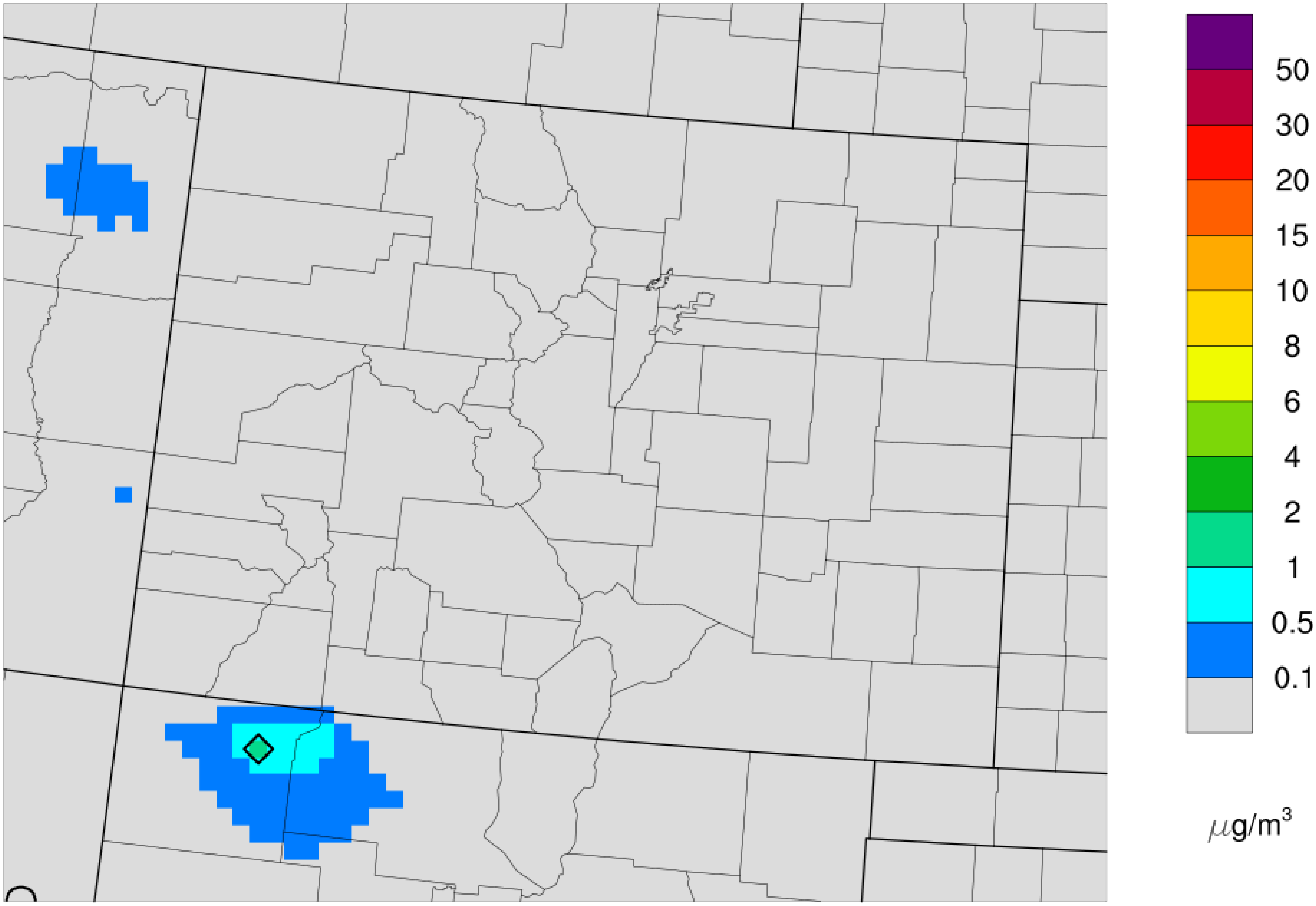


Figure CO.PM10.ann.8
Annual average PM_{10} concentration
OilGas_Fed_Other_States



◇ max(16,10) = 1.0 $\mu g/m^3$
○ min(2,1) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.9
Annual average PM_{10} concentration
OilGas_NonFed

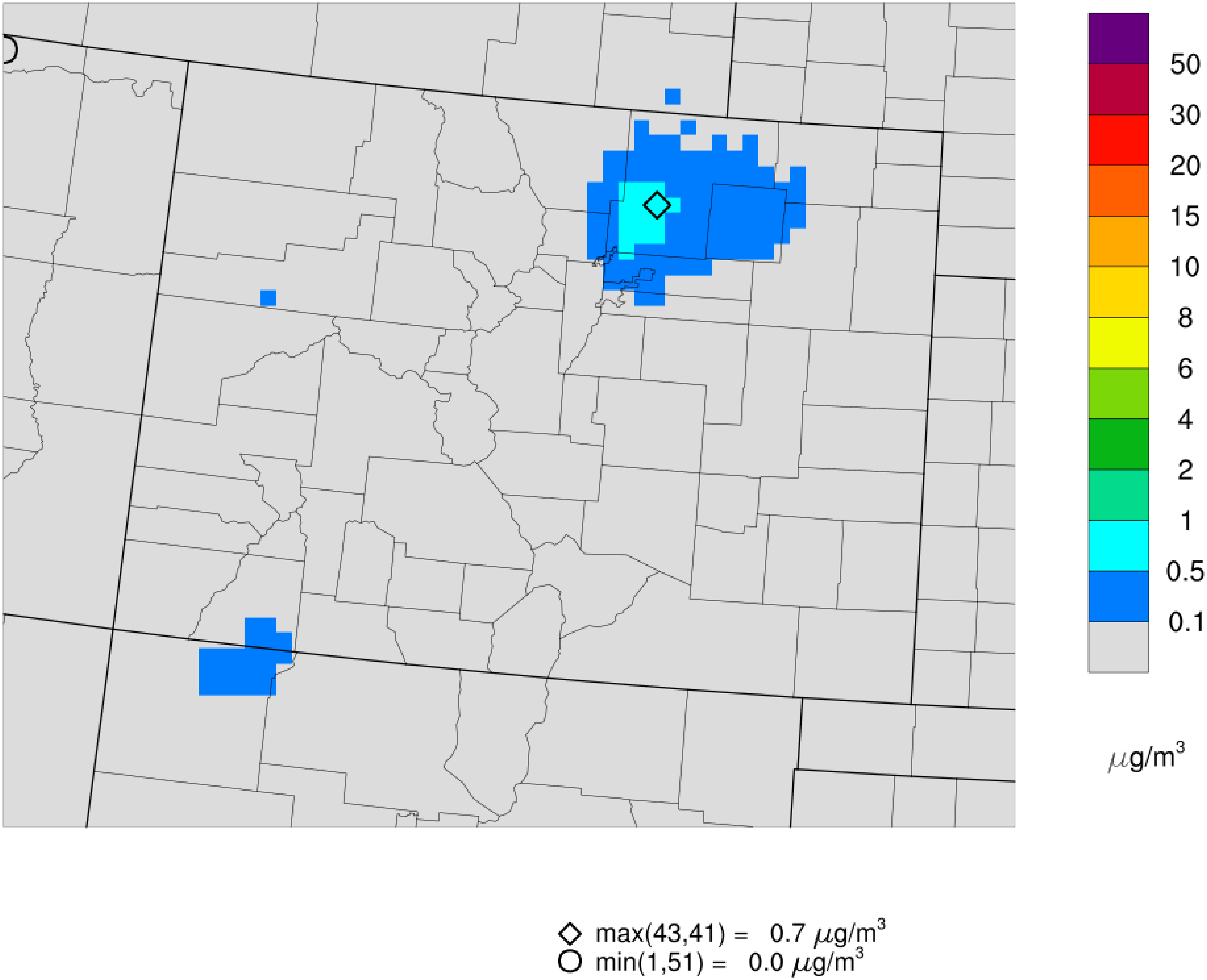
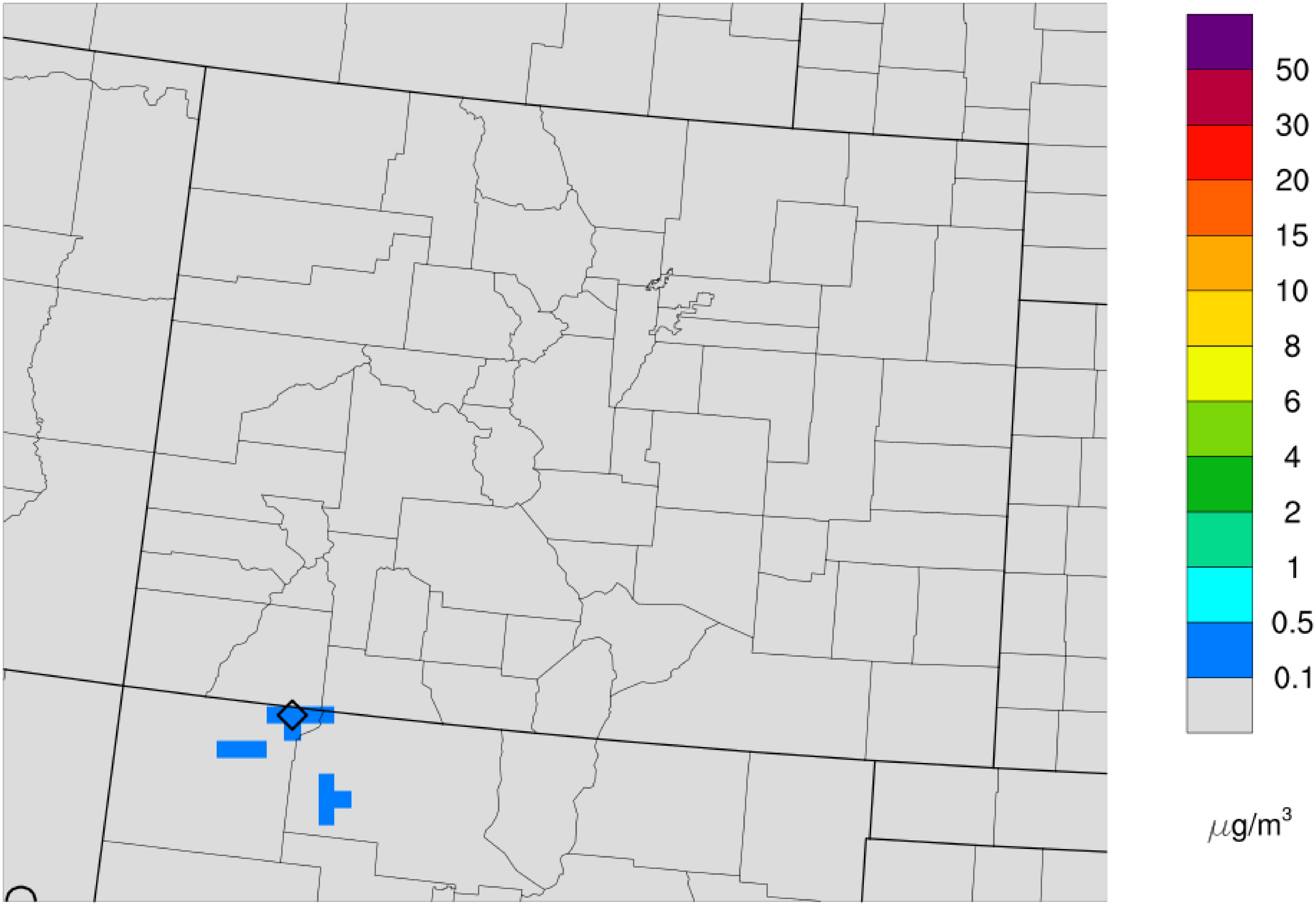


Figure CO.PM10.ann.10
Annual average PM_{10} concentration
OilGas_ExistTribal



◇ max(18,12) = 0.4 $\mu g/m^3$
○ min(2,1) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.11
Annual average PM_{10} concentration
OilGas_NewTribal

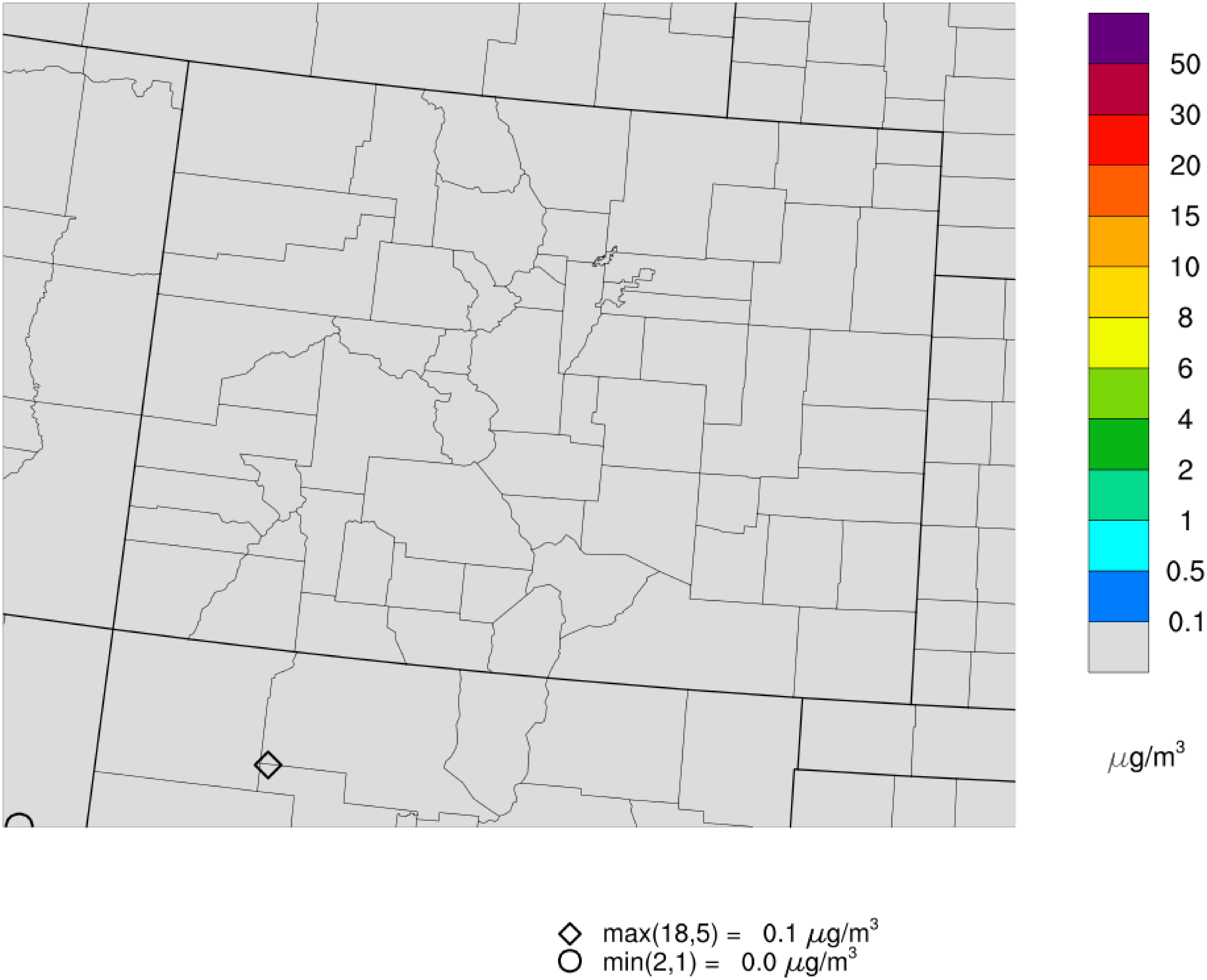
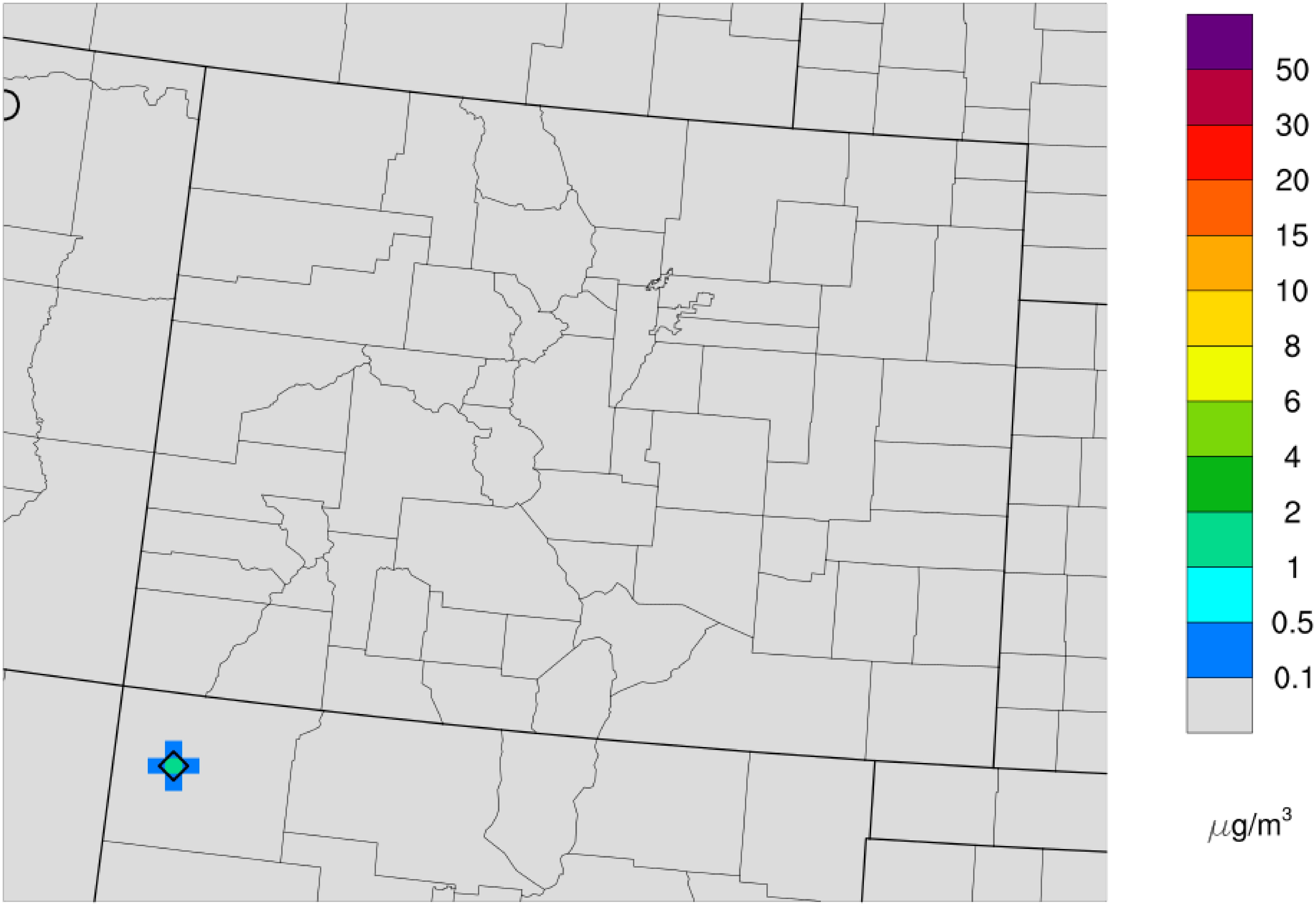


Figure CO.PM10.ann.12
Annual average PM_{10} concentration
Coal_Fed



◇ max(11,9) = 1.5 $\mu g/m^3$

○ min(1,48) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.13
Annual average PM_{10} concentration
Coal_NonFed

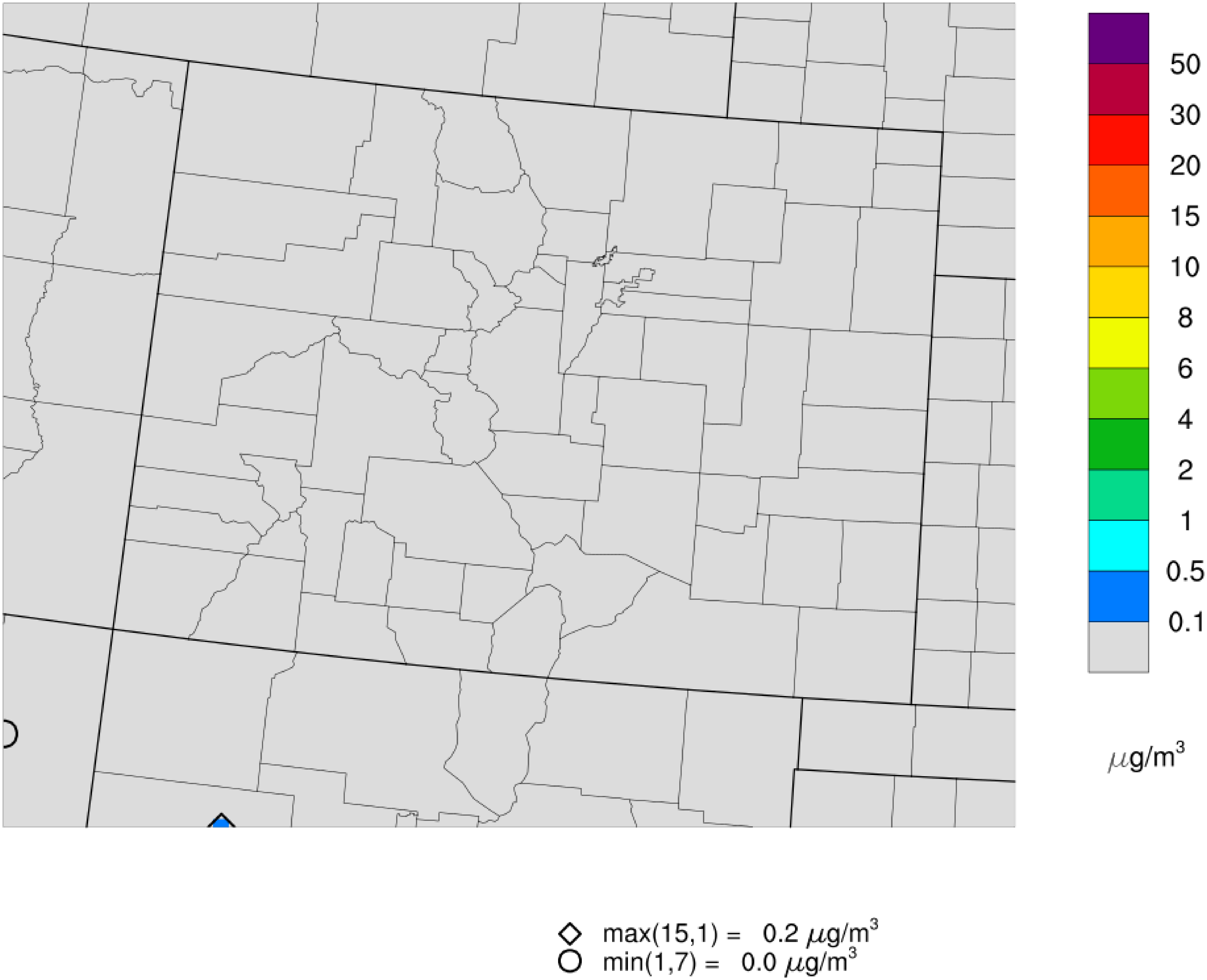
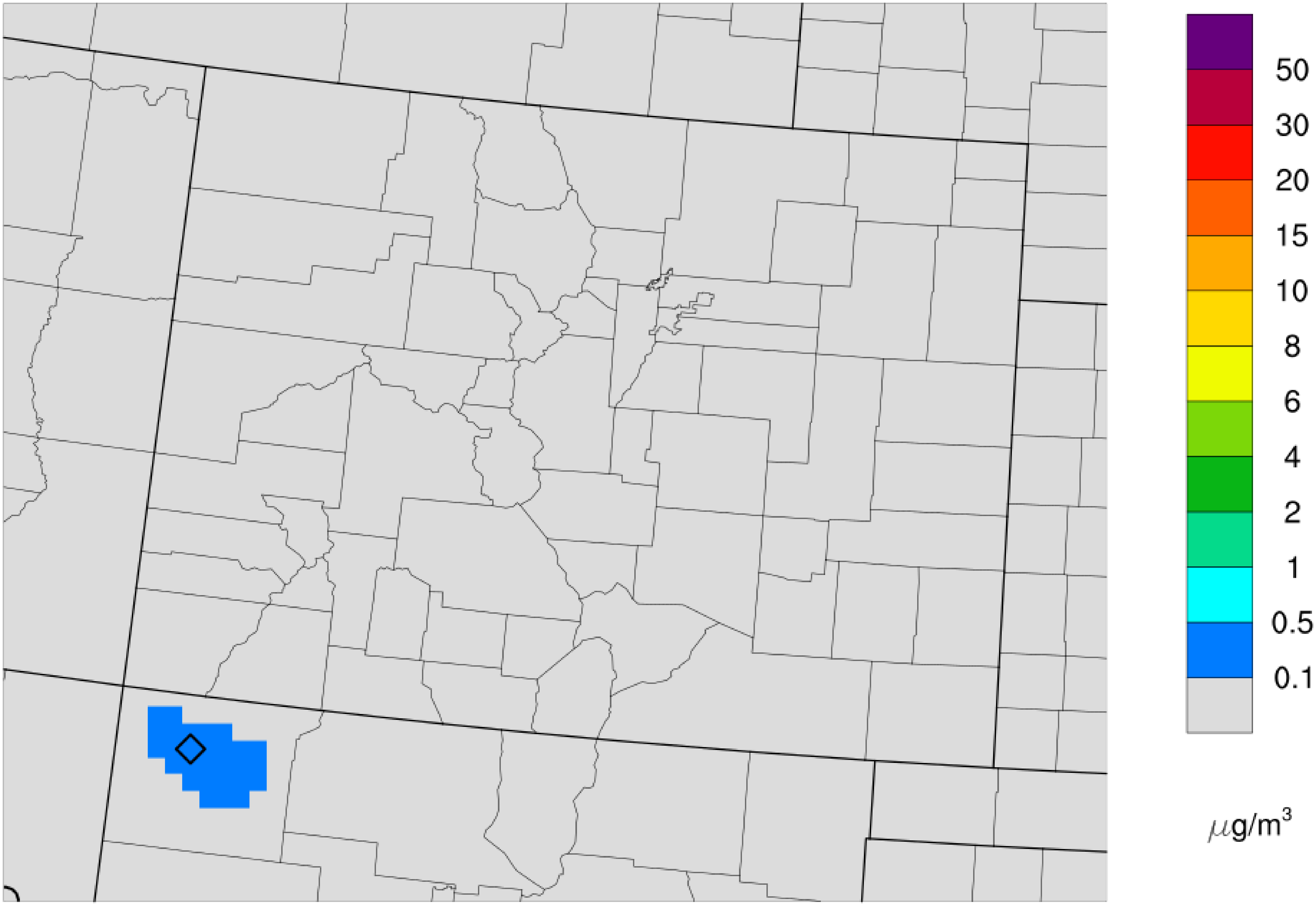


Figure CO.PM10.ann.14
Annual average PM_{10} concentration
Coal_EGU WRAP states



◇ max(12,10) = 0.4 $\mu g/m^3$
○ min(1,1) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.15
Annual average PM_{10} concentration
Coal_Comb WRAP states

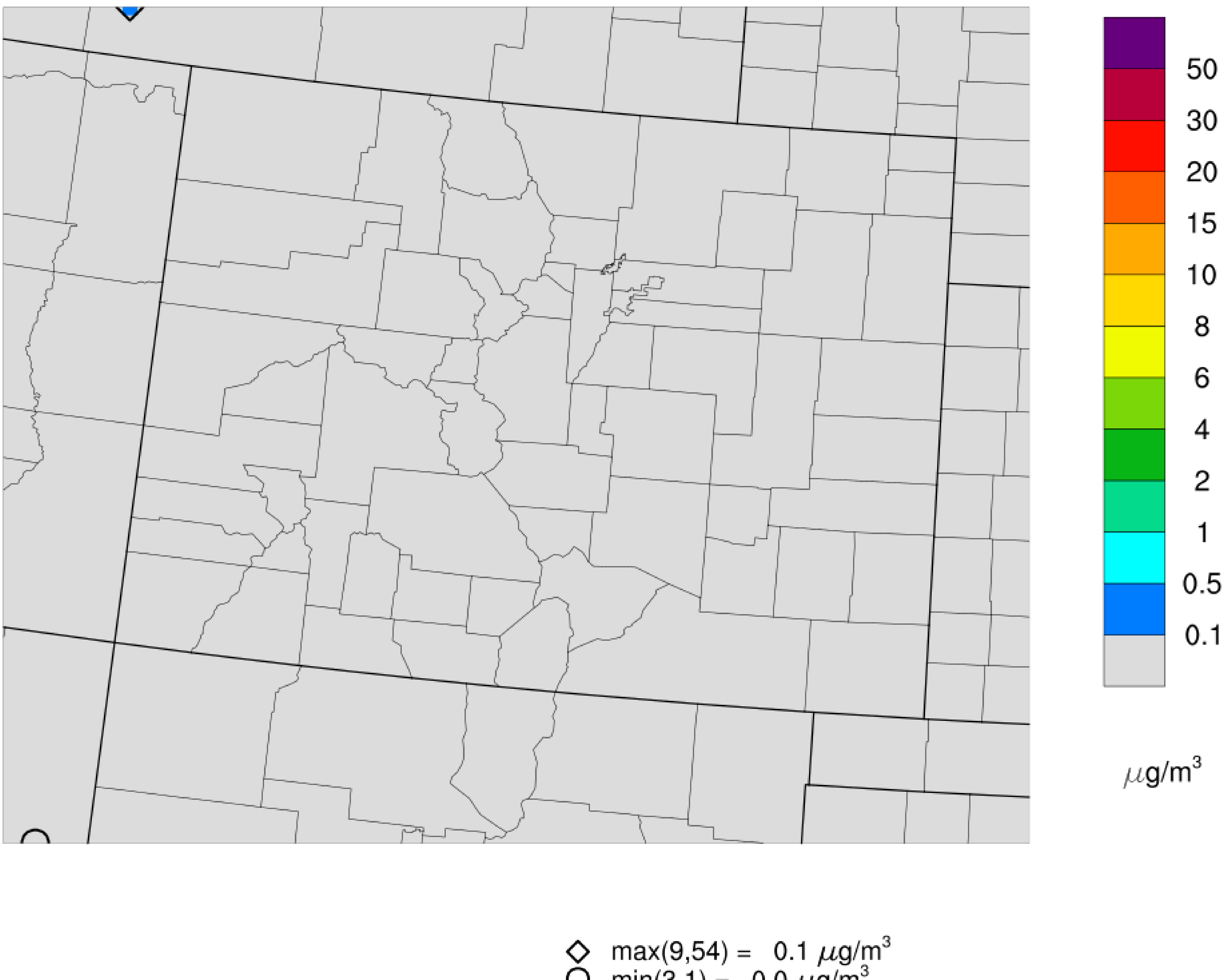
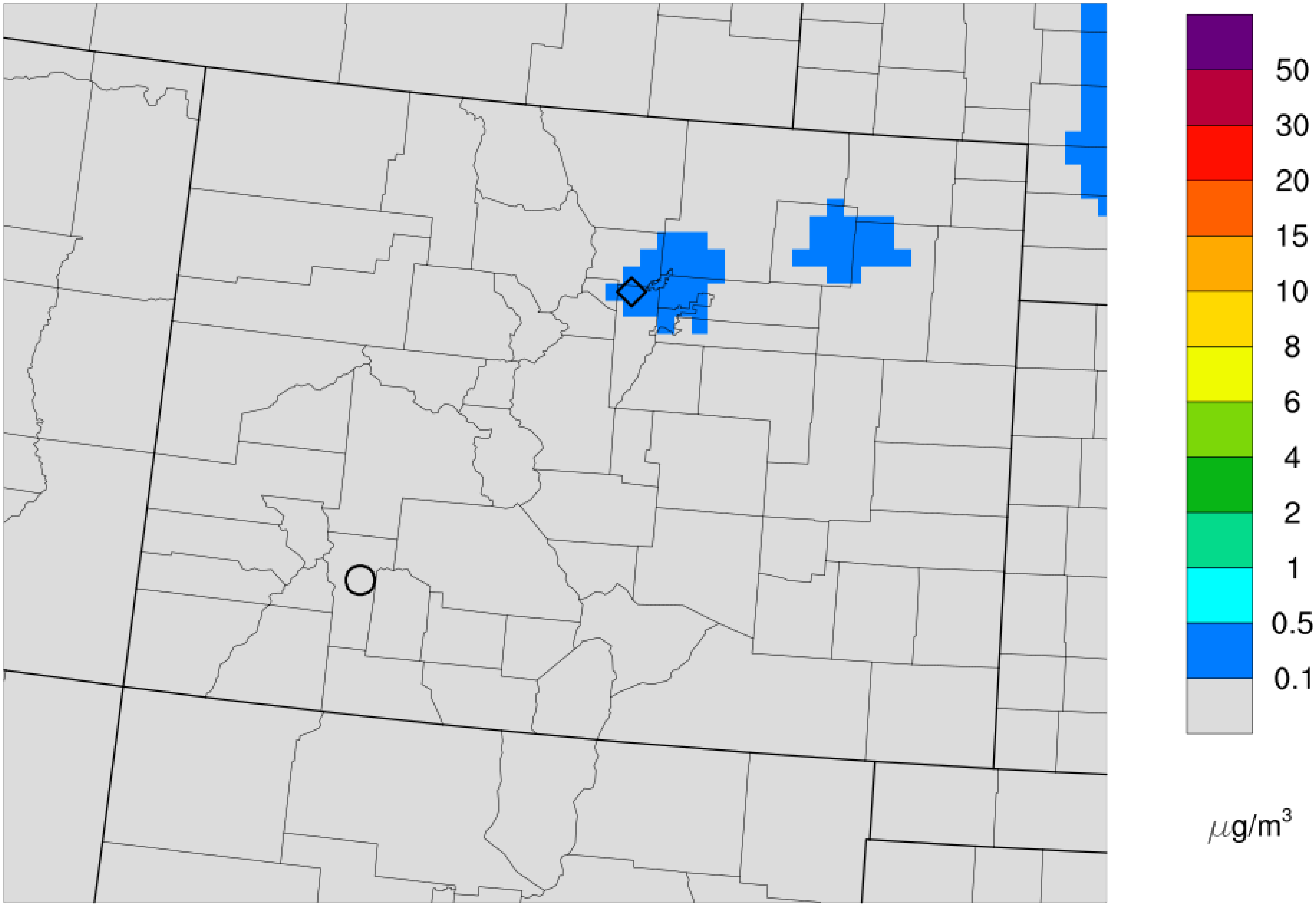
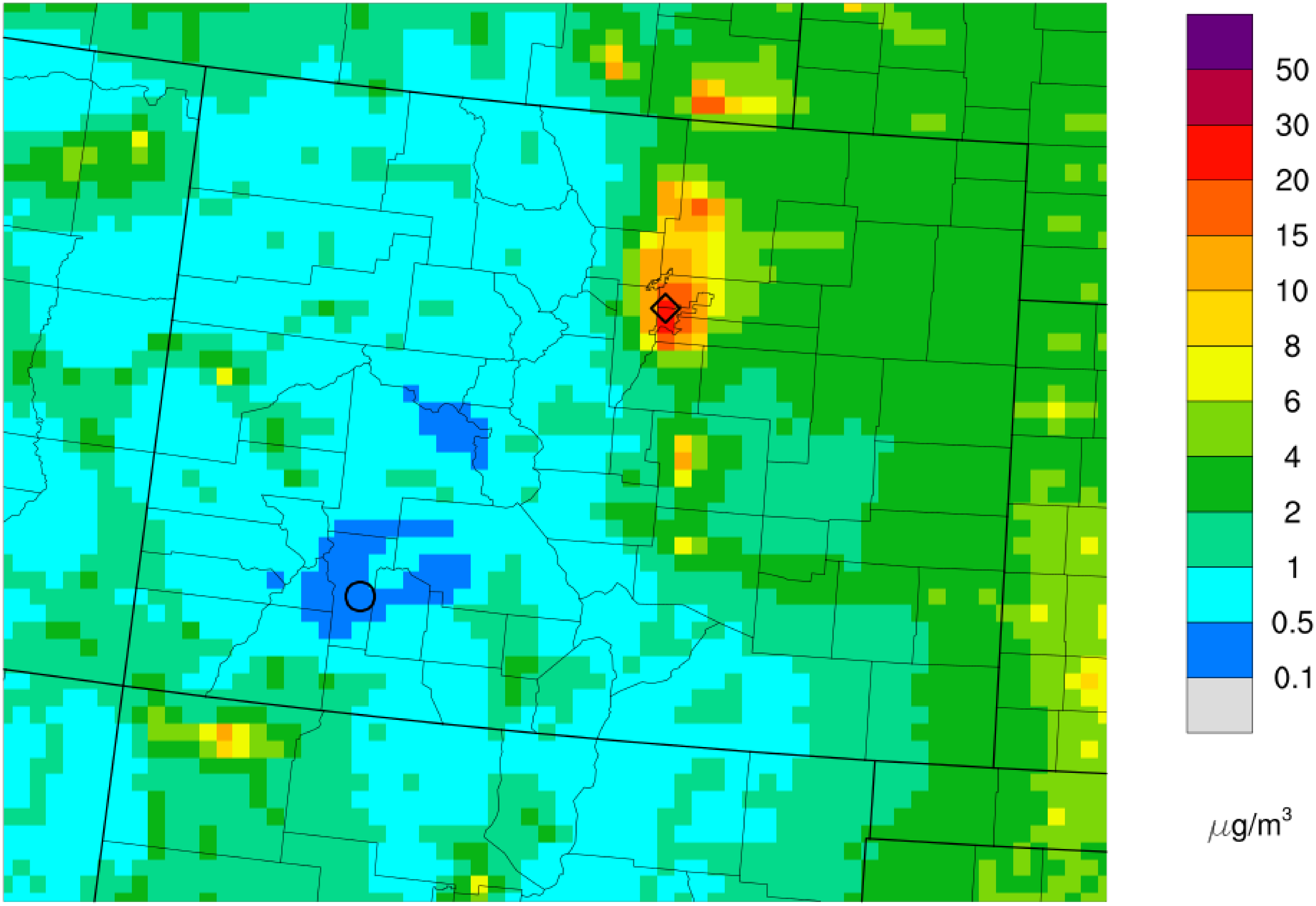


Figure CO.PM10.ann.16
Annual average PM_{10} concentration
OtherEGU



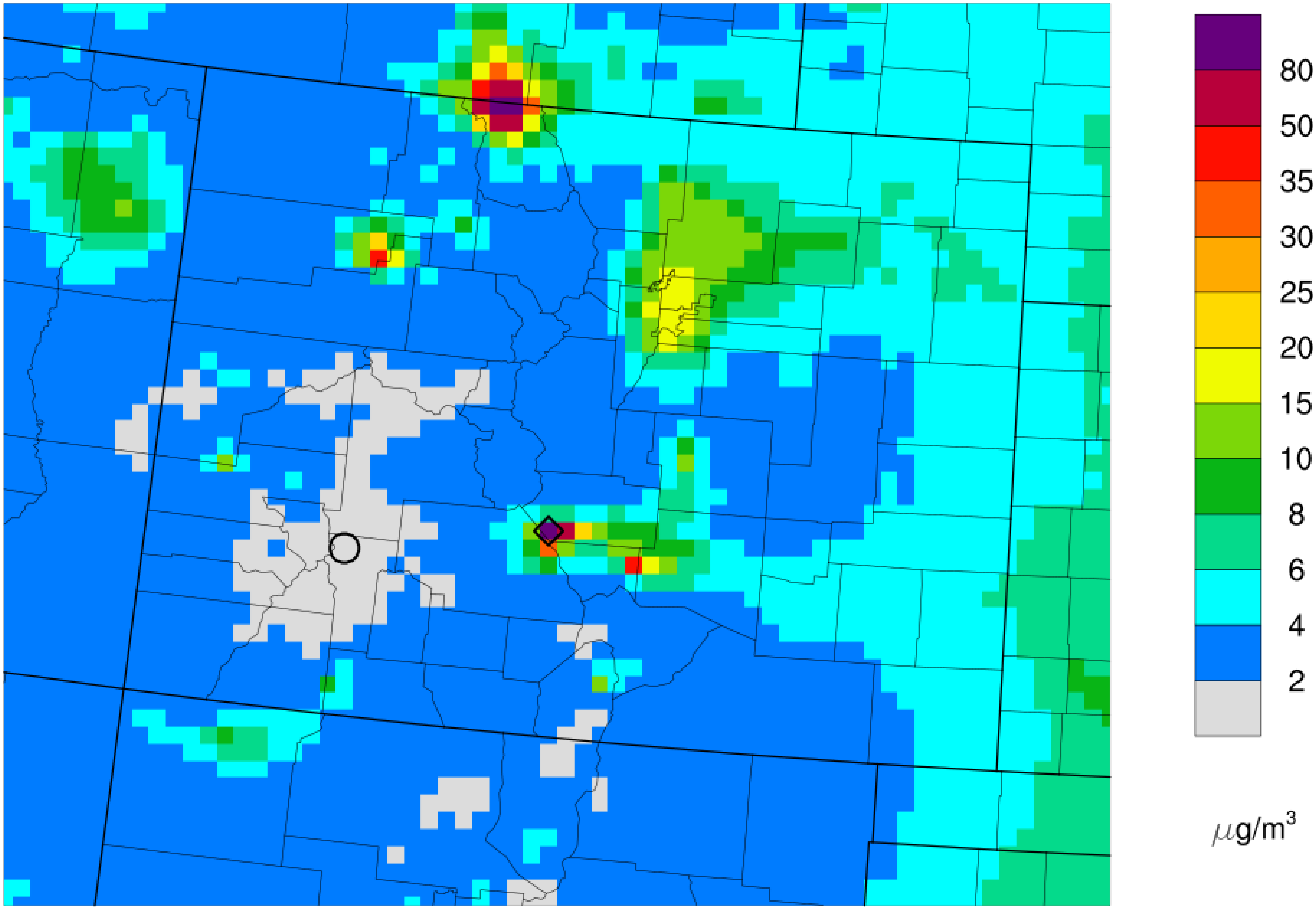
◇ max(38,37) = 0.4 $\mu g/m^3$
○ min(22,20) = 0.0 $\mu g/m^3$

Figure CO.PM10.ann.17
Annual average PM_{10} concentration
Anthro_Rest



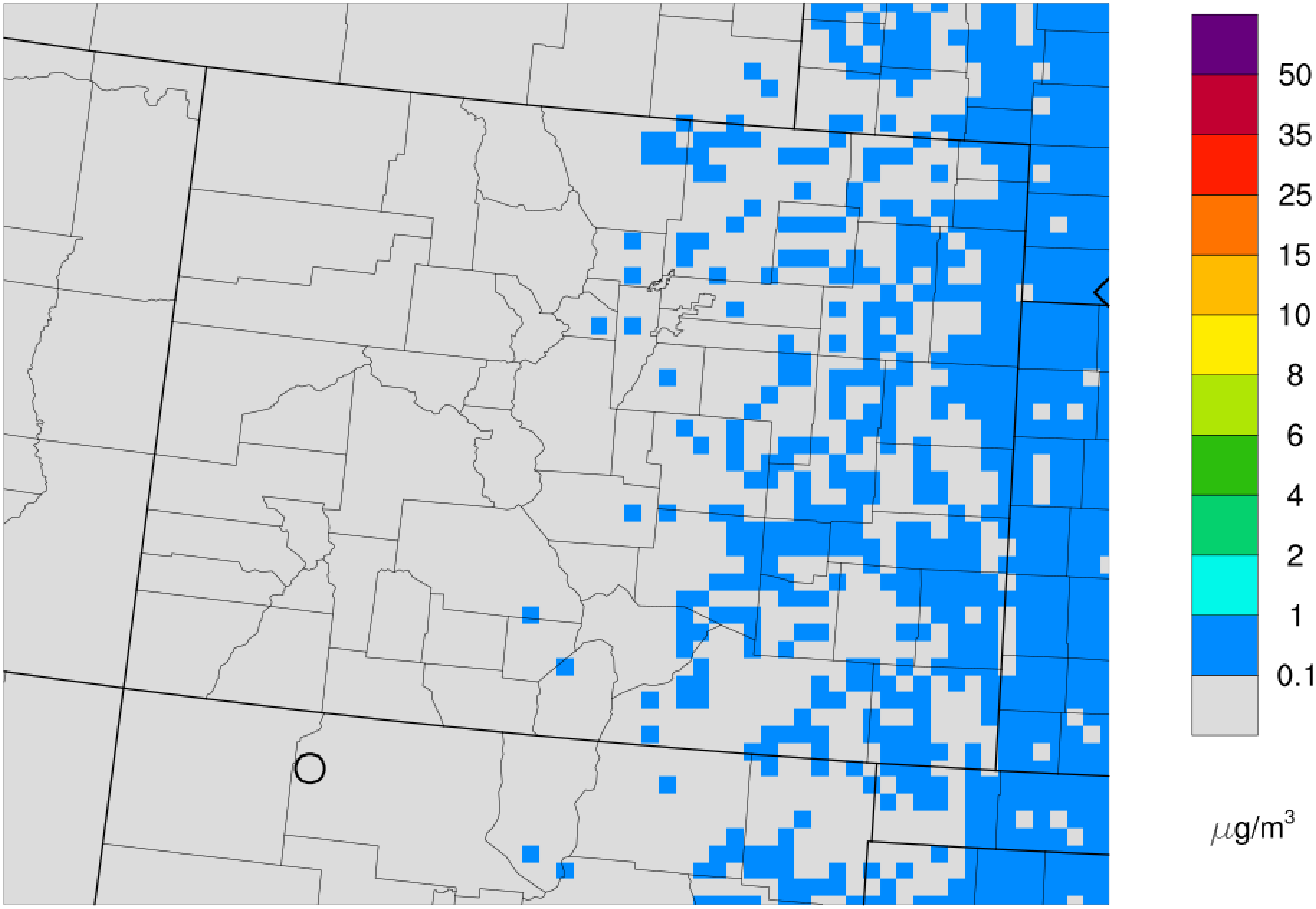
◇ max(40,36) = 23.3 $\mu g/m^3$
○ min(22,19) = 0.4 $\mu g/m^3$

Figure CO.PM25.dly.1
8th highest daily average $PM_{2.5}$ concentration
Cumulative



◇ max(33,23) = 123.3 $\mu g/m^3$
○ min(21,22) = 1.6 $\mu g/m^3$

Figure CO.PM25.dly.2
8th highest daily average $PM_{2.5}$ concentration
Natural



◇ max(66,37) = 1.0 $\mu g/m^3$
○ min(19,9) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.3
8th highest daily average $PM_{2.5}$ concentration
Wildfire

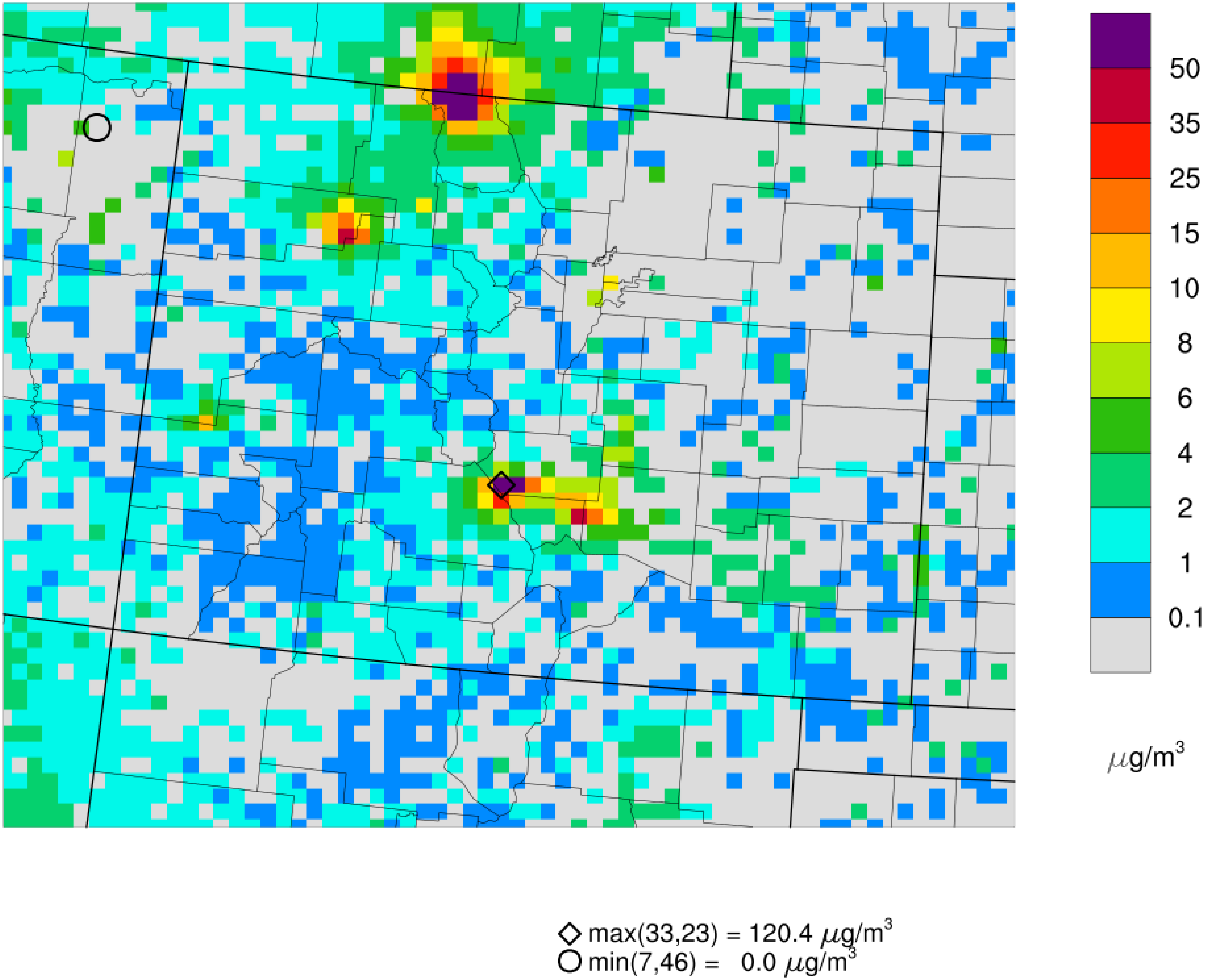
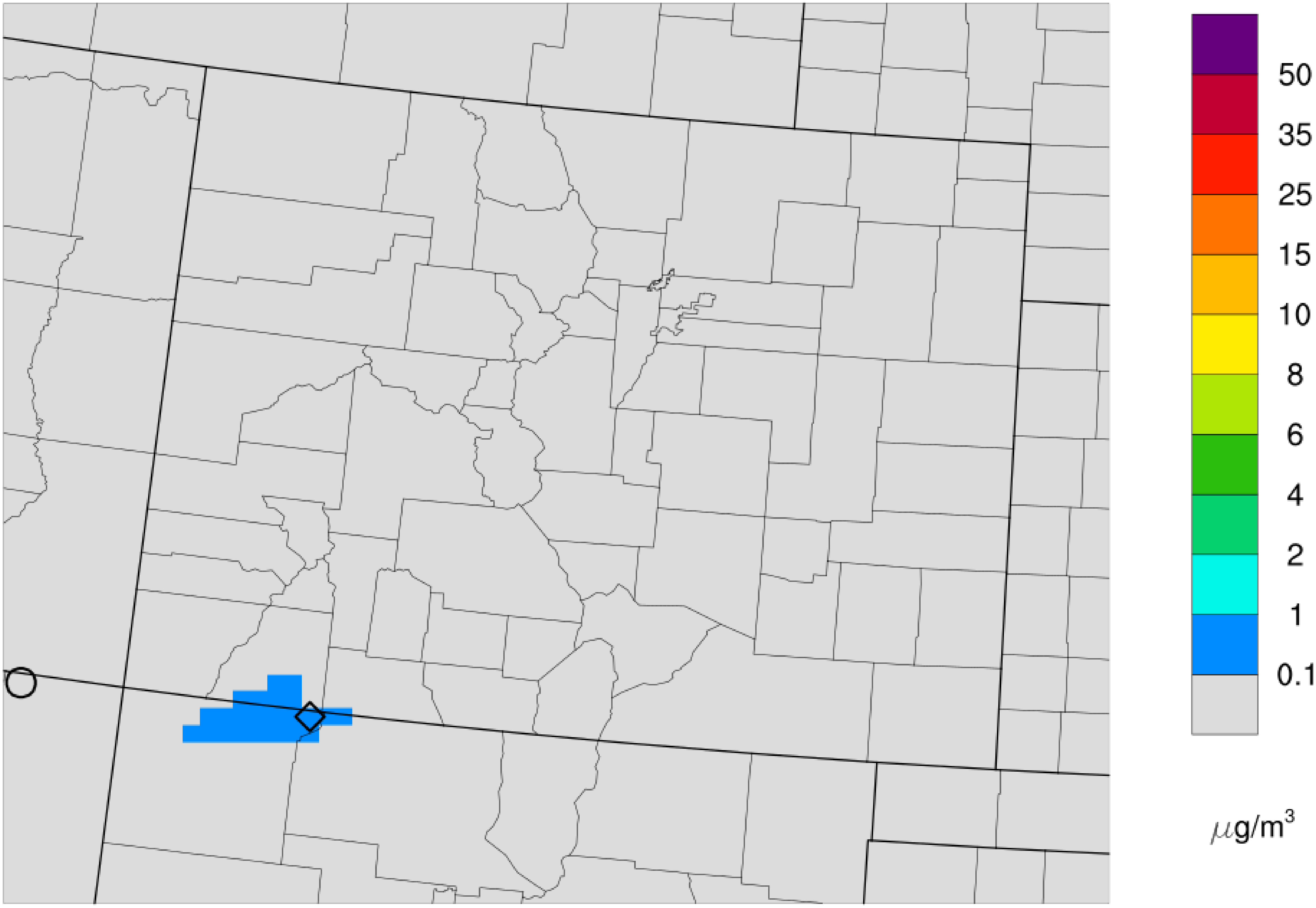
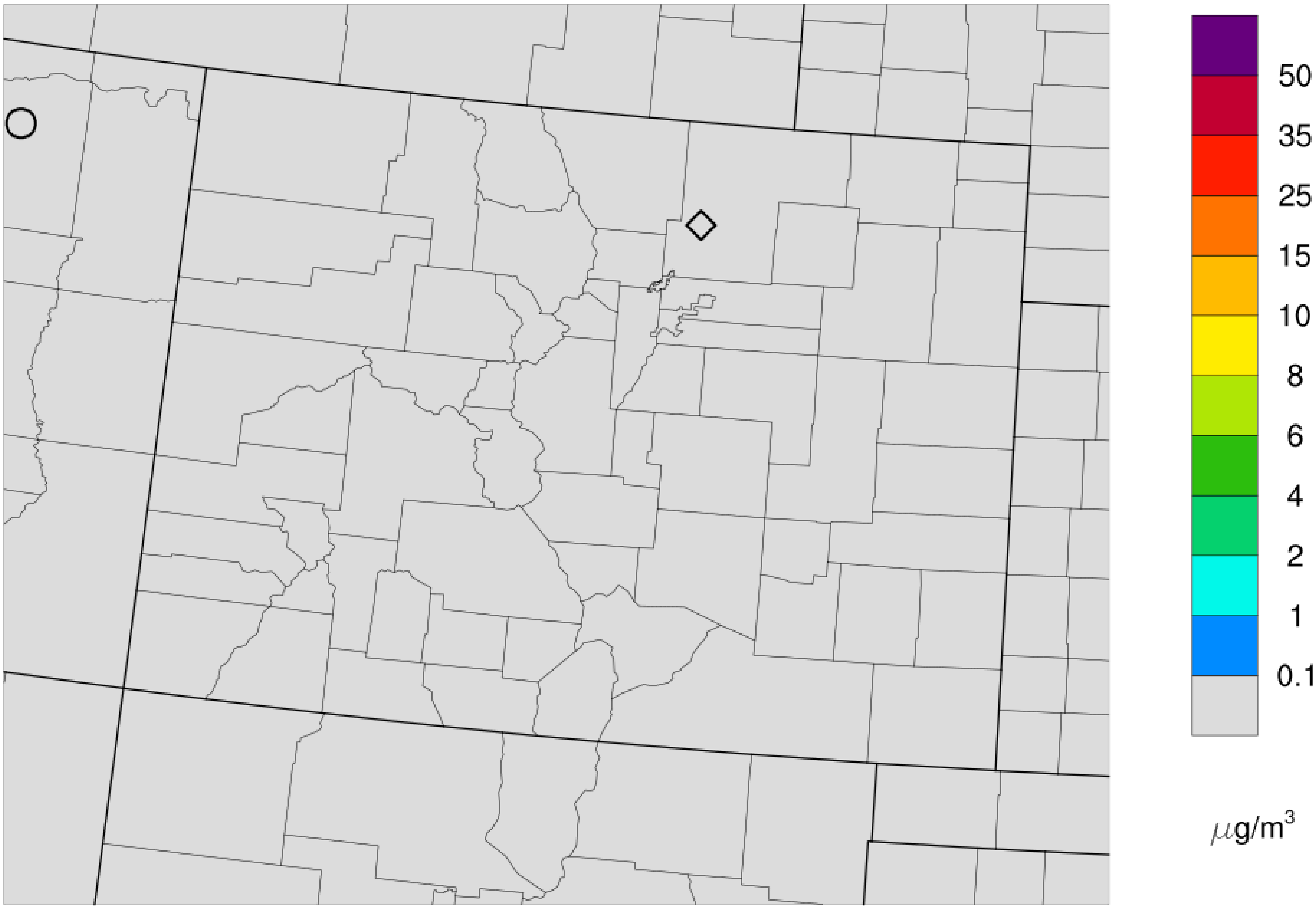


Figure CO.PM25.dly.4
8th highest daily average $PM_{2.5}$ concentration
OilGas_ExistFed_WesternCO



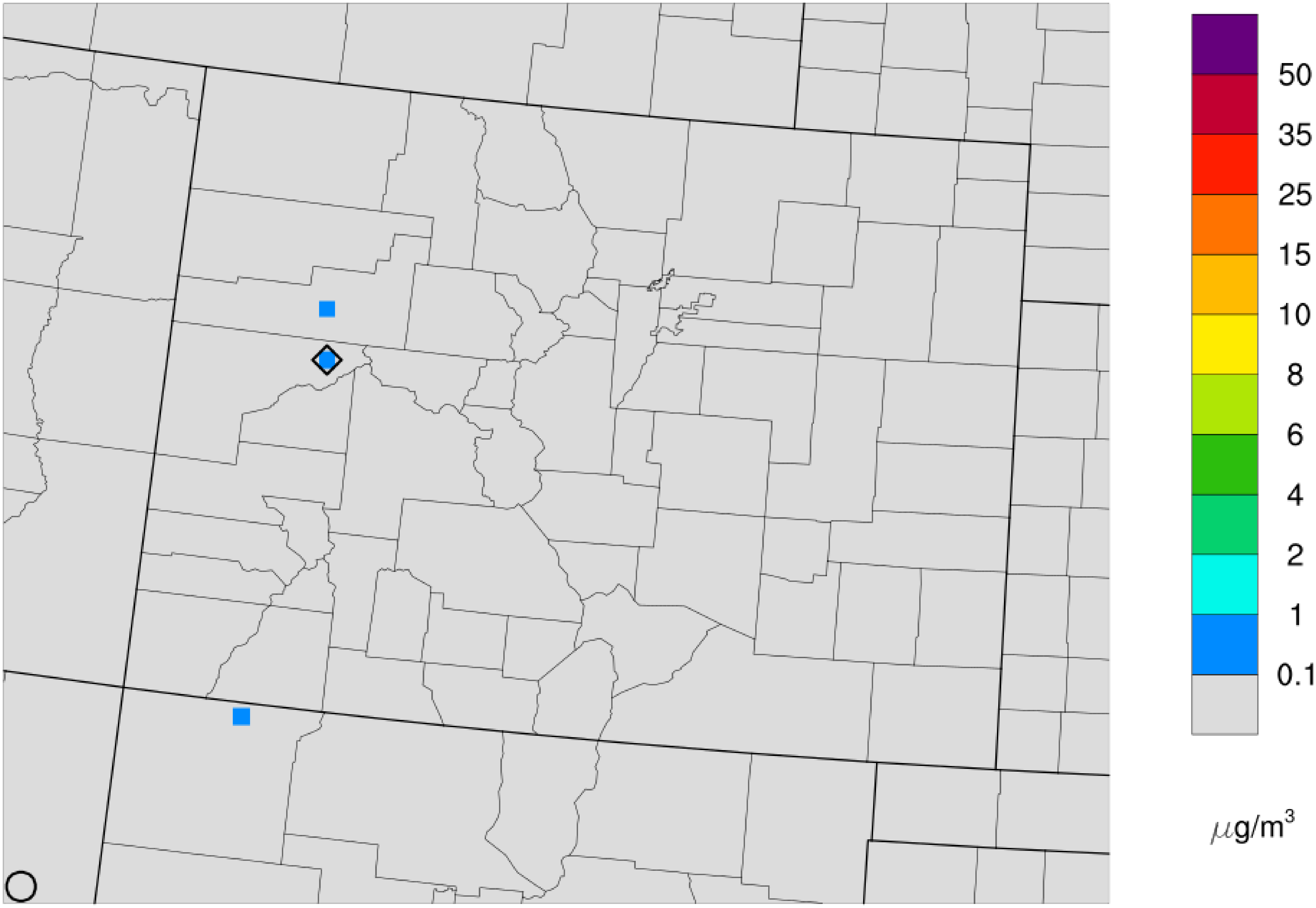
◇ max(19,12) = 0.7 $\mu g/m^3$
○ min(2,14) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.5
8th highest daily average $PM_{2.5}$ concentration
OilGas_ExistFed_RoyalGorge



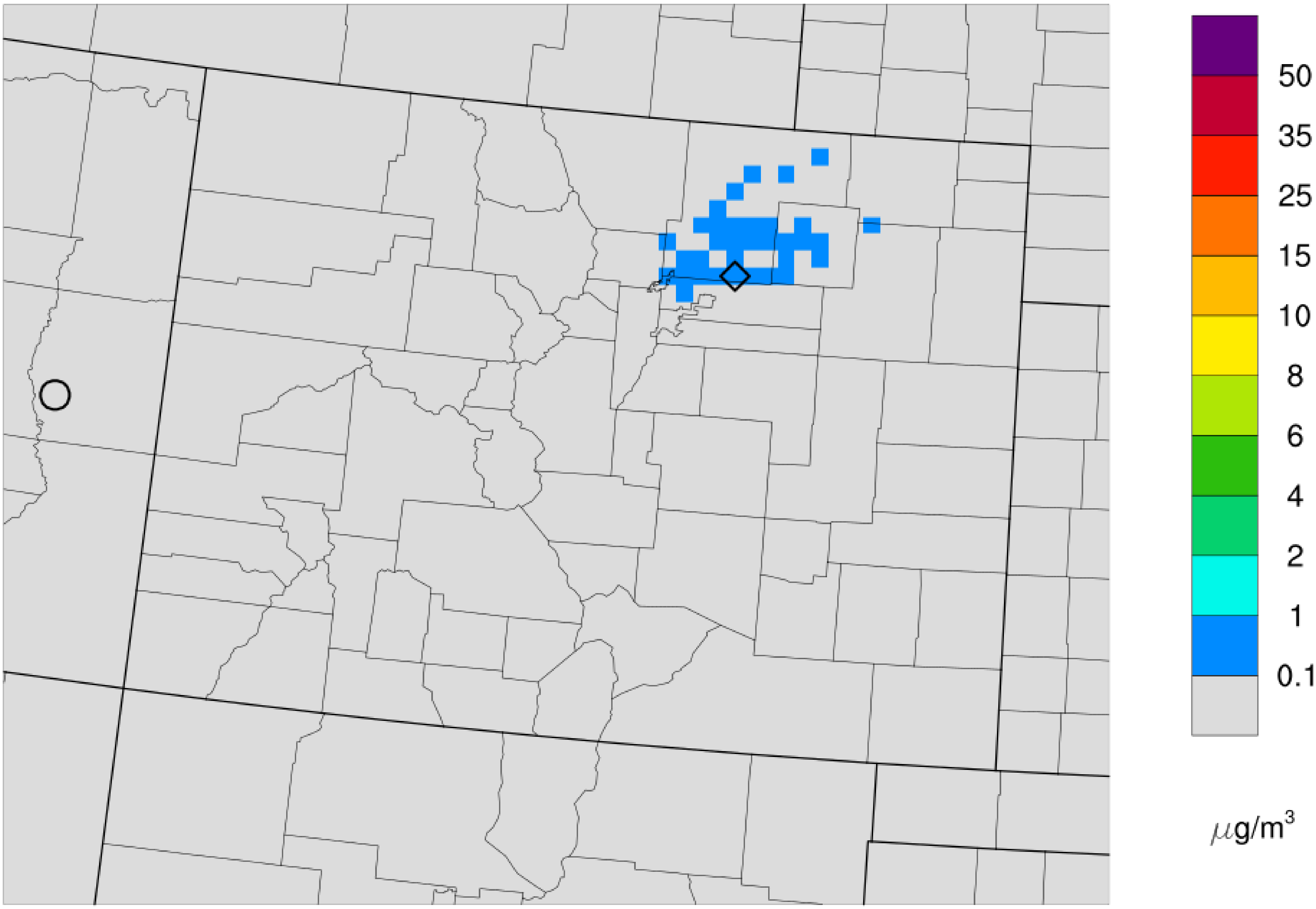
◇ max(42,41) = 0.0 $\mu g/m^3$
○ min(2,47) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.6
8th highest daily average $PM_{2.5}$ concentration
OilGas_NewFed_WesternCO



◇ max(20,33) = 0.2 $\mu g/m^3$
○ min(2,2) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.7
8th highest daily average $PM_{2.5}$ concentration
OilGas_NewFed_RoyalGorge



◇ max(44,38) = 0.3 $\mu g/m^3$
○ min(4,31) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.8
8th highest daily average $PM_{2.5}$ concentration
OilGas_Fed_Other_States

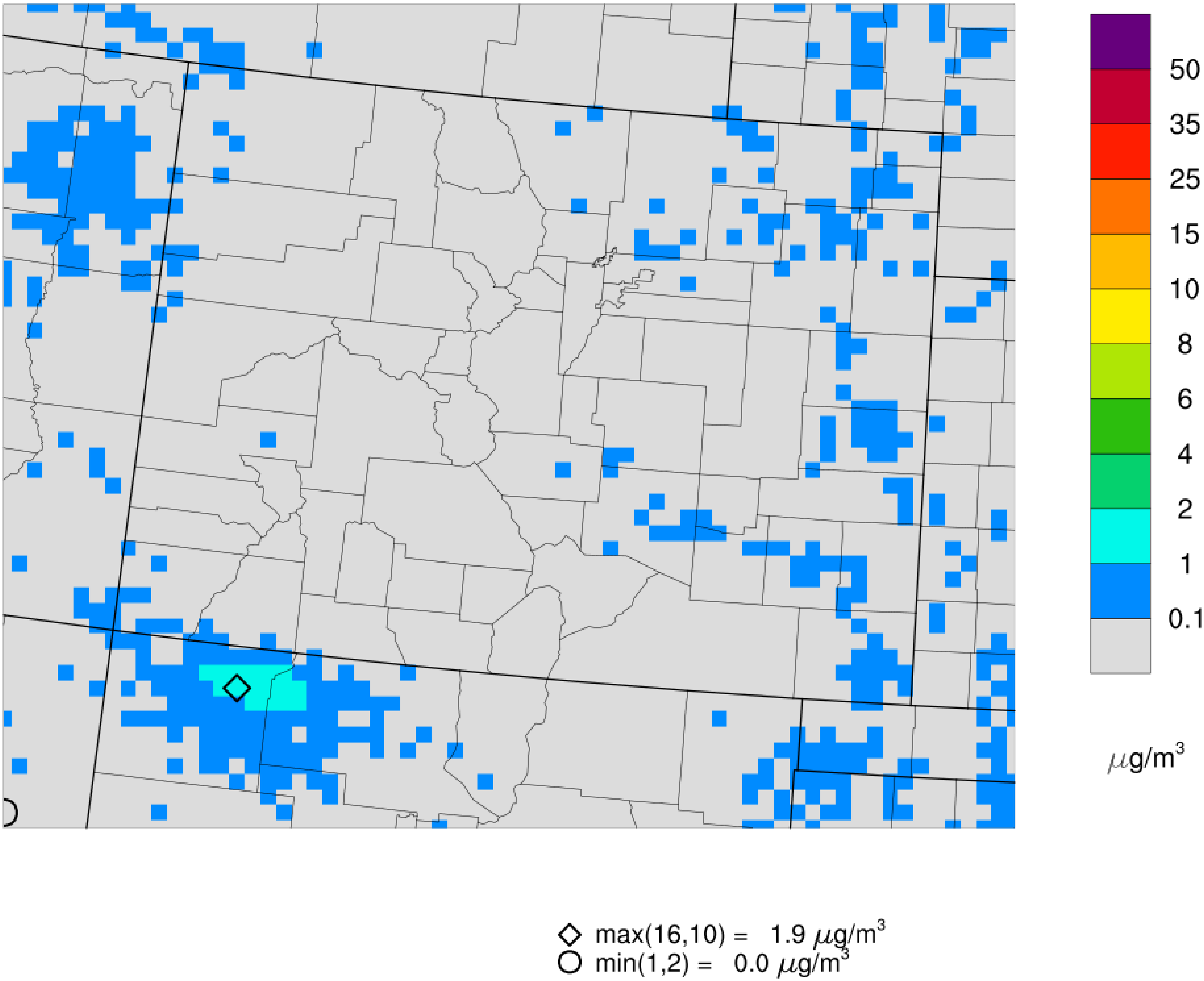
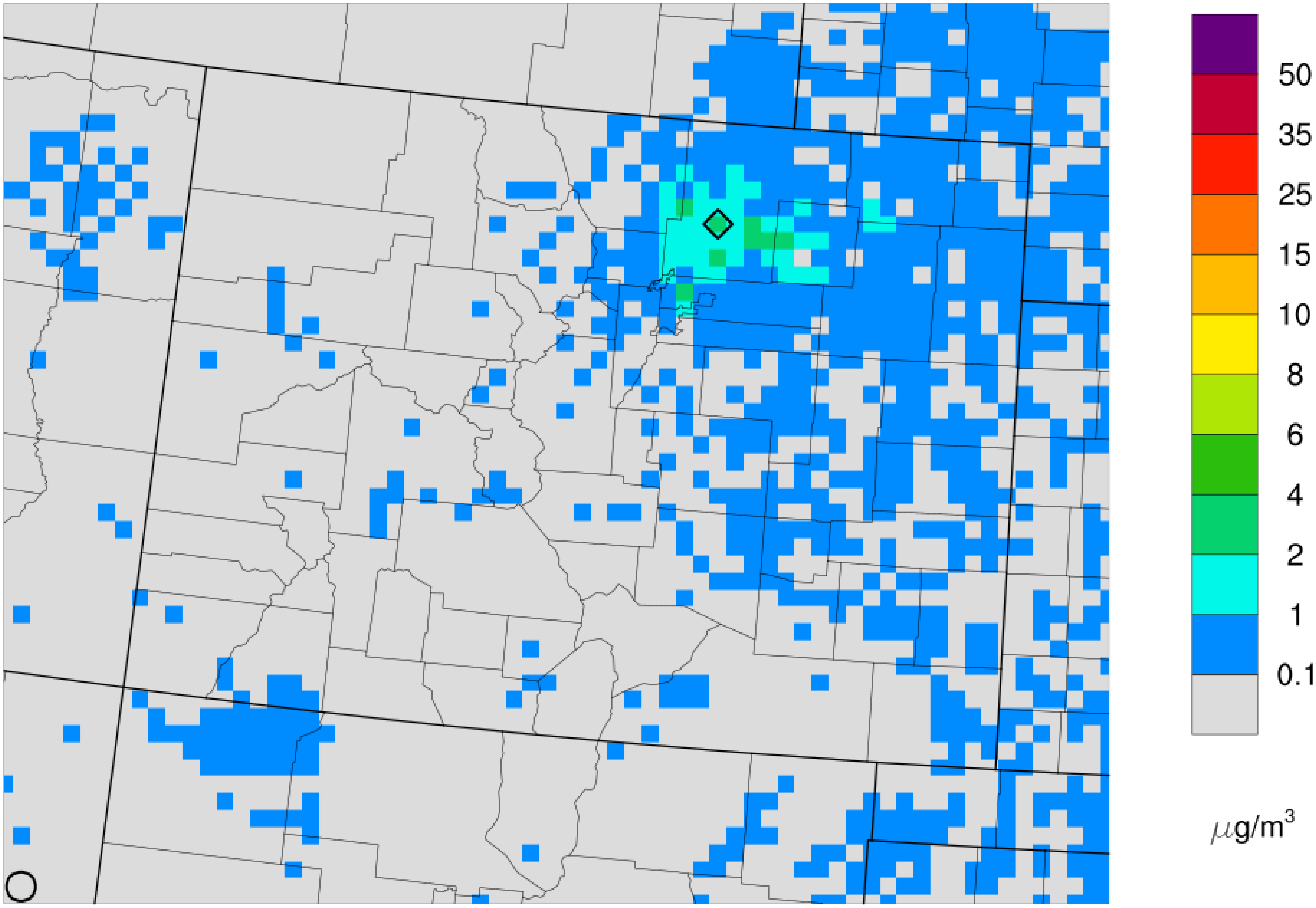
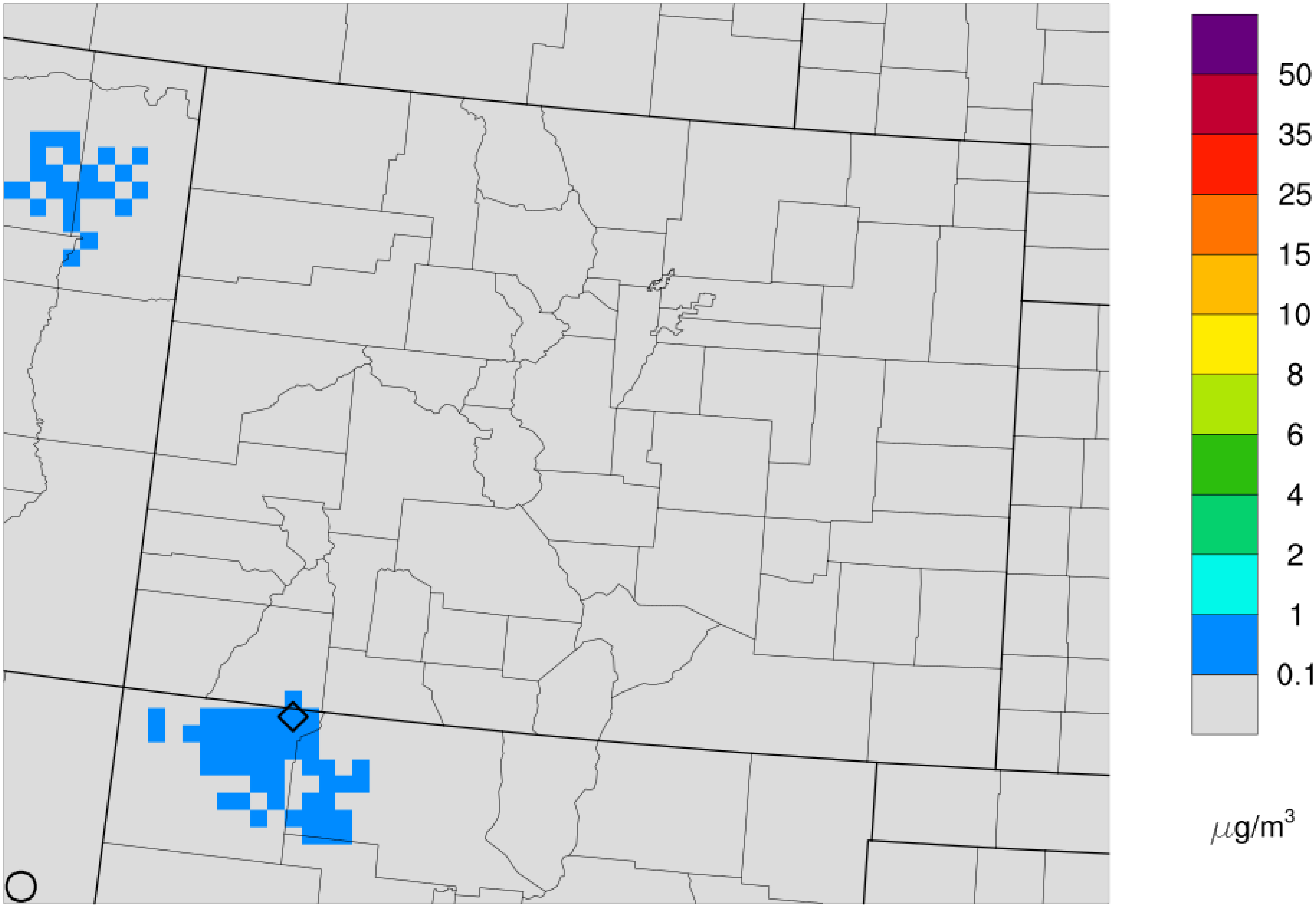


Figure CO.PM25.dly.9
8th highest daily average $PM_{2.5}$ concentration
OilGas_NonFed



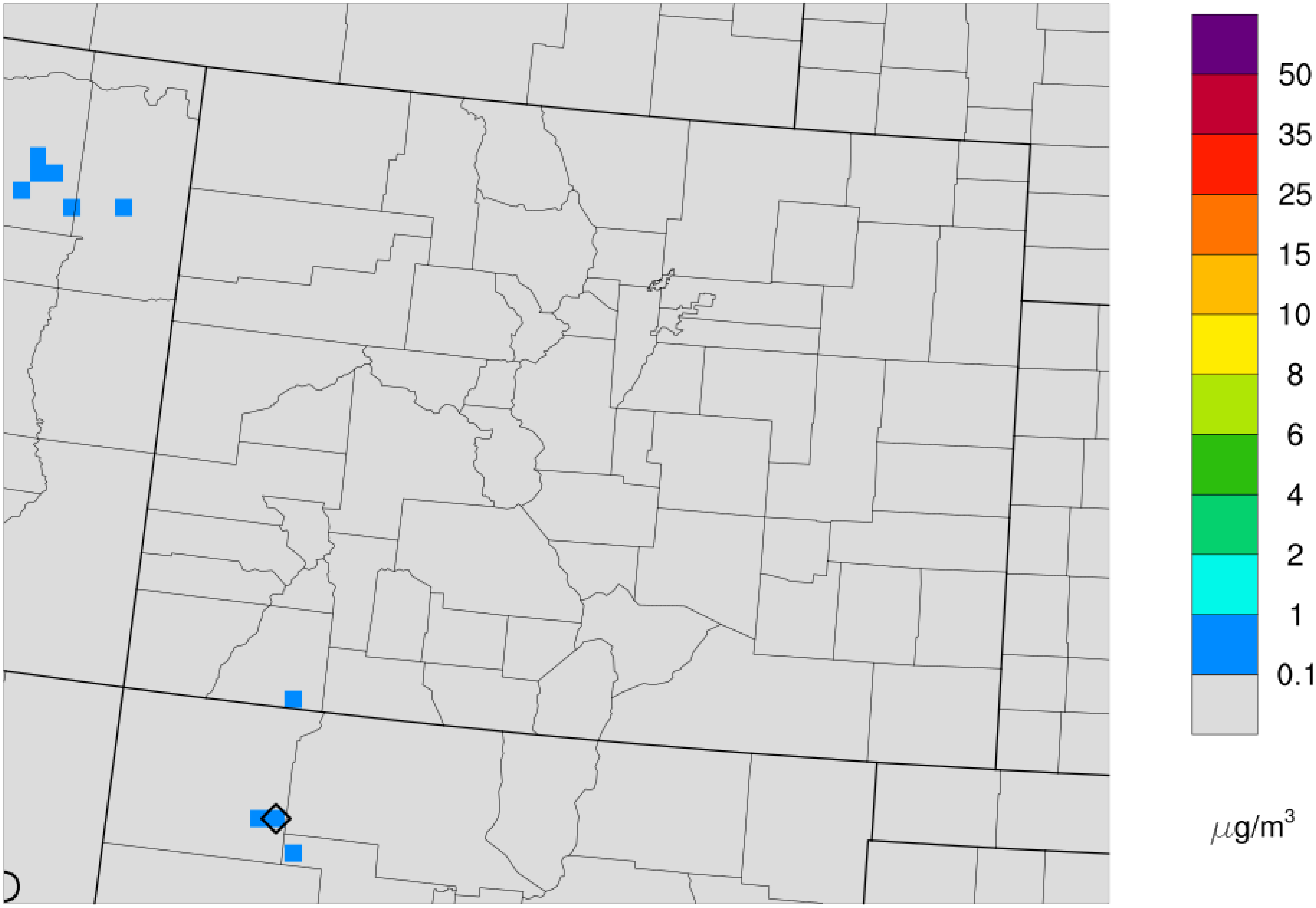
◇ max(43,41) = 2.9 $\mu g/m^3$
○ min(2,2) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.10
8th highest daily average $PM_{2.5}$ concentration
OilGas_ExistTribal



◇ max(18,12) = 0.5 $\mu g/m^3$
○ min(2,2) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.11
8th highest daily average $PM_{2.5}$ concentration
OilGas_NewTribal



◇ max(17,6) = 0.1 $\mu g/m^3$
○ min(1,2) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.12
8th highest daily average $PM_{2.5}$ concentration
Coal_Fed

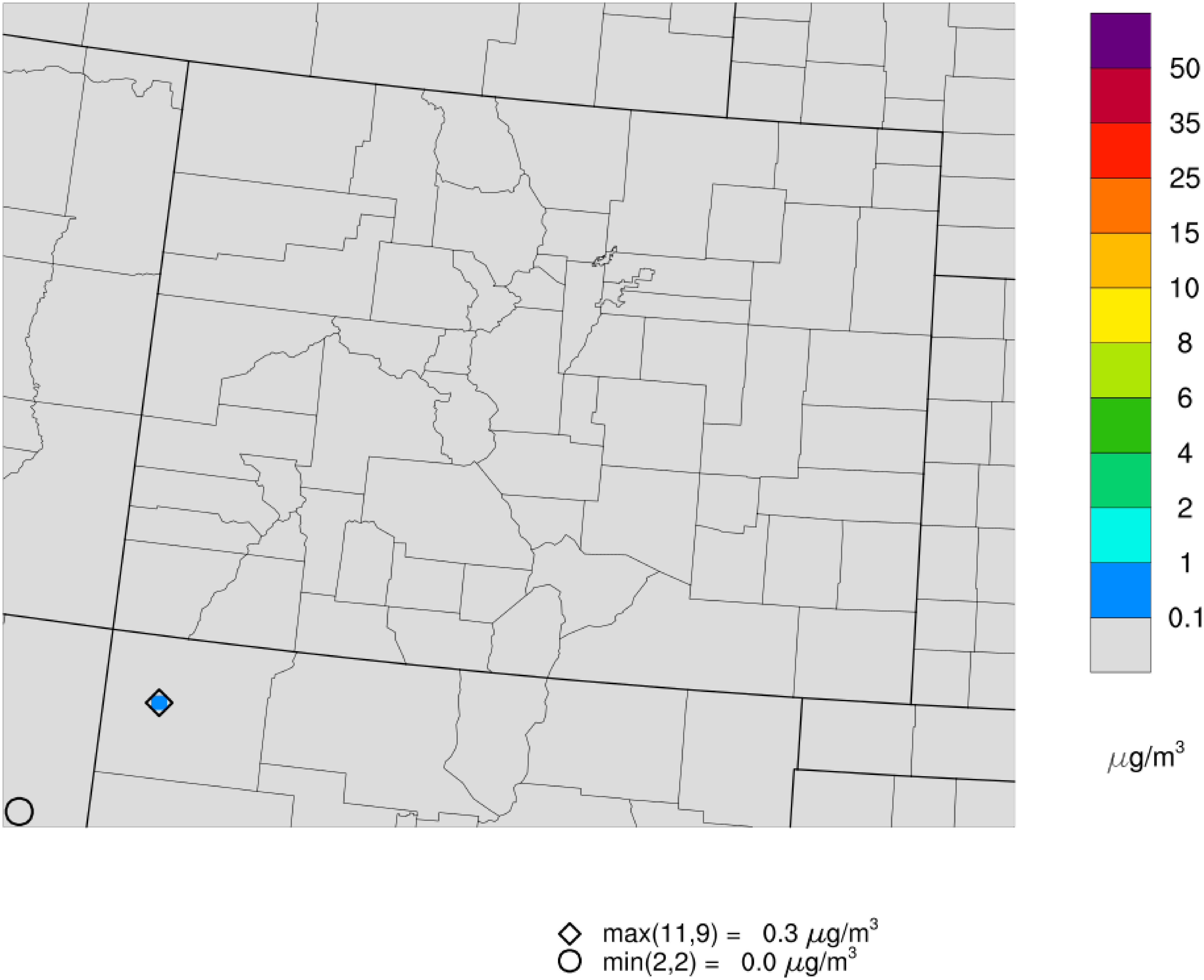


Figure CO.PM25.dly.13
8th highest daily average $PM_{2.5}$ concentration
Coal_NonFed

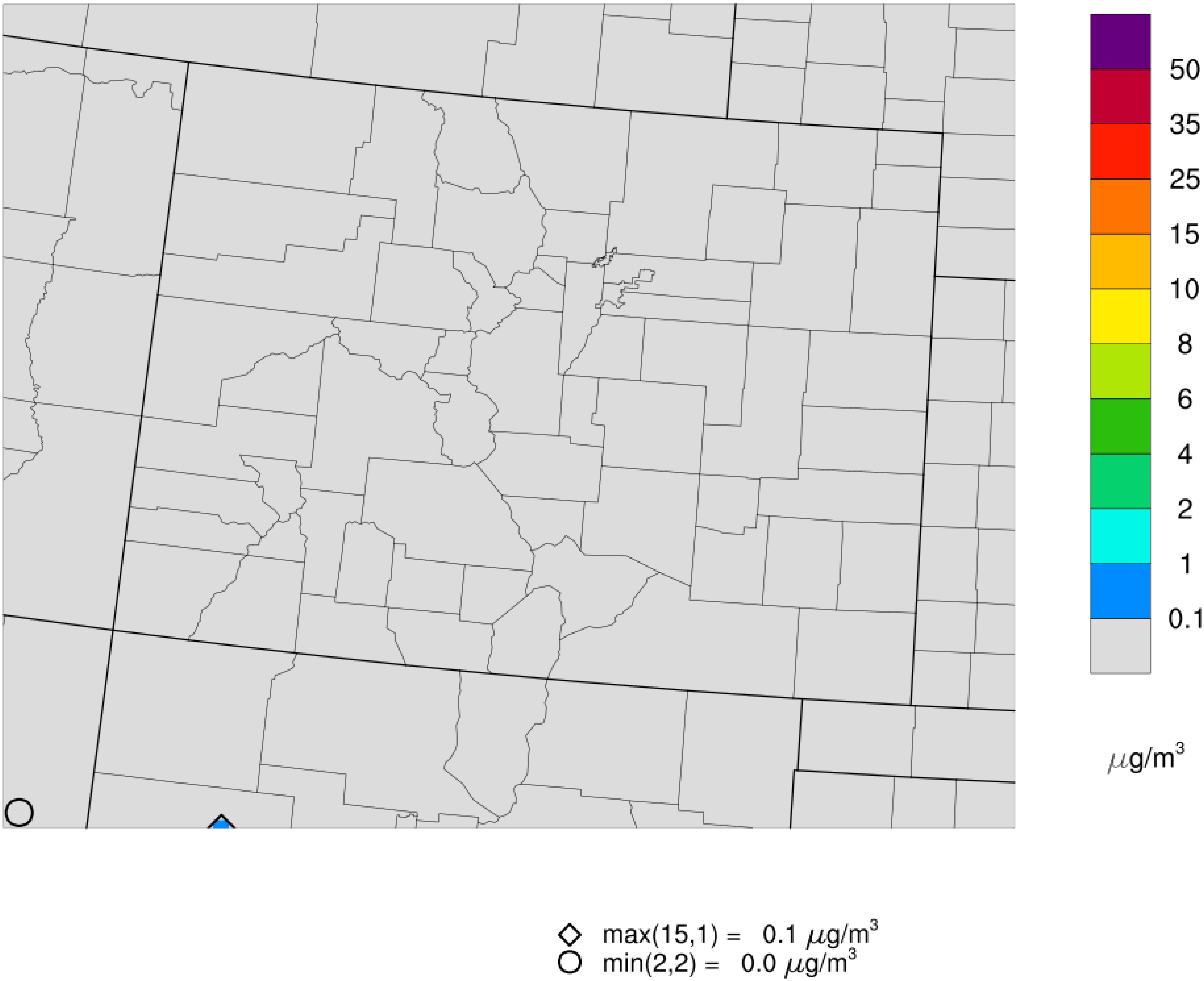
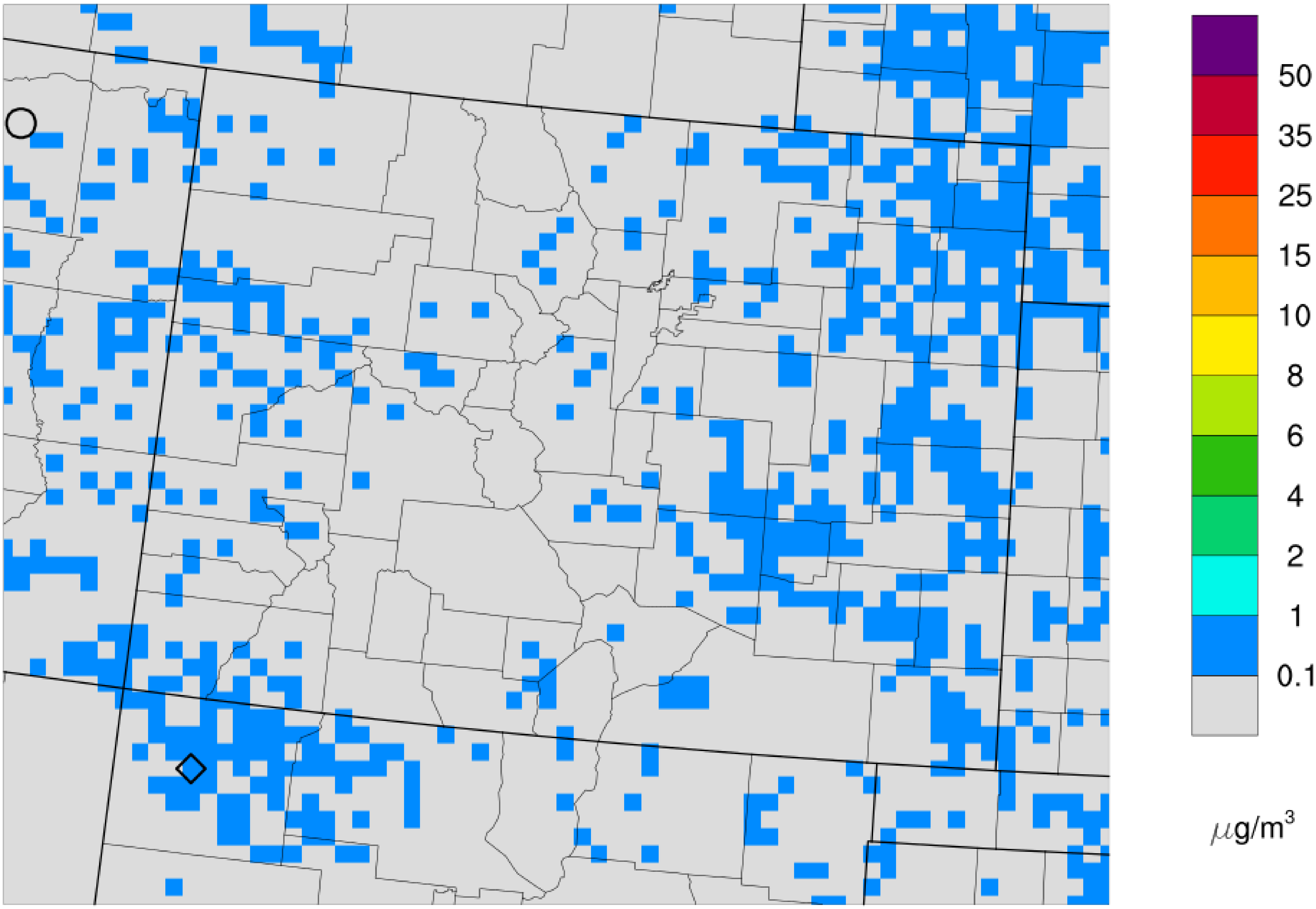


Figure CO.PM25.dly.14
8th highest daily average $PM_{2.5}$ concentration
Coal_EGU WRAP states



◇ max(12,9) = 0.8 $\mu g/m^3$
○ min(2,47) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.15
8th highest daily average $PM_{2.5}$ concentration
Coal_Comb WRAP states

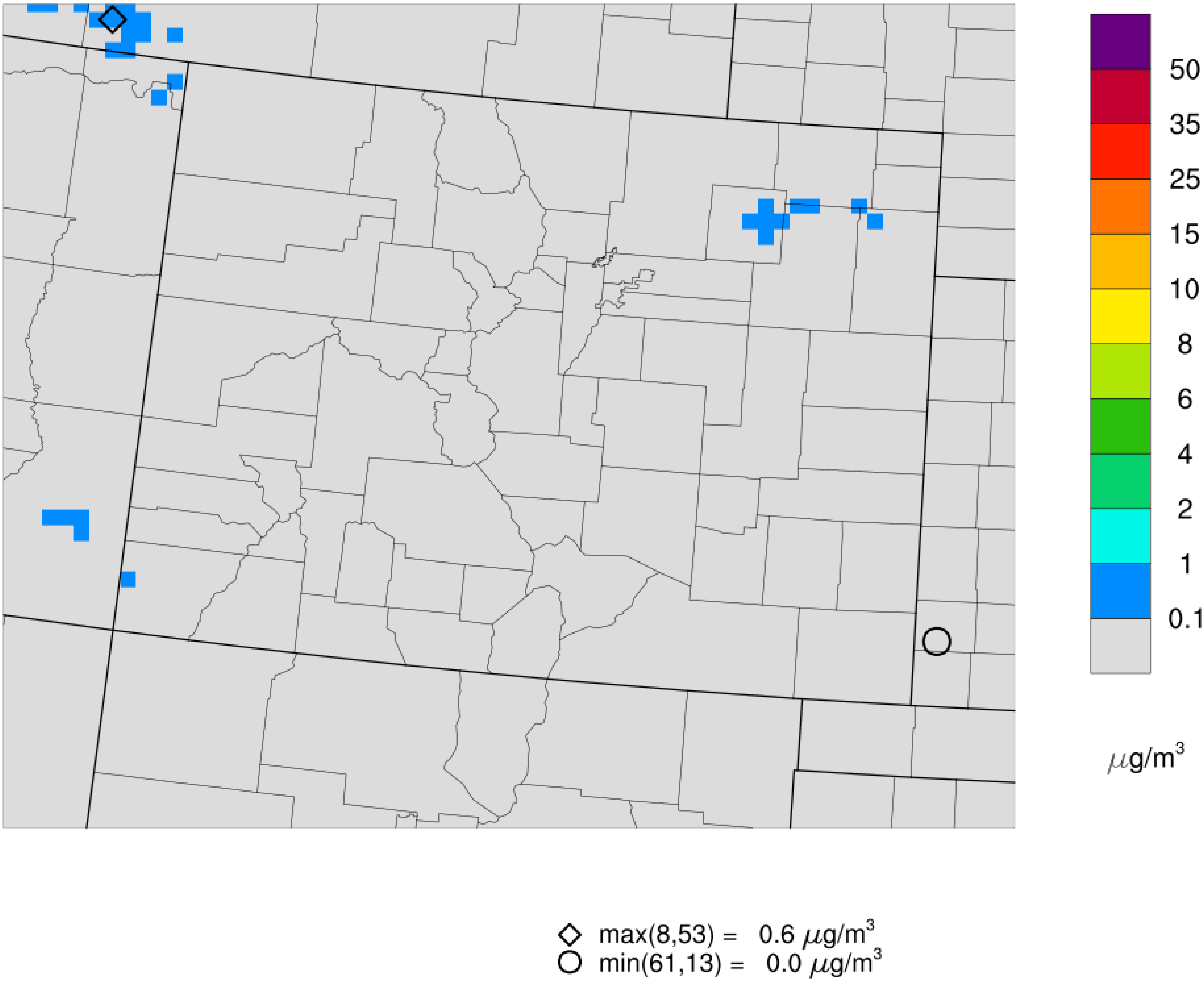
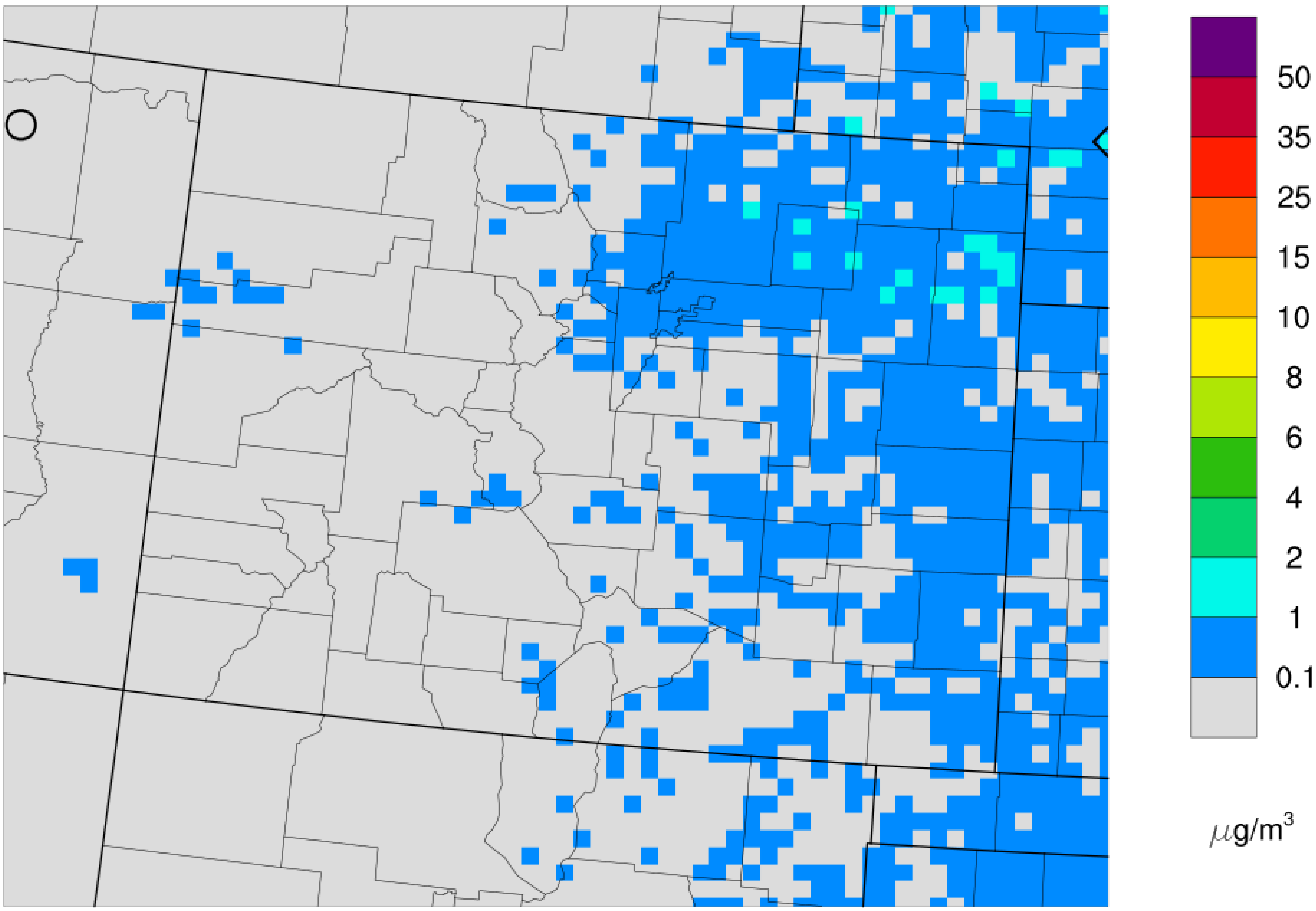
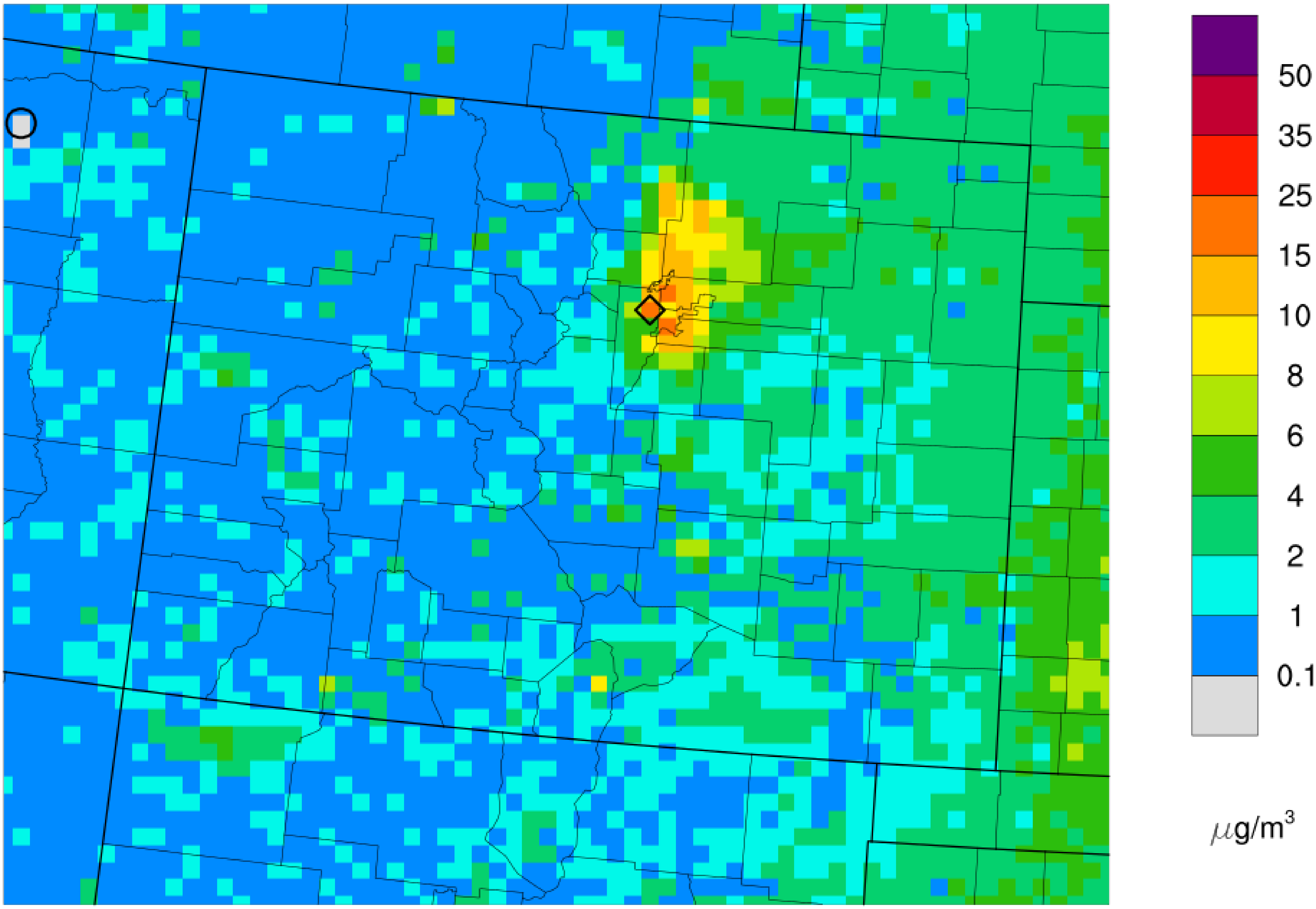


Figure CO.PM25.dly.16
8th highest daily average $PM_{2.5}$ concentration
OtherEGU



◇ max(66,46) = 2.0 $\mu g/m^3$
○ min(2,47) = 0.0 $\mu g/m^3$

Figure CO.PM25.dly.17
8th highest daily average $PM_{2.5}$ concentration
Anthro_Rest



◇ max(39,36) = 17.1 $\mu g/m^3$
○ min(2,47) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.1
Annual average $PM_{2.5}$ concentration
Cumulative

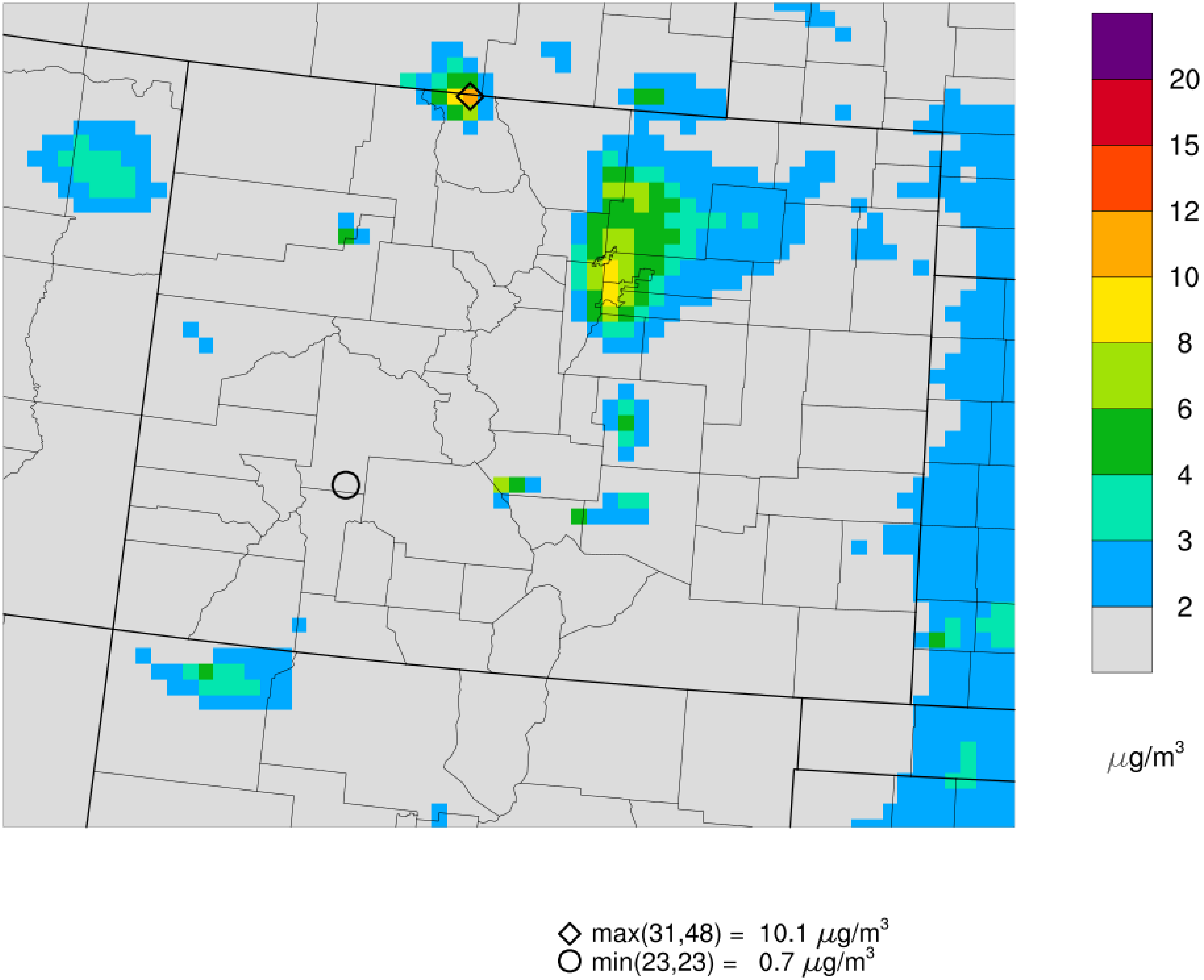
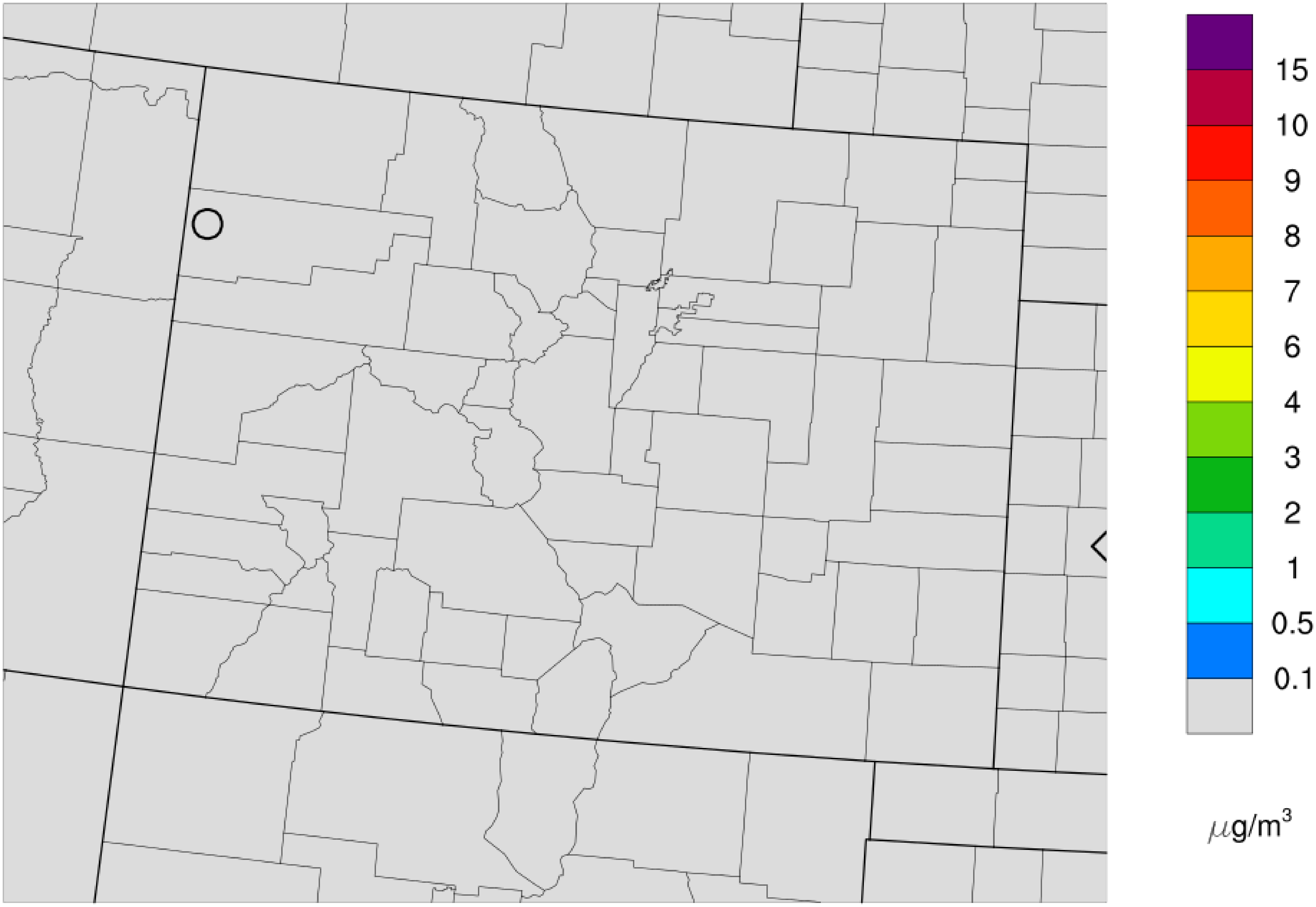


Figure CO.PM25.ann.2
Annual average $PM_{2.5}$ concentration
Natural



◇ max(66,22) = 0.1 $\mu g/m^3$
○ min(13,41) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.3
Annual average $PM_{2.5}$ concentration
Wildfire

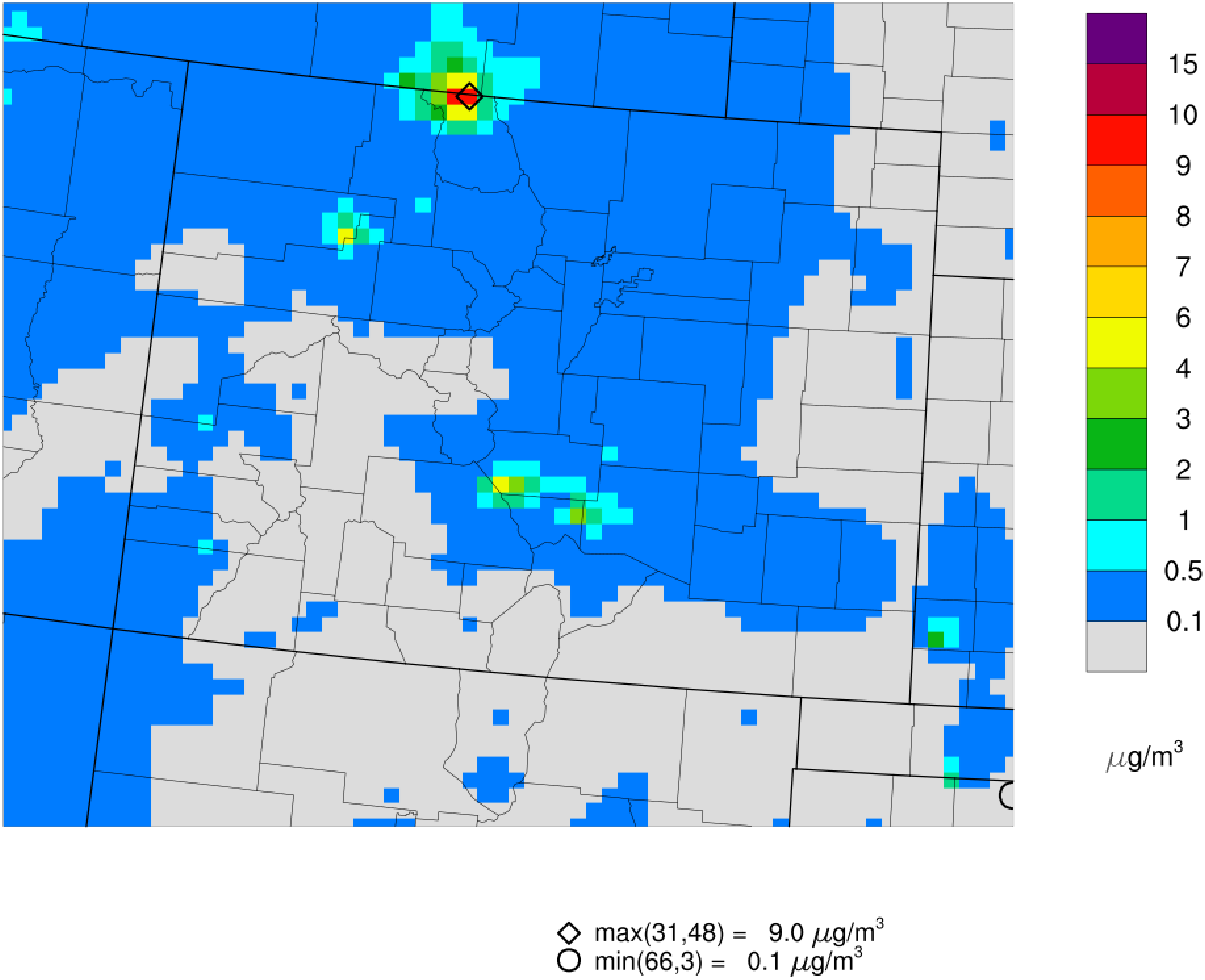


Figure CO.PM25.ann.4
Annual average $PM_{2.5}$ concentration
OilGas_ExistFed_WesternCO

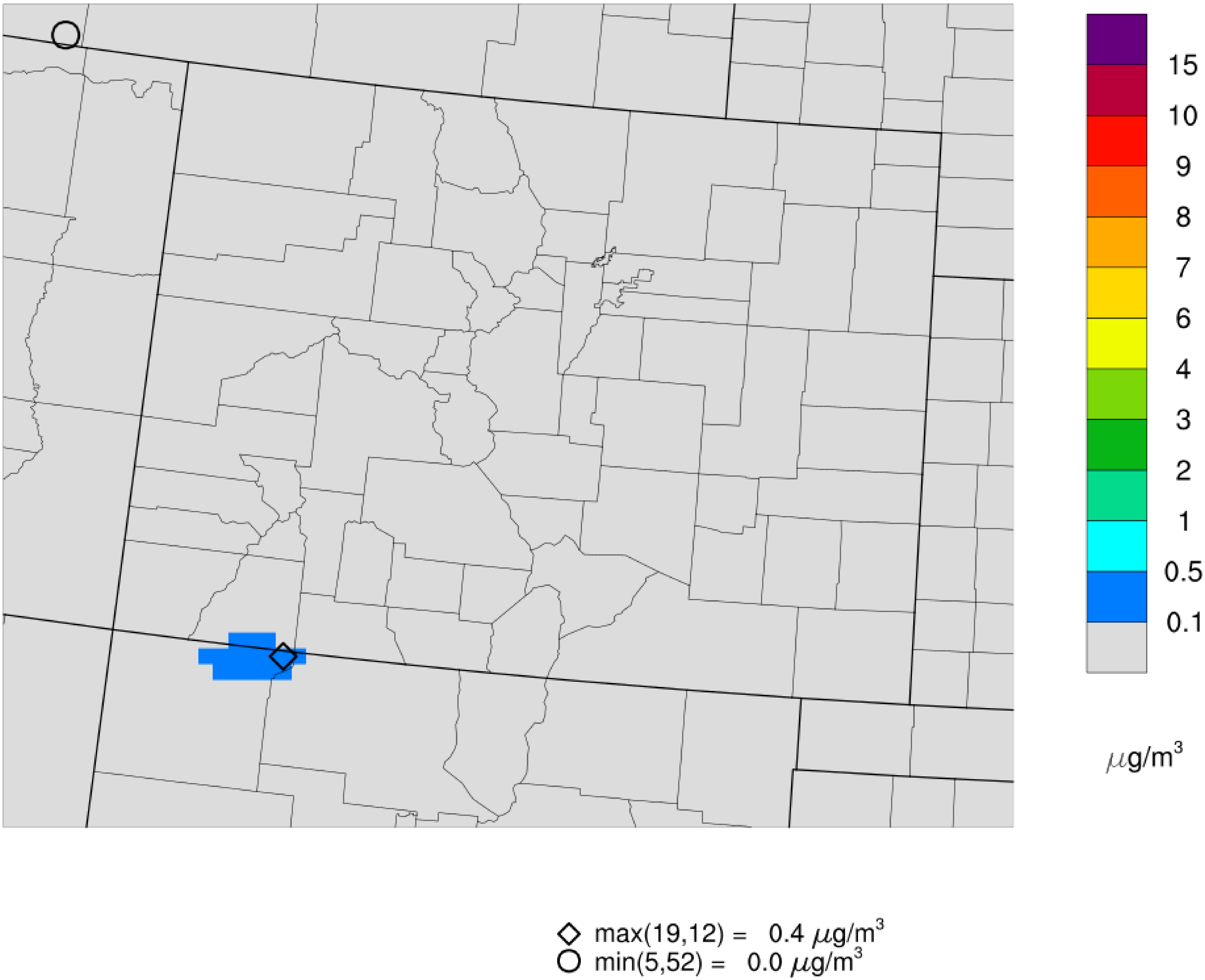
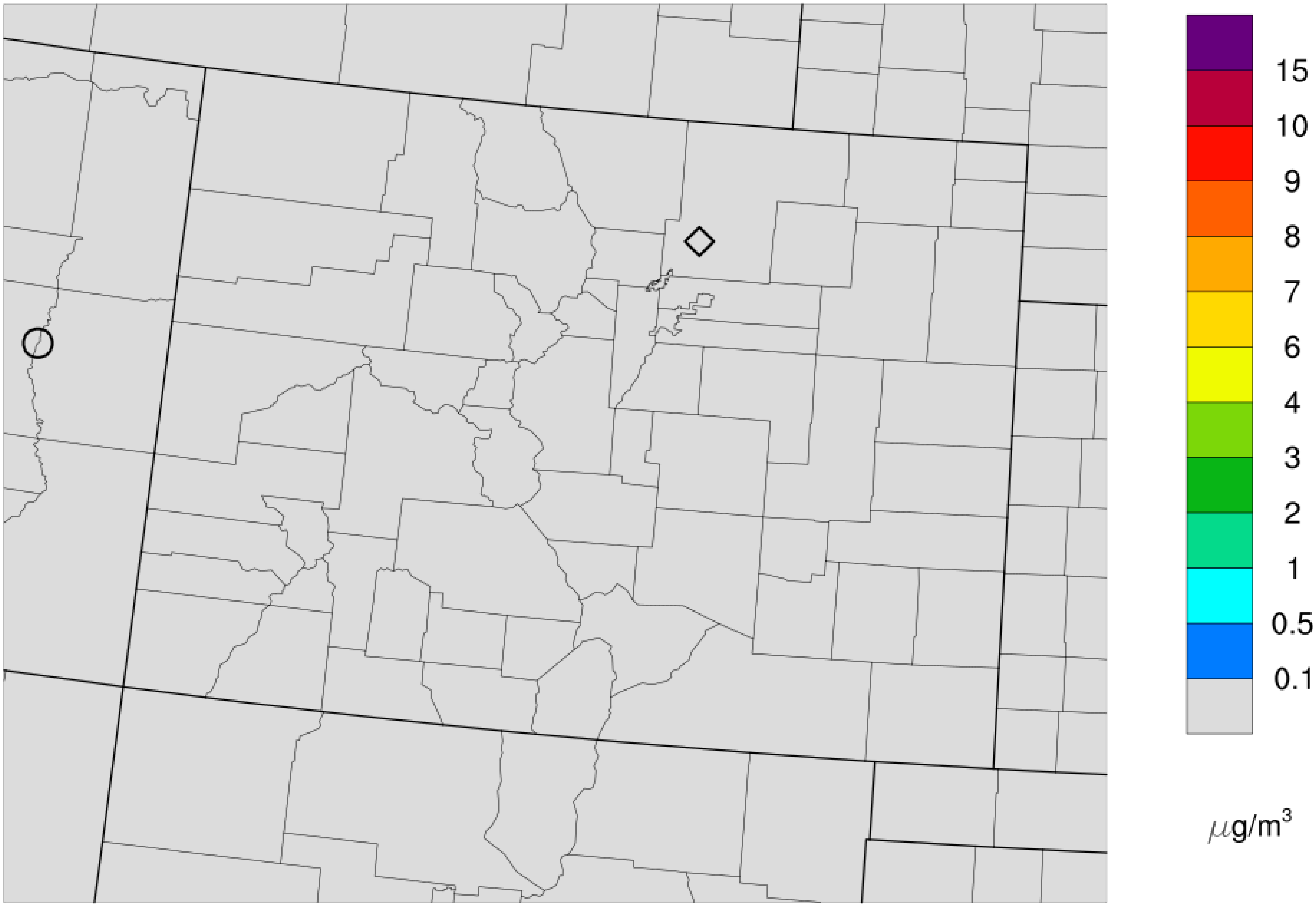
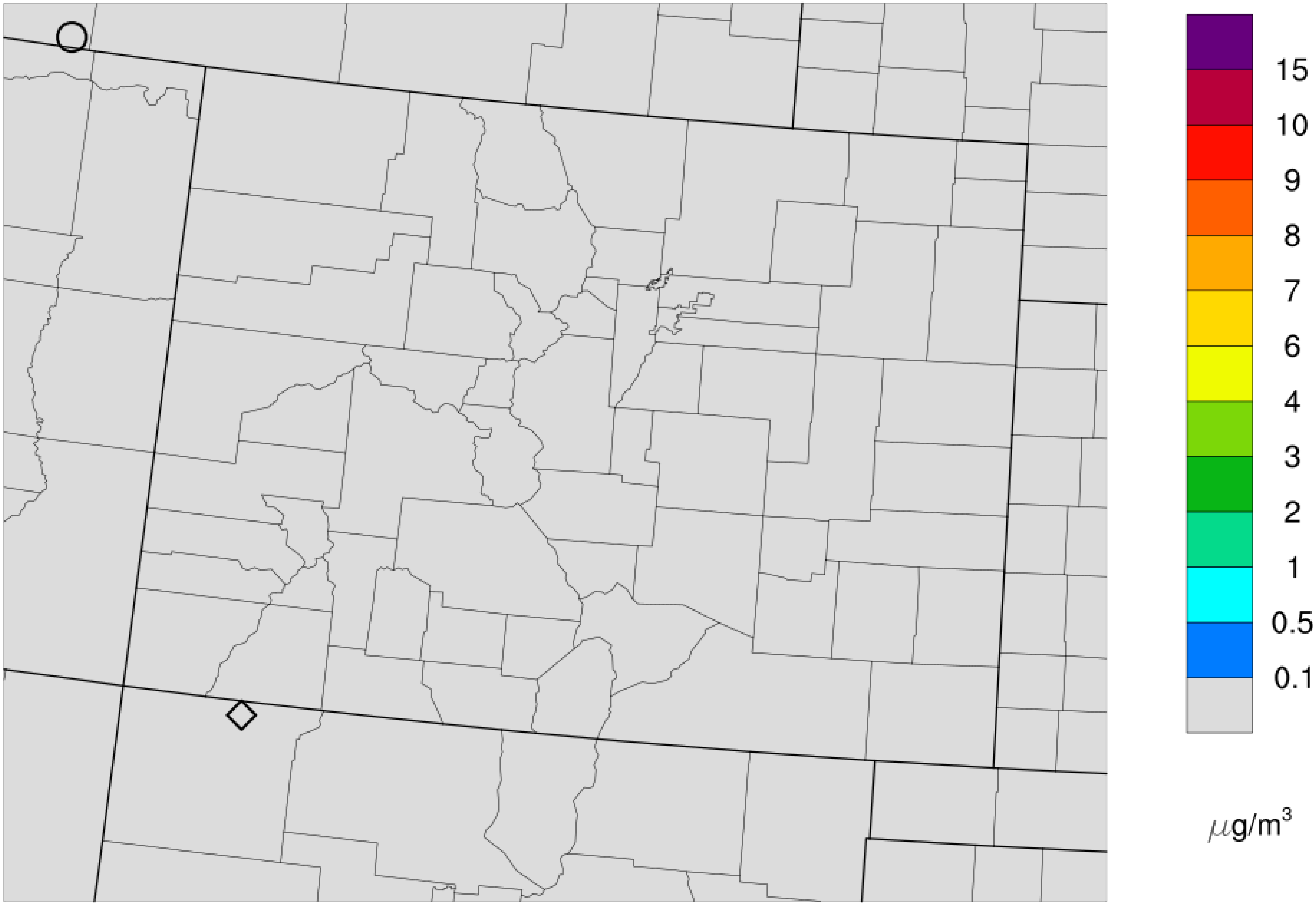


Figure CO.PM25.ann.5
Annual average $PM_{2.5}$ concentration
OilGas_ExistFed_RoyalGorge



max(42,40) = 0.0 $\mu g/m^3$
min(3,34) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.6
Annual average $PM_{2.5}$ concentration
OilGas_NewFed_WesternCO



◇ max(15,12) = 0.1 $\mu g/m^3$
○ min(5,52) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.7
Annual average $PM_{2.5}$ concentration
OilGas_NewFed_RoyalGorge

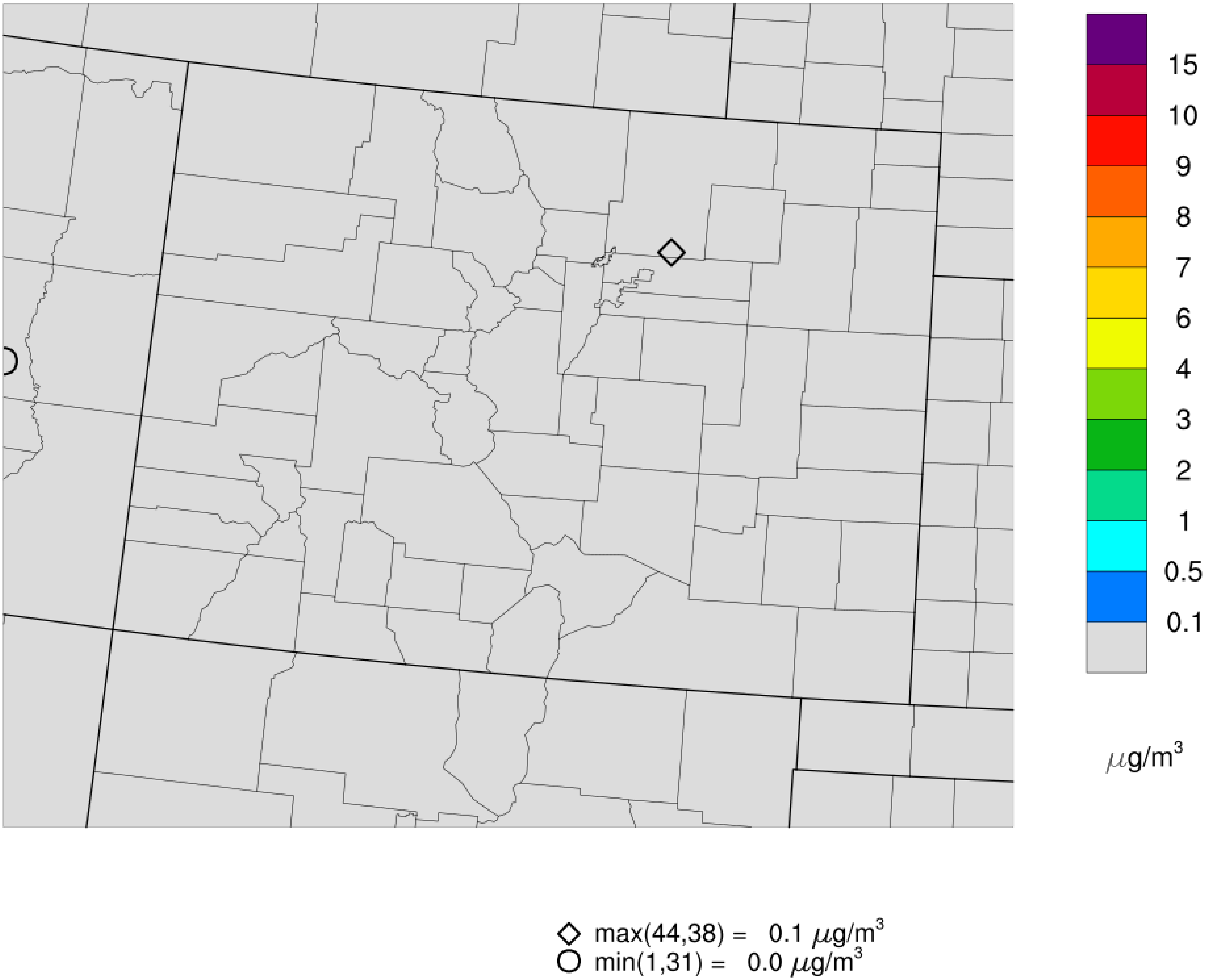


Figure CO.PM25.ann.8
Annual average $PM_{2.5}$ concentration
OilGas_Fed_Other_States

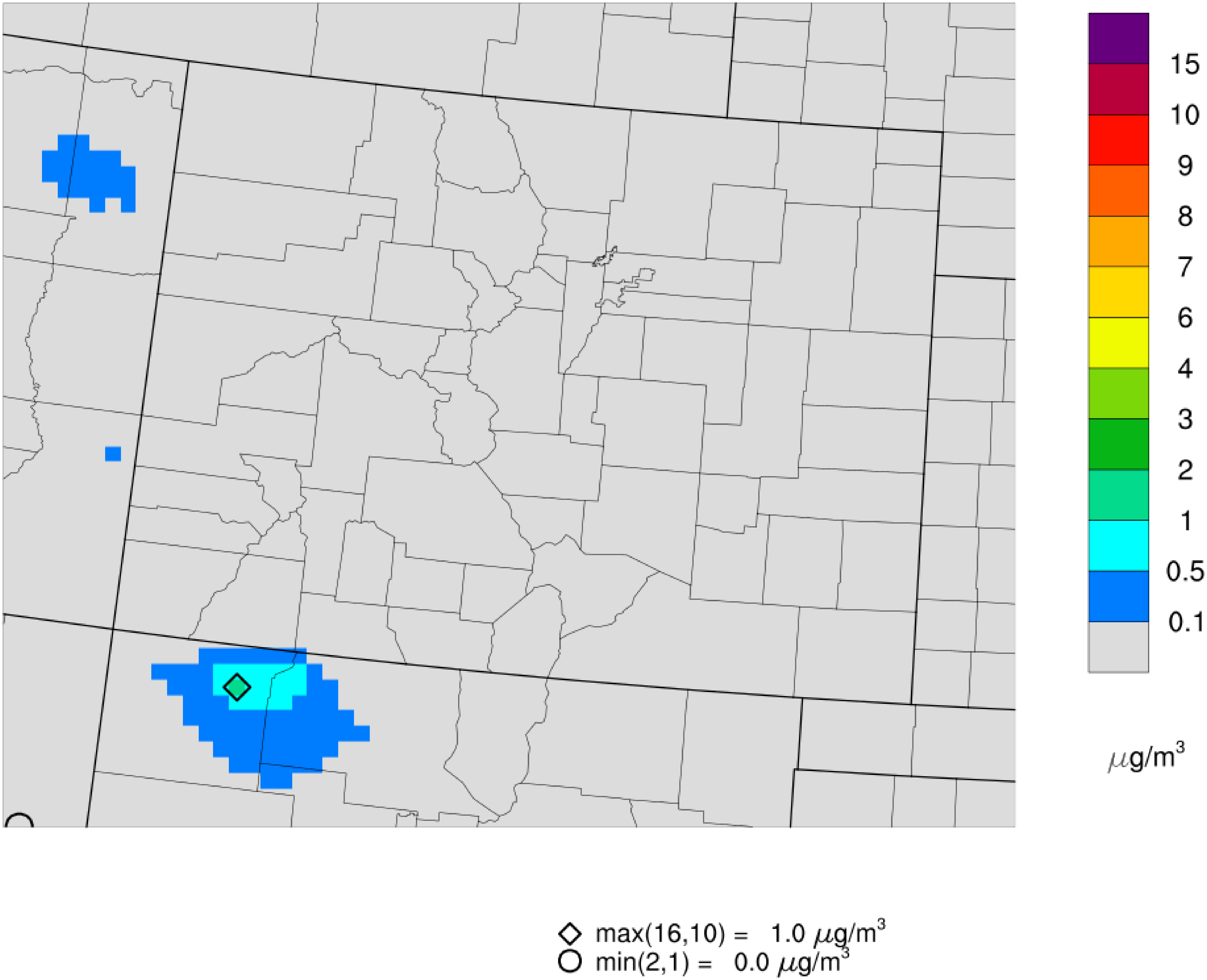
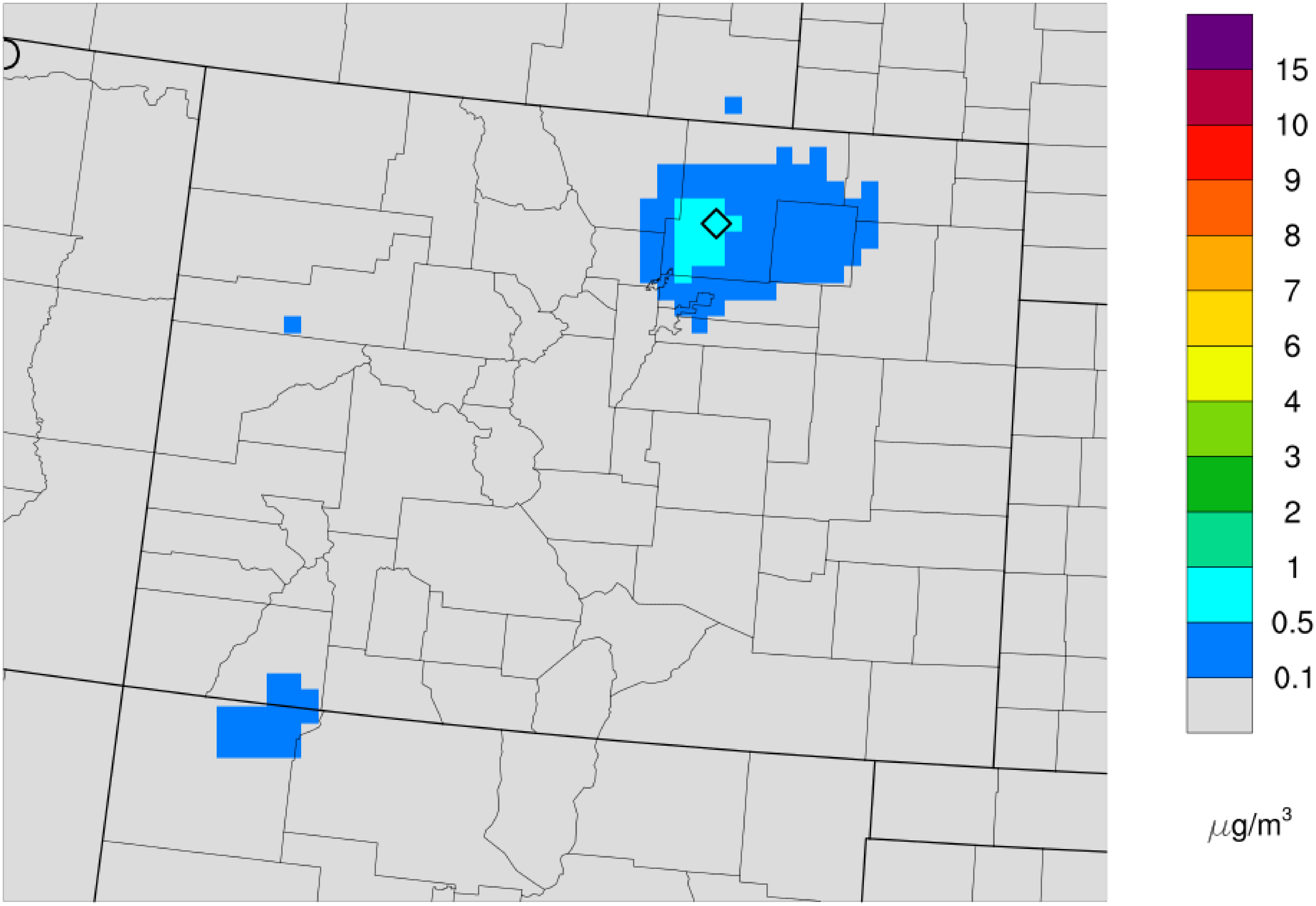
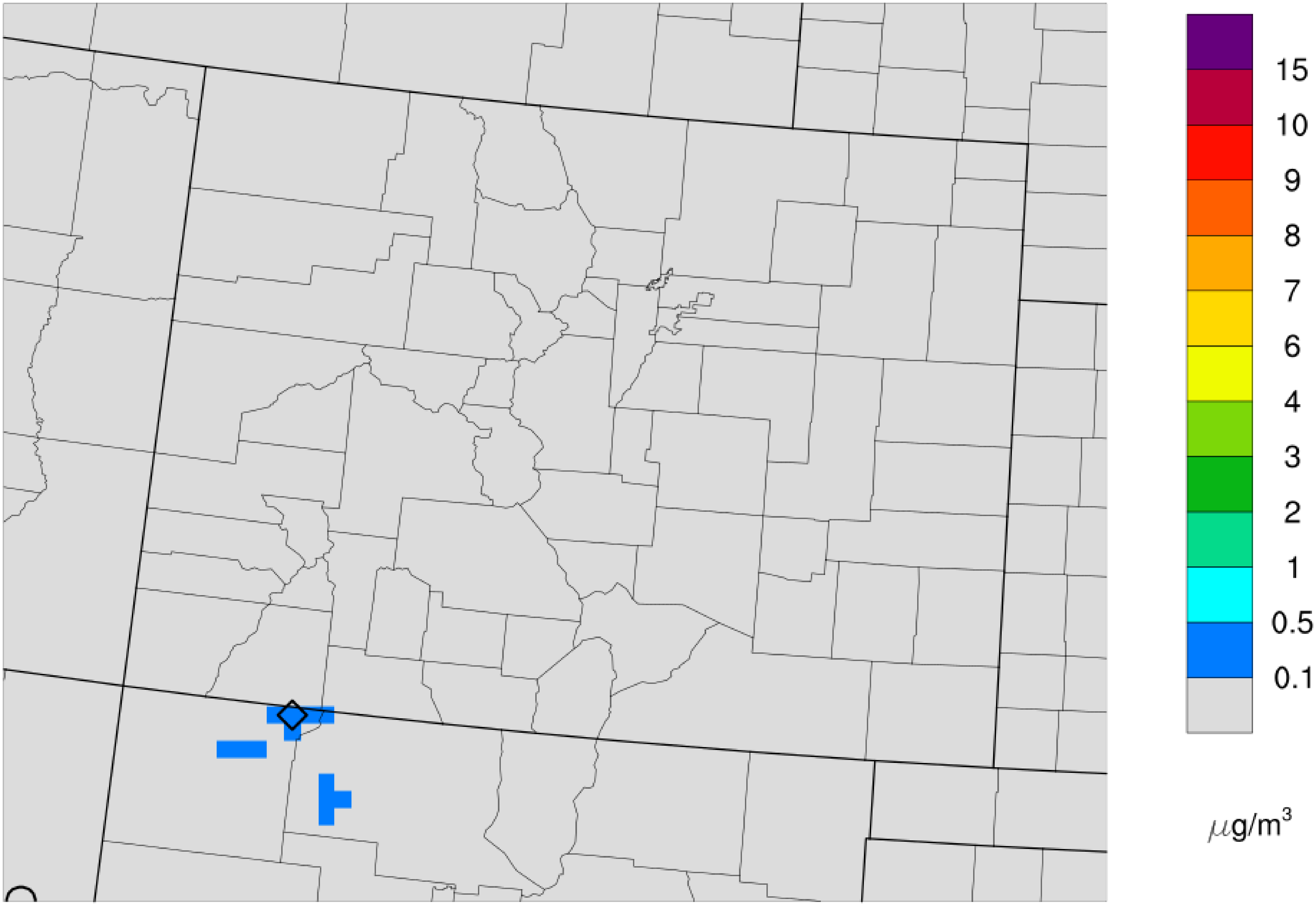


Figure CO.PM25.ann.9
Annual average $PM_{2.5}$ concentration
OilGas_NonFed



◇ max(43,41) = 0.7 $\mu g/m^3$
○ min(1,51) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.10
Annual average $PM_{2.5}$ concentration
OilGas_ExistTribal



◇ max(18,12) = 0.3 $\mu g/m^3$
○ min(2,1) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.11
Annual average $PM_{2.5}$ concentration
OilGas_NewTribal

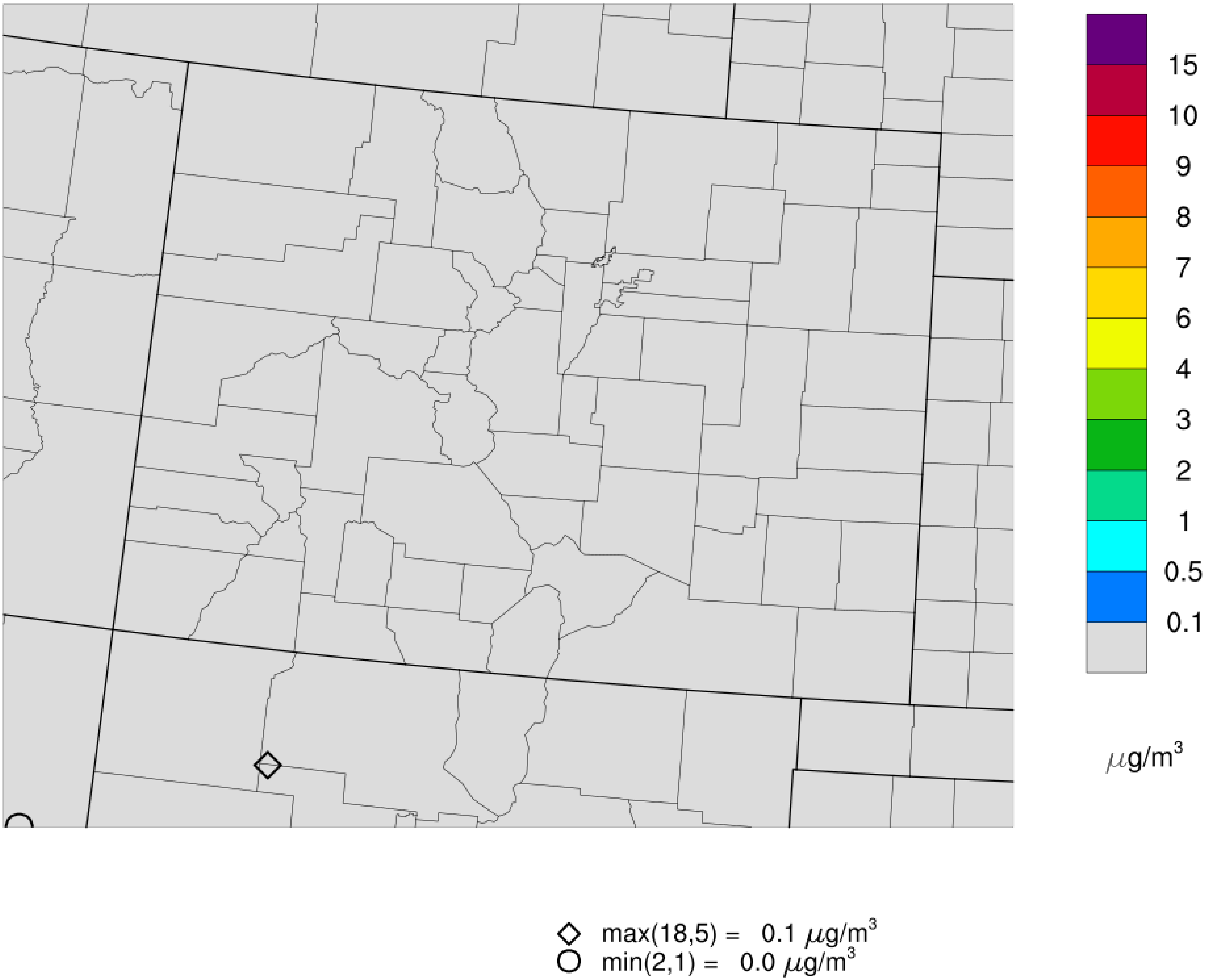
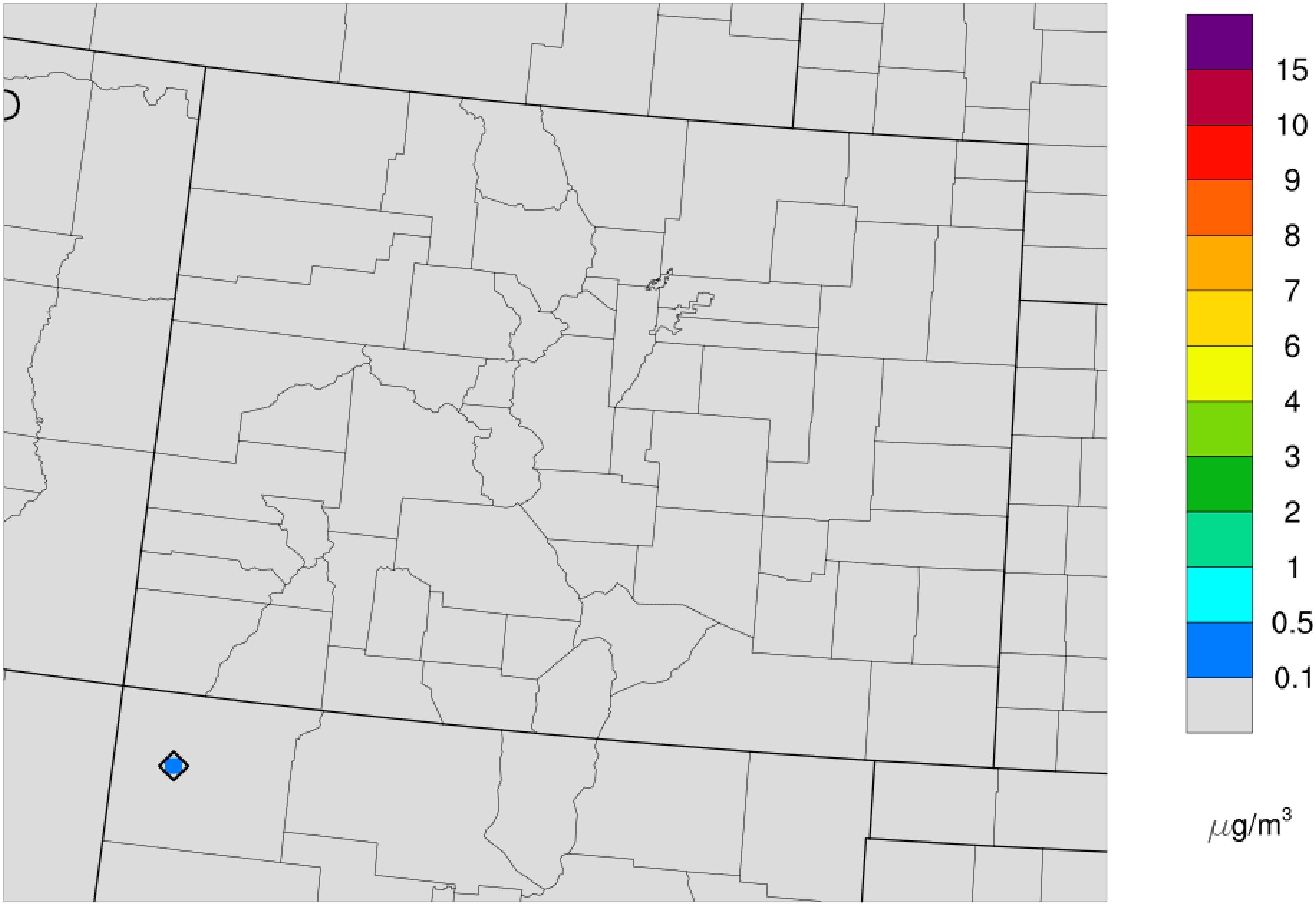
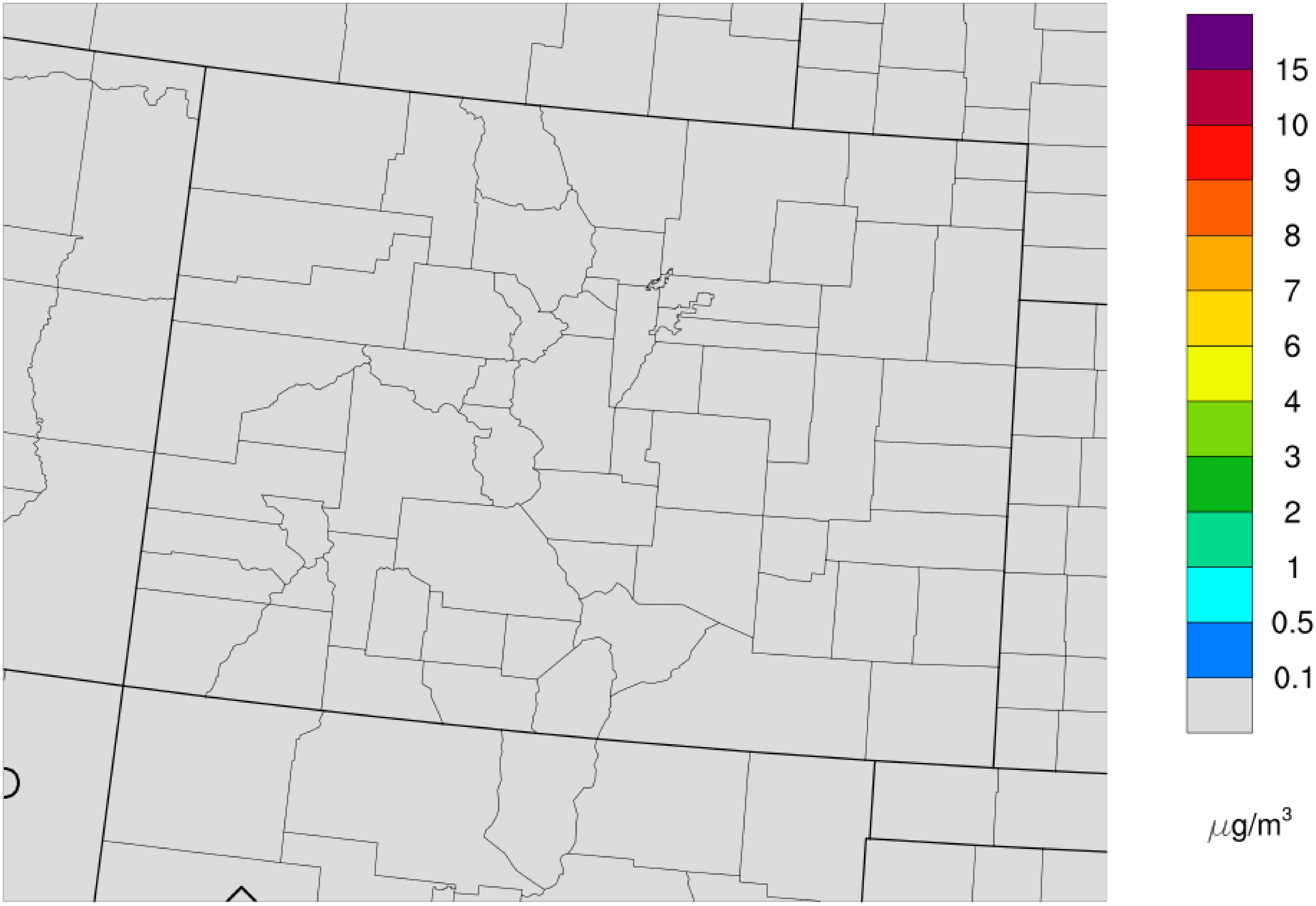


Figure CO.PM25.ann.12
Annual average $PM_{2.5}$ concentration
Coal_Fed



◇ max(11,9) = 0.3 $\mu g/m^3$
○ min(1,48) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.13
Annual average $PM_{2.5}$ concentration
Coal_NonFed



◇ max(15,1) = 0.0 $\mu g/m^3$
○ min(1,8) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.14
Annual average $PM_{2.5}$ concentration
Coal_EGU WRAP states

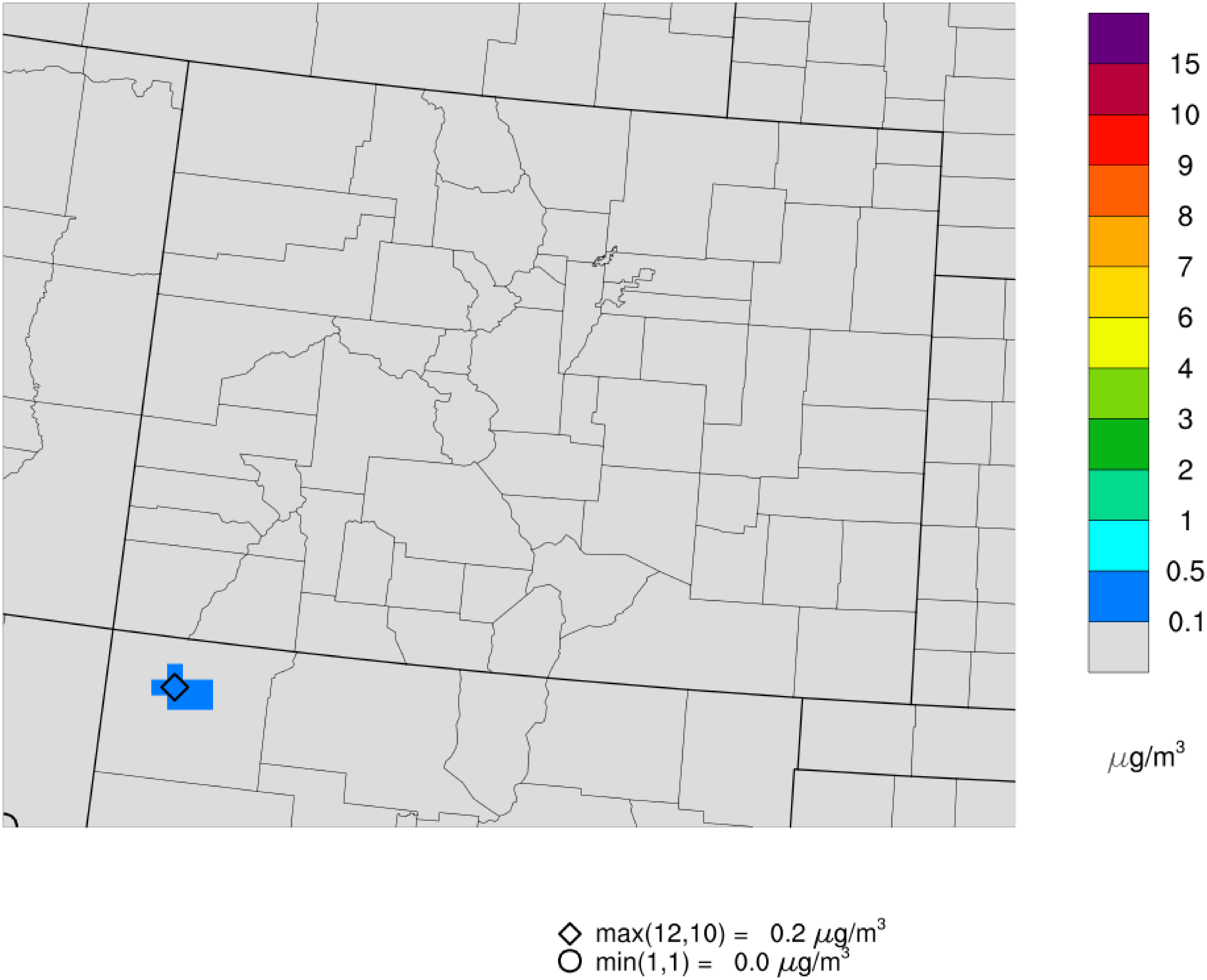
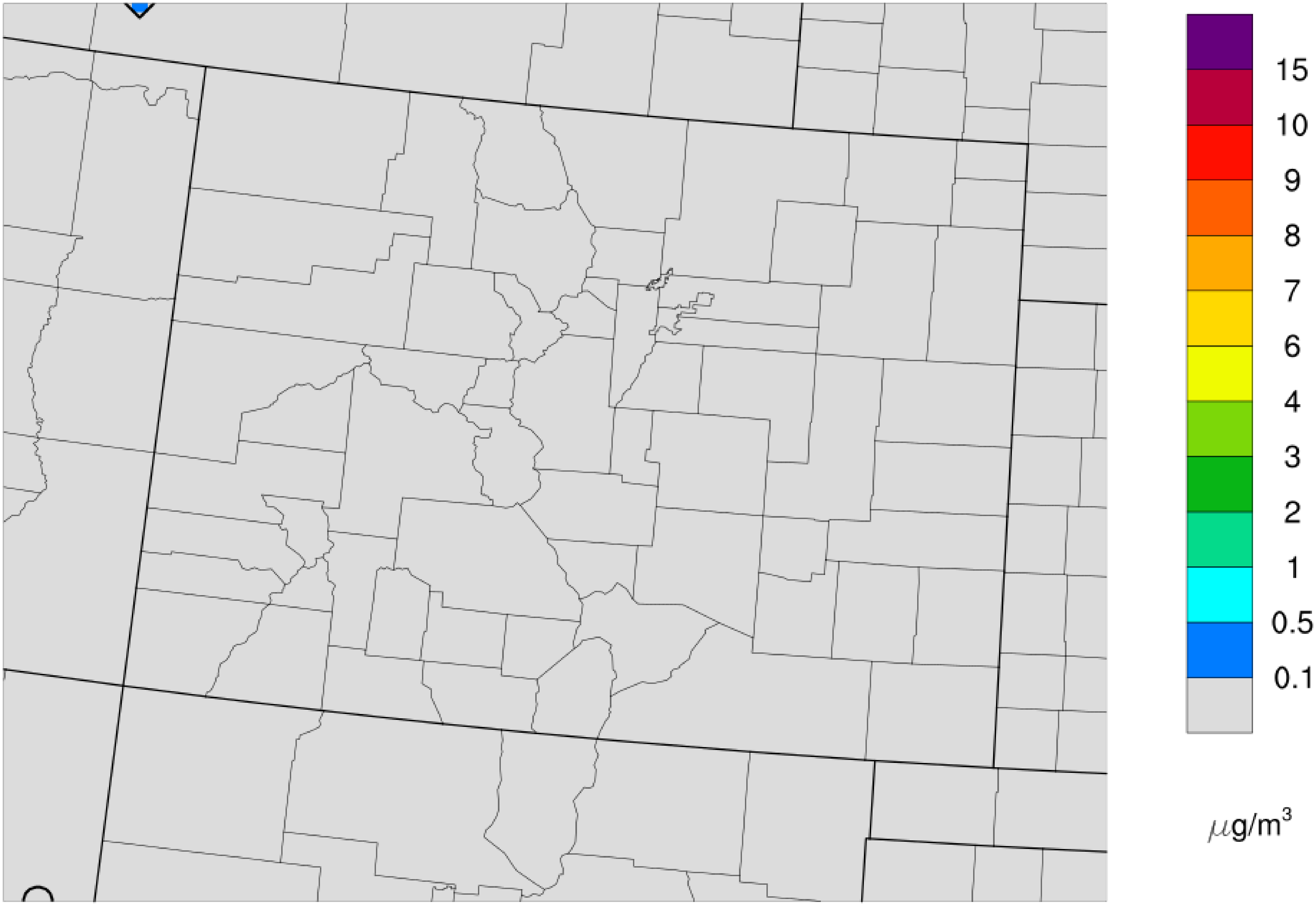
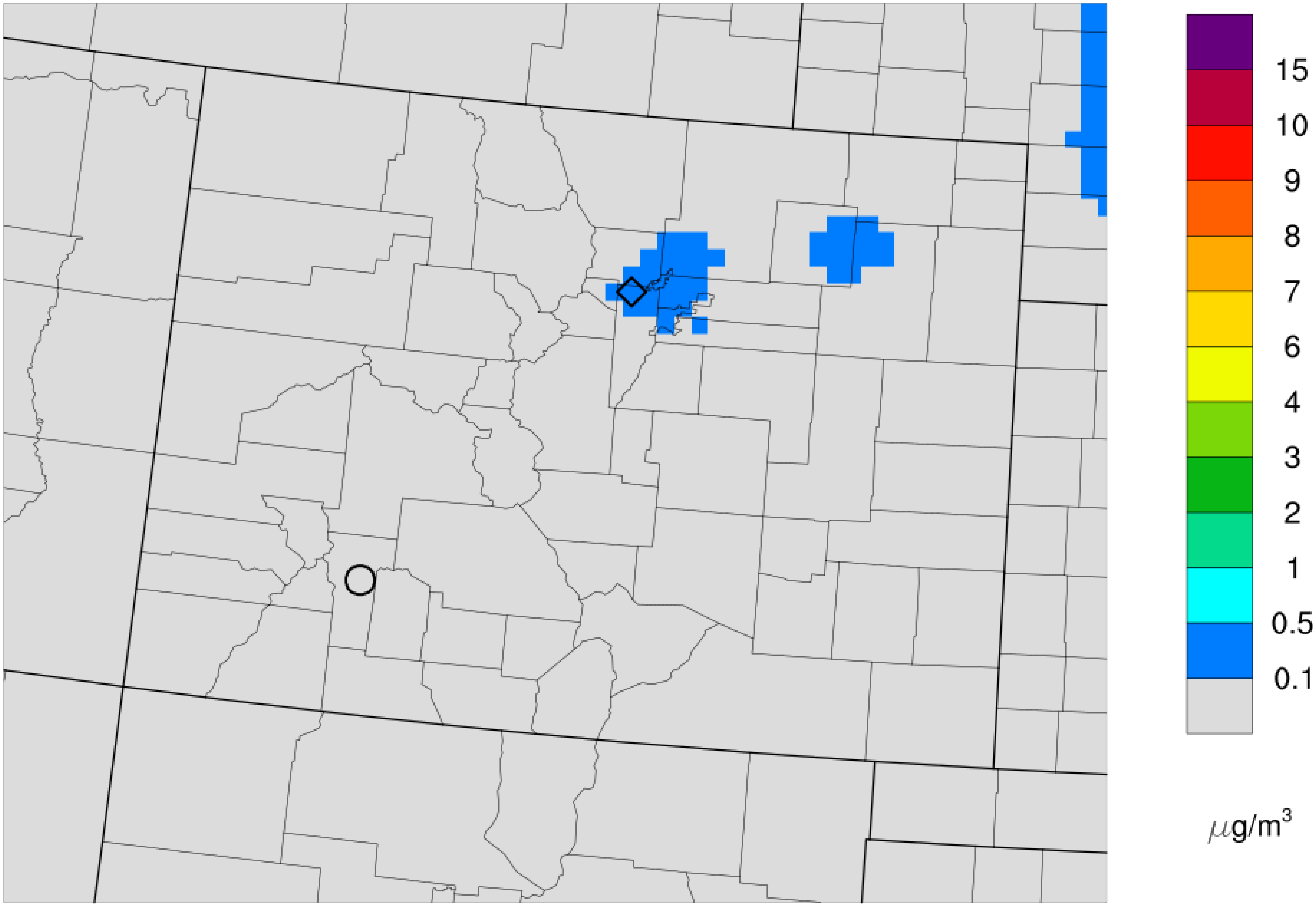


Figure CO.PM25.ann.15
Annual average $PM_{2.5}$ concentration
Coal_Comb WRAP states



◇ max(9,54) = 0.1 $\mu g/m^3$
○ min(3,1) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.16
Annual average $PM_{2.5}$ concentration
OtherEGU



◇ max(38,37) = 0.4 $\mu g/m^3$
○ min(22,20) = 0.0 $\mu g/m^3$

Figure CO.PM25.ann.17
Annual average $PM_{2.5}$ concentration
Anthro_Rest

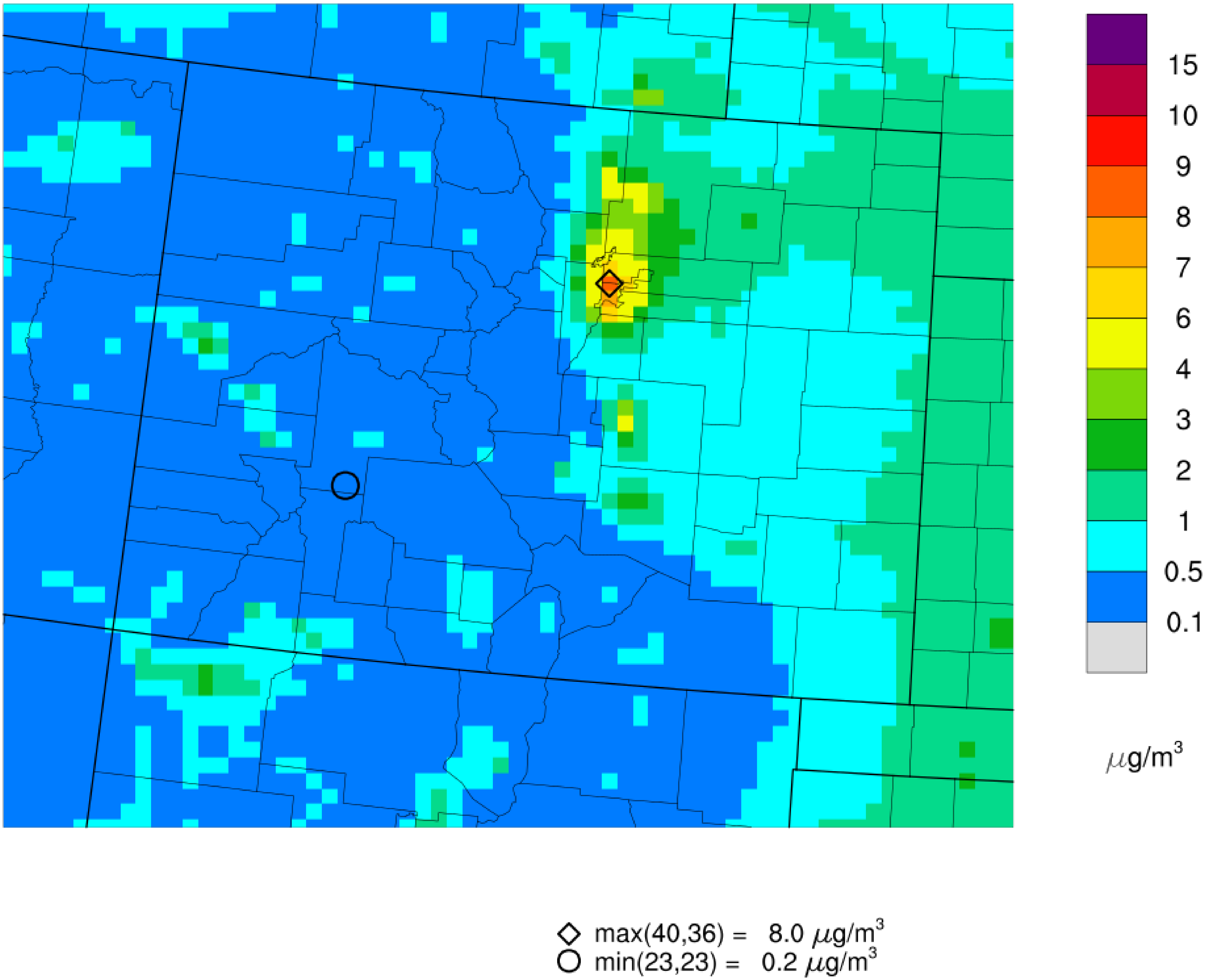


Figure CO.SO2.3hr.1
The 2nd highest 3hr average SO_2 concentration
Cumulative

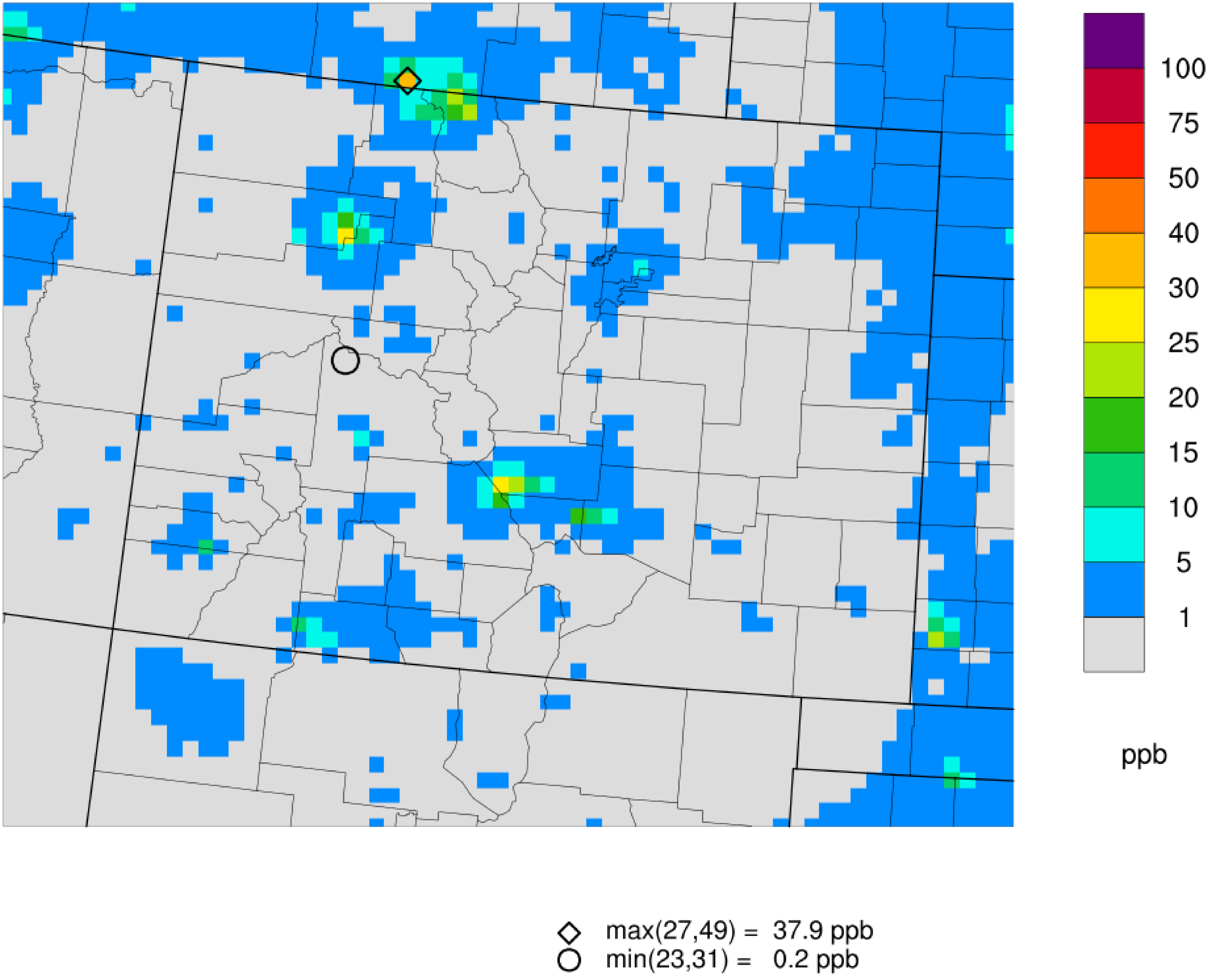


Figure CO.SO2.3hr.2
The 2nd highest 3hr average SO_2 concentration
Natural

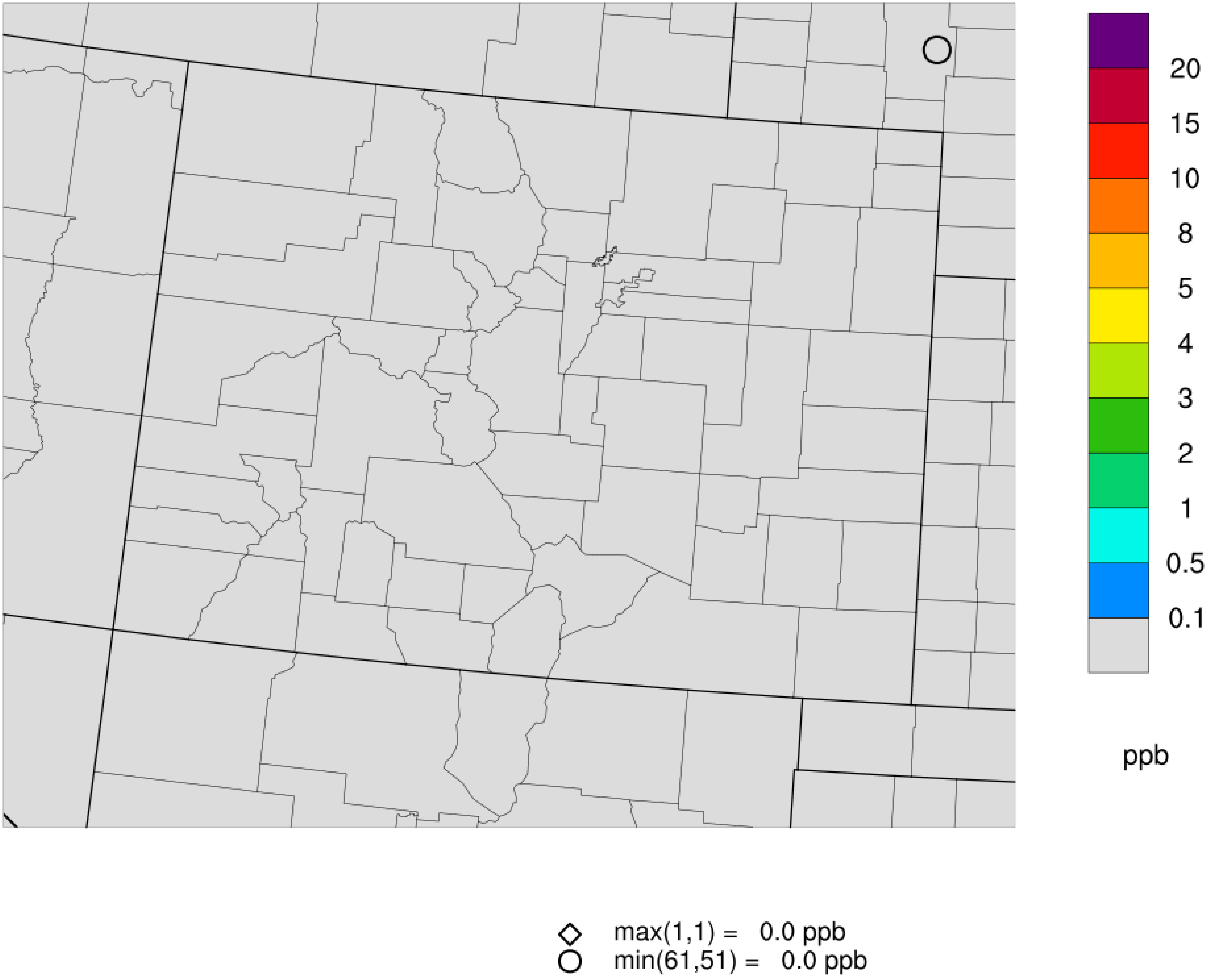
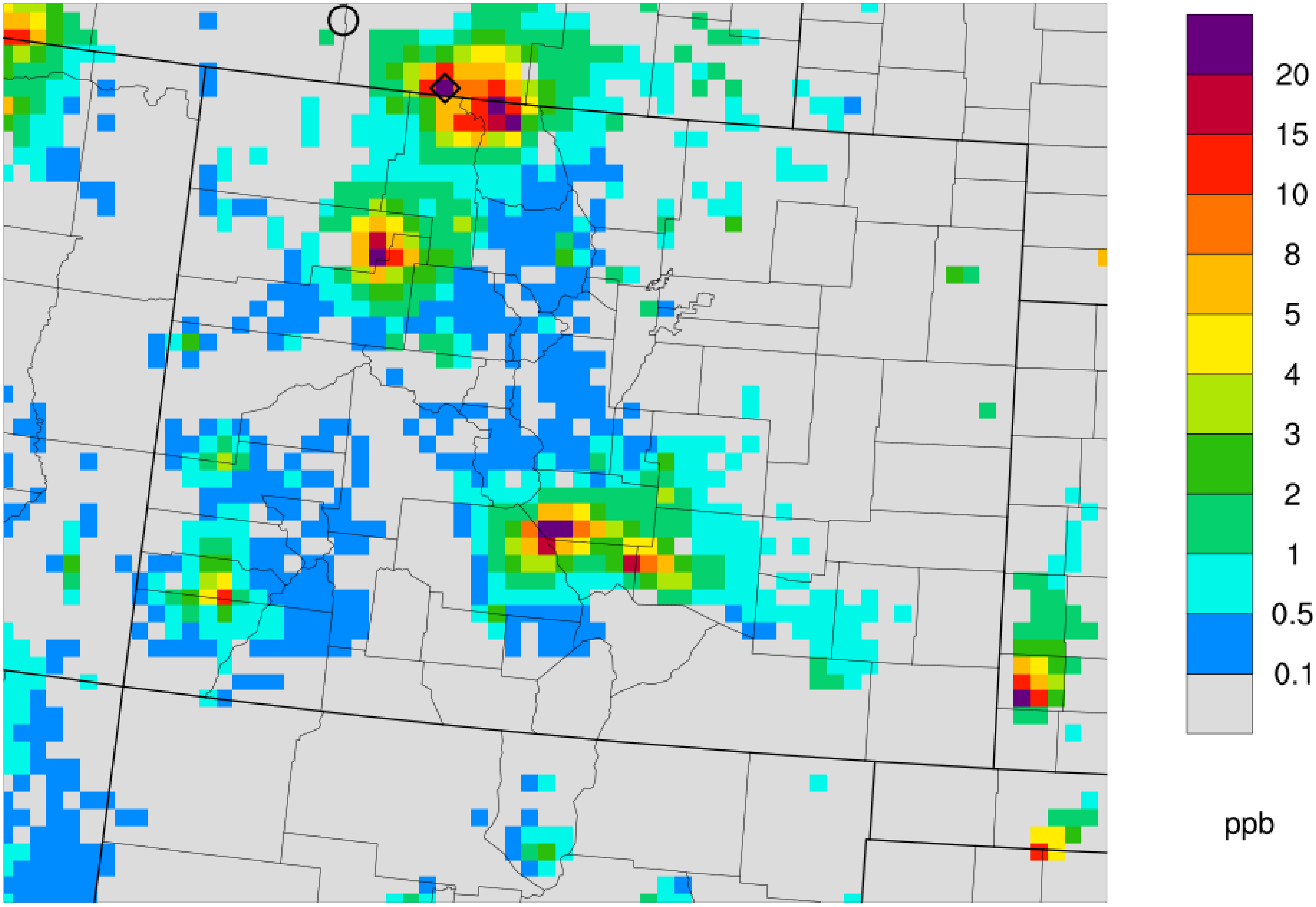
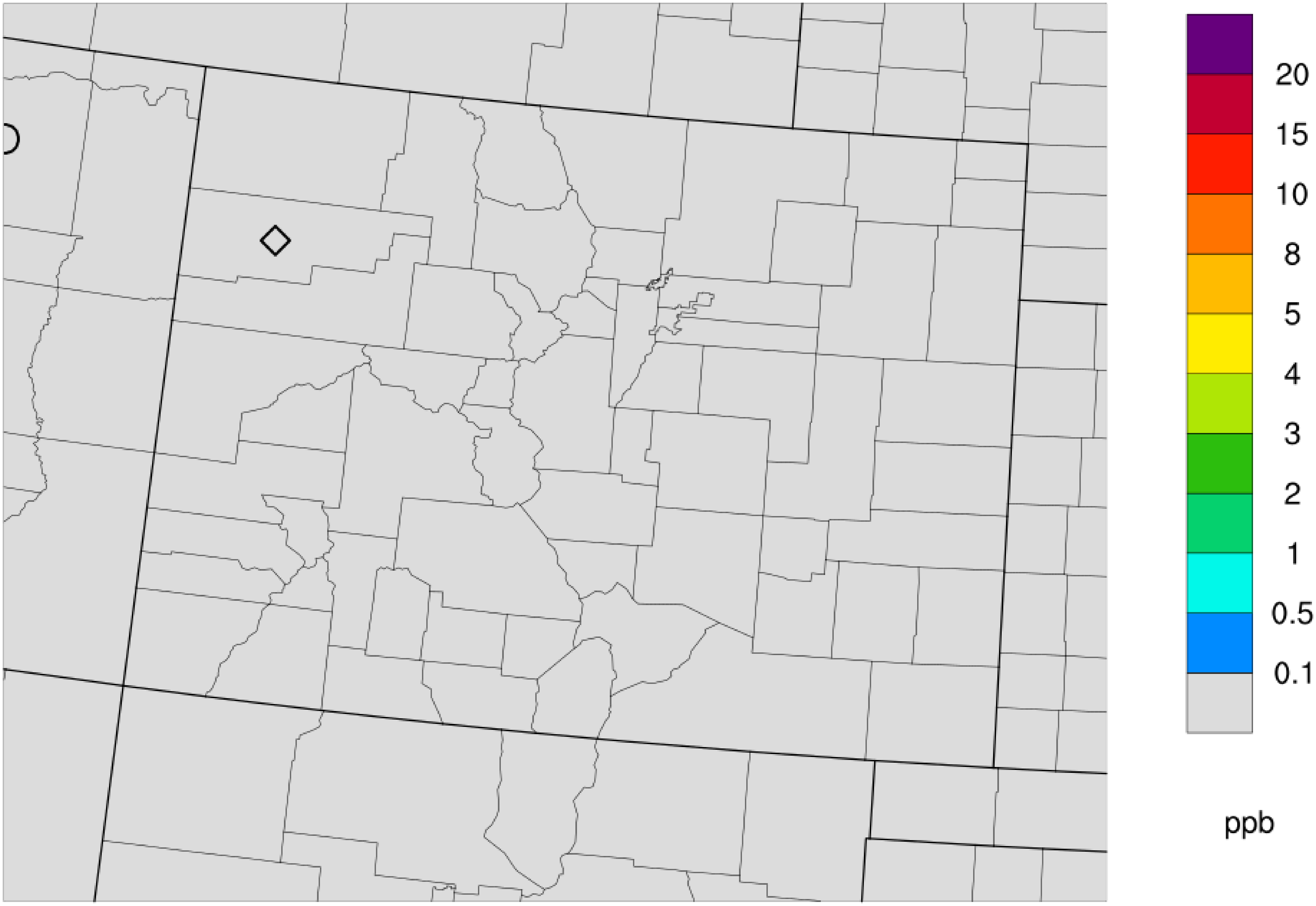


Figure CO.SO2.3hr.3
The 2nd highest 3hr average SO_2 concentration
Wildfire



◇ max(27,49) = 37.7 ppb
○ min(21,53) = 0.0 ppb

Figure CO.SO2.3hr.4
The 2nd highest 3hr average SO_2 concentration
OilGas_ExistFed_WesternCO



◇ max(17,40) = 0.1 ppb
○ min(1,46) = 0.0 ppb

Figure CO.SO2.3hr.5
The 2nd highest 3hr average SO_2 concentration
OilGas_ExistFed_RoyalGorge

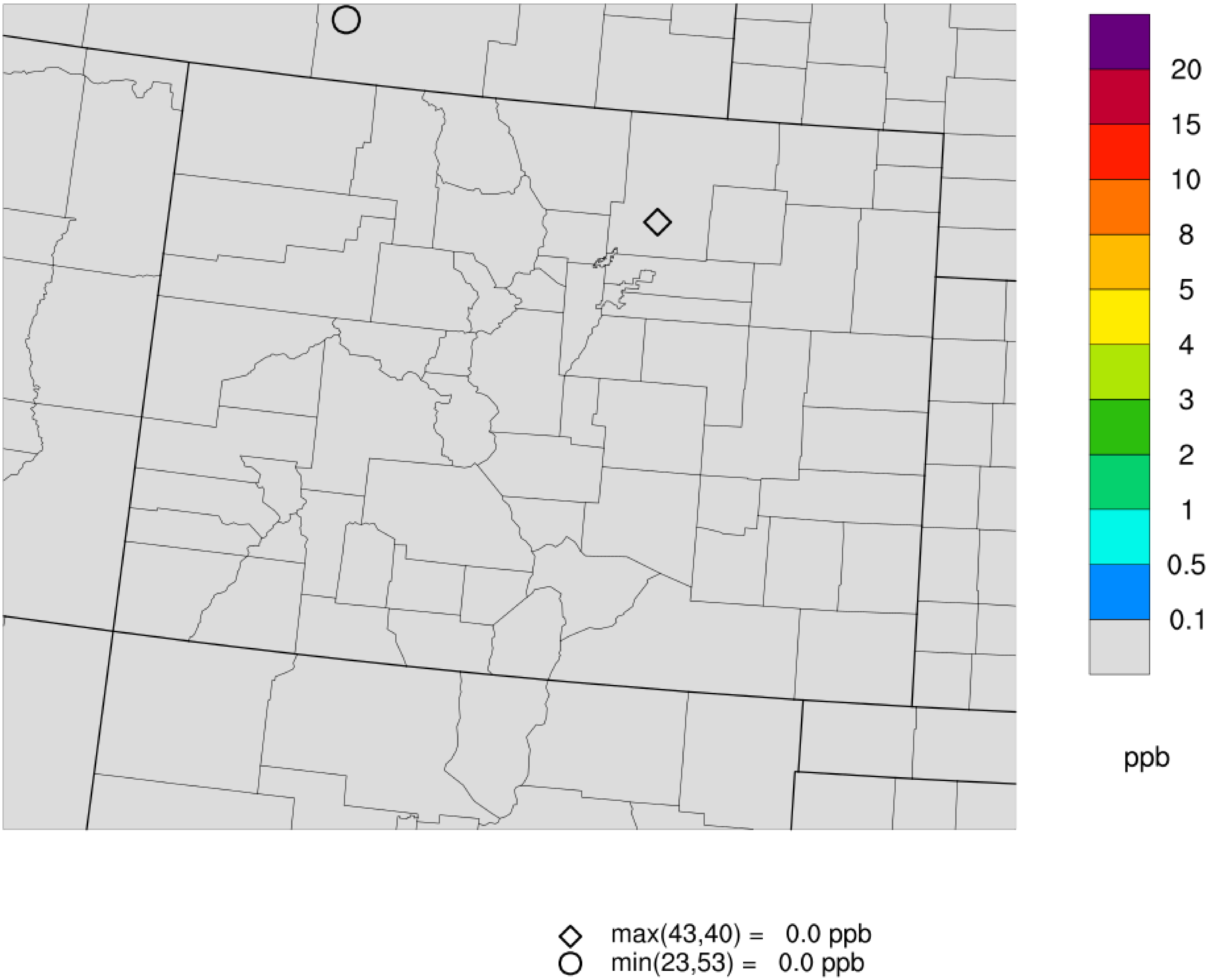


Figure CO.SO2.3hr.6
The 2nd highest 3hr average SO_2 concentration
OilGas_NewFed_WesternCO

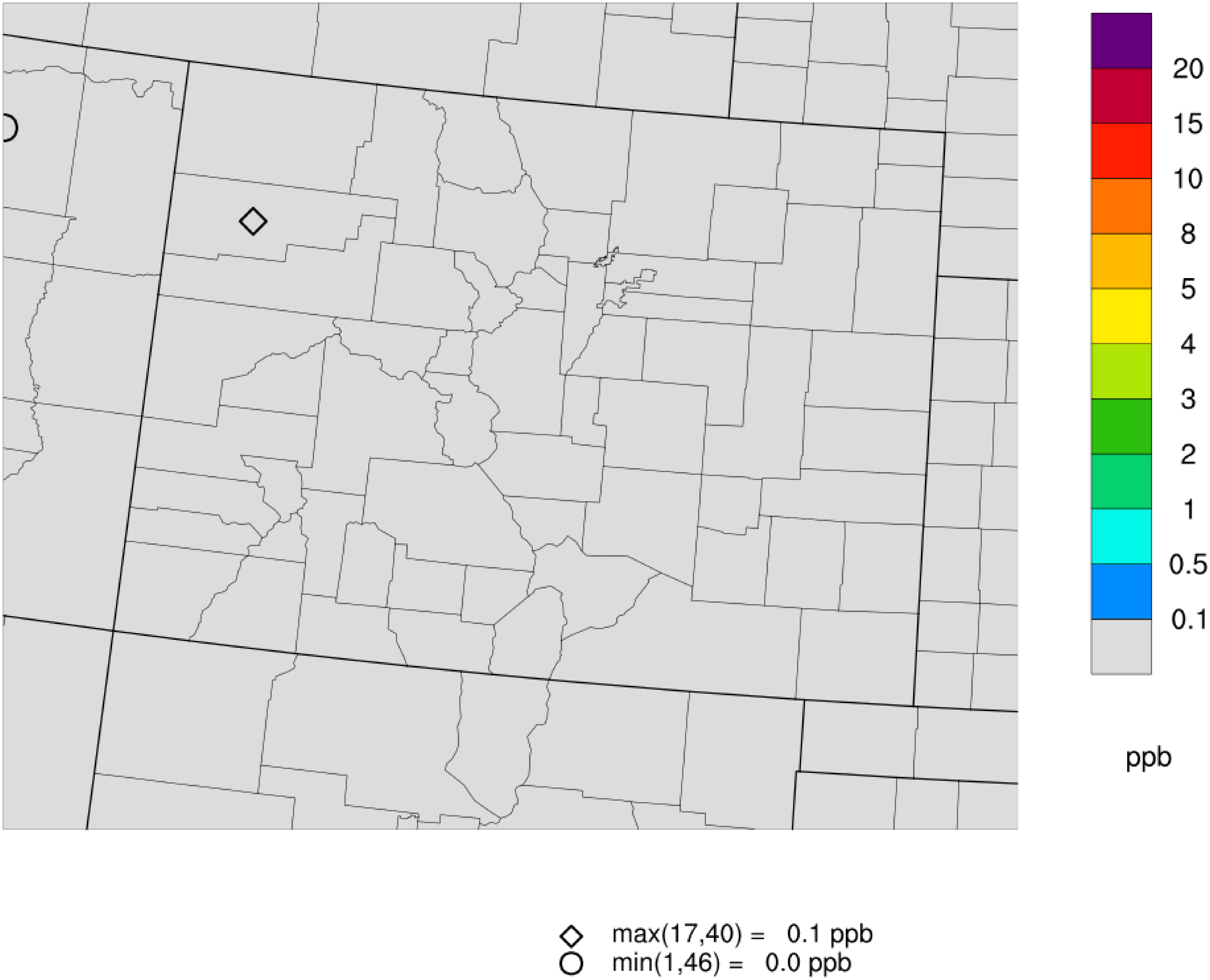


Figure CO.SO2.3hr.7
The 2nd highest 3hr average SO_2 concentration
OilGas_NewFed_RoyalGorge

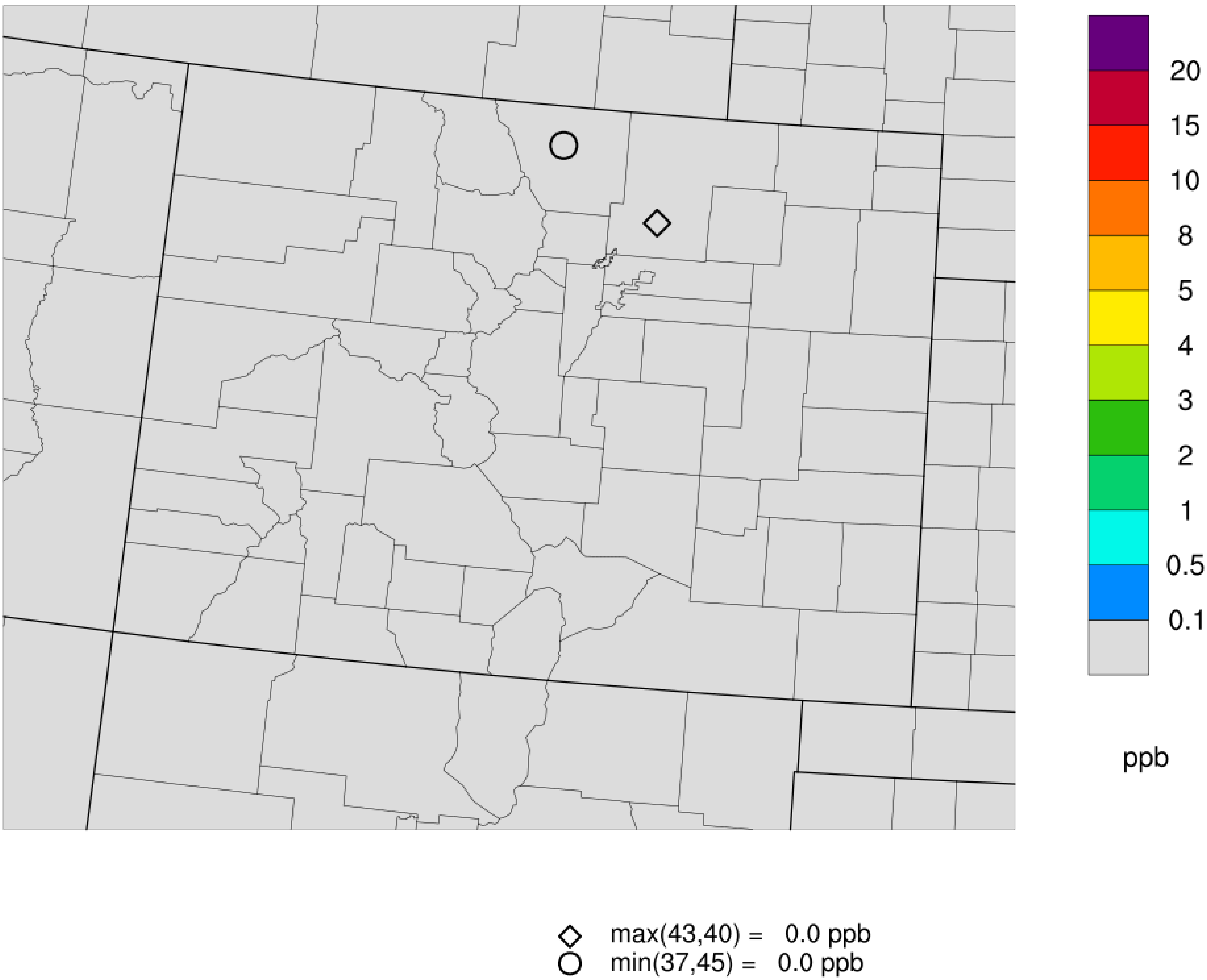


Figure CO.SO2.3hr.8
The 2nd highest 3hr average SO_2 concentration
OilGas_Fed_Other_States

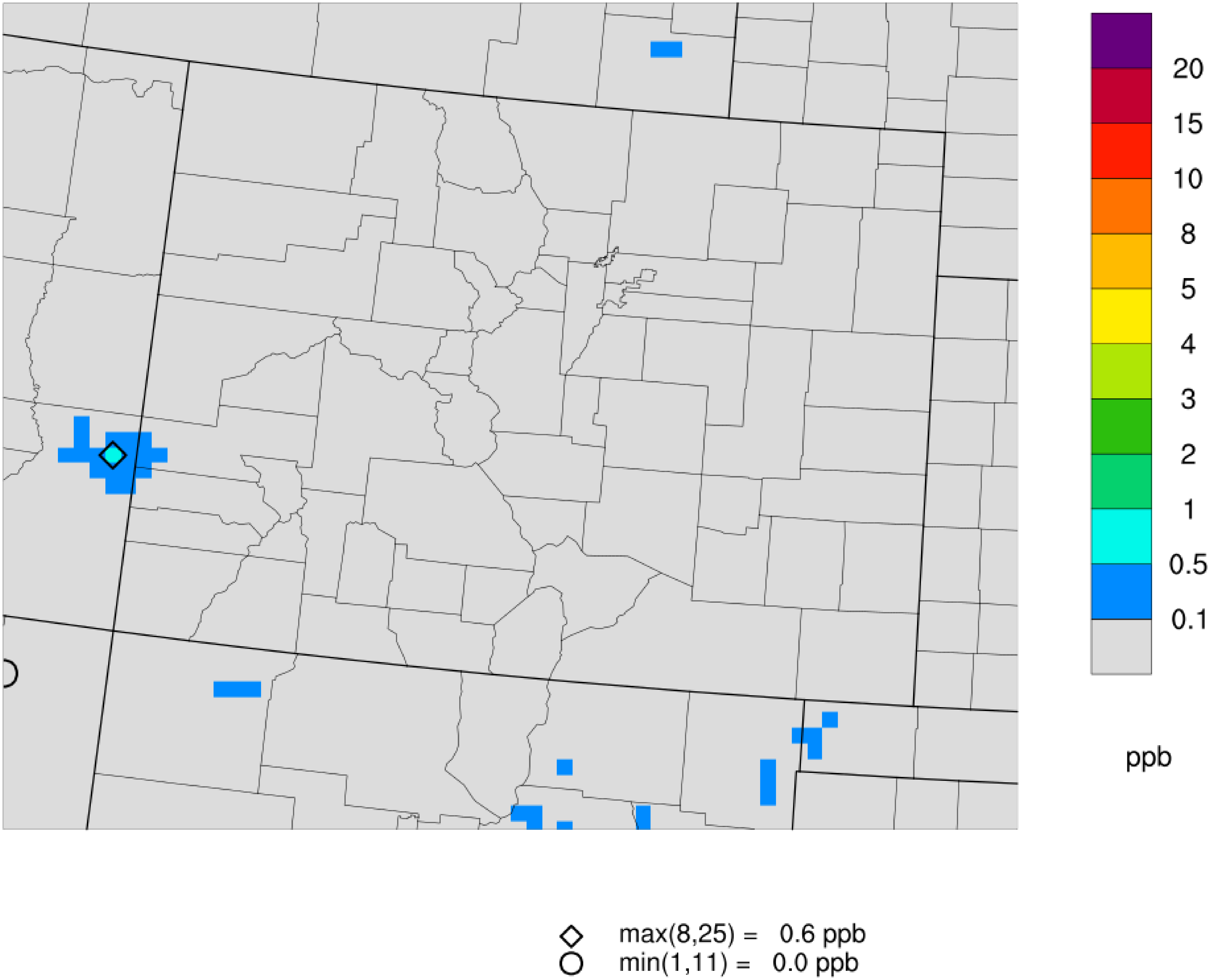


Figure CO.SO2.3hr.9
The 2nd highest 3hr average SO_2 concentration
OilGas_NonFed

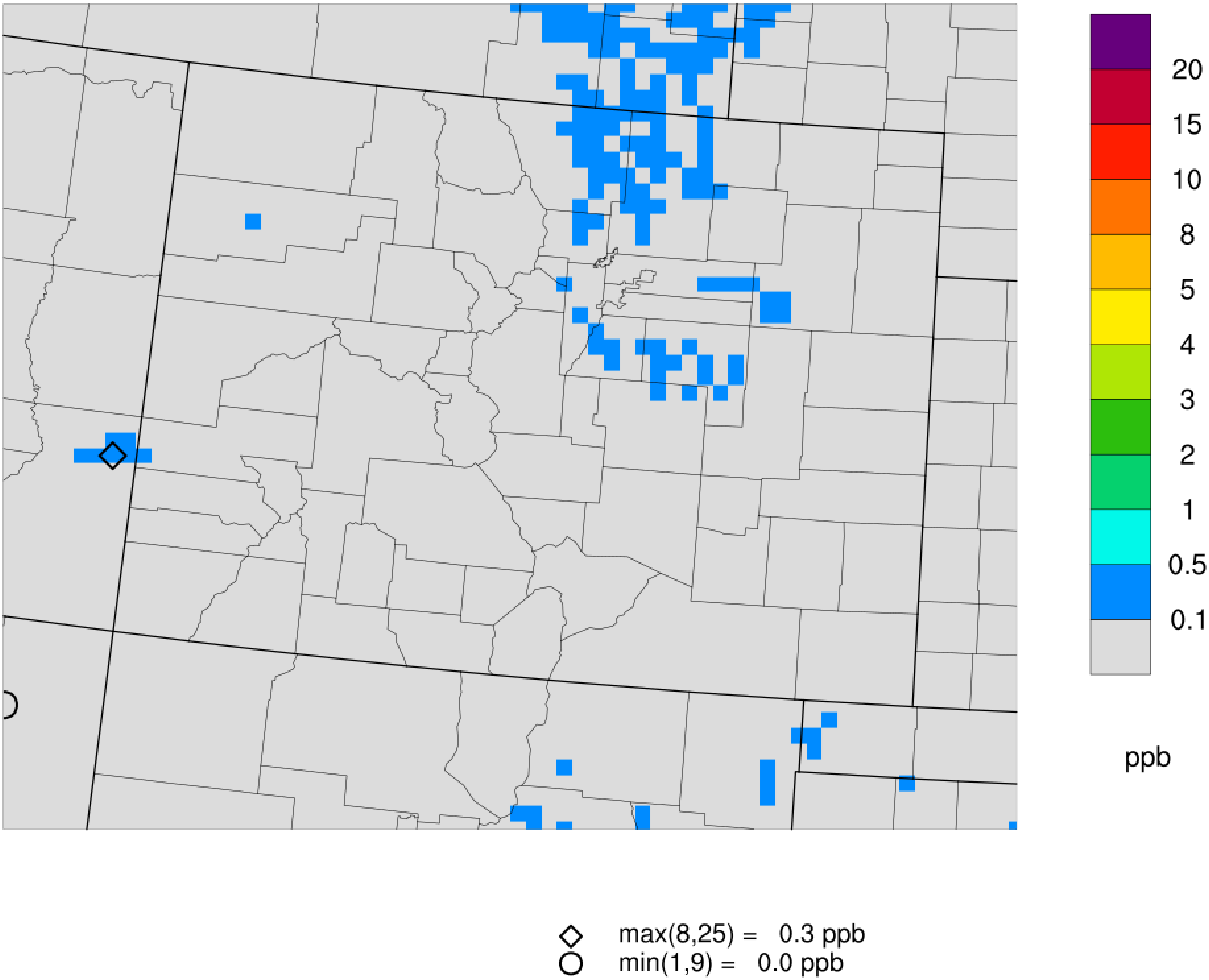


Figure CO.SO2.3hr.10
The 2nd highest 3hr average SO_2 concentration
OilGas_ExistTribal

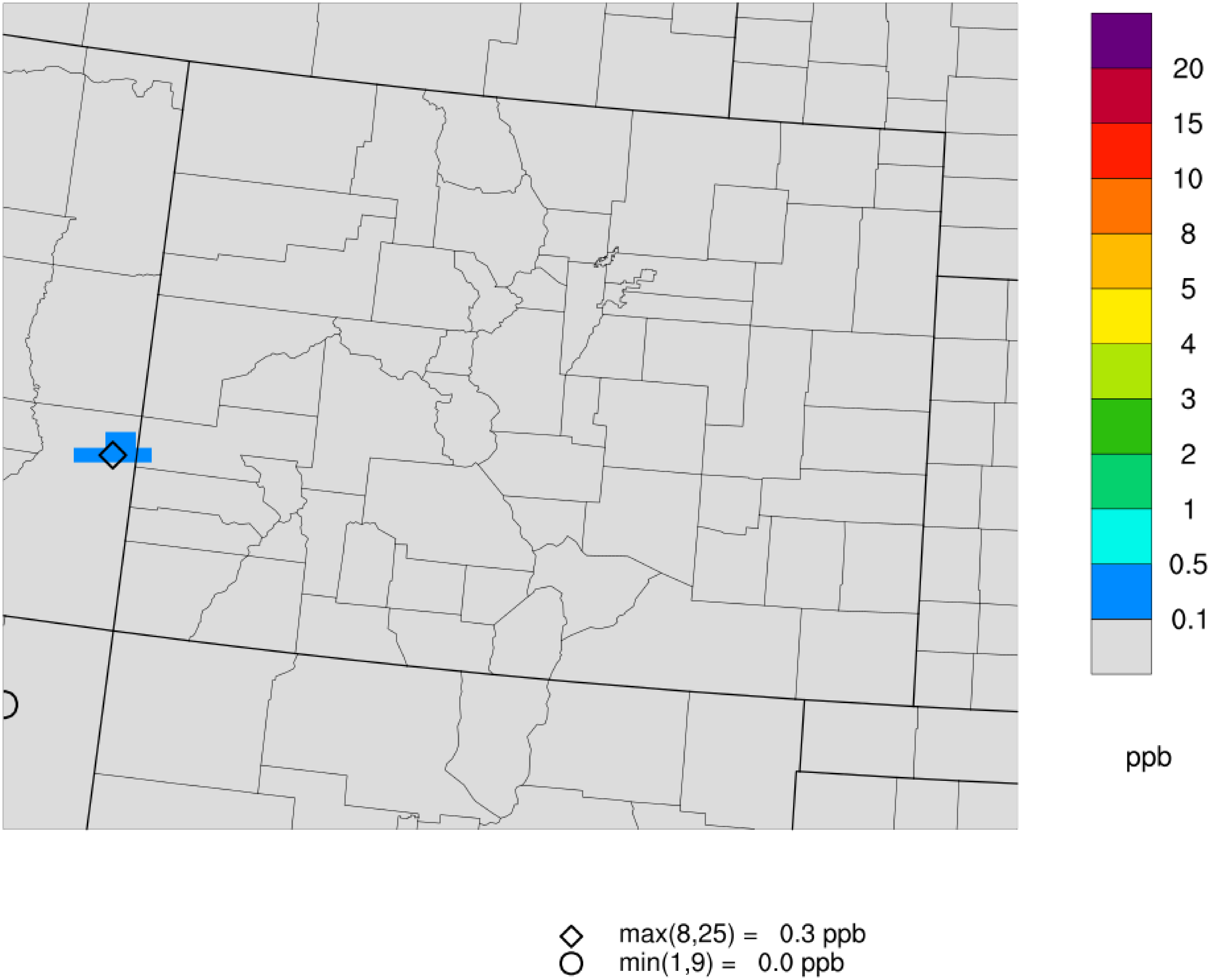


Figure CO.SO2.3hr.11
The 2nd highest 3hr average SO_2 concentration
OilGas_NewTribal

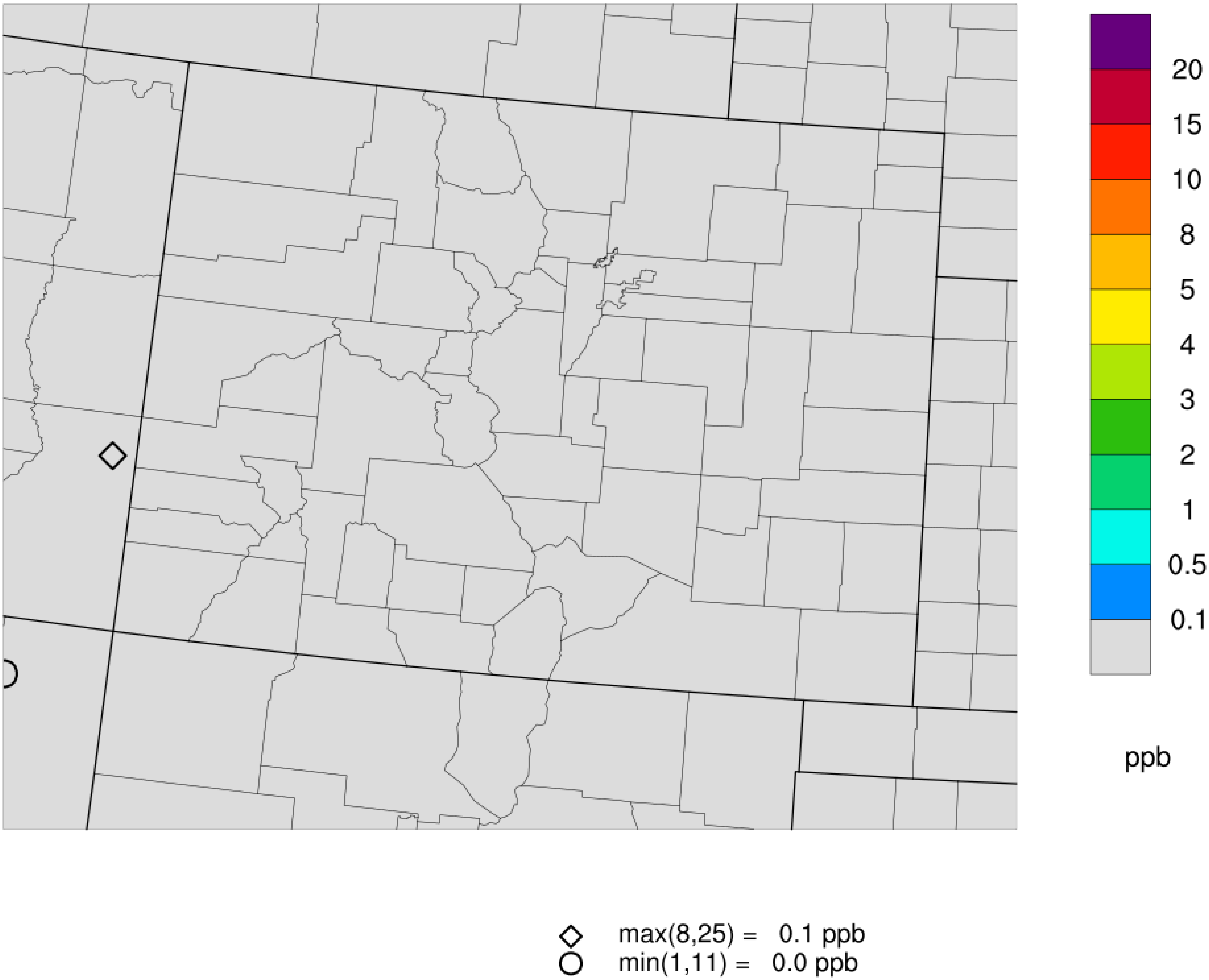


Figure CO.SO2.3hr.12
The 2nd highest 3hr average SO_2 concentration
Coal_Fed

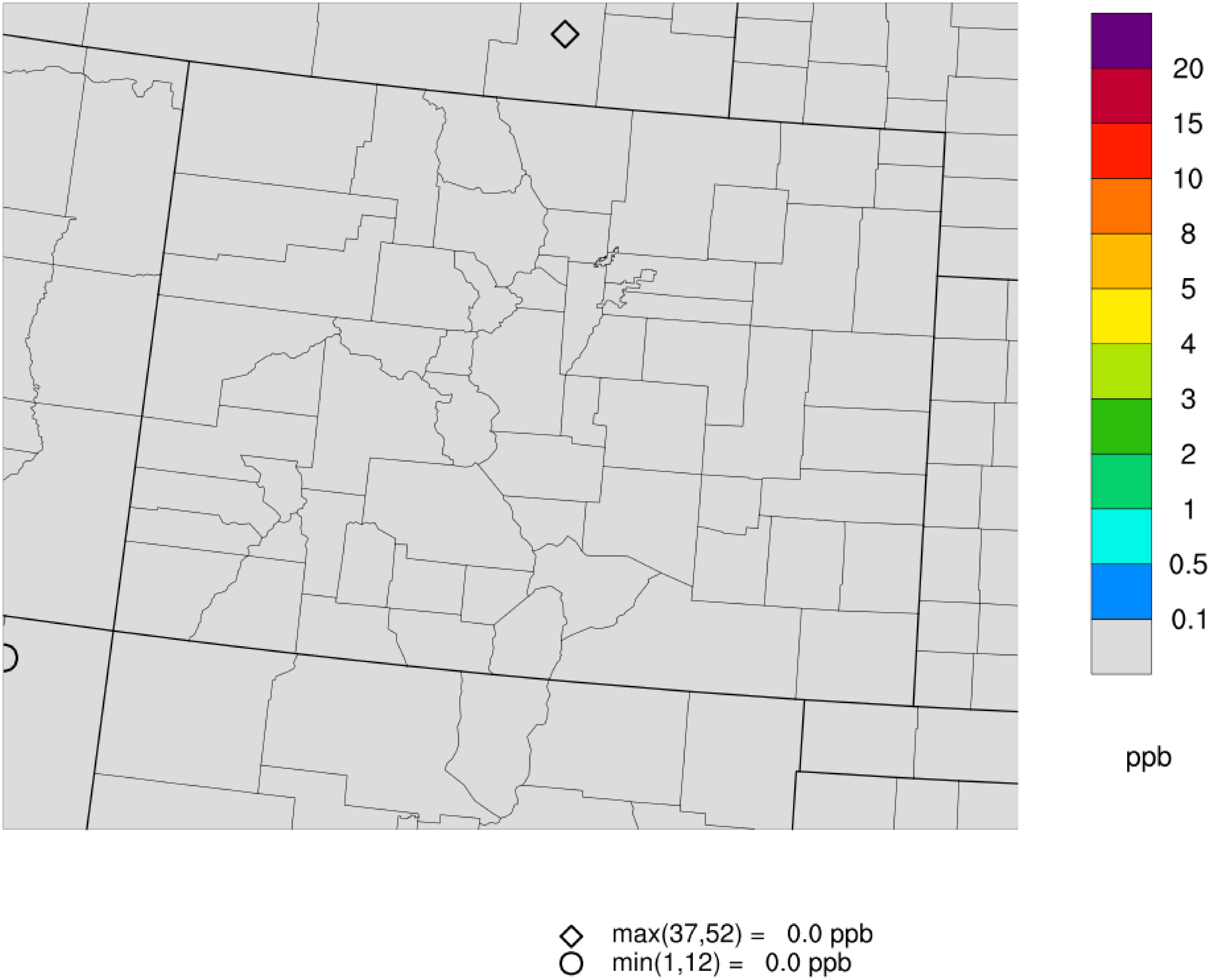


Figure CO.SO2.3hr.13
The 2nd highest 3hr average SO_2 concentration
Coal_NonFed

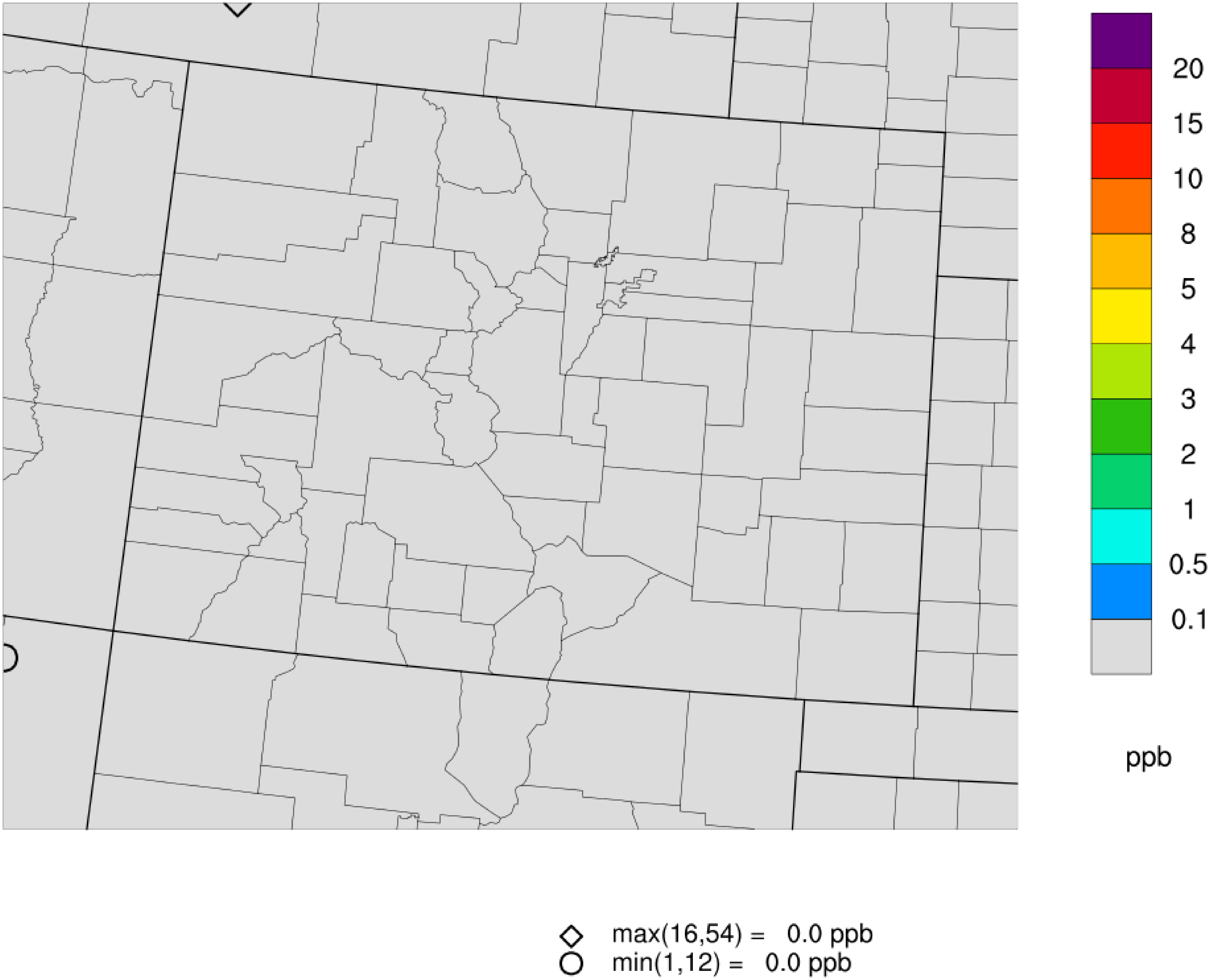
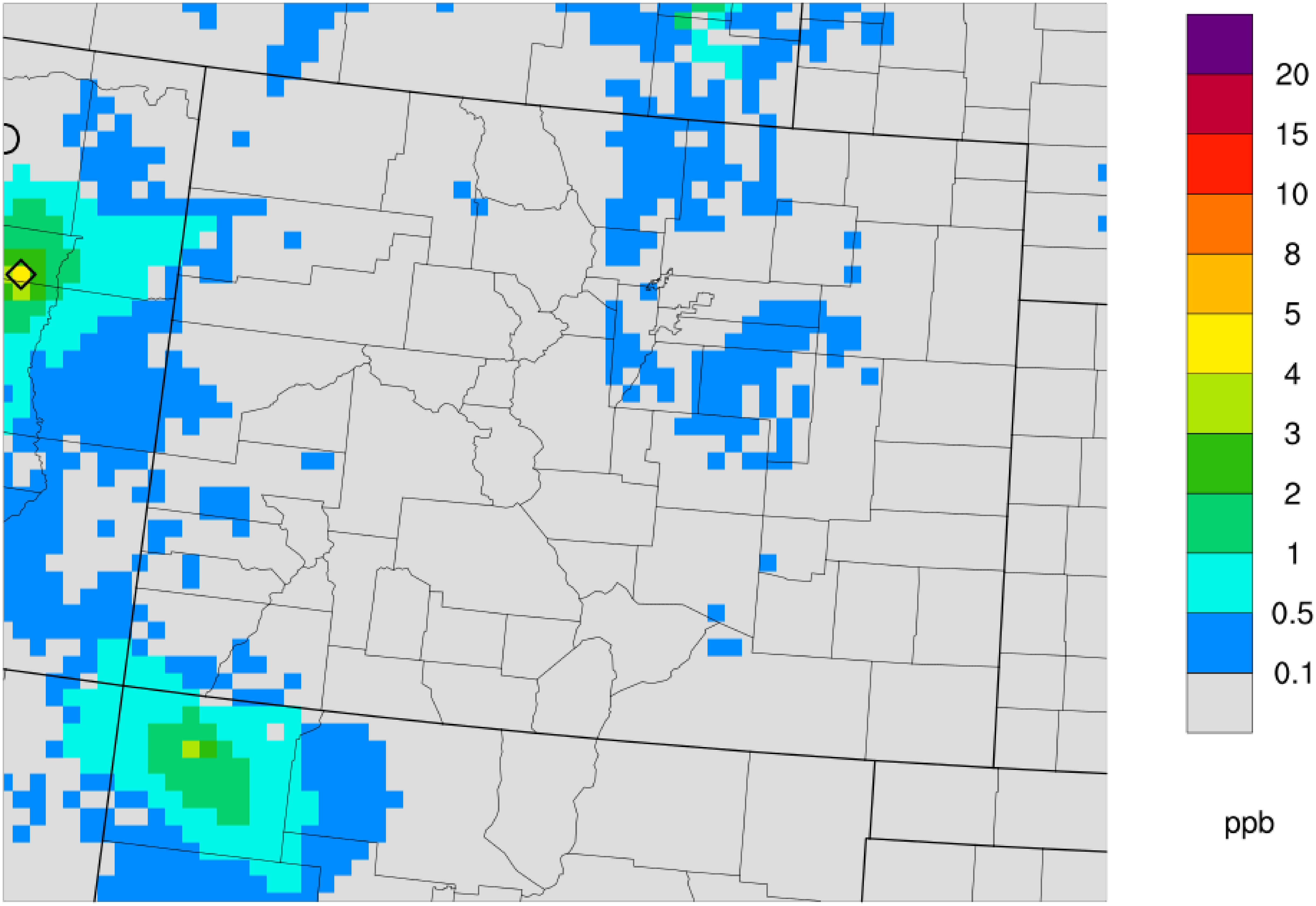


Figure CO.SO2.3hr.14
The 2nd highest 3hr average SO_2 concentration
Coal_EGU WRAP states



max(2,38) = 4.5 ppb
min(1,46) = 0.0 ppb

Figure CO.SO2.3hr.15
The 2nd highest 3hr average SO_2 concentration
Coal_Comb WRAP states

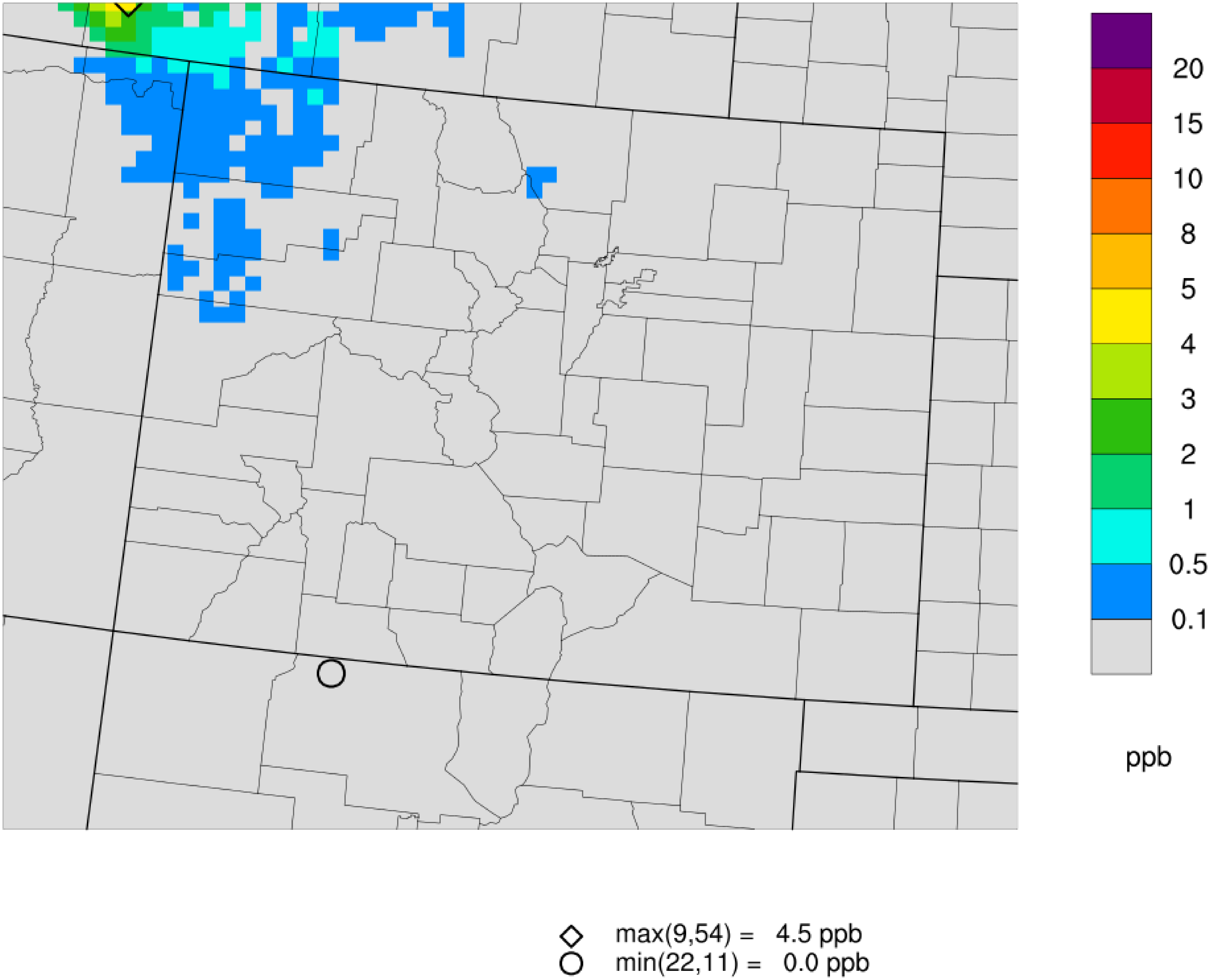
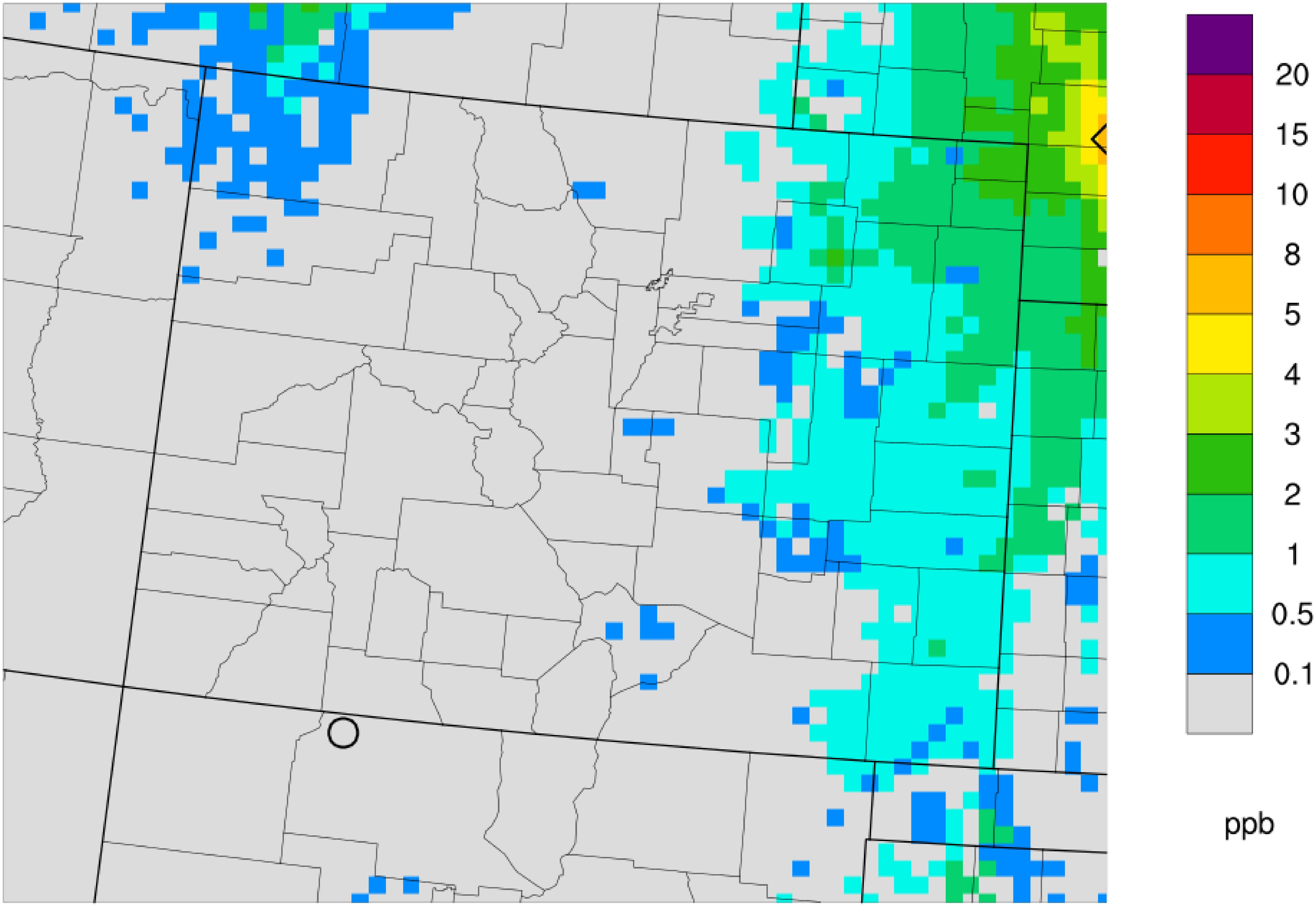


Figure CO.SO2.3hr.16
The 2nd highest 3hr average SO_2 concentration
OtherEGU



◇ max(66,46) = 7.2 ppb
○ min(21,11) = 0.0 ppb

Figure CO.SO2.3hr.17
The 2nd highest 3hr average SO_2 concentration
Anthro_Rest

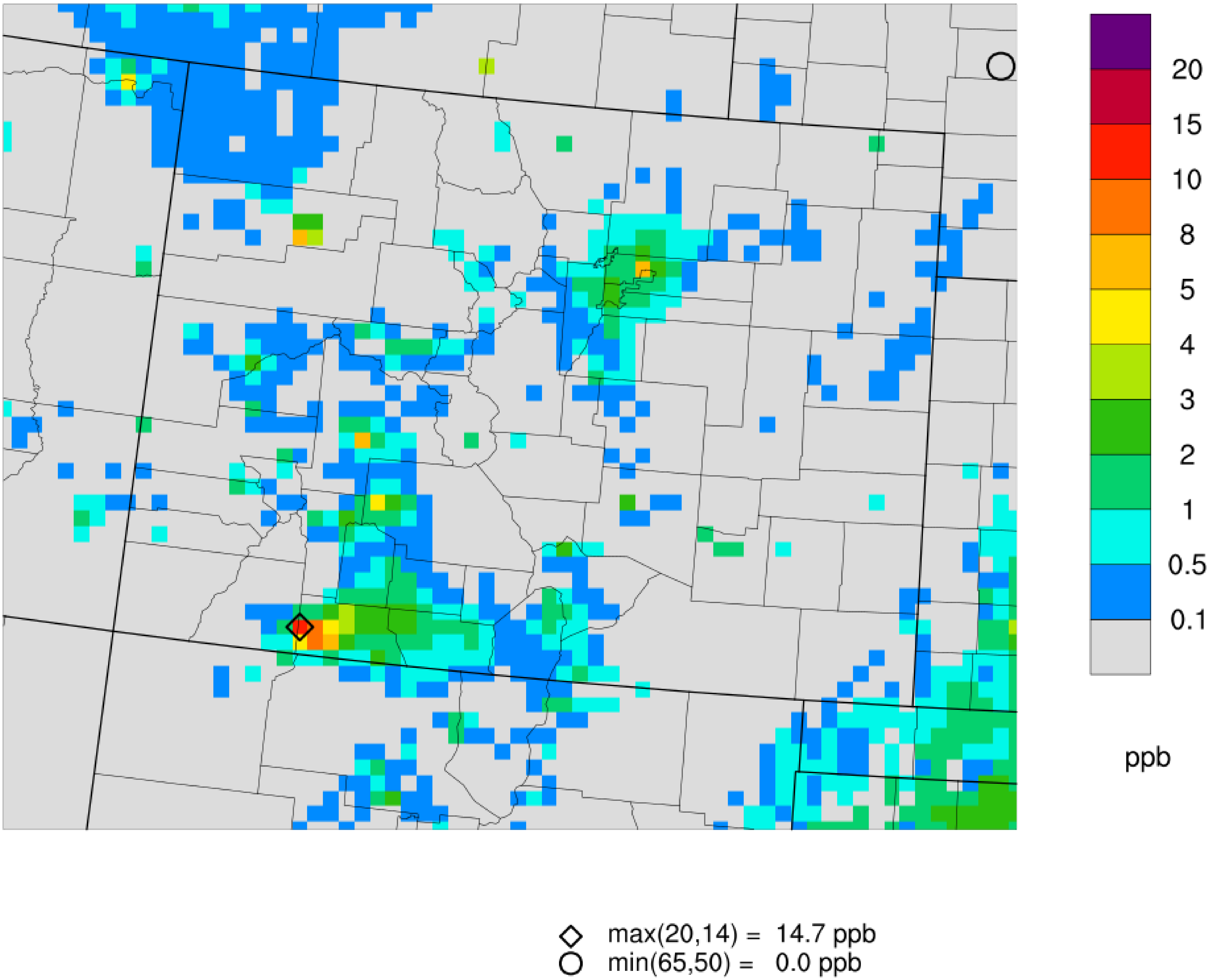


Figure CO.SO2.1hr.1
The 4th highest 1 hour daily max SO_2 concentration
Cumulative

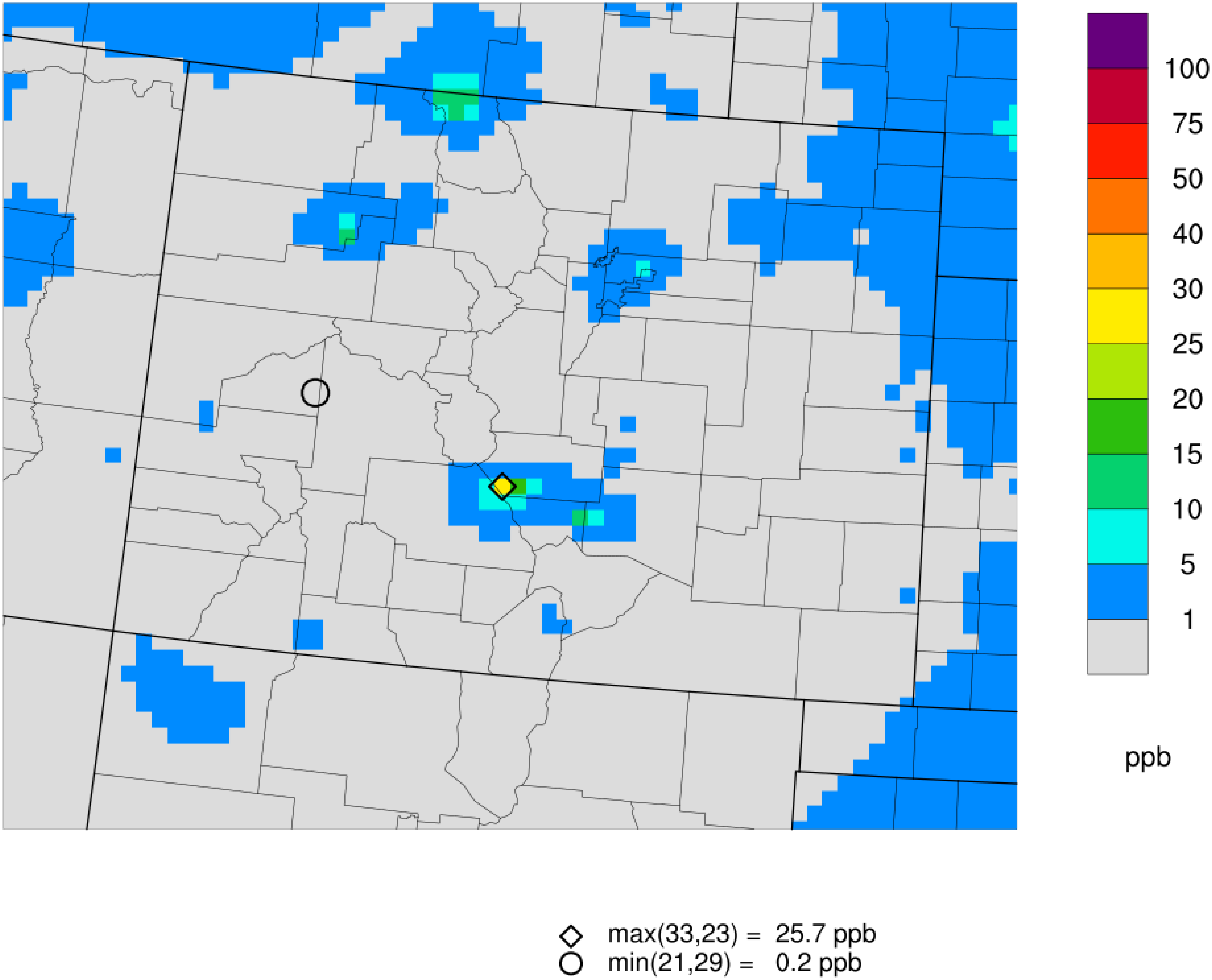
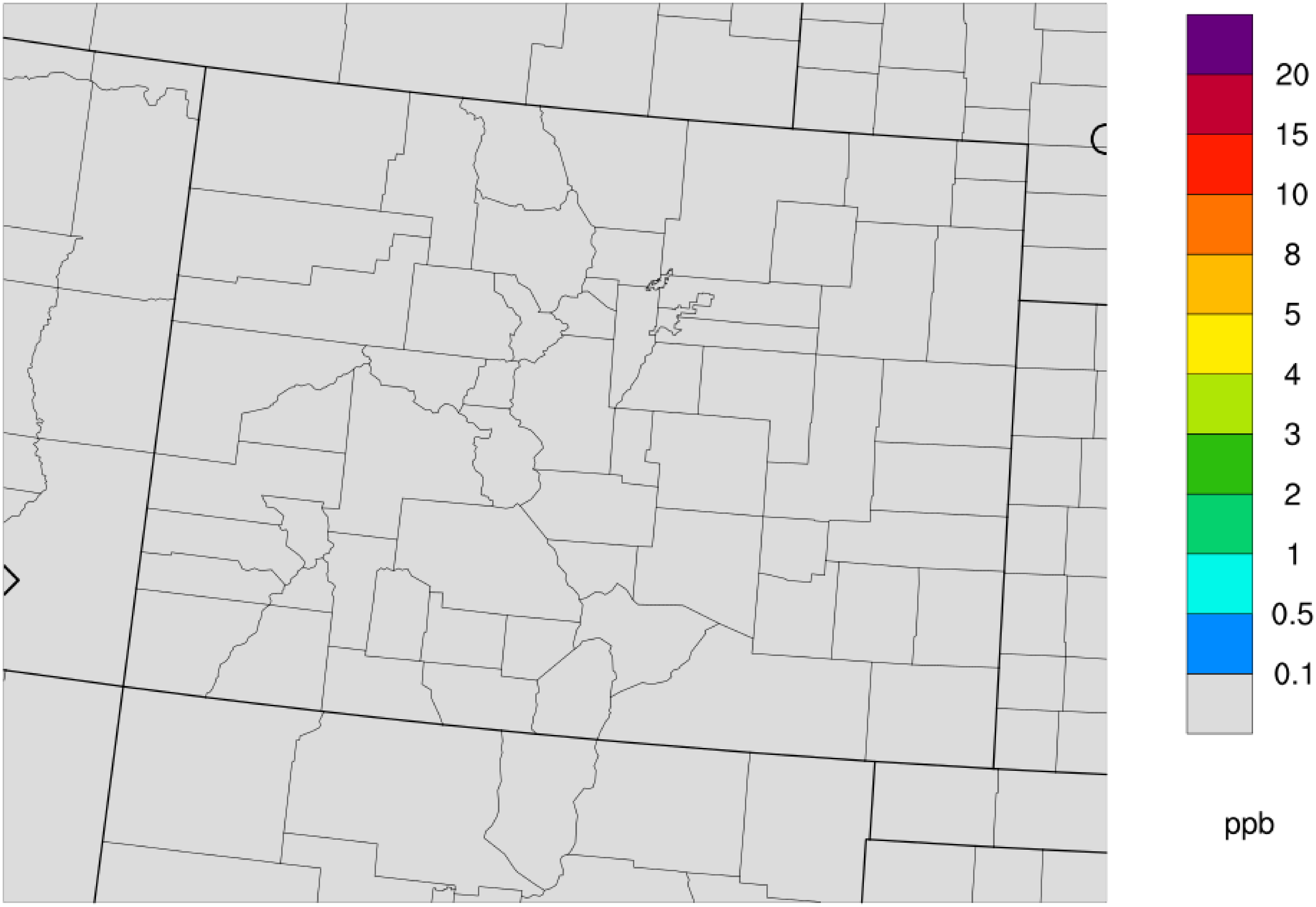


Figure CO.SO2.1hr.2
The 4th highest 1 hour daily max SO_2 concentration
Natural



◇ max(1,20) = 0.0 ppb
○ min(66,46) = 0.0 ppb

Figure CO.SO2.1hr.3
The 4th highest 1 hour daily max SO_2 concentration
Wildfire

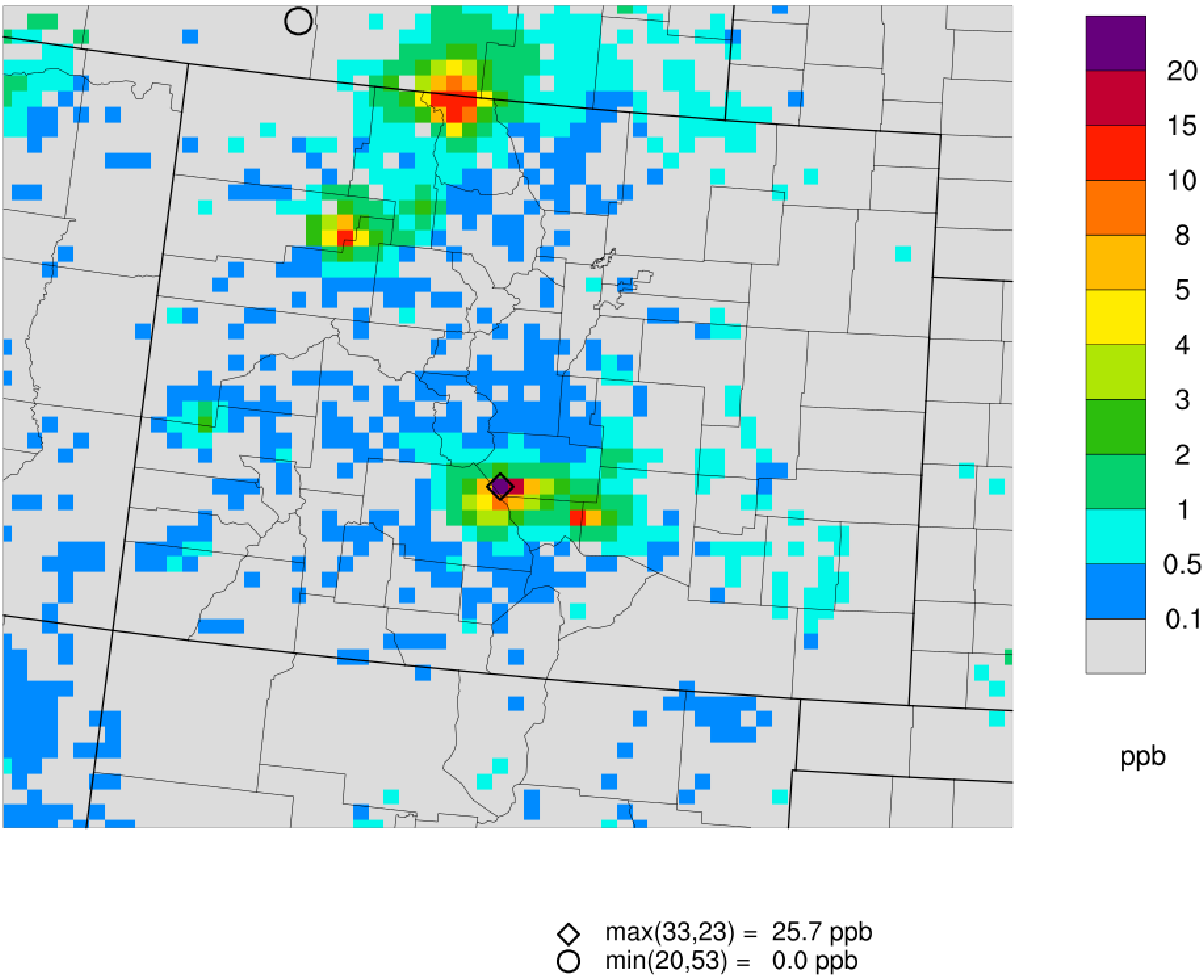
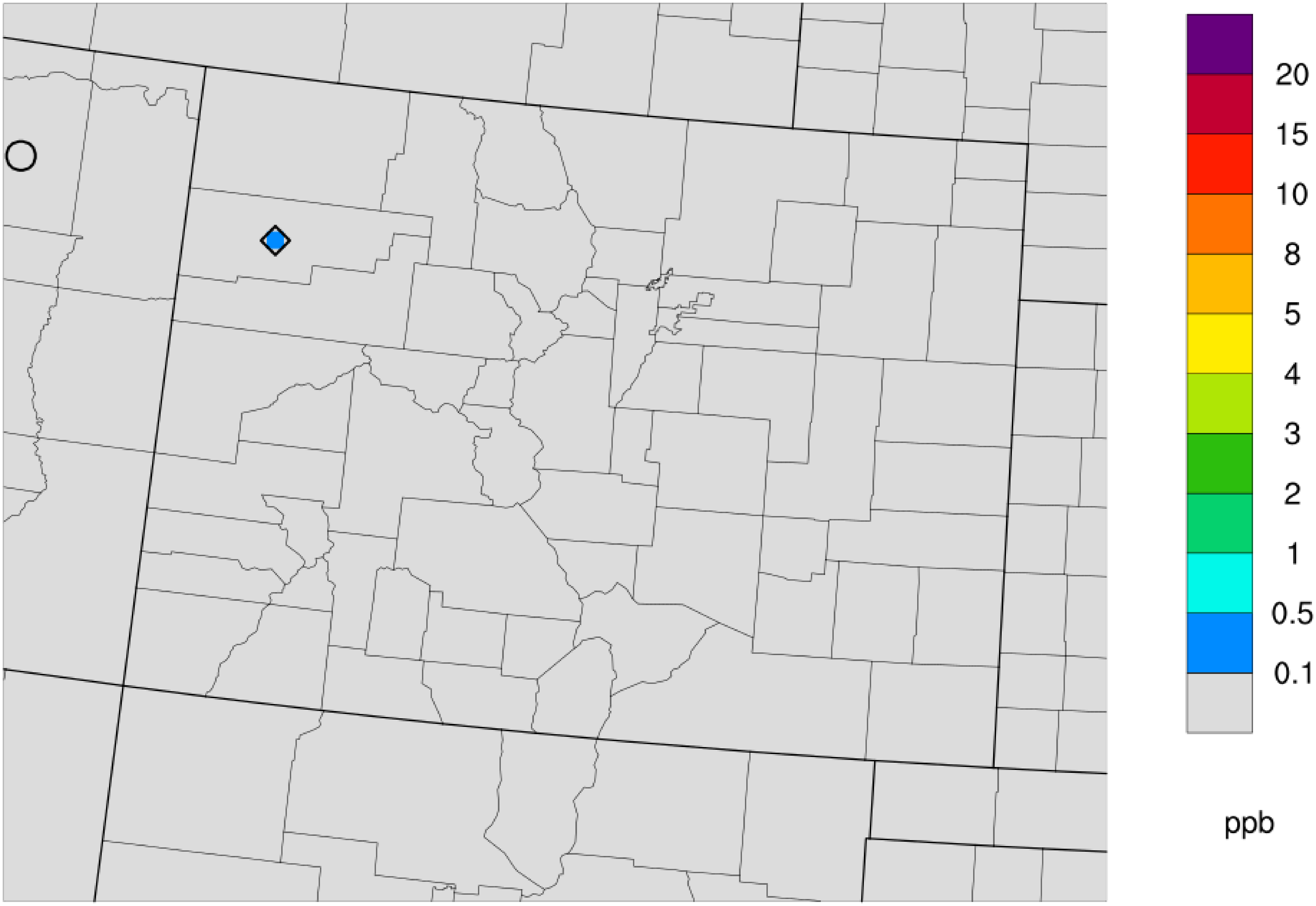
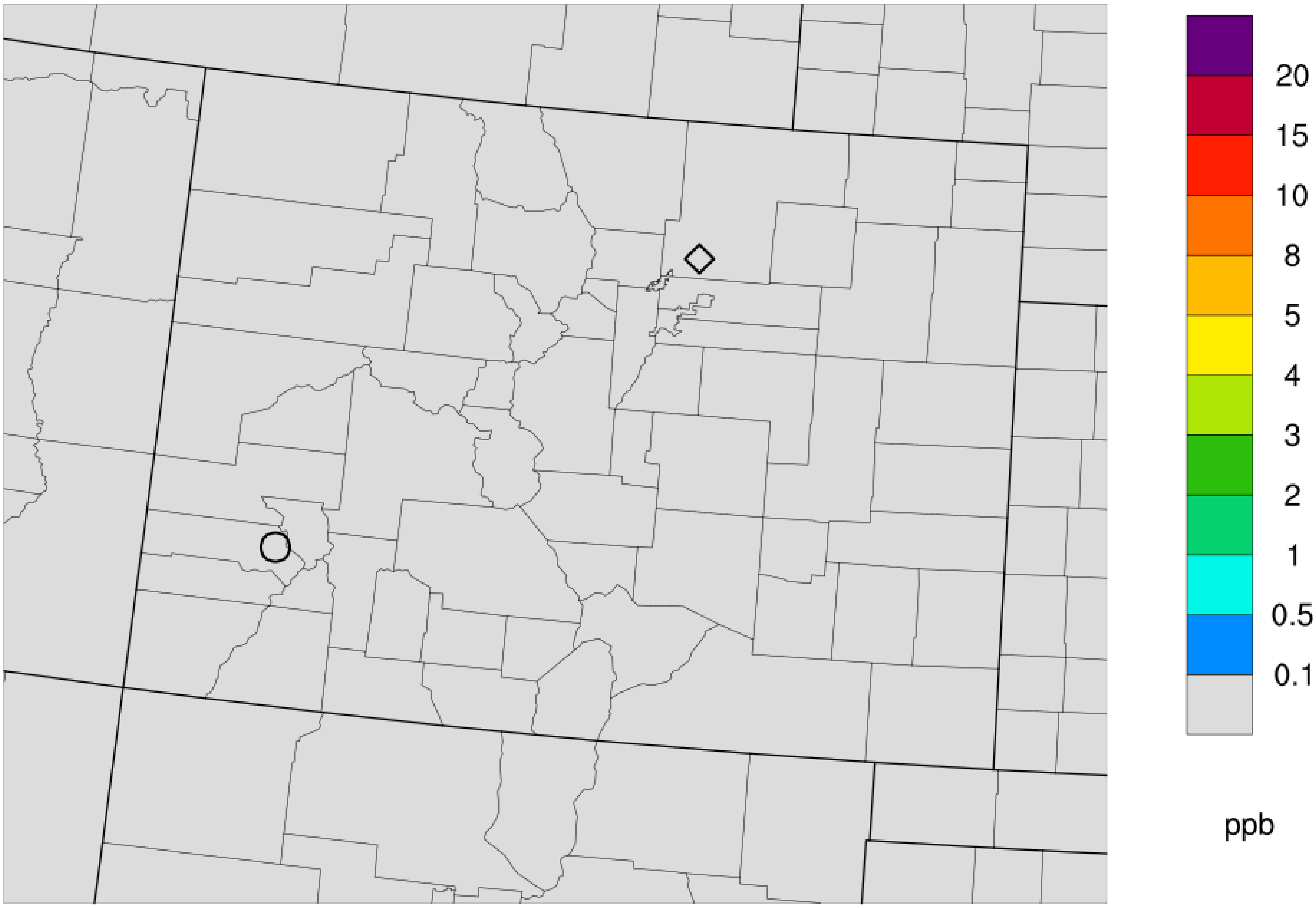


Figure CO.SO2.1hr.4
The 4th highest 1 hour daily max SO_2 concentration
OilGas_ExistFed_WesternCO



◇ max(17,40) = 0.1 ppb
○ min(2,45) = 0.0 ppb

Figure CO.SO2.1hr.5
The 4th highest 1 hour daily max SO_2 concentration
OilGas_ExistFed_RoyalGorge



◇ max(42,39) = 0.0 ppb
○ min(17,22) = 0.0 ppb

Figure CO.SO2.1hr.6
The 4th highest 1 hour daily max SO_2 concentration
OilGas_NewFed_WesternCO

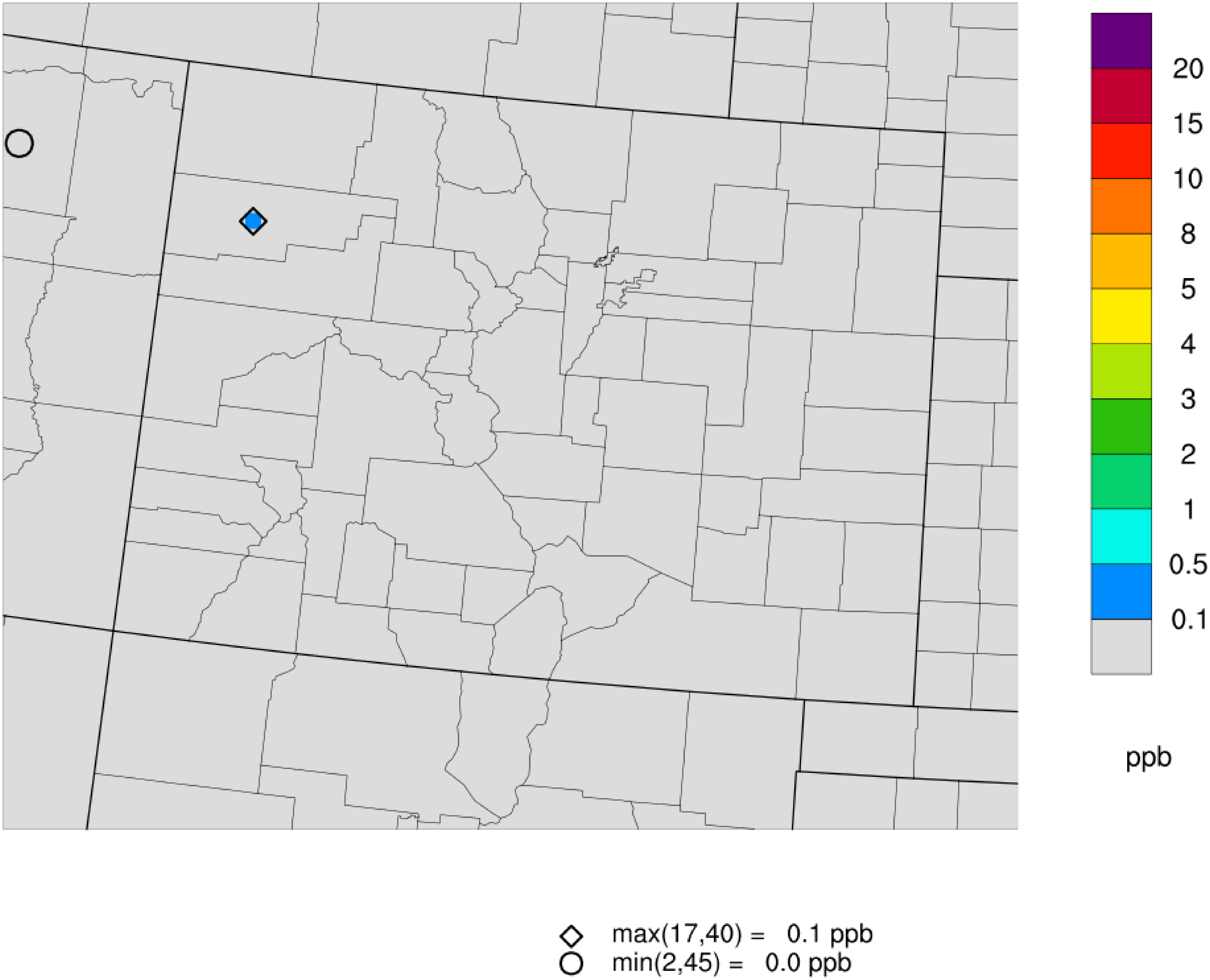


Figure CO.SO2.1hr.7
The 4th highest 1 hour daily max SO_2 concentration
OilGas_NewFed_RoyalGorge

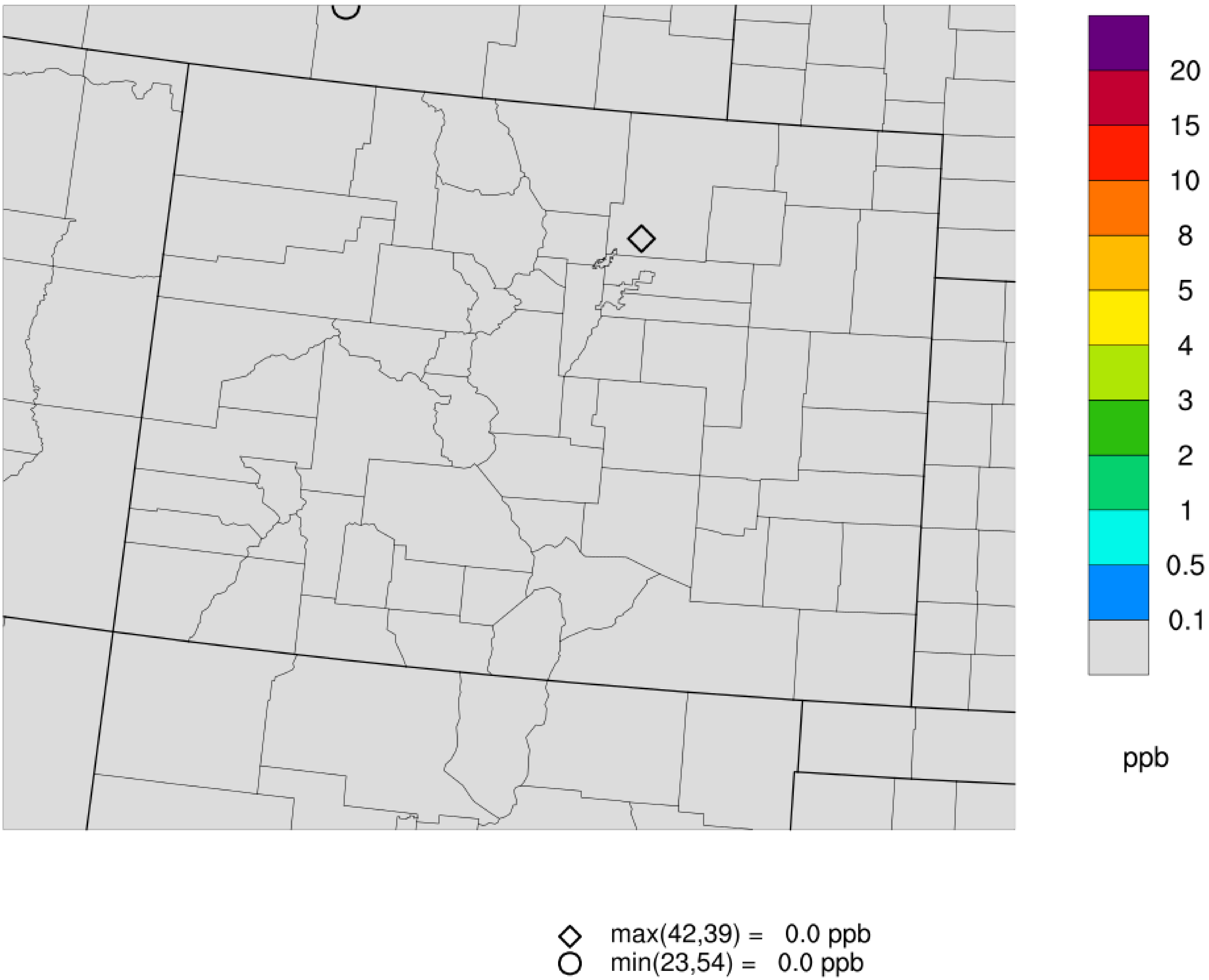


Figure CO.SO2.1hr.8
The 4th highest 1 hour daily max SO_2 concentration
OilGas_Fed_Other_States

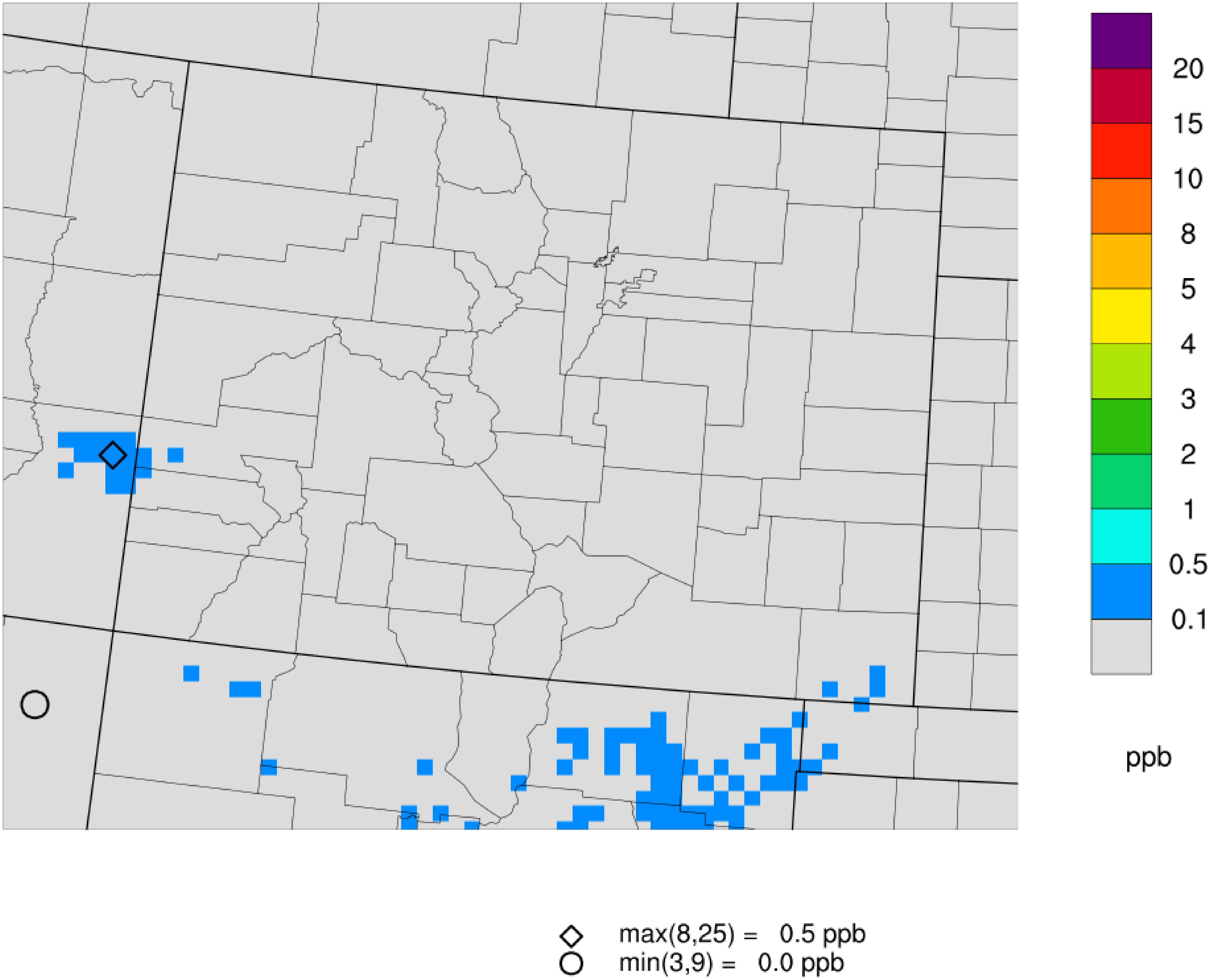


Figure CO.SO2.1hr.9
The 4th highest 1 hour daily max SO_2 concentration
OilGas_NonFed

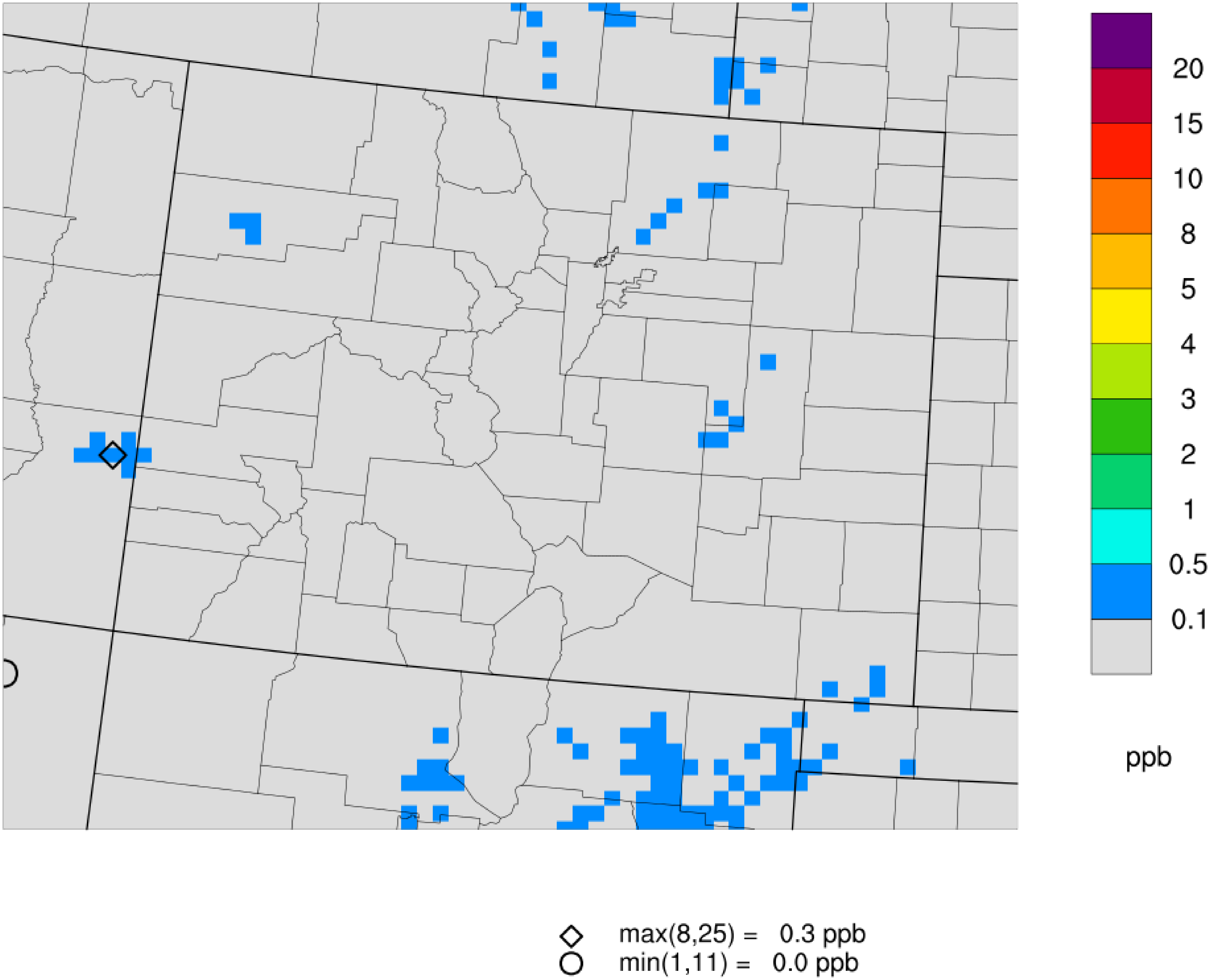


Figure CO.SO2.1hr.10
The 4th highest 1 hour daily max SO_2 concentration
OilGas_ExistTribal

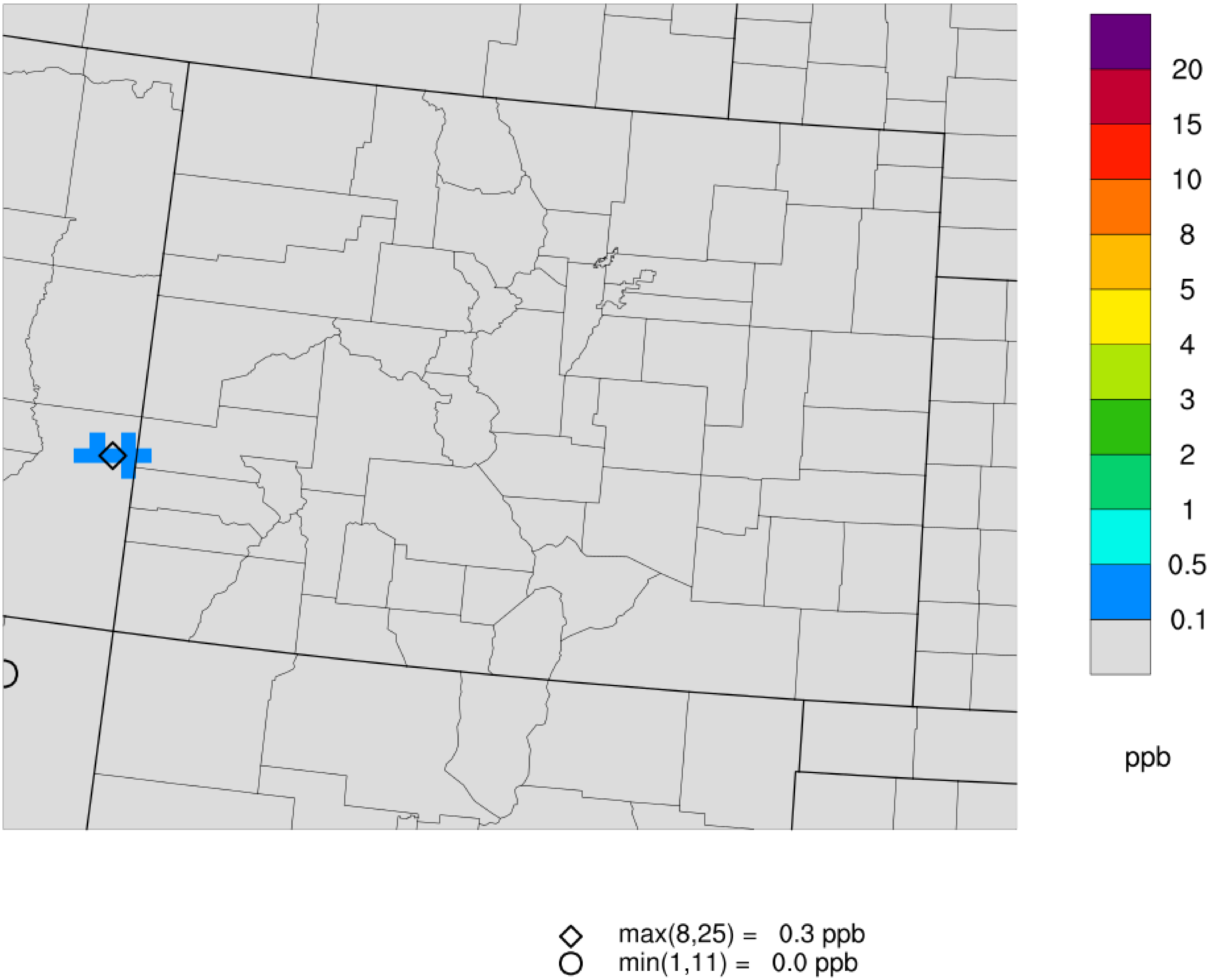


Figure CO.SO2.1hr.11
The 4th highest 1 hour daily max SO_2 concentration
OilGas_NewTribal

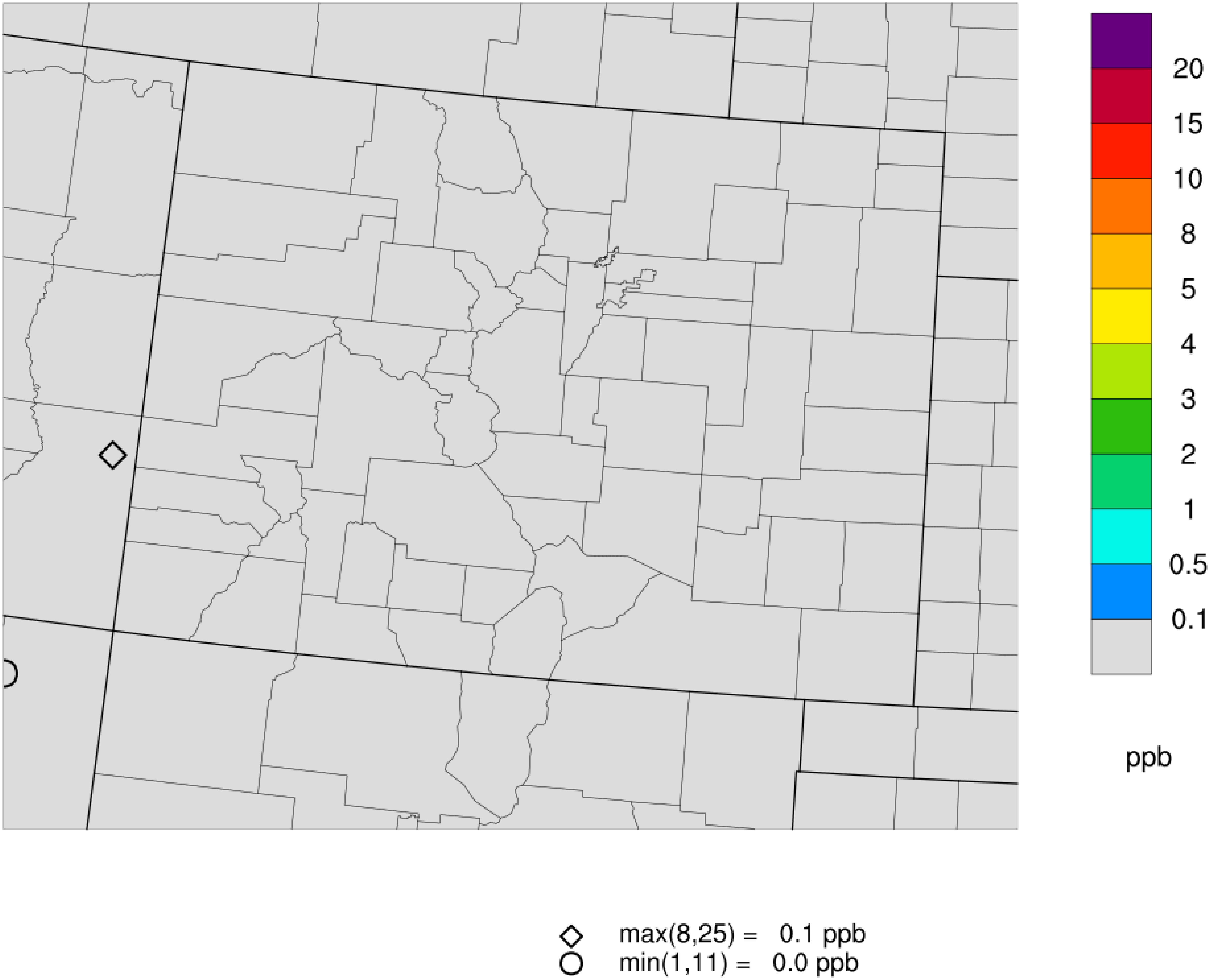


Figure CO.SO2.1hr.12
The 4th highest 1 hour daily max SO_2 concentration
Coal_Fed

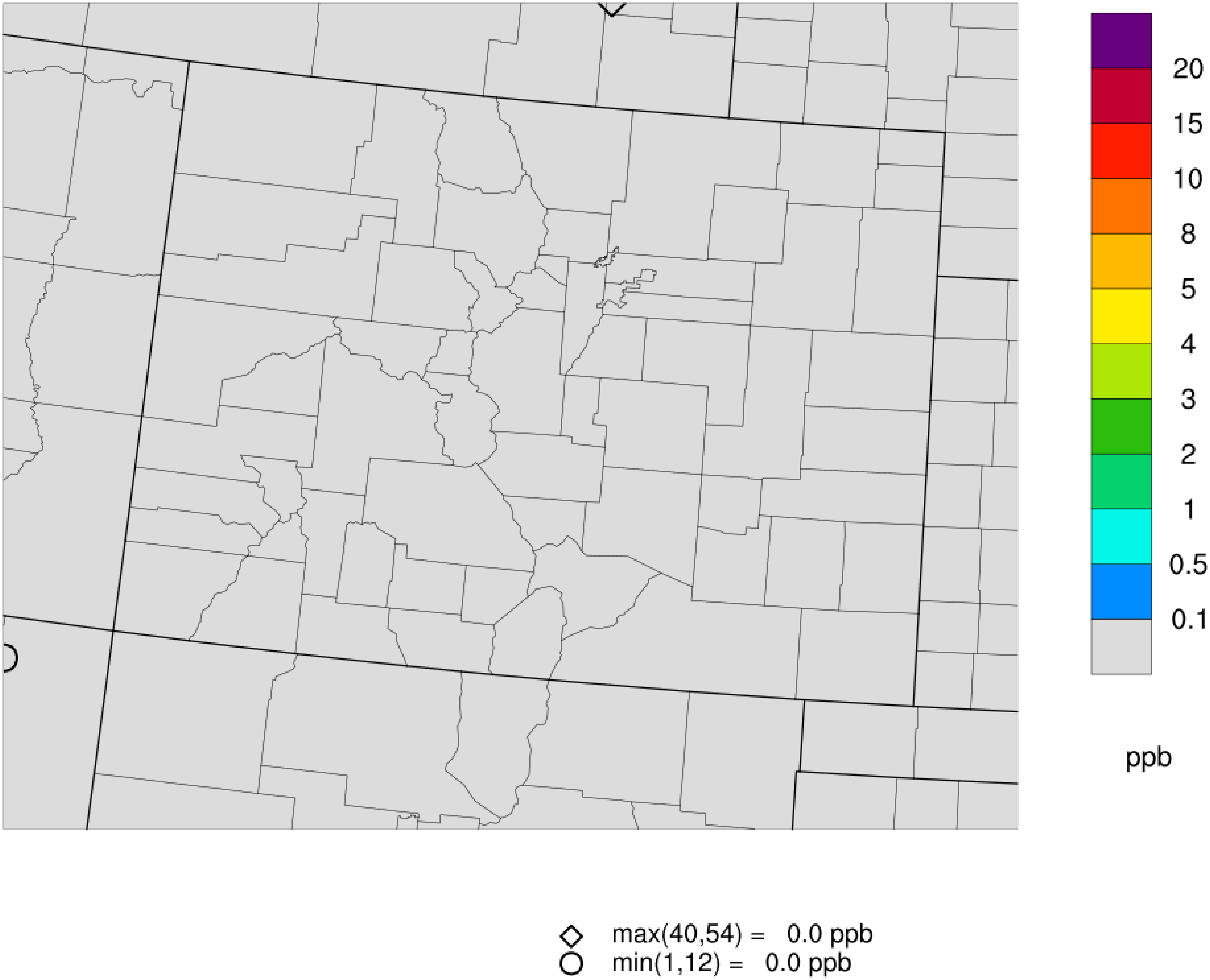


Figure CO.SO2.1hr.13
The 4th highest 1 hour daily max SO_2 concentration
Coal_NonFed

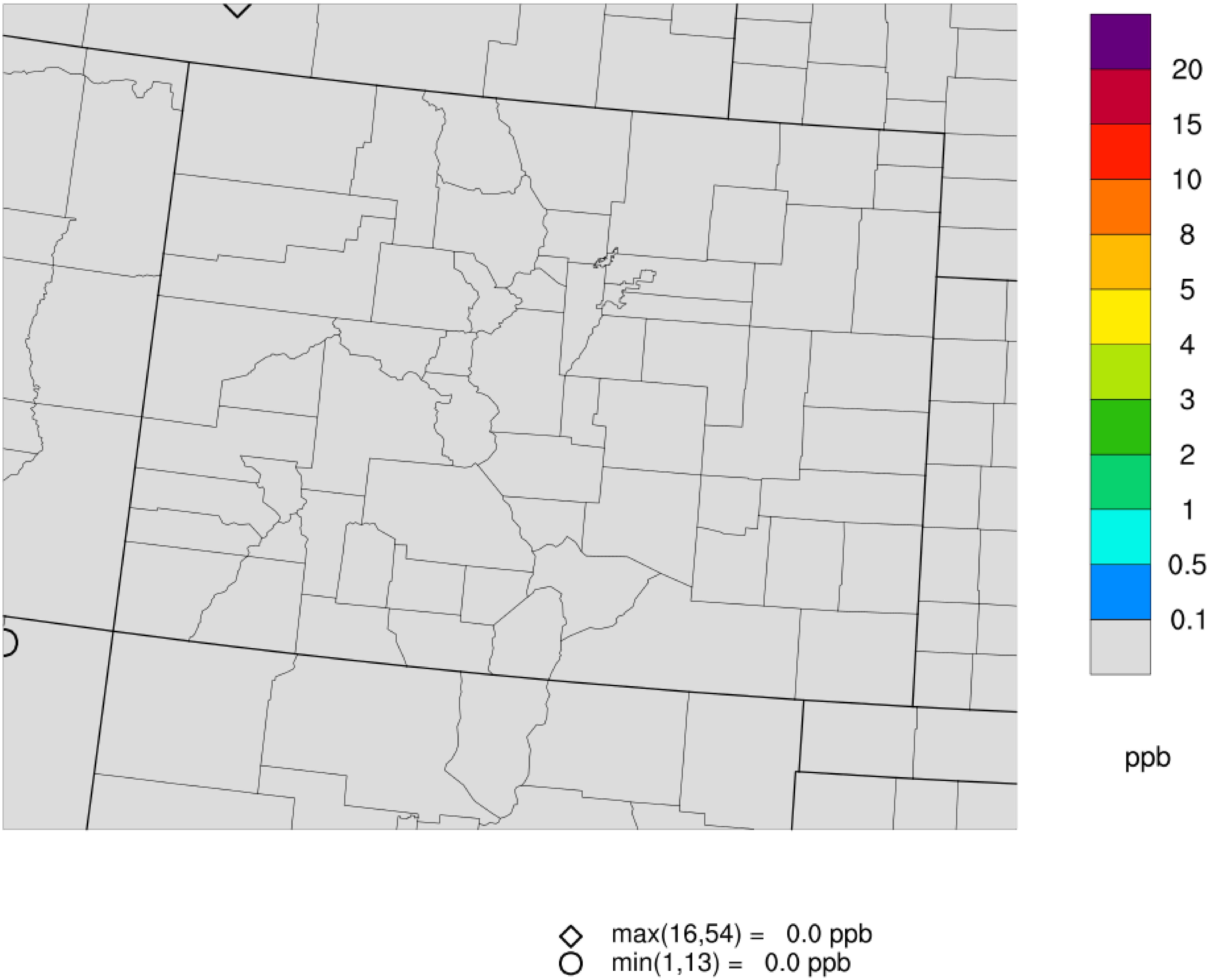
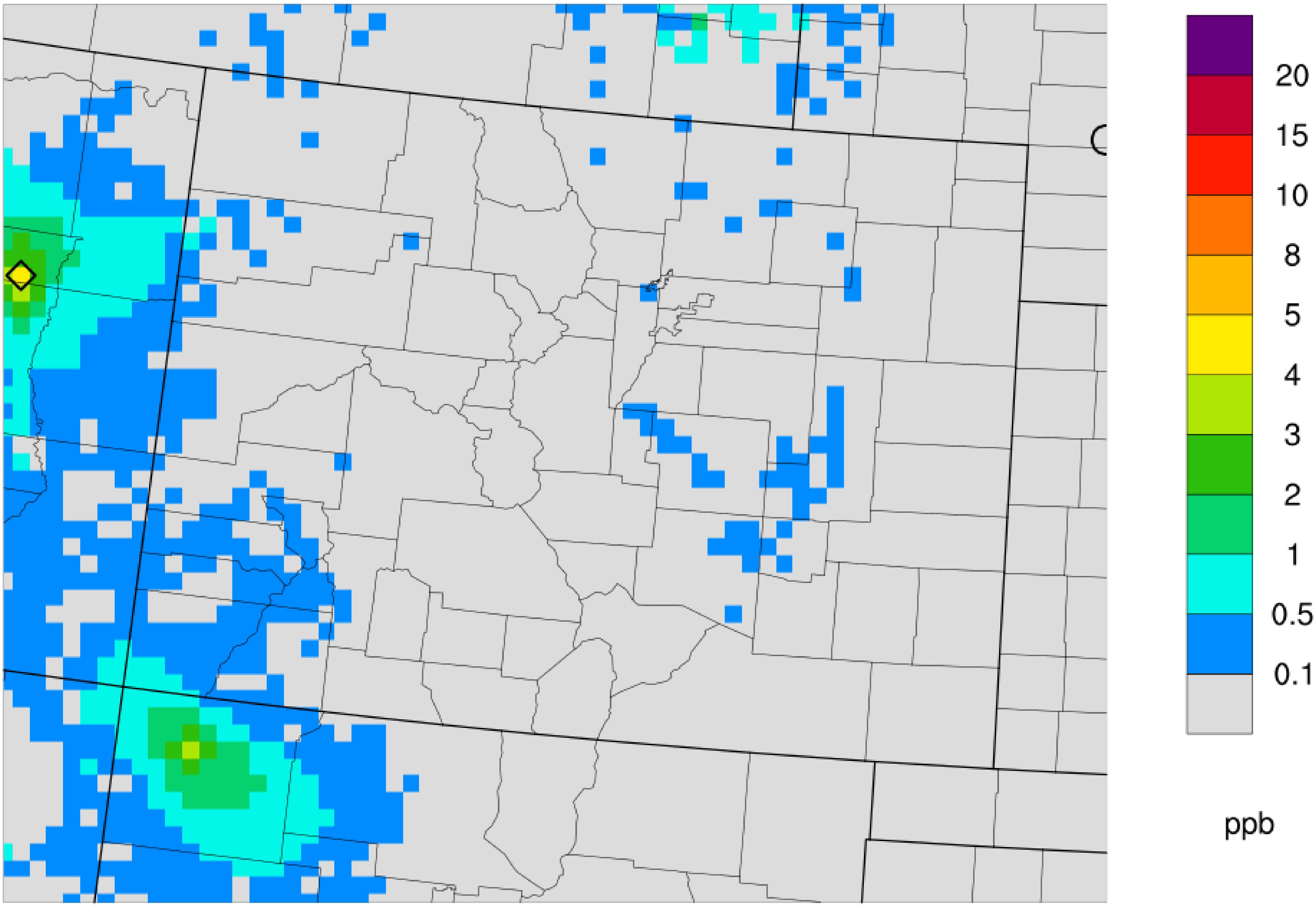
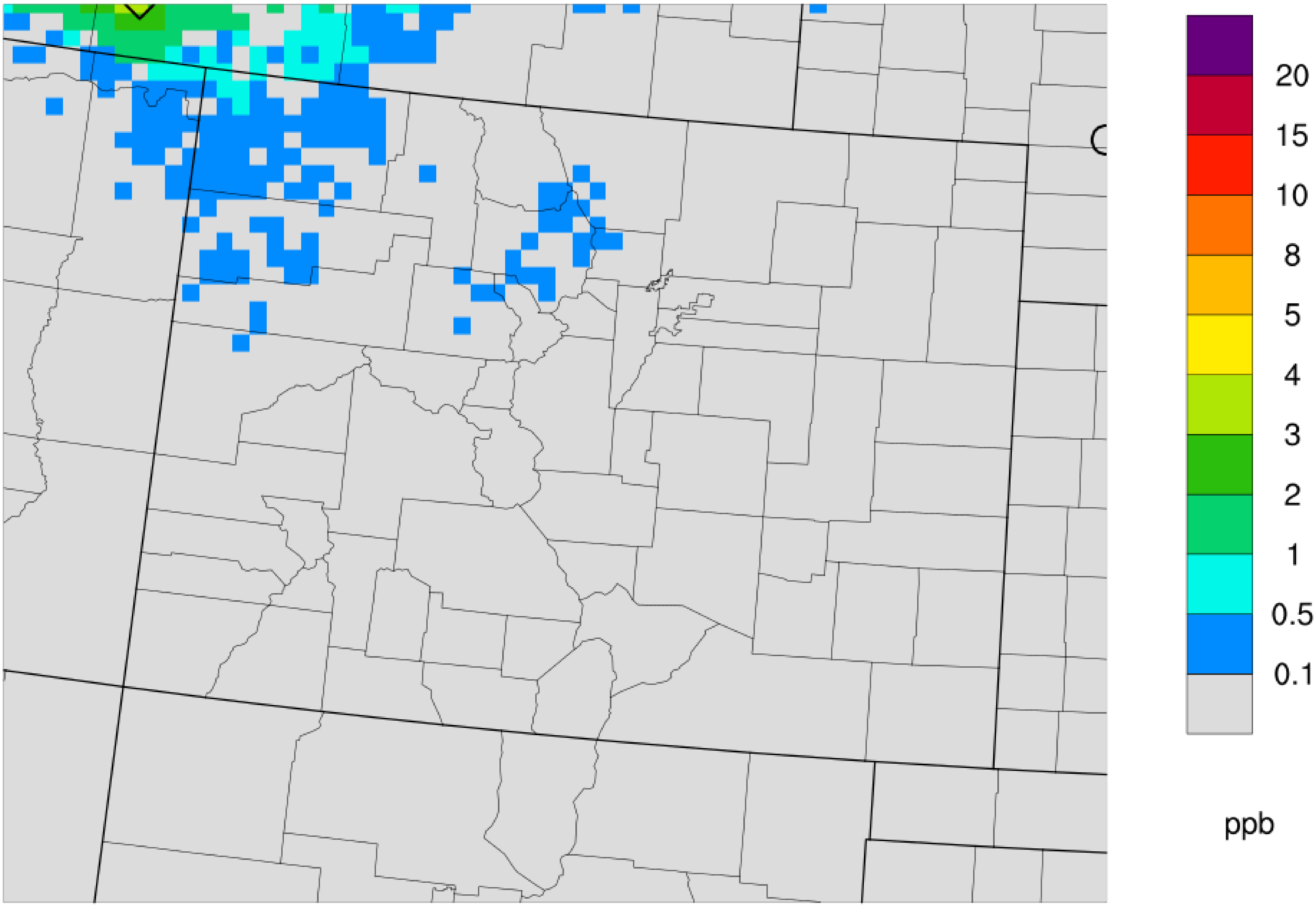


Figure CO.SO2.1hr.14
The 4th highest 1 hour daily max SO_2 concentration
Coal_EGU WRAP states



◇ max(2,38) = 4.0 ppb
○ min(66,46) = 0.0 ppb

Figure CO.SO2.1hr.15
The 4th highest 1 hour daily max SO_2 concentration
Coal_Comb WRAP states



◇ max(9,54) = 3.9 ppb
○ min(66,46) = 0.0 ppb

Figure CO.SO2.1hr.16
The 4th highest 1 hour daily max SO_2 concentration
OtherEGU

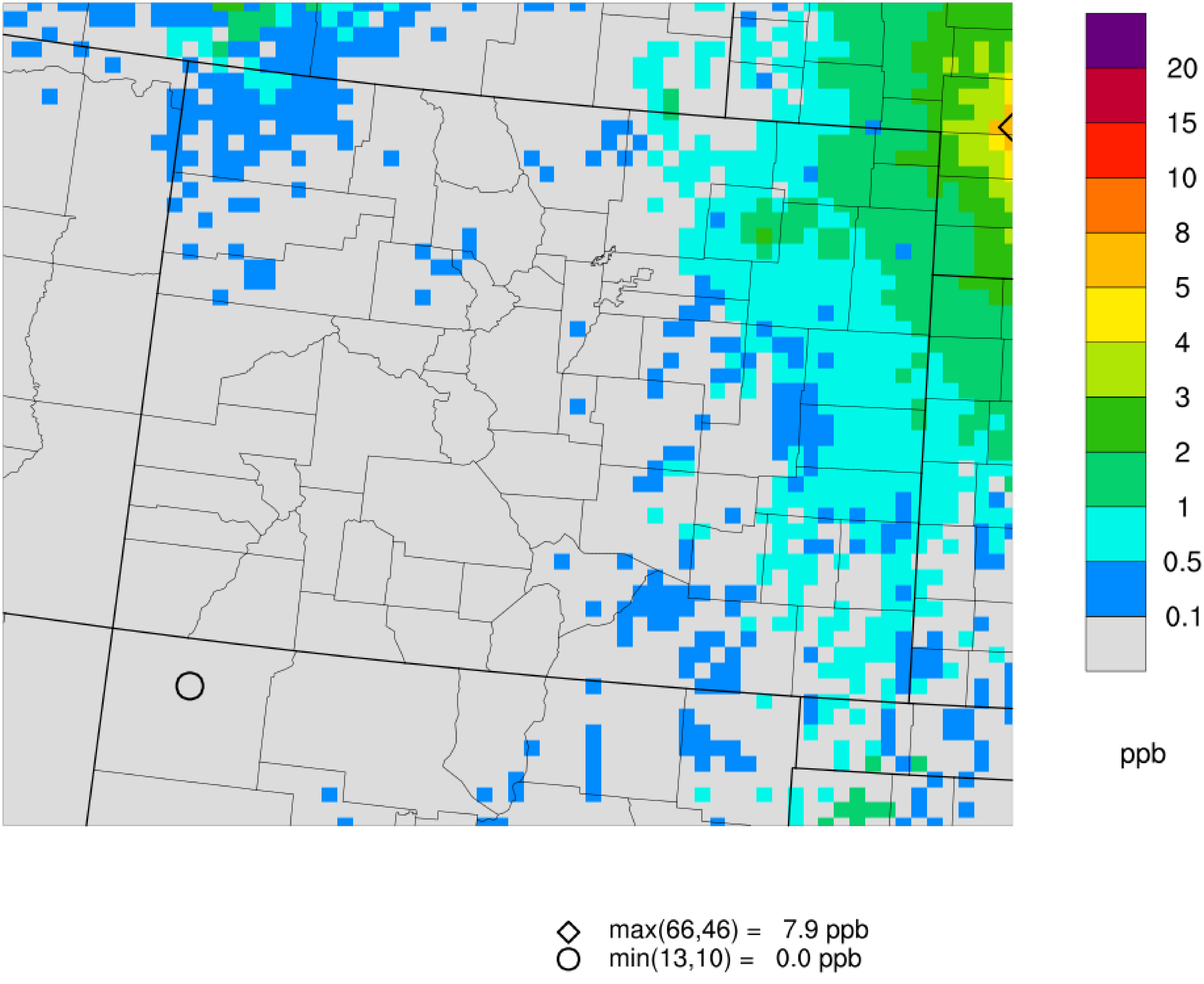


Figure CO.SO2.1hr.17
The 4th highest 1 hour daily max SO_2 concentration
Anthro_Rest

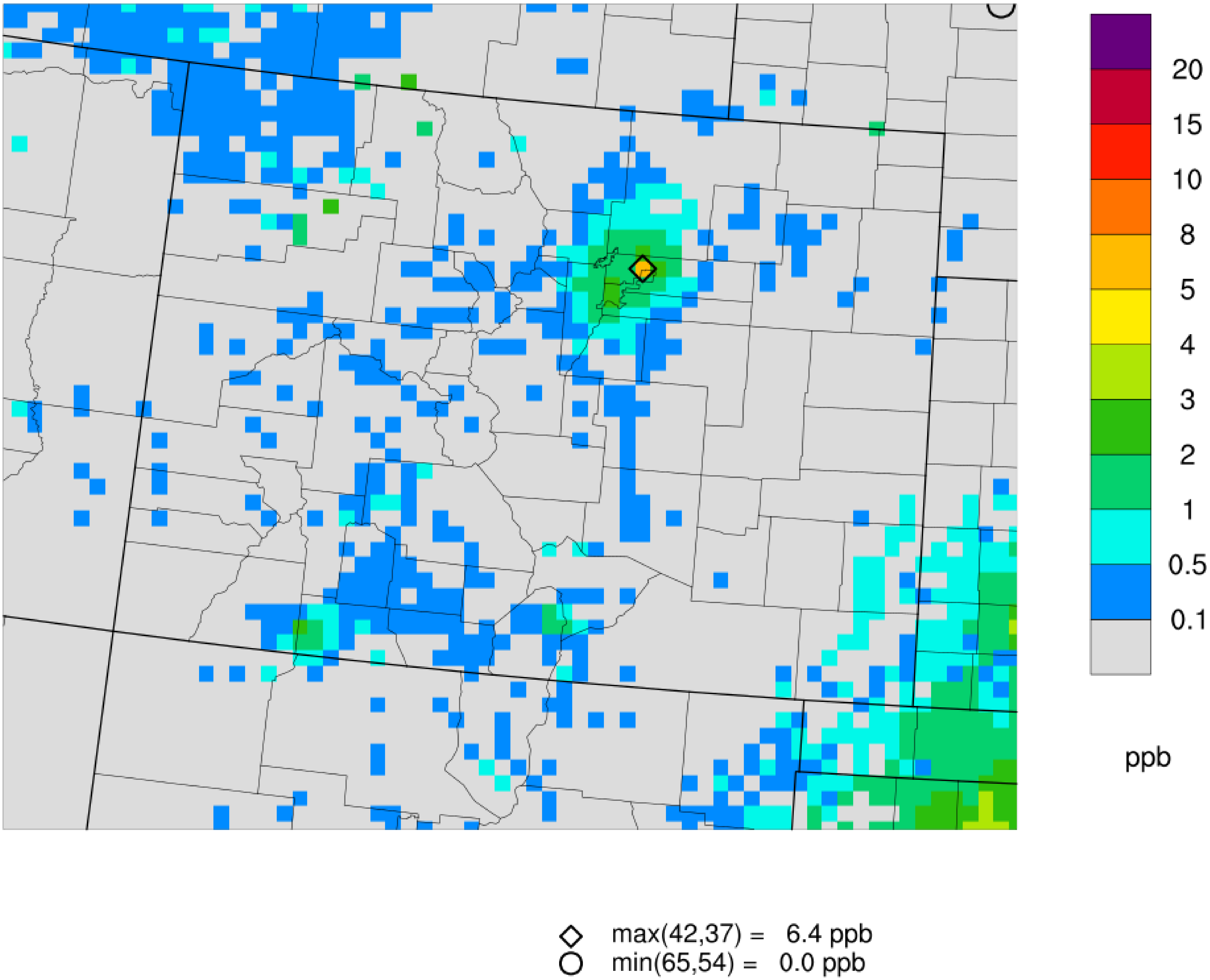


Figure CO.SO2.ann.1
Annual average SO_2 concentration
Cumulative

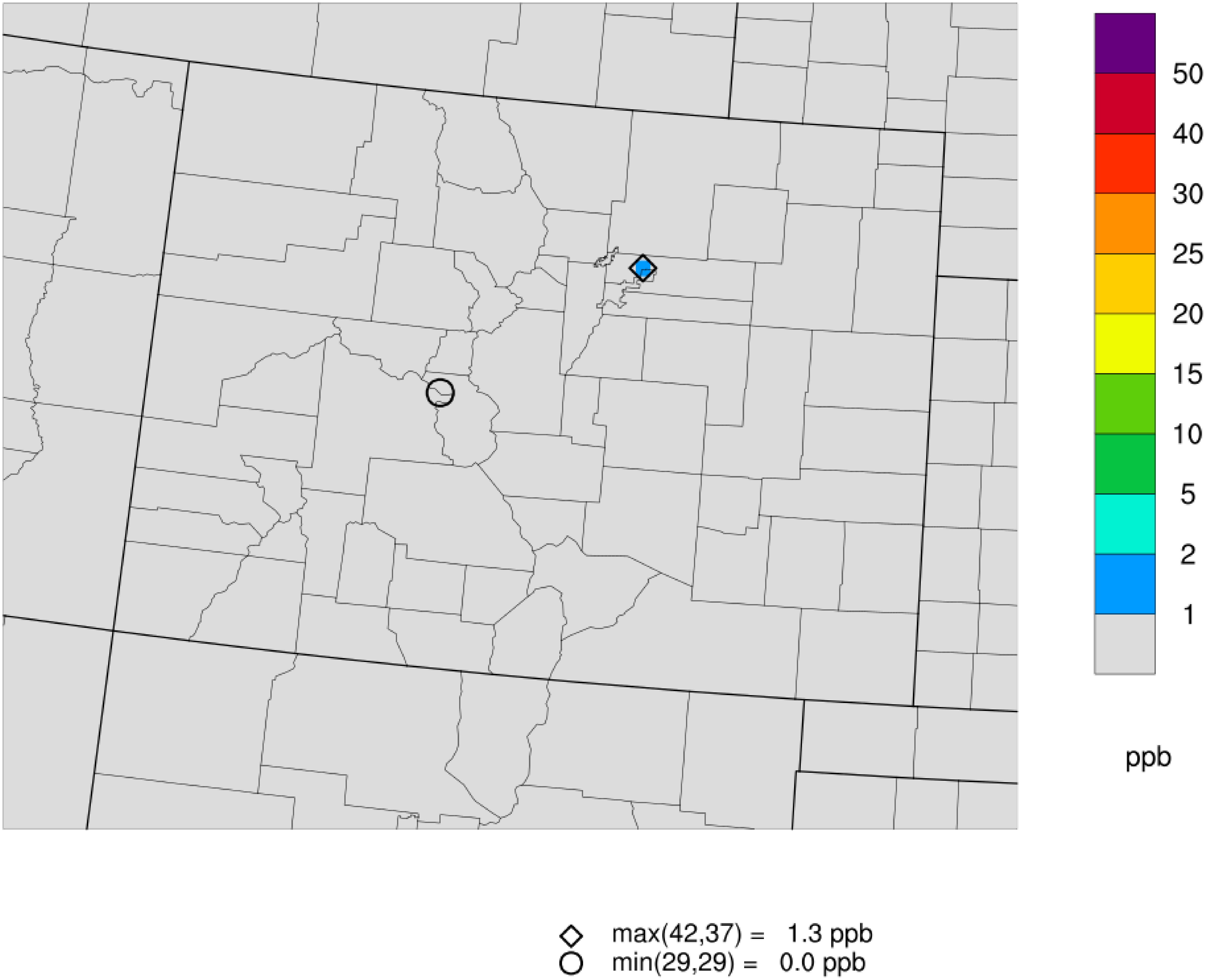


Figure CO.SO2.ann.2
Annual average SO_2 concentration
Natural

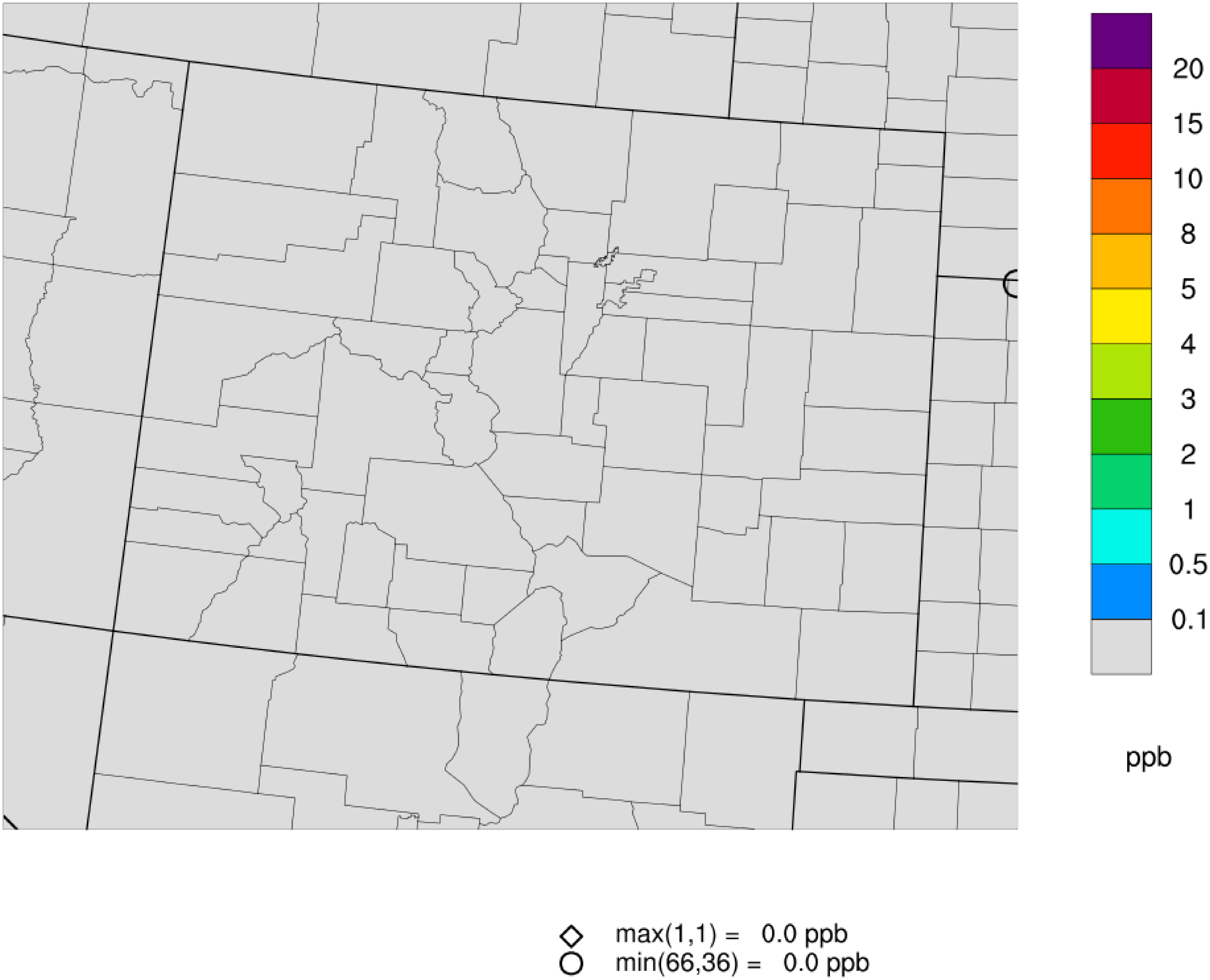


Figure CO.SO2.ann.3
Annual average SO_2 concentration
Wildfire

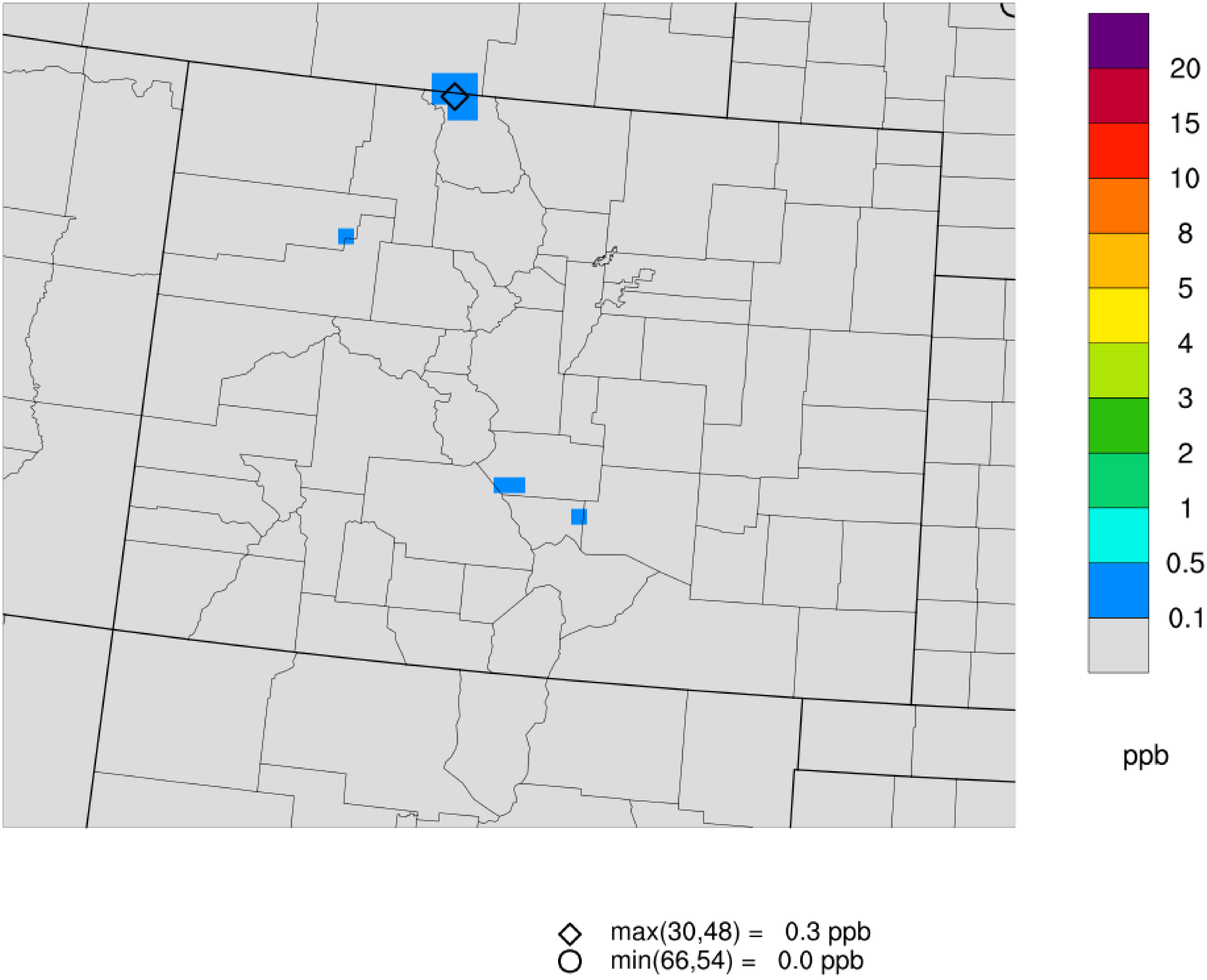


Figure CO.SO2.ann.4
Annual average SO_2 concentration
OilGas_ExistFed_WesternCO

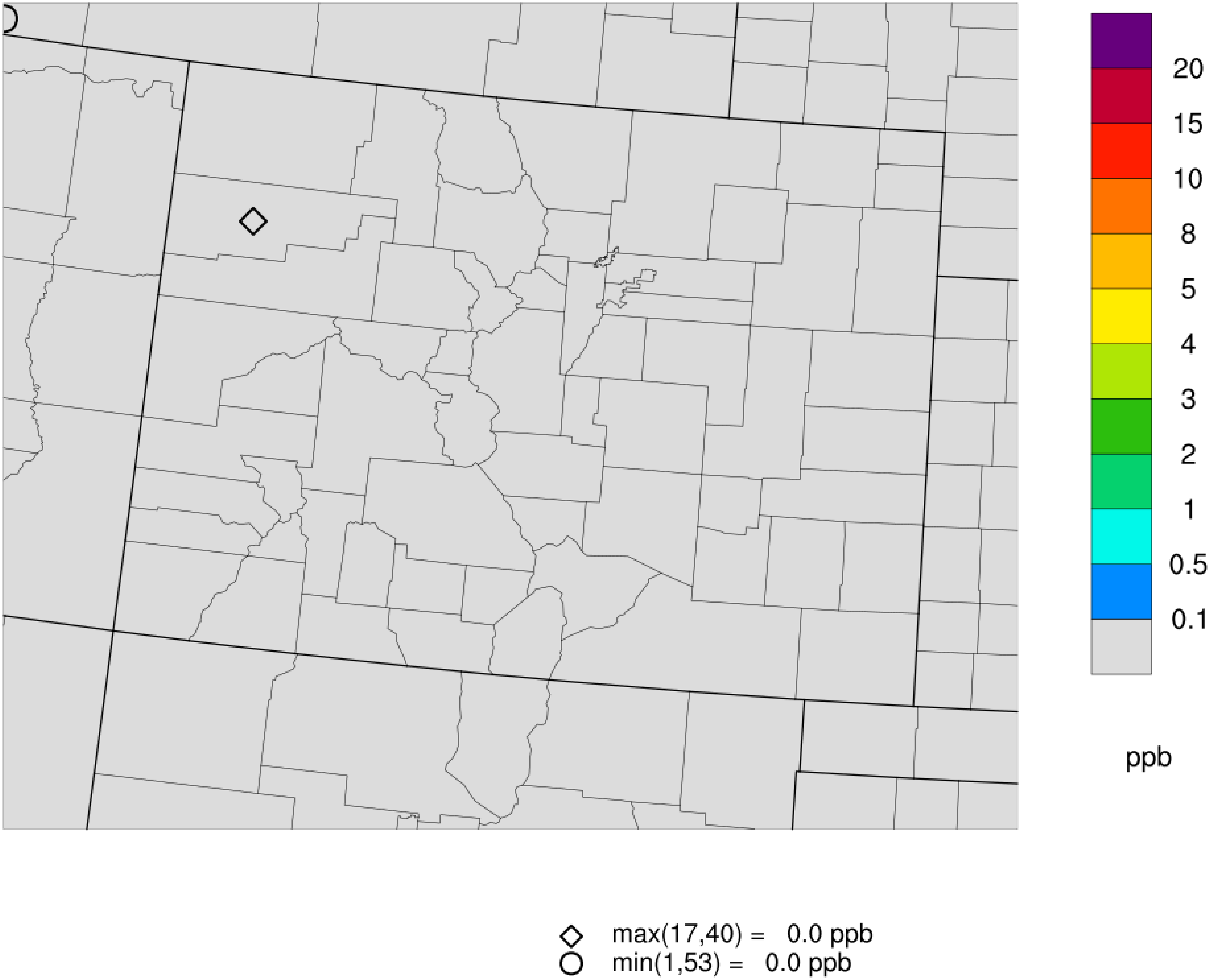
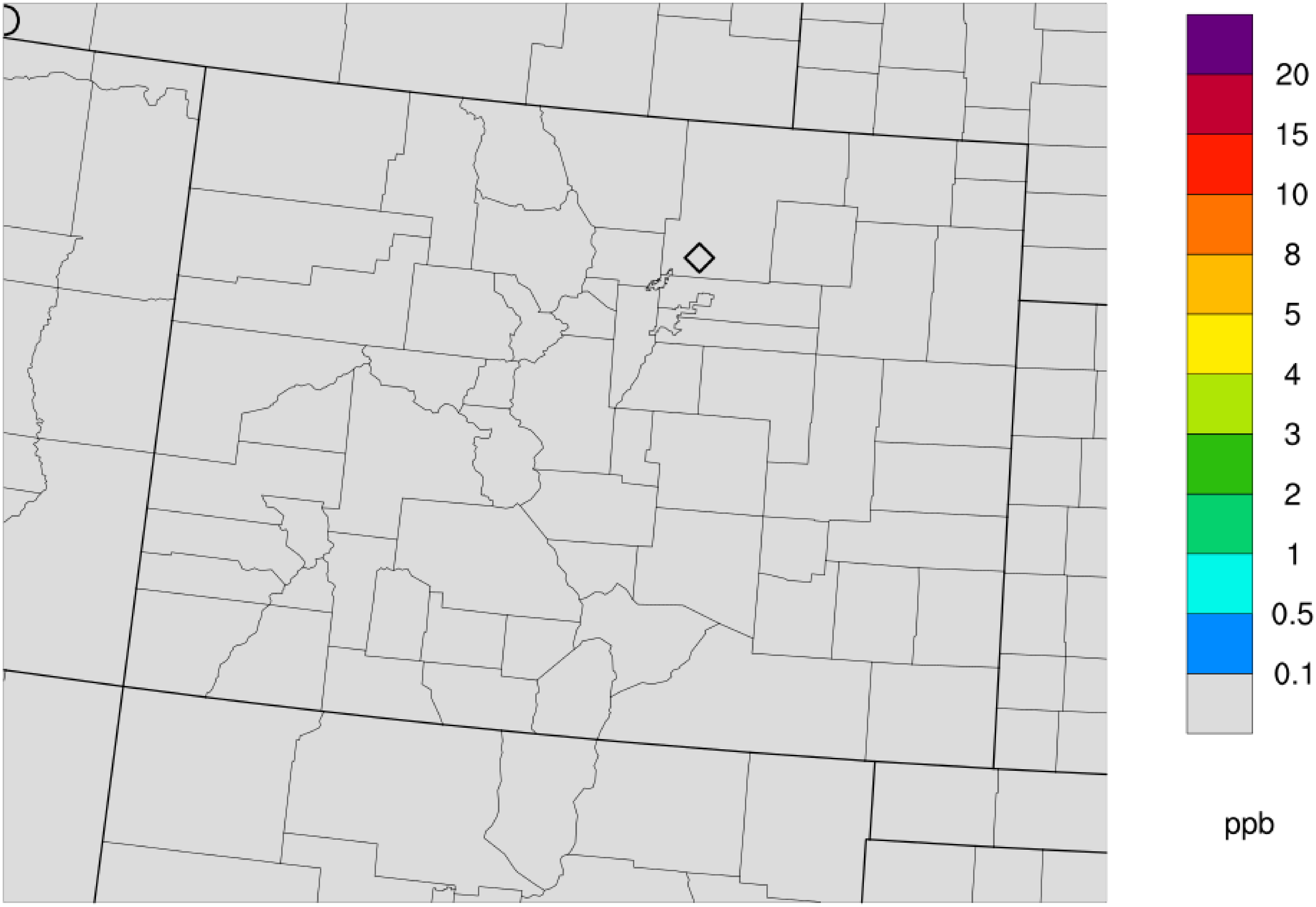


Figure CO.SO2.ann.5
Annual average SO_2 concentration
OilGas_ExistFed_RoyalGorge



◇ max(42,39) = 0.0 ppb
○ min(1,53) = 0.0 ppb

Figure CO.SO2.ann.6
Annual average SO_2 concentration
OilGas_NewFed_WesternCO

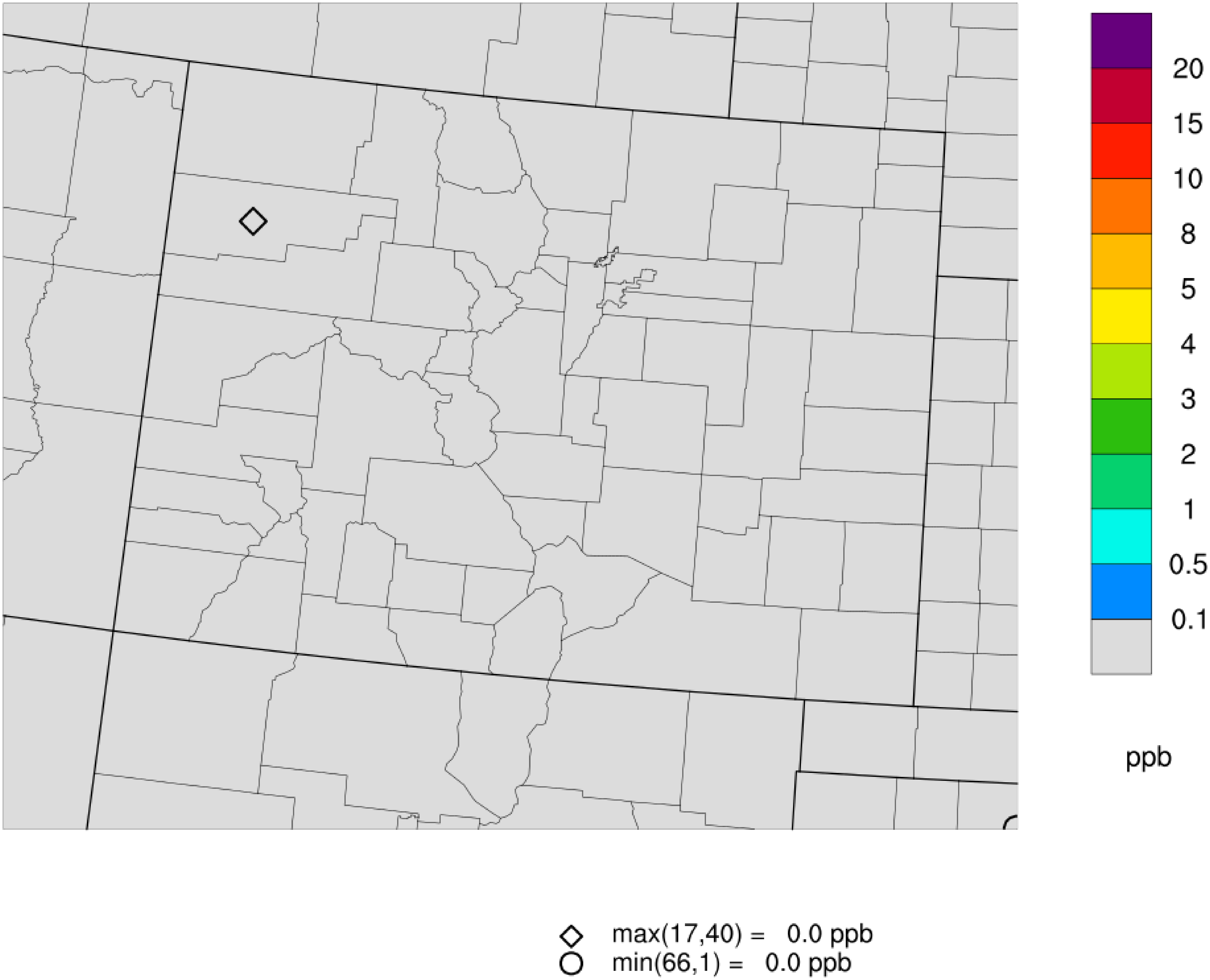
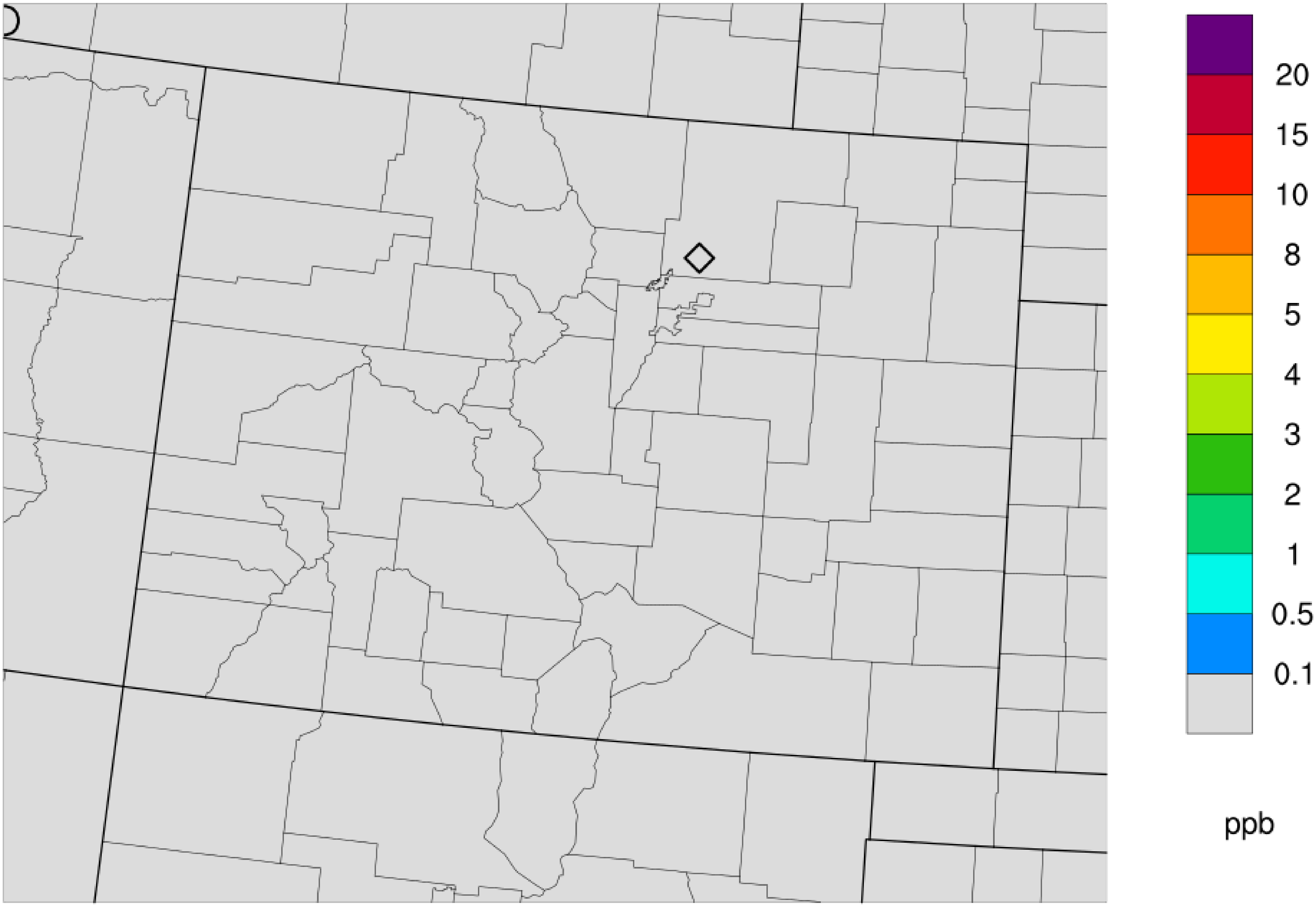


Figure CO.SO2.ann.7
Annual average SO_2 concentration
OilGas_NewFed_RoyalGorge



max(42,39) = 0.0 ppb
min(1,53) = 0.0 ppb

Figure CO.SO2.ann.8
Annual average SO_2 concentration
OilGas_Fed_Other_States

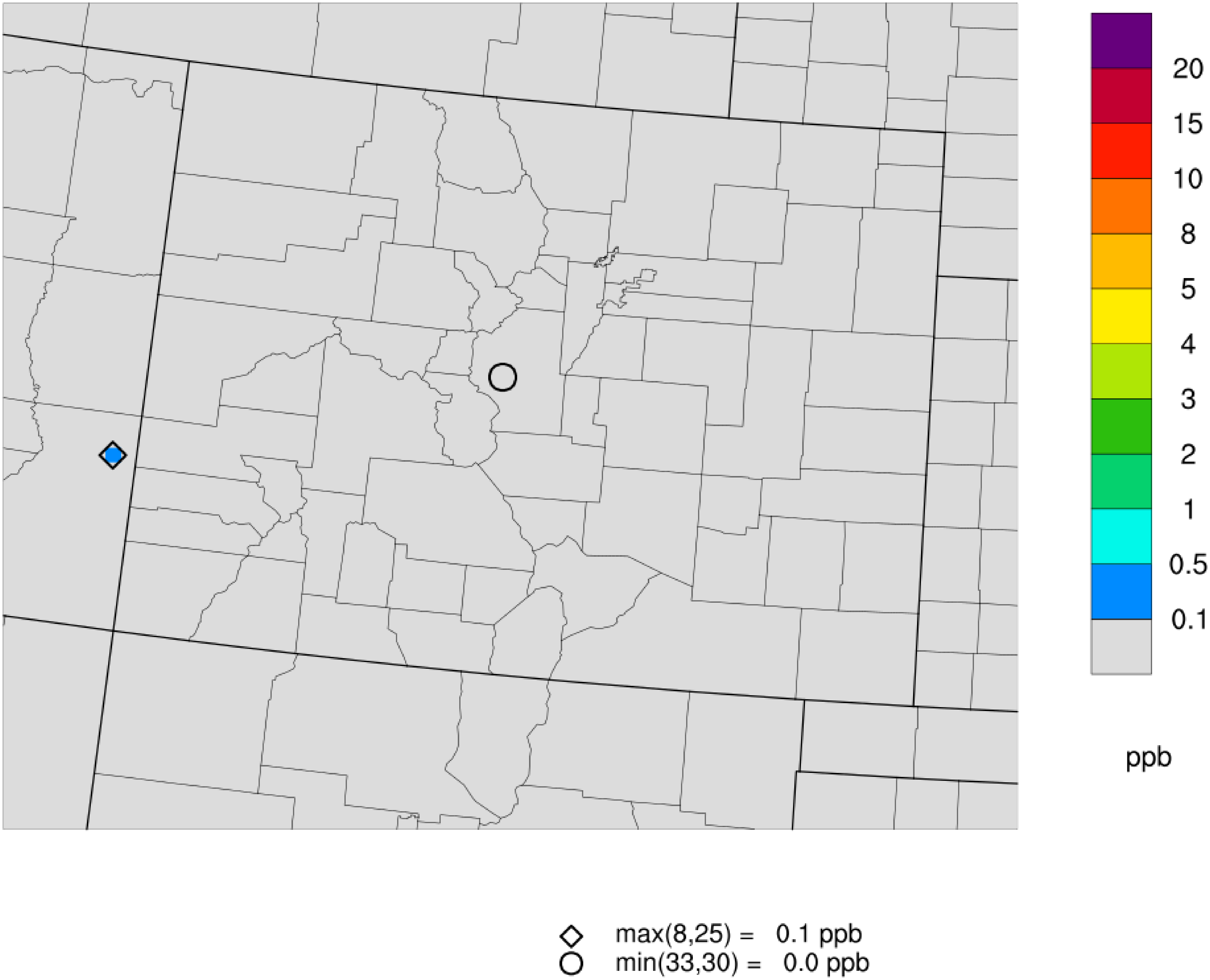
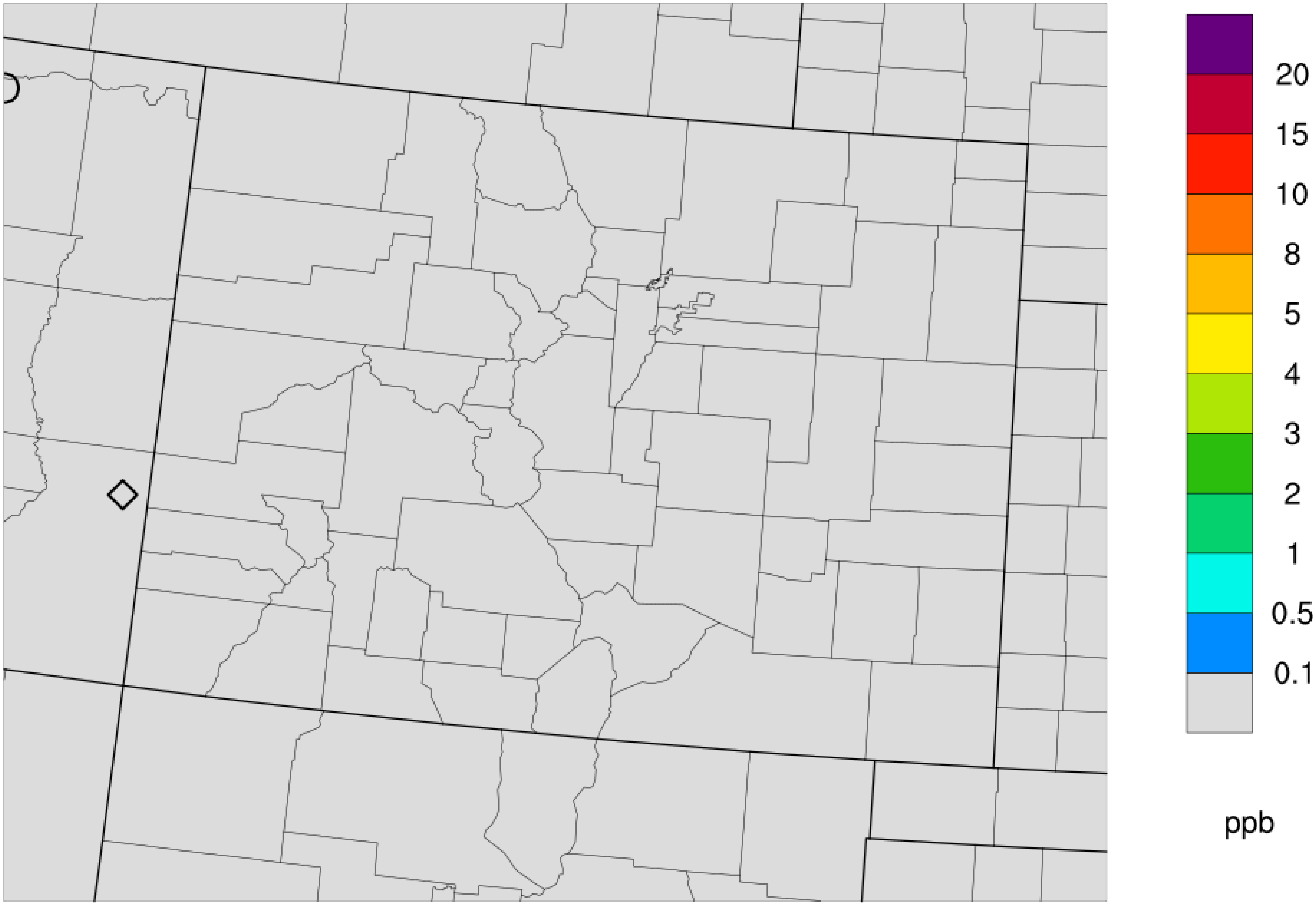
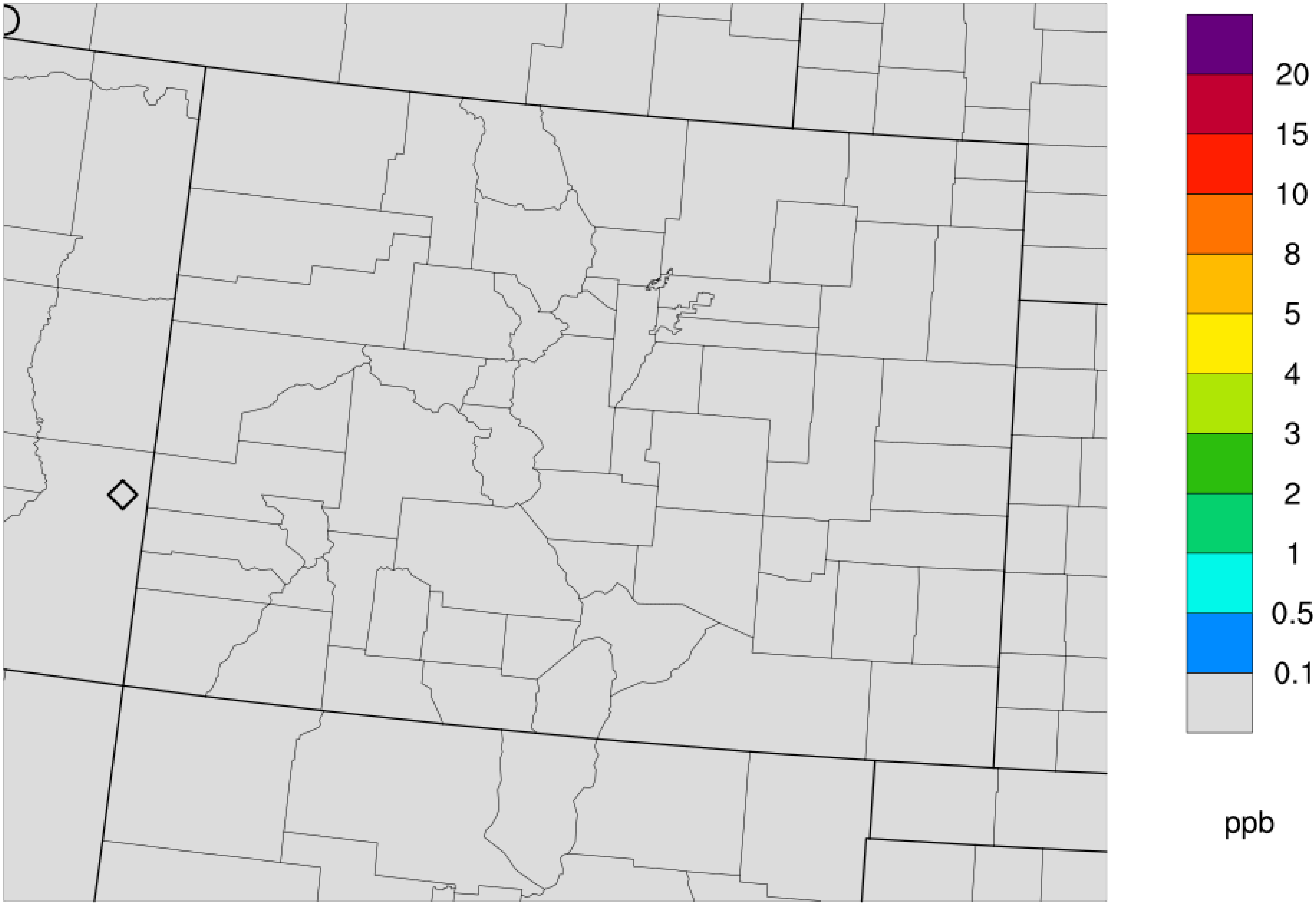


Figure CO.SO2.ann.9
Annual average SO_2 concentration
OilGas_NonFed



max(8,25) = 0.1 ppb
min(1,49) = 0.0 ppb

Figure CO.SO2.ann.10
Annual average SO_2 concentration
OilGas_ExistTribal



max(8,25) = 0.1 ppb
min(1,53) = 0.0 ppb

Figure CO.SO2.ann.11
Annual average SO_2 concentration
OilGas_NewTribal

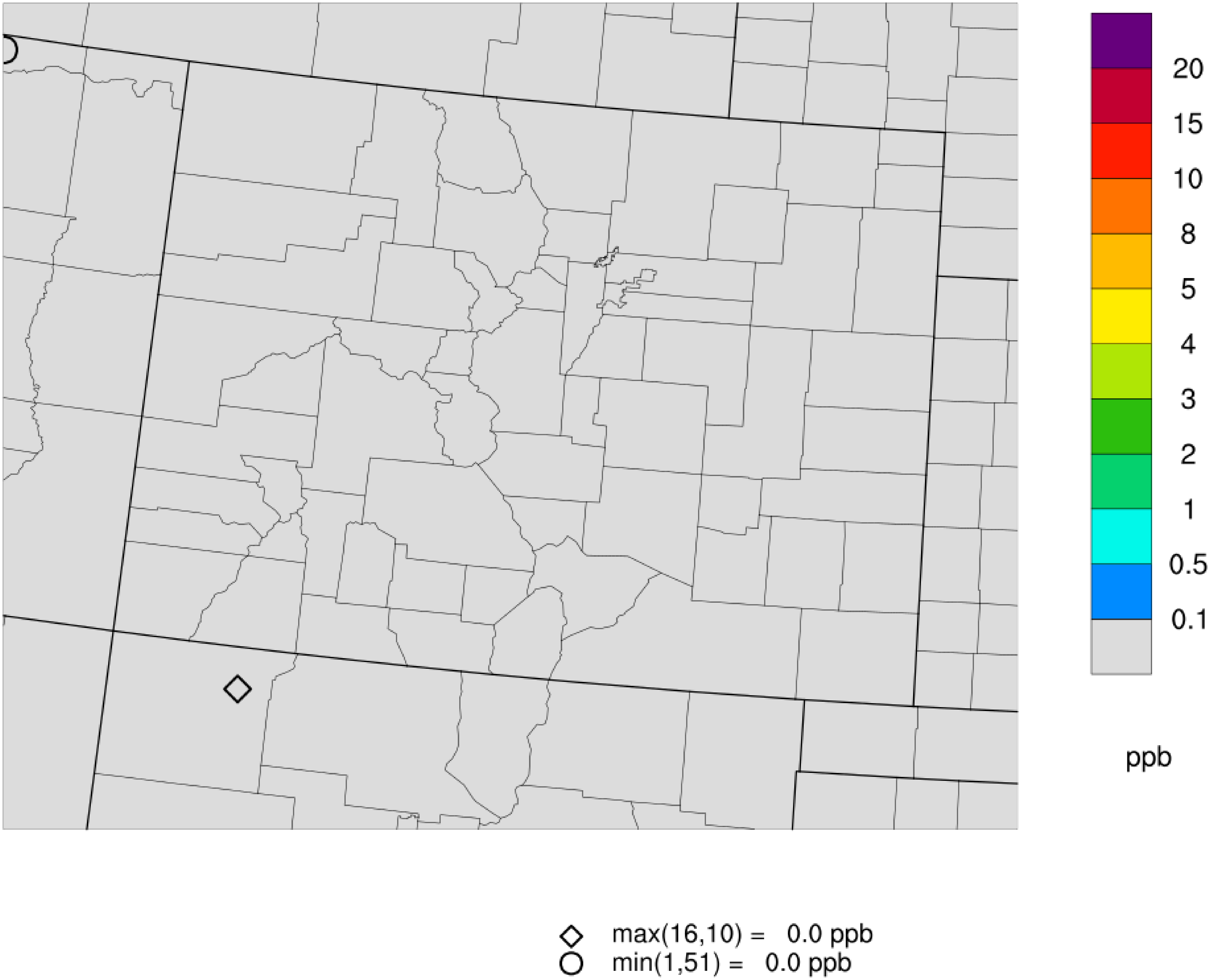
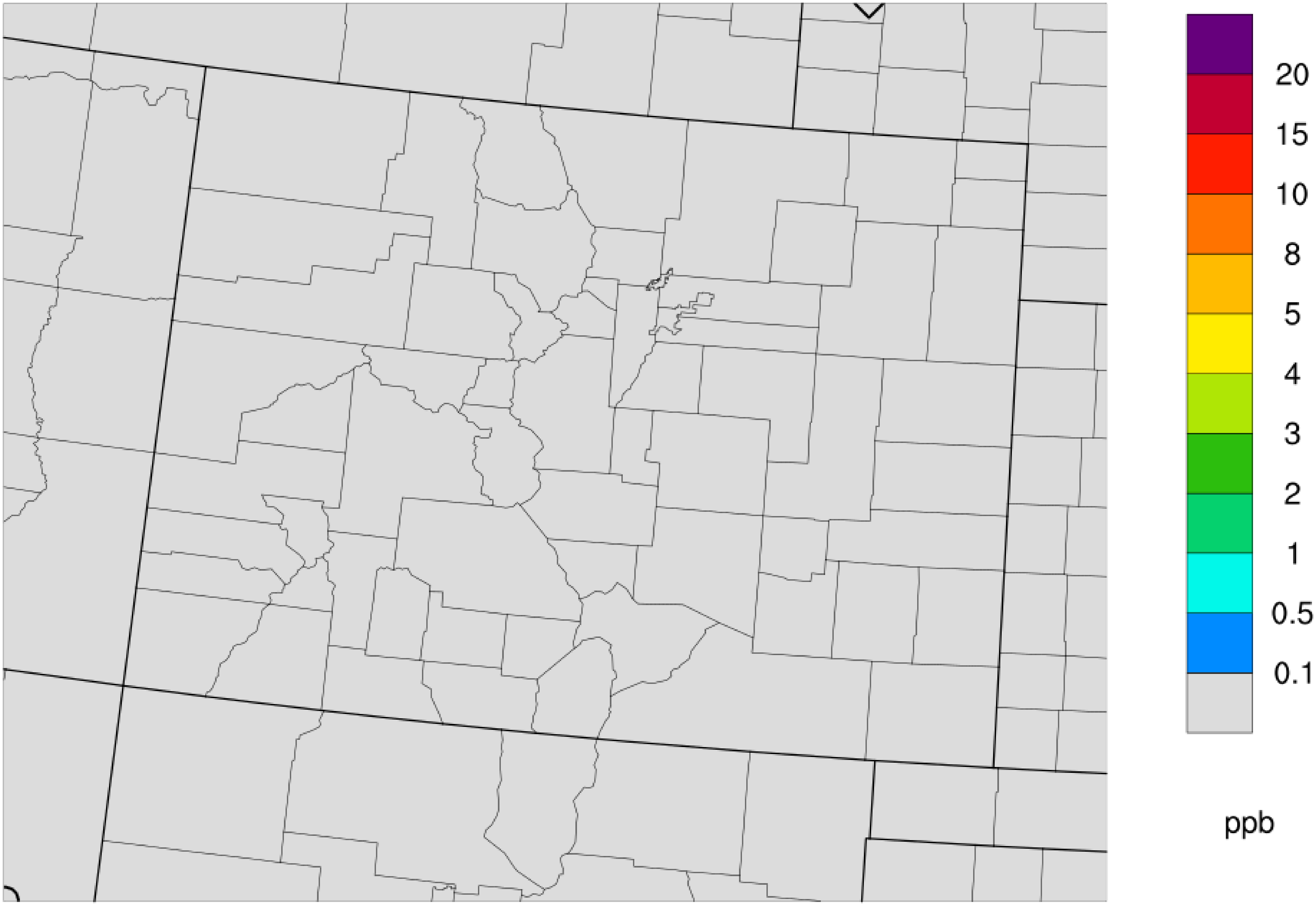
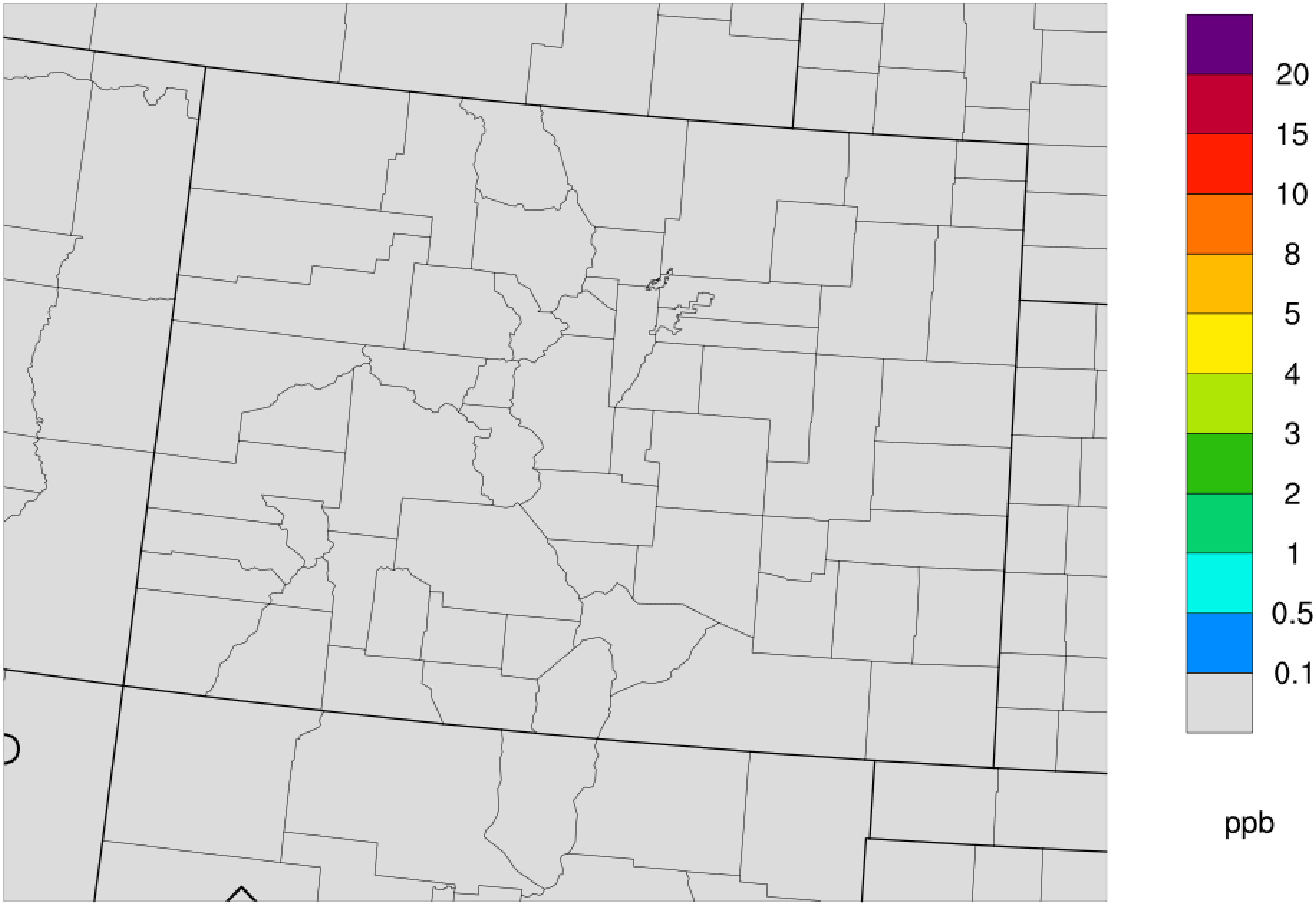


Figure CO.SO2.ann.12
Annual average SO_2 concentration
Coal_Fed



max(52,54) = 0.0 ppb
min(1,1) = 0.0 ppb

Figure CO.SO2.ann.13
Annual average SO_2 concentration
Coal_NonFed



◇ max(15,1) = 0.0 ppb
○ min(1,10) = 0.0 ppb

Figure CO.SO2.ann.14
Annual average SO_2 concentration
Coal_EGU WRAP states

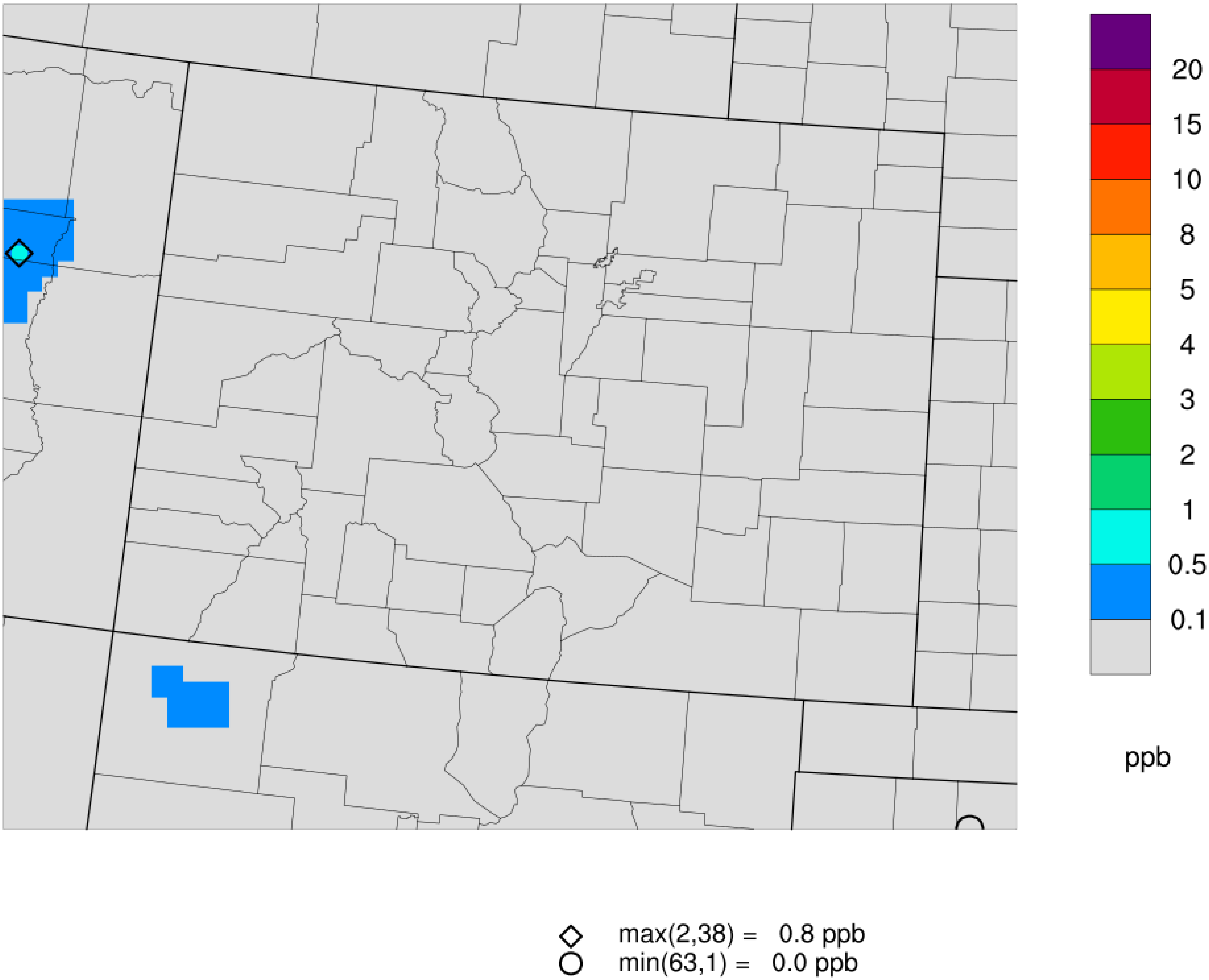
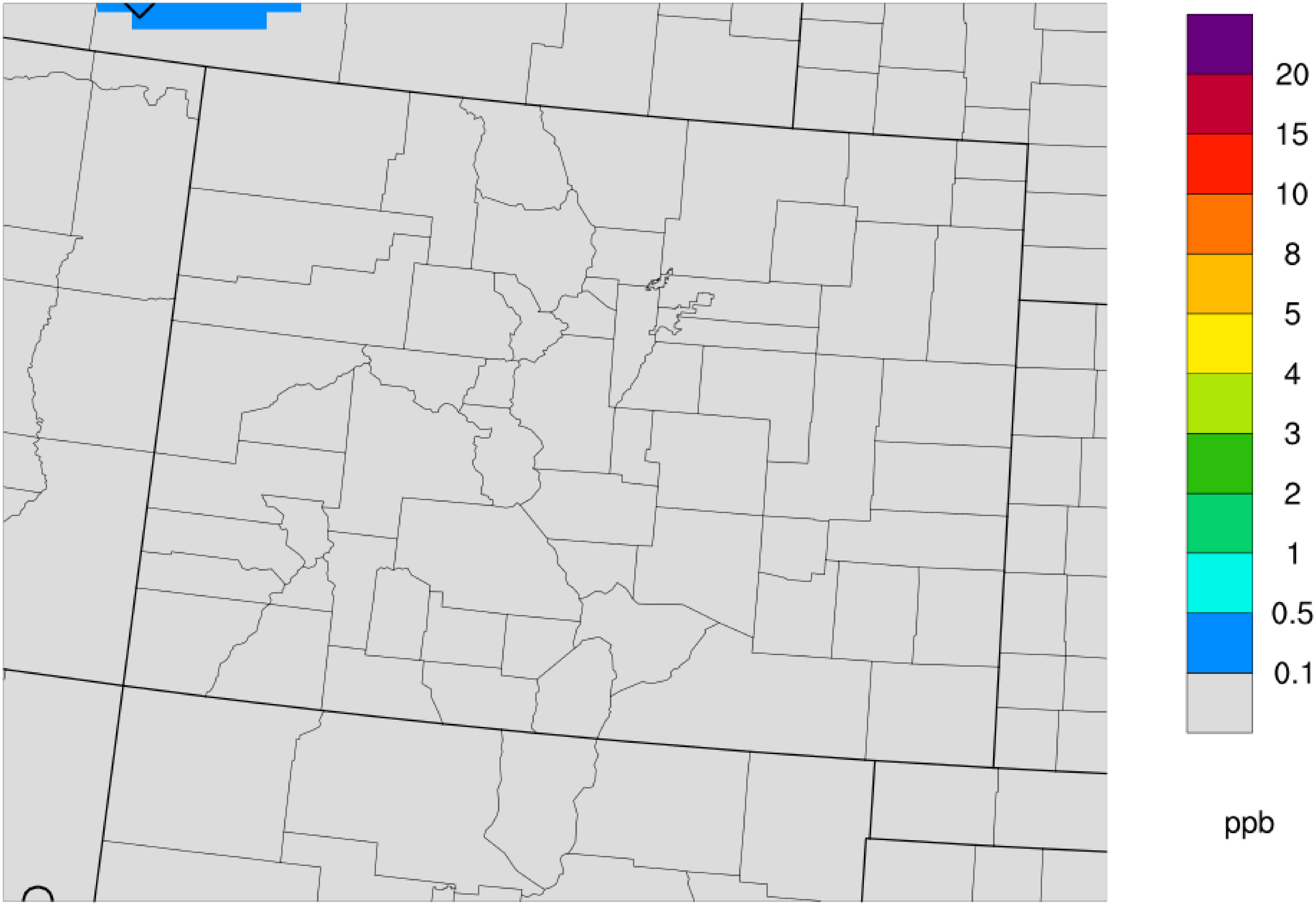
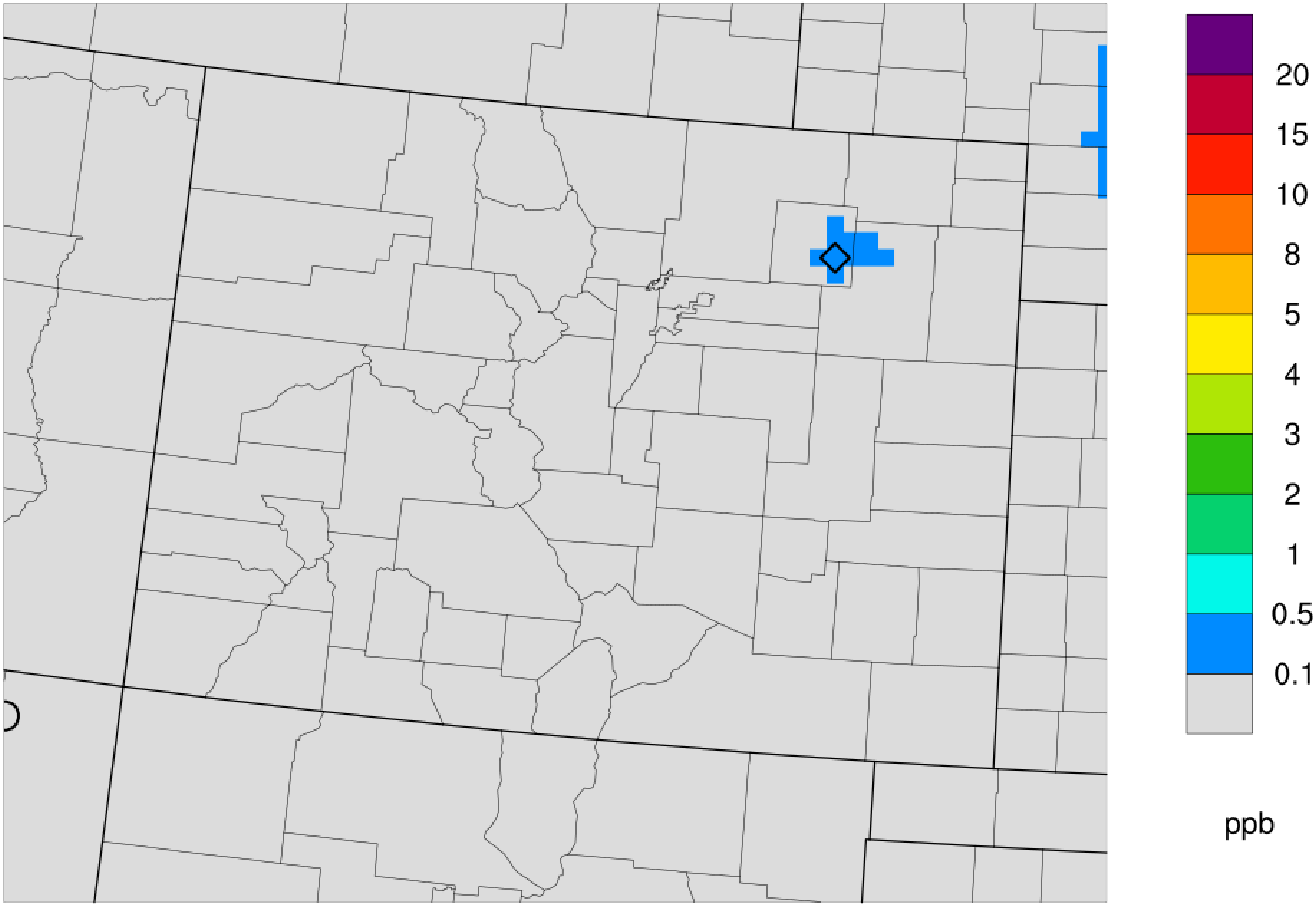


Figure CO.SO2.ann.15
Annual average SO_2 concentration
Coal_Comb WRAP states



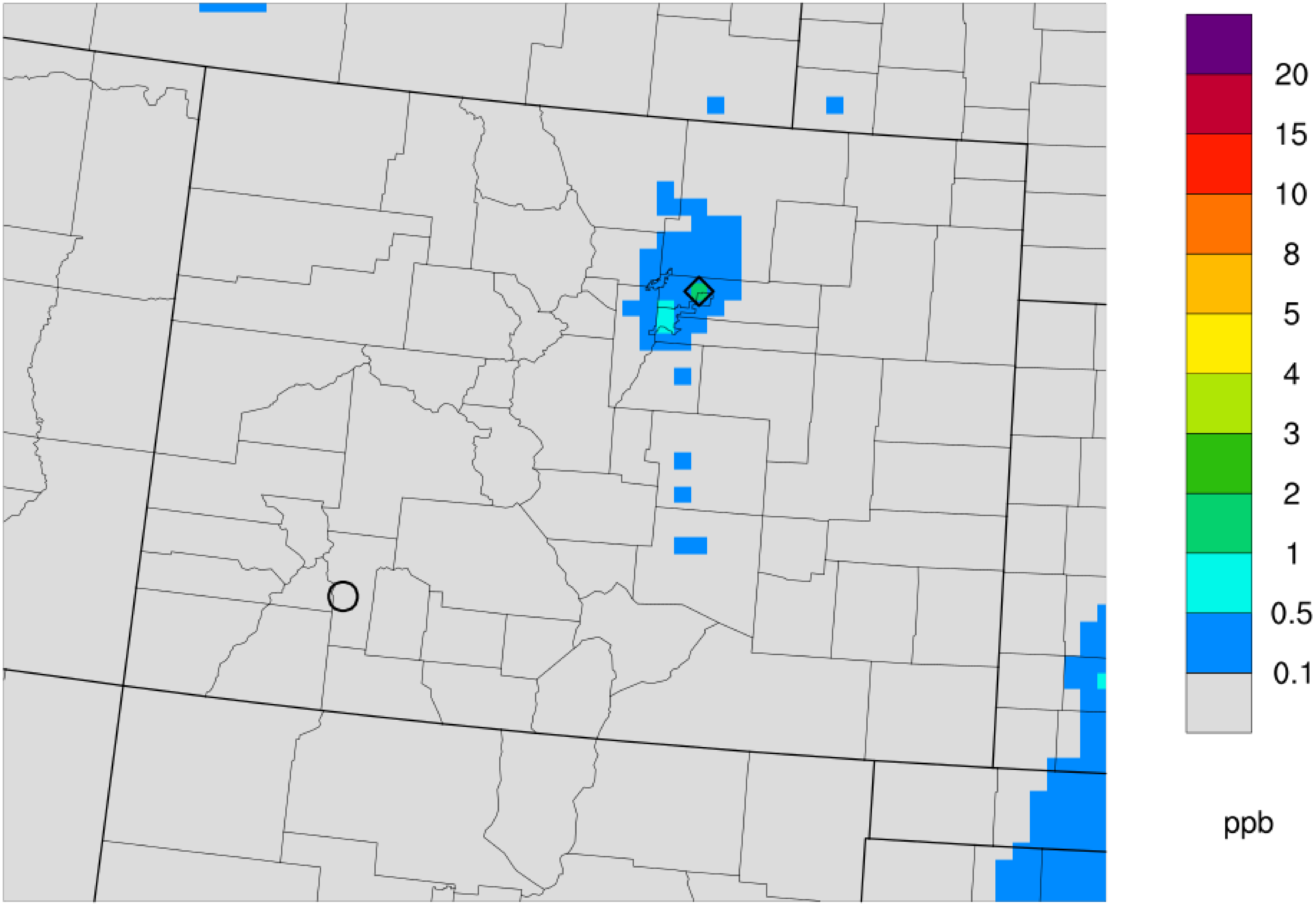
max(9,54) = 0.2 ppb
min(3,1) = 0.0 ppb

Figure CO.SO2.ann.16
Annual average SO_2 concentration
OtherEGU



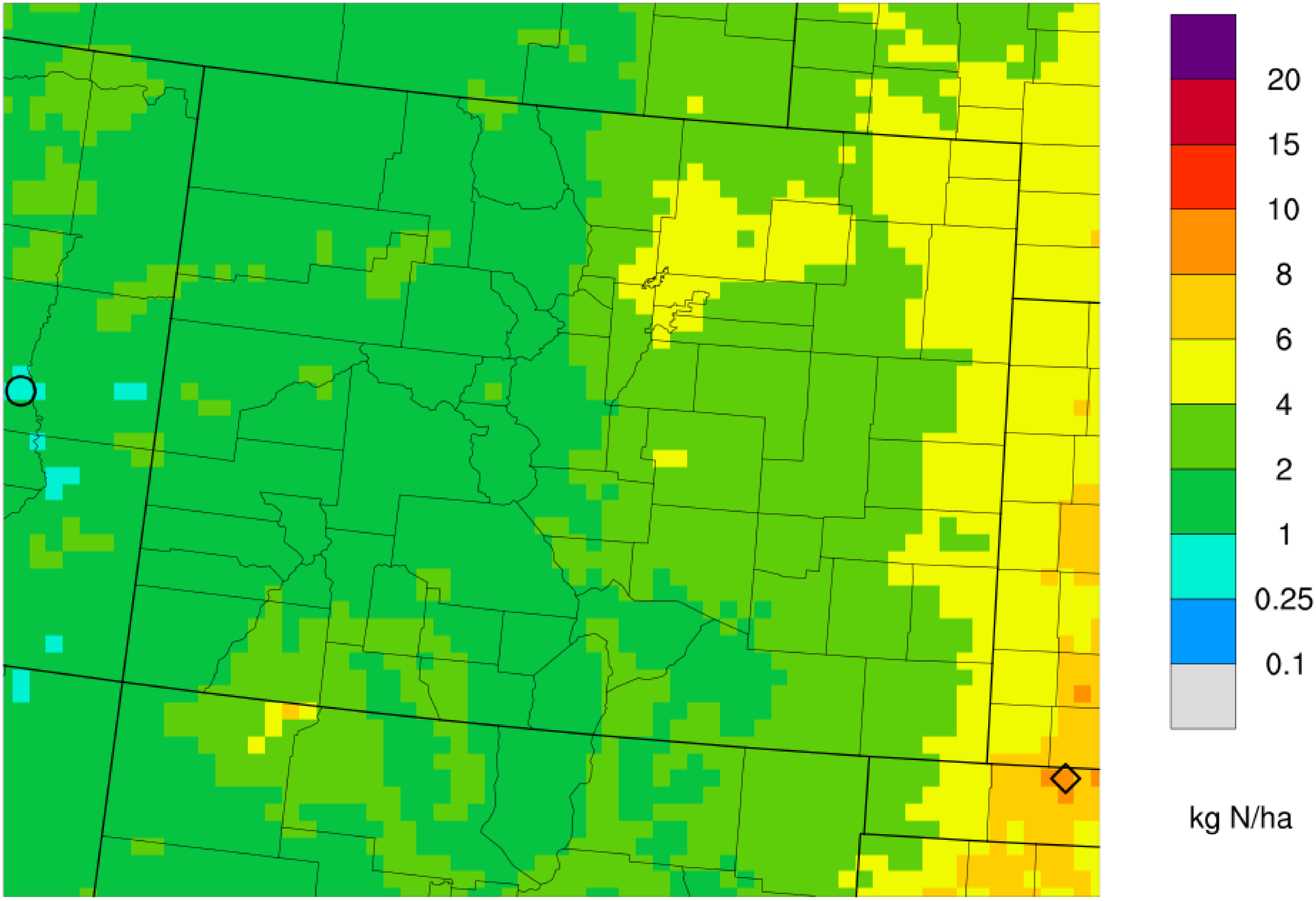
max(50,39) = 0.4 ppb
min(1,12) = 0.0 ppb

Figure CO.SO2.ann.17
Annual average SO_2 concentration
Anthro_Rest



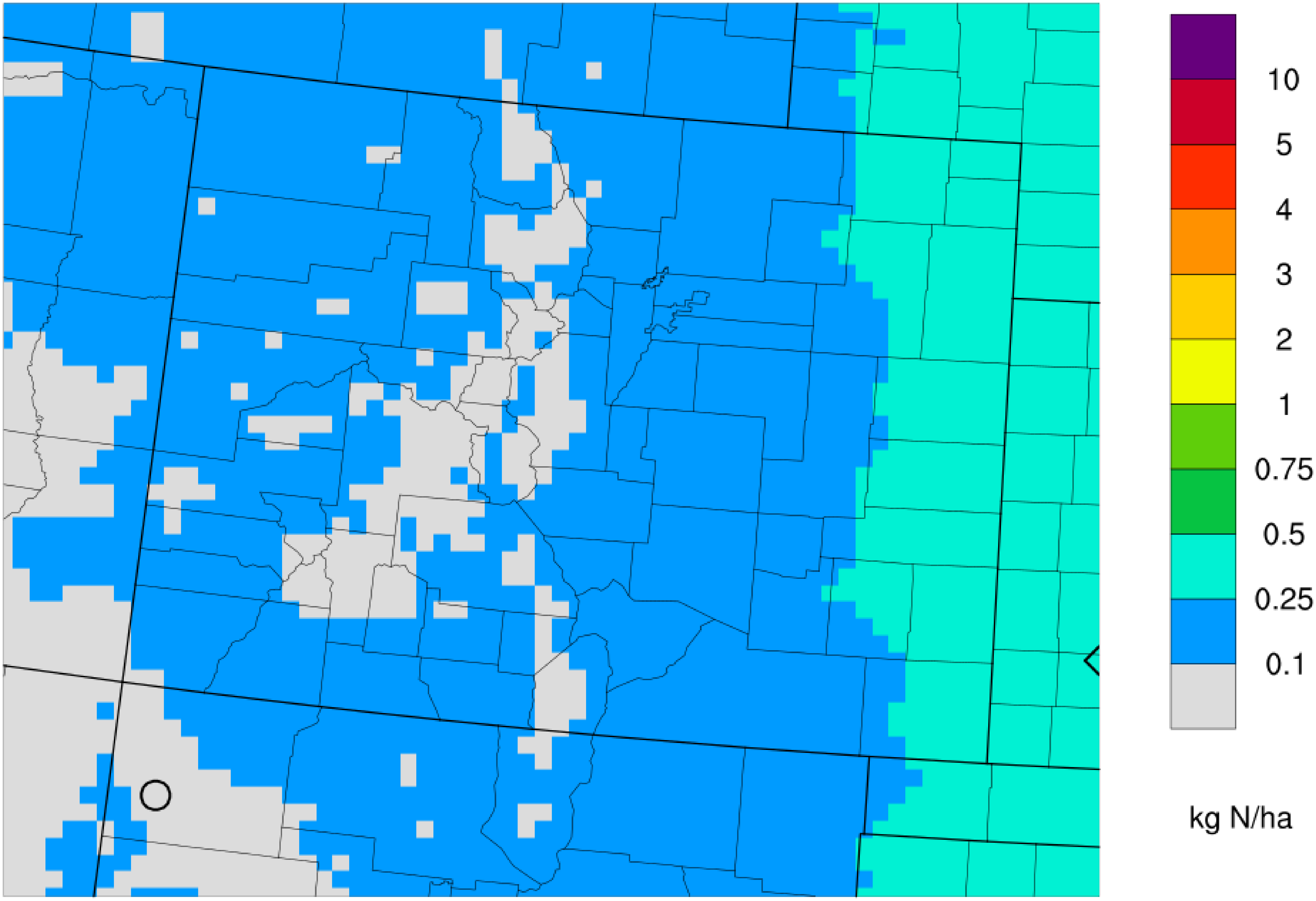
◇ max(42,37) = 1.3 ppb
○ min(21,19) = 0.0 ppb

Figure CO.NDEP.1
Annual Total Nitrogen Deposition
Cumulative



max(64,8) = 9.7 kg N/ha
min(2,31) = 0.9 kg N/ha

Figure CO.NDEP.2
Annual Total Nitrogen Deposition
Natural



◇ max(66,15) = 0.5 kg N/ha
○ min(10,7) = 0.1 kg N/ha

Figure CO.NDEP.3
Annual Total Nitrogen Deposition
Wildfire

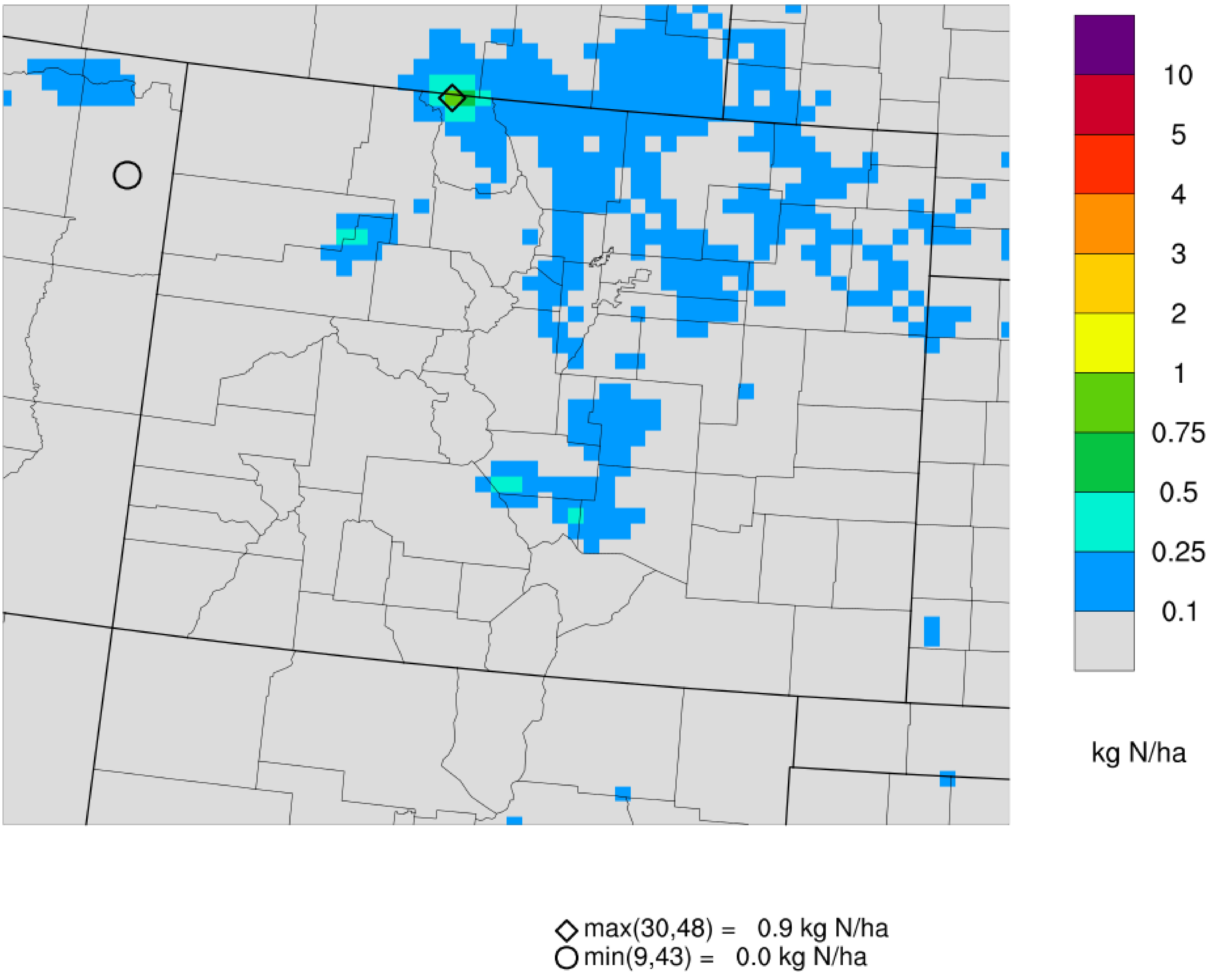
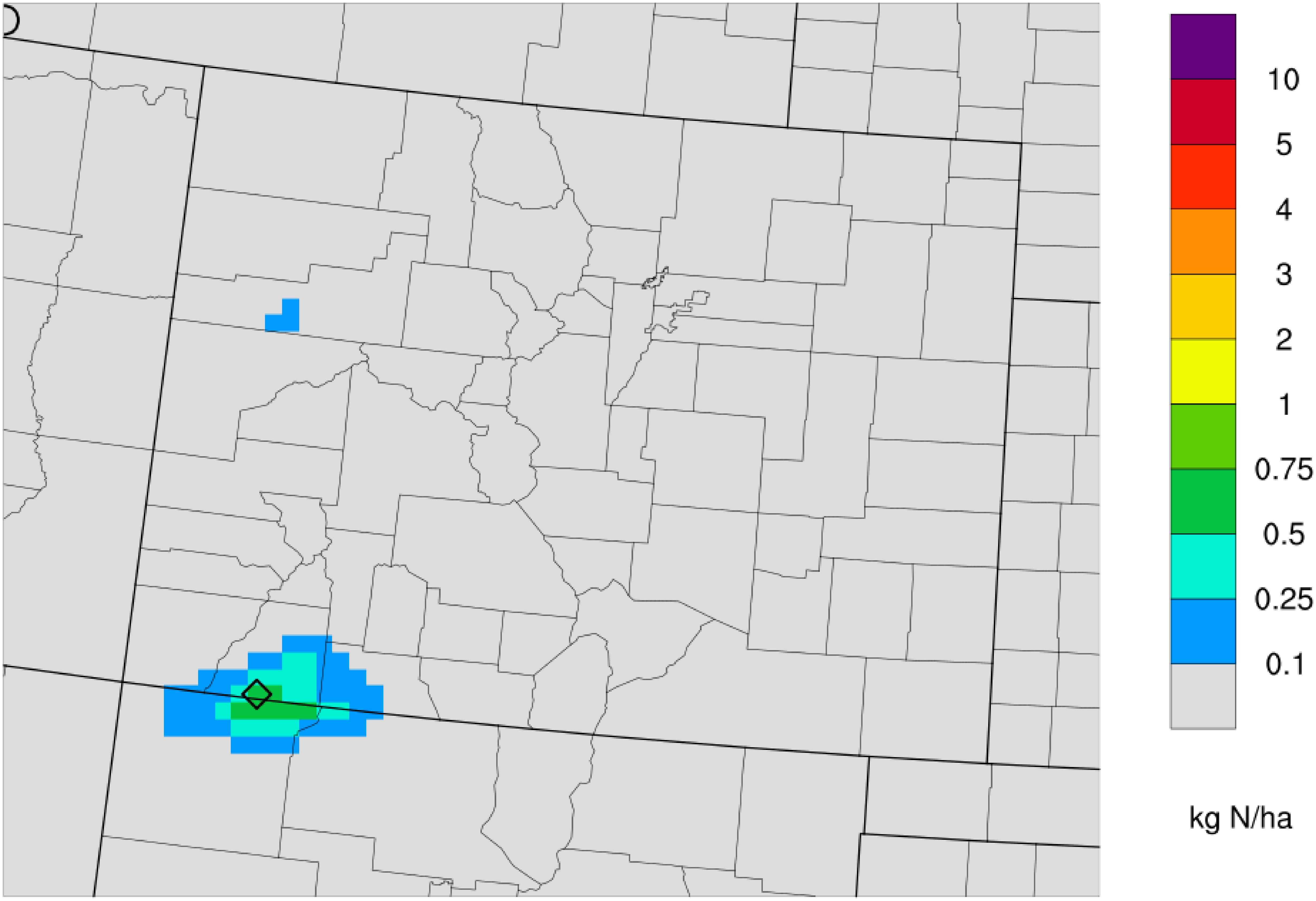
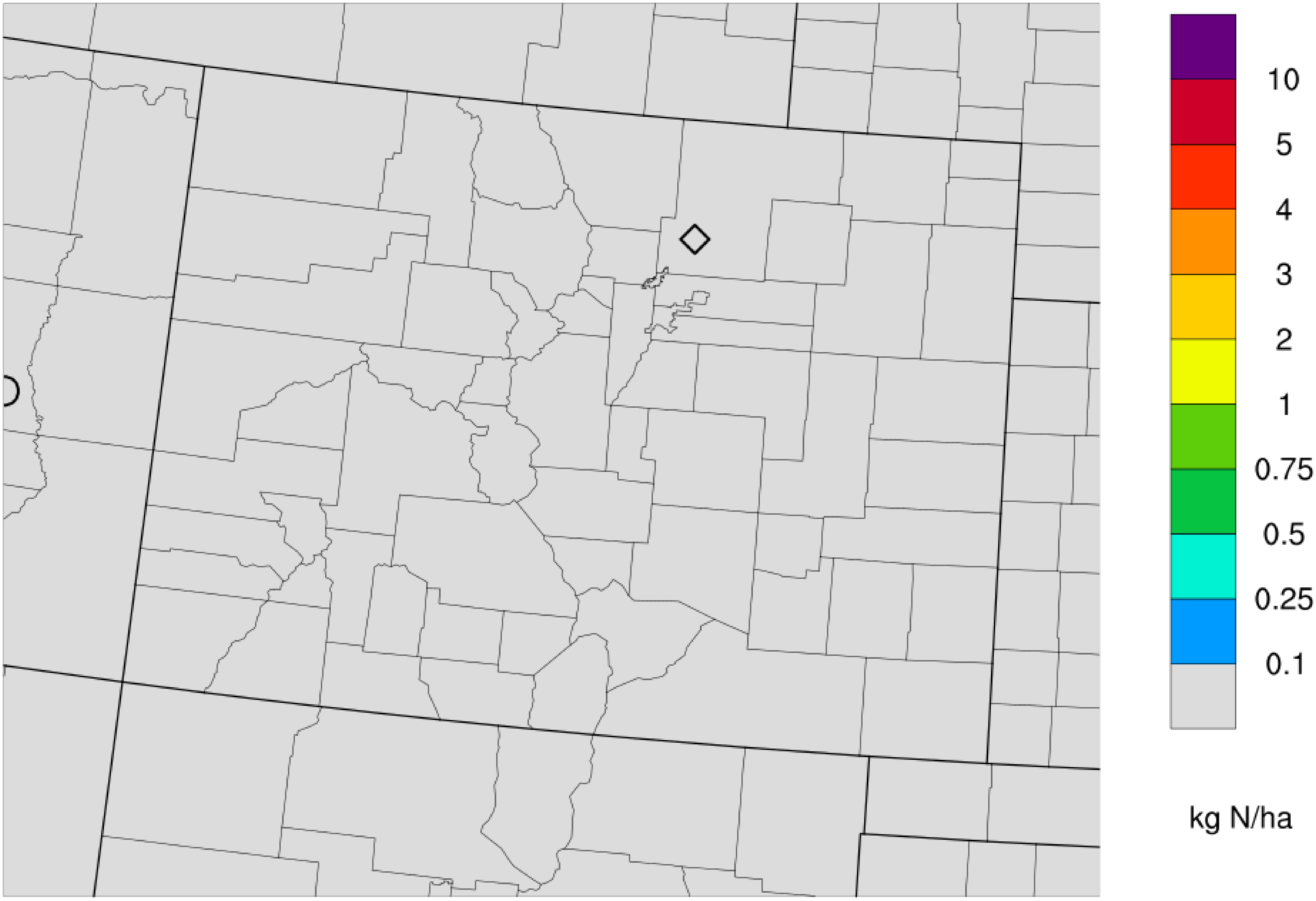


Figure CO.NDEP.4
Annual Total Nitrogen Deposition
OilGas_ExistFed_WesternCO



◇ max(16,13) = 0.7 kg N/ha
○ min(1,53) = 0.0 kg N/ha

Figure CO.NDEP.5
Annual Total Nitrogen Deposition
OilGas_ExistFed_RoyalGorge



◇ max(42,40) = 0.0 kg N/ha
○ min(1,31) = 0.0 kg N/ha

Figure CO.NDEP.6
Annual Total Nitrogen Deposition
OilGas_NewFed_WesternCO

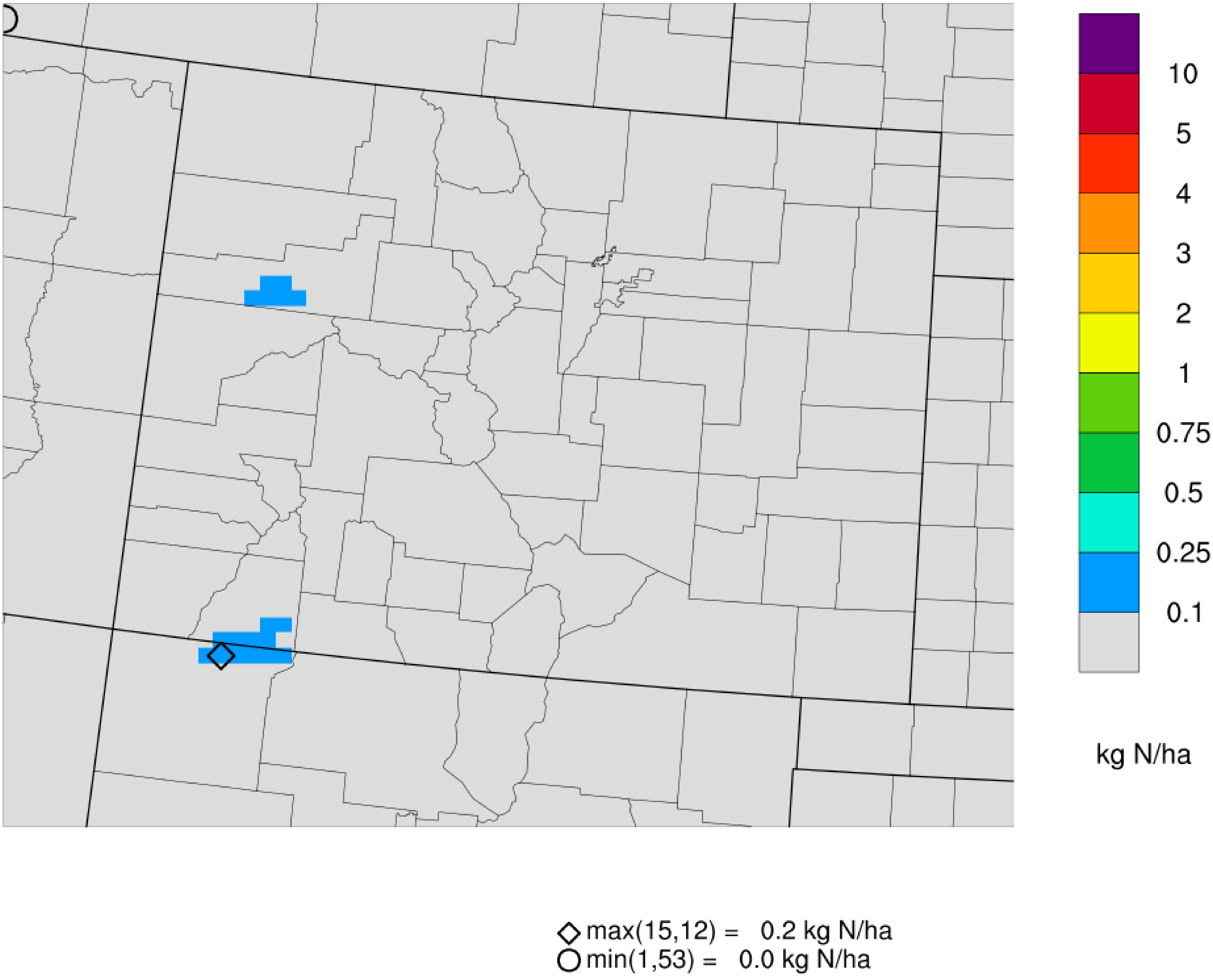


Figure CO.NDEP.7
Annual Total Nitrogen Deposition
OilGas_NewFed_RoyalGorge

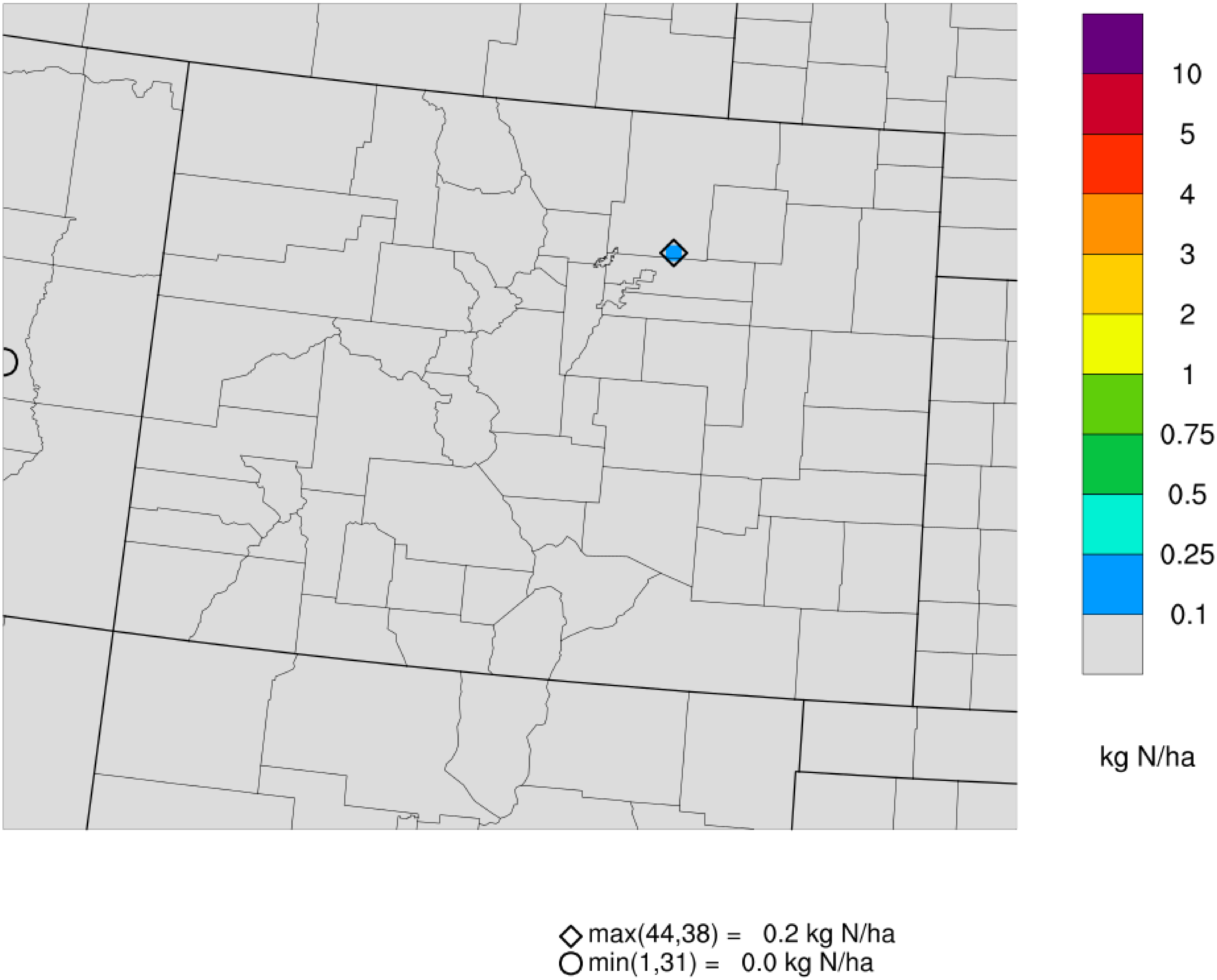
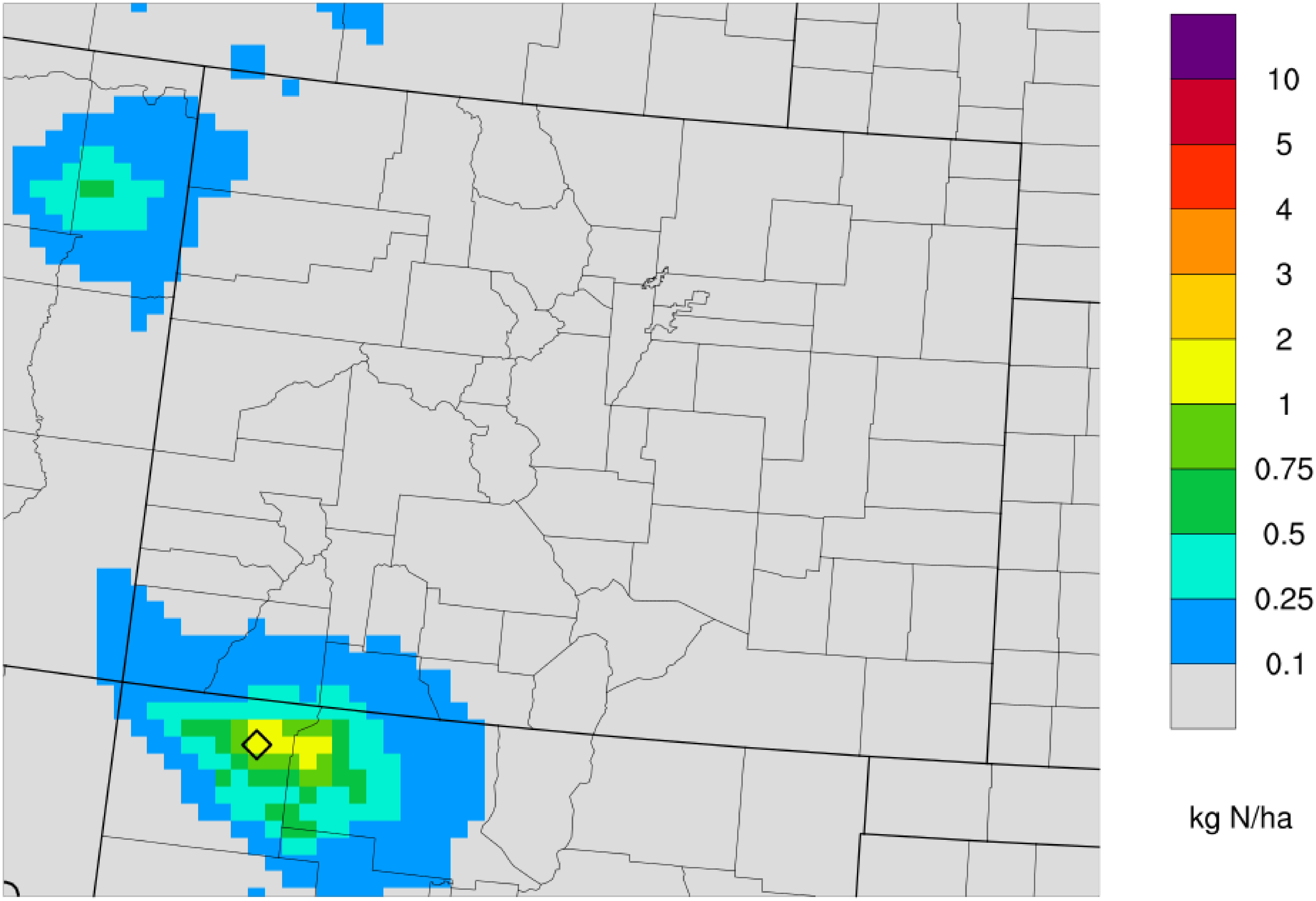


Figure CO.NDEP.8
Annual Total Nitrogen Deposition
OilGas_Fed_Other_States



◇ max(16,10) = 1.7 kg N/ha
○ min(1,1) = 0.0 kg N/ha

Figure CO.NDEP.9
Annual Total Nitrogen Deposition
OilGas_NonFed

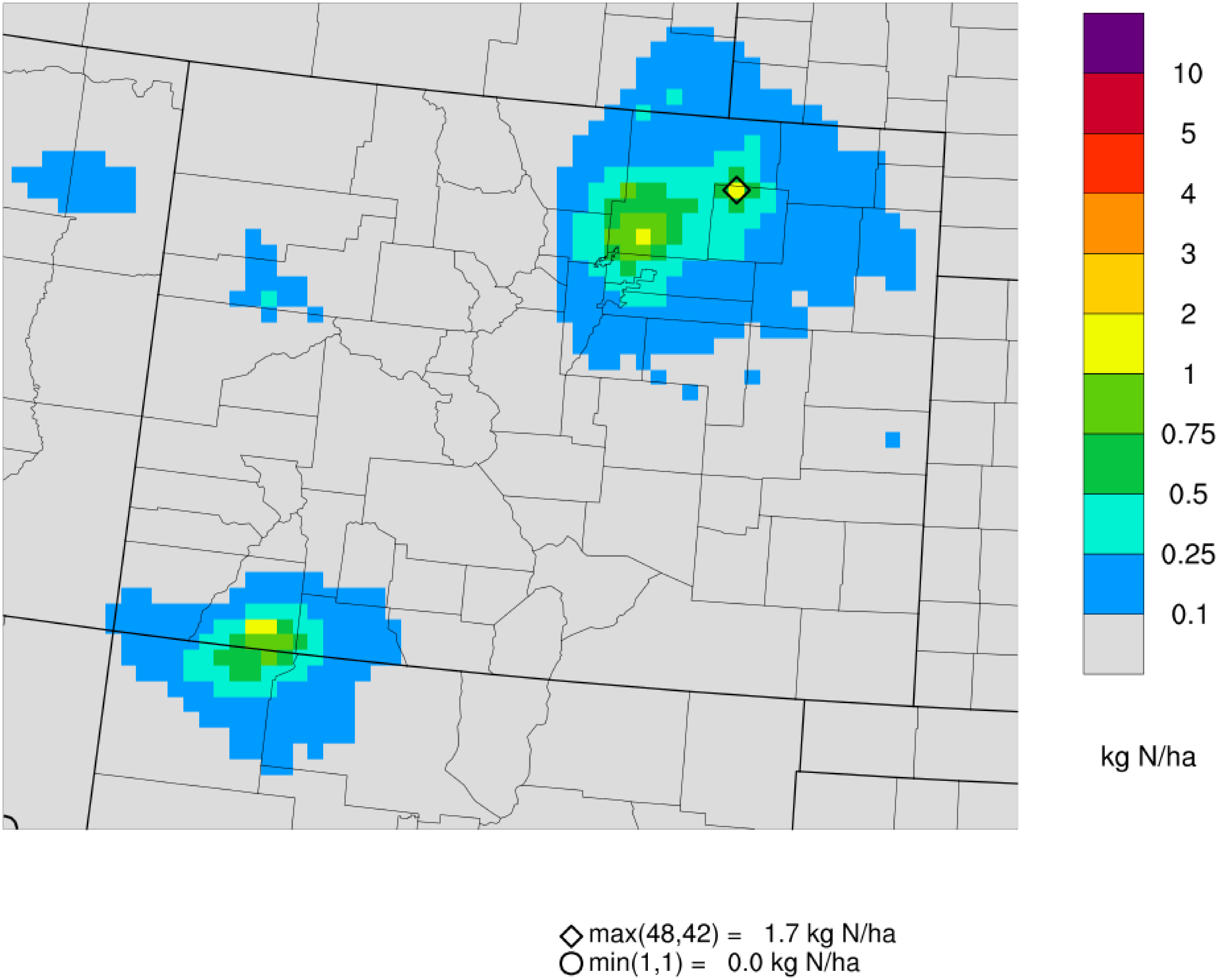
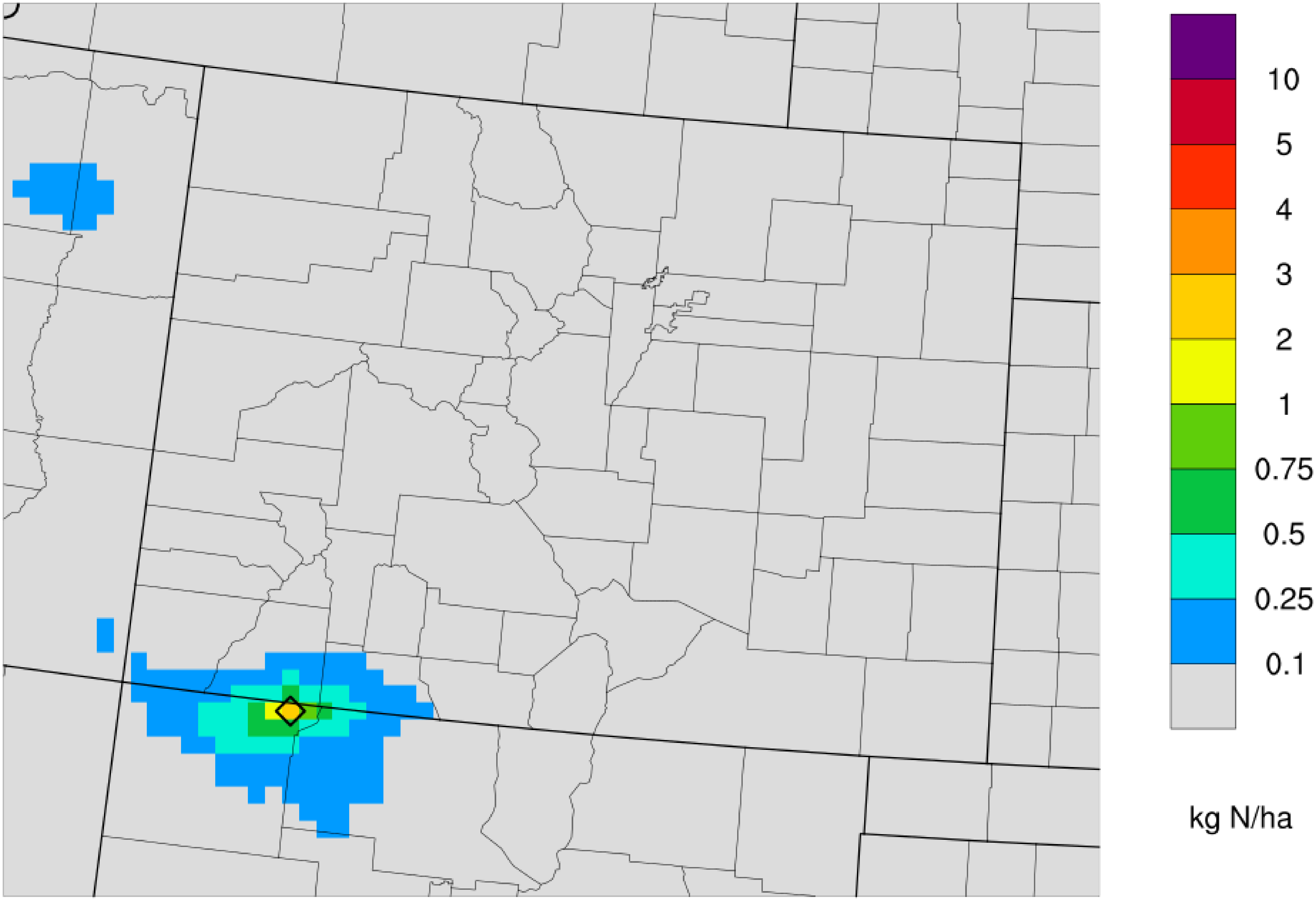
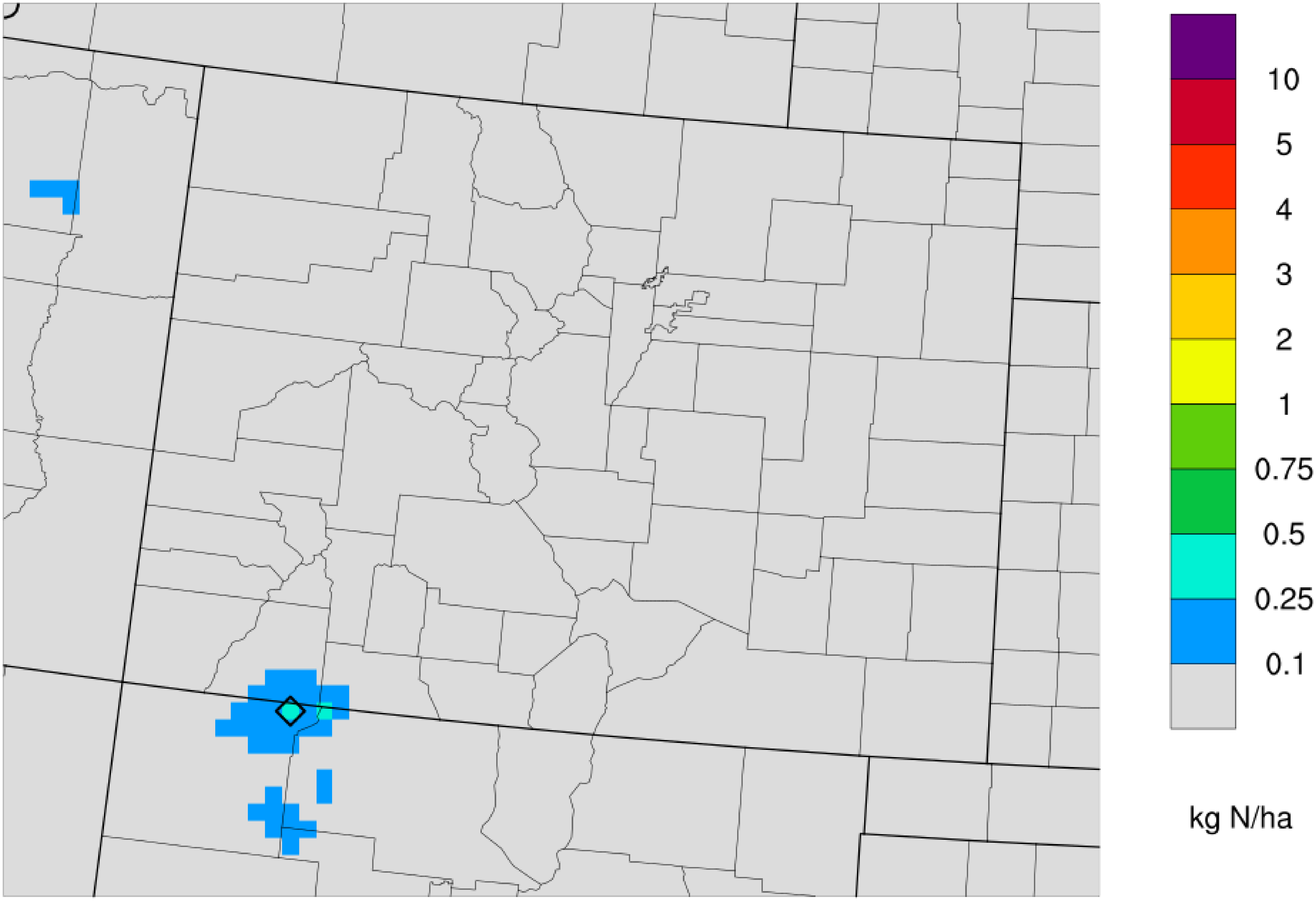


Figure CO.NDEP.10
Annual Total Nitrogen Deposition
OilGas_ExistTribal



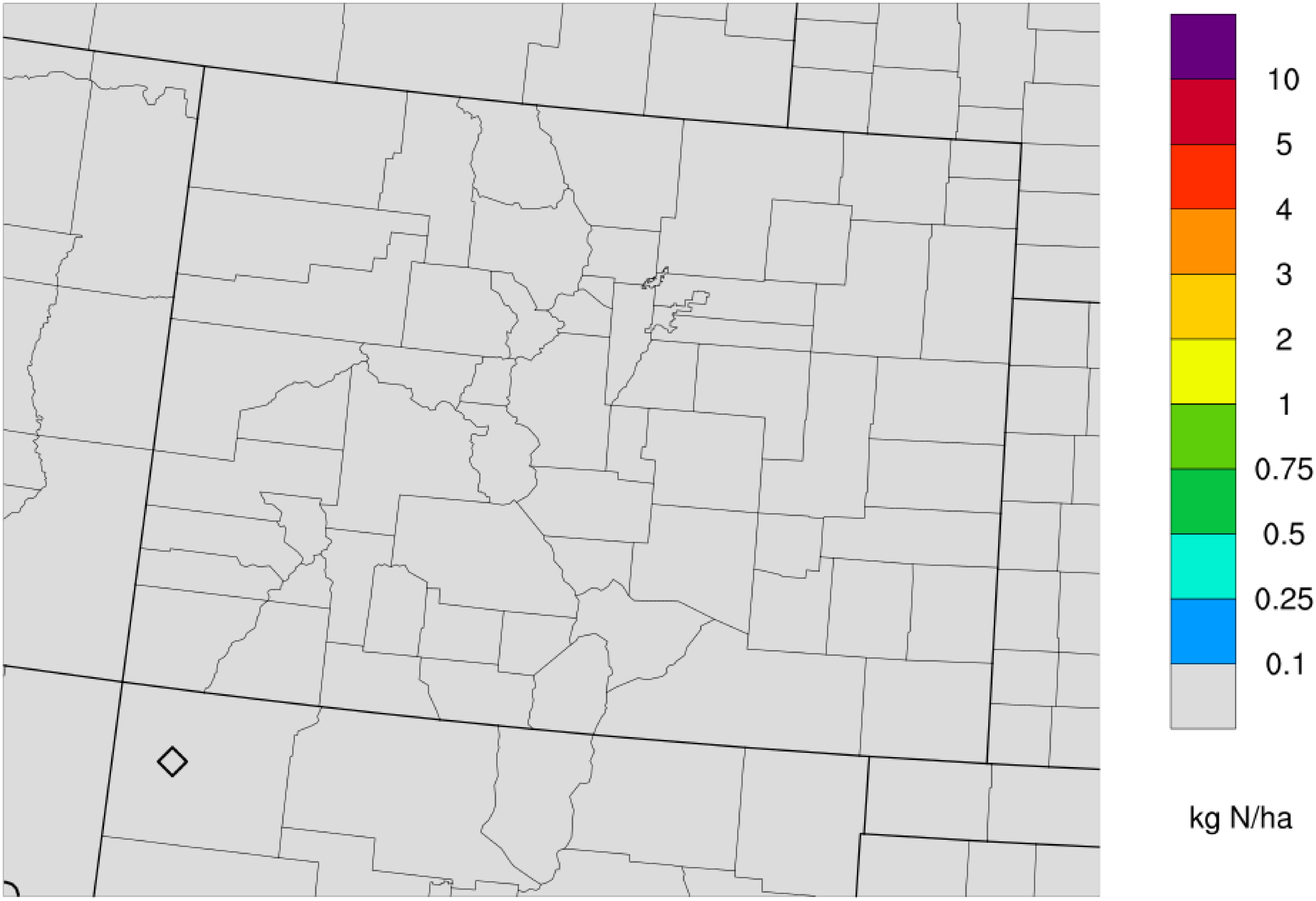
◇ max(18,12) = 2.3 kg N/ha
○ min(1,54) = 0.0 kg N/ha

Figure CO.NDEP.11
Annual Total Nitrogen Deposition
OilGas_NewTribal



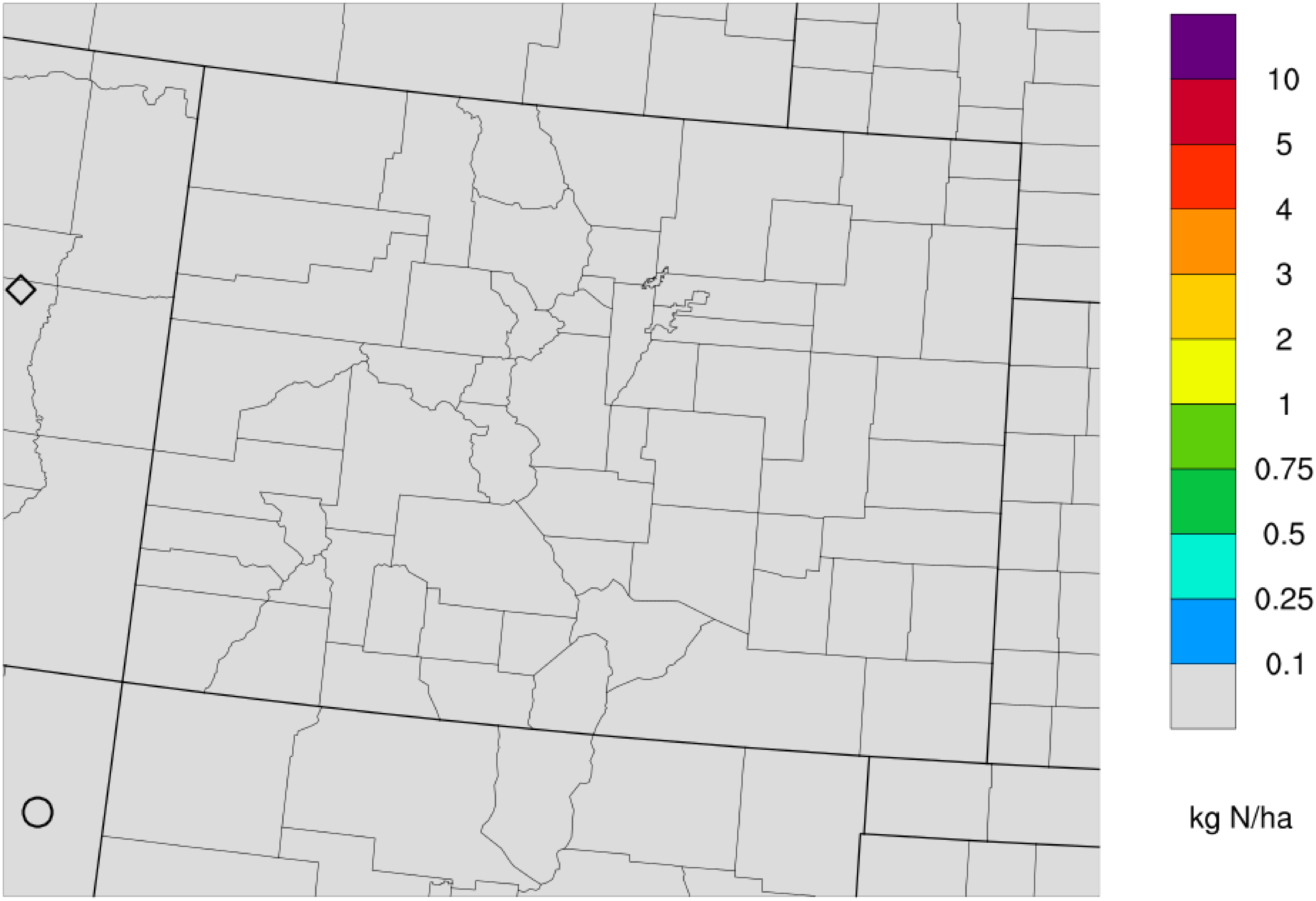
◇ max(18,12) = 0.4 kg N/ha
○ min(1,54) = 0.0 kg N/ha

Figure CO.NDEP.12
Annual Total Nitrogen Deposition
Coal_Fed



◇ max(11,9) = 0.0 kg N/ha
○ min(1,1) = 0.0 kg N/ha

Figure CO.NDEP.13
Annual Total Nitrogen Deposition
Coal_NonFed



max(2,37) = 0.0 kg N/ha
min(3,6) = 0.0 kg N/ha

Figure CO.NDEP.14
Annual Total Nitrogen Deposition
Coal_EGU WRAP states

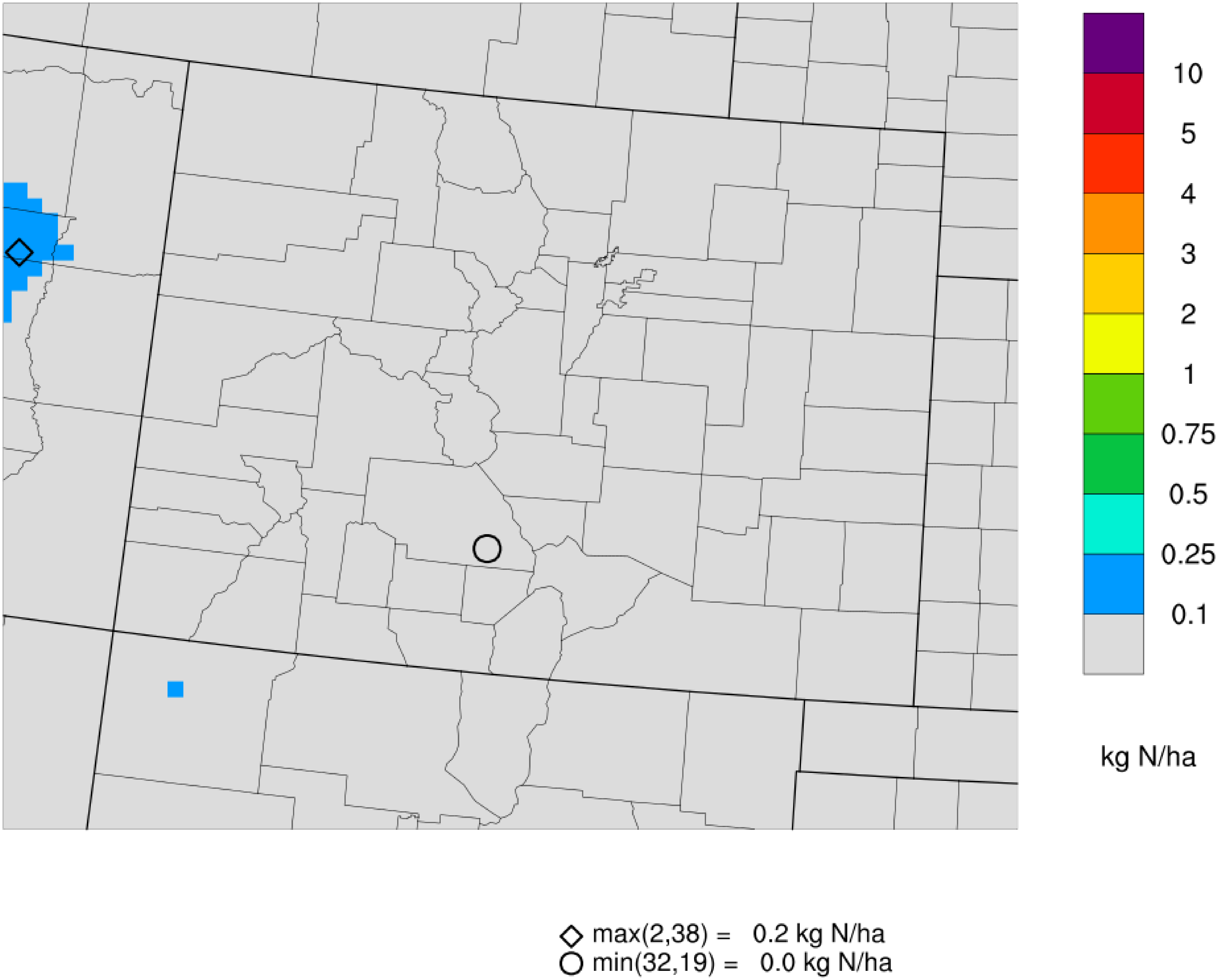


Figure CO.NDEP.15
Annual Total Nitrogen Deposition
Coal_Comb WRAP states

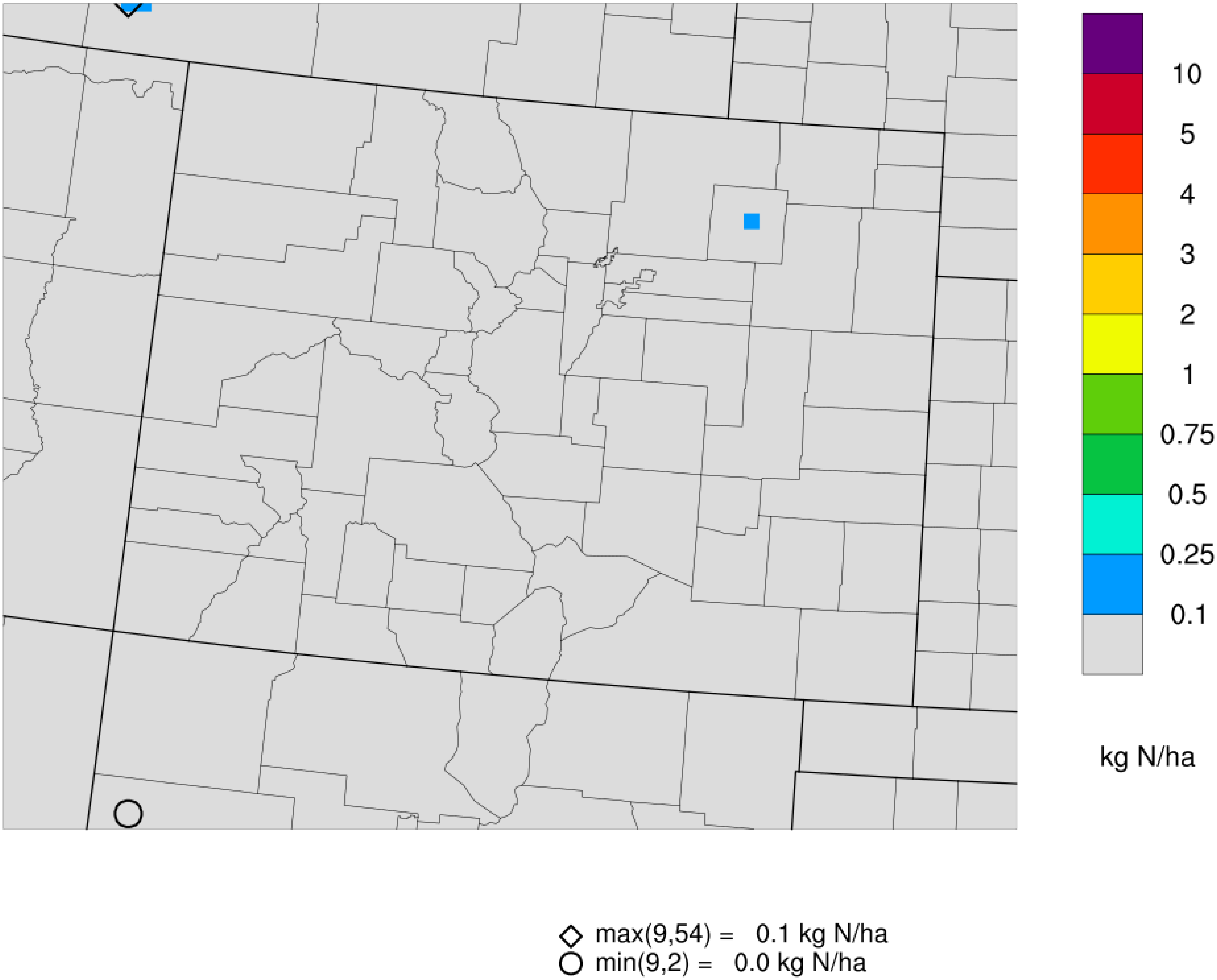


Figure CO.NDEP.16
Annual Total Nitrogen Deposition
OtherEGU

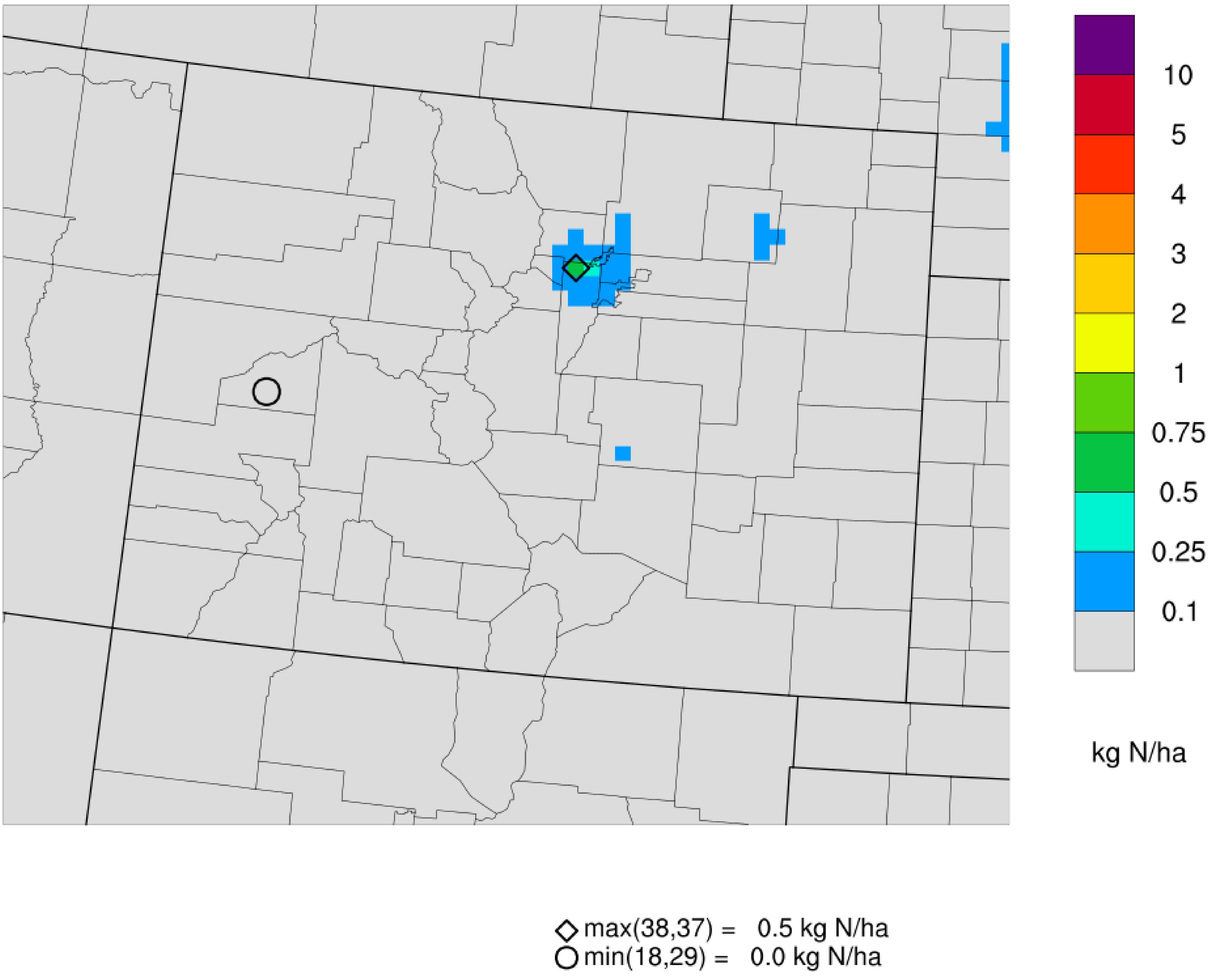
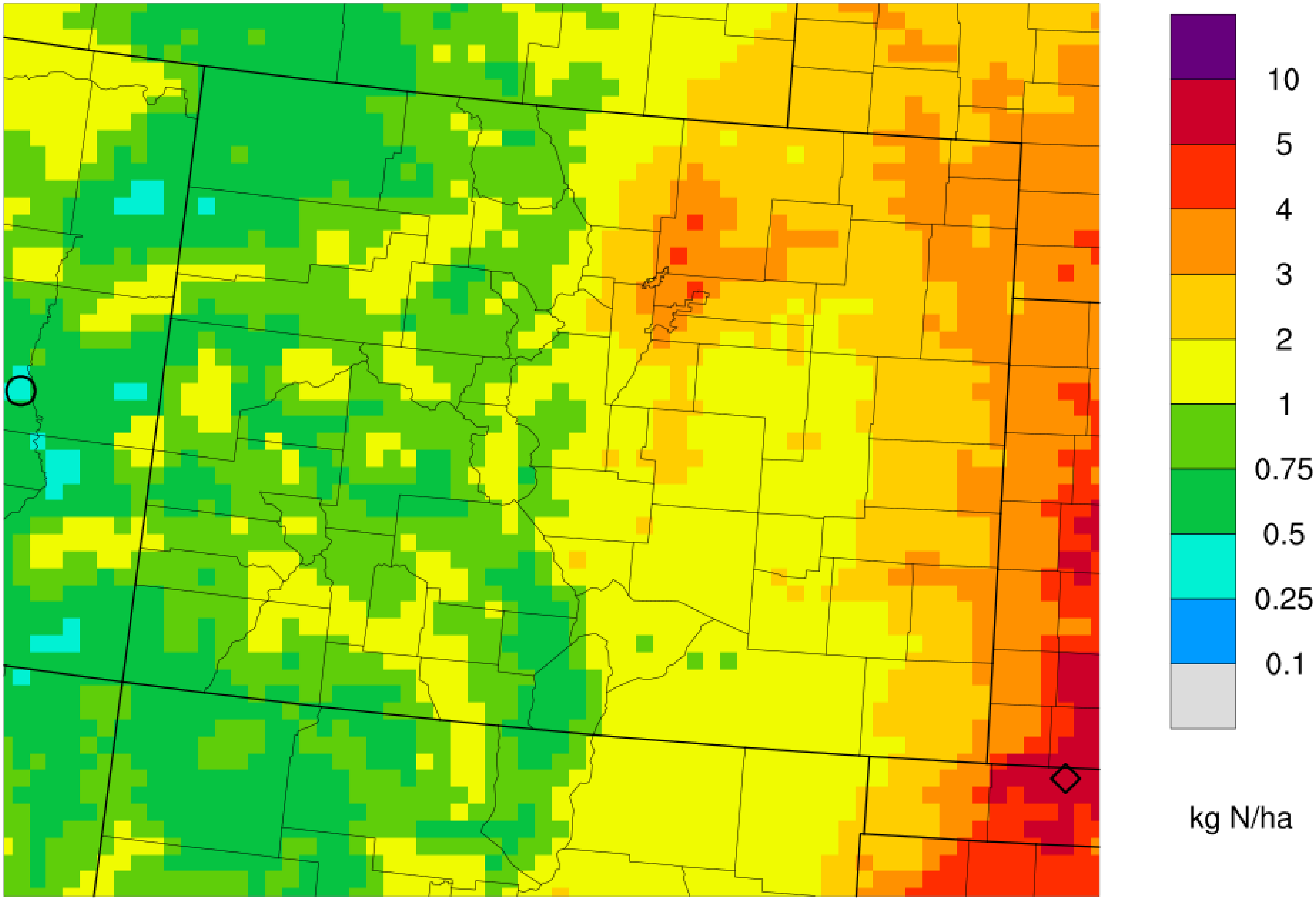


Figure CO.NDEP.17
Annual Total Nitrogen Deposition
Anthro_Rest



◇ max(64,8) = 8.1 kg N/ha
○ min(2,31) = 0.4 kg N/ha

Figure CO.SDEP.1
Annual Total Sulfur Deposition
Cumulative

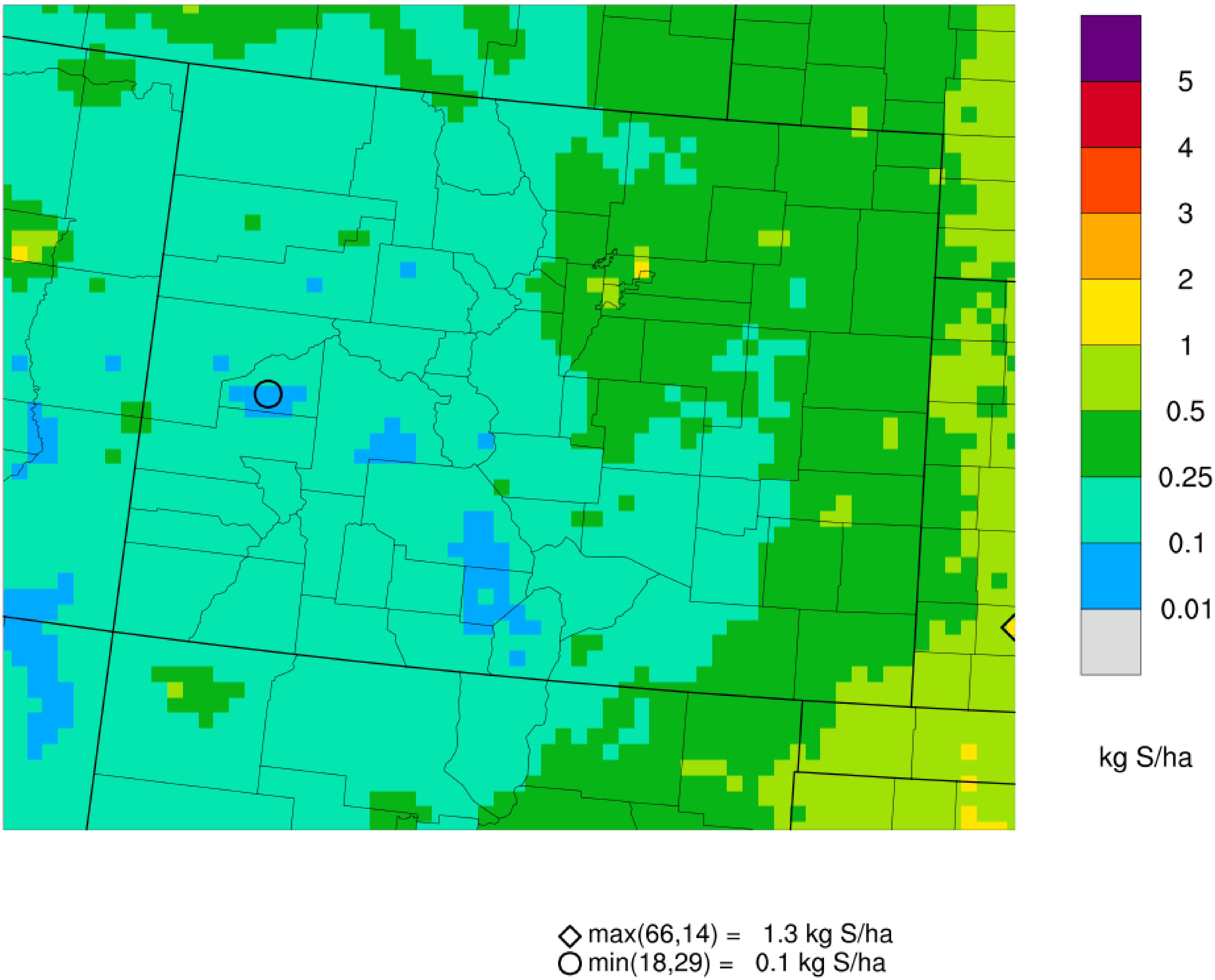


Figure CO.SDEP.2
Annual Total Sulfur Deposition
Natural

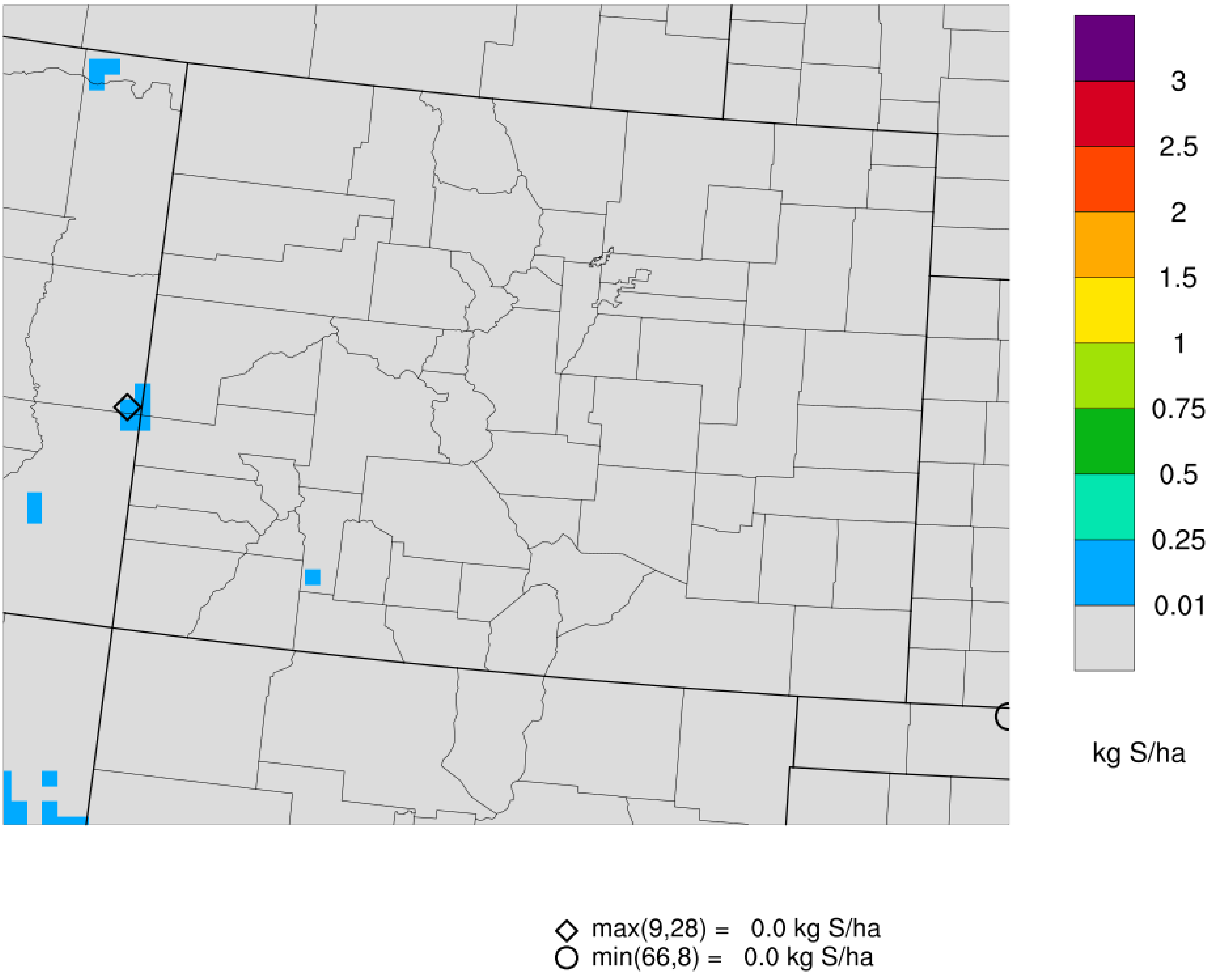
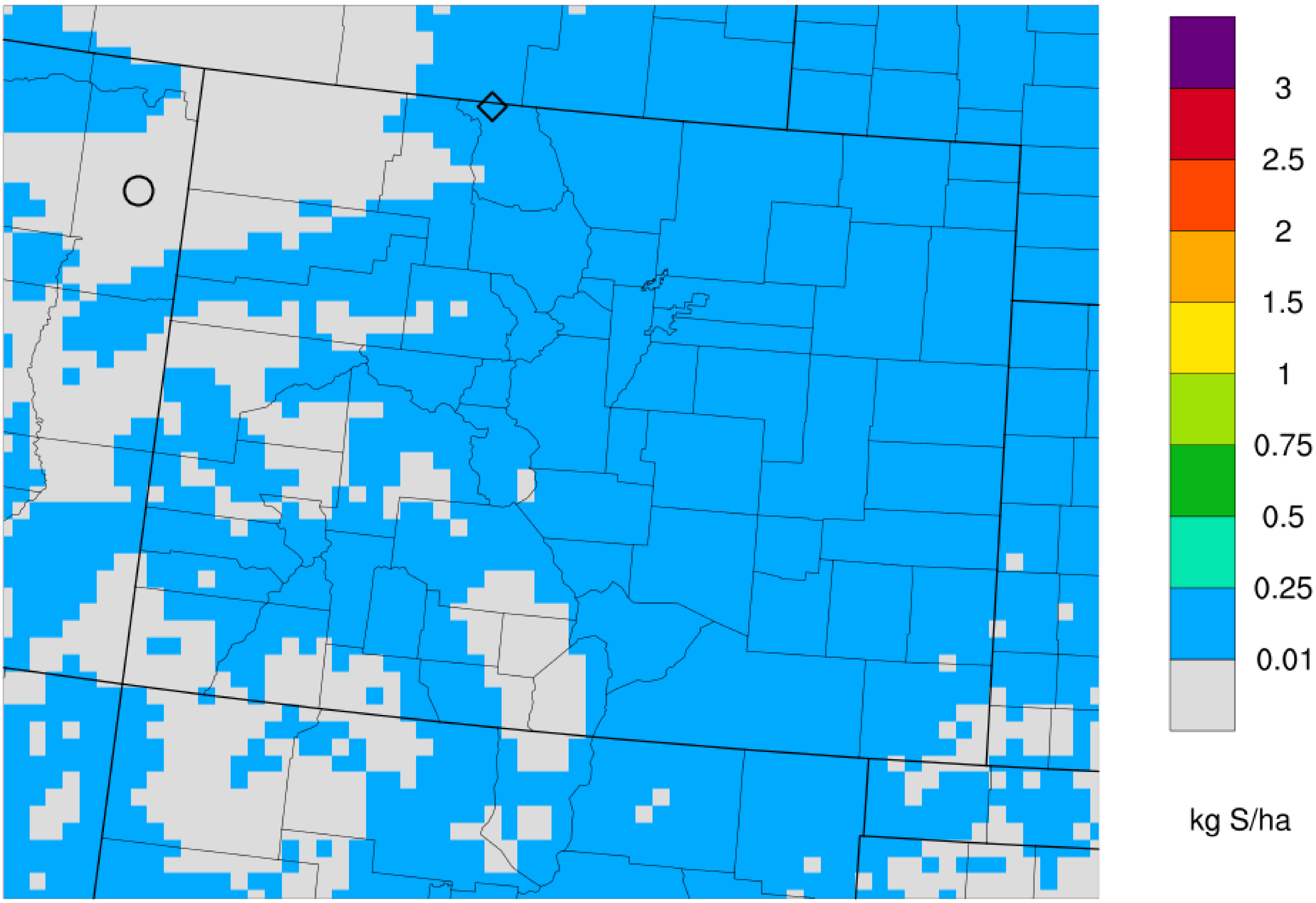
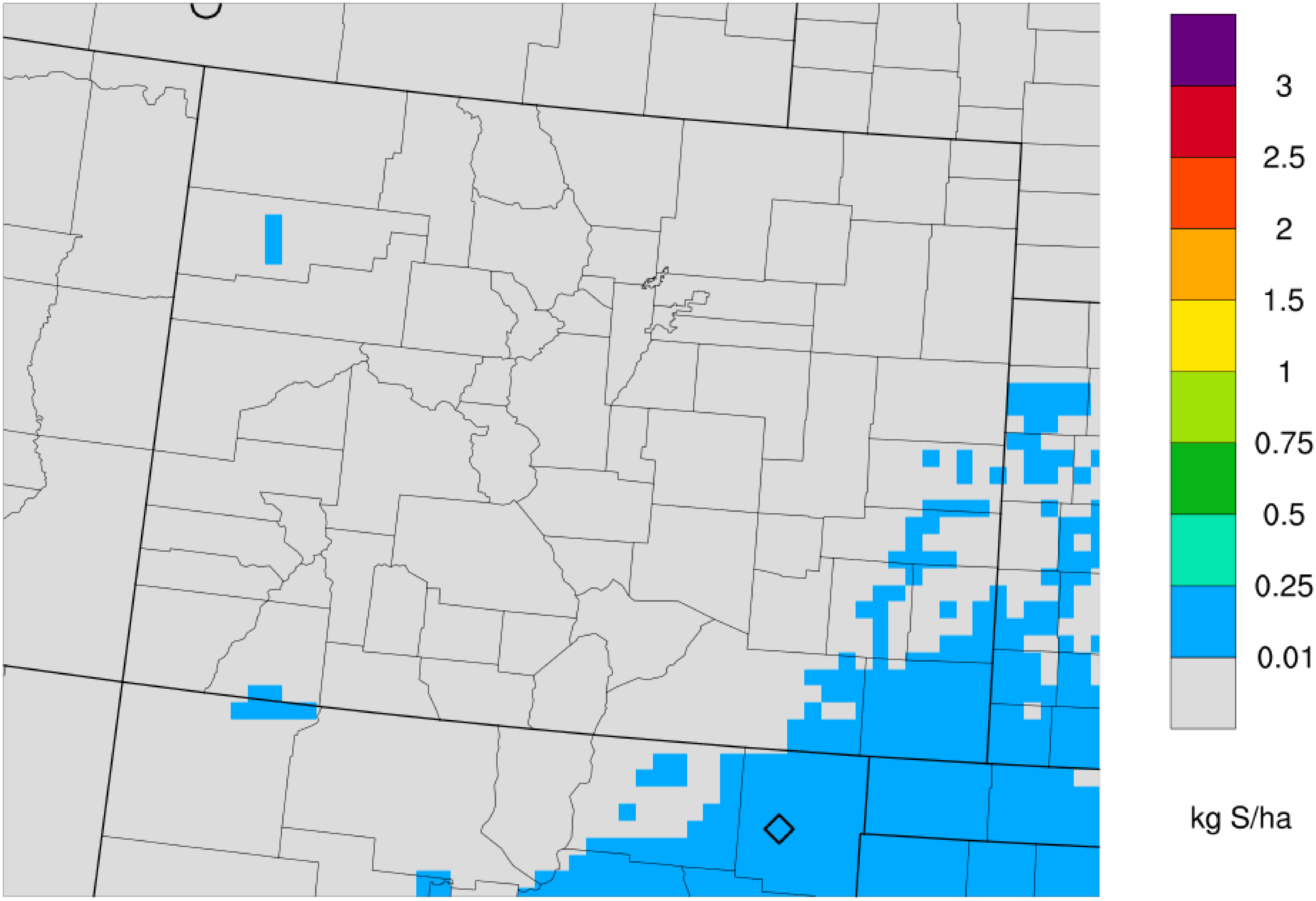


Figure CO.SDEP.3
Annual Total Sulfur Deposition
Wildfire



◇ max(30,48) = 0.2 kg S/ha
○ min(9,43) = 0.0 kg S/ha

Figure CO.SDEP.4
Annual Total Sulfur Deposition
OilGas_ExistFed_WesternCO



◇ max(47,5) = 0.0 kg S/ha
○ min(13,54) = 0.0 kg S/ha

Figure CO.SDEP.5
Annual Total Sulfur Deposition
OilGas_ExistFed_RoyalGorge

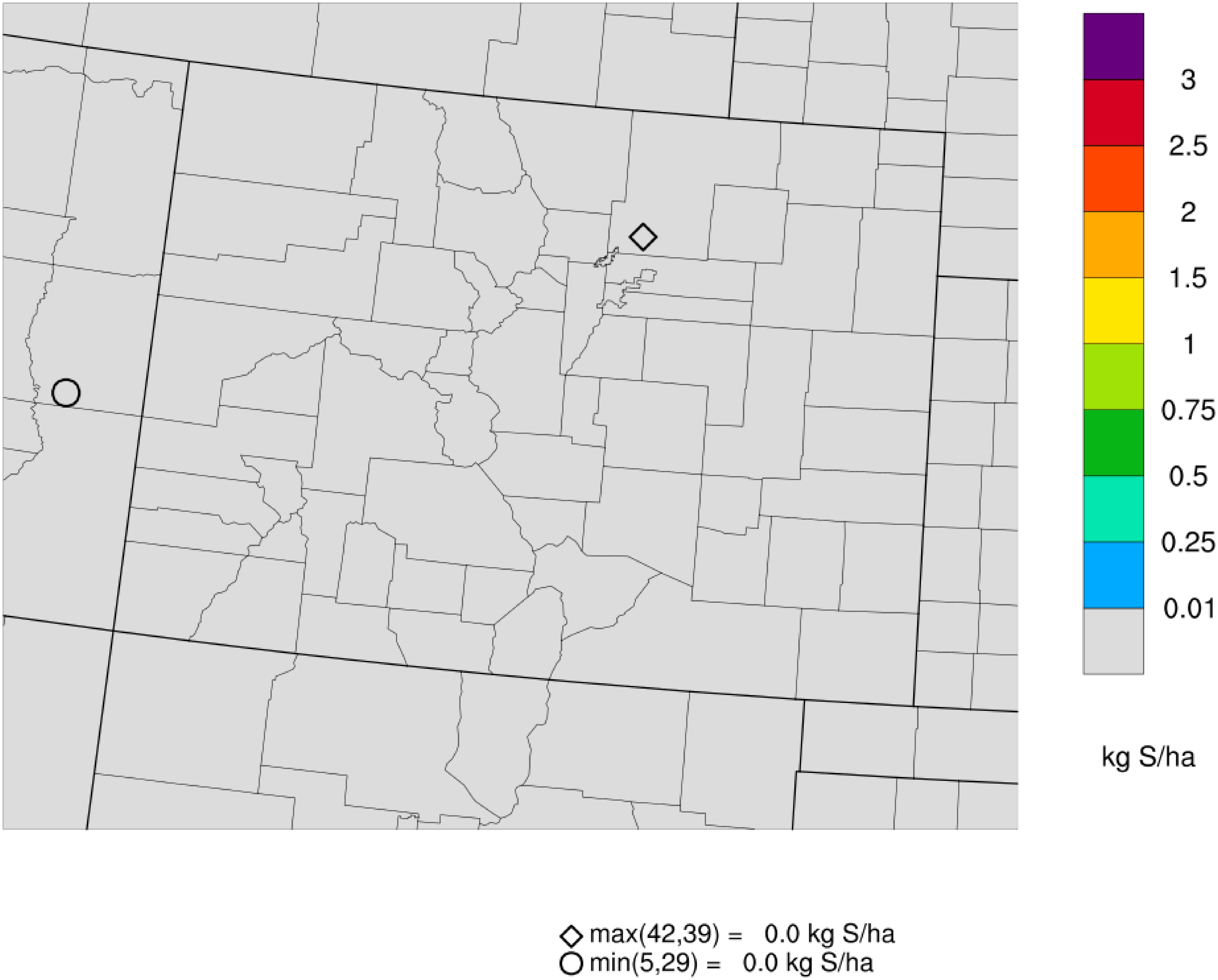
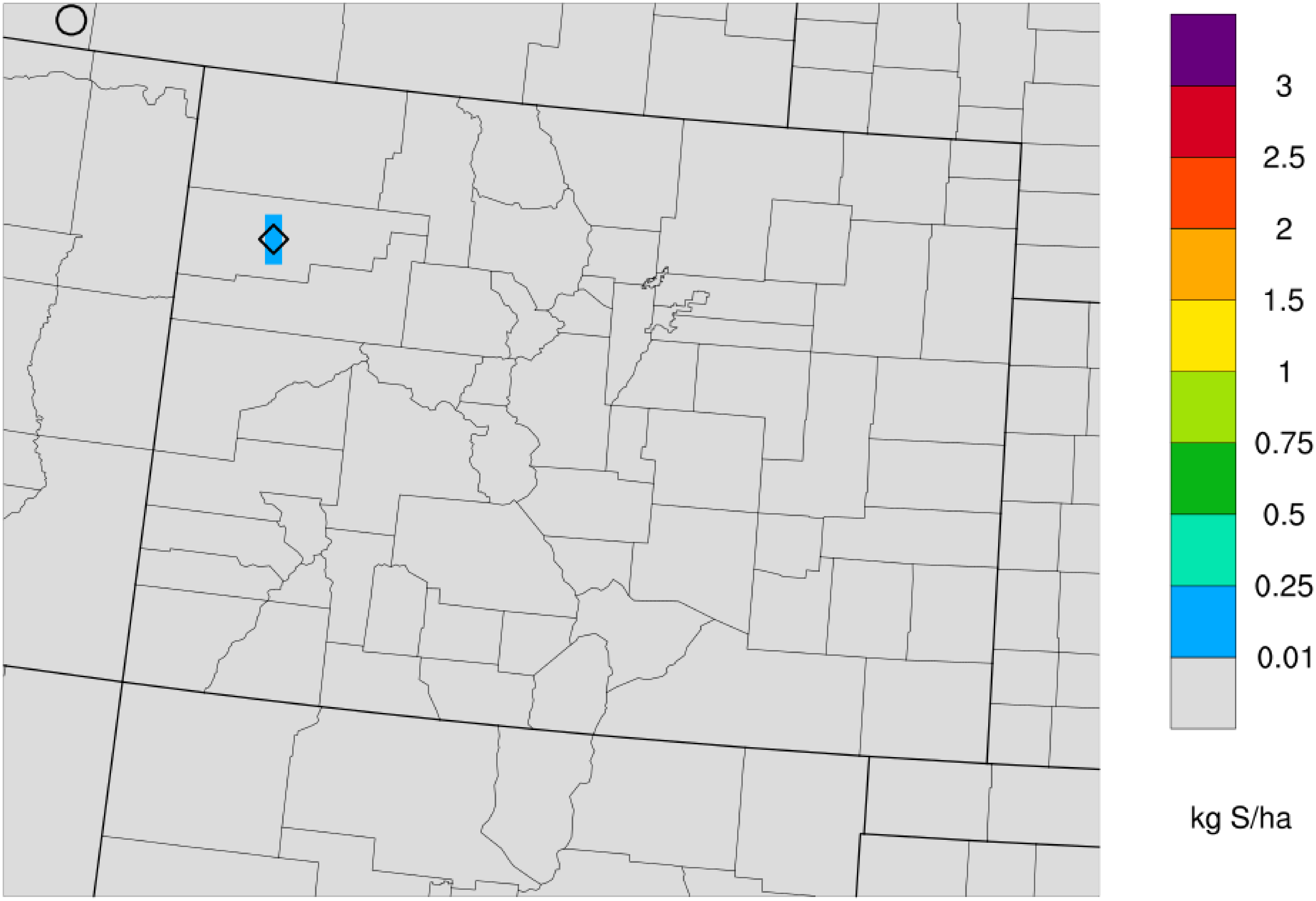
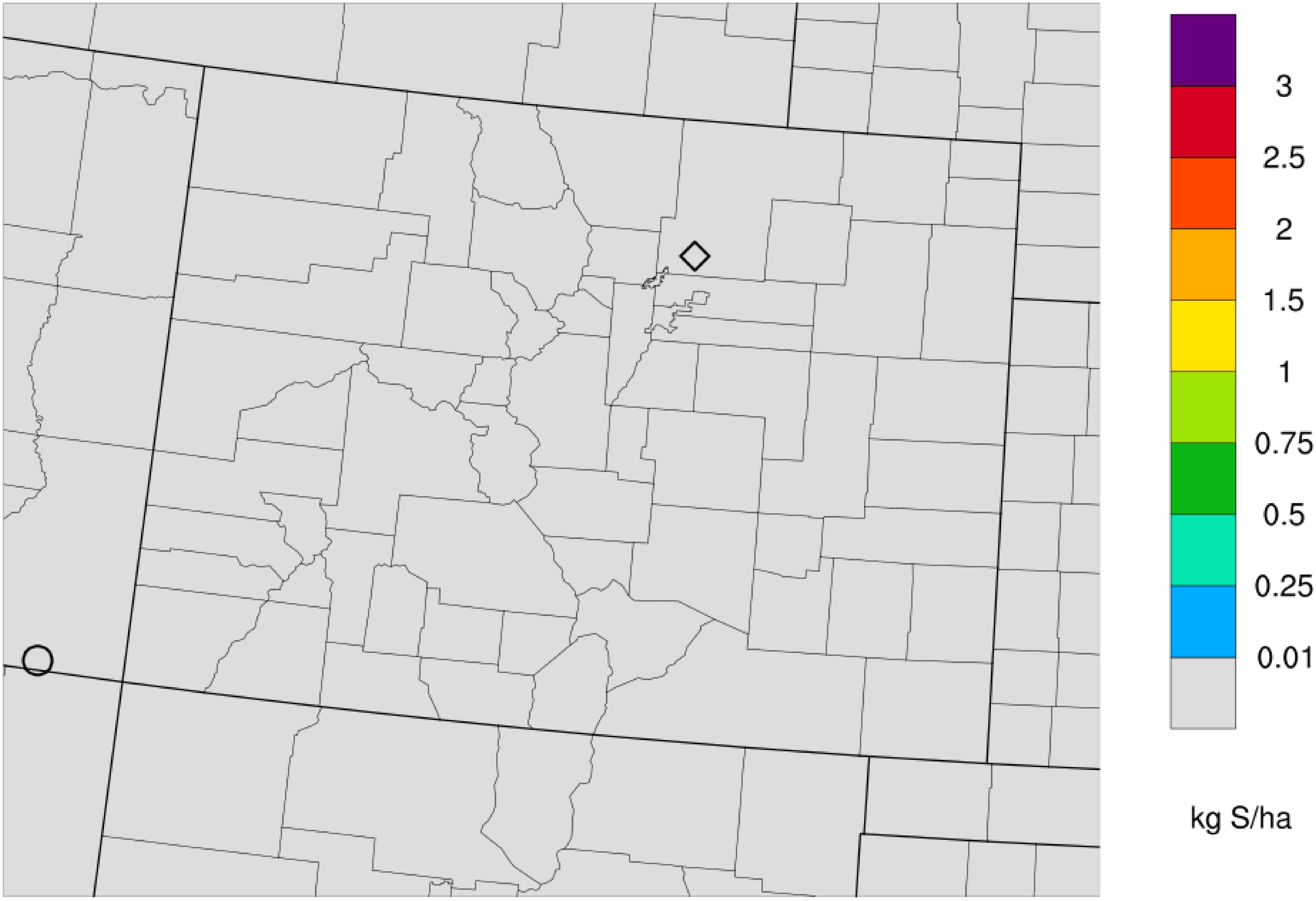


Figure CO.SDEP.6
Annual Total Sulfur Deposition
OilGas_NewFed_WesternCO



◇ max(17,40) = 0.0 kg S/ha
○ min(5,53) = 0.0 kg S/ha

Figure CO.SDEP.7
Annual Total Sulfur Deposition
OilGas_NewFed_RoyalGorge



◇ max(42,39) = 0.0 kg S/ha
○ min(3,15) = 0.0 kg S/ha

Figure CO.SDEP.8
Annual Total Sulfur Deposition
OilGas_Fed_Other_States

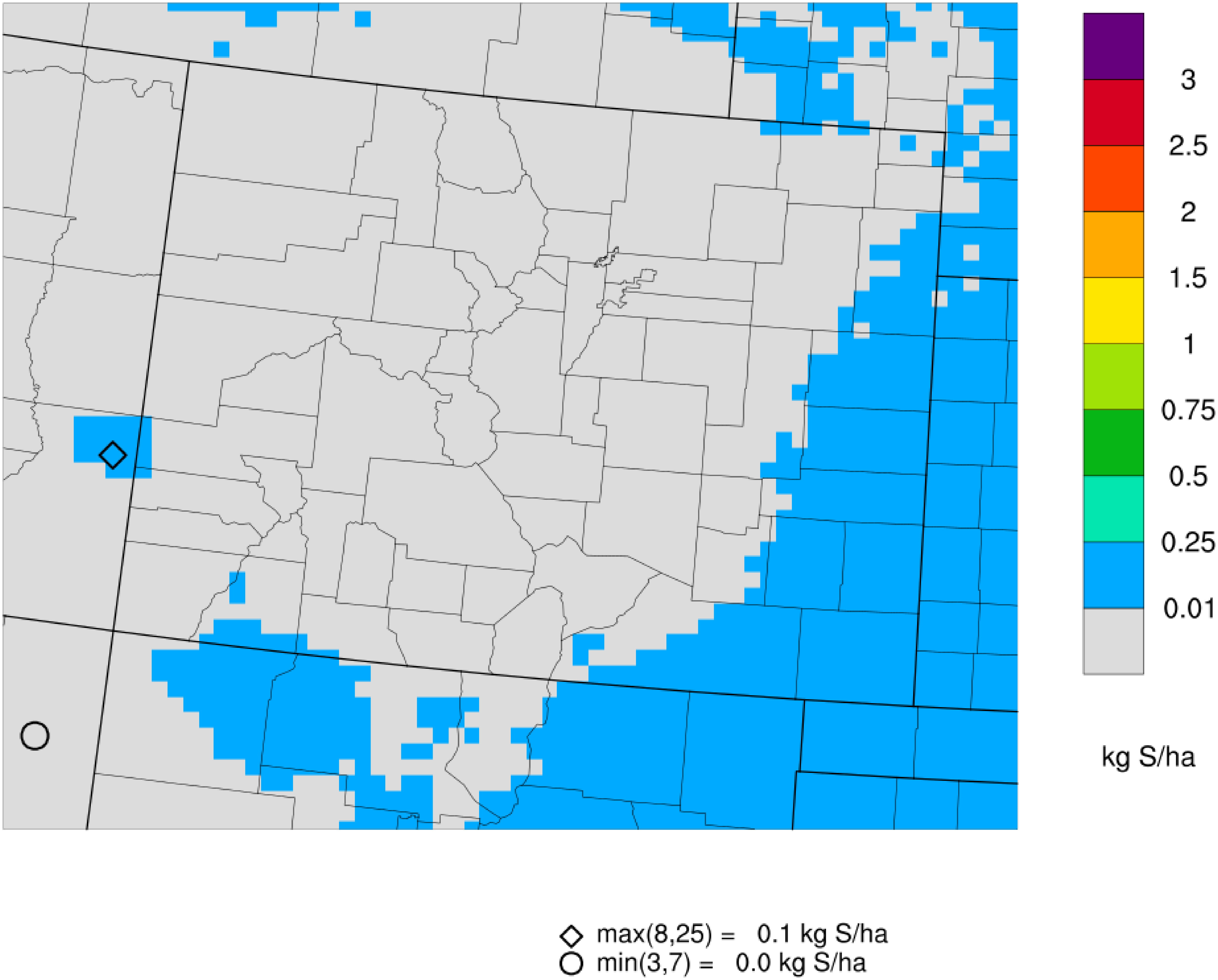


Figure CO.SDEP.9
Annual Total Sulfur Deposition
OilGas_NonFed

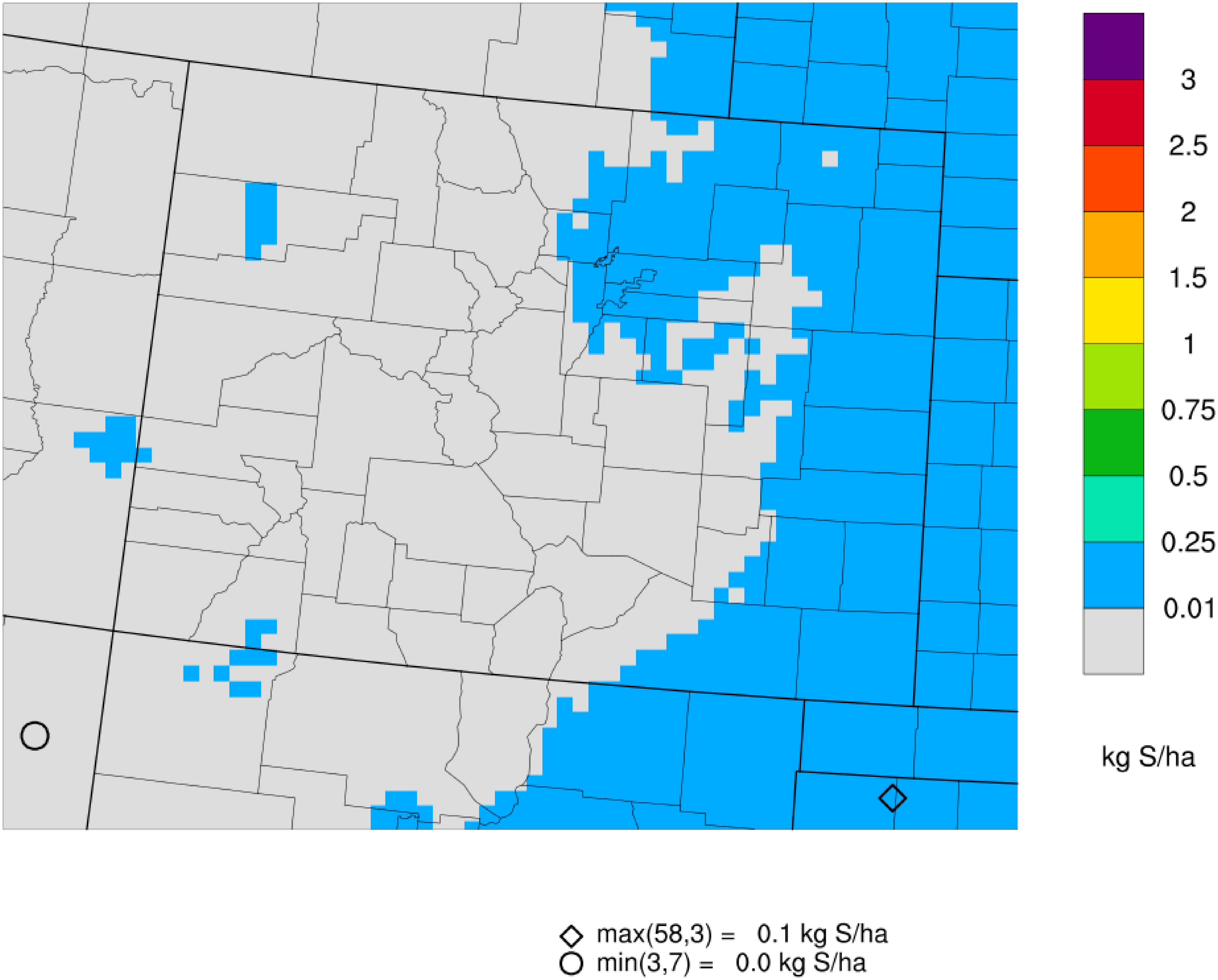


Figure CO.SDEP.10
Annual Total Sulfur Deposition
OilGas_ExistTribal

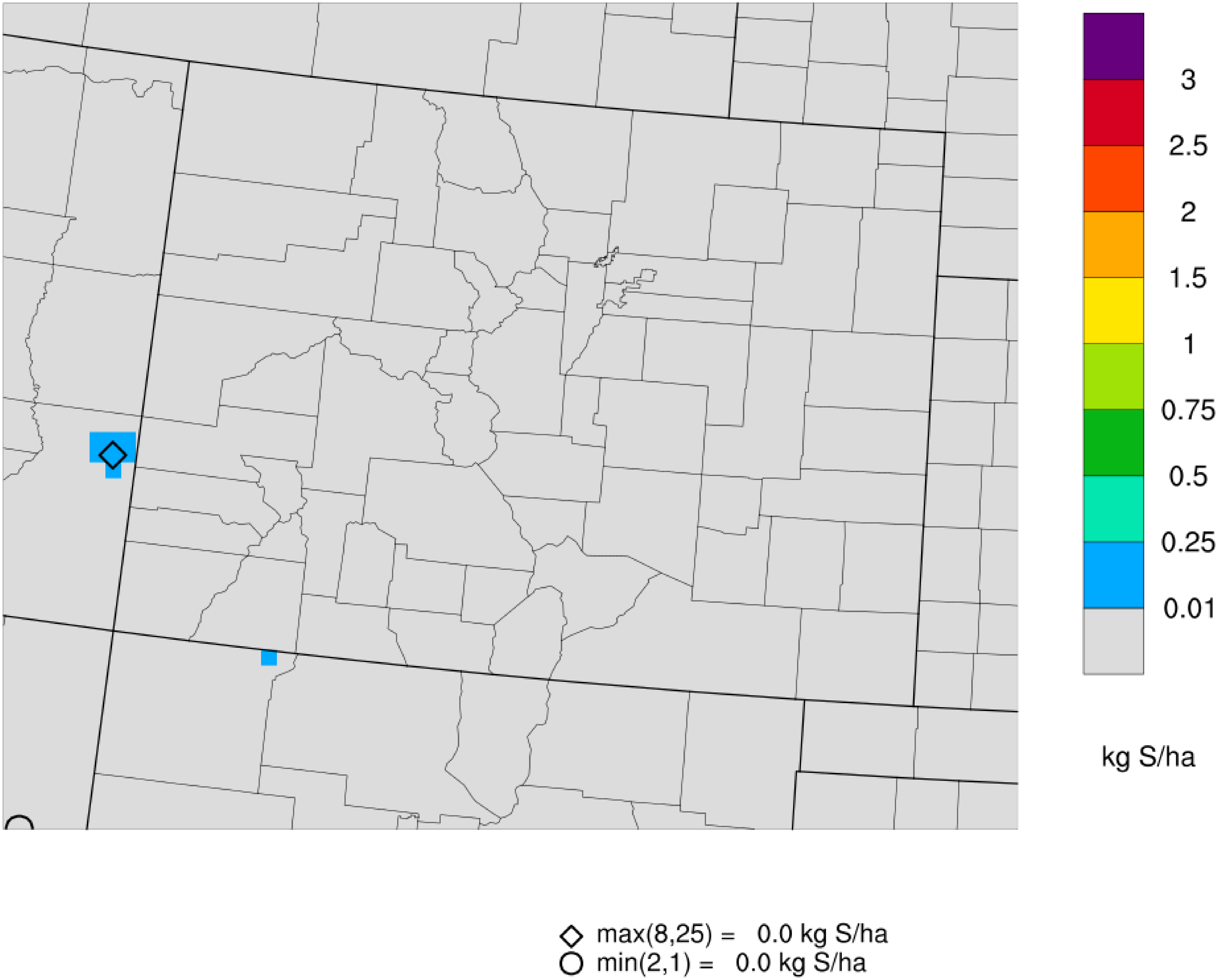


Figure CO.SDEP.11
Annual Total Sulfur Deposition
OilGas_NewTribal

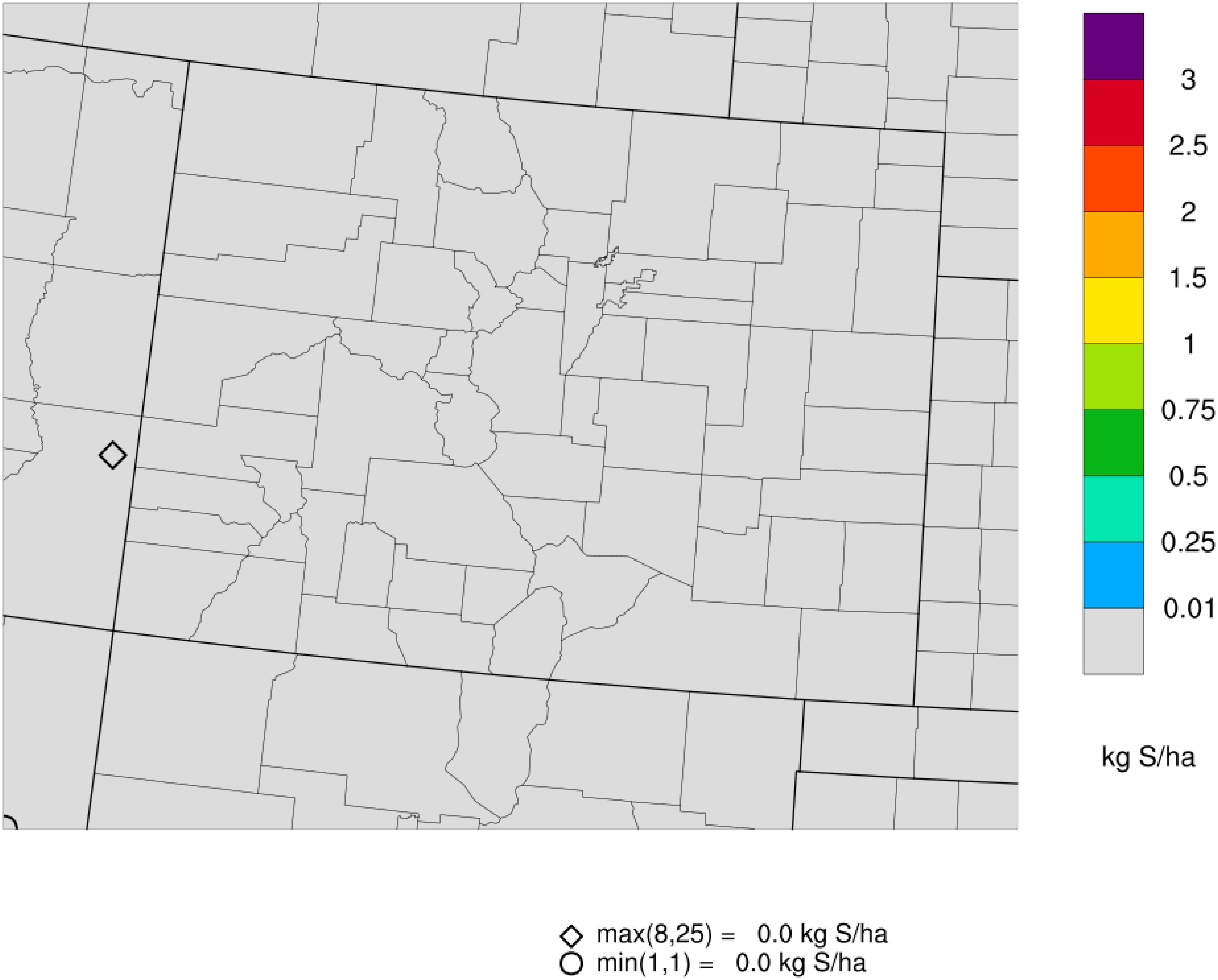


Figure CO.SDEP.12
Annual Total Sulfur Deposition
Coal_Fed

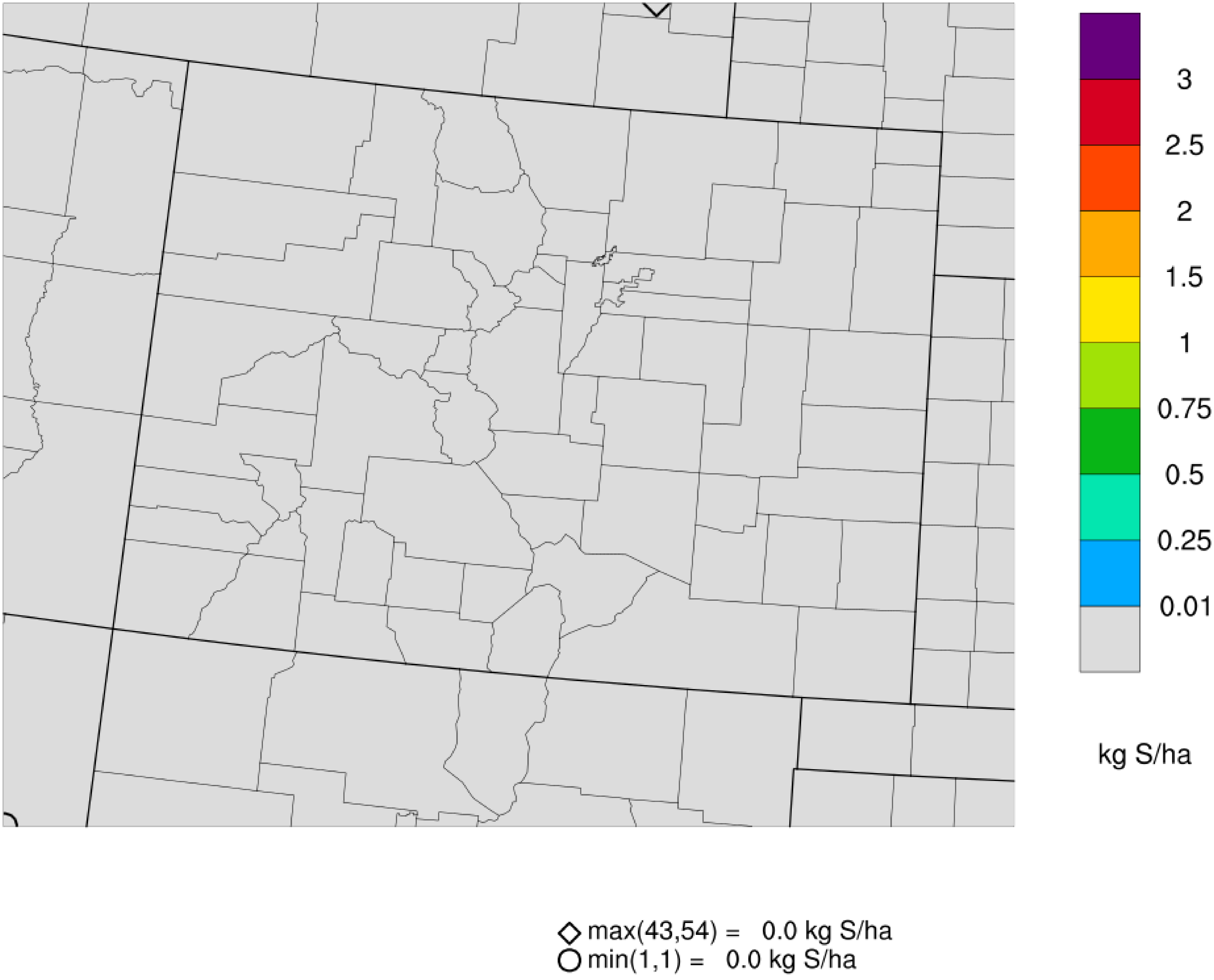
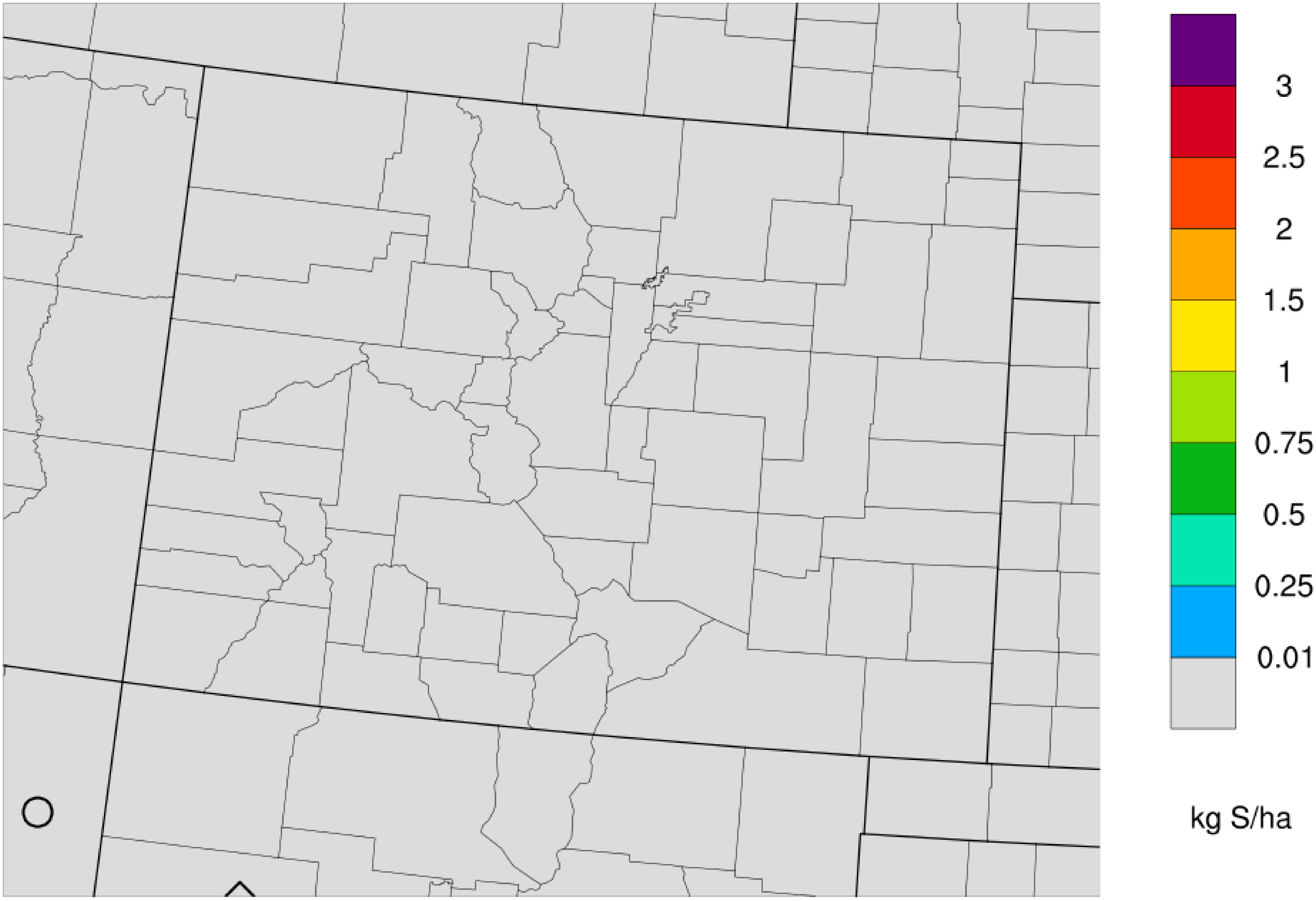
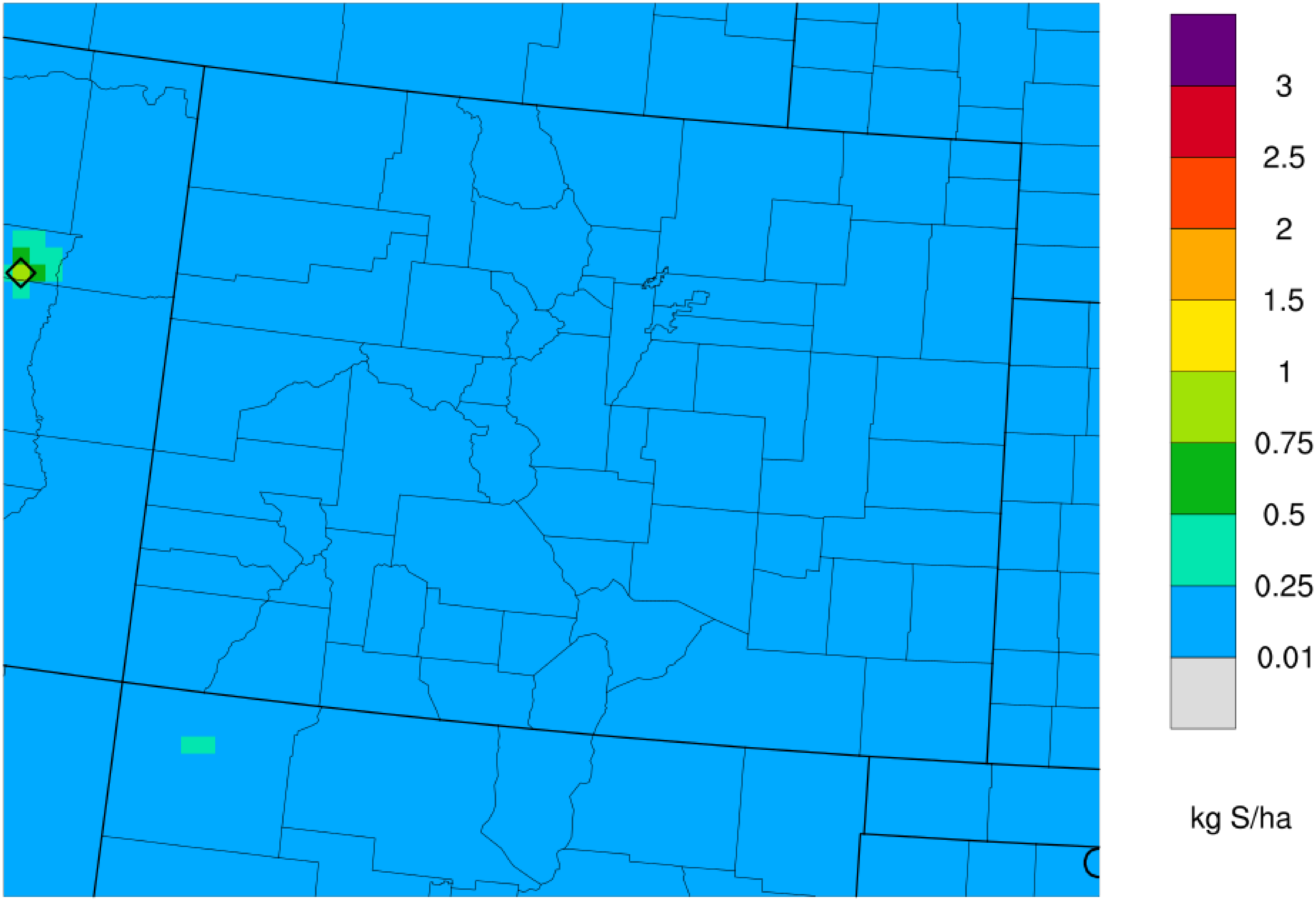


Figure CO.SDEP.13
Annual Total Sulfur Deposition
Coal_NonFed



◇ max(15,1) = 0.0 kg S/ha
○ min(3,6) = 0.0 kg S/ha

Figure CO.SDEP.14
Annual Total Sulfur Deposition
Coal_EGU WRAP states



◇ max(2,38) = 1.0 kg S/ha
○ min(66,3) = 0.0 kg S/ha

Figure CO.SDEP.15
Annual Total Sulfur Deposition
Coal_Comb WRAP states

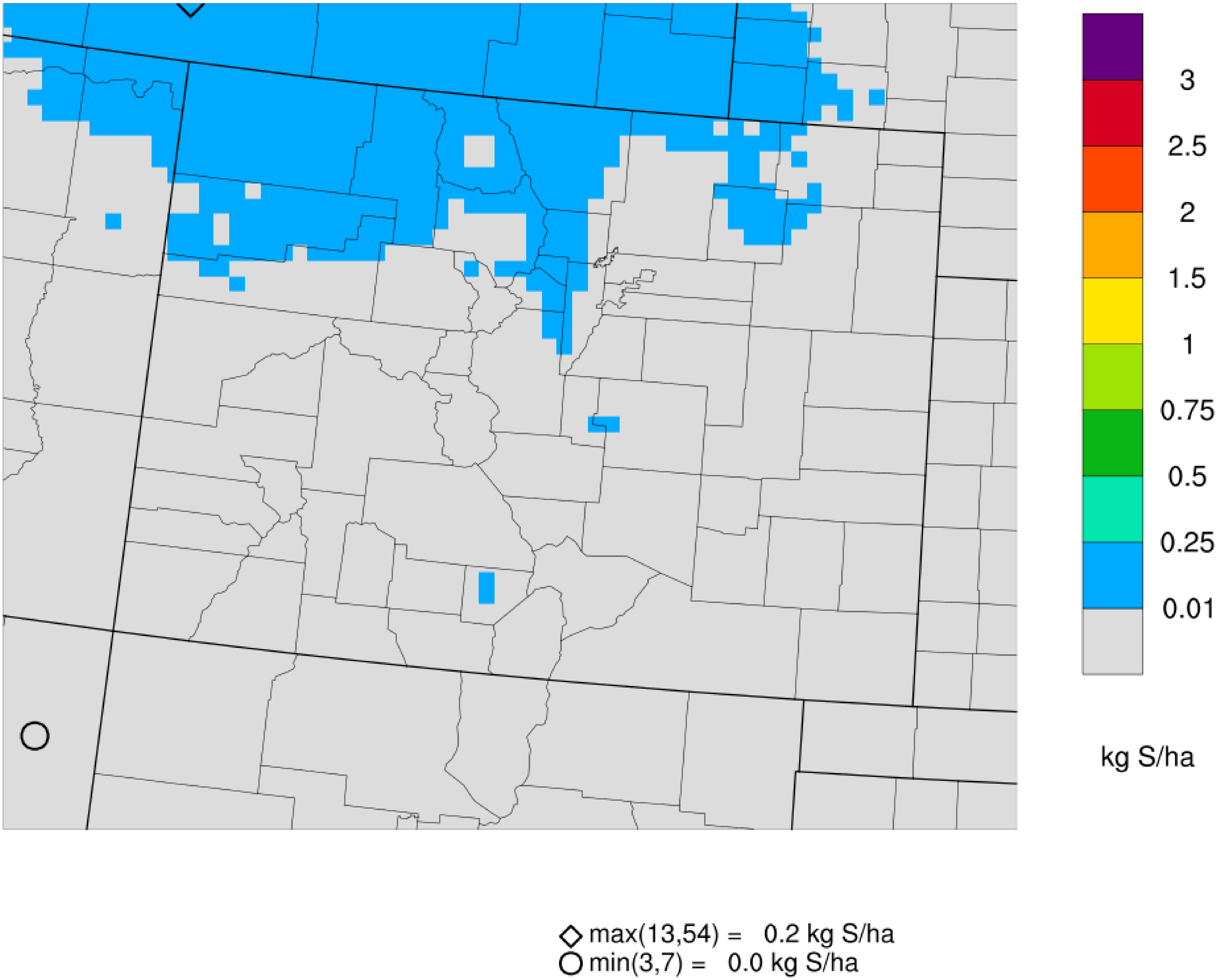


Figure CO.SDEP.16
Annual Total Sulfur Deposition
OtherEGU

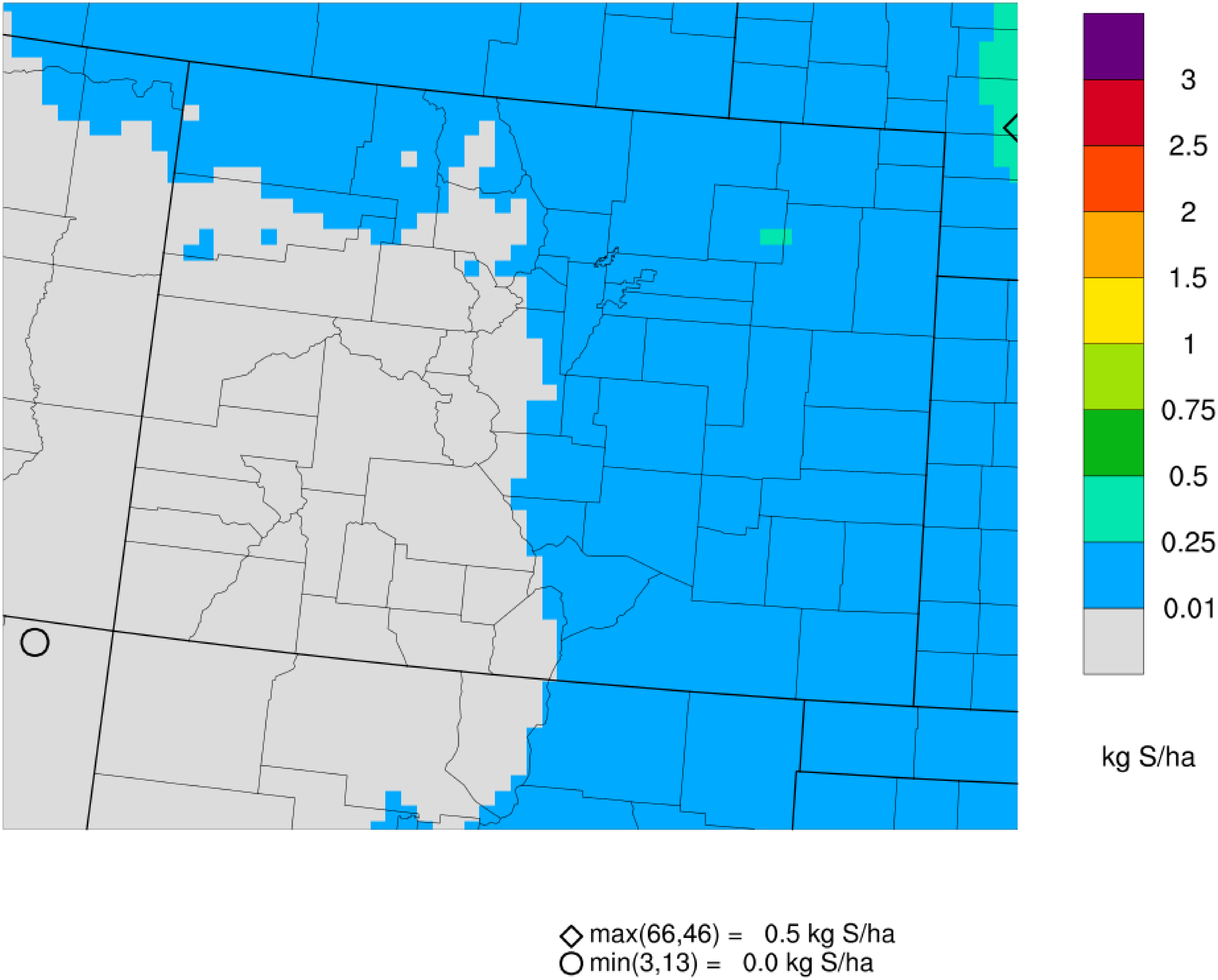


Figure CO.SDEP.17
Annual Total Sulfur Deposition
Anthro_Rest