

Novel tools for emissions inventory development and verification

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Overview

- Web-based tools for emissions inventory review and QA
- On-the-fly aggregations across emissions sectors, pollutants, geographic regions
- Dynamic charts and GIS capabilities
- Metadata overlays
- Potential applications in emissions inventory development, QA, and validation for air quality modeling studies

Outline

- Display tool for 2014 NEIv2 (see also EPA NEI Report Dashboard¹)
- Review tool for 2016 Inventory Collaborative emissions modeling platform (includes 2011, 2014 and 2016 base years and projections)
- Inventory development (e.g. 2017 NEI)
- Research applications (e.g. NPS air quality modeling study on reduced N impacts)

Emissions Inventory Data

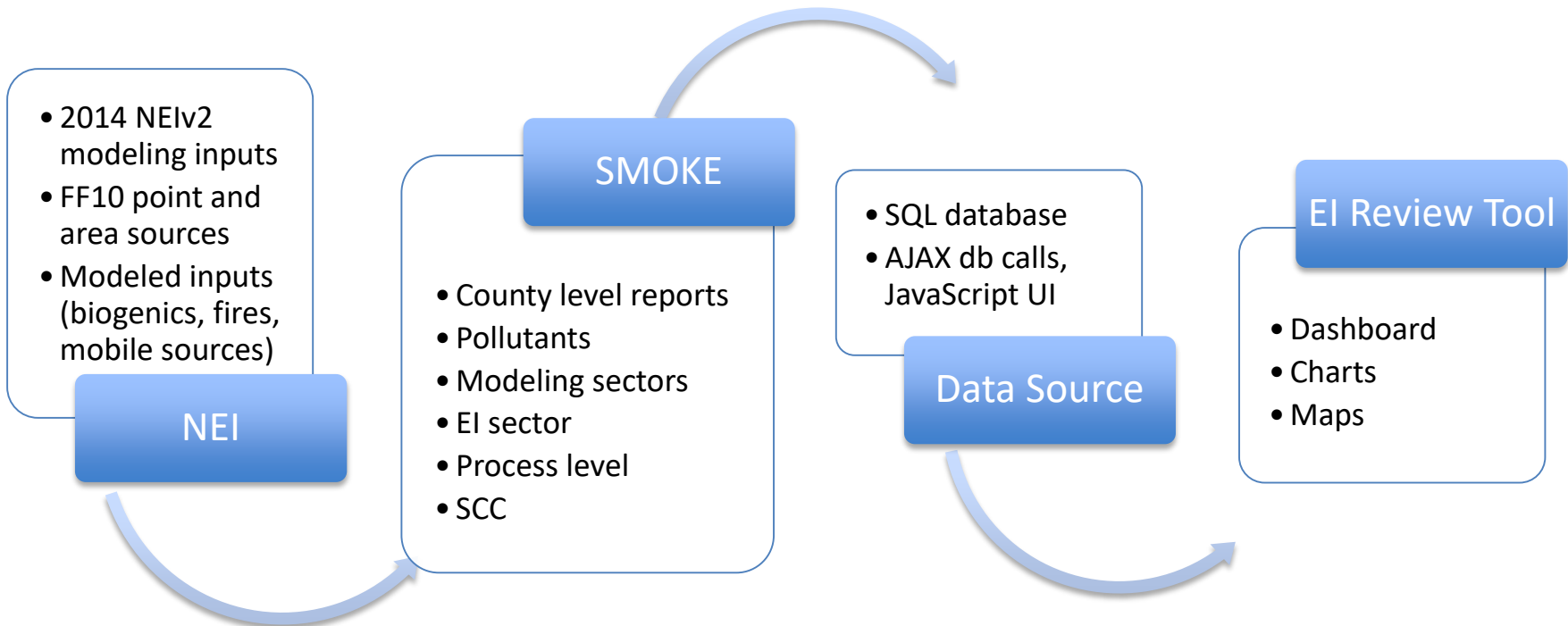
Bottom-up (NEI)

- Modeling platform inputs (point and area sources)
- SMOKE processed emissions (county level reports, gridded inputs for AQ models)
- EPA summary data for 2014 NEIv2 includes EI sectors, process, CAPs and HAPs
- 2014 NEI derivative datasets for AQ modeling (e.g. 2016 Inventory Collaborative)
- Tools presented here focus on US national and regional modeling applications

Top-down (Satellite)

- IASI (MetOp-A,B), TES (Aura), CrIS (JPSS), AIRS (Aqua)
- Applications shown here focus on retrievals from microwave sounders onboard polar orbiting satellites

2014 NEIv2 Review



Implementation:

- 2014 NIEv2 EPA summary data². Tool access through OGEC Information Repository, <http://vibe.cira.colostate.edu/ogec/Emissions/2014NEIv2>

2014 NEIv2 Review

Emissions Inventory Charting Tool

A visualization tool for EPA's 2014 NEIv2 summary data. Any combination of pollutants and emissions sectors can be displayed on the chart, and state or county map. The maps allow for drilldown to individual state or county data in the chart view. Underlying data for the maps and charts is shown in tabular format. More information on the emissions inventory charting tool is available [here](#). Source data are EPA's [county_tribe_allsector](#) data files.

Pollutants 20 CAPs HAPs

- PM Condensable
- PM10 Filterable
- PM10 Primary (Filt + Cond)
- PM10-Primary from certain diesel engines
- PM2.5 Filterable
- PM2.5 Primary (Filt + Cond)
- PM25-Primary from certain diesel engines
- Remaining PMFINE portion of PM2.5-PRI
- Sulfate Portion of PM2.5-PRI
- Sulfur Dioxide
- Tert-butyl Acetate
- Volatile Organic Compounds

Clear All PM2.5 QA

Filter pollutant list by selected sector(s)

Sectors 60

- Fuel Comb - Residential - Other
- Fuel Comb - Residential - Wood
- Gas Stations
- Industrial Processes - Cement Manuf
- Industrial Processes - Chemical Manuf
- Industrial Processes - Ferrous Metals
- Industrial Processes - Mining
- Industrial Processes - NEC
- Industrial Processes - Non-ferrous Metals
- Industrial Processes - Oil & Gas Production
- Industrial Processes - Petroleum Refineries
- Industrial Processes - Pulp & Paper
- Industrial Processes - Storage and Transfer

Select All All Anthro

Filter sector list by selected pollutant(s) No Filters

Regions

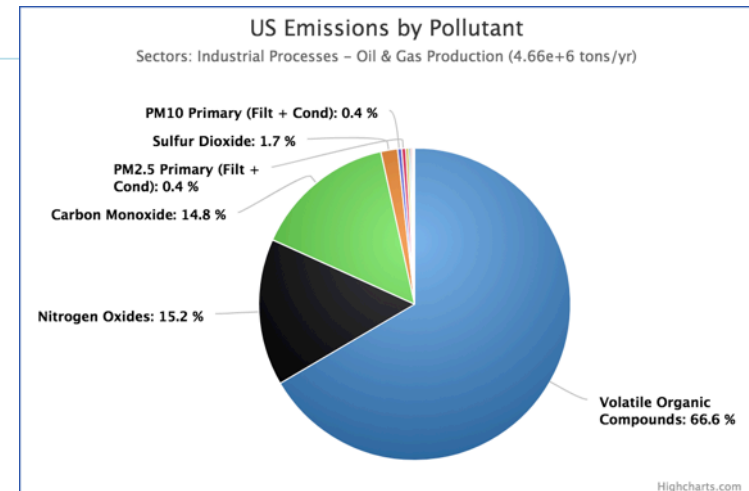
- US** Total emissions across all states (includes tribal emissions)
- Tribal Lands** Emissions totals across all tribal lands
- States** Emissions totals by state (opens a map view). Note that state totals include "Portable Facilities", which are reported at the state level.
- Counties** Emissions totals by county (opens a map view)
- Individual Tribal Lands** Emissions totals by individual tribe (tabular data and pie chart only)

Filter states or counties by RPO

Note: click on "States" or "Counties" above, then press "Update", to open a Map View.

Dashboard

- Pollutants: CAPs (all)
- Sectors: O&G Production
- Region: US totals



2014 NEIv2 Review

Emissions Inventory Charting Tool

A visualization tool for EPA's 2014 NEIv2 summary data. Any combination of pollutants and emissions sectors can be displayed on the chart, and state or county map. The maps allow for drilldown to individual state or county data in the chart view. Underlying data for the maps and charts is shown in tabular format. More information on the emissions inventory charting tool is available [here](#). Source data are EPA's [county_tribe_allsector](#) data files.

Pollutants 282 CAPs HAPs **Sectors 56** **Regions**

1,1,1,2,2-Tetrachloroethane	Industrial Processes - Chemical and Allied Products
1,1,2-Trichloroethane	Industrial Processes - Ferrous Metals
1,1-Dimethyl Hydrazine	Industrial Processes - Mining
1,2,3,4,5,6-Hexachlorocyclohexane	Industrial Processes - NEC
1,2,3,4,6,7,8-Heptachlorodibenzofuran	Industrial Processes - Non-ferrous Metals
1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	Industrial Processes - Oil & Gas Production
1,2,3,4,7,8,9-Heptachlorodibenzofuran	Industrial Processes - Petroleum Refineries
1,2,3,4,7,8-Hexachlorodibenzofuran	Industrial Processes - Pulp & Paper
1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	Industrial Processes - Storage and Transfer
1,2,3,6,7,8-Hexachlorodibenzofuran	Miscellaneous Non-Industrial NEC
1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	Mobile - Aircraft
1,2,3,7,8,9-Hexachlorodibenzofuran	Mobile - Commercial Marine Vessels
1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	Mobile - Locomotives

Filter states or counties by RPO:

Note: click on "States" or "Counties" above, then press "Update", to open a Map View.

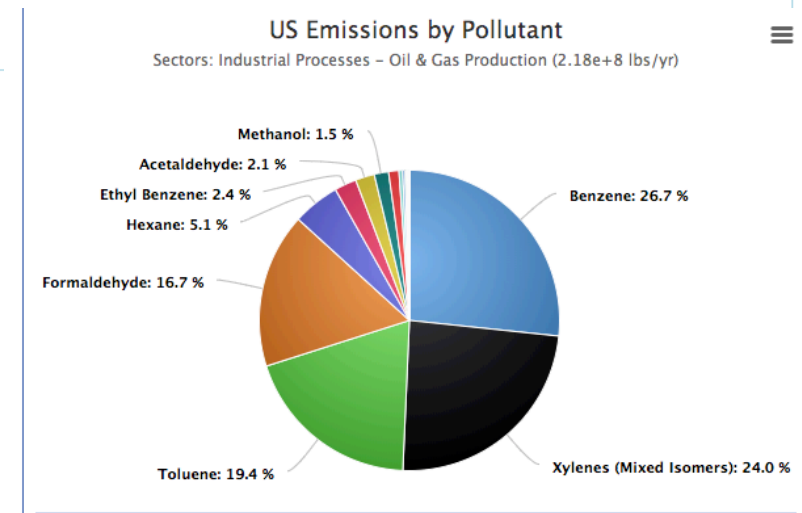
Regions:

- US** Total emissions across all states (includes tribal emissions)
- Tribal Lands** Emissions totals across all tribal lands
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Filter pollutant list by selected sector(s) Filter sector list by selected pollutant(s) No Filters

Dashboard

- Pollutants: HAPs (all)
- Sectors: O&G Production
- Region: US totals



2014 NEIv2 Review

Emissions Inventory Charting Tool

A visualization tool for EPA's 2014 NEIv2 summary data. Any combination of pollutants and emissions sectors can be displayed on the chart, and state or county map. The maps allow for drilldown to individual state or county data in the chart view. Underlying data for the maps and charts is shown in tabular format. More information on the emissions inventory charting tool is available [here](#). Source data are EPA's [county_tribe_allsector](#) data files.

Pollutants 90 **Sectors 56** **Regions**

CAPs HAPs

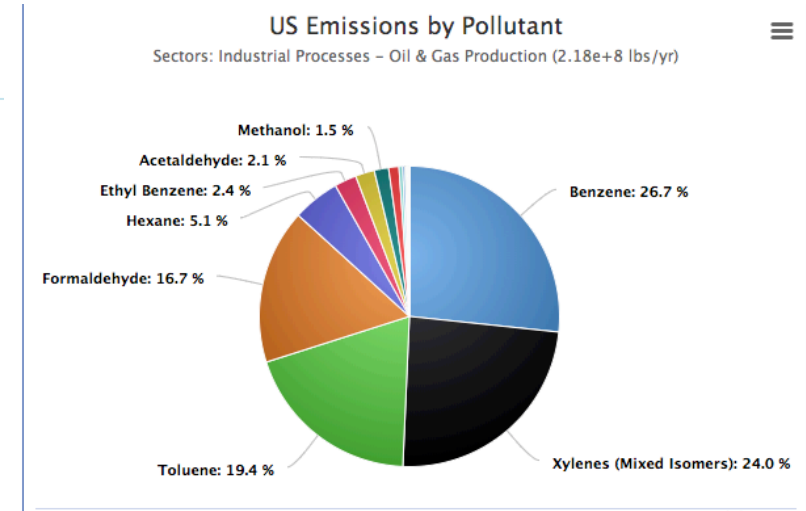
1,1,2,2-Tetrachloroethane	Industrial Processes - Cement Manuf
1,1,2-Trichloroethane	Industrial Processes - Chemical Manuf
1,2,4-Trichlorobenzene	Industrial Processes - Ferrous Metals
1,3-Butadiene	Industrial Processes - Mining
1,3-Dichloropropene	Industrial Processes - NEC
1,4-Dichlorobenzene	Industrial Processes - Non-ferrous Metals
2,2,4-Trimethylpentane	Industrial Processes - Oil & Gas Production
2-Methylnaphthalene	Industrial Processes - Petroleum Refineries
3-Methylcholanthrene	Industrial Processes - Pulp & Paper
7,12-Dimethylbenz[a]Anthracene	Industrial Processes - Storage and Transfer
Acenaphthene	Miscellaneous Non-Industrial NEC
Acenaphthylene	Mobile - Aircraft
Acetaldehyde	Mobile - Commercial Marine Vessels

Filter states or counties by RPO:

Note: click on "States" or "Counties" above, then press "Update", to open a Map View.

Dashboard

- Pollutants: HAPs (filtered to sectors)
- Sectors: O&G Production
- Region: US total



2014 NEIv2 Review

Emissions Inventory Charting Tool

A visualization tool for EPA's 2014 NEIv2 summary data. Any combination of pollutants and emissions sectors can be displayed on the chart, and state or county map. The maps allow for drilldown to individual state or county data in the chart view. Underlying data for the maps and charts is shown in tabular format. More information on the emissions inventory charting tool is available [here](#). Source data are EPA's [county_tribe_allsector](#) data files.

Pollutants 90 **Sectors 56** **Regions**

CAPs HAPs

1,1,1,2-Tetrachloroethane 1,1,2-Trichloroethane 1,2,4-Trichlorobenzene 1,3-Butadiene 1,3-Dichloropropene 1,4-Dichlorobenzene 2,2,4-Trimethylpentane 2-Methylnaphthalene 3-Methylcholanthrene 7,12-Dimethylbenz[a]Anthracene Acenaphthene Acenaphthylene Acetaldehyde	Industrial Processes - Cement Manuf Industrial Processes - Chemical Manuf Industrial Processes - Ferrous Metals Industrial Processes - Mining Industrial Processes - NEC Industrial Processes - Non-ferrous Metals Industrial Processes - Oil & Gas Production Industrial Processes - Petroleum Refineries Industrial Processes - Pulp & Paper Industrial Processes - Storage and Transfer Miscellaneous Non-Industrial NEC Mobile - Aircraft Mobile - Commercial Marine Vessels
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US Total emissions across all states (includes tribal emissions)
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 States Emissions totals by state (opens a map view). Note that state totals include "Portable Facilities", which are reported at the state level.
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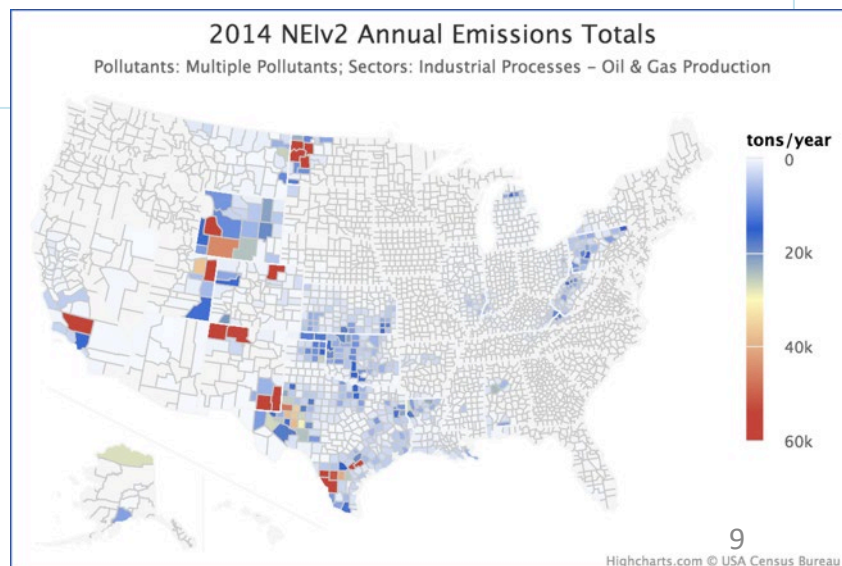
Filter states or counties by RPO:

Note: click on "States" or "Counties" above, then press "Update", to open a Map View.

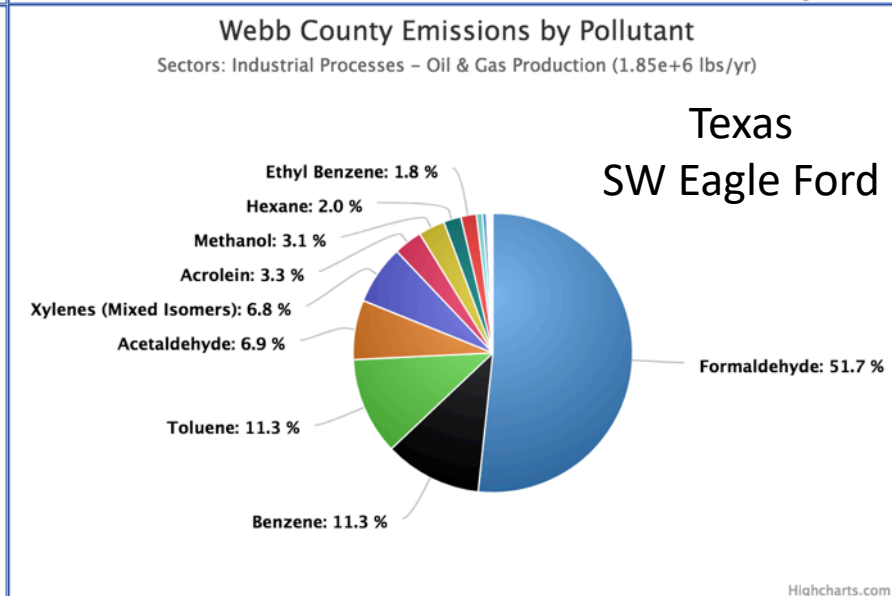
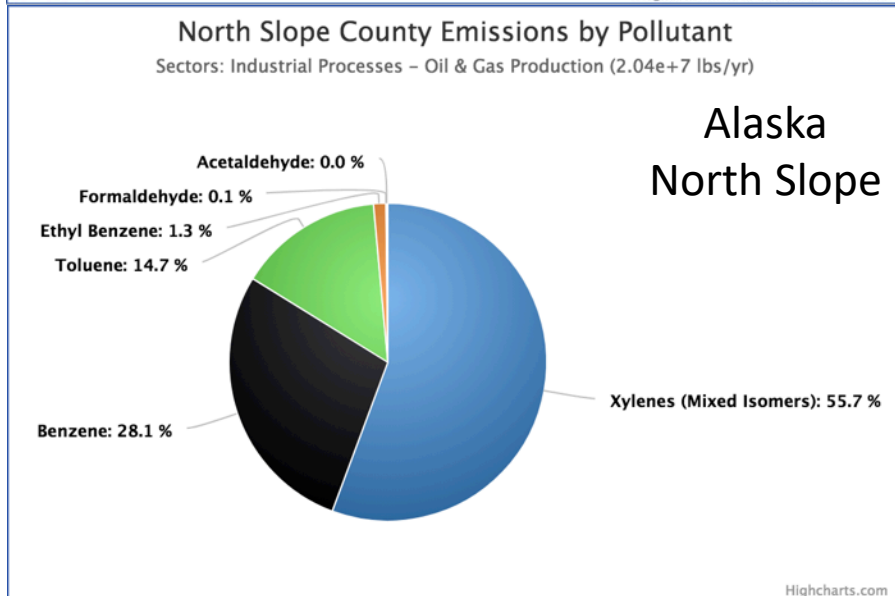
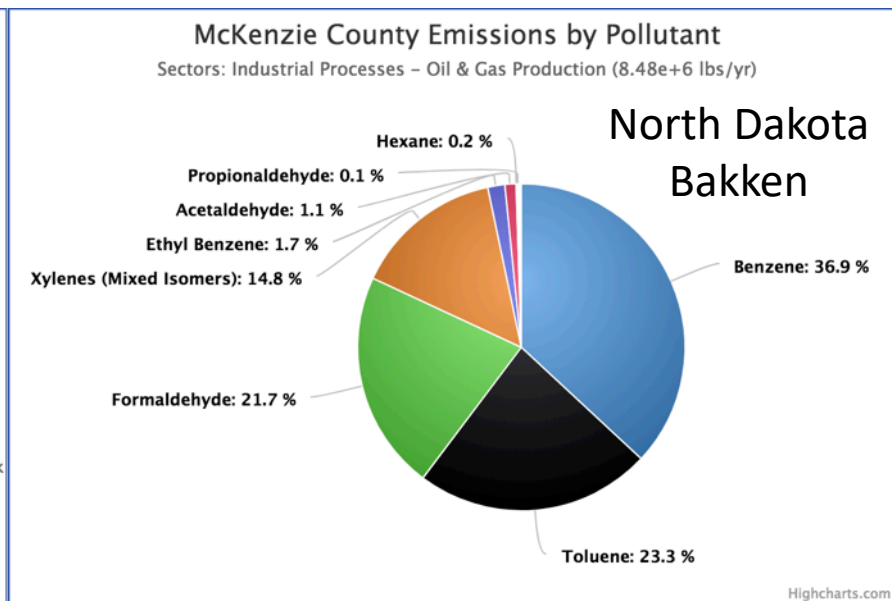
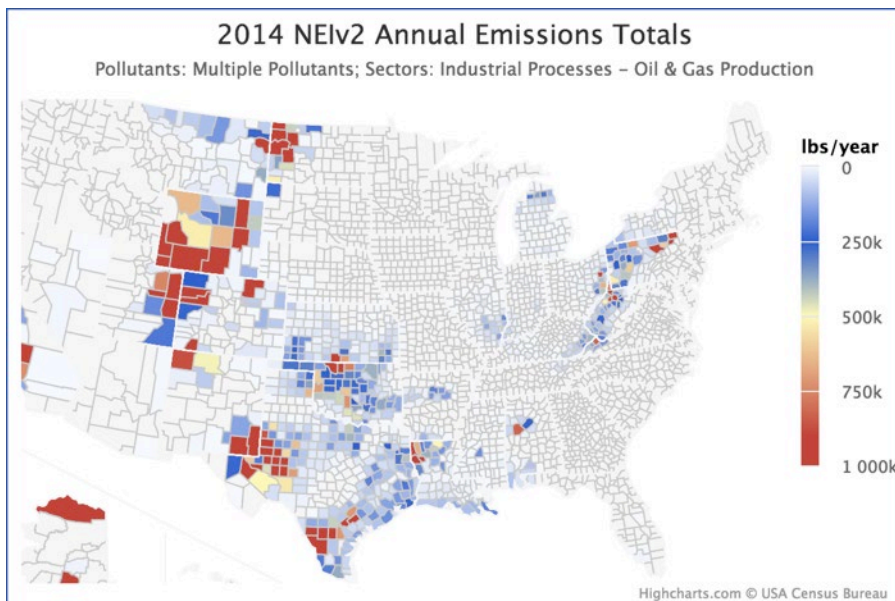
Filter pollutant list by selected sector(s) Filter sector list by selected pollutant(s) No Filters

Dashboard

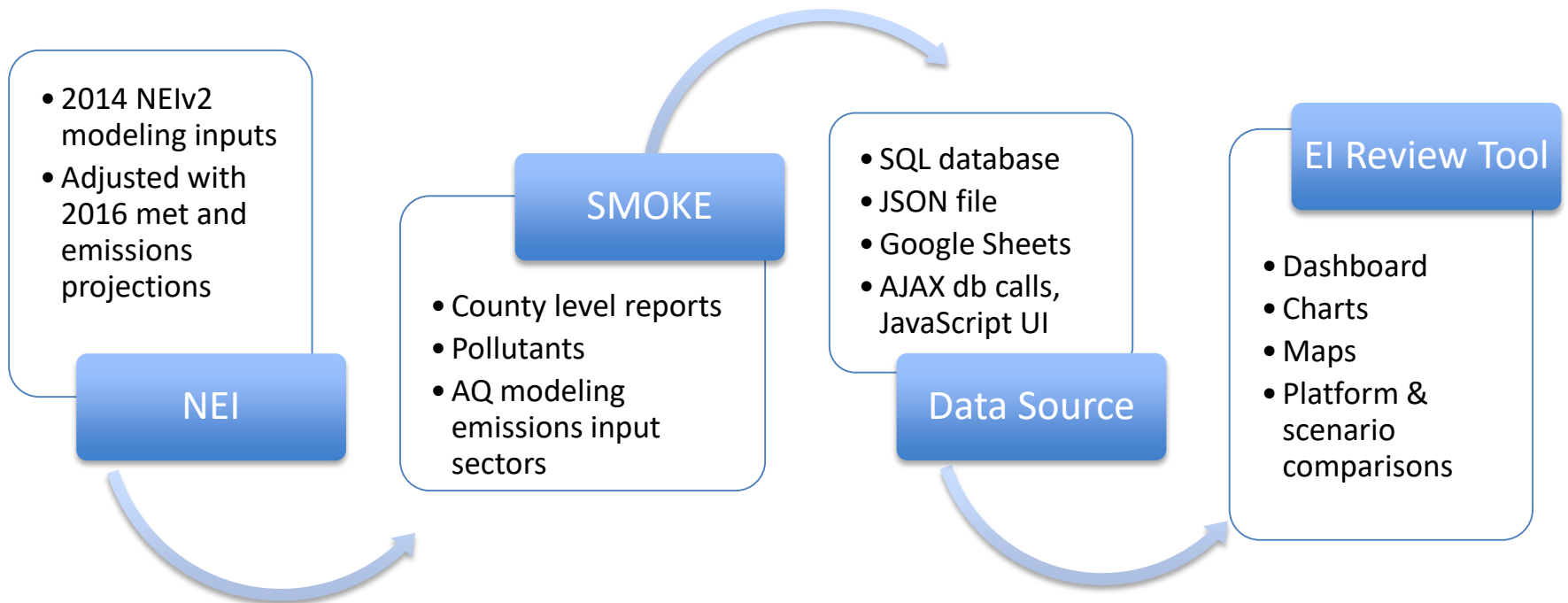
- Pollutants: HAPs (all)
- Sectors: O&G Production
- Region: US total



Case Study: Industrial Oil & Gas Production Sector. The pie charts show the contribution of HAPs in inventories from three oil & gas basins. Note the difference in chemical composition, with high aldehydes contributions in Eagle Ford Shale, and BTEX compounds in the Bakken and North Slope.



Inventory Collaborative



Implementation:

- 2016 EMP Tool access on LADCO website

<https://www.ladco.org/technical/modeling-results/2016-inventory-collaborative/>

Inventory Collaborative

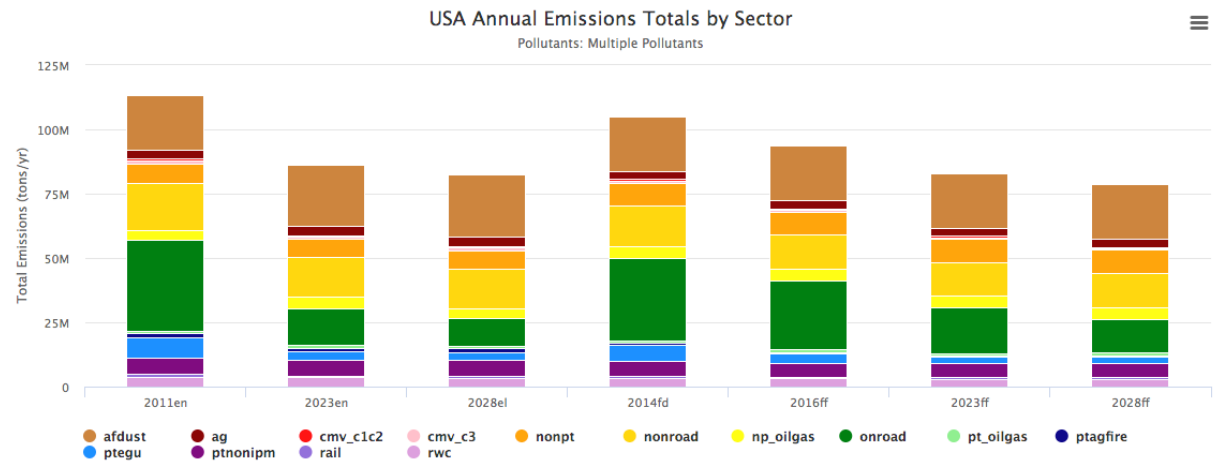
Emissions Inventories - 2016 EMP

This site displays emissions inventories developed by the [Inventory Collaborative](#) for the 2016 Emissions Modeling Platform (EMP). Select emissions sectors, pollutants and modeling platforms/scenarios, then press the Update button to refresh the charts and map. The tab name for the bar charts below indicates the respective chart's x-axis. The map shows either state or county emissions totals for a single platform or platform comparison. The 2016 beta platform base and future year reflect county level SMOKE reports updated on 04 April 2019. Modeling platform descriptions and instructions for using this tool are available [here](#). **Note: Biogenics are not included in beta scenarios 2023ff and 2028ff.**

Parameters		Platforms		Region	
Sectors - 16	Pollutants - 7	Platforms/Scenarios	Comparisons	Map Display	
<ul style="list-style-type: none"> afdust ag beis cmv_c1c2 cmv_c3 nonpt nonroad np_oilgas onroad pt_oilgas ptagfire ntegu 	<ul style="list-style-type: none"> CO NH3 NOX PM10-PRI PM25-PRI SO2 VOC 	<ul style="list-style-type: none"> 2011v6.3 2011en 2023en 2028el 2014 NATA 2014fd 2016 alpha 2016fe 2016 beta 2016ff 2023ff 2028ff 	<ul style="list-style-type: none"> 2016ff-2011en 2016ff-2014fd 2016fe-2014fd 2016ff-2016fe 2023ff-2016ff 2028ff-2016ff 2023ff-2023en 2028ff-2028el 	Filter Results by Region <input type="text" value="USA"/>	
<input type="button" value="Select All"/> <input type="button" value="Clear All"/>		<input type="button" value="Update"/> If the "Update" button is colored red, press it to refresh the chart and map views.			
The buttons below update the charts and map without pressing the "Update" button.					
Charts: Sum by <input type="radio"/> Sectors <input checked="" type="radio"/> Pollutants					

Tip: Click on a chart series legend item to add/remove the series from the chart.

Platform



Dashboard

- Sectors: All anthro.
- Pollutants: CAPs
- Scenarios: 2011, 2014, 2016 beta Region: US
- Aggregation: by pollutant

Inventory Collaborative

Emissions Inventories - 2016 EMP

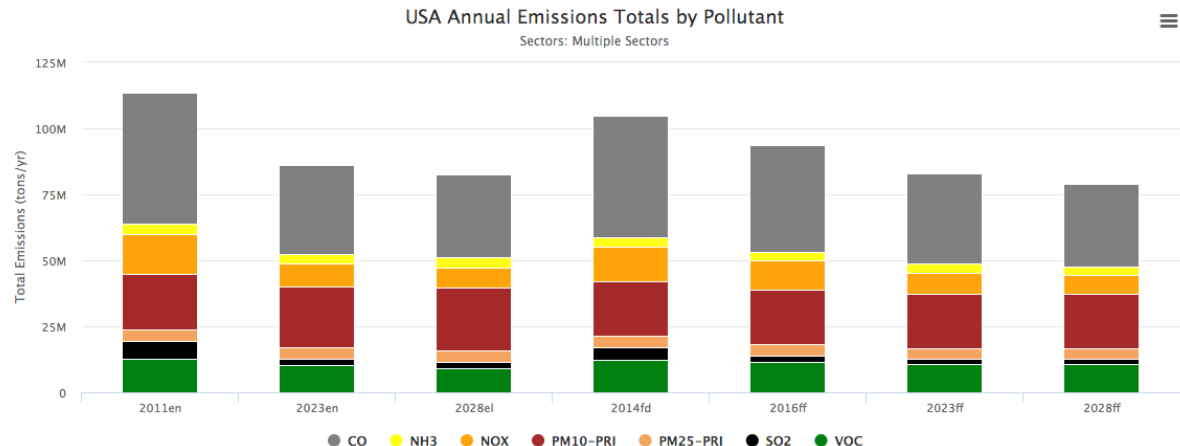
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Sectors - 16	Pollutants - 7	Platforms/Scenarios	Comparisons	Map Display	
afdust ag beis cmv_c1c2 cmv_c3 nonpt nonroad np_oilgas onroad pt_oilgas ptagfire nteau	CO NH3 NOX PM10-PRI PM25-PRI SO2 VOC	2011v6.3 2011en 2023en 2028el 2014 NATA 2014fd 2016 alpha 2016fe 2016 beta 2016ff 2023ff 2028ff	2016ff-2011en 2016ff-2014fd 2016fe-2014fd 2016ff-2016fe 2023ff-2016ff 2028ff-2016ff 2023ff-2023en 2028ff-2028el	Filter Results by Region USA	
<input type="button" value="Select All"/> <input type="button" value="Clear All"/>				<input type="button" value="Update"/> If the "Update" button is colored red, press it to refresh the chart and map views.	
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Charts: Sum by <input checked="" type="radio"/> Sectors <input type="radio"/> Pollutants					
Tip: Click on a chart series legend item to add/remove the series from the chart.					

Dashboard

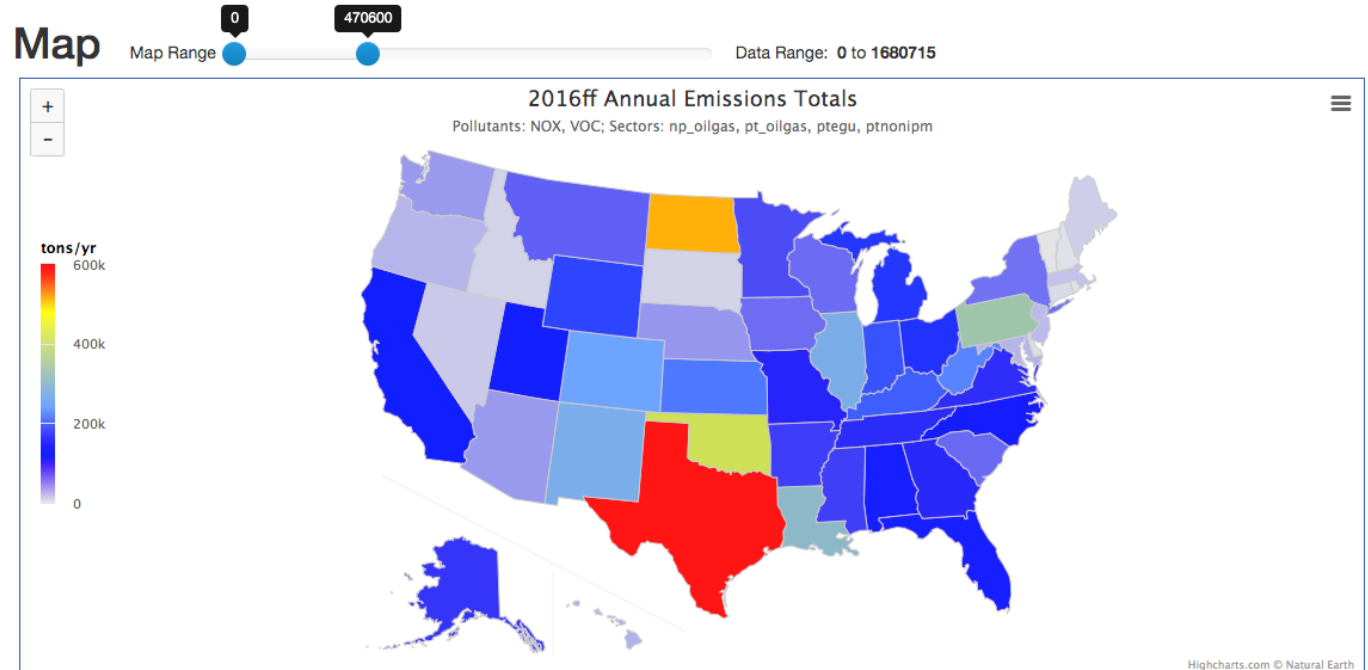
- Sectors: All anthro.
- Pollutants: CAPs
- Scenarios: 2011, 2014, 2016 beta Region: US
- Aggregation: by sector

Platform



Inventory Collaborative

Parameters	Platforms	Region
Sectors - 16 cmv_c3 nonpt nonroad np_oilgas onroad pt_oilgas ptagfire ptegu ptfire ptnonipm rail rwc <input type="button" value="Select All"/>	Pollutants - 7 CO NH3 NOX PM10-PRI PM25-PRI SO2 VOC <input type="button" value="Clear All"/>	Platforms/Scenarios 2011v6.3 2011en 2023en 2028el 2014 NATA 2014fd 2016 alpha 2016fe 2016 beta 2016ff 2023ff 2028ff
Comparisons 2016ff-2011en 2016ff-2014fd 2016fe-2014fd 2016ff-2016fe 2023ff-2016ff 2028ff-2016ff 2023ff-2023en 2028ff-2028el	Map Display Filter Results by Region USA <input type="button" value="Update"/> <p>If the "Update" button is colored red, press it to refresh the chart and map views.</p> <p>The buttons below update the charts and map without pressing the "Update" button.</p> <p>Charts: Sum by <input type="radio"/> Sectors <input checked="" type="radio"/> Pollutants</p> <p>Map: States <input checked="" type="radio"/> Counties <input type="radio"/> Units: <input checked="" type="radio"/> tons/yr <input type="radio"/> tons/yr/km2 Labels: <input type="radio"/> on <input checked="" type="radio"/> off</p>	



Dashboard

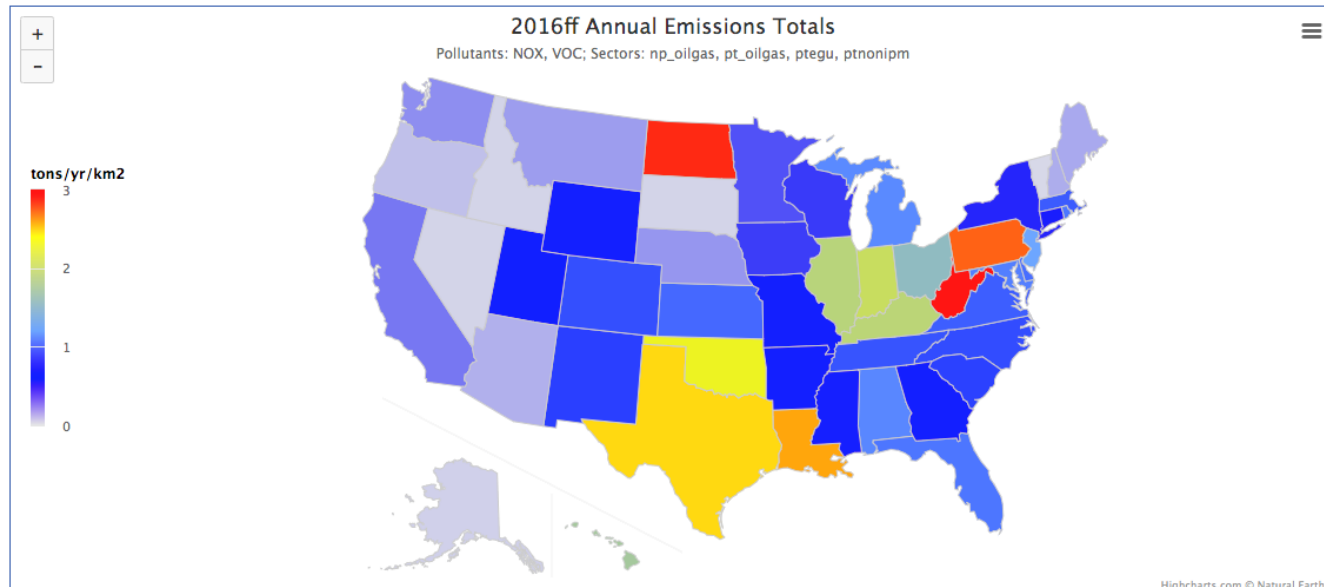
- Map
- States
- Emissions totals

Inventory Collaborative

Parameters	Pollutants	Platforms	Comparisons	Region
Sectors - 16 cmv_c3 nonpt nonroad np_oilgas onroad pt_oilgas ptagfire ptegu ptfire ptnonipm rail rwc <input type="button" value="Select All"/>	Pollutants - 7 CO NH3 NOX PM10-PRI PM25-PRI SO2 VOC	Platforms/Scenarios 2011v6.3 2011en 2023en 2028el 2014 NATA 2014fd 2016 alpha 2016fe 2016 beta 2016ff 2023ff 2028ff <input type="button" value="Clear All"/>	Comparisons 2016ff-2011en 2016ff-2014fd 2016fe-2014fd 2016ff-2016fe 2023ff-2016ff 2028ff-2016ff 2023ff-2023en 2028ff-2028el	Map Display Filter Results by Region <input type="text" value="USA"/> <input type="button" value="Update"/> If the "Update" button is colored red, press it to refresh the chart and map views. The buttons below update the charts and map without pressing the "Update" button. Charts: Sum by <input type="radio"/> Sectors <input checked="" type="radio"/> Pollutants Map: <input type="radio"/> States <input checked="" type="radio"/> Counties <input type="radio"/> Units: <input type="radio"/> tons/yr <input checked="" type="radio"/> tons/yr/km2 Labels: <input type="radio"/> on <input checked="" type="radio"/> off

Map

Map Range Data Range: 0 to 3.48



Dashboard

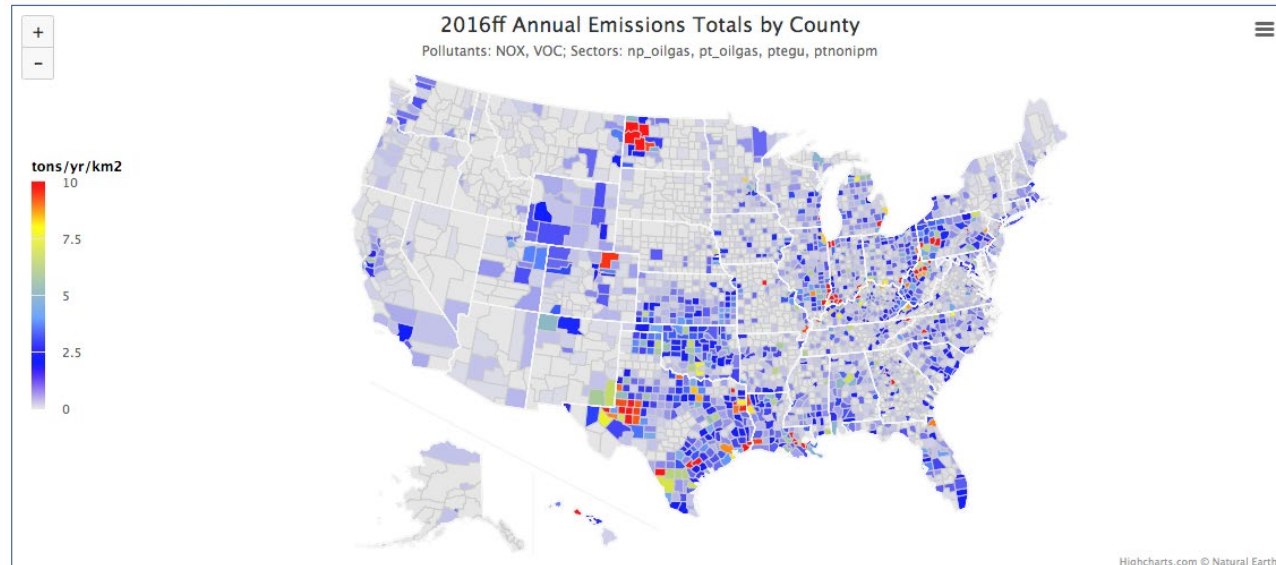
- Map
- States
- Emissions densities

Inventory Collaborative

Parameters		Platforms		Region		
Sectors - 16		Pollutants - 7		Map Display		
<ul style="list-style-type: none"> cmv_c3 nonpt nonroad np_oilgas onroad pt_oilgas ptagfire ptegu ptfire ptnonipm rail rwc 	<ul style="list-style-type: none"> CO NH3 NOX PM10-PRI PM25-PRI SO2 VOC 	<ul style="list-style-type: none"> 2011v6.3 2011en 2023en 2028el 2014 NATA 2014fd 2016 alpha 2016fe 2016 beta 2016ff 2023ff 2028ff 	<ul style="list-style-type: none"> 2016ff-2011en 2016ff-2014fd 2016fe-2014fd 2016ff-2016fe 2023ff-2016ff 2028ff-2016ff 2023ff-2023en 2028ff-2028el 	Filter Results by Region <input type="text" value="USA"/>	<input type="button" value="Update"/> <p>If the "Update" button is colored red, press it to refresh the chart and map views.</p> <p>The buttons below update the charts and map without pressing the "Update" button.</p> <p>Charts: Sum by <input type="radio"/> Sectors <input checked="" type="radio"/> Pollutants</p>	
<input type="button" value="Select All"/>	<input type="button" value="Clear All"/>			Map: States <input type="radio"/> Counties <input checked="" type="radio"/>	Units: <input type="radio"/> tons/yr <input checked="" type="radio"/> tons/yr/km2	Labels: <input type="radio"/> on <input checked="" type="radio"/> off

Map

Map Range Data Range: Min: 0 to Max: 300.8



Dashboard

- Map
- Counties
- Emissions densities

Inventory Collaborative

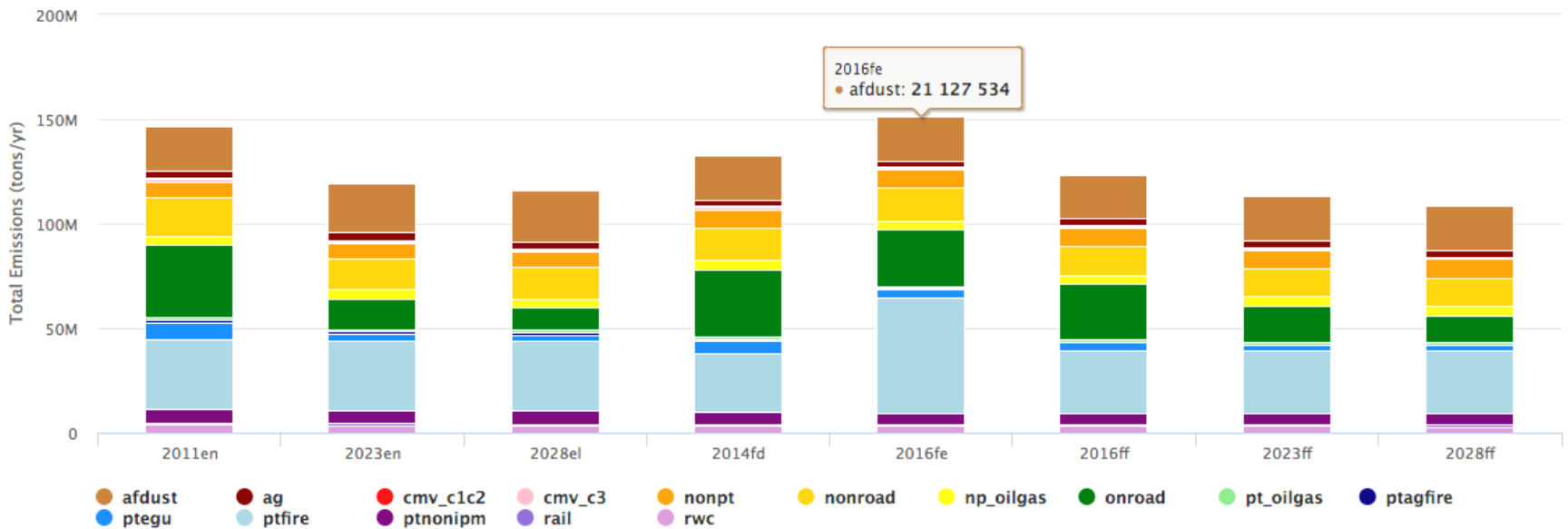
Tip: Click on a chart series legend item to add/remove the series from the chart.

Parameter Platform State County

Platform

USA Annual Emissions Totals by Sector

Pollutants: Multiple Pollutants



Feature

- Interactive metadata

Inventory Collaborative

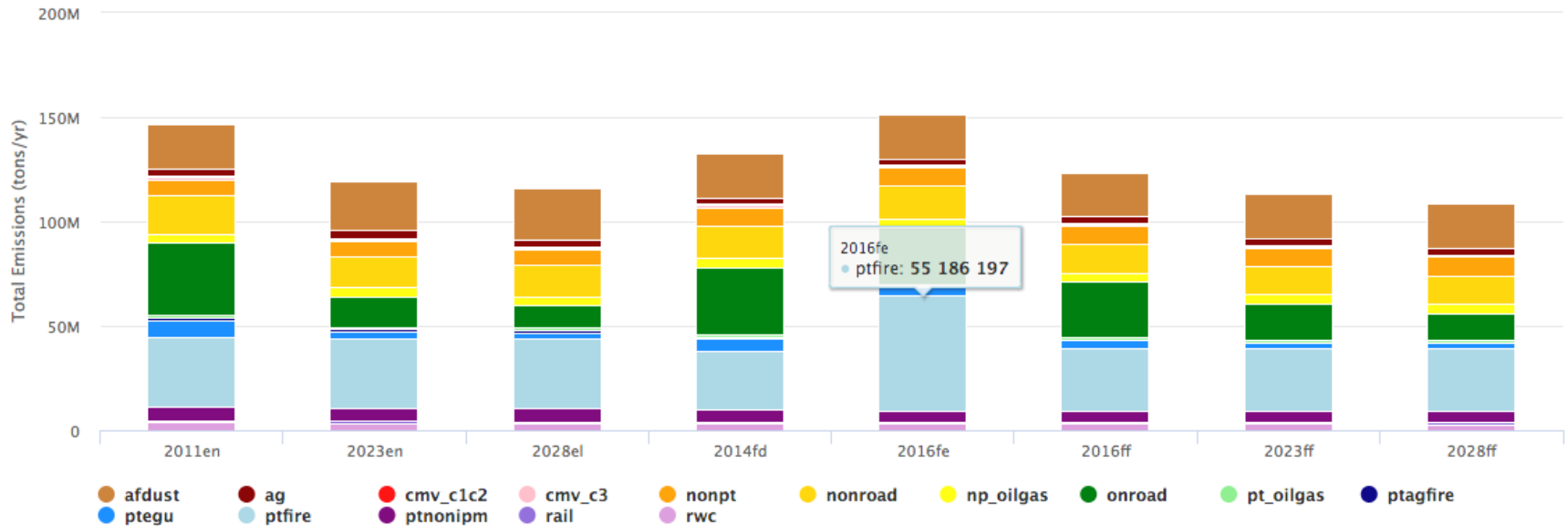
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Parameter Platform State County

Platform

USA Annual Emissions Totals by Sector

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Feature

- Interactive metadata

Inventory Collaborative

Parameter Platform State County

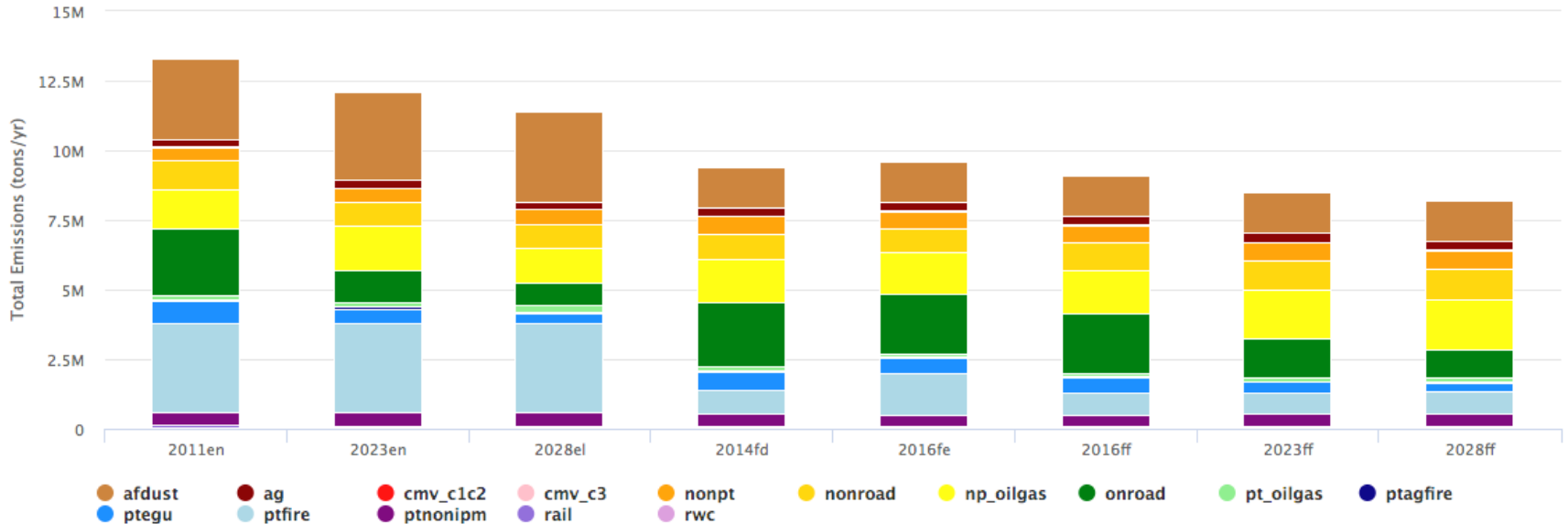
Tip: Click on a state (on the map, below) to display emissions totals for the selected state. The selected state also updates the county chart.

State

Platforms: 2011en, 2023en, 2028el, 2014fd, 2016fe, 2016ff, 2023ff, 2028ff

Texas Annual Emissions Totals by Sector

Pollutants: Multiple Pollutants



Feature

- State drill down
- Sum by pollutant

Inventory Collaborative

Parameter Platform **State** County

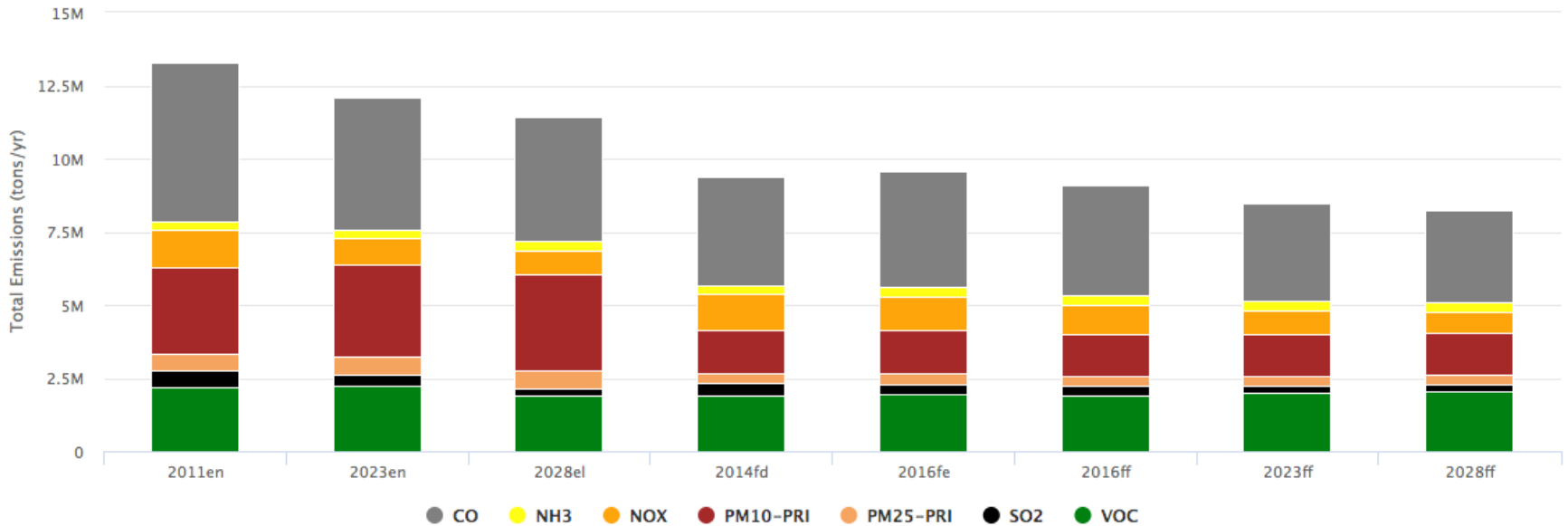
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State

Platforms: 2011en, 2023en, 2028el, 2014fd, 2016fe, 2016ff, 2023ff, 2028ff

Texas Annual Emissions Totals by Pollutant

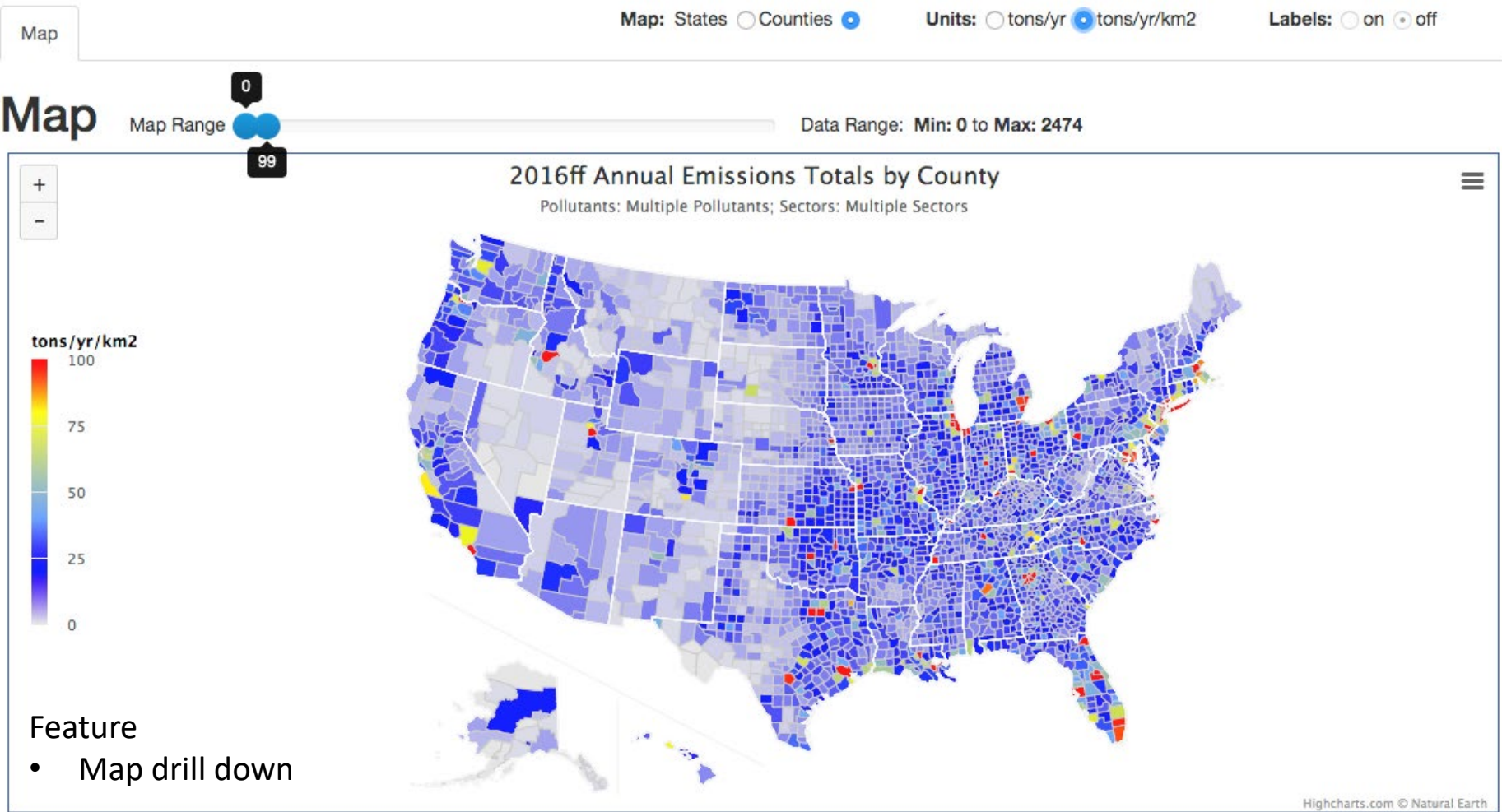
Sectors: Multiple Sectors



Feature

- State drill down
- Sum by sector

Inventory Collaborative



Inventory Collaborative

Map

Map: States Counties

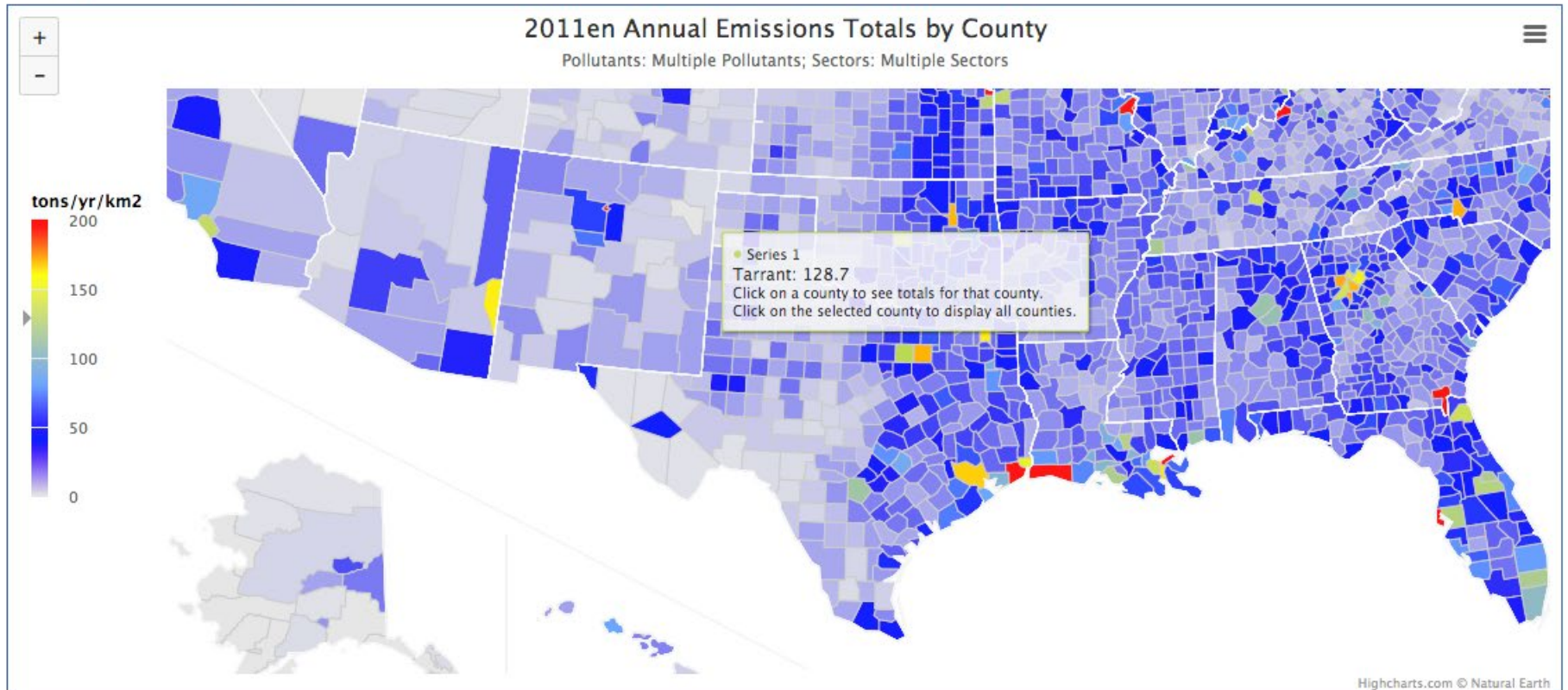
Units: tons/yr tons/yr/km²

Labels: on off

Map

Map Range

Data Range: Min: 0 to Max: 3052



Feature

- Map drill down

Inventory Collaborative

Parameter Platform State **County**

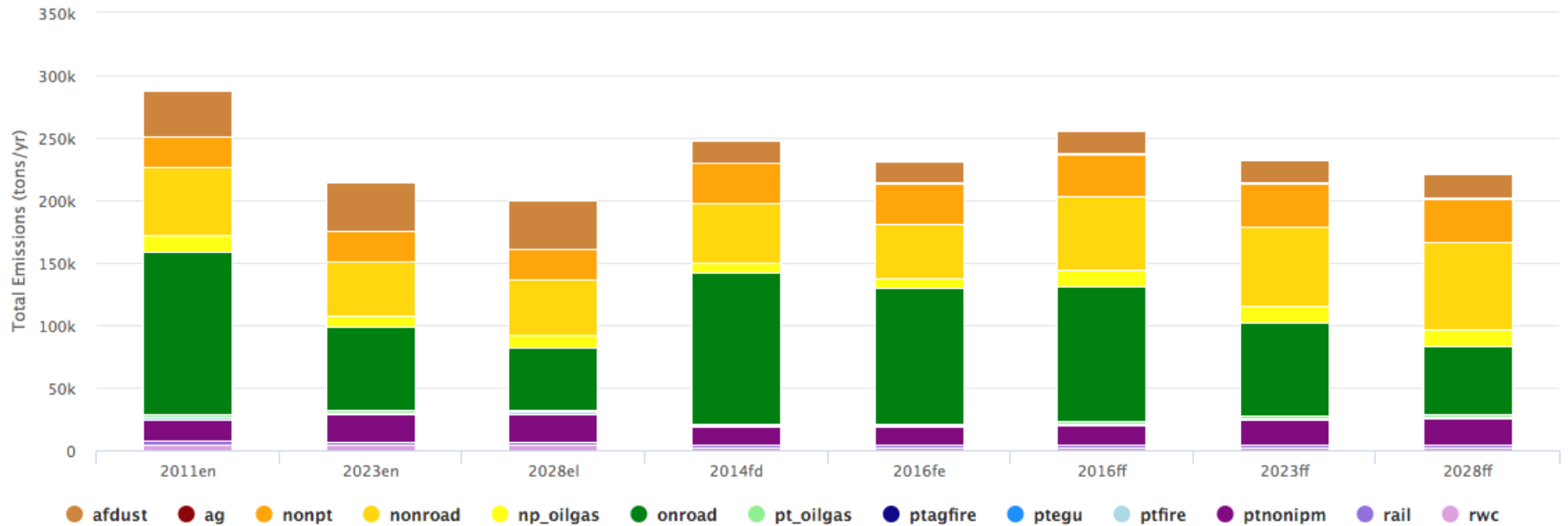
Tip: Click on a county or state (from the state or county map, below) to display county level emissions for that state. Click on a county (from the county map) to show emissions for the selected county. The county chart is refreshed by a map selection (not the "Update" button).

County

Platforms: 2011en, 2023en, 2028el, 2014fd, 2016fe, 2016ff, 2023ff, 2028ff

Tarrant County, Texas, Annual Emissions Totals by Sector

Pollutants: Multiple Pollutants



Feature

- County level drill down
- Sum by pollutant

Inventory Collaborative

Parameter Platform State **County**

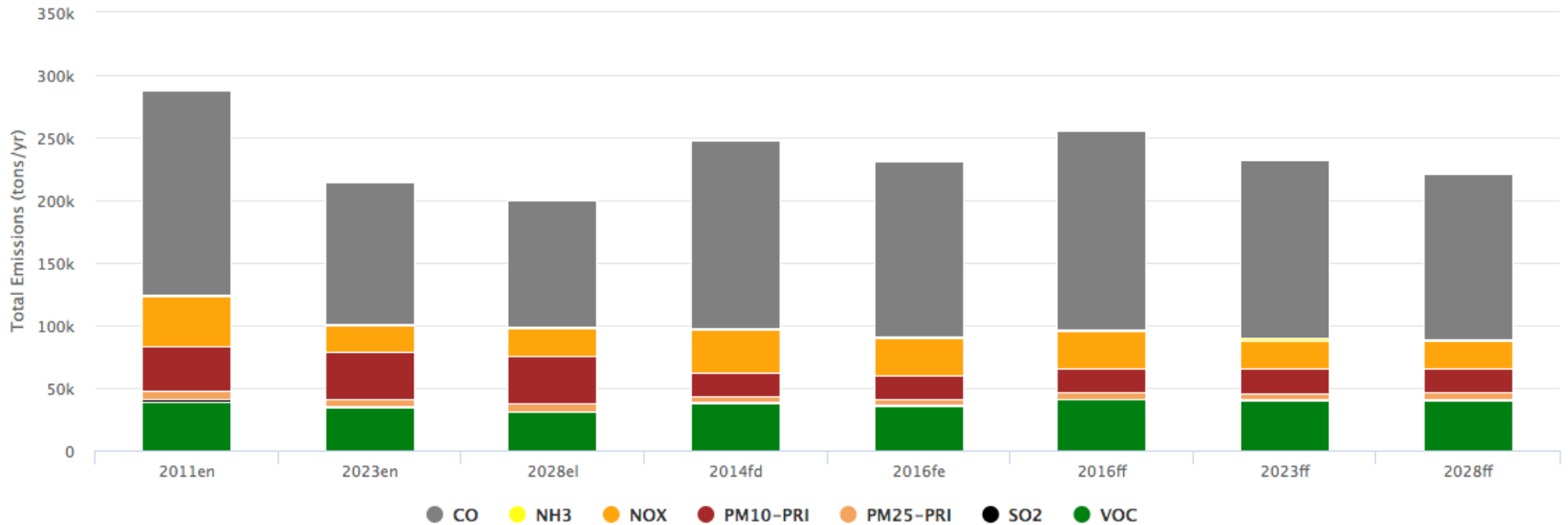
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County

Platforms: 2011en, 2023en, 2028el, 2014fd, 2016fe, 2016ff, 2023ff, 2028ff

Tarrant County, Texas, Annual Emissions Totals by Pollutant

Sectors: Multiple Sectors



Feature

- County level drill down
- Sum by sector

Inventory Collaborative

Map

Map: States Counties

Units: tons/yr tons/yr/km²

Labels: on off

Map

Map Range

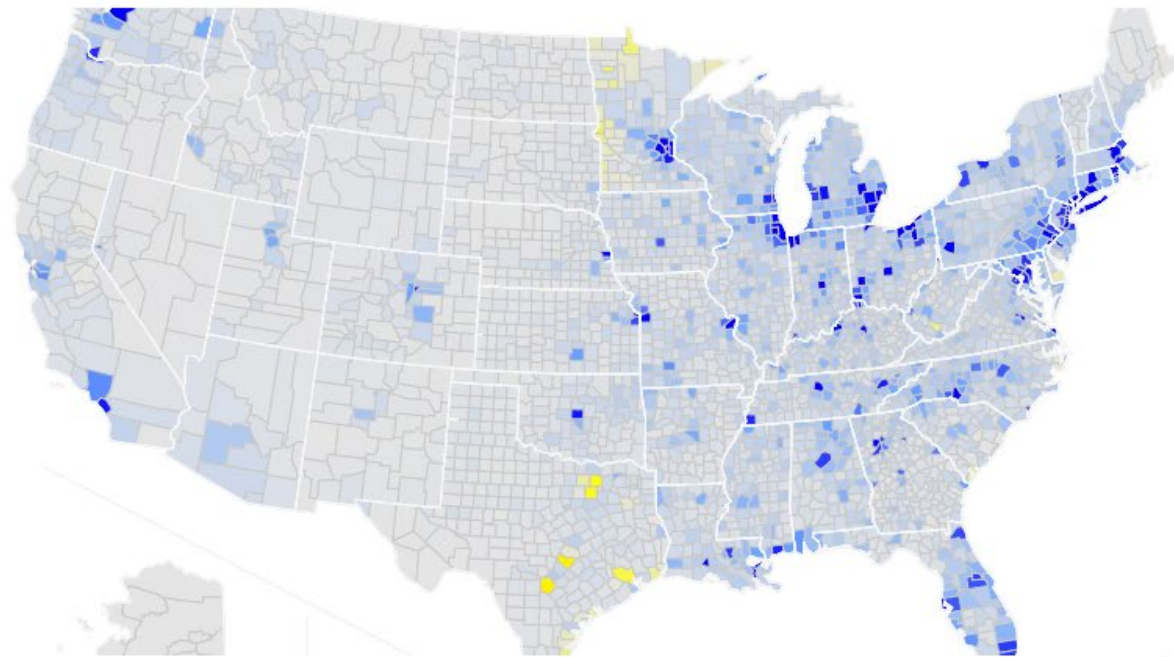


Data Range: Min: -643.58 to Max: 5.28

2016ff-2014fd Annual Emissions Totals by County

Pollutants: Multiple Pollutants; Sectors: nonroad, onroad

tons/yr/km²



Highcharts.com © Natural Earth

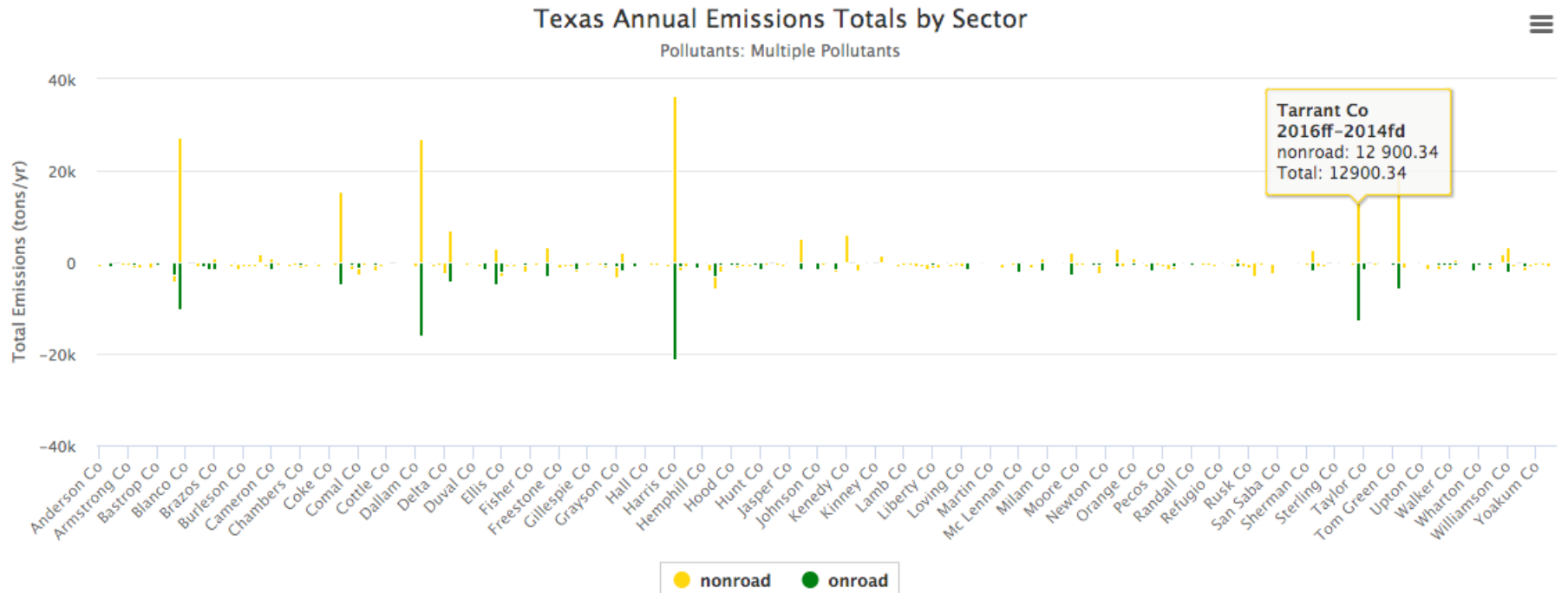
- Mobile sources
- Platform comparison 2016-2014 (base)

Inventory Collaborative

Parameter Platform State **County**

Tip: Click on a county or state (from the state or county map, below) to display county level emissions for that state. Click on a county (from the county map) to show emissions for the selected county. The county chart is refreshed by a map selection (not the "Update" button).

County Platforms: 2016ff-2014fd



Highcharts.com

- Platform comparison (2016-2014)
- Mobile sources

Inventory Collaborative

Map

Map: States Counties

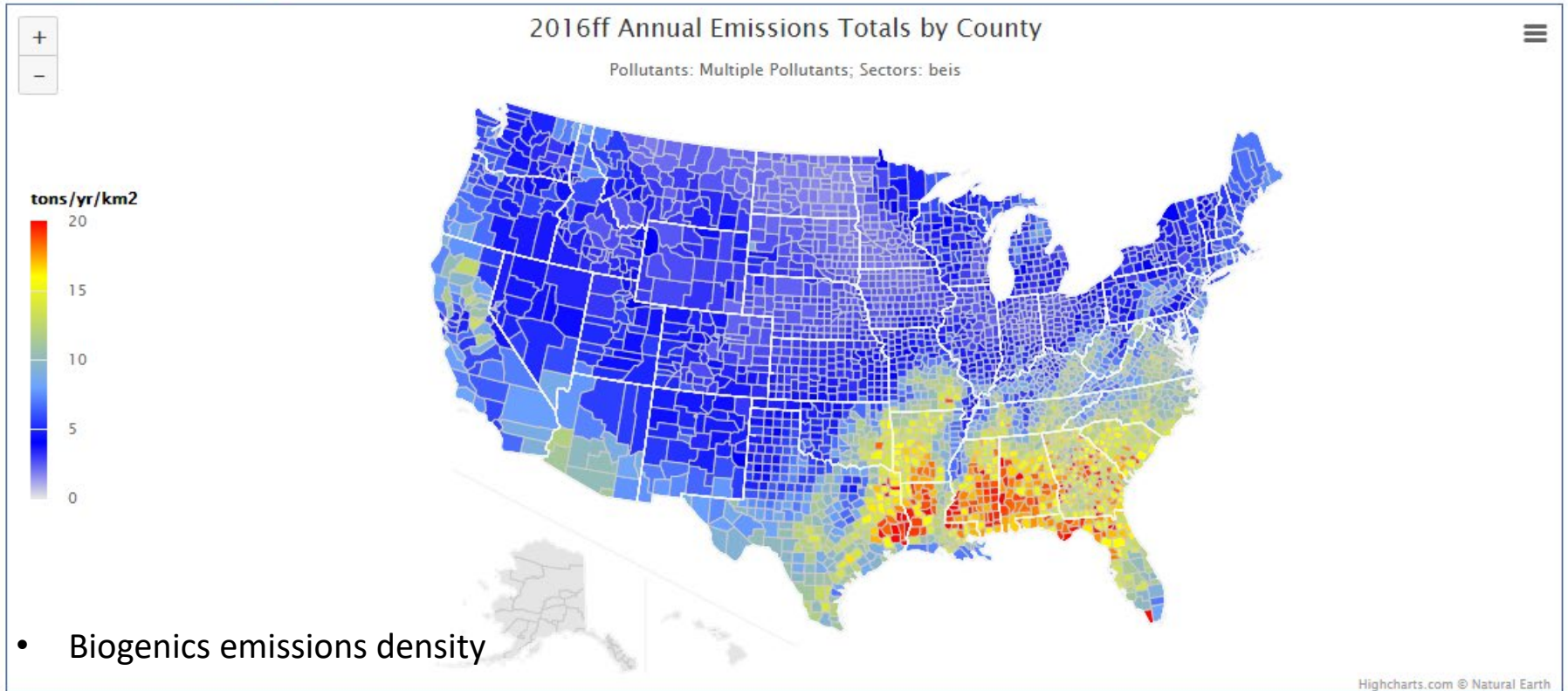
Units: tons/yr tons/yr/km²

Labels: on off

Map

Map Range

Data Range: Min: 0 to Max: 219.5



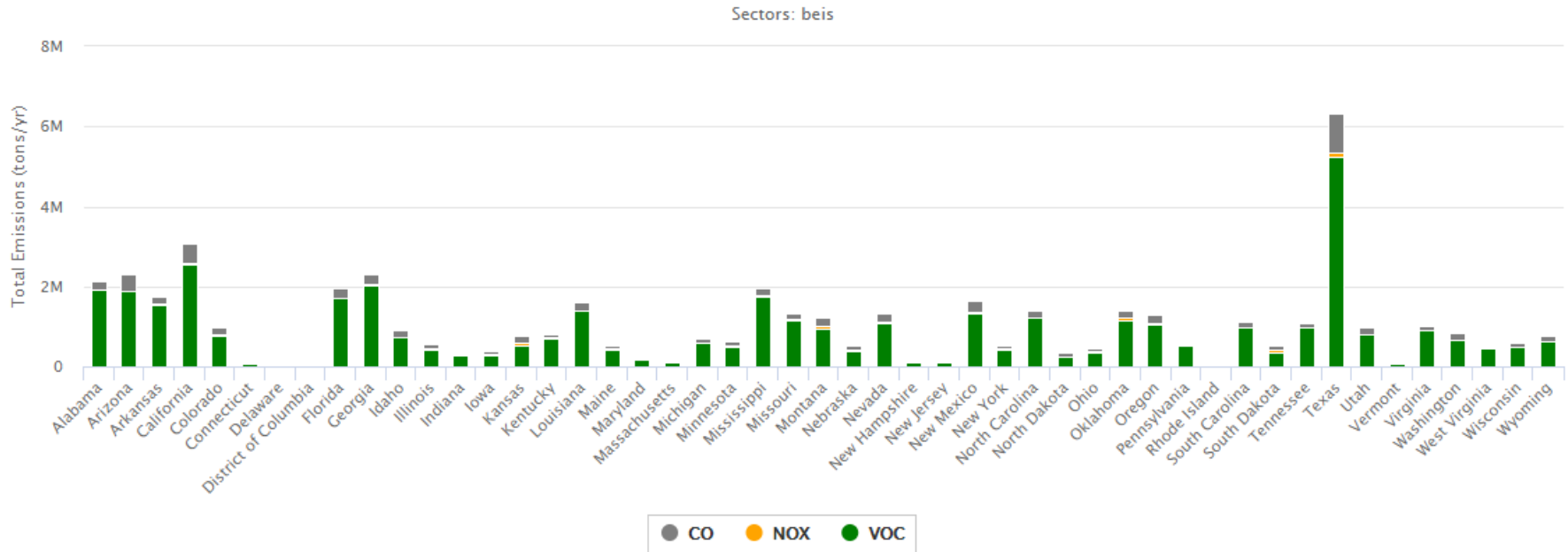
Inventory Collaborative

Parameter Platform State County

Tip: Click on a state (on the map, below) to display emissions totals for the selected state. The selected state also updates the county chart.

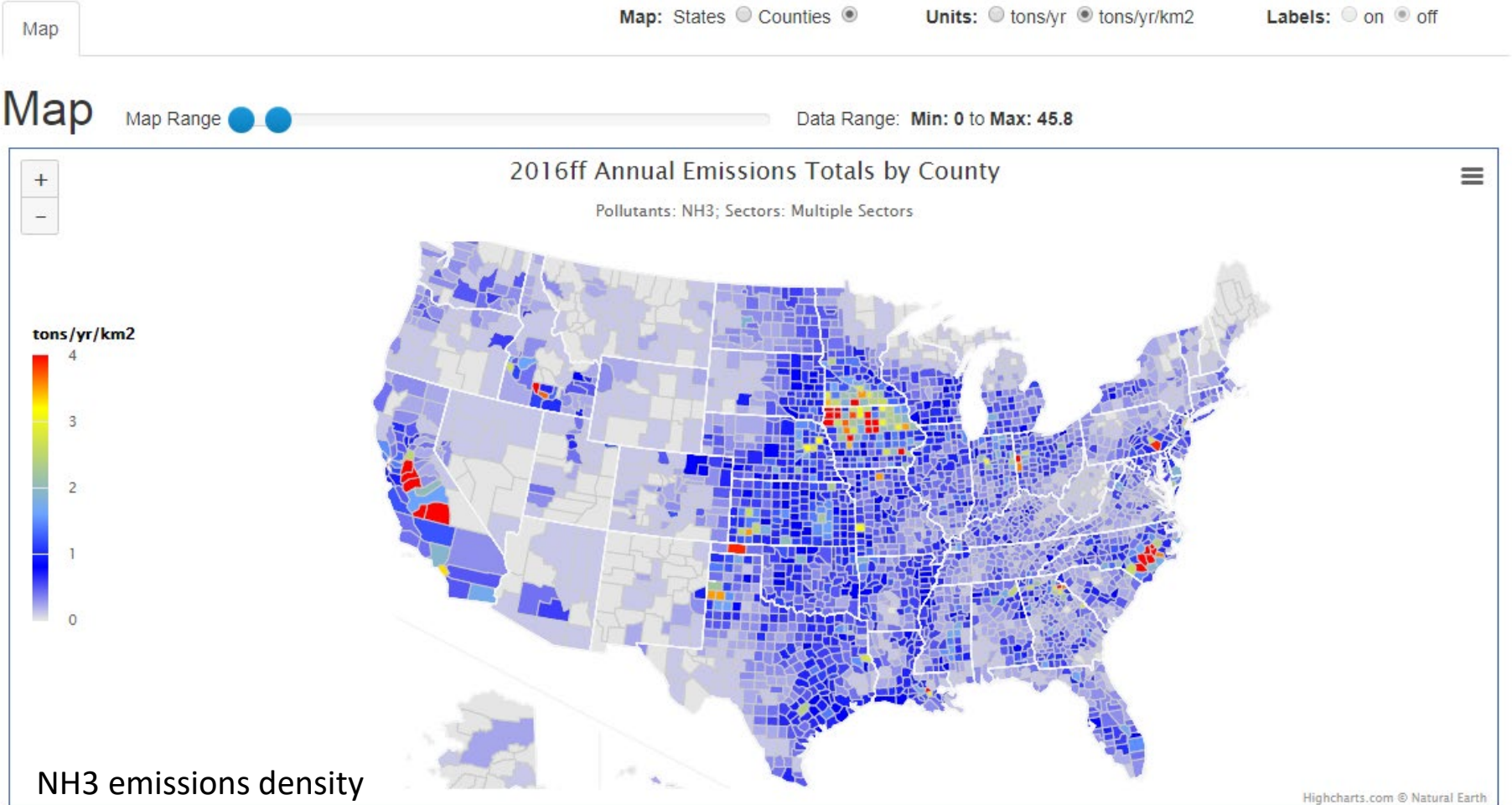
State Platforms: 2016ff

USA Annual Emissions Totals by Pollutant

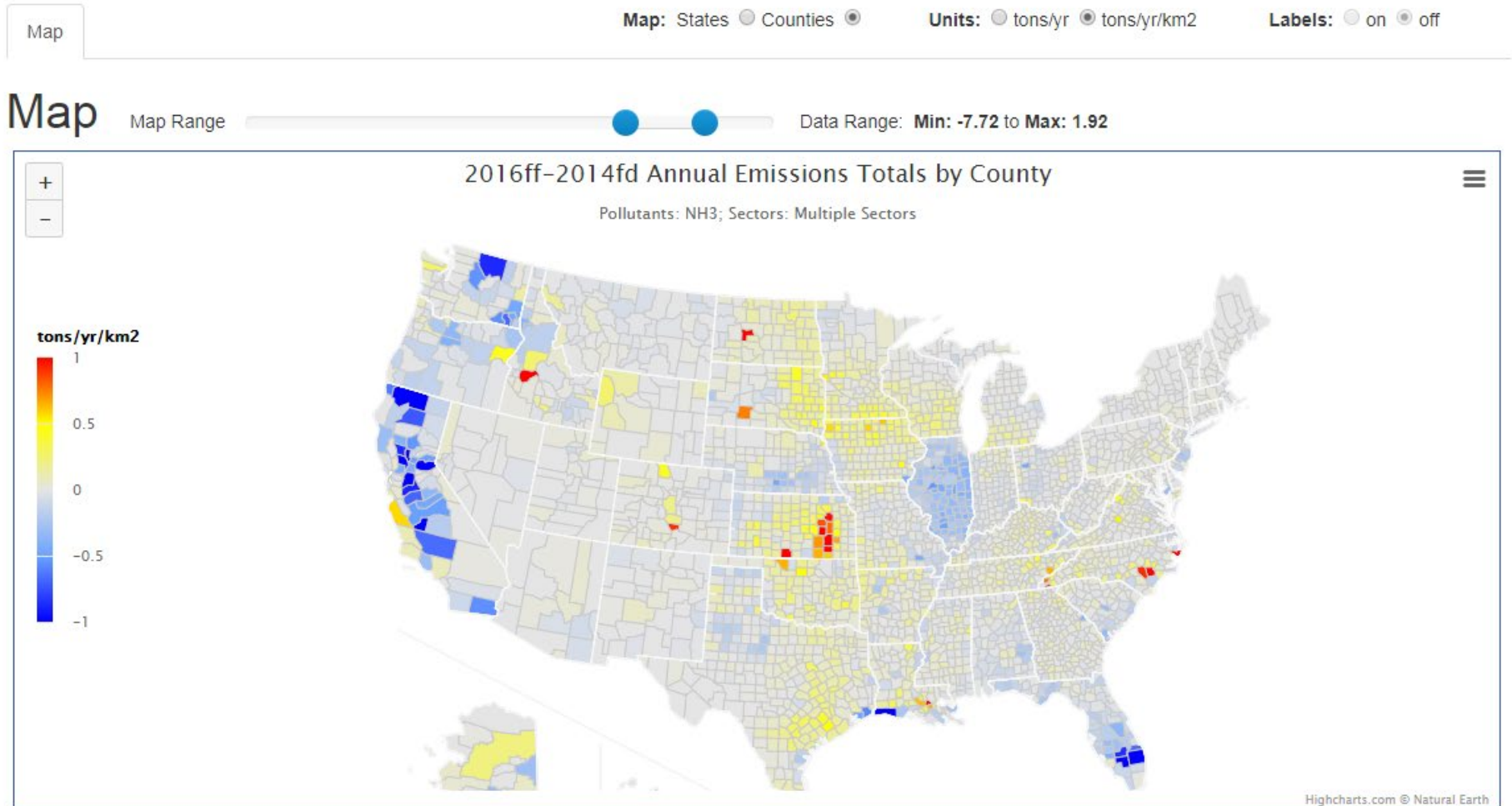


- Biogenic pollutants by state

Inventory Collaborative



Inventory Collaborative



- NH3 2016-2014 (base years)

Inventory Collaborative

Parameter Platform **State** County

Tip: Click on a state (on the map, below) to display emissions totals for the selected state. The selected state also updates the county chart.

State Platforms: 2016ff-2014fd

AQ Planning Organizations Annual Emissions Totals by Sector

Pollutants: NOx, VOC



- O3 precursors by AQPO
- Oil & gas sectors

Highcharts.com

Inventory Collaborative

Map

Map: States Counties

Units: tons/yr tons/yr/km2

Labels: on off

Map

Map Range

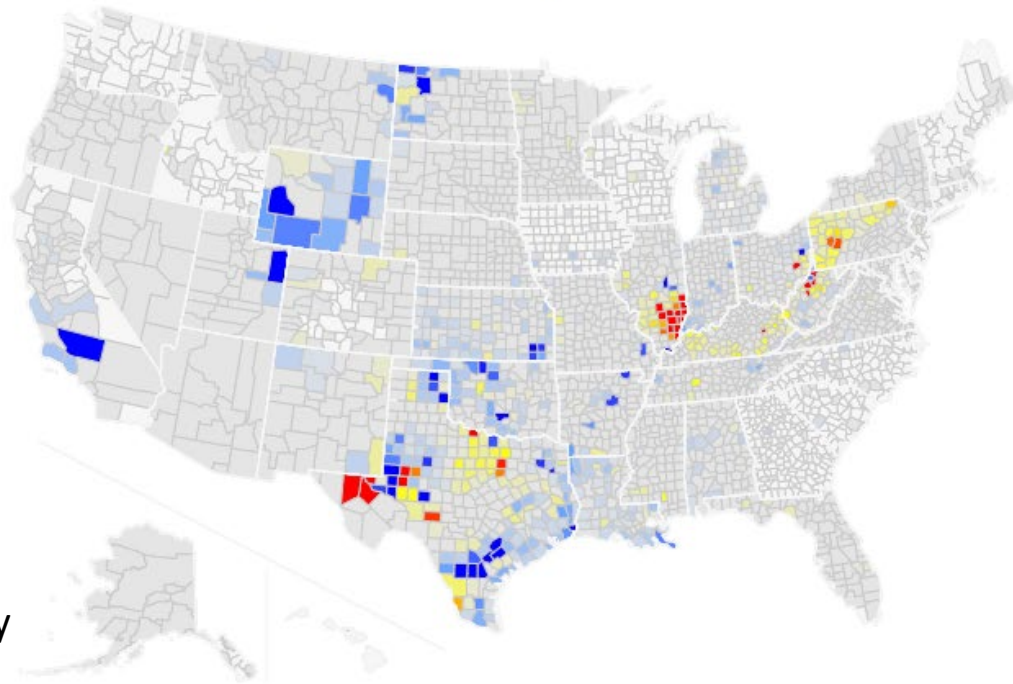


Data Range: **Min: -14.3 to Max: 16.3**

2016ff-2014fd Annual Emissions Totals by County

Pollutants: NOX, VOC; Sectors: np_oilgas, pt_oilgas

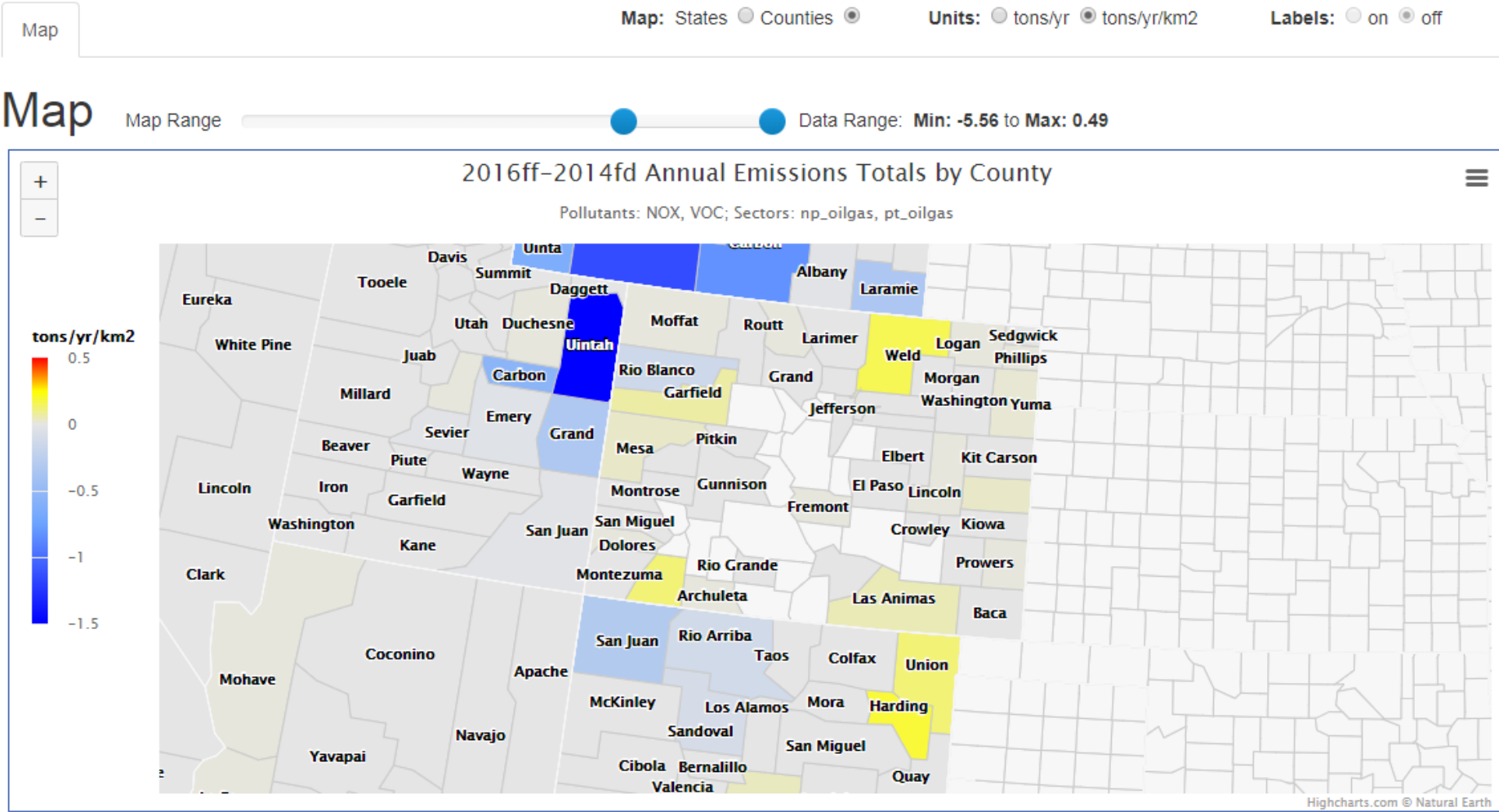
tons/yr/km2



- O3 precursors by county
- Oil & gas sectors

Highcharts.com © Natural Earth

Inventory Collaborative



- O3 precursors by county
- Oil & gas sectors
- Colorado and Utah

Inventory Collaborative

Map

Map: States Counties

Units: tons/yr tons/yr/km2

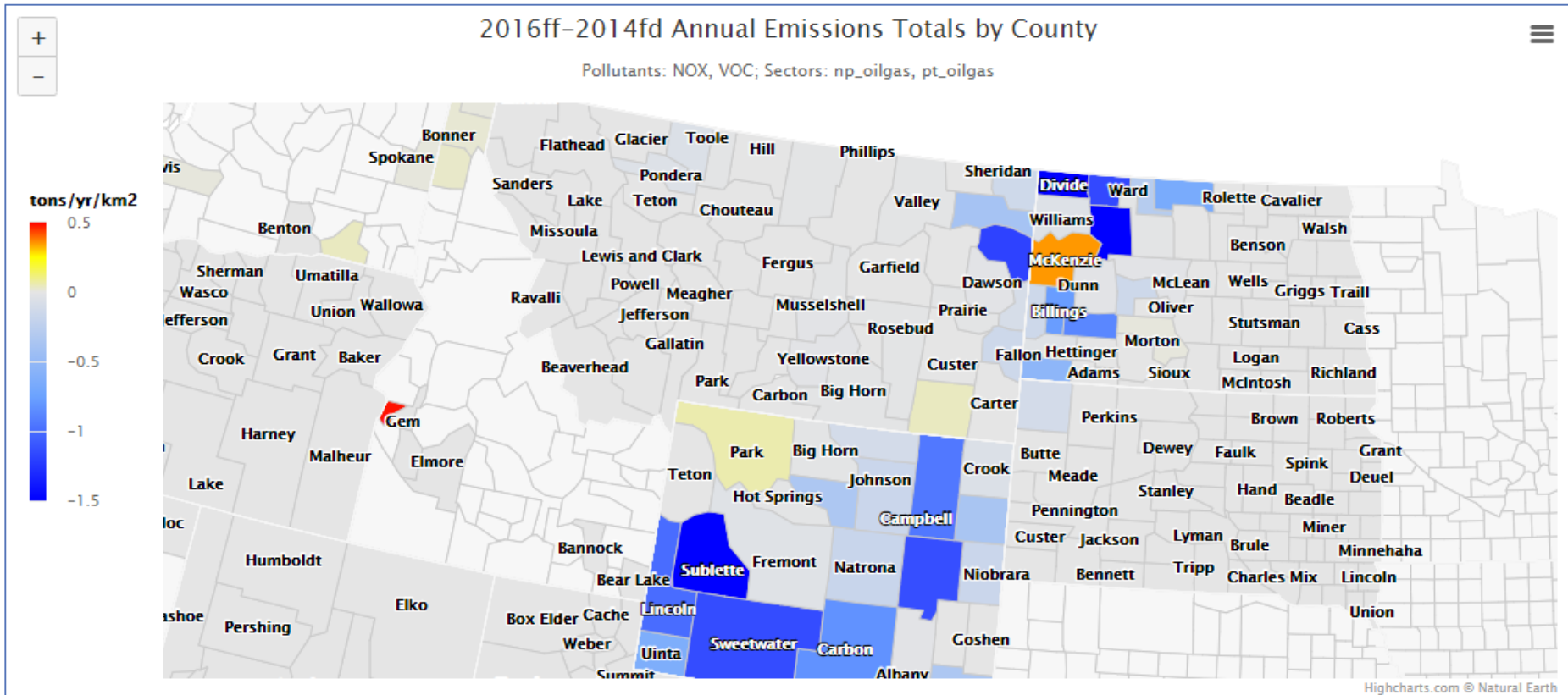
Labels: on off

Map

Map Range



Data Range: Min: -5.56 to Max: 0.49



- O3 precursors by county
- Oil & gas sectors
- MT & Dakotas

Inventory Collaborative

Map

Map: States Counties

Units: tons/yr tons/yr/km2

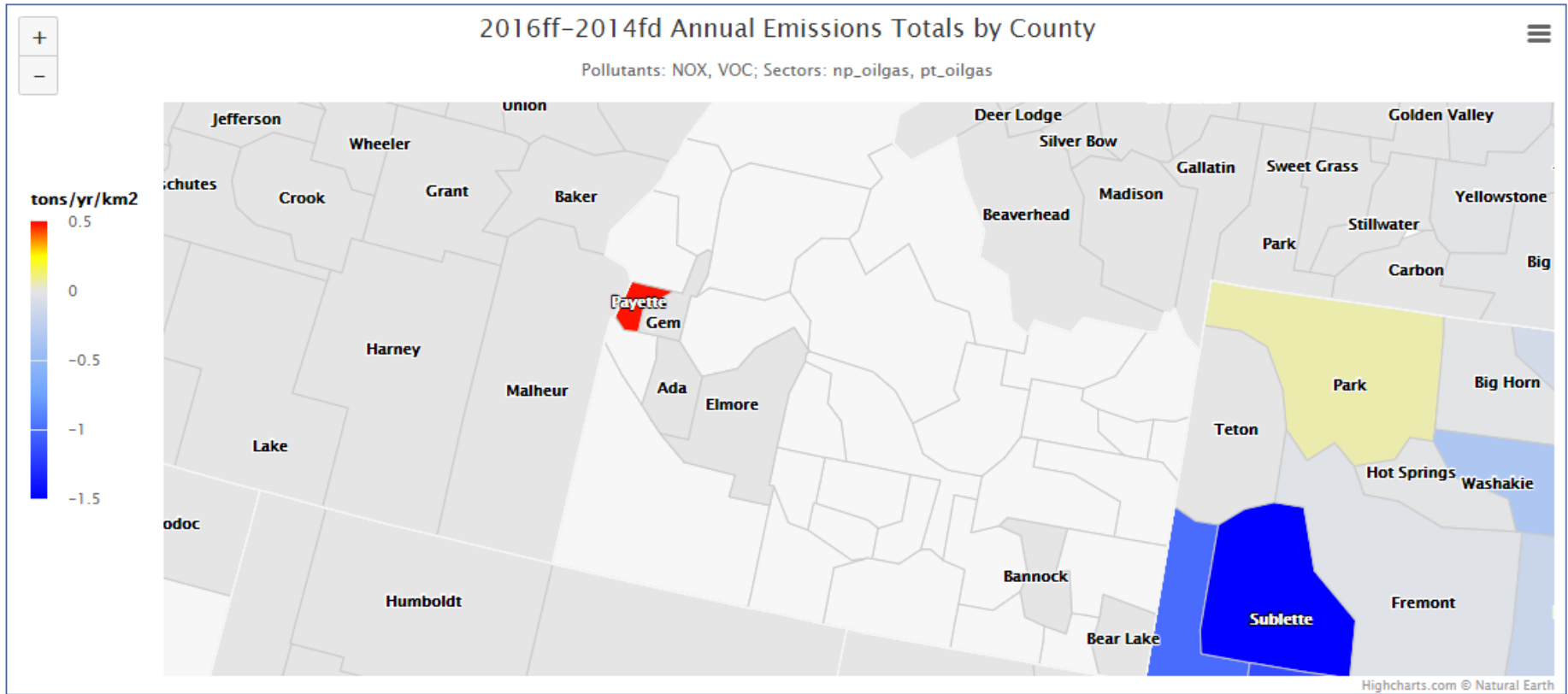
Labels: on off

Map

Map Range



Data Range: Min: -5.56 to Max: 0.49



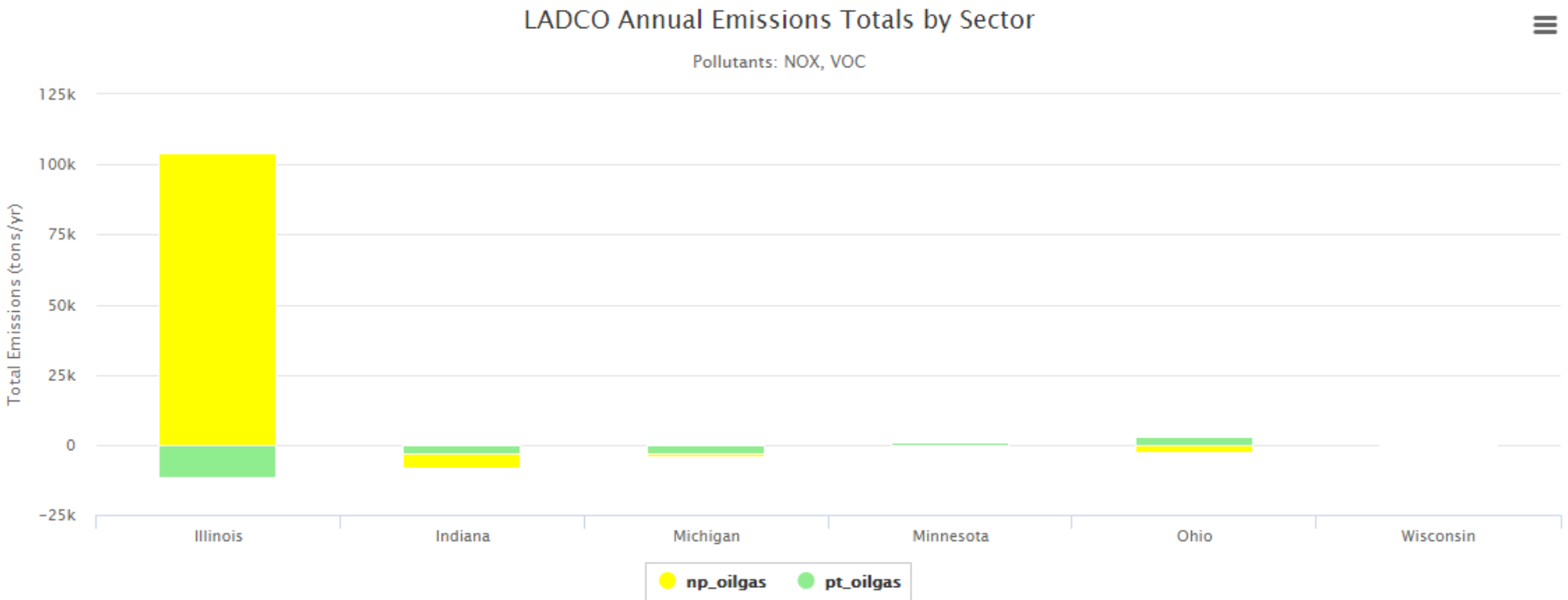
- O3 precursors by county
- Oil & gas sectors
- Idaho

Inventory Collaborative

Parameter Platform State County

Tip: Click on a state (on the map, below) to display emissions totals for the selected state. The selected state also updates the county chart.

State Platforms: 2016ff-2014fd



Highcharts.com

- O3 precursors
- Oil & gas sectors
- LADCO states

Inventory Collaborative

Map

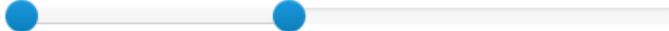
Map: States Counties

Units: tons/yr tons/yr/km2

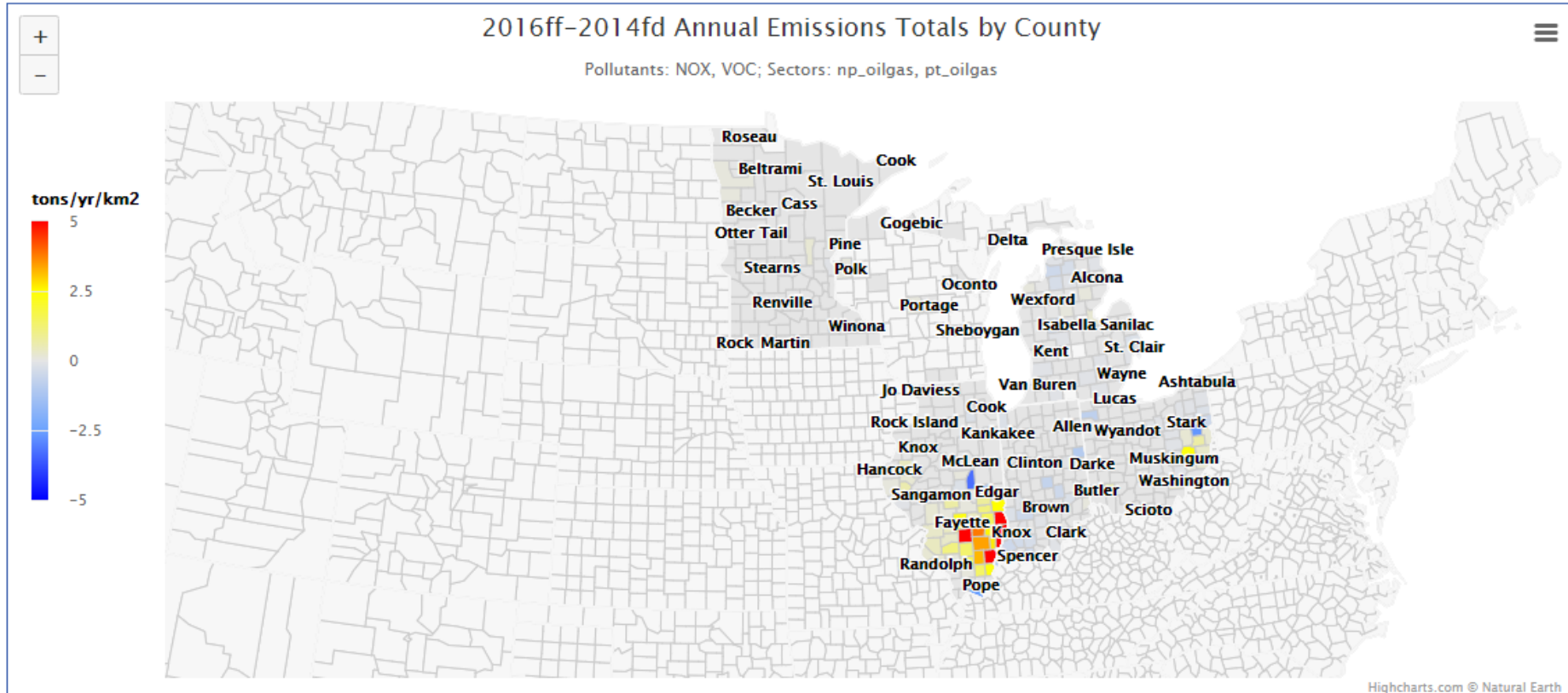
Labels: on off

Map

Map Range



Data Range: Min: -3.3 to Max: 16.3



- O3 precursors
- Oil & gas sectors
- LADCO counties

Inventory Collaborative

Map

Map: States Counties

Units: tons/yr tons/yr/km2

Labels: on off

Map

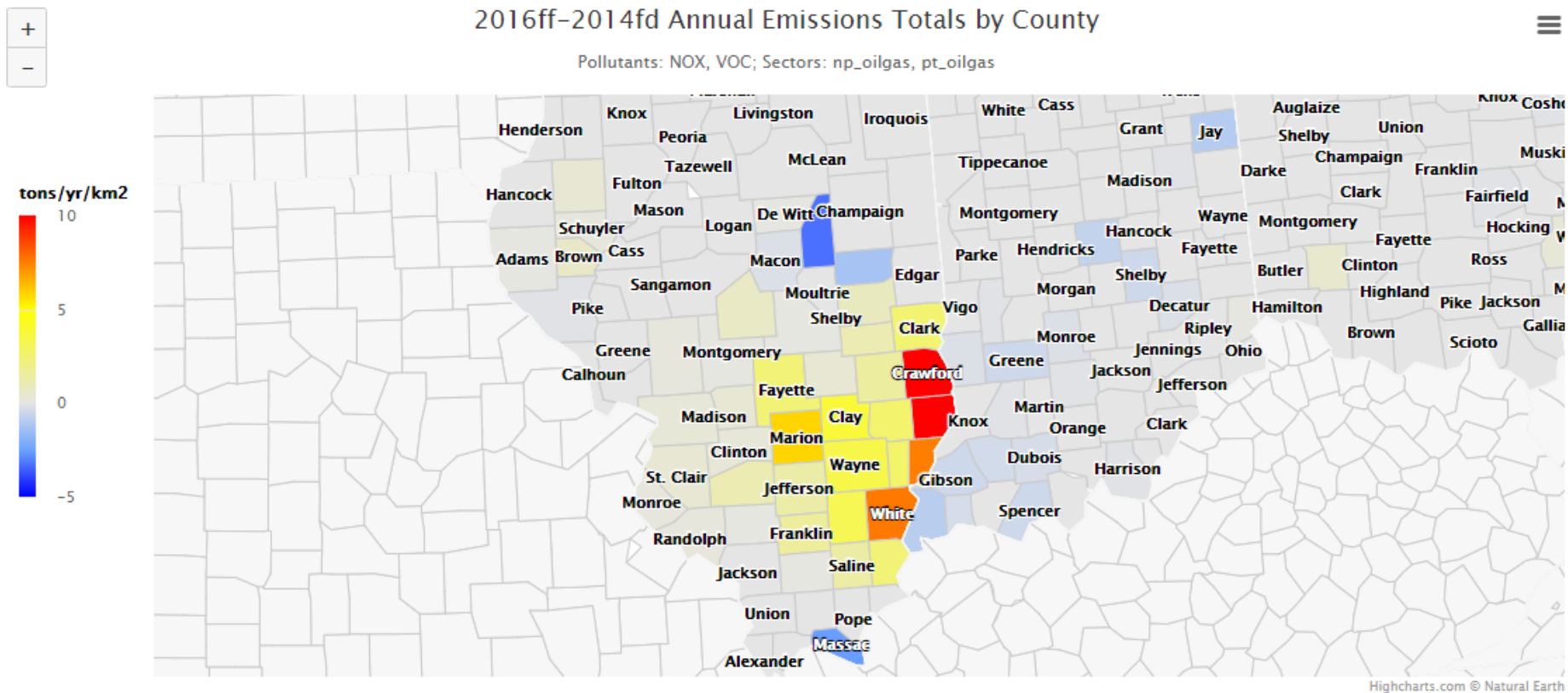
Map Range



Data Range: Min: -3.3 to Max: 16.3

2016ff-2014fd Annual Emissions Totals by County

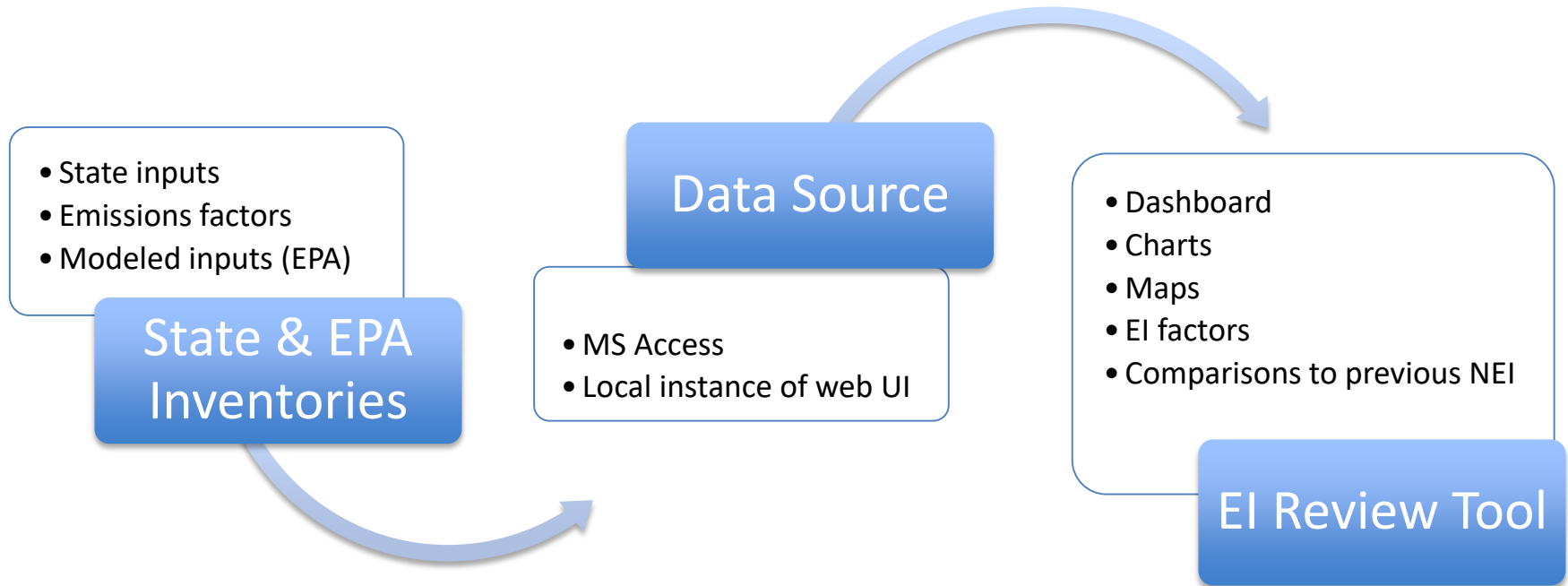
Pollutants: NOx, VOC; Sectors: np_oilgas, pt_oilgas



Highcharts.com © Natural Earth

- O3 precursors
- Oil & gas sectors
- LADCO counties

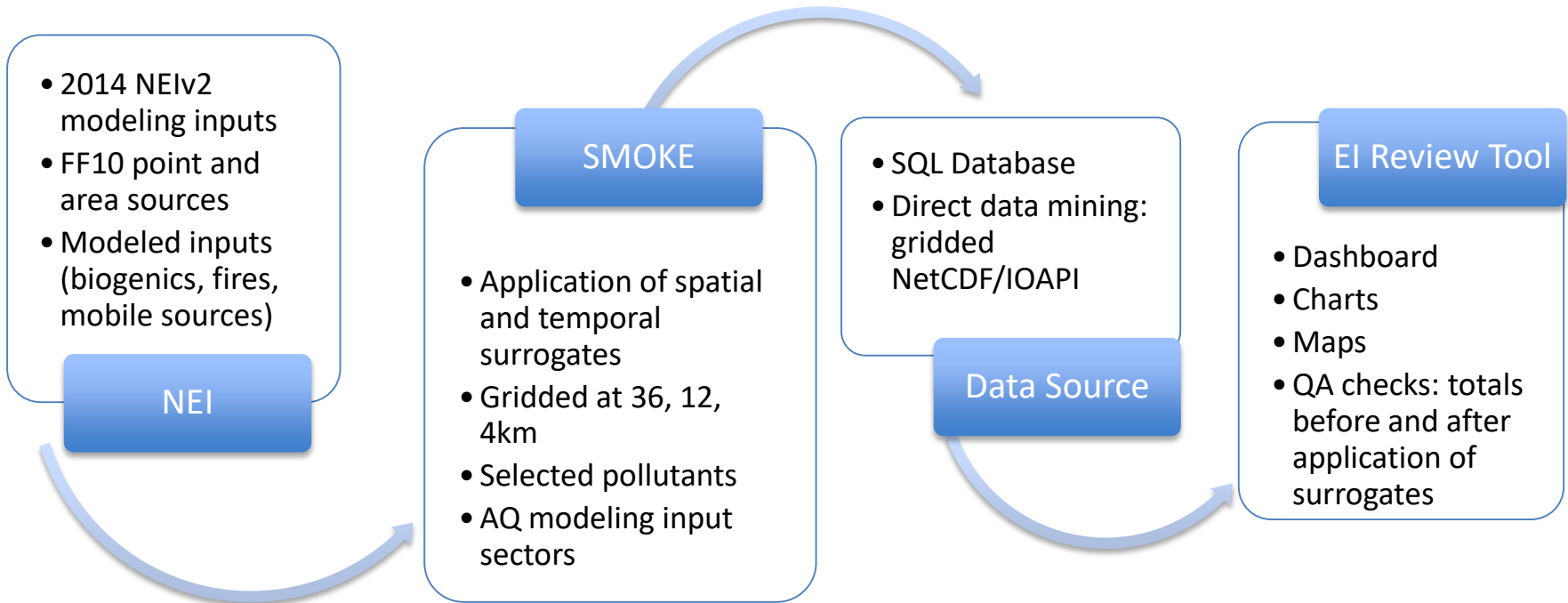
Emissions Inventory Development



Implementation:

- 2017 O&G Tool prototype?

AQ Modeling Studies



Implementation:

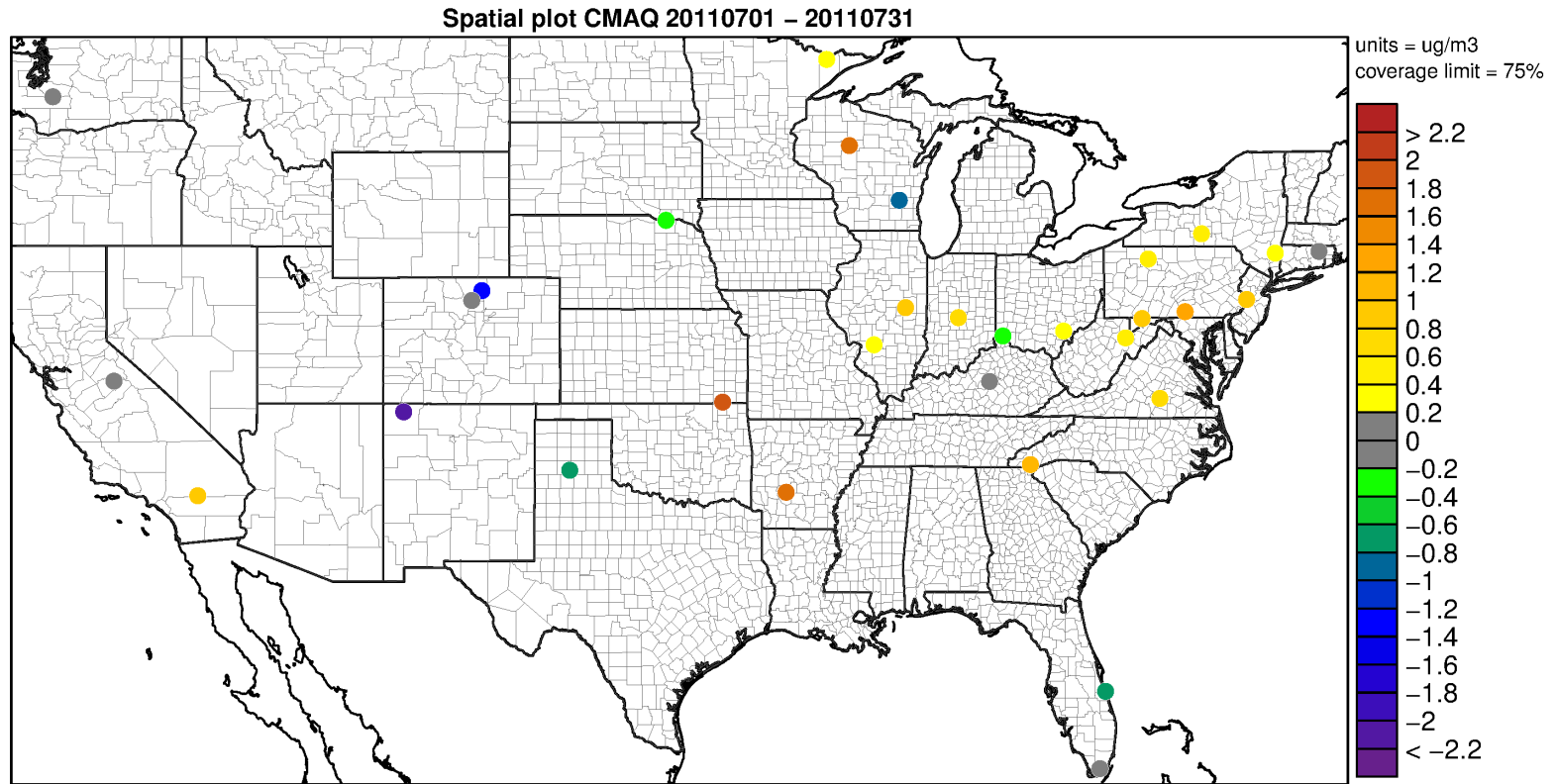
- AQ modeling study prototype?

AQ Modeling Studies

Impetus: verify ammonia emissions inputs

- NH_4NO_3 (NAAQS PM, Haze, N deposition)
- Emissions from NH_3 based fertilizers, wildfires, NH_3 and NO_2 from mobile sources
- Modeling studies can inform mitigation strategies - there are no (explicit) NH_3 AQ regulations in the US, however NH_3 is regulated in Europe³
- NPS-ARD study will assess the impacts of reduced nitrogen emissions on haze and N deposition in sensitive ecosystems (e.g. alpine lakes in Rocky Mountain NP)
- Evaluate NH_3 inventories/AQ modeling results and compare to satellite based “top-down” observations
- NH_3 has a short (~few days) life span in the atmosphere; confined to BL; retrievals during optimal conditions^{3,4,5}
- Remote sensing products from IASI (MetOp-A,B), TES (Aura), CrIS (JPSS), AIRS (Aqua)

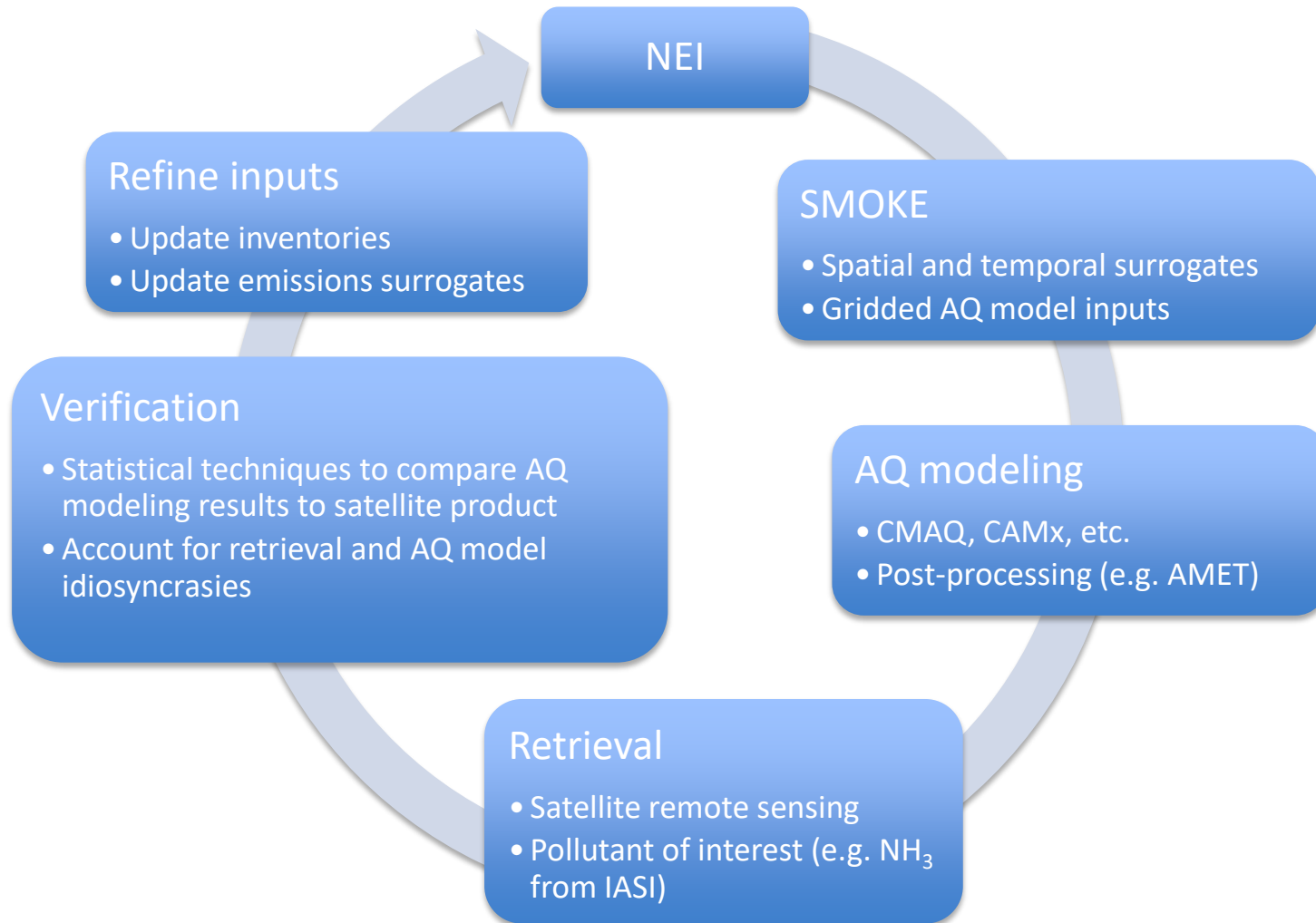
AQ Modeling Studies



CIRCLE=AMON;

CMAQ – AMON monthly average NH_3

Inventory Verification



IASI (Metop-A) NH₃
2008-2016 high-resolution column NH₃
Van Damme et al. (2018)

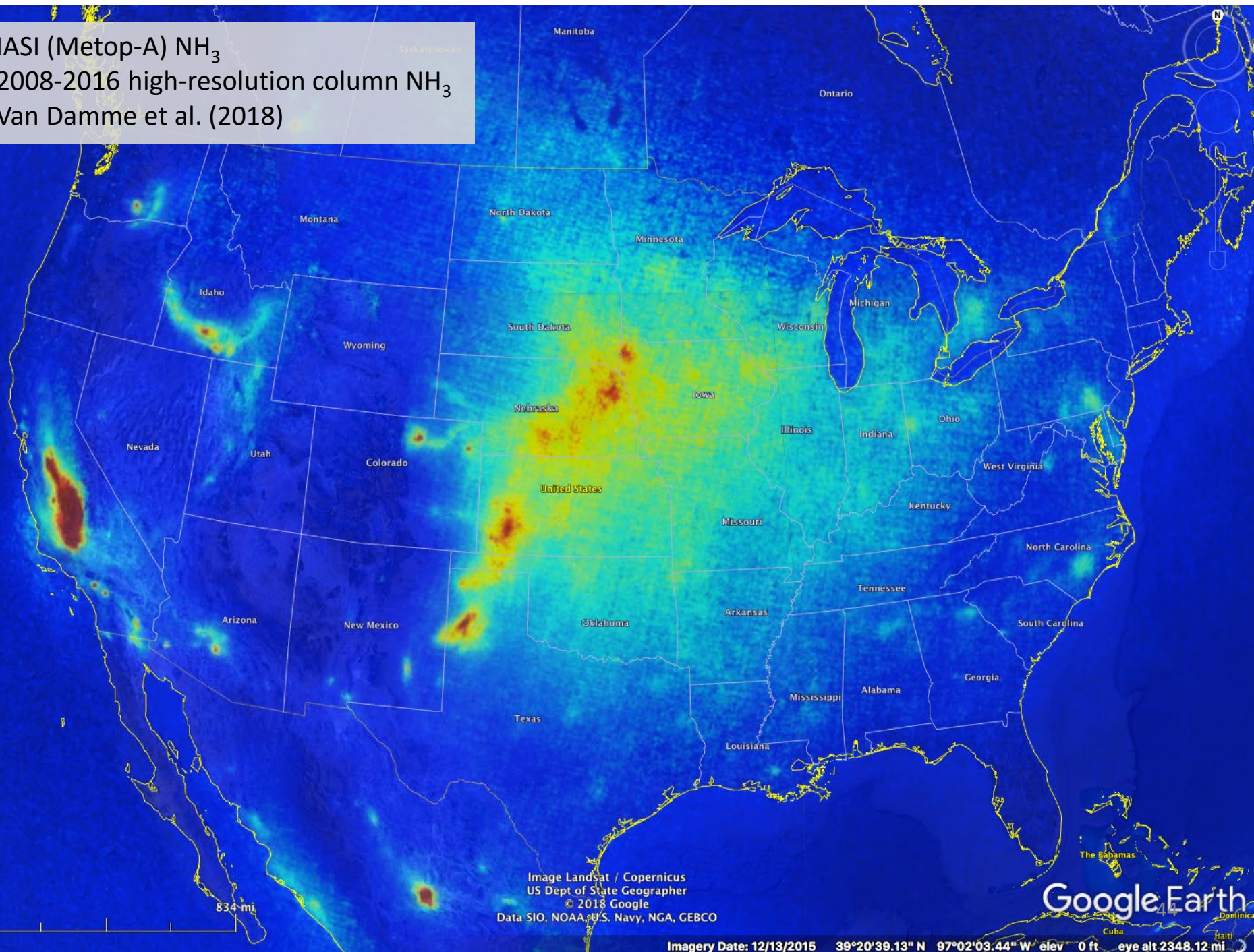


Image Landsat / Copernicus
US Dept of State Geographer
© 2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth

Imagery Date: 12/13/2015 39°20'39.13" N 97°02'03.44" W elev 0 ft eye alt 2348.12 mi

IASI (Metop-A) NH₃
2008-2016 high-resolution column NH₃
Van Damme et al. (2018)

Cheyenne

Fort Collins

Greeley

Boulder

Denver

Colorado

Greeley

Eckley-Yuma
5-Rivers Cattle LLC

NE Colorado

48 mi

Image Landsat / Copernicus

© 2018 Google

Colorado Springs

Google Earth

39°42'39.56" N 104°33'01.73" W elev 0 ft eye alt 202.20 mi

IASI (Metop-A) NH₃
2008-2016 high-resolution column NH₃
Van Damme et al. (2018)

10m climatological winds

Fort Collins

Loveland

Greeley

RMNP

Longmont

Boulder

Broomfield

EPA CONUS 12km WRF grid

NE Colorado

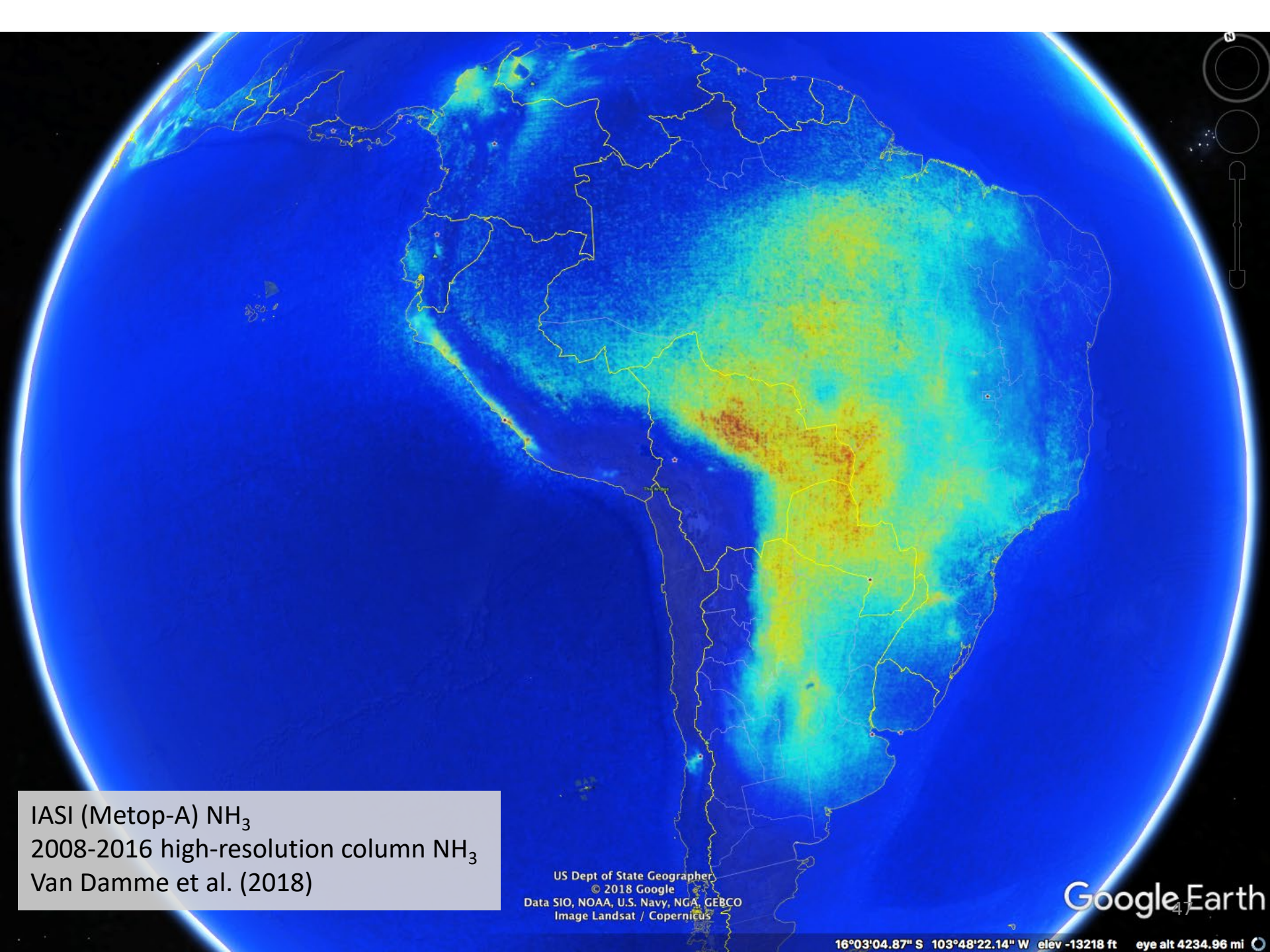
25.2 mi

Image Landsat / Copernicus

Denver © 2018 Google

Google Earth

40°13'55.78" N 105°49'20.56" W elev 0 ft eye alt 107.86 mi

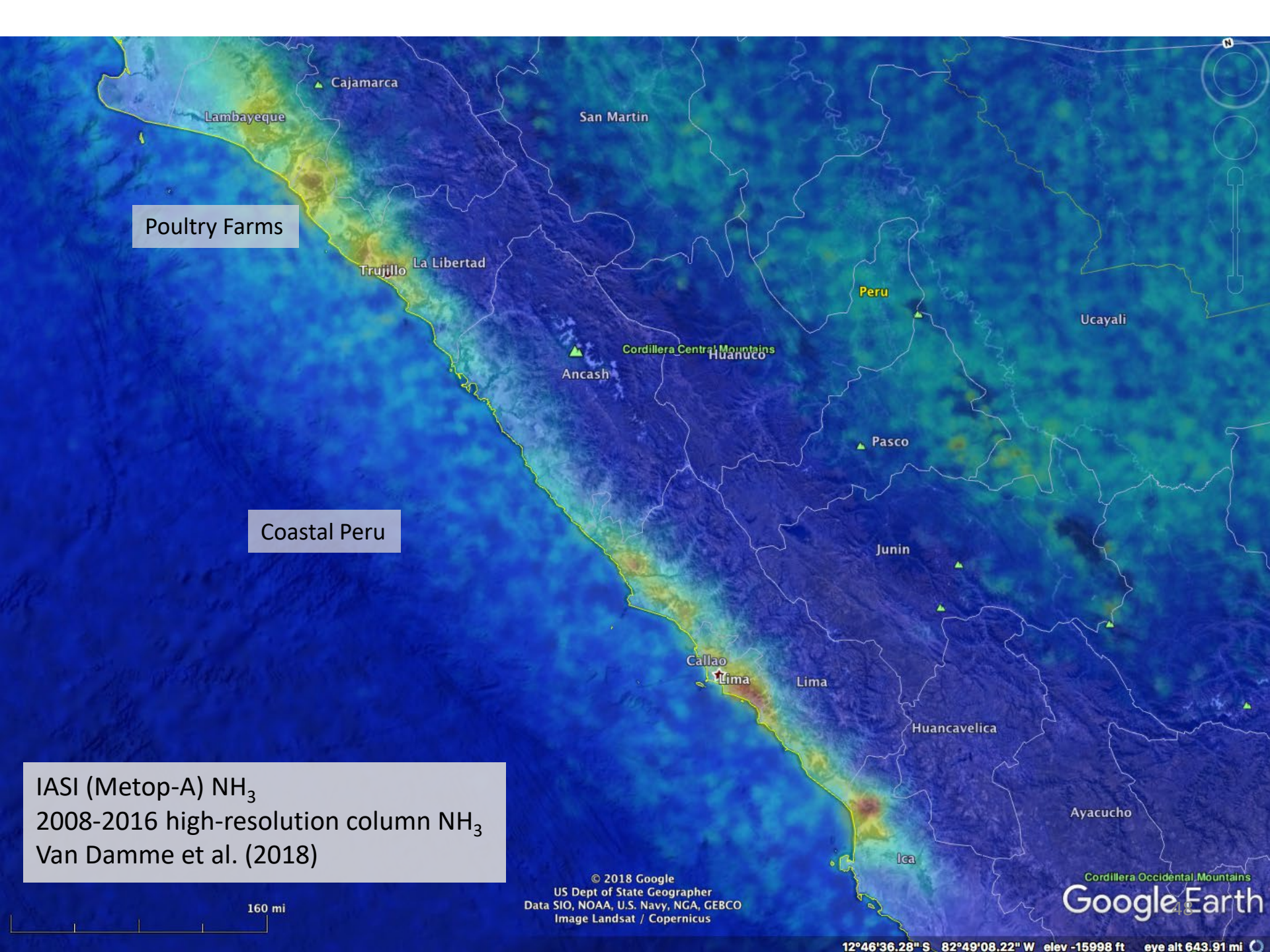


IASI (Metop-A) NH₃
2008-2016 high-resolution column NH₃
Van Damme et al. (2018)

US Dept of State Geographer
© 2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

Google Earth

16°03'04.87" S 103°48'22.14" W elev -13218 ft eye alt 4234.96 mi



Poultry Farms

Coastal Peru

IASI (Metop-A) NH₃
2008-2016 high-resolution column NH₃
Van Damme et al. (2018)

160 mi

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US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

Cordillera Occidental Mountains
Google Earth

12°46'36.28" S 82°49'08.22" W elev -15998 ft eye alt 643.91 mi

Summary

- Production tools for emissions inventory review and QA
- Tools were developed to support review of 2014 NEIv2 based air quality modeling platform emissions inputs (e.g. 2016 Inventory Collaborative)
- Prototype tools for emissions inventory development and emissions QA for air quality modeling studies
- Framework for emissions inventory verification using NH₃ satellite products
 - “Our results suggest that it is necessary to revisit the input data used for traditional bottom-up NH₃ inventories and that space measurements can make an important contribution to the monitoring of ammonia emissions.” (Van Damme et al., 2018)

Acknowledgements

- Cooperative Institute for Research in the Atmosphere (CIRA)
- National Park Service – Air Resources Division (NPS-ARD)
- National Oil & Gas Emissions Committee (OGEC)
- Inventory Collaborative
- USEPA
- Community Modeling and Analysis System (CMAS)
- Highsoft (Highcharts & Highmaps)

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2. EPA, 2014 NEIv2 summary data, ftp://newftp.epa.gov/air/nei/2014/data_summaries/2014v2/
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4. Sun, K., et al., (2018), A physics-based approach to oversample multi-satellite, multispecies observations to a common grid, Atmos. Meas. Tech., 11, 6679-6701, <https://doi.org/10.5194/amt-11-6679-2018>, 2018
5. Van Damme, M., et al., (2018), Industrial and agricultural ammonia point sources exposed, Nature, Volume 564, pages 99–103, <https://www.nature.com/articles/s41586-018-0747-1>
6. Van Damme, M., et al., (2018), Level 2 dataset and Level 3 oversampled average map of the IASI/Metop-A ammonia (NH₃) morning column measurements (ANNI-NH₃-v2.1R-I) from 2008 to 2016. PANGAEA, <https://doi.org/10.1594/PANGAEA.894736>