

# GRA<sup>2</sup>PES (Greenhouse gas And Air Pollutants Emissions System)

slides by B. McDonald (9/29/22)

## Research Objectives

- Joint initiative between NIST Greenhouse Gas Measurement Program and NOAA Chemical Sciences Laboratory
- Measure, model, and map emissions of greenhouse gases and air pollutants in consistent spatial/temporal pattern
- Development of uncertainty analyses for emission inventories
- Enable nowcasting, forecasting, or hindcasting of GHGs and air pollutants at multiple spatial scales – city, state and national

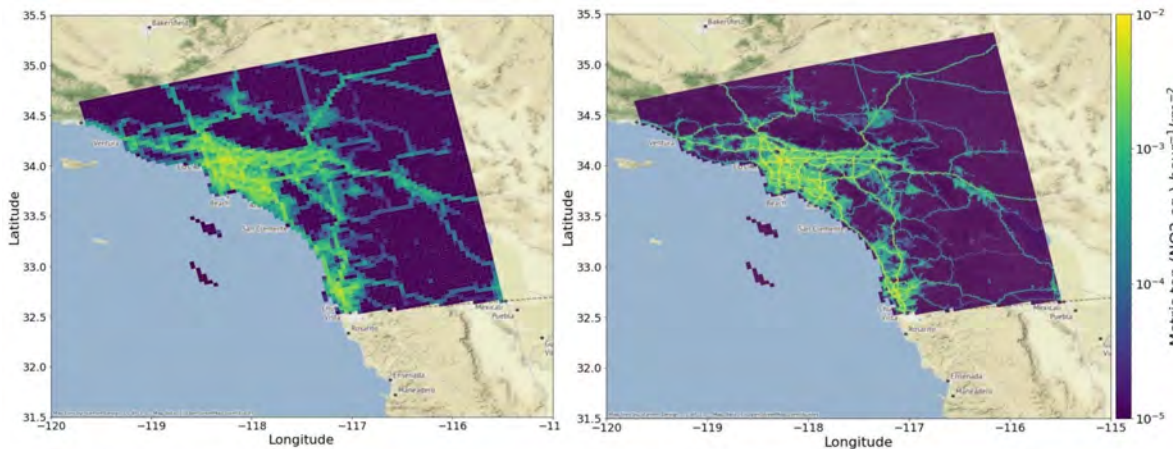
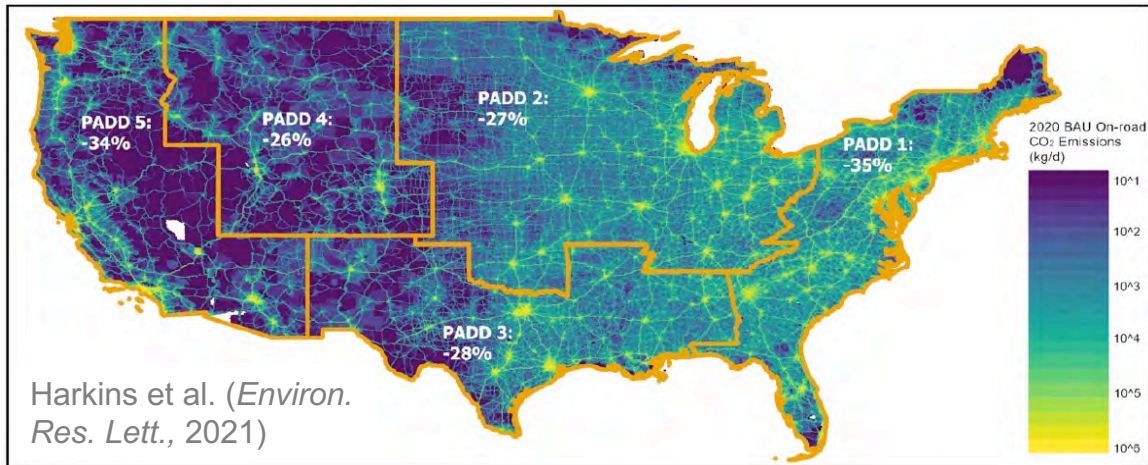


Figure provided by Katelyn Yu (UC-Berkeley/NOAA CSL)

# NOAA Chemical Sciences Laboratory Research

## ATMOSPHERIC CHEMISTRY & CLIMATE RESEARCH at the NOAA Chemical Sciences Laboratory

### Emissions Sources

- » Food production & agriculture
- » Mobile (e.g., trucks, airplanes, on- and off-road vehicles)
- » Energy production
- » Urban & industrial
- » Biomass burning
- » Biogenics
- » Marine

### Air Quality

- » Chemical kinetics
- » Chemical mechanisms
- » Photochemical processes
- » Deposition
- » Particle formation
- » Mixing and transport

### Aerosols

- » Aerosol-cloud-precipitation interactions
- » Radiative processes & forcing
- » Aerosol composition
- » Convective transport

### Atmospheric Dynamics

- » Fire weather
- » Transport
- » Boundary layer dynamics
- » Sudden stratospheric warmings

### Stratosphere

- » Circulation
- » Radiative processes
- » Ozone, water vapor, & aerosols
- » Ozone chemical processes
- » Stratosphere-troposphere coupling
- » Stratosphere-troposphere exchange

**Our Mission:** *To advance scientific understanding of the **chemical and physical processes** that affect Earth's atmospheric composition and climate.*

**Our Vision:** *A nation with the **best scientific understanding and information** about atmospheric chemistry and composition necessary to make **optimal decisions** for current and future generations.*



Chelsea R. Thompson/NOAA



<https://csl.noaa.gov/research/>



# Using Field Observations to Evaluate Emission Inventories

## Transportation (FIVE)



## Volatile Chemical Products (VCPs)



## Oil & Natural Gas (FOG)



**ENVIRONMENTAL**  
Science & Technology

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Article  
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### Modeling Ozone in the Eastern U.S. using a Fuel-Based Mobile Source Emissions Inventory

Brian C. McDonald,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Stuart A. McKeen,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Yu Yan Cui,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Ravan Ahmadov,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Si-Wan Kim,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Gregory J. Frost,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Ilana B. Pollack,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Jeff Peischl,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Thomas B. Ryerson,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> John S. Holloway,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Martin Gaus,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Carsten Warneke,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Jessica B. Gilman,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Joost A. de Gouw,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Jennifer Kaiser,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Frank N. Keutsch,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Thomas F. Hanisco,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Glenn M. Wolfe,<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> and Michael Trainer<sup>1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup>

RESEARCH

RESEARCH ARTICLE

Science

ATMOSPHERIC CHEMISTRY

### Volatile chemical products emerging as largest petrochemical source of urban organic emissions

Brian C. McDonald,<sup>1,2,\*</sup> Joost A. de Gouw,<sup>1,2</sup> Jessica B. Gilman,<sup>2</sup> Shantanu H. Jathar,<sup>3</sup> Ali Akherati,<sup>3</sup> Christopher D. Cappa,<sup>4</sup> Jose L. Jimenez,<sup>1,5</sup> Julia Lee-Taylor,<sup>1,6</sup> Patrick L. Hayes,<sup>7</sup> Stuart A. McKeen,<sup>1,2</sup> Yu Yan Cui,<sup>1,2,†</sup> Si-Wan Kim,<sup>1,2</sup> Drew R. Gentner,<sup>8,9</sup> Gabriel Isaacman-VanWertz,<sup>10</sup> Allen H. Goldstein,<sup>11,12</sup> Robert A. Harley,<sup>12</sup> Gregory J. Frost,<sup>2</sup> James M. Roberts,<sup>2</sup> Thomas B. Ryerson,<sup>2</sup> Michael Trainer<sup>2</sup>

**ENVIRONMENTAL**  
Science & Technology

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Article  
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### Development of a Fuel-Based Oil and Gas Inventory of Nitrogen Oxides Emissions

Alan M. Gorchov Negron,<sup>1,4,5</sup> Brian C. McDonald,<sup>6,7,8,9</sup> Stuart A. McKeen,<sup>1,8</sup> Jeff Peischl,<sup>1,8</sup> Ravan Ahmadov,<sup>1,11</sup> Joost A. de Gouw,<sup>1,8,9</sup> Gregory J. Frost,<sup>8</sup> Meredith G. Hastings,<sup>1</sup> Ilana B. Pollack,<sup>1,8,9,10</sup> Thomas B. Ryerson,<sup>8</sup> Chelsea Thompson,<sup>1,8</sup> Carsten Warneke,<sup>1,8</sup> and Michael Trainer<sup>8</sup>



# Adding Fossil CO<sub>2</sub> to AQ Inventory + Evaluation with <sup>14</sup>C Obs.

SUNVEx 2021 Field Campaign  
3 sites with <sup>14</sup>C → Fossil CO<sub>2</sub>

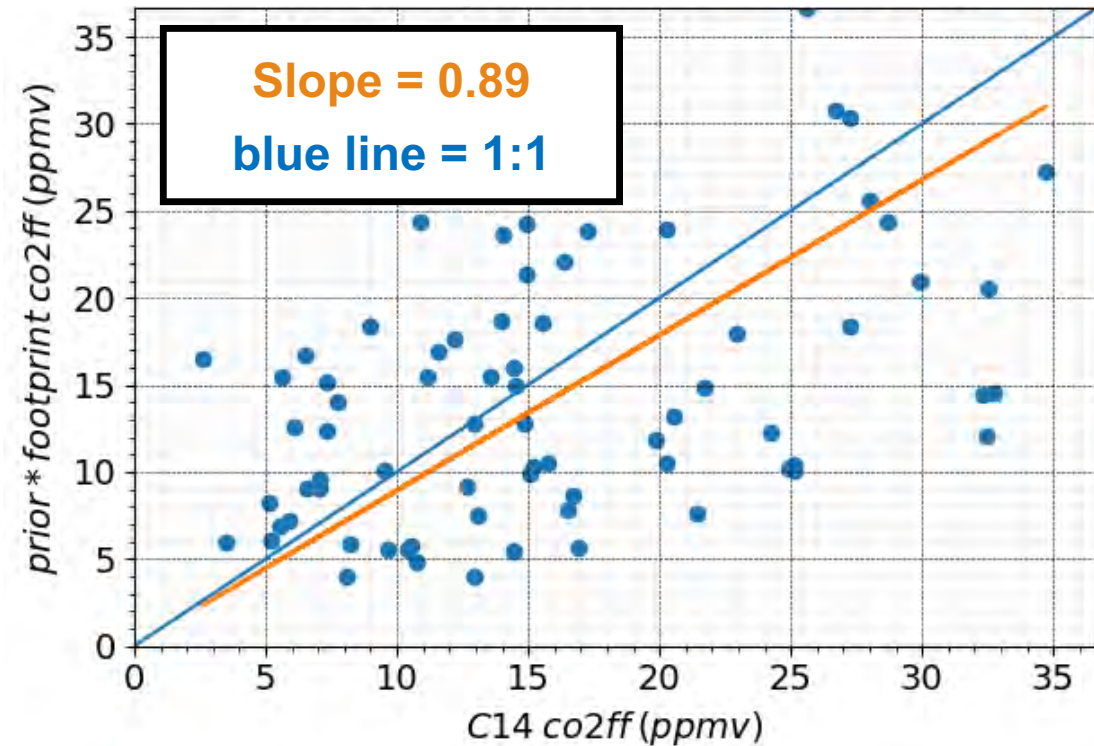
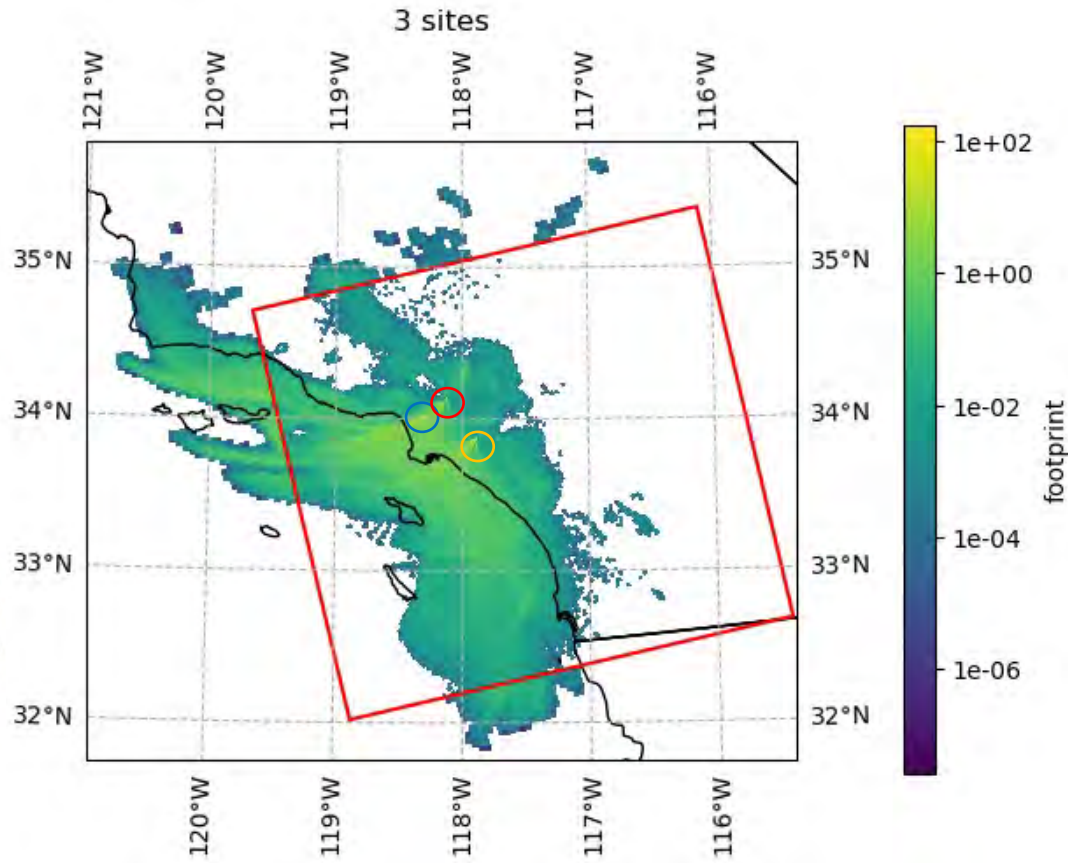
NOAA Fossil CO<sub>2</sub> Inventory  
within ~10% of Los Angeles obs.



Trammell Lyu  
(NOAA CSL)

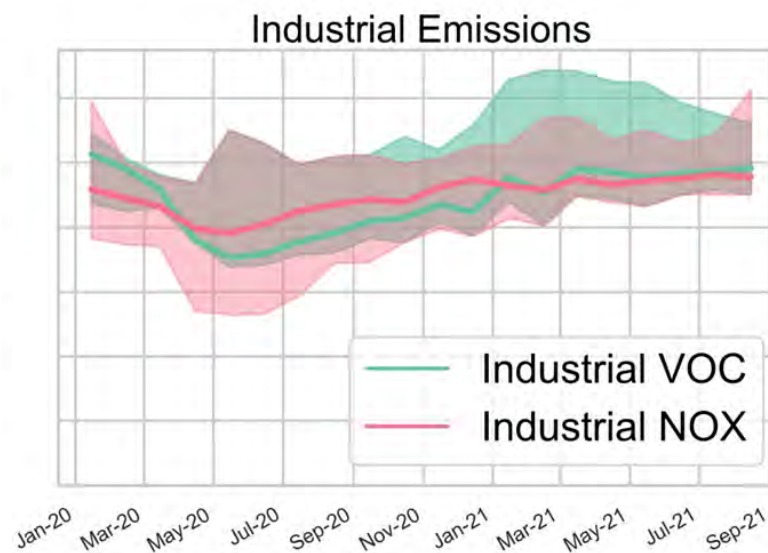
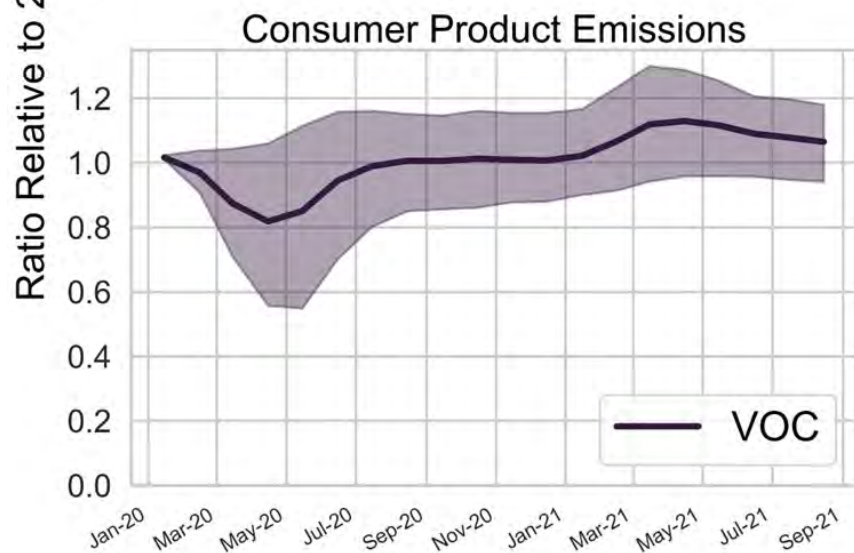
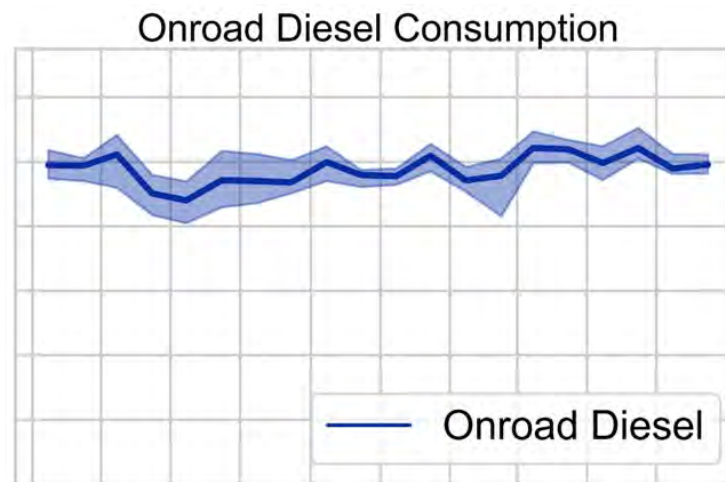
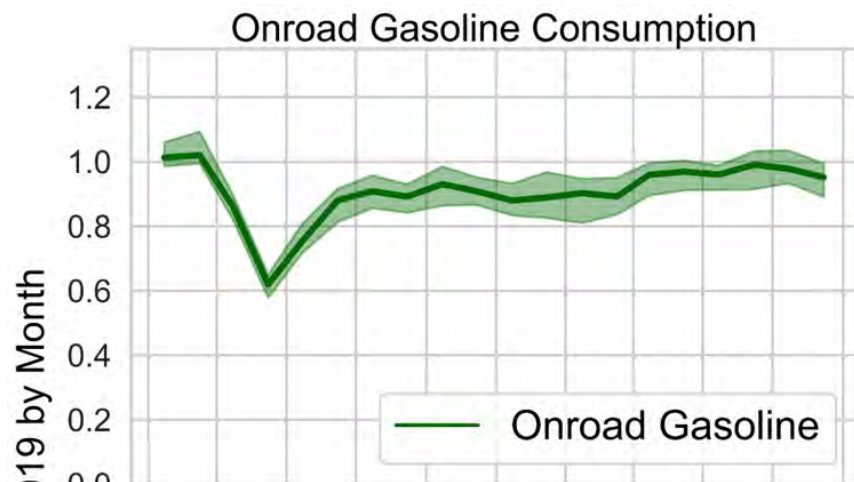


John Miller  
(NOAA GML)



<https://csl.noaa.gov/projects/sunvex/>

# Development of Near Real-Time Emissions Updating System



1. Able to update with 2-3 month lag using data on energy (DOE) and the economy (DOC)
2. Back to pre-pandemic levels of by 2021

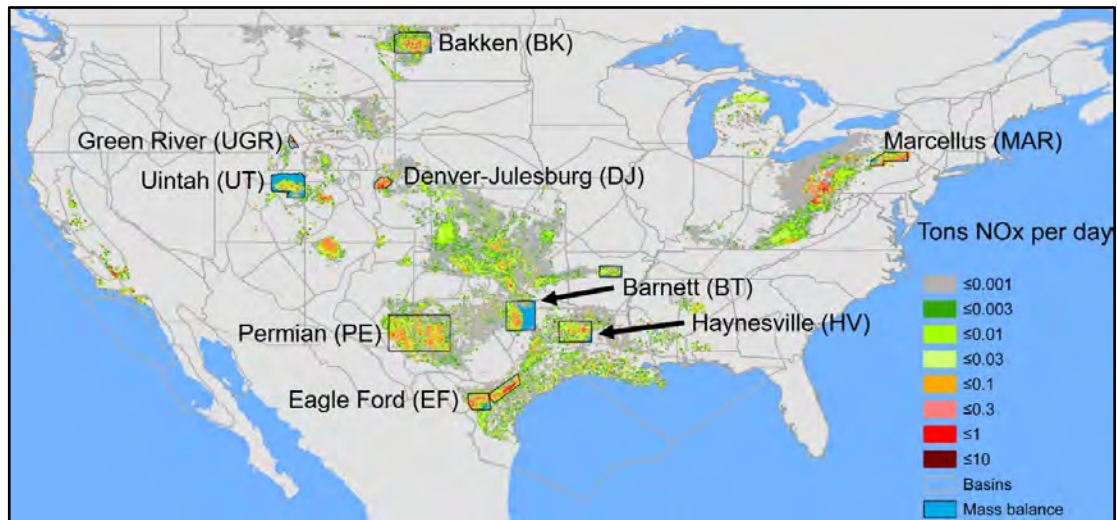


Colin Harkins  
(NOAA CSL)

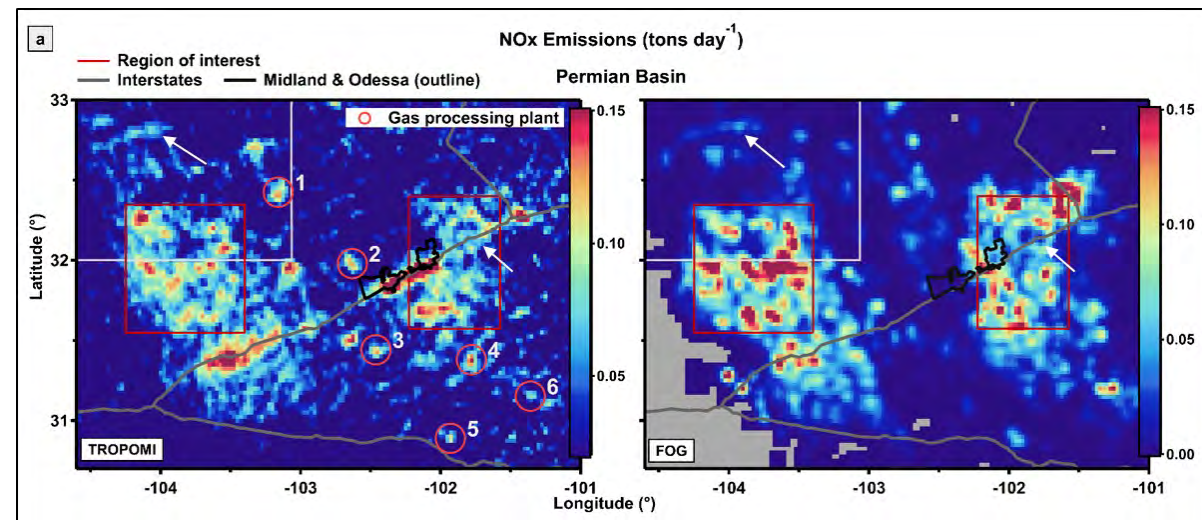


# Detecting Oil & Gas Emissions and Their Trends from Space

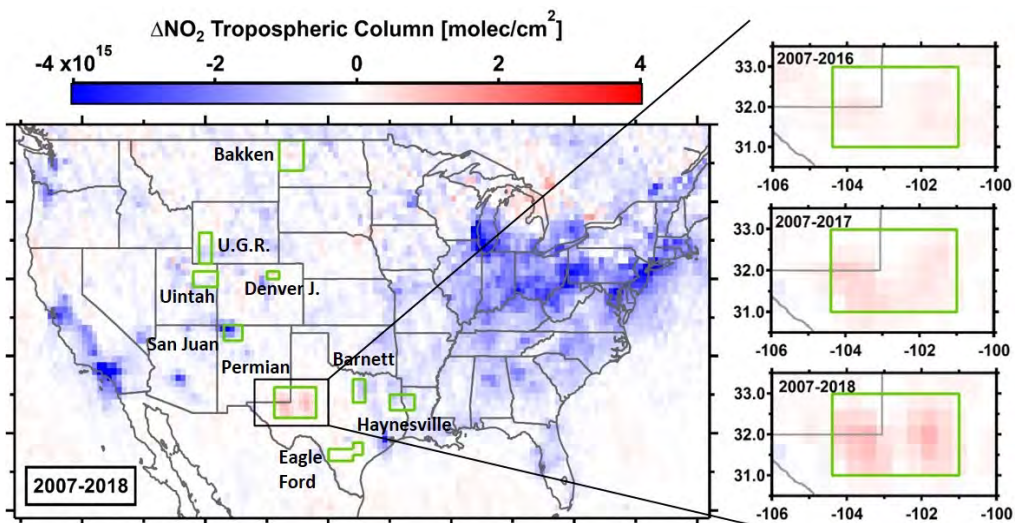
(NASA ACPMAP 80NSSC19K0979)



Francoeur et al. (*Environ. Sci. Technol.*, 2021)



Dix et al. (*ACS Earth & Space Chemistry*, 2022)



Dix et al. (*Geophys. Res. Lett.*, 2020)

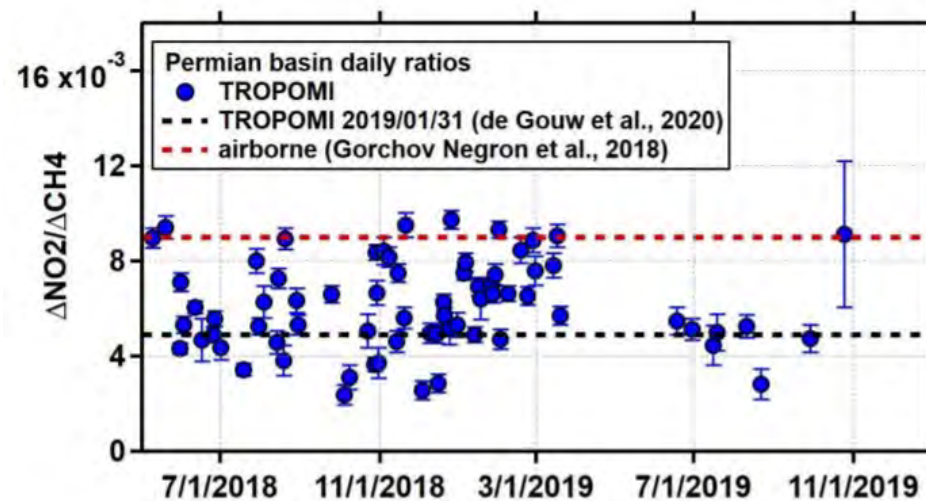
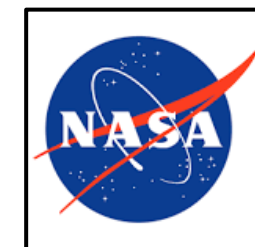
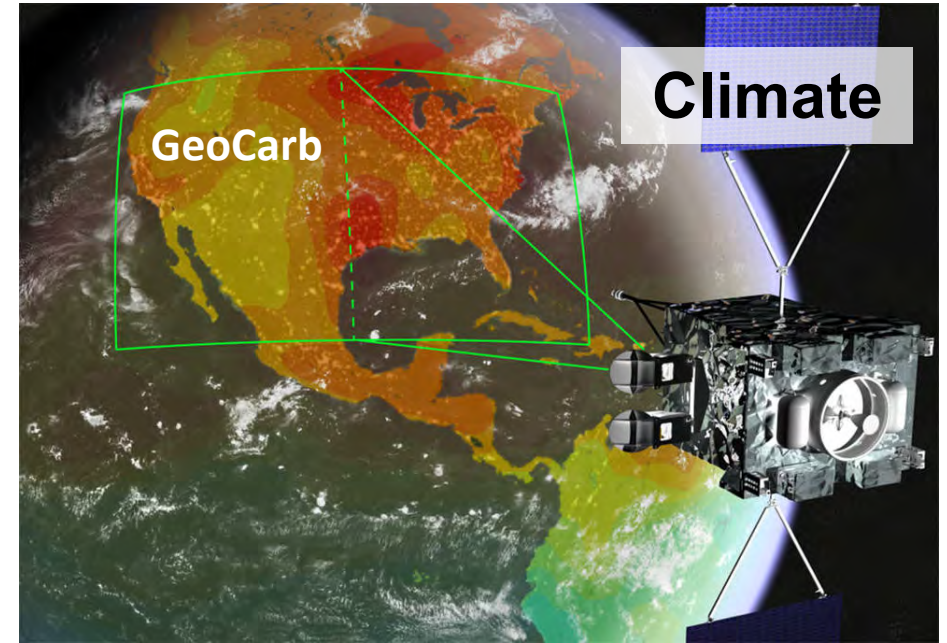
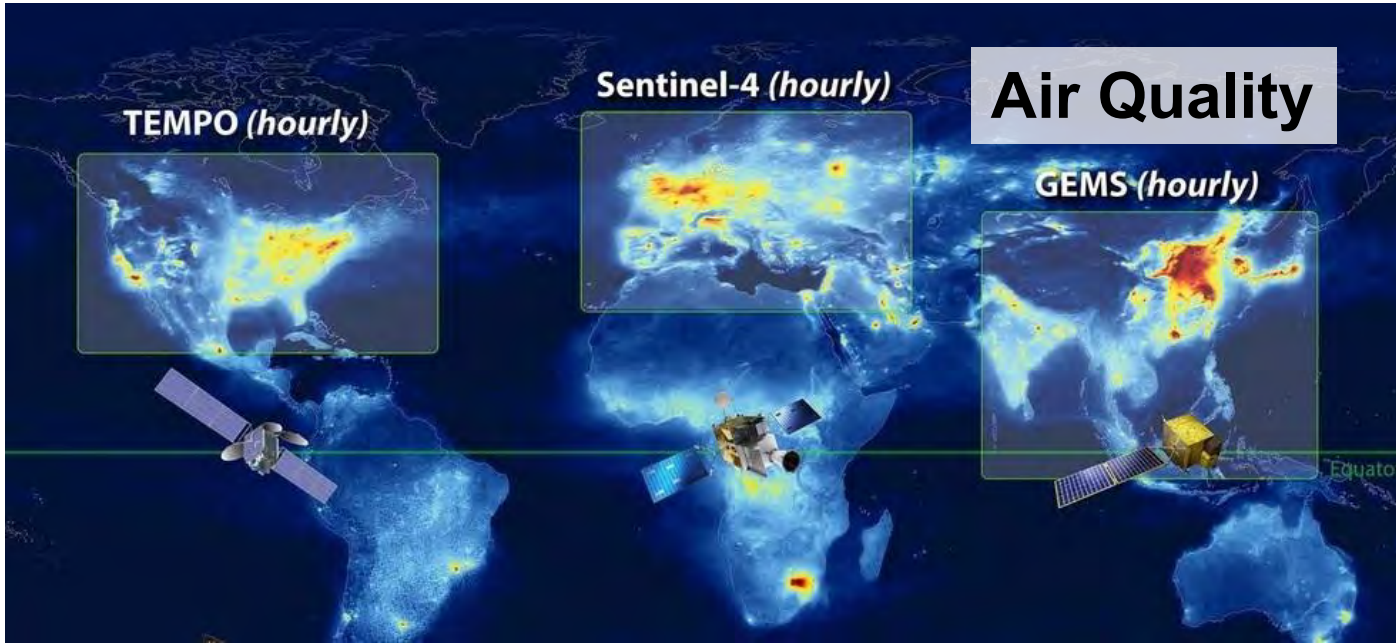


Figure provided by Barbara Dix

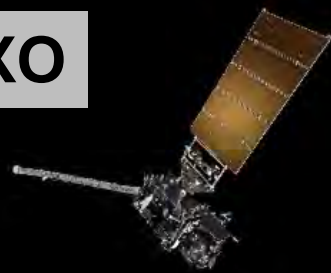




# Entering Geostationary Era of AQ and GHG Satellites



## GeoXO



**GEO-West**  
Vis/IR Imager  
Lightning Mapper  
Ocean Color  
Space Wx Suite\*



**GEO-Central**  
Hyperspectral IR Sounder  
Atmospheric Composition  
Partner Payload



**GEO-East**  
Vis/IR Imager  
Lightning Mapper  
Ocean Color  
Space Wx Suite\*





# NOAA CSL Scientists Contribute to Global Emissions Activities



Brian McDonald  
(NOAA CSL)



Claire Granier  
(NOAA CSL)

