Urban and On-Road Emissions: Underappreciated Sources of Atmospheric Ammonia

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PSW Res. Stn.

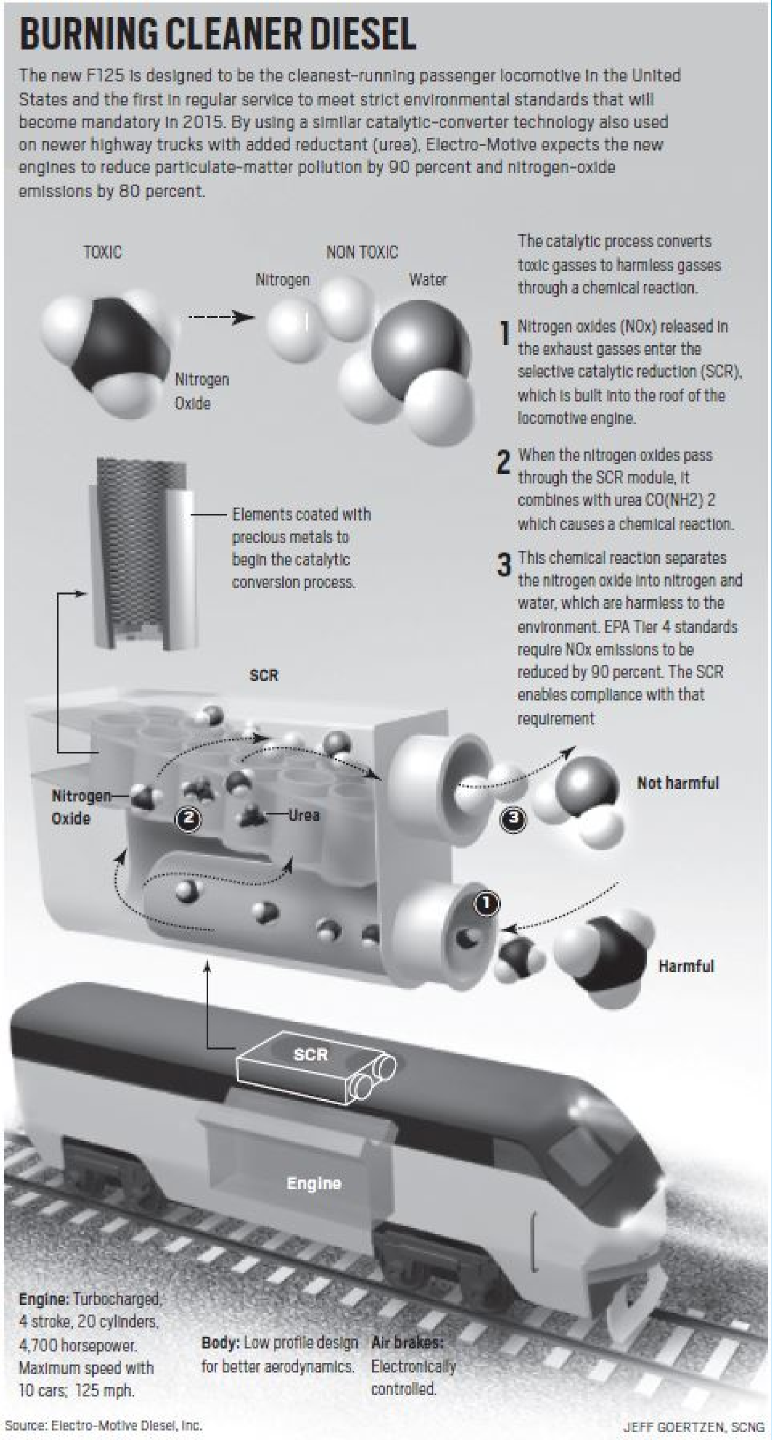
Why Talk About NH_x Deposition in CA & Elsewhere?

- **Increasing data showing high NH_x in areas traditionally dominated by NO_y**
- **Modern light duty and newer heavy duty vehicles an important source of NH_3**
- **High sensitivity of lichens and vegetative communities to NH_3 and NH4 deposition**
- **Observations of increasing relative importance of NH_x compared to NO_x in many locations, even in the absence of major agricultural sources**

NH_3 Emissions from Modern Heavy Duty Vehicles

- **Heavy-duty vehicles now include a mix of natural gas engines with three-way catalytic converters and diesel engines equipped with selective catalytic reduction (SCR), resulting in NH_3 emissions**
- **For the latter device, aqueous urea is injected as a reductant for NO_x control**
- **Emission rates of NH_3 for heavy-duty vehicles using natural gas engines equipped with three-way catalytic converters had NH_3 emission rates that were 5-10 times greater than light duty vehicles (Bishop et al. 2011, Thiruvengadam et al. 2016)**

A recent example of the trend of increasing NH_3 production by additional types of vehicles and engines.

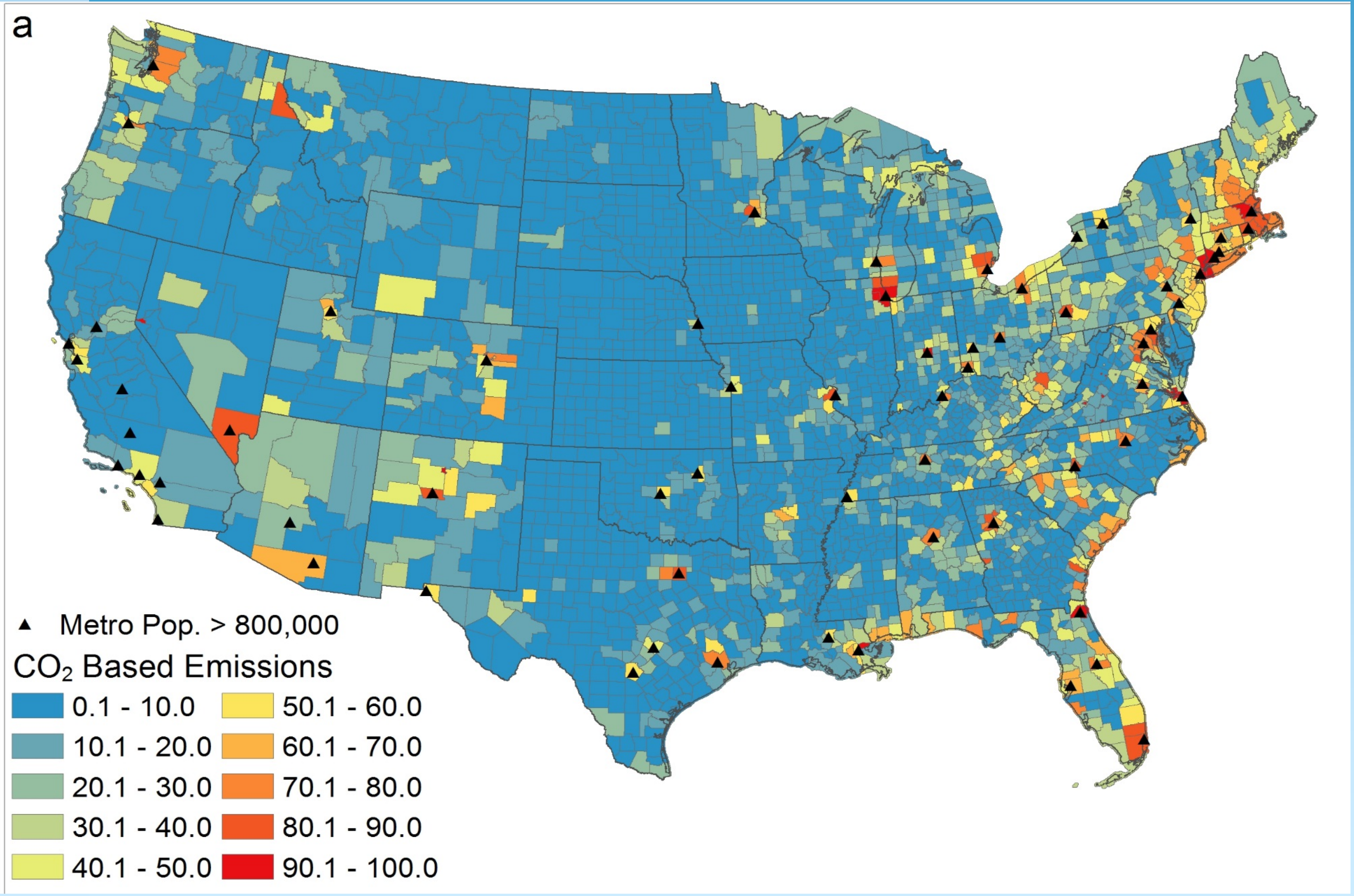


bluesky
diesel exhaust fluid®
An Aqueous Urea Solution | Complies with ISO 22241
High purity urea solution for the after treatment of SCR diesel engines.
PRODUCT INFORMATION
Optimal storage temperature 23° F to 77° F
Avoid direct exposure to sunlight
Please take note of applications and materials compatibility. For more information see our Product Data Sheet and MSDS Safety Data Sheet.
CAUTION DO NOT MIX WITH DIESEL FUEL.
Solution d'urée de très haute qualité pour le traitement ultérieur des gaz d'échappement SCR.
Informations sur le produit
Température de stockage optimale
23° F à 77° F / -5°C à 25°C
Éviter toute exposition directe aux rayons du soleil
Tenir compte de la manipulation et de la compatibilité des matériaux. Consulter notre fiche technique et notre fiche de sécurité MSDS pour plus d'informations.
Précaution ne versant pas dans la citerne de diesel.
Solución de urea de alta pureza para tratamiento de SCR. en motores de diésel.
Información del producto
Temperatura óptima de almacenamiento
23° F y 77° F / -5°C y 25°C
Evitar la exposición directa al sol
Por favor considerar la compatibilidad entre aplicaciones y materiales. Referirse a las tablas de datos incluidas en Especificaciones del producto y MSDS.
Precaución no mezclar con combustible diesel.
2 x 2.5 gallon bottles | 9.46 liter bottles | Made in the U.S.A
API
AMERICAN PETROLEUM INSTITUTE
CERTIFIED
DIESEL EXHAUST FLUID
Manufactured by:
Blue Sky East, LLC
800 Roosevelt Avenue
Carteret, NJ 07008
Distributed by:
Blue Sky Rocky Mountain
Fort Lupton, CO 80621
7 97734 31208 9
The Clear Choice for Clean Air™
855.258.7593 | BlueSkyDEFna.com

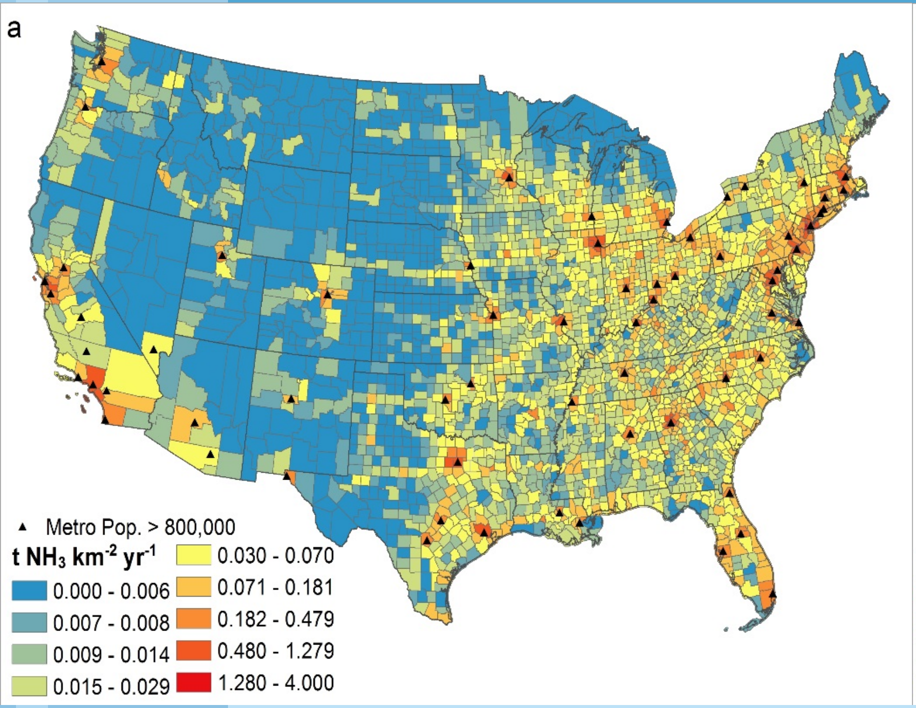
General Rule:

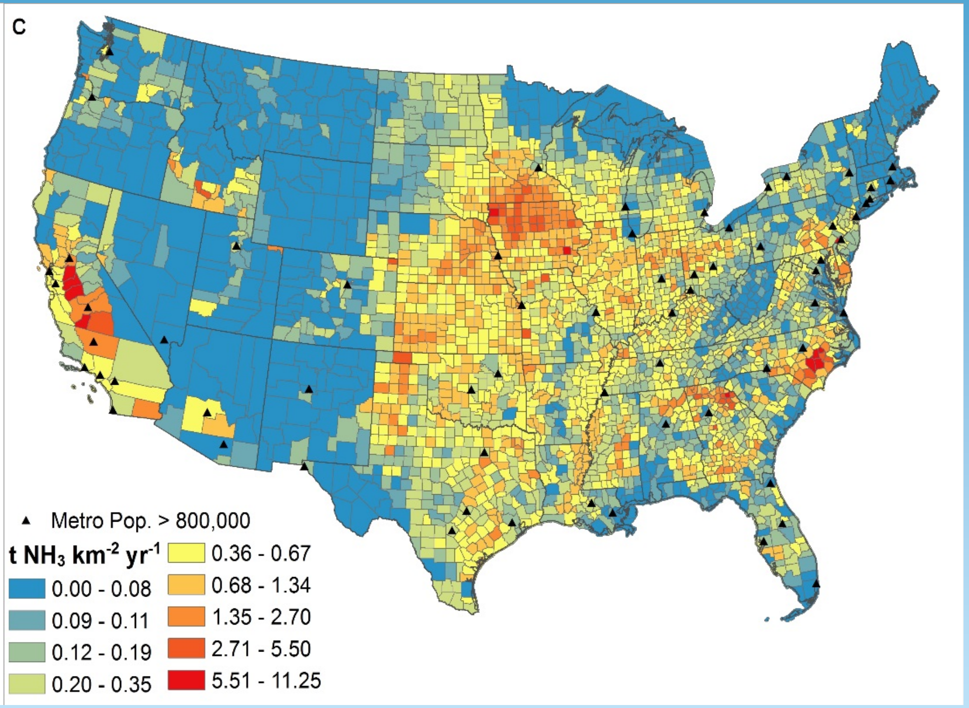
Conditions and emissions control mechanisms that result in highly effective NO_x reduction result in greater NH_3 production and emissions

Percent NH_3 Emissions From On-Road Sources (by county)

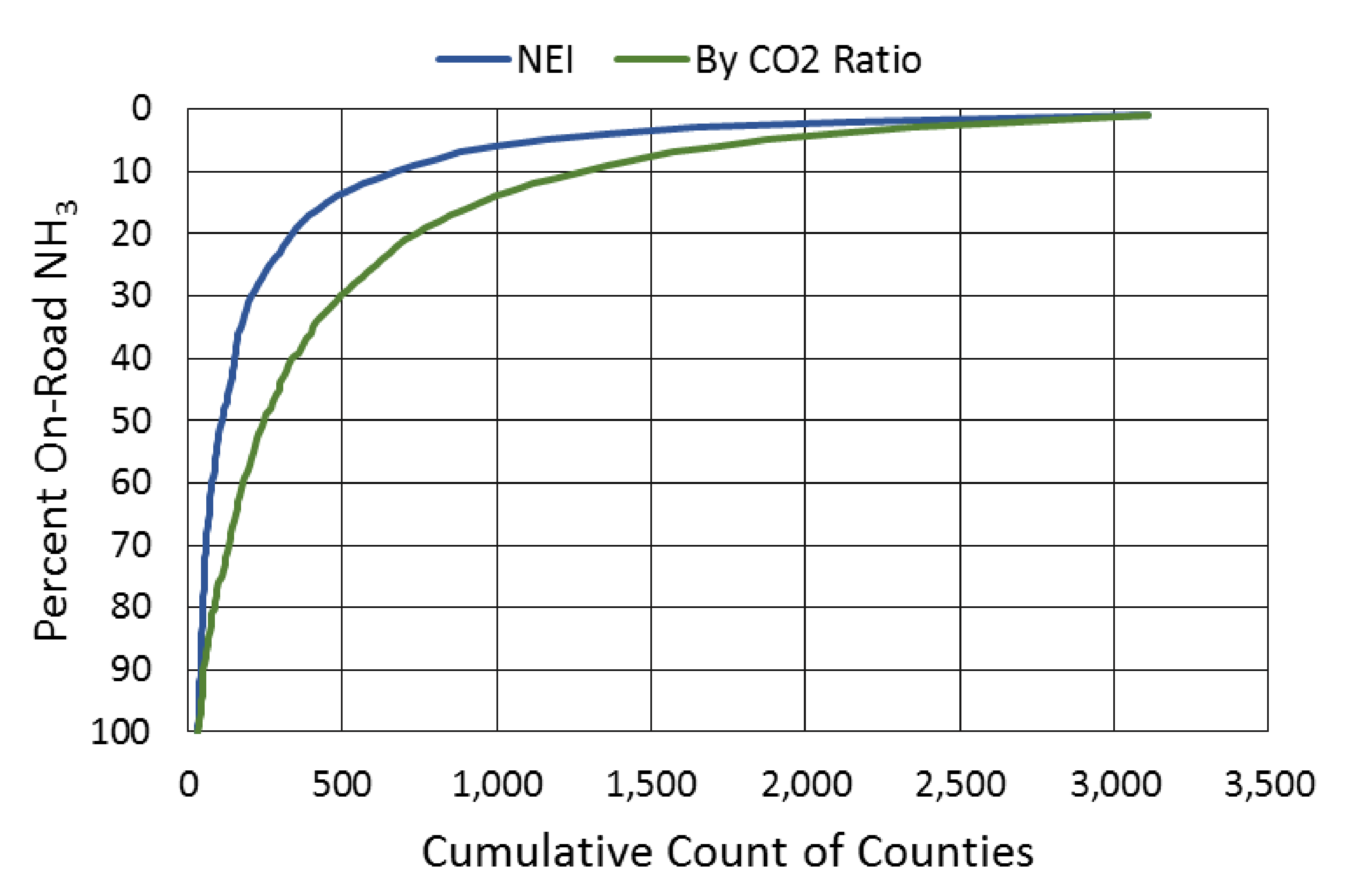


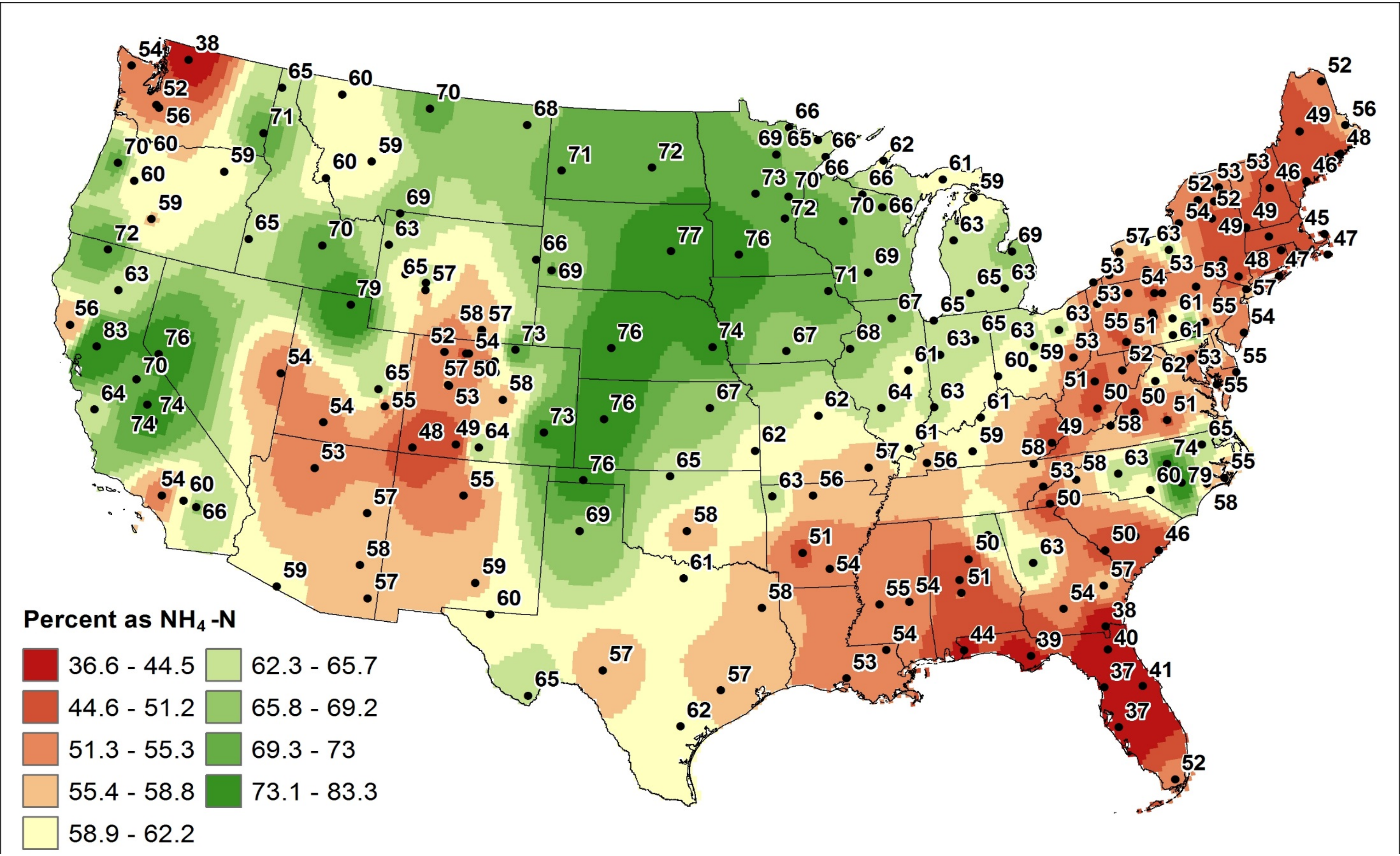
On-road NH_3 emission (2012) | **Agricultural NH_3 emissions (NEI-2014)**





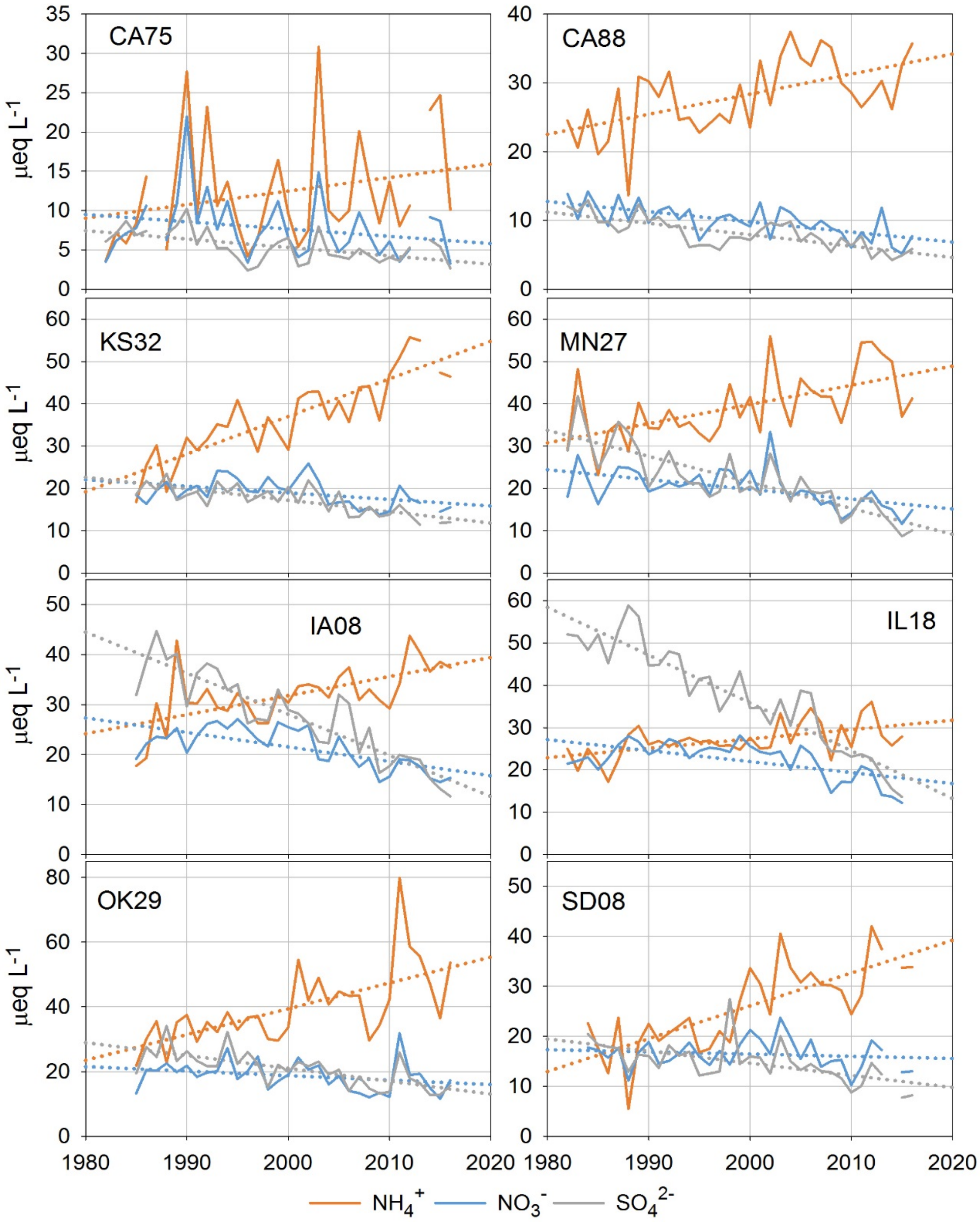
Cumulative Distribution of US Counties in Relation to the Percent NH_3 Emissions From On-Road Sources



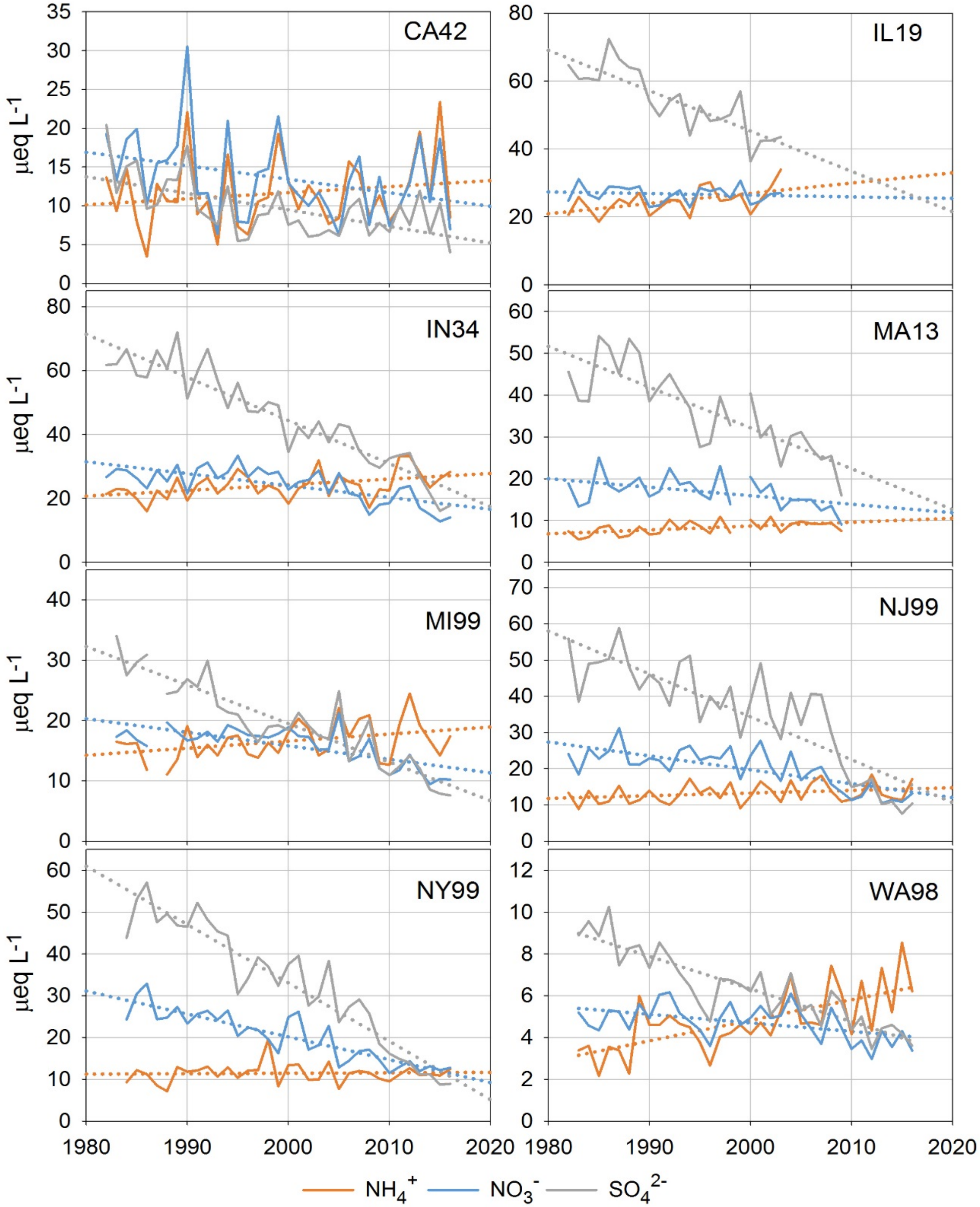


Percent as NH4 -N
36.6 - 44.5
44.6 - 51.2
51.3 - 55.3
55.4 - 58.8
58.9 - 62.2
62.3 - 65.7
65.8 - 69.2
69.3 - 73
73.1 - 83.3

Ag-affected NADP/NTN Sites: Trends in NH_4, NO_3 and SO_4 concentrations



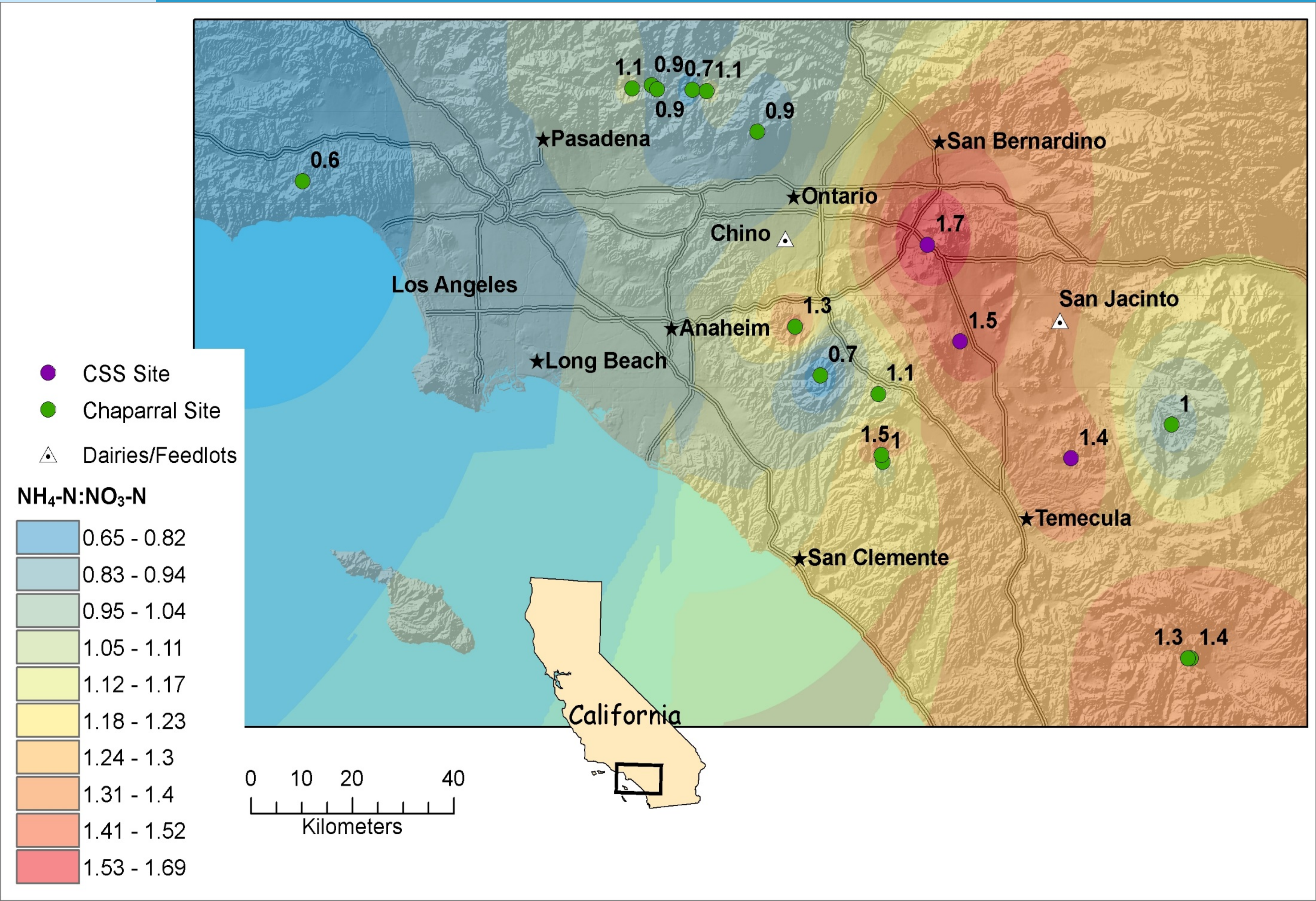
Urban-affected NADP/NTN Sites: Trends in NH_4, NO_3 and SO_4 concentrations



Importance of NH_4^+ Deposition in Urban OR and WA

Throughfall Site	N Deposition (kg/ha/yr)	NH4-N:NO3-N
Portland, Forest Park	11.8	0.9
Portland, Zoo	21.0	1.3
Eugene, Hendrix Park	8.1	1.0
Seattle, Seward Park	9.9	0.8
	MEAN:	**1.0**
Open Site		
Portland, Forest Park	3.0	2.2
Portland, Zoo	5.7	2.9
Eugene, Hendrix Park	1.7	2.3
Seattle, Seward Park	2.7	1.8
	MEAN:	**2.3**

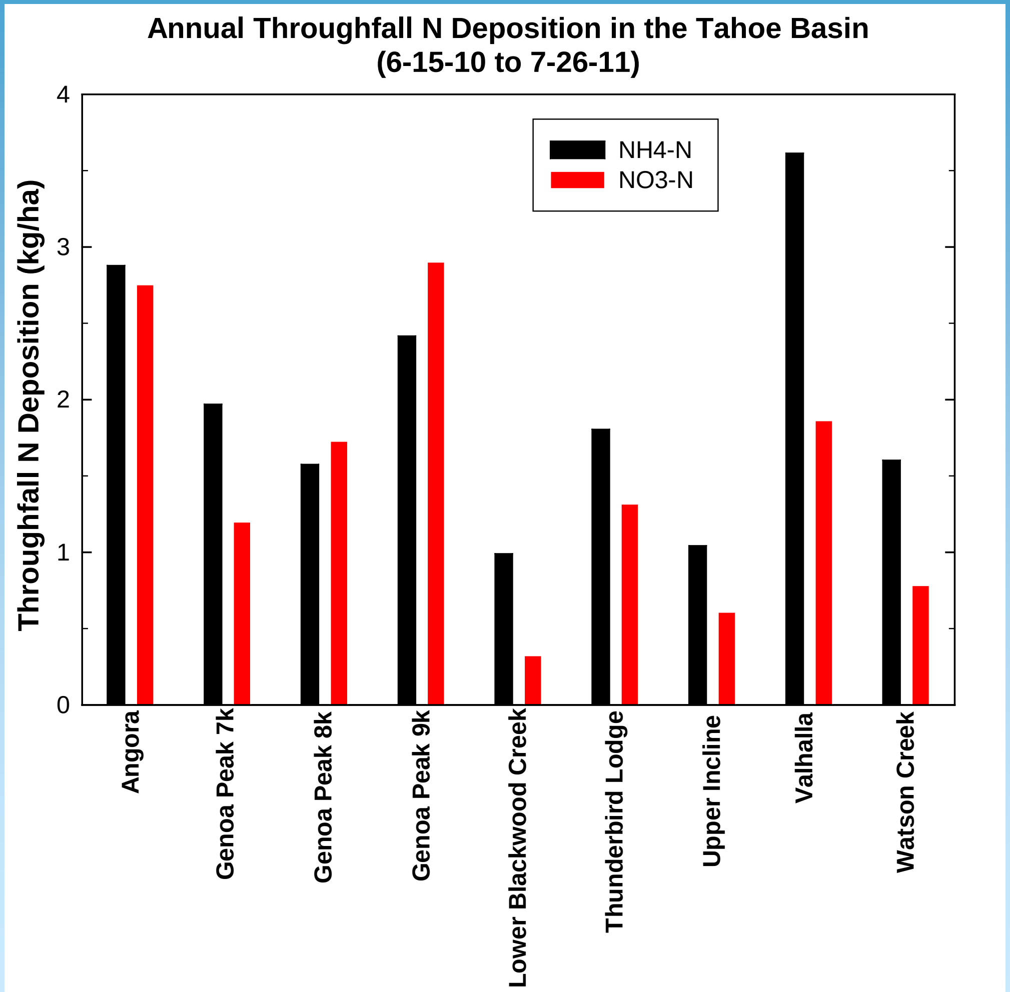
NH_4:NO_3 in Throughfall Under Shrubs: LA Basin



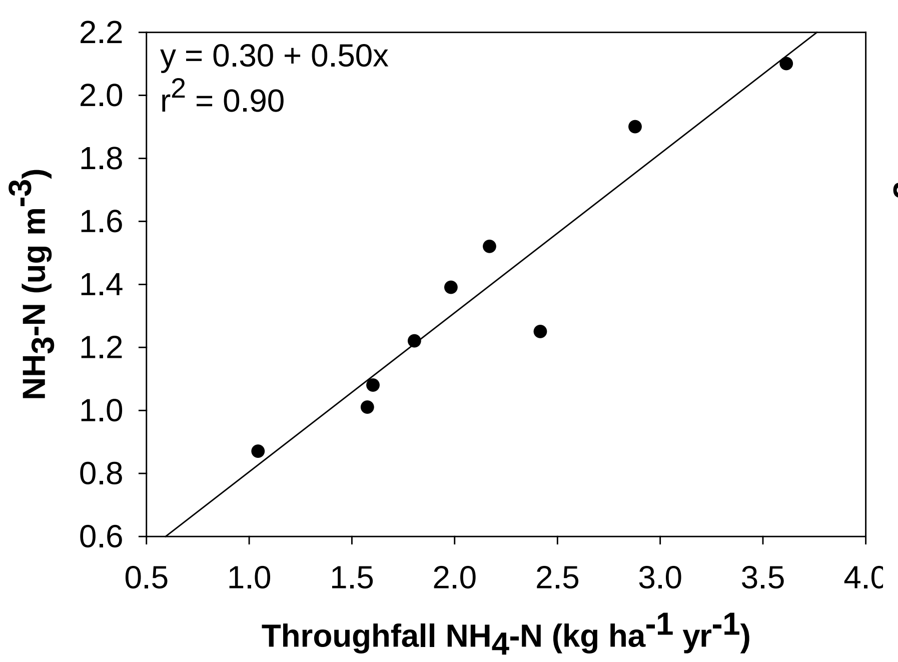
IER throughfall collector for sampling under shrub canopies

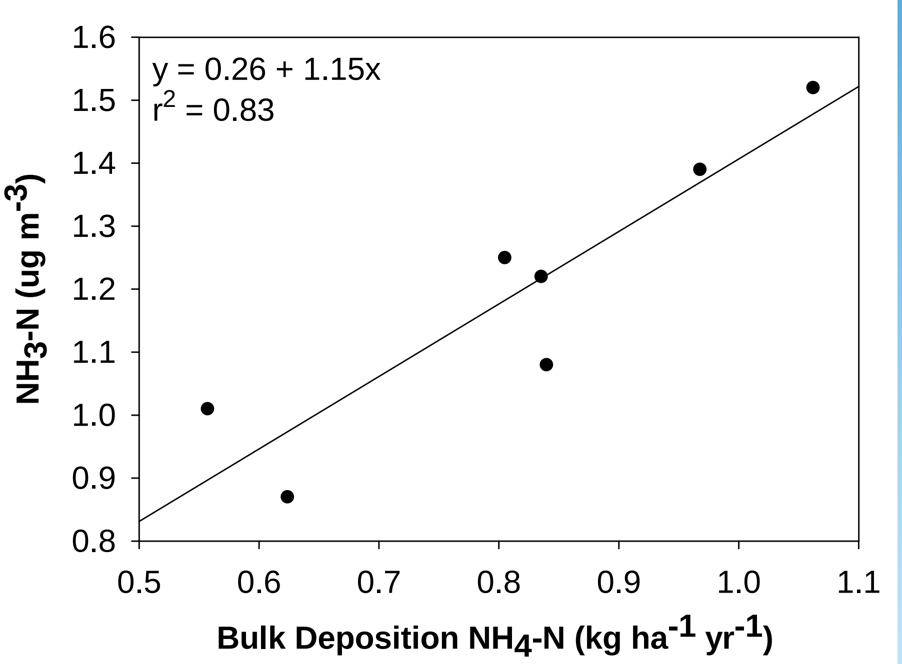
Lake Tahoe Basin---Affected by in-basin urban and on-road N emissions

Lake Tahoe: Throughfall Deposition of N

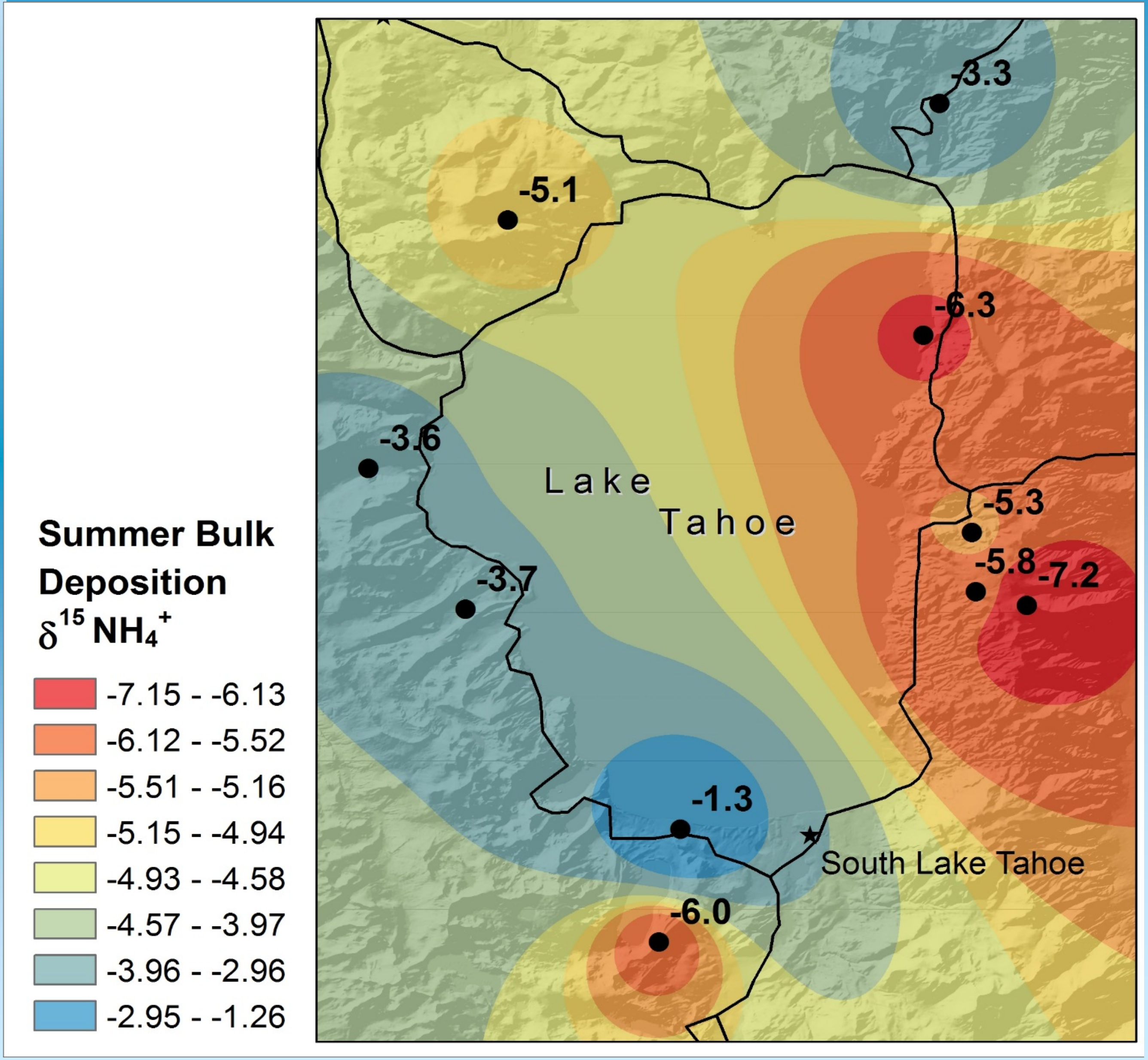


Lake Tahoe Basin: NH_4^+ Deposition vs. Atmospheric NH_3 Concentrations

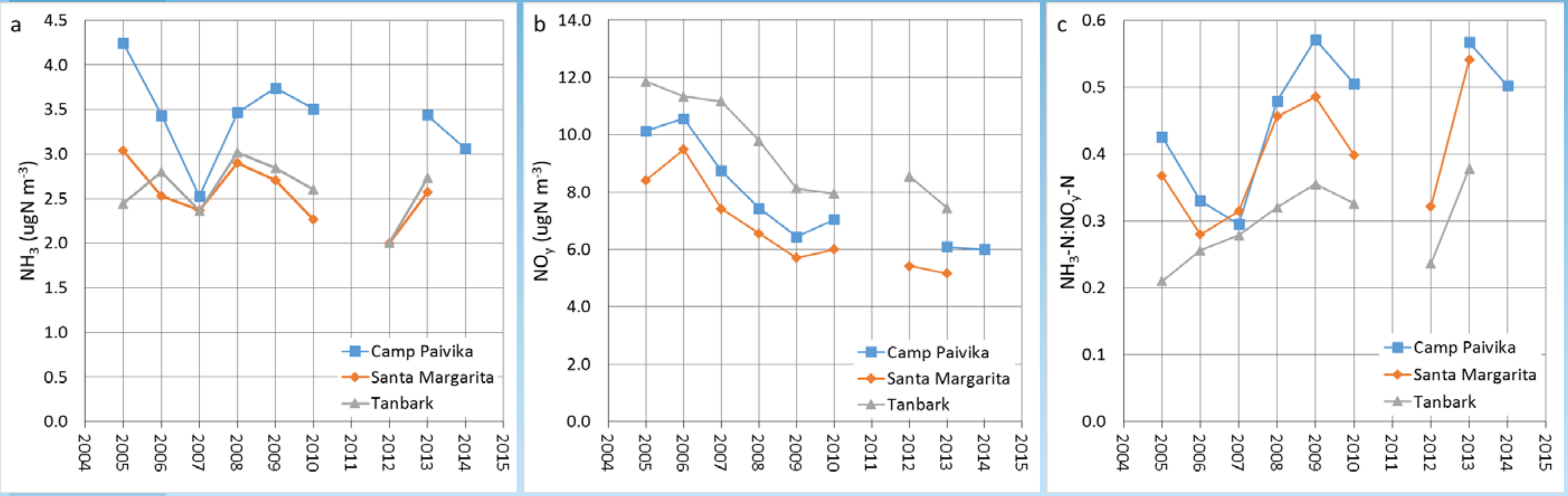




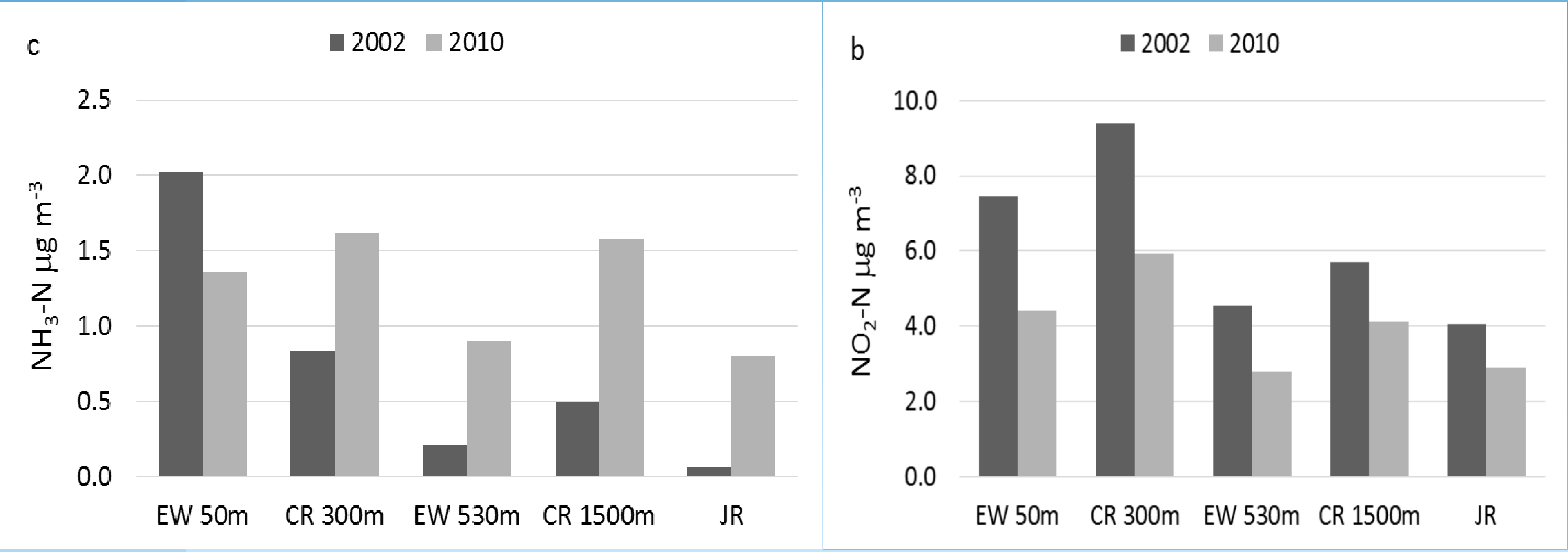
Values for $\delta^{15}NH_4^+$ in bulk deposition in Lake Tahoe



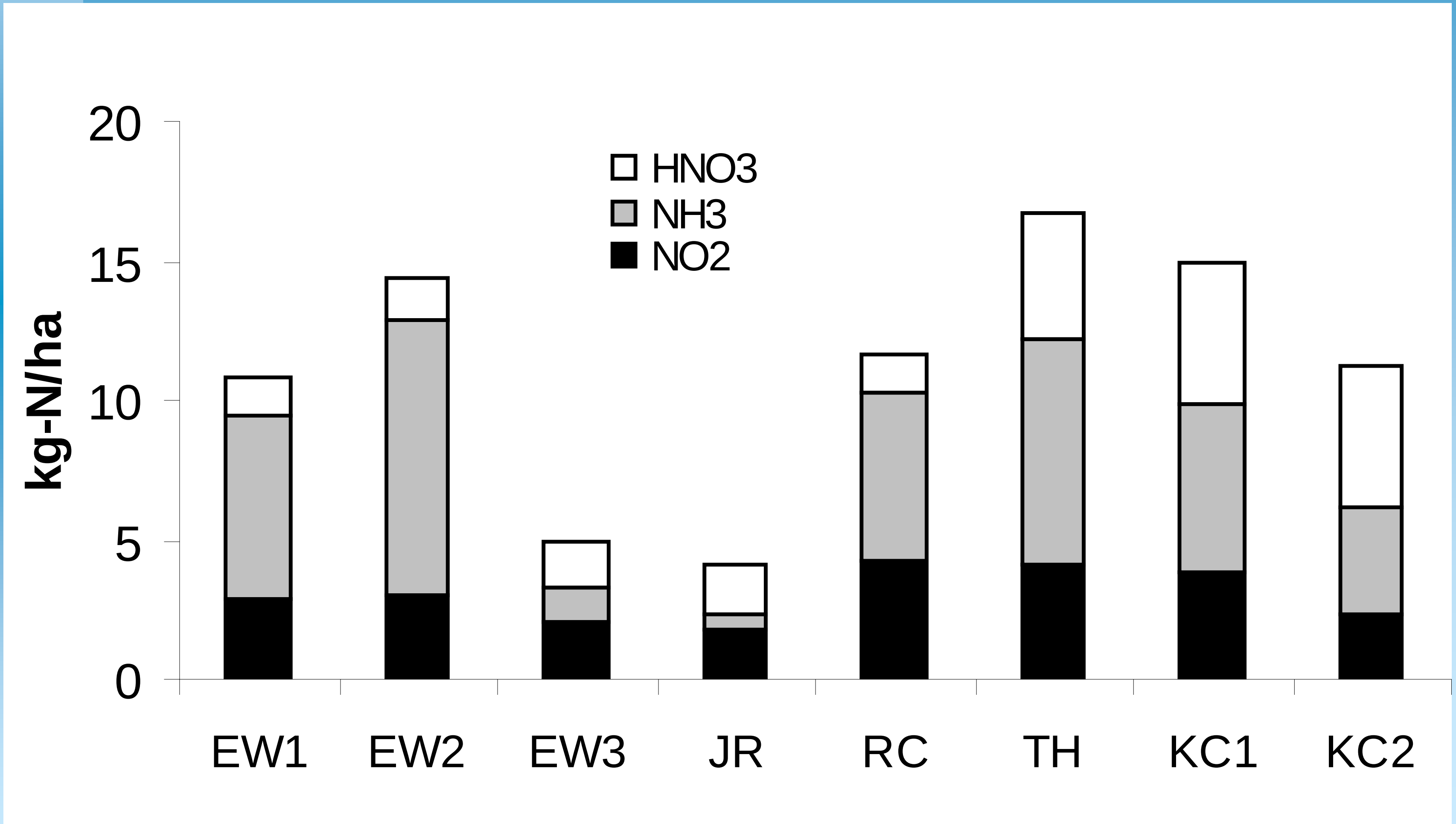
Gaseous Pollutants: NH_3 and NO_y Temporal Trends at Rural Sites in Southern California



Concentrations of NH_3 and NO_2 Near Highways in the San Francisco Bay Area



N gaseous pollutant deposition to a California grassland near a major highway (280) in the coastal San Francisco peninsula and in near-urban sites



CONCLUSIONS

- **As a rule, stringent NO_x controls lead to NH_3 production from on-road and industrial sources**
- **Proportion of on-road N emissions as NH_3 is increasing due to decreasing emissions of NO_x and growing segment of the vehicle fleet emitting NH_3**
- **NH_4-N deposition in urban and near-urban sites is increasingly greater than NO_3-N**
- **Urban NH_3 emissions have strong effects on aerosol production (e.g., $PM_{2.5}$)**

CONCLUSIONS

- On-road NH_3 emissions contribute ≥ 50% of total NH_3 emissions in many counties
- Such on-road and urban NH_3 emissions are not widely acknowledged
- Deposition/atmospheric exposure footprint of on-road NH_3 emissions not fully understood
- In many areas both ag and on-road emissions of NH_3 are important contributors to environmental and ecological impacts