Using CrIS Ammonia Observations to Improve Decision Making on $PM_{2.5}$ Control Policies

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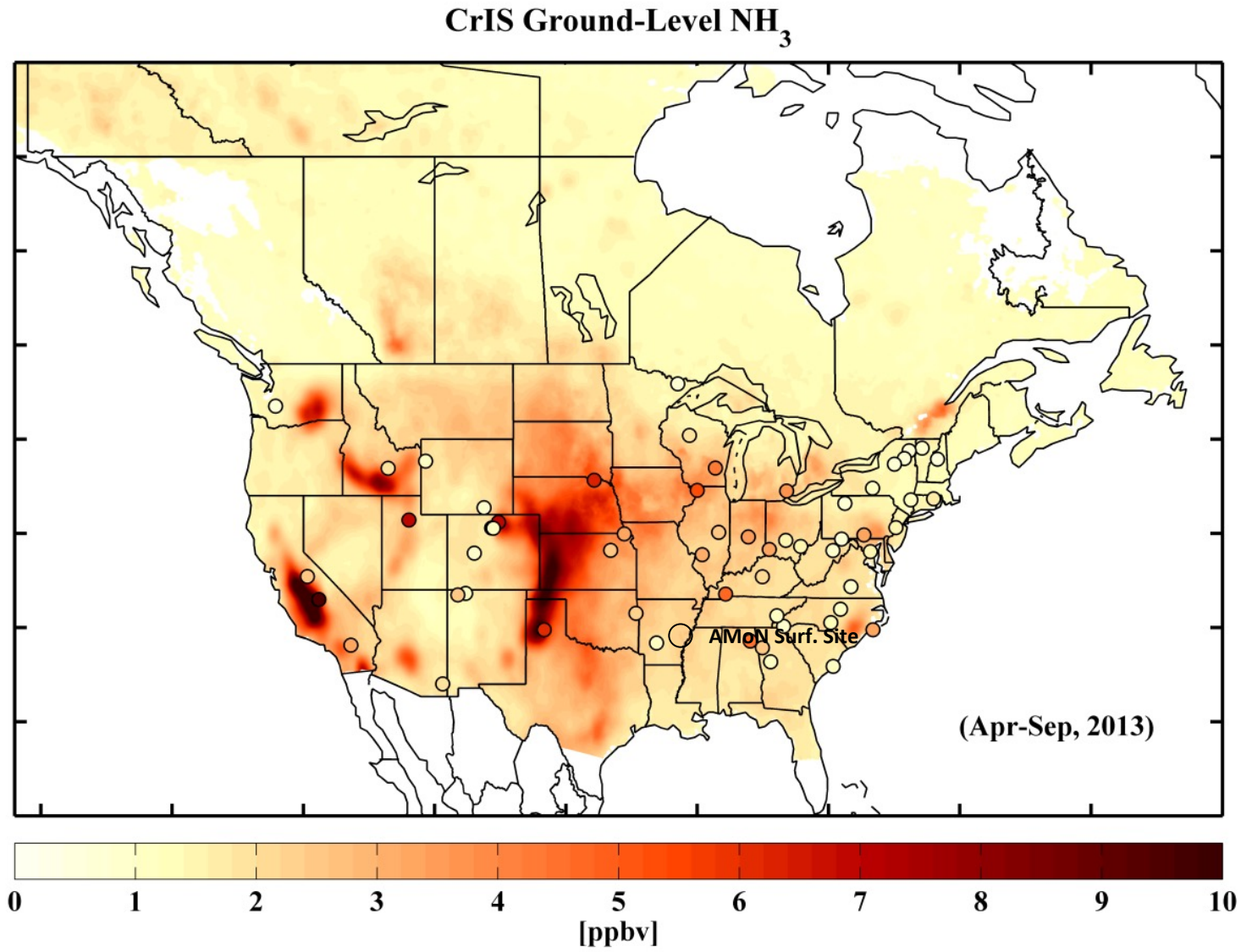
Overall Project Goal

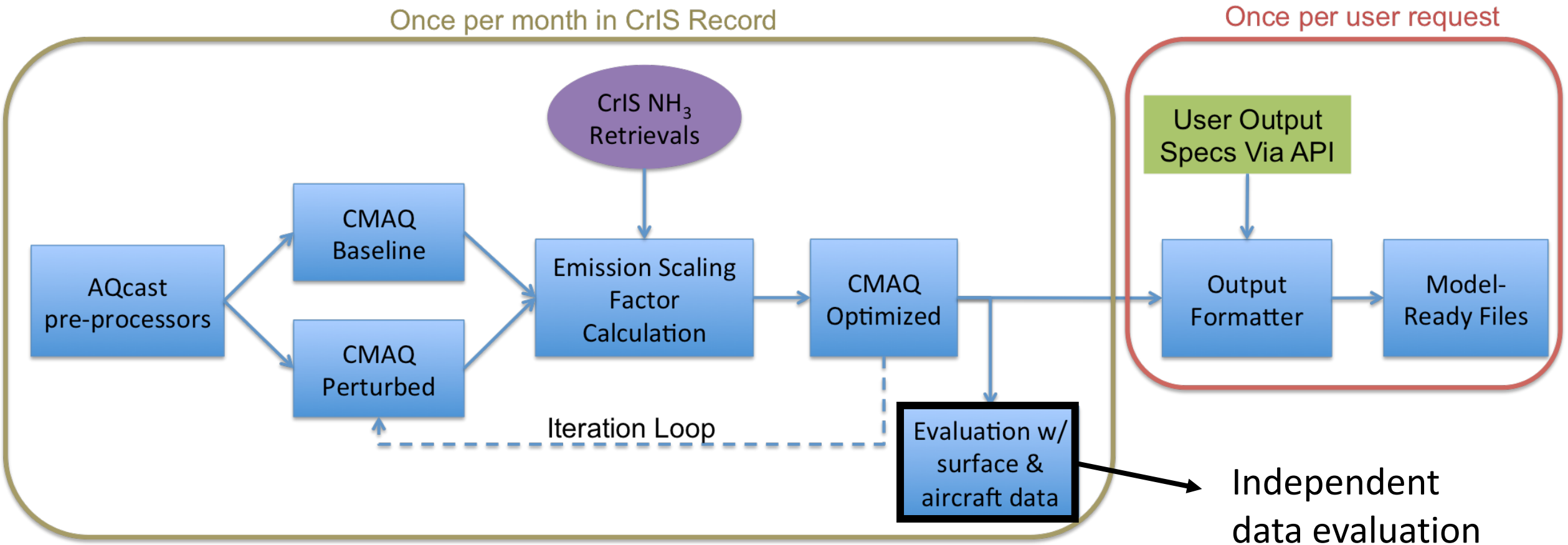
Use CrIS observations in a FDMB inversion to provide more accurate NH_3 emissions to AQ forecasters, AQ managers, and other stakeholders to improve decision-making on $PM_{2.5}$

CrIS Can Identify NH_3 Sources

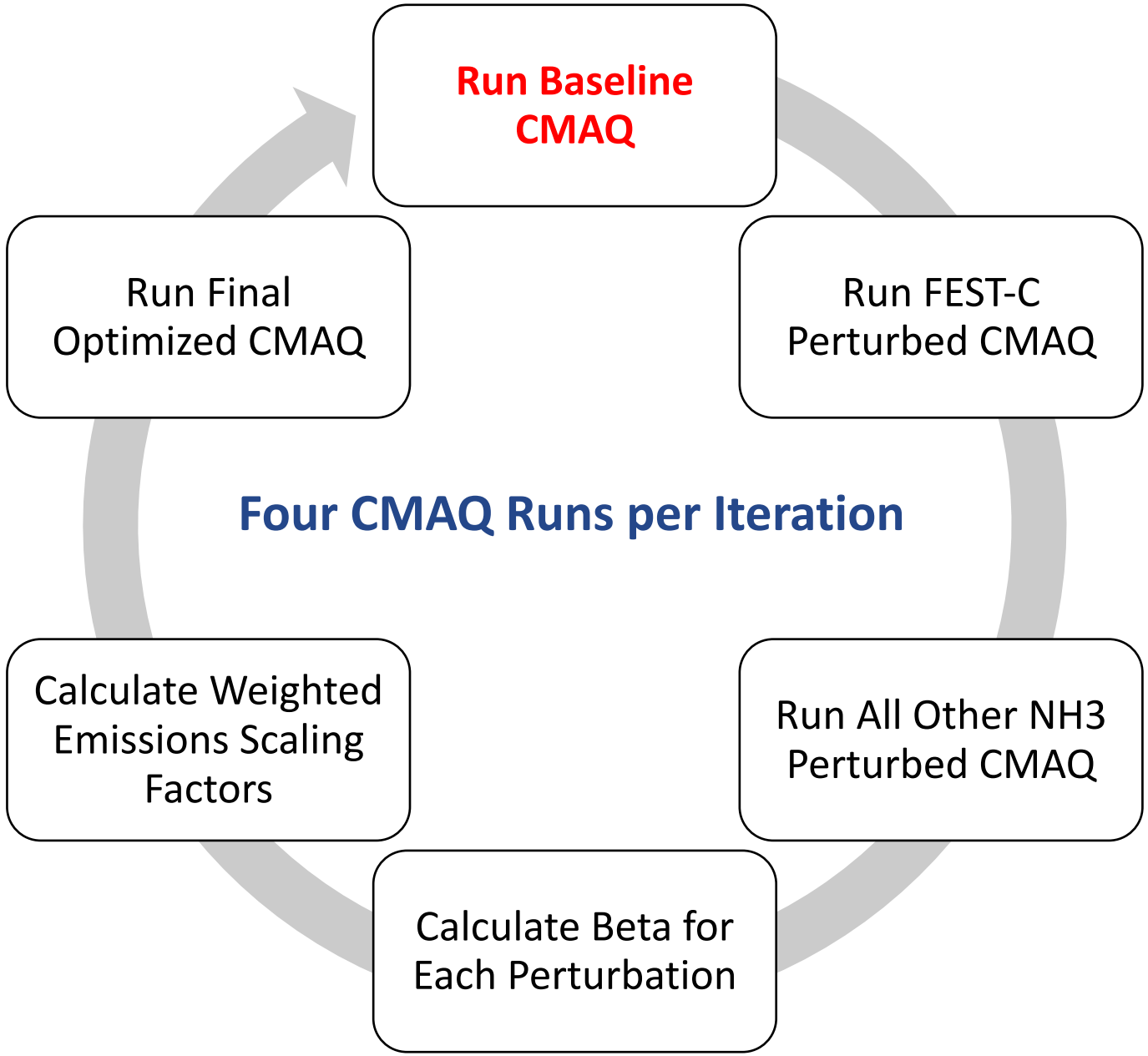
- CrIS Satellite NH_3 warm season (Apr. – Sept., 2013) average surface map, with corresponding AMoN surface network measurements overlaid.



Schematic Overview of Project Workflow



Calculation of Final NH_3 Emissions using bidirectional flux



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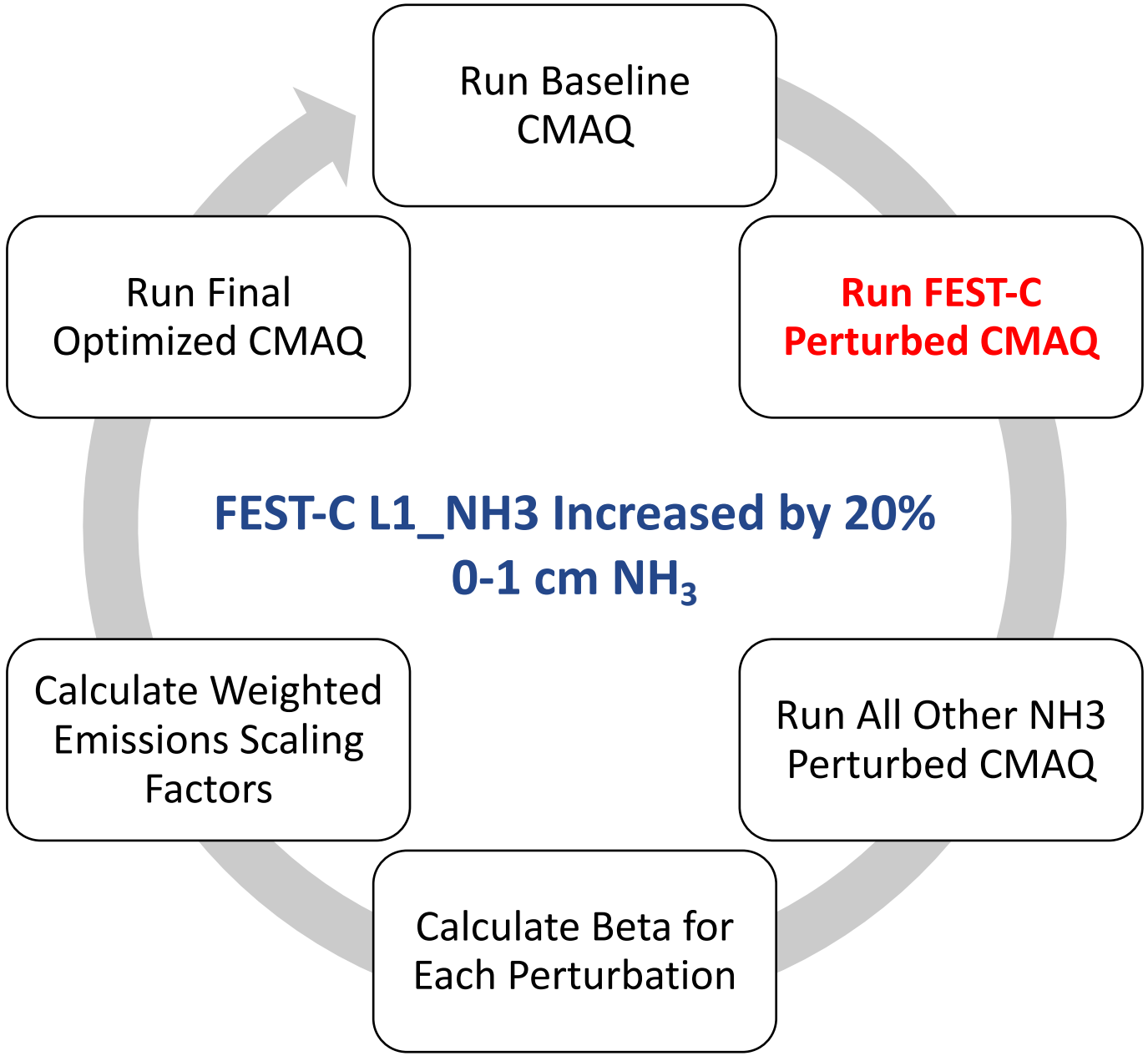

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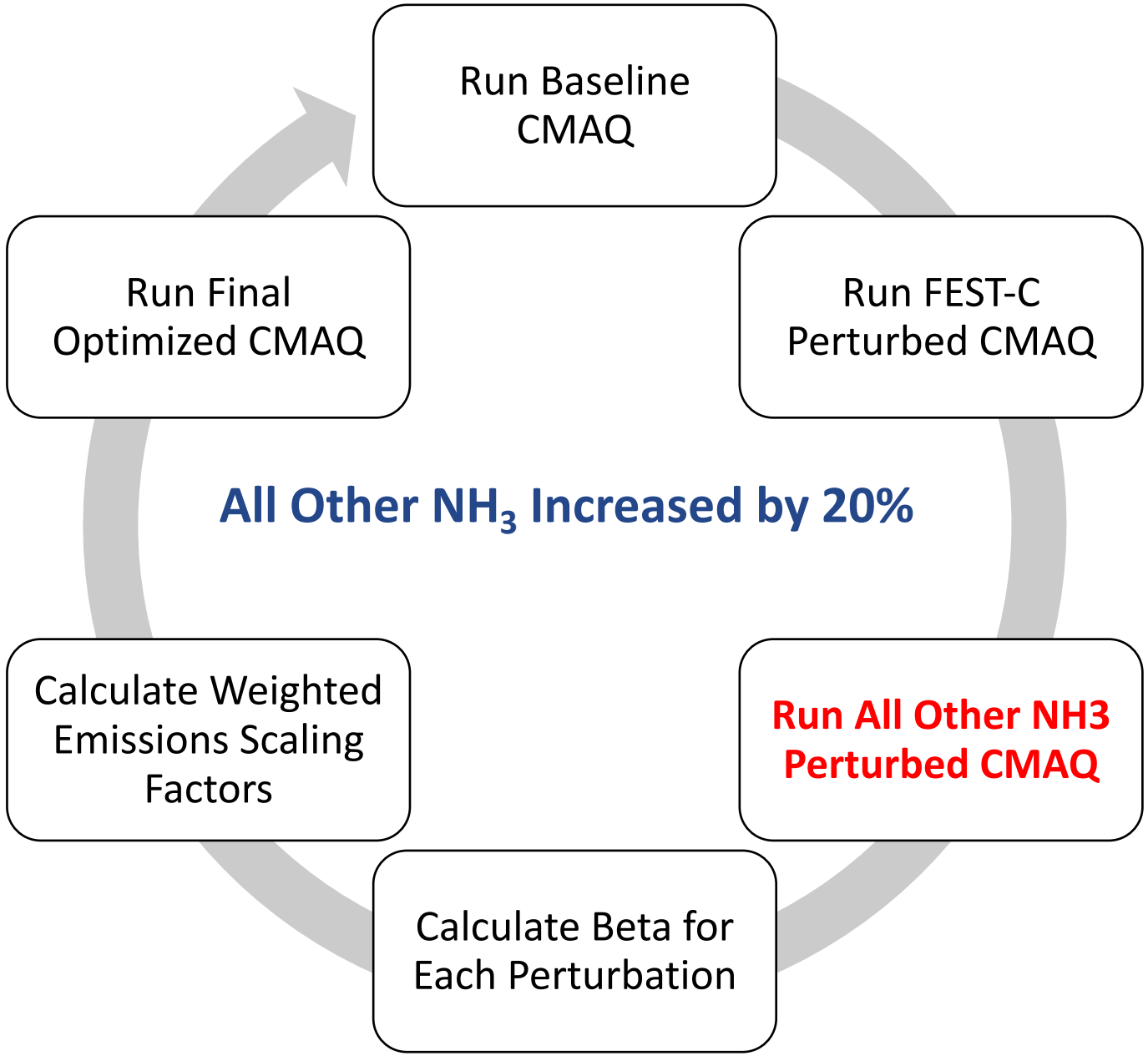

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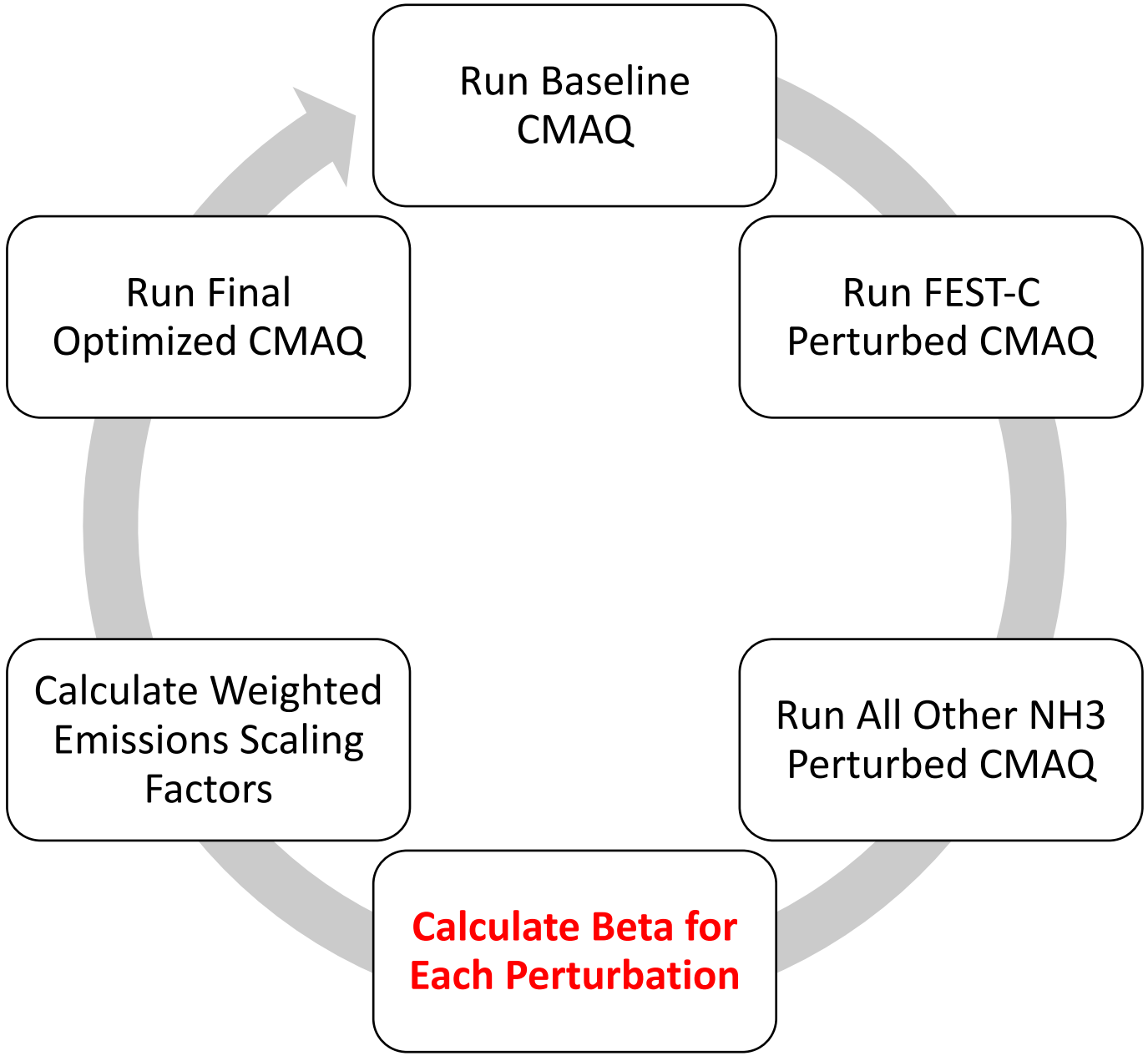


Beta is Sensitivity of Simulated Surface Concentrations to Emissions Perturbations

$$\frac{\Delta E}{E_a} = \beta\left(\frac{\Delta \Omega}{\Omega_a}\right)$$

β Limit
0.1 - 10

ΔE = Change in emissions (perturbed minus base)

E_a = Base emissions

$\Delta \Omega$ = Change in surface concentration

Ω_a = Baseline surface concentration

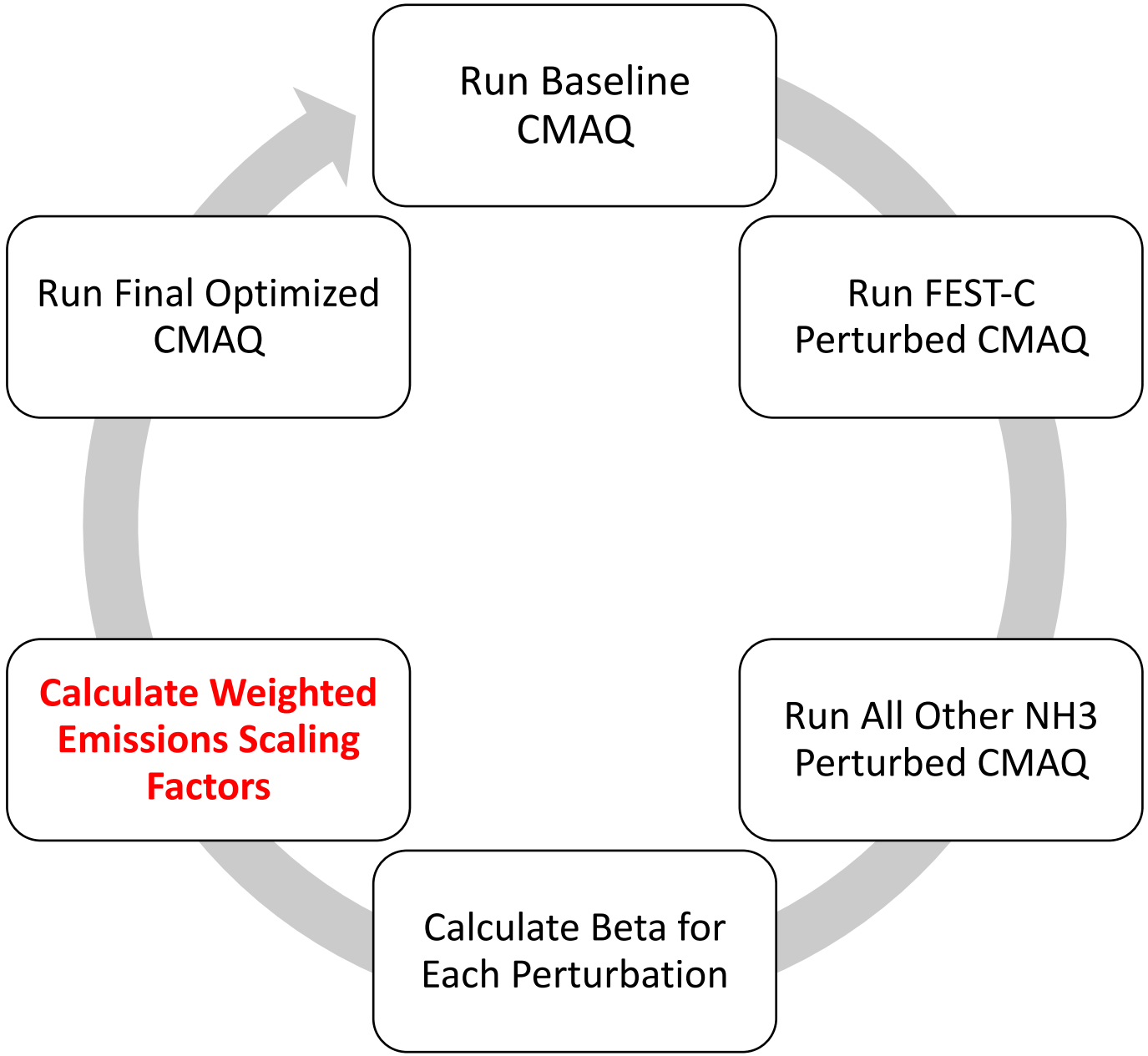
Beta is Sensitivity of Simulated Surface Concentrations to Emissions Perturbations

$$\frac{\Delta E}{E_a} = \beta \left(\frac{\Delta \Omega}{\Omega_a} \right)$$

β Limit
0.1 - 10

Beta calculation performed separately for each perturbation (bidi input and all other NH_3 from SMOKE emissions)

Calculation of Final NH_3 Emissions using bidirectional flux



Final Weighted Emissions Scaling Factors

Applied to Bidirectional Flux Input

$$E_{t_{bidi}} = E_{a_{bidi}} \underbrace{\left(1 + \frac{\Omega_o - \Omega_a}{\Omega_a}\left(\frac{NH3_{FESTC}}{NH3_{TOTAL}}\right)\beta_{festc}\right)}$$

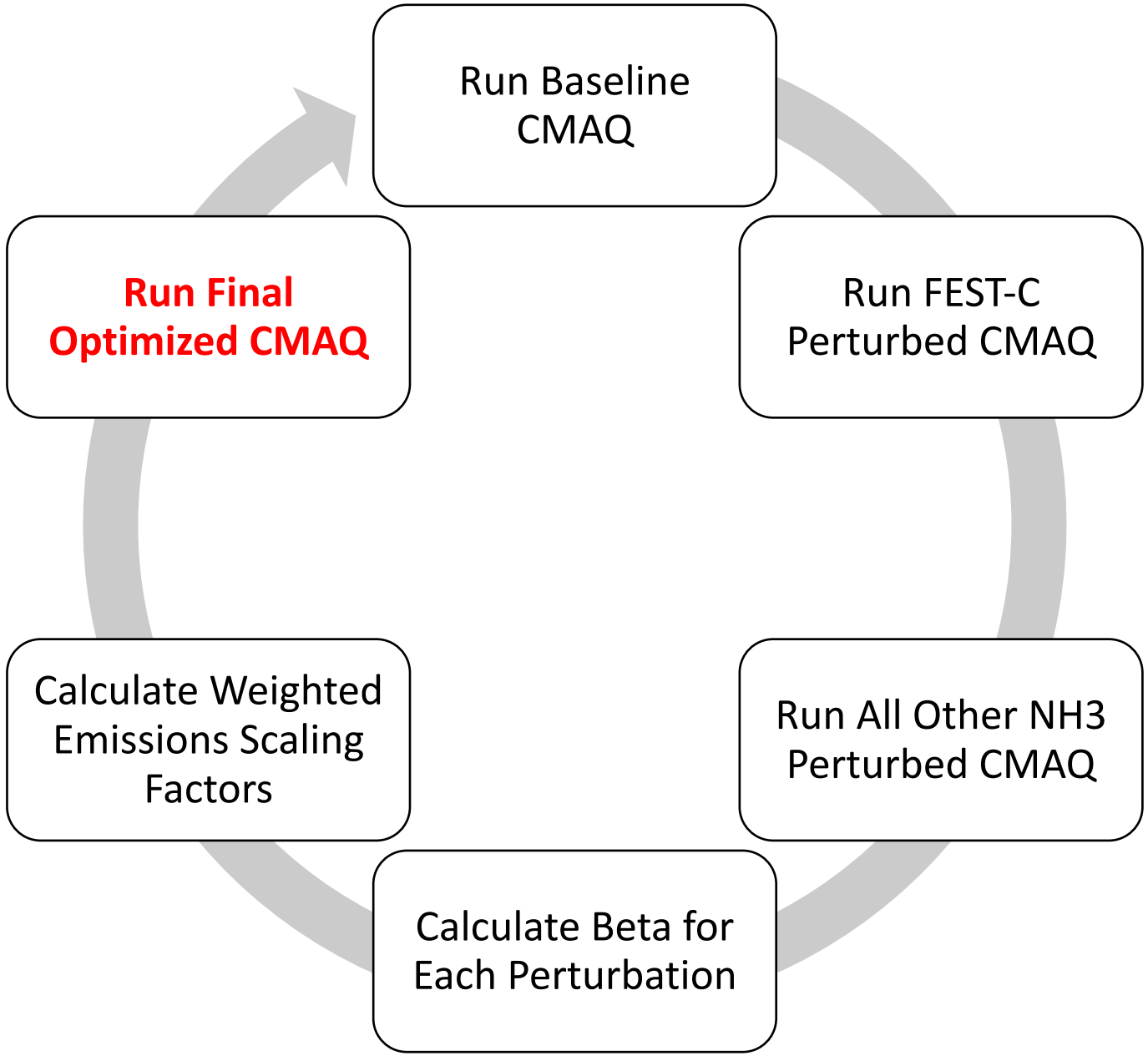
Limit: 0 – 5

Applied to All Other NH_3 Input

$$E_{t_{other}} = E_{a_{other}} \underbrace{\left(1 + \frac{\Omega_o - \Omega_a}{\Omega_a}\left(\frac{NH3_{OTHER}}{NH3_{TOTAL}}\right)\beta_{other}\right)}$$

Limit: 0 – 5

Calculation of Final NH_3 Emissions using bidirectional flux



June 2015 Prototype Simulations

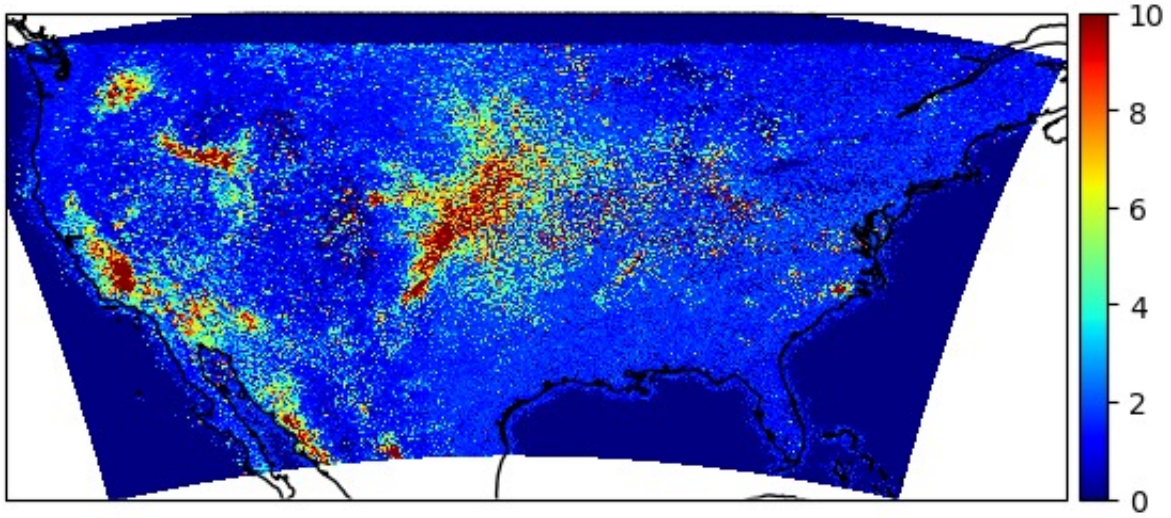
WRF v3.8

- YSU PBL
- NOAH LSM
- AER RRTMG Radiation
- Grell Freitas Cumulus

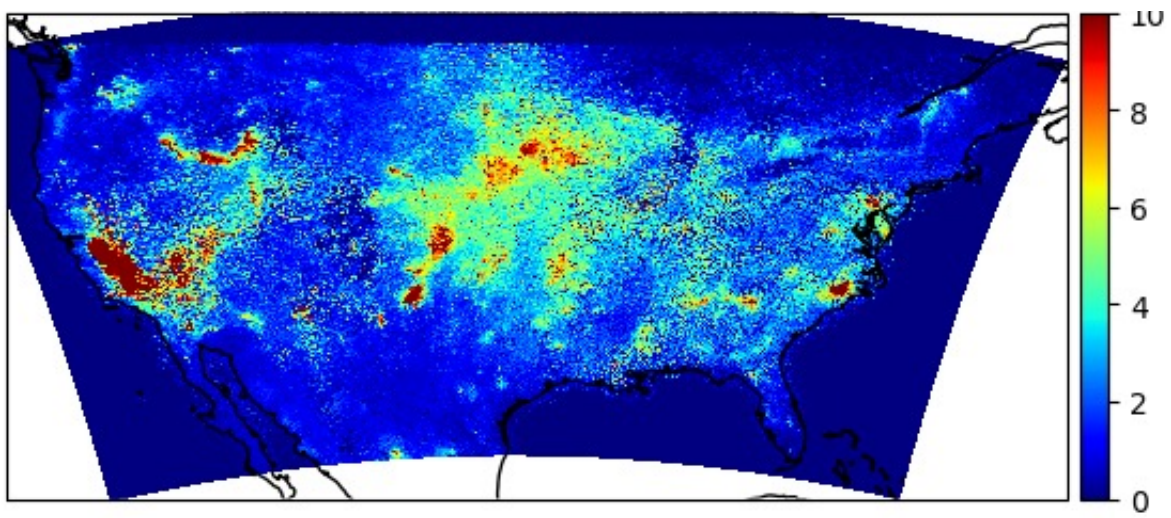
CMAQ v532

- CONUS 12 km dom.
- CB6r3 Chemical Mech.
- AE7 Aerosols
- NEI 2011 Emissions

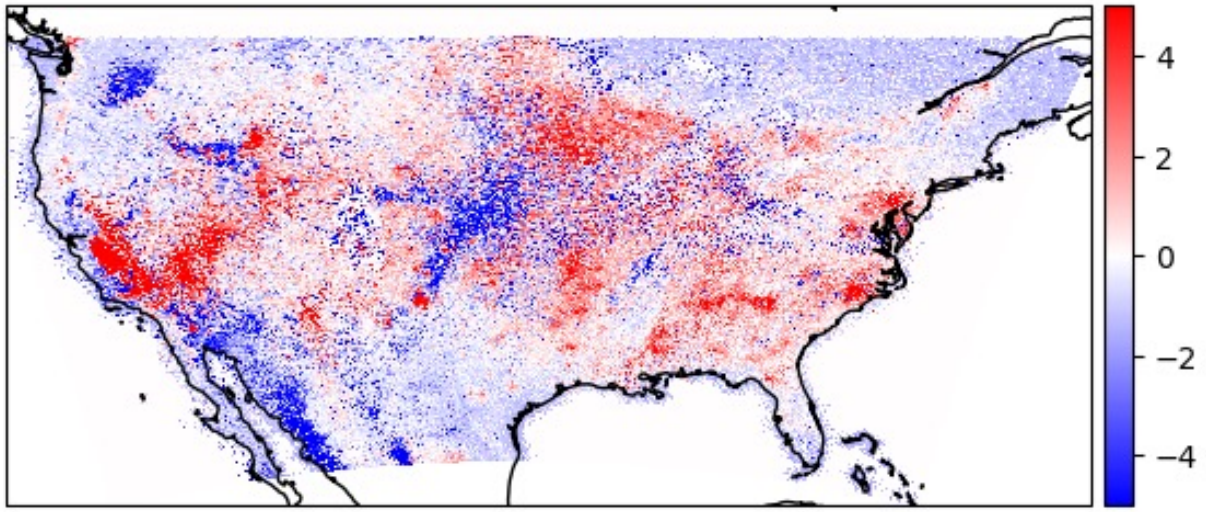
CrIS Monthly-Averaged Surface Conc (ppb)



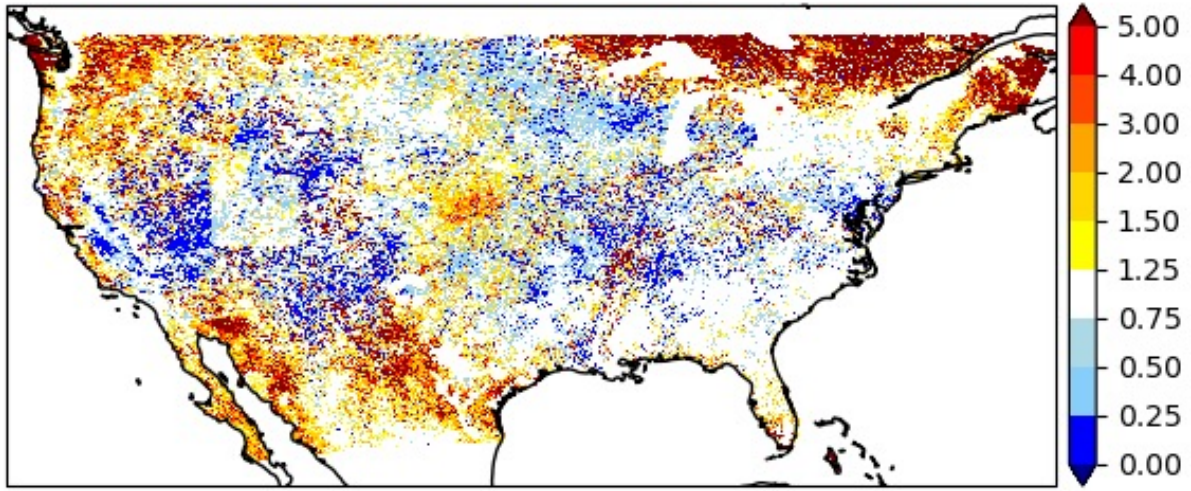
CMAQ Base Monthly-Averaged Surface Conc (ppb)



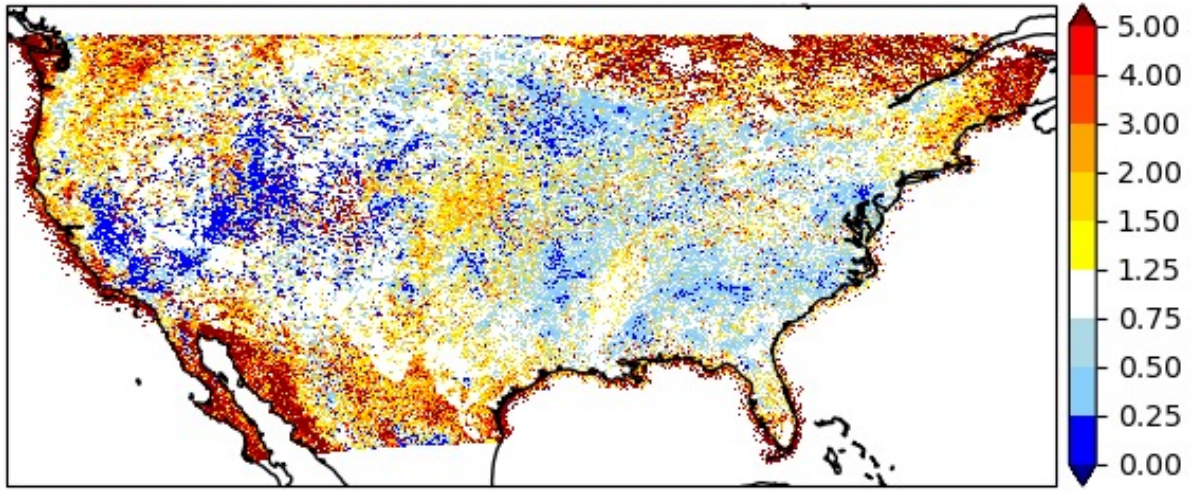
Difference (CMAQ minus CrIS)



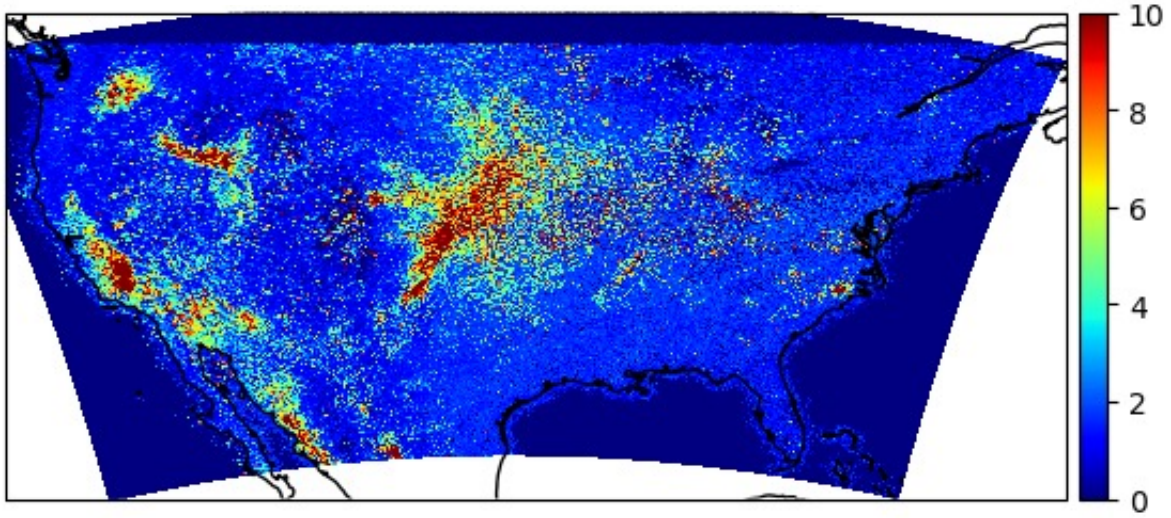
Final Emissions Scaling Factor Applied to Bidirectional Flux Input



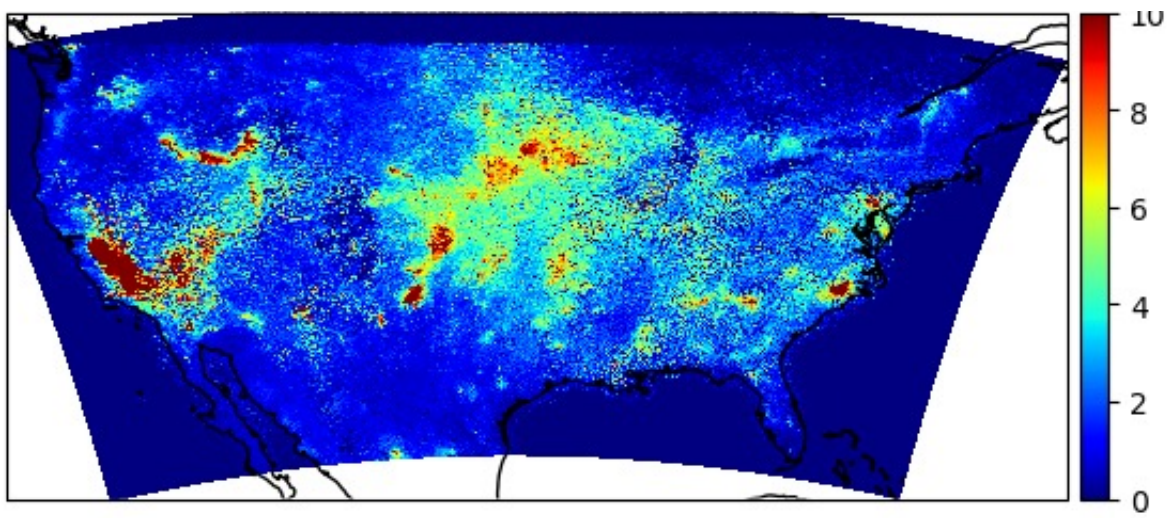
Final Emissions Scaling Factor Applied to All Other NH_3 Input



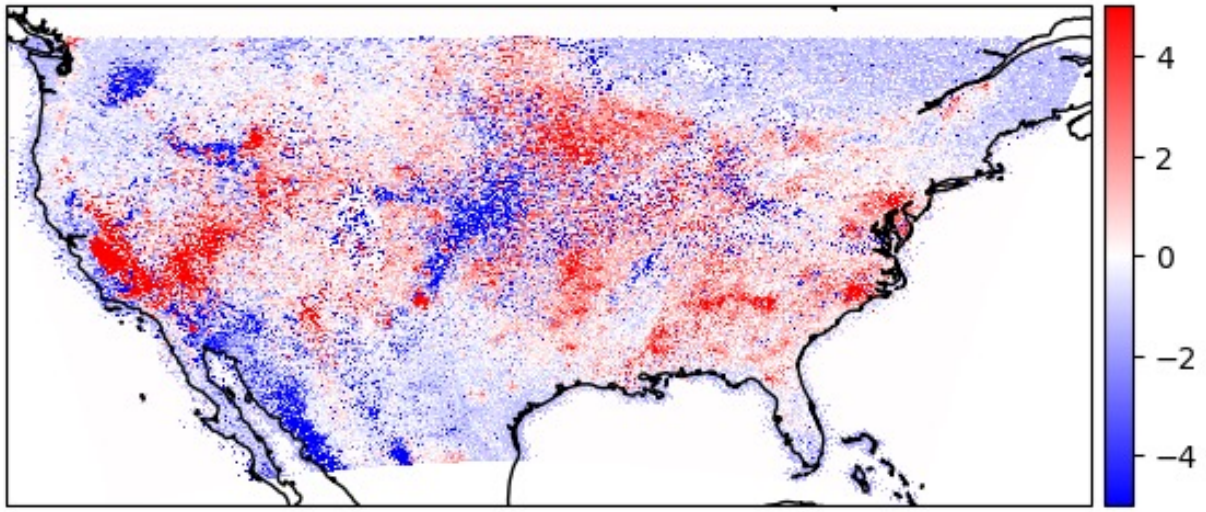
CrIS Monthly-Averaged Surface Conc (ppb)



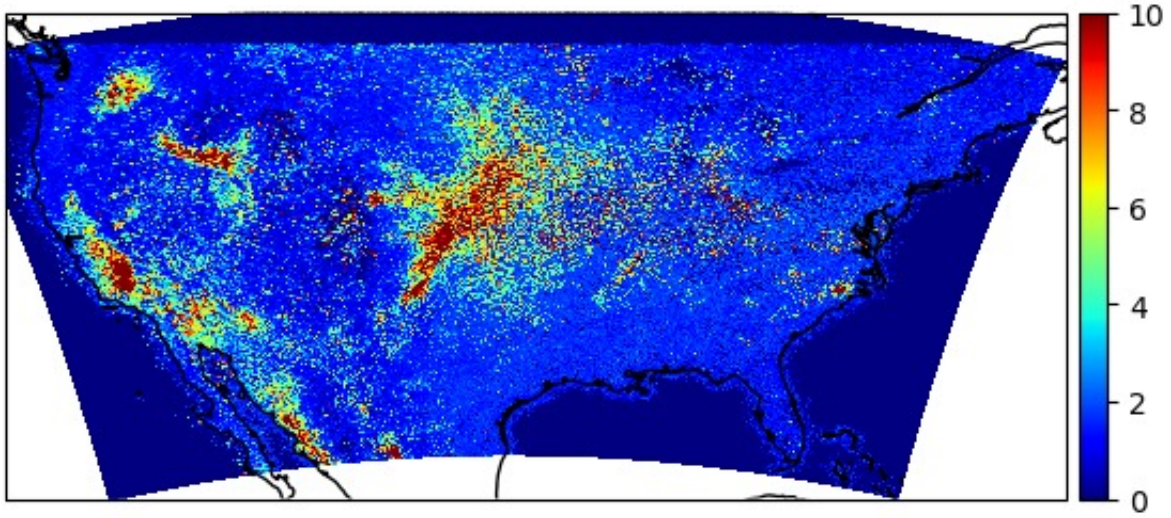
CMAQ Base Monthly-Averaged Surface Conc (ppb)



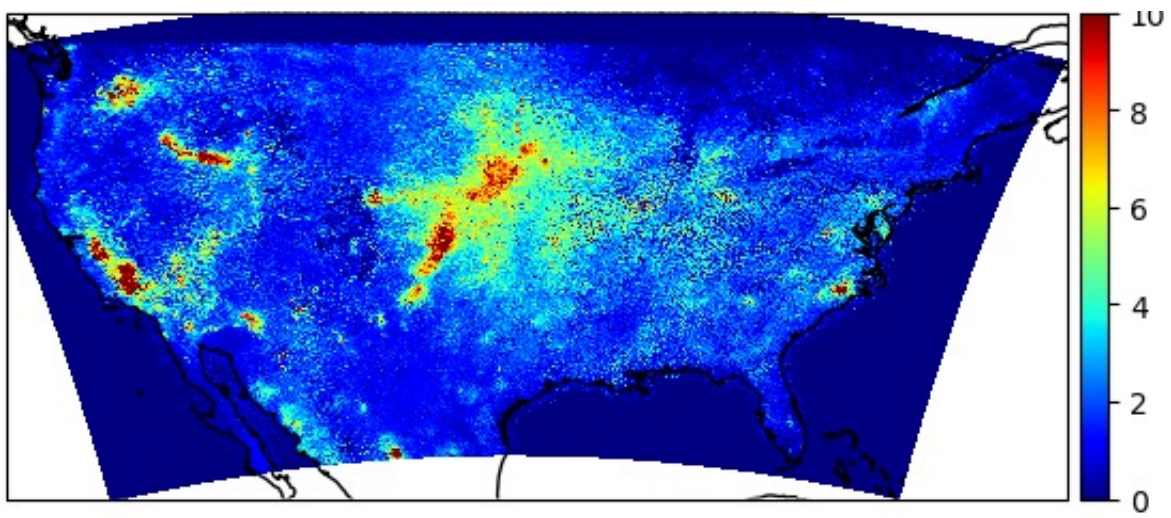
Difference (CMAQ minus CrIS)



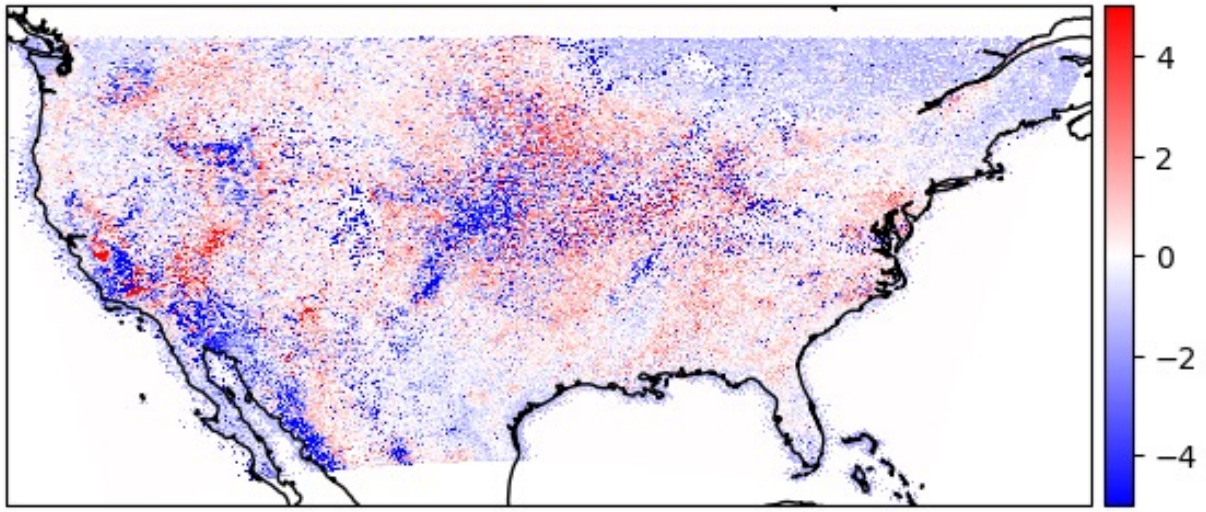
CrIS Monthly-Averaged Surface Conc (ppb)



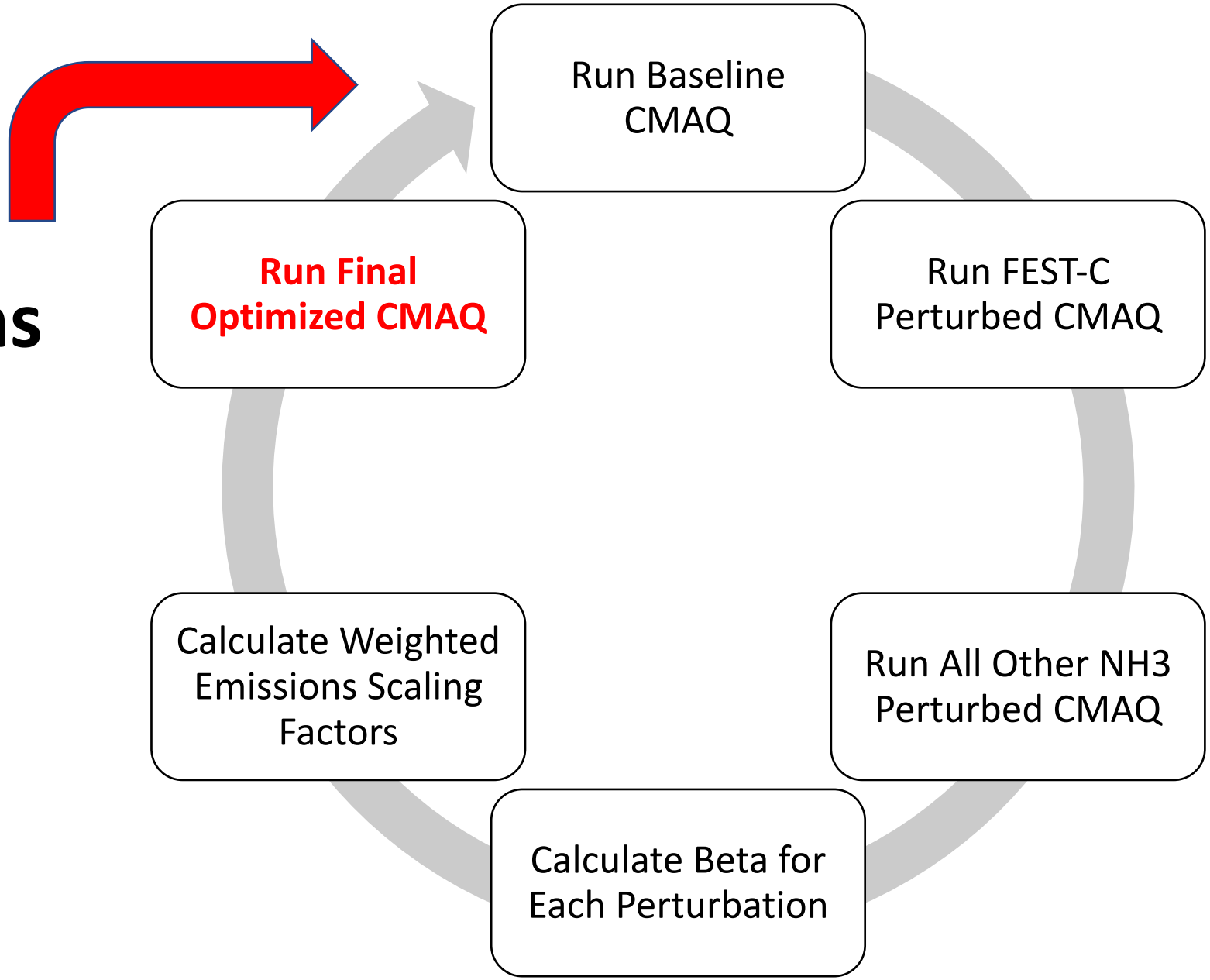
CMAQ Sfc-Inv Monthly-Averaged Surface Conc (ppb)



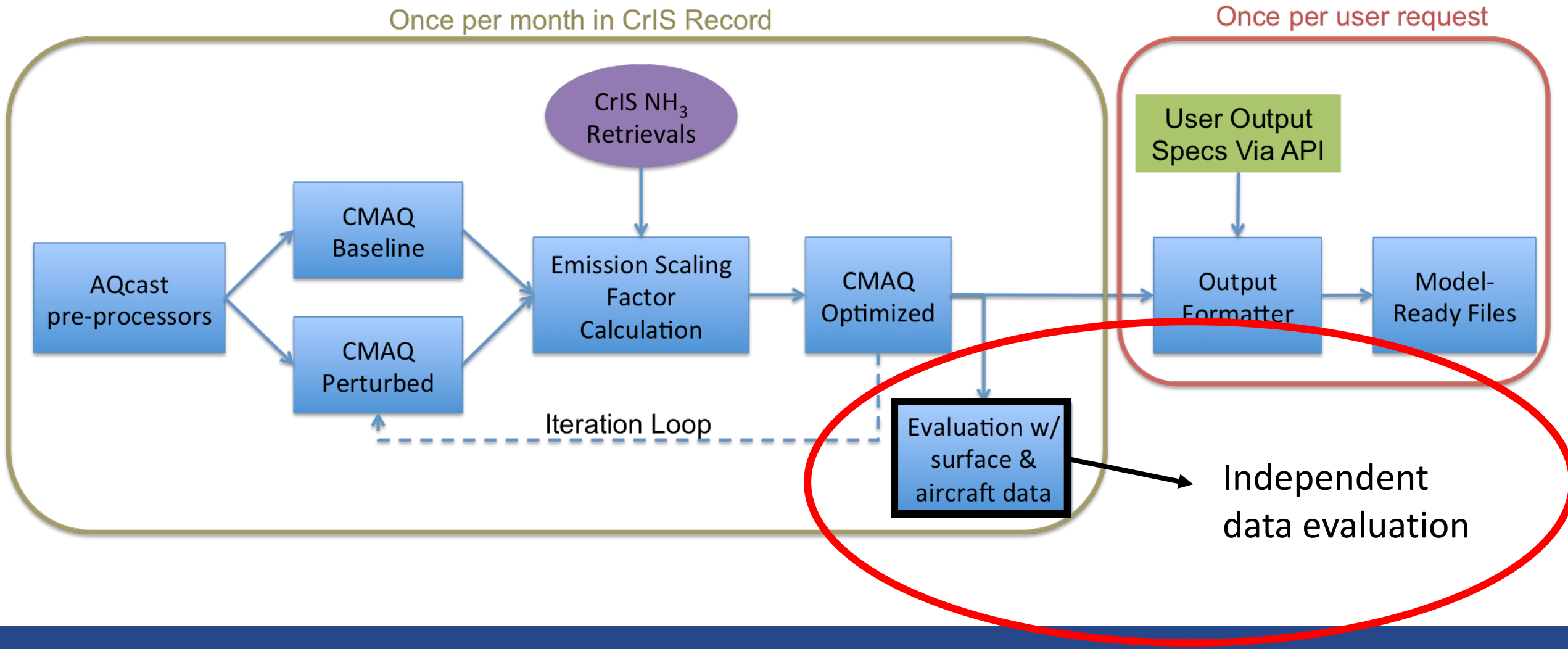
Difference (CMAQ minus CrIS)



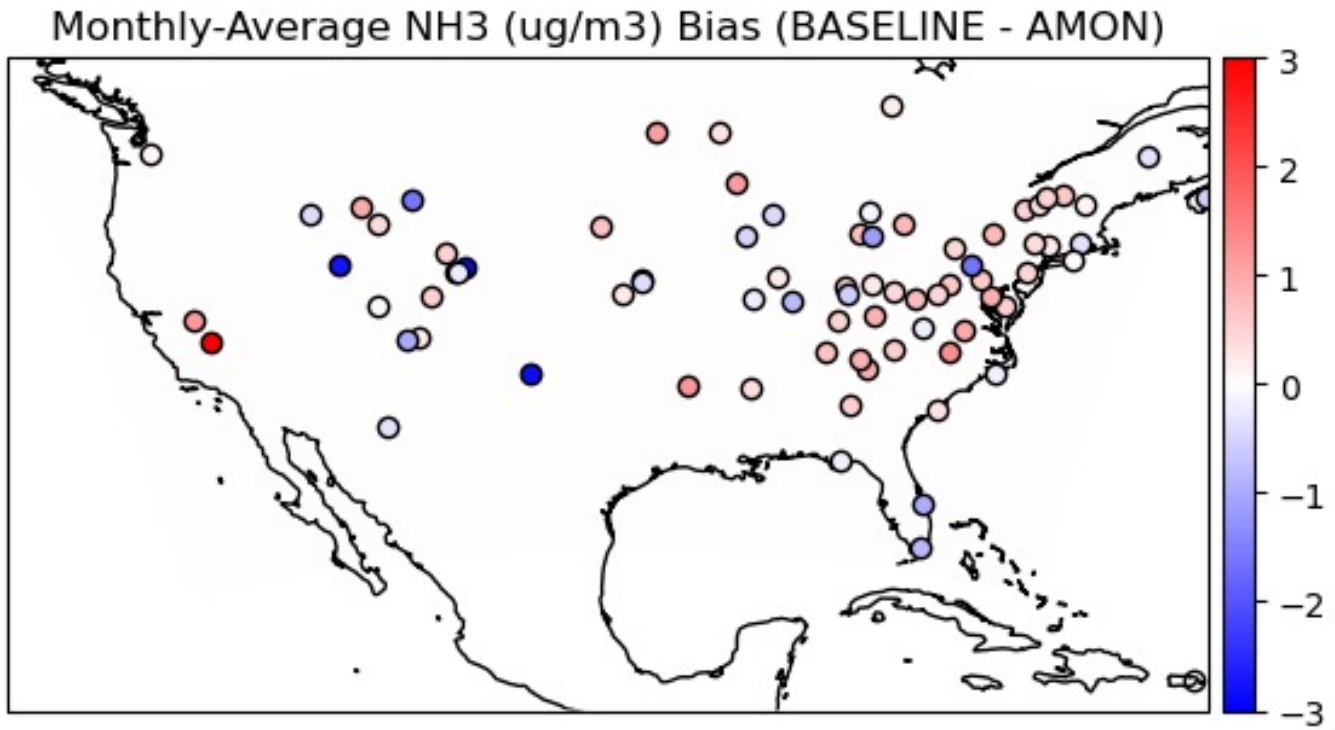
Multiple iterations will be used for final emissions estimates

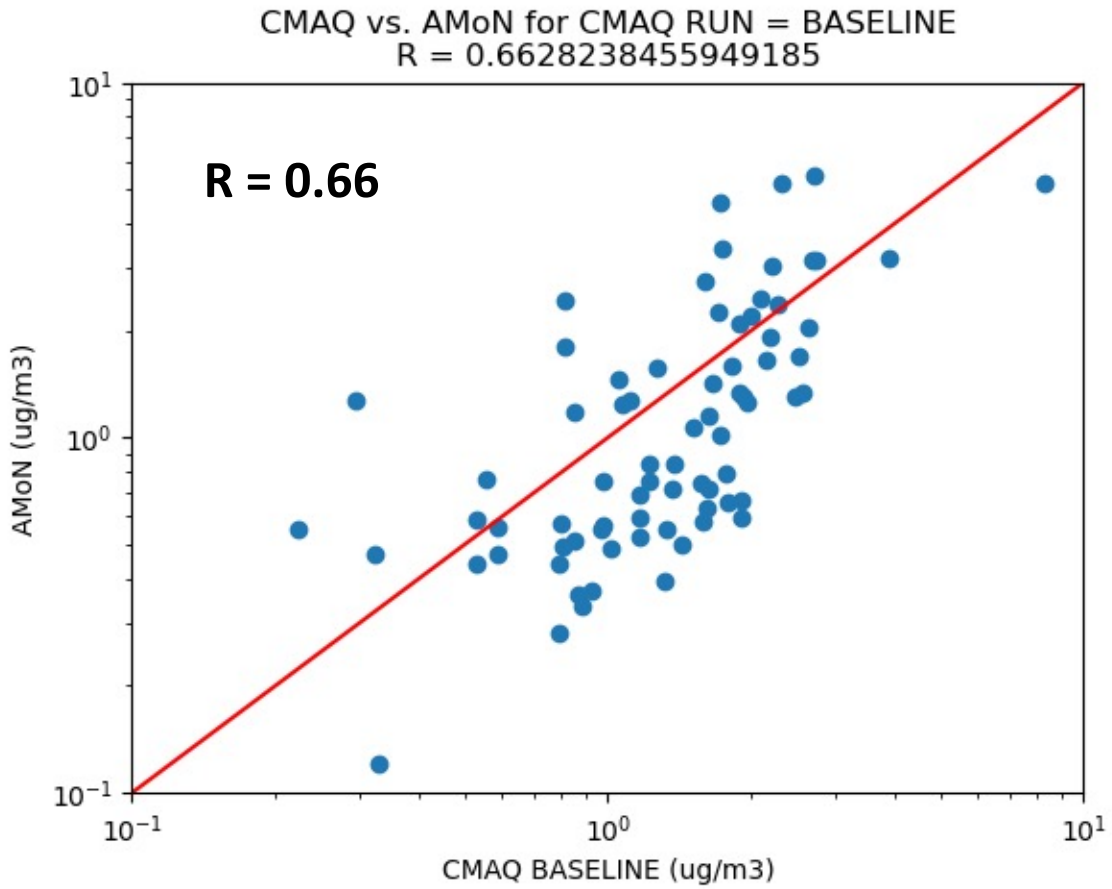


Evaluation with Independent Dataset

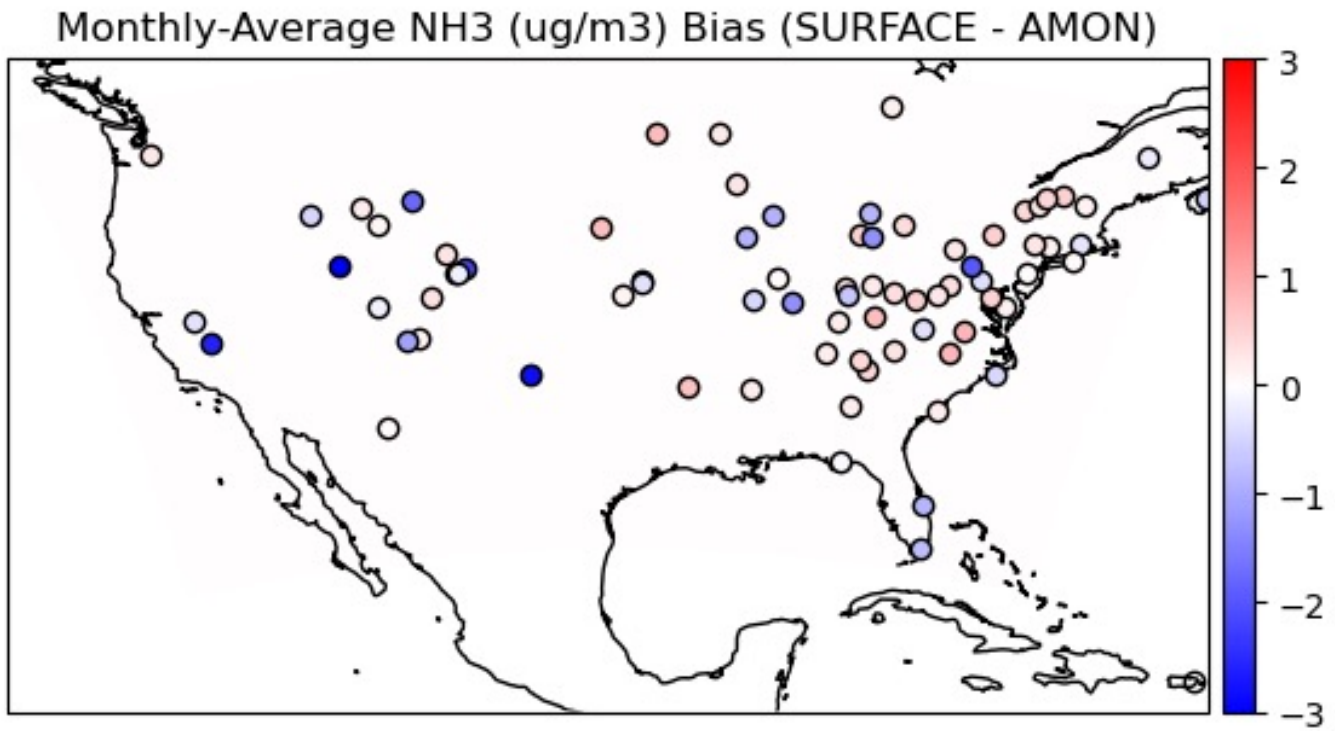


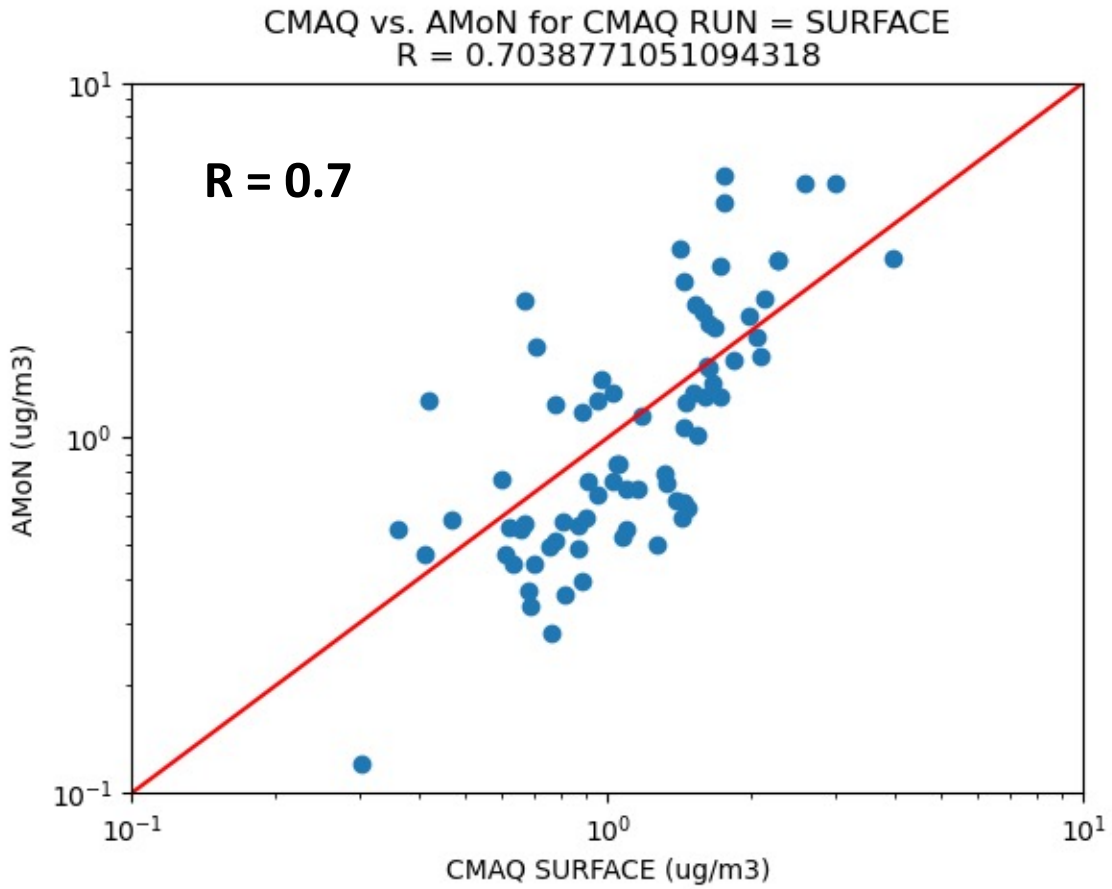
CMAQ BASE Comparison with AMoN





CMAQ Iteration 1 – Surface Inversion Comparison with AMoN





Summary

- This work will provide improved NH_3 emission inventories to air quality forecasters, managers, and other stakeholders.

- Prototype application of the inversion using bidirectional NH_3 flux for June 2015 proved successful. The process improved comparisons with CrIS and an independent dataset, AMoN.

- Future work is focusing on AWS automation, updating SMOKE, and building the final code for end-users to apply the data in their model.