Greenhouse Gas Emissions from Agroecosystems

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Outline

- Modeling Methods
- Uncertainty
- Importance of different gases
- Mitigation

Modeling Methods

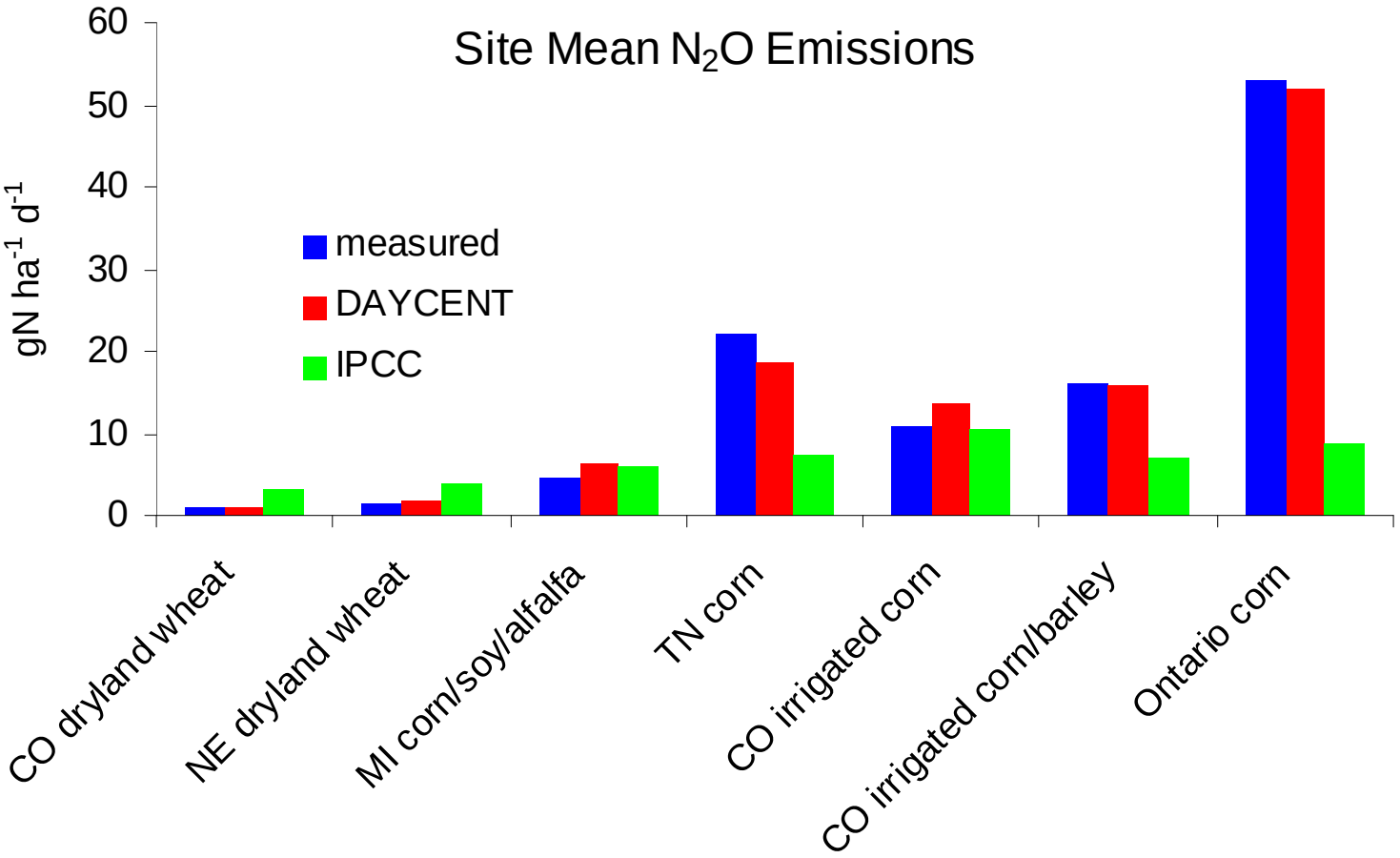
Empirical:

- Simple regression eqns.
- Easy computations
- High transparency
- e.g. default IPCC emission factors

Process Based:

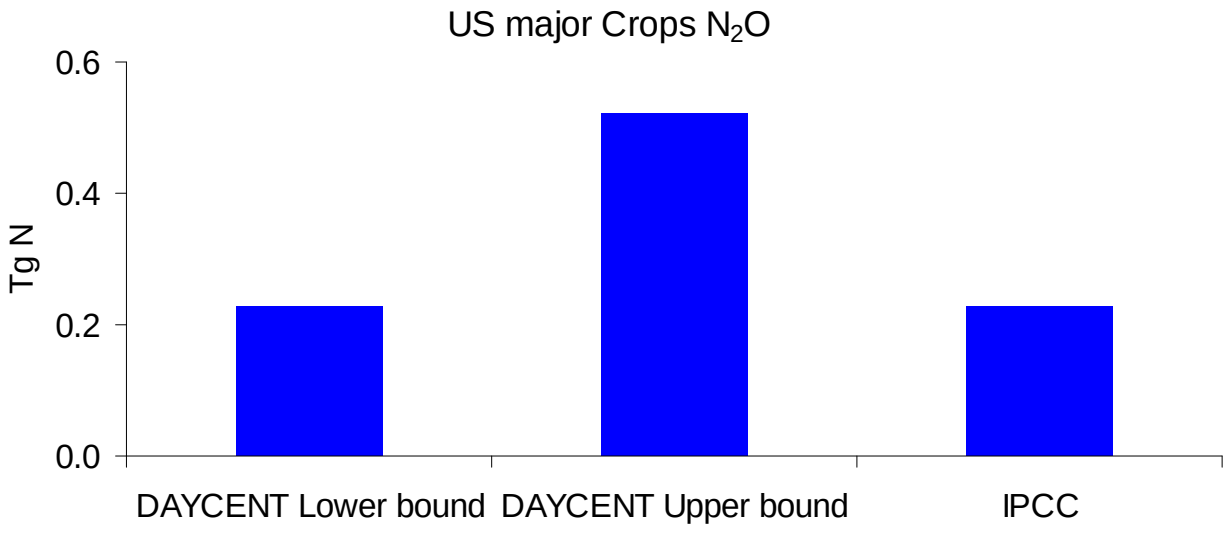
- Simulate mechanisms
- Complex algorithms
- Low transparency
- e.g. DAYCENT, DNDC

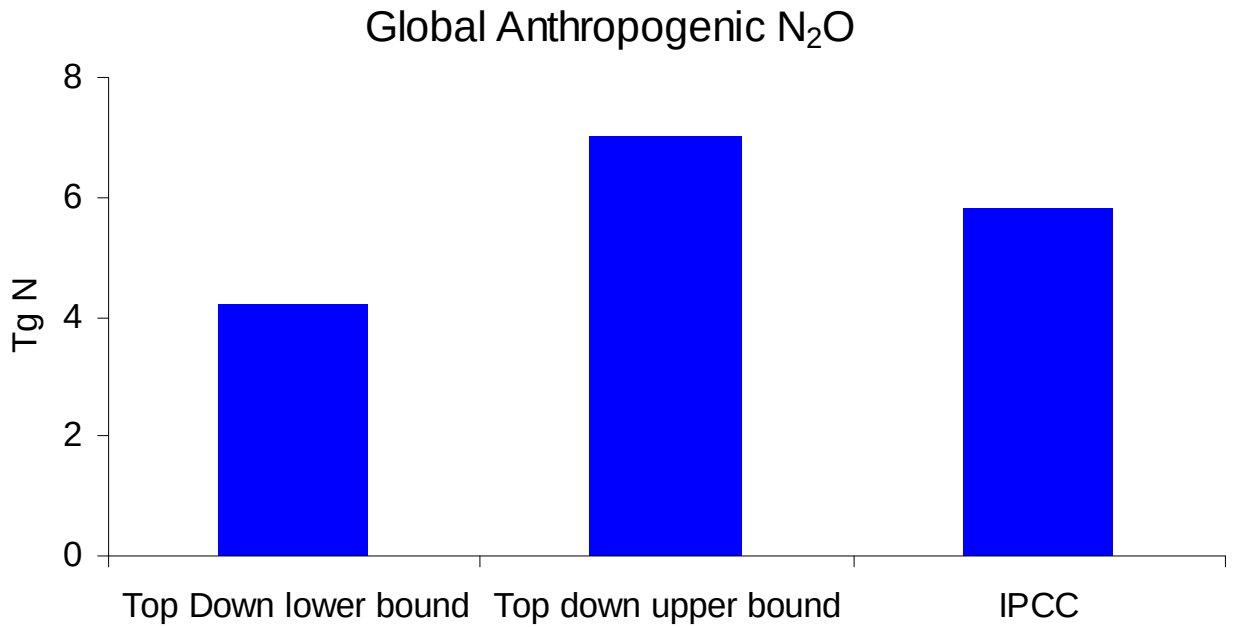
At plot level, process based models usually perform better than simple models



Del Grosso et al. 2010

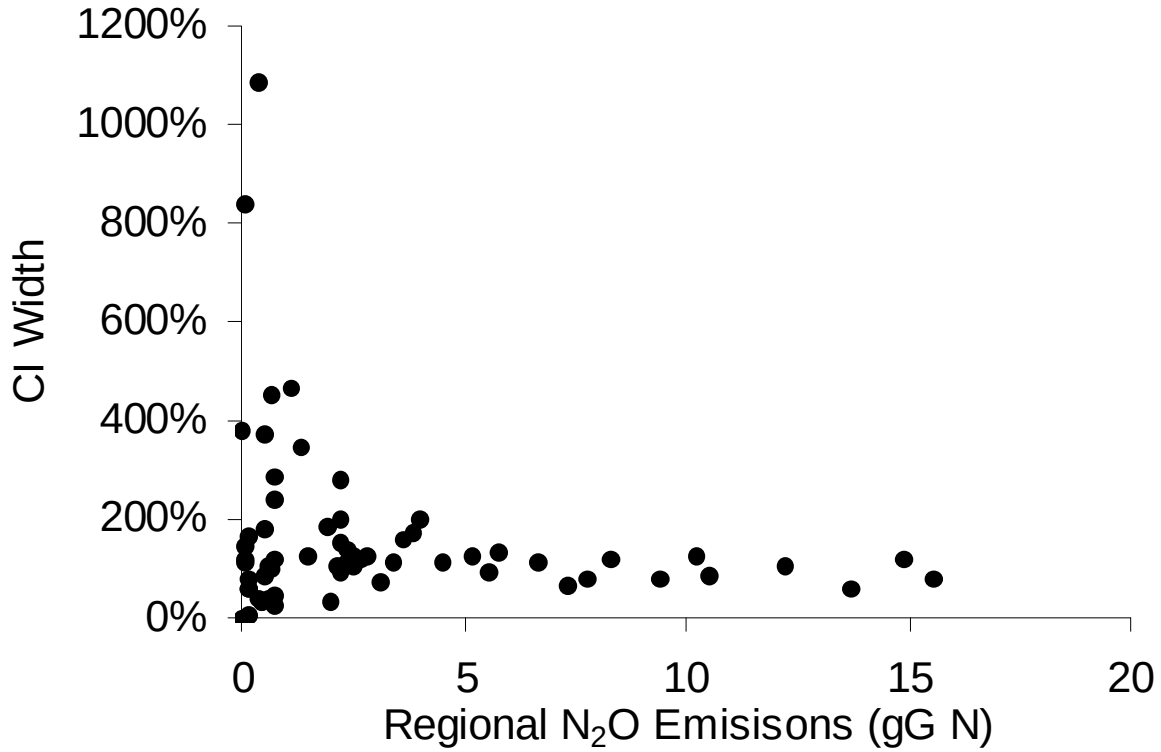
As scale increases, simple models become more reliable





Del Grosso et al. 2008

as scale decreases, CIs get wider



Most of this uncertainty is due to model structure

Del Grosso et al. 2010

Which gases are the big players?

US Agricultural GHG Emissions

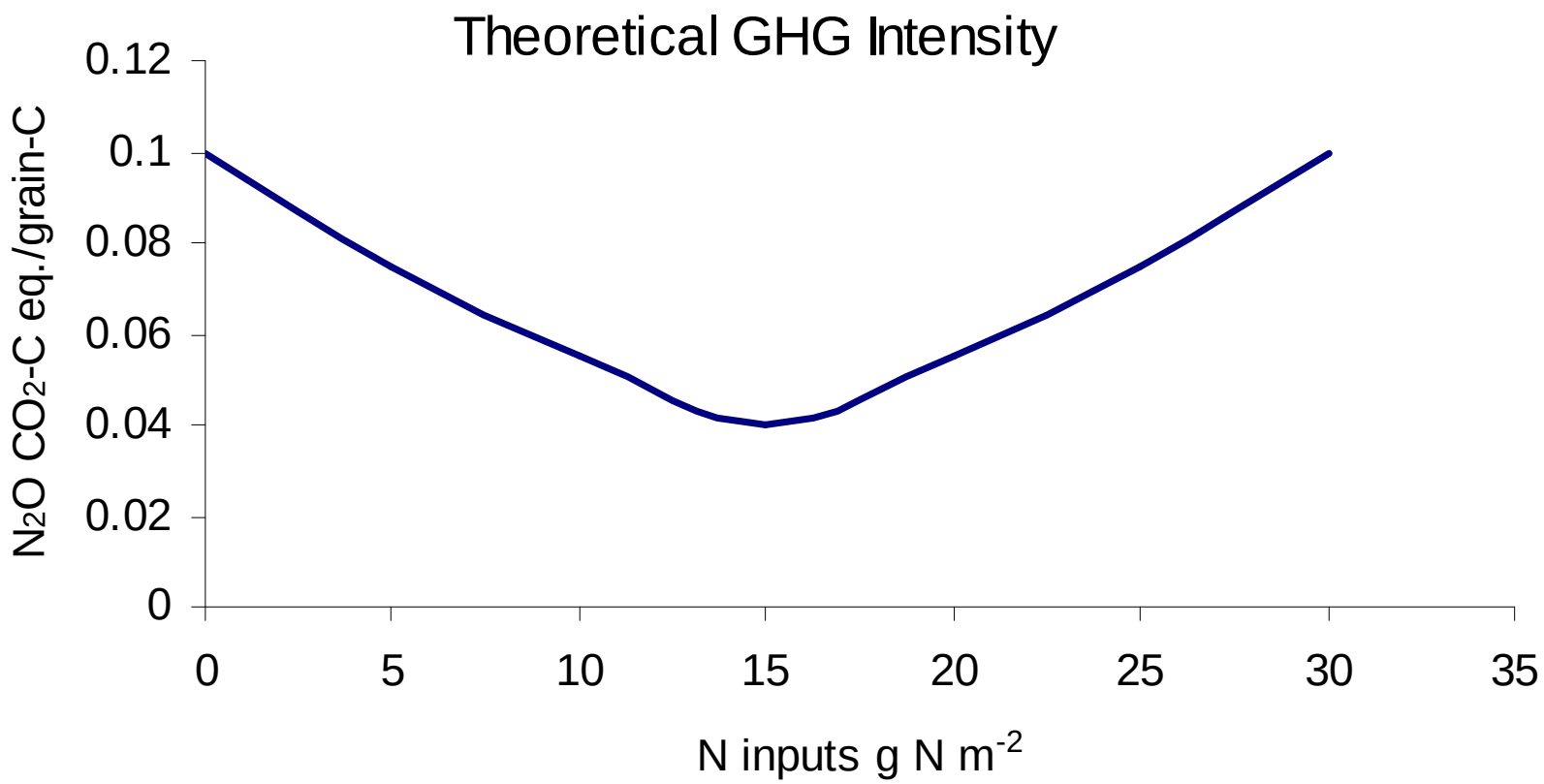
- ~525 Tg CO_2 eq. (~7% of US total)

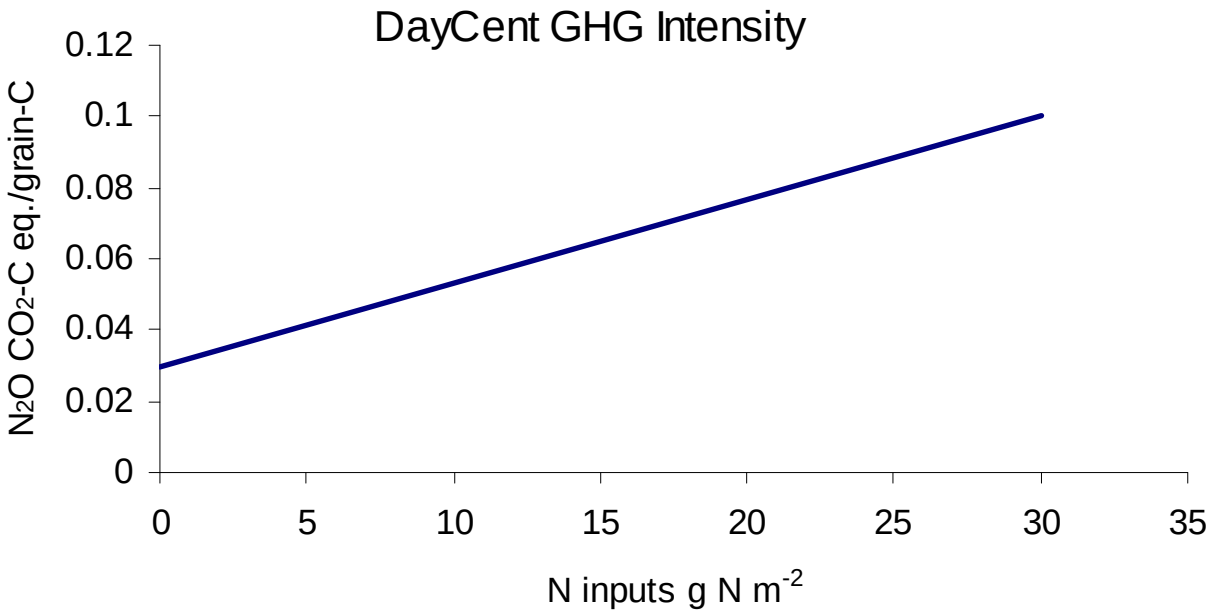
Agricultural **Soils** in US:

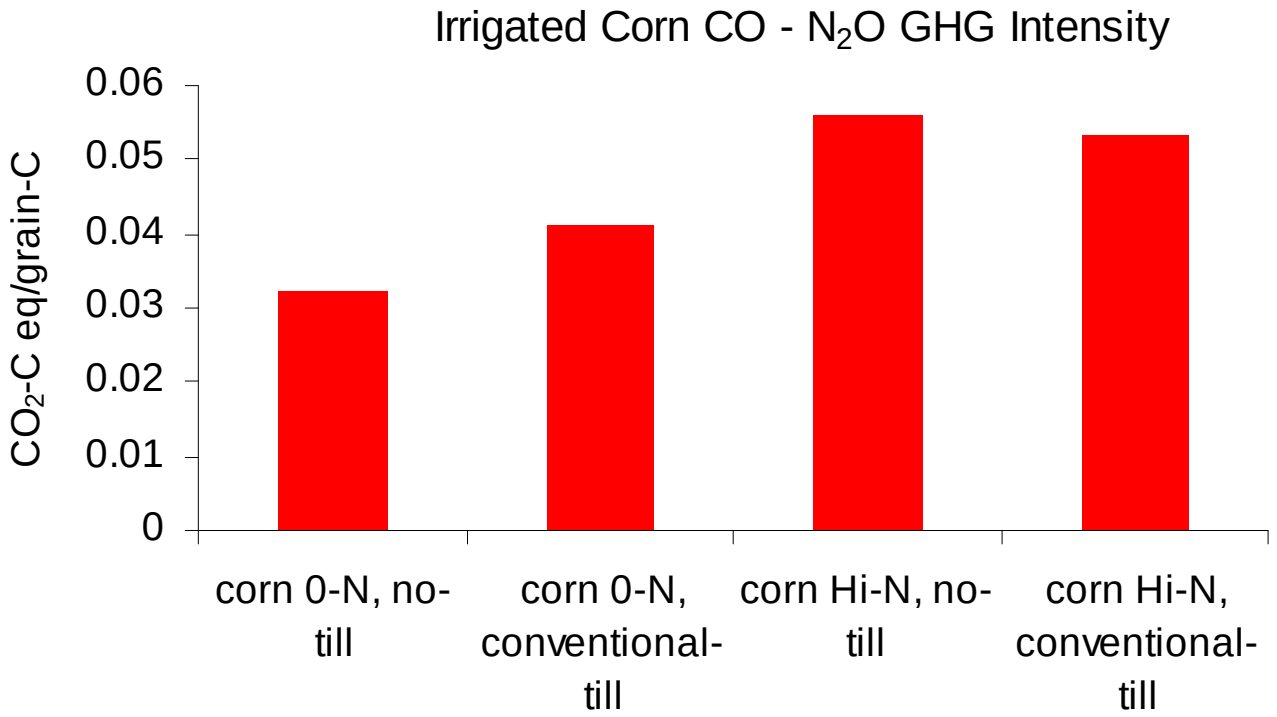
- Net CO_2 sink of ~ 32 Tg CO_2 eq. (mostly CRP)
- Major N_2O source ~260 Tg CO_2 eq.
- Small CH_4 source <5 Tg CO_2 eq.

Mitigation of N_2O

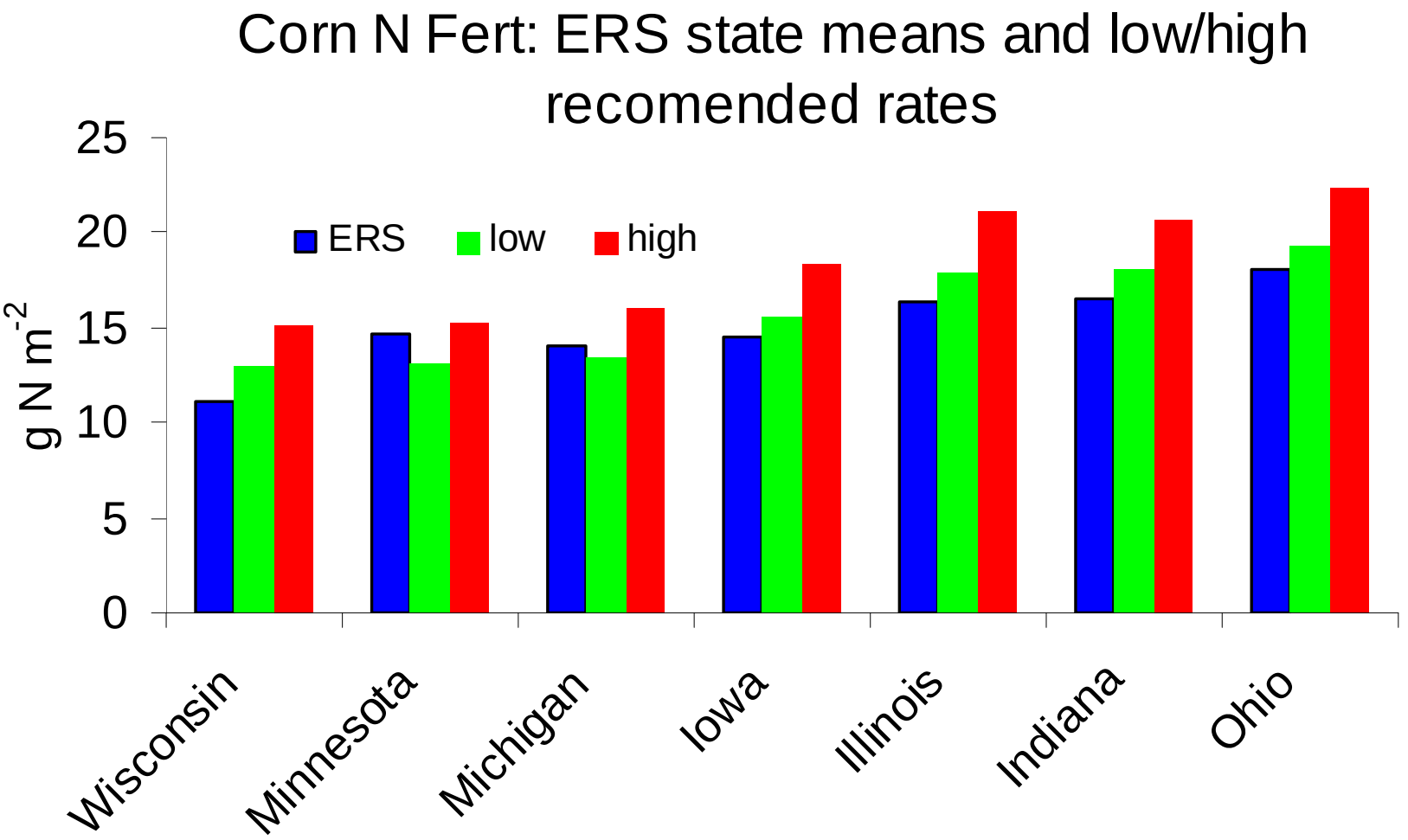
- GHG intensity (emissions per unit product)
- Reduce fert
- Fert source


Theoretical GHG Intensity
0.12
0.1
0.08
0.06
0.04
0.02
0
N2O CO2-C eq./grain-C
0
5
10
15
20
25
30
35
N inputs g N m-2

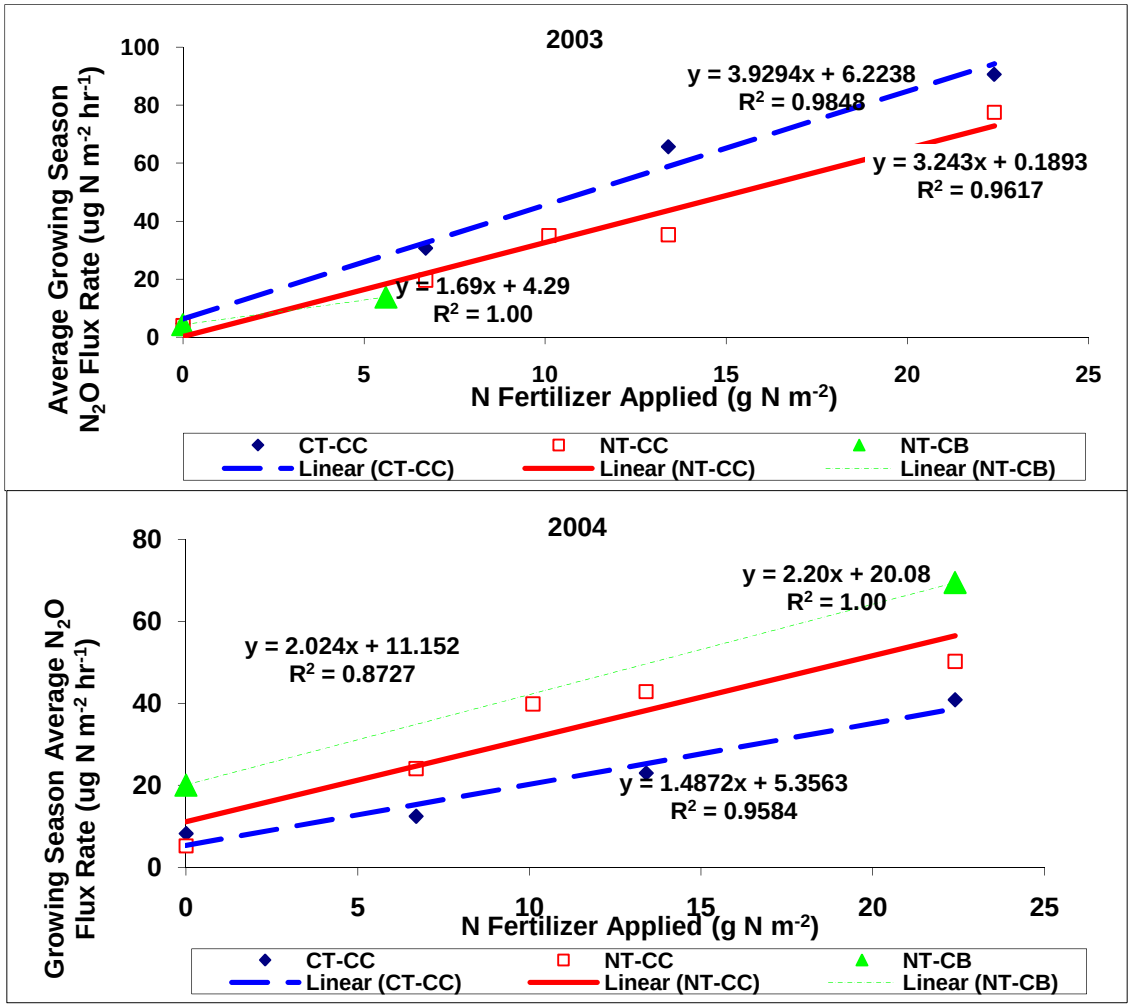

DayCent GHG Intensity
0.12
0.1
0.08
0.06
0.04
0.02
0
N2O CO2-C eq./grain-C
0
5
10
15
20
25
30
35
N inputs g N m-2


Irrigated Corn CO - N2O GHG Intensity
0.06
0.05
0.04
0.03
0.02
0.01
0
CO2-C eq/grain-C
corn 0-N, no-till
corn 0-N, conventional-till
corn Hi-N, no-till
corn Hi-N, conventional-till

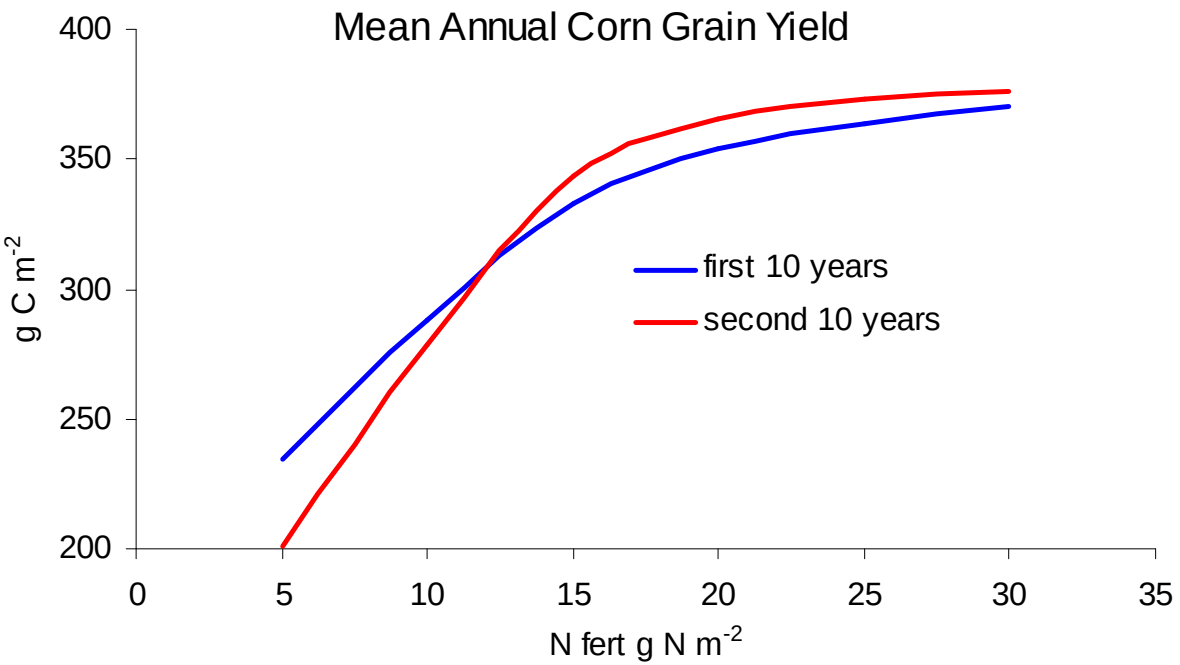
Do we over fertilize?

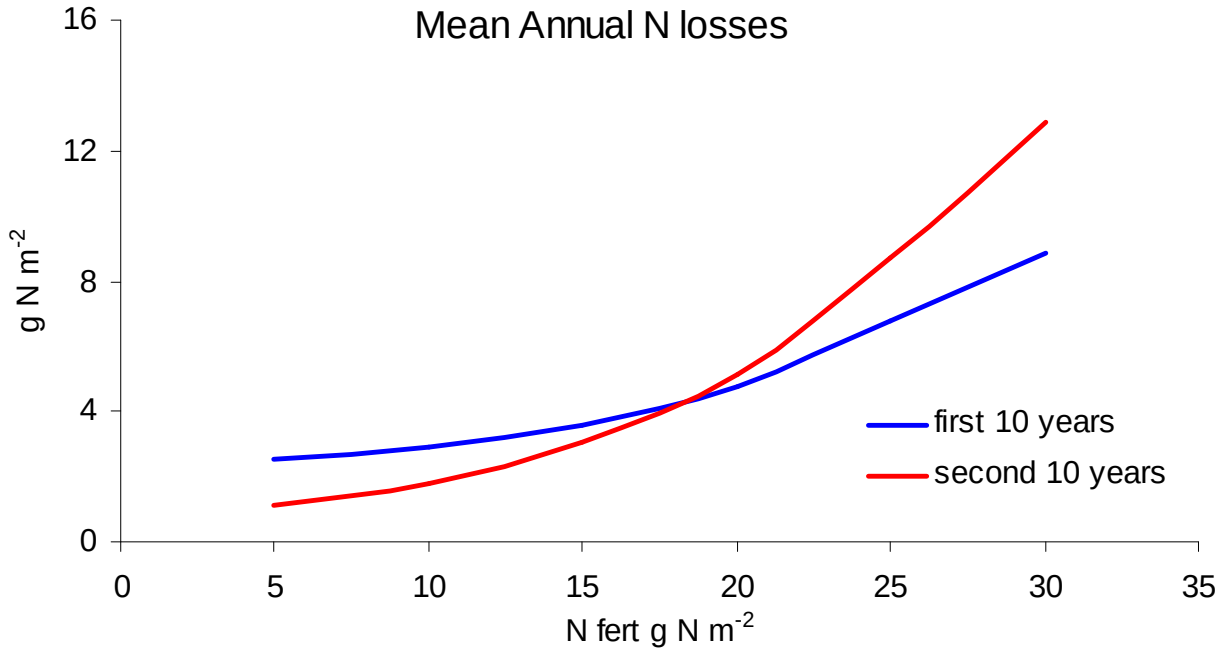

Corn N Fert: ERS state means and low/high recomended rates
g N m-2
25
20
15
10
5
0
ERS
low
high
Wisconsin
Minnesota
Michigan
Iowa
Illinois
Indiana
Ohio

Is N_2O response non-linear?



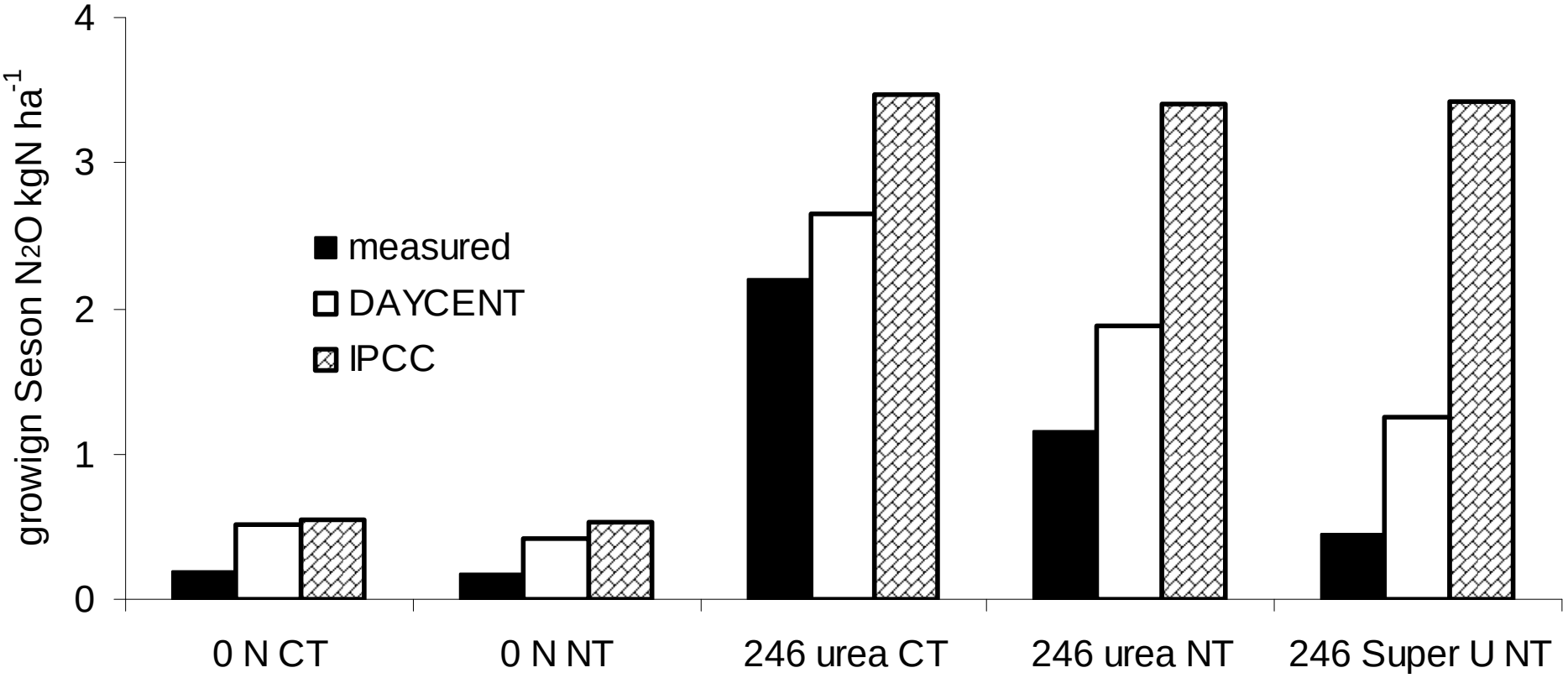
What About Grain Yields and Total N losses?

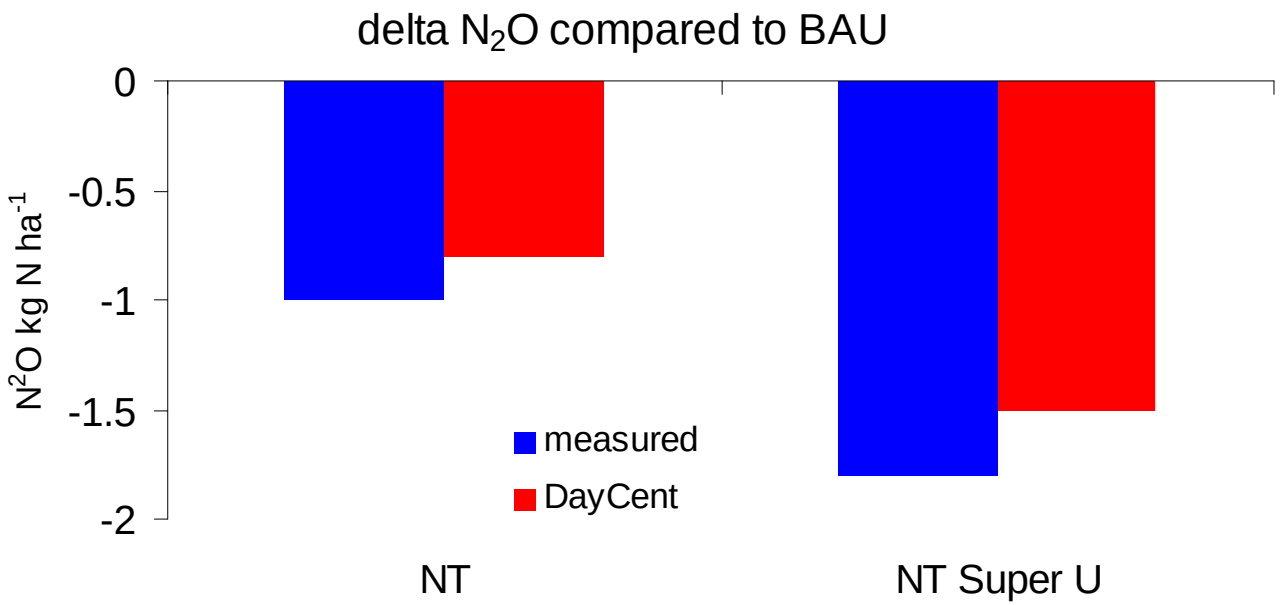

Mean Annual Corn Grain Yield
400
350
300
250
200
g C m-2
0
5
10
15
20
25
30
35
N fert g N m-2
first 10 years
second 10 years

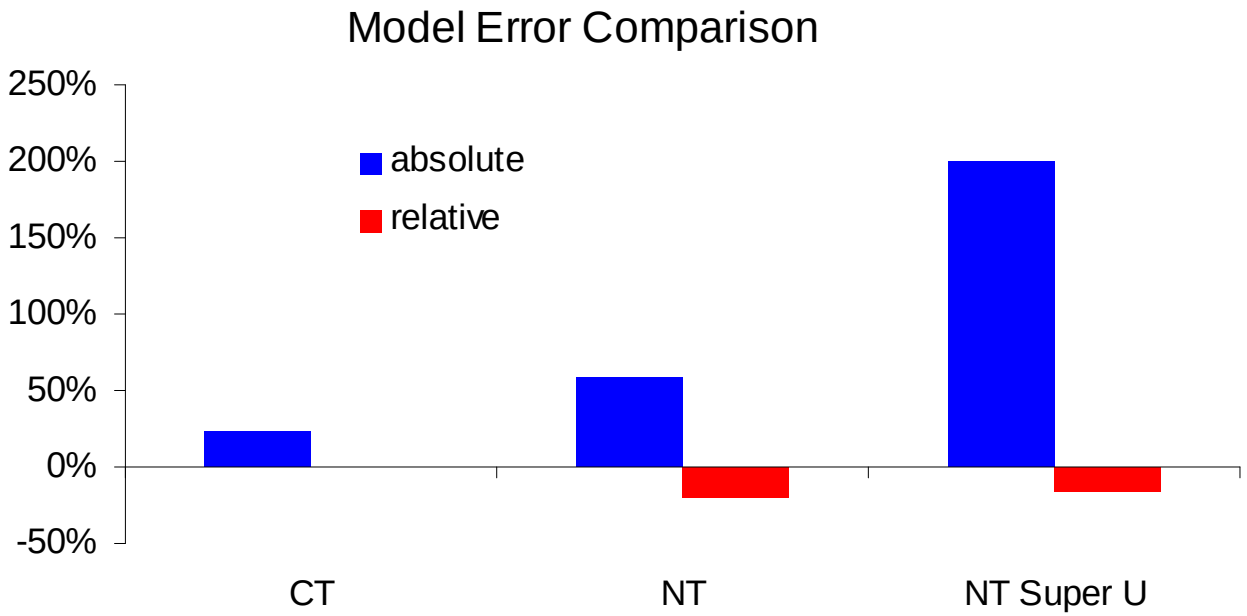

Mean Annual N losses
16
12
8
4
0
g N m-2
0
5
10
15
20
25
30
35
N fert g N m-2
first 10 years
second 10 years

What about N sources?

CO Irrigated Corn




delta N_2O compared to BAU
0
-0.5
-1
-1.5
-2
N^2O kg N ha^{-1}
measured
DayCent
NT
NT Super U


Model Error Comparison
250%
200%
150%
100%
50%
0%
-50%
absolute
relative
CT
NT
NT Super U

Conclusions

Process based modes are our only hope

N_2O is the big opportunity

Uncertainty is big and not likely to decrease much

Stabilized N sources look promising