Impacts of Climate and Land Use Change on Soil Trace Gas Fluxes

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Agricultural Soils Are:

- Major Source of N_2O
- Important Source of NH_3, NO_x
- Source and Sink of CH_4, CO_2

Global Warming Potential

Gas	Atmospheric lifetime (yrs)	GWP
CO_2	50-200	1
CH_4	12	21
N_2O	120	300

Mechanisms and Controls of Soil Trace Gas Fluxes

- **N Gas**

  Nitrification = F (NH_4, $[O_2]$, H_2O, Temp, pH)

  Denitrification = F (NO_3, C_{labile}, $[O_2]$, H_2O, Temp)

- **CO_2**

  Photosynthesis = F (Veg, Phenology, H_2O, Temp, Radiation)

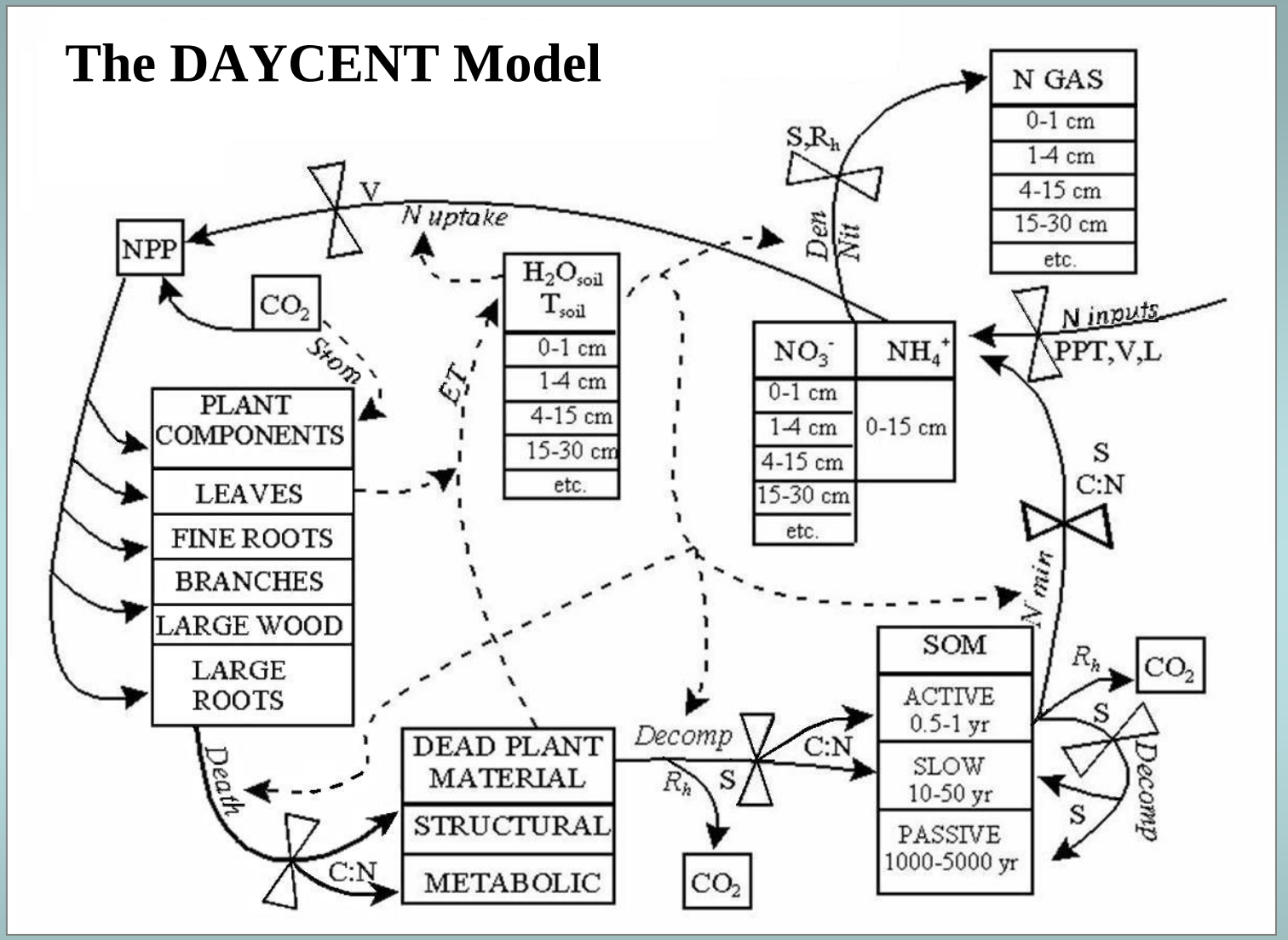
  Decomposition = F (C, H_2O, Temp)

- **CH_4**

  Methanogenesis = F (C_{labile}, $[O_2]$)

  CH_4 Oxidation = F (Diffusivity, H_2O)

The DAYCENT Model



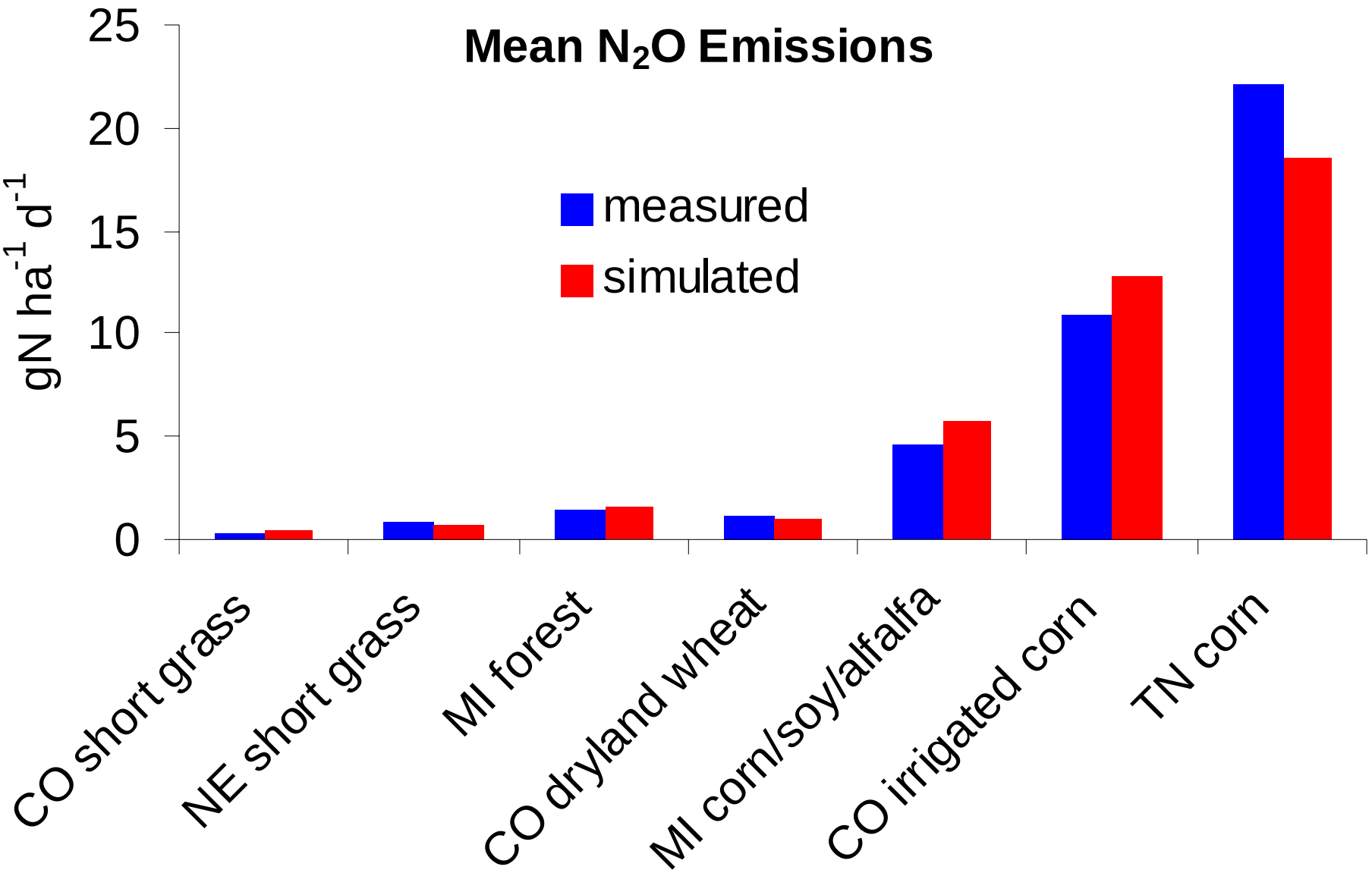
= C, N flows
= Feedbacks, information flow
= Control on process
H_2O_{soil} = Soil water content
T_{soil} = Soil temperature
S = Soil texture

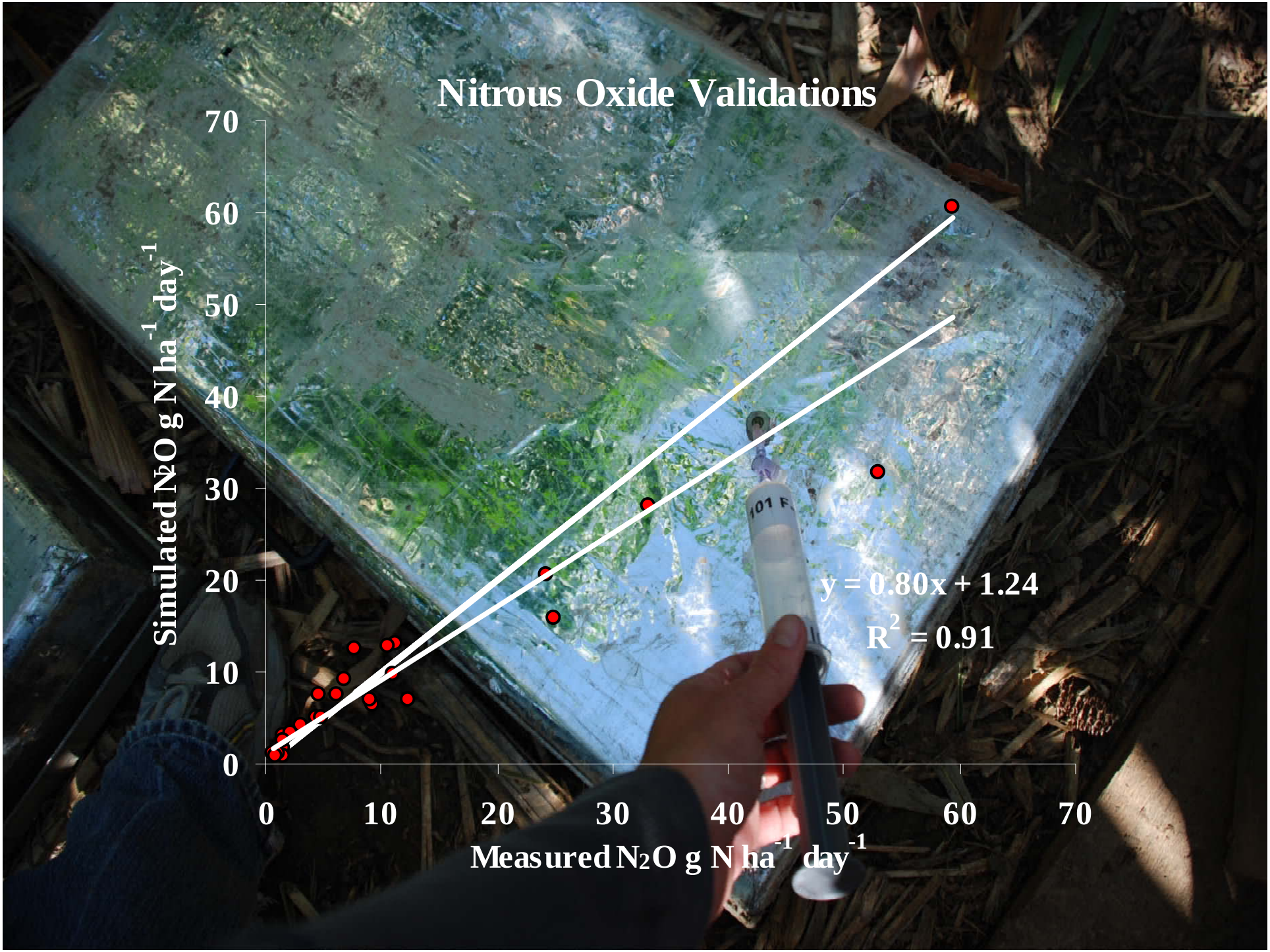
C:N = Carbon:Nitrogen ratio of material
V = Vegetation type
SOM = Soil Organic Matter
L = Land use
R_h = Heterotrophic respiration

N GAS = N_2O, NO_X, N_2
Processes designated by *italics*
Stom = Stomatal conductance
Death = Plant component death
Decomp = Decomposition
Ninputs = N Fixation, N deposition, N fertilization

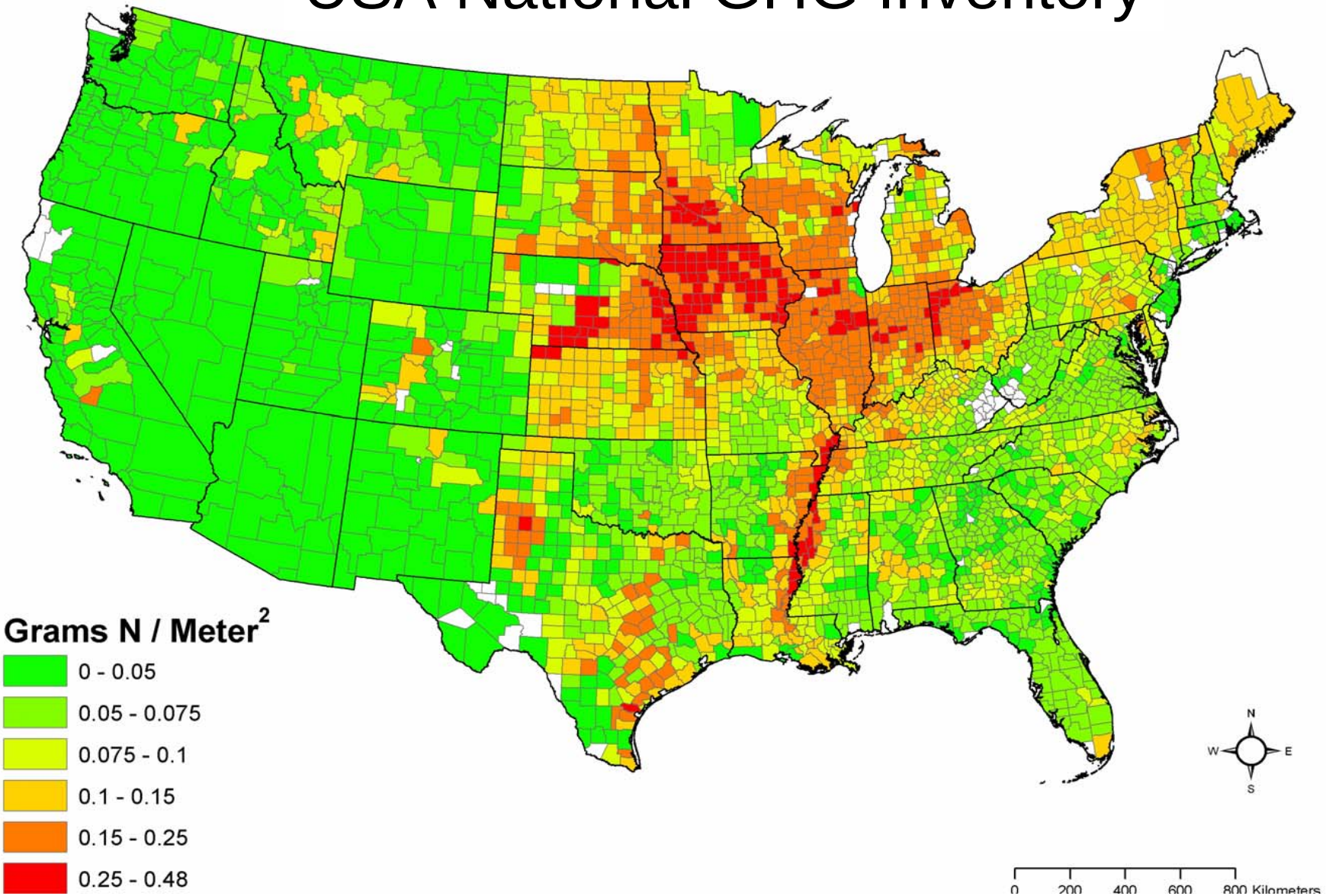
Nit = Nitrification
Den = Denitrification
Nmin = N mineralization
ET = Evapotranspiration

Model Verification



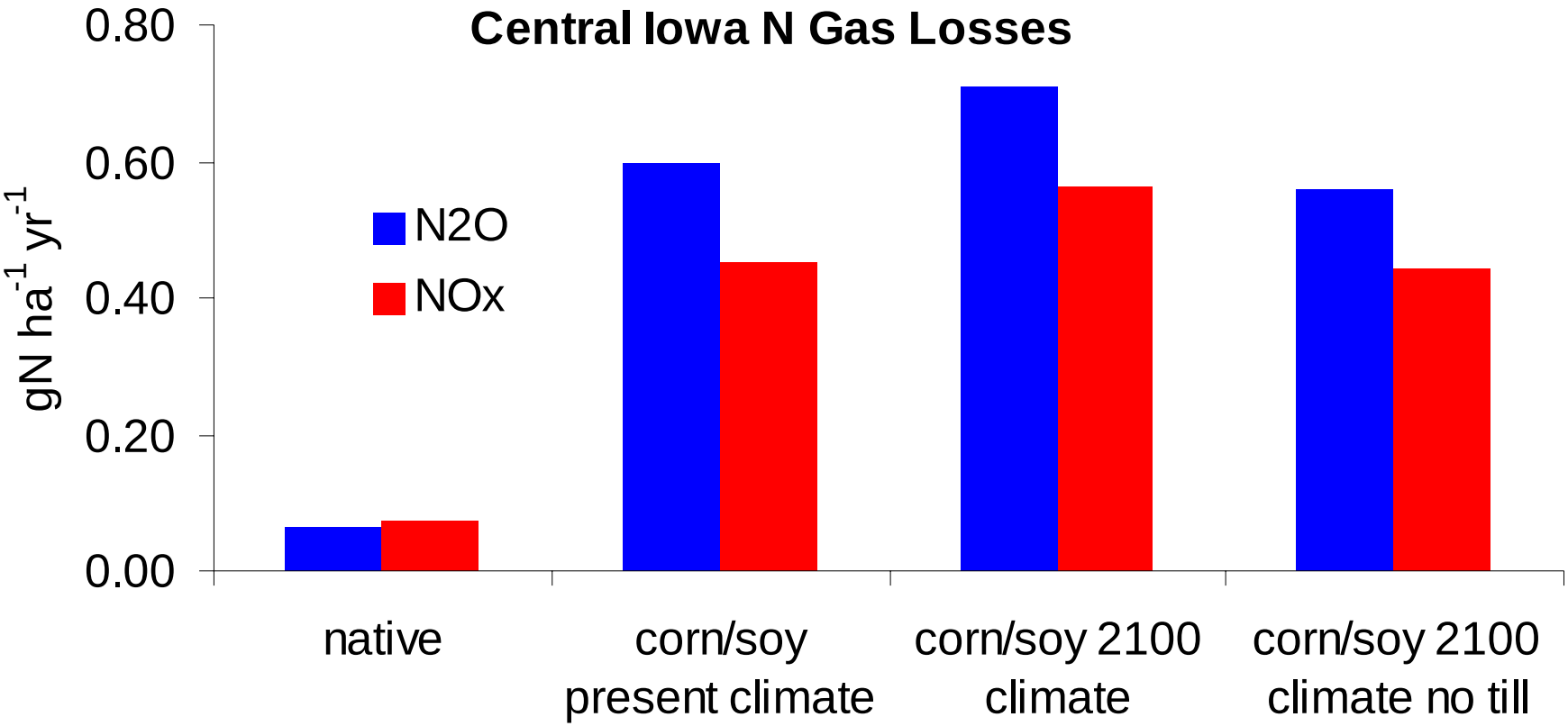

Nitrous Oxide Validations
Simulated N2O g N ha-1 day-1
Measured N2O g N ha-1 day-1
0
10
20
30
40
50
60
70
y = 0.80x + 1.24
R2 = 0.91

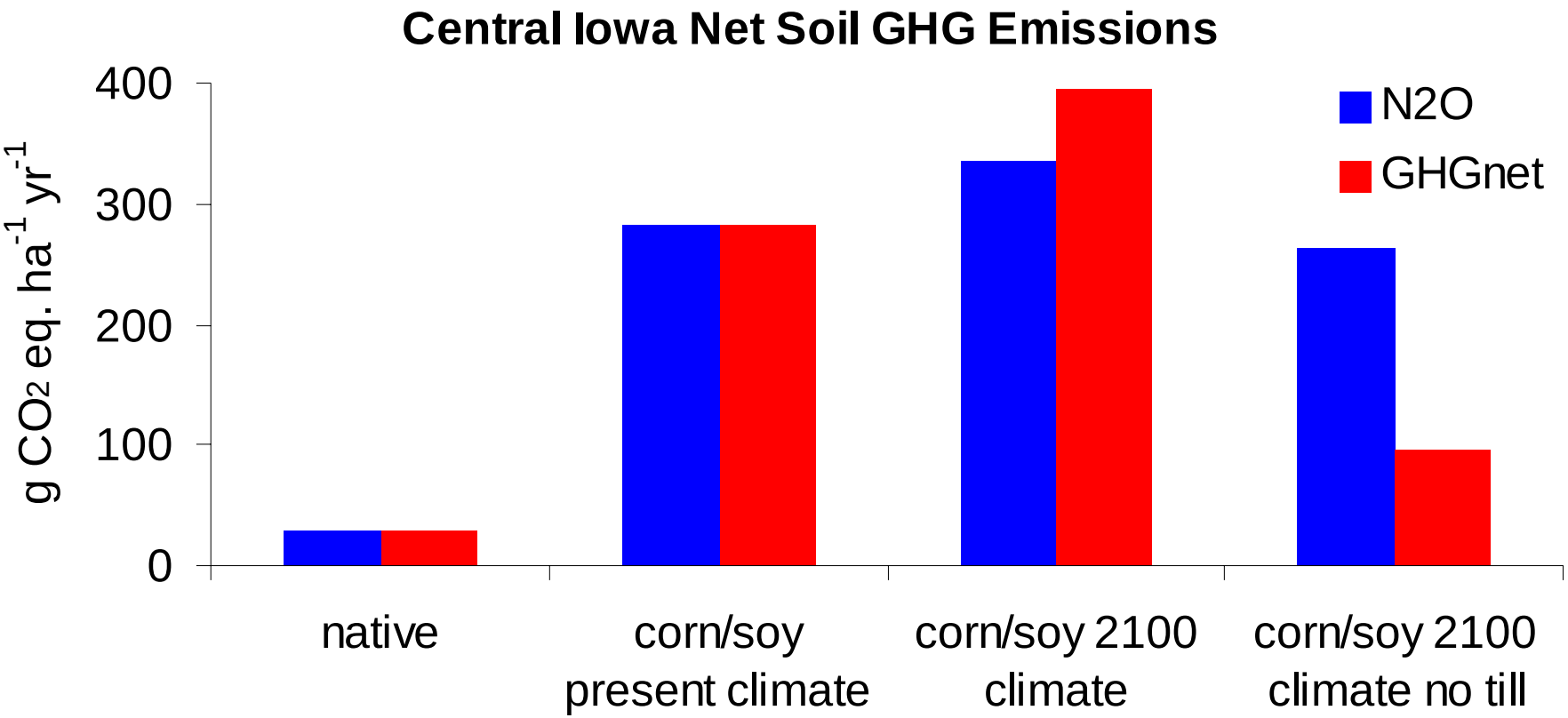
DAYCENT Simulated N_2O for USA National GHG Inventory

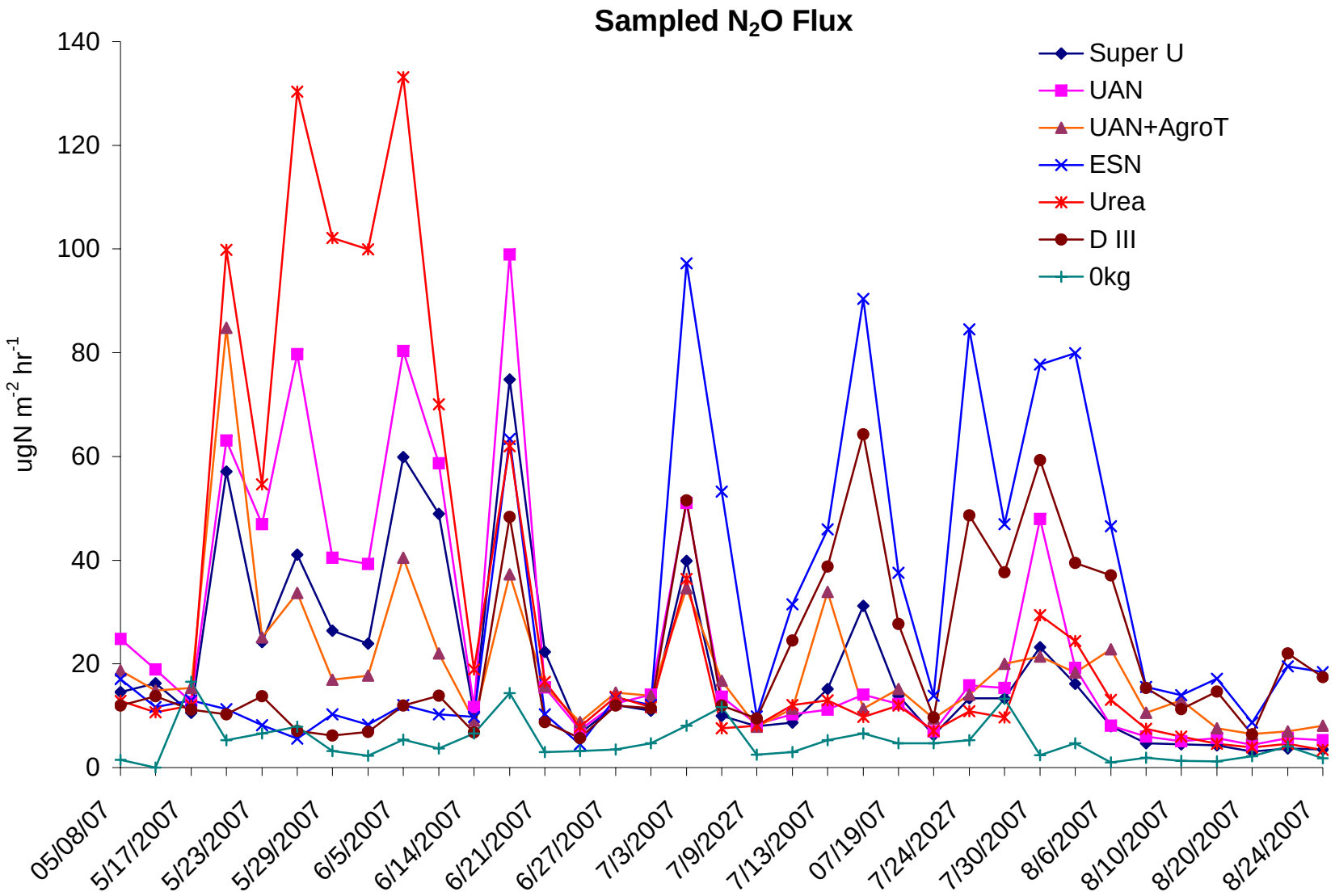


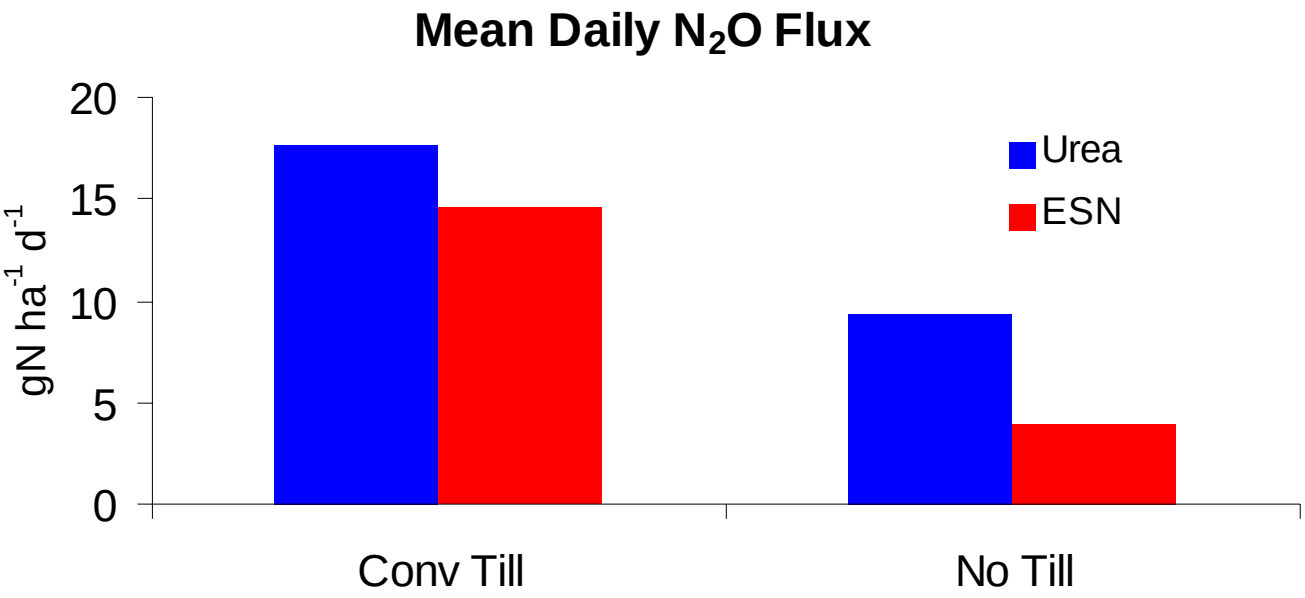
Climate Change Scenario

- Gradually increase [CO_2] to 720 ppm by 2100
- Gradually increase daily Tmax 2 ^{O}C by 2100
- Gradually increase daily Tmin 1 ^{O}C by 2100


Central Iowa N Gas Losses
0.80
0.60
0.40
0.20
0.00
gN ha-1 yr-1
N2O
NOx
native
corn/soy present climate
corn/soy 2100 climate
corn/soy 2100 climate no till


Central Iowa Net Soil GHG Emissions
400
300
200
100
0
g CO2 eq. ha-1 yr-1
N2O
GHGnet
native
corn/soy present climate
corn/soy 2100 climate
corn/soy 2100 climate no till


Sampled N2O Flux
ugN m-2 hr-1
140
120
100
80
60
40
20
0
05/08/07
5/17/2007
5/23/2007
5/29/2007
6/5/2007
6/14/2007
6/21/2007
6/27/2007
7/3/2007
7/9/2027
7/13/2007
07/19/07
7/24/2027
7/30/2007
8/6/2007
8/10/2007
8/20/2007
8/24/2007
Super U
UAN
UAN+AgroT
ESN
Urea
D III
0kg


Mean Daily N2O Flux
20
15
10
5
0
gN ha-1 d-1
Urea
ESN
Conv Till
No Till