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· August 15-18, 2010 · Dallas, Texas ·
· Dallas Convention Center ·

GHG Emissions from Agriculture, Mitigation Potential, and Decision Support Tools

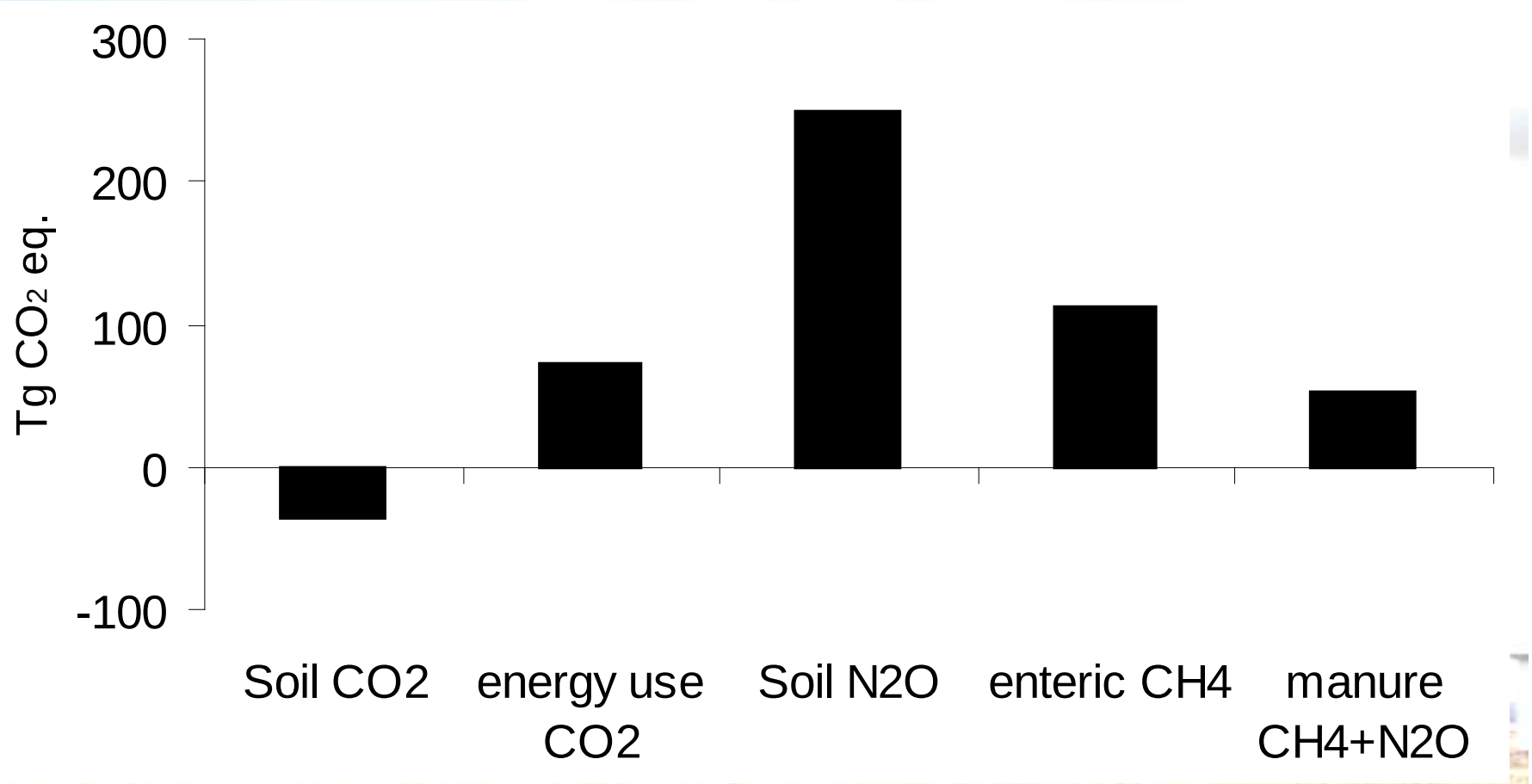
Questions Addressed

- Role of agriculture?
- How are soil GHG fluxes quantified?
- How is uncertainty quantified?
- What is the mitigation potential?
- Farm level tools?

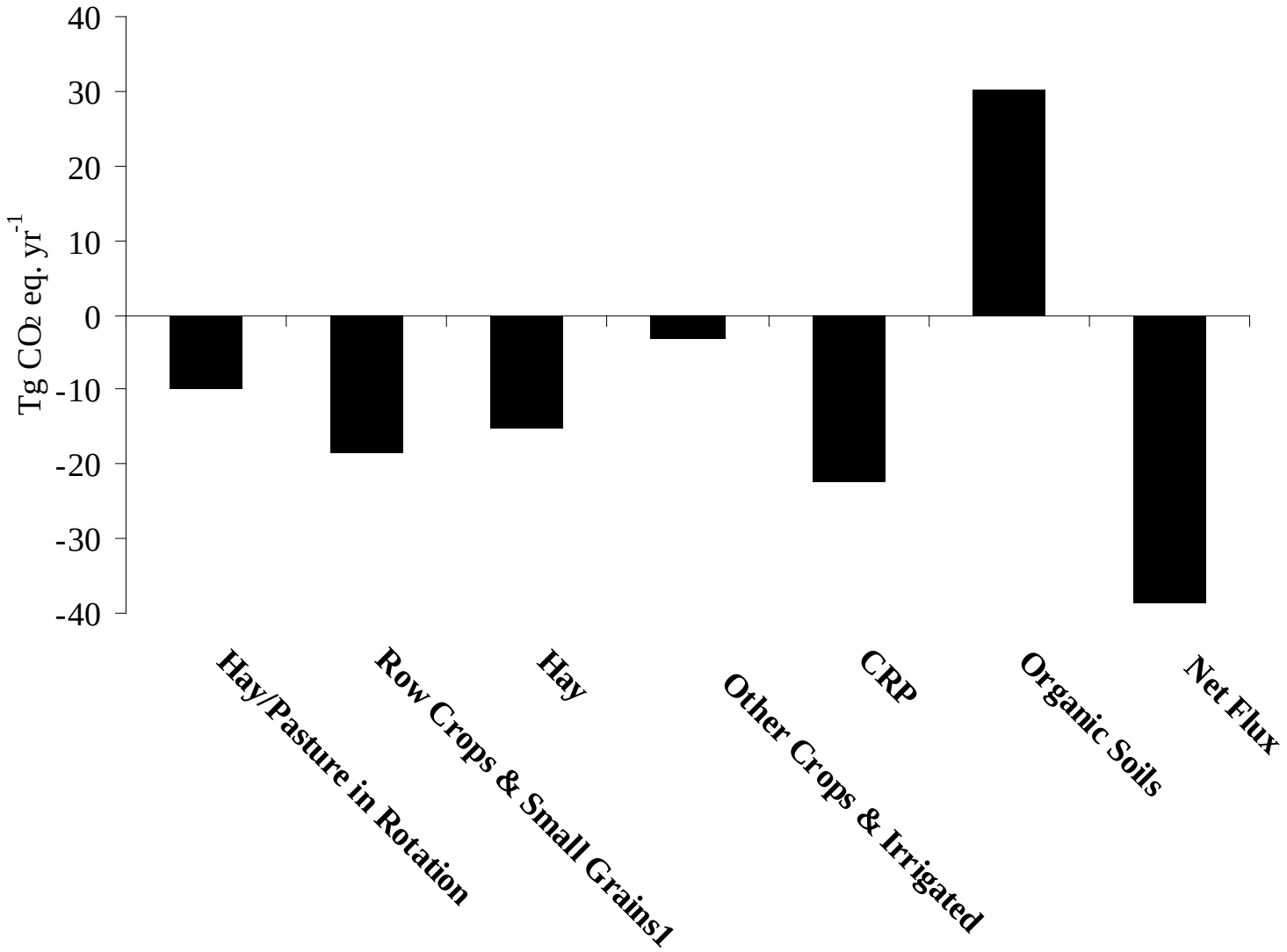
Global Warming Potential (CO_2 eq.)

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

US Agricultural GHG Emissions



US Cropped Land Δ Soil C



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Sampling Methods

Bottom Up

•Appropriate for plot level
•But requires disturbance of vegetation/soil
•Snapshot of emissions in small slices of time/space

Tower Top Down

•Cannot distinguish emissions from plots receiving different treatments
•Impacted by wind velocity
•Appropriate for field scale
•Almost continuous sampling through time

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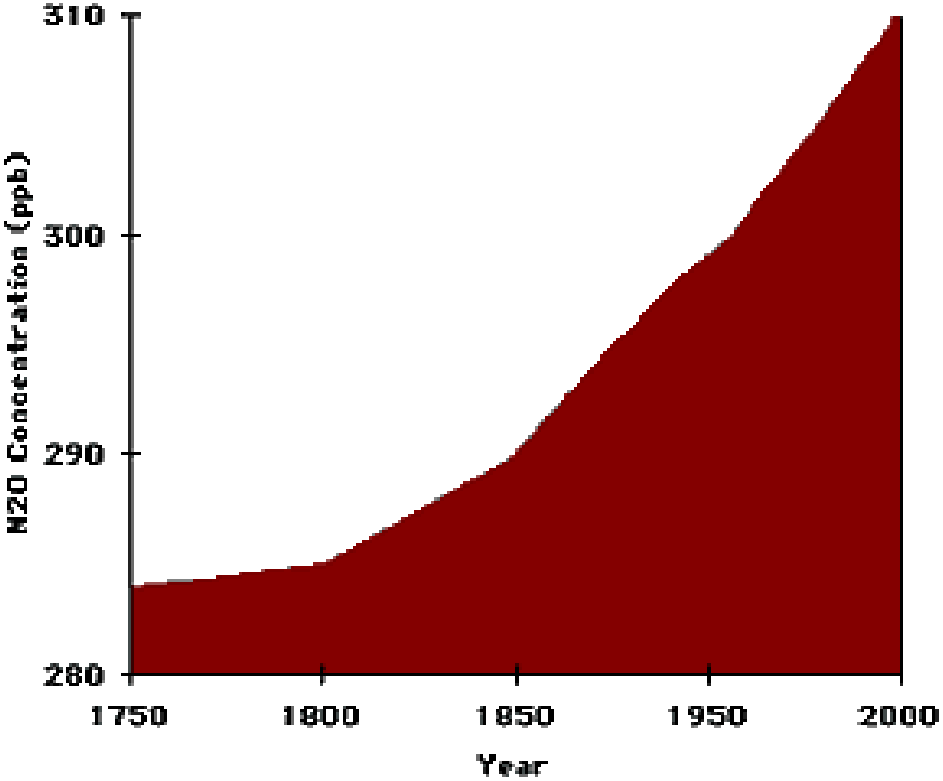
Sampling Methods

Aircraft Top Down

- Large foot print (> 10 km2)
- Brief periods of time sampled
- Expensive

Global Top Down
source – sink = Δatmos



- atmospheric concentration is well quantified
- Well established chemistry
- Cannot distinguish sources

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Modeling Methods

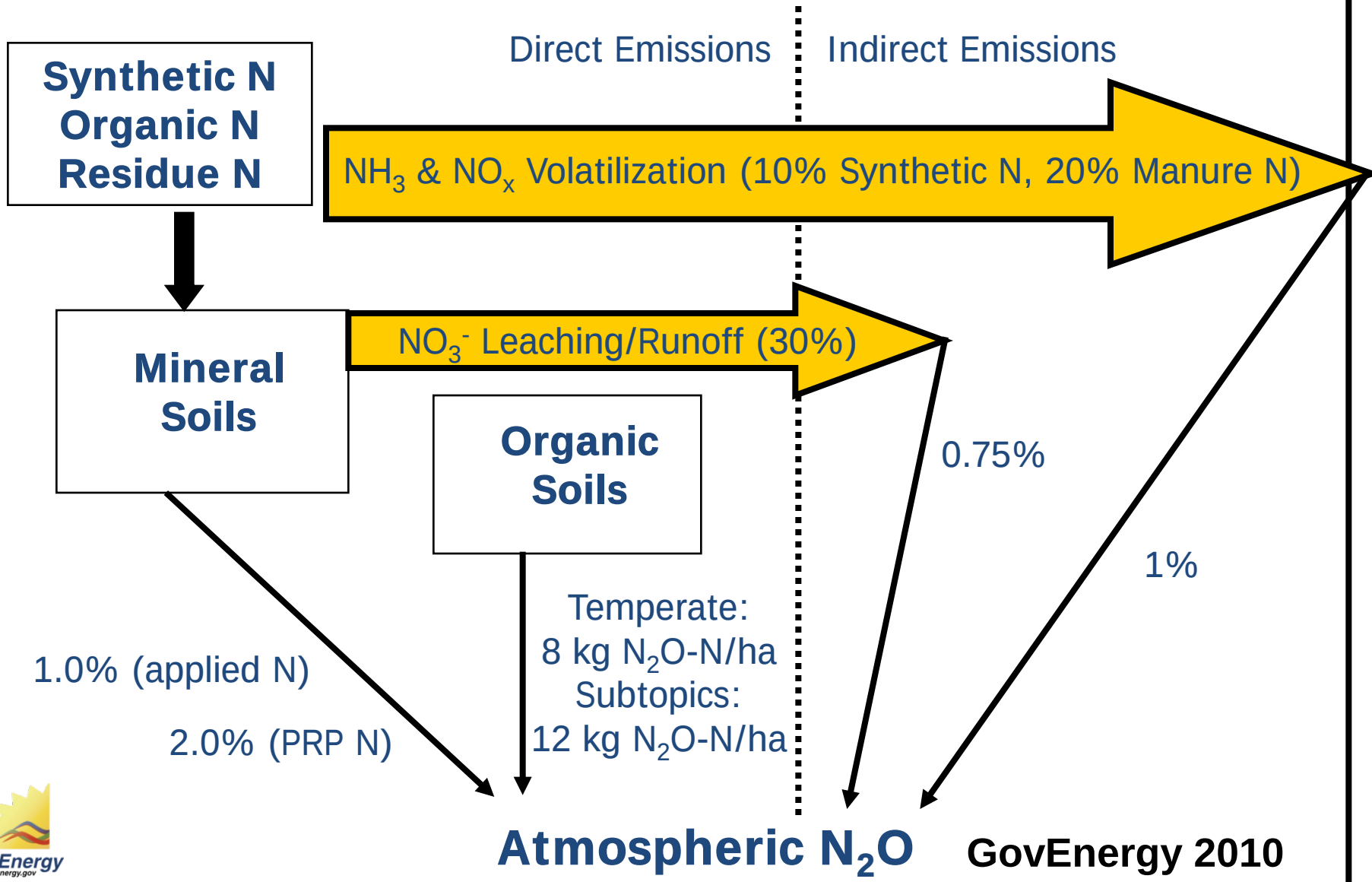
Empirical:

- 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

IPCC METHODOLOGY FOR N_2O



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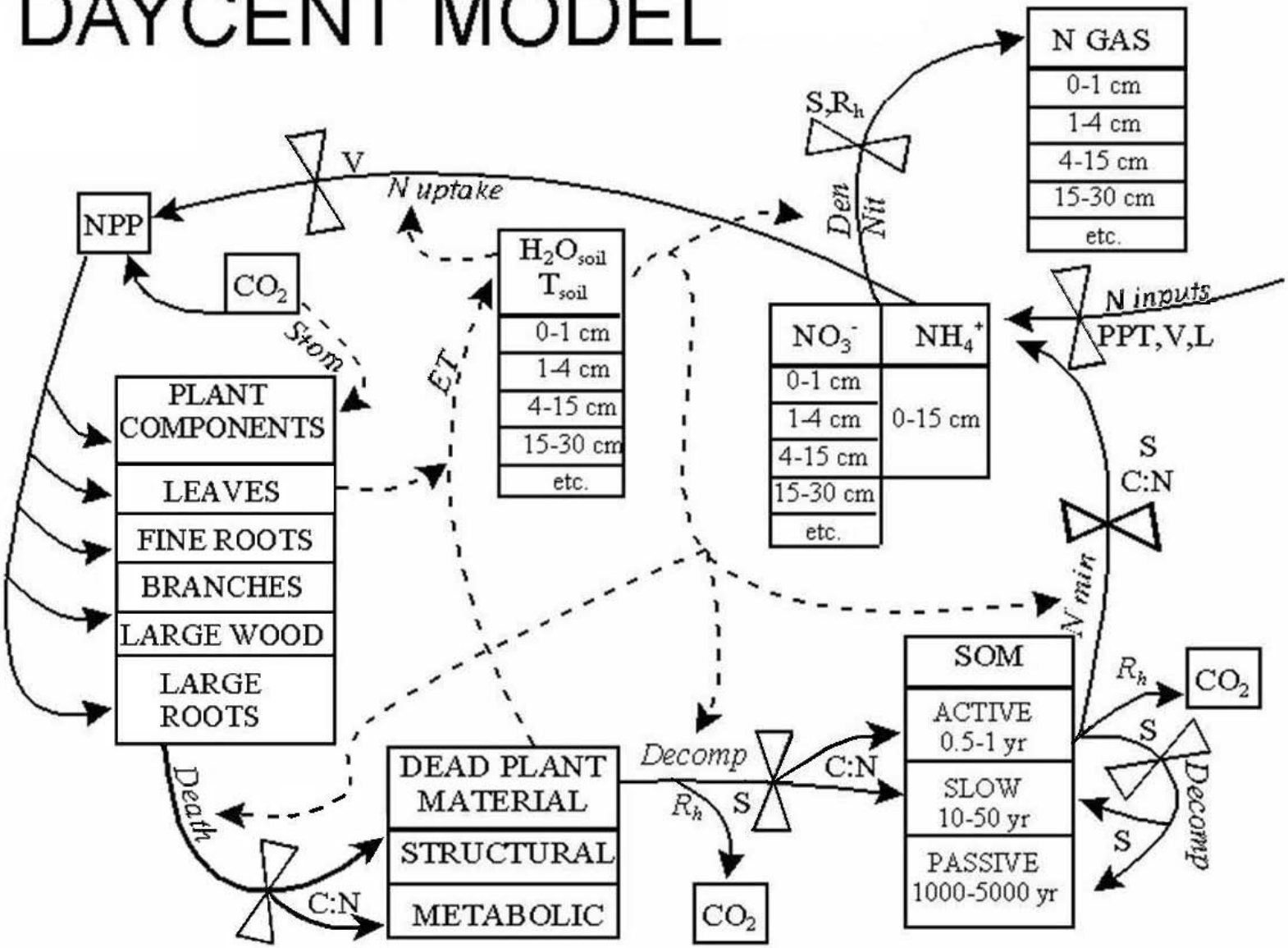
DAYCENT MODEL



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DAYCENT: Primary Inputs/Outputs

Climate
- Daily Precipitation
- " Max/Min Temperature

Soil Properties
- Texture
- Bulk Density
- FC, WP, K_{sat}

Land Use
- Vegetation Type
- Nutrient, H_2O Inputs
- Tillage/Harvest
- Grazing/Burning

DAYCENT MODEL

Plant Production
- NPP Allocation
- Grain Yields

SOM Changes
- active/slow/recalcitrant pools

Trace Gas Fluxes
- CO_2, CH_4
- N_2O, NO_X

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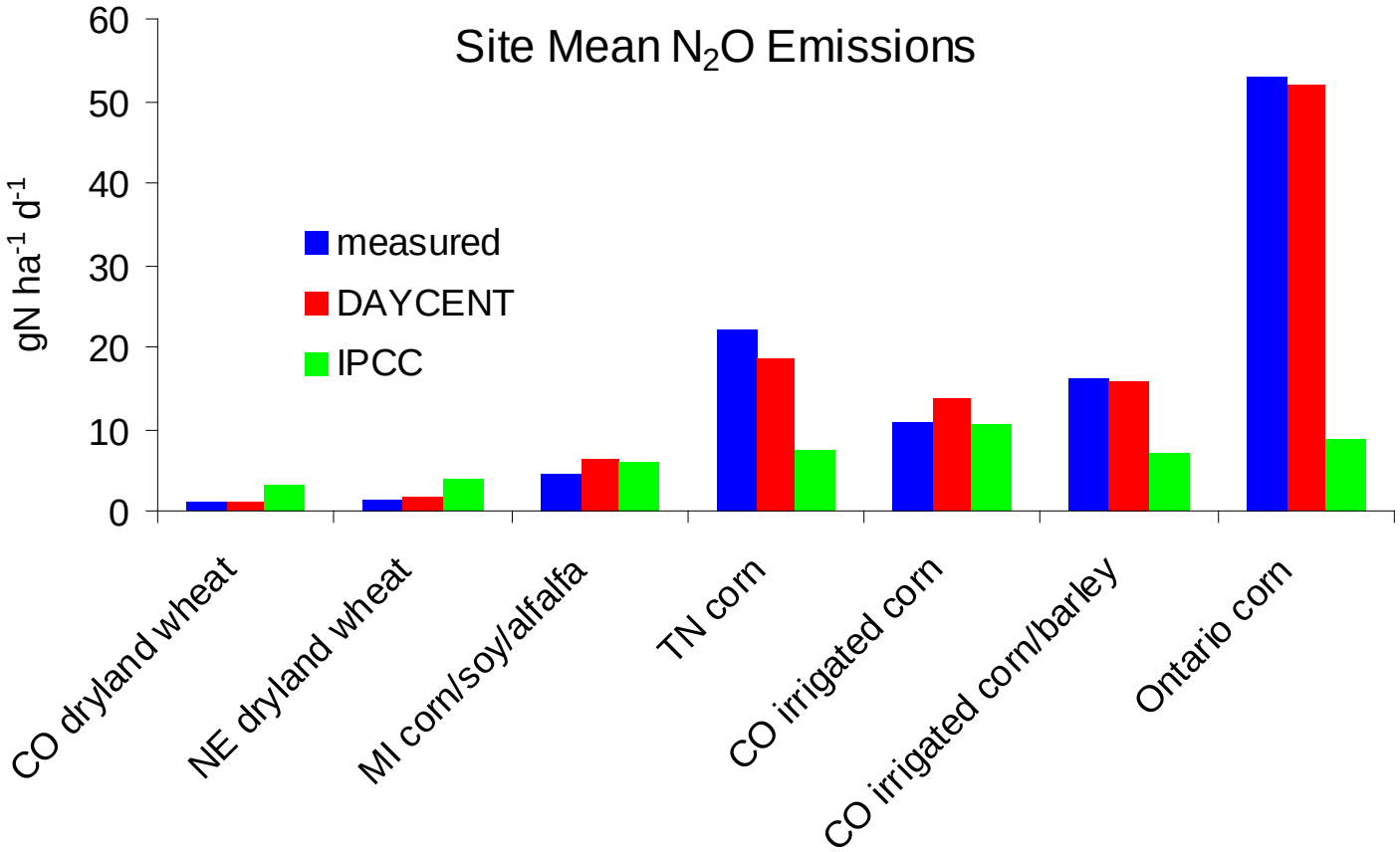
At plot level, process based models usually perform better than simple models



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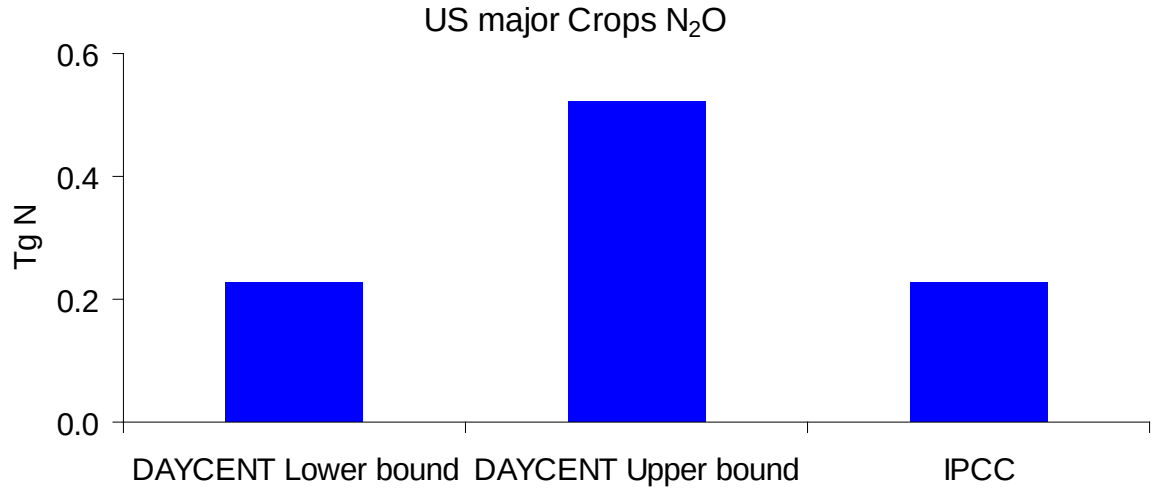
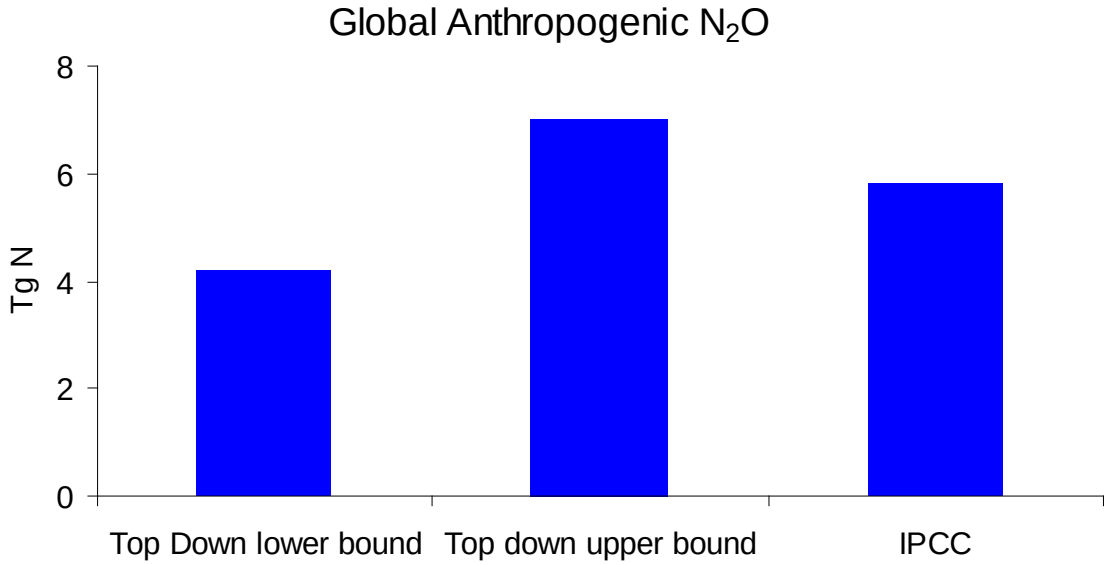
As scale increases, simple models become more reliable





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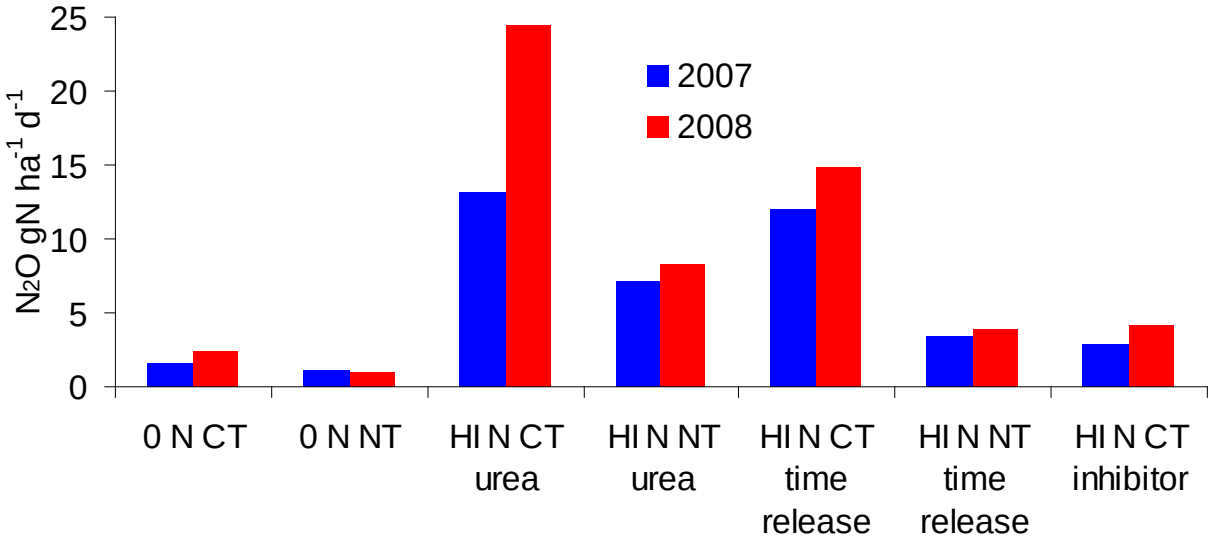
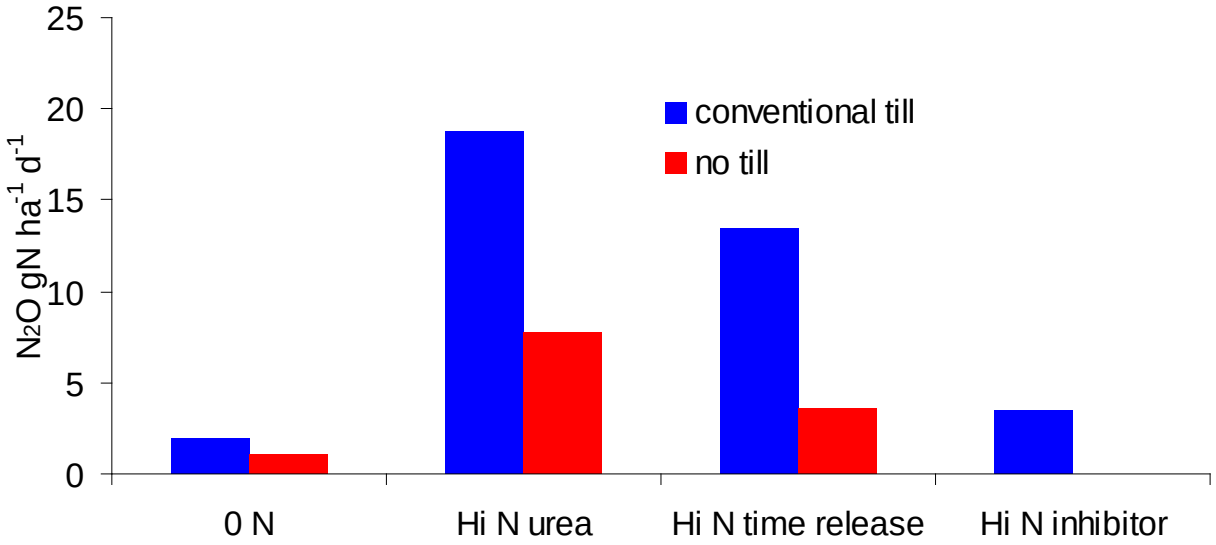
N_2O Mitigation

Source of ~ 250Tg CO_2 eq.:

- Cropped Soils ~ 155 Tg CO_2 eq.
- Grazed Soils ~ 95 Tg CO_2 eq.
- ~10 Tg N fertilizer and 16 Tg N fixed per year
- ~ 45% of this N leached or lost as N gas
- Nitrification/urease inhibitors
- Time released fertilizers

Fertilizer Type and Tillage Intensity Study – Colorado Irrigated Corn





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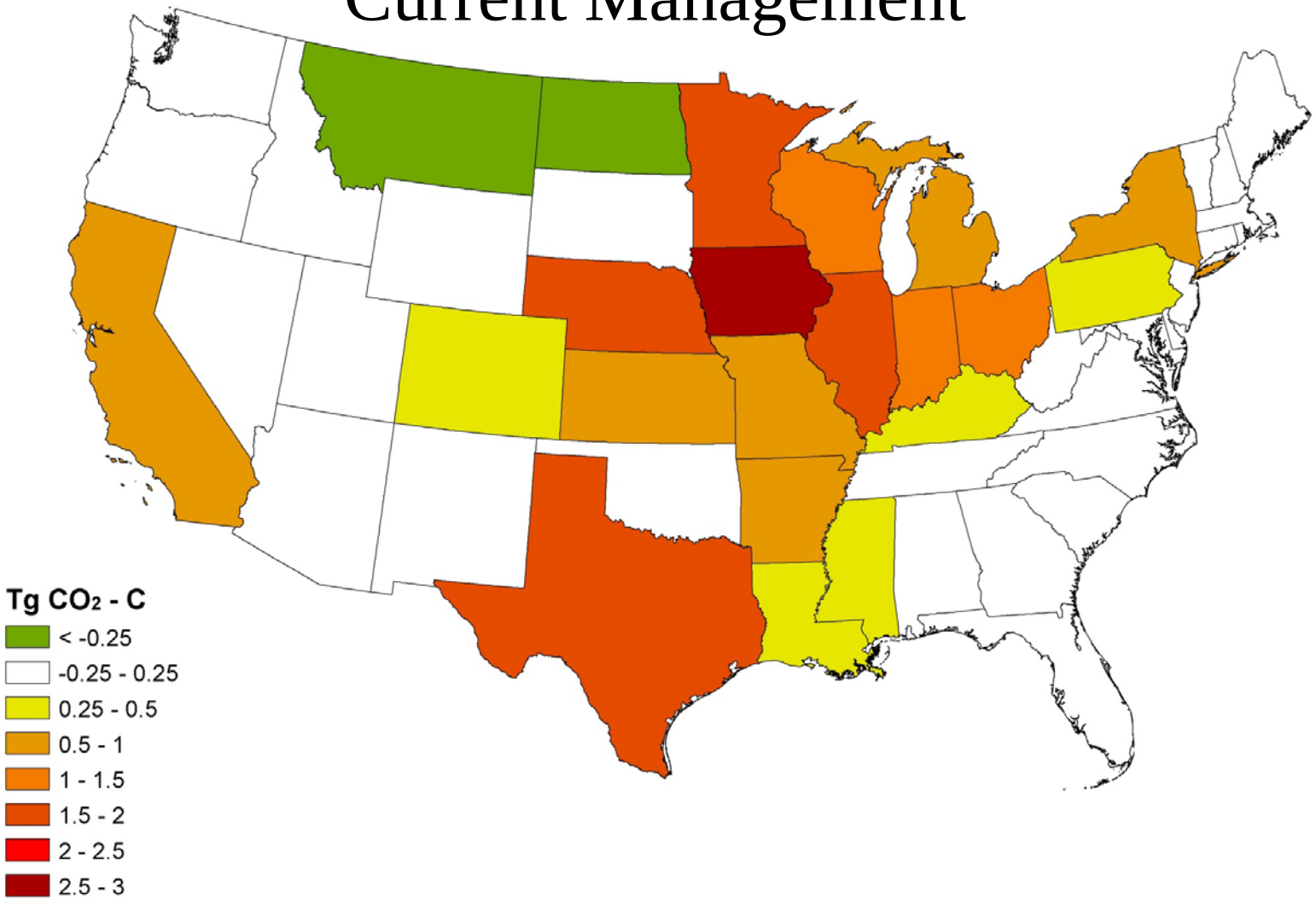
Mineral Soil GHG Fluxes Major Crops Current Management



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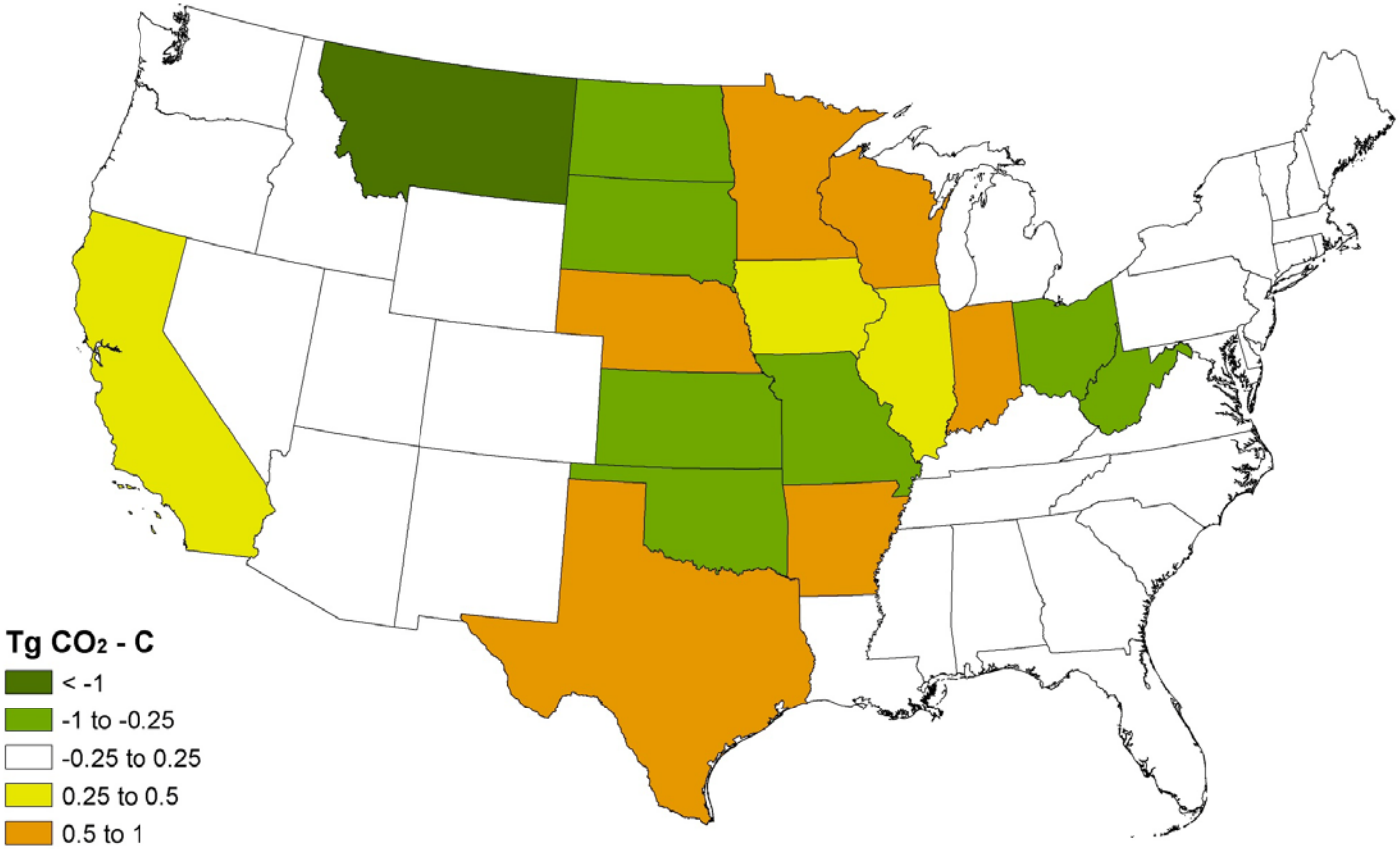
Mineral Soil GHG Fluxes Major Crops Improved Management



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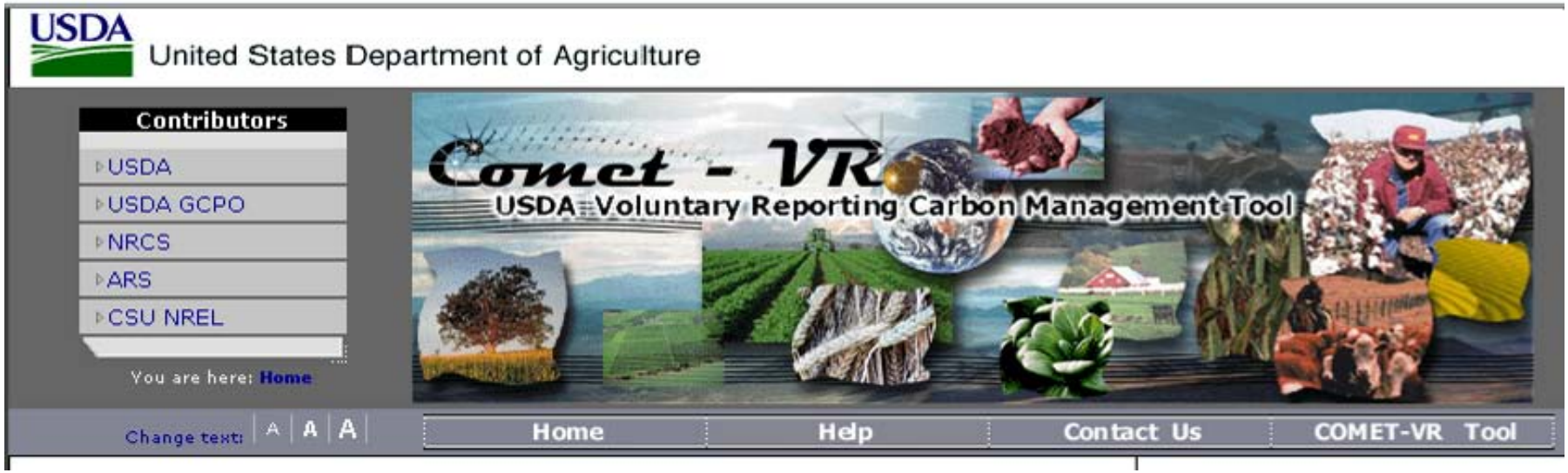
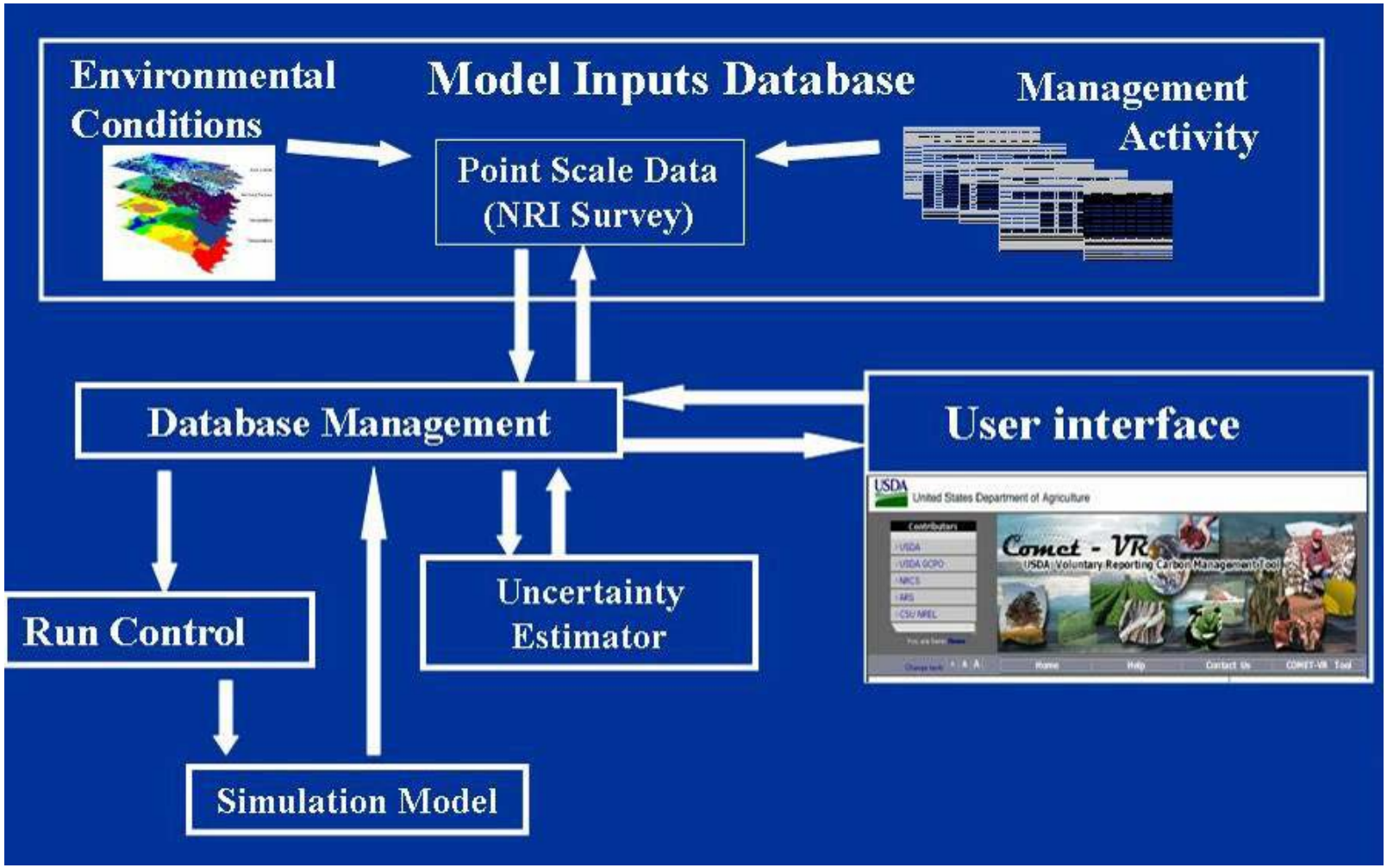
COMET-VR (CarbOn Management and Evaluation Tool – Voluntary Reporting)



- First developed for cropland/grassland soil C & fuel use
- New version includes:
  - N_2O emissions
  - Agroforestry
  - Orchards and vineyards

COMET-VR model
(www.cometvr.colostate.edu)



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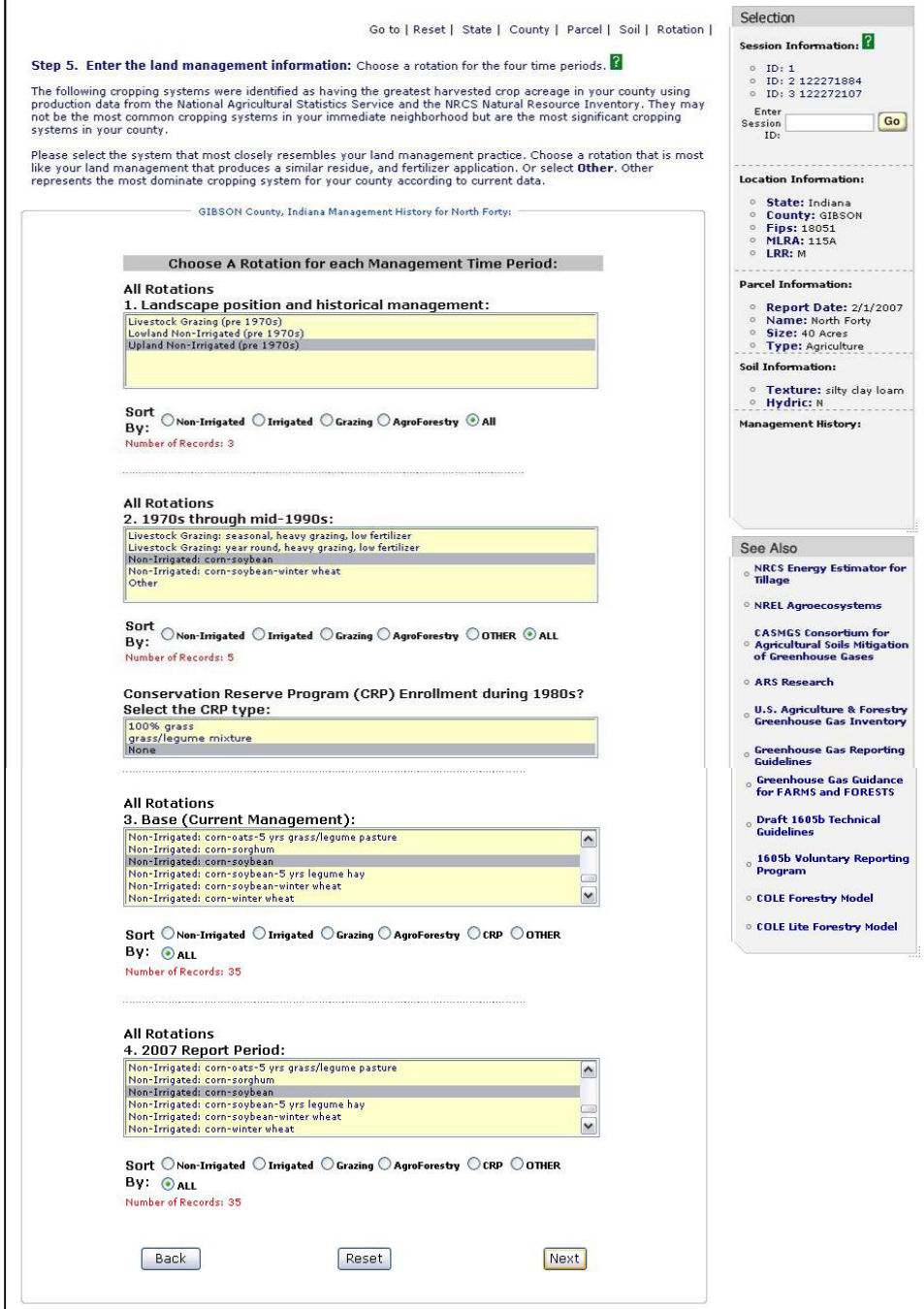
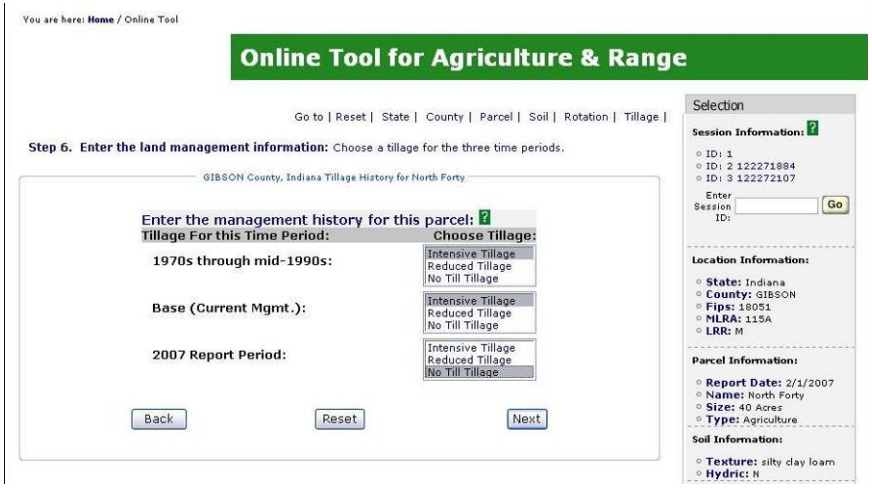


Select management sequences

Select tillage management sequence



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Voluntary Reporting
Carbon Management Tool COMET-VR
Carbon Storage Report
Report Year: 2008

Session ID: 80747966

Parcel Description

Parcel Type:	Agriculture
Total Parcels for this Entity:	1
Parcel Name:	Parcel 1
Parcel Size:	100 Acres
Location:	GIBSON, Indiana
Soil:	Non-hydric loam

Parcel Management History

Historic:	Lowland Non-Irrigated (pre 1970s)
70s to 90s:	Non-Irrigated: corn-soybean; Intensive Tillage
Current:	Non-Irrigated: corn-soybean; Intensive Tillage
Report Period:	Non-Irrigated: corn-soybean; No Till Tillage

Predicted Change in Soil Carbon for the Parcel

Annual Change for 2008

	Carbon Change	Uncertainty		
		Avg Percent	Lower Bounds CI*	Upper Bounds CI*
Total Tons Carbon per year:	**15.27**	**30.16 %**	10.79	20.00
Total Tons CO2 Equivalent per year:	**56.00**	**30.16 %**	39.57	73.34

Values recorded in English units. One **ton** of carbon is equivalent to 3.667 **tons** of carbon dioxide.

Please report the **Large Bolded Values** on your 1605(b) report for carbon change and uncertainty. We are 95% confident that your average carbon change value is within (+-) 30.16 % of the modeled carbon change value shown on this report.

- **MLRA:** 115A
- **LRR:** M

Parcel Information:

- **Report Date:** 9/29/2008
- **Name:** Parcel 1
- **Size:** 100 Acres
- **Type:** Agriculture

Soil Information:

- **Texture:** loam
- **Hydric:** N

Management History:

- **Historic:** Lowland Non-Irrigated (pre 1970s)
- **70's - 90's:** Non-Irrigated: corn-soybean,Intensive Tillage, CRP: None
- **Current:** Non-Irrigated: corn-soybean,Intensive Tillage,
- **Report Period:** Non-Irrigated: corn-soybean,No Till Tillage,

See Also

- NRCS Energy Estimator for Tillage
- NREL Agroecosystems
- CASMGS Consortium for Agricultural Soils Mitigation of Greenhouse Gases
- ARS Research
- U.S. Agriculture & Forestry Greenhouse Gas Inventory
- Greenhouse Gas Reporting Guidelines
- Greenhouse Gas Guidance for FARMS and FORESTS
- Draft 1605b Technical Guidelines
- 1605b Voluntary Reporting Program
- COLE Forestry Model
- COLE Lite Forestry Model

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Limitations

- Models that COMET is based on have been verified with measurements from controlled experiments
- But what about farm level?
  - A national monitoring system for soil C is being planned
  - Something similar for N_2O?

A National Soil Inventory Network

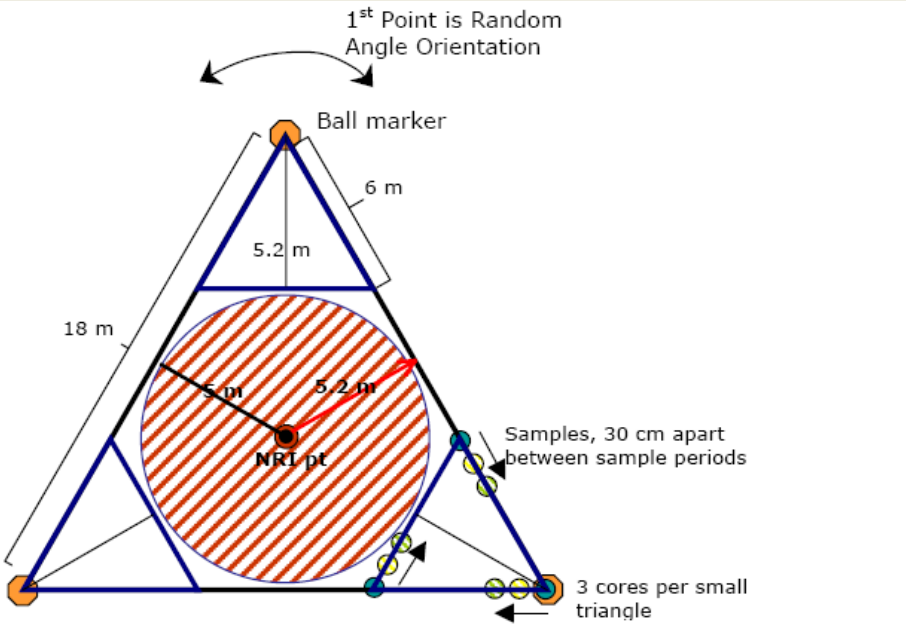

Figure 4. Layout of a monitoring site in proximity to a NRI point location.

- Prototype network under development with USDA/NRCS-NRI
- Proposed build-out to 5000-10,000 locations, with 1000-2000 locations per year

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Conclusions

- No perfect method to quantify soil GHG fluxes
- As scale increases, different methods tend to converge
- Improved fertilizers can substantially reduce soil N losses
- Farm level tools can estimate offsets, BUT:
- A national monitoring system is needed to further verify the ability of models to represent the impacts of management practices
- Aggregation is necessary

Stephen Del Grosso, Stephen Ogle, Bill Parton, Keith Paustian, Tom Wirth, Jay Breidt, et al.