Mitigating greenhouse gases – Agriculture's role

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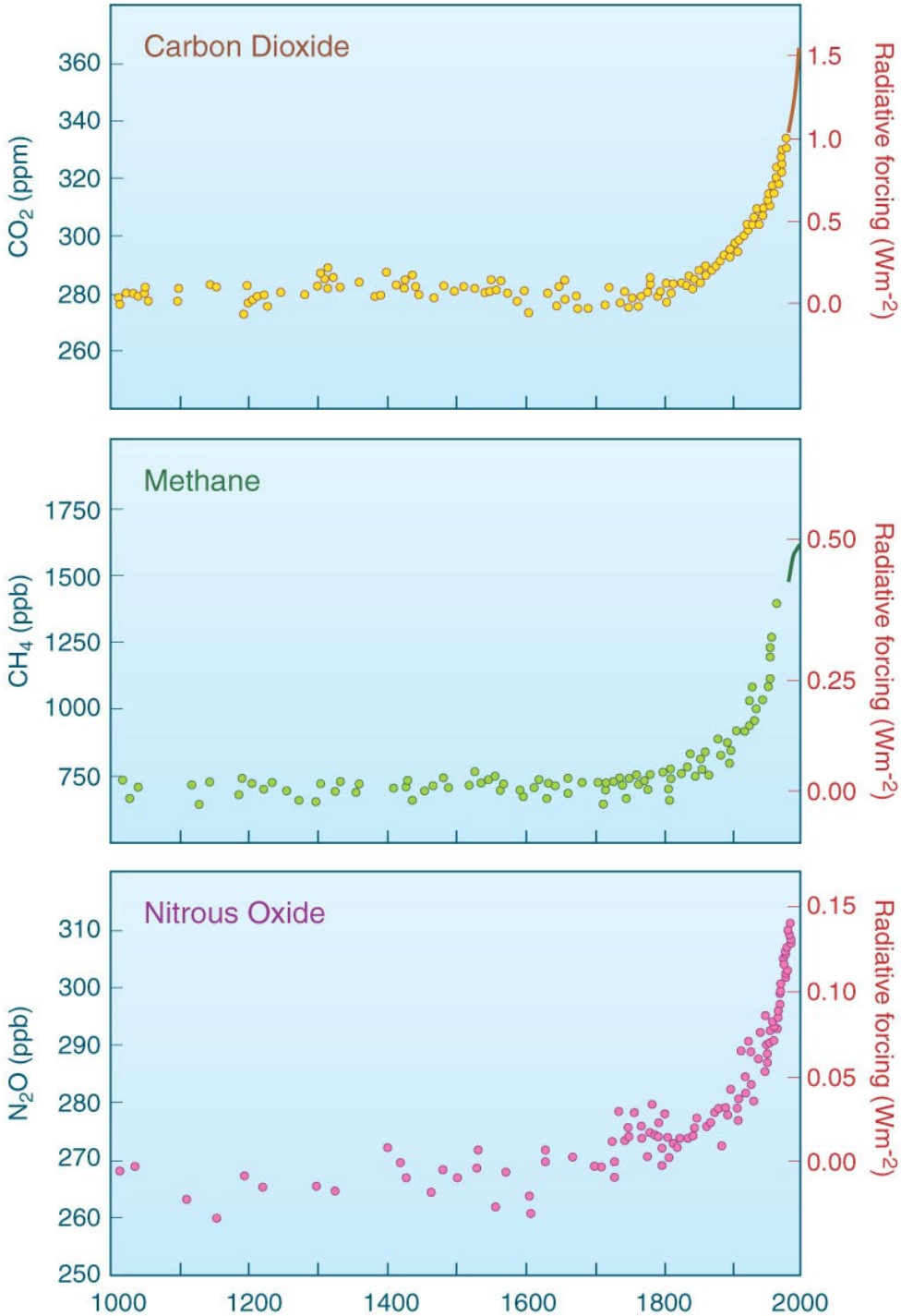
Funded by PIER


Carbon Dioxide
CO_2 (ppm)
360
340
320
300
280
260
1.5
1.0
0.5
0.0
Radiative forcing (Wm^{-2})
Methane
CH_4 (ppb)
1750
1500
1250
1000
750
0.50
0.25
0.00
Radiative forcing (Wm^{-2})
Nitrous Oxide
N_2O (ppb)
310
300
290
280
270
260
250
0.15
0.10
0.05
0.00
Radiative forcing (Wm^{-2})
1000
1200
1400
1600
1800
2000

Sources and sinks in agriculture

CO_2

Sources: Fossil fuels, biomass burning, soil degradation
Sinks: Buildup soil organic matter and plant biomass
GWP (Global Warming Potential) = 1

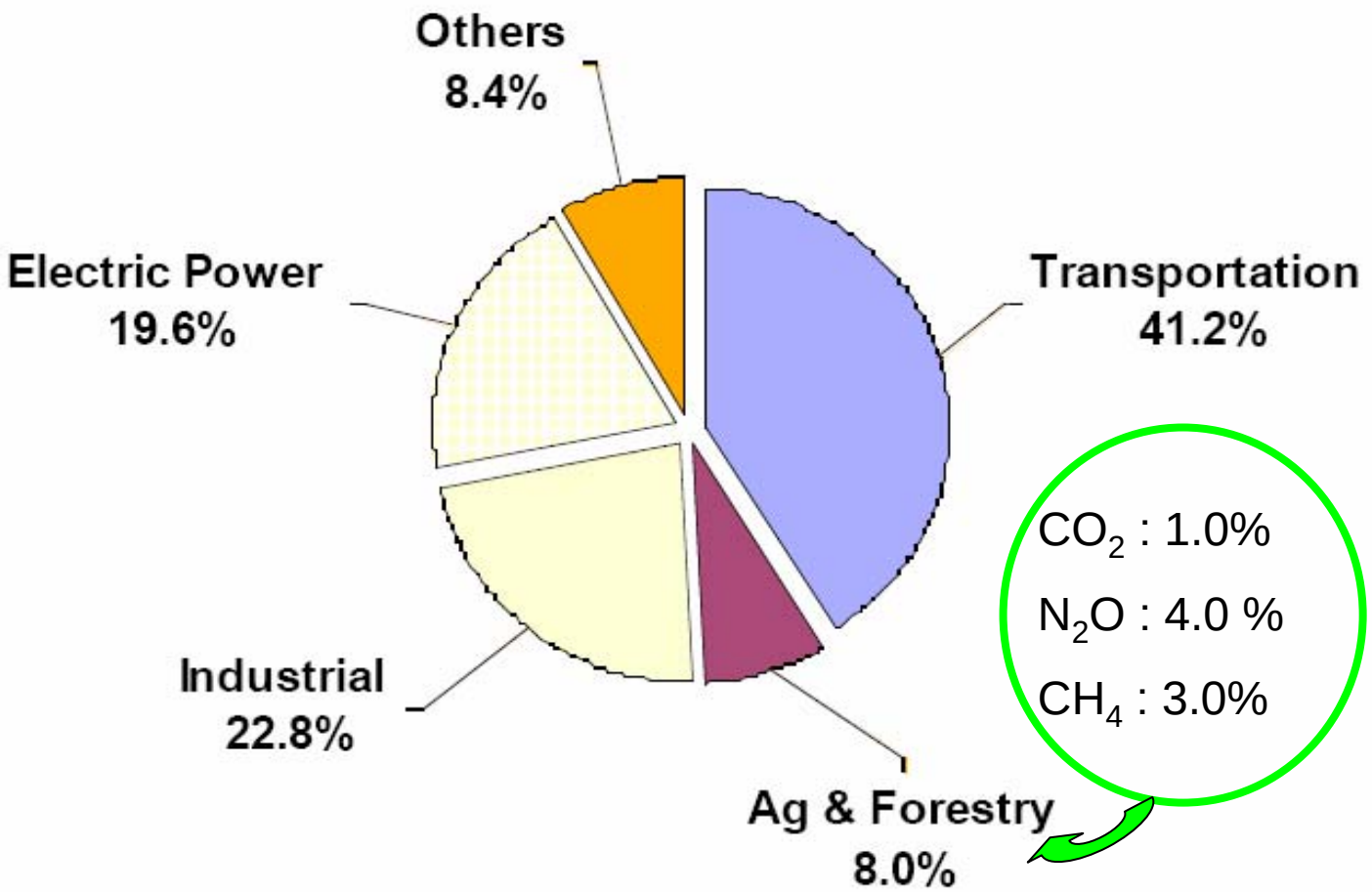
N_2O

Sources: Fertilizer, crop residues, manure
Sinks: No agricultural sinks
GWP = ~300

CH_4

Sources: Livestock, manure, anaerobic soils (rice)
Sinks: Aerobic soils, especially forests and grasslands
GWP = ~20

California



Source: California Energy Commission

Practices for C sequestration

- Reduced and zero tillage
- Set-asides/conversions to perennial grass
- Reduction in cultivated organic soils
- Winter cover crops
- More hay in crop rotations

Practices for N_2O & CH_4 emission reduction

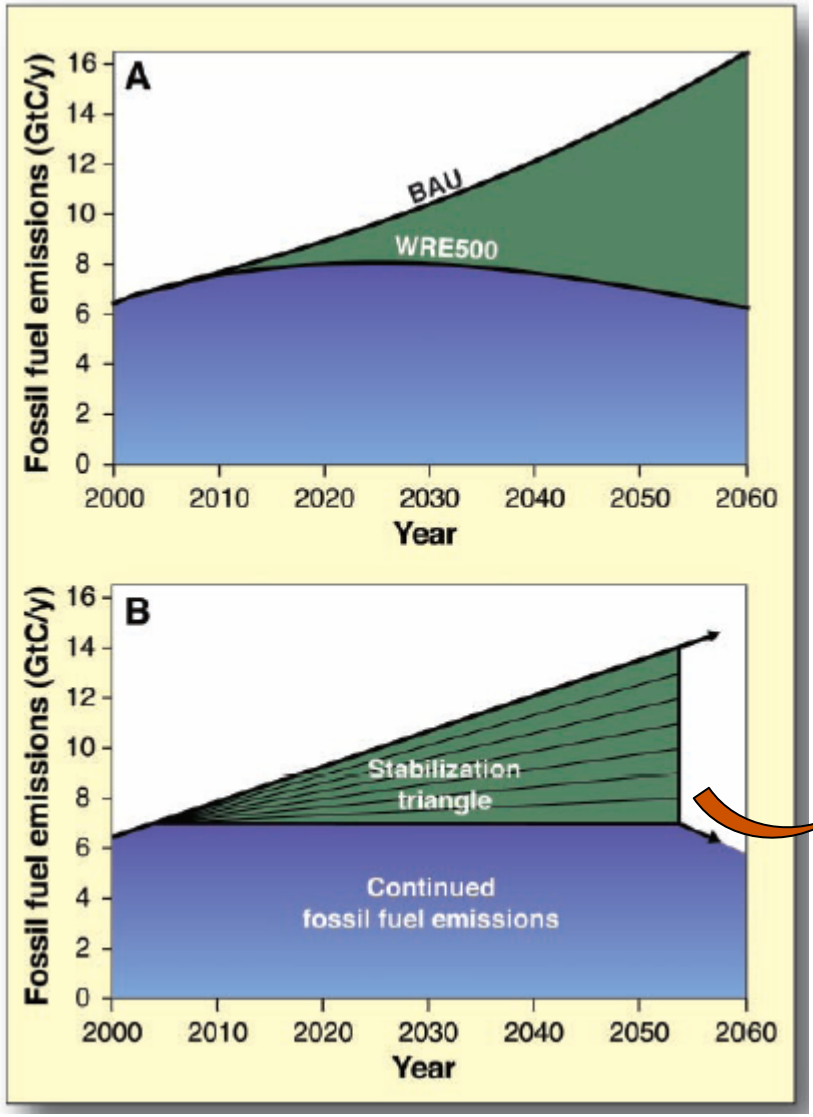
N_2O mitigation

- Better match of N supply to crop demand
- Better organic N (e.g. manure) recycling
- Advanced fertilizers (e.g. controlled release, nitrification inhibitor)

CH_4 mitigation

- Improved livestock breeding and reproduction
- Nutrition (e.g. forage quality, nutrient balance, additives)
- Manure composting
- Rice (water and nutrient management)

Part of the solution

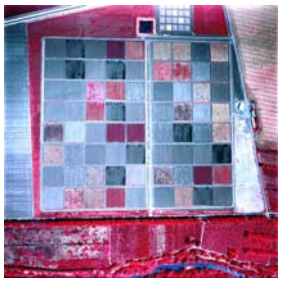


One of the wedges is best management practices in agriculture

Pacala and Socolow 2004

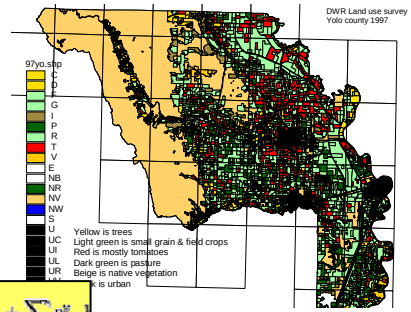
Integrated modeling approach

Field experiments

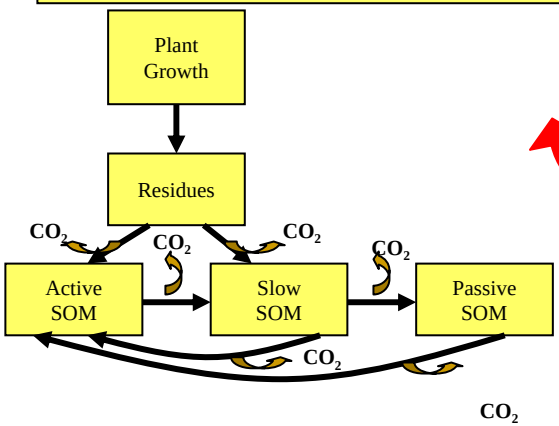


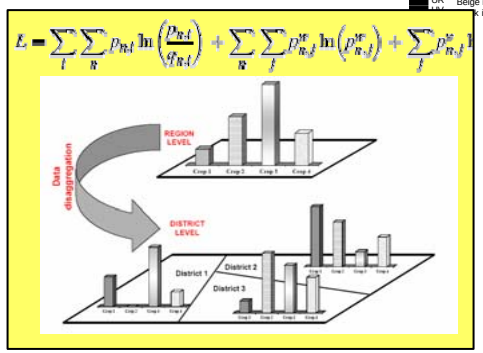
Land use and management identification

Spatial Information



Ecosystem model





Dynamic economics

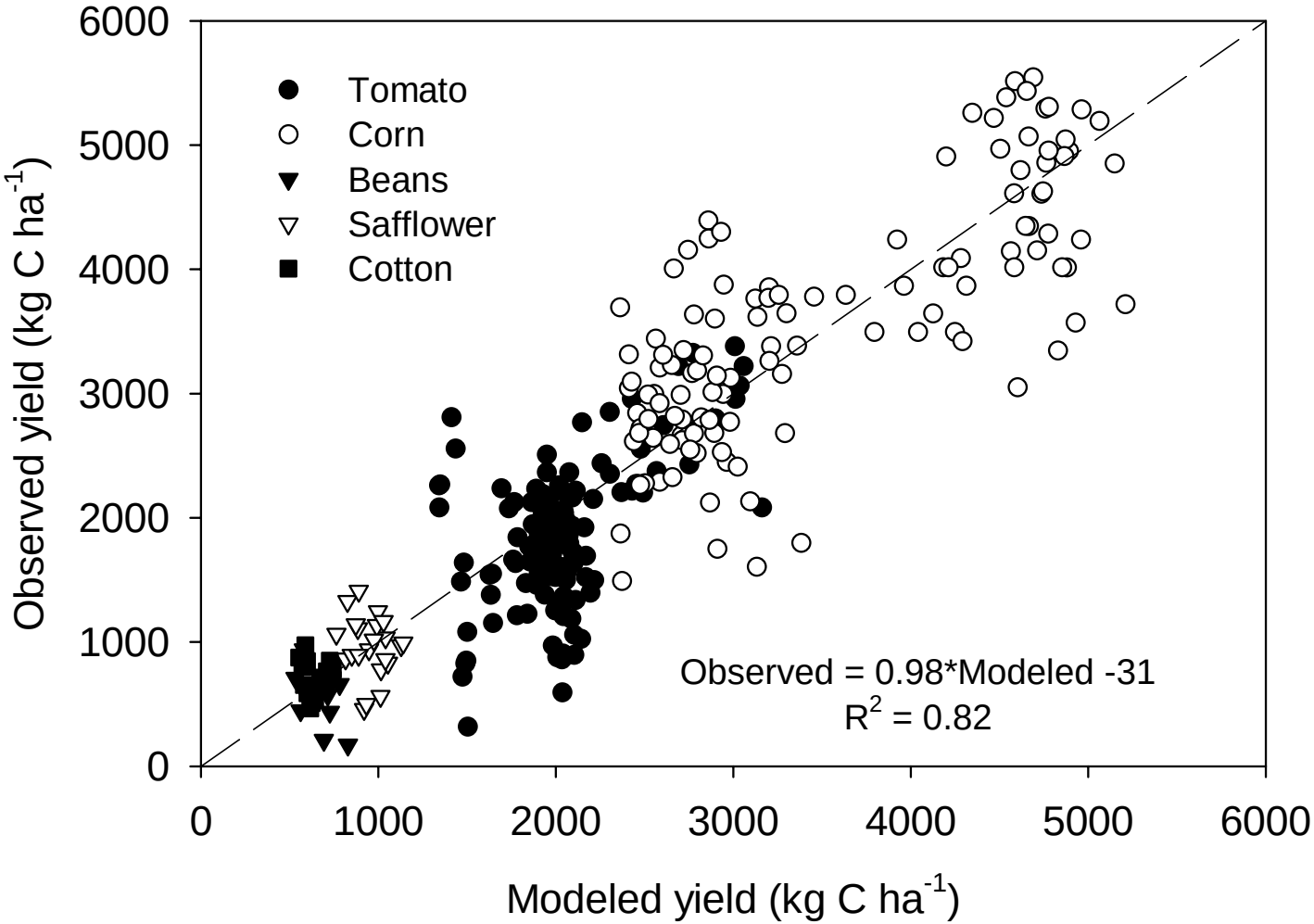
Decision support

With uncertainty estimates

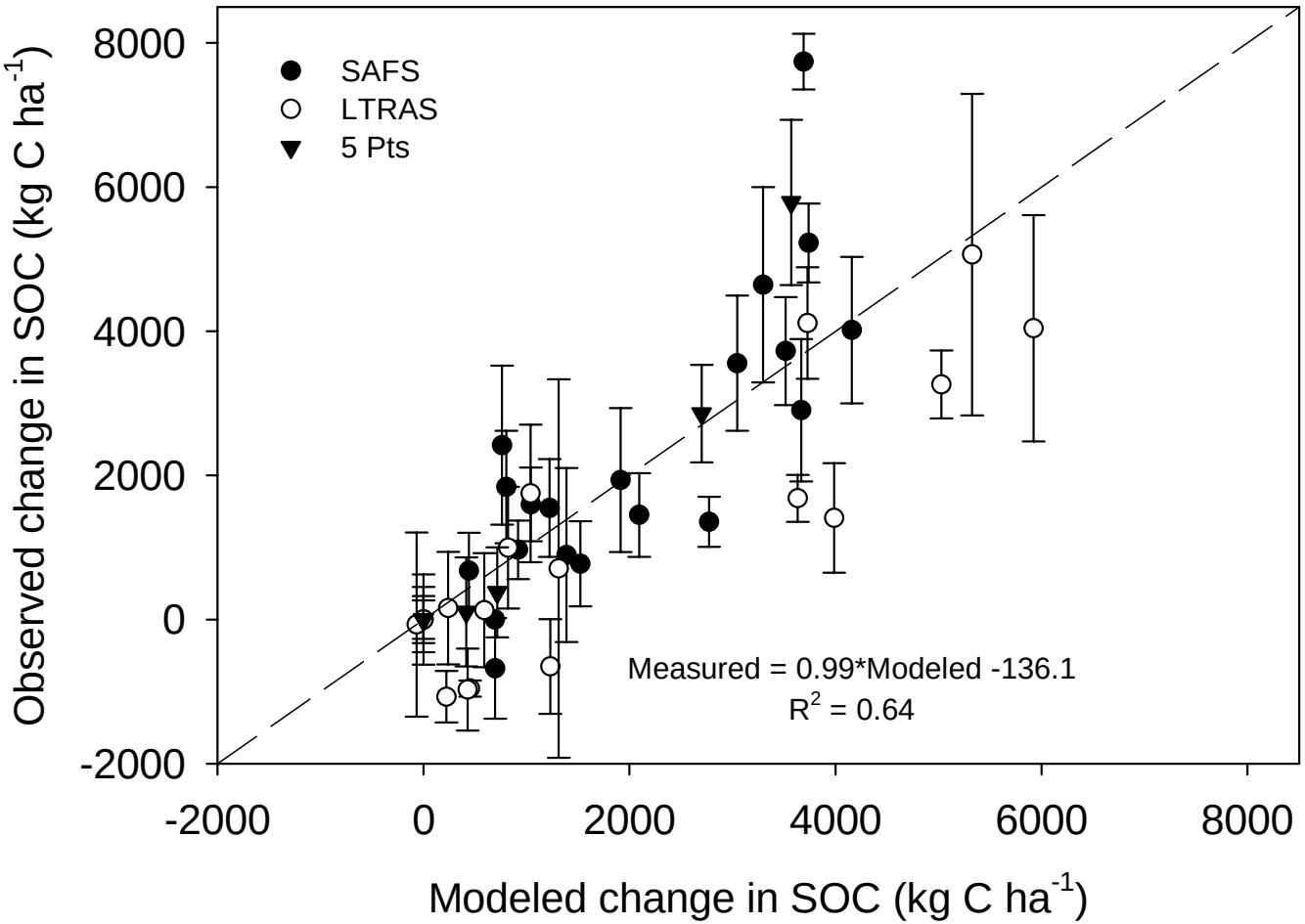
Yield Calibration

SAFS
LTRAS
5Pts

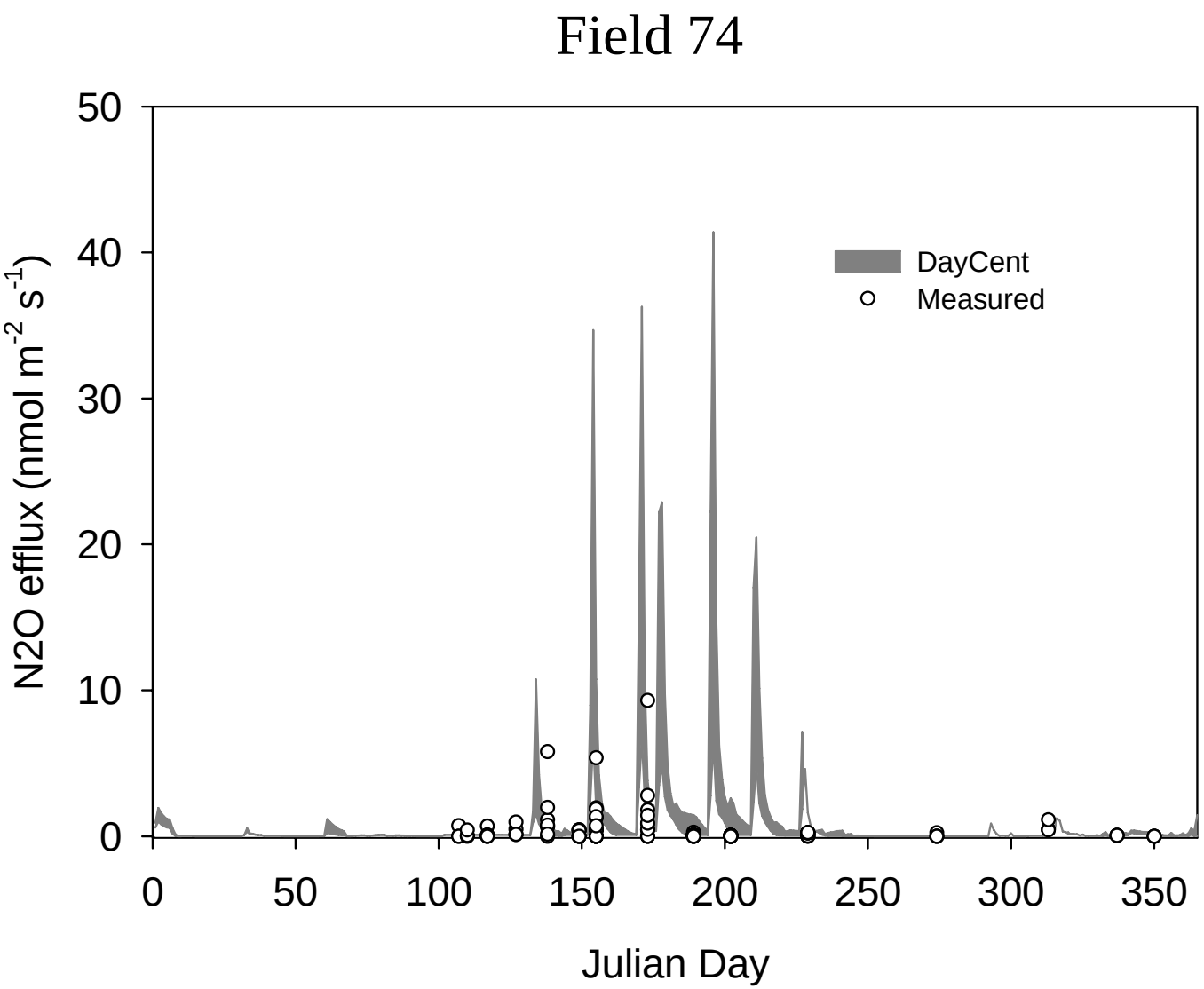
Based 3 long-term field experiments



SOC Calibration



N_2O Calibration



Greenhouse gas budget: Five Points

- Reduced tillage can cut fuel-CO_2 emissions by half
- Integration of reduced tillage with cover cropping!

		$tCO_2e\ ha^{-1}$			
		STNO	**STCC**	**CTNO**	**CTCC**
SOC					
	Cotton	-0.11	-2.42	-0.92	-4.20
	Tomato	-0.65	-2.53	-0.87	-3.71
N_2O	297				
	Cotton	1.62	1.04	1.33	0.80
	Tomato	1.69	1.63	1.36	1.17
CH_4	31				
	Cotton	-0.11	-0.12	-0.11	-0.11
	Tomato	-0.11	-0.11	-0.11	-0.11
Fuel-C					
	Cotton	0.51	0.57	0.25	0.27
	Tomato	0.63	0.85	0.30	0.34
SUM					
	Cotton	1.91	-0.93	0.54	-3.25
	Tomato	1.56	-0.17	0.68	-2.31
	system	**1.73**	**-0.55**	**0.61**	**-2.78**

Sustainable Agricultural Farming Systems Project

SUM	Conventional	Low Input
Bean	2.55	4.02
Corn	-0.06	-0.83
Saf	0.83	-1.16
Tom	3.46	2.32
system	**1.69**	**1.09**

Long Term Research Agricultural Systems Project

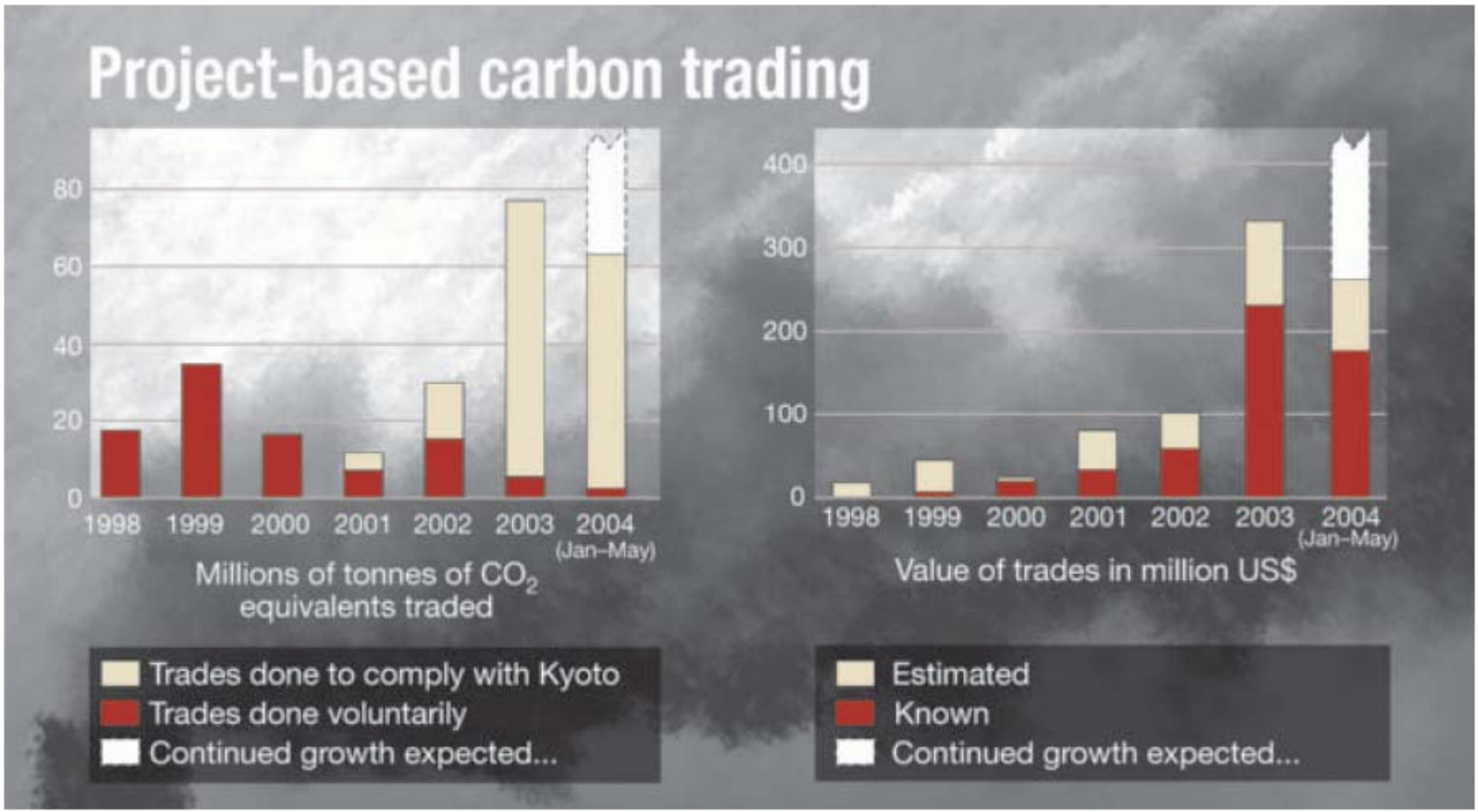
SUM	Conventional	Low Input	Organic
Corn	6.54	2.23	1.59
Tomato	4.46	2.54	-1.28
system	**5.50**	**2.39**	**0.15**

Low Input and Organic have quite some potential for mitigation!

Implementation

Slide courtesy
Paustian

Economics



Hopkins 2004

Cost to Mitigate

Five Points	STNO -> STCC	$35
	STNO -> CTNO	$0
	STNO -> CTCC	$35
SAFS	Conv -> Low Input	$18
LTRAS	Conv -> Low Input	$22
	Conv -> Organic	$0

European Market: $34/t$CO_2e$

Ancillary benefits of GHG mitigation

C sequestering practices

- Reduced erosion
- Improved soil quality and fertility
- Improved water quality
- Conservation Reserve lands - Wildlife habitat and biodiversity
- Biofuel production

N_2O emissions reductions

- Reduced leaching and ammonia volatilization
- Improved water quality (well nitrate, hypoxia, algae blooms)
- Less fertilizer waste

CH_4 emission reductions

- Improved water and air quality (manure handling, odors, runoff)

Conclusions

- Cover cropping, low input, reduced tillage and organic seem to have potential in California.

  What about manure, compost, drip irrigation and set-aside?

- Fuel C and N_2O are major player in greenhouse gas budgets; especially in California

  But measurements and modeling issues with N_2O

Conclusions

- Use of improved management practices show a significant technical potential for GHG mitigation, but agriculture is **only part** of the solution.

- Bundling' GHG mitigation with other environmental goals should increase benefit and cost-efficiency of agricultural GHG policies.