Land Surface Classification Opportunities

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Introduction

- Reliable estimates of surface heat fluxes require accurate classification of land surfaces.
- In agricultural regions, land surfaces are dynamic.
  - Bare soil, Green vegetation, Senesced vegetation
  - All classes present, but proportions change with time and space.
- HyspIRI will provide opportunities to improve surface classification by simultaneously acquiring VSWIR and thermal IR.

What is crop residue?

The portion of a crop that is left in the field after harvest.

- Crop residues on the soil surface:
  - Decrease soil erosion
  - Increase soil organic matter
  - Alter surface energy balance
    - Albedo and emissivity
- Soil tillage and biomass harvesting
  - Reduce residue cover

Current Methods of Measuring Crop Residue Cover

Line Point Transect

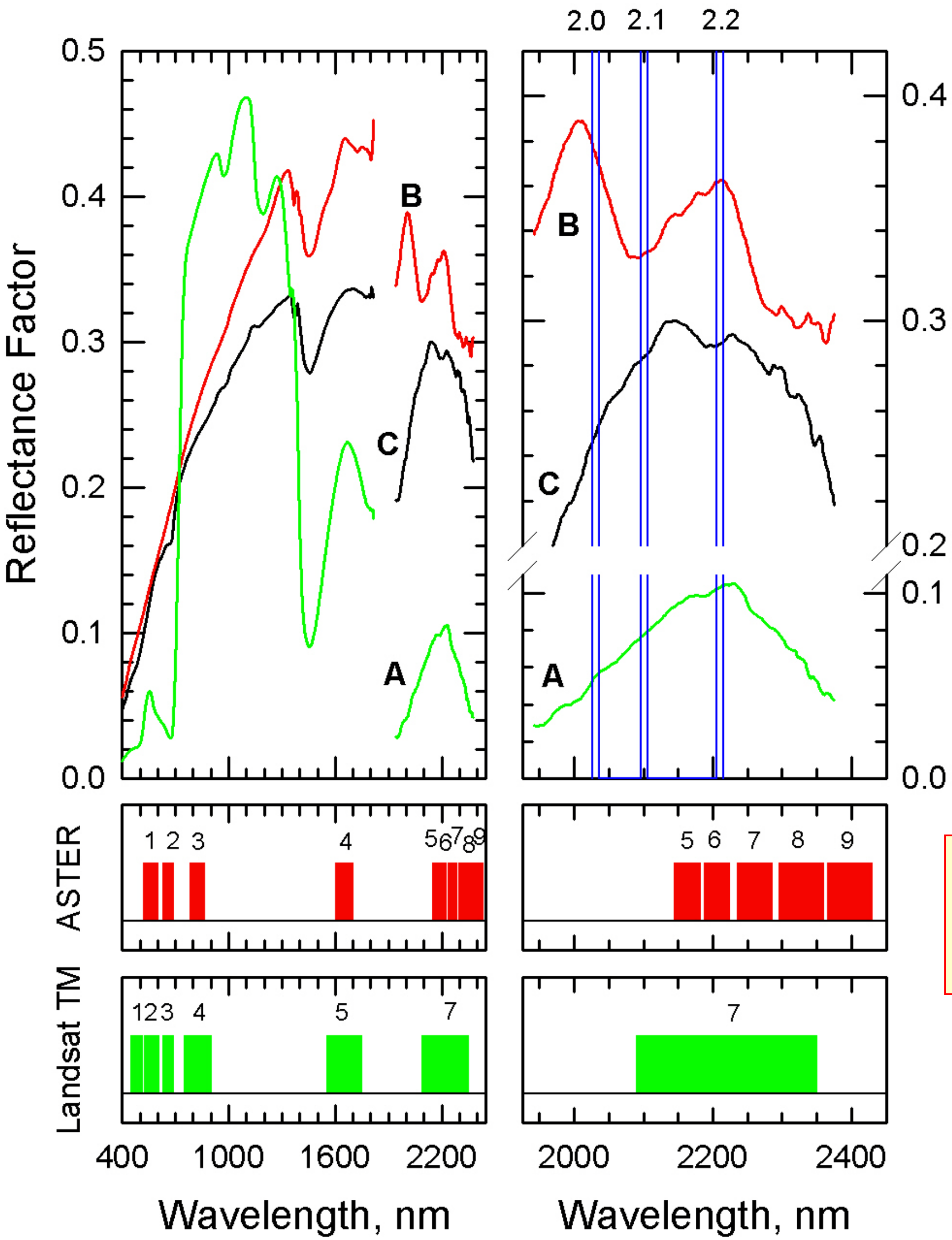
- Stretch Line-Point Transect across rows and count the number of markers that intersect residue.
- Accuracy depends on length of line, number of points, and size of residue pieces.

Windshield Survey

- Trained observers stop at intervals along a fixed route and assess fields on both sides of road.
- Errors due to subjective interpretation and limited observation of field conditions near the road.

Traditional methods of measuring crop residue cover are inadequate for many fields and large areas.

Reflectance Spectra



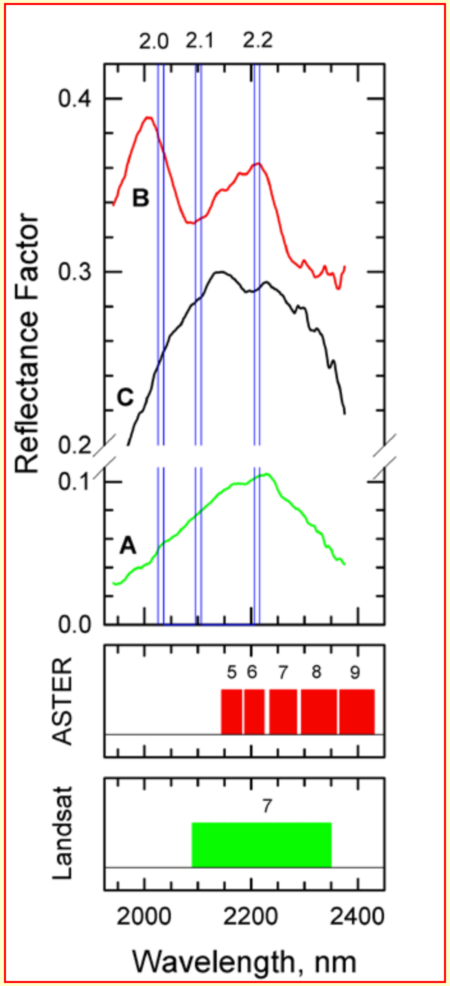
Corn residue

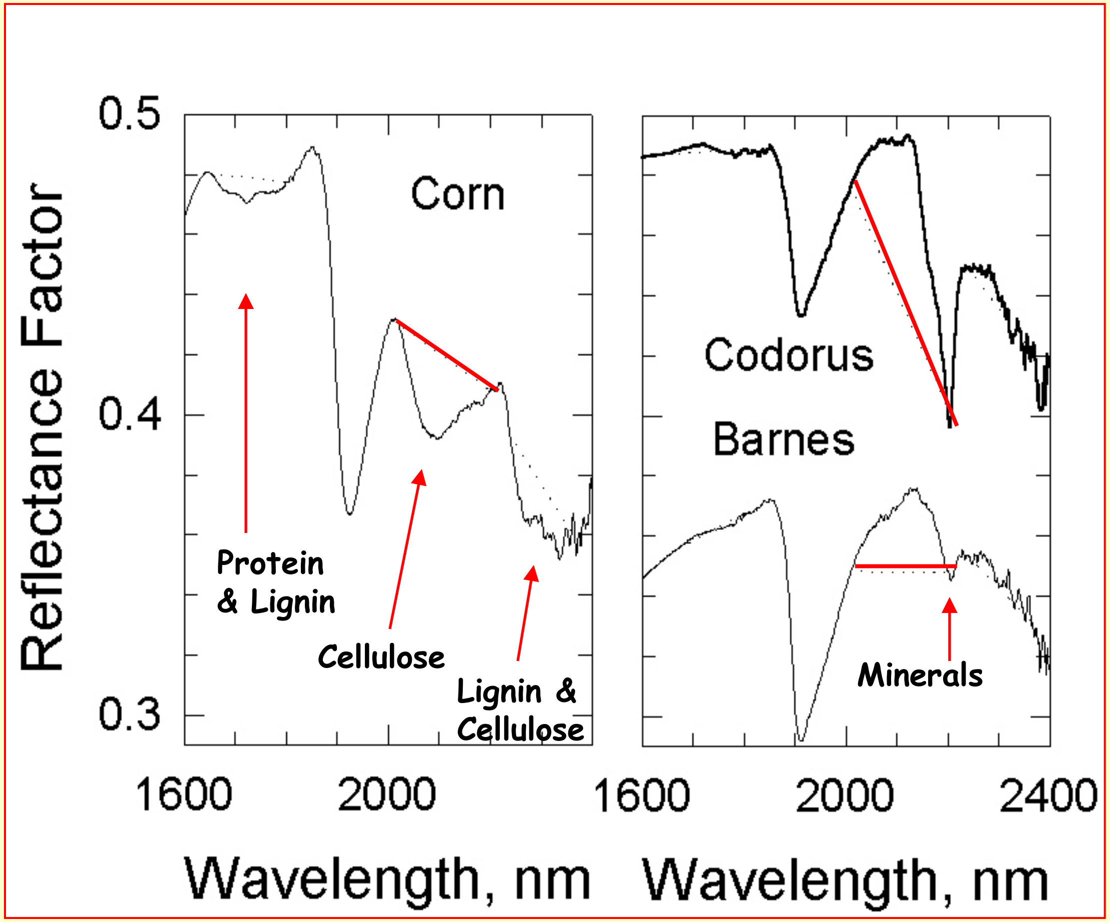
Bare soil

Green vegetation

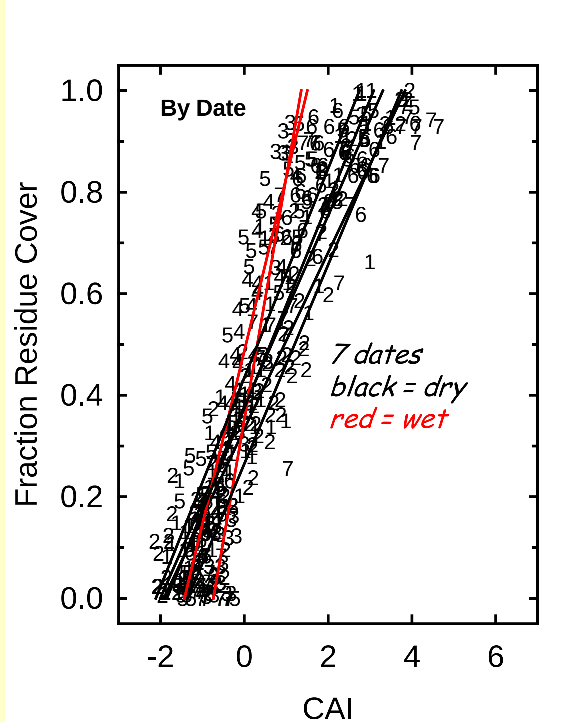
- Crop residues and soils have very similar spectral signatures in the 400-1100 nm wavelength region.

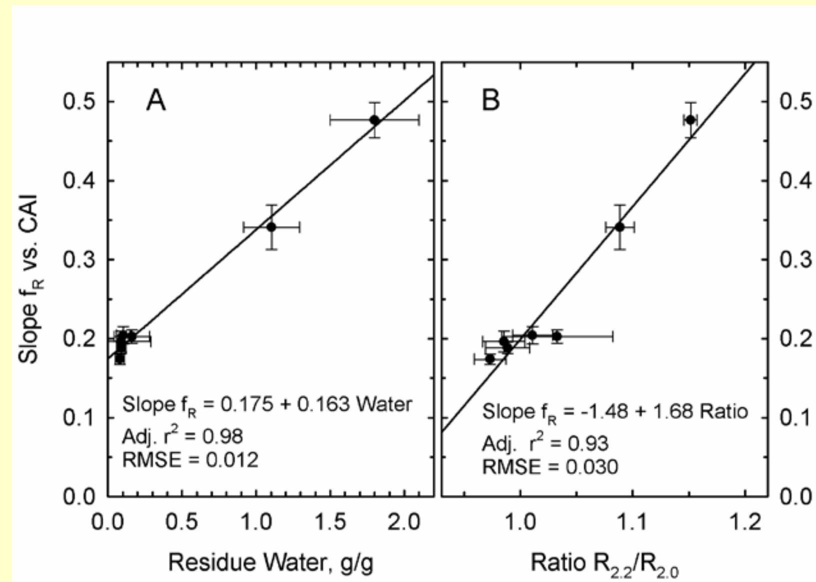
- Cellulose Absorption Index (CAI) is a measure of the relative depth of the absorption feature near 2100 nm.
- Other features are associated with protein, lignin, and minerals.





Basic Research: Lab & Field Reflectance Spectra





Cellulose Absorption Index

- CAI = 100 [0.5 (R_{2030} + R_{2210}) – R_{2100}]
- CAI measures the relative intensity of the absorption feature at 2100 nm.
- Crop residue cover is linearly related to CAI, but water in the scene attenuates the reflectance signal and changes the slope of relationship.
- A ratio index measured relative scene moisture and improved estimates of crop residue cover.

Daughtry and Hunt 2008. Remote Sensing Environment 112:1647-1657.

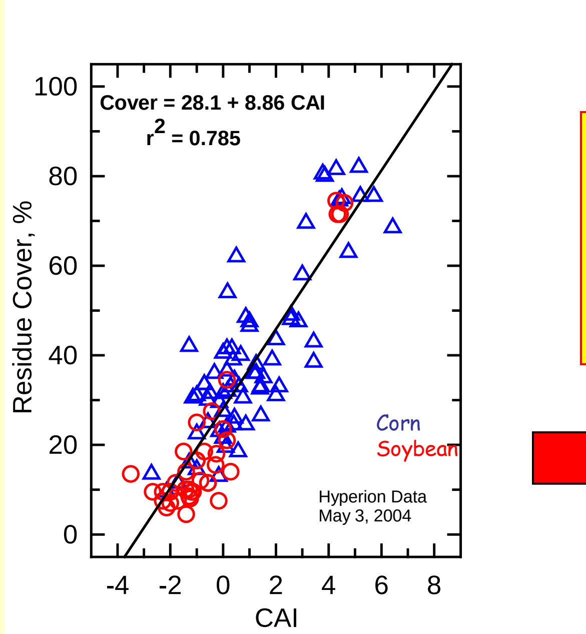
Scaling-up: Airborne & Satellite Imaging Spectrometer Data

EO-1 Hyperion
- 400-2500 nm
- ~10 nm bands
- 30 m pixels;

AVIRIS (NASA)
- 400-2450 nm
- ~10 nm bands
- 20 m pixels;

AISA Sensor (SpecTIR)
- 400-2450 nm
- ~5-10 nm bands
- 0.5 to 4 m pixels

Iowa 2004

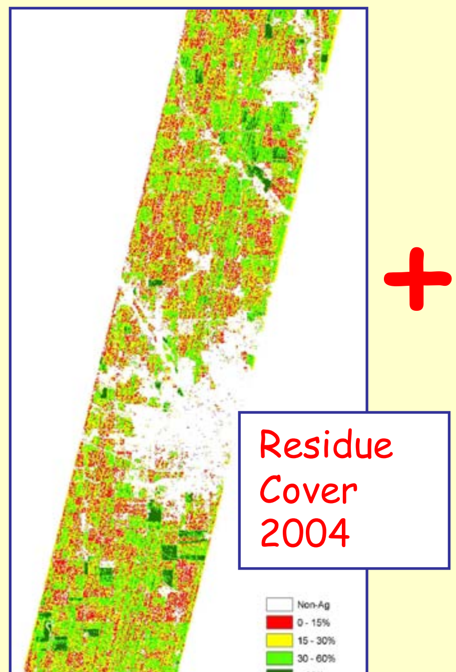


Slope of line is similar to ground-based (ASD) and aircraft (AVIRIS & AISA) data in MD, IN, and IA.

Residue cover was measured: May 10-12

Planting progress for May 9
(Iowa Crop & Weather, 2004)
Corn:
93% planted;39% emerged
Soybeans:
54% planted; 4% emerged

Hyperion Imagery was acquired: May 3



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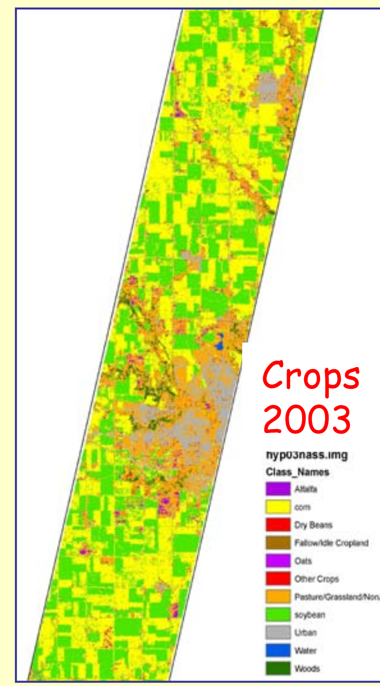


Residue Cover Category

Tillage Class = Intensive Reduced Conservation

	<15%	15-30%	>30%	Area
2003 Crop	%	%	%	ha
Corn	18	36	46	27,286
Soybean	35	40	25	20,832
Overall	**25**	**38**	**37**	**48,118**

May 3, 2004

Crop residue cover classes derived from Hyperion data using CAI, were combined with the Cropland Data Layer product from NASS.

	<15%	15-30%	>30%	Area
2004 Crop	%	%	%	ha
Corn	7	38	55	35,034
Soybean	3	21	76	25,261
Overall	**5**	**31**	**64**	**60,295**

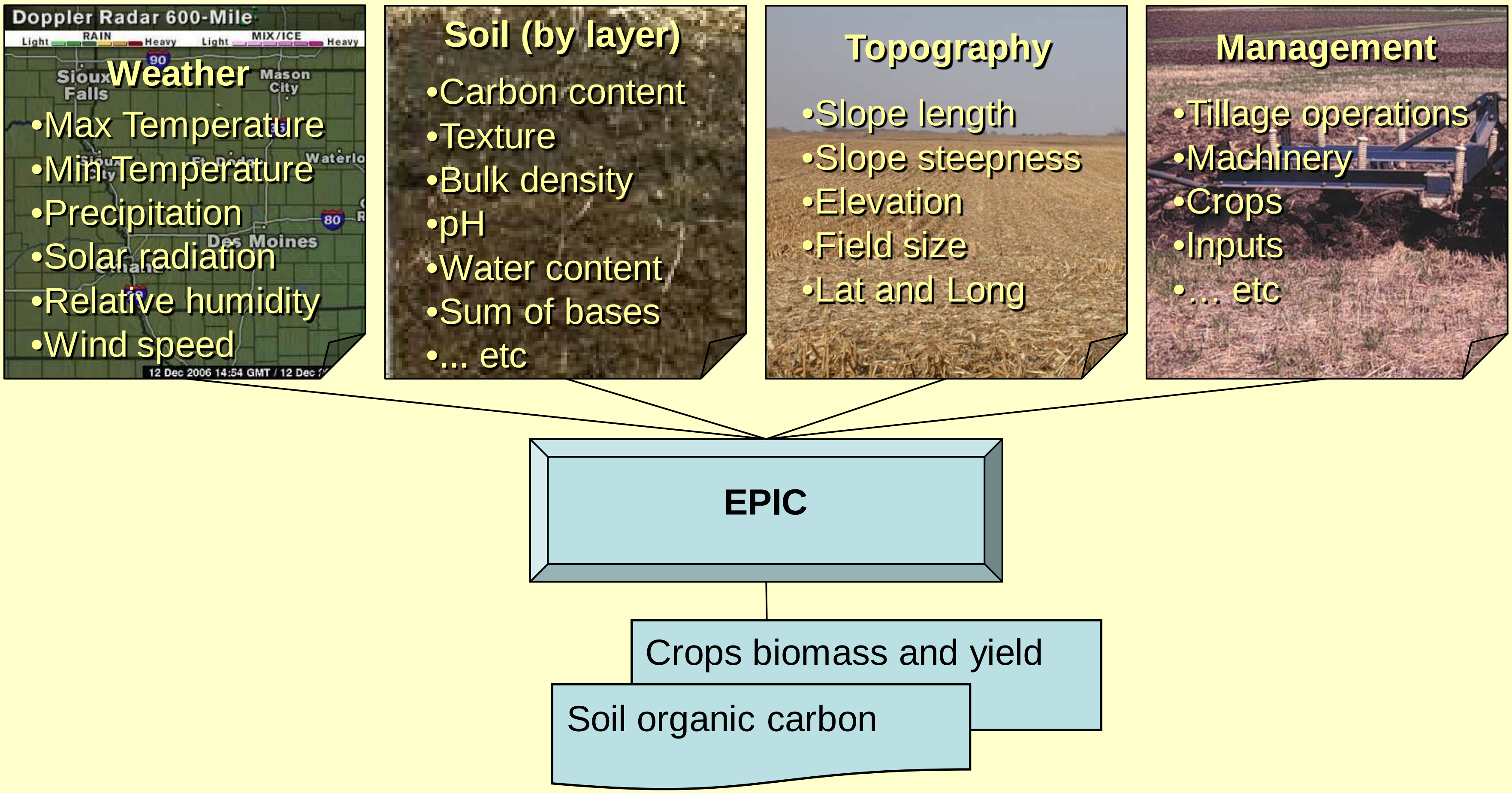
May 22, 2005

- Previous crop and its biomass (yield) determine the potential (maximum) crop residue cover.
- Tillage practices (intensity) and/or biomass harvesting determine the actual crop residue cover.

- Weather at planting influences tillage intensity.
  - 2004: warm, dry = more intense tillage
  - 2005: cool, wet = less intense tillage

The Environmental Policy Integrated Climate (EPIC) model was used to predict the long-term impacts of management practices on crop yields and soil organic carbon (SOC) across the US Corn Belt.

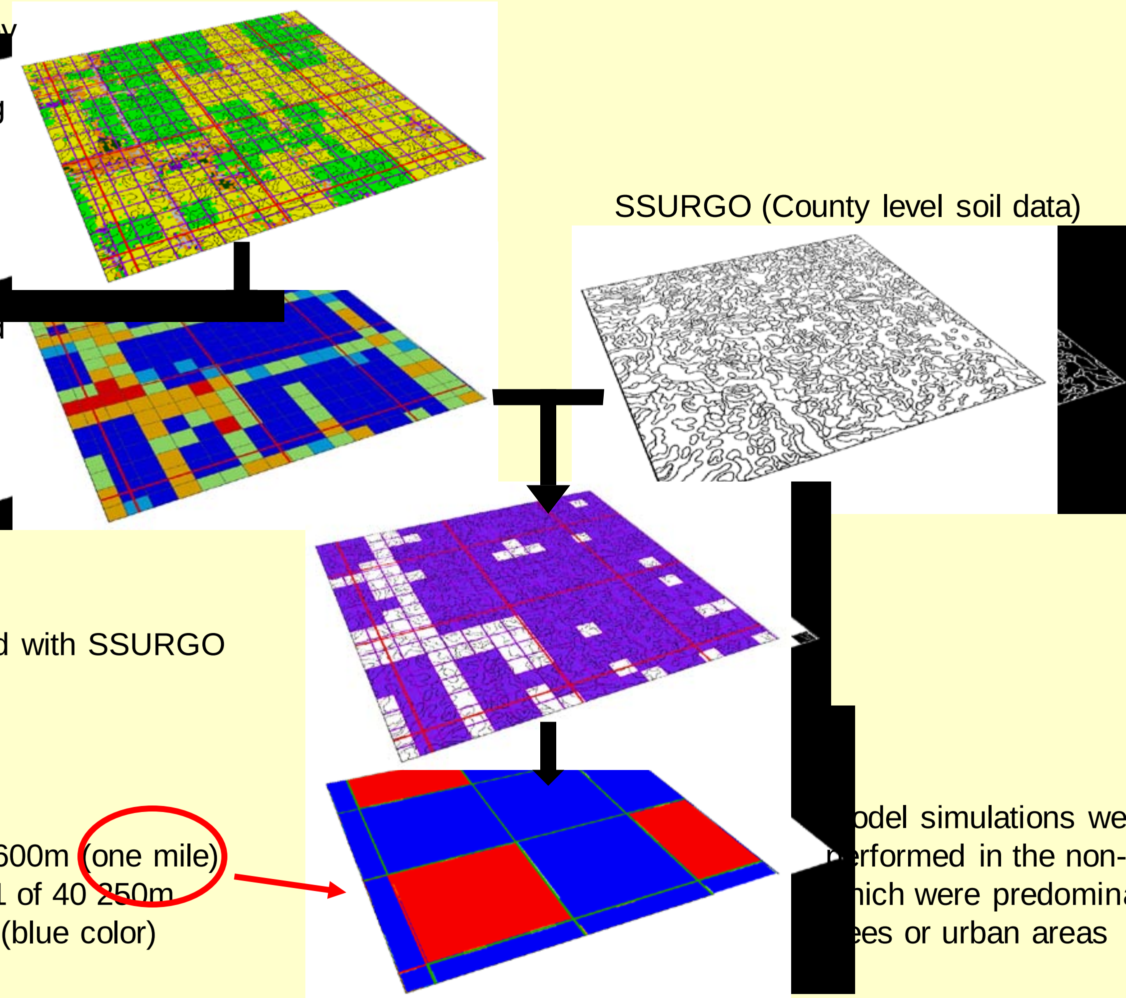
http://www.public.iastate.edu/~tdc/i_epic_main.html



Preparation of the Database

Crop classification developed by the USDA-Nation[illegible]ultural Statistics Service (NASS) using 30m pixels Lansa[illegible] TM imagery

SSURGO (County level soil data)



NASS crop class[illegible]n aggregated to 250m pixels, and those with >90% co[illegible]-soybean masked (blue color)

Corn-soybean mask intercepted with SSURGO

Statistics were performed on 1600m (one mile) pixels that contained at least 21 of 40 250m corn-soybean/SSURGO pixels (blue color)

[illegible]odel simulations were not [illegible]erformed in the non-crop areas, [illegible]hich were predominantly grass, [illegible]ees or urban areas

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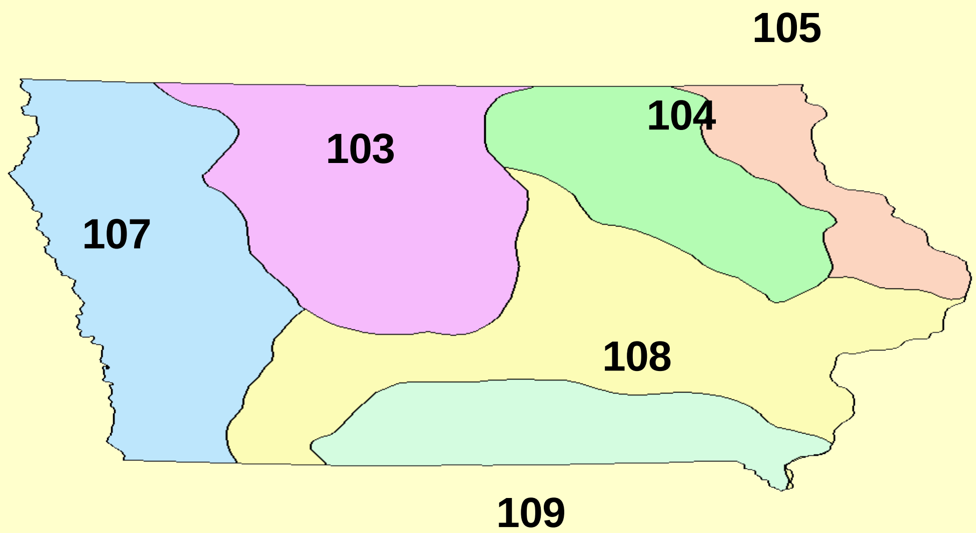
Simulated Changes in Soil Organic C (1980-2019)



- Climate, physiography, soil, and tillage practices affects the magnitude of change in SOC.

Simulated Changes in Soil Organic C (1980-2019)

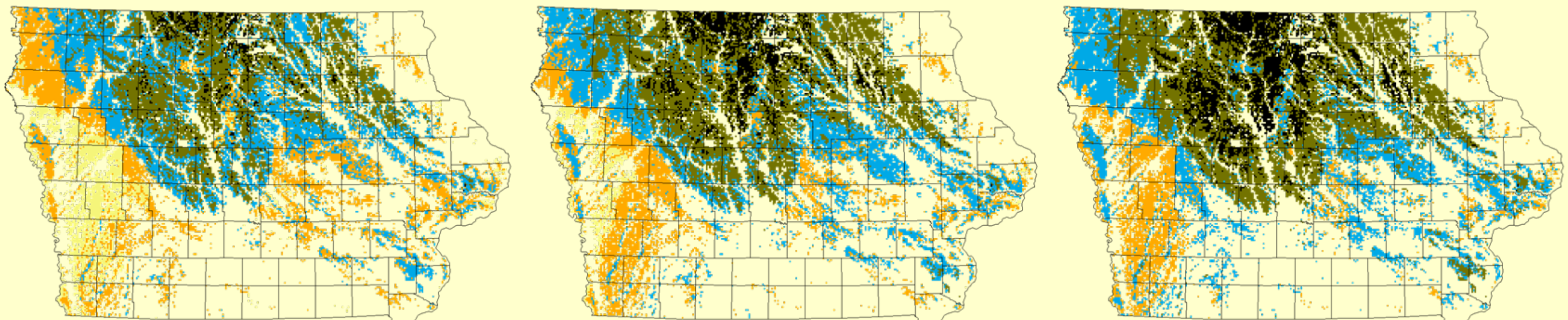
Major Land Resource Area	Tillage System		
	Conventional	Reduced	No Till
	-- Simulated SOC Changes (Mg ha^{-1}) --		
103 Central Iowa and Minnesota Till Prairies	-7.35	-0.79	14.79
104 Eastern Iowa and Minnesota Till Prairies	-8.48	-2.42	11.66
105 Northern Mississippi Valley Loess Hills	-8.49	0.08	14.33
107 Iowa and Missouri Deep Loess Hills	-4.67	3.52	18.35
108 Illinois and Iowa Deep Loess and Drift	-5.74	1.06	15.88
109 Iowa and Missouri Heavy Till Plain	-6.37	0.02	14.37

Causarano, H.J., P.C. Doraiswamy, G.W. McCarty, J.L. Hatfield, S. Milak, and A.J. Stern. 2008. EPIC modeling of soil organic carbon sequestration in croplands of Iowa. . J. Environmental Quality, 37: 1345-1353.

Temporal Changes in Soil Organic C Stocks

SOC (Mg/ha) in the top 20 cm

18.4 38.7 56.1 73.5 90.8 108.0



1980	2000	2019
100% Conventional Tillage	**14% Conventional Tillage**	**3% Conventional Tillage**
	25% Reduced Tillage	**19% Reduced Tillage**
	61% No Tillage	**78% No Tillage**
451 Tg C	**501 Tg C**	**539 Tg C**
		+88 Tg

Simulations conducted at 2.56 km^2 resolution in the crop areas for a 50-year period.
Model was initiated in 1970 when the NRCS STATSGO data were developed.

Causarano, H.J., P.C. Doraiswamy, G.W. McCarty, J.L. Hatfield, S. Milak, and A.J. Stern. 2008. EPIC modeling of soil organic carbon sequestration in croplands of Iowa. . J. Environmental Quality, 37: 1345-1353.

Conclusions

- Relationships developed with ground-based spectroradiometers (ASD) are extendable to airborne (AISA & AVIRIS) and space-borne (Hyperion & ASTER) sensors.

- Maps and inventories of crop residue cover and soil tillage practices across agricultural landscapes are possible.

- Estimates of surface energy balance can be improved by better characterization of the surface.