Role of Satellite Based Remote Sensing for Measuring, Monitoring and Verifying Ag GHG Emissions

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Setting the stage...

- Spaceborne RS can be used to estimate GHG emissions...inversion of atmospheric trace gas measurements (e.g. SCIAMACHY, etc)
  - Extremely useful for atmospheric chemistry, inversion modeling and reconciling bottom up regional modeling, etc.
- However, limited use of agricultural GHG MRV due to spatial resolution (e.g. 10s of KMs). We need field level estimates.
- So... focus on role of remote sensing for verifying field management practices or outcomes (e.g. increase in productivity).
Role of Remote Sensing

- Document field eligibility: Rice Protocol Examples
  - Rice was grown at least 3 of the past 5 years.
  - Fields have been water seeded

- Baseline management:
  - General plant/harvest dates (corroborate project documents)
  - Rice water management: e.g. Winter Flooding

- Project monitoring
  - Rice field was drill seeded
  - Rice AWD (on-going RS research)
RS Case Studies: 3 examples

• Tillage Monitoring
  • Mapping crop residue
  • Categorization of tillage classes (Conventional, reduced or no-till)

• Grassland/rangeland/pasture management
  • Mapping rangeland productivity
  • Differentiating weather versus management induced changes in productivity

• Rice Monitoring
  • Eligibility
  • Water management
Mapping tillage practices over large areas
Summary

• We have developed a prototype OpTIS to:
  • map crop residue cover and winter cover crops
  • across wide regions
  • using satellite data combined with other information

• Working with the Conservation Technology Information Center (CTIC) and the Univ. of Toledo, we have demonstrated that the system is feasible

• We seek public/private funds to demonstrate the system over wide regions.
  • have pledged support from Monsanto, John Deere, et al.
  • seeking NASA and USDA support
Our approach
Convert satellite data to crop residue cover estimates

April 19, 2012 Landsat 7 image
(R-SWIR1, G-NIR, B-Red)

Estimate of crop residue cover
(Brown: 0%; Yellow: 40%; Green: 80%)

Livingston County example (Streator, IL)
Our approach

Estimate tillage practice from residue cover over large areas

Estimate of crop residue cover
(Brown: 0%; Yellow: 40%; Green: 80%)

Field-level Tillage Practice
(Brown: CT; Yellow: RT; Green: NT)

Livingston County example (Streator, IL)
Wide-area application

Applied test sites in Indiana, Illinois, Georgia, and Alberta
Documenting effects of management on rangeland productivity.
Estimates of vegetation productivity and total cover from MODIS

- Estimates of productivity and total vegetation cover (green + senescent) are derived from MODIS observations over the western rangelands.
Separating effects of management from weather-driven effects

- From upper left: MODIS derived canopy cover for Arizona with the Common Resource Area subdivisions overlaid; Annual average precipitation in mm; Management units, either allotments, ranch boundaries, or 8 digit HUCs (watersheds); Difference between observed and expected canopy cover by management unit.
Separating effects of management from weather-driven effects

- A comparison of 50 EQIP applicants overlain on the statewide distribution of observed cover to expected cover. Observed cover is derived from MODIS observations. Expected cover is calculated from a modeled relationship between precipitation and observed cover.
Monitoring rice practices over large areas

Goal to reduce costs for project development and verification

Discussed in previous C-AGG meetings
May 12, 2008
Dark Areas are rice field
Flooded for seeding

August 24, 2008
Bright green areas are rice fields

January 31, 2009
Dark Areas are fields that are flooded
Farm field-scale monitoring products to support V protocol
Monitoring over 6000 separate fields annually

Active 2012-2013 paddies
Winter Flood vs. No Winter Flood
Winter Flood Uncertainty

- Green: Active
- Brown: Dormant
- Blue: Flooded
- Gray: Not Flooded
- Low
- High

Derived from NDVI dynamic range
CART driven by indices
Bootstrap out of sample

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Mapping Rice Planting Dates
Take Home Messages

• RS can be used to map crop types with high accuracies (See NASS work)
• Map management information: plant/harvest dates, tillage practices, rice flooding
• Map productivity: separate weather driven variability from management
• Provides a synoptic, large area assessment
• Reduce costs for verification
• Not perfect, needs to be used in a risk management framework by developers and verifiers…