

Comparison of Methods for Remote Sensing of Plant Growth and Nutrient Management

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Remote Sensing Platforms

Satellite



Wide coverage
Excellent sensors
Low spatial/temporal
Cloud cover

Aircraft



Small coverage
Wide variety of sensors
High spatial/temporal
Highest cost per area

Radio-controlled aircraft



Smallest coverage
Few sensors available
High spatial/temporal
Very low cost/quality

Can it work? Is it good enough?

Radio-Controlled Model Platforms



| Ease of Use | Takeoff/Landing | Wind | Distance | Failure |
|-------------|-----------------|------|----------|---------|
| Easy | Vertical | None | Least | Sink |

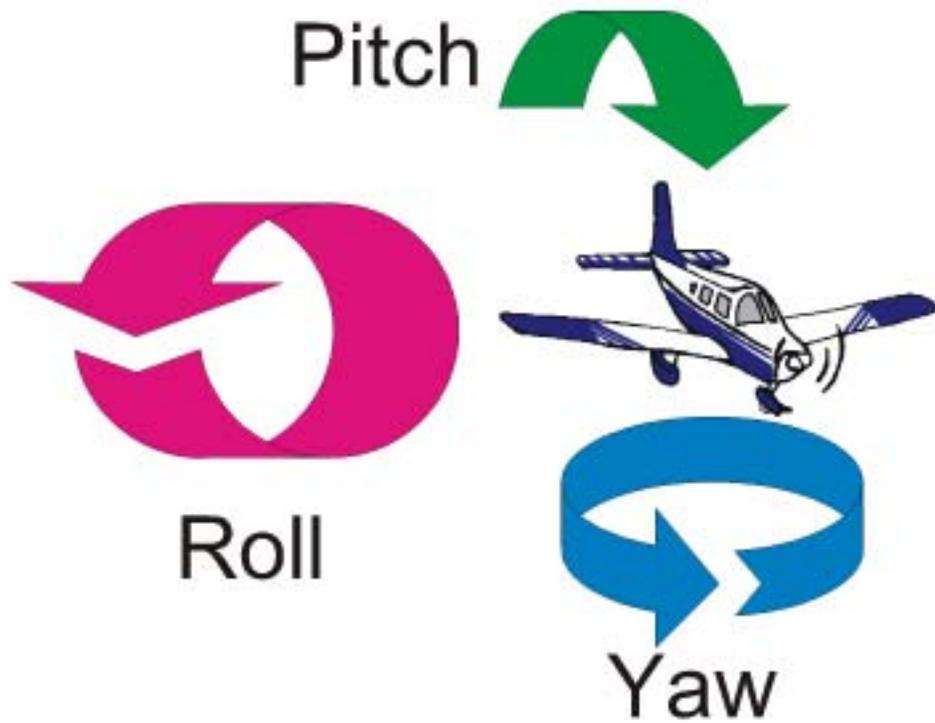


| | | | | |
|--------|--------|----------|------|-------|
| Middle | Runway | Moderate | Most | Glide |
|--------|--------|----------|------|-------|



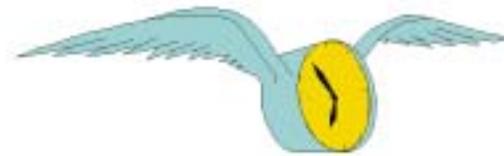
| | | | | |
|------|----------|-------|--------|----------|
| Hard | Vertical | Light | Middle | Crash(?) |
|------|----------|-------|--------|----------|

Problem: Aircraft motion due to wind



Worse problem!

Problem: Short flight time

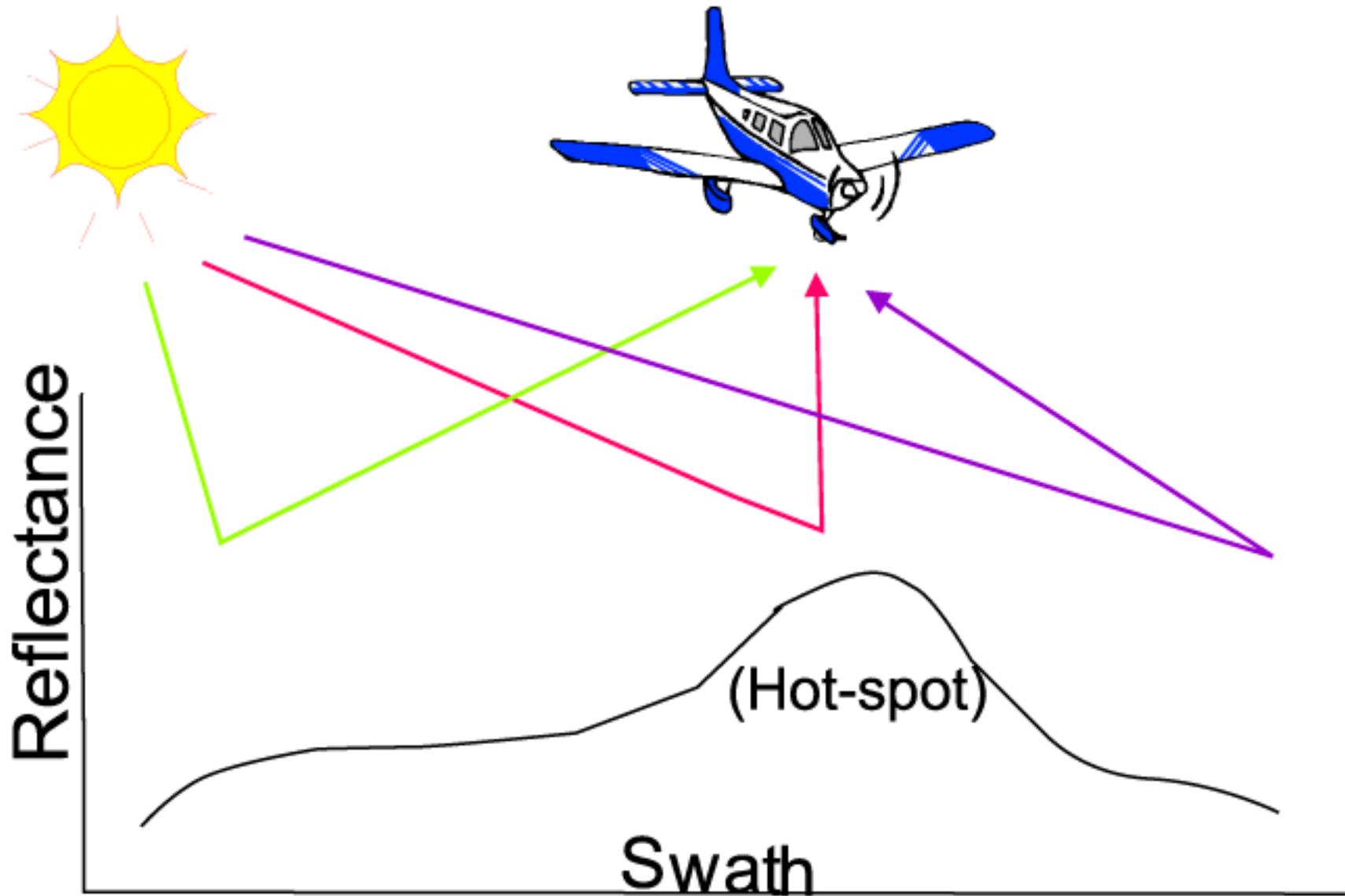


Worse problem: flight failure



Problem: Anisotropy

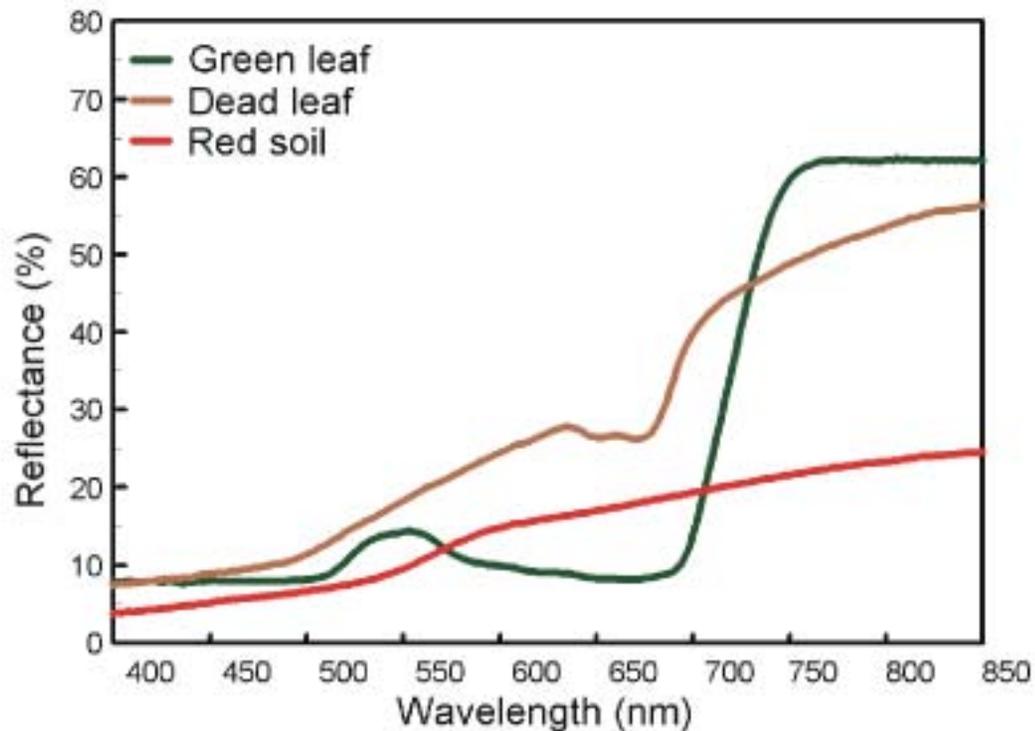
Worse problem: Wavelength dependent



Vegetation Indices

Enhance difference between plant and soil

Correct somewhat for solar/atmosphere effects



NDVI (Rouse et al. 1973)

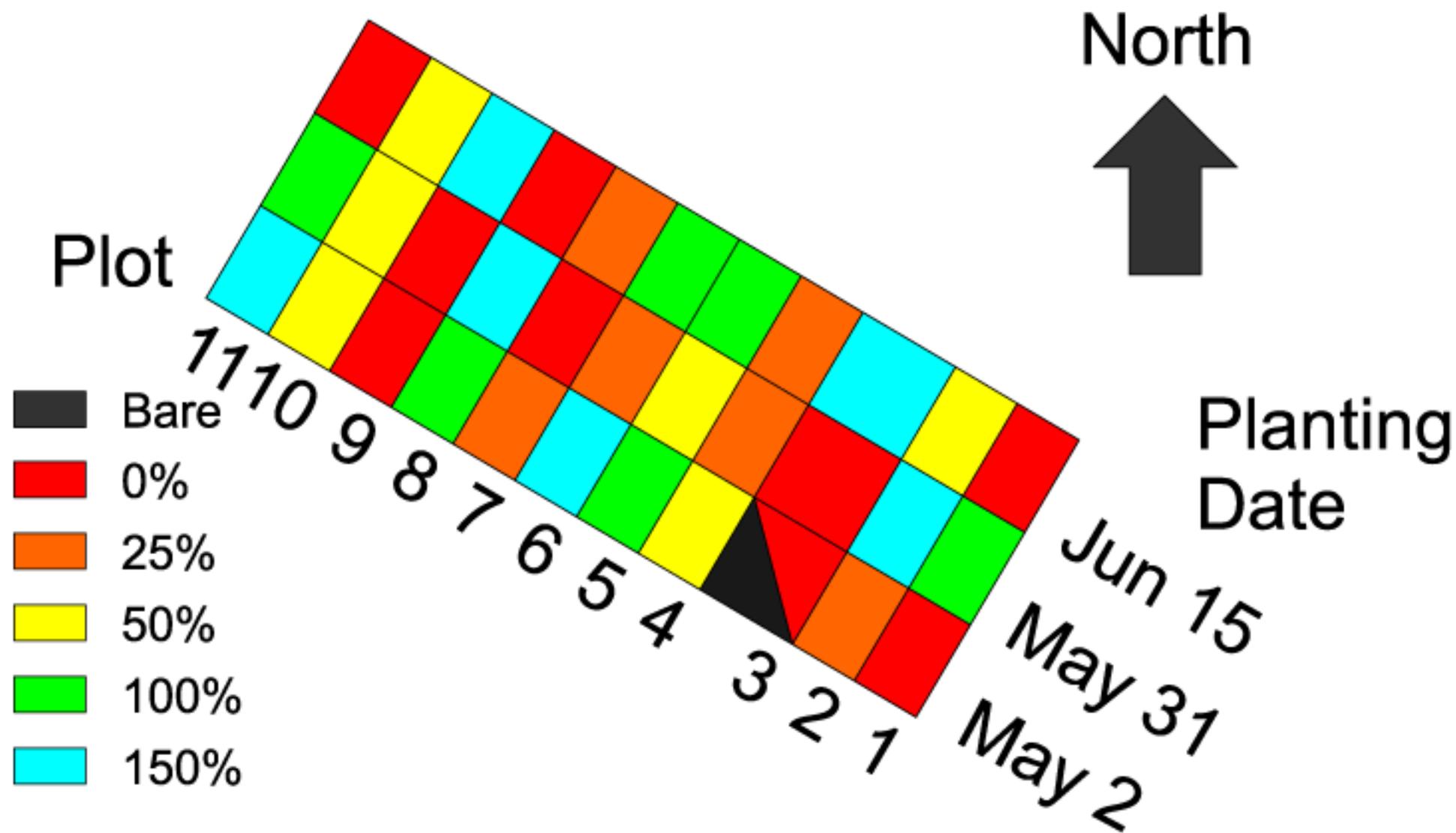
Normalized Difference
Vegetation Index

$$(NIR - Red)/(NIR + Red)$$

MCARI (Kim 1994)

Modified Chlorophyll
Absorption Reflectance
Index

$$[(R_{700} - R_{670}) - 0.2 (R_{700} - R_{550})] \\ * (R_{700}/R_{670})$$



Nitrogen Application (% of normal)

Beltsville Agricultural Research Center
 Field 5-21, Zea mays

AISA Image Acquisition



July 7, 2001

34 Bands (450 to 900 nm)
2.5 m pixels

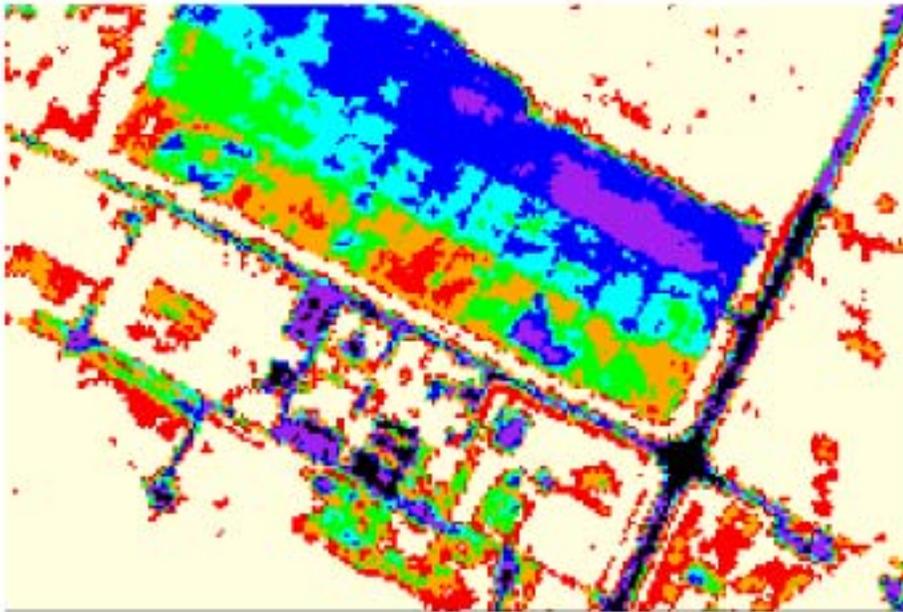


August 22, 2001

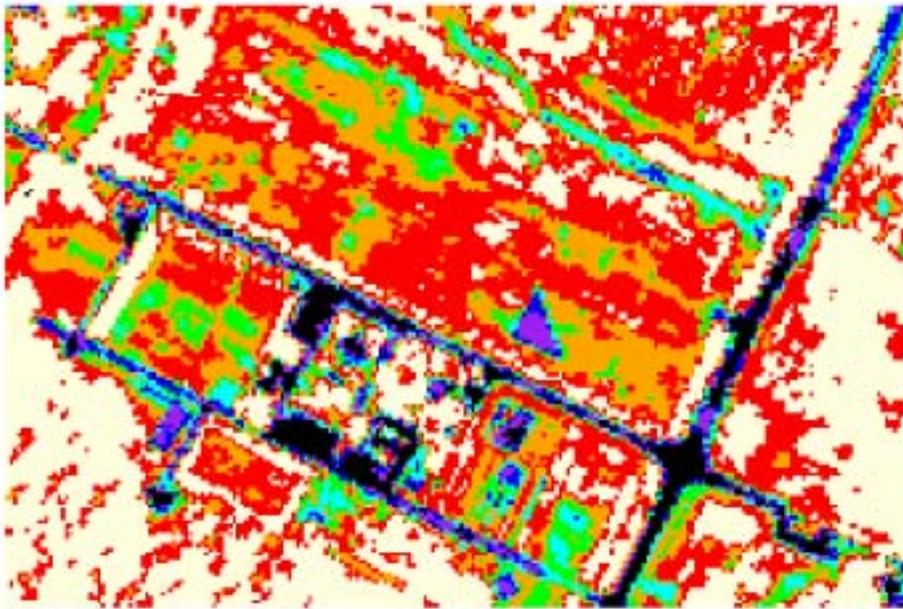
AISA NDVI

$(\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$

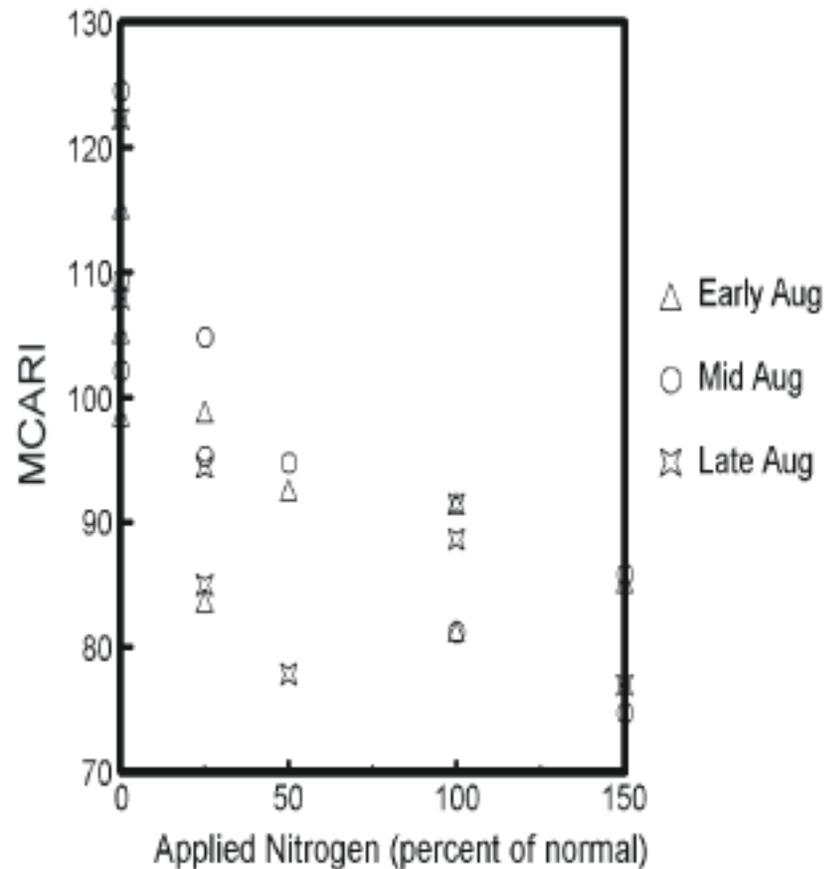
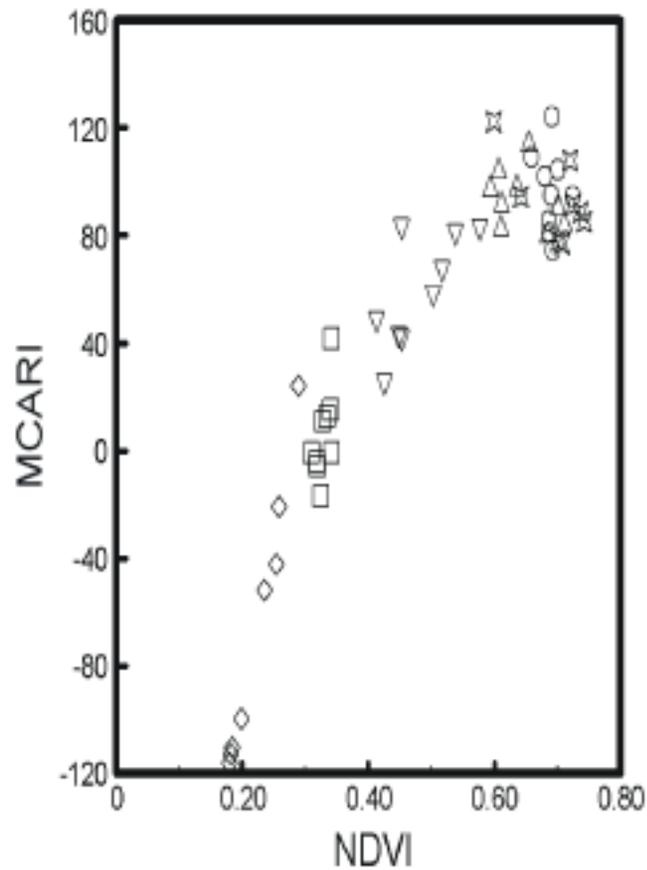
July 7, 2001



August 22, 2001



Vegetation indices from AISA for different applied nitrogen



Radio-controlled model aircraft

Altitude: 100-150 m agl

Speed: 40-60 km/h

Frame every second

Frame overlap about 50%



Hanger 9 Xtra Easy

Color Infrared Air Photographs

Olympus Automatic Camera

Wide-angle lens f28

Kodak EIR Color Infrared film

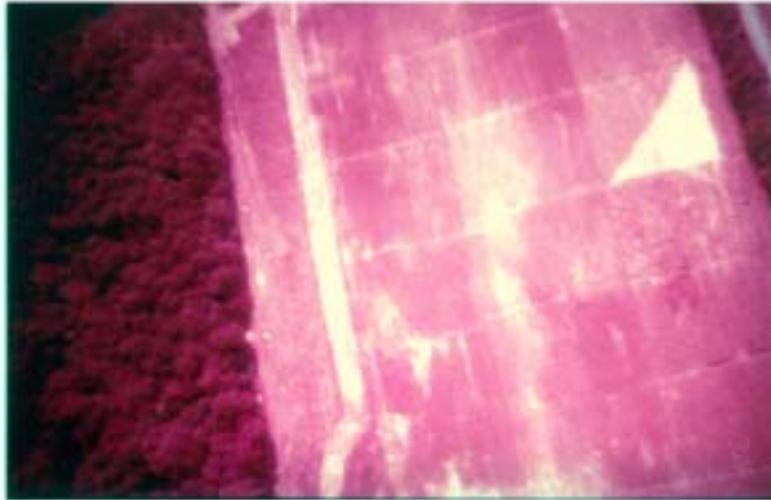
Yellow cellophane filter

E6 processing (adjustment
for overexposure)

Slides scanned in at
1600 lines/inch

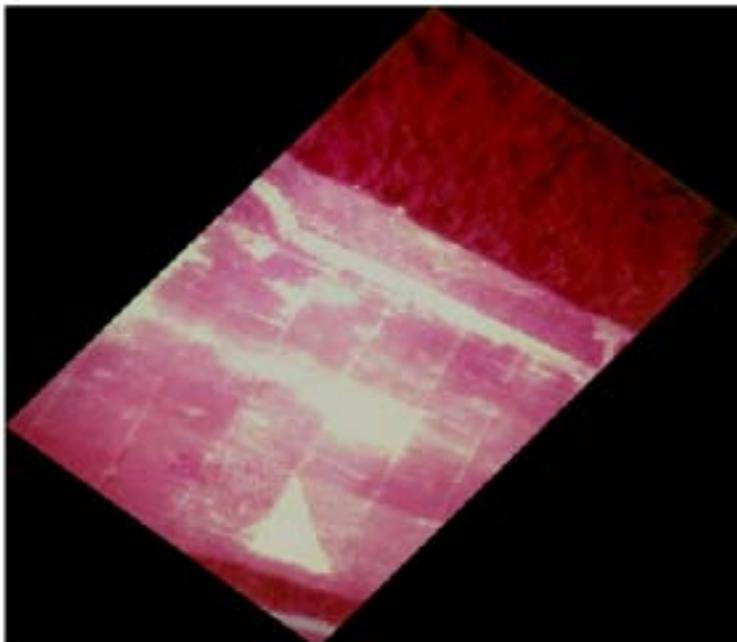


RCMA Air Photo Processing



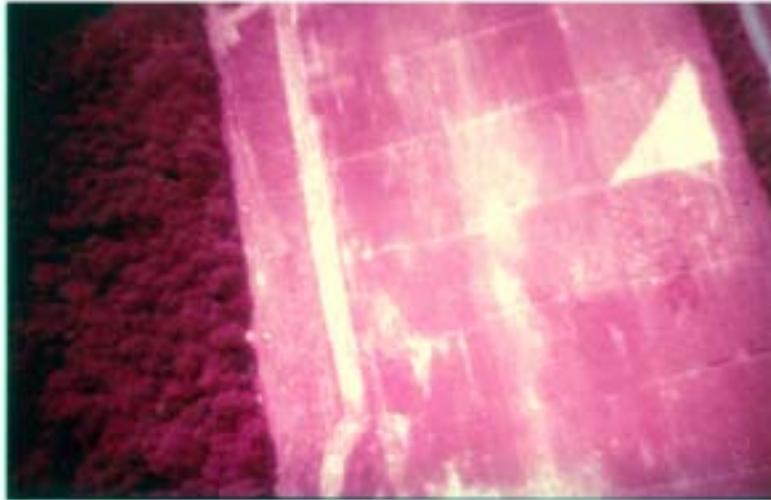
Camera Resolution
~ 20 cm/130 m agl

Scanned slide
~55 cm pixels



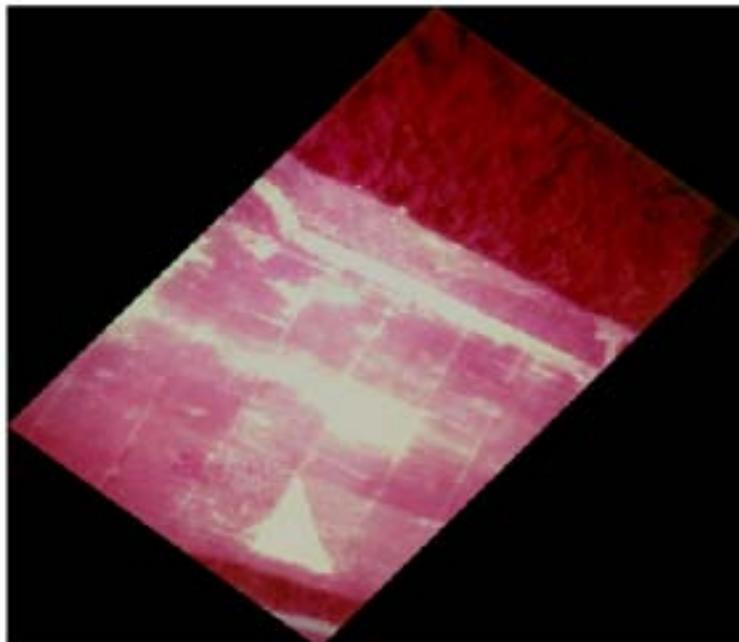
Ground control points
and geocorrection

RCMA Air Photo Processing



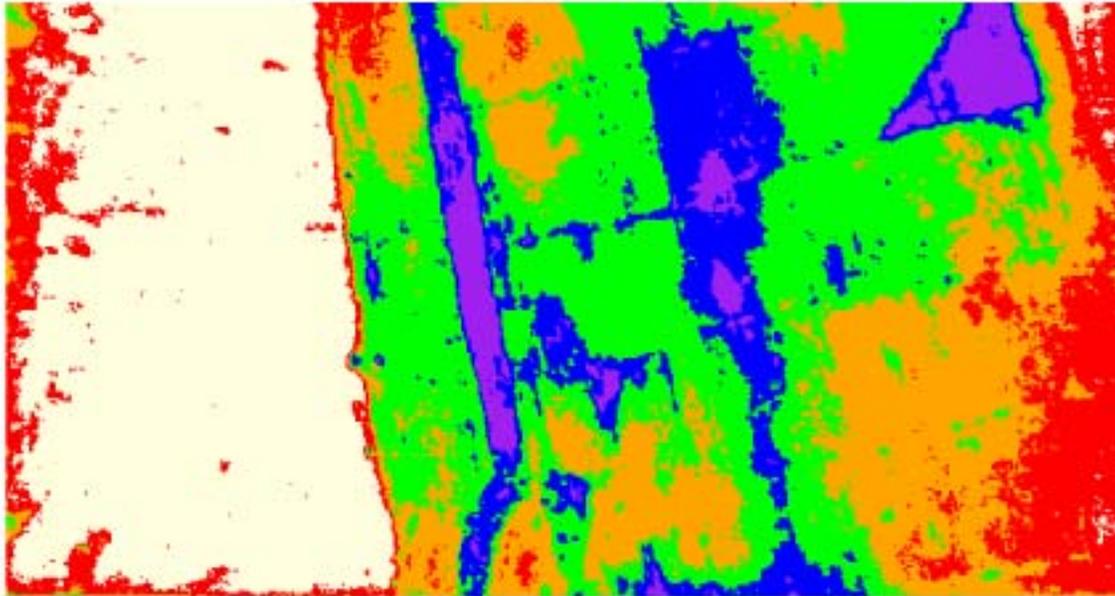
Camera Resolution
~ 20 cm/130 m agl

Scanned slide
~55 cm pixels



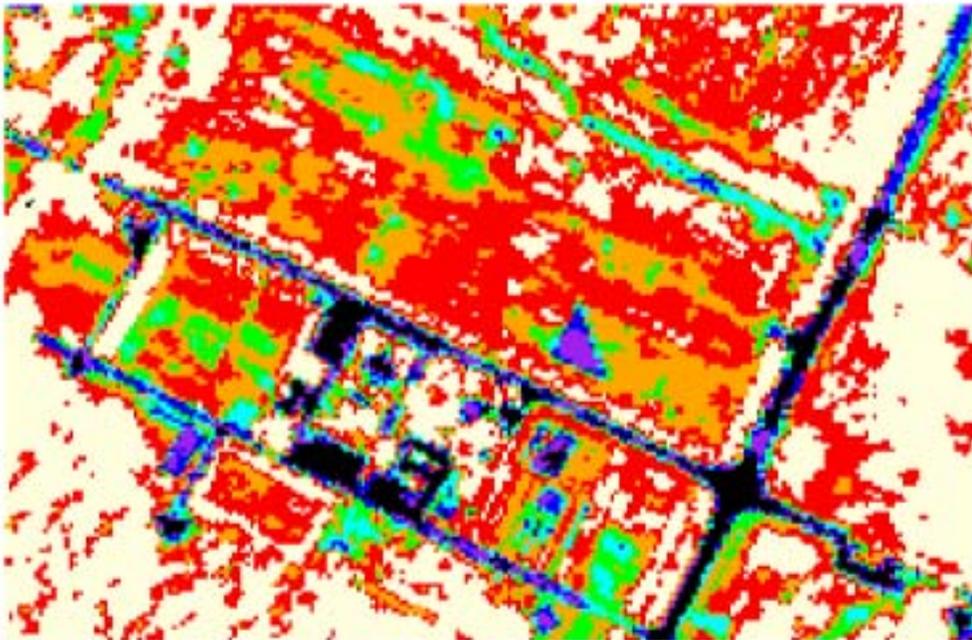
Ground control points
and geocorrection

Comparison of RCMA and AISA NDVI



RCMA CIR Photo

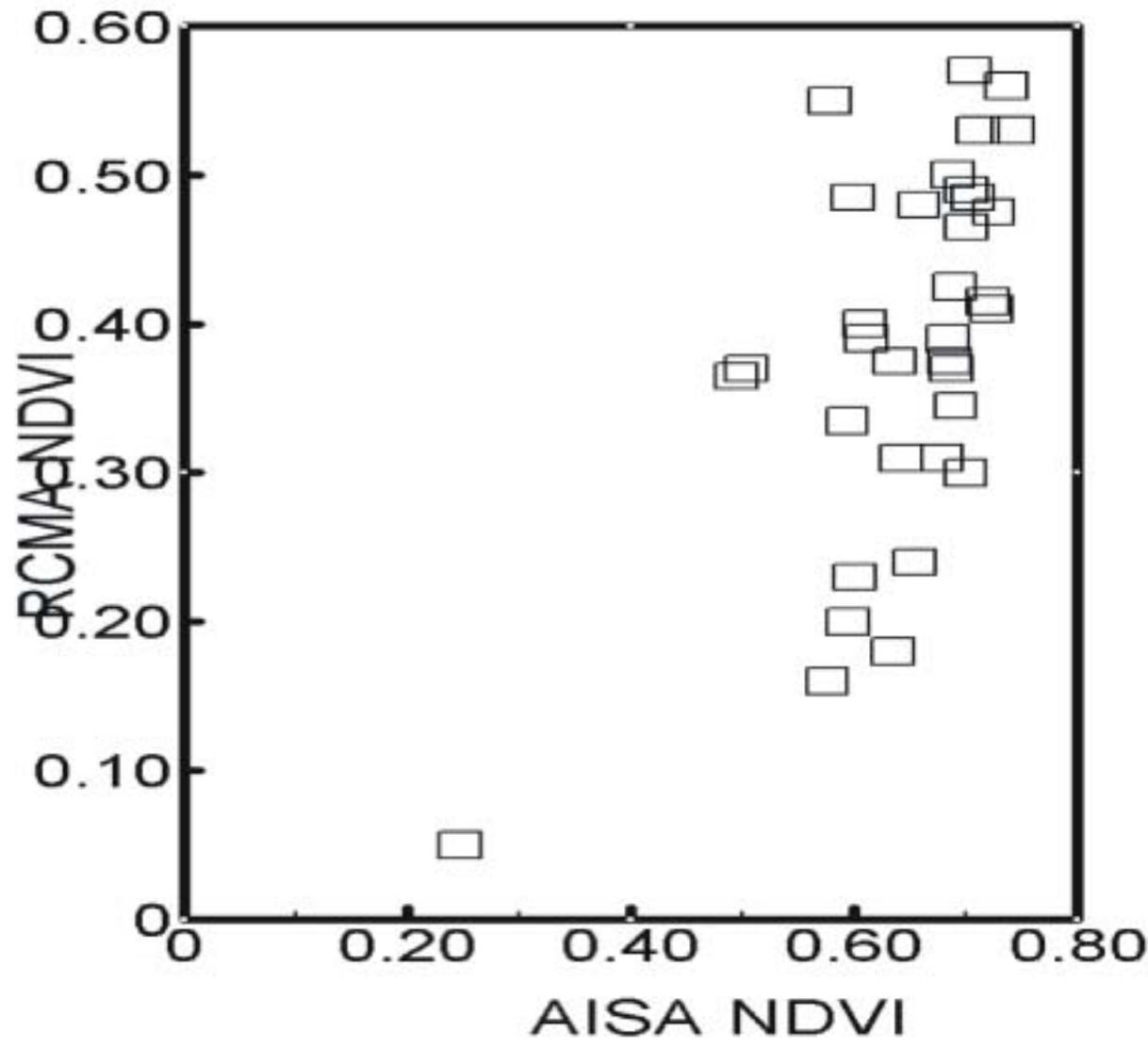
August 29, 2001



AISA Narrow bands

August 22, 2001

Comparison of NDVI from AISA and Radio-controlled Model Aircraft

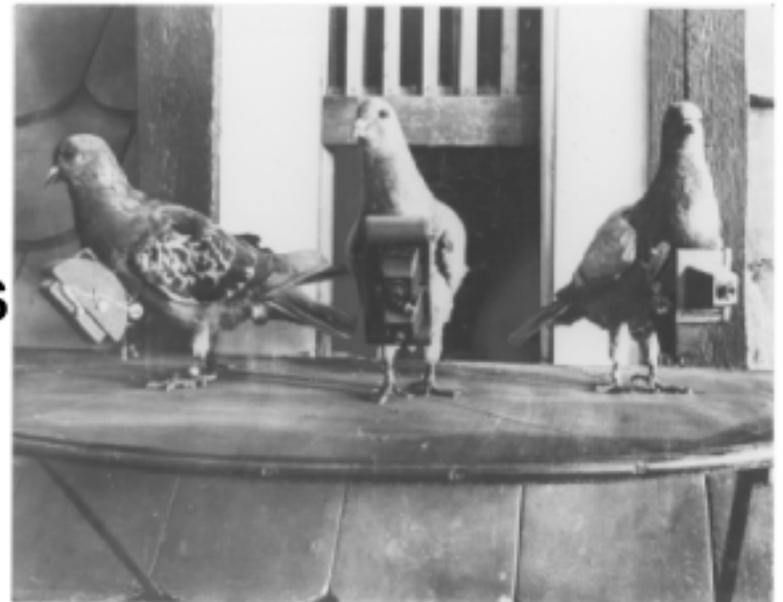


Conclusions:

1. RCMA air photos are good for visual interpretation
2. NDVI from CIR photos have problems but are comparable to airborne sensors (AISA)
3. NDVI from RCMA and AISA alone are not useful for nutrient management, more related to cover
4. MCARI from AISA is very promising, when sufficient canopy cover

Question:

With better multispectral sensors will RMCA data be more useful?



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