Spatial Characterization of IKONOS

R. A. Schowengerdt
Digital Image Analysis Lab
University of Arizona

High Spatial Resolution Commercial Imagery Workshop
March 26, 2002

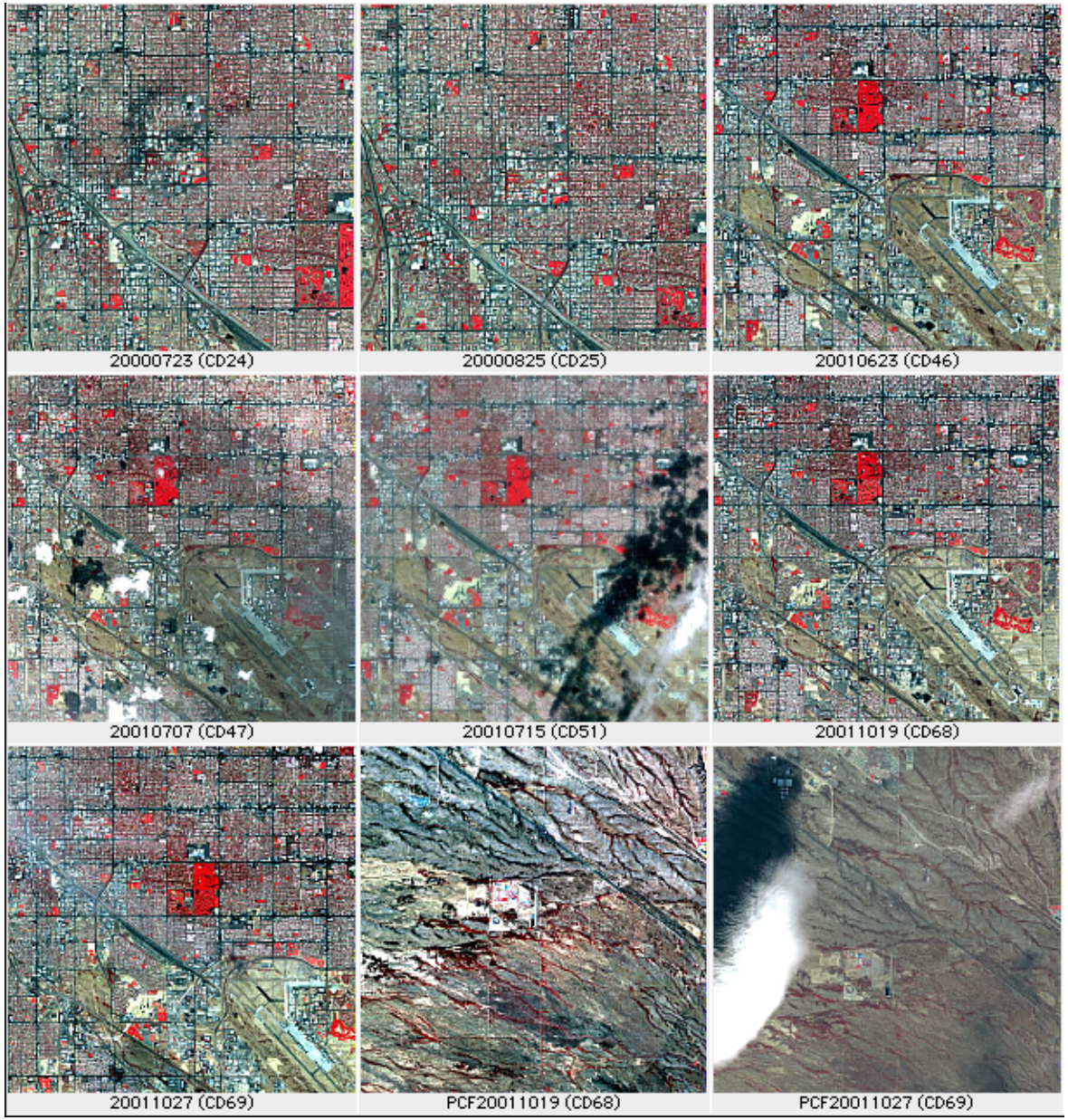
Topics

- stability
- noise
- spatial response (MTF)

Data

* MTFc-on and MTFc-off products

date	location	Ikonos	underflight	target	products	remarks
2000.07.12	Tucson	✖	color photos	✓	NA	clear
2000.07.23	Tucson	✓	6	✓	std original prec orig	thin cloud
2000.08.25	Tucson	✓	color IR photos, ATLAS (NASA SSC)	✓	std orig* prec orig std master prec master	clear
2002.06.23	Tucson	✓			std orig	clear
2002.07.07	Tucson	✓			std orig	partly cloudy
2002.07.15	Tucson	✓			std orig	partly cloudy
2002.10.19	Tucson, Pima County Fairgrounds	✓			std orig	clear
2002.10.27	Tucson, Pima County Fairgrounds	✓	ADAR multispectral	✓	std orig	partly cloudy


20000723 (CD24)
20000825 (CD25)
20010623 (CD46)
20010707 (CD47)
20010715 (CD51)
20011019 (CD68)
20011027 (CD69)
PCF20011019 (CD68)
PCF20011027 (CD69)

Stability

Has there been any change in spatial image quality from 2000 to 2001?

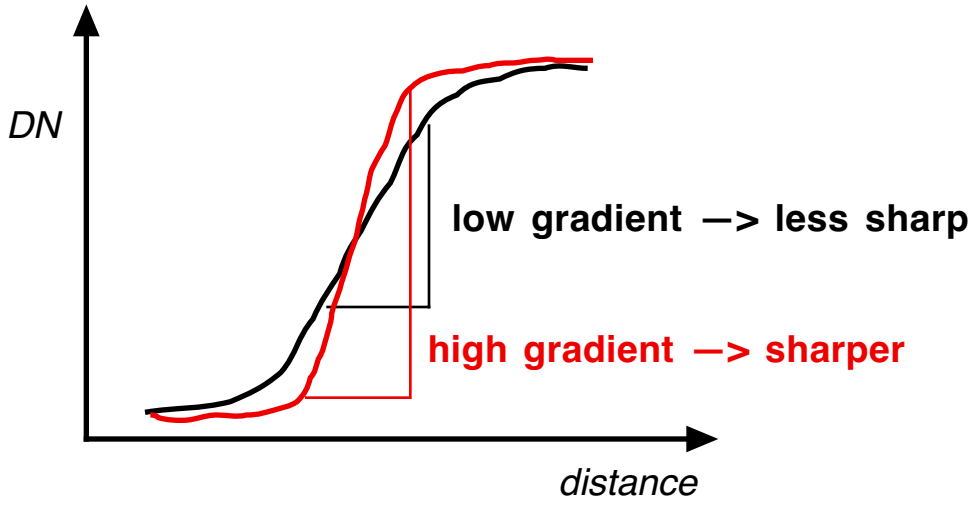
Compare anniversary images

Date	Solar Azimuth (°)	Solar Elevation (°)	Collection Azimuth (°)	Collection Elevation (°)
2000.07.23	113.8	65.4	136.1	84.2
2001.07.15	117.7	70.2	276.8	84.1

Metric

DN gradient

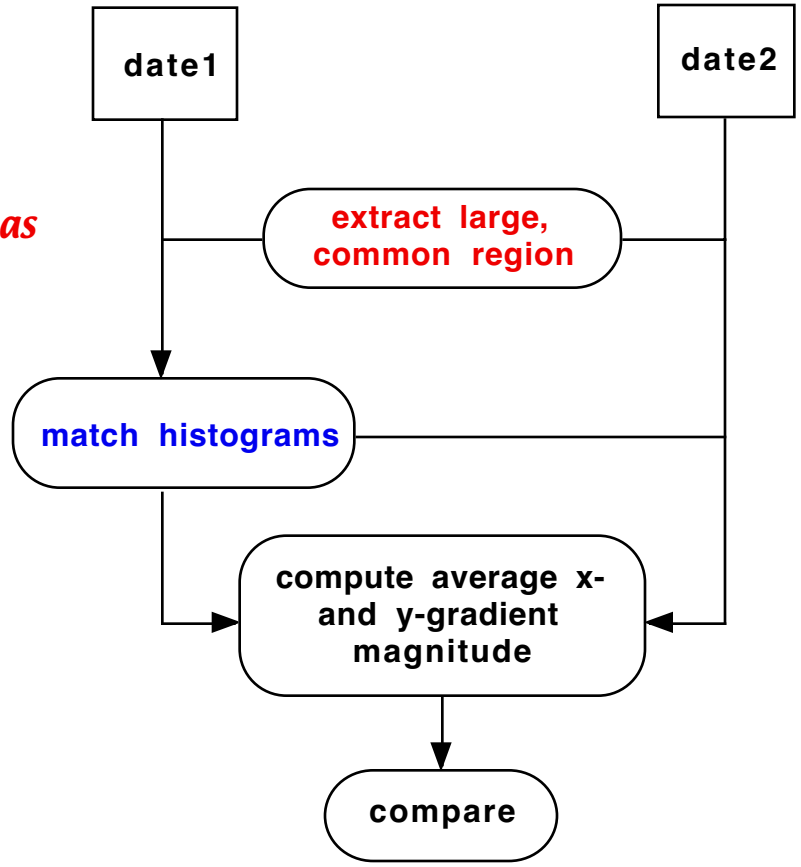
measures edge “sharpness”



Procedure

reduces effect of changes in small areas (e.g. new paving)

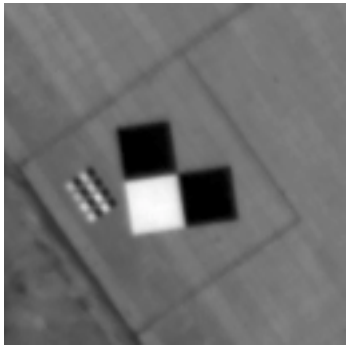
removes residual solar angle, atmospheric, and calibration differences

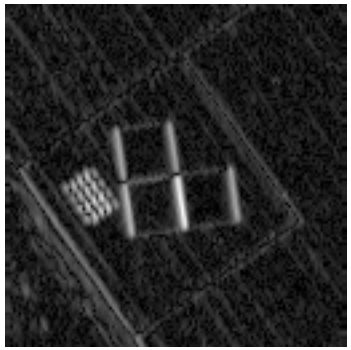


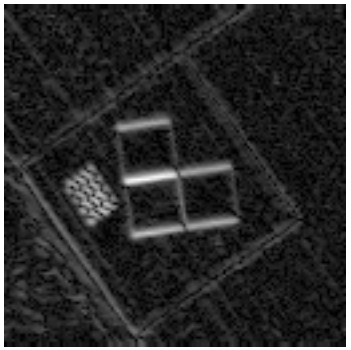
Example for “calibration”

Big Spring, TX 2000.03.26

MTFc - OFF

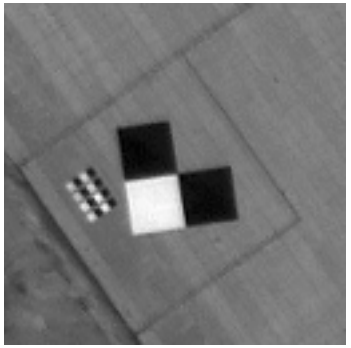


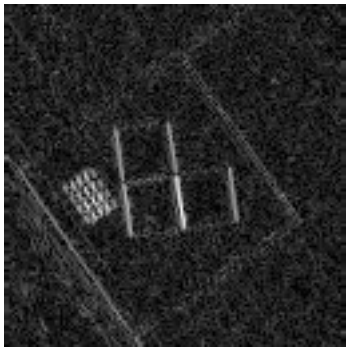


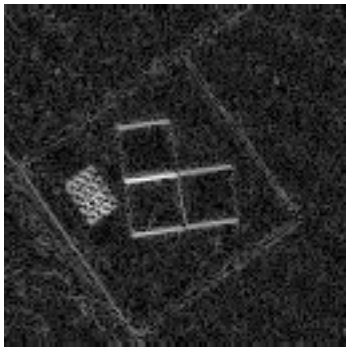


avg grad x = 13.07 **avg grad y = 11.76**

MTFc - ON







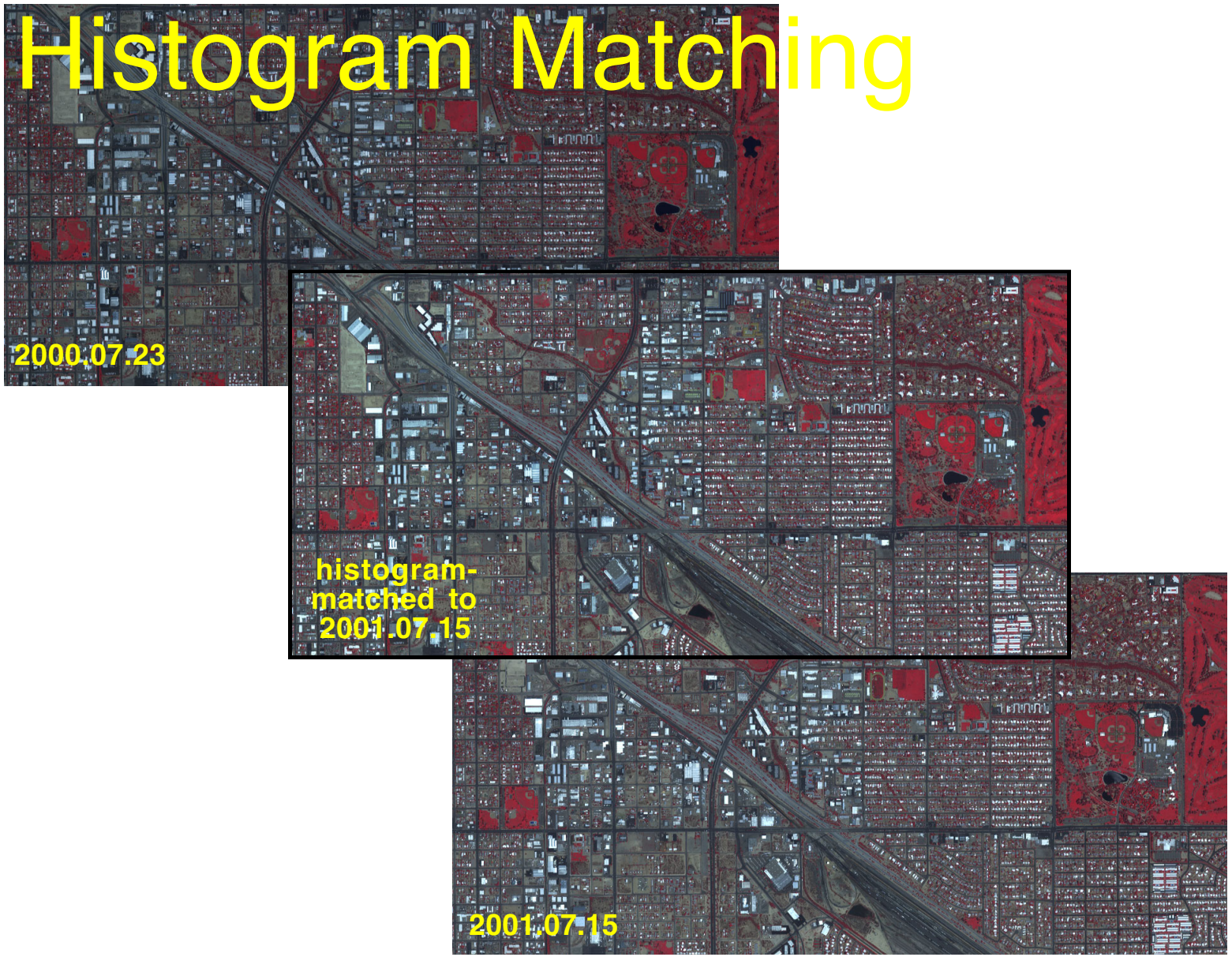
avg grad x = 23.09 **avg grad y = 21.30**

Another example

Full scene, Tucson, 2000.08.25

band	direction	average gradient magnitude (DN)		% difference
		MTFc-OFF	MTFc-ON	
pan	x	82.9	107.9	+15.7
	y	79.2	95.0	+19.9

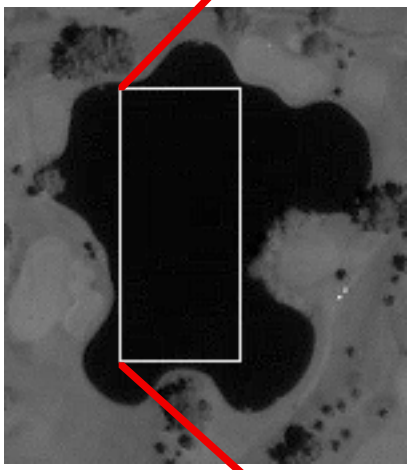
Histogram Matching



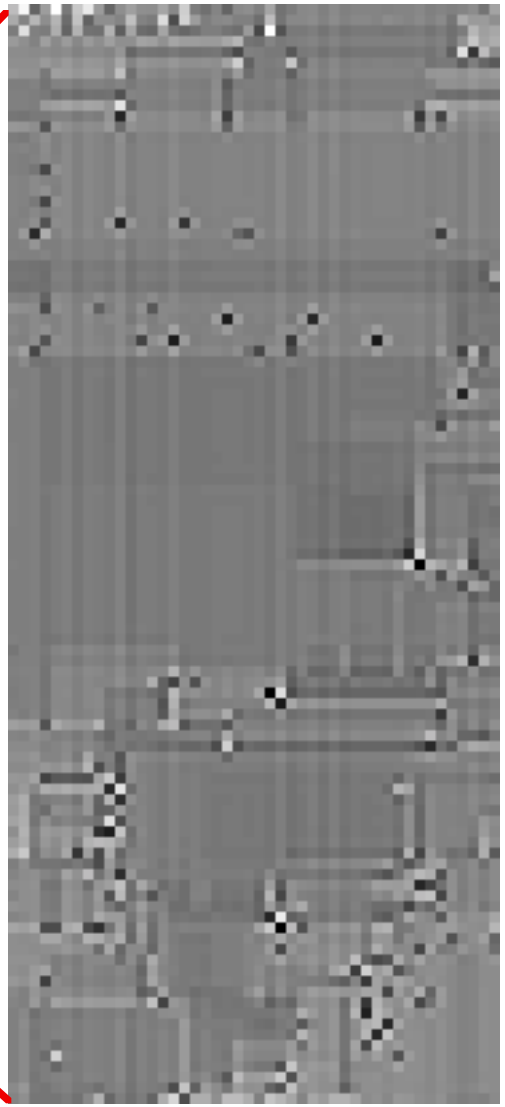
Results

band	direction	July 23, 2000	July 15, 2001	% difference
blue	x	85.6	88.4	+3.3
	y	76.2	77.2	+1.3
green	x	120.1	124.8	+3.9
	y	106.8	108.9	+2.0
red	x	133.5	128.8	-3.5
	y	116.6	114.5	-1.8
NIR	x	114.3	123.6	+7.1
	y	98.8	106.1	+7.4

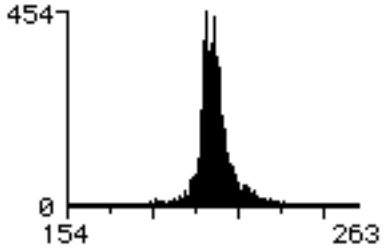
Noise



lake (Tucson, 2001.07.15)



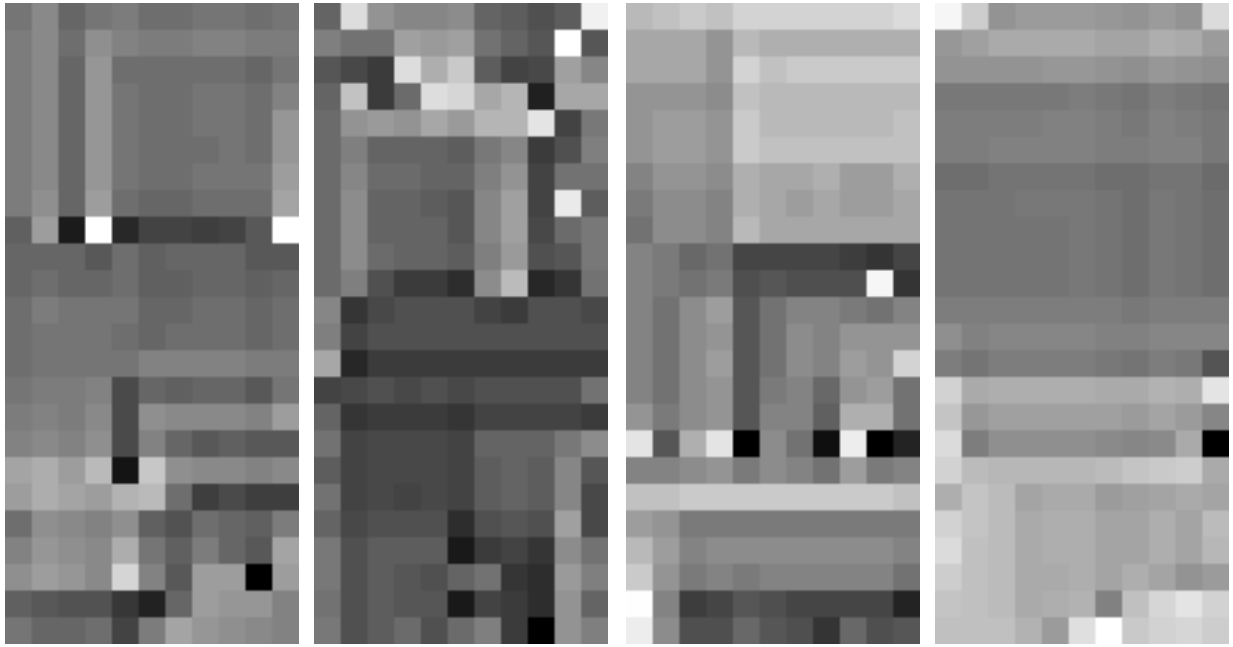
mean DN = 209
stdev DN = 8.23
range DN = 154-263



Noise (cont)

MS bands

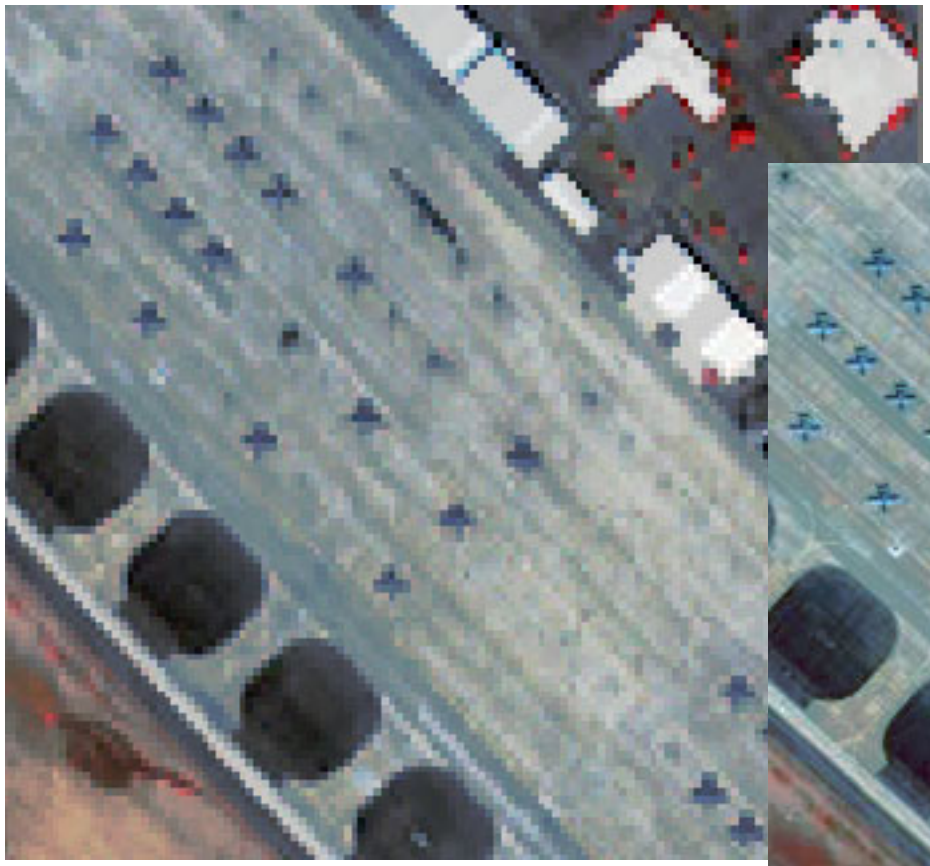
	blue	green	red	nir
mean DN =	314.3	323.1	207.4	182.4
stdev DN =	4.41	6.09	5.03	7.45



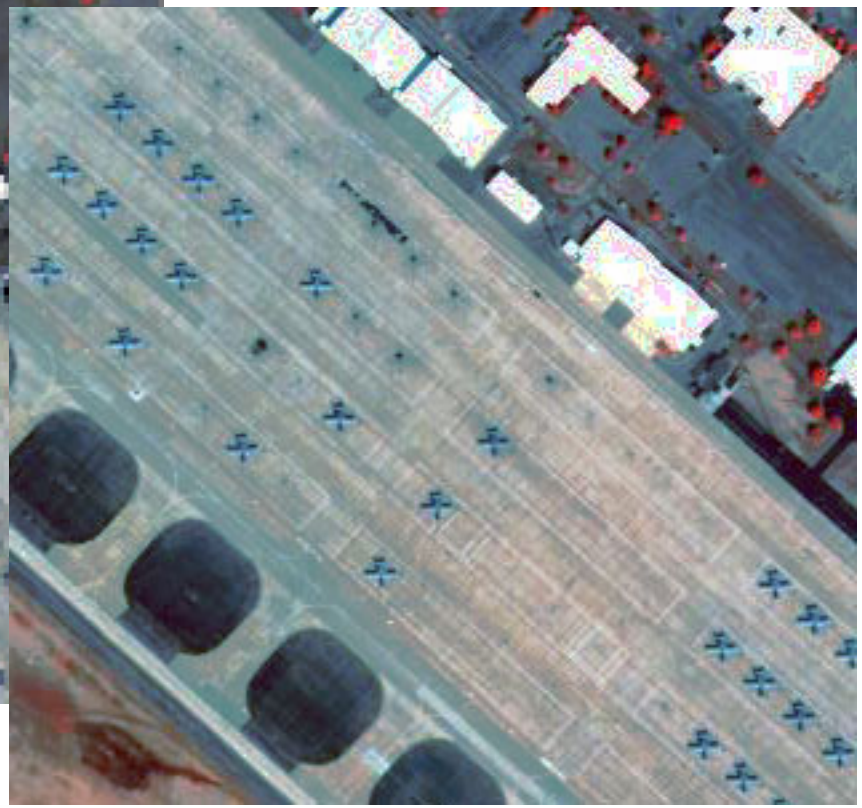
Work In-Progress

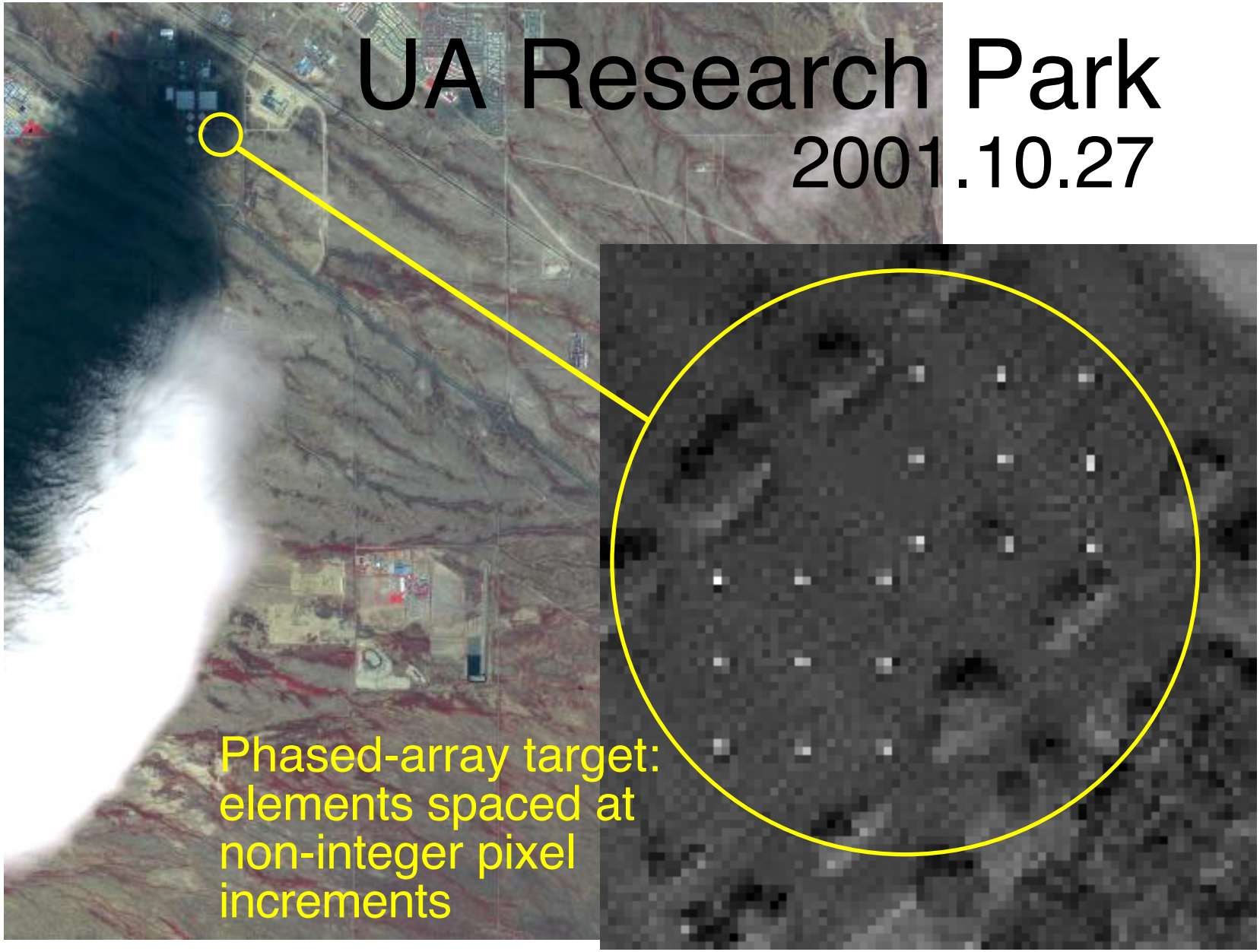
Spatial Response

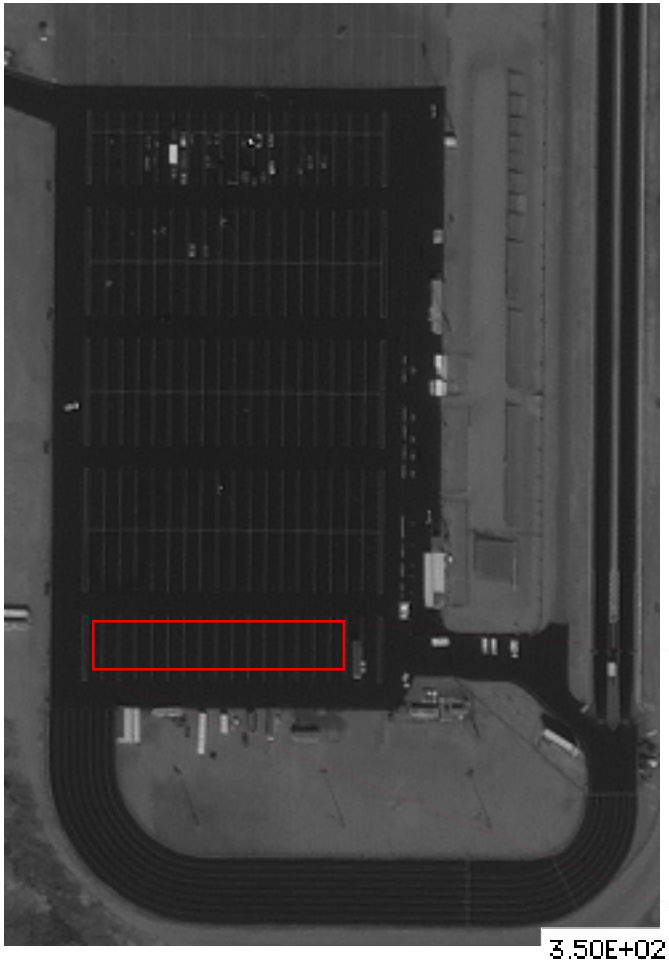
IKONOS (Tucson, 2001.10.27)



1-m multispectral coincident ADAR



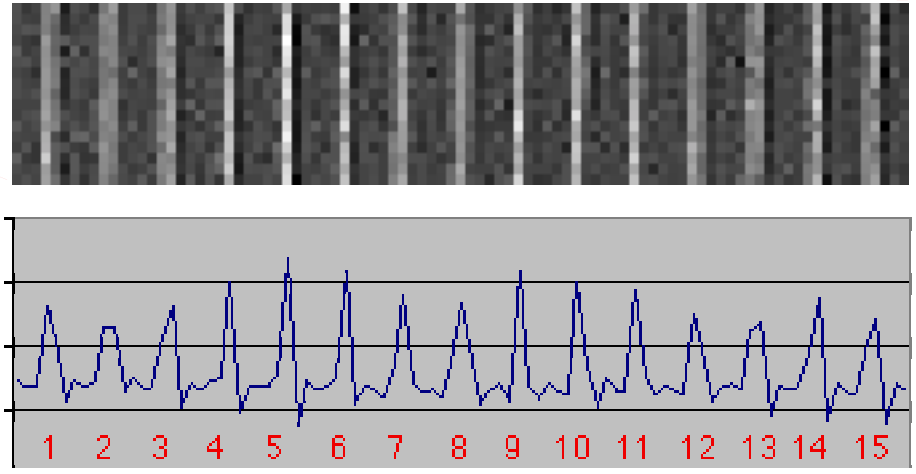

UA Research Park
2001.10.27
Phased-array target:
elements spaced at
non-integer pixel
increments



Pima County Fairgrounds

Southwestern International Raceway

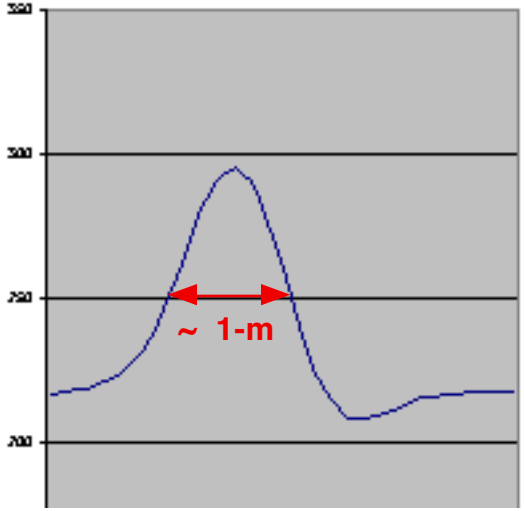
Phased parking stripes, 4-in wide



Procedure

(see Helder and Choi's poster paper)

- Interpolate data 8x
- Shift each line profile to align maxima
- Average to get Line Spread Function (LSF)



Note asymmetry and undershoot (see also Blonski's and Helder's target results)

Summary

Stability

System imaging performance shows no measurable change
July 2000 - July 2001

Noise

Structured noise, about 4% of signal at low DN

Spatial performance

In progress, waiting for MTFc-reprocessed samples

Acknowledgements

NASA
and
Lockheed-Martin
Stennis Space Center

Targeteers:
Alejandro Angel
Alexandre Braga
Dan Filiberti
Giri Gopalan
Mark Hickman
Tai Hong
Francisco "The Pixel" Rojas
Anand Shastry
Jim Storey