Multiangle Remote Sensing of Cloud Properties Using MISR Data

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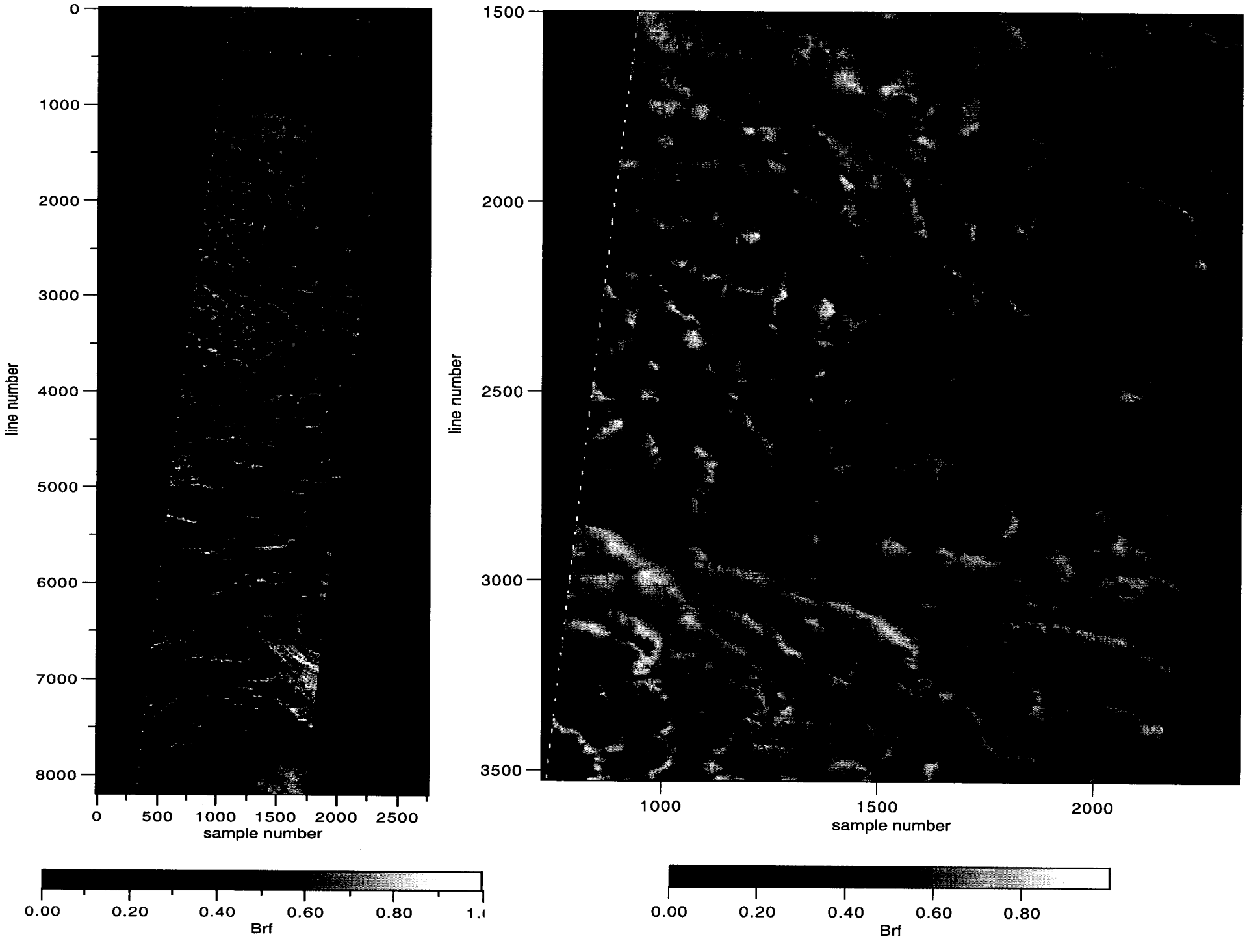
Multiangle techniques being used

- stereo to get cloud heights
- hyper-stereo for cloud winds
- band-differenced angular signatures for thin cirrus
- texture indices by angle for classification
- improved albedo estimates
- identification of cloud heterogeneity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3000
4000
5000
6000
7000
8000
line number
0
500
1000
1500
2000
2500
sample number
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0.20
0.40
0.60
0.80
1.0
Brf
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sample number
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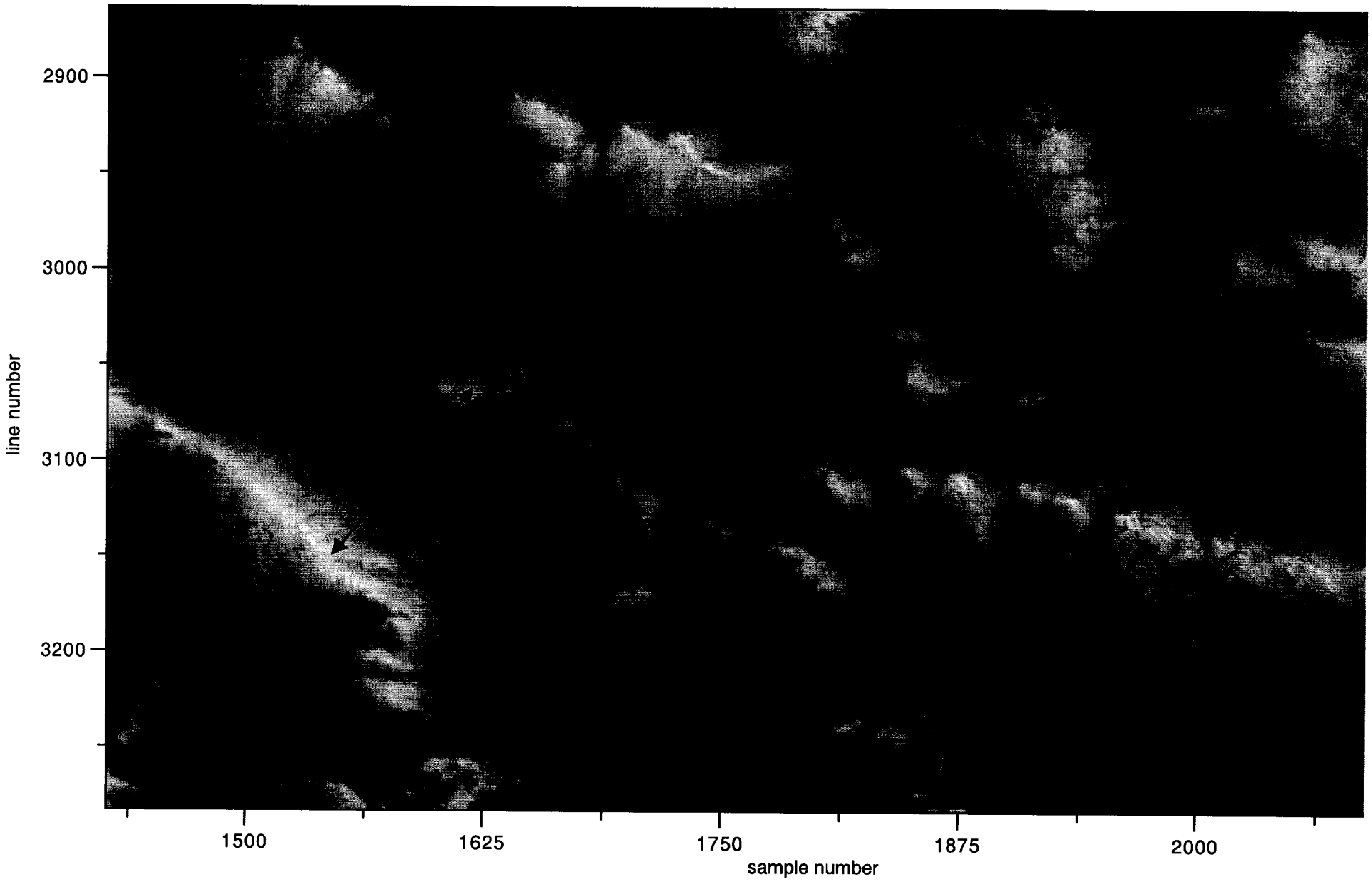
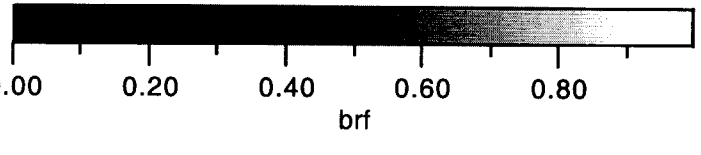
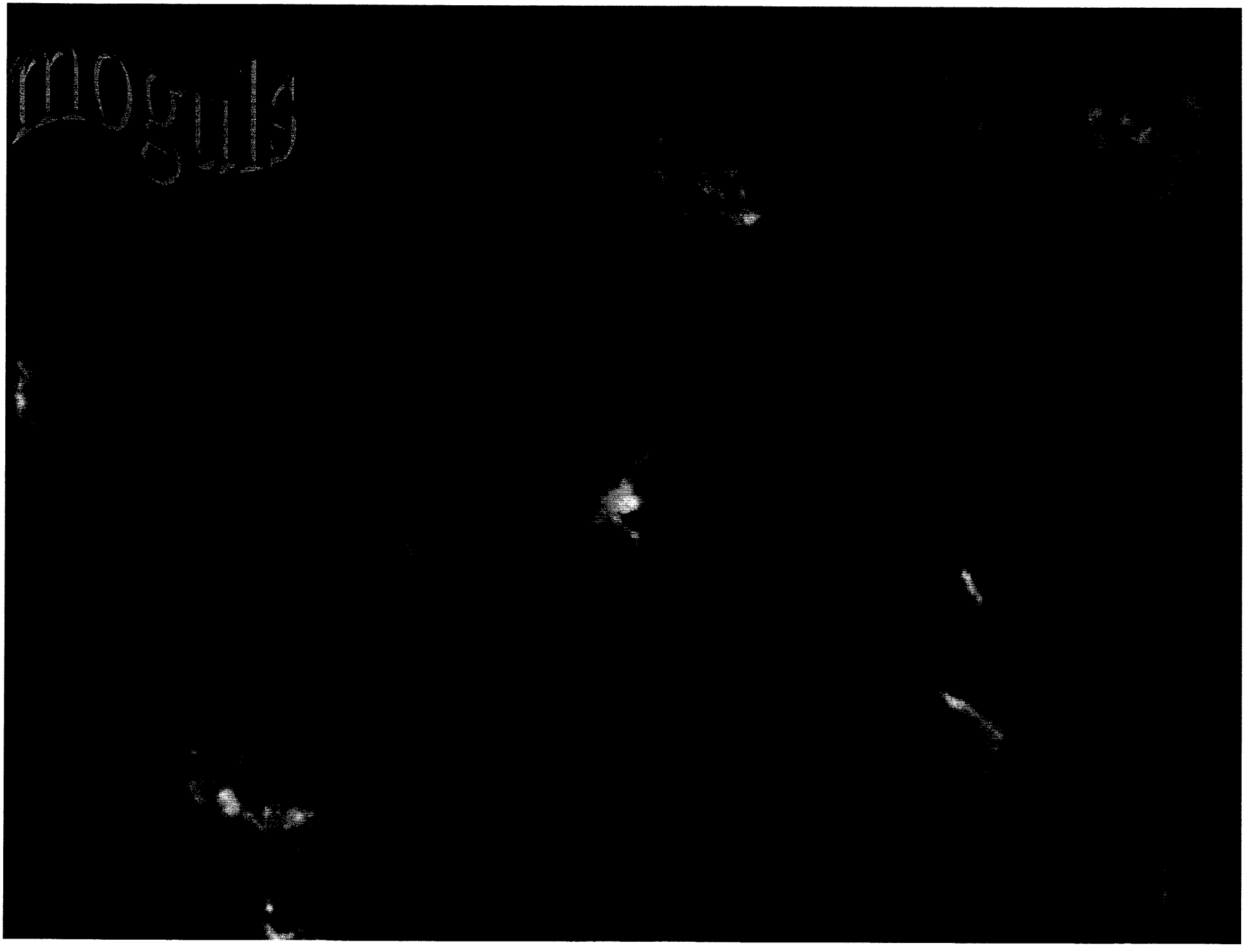
0.60
0.80
Brf



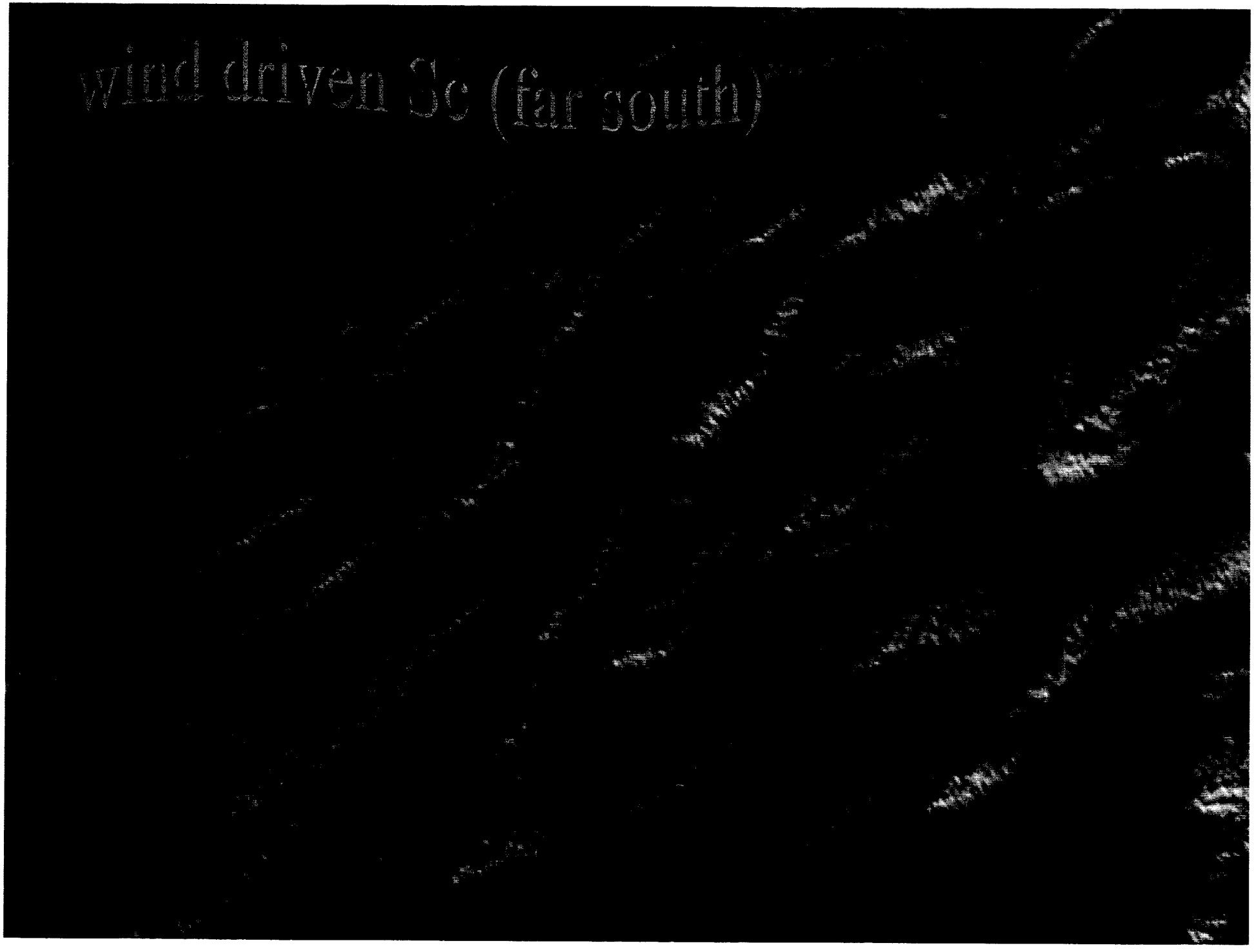
closed+open cells




Rogues

small closed cell

cirrus over cumulus

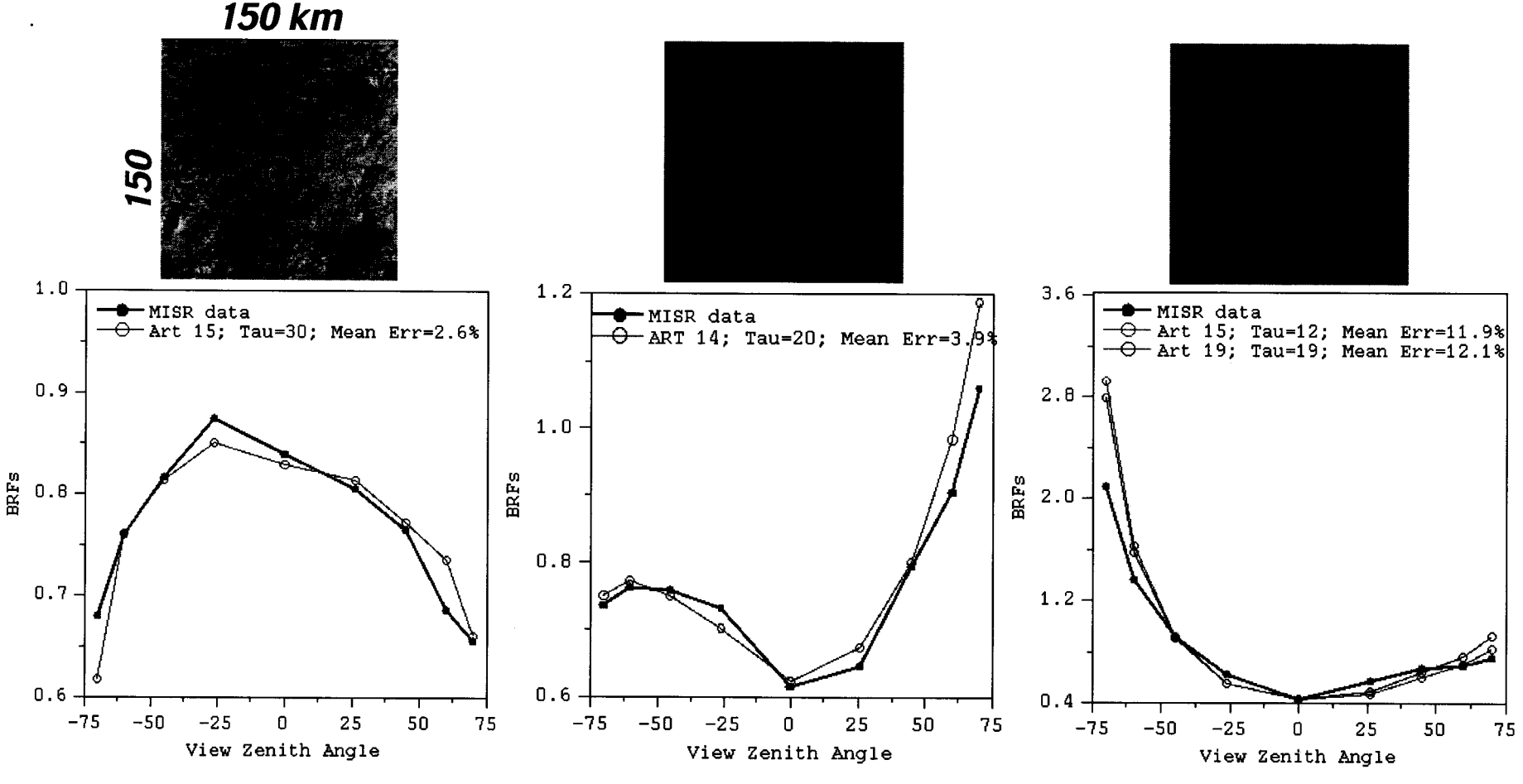

wind driven 3c (far south)

Spatial homogeneity test

- 16 orbits on April 9, 2001
- 8.8 km nadir radiance within ± 5%
- exclude ice sheets (65°N, 55°S)
- exclude clear ocean
- homogeneity pass rate

  1.3 (±0.3) %

Good agreement with 1D theory for homogenous scenes — can retrieve microphysical properties

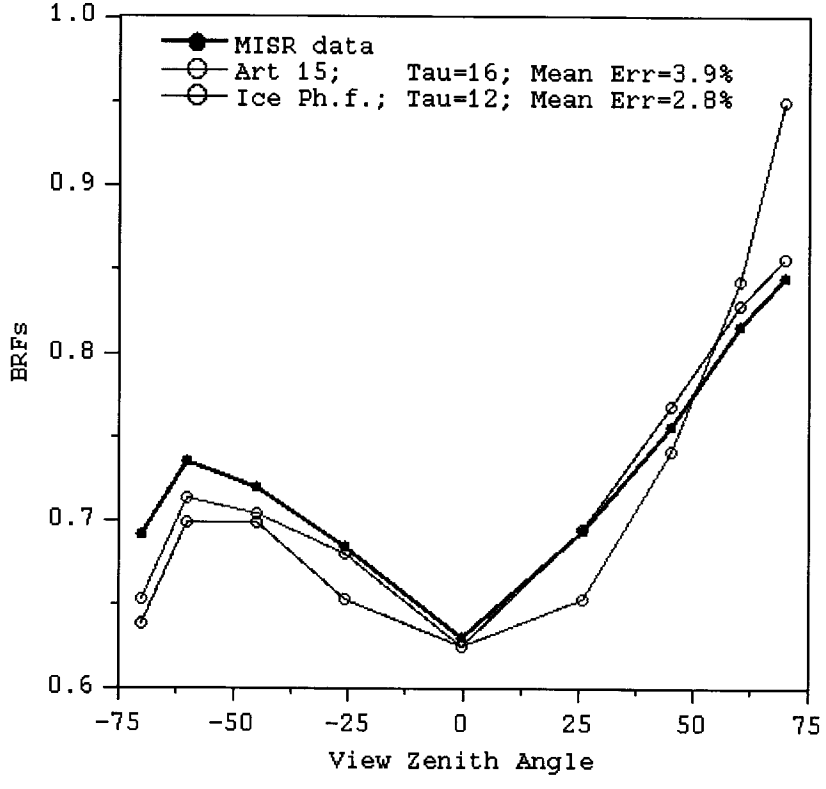


SZA=28°
Hc~5km

SZA=55°
Hc~2km

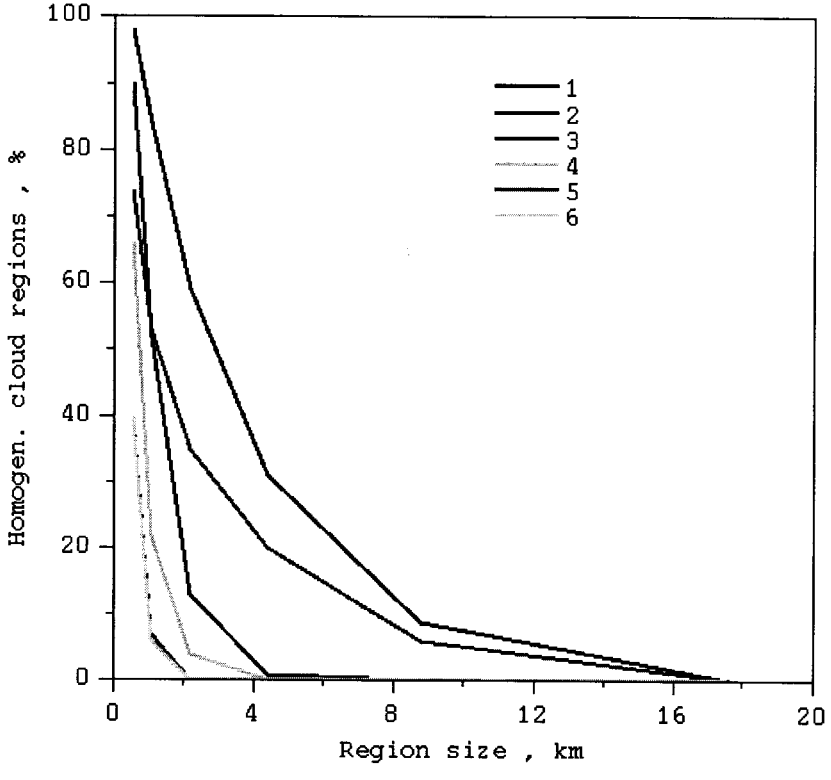
SZA=73°
Hc~2km

Homogeneous Ice Cloud



SZA=47°

Hc~12 km

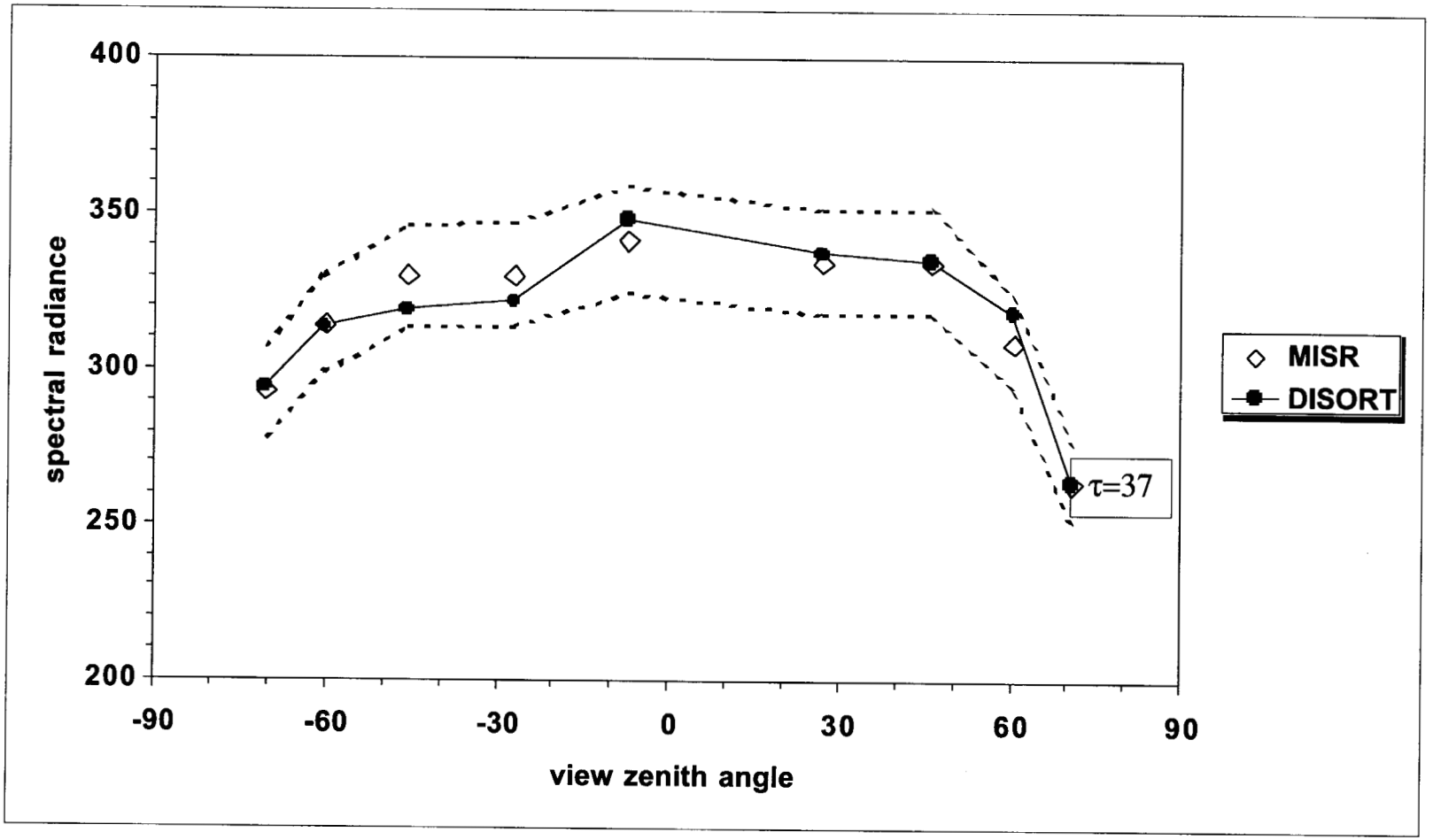


% passing spatial homogeneity test as a function of region size

Angular test for 1D Consistency

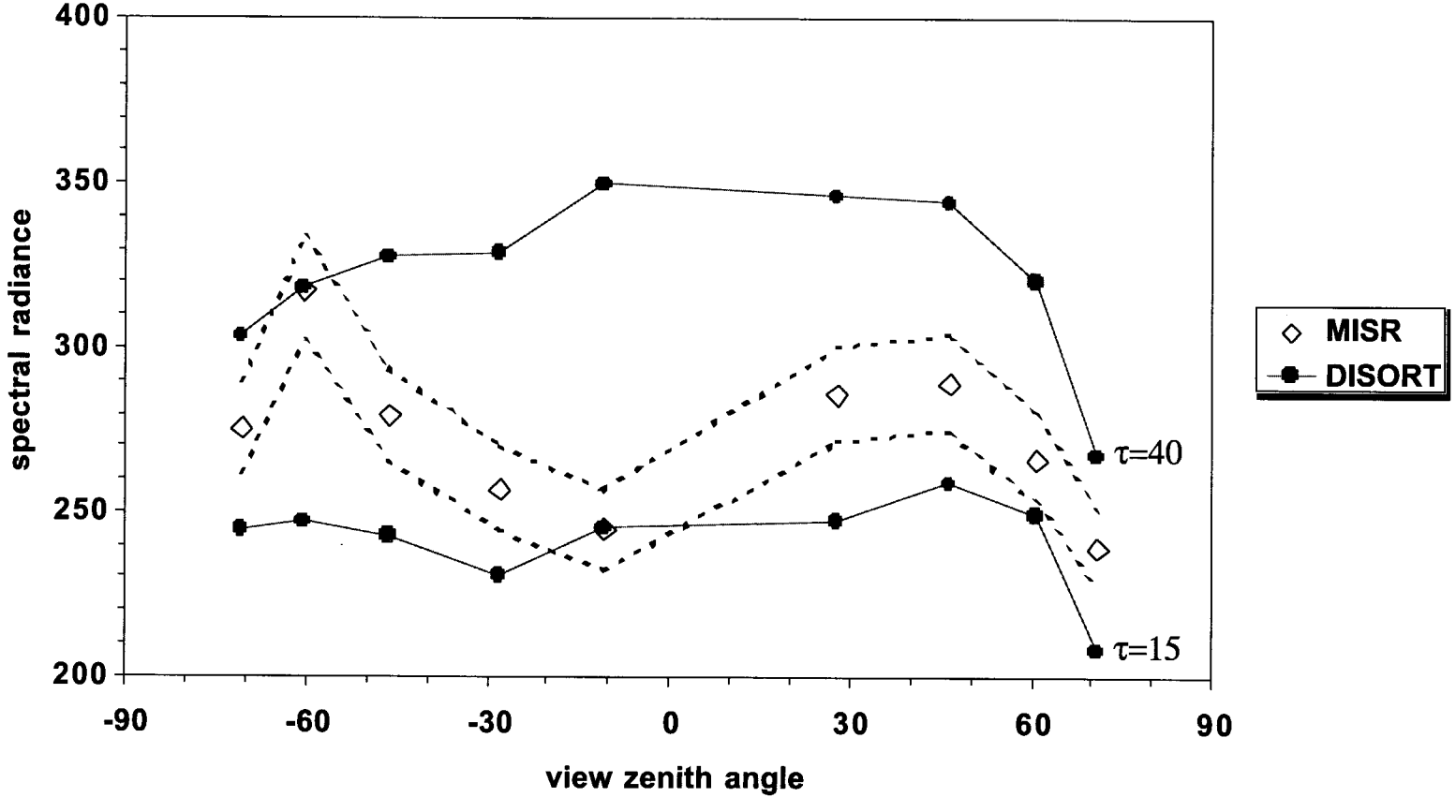
- compare angular data with DISORT
- seek optical depths within ±5%
- include Rayleigh scattering
- ignore angles in sun glint region
- examine effect of pixel resolution
- but first co-register data, allowing for cloud height and winds

"Homogeneous" example



	Da	Ca	Ba	Aa	An	Af	Bf	Cf	Df
	36	37	42	40	34	35	36	32	36

"Heterogeneous" example

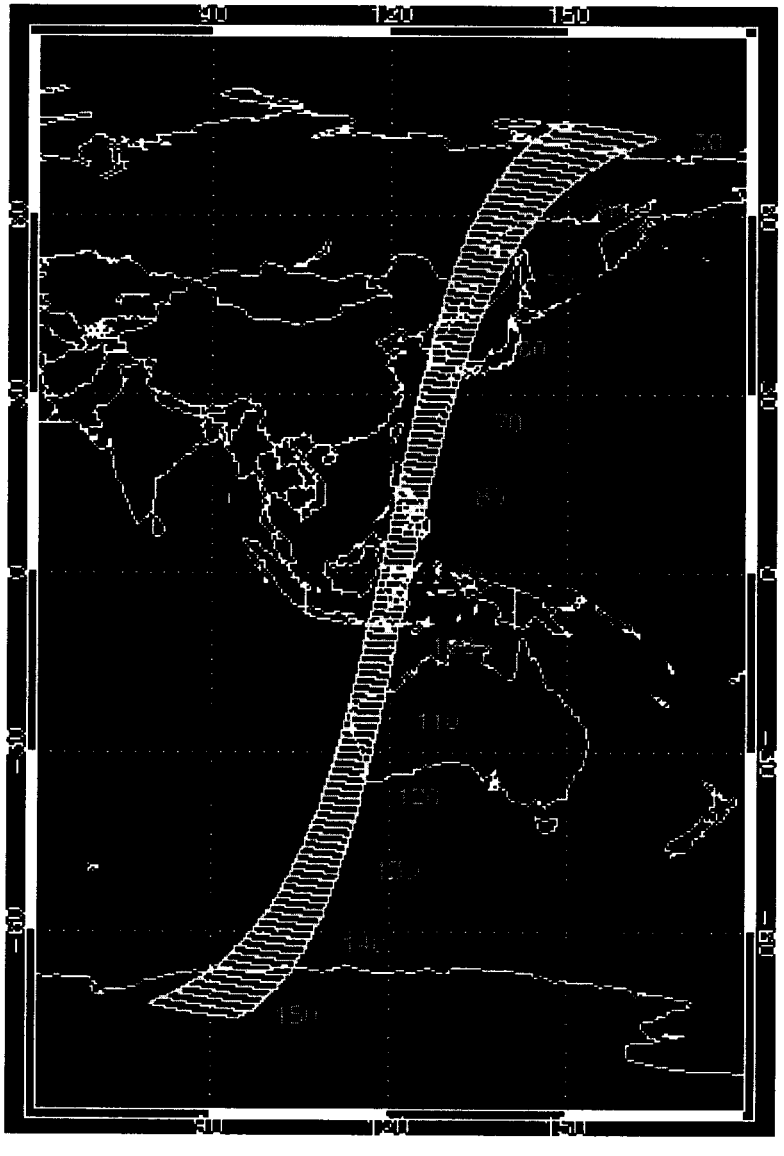


	Da	Ca	Ba	Aa	An	Af	Bf	Cf	Df
	24	40	22	19	15	21	21	19	24

1D angular test results

- a small fraction of cloudy pixels is consistent with the plane-parallel model (≈9% at 275 m resolution)
- this is more than passed the spatial test
- more pass the test at coarser resolution

Orbital statistics
(path 114, orbit 6156)



275 m	~9.1%
1.1 km	~11.3%
8.8 km	~16.3%
17.6 km	~17.9%
35.2 km	~19.6%

In Summary

- MISR has revealed intriguing examples of cloud heterogeneity at 275m scales
- MISR mutiangle brf's 'agree' with 1D theory for <10% of global cloud cover
  - indiscriminate application of homogeneous remote sensing theory clearly flawed
  - multiangle remote sensing may provide a more general solution in the future
  - for now, multiangle remote sensing provides confidence for the judicious use of homogeneous cloud theory