Ice Dolines on Larsen Ice Shelf, Antarctica: An Application of IKONOS Data

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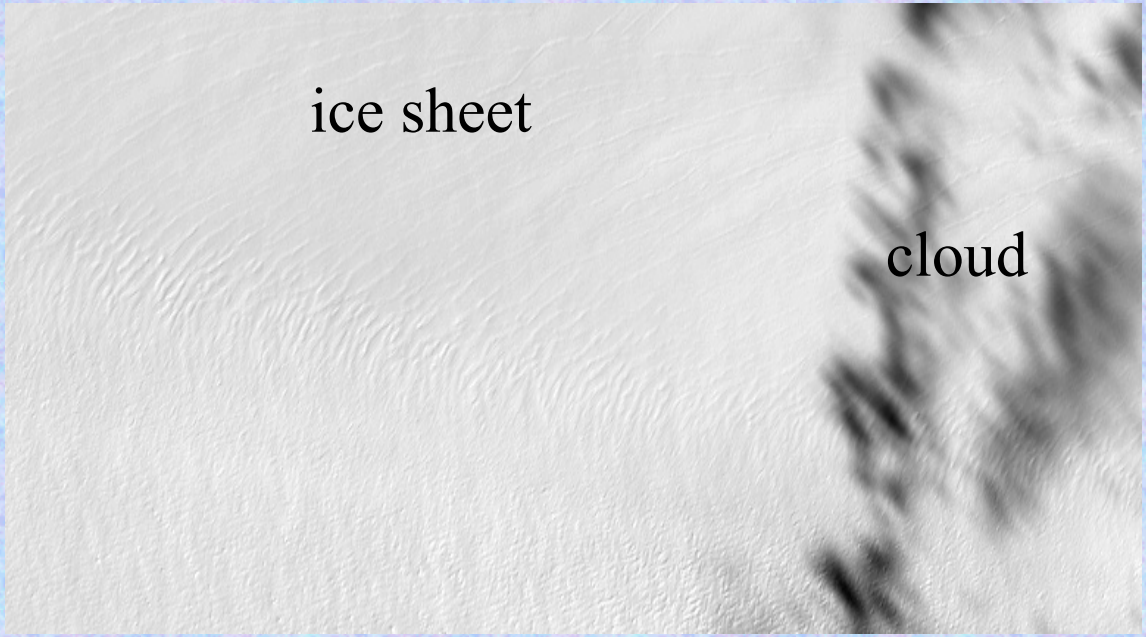
Outline

- Data selection
- Qualitative use
- Quantitative use

Data Selection

- Web page is great
- Cloud discrimination is not

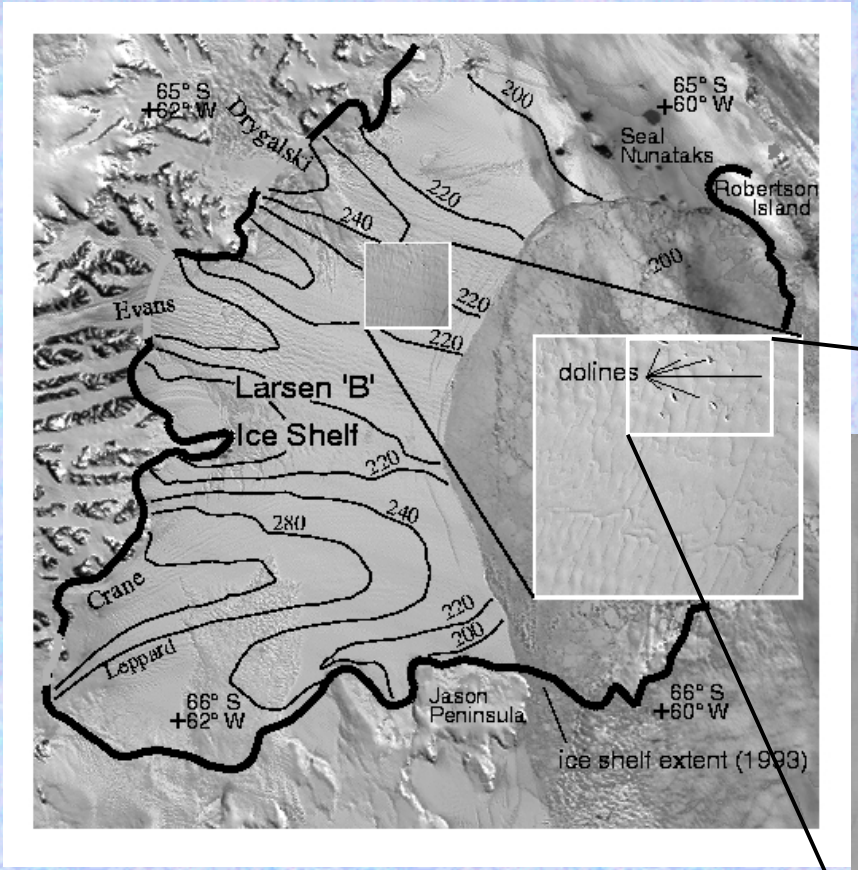


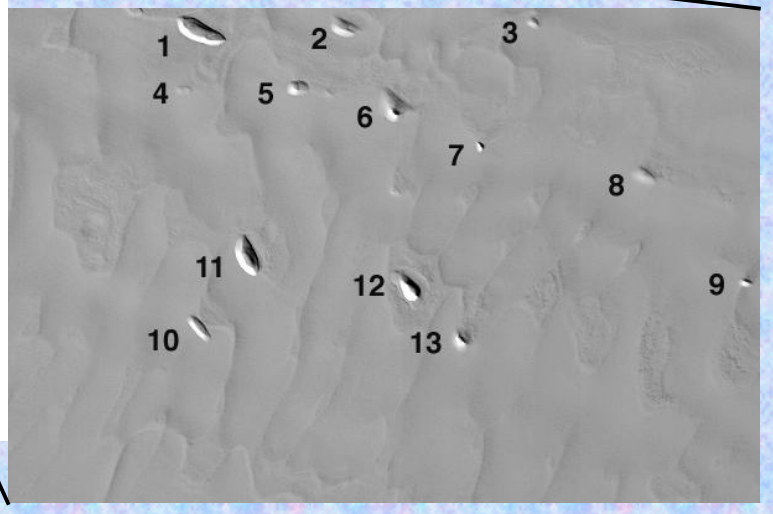
Task 625
January 6, 2001

MCCA: 99%

Actual Cloud
Cover: <20%

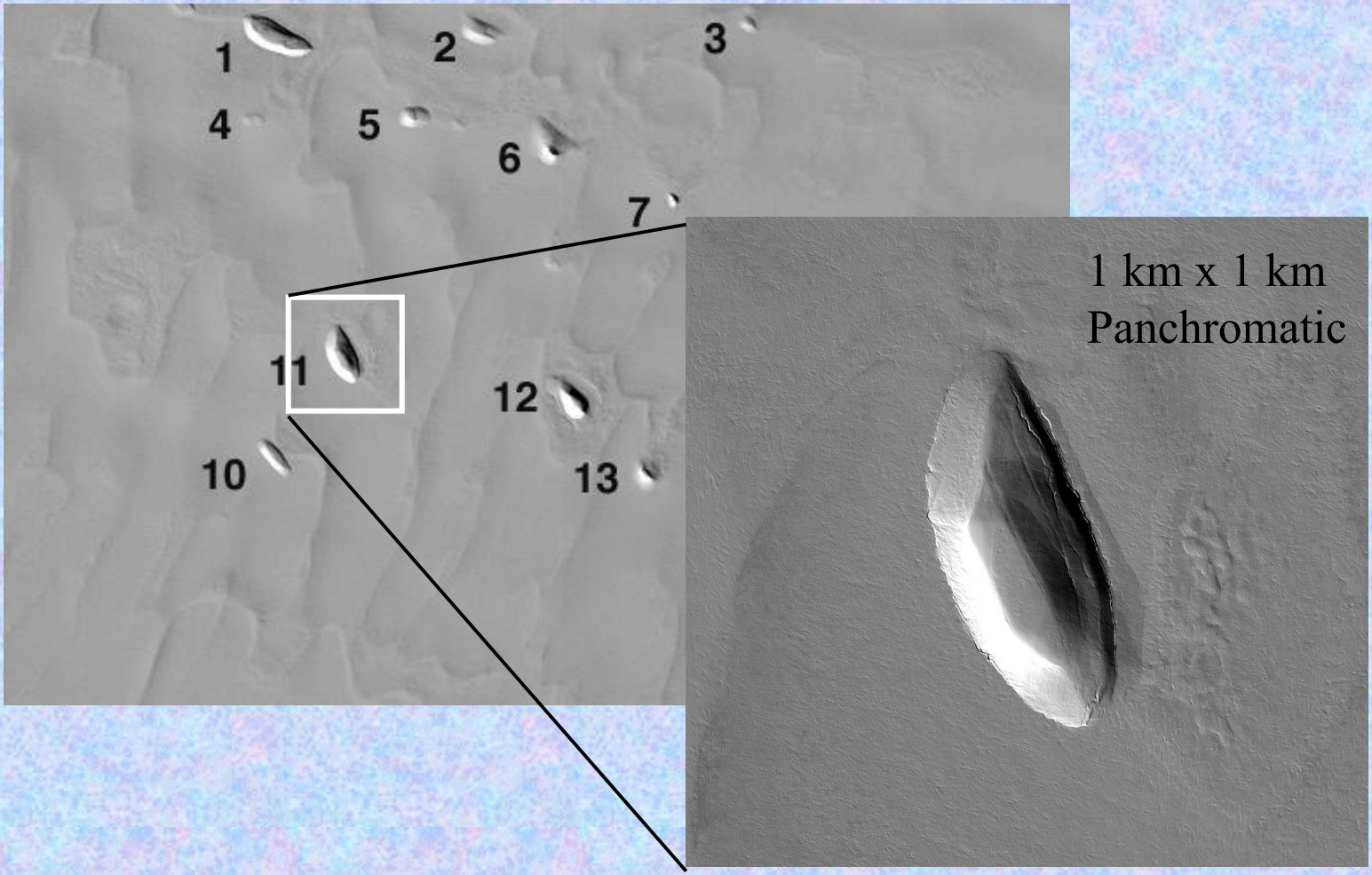
Qualitative Use





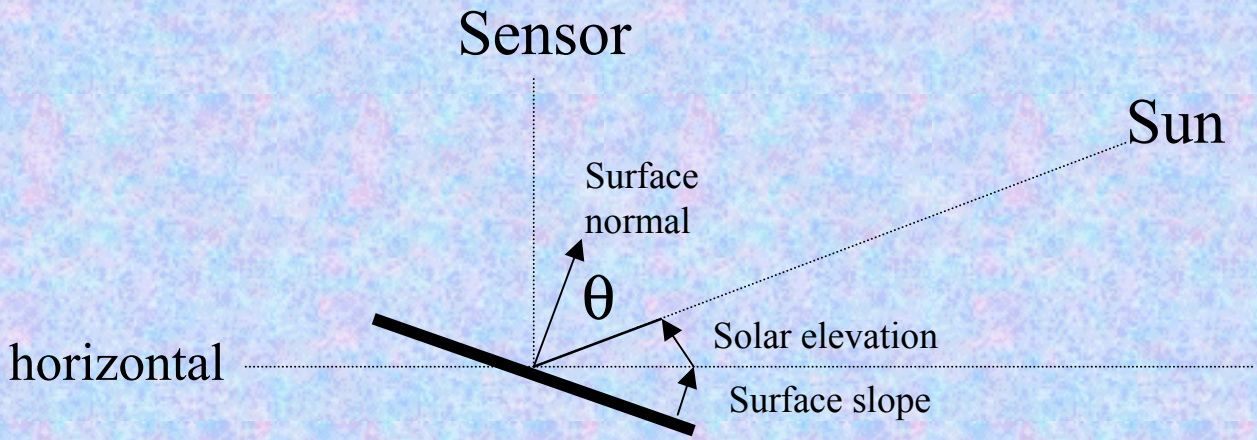
Ice Doline Field,
Larsen Ice Shelf,
Antarctica

Stunning Detail!!



Quantitative Use

Photoclinometry - Conversion of image brightness to surface slope

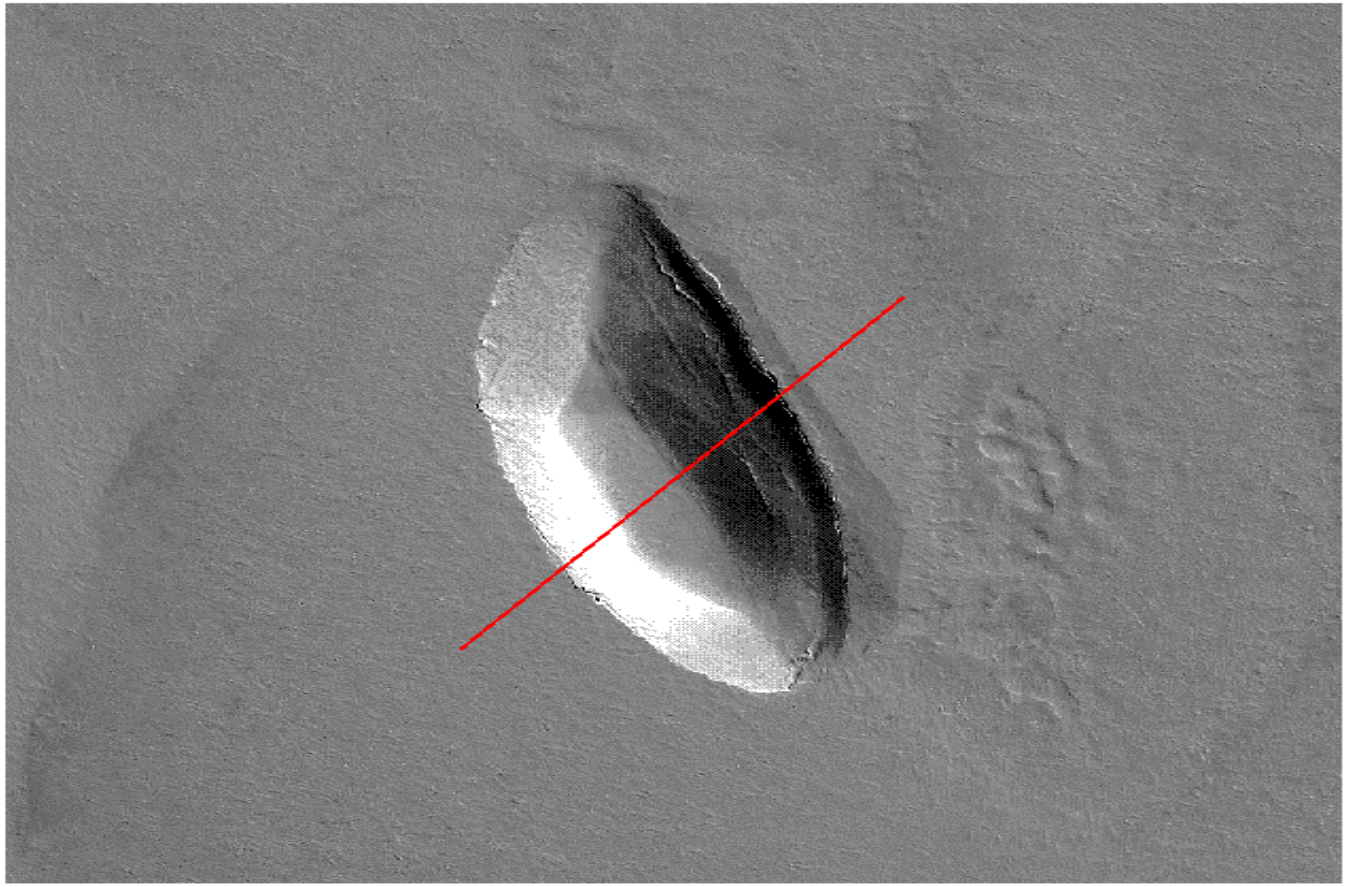


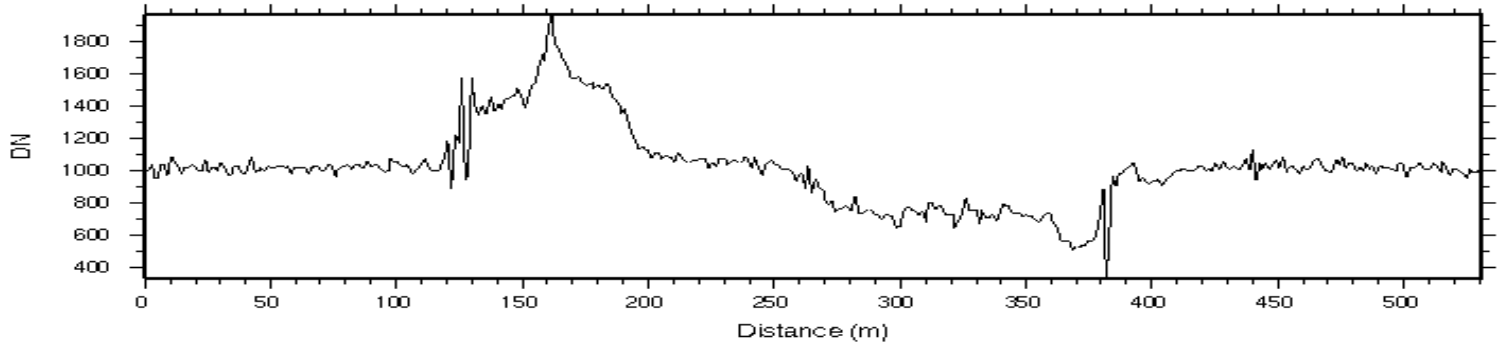
$$DN = C \int_{\lambda} T(\lambda)[I(\lambda)R\cos\theta - L_o(\lambda) + S(\lambda)]d\lambda$$

$$DN = CI_f R \cos\theta + B$$

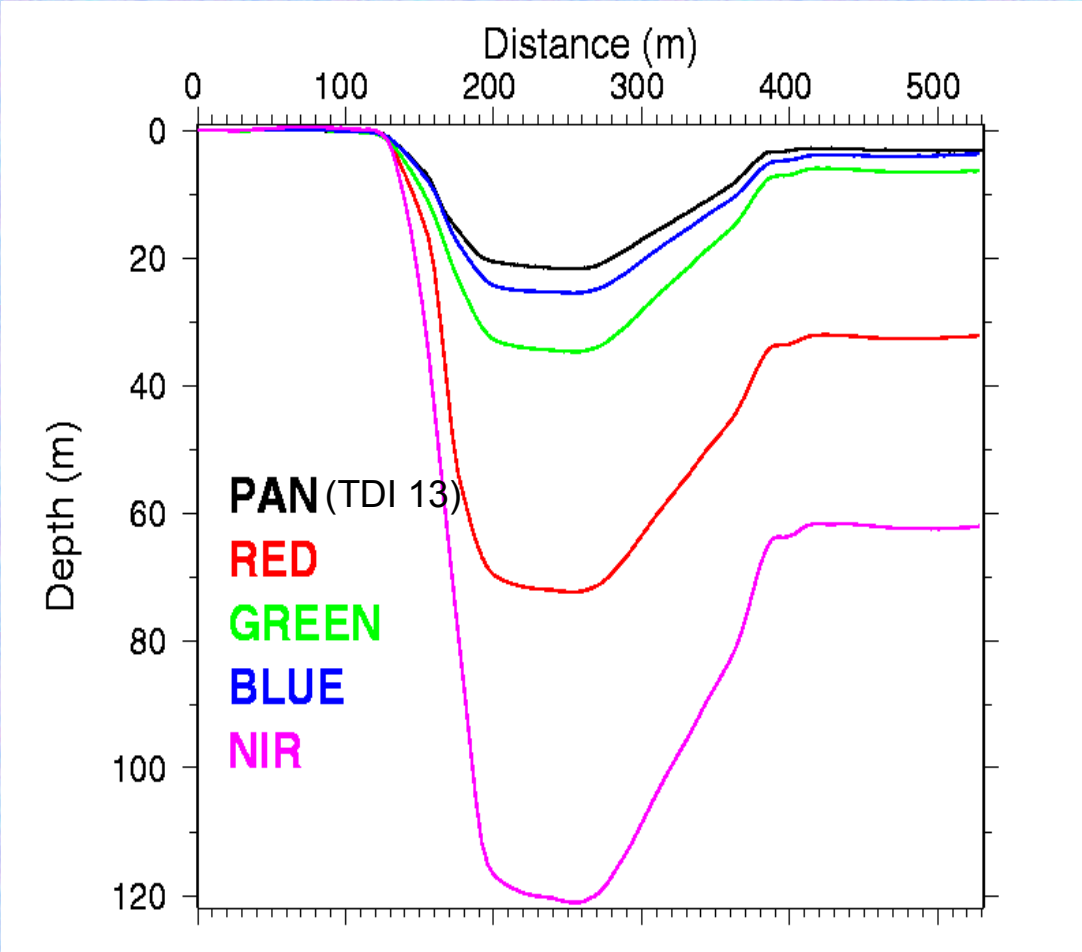
- DN = image brightness
- C = calibration coefficient (converts radiance to DN)
- I_f = "bandpassed" solar irradiance
- R = "bandpassed" surface reflectance
- θ = illumination angle
- B = path radiance (scattering) and sensor radiance offset

#2: 1050m x 1000m





Using Space Imaging Parameters



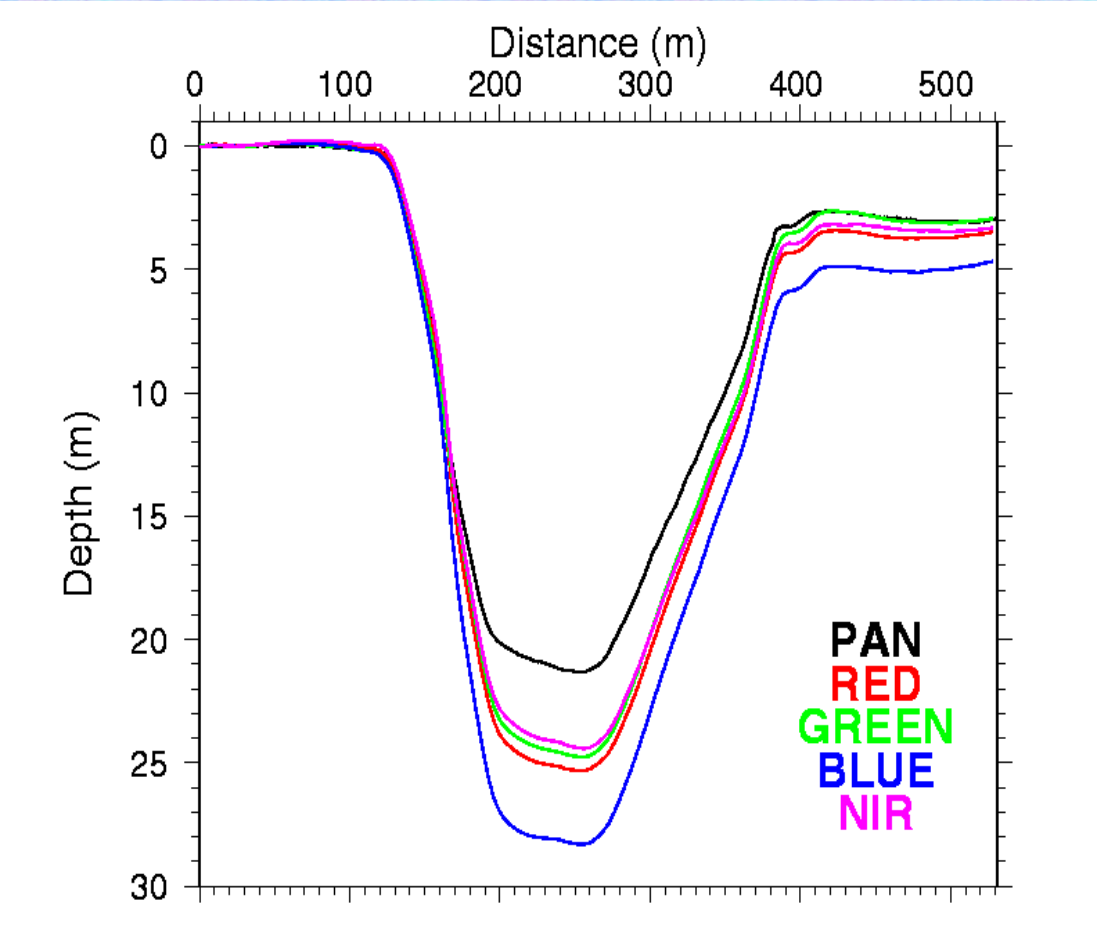
$$DN = CI_f R \cos\theta + B$$

B adjusted so mean DN is horizontal surface

Results:

- B values unreasonable
- Spectral bands produce different profiles
- Surface is sloped

Using "Dark Object" and "Flat Shelf"



$$DN = CI_f R \cos\theta + B$$

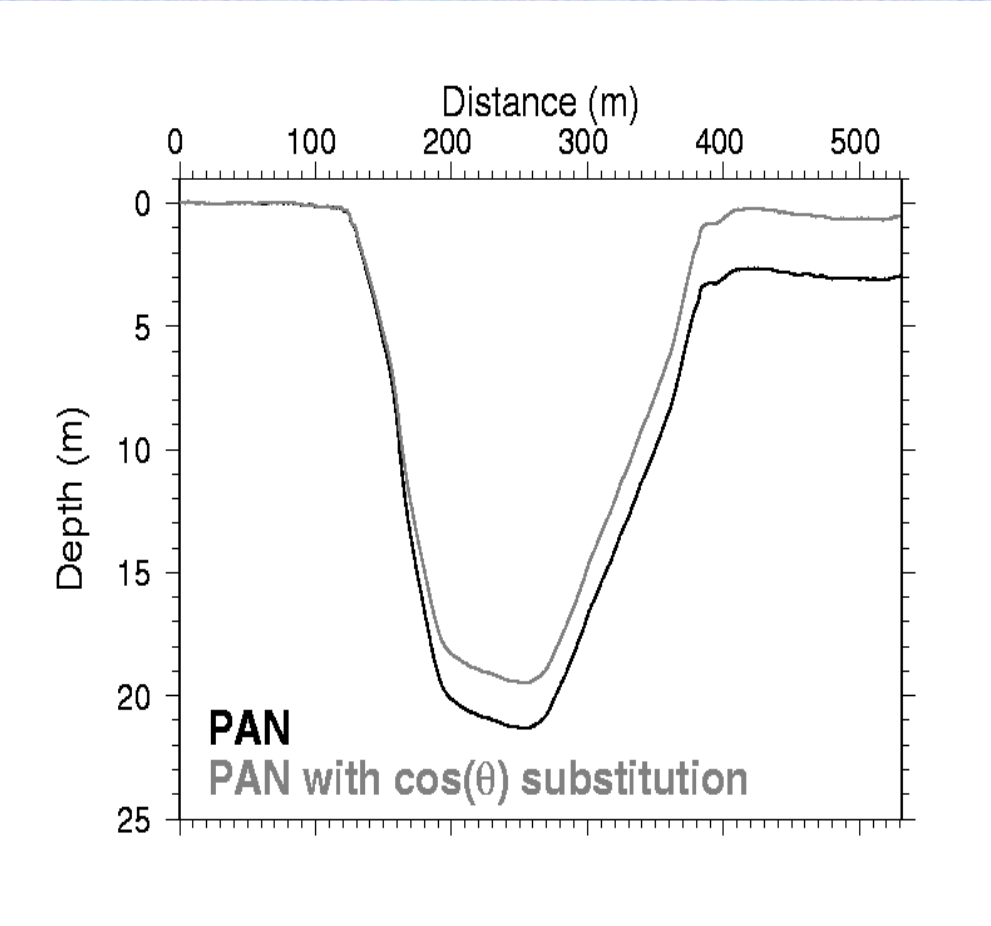
B=119 (darkest pixel)

Flat ice shelf:
DN (θ=65.5°)=1004

Results:

- Depth is about right
- Surface still sloped

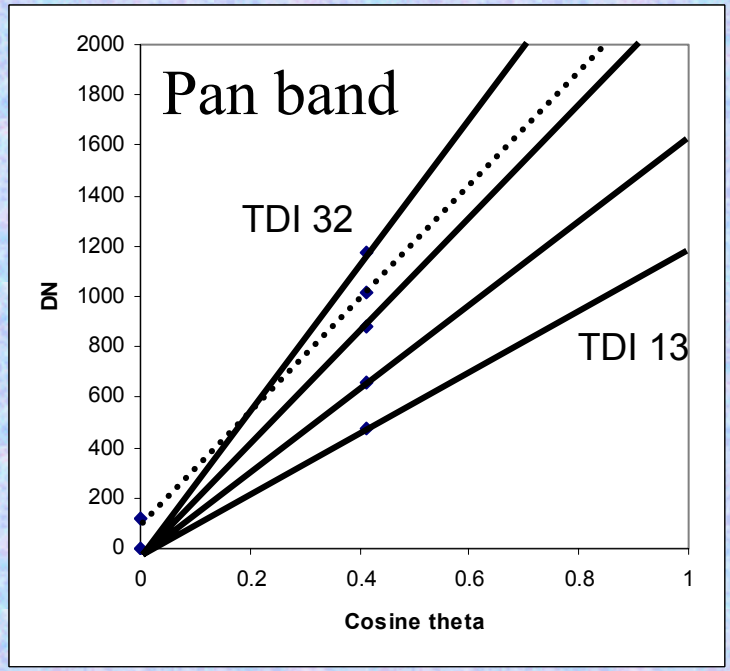
Sloped Surface Effect

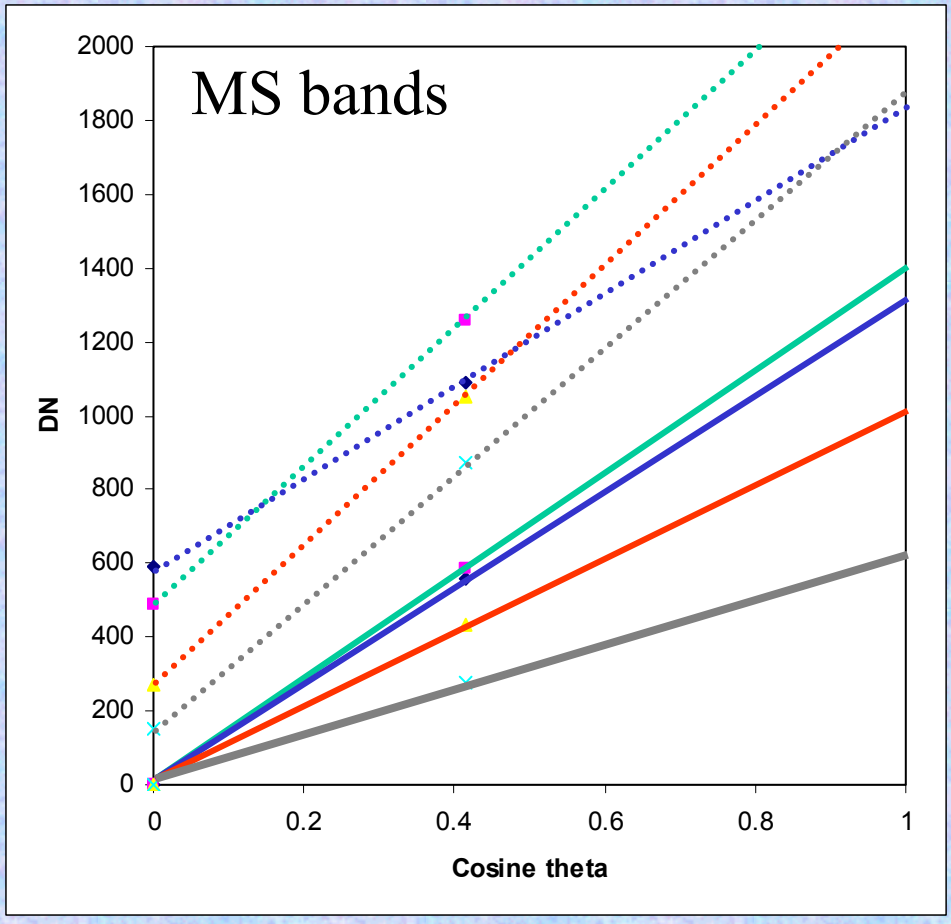


Could be due to:

- non-Lambertian reflectance (replace cosθ with symmetric function)
- non-linear sensor response
- non-linear adjustment of data supplied to customer

Calibration Discrepancies





Space Imaging parameters

Two-point method

Apparent Reflectance

$$DN = CI_f R \cos\theta + B$$

	DN mean	*I (W/m2)*	*B*	*C (DN/W/m2)*	*R Apparent*	*R Correct*
Pan (TDI-24)	1014	562	119	4.73	0.81	0.8
MS-1 (Blue)	1092	140	590	10.15	0.85	0.95
MS-2 (Green)	1255	167	489	9.11	1.22 ↔	0.93
MS-3 (Red)	1050	110	272	10.54	1.62 ↔	0.9
MS-4 (NIR)	873	110	151	8.06	1.97 ↔	0.75

Differences between last two columns indicates miscalibration

Please, Please, Please

with the data

“Wasted” Dynamic Range

	Dynamic Range	DN Range	Sensitivity	Solar Irradiance	Range/ Solar	Normalized Sensitivity
	W/m2		DN/W/m2	W/m2		
Pan (TDI-13)	741	1900	2.6	562	1.32	1441
Pan (TDI-32)	301	1900	6.3	562	0.54	3548
MS-1 (Blue)	187	1900	10.2	140	1.34	1422
MS-2 (Green)	209	1900	9.1	167	1.25	1518
MS-3 (Red)	180	1900	10.6	110	1.64	1161
MS-4 (NIR)	236	1900	8.1	110	2.15	886
AVHRR-ch1 *	329	982	3.0	338	0.97	1009
TM-band1 *	58	255	4.4	235	0.25	1033
TM-band4 *	183	255	1.4	302	0.61	421

* from Bindschadler and Vornberger (2000)

Conclusions

- IKONOS imagery are high quality
- Potential uses are enormous
- At-sensor radiance calibration must be improved
- Earth Science users must be given unmodified data (or given a means to recover reliable at-sensor radiance)
- Radiometric resolution could be improved