Assessing the Accuracy of ASTER DEM's as Compared to SRTM DEM's

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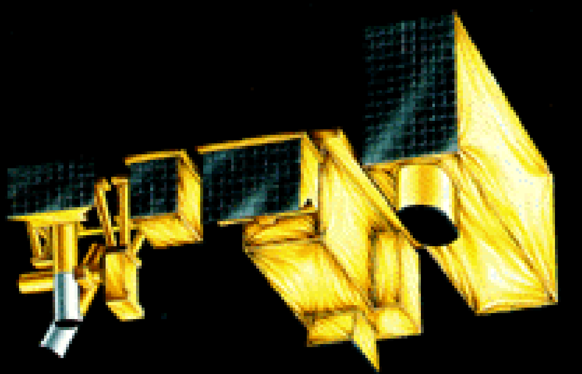
Presentation Outline

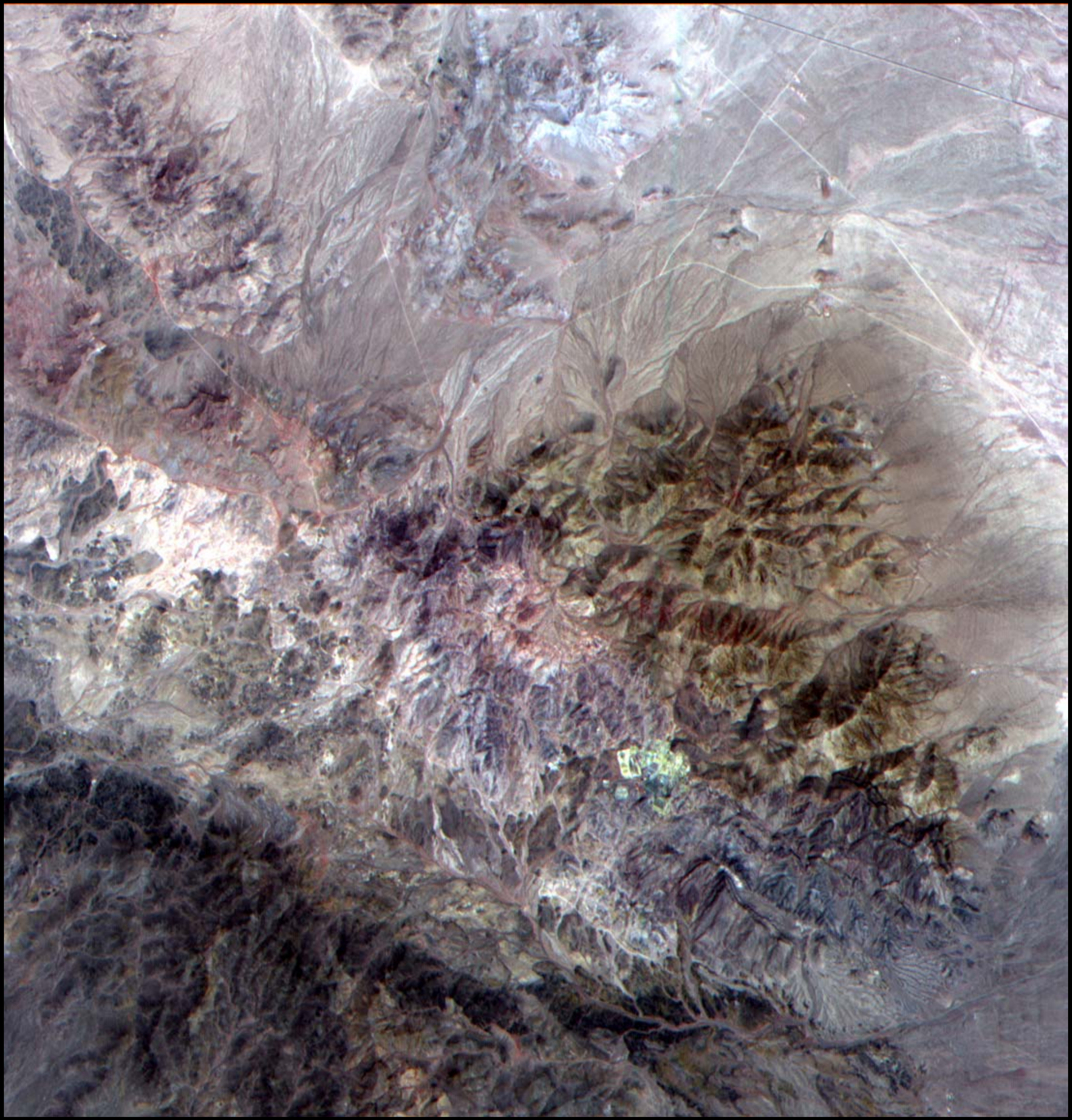
- Introduction
  - ASTER Characteristics
  - ASTER Digital Elevations Models (DEM's)
- Sources of ASTER DEM Data
- ASTER DEM Generation System Accuracy Assessment
- Important Factors for High-Accuracy ASTER DEM's
- Comparison of SRTM and ASTER DEM Data
- Summary and Conclusions

EOS Terra ASTER
Instrument Characteristics

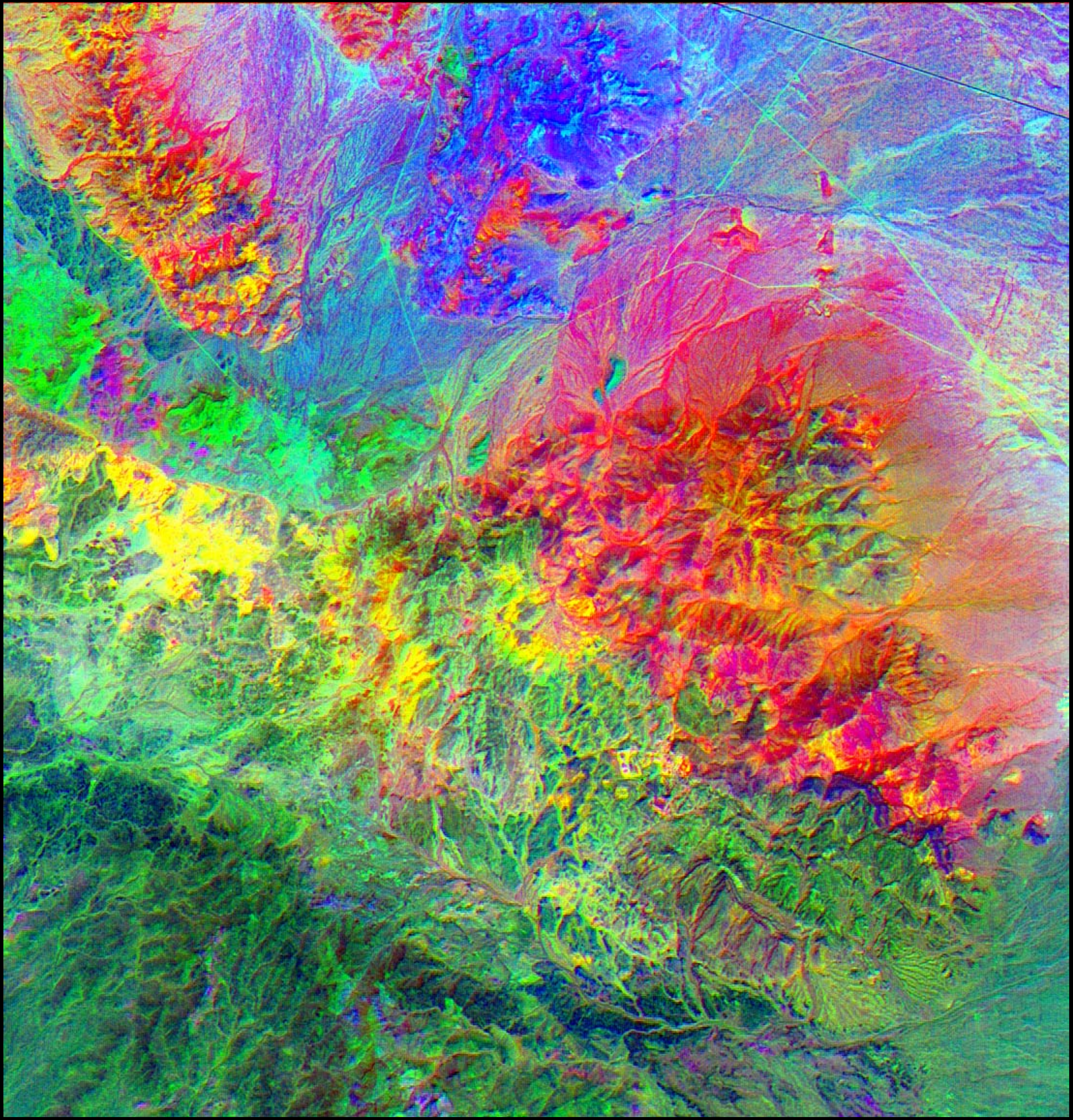


Band Number	Spectral Range (micrometers)	Ground Resolution (m)
1	0.52 to 0.60	15
2	0.63 to 0.69	15
3 (N & A)	0.76 to 0.86	15
4	1.60 to 1.70	30
5	2.145 to 2.185	30
6	2.185 to 2.225	30
7	2.235 to 2.285	30
8	2.295 to 2.365	30
9	2.360 to 2.430	30
10	8.125 to 8.475	90
11	8.475 to 8.825	90
12	8.925 to 9.275	90
13	10.25 to 10.95	90
14	10.95 to 11.65	90

Swath Width:	60 km
Repeat Coverage Interval:	8 days (via pointing)
Altitude:	705 km
Quantization:	8 VNIR/SWIR, 12 TIR
Inclination:	Sun-synchronous, 98.2^{o}
Equatorial Crossing:	Descending, 10:45 a.m.
Launched:	December 18, 1999



ASTER FCC of the Drum Mts. area, Utah



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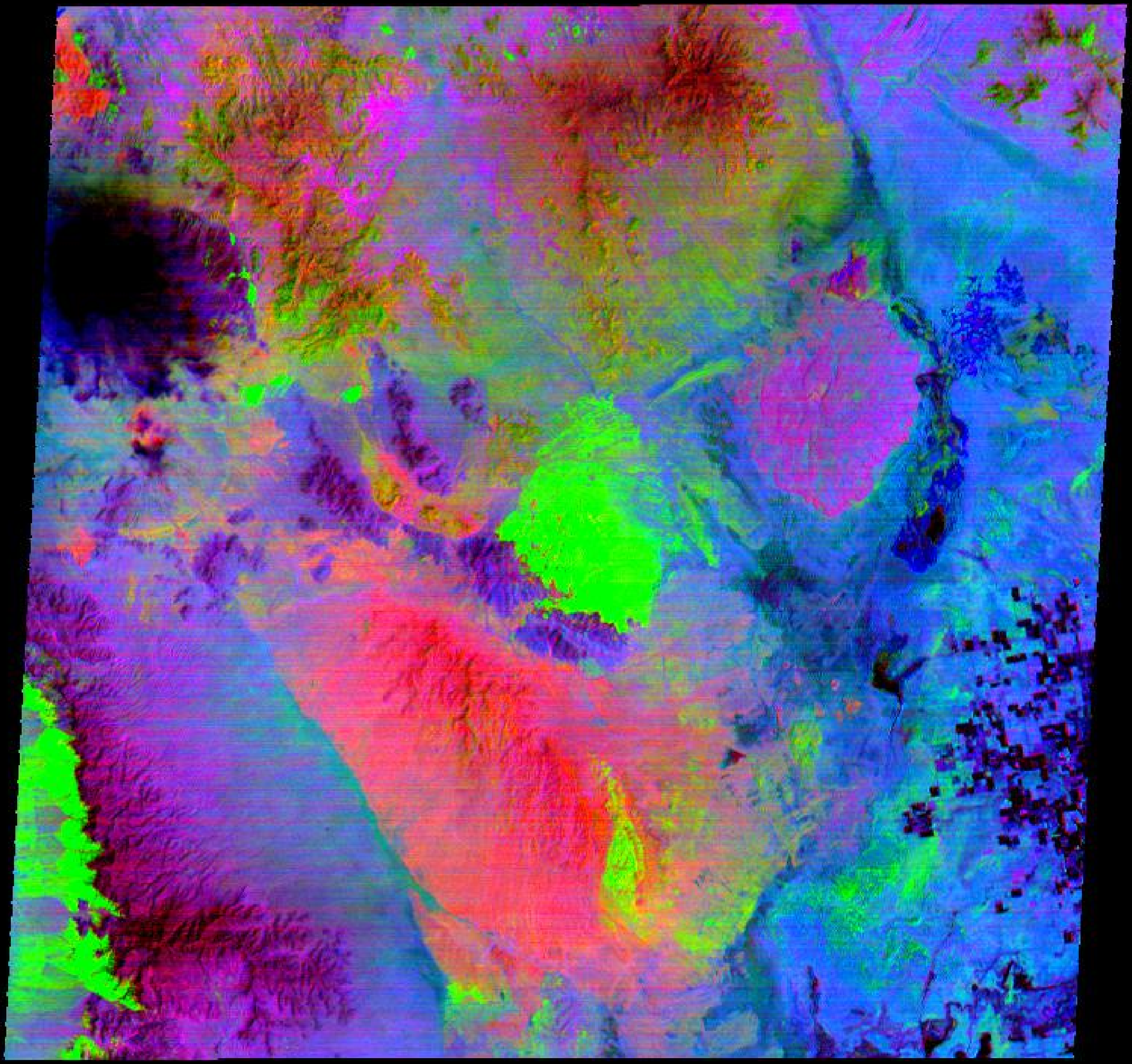
ASTER vnir-swir Decorrelation Stretch 4(R) 3(G) 7(B) Saturation Stretch



ASTER TIR Decorrelation Stretch Standard Data Product (AST 06T)

ASTER Standard Data Products – U.S. Version

Level	Short Name	Product Description	Release Status	Release Date
1A	AST_1A	Radiance at sensor	Validated	11/10/00
1B	AST_1B	Registered radiance at sensor	Validated	11/10/00
2	AST_04	Brightness temperature	Validated	12/22/00
2	AST_05	Surface emissivity	Validated	4/9/01
2	AST_06	Decorrelation stretch (VNIR, SWIR, TIR)	Validated	Rout.12/8/00 OD 12/22/00
2	AST_07	Surface reflectance (VNIR,SWIR)	Validated	1/24/01
2	AST_08	Surface kinetic temperature	Validated	4/9/01
2	AST_09	Surface radiance (VNIR,SWIR)	Validated	1/24/01
2	AST_09T	Surface radiance (TIR)	Validated	3/28/01
2	AST13POL	Polar surface and cloud classification	Provisional	10/26/01
3	AST14DEM	Digital elevation model	Validated	3/16/01

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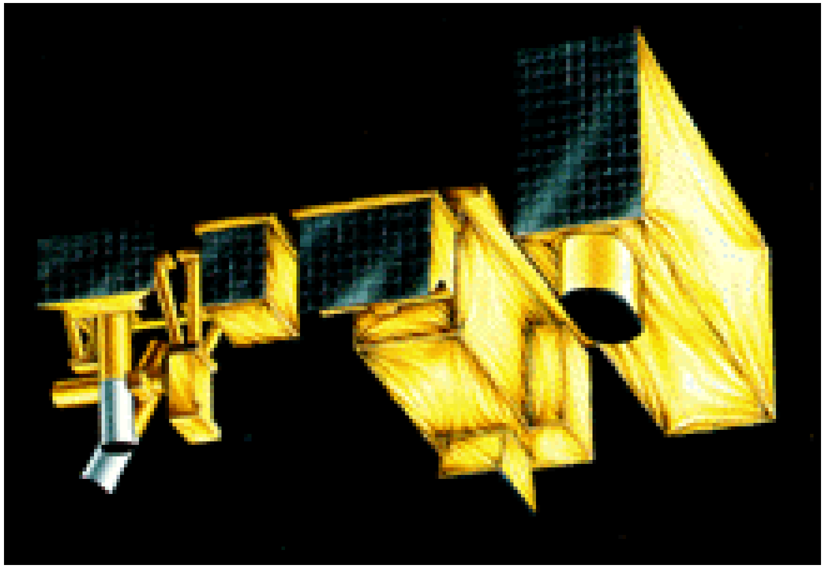
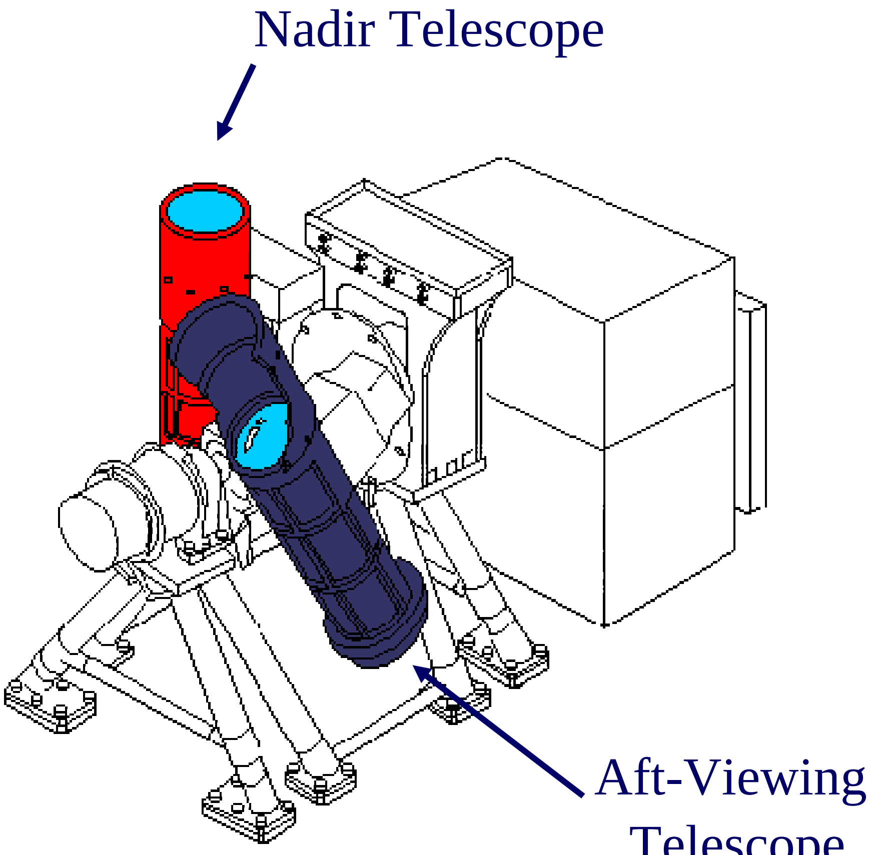
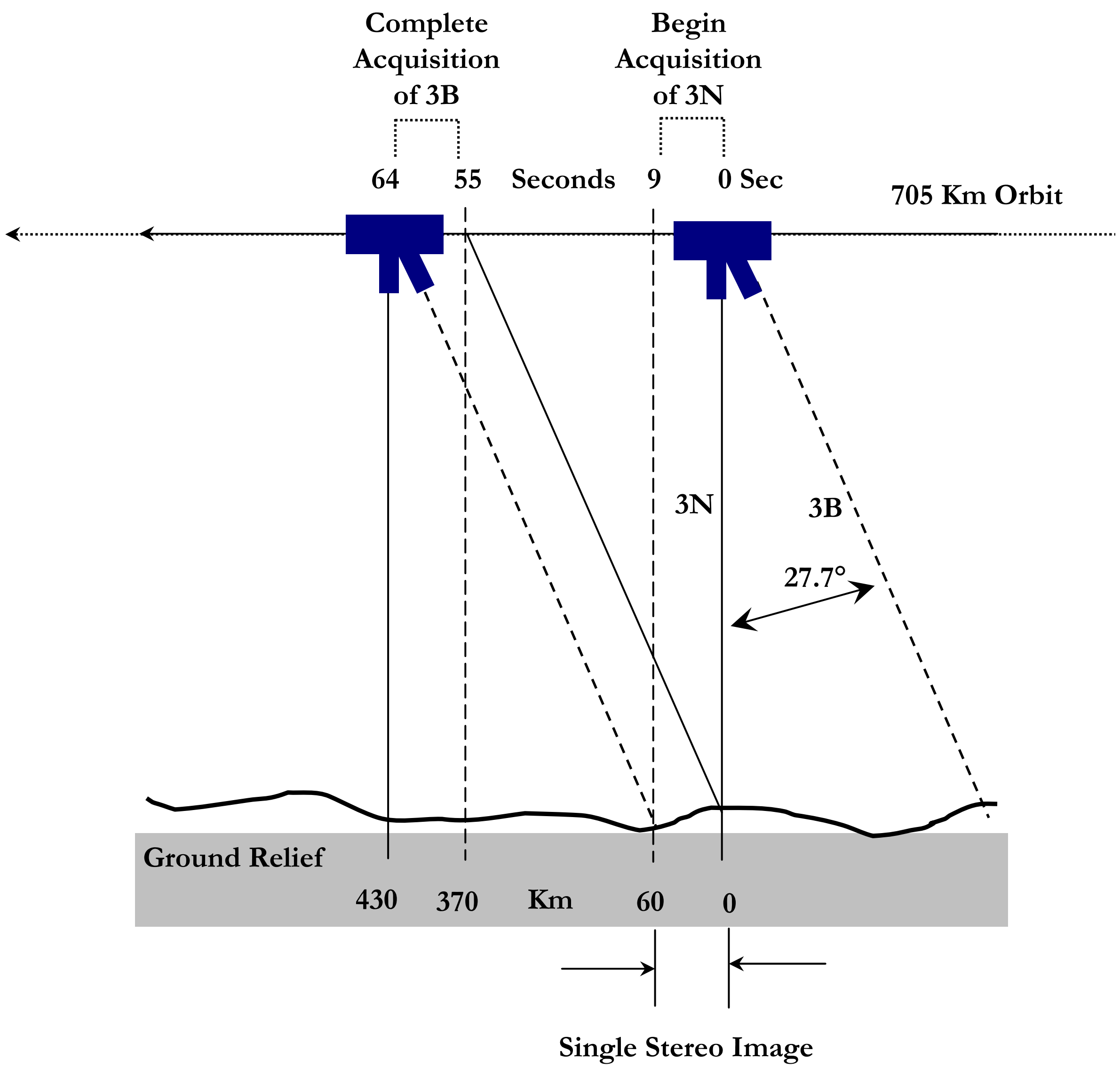
ASTER VNIR Telescopes – Nadir- and Aft-Looking



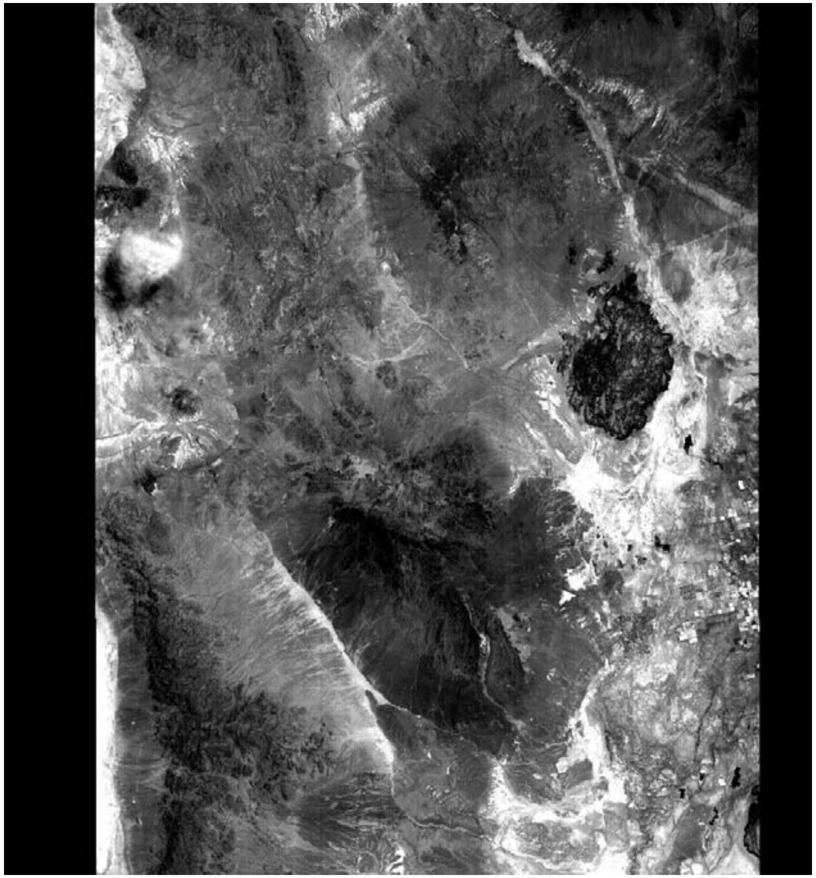


Along-Track Imaging Geometry of the ASTER VNIR Nadir and Aft-Viewing Sensors



ASTER Stereo Image Data

ASTER 3N Image



ASTER 3B Image

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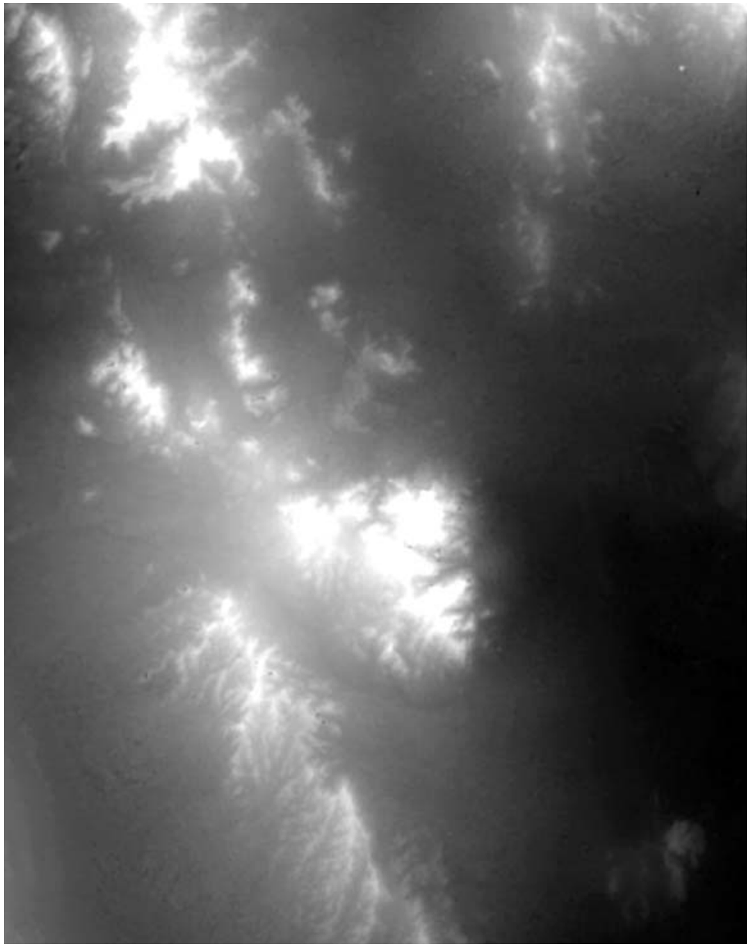
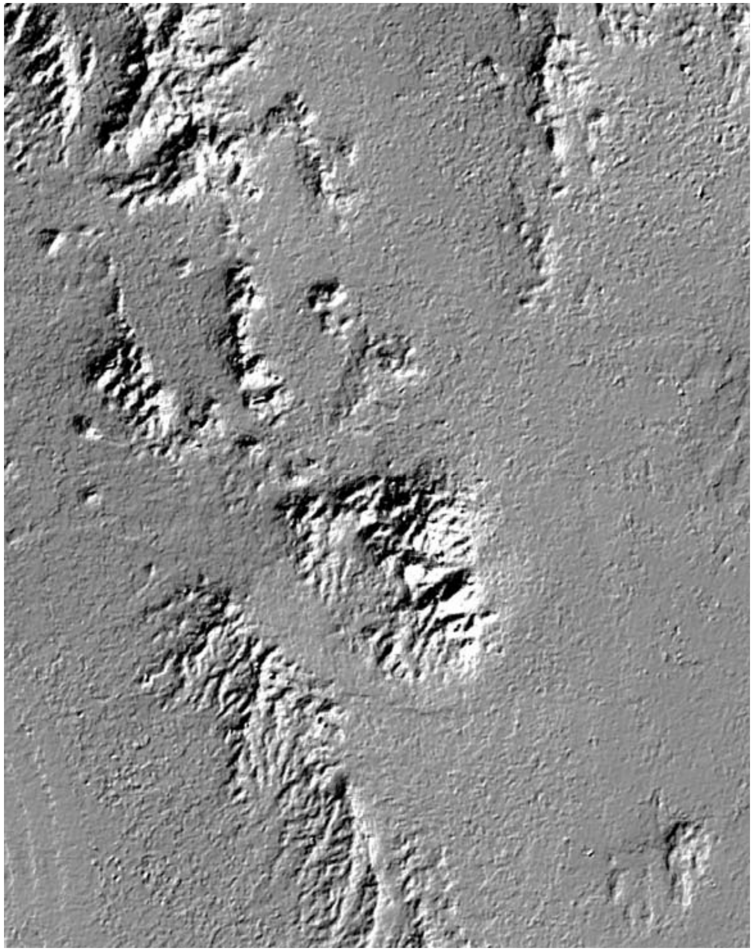
ASTER Digital Elevation Models



ASTER DEM Intensity Image



ASTER DEM Shade Relief Image

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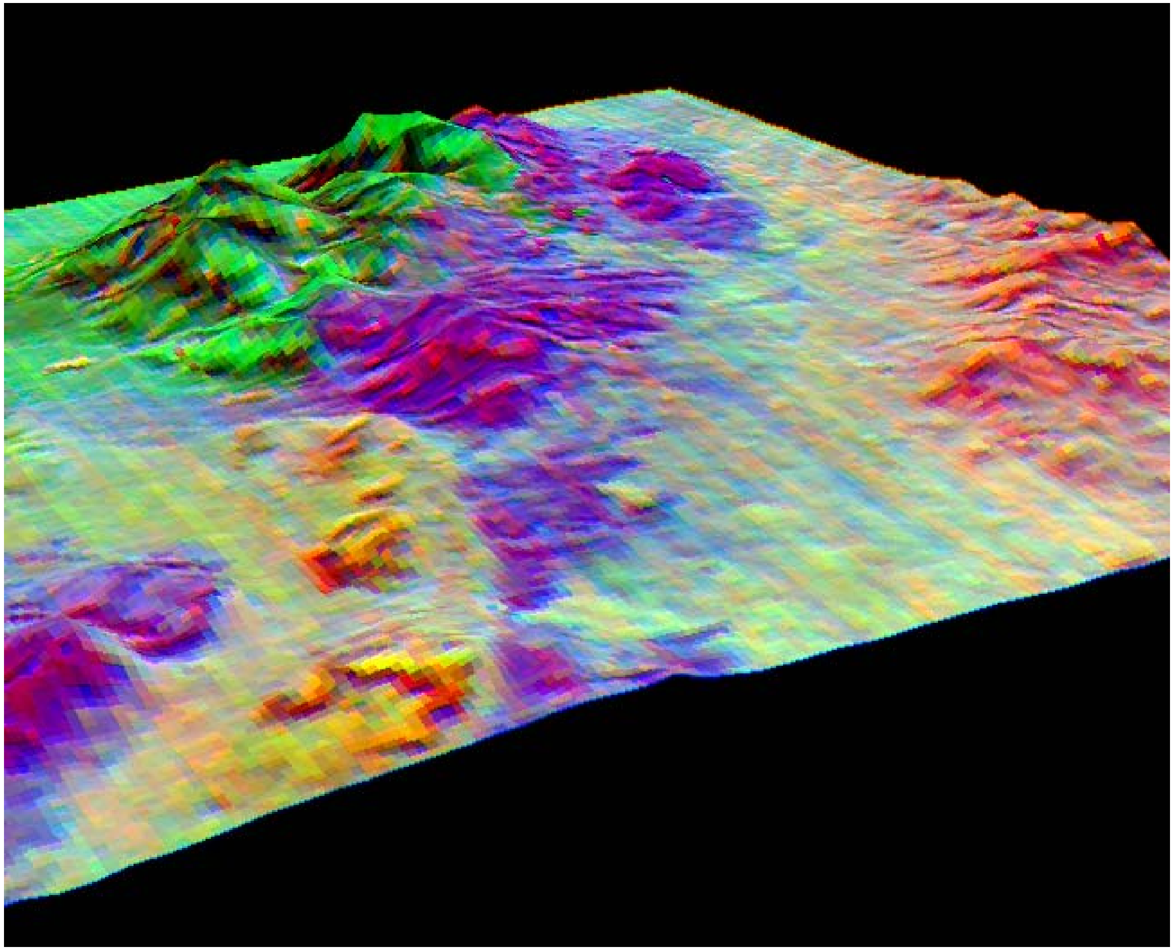
Combining ASTER TIR and DEM Data



ASTER TIR (90 m) Data Draped on ASTER DEM

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Sources of ASTER DEM Products

- ASTER DEM's may be ordered by users as on-demand data products.
  - **ASTER GDS** offers a relative (systematic) DEM as a Semi-Standard data product.
  - The **Land Process DAAC** offers an absolute and a relative (systematic) DEM as a Standard Data Product.
- High-quality ASTER DEM generation software packages now are available for purchase from which users may produce their own ASTER DEM's.
  - **SILCAST ASTER DEM/Ortho Software** available from Sensor Information Laboratory Corp. in Tsukuba, Japan.
  - **AsterDTM Software** available from SulSoft in Porto Alegre, Brazil.
  - Others

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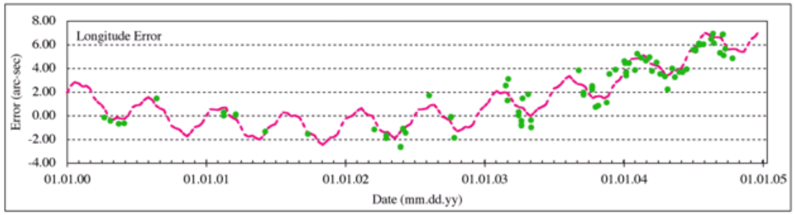
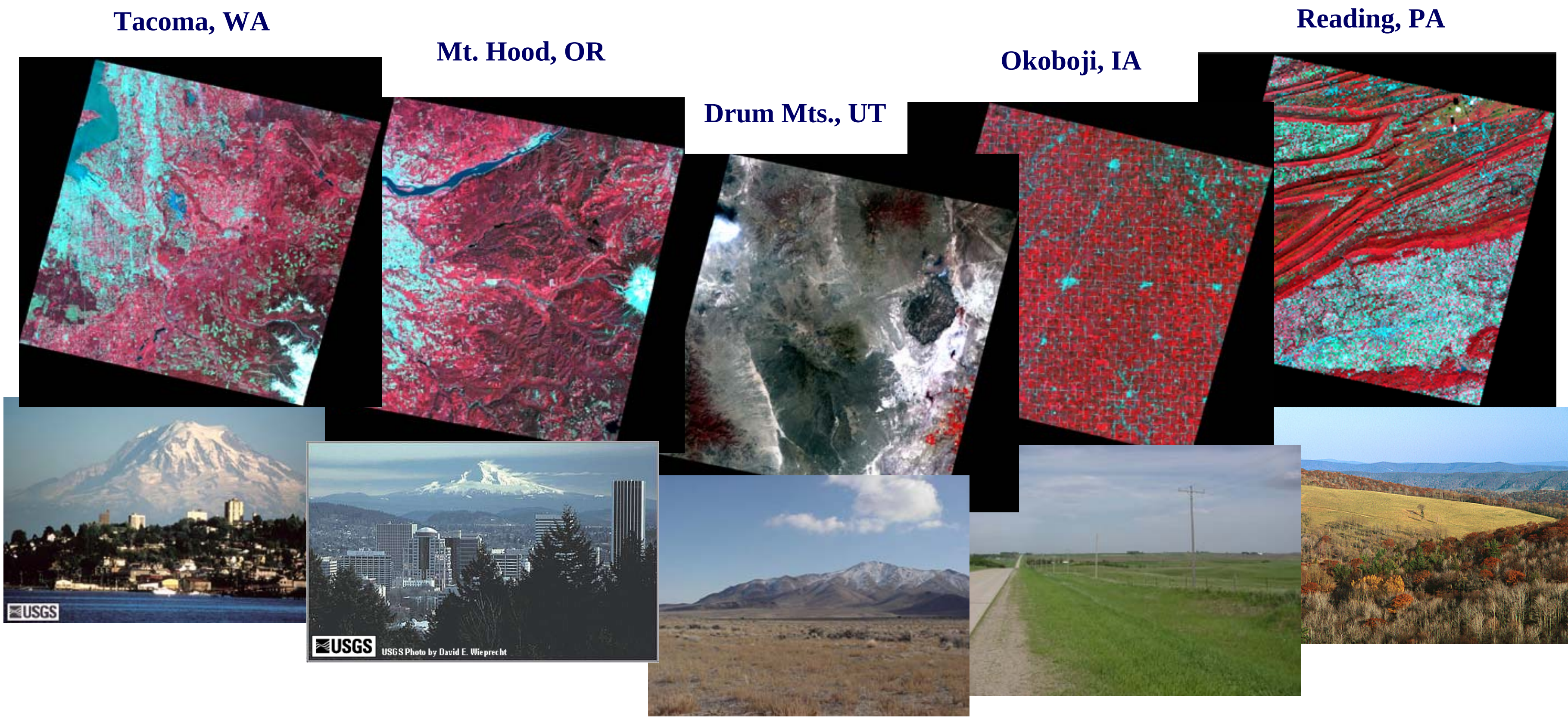
ASTER DEM Assessment Study Objectives

- Evaluate the accuracy of ASTER DEM's, given the known geolocation accuracy effects, particularly over time.
  - Earth rotation rate error
  - Terrain error
  - Earth nutation error



- Assess the accuracy and characteristics of ASTER DEM's generated by various production systems in consideration of possibly changing LP DAAC production software.
  - LP DAAC
  - ASTER GDS
  - SILCAST (SILC)
  - AsterDTM (SulSoft)

Study Site Selection and Characteristics



- Five sites selected
- Variable terrain
- Two ASTER scenes per site
- Early & recent dates
- Multiple pointing angles

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General Methodology

- Generate DEM's from ASTER L1A data (30 m postings).
  - GDS and LP DAAC produced DEM's per our request.
  - We produced DEM's using SILCAST and AsterDTM software.
- Assess horizontal accuracies.
  - Used USGS orthophoto quads and topo maps to determine x-y offsets.
  - Calculate statistics to determine RMSEx and RMSEy values.
- Assess vertical accuracies.
  - Used USGS National Elevation Data (NED) as primary reference data.
  - Produced NED - ASTER DEM "difference" images.
  - Calculated means and standard deviations on all difference images.
  - Calculated RMSEz values from 25 randomly selected and evenly distributed points within each difference image.

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Typical Ground Control Point Distribution

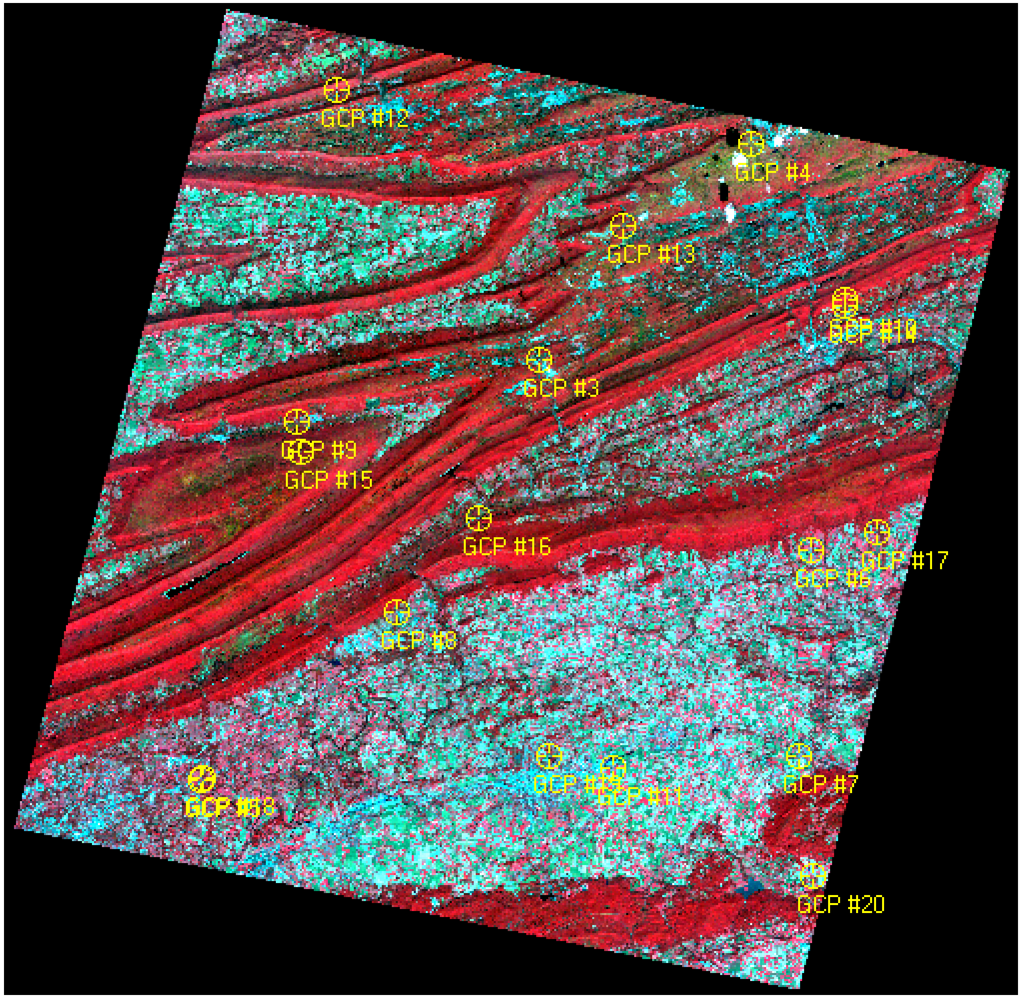
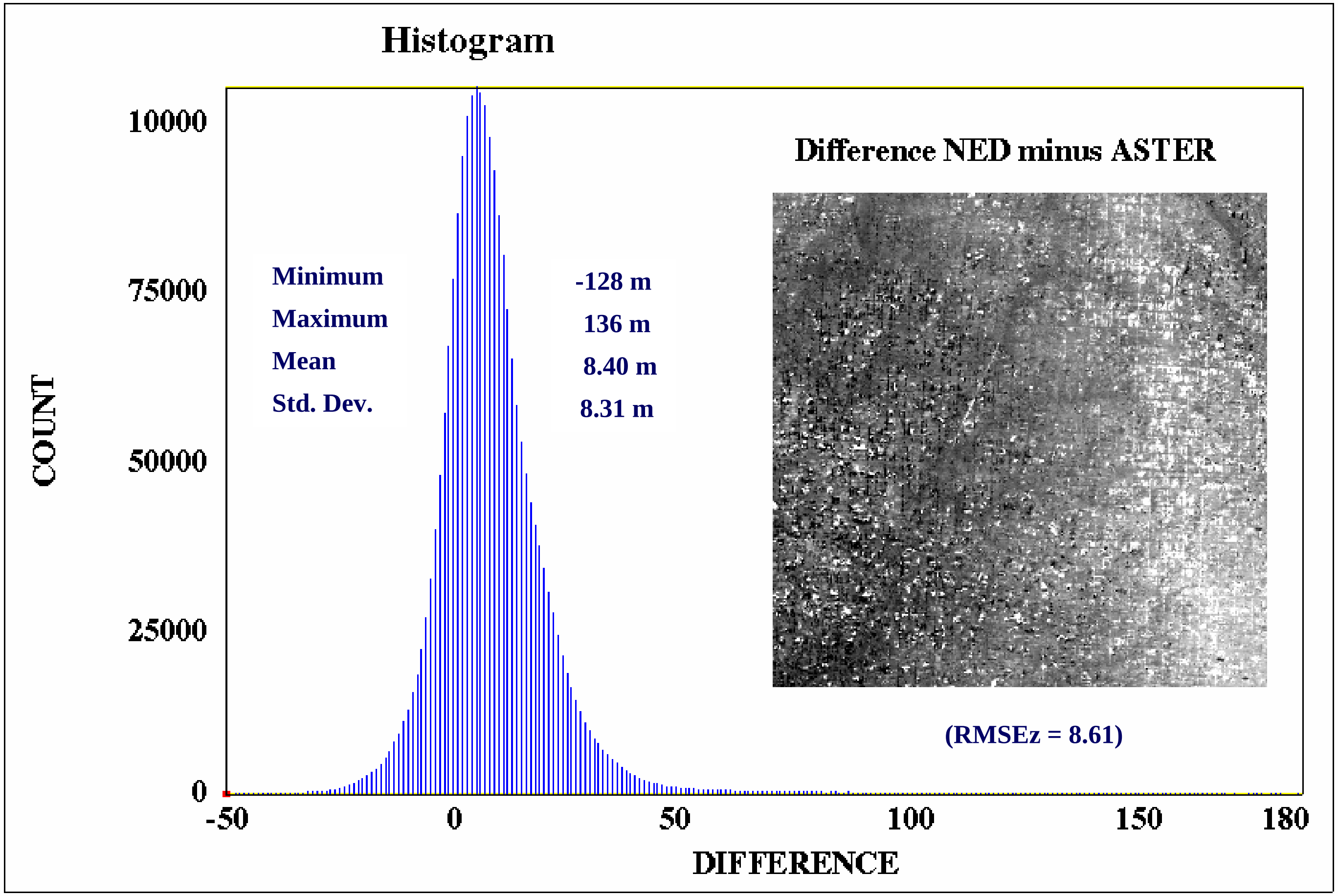


Image Statistics Derived from Difference Image



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Horizontal Accuracies by DEM Generation System

Software System	Uncorrected X-Dir. Error	X RMSEx	Y RMSEy	Uncorrected X-Dir. Error	X RMSEx	Y RMSEy
SILC Early		16.98	14.08		19.87	14.81
SILC Recent		22.76	15.53			
GDS Early	44.29	50.71	10.60	75.04	73.13	14.00
GDS Recent	105.78	95.55	17.39			
SulSoft Early	44.29	20.66	21.99	75.04	43.06	22.92
SulSoft Recent	105.78	65.46	23.85			
DAAC Early	44.29	68.03	23.13	75.04	86.20	25.65
DAAC Recent	105.78	104.36	28.16			

* Recent S/W enhancements implemented by GDS, SulSoft, and LP DAAC since completion of this study may improve some results shown in this table.

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Vertical Accuracies by DEM Generation System

Software System		X	Y	Z				Z		
		RMSEx	RMSEy	Mean	Std Dev	RMSEz		Mean	Std Dev	RMSEz
SILC Early		16.98	14.08	10.46	15.40	14.36		7.04	13.89	11.64
SILC Recent		22.76	15.53	3.63	12.38	8.92				
GDS Early		50.71	10.60	9.68	14.23	14.00		10.13	15.87	15.68
GDS Recent		95.55	17.39	10.58	17.51	17.36				
SulSoft Early		20.66	21.99	24.47	18.69	18.97		22.70	20.33	18.99
SulSoft Recent		65.46	23.85	20.92	21.97	19.00				
DAAC Early		68.03	23.13	17.71	21.66	26.77		20.73	25.22	31.18
DAAC Recent		104.36	28.16	23.76	28.78	35.58				

* Recent S/W enhancements implemented by GDS, SulSoft, and LP DAAC since completion of this study may improve some results shown in this table.

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ASTER DEM Generation System Study Conclusions

- DEM’s from all of the sources tested in this study met pre-launch specifications for accuracy, which were 30 m RMSExyz for ASTER DEM standard data products generated without use of GCP’s.
- However, accuracies determined by this study did vary among systems evaluated, depending on the extent to which know geolocation errors were corrected by the software, as well as on the fundamental DEM generation approach and methodology adopted by each system.

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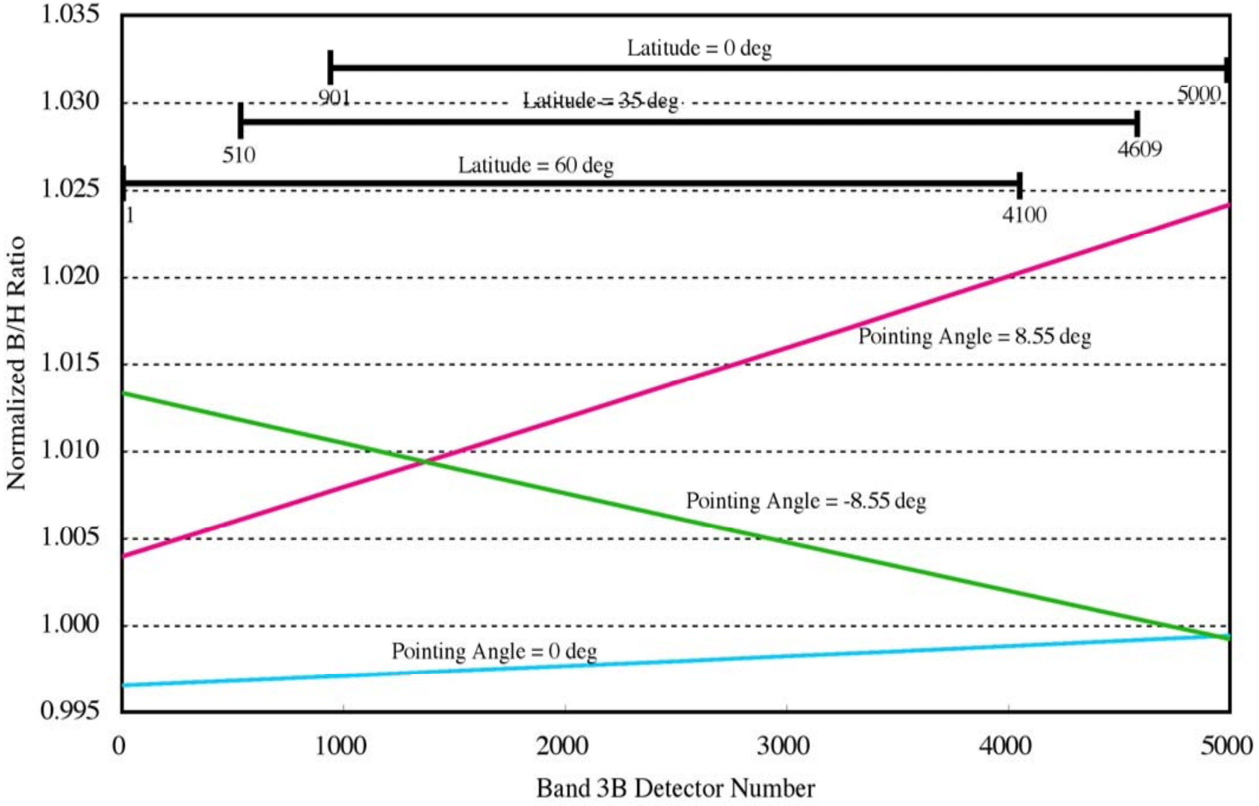
Important Considerations for Calculating High-Accuracy ASTER DEM's

- Elevation value can be calculated as follows:

$$H = \frac{\text{(Parallax between Band 3N and 3B) x Pixel Size}}{\text{B/H Ratio}}$$

- Parallax between Band 3N and Band 3B can be evaluated using the correlation method.
- Pixel size of ASTER is exactly 15 m in the along-track direction.
- Nominal B/H ratio is designed to be 0.6 for ASTER.
- However, detailed information on B/H ratio is very important for high quality DEM generation, because true B/H ratio depends on observation conditions such as cross-track pointing angle, latitude, and pixel scene position.

ASTER Instrument Parameter Dependence of Parallax (B/H Ratio)



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Vertical Accuracies Compared: SRTM vs. ASTER DEM's

ASTER (SilCast)

Test Site	Acquisition Date	Z Mean	Z Std Dev	Z RMSEz
Drum Mountains, UT	31-Jul-00	-8.83	11.17	11.29
Mt Hood, OR	24-Sep-02	-21.79	15.91	20.02
Okoboji, IA	31-Aug-01	11.49	18.85	15.02
Reading, PA	05-Oct-01	-8.14	15.93	15.27
Tacoma, WA	28-Jun-00	2.03	15.15	10.22
	Average (Abs)	10.46	15.40	14.36
Drum Mountains, UT	20-Mar-04	0.15	8.78	8.78
Mt Hood, OR	27-Jul-04	-3.97	18.84	9.73
Okoboji, IA	22-Oct-03	-3.93	9.68	9.23
Reading, PA	06-May-04	4.61	11.67	8.50
Tacoma, WA	05-Jun-03	5.49	12.94	8.35
	Average (Abs)	3.63	12.38	8.92

SRTM

Test Site	Acquisition Date	Z Mean	Z Std Dev	Z RMSEz
Drum Mountains, UT	N/A	-2.20	2.95	2.78
Mt Hood, OR	"	-13.80	14.23	16.83
Okoboji, IA	"	4.71	1.78	4.83
Reading, PA	"	-5.63	6.25	8.02
Tacoma, WA	"	-1.99	10.75	7.91
	Average (Abs)	5.67	7.19	8.07

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Summary and Conclusions

- The ASTER instrument onboard NASA's Terra satellite provides 15 m stereo image data capable of generating high-accuracy DEM's without use of GCP's.
- The ability to produced high-accuracy DEM's depends on precise utilization of information available in ASTER L1A data, particularly LOS vector tables.
- Accuracy of DEM's produced without use of GCP's from ASTER L1A data acquired under normal operating conditions compared favorably with DEM's generated over the same locations from SRTM data.
- High-accuracy ASTER DEM's should be viable candidates for supplementing SRTM DEM's in areas where gaps in those data exist.

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Back-Up Slides

ASTER Line-of-Sight (LOS) Vector Table

(Pointing Angle = 8.591 degrees)

Band 3B L0S Table

Nagoya=3B

Roll

-0.462196	-0.462382	-0.462526	-0.462628	-0.462691	-0.462715	-0.462701	-0.462649	-0.462558	-0.462428	-0.462258
-0.462192	-0.462379	-0.462522	-0.462625	-0.462688	-0.462712	-0.462698	-0.462645	-0.462555	-0.462425	-0.462254
-0.462193	-0.462379	-0.462523	-0.462625	-0.462688	-0.462712	-0.462698	-0.462646	-0.462555	-0.462425	-0.462254
-0.462194	-0.462380	-0.462523	-0.462626	-0.462689	-0.462712	-0.462698	-0.462646	-0.462555	-0.462425	-0.462254
-0.462194	-0.462381	-0.462524	-0.462626	-0.462689	-0.462713	-0.462699	-0.462646	-0.462555	-0.462425	-0.462255
-0.462195	-0.462381	-0.462525	-0.462627	-0.462690	-0.462713	-0.462699	-0.462647	-0.462556	-0.462426	-0.462255
-0.462196	-0.462382	-0.462525	-0.462627	-0.462690	-0.462714	-0.462700	-0.462647	-0.462556	-0.462426	-0.462255
-0.462196	-0.462383	-0.462526	-0.462628	-0.462691	-0.462714	-0.462700	-0.462647	-0.462557	-0.462426	-0.462256
-0.462197	-0.462383	-0.462526	-0.462629	-0.462691	-0.462715	-0.462700	-0.462648	-0.462557	-0.462427	-0.462256
-0.462197	-0.462383	-0.462526	-0.462629	-0.462691	-0.462715	-0.462700	-0.462648	-0.462557	-0.462427	-0.462256
-0.462197	-0.462384	-0.462527	-0.462629	-0.462691	-0.462715	-0.462701	-0.462648	-0.462557	-0.462427	-0.462256
-0.462198	-0.462384	-0.462527	-0.462629	-0.462692	-0.462715	-0.462701	-0.462648	-0.462557	-0.462427	-0.462256
-0.462198	-0.462384	-0.462527	-0.462629	-0.462692	-0.462715	-0.462701	-0.462648	-0.462557	-0.462427	-0.462256
-0.462198	-0.462384	-0.462528	-0.462630	-0.462692	-0.462716	-0.462701	-0.462649	-0.462558	-0.462428	-0.462257
-0.462202	-0.462388	-0.462531	-0.462633	-0.462696	-0.462720	-0.462705	-0.462653	-0.462562	-0.462431	-0.462260

Pitch

0.157302	0.148078	0.138868	0.129666	0.120468	0.111266	0.102056	0.092830	0.083581	0.074302	0.064985
0.157300	0.148076	0.138866	0.129664	0.120466	0.111264	0.102054	0.092828	0.083579	0.074300	0.064983
0.157298	0.148074	0.138864	0.129662	0.120464	0.111263	0.102052	0.092826	0.083577	0.074298	0.064981
0.157296	0.148072	0.138862	0.129660	0.120462	0.111261	0.102050	0.092824	0.083575	0.074296	0.064980
0.157294	0.148070	0.138860	0.129658	0.120460	0.111259	0.102048	0.092822	0.083573	0.074294	0.064978
0.157292	0.148068	0.138858	0.129657	0.120458	0.111257	0.102046	0.092820	0.083571	0.074292	0.064976
0.157290	0.148066	0.138856	0.129654	0.120456	0.111254	0.102044	0.092818	0.083569	0.074290	0.064973
0.157284	0.148060	0.138850	0.129648	0.120450	0.111249	0.102038	0.092812	0.083563	0.074284	0.064968
0.157282	0.148058	0.138848	0.129646	0.120448	0.111247	0.102036	0.092810	0.083561	0.074282	0.064966
0.157282	0.148058	0.138848	0.129646	0.120448	0.111247	0.102036	0.092810	0.083561	0.074282	0.064966
0.157281	0.148057	0.138846	0.129645	0.120446	0.111245	0.102035	0.092809	0.083560	0.074281	0.064964
0.157280	0.148056	0.138846	0.129644	0.120445	0.111244	0.102034	0.092808	0.083559	0.074280	0.064963
0.157280	0.148056	0.138846	0.129644	0.120446	0.111244	0.102034	0.092808	0.083559	0.074280	0.064963
0.157280	0.148056	0.138846	0.129644	0.120446	0.111244	0.102034	0.092808	0.083559	0.074280	0.064963
0.157280	0.148056	0.138846	0.129644	0.120446	0.111244	0.102034	0.092808	0.083559	0.074280	0.064963

Yaw

0.872716	0.874229	0.875663	0.877019	0.878297	0.879497	0.880621	0.881668	0.882641	0.883538	0.884361
0.872718	0.874231	0.875666	0.877021	0.878299	0.879499	0.880623	0.881671	0.882643	0.883540	0.884363
0.872718	0.874231	0.875666	0.877021	0.878299	0.879499	0.880623	0.881671	0.882643	0.883540	0.884364
0.872718	0.874231	0.875666	0.877021	0.878299	0.879499	0.880623	0.881671	0.882643	0.883540	0.884364
0.872718	0.874231	0.875666	0.877021	0.878299	0.879499	0.880623	0.881671	0.882643	0.883540	0.884364
0.872718	0.874231	0.875666	0.877021	0.878299	0.879499	0.880623	0.881671	0.882643	0.883540	0.884364
0.872718	0.874232	0.875666	0.877021	0.878299	0.879499	0.880623	0.881671	0.882643	0.883540	0.884364
0.872719	0.874232	0.875666	0.877022	0.878299	0.879500	0.880623	0.881671	0.882643	0.883541	0.884364
0.872719	0.874232	0.875666	0.877022	0.878299	0.879500	0.880623	0.881671	0.882643	0.883541	0.884364
0.872719	0.874232	0.875666	0.877022	0.878299	0.879500	0.880623	0.881671	0.882643	0.883541	0.884364
0.872719	0.874232	0.875666	0.877022	0.878299	0.879500	0.880623	0.881671	0.882643	0.883541	0.884364
0.872719	0.874232	0.875666	0.877022	0.878299	0.879500	0.880623	0.881671	0.882643	0.883541	0.884364
0.872719	0.874232	0.875666	0.877022	0.878299	0.879500	0.880623	0.881671	0.882643	0.883541	0.884364
0.872719	0.874232	0.875666	0.877022	0.878299	0.879499	0.880623	0.881671	0.882643	0.883540	0.884364
0.872717	0.874230	0.875664	0.877020	0.878297	0.879498	0.880621	0.881669	0.882641	0.883538	0.884362

Band 3N L0S Table

LOS_NIIGATA_3N

Roll

0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370
0.000349	0.000347	0.000348	0.000350	0.000352	0.000355	0.000358	0.000361	0.000363	0.000366	0.000370

Pitch

-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347
-0.106851	-0.115583	-0.124284	-0.132958	-0.141611	-0.150246	-0.158869	-0.167485	-0.176099	-0.184718	-0.193347

Yaw

0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130
0.994275	0.993298	0.992246	0.991121	0.989922	0.988649	0.987300	0.985875	0.984372	0.982792	0.981130

Off-Nadir Angle (Band 3N)

Off-nadir Angle

0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607
0.020111	0.020016	0.020095	0.020233	0.020373	0.020574	0.020776	0.020980	0.021129	0.021337	0.021607

- Off-nadir angle can be calculated from roll and yaw components of LOS vectors.
- Off-nadir angle is almost constant (0.2) all over scene for Band 3N.

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Off-Nadir Angle (Band 3B)

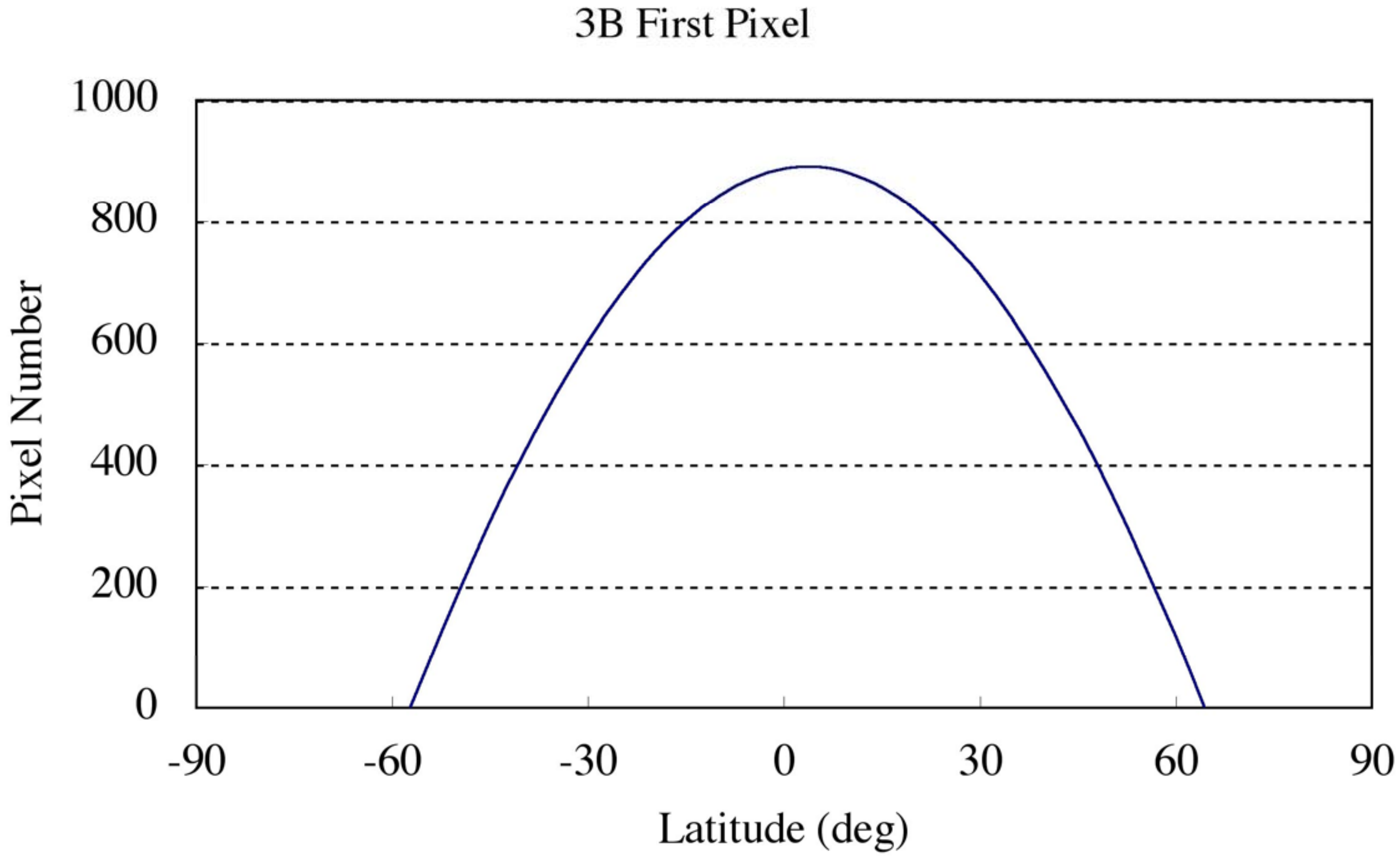
Det No.

Off-nadir Angle(AT)

0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
-27.905982	-27.874480	-27.843055	-27.811671	-27.780473	-27.749451	-27.718595	-27.687923	-27.657295	-27.626756	-27.5961
-27.905722	-27.874272	-27.842770	-27.811464	-27.780266	-27.749244	-27.718388	-27.687639	-27.657088	-27.626550	-27.5959
-27.905774	-27.874272	-27.842821	-27.811464	-27.780266	-27.749244	-27.718388	-27.687689	-27.657088	-27.626550	-27.59591
-27.905825	-27.874324	-27.842821	-27.811515	-27.780317	-27.749244	-27.718388	-27.687689	-27.657088	-27.626550	-27.59591
-27.905825	-27.874375	-27.842872	-27.811515	-27.780317	-27.749295	-27.718439	-27.687689	-27.657088	-27.626550	-27.5959
-27.905876	-27.874375	-27.842923	-27.811566	-27.780368	-27.749295	-27.718439	-27.687740	-27.657139	-27.626601	-27.5959
-27.905928	-27.874399	-27.842923	-27.811566	-27.780368	-27.749346	-27.718490	-27.687740	-27.657139	-27.626601	-27.5959
-27.905900	-27.874450	-27.842974	-27.811590	-27.780419	-27.749320	-27.718490	-27.687740	-27.657190	-27.626575	-27.59601
-27.905952	-27.874450	-27.842974	-27.811642	-27.780419	-27.749371	-27.718490	-27.687791	-27.657190	-27.626626	-27.59601
-27.905952	-27.874450	-27.842974	-27.811642	-27.780419	-27.749371	-27.718490	-27.687791	-27.657190	-27.626626	-27.59601
-27.905952	-27.874501	-27.843025	-27.811642	-27.780419	-27.749371	-27.718541	-27.687791	-27.657190	-27.626626	-27.59601
-27.906003	-27.874501	-27.843025	-27.811642	-27.780470	-27.749371	-27.718541	-27.687791	-27.657190	-27.626626	-27.59601
-27.906003	-27.874501	-27.843025	-27.811642	-27.780470	-27.749371	-27.718541	-27.687791	-27.657190	-27.626626	-27.59601
-27.906003	-27.874501	-27.843077	-27.811693	-27.780470	-27.749449	-27.718541	-27.687842	-27.657241	-27.626703	-27.5960
-27.906262	-27.874760	-27.843284	-27.811900	-27.780728	-27.749679	-27.718799	-27.688100	-27.657498	-27.626909	-27.5962

- Off-nadir angle depends on pixel position only, and almost constant for line position.
- Parallax between Band 3N and Band 3B can be calculated from two tables.

ASTER Band 3B First Pixel



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Pointing Angle Dependence