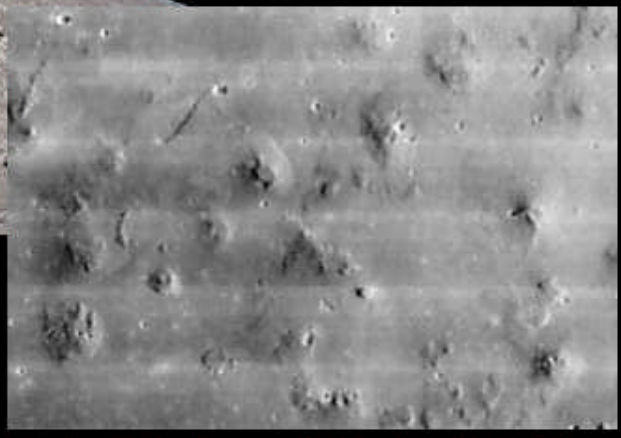
Simple Shape-from-shading (SfS) with Carlotto's method and MS-Excel
Part 2: The Parts of DEMCarlottoMethod.xls

Katima, Alaska

Mons Rumker - Apollo 15 AS15-97-13252



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Learning objectives for this part

1) What are the parts of the digital elevation model generating spreadsheet DEMCarlottoMethod.xls?

2) How do those spreadsheet parts relate to the components of the Shape-from-Shading (SfS) Carlotto algorithm discussed in Part 1 of this training presentation?

3) Where is the test data located?

4) How is a DEM generated using the test data?

This part, Part 2, focuses on generating a DEM using the spreadsheet, after you have imported the image's pixel data into this spreadsheet. The next part, Part 3, focuses on converting your image's pixels into a text file and then importing that data into this spreadsheet, DEMCarlottoMethod.xls.

Learning objectives for this part - continued

5) How can the zero-base elevation of the DEM be adjusted?

6) How is DEM data exported to text files for subsequent 3-D rendering?

7) What are the limitations of 3-D rendering using a VRML browser client?

8) What are the basic controls of a VRML 3-D browser client?

9) How is image data, filed for long-term storage, moved in the working image pixel map?

Learning objectives for this part - continued

This part concerns basic operations of DEMCarlottoMethod.xls, except for converting an image to digitzed text data and importing that data into the spreadsheet.

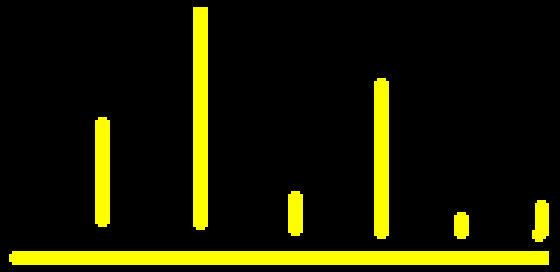
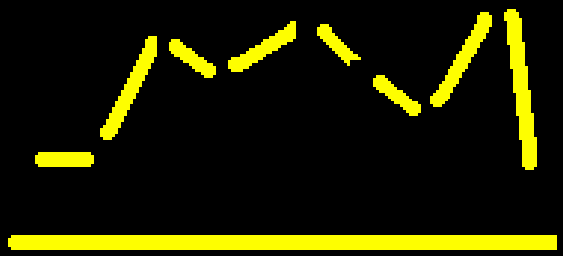
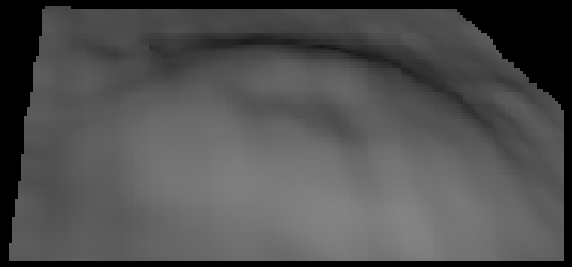
That last topic is covered in Part 3.

Backup copy

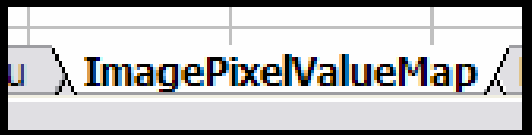
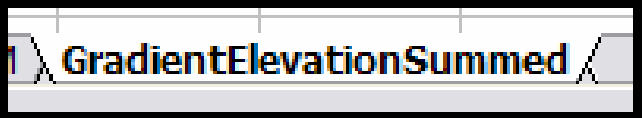
Make a backup copy of the spreadsheet DEMCarlottoMethod.xls as downloaded from the project website.

If you inadvertently erase parts of your spreadsheet during learning and practice, then you can quickly restore and resume learning.

Basic objects used by Carlotto's simplied SfS algorithm

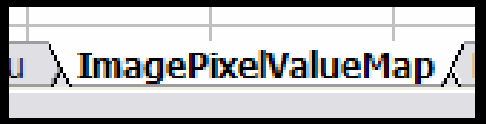
		Worksheet name
Image pixel map a.k.a. the reflectance map		Image pixel map
Gradient elevation map		None
Summed gradient map		Gradient sum map
Digital elevation model (DEM)		DEM

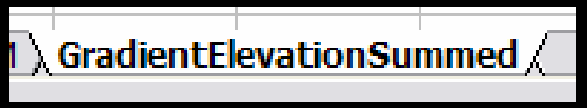
Basic objects used by Carlotto's simplied SfS algorithm

	Worksheet name	
Image pixel map a.k.a. the reflectance map	Image pixel map	
Gradient elevation map	None	
Summed gradient map	Gradient Elevation Summed	
Digital elevation model (DEM)	DEM	

Operations between objects in DEMCarlottoMethod.xls

	Worksheet name
Image pixel map a.k.a. the reflectance map	Image pixel map
conversion equation applied	
Gradient elevation map	None
summation addition	
Summed gradient map	Gradient Elevation Summed
multiply by horizontal scale	
Digital elevation model (DEM)	DEM





The Work Flow Menu controls the execution of these operations on the basic SfS objects

WorkflowMenu

Image pixel map a.k.a. the reflectance map

conversion equation applied

Gradient elevation map

summation addition

Summed gradient map

multiply by horizontal scale

Digital elevation model (DEM)

A - Process image to digital elevation map						
Step 1 - Paste source image's luminance pixel values into worksheet Ima as an NxM matrix						
Step 2 - Identify the range of the image pixel values to this spreadsheet						
	2a	Enter the upper left-hand pixel cell name:			$A$1	as
	2b	Enter the lower right-hand pixel cell name:			$BA$42	as
	2c	Click button to identify and name the range:				
	Name pixel range		Current value:		ImagePixelVa	
	Clear Image Pixel Map					
Step 3 - Enter image characteristics						
	3a	Image scale:	363	meters/px		36
	3b	Solar altitude:	4.19	degrees		85
	3c	Base terrian radius:	0	meters or kilometers		
Step 4 - Generate the digital elevation map						
	4a	Build DEM with precision:		1	digits	
	4b	Click button to generate DEM:				
	Generate DEM		Process status:			
	Delete DEM	Delete Gradient Sum Map			DEM Statistic	
	Before regenerating the DEM, first delete				DEM Min:	
	the current worksheet DEM				Image reflec	
	and GradientElevationSummed				E[i]:	

Data entry

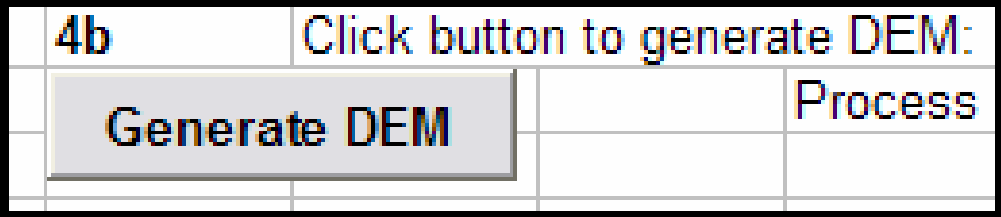
Result

36.3	meter/px	uncertainty
85.81	Zenith angle degrees	

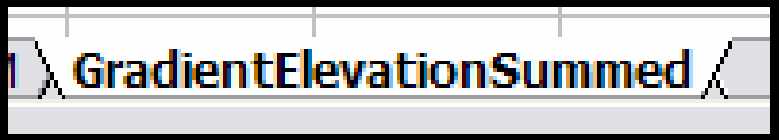
Open the spreadsheet DEMCarlottoMethod.xls and press the button "Generate DEM"

This will generate a new DEM and new gradient summed map using default test data.

+



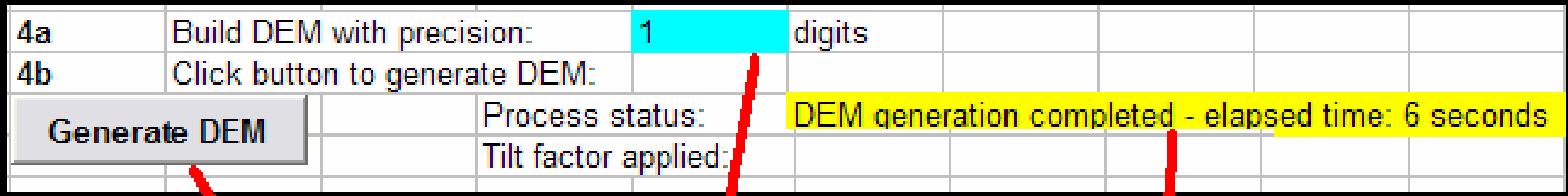
makes



Gradient elevation map

Digital elevation model (DEM)

The Work Flow Menu - control box types



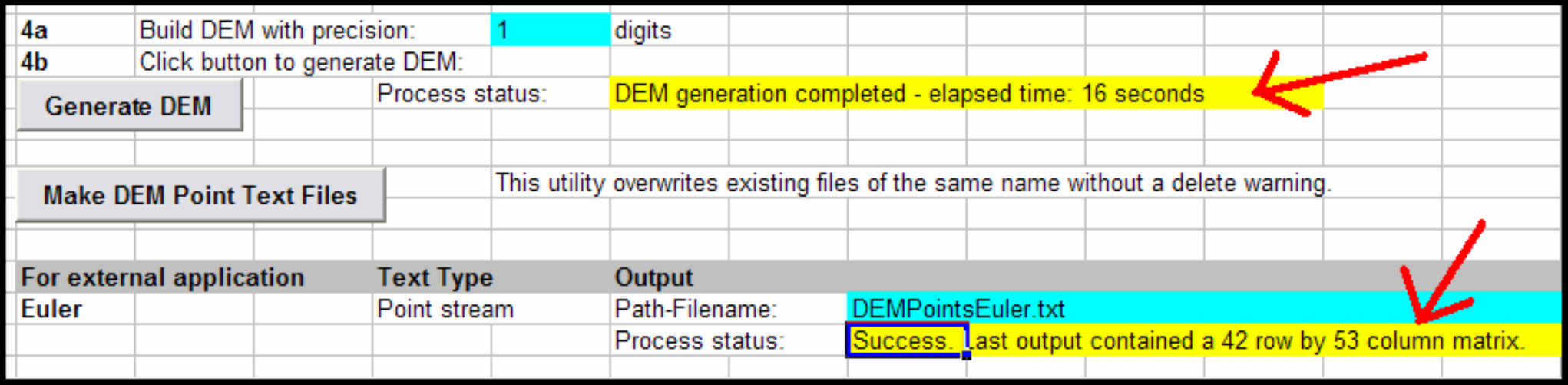
Command button

Blue is for entering data

Yellow are status messages or statistics reported by the program

DEM re-generation

As you are generating a DEM or outputting DEM data to text files, yellow highlighted status messages report processing progress. The current processing row, success and elapsed time are displayed.



4a	Build DEM with precision:	1	digits	
4b	Click button to generate DEM:			
Generate DEM		Process status:	DEM generation completed - elapsed time: 16 seconds	
Make DEM Point Text Files		This utility overwrites existing files of the same name without a delete warning.		
For external application		**Text Type**	**Output**	
Euler		Point stream	Path-Filename:	DEMPointsEuler.txt
			Process status:	Success. Last output contained a 42 row by 53 column matrix.

DEM generation cycle on the Work Flow Menu

WorkflowMenu

First, an image's data is loaded into the Image Pixel Map worksheet. A typical pattern of task emerges when using the Work Flow Menu to re-generate successive refined versions of a DEM:

1) Characteristics of the image will be modified.

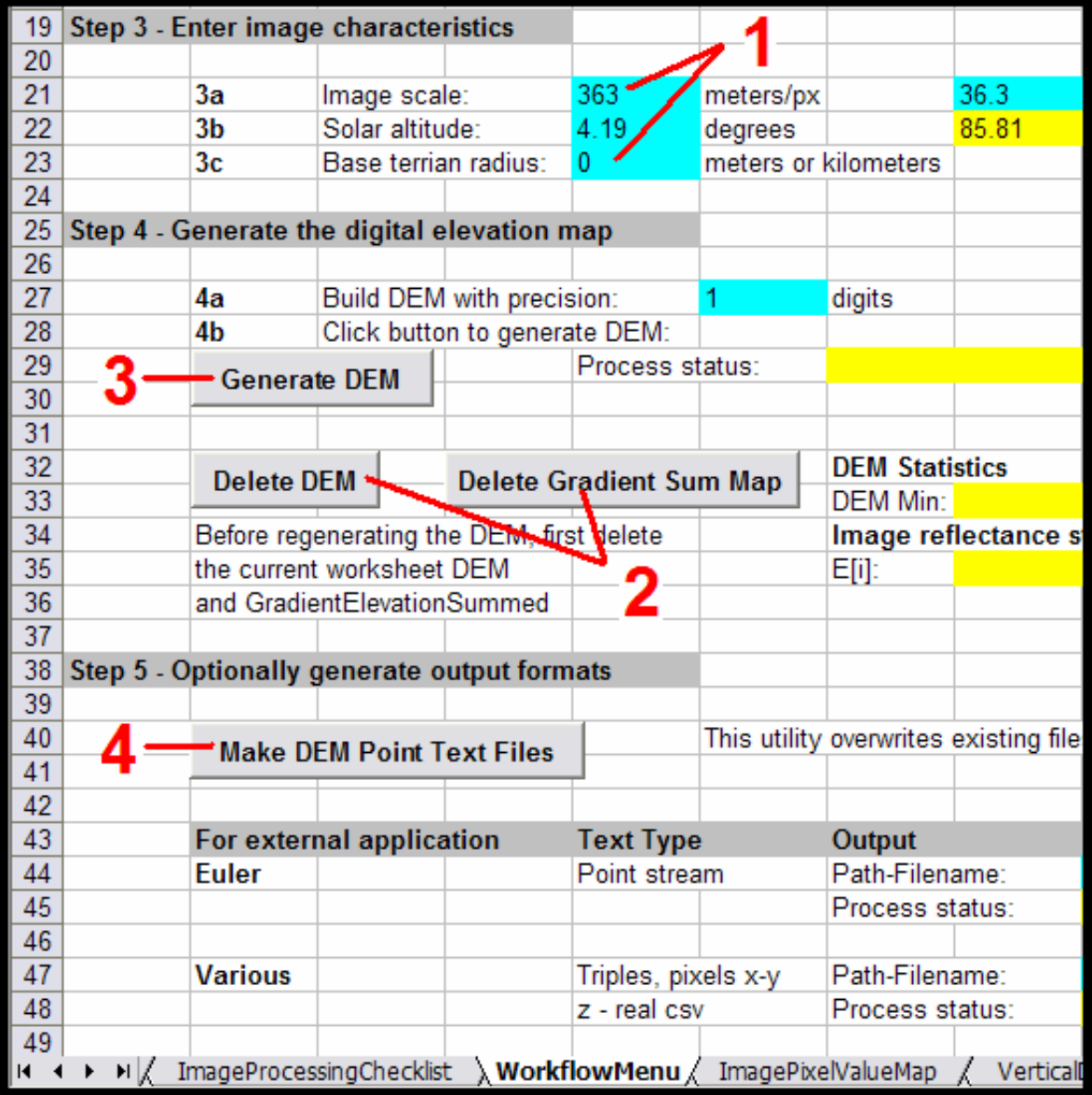
2) The prior Gradient Summed Map and DEM are deleted.

3) A new DEM and Gradient Summed Map are generated.

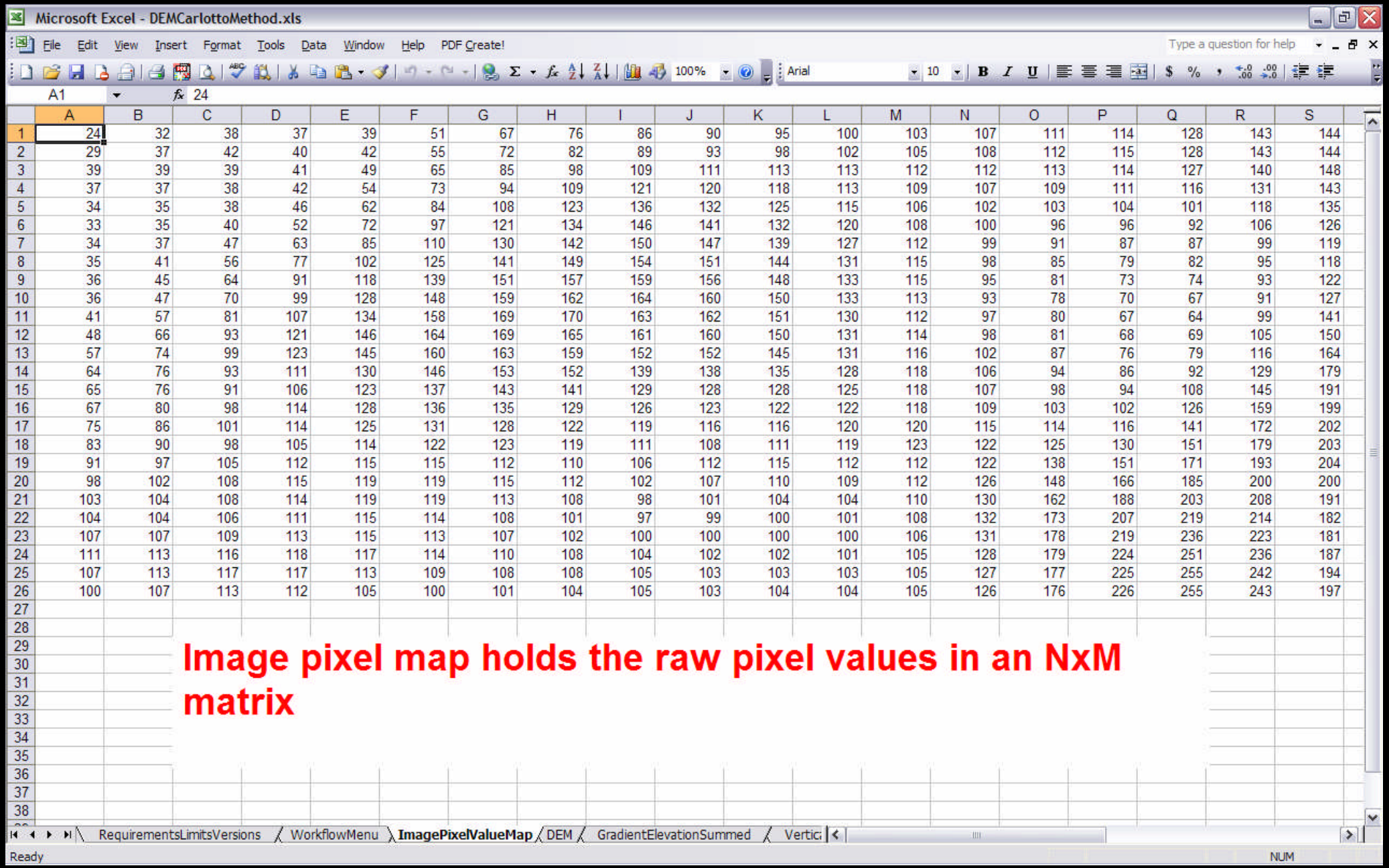
4) Output text files are generated and the 3-D elevation grid is viewed in VRML.

Test data for the Cauchy Omega dome is pre-loaded into the default version of DEMCarlottoMethod.xls.

Try running this cycle several times, until you are comfortable with the process.



Review the major worksheets in DEMCarlotto Method.xls



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	24	32	38	37	39	51	67	76	86	90	95	100	103	107	111	114	128	143	144
2	29	37	42	40	42	55	72	82	89	93	98	102	105	108	112	115	128	143	144
3	39	39	39	41	49	65	85	98	109	111	113	113	112	112	113	114	127	140	148
4	37	37	38	42	54	73	94	109	121	120	118	113	109	107	109	111	116	131	143
5	34	35	38	46	62	84	108	123	136	132	125	115	106	102	103	104	101	118	135
6	33	35	40	52	72	97	121	134	146	141	132	120	108	100	96	96	92	106	126
7	34	37	47	63	85	110	130	142	150	147	139	127	112	99	91	87	87	99	119
8	35	41	56	77	102	125	141	149	154	151	144	131	115	98	85	79	82	95	118
9	36	45	64	91	118	139	151	157	159	156	148	133	115	95	81	73	74	93	122
10	36	47	70	99	128	148	159	162	164	160	150	133	113	93	78	70	67	91	127
11	41	57	81	107	134	158	169	170	163	162	151	130	112	97	80	67	64	99	141
12	48	66	93	121	146	164	169	165	161	160	150	131	114	98	81	68	69	105	150
13	57	74	99	123	145	160	163	159	152	152	145	131	116	102	87	76	79	116	164
14	64	76	93	111	130	146	153	152	139	138	135	128	118	106	94	86	92	129	179
15	65	76	91	106	123	137	143	141	129	128	128	125	118	107	98	94	108	145	191
16	67	80	98	114	128	136	135	129	126	123	122	122	118	109	103	102	126	159	199
17	75	86	101	114	125	131	128	122	119	116	116	120	120	115	114	116	141	172	202
18	83	90	98	105	114	122	123	119	111	108	111	119	123	122	125	130	151	179	203
19	91	97	105	112	115	115	112	110	106	112	115	112	112	122	138	151	171	193	204
20	98	102	108	115	119	119	115	112	102	107	110	109	112	126	148	166	185	200	200
21	103	104	108	114	119	119	113	108	98	101	104	104	110	130	162	188	203	208	191
22	104	104	106	111	115	114	108	101	97	99	100	101	108	132	173	207	219	214	182
23	107	107	109	113	115	113	107	102	100	100	100	100	106	131	178	219	236	223	181
24	111	113	116	118	117	114	110	108	104	102	102	101	105	128	179	224	251	236	187
25	107	113	117	117	113	109	108	108	105	103	103	103	105	127	177	225	255	242	194
26	100	107	113	112	105	100	101	104	105	103	104	104	105	126	176	226	255	243	197
27																			
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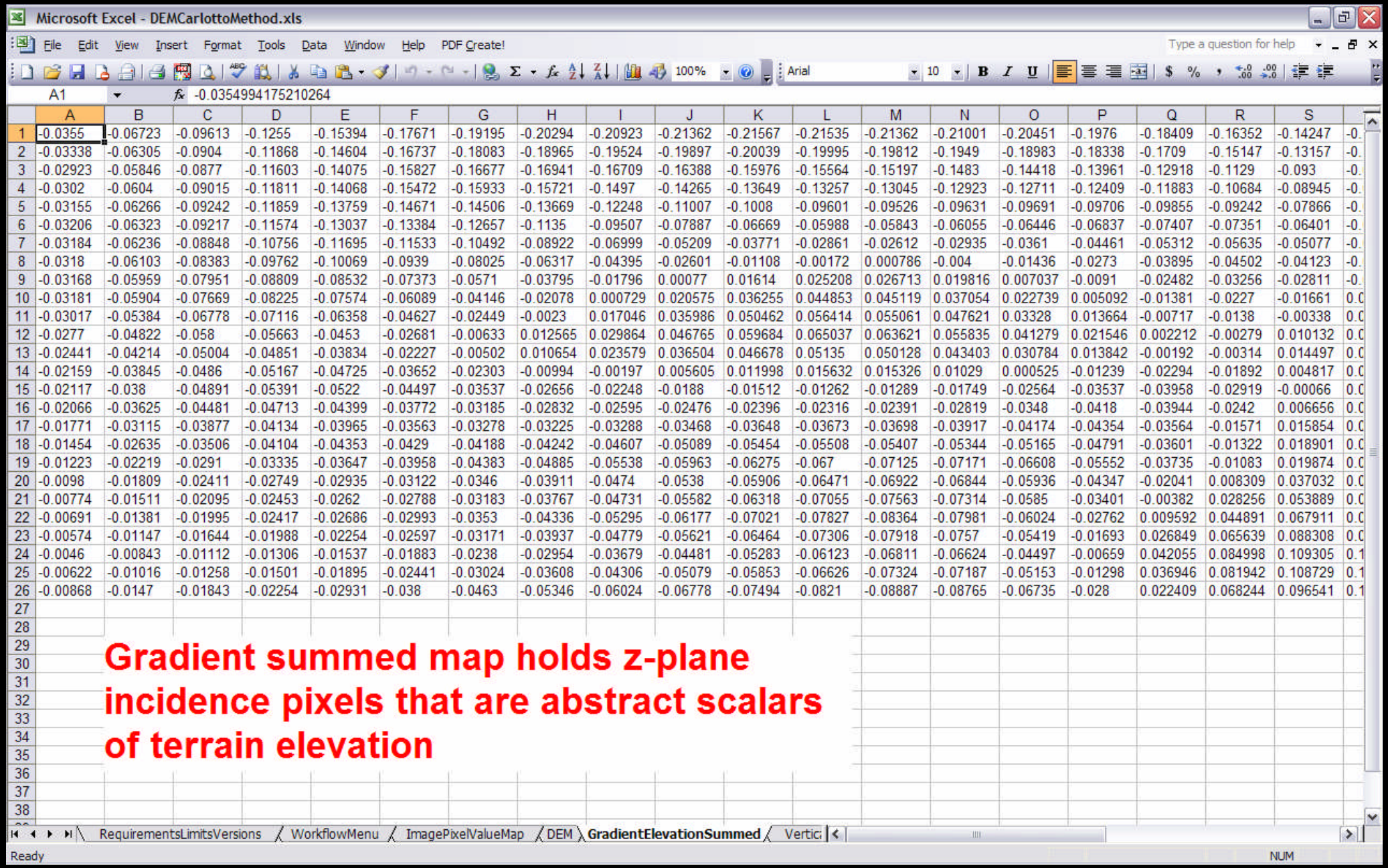
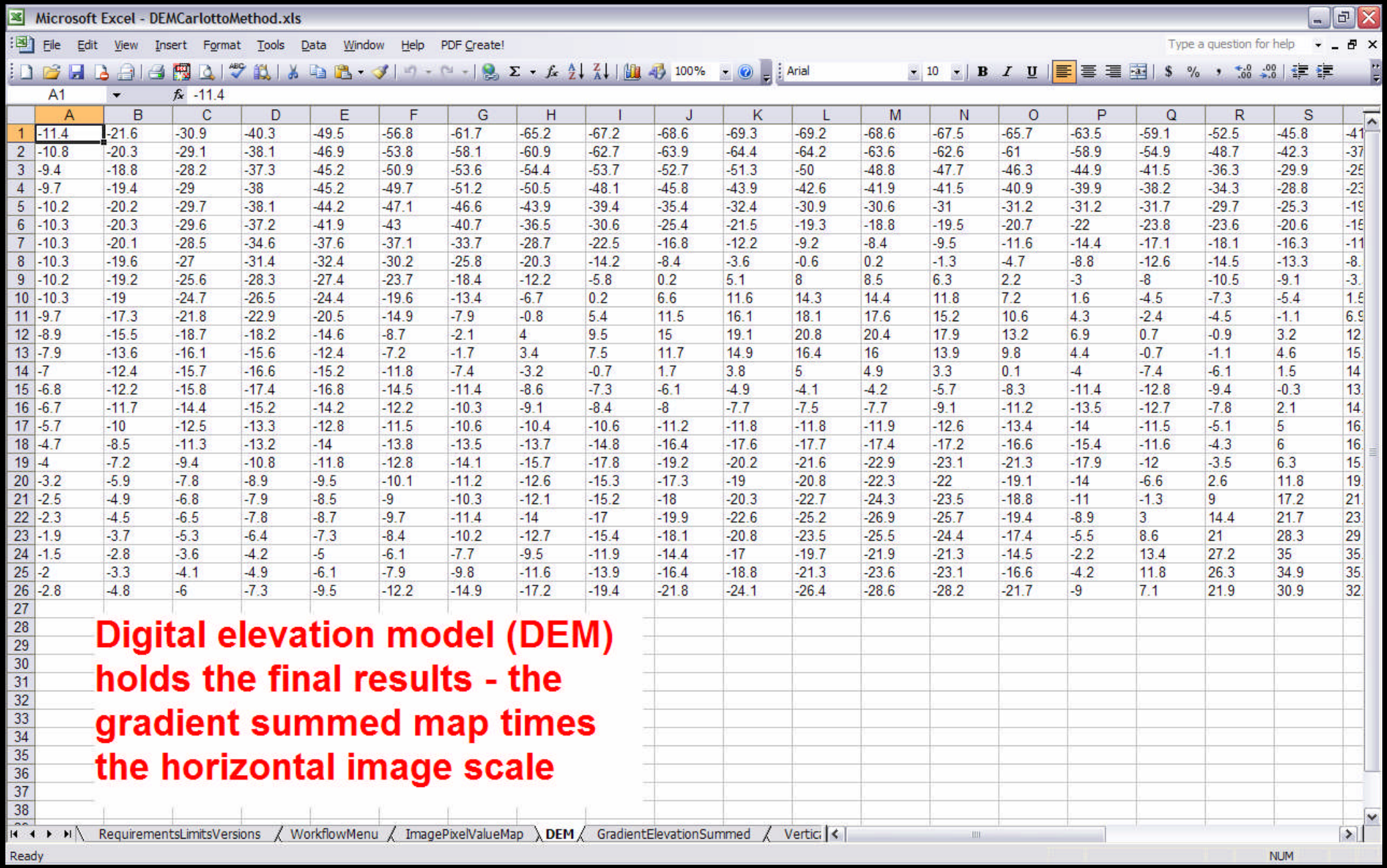
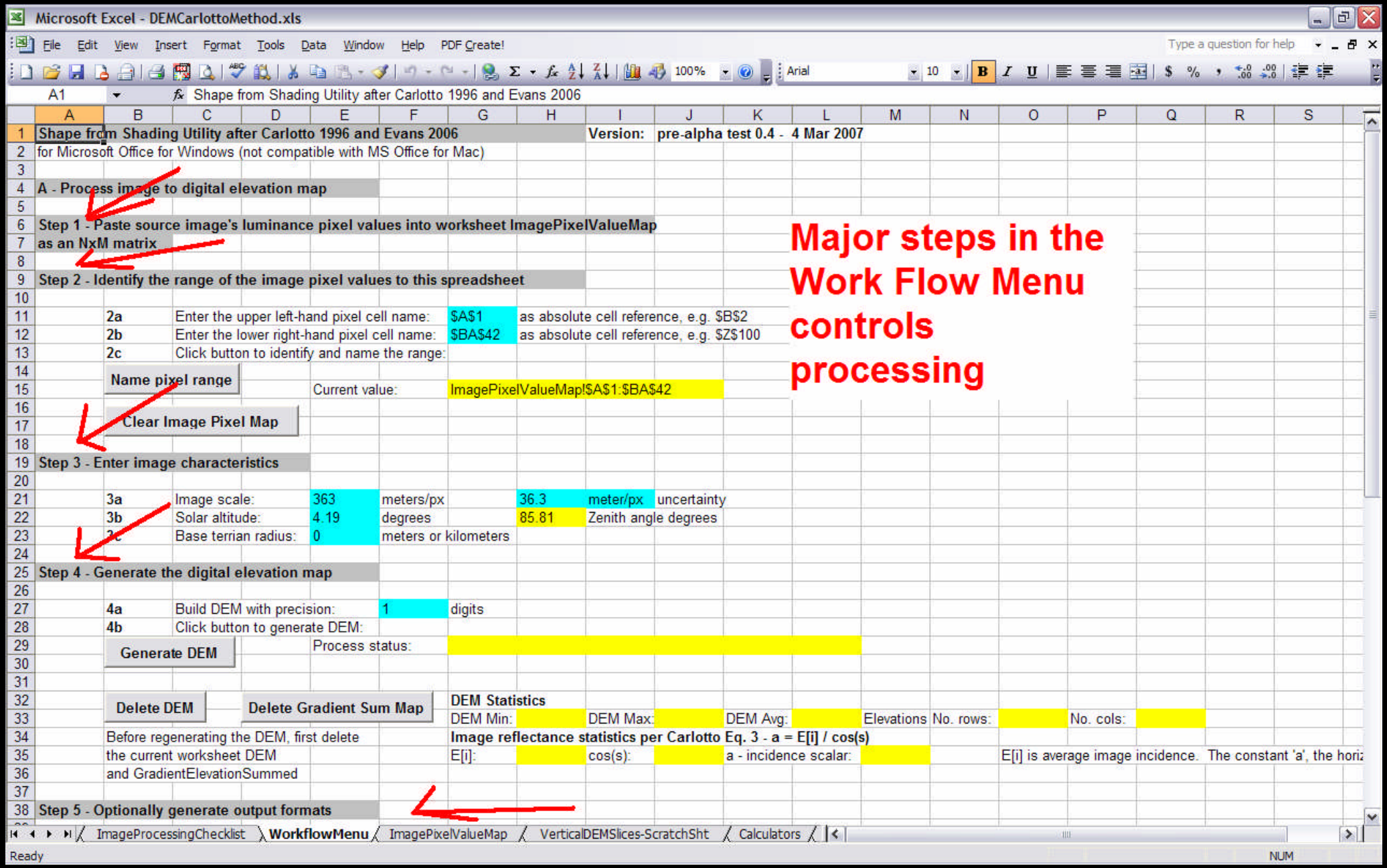


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	-0.0355	-0.06723	-0.09613	-0.1255	-0.15394	-0.17671	-0.19195	-0.20294	-0.20923	-0.21362	-0.21567	-0.21535	-0.21362	-0.21001	-0.20451	-0.1976	-0.18409	-0.16352	-0.14247
2	-0.03338	-0.06305	-0.0904	-0.11868	-0.14604	-0.16737	-0.18083	-0.18965	-0.19524	-0.19897	-0.20039	-0.19995	-0.19812	-0.1949	-0.18983	-0.18338	-0.1709	-0.15147	-0.13157
3	-0.02923	-0.05846	-0.0877	-0.11603	-0.14075	-0.15827	-0.16677	-0.16941	-0.16709	-0.16388	-0.15976	-0.15564	-0.15197	-0.1483	-0.14418	-0.13961	-0.12918	-0.1129	-0.093
4	-0.0302	-0.0604	-0.09015	-0.11811	-0.14068	-0.15472	-0.15933	-0.15721	-0.1497	-0.14265	-0.13649	-0.13257	-0.13045	-0.12923	-0.12711	-0.12409	-0.11883	-0.10684	-0.08945
5	-0.03155	-0.06266	-0.09242	-0.11859	-0.13759	-0.14671	-0.14506	-0.13669	-0.12248	-0.11007	-0.1008	-0.09601	-0.09526	-0.09631	-0.09691	-0.09706	-0.09855	-0.09242	-0.07866
6	-0.03206	-0.06323	-0.09217	-0.11574	-0.13037	-0.13384	-0.12657	-0.1135	-0.09507	-0.07887	-0.06669	-0.05988	-0.05843	-0.06055	-0.06446	-0.06837	-0.07407	-0.07351	-0.06401
7	-0.03184	-0.06236	-0.08848	-0.10756	-0.11695	-0.11533	-0.10492	-0.08922	-0.06999	-0.05209	-0.03771	-0.02861	-0.02612	-0.02935	-0.0361	-0.04461	-0.05312	-0.05635	-0.05077
8	-0.0318	-0.06103	-0.08383	-0.09762	-0.10069	-0.0939	-0.08025	-0.06317	-0.04395	-0.02601	-0.01108	-0.00172	0.000786	-0.004	-0.01436	-0.0273	-0.03895	-0.04502	-0.04123
9	-0.03168	-0.05959	-0.07951	-0.08809	-0.08532	-0.07373	-0.0571	-0.03795	-0.01796	0.00077	0.01614	0.025208	0.026713	0.019816	0.007037	-0.0091	-0.02482	-0.03256	-0.02811
10	-0.03181	-0.05904	-0.07669	-0.08225	-0.07574	-0.06089	-0.04146	-0.02078	0.000729	0.020575	0.036255	0.044853	0.045119	0.037054	0.022739	0.005092	-0.01381	-0.0227	-0.01661
11	-0.03017	-0.05384	-0.06778	-0.07116	-0.06358	-0.04627	-0.02449	-0.0023	0.017046	0.035986	0.050462	0.056414	0.055061	0.047621	0.03328	0.013664	-0.00717	-0.0138	-0.00338
12	-0.0277	-0.04822	-0.058	-0.05663	-0.0453	-0.02681	-0.00633	0.012565	0.029864	0.046765	0.059684	0.065037	0.063621	0.055835	0.041279	0.021546	0.002212	-0.00279	0.010132
13	-0.02441	-0.04214	-0.05004	-0.04851	-0.03834	-0.02227	-0.00502	0.010654	0.023579	0.036504	0.046678	0.05135	0.050128	0.043403	0.030784	0.013842	-0.00192	-0.00314	0.014497
14	-0.02159	-0.03845	-0.0486	-0.05167	-0.04725	-0.03652	-0.02303	-0.00994	-0.00197	0.005605	0.011998	0.015632	0.015326	0.01029	0.000525	-0.01239	-0.02294	-0.01892	0.004817
15	-0.02117	-0.038	-0.04891	-0.05391	-0.0522	-0.04497	-0.03537	-0.02656	-0.02248	-0.0188	-0.01512	-0.01262	-0.01289	-0.01749	-0.02564	-0.03537	-0.03958	-0.02919	-0.00066
16	-0.02066	-0.03625	-0.04481	-0.04713	-0.04399	-0.03772	-0.03185	-0.02832	-0.02595	-0.02476	-0.02396	-0.02316	-0.02391	-0.02819	-0.0348	-0.0418	-0.03944	-0.0242	0.006656
17	-0.01771	-0.03115	-0.03877	-0.04134	-0.03965	-0.03563	-0.03278	-0.03225	-0.03288	-0.03468	-0.03648	-0.03673	-0.03698	-0.03917	-0.04174	-0.04354	-0.03564	-0.01571	0.015854
18	-0.01454	-0.02635	-0.03506	-0.04104	-0.04353	-0.0429	-0.04188	-0.04242	-0.04607	-0.05089	-0.05454	-0.05508	-0.05407	-0.05344	-0.05165	-0.04791	-0.03601	-0.01322	0.018901
19	-0.01223	-0.02219	-0.0291	-0.03335	-0.03647	-0.03958	-0.04383	-0.04885	-0.05538	-0.05963	-0.06275	-0.067	-0.07125	-0.07171	-0.06608	-0.05552	-0.03735	-0.01083	0.019874
20	-0.0098	-0.01809	-0.02411	-0.02749	-0.02935	-0.03122	-0.0346	-0.03911	-0.0474	-0.0538	-0.05906	-0.06471	-0.06922	-0.06844	-0.05936	-0.04347	-0.02041	0.008309	0.037032
21	-0.00774	-0.01511	-0.02095	-0.02453	-0.0262	-0.02788	-0.03183	-0.03767	-0.04731	-0.05582	-0.06318	-0.07055	-0.07563	-0.07314	-0.0585	-0.03401	-0.00382	0.028256	0.053889
22	-0.00691	-0.01381	-0.01995	-0.02417	-0.02686	-0.02993	-0.0353	-0.04336	-0.05295	-0.06177	-0.07021	-0.07827	-0.08364	-0.07981	-0.06024	-0.02762	0.009592	0.044891	0.067911
23	-0.00574	-0.01147	-0.01644	-0.01988	-0.02254	-0.02597	-0.03171	-0.03937	-0.04779	-0.05621	-0.06464	-0.07306	-0.07918	-0.0757	-0.05419	-0.01693	0.026849	0.065639	0.088308
24	-0.0046	-0.00843	-0.01112	-0.01306	-0.01537	-0.01883	-0.0238	-0.02954	-0.03679	-0.04481	-0.05283	-0.06123	-0.06811	-0.06624	-0.04497	-0.00659	0.042055	0.084998	0.109305
25	-0.00622	-0.01016	-0.01258	-0.01501	-0.01895	-0.02441	-0.03024	-0.03608	-0.04306	-0.05079	-0.05853	-0.06626	-0.07324	-0.07187	-0.05153	-0.01298	0.036946	0.081942	0.108729
26	-0.00868	-0.0147	-0.01843	-0.02254	-0.02931	-0.038	-0.0463	-0.05346	-0.06024	-0.06778	-0.07494	-0.0821	-0.08887	-0.08765	-0.06735	-0.028	0.022409	0.068244	0.096541



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	-11.4	-21.6	-30.9	-40.3	-49.5	-56.8	-61.7	-65.2	-67.2	-68.6	-69.3	-69.2	-68.6	-67.5	-65.7	-63.5	-59.1	-52.5	-45.8
2	-10.8	-20.3	-29.1	-38.1	-46.9	-53.8	-58.1	-60.9	-62.7	-63.9	-64.4	-64.2	-63.6	-62.6	-61	-58.9	-54.9	-48.7	-42.3
3	-9.4	-18.8	-28.2	-37.3	-45.2	-50.9	-53.6	-54.4	-53.7	-52.7	-51.3	-50	-48.8	-47.7	-46.3	-44.9	-41.5	-36.3	-29.9
4	-9.7	-19.4	-29	-38	-45.2	-49.7	-51.2	-50.5	-48.1	-45.8	-43.9	-42.6	-41.9	-41.5	-40.9	-39.9	-38.2	-34.3	-28.8
5	-10.2	-20.2	-29.7	-38.1	-44.2	-47.1	-46.6	-43.9	-39.4	-35.4	-32.4	-30.9	-30.6	-31	-31.2	-31.2	-31.7	-29.7	-25.3
6	-10.3	-20.3	-29.6	-37.2	-41.9	-43	-40.7	-36.5	-30.6	-25.4	-21.5	-19.3	-18.8	-19.5	-20.7	-22	-23.8	-23.6	-20.6
7	-10.3	-20.1	-28.5	-34.6	-37.6	-37.1	-33.7	-28.7	-22.5	-16.8	-12.2	-9.2	-8.4	-9.5	-11.6	-14.4	-17.1	-18.1	-16.3
8	-10.3	-19.6	-27	-31.4	-32.4	-30.2	-25.8	-20.3	-14.2	-8.4	-3.6	-0.6	0.2	-1.3	-4.7	-8.8	-12.6	-14.5	-13.3
9	-10.2	-19.2	-25.6	-28.3	-27.4	-23.7	-18.4	-12.2	-5.8	0.2	5.1	8	8.5	6.3	2.2	-3	-8	-10.5	-9.1
10	-10.3	-19	-24.7	-26.5	-24.4	-19.6	-13.4	-6.7	0.2	6.6	11.6	14.3	14.4	11.8	7.2	1.6	-4.5	-7.3	-5.4
11	-9.7	-17.3	-21.8	-22.9	-20.5	-14.9	-7.9	-0.8	5.4	11.5	16.1	18.1	17.6	15.2	10.6	4.3	-2.4	-4.5	-1.1
12	-8.9	-15.5	-18.7	-18.2	-14.6	-8.7	-2.1	4	9.5	15	19.1	20.8	20.4	17.9	13.2	6.9	0.7	-0.9	3.2
13	-7.9	-13.6	-16.1	-15.6	-12.4	-7.2	-1.7	3.4	7.5	11.7	14.9	16.4	16	13.9	9.8	4.4	-0.7	-1.1	4.6
14	-7	-12.4	-15.7	-16.6	-15.2	-11.8	-7.4	-3.2	-0.7	1.7	3.8	5	4.9	3.3	0.1	-4	-7.4	-6.1	1.5
15	-6.8	-12.2	-15.8	-17.4	-16.8	-14.5	-11.4	-8.6	-7.3	-6.1	-4.9	-4.1	-4.2	-5.7	-8.3	-11.4	-12.8	-9.4	-0.3
16	-6.7	-11.7	-14.4	-15.2	-14.2	-12.2	-10.3	-9.1	-8.4	-8	-7.7	-7.5	-7.7	-9.1	-11.2	-13.5	-12.7	-7.8	2.1
17	-5.7	-10	-12.5	-13.3	-12.8	-11.5	-10.6	-10.4	-10.6	-11.2	-11.8	-11.8	-11.9	-12.6	-13.4	-14	-11.5	-5.1	5
18	-4.7	-8.5	-11.3	-13.2	-14	-13.8	-13.5	-13.7	-14.8	-16.4	-17.6	-17.7	-17.4	-17.2	-16.6	-15.4	-11.6	-4.3	6
19	-4	-7.2	-9.4	-10.8	-11.8	-12.8	-14.1	-15.7	-17.8	-19.2	-20.2	-21.6	-22.9	-23.1	-21.3	-17.9	-12	-3.5	6.3
20	-3.2	-5.9	-7.8	-8.9	-9.5	-10.1	-11.2	-12.6	-15.3	-17.3	-19	-20.8	-22.3	-22	-19.1	-14	-6.6	2.6	11.8
21	-2.5	-4.9	-6.8	-7.9	-8.5	-9	-10.3	-12.1	-15.2	-18	-20.3	-22.7	-24.3	-23.5	-18.8	-11	-1.3	9	17.2
22	-2.3	-4.5	-6.5	-7.8	-8.7	-9.7	-11.4	-14	-17	-19.9	-22.6	-25.2	-26.9	-25.7	-19.4	-8.9	3	14.4	21.7
23	-1.9	-3.7	-5.3	-6.4	-7.3	-8.4	-10.2	-12.7	-15.4	-18.1	-20.8	-23.5	-25.5	-24.4	-17.4	-5.5	8.6	21	28.3
24	-1.5	-2.8	-3.6	-4.2	-5	-6.1	-7.7	-9.5	-11.9	-14.4	-17	-19.7	-21.9	-21.3	-14.5	-2.2	13.4	27.2	35
25	-2	-3.3	-4.1	-4.9	-6.1	-7.9	-9.8	-11.6	-13.9	-16.4	-18.8	-21.3	-23.6	-23.1	-16.6	-4.2	11.8	26.3	34.9
26	-2.8	-4.8	-6	-7.3	-9.5	-12.2	-14.9	-17.2	-19.4	-21.8	-24.1	-26.4	-28.6	-28.2	-21.7	-9	7.1	21.9	30.9


Microsoft Excel - DEMCarlottoMethod.xls
Shape from Shading Utility after Carlotto 1996 and Evans 2006
Version: pre-alpha test 0.4 - 4 Mar 2007
for Microsoft Office for Windows (not compatible with MS Office for Mac)
A - Process image to digital elevation map
Step 1 - Paste source image's luminance pixel values into worksheet ImagePixelValueMap as an NxM matrix
Step 2 - Identify the range of the image pixel values to this spreadsheet
2a Enter the upper left-hand pixel cell name: $A$1 as absolute cell reference, e.g. $B$2
2b Enter the lower right-hand pixel cell name: $BA$42 as absolute cell reference, e.g. $Z$100
2c Click button to identify and name the range:
Name pixel range
Current value: ImagePixelValueMap!$A$1:$BA$42
Clear Image Pixel Map
Step 3 - Enter image characteristics
3a Image scale: 363 meters/px 36.3 meter/px uncertainty
3b Solar altitude: 4.19 degrees 85.81 Zenith angle degrees
3c Base terrian radius: 0 meters or kilometers
Step 4 - Generate the digital elevation map
4a Build DEM with precision: 1 digits
4b Click button to generate DEM:
Generate DEM
Process status:
Delete DEM
Delete Gradient Sum Map
Before regenerating the DEM, first delete the current worksheet DEM and GradientElevationSummed
DEM Statistics
DEM Min: DEM Max: DEM Avg: Elevations No. rows: No. cols:
Image reflectance statistics per Carlotto Eq. 3 - a = E[i] / cos(s)
E[i]: cos(s): a - incidence scalar:
E[i] is average image incidence. The constant 'a', the horiz
Step 5 - Optionally generate output formats
Major steps in the Work Flow Menu controls processing
ImageProcessingChecklist
WorkflowMenu
ImagePixelValueMap
VerticalDEMSlices-ScratchSht
Calculators
Ready
NUM

Other worksheets in DEMCarlottoMethod.xls

- Storage of Image Pixel Maps
- Storage of Characteristics of Image Pixel Maps
- Image Processing Checklist
- Utility Calculators
- Vertical Slice Charts

Other worksheets in DEMCarlottoMethod.xls
Storage of Image Pixel Maps

Working Image Pixel Map

	A	B	C	D	E	F	G
1	24	32	38	37	39	51	67
2	29	37	42	40	42	55	72
3	39	39	39	41	49	65	85
4	37	37	38	42	54	73	94
5	34	35	38	46	62	84	108
6	33	35	40	52	72	97	121
7	34	37	47	63	85	110	130
8	35	41	56	77	102	125	141
9	36	45	64	91	118	139	151
38							

RequirementsLimitsVersions | WorkflowMenu | **ImagePixelValueMap**

Ready

Long-term Storage of Feature Image Pixel Maps

20	146	145	142	137	137	140	137	132
21	146	144	141	140	144	147	141	132
22	146	146	144	143	146	150	146	139
23	144	147	147	142	141	144	145	144
24	143	147	146	141	137	139	141	141
25	146	148	147	142	141	142	139	134
26	151	151	148	147	149	149	140	129
27	153	154	151	148	147	146	140	132
28	148	149	149	147	148	150	146	140

StoreImage_InfoLog | **StoreIPM_CauchyOmega_Evans2006i** | S

Ready

Other worksheets in DEMCarlottoMethod.xls
Storage of Characteristics of Image Pixel Maps
Immediate Working Data on WorkflowMenu

WorkflowMenu

19	Step 3 - Enter image characteristics							
20								
21		3a	Image scale:	321	meters/px	32.1	meter/px	uncertainty
22		3b	Solar altitude:	2.68	degrees	87.32	Zenith angle	degrees
23		3c	Base terrian radius:	0	meters or kilometers			
24								

Long-term Storage in Worksheet StoreImage_InfoLog

Microsoft Excel - DEMCarlottoMethod.xls

File Edit View Insert Format Tools Data Window Help PDF Create!

F1 fx Observer_location_text

	F	G	H	I	J	K	L	M	N	O
1	Observer	Observer_	Observer_	Feature	Feature_I	Image sca	Image sca	Image sca	Solar altit	Base t
1	Observer	Observer_	Observer_	Feature	Feature_I	Image sca	Image sca	Image sca	Solar altit	Base t
2	Unknown	Unknown	Unknown	7.23	38.32	363	meters/px	10%	4.19	Unknow
3	Unknown	Unknown	Unknown	7.23	38.32	363	meters/px	10%	4.19	Unknow
4	Unknown	Unknown	Unknown	21.96	7.66	321	meters/px	10%	2.68	Unknow
11										

StoreImage_InfoLog | StoreIPM_CauchyOmega_Evans2006i | S

Ready

Other worksheets in DEMCarlottoMethod.xls
Image Processing Checklist

Item	Software	Software type	Task type	Task
1	AIP4WIN	Image processing	Pre-process image - rectify	Convert color source fits to color jpg
2	LTVT	Lunar observing	Pre-process image - rectify	Two-point register and rectify image
3	LTVT	Lunar observing	Pre-process image - rectify	Export rectified color jpg to file
4	AIP4WIN	Image processing	Pre-process image - make greyscale levels	Convert color source jpg to 8-bit or
5	AIP4WIN	Image processing	Pre-process image - rotate and crop to rectangular	Rotate the image so the apparent s
6	AIP4WIN	Image processing	Pre-process image - rotate and crop to rectangular	Crop the image
7	AIP4WIN	Image processing	Pre-process image - rotate and crop to rectangular	Resave the image as an 8 bit or 16-
8	FV Tool	Digitize pixel values	Convert image to csv text data	Export the greyscale image to an N
9	Microsoft Excel	General spreadsheet	Convert csv text data to Excel worksheet	Import the csv data as an Excel wor
10	DEMCarlottoMethod.xls	Purpose-built spreadsheet	Import NxM matrix to DEM spreadsheet	Copy/move the NxM matrix in the E worksheet in DEMCarlottoMethod.x
11	DEMCarlottoMethod.xls	Purpose-built spreadsheet	Store info on image	Update worksheet StorelPM_Info wo
12	DEMCarlottoMethod.xls	Purpose-built spreadsheet	Generate DEM - enter data	Generate the DEM using DEMCarlo
13	DEMCarlottoMethod.xls	Purpose-built spreadsheet	Generate DEM - enter data	Copy the stored image pixel data to worksheet ImagePixelValueMap
14	DEMCarlottoMethod.xls	Purpose-built spreadsheet	Generate DEM - enter data	Update the image characteristics to WorkflowMenu
15	DEMCarlottoMethod.xls	Purpose-built spreadsheet	Generate DEM - enter data	Identify/name the working image pix
16	DEMCarlottoMethod.xls	Purpose-built spreadsheet	Generate DEM - housekeeping	Delete any preexisting DEM or Grac

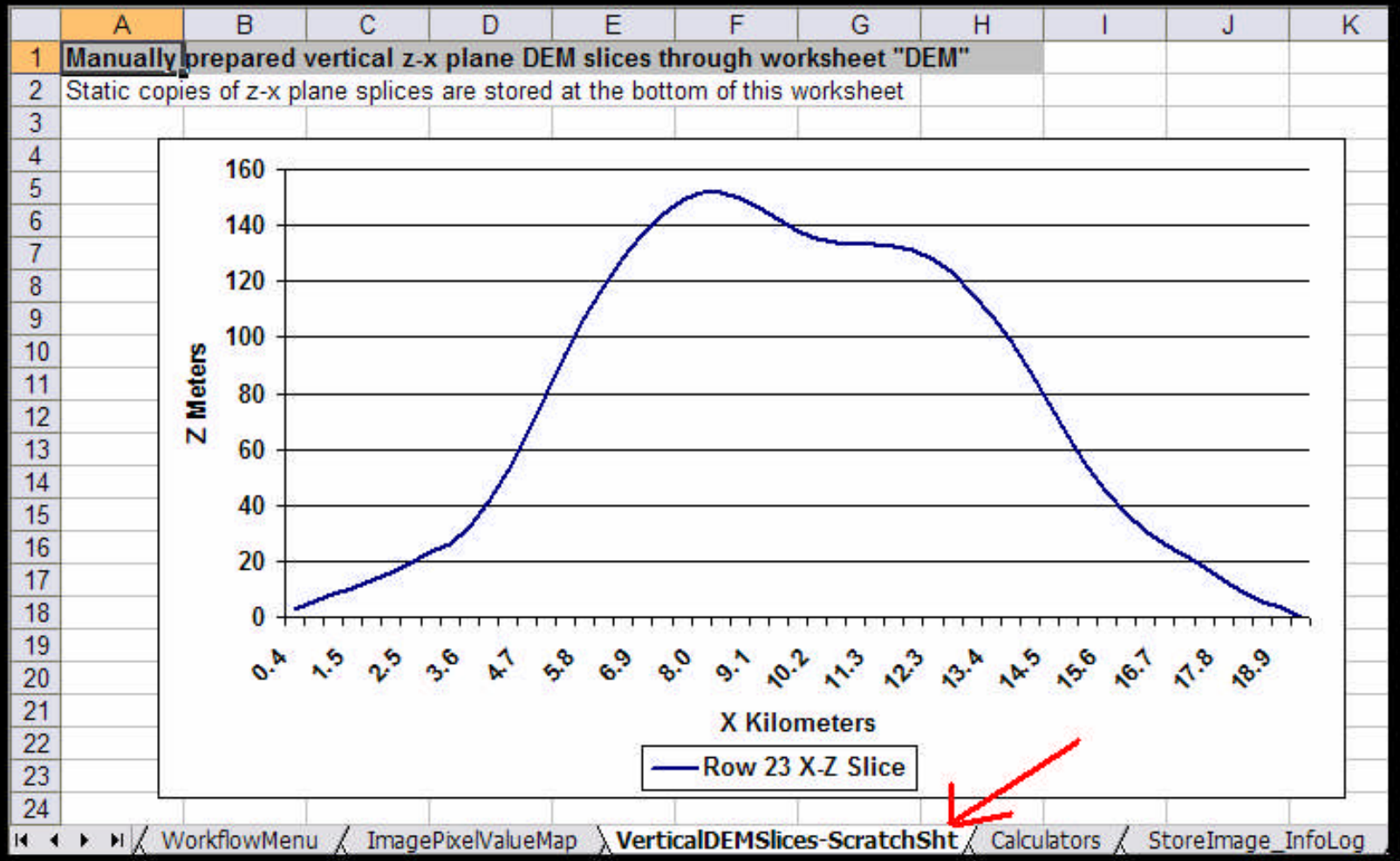
ImageProcessingChecklist | WorkflowMenu | ImagePixelValueMap | VerticalDEMSlices-ScratchSht | Calculators

The imaging processing checklists provides a step-by-step overview of the entire process

Other worksheets in DEMCarlottoMethod.xls

Vertical Slice Chart Scratch-Sheet

The vertical slice chart scratch-sheet contains a static copy of the DEM data in a row and column. The data is cut and paste manually from the final DEM worksheet. Typically, the row and column contains the maximum elevation in the feature. This data can then be plotted into vertical slice charts.



The charts are prepared using ordinary MS-Excel charting techniques.

Other worksheets in DEMCarlottoMethod.xls
Utility Calculators

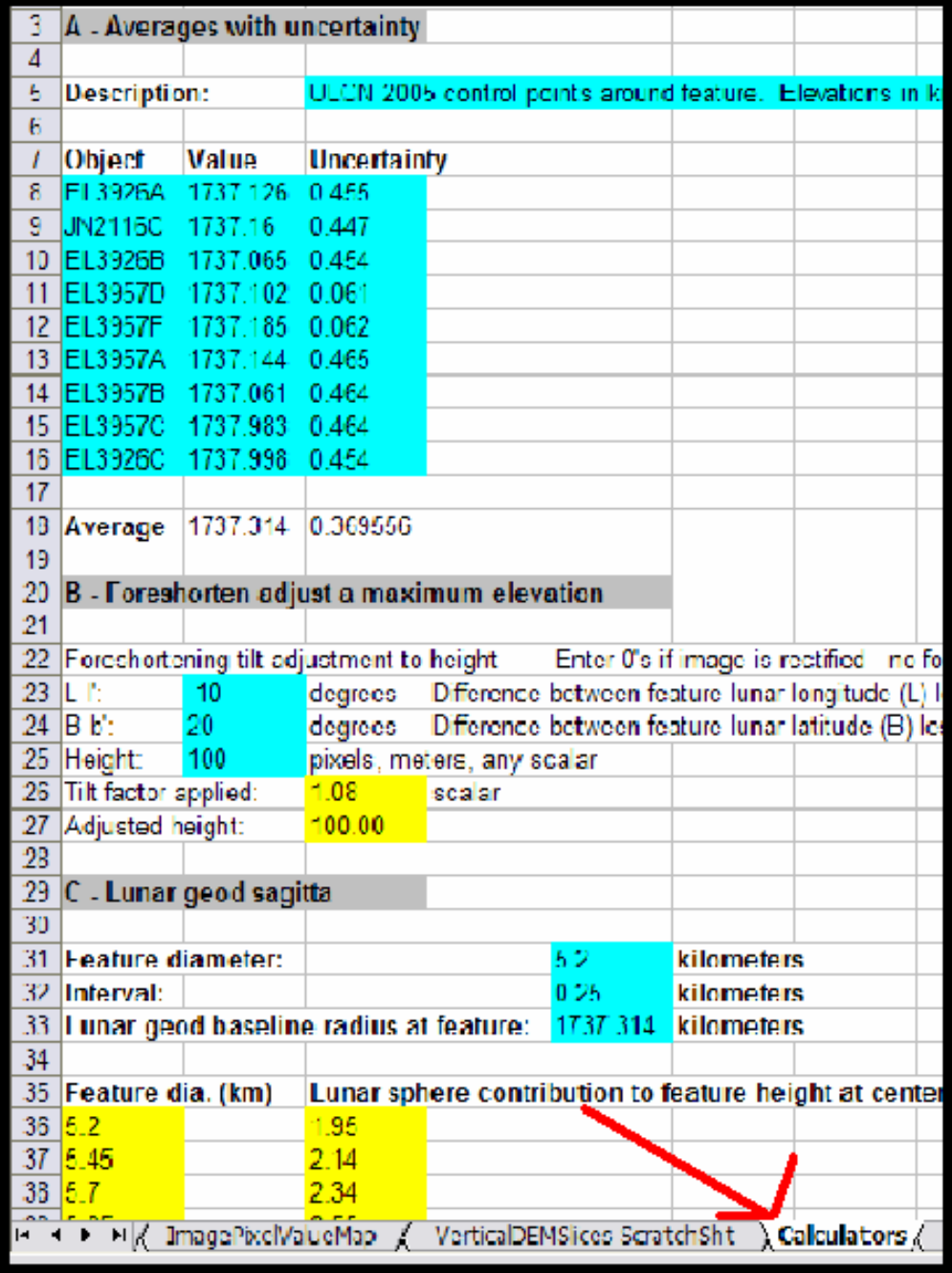
Three utility calculators can be used to:

1) Average control point elevations to find the lunar radius of the base terrain level.

2) Adjust a point maximum elevation for foreshortening.

3) Determine the portion of a dome's apparent maximum elevation that can be attributed to the curvature of the Moon's spheriod. This sagitta adjustment is subtracted from the maximum elevation of a feature found in the DEM.

Typically, the lunar sagitta adjustment is included in the final written observing report.

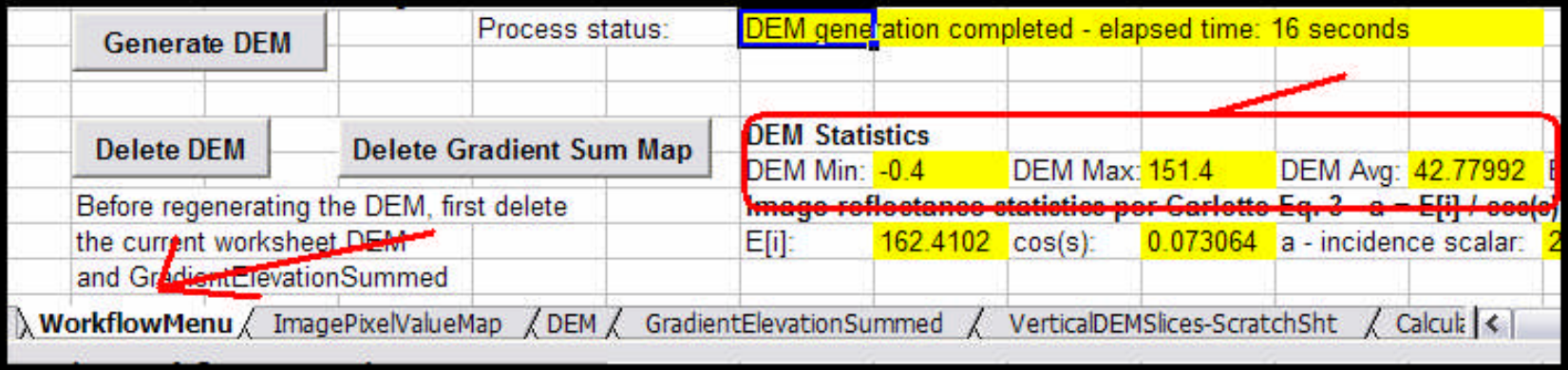


3	A - Averages with uncertainty						
4							
5	Description:	ULCN 2005 control points around feature. Elevations in k					
6							
7	Object	Value	Uncertainty				
8	EL3926A	1737.126	0.455				
9	JN2116C	1737.16	0.447				
10	EL3926B	1737.065	0.454				
11	EL3957D	1737.102	0.061				
12	EL3957F	1737.185	0.062				
13	EL3957A	1737.144	0.465				
14	EL3957B	1737.061	0.464				
15	EL3957C	1737.983	0.464				
16	EL3926C	1737.998	0.454				
17							
18	Average	1737.314	0.309556				
19							
20	B - Foreshorten adjust a maximum elevation						
21							
22	Foreshortening tilt adjustment to height			Enter 0's if image is rectified no fo			
23	L l':	10	degrees	Difference between feature lunar longitude (L) l			
24	B b':	20	degrees	Difference between feature lunar latitude (B) lo			
25	Height:	100	pixels, meters, any scalar				
26	Tilt factor applied:	1.08	scalar				
27	Adjusted height:	100.00					
28							
29	C - Lunar geod sagitta						
30							
31	Feature diameter:			5.2	kilometers		
32	Interval:			0.25	kilometers		
33	Lunar geod baseline radius at feature:			1737.314	kilometers		
34							
35	Feature dia. (km)	Lunar sphere contribution to feature height at center					
36	5.2	1.95					
37	5.45	2.14					
38	5.7	2.34					

ImagePixelValueMap | VerticalDEMSlices ScratchSht | Calculators

More on Generating a DEM - Zero-basing your DEM

In a typical DEM, the range of elevations can be positive or negative and surround the average brightness in the image. When computed a DEM, the spreadsheet reports statistics about the DEM, including the mininum and maximum elevations.



The elevations in the DEM are relative and based on arbitrary base elevation. This base may not coincide with the real zero base elevation. For example, in inspecting the DEM worksheet, you may decide that a particular DEM cell represents the zero-base elevation, for example, cell 5, 6 in the following illustration:

	A	B	C	D	E	F	G	H
1	2.9	5.8	8.9	12.2	15.3	17.6	18.8	19
2	1.3	2.6	4.2	6.2	8.3	10.1	11	11
3	-0.1	0	0.4	1.5	3	4.4	5.3	5.7
4	0.2	0.3	0.7	1.6	3	4.5	5.8	6.7
5	0.8	1.4	2	2.7	3.8	5	6.1	6.8
6	1.4	2.3	2.8	3.2	3.9	4.5	4.9	5.1
7	2	3.4	4.4	5	5.8	6.5	7.3	7.8
8	2.7	4.9	6.3	7.5	9	10.5	12.1	13.5
9	2.3	4.3	6	7	7.4	7.2	6.8	6.2
10	2	4.2	6.4	8.1	9.4	10	10.2	10.4

WorkflowMenu | ImagePixelValueMap | DEM | GradientElevationSummed

Ready

DEMCarlottoMethod.xls contains a feature to adjust this base elevation in cell 5,6 to a "0" base elevation. All other elevations are adjusted accordingly.

More on Generating a DEM - Zero-basing your DEM

To zero-base a DEM, enter an adjusting base-elevation in the characteristics settings step on the Work Flow Menu. Then re-generate the DEM. All the elevations will be adjusted relative to this new zero-based elevation.

19	Step 3 - Enter image characteristics							
20								
21		3a	Image scale:	363	meters or km / pixel	36.3	meter/px	uncertainty
22		3b	Solar altitude:	4.19	degrees	85.81	Zenith angle degrees	
23		3c	Base terrian radius:	-5	meters or kilometers			
24								

WorkflowMenu | ImagePixelValueMap | DEM | GradientElevationSummed | VerticalDEMSlices-Scratc

Another use for this feature is to register all elevations in the DEM to an absolute lunar radius. This allows you to register contour maps made from your DEM to other lunar maps, such as the Lunar Topoorthographic (LTO) maps or other modern professional DEMs.

For example, a base elevation can be found using ULCN 2005 control points:

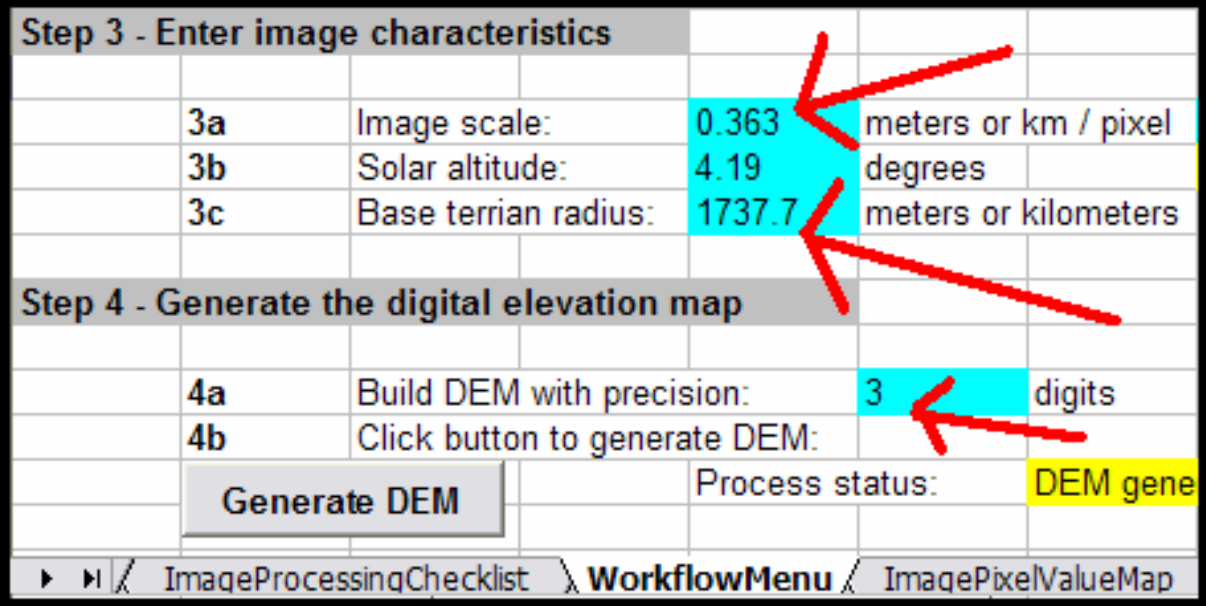
3	A - Averages with uncertainty		
4			
5	Description:	ULCN 2005 control points	
6			
7	Object	Value	Uncertainty
8	EL3926A	1737.126	0.455
9	JN2116C	1737.16	0.447
10	EL3926B	1737.065	0.454
11	EL3957D	1737.102	0.061
12	EL3957F	1737.185	0.062
13	EL3957A	1737.144	0.465
14	EL3957B	1737.061	0.464
15	EL3957C	1737.983	0.464
16	EL3926C	1737.998	0.454
17			
18	Average	1737.314	0.369556

Calculators | StoreImage | InfoLog

Here, a base elevation surrounding a lunar feature, expressed as a lunar radius of 1,737.314 kilometers, is found from the average of 10 ULCN 2005 control points. If these average elevation can be paired to a region of flat terrain in your image and DEM, the DEM can be adjusted - or registered - to the ULCN 2005 system.

More on Generating a DEM - Zero-basing your DEM

For example, let's say that you have decided that the zero-base elevation in cell 5,6 is a lunar radius of 1,737.705 kilometers. Cell 5,6 of your DEM already computes to an elevation of 5 meters. Such enter an adjusting base terrain elevation of 1737.700 kilometers in the image characteristics section of the Work Flow Menu.



Remember to adjust related settings. The image scale of 363 meters should be changed to units of kilometers. Since the final DEM is in kilometers, the precision of the DEM is increased to display one meter increments of a kilometer.

Now re-generate the DEM.

More on Generating a DEM - Zero-basing your DEM

In the re-generated DEM, all of the elevations will be relative to a base elevation of 1,737.705 kilometers shown in cell 5,6:

	A	B	C	D	E	F	G	H
1	1737.702	1737.705	1737.708	1737.712	1737.715	1737.717	1737.718	1737.719
2	1737.701	1737.702	1737.704	1737.706	1737.708	1737.71	1737.711	1737.711
3	1737.699	1737.7	1737.7	1737.701	1737.703	1737.704	1737.705	1737.705
4	1737.7	1737.7	1737.7	1737.701	1737.703	1737.704	1737.705	1737.706
5	1737.7	1737.701	1737.702	1737.702	1737.703	1737.705	1737.706	1737.706
6	1737.701	1737.702	1737.702	1737.703	1737.703	1737.704	1737.704	1737.705
7	1737.702	1737.703	1737.704	1737.705	1737.705	1737.706	1737.707	1737.707
8	1737.702	1737.704	1737.706	1737.707	1737.709	1737.71	1737.712	1737.713
9	1737.702	1737.704	1737.706	1737.707	1737.707	1737.707	1737.706	1737.706
10	1737.702	1737.704	1737.706	1737.708	1737.709	1737.71	1737.71	1737.71
11	1737.701	1737.702	1737.704	1737.706	1737.708	1737.709	1737.709	1737.709
12	1737.699	1737.7	1737.701	1737.703	1737.704	1737.705	1737.705	1737.705
13	1737.699	1737.7	1737.701	1737.703	1737.704	1737.705	1737.706	1737.707
14	1737.701	1737.702	1737.703	1737.705	1737.707	1737.709	1737.711	1737.713

ImagePixelValueMap | **DEM** | GradientElevationSummed | VerticalDEMSlices-S

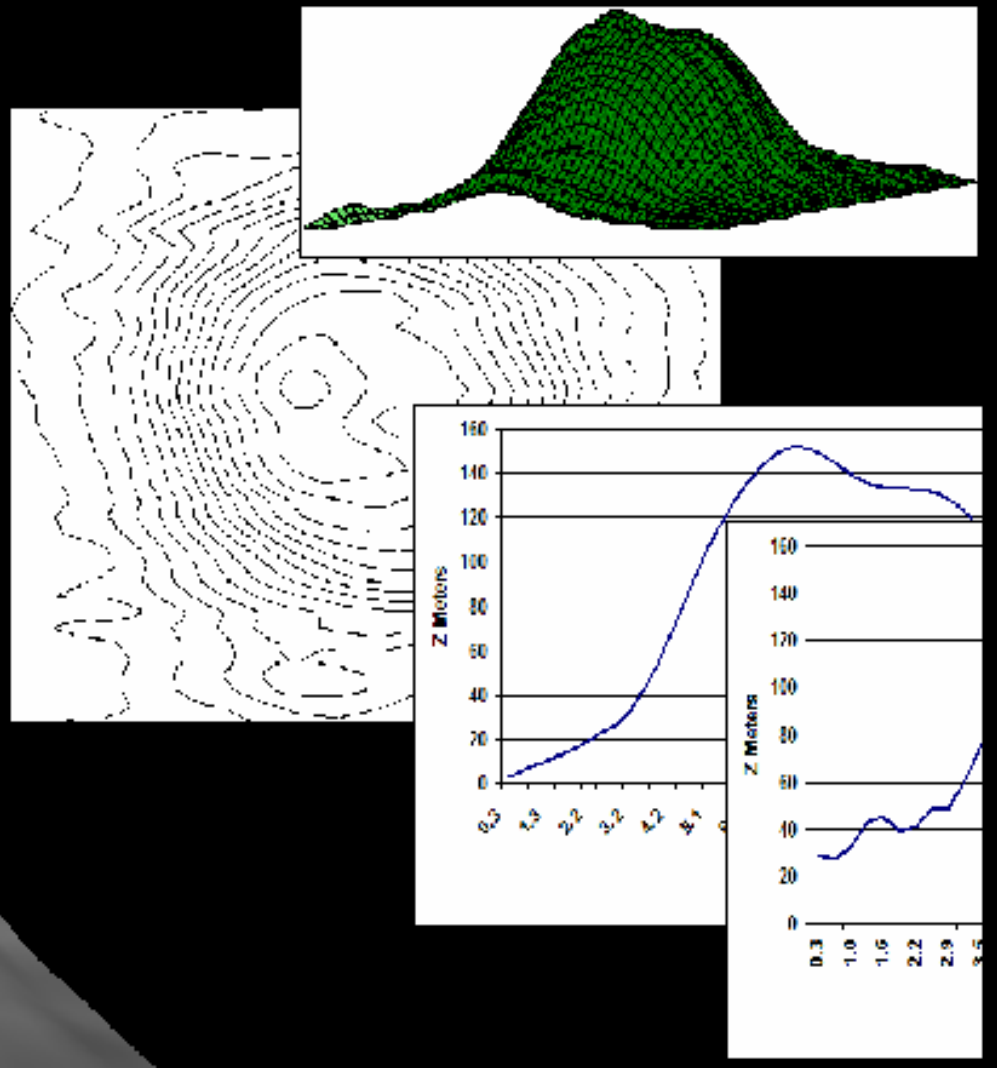
A contour map generated from this DEM can be directly applied to any DEM based on the same ULCN 2005 control point system.

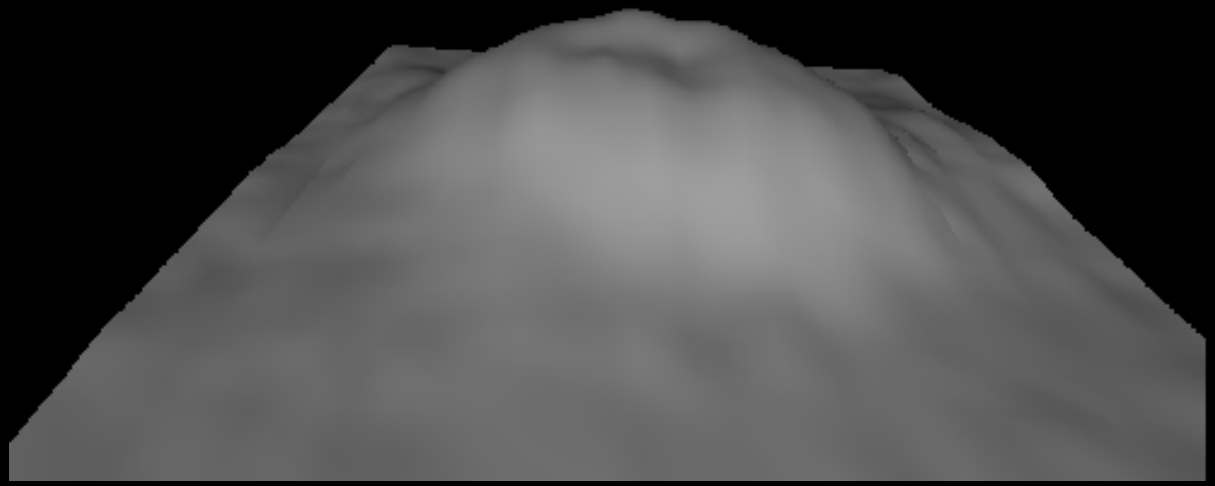
Outputting the DEM to text files and viewing results

1) How to generate output text files

2) Types of output

- Gradiant elevation maps (VRML)
- 3-D Floating point maps (VRML)
- Vertical slice maps
- Other output forms





Outputting the DEM to text files and viewing results

After you have refined your DEM, the last step in the process is to export text files that can used by other software to generate 3-D graphical renderings. A single command button on the Work Flow Menu generates five types of output files. Full path names can entered in the destination path-file name data entry box. If only filenames are entered, Windows XP sends the output files to the default "My Documents" directory.

42	Step 5 - Optionally generate output formats							
43								
44		Make DEM Point Text Files	This utility overwrites existing files of the same name without a delete warning.					
45								
46								
47		For external application	Text Type	Output				
48		Euler	Point stream	Path-Filename:	DEMPointsEuler.txt			
49				Process status:	Success. Last output contained a 26 row by 36 column matrix.			
50								
51		Various	Triples, pixels x-y	Path-Filename:	DEMPointsTriplesPixel.csv			
52			z - real csv	Process status:	Success. Last output contained a 26 row by 36 column matrix.			
53								
54		Various	Triples csv	Path-Filename:	DEMPointsReal.csv			
55			x,y,z real	Process status:	Success. Last output contained a 26 row by 36 column matrix.			
56								
57		VRML	Elevation grid	Path-Filename:	DEMVRMLElevationGrid.wrl			
58			x-y pixels, z-real	Height exaggerate:	3	x-y pixel spacing:	70	multipler
59				Process status:	Success. Last output contained a 26 row by 36 column matrix.			
60								
61		VRML	3-D points	Path-Filename:	DEMVRML3DPoints.wrl			
62				Height exaggerate	20	multipler		
63			x,y,z real	Process status:	Success. Last output contained a 26 row by 36 column matrix.			
64								

Other options allow for exaggerate the z-plane height of features rendered using VRML.

Outputting the DEM to text files and viewing results

Option for VRML export - the x-y multipler - allows for the generation of elevation grids that scale the 3-D close to the object's proportions.

Elevation grid	Path-Filename:	DEMVRMLElevationGrid.wrl			
x-y pixels, z-real	Height exaggerate:	3	x-y pixel spacing:	70	multipler
	Process status:	Success. Last output contained a 26 row by 36 column matrix.			

One problem inherent to 3-D rendering software is the "shrink wrap" problem. It is very difficult to "shrink wrap" a surface to a set of random 3-D floating points. Conversely, elevation grids - where the surface is a regular NxM matrix of grid points - is much easier to compute. Many low and mid-range software packages will support generate of elevation grids.

Elevation grids do not render true 3-D grids with an x-y plane that matches real physical x-y points. For example, a lunar dome grid with a x-y plane pixel dimensions of 42 x 53 and z-plane elevations of 300 meters, when rendered in an elevation grid looks like this:

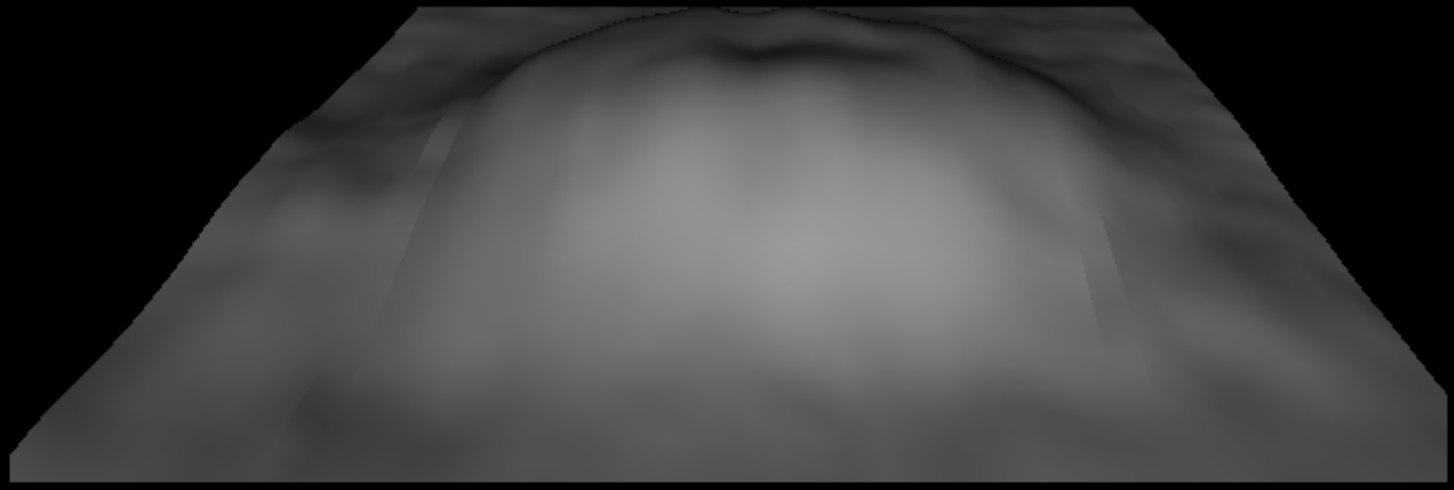
Outputting the DEM to text files and viewing results

If you look closely at the lunar dome DEM figures in Selenology Today, you will notice that many are scaled in abstract x-y plane pixels. Only the z-plane is rendered in meters. This is a result of software limitations preventing a true "shrink wrap" rendering of a surface based on random 3-D floating points.

The feel of a "shrink wrap" surface can be approximated using elevation grids and x-y grid scaling.

Elevation grid	Path-Filename:	DEMVRMLElevationGrid.wrl				
x-y pixels, z-real	Height exaggerate:	3	x-y pixel spacing:	70	multipler	
	Process status:	Success. Last output contained a 26 row by 36 column matrix.				

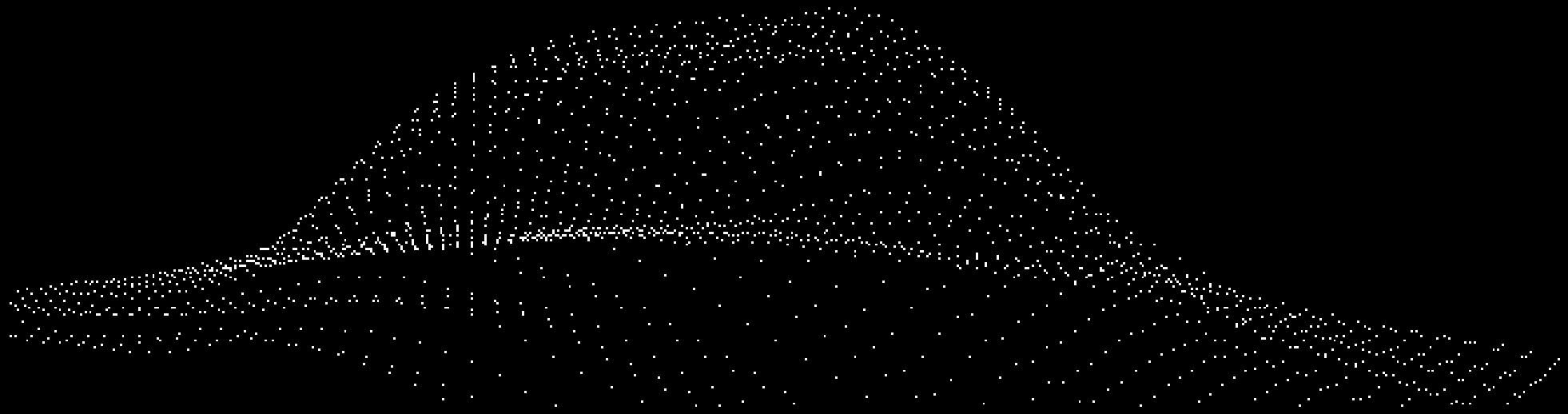
By increasing the relative scale of the x-y elevation grid, a 3-D rendering can be achieved that looks closer to the DEM's real proportions.



This figure shows the same DEM elevation grid as the prior slide, except 70 times x-y scaling mulitplier has been applied.

Outputting the DEM to text files and viewing results

But if all you want to do is to 3-D render a set of random 3-D points - without a "shrink wrapped" surface - most 3-D rendering packages can easily handle that graphics task.



DEMCarlottoMethod.xls also exports 3-D floating point VRML files that can be scaled to the DEMs real physical proportions.

Viewing 3-D DEMs in VRML - Controls in VRML clients

1) Study and Turn Mode
2) Study and Roll Mode
3) The Fit Action

Controls in VRML clients - that plug into your internet browser - are standardized.

VRML browsers are used to view the two VRML files created by DEMCarlottoMethod.xls. These files have extensions *.wrl and have the default names of:

DEMVRMLElevationGrid.wrl
DEMVRML3DPoints.wrl

You have generated these files from prior exercises in this presentation. We will use the first file to learn basic VRML browser operation.

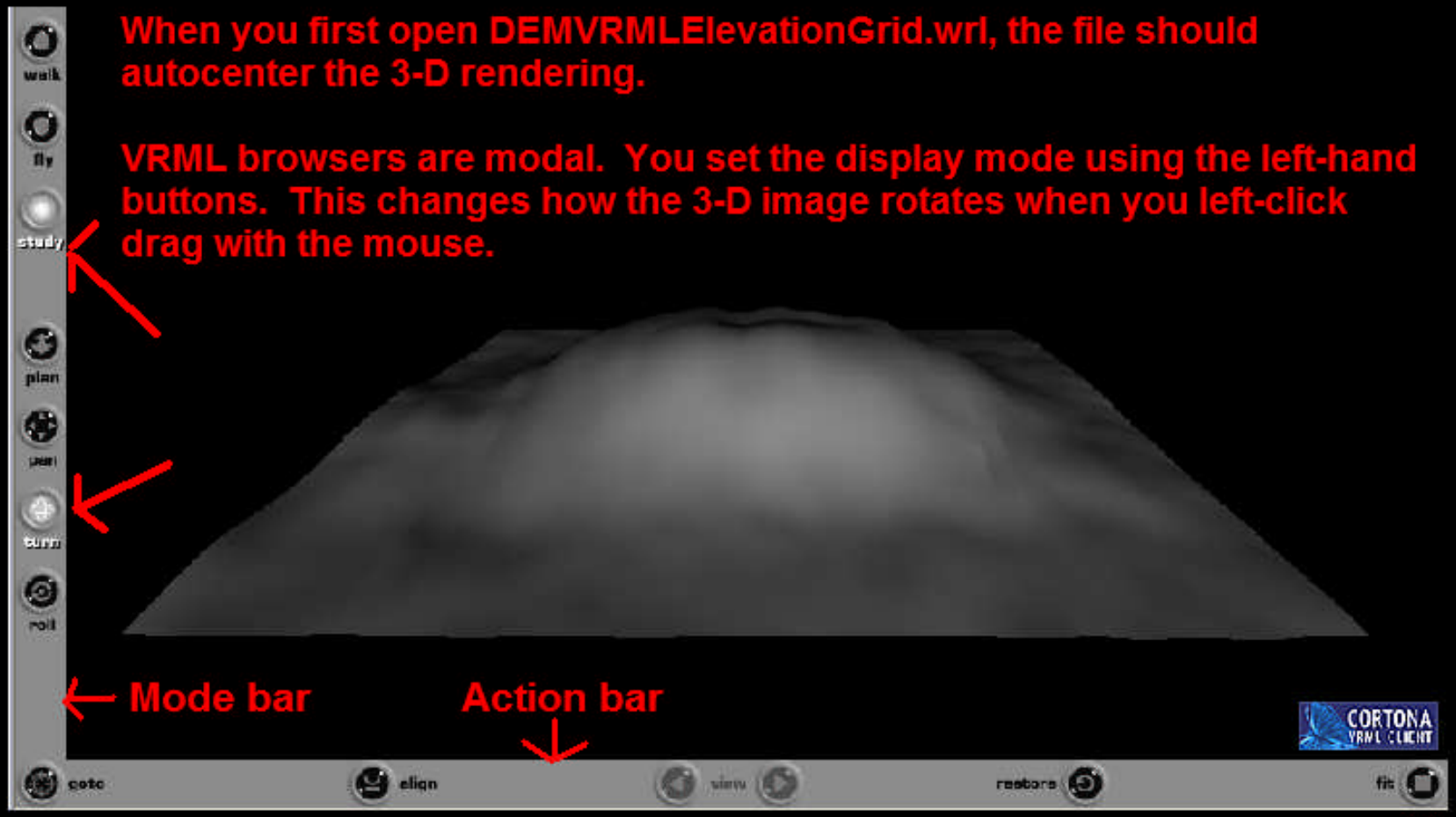
Viewing 3-D DEMs in VRML - Controls in VRML clients

If you do not have a VRML browser client installed in your internet browser, install one now. This presentation is based on the free Parallelgraphics Cortona VRML plug-in for MS -Explorer, Netscape and Safari.

Viewing 3-D DEMs in VRML - Controls in VRML clients

When you first open DEMVRMLElevationGrid.wrl, the file should autocenter the 3-D rendering.

VRML browsers are modal. You set the display mode using the left-hand buttons. This changes how the 3-D image rotates when you left-click drag with the mouse.

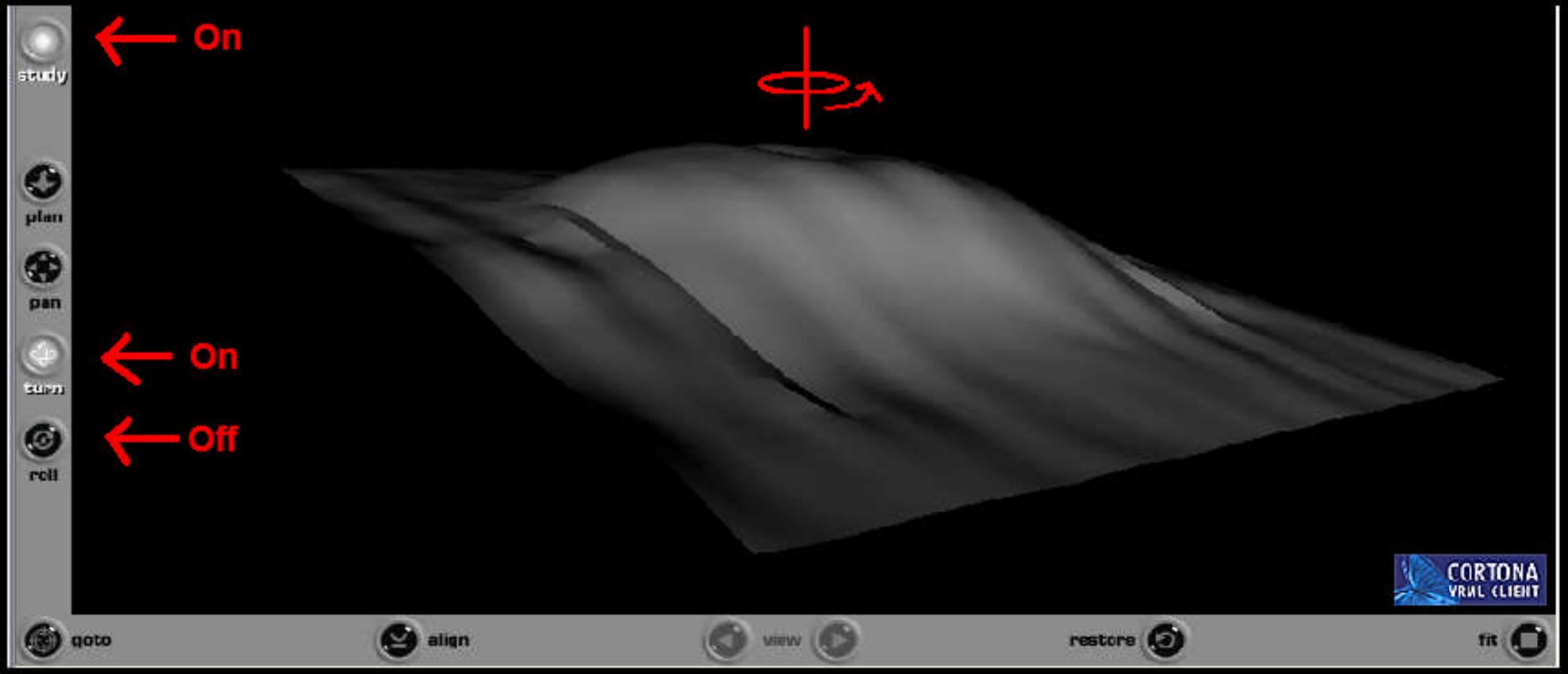


The first key mode is Study and Turn modes. Click on the radio buttons to activate these modes. In Study and Turn modes, the image will rotate around its central z-plane axis.

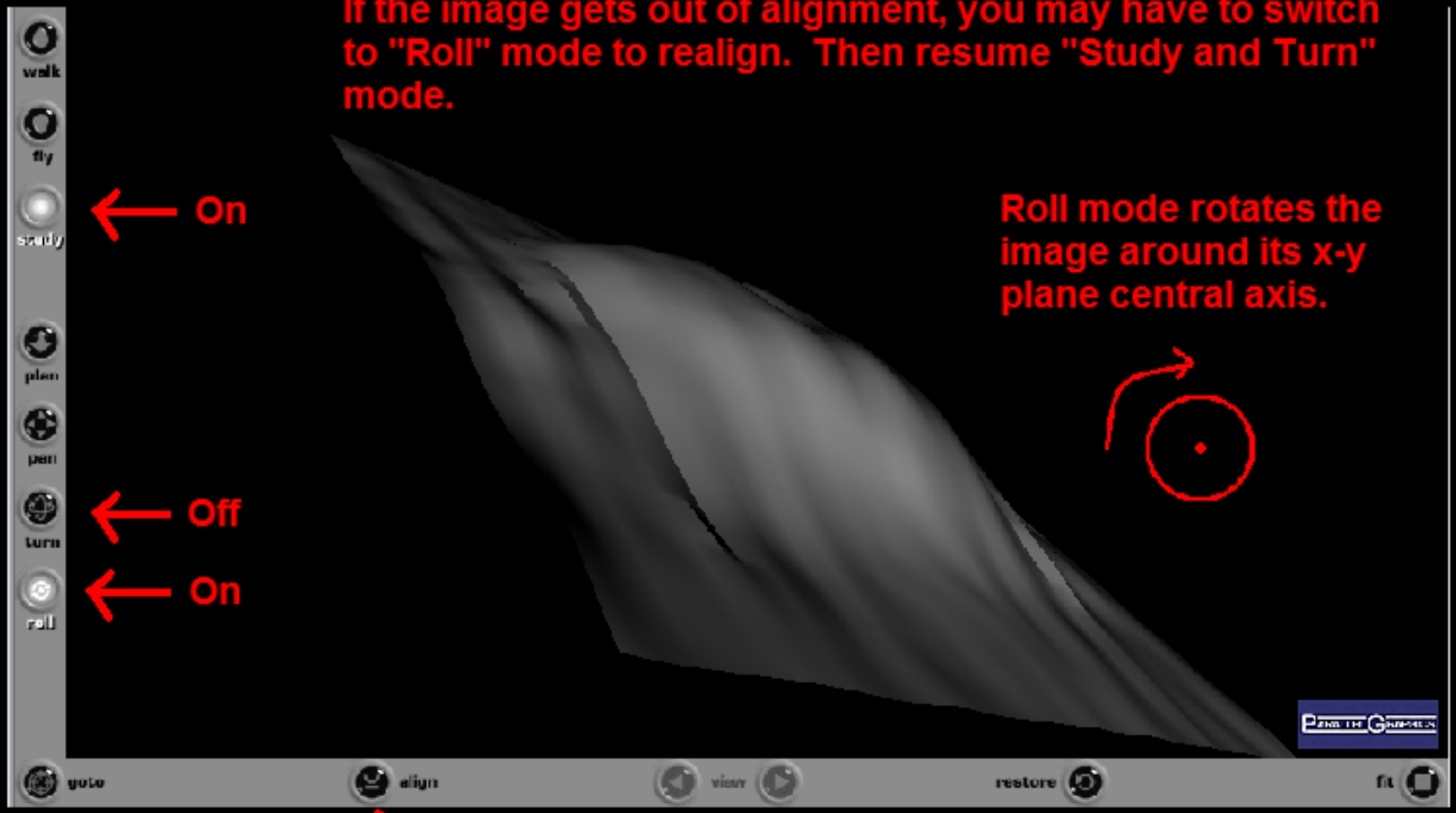
If when you open the file, the image is not centered, press the "Fit" action to center the 3-D rendering in the browser window.

Viewing 3-D DEMs in VRML - Controls in VRML clients

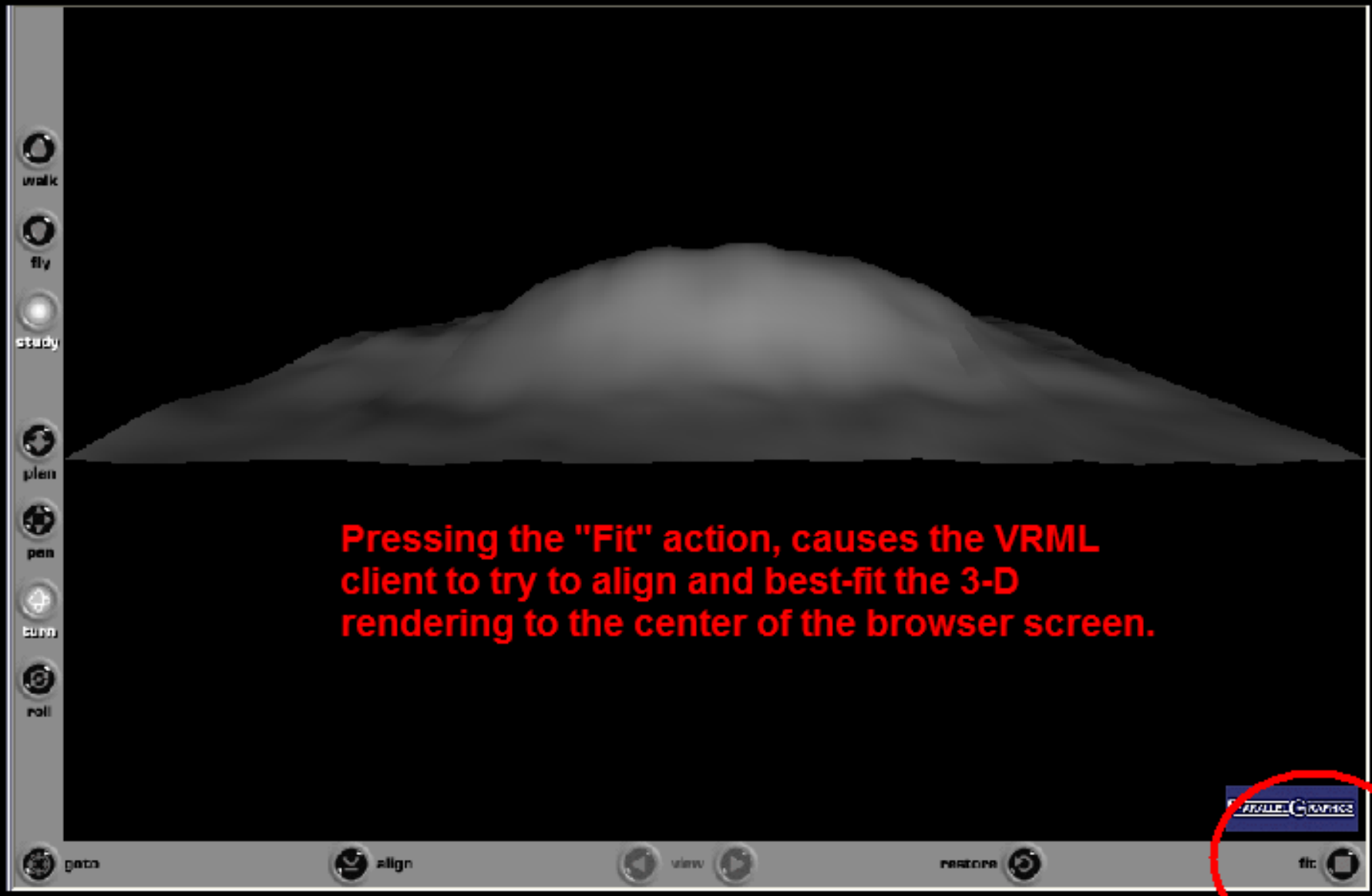
In Study and Turn modes, the 3-D object rotates around its central 3-D axis in response to a left-mouse drag. Try to rotate the object in displayed in your 3-D browser.



Viewing 3-D DEMs in VRML - Controls in VRML clients



Viewing 3-D DEMs in VRML - Controls in VRML clients



Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet

Up to now, we have been using only the Cauchy Omega dome data, stored by default into the Image Pixel Map worksheet. There are 10 sets of example data stored in DEMCarlottoMethod.xls. These are the worksheets whose names are prefixed with "Store".

In learning the last skill of this presentation, you will find out:

1) How to move image data from long-term storage to the working Image Pixel Map worksheet.

2) How to tell the spreadsheet the dimensions of your new working Image Pixel Map.

Once data about a new working image is loaded into the Image Pixel Map worksheet, you can re-generate a new DEM.

Working Image Pixel Map

	A	B	C	D	F	F	G
1	24	32	38	37	39	51	67
2	29	37	42	40	42	55	72
3	39	39	39	41	49	65	85
4	37	37	38	42	54	73	94
5	34	35	38	46	62	84	108
6	33	35	40	52	72	97	121
7	34	37	47	63	85	110	130
8	35	41	56	77	102	125	141
9	36	45	64	91	118	139	151
38							

RequirementsLimitsVersions | WorkflowMenu | ImagePixelValueMap

Ready

Long-term Storage of Feature Image Pixel Maps

20	146	146	142	137	137	140	137	132
21	146	144	141	140	144	147	141	132
22	146	146	144	143	146	150	146	139
23	144	147	147	142	141	144	145	144
24	143	147	146	141	137	139	141	141
25	146	148	147	142	141	142	139	134
26	151	151	148	147	149	149	140	129
27	153	154	151	148	147	146	140	132
28	148	149	149	147	148	150	146	140

StoreImage_InfoLog | StoreIPM_CauchyOmega_Evans2006i | S

Ready

Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet

When moving image pixel data from storage to the working Image Pixel Map worksheet, five objects in DEMCarlottoMethod.xls are used:

1) The long-term storage image pixel data worksheet. (E.g. worksheet "StoreIPM_CauchyTau_Evans2006i")

2) The temporary Image Pixel Map worksheet. (worksheet "ImagePixelValueMap")

3) Information about the characteristics of the stored image data. (worksheet "StoreImage_InfoLog")

4) Steps 1 and 2 on the Workflow Control Menu. (worksheet "WorkflowMenu")

5) Step 3 on the Workflow Control Menu. (worksheet "WorkflowMenu")

By now, you should be familiar with all these parts of the spreadsheet DEMCarlottoMethod.xls. Take a moment to review the location of these objects in the spreadsheet.

In the working example, we will copy stored image data about the dome Cauchy Tau into the working Image Pixel Value Map to generate a new DEM for that lunar feature.

Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet - Review of parts of DEMCarlottoMethod.xls

Working Image Pixel Map and Long-Term Storage

	A	B	C	D	E	F	G
1	24	32	38	37	39	51	67
2	29	37	42	40	42	55	72
3	39	39	39	41	49	65	85
4	37	37	38	42	54	73	94
5	34	35	38	46	62	84	108
6	33	35	40	52	72	97	121
7	34	37	47	63	85	110	130
8	35	41	56	77	102	125	141
9	36	45	64	91	118	139	151
36							
37							
38							

RequirementsLimitsVersions | WorkflowMenu | **ImagePixelValueMap**

Ready

20	146	145	142	137	137	140	137	132
21	146	144	141	140	144	147	141	132
22	146	146	144	143	146	150	146	139
23	144	147	147	142	141	144	145	144
24	143	147	146	141	137	139	141	141
25	146	148	147	142	141	142	139	134
26	151	151	148	147	149	149	140	129
27	153	154	151	148	147	146	140	132
28	148	149	149	147	148	150	146	140

StoreImage_InfoLog | **StoreIPM_CauchyOmega_Evans2006i** | S

Ready

Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet - Review of parts of DEMCarlottoMethod.xls

Step 2 on the Workflow Menu where dimensions of the new image pixel are entered.

8					
9	Step 2 - Identify the range of the image pixel values to this spreadsheet				
10					
11		2a	Enter the upper left-hand pixel cell name:	$A$1	as absolute cell reference, e.g. $B$2
12		2b	Enter the lower right-hand pixel cell name:	$AJ$26	as absolute cell reference, e.g. $Z$100
13		2c	Click button to identify and name the range:		
14		Name pixel range			
15			Current value:	ImagePixelValueMap!$A$1:$AJ$26	
16					
17		Clear Image Pixel Map			

	A	B	C	D	E	F	G	H
1	24	32	38	37	39	51	67	76
2	29	37	42	40	42	55	72	82
3	39	39	39	41	49	65	85	98
4	37	37	38	42	54	73	94	109
5	34	35	38	46	62	84	108	123
36								
37								
38								

RequirementsLimitsVersions | WorkflowMenu | **ImagePixelValueMap** | DEM

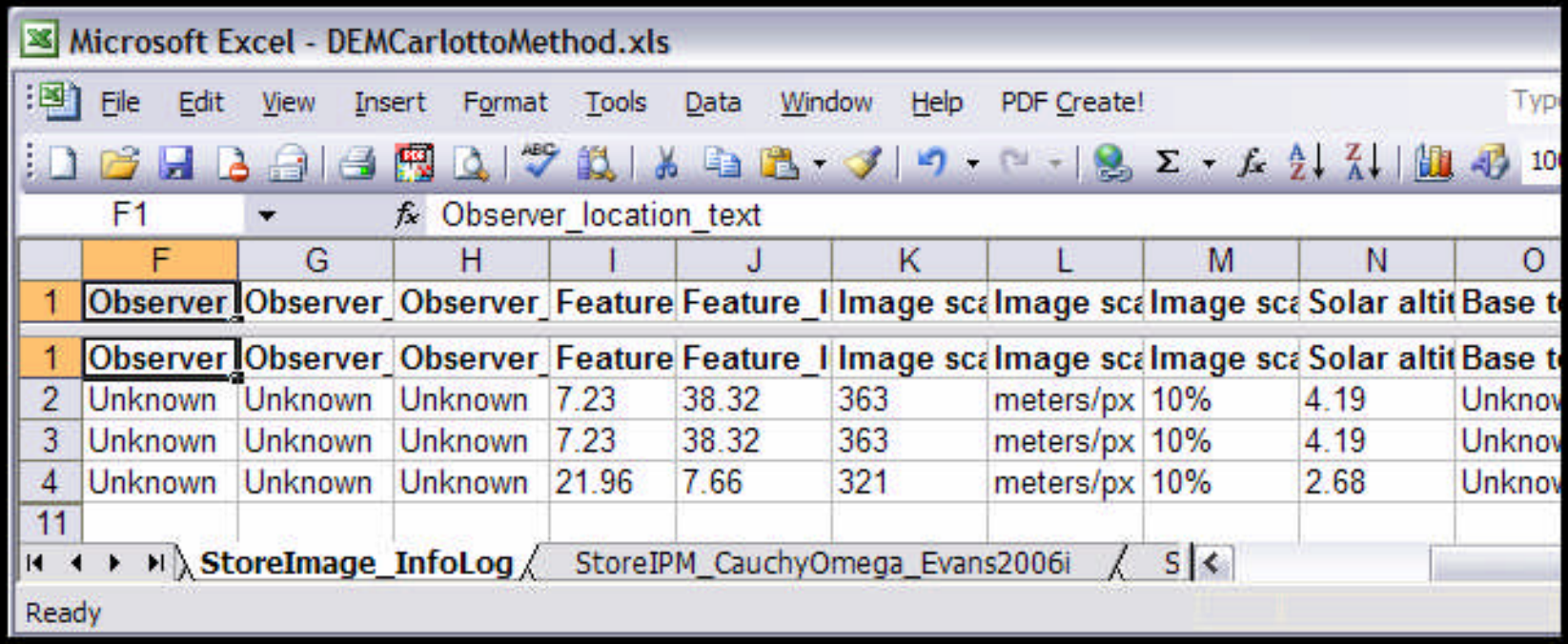
Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet - Review of parts of DEMCarlottoMethod.xls

Long-term storage of image information

and

Step 3 on the Workflow Menu where the stored image information is reentered.

19	Step 3 - Enter image characteristics							
20								
21		3a	Image scale:	321	meters/px	32.1	meter/px	uncertainty
22		3b	Solar altitude:	2.68	degrees	87.32	Zenith angle degrees	
23		3c	Base terrian radius:	0	meters or kilometers			
24								



	F	G	H	I	J	K	L	M	N	O
1	Observer	Observer_	Observer_	Feature	Feature_I	Image sca	Image sca	Image sca	Solar altit	Base t
1	Observer	Observer_	Observer_	Feature	Feature_I	Image sca	Image sca	Image sca	Solar altit	Base t
2	Unknown	Unknown	Unknown	7.23	38.32	363	meters/px	10%	4.19	Unknov
3	Unknown	Unknown	Unknown	7.23	38.32	363	meters/px	10%	4.19	Unknov
4	Unknown	Unknown	Unknown	21.96	7.66	321	meters/px	10%	2.68	Unknov
11										

Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet

First erase the old image data. A button on the Workflow Control Menu will erase the old data for you. If the data in ImagePixelValueMap is not fully erased, manually delete all cells in worksheet ImagePixelValueMap.

8					
9	Step 2 - Identify the range of the image pixel values to this spreadsheet				
10					
11	2a	Enter the upper left-hand pixel cell name:	$A$1	as absolute cell reference, e.g. $B$2	
12	2b	Enter the lower right-hand pixel cell name:	$AJ$26	as absolute cell reference, e.g. $Z$100	
13	2c	Click button to identify and name the range:			
14	Name pixel range				
15		Current value:	ImagePixelValueMap!$A$1:$AJ$26		
16					
17	Clear Image Pixel Map				

Manually cut and paste the stored image data into Image Pixel Map. StoreIPM_CauchyTau_Evans2006i -> ImagePixelValueMap

23	144	147	147	142	141	144	145	144
24	143	147	146	141	137	139	141	141
25	146	148	147	142	141	142	139	134
26	151	151	148	147	149	149	140	129
27	153	154	151	148	147	146	140	132
28	148	149	149	147	148	150	146	140

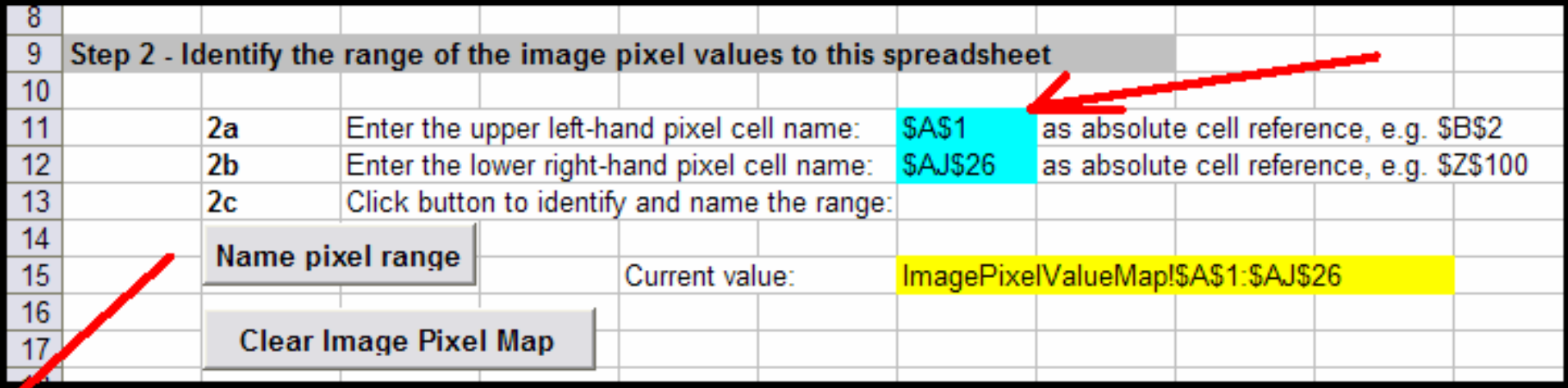
StoreImage_InfoLog | StoreIPM_CauchyOmega_Evans2006i | S

Ready

lowMenu | ImagePixelValueMap | D

Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet

Tell the spreadsheet the names of the upper left-hand and lower right -hand cells of your NxM image matrix, newly pasted into worksheet Image Pixel Map. These need to be in "A1" notation using the dollar signs as illustrated.

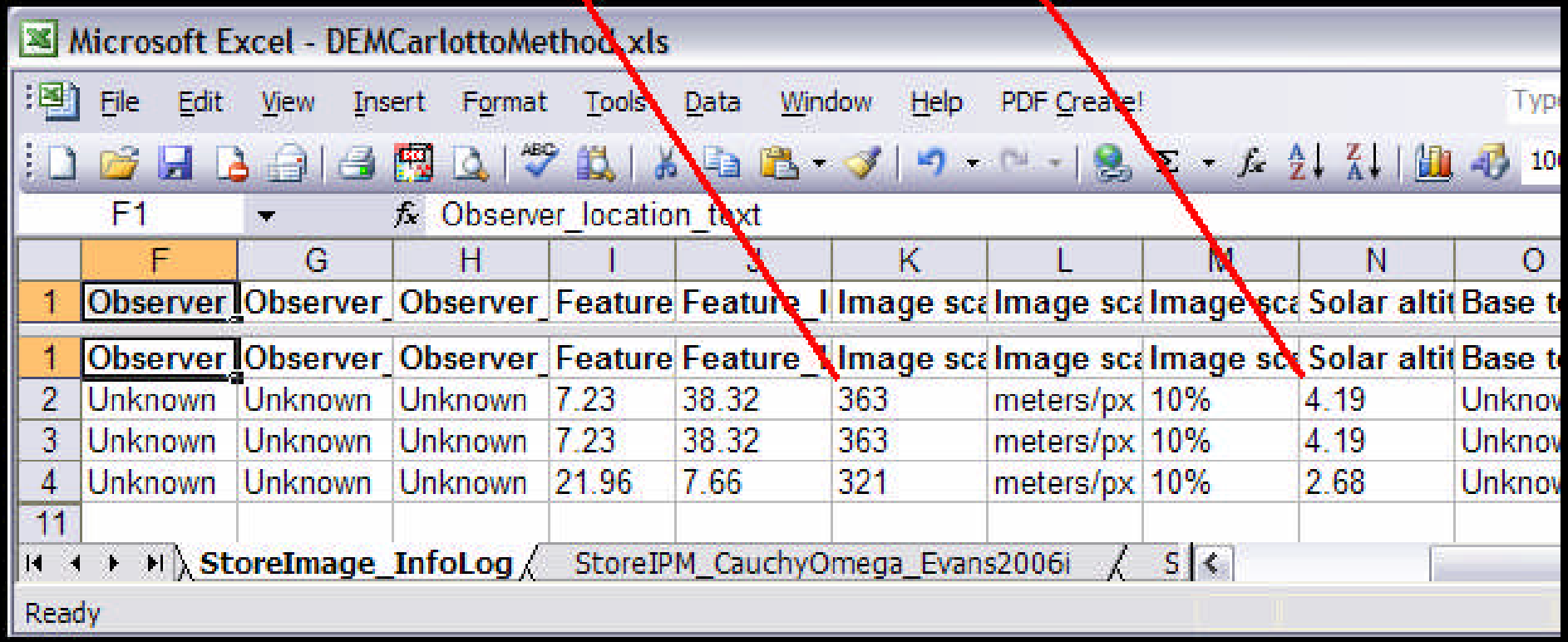


Press the "Name pixel range" to identify the new dimensions of your image data to the spreadsheet.

Moving Image Data from Long-Term Storage to the Image Pixel Map Worksheet

Update the image characteristics in Step 3 of worksheet Image Pixel Map.

19	Step 3 - Enter image characteristics							
20								
21	3a	Image scale:	321	meters/px	32.1	meter/px	uncertainty	
22	3b	Solar altitude:	2.68	degrees	87.32	Zenith angle degrees		
23	3c	Base terrian radius:	0	meters or kilometers				
24								



	F	G	H	I	J	K	L	M	N	O
1	Observer	Observer_	Observer_	Feature	Feature_I	Image sca	Image sca	Image sca	Solar altit	Base t
1	Observer	Observer_	Observer_	Feature	Feature_I	Image sca	Image sca	Image sc	Solar altit	Base t
2	Unknown	Unknown	Unknown	7.23	38.32	363	meters/px	10%	4.19	Unknov
3	Unknown	Unknown	Unknown	7.23	38.32	363	meters/px	10%	4.19	Unknov
4	Unknown	Unknown	Unknown	21.96	7.66	321	meters/px	10%	2.68	Unknov
11										

Review

1) What are the parts of the spreadsheet DEMCarlottoMethod.xls?

- Work Flow Control Menu
- Image Processing Checklist
- Image Pixel Map
- Gradient Summed Map
- Storage of information on stored images
- Storage of image pixel maps
- Utility calculators
- Vertical Slice Scratch Sheet

2) Where is the test data located?

- Storage of image pixel maps in worksheets with prefix "StoreIM"

Review

3) How is a DEM generated using the test data?

A typical cycle of DEM refinement involves:

Delete any prior DEM and Gradient Sum Map
Change characteristics
Regenerate the DEM

4) How do you adjust the zero-base elevation of a DEM?

Workflow Control Menu, Step 3, Base terrian radius data entry field
Then regenerate the DEM

5) How to do you export the DEM to text files?

Workflow Control Menu, Step 4, Button "Make DEM Point Files"

Review

6) How do you view a DEM using a 3-D VRML browser plug-in?

- Install a VRML viewing client in your internet browser
- Click on the files with the suffix "*.wrl" created by this spreadsheet
- Left-mouse drag on the background to make the 3-D DEM graphic rotate
- Use "Study & Turn" mode to rotate the 3-D DEM graphic around the z-axis
- Use "Study & Roll" to fix alignment
- Use the "Fit" or "Align" actions to correct a figure that has rolled to an odd angle

Review

7) How do you move long-term stored image data to the temporary ImagePixelValueMap worksheet?

Delete the old working image pixel map.

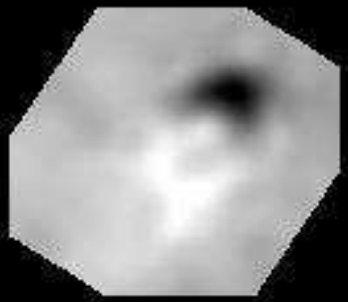
Manually paste and copy a storage image pixel map to the working ImagePixelValueMap worksheet.

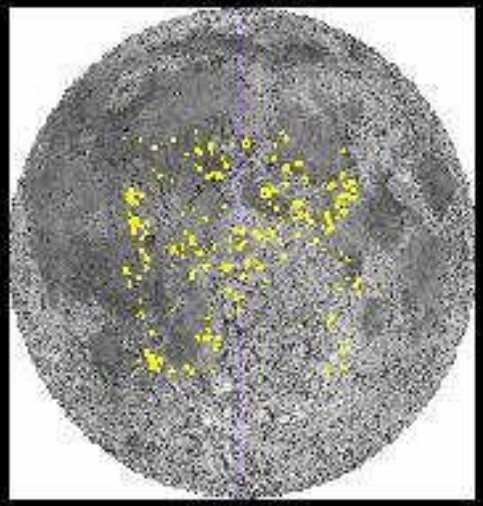
Identify the new image pixel map's dimensions to the spreadsheet.

Update the image characteristics from stored information.

End of Part 2 - Parts of DEMCarlottoMethod.xls

Katima, Alaska





Mons Rumker - Apollo 16 AS16-97-13262

Marius Hills - Lunar Orbiter IV - IV-164-H2

3D floating point

z-plane 1x