

Lunar South Pole Digital Elevation Models From Lunar Reconnaissance Orbiter Narrow Angle Camera

M. R. Rosiek (PRESENTED BY: T. Hare)

O. Thomas

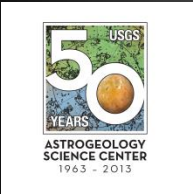
E. Howington-Kraus

E. Foster

*Because of U.S. Department of Interior policies related to sequestration,
Mark Rosiek was not able to attend LPSC.
Please contact Mark by e-mail mrosiek@usgs.gov
if you have questions related to this presentation.*

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Astrogeology Science Center, U. S. Geological Survey, 2255 N. Gemini Dr.,
Flagstaff AZ, 86001



Objective Study Area

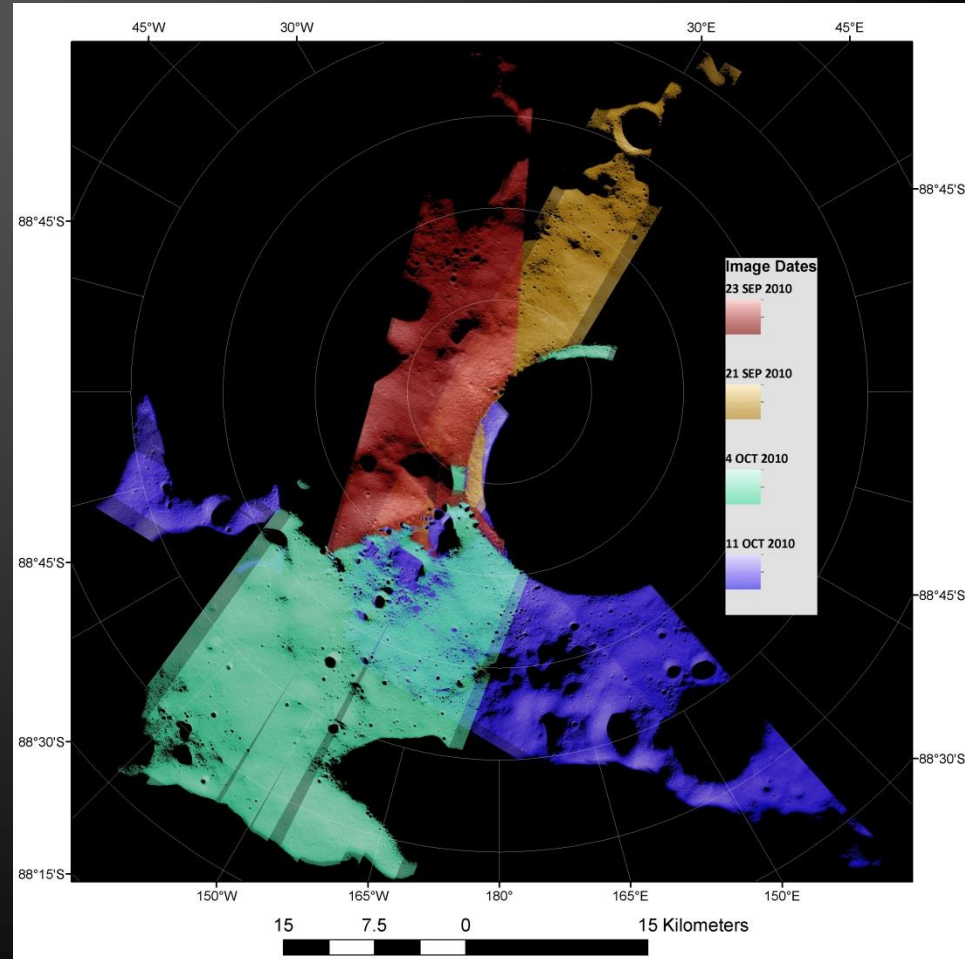
Date	Avg % Valid	Min % Valid	Max % Valid	# of Images
21-Sep-2010	34.3%	24.7%	41.6%	6
23-Sep-2010	34.0%	28.2%	38.3%	13
4-Oct-2010	41.4%	28.0%	50.2%	24
11-Oct-2010	31.5%	19.0%	47.7%	28

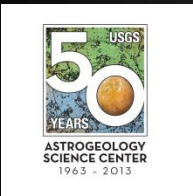
➤ Objective:

- Provide elevation and slope information for the lunar south pole

➤ Study area:

- Coverage area is shown in figure to the right
- Image resolution 1.0 – 1.3 m
- Images are 50 % or more in shadow
- Stereo and mono coverage can be seen in gaps.
- Areas where the DEM had to be blended can be seen

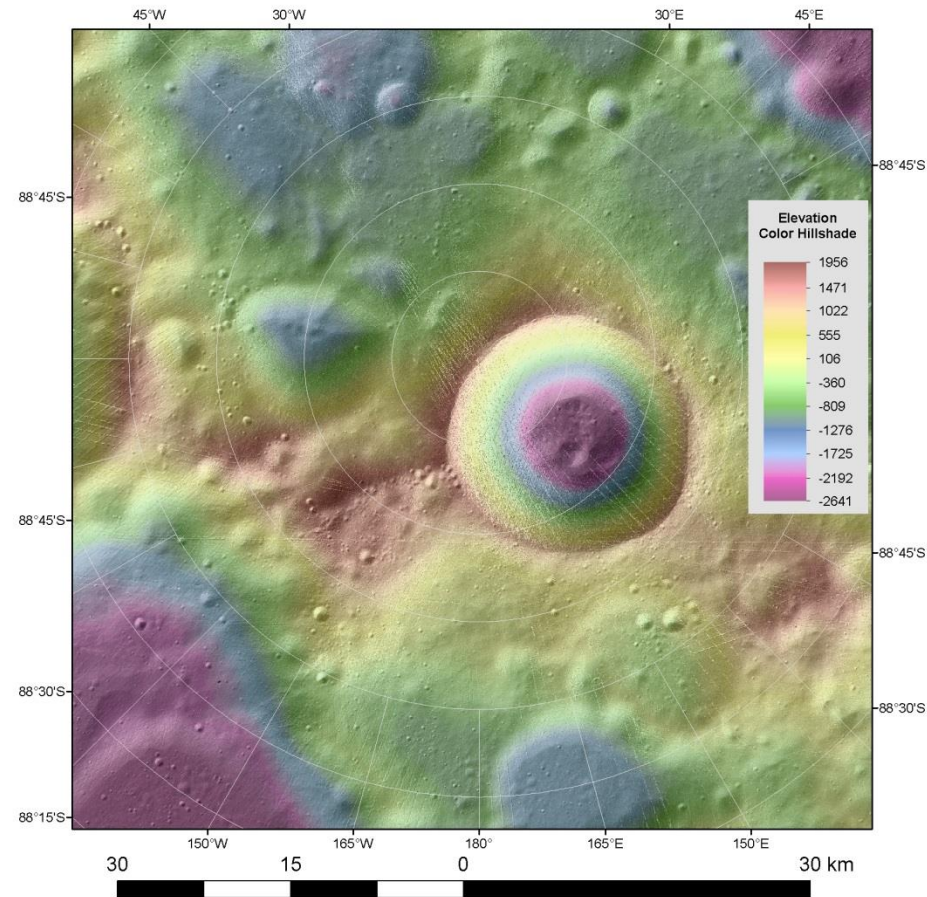
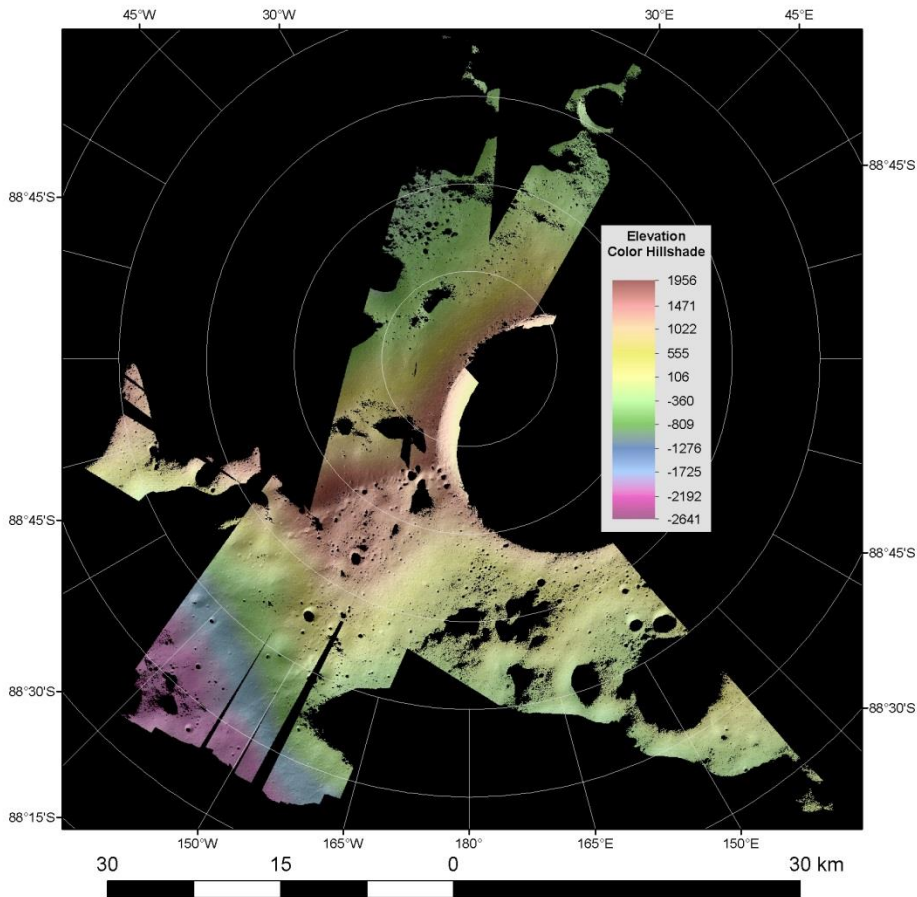


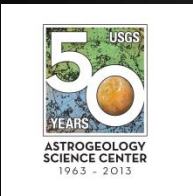


LROC NAC 4 m DEM

LOLA 5 m DEM

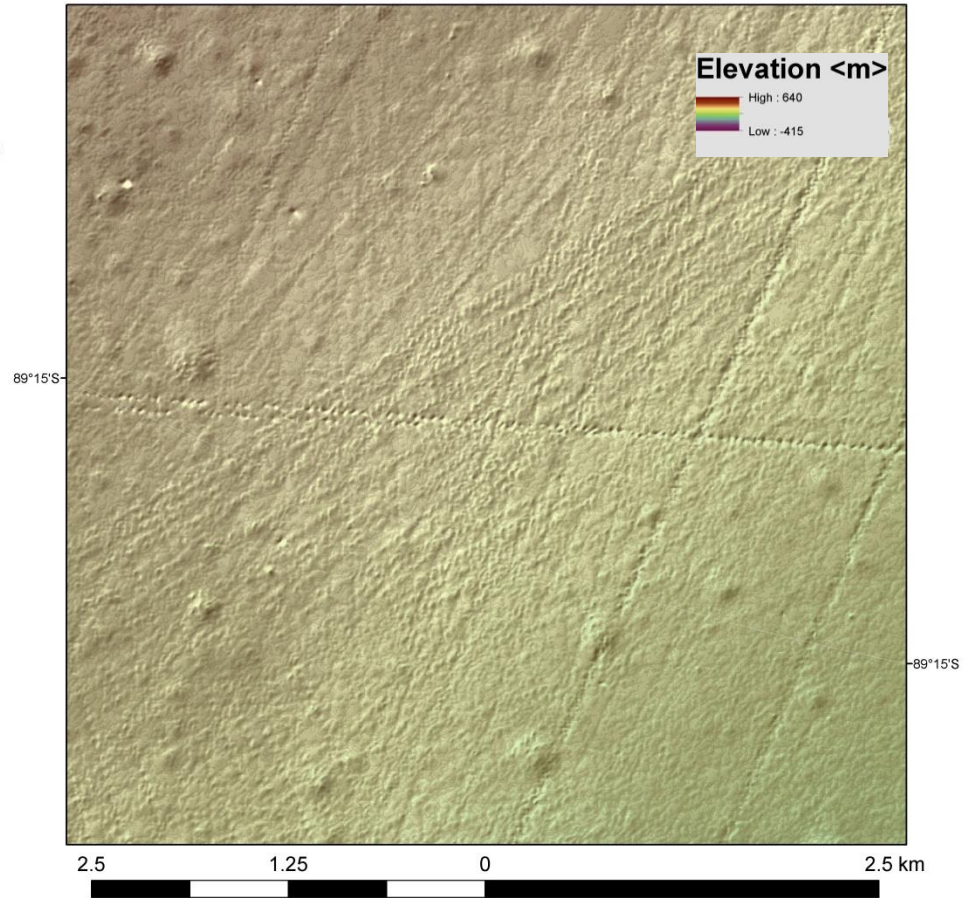
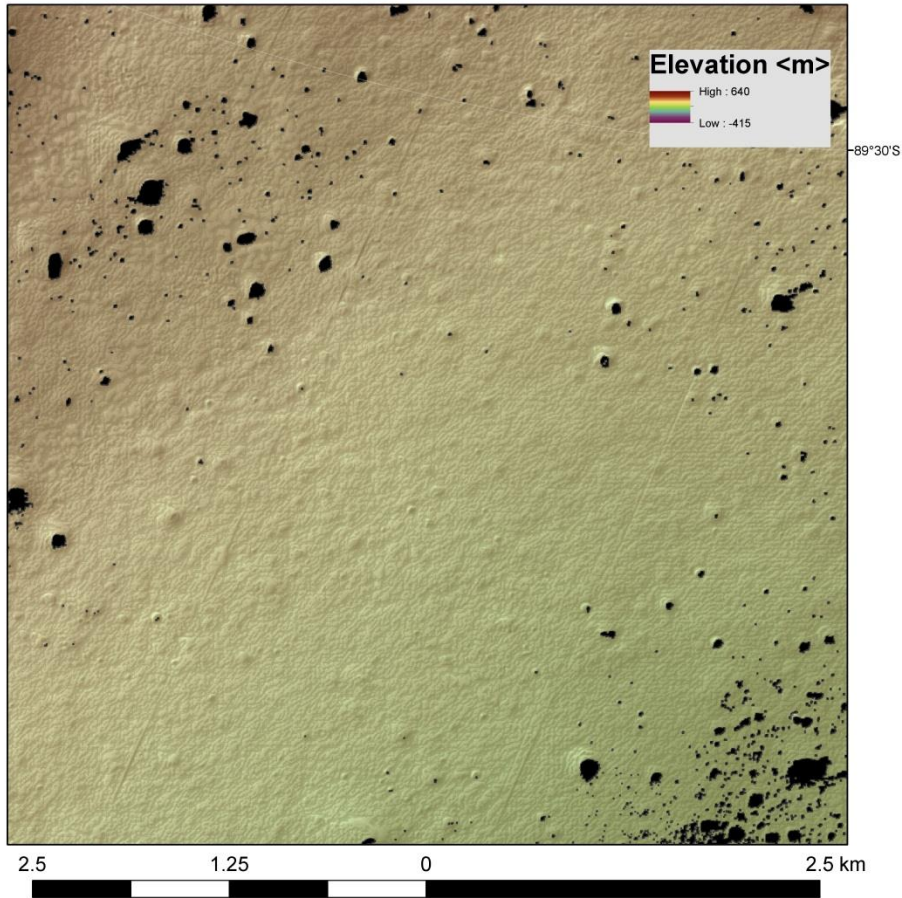
- 67 LROC NAC images were used – Left and Right Camera
- 76 DEMs were collected – not all were used in the final product
- 66,555,500 grid cells - 1,065 sq km



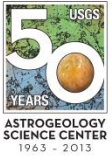


DEM close up

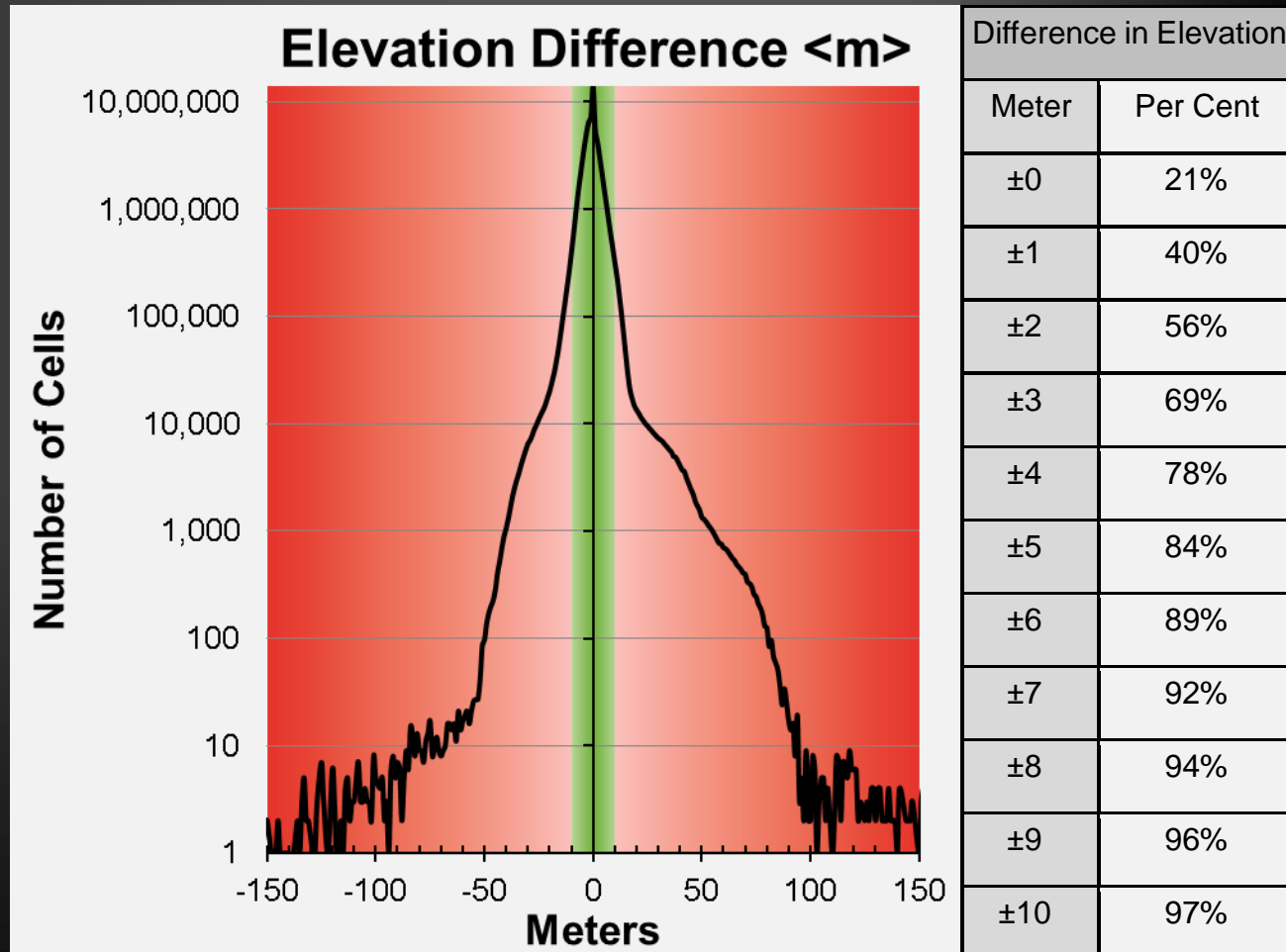
- LROC NAC DEMs were shadow masked
 - Shadows have DNs 10 – 20 - edit shadow edges - stray pixels in middle of shadows
- Seams between stereo models

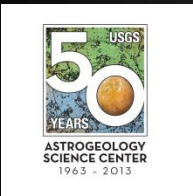


Difference in elevation values



- 56% of the elevation values are within 2 m
- 97 % of the elevation values are within 10 m (green area)
- DEM was edited to remove errors at edges of shadows
- Spikes in LOLA grid cause large tails
 - Min -618 m
 - Max 2,343



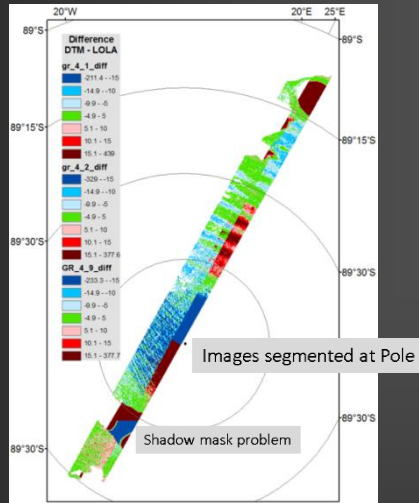


Changes made to SOCET SET sensor model

Improved match between DEMs

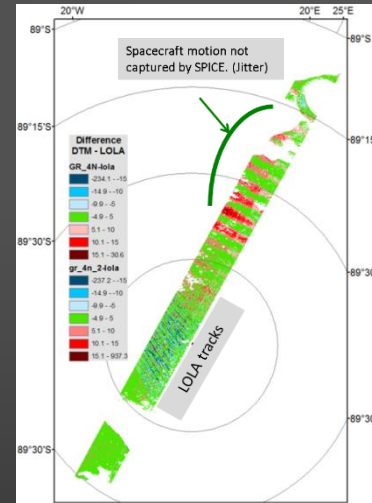
Able to traverse the Pole

Old SOCET SET sensor model

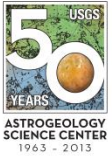


- Single CK Data point - works for stable images
- Problem with images crossing the Pole
 - Root finding algorithm
- 3 stereo models – due to segmented image over the pole
 - M139716114LE with M139709342LE (segmented)
 - M139716114LE with M139722912LE

New SOCET SET sensor model

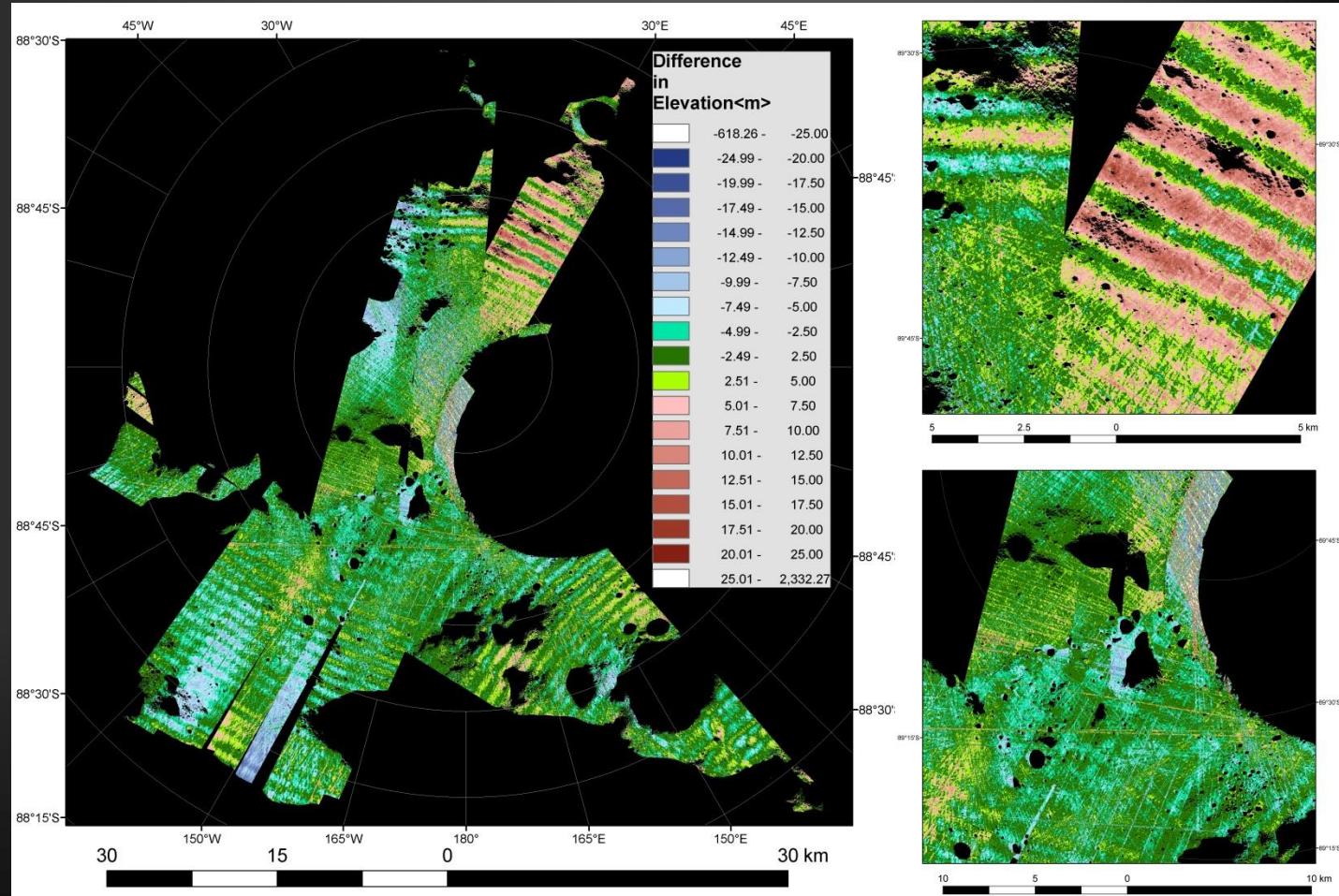


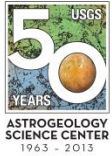
- CK Data in ISIS is at a variable spacing and transferred to SOCET SET at shortest time
- 2 stereo models – able to traverse the Pole
 - M139716114LE with M139709342LE
 - M139716114LE with M139722912LE



Elevation Difference Map 2.5 m bins

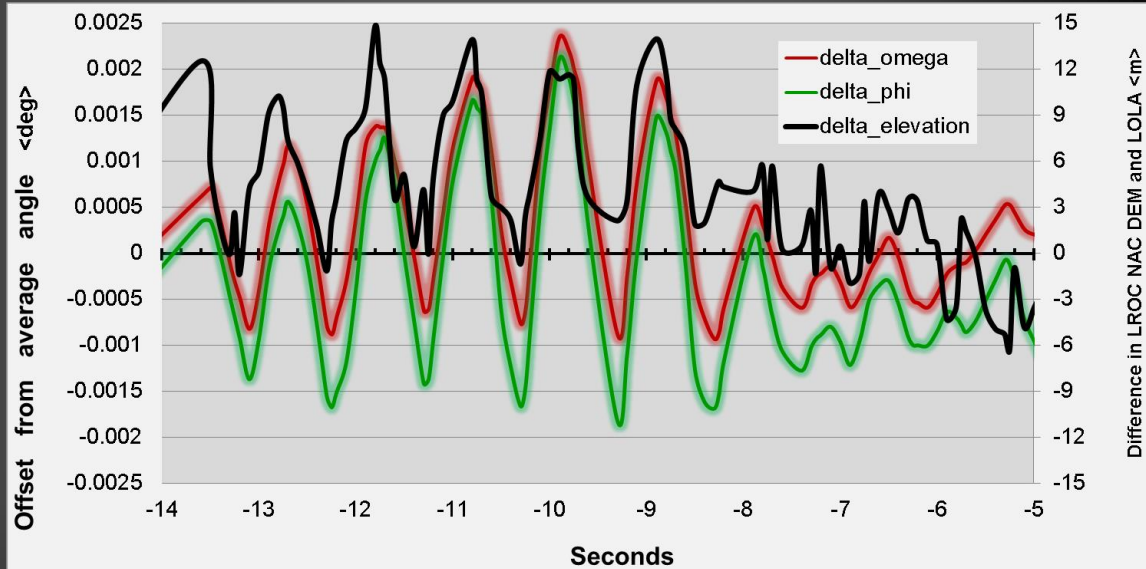
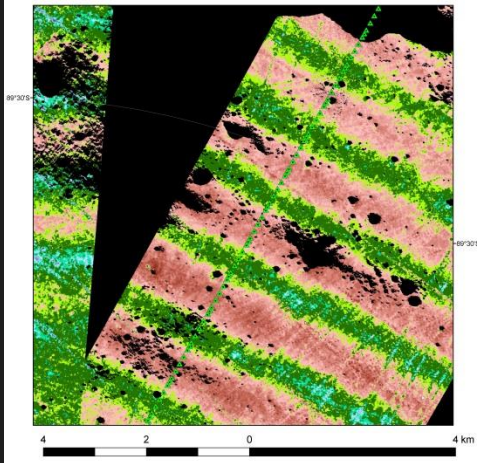
- Systematic errors in DEMs from jitter (un-modeled image motion)
- Errors where stereomodels are merged
 - Improved how camera angles are passed from ISIS to SOCET SET
- Horizontal offset of LOLA tracks



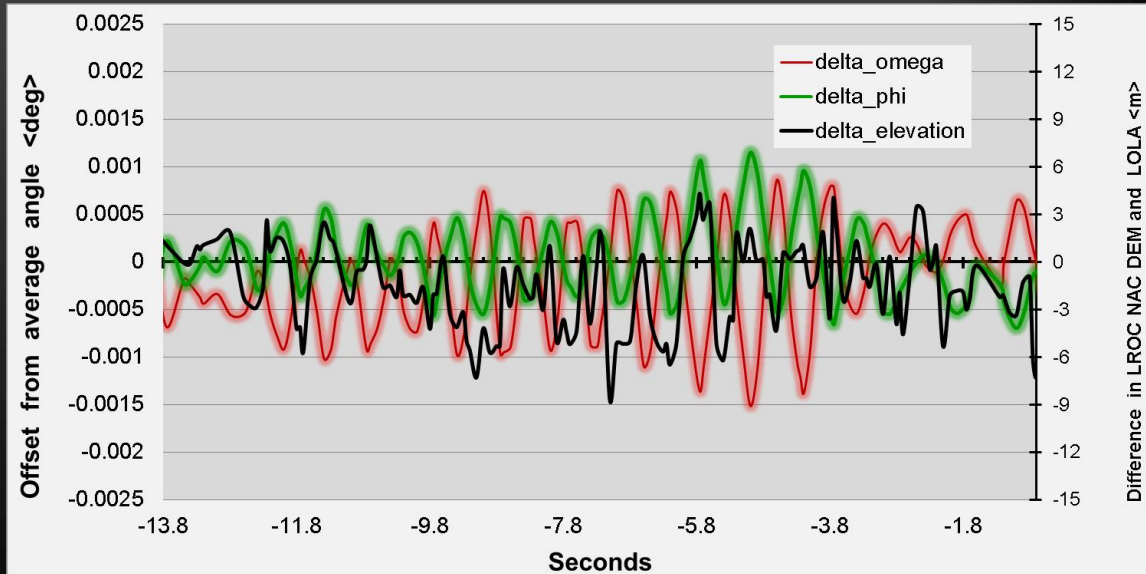
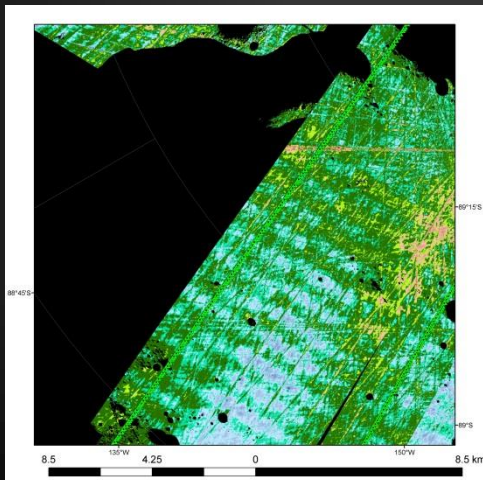


Correlation of image motion and elevation error

M139716114LE

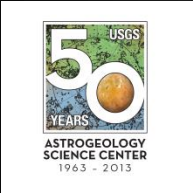


M140856145LE

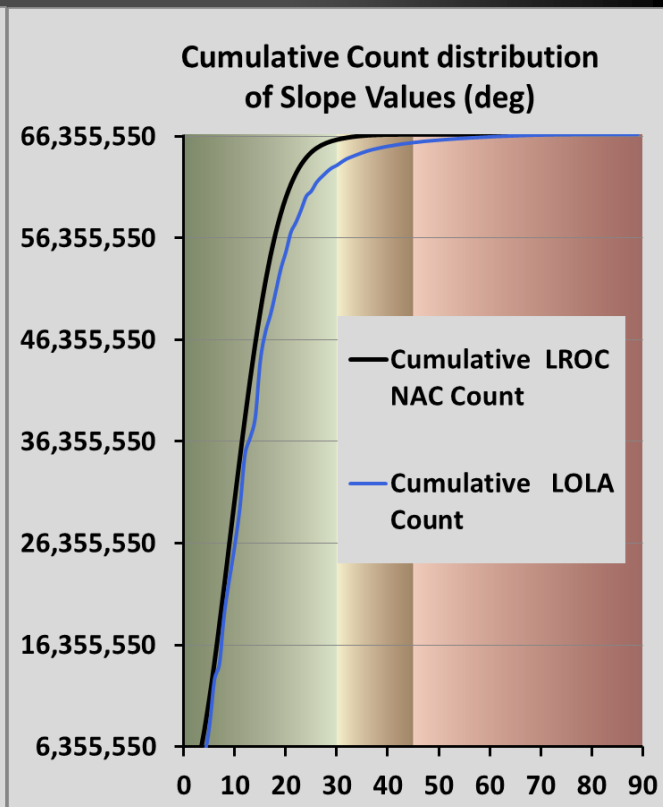
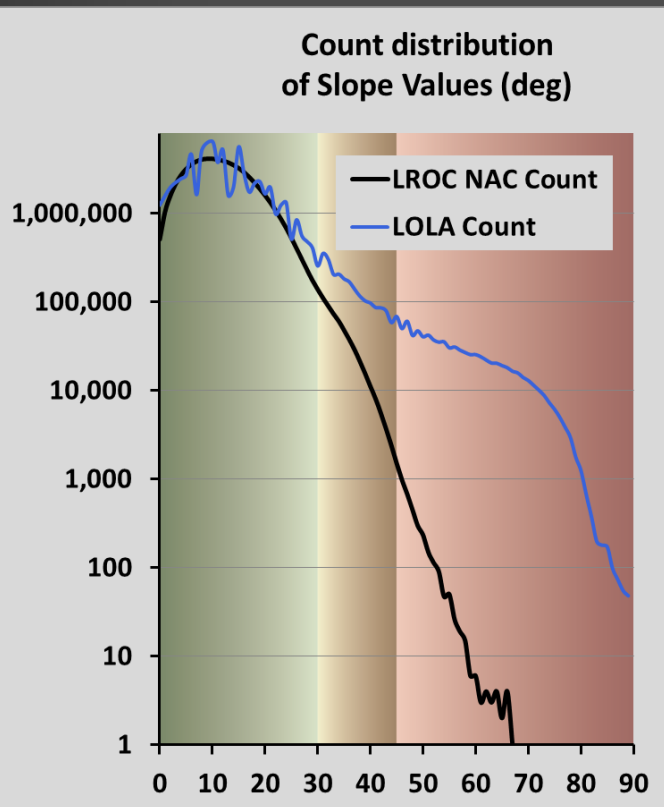


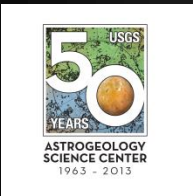
Slope analysis

- LROC NAC 4 m DEM – 8 m baseline
 - Seam errors - Shadow errors
- LOLA 5 m DEM – 10 m baseline
 - LOLA elevation values 0.5 m bins
 - Horizontal displacement in LOLA tracks
 - Few blunders



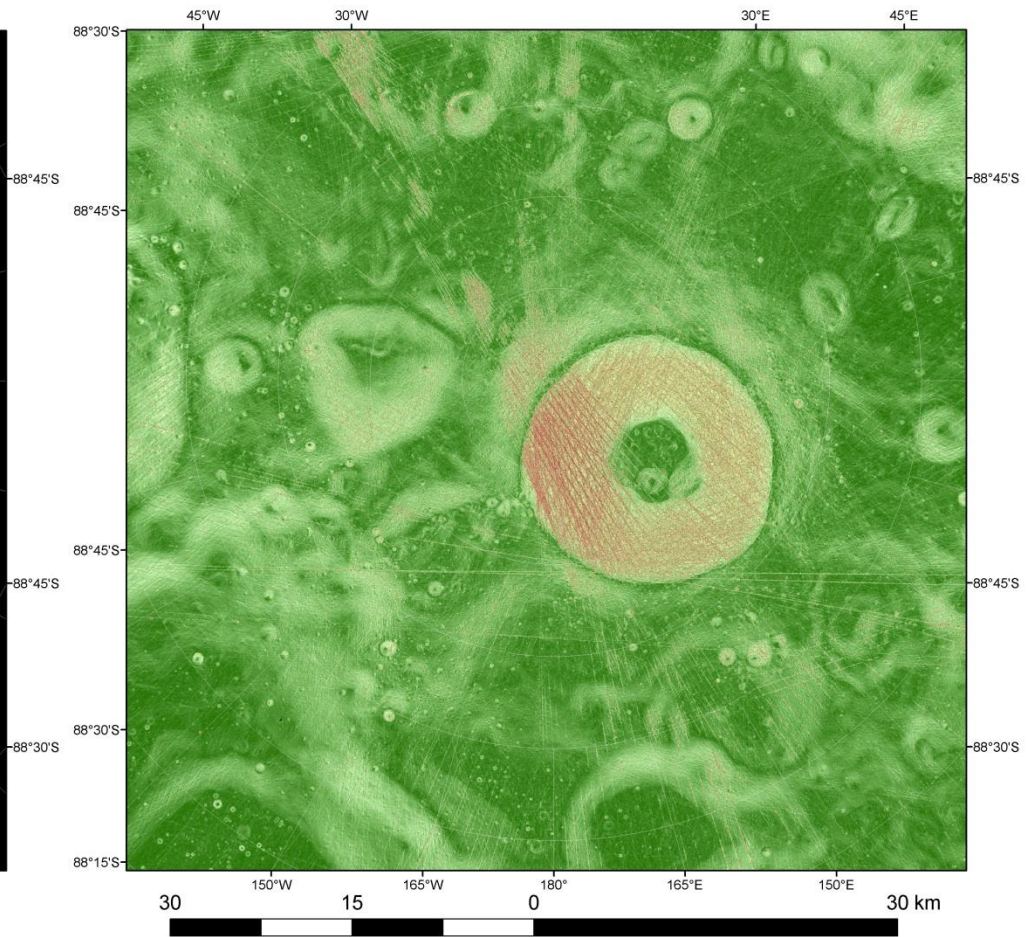
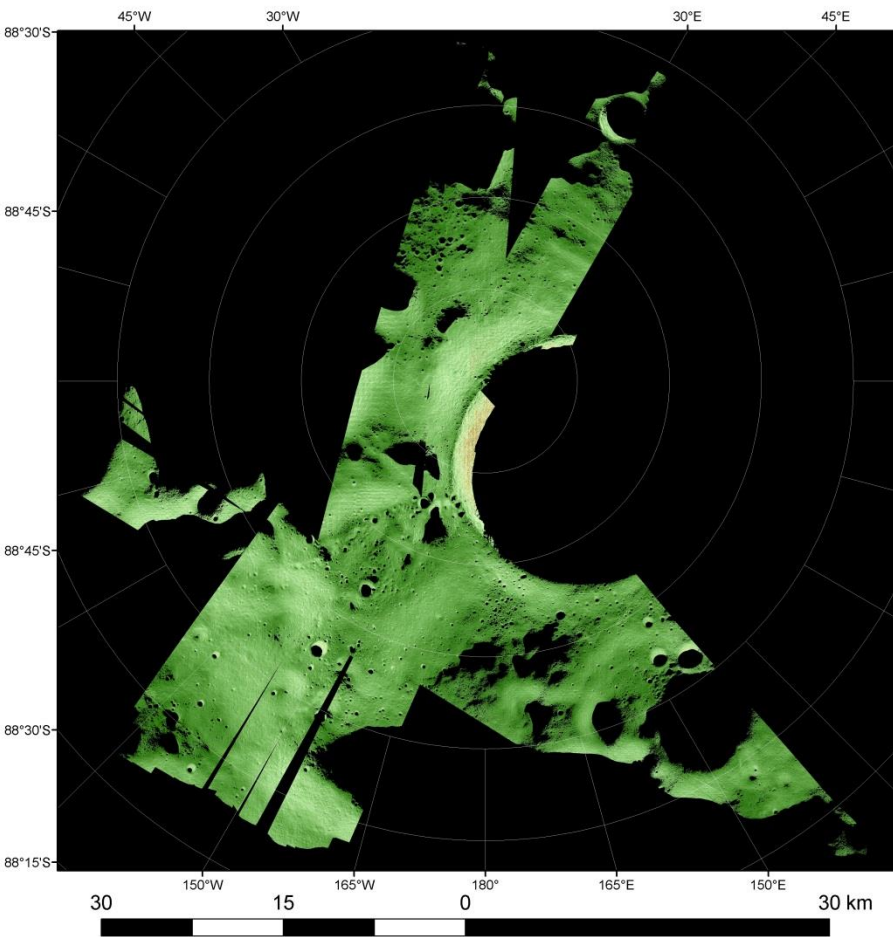
Slope <deg>					
LROC NAC 8 m baseline		LOLA 10 m baseline			
0 - 1	16	31	46	61	76
2	17	32	47	62	77
3	18	33	48	63	78
4	19	34	49	64	79
5	20	35	50	65	80
6	21	36	51	66	81
7	22	37	52	67	82
8	23	38	53	68	83
9	24	39	54	69	84
10	25	40	55	70	85
11	26	41	56	71	86
12	27	42	57	72	87
13	28	43	58	73	88
14	29	44	59	74	89
15	30	45	60	75	90

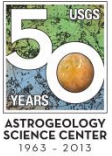




LROC NAC and LOLA Slope Maps

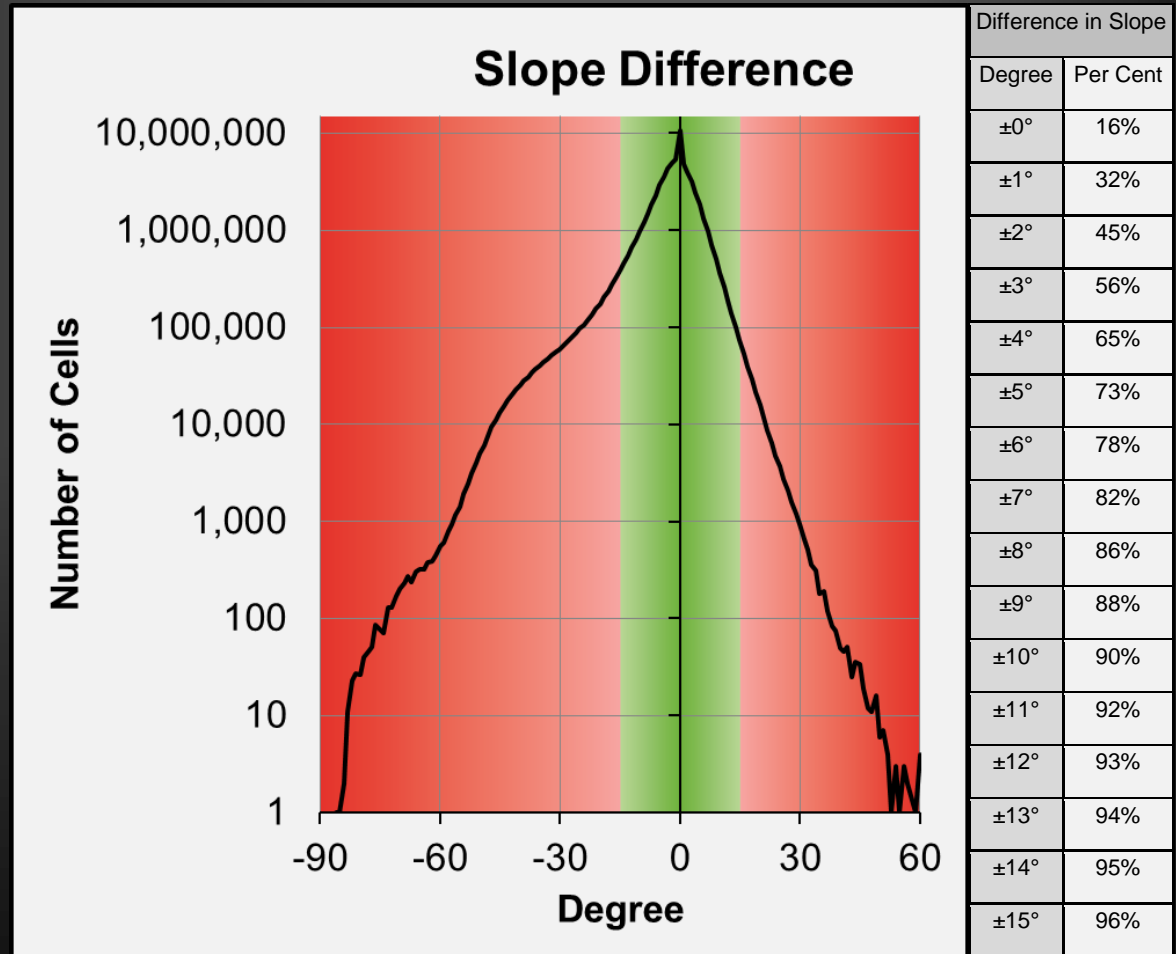
➤ Legend on previous slide

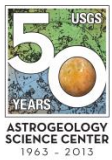




Difference in Slope values

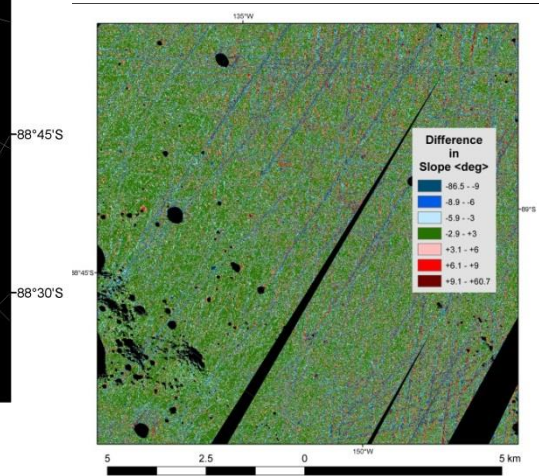
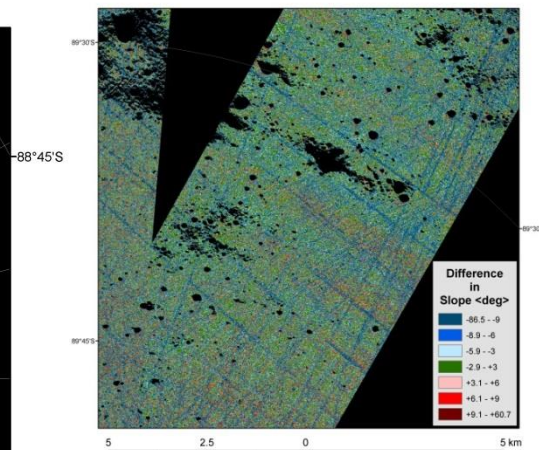
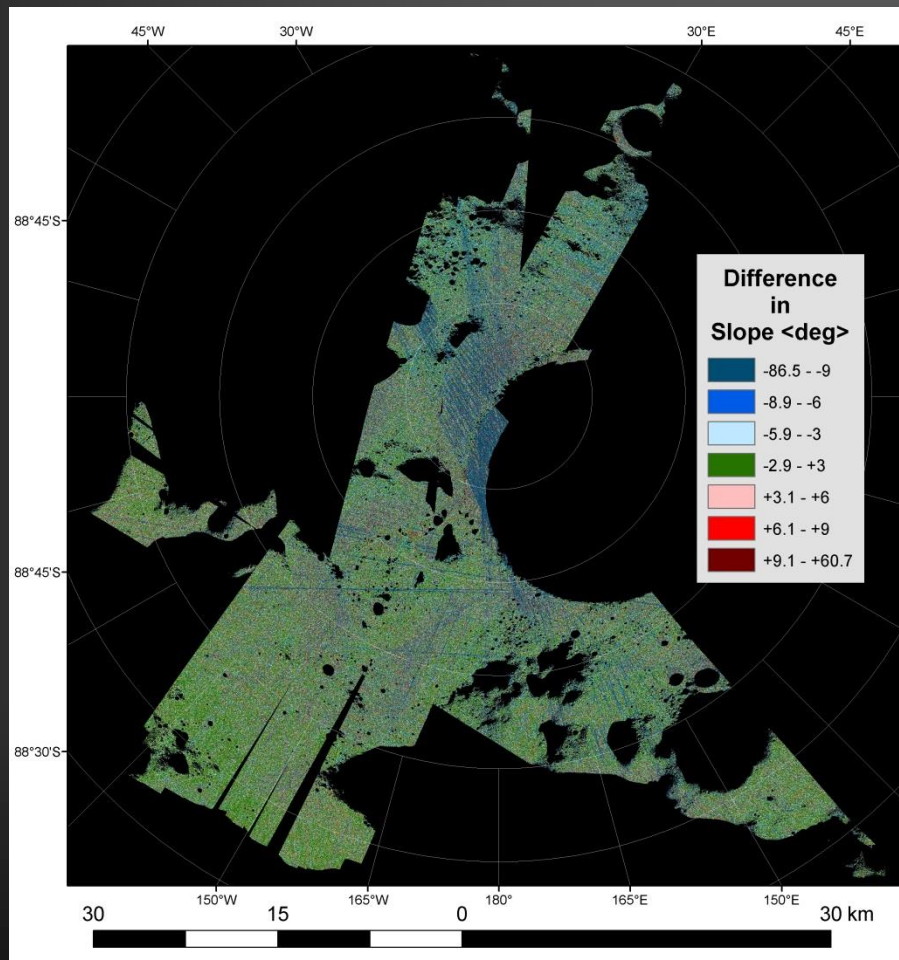
- 56% of the slope values are within $\pm 3^\circ$
- 96% of the slope values are within $\pm 15^\circ$ (green area)





Slope Difference Map 3° bins

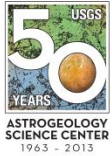
- Image motion
- Seams between Stereomodels
- LOLA horizontal track offset





Conclusions

- 4 m DEM provides elevation and slope information for the lunar south pole
- Changes made to SOCET SET sensor model provides improved DEMs
- Remaining un-modeled image motion is causing errors in DEM
 - Image motion recorded at 10 Hz released at 5 Hz
 - Use overlapping stereo models – stereo triplets
 - Images are tied to LOLA track points at a few location
 - Improve the tie between LOLA and images – adjust horizontal position of LOLA tracks
 - Use LOLA elevation data to improve how spacecraft motion is modeled
- DEM could be used to improve alignment of LOLA tracks
 - Gläser P. - previous talk - Improvement of Local LOLA DTMs using LROC NAC DTMs — Example for an ESA Lunar Lander Candidate Landing Site



Conclusions

- DEM will be available through Astropedia
 - <http://astrogeology.usgs.gov/search>
- Questions email mrosiek@usgs.gov

