MOLA Slopes at 1.2 km Scale and Roughness at 150 m Scale for the Landing Site Ellipses

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3rd MER Landing Site Workshop

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ENGINEERING SLOPE REQUIREMENTS

- Serious MER Engineering Concern About Slopes
  - Pathfinder Experience - >15 Bounces, Traversed ~1.2 km
- MER Expecting 60 Bounces [Manning]
  - Possibly Higher Winds Due to Afternoon Landing
- 1 km Scale <2° - Non-Accelerating Roll
  - MOLA Shot to Shot Elevation Measurements*
- 100 m Scale <5° - Radar Spoof, Mesa Failure
  - MOLA Pulse Spread*; 5° Over this Scale ~10 m
- 5 m Scale <15° - Impact Velocity & Horizontal Bounce
  - MOC Stereo and Photoclinometry
- *Slope and Roughness Maps and Statistics for Ellipses

1.2 km SLOPE CALCULATION

[Bi - Bidirectional]

- MOLA Elevations within Ellipses Only
- Calculation of Slope between Shots Spaced 1.2 km
  - Running Calculation between every 5th Adjacent Shot
  - Shots Spaced 300 m, 5 Shots is 1.2 km Baseline
- Individual Slope Calculations (700-900/ellipse)
- Averaged into 0.3 km Bins for Statistics
  - Mean, sd, Max, Min, Histogram
- Averaged into 1.2 km Bins to Display as Map
- Measurements Akin to Bi-directional Slopes [Kirk]
  - MOLA Tracks Nearly N-S

1.2 km Slope Calculation
[A - Adirectional]

- MOLA Elevations within Ellipses Only
- Average All Elevation Shots in 1.2 km Bins
- Delete All Bins without MOLA Shots
- Calculate Slopes between All Remaining Adjacent Pixels with MOLA Shots in them
- Display as Map
- Calculate Statistics
  - Mean, sd, Max, Min, Histogram
- Measurements Akin to Adirectional Slopes [Kirk]
- Slopes are Averaged (Reduced) by Binning
  - But May be More Directly Applicable to Engineering Requirement

150 m ROUGHNESS CALCULATION

- MOLA Pulse Spread within 150 m Diameter Surface Shot
  - RMS Measure of Relief within Spot
  - Don't Know Length Scale of Relief, But Upper Limit Over 150 m, Subject to Reductions in Processing (next)
- Took Global Data Set Prepared by Garvin
  - Subtracted 300 m Along- and Cross-Track Slopes
  - Other Processing As Described by Garvin, Less than Total Relief
- Produced Maps of Pulse Spread for Ellipses
  - Calculated Mean, sd, Max, Min, Histogram Within Ellipse
- Evaluated Roughness Based on Garvin Pulse Width Scale
  - 1 m - Smooth
  - 2 m - Mostly Smooth 1-2 m PW Equivalent to <10 m Relief
  - 3 m - Rough
  - >4 m - Very Rough

SLOPE AND PULSE STATISTICS

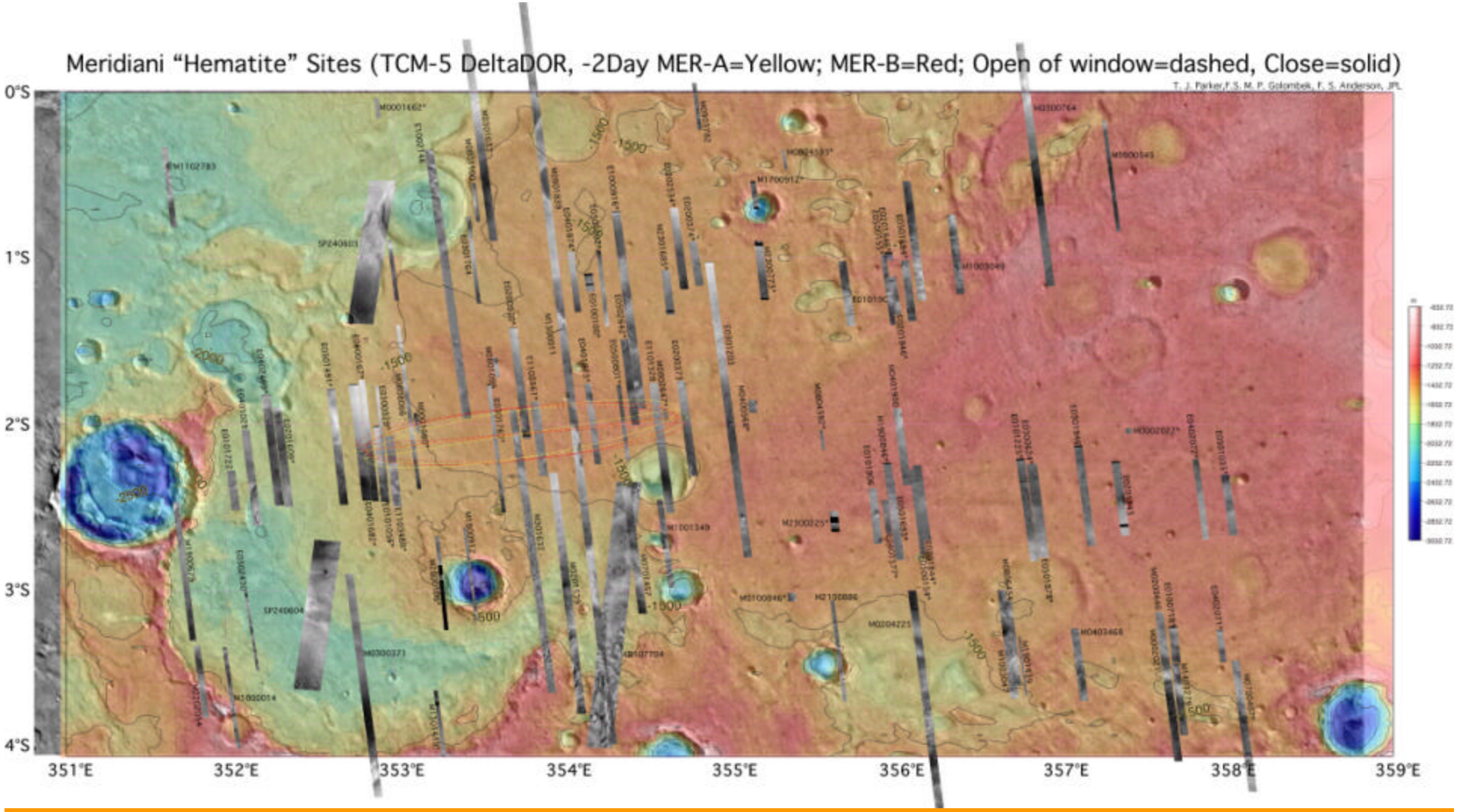
Site	B1.2	A1.2	B sd	1.2 A sd	Av PW	sd PW
TM10A2	0.15	0.21	0.18	0.45	0.75	0.24
TM20B2	0.16	0.22	0.20	0.47	0.75	0.24
VM53A2	1.22	1.13	1.35	0.65	1.18	0.73
VM53B2	1.29	1.15	1.49	0.68	1.24	0.75
IP84A2	0.19	0.14	0.24	0.10	1.10	0.35
IP96B2	0.18	0.14	0.24	0.10	1.08	0.33
EP55A2	0.20	0.16	0.44	0.20	1.42	0.44
VM41A2	1.22	0.94	1.87	0.98	1.06	1.14
EP49B2	0.20	0.18	0.35	0.23	1.18	0.35
VL1	0.27	0.32	1.02	1.01		
VL2	0.28	0.27	0.28	0.19		
MPF	0.30	0.25	1.07	0.68		

B1.2, A1.2-Mean Bidirectional, Adirectional Slope; sd-Standard Deviation; Av PW-Mean Pulse Width

SUMMARY OF ELLIPSE SLOPES

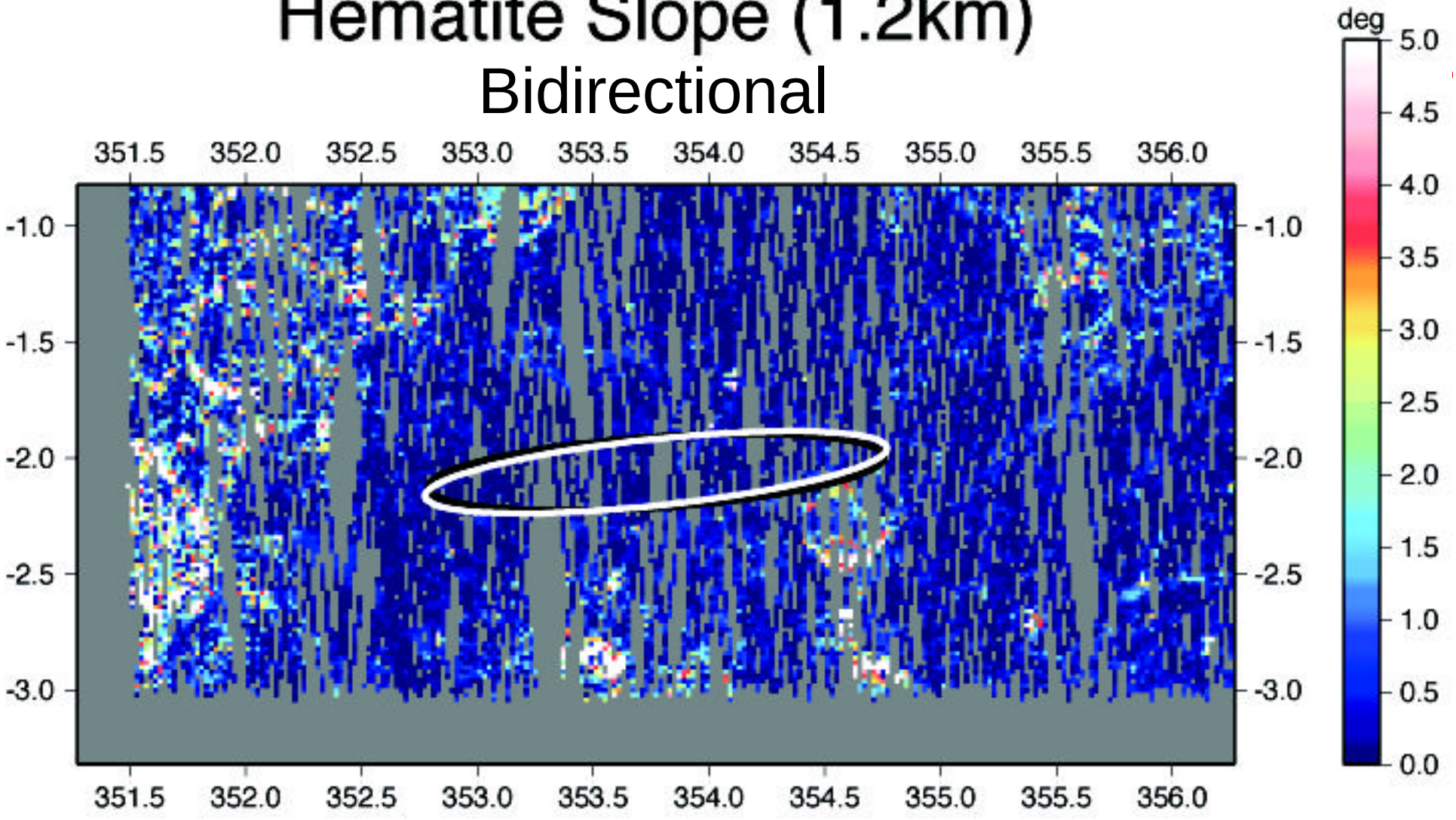
- All Sites Meet 1.2 km Slope Criterion <2°
  - Hematite, Isidis, Gusev, Athabasca Very Smooth
    - Average ~0.2°: Comparable to VL1, VL2 & MPF
  - Melas & Eos Higher, Average ≥1°
- All Sites Meet 100 m Slope Criterion <5°
  - Hematite, Isidis, Melas, Athabasca, Eos PW
    - Average <1.2 m
  - Gusev Slightly Higher, Average ~1.4 m
- To Come: Sites Rough at 100 m are Rough at 10 m
  - Rough to Smooth:
  - Melas, Eos, Gusev, Isidis, Athabasca, Hematite

HEMATITE - TERRA MERIDIANI

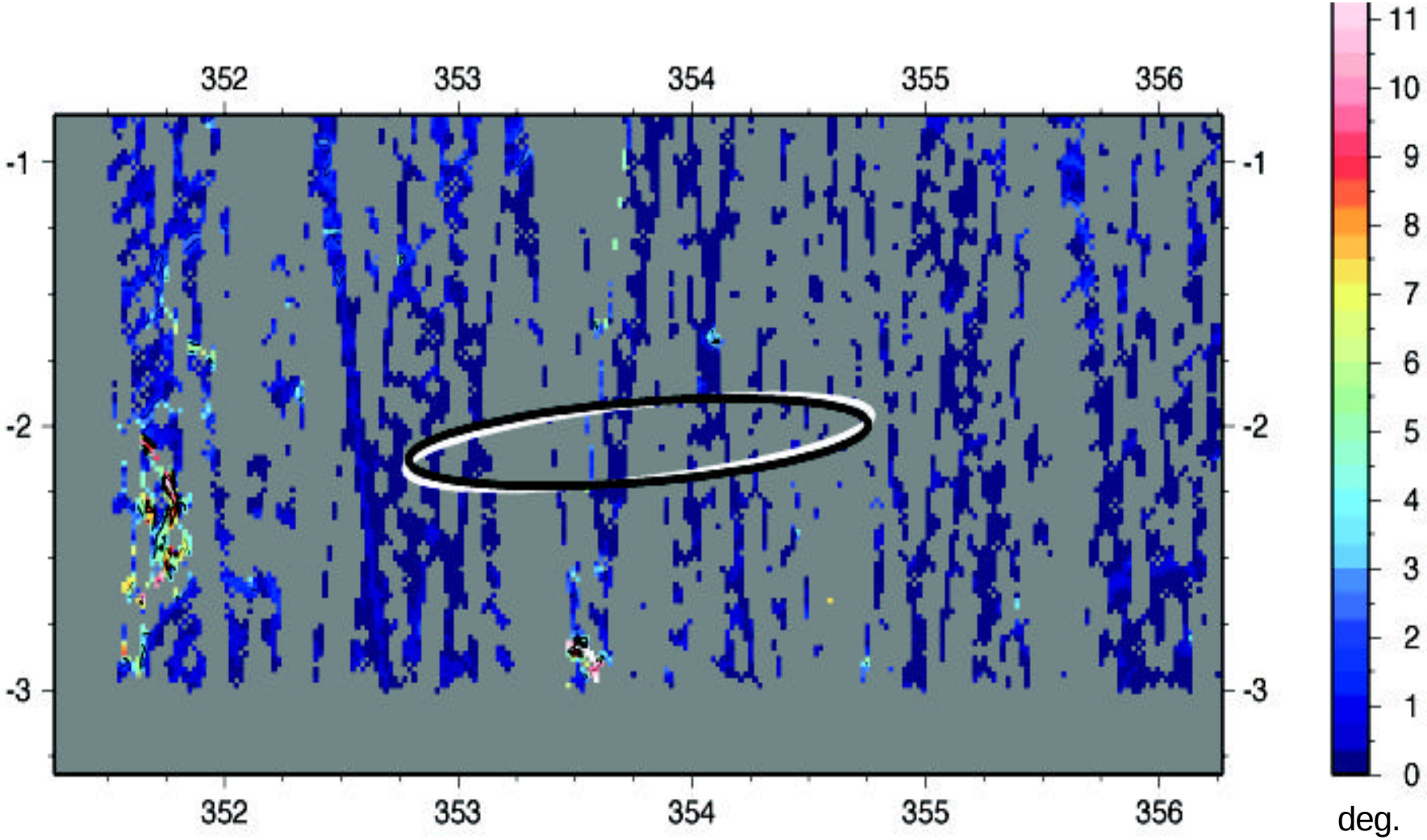


Hematite Slope (1.2km)

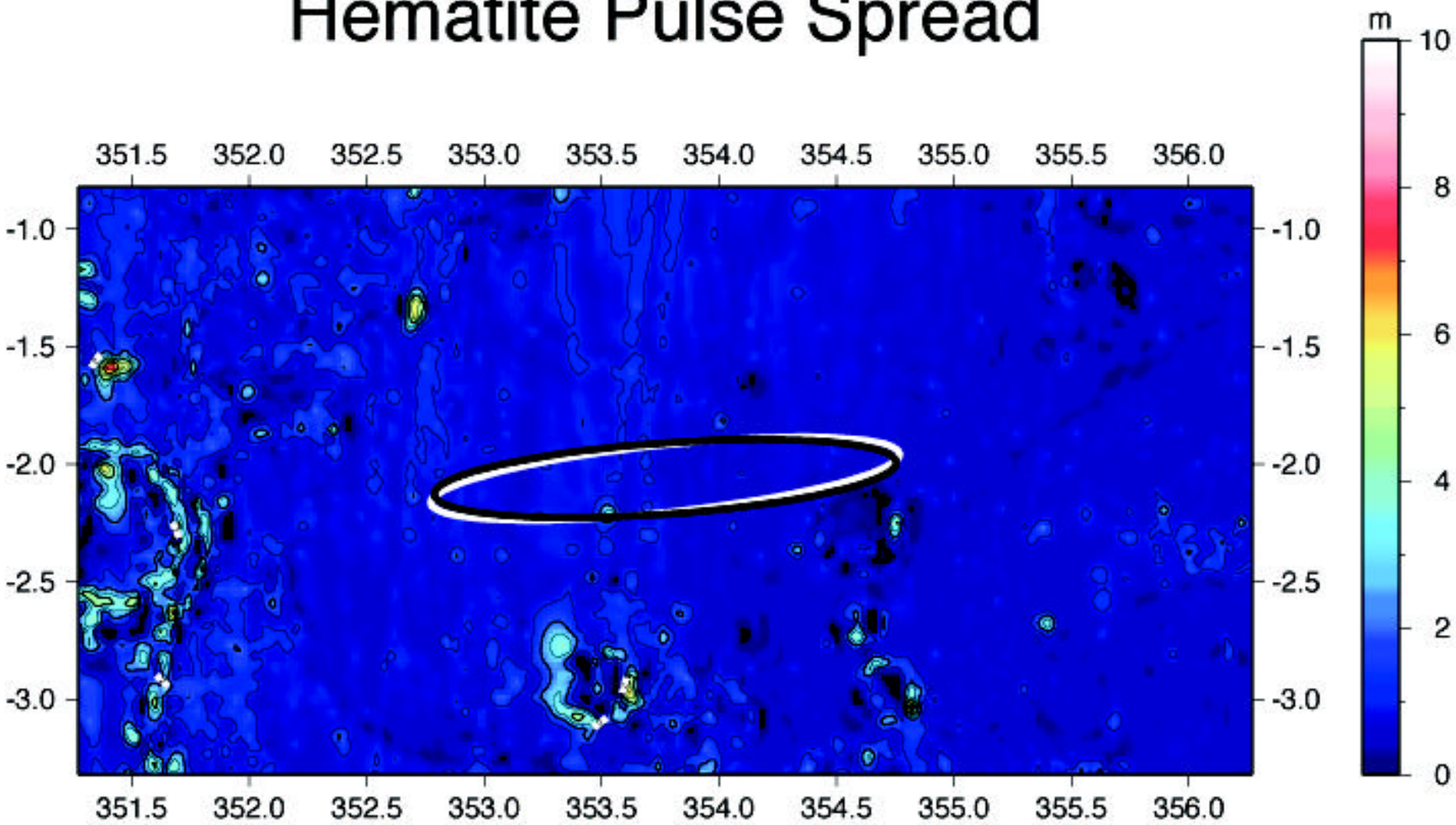
Bidirectional



Hematite 1.2 km Adirectional Slope



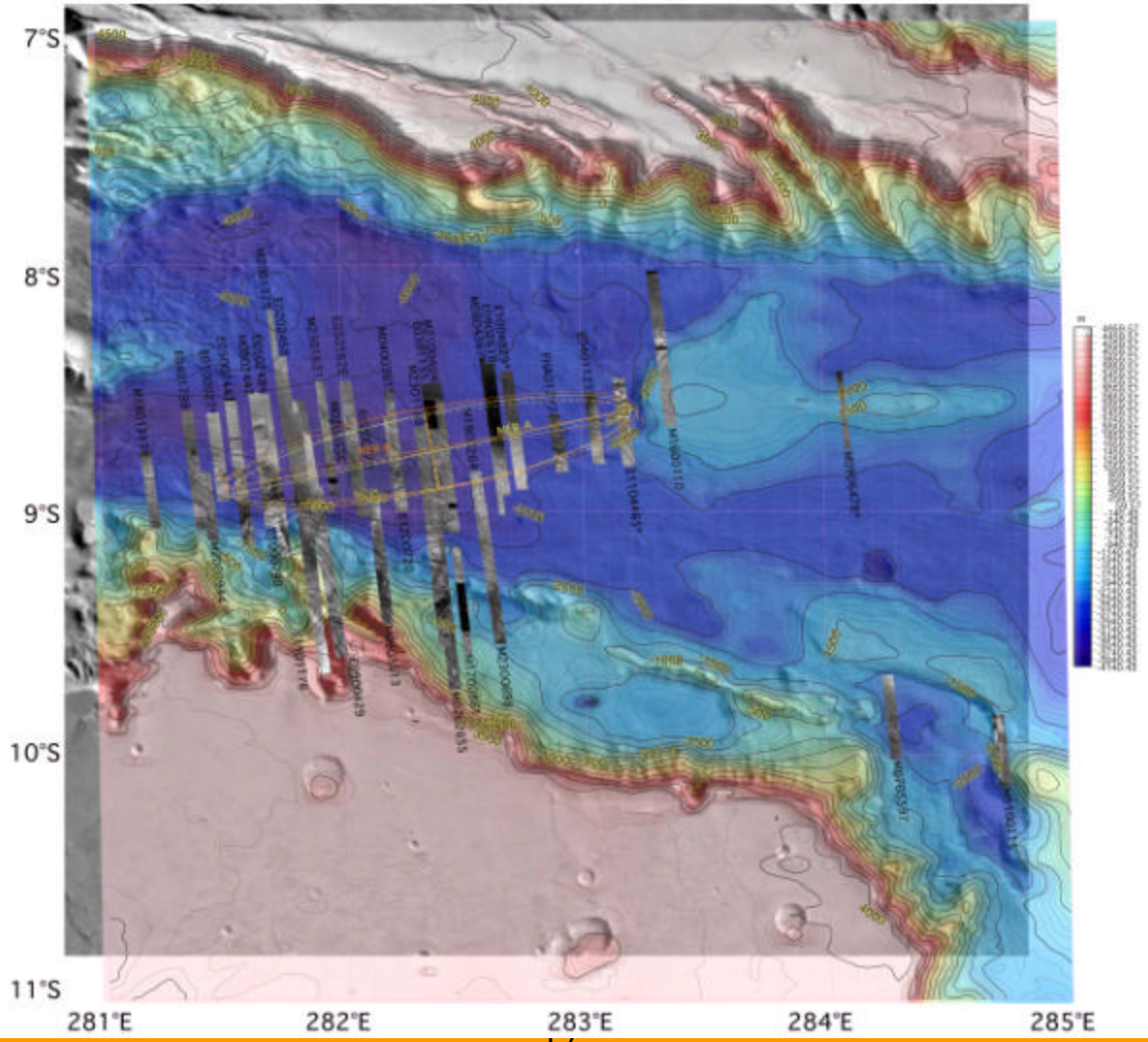
Hematite Pulse Spread



MELAS CHASMA

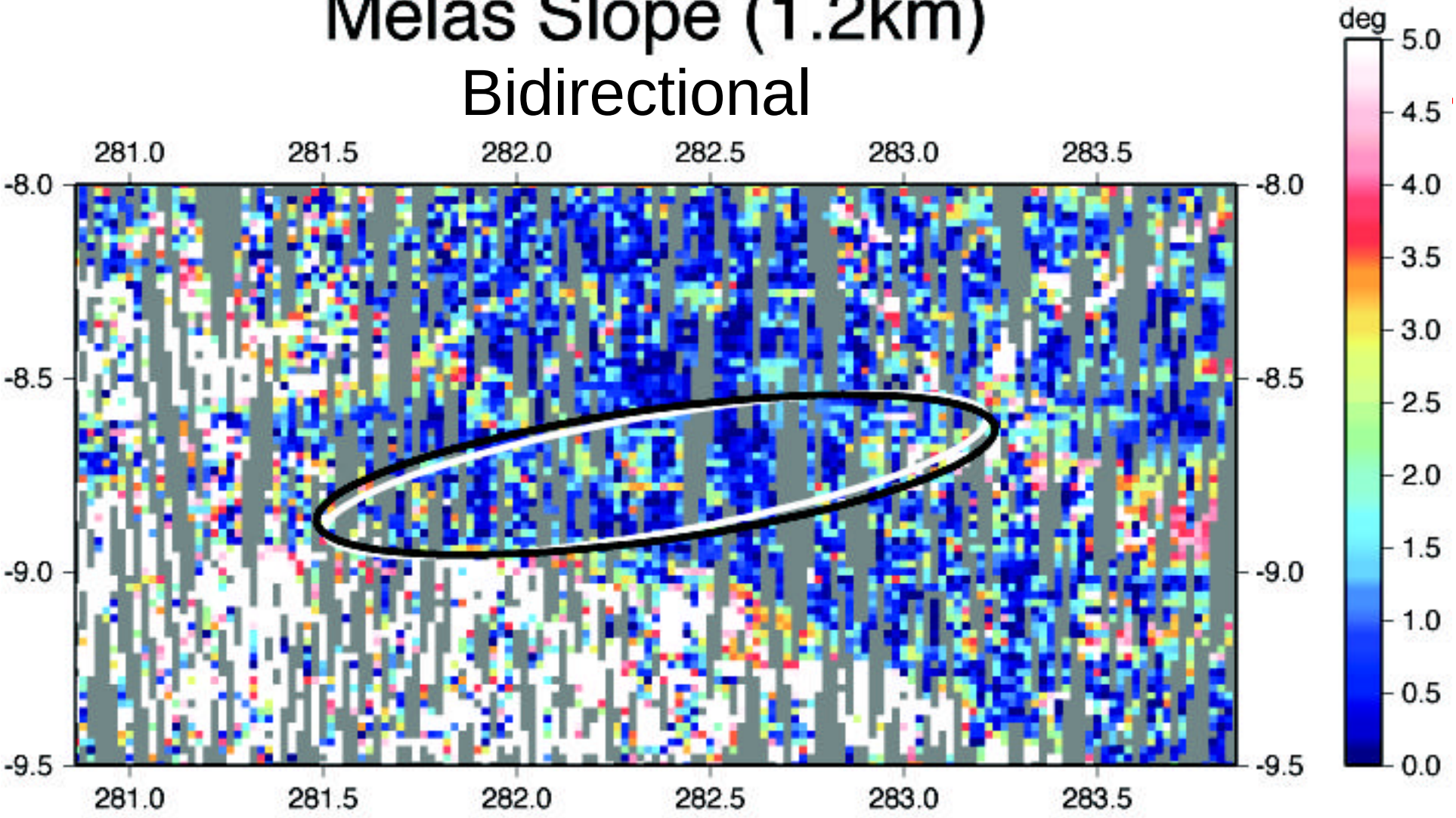
Valles Marineris Melas Site(TCM-5 DeltaDOR, -2Day:
MER-A=Yellow; MER-B=Orange; Open of window=dashed, Close=solid)

T. J. Parker, JPL

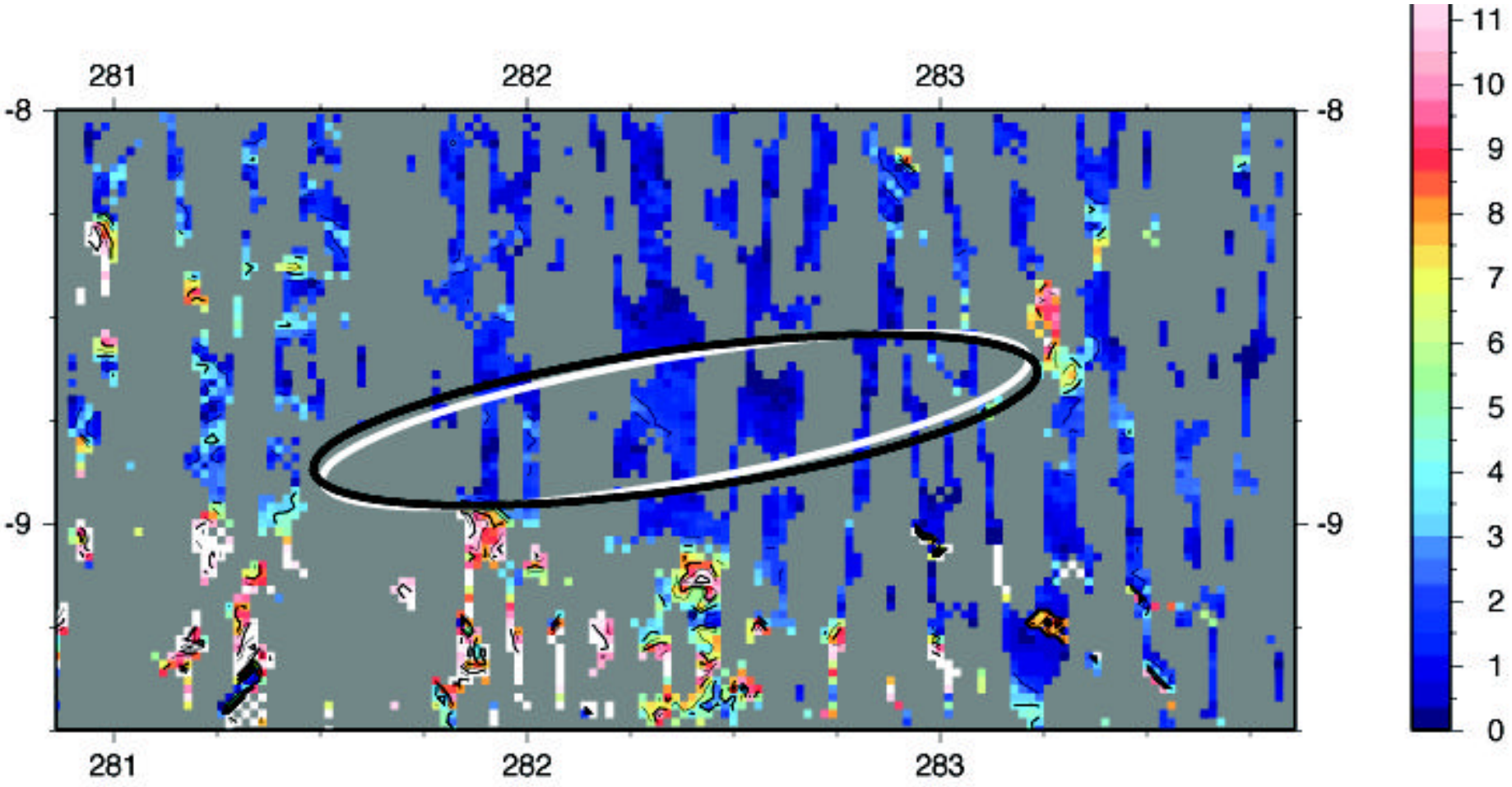


Melas Slope (1.2km)

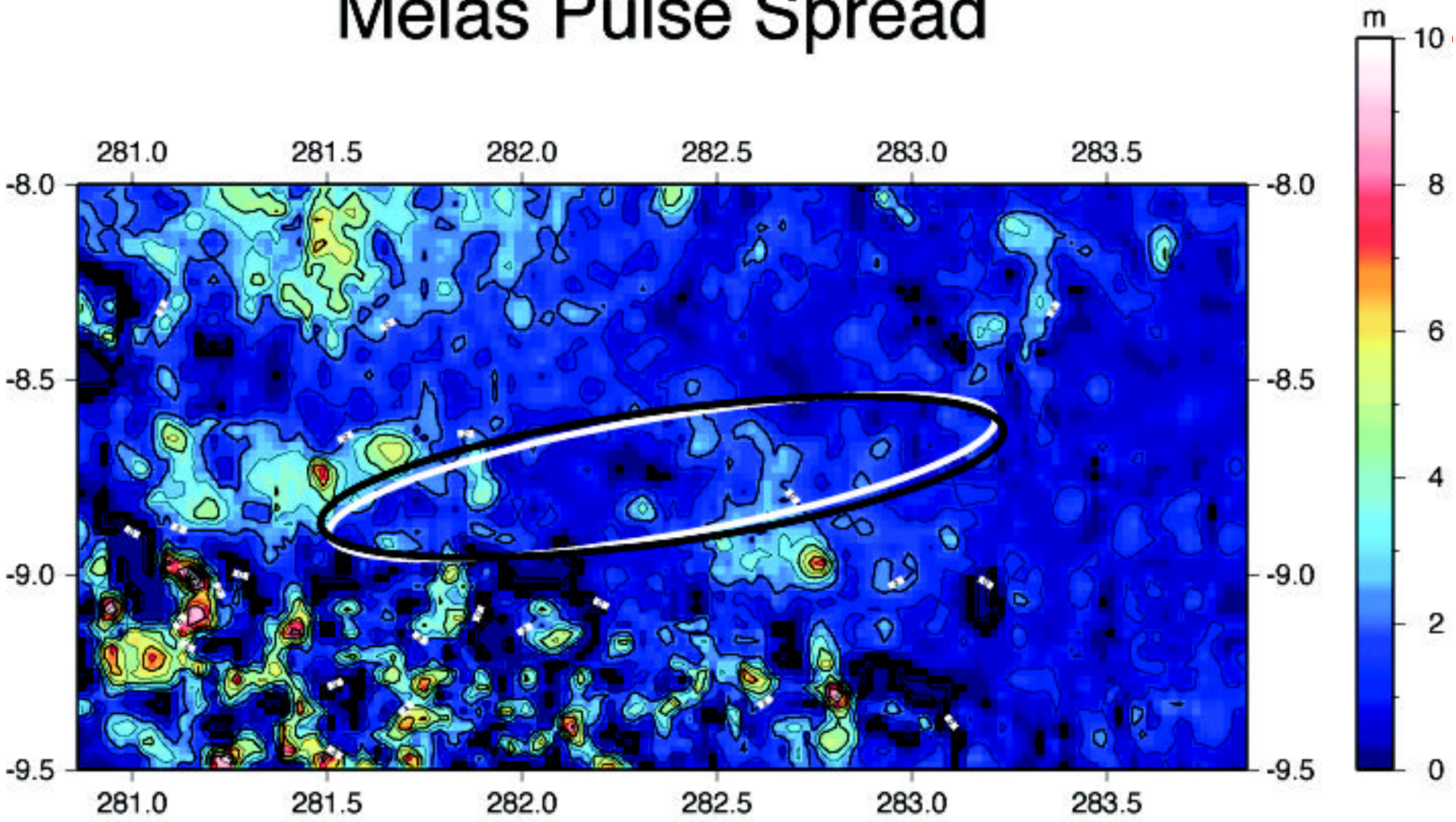
Bidirectional



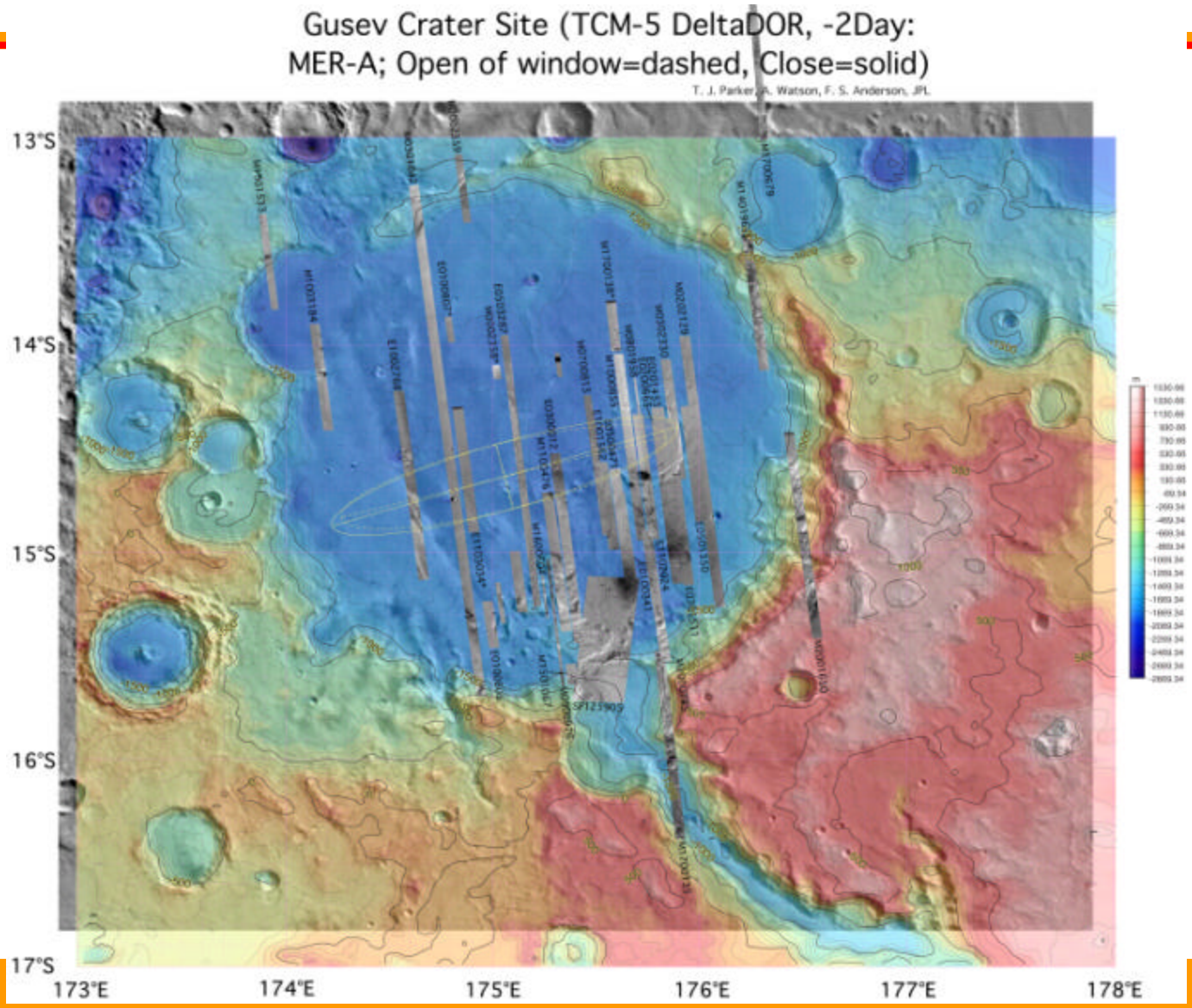
Melas 1.2 km Adirectional Slope



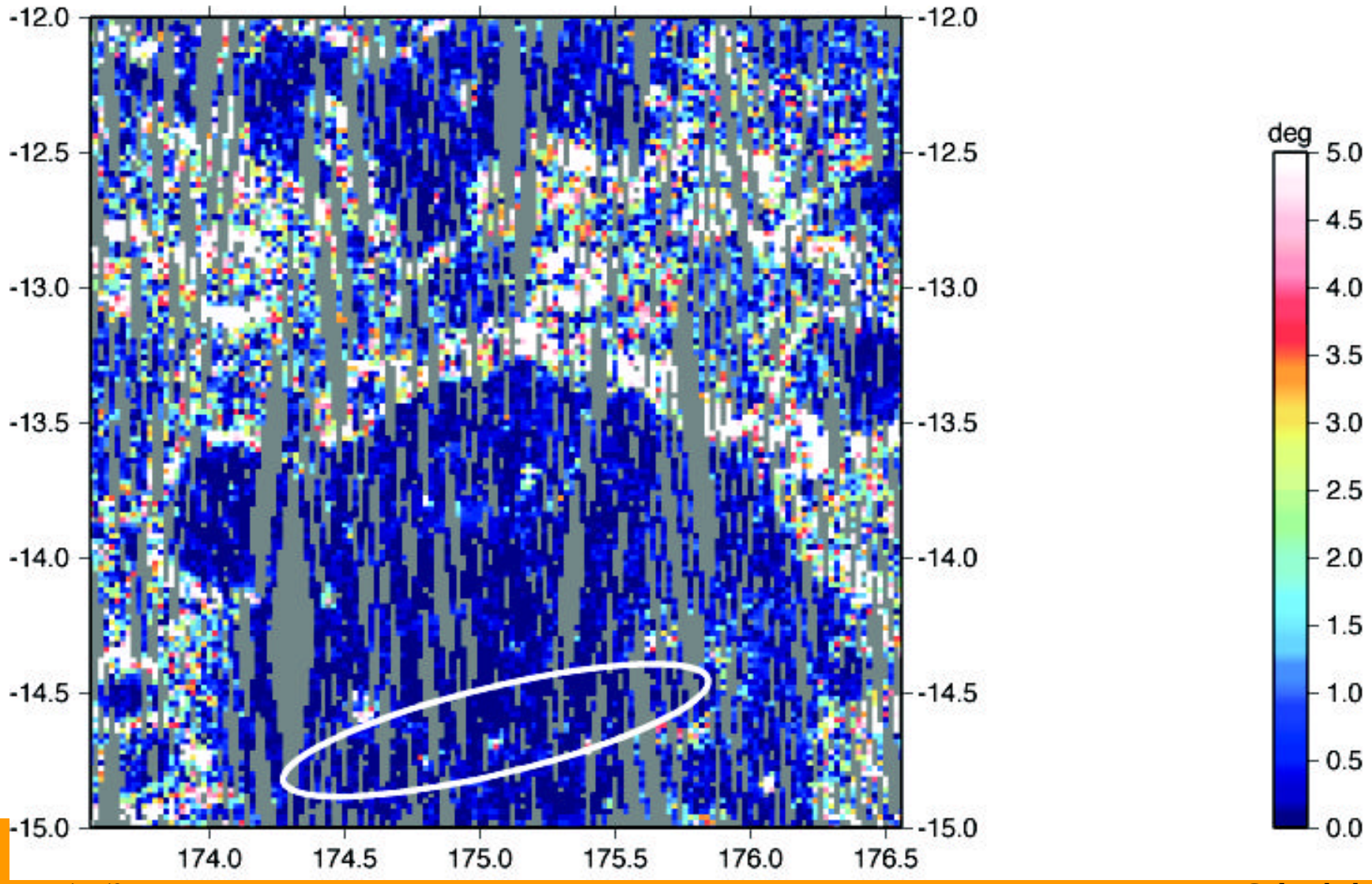
Melas Pulse Spread



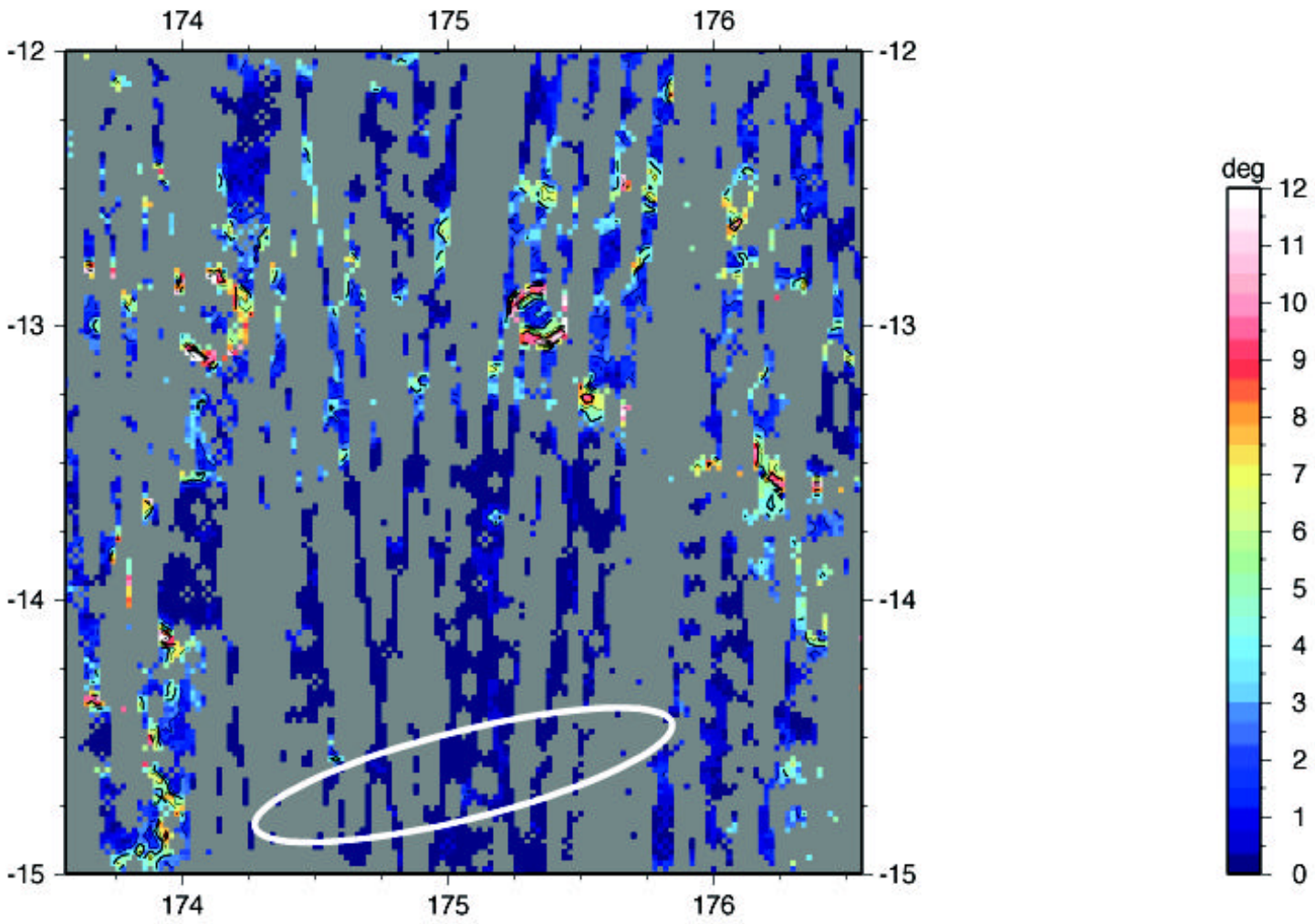
GUSEV CRATER



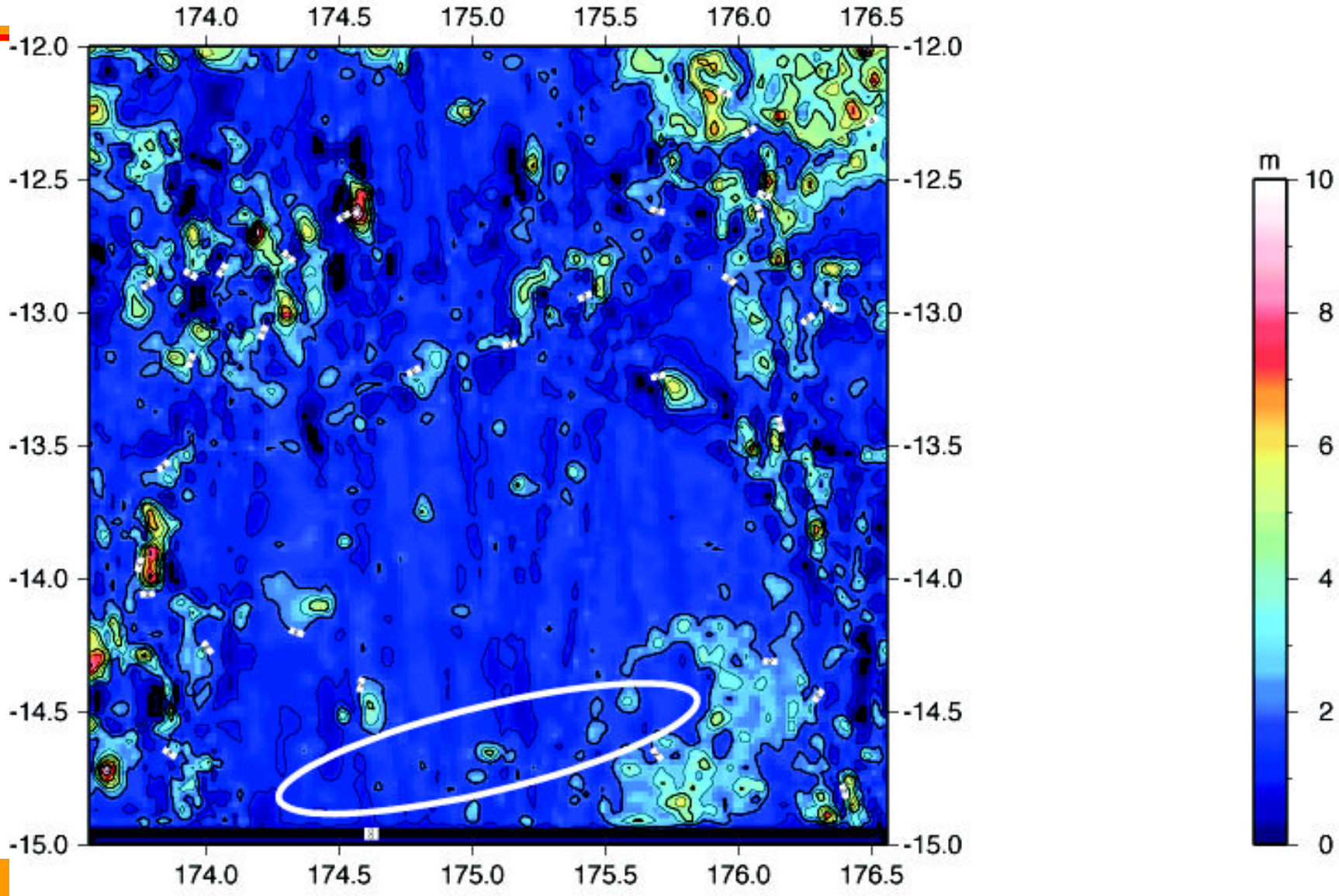
Gusev 1.2 km Bidirectional Slope



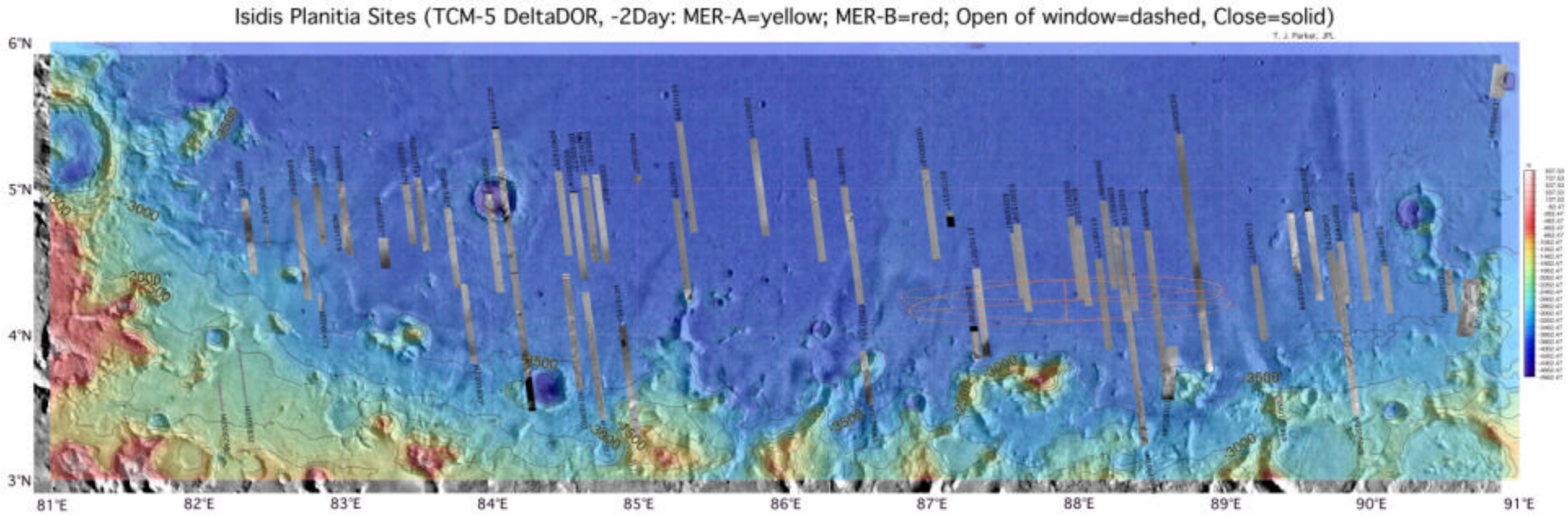
Gusev 1.2 km Adirectional slopes



Gusev Pulse Spread

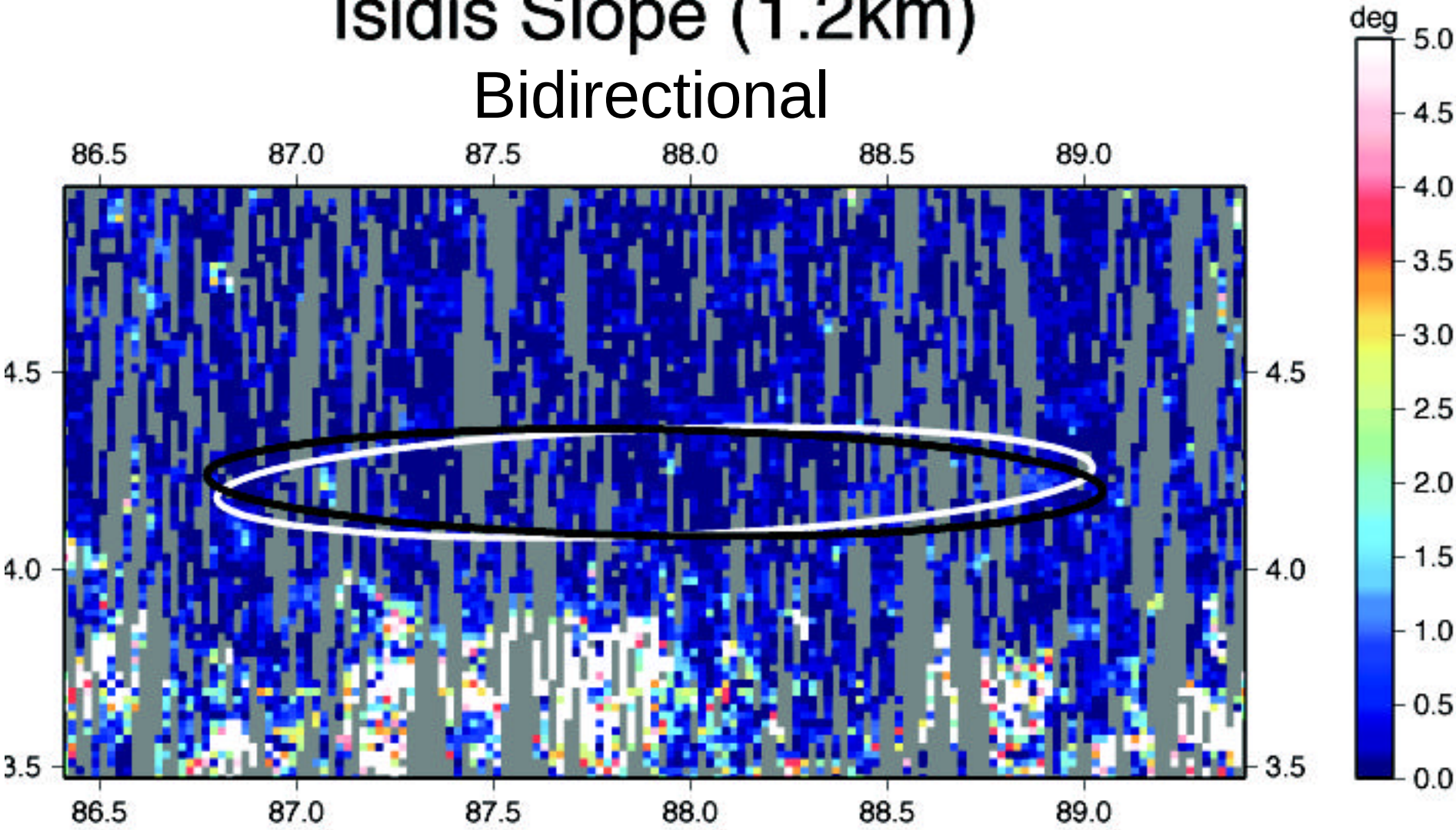


ISIDIS PLANITIA

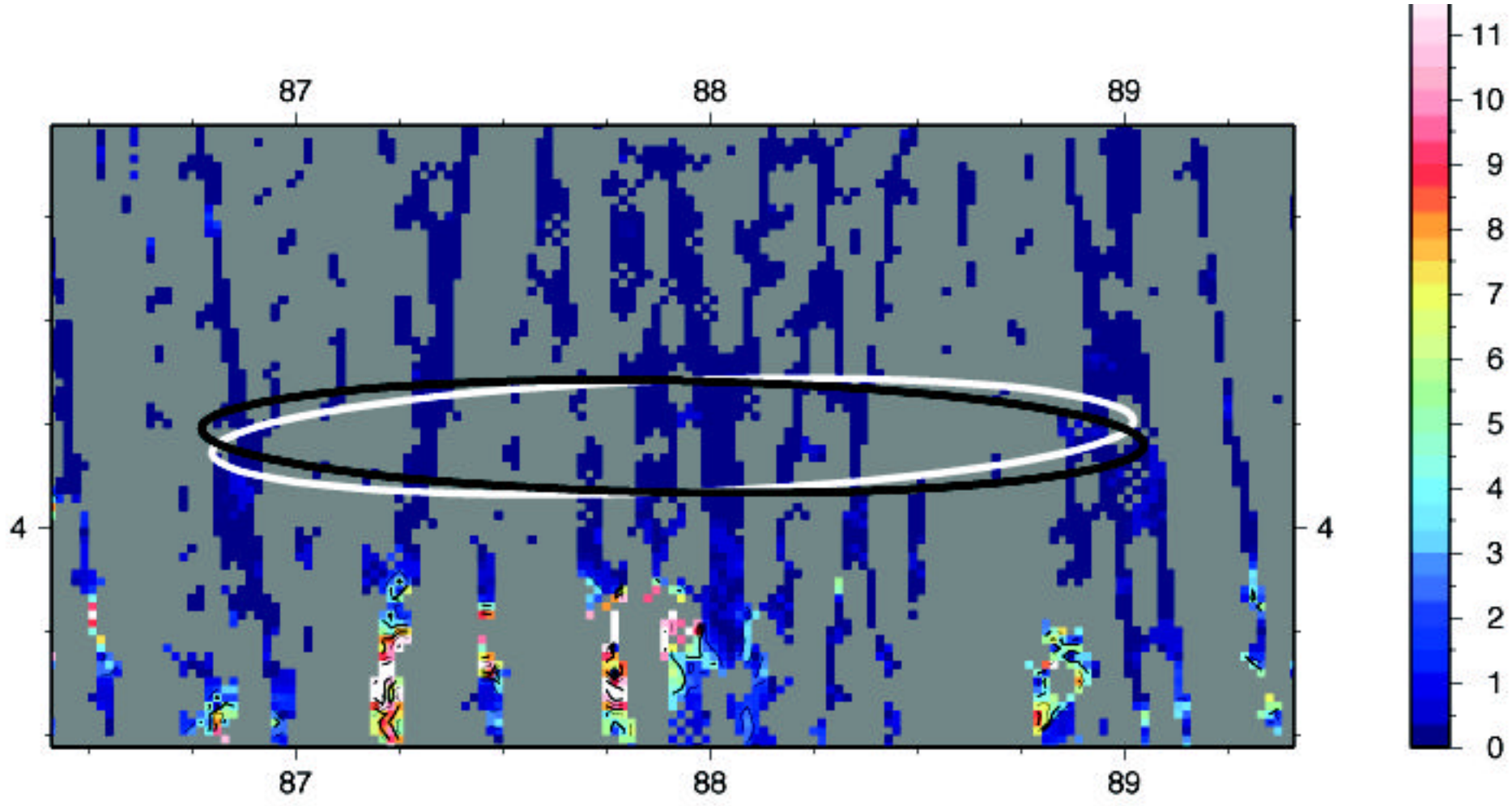


Isidis Slope (1.2km)

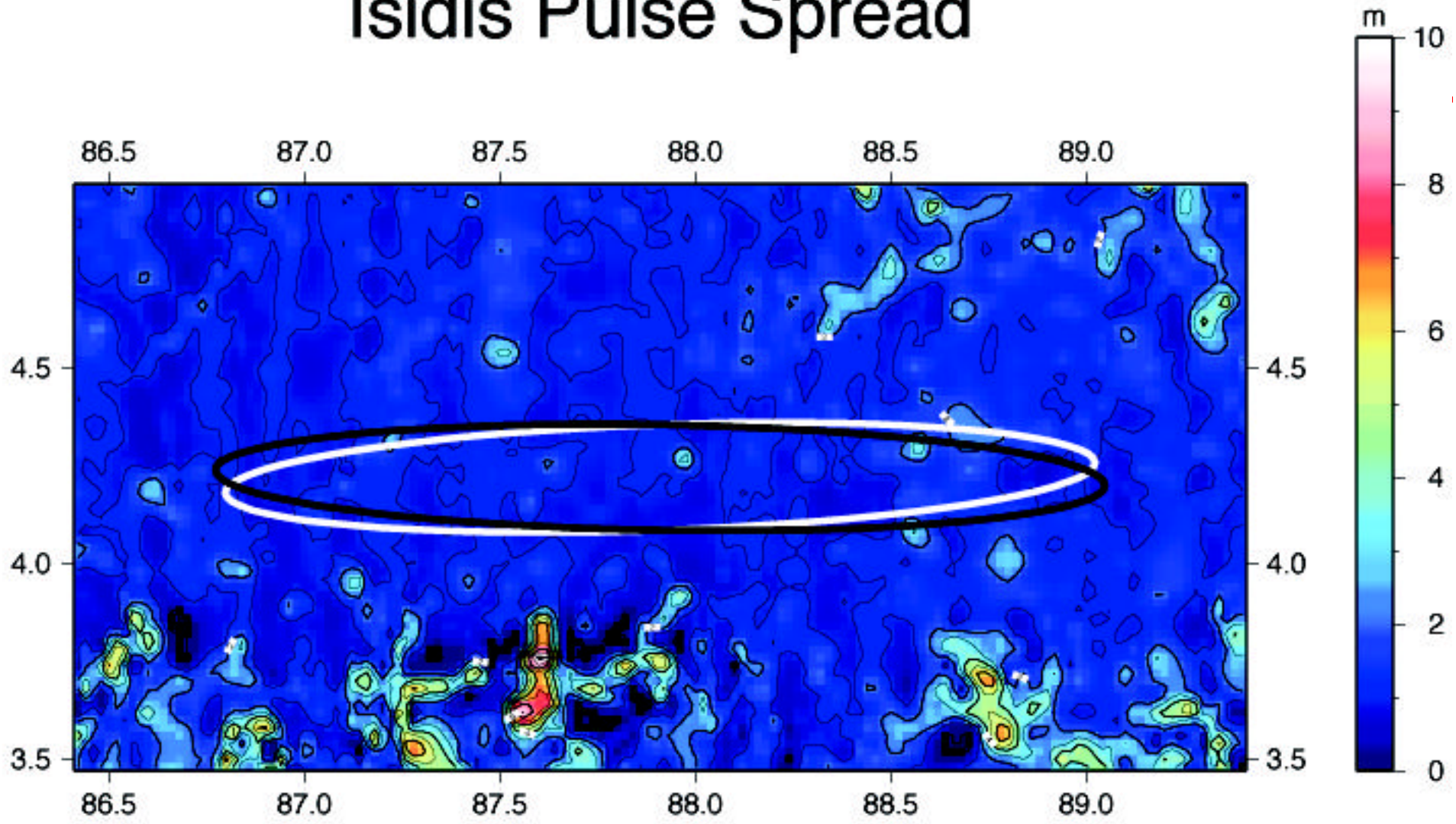
Bidirectional



Isidis 1.2 km Adirectional slopes

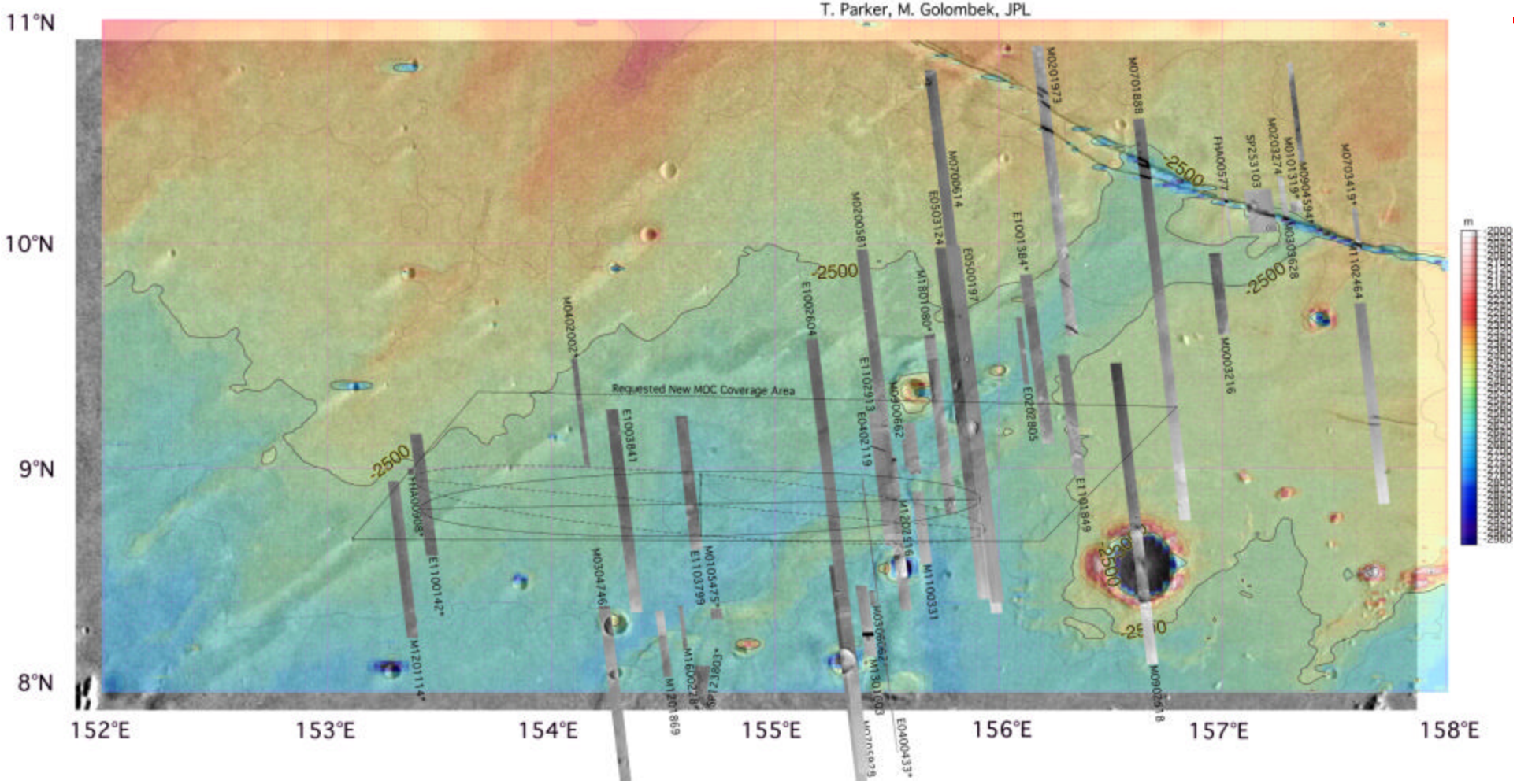


Isidis Pulse Spread



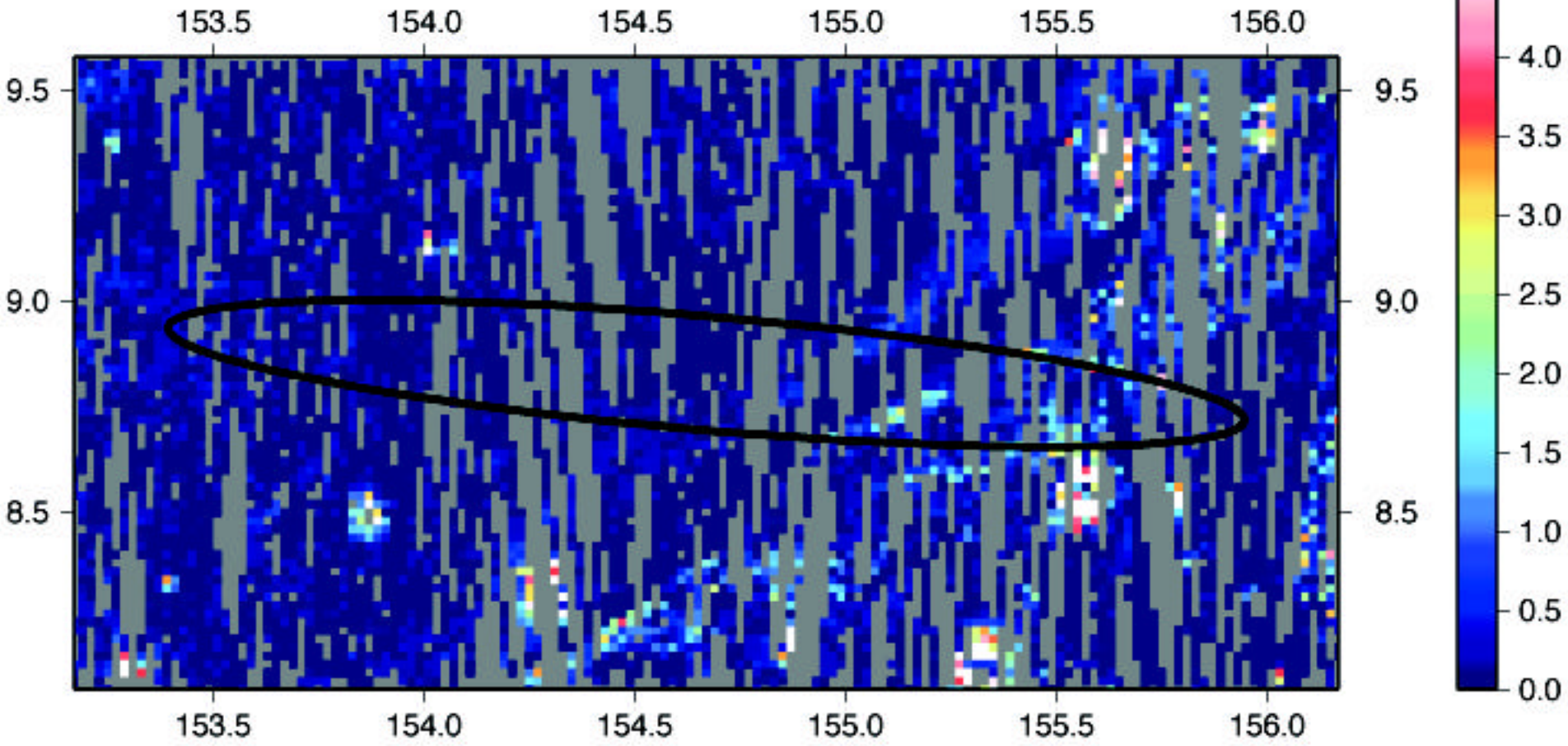
Athabasca Vallis Site (MER-B=red)

T. Parker, M. Golombek, JPL

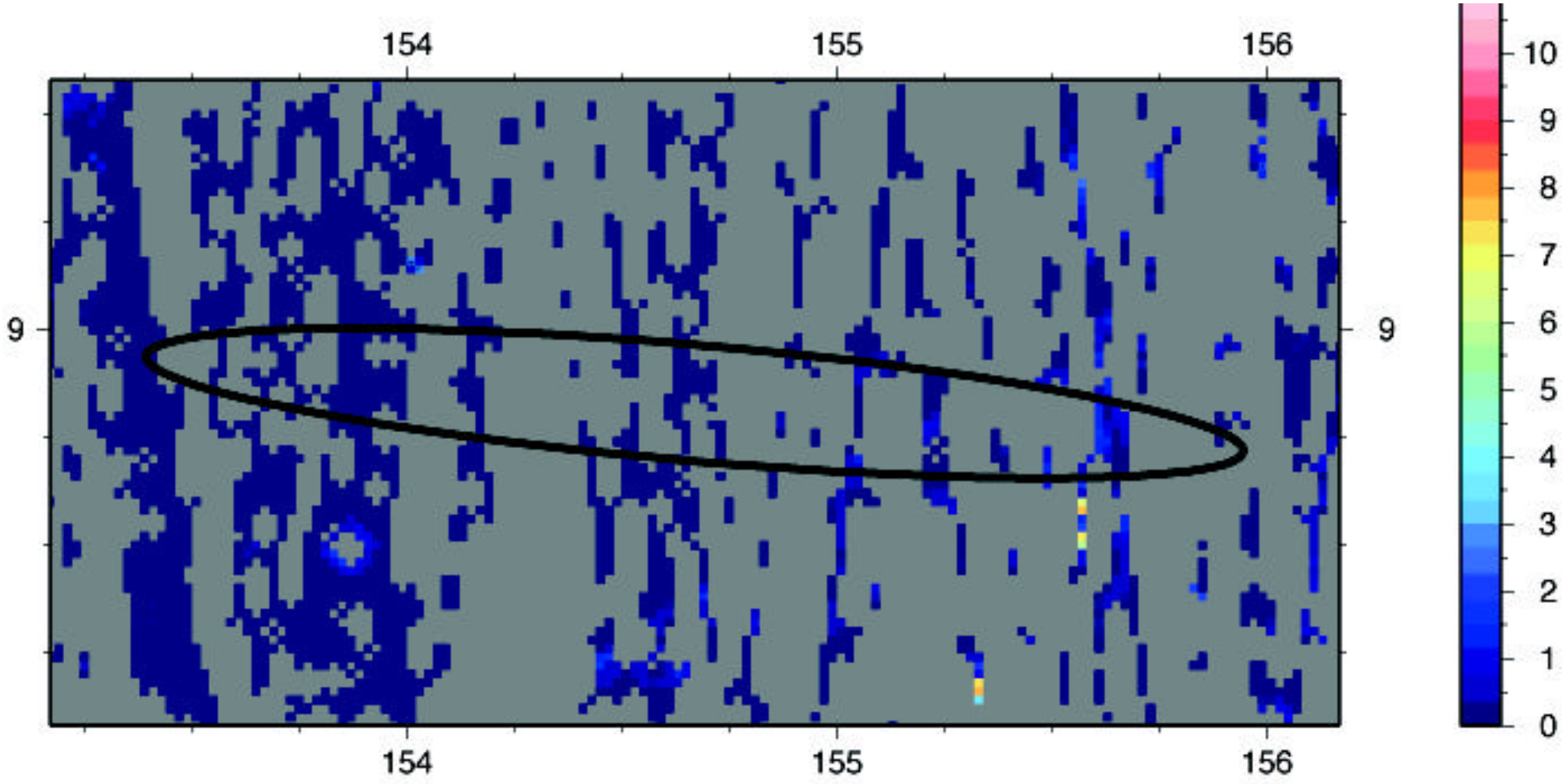


Athabasca Slope (1.2km)

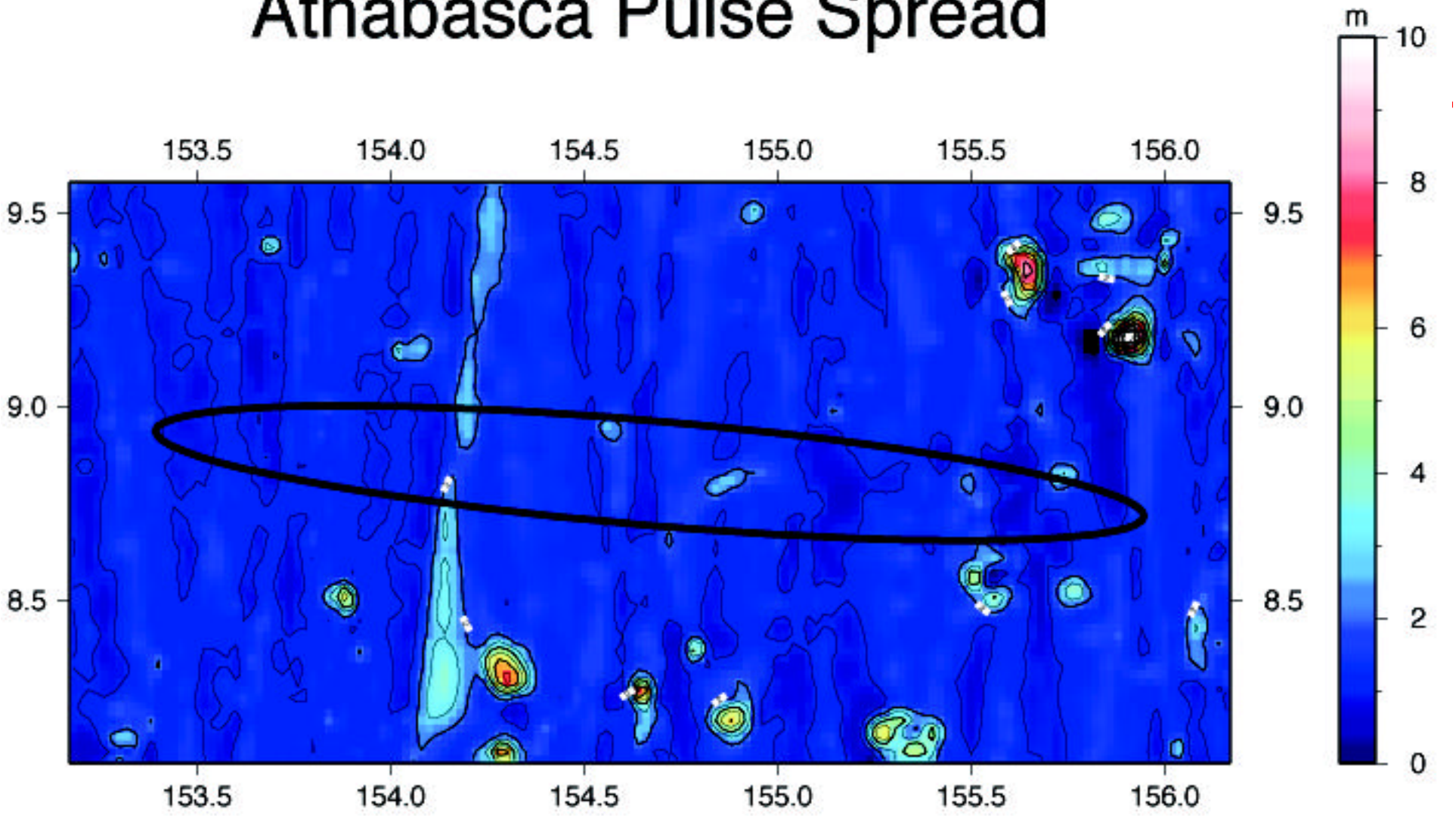
Bidirectional



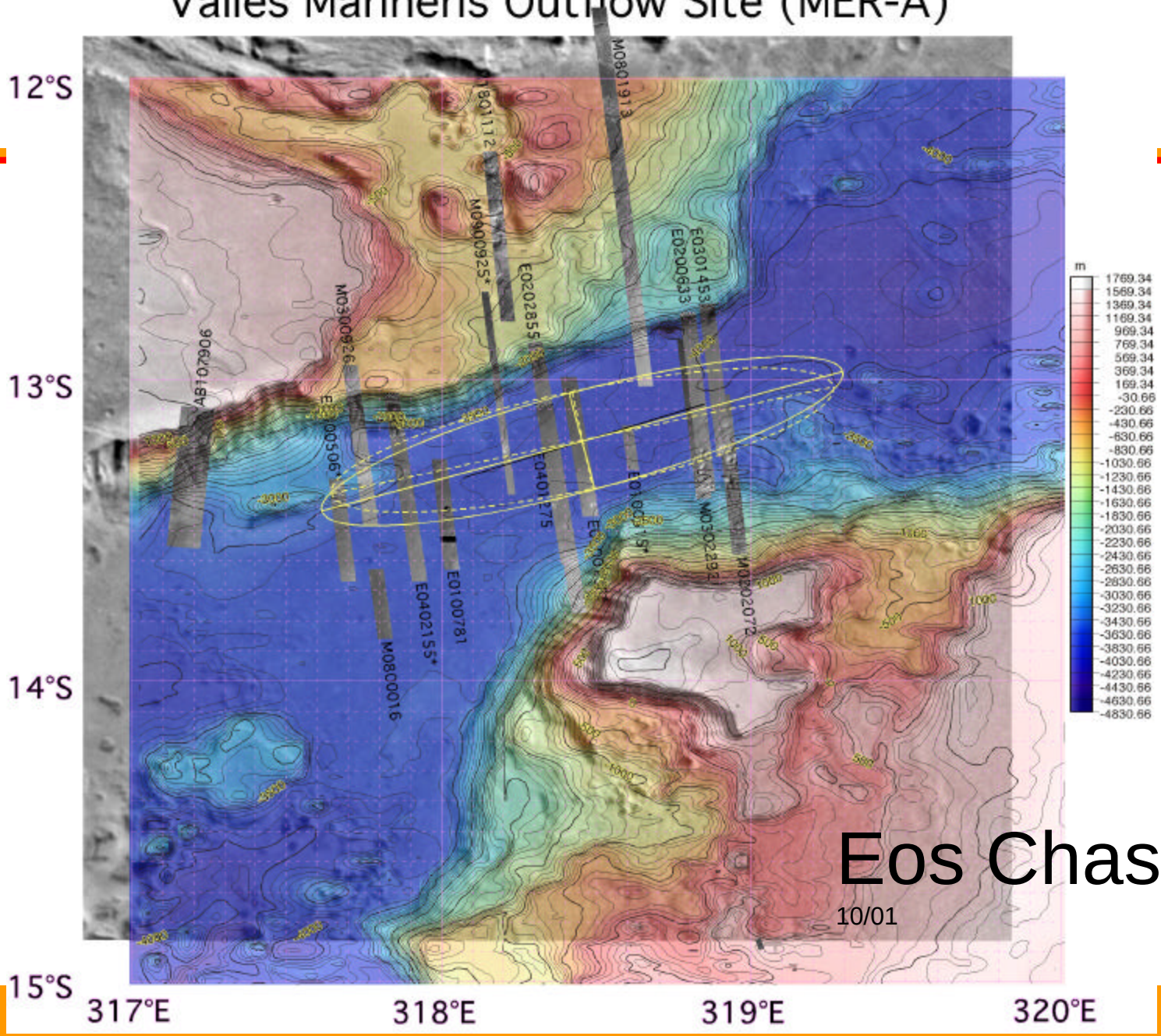
Athabasca Adirectional 1.2 km Slopes



Athabasca Pulse Spread

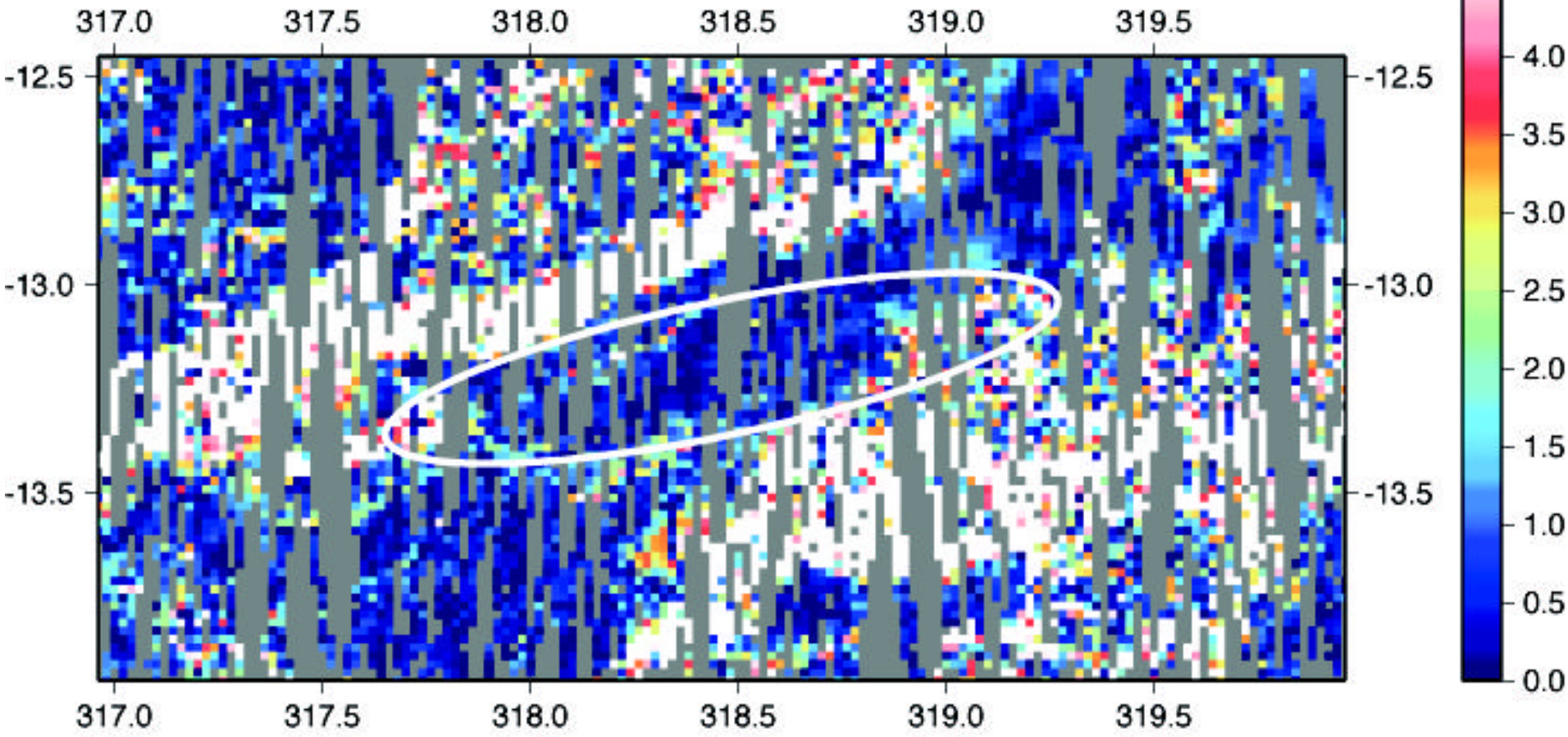


Valles Marineris Outflow Site (MER-A)

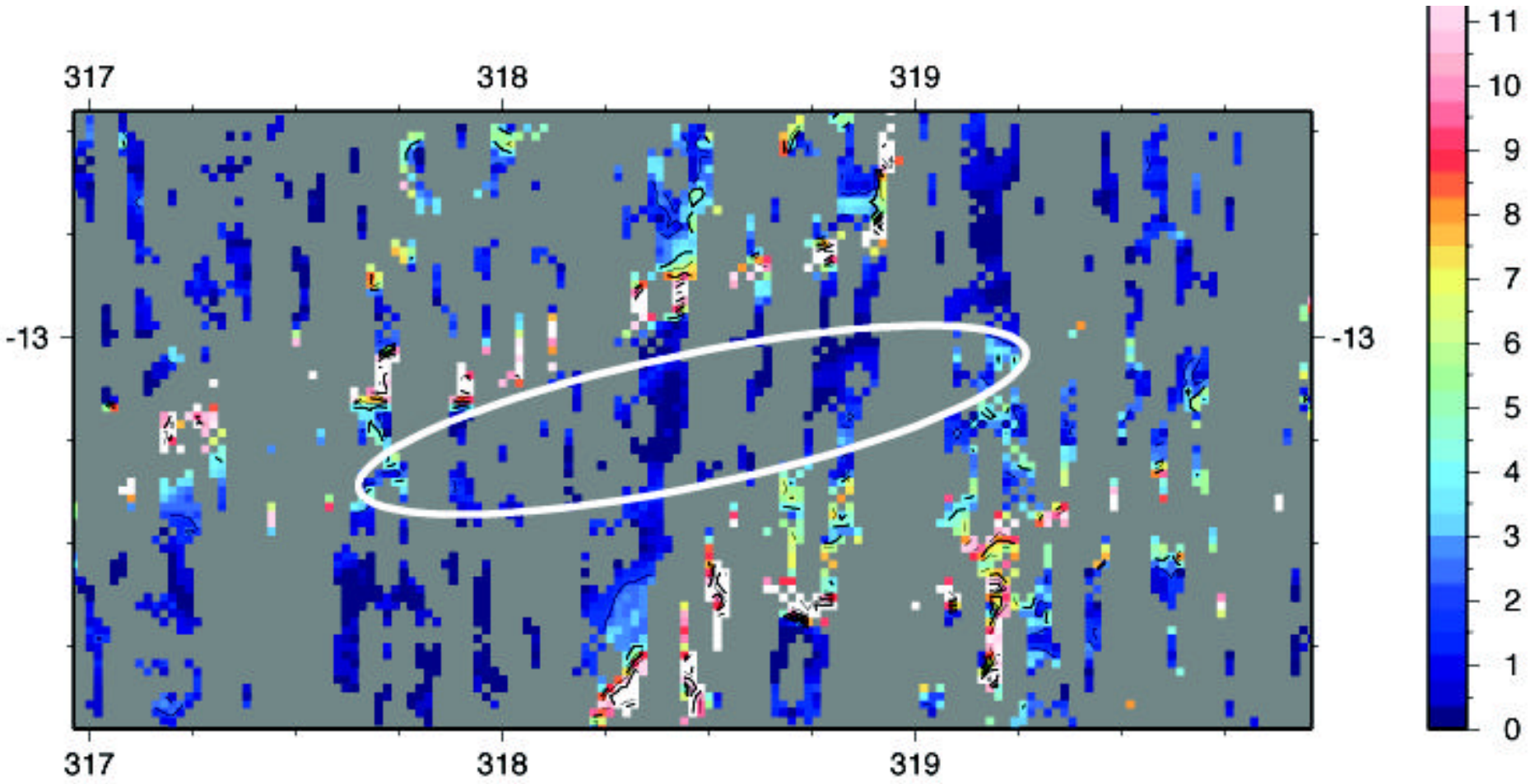


Eos Slope (1.2km)

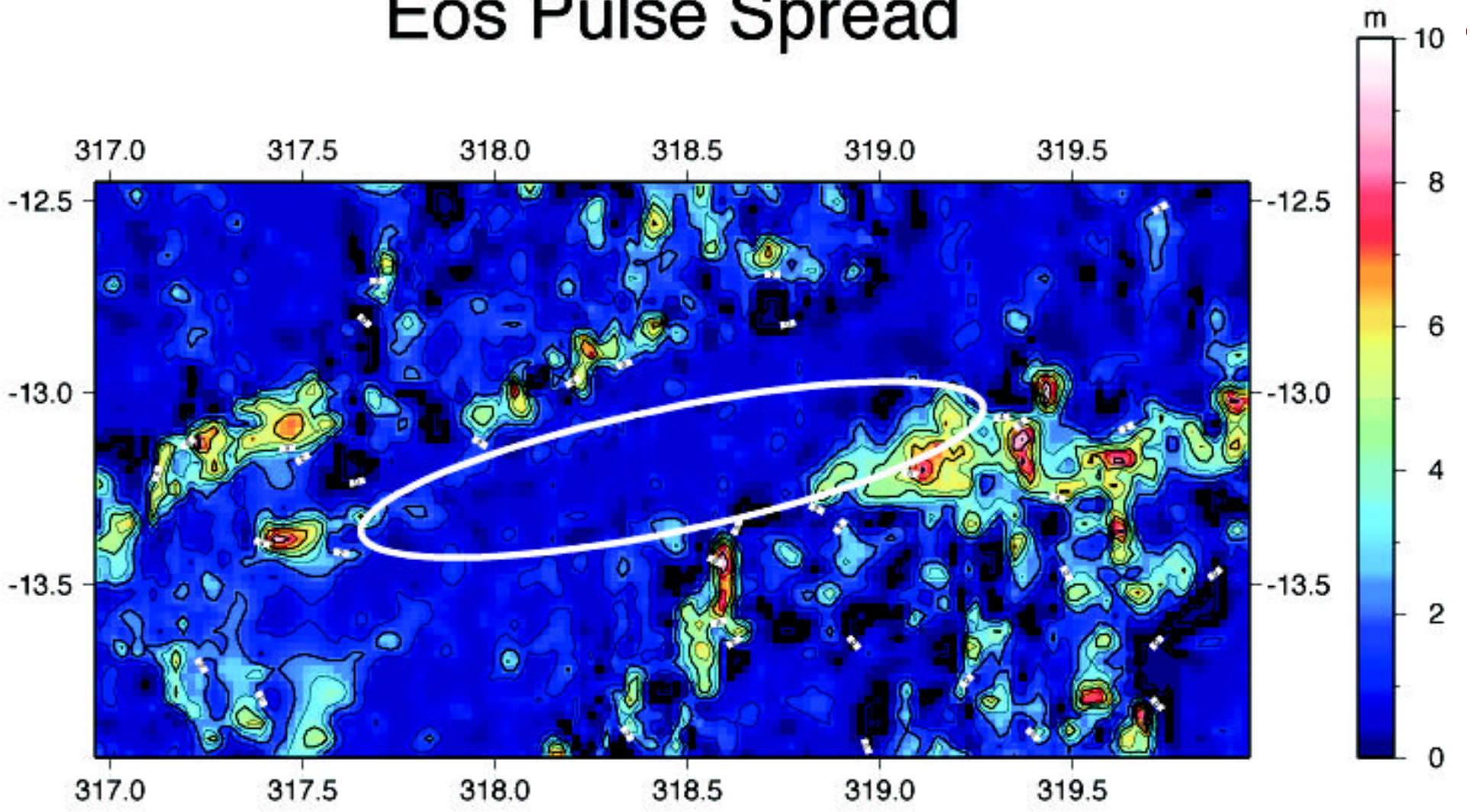
Bidirectional



Eos 1.2 km Adirectional Slopes

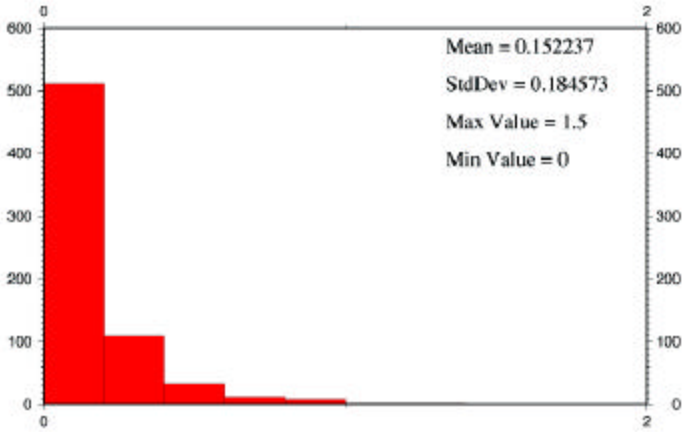


Eos Pulse Spread

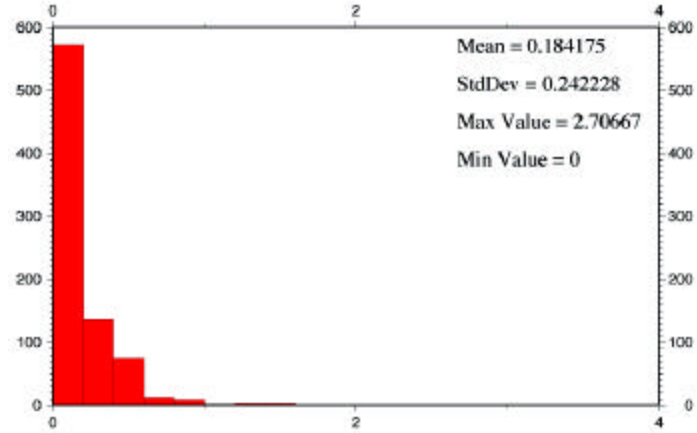


EXAMPLE 1.2 km Bi SLOPE HISTOGRAMS

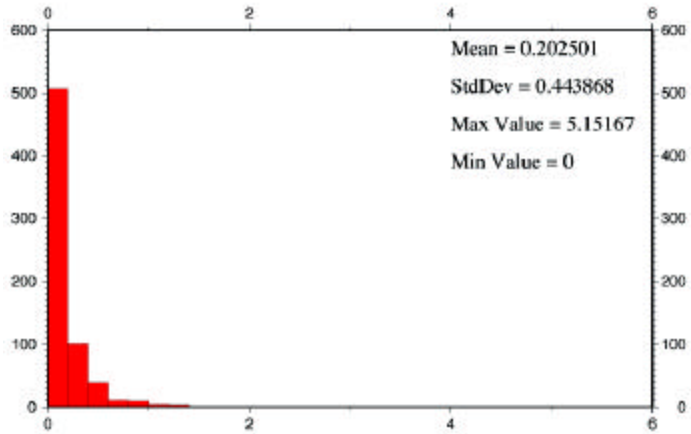
TM10A2 Slope Histogram(1.2 km)



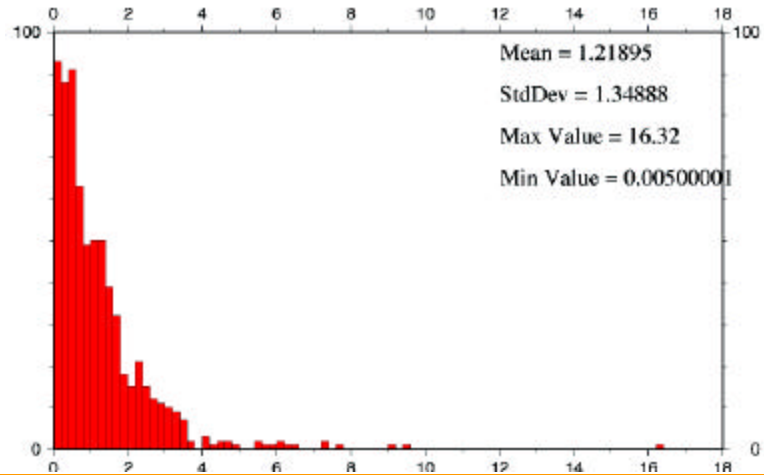
IP96B2 Slope Histogram(1.2 km)



EP55A2 Slope Histogram(1.2 km)

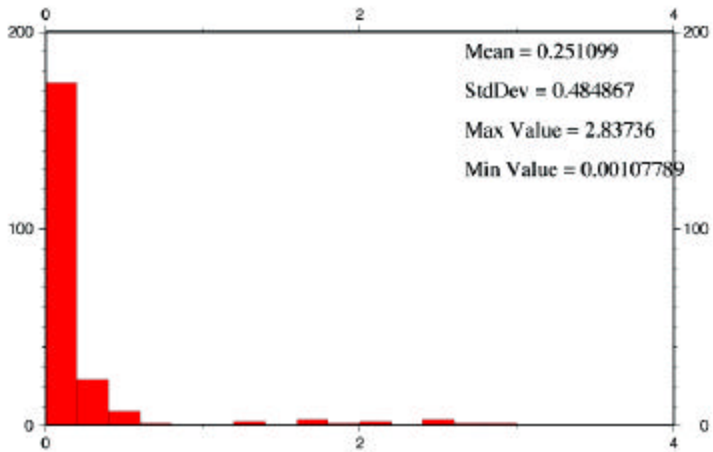


VM53A2 Slope Histogram(1.2 km)

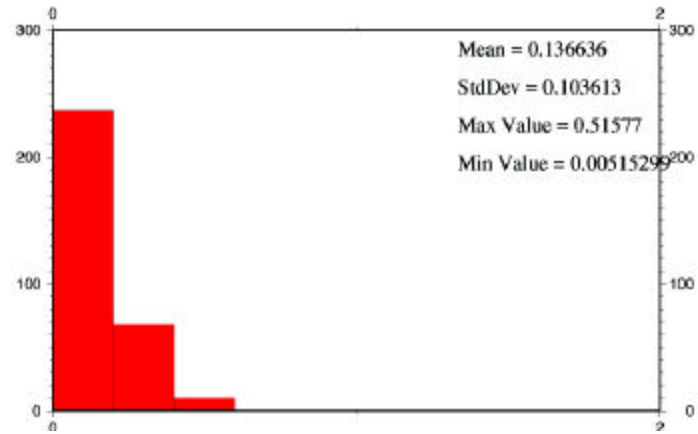


Example 1.2 km Adirectional Slope Histograms

TM20B2 1.2 km slope hist., gridded, non-int.



IP84A2 1.2 km slope hist., gridded, non-int.



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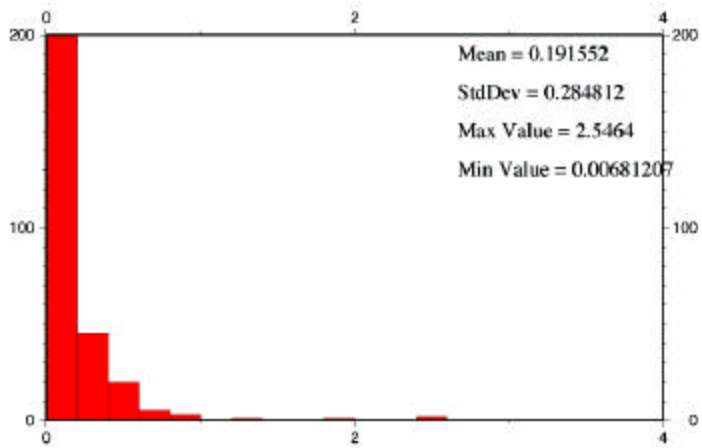
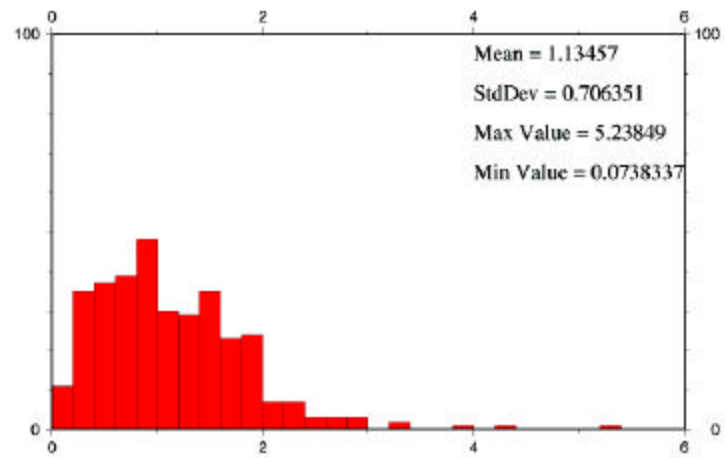
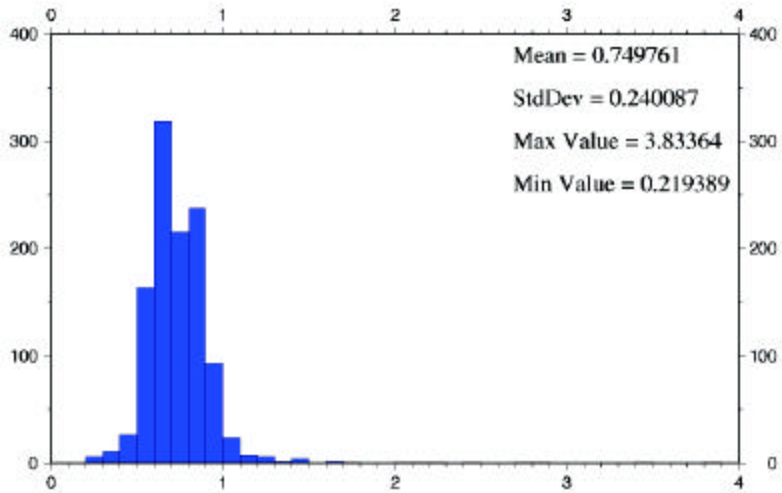


VM53B2 1.2 km slope hist., gridded, non-int.

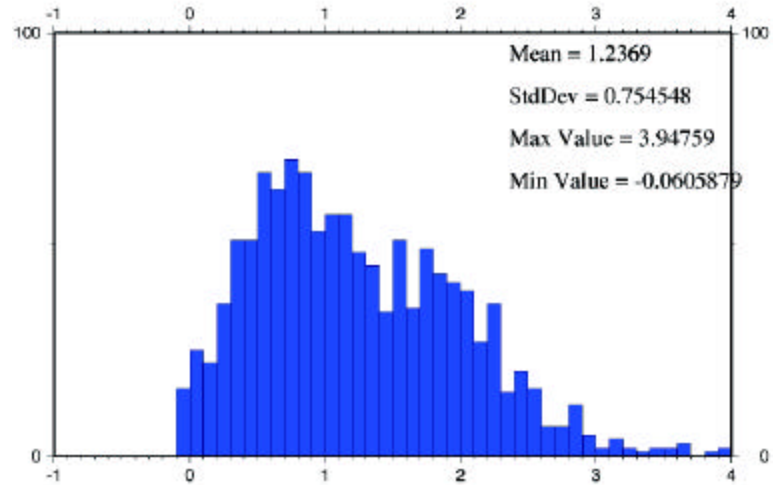


EXAMPLE PULSE WIDTH HISTOGRAMS

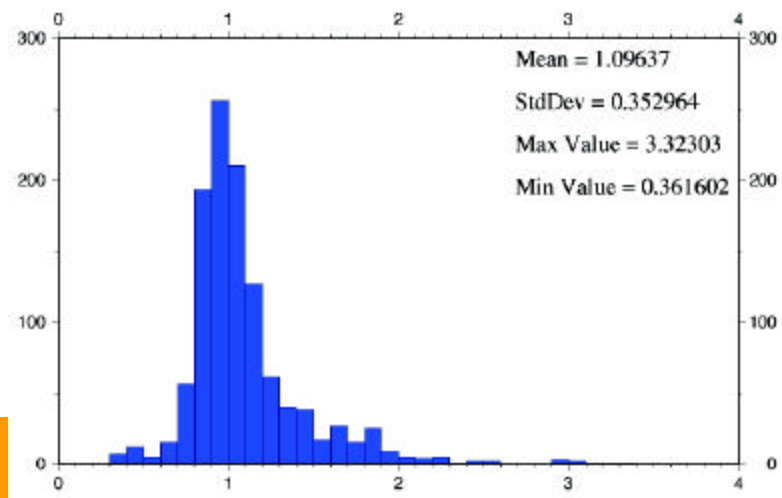
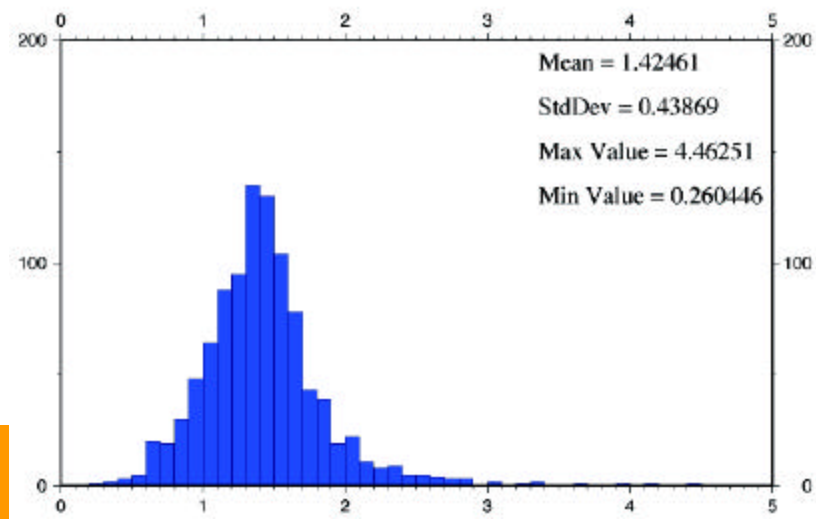
TM10A2 Pulse Spread



VM53B2 Pulse Spread



IP84A2 Pulse Spread



EP55A2 Pulse Spread