Evaluation of TOPSAR DEMs for geomorphic studies of landform modification: Long Valley caldera area, Nevada-California

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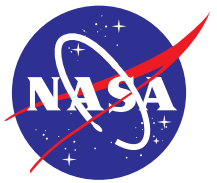
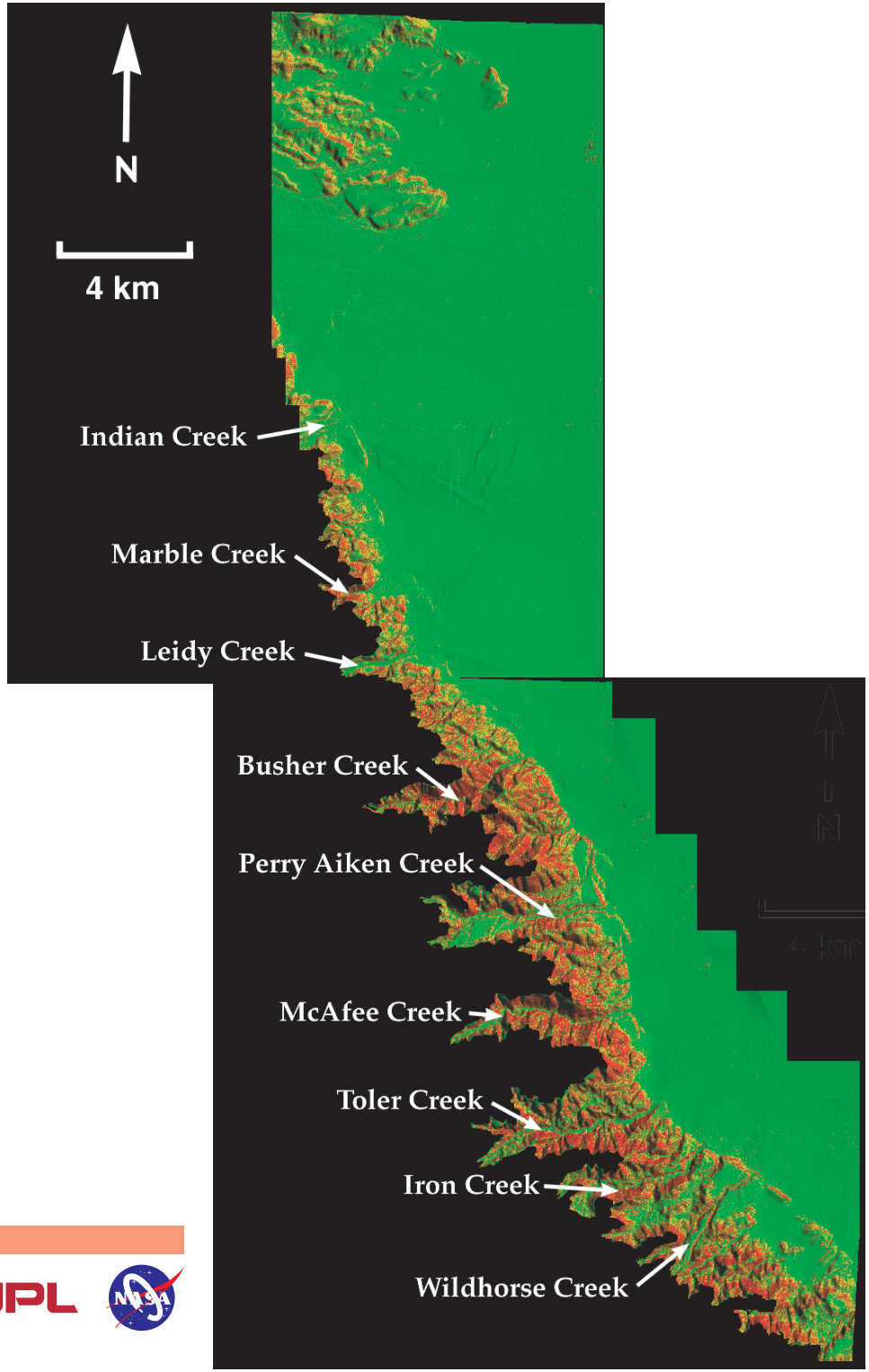


Implications

- Fault scarp morphology has been used in the past to estimate earthquake age, and also to divide fault zones into sections to estimate earthquake size. Faults typically break at section boundaries, and section length determines magnitude




Nevada
Fish Lake Valley
Study Site
Tonopah
Bishop
Las
Vegas
California

Organization

Introduction

- Data: TOPSAR dataset of Long Valley area with 5 m posting and 1-2 m nominal vertical resolution
- Motivation: Wanted to test fidelity of TOPSAR DEM against field observations, and test if TOPSAR data could be reliably used for neotectonics

Qualitative Comparison

Quantitative Comparison

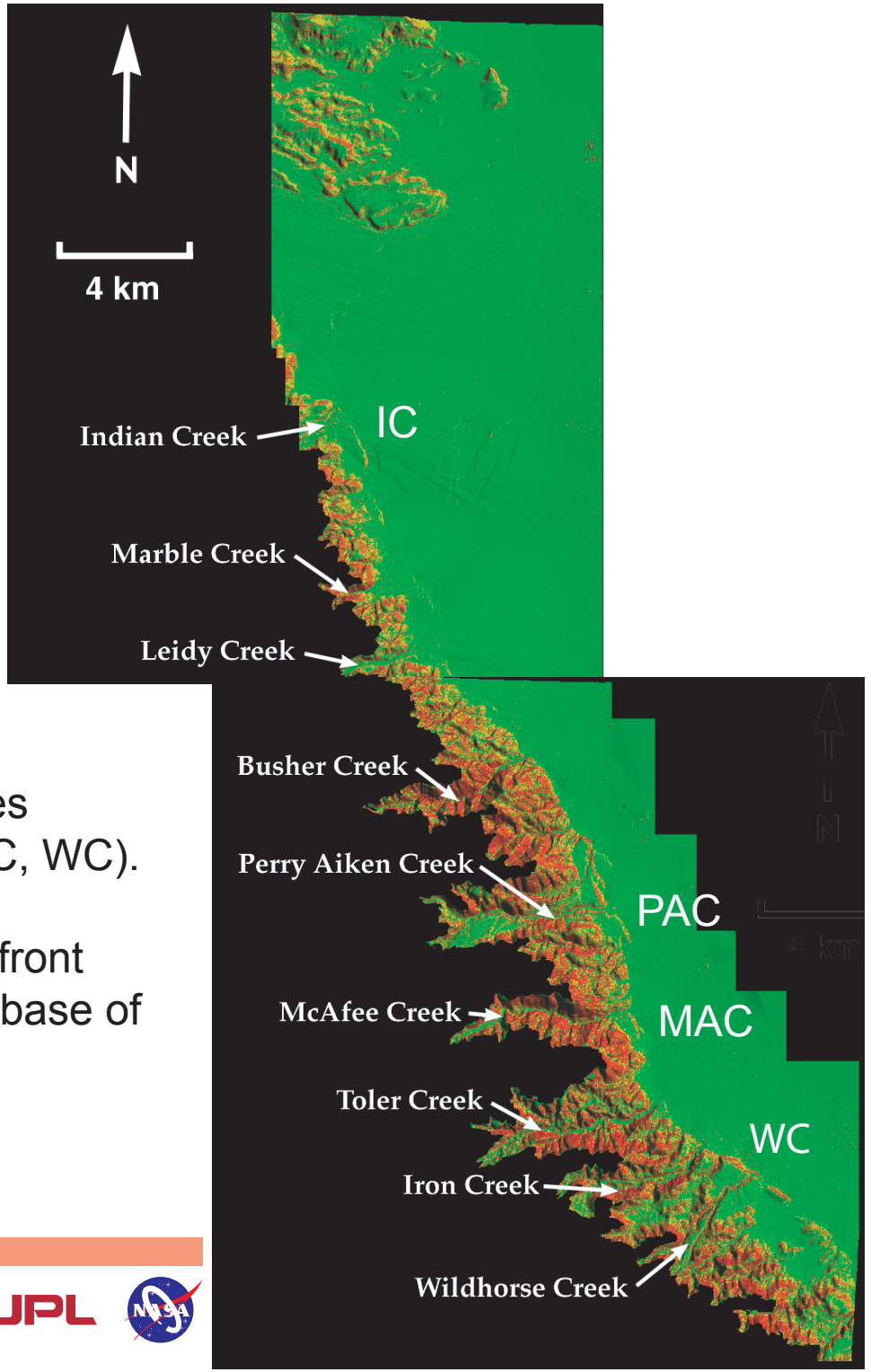
Implications

Conclusions

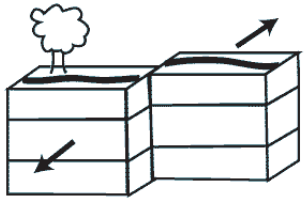
The slope map (right) shows locations of sites discussed in this presentation (IC, PAC, MAC, WC).

The slope map highlights positions of range front and Quaternary fault scarps at and near the base of the range front escarpment.

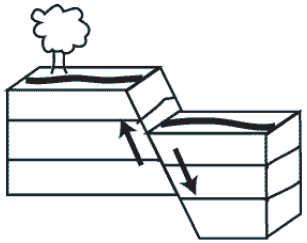
Red > 35 ; green < 15



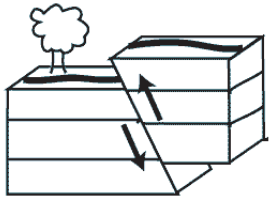
Fault Types



Strike slip



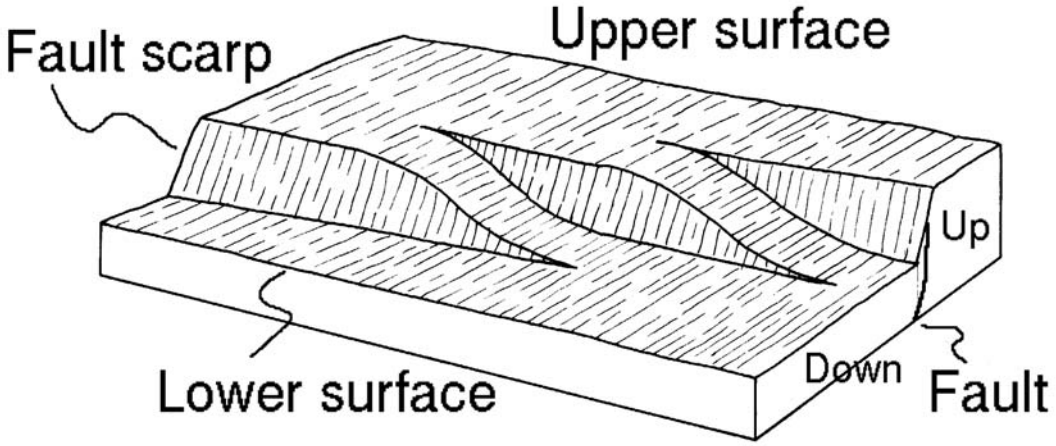
Normal



Thrust

Normal Fault

- Scarp profile erodes and degrades with time
- Amount of degradation is indicative of time since faulting



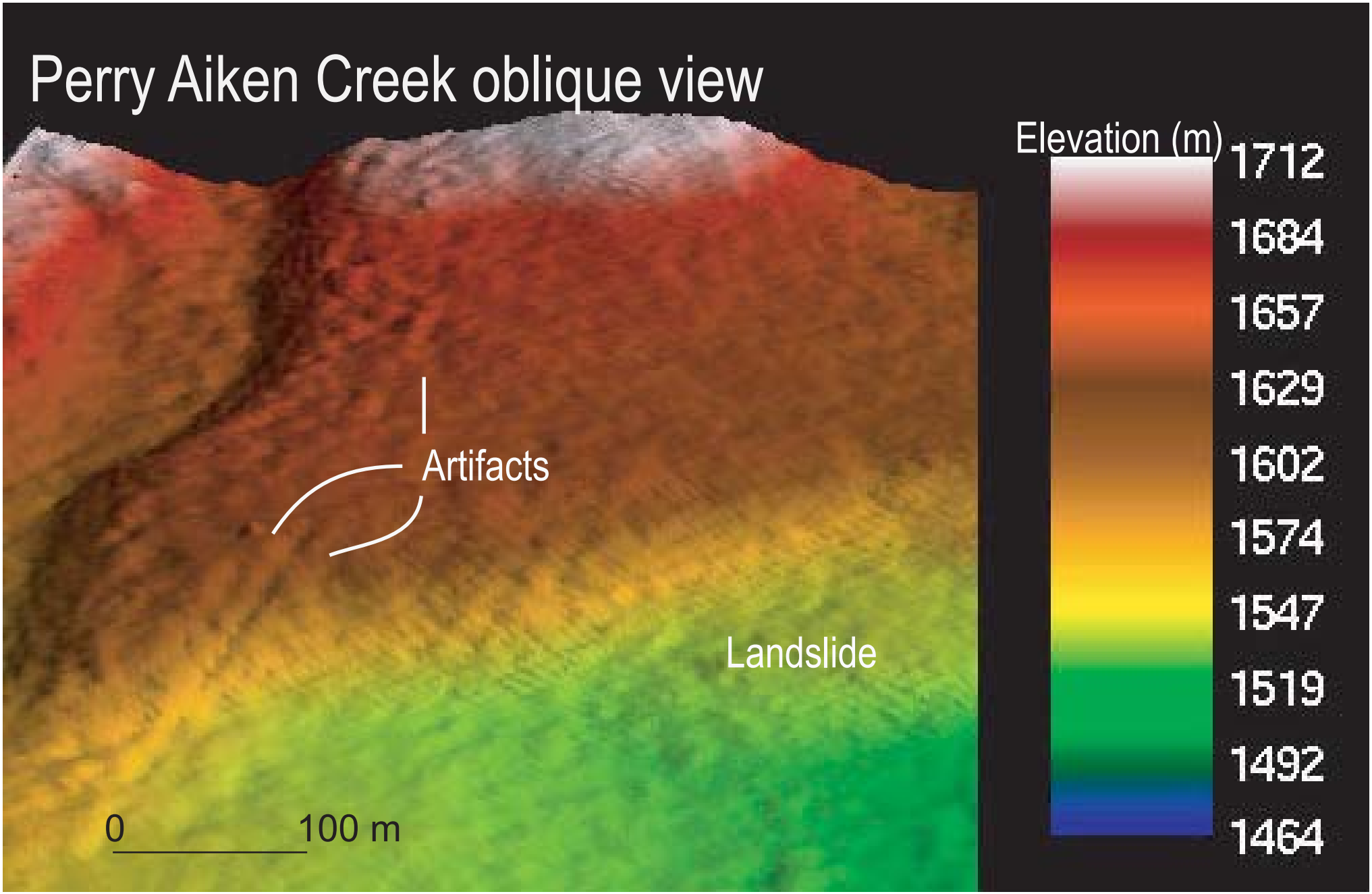
Owens Valley Fault

Qualitative Comparison

- In general, positions of fault scarps and other Quaternary features agree with published geological maps

- DEM contains artifacts
  - Missing data - mostly in steep canyon walls
  - Bumpy - typical of TOPSAR data
  - Some lineations and unusual bumps - uncorrelated with anything on ground

Perry Aiken Creek oblique view

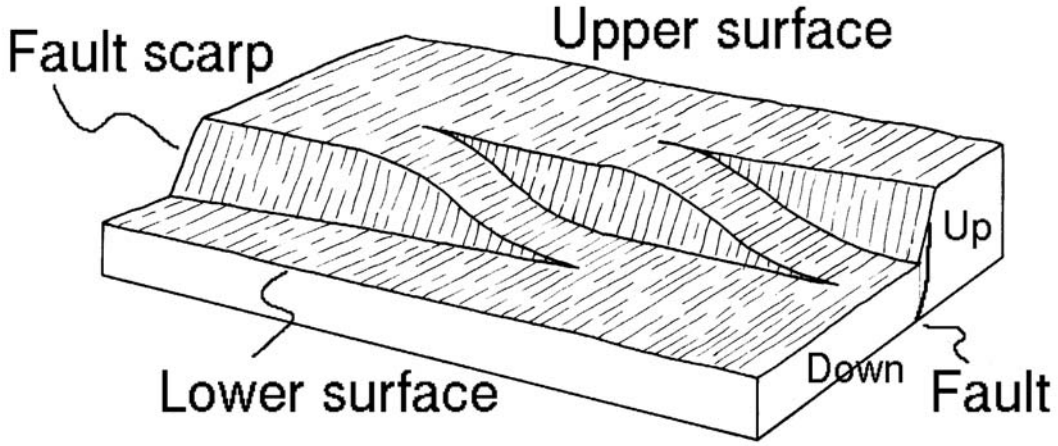


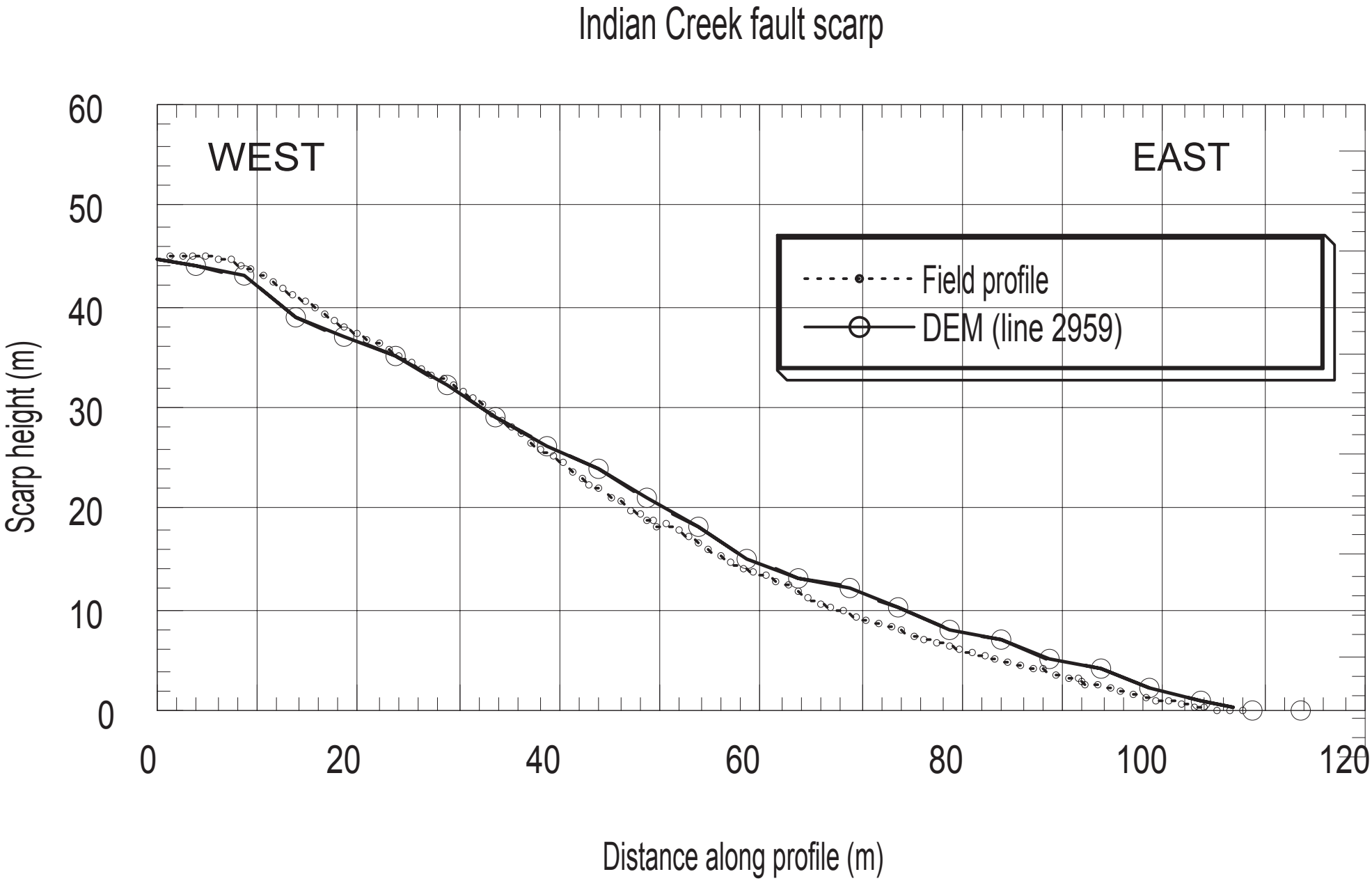
Quantitative Comparison

- Profiles of fault scarps extracted from the DEM were compared with profiles made with surveying instruments

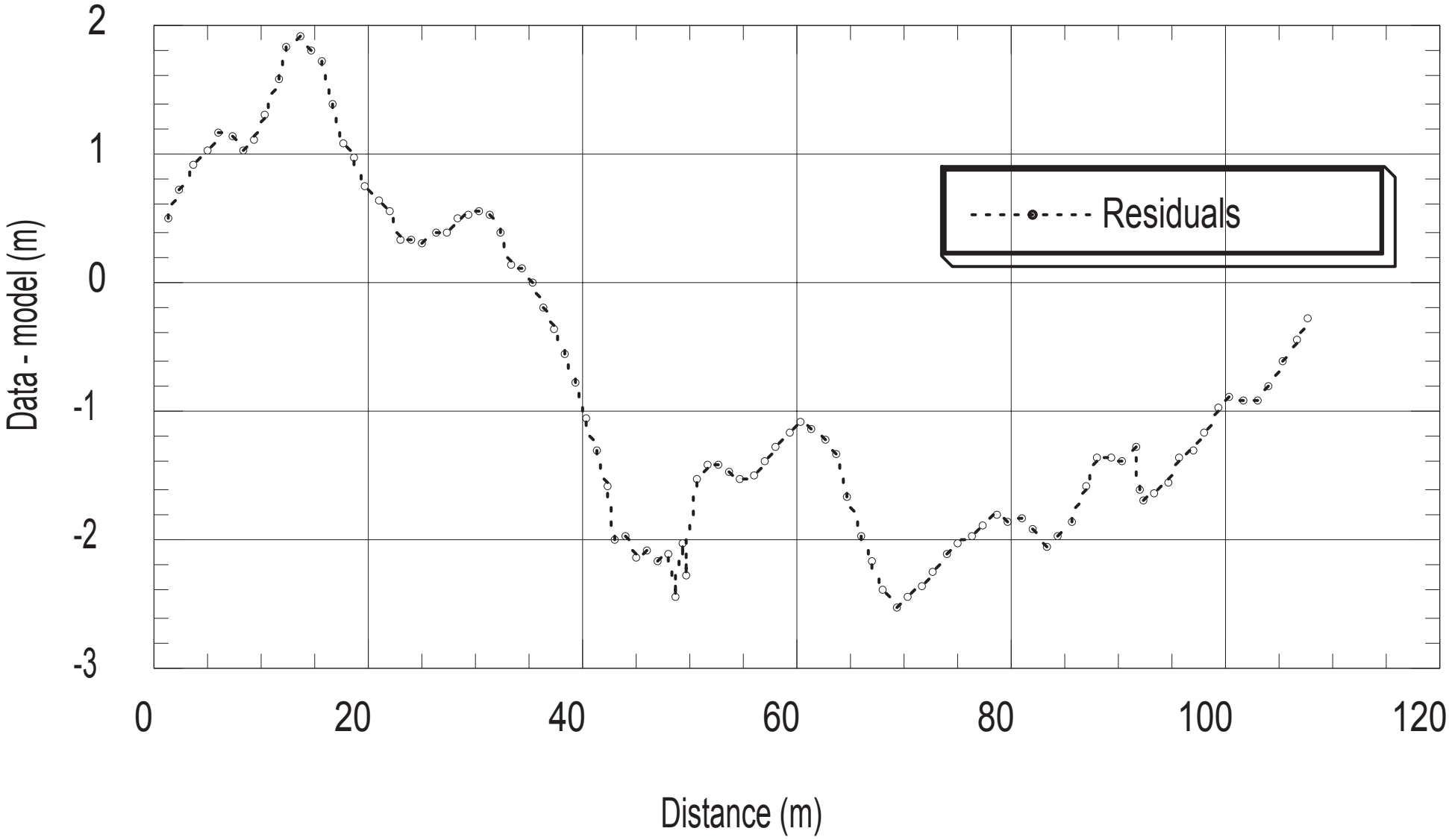
- Agreement between the two is good, with mean residual of 1.3 m

- Residuals are systematic - generally, field (data) profile is above DEM (model) profile near top of scarp, below near bottom. Only one exception in 6 profiles.

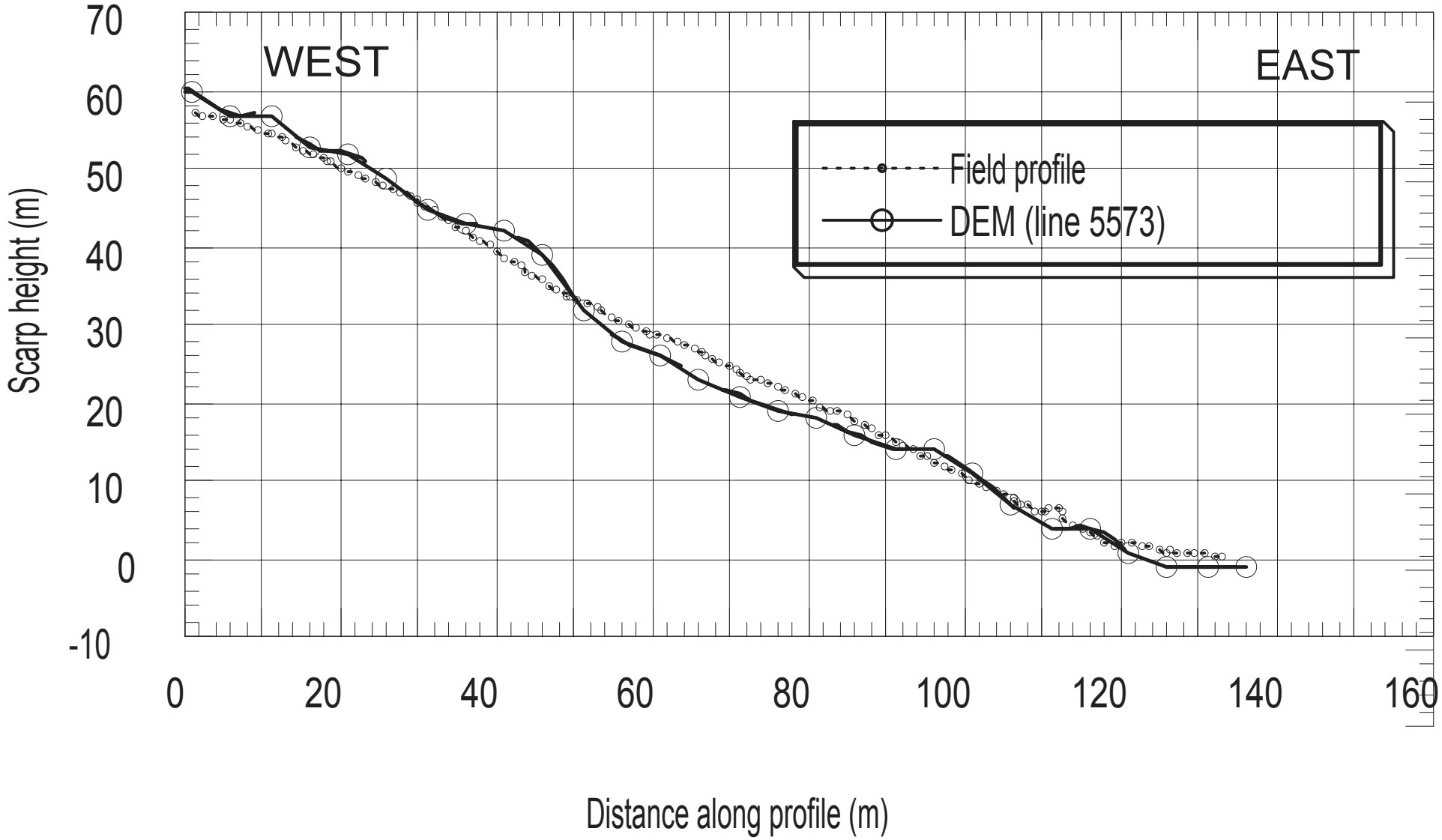


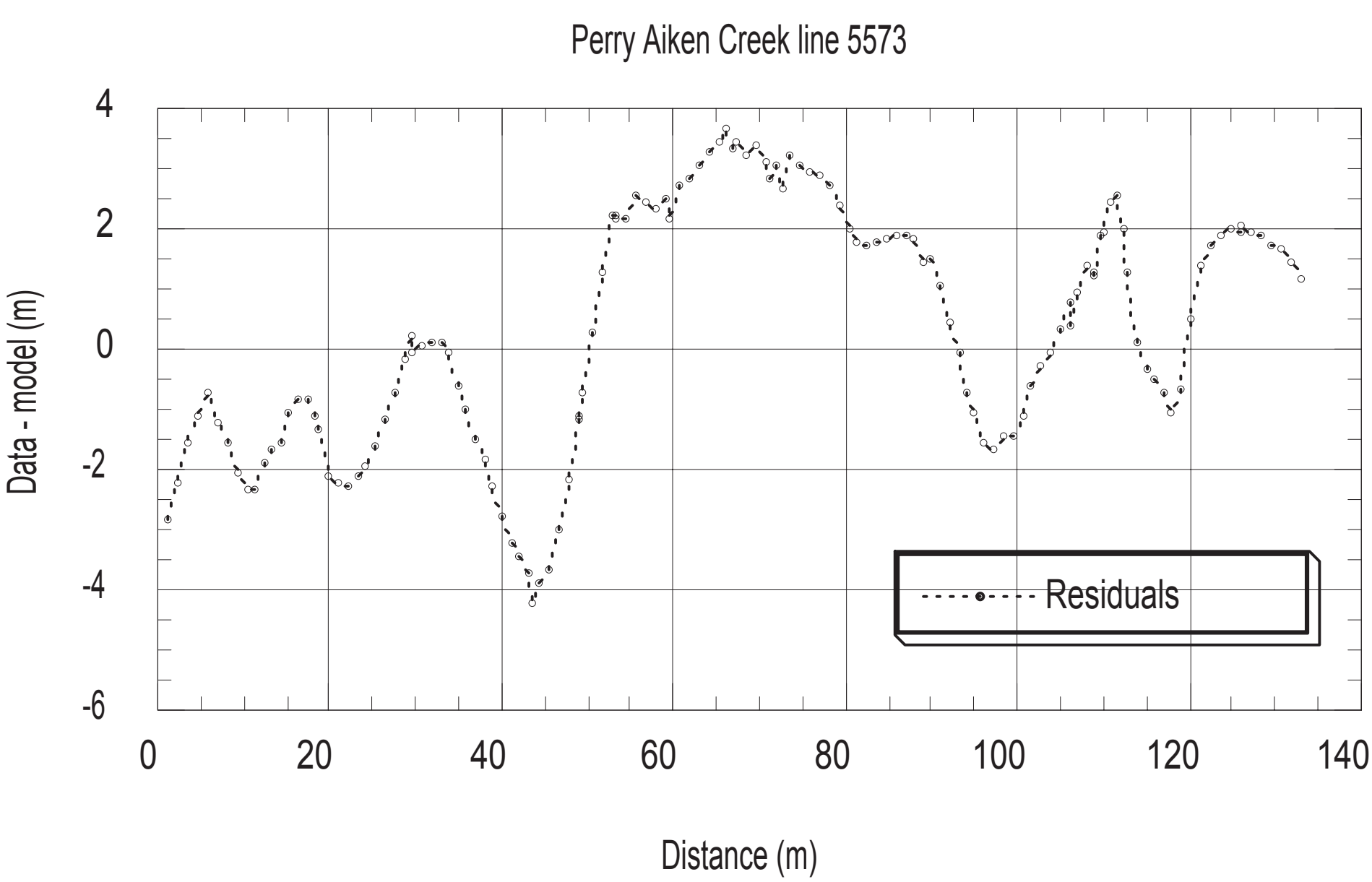

Indian Creek fault scarp
WEST
EAST
Field profile
DEM (line 2959)
Scarp height (m)
Distance along profile (m)
0
10
20
30
40
50
60
0
20
40
60
80
100
120

Indian Creek line 2959



Perry Aiken Creek fault scarp (profile #1)

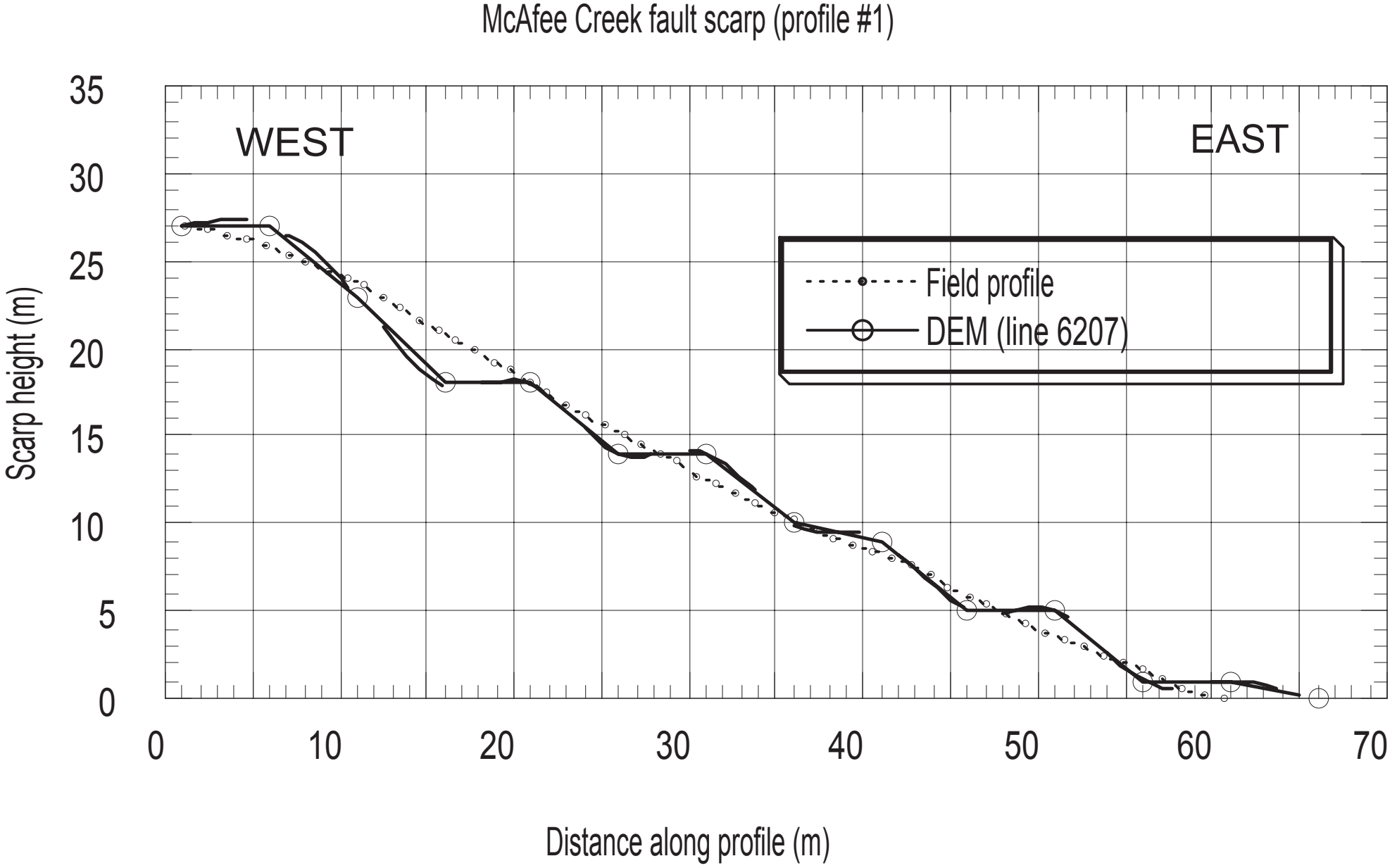


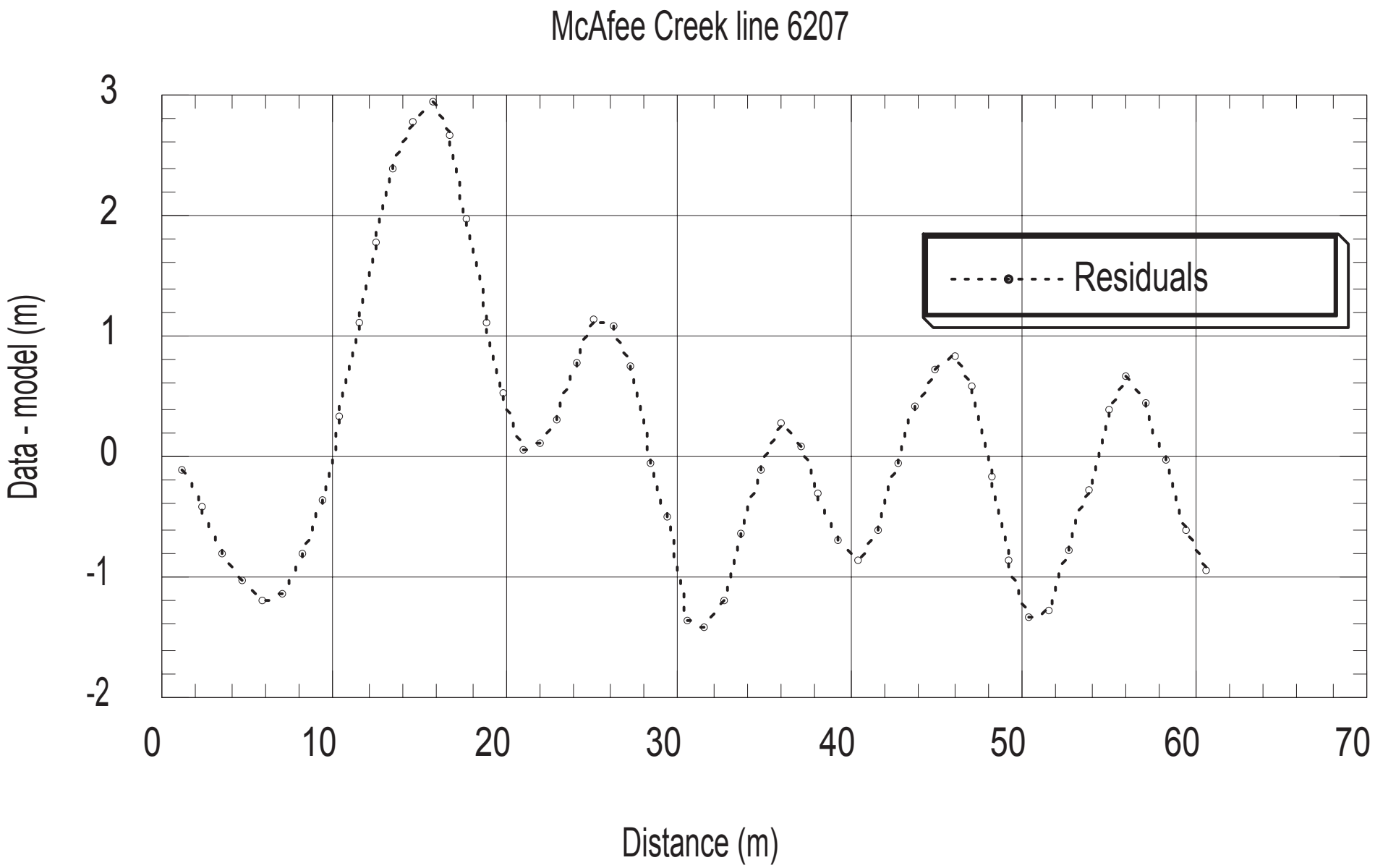

Perry Aiken Creek line 5573
Data - model (m)
4
2
0
-2
-4
-6
0
20
40
60
80
100
120
140
Distance (m)
Residuals

Quantitative Comparison

- One profile was unusual - TOPSAR DEM displayed periodic "steplike" variations along the profile, which is best seen in the residuals

- Note: Both a straight-line connection and a spline interpolation between sample points are shown on the DEM profile. Residuals are calculated from the spline.


McAfee Creek fault scarp (profile #1)
WEST
EAST
Field profile
DEM (line 6207)
Scarp height (m)
Distance along profile (m)
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70


McAfee Creek line 6207
Data - model (m)
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
Distance (m)
Residuals

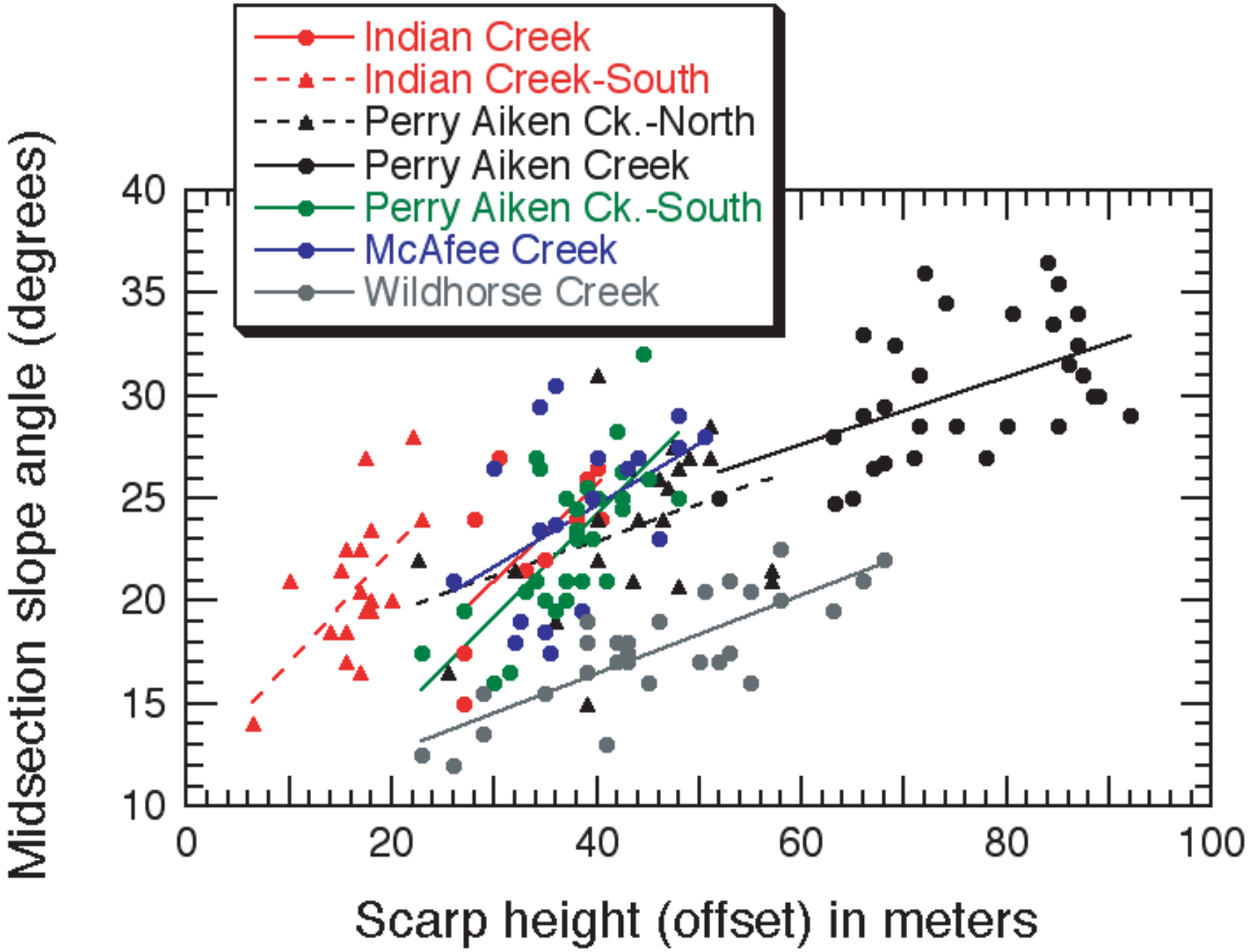
Implications

- As a fault scarp degrades, slope angle at the midsection of the scarp slope decreases

- The decrease in midsection slope angle is more rapid for scarps of lower total height

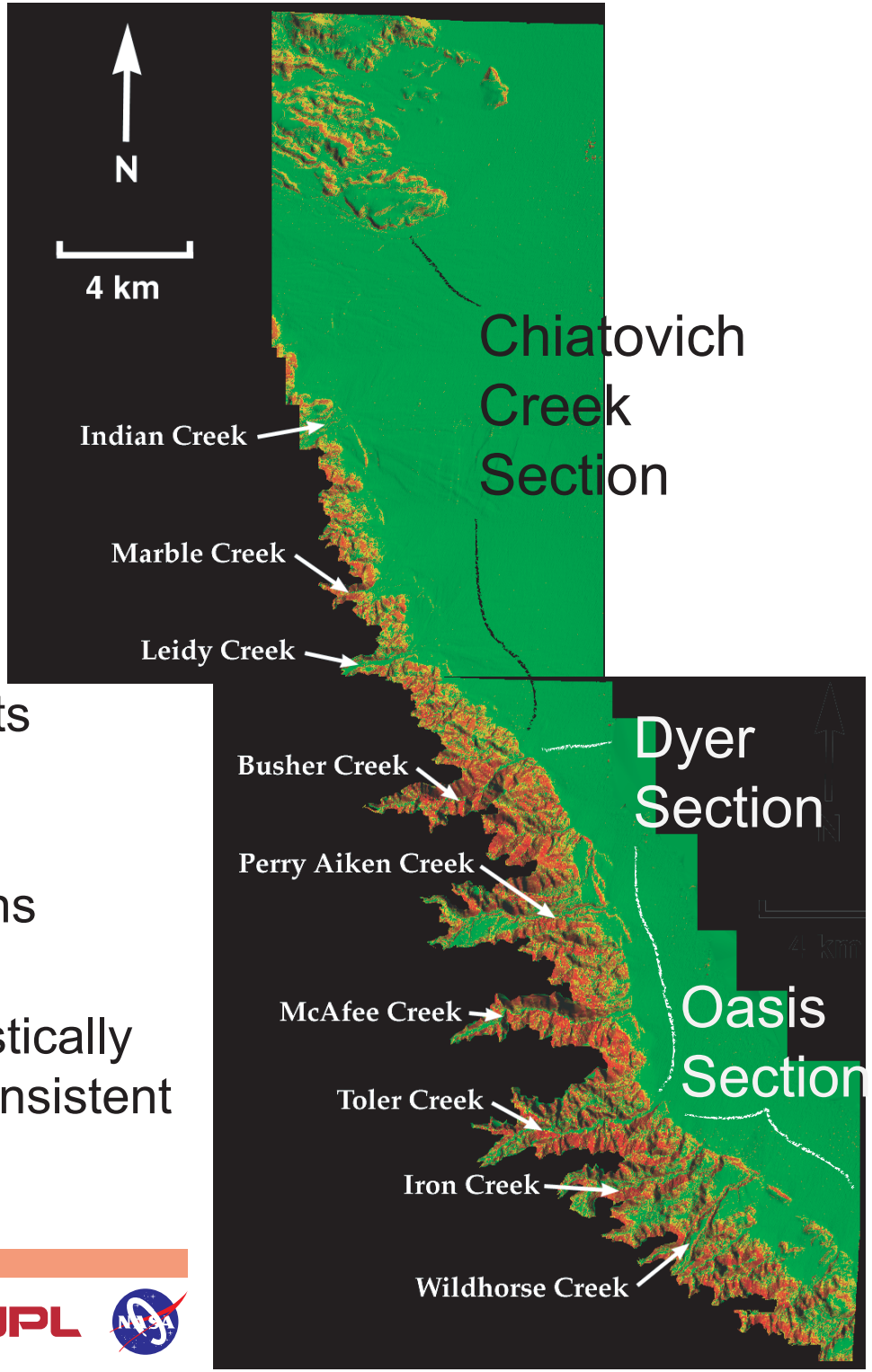
- Groups of scarps with similar slope angles as a function of height may have the same faulting history, and therefore define a section

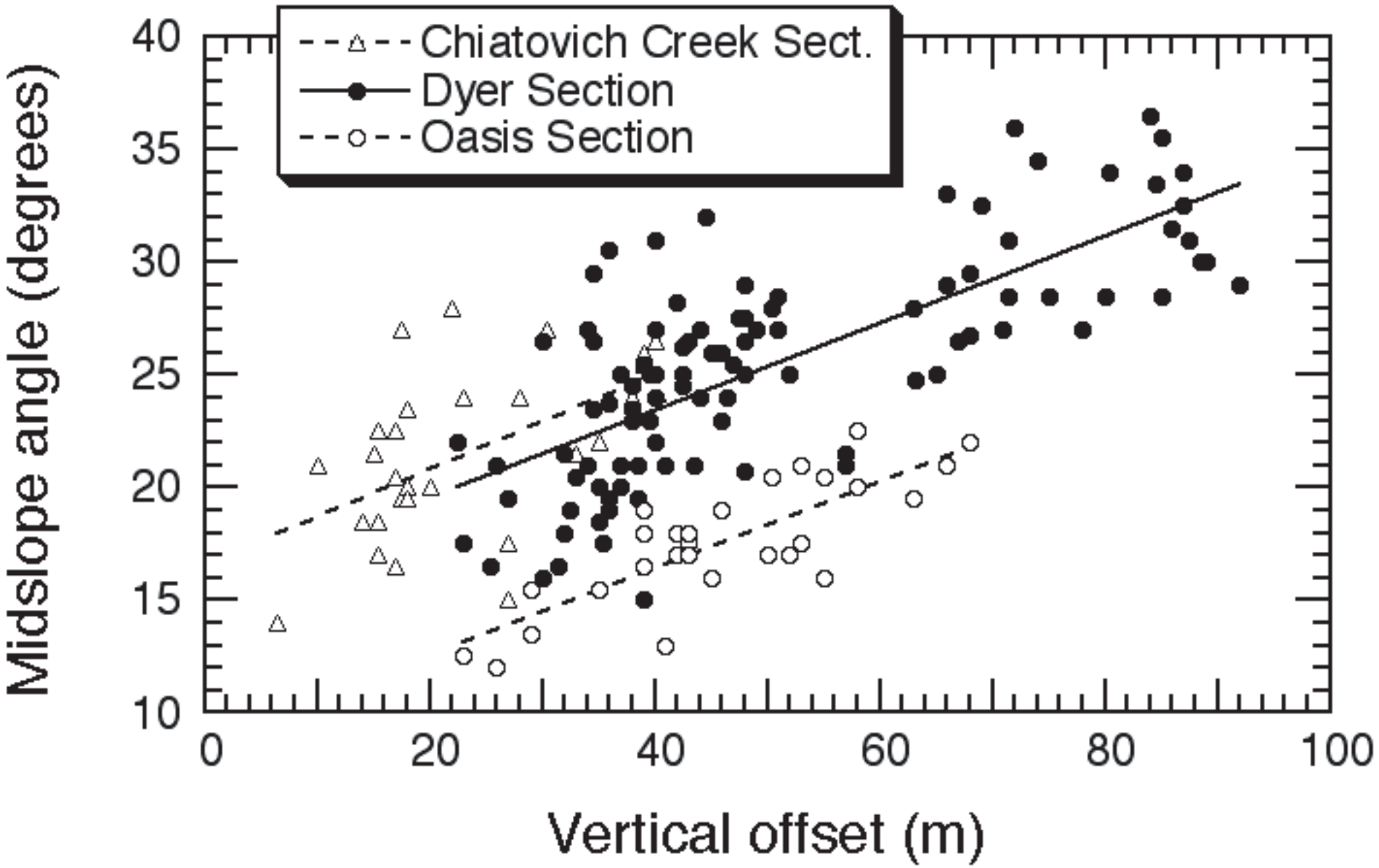
- Sample size of 159 scarp profiles to test TOPSAR data against "known" fault sections


Indian Creek
Indian Creek-South
Perry Aiken Ck.-North
Perry Aiken Creek
Perry Aiken Ck.-South
McAfee Creek
Wildhorse Creek
Midsection slope angle (degrees)
40
35
30
25
20
15
10
0
20
40
60
80
100
Scarp height (offset) in meters

Implications

- Brogan et al. (1991) and Reheis and Sawyer (1997) divided the fault into Chiatovich Creek, Dyer, and Oasis sections based on fault trend, scarp morphology, and apparenttiming of most recent events
- Data from the different sections define parallel but not colinear line segments
- This is consistent with different faulting histories for different sections (lower slope angle at the same height means older average age for earthquakes)
- Samples of scarp parameters are statistically different for the different sections, consistent with different faulting histories




Chiatovich Creek Sect.
Dyer Section
Oasis Section
Midslope angle (degrees)
Vertical offset (m)
40
35
30
25
20
15
10
0
20
40
60
80
100

Conclusions

- The accuracy of TOPSAR DEMs has been tested, and their suitability for use in studies of fault scarp morphology

- The DEMs contain few artifacts of unkown origin

- The mean residual between DEM elevation and field data is 1.3 m for slope angles up to ~35

- Fault sections defined from DEM scarp morphology are consistent with previous interpretations of three fault sections.

- This has implications for the size and frequency of earthquakes in Fish Lake Valley